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Research Article

How the Magnetic North Pole and Energetic Particle Precipitation Control Earth's Climate.

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Abstract— The hypothesis that the position of the magnetic North Pole latitude ought to be very highly correlated with global temperature change has been tested and shown to be correct. Two new climate models are developed and tested, one includes CO2, the other does not. Model 2 without CO2 predicts 89% of all modern warming and gives seamless hindcasts of the Roman Warm Period and LALIA, the Medieval Warm Periods, and a smooth transition through the Little Ice Age into the Modern Warm Period with the correct timescales and recent temperature amplitudes, figures 2-5. As the Pole swings Northwards, the energetic particle (EEP) interacting region shifts to higher ionospheric altitudes, and this reduces albedo and hence increases forcing (figure 4) by virtue of changes to the world's clouds. Calculations suggest that the EEP process is responsible for some 81% of recent warming, with the rest (up to 12.7%) mainly of solar origin. CO_2/other GHG/aerosols/aviation cirrus etc. at most, could contribute ~6% of all warming. The detail disclosed represents a profound and crucial discovery for climate science and its future direction.

Keywords— Climate change, Global warming, Modern Warming, Pole shift, Albedo, Climate model, GHG, EEP, GCR, RWP, MWP, Warm Period, Little Ice Age, Forcing, Clouds.

1. Introduction

Earth's climate system runs on an incredibly complex interplay of the solid earth, its oceans, atmosphere at all levels, solar and other extra-terrestrial inputs. Thermodynamically the earth is unique. Not only does radiation pass all the interfaces in the above system but also other wave energies and particulate matter in all four states. Undeniably the climate is changing, one aspect of which is global warming. Global warming of late appears to have proceeded at an alarming rate [1] which cannot readily be accounted for by existing models. This paper addresses and explains this issue and creates models capable of explaining almost 90% of all post-industrial warming and simultaneously and successfully hindcasting previous changes for some 2000 years.

1.1 Causation

Consensus to date has held that the primary driver of warming was anthropogenic greenhouse gases (GHG), especially CO2. This paper considers that possibly something is wrong the notion of CO_2 as dominant driver, what if for instance if more dominant drivers have possibly been overlooked? For example, it was recently discussed how earthquake induced obliquity could alter climate [2], and Lu, Q.-B. [3] had noted 'No significant trends in total greenhouse gas effect in : A study of polar and non-polar regions. What if a hitherto undiscovered factor was to be driving climate? What if, especially, that factor was driving climate at a temporal rate very similar to the evolution of CO2? The consequences would be that all climate models would be incorrect and moreover and importantly all would be vastly overestimating the climate sensitivity to CO2. This present paper seeks out and identifies such a factor.

1.2 Magnetic Pole Drift

One of the physical factors on Earth that too has had recently accelerating rates of change is the position of the North Magnetic Pole. The drift of the magnetic North Pole from Canada to Siberia has increased from an average rate of 9 kilometers per year until 2000 to about 50–60 kilometers per year afterward. Yet in the Maunder and Dalton minima, the said Pole moved slowly, remaining in a most south-westerly position, whereas it has since moved significantly northwards. Hence, an initial inspiration for a testable hypothesis arose, i.e. is Pole Shift the crucial, missing, driving factor of climate?

2. Related Work

2.1 Albedo and Clouds

In addition to the above, almost all recent warming can be shown to be due to a fall in Earth's albedo and changed cloud distributions. See for example, Goessling et al.[4], Wu et al.[5], and especially Nikolov and Zeller [6]. With reduced albedo, solar forcing often comes into play. For example, its effect in Nigeria has been discussed in detail by Chibuogwu1 & Obiekezie [7].

2.2 Energetic Particles

Although the total electron count depends highly on the sun [8], the author had also made private unpublished observations of an anthropogenic warming somehow linked to Earth's power systems and had previously ascribed their influence on the Van Allen Belts and energetic particles, especially electrons (EEP) but also solar protons (SPP) [9]. The paper also seeks a link between Magnetic Pole movement and the note albedo and cloud changes. Since the auroral oval is centered around the North Dip Pole, where field lines are perpendicular to the surface and not the North Pole per se, any shift in energetic particle interactions brought about either anthropogenically or by movement of the magnetic pole itself ought to change the polar electrojet, the stratospheric polar vortex (SPV), jet streams, atmospheric chemistry and clouds in general, especially lower ones, see Lam et al [10], hence also changing the weather and climate.

3. Theory

3.1 Factors linked to the Pole

The interplanetary magnetic field (IMF) also varies and interacts with our wandering magnetic North Pole. The Pole has hence an IMF and EEP connection, but also changes Earth's tilt, sphericity, and rotation, known about since the 1950s, see for example Vestine [9] causing amplification or modulation effects on TSI and on atmospheric angular momentum pressure, see for example Lam et al.[10] Thus, the hypothesis here is that the position of the magnetic North Pole through a combination of these factors, to be very highly correlated with global temperature and climate change on Earth. Bucha [11] explored the first correlations between geomagnetic, climatic, and meteorological phenomena, and attempted to demonstrate how the function of the geomagnetic pole and changes of its position might control the climate and weather. It was not until 2009 that Kerton [12] speculated on a possible connection but was still unable to establish the full causes.

3.2 Climactic theory and ocean circulation

Goralski [13] advanced a new climatic theory, explaining how the effects of Earth's coating movement result in magnetic pole movement. There are also known weak influences of Earth's field on ocean circulation, but with longer timescales than those considered here, see Tyler[14].

4. Experimental Method/Procedure/Design

4.1 Pole bearing and acceleration

When it comes to movements of the geomagnetic North Pole, there are several possibilities to consider for possible correlation with Earth temperature changes. Does one, for instance, consider latitude or longitude or a combination of the two? If the latter, then from where does one take a bearing? Also, the pole movement has been accelerating a lot more of late. Interestingly, so has climate change. Does one need to factor in this acceleration in some way? For instance, the distance moved by the pole per year, see Williams [15], looks tantalizingly close in form to a plot of modern global warming but with temperature lagged somewhat.

4.2 Datasets

For temperature, the NASA Goddard Institute for Space Studies (GISS) Surface Temperature Analysis (GISTEMP) dataset, v4 was employed. For the position of the magnetic North Dip Pole, data from NOAA[IGRF] was employed.

4.3 Plotting methodologies

Since the pole has moved both northwards and eastwards since the Dalton Minimum, the first logic considered was plotting its Haversine bearing relative to an arbitrary starting position in 1830. At least this ought to simplify matters and provide a single, testable variable.

Plotting pole bearing and temperature just every 5 years produced a near-perfect correlation, seeming accounting for hiatuses as well. The plot, not shown, gave R = 0.993 for the above data, and the two-tailed P-value was less than 0.0001; in other words extremely statistically significant. Moreover, this represents some 98.6% of all warming since 1830. Mindful, however, that this high R-value had been generated from a mere 14 degrees of freedom, the Haversine procedure with a much larger dataset spanning 1880–2020, hence providing over twelve times as many degrees of freedom. This time the regression was much weaker. Perhaps the dog-leg motion of the pole in the 1800s was the cause? In any event EEP interaction is initiated above the auroral oval, which will on average encircle all longitudes at whatever value of latitude it descends to, i.e. latitude of the Dip Pole ought to be the most significant variable. To test, a single linear regression of all 170+ data points, latitude versus temperature change was performed yielding an R-value considerably higher than for the same temperature data regressed against the Haversine bearing. Also, despite the above trial result suggesting the irrelevance of CO_2, I decided, given recent "consensus," to include it as an additional X variable and employ multiple linear regression analysis on the same 170+ points using the calculator at https://www.statskingdom.com/410multi_linear_regression.html.

5. Results and Discussion

5.1 Model including CO2

The model derived is equation (1), wherein X_1 is the CO_2 concentration in ppm and X_2 is the latitude.

