Relations and Implications of Aperiodic Earth Core / Geomagnetic Field Reversals with Earth Glaciations

José L. Fernández-Solís, PhD

jsolis@tamu.edu

(979) 458-1058

3137 TAMU

College Station, TX 77845

Swedish Academy of Science

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Executive Summary

This research answers the critical question: What happens when earth loses its magnetic field ("temporarily in geological times– i.e. several thousand years")? How does earth loses its magnetic field? What are the consequences of galactic-cosmic and solar space radiation flux and a weakened, chaotic or disappearing geomagnetic field? What are the relationships among earth's core reversal, magnetic field reversal, magma displacement, accelerated tectonic activity, supervolcanic eruptions, and climatic consequences?

The current, and considerable, scientific body of knowledge does not take fully into consideration earth's aperiodic and irregular but real and in human time scale, long-lasting geomagnetic field reversals. A total geomagnetic reversal is a change in a planet's magnetic field such that the positions of magnetic north and magnetic south interchange. We are 200+ years into the midst of geomagnetic field reversal phenomena, within an extended earth glacial period. The current reversal's consequences will last thousands of years, but no research links existing body of knowledge to this phenomenon.

Reversals can have relatively mild consequences such as the last Little Ice Age, or Snowball Earth or even more critical, icehouse Earth. The Little Ice Age occurred 1300 – 1870 CE. The last snowball earth was 21,000 years ago and ended 11,500 years ago, lasting approximately 10,000 years! This event is calculated to have covered New York City in glacial ice, three Empire State Buildings or higher. The geomagnetic field was 40% weaker than normal during the last snowball earth. Today, the geomagnetic field is 80-85% strong and weakening.

Reversals are manifested in weakening, then chaotic and if full reversal, the twisting of the geomagnetic field into multiple and random loops. The loops create negative pressure as in a hurricane, tornado, or nor'easter. The center gap of the depression allows higher levels of total solar irradiance at surface level, higher levels of galactic-cosmic ray flux at troposphere, stratosphere, atmosphere and even surface levels, creating an imbalance in earth radiation budgets that produce ozone-hole depletions inducing temperature shifts. More importantly, cosmic frigid temperatures penetrate the weakened geomagnetic field in the negative pressure gap, much closer to the earth's surface levels, hence a long-lasting glaciation.

Scientists expected the late 20th century to be cooler than the early 20th century but the reverse happened. Increase in anthropocentric CO_2 and other gases such as methane have kept the earth warming, but the levels of CO_2 now indicate that the earth should be much warmer. Two conflicting but real forces may explain this paradox. Earth should be getting cooler because the CO_2 and methane anthropocentric emissions levels and the healing of the ozone-hole have delayed the cooling due to the ongoing geomagnetic reversal.

In summary, this paper proposes theories that supplant the Milanković cycle theory that does not explain recent glaciation cycle history. Finally, this paper will challenge NASA and other scientists who have developed accurate measurements of current conditions and the interrelation of cosmic-galactic, and sun – earth's (troposphere, stratosphere, atmosphere, and land and ocean) feedback. Forward thinking must consider what scientific measurements are needed to consider the effects of the forcing and feedback mechanisms proposed in this paper: mechanisms that could lead to complex, dynamic, and chaotic events of Earth's core and geomagnetic field reversals with the consequence of a glacial snowball or icehouse earth!

Abstract

The Little Ice Age, a snowball earth, and icehouse phenomena requires causal explanations, which have eluded scientists up to now.

A serious deficiency exists with current global warming theories. Current theories are not taking into account the most significant factor in our upcoming century**: in the past 200 years, Earth's magnetic field has lost 15% of its strength and its polarity has shifted considerably** on the way toward a magnetic field reversal in a few centuries (John Shaw; Daniel Lathorp; Woodrow Shoe). A total geomagnetic reversal is a change in a planet's magnetic field such that the positions of magnetic north and magnetic south interchange. The effects of this reversal are considerable, critical for human survival, and may last several thousand years. It first has the effect of further global warming, followed by an ice age that could assume several levels of magnitude: like the Little Ice Age, a snowball earth or worst-case scenario, icehouse earth.

Earth geomagnetic reversal has some of the same physical characteristics of the sun's more periodic magnetic reversals every 11 years that take only one year to complete. Earth's brief complete geomagnetic reversal takes an estimated 500-600 years from normal to half-way and another 500-600 years to full reversal. In a core and geomagnetic field reversal, total or brief complete, Earth's 400,000,000 mile long magnetic field decomposes, and like that of the sun, becomes chaotic, creates irregular magnetic loops and cold spots and is vulnerable to galactic-cosmic and solar output. Over 1,000 years, the sun will experience more than 100 magnetic shifts, each capable of emitting deadly coronal mass ejections targeting an earth with weak or no magnetic field defenses.

The implications are complex but the executive narrative goes like this for a brief complete reversal:

- As the magnetic field weakens over a 500-600 year period that started 300 years ago, more solar maximum, galactic-cosmic radiation flux (GCRF) reaches the planet and produces global warming, on top of anthropocentric global warming contributions, creating a greenhouse earth without ice at the poles, Greenland, or glaciers.
- The warming exponentially increases atmospheric moisture and decreases polar and glacier ice; sea level rises and climate change is magnified.
- Earth's magnetic field becomes chaotic when weakened past 30%, and in places, it randomly disappears (NASA model of earth geomagnetic field reversal).
- At the same time that the amount of solar and space energy becomes more intense, the coldness of space enters our atmosphere at multiple places, including the equator. Note that solar thermal emission variations between 0.05% and 0.17% are normal. NASA states that any variations of 0.3% are significant. Increased levels of solar and cosmic energy variations of 3%, at the earth's surface are critical to all life.
- Cosmic coldness breaching the earth's magnetic field results in a long geological ice age in the form of snowball earth or icehouse earth.
- During normal conditions there exist permanent polar vortices at the north and south poles, but when the earth's geomagnetic field becomes chaotic, and magnetic lines go out of earth like coronal mass ejection (CME), when the plasma comes back, it creates much colder sunspots and the chaotic field creates areas of extreme low-pressure vortices all over the earth. These vortices are the mechanisms through which the extreme coldness of space comes near the atmosphere for sufficient temperature drop. Imagine Earth's mean

temperature dropping 40 Kelvin, icing all the oceans at the same time more than 1,000 feet deep.

- No other mechanism explains the presence of ice the depth of three Empire State Buildings in Canada, Russia, Europe and down to New York City, or snow and ice several miles deep all over the planet (snowball earth) or the oceans and waters freezing 1,000 feet deep at the same time for an extended period of time (icehouse earth).
- Earth's bouncing inner core also creates massive tectonic plate displacements with associated super volcanic and mega earthquake activity, in other words, events that takes millions of years are accelerated in a quantum-shift manner.

In summary, the earth's aperiodic magnetic reversals explain observed phenomena that are not justified by scientific research.

Key Words

Earth core, geomagnetic field reversal, earth glaciation, galactic-cosmic space radiation flux, solar irradiance, solar output, solar coronal mass ejection, tectonic displacement, supervolcanic activity, greenhouse earth, snowball earth, icehouse earth, ozone hole, anthropocentric emissions, NASA, changes in earth orbit, astronomical cycles, changes in orbital axis eccentricity

Acknowledgements

Bruce McCarl, PhD, of Texas A&M University (TAMU) and prominent Nobel Prize winner for his contributions to the International Panel on Climate Change (IPCC), and friend for more than ten years, introduced me to Gerald R. North, PhD, also of TAMU. Gerald was the chair of the National Academy's Committee on the Effects of Solar Variability on Earth's Climate. His work, and its many references, has broadened my understanding of the many mechanisms acting on our climate externally and internally through feedback loops. Gerald is a firm proponent that anthropocentric emissions are creating a greenhouse condition on earth. He is correct, as also shown by the first effects of a core-geomagnetic reversal. However, there is a paradox at work with countering mechanisms. I am most grateful for all his comments and critiques that have helped sharpen my thoughts and logic.

My dear friend, and colleague, William (Bill) Schneider of TAMU, and retired NASA scientist, with acclaim and a multitude of inventions, introduced me to Harold (Hal) Doiron, PhD, of NASA. Hal leads a group of NASA dedicated scientists on climate change and he provided insights, feedback, and a list of further research authors for consultation. For his encouragement and contributions, I am most grateful. Hal is correctly not convinced that anthropocentric emissions are the sole cause of global warming and has observed that there are other uncovered mechanisms involved. In this sense, we bonded immediately and I found a kindred spirit.

Gerald and Hal educated me to the nuances and current state of the art research that led me to read massive numbers of authors in fields that critique or support existing knowledge on the topics. This new learning motivated me to visit Panama, Costa Rica, Guatemala, Mexico, and California to consult experts on plate tectonics, volcanos and earthquakes. However, the journey started with my dissertation more than 20 years ago, when I discovered that more than 30,000 years ago, Earth experienced a Little Ice Age and its consequences. In my dissertation, I analyzed complex wicked problems with dynamic variables in the form of vectors.

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b. Sun magnetic field reversals
c. Solar activity – cosmic ray flux
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1. Introduction

The scientific world reports two indicators of the current geomagnetic field reversal. The first one is a meandering magnetic north beyond past-observed positions. The second and more directly related to the topic is the wreaking of Earth's magnetic field intensity by 15 to 20 percent from a past (1,000 years) estimated normal. In addition, we are long due for a geomagnetic field reversal, and we are long past due for supervolcanic activity (those of Volcanic Explosivity Index – VEI – 7 or higher; Miller et al. 2012), mega earthquakes and earth tectonic activity that moves continents beyond the normal patterns. This paper proposes that these events are concatenated and not isolated, with the earth's core reversal at its causal center.

Unlike the sun's periodic magnetic field reversals that are mostly predictable, although some sun reversals have taken much longer than the norm, the earth's magnetic field reversals have been aperiodic. When they have occurred, their intensity was highly variable and the occurrences were unpredictable. When geomagnetic field reversals have taken place, the reversals do not vanish completely. North is now south and the pole locations meander as proven by geological findings (Glatzmaier 2013). Within a relatively short geological time north has pointed in many directions before settling into a mostly north/south position.

The VEI 7 and 8 events by themselves are thought to have caused Ice Age phenomena because of extreme and constant ash production, lower temperatures, snowfall, and electrical storms. Likewise, intense plate tectonic movements opening and closing isthmuses and changing global thermal currents, and mega earthquakes contributed to Ice Age conditions.

The sun and galactic-cosmic ray flux intrusions are theorized to have caused Ice Age events. Other theories say the earth's tilt changed radically or that its orbit changed radically or that the solar system moving though the galaxy passed through media that caused Ice Age conditions.

This paper hypothesizes that the earth's magnetic core moving around in its polar reversal causes extreme volcanism, tectonic movement, and earthquakes, along with a weakened, then chaotic and then gapped, magnetic field that allows galactic-cosmic and sun solar output to penetrate in levels that humanity has not experienced.

