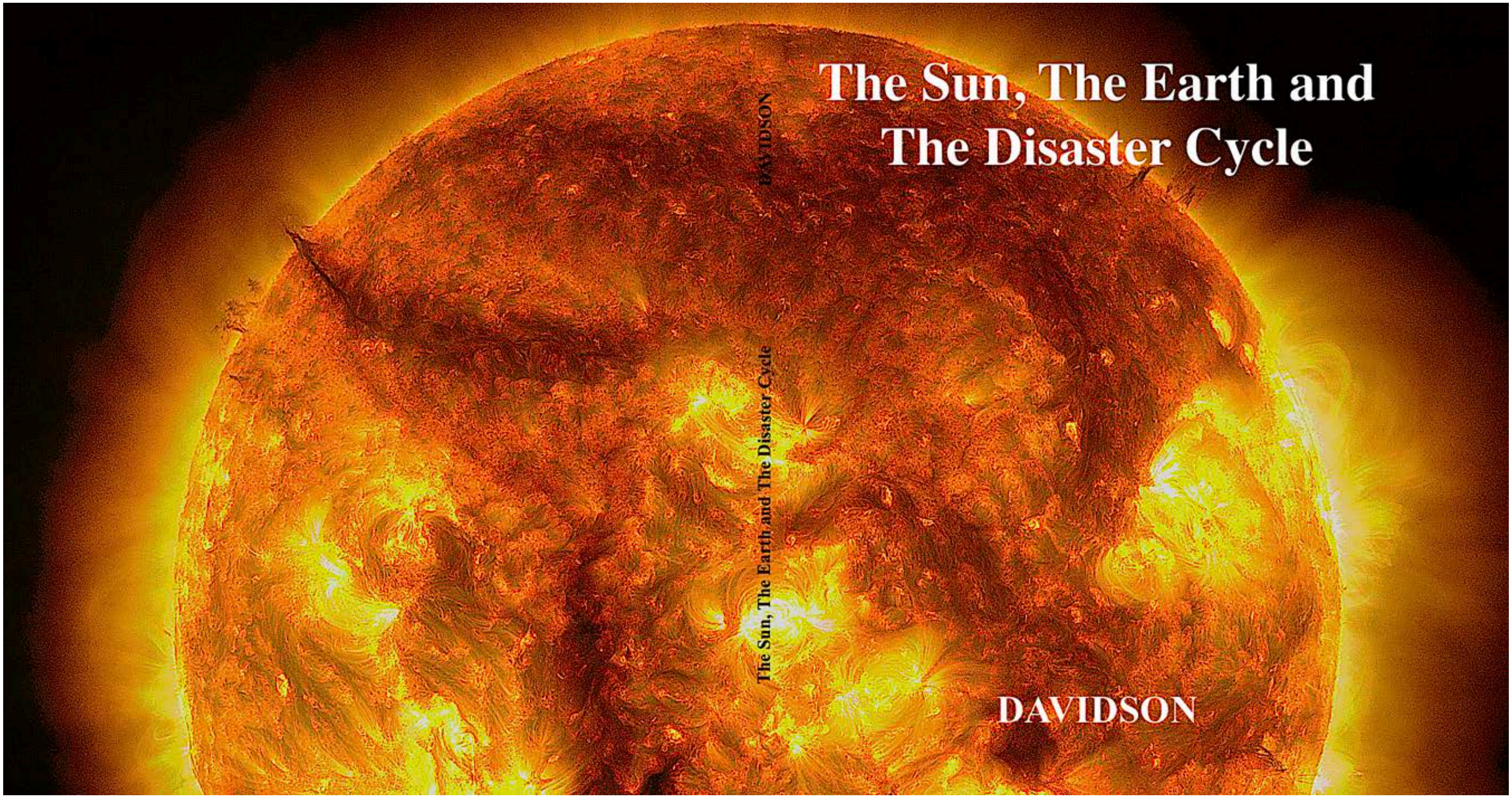
The Sun, The Earth and
The Disaster Cycle
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Table of Contents

Earth's history is not one of stability, but of cycles, where periodic upheavals reshape the planet and everything living here. This book provides a comprehensive analysis of how solar activity, geomagnetic changes, and planetary forces align to have dramatic effects on the atmosphere, the crust, and life on earth. They also combine in a repeating sequence of destruction and renewal of our planet.

Unlike conventional climate and astrophysics studies, this book does not shy away from challenging entrenched narratives. The scientific community often compartmentalizes data, dismissing interdisciplinary connections that reveal a larger picture. Here, we bring those connections into focus—examining the interactions between solar forcing, cosmic rays, magnetic excursions, and their direct impact on Earth's climate, biodiversity, and human civilization.

We do this with rigor, drawing from peer-reviewed research, historical records, and physical evidence while refusing to ignore inconvenient truths. To fully understand the disaster evidence, we first must fully grasp the ways in which solar and cosmic energy interact with the atmosphere, the crust, and life on earth.

Despite the thousands of years in which humans have looked at the sun, studied it, and even worshiped it, we have learned more in the last two decades than in the previous millennia combined.

Data and images from satellites such as the Solar Dynamics Observatory (below) have allowed us to literally see our star in a new light, as we can see in numerous ultraviolet and x-ray wavelengths. Most importantly, these satellites have opened the door for progress, understanding, imagination... and controversy.

It takes a few seconds to fall in love with the sun when seen through our best technologies, a few short hours to become significantly knowledgeable about what you are seeing, and a lifetime to get bored with it.

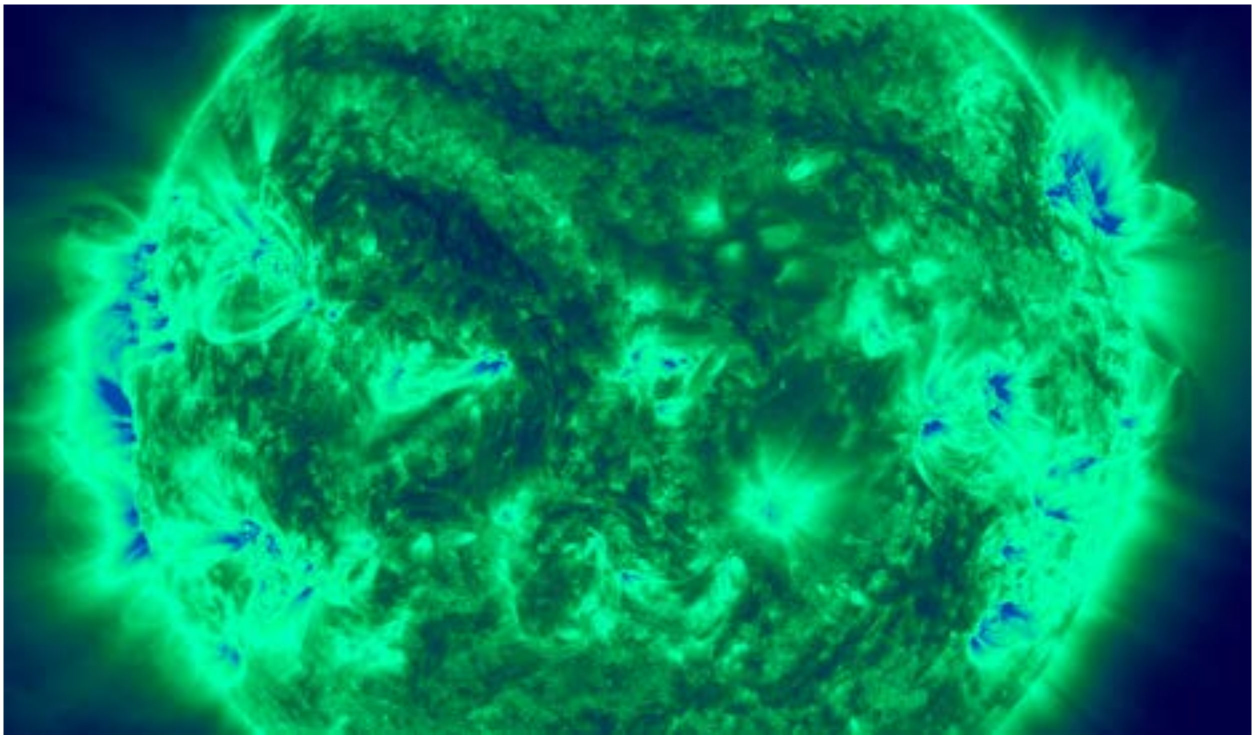
Despite the infancy of the science of studying the sun at this level of detail, there are already many public resources available. In addition to data portals from government organizations, including NASA (USA), NOAA (USA), ESA (Europe) and IPS (Australia), there are numerous resources like our free one- www.SpaceWeatherNews.com, designed with simplicity in mind.

There are millions of people who have already discovered the power and beauty of our star, and they are making a big difference in the development, perception, and popularity of the field. If two heads are better than one, then millions of enthusiasts are essential to the handful of scientists who would otherwise be working alone.

With widespread interest and involvement come problems. For example, there are few sciences that are as misunderstood as solar-terrestrial interactions; the interplay of heliophysics (study of the sun), and geophysics (study of the Earth).

Most of the correlations, connections and patterns that describe how space weather affects our planet could not have been conceived just two decades ago, let alone some more-recent studies that detail the mechanisms by which these events modulate our climate, short-term weather, technology, health, seismicity and volcanism.

You are going to learn about the sun, how it sends energy to the Earth, how the Earth handles that energy, and how the sun is modulating everything from day-to-day storms to major earthquakes to heart attacks.



More importantly, you will be given a list of resources that you can use to be part of the process and begin observing the sun and Earth relationship for yourself. The field of space weather is a practical culmination of astronomy, physics, and chemistry, and it is poised to become one of the most important and fastest-growing fields of science over the next 20 years.

Picture it is 2030- you wake up and have your morning coffee or breakfast, and you turn on the local weather forecast. Your meteorologist is discussing solar wind and how it could affect the weather in your area, or showing cosmic ray readings relating to a hail storm forecast for that evening.

They may be showing different tracks for a tropical storm and describe how one track is forecasted if the sunspots on the sun release large solar flares, and how quiet solar activity means the other track of the storm is more likely.

The forecast may include more than the weather- perhaps there will be forecasts for technological performance of your devices, outlooks for those with certain health conditions, and even warnings of earthquakes.

Imagine if your meteorologists could warn you of high-cardiac-risk space weather- perhaps you wouldn't ignore that heavy feeling in your chest that day. What if you could receive mental and cognitive health alerts based on Jupiter-sized x-ray explosions on the sun? What if your meteorologist could show you electric activity in the atmosphere and forecast the seismic risk for your location?

Many of those things are already happening on a daily basis – just not on CNN or FOX.

This book details a lot of what will come with the future of meteorology and how you can find it NOW. This book is your introduction to that world, at a level you can comprehend, and to a degree that 99% of professional meteorologists do not yet know and understand. You are about to be ready for tomorrow's weather forecasting... today.

Chapter 1

Space Weather

In this chapter, we will learn about space weather:

- Space weather involves light energy, particle energy and magnetic field interactions between the earth and the sun.
- Sunspots, solar wind, solar flares, coronal mass ejections, coronal holes, solar energetic particles, cosmic rays, geomagnetic storms are all part of space weather.
- There are distinct cycles of solar activity.

Introduction to Space Weather

The sun is much more than the star that gives us light each day. The sun's output spans the entire electromagnetic (EM) spectrum and includes particle radiation as plasma and neutral particles. In order to understand the sun's impact on us and our world, we must first understand the sun - energetically.

We Interact with the sun in four ways: gravity, electromagnetic waves, electromagnetic particles, and magnetic fields. Gravity is pretty simple in terms of its real-world effects for orbital dynamics, and much of the story of its light is fairly straightforward for anyone capable of reading english. But the rest of the light, the particles, and the fields, those require a bit of tuning before we dive into the topics in this book. The sun emits the entire range of light, from radio to gamma, and these interact with the earth in different ways, some are invisible but dramatic.

Electromagnetic (Light) Wave Radiation Spectrum

Gamma Rays X-Rays UV Rays Visible Infrared Waves Microwaves Radio Waves

< HIGH ENERGY < > LOW ENERGY >

The sun also emits particle radiation. This is called the solar wind, and it is released and pushed outward in all directions from the sun, and all stars, and it works as a tiny energetical particle radiation opposite flow to gravity. While everything we normally would think of would fall into the star's gravity, these electromagnetic particles are accelerated away from the sun, impacting the planets and moons and our satellites and everything else in the solar system. In addition to solar wind, there are particles from the galaxy (galactic cosmic rays) that are constantly hitting our planet too. Earth has been bathed in this solar and galactic particle radiation for its entire existence.

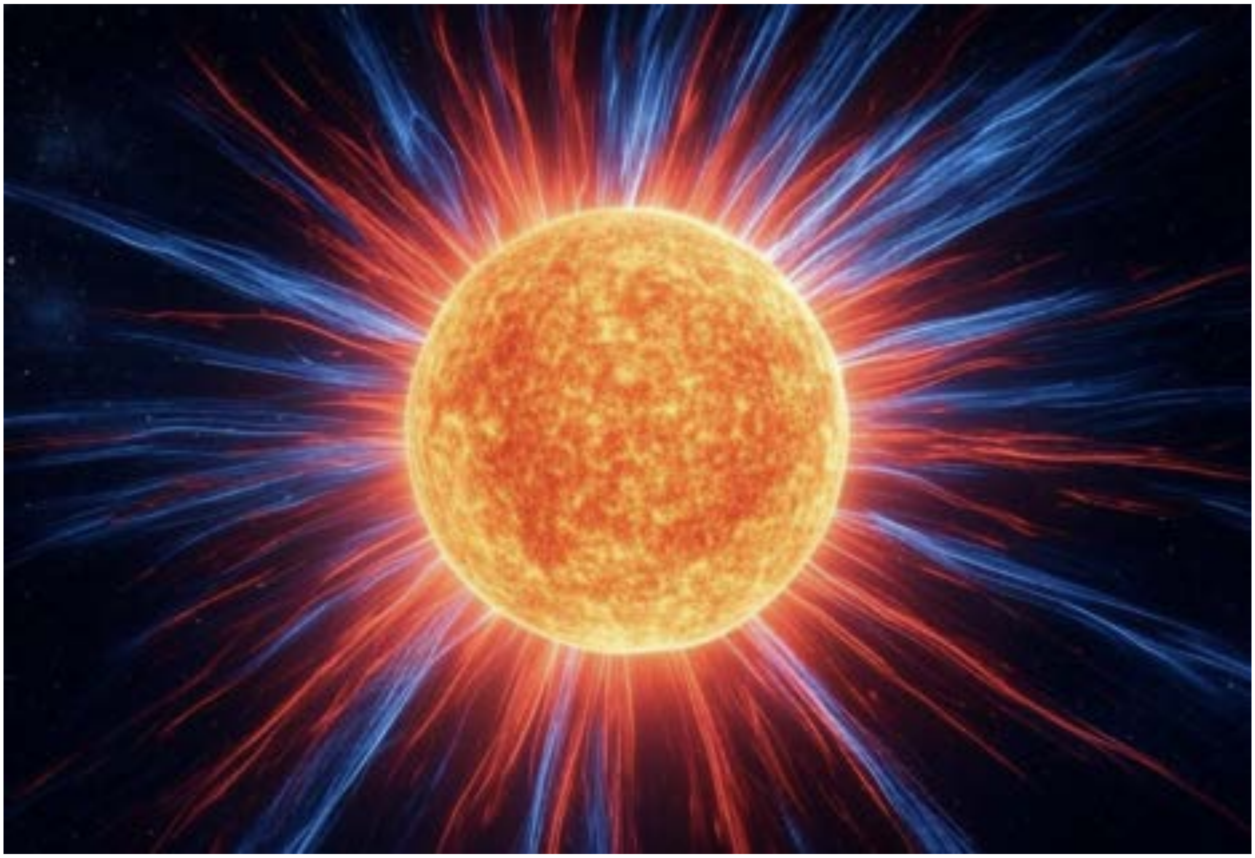
Electromagnetic (Particle) Radiation Spectrum

Protons	Electrons	Neutrons	Charged Atoms	Muons	Positrons
+	-	0	+	0	+

The sun also has interplanetary magnetic fields that stretch throughout the solar system, we will learn more about each of those in this chapter. The important layers that interact with space weather are the earth's magnetosphere, the ionosphere, the atmosphere, and the solid earth.

The important layers above our heads are: The troposphere, where we live, and where weather happens. The stratosphere, where air density is lower and subtle changes can have big impacts below. The mesosphere, where the charged particle counts rise as the atmosphere transitions to the ionosphere. The ionosphere, an electric particle multi-layer shell at the top of the sky. The magnetosphere, the magnetic bubble protecting our planet from dangerous space energy.

Solar Wind



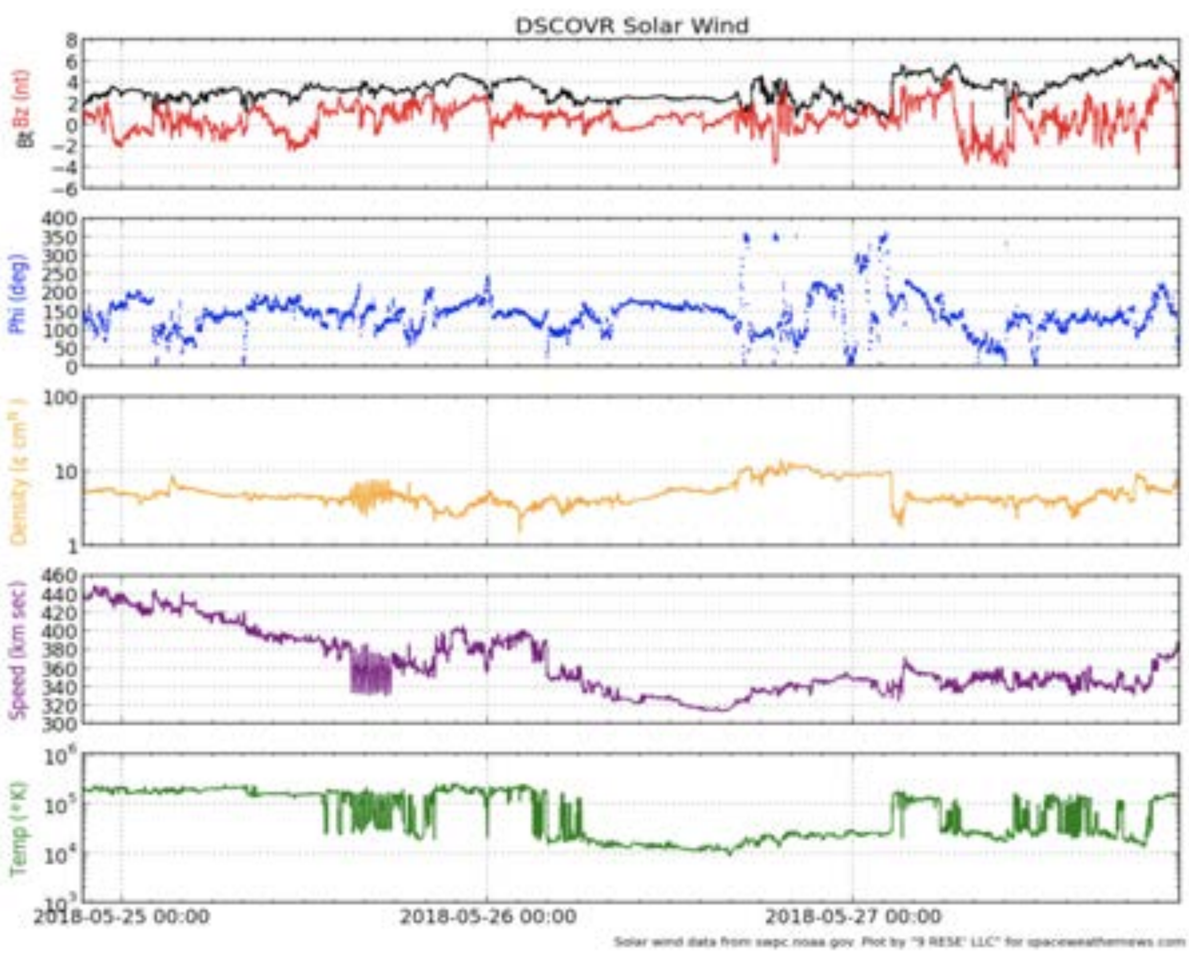
The first subject everyone must learn about space weather is the solar wind, the charged particles constantly streaming away from the sun in all directions, all the time. The solar wind streams out past Pluto where it slows down and stops in the outer reaches of the solar system. NASA's Genesis mission discovered that nearly every known element can be found in the solar wind, but most are there only in trace amounts. The majority of the solar wind is made up of +Hydrogen ions, electrons, protons, and some neutral elements like Helium. The solar wind creates a field of plasma that surrounds the solar system. What does this mean?

The solar wind streaming outward throughout the solar system, is an electric field of charged particles- plasma. These solar wind particles race away from the sun in various densities, ranging from a few particles per cubic foot to dozens, hundreds, or even thousands of particles per cubic inch, especially as the solar wind slows down near Mars, bunches up, and becomes extremely dense.

At Earth, the speed of these particles whizzing past Earth generally ranges between 200 to 275 miles per **second** (*not* miles per hour!) during normal quiet times, but can spike to over 600 miles per second, which is more than 2 million miles per hour, during major space weather events. Solar wind density and particle speed are usually given in metric units, so 300 to 400 kilometers per second (km/sec) would be average speed, along with average density of 0.1 to 10 protons per cubic centimeter (*p*/cm3).

More intense streams can exceed 800 kilometers per second and can be dozens to hundreds of protons dense per cubic centimeter. These intense portions of solar wind tend to be hotter by a factor of 10 to 100 (usually given in Kelvin scale) and can also have drastically different impacts in terms of their magnetism and angle of approach, which creates various interactions with the Earth and its various electromagnetic layers, especially the magnetosphere and ionosphere.

The image below displays solar wind telemetry from the DSCOVR satellite for May 25 - May 27, 2018, with a description below.



The bottom three panels tell us what kind of space weather we are experiencing: the solar wind density (orange), speed (purple), and temperature (green) are also labeled on the y-axis. In this image, we see solar wind speed decreasing from about 450 km/sec to about 350 km/sec, indicating a faster solar wind stream was ending during this time, at relatively normal density, accompanied by the return to normal calmer speeds. Even the faster stream was not very extreme, since solar wind speed above 600 km/sec is considered fast, and this stream was just barely over the normal average range ceiling of 400 km/sec.

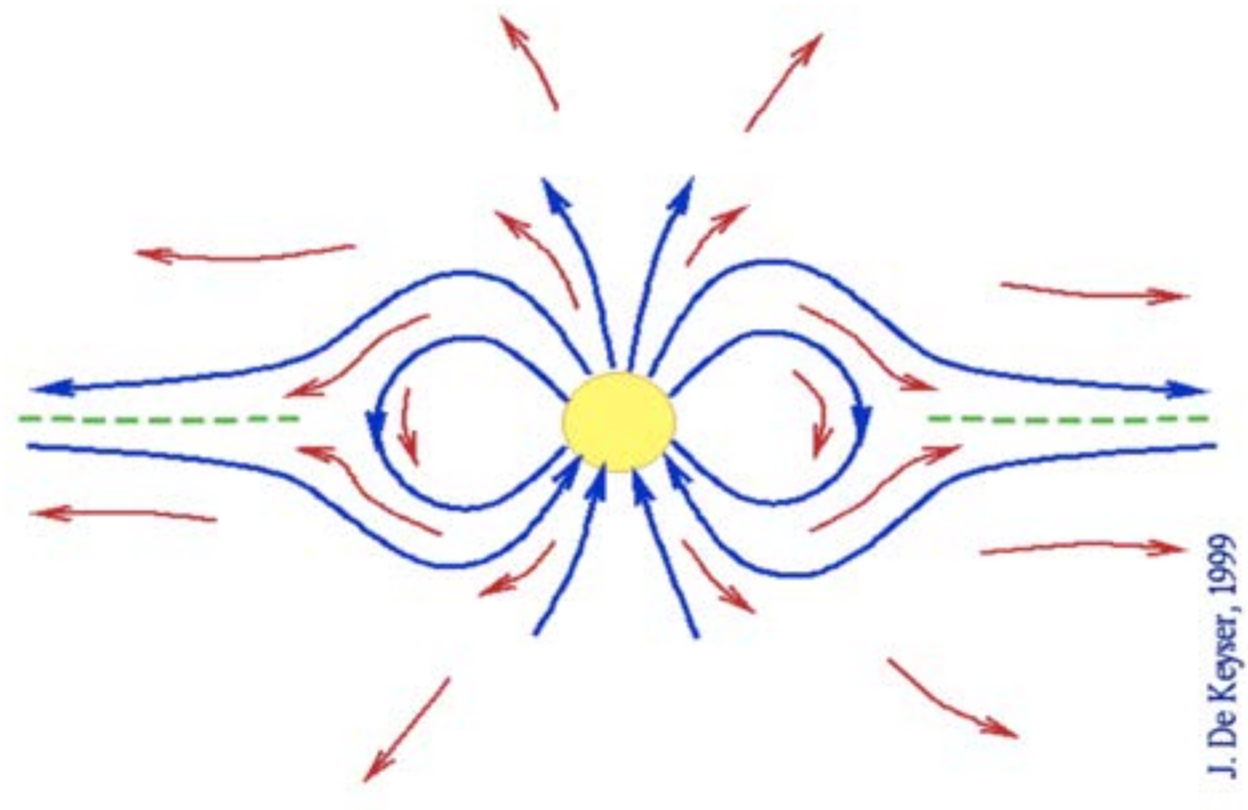
The top two panels are a bit more complex. The blue “Phi angle” of the solar wind indicates the magnetic field direction (a topic we’ll discuss soon), where ~180° changes offer intensity fluctuations similar to those caused by a dense/fast solar wind stream. The top panel (red, Bz index) shows the power of the stream and likeliness to affect Earth’s magnetic field. While the absolute magnitude of the Bz (“Bt” – black line) tells us about the power of the solar wind, the negative numbers on the red curve, known as south-facing polarity, have a stronger effect than positive (north-facing) polarity streams of solar wind. Positive Bz solar wind is more-easily deflected by earth’s magnetosphere, while negative Bz streams tend to merge or ‘couple’ with the earth system.

In other words, magnitude isn’t the entire story, magnetism matters too. Negative (south) is likely to couple, integrate, disrupt, etc. This plays a critical role in whether the solar wind is significantly influencing the rest of the Earth’s layers below.

The differences between the quiet and intense streams of solar wind are central to studying and monitoring space weather. Solar flares and coronal holes (described later in this chapter) can intensify the normal solar wind, delivering “interplanetary shockwaves” and “high-speed” solar wind streams that affect the different layers of Earth directly and indirectly. The secondary (indirect) effects are critical to this book, and often have lagged-forcing effects over days to years, which means that the primary effects might be seen rapidly, or not for some time after the solar events.

Heliospheric Current Sheet – The Solar Wind Electric Field: The particles moving away from the sun create a streaming sea of charged material and plasma. This field of solar wind particles encompasses the entire solar system and technically means that outer space is not a true vacuum. The solar wind and trace dust/gases are divided into north and south, and the region between them makes up the “heliospheric current sheet”. Here is a view of the current sheet dividing north and south:

With the sun in the center, the all-directions-outward solar wind is not depicted in this image, but rather the quasi-equatorial boundary between the *magnetic* north and south hemispheres of the solar system is shown by that wavy, rippling field. This boundary separates the magnetic field direction of the interplanetary magnetic field, which is different from the solar wind electric field. The next image looking edge-on at a slice of the sun’s current sheet should help explain:



In this graphic, the sun is in the middle, the red arrows show the solar wind streaming out in all directions, but the blue lines show the sun's largest magnetic fields, which go out through the solar system. Just as Earth's fields connect point to point on Earth, they do so on the sun - but often the sun's fields go out past Pluto before reconnecting.

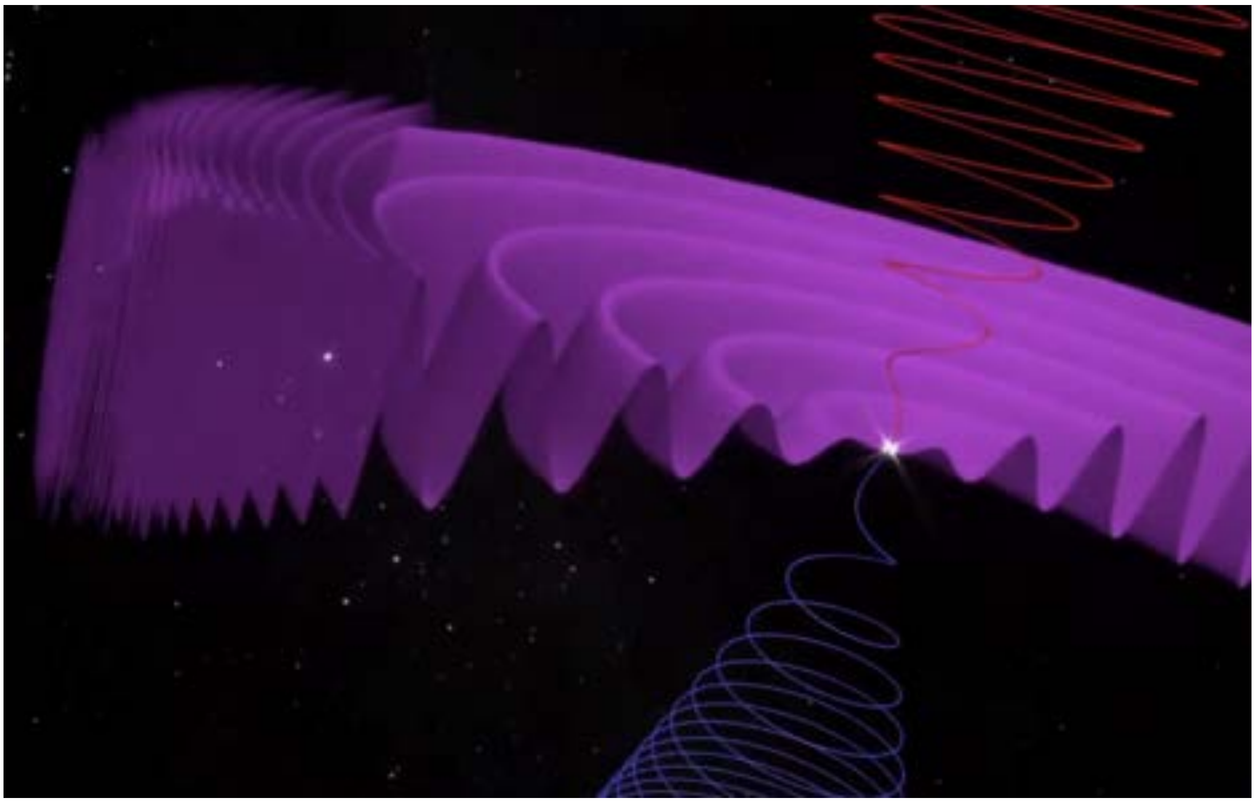
The "heliospheric current sheet" from the previous image is contained within the equatorial zone (green), where all magnetic fields north flow one direction and all fields on the south oppositely. If we could zoom out from this graphic the green line would begin to wave and ripple like we saw in the previous image.

The field flow pattern (blue) reverses on the sun every 11 years, so the specific direction and its placement north or south depicted here are arbitrary. Due to the fact that the sun spins in ~27 days, the heliospheric current sheet zips around the solar system much faster than the planets are orbiting. All the planets in the solar system spend time above and below the undulating current sheet in their orbit; each crosses that rippling field.

Electromagnetic Interaction. The sun and planets are sphere magnets, with either intrinsic or induced magnetic fields existing in some form at each of the planets. This causes a direct magnetic connection between the planets and sun to arise within the electric field of solar wind. This magnetic connection acts like a wire connecting the spheres, or perhaps better-imagined as a path of least resistance through an electrified medium.

These connections of planet-to-sun are called interplanetary magnetic fields (IMF), and they can drive charged particles across space at incredible speeds, bypassing a planet's defenses against space

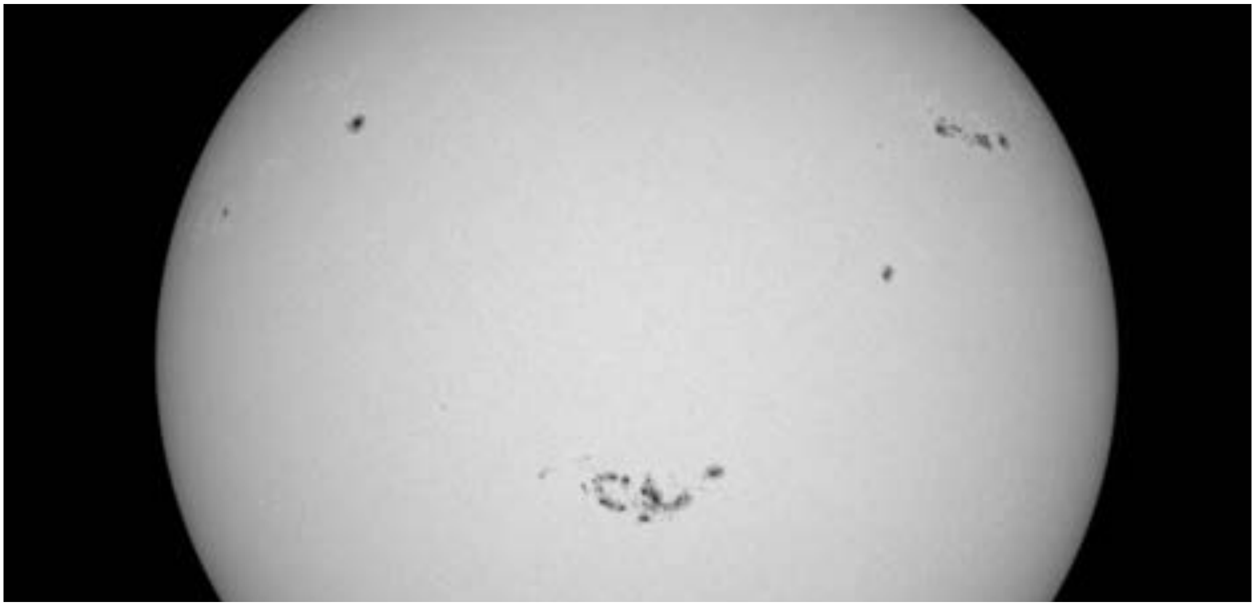
energy (magnetosphere), and allowing solar wind to pour into the atmosphere. We see this on Earth **every eight minutes** in energetic exchanges called flux transfer events (FTEs), and on other planets on different timescales. The amount of energy exchanged is not always the same.



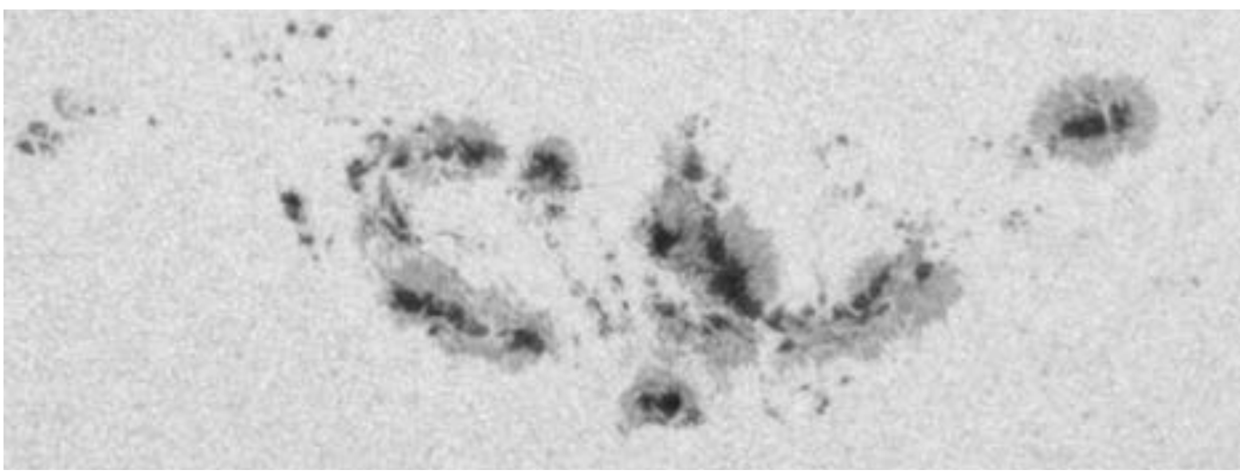
The Phi angle of the solar wind tells us whether Earth is above or below the heliospheric current sheet, and whether the IMF is flowing to the Earth from the sun or is feeding back to the sun from the Earth. Phi angle is measured in radial degrees, as you would mark them around a circle; while the scale in the image above goes up to 400°, you will never see it above 360°. 0° & 360° are actually the same thing on a radial graph, and that field angle indicates that the IMF is streaming directly back at the sun from the Earth. When the IMF Phi angle is 180° it indicates that the IMF is streaming directly towards Earth from the sun. The solar wind plasma field always streams outward; the plasma travelling along the IMF can go both ways.

The following sections of this chapter involve solar phenomena that affect the solar wind, the heliospheric current sheet, or the IMF, and therefore have a chance to affect the Earth as well.

Sunspots



Sunspots have been studied for centuries; long before fancy satellites and telescope filters, humans were able to see sunspots and even keep records of their numbers. Sunspots are areas where electric current/magnetic fields enter and exit the **solar surface (photosphere)**, causing unstable areas in the **solar atmosphere (corona)** above and around them.

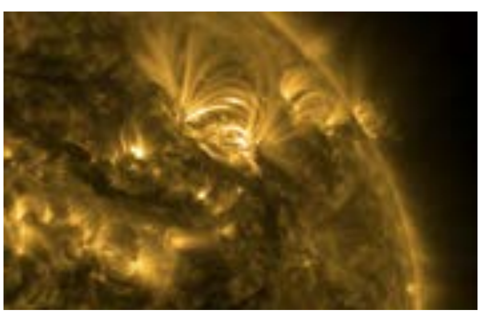


Zoomed-in image of the large sunspot in the image above.

The dark black cores of sunspots are called sunspot **umbra**, and the interface area surrounding the umbra is called the **penumbra**, which looks like filaments or hair streaming away from the umbra. The umbra is where current/magnetic fields enter or exit the surface of the sun. The penumbra is an electric effect at the surface (perpendicular to the currents and fields going vertically through the sunspot). The activity of these sunspots is key to understanding much of space weather.

In the SDO image above we see multiple sunspot regions. The group on the right has two main umbral cores and small spots to the south of one of them, while the one on the left has only one main sunspot and small spots around it. Since the sun rotates left-to-right from our perspective, the far- right sunspot in a grouping is called the “leading spot” and the left side is the “trailing spot” or “spots”.

The small spots in the right-side group sit south of the “trailing spot”. Sunspots like the ones on the right are extremely volatile and often contain numerous smaller sunspot umbra like the ones on the previous page. The sunspot on the left is less volatile; the explanation follows:



In the image to the left we see ionized Iron (171 Ångströms of light) trapped in the magnetic fields coming in and out of the same sunspots that we saw above. The arcs are “umbral magnetic fields”. Unlike the IMF, which connects planets to the sun, umbral fields only connect the sun to the sun, doing so in loops, as you see here. We usually see a spot-to-spot connection, but they can also loop back down to areas of the surface that are magnetic.

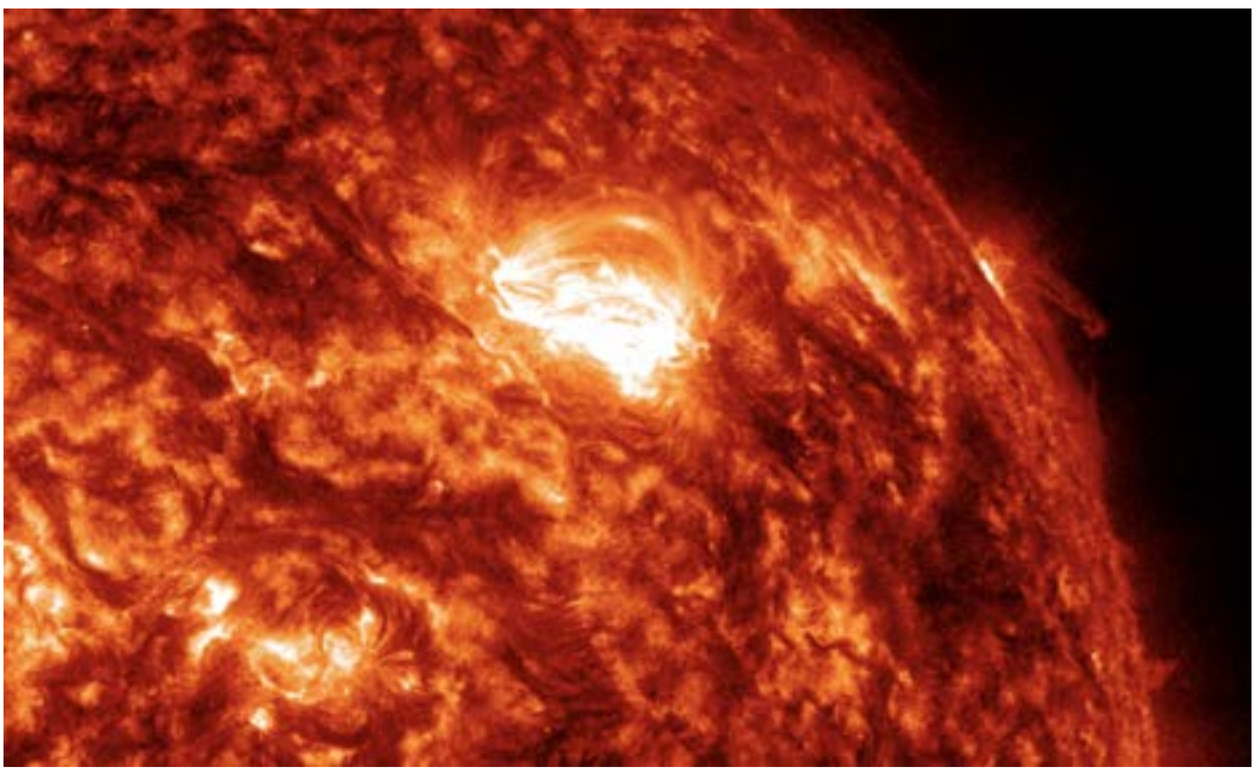
The single spot on the left side has too many fields to be contained within the smaller surrounding umbra, so it reaches out for other connection points towards the right-side sunspots. The right-side sunspots are much more contained in terms of their magnetic field loops, because there are many sunspot umbrae to contain them, unlike the group on the left, which must reach out to connect. The large reach on the left is a stable scenario; the compact/complex field setup on the right is more unstable.

In the next SDO image (red) we see the same sunspot groups for the third time. Unlike the first two images, which showed sunspot umbra and umbral magnetic fields, respectively, the image below shows ionized Helium glowing in 304 Ångströms of light.

The brightness indicates just how active and unstable the sunspot areas are compared to the rest of the solar surface and corona, and the superior brightness of the grouping on the right is due to its being more unstable and having more umbra compacted and confined to the small area of the group.

At the three levels we've examined, we have learned that (1) many sunspots of different sizes, in complex arrangements, are the most unstable and at-risk (what that means is coming up in the next section), (2) that those at-risk regions have confined (rather than spread out and far-reaching) umbral magnetic fields, and (3) they shine brightly in 304 Ångströms, while they may not in 171 Ångströms.

These are KEY components of gauging the risk of any given sunspot group.



You can interpret the brightness in this image to mean that more activity and interaction between the complex fields is taking place at the sunspot group itself. **The interactions of the**

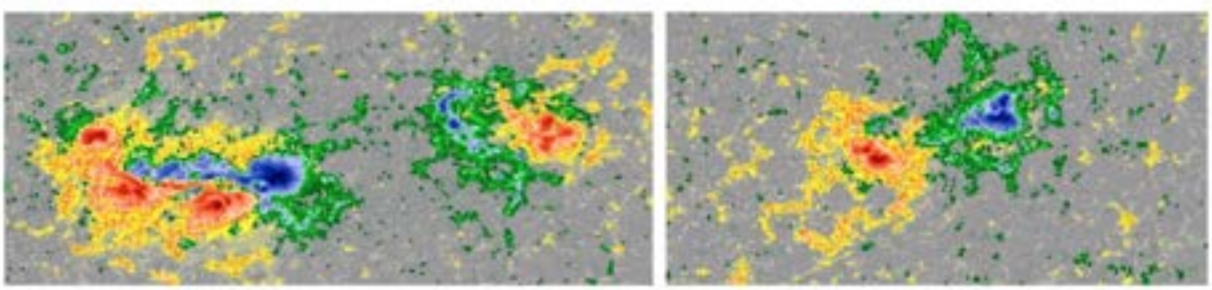
plasma and ions in the regions above the sunspots are the drivers of the most exciting space weather event: the solar flare.

Note: Sunspots are a general indicator of the sun's activity and the character of the heliospheric current sheet. During times when there are lots of sunspots, we tend to see a denser and more intense electric field of solar wind throughout the solar system.

In addition to looking at multiple layers of a sunspot group to determine the likelihood of solar flares, this can be accomplished by looking at only the sunspots themselves. In the next images we compare the two types of images returned by the Helioseismic and Magnetic Imager (HMI) on the SDO satellite:

(Above) SDO HMI neutral iron image of a few sunspot groups.

(Below) The HMI magnetic imager's close-ups of the northern spots (left) and southern spots (right).

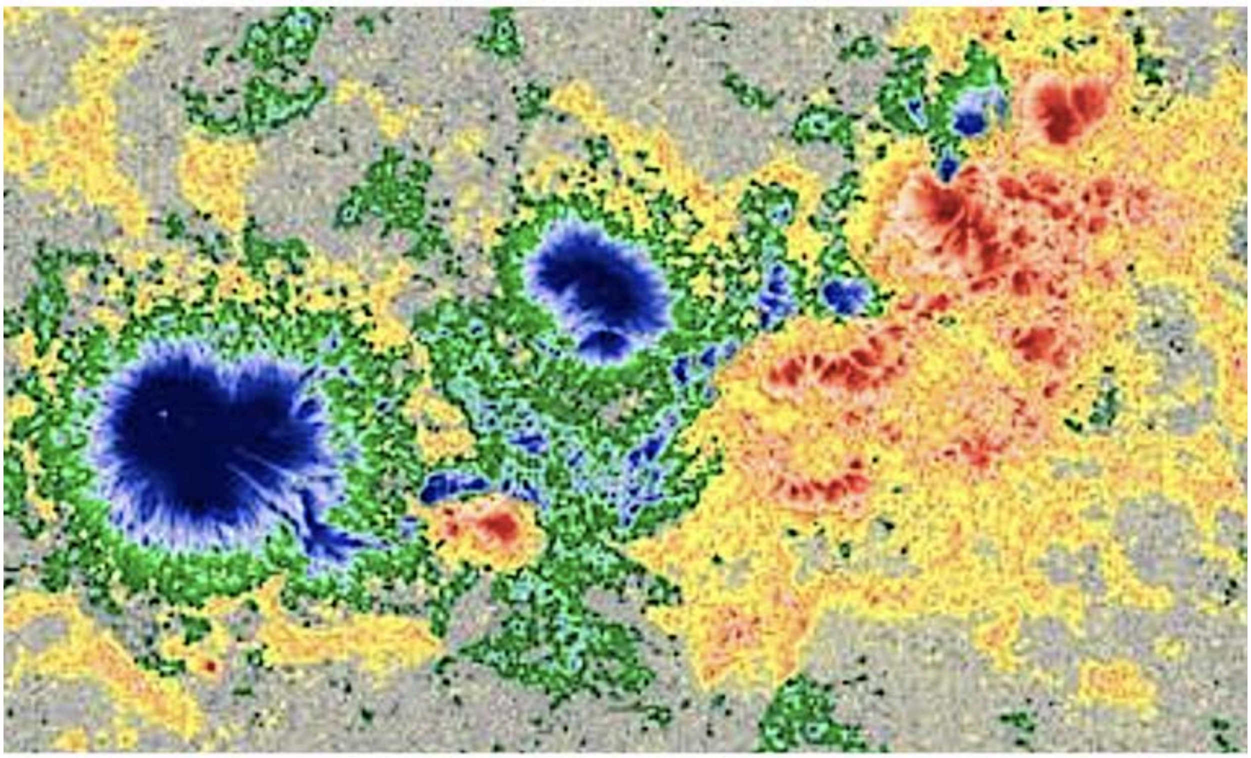


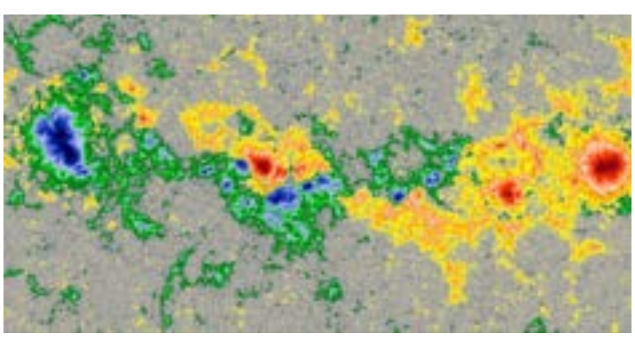
Blue shows positive polarity, red shows negative polarity - the umbral magnetic field loops always connect positive to negative. Lower-energy magnetic areas around the sunspots (yellow/green), are where less-contained and far-reaching umbral fields may connect if they do not have a sunspot with which to connect.

One of the most reliable means of confirming the danger of a sunspot group is to find its "magnetic classification". Sunspots may have more than one classification:

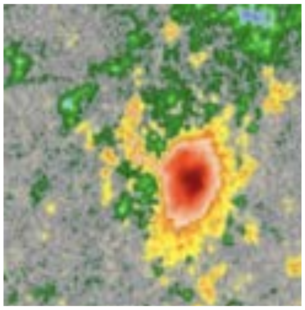
Magnetic Class	Magnetism Description	Solar Flare Risk
Alpha	One polarity (charge) only. All umbral fields connect to outside surface magnetism.	Low
Beta	Both positive and negative polarity spots found in the group.	Moderate
Gamma	Occurs in beta groups where a continuous line cannot separate the polarity groupings.	High
Delta	Where positive and negative spots share penumbra (close proximity).	Highest

All sunspots in the previous images are beta, and the one on the bottom far-left is also delta due to the stretch of close proximity spots of opposite polarity in the center (blue on top, red on the bottom). The next image is a sunspot group that is beta-gamma-delta; it has both polarities (beta), the blue spot on top and the red spot near the bottom are separated from the rest of their like- polarity spots (gamma), and many “delta class” close-proximity regions exist down the middle. Delta and gamma classifications present the largest solar flare risks.

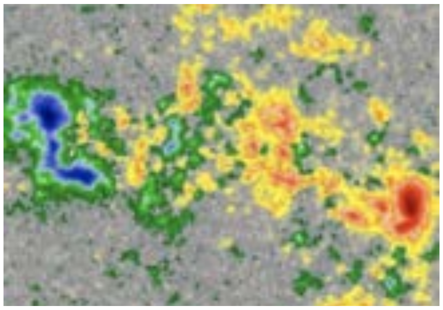




To the left, we find another example of a beta-gamma-delta sunspot group. It has both polarities (beta), regions where sunspots are cut-off from their larger group of like-polarity spots (gamma), and heavy interaction in the central region between red and blue (delta).

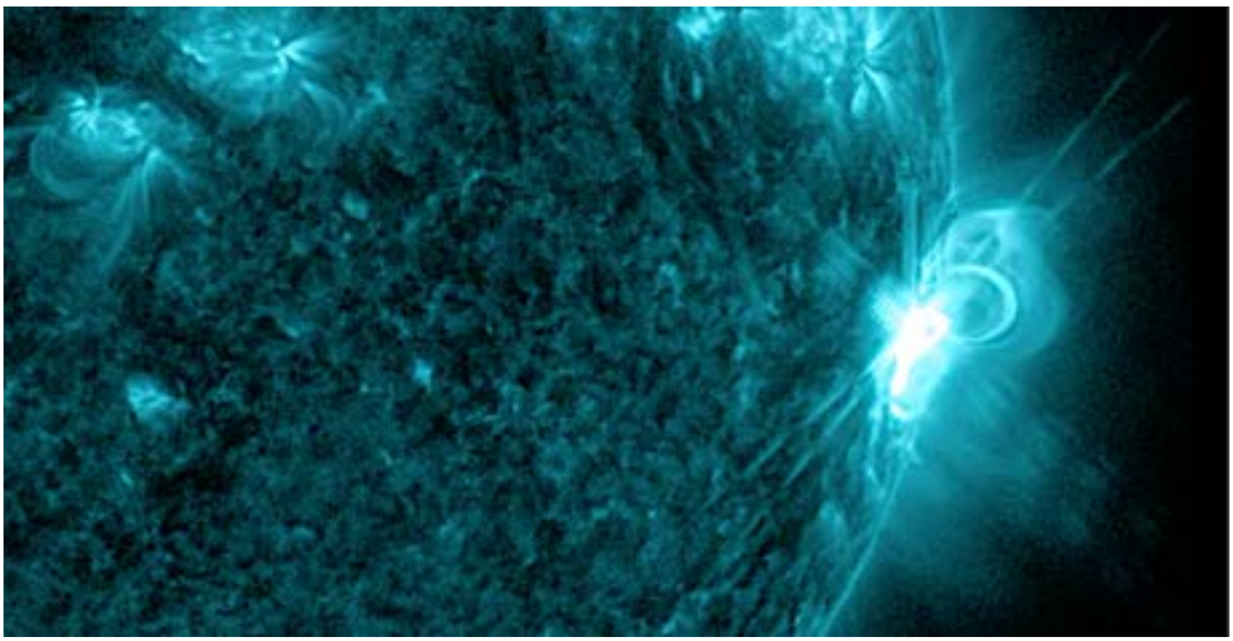


The image left shows an alpha class sunspot. All sunspots are going to have magnetic surface regions around them, but they will not count for magnetic classification of the active region unless they have proper umbra and surrounding penumbra. Alpha class active regions are the least likely to be actively flaring, regardless of their size. The surrounding magnetic regions are the places to watch for further sunspot development, which may ultimately change the classification of the region, which may be the case here in blue to the north.



This image shows a beta class sunspot group, with the opposite polarity cores leading and bringing up the rear of the active region. The region in the center, where we'd watch for further development based on the surface magnetism, would be able to add gamma and delta classifications to the sunspot group with only a few hours of development. **Inactive sunspots can develop and begin flaring within hours.**

Solar Flares



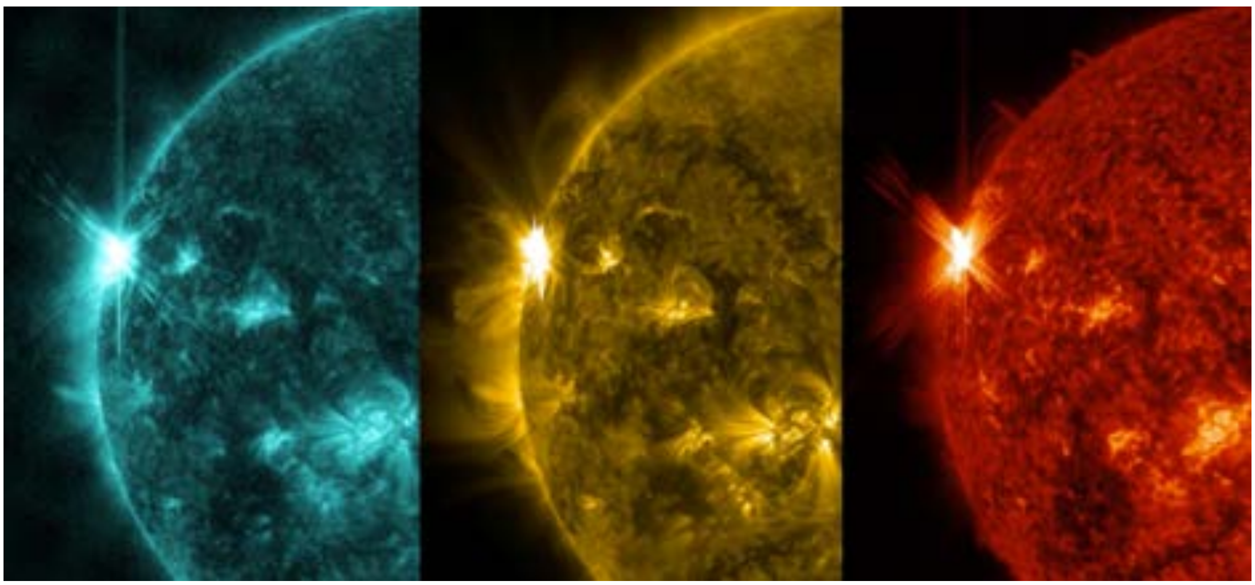
SDO Image of a solar flare (bright flash) during an incredible flurry of flare activity in September 2017.

The most exciting aspect of space weather is the solar flare. Solar flares are planet-sized X-ray explosions on the sun that can even produce Gamma rays during the strongest events. Notice the Earth scale on the bottom left of the image above compared to the size of the bright flare on the right.

This **electromagnetic (EM)** radiation travels at the speed of light, arriving at Earth in about 8 minutes, just like the light we see with our eyes.

The X-rays from solar flares can produce ionization (electrification) of Earth's upper atmosphere and ionosphere, which directly affect, and often disrupt, high-frequency radio communications. When a strong solar flare excites the upper atmosphere to the point of disrupting communications, we call it a "radio blackout".

This occurs because high frequency radio communication often uses the ionosphere to bounce or "skip" a message over great distances across the globe, so the disruption of the ionosphere affects this communication ability.

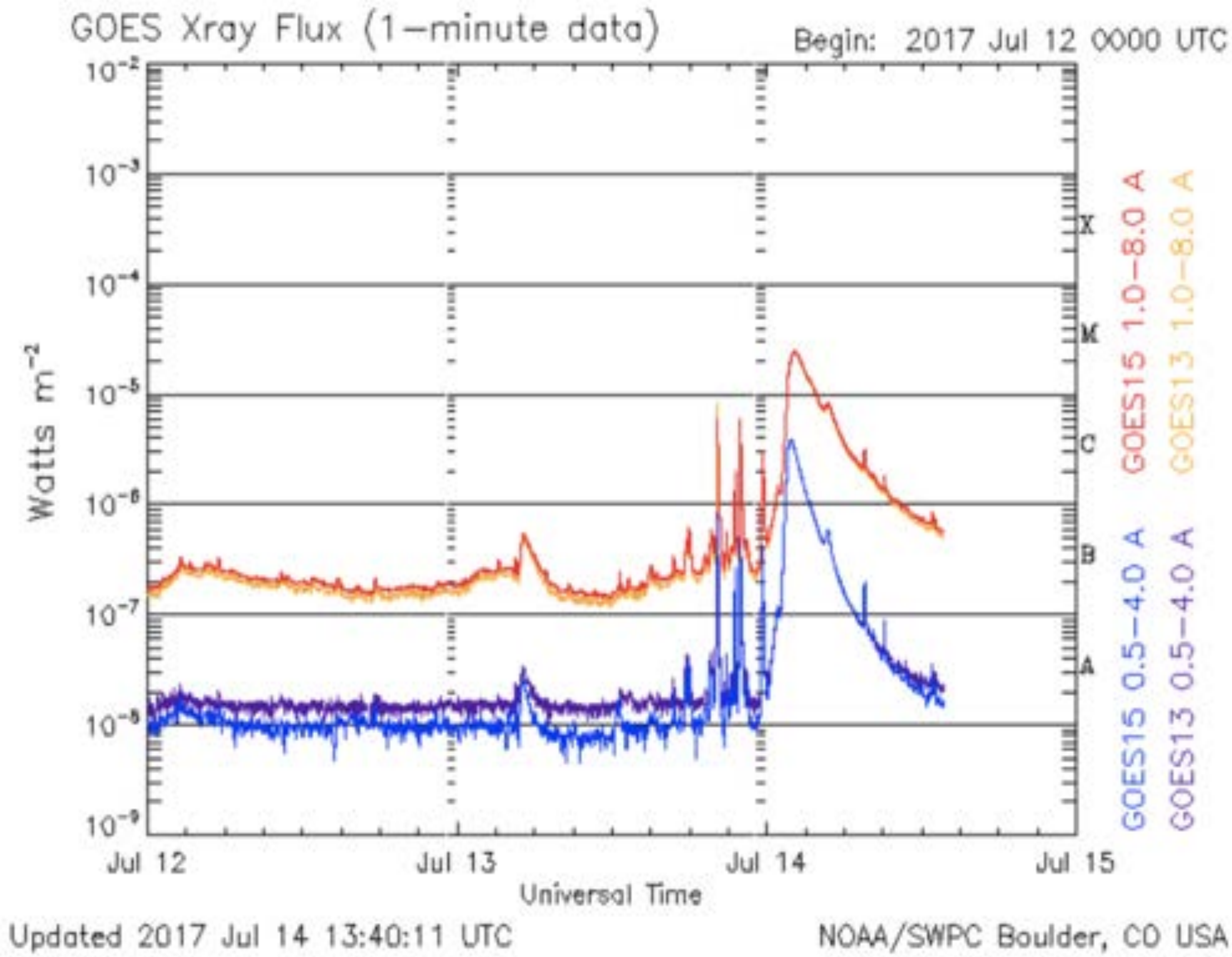


Only the sun-facing (daytime) side of the Earth is affected by the solar flare EM waves, and the blackout begins to fade the moment the solar flare ends. Solar flares can last from just a few minutes to a few hours.

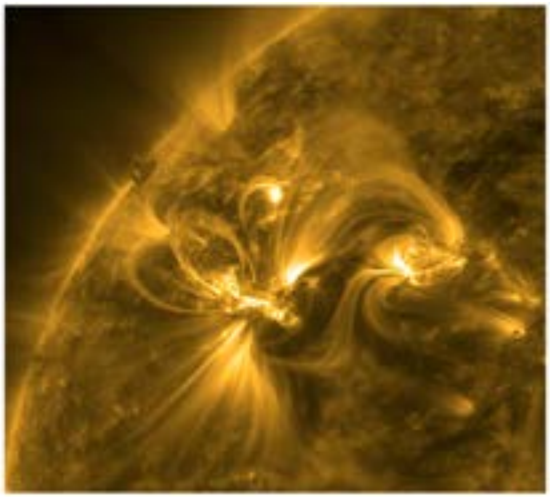
Short flares are called 'impulsive' flares, and longer ones are called 'long-duration' flares. Long-duration solar flares not only produce longer-lasting radio blackouts, but also have a greater chance of disrupting the solar wind with a coronal mass ejection.

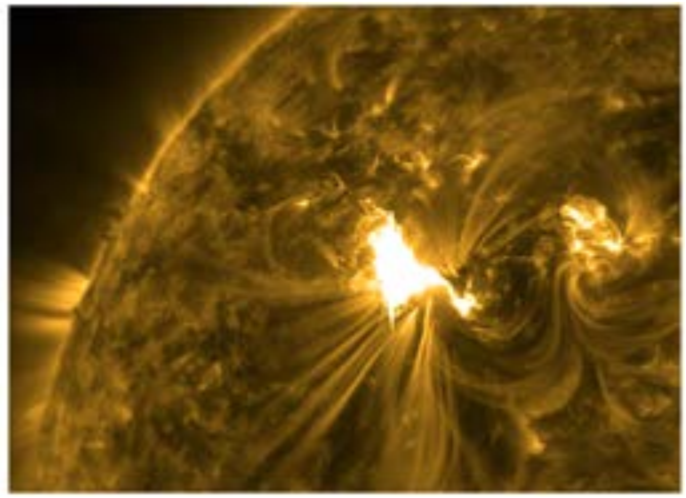
The next image shows a 3-day readout of X-ray flares detected by the GOES 13 and 15 satellites. We see both short-duration impulsive flares and a longer-duration flare at the end of that uptick.

Notice how the impulsive events look like spikes, while the long-duration event looks like a mountain. Even this long-duration event is not as long as some, which can peak into high M and X class range (right y-axis) and stay there for half a day.

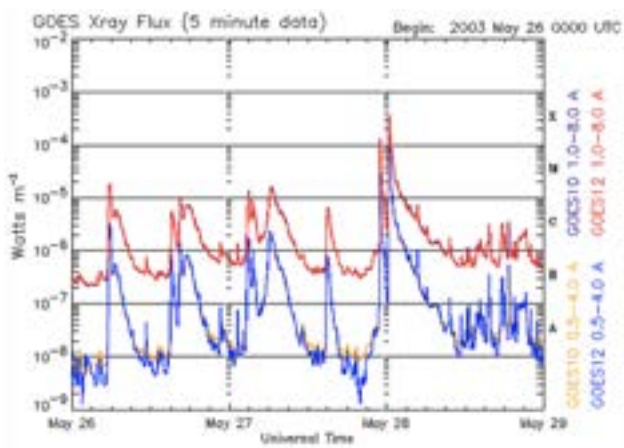


In the next image, we see two SDO images taken just minutes apart. On the left we see arching umbral magnetic field loops of sunspots in a complex arrangement. On the right we see a bright solar flare (white); the charged material in the magnetic fields above the sunspots destabilized, merged and accelerated particles to near-light speed. Notice the loops on the left side, missing on the right- they collided and exploded. The X-ray emission area here is larger than Jupiter.



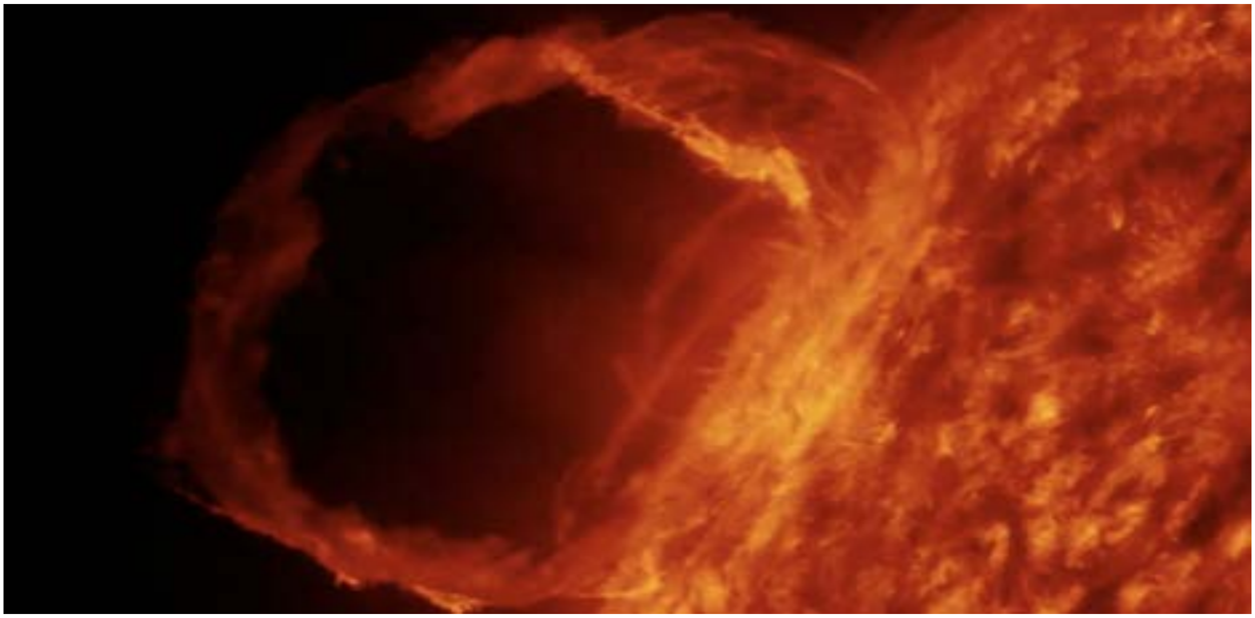


Solar flares are classified on a logarithmic scale from lowest energy to highest; the rating levels are A, B, C, M, and X.

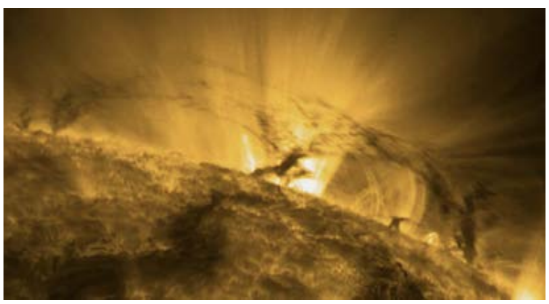


In general, solar flares are not going to produce significant space weather unless they are M-class or higher, except for long-duration (>2hr) C-class flares, which can also be significant. An A1 flare is 10x weaker than a B1, which is 10x weaker than a C1 . . . X1. Since X class is the highest, an X10 is 10x weaker than an X20, which is 10x weaker than an X30 . . . and so on. In the chart to the left, we have two X class flares, and a few other M class flares.

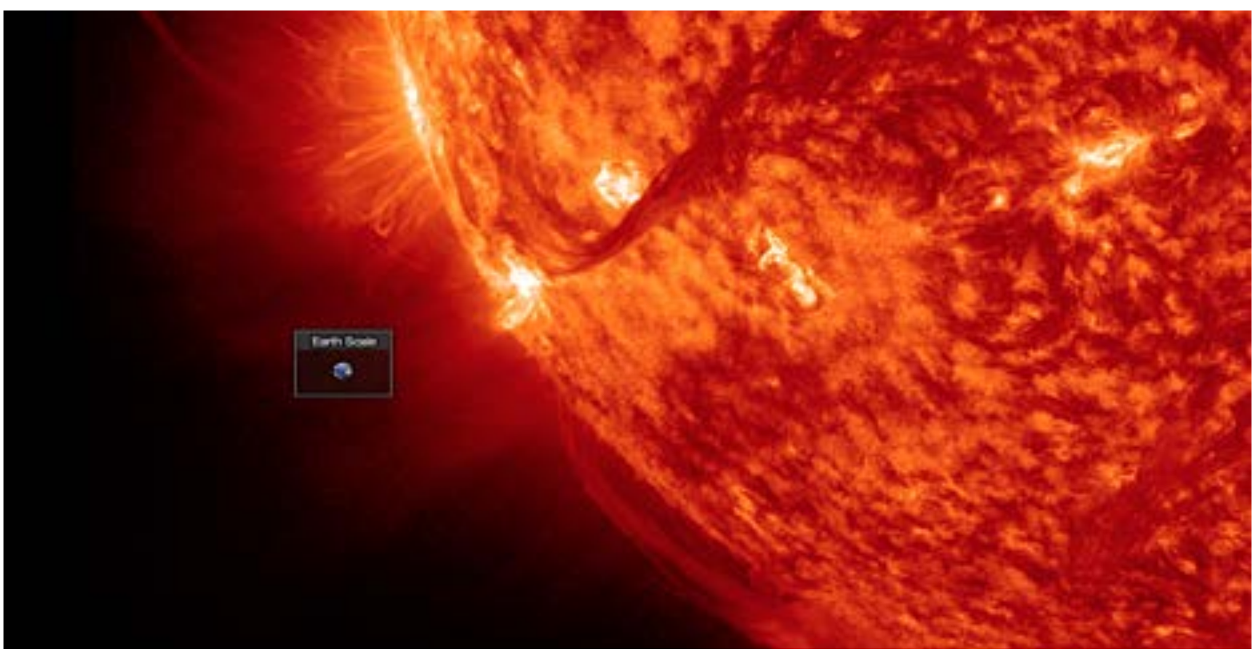
The lettering going up the right side of the chart (A,B,C,M,X) shows the scale.We will discuss how bad things can get in more detail in a later chapter, but for now, anything in the X class range is going to be relatively exciting, and when we get to X10 things really start to rock and roll. At X20 we start to get scared, and if you see an X30 aimed this way, it is about to be a bad week on Earth.