$\hat{Y}$ = -4.319873 + 0.00498917 X1 + 0.0362757 X2

Table 1: Pearson Correlation Matrix

	Y	X_1	X_2
Y	1	0.942728	0.942907
X_1	0.942728	1	0.985827
X_2	0.942907	0.985827	1

It can be seen from the correlation matrix (Table 1) that both variables appear to carry almost equal weight.

The model predicts some 90% of all warming since 1850. There is however, However, there was a high multicollinearity concern as some of the VIF values are bigger than 10. The multicollinearity may influence the coefficients or the ability to choose the predictors, but not the dependent variable (Y). At first glance it seems all the independent variables (X_i) are significant. In any event it is impossible to see how CO2 could drive a parameter of the solid earth. This is discussed in detail later and when modelling the Roman and Medieval Warm Periods. Based on p-values, the AI calculator suggested removal of X_1 from the model. But before this was done, the residuals and the climate sensitivity of the two parameters were investigated.

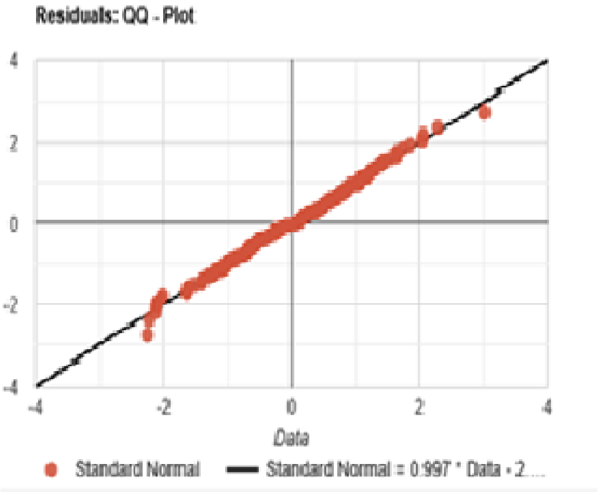

Figure1. Residuals QQ Plot

The residual QQ plot (figure1) is well balanced, and histogram has a good bell curve, see figure 2, both suggestive of real, meaningful data. There is huge multicollinearity (table 1) yet there is no known physical way in which CO_2 or temperature could drive an internal parameter of the "solid" Earth. However, if pole shift is driving temperature, then it could be driving additional natural CO_2 as well. Alternatively, another parameter related to pole shift or its dominant dependent variable EEP change could be cross correlated with CO_2.

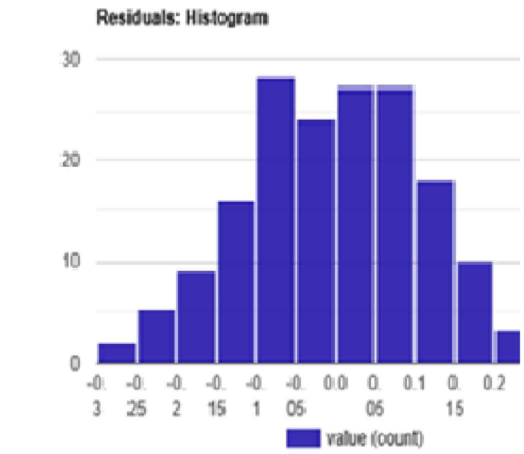

Figure 2. Residuals Histogram.

5.2 Model 1: Climate Sensitivity

Assuming, for the moment, both X variables in the model to be real yields roughly equal climate sensitivity of ~30 mK per decade for X_1 and X_2, respectively. For CO_2, this would represent a further 1.506°C of warming if CO_2 were to double to 850 ppm, assuming linearity. However, the reality of CO_2 in the model is questionable, and interestingly, simple unpublished solar system calculations made privately by the author show that the order of warming by CO_2 at present levels in Earth's atmosphere ought to be of the order of a few milli-Kelvin. A questionable CO2 dependency is also found in the work of Qing-Bin Lu (2025)[3]. Also, Koutsoyiannis and Kundzewicz [16] found that for Earth CO_2 concentrations, the dominant direction is that temperature (T) first increases, and then CO_2 concentration follows with CO_2 following T by about six months on a monthly scale, or about one year on an annual scale. One interpretation of this result would again be if CO_2 is not a significant driver and that another factor causes temperature rise, as in line with the present discovery perhaps. Hwang et al. [17] found, using satellite measurements, no evidence for a global decrease in CO_2 concentration during the first wave of the COVID-19 pandemic, despite others finding local decreases adjacent to roads, power stations, and factories and the like. One possible conclusion here is that perhaps the warming Earth is generating far more of its own CO_2 to the extent wherein human-generated CO_2 pales to insignificance. On the other hand, Feldman et al. [18] claim to have measured the real effect of a CO_2 increase of 22 ppm in the atmosphere, but its arguments have several weaknesses especially in that it is only a two location non-global study. Moreover, other recent satellite studies have shown that almost all warming in the last two decades has been due to albedo changes which can be linked to the disappearance of mid- and low-level clouds[4-6]. Another laboratory study was recently tried by Seim and Olsen [19] to try and prove the CO_2 greenhouse effect. The upshot was that despite using highly sensitive thermopiles they could only produce some 35% of the expected increase.

5.3 Model 2: Magnetic Pole Shift Alone

Bearing in mind the above, a second model was created not including CO2 (X_1), which also fitted with the AI-driven calculator's suggestion of removing X_1 given multicollinearity and higher p-value. The model is shown by equation (2).

$$\hat{Y} = -5.30949 + 0.0711015 X_2 \tag{2}$$

This accounts for the bulk of the temperature change across the 170-year period. Results of the multiple linear regression indicated that there was a very strong collective significant effect between X_2 and Y, ($F(1, 169) = 1413.67$, $p < .001$, $R^2 = 0.89$, $R^2\_adj = 0.89$).

5.4 Feedback implausibility

The results (model 2) show that Magnetic North Pole Shift alone can account for 89% of the total temperature change since 1850. Considering model 1, there is clearly no way that CO_2 can change the position of a physical entity beneath Earth's surface, so it is clear we are looking here at a real causative link between the said position and Earth temperature. The geomagnetic field arises from dynamo action in the molten outer core (2900–5100 km deep), driven by convection of liquid iron and nickel, Earth's rotation, and heat flow from the inner core. Temperatures there are 4000–6000 K, and pressures are 1–3 million atm. Surface changes in CO_2 from 280 ppm to circa 420 ppm or a 1°C temperature shift are trivial compared to this. The heat flux from the core to mantle is ~0.03–0.1 W/m², dwarfed by solar input (340 W/m²) or greenhouse forcing (2–3 W/m²).

Feedback implausibility is also conserved. First, CO_2: A greenhouse feedback loop (warming → ocean outgassing → more CO_2) operates on the surface carbon cycle, not the core. CO_2's radiative effect is atmospheric, absorbing IR at 15 μm—there is no mechanism linking this to core convection or field generation. Second, temperature: A 1–2°C surface shift might tweak mantle heat flow slightly (e.g., via volcanism), but the core's thermal inertia (timescale ~10^6 years) shrugs off millennial surface wiggles. Paleomagnetic shifts (e.g., excursions like Laschamp, ~41 ka) occur without clear climate triggers, suggesting core dynamics are independent [20].

The magnetic pole's wander (e.g., 69°N to 86°N since 1830) reflects core flow changes [21,22], not atmospheric CO_2 or temperature. Reversing causality—CO_2 or warming driving pole shifts—lacks a physical pathway. This flips the greenhouse feedback: if anything, pole shifts might warm the surface, then nudge CO_2 (e.g., via oceans), as the residuals hint.

5.5 Granger Plausibility : Temperature lags Pole shift

Moreover, due to the exceptionally high regression value, the probability of such a correlation occurring at random is virtually zero. The proposals for driver(s) as to how that link might come about have been advanced above and are further discussed below. The ultimate test of ruling out pole shift as a symptom is to look at Granger causality. For instance, Koutsoyiannis [16] shows temperature leads CO_2 by 6–12 months. Applying this to latitude: does pole position lead temperature? A Granger test in R on latitude causing ΔT gives p = 6x10^-10 at 1 year delay and 3.6x10^-7 at 2 years delay respectively but ΔT doesn't cause latitude (p = .107 and .514 respectively). A full plot on the 1850–present day dataset, confirming causation in addition to correlation, see figure 3.

