The Anthropocene and other Factors in the Climate Change Arguments

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Abstract

This article links current understanding of major factors that cross critical climate thresholds: 1. Earth's Anthropocene Epoch of exponential and unsustainable population, consumption, waste, and emissions damaging Earth support systems; 2. Increased cosmic and solar radiation at atmospheric and surface levels that directly and indirectly affect climate; 3. Weakening Earth electromagnetic shield that allows additional solar and cosmic radiation into Earth's atmosphere and surface with adverse climatic effects; 4. Polar ozone depletion causing colder stratosphere while lower atmosphere sizzles by global warming feedback and further compromising Earth support systems. These four independent factors are conspiring to critically change earth climate.

Anthropocentric forcing of climate change is real. However, this article alleges that there are three other major forces with the potential for a greater effect on earth's climate.

The science behind this article is vast and if used directly noted as reference or listed as bibliography if consulted. The purpose of this article is to provide a credible background behind the several factors affecting climate change and illustrate the complexity and logic of the intertwining arguments.

Further work is demanded by the risks implied to humanity and the consequences to future generations that are not single, one-of-a-kind events but recurring although aperiodic, long-lasting, and extreme in force.

Lastly, please do not hesitate to contact me and let me know your comments and constructive criticism of this work.

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The Anthropocene Epoch

Syvitski et al (2020) coined "The Anthropocene Epoch" (AE) term that in geologic chronology follows the Holocene, "Laschamp Event," and "Earth's Little Ice Age".

The Laschamp event – occurred some 41,000 years ago, and is thought to have lasted roughly 20,000 years, when ice spread over much of North America and Eurasia, Fig. 1, "Earth's Little Ice Age".

The Holocene Epoch began 11,700 years ago. The AE proponents argue that for all those 11,700 years, up to 2023, we were in the Holocene. AC scientists argue that current trends are changing Earth's climate systems irreversibly, we are on a "Termination Event," and the start of the Anthropocene.

Earth's systems are experiencing a transition from freezing, Fig. 2, to current zizzling hot.

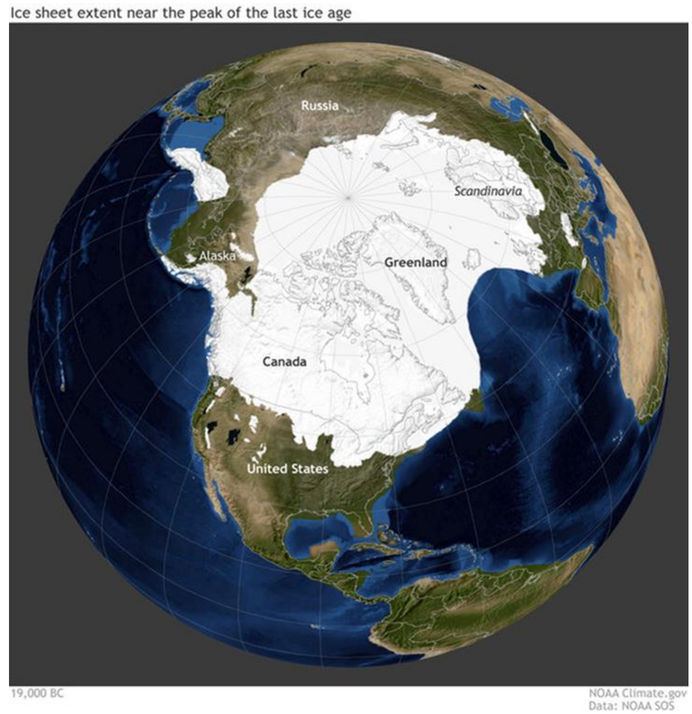

Figure 1. Laschamp Event. NOAA/SOS

The Anthropocene is characterized by exponential population growth, exponential migration from low to intensive resource and high energy consumption and exponential waste and emissions generations, Foley, et al. (2013).

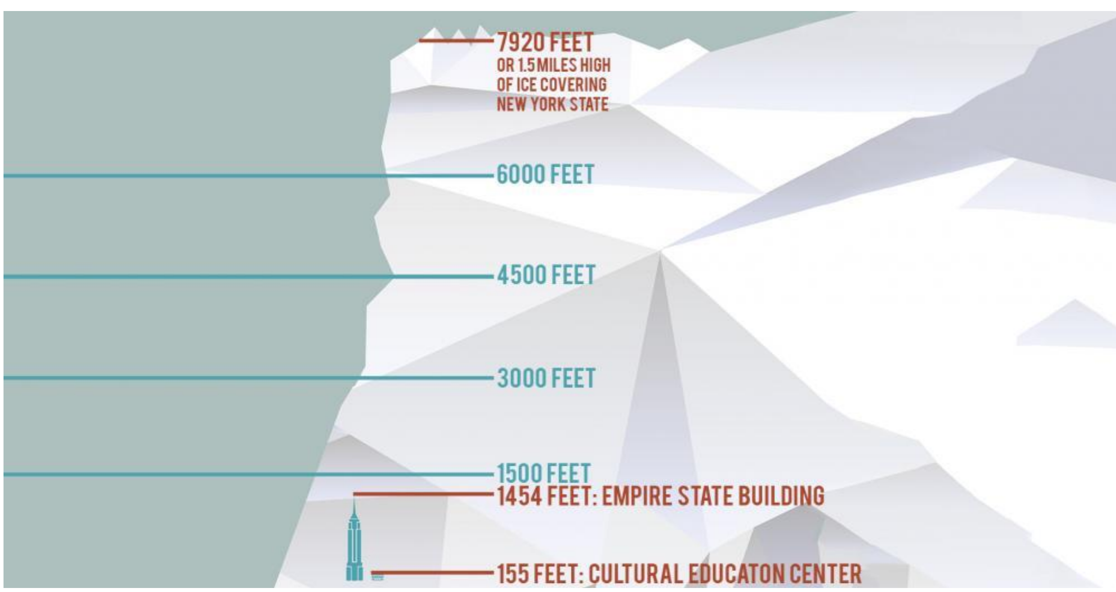

Figure 2. Little Ice Age (14th – 19th Century) glacier covered nearly all of New York State. NY State Museum, public domain.

García Bacca (1989) coined the word exponetialoid to capture the various factors that when aggregated through vectorial calculus produce the resultant human population exponential growth shown in Fig. 3. In summary, human population exponential growth curve is generated by data compounded from multiple exponentialoid factors, Fernández-Solís (2008).