Plasma Filaments



Plasma filaments, sometimes called solar prominences, are large rope-like structures of plasma hovering in the corona (the sun's atmosphere). In this SDO image we see a plasma filament as a dark silhouette arching in front of bright umbral magnetic fields. These silhouettes often give-away the presence of filaments the moment they arrive at the side (limb) of the sun.

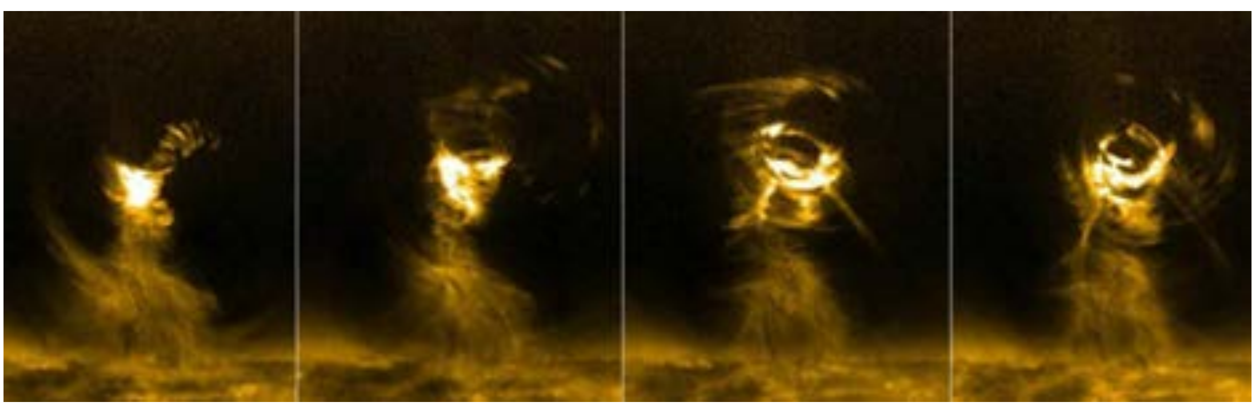


Filaments contain all the same material that we find on the sun (hydrogen, plasma, ionized helium and ionized iron) and are governed by the same magnetic forces we see across the surface; however, they are at a much lower energy state. Filaments can contain billions of tons of plasma and can stretch out in thin lines hundreds of thousands of miles long. In the SDO image above, we see three plasma filaments- two are easily seen arching over the limb (horizon/outside of the sun-circle) and one horizontal filament is already on the Earth-facing half.

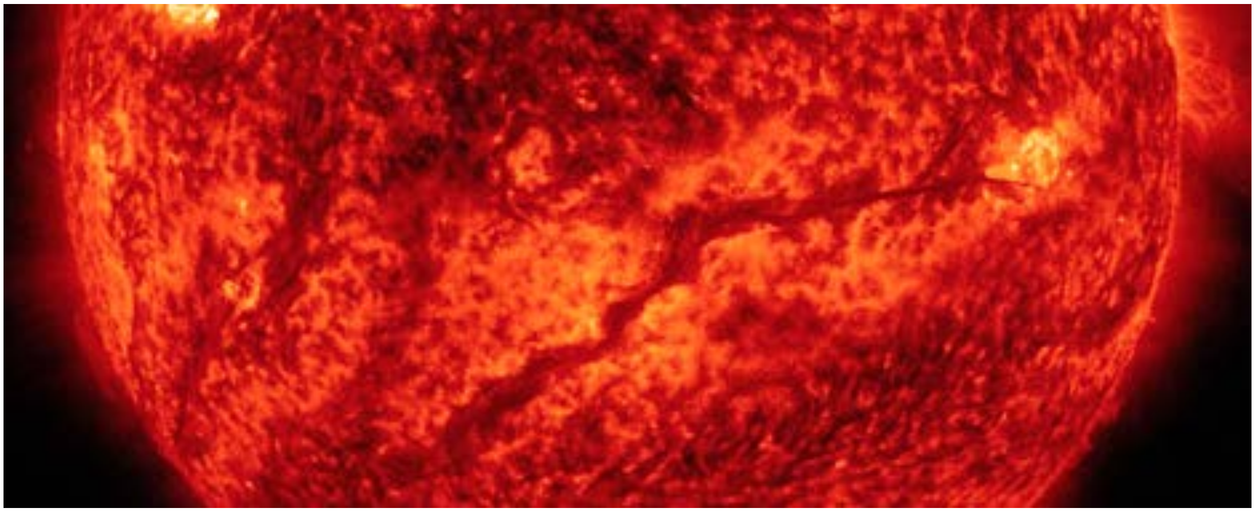
The leading filament appears as the thin, dark, continuous arc near the top-right corner of the “Earth scale” box. Many filaments are as long as 10, 20, 30 earth diameters or more.

Plasma filaments can be seen in other wavelengths as well. Seven of the nine SDO color-enhanced views offered by NASA allow us to see these filaments. In the SDO image left (pink) it appears as the dark protrusion upward from the surface near where the 10-10:30 position on a clock would be. This is 211 Ångströms, showing iron ionized to a different level than in the yellow images.

In the pink image, we can see that the size of this small filament still matches the size of the bright sunspot groups around it. In the red image above, it is clear how much larger filaments can be than those sunspots, dwarfing the size of the Earth. While plasma filaments can weigh trillions of tons, they can utterly defy the sun’s tremendous attractive pull. They are suspended by electromagnetic forces that are larger in scale than the umbral fields, and they can come in any orientation, including standing straight up from the surface- like a tornado on the sun (below).



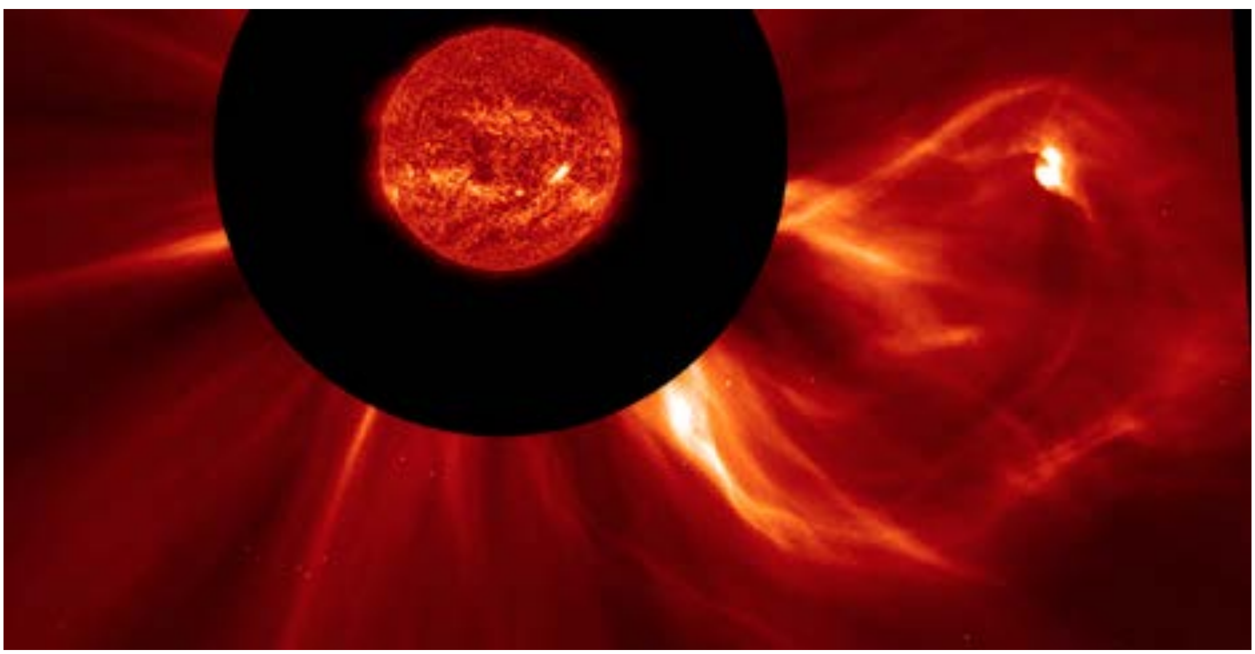
The vortex-like appearance is no mistake; the electromagnetic forces at work on the sun often create such spiral/helical shapes. Plasma filaments have been seen stretching halfway across the sun at mid-latitude. In the image below, the dark filament is more than 700,000 km from end to end. Plasma filaments, and the X-ray solar flares we learned about in the previous section, are the two solar phenomena that can trigger the release of a “coronal mass ejection.”



Coronal Mass Ejections (CMEs)

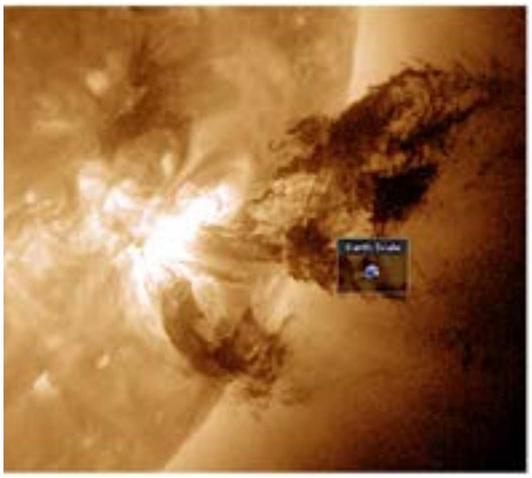
If the solar flare is the most exciting space weather event, CMEs are a close second place - the thunder to the lightning. While thunder is a sound-based shockwave caused by extreme lightning heat, a CME is an electromagnetic shockwave caused by the X-ray solar flare.

CMEs are the main producer of significant space weather events on Earth. While a solar flare sends electromagnetic waves (photons) out at the speed of light, a CME is made of plasma, just like the solar wind.



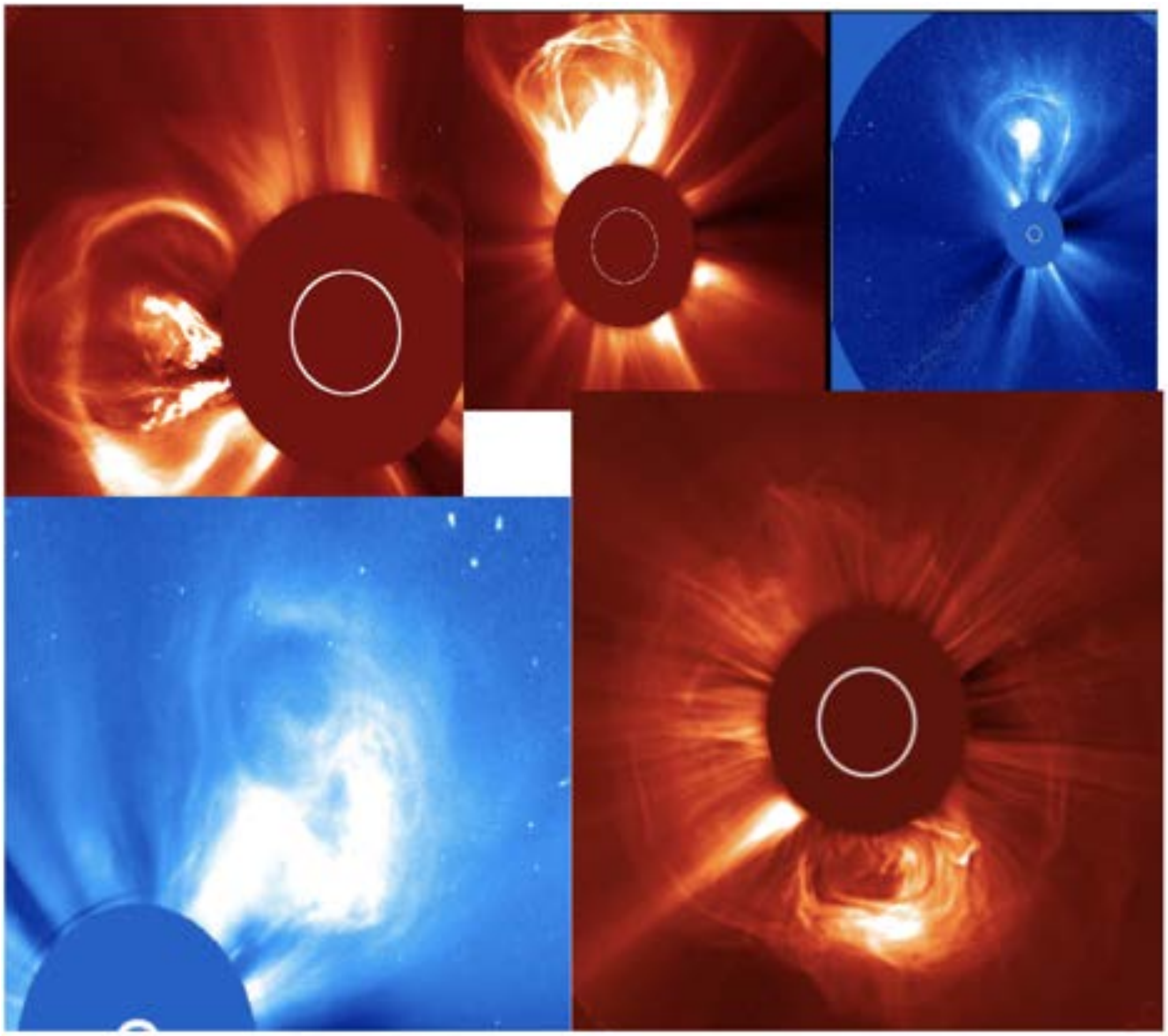
In the image above we see a powerful CME from a solar flare expand to exceed the size of the sun within 1 hour of exploding. Within a day, it was as wide as Mercury's orbit; within a week it was a shockwave cloud that could fit millions of suns inside as it travelled out past Mars.

Below are two closer-in SDO images of CMEs leaving the corona. On the right, a plasma filament is ripping away from the sun (the same one we saw in the last section), and on the left, charged material is ejected from a sunspot group during a solar flare.



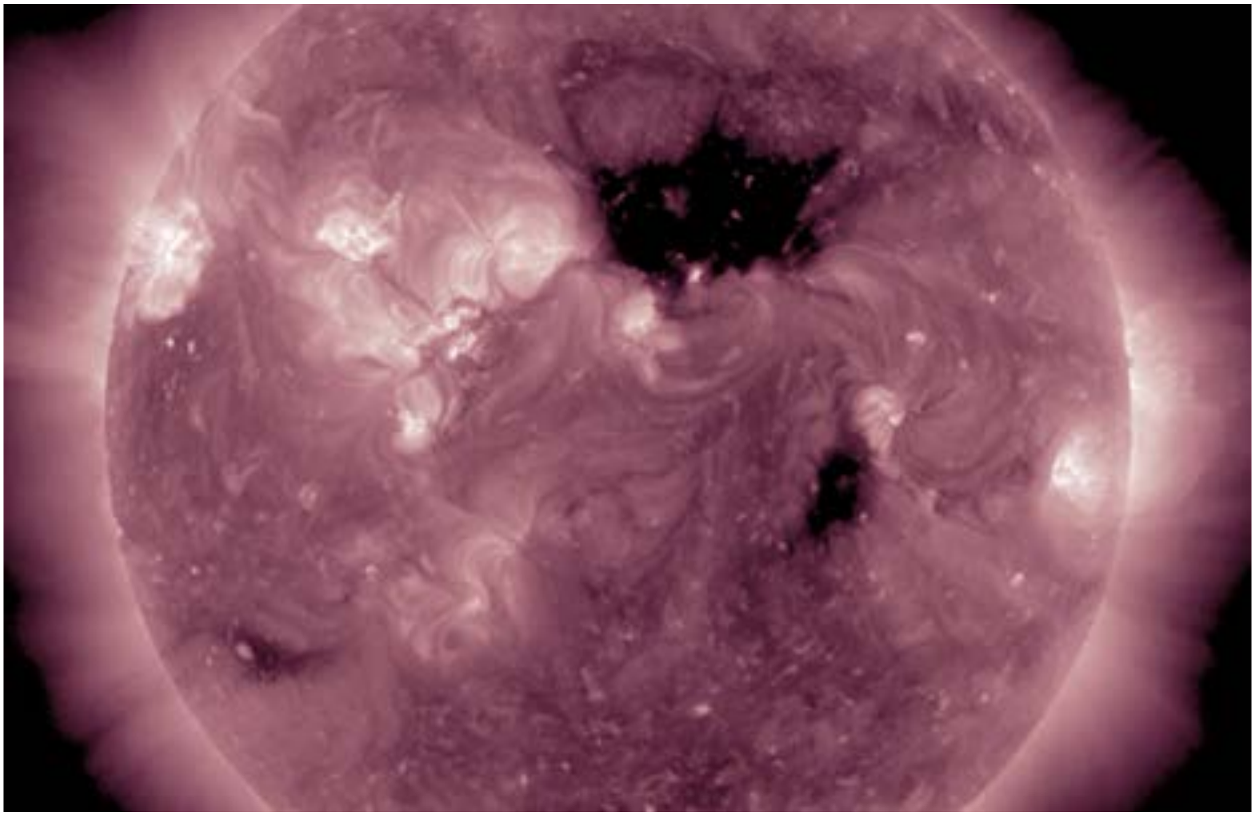
These CME shockwaves deliver waves of solar wind particles that are fast, dense and hot. The next image is a collage of these CMEs from the SOHO satellite coronagraph cameras. They are ultra-sensitive to solar plasma, so an opaque disk is centered to block the sun's glare; otherwise, each image would be white.

The bottom-right image shows a CME coming towards Earth, which is called a 'halo' eruption because as it expands, it looks like a halo around the sun. Since these cameras always look from Earth, each of the other images shows CMEs that will miss our planet (they are going off to one side).



Consider the size of these eruptions: the sun is a tiny dot behind the central inner circle, so these images taken within hours of a solar flare or filament eruption, show CME clouds already big enough to hold dozens to hundreds of suns.

Coronal Holes



If you can see the black areas just right and up from center in the solar image here (and the smaller ones near the bottom and left side), congratulations, you can locate coronal holes! These are areas in the corona that are nearly devoid of charged particles and plasma.

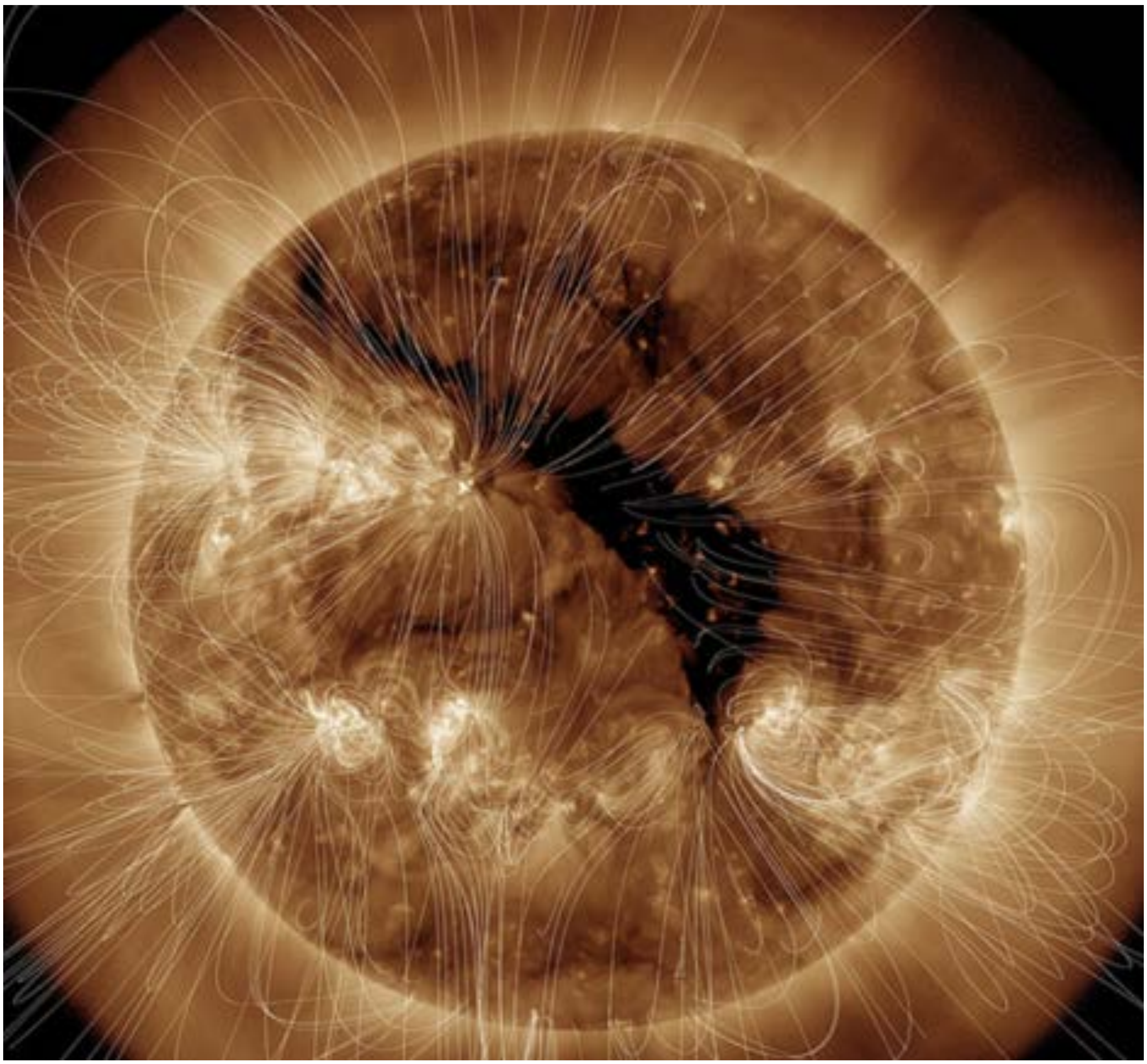
Corona = Solar Atmosphere; Coronal Hole = Hole in the Sun's Atmosphere. This image is from SDO in 211 Ångströms (wavelength) of light, which is especially good for spotting these coronal holes.

Coronal holes are nearly-empty areas that extend from near the solar surface up into outer space. Plasma filaments can also appear dark, but they are thin and often visible separate from (above) the solar surface. Unlike the thinner filaments, coronal holes are usually larger patches like you see here, not at all thin, and easily contrast with the bright white umbral magnetic fields above sunspots.

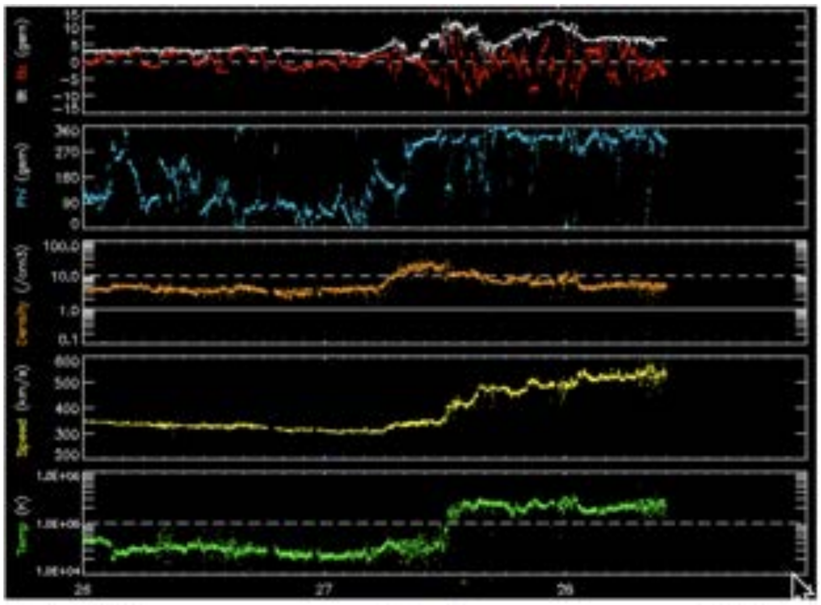
Why are these regions empty? Because of the solar system's interplanetary magnetic field (IMF), which we learned about earlier in this chapter. The IMF takes all the charged material in those areas of the corona out with them, leaving the area vastly less populated with plasma than the surrounding regions. These are the same IMF connecting planets to the sun through the solar wind electric field of plasma.

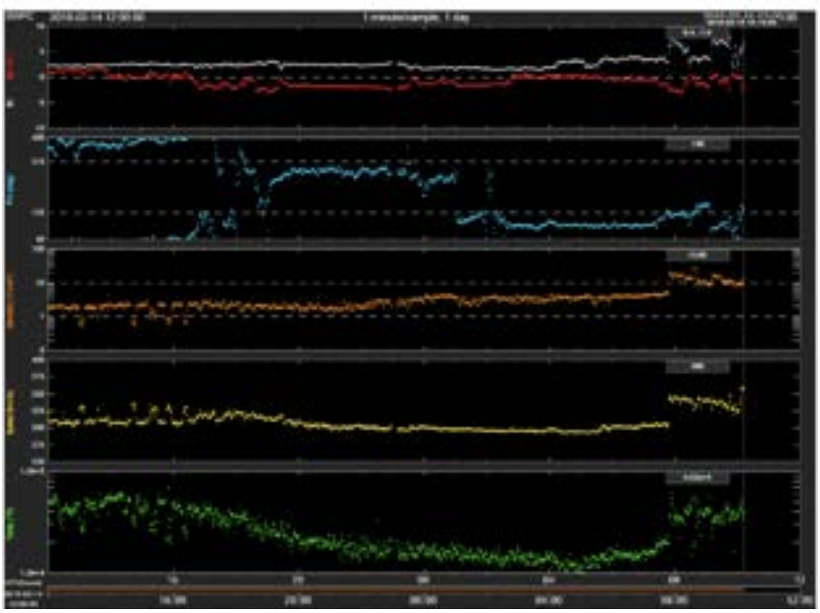
Umbral field loops, and the larger coronal magnetic fields seen in the next image, not only contain particles in their loops, but they create a magnetic shell that traps escaping solar wind. Here we see the magnetic fields associated with the sun.

Notice how the umbral magnetic fields of sunspots are looped and confined to the sunspots groups, while the fields associated with the large coronal hole are straight lines outward into space. Those larger white fields arching over larger areas are the coronal fields we mentioned in the previous paragraph.



The practical effect of the “open” fields of coronal holes is extra force for the solar wind, coupled with less magnetic restriction on those electric particles. This is why coronal holes often emit intensified solar wind. The solar wind streams from coronal holes themselves are not tremendously dense, just very fast and hot, but they catch up to slower-moving solar wind out ahead of them, bunching up those slower particles like snow on the blade of a shovel. This creates a density shockwave at the leading edge of the fast coronal hole stream that acts very much like a CME. Because of this shockwave, coronal hole streams can also produce geomagnetic storms.





In the top image, we see a coronal hole stream impact in the solar wind. The plasma density of the solar wind (orange) has a sharp increase on the 27th, lasts for a few hours, and then begins to descend. It begins to descend before the speed (yellow) and plasma temperature (green) begin to rise, and density continues to drop as the speed and temperature continue to rise/remain higher. The rise in speed and temperature represents the arrival of the fast, sparse solar wind stream, and the density peak before it represents that “snow on the shovel blade” - the slower particles bunched up ahead of the faster coronal hole stream. Contrast this with a CME impact (bottom image), where changes in the solar wind telemetry are simultaneous; coronal holes deliver the density shockwave first (along with the phi angle change in blue) and then the fast/hot coronal hole stream onset begins.

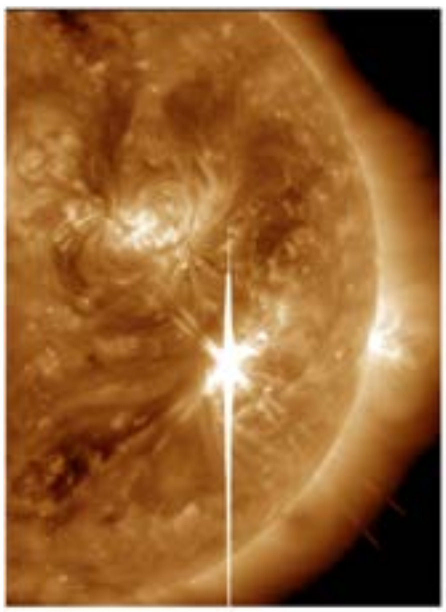
Coronal Hole or CME? It Is About Timing the Density & Speed Effects:

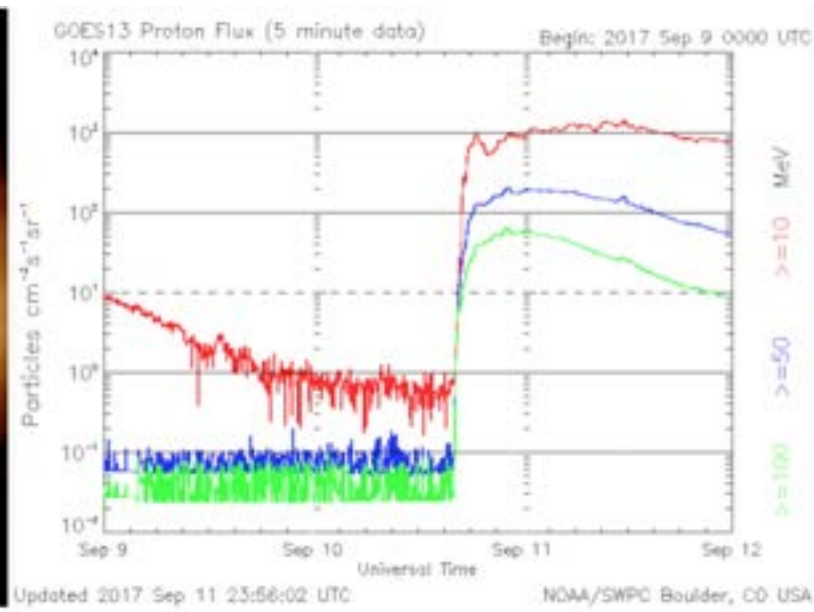
If the density wave precedes the speed/temperature rise, it is a coronal hole. If the solar wind changes all at once, it is a coronal mass ejection (CME). While this distinction is a critical aspect of analyzing space weather, both CMEs and coronal holes can cause geomagnetic storms.

Solar Energetic Particle Events (SEPs)

We have mentioned that solar flares, plasma filaments, their CMEs, and coronal hole streams can intensify the solar wind and cause a “geomagnetic storm”, but there is often a critical step in between. Strong solar flares can hit Earth with particles long before its CME arrives; this is called an SEP event.

The images below show a solar flare on the left, from SDO, and an SEP event (a proton radiation storm) on the right, which occurred minutes later. We can see that energetic protons of different energies surged from their low levels around 1 proton every 1-2 cm3 up to 10-1000 protons per cm3 - an average increase of 1000x across all three tracked proton energy levels.





We discussed the interplanetary magnetic field (IMF) that connects the planets back to the sun, and we learned that every 8 minutes, a flux transfer event sends charged particles directly along this IMF, which bypasses Earth’s magnetosphere, and pours solar plasma into the upper atmosphere.

Sometimes, the surge of particles to Earth is extreme. This occurs following a large solar flare and CME that hits Earth’s magnetic connection to the sun (IMF), driving a different kind of particle explosion through space.

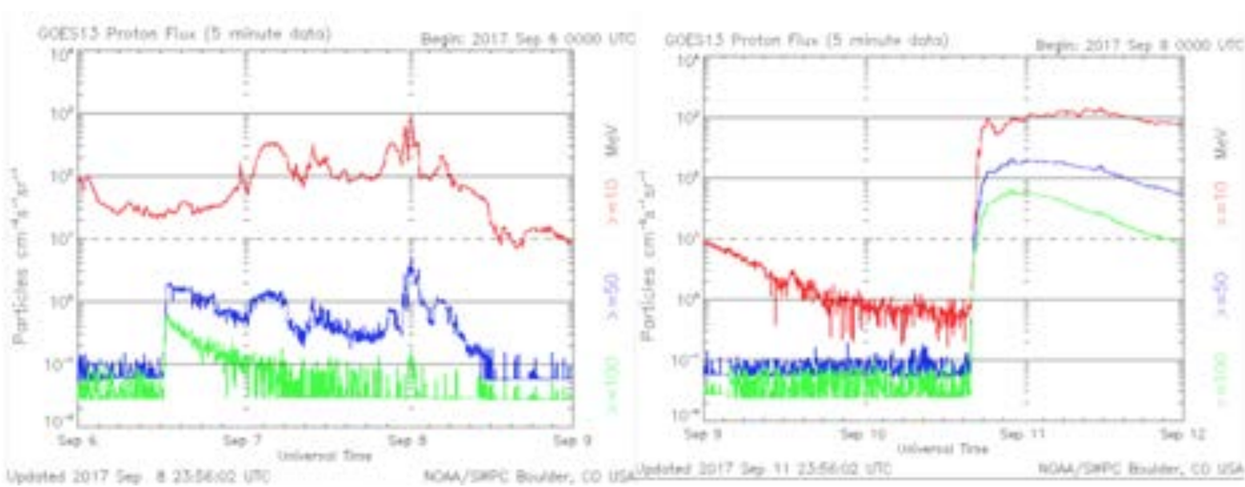
When a powerful flare/CME hits Earth’s IMF connection to the sun, it helps fuel extreme surges of these charged particles - an extreme flux transfer event that can last for hours to days. While CMEs take a few days to arrive in most cases, the highly-energetic SEPs arrive within minutes of the solar flare.

While we can see solar flares in SDO's view of ultraviolet light, and can see CMEs via SOHO's coronagraphs, there is no way to see the energetic particles from the sun traveling along the IMF to Earth.

During these SEP events, either protons or electrons streaming towards Earth undergo a large spike in particle counts. This influx of charged material occurs near the polar regions, spreading to lower latitudes only in the most extreme circumstances. Our main protection from these events is the atmosphere because SEP events often bypass Earth's magnetic field along the IMF.

Luckily, the atmosphere does a very good job protecting those on the ground. Astronauts and passengers on high- latitude flights are most at risk from radiation due to SEP events, which is why space stations have shielded safe rooms, and airlines will reroute polar flights during major solar flares.

When viewing an SEP event, one can often tell if there is more coming or if the worst is already underway. Compare the two images of SEP proton storms below:



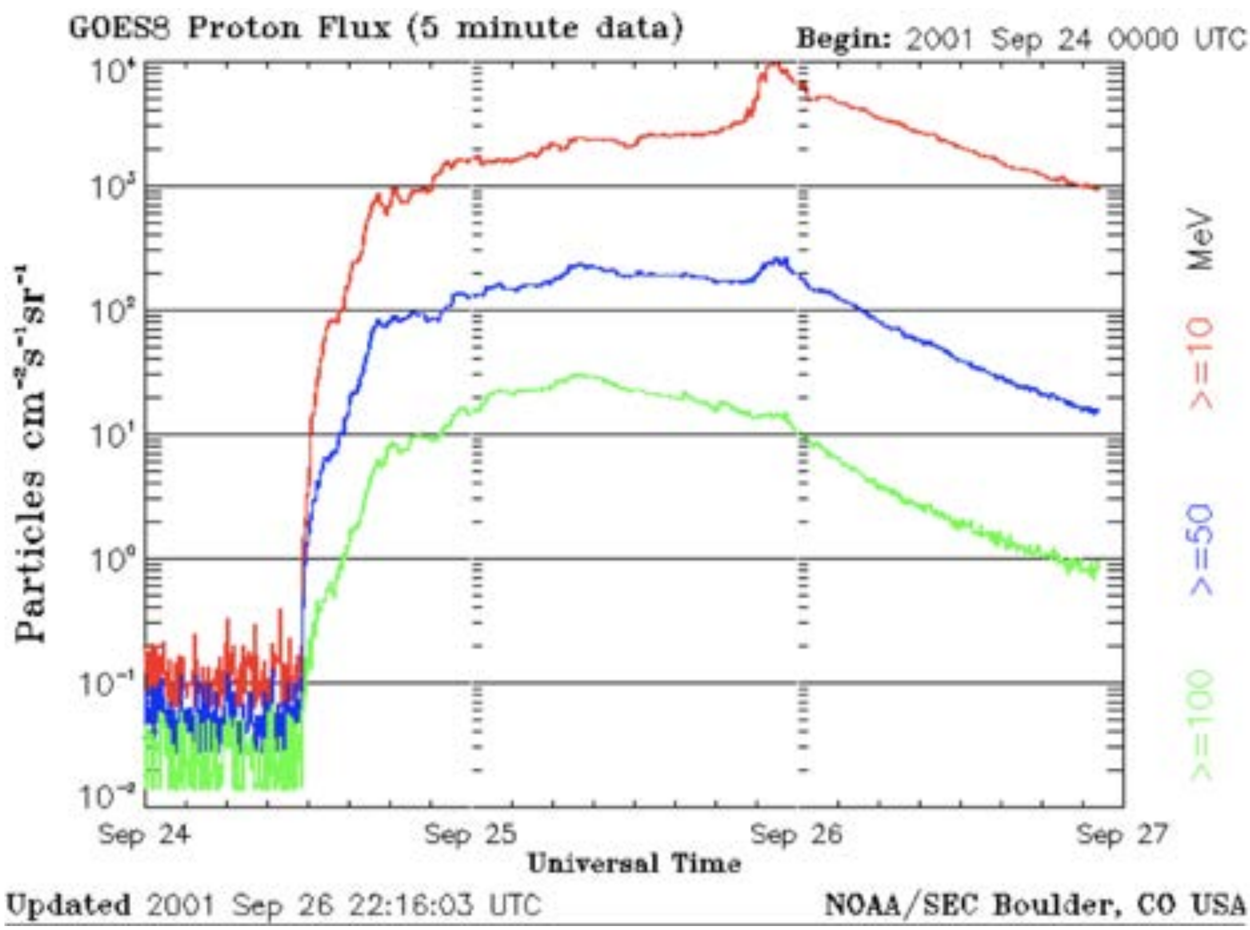
On the left, we see enhanced proton counts that follow no real shape or pattern; these are probably always going to signify that the worst has arrived unless more solar flares occur, and indeed all of the upward enhancements on the left are due to additional solar flare eruptions, including one that happened at exactly 00:00 UTC on September 8th. It was a flurry of activity that produced seven distinct SEP events over almost three days.

By contrast, on the right side we see a very well-defined shape; there is a sharp rise upward followed by a flat top and much less variation. In this event, there was just one solar flare. **When we see that "UP and FLAT" profile, we have hit the proton "stream limit".**

Powerful flares and CMEs are what drive large/fast spikes in proton bombardment, however those CME shockwaves are highly electromagnetic themselves, and if strong enough, can hold back further increases in the SEP stream density due to their own magnetism (creating the flat top). This means that when you hit the stream limit, an even stronger "punch" of protons is waiting to arrive with the CME.

This second punch does not always occur when you hit the stream limit, as was the case in the period depicted in the right-side image, when the CME carrying the extra punch did not hit Earth, taking the extra protons out with it.

Below we have an example where a powerful solar flare and CME caused an SEP proton radiation storm that hit the "stream limit" AND Earth received the secondary punch of protons that occurred when (and only because) the CME did in fact impact Earth.



In the image above, the solar flare and CME occurred on September 24th. The stream limit was reached that night and continued on the 25th. The CME arrived at Earth late on the 25th, producing the second spike in protons to ~5x the density flow of the stream limit reached by the >10 MeV (red) protons, and ~75 to 100 % higher bombardment in the >50 MeV (blue) protons.

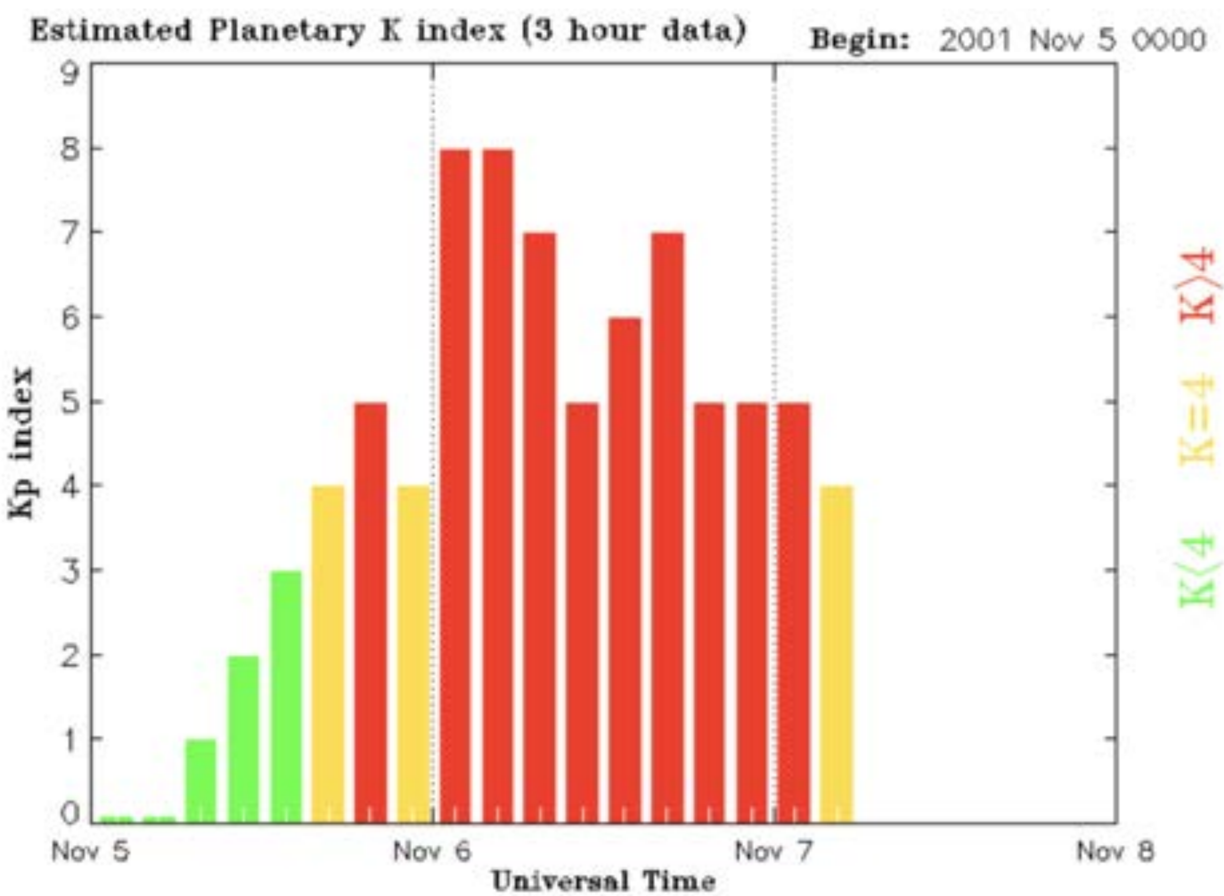
To illustrate how large of a "punch" this is: the >10 MeV protons (red) began at less than 1 proton/cm3 on the 24th and surged to a stream limit of ~2000 protons/cm3 that night. However, the 3 secondary punches delivered by the CME impact reached nearly 10,000 protons/cm .

That bump up top might look small, but it's actually 5x greater a spike than the initial rise on the 24th, which appears bigger to the eye due to the logarithmic scaling of the chart.

This is a rare example of a 10,000x particle increase event. The initial rise in the >50 MeV (blue) protons was from 1 to ~100 33 protons/cm , while the "punch" took levels to nearly 200 protons/cm - again, the bump only *looks* small.

The CME impact is where the big show begins on Earth, and that second SEP wave, the "punch", and the radiation storms they deliver, are only part of the story. The main effect of space weather events (solar flares/CMEs, filament eruptions, coronal holes) acts on the Earth's magnetosphere, and if that effect is great enough a geomagnetic storm occurs.

Geomagnetic Storms



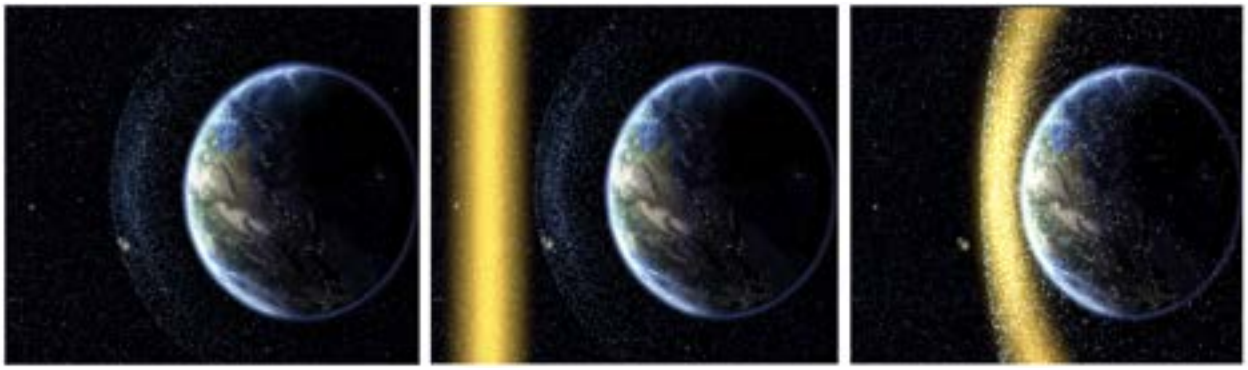
Geomagnetic storms are the bread-and-butter of Earth-focused space weather. Solar flare energy can ionize the atmosphere, and solar energetic particles (SEP) can deliver solar plasma directly into the upper atmosphere, but neither is as powerful in influencing all layers and planetary systems as the geomagnetic storm. This is the aspect of solar storms that can send our civilization back to the stone age - the solar EMP or "solar killshot".

The image above is of the “Kp index”, which measures the total disruption to Earth’s magnetosphere. On the scale, 0-3 (green) presents relatively calm conditions, 4 (yellow) indicates instability of the magnetosphere, and 5-9 (red) indicates geomagnetic storm conditions. Within even one of the color groups there exists a great deal of variation. It takes utter silence to have a Kp of 0, while there is usually slightly-above average solar wind intensity during Kp3 events.

A Kp5 geomagnetic storm is likely to produce beautiful auroral displays near the poles, but the scarier effects are reserved for Kp8+ storms, which can be 1000 to 10,000 times more powerful. CMEs and coronal hole streams present sharp changes in the electric environment of near-Earth space. When a CME or coronal hole stream strikes our planet, the magnetosphere is compressed, and there is a **simultaneous change** in the profile of the solar wind across nearly all metrics.

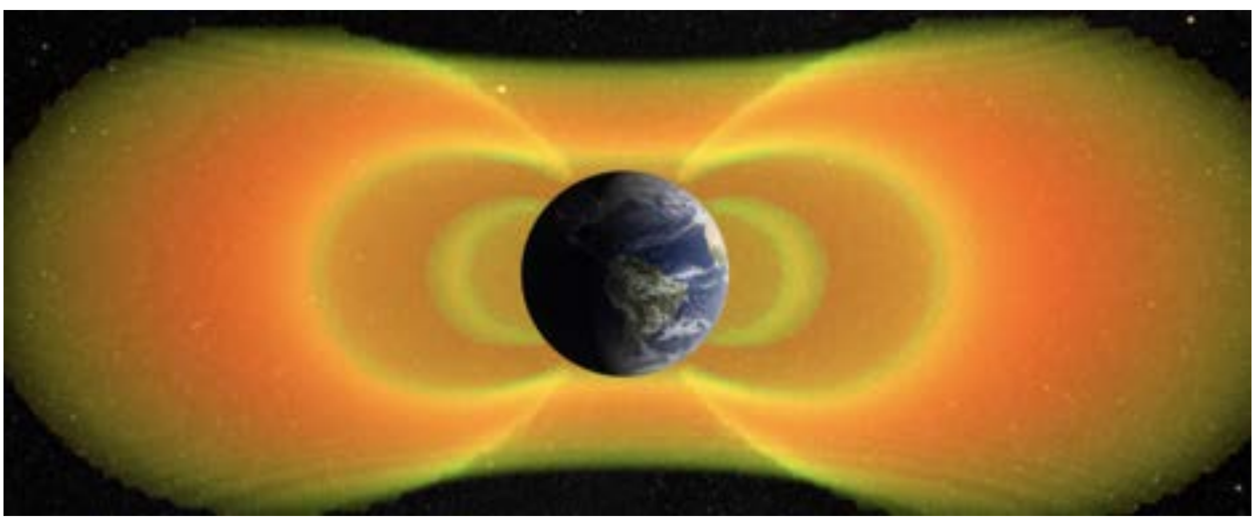
Using the timestamps across the bottom of the image below, find the 23:00 hour near the middle of the plot, the hash-mark to the left of 00:00. This is the same type of solar wind data as before, except from the ACE satellite.

The bottom three panels all increased at the same time, along with the top panel, and what had been a calm trend in the blue Phi angle took a hit to lower degree angles at the time the other panels showed the change. The key item in identifying a CME impact is the simultaneous change in telemetry. **CMEs are one of the primary causes of geomagnetic storms at Earth.**

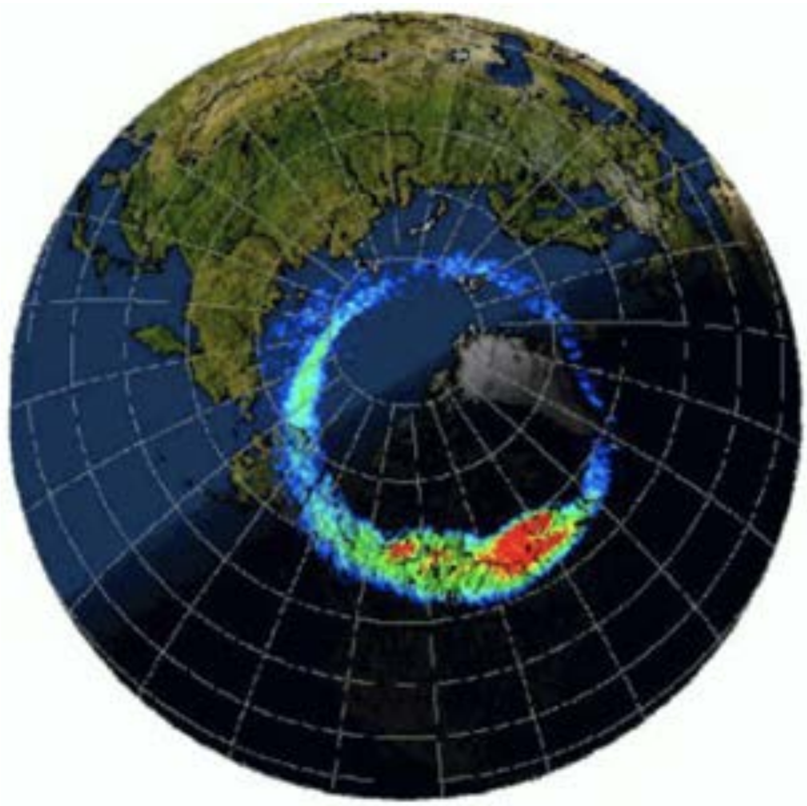


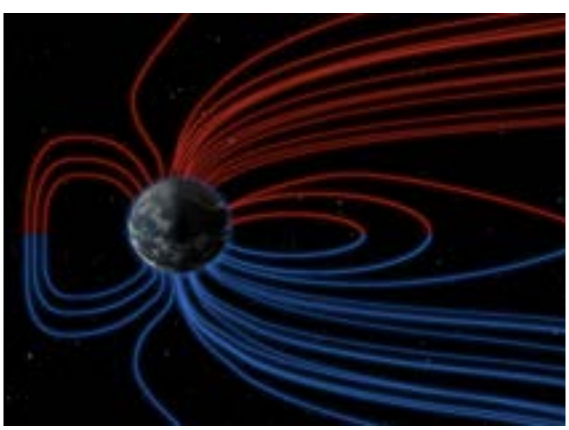
Pre-CME Impact   Impact Imminent   Compression/Coupling

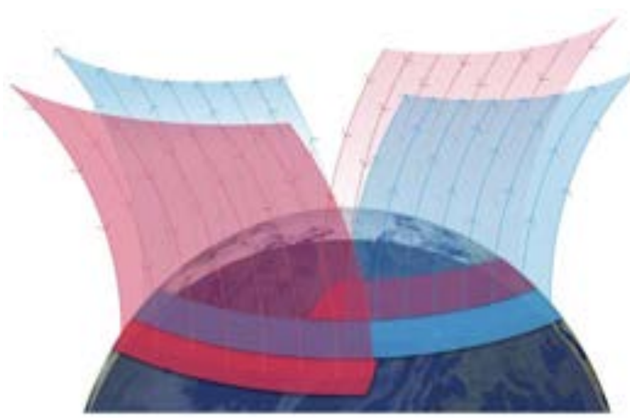
The compression of Earth's magnetic field can be seen above. The sequence portrays a CME shockwave (yellow) hitting Earth's magnetic field and being directed around our planet, while partially interacting (coupling) with the magnetosphere to deliver its energy to the Earth system. The compression of the field affects the Van Allen radiation belts and the ionosphere, whereby during CME impacts, electrons are driven downward towards the atmosphere on the sun-facing side. In the right-side image above you can picture how plasma pressure of the CME might force the Van Allen belts (pictured below) into the atmosphere.



Earth's primary magnetic field connects to the Earth at the polar regions. During CME and coronal hole stream impacts, the magnetosphere helps guide the impacting particles around to the poles. On days when there are exceptional auroras, it is almost certain that a CME or coronal hole stream has impacted our magnetic field and caused a geomagnetic storm.

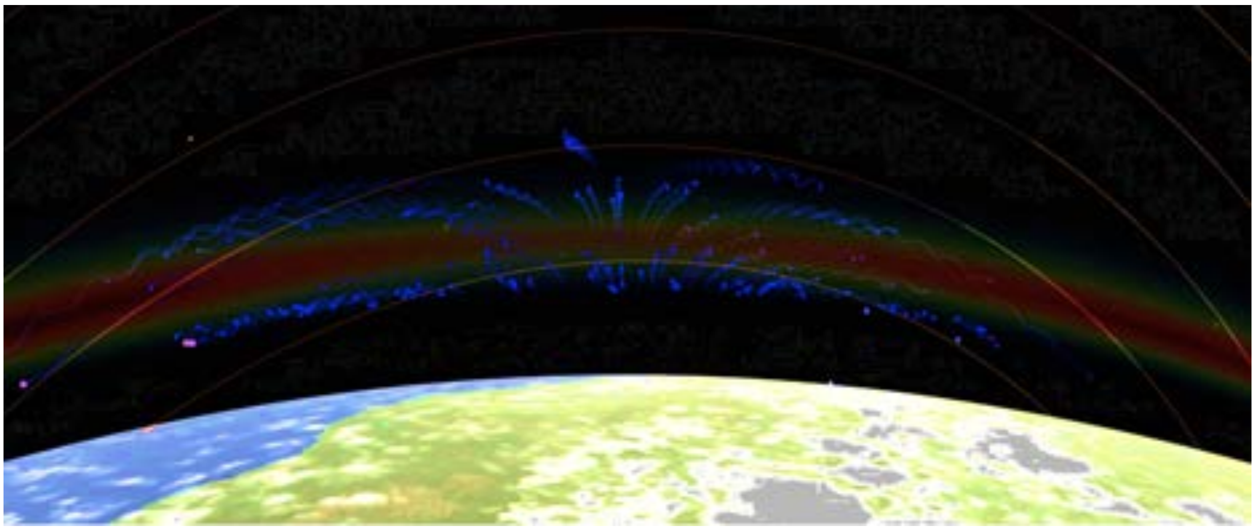




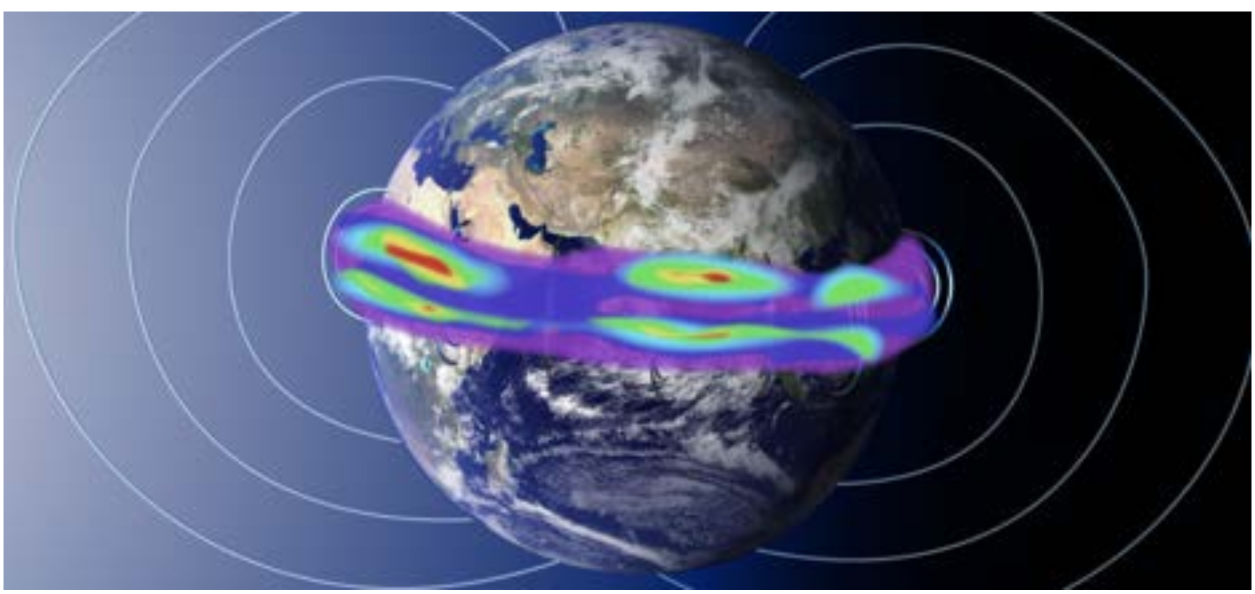


The aurorae are not randomly situated in a circle around the polar regions, and it is no coincidence that only during the strongest geomagnetic storms do the aurorae spread to lower latitudes- a ring of energy called the auroral electrojet exists at the poles and it is fed by the particles directed along Earth's magnetosphere to these polar regions.

A third ring called the "equatorial electrojet" sits above the tropical regions, but does not often present itself visually with auroras. The equatorial electrojet forms from an ion fountain above the equator (next image) and is strengthened via magnetosphere compression (rather than energy deflected to the auroral zones).



That compression pushes particles into the ionosphere and upper atmosphere from the Earth's magnetic fields, Van Allen belts, and the ionosphere itself. Both polar electrojets and the equatorial electrojet are found in the ionosphere. The image above shows us positioned on the equator, looking directly across the equator at the fountain of ions that constantly eject – the equatorial ion fountain. The image below shows the stronger return where the ions fall back down. Both images are from NASA.gov.

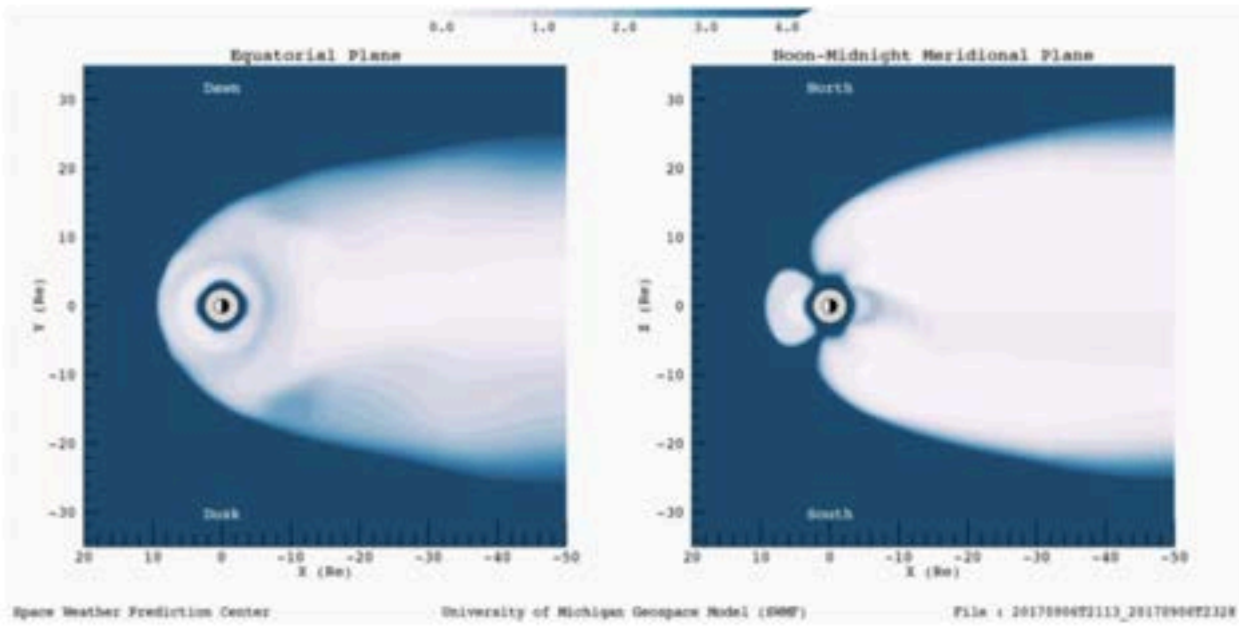


CME impact compression of the magnetic fields (thin arches) will intensify the particles' downward flow. This is how the equatorial electrojet is intensified, largely with Earth's own particles, whereas those same arching fields are driving the solar particles to the poles to intensify the auroral electrojets.

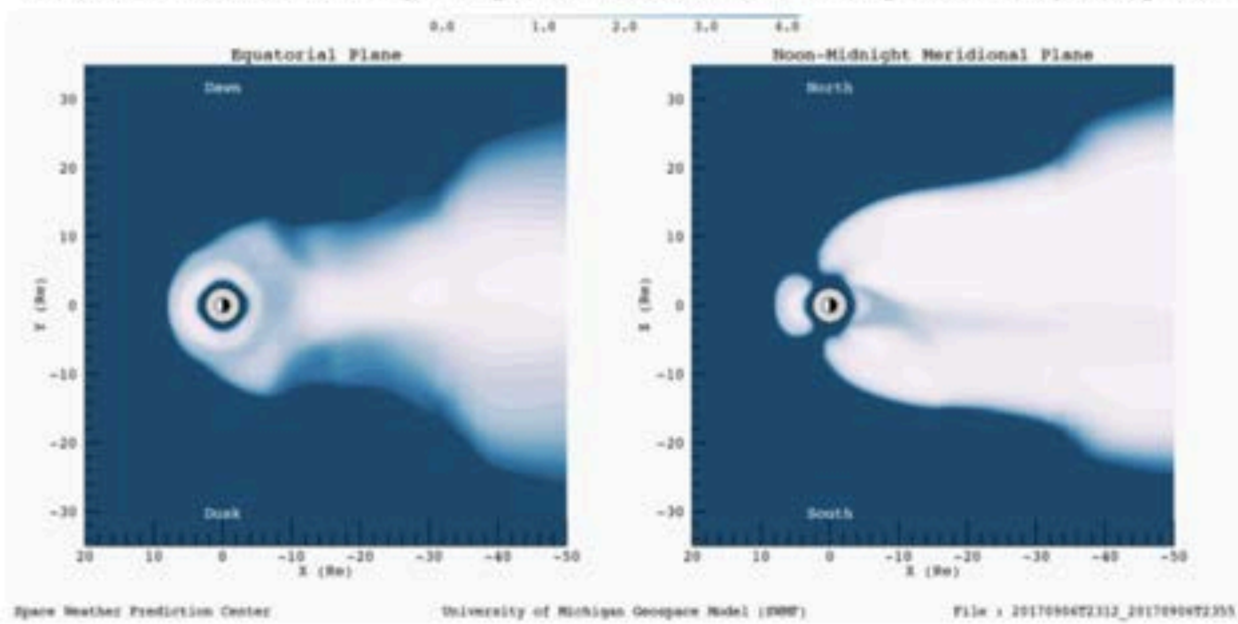
When a CME impacts the planet and energizes the ionospheric electrojets, they can further create or "induce" powerful electric currents in the atmosphere and the ground. These currents are a critical piece of solar-terrestrial physics, and they influence a wide range of relevant events.

There are no absolute general rules when it comes to CMEs and coronal hole streams; each is different and somewhat unpredictable beyond its general speed and density. Every time a CME strikes Earth, everything electromagnetically vulnerable (technology, water, metal) is at risk of taking an amount of that energy that exceeds the system limitations, whether that system is the power grid on the street, a stream of water vapor in the atmosphere, or the circuit in your brain.

This section ends with two density-model displays of Earth's magnetic field blown to the right by the solar wind (next page), and the sun implied to be off to the left. The top image shows a full magnetic shell (white, high density of particles due to strong and stable field) while the bottom image shows our planetary shield just after CME impact. Images on the left side show the equatorial plane, while images on the right show noon-midnight plane.



Above - Broad, stable magnetosphere. Bottom - CME-compressed magnetosphere



The disruption to Earth's magnetic field not only adds solar energy to Earth's system, but the compression of the field forces that higher amount of energy to cycle through a circuit of even smaller size than normal; this excess energy directly penetrates to the ionospheric layer, induces electric currents in the crust, and even resonates magnetic fields near the surface to produce very low, ultra-low, and extremely low frequencies (VLF, ULF, ELF).

In the biggest of solar storms, the induced currents would fry transformers, melt copper wires, destroy circuits and basically eliminate all modern technology. The US government estimates that if a big solar storm like that happened today, in six months 90% of humans could be dead from lack of infrastructure for water, heat, food distribution, energy, banking, communication and transportation - all of which rely on electricity.

Cosmic Rays

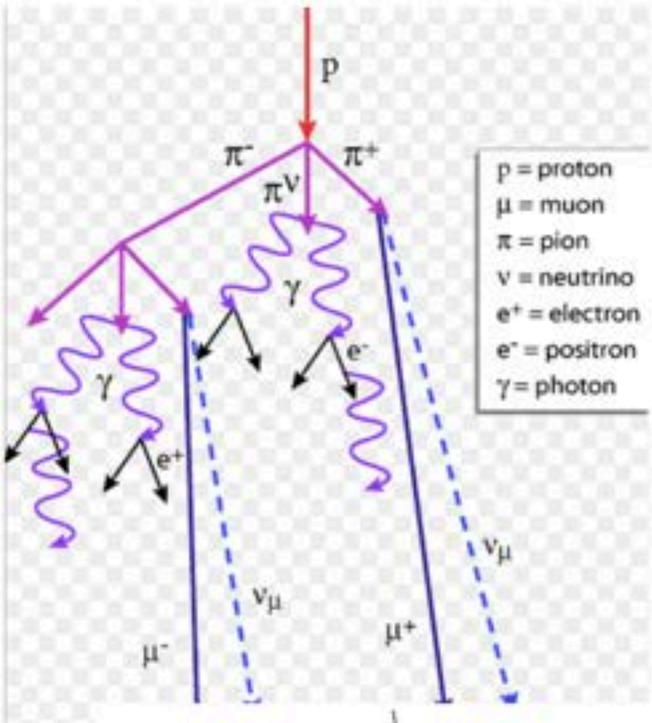
Earth's magnetic field protects the Earth from more than just the sun's rays and solar wind; it protects against most interstellar and intergalactic waves and particles. While the energetic waves are usually well-deflected, many high-energy particles can penetrate the magnetosphere, and can even penetrate to the core of the Earth.

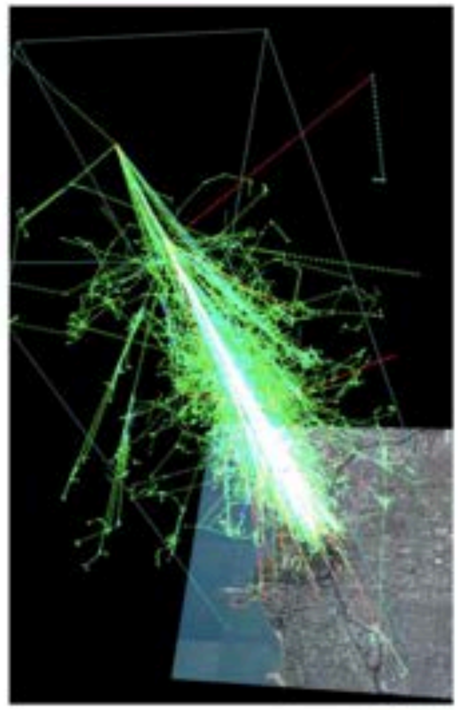
Those high-energy particles consist of atomic nuclei stripped of electrons called **Galactic Cosmic Rays (GCR)**. GCR are mostly protons and hydrogen nuclei, but other atomic nuclei such as iron, selenium, magnesium, oxygen, carbon and most other elements have been detected in various amounts.

