RESEARCH REVIEW International Journal of Multidisciplinary 2021; 6(5):1-20
ISSN: 2455-3085 (Online)
https://doi.org/10.31305/rrijm.2021.v06.i05.001

Research Paper

Double Blind Peer Reviewed/Refereed Journal
https://www.rrjournals.com/

Continuous Heat Signatures from Solar Winds Might Triggered Iron Jet Stream in Earth's Outer Core and Polar Migration Over Decades Resulting in Polar Reversals

[*1]Vikram Nath and [2]Jagatjyoti Nandy

[*1]*B.Sc Student, Department of Geology Mahishadal Raj College, West Bengal, India*
[2]*M.Sc Student, Department of Geology Ranchi University, Jharkhand, India*

ABSTRACT

Solar winds consisting of streams of charged particles/plasma comprising electrons, protons and alpha particles with kinetic energy between 0.5 and 10 KeV continuously sticks Earth's magnetosphere; these solar winds are embedded with their own interplanetary magnetic fields which interacts with Earth's magnetic fields and might impact earth's outer core turbulent convection. These solar winds could have created some unexpected anomaly in Earth's outer core in 2016 which was detected by European Swarm Satellites. Some fast-flowing river of liquid iron that surging westward under Alaska and Siberia named "Jet Stream" were observed. As according to the records, solar winds have been continuing to strike and interact with earth's magnetosphere for quite a period of time and could be directly linked with the polar migration. Continuous interaction with these solar winds with earth's outer core turbulent convection might have been affecting earth's magnetic fields could explain Earth's continuous polar shifts for few decades according to the reports. The evidences of solar wind strike on Earth's magnetosphere are quite convincing as a solar wind strike leads to a geo magnetic storms and there are adequate that the outer core anomaly could have been caused by such an Heat signature of highly energized plasma or particles from the Sun.

Keywords: *Magnetic Poles Shifting, Solar Winds, Iron Jet Stream, Geomagnetic Storms, Polar Migration, Polar Reversal*

Article Publication

Published Online: 15-May-2021

[*]Author's Correspondence

Vikram Nath

B.Sc Student, Department of Geology Mahishadal Raj College, West Bengal, India

vnath0033[at]gmail.com

1. Introduction

From Decades of date records, it could be seen that coronal discharge from the sun's surface, geomagnetic storms and polar shifting are continuously occurring at same rates. Earths has been continuously shielding against the highly charged and energized particles from the solar winds through its magnetosphere and this barrier is a resultant due to rotation, convection and electrically conducting fluid in the outer core explained by Dynamo Theory [1]. The conductive fluid in the geodynamo is liquid iron in the outer core goes through convection, driven by heat flow from the inner core, organized into rolls of column by Coriolis Force, creates circulating electric currents, which generates the magnetic field.

When the solar winds contact with a well-developed magnetic field of a planet, the charged particles get deflected by Lorentz force. Most of the particles travel around the planet rather than bombing the atmosphere of Earth, however some of the charged particles get passed and trapped in the Van Allen Radiation Belt. A smaller number of particles from the solar wind manage to travel, as in a transmission line of electromagnetic energy, towards the upper atmosphere of the Earth and the ionosphere in the auroral zones. The only time the solar wind can be observed on Earth is when it is strong enough to produce phenomena such as auroras and geomagnetic storms. Bright auroras strongly heat the ionosphere, causing its plasma to expand into the magnetosphere, increasing the size of the Earth's plasma and injecting atmospheric material into the solar wind. Geomagnetic storms occur when the plasma pressure inside the magnetosphere is large enough to amplify and thus distort the geomagnetic field. Solar winds with very high heat signature and mass causing geomagnetic storms could force to compress the Earth's magnetic field inward, this could lead change in the

convection currents occurring in the outer core of Earth. This extra compression might lead to some disturbance in the equilibrium of convection of liquid iron in outer core. To overcome this compression, convection currents inside earth's core might have risen. This convection current of iron could be the same as the iron jet stream detected by the Europe's Swarm Satellites. This jet of liquid iron is moving about fifty kilometers per year. It also should be considered that moving a very dense liquid metal would take a large amount of energy and considering the heat signatures of the solar winds it could be directly related and comparing the changes in the flow of molten material in the planet's interior have altered the strengths of the regions of negative magnetic flux. The movement pattern of iron jet stream in the inner core is surging westwards under Alaska towards Siberia and polar wandering tracks a shift from Canada towards Siberia indicate a similar path.

2. Dynamo Theory

Dynamo theory describes the process through which a rotating, convicting, and electrically conducting fluid acts to maintain a magnetic field. This theory is used to explain the presence of anomalously long-lived magnetic fields in astrophysical bodies. The conductive fluid in the geodynamo is liquid iron in the outer core, and in the solar dynamo is ionized gas at the tachocline. Dynamo theory of astrophysical bodies uses magneto hydrodynamic equations to investigate how the fluid can continuously regenerate the magnetic field. It was actually once believed that the dipole, which comprises much of the Earth's magnetic field and is misaligned along the rotation axis by 11.3 degrees, was caused by permanent magnetization of the materials in the earth. This means that dynamo theory was originally used to explain the Sun's magnetic field in its relationship with that of the Earth.

There are three requisites for a dynamo to operate:

- An electrically conductive fluid medium
- Kinetic energy provided by planetary rotation
- An internal energy source to drive convective motions within the fluid.

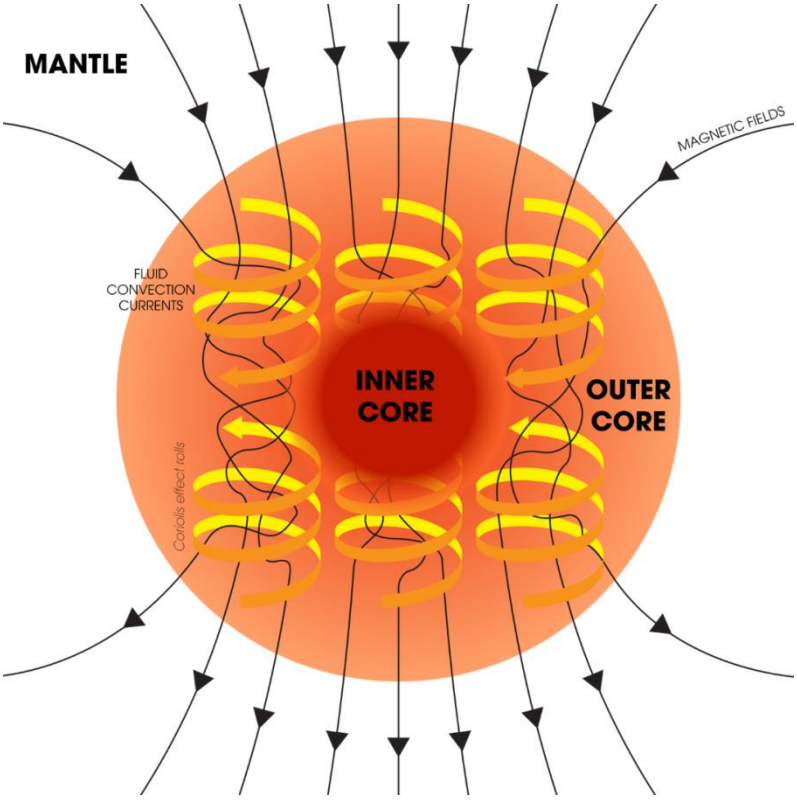


Figure 1: Dynamic imaging of the Earth's magnetic field: the convection pipes of the Earth's internal water circuit, driven by heat from the inside of the earth, are enclosed in Coriolis energy, which generate circular electricity, which provides the Earth's atm.

In the case of the Earth Figure 1, the magnetic field is induced and constantly maintained by the convection of liquid iron in the outer core. A requirement for the induction of field is a rotating fluid. Rotation in the outer core is supplied by the Coriolis Effect caused by the rotation of the Earth. The Coriolis force tends to organize fluid motions and electric currents into columns (also see

Taylor columns) aligned with the rotation axis. Induction or creation of magnetic field is described by the induction equation:

$$\frac{\partial B}{\partial t} = \eta \nabla^2 B + \nabla \times (u \times B)$$

Where u is velocity, *B* is magnetic field, t is time, and $\eta = 1/\sigma\mu$ is the magnetic diffusivity with electrical conductivity and μ permeability. The ratio of the second term on the right-hand side to the first term gives the Magnetic Reynolds number, a dimensionless ratio of advection of magnetic field to diffusion. [1]

2.1. Core Dynamics

Mean-field dynamo theories developed in the 1960s have demonstrated that the interaction of the small scales of a turbulent flow in a conducting fluid with the small scales of the magnetic field they induce can produce a large-scale magnetic field.

The result of radioactive heating and chemical differentiation, the Earth's outer core is in a state of turbulent convection. This sets up a process that is a bit like a naturally occurring electrical generator, where the convective kinetic energy is converted to electrical and magnetic energy. Basically, the motion of the electrically conducting iron in the presence of the Earth's magnetic field induces electric currents. Those electric currents generate their own magnetic field, and as the result of this internal feedback, the process is self-sustaining so long as there is an energy source sufficient to maintain convection. [2]

2.2. Molten Jetstream Detected on Earth Core

A band of molten iron is churning slowly deep inside Earth, much in the same way as a jet stream, a new study finds. Scientists discovered the so-called molten jet stream while analyzing data from a trio of European satellites, called Swarm. The satellites launched in 2013 with the goal of studying Earth's magnetic field. In this case, Swarm's observations helped create a view akin to an X-ray of the planet.

Earth's core is buried under about 1,900 miles (3,000 kilometers) of rock, so scientists study it indirectly by measuring the planet's magnetic field. For instance, changes in the magnetic field suggested that liquid iron in the outer core moves faster in the Northern Hemisphere, largely beneath Alaska and Siberia, the researchers said.