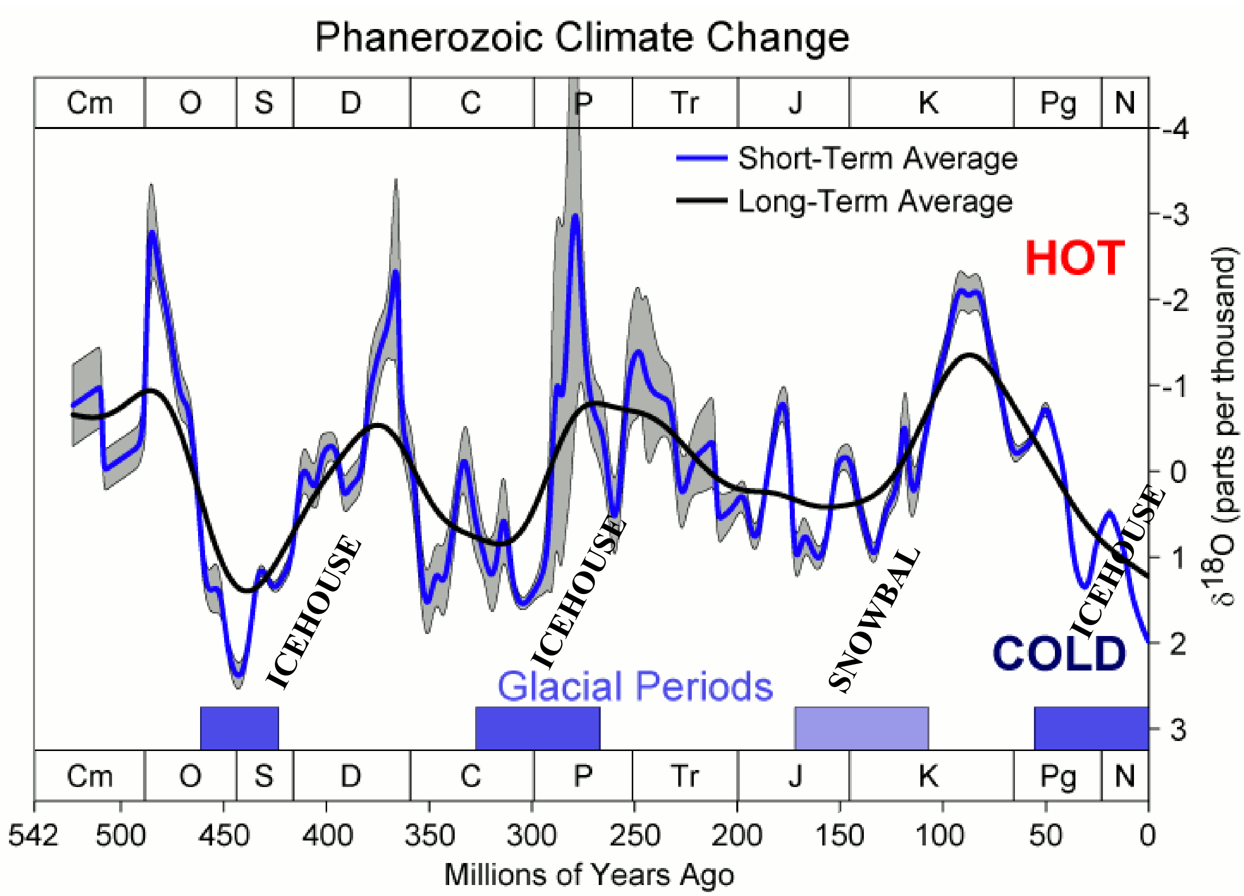
Extreme tilts of the earth's axis or the solar system passing through inhospitable galactic-cosmic environments are considered theoretical fictions in this paper.

a. Methodology

This paper is an integrative literature review. This form of research reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new frameworks, insights, and perspectives are generated (Torraco 2005). Integrative literature review structure uses a set of competing or parallel ideas, concepts and models.

b. Aperiodic earth glaciation

We do not have a good scientific understanding, explanation or hypothesis on what causes earth glaciation, also known as an ice age. The proposed explanations do not have the capacity to create a global ice age, one that encompasses the tropics and equators. Figure 1 showcase the last 500 million years of earth glacial periods in terms of short-term and long-term averages. The dark blue indicates icehouse glaciation and the light blue snowball earth glaciations. Below are earth's geologically corresponding geomagnetic field reversals in terms of Chron and Subchron. Earth glaciation periods follow geomagnetic reversals, suggesting that there is a lag mechanism between these events. This generates questions: are they unrelated or is there a causal effect mechanism at work? What we know is that earth glaciation has occurred, although not on a regular basis. What we also know is that earth geomagnetic field reversals have occurred and, although not on a regular basis, there is a pattern. Do the patterns of these two events relate or not? Before we can answer this question, we need to visit what science knows about the earth's core and its magnetic field.



500 Million-year record shows current and previous two major Icehouse glacial periods

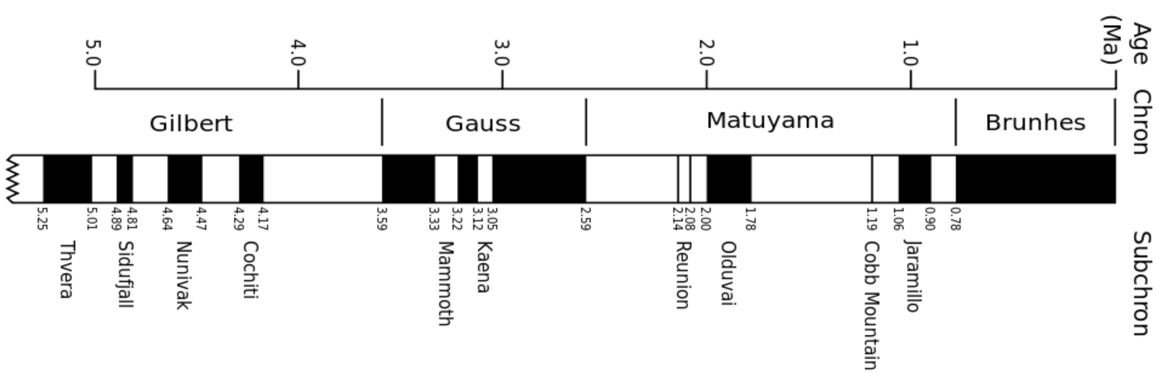


Fig. 1 Earth glacial periods (last 500 million years) and geomagnetic polarity.

Figure 1 compares aperiodic glaciation events with geomagnetic field reversal phenomena. Science needs to verify the apparent correlation or establish that this is a coincidence with no cause/effect connection.

However, Figure 1 shows patterns of the last 500 million years with the following details (Banerjee, 2001):

- Rate of reversals in Earth's magnetic field has varied widely over time.
- 72 Ma (million years ago), the field reversed 5 times in a million years.
- Across a 4-million-year period centered on 54 Ma, there were 10 reversals; at around 42 Ma, 17 reversals took place in the span of 3 million years.
- In a period of 3 million years centered on 24 Ma, 13 reversals occurred.
- No fewer than 51 reversals occurred in a 12-million-year period centered on 15 Ma; two reversals occurred during a span of 50,000 years.

These eras of frequent reversals have been counterbalanced by a few "superchrons" – long periods when no reversals took place. What is now North becomes South and vice versa. These periods are called *chrons*.

c. Earth's core and magnetic field

Earth's core and magnetic field are less understood than the sun's core and magnetic field. We know that the sun's core polar shifts every eleven years on a semi-regular basis. The polar shift of north to south and back again on this regular basis takes place because the sun's core migrates accordingly. The reversal takes approximately one year to complete. During this time, the sun's magnetic field becomes chaotic and displays what is called coronal mass ejections as the magnetic field twists and becomes irregular. The sun's surface, called the photosphere, has a gas temperature of about 6050 K but inside a sunspot, which is a solar disturbance of strong, dense magnetic fields of circulating plasma, surges and dips. As it dips, it allows the coldness of the cosmos to enter and drop the gas temperature to 4,200 K or less. The sunspot emits less light, hence its darkness in relation to the rest of the photosphere.

i. Earth's core shape

Scientists speculate that Earth's core is like the sun's core, composed not of one mass of dense material, but made of several potato-shaped masses of dense material. On both the sun and earth, the materials produce the magnetic field that projects into space. Shape is important during a flip as the potato-shaped cores may move synchronously or asynchronously. If asynchronously, like in the sun, several magnetic loops or poles may develop in one reversal. This may explain why, on earth, the telltale signs of geomagnetic field reversals vary widely within a short geological period.

ii. Earth's magnetic field

The sun's magnetic field projects into the heliosphere beyond the planetary system as solar wind. NASA states that the earth's magnetic field is around 0.5 Gauss while the sun's is 1.0 Gauss. Earth's magnetic field extends into space between 373-400 thousand miles (see Figure 2), compared to the sun's magnetic field extension of 100 million miles (see Figure 3). However, this is relatively strong, considering the disproportional size of Earth in comparison to the sun, which holds 1.3 million earths. In other words, while the sun is 1.3 million times bigger than the earth, its magnetic field is only 268 times the strength of Earth's. The strength of the earth's magnetic field may indicate why its reversals are relatively infrequent compared to the sun's and are longer lasting and unpredictable. This area merits further theory development and research.

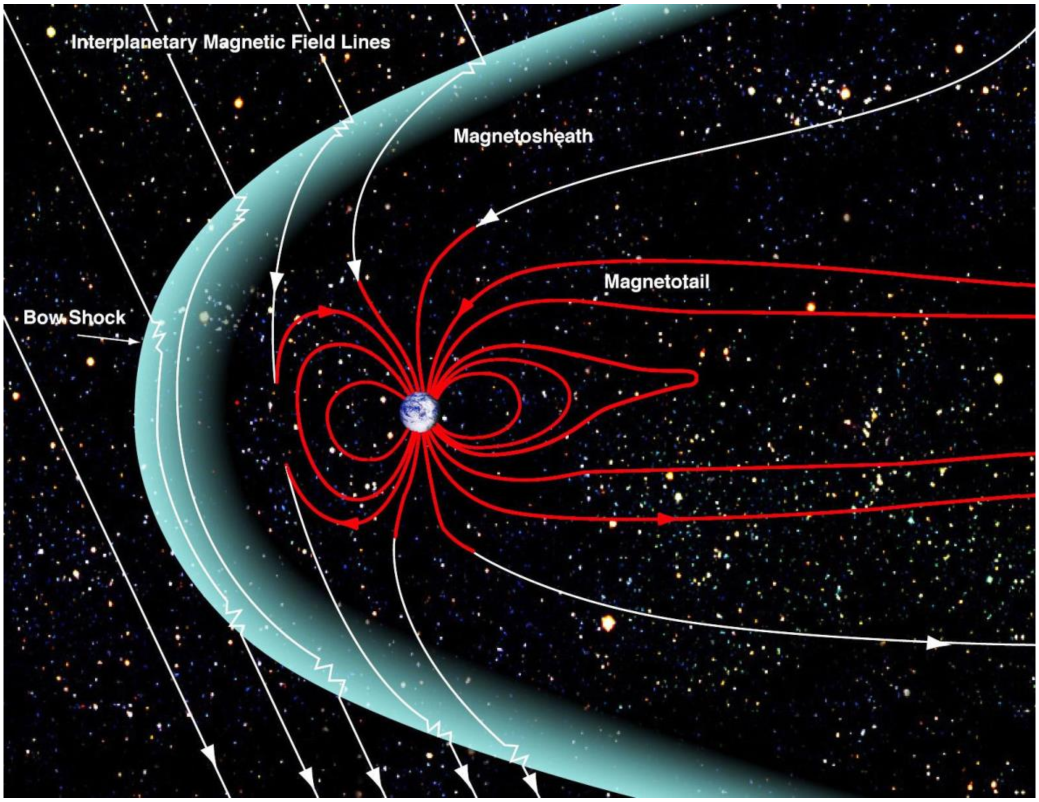


Fig. 2 Artist's conception of Earth's magnetic field, bow shock 400,000 miles into the sun and its magnetotail