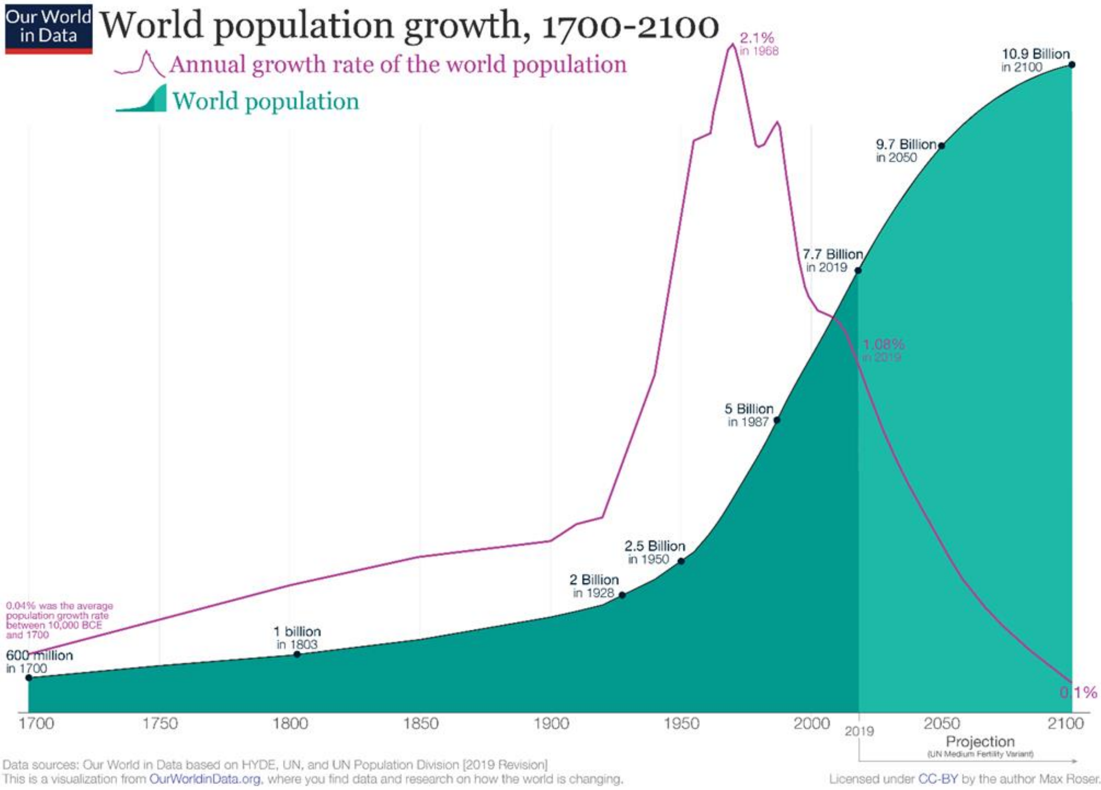

Figure 3. World population growth and rate By OurWorldInData.org

Exponentialoids contribute, directly or indirectly, to the greenhouse gas emission exponential growth. Every person on the planet consumes energy and generates personal and aggregate emissions. Hence, at a basic level, more people more per capita emissions. However, some emit more than others, so the total emissions are modified by levels of consumption, Fig. 4. The more affluent a country becomes, (the more developed countries); the more energy is consumed, waste and emissions generated. The world trend is towards both increasing population and economic growth, therefore higher Human Capital Index (HCI), see Fig. 5. A

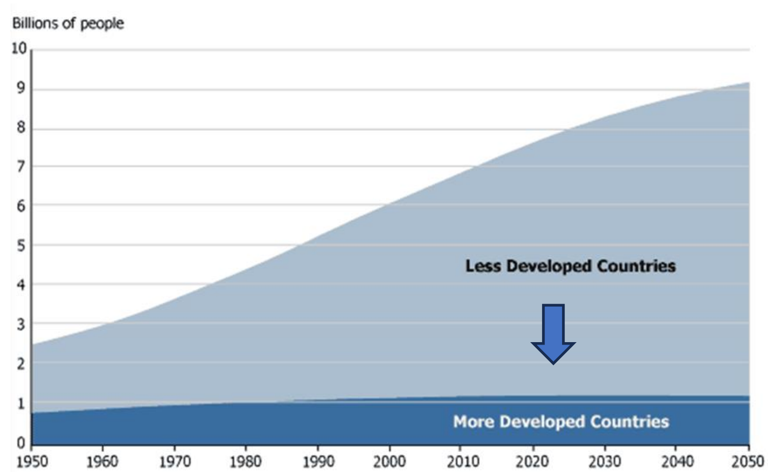

Figure 4. World population developing to developed ratio By OurWorldInData.org

country development is defined when the basic needs are met, and capital growth allows wants to be met. Basic human needs, according to Max-Neef (1991), are defined as finite, few, and classifiable. Wants on the other hand do not have boundaries. The migration from less developed to more developed status specially by countries with the largest population creates a tremendous demand on resources as well as generate greater waste at all levels. McHale (1978) established three levels of development: (A) deficiencies first level needs are threshold physical needs that must be met to maintain marginal survival; B) sufficiency needs are those that should be met to maintain living standards beyond marginal survival; (C) growth needs go beyond sufficiency standards and allow the movement from material sufficiency to enjoyment of non-material ends and aspirations, fulfillment of wants.