That speed is three times faster than normal outer-core speeds and hundreds of thousands of times faster than the rate at which Earth's tectonic plates move, they noted. Swarm's data also allowed the researchers to pinpoint the jet stream's location: It flows along a boundary between two different regions in the core, the researchers found. This movement is likely caused when liquid in the core flows toward the boundary from both sides, and then is squeezed out sideways, they said. The magnetic field is forever changing, and this could even make the jet stream switch direction. [3]

3. Magnetic Polar Wandering

The first in situ measurements in 1831 of its location in the Canadian arctic, the Magnetic North Pole has drifted inexorably towards Siberia, accelerating between 1990 and 2005 from its historic speed of 0–15 km yr−1 to its present speed of 50–60 km yr−1. In late October 2017 the north magnetic pole crossed the International Date Line, passing within 390 km of the geographic pole, and is now moving southwards. [10]

The last two decades the position of the north magnetic pole has been largely determined by two large-scale lobes of negative magnetic flux on the core–mantle boundary under Canada and Siberia. Localized modeling shows that elongation of the Canadian lobe, probably caused by an alteration in the pattern of core flow between 1970 and 1999, and substantially weakened its signature on Earth’s surface, causing the pole to accelerate towards Siberia. A range of simple models that capture this process indicate that over the next decade the north magnetic pole will continue on its current trajectory, traveling a further 390–660 km towards Siberia.[10]

To demonstrate that this elongation effect is the primary cause of the recent north magnetic pole movement, numerical experiment were performed where isolated geomagnetic variation over the period 1999–2019 to within the wedge, the geomagnetic field being held fixed at its 1999 structure elsewhere, and calculated the geomagnetic signature on Earth’s surface (Methods). This simple model reproduces the weakening of the large-scale part of the Canadian flux lobe at the CMB and the concomitant weakening of the Canadian patch at Earth’s surface, in accord; it also reproduces the growth of the Siberian surface patch. Furthermore, it

accounts for 961 km of the 1,104 km (87%) distance traveled by the north magnetic pole over the period 1999–2019 Figure 2. [10]

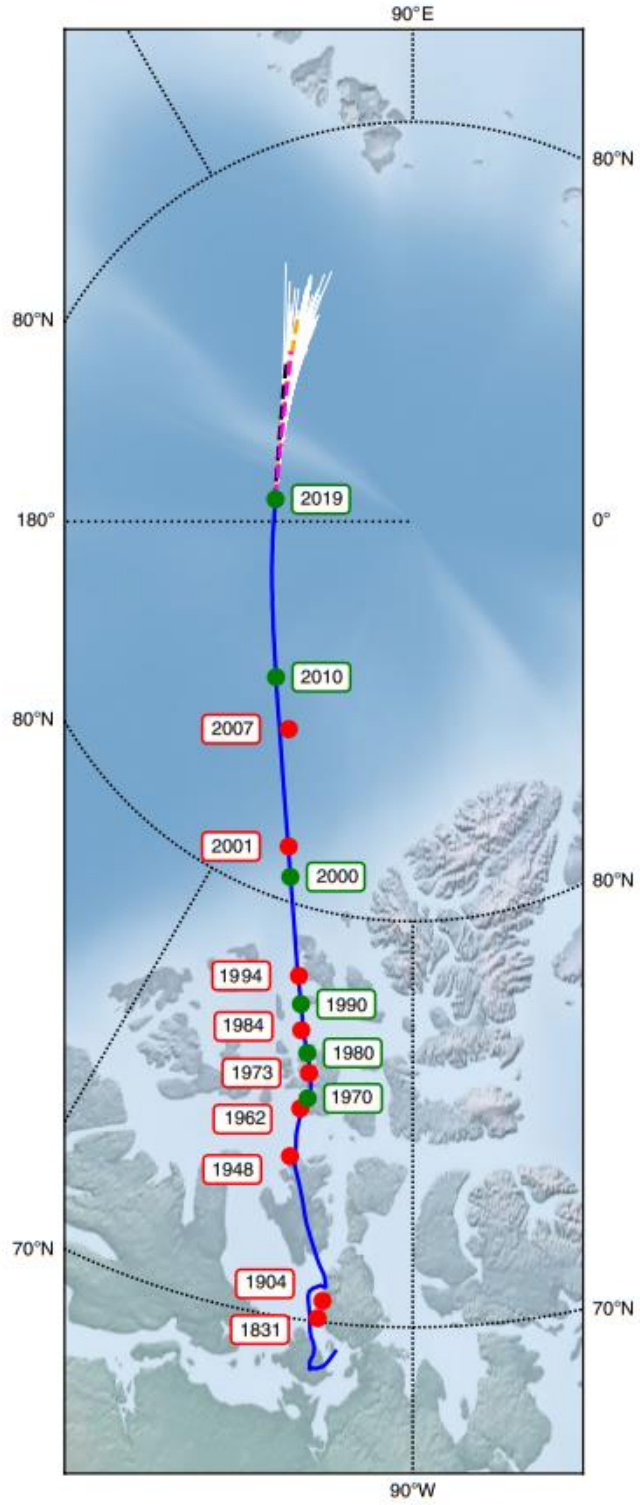


Figure 2: Historical movement and predicted future path of the north magnetic pole in stereo graphic projection [10]. Solid blue shows the pole's evolution according to the COV-OBS.x1 (1840–1999) and CHAOS-6-x8 (1999–2019) geomagnetic field models, with green cir

3.1. Course of Earth's Magnetic Polar Shift

Time variation of the geomagnetic field arises through a combination of core flow and magnetic diffusion. The reconfiguration of the Canadian flux lobe A Figure 3 requires a change in the signature of either or both of these effects within the core under Canada,

although inference of any single underlying dynamical process is non-unique. Here base interpretation on the frozen-flux assumption, which asserts that over decadal timescales the impact of core flow is probably dominant, [11] and is consistent with the formation and advection of lobe B Figure 3.

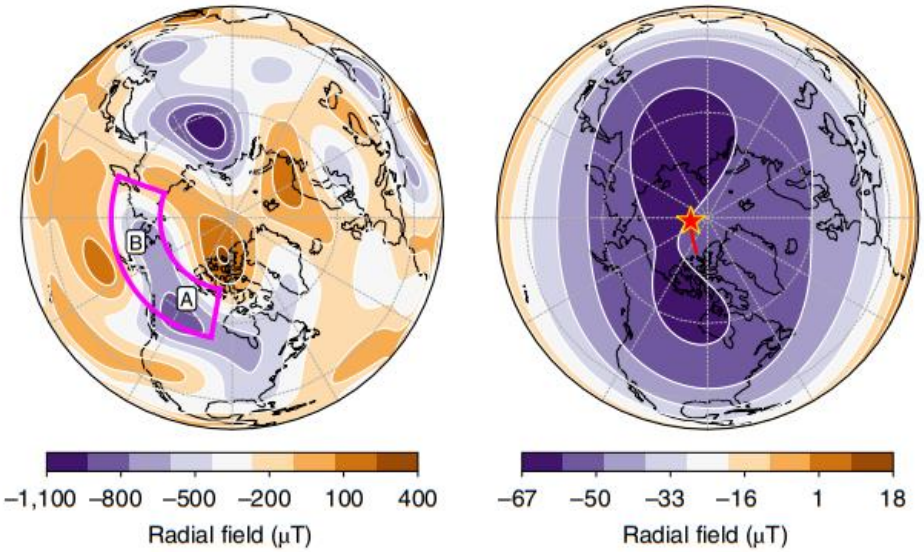


Figure 3: Contours of the radial component in 1999 according to CHAOS-6-x8, [10] Radial field on Earth's surface with the north magnetic pole (red star), whose tail indicates its path since 1999, produced only by changes within the wedge between 1999 and 2019. In each panel lines of constant latitude and longitude are marked every 30°. [10]

By 1999 the flow had altered into a broad trans-North-America stream that converged and strengthened under Alaska: this differential velocity was efficient at elongating (by stretching) the Canadian lobe westwards. By 2017 the flow under Alaska had further strengthened, advection and further stretching acting to separate the Canadian lobe into two pieces. Our interpretation based on the presented ensemble mean flow is reinforced by the fact that the basic sequence of events described above occurs in all flow ensemble members.

The strengthening azimuthally flow under the Bering Straits, a key part of the core-flow changes described above, may also be associated with the appearance of an intense tangent-cylinder jet in this region, which has a clear observational signature in the small-scale magnetic field (above spherical-harmonic degree 11) after 2004[12]. Although the tangent cylinder jet is in itself too localized at high latitude to be directly responsible for the elongation of the Canadian lobe in the 1990s, it could be part of a more general alteration in the global gyre structure [13] [14] beneath North America that caused flux lobe elongation and subsequently the rapid acceleration of the north magnetic pole.

3.2. Polar Reversal

In the 1950s, evidence began to accumulate that Earth's magnetic field has periodically reversed its polarity in the past. Such a change in the polarity of the magnetic field is a magnetic reversal. During a time of normal polarity, magnetic lines of force leave Earth near the geographic South Pole and reenter near the geographic North Pole. This orientation is called "normal" polarity because it is the same as the present polarity. During a time of reversed polarity, the magnetic lines of force run the other way, leaving Earth near the North Pole and entering near the South Pole. In other words, during a magnetic reversal, the north magnetic pole and the south magnetic pole exchange positions.

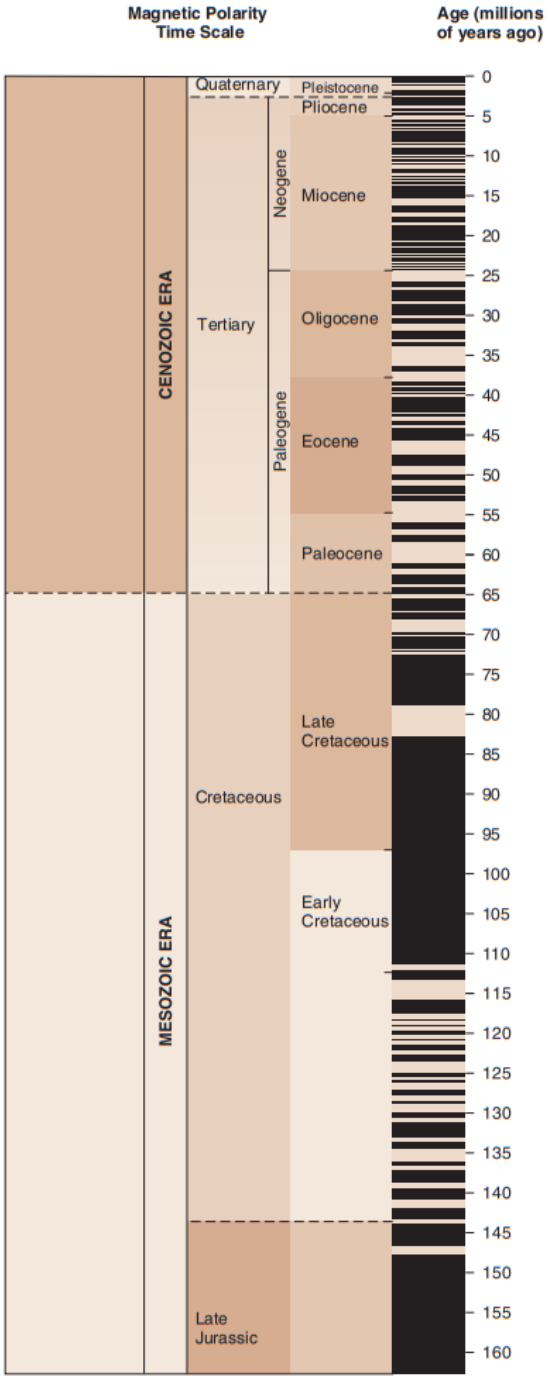


Figure 4: Worldwide magnetic polarity time scale for the Cenozoic and Mesozoic Eras. Black indicates positive anomalies (and therefore normal polarity). Tan indicates negative anomalies (reverse polarity). [15] Modified from R. L. Larson and W. C. Pitman, III, 19