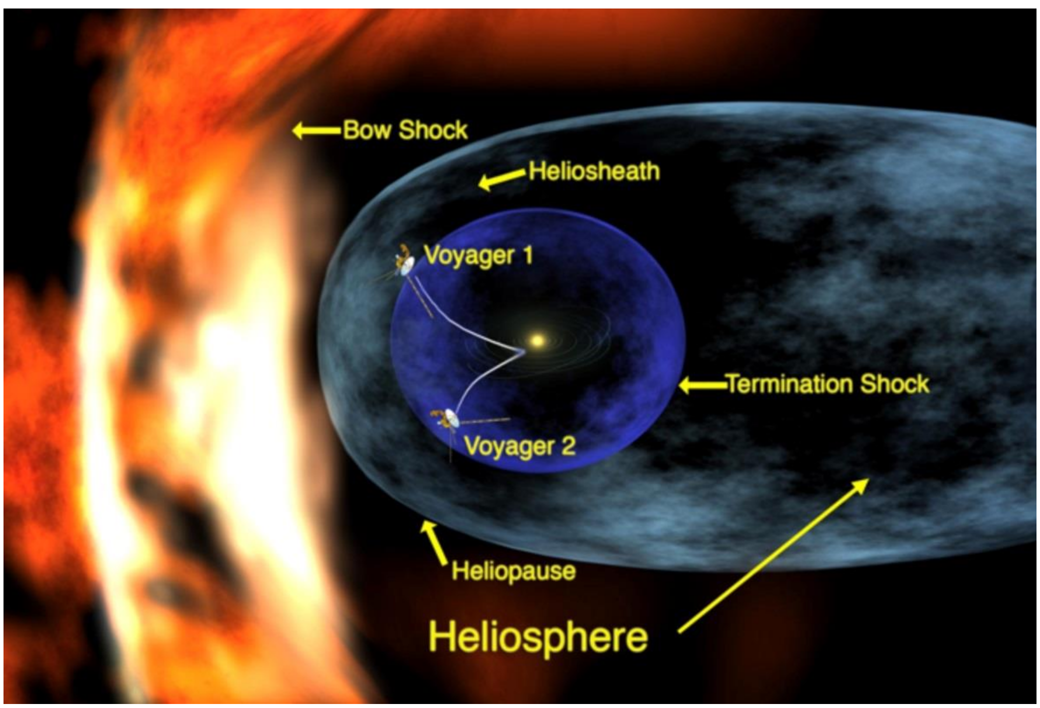


Fig. 3 Artist's conception of the sun's magnetic field, bow shock 100 million miles into space

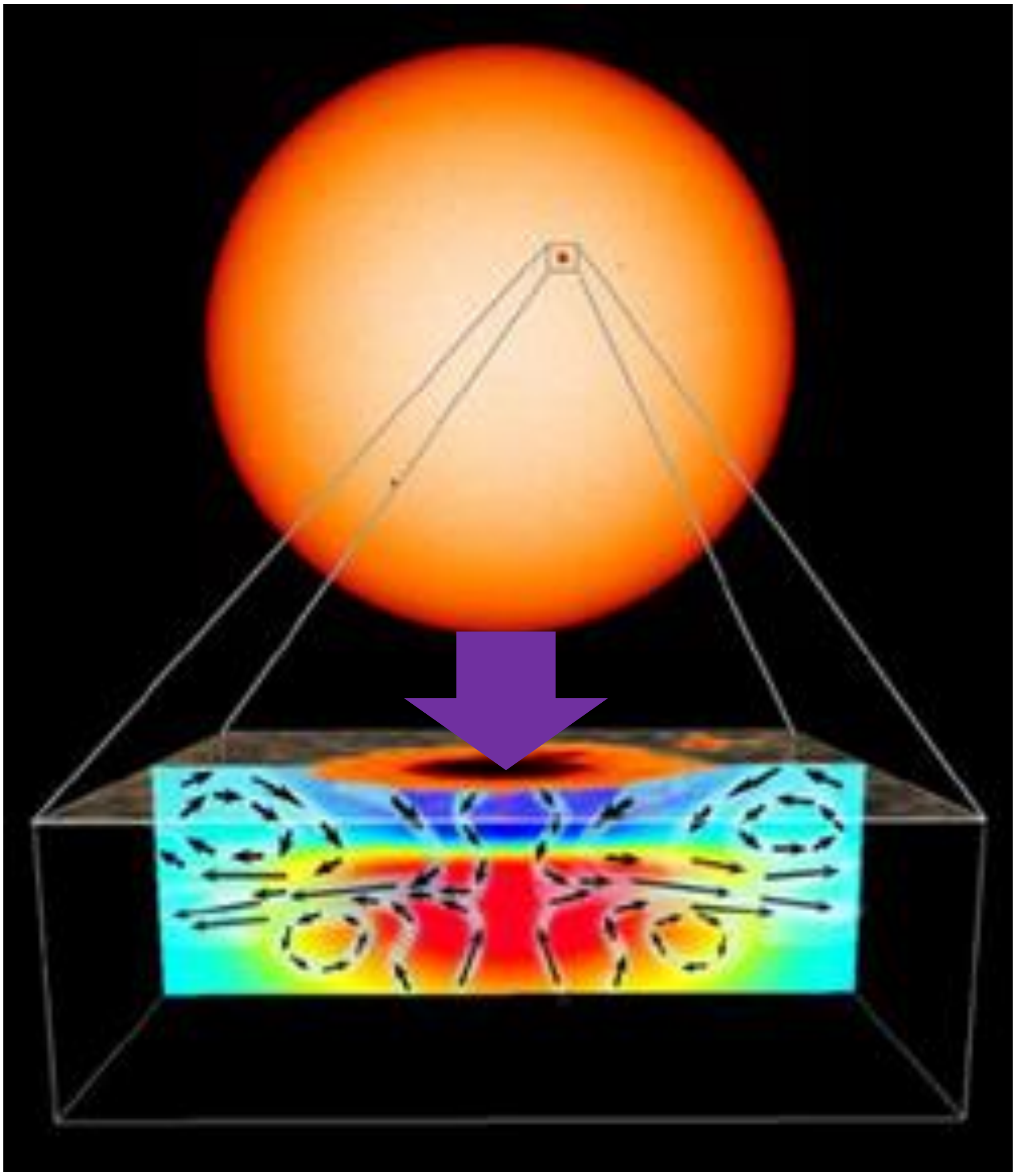


Fig. 4 Scientists solve centuries-old query: what is inside a sunspot. Stanford Report, November 6, 2001. http://news.stanford.edu/news/2001/november7/sunspot-117.html

The strength of the earth's magnetic field is the source of our protection from galactic-cosmic and sun solar output. At the same time, when a geomagnetic field reversal take's place and the magnetic shield weakens, becomes chaotic and in places, disappears for a much longer period of time than does the sun's, the consequences to humanity may be much more pronounced.

During the 1000+ years of a geomagnetic field reversal, the sun will have more than 100 solar field reversals. During a solar maximum, when the sun magnetic field wakes and becomes chaotic, Earth experiences higher exposure to coronal mass ejections. But more critical, during a solar minimum when the sun's magnetic field is stronger, there is more solar background radiation.

The sun’s photosphere is 6050 K, sunspots are 4200 K (see Figure 4), cosmic space is 2.57 K, the International Space Station (ISS) is in a relatively near-earth environment of 40 K (cosmic space warmed by the sun’s solar output, solar magnetic field (SMF), and the earth’s magnetic field entrapment of galactic-cosmic and solar radiation). When the earth’s magnetic field weakens and becomes chaotic, the ISS environment may experience a cooling as well as an unexpected increase in galactic-cosmic and sun solar output. Earth, likewise, will experience a similar increase in radiation as well as increased cooling all around the globe.

2. Past theories of earth glaciation causes

No completely satisfactory theory accounts for Earth's history of glaciation. The cause of glaciation is related to several simultaneous factors, such as changes in orbit, astronomical cycles, changes in orbital axis eccentricity, atmospheric composition, plate tectonics and ocean currents, volcanic forcing, variation in sun solar output, and GCRF. Forcing denotes an externally imposed perturbation in the radiative energy budget of the earth’s climate system. The following sections offer summaries of a variety of past theories.

a. Changes in Earth’s orbit

The Danish-Norwegian geologist Jens Esmark (1762–1839) argued for the existence of a sequence of worldwide ice ages. In a paper published in 1824, Esmark proposed changes in climate as the cause of those glaciations. He attempted to show that they originated from changes in Earth's orbit.

At the beginning of 1837, Schimper coined the term "ice age" (*"Eiszeit"*) for the period of the glaciers. However, most contemporary scientists thought that the Earth had been gradually cooling down since its birth as a molten globe.

In the late 19th century, James Croll advanced a theory that considered the role of Earth’s orbital changes in controlling climate. Later, Milutin Milanković, a Serbian geophysicist, elaborated on the theory and calculated that these irregularities in Earth's orbit could cause the climatic cycles. According to Milanković, ice age cycles are the result of the additive behavior of several types of cyclical changes in Earth's orbital properties (see Figure 5).

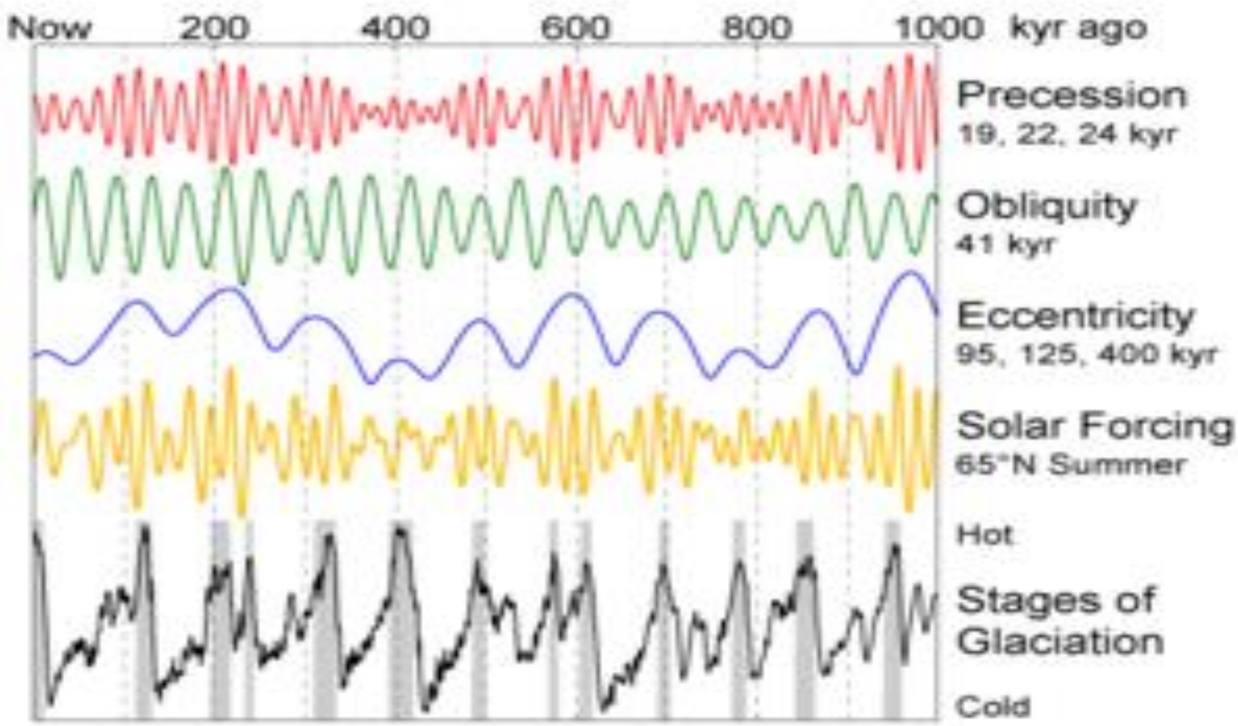


Fig. 5 Milanković's theory relating Earth's orbit to periods of glaciation

b. Astronomical cycles

The theory behind astronomical cycles assumes that the earth's ice ages are products of the earth's and the solar system's rotations around the center of our galaxy, encountering some gaseous medium that cools the planet for prolonged periods. However, astronomers calculate that it takes approximately 230 million years for the earth to complete one orbit of the Milky Way, which does not correlate with the irregularity of earth glaciation, observed and estimated events.