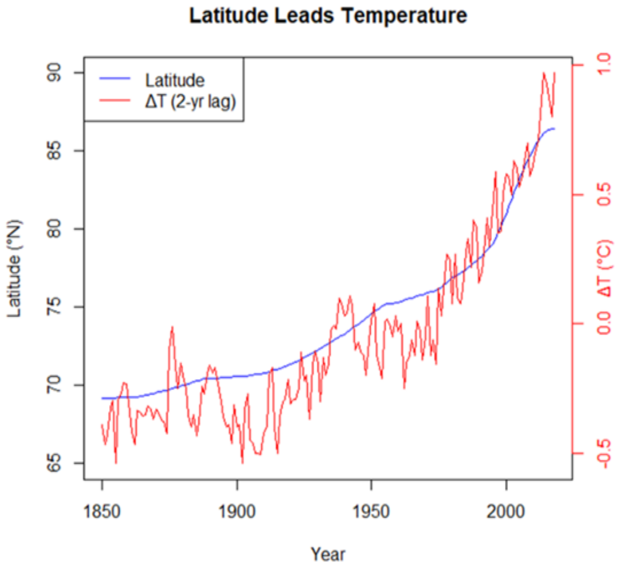

Figure 3. Latitude and temperature changes plotted since 1850 with a two-year lag in temperature

5.6 Modelling Previous Warm Periods

The ultimate test of these new and novel climate models is to explore their ability, if any, to predict not only modern warming but also previous warm periods, both in terms of date and amplitude. Latitudes and longitudes of the geomagnetic North Pole are available from 1591 until the present day from BGS or NOAA. As far as the present author is aware, there is only one other source in the literature, namely "Paleomagnetism Near the North Magnetic Pole: A Unique Vantage Point for Understanding the Dynamics of the Geomagnetic Field and its Secular Variations" by Guillaume St-Onge and Joseph S. Stoner [23]. This source gives a virtual North Magnetic Pole projection (NMP) every 50 years from 200 to 1800 AD. The reconstruction is based on virtual geomagnetic pole (VGP) transformation of paleomagnetic data from lower Murray Lake (inclination and declination; averaged over a 100-year window every 50 years). The data are not tabulated and appear on the projection in graphical form only. The present author thus interpolated latitudes accordingly every 50 years from 200 AD to 1600 AD and constructed a combined data file in Excel and then applied equation (1) using a fixed CO_2 level of 295 ppm and generated a temperature difference versus date reconstruction, figure2. It is justified to use a fixed CO_2 level since ice core data (e.g., Law Dome, EPICA Dome C) peg CO_2 at 275–285 ppm during both the MWP (950–1250 CE) and RWP (~250 BCE–400 CE)[50]. Moreover, these levels were then, as far as we know, stable, hovering around the pre-industrial baseline until the 19th century and beyond when they climb to circa 420 ppm today.

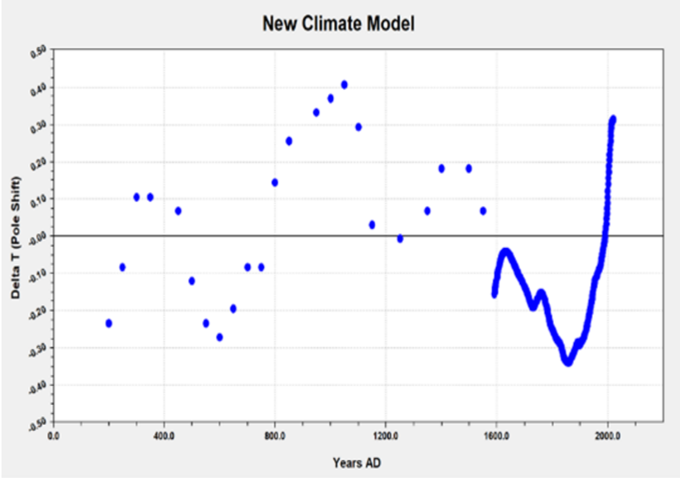

Figure 4. Output of Model 1, CO2+ Pole Shift.

It can be clearly seen from Figure 4 that both a Roman and Medieval Warm Period are produced. The solid blue line is due to the increased frequency of data points and shows the Maunder and Dalton minima and modern warming. Although the positions date-wise have been produced correctly, the amplitudes are somewhat lacking. The same procedure has been employed for equation (2), feeding in latitude figures only to form model 2 (see Figure 5).

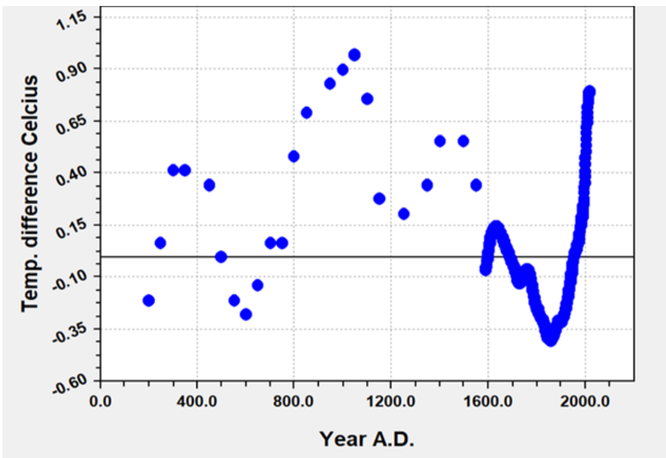

Figure 5. Output of Model 2, Pole Shift alone.

Model 2, figure 5 above, also correctly produces a Roman and Medieval Warm Period, and this time with much more realistic temperature amplitudes. According to various sources, the Medieval Warm Period (MWP) was a period of warming that occurred roughly from 800 to 1200 AD. The MWP was probably 1–2°C warmer than early 20th-century conditions in Europe. A study from the University of Waikato found that the MWP was 0.75°C warmer than the Current Warm Period [24]. The IPCC concluded that the warmest period prior to the 20th century very likely occurred between 950 and 1100 [25] . Model 2 is in excellent agreement with the above-wise and temperature-wise. On the other hand, many references state that the Roman Warm Period was warmer than the MWP. The Roman Warm Period, or **Roman**

Climatic Optimum, was a period of unusually warm weather in Europe and the North Atlantic that ran from approximately 250 BC to AD 400. Both Models 1 and 2 reproduce correct dates for the Roman Warm Period, but the temperature elevations are weaker. The reason for this is presently uncertain

A search of current literature gives possible causes of the MWP as increased solar activity, decreased volcanic activity, and changes in ocean circulation. Hunt (2006)[26] has suggested that present modelling evidence has shown that natural variability is insufficient on its own to explain the MWP and that an external forcing had to be one of the causes. In the present study, a single parameter of the solid Earth predicts MWP. It must not be overlooked, however, that as the geomagnetic pole shifts, secondary dependent variables such as EEP and hence solar amplification effects will change and cause the bulk of the actual climate control. Moreover, Earth's geomagnetic field is electromagnetically linked with ocean currents [27,28]. The notion of decreased volcanic activity is interesting. The question posed here is indeed is: was there truly less volcanic activity or merely fewer clouds, as is the present narrative? The latter would then line up exactly with what has been observed recently.