Many rocks contain a record of the strength and direction of the magnetic field at the time the rocks formed. When the mineral magnetite, for example, is crystallizing in a cooling lava flow, it aligns its internal magnetization with that of the ambient magnetic field, specifically, the magnetic North Pole. As the lava cools slowly below the Curie point (580°C for magnetite), this magnetic record is permanently trapped in the rock Figure 5-A. Unless the rock is heated again above the Curie point temperature, this magnetic record is retained and when studied reveals the direction of Earth's magnetic field at the time the lava cooled. Other rock types, including sedimentary rocks such as limestone, mud stones, and red-colored sandstone stained red by iron-oxide minerals, also record former magnetic field directions. For a rock to record the Earth's magnetic field, it must contain iron-bearing minerals, such as magnetite (Fe_3O_4) and/or hematite (Fe_2O_3), which are capable of maintaining a permanent magnetization, or remanence, over geologic time scales (e.g., billions of years). The study of ancient magnetic fields is called paleomagnetism. [15]

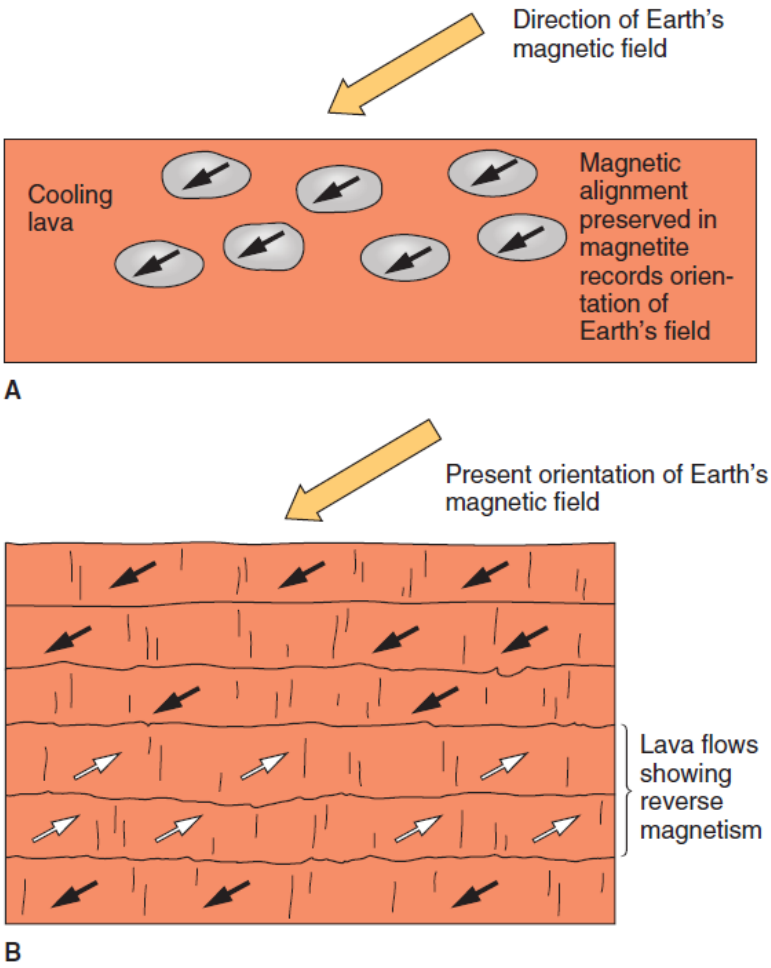


Figure 5: (A) Some rocks preserve a record of Earth's magnetic field. (B) Cross section of stacked lava flows showing evidence of magnetic reversals. [15]

Most of the evidence for magnetic reversals comes from lava flows on the continents. Paleomagnetic studies of a series of stacked lava flows often show that some of the lava flows have a magnetic orientation directly opposite that of Earth's present orientation Figure 5-B. That is, at the time these lava flows cooled, the magnetic poles had exchanged positions. During this time of magnetic reversal, a compass needle would have pointed south rather than north. Many periods of normal and reverse magnetization are recorded in continental lava flows. They are worldwide events. Since lava flows can be dated isotopically, the time of these reversals in Earth's past can be determined. Although reversals appear to occur randomly, records for the last ten million years suggest that Earth's field reverses on average about once every 500,000 years. The present normal orientation has lasted for the past 700,000 years. It takes time for one magnetic orientation to die out and the reverse orientation to build up. Most geologists think that it takes roughly 10,000 years for a reversal to develop, although new evidence from lavas in Nevada suggests that a reversal can occur over time scales of a few years. [15]

A record of all the geomagnetic reversals that have occurred over the last 200 million years is well-preserved within the oceanic crust and forms the basis for the geomagnetic polarity time scale Figure 4. Reversals preserved within the basalts and sheeted dikes of the oceanic crust were first discovered in the 1940s and 1950s by researchers who were trying to improve the way in which submarines could navigate the deep oceans. Ultimately, the normal and reversed magnetization s preserved within the oceanic crust served as the basis for the development of the modern theory of plate tectonics and the Vine-Matthews hypothesis of seafloor magnetic anomalies. [15]

4. Solar Wind

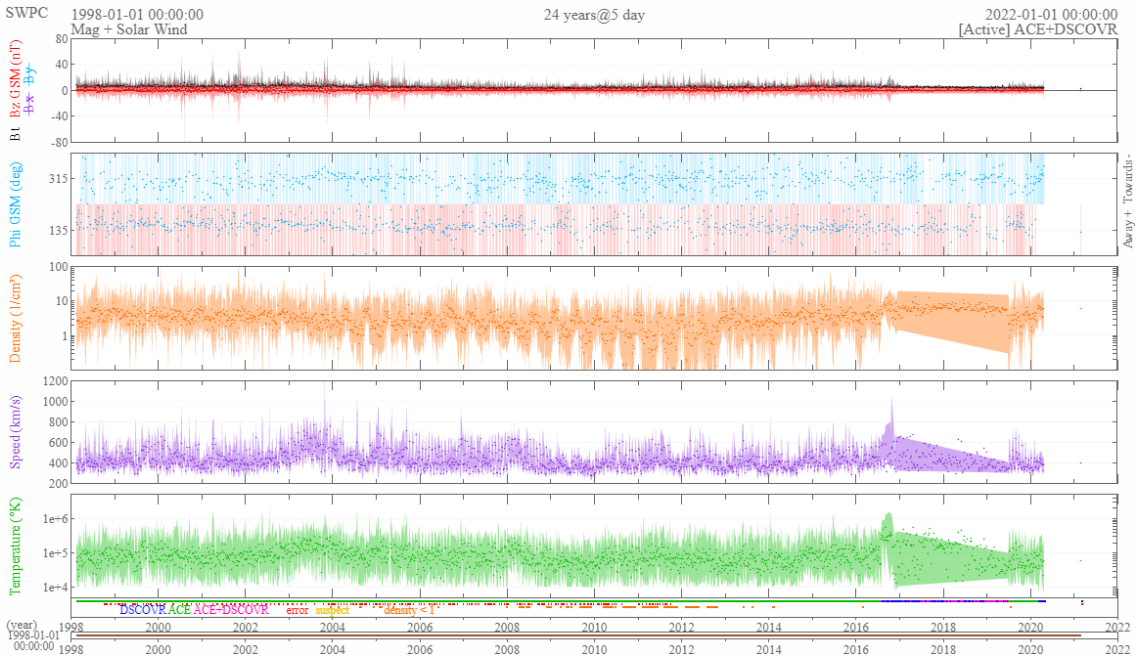
Solar wind is an ionized gas made up primarily of protons and electrons with minor ions in amounts similar to those in the corona. The electrons and ions are very tightly bound to lines of magnetic flux, again like the coronal plasma in streamers. However,

the magnetic field in the solar wind is relatively weak and thus is carried along by the solar wind. The rotation of the Sun results in the lines of magnetic flux in the solar wind being drawn into Archimedean spirals. This occurs because the Sun revolves once every ~25.5 days while, as mentioned above, it takes solar wind several days to reach 1 AU. Therefore, the Sun revolves through a significant angle during the time it takes the solar wind to reach the Earth. For example, taking a typical speed of 400 km s−1, it takes solar wind 4.34 days to reach 1 AU. During the same time, the Sun will have resolved through about 60°, or about 1/6 of a full rotation. The magnetic field in the solar wind, called the interplanetary magnetic field, or IMF, is attached to the Sun at the point where the solar wind began. Thus, the point on the field line attached to the Sun is turned through an angle of 60° relative to the point on the magnetic field line that is at 1 AU. The field line between the Sun and 1 AU traces a continuous curve between these two points. Assuming the solar wind speed, v (km s−1), is independent of distance from the Sun, this curve is described by Equation 1.

$$r - r_0 = \frac{-v}{\Omega(\cos\theta)}(\phi - \phi_0)$$

In Equation 1 r is the distance from the center of the Sun in km, $r_0 6.96\times10^5$ km is the radius of the Sun, $\Omega = 2.85\times10^{-6} s^{-1}$ is the angular velocity of the sun, and $(\phi - \phi_0)$ is the difference in longitude (in radians) at the two points on the field line. θ is solar latitude and the Earth lies in the range $-7.25 < \theta < 7.25$ degrees because the plane of the ecliptic is inclined to the solar equator by 7.25°. The angle $(\phi - \phi_0)$ is also the angle between the magnetic field line and the radial direction at 1 AU, or wherever Equation 1 is evaluated. This is called the spiral angle. The geometry of the curved field line is precisely an Archimedean spiral when v is constant and this is one of the important predictions made by E. Parker when he developed his theory for the solar wind in the 1950s and 1960s. Figure 5 illustrates two spirals computed using Equation1. The tighter spiral above results from low speeds, <500 km s−1, and the spiral angle is >45° at 1 AU. Conversely, the spiral angle at 1 AU is <45° for speeds >500 km s−1. Parker predicted that $(\phi - \phi_0) \approx 45$ (0.785 radians) at 1 AU and this is what has been measured for the average spiral angle by several different spacecraft. [16]

4.1. Records of Last 2 Decades of Solar Wind



Graph 1: This Graph shows all the Solar Wind Activities in the last 2 decades with minimal to the highest heat signatures in Degree Celsius. [17]

The Graph shows all the coronal discharge from the Sun's surface as solar wind recorded by NOAA & International Weather Service for the past 2 decades:

Date [mm/dd/yyyy]	Dens-med	Dens-min	Dens-max	Speed-med	Speed-min	Speed-max	Temp-med	Temp-min	Temp-max
2/9/2001	3.56	1.64	7.2	417.74	384.79	580.63	85123	42505	589130
2/14/2001	1.41	0.83	5.06	480.69	286.64	601.2	142950	10927	413470
2/24/2001	3.61	1.38	14.32	355.91	288.78	544.87	49699	11046	434570
3/31/2001	1.75	0.22	29.21	583.11	265.76	827.38	96300	16213	1561400
4/5/2001	2.99	0.51	13.36	545.07	430.7	794.64	162180	36101	1149200
4/10/2001	1.47	0.26	16.62	642.13	499.25	836.65	117550	11940	1059900
5/5/2001	4.03	1.32	10.35	382.2	313.17	562.71	75546	10683	446140
5/10/2001	3.94	0.98	12.25	488.97	396.44	657.24	103120	13351	525520
5/25/2001	1.98	0.77	9.28	478.69	385.01	606.37	97233	10798	491590
5/30/2001	2.81	0.26	36.85	369.08	316.47	578.59	55056	11261	595460
6/19/2001	0.78	0.22	4.42	492.96	377.35	798.54	182340	45066	735830
7/14/2001	3.83	0.55	12.37	464.09	379.36	692.76	183000	28225	574530
7/29/2001	5.05	1.61	41.89	393.8	307.98	605.76	69391	22343	403600
8/18/2001	3.44	1.17	12.89	486.48	385.06	633.12	62130	14762	522270
8/23/2001	3.38	0.63	14.96	424.33	348.06	574.16	89254	15156	403250
9/22/2001	5.65	0.59	21.35	324.68	257.37	575.04	87521	15200	1149200
9/27/2001	2.25	0.24	22.75	515.13	265.45	704.72	134250	20199	819020
10/7/2001	3.94	1.18	23.44	391.66	316.37	567.87	73903	17442	815930
10/12/2001	3.96	1.05	27.19	426.98	346.67	578.9	81029	12340	322760
10/17/2001	3.81	0.71	20.33	329.81	288.44	659.14	42453	13684	731430
12/11/2001	6.06	0.98	37.49	332.98	266.43	478.17	43634	10854	450900
12/16/2001	2.52	0.78	17.86	445.71	352.92	571.16	92448	27422	457120
12/21/2001	4.84	1.76	27.86	395.49	316.09	612.62	112110	20918	458130
12/26/2001	5.78	1.04	60.45	379.03	271.81	639.41	65740	10797	970020
12/31/2001	2.62	1.31	6.26	404.06	297.55	610.59	70346	15404	406830
1/10/2002	3.14	1.69	9.78	525.91	340.26	652.11	109510	34342	684550
2/4/2002	3.17	1.57	31.55	538.4	320.26	672.02	136870	31567	560200
3/1/2002	3.86	1.28	25.96	392.14	322.83	713.15	83754	24074	528680
3/16/2002	3.57	0.1	50.28	329.83	273.27	577.6	40683	13260	462010
3/26/2002	2.97	1.18	22.5	440.84	310.19	647.04	86753	19513	444910
3/31/2002	1.43	0.83	5.23	648.56	428.58	780.96	151840	42083	661390
4/15/2002	5.78	0.42	21.97	379.39	325.56	644.36	67637	11780	639670
4/20/2002	3.89	0.3	14.4	483.86	256.83	636.42	106050	12815	836100
5/20/2002	4.1	0.1	26.84	440.05	364.97	872.06	98302	16007	1924000
5/25/2002	1.51	0.1	5.66	509.11	374.91	789.16	188100	27516	884140
7/4/2002	3.6	1.47	16.69	401.3	299.03	574.61	78110	22802	402970
7/14/2002	4.28	0.39	20.58	406.27	298.8	516.59	88123	13412	406240
7/19/2002	2.19	0.1	14	513.78	431.01	923.21	106460	14268	2204800
7/29/2002	3.36	0.54	9.6	444.64	368.81	535.66	81103	13481	424770
8/13/2002	1.43	0.4	3.73	503.45	421.47	649.47	147500	40932	829340
8/18/2002	2.7	0.7	12.83	453.54	373.99	584.49	54291	11040	619720
9/7/2002	2.5	0.35	12.66	452.78	357.43	563.1	88543	13511	542360
9/17/2002	2.11	0.38	5.24	468.11	386.23	736.21	176890	32180	535100
10/12/2002	4.43	1.45	23.44	361.3	285.62	606.48	80380	18593	771040
10/17/2002	1.67	0.64	4.95	604.67	519.79	730.97	197180	82691	609940

10/27/2002	4.11	1.56	25.46	547.53	408.46	775.98	157110	37748	531760
11/21/2002	3.41	1.88	47.35	508.5	424.63	737.02	132080	58214	574970
11/26/2002	4.76	2.26	15.43	510.68	371.16	594.79	150260	18869	589790
12/6/2002	2.36	1	24.4	519.66	369.41	646.76	171730	24812	482500
12/11/2002	2.35	0.84	12.71	385.03	319.45	559.67	97571	17308	542330
12/11/2002	2.35	0.84	12.71	385.03	319.45	559.67	97571	17308	542330
12/26/2002	2.57	0.97	8.97	588.83	391.44	773.06	180180	38308	607190
1/20/2003	3.08	0.6	6.89	638.5	522.59	795.48	249980	90421	704680
1/30/2003	4.36	0.23	22.2	489.38	383.45	782.17	138950	15904	796350
2/4/2003	2.29	1.11	8.47	514.31	458.26	632.93	192100	73212	485050
2/14/2003	2.94	1.1	12.32	606.67	383.21	704.23	179030	15199	457870
2/19/2003	3.08	1.39	10.24	879.73	511.52	705.61	180460	34114	433260
2/24/2003	3.26	1.25	28.59	458.91	390.27	598.66	108200	34961	482450
3/11/2003	3.64	1.27	9.57	471.66	387.54	673.27	157820	32568	401010
3/16/2003	1.41	0.54	3.46	697.04	613.83	826.02	280240	117030	625620
3/26/2003	5.97	1.61	23.3	462.06	367.75	638.29	97309	23495	607930
4/10/2003	2.68	1.27	11.18	574.89	449.83	742.26	180110	63662	493050
4/15/2003	3.07	1.27	9.26	623.52	542.56	785.08	195840	91554	454750
4/25/2003	1.5	0.18	9.47	521.66	336.75	576.1	220880	44813	1169400
5/5/2003	2.55	0.43	10.95	711.87	417.65	878.34	276970	67236	613900
5/10/2003	2.59	1.07	8.84	671.83	559.02	810.32	249610	39310	530630
5/25/2003	3.17	1.42	35.24	538.12	444.92	781.23	176830	41742	666990
5/30/2003	2.57	1.12	31.51	695.99	557.05	856.26	232790	64154	884130
6/4/2003	2.09	0.84	5.91	671.32	482.37	828.07	227360	71392	540860
6/9/2003	1.89	0.83	4.04	638.11	396.45	761.41	167280	38168	401640
6/14/2003	3.13	0.47	14.79	519.15	448.67	636.45	123220	24285	577900
6/24/2003	2.4	0.93	6.6	590.43	489.75	758.93	249550	54617	552390
6/29/2003	1.18	0.54	6.12	651.65	460.43	806.4	218550	60148	515350
7/4/2003	1.03	0.23	4.03	641.61	440.45	802.39	236110	78768	701180
7/9/2003	3.22	0.85	19.83	435.24	336.59	670.44	101070	17868	692260
7/14/2003	2.91	0.78	10.62	570.63	452.23	677.86	156100	56665	527320
7/24/2003	3.7	0.65	37.95	433.45	308.44	785.48	112360	14665	990670
7/29/2003	1.61	0.73	3.04	769.91	669.96	863.25	301400	167400	552260
8/3/2003	4.18	1.11	18.51	514.86	421.06	682.76	128480	20792	440000
8/8/2003	1.84	0.64	6.17	645.34	514.27	792.14	200670	90468	553710
8/18/2003	2.79	0.49	16.67	472.58	369.19	797.74	139770	15390	572730
8/23/2003	1.58	0.53	4.22	594.85	418.76	794.35	200960	47040	422850
8/28/2003	2.13	0.68	9.78	449.65	392.27	621.65	119040	36585	403820
9/7/2003	1.76	0.65	10.14	559.43	378.15	703.02	166380	24392	662910
9/17/2003	1.4	0.54	13.09	703.5	495.47	830.08	285120	110060	535940
9/22/2003	2.43	0.62	5.59	586.33	462.59	734.88	172460	69278	401480
10/2/2003	3.98	0.18	14.84	443.43	302.27	618.87	125710	21015	448630
10/12/2003	3.96	1.22	20.21	501.93	303.51	730.9	162380	11437	718440
10/17/2003	4.22	1.76	7.07	585.47	522.07	730.36	168440	89548	482350
10/22/2003	2.74	0.72	37.54	525.58	372.38	739.45	89462	10691	559850
10/27/2003	2.72	0.15	81.69	328.71	258.55	1200	98609	22216	1319800
11/1/2003	2.33	0.28	11.75	560.55	260.04	801.37	95796	13278	1315600