c. Changes in orbital axis eccentricity

Changes in the orbital eccentricity of Earth occur cyclically about every 100,000 years. The inclination, or tilt, of Earth's axis varies periodically between 22° and 24.5°. The tilt of Earth's axis is responsible for the seasons; the greater the tilt, the greater the contrast between summer and winter temperatures. Changes in the tilt occur in a cycle 41,000 years long. Precession of the equinoxes, or wobbles on Earth's spin axis, complete every 21,700 years. According to the Milanković theory, these factors cause a periodic cooling of Earth, with the coldest part in the cycle occurring about every 40,000 years. The main effect of the Milanković cycles is to change the contrast between the seasons, not the amount of solar heat Earth receives. These cycles within cycles predict that during maximum glacial advances, winter and summer temperatures are lower. The result is less ice melting than accumulating, and glaciers build up.

A problem with Milanković's theory is that the astronomical cycles have been in existence for billions of years, but glaciation is a rare occurrence. Astronomical cycles correlate perfectly with glacial and interglacial periods, and their transitions, *inside* an ice age. Other factors, such as the position of continents and the effects this phenomenon has on Earth's oceanic currents, or long-term fluctuations inside the core of the sun that cause Earth's temperature to drop below a critical threshold and thus initiate the ice age in the first place, must also be involved. Milanković's theory requires that a series of non-concatenated events occur simultaneously in cycles that are millions of years apart. If so, they could exacerbate an ice age but are unlikely to be the cause of earth glaciation. However, once an ice age occurs, Milanković cycles could act to force the planet in and out of glacial periods.

d. Atmospheric composition

One theory holds that decreases in atmospheric CO_2, an important greenhouse gas, started the long-term cooling trend that eventually led to glaciation. Recent studies of the CO_2 content of gas bubbles preserved in the Greenland ice cores lend support to this idea. The geochemical cycle of carbon indicates more than a 90% decrease in atmospheric CO_2 since the middle of the Mesozoic Era. An analysis of CO_2 reconstructions from alkenone records shows that CO_2 in the atmosphere declined before and during Antarctic glaciation and supports a substantial CO_2 decrease as the primary cause of Antarctic glaciation.

CO_2 levels also play an important role in the transitions between interglacials and glacials. High CO_2 contents correspond to warm interglacial periods, and low CO_2 to glacial periods. However, studies indicate that CO_2 may not be the primary cause of the interglacial-glacial transitions, but instead acts as a feedback. The explanation for this observed CO_2 variation remains a difficult attribution problem. For example, 2018 CO_2 levels reached above 410 parts per million (PPM), a 43% increase since the age of industrialization started, and its increase is expected to continue. Anthropomorphic contribution is approximately 50% and global temperatures, related to this level of concentration, are estimated to increase by at least 2 degrees Celsius by 2020. However, this increase has not taken place at the pace and intensity anticipated. The temperature rise could be masked by earth trending toward a geomagnetic reversal with its associated intrusion of cosmic cooling. This hypothesis remains to be tested.

None of the atmospheric composition theories alone or in conjunction with other theories has the potential to explain an ice age of the snowball or icehouse type where oceans are frozen for 1,000 feet deep all over the world.

e. Plate tectonics and ocean currents

An important component in the long-term temperature drop is the position of the continents, relative to the poles (but it cannot explain the rapid retreat and advances of glaciers). This relationship can control the circulation of the oceans and the atmosphere, affecting how ocean currents carry heat to high latitudes. Throughout most of geologic time, the North Pole appears to have been in a broad, open ocean that allowed major ocean currents to move unabated. Equatorial waters flowed into the Polar Regions, warming them with water from the more temperate latitudes. This unrestricted circulation produced mild, uniform climates that persisted throughout most of geologic time.

Throughout the Cenozoic Era, the large North American and South American continental plates moved westward from the Eurasian plate. This drift interlocked with the development of the Atlantic Ocean, trending north south, with the North Pole in the small, nearly landlocked basin of the Arctic Ocean. The Isthmus of Panama developed at a convergent plate margin about 3 million years ago, and further separated oceanic circulation, closing the last strait, outside of the Polar Regions, that had connected the Pacific and Atlantic oceans.

Plate tectonics have moved at different rates throughout history. Accelerations have occurred during the earth's geomagnetic reversals, because the inner core becomes active and its movements chaotic, accelerating not only tectonic but volcanic activity and earthquakes at magnitudes that humanity has not experienced but exist in geological records. On the other hand, isthmus openings and closings, as well as world ocean current changes, are not recurring events that could be cited as forcing mechanisms of glaciation events. However, plate tectonics and ocean current changes are indicative of the earth's core activity that is consistent with a geomagnetic reversal event.

f. Volcanic forcing

Super volcanic activity may be indicative of geomagnetic field reversals where the earth's core bounces on its journey toward a polar flip and comes closer to the earth's crust pushing magma at levels needed for a VEI 7 or 8 event, while other forcing mechanisms are causing global glacial events exacerbated by volcanism but for which it is not a primary causal forcing phenomenon. Table 1 depicts super volcanic activity, VEI 7 or 8, from 12 Ma and the corresponding geomagnetic reversal. Super volcanic activity takes place around the earth's glaciation chrons. There is doubt among scientists that super explosive volcanic eruptions with VEI 7 or 8 provide significant and continuous aerosols to the atmosphere and above during the Maunder and Dalton minima. However, they are not the cause of the glaciation. Super volcanic activity is indicative of an earth core reversal, which bumps into magma creating super volcano eruptions. The earth's core reversal is also the cause of the weakening of the geomagnetic field and then, if a total or brief complete reversal takes place, making the geomagnetic field chaotic, disappearing in places, and like the sun, allowing sunspots where the coldness of space comes nearer to earth's surface and hence the glaciation. There is no doubt that supervolcanic activity affects the climate on a short-term time scale unless multiple and continuous supervolcanic activity takes place during a total reversal as shown in Table 1 below.

Table 1 Volcanic activity VEI 7 & 8

Name	VEI	Zone (additional # of VEI 7 eruptions)	Location	Years Ago	Chron
Cerro Panizos	7	Altiplano-Puna volcanic complex	Argentina, Bolivia	12,000,000	Pg. Relatively warm
Brueau-Jarbidge caldera	7	Yellowstone Hotspot	USA, Idaho	11,830,000	
Heise volcanic field	7			6,400,000	
	8			6,000,000	
Cerro Guacha	8	Altiplano-Puna volcanic complex	Bolivia	5,700,000	Gilbert (3 reversals)
Heise volcanic field	8	Yellowstone Hotspot	USA, Idaho	4,500,000	
Atana Ignimbrite	8	Pacana Caldera	Chile, Northern	4,000,000	
Pasto Grande Ignimbrite	7	Pasto Grande Caldera	Bolivia	2,900,000	Gauss (3 reversals) Artic glaciation
Huckleberry Ridge	8	Yellowstone Hotspot	USA, Idaho/Wyoming	2,100,000	Matuyama (5 reversals) Quaternary glaciation
Karimshina	7	Kamchatka	Russia	1,780,000	
Henry's Fork Caldera	7	Yellowstone Hotspot	USA, Idaho	1,300,000	
Valles Caldera	7	(2) Jemez volcanic field	USA New Mexico	1,250,000	
Mangakino	7	(3) Taupo Volcanic zone	New Zealand, North Island	970,000	
Long Valley Caldera	7	Bishop Tuff	USA California	760,000	
Lava Creek Eruption	8	Yellowstone Hotspot	USA Wyoming	640,000	Brunhes (1 reversal) Older Dryas
Whakamaru Mount Curl Tephra	8	Taupo volcanic zone	New Zealand, North Island	340,000	

Mount Aso	7	(4) Kyūshū	Japan	300,000	
Matahina Ignimbrite	7	Taupo Volcanic zone, Haroharo caldera	New Zealand, North Island	280,000	
Mamaku Ignimbrite	7	Taupo Volcanic zone, Rotorua caldera	New Zealand, North Island	240,000	
Reporoa Caldera	7	Taupo Volcanic zone	New Zealand, North Island	230,000	
Lake Toba	8	Lake Toba, North Sumatra	Indonesia, Sumatra	74,000	
Lake Maninjau	7	Lake Maninjau, West Sumatra	Indonesia, Sumatra	52,000	
Rotoiti Ignimbrite	7	Taupo Volcanic zone	New Zealand, North Island	50,000	
Campanian Ignimbrite	7	Campi Flegrei	Italy, Naples	39,280	Brunhes (1 reversal) Younger Dryas Flandrian interglacial
Oruanui Ignimbrite	8	Taupo Volcanic zone	New Zealand, North Island	26,500	
Aira Caldera	7	Kyūshū	Japan	22,000	
Kurile Lake	7	Kamchatka	Russia	10,500	
Kikai Caldera	7	Ryuku Islands	Japan	6,300	
Macauley Island	7	Kermadec Islands	New Zealand	6,300	

g. **Variations in solar output**

Solar irradiance, the flux of the sun's output directed towards the earth, is earth's main energy source. About every 11 years, its sunspot activity cycles, erupts and releases massive amounts of energy in CME. Studies have shown that the sun has magnetically driven variability, which connects with earth's climate variability, for the last 10,000 years. Even small variations in the amount or distribution of the sun's energy received on Earth can have a major influence on the earth's climate when they persist for decades. This statement of 2007 National Academy Press' (NAP) "The effects of solar variability on earth climate: a workshop report" is based on the sun's magnetic field variability, but it assumes that the earth's magnetic field is constant. The same report acknowledges, "The discussion of the paleoclimate record emphasized that the link between solar variability and earth's climate is multifaceted and that some components are understood better than others." One key component thus far not considered is that Earth's own geomagnetic field weakens, becomes chaotic and like CME, is sporadic with earthspots (like sunspots – a new word) during core and geomagnetic field reversals with major and critical implications.

Observed and measured solar output variability closely relates to the structure and magnitude of the SMF. Solar irradiance is the dominant energy source for the earth by four levels of magnitude greater than the next largest contributor, radioactivity decay. However, solar irradiance flux is of sufficiently high frequency (11-year SMF reversal cycle) as to not have cumulative significant effects on climate variability because of the strength and consistency of the magnetic field. Total solar irradiance (TSI) is greater at the tropics (bottom up driver) while ultra violet rays influence the stratospheric temperatures with little contribution to global temperature variations under normal geomagnetic field strength conditions.