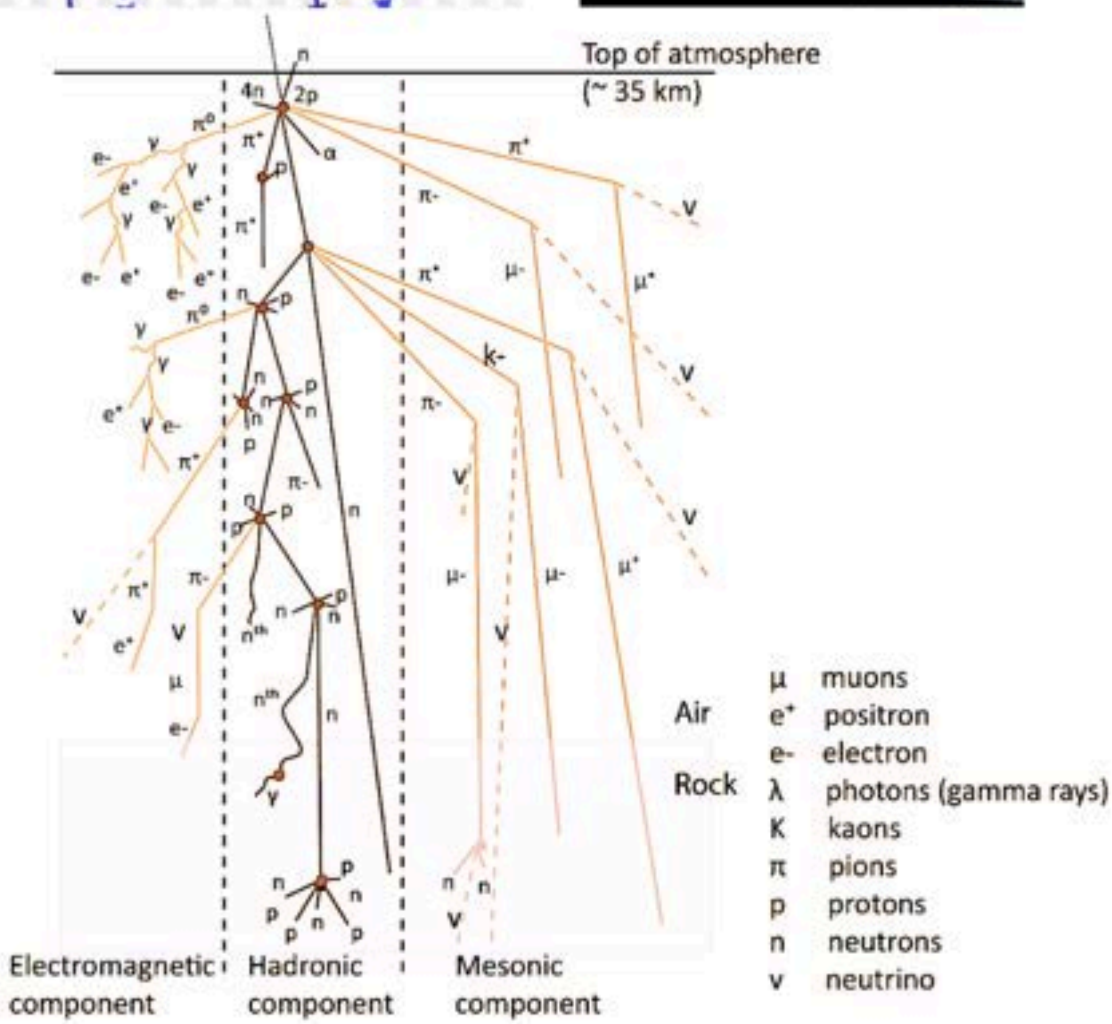
These particles vary in energy, and despite the fact that our magnetosphere blocks a great deal of them, enough still penetrate to strike every square meter of the upper atmosphere every second. The highest energy (and most penetrating) particles may only strike once per year in a square kilometer area, and those will reach the Earth's mantle or core. Lower energy GCR usually hit atmospheric particles.

Just one low energy GCR can shower a few acres with energetic particle cascades (image above). Now picture that one particle decay shower is accompanied by another starting at every square meter of the upper atmosphere, overlapping with one another every second; the ground level is constantly showered in the cascade.

In the images on the next page, we find depictions of the shower of particles from one GCR, called a “cosmic ray cascade”, with explanations on the following page. Images on the next page come from the HAWC Observatory (top left), PhysicsOpenLab.org (top right), and AntarcticGlaciers.org (bottom).


p
π-
π+
πν
γ
e-
e+
νμ
μ-
μ+
p = proton
μ = muon
π = pion
ν = neutrino
e+ = electron
e- = positron
γ = photon

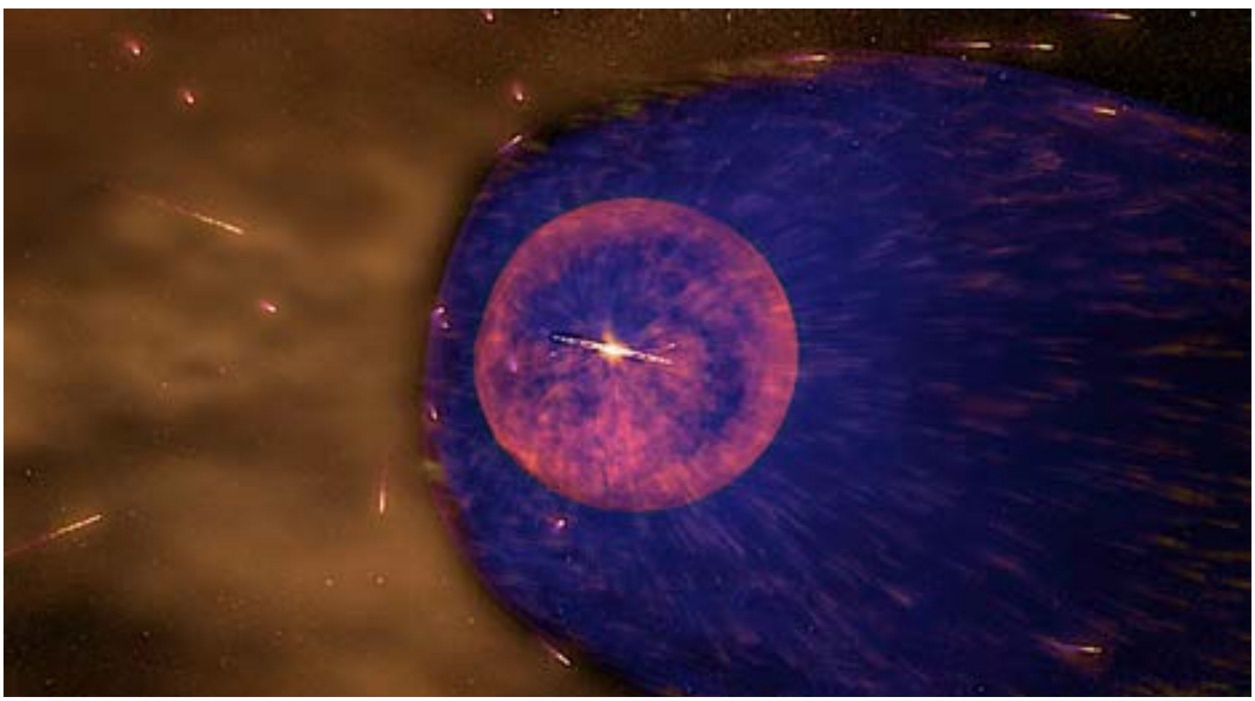



Top of atmosphere
(~ 35 km)
Air
Rock
Electromagnetic component
Hadronic component
Mesonic component
μ muons
e+ positron
e- electron
λ photons (gamma rays)
K kaons
π pions
p protons
n neutrons
v neutrino

There is not yet any standard means of describing the cascade effects (a confounding aspect of the field), which is why the annotation and charge symbols are not the same in the images on the previous page. Each of those massive lightning-looking breakouts of particles (cascades) starts with just one GCR hitting the upper atmosphere. If one were to similarly trace all the cosmic ray cascades at any given time you would not see anything else in the picture. Good news: most of the particles pass right through our bodies, harmlessly, about 33 times every second.

While it can seem scary, we all live inside of this cascade every day and have been doing so our entire lives. Despite their ubiquity in our existence, the variation of these GCR are able to affect numerous geophysical and biophysical processes. What causes these variations in GCR rates? The sun and Earth's magnetic field.

The Earth actually has two magnetic shields against cosmic rays: our planet's own magnetosphere, and the sun's magnetic field, called the "heliosphere". The solar wind electric field and IMF streaming out past Pluto protect the solar system just as Earth's magnetic field bubble protects our planet alone. **The GCR are charged (+ or -), so the IMF and electric field of solar wind act like a shield against the rest of the galaxy and the universe.**



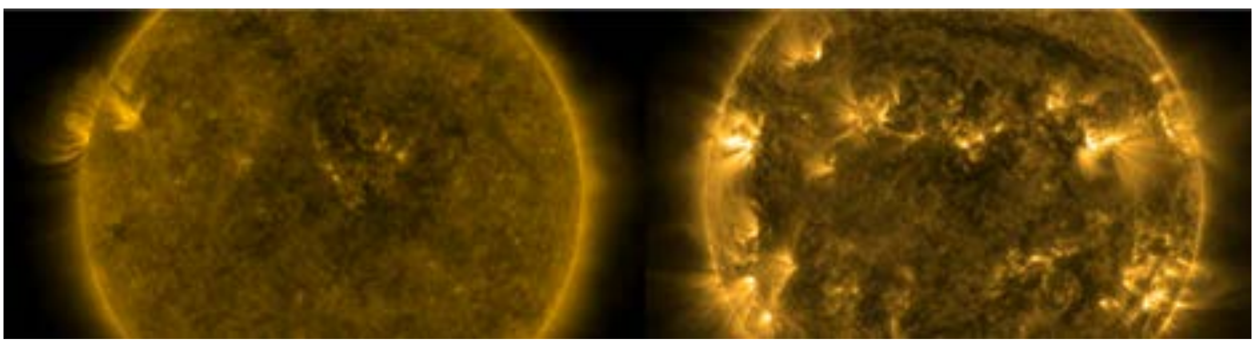
During times when solar activity (sunspots, solar flares, CMEs) is high, cosmic rays are low due to extra energy and particle shockwaves blocking them. During periods of a quiet sun, we see far more cosmic rays, as the electric field of solar wind becomes less dense and the IMF is less energized. This inverse relationship (anticorrelation) is entirely based on the premise with which we began: the important aspects of space weather are electromagnetic and involve how the sun's activity affects the solar wind. High solar activity enhances the solar wind, and therefore, enhances one of the shields against cosmic rays, and does so for the exact same electromagnetic reason that Earth's magnetosphere blocks energy from the sun.

On a short timescale, an event known as a "Forbush Decrease" exhibits this modulation. A Forbush decrease refers to the sudden drop in cosmic rays that occurs just before and during Earth-impact from CMEs.

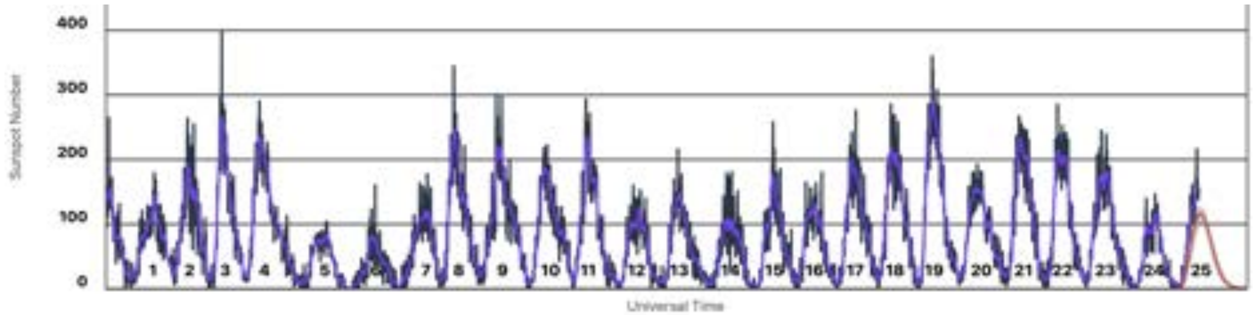
In the same way that the electric field of solar wind acts like an electromagnetic shield for the entire solar system, when intensified solar wind streams such as CMEs hit Earth, those streams help to block cosmic rays. Think of this like Earth technically being inside of a giant electromagnetic cloud (extra shielding) during CME impact, even if that cloud is having its own electromagnetic effects on our planet, like geomagnetic storms.

Solar Cycles

Solar cycles are fundamental to understanding space weather patterns and the effects they can have on our planet.



The most well-known and fundamental solar cycle is ~11 years long. It can range from 9 to 13 years and is often called the "sunspot cycle". There is a predictable rise and fall to sunspot activity, and therefore, a predictable rise and fall to solar flares, CMEs, SEP events, geomagnetic storms and cosmic ray activity. Over this ~11-year period, sunspots have a minimum and maximum of activity, which is depicted above in the left and right SDO images, respectively. In the images on the following pages, we see the undulation of the 11-year cycle on the sun over various timescales.



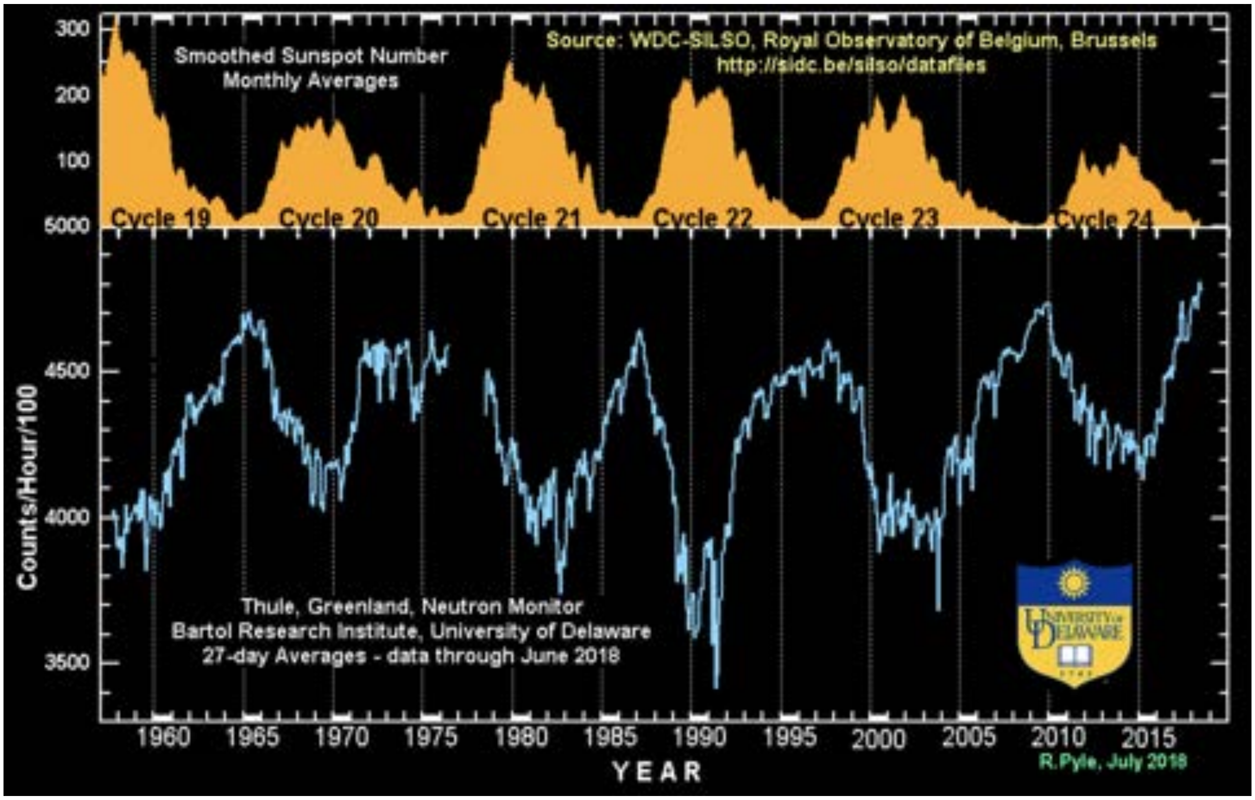
You can see in the previous image how the cycles are not always the same size, but they are approximately the same duration and distance apart, ~11yrs. It is called the sunspot cycle because for centuries the sunspot has been the central focus of space weather.

Patterns of solar flares, CMEs and geomagnetic storms rise and fall on the same cycle, but our ancestors knew little of their occurrence or effects apart from seeing the aurorae.

For a long time, this cycle was gauged with sunspot observations by reflection telescopes and horizon sunspot watching, which established the cycles that we can track in greater detail today.

We now have much more information about things such as coronal holes and plasma filaments, and even the radio wave output of the sun which matches the sunspot cycle. There are MANY ways we could in-fact gauge the sunspot cycle.

For cosmic rays, the curve over time is roughly the same, except it peaks when sunspots are at minimum, and drops into cosmic ray minimum when sunspots are more numerous at their maximum (anticorrelation). The chart on the next page shows how sunspots (orange) and cosmic rays (blue) have an inverse relationship.

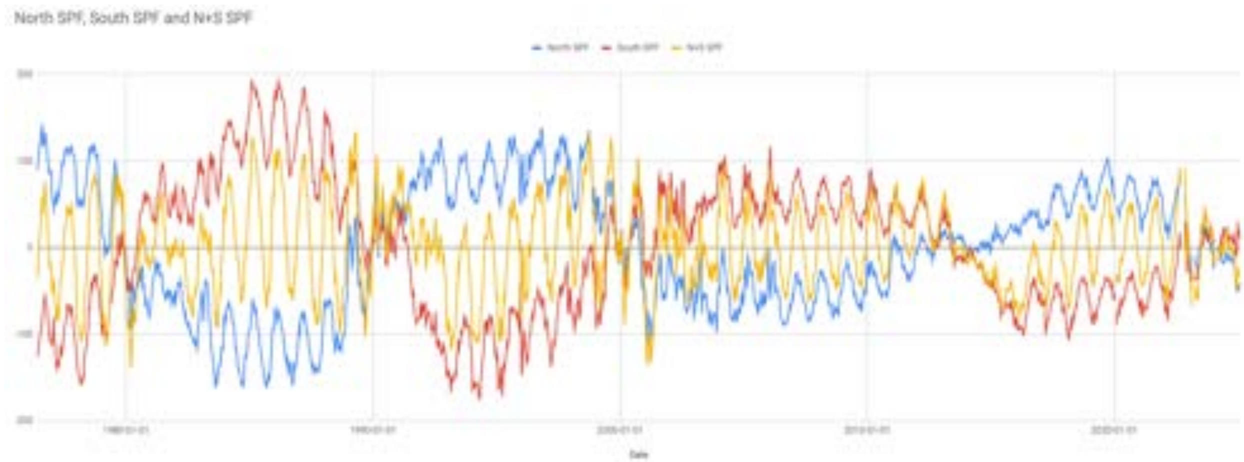


The more we learn about space weather, the more important cosmic rays seem to be to solar- terrestrial physics, and the more things that sunspots must compete with on the other side of the table. So, if cosmic rays peak opposite of sunspots on the same cyclical timeline, are there different ways to judge maximum and minimum of the cycle?

There is another feature on the sun that also follows a cycle opposite to sunspots; it matches the cosmic ray maximum/minimum phases and is considered the primary driver of sunspots and flare activity: **The Solar Polar Magnetic Fields (SPF)**. The SPF are interplanetary magnetic fields (IMF) just like other open solar magnetic fields streaming out into space, except the SPF are measured only from the high-latitude regions of our star.

The sun’s magnetic field reverses every sunspot cycle, with the north and south magnetic polarity switching hemispheres. This feature determines when one sunspot cycle begins and when it ends. Many of the world’s best solar physicists believe it also determines how many sunspots will come in a given cycle, and how active those sunspots will be.

The SPF determines where the coronal holes and plasma filaments are found (heliographic latitude), and what the character of the solar wind current sheet/IMF will be. The SPF are actually the driving force behind many of the solar phenomena discussed so far. The next image shows the SPF data from Stanford’s Wilcox Solar Observatory:



The curves reverse polarity (cross the 0 “baseline”) every ~11 years, triggering sunspot maximum. However, this is the minimum magnetism of the SPF, and also the GCR minimum. When the SPF are strong, so are GCR, but we are generally in sunspot minimum.

The blue curve is the northern field strength and red is the south. The short-duration waveform between the larger 11-year reversal waves are approximately one year long each. These shorter waveforms are caused by Earth’s slightly tilted orbit, putting us closer to one solar pole than the other each half of the year. In the northern spring we are slightly south of the solar equator and in northern autumn we are slightly north.

Since it is appropriate to consider the solar polar fields (SPF) to be the driving force behind the 11- year sunspot cycle, it is also the indirect driver of cosmic ray levels at earth- via that sunspot activity. As we will see later in this book, these fields not only drive actions on the sun, but are able to affect the Earth themselves.

Other well-known solar cycles include:

~28 Days: The length of one solar day (1 solar rotation). The polar regions turn a little slower (+30 days), and the equator can spin around in as fast as 25 days. We call this ‘differential rotation’ and it is depicted in the top-right image on the previous page.

~3/6 Months: Reiger cycle upticks in sunspot production, flaring, solar wind enhancement.

~6 Months: For reasons not-entirely understood, the Earth is more vulnerable to geomagnetic storms during the equinox than solstice periods. This could be due to the tilt of the earth's axis being most misaligned with the sun during the equinox.

~22 Years (Hale Cycle): As the sun’s polar magnetic fields reverse every ~11 years, a full magnetic cycle is two ~11-year cycles. Numerous other patterns have been discovered, such as the ‘even-odd’ rule; for unknown reasons, an odd-numbered solar cycle is usually stronger than the even-numbered cycle that came before it. This cycle appears often in long- term climate data as well, along with its harmonic cycles, many of which are listed below.

~80 - 88 Years (11/22-year harmonic): A well-known oscillation of solar activity over ~80 years is known to occur, often called the Gleissberg cycle. It is probably another harmonic of the sunspots/polar field cycles, with the variability due to the variability in the ~11-year cycle itself. This cycle is easily seen in radiocarbon data, with some evidence in the geomagnetic data and auroral records. This cycle also matches Uranus' orbital period of ~84 years, and since Jupiter's orbit is ~10-11 years, these types of coincidences are worth noting in your mental archive.

~200 Years: A much debated and often differently named cycle has been shown in radiocarbon data but is not easily noticeable over long-term sunspot reconstructions. However, a harmonic of this cycle can easily be seen in long-term sunspot data.

~400 - 440 Years (Grand Solar Cycle): Long- term reconstructions of sunspot data, over hundreds to thousands of years, look very similar to shorter-term data. This image is one such reconstruction from Ilya Usoskin, and it demonstrates how these peaks and troughs occur at quasi-regular intervals, even if their amplitude (height) varies a great deal. We saw that exact same pattern in sunspot numbers over the ~11-year cycle, in which regular cycles varied in strength but not in their duration (wavelength).

We will discuss cycles specific to solar super flaring later in this book.

Chapter 2

Global Warming

In this chapter, we review excellent reasons to begin to question the mainstream climate narrative:

- CO_2 may not have such a large impact on global temperatures.
- Modern global warming is not extreme at all.
- CO_2 is good, and so is warmer weather.
- Global warming might not be real.
- Warming actually triggers cooling via ice melt.

Reevaluating the Role of CO_2 in Climate Change

While the prevailing scientific consensus attributes recent global warming primarily to rising carbon dioxide (CO_2) levels, several studies suggest that CO_2 may not be the dominant factor influencing Earth's climate.

These alternative perspectives challenge the assertions of mainstream climate models and highlight the role of natural climatic forces such as solar activity, geomagnetic variations, and the magnitude of historical temperature fluctuations.

By analyzing long-term instrumental records, paleoclimate data, and modern temperature trends, these studies provide a more nuanced view of the factors driving climate change.

Studies have examined long-term temperature records and found that significant warming and cooling periods occurred well before the industrial era- recent temperature trends may not be solely attributable to anthropogenic CO_2 emissions (1).

The study analyzed both instrumental and reconstructed temperature data, demonstrating cyclical fluctuations that correspond more closely with natural climate variations than with rising CO_2 levels.

Another study further explored this issue by forecasting global temperature trends based on CO_2 emission scenarios. Their findings (and others) suggested that future warming may be less severe than commonly projected (2).

Instead, their analysis indicated that low-sensitivity models, which assign a reduced influence to greenhouse gas emissions, may offer more accurate projections of future temperature changes (2, 3).

Similarly, another study reviewed past glacial-interglacial cycles and concluded that CO_2 played a secondary role in driving historical climate shifts. By analyzing paleoclimate data, the study highlighted that solar activity and other natural variables were more influential in shaping Earth's temperature fluctuations over geological timescales (4).

A critical examination of climate modeling argues that some studies establishing causality between CO_2 and global temperature might be methodologically flawed. They suggested that statistical artifacts could create misleading correlations, reinforcing the need for a more rigorous evaluation of CO_2's true climatic impact (5).

Taken together, these studies challenge the assumption that CO_2 is the primary driver of global temperature changes. Instead, they emphasize the importance of considering natural climatic factors such as solar activity, geomagnetic variations, and how normal modern climate change is compared to historical temperature fluctuations.

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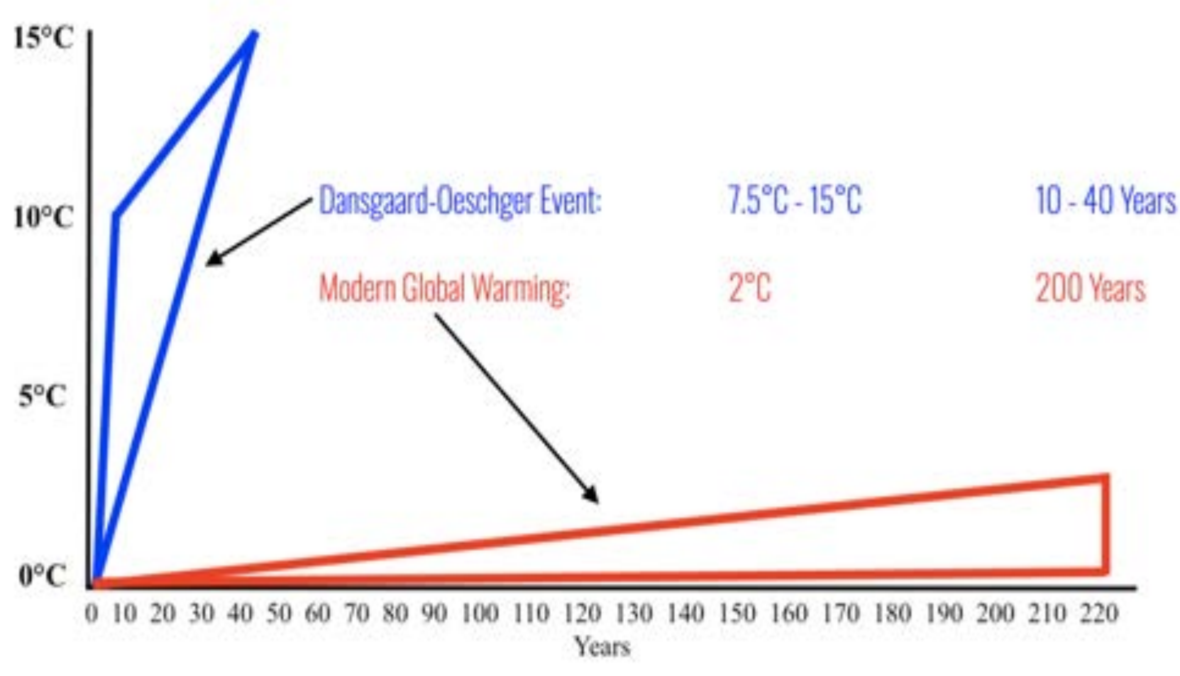
Modern Warming is Not Extreme

Paleoclimatic records indicate that “Dansgaard-Oeschger” (D-O) events caused temperature increases of up to 15°C, particularly in Greenland and the surrounding North Atlantic region (1). These estimates are derived from oxygen isotope ratios (δ18O) in ice cores, which serve as proxies for past temperature variations. High-resolution analyses from the North Greenland Ice Core Project (NGRIP) suggest δ18O changes of mostly around 5 to 8 per mil, corresponding to temperature increases between 7.5°C and 12°C, with some cases reaching the upper limit of 15°C (2,3).

The rapid nature of these shifts makes them a focal point for understanding abrupt climate change. One of the most remarkable aspects of D-O events is the speed at which they unfold. Initial studies suggested that these warming events occurred over several decades. However, more recent ice core data indicate that transitions could happen within 10 years, and in some cases, even faster (4, 5).

Some studies suggest that the most extreme warming phases may have taken place over 1 to 3 years, with certain records proposing significant changes occurring in under a year (6). The graphic below shows a comparison of D-O events and “modern global warming” - you can see that D-O events are far more extreme and happen more quickly.



Dansgaard-Oeschger events provide crucial insights into the potential for rapid and extreme climate change. With temperature swings of up to 15°C and transitions occurring within as little as 10 years—or possibly even faster—these events challenge the assumption that climate change always occurs gradually.

The connection between D-O events and oceanic circulation shifts highlights the importance of understanding feedback mechanisms that could drive abrupt climate shifts in the future. Most importantly, they frame modern global warming in its proper, non-frightening place.

Earth has warmed 1 or 2 degrees in over a century. D-O events can produce 3x to 15x the changes in less than 10% of the time. Modern warming is not extreme by any comparison to numerous events that were entirely natural in origin.

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CO2 is Good, and So is Warmer Weather

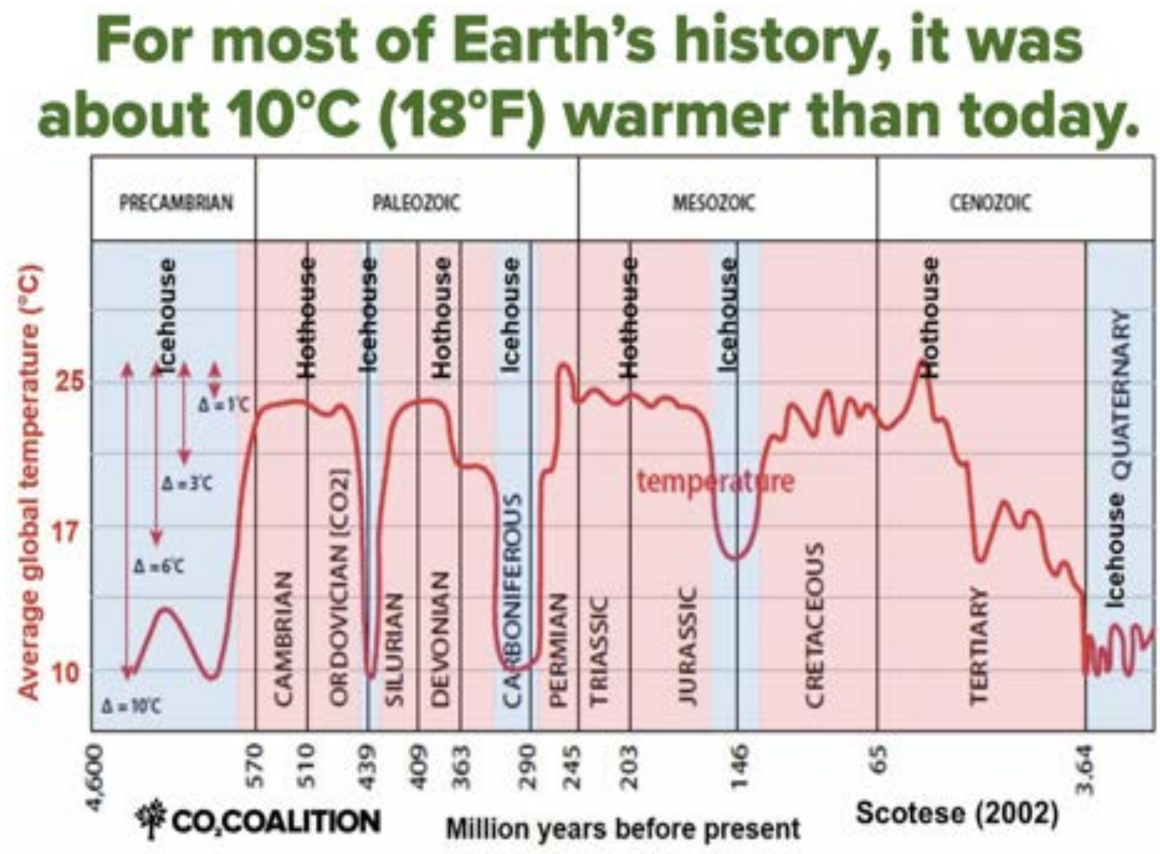
Carbon dioxide (CO2) and elevated temperatures have historically played a vital role in fostering life on Earth. Contrary to the prevailing view that rising CO2 levels pose an existential threat, evidence from paleoclimate records and plant physiology suggests that higher CO2 concentrations and warmer temperatures can be beneficial for ecosystems and biodiversity.

CO_2 is an essential component of photosynthesis, the process through which plants convert sunlight into energy. The current atmospheric CO_2 concentration, approximately 420 parts per million (ppm), is significantly lower than historical levels. **It is not an overstatement to suggest that plants have been near starvation on earth for the last 4 million years.** During the Cambrian and Devonian periods, when plant life proliferated, CO_2 levels exceeded 4,000 ppm (1).

Studies have shown that when CO_2 drops below 150 ppm, most plant life struggles to survive, and at levels below 100 ppm, photosynthesis ceases, leading to widespread plant death and a potential collapse of the food chain (2). Thus, from a biological perspective, higher CO_2 levels provide a buffer against the starvation of plant life, ensuring robust agricultural productivity and the survival of wild ecosystems.

Paleoclimatic evidence indicates that Earth's warm periods have been associated with explosions of biodiversity. The Mesozoic era, often referred to as the "Age of Dinosaurs," saw CO_2 levels reaching between 1,000 and 2,500 ppm, alongside global temperatures significantly higher than today (3).

During this time, plant and animal life flourished, with lush forests covering the planet and an abundance of megafauna. This suggests that elevated CO_2 and warmth are not inherently detrimental but rather have historically coincided with periods of high biological productivity and evolutionary advancement (4).



Moreover, increased CO2 levels enhance plant growth efficiency. Studies demonstrate that elevated CO2 concentrations improve water-use efficiency by reducing stomatal conductance, which decreases transpiration loss and allows plants to thrive in arid environments (5).

This mechanism is particularly crucial in regions facing desertification, as higher CO2 can mitigate water stress and promote vegetation expansion (6). Additionally, many crops exhibit increased yields under elevated CO2, providing a potential solution to global food security challenges (7, 8). If the math in this study is correct, higher CO2 (1000 ppm) would prevent approximately 15% of the current earth deserts from stagnating in their arid, plant-less condition.

Warmer temperatures, if correlated with increased CO2, would also be beneficial. Higher temperatures extend growing seasons in temperate regions, reduce frost damage, and expand the habitable range of various species (9).

In past interglacial periods, biodiversity flourished due to milder climates, fostering ecological richness. Conversely, colder periods, such as the Little Ice Age (circa 1300–1850 AD), were associated with widespread crop failures, famine, and societal disruptions (10).

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Modern Warming Might Not Be Real

John Shewchuk, active on X under the handle @_ClimateCraze, has brought attention to what he calls "NOAA ghost stations"—weather stations that he claims are no longer operational yet continue to have data reported or adjusted by the National Oceanic and Atmospheric Administration (NOAA).

Independent peer-review (by this author) has demonstrated he appears to be correct. Essentially they are just “making up the data.” He further asserts that this practice affects a significant portion of U.S. climatological temperature data, with nearly half potentially being fabricated. This raises concerns about the removal of weather stations and the reliance on modeled data, which, at the very least, is potentially problematic for several reasons.

NOAA, through its U.S. Historical Climatology Network (USHCN), manages a dataset of temperature records from weather stations across the United States, many of which are part of the Cooperative Observer Program (COOP) Network.

Over time, some of these stations have been decommissioned—meaning they no longer physically exist or collect data—due to factors like budget cuts, technological upgrades, or site-specific issues. Critics, including meteorologist John Shewchuk, have claimed that NOAA continues to report temperature data for these "ghost stations," suggesting that the agency fabricates or estimates this data rather than relying on actual measurements.

Based on the available evidence, **NOAA does indeed use estimated or modeled data for decommissioned stations** to maintain continuity in their climate records. This practice is called interpolation, and is inferred from several key points:

NOAA generates temperature readings for decommissioned stations like USHCN No. 82850 (Everglades) and USHCN No. 121229 (Cambridge City, Indiana). This data is often marked with an "E" to indicate it is estimated, suggesting NOAA uses computer models or data from nearby stations to fill in these gaps.

In climate science, it’s common to estimate missing data to ensure long-term records remain usable for trend analysis. Data from nearby operational stations is often used to interpolate or model what the decommissioned station might have recorded. The problem is that, again, they aren’t actual measurements of reality.

One major issue is the potential lack of transparency in NOAA's data practices. If NOAA is using modeled or estimated data to represent readings from decommissioned stations without explicitly labeling it as such, it risks misleading those who depend on this information.

For example, if a ghost station’s data is interpolated from a station miles away with different microclimatic conditions, the result might not reflect the true state of the original location. Such inaccuracies could ripple through climate models, affecting forecasts and research outcomes.

The potential problems extend beyond science into real-world impacts. If modeled data from ghost stations distorts our understanding of temperature trends, it could lead to flawed climate models. This is amplified by the urban heat island effect. The urban heat island (UHI) effect describes the tendency for cities to be significantly warmer than their surrounding rural areas, mainly due to human alterations of the landscape (1).

The loss of trees and greenspace means less shade and evapotranspiration cooling, so there is reduced natural heat dissipation in cities (2). Urban design factors also contribute: densely built city geometries trap heat by blocking wind flow and reducing nighttime heat loss, and waste heat from vehicles, industry, and air conditioning units further warms the urban atmosphere (2). Studies have found that higher urban air temperatures significantly increase electricity demand – one review noted that the UHI (along with global warming) could nearly **double** the cooling energy use of buildings in some cities (3).

During extreme heat events, the UHI effect further **amplifies** conditions by keeping nighttime temperatures high, so heat waves become even more intense in urban areas (4). Finally, several studies raise significant concerns over data reliability overall (5, 6) and if those UHI-impacted stations are used for interpolation, then it spreads this false warming into rural areas.

In short, yes, NOAA Ghost stations are real. You can learn much more at John's X page, and in his publications about the ghost stations, like this one which is recent as of early 2025: http://www.climatecraze.com/doc/GhostStations77.pdf. This is problematic, and made worse by the fact that "nearby" stations are increasingly subject to the urban heat island effect. These two facts call into question a measurable portion of temperature data.

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Actually, There is Another Problem With The Data

Adjustments to historical temperature records by climate science organizations such as NOAA (National Oceanic and Atmospheric Administration) and NASA (National Aeronautics and Space Administration) are routine practices performed to account for inconsistencies, biases, and changes in data collection methods over time.

Primary reasons for these adjustments include correcting for shifts in station location, modifications in instrumentation, changes in observation practices, and urban heat island effects that can artificially influence temperature records (1). For example, a weather station initially situated in a rural area might become surrounded by urban infrastructure over decades, causing temperatures to artificially rise. Adjustments are therefore applied to ensure data accurately reflect true climatic changes rather than artificial biases (2).

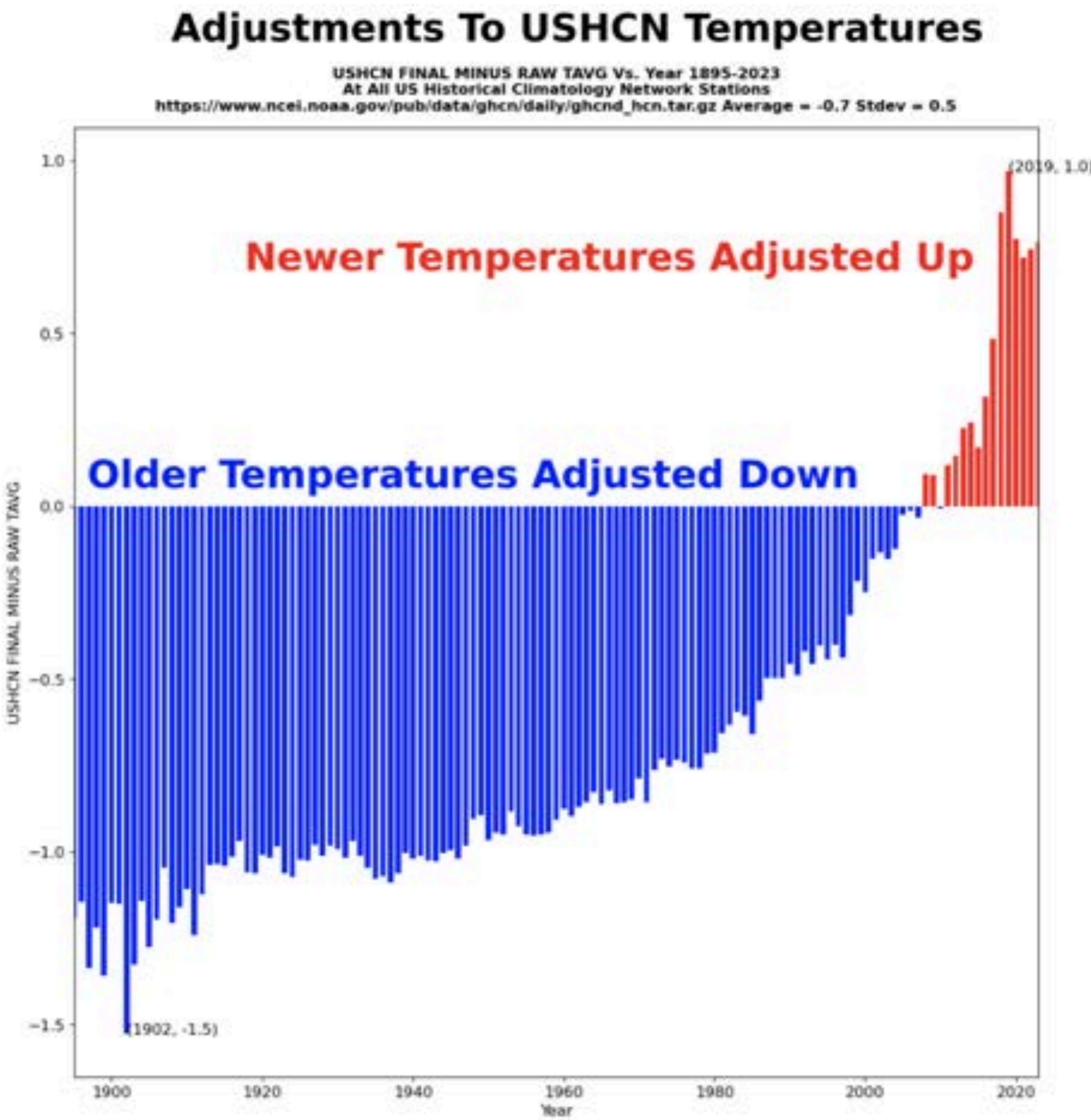
Critics such as Tony Heller, however, assert that these adjustments are intentionally applied to exaggerate warming trends to align with a global warming agenda. Heller and similar critics frequently point to examples such as NOAA's revisions to historical temperature data for U.S. states, arguing that the original unadjusted records show earlier decades, like the 1920s or 1930s, to be warmer or comparable in temperature to modern times.

They contend that repeated adjustments tend to cool historical records and warm recent data points, thus artificially enhancing apparent trends of warming over the past century (3). Heller specifically mentions cases such as Texas, where he claims that NOAA's adjustments altered the state's original temperature records from 1921 downward (cooler); it was formerly a notably hot year but now has been altered to strengthen contemporary warming narratives.

Mainstream climate scientists, however, emphasize the robust scientific rationale behind adjustments, citing transparency in methods and peer-reviewed validation of their processes. They argue that adjustments are necessary due to documented issues such as changes in measuring instruments, observation times, station relocations, and urban heat island effects, which would otherwise skew climate records (4). Nevertheless, critics continue to voice concern over the magnitude and frequency of adjustments, questioning the reliability and transparency of the data manipulation.

They advocate for open access to raw, unadjusted datasets and improved clarity regarding adjustment rationales. Transparency and open dialogue about methodologies and reasoning behind adjustments are important to maintain public trust in climate science. As such, ongoing debates surrounding the legitimacy and transparency of temperature data adjustments highlight the need for continued openness, communication, and methodological scrutiny within the scientific community (5).

One thing is certain, when you see Heller’s charts of the before-and-after of the adjustments it is pretty shocking how much the “warming” appears to be amplified. Here is one example:



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This is a Lot To Ignore

Significant temperature fluctuations occurred before industrialization, driven by solar and natural forces rather than CO_2. The low-sensitivity climate models, which downplay CO_2's role, better match observed trends. Paleoclimate data, including Dansgaard-Oeschger events with rapid 15°C spikes over decades or less, dwarf modern warming of 1-2°C over a century, framing it as neither extreme nor unprecedented.

Furthermore, research shows CO_2 has little effect on thermospheric temperature, questioning its assumed dominance at the surface. On the flip side, higher CO_2 and warmer climates are shown to boost plant growth, water efficiency, and biodiversity, as seen in thriving ecosystems during past warm periods like the Mesozoic with CO_2 levels up to 4,000 ppm.

Adding to the debate, critics like John Shewchuk point to NOAA's "ghost stations"—decommissioned sites with estimated data—potentially skewed by urban heat island effects, while Tony Heller argues historical temperature adjustments exaggerate modern warming. Taken together, these findings call for a reassessment of CO_2's role, emphasizing natural drivers and data integrity over a CO_2-centric narrative, urging more transparent and nuanced climate science.

but…

Let's Pretend CO2 is Causing Warming At Scary, Record Levels:

Heating causes cooling. The Earth's climate history reveals that warming can paradoxically lead to cooling through ice-sheet destabilization and freshwater-induced climate shifts. Heinrich events are prime examples.

These events were characterized by massive discharges of icebergs from the Laurentide Ice Sheet into the North Atlantic, typically following periods of gradual warming (1). The melting icebergs released vast amounts of freshwater, disrupting ocean circulation and reducing northward heat transport, triggering widespread cooling (2). This feedback mechanism, where warming leads to ice-sheet collapse and subsequent cooling, is well-documented in paleoclimate records.

One key driver of this process is the influx of freshwater into the North Atlantic, which reduces the salinity and density of surface waters. This prevents the normal sinking of cold, salty water that drives deep-ocean circulation, leading to a slowdown in heat transport and cooling across the Northern Hemisphere (3).

Heinrich Event 1 (~17,000 years ago) is particularly well-studied, with evidence from sediment cores showing that freshwater input weakened ocean circulation and expanded sea ice, reinforcing the cooling (4). Similar mechanisms played a role in the Younger Dryas (~12,800 years ago), when meltwater from retreating ice sheets abruptly reversed warming trends, causing temperatures in the North Atlantic region to drop by several degrees within decades (5).

The climatic impact of these events extended beyond the North Atlantic. Cooling in the Northern Hemisphere altered atmospheric circulation, shifting the tropical rain belts southward and causing drought in monsoon-dependent regions like Africa and Asia (6).

Meanwhile, the "bipolar seesaw" effect caused a relative warming of the Southern Hemisphere, as heat accumulated in southern waters rather than being transported northward (7). These shifts illustrate how localized warming-induced ice melt can propagate global cooling effects through complex climate feedbacks.

These past climate shifts provide insight into the delicate balance between warming and cooling mechanisms. While modern climate conditions differ from those of the last ice age, the fundamental physics remain the same. As polar ice continues to melt, understanding these feedbacks is crucial for predicting future climate variability. Historical evidence suggests that rapid ice loss can lead to abrupt and unexpected climate shifts, reinforcing the need for continued monitoring of polar regions and ocean circulation patterns (8).

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The Cold Hammers of the Process: AMOC

The Atlantic Meridional Overturning Circulation (AMOC) is a critical component of Earth's climate system, responsible for transporting warm surface waters northward and returning cold deep waters southward. This circulation plays a pivotal role in regulating global climate patterns, particularly influencing the mild climate of Western Europe. Recent studies have raised concerns about the potential weakening or collapse of the AMOC due to anthropogenic climate change, which could trigger substantial climatic shifts, including regional cooling events (1).

Paleoclimatic records indicate that past disruptions of the AMOC have led to abrupt climate changes. For instance, during the last ice age, Heinrich events—periods characterized by massive discharges of icebergs into the North Atlantic—resulted in significant cooling in the Northern Hemisphere (2).

These events were associated with a weakened AMOC, leading to reduced heat transport and subsequent temperature declines. Similarly, the Younger Dryas period, approximately 12,800 years ago, saw rapid cooling attributed to a slowdown in the AMOC caused by freshwater influx from melting ice sheets (3). These historical precedents suggest that significant alterations in the AMOC can induce major cooling events (4).

Another study employed machine-learning techniques to predict the potential collapse of the AMOC. The researchers utilized synthetic and empirical data to forecast a possible collapse window spanning from 2040 to 2065, aligning with other projections in the current literature (4). This approach underscores the utility of advanced computational methods in anticipating critical climate tipping points.

The potential consequences of an AMOC collapse have been popularized in the 2004 film *The Day After Tomorrow*, which depicts a series of extreme weather events leading to a new ice age as a result of disrupted ocean currents. While the film's portrayal is dramatized, it brings attention to the critical role of oceanic circulations like the AMOC in regulating Earth's climate.

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The Cold Hammers of the Process: Beaufort Gyre

Paleoclimate evidence shows that sudden influxes of freshwater into the North Atlantic can weaken ocean circulation and induce rapid cooling. One prime example is the Younger Dryas, when a massive meltwater pulse from the retreating Laurentide Ice Sheet flooded into the North Atlantic. This freshwater surge sharply reduced North Atlantic Deep Water formation and slowed the ocean heat transport, triggering a return to near-glacial conditions in the Northern Hemisphere (1).

Another abrupt cooling, the 8.2 ka event, occurred ~8200 years ago when an ice-dammed glacial lake drained into the Labrador Sea (2). The resulting freshwater influx weakened the Atlantic Meridional Overturning Circulation (AMOC), cutting down northward heat transport and cooling Greenland by over 2 °C for about 160 years (2). These past events illustrate the climate's sensitivity to freshwater forcing, with regional cooling spreading across much of the North Atlantic and beyond.

Today, the Beaufort Gyre in the Arctic Ocean has become the largest Arctic freshwater reservoir, increasing its liquid freshwater content by ~40% over the last two decades (3). Scientists warn that if this excess freshwater is released suddenly (for example, due to shifting winds or ice loss), it could freshen the upper North Atlantic Ocean, weaken deep convection, and slow the AMOC (3).

Notably, a similar but smaller release of Beaufort Gyre water in the 1980s caused a strong freshening in the western Labrador Sea (3), suggesting that a release of the much larger current volume could have even greater cooling impacts. Model simulations indicate that a rapid

Beaufort Gyre outburst (around 0.02 Sv of freshwater) could lower Labrador Sea surface salinity by up to ~0.4, enough to significantly hinder deep water formation (3).

Such an event would likely induce regional cooling across the North Atlantic (potentially akin to the Great Salinity Anomaly of the 1970s) and could even dampen northern hemispheric warming for a period, representing a real future climate risk (3).

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Summary:

This chapter challenges the mainstream view that carbon dioxide (CO_2) is the dominant driver of climate change, and that modern warming is catastrophic and out of control. It also presents significant concerns about the modern state of climate science, and the cold future.

Reevaluating the Role of CO_2 in Climate Change

- Major warming and cooling cycles occurred before industrial CO_2 emissions. Low sensitivity models (less scary) are far more successful. Solar activity is shown to have played a more significant role than CO_2 in past climate shifts. Potential statistical artifacts that could exaggerate the influence of CO_2 have been identified.

Modern Warming is Not Extreme

- Paleoclimate records of Dansgaard-Oeschger (D-O) events show temperature spikes up to 15°C, much larger and more rapid than modern warming, within a decade or less; Modern warming of 1–2°C over a century is minor compared to past natural climate fluctuations.

CO_2 is Good, and So is Warmer Weather

- Past CO_2 levels exceeding 4,000 ppm supported lush ecosystems. When CO_2 drops below 150 ppm, plant life struggles, and at 100 ppm, photosynthesis ceases. Warmer periods, such as the Mesozoic, were associated with biodiversity expansion, challenging the notion that warming is inherently harmful. Increased CO_2 improves plant water efficiency and crop yields, particularly in arid environments. Cold periods like the Little Ice Age led to widespread famine and societal stress.

Modern Warming Might Not Be Real

- NOAA uses data from "ghost stations" to estimate temperatures, raising concerns about data accuracy. The urban heat island effect exaggerates warming trends, and impacts ghost station data. Critics argue that NOAA's data adjustments are artificially amplifying warming trends by cooling past records and warming recent ones.

Heating Causes Cooling

- Warming can trigger cooling through ice-sheet destabilization and freshwater disruptions, as seen in Heinrich events and the Younger Dryas. Freshwater influxes weaken deepwater formation and slow heat transport, leading to abrupt regional cooling.

The Cold Hammers of the Process: AMOC & Beaufort Gyre

- The AMOC, responsible for heat distribution, has weakened in the past due to ice melt, triggering rapid cooling events. Modern studies warn that AMOC weakening could lead to abrupt climate shifts, echoing past cooling events such as the Younger Dryas. The Beaufort Gyre in the Arctic stores large amounts of freshwater, and a sudden release could freshen the North Atlantic, weakening ocean circulation and inducing cooling.

Chapter 3

The Sun Signature in Atmospheric Dynamics

In this chapter, we will learn about how solar energy works large-scale oscillations and systems:

- The biggest problem with “solar forcing” in climate science.
- Hadley cells, Walker circulation, atmospheric pressure.
- ENSO, PDO, NAO and other oscillations and modes.

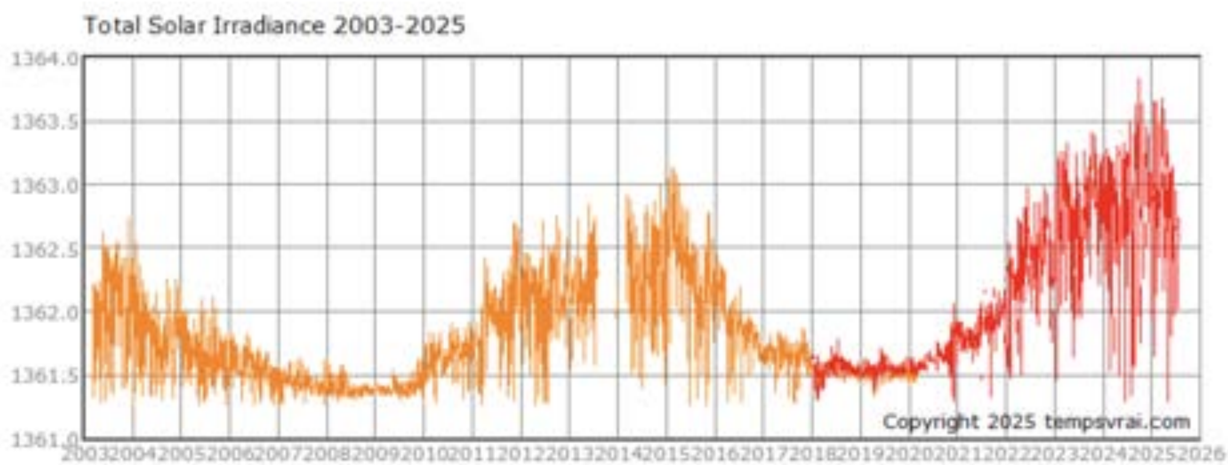
How Climatologists Ignore the Sun

Total Solar Irradiance (TSI) has long been the primary metric used to assess the Sun's influence on Earth's climate, but its limitations have led to incomplete and potentially misleading interpretations of solar forcing. While TSI varies by only ~0.1% over an 11-year solar cycle, the Sun's impact on Earth extends beyond this steady radiative UV output, including spectral variability, energetic particle emissions, and geomagnetic interactions that are left out of climate models.

Case studies—including the Halloween Storms of 2003 and the September 2017 solar storms—demonstrate how TSI paradoxically decreases during some of the most intense solar outbursts, missing significant non-radiative energy injections into Earth's atmosphere. These events, despite their substantial impacts on the ionosphere, stratosphere, and regional climate patterns, are largely invisible in TSI-based climate assessments.

Total Solar Irradiance (TSI) is defined as the total electromagnetic energy from the Sun incident at the top of Earth's atmosphere at 1 AU, averaged over all wavelengths and over a spherical Earth. Continuous satellite monitoring since 1978 shows TSI averages about 1361 W/m² and varies by only ~0.1% (~1.3 W/m²) between the minimum and maximum of recent 11-year solar cycles. This small variability has led climate assessments (e.g., IPCC reports) to treat solar radiative forcing as a minor, nearly constant influence compared to rising anthropogenic greenhouse gases. TSI is often used as the sole solar input in climate models.

During extreme solar events, TSI can paradoxically decrease even as the Sun unleashes intense energy in other forms. During solar flares, the ejection of plasma can block the UV light and cause a "solar dimming" drop in TSI, but during these events, the Sun emits bursts of X-rays and EUV that heat Earth's upper atmosphere. The Sun also affects Earth via particles and fields. Major solar eruptions launch coronal mass ejections (CMEs) and accelerate solar energetic particles (SEPs) to near-relativistic speeds.



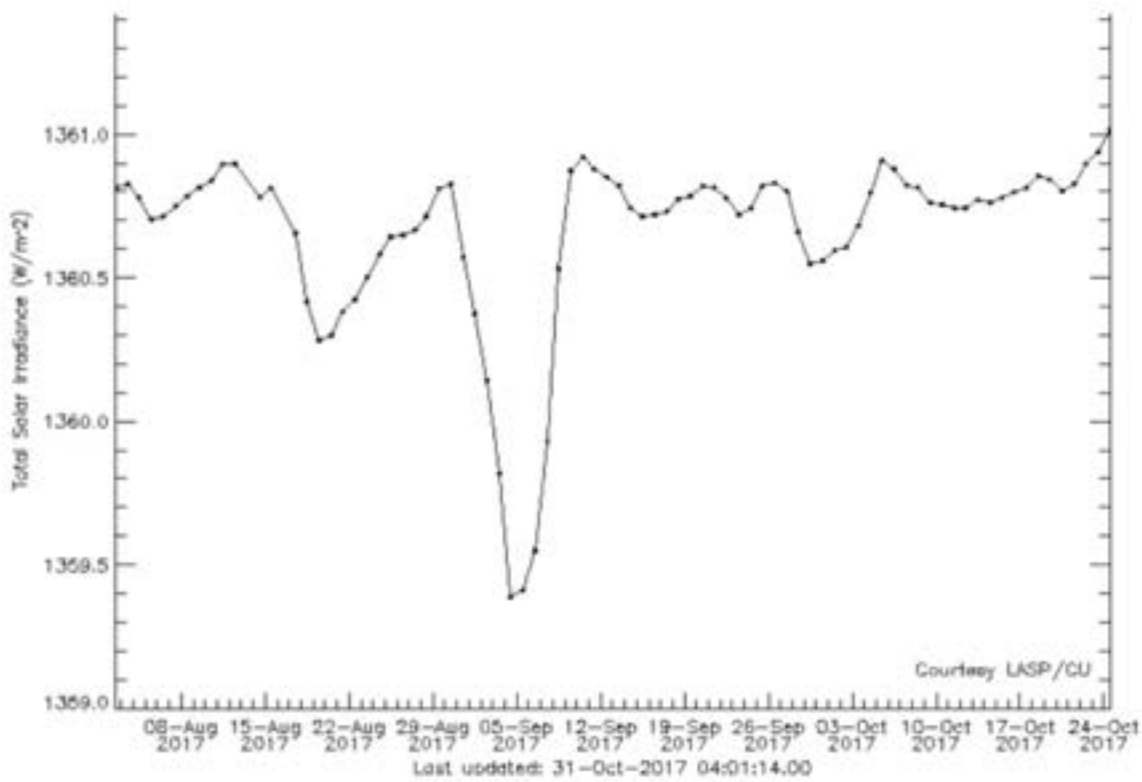
When these reach Earth, they do not register in TSI (which measures sunlight, not solar wind or particles). Instead, they disturb Earth's magnetosphere and atmosphere through geomagnetic storms, auroral currents, and atmospheric ionization. Similarly, the Sun's variable magnetic activity modulates the flux of galactic cosmic rays (GCRs) reaching Earth- another pathway entirely missing from TSI. In summary, TSI ignores all solar forcing that is not purely radiative, including charged particle precipitation, magnetic field coupling, and associated chemical/climate effects.

EUV and X-ray flux (10–120 nm) is even more variable and is key for the thermosphere and ionosphere. Solar flares cause massive spikes in EUV/X-ray output – often a tenfold or greater increase in X-ray irradiance in minutes. SORCE's X-ray Photometer System (XPS) instrument showed that during the strongest flares of Solar Cycle 23 (e.g., the X17 and X28 flares in

Oct–Nov 2003), the surge in XUV irradiance far exceeded the normal solar-cycle variation at those wavelengths in a matter of days.

In other words, a single large flare can insert more short-wave energy into the upper atmosphere than the entire 11-year change from solar minimum to maximum for TSI wavelengths. Under TSI, it shows a drop in solar energy, so the correlations are missed, and the actual (real) effects are attributed to anthropogenic sources.

This also happened during powerful flares and geomagnetic storms in 2017. In the next image, we see the TSI readings during this event dropping significantly, when in fact it was a tremendous influx of X-ray and solar wind particle energy to earth. According to TSI, the sun dropped its output, but in fact it delivered 10 to 100 times the normal energy in various ways. The effects of this energy are currently attributed to anthropogenic activity in models that utilize TSI for solar forcing.



Solar Energetic Particles (SEPs) are high-energy protons and other ions ejected by solar flares and CMEs. When these particles bombard Earth's atmosphere (especially near the poles, where the geomagnetic shield funnels particles in), they ionize atmospheric constituents and trigger chemical reactions. SEP events represent a direct injection of energy and charged particles into the middle and upper atmosphere, constituting a form of solar forcing entirely independent of solar irradiance.

Over-reliance on TSI as the sole solar forcing metric in climate studies can lead to an underestimation of the Sun's role in climate variability and a potential bias in attribution toward anthropogenic causes.

For instance, IPCC AR5 adopted a low or zero trend in solar irradiance since ~1950, and assigned a tiny radiative forcing of about +0.05 W/m² for solar increase from 1750 to 2011 (compared to ~+2.3 W/m² from well-mixed greenhouse gases). This leads to the incorrect conclusion that solar contribution to late 20th century warming is negligible.

The Sun Impacts Atmospheric Pressure, Walker Circulation, Hadley Cells

When the Sun is active it heats the upper atmosphere, and there can be rapid changes to large-scale circulations and systems, with modulation of air pressure, affecting jet streams and even leading to extreme weather events like cold snaps and major storms.

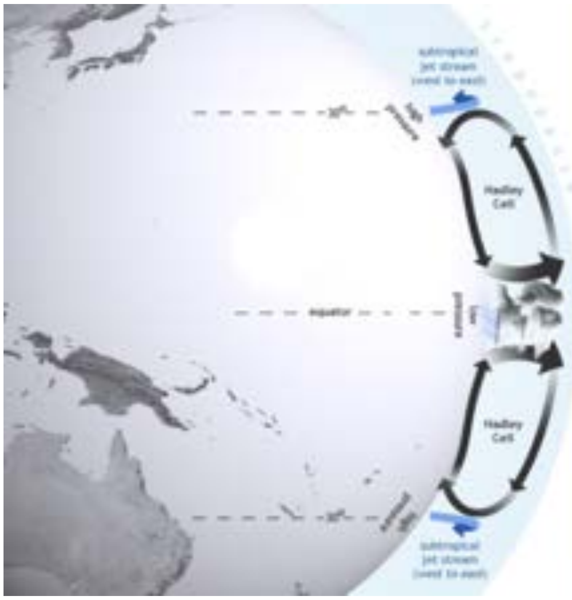
Here are some key details:

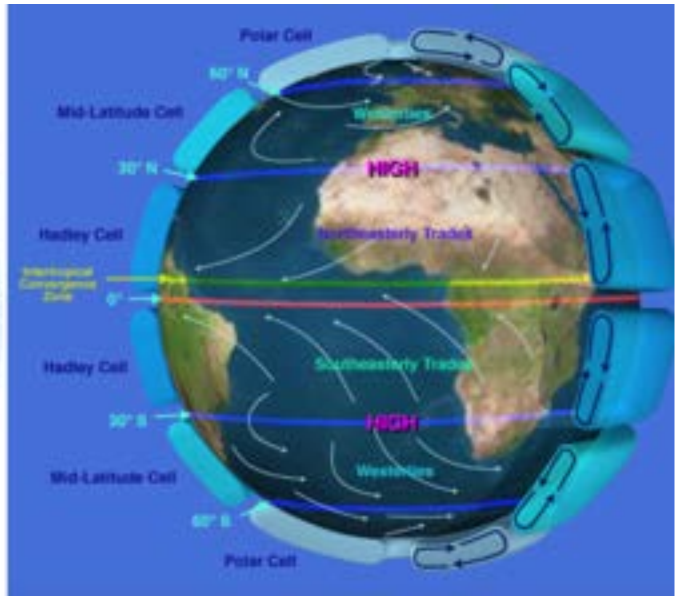
Solar activity plays a fundamental role in modulating atmospheric pressure systems, particularly through its influence on the Hadley cells and Walker circulation. Variability in total solar irradiance (TSI), the interplanetary magnetic field (IMF), and solar wind events such as coronal hole streams and coronal mass ejections (CMEs) have been shown to directly impact long-term surface pressure at high latitudes, particularly in the Arctic and Antarctic regions (1).

These effects propagate into the troposphere, where increased solar activity enhances stratospheric heating, leading to an expansion of the Hadley cells and a strengthening of surface pressure gradients (2). This expansion alters the subtropical jet stream, reinforcing trade winds and modifying moisture transport (3). Conversely, solar minima suppress the Aleutian low, shifting it eastward and enhancing Northern Pacific high-pressure systems, which significantly alters North American rainfall patterns (4).

The modulation of the Intertropical Convergence Zone (ITCZ) during millennial-scale solar minima has been linked to the southward migration of polar air masses, contributing to cooling over northern continents while simultaneously confining tropical storm systems (5). This strengthens the subtropical highs, reinforcing trade winds and modulating global precipitation patterns (6). High-speed solar wind and solar energetic particle (SEP) events have also been shown to intensify convective activity within the Hadley system, amplifying atmospheric electrical activity and impacting cloud microphysics (7).

Conversely, solar minima contract the Hadley cells, allowing colder air to penetrate further equatorward, leading to increased winter severity in mid-latitudes (8). The synchronization of Hadley and Walker circulation shifts due to solar forcing is a key factor in regional climatic variability, particularly in monsoonal regions (9).





Walker circulation, the primary mechanism of zonal atmospheric flow in the equatorial Pacific, exhibits pronounced responses to solar variability. Short-term fluctuations in solar radiation, particularly during geomagnetic storms and CMEs, induce rapid changes in surface pressure, modifying the intensity of the Walker circulation (10). These effects are most pronounced during declining phases of the solar cycle, when geomagnetic activity peaks and enhances tropospheric coupling (11).

Solar activity also plays a role in modulating pressure anomalies through the global electric circuit. High-speed solar wind events, which frequently occur during solar maxima, have been shown to induce positive anomalies in surface pressure across the Northern Hemisphere by altering the atmospheric electrical field and enhancing ionization processes (12). These effects extend beyond the immediate influence of the Hadley and Walker circulations, affecting regional pressure cells such as the Siberian High and Aleutian Low (13). Observational data suggest that the influence of the Sun on surface pressure is most pronounced during years of high geomagnetic activity, supporting the hypothesis that solar-magnetic interactions play a significant role in modulating lower atmosphere dynamics (14). Much more will come later on the global electric circuit.

The observed correlations between solar activity and large-scale circulation patterns indicate that external solar forcing is a fundamental driver of atmospheric variability. The 11-year solar cycle, along with longer-term variations in solar output, provides a consistent mechanism for modulating pressure gradients, convective cells, and zonal flow across multiple spatial and temporal scales (15). The solar influence on these atmospheric processes is further reinforced by stratosphere-troposphere coupling, which acts as a conduit for energy transfer from the upper atmosphere to surface climate systems (16). This highlights the necessity of integrating solar forcing into climate models to accurately capture the dynamic interactions between solar variability, atmospheric circulation, and regional climate patterns (17).