11/6/2003	5.68	1.03	28.08	508.28	414.54	656.65	154330	49091	601500
11/11/2003	2.97	1.5	8.58	676.74	605.63	785.11	257350	141560	734830
11/16/2003	1.81	0.85	11.18	723.05	544.3	819.49	270960	68223	569330
12/6/2003	2.05	0.34	10.78	551.75	380.97	841.32	228840	47218	663460
12/11/2003	0.91	0.45	1.84	757.89	659.06	858.76	283730	146770	482420
1/5/2004	1.86	0.43	11.75	601.57	492.88	764.01	188800	22408	655660
1/10/2004	3.46	0.2	17.39	538.48	452.87	679.79	174300	14357	457610
1/20/2004	3.37	1	21.04	523.82	456.68	681.65	93578	22688	784820
1/30/2004	2.76	0.9	11.53	583.08	426.17	677.4	174160	630887	445840
2/9/2004	2.66	0.69	21.99	414.32	359.48	730.01	98943	24743	551690
2/14/2004	0.43	0.1	3.3	537.81	406.14	761.15	176310	14919	994430
2/24/2004	2.13	0.86	9.71	378.72	300.27	552.63	59096	11174	442020
2/29/2004	1.09	0.52	2.89	639.26	466.93	727.96	207130	60825	777400
3/5/2004	1.36	0.31	14.89	385.11	314.25	616.05	74479	12215	454740
3/10/2004	1.55	0.55	5.83	598.39	447.52	789.43	128090	53376	682010
3/25/2004	2.12	0.66	11.76	579.21	346.65	909.46	187510	34800	995240
4/24/2004	2.95	1.15	8.12	467.63	417.25	565.35	127150	32193	494880
5/4/2004	3.42	1.3	10.38	484.04	377.75	619.81	117590	49733	400330
6/13/2004	1.28	0.37	7.8	477.67	311.29	589.43	140800	11457	407690
6/28/2004	1.9	0.62	14.19	519.59	327.52	586.68	109170	36987	417720
7/8/2004	2.81	0.6	11.59	335.87	293.37	561.96	58647	13478	478860
7/18/2004	1.76	0.45	13.93	446.85	360.43	687.52	117160	27656	536420
7/23/2004	1.07	0.1	9.15	605.96	486.37	1018.2	147810	12119	1887800
7/28/2004	1.14	0.18	4.85	485.04	429.95	903.25	112660	44930	416670
8/7/2004	1.51	0.42	13.92	439.76	331.57	604.89	129570	13068	426630
9/11/2004	1.04	0.1	11.73	528.01	231.95	609.76	97141	10971	555310
9/21/2004	3.48	1.28	8.77	427.59	369.63	530.49	72412	25133	404649
11/5/2004	3.49	0.52	41.19	413.05	320.17	818.29	45102	19288	1366146
11/25/2004	2.47	0.53	9.84	475.73	391.37	627.24	132464	26577	467408
12/30/2004	2.83	0.43	13.49	511.36	411	797.1	152852	60262	943535
1/14/2005	1.97	0.34	12.08	542.13	259.63	925.02	116689	29409	1149733
1/19/2005	1.07	0.1	17.41	687.19	261.56	970.76	131855	27637	998997
1/29/2005	1.71	0.27	13.79	551.3	374.44	673.56	129338	18693	482382
2/3/2005	0.97	0.3	9.39	428.34	345.62	727.54	118157	14211	569059
2/8/2005	0.89	0.33	2.71	669.43	472.16	759.67	210931	54609	500544
3/5/2005	2.64	0.47	23.21	639.45	383.38	782.46	250334	25051	463057
3/25/2005	2.44	0.71	9.86	548.57	410.37	699.66	149674	44190	502461
4/4/2005	3.4	1.31	11.5	488.49	348.78	651.32	99803	22800	480356
4/19/2005	3.79	0.87	13.1	476.48	327.58	583.42	141754	23764	431710
4/29/2005	3.1	0.8	18.7	542.99	332.7	687.81	186726	24782	604317
5/4/2005	1.97	0.4	14.63	389.33	332.53	827.54	77658	25423	1037134
5/14/2005	0.74	0.13	8.38	529.17	277.02	955.84	75483	10792	1099262
6/3/2005	1.89	0.65	8.23	486.46	382.6	661.52	166761	34817	432884
6/13/2005	0.85	0.85	13.92	497.07	435.83	685.33	108578	12050	612033
6/23/2005	2.14	0.68	36.7	493.18	335.13	660.62	151104	23454	420943
6/28/2005	2.88	0.54	10.18	395.89	330.43	619.72	83028	14198	420879
7/8/2005	4.28	0.57	28.38	408.78	305	535.03	40703	11761	412367

7/18/2005	5.16	1.03	14.08	496.67	381.68	622.92	135283	21933	428593
8/2/2005	2.79	0.59	16.43	460.8	399.37	627.32	97496	35754	494829
8/7/2005	1.62	0.38	5.77	468.5	377.1	726.45	78687	17146	717071
8/12/2005	2.77	0.3	4.34	460.6	336.56	671.77	121805	18866	483107
8/22/2005	2.69	0.36	25.41	536.68	425.13	735.15	142369	28948	1634471
9/1/2005	2.64	0.53	9.1	556.52	418.27	767.35	173822	45749	780260
9/6/2005	2.57	0.31	10.28	380.52	251.54	469.53	66261	15940	467387
9/11/2005	1.05	0.1	6.48	713.9	271.1	996.69	121637	24428	1523199
9/16/2005	1	0.33	1.82	541.34	378.71	698.68	156963	13423	451871
10/6/2005	2	0.87	28.61	607.94	307.49	729.21	187133	23076	692235
10/31/2005	4.32	0.95	14.2	392.88	350.99	725.97	91614	18555	472038
11/30/2005	1.29	0.67	3.69	681.17	539.01	749.26	228920	90376	416061
12/5/2005	1.2	0.24	10.88	391.65	264.81	577.65	24185	10153	99610
12/10/2005	2.53	0.5	8.96	433.37	293.68	566.07	109462	22040	465200
12/20/2005	1.79	0.2	5.71	448.18	316.9	620.74	88580	11642	584416
12/25/2005	1.65	0.29	21.52	510.63	317.48	729.31	151872	13277	572563
1/19/2006	2.46	0.51	9.78	442.94	366.41	612.52	82082	27236	440151
2/18/2006	3.1	1.2	12.58	538.96	341.78	687.35	117018	17244	422106
3/20/2006	2.33	0.93	8.94	549.48	375.75	725.19	104375	37246	400966
4/9/2006	2.8	1.16	17.22	523.38	360.27	690.34	97733	17845	525620
5/4/2006	2.94	0.64	18.63	404.45	303.39	645.56	84791	23358	433492
5/9/2006	1.36	0.65	10.92	542.47	383.08	659.14	142793	14860	441485
5/14/2006	1.24	0.26	9.2	399.77	308.93	590.5	79216	11547	418118
6/13/2006	1.73	0.45	12.82	552.86	333.9	617.97	175554	22038	556712
6/28/2006	2.99	1.15	10.23	465.34	340.96	595.31	89164	23976	464031
7/3/2006	2.16	0.59	25.81	514.14	283.83	640.16	114088	13579	502886
7/23/2006	4.72	1.32	16.87	339.28	304.13	502.5	48393	12761	450862
7/28/2006	3.18	1.03	11.09	513.51	377.96	667.28	141579	33266	595914
8/7/2006	1.93	0.75	34.11	487.51	359.59	641.74	140306	46216	512412
8/27/2006	3.66	1.2	22.66	516.9	326.3	655.39	86169	10876	651484
9/1/2006	5.89	1.37	22.27	433.73	361.73	625.98	101722	27197	508959
9/21/2006	6	1.04	61.58	352.26	296.51	672.45	33099	11705	454485
11/10/2006	1.57	0.57	7.37	513.67	341.29	643.05	102890	20605	481922
12/5/2006	3.44	0.15	11.53	421.14	261.47	604.53	110791	13244	413680
12/10/2006	1.31	0.31	5.72	630.15	269.4	919.25	232972	32670	1253105
12/30/2006	2.91	0.88	18.15	385.66	297.98	699.21	104235	10947	417335
1/14/2007	1.57	0.13	18.25	616.08	303.59	700.34	200275	10806	665418
1/29/2007	2.04	0.71	27.73	607	350.97	727.08	163650	40370	547933
2/8/2007	2.72	0.1	32.32	407.83	240.33	546.33	77066	12242	418117
2/13/2007	2.36	0.89	8.35	568.1	455.65	738.08	193271	56882	418138
3/10/2007	4.37	1.26	28.71	495.37	305.61	705.83	159083	15889	444360
5/4/2007	2.65	0.47	49.93	336.74	271.41	655.64	45808	10131	544143
5/14/2007	2.42	0.78	28.78	319.95	293.61	613.41	41217	10191	503647
7/3/2007	1.65	0.68	9.12	447.53	329.39	628.24	96175	17106	407780
7/8/2007	1.31	0.48	47.32	402.18	292.85	593.23	65247	10506	501190
7/28/2007	1.93	0.44	22.89	547.17	353.78	645.41	183944	25123	421014
8/7/2007	2.85	1.35	14.31	517.2	355.82	684.15	111341	33533	407433

8/27/2007	2.47	1.07	8.42	500.54	366.48	681.38	99607	24700	458748
10/16/2007	2.36	0.7	6.03	426.2	297.51	676.69	113262	10940	592408
10/21/2007	1.92	0.62	11.74	432.5	337.54	700.42	62513	29264	770188
11/10/2007	3.31	1.35	19.77	422.58	352.14	674.63	111025	28293	402803
11/20/2007	1.87	0.38	7.97	552.55	445.17	676.71	141148	19501	443905
12/10/2007	1.34	0.43	14.38	542.9	327.99	649.22	158470	33343	514630
12/15/2007	2.48	0.53	39.84	569.38	352.87	698.69	142520	27458	413746
12/20/2007	0.87	0.5	2.4	592.99	391.97	723.81	154867	41974	455962
1/4/2008	1.26	0.42	16.49	624.1	292.48	718.68	231914	10429	561460
2/8/2008	3.33	1.61	21.16	581.06	369.42	741.25	162625	27443	438815
2/28/2008	1.17	0.44	15.58	631.01	424.74	800.19	266449	60458	564075
3/9/2008	2.21	1.06	17.89	639.96	458.04	714.91	194619	112597	501714
3/24/2008	2.14	0.72	8.37	459.38	365.54	694.57	95682	25474	454320
4/3/2008	1.5	0.39	6.9	593.49	324.81	724.14	172567	13798	496261
4/23/2008	0.99	0.42	13.98	515.76	411.68	665.56	126447	50226	911538
5/28/2008	2.35	0.5	26.47	558.19	338.05	635.64	195538	34039	541155
6/17/2008	0.55	0.23	4.87	564.12	444.84	750.16	133079	56168	444972
7/12/2008	1.46	0.3	6.01	626.85	474.93	707.98	164051	63448	428327
7/22/2008	2.5	0.26	7.45	470.82	370.88	659.4	97453	19745	403996
8/6/2008	3.42	0.73	27.49	364.03	300.06	659.94	66918	14836	541116
9/30/2008	1.62	0.29	5.8	584.61	341.92	703.19	183660	47709	426792
10/25/2008	2.19	0.11	14.16	380.54	291.02	711.53	86370	10733	408525
11/24/2008	0.82	0.24	32.53	555.93	265.49	648.28	145675	10433	546484
6/22/2009	2.64	0.6	12.09	406.82	254.85	492.8	54242	10103	412126
10/5/2009	0.33	0.1	1.5	348.43	269.91	425.1	49597	10331	464949
3/9/2010	0.79	0.18	4.1	435.81	344.52	560.53	101546	19700	405093
4/3/2010	0.58	0.1	3.87	547.91	452.52	778.77	133823	18371	762538
4/28/2010	2.55	0.1	24.56	376.91	302.42	654.58	48805	10711	670867
5/28/2010	0.8	0.1	10.39	445.36	317.64	623.18	110550	19984	426387
8/1/2010	2.52	0.62	11.78	494.37	403.57	599.56	87396	11988	439945
8/21/2010	2.57	0.21	32.50	310.16	264.33	699.70	45743	10614	475188
10/20/2010	1.1	0.15	8.07	439.11	356.88	683.44	105690	29917	432280
11/14/2010	0.31	0.1	3.81	522.04	420.46	656.12	157251	29439	450184
12/19/2010	2.63	1.12	5.14	512.46	385.03	665.33	138411	42530	451971
2/2/2011	0.73	0.1	12.98	447.04	313.91	641.51	92331	24830	728171
2/17/2011	0.58	0.1	5.63	419.25	334.39	620.27	66467	17902	1435699
2/27/2011	1.3	0.1	9.55	400.25	292.51	679.39	123432	11145	480019
3/29/2011	1.44	0.1	33.81	363.65	312.29	655.57	43685	10928	563504
4/8/2011	0.33	0.1	12.27	420.41	321.66	633.86	74153	13365	412590
4/23/2011	0.36	0.1	3.08	403.56	337.76	571.06	68755	14753	414385
4/28/2011	0.4	0.1	4.11	631.56	343.5	711.09	183678	29998	799209
5/13/2011	0.72	0.1	5.07	452.67	305.63	597.52	103262	10950	416285
5/28/2011	1.07	0.1	8.04	581.56	464.95	774.06	160958	15715	920001
6/7/2011	2.64	0.4	15.78	424.95	348.84	565.22	108416	21839	635533
6/22/2011	1.84	0.7	6.94	583.6	420.17	658.4	138536	42909	445286
7/7/2011	4.34	1.34	15.93	385.59	335.24	681.18	86595	14099	596753
7/12/2011	1.04	0.11	7.19	485.75	366.19	719.5	94958	11585	586553