Statistical studies suggest that natural influences – including the sun, aerosol effects from volcanic eruptions and changes in the earth, atmosphere and ocean -- together explain roughly 15% of geologically recorded past temperature anomalies. However, they do not have the potential of causing earth glaciation at the icehouse or snowball earth levels.

Finally, the Intergovernmental Panel on Climate Change's Fourth Assessment, and the recent National Research Council Report on Climate Choices, agree that there is no substantive scientific evidence that solar variability is the cause of climate change during the past 50 years. However, they go on to stipulate that understanding the mechanisms by which solar variations can affect climate over longer timescales remains an open area of research.

h. **Galactic-cosmic ray flux**

The SMF determines how much GCRF gets through to the planets. GCRF is higher at a solar minimum as shown by 'C' and 'Be' isotopes present in trees and ice cores. Higher C and 'Be' isotopes at earth level are indicative of other isotopes at atmospheric levels affecting the earth's protective ozone layers. Stratospheric ozone depletion is due to increases in nitrogen oxides and lower atmospheric ozone increases because of chloride-oxide destruction through reactions with nitrogen oxides. The destruction of stratospheric ozone changes the energy balance in the atmosphere because ozone absorbs solar radiation.

The coupling of stratosphere, atmosphere and earth climate is a study in progress with computer model development by various entities. Understanding catastrophic and chaotic disruptions in the earth's magnetic field during a geomagnetic field reversal is a much-needed study.

At lower latitudes, there is little Be variation (plus total solar irradiance [TSI] variations, ultra violet irradiance and corpuscular variations) with solar cycles due to the stronger geomagnetic shielding. The observation of higher 'Be' variations with solar cycles at lower latitudes during earth geomagnetic reversals would be a good signal that the shields are weakening, becoming chaotic and disappearing. There is a high response in equatorial Pacific to variations in solar cycle flux, a cooling of almost one degree Celsius, which is 10 times that expected from solar heating relative to average climatology. During a geomagnetic reversal, climate forcing from the solar cycle flux will be levels of magnitude higher, with a much greater heating response at the equatorial regions and tropical oceans.

3. Proposed unifying theory

This paper proposes that geomagnetic reversals caused by the reversal of the earth's central core, like the sun's reversals, are the root cause of earth glaciation. Glaciations are due to the weakening, chaotic and then partially and randomly disappearing protective magnetic field, creating magnetic vortices like the plasma vortices of the sun (see Figure 6), allowing the intrusion of cosmic coldness ever nearer to the earth's crust. This type of glaciation may be partial, such as during the last Little Ice Age, for which we have the most data, or glaciation could create a snowball earth or worse, an icehouse earth. Furthermore, geomagnetic reversals due to the meandering of the earth's central core are also the root cause of accelerated and more intense tectonic displacements, super volcanic aerosol emissions, tropospheric ozone depletion, increases in natural CO_2 emissions, increases of solar irradiation at surface, atmospheric and tropospheric levels, and increases in GCRF and solar irradiation at all levels of earth atmosphere and surface. Earth geomagnetic shifts take from a thousand years to multiple fast reversals. In fast reversals the effects of solar maximum and minimum are magnified at earth surface.

Of interest to this paper is the fact that the highest flux of GCRF on record occurred during the 2006 solar minimum. In 2006 the earth's magnetic field had weakened by 10% from normal. Normal, according to NASA, is an inconstant magnetic field of 0.5 Gauss by =/- 0.03 Gauss. A 10% decrease is -0.05 which is double the window of error. More current reports indicate that earth magnetic field has further deteriorated in the last 10 years to 15% of normal. That is a decrease of -0.075. A trend of 5 % decrease per decade, if it does not accelerate or decelerate will have 50% strength mark in less than 40 years! However, it is reasonable to expect that reversals do not follow a linear time scale. If so, this paper assumes that it will take approximately 100 years to reach 50% but its effects will be felt much earlier.

a. Aperiodic geomagnetic reversal

The sun typically has periodic magnetic reversals. Earth's geomagnetic reversals, as recorded in time, are aperiodic. That is, there is no reliable pattern of when they occur or how long they last but once the magnetic field starts weakening and the magnetic north starts meandering outside the normal, it is safe to assume that a reversal has begun.

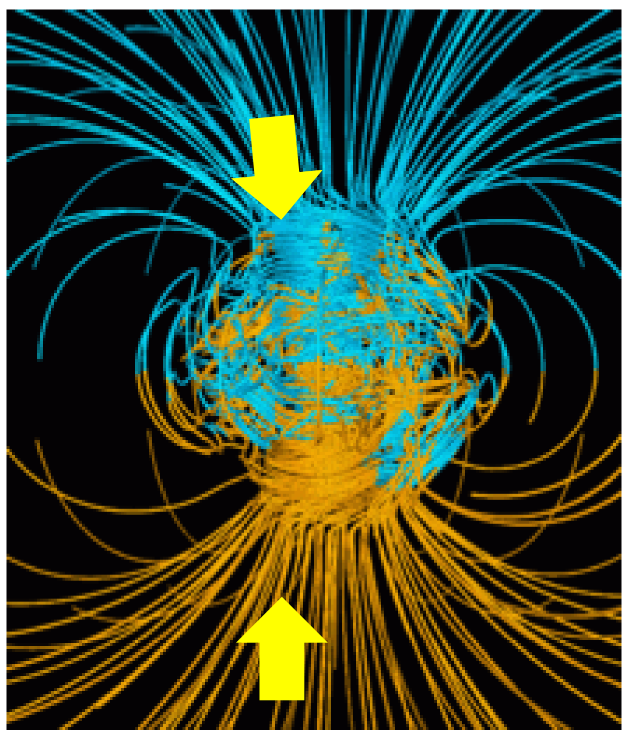


Fig. 6. NASA model of Earth's magnetic field; North is blue

i. Total geomagnetic reversal

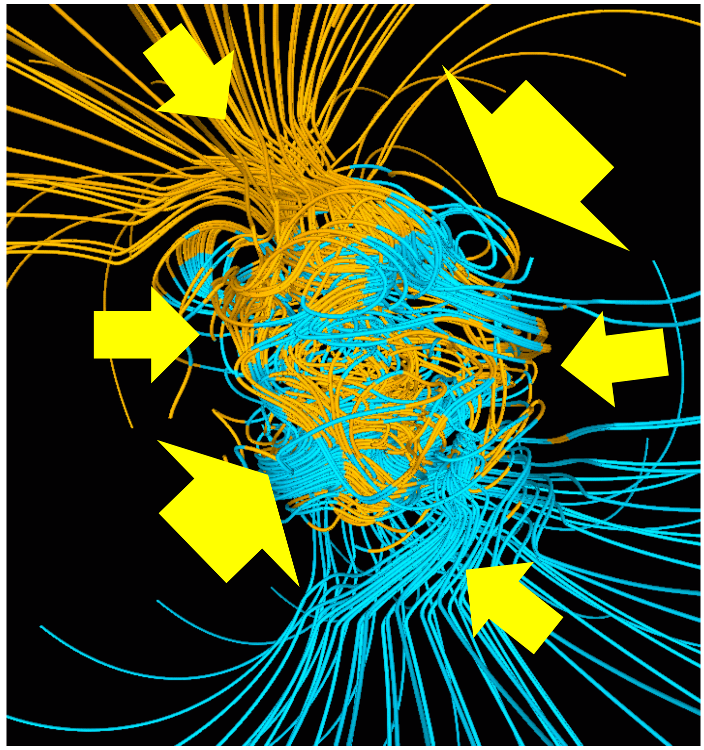


Fig. 7 NASA model of earth magnetic field North is blue (but now on the southern hemisphere)

A total geomagnetic reversal is a change in a planet's magnetic field such that the positions of magnetic north and magnetic south interchange. The ultimate location is not an exact match to the original of the other pole. Earth's magnetic field has alternated between periods of normal polarity (North as we currently experience it) and reverse polarity, in which the field is opposite. What is now North becomes South and vice versa. These periods are called *chrons*. The time spans of chrons are aperiodical, ranging between 0.1 and 1 million years with an average of 450,000 years between reversals. Most reversals take between 1,000 and 10,000 years. The last chron, the Brunhes-Matuyama reversal, occurred 780,000 years ago and lasted 10,000 years. These types of reversals are associated with snowball and icehouse glacial phenomena. See Figures 6 and 7 with yellow arrows indicating spaces where cosmic temperatures penetrate Earth's chaotic magnetic field).

i. A brief complete reversal

A brief complete reversal known as the *Laschamp event*, occurred approximately 41,000 years ago during the last glacial period. That reversal lasted 440 years with the actual change of polarity lasting 250 years. During this reversal, the strength of the magnetic field weakened by 95%; that is, the magnetic field weakened to 5% of normal strength. This is when the "Little Ice Age" occurred. The polar ice caps dropped towards the Tropics of Cancer and Capricorn, but did not cover the entire planet.

ii. Geomagnetic excursions

Geomagnetic excursions are brief disruptions of the earth's magnetic field but they do not result in a reversal. The excursions may record different or meandering north and south locations. Excursions may take many thousand years and the core may be in an unsettled or continuous state of flux. Current conditions may be geomagnetic excursions or harbingers of a total geomagnetic reversal.

Figure 8 shows changes measured by the Swarm satellite over the past 6 months indicating that Earth's magnetic field polarity is changing locations and strength. Shades of red show areas where it is strengthening, and shades of blue show areas that are weakening.

The sequence of geomagnetic polarity reversals in the Geomagnetic Polarity Time Scale (GPTS) is reasonably well defined as far back as 275 Ma, and although there are gaps from earlier times, a partial GPTS was compiled for much of the Phanerozoic period (Ogg, 2012) as quoted by Olson 2012.