Feng Shi et al. (2022)[29] have suggested that the Roman Warm Period (RWP) is likely linked with the increased radiative forcing associated with weaker volcanic eruptions in the RWP, which results in reduced sea ice area and pronounced high-latitude warming through surface albedo and lapse-rate feedback, the latter also being exactly what is being observed recently. The present model elegantly links these albedo changes past and present. The hindcasts indeed further reinforce the entire narrative. Changing from Model 1 to Model 2 barely changes the correlation. Pre-1850, CO_2 flatlines, yet temperature doesn't. If CO_2 drives warming via radiative forcing and using a standard estimate: ~1.5–2°C per doubling from 280 ppm, its stability during MWP and RWP (no doubling, just 280 ± 5 ppm) [30] can't explain the observed 0.75–2°C anomalies . Yet dip pole latitude shifts as interpolated from St-Onge and Stoner[23] as ~87–89°N during MWP vs. ~80°N pre/post MWP track the warming peaks in Model 2, suggesting latitude, not CO_2, is the active variable. In the 1850–2025 regression, CO_2 (X_1) and latitude (X_2) show high multicollinearity (VIF > 10), meaning they're intertwined. But during MWP/RWP, CO_2 is static while latitude varies. Dropping CO_2 (as in Model 2) still captures 89% of modern variance and hindcasts MWP/RWP, implying that CO_2's role is at most redundant or if not secondary. The stable 280 ppm [30] back then strengthens this notion, CO_2 can't be the mover if it's not moving.

The gold star test is not only to make warm period hindcasts but also to predict additionally the cold periods such as Late Antique Little Ice Age (LALIA) and Little Ice Age (LIA). The result of Model 2 shows that the same single model is predictive of the bulk of temperature over the last two thousand or so years. This has indeed been shown here to be the case and not only so, but the predicted values merge seamlessly with those of the dataset for Modern Warming, see figure 6. Hence, uniquely, we have a single parameter model predictive of the bulk of all temperature changes for approaching the last 2000 years.

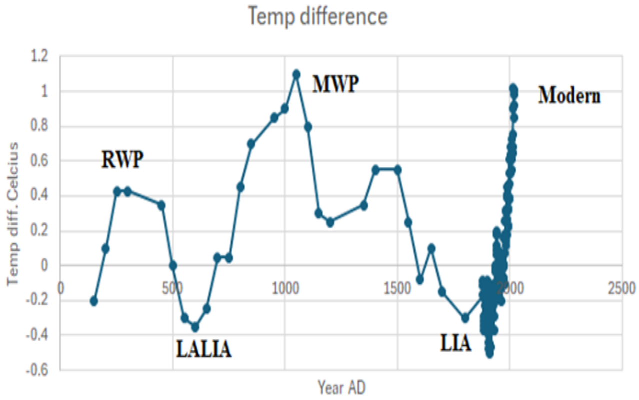

Figure 6. Model 2 output with seamless display temperature difference induced by of all significant warm and cold periods for almost 2000 years since 150AD. Limited only by availability of paleomagnetic Pole Position data.

5.7 Apportioning mechanisms to the Magnetic Pole Shift Induced Temperatures

Model 2 developed in this present work accounts for almost 90% of changes over the last 2000 years as a result of Magnetic Pole Shift alone. This can be further apportioned as follows.

When the pole shifts there can be three possible coincidence effects. These are:

a) Earth geometric effects such as shape, tilt, rotation, precession and ocean floor effects.

b) Ocean heat and ocean current effects.

c) Changes to cosmic ray interactions, hence energetic particle precipitation.

Viterito (2022) [31] identified Pole Shift as a climate driver, stating it was responsible for 62% of all warming in the period 1975-2015, r=.785. However, he ascribed the driver as internal and being mid-ocean geothermal flux. As far as the present author knows this has not been further verified. It seems more logical to the present author to presume that because convection currents driving Pole Shift are linked to heat release from the earth's core that changes in ocean heat flux would be secondary driven elements rather than primary drivers. Nevertheless, there remains the possibility that such heat flux could influence ocean currents and circulation.

The other two likely drivers as a result of Pole Shift are changed Energetic Particle Precipitation especially electrons (EEP) via influence on clouds and geometric effects on TSI. For instance, heavy entities in the mantle linked to convection currents driving pole Shift simultaneously changing obliquity leading in turn to changes in TSI on different parts of the globe.

5.8 EEP Plausibility and Mechanisms

The solar wind can cause as variable flow of current density (J_z) in the global electric circuit: (A) and changes in the galactic cosmic ray energy spectrum, (B) it can also change the precipitation of relativistic electrons from the magnetosphere (EEP), and (C) it can also change the ionospheric potential distribution in the polar caps due to magnetosphere-ionosphere coupling. A current density J_z flows between the ionosphere and the surface, and as it passes through atmospheric conductivity gradients, it generates space charge concentrations dependent on J_z. Further, there are distinct links between the upper ionosphere and the lower levels of the atmosphere, including: heat/light energy fluxes, the global electric circuit, two-way propagating acoustic gravity waves (AGW), and atmospheric chemistry.

Considering EEP effects first, EEP is thought to be involved with the global electric circuit and global cloudiness. Tinsley and Deen (1991) [32] described how the troposphere responds to MeV-GeV particle flux variations and the connection via electro-freezing of supercooled water in high-level clouds. Ion flux in interplanetary space is dominated by the ~1 keV/nucleon solar wind. Ionization production in the lower atmosphere is created by MeV-GeV particles arising mainly from galactic cosmic rays and solar flares and have well-defined variations on a day-to-day timescale related to solar activity, and on decadal timescales is related to the sunspot cycle. The paper took 33 years of northern hemisphere meteorological data and showed clear correlations of winter cyclone intensity (measured as the changes in the area in which vorticity is above a certain threshold) with day-to-day changes in the cosmic ray flux. The authors also noted correlations between winter cyclone intensity, the related storm track latitude shifts, and cosmic ray flux changes on a decadal timescale, hinting at a mechanism in which atmospheric electrical processes alter tropospheric thermodynamics, with a requirement for enormous energy amplification by a factor of about 10^7 and a timescale of hours. Thus, it was suggested that ionization affects the nucleation and/or growth rate of ice crystals in high-level clouds by enhancing the rate of freezing of thermodynamically unstable supercooled water droplets always present at the tops of high clouds. The subsequent electro-freezing increases the flux of ice crystals that can glaciate mid-level clouds critical to this present discovery. It is further explained that in warm-core winter cyclones release of latent heat intensifies convection and extracts energy from the baroclinic instability to further intensify the cyclone. As a result, the general circulation in winter is affected in a way consistent with observed variations on an inter-annual/decadal timescale. The authors also proposed effects on particle concentration and size distributions in high-level clouds may also influence circulation via radiative forcing. They report that net cloud radiative forcing is positive in most cirrus cases. Interestingly, increases in aviation are also providing more and more cirrus clouds, see Zerefos et al [33] which themselves are another concern in climate forcing.

Harrison (2015) [34] was also able to link energetic particles to atmospheric processes. Frank-Kamenetsky et al [35] show that variations of up to 40% in the atmospheric electric field in the near-pole region are also related to the interplanetary magnetic field,

Critically, Rozanov et al. (2005) [36] have results that confirm that the magnitude of the atmospheric response to EEP events can be larger than the effects from solar UV fluxes, in other words showing a huge climate amplification factor. Rozanov (2012)[37] showed that the thermal effect of EEP was as a result of stratospheric ozone depletion which propagates down, giving 1 K of warming averaged over some 46 years over Europe during the winters. Their results suggest that energetic particles can significantly affect atmospheric chemical composition, dynamics, and climate. Indeed, this alone would amount to about 60% of recent warming in European winters. Andersson et al. (2014)[38] discuss EEP as the "missing driver in the Sun–Earth connection'' because of the way energetic electron precipitation impacts mesospheric ozone. They conclude that on solar cycle timescales, EEP causes ozone variations of up to 34% at 70–80 km. With such a large magnitude, it is perfectly reasonable to suspect that EEP is a crucially important part of the atmosphere and climate system. Kilifarska [39] describes ozone layers as the mediator of cosmic rays. Indeed, cosmic rays provide the bulk of ionization in most of the atmosphere over the recent long-term (50 years) shown by measurements by Yu.I. Stozhkov et al. (2009) [40].