7/27/2011	1.08	0.1	6.76	395.63	293.21	683.23	81532	11280	634269
8/1/2011	0.66	0.1	14.44	425.69	342.99	671.61	85989	15201	573142
8/6/2011	0.76	0.1	7.63	554.66	422.79	636.37	148748	13462	749587
9/5/2011	0.21	0.1	5.94	408.91	308.78	557.84	72375	11198	533303
9/25/2011	0.59	0.1	13.21	504.51	299.41	685.22	97994	13494	961920
10/20/2011	1.1	0.1	14.78	347	285.63	516.49	50902	10586	486547
1/23/2012	1.73	0.15	10.7	458.99	266.51	622.82	112430	23193	660476
2/22/2012	1.18	0.1	10.14	426.1	374.06	517.17	94649	25813	423743
3/8/2012	1.88	0.1	26.96	438.13	253.62	728.2	91593	10980	758446
3/13/2012	0.1	0.1	3.49	623.57	434.96	768.85	175528	20399	673473
4/12/2012	0.1	0.1	9.93	475.46	317.56	643.14	92724	12163	518686
4/22/2012	0.86	0.1	17.96	465.33	310.97	718.75	85540	16621	765469
5/7/2012	0.82	0.1	7.62	514.94	285.01	651	134655	13309	516215
5/22/2012	1.06	0.1	7.36	455.12	360.42	651.36	111992	19758	432736
6/1/2012	2.86	0.17	14.65	365.68	319.11	724.68	48165	10773	505797
6/6/2012	1.08	0.1	6.13	568.26	396.73	739.31	77804	12952	418042
6/16/2012	1.22	0.1	23.74	418.32	310.28	549.75	67474	12735	613530
6/26/2012	3.89	0.56	12.98	422.95	367.41	683.27	100049	24672	538967
7/1/2012	1.68	0.1	7.46	567.73	458.37	692.91	132916	12389	434610
7/11/2012	2.3	0.1	16.68	464.41	318.09	679.22	51543	13175	789682
7/16/2012	1.02	0.2	8.55	438.99	368.23	533.44	104428	18938	450599
8/25/2012	0.1	0.1	4.81	516.98	407.29	684.62	130223	31593	535377
10/9/2012	0.23	0.1	4.9	483.73	362.61	587.38	99426	13781	405511
10/14/2012	0.13	0.1	3.74	474.56	336.67	604.91	121129	23732	515414
1/22/2013	2.66	1.18	17.71	319.18	260.92	535.08	25413	10420	461187
2/26/2013	5.52	0.8	19.2	346.67	303.12	650.64	51805	16168	492236
3/13/2013	4.14	1.01	13.27	427.11	297.67	731.4	77951	16130	626178
4/22/2013	4.43	0.5	50.91	383.69	258.96	588.27	99779	10422	435370
5/2/2013	2.42	0.29	15.71	430.94	331.83	546.98	84847	22025	430733
5/22/2013	3.45	0.15	16.12	470.36	263.7	758.65	112075	11538	681749
5/27/2013	0.74	0.2	32.32	527.94	328.17	785.58	92721	11917	885872
6/1/2013	1.54	0.51	15.81	620.68	396.16	776.99	156818	44391	612886
6/21/2013	1.76	0.47	9.8	541.42	444.94	700.18	183928	68137	608200
7/31/2013	1.51	0.1	20.55	344.07	300	550.1	34119	13064	720617
8/5/2013	0.5	0.1	4.57	440.22	344.7	562.88	95045	18070	560800
8/15/2013	1.02	0.1	7.69	571.64	432.89	781.74	134798	35756	553985
9/29/2013	2.52	0.1	15.59	343.19	242.9	628.15	27229	10309	727789
11/28/2013	2.63	0.32	13.32	376.66	264.04	533.72	60367	11637	419493
12/8/2013	2.48	0.66	21.89	402.02	276.96	636.16	49146	16013	691391
1/12/2014	1.13	0.15	2.61	566.84	376.06	865.02	123022	19967	1360480
1/17/2014	1.4	0.16	5.91	384.68	348.04	588.81	99390	16792	503769
1/27/2014	0.98	0.1	3.64	354.97	299.27	492.92	35405	10845	472624
2/16/2014	2.45	0.1	21.74	404.41	354.69	617.18	81700	11948	564941
4/17/2014	4.61	0.71	20.94	491.89	346.4	696.33	95998	11104	682435
5/22/2014	2.42	0.83	13.39	408.93	312.61	533.94	66667	21022	535475
6/16/2014	4.41	1.26	13.37	415.6	343.54	482	68691	17082	438777
9/9/2014	4.75	0.3	23.18	389.56	344.81	729.28	63611	15262	817826

9/19/2014	3.22	1.04	38.31	449.92	354.85	575.14	114808	20749	428724
10/19/2014	6.36	2.51	19.26	428.29	365.08	642.25	112591	32893	433915
12/3/2014	4.71	1.44	19.16	471.02	396.93	767.96	123882	40718	582250
12/8/2014	3.7	1.35	17.87	510.8	385.5	722.32	141004	33687	479398
12/23/2014	3.29	0.86	10.94	454.21	338.83	568.16	129564	35022	589375
12/28/2014	4.53	1.24	12.74	513.38	356.76	714.23	139498	29890	467679
1/2/2015	4.29	0.24	17.38	448.56	371.59	538.87	102818	22368	477308
2/1/2015	1.37	0.1	8.69	538.73	391.52	710.93	117906	27228	591632
2/26/2015	5.51	1.48	23.08	405.64	322.01	652.92	108404	18867	451128
3/13/2015	7.9	2.52	30.38	374.12	296.89	631.92	58827	18271	817915
3/18/2015	2.11	0.38	8.36	595.8	521.5	706.53	189098	36728	424083
4/12/2015	7.38	1.67	41.4	351.38	289.91	677.17	54788	11220	549900
4/17/2015	3.71	1.15	20.5	531.9	375.06	712.31	111891	28756	407058
6/6/2015	4.15	1.25	45.84	546.64	281.23	681.24	155024	13695	610464
6/21/2015	2.42	0.14	32.48	570.44	277.98	750.19	165928	10391	1103275
6/26/2015	1.89	0.12	20.8	445.11	359.04	803.04	83107	12504	1390981
7/1/2015	3.83	1.42	25.18	374.48	304	566	69634	17132	451979
7/11/2015	2.32	0.64	10.09	537.25	429.7	651.07	166869	20043	601280
9/9/2015	5.32	1.66	24.11	455.51	385.7	650.73	83517	11084	405191
9/19/2015	3.37	1.05	12.38	510.88	387.77	638.31	132551	33727	582641
10/4/2015	3.97	0.98	24	455.86	376.25	793.44	129528	18837	739016
10/9/2015	2.46	0.69	9.26	530.36	426.3	741.09	173062	35613	411964
11/3/2015	2.34	0.6	86.42	555.29	330.38	738.15	132404	18557	741038
11/8/2015	1.96	0.52	4.67	524.66	420.28	729.71	168146	14762	515342
12/3/2015	3.72	1.24	10.93	428.74	357.33	658.78	126550	25268	535036
12/8/2015	2.65	0.97	10	565.16	431.51	682.32	160986	32621	410037
12/13/2015	2.55	0.58	30.19	480.47	384.07	610.43	125345	25376	451469
1/7/2016	2.69	0.43	9.41	471.5	394.78	603.37	89170	24935	735324
1/12/2016	1.41	0.1	10.21	481.64	332.12	609.63	101926	16635	596441
2/16/2016	0.93	0.1	21.44	558.03	394.31	663.32	144804	26417	413154
3/2/2016	4.27	0.94	24.96	391.4	344.22	518.19	62875	12258	522346
3/7/2016	4.21	0.39	42.27	423.44	309.98	596.5	64657	17890	434775
3/12/2016	3.51	0.9	19.58	478.03	366.92	588.06	142002	28311	651794
5/1/2016	3.96	1.05	13.4	440.01	360.94	586.56	107333	20679	400435
5/6/2016	2.99	0.55	20.81	551.37	367.66	695.12	183352	27342	726570
5/21/2016	2.25	0.49	12.6	469.49	355.63	639.44	128599	23826	536720
6/5/2016	3.15	1.01	51.68	453.23	309.38	637.83	113198	17420	571724
6/10/2016	4.79	1.4	23.12	463.85	340.73	595.6	133440	14574	500369
6/15/2016	2.16	0.81	6.93	566.72	469.3	695.9	159992	53102	528270
7/5/2016	4.32	1.03	24.27	430.8	308.87	659.11	125033	13691	458575
7/10/2016	2.2	0.26	6.27	549.73	458.07	654.08	150497	49744	442147
7/15/2016	2.32	0.86	8.21	454.76	317.96	682.26	73995	15836	412805
7/20/2016	2.14	0.1	20.74	422.29	361.26	578.64	48094	12579	505828
7/25/2016	5.82	0.9	31.26	380.8	319.9	611.9	45568	10563	409794
7/30/2016	6.79	3.62	29.33	407	330.7	569.9	260644	16529	435259
8/4/2016	4.29	3.02	6.5	575.2	463.8	698.5	327601	84389	996599
8/9/2016	4.19	3.01	7.51	588.4	433.7	667.9	479031	236262	854828