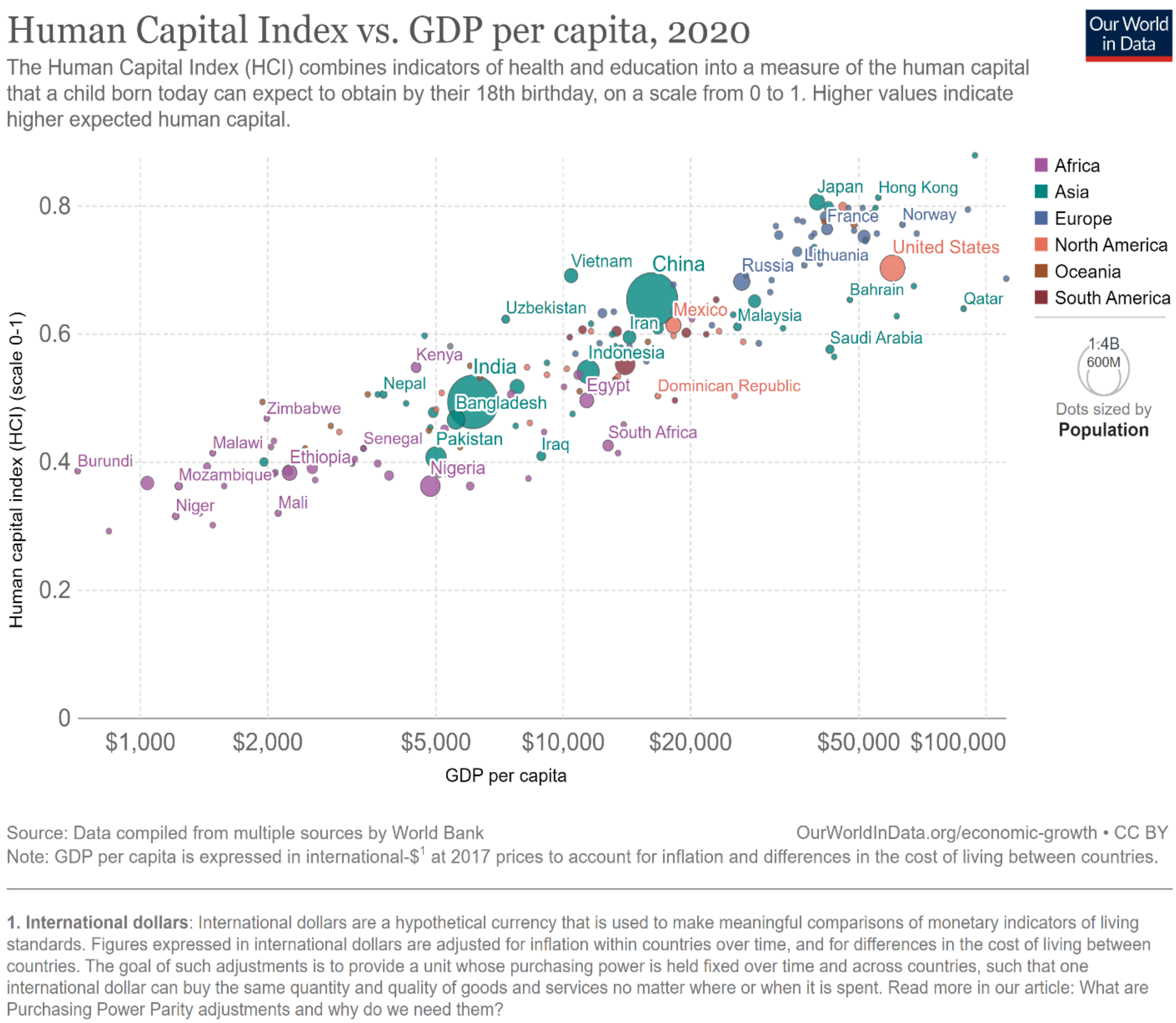

Figure 5. Human Capital Index vs. GDP per Capita. By OurWorldInData.org/economic growth

The population global growth trend is upwards. Other exponential upwards trends are capital generation – gross domestic product (GDP), energy generation and consumption, waste generation and especially anthropogenic gases generation.

The United States of America, some European Union, and other few countries have started to decrease emissions generation while China and India with the largest population continue to increase. China and India have given no indication to slow or decrease the use of fossil fuel consumption, Fig. 6. Emissions increases are disproportionately greater than the reductions. Governments in those countries, and others that are increasing fossil fuel emissions argue that

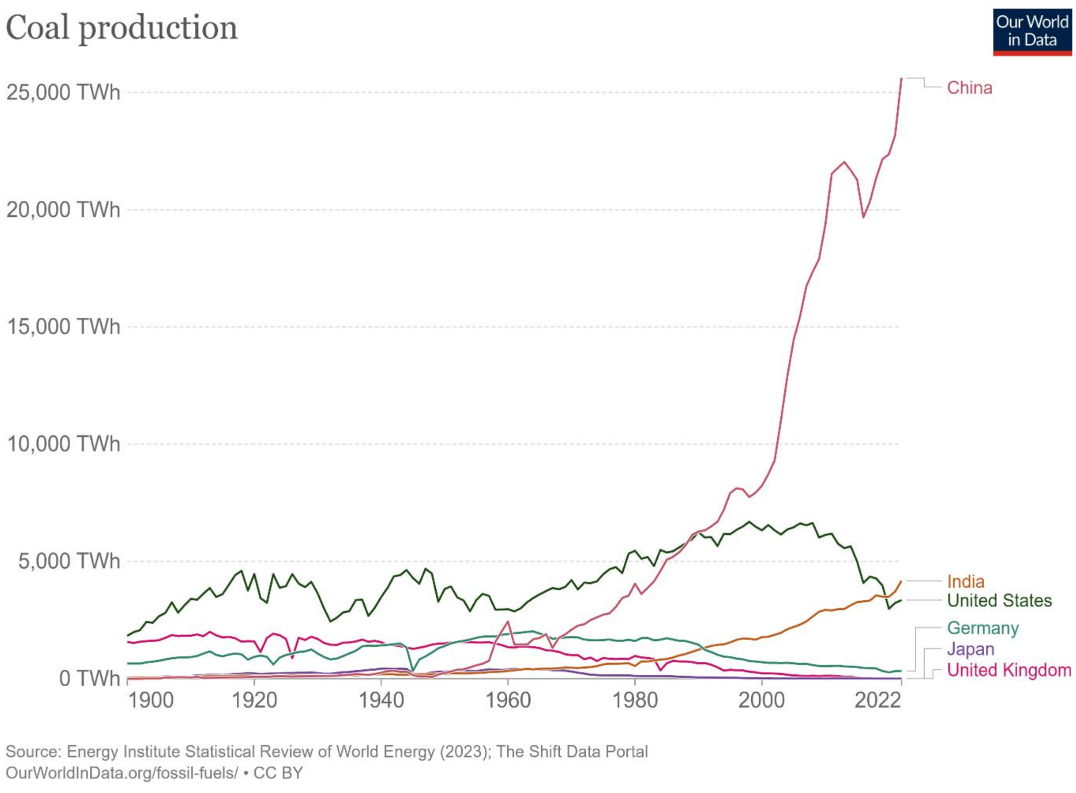

Figure 6. Coal Production by Country. By OurWorldInData.org/economic growth

they have not achieved per capita economic parity at personal and country level (GDP) with the more developed and higher per capita power consuming countries. Therefore, in their eyes they should not be restricted to limiting fossil energy production.

Humans, by exponential increases in population and economic consumption, have created a new paradigm. Some argue that in this new paradigm of current and future consumption and greenhouse emissions, most Earth life support systems are collapsing (on the verge of) reaching or at the “Termination Event.” Anthropocentric proponents argue that the critical thresholds have been crossed and systems are on a decadent spiral which does not appear to be recoverable.

Nature has responded to the initial global warming by contributing methane emissions from tropical and marsh wetlands. Scientists estimate that within the next decades we may reach a

“Termination Event” that ends the Holocene Epoch by replacing frosty expanses of tundra with tropical savanna, as in past epochs. Nisbet (2023) defines the “Termination Event” as a major reorganization of Earth’s climate systems.

Fig. 7 argues that we are entering the Anthropocene because of the graphically represented human activities. Each graph has in common an exponential growth curve for an activity that consumes resources, (Höök, and Tang 2013), and generates by product waste and emissions. Each activity plus many others natural occurring and anthropogenic (human generated) adds to the current paradigm where Earth climate is changing.