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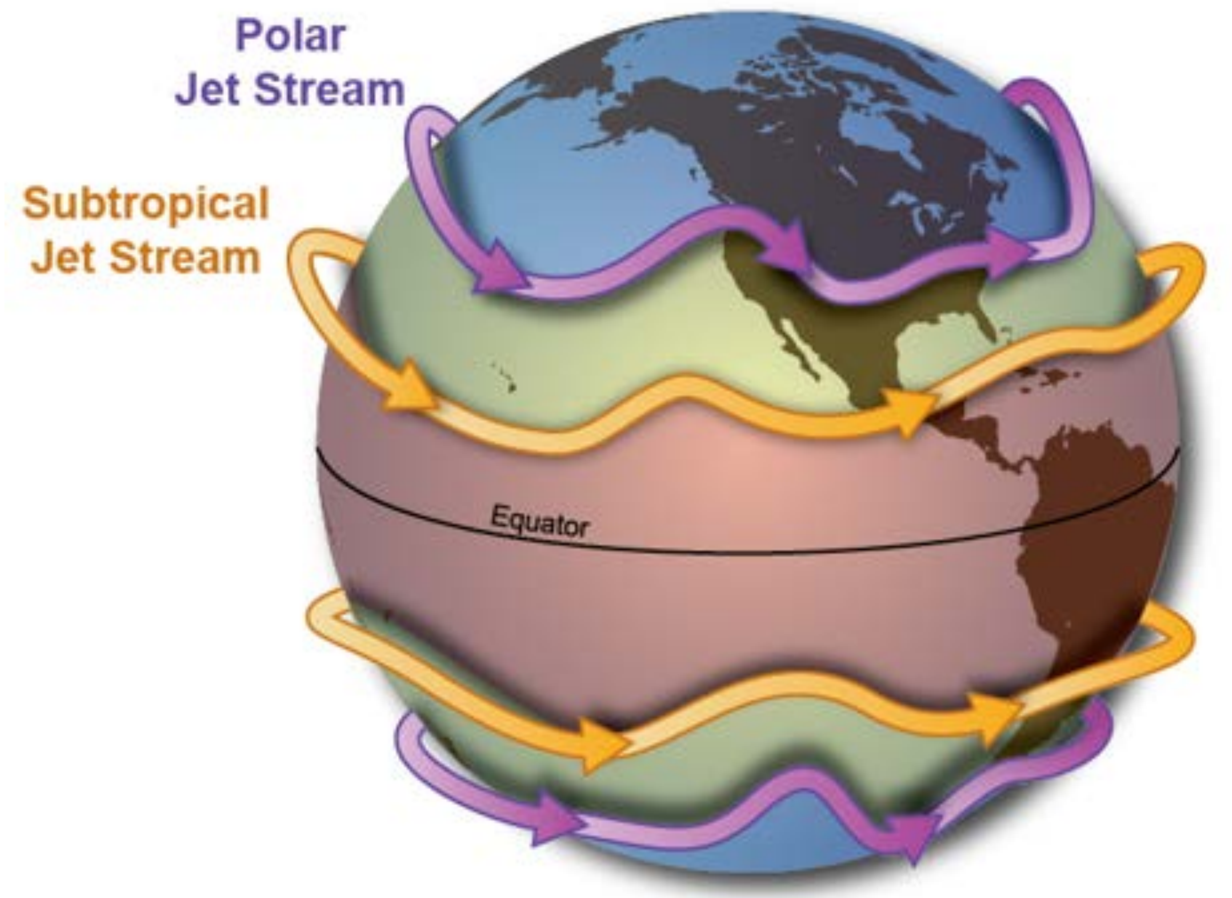

The Sun Impacts the Jet Streams

When the Sun is active, increased ultraviolet radiation and geomagnetic effects strengthen and push the jet streams poleward, leading to more stable weather patterns with fewer extreme cold outbreaks. The subtropical jets accelerate, reducing atmospheric blocking events, while the polar jet stream remains more zonal, limiting Arctic air intrusions into mid-latitudes. This results in milder winters, stronger storm tracks at higher latitudes, and more predictable climate patterns. Low solar activity causes more blocking, floods, and cold events.

Here are some key details:

During periods of high solar activity, increased ultraviolet (UV) radiation enhances stratospheric heating, leading to a poleward shift of the subtropical jets and an expansion of the Hadley cells (1). This effect strengthens the zonal wind component, increasing subtropical jet stream velocity and reducing the likelihood of meridional flow disruptions (2).

Observations indicate that subtropical jets can experience speed variations of up to 10 m/s between solar maxima and minima, directly impacting mid-latitude storm tracks and precipitation patterns (3). Conversely, during solar minima, weaker solar forcing contracts the Hadley circulation, which, in turn, weakens the subtropical jets and allows for greater atmospheric blocking events (4).

Geomagnetic activity associated with solar wind and coronal mass ejections (CMEs) influences jet stream behavior by modulating the stability of the polar vortex. Strong solar forcing enhances the stability of the vortex, keeping the polar jet stream more zonal and reducing the frequency of Arctic air intrusions into mid-latitudes (5).

During low solar activity, weakened stratospheric winds contribute to increased polar vortex disruptions, which lead to a more meandering, meridional jet stream pattern associated with extreme winter events in Europe and North America (6). This effect has been observed in historical climate reconstructions, with evidence suggesting that prolonged solar minima correlate with increased instances of stratospheric warming events that weaken the polar vortex and disrupt jet stream stability (7).

While greenhouse gas-driven warming is a major factor in these shifts, solar activity remains an important driver through its impact on stratospheric temperature gradients and planetary wave propagation (8). Studies emphasize that the observed changes in jet stream dynamics cannot be fully explained without accounting for the role of solar forcing, particularly in modulating the interaction between the troposphere and stratosphere (9).

Further research is needed to disentangle the interplay between anthropogenic climate change and natural solar variability to refine predictions of future jet stream behavior (10). The ongoing assessment of solar-terrestrial coupling mechanisms will be essential for improving climate models and understanding the broader implications of jet stream variability on global weather patterns (11).

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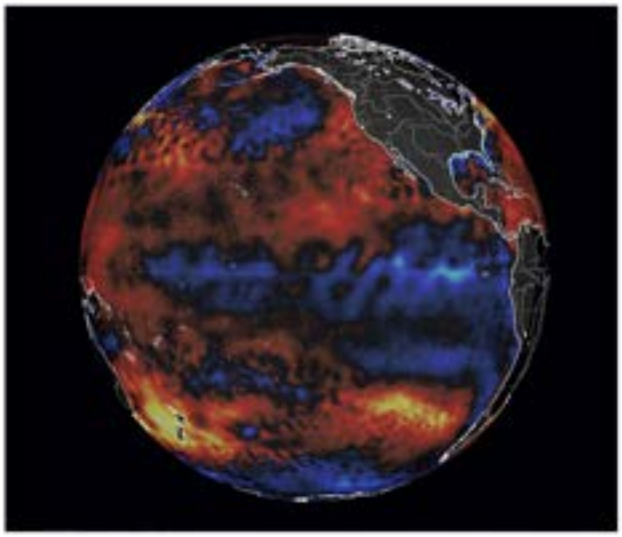
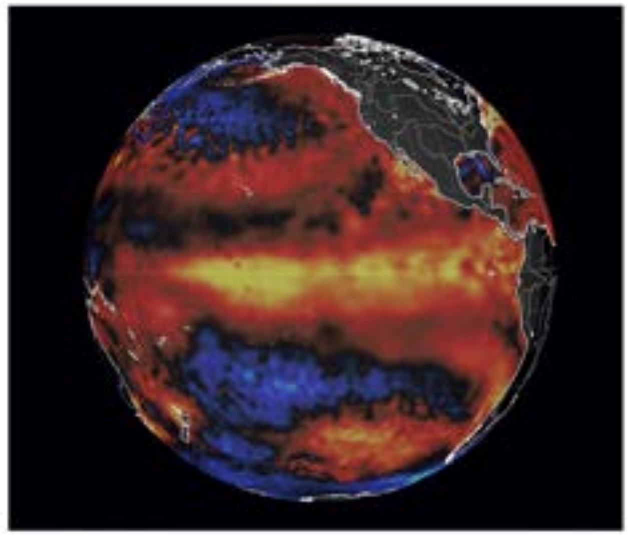
The Sun Impacts ENSO

ENSO, a major driver of global climate variability, has significant impacts on weather patterns, precipitation, and temperature across the globe. It touches EVERYTHING. While ENSO cycles primarily involve oceanic and atmospheric interactions, accumulating evidence highlights a significant modulation of ENSO by solar variability, suggesting that solar forcing may be a critical external factor shaping the weather.



ENSO Negative - Cold Equatorial Water (Blue)



ENSO Positive - Hot Equatorial Water (Red, Yellow)

Here are some key details:

The relationship between sunspot cycles and ENSO events has been established through statistical analyses, which show correlations between sunspot number fluctuations and ENSO phases. Specifically, increased sunspot numbers have been correlated with alterations in ENSO intensity and frequency, providing evidence of solar-driven modulation of ocean-atmosphere interactions (1,2).

These findings have been further supported by modeling approaches, including the application of Markov methods, highlighting statistical predictability of ENSO behavior based on solar activity metrics such as sunspots and solar irradiance (3).

Variations in solar wind energy flux also appear to affect ENSO variability. Enhanced solar wind flux in one year has been correlated with significant shifts in the strength and characteristics of ENSO events in the subsequent year, indicating a delayed but significant climatic response to solar inputs at interannual timescales (4). This relationship suggests a lagged atmospheric response mechanism where solar wind-driven changes in Earth's magnetosphere and upper atmosphere potentially propagate downward, impacting atmospheric circulation patterns linked to ENSO variability.

The termination phase of solar cycles—the rapid transition period from one solar cycle to the next—has been particularly highlighted for its potential to significantly alter ENSO variability. Recent studies have identified clear correlations between solar cycle terminations and subsequent tropospheric disturbances, influencing the occurrence, duration, and severity of La Niña and El Niño events (5,6).

Historical data analyses reveal robust links between these solar transition phases and notable climatic anomalies, such as the triple-dip La Niña episodes observed in recent decades, further underscoring solar cycle terminations as a critical predictive indicator for ENSO extremes.

Paleoenvironmental evidence additionally supports the long-term solar modulation of ENSO behavior. Geological records and climate proxies indicate a significant increase in ENSO variability coinciding with historical periods of heightened solar activity, suggesting that solar forcing could influence oceanic heat distribution and atmospheric circulation patterns over century-scale timeframes (8, 9).

Recent paleoclimate studies reinforce this view, identifying pronounced multi-decadal ENSO-like fluctuations linked explicitly to variations in solar radiation, thereby affirming the sun's role as a persistent external climate driver through geological history (10).

Theoretical modeling efforts further clarify how solar activity might modulate ENSO. It has been proposed that solar variations influence tropopause temperatures and atmospheric circulation dynamics, thereby modulating ENSO intensity and frequency (11).

Chaotic dynamics studies of ENSO reinforce the hypothesis that solar-induced changes in ocean-atmosphere interactions could induce significant shifts in the oscillatory patterns of ENSO, suggesting a nuanced but meaningful solar forcing mechanism on global climate variability (7,11).

The Intergovernmental Panel of Climate Change (IPCC) has even recently acknowledged the solar impact on ENSO, and has directed scientists to include it in future modeling.

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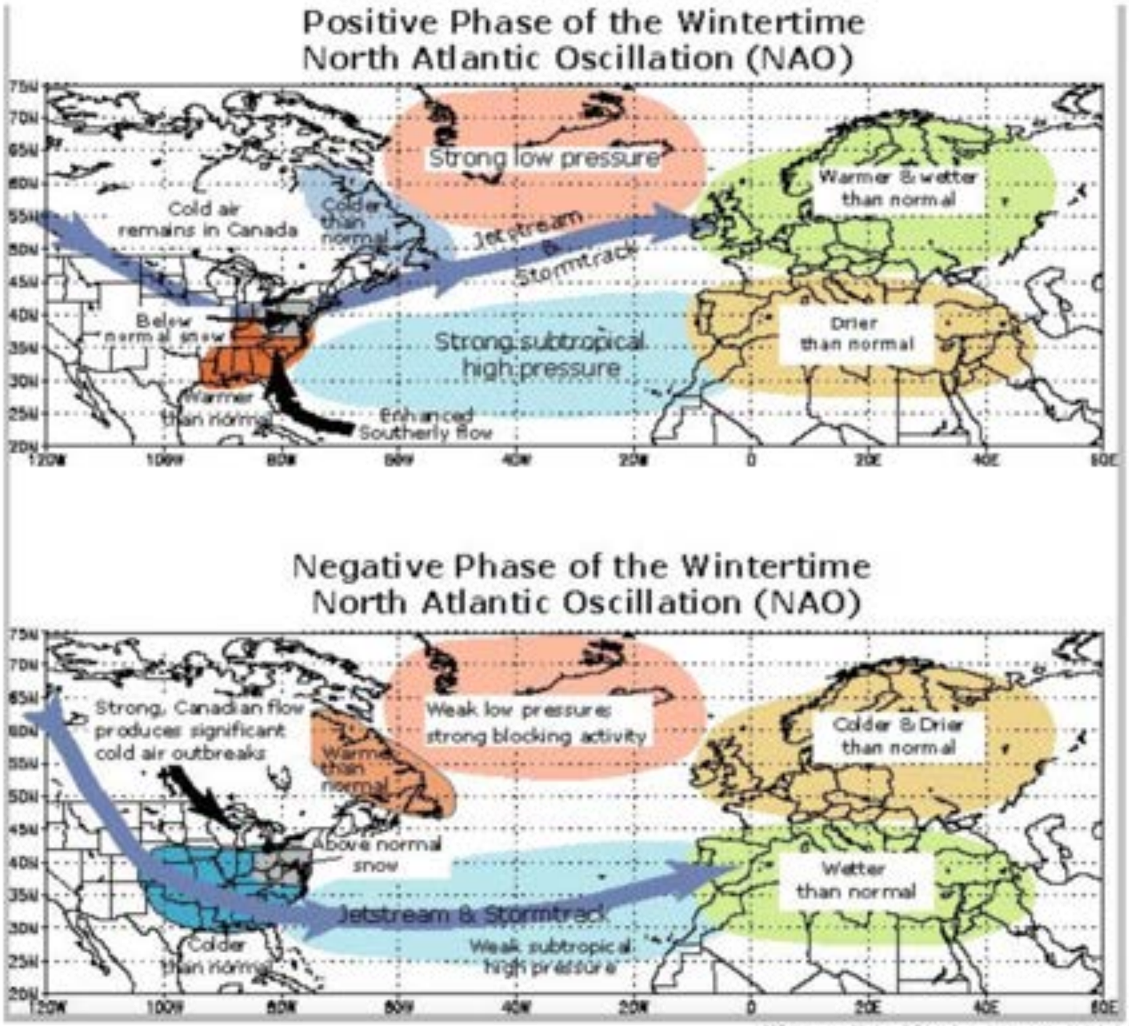
The Sun Impacts the North Atlantic Oscillation

When the Sun becomes active, the NAO shifts into a positive phase, strengthening the Icelandic Low and Azores High, which intensifies westerly winds across the North Atlantic. This leads to milder, wetter winters in northern Europe and the eastern U.S., while reducing Arctic air outbreaks and extreme cold in mid-latitudes. During low solar activity, the NAO tends toward a negative phase, weakening the westerlies, increasing atmospheric blocking, and allowing colder Arctic air to push southward, leading to harsher winters and drier conditions in some regions. These shifts can lag solar cycles by 1–4 years, meaning that the weather impacts may not be immediate but are still strongly tied to solar variability. The Sun's influence on the NAO is a key factor in seasonal and decadal climate patterns, making it essential for long-term weather forecasting and climate modeling.



NOAA.gov - National Oceanic and Atmospheric Administration

Here are some key details:

The North Atlantic Oscillation (NAO) is a critical component of atmospheric variability in the Northern Hemisphere, and its fluctuations are strongly influenced by solar activity. High solar activity tends to drive a positive NAO phase, characterized by a strengthened Icelandic Low and Azores High, which enhances the westerly flow across the North Atlantic, bringing milder and wetter winters to Europe and the eastern United States (1).

Conversely, low solar activity is associated with a negative NAO phase, leading to weaker westerly winds, increased atmospheric blocking, and colder conditions in mid-latitudes (2). These relationships have been observed over both short-term and multi-decadal timescales, suggesting that solar variability plays a persistent role in modulating regional climate patterns (3).

Geomagnetic activity, which is modulated by solar wind and coronal mass ejections (CMEs), plays a key role in shaping NAO behavior. During periods of heightened geomagnetic activity, the upper atmosphere experiences increased heating, which strengthens the polar vortex and reinforces the positive NAO phase (4). This mechanism helps maintain a stable zonal circulation pattern, reducing the occurrence of extreme winter weather events (5).

Conversely, during solar minima, weakened geomagnetic forcing contributes to increased stratospheric warming events, leading to a disrupted polar vortex and a greater likelihood of a negative NAO phase (6). This process has been supported by historical records, which show a strong correlation between solar minima and prolonged negative NAO phases during periods such as the Maunder Minimum (7).

The NAO's sensitivity to solar forcing is also evident in its interaction with the global electric circuit. Solar wind-induced electric field changes influence cloud microphysics and atmospheric ionization, which in turn modulate pressure differentials in the North Atlantic (8).

These electric field variations can contribute to shifts in atmospheric circulation, amplifying the effects of solar variability on NAO patterns (9). This mechanism provides a pathway for solar activity to influence climate on both short-term and long-term scales, reinforcing the importance of space weather in shaping atmospheric dynamics (10).

Multi-century reconstructions of NAO variability indicate that prolonged changes in solar output significantly alter the oscillation's long-term behavior. Statistical analyses have shown that extended periods of low solar activity are linked to an increased prevalence of negative NAO phases, which coincide with colder climatic conditions in Europe and North America (11).

Conversely, solar maxima tend to reinforce positive NAO phases, promoting warmer and wetter conditions in affected regions (12). These findings underscore the necessity of incorporating solar variability into long-term climate projections, as failing to do so may result in an incomplete understanding of regional climate trends (13).

The influence of solar variability on the NAO is not confined to the North Atlantic region alone, as recent studies suggest a link between NAO and tropical Pacific sea surface temperature anomalies. Solar-induced changes in the Pacific influence atmospheric wave propagation, which subsequently affects mid-latitude pressure systems, including the NAO (14).

This teleconnection provides further evidence that solar variability plays a fundamental role in shaping large-scale climate oscillations beyond its direct effects on the North Atlantic sector (15). Understanding these interactions is crucial for improving climate predictability and refining models that incorporate solar-terrestrial coupling (16).

Another important aspect of NAO variability is its delayed response to solar forcing. Observations indicate that changes in NAO phase often lag solar maxima by one to four years, reflecting the time required for solar-driven stratospheric modifications to propagate downward into the troposphere (17). This delayed response is primarily driven by the modulation of planetary wave activity, which affects the stability of the polar vortex and the subsequent evolution of NAO patterns (18).

The presence of a secondary lag of approximately seven years following the solar cycle suggests additional mechanisms, such as ocean-atmosphere interactions, that contribute to the persistence of solar-induced NAO variability (19).

Recent advancements in decadal climate predictability models have highlighted the importance of solar influences in forecasting NAO behavior. By integrating solar forcing into climate models, researchers have improved the ability to anticipate shifts in NAO phases and their associated climatic impacts (20). This progress underscores the need for continued research into the mechanisms linking solar activity to atmospheric circulation, particularly in the context of a rapidly evolving climate system (21).

Future studies should aim to further refine the understanding of how variations in solar output interact with other climate drivers, including greenhouse gas forcing, to shape regional and global climate patterns (22).

The NAO’s response to solar variability is a crucial factor in understanding winter climate variability in the North Atlantic region. The interplay between solar radiation, geomagnetic activity, electric field modulation, and ocean-atmosphere interactions creates a complex but identifiable pattern of solar influence on the oscillation (23).

While significant progress has been made in identifying these relationships, further research is required to fully elucidate the underlying mechanisms and to integrate solar variability into comprehensive climate prediction frameworks (24). Given the NAO’s strong influence on regional weather extremes, improving the understanding of its solar-driven variability is essential for advancing climate resilience and preparedness efforts (25).

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The Sun Impacts Annular Modes

When the Sun is active, the NAM and SAM shift into a positive phase, strengthening the polar vortex and westerly winds. This leads to milder winters in mid-latitudes, fewer extreme cold outbreaks, and stronger storm tracks in both hemispheres. In the Southern Hemisphere, a positive SAM phase keeps cold air trapped near Antarctica, reducing severe winter events in places like Australia. Conversely, during low solar activity, NAM and SAM favor their negative phases, weakening the polar vortex, allowing cold air intrusions, and increasing harsh winter conditions at mid-latitudes.

Here are some key details:

The Northern Annular Mode (NAM) is strongly influenced by solar variability through both short-term and long-term processes. Increased solar activity, particularly during solar maxima, enhances the downward propagation of stratospheric anomalies into the troposphere, leading to a strengthened NAM in its positive phase (1).

High solar wind speeds and geomagnetic activity contribute to this effect by intensifying the polar vortex and reinforcing zonal wind patterns, which promote a stronger westerly flow in the mid-latitudes (2).

These changes are also linked to interactions with the subtropical jet, where solar-modulated planetary waves influence the overall structure and variability of NAM (3).

Charged particle precipitation further amplifies these effects, as it alters stratospheric ozone concentrations, which in turn modulate the thermal gradient and zonal wind strength (4).

However, during periods of low solar activity, NAM tends to favor its negative phase, characterized by weaker westerlies and an increased likelihood of polar air intrusions into mid-latitudes (5).

The Southern Annular Mode (SAM) exhibits a similar solar response, particularly during austral summer. High solar activity is associated with a more positive SAM phase, leading to stronger westerly winds encircling Antarctica, which enhances the polar vortex and reduces the occurrence of extreme cold events in the Southern Hemisphere (6).

This effect is most pronounced when solar variability interacts with stratospheric dynamics, leading to a delayed but significant impact on surface climate (7).

Conversely, during solar minima, SAM shifts toward its negative phase, with weaker circumpolar winds and more frequent meridional flow disruptions that allow cold air to penetrate into lower latitudes, leading to increased cold events in regions such as Australia (8).

The modulation of SAM by the solar cycle is linked to both direct radiative effects on the stratosphere and indirect influences through changes in wave-mean flow interactions, further demonstrating the complex interplay between solar variability and large-scale atmospheric circulation (9).

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The Sun Impacts Pacific Decadal Oscillation

When the Sun is active, the Pacific Decadal Oscillation (PDO) shifts into a positive phase, bringing warmer waters to the eastern Pacific, stronger storms along the U.S. West Coast, and milder winters in North America. When the Sun is quiet, the PDO tends toward a negative phase, cooling the eastern Pacific, reinforcing La Niña conditions, and increasing drought risks in the western United States.

Here are some key details:

Solar activity influences PDO variability through its 11-year and 5.5-year cycles, which modulate ocean-atmosphere interactions in the Pacific (1).

During solar maxima, increased ultraviolet (UV) radiation strengthens the Aleutian Low, intensifying the North Pacific gyre and reinforcing a positive PDO phase characterized by warm anomalies in the eastern Pacific and cool anomalies in the west (2). In contrast, low solar activity weakens this circulation, shifting warm waters westward and supporting a negative PDO phase (3).

These solar-induced PDO shifts also interact with ENSO, altering long-term ocean heat distribution and influencing storm activity across the Pacific (4).

The degree to which PDO aligns with the 11-year solar cycle affects the stability of atmospheric pressure systems, particularly in the Gulf of Alaska—when in-phase, pressure anomalies remain localized, but when out-of-phase, they expand southward and westward, shifting precipitation patterns (5).

Recent research also suggests that greenhouse warming reduces the predictability of solar-PDO coupling, making future decadal climate trends more uncertain (6).

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The Sun Impacts Atlantic Multidecadal Oscillation

When the Sun is active, the Atlantic Multidecadal Oscillation (AMO) shifts into a positive phase, leading to warmer North Atlantic sea surface temperatures (SSTs), increased hurricane activity, and wetter conditions in Europe and North America. When solar activity is low, the AMO favors a negative phase, cooling the North Atlantic, reducing tropical storm frequency, and increasing the likelihood of droughts in North America and the Mediterranean. These shifts occur on multi-decadal timescales, meaning long-term climate trends are closely linked to solar variability.

Here are some key details:

Total solar irradiance (TSI) fluctuations influence AMO variability by modulating the Atlantic Meridional Overturning Circulation (AMOC), which controls heat transport in the North Atlantic (1). Studies confirm that AMO trends align with variations in solar cycles, with high solar activity reinforcing warm SSTs and low solar activity amplifying cooling trends (2).

This relationship weakened during the Little Ice Age, when ultra-low solar activity disrupted AMO's typical variability, breaking the usual solar-climate connection (3).

The AMO also exhibits 11-year cycle modulation, where stronger solar activity is linked to positive AMO trends due to increased solar-driven oceanic heating (4).

Solar particle forcing influences AMO trends by altering cloud cover, ocean-atmosphere interactions, and broader climate dynamics (5).

The interaction between AMO and solar variability has significant implications for regional climate predictability. Increased solar activity correlates with higher groundwater recharge rates in Italy, linking AMO shifts to long-term hydrological cycles (6).

High solar activity also enhances storm development and tropical cyclone intensity, reinforcing the role of AMO in driving Atlantic hurricane variability (7).

Further, AMO’s phase alignment with long-term solar cycles provides insight into future climate trends, particularly as greenhouse gas forcing modifies traditional ocean-atmosphere interactions (8).

Understanding the solar-AMO connection remains crucial for improving decadal climate forecasting and assessing regional climate risks.

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Chapter 4

The Sun,
The Weather
And Climate

In this chapter, we will see what specific practical weather and climate parameters can be tied to space weather:

- Temperature, precipitation, clouds, lightning, storms.
- Correlation and mechanism analysis.

The Sun Impacts Temperatures

When the Sun is active, global temperatures rise, with increased solar radiation, geomagnetic activity, and solar wind interactions contributing to regional warming patterns. During solar maxima, stratospheric heating strengthens atmospheric circulation, reducing cold air intrusions in mid-latitudes and increasing oceanic heat absorption. In contrast, solar minimum allows weakened atmospheric flow, leading to cooler global temperatures, more frequent jet stream blocking events, and regional climate anomalies.

Global Temperature Impacts

Variations in total solar irradiance (TSI) directly influence Earth's energy balance, affecting long-term temperature trends (1). Studies show that solar maximum amplifies warming trends, particularly in the upper atmosphere, where increased ultraviolet (UV) radiation enhances stratospheric-tropospheric coupling (2). During strong solar activity, geomagnetic storms and coronal mass ejections (CMEs) introduce additional thermal energy into the lower atmosphere, causing short-term warming spikes (3). Historical data confirm that periodic solar fluctuations align with major temperature shifts, with cooling events often occurring during prolonged solar minima, such as the Maunder Minimum (4).

Solar forcing modulates planetary wave activity, which influences temperature variability across multiple timescales (5). The Sun's 11-year and 22-year cycles are strongly correlated with decadal temperature oscillations, with recent studies identifying a bi-decadal periodicity linked to solar magnetic field strength (6). Cosmic rays, which are modulated by solar wind intensity, further impact upper-atmosphere chemistry by altering ozone concentrations, indirectly affecting global heat distribution (7). These interactions reveal that solar variability is a fundamental driver of both long-term warming trends and short-term temperature anomalies (8).

Regional Temperature Impacts

The Northern Hemisphere experiences pronounced temperature shifts due to solar modulation of atmospheric circulation patterns (9). Solar-driven changes in the Northern Annular Mode (NAM) influence winter temperatures, with solar maxima producing milder conditions in Europe and North America. Similarly, solar variability affects the Pacific Decadal Oscillation (PDO) and Atlantic Multidecadal Oscillation (AMO), altering regional SSTs and storm activity, which in turn influence continental temperature trends (10). Solar maxima tend to reinforce warm phase PDO and AMO conditions, enhancing coastal warming and tropical cyclone intensity (11).

In Eurasia, solar activity significantly impacts summer temperature distribution, with warming trends aligning with increased solar irradiance (12). Stratospheric warming during solar maxima enhances monsoonal patterns, increasing regional heatwaves and drought frequency (13). Conversely, solar minima have been linked to stronger blocking patterns, allowing Arctic air to intrude into lower latitudes, resulting in colder-than-average winters in Russia, China, and Central Asia (14). These mechanisms emphasize the critical role of solar variability in shaping Eurasian climate extremes (15).

In the Southern Hemisphere, solar-driven shifts in the Southern Annular Mode (SAM) regulate temperature anomalies across Australia, South America, and Antarctica (16). Positive SAM phases associated with solar maxima contribute to warmer conditions in Australia and increased Antarctic ice melt, while solar minima drive colder, stormier conditions (17). The influence of cosmic rays on Antarctic stratospheric temperatures further modulates the region’s thermal structure, reinforcing decadal cooling and warming trends (18).

Solar activity also influences tropical and equatorial temperature dynamics, particularly through its impact on El Niño-Southern Oscillation (ENSO) variability (19). Increased solar irradiance strengthens El Niño-like conditions, leading to higher surface temperatures in the Pacific, whereas solar minima favor La Niña events, intensifying regional cooling and precipitation anomalies (20). This dynamic is particularly evident in South Asia and Africa, where solar-driven ENSO variability modulates seasonal monsoons and heatwave occurrences (21).

In North America, solar cycles have been linked to regional warming and drought trends, particularly in the Pacific Northwest, Canadian Prairies, and Midwest United States. Increased solar activity enhances high-pressure anomalies, leading to drier, warmer conditions, while solar minima favor colder winters and increased storm frequency (22). This effect extends to Mexico and the southwestern United States, where solar-modulated atmospheric circulation shifts drive fluctuations in heatwave frequency and precipitation patterns.

Long-term climate reconstructions confirm that solar variability plays a dominant role in regional and global temperature patterns, reinforcing multi-decadal oscillations and seasonal anomalies

(23, 24). Understanding these solar-terrestrial interactions is essential for improving climate predictability and developing regional adaptation strategies (25).

It's real, repeatedly documented, and covers the entire world.

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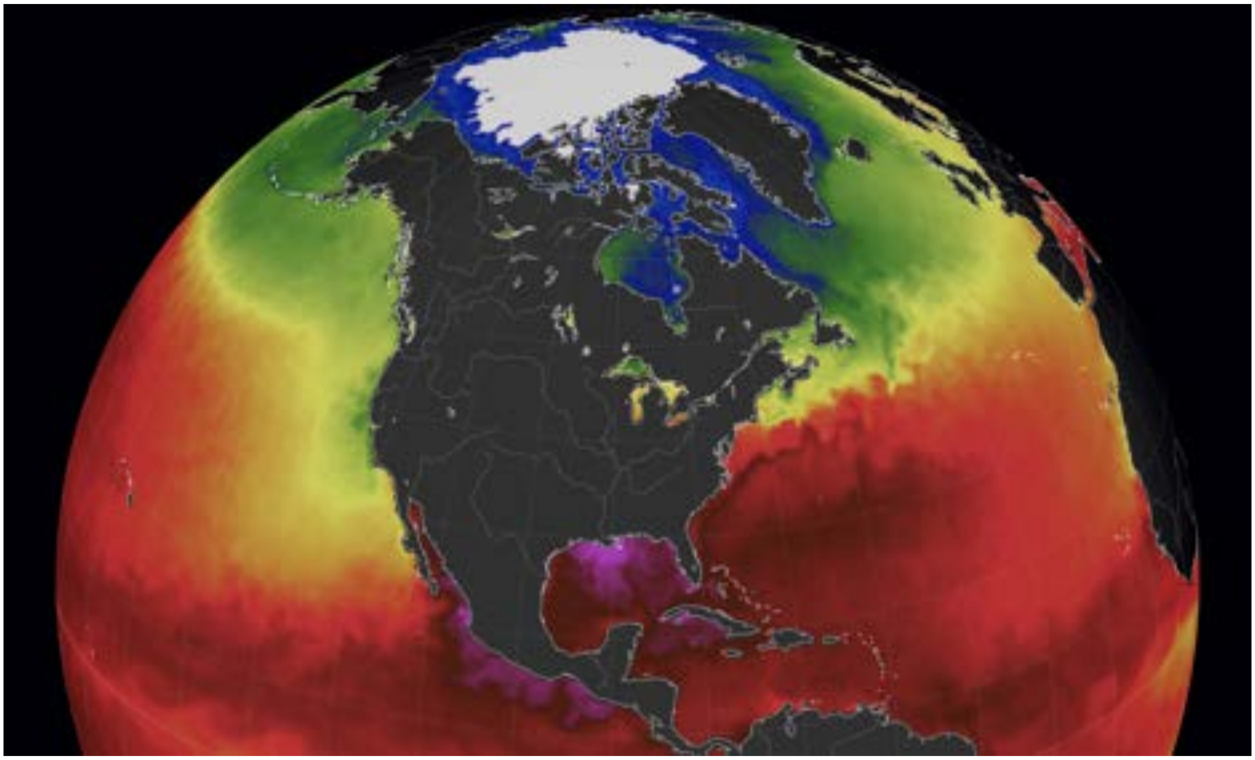

The Sun Impacts Ocean Temperatures

When the Sun is active, ocean temperatures rise, driven by increased solar irradiance, geomagnetic activity, and solar wind interactions. These processes enhance heat absorption in the upper ocean, strengthen ocean-atmosphere coupling, and modulate long-term sea surface temperature (SST) cycles. During solar minima, weakened solar forcing leads to cooler SSTs, shifts in ocean currents, and regional cooling effects in key climate zones.

Global Ocean Temperature Impacts

Solar variability directly influences long-term SST trends, with increasing total solar irradiance (TSI) driving global ocean warming (1). The 11-year solar cycle is strongly linked to decadal SST variability, as solar maxima reinforce ocean heat retention, while solar minima allow heat loss through radiative cooling (2). Historical reconstructions confirm that SSTs exhibit multi-decadal fluctuations tied to solar forcing, with external influences shaping Atlantic and Pacific SST anomalies (3). Solar-induced stratospheric changes also impact upper-ocean heat distribution, altering regional temperature gradients (4).

The Sun's influence on oceanic wind patterns further affects surface temperature variability. Solar-modulated planetary wave activity impacts ocean circulation, affecting wind-driven upwelling zones where cooler deep waters mix with surface layers (5). These effects have been observed in the Atlantic Multidecadal Oscillation (AMO) and Pacific Decadal Oscillation (PDO), reinforcing solar-driven temperature trends in both basins (6). In addition, solar-induced wind anomalies drive wave height variations, which further modulate surface heat exchange (7).

Regional Ocean Temperature Impacts

In the North Atlantic, solar forcing modulates the Atlantic Meridional Overturning Circulation (AMOC), influencing multi-decadal SST trends (8). A strong AMOC, driven by solar maxima, increases warm water transport northward, enhancing regional warming in Europe and North America (9). In contrast, solar minima weaken the AMOC, promoting cooler conditions and increased storm activity (10). These shifts have been observed in historical records, with solar-induced AMO variability affecting hurricane frequency and coastal climate patterns (11).

In the Pacific Ocean, solar forcing plays a major role in ENSO (El Niño-Southern Oscillation) variability, which regulates global temperature anomalies (12). Increased solar activity strengthens El Niño-like conditions, leading to warmer eastern Pacific waters, while solar minima favor La Niña events, reinforcing colder SSTs and stronger trade winds (13). Solar-modulated Pacific SST anomalies are further influenced by geomagnetic activity, which impacts upper-ocean mixing and atmospheric convection patterns.

The Southern Hemisphere experiences distinct solar-driven oceanic shifts, particularly in the Southern Ocean and Antarctic Circumpolar Current (ACC) (14). During solar maxima, increased solar energy input accelerates ice sheet melt and warming trends, while solar minima corresponds to enhanced cold-water upwelling and regional cooling (15). Similar trends are observed in the Caspian Sea, where SST variability correlates with solar-modulated wind patterns and geomagnetic field fluctuations (16).

The influence of solar forcing on ocean temperatures extends to the Indian Ocean, where solar-driven changes in monsoon intensity impact regional SST patterns (17). Increased solar activity enhances warm-phase monsoon conditions, intensifying upper-ocean heating, while low solar activity corresponds to stronger cold-phase monsoon circulation (18). These effects are also linked to solar-induced cloud variability, which influences solar radiation absorption at the ocean surface (19). Long-term ocean reconstructions confirm that solar-driven SST trends persist over millennial timescales, highlighting the fundamental role of solar variability in oceanic climate dynamics (20).

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The Sun Dramatically Impacts Precipitation

Solar activity significantly influences Earth's precipitation patterns through mechanisms involving solar irradiance, cosmic rays, and associated geomagnetic interactions. An active Sun, characterized by increased sunspot numbers and elevated solar wind conditions, injects additional energy and particles into Earth's atmosphere, influencing cloud formation processes, atmospheric circulation patterns, and subsequently altering global and regional precipitation patterns. These solar-driven changes manifest in complex and diverse ways across different geographical regions.

Global Impacts

The global impacts of solar activity on precipitation primarily stem from variations in solar irradiance and cosmic radiation. Studies confirm solar irradiance fluctuations correlate with precipitation variability, affecting global cloud cover and rainfall distribution (1). Increases in solar radiation input directly alter ocean surface temperatures, significantly influencing atmospheric moisture availability and precipitation cycles globally (2).

Solar cycles modulate large-scale climate phenomena, such as the El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO), profoundly impacting global precipitation patterns. Periods of heightened solar activity align closely with intensified ENSO episodes, modifying rainfall patterns worldwide (3). Similarly, small amplitude solar irradiance variations have amplified effects on the Pacific climate system, driving notable shifts in precipitation distribution through enhanced atmospheric and oceanic feedback processes (4). Galactic cosmic rays (GCRs), which vary inversely with solar activity, are a critical factor influencing cloud nucleation and thus precipitation on global scales. Decreases in cosmic ray flux during high solar activity periods lead to fewer cloud condensation nuclei, resulting in reduced global cloud coverage and altered precipitation patterns (5). These changes are especially pronounced during solar maxima, when Earth's atmosphere receives significantly higher particle fluxes (6).

Solar-induced changes in atmospheric electricity further demonstrate the global nature of solar forcing on precipitation. Increased geomagnetic activity, typical of active solar phases, has a documented impact on the global atmospheric electric circuit, influencing cloud electrification and enhancing precipitation processes globally (7). Such influences underscore the extensive scope of solar-terrestrial interactions beyond mere irradiance.

Regional Impacts

In North America, solar activity strongly correlates with regional precipitation variability. Analysis of sunspot numbers and precipitation data across the United States indicates significant solar-cycle modulation of rainfall, especially pronounced in the northwest and southwest regions (8, 9, 10). Extended drought conditions historically observed in the central and southwestern U.S. align consistently with periods of reduced solar activity, underscoring solar irradiance's role in regional hydroclimate variability (11, 12).

South American precipitation patterns also exhibit distinct responses to solar variability. Brazilian rainfall displays robust solar cycle correlations, with heightened solar activity typically linked to reduced rainfall (13, 14). Multi-decadal analyses of monsoonal zones and river streamflow patterns across South America affirm solar forcing as a substantial driver of regional hydroclimate fluctuations (15, 16). Additionally, southern Argentina's rainfall significantly correlates with sunspot cycles and geomagnetic activity, demonstrating solar impacts extending to high southern latitudes (17, 18).

In the Caribbean and Central America, historical reconstructions tie periods of low solar activity (solar minima) directly to extensive droughts, indicating solar forcing significantly influences regional precipitation extremes (19). Similarly, solar cycles modulate monsoon dynamics within these regions, highlighting how solar-driven sea surface temperature anomalies substantially affect regional rainfall variability (20).

Across Europe, solar activity exerts clear control over precipitation extremes. In the Western Mediterranean and Alpine regions, solar variability closely aligns with flood frequency and hydroclimate oscillations, notably influenced by modulations in North Atlantic atmospheric circulation (21, 22). Observations from Italy and central Europe indicate precipitation patterns, particularly flooding potential, correlate strongly with solar cycle phases and cosmic ray intensities (23, 24).

Eastern European precipitation also exhibits sensitivity to solar forcing, as exemplified by Serbia, where solar wind streams significantly modulate regional rainfall (25). Studies across broader European contexts emphasize cosmic ray impacts on rainfall variability, establishing a distinct link between solar activity and precipitation anomalies (26, 27).

Asian regions further underscore the critical influence of solar activity on precipitation dynamics. Northern China’s monsoon variability over decadal and centennial scales aligns closely with solar activity cycles, suggesting significant solar influence on regional rainfall (28). Similarly, the East Asian monsoon circulation exhibits marked modulation by solar variability, with fluctuations in solar irradiance profoundly impacting seasonal precipitation distribution (29).

In India, solar variability distinctly modulates monsoon rainfall. Solar cycle-induced variations in the tropical easterly jet significantly affect Indian monsoon dynamics, impacting rainfall patterns during active solar periods (30). Historical data further reveal abrupt monsoon failures coinciding with grand solar minima, confirming solar forcing as a key determinant of Indian rainfall extremes (31).

Further east, monsoon variability in East Asia directly aligns with the 11-year solar cycle. Enhanced solar activity typically intensifies summer monsoons, leading to increased precipitation across the region (32). Detailed studies in Kerala, India, establish robust correlations between solar indices, such as sunspot number and F10.7 flux, and extreme rainfall events, confirming solar activity’s critical role in shaping regional precipitation extremes (33).

In the Middle East, notably Iraq, precipitation variability strongly associates with solar wind parameters, including geomagnetic indices and plasma velocities, affirming solar influence on regional rainfall (34). Similarly, rainfall fluctuations in Crimea demonstrate explicit correlations with solar activity and cosmic radiation, further emphasizing solar forcing’s regional specificity (35).

Across North Africa and the Mediterranean, recent studies highlight solar and cosmic ray influences on rainfall variability. Solar activity variations influence precipitation extremes, notably observed during extreme rainfall events in Greece and Libya, directly correlating solar-induced sea surface temperature anomalies with precipitation patterns (36).

Observations from Mexico link lunar-induced tidal interactions and solar radiation cycles to distinct precipitation regimes (37). Similarly, machine learning analyses incorporating solar-driven climate variables significantly improve precipitation prediction accuracy across China's Xinjiang region, emphasizing solar activity’s essential role in regional rainfall forecasting (38).

Solar variability’s impacts extend profoundly to large-scale climate phenomena like the Madden-Julian Oscillation (MJO), affecting precipitation patterns across equatorial regions (39). Short-term solar ultraviolet fluctuations significantly modulate MJO-related tropical convection and rainfall, underscoring solar activity’s direct influence on intraseasonal precipitation variability (40).

Solar forcing critically shapes historical precipitation patterns documented during solar minima events, such as the Maunder Minimum, profoundly impacting regional climate regimes in Europe and North America (41, 42, 43). Additionally, cosmic radiation flux variations driven by solar cycles correlate significantly with European precipitation regimes, reinforcing solar influences' widespread regional significance (44).

Finally, across South America's monsoon systems, solar variability consistently modulates regional rainfall patterns, affirming its crucial role in shaping continent-wide hydroclimatic conditions (45).

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The Sun Impacts Clouds

The Sun and galactic cosmic rays (GCRs) exert substantial influence on cloud formation, significantly impacting Earth's climate through changes in cloud cover, albedo, and atmospheric circulation patterns. Variations in solar activity modulate the influx of GCRs, which, in turn, affect atmospheric ionization processes crucial to cloud microphysics. There was once a great debate on this topic, but the last decade has tipped strongly in favor of the correlation.

Here are some key details:

Galactic cosmic rays directly influence the formation of high-altitude clouds, particularly within tropical regions. Studies demonstrate a notable correlation between GCR cycles and changes in tropical convective cloud systems, suggesting that enhanced atmospheric ionization promotes cloud nucleation at upper altitudes (1). Furthermore, solar modulation of regional atmospheric circulation significantly alters global cloud distributions, with distinct patterns associated with solar-cycle phases (2, 3).

Solar cycle variations also significantly impact lightning frequency, which is indirectly linked to cloud electrification. Increased cosmic ray flux during low solar activity periods provides additional ionization sources, enhancing lightning formation and affecting cloud dynamics at both regional and global scales (4). These variations underscore the interconnectedness of solar-driven cosmic ray flux and cloud electrification processes, integral to Earth's atmospheric dynamics.

Investigations into solar and geomagnetic influences on cloud formation reveal clear relationships between solar activity, cloud condensation nuclei (CCN), and aerosol scavenging processes. Ionization-induced aerosol formation due to variations in solar radiation and cosmic rays significantly impacts cloud properties by modifying CCN concentrations and influencing the depth and lifespan of cloud structures (5, 6, 7, 8). High-speed solar wind streams are associated with intense mesospheric turbulence, influencing the vertical distribution and formation of clouds at high latitudes, further illustrating the breadth of solar impact on atmospheric phenomena (9).

Long-term observations have shown consistent links between nocturnal cloudiness and solar activity, highlighting that variations in geomagnetic conditions alter cloud cover, particularly at low latitudes (10, 11). Additionally, comprehensive parameterizations of aerosol scavenging due to ionization at different atmospheric altitudes confirm significant modulation of cloud characteristics by solar-induced ionization variations, revealing mechanisms behind cloud response to changing cosmic ray environments (12).

Solar wind changes are observed to affect winter atmospheric circulation directly, altering cloud patterns through modifications in atmospheric electricity and microphysics. Changes in solar wind intensity can shift tropospheric weather systems, affecting precipitation and cloud cover through enhanced ionization processes (13, 14). Furthermore, electrical modulation of cloud microphysics has been explicitly linked to solar-driven variations in the global electric circuit, confirming solar activity's influence on clouds and weather (15, 16).

Physical mechanisms proposed to explain these effects involve the solar wind's modulation of electrical characteristics within Earth's lower atmosphere. Through the redistribution of condensation nuclei and electric field alterations, solar variability influences cloud formation and precipitation processes significantly (17, 18). Cosmic ray variability further contributes to cloud dynamics by altering thermal and electric atmospheric characteristics, reinforcing the coupling between solar radiation fluctuations and cloud response (19, 20).

Cloud microphysical processes directly influenced by solar and cosmic ray variability have been integrated into climate models, resulting in improved predictions of cloud dynamics and climatic impacts. Stochastic parameterizations of cloud dynamics have confirmed the importance of accurately representing solar and cosmic ray influences in climate simulations, particularly to understand and predict climate hiatus periods and cloud cycle biases (21, 22). The modulation of cloud microphysics via electric fields driven by solar activity constitutes a significant, though complex, component of Earth's atmospheric system, reinforcing the critical role solar variability plays in global climate regulation (23).

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The Sun Impacts Lightning

The relationship between solar and cosmic ray activity and lightning occurrence represents a critical interdisciplinary intersection of atmospheric physics and space weather science. Variability in solar activity and cosmic ray intensity demonstrably modulates Earth's atmospheric electric circuit and influences lightning formation and frequency through diverse pathways involving ionization, cloud microphysics, and atmospheric conductivity.

Here are some key details:

The heliospheric magnetic field polarity significantly influences terrestrial lightning incidence, manifesting modulation linked to solar cycles and solar wind fluctuations (1). This solar-driven variation in lightning occurrences indicates that Earth's electrical environment responds dynamically to solar conditions (2). Such a relationship is observable globally, from tropical to temperate regions, highlighting a robust interconnection between solar activity and atmospheric electricity.

The solar modulation of atmospheric electricity results primarily from alterations in cosmic ray flux, which impacts cloud electrification processes. Decreased cosmic ray intensities, known as Forbush decreases, notably correspond to periods of reduced lightning activity, illustrating a clear cosmic-atmospheric linkage (3). The causal connection between cosmic ray variability and global lightning patterns has been firmly established through statistical correlations and geophysical modeling (4).

Solar energetic particle (SEP) events enhance ionization rates in Earth's lower atmosphere, directly altering atmospheric electrical parameters and subsequently modifying lightning frequency (5). These events have demonstrated rapid atmospheric responses detectable at midlatitudes, affirming the sensitivity of atmospheric electricity to even transient solar phenomena (5). Observations indicate heightened thunderstorm electrification shortly following intense solar events, underscoring the responsiveness of lightning to space weather episodes (6).

The interaction between the heliospheric current sheet and Earth's magnetosphere has notable implications for lightning initiation and frequency. Thunderstorm activity displays marked increases during periods of current sheet crossings, suggesting an integral role for magnetospheric perturbations in lightning modulation (7). Similar patterns are documented within solar rotational cycles, with recurring intervals of heightened lightning occurrences corresponding closely with solar rotation periods, further emphasizing solar control mechanisms (8).

Forbush decreases provide compelling examples of solar-driven atmospheric responses, with observed reductions in cosmic ray flux aligning with measurable decreases in lightning incidence across wide geographic regions including continental Africa and the United States (9). These solar-induced cosmic ray fluctuations demonstrate a potent modulation capability, underscoring the fundamental linkage between extraterrestrial phenomena and terrestrial electrical processes (8).

Solar wind variations drive notable changes in secondary cosmic ray fluxes, influencing ionization processes crucial for the development and intensification of electric fields within thunderstorms (9). The secondary cosmic rays produced by solar wind interactions substantially affect atmospheric conductivity, thus impacting lightning discharge characteristics (10). Enhanced atmospheric conductivity induced by increased cosmic ray penetration modulates lightning initiation by altering charge distribution processes within clouds (10).

Comprehensive analysis of historical lightning records in Japan indicates robust alignment with solar rotational cycles over extensive historical periods, reinforcing the global significance of solar forcing mechanisms on lightning (11). Such long-term analyses further solidify the foundational understanding of solar modulation effects, presenting strong evidence that lightning rates respond cyclically to variations in solar and cosmic parameters (12).

Diurnal variability of lightning activity, although primarily governed by local meteorological conditions, also reflects subtle influences from solar-induced global electric circuit perturbations, highlighting the complexity and multiscale nature of atmospheric electrical phenomena (13). Cosmic ray flux, specifically galactic cosmic rays (GCRs), exerts pronounced effects on atmospheric conductivity and ionization, directly impacting lightning formation mechanisms and atmospheric electric field strengths (14).

Measurements of atmospheric electric fields during space weather events confirm the direct impact of solar disturbances on local and regional electrical environments, emphasizing the importance of monitoring these parameters to understand lightning dynamics comprehensively (15). The electrification mechanisms within thunderstorms, including the initiation and development of lightning, remain intricately linked to cosmic ray-induced ionization processes, influencing ice-phase hydrometeor interactions critical to charge separation (16).

Further, it is established that lightning plays a pivotal role within Earth's global electric circuit, responding dynamically to solar modulations and cosmic ray influx, illustrating a coupling between space weather phenomena and atmospheric electrical behavior (17). Notably, localized studies indicate substantial variations in lightning rates correlated with solar activity, reinforcing the broader cosmic-atmospheric electricity connection (18).

The state of space weather significantly impacts terrestrial lightning, as evidenced by observations during geomagnetic storms and SEP events, which directly alter atmospheric conductivity, thereby influencing thunderstorm electrification processes (19). Additionally, research into hailstorms highlights the dependency of lightning flash rates on the internal storm structures modulated by cosmic-ray-induced ionization effects, further linking solar activity to specific storm characteristics (20).

Detailed analyses of lightning characteristics during hailstorms have identified correlations between radar reflectivity structures and lightning flash rates, which are sensitive to cosmic ray-induced ionization fluctuations (21). Similarly, the lifecycle of severe convective storms demonstrates consistent changes in lightning frequency and intensity, modulated by short-term solar wind variations (22).

Ice precipitation processes within thunderstorms, which are vital to lightning initiation, exhibit sensitivity to ionization effects from cosmic rays, underscoring the indirect yet robust relationship between solar activity and lightning via atmospheric microphysical pathways (23). Additionally, fluctuations in lightning activity closely correlate with solar cycle phases, displaying recognizable periodicities in concert with variations in solar energetic output (24).

Investigations into solar wind's influence on atmospheric electricity reveal clear modulation pathways through secondary cosmic ray processes, fundamentally shaping Earth's electric circuit and lightning dynamics (25). Furthermore, ground level enhancements (GLEs) induced by solar particle events lead to measurable short-term responses in lightning rates, clearly demonstrating immediate terrestrial impacts of extraterrestrial energetic phenomena (26).

These findings collectively illustrate the complexity and depth of the relationship between solar activity, cosmic rays, and lightning, highlighting an active extraterrestrial-terrestrial coupling in atmospheric electrical phenomena.

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The Sun Impacts Storms

The influence of solar activity on major storms is a complex interplay of radiative, electromagnetic, and atmospheric processes. During periods of heightened solar activity, increased ultraviolet radiation and variations in the solar wind alter large-scale circulation patterns, influencing the development and intensity of hurricanes, typhoons, and extratropical cyclones. The effects extend beyond direct heating, affecting atmospheric electricity, cloud microphysics, and even the frequency and intensity of severe thunderstorms. The relationship between solar variability and storm behavior is evident across multiple spatial and temporal scales, linking space weather phenomena with Earth’s meteorological systems.

Here are some key details:

Tropical cyclones in the Western North Pacific exhibit a strong correlation with solar activity, particularly during low solar output phases when cyclone frequency increases significantly. This suggests that solar-induced changes in atmospheric circulation, such as modifications in the Walker Circulation and subtropical jet, create favorable conditions for storm formation and intensification (1). Similarly, solar wind variability influences atmospheric electricity, altering ionization levels that affect cloud formation and, subsequently, cyclone intensity (2). The role of charged particles in modulating cloud microphysics highlights an indirect but crucial solar forcing mechanism.

Galactic cosmic rays (GCRs), which are modulated by solar activity, further contribute to cyclogenesis by increasing atmospheric ionization. During periods of low solar activity, higher GCR flux enhances cloud condensation nuclei, leading to increased cyclonic activity due to changes in cloud microphysics and precipitation dynamics (3). This inverse relationship between solar activity and GCR penetration suggests a solar-mediated mechanism for storm modulation.

In the Northern Hemisphere, winter storm tracks shift equatorward during solar minima, increasing storm frequency and intensity in regions such as the Mediterranean and southern Europe. This pattern results from reduced stratospheric heating, which alters the positioning of the polar and subtropical jets, ultimately affecting extratropical storm development (4). Similarly, solar activity has been linked to increased occurrences of severe thunderstorms, with heightened solar output enhancing atmospheric instability and convective processes (5).

The connection between space weather and hurricane activity is evident in case studies of major Atlantic storms, such as hurricanes Irma, Jose, and Katia. Variations in geomagnetic conditions, driven by solar wind disturbances, coincide with changes in hurricane intensity, suggesting that electromagnetic interactions contribute to storm dynamics (6). Additionally, the repetitive nature of certain meteorological phenomena appears to be linked to solar cycles, reinforcing the role of the Sun in modulating atmospheric patterns (7).

Long-term historical records further support the solar-storm relationship. A 300-year dataset of typhoons in Taiwan reveals a persistent link between solar activity variations and typhoon frequency, highlighting the long-term influence of solar forcing on regional storm climatology (8). Similarly, solar cycle extremes serve as predictors of Atlantic hurricane activity, with solar maximum conditions corresponding to shifts in storm frequency and intensity (9).

Spatial analyses reveal a geographically dependent response of hurricanes to solar variability. In the North Atlantic, solar influences on storm frequency vary with oceanic and atmospheric conditions, suggesting that regional factors mediate the solar-weather connection (10). Further evidence indicates that daily tropical cyclone intensity responds to variations in solar ultraviolet radiation, providing insight into short-term solar forcing mechanisms (11).

The connection between solar cycles and United States and Caribbean hurricane activity has been well established, with storm frequency peaking during specific phases of the solar cycle (12). A similar relationship has been observed for hurricanes in the Pacific, reinforcing the global nature of solar-driven storm modulation (13). These findings suggest that solar variability plays a fundamental role in shaping regional and global storm patterns.

Coastal storm surges also exhibit sensitivity to solar forcing. Analysis of Australian storm surge records indicates that changes in atmospheric circulation associated with solar variability influence the intensity of storm-induced coastal flooding (14). Additionally, studies on Pacific tropical cyclones confirm a solar influence on storm development, further supporting the widespread impact of solar variability (15).

Paleoclimate data provide additional validation of these findings. Historical shipwreck records in the Caribbean have been used to infer past hurricane activity, demonstrating a clear correlation between storm frequency and past solar forcing levels (16). Similar trends in hurricane occurrences across different ocean basins reinforce the persistence of this relationship over long timescales (17).

Cloud dynamics offer another pathway for solar influence on storms. Variations in cloud cover and circulation patterns linked to solar activity contribute to fluctuations in storm frequency and precipitation rates (18). The relationship between the Sun and hurricanes is further supported by statistical models diagnosing solar impacts on storm intensity and frequency (19).

Geomagnetic conditions, influenced by solar wind interactions with Earth's magnetosphere, also play a role in storm-related atmospheric processes. The effects of geomagnetic disturbances on the ionosphere have been linked to variations in atmospheric stability, potentially affecting storm development (20). Additionally, high-speed solar wind streams have been associated with extreme weather events, including hurricanes and extratropical cyclones (21).

The influence of solar wind energy flux extends to large-scale climate oscillations such as ENSO, which plays a critical role in storm variability. The solar wind-ENSO connection highlights a mechanism through which solar activity indirectly influences storm patterns by modulating ocean-atmosphere interactions (22). These complex interactions illustrate the multi-faceted role of solar activity in shaping storm behavior. (23 - 25)

The September 2017 hurricane season was marked by an unusual convergence of extreme solar and meteorological activity, exemplified by hurricanes Irma, Jose, and Maria. During this period, solar activity surged, with multiple X-class solar flares and coronal mass ejections (CMEs) impacting Earth's magnetosphere. High-speed solar wind streams and geomagnetic disturbances coincided with the rapid intensification of these hurricanes, suggesting a potential link between space weather and storm dynamics (6).

Studies have indicated that solar-induced atmospheric ionization can modulate cloud microphysics and cyclone strength, with geomagnetic disturbances influencing vertical wind shear and convective processes (2, 20). The simultaneous presence of powerful hurricanes and heightened solar activity aligns with research showing that solar cycles and geomagnetic conditions can influence hurricane frequency, intensity, and trajectory (9, 14, 22).

The September 2017 events provide a compelling case study of how solar variability and extreme weather may be interconnected, underscoring the need for further investigation into the mechanisms linking space weather to tropical cyclone behavior.

In October 2017, 15-year-old Faris Irwin Wald from Santa Fe, New Mexico, earned the prestigious $25,000 Samueli Foundation Prize at the Broadcom MASTERS® competition, a leading national science and engineering contest for middle school students. Wald's project investigated the correlation between solar coronal holes—regions on the sun's surface with lower density plasma—and the formation of tropical and extratropical cyclones on Earth.

His research aimed to enhance the understanding of how solar phenomena might influence terrestrial weather patterns, potentially contributing to improved forecasting of cyclonic events. The Broadcom MASTERS program encourages middle school students to engage deeply with STEM subjects, fostering a passion for scientific inquiry and innovation. Everywhere we look, the sun is gaining recognition.

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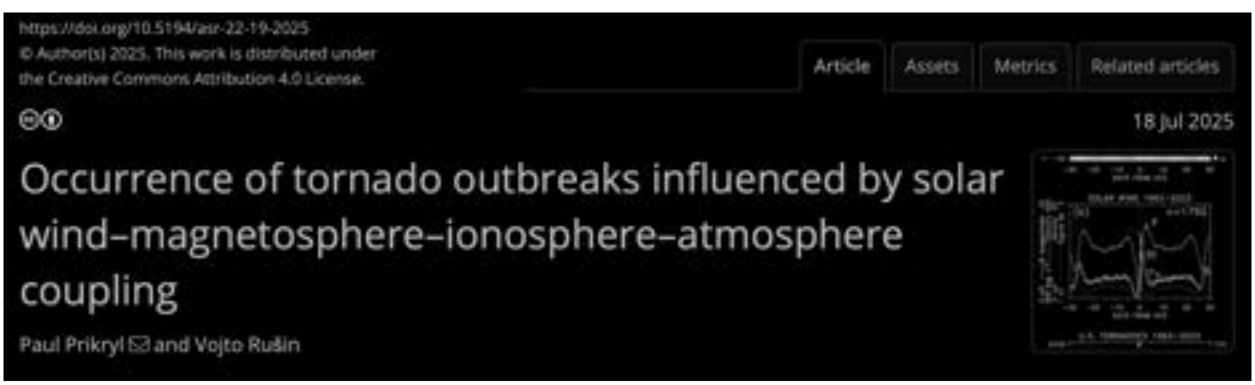
2025 Breaking Update!

During the editing phase of this textbook, a critically important study was released, **confirming the connection between solar storms and tornado activity**. The auroral excitement of the atmosphere can amplify frontal boundaries and sheer, amplifying spin within micro-systems of a storm. An image of the new release can be found below:


https://doi.org/10.5194/asr-22-19-2025
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Occurrence of tornado outbreaks influenced by solar wind–magnetosphere–ionosphere–atmosphere coupling

Paul Prikryl and Vojto Rušin

Chapter 5

Space Weather and the Global Electric Circuit

In this chapter, we will examine the rapid electromagnetic particle forcing pathway via the global electric circuit:

- Solar impact on atmospheric electricity.
- The global electric circuit.
- Solar impact on the global electric circuit.
- Global electric circuit impact on weather.

The Sun Impacts Atmospheric Electricity

Solar activity directly influences Earth's atmospheric electricity through solar wind, geomagnetic storms, solar proton events, and variations in solar irradiance. Enhanced solar activity alters the electrical state of Earth's atmosphere, modulating the atmospheric electric potential gradient. These interactions have far-reaching implications for climate dynamics, weather patterns, and cloud microphysics.

Here are some key details:

Variations in solar wind significantly impact Earth's atmospheric electricity by modulating the global atmospheric electric circuit. Changes in solar wind magnetic fields penetrate the polar regions, altering atmospheric electric fields and affecting cloud electrification processes (1, 2). Such disturbances in the atmospheric potential gradient during periods of intensified solar activity can lead to pronounced shifts in atmospheric circulation, impacting regional weather systems globally (3).

Extreme solar proton storms, triggered by intense solar activity, induce considerable atmospheric ionization, altering Earth's atmospheric chemistry. These storms substantially deplete stratospheric ozone, modifying the atmospheric column's electrical conductivity, and thus altering the potential gradient (4). This ozone depletion directly affects atmospheric electrical parameters, demonstrating the interconnectivity between solar activity, atmospheric chemistry, and electric fields.

Geomagnetic super storms also significantly modify atmospheric electric fields, as evidenced by measurements from Antarctica's Concordia Station. These storms introduce pronounced anomalies in the vertical atmospheric electric field, illustrating the critical role of solar-driven geomagnetic disturbances in the near-surface atmospheric electrical environment (5). The resultant shifts have implications for cloud dynamics, precipitation patterns, and atmospheric stability.

Solar-induced geomagnetic activity has a complex relationship with climatic patterns, such as the North Atlantic Oscillation (NAO). The coupling mechanism involves electrical modulation of atmospheric circulation patterns, mediated by alterations in the global atmospheric electric circuit (6). Similar solar-driven atmospheric electric coupling has been observed at Antarctic and sub-Antarctic latitudes, reflecting variations in regional temperature anomalies attributed to geomagnetic effects (7).

Solar variability and associated terrestrial drivers profoundly influence decadal atmospheric circulation variability. Studies emphasize the importance of electrical processes induced by solar activity, driving variations in Northern Hemisphere winter circulation patterns and consequently influencing regional climate and weather phenomena (8). Additionally, solar wind-driven magnetic disturbances affect longwave irradiance levels at high latitudes, directly impacting Earth's atmospheric electric characteristics (9).

Solar wind signatures, observed extensively in Earth's high-latitude atmosphere, confirm that space weather directly influences atmospheric electricity. Observational evidence establishes that the vertical atmospheric column's electric properties respond distinctly to variations in solar wind parameters (10). Remotely sensed evaluations of stratiform cloud base charges further confirm the direct link between atmospheric electrical states and solar wind-induced perturbations (11).

The measurement of atmospheric electrical fields provides crucial insights into how solar activity shapes Earth's weather. Ground-level electric field measurements at multiple latitudes confirm strong correlations between fluctuations in space weather and variations in the atmospheric potential gradient (12). This coupling, further elucidated through space weather fundamentals, highlights solar influences on the electrical state of Earth's lower atmosphere (13).

Solar irradiance variability further modulates Earth's atmospheric electricity. Long-term solar irradiance changes correlate strongly with atmospheric electrical properties, directly impacting cloud formation and climate through variations in the global atmospheric electric circuit (14). Similarly, solar wind influences winter atmospheric processes significantly in polar regions, demonstrating the direct connection between solar variability and tropospheric electrical phenomena (15).

Magnetic interactions driven by the solar wind profoundly impact the global atmospheric electric circuit, notably altering tropospheric temperatures in Antarctica. Such interplanetary magnetic field-driven changes illustrate the broad-reaching influence of solar activity on atmospheric electrical processes, emphasizing the solar-atmospheric electrical linkage's strength and complexity (16).

Solar wind-atmospheric electric interactions have far-reaching consequences for cloud microphysics, precipitation formation, and climate systems. Detailed studies reveal clear connections between solar-driven electrical enhancements and meteorological phenomena, such as variations in longwave radiation observed at the South Pole (17). These interactions significantly shape atmospheric processes, reinforcing the importance of solar activity in the global climate system.

It should be no surprise that solar activity and cosmic rays impact lightning since their impact on atmospheric electricity is so great, but their reach extends far beyond the most exciting part of thunderstorms.

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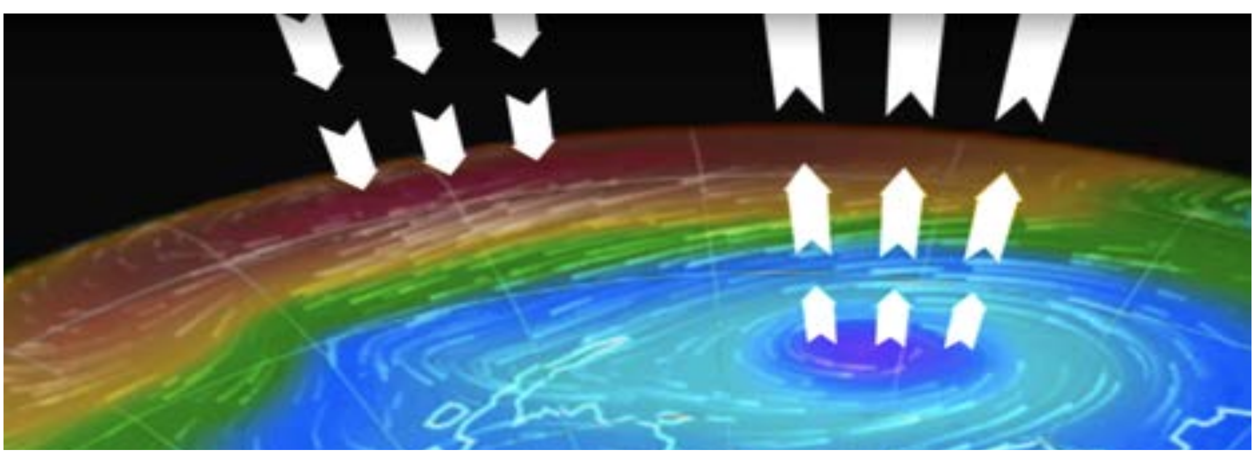
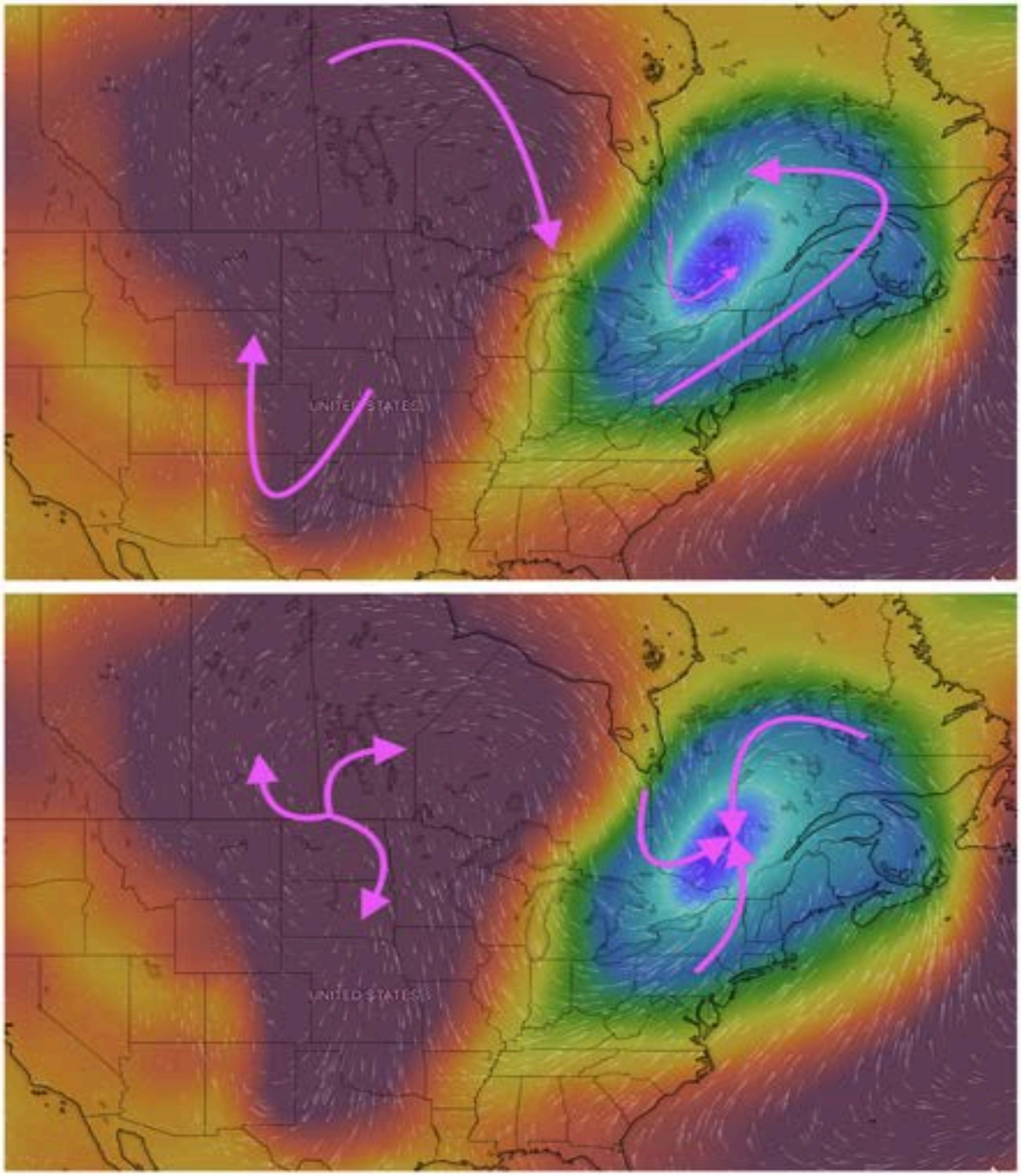
The Global Electric Circuit

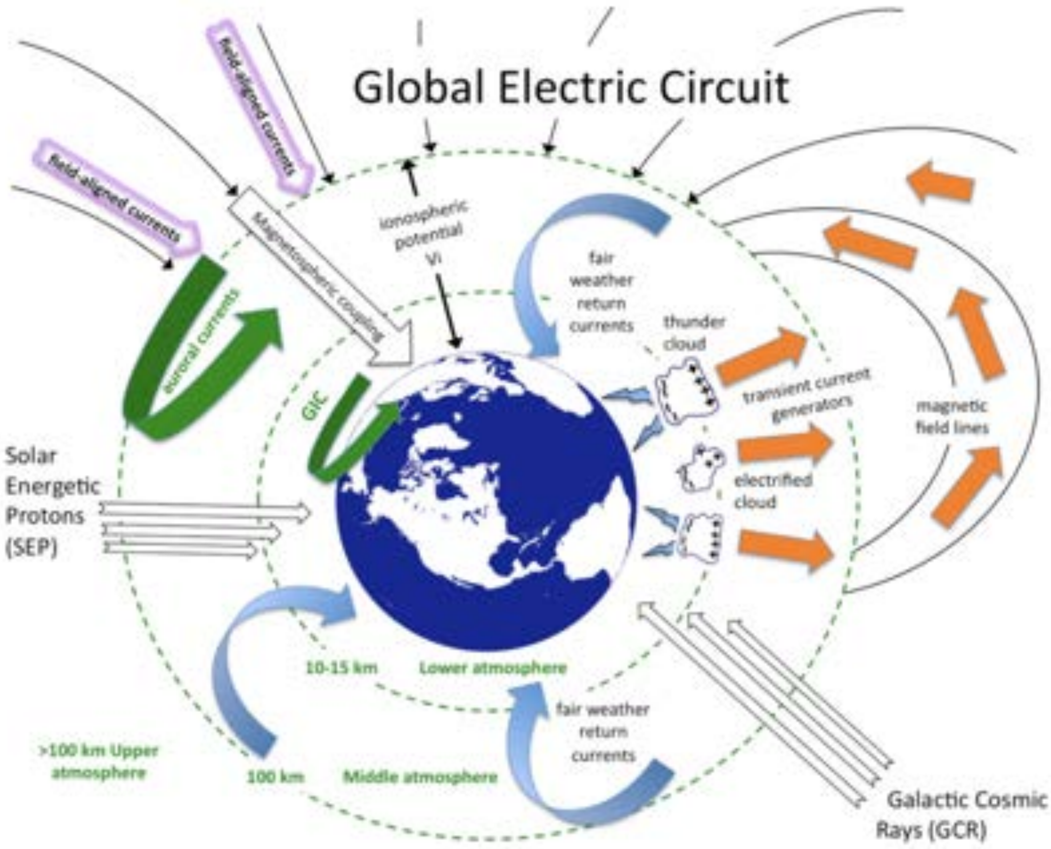
The global electric circuit is an up-down vertical flow of electric current in the earth's atmosphere. The ceiling of this circuit is the ionosphere, the floor is the ground, and the vertical pathways move through pressure cells, with the current flowing downward in high pressure (fair weather) and upward in low pressure cells.