Crucially, Srivastava et al. (2025)[41] have provided the missing link in the chain which enables the present author to show without doubt that Magnetic Pole modulated EEP drives our climate. Their finding is that in the northern hemisphere, the penetration altitude of energetic protons has been affected by the changes in the magnetic field linked to the magnetic North Pole drift. They found that the penetration altitude of the energetic protons was around 400–1200 km higher in 2020 as compared with 1900 for protons of MeV-keV range having a low pitch angle.

Thus, based on the above considerable body of evidence, it abundantly clear that Pole driven EEP acts as a solar cycle amplifier and modulator. This amounts to the critical link in our climate system.

Friis-Christensen and Svensmark [42] noted a variation of 3–4% in the global cloud cover between 1980 and 1995 thought to be directly correlated with the change in galactic cosmic radiation flux over the solar cycle. Solar cycle modulation of cosmic radiation is, however, only part of the story because there are also changes in the energetic particles impinging at the top of the atmosphere and precipitating downwards because of the long-term evolution of the geomagnetic field, as crucially exposed in this present work. Accordingly, this is why Svensmark's simpler hypothesis fails and why when attempts are made at correlating global neutron monitor counts with solar cycles and warming, they do not produce strong results.

NASA's Earth Observatory estimates that at any given time, around 67% of Earth's surface is covered by cloud Cloud albedo varies from 0.5 to 0.9. TSI is of the order of 1370 W/m^2 but averaged over the whole top of the atmosphere (TOA) this reduces to 340 W/m^2. Assuming of reflectivity over a very broad spectrum and taking an average of albedo of 0.7, by calculation this amounts to a reflection of some 238 W/m². An average variation of 3.5% of this figure amounts to some 11 W/m², which is greater than 5x estimates for CO_2-induced warming to date. Is this feasible? So, we know that when the Dip Pole was previously 17 degrees further south, this would have doubled tropospheric ionization (5–50 ions/cm³/s) and would have driven a 2–3% cloud cover increase, yielding 6–9.5 W/m² less forcing which is close to the 11 W/m^2 increase from Pole Shift or inferred 3.5% albedo drop. With ozone and jet stream amplification, it is quite feasible EEP accounts for ~81% of recent warming, whereas model 2 predicts 89% due to Pole shift. TSI modulation due to changes in obliquity, sphericity and rotation could then at most make up the other 8% in the model over the period and equivalent to a forcing of 1.1 W/m^2 over the same period, leaving just another 10% unaccounted for by the model, feasibly due to a mix of anthropogenic GHS, particulates, increased cirrus cloud [31] and aerosols.

Are these ionization rates feasible? Typical baseline GCRs yield 10 ions/cm³/s at 15 km [36]. EEP adds bursts, and Rozanov (2012) [37] suggests 10–100 ions/cm³/s at 50–80 km, dropping to ~1–10 ions/cm³/s lower down. Even a 20 km drop in interaction heights could boost tropospheric ionization by 2–5x (e.g., 5–50 ions/cm³/s), per Tinsley (1991)[32], as postulated above. Now reconsider cloud nucleation. Svensmark (2013)[43] lab data shows a 50% ion increase raises aerosol nucleation by ~20–30%, potentially increasing cloud cover 1–2% regionally. Here, I propose 3.5% global shift in accord with Friis-Christensen & Svensmark [42] equivalent to 11 W/m² (matching 313 W/m² reflected, 67% cover, 0.7 albedo). For an initial EEP effect (polar-focused), I assume 1% global forcing ~3 W/m². A Magnetic Pole drift 17° Northwards scales this forcing to 2–3% → 6-9 W/m². This is before we even consider any amplification or non-linear effects. Rozanov [37] ties EEP to 1 K warming via ozone loss over 46 years (0.6°C of 1.1°C modern warming). Andersson (2014)[40] shows 34% ozone swings at 70–80 km—assume 10–20% cloud albedo drops in polar regions, amplifying to 7.2-10.8 W/m² globally with circulation feedback, e.g., jet stream shifts. The present author thus concludes the estimate of EEP forcing from global cloud changes and from Srivastava's pole-driven shift could easily reach 10.8 W/m^2 which approaches his original estimate of 11 W/m². By adding ozone and circulation effects, 81% of modern warming is easily within reach. This leaves some 8% predicted by the model to be accounted for by obliquity or perhaps other geometric effects on TSI. To highlight this, a plot of EEP forcing versus Pole Shift has been included, see Figure 7.

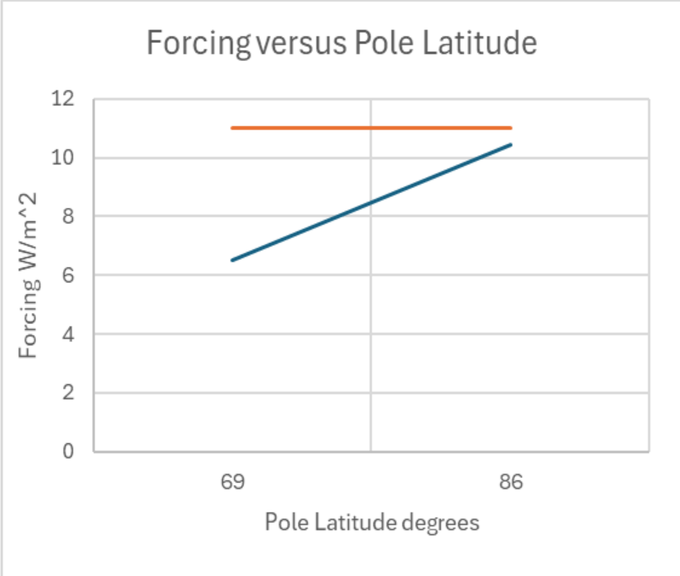

Figure 8. Showing how theoretical maximum forcing is achieved as Pole migrates Northward.

Strongly supportive of the above findings, V.A. Dergachev [44] showed that there was a large global cooling around 2700 BP. They concluded that changes in galactic cosmic ray intensity may play a key role as the causal mechanism of climate change. They looked at cosmogenic isotope level in Earth's atmosphere showing it is modulated by the solar wind and by the terrestrial magnetic field, concluding this an important mechanism for long-term solar climate variability. Gherzi (1950)[45] also established a link between the ionosphere and weather forecasting. Their examination of radio echoes from the ionosphere led them to conclude they were forecasting aspects relating to the future movements of the world's major air masses. It is usually accepted that the ionosphere is controlled at least in part by space weather input such as solar flux and GCR flux.

5.9 TSI and Obliquity Contributions and links with Svensmark.

Although solar TSI only varies by about 1.3% across the 11-year solar cycle, polar magnetic effects in all their guises are shown below to be acting as non-linear amplifiers. For straight TSI alone, assuming 67% cloud cover and a fixed dip-pole latitude, I calculate a variance of 1.4 W/m². Courtillot et al. (2007)[46] suggest that correlation between decadal changes in amplitude of geomagnetic variations of external origin, solar irradiance, and global temperature is strong and could have been a major forcing function of climate until the mid-1980s.

Rivera and Khan (2012)[2] discussed the link between earthquakes and shifts in Earth's magnetic poles. They explain how this increased Earth's obliquity and induced global warming and possibly emission of greenhouse gases. Their model of seismic-induced oceanic force explains enhanced obliquity. A changed tilt then leading to increased solar radiative flux. The increase of the absorbed solar radiation was also shown by the SOLRAD model, which computed a net gain of solar radiative forcing due to enhanced obliquity. SOLRAD also revealed a poleward gain of solar radiative flux, which could have facilitated the observed polar amplification of global warming. Multiple regression analysis also showed that polar shift and solar irradiance played a major role in the temperature rise and CO_2 increase in recent years. Their analysis showed that obliquity change due to the North Pole shift and total solar irradiance accounted for 63.5% and 36.4%, respectively, while CO_2 changes accounted for 0.1% of the observed warming. Their work with respect to the reduced relevance of CO_2 is also support consistent with arguments developed here. Assuming magnetic pole drift has substantially changed the EEP effect, then these figures would be in good agreement with the present author's calculations based on Rozanov (2012)[37]. Moreover, it is very in line with the conclusions of Rozanov et al. (2005)[36] about EEP events exceeding the effects of solar UV flux.