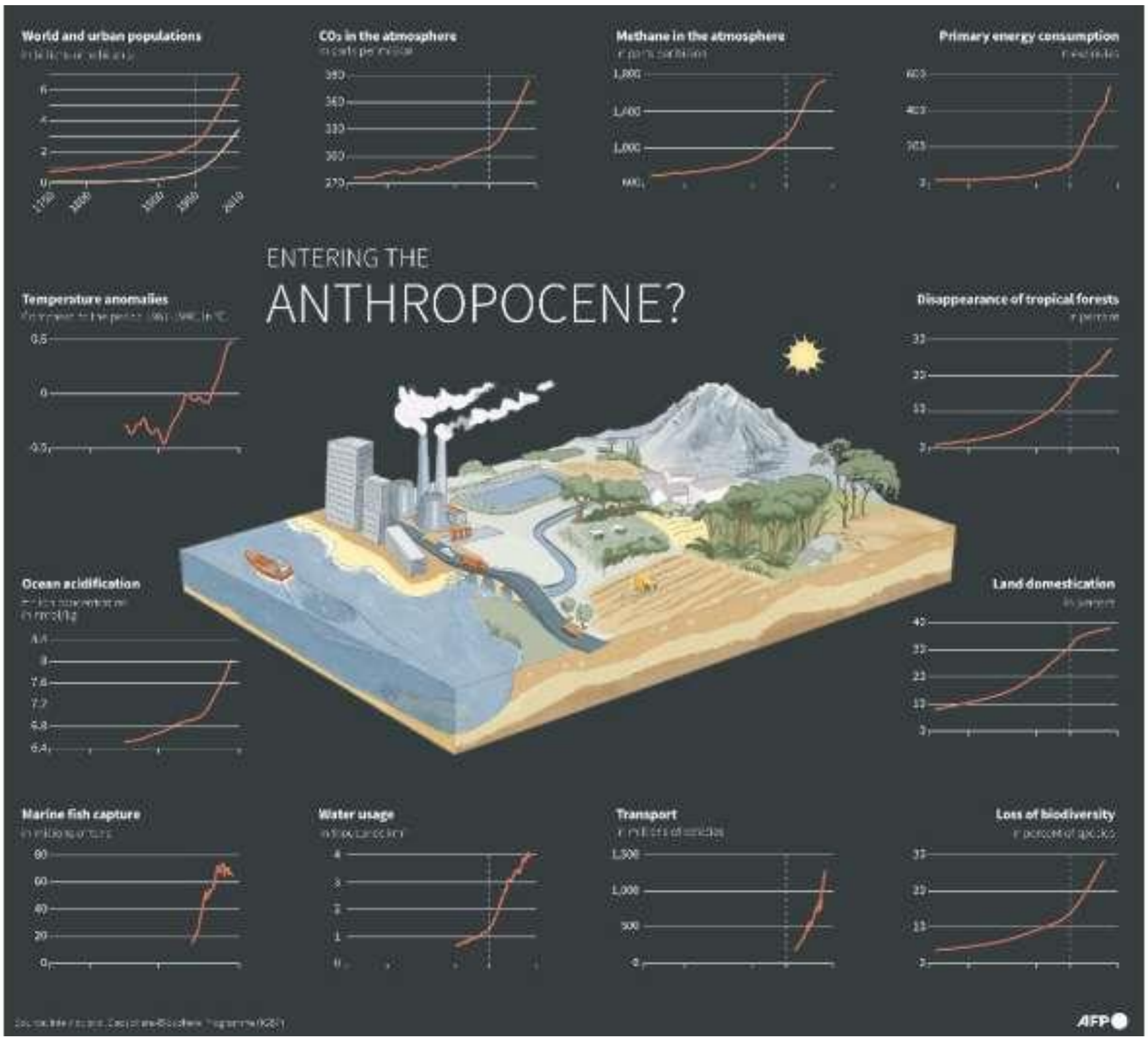

Figure 7. Is Earth entering the Anthropocene?

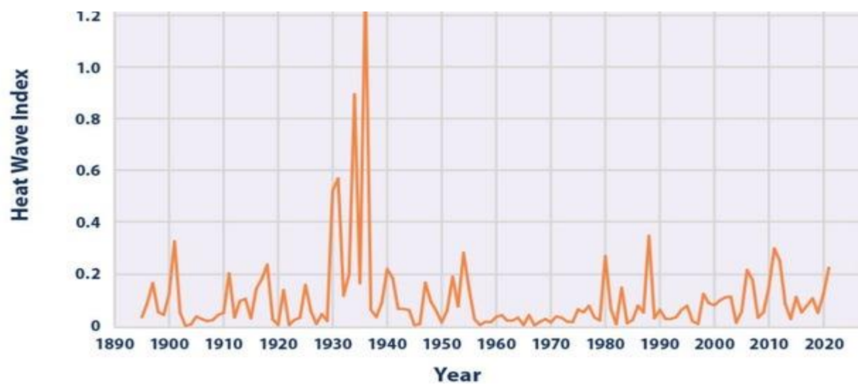

Figure 8. U.S. Annual Heat Wave Index, 1895–2021 (EPA)

Fig. 8 Environmental Protection Agency (EPA) graph indicates that the 1930's heat wave was much more pronounced, four times more intense, than the current one. The 1930's spike lasted nine years.

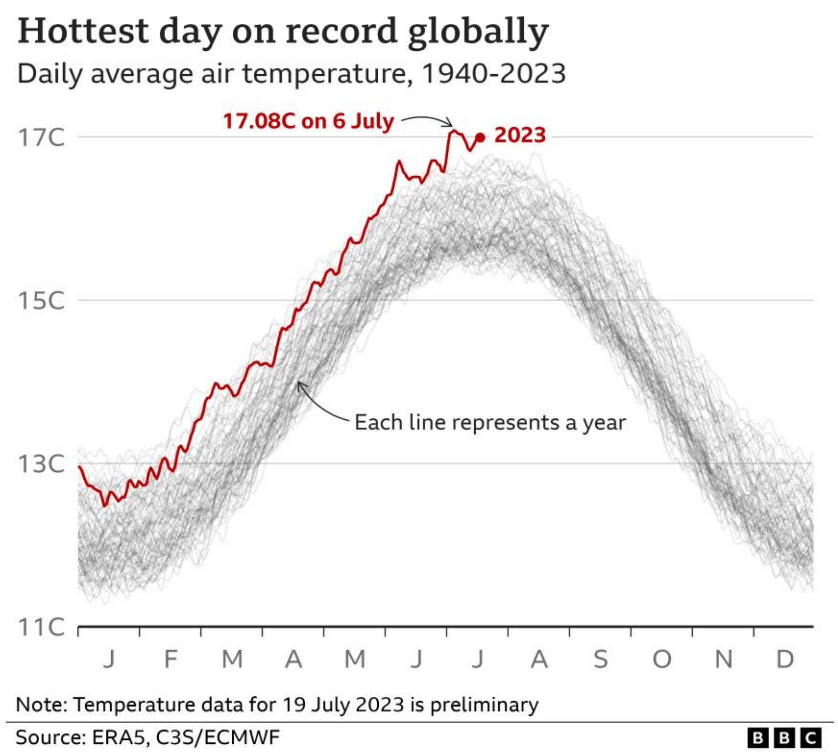

Figure 9. Hottest day 1940-2023 (ERA5, C3S/ECMWF BBC), 1930's data is not included.