Pink arrows show macro-scale rotation of cells (top) and the outward push of the highs/inward pull of the lows (bottom). These are surface air flows, so where is the air coming from in highs – and where is it going in lows? The answer to both questions is *the atmosphere above*.

When anything impacts the ionosphere, like a solar flare, geomagnetic storm or cosmic rays, it changes particle counts, conductivity and more, leading to an impact on the vertical current flows, which then impact several aspects of the weather in the troposphere.



The Sun, The Global Electric Circuit, and the Weather

The Sun exerts a profound influence on Earth's Global Electric Circuit (GEC), a planetary-scale system linking the atmosphere, ionosphere, and magnetosphere through electrical processes. Variations in solar activity, including solar flares, coronal mass ejections (CMEs), and changes in solar wind, directly impact the ionospheric potential and atmospheric conductivity, modulating the strength of the GEC. These fluctuations, in turn, influence cloud microphysics, atmospheric pressure patterns, and precipitation, thereby playing a role in shaping weather and climate.

Here are some key details:

Solar flares are among the most significant drivers of ionospheric disturbances, causing rapid heating and enhancing ionization levels within the upper atmosphere (1). This increased ionization modifies the electrical conductivity of the ionosphere, which alters the flow of current within the GEC (2). The impact of solar flares extends beyond immediate ionospheric heating, as they can generate traveling ionospheric disturbances that propagate through the upper atmosphere, influencing electric field distributions and atmospheric coupling processes (3).

CMEs inject large quantities of charged particles and magnetic fields into Earth's space environment, often triggering geomagnetic storms. These disturbances compress the magnetosphere, enhance electric currents in the ionosphere, and modify the potential difference driving the GEC (4). Geomagnetic storms have been linked to short-term variations in atmospheric electrical conductivity, which in turn affect cloud formation and thunderstorm activity (5). The modulation of cloud microphysics by the GEC provides a pathway through which space weather events influence climate dynamics (6).

The solar wind, a continuous stream of charged particles emitted by the Sun, exerts a persistent influence on the GEC. Variability in solar wind conditions can modulate the downward current density in the GEC, affecting ionospheric potential and altering the distribution of atmospheric electric fields (7). This modulation has been observed to correlate with changes in cloud cover, humidity, and precipitation, reinforcing the role of atmospheric electricity in meteorological processes (8).

Galactic cosmic rays (GCRs), which are modulated by solar magnetic activity, contribute significantly to atmospheric ionization. During periods of high solar activity, increased solar wind pressure reduces the flux of GCRs reaching Earth's atmosphere, leading to lower atmospheric ionization and reduced conductivity within the GEC (9). Conversely, during solar minimum conditions, higher GCR flux enhances atmospheric ionization, increasing the electric field strength and potentially influencing cloud microphysics (10).

The impact of solar-modulated atmospheric electricity on cloud dynamics is evident in polar regions, where variations in the GEC have been linked to changes in tropospheric pressure and temperature (11). Studies suggest that fluctuations in atmospheric conductivity influence cloud condensation processes, affecting the spatial distribution and intensity of cloud cover in high-latitude regions (12). These interactions provide evidence for a coupling mechanism between solar activity, atmospheric electricity, and climate variability.

Geomagnetic activity, driven by solar events, has been found to correlate with changes in tropospheric temperature, specific humidity, and cloud properties in both high and mid-latitudes (13). This relationship underscores the influence of space weather on atmospheric energy balance, as variations in electric field strength can enhance or suppress cloud formation depending on prevailing meteorological conditions (14).

The role of the GEC in lightning activity further highlights the link between solar variability and weather phenomena. Lightning frequency and intensity have been observed to fluctuate in response to changes in cosmic ray flux and atmospheric electrical conductivity, suggesting that space weather events can influence convective storm activity through modulation of the GEC (15). This mechanism contributes to the broader understanding of how solar-induced changes in atmospheric electricity translate into weather variability.

Long-term variations in solar activity, such as the 11-year sunspot cycle, introduce periodic changes in the strength of the GEC. These variations have been linked to shifts in regional climate patterns, with implications for precipitation trends and atmospheric circulation (16). The response of the GEC to solar activity further reinforces the need to consider space weather as a factor in climate modeling and prediction (17).

The influence of the GEC extends beyond tropospheric weather, as it has been implicated in modulating atmospheric pressure anomalies. Changes in ionospheric potential, driven by solar wind interactions, have been associated with fluctuations in zonal-mean tropospheric pressure patterns (18). This mechanism provides further evidence for the role of atmospheric electricity in large-scale climate variability (19).

Observations have shown that short-term variations in the GEC can influence atmospheric dynamics on daily to seasonal timescales. Electric field fluctuations within the atmosphere, modulated by space weather events, have been linked to shifts in cloud properties and precipitation patterns (20). These findings highlight the complex interactions between solar variability, atmospheric electricity, and meteorological processes.

Transient changes in atmospheric electricity during space weather events, such as solar storms and CMEs, can lead to rapid modifications in cloud cover and precipitation rates (21). These events provide natural experiments for studying the impact of ionospheric disturbances on tropospheric weather and climate (22).

The role of atmospheric electricity in cloud formation processes has been further supported by studies on the impact of ionospheric electric fields on cloud microphysics. Variations in the GEC have been linked to changes in cloud droplet size distribution, which can influence rainfall intensity and storm development (23). These interactions highlight the importance of atmospheric electricity in weather prediction models (24).

Uncertainties in climate projections have been partially attributed to the incomplete representation of solar-induced variations in atmospheric electricity. Errors in modeling the influence of the GEC on cloud properties and precipitation patterns can propagate through climate simulations, affecting long-term predictions of global temperature trends (25). Understanding the contribution of space weather to climate variability is therefore critical for improving climate forecasting capabilities (26).

Recent studies have demonstrated that solar-driven changes in the GEC can influence atmospheric circulation patterns at regional and global scales. Fluctuations in atmospheric conductivity have been linked to variations in jet stream positioning, which in turn modulate storm tracks and precipitation distributions (27). These findings suggest that solar activity indirectly shapes weather patterns through its influence on atmospheric electricity (28).

The impact of the GEC on surface atmospheric pressure systems provides another mechanism for solar-climate coupling. Observations indicate that variations in ionospheric potential can alter pressure gradients in the lower atmosphere, influencing wind patterns and storm development (29). This mechanism reinforces the role of space weather in shaping meteorological phenomena (30).

In summary, the Sun's activity exerts a significant influence on the GEC, which in turn affects weather and climate. Through mechanisms such as ionospheric heating, modulation of cosmic rays, and geomagnetic interactions, solar variability alters the GEC's properties, **leading to changes in atmospheric dynamics, impacts cloud microphysics, cloud cover, precipitation, atmospheric pressure patterns, temperature, humidity, thunderstorm activity, lightning frequency, storm development, wind patterns, jet stream positioning, storm tracks, and regional climate variability.**

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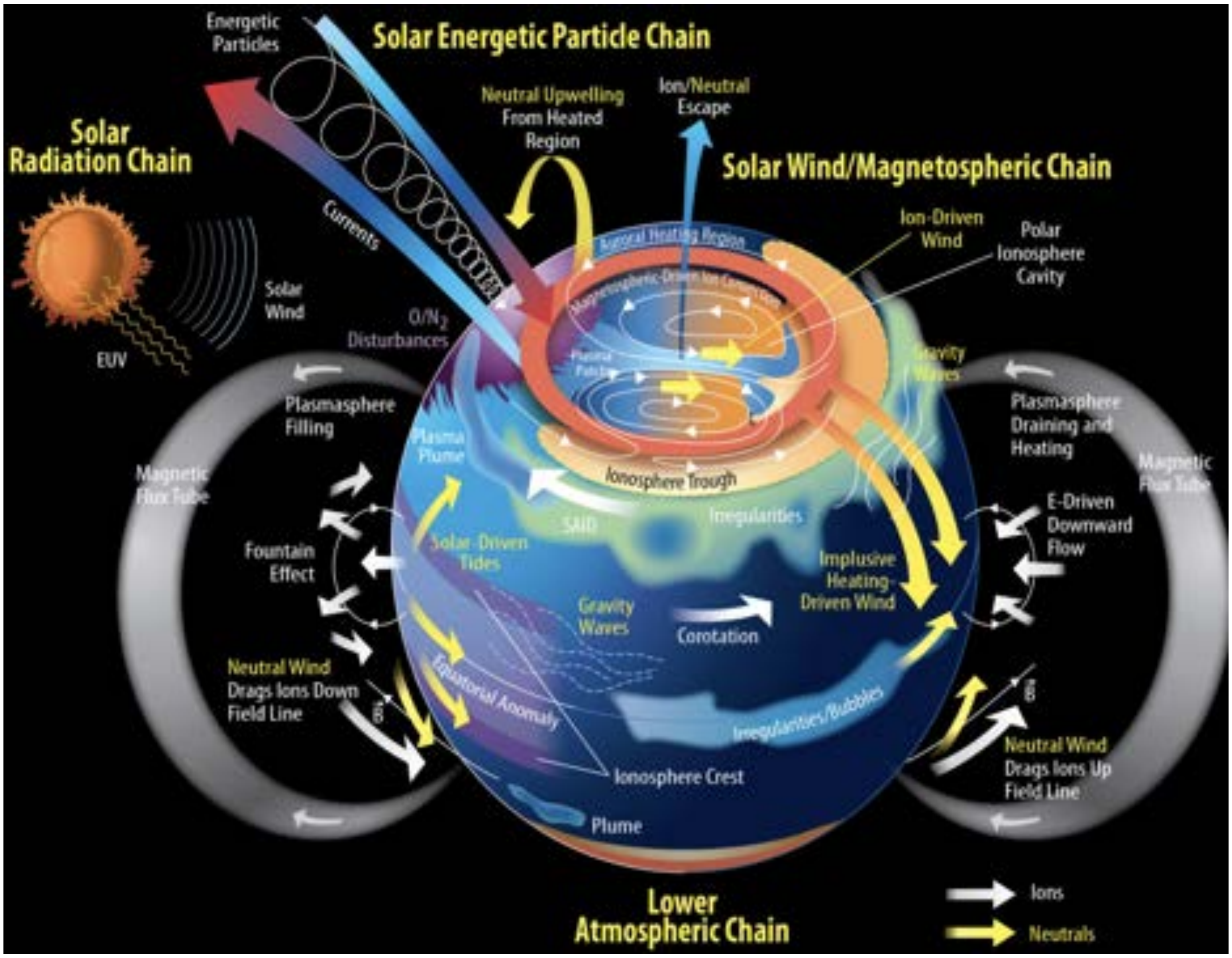

The Latest Electric Details

The Sun plays a fundamental role in shaping Earth's atmospheric structure and dynamics. Its variability influences atmospheric ionization, electric currents, and thermospheric density through interactions with the interplanetary magnetic field (IMF) and solar energetic particles. Solar-driven processes modify the ionosphere, affecting global circulation patterns and contributing to space weather phenomena.

The response of the upper atmosphere to solar activity is particularly strong in the polar regions, where charged particles penetrate more easily, altering conductivity and atmospheric flows. Recent studies paint a clear picture that the sun needs to be given much more credit for the climate:

The impact of solar energetic particles on the ionosphere has been recently revised significantly, revealing that ionization rates over the polar cap are approximately **three times higher than previously estimated** (1).

This correction enhances our understanding of how solar radiation and particle precipitation alter atmospheric conductivity, **influencing the strength and extent of ionospheric disturbances and the GEC**. Additionally, the interaction between the IMF and Earth's bow shock plays a key role in energy conversion, with up to **11% of incoming solar wind energy being transferred into geomagnetic processes, which is wholly missing from current models** (2). This energy injection contributes to large-scale atmospheric currents, affecting ionospheric potential and thermospheric behavior.

The orientation of the IMF dictates the structure of field-aligned currents, which are critical for regulating ionospheric convection patterns in the polar regions (3). Variability in the IMF has historically been underestimated, despite its role in shaping magnetospheric dynamics and **influencing atmospheric conductivity** (4).

Small shifts in the IMF direction can induce significant changes in polar cap dynamics, altering **electric field penetration into the lower atmosphere and modifying auroral electrojet intensity** (5). These fluctuations affect the transfer of solar wind energy to the ionosphere, leading to shifts in atmospheric circulation and localized heating.

The IMF's ability to modulate auroral excitation and polar cap patches extends beyond high latitudes, influencing atmospheric penetration fields at lower latitudes (6).

These processes reveal how solar-driven ionospheric currents contribute to space weather variability, affecting **atmospheric electrical fields on a global scale** (7). The complexity of IMF coupling has also been underestimated in ionospheric models, with charge exchange and polarization effects contributing to previously unexplained variations in electrodynamic forcing (8).

These unaccounted interactions are particularly relevant for understanding hemispheric asymmetries in atmospheric response, where variations in magnetic field orientation produce different effects across the two hemispheres (9). Recognizing these asymmetries is crucial for refining models of atmospheric behavior and improving space weather forecasts (10).

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Humans Accidentally Proved This is All True

The United Arab Emirates (UAE) has embarked on innovative weather modification techniques to address its water scarcity challenges. Traditionally, cloud seeding involved dispersing substances like silver iodide or salts into clouds to stimulate precipitation.

However, since 2021, the UAE has been experimenting with drones equipped with electric-charge emission instruments and customized sensors. These drones fly at low altitudes, delivering electric charges to air molecules, a method that successfully produced significant rainfall in July 2021. This made huge international news in 2024 for its success in rain-production.

This approach mirrors natural atmospheric processes where cosmic rays and solar activity influence cloud formation through the Global Electric Circuit (GEC). The GEC describes the continuous flow of electrical currents between the Earth's surface and the ionosphere, maintained by thunderstorms and influenced by solar radiation and cosmic rays.

Variations in solar activity, such as solar flares or changes in the interplanetary magnetic field, can modulate cosmic ray flux reaching the Earth's atmosphere, subsequently affecting cloud condensation nuclei and cloud properties.

The UAE's experiment can be viewed as a controlled simulation of these natural processes. By introducing electric charges directly into the atmosphere, the drones enhance cloud droplet formation, akin to how cosmic rays ionize atmospheric molecules, leading to cloud nucleation.

This deliberate manipulation provides empirical evidence supporting theories that electrical charges, whether from natural cosmic rays or artificial sources, play a crucial role in cloud microphysics and precipitation processes.

Moreover, the success of this experiment underscores the significance of electrical forces in weather modification. It aligns with findings from experiments like CERN's CLOUD project, which investigates the influence of cosmic rays on cloud formation under controlled conditions.

Both approaches highlight the pivotal role of ion-induced nucleation in cloud dynamics, offering insight into how variations in atmospheric ionization, whether from natural or artificial sources, can impact weather patterns.

The UAE's electric charge-based rain enhancement experiment not only offers a practical solution to regional water scarcity but also serves as a real-world validation of the interactions between solar activity, cosmic rays, the GEC, and cloud formation.

Ironically, the same people championing weather modification techniques like this are some of the people who want to keep these electrodynamic solar forcing studies out of climate models.

Rapid Forcing of Solar Impact

The Sun's influence on Earth's atmosphere can be both immediate and profound, with solar activity capable of inducing near-instantaneous changes in the ionosphere and thermosphere. Solar wind fluctuations, geomagnetic storms, and interplanetary magnetic field (IMF) variability drive electric fields and particle precipitation that can rapidly alter atmospheric conductivity, ion drifts, and energy transport. These rapid interactions highlight the fundamental role of space weather in shaping Earth's atmospheric dynamics.

One of the fastest solar-induced effects on the atmosphere is the sudden injection of MeV electrons into the outer radiation belt, leading to rapid and step-like enhancements in electron flux (1).

These events, occurring **within minutes** of solar wind disturbances, can significantly alter atmospheric ionization and thermospheric density. The electric fields generated by geomagnetic sudden commencements propagate globally through the Earth-ionosphere waveguide at **near-light speed, affecting high and low latitudes almost simultaneously** (2).

These disturbances drive subauroral polarization streams (SAPs), which manifest as intense, westward-directed ion flows that extend toward the equator, significantly influencing the global electric circuit (3).

Challenges in modeling these interactions have stemmed from neglected charge exchange processes and polarization components in ionospheric models. These previously unaccounted factors have led to miscalculations in electrodynamic forcing and energy transfer rates (4).

Additionally, hemispheric asymmetries in ionospheric response to IMF variability have disguised key correlations in observational data, making it difficult to accurately predict space weather impacts on atmospheric structure and dynamics (5).

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Chapter 6

The Sun and the Model

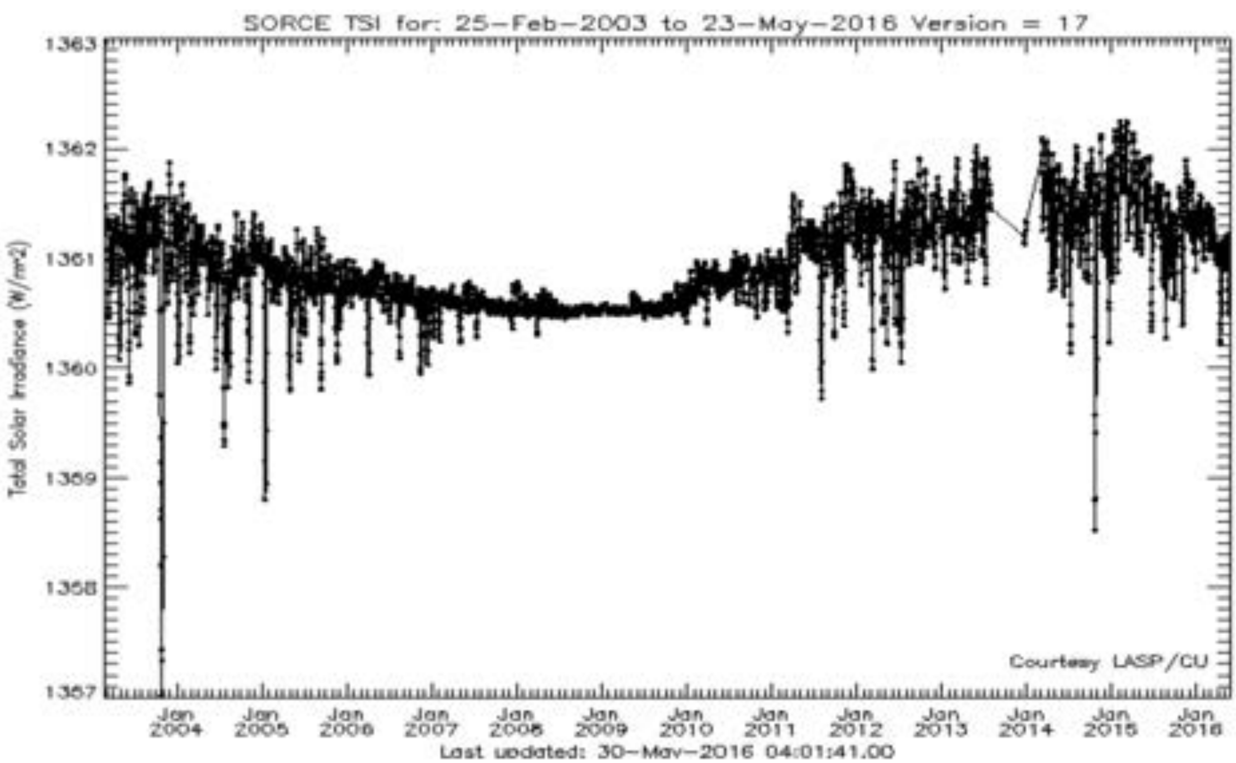
In this chapter, we will see what needs to be added to climate models to accurately represent solar forcing:

- Fix irradiance data which shows reverse-forcing during extreme events.
- Include ignored mechanisms and forcing pathways.

The Glaring Catastrophe of Solar Irradiance (Quick Review)

Climate science is currently marred by the single greatest blunder in the history of geophysics: In official climate models, there is only 0.1% solar variability over the 11-year cycle in terms of influencing Earth's climate.

Until the last 20 years, very few studies of solar forcing on Earth's climate looked at anything other than sunspots or total solar irradiance (TSI). There has been a prevailing theory that the sun is relatively constant in its energetic output (in terms of heating the Earth) and that its effect on the climate is minimal compared with anthropogenic forcing (human pollution, deforestation, etc.). This has come to be known as "the solar constant"- and this is the blunder. TSI measures watt energy input to the atmosphere by sunlight. This short window provided by the Laboratory for Atmospheric and Space Physics essentially shows what the entire timeline shows: TSI and Solar Spectral Irradiance (SSI) vary by approximately 0.1% over the ~11-year sunspot cycle. That is 1/10th of 1%.



Indeed, these TSI readings match the ~11-year frequency of the sunspots and radio waves we saw in Chapter 2, but fluctuate in a much smaller range. **Since this 0.1% variability cycle perfectly matches the sunspot variability, it has been considered that the practical effect of this ~11-year fluctuation is imperceptible and negligible in terms of its effects on the global climate system.**

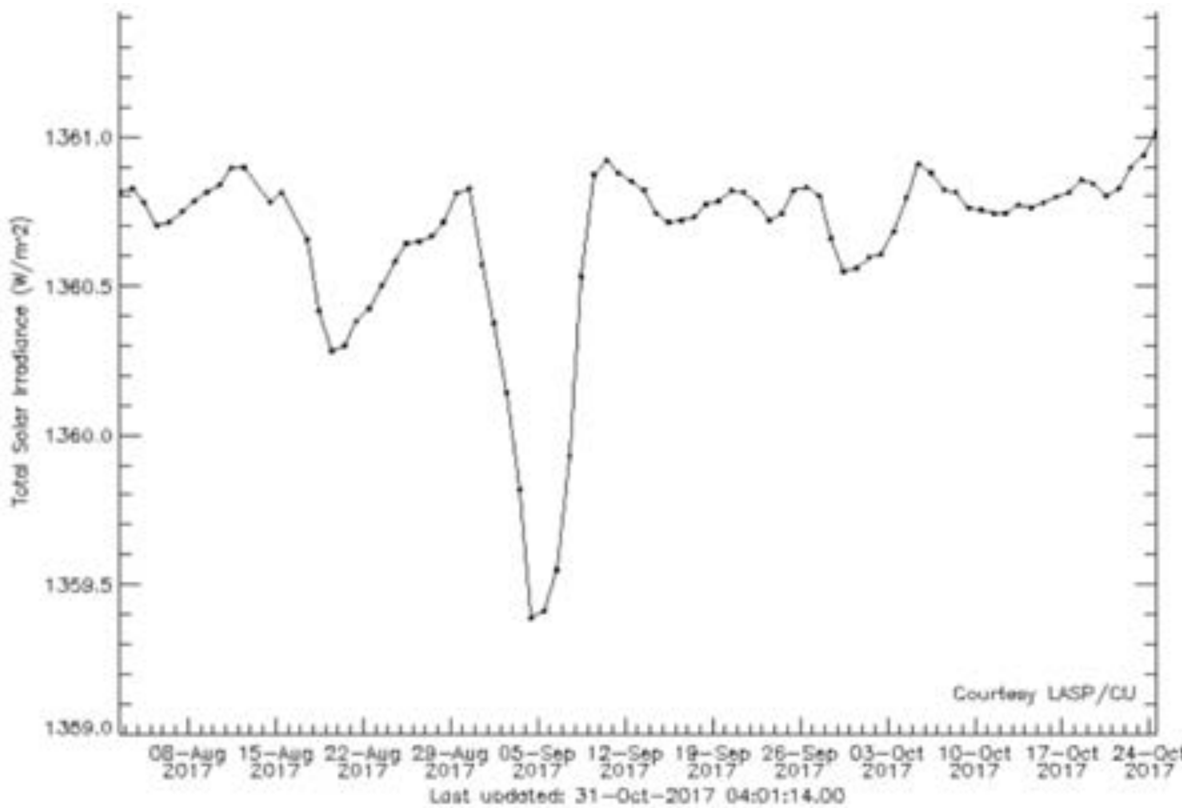
So, what is the problem with that? Answer: The enormous drops in the data curve!

What were the large spikes downward in the graph? They represent times when massive sunspot groups produced large solar flares and CMEs.

A sudden drop in certain UV wavelengths does occur however, in reality this represents a movement in data that is opposite of the actual solar influence, which in fact would be a sharp increase in energy to Earth via X-rays and particles.

One of the best examples of this flaw occurred in early September 2017, with the largest solar flare in 12 years. Due to its direct effects being on Earth layers other than the upper atmosphere, this showed up as an enormous drop in solar energy received when it was a major surplus (next image).

The September 2017 event was one of the most tremendous space weather events on record, with ~1000x increases in particle and x-ray delivery, and it shows up as a drop in solar forcing on the Earth.



Since the true effect of this energy does not go into climate models, the climatological effects we observe (and must account for) are attributed to human activity. This has caused nearly 100% of the confusion surrounding solar climate forcing, and it is a colossal error.

The simple fact is that the energy of strong flares, CMEs and geomagnetic storms affect the Earth in ways other than the near-constant UV output, leaving the prevailing solar dataset to indicate that the sun begins to give us less energy- when in fact the opposite is true.

In terms of solar flares, the X-ray energy received by Earth can vary by 10x over a sunspot cycle, with short-term activity offering 100x to 1000x the energy. In terms of particle radiation, there are almost never any SEP events during sunspot minimum and there are only 1-10% of the number of CMEs during those inactive periods as well.

Geomagnetic storm activity falls during sunspot minimum by a factor of 10x to 20x. GCR fluctuations over the 11-year cycle, and during short-term space weather events, can be 5% to 10% or more. This is all compared to 0.1% variability that has been alone in the climate models throughout the modern evolution of the scientific field.

What *Should* Be in the Climate Models

The lay of the land of solar forcing in climate models as of 2025:

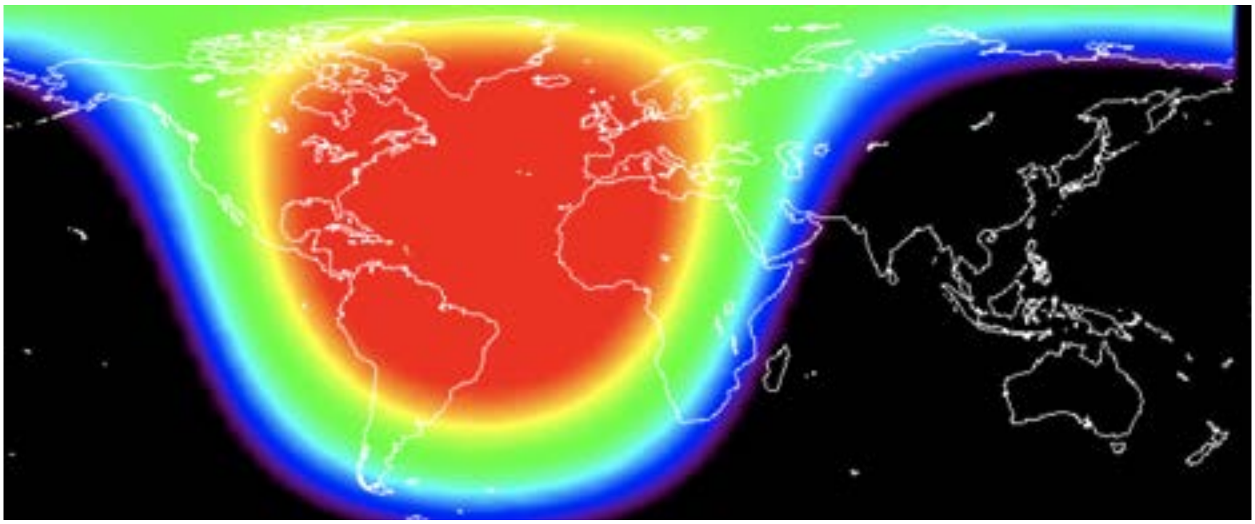
SPACE WEATHER	FORCING ITEM	MODEL INCLUSION NOW?
Irradiance	UV Light	Yes
Flares	X-Ray Light	No
Protons	Particles	No
Solar Wind	Particles	No
Geomagnetic Storms	Magnetism	No
Cosmic Rays	Particles	No

The majority of solar climate/weather forcing is ignored in climate models, one of the more conservative estimates suggests that irradiance is 20% of solar forcing, with the ignored elements accounting for 80% (1), which is 4x the forcing of irradiance alone, and other studies suggest it could be an even greater disparity.

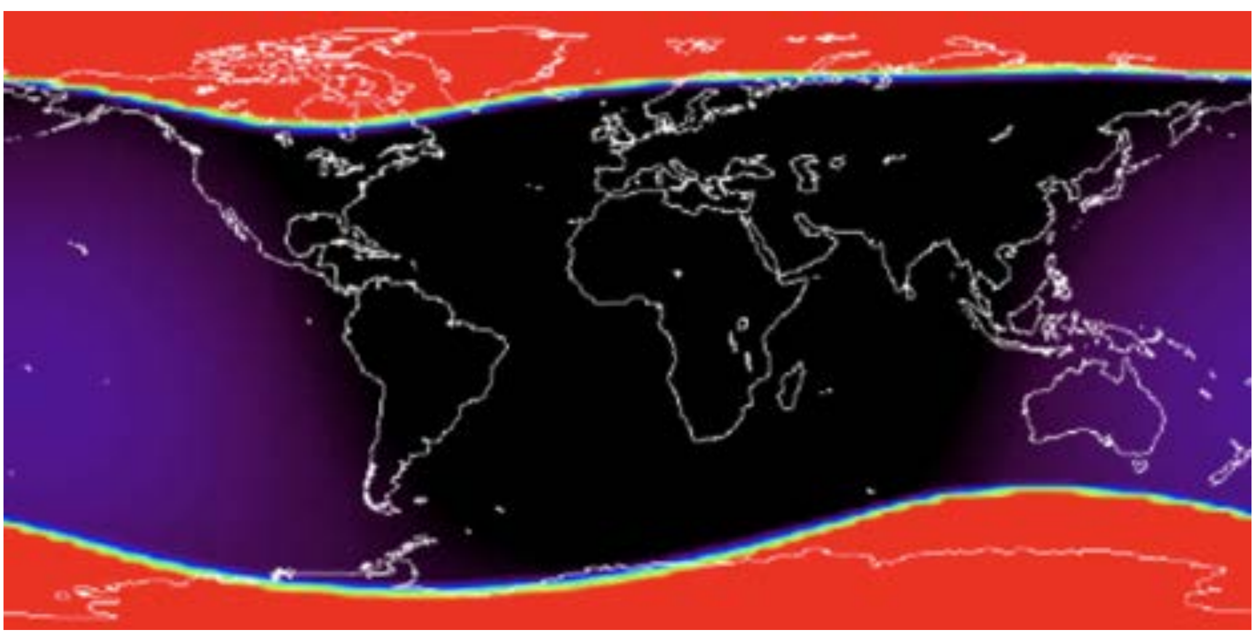
The studies we have covered so-far make it clear that there are a few key pathways that this energy takes on the path toward being integrated into the earth system.

X-Ray Solar Flares: These directly ionize the upper atmosphere and ionosphere, causing a phenomenal delta in conductivity and particle motion within the global electric circuit, which modifies clouds, pressure, wind, temperature and precipitation, while causing induction currents in the ground during flares that are large enough.

The next image shows the ionization event (red) from a flare that occurred while the sun was over the Atlantic ocean, which then quickly (minute-scale) spreads east/west across the globe through the ionospheric waveguide.

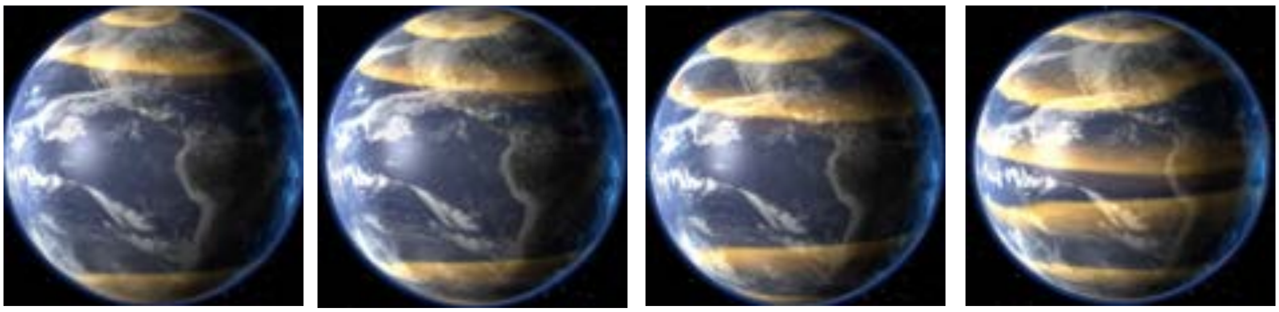


Solar Protons: Large solar eruptions from flares and CMEs can accelerate high-energy protons along the interplanetary magnetic fields threading the solar system, which arrive at earth and enter at the polar cusps, allowing them to easily enter the upper atmosphere, impacting the global electric circuit. In the next image, we can see this polar impact (red) while the solar flaring was not as much of an ionization factor (purple).

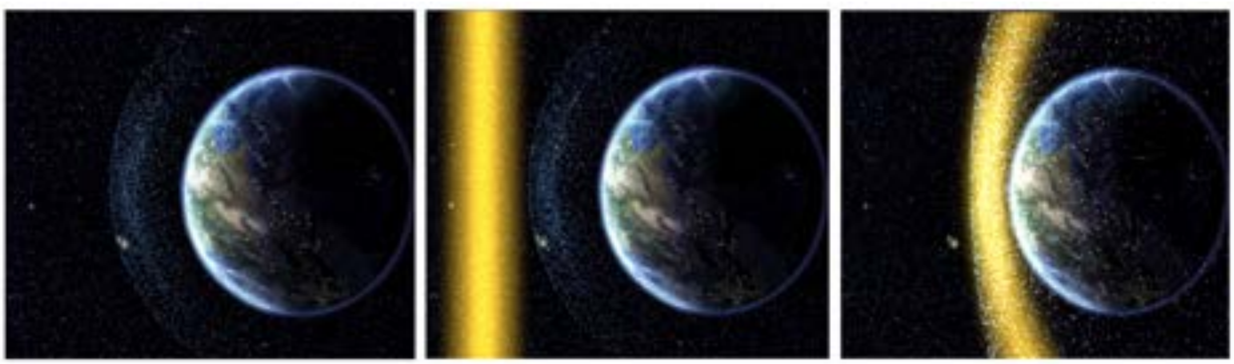


Solar Wind: The solar wind and associated CME/coronal hole enhancements enter the polar cusp, causing similar polar ionization and auroral production.

The auroral energy travels towards the equator (next image sequence, top) while the plasma pressure on the sun-facing side of earth pushes Van Allen belt electrons down into the atmosphere at the equator (image sequence, bottom). This presents a global excitement of the electric circuit.



Auroral Ring Current Energy, Beaming Towards the Equator



Pre-CME Impact　　CME Impact Imminent　　Compression/Coupling

Geomagnetic Storms: While the solar wind disruption is directly adding particle energy to the polar region and the equatorial zone, the plasma is also disrupting the stable baseline state of earth's magnetic field.

These geomagnetic storms cause the magnetic field to fluctuate significantly, causing electric currents to surge through the lower atmosphere and crust, and EMF emissions throughout the surface field zone, which touch every inch of the globe.

Cosmic Rays: These particles do not need to integrate into the global electric circuit (although they do impact it in the same way as other particles) and instead drive straight down into the atmosphere producing their electric particle cascades, and further impacting the clouds, rain, wind, etc. The next image shows the breakout cascade of just one cosmic ray.

The studies describing the sun's impact on major oscillations and modes are fairly long-term, with lag periods from 1 to 20 years. However, the sun's impact on temperatures, precipitation, clouds, wind, lightning, storms, and jet streams is often noted to be much faster (minutes to hours).

The rapid impacts (directly, and through the global electric circuit excitement) are the result of the electromagnetic interactions of the X-rays, solar particles, and magnetic field of earth. While high-energy proton events primarily impact the polar region, the other solar forcing pathways are spread across the globe in nearly no time at all, regardless of what side of earth is facing the sun during the impactful event.

Until these forcing pathways (and the associated statistical correlations) are included in climate models, there will be no truth in their forecasts, or in their attribution of climate change.

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Chapter 7

The Sun and the Human Body

In this chapter, we will examine how the sun impacts our biology:

- Solar activity connections to various cardiac events.
- Solar connection to other physiological events.
- Solar connections to psychological, mental, emotional events.

The Sun and the Heart

The Sun's activity exerts significant influence over the human cardiac system, particularly through its modulation of geomagnetic fields, cosmic ray flux, and atmospheric electric currents. These space weather variables impact heart rate variability, arterial pressure, and cardiovascular disease incidence. As solar activity fluctuates, the interactions between the solar wind, Earth's magnetosphere, and atmospheric processes create an environment where geomagnetic storms and cosmic rays can alter the function of the autonomic nervous system, affecting circulation and cardiovascular stability.

Here are some key details:

Geomagnetic storms, driven by solar activity, have been linked to changes in blood pressure, particularly in elderly populations. Long-term observational studies have demonstrated that fluctuations in geomagnetic activity correlate with **increased blood pressure levels**, with effects comparable to those of traditional air pollution (1).

Similarly, **heart rate variability**, a key measure of autonomic nervous system function, has been shown to decrease during periods of heightened solar activity, indicating **increased cardiac stress and potential cardiovascular risk** (2).

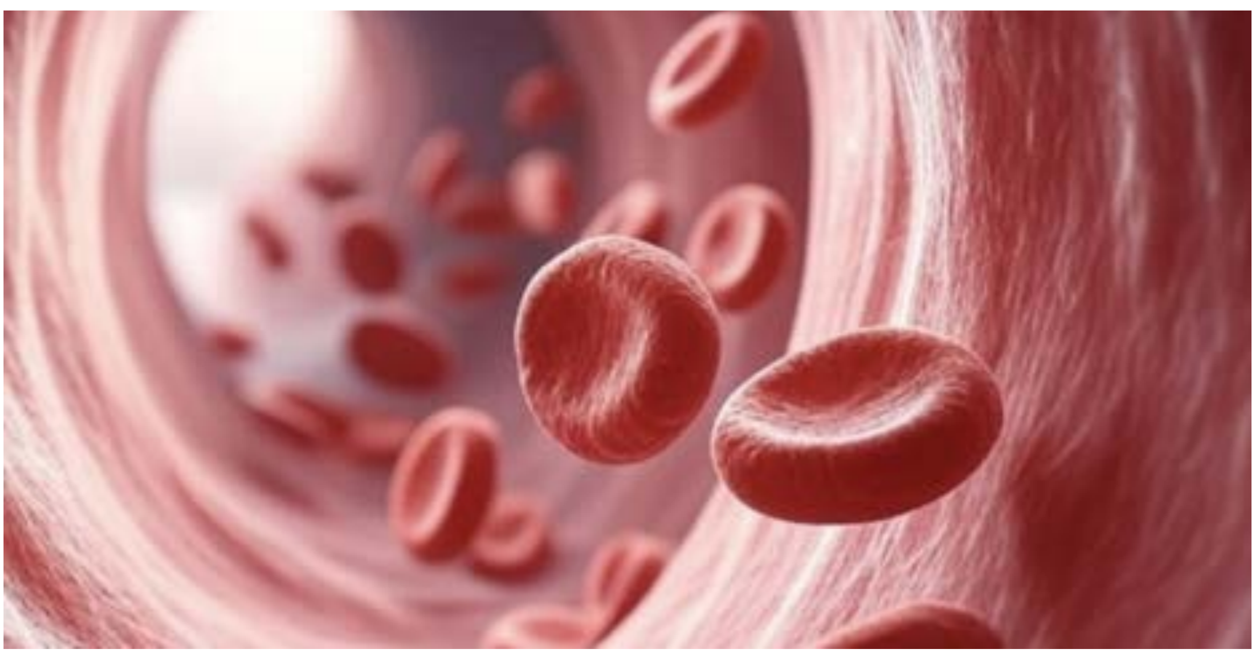
The impact of space weather extends beyond the immediate solar cycle, as geomagnetic disturbances have been associated with **acute myocardial infarction and ischemic heart disease mortality**, highlighting the systemic effects of solar-induced electromagnetic fluctuations on cardiovascular health (3).

The relationship between solar activity and cardiovascular function has been well documented in clinical settings. Studies have shown that geomagnetic disturbances influence microcirculatory blood flow, altering capillary function and arterial pressure variability (4).

Increased geomagnetic activity correlates with disruptions in autonomic nervous system balance, potentially leading to higher incidences of cardiac arrhythmias (5).

The effects of these space weather variables are not limited to patients with preexisting cardiovascular conditions; even healthy individuals experience fluctuations in blood flow velocity and vascular tone in response to geomagnetic storms (6).

The physiological impact of cosmic rays, which are modulated by solar activity, is another crucial factor in cardiovascular health. High cosmic ray flux during periods of low solar activity has been linked to increased cardiovascular disease mortality, particularly in populations susceptible to stroke and myocardial infarction (7).



This connection suggests that both extremes of the solar cycle—high geomagnetic activity and high cosmic ray flux—can influence cardiovascular outcomes. Furthermore, studies have demonstrated that the days of lowest geomagnetic activity coincide with spikes in sudden cardiac deaths, reinforcing the complex interplay between solar variability and cardiovascular events (8).

The effects of solar-induced geomagnetic disturbances extend to changes in arterial pressure and blood coagulation, which can predispose individuals to cardiovascular complications. Observational studies have recorded significant increases in myocardial infarction rates and stroke incidence following geomagnetic storms, with the highest risk occurring within days of a major solar event (9). The mechanisms underlying these effects likely involve alterations in blood viscosity, vascular tone, and oxidative stress, all of which can contribute to heightened cardiovascular risk.

Emerging evidence suggests that metabolic disorders, such as diabetes, may exacerbate susceptibility to geomagnetic influences. Patients with diabetes and other metabolic syndromes exhibit a heightened risk of acute coronary syndrome during periods of high geomagnetic activity, particularly when exposed to solar wind-driven magnetic fluctuations (10). These findings emphasize the importance of understanding how individual health conditions interact with space weather variables to influence cardiac outcomes.

Astronauts provide another important case study in solar-induced cardiovascular effects. Research on Apollo astronauts has revealed higher rates of cardiovascular disease mortality compared to non-spacefaring populations, likely due to prolonged exposure to galactic cosmic rays and the absence of Earth's protective geomagnetic shielding (11).

Experimental studies simulating cosmic ray exposure have further demonstrated that low-dose radiation can induce vascular damage, increasing the likelihood of long-term cardiovascular disease development (12).

At a molecular level, solar activity has been found to influence biochemical markers of cardiovascular health. Studies have reported that blood troponin levels, a key indicator of cardiac stress, fluctuate in response to geomagnetic activity and cosmic ray flux, suggesting a direct link between solar variability and physiological stress responses (13).

Additionally, localized geomagnetic variations have been shown to impact human arterial pressure, reinforcing the concept that even minor solar-induced electromagnetic changes can have measurable effects on cardiovascular function (14).

Exceptionally-detailed investigations have confirmed the increased risk of death from acute myocardial infarction and ischemic heart disease, starting at the moment of the solar flare and lasting for 3 days after the geomagnetic storm (15).

As research continues to explore the intricate relationship between solar activity and human health, it is becoming increasingly clear that space weather plays a crucial role in cardiovascular physiology. Whether through geomagnetic storms, cosmic ray modulation, or atmospheric electric field variations, the Sun's influence on heart function is evident across multiple levels, from autonomic regulation to vascular health. Recognizing these effects is essential for developing preventive strategies to mitigate cardiovascular risk in vulnerable populations.

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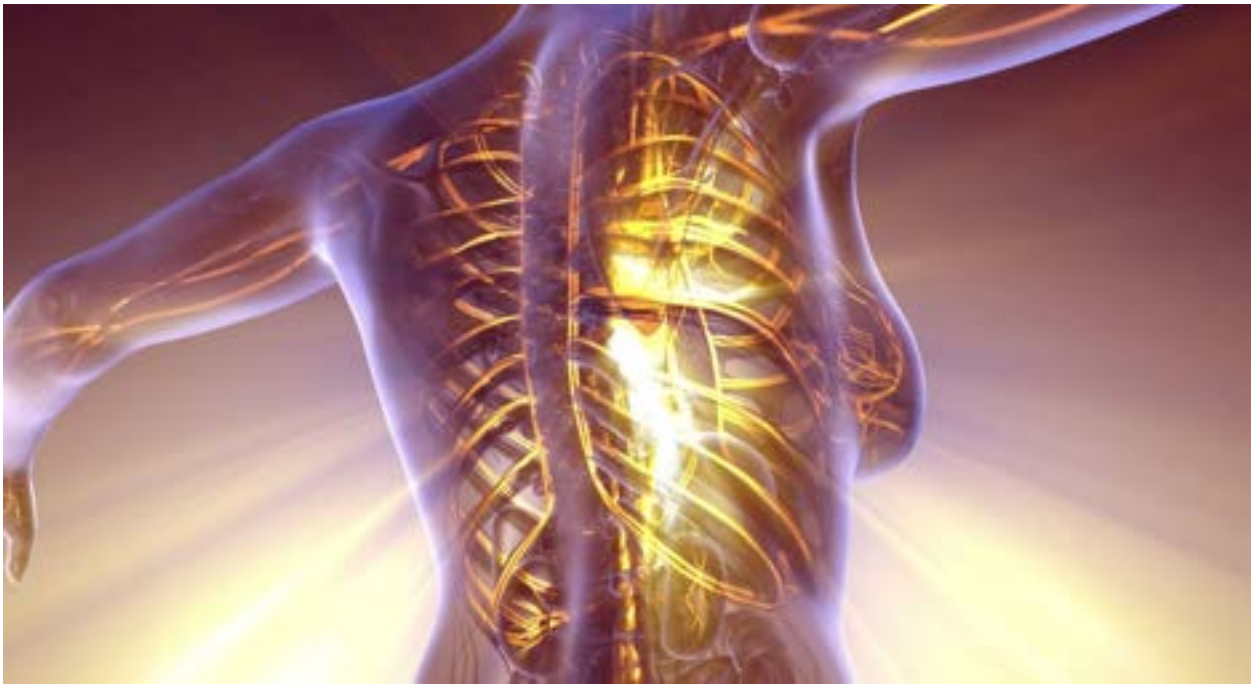

The Influence of Solar Activity on Human Physiology and Health

The sun, the ever-present force in human existence, impacts human health through various direct and indirect mechanisms. While solar energy drives fundamental biological processes necessary for life, such as circadian rhythms, vitamin D synthesis, and mood regulation, its influence extends significantly into the realms of human physiology and health, mediated primarily through electromagnetic interactions and ionizing radiation. The interplay between solar phenomena—such as solar flares, coronal mass ejections (CMEs), geomagnetic storms, and cosmic radiation—and human health outcomes has profound implications for understanding biological vulnerabilities, chronic disease exacerbations, and disruptions of physiological and psychological functioning.

Here are some key details:

Geomagnetic storms, resulting from solar activity, significantly disrupt human circadian rhythms, leading to substantial physiological effects including increased inflammation and fatigue. These disruptions exacerbate chronic illnesses and can notably worsen pre-existing conditions by interfering with the natural biological clock mechanisms integral to maintaining homeostasis (1).

Moreover, research has shown that different levels of geomagnetic activity can distinctly influence circadian rhythms, altering sleep patterns and physiological stability (2).

Evidence also suggests geomagnetic disturbances are correlated with fluctuations in arterial blood pressure, particularly exacerbating hypertension in vulnerable populations. Such effects are more pronounced during stronger geomagnetic events, implicating the geomagnetic field as an environmental stressor capable of altering cardiovascular health (3). Additionally, research indicates that geomagnetic storms and cosmic ray flux variations inversely correlate with human health indicators; for example, days with extremely low geomagnetic activity (high cosmic ray influx) see increases in medical emergencies, psychiatric admissions, accidents, and even suicides (3,4).

The synchronization of human autonomic nervous system rhythms with geomagnetic activity reveals deeper connections between environmental electromagnetic fields and physiological processes. These interactions can disrupt homeostasis, contributing to a variety of health outcomes ranging from minor disturbances in attention and cognition to profound neurological and psychiatric conditions (5). Such disruptions emphasize the underlying role of geomagnetic fluctuations in both acute and chronic health conditions.

The specific neurological consequences of solar activity, notably during strong geomagnetic storms, include increased occurrences of seizures, migraines, and other neurological disorders. The mechanisms behind these effects include alterations in neural excitability, changes in cerebral blood flow, and disruptions to neurotransmitter functions, which collectively exacerbate neurological vulnerabilities (6).

The evidence supporting geomagnetic activity's impact on neurological health has become increasingly robust, extending to implications for broader cognitive and psychological functioning (7).

Solar activity has also been identified as a potential risk factor for autoimmune diseases. Geomagnetic disturbances appear to influence autoimmune responses, possibly by triggering systemic inflammation and disrupting normal immune system function, thereby increasing susceptibility to autoimmune disorders (8).

These associations are reinforced by epidemiological studies linking increased autoimmune disease incidence with periods of heightened solar activity (9).

Research into multiple sclerosis (MS) has found consistent correlations between geomagnetic disturbances and both the onset and exacerbation of symptoms. Specifically, strong geomagnetic storms have been linked to increased hospital admissions and disease flares, with these effects persisting months after the storm events (10,11).

Notably, pediatric MS onset has similarly been associated with periods of elevated geomagnetic activity, suggesting lifelong vulnerability to solar-induced environmental stressors (12).

Solar radiation, particularly solar proton events, presents direct biological risks, primarily affecting airline passengers, astronauts, and aircrew through increased radiation exposure. Such events can deliver biologically significant doses of radiation, raising cancer risk and genetic damage concerns for frequent flyers and space travelers (13,14).

Recent assessments highlight that frequent and prolonged exposure to such radiation could indeed pose substantial long-term health risks, including carcinogenesis (15).

Neurological health, particularly cognitive performance and hippocampal function, is demonstrably impaired following exposure to charged particle radiation common in solar energetic particle (SEP) events. Animal models exposed to neutron radiation—a component of cosmic rays—exhibit significant memory impairment and diminished neurogenesis within the hippocampus, demonstrating clear evidence of solar radiation's harmful effects on critical brain structures (16,17).

The biological effects of magnetic storms and extremely low-frequency (ELF) magnetic fields have been further elucidated through their impact on fundamental cellular processes. These include DNA damage, disruptions in cellular reproductive mechanisms, inflammation, reduced immune response, and impaired wound healing—all processes essential to maintaining health and resilience against disease (16,17). Such fields, often intensified during solar storm events, represent an underappreciated environmental factor influencing general health outcomes.

Moreover, the impact of solar-driven geomagnetic activity extends to human psychological states, with established correlations to mood disorders and anxiety levels. Solar events, through the modulation of global electromagnetic environments, appear capable of influencing mental health outcomes, likely via altered brainwave patterns and neural synchronization (18,19).

This connection is particularly evident in studies showing increased suicide rates and mood disorders during specific cosmic ray and geomagnetic conditions (20).

Solar activity's effect on infectious disease prevalence, notably influenza, has historical backing, suggesting that periods of high solar and geomagnetic activity correlate with increased severity and frequency of influenza outbreaks. It is hypothesized that this correlation stems from solar modulation of atmospheric conditions conducive to virus survival and transmission (21).

Solar radiation also influences physiological stress responses, observable through measurable changes in human skin conductance and muscle electrical activity. Such responses represent immediate bioelectrical adaptations to environmental electromagnetic changes induced by solar disturbances, reflecting deeper biological sensitivities to electromagnetic stimuli (22,23).

Emerging studies extend these findings, demonstrating that ELF and ultra-low-frequency (ULF) electromagnetic field exposure influences gene expression related to circadian rhythms and neurological functions. This molecular-level interaction offers insight into how subtle changes in environmental electromagnetic fields can significantly impact human biological functioning at the genetic and cellular levels (24,25).

Interestingly, human emotional and psychological well-being has been statistically linked to solar activity, with happiness indices demonstrating inverse relationships with sunspot numbers. Periods of low solar activity and higher cosmic ray influx correlate with increased subjective well-being in certain populations, suggesting a nuanced, frequency-dependent relationship between solar activity and psychological health (24).

In our next section, we will break out the expanding science on how these space weather impacts use electromagnetic interactions like direct particle radiation, the schumann resonance and magnetic resonance to impact the brain. (26, 27,28).

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The Sun and the Brain

Solar activity profoundly affects human physiology, psychology, and overall health. Variations in solar phenomena, including solar flares, geomagnetic storms, and galactic cosmic rays (GCR), directly and indirectly impact neurological, cognitive, emotional, and behavioral responses in humans. These solar-driven events influence neural functioning, mood regulation, cognitive capabilities, and behavior, highlighting the intricate biological responses to our dynamic solar environment.

Galactic cosmic radiation exposure poses a risk to cognitive functions, particularly during prolonged space travel such as missions to Mars. Cognitive impairments resulting from exposure include deficits in learning, memory, and executive functioning, all critical to astronaut health and mission success (1,2,3,4).

Studies utilizing animal models exposed to simulated cosmic rays consistently demonstrate sustained cognitive dysfunction, suggesting lasting neurological vulnerability due to cosmic radiation (5,6).

Geomagnetic storms, another consequence of increased solar activity, disrupt human psychological states significantly. Psychological disturbances such as anxiety, agitation, and mood disorders often correlate with heightened geomagnetic conditions, reflecting a direct interaction between geomagnetic fluctuations and neural stability (7,8). These disruptions are particularly pronounced during extreme geomagnetic activity, correlating with altered brainwave activity, especially within the theta frequency range, which modulates emotional and cognitive processes (7,8).

Further research has indicated that solar events directly influence behavior and psychological states in animal studies, manifesting as increased aggression, excitability, and abnormal behaviors during heightened solar activity (9,10).

Low-frequency electromagnetic fields linked to solar and geomagnetic disturbances have similarly been shown to influence aggressive behaviors and high-risk decision-making, reinforcing their potential role in modifying neural processing and psychological stability in humans as well (11).

Extremely low-frequency (ELF) electromagnetic fields generated during severe geomagnetic storms significantly impact critical brain regions such as the locus coeruleus. This region, essential for managing stress and anxiety responses, becomes disrupted under conditions of elevated geomagnetic activity, contributing to heightened panic and anxiety episodes in susceptible individuals (11,12).

Such disruptions are further supported by evidence of alterations in circadian rhythms and gene expression patterns in brain tissues following exposure to ultralow-frequency electromagnetic fields, suggesting molecular mechanisms underlying these observed psychological changes (13,14).

At the cellular level, exposure to static and extremely-low frequency electromagnetic fields during geomagnetic events triggers oxidative stress, causing widespread cellular damage through free radical generation. This oxidative stress can impair cellular function, thereby influencing cognitive and neurological outcomes (13,14).

Meta-analyses have confirmed cognitive impairments following exposure to radiation types frequently encountered during solar events, further implicating the role of oxidative stress and cellular dysfunction (15,16).

Studies on heavier cosmic radiation particles, particularly iron nuclei, illustrate that these highly energetic particles significantly exacerbate cognitive deficits by damaging neuronal structures, accelerating oxidative stress, and diminishing neurogenesis, primarily in brain areas responsible for learning and memory (16,17).

Helium nuclei exposure has similarly been linked to substantial cognitive deterioration, reinforcing the broad neurotoxic potential of cosmic ray constituents beyond just protons and iron nuclei (17,18).

Neurological damage caused by cosmic radiation is further exacerbated through oxidative stress and neuroinflammatory pathways. Such inflammation can result in pronounced cognitive deficits, persistent changes in neuronal function, and vulnerability to neurological diseases, particularly affecting memory and cognitive flexibility (19,20). These findings underscore the extensive risks associated with prolonged or repeated exposure to cosmic radiation.

Additionally, high geomagnetic activity has been statistically associated with significant increases in suicide rates. These correlations appear driven by geomagnetic disruptions affecting neurochemical pathways related to mood regulation, emphasizing the profound psychological consequences of solar disturbances (21).

Independent reviews also support associations between geomagnetic disturbances and increased occurrences of depression, anxiety, agitation, and general cognitive impairment, further solidifying this relationship (22).

Long-term statistical analyses reinforce that solar and geomagnetic activity correlate strongly with fluctuations in violent crime rates, especially within urbanized areas. This correlation suggests a broad impact of geomagnetic disturbances on human behavioral control and social interactions, with elevated geomagnetic activity coinciding with increased incidences of violent behavior and crime (23).

Furthermore, global analyses show concurrence between increased instances of aggressive behaviors, including acts of terrorism, and heightened solar-geomagnetic activity over extended periods, highlighting widespread societal impacts (24).

In parallel, research into suicide rates reveals significant associations between elevated geomagnetic activity and increased occurrences of suicide, providing a possible link between geomagnetic disturbances and altered neurochemical regulation within the human brain, particularly involving mood-stabilizing neurotransmitters (21). This evidence reinforces the potential role of geomagnetic fluctuations as a significant environmental trigger for mental health crises.

Thus, solar-induced geomagnetic phenomena, through electromagnetic interactions and cosmic radiation, significantly modulate biological processes from cellular function to cognitive and psychological health, illustrating the broad and nuanced ways in which the sun influences human well-being.

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GEOMAGNETIC & COSMIC RAYS HEALTH RISKS

AT THE EXTREMES OF THE SCALE

Kp Index Score:

0 1 2 3 4 5 6 7 8 9

Cosmic Ray Risk* **S A F E Z O N E** **Geomagnetic Storms**

All Biological Life:

Increased Risk/Exacerbation of Seizure, Migraine, Cognitive Diminution, Melanin and Light-Based Disorders, Multiple Sclerosis, Auto-Immune Disorders (including Lupus, Arthritis, Epidermal/Glandular), Anxiety, Emotional Instability

High Risk Patients:

ALL Cardiac Risks Elevate During Geomagnetic & Cosmic Ray Events. Numerous Negative Mental Health Events are Associated with the Extremes of the Scale (Suicide, Hospitalizable Episodes of Depression, Anxiety, Bipolar disorder, etc.)

* Cosmic Ray events begin after ~12hrs of Kp=0 or ~24hrs of Kp<1
"Major" alerts occur at 24hrs of Kp=0 or 48hrs of KP<1

Solar Proton Radiation Storm (SEP Event) Risks are the Same as for Geomagnetic Storms, Except They Are Initiated by Solar Flares

SOLAR FLARE HEALTH RISKS

INTENSITY-BASED RISK

Solar Flare Index

A1 B1 C1 C5 M1 M5 X1 X5 X10 X20

"The Stronger The Flare, The Higher The Risk"

All Biological Life:

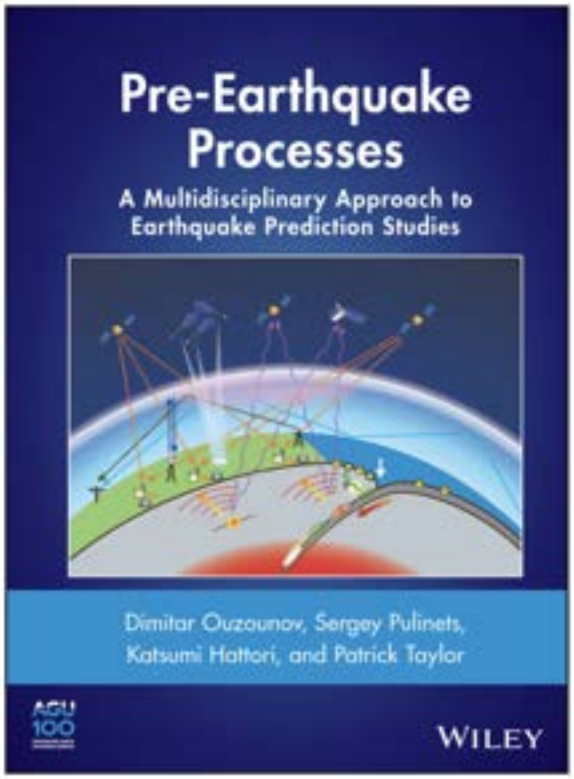
Increased Risk/Exacerbation of Seizure, Migraine, Visual Impairment, Reduced Cognition/Reaction Time, Melanin and Light-Based Disorders, Auto-Immune Disorders (including Lupus, Digestive, Glandular), Significant Anxiety/Depression Events

Chapter 8

Electroquake Triggering By the Sun

In this chapter, we will see how the sun triggers earthquakes:

- Electromagnetic pre-earthquake signals.
- Solar forcing of seismicity.
- Solar forcing of volcanos.
- Energy interaction with the crust.



The Sun and Earthquakes

An active sun influences Earth's geophysical environment in many ways, including its impact on seismic activity. When solar activity increases, the Earth experiences heightened exposure to solar wind, geomagnetic storms, and fluctuations in the magnetosphere. These energetic interactions are hypothesized to affect the Earth's lithosphere, atmosphere, and ionosphere, potentially influencing earthquake occurrence. The connection between solar activity and seismic events remains an area of scientific debate, yet accumulating evidence suggests a correlation driven by geomagnetic disturbances, ionospheric fluctuations, and electromagnetic coupling between the Sun and Earth's crust.

Solar activity influences the Earth's magnetosphere through solar flares and coronal mass ejections (CMEs), which introduce large-scale perturbations to the geomagnetic field (1). These perturbations can generate geomagnetically induced currents (GICs) in the Earth's lithosphere, altering stress distributions in fault zones and potentially triggering seismic events (2). Studies have found that strong solar flares, particularly those preceding geomagnetic storms, are associated with an increase in large-magnitude earthquakes, suggesting a solar-geomagnetic influence on seismic activity (3). Furthermore, the impact of CMEs can last for days, continuously affecting the Earth's ionosphere and lithosphere (4).

The ionospheric response to solar activity has also been linked to pre-earthquake signals. Variations in total electron content (TEC) and anomalies in ionospheric electron density have been observed prior to seismic events, with these perturbations often aligning with solar storm occurrences (5). The ionosphere, influenced by solar radiation and geomagnetic activity, undergoes electrical and thermal variations that could interact with tectonic stresses below (6). Satellite observations have confirmed that ionospheric anomalies correlate with earthquake-prone regions, further supporting the idea of a space-Earth coupling mechanism (7).

Electromagnetic signals, including ultra-low-frequency (ULF) and very-low-frequency (VLF) emissions, are another key indicator of pre-earthquake activity. These emissions are affected by geomagnetic storms and solar-driven electric field fluctuations (8). Statistical analyses show that ULF electromagnetic anomalies frequently precede significant seismic events, possibly due to stress-induced piezoelectric effects in the crust (9). The presence of these electromagnetic anomalies prior to earthquakes suggests that solar-induced geomagnetic variations may play a role in earthquake triggering (10).

The role of radon emissions as a seismic precursor has also been examined in relation to solar activity. Radon gas, released from the Earth's crust due to tectonic stress, exhibits variations in response to geomagnetic storms (11). Increased cosmic ray flux, which occurs during geomagnetic disturbances, can enhance radon release through ionization effects in the subsurface (12). This interaction provides another potential link between solar activity and earthquake precursors, reinforcing the argument that space weather may influence seismicity (13).

Historical correlations between solar cycles and seismic events have been investigated, revealing patterns that align with solar maxima and minima. Some studies indicate that periods of high solar activity correspond to an increased frequency of large earthquakes, potentially due to cumulative effects of geomagnetic stress on the Earth's lithosphere (14). Conversely, seismic quiet periods have been observed during solar minima, further implying a connection between the Sun's activity and earthquake distribution (15).

Additionally, weakening of the Earth's magnetic field, as observed in current trends, has been linked to increased geoelectric effects and space-weather interactions, which could in turn amplify stress distributions in the crust (16). Geomagnetic fluctuations have been found to influence radon emissions and other pre-earthquake signals, supporting the idea that space weather may contribute to seismicity through electromagnetic coupling mechanisms (17). With ongoing solar cycle variations and increasing geomagnetic excursions, concerns have been raised about potential space-weather-induced seismic activity in the coming decades (18).

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Cosmic Volcanic Forcing

Solar activity, including solar flares, geomagnetic storms, and variations in cosmic rays, can potentially influence volcanic eruptions. These solar phenomena interact with Earth's geophysical systems, possibly triggering volcanic activity through electromagnetic effects, particle bombardment, and induced stress changes within Earth's crust.

Cosmic rays are among the solar phenomena implicated in influencing volcanic eruptions. High-energy cosmic rays may interact with volatile substances in volcanic magma chambers, triggering nucleation processes similar to those observed in bubble chamber experiments. This interaction can destabilize underground gases, causing explosive eruptions (1). Statistical analyses further strengthen this connection, identifying correlations between periods of heightened solar wind activity and increased global volcanic eruptions (2).

The relationship between solar activity and volcanic events has been observed through variations in electromagnetic fields associated with solar disturbances. During periods of elevated geomagnetic activity, induced electrical currents within Earth's crust may impact volcanic stability by influencing magma chamber pressures or altering the stress distribution in volcanic structures (3,4). Geomagnetic storms, driven by increased solar emissions, have preceded volcanic events, reinforcing the potential causal connection between solar-induced magnetic disturbances and volcanic activity (3,4).

Cosmic ray interactions also extend deeper into the geological environment, affecting subterranean radon emissions and electromagnetic fields preceding volcanic activity. Radon anomalies often correlate temporally with peaks in solar and cosmic ray activity, providing an indirect yet significant indicator of solar influence on volcanism through geochemical pathways (3). These anomalies, coupled with electromagnetic precursors detected prior to eruptions, reinforce the hypothesis of a solar-driven triggering mechanism (4).

Additionally, studies have identified thermal anomalies preceding eruptions, suggesting another pathway through which solar activity might influence volcanic processes. Satellite observations consistently detect increased surface temperatures preceding major volcanic eruptions, a phenomenon possibly resulting from solar-induced electromagnetic disturbances interacting with Earth's crustal stresses (4). Variations in ionospheric electron density, another indicator sensitive to solar activity, have also been documented prior to volcanic events, highlighting broader geophysical reactions to solar influences (5).

Research further indicates that the sun's electromagnetic activity may directly induce physical stresses in the Earth's crust. Increased electromagnetic currents generated by solar disturbances might affect volcanic conduits by altering magma pressures and physical conditions within the Earth's lithosphere, enhancing eruption likelihood during periods of intense solar activity (6). Laboratory studies replicating solar-driven electromagnetic conditions demonstrate their capacity to generate mechanical stress sufficient to facilitate volcanic events through induced piezoelectric effects (6).

Satellite-based studies have contributed significantly to understanding solar-volcano interactions, consistently revealing thermal and electromagnetic anomalies preceding major volcanic eruptions. Observations from satellite systems have clearly linked periods of intensified solar activity with subsequent terrestrial volcanic events, demonstrating a strong statistical and temporal association that supports solar triggering mechanisms (7).