The above two references taken with the present work represent extremely important conclusions. Thus, I have also made my own estimates of the relative contributions of these climate drivers. The assumption needed is to assume that EEP controls all clouds. Energetic electron precipitation (EEP) affects cloud condensation nuclei (CCN) indirectly by altering atmospheric chemistry, particularly the production of odd-hydrogen (HOx) and odd-nitrogen (NOx) radicals. These radicals, produced during EEP events, can influence the formation of cloud condensation nuclei through various chemical pathway First, I calculate the forcing effect of CO_2. I have taken the standard figure from the literature, although it considerably exceeds my own estimates; I will show it to be rather insignificant beside EEP (cloud) control. A standard figure of 3.5 W/m² for doubling yields 1.56 W/m² from pre-industrial to right now. Following the above and assuming 67% cloud cover and based on an average 70% albedo, I arrived at ±11 W/m² for EEP/ cloud. For TSI, I assume 1.3% variation and 33% penetration, which amounts to ±1.4 W/m². This yields a total possible variation of 15.4 W/m². As percentages, this leaves EEP/Cloud = 81%, TSI direct and via tilt effects etc. 12.7 % hence to make 100%. The difference between EEP and the model is 8% which suggests that some 4.7% were unamplified by geometric change. Total 'others' including presumably CO_2 must ~6%. Further, as an additional check, I have made multiple regression analyses (not shown here) of TSI and temperature with various time lags to account for the AMO cycle and the like, not shown here. Without time lag, TSI accounts for 4.6% change, increasing to a maximum of 15.1% at 68 years' time lag, which is in very good agreement with the above. An independent check on obliquity can be made. A change of tilt of 2.4 degrees over 41000 years is equivalent to about 10^-2 in the last 170 years. Taking the ice age as 6C colder than present equates to a warming of only 25 milli-Kelvin world- wide in recent times, this amounts to an increase of 1.7%. It was known ,however, that the Poles were some 15C colder, translating into an increase 4.2% which still falls somewhat short of the above.

During the 1990s, Danish physicist Henrik Svensmark and colleagues first published studies arguing that the Sun's influence on the climate is amplified by galactic cosmic rays. When the Sun gets brighter, greater solar wind shields the atmosphere from cosmic rays that constantly bombard the atmosphere, hence suppressing cloud formation and amplifying warming. Essentially Svensmark would work if every solar cycle were identical, GCRS were highly constant, and the magnetic poles did not move. Thus, his work has been a subject of intense debate ever since, especially since it might account for a lot of 20th-century warming and thus leave less to blame on CO_2. However, in strong support, a 2013 laboratory study by Svensmark et al [43] showed that there is in fact a correlation between cosmic rays and the formation of aerosols of the type that seed clouds. Extrapolating from the laboratory to the actual atmosphere, these authors asserted that solar activity is responsible for approximately 50% of temperature variation. They had identified at least part of the climate amplifier described herein.

A new study from Japan, Ueno et al. [47] circumvents the issue by considering indirect evidence over a long geological epoch. During the last so-called geomagnetic reversal, cosmic ray intensity in the atmosphere went way up and stayed up for 5,000 years. Concurrently dust layers near the Gobi Desert related to the winter monsoon thickened, which happens when the monsoon intensifies. The authors concluded cloud cover had to form an "umbrella effect" over that period. They also noted that temperatures in the region dropped by several degrees. It seems Svensmark was correct. Indeed, my own recent work is also very supportive of Svensmark. It is possible that some scientists have misunderstood Svensmark or misinterpreted his work. Consideration of Neher (1967)[48] shows that cosmic-ray particles changed significantly across two solar cycles from 1954 to 1958 to 1965. The authors did this by measuring differential spectra of protons found by other observers using satellites and high-altitude balloons. From the integral of the differential spectra obtained for the different years, it was found that the total number of primary protons increased by a factor of 3.1 between 1958 and 1965. From similar flights made during the previous solar minimum, the change from 1954 to 1958 is found to be a factor of 4.2. Their measurements, in addition to solar activity data, indicate that there appeared to be much more residual modulation of the primary cosmic radiation during the minimum of 1965 than was present in 1954. In line with the present work, as time had proceeded to the later solar cycle the Pole would have marched Northwards and energetic particle reactions would take place higher in the atmosphere. With such modulation and dip-pole movements critically discovered herein both combined, there is no wonder that Earth neutron counts, supposedly representative of GCR are not perfectly correlated with global temperature. Moreover, the findings of the present study seem to be what Svensmark would have been lacking in order to have made a better hypothesis.

Indeed, not only did cosmic rays seed clouds during the last geomagnetic reversal, see Kitaba et al [49] , but winter monsoons and extreme weather also became considerably stronger [47]. This present paper has demonstrated a new, crucial, and indisputable link between the solid Earth, space weather, and its climate system. Very recently, other periodicities of the solid Earth have also been found in the climate system, which adds even further weight, see Cazanave et al [50] . In addition to these changes in the solid Earth, there has been a doubling of the Sun's coronal magnetic field during the last 100 years, see Lockwood [51] . The IMF increased by 80% from 1901 to 1964 and by a further 150% from 1964 to the present day. As with the Earth climate system, the solar dynamo is also a chaotic stochastic system. These effects may serve to compound the above discovery. For example, Troshichev et al.[52] have shown that cloudiness is implicitly linked to the IMF, which also impacts the wind regime in Antarctica.

The detail disclosed in this present paper represents a profound and crucial discovery for climate science and its future direction. Because Magnetic Pole shift modulated EEP is such an overwhelming driver, dwarfing the effects of CO_2, we may need no longer to be so concerned with carbon mitigation, but we will desperately need to focus on a fuller understanding of our geomagnetic climate, cloud nucleation processes, and possibly also consider if other anthropogenic factors such as ELF radio transmitters and power systems and aviation (aerosol and cirrus) also affect EEP. For instance, although the radiated power to space from power grids is small compared with the power of the Sun, we perhaps would need to keep uppermost in our minds the 10^7 amplification factor explained by Tinsley and Deen [32].

5.10 The South Magnetic Pole

Following the arguments presented throughout this work, it becomes glaringly apparent that one main physical process has been the dominant driver of our climate for the last 2000 years, and that is the random wandering of Earth's Magnetic North Pole. It would be worthy to make similar investigations for the position of the South Magnetic (Dip) Pole. The present author has conducted such a preliminary investigation, and it shows that the longitude of the South Dip Pole correlates with temperature change. Given that the two dip poles are not antipodal, such a result is perhaps not unexpected. The highest achievable temperature variance for the warming period 1900–2023 (limited by accurate magnetic data) that could be accounted for was 86.8% of all modern warming. Courtillot et al. [47] have suggested geomagnetic field variations found at irregular intervals over the past few millennia, using the archaeological record from Europe to the Middle East, seem to correlate with significant climatic events in the eastern North Atlantic region, and they have proposed a mechanism involving variations in the geometry of the geomagnetic field—that is, the tilt of the dipole to lower latitudes—resulting in enhanced cosmic-ray-induced nucleation of clouds. Shoemaker[53] has discussed "Probing the Association Between the Magnetic Dip Poles and Climate Change Using Indicator Variable Regression" and discusses the validity of the said association. The conclusions were twofold: 1) The validity is verified; 2) CO_2 levels are an insignificant predictor of global temperature deviations (p-value = 0.512) when the location of the dip pole is in the model. The paper further concludes that, in addition to predicting annual global temperatures, it may be possible to predict monthly global temperatures if the actual location of the North Magnetic Dip Pole were to be measured on a more regular basis and that CO_2 levels and relative strength of the magnetic field do not seem to add any additional significant information for prediction. The paper is purely statistical and gives only a tentative explanation for this phenomenon, which is stated as being "the entrance of cosmic particles through the cusps of the magnetosphere and subsequent changes to the magnetosphere as the cusps move toward more climate-sensitive regions such as the ice cap at the geographic North Pole." Nevertheless, this is highly supportive of the present author's findings on Pole Shift modulated EEP effects. However, unlike the present work, however, the paper of Shoemaker [53] does not produce any hindcasts.