As climate records tumble, Figs. 9-11, Earth is in uncharted post Holocene Epoch territory.

Fig. 10 daily average sea surface temperature between 60˚ North and 60˚ South 1973-2023.

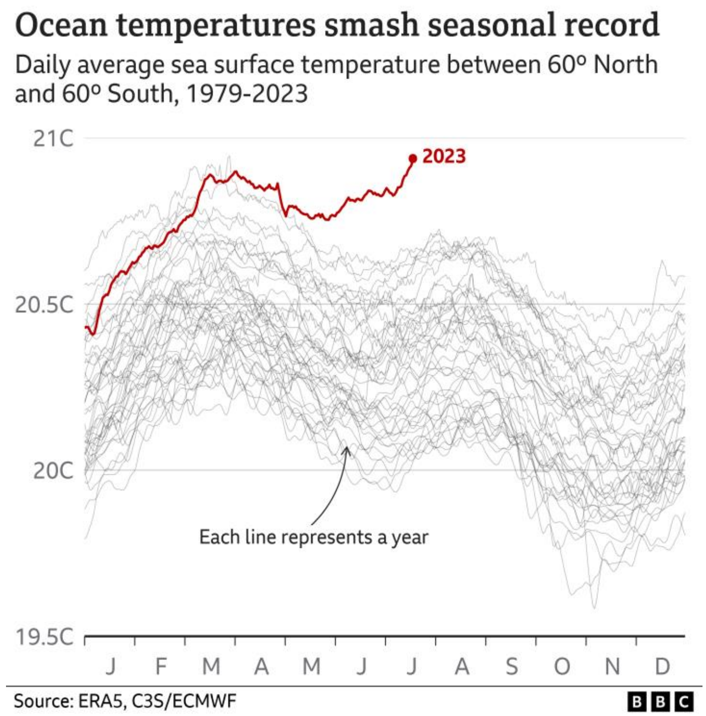

Figure 10. Ocean Temperatures 1979-2023 (ERA5, C3S/ECMWF BBC), 1930 data is not included.

Fig. 11 Antarctic sea-ice extent 1979-2023.

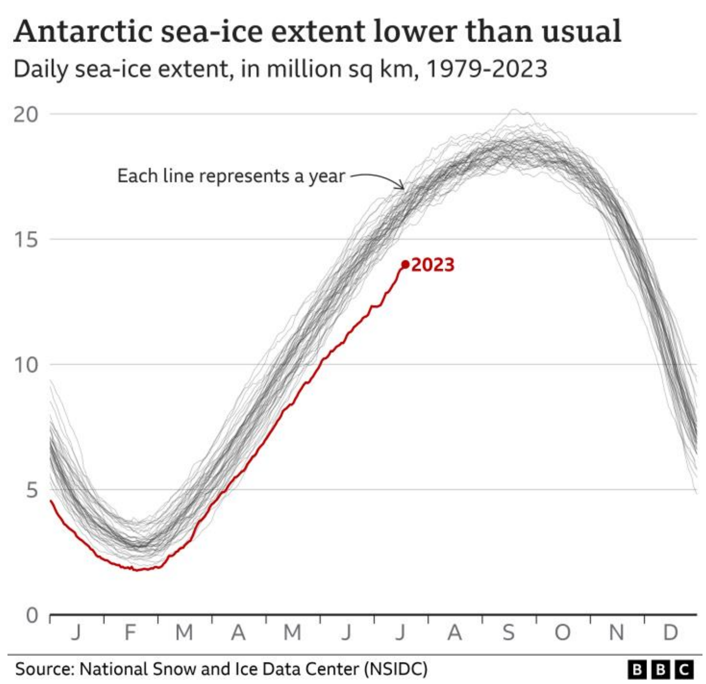

Figure 11. Antarctic Sea Ice Extent 1979-2023 (National Snow and Ice Data Center NSIDC - BBC), 1930 data is not included.

However, scientists have begun to question if these forcings are only attributed to anthropogenic activity - global warming due to greenhouse gases (carbon dioxide - CO_2, methane CH_4, Nitrous Oxide – N_2O, fluorinated gases), and their feedback mechanisms.

Additional Climate Change Sources

Besides the anthropogenic and natural global warming gases above mentioned there are four other possible sources of climate change forcing: Increased ground level Cosmic, and Solar radiation, weakening of the Geomagnetic field, and depletion of the atmospheric ozone.

Cosmic Rays

The possibility of cosmic rays affecting Earth climate are now being discovered, such as intergalactic gamma rays traveling close to the speed of light and other phenomena, Usoskin and Kovaltsov (2008). Research in these fields and how the findings may further affect Earth's climate is ongoing.

Solar Energy

Scafetta (2023) states that although the sun provides most of the energy to warm the planet, its contribution to climate change is widely questioned. Solar energy is calculated and summarized as a Solar Constant (SC).

The SC is the total radiation energy received from the Sun per unit of time per unit of area on a theoretical surface perpendicular to the Sun's rays and at Earth's mean distance from the Sun. It is most accurately measured from satellites where atmospheric effects are absent, Friis-Christensen at al. (2006) and Olsen et al. (2006 & 2009), ("Solar constant | Sunlight, Solar Radiation, Insolation | Britannica"). The value of the constant at high altitude is approximately 1,366 kilowatts per square meter, increasing by only 0.2 percent at the peak of each 11-year solar cycle. Sunspots block out the light and reduce the emission by a few tenths of a percent, but bright spots, called plagues, which are associated with solar activity are more extensive and longer lived, so their brightness compensates for the darkness of the sunspots.

Current scientific thought and textbooks portray Earth atmosphere as a dampening force that tames Sun's as well as cosmic rays. Scafetta (2023) analyses the data by comparing atmospheric and volcanic radiation (A), and solar effective radiation forcing (B) in Fig. 11.

Total Solar Irradiance (TSI) has been measured by satellites since 1978 and are proxies for Total Solar Activity (TSA) Coddington et al. (2016). Scafetta postulates that "if the proposed solar records are used as TSA proxies, and the climatic sensitivity to them is allowed to differ from the sensitivity to radiative forcings, **a much greater solar impact on climate change** is found, along with a significantly reduced radiative effect.