8/14/2016	7.54	5.17	22.68	376.4	301.3	448.5	285794	16280	459235
8/29/2016	7.96	4.98	18.06	439.3	325.1	695.1	241007	18017	967632
9/3/2016	6.54	3.42	11.59	582.1	454.7	760.7	543609	188936	1259243
9/18/2016	5.33	2.76	19.34	468.5	327.9	718.6	305316	51531	936885
9/23/2016	8.59	4.33	17.62	404.6	352.5	682.8	218170	53627	557860
10/3/2016	5.68	4.01	10.08	487.6	407.75	560.8	328649	68196	488293
10/8/2016	9.34	5.28	16.08	392.1	353.8	454.4	310540	56343	488006
10/13/2016	5.04	1.25	22.59	498	354.54	796.1	389882	13836	1584309
10/18/2016	7.81	2.96	15.81	419.8	336.3	714.2	341077	26822	1188791
10/23/2016	7.9	1.98	17.73	546.1	375.1	1062.9	337402	51230	1440496
11/12/2016	3.47	1.74	12.58	608.8	395.4	737.7	154139	19434	439114
11/22/2016	4.96	1.43	13.33	505.1	327.9	720.7	170431	29751	437940
12/7/2016	4.91	2.87	37.49	612.5	327.5	706	225337	18695	444956
12/17/2016	6.95	1.41	19.43	368.3	325.8	656.1	40972	10860	432334
12/22/2016	4.05	1.87	6.11	650.3	575.9	733.8	223409	80937	400226
1/1/2017	6.1	2.77	26.98	481.8	369.2	705.4	100849	21795	485943
1/6/2017	3.19	1.57	5.29	656	515.4	738.3	150557	15440	403383
1/26/2017	7.58	4.14	21.63	485.4	334.7	641.3	201776	27308	798592
1/31/2017	6.14	3.69	16.09	642.2	446.5	757	492925	124357	913041
2/5/2017	5.89	4.43	8.63	510.6	412.5	642.2	233204	58873	639601
2/20/2017	7.08	3.93	14.07	468	378.1	639.6	187299	14970	624191
2/25/2017	5.6	4.05	20.01	412.9	347.3	708.2	166953	21693	483138
3/2/2017	4.9	3.15	10.3	650	576.6	741.8	376406	209933	645800
3/17/2017	6.6	4.38	35	324.4	299.4	654.3	22074	11912	685496
3/27/2017	5.06	1.69	24.96	661.7	379	751.5	359005	30832	922702
4/1/2017	5.37	3.34	20.45	446.2	387.8	636.6	175917	14911	416879
4/16/2017	9.71	2.62	36.76	333.4	291	607.6	61533	8976	515316
4/21/2017	9.23	3.9	21.83	674.5	470.2	770.5	554738	229253	926722
5/11/2017	13.6	4.24	61.94	358.2	297.7	600.4	22357	8289	514592
5/16/2017	8.29	4.23	19.36	504.5	327.9	720.2	331333	16501	660875
5/21/2017	3.84	1.13	6.2	521.8	356.5	668.4	343134	17071	760516
5/26/2017	6.08	1.05	55.33	370.1	292.7	781.7	64244	8703	1517229
5/31/2017	5.35	1.48	32.73	381.8	334.1	777.6	44968	11468	2032288
6/20/2017	3.95	0.67	17.98	356.4	312.6	801.9	33885	5000	2428892
7/5/2017	6.35	1.41	37.28	356.5	298.23	588.7	44315	7677	600342
7/10/2017	4.81	3.22	8.94	499.3	355.9	670	208794	21316	776455
7/15/2017	4.29	0.51	37.86	499.1	369.5	662.4	134650	8366	821192
7/20/2017	5.71	0.29	13.89	589.9	376.5	719.1	343871	11504	1019425
7/30/2017	5.97	1.55	33.85	381.2	308.8	758.2	152745	7406	1151156
8/4/2017	5.94	4.15	46.42	593	393.9	753	380929	34673	1060688
8/24/2017	4.25	0.16	10.03	365.8	267.23	809.4	97297	9293	1692491
8/29/2017	7.05	1.98	46.78	563.4	296.39	688.8	335095	12311	945724
9/8/2017	5.75	2.29	19.36	582	463.1	834.2	537195	13448	1498751
9/18/2017	5	2.52	7.88	468.9	347.4	687.5	227534	22355	516651
9/23/2017	6.31	1.84	43.44	354.4	308	665.7	48419	8411	704997
9/28/2017	5.62	3.62	12.55	511.7	393.7	710.9	251782	108819	810116
10/13/2017	6.55	4.27	11.54	541.6	437.9	720.5	377907	174453	669853

10/23/2017	6.82	4.78	36.24	491.9	340	632.8	243987	13636	646695
11/7/2017	6.41	2.57	38.89	577	301	690.9	274238	11220	588533
11/27/2017	8.48	3.16	22	440.2	321	513	148353	14279	449330
12/2/2017	6.24	1.13	30.04	427.8	307.5	615.9	176880	11296	488514
12/17/2017	6.24	1.96	20.6	487.1	358.5	646.5	248718	17266	516676
1/11/2018	6.41	1.71	28.58	402.2	316.8	589.3	135406	8759	451206
1/21/2018	7.51	3.55	19.49	431.2	350.3	546	187897	11645	406111
2/15/2018	8.4	2.63	26.85	476.4	294.11	624.5	230688	11382	709958
2/20/2018	6.26	2.42	13.89	446.2	351.1	552	191160	12263	488929
3/12/2018	8.01	3.09	15.61	387.2	311.5	509.5	143546	7740	664131
5/1/2018	4.93	1.28	30.22	369.5	321.4	627.7	103770	8678	458706
5/6/2018	5.78	3	12.45	627.3	523.1	714	388839	198569	927265
5/31/2018	6.55	3.57	22.8	612.6	350.7	766.4	452484	13989	1323601
6/15/2018	11.1	1.31	22.94	324.4	292.4	537.2	22939	8300	488200
6/25/2018	5.74	3.85	18.37	505.5	400.6	644.8	304135	13617	735782
8/19/2018	2.25	15.53	492.2	383.5	672.3	265725	265725	19799	1000690
8/24/2018	6.27	3.07	24.03	447.9	323.9	624.6	221908	12593	473418
12/7/2018	6.23	2.31	18.42	547.8	374.5	643.1	250250	32291	474910
12/17/2018	5.68	2.21	21.67	450.8	329.6	615.3	143597	20292	436659
1/21/2019	6.79	0.46	19.11	411.5	303.9	627	79967	12383	405625
2/25/2019	7.02	3.54	35.36	357.55	306.2	599.2	71115	13532	517409
3/2/2019	5.52	0.63	9.85	437.4	351.3	570	146274	8041	642473
3/12/2019	5.95	1.2	13.3	353.5	326.3	451.8	43415	16408	518033
5/11/2019	5.9	0.29	21.22	367.1	313.3	549.1	29242	5000	446406
7/5/2019	2.17	0.1	9.84	358.62	297.95	624.15	54704	10672	437928
7/10/2019	0.84	0.1	3.68	466.13	416.95	650.81	117566	31251	444357
8/29/2019	2.95	0.62	15.23	643.96	348.96	762.46	197035	12827	496349
9/23/2019	3.62	1.46	21.09	380.18	301.05	695.42	44763	13129	476119
10/23/2019	2.04	0.56	30.38	574.62	320.22	664.35	161920	13186	421904
11/17/2019	4.63	1.64	15.33	365.2	318.34	596.2	41535	18748	405725

Table 1.[17] Shows all the Solar Wind Records of 2 Decades with detailed information about Dens-med, Dens-min, Dens-max, Speed-med, Speed-min, Speed-max, Temp-med[°C], Temp-min[°C] & Temp-max [above 400000°C]. In the last 2 decades, 1624 proper cases of solar wind emissions have been recorded and 404 Heat signatures above 400,000°C is being presented.

4.2. Geomagnetic Storms

Earth is largely protected from the solar wind, a stream of energetic charged particles emanating from the Sun, by its magnetic field, which deflects most of the charged particles. Some of the charged particles from the solar wind are trapped in the Van Allen radiation belt. A smaller number of particles from the solar wind manage to travel, as though on an electromagnetic energy transmission line, to the Earth's upper atmosphere and ionosphere in the auroral zones. The only time the solar wind is observable on the Earth is when it is strong enough to produce phenomena such as the aurora and geomagnetic storms. Bright auroras strongly heat the ionosphere, causing its plasma to expand into the magnetosphere, increasing the size of the plasma geosphere, and causing escape of atmospheric matter into the solar wind. Geomagnetic storms result when the pressure of plasma contained inside the magnetosphere is sufficiently large to inflate and thereby distort the geomagnetic field. The cause of the field can be explained by dynamo theory. A magnetic field extends infinitely, though it weakens with distance from its source. The Earth's magnetic field, also called the geomagnetic field, which effectively extends several tens of thousands of kilometers into space, forms the Earth's magnetosphere. [18]

Records of last 2 decades of Geomagnetic Storms occurring on Earth’s magnetosphere due to solar winds are as follows.

2001-2005													
2001			2002			2003			2004			2005		
Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max
20/03	74	7+	17/04	62	7+	01/05	43	7-	22/01	64	7	07/01	40	8-
31/03	192	9-	18/04	63	7	10/05	42	7-	11/02	28	6+	08/01	36	7
08/04	63	7	19/04	62	7-	29/05	109	8+	10/03	45	6+	18/01	84	8-
11/04	85	8+	20/04	70	7+	30/05	59	7+	11/03	40	6+	21/01	66	8
12/04	50	7+	11/05	49	7-	18/06	60	7-	03/04	41	6+	05/04	50	7
13/04	50	7+	23/05	78	8+	12/07	43	7-	05/04	24	6+	08/05	91	8+
18/04	50	7+	04/09	42	6+	18/08	108	7+	22/07	31	7	15/05	87	8+
17/08	42	7	07/09	57	7+	17/09	70	7	25/07	154	8	30/05	90	8-
25/09	33	7+	08/09	36	7+	14/10	66	7+	26/07	47	7+	13/06	54	7+
02/10	52	7-	01/10	67	7+	29/10	204	9	27/07	186	9-	23/06	50	7
03/10	69	7	02/10	53	7+	30/10	191	9	30/08	42	7	24/08	102	9-
21/10	57	8-	03/10	45	6+	31/10	116	8+	07/11	50	8	31/08	49	7
22/10	96	7+	04/10	64	7+	04/11	38	7	08/11	140	9-	11/09	101	8-
06/11	142	9-	24/10	63	6+	20/11	150	9-	09/11	119	9-	12/09	75	7
24/11	104	8+	21/11	50	7-	21/11	42	7-	10/11	161	9-	15/09	52	7
2006-2010														
2006			2007			2008			2009			2010		
Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max
26/01	30	5+	29/01	28	5+	02/02	19	5+	03/01	11	4-	05/04	55	8-
18/03	30	6-	13/02	21	6-	10/02	21	5-	19/01	9	4	06/04	44	5+
19/03	38	6+	13/03	24	5	29/02	31	5+	04/02	14	4-	12/04	19	6-
05/04	29	5+	01/04	29	5	01/03	22	5+	14/02	17	4+	14/04	10	5
09/04	46	6	02/04	22	5	09/03	30	6-	27/02	11	4	02/05	36	6
14/04	65	7	23/05	34	5+	26/03	26	5	13/03	17	5-	03/05	24	5
28/07	25	6	24/05	30	6-	27/03	36	5	08/05	11	4	29/05	28	5+
07/08	32	6-	11/07	21	5	05/04	18	5	24/06	16	5	30/05	21	5
19/08	38	6	14/07	19	5+	06/04	20	5-	28/06	10	4	04/06	14	5-
20/08	22	6	06/08	16	6-	23/04	27	5+	22/07	24	6-	03/08	25	7-
04/09	20	6-	07/08	22	5	14/06	18	6-	06/08	10	4	04/08	49	6+
13/10	29	5+	27/09	18	5	09/08	21	5+	30/08	20	6-	25/08	18	5-
10/11	36	6	28/09	24	5	18/08	19	5-	22/10	13	4-	23/10	26	5
14/12	47	8-	29/09	30	5	04/09	31	6	23/10	10	4-	11/11	17	5-
15/12	94	8+	20/11	24	5+	11/10	34	6+	24/10	8	4	27/11	11	5-
2011-2015														
2011			2012			2013			2014			2015		
Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max
04/02	22	6-	07/03	48	6	17/03	72	7-	08/02	23	5-	07/01	31	6+
11/03	37	6-	09/03	87	8	29/03	28	5+	16/02	19	5	17/03	108	8-
28/05	45	6+	12/03	32	6+	01/05	29	6-	19/02	43	6+	18/03	47	6
29/05	34	5+	15/03	36	6+	18/05	19	5+	20/02	37	6	22/03	24	6+
05/06	25	6+	24/04	41	7-	24/05	20	6-	27/02	20	5+	22/06	57	8+
05/08	42	8-	16/06	20	6+	25/05	37	5	20/04	22	5	23/06	72	8-
06/08	31	6+	17/06	43	6	01/06	58	7	23/05	17	5+	15/08	39	6+
09/09	30	6-	09/07	42	7-	07/06	27	6-	08/06	38	6+	27/08	52	6+
10/09	40	6-	15/07	78	7	29/06	50	6+	19/08	15	5+	07/09	44	6+
17/09	32	5+	16/07	42	6+	15/07	24	5+	12/09	37	6+	09/09	59	6
26/09	38	6+	01/10	32	7-	16/08	26	5+	14/10	18	5	11/09	60	7
27/09	30	6-	08/10	40	6+	02/10	58	8-	20/10	24	5	20/09	44	7
29/09	24	6-	09/10	46	7-	08/10	17	6-	07//12	25	5-	07/10	74	7+
24/10	26	7	13/10	47	6-	09/10	29	5+	22/10	19	5+	20/12	70	7-
25/10	38	7+	14/11	37	6+	08/12	28	6	29/10	21	5-	21/12	38	7-
2016-2020														