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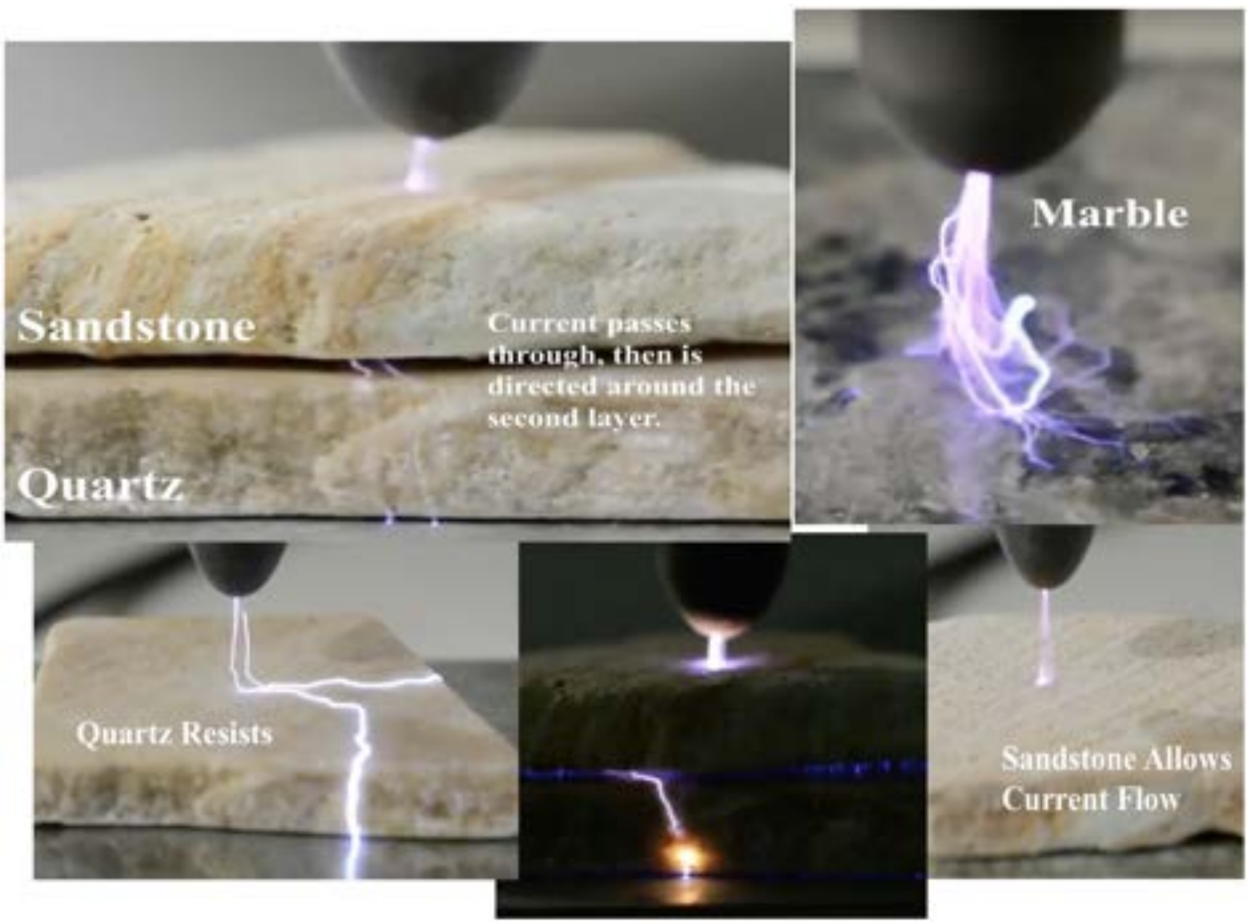
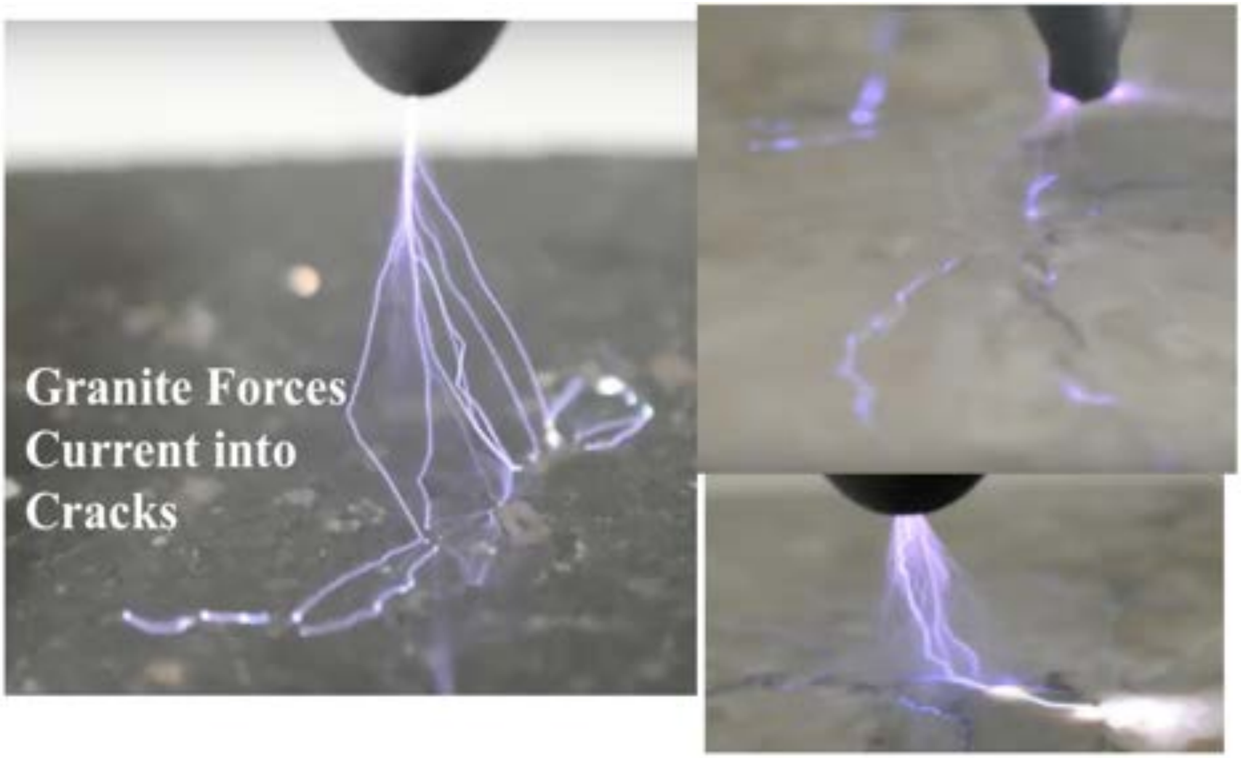
When Electromagnetic Energy Reaches the Ground

How do we know what Earth's energy does when it gets to the ground? We Tried It!

Understanding the process by which Earth's electricity triggers ground changes needs no time to work through the red tape of academia, you just need your eyes. The images on the following pages show how the circuit will bend, accumulate, and transfer through and around different rocks based on their composition and water content.

The following compilations are produced from images taken by Billy Yelverton Jr. in his lab. These are arc-discharges and glow-mode plasma (for visibility) but on Earth, the plasma is in 'dark-mode' while still very much flowing in currents.



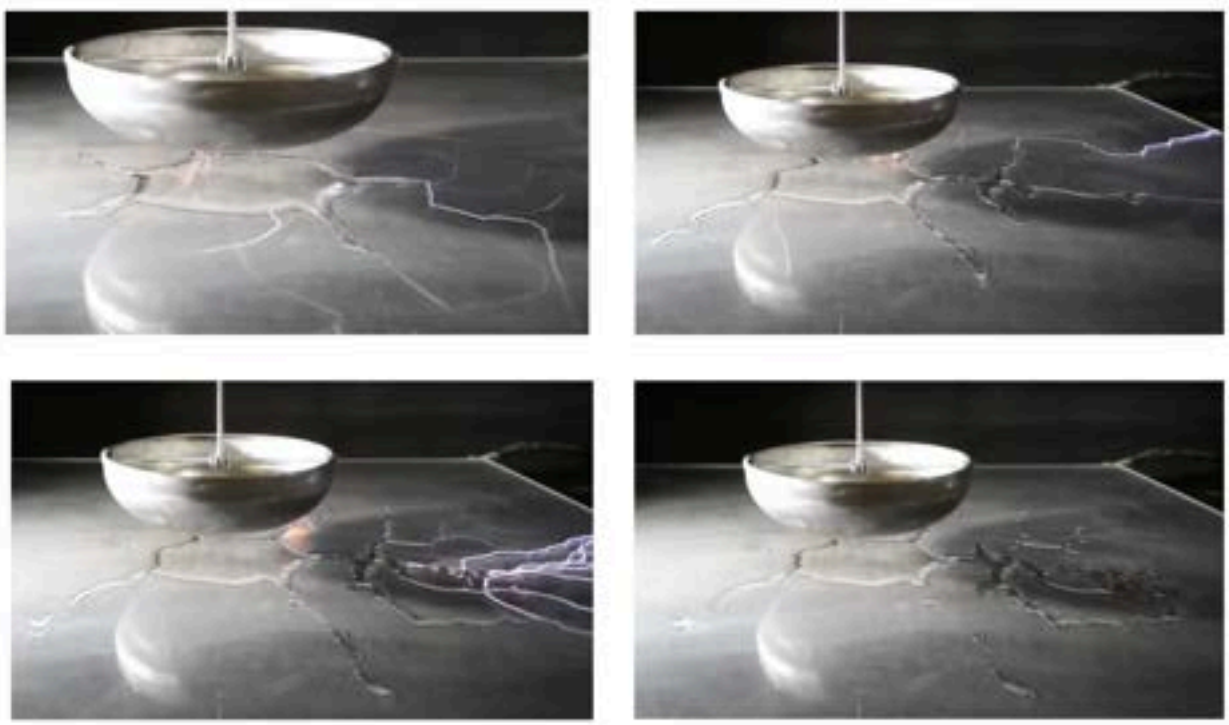


ABOVE: (Left) Current into granite. (Right) Cracks in granite become illuminated with plasma.
BELOW: More examples, with the lights off.

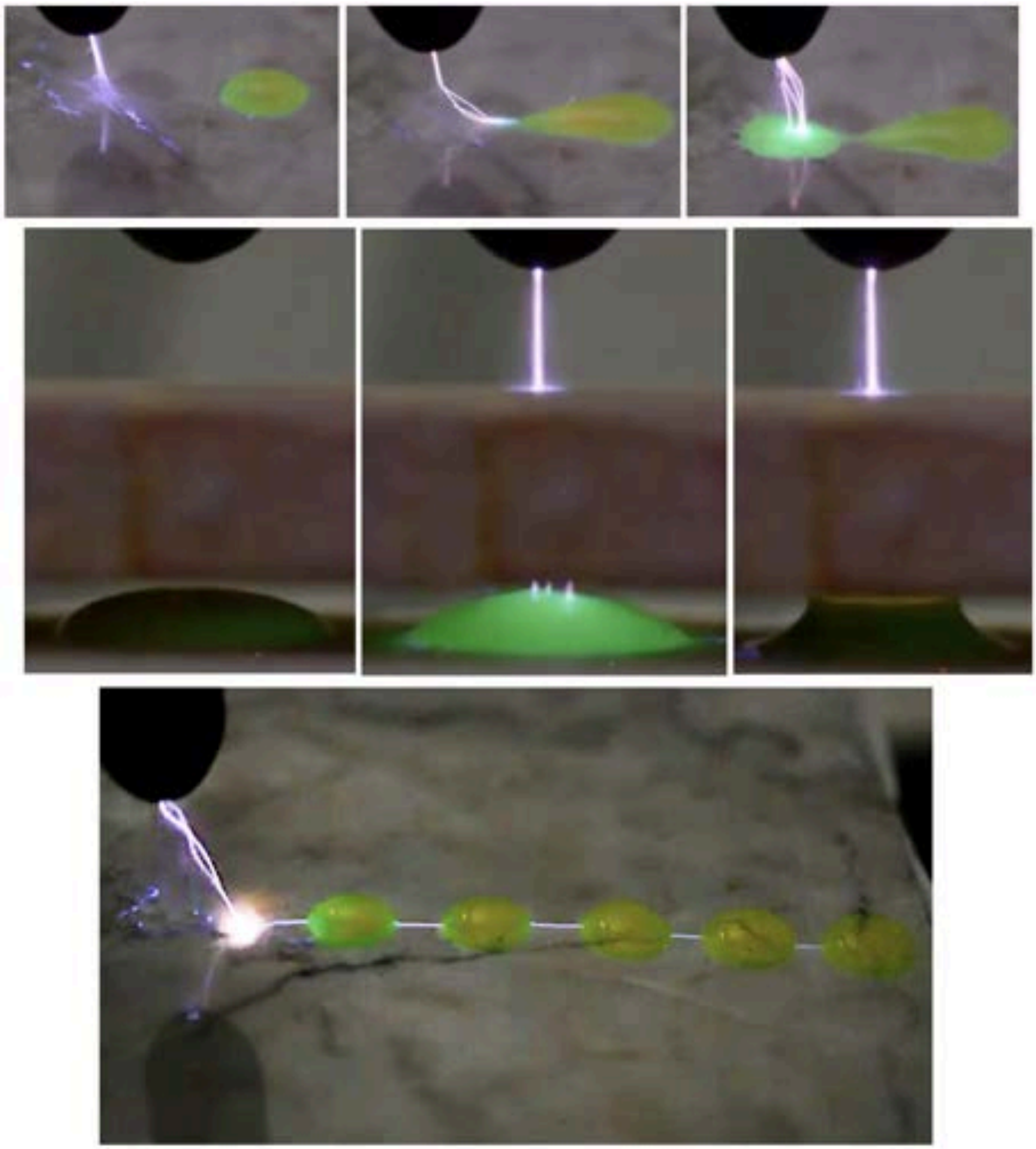
Water is very abundant in the crust and further below. It is estimated that an entire ocean's worth of water is hiding in the mantle. How does water in the ground create a push/pull over large areas when following the electric current?

ABOVE: We begin pumping current down into the water on the left, sitting atop an insulator to induce lateral current flow (like the crust). The current quickly begins exiting the water in multiple places on the right, and the water begins to follow.

BELOW: The water continues following the current, creating a better pathway for more to flow with it. The water may be permanently displaced by the current (bottom, right image) even after the current disappears.



The top two lines here are sequential, left to right. The top line shows salt water with pyranine, sucked into the current. In the second line, the water is between rock plates, and when hit with the current it defies gravity and pushes up. In the bottom image we see that the breadth of effect is based on what is nearby, and that electricity *really* loves salt water- complete attraction.



Imagine what will happen to groundwater, trillions of tons over thousands of miles when it is hit by these currents. Remember, the GEC current seeks the path of least resistance (fault lines); this delivers major force, at the right place.

Fun Fact - Fault lines are the most conductive parts of the crust. They attract electric current and respond to magnetic changes

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Chapter 9

Major Events and Cycles Of the Earth and Sun

In this chapter we will learn about the most extreme events and important cycles of the earth and sun:

- Super flares and the sun.
- A combination of disasters; a solar, climate, geomagnetic cycle.
- The earth disaster cycle.

Superflares and The Sun

Solar superflares are intense bursts of radiation and charged particles far exceeding the magnitude of typical solar flares. The sun follows long-term cycles capable of producing superflares, some hundreds of times more energetic than historically documented events, such as the Carrington Event of 1859. Theoretical models suggest that the sun could produce superflares with intensities ranging up to X100 or greater, far surpassing any flare observed in modern times.

Superflares represent an extreme form of solar activity, with significant potential consequences for planetary atmospheres, climate systems, and habitability. Observational studies using Kepler mission data have confirmed that solar-type stars commonly produce superflares, with energies far surpassing previously recognized limits for the sun (1).

Statistical analysis indicates that even relatively quiet, sun-like stars can sporadically produce superflares several orders of magnitude more powerful than the largest historical solar events, pointing to an inherent capability within stars like our own sun (1).

Cosmogenic radionuclide data provide another perspective on superflares, enabling the reconstruction of past solar activity over millennial timescales. These radionuclides, formed through the interaction of cosmic rays with Earth's atmosphere, reveal that superflares occur within cyclical patterns spanning hundreds to thousands of years (2).

Analysis of this geological evidence confirms that superflares capable of causing substantial geomagnetic disruptions are not only possible but occur periodically, reinforcing the potential severity of future solar-driven catastrophes (2).

A crucial impact of solar superflares is the immediate effect on Earth's magnetosphere and ionosphere, which can generate a powerful electromagnetic pulse (EMP). Studies revisiting the 1859 Carrington event, one of the largest solar storms recorded, suggest it represents only a moderate flare within the spectrum of possible superflares, implying significantly more intense events are conceivable (3).

The magnitude of electromagnetic disturbances from such superflares could critically damage modern technological infrastructure, severely affecting communications, navigation, and power grids worldwide (3).

The broader implications of solar superflares extend to planetary habitability. Research exploring the effects of stellar superflares on planets within habitable zones shows that extreme flare events can profoundly influence atmospheric composition, surface radiation levels, and ultimately the potential for life (4). The 1859 super flare appears to have caused a multi-degree spike in temperatures that lasted for several weeks (4).

Recent theoretical studies highlight the heightened vulnerability of terrestrial atmospheres to frequent superflares, emphasizing the importance of understanding the upper limits of solar activity to assess risks accurately for Earth and similar exoplanets (5).

Cycle Length	Flare Magnitude	Energy Level
~11 Years	X10	Dangerous for Satellites
~250 Years	X50+	Dangerous for Ground Technology
~1000 Years	X200+	Dangerous for Ozone
~3000 Years	X500+	Dangerous for Ice Caps
~6000 Years	~X1000	Dangerous for Everything

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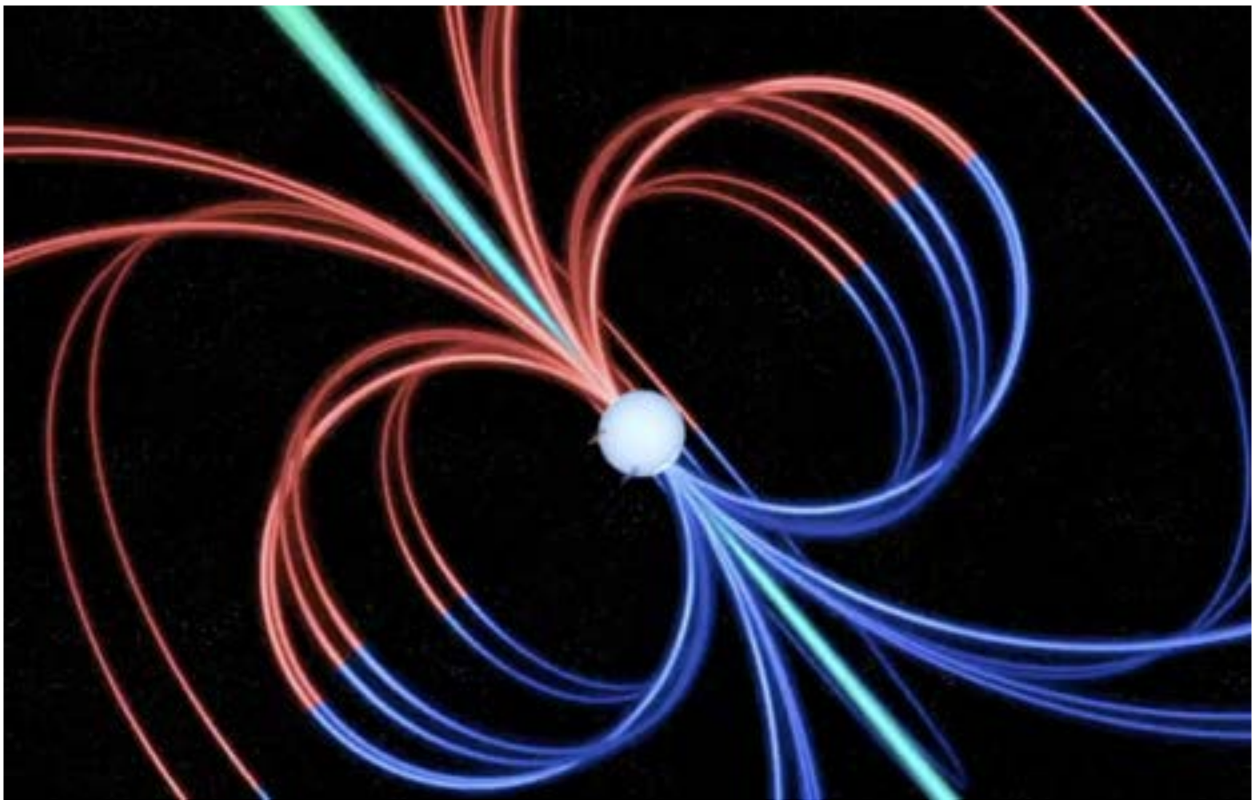
6000 Years Ago

Around 6,000 years ago, near the midpoint of the Holocene epoch, Earth experienced a unique combination of significant climatic, volcanic, and geomagnetic events. These simultaneous disturbances profoundly affected global environments, leading to substantial shifts in ecosystems, climate patterns, and human populations.

Here are some key details:

A notable geomagnetic event occurred during this period, evidenced by paleomagnetic secular variations identified in marine sediments within the Tohoku-oki earthquake rupture zone off the coast of Japan.

High-resolution analyses of these sediments demonstrate clear geomagnetic anomalies around 6,000 years ago, indicating a significant disruption of Earth's magnetic field at the time (1). Complementary research from speleothems collected from Vorontsovskaya Cave in Russia independently confirmed this geomagnetic excursion, accurately constraining its age to approximately the same period, thereby reinforcing its global significance (2).



Concurrent with these geomagnetic changes, extensive volcanic activity significantly influenced regional and global climate. The eruption of Changbaishan-Tianchi volcano, marked by the Qixiangzhan eruption, was a major explosive event that deposited volcanic ash widely across Northeast Asia. This event not only coincided with the geomagnetic excursion but also had implications for climatic shifts across East Asia (3).

Another critical volcanic event was the basaltic plinian eruption that formed the Masaya caldera in Nicaragua around 6,000 years ago. The eruption, responsible for dispersing the San Antonio Tephra, significantly impacted local ecosystems and climate, emphasizing the global scale of volcanic disturbances during this period (4).

Similarly, the mid-Holocene Towada-Chuseri eruption of the Towada volcano in Japan produced widespread tephra deposits identifiable as a marker layer throughout Japan and extending into Northeast China. This event provides crucial evidence of intense volcanic activity coinciding closely with both the geomagnetic anomaly and climatic shifts across East Asia (5). The synchronization of these significant volcanic eruptions with the documented geomagnetic excursion strongly suggests a geophysical linkage or common triggering mechanism operative around this time.

Additionally, dramatic hydroclimatic transformations were recorded globally, exemplified by remarkable changes in regional rainfall patterns and monsoonal dynamics. The wetlands of North Africa, for instance, expanded dramatically during the mid-Holocene, covering an area at least five times larger than today.

This extensive humidification underscores substantial shifts in rainfall distribution and hydrological regimes, reshaping ecosystems and human settlements across North Africa (6). Contrastingly, in Asia, an abrupt and extensive contraction of the Indo-East Asian monsoon abruptly ended the previously prolonged Holocene humid period, profoundly affecting environmental stability and human societies dependent on monsoonal rains (7).

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A Solar-Climate-Geomagnetic Cycle

The convergence of events 6000 years ago is not unique in geology, it happened 12,000 years ago, and about every 6000 years before that.

Volcanic events correlate with the Dansgaard-Oeschger cycle of ~1500 years (1), which quadruples to the 6000 year mark (2). These climate/volcanic-uptick events happen on the same cycle, although not in the same way. 6000 years ago it was a tropical hydroclimate event, 12,000 years ago it was the younger dryas and the Heinrich event they call “H0”. There was a rapid warming 18,000 years ago, and the last glacial maximum was 24,000 years ago.

These “Heinrich Events” are characterized by a Dansgaard-Oeschger warming that melts too much ice, cools and freshens the oceans, which shuts down the oceanic heat transport and chills the atmosphere, leading to a rapid cooling transition. This was the case with every Heinrich event (during the last glacial period) and the most recent one, 6000 years ago, the first one in an interglacial period in over 100,000 years, was a tropical event rather than a polar one. Here are the known Heinrich Events:

Event Designation	Age	Climate Period
Tropical/Mid-Latitude Hydroclimate Event	~6000 Years Ago	Interglacial (Warm)
Younger Dryas “H0”	~12,000 Years Ago	Glacial (Cold)
Heinrich Event “H1”	~18,000 Years Ago	Glacial (Cold)
Heinrich Event “H2”, Last Glacial Maximum	~24,000 Years Ago	Glacial (Cold)
Heinrich Event “H3”	~30,000 Years Ago	Glacial (Cold)
Heinrich Event “H4”	~36,000 Years Ago	Glacial (Cold)

With the exception of H1, they hit the cycle fairly perfectly, and even still, it’s close, and those are approximations. The point is that what happened with the climate happens every 6000 years, with the volcanic upticks coming along with their 1500 year upticks, since the Heinrich and D-O cycles are synchronized (2). But it is far more than just climate and volcanos, it is geomagnetic events as well:

Event Designation	Age
Tianchi Excursion	~6000 Years Ago
Gothenburg Excursion	~12,000 Years Ago
Hilina Pali Excursion	~18,000 Years Ago
Lake Mungo Excursion	~24,000 Years Ago
Michoacan Excursion	~30,000 Years Ago
Mono Lake	~36,000 Years Ago
Laschamp	~42,000 Years Ago

Heinrich (climate) events and geomagnetic excursions on a pretty regular, and synchronized cycle, and while the events get harder to see further back in time, they have been recognized, and even the smaller D-O events going back into the triassic period. They are not only harder to find but harder to date; the H5 event is listed as around 45,000 years ago, but with a fairly large uncertainty that makes it easy to tie to the Laschamp excursion 42,000 years ago, just as Hilina Pali and H1 are likely only spread apart due to dating uncertainties and issues with using different isotopes. The 6000-year geomagnetic/climate cycle is solid.

But wait, we already saw this 6000-year cycle earlier:

Cycle Length	Flare Magnitude	Energy Level
~11 Years	X10	Dangerous for Satellites
~250 Years	X50+	Dangerous for Ground Technology
~1000 Years	X200+	Dangerous for Ozone
~3000 Years	X500+	Dangerous for Ice Caps
~6000 Years	~X1000	Dangerous for Everything

The solar superflare cycle, the X1000 event, is on the same 6000-year clock. That seems pretty remarkable doesn't it? So do scientists. One even went so far as to give this thing a name: the Heinrich-Bond Solar Cycle (3). It is not until you bring paleomagnetism into the picture that it is recognized for being a solar, climate, and geomagnetic event.

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The Next Event is Happening Now

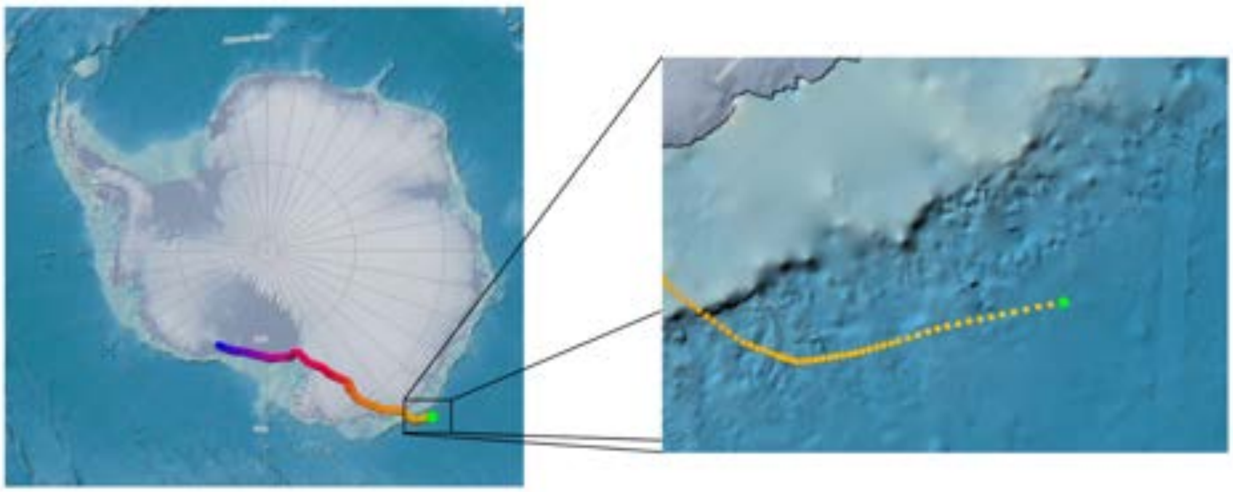
This impressive 6000 year cycle of climate upheaval, geomagnetic changes, and solar forcing (amplified because of the geomagnetic excursion), takes on a new wrinkle when you realize the last combined disaster event was 6000 years ago. Are we due? It would seem so. Is there any indication of a climate or geomagnetic change yet? Definitively, yes.

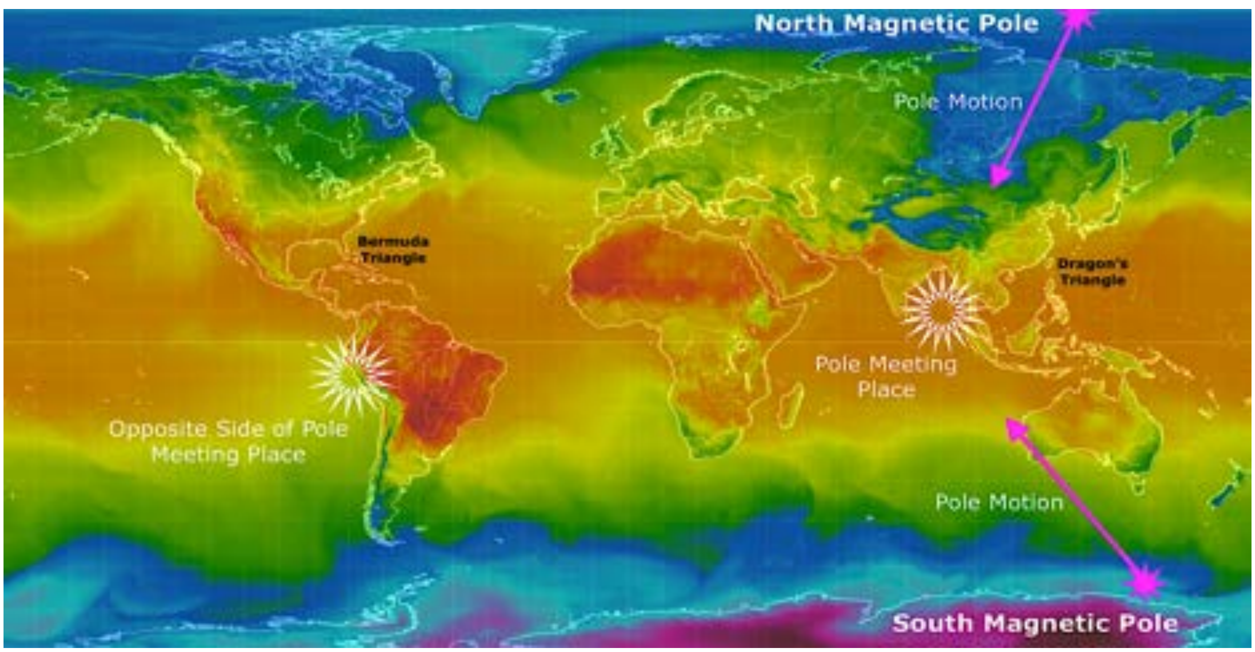
Earth's magnetic field was known to have weakened ~10% from the mid-1800s to the year 2000, but in 2010 and 2011 the European Space Agency announced that this number had quickly risen to 15% in only a decade more (1).

At the time, the director of their SWARM magnetic field mission was Rune Floberghagen, who said that earth had gone from losing 5% of the field per century to 5% per decade, speeding up 10x faster than before, and that earth's magnetic poles are preparing to flip (2). There have been slight accelerations since then, to where earth is likely losing 5% every 8 years, and earth has likely lost 20-35% of its total magnetic field strength enjoyed for the last thousand years.

Beyond this weakening of the magnetic field, the magnetic poles have been shifting, with their motion accelerating over time, same as the weakening of the field, this remains true in 2025 (3). The north pole is racing towards Siberia and is accelerating its motion over time (as the field weakening also accelerates).

The south pole is heading towards the Indian Ocean, and has recently sped-up its motion considerably.

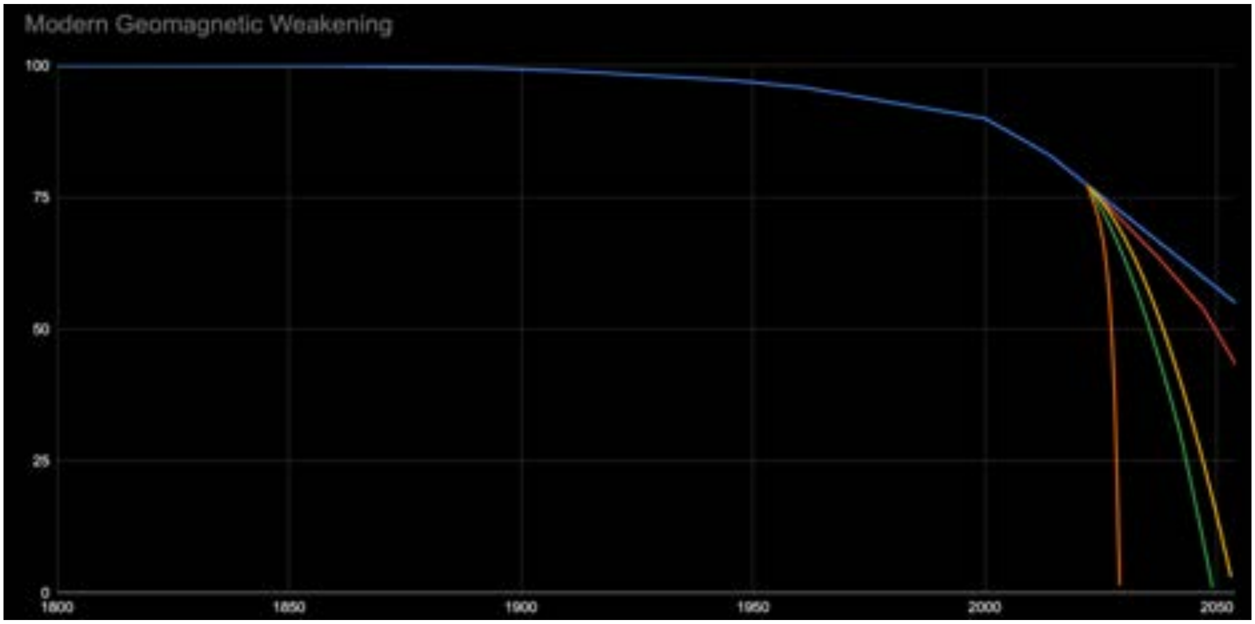




The north and south magnetic pole motion is not only speeding up over time, but the poles are on a collision course near India.

The cycle is approximately 6000 years, it has been that long since the last one, and the magnetic field of earth is changing exactly as expected. **Upon reaching peak acceleration, the magnetic pole shift will be going 100x faster than it is now (4).**

If earth's weakening field has gone from losing 5% per century to 5% per decade, and the magnetic pole shift has gone from moving a handful of kilometers/year to dozens of kilometers/year, then we are heading towards a zenith period of this event where we lose 5% of the field every 2 months, and endure +2000km/year pole motion. The next chart shows this acceleration so-far, and extrapolates it out to the full geomagnetic excursion.



The blue line shows the data so far up to the point where it breaks out into other colors. The acceleration events appear to be occurring during geomagnetic jerk events in the earth's core, which happen about 2 or 3 times per decade. If those were to stop, we would get the blue line continuing down slightly.

The chances of geomagnetic jerks just "stopping" is not high. The green line is the most likely extrapolation, with the orange yellow and red lines showing various other scenarios.

It's a cycle, we're due for it to happen again, it IS happening again now. The current best-estimate on when this event will be its worst is in the 2040s.

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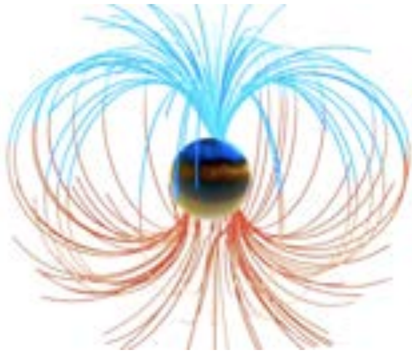
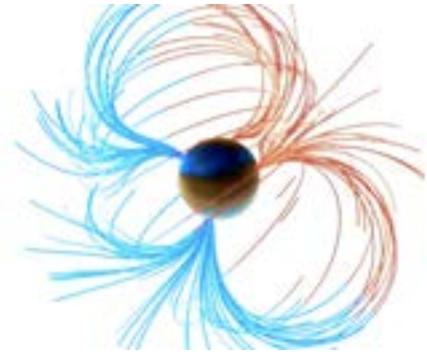
Chapter 10

The Earth Disaster Cycle is A Major Problem

In this chapter we will break down why this unfolding event is a big problem for our society, and for life on earth:

- Extra radiation destroys ozone.
- Less ozone amplifies UV radiation.
- Solar forcing off the charts.
- Animal navigation failures.
- Technological catastrophe.





Why Does the Magnetic Pole Shift Matter to Humanity?

We have established that this solar-climate-geomagnetic cycle is fairly reliable, it has been the correct amount of time since the last one (we're due), and the exact signs you would expect to see are there. But does that matter? Why should we care?

First and foremost, geomagnetic excursions, reversals, and various variations are near-extinction to extinction level events (1-5). This is repeatedly demonstrated in the scientific papers, and it results from a confluence of factors based on the fact that **a weaker magnetic field allows more solar protons, relativistic electrons, and cosmic rays to enter the atmosphere.**

The primary effect of these particles is ozone destruction. The ozone is in a constant state of destruction and replenishment, with a relative balance between photoionization/photochemical creation of ozone, and proton/electron destruction of ozone.

When the magnetic field weakens during these geomagnetic excursions, only a tiny fraction more of light penetrates into the atmosphere, but there is a 60% - 200% increase in the particle precipitation from space. The ozone destruction allows more UV rays to reach the surface, which impacts weather and biological cells, especially DNA in skin, and plant leaves/flowers, as well as insect eyesight.

In previous chapters we saw how these particles dramatically impact the atmosphere, touching all aspects of the weather and climate via the global electric circuit and cloud forcing. They also impact biological cells/electrolytes/ion channels/organs and various aspects of psychological health.

That means that these extra charged particles deliver a climatological and biological challenge on their own, AND bring an extra challenge in each category due to their destruction of the ozone. Microbes and tiny life like plankton and soil biomes are very sensitive to radiation, making the foundation of the food chain extremely vulnerable to a magnetic pole shift.

While these four biosphere challenges are unfolding (2 climatological, 2 biological) there is also a widespread challenge to the food chain of navigational failure. Birds are not the only creatures that use the earth's magnetic field for navigation.

In addition to avian migration, the earth's field is used by insects, reptiles, marine creatures, and mammals to navigate for migration, foraging, retreat from predators, and in locating mating territory. Plant performance from seedling to flowering can also be strongly impacted by abnormal magnetic fields.

That makes 2 climatological, 2 radiation (biological), and 1 navigational challenge for the biosphere, all happening at the same time. However, there is another major risk for our civilization, specifically.

For humans, our electro-dependent way of life ends without the magnetic field because of solar EMP risk, so while those five major biosphere challenges are impacting the entire food chain, our civilization will return to pre-industrial times - no internet, no electricity, no phones, no refrigeration, no heating, no water sanitation, no transportation - just us, back in nature among the beasts.

Most of the studies highlighting the extreme risk to life from a magnetic pole shift focus on the ozone destruction and resulting climatological and biological impacts, but the navigational struggles should not be discounted, and neither should the specific risk to humans of losing our power grids and critical infrastructure.

When combined, it should be easy to see why the best geophysicists in the world clearly see not-only the danger of these events, but have tied specific surges in species extinction to these geomagnetic events (1-5).

The geomagnetic excursion earth is enduring now, due to peak in the 2040s, is a major risk event, it is almost certainly the primary cause of the “climate change” observed over the last 200 years, and will likely result in several species lost to extinction, along with a significant fraction (50-95%) of the human race.

This is the most important thing that almost nobody is talking about, and unlike world war three, economic collapse, or any of the other things that challenge the stability of our future, this one is 100% out of our control.

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The Damage A Flare Can Do

We have covered the risk of solar flares to our way of life, biology, and weather, but how bad can it get in terms of the atmospheric temperatures?

Two of the top astrophysicists at Harvard attempted to answer that question in 2017, and the results were pretty terrifying. They looked at two previous unexplained extreme warming events and concluded that the October 2003 solar flare and solar storm caused a spike of 3°C for several weeks, while the 1859 Carrington event superflare caused a 7°C spike over a few months (1).

Imagine a flare 100x more powerful than the 1859 event (expected every 6000 years) and it happens during a geomagnetically weak period - when our planetary shield is low. Using similar equations, the spike in temperatures could be 10-25°C, which would cause a rapid melting of polar ice, and extremification of every weather pattern on earth.

This is why, in our interview with Dr. Robert Schoch (Professor at Boston University), he said that the last ice age may have ended in one day due to a major solar event. During these extreme events, the particle surges can exceed 10,000x normal levels, and X-ray/Extreme ultraviolet light can surge by 100x to 1000x. This is considerably more energy than our atmosphere is made to handle without reacting violently.

In this event, we would also completely lose our electrified way of life. A flare that big would not only destroy all technology due to geomagnetic induction, but the x-ray ionization of the upper atmosphere would cause its own instant-EMP (2) like in the movie Goldeneye, with a high-altitude nuclear detonation. In this scenario, there is no waiting time, no warning - when the flare light reaches us (first detection of the flare), the lights simply go out and they never come back on.

The weaker magnetic field of earth is already a dramatically bad problem for life on earth. A super flare from the sun during the same time period would be as extreme as a Hollywood disaster movie. Imagine a 2-3 day period where hundreds of catastrophic floods, lightning storms, earthquakes and volcanos take place, and slightly lesser disasters unfold for the following two weeks.

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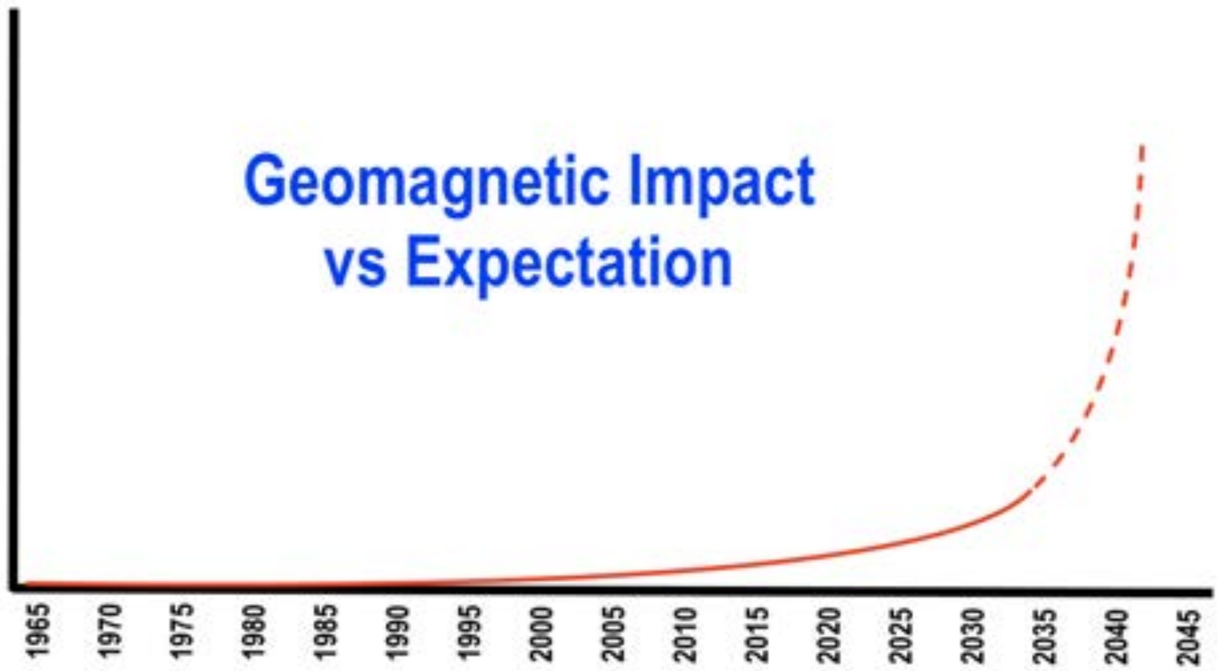

Tipping Point - March 2023

Starting in April 2023, after having to report a few instances over the previous decade where a solar storm produced more of an earth-disturbance than was expected based on the size of the solar flare or the impact of the solar wind, we had 9 instances of excess-impact solar storms in the last 9 months of 2023, about 10 more in 2024, and as of this writing, several more as of mid 2025. What does this mean? How can you visualize this? Imagine…

Imagine a light summer breeze rips off your roof - not a hurricane, a breeze. Imagine baseball players start banging home run balls out into space. Imagine kindergarten children begin setting world records in weightlifting. You would have to conclude that “something is going on, this isn’t right.” Exactly - there is no way the space weather disruptions earth has taken should be causing this extreme of activity that has been seen over the last 2+ years.

These outsized impacts imply that earth’s magnetic field had taken another step towards excursion, leaving earth more vulnerable to solar activity. The chart above shows the trend and where it is likely going in the near future.

It wasn’t until April 2024 when we learned *why* there had been such an enormous surge in these events. A top Russian geophysicist, Dr. Sergey Simonenko, shared data showing a major acceleration in the magnetic field shift in March 2023, and a signalling of descent into the pole shift (1).

A significant solar event in April of 2023, just one month after the anomaly, has already been studied in detail by mainstream astronomers, with the most-common theme being an attempt to explain why such a small solar event caused so much geomagnetic disruption. The same types of studies are already coming out for the two big solar events in 2024, which occurred in May and October.

These papers all attempt to justify the extreme earth-impact based on magnetic character of the solar storm or strength of the plasma stream, but none can avoid the fact that similar storms routinely hit earth over the last century and produced nothing even remotely close to the same level of impact.

The news surrounding the May 2024 (Mother's Day) solar storms has been widespread, but it has not been comprehensive, or appropriately descriptive of the extremity of the event. Aurorae were seen in the tropics, and a level 5 geomagnetic storm event occurred in earth's magnetic field. Neither of those things should have happened.

Earth has taken approximately 25 stronger solar wind impacts over the last 50 years, and only two storms in that time matched the magnetic disturbance of the May 2024 event. None matched the auroral extent.

The only other solar storm on record to match the aurora of the May 2024 event was the 1859 Carrington event superflare, which was approximately 40-100x stronger than the 2024 event. Why was the 2024 event able to produce similar auroras to 1859? Because earth's magnetic field is weakening, and our planetary vulnerability is increasing.

A solar storm in October 2024 should have produced a very low level storm, it was not a strong solar event at all, but magnetic disturbance reached level 4, and again produced low latitude auroras.

Low-latitude auroral events used to occur once or twice per decade; there have been 20 such events since March 2023, and NONE of those solar storm events *should* have produced them- they were too small. These events are an indirect confirmation of what the geomagnetic data has been telling us for years: we are entering the next geomagnetic excursion/rapid pole shift, and things are accelerating. There is perhaps no greater sign than the outsized auroral activity we are seeing from normally-underwhelming solar storm activity.

This is why, with 15-20 years left until the actual magnetic flip, we <u>strongly</u> encourage preparation and awareness for a total loss of technological capability here on earth well before the 2040s. As the earth's magnetic field weakens, and the planet becomes more vulnerable to the sun, it is highly likely that a solar storm will send us back to the stone age years before the actual zenith of the geomagnetic shift.

Other studies have already identified cosmic energy/particles breaking through the magnetic field and reaching deeper and deeper levels in the atmosphere (2), and suggest that at some point lethal radiation will be breaking through to ground level (3).

The impact of this increasing radiation penetration is already having noticeable impacts on the ionosphere, for example, despite the fact that solar activity has been declining for the last 80 years, the disruption to the ionosphere has not decreased (4). The ionosphere is still behaving as if the sun is much more active because more of the space weather energy is penetrating past earth's weakening magnetic field. Similar trends can be seen in layered ionization, such as the increase in polar summer mesospheric echoes, the recent first-ever detection of the F4 layer of the ionosphere, and the first detection of the F3 layer over low latitude (5).

As the magnetic field continues to weaken, every solar impact on weather, seismicity and biology that we have covered in this book gets amplified. This level of environmental change is why this event is such a big deal, and why the world's most diligent scientists can so-easily trace extinction surges and biosphere struggles to these events.

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Death by 1000 Tiny Cuts

While humans (and the biosphere as a whole) are dealing with the negative technological, climatological and radiation impacts of this ongoing event, the negative health impacts reviewed in chapter 7 are also likely to increase.

The double dose of climatological and radiation hazard, coupled with navigational difficulty in the food chain and the extra stress on humans of losing our electrified way of life, are major problems. But there are also minor aspects of the process that present more challenges sprinkled on top of the major ones.

From a health perspective, it is about more than extra UV light and cosmic ray interaction with DNA, but the amplification of everything from Chapter 7 due to the ongoing magnetic pole shift and increasing vulnerability of earth.

The solar storm triggering of heart attacks, strokes, seizures, etc. will be much more common, with a lower threshold of solar storm power to create the same effects on a wider scale. The two main mental symptoms are also expected to amplify: cognitive diminution and emotional instability - which a reasonable person could argue are already off-the-charts on a large scale in our population today.

In addition to large scale climatological changes, individual weather events will become more extreme too. This would include lightning and flooding events most of all. Earth has been recording record lightning deaths and extreme flooding across numerous areas the last several years already.

Picture any living creature on earth: Nature is challenging enough without having to go through climate change, radiation surges, navigational struggles, unprecedented storm impacts and variable heart rate, fluctuating stress and anxiety conditions, and extreme emotional states at the same time. This will make life even more dangerous. This makes survival a challenge.

Chapter 11

The Solar System Shift and Galactic Current Sheet

In this chapter we will see that this is not just an earth cycle unfolding now, but throughout the solar system, triggered by the galaxy:

- Changes on other planets and the sun.
- Changes in the solar system space.
- The galactic current sheet.

Solar System Shift

There is no question that earth's magnetic field goes through cycles, where long (1000s of years) periods of stability are punctuated by extreme changes; weakening field, shifting magnetic poles, and resulting elevated existential risk for life on earth. That cycle is due again now, the magnetic poles are shifting, and the field is weakening.

But this does not appear to be confined to the earth.

The entire solar system is changing, and even the space between the planets is changing. This cannot happen without a cause at the solar or galactic level. While the sun *is* changing too, it is doing so gradually, same as the planets are, as though it is being impacted alongside the rest of the solar system.

In this chapter we will go over the changes throughout the solar system, the likely cause at the galactic level, and how this process will unfold over the coming years.

It is critical that during this section you recall the ways in which solar activity impacts a planet, and how changing magnetic fields alter (amplify) that relationship. Doing so will allow for a coherent hypothesis to form regarding *why* the solar system is changing the way that it is.

SwRI scientists confirm decrease in Pluto's atmospheric density

October 4, 2021 — When Pluto passed in front of a star on the night of August 15, 2018, a Southwest Research Institute-led team of astronomers had deployed telescopes at numerous sites in the U.S. and Mexico to observe Pluto's atmosphere as it was briefly backlit by the well-placed star. Scientists used this occultation event to measure the overall abundance of Pluto's tenuous atmosphere and found compelling evidence that it is beginning to disappear, refreezing back onto its surface as it moves farther away from the Sun.

Press Resources

Media Contacts

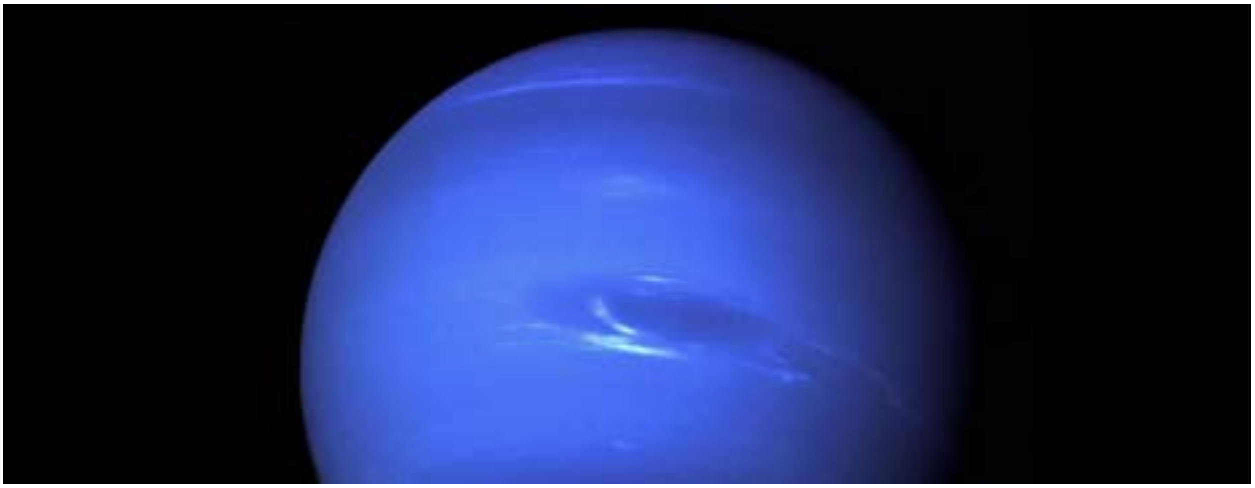
Media Kit

Pluto: We begin with Pluto, where a major event has taken place in the last few years. While scientists had expected (and continue to expect) a near-complete freeze-out of Pluto's atmosphere by 2030, due to the winter period of its orbit causing a cooling, condensing, and precipitation-out of material from its atmosphere, around 2018 a major event took place.

In just 14 months of observations, it lost 20% (one fifth) of its atmosphere. That wasn't supposed to happen. That level of atmospheric loss is outside of all physical possibilities for its descent into winter. Alas, it happened.

When a planet loses its magnetic field, it loses its atmosphere - this is what happened to Mars.

Among the possible explanations (other than Plutonian winter) for such a rapid and massive loss of Pluto's atmosphere, a sharp decline in its magnetic field (just like what is happening on earth) would explain the sudden change on the planet.



Neptune: Neptune is next, and for years stories had been emerging about record-breaking storms on the blue planet. Storm amplification is part of solar forcing, and a magnetic change on Neptune would allow for greater forcing.

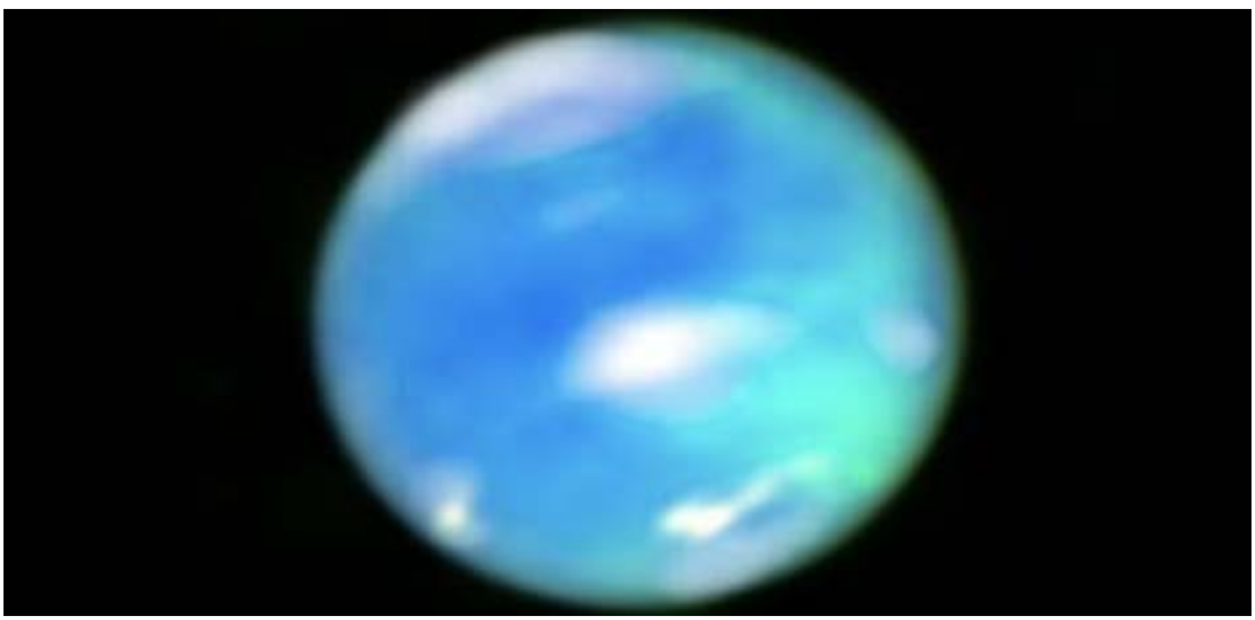
ANALYSIS OF NEPTUNE'S 2017 BRIGHT EQUATORIAL STORM

Edward Molter,[1] Imke de Pater,[1,2] Statia Luszcz-Cook,[3,4] Ricardo Hueso,[5] Joshua Tollefson,[2] Carlos Alvarez,[6] Agustín Sánchez-Lavega,[5] Michael H. Wong,[1] Andrew I. Hsu,[1] Lawrence A. Sromovsky,[7] Patrick M. Fry,[7] Marc Delcroix,[8] Randy Campbell,[6] Katherine de Kleer,[9] Elinor Gates,[10] Paul David Lynam,[10] S. Mark Ammons,[11] Brandon Park Coy,[1] Gaspard Duchene,[1,12] Erica J. Gonzales,[13] Lea Hirsch,[1] Eugene A. Magnier,[14] Sam Ragland,[6] R. Michael Rich,[15] and Feige Wang[16]

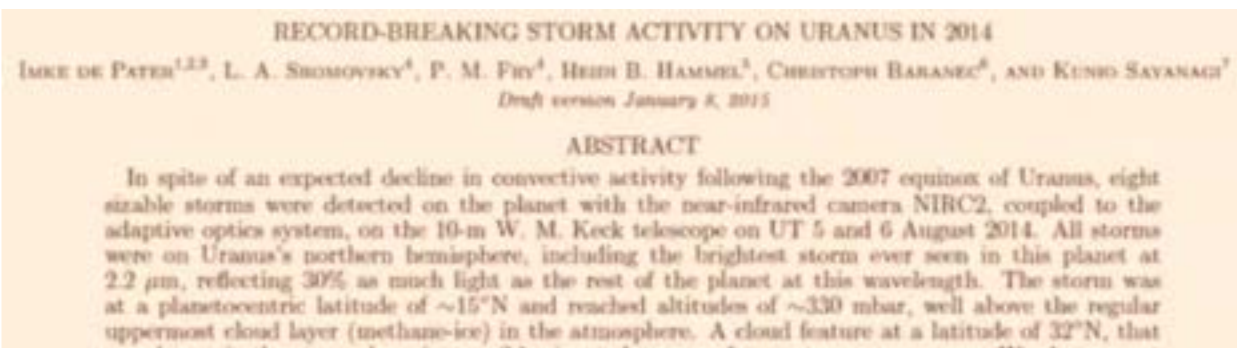
But there's much more; Neptune's storm patterns also changed. Just like earth's weather follows patterns, like the motion of Hurricanes from the coast of Africa west across the Atlantic towards the Caribbean and the Americas.

However, the well-known storm patterns on Neptune just reversed (next image), which is well beyond anything seen yet here on earth. Given the importance of solar electromagnetic forcing for storms and storm tracks and wind patterns, a magnetic change on the planet would also explain this storm reversal.

Beyond the storm events on Neptune, perhaps the biggest change on the blue giant is not being widely discussed - in fact, when it came out the NASA team didn't even focus on the primary discovery in the observation period. In the image below, which is a recent image from the James Webb Space Telescope, look at the aurora (green) that can be seen. It is not confined to the polar region as expected, but is crossing the equator. This is what happens to the aurora when a planet's magnetic poles shift, which is the ONLY explanation for such an event. A magnetic change on Neptune explains not only these aurora, but the storm anomalies as well.



Uranus: The teal gas giant has seen record storms (above) and the first auroral appearances (below) in the last few years, which would be expected if the planet was also having a magnetic shift. However, a recent story from NASA mentions a major change on the planet in a very peculiar way.



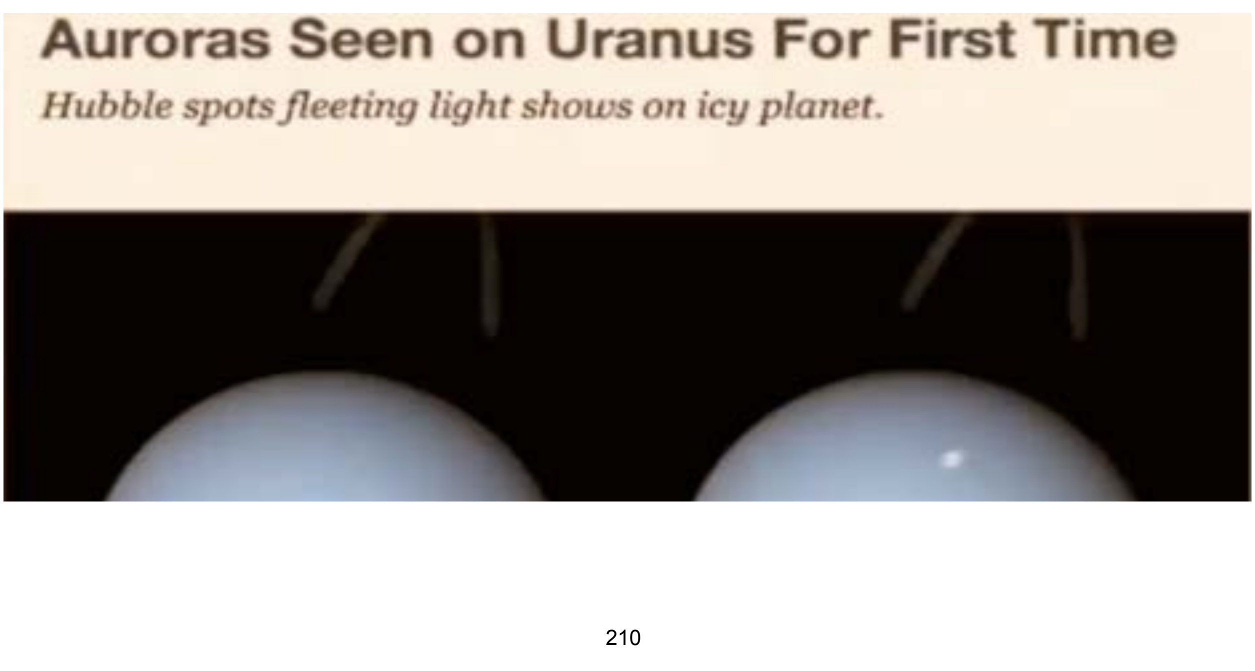
RECORD-BREAKING STORM ACTIVITY ON URANUS IN 2014

Imke de Pater[1,2,3], L. A. Sromovsky[4], P. M. Fry[4], Heidi B. Hammel[5], Christoph Baranec[6], and Kunio Sayanagi[7]

Draft version January 8, 2015

ABSTRACT

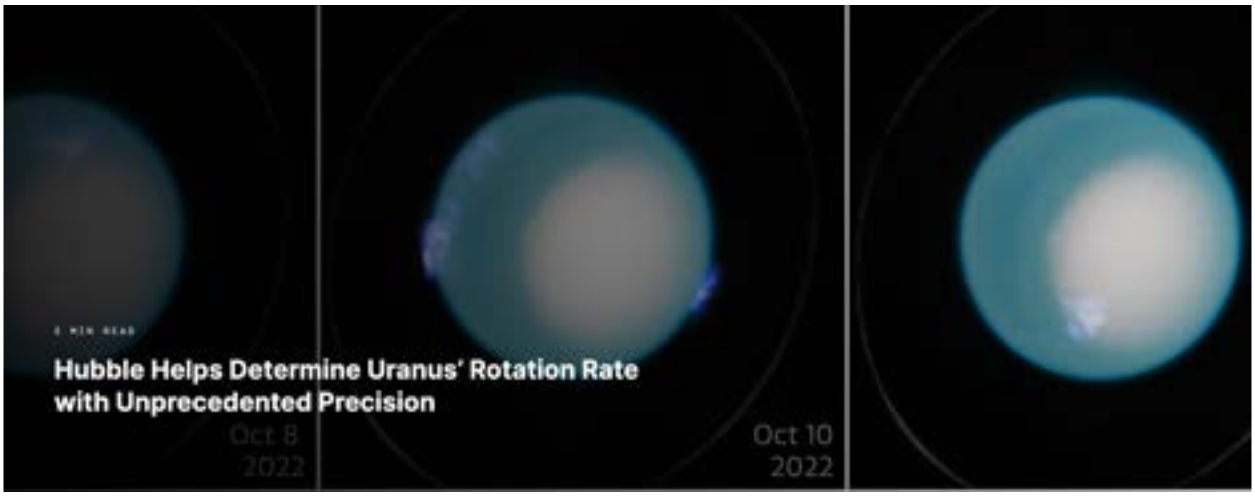
In spite of an expected decline in convective activity following the 2007 equinox of Uranus, eight sizable storms were detected on the planet with the near-infrared camera NIRC2, coupled to the adaptive optics system, on the 10-m W. M. Keck telescope on UT 5 and 6 August 2014. All storms were on Uranus's northern hemisphere, including the brightest storm ever seen in this planet at 2.2 μm, reflecting 30% as much light as the rest of the planet at this wavelength. The storm was at a planetocentric latitude of ~15°N and reached altitudes of ~330 mbar, well above the regular uppermost cloud layer (methane-ice) in the atmosphere. A cloud feature at a latitude of 32°N, that



Auroras Seen on Uranus For First Time

Hubble spots fleeting light shows on icy planet.

A recent study (next image) aimed at studying the rotation rate of Uranus, but in the middle of the news release, NASA casually states that this has been challenging here in the space age because it requires an accurate pin-pointing of its polar region, and that is exceptionally challenging at Uranus because its magnetic poles are shifting over time.



This is a big deal, made even bigger by the way in which it was delivered. The shifting magnetic poles didn't get their own press release. NASA just casually mentioned it in this release about tracking the rotation rate. Regardless of the somewhat sneaky release of this information, we can now say that Uranus' magnetic poles are indeed shifting.

So far, in addition to the earth's geomagnetic excursion, we know Uranus is having one as well, and the only way to explain the changes on Neptune and Pluto (without invoking multiple simultaneous anomalies) is to suggest that the outer system planets are also enduring a magnetic field shift.

SUPER STORM ON SATURN

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May 19, 2011: NASA's Cassini spacecraft and a European Southern Observatory ground-based telescope are tracking the growth of a giant early-spring storm in Saturn's northern hemisphere so powerful that it stretches around the entire planet. The rare storm has been wreaking havoc for months and shooting plumes of gas high into the planet's atmosphere.

"Nothing on Earth comes close to this powerful storm," says Leigh Fletcher, a Cassini team scientist at the University of Oxford in the United Kingdom, and lead author of a study that appeared in this week's edition of Science Magazine. "A storm like this is rare. This is only the sixth one to be recorded since 1876, and the last was way back in 1990."

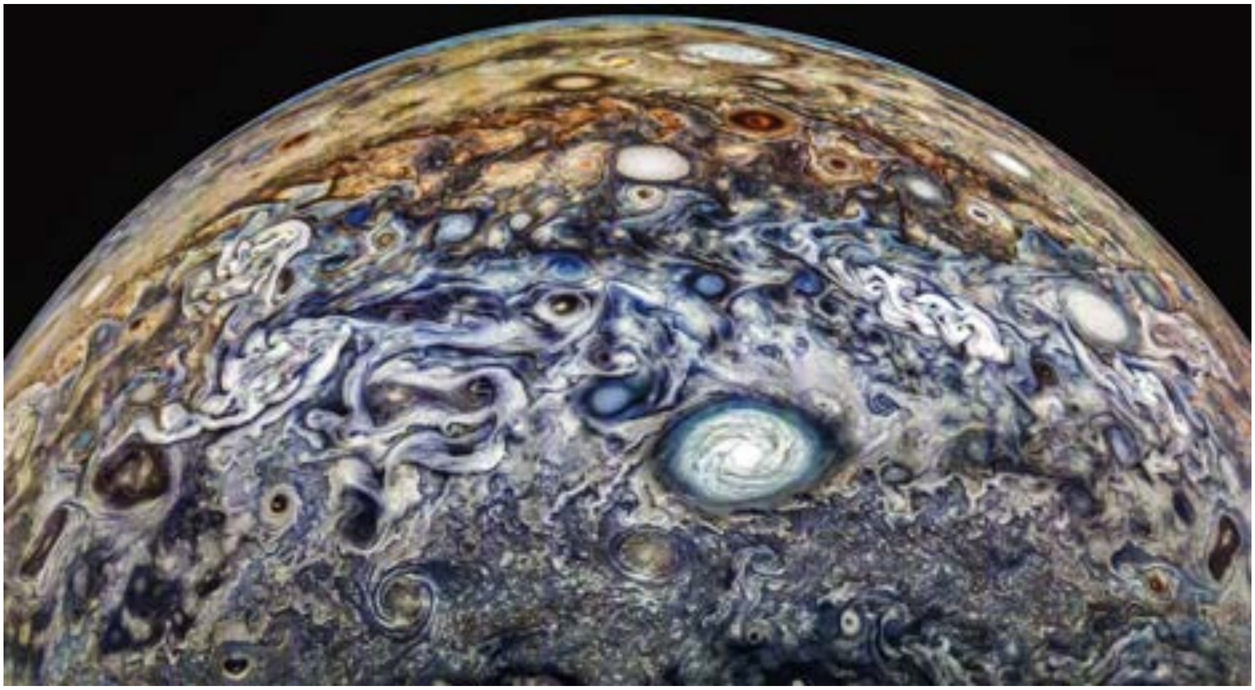
Cassini's radio and plasma wave science instrument first detected the large disturbance in December 2010, and

Saturn: There is a superstorm cycle on Saturn, linked to its 30-year orbit. The orbit isn't a perfect circle, meaning that every 30 years Saturn has a closest-approach to the sun, where it is closer than during any other time in its Saturnian year.

However, the article pictured above is about this superstorm arriving 10 years early. It formed in 2010, and wasn't supposed to form until it's close-approach to the sun in 2020.

What happened? The cause of the storm cycle itself is the key. It is widely believed that the extra solar energy taken-in at its closest point is responsible for tipping the atmospheric scales to create the superstorm, which one would have to agree-with based on what we know about solar forcing of storms. So, then, why did it show up early?

If Saturn is losing its magnetic field as well, then extra solar energy and solar forcing would impact the planet, perhaps tricking the atmosphere into "thinking" it has reached that closest-point in orbit, taking in the requisite amount of solar energy, and forming the storm an entire decade early.



Jupiter: The largest planet in our solar system may be the most-changing. It began with storm and cloud anomalies (pictured below) which would be perfectly explained by a magnetic shift on Jupiter.

Big Mystery: Jupiter Loses a Stripe

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Lost: A giant belt of brown clouds big enough to swallow Earth twenty times over. If found, please return to Jupiter.

May 20, 2010: In a development that has transformed the appearance of the solar system's largest planet, one of Jupiter's two main cloud belts has completely disappeared.