Scafetta (2023) calculates the Equilibrium Climate Sensitivity (ECS) due to TSA is between 1.4˚C and 2.8˚C on the current International Panel on Climate Change (IPCC) model that states that the ECS cue to anthropogenic global warming (AGW) varies between 1.8˚C and 5.7˚C. Therefore, Scafetta argues that the **IPCC is overstating AGW by 2/3, or 66% a significant overestimated amount**.

Scafetta (2023) also notes that about 80% of the above TSA contribution to the ECS may not be induced by TSI forcing alone, but rather by other sun-climate processes (e.g., by solar magnetic modulation of cosmic ray and other particle fluxes).

Earth's atmosphere is a complex system of thermal layers and chemistry that filters most cosmic and solar radiation, Wang et al. (2005), Wagner et al. (2001), Wilson and Hudson (1991). The red lines in Fig. 12 show temperatures in Kelvin during nighttime and daylight conditions accentuating the degree to which the atmosphere shields Earth from Solar radiation, Dergachev et al. (2011).

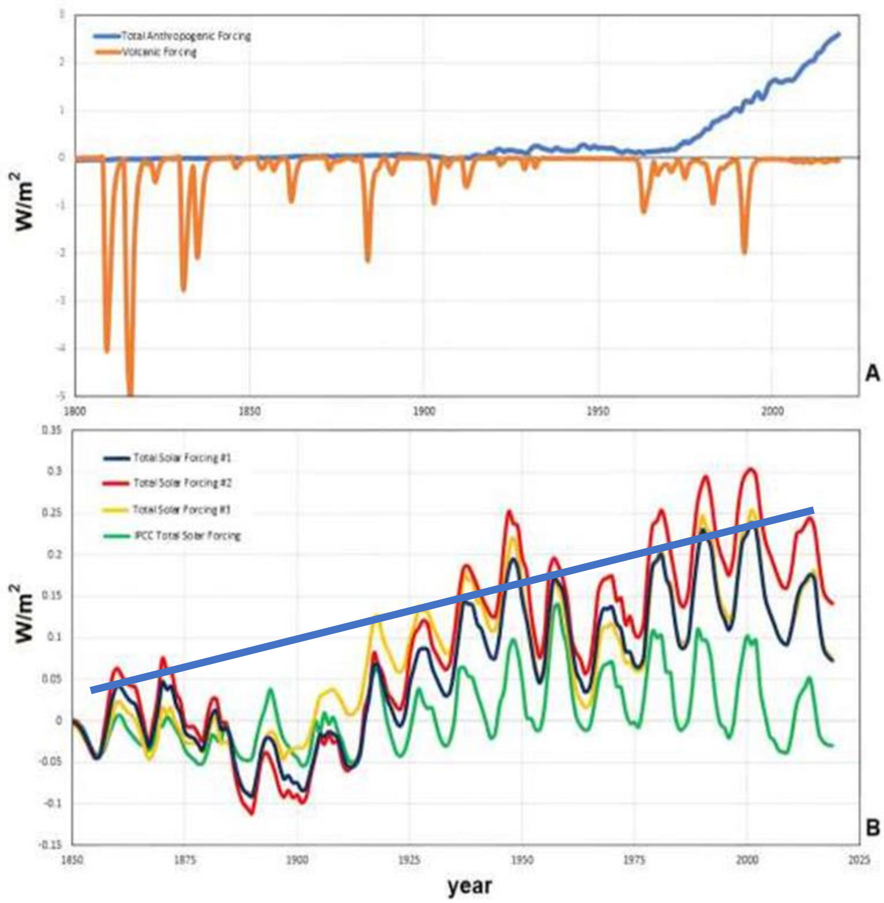

Figure 11. "(A) Anthropogenic (blue) and volcanic (orange) effective radiative forcing functions adopted by the CMIP6 GCMs." ("Understanding the role of the sun in climate change - Phys.org") (B) Possible solar effective radiative forcing functions (Blue line average). Credit: *Geoscience Frontiers* (2023).

Earth electromagnetic shield provides even more shielding from the Solar radiation, Stickler (2016). There are two kinds of solar radiation: non-ionizing and ionizing. Non-ionizing has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to remove electrons from atoms, Hansen et al. 2012) and Kelley (1989).

New insights into the activity of high energy electrons have come from a simulation study by geophysicists Katoh et al. (2023) and Sugo et al. (2023). The ionosphere is a wide region between roughly 60 to 600 kilometers above Earth and includes the Mesosphere, Thermosphere, and Exosphere, Ratcliffe (1972). Incoming electrons collide with gas molecules, a

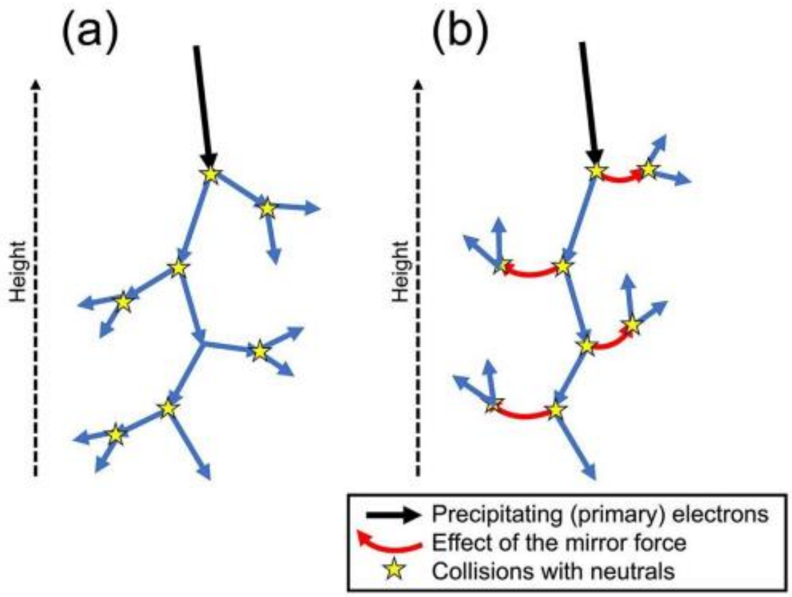

Figure 13. Relation between precipitating electrons, mirror force, and collisions with neutrals. Credit Yuto Katoh et al. ("Geomagnetic field protects Earth from electron showers - Phys.org").

process that is heavily influenced by the effects of the geomagnetic field on the charged particles involved, Prölss (2004). The Katoh team in cooperation with other universities focused on simulating the effects of a relatively unstudied "mirror force" on electron precipitation. This mirror force is caused by the magnetic force acting on charged particles under the influence of the geomagnetic field, Fig. 13.

The simulations demonstrated how the mirror force (a) causes relativistic electrons to bounce back upwards, to an extent dependent on the angles at which the electrons arrive, ("Geomagnetic field protects Earth from electron showers - Phys.org"), The predicted effect means that the electrons collided with other charged particles higher in the ionosphere than previously suspected. This confirms the higher temperatures on the upper ionosphere where sun flux interacts with the geomagnetic field, see heat shield.