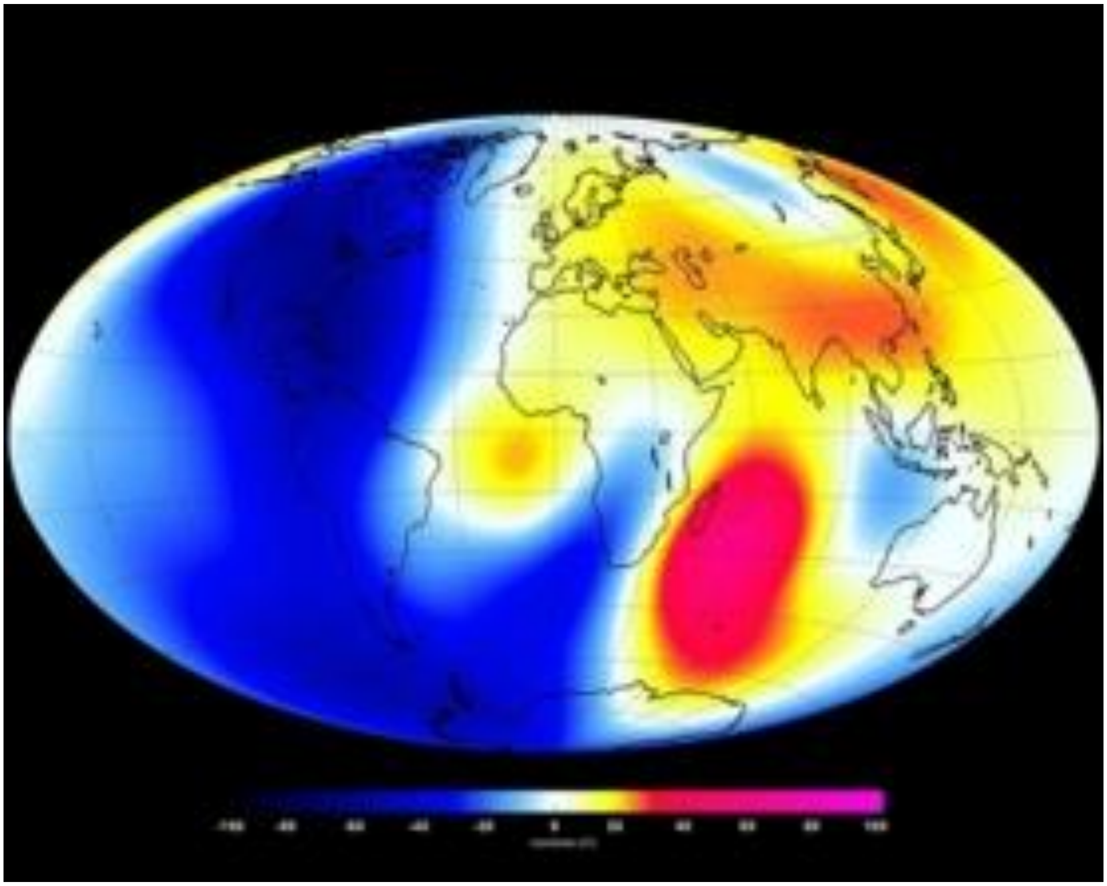


Fig. 8 Earth's magnetic south polarity change. *Credit: ESA/DTU*

b. Types of earth glaciation

Earth glaciation is a common phenomenon but on a geological time scale that has avoided humanity except for the Little Ice Age. The familiar, current picture of an ice age is of a comparatively mild one: others were so severe that the entire Earth froze over, for tens of thousands years.

In fact, the planet seems to have three main settings: greenhouse, when tropical temperatures extend to the poles and there are no ice sheets at all; snowball (Figure 9), in which the planet's entire surface is frozen over, and icehouse (Figure 10), when there is permanent ice throughout all water and oceans. Glaciologists, as of this writing, have no convincing explanation about how (mechanics, periodicity and source of potential planetary icing) of these phenomena, hence this paper. However, these three settings have aperiodically alternated with a certain degree of frequency.

Fig 9. Artist conception of "snowball Earth" by www.space.cp, 591x600 323x3

Fig 10. Artist conception of "icehouse Earth" by Ittiz-Own work, cc by – SA 3.0

c. Timeline of known earth glaciation

2.4 to 2.1 billion years ago

The Huronian glaciation is the oldest ice age we know about. The early stages of the Huronian, from 2.4 to 2.3 billion years ago, seem to have been particularly severe, with the entire planet frozen over as the first snowball Earth.

850 to 630 million years ago

During the 200 million years of the Cryogenian period, the Earth was plunged into some of the deepest cold it has ever experienced – and the emergence of complex life may have caused it.

There seem to have been two distinct Cryogenian ice ages: the so-called Sturtian glaciation between 750 and 700 million years ago, followed by the Varanger (or Marinoan) glaciation, 660 to 635 million years ago. There is some evidence that Earth became a snowball at times during the big freezes, but researchers are still trying to work out exactly what happened.

460 to 430 million years ago

Straddling the late Ordovician period and the early Silurian period, the Andean-Saharan ice age was marked by a mass extinction, the second most severe in Earth's history. Nevertheless, as the ecosystem recovered after the freeze, it expanded, with land plants becoming common over the course of the Silurian period.

360 to 260 million years ago

Like the Cryogenian glaciation, the Karoo ice age featured two peaks in ice cover that may well have been distinct ice ages. They took place in the Mississipian period, 359 to 318 million years ago, and again in the Pennsylvanian 318 to 299 million years ago. These ice ages may have been the result of the expansion of land plants that followed the Cryogenian.

14 million years ago

Antarctica was not always a frozen wasteland. It was not until around 34 million years ago that the first small glaciers formed on the tops of Antarctica's mountains. In addition, it was 20 million years later, when worldwide temperatures dropped by 8°C, that the glaciers' ice froze onto the rock, and the southern ice sheet was born. The northern hemisphere remained relatively ice-free for longer, with Greenland and the Arctic becoming heavily glaciated only around 3.2 million years ago.

2.58 million years ago

The Quaternary glaciation started just a few million years ago – and is ongoing. Therefore, its history is relatively recent, in geological terms, and is studied in far more detail than others have been. It is evident that the ice sheets have gone through multiple stages of growth and retreat over the course of the Quaternary.

During glacial stages, the temperature was low and ice extended far away from the poles. During interglacial stages, the temperature was somewhat warmer and the ice retreated. Brief, inconclusive periods of advancing ice (stadials), typically lasted less than 10,000 years; conversely, periods occurred when the ice retreated (interstadials), but only briefly.

The Quaternary glaciation saw a continuing fall in the level of CO_2 in the atmosphere.

To make matters more complicated, the ice did not advance and retreat simultaneously all around the world. Often it would begin advancing on one continent, with the others covered thousands of years later, and then linger on a few continents several millennia after it disappeared from the others.

110,000 to 12,000 years ago

As the glacial period ended and temperatures began to rise, there were two final cold snaps. First, the chilly Older Dryas of 14,700 to 13,400 years ago transformed most of Europe from forest to tundra, like modern-day Siberia. After a brief respite, the Younger Dryas, between 12,800 to 11,500 years ago, froze Europe solid within a matter of months – probably because of meltwater from retreating glaciers shutting down the Atlantic Ocean's "conveyor-belt" current, although there could have been a cometary impact (see Figures 11 and 12).

Twelve thousand years ago, the great ice sheets retreated at the beginning of the latest interglacial – the Flandrian – allowing humans to return to northern latitudes. This period has been relatively warm, and the climate relatively stable, although it has been slightly colder than the last interglacial, the Eemian, and sea levels are currently at least 3 meters lower – differences scrutinized closely by researchers keen to understand how our climate will develop.

Earth glaciations, due to core reversal, increase the magnitude of all events (e.g., tectonic plate movements, earthquakes, volcanic eruptions, aerosol emissions, tsunamis, etc.) suffers, like in chemistry and physics, a quantum shift. What typically happens in slow motion and moderate levels of intensity, during core reversal, it happens in fast motion and exponential levels of intensity.

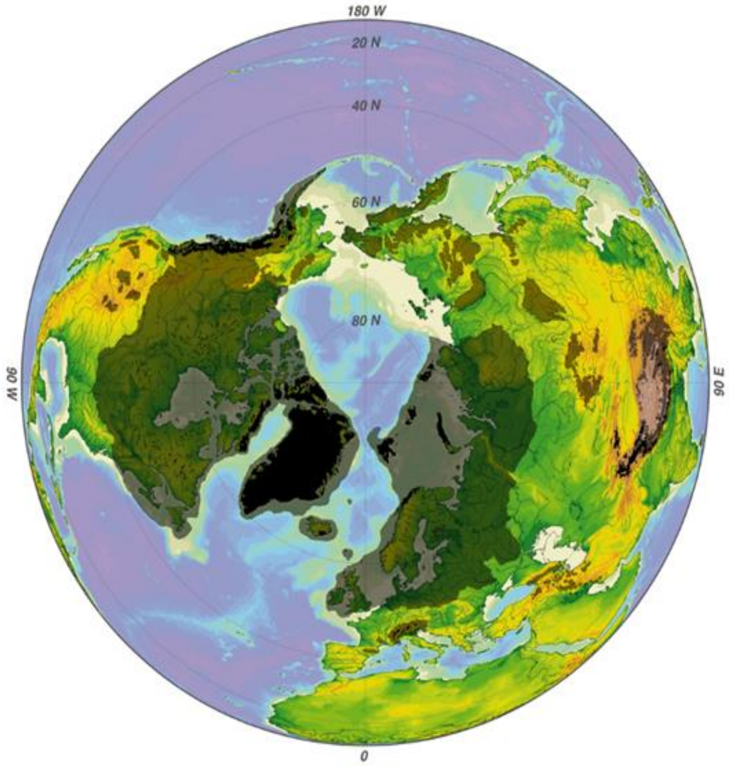


Fig. 11 Minimum (interglacial, black) and maximum (glacial, grey) glaciation of the northern hemisphere

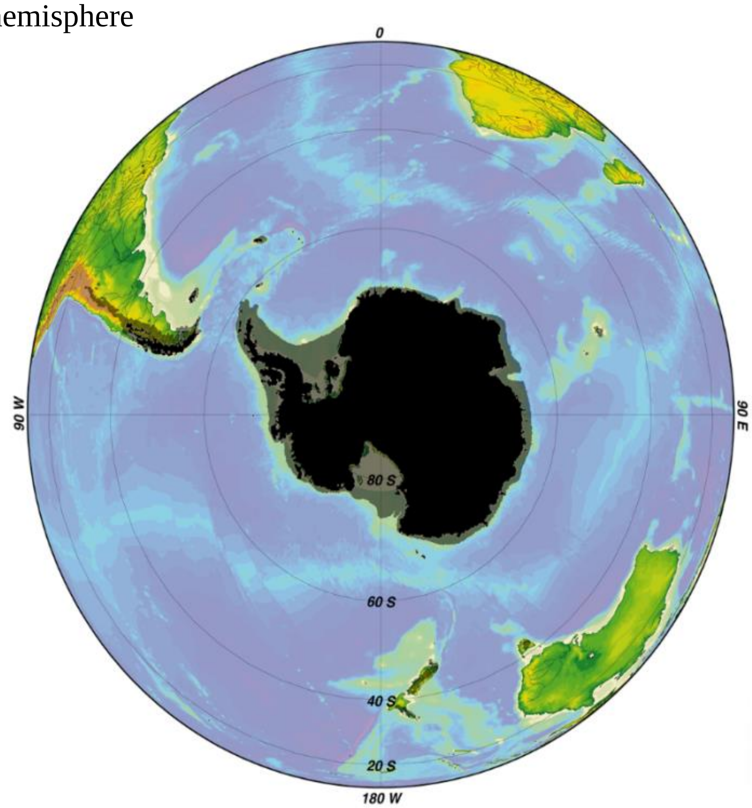


Fig. 12 Minimum (interglacial, black) and maximum (glacial, grey) glaciation of the southern hemisphere

5. New theory of geomagnetic field reversal as primary glaciation forcing

a. Earth glaciation taxonomy

- i. Earth core
  - Geomagnetic field
  - Magma
    - Tectonic plate displacement
      - Volcanoes
      - Earthquakes
- ii. Sun core
  - Solar magnetic field
    - Coronal mass ejection
    - Solar output
- iii. Galactic-cosmic ray flux
  - Troposphere – Ozone
  - Stratosphere – Ultra violet
  - Atmosphere
    - Earth surface
      - Oceans
      - Land
- iv. Gases
  - CO_2
  - Methane
  - NO_2

b. The S geological curve of geomagnetic field reversal and glaciation

Below is this paper's hypothetical sequence of events during an earth core reversal, a brief complete geomagnetic field reversal (and its phases) lasting 1,200 years, solar-galactic-cosmic flux at the troposphere, stratosphere, atmosphere and earth level (land and water), tectonic displacement, super volcanic activity and atmospheric gases. This is a draft hypothesis, a work in progress, submitted so that other scientists may correct, complete and make it contemporary to developing knowledge.