The concept of monthly forecasts is really one worth testing in the future too. The present author suggests this should be very real and very possible by taking on board the work of Lam et al.[10], who discuss how the IMF affects mid-latitude surface pressure and how solar amplification happens via non-linear effects of the global electric circuit and atmospheric dynamics, and reinforcing this with the work of Cnossen et al. [54], who conclude: Magnetic field changes from 1900 to 2000 cause significant changes in temperature of up to ±2 K and wind in the whole atmosphere system (0–500 km) in December to February. Further, they conclude that direct responses form in the thermosphere and propagate downward dynamically, initially via the gravity wave-induced residual circulation. In the middle atmosphere, changes in planetary waves become also important, but these may not be correctly represented in the Southern Hemisphere.

Finally, attempts at multiple linear regression analysis on the movements of the South Magnetic Dip Pole were made, not shown here. Correlations with global SSTs are at best 0.77. The South Dip Pole is moving slower and is moving away from the Southern auroral oval. Climate scientists have long struggled to understand why Antarctica shows less warming than the Arctic. Clearly, following the narrative developed above, there would be expected to be more mid- and low-level cloud in the Southern Hemisphere, hence more cloud albedo and less warming. This is exactly what is seen, see Radenz et al [55]. They contrast sites in the Northern Hemisphere (Leipzig, Germany, a polluted and strongly dust-influenced eastern Mediterranean site, Limassol, Cyprus) with a clean marine site in the southern mid-latitudes (Punta Arenas, Chile) for investigation of shallow stratiform liquid clouds. After considering boundary layer and gravity wave influences, Punta Arenas shows lower fractions of ice-containing clouds by 0.1 to 0.4 absolute difference at temperatures between -24 and -8°C. These potentially ascribe differences as being caused by the “contrast” in the ice-nucleating particle (INP) reservoir between the different sites. It can be argued this is linked directly to magnetic EEP modulation following entirely the present narrative. This only serves to strengthen my earlier point that the direction of climate science now needs urgently to shift. “Opposing temperature trends of the Medieval Climate Anomaly (MCA) in Antarctica”, see Luning [56] and Steig (2016) [57] showed that Antarctica has always behaved differently from the Northern Hemisphere. McCracken [58] has studied cosmogenic isotopes, especially 10Be. They point out that die to the geomagnetic modulation 10Be precipitation in the southern polar cap will be strong. Clearly differences in North and South dip-pole movements as the driver of this Antarctic phenomenon demands further and urgent investigation. The present author is already engaged in such an investigation. Mironova [59] made a comprehensive review EEP and their effect on earth’s atmosphere and concluded that any responses in clouds to energetic particles within the lower troposphere are, in principle, of great interest because of their importance to the planetary radiative balance’. This, according to the crucial revelation of this present work, was possibly a significant understatement but nevertheless one required to advance our complex jigsaw of ever-expanding knowledge of earth’s climate and its drivers. Even earth power systems and ELF transmitters could possibly influence EEP, see for example Bazilevskaya et al [60]. Magnitudes of EEP effects can be truly dramatic. Seppälä et al., 2009 [61] found that surface level air temperatures could differ by as much as ±4.5 K between high and low geomagnetic storm periods but that these changes were not linked to changing solar irradiance/EUV levels. Thus, they argued that the seasonality and temporal offsets observed strongly suggest that the dominant driver for this temperature variability comes from EEP coupling to ozone through NOx production. Small wonder then that the long-term drift in EEP interactions discovered in this present work in association with our wandering magnetic poles is the hitherto unaccounted for major driver of climate. #

6. Conclusion and Future Scope

The hypothesis that the position of the magnetic North Pole (Dip Pole) (latitude) ought to be very highly correlated with global temperature change on Earth since 1830 has been tested and shown to be correct. The probability of such a correlation happening by chance is close to zero. Moreover, given the results of the modelling included, this has likely been the dominant climate driver for the last 2000 years. The climate models developed here have been tested and successfully predict the epoch and amplitude of previous warm periods, the latter being reflective especially of the MWP. They are also able to predict the LALIA and LIA and all with a seamless transition into the data set which represents Modern Warming. Granger Causality test shows Pole Shift to be the real driver with Temperature lagging by up to 2 years. According to the calculations herein, combined particle precipitation (EEP) via its effects atmospheric chemistry and hence on the world’s clouds, and subsequent reduced albedo therefrom, yields up to 81% of total model generated change since 1850, geometrically modulated TSI the yields remaining 8% of model generated change, with the rest uncertain and outside model scope, but most likely consisting of some ~ 4% of solar modulated TSI and a remainder ~6% which could comprise and be due to in various proportions CO_2, other GHS, particulates, aerosols, and aviation borne cirrus cloud increase. The detail disclosed above represents a profound and crucial discovery for climate science and its future direction. Perhaps we need no longer to try to mitigate so much for CO_2, but we will desperately have to understand our geomagnetic climate and possibly even how other anthropogenic factors such as aviation, ELF radio transmitters and power systems affect EEP.

Data Availability

For temperature, the NASA Goddard Institute for Space Studies (GISS) Surface Temperature Analysis (GISTEMP) dataset, v4 was employed. For the position of the magnetic North Dip Pole, data from NOAA[IGRF] was employed. For Paleomagnetic data, reference [23] was employed as per text hereinabove.