On the other hand, a weak or ineffective magnetic field (b) allows the same particles to continue traveling downward towards Earth surface and warm it. Katoh (2023) explains that "Precipitating electrons that manage to pass through the mirror force can reach the middle and lower atmosphere, contributing to chemical reactions related to variations in ozone levels. Decreased ozone levels reduce protection ozone offers living organisms from additional ultraviolet radiation.

Solar radiation does reach the Earth's surface, Foukal (1981) and Foukal et al. (2006). The sunniest spot on Earth is the Altiplano of the Atacama Desert, an arid plateau near the Andes mountains in Chile that receives as much sunshine as Venus. Scientists measured the world record at the plateau at 2,177 watts per square meter, ("Chile's Atacama Desert is the sunniest spot on Earth, catching as many ..."). For comparison, the radiation at the top of Earth's atmosphere is approximately 1,366 watts per square meter, and Earth's daylight surface radiation is estimated to be on average 340 watts per square meter, a number that needs to be revised upwards in light of current scientific findings, Frigo et al. (2018).

Solar Radiation

Nisa et al. (2023) found that the energy coming from the sun and reaching Earth high altitude is at a much higher intensity than previously thought. The aftermath of gamma rays striking air in the atmosphere create what are called air showers, like particle explosions, imperceptible to the eye. "The energy of the original gamma ray is liberated and redistributed among new fragments consisting of **lower energy particles and light**," ("Scientists discover the highest-energy light coming from the sun - Phys.org").

These new particles are then visible and measurable to the High Altitude Water Cherenkov Observatory in Mexico (HAWC). Examples of this kind are radio waves, visible light and microwaves, ("Radiation Basics | US EPA"). The HAWC is located on the flanks of the Sierra Negra volcano in the Mexican state of Puebla at an altitude of 4,100 meters.

The sun through its nuclear reaction gives light spanning a range of energies where some are more abundant than the others, Fig. 14. Visible light carries an energy of about 1 electron volt. In the 1990's scientists predicted that the sun could produce gamma rays when high-energy cosmic rays smash into protons in the sun, ("Solar Surprise: Scientists Discover Unprecedented High-Energy Light ..."). However, based on what was known about cosmic rays and the suns, the researchers hypothesized it would be rare to see gamma rays reach Earth, Svensmark and Friis-Christensen (1997), Svensmark (1998).

The first observation of gamma rays came from NASA's Fermi Gamma Space Telescope in 2011 with energies of more than a billion electron volts, ("Fierce blast of light changes major

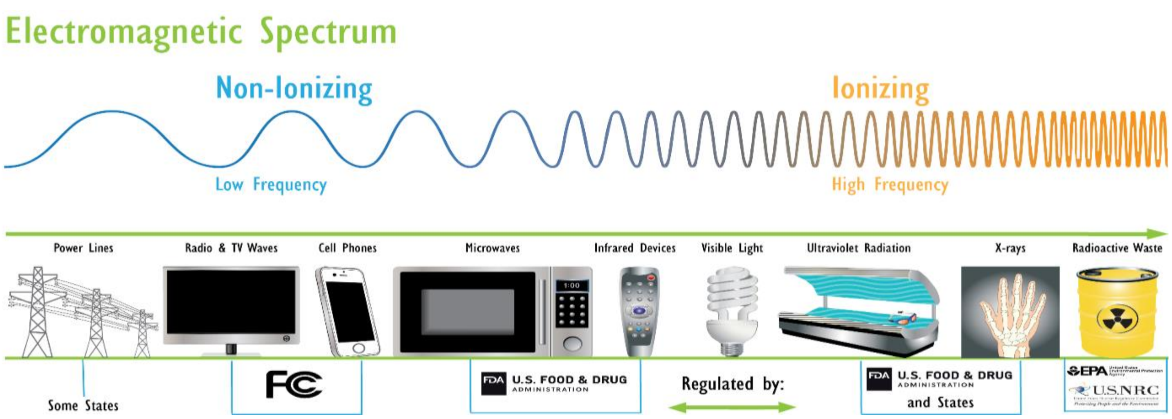

Figure 14. Solar flux in the electromagnetic spectrum, frequencies, and regulatory entities.

scientific belief about the Sun ..."). Over the years the Fermi mission showed that not only could these rays be very energetic but also that there were about seven times more of them than scientists had originally expected, ("Scientists discover the highest-energy light coming from the sun - Phys.org"). Fermi's telescope detectors maxed out around 200 billion electron volts of gamma ray energies.

The gamma rays that Nisa et al. (2023) observed in Mexico, at HAWC ground level had about 1 trillion electron volts or 1 tera electron volt (1TeV). A surprising energy level and even more the fact that they were seeing so much of it. New reading indicates that the energies have not peaked at the current reading of 10 TeV. These lower energies particles and frequencies, Table 1, indicate increased visible light spectrum as well as ultraviolet and others.

Katoh's (2023) discovery of Earth's electromagnetic shield acting as a mirror of particles may be key to the questions of why we are seeing so much and such powerful gamma particles. A weakened magnetic field is allowing more gamma rays to penetrate Earth's outer atmosphere instead of being reflected upwards.

Ionizing radiation has so much energy it can knock electrons out of atoms, a process called ionization and the atoms then undergo radioactive decay. Examples of ionizing radiation are Alpha Particle (α), Beta Particles (β), Gamma Rays (γ), and X Rays (χ). χ rays are similar to