"This is a big event," says planetary scientist Glenn Orton of NASA's Jet Propulsion Lab. "We're monitoring the situation closely and do not yet fully understand what's going on."

Jupiter's New Red Spot

Like 49 Tweet 1 Share 0 Pin it

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March 3, 2006: Backyard astronomers, grab your telescopes. Jupiter is growing a new red spot.

However, there is also direct evidence of Jupiter's magnetic field changing. Jupiter sings a fairly consistent radio signature, and it happens to be in the FM range - yes, just like a radio.

This signal has been detected and measured for decades, and results from electrons accelerated in Jupiter's magnetic field, which then emit the radio signal. In 2012, that song began to change (below) and since the nature of an electron didn't change at Jupiter (and only at Jupiter) then the only explanation is that the accelerator (Jupiter's magnetic field) is changing.

SCIENTIFIC BLOGGING
SCIENCE 2.0

Now Broadcasting From Radio Jupiter

By News Staff | August 27th 2012 03:20 PM | 1 comment | Print | E-mail | Track Comments

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A project that investigated the planetary radio-frequency emissions of the Earth and Saturn also discovered a strange radio emission from the planet Jupiter.

Their entire magnetic field model changed at the end of the Juno mission to monitor the planet (below), along with a new type of stratospheric wind pattern (similar to Neptune's atmospheric reversal pattern).

JGR Planets

Research Article | Open Access

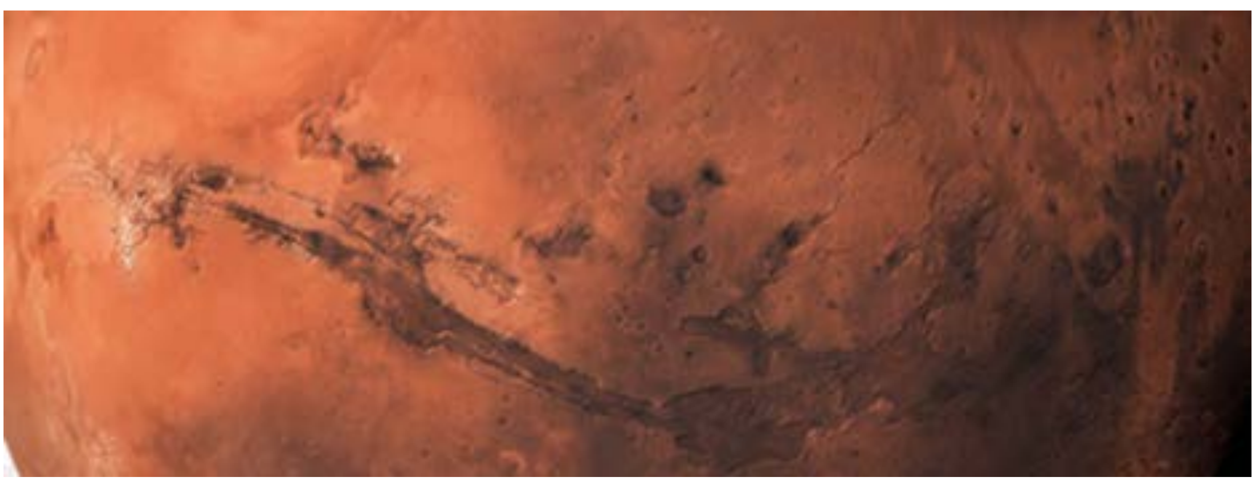
A New Model of Jupiter's Magnetic Field at the Completion of Juno's Prime Mission

J. E. P. Connerney, S. Timmins, R. J. Oliversen, J. R. Espley, J. L. Joergensen, S. Kotsiaros, P. S. Joergensen, J. M. G. Merayo, M. Herceg, J. Bloxham, K. M. Moore, A. Mura, A. Moirano, S. J. Bolton, S. M. Levin

First published: 17 December 2021 | https://doi.org/10.1029/2021JE007055 | Citations: 70

This article is a companion to Bloxham et al. (2022), https://doi.org/10.1029/2021JE007138.

Finally, in late 2024, even the moons of Jupiter began getting active. A super-eruption on the volcanic moon Io broke every record we have for volcanos in the solar system. It was so bright it over-saturated the sensors on Juno, and is bigger (relative size) than even the greatest volcanic eruption in the history of earth - the Siberian Traps.



Mars: The red planet is experiencing “global warming” that dwarfs what we see on earth. The dramatic change in Mars’ environment not only suggests that earth’s climate change is misattributed to human activity (since we aren't polluting Mars) but would be perfectly explained by a change in its already-weak magnetic fields.

Mars Melt Hints at Solar, Not Human, Cause for Warming, Scientist Says

Kate Ravilious
for National Geographic News
February 28, 2007

Simultaneous warming on Earth and Mars suggests that our planet's recent climate changes have a natural—and not a human-induced—cause, according to one scientist's controversial theory.

Over the last 5 years the increasing seismic activity on Mars has been a feature news story on about 7 different occasions. While astronomers state they can't explain it, we already know that an increase in solar forcing impacts seismic activity, and a change in Mars' magnetic environment explains the seismic anomalies as well.

Most interestingly, Mars has long been believed to be a completely dead planet internally, but recent data suggest that the mantle is in fact active and alive. While astronomers attempt to explain why they got it wrong before, what if they didn't get it wrong. What if Mars is waking back up? A magnetic change at Mars explains two, and possibly all three major environmental anomalies reported in recent years.

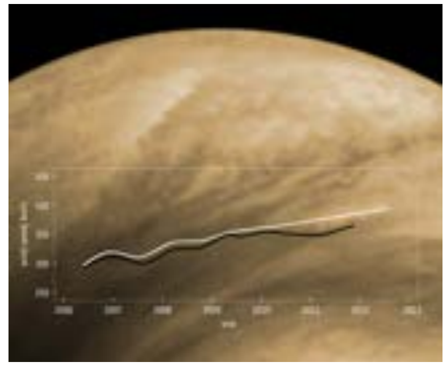
'Mars' interior is not behaving,' active mantle plume reveals

News By Joanna Thompson published December 16, 2022

In a first, planetary geologists describe an active mantle plume on the surface of Mars.

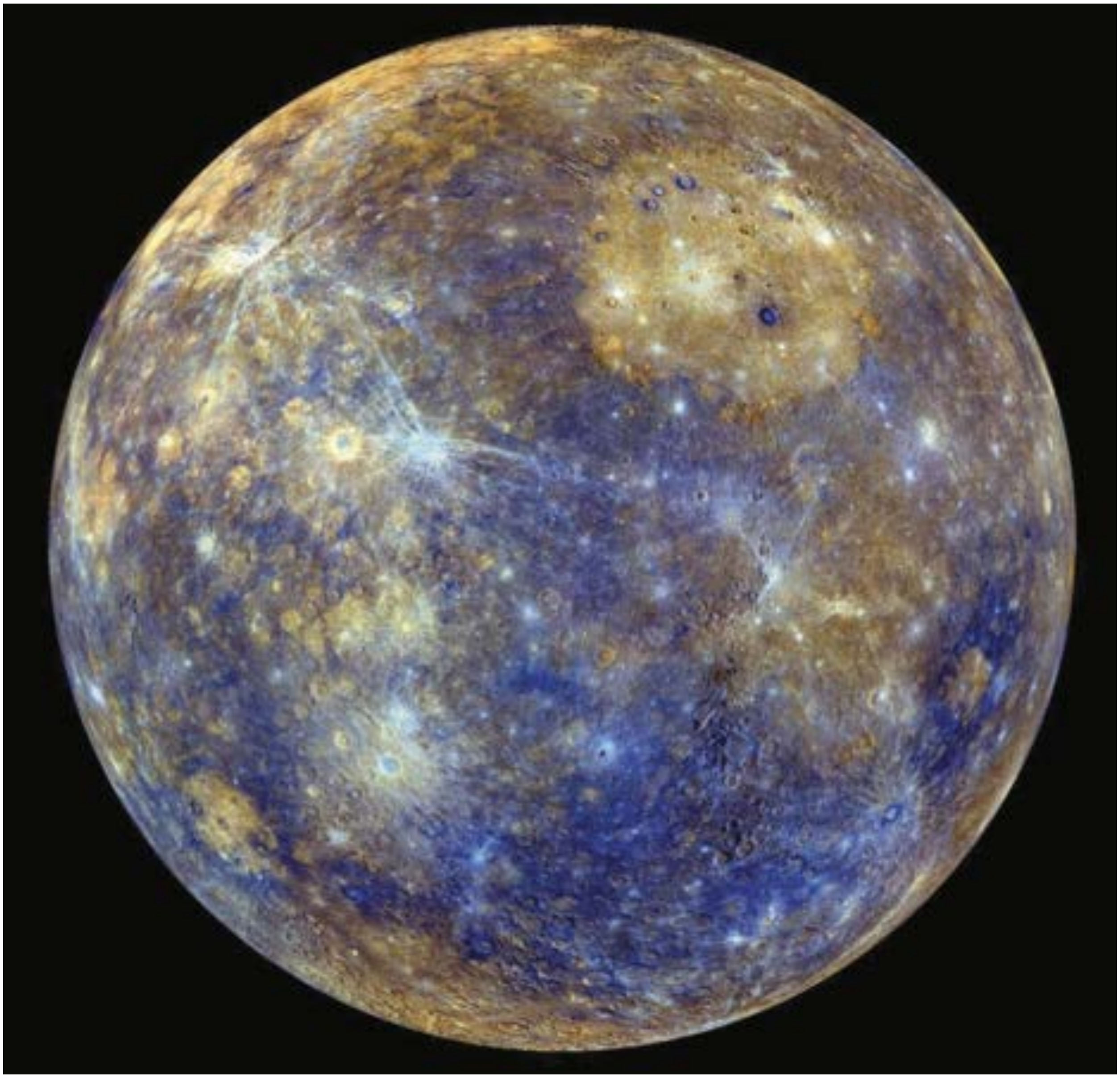
In late 2024, Martian auroras were visible to the naked eye for the first time through the cameras on the Perseverance rover, marking a new paradigm in space weather impact to the red planet. No previous mission has ever seen them either, and they were supposed to be "impossible."

The fast winds of Venus are getting faster



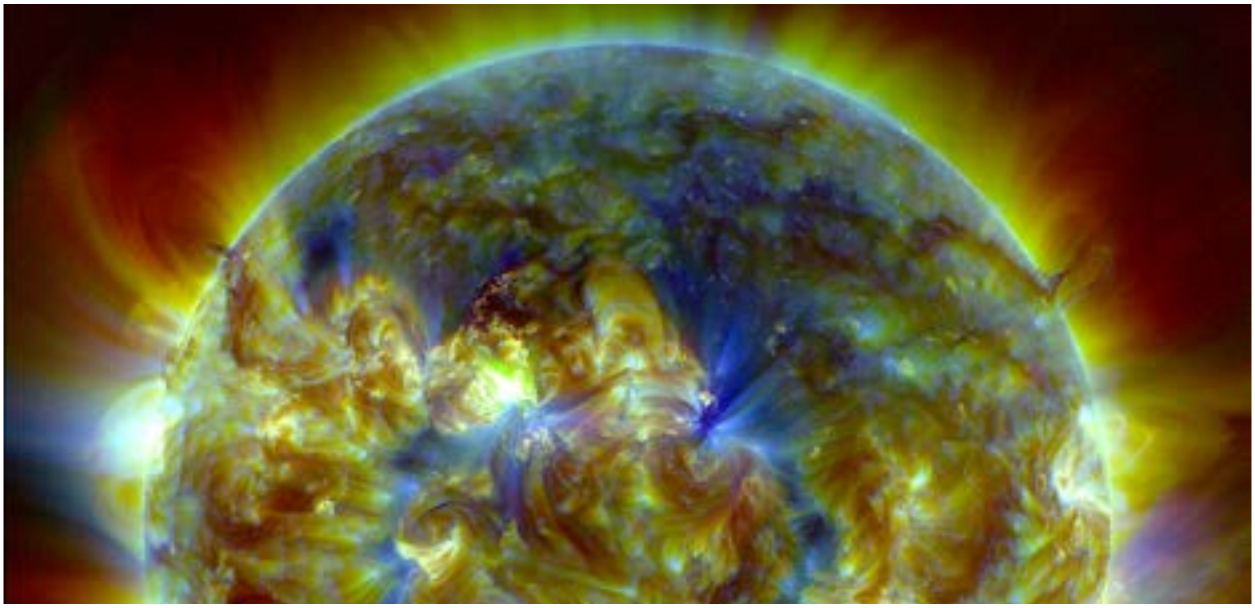
European Space Agency ESA.INT

Venus: The title here pretty much says it all. The fastest winds on Venus are screaming 33% faster, and that was as of the latest update - a decade ago. During that entire timeline, the earth's fastest winds increased by 4%. Solar forcing impacts wind speed, and so a magnetic change on Venus' already-unusual fields could be allowing more solar excitation of the particle flows.



Mercury: Mercury is the lone hold-out among the planets… maybe. Only one mission has ever gotten close enough to study its tenuous atmosphere and magnetic field - the Messenger mission 15 years ago.

Now, the BepiColumbo mission is one year from orbital insertion, and we know it will be studying Mercury's magnetic field. We should expect the reporting of changes in its field/atmosphere in the coming years as Bepi's science mission unfolds. Once we get confirmation of even one similar change on the innermost planet, the picture of the full (magnetic) shift in our solar system will be complete.



The Sun: Changes in the Helium abundance of the corona and solar wind is changing, this has been confirmed twice since the initial discovery, and is directly tied to a change in the sun's magnetic fields.

That means we have direct evidence of a magnetic shift on the Sun, Earth, Jupiter, and Uranus, and indirect evidence strongly suggesting a magnetic shift on Venus, Mars, Saturn, Neptune and Pluto. A solar system magnetic shift is the only single item that can explain everything.

There are other KEY changes in the solar system "space" - the space between the planets, but before we touch that topic, we have to ask - what could cause a magnetic shift of the entire solar system, including the sun?

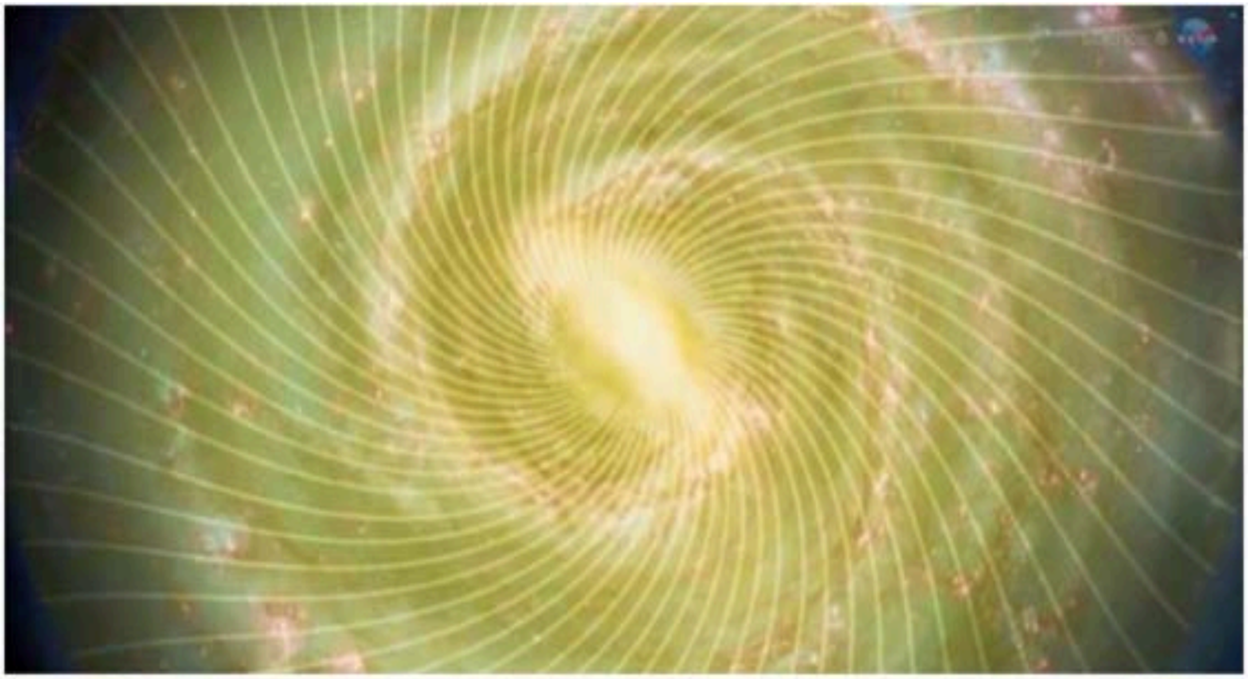

JOURNAL ARTICLE

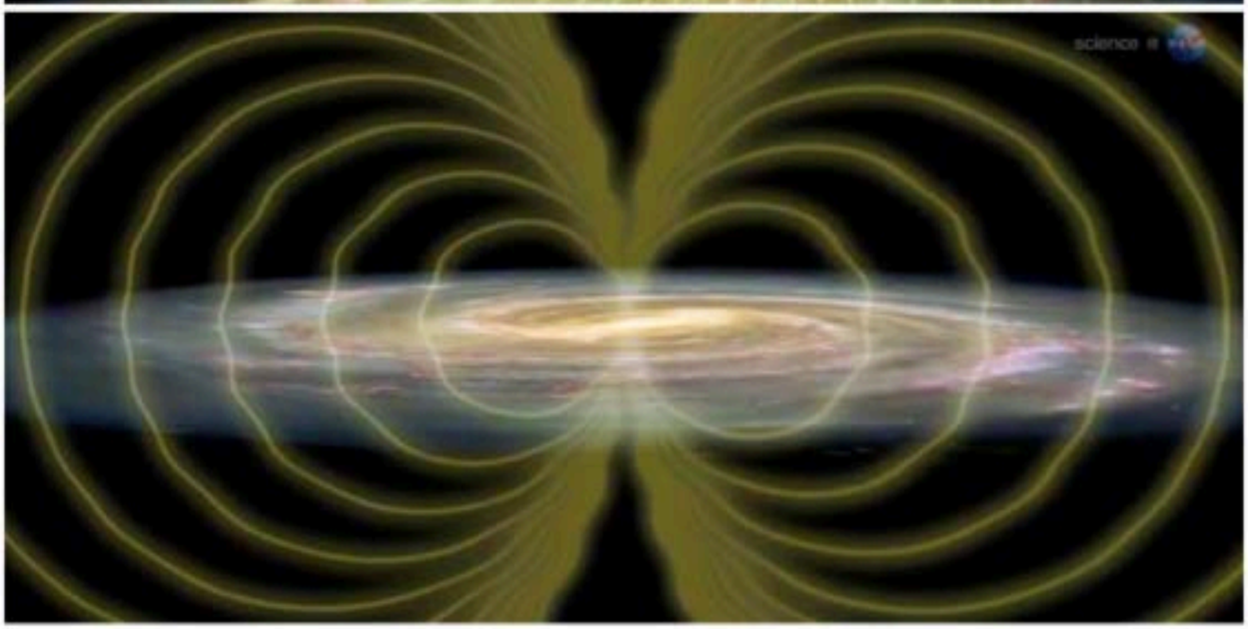
Evidence for distinctive changes in the solar wind helium abundance in solar cycle 24 FREE

Yogesh, D Chakrabarty, N Srivastava

Monthly Notices of the Royal Astronomical Society: Letters, Volume 503, Issue 1, May 2021, Pages L17–L22, https://doi.org/10.1093/mnrasl/slab016

Published: 13 February 2021 **Article history** ▼

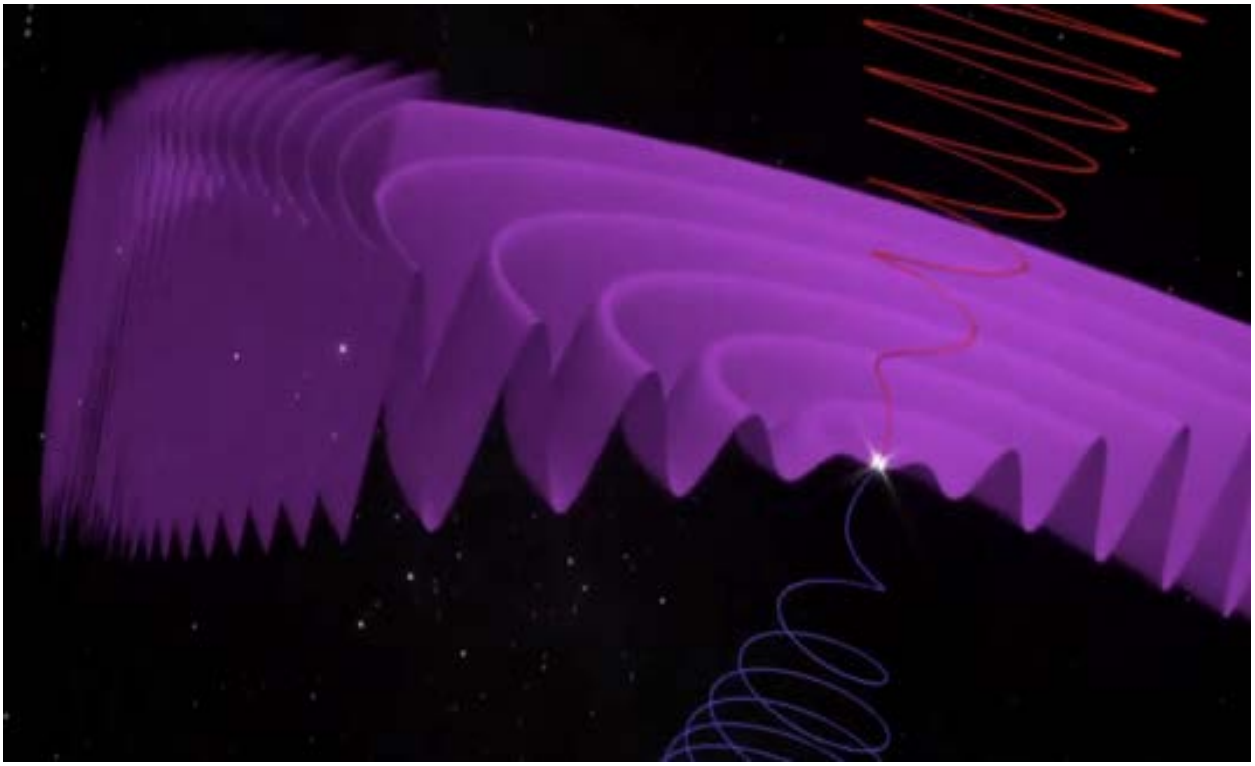




The Galactic Current Sheet

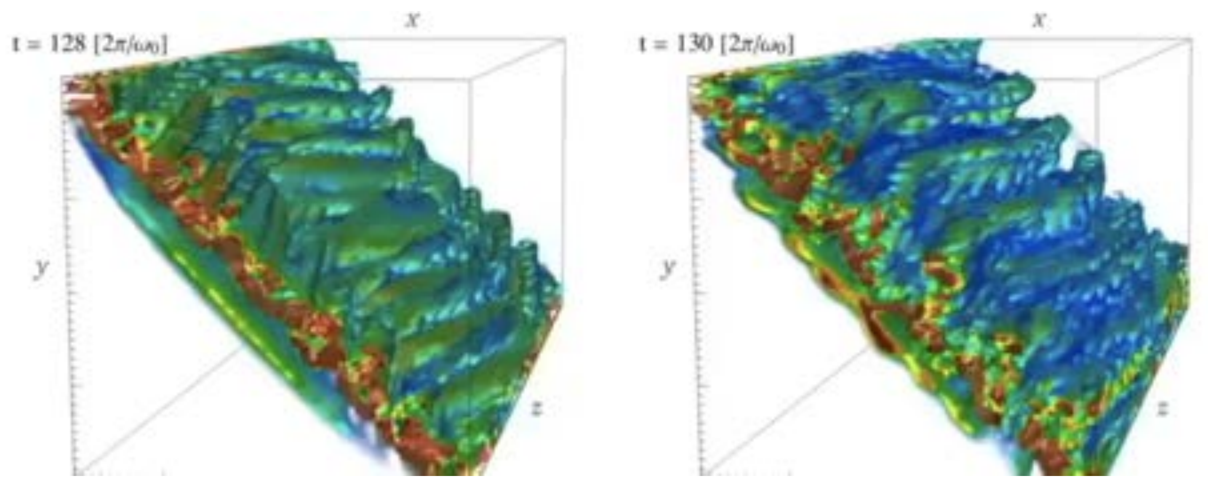
The equatorial and polar fields of the Milky Way galaxy (seen in the NASA model above as yellow lines) are part of a known and ubiquitous magnetic system in physical science. In this model, which holds true at all the galaxies we can study “face on”, all the stars with strong magnetic fields including the sun, and even in a laboratory with a spinning sphere magnet.

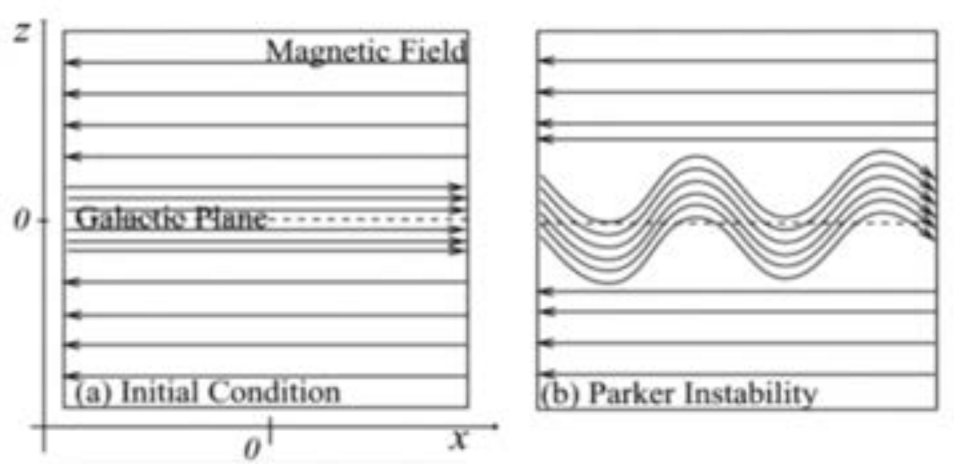
Running along the equator in these systems in an electric current sheet (purple wave below) that contains an abundance of density and the magnetic reversal point of the system. It radiates outward, such that an object near the equator of the system will repeatedly take impacts from this sheet over and over.



In the Milky Way, astronomers know this current sheet is 150-300 light years tall (encompassing the space where 90% of the stars in the galaxy can be found, including the sun. They also know it is approximately 30 light years thick (not a thin line) and is moving between 700 and 2000 km/s outward from the center of the galaxy.

The system was first noticed years ago as alternating magnetic directions coming up off the galactic plane (previous image) and was subsequently modeled at the galactic level, and every time they get the same rippling, wave current sheet (below).





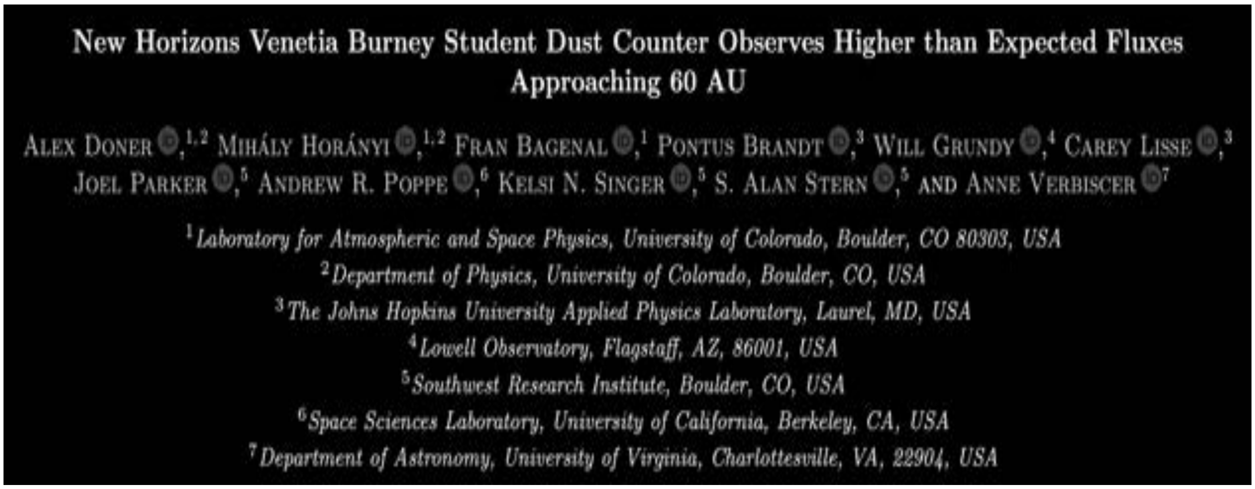
[Tunama et al. 2001]

In the solar system, earth takes impact from the sun's current sheet every 5-10 days, resulting in a reversal of the magnetic field embedded within the solar wind, a density change in the solar wind, and geomagnetic disruption. It is not surprising that the galactic version would impart a similar magnetic disturbance to the solar system when it arrives.

Given that the galactic version brings a galactic magnetic reversal, and that we have to be hit by this sheet on a regular recurring cycle, one must question whether the cyclical disaster on earth is actually a cyclical disaster of the solar system, delivered by the cyclical passage of the galactic current sheet.

While we know it exists, and what it brings, there remains the density aspect of the current sheet. IF the galactic sheet is in fact delivering a galactic magnetic reversal to our solar system in present time, then we should expect to see the extra density of material, primarily galactic dust, inside the solar system as well.

Starting in 2020, astronomers began to detect excess dust in the solar corona, in the interplanetary space of the planets, and most recently, in 2024, excess dust past the planet of Pluto (below), the extra dust is everywhere.


New Horizons Venetia Burney Student Dust Counter Observes Higher than Expected Fluxes Approaching 60 AU

Alex Doner,[1,2] Mihály Horányi,[1,2] Fran Bagenal,[1] Pontus Brandt,[3] Will Grundy,[4] Carey Lisse,[3] Joel Parker,[5] Andrew R. Poppe,[6] Kelsi N. Singer,[5] S. Alan Stern,[5] and Anne Verbiscer[7]

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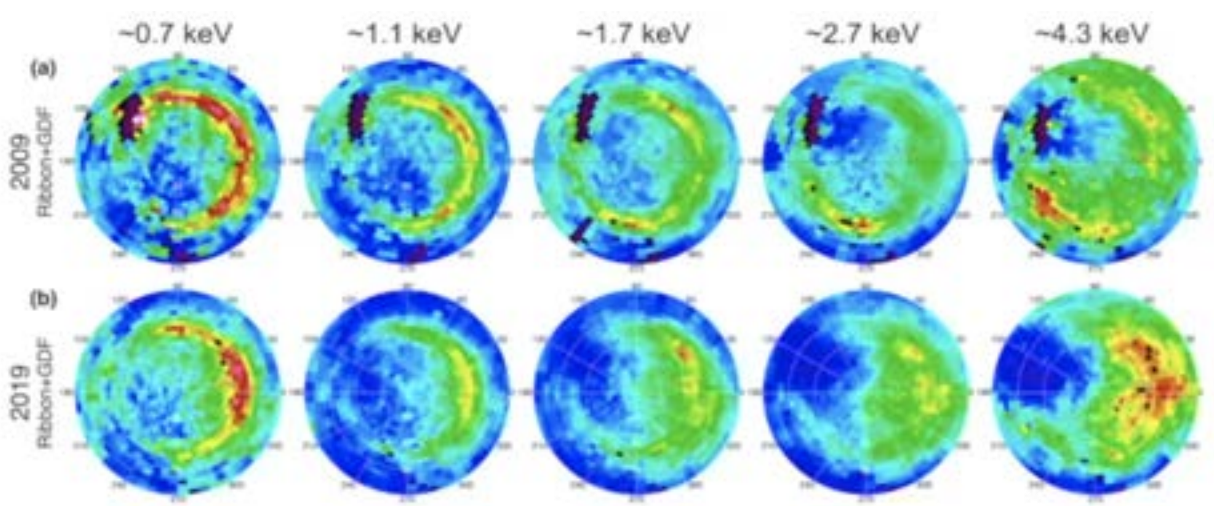
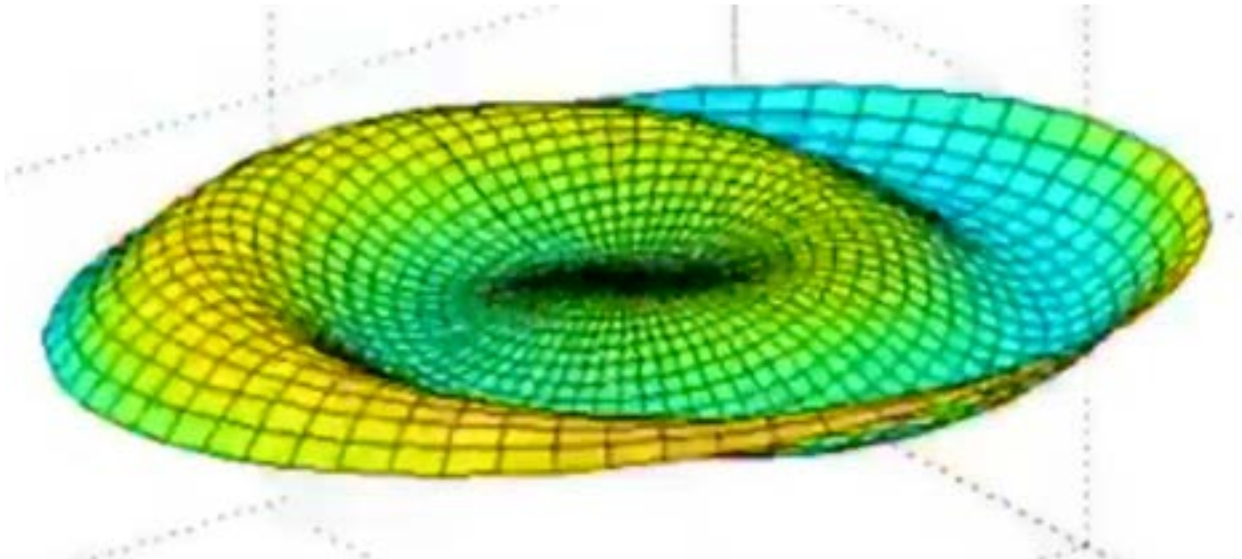
The Voyager spacecraft and New Horizons have both also noted increases in energetic neutral atoms and interstellar ions, which would also be accelerated and carried by the galactic current sheet. These energetic neutral atoms are also changing their penetration profile (below).



In just ten years, with readings taken at the low-phase of the sunspot cycle to avoid solar activity effect noise, we see that the flux includes a reduction in low energy (.7 keV) and increase in high energy (4.3 keV) particle counts. This is significantly higher of a change than would ever be expected in a decade, and is likely a result of the galactic current sheet constituents arriving.



The entire solar system is enduring magnetic changes, concurrent with the earth's changes, which we know to be a cycle.

The galactic current sheet exists, has been characterized, it impacts stars in a cyclic pattern, and brings both a galactic magnetic reversal and extra dust density.

The extra dust expected to be seen is definitively seen in the solar system, from the sun out to beyond the orbit of Pluto.

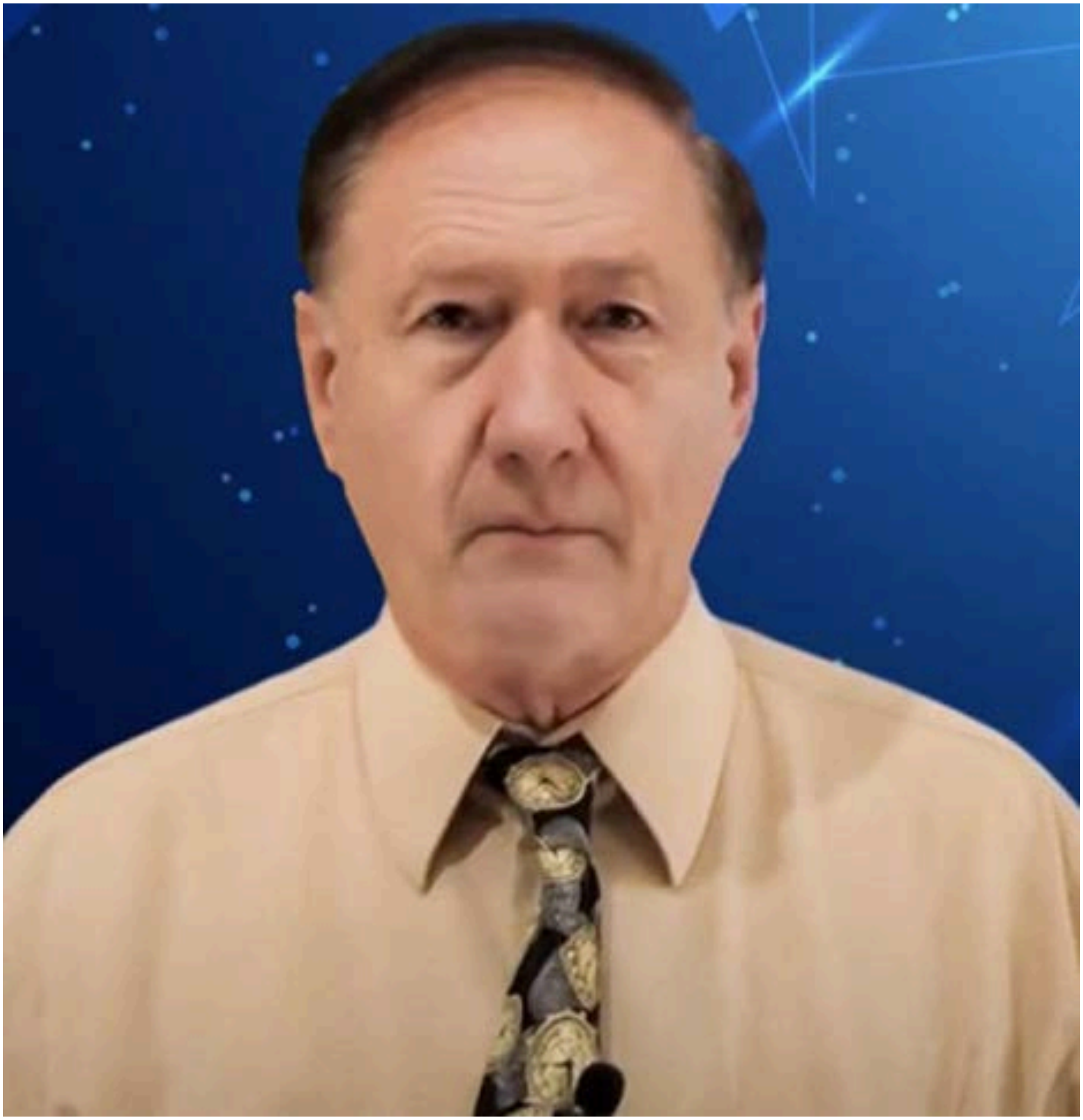
This is the cause of the disaster cycle, and it is happening again now.

Chapter 12

The Solar Micronova

In this chapter we will review the evidence that the galactic current sheet induces a micronova event on the sun:

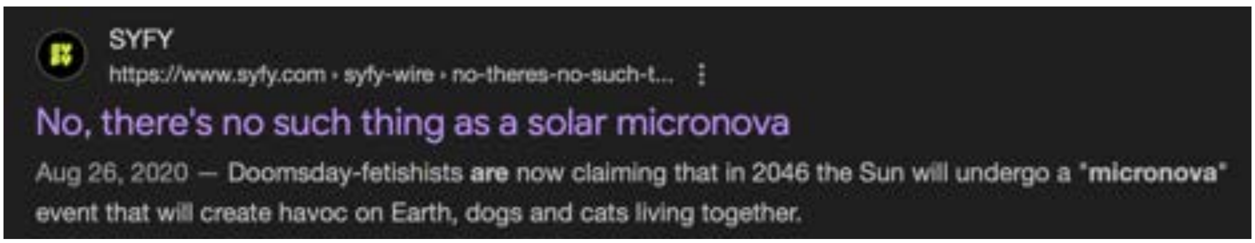
- What evidence exists that a solar micronova is part of the cycle?
- How are nova events triggered on stars?
- Can the galactic current sheet deliver any mechanism to induce a nova event?
- The solar micronova fixes galactic physics.



This is Doug Vogt. He made one of the most important contributions to modern catastrophism. Unfortunately, he passed away in 2023. Doug meticulously studied decades-old papers published in *Nature* and *Science* and discovered interesting data that had been forgotten, either by accident or because it did not fit the “approved narrative.”

On earth, geologists have discovered numerous isotopes that are classified as “nova-level isotopes.” Several of the nova-level isotopes discovered on earth are concentrated in the same layers and fossils as the rest of the evidence of this disaster cycle. Only a nova event at a star can make them, and the ones most-concentrated in the disaster layers of sediment have very short half-lives. While many of the iron and nickel nova-level isotopes found on the sea floor have half-lives of millions of years, the ones found concentrated within the “disaster layers” decay very quickly over astronomical timescales.

Why is this important? It is important because it opened the door to a multi-layered stream of research that indicates that the sun has a micronova event (small nova) during these cyclical impacts from the galactic current sheet. When we first began making the claim that the sun had a micronova event, the term “micronova” did not yet exist, and we were chastised within the astronomical and broader science community for suggesting it. Articles like the one pictured below were numerous in 2019-2021, and were an attempt to directly address and debunk our ideas.


SYFY
https://www.syfy.com › syfy-wire › no-theres-no-such-t...

No, there's no such thing as a solar micronova

Aug 26, 2020 — Doomsday-fetishists **are** now claiming that in 2046 the Sun will undergo a "**micronova**" event that will create havoc on Earth, dogs and cats living together.

When micronova events were officially discovered in 2022 (image below) there was precisely zero acknowledgement of our previous claims. Even with the new discovery, the astronomers still insisted that such an event could never take place on the sun.


Astronomers discover micronovae, a new kind of stellar explosion

20 April 2022

We Cannot Blame Other Stars for the Nova-Level Isotopes:

The fact that these particular isotopes found concentrated in the disaster sediments have short half-lives is important because it tells us they cannot possibly have come from other stars, or from the pre-sun nova event that seeded our solar system - the isotopes would have decayed by now.

If Proxima Centauri, the closest star to our own, went supernova, the light would arrive here in only 4 years, but it would be millions of years before any particles (isotopes) reached us, since they are moving much more slowly than light. The travel-time makes the inclusion of these isotopes in the disaster layers mathematically impossible - imagine different stars having supernova events that happen to have their isotopes arrive at earth at the exact same time as these disaster cycles are taking place, arriving in perfect sequence at the right moment after travelling millions of years from other stars.

That would be a coincidence of cosmically impossible proportions, and that is ***before*** you consider that the isotopes would have decayed by the time they arrived.

Furthermore, research that includes the magnetic fields of supernova events suggest that the dust and isotopes are actually trapped inside the remnant by the fields, and they never escape (image below).

FREE ARTICLE

Magnetic Imprisonment of Dusty Pinballs by a Supernova Remnant

Brian J. Fry, Brian D. Fields, and and John R. Ellis

Published 2020 May 12 • © 2020. The American Astronomical Society. All rights reserved.

The Astrophysical Journal, Volume 894, Number 2

Citation Brian J. Fry *et al* 2020 *ApJ* **894** 109

DOI 10.3847/1538-4357/ab86bf

Previous studies opted to exclude the magnetic fields from their models and analysis, but the inclusion offers the third proof that the earth-bound nova-isotopes concentrated in the disaster layers are almost certainly not from other stars or from long-ago.

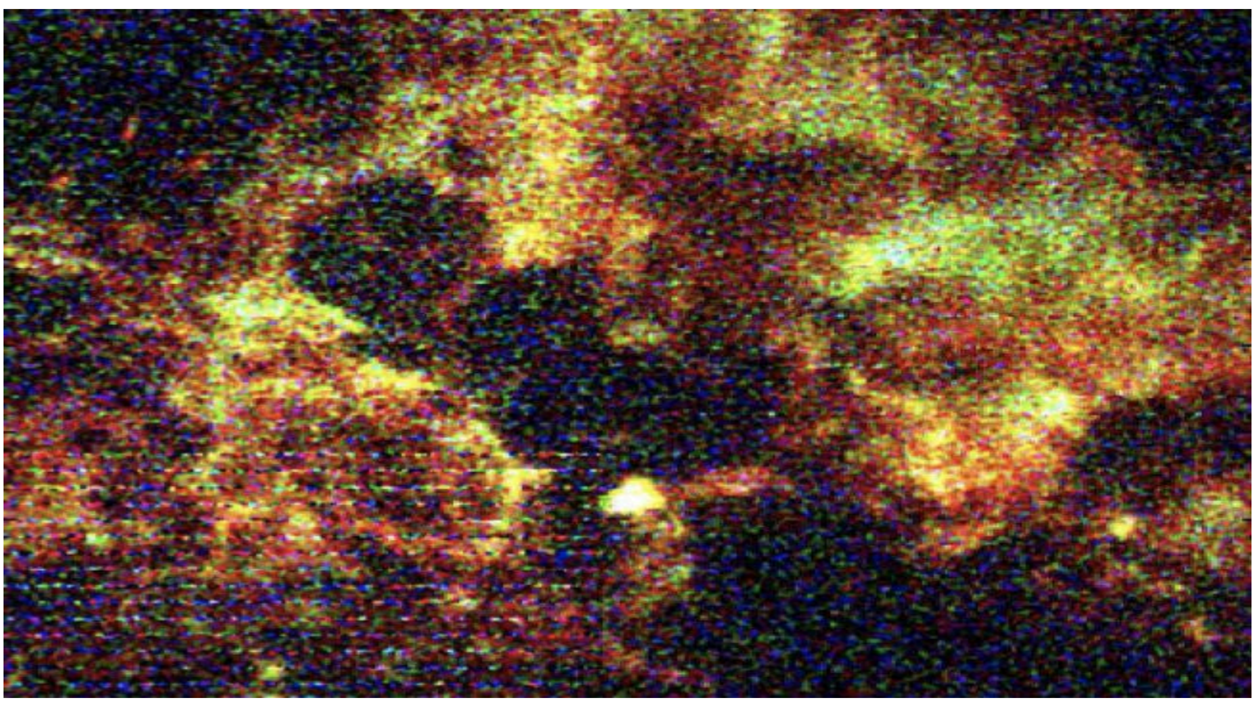
So that means these nova-level isotopes are coming from the sun, and that the sun has a regular recurring micronova event lining-up with these disaster cycles, which means it must be triggered by this cyclical process and external (galactic) forces.

What Kind of Nova Event Does the Sun Have?

When most people think of a “nova” event at a star, they think about a supernova. Only about 1 out of 1000 to 10,000 nova events is a “supernova” that signals the end-of-life of the star; in fact most nova events are recurrent, smaller nova events. This is where we must look to analyze the sun’s event, since a major nova event would destroy the entire solar system. Astronomers have discovered dwarf novae, micronovae, mini-novae, classical novae and several other types of stellar outbursts. But are these even possible on the sun? To answer that, we have to ask how does a star go nova?

Currently, there are only two ways that astronomers know how to trigger a recurrent nova event at a star:

1) Accretion. Basically, if material is dumped onto a star it can trigger a nova event. The most common form of this known in space is the binary effect, where one star siphons material off the other, but there are also at least three instances of this mechanism working when a star encounters a thick dusty/molecular cloud of material, which can also provide the material. Until the discovery of these dark nova bubbles (image below) it was believed that only binary stars could have small nova events.



2) Magnetic Kick. A relatively new mechanism was first proposed in 2023, and was officially published in 2024, whereby a star goes too close to a “black hole” and the magnetic forces of that encounter trigger the nova event all by itself (next image).

OPEN ACCESS

A 9 Month Hubble Space Telescope Near-UV Survey of M87. II. A Strongly Enhanced Nova Rate near the Jet of M87

Alec M. Lessing, Michael M. Shara, Rebekah Hounsell, Shifra Mandel, Nava Feder, and William Sparks

Published 2024 September 27 • © 2024. The Author(s). Published by the American Astronomical Society.

The Astrophysical Journal, Volume 973, Number 2

Citation Alec M. Lessing *et al* 2024 *ApJ* **973** 144

DOI 10.3847/1538-4357/ad70b7

Now, let's take a look at what this galactic current sheet is doing to our solar system:

1) It is dumping dust and gas into the solar system, with excess material already seen from the sun's corona to distances past Pluto. (Material dump)
2) The galactic current sheet delivers a galactic-level magnetic reversal. (magnetic kick)

That appears to indicate that this cyclical galactic event delivers BOTH known methods for triggering a nova, it does so at the exact same time, and does so at the exact time required to have the isotopes found in the geological disaster layers. That is quite the 3-way coincidence, but actually, it is a 4-way coincidence:

One of the biggest and longest-lasting problems with galactic physics was the concept that in the official math and models, the galactic current sheet would always stop propagating about halfway through the galaxy - but this is not what the astronomers ever observed, the wavy current sheet always extends out past the visible stars and spiral arms.

In 2021, a team presenting at APS Physics conference in Pittsburgh, PA noted that nova events injected directly into the current sheet would provide the "buoyancy" needed to sustain the sheet (next image). So not only do you need the solar micronova to explain the geologic evidence, not only does this cyclical galactic event bring both nova events at the same time, but the triggering of nova events by the passage of this sheet is what you need to fix galactic physics. That is a lot of coincidences one would need to ignore.

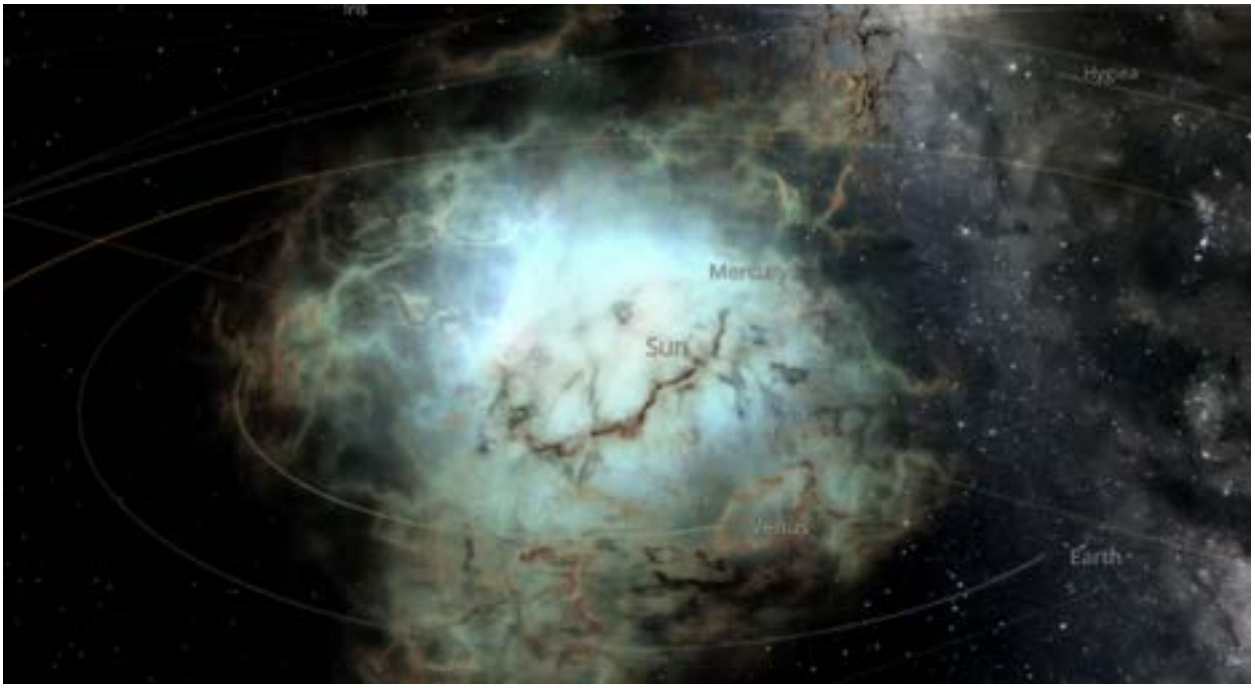
63rd Annual Meeting of the APS Division of Plasma Physics

Volume 66, Number 13

Monday–Friday, November 8–12, 2021; Pittsburgh, PA

Session JP11: Poster Session IV:
Astrophysical Plasma Phenomena
Education and Outreach: Public Engagement, Workforce Development, DEI, High School Research, Undergraduate Research
MFE - Exhaust and PMI: Disruptions and Runaway Electrons; Energetic Particles
2:00 PM - 5:00 PM
Tuesday, November 9, 2021
Room: Hall A

Abstract: JP11.00015 : Buoyancy of Cosmic Ray Loaded Magnetic Flux Tubes in the Galactic Disk*



When we take closer looks at the disaster cycle, the earth usually endures a rapid (albeit briefly lasting) cooling like in the Younger Dryas event 12,000 years ago. There is the magnetic excursion aspect, the volcanos, nova-level isotopes, the cyclical nature of the event, and impactor craters dating to the same times. How do we explain the impactors?

With the sun blasting off a micronova event, it is likely that some of that material would congeal as it traveled through space, turning into small impactors that would target everything in the solar system. A micronova can make impactors, but impactors cannot make excursions, nova-level isotopes, and would not follow a regular cycle.

In the following chart, we have the events that come with the cycle, along with explanations for the candidate event that triggered the disasters of the past. As you can see, only two can explain all the evidence, the solar micronova and the galactic superwave theory by Dr. Laviolette.

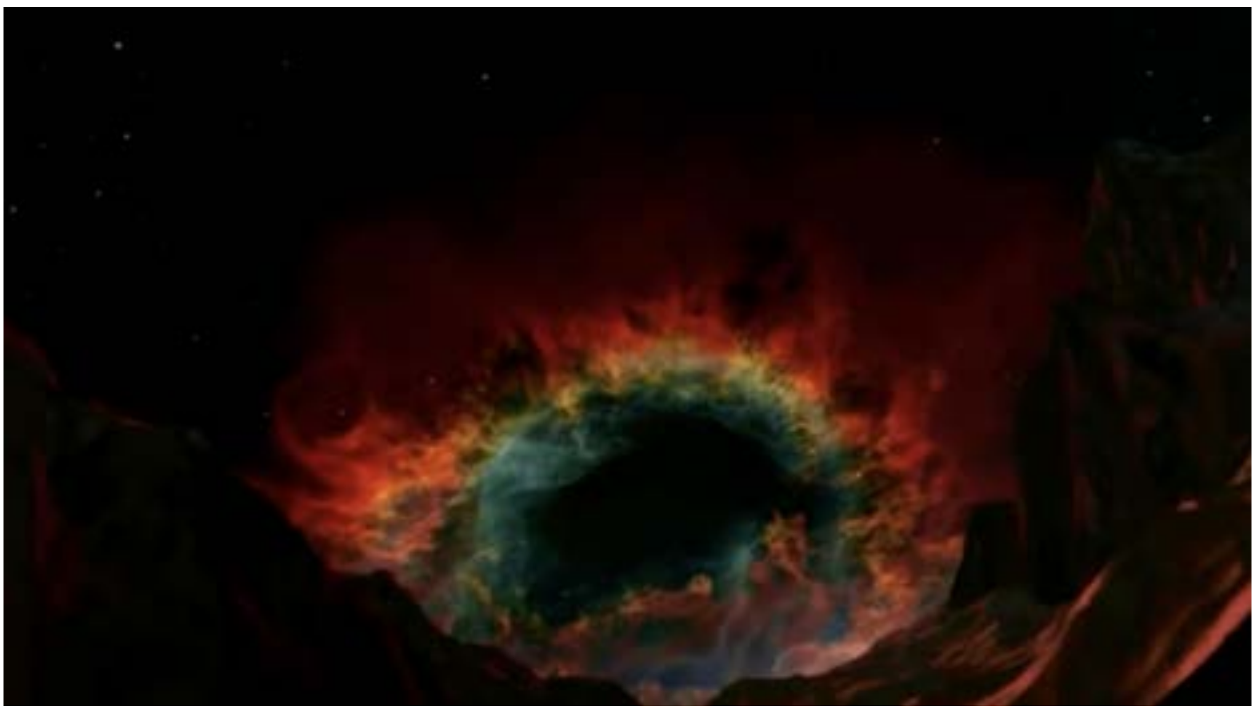
DISASTER EVENT CANDIDATE	Global Cooling	Magnetic Excursion	Impactors	Volcanos	Isotopes	Cyclical
Volcanos Only	✓	X	X	✓	X	✓
Magnetic Excursion Only	✓	✓	X	✓	X	✓
Impactors (Comets/Asteroids)	✓	X	✓	✓	X	✓
Solar Micronova/Galactic Current Sheet	✓	✓	✓	✓	✓	✓
Galactic Superwave	✓	✓	✓	✓	✓	✓

Why do we favor the solar micronova and galactic current sheet over the superwave theory? There are two reasons.

First, the superwave is a nice idea, but we don't see any superwaves in any of the millions of galaxies visible in the cosmos. Second, the superwave is a light wave, meaning that when it arrives, the impacts are immediate, with no lead-up or build-up to the disaster.

Clearly these events in the earth disaster cycle are not triggered all at one time, and we can see now in this instance of the cycle that it is drawn out over at least a few decades of magnetic change.

Finally, even Dr. Laviolette himself said that this event would destroy the atmosphere and kill all life on earth, so that can't be our 6000-year event.

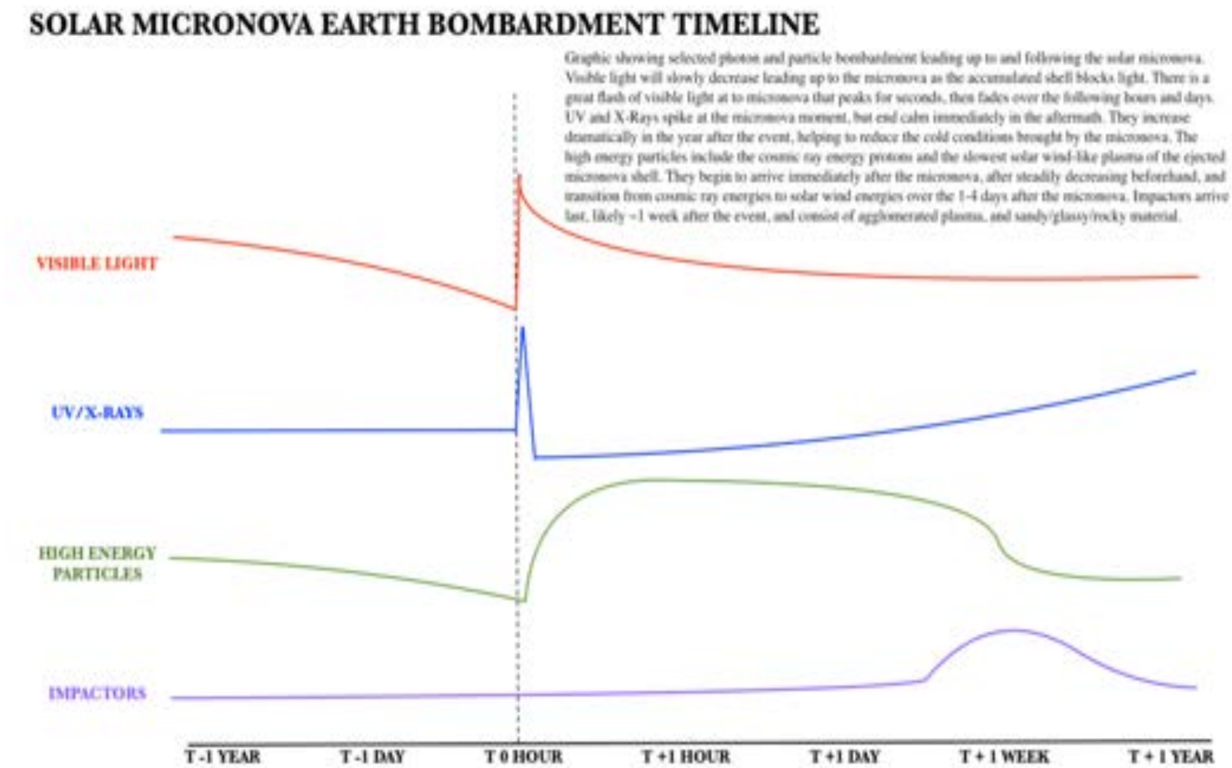


The micronova shell will contain impactors, deliver the nova-level isotopes, and the dusty plasma of the nova event will block the sunlight and trigger the rapid cooling event. The galactic current sheet explains the cycle, the magnetic changes, and the extra cosmic energy that triggers earthquakes and volcanos.

This is the only way to explain ALL the evidence that shows-up time after time, cycle after cycle.

The Next Solar Micronova:

The solar micronova will create a major flash of extreme UV light and X-rays, this will be able to burn the surface to the point of melting rock, but luckily will only last for seconds to a minute. The high energy proton bombardment begins in minutes, depleting ozone and causing atmospheric wind/lightning effects and inducing geomagnetic currents in the ground.

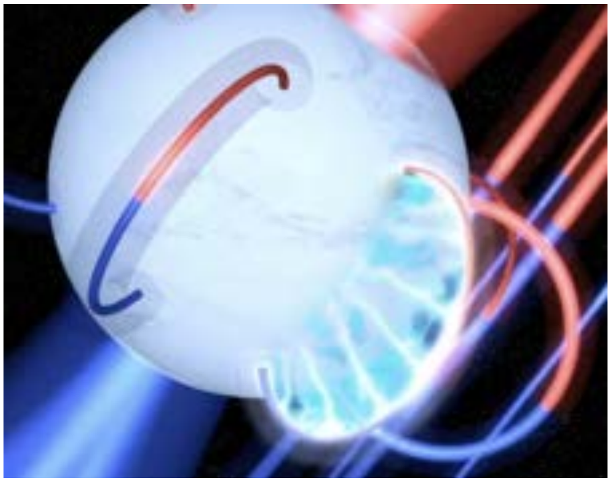


Approximately 18 hours after the eruption, the main shockwave of plasma arrives. It consists mostly of plasma and small impactors at first, with larger impactors coming in the days that follow, since they cannot travel as quickly as accelerated energetic particles.

The interaction of the energetic particles will cause dramatically severe weather for a week or two, followed by periodic larger impact events.

The most dramatic physical impact of the solar micronova could be a “thunderbolt of the gods”, an event described in numerous myths and stories in antiquity, where a massive lightning bolt appears to come down from the top of the sky, and strike the ground with tremendous energy.

This is what supposedly happens on a magnetar, where too much energy surges through the lowest magnetic field shells, and discharges downward (arc discharge), cracking the surface of the star itself (next image).

When we can see examples of modern-day lightning carving concrete or land, we must consider that the micronova arc discharge event is capable of blasting away rock, carving canyons, and displacing water on a continent-scale. If you remember the hydro-electric experiments from chapter 8, imagine such a discharge event pulling-up the ocean by hundreds to thousands of feet, only to drop it back down and send a massive wave out from the strike point.

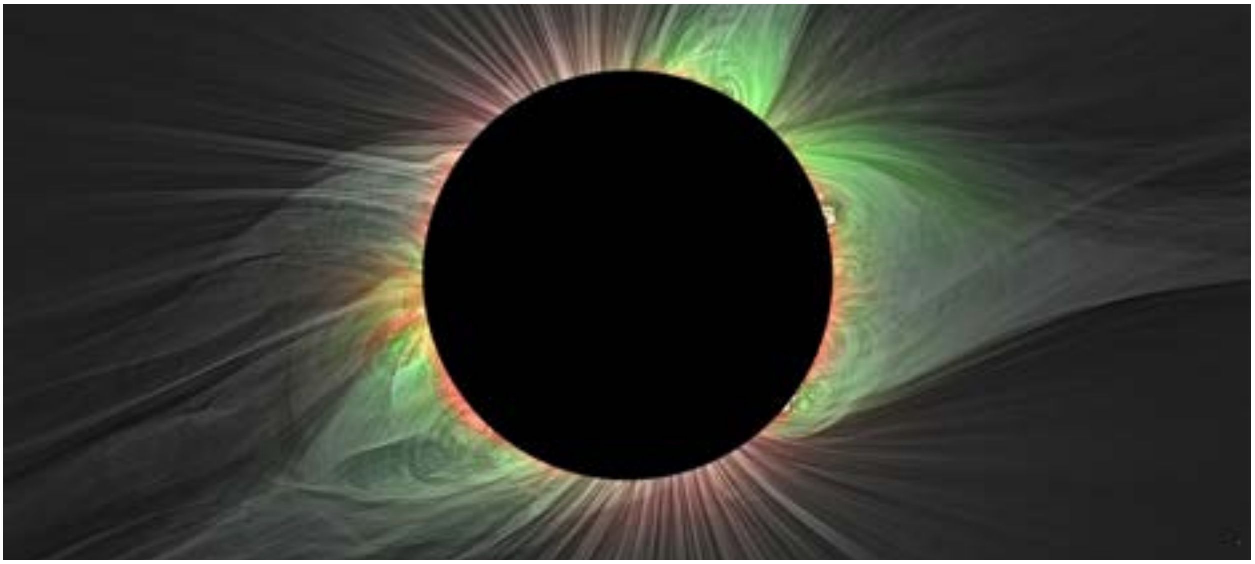
The good news is that the micronova induces energy all the way to the core, which recharges it, amplifying earth's magnetic field back to normal levels. This is why the ancient stories about this event describe a week of cosmic hell, followed pretty-much instantly by a new golden age of earth, where the same destructive electric force changes the planet for the better in the long run by amplifying the earth's magnetic field, calming the weather, and blocking out the cosmic radiation.

The four horsemen of the apocalypse and the solar micronova:

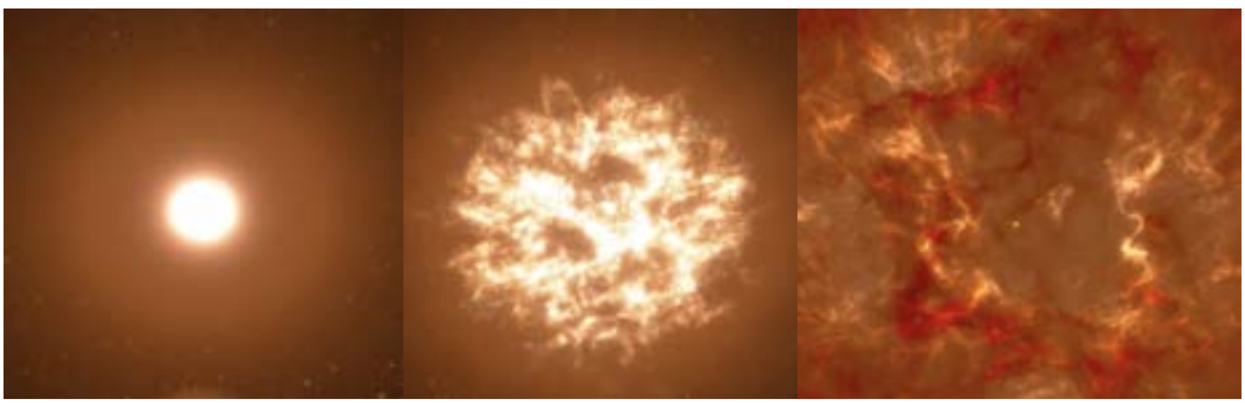
Right now, the sun doesn't appear yellow anymore, it's white, so bright that it wears a crown of rays and streaks at the top of the sky. The first horse is white, associated with a crown.

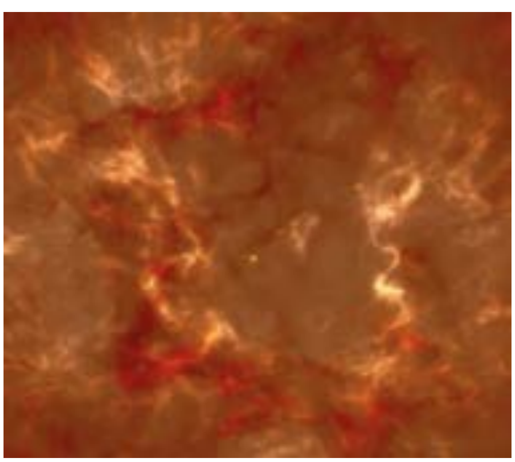
When the galactic magnetic reversal impacts the sun, the luminosity production will drop, as well as the solar wind. Lower luminosity and increased dust accumulation without the solar wind will begin to turn the sun red. The second horse is red, is said to "steal the civility" of the populace, and a red sun would certainly do that.

The third horse is black, and carries the scales (balances). The red will slowly turn to black as the maximum dust accumulation and luminosity loss occurs. When this happens, the main glow will come from the sun's Van Allen torus, which will look like balancing scales on either side of the sun (next image).



Finally, the micronova erupts. The fourth horse is pale, the rider’s name is death, and hell followed with him. Through the dust and plasma of the micronova we will once again see that pale yellow hue, but hell follows with it.