The S curve is a scheme made of vectors. Each vector is the result of the contribution of different forcing mechanisms, multiple vectors. A weight scale that is modified by feedback mechanisms modifies each contributing vector. The algorithms that make each contributing and resultant vector need to be determined in future work.

The proposed schema timeline is hypothetical as each geomagnetic reversal and earth glaciation has unique periods (see Figure 13). However, the above timeline is for a total geomagnetic reversal, while a total complete reversal and a geomagnetic excursion may take thousands of years. For example, currently we are on a very long geomagnetic excursion, but if the geomagnetic field's weakening continue into the 30 to 40% range, it may end up in either a total complete core or magnetic reversal.

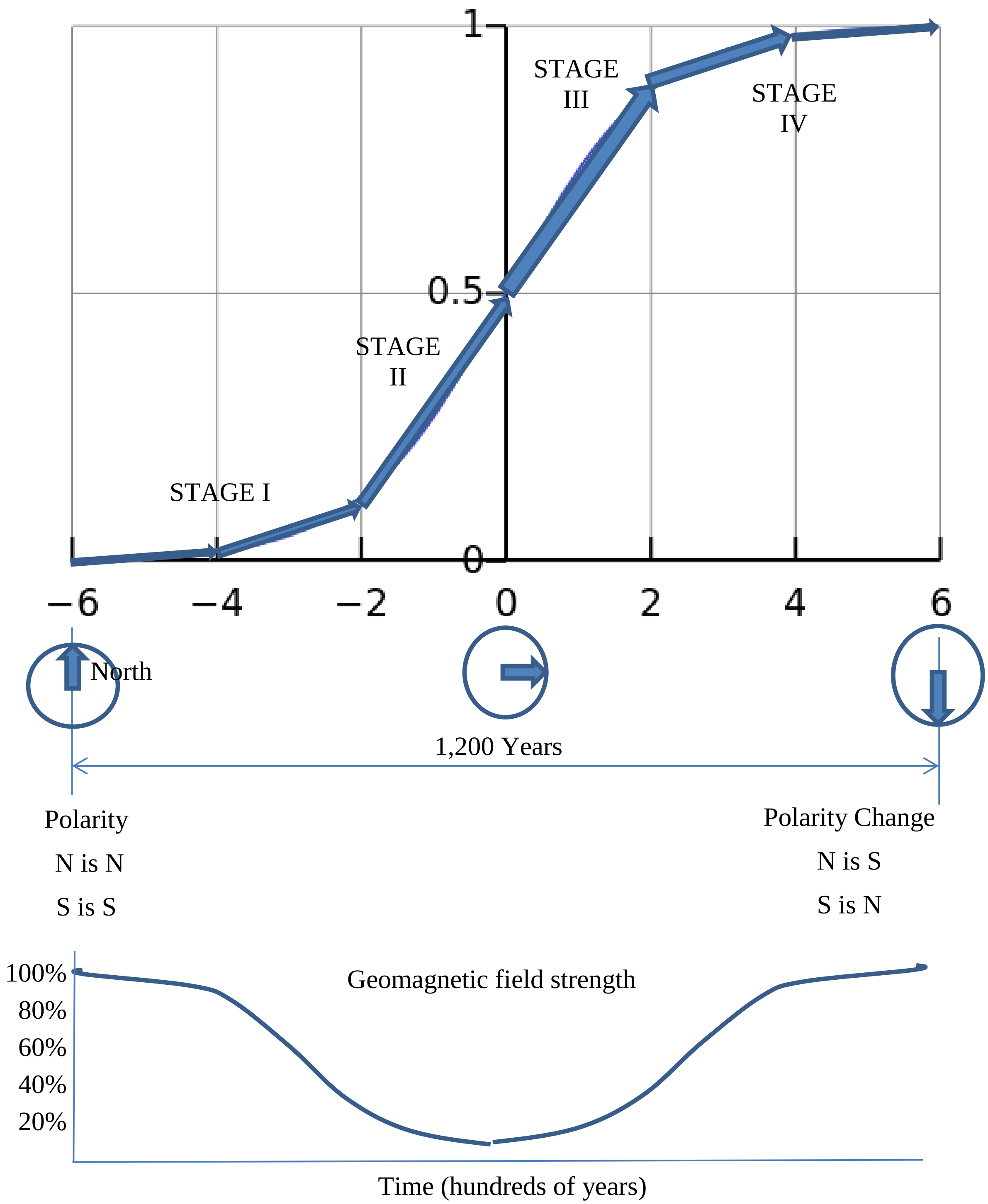


Fig. 13 Schema of core and geomagnetic reversals

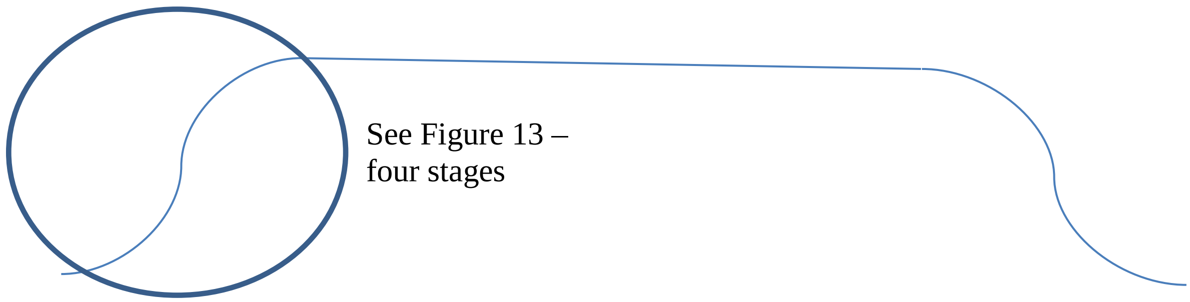


Fig. 14 Schema of core and geomagnetic reversals in chrons and subchrons

STAGE I – Polarity starts to reversing (resultant vector components)

- Earth's core starts reversing (assume total reversal of 1,200 years).
- Geomagnetic field weakens by 30% every 200 years.
- Increased solar radiation at the earth's surface level by 10% every 200 years.
- The first 200 years sees galactic-cosmic flux increase by 5%. The second 200 years has an additional 10% increase in galactic-cosmic flux. This is happening during the many solar maxima and minima that occur during the time period.
- Increases in Earth's temperatures, evaporation and rain/snow precipitation by 10% the first 200 years and an additional 20% the second 200 years
- Gaps in the geomagnetic field allow increased cosmic frigid temperatures into the atmosphere, resulting in heat/cold atmospheric differentials, increased winds, and increased isarithmic lines.
- Vortices appear in regions where they are not expected.
- Tectonic plate displacement accelerates.
- Super volcanos start appearing worldwide.
- Mega earthquakes start appearing worldwide.

STAGE II – Polarity shifts near completion (resultant vector components)

- Earth's core reversal accelerates (assume total reversal of 1,200 years).
- Geomagnetic field weakens by 35% the last 200 years to the full reversal.
- Geomagnetic field strength at the reversal (600 years) is 10% or less.
- The last 200 years has a 15% increase of solar radiation at the earth's surface level. This is happening during the many solar maxima and minima that occur during the time period.
- Galactic-cosmic flux increases by an additional 15% during the last 200 years.
- Earth's temperatures, evaporation and rain/snow precipitation increase by 15% the last 200 years.
- Gaps in the chaotic and vanishing geomagnetic field allow increased cosmic frigid temperatures into the atmosphere, resulting in differential heat/ cold atmospheric differentials, increased winds, and increased isarithmic lines.
- Vortices appear in multiple regions at a higher frequency.

- Global warming yields to global cooling where cosmic frigid temperatures now are closer to earth in multiple places including the equator.
- Tectonic plate displacement continues accelerating.
- Super volcanos continue appearing and increase in VEI worldwide.
- Mega earthquakes continue happening worldwide.
- Continental plate shifting accelerates.

STAGE III – Polarity shifts completed (resultant vector components)

- Earth snowball or icehouse condition affects the entire planet.
- Earth's core reversal decelerates (assume total reversal of 1,200 years).
- Geomagnetic field strengthens by 20% during fourth and fifth 200 years to the full reversal.
- Solar radiation at the earth's surface decreases by15% the fourth and fifth 200 years due to super volcanic activity. This is happening during the many solar maxima and minima that occur during the time period.
- Decreased galactic-cosmic flux by 15% during the fourth and fifth 200 years to full reversal.
- Earth's temperatures, evaporation and rain/snow precipitation decrease by 15% the fourth and fifth 200 years due to partial restoration of the earth's geomagnetic field.
- Partial restoration of geomagnetic field results in decreased cosmic frigid temperatures.
- Vortices start disappearing in multiple regions.
- Global cooling yields to global warming where cosmic frigid temperatures are repelled by the restoration of the geomagnetic field.
- Tectonic plate displacement continues but at a slower pace.
- Super volcanos continue to decrease in VEI worldwide.
- Mega earthquake frequency decreases worldwide.
- Continental plate shifting decelerates.

STAGE IV – Polarity normalcy (resultant vector components)

- Normal solar radiation at Earth's surface level.
- Normal level of global warming due to galactic-cosmic radiation.
- Normal global cooling.
- Normal evaporation and snow precipitation.
- Vortices disappear.
- Normal winds.

c. Tectonic plates, earthquakes and supervolcanic forcing

Earth's core is odd shaped or like the sun's, is composed of multiple massive potato-shaped, super-heated and dense minerals spinning at a rate different than earth's rotation and thus creating the geomagnetic field. When the core starts reversing, several of the protrusions most likely will push magma to the surface. If the magma forcing occurs at the current ridges, there will be accelerated continental plate displacement. This correlation may explain the creation of the mountains and the moving of continental plates that is not justified by normal displacement.

Continental place displacement, in turn, creates massive or mega earthquakes and super volcanoes. The contribution of tectonic plate displacement, the changing of ocean currents and volcanic forcing to earth glaciation is thus explained by the proposed hypothesis, pending further scrutiny and revision of current theories to take into consideration Earth's core reversal as the main forcing mechanism and cause of earth glaciation.

d. Solar-galactic-cosmic ray flux

i. Supply side

The sun's 11-year (mostly) periodic magnetic field reversal cycle in what is called solar maximum (during reversal) and solar minimum (once the poles stabilize) influences how much solar radiation the earth receives. It also influences how much galactic-cosmic background radiation the earth's magnetic field receives and allows through to the troposphere, stratosphere, and atmosphere, filtering down to the earth's surface (land and water).

Currently, in 2018, the sun is at a solar minimum where the sun's heliosphere activity is quiet in relation to coronal mass ejections and their related signature sunspots. Paradoxically, NOAA reports of solar geophysical activity as received at the ISS and earth's surface has increased.

During a solar maximum, the sun's core is reversing, its magnetic field is chaotic, and coronal mass ejections are observed along with the sunspots, but its overall magnetic field weakens. The combination of a weak solar magnetic field and the concentrated plasma at the CME allows the ejection into space of large quantities of solar flux. During the solar maximum, because the sun's magnetic field weakens, the galactic-cosmic flux received at earth is greater.