R-code Model 1

```
if(!"car" %in% installed.packages()){install.packages("car")}

library("car")

y0 <- c(-0.2813,-0.3902,-0.3888,-0.4672,-0.4291,-0.3204,-
0.2969,-0.5364,-0.2915,-0.2704,-0.2294,-0.2333,-0.3442,-
0.4177,-0.4655,-0.3325,-0.3413,-0.357,-0.3518,-0.3166,-
0.3279,-0.3686,-0.3281,-0.3413,-0.3733,-0.3756,-0.4241,-
0.1011,-0.0113,-0.16,-0.25,-0.15,-0.2,-0.25,-0.355,-0.4,-0.35,-
0.43,-0.38,-0.24,-0.27,-0.19,-0.16,-0.19,-0.17,-0.23,-0.3,-
0.36,-0.4,-0.39,-0.46,-0.315,-0.4,-0.39,-0.54,-0.33,-0.27,-
0.45,-0.46,-0.5,-0.5,-0.505,-0.42,-0.4,-0.2,-0.17,-0.4,-0.5,-
```



```
0.36,-0.3,-0.29,-0.215,-0.31,-0.29,-0.29,-0.25,-0.11,-0.22,-
0.2,-0.37,-0.16,-0.1034,-0.15,-0.3,-0.13,-0.2,-0.155,-0.024,-
0.005,-0.02,0.1,0.08,0.03,0.04,0.11,0.07,-0.1,-0.07,-0.11,-
0.12,-0.2,-0.064,0.0127,0.08,-0.12,-0.17,-0.21,0.01,0.02,-
0.01,-0.05,0.03,-0.03,0,-0.25,-0.15,-0.12,-0.06,-0.12,0.01,-
0.03,-0.14,-0.05,0.11,-0.12,-0.06,-
0.155,0.14,0.03,0.135,0.27,0.25,0.08,0.27,0.1,0.08,0.14,0.28,
0.33,0.22,0.4,0.37,0.16,0.2,0.28,0.41,0.3,0.44,0.59,0.35,0.36,
0.51,0.58,0.57,0.5,0.63,0.6,0.53,0.57,0.63,0.7,0.57,0.61,0.66,
0.71,0.86,0.97,0.93,0.88,0.8,0.97)

y <- c(y0)

x10 <-
c(285.2,285,285,285,285,285.1,285.4,285.6,285.9,286.4,286.
7,286.7,286.8,286.9,287.1,287.2,287.3,287.4,287.5,287.7,287
.9,288.2,288.3,288.4,288.6,288.7,288.8,288.9,290.1,290.8,29
1.4,292,292.5,292.8,293.3,293.8,294,294.1,294.2,294.4,294.6
,294.65,294.7,294.7,294.8,294.9,294.9,294.9,295.3,294.4,295
.7,296.6,297,297.5,298,298.4,298.8,299.3,299.7,300,300.6,30
1,301.3,301.4,301.6,302,302.4,302.8,303,303.4,303.7,304.1,3
04.5,304.9,305.3,305.8,306.2,306.6,307.2,307.6,308,308.3,30
8.9,309.3,309.7,310.1,310.6,311,311.2,311.3,311,310.8,310.8
,310.2,310.3,310.3,310.4,311,311.4,311.4,311.8,312.2,312.6,
313.3,313.7,314.3,314.8,315.34,315.98,316.91,317.64,316.91
,317,319.62,320,321.4,322,323,324.6,325,326.3,328,329,330.
2,331.5,332,333.8,335.4,336.8,336.84,338.76,341.5,343.15,3
44.87,346.35,347.62,349.31,351.69,353.2,354.45,355.7,356.5
4,357.21,358.96,360.97,362.74,363.88,366.84,368.54,369.71,
371.32,373.45,375.98,377.7,379.98,382.09,384.02,385.83,38
7.64,390.1,391.85,394.06,396.74,398.81,401.01,404.01,406.7
6,408.72,411.65,414.41,416.41)

x1 <- c(x10)

x20 <-
c(69.174,69.178,69.18,69.192,69.196,69.205,69.219,69.225,6
9.23,69.24,69.249,69.259,69.259,69.271,69.296,69.336,69.37
5,69.414,69.455,69.496,69.536,69.575,69.615,69.659,69.708,
69.76,69.812,69.863,69.914,69.964,70.013,70.061,70.111,70.
163,70.218,70.276,70.335,70.394,70.43,70.433,70.448,70.44
9,70.46,70.483,70.497,70.499,70.525,70.539,70.546,70.564,7
0.578,70.584,70.592,70.6,70.618,70.657,70.683,70.708,70.73
4,70.76,70.785,70.834,70.883,70.931,70.981,71.03,71.091,71
.152,71.214,71.275,71.337,71.426,71.516,71.606,71.696,71.7
86,71.881,71.977,72.073,72.17,72.268,72.371,72.475,72.58,7
2.687,72.796,72.894,72.993,73.093,73.195,73.299,73.421,73.
544,73.67,73.797,73.926,74.066,74.208,74.35,74.494,74.638,
74.741,74.848,74.957,75.069,75.184,75.208,75.232,75.255,7
5.278,75.301,75.364,75.429,75.494,75.56,75.626,75.677,75.7
28,75.778,75.829,75.878,75.934,75.989,76.044,76.098,76.15
3,76.303,76.454,76.604,76.755,76.906,77.005,77.104,77.202,
77.3,77.398,77.537,77.677,77.816,77.956,78.095,78.286,78.4
76,78.665,78.854,79.043,79.417,79.798,80.185,80.576,80.97
2,81.427,81.879,82.325,82.762,83.186,83.602,83.995,84.363,
84.702,85.02,85.37,85.676,85.933,86.138,86.289,86.395,86.4
48,86.455,86.471,86.502)

x2 <- c(x20)

model1 = lm(y~x1+x2)
```

R-code Model 2

```
if(!"car" %in% installed.packages()){install.packages("car")}

library("car")

y0 <- c(-0.2813,-0.3902,-0.3888,-0.4672,-0.4291,-0.3204,-
0.2969,-0.5364,-0.2915,-0.2704,-0.2294,-0.2333,-0.3442,-
0.4177,-0.4655,-0.3325,-0.3413,-0.357,-0.3518,-0.3166,-
0.3279,-0.3686,-0.3281,-0.3413,-0.3733,-0.3756,-0.4241,-
0.1011,-0.0113,-0.16,-0.25,-0.15,-0.2,-0.25,-0.355,-0.4,-0.35,-
0.43,-0.38,-0.24,-0.27,-0.19,-0.16,-0.19,-0.17,-0.23,-0.3,-
0.36,-0.4,-0.39,-0.46,-0.315,-0.4,-0.39,-0.54,-0.33,-0.27,-
0.45,-0.46,-0.5,-0.5,-0.505,-0.42,-0.4,-0.2,-0.17,-0.4,-0.5,-
0.36,-0.3,-0.29,-0.215,-0.31,-0.29,-0.29,-0.25,-0.11,-0.22,-
0.2,-0.37,-0.16,-0.1034,-0.15,-0.3,-0.13,-0.2,-0.155,-0.024,-
0.005,-0.02,0.1,0.08,0.03,0.04,0.11,0.07,-0.1,-0.07,-0.11,-
0.12,-0.2,-0.064,0.0127,0.08,-0.12,-0.17,-0.21,0.01,0.02,-
0.01,-0.05,0.03,-0.03,0,-0.25,-0.15,-0.12,-0.06,-0.12,0.01,-
0.03,-0.14,-0.05,0.11,-0.12,-0.06,-
0.155,0.14,0.03,0.135,0.27,0.25,0.08,0.27,0.1,0.08,0.14,0.28,
0.33,0.22,0.4,0.37,0.16,0.2,0.28,0.41,0.3,0.44,0.59,0.35,0.36,
0.51,0.58,0.57,0.5,0.63,0.6,0.53,0.57,0.63,0.7,0.57,0.61,0.66,
0.71,0.86,0.97,0.93,0.88,0.8,0.97)

y <- c(y0)

x20 <-
c(69.174,69.178,69.18,69.192,69.196,69.205,69.219,69.225,6
9.23,69.24,69.249,69.259,69.259,69.271,69.296,69.336,69.37
5,69.414,69.455,69.496,69.536,69.575,69.615,69.659,69.708,
69.76,69.812,69.863,69.914,69.964,70.013,70.061,70.111,70.
163,70.218,70.276,70.335,70.394,70.43,70.433,70.448,70.44
9,70.46,70.483,70.497,70.499,70.525,70.539,70.546,70.564,7
0.578,70.584,70.592,70.6,70.618,70.657,70.683,70.708,70.73
4,70.76,70.785,70.834,70.883,70.931,70.981,71.03,71.091,71
.152,71.214,71.275,71.337,71.426,71.516,71.606,71.696,71.7
86,71.881,71.977,72.073,72.17,72.268,72.371,72.475,72.58,7
2.687,72.796,72.894,72.993,73.093,73.195,73.299,73.421,73.
544,73.67,73.797,73.926,74.066,74.208,74.35,74.494,74.638,
74.741,74.848,74.957,75.069,75.184,75.208,75.232,75.255,7
5.278,75.301,75.364,75.429,75.494,75.56,75.626,75.677,75.7
28,75.778,75.829,75.878,75.934,75.989,76.044,76.098,76.15
3,76.303,76.454,76.604,76.755,76.906,77.005,77.104,77.202,
77.3,77.398,77.537,77.677,77.816,77.956,78.095,78.286,78.4
76,78.665,78.854,79.043,79.417,79.798,80.185,80.576,80.97
2,81.427,81.879,82.325,82.762,83.186,83.602,83.995,84.363,
84.702,85.02,85.37,85.676,85.933,86.138,86.289,86.395,86.4
48,86.455,86.471,86.502)
```



```
x2 <- c(x20)

model12= lm(y~x2)
```

Conflict of Interests

None

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Author's contribution

The single present author was responsible for 100% of the ideas, research, theories and entire drafting of the paper.

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