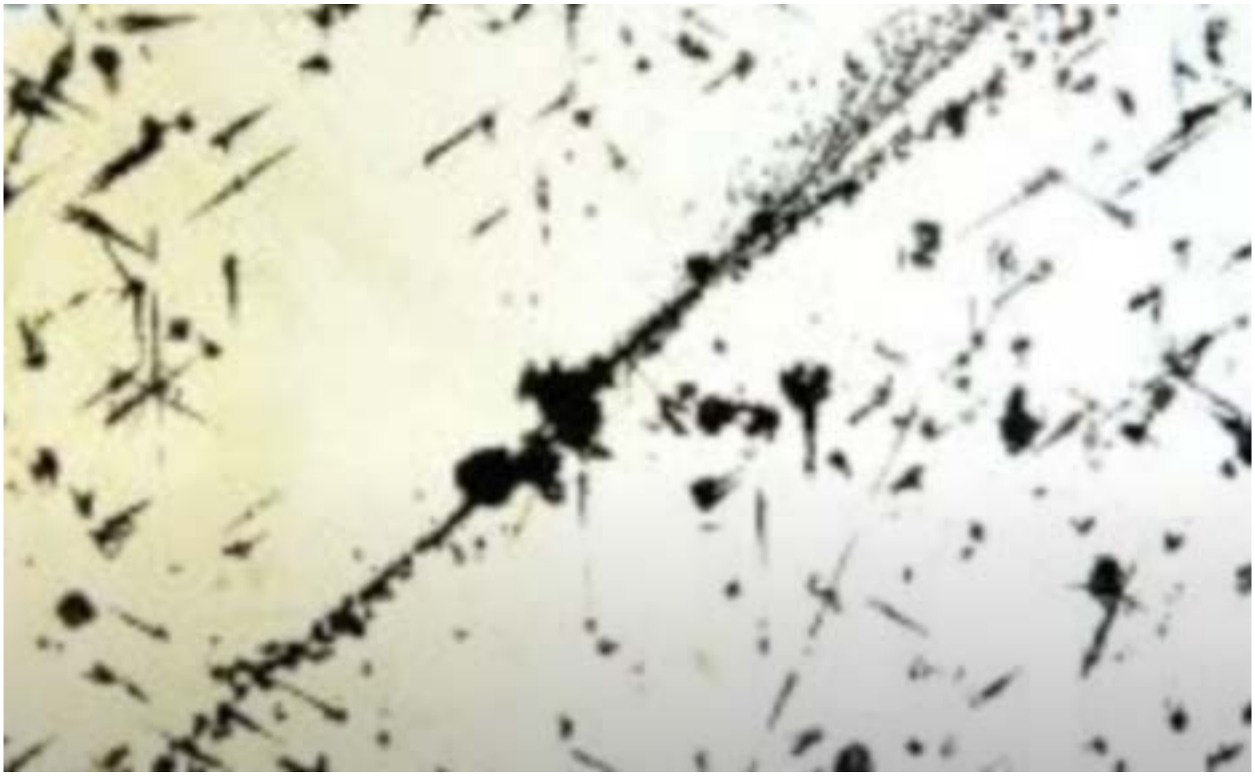




<<< Pale Yellow Sun Visible Through The Dust

Look at the mission badge for Apollo 13 (below). Why are there horses of different colors? Is the sun the 4th horse? The earth and moon are visible, but the sun takes a more significant position in the design, and it looks very strange doesn't it - and like it is exploding in all directions with part of it having darkened to a red color. Why name the mission Apollo if Apollo was a sun god, and not associated with the moon? Why does the physics and chemistry of the micronova match the four horsemen of the apocalypse, and what does this mission badge tell us about why they really went to the moon? The glass found on the moon is similar to that found on earth, exactly where Doug Vogt found the micronova evidence.

Rare Cosmological Event Crystals:



It is worth considering if the “rare cosmological” events are caused by a solar micronova. The image above is a zoomed-in look at deformations and imperfections inside a crystal. The central, largest one is the object in question.

It is not an inclusion, but a void, a space opened up inside the crystal after its formation. The polar jet-like features coming from the central zone bleed out to nothing. Every other imperfection is either a piece of something else locked in the crystal during formation, or something that broke into the crystal after formation.

Scientists currently cannot explain the central feature. They know that something must have saturated the crystal in a powerful electric field, causing a piezoelectric charge-up that could not discharge outward (outside the crystal) due to the persistent presence of the high electric field, and instead implode-transformed and evacuated the very center of the crystal in a void-creating pop that shot jets out of the opposite sides of the void.

They cannot imagine any way to accomplish this here on earth, but they never looked at a fantastic solar outburst.

Solar Micronova Coincidences:

- Geologic evidence of short-lived nova-level isotopes within the disaster layers
- Other stars cannot be blamed, it can only be the sun
- Both nova triggers come at the exact same time with the galactic current sheet
- This double-trigger is perfectly timed to include the isotopes in the disaster layers
- This timing is the only way to fix galactic physics
- Apollo mission badge is eerily telling and suggestive
- Rare cosmological event crystals

Chapter 13

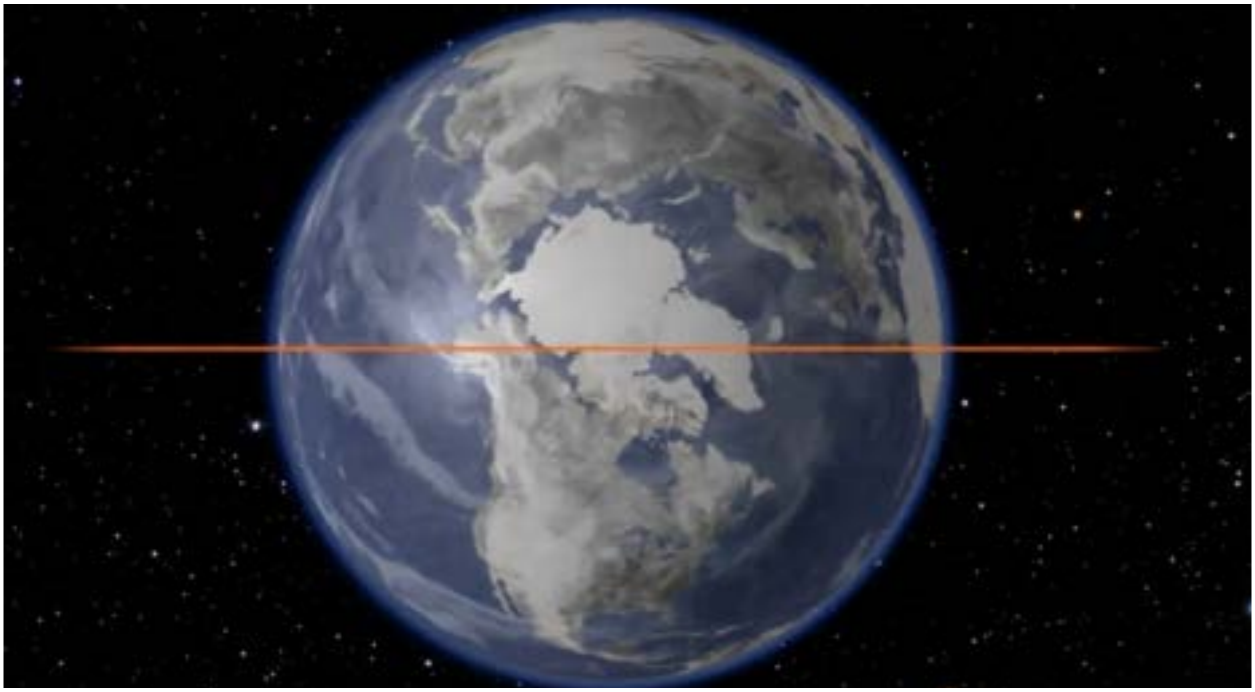
The Great Waves and Pole Shift

In this chapter we will put-forth the argument that the zenith of earth-impacts of the disaster cycle is a tilting of the crust, and the creation of great tsunami waves because of it:

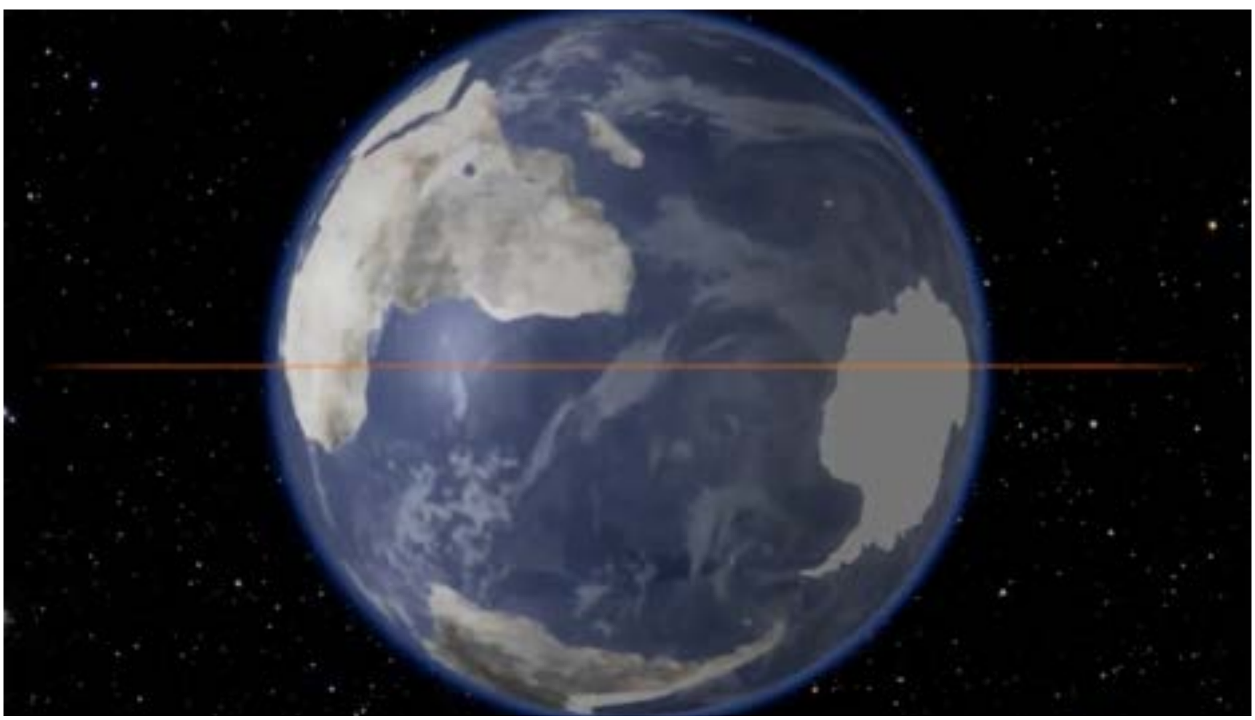
- Evidence suggests the earth flips over 90 degrees.
- This causes major tsunamis.
- The most-likely angle of tilt is known, and therefore, the tsunami directions.
- The micronova is the cause of the earth crust displacement.

Surge deposits in Alaska, Africa, Australia, China and Russia all contain massive heaps of debris, mud, fossils, trees, muck and sand. They are the result of a massively powerful sweeping force across the land depositing everything in its way into enormous piles and masses. Some geologists question whether these could be from meteor impacts, but virtually none of the surge deposit materials have significant burning evidence.

The real source of these muck piles is water - the great waves of the disaster cycle. The isotope dating puts nearly every surge deposit on earth into one of the cycle timelines, and specific isotopes indicating the solar micronova event are found in the bones and petrified wood. There are several pieces of evidence suggesting that this happens during these cycles, and there is a mathematical and scientific rationale for their occurrence. This chapter describes “the what, the where and the how.”



The Earth turns over. It is an ~90 degree shift bringing Greenland and Antarctica to the equator. This process is triggered by the solar micronova, which unlocks the crust and mantle through electromagnetic forces, driving continent-sized tsunamis that will impact every coastline, and in some cases, travel a significant way across the landmasses.



original, of great simplicity, and—if it continues to prove itself—of great importance to everything that is related to the history of the earth's surface.

A great many empirical data indicate that at each point on the earth's surface that has been carefully studied, many climatic changes have taken place, apparently quite suddenly. This, according to Hapgood, is explicable if the virtually rigid outer crust of the earth undergoes, from time to time, extensive displacement over the viscous, plastic, possibly fluid inner layers. Such displacements may take place as the consequence of comparatively slight forces exerted on the crust, derived from the earth's momentum of rotation, which in turn will tend to alter the axis of rotation of the earth's crust.

In a polar region there is continual deposition of ice, which is not symmetrically distributed about the pole. The earth's

This image is part of Albert Einstein's foreward to Charles Hapgood's book on crustal displacement. He and several other major researchers have come to similar conclusions, that the best explanation for the rapid destruction and climatological changes across the world is a displacement of the crust.

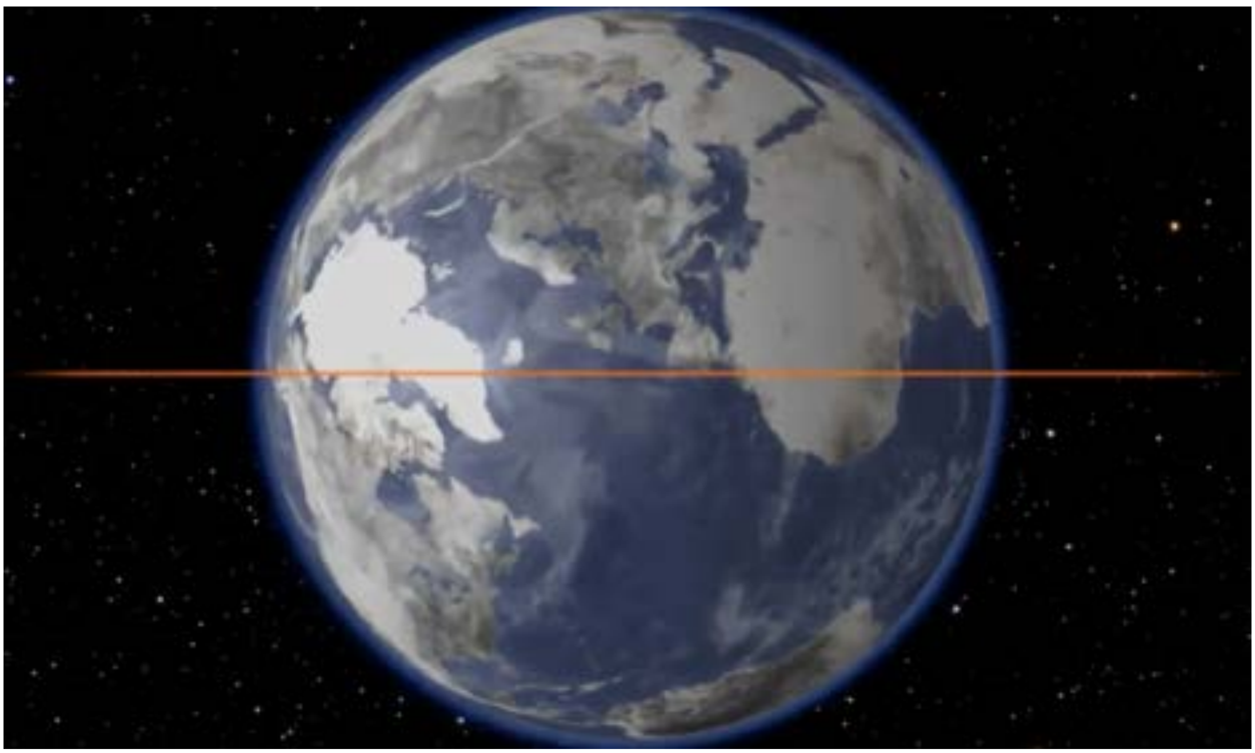
This author is in possession of additional information on Einstein's beliefs regarding the pole shift, which are not publicly known.

- Several letters were exchanged between Einstein and Immanuel Velikovsky regarding the crustal reorganization.
- Velikovsky's friend, Michael Steinbacher, was given a copy of three of these letters from Einstein to Velikovsky, which were sent in the last 3 years of Einstein's life.
- Steinbacher was a good friend of mine until he passed in the late 2010s, and he allowed me to study the letters.
- Most of the ~35 pages were not relevant, a small fraction was about the earth disaster cycle and crustal shift, and the most important part of that was Einstein's math regarding the tilt. This is what the letters discussed:

Physics principles tell us that the heaviest part of a spinning object wants to be at the point of greatest centrifugal force (the equator of a sphere like the earth), and on the earth, the heaviest portions are the polar regions, where ice has accumulated for the last 12,000 years and tipped the balance away from homogeneity.

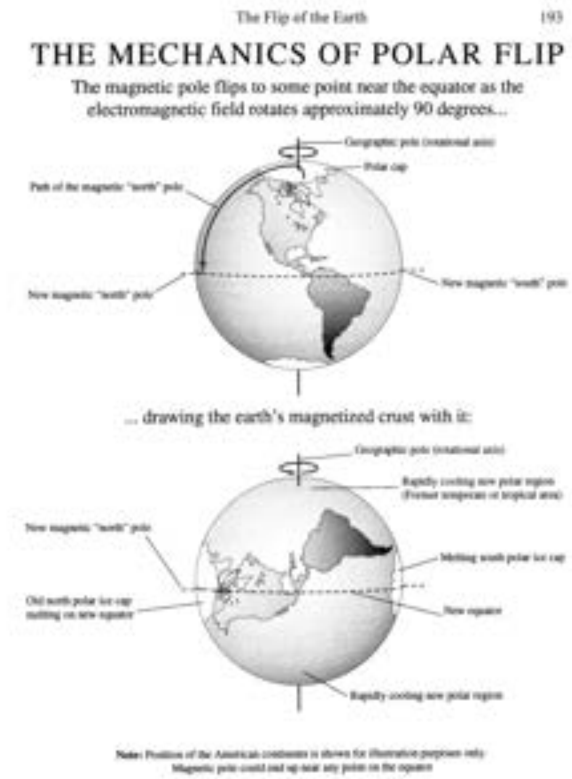
While the ocean and crust and mountains provide only a small deviation from a homogeneous outer shell to our planet, the ice caps sit on top of the crust, making for a large and significant deviation from our spherical planet. While we do have an equatorial bulge, making earth an “oblate spheroid” it is a very small bulge.

If you can picture a cue ball on a pool table, the tiny imperfections in that cue ball are greater in relative size than the equatorial bulge on earth; even the highest mountains and deepest ocean trenches do not change the spherical nature and balance of the planet very much - but the ice matters a great deal.



The ice caps “want” to be at the equator, but cannot get there right now because the crust and mantle are locked together. In his letters, Einstein had some doodles and math suggesting that Greenland and the East Antarctic sheet were the main heavy heterogeneities, meaning they would pull towards the equator if the crust could be unlocked, leaving the earth in the position of the two images shown earlier in this chapter, with the new poles found near India and South America.

We will revisit this locked-crust concept, and how it unlocks, but first, there is more than the geologic evidence across the world, which was detailed by Hapgood, Einstein, Chan Thomas (The Adam and Eve Story), and other researchers like Newton, Cuvier, Leibnitz, DeLuc and Walker (Cyclical Deluges). Dozens of books and other writings were published on this crustal shift over the last 250 years.



Perhaps the most important of the dozens of books on this topic wasn't published until 1992. It is written by Ken White, who is the son of Major Maynard E. White, who led the Project Nanook mission to the Arctic circle in the 1940s. The book is called "World in Peril."

Major White committed treason, and we are very lucky he did. He took classified documents from the mission, and from their meetings at the Pentagon with the Office of Strategic Services (OSS, predecessor to the CIA) and the Rand Corporation (#1 Classified-Science Company for the US Government in the 1900s).

These documents were given to his son Ken, who was instructed to publish them upon Major White's retirement. The book contains detailed information on their discoveries and the analysis by the government scientists. The goal of the mission was originally to perfect polar military activities - which would be different to everything they previously knew due to the cold, and the navigational difficulties of being so close to the magnetic pole. At the time, the US government was worried about Russia "coming over the top of the world" and attacking the US, so they sent the mission to locate the magnetic pole and learn how to operate in such frigid temperatures.

However, in their attempt to locate the actual pole, they found evidence of it moving over time, and when they dug down, they found layers of major disaster sedimentation, again and again, on the same approximate timescale of the geomagnetic changes of ~12,000 years.

Furthermore, in some of the layers they found only polar fossils (as expected) but others showed tropical fossils, and according to official mainstream science, those regions have never been in the tropics, certainly not in the last 100,000 years. However, several layers suggest that the region was in fact in the tropical zone several times during the last 100,000 years. **The pentagon, the OSS scientists, and the RAND Corporation did a full analysis; this 90 degree tilt of the crust was determined to take only one day.**

The books of history, Einstein's conclusions and math, religious stories and myths describing the earth turning over, swaying like a drunkard, or the sun rising in the wrong place or standing still in the sky, all point to this crustal displacement, but this author's favorite piece of evidence is one with which most of you are familiar: The Mammoths.

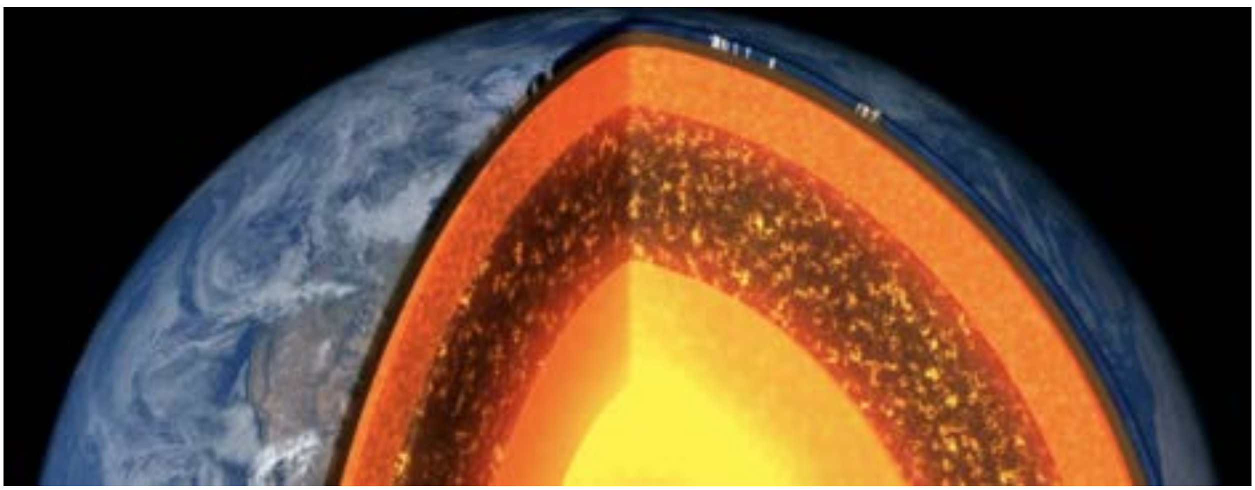
We have all heard the story, right? They dug mammoths out of 20 to 30 feet of polar ice, and they had been frozen so quickly that food was undigested in their mouths and stomachs, and the explorers were even able to feed the mammoth meat to their sled dogs. Everyone asks the wrong question: "How did the mammoths freeze so quickly?" The better question is: "What were they eating, and what were they doing there?"

Mammoths needed about 1000 pounds of vegetation food a day, and they dug them out of 20 to 30 feet of ice in the 1900s, which is ~12,000 years into the modern hot interglacial cycle. Those mammoths were frozen in the glacial period, when it was 10-20 degrees colder. So, if there is nothing growing there now, after 12,000 years of hotter weather, there was almost certainly nothing to eat in those locations when the mammoths were frozen.

Furthermore, the mammoths were not found on top of ice and snow, but right at the ground level, meaning the region did not have tons of snow and ice when the mammoths were there, which is impossible for that polar region during the glacial cycle, unless that area was not at the polar region at that time.

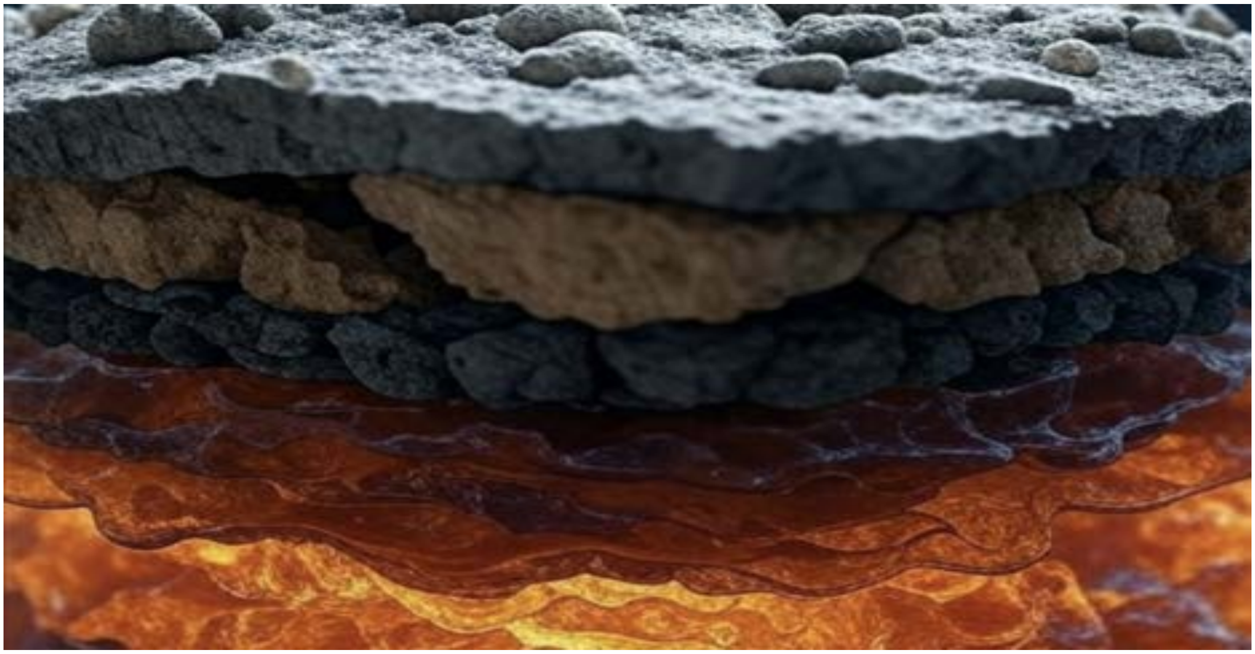
If Einstein, the historical authors, and Major White's information is correct, this also explains the mammoth finding: they were in the low to mid latitude regions, eating vegetation, and when the earth tilted, they found themselves at the polar region, instantly freezing, and left to be buried under feet of snow and ice.

So now, let's come back to HOW it happens. How does the crust unlock from the mantle to allow the polar ice caps to move the crust? First, we must understand HOW the crust is locked to the mantle.

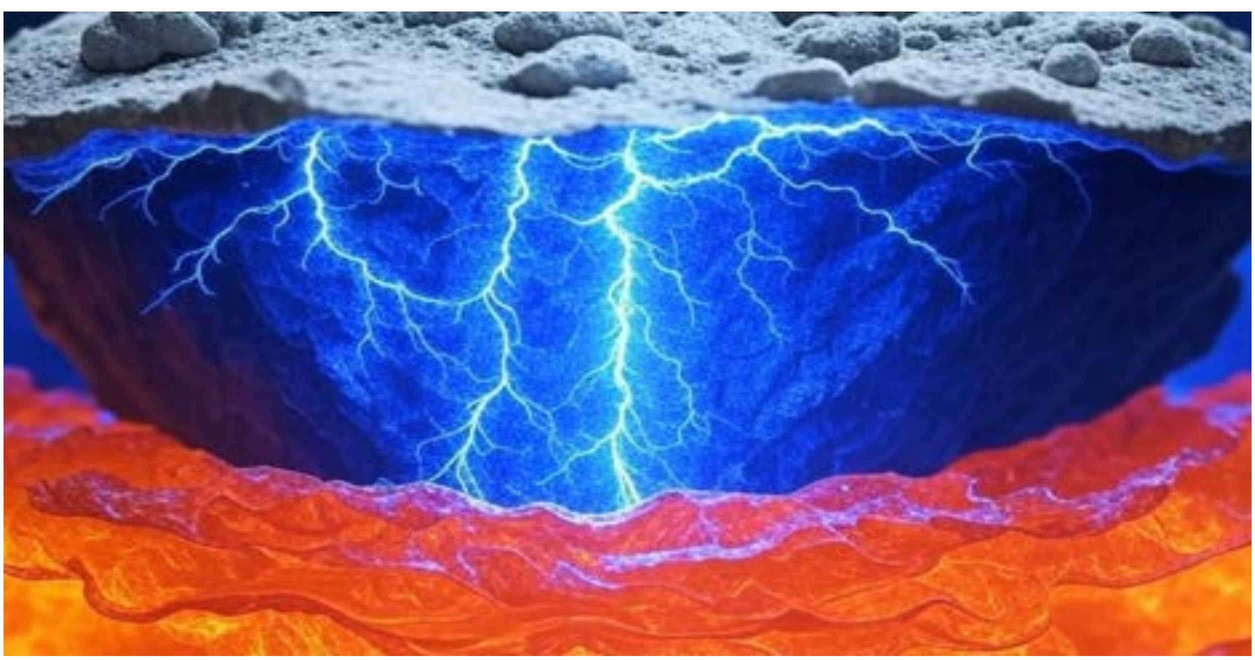


The letters Michael Steinbacher showed me indicated a grand frustration on the part of Einstein in not being able to determine how the crust would unlock. He tried to do the math with asteroid impacts, triple the snow and ice at the polar region, and several other methods, but was never able to make the math work out. He never once mentioned the sun or earth's magnetic field, and this is almost certainly where the answer is found.

The thin solid crust does not simply sit on top of the liquid mantle (like plywood floating on a lake), but there is a small transition region of partially melted rock called the low-velocity zone (LVZ). It is the most conductive spherical shell layer on earth, and it locks the crust and mantle together by causing the layers to stick together almost as though there is glue between them. This LVZ is slightly melted at the top, acting like a molasses holding the crust to the low velocity zone. Its liquidity (melt fraction) increases slightly as you go down, until you reach the bottom portion, where the LVZ is liquid enough to blend and flow with the mantle below.

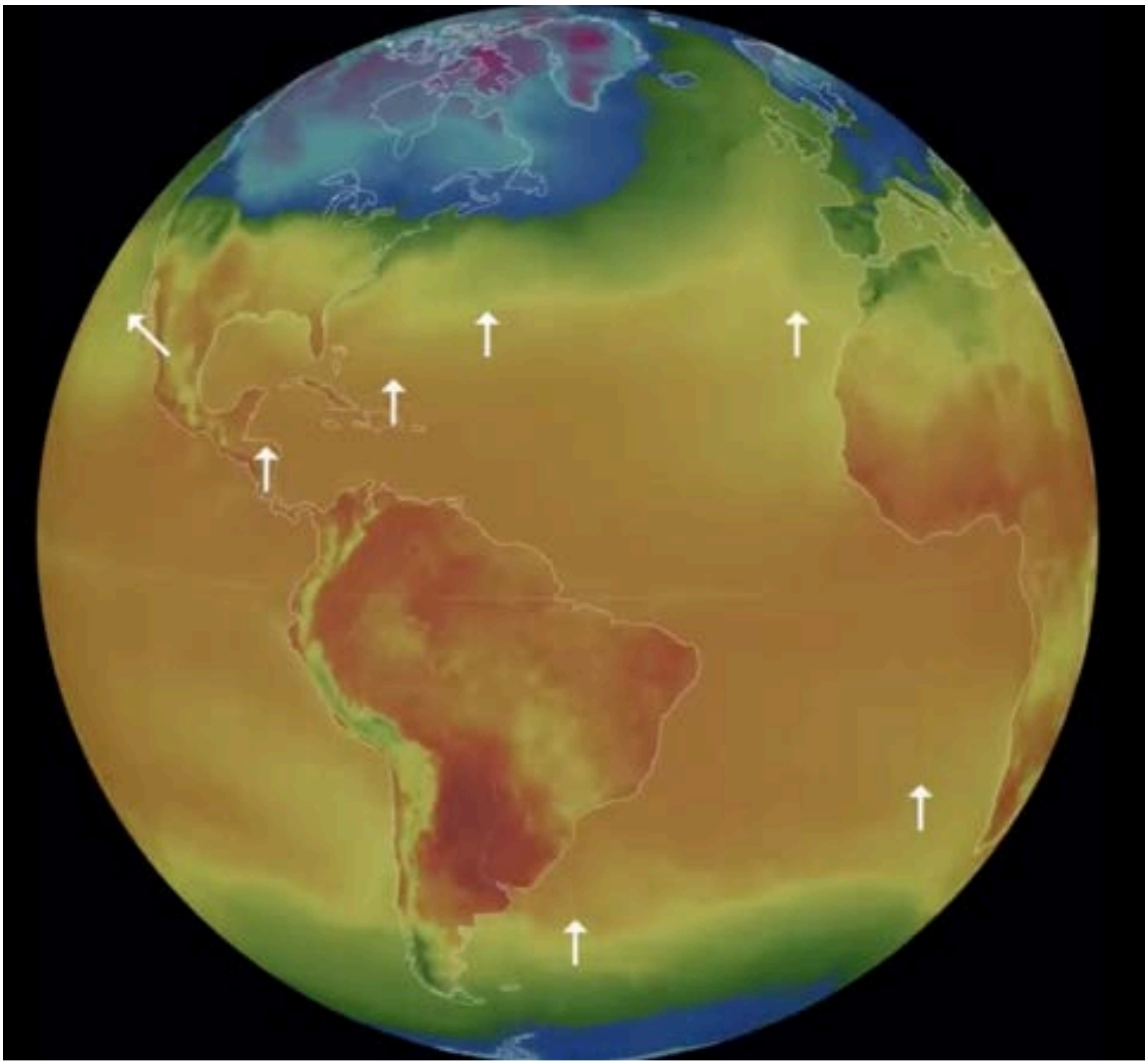


Modern solar storms are known to induce electric current not only through the lower atmosphere and crust, but into the LVZ and the upper mantle. It is estimated that major solar storms (like those from a super flare) could cause induction down all the way to the core. So let's consider the solar micronova, or even a significant solar storm impacting when earth's magnetic field is very weak - the level of current flow into the LVZ would be tremendous. This current flow, through ohmic (joule) resistance heating, would easily melt the LVZ, unlocking the crust from the layers below, and allow the ice caps to begin their movement towards the equator, tilting the entire crust with them.



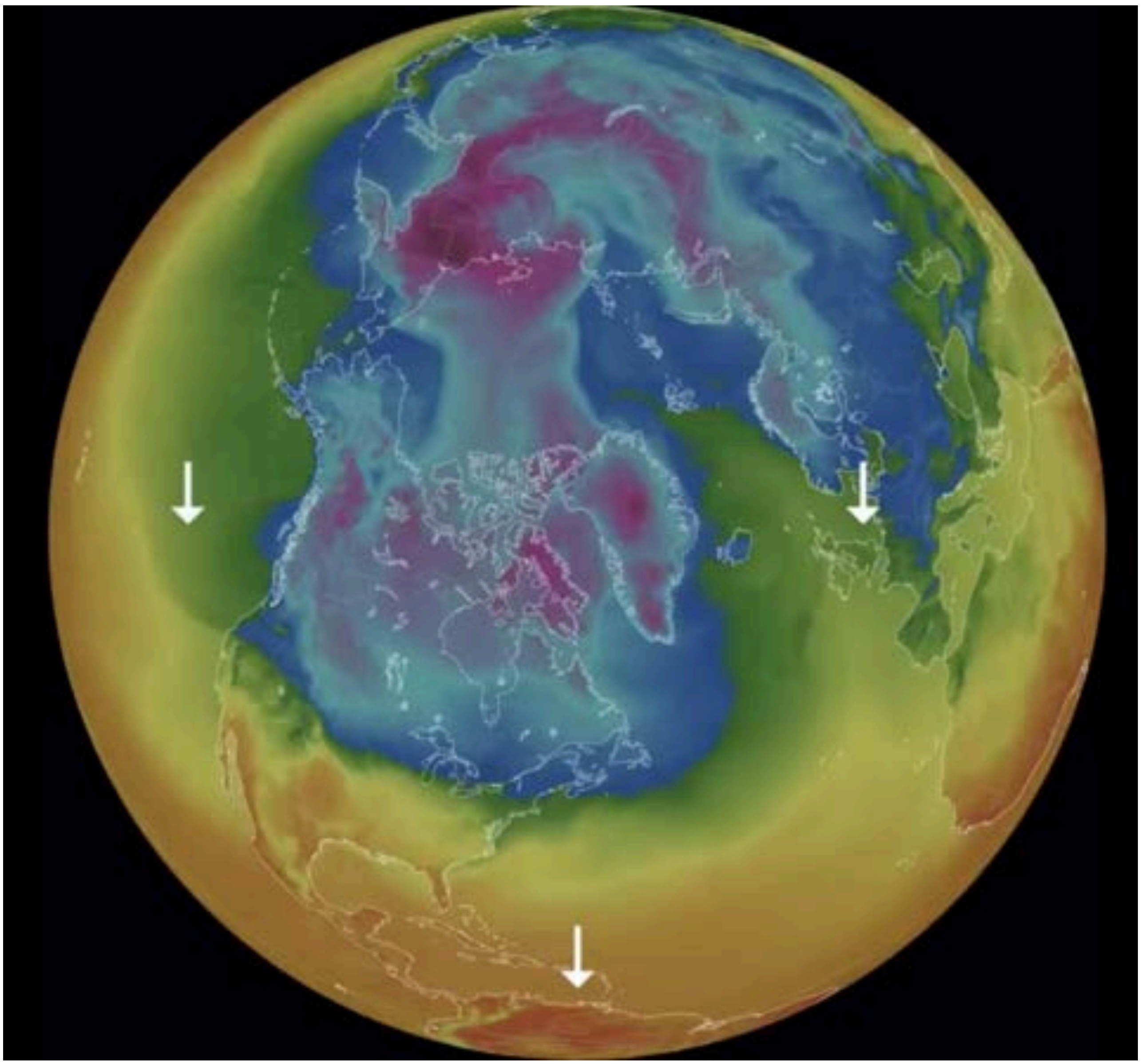
This mechanism allows the crust weight to re-stabilize, ice to accumulate at the new poles for several thousand years, and when the event happens again during the next disaster cycle, it is another 90 degree tilt, time and time again.

The next images are an example of how you can gauge where the tsunamis will go. There are two phases of great tsunamis, the initial inertial wave, and the slosh-back of the water. The initial inertial wave moves opposite of the crustal tilt, since the water of the oceans has inertia and will not shift with the crust. It will take-on some of the tilt momentum and have it continue when the earth stops tilting, sending a wave back in the other direction.



The previous image shows where the inertial waves will travel in the western hemisphere. As Greenland and the western hemisphere tilts southward, the oceanic inertia keeps it relatively in place, meaning that the land will push into the water, driving it up and over the land in a northward direction. The Gulf of America will enter the central USA, the far-east Pacific will impact Central America and Mexico, the Atlantic will impact the US East Coast, western Europe, eastern South America and West Africa. The Mediterranean Sea and Atlantic Ocean will impact Europe, and the Caribbean Islands will all be impacted significantly. These tsunamis are like a fast-rising high tide, and last for the entire duration of the tilt, which is expected to be 12-24 hours, allowing the water to reach great distances into the landmass.

The next image shows where the slosh-back waves will travel:



When the earth-tilt stops, the water rushes back the other way. This slosh-back wave is more like one would imagine a massive tidal wave, rather than a rising tide, and while it impacts more dramatically, it does not travel as far inland, and lasts for a much shorter time period. During the slosh-back, the Atlantic will hit northern South America, the Arctic Ocean will hit Europe, and the Pacific will impact the US west coast.

It is important to remember that lakes will have both of these same effects - so considerations for flooding are necessary near the Great Lakes, the Hudson Bay, etc. The same process can be performed for the opposite side of earth (Australia, Asia) where the initial inertial wave goes south, and the slosh-back comes north.

So where will it be safest from the waves? Based on the waves alone, an excellent method for determining if you will avoid the flooding is to take your elevation in feet + your distance to the ocean in miles, and it is best if that equation leaves you with a score over 5000. Scores under 3000 are where you should consider yourself to be in danger, and anything under 1500 is a big problem.

According to this method alone, the best places on earth are:

- The Rocky Mountains (Colorado - Alberta CAN)
- Northern Himalayas (Tibet/China)
- Karakoram Range (Northern Pakistan/China)
- Andes (Argentina)
- Ethiopian Highlands (Near Ras Dashen)
- Antarctic Plateau (Near Vinson Massif)

However, obviously not all of these places are reasonable. Some may be difficult to get to, or impossible to live near now (Antarctica). Others are dangerous for other reasons, like Ethiopia, where conditions are dangerous culturally, and the east African rift presents significant earthquake and volcano risks. Other areas are problematic due to where the new pole positions will cause extreme freezes near India and South America.

So, if you are trying to pick the best survival location, you need to consider more than just the great waves:

1) Avoid Major Pitfalls

    a) Big cities where resources will be scarce and violence will be high
    b) Places where it is too cold now or where the new poles will be
    c) Major fault lines, volcanic areas, coastlines

2) Avoiding the Great Waves

    a) Elevation in Feet + Miles from Ocean (Aim for +5000)
    b) Scores under 2000 should absolutely prepare to need to “float away”

3) Managing the Intermediate Period

    a) The sun may take-out power/civilization long before the earth tilts
    b) Can you survive if there is no power, no infrastructure, and worse weather than the region has now?

This leaves the best options as the Rocky Mountains, northern parts of Himalaya/Karakoram, and southern parts of Mongolian mountain range. The best region in Europe is the northern portion of the Carpathian mountains near the border of Romania and Ukraine. Australia is challenging because the best place (central mountains) is relatively inhospitable now, and the Mountains between New South Wales and Queensland may not be big enough.

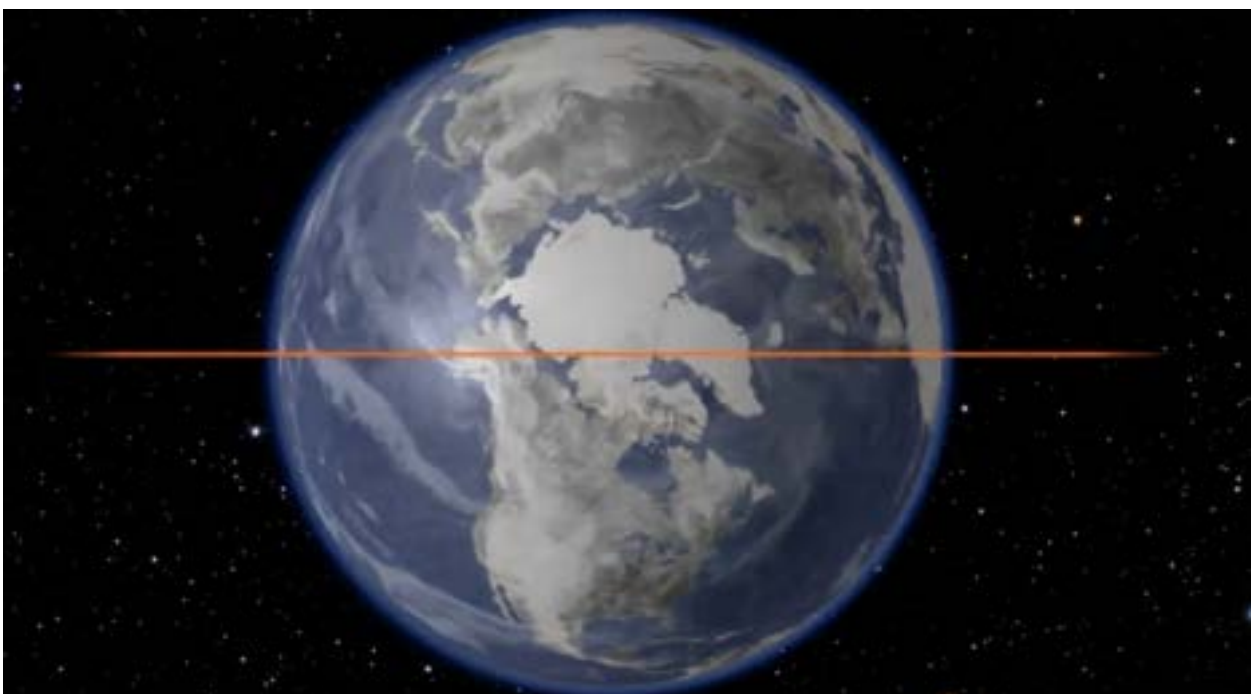
Ultimately, you must make these judgments for yourself.

It is important to know that a plan to “float away” if you are at lower elevations is not a death sentence, but it must be done correctly, and requires an additional consideration:

- If you saw the Japan tsunami from 2011 you know it was not just water - there were cars, trees, rocks, metal, and other items in the turbulent waters. This is likely to be the case in the great disaster event as well, and so an inflatable floating device is not likely to work. It needs to be strong enough to get “banged around” and still float.

- If you manage to float away, expect to be floating in one direction for about 12 hours. Then you will stop and begin to float the other direction. At this stage, you need to get to land as soon as possible - you are being dragged out to sea. It would be a shame to survive everything about this event, only to die alone in the middle of the ocean.

- Your floatation option needs to be fairly large. Not only do you need room for everyone in your family/group, but you need supplies. Not only is it going to be nearly impossible to find your way back to where you began, but even if you do, everything you had will have been washed away by the waves. If you plan to float - plan on having EVERYTHING float with you.



It is worth trying to gauge what your climate will be like after the earth flips. Obviously you want to avoid the new polar regions, but what if you are far away from those areas already? Try looking at your location on a globe if you tilt the way we have described. Greenland comes to the equator, the new north pole is near India and the south pole near South America. Using North America as an example, it is located with the same orientation, but in the southern hemisphere.

In this scenario, Canada and Mexico switch climates. Maine and Florida switch climates. Montana will be more like Texas is now. Arizona will more closely resemble Michigan. This not only can assist you in preparing your clothing and shelter options, but it can tell you which seeds are more likely to grow in your new climatological zone.

Some examples:

- The citrus fruits in Florida likely won't grow well in its new location - opt for berries and apples.

- Animals that currently do well in Colorado or Nebraska will likely have a similar climate after the flip (albeit in the opposite hemisphere).

- Canadians who plan to ride out the cold in the before-period may want to plan on growing pineapples and coconuts in the aftermath.

- The states bordering the Gulf of America will be trading hurricane concerns for blizzard worries in the aftermath.

- Greenland will likely be a primary target for tropical storms that form in the Atlantic ocean after the tilt event.

One last oddity that may tell us that this earth-tilt has been happening for the entire history of earth:

Dr. Erickson and Dr. Druckenmiller (pictured) from the University of Alaska, Fairbanks, were the center of a fascinating story on dinosaur eggs found in the Arctic. They were postulating whether the globe was exceptionally hot or the dinosaur species may not have been the cold-blooded creature they imagined- otherwise, there is no way those dinosaurs could have lived in that region.

Normally their hypotheses about warm-blooded dinosaurs or hot-house earth conditions would make sense - if not for the paleoclimate data or basic biology about reptiles - but what if instead the earth tilted?

Ultimately, the scientists determined that it was an open, ongoing mystery. Instead, it may be possible that these eggs were flash frozen when the earth tilted during the times of the dinosaurs, just like the mammoths, and the eggs were covered in freezing sediment, which perfectly preserved them.

Chapter 14

The Next Age of Earth

In this chapter we will see that:

- The elites know about the disaster
- How we're getting there, stage by stage
- Survival long-term, and what it takes

“They Know”

The governments, billionaires and other select individuals are well aware of what is coming and have known for a long time.

The Government:

- Information is power, and the government has a lot of both. It is logical to think “they know”.
- They classified everything related to the pole shift from Project Nanook, and nothing else about the mission.
- They participated in the cover-up, using Charles Hapgood and Einstein.

Charles Hapgood is the man who published “Earth’s Crust Displacement Theory”. Many people think Hapgood was just a random professor with a crazy idea about the crust shifting; this is very false. He was one of the lead geophysical scientists for the OSS (now the CIA) during the time Project Nanook findings were discussed. The conclusions and data that Major White handed down to his son were in fact something that Hapgood himself was a part of creating.

So then, why did he publish the version he did? Armed with a forward by Einstein, Hapgood advocated for a 7 degree tilt, not 90, and one that took 1000 years or more, rather than the one day advocated in World in Peril, which he helped create, and the version he later espoused was so easily debunkable that it created a stigma around the topic as fringe pseudoscience, and nearly torpedoed the entire field of catastrophe science.

Why did he change his tune? Because that was his job. You never “stop working for” the CIA. Part of the coverup of this disastrous crustal shift was Hapgood intentionally tanking the scientific subfield, even though he knew exactly what happens is far from what he published. Since Einstein had been dead when the book came out, it is possible that it was altered or clipped to support the fake-version meant to destroy the field. There is also ample evidence to suggest Einstein worked with the CIA, so this must also be considered. Now it becomes even clearer why Major White was so important.

The Elites:

- Elon Musk has SpaceX and the Boring Company (tunnel drilling), so he can go up or down, and has spoken about the magnetic pole shift on podcasts before.
- Jeff Bezos is hollowing out a mountain across the street from his Blue Origin launch facility on the border of Texas and New Mexico.
- Mark Zuckerberg has an enormous bunker complex he described as “it’s just a basement” when pressed about why he needed it.
- Several billionaires and numerous celebrities have had their bunkers detailed and even filmed. It is estimated there are 3-10x more that are kept secret.


JGR Solid Earth

Geomagnetism and Paleomagnetism/Marine Geology and Geophysics | Free Access

Apparent and true polar wander and the geometry of the geomagnetic field over the last 200 Myr

Correction(s) for this article

Jean Besse, Vincent Courtillot

First published: 15 November 2002 | https://doi.org/10.1029/2000JB000050 | Cited by: 506

Scientists with CIA funding through the National Science Foundation grants have repeatedly aided in the suppression of this science. The example above is very common. The paper suggests that the earth does not flip over at all, and offers past pole positions as proof. It is cited over 500 times.

However, there are corrections for the article, which put the pole positions on opposite sides of the globe from the initial publication - seriously, you can verify this paper and the corrections yourself. The corrections have less than 10 citations. This is what the ENTIRETY of studies attempting to discount the crustal shift concepts does.

Even if they were correct about pole positions in the current place over time, that is not in conflict with the crustal shift model, where 90 degree tilts put the poles in the same positions over and over again over time. Either way you approach this, nothing has actually ever debunked the crustal shift/tilt.

Distractions

It is the author's opinion that the "clown world" our civilization has become is intentional, and the result of a combination of two facets of the activities of the government/elites in preparation for the disaster.

First, while you may have been watching Alex Jones 20 years ago and had an idea about the workings of the powerful people on earth, but if you were not, you didn't know - they were careful, slow, incremental, cautious, subversive, patient and secretive. That is not the case now. They are spending like wild, stealing our freedoms, and doing things that don't seem to make any sense. They are acting quickly, obviously and recklessly in terms of secrecy. Why? They realized how short the timeline actually is, and are racing to get ready.

Second, the last thing they want is for everyone to figure out what is happening. This is why there is so much weirdness in the world today, and it seems to be supported and promoted by powerful interests. If they can keep us focused on crazy things happening politically, culturally, economically, socially and religiously, then the chances of us focusing on a natural catastrophe creeping towards us is significantly diminished.

If you recall the studies on psychological impacts of solar activity, and recognize that they would be amplified as earth's magnetic field weakens, then specifically the lowered cognition and amplified emotional instability play right into the clown world, and further fuel the lunacy while preserving the secrecy about the event.

This is the barrier to widespread awareness that needs to be overcome - it is unclear if that is even possible at this point.

Preparing for the Disaster

It is important you understand how this event differs from other emergency prepping scenarios. Unlike hurricane or earthquake readiness, this is a much longer-term preparation process.

Since the most-likely result of the disaster cycle is that humanity is severely reduced in number, with much if not most of our knowledge being lost and our species being flung back into the stone age, having to start-over. It helps to remember that there are the short-term supplies you will need immediately, and THEN a longer-term plan for food production and life overall.

In the immediate aftermath you will need water and food and shelter. There is a good chance you will need to defend yourself as well. The preparation for the first days/weeks after the disaster is not much different than preparing for a hurricane or an earthquake.

However, as the weeks go by, food and water supplies will run low, and you will need to be able to grow food or hunt. Clothes will tear and will need mending or replaced, the same goes for shoes and tools. Shelter will require maintenance. Sickness and injury will require medical treatments. Seasonal climate variation will require food storage and preservation. Eventually new children will come into the world, and they must be delivered, kept alive, and then taught the knowledge of how to survive.

Since most of us do not live a life like this now, and quickly learning a lifetime of survival skills may be impossible, you need to have a lot of resource material. Books on how to do these things, like making a trap or sewing or mending a roof, will be very valuable. It helps to consider the disaster in phases:

Phases of The Disaster

From where our civilization currently stands, there are likely four phases we will endure as this disaster cycle event unfolds:

1) Now - “The Clown World”

    a) From now until the sun takes-out power due to the weakening magnetic field
    b) Largest risks are war, economic, cultural/political
    c) Highest priority is preparation for the disaster
    d) Resist going off grid before it is necessary!

    The world is getting weirder and more challenging but you can’t quit, and you can’t rush off into the mountains now. You need to keep life going, keep supplies fresh, keep children learning, keep yourself aware and sharp and improving. Do not get distracted by the circus on the television. Do not grow complacent with a survival plan or preparation. Get better every day.

2) Solar EMP - “Lights Out”

a) Unpredictable: Could happen tomorrow or not at all until the micronova
b) Either a super flare or the weakness of earth’s magnetic field allows space weather to take-out the power grids and critical infrastructure
c) US government estimates this event would kill 90% of humans in 6 months

The moment the grids go down the “game” begins. Within a few days there is no help, no stores, nothing. Just you, your “network”, your preparedness and your plan. The #1 killer during this period will be the reliance on infrastructure; you need to be able to “click into gear” in terms of food and safety when the time comes. During this time, other people (not in your network) present the 2nd biggest hazard, and should be treated very cautiously. Some advocate a period of no-friend-making after the disaster begins; after about a month or two, everyone still alive will have something about them of value, something that kept them alive. Before that time, everyone is potentially desperate and a threat.

3) Micronova & Pole Shift - “The Event”

a) The sun begins to turn red, and then black, and then has the micronova ~3 days later
b) The micronova impacts earth and unlocks the crust within 24 hours on eruption
c) The crustal shift takes one day, with the oceans sloshing around and very bad weather (hail/wind/lightning) for ~7 days
d) Expected to happen in the 2040s

This event will last approximately 10-20 days. When the sun turns red, it is recommended that underground shelter be sought to avoid the radiation of the micronova event. When the earth begins to shake, it means the nova has impacted earth, and you should come back out to survey the situation. The wind, hail, radiation and other risks will be very high during this time. This is also when the crust unlocks and the great waves occur.

4) The Aftermath - “Next Age of Earth”

a) The earth has stopped tilting, the magnetic field is rejuvenated, weather is improving, plants are growing, animals are roaming
b) Your new location is your new home to begin the next age

c) You begin to rebuild civilization

The few myths that have survived from previous disasters suggest that after this cosmic disaster of a few weeks to a month, a new golden age emerges. The stories describe favorable temperatures, calm weather, and abundance of plant and animal life. This is what you are trying to reach. If you survive the first three stages, and you have planned to re-start life and civilization, the earth will be a receptive place to do so. This is where the skills and books will be needed to implement the plan and teach the next generations.

You need to be able to handle every stage of this event, understand how they differ, and execute survival strategies in a competent and timely manner if you hope to save yourself and your family. This is about supplies and skills, physical and mental toughness. Most people think a lot about supplies, but not as much about books, skills, and scenario planning.

Developing a network is perhaps the most challenging and most important aspect of this entire process. Most people imagine themselves being able to survive but that is almost always untrue. Everyone gets sick, or twists an ankle, or has a weakness in something. Imagine trying to learn everything needed to survive:

You would need to be a farmer, a hunter, a seamstress, an engineer, an architect, a handyman, a doctor, a midwife, a chef, a carpenter, a teacher of EVERYTHING… and much more. Having a community, united by one purpose, fixes this enormous problem, but it's not easy to achieve. How do you convince a group of people to do this with you? To prepare with you and commit to the process for what might be years?

This is beyond "prepping" or homesteading or getting "off the grid" - you essentially need everyone in the group to understand everything in this book, and everything that will happen, so that they understand why the specific preparations are being made. This is no small task.

The "underground shelter" aspect of prepping is important. The civilizations that appear to have survived the last disaster had a propensity to develop underground living/shelter areas at a rate so high that it cannot be random that those groups also survived. Whether you look at the "cliff dwellings" in Colorado or the underground cities in Turkey, it is a shared aspect of the civilizations that "made it" through to the next age of earth.

What should these underground shelters look like? How should they be made? How big do they need to be? How long will they need to be used?

The first consideration of a bunker or subterranean shelter is survivability, this begins by looking at your location in general. If you live in a big city, is building a bunker even feasible? Can it be hidden from other people? The answer to both of those is probably no. If your location is rural, but you are 2 miles from the beach and less than 100 feet in elevation, you are most likely to have water infiltrate your bunker, or have the entrance blocked by tons of debris and mud. In these situations (bad location) you could construct the most extremely-solid bunker imaginable and it will be nothing but a death trap.

If you have access to a natural shelter like a cave, or even an abandoned mine, this can work very well - there are enough cave drawings from antiquity to suggest they were successfully used to survive cataclysmic events. But most of us need to construct our own shelter, like a bunker or even a root cellar. This structure needs to survive the event - most notably, the solar storm induction and the great earthquake, which is expected to shake the entire world when the crust unlocks from the mantle.

For the solar storm induction, your biggest concern is metal. This goes beyond the basic construction materials and the items inside the bunker, and includes rebar used to reinforce concrete you may use for the bunker itself. Imagine you build an incredibly strong bunker but the solar storm/micronova induction creates lightning discharges inside your bunker from the rebar, or imagine it heats the air inside to 200 degrees - that’s a bad day to be in that bunker.

So how do you make it strong enough with that risk? First, you can use stone - this is what the ancients used to build, and many of their megalithic constructions still stand today. However, this may not be practical for everyone. That means that the construction process for you is likely to be a blend of seeking strength while avoiding using too much metal.

Most people are very focused on the strength of the roof, and not the side walls, but there is much more risk of inward collapse of the side walls due to lateral pressure than there is from having the roof collapse. Most bunkers do not need to be very far underground - a few inches to a foot of soil is really all you need. The major need for this bunker is to protect from UV light, which cannot penetrate much of anything, and to shelter from wind, temperature variations, and hail. This does not require a deep bunker, just one that will allow protection from the weather.

*** Many people discuss the deep underground military bases (DUMBs) and I truly think they are death traps - an absolutely terrible idea. From what little information about them is public, they are fully electrified, with metal piping and wires. This is not good - induction gets worse the deeper you go, and these DUMBs are not likely to survive the electric currents produced during the solar micronova. The shaking of the “Great earthquake” is centered at the base of the crust, so the deeper you go, the closer you are to the shaking source. Finally, I expect most volcanos to have some level of activity, along with significant mantle heaving and magma movement; this is a lot to risk going so deep underground, when truly, a rural location and a few inches of soil on top is what you need. ***

One of the best pieces of advice for building your underground bunker is to have the walls angled slightly outward. This transfers the force from the outside into one that pushes upward as much as it does inward, reducing the chances of collapsing wall structures. Your bunker needs to be big enough to sleep your family/network, and house supplies, but does not need to be made for long-term living. At most you will need to spend a few days inside; and most of the usage will be for short-term (a few hours) shelter from bad weather.

On the next page is a score-card, a self-reporting sheet of readiness across various vectors. It does not contain everything possible, but it may help you to see where you stand and how much more preparation is needed.

SPEND TIME WITH THE LIST ON THE FOLLOWING PAGE, THINK ABOUT IT, USE YOUR BRAIN!

Self-Evaluation Scorecard: Score Your Situation/Preparedness (5 Best - 1 Worst)

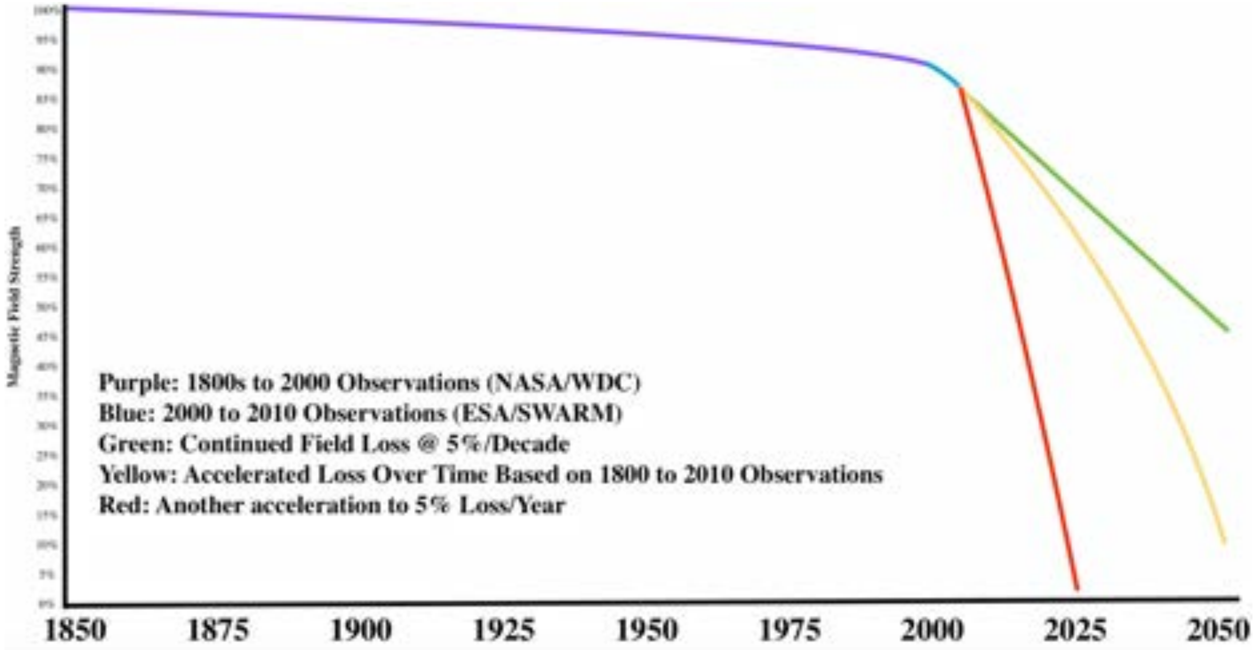
Your Self (Individual)		
	Fitness (Mobility, BMI, Strength, Stamina)	________
	Senses (Eyesight, Hearing, Smell)	________
	Diseases (Diabetes, Cancer, Heart, other)	________
	Substance Abuse (Drugs, Alcohol, Sugar)	________
	Faith (Spiritual Readiness)	________
	Psychological (Anger Issues, Solitude, Trauma)	________
	Sleep Schedule (6-8hrs Daily)	________
Preparations		
	Food (Stored, Non-Perishable, +1 Year)	________
	Water (Stored, Sourced, or Purification Method)	________
	Defense (Guns/Bullets, Knives, Bow, Camo)	________
	Key Spices (Salt, Garlic, Essential Oils)	________
	Seeds and Pre-Industrial Farming Equipment	________
	Tools and Supplies (Clothes, Wood, Nails, Blankets)	________
	Disinfectants (Bleach, Alcohol, Silver, etc)	________
	Medicine (Antibiotics, Personal-Specific, First Aid)	________
Knowledge/Plans		
	If I have to Bug Out (Navigation/Maps)	________
	If People Show Up (Weapons/Tactical)	________
	Adaptability (If _____ Fails, What Happens Next)	________
	Agriculture/Hunting/Trapping	________
	Building Shelter	________
	Industrial/Craft/Mechanical	________
	Carpentry, Architecture, Engineering	________
	Sewing/Leather/Shoe-Making	________
	Build a Fire	________
	First Aid/Trauma	________
Location Safety		
	Tsunami Risk Score (Elevation + Distance to Ocean)	________
	Population Density (Low is Better)	________
	Population Risk (Cartels/Reservations)	________
	Water Access (Rivers/Springs/Streams)	________
	Nearby Risks (Gov/Nuclear)	________
	TOTAL	/150

It is worth considering that evidence of great past civilizations is largely lost. Most people have heard about Atlantis, or have questions about the age of the Sphinx and pyramids in Egypt, or Gobekli Tepe, but there is likely much more evidence that is simply buried from view. One of the best examples of this is the Texas Rock Wall.

The images above are of the excavation of the underground wall on the left and the total structure on the right. It encloses a 20 square mile area, the walls are 70 feet high - uniformly around the enclosure - and there are right angles, squares, triangles and other geometries with perfectly straight lines. The rocks are uniform in shape and size, and there is mortar between them, windows, and foot-holes for climbing. Mainstream scientists say this structure is a natural formation; it is one of the most egregious and gaslighting lies they tell about the ancient world. Imagine rock walls 70 feet high around a city, and it was entirely covered up in the great catastrophe. Imagine the event needed to completely cover this structure.

The following pages contain helpful images and some final notes:

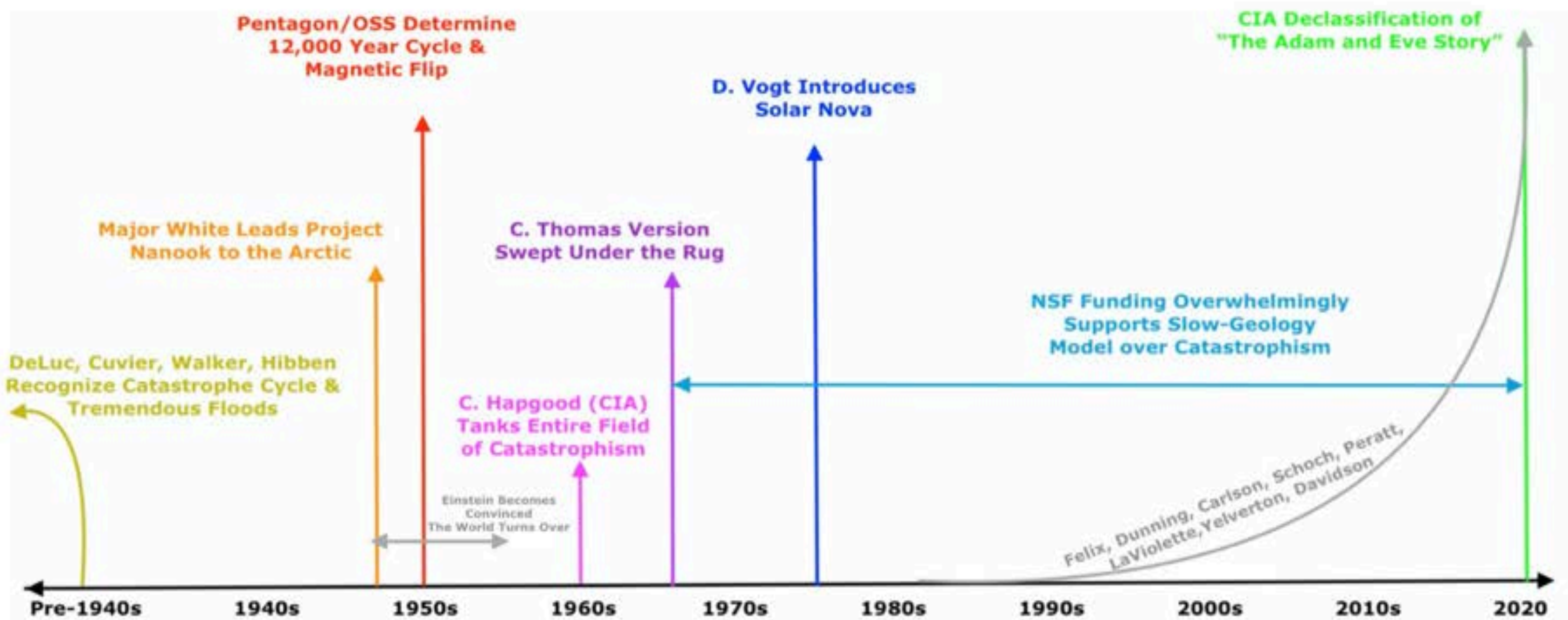
Ongoing magnetic field weakening:



REMEMBER:

- The disaster cycle is robust
- We are due for the disaster again now
- Everything we see says it has already begun and is speeding up
- These are potentially extinction-level events

Catastrophist	Cycle (Years)	Cause	Crustal Shift?	End Date Notes
August Dunning	~12,000	Solar Outburst, Possible Galactic Trigger	Crustal Disruption (General)	The Coming Decades
Robert Schoch	1000s	Solar Outburst	?????	?????
Paul LaViolette	12,000 - 13,000	Galactic Superwave	?????	The Coming Centuries
Douglas Vogt	12,068	Solar Outburst, Unviersal Clock Cycle	Rotation Reversal (Whole Earth), No Tilt	~October 2046 A.D.
Maynard White/Pentagon	10,000 - 12,000	Magnetic Excursion/Reversal	90° Tilt and Tilt Back	The Coming Centuries
Charles Hapgood	25,000 - 30,000	Ice Weight Distribution	Small (7°) Tilts	1000s of Years Away
Robert Felix	12,000	Magnetic Excursion/Reversal	?????	The Coming Decades
Chan Thomas	Changing	Galactic Magnetic Reversal	90° Tilt and Tilt Back	The Coming Decades
Anthony Peratt	1000s	Solar Outburst	?????	?????
Impactor Theorists	Various	Impactors	No Change	None, No Solid Cycle
Ben Davidson	~12,000	Solar Outburst, Galactic Magnetic Reversal	90° Tilt and Tilt Back	The Coming Decades



Event/Fact Certainty:

ITEM	NOTES	CONFIDENCE
Disaster Cycle	~6000 Years; includes Solar/Climate/Geomagnetic Events	+99%
Cycle Due NOW	Last Ones: 6k, 12k, 18k, 24k, 30k, 36k, 42k Years Ago;	+99%
Happening NOW	Magnetic Pole Shifting, Field Weakening - Both Accelerating	+99%
Extinction Risk	Ozone, UV, Cosmic Rays, Navigation, Tech Loss	+90%
Timing	1859 - 2000 (10% lost), 2010 update (15% lost): Due 2040s	~90%
Galactic Trigger	Cyclic Nature, Entire Solar System Effected, Known Mechanism	~90%
Solar Micronova	Isotopes, Galactic Trigger Mechanism	~80%
Earth Turns Over	Geographic Pole Shift, Mammoth/Tsunami Evidence, Nanook	~75%
Tilt Angle *	Greenland due south to Eq. New Poles: India,S.Amer.	~75%
Tilt Angle **	ECDO Theory (TheEthicalSkeptic on X)	~25%
Safe Zone 1	"New Valley of the Sun" (Eastern range of Rockies)	~70%
Safe Zone 2	Mongolian Mountain Range	~70%
Safe Zone 3	Eastern Europe Mountain Range (Carpathian)	~65%
Safe Zone 4	Highest Elevation, Appalachia	~55%

*, ** The tilt angle is under dispute between what I would consider the top names in modern catastrophism. This author favors the * option while another popular one is called ECDO, and is detailed by user “TheEthicalSkpetic” on X.com

Even if the “crazier” aspects of the disaster event do not occur - like the micronova, crust tilt, great waves - the magnetic event is still happening, and is still a VERY big deal.

Final Notes & Reminders:

- The disaster is expected to peak in the 2040s, but society may break down due to other factors much earlier.
- The human population after the events is likely to be between 100 Million and 1 Billion.
- Biosphere population reductions are expected to be between 20% and 80%, with several species going extinct (mostly larger fauna).

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