2016			2017			2018			2019			2020		
Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max	Date	Ap	Kp Max
01/01	30	6	01/03	35	6-	27/02	18	5+	01/05	16	5	19/03	10	4+
21/01	33	6-	27/03	46	6+	18/03	22	6	31/05	14	5+	20/04	16	5-
17/02	34	6-	20/04	28	6-	20/04	43	6	28/02	23	5-	28/08	10	5-
06/03	31	6+	22/04	47	6-	05/05	23	6-	11/05	24	5	31/08	24	5-
08/05	70	6+	28/05	49	7	06/05	26	6-	14/05	32	6+	01/09	17	4+
09/05	30	6+	17/07	26	6-	01/06	23	5-	08/06	20	5+	24/09	20	6-
14/06	21	6+	16/07	44	6	25/06	12	5	09/07	15	5	25/09	17	4+
02/09	37	6	07/09	36	8-	26/08	67	7+	05/08	34	5+	26/09	24	5-
03/09	36	6-	08/09	106	8+	27/08	25	6-	31/08	28	6-	27/09	20	5+
27/09	35	6-	15/09	34	6-	10/09	20	5	01/09	45	5+	28/09	32	5
28/09	36	6-	27/09	37	6+	11/09	35	6	02/09	22	5	05/10	10	4+
13/10	46	6+	28/09	51	7-	22/09	27	5-	27/09	22	5+	23/10	14	5-
25/10	57	6+	13/10	37	6-	07/10	24	5+	28/09	24	5-	21/11	12	4+
26/10	44	6-	07/11	35	6+	04/11	16	5+	25/10	25	5+	22/11	24	5-
21/12	23	6	08/11	44	6+	05/11	32	6-	26/10	24	5-	23/12	11	4+

Table 2. [19] This table shows 20 years of data of Top 15 Geomagnetic Storms of each year separately with Kp Values and Amplitude ap.

K, Kp, and ap Indices

The K-index is quasi-logarithmic local index of the 3-hourly range in magnetic activity relative to an assumed quiet-day curve for a single geomagnetic observatory site. It consists of a single-digit 0 thru 9 for each 3-hour interval of the universal time day (UT).

The planetary 3-hour-range index Kp is the mean standardized K-index from 13 geomagnetic observatories between 44 degrees and 60 degrees northern or southern geomagnetic latitude. The scale is O to 9 expressed in thirds of a unit, e.g. 5- is 4 2/3, 5 is 5 and 5+ is 5 1/3. This planetary index is designed to measure solar particle radiation by its magnetic effects. The 3-hourly ap (equivalent range) index is derived from the Kp index as follows:

Kp =	**0o**	**0+**	**1-**	**1o**	**1+**	**2-**	**2o**	**2+**	**3-**	**3o**	**3+**	**4-**	**4o**	**4+**
ap =	**0**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**12**	**15**	**18**	**22**	**27**	**32**
Kp =	**5-**	**5o**	**5+**	**6-**	**6o**	**6+**	**7-**	**7o**	**7+**	**8-**	**8o**	**8+**	**9-**	**9o**
ap =	**39**	**48**	**56**	**67**	**80**	**94**	**111**	**132**	**154**	**179**	**207**	**236**	**300**	**400**

Table 3: Values of Kp and ap Indices

5. Hypothetical Connection of Solar Wind Strike with Polar Shifting

Earth is protected from the sun solar flares by the barrier of its magnetosphere or magnetic field lines. The solar wind contains its own magnetic properties and while coming in contact with another planet's magnetic field could effect the planet's magnetic field properties. As the Earth's magnetic field is a result of the molten iron convection current in its outer core explained by Dynamo Theory, interaction or bombardment of solar winds over earth's magnetosphere, might resulted in compression of the earth's magnetic lines of forces triggering more pressure on the convection currents in Earth's Outer Core. Immense pressure of the molten currents in earth's outer core could have resulted in convection current flow under Alaska towards Siberia. This movement of convection currents in outer core is recorded by the European Swarm Satellites. This movement subsequently followed by the Polar shifting in the same direction. Polar shifting is not happening over some decades, it's been a continuous process as polar reversal evidences have been found in iron bearing rocks which contains orientations of iron particles according to the earth's magnetic field orientations.

6. Conclusion

The process of continuous dispatch of solar masses from the sun's surface and solar wind stick on the earth's magnetosphere resulting Geomagnetic Storms and Aurora has been occurring for millions of years. Effects and compression of Earth's magnetic fields by the huge masses of charged solar masses is also happening at the same rate and polar reversal is also occurring at the same instance. So hypothetically it could be concluded that, solar wind influence on earth's outer core convection might have been resulting of polar migration and polar reversal over millions of years and it will continue in the future.

Acknowledgement

For completion of our Solar Wind with Polar Shift, We hearty thank both Geology Departments of Mahishadal Raj College and Ranchi University as well as NOAA Data Site for providing us with the valid Scientific Solar Data and Space Weather Live for Geomagnetic Storms data. We also thank the Reviewer Committee for patiently going through our Concepts.

References

1. Andrew D. Gilbert, Chapter 9 Dynamo Theory, Editor(s): S. , D. , Handbook of Mathematical Fluid Dynamics, North-Holland, Volume 2, 2003, Pages 355-441, ISSN 1874-5792, ISBN 9780444512871, https://doi.org/10.1016/S1874-5792(03)80011-3.
2. U.S. Geological Survey, Geomagnetism FAQs, https://web.archive.org/web/20150118213104/http://www.usgs.gov/faq/?q=categories%2F9782% F2738.
3. Laura , live science, Molten 'Jet Stream' Discovered Deep Inside Earth, https://www.livescience.com/57259-earth-iron-core-jet-streamdiscovered.html#:~:text=A%20band%20of%20molten%20iron,stream%2C%20a%20new%20study%20finds.&text=For%20instance%2C%20changes%20in%20the,and%20Siberia%2C%20the%20researchers%20said.
4. L. R., A. & , J.-J. Location of the North Magnetic Pole in April 2007. Earth Planets Space 61, 703–710 (2009).
5. M. & E. Asymmetric behavior of magnetic dip poles. Earth Planets Space 55, 153–157 (2003).
6. et al. Out-of-Cycle Update of the US/UK World Magnetic Model for 2015–2020: Technical Note (NOAA National Centers for Environmental Information, 2019).
7. M. C., , P. W., Mound, J. E. & , C. D. secular variation with only magnetic diffusion. . J. Int. 219, S58–S82 (2019).
8. O., Hammer, M. D., , C. C., Martin, Y. & , N. Assimilation of ground and satellite magnetic measurements: inference of core surface magnetic and velocity field changes. . J. Int. 215, 695–712 (2018).
9. O. et al. Erratum: ‘Contributions to the geomagnetic secular variation from a reanalysis of core surface dynamics’ and ‘Assimilation of ground and satellite magnetic measurements: inference of core surface magnetic and velocity field changes’. . J. Int. 216, 2106–2113 (2018).
10. P.W., , C.C. & , M. Recent north magnetic pole acceleration towards Siberia caused by flux lobe elongation. Nat. . 13, 387–391 (2020). https://doi.org/10.1038/s41561-020-0570-9
11. Roberts, P. H. & Scott, S. On analysis of the secular variation. 1. A constraint: theory. J. . . 17, 137–151 (1965).
12. P. W.,, R. & , C. C. An accelerating high-latitude jet in Earth’s core. Nat. . 10, 62–68 (2017).
13. & , D. flows responsible for the secular variation of the Earth’s magnetic field. . J. Int. 173, 421–443 (2008).
14. N., , D. & , C. C. Planetary , time-dependent eddies, torsional waves, and equatorial jets at the Earth’s core surface. J. . Res. 120, 3991–4013 (2015).
15. Charles (Carlos) Diane Carlson, physical geology, Earth’s Interior and Geophysical Properties 425, (2015).
16. John D. Richardson, The Solar Wind: Probing the with Multiple Spacecraft, Editor(s): Klaus , , Hans Jörg Fahr, , COSPAR Series, , Volume 11, 2001, Pages 301-310, ISSN 0964-2749, ISBN 9780444509093, https://doi.org/10.1016/S0964-2749(01)80070-6.
17. Real-Time Solar Wind (RTSW) data refers to data from any spacecraft located upwind of Earth, typically orbiting the L1 Lagrange point, that is being tracked by the Real-Time Solar Wind Network of tracking stations. The NOAA/DSCOVR satellite became the operational RTSW spacecraft on July 27, 2016 at 1600UT (noon EDT, 10am MDT). (https://www.swpc.noaa.gov/products/real-time-solar-wind)
18. Cosmos Online Solar wind ripping chunks off Mars (http://www.cosmosmagazine.com/news/2369/solar-wind-ripping-chunks-mars).
19. SpaceWeatherLive Records Of Geomagnetic Storms and Activities (https://www.spaceweatherlive.com/en.html).