In reverse, during a solar minimum, the sun's core is stable, its magnetic field is stable and strong and there should be less solar flux emission. During this time, CME and sunspots are rare but sometimes observed. However, if at the receiving end, if the earth's magnetic field weakens, even if the solar flux at a minimum is relatively constant, more of the flux will be received at the ISS and earth at all atmospheric and surface levels. During the solar minimum, the sun's magnetic field is strong and hence, less galactic and cosmic flux is allowed to penetrate the earth's magnetic field.

ii. Receiving side

During a solar maximum, as noted above, the sun's magnetic field is chaotic, the solar flux is low, its CME is strong, and the galactic-cosmic flux is high.

Case 1: Earth's core is stable

If the earth's core is stable and its geomagnetic field strong, the atmospheric and surface solar-galactic-cosmic flux is normal unless hit directly by a CME.

Case 2: Earth's core is reversing

Earth's geomagnetic field is weak or nonexistent, the atmospheric and surface solar-galactic-cosmic flux is high.

During a solar minimum, as noted above, the sun's magnetic field is strong, the solar flux is high, its CME is low, and the galactic-cosmic flux is low.

Case 3: Earth's core is stable

If the earth's core is stable and its geomagnetic field strong, the atmospheric and surface solar-galactic-cosmic flux is normal.

Case 4: Earth's core is reversing

Earth's geomagnetic field is weak or nonexistent; the atmospheric and surface solar-galactic-cosmic flux is at its highest.

iii. Timelines

Sun core reversal lasts (mostly) 12 months and occurs (mostly) every 11 years.

Earth core reversal lasts (mostly) 1,200 years and occurs in aperiodic sequences that are not predictable.

Hence, although we do not know when, we do know that any earth core reversal will experience the consequences of several sun core reversals, magnifying and accelerating all other contributing mechanisms: tectonic, volcanic, earthquake and atmospheric.

e. Geomagnetic vortices

The morning of January 2, 1985, the polar vortex phenomenon set a 480 mbar record (see Figure xx). This vortex affected the stratosphere where a reading of 50 mbar was recorded at 20 km altitude. An EF-5 tornado clocks at 819 mbar, and class 5 hurricane at 870 mbar. Earth's surface pressure is calculated at 1023.2 mbar.

A magnetic vortex, not only at the poles, but during a total or brief complete geomagnetic reversal has the potential to reach levels much lower than 350 mbar at surface level and less than 25 mbar at stratospheric levels. This creates a vacuum at stratospheric, tropospheric and atmospheric levels where the relative warmth of the earth rises while the coldness of space drops down to the earth's surface level.

The earth core reversal timeline, from hundreds to several thousand years, will encounter several solar maximum and minimum events. During this time, Earth will probably experience CME events during the period; create accelerated tectonic plate displacements, causing super volcanic eruptions of VEI 7 or 8 (possibly even with higher explosivity index which is logarithmic), and mega earthquakes; and most of all, create the cooling mechanisms of multiple geomagnetic induced vortices at the same time. The net effect is earth glaciation of the snowball or icehouse earth type.

Solar and planetary vortices are common, lasting thousands and even millions of years. The possibility is real, although with a more restricted duration window on Earth.

Severe wind conditions are to be expected. More recently, the winter of 2017-2018 experienced more than four northeastern events in succession all over the same area as the 1985 event. This is an area where the earth's core is pointing and hence, the geomagnetic field may be weaker. Further studies need to verify this assumption.

5. Conclusions

For the last 300 years, we have been through the early stages of Earth core reversal which is a harbinger of a geomagnetic field reversal. In any reversal case (total, brief complete, or excursion), Earth is in for a long-term change of hundreds, thousands or several thousand years with unimaginable consequences.

6. Acronyms and *terms*

ACR	Anomalous Cosmic Ray
AMO	Atlantic Multidecadal Oscillation

Atmosphere	*The mass of air that surrounds the earth or a heavenly body*
Brief complete reversal	*A brief complete reversal, known as the Laschamp event, occurred approximately 41,000 years ago during the last glacial period. That reversal lasted 440 years with the actual change of polarity lasting 250 years. During this reversal, the strength of the magnetic field weakened 95% of the normal strength of the magnetic field. That is, the magnetic field weakened to 5% of normal strength.*
CME	*Coronal Mass Ejection*
Chron	*A **chronozone** or **chron** is a slice of time that begins at a given identifiable event and ends at another. The Earth's field has alternated between periods of normal polarity, in which the predominant direction of the field was the same as the present direction, and reverse polarity, in which it was the opposite. These periods are called chrons.*
Cosmic ray	*Highly energetic atomic nucleus that travels through space at nearly the speed of light*
Dalton Minima	*A period of low solar activity lasting from 1790 to 1830 named after John Dalton*
Earth core	*The central or innermost portion of the **Earth**, lying below the mantle and probably consisting of iron and nickel. It is divided into a liquid outer **core**, which begins at a depth of 2,898 km (1,800 mi), and a solid inner **core**, which begins at a depth of 4,983 km (3,090 mi)*
Earth glaciation	*To cover an area with glaciers, ice or cover the entire planet (land and sea) with ice or snow*
Earth magnetic field	*The strength of Earth's magnetic field is 0.5 Gauss and extends 400,000,000 miles towards the sun, while the sun's magnetic field is 1.0 Gauss and extends 1.3 million miles in all directions.*
Forcing	*Externally imposed perturbation as in the radiative energy budget of Earth's climate system, also called radiative forcing*
Geomagnetic excursion	*Brief disruptions of the earth's magnetic field that do not result in a reversal. The excursions may record different or meandering north and south locations.*
Geomagnetic field reversal	*A geomagnetic reversal is a change in a planet's magnetic field such that the positions of magnetic north and magnetic south are interchanged, while geographic north and geographic south remain the same.*
GCM	Global Climate Model
GCRF	*Galactic-cosmic radiation flux*
GPTS	Geomagnetic Polarity Time Scale

Greenhouse earth	*The condition when tropical temperatures extend to the poles and there are no ice sheets at all*
Hadley cell	*Atmospheric circulation with rising motion near the equator, poleward flow, sinking motion in the subtropics*
Icehouse Earth	*The condition when there is permanent ice on all water and oceans. Ocean icing, as well as that for all other water bodies, is to a depth of 1,000 feet*
Interstadials	*Periods of earth glaciation history when the ice retreated, but only briefly*
ISS	*International Space Station circling the earth at 248 miles (although it can be moved higher or lower) where space temperatures are 40K approximately*
K	*Kelvin degrees*
Little Ice Age	*A cooling period from 1550 to 1850 (possible geomagnetic expedition reversal)*
Ma	Million years ago
Maunder Minimum	*A period of low solar activity lasting from 1645 to 1715 named after Edward W. Maunder*
Milanković cycle	*Theory proposing that long-term changes in Earth's orbit in turn affect its climate over a long period of time*
NASA	National Aeronautics and Space Administration
Older Dryas	*110,000 to 12,000 years ago, as the glacial period ended and temperatures began to rise, there were two final cold snaps. First, the chilly Older Dryas of 14,700 to 13,400 years ago transformed most of Europe from forest to tundra, like modern-day Siberia*
Photosphere	*Visible surface of the sun*
SEP	Solar energetic particle
SMF	Solar magnetic field
Snowball earth	*The state in which the planet's entire surface is frozen over and covered like a snowball at the poles while the equators are frozen*
Solar maximum	*A regular period of greatest sun activity during the 11-year solar cycle. During solar maximum, large numbers of sunspots appear, and the solar irradiance output grows by about 0.07%.*
Solar minimum	*The period of least solar activity in the 11 year solar cycle of the sun. During this time, sunspot and solar flare activity diminishes, and often does not occur for days at a time.*
SPE	Solar proton event
Spörer minimum	*A period of low solar activity lasting from 1460 to 1550 named after Gustav Spörer*

SSI	Solar spectral irradiance
SST	Sea surface temperature
Stadials	*Brief, inconclusive periods of advancing ice – typically lasting less than 10,000 years*
Stratosphere	*The part of the earth's atmosphere which extends from the top of the troposphere to about 30 miles (50 kilometers) above the surface and in which temperature increases gradually to about 32° F (0° C) and clouds rarely form.*
Subchron	*A slice of time between a given identifiable event and ending at another.*
Sunspot	*Are on sun's photosphere where plasma returns from a CME back into the photosphere and is approximately 2,000 K cooler than the adjacent surface hence appears to be black in terrestrial observations*
Super volcanos	*Defined in this paper as those that have a VEI of 7 or 8*
Total geomagnetic reversal	*A total geomagnetic reversal is a change in a planet's magnetic field such that the positions of magnetic north and magnetic south interchange.*
Troposphere	*The lowest layer of the atmosphere, 6 miles (10 km) high in some areas and as much as 12 miles (20 km) high in others, within which there is a steady drop in temperature with increasing altitude and within which nearly all cloud formations occur and weather conditions manifest themselves.*
TSI	Total solar irradiance
VEI	Volcanic explosivity index
Vortices	*Geomagnetic created vortices are like the sun's plasma vortices returning from a CME that create a much cooler area called sunspots. O Earth, the vortices create a funnel where cosmic frigid temperatures reach the atmosphere level and are the main source of earth glaciation.*
Younger Dryas	*Colder period, between 12,800 to 11,500 years ago, froze Europe solid within a matter of months*

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Earth magnetic field reversals

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Appendix

Dr. Doiron asked for a conjecture of what could have happened to Mars following the lines and logic of this paper. Below is a conjecture of Mars past.

Scientists now believe that Mars may have had an atmosphere and oceans like Earth. But both disappeared millions of years ago.

Table 2 below compares the Sun, Earth and Mars regarding items that relate to their core, size, magnetic fields, average surface temperatures, axis of rotation and gravity. These parameters (rounded up or down) are then used to create a historical conjecture to explain why the atmosphere and oceans were lost.

Table 2 Comparison of selected Sun, Earth, Mars parameters, with the research help of Zachary T. Schwab, my grandson.

Item	units	Sun	Earth	Mars	Remarks
Size (radius)	miles	432,169	3,959	2,106	
Distance to the sun	M. miles	-	92.6	141.6	
Magnetic field	Gauss	1.0	0.5	6.5^{-7}	Mars magnetic field is extremely week to protect an atmosphere or ocean from the sun and cosmic-galactic flux
Magnetic field reach	M. miles	1.3	0.44	?	
Average surface temperature	Kelvin	5,778	288	218	Mars is relatively frigid compared to earth but baked because it has no atmosphere
Axis rotation	Days	27 at equator and 35 at poles	1	1.01	
Rotation around the sun	Days	-	365	687	
Gravity	m/s^2	274	9.8	3.7	
Core Temperature estimate	Kelvin	15M	5,700	1,500	Earth needs 1,773K of core hotter than magma to spur thermal movement and have a magnetic field
Average surface temperature	Kelvin	6,000	287	218	Water freezes at 273.15K

The scenario of how Mars lost its atmosphere and oceans goes like this:

- Mars has no moon to steady its axial rotation, therefore its surface and core gyrate at different speeds and most importantly not in sync with each other. Similar to the sun, it has a different rotation speed at the equator than at the poles
- Mars's core and magnetic field reversal lasted thousands if not millions of years, suffering an even more chaotic event than earth's core-geomagnetic field reversals
- Vortices appeared everywhere, allowing the sun, cosmos and galactic flux to enter and create a cloud covered planet
- Mars received several direct CME hits from the sun that evaporated all oceans into space
- The chaotic field vortices also allowed frigid space temperature to penetrate and cool down the magma and further slow down its core

NASA is now most interested in re-generating Mars' magnetic field as a critical and essential precursor for having human settlements on the planet. This is another topic for future cogitation.