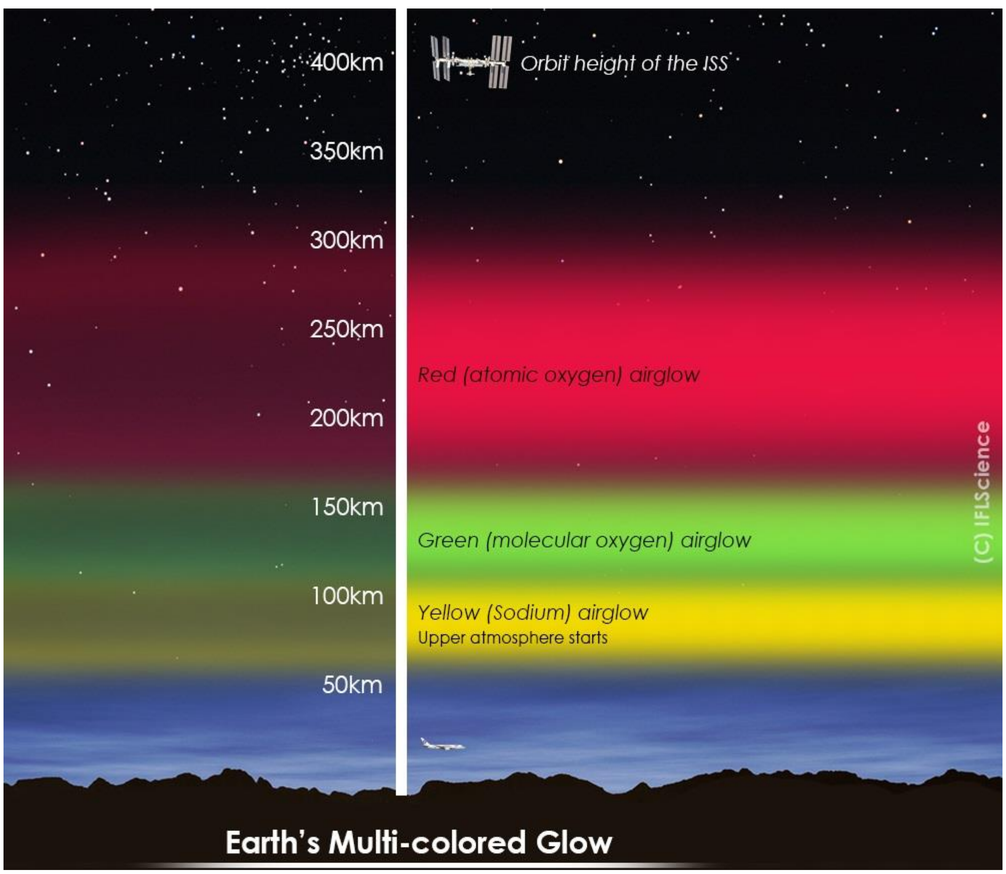

Figure 15. The altitude at which solar winds react with Earth's atmosphere determines the color of the aurora. *Image credit: © IFLScience*

Gamma rays in that they are photons of pure energy but come from different parts of the atom (χ rays from processes outside the nucleus and γ rays from inside the nucleus), ("Radiation Basics | US EPA").

Incoming ultraviolet, visible, and a limited portion of infrared energy (short wave radiation) from the Sun drive the Earth's climate system, ("The Earth's Radiation Budget | Science Mission Directorate"). Some of this radiation is reflected by clouds. More heat, more condensation, more clouds. Some are absorbed by the atmosphere, interacting with larger aerosols, such as anthropogenic emissions (greenhouse and natural gases) heating the upper atmosphere. Some passes through and heats Earth's surface.

The amount of solar flux that penetrates Earth magnetic shield is determined mostly by the strength of the shield given our observations of solar fluctuations over time. From 24th to th3 28th of September 2023, Earth atmosphere experienced massive spews of plasma from the sun, coronal mass ejections (CME) that punched a hole in earth magnetic field, enabling highly charged particles to pour through and trigger a G2-class geomagnetic storm. Typically, solar winds reach an altitude between 100 and 150 kilometers where there is a high concentration of oxygen atoms for suns photons to react with and emit yellow-green lights, the dominant color or auroras. This time the amount of photons in the Sun's plasma was over 200% higher, affecting higher altitudes, 150 to 400 km where there is less oxygen and emitting scarlet red auroras due to the intensity of the plasma as well as a weakened earth magnetic field, Fig. 15.

Currently Earth's magnetic shield strength is decreasing. In this case more total insolation arriving at Earth's surface is now shown that is increasing by more than 1% in the past twenty years, Kate and Fernandez-Solis 2021, Fig. 15. Therefore, the whole electromagnetic spectrum reaching Earth's surface to some degree is increasing, but especially the non-ionizing radiation. Earth is receiving a minimum of 340 + 40 = 380 watts per square meter of daylight average.

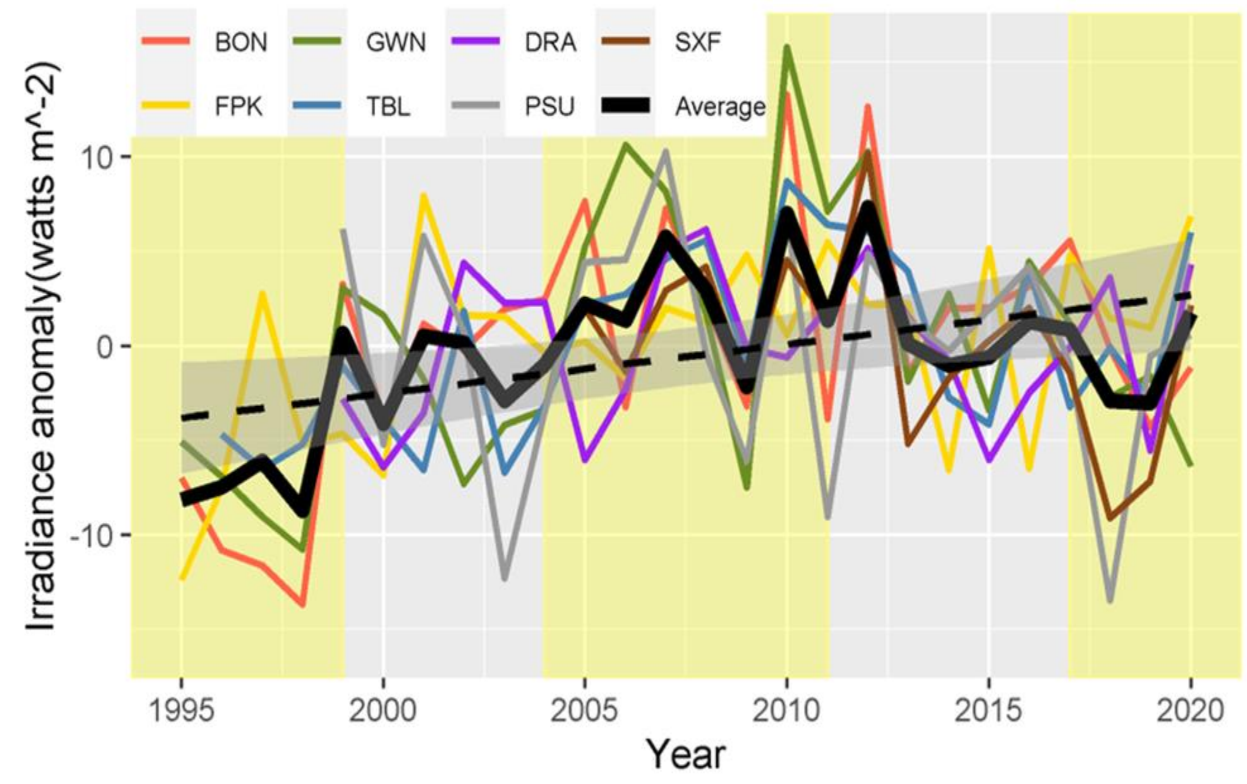

Figure 15. Solar irradiances increase over time across multiple solar maxima and minima from multiple observatory stations in the USA.

There are several measured types of solar irradiance.

- **Total Solar Irradiance** (TSI) is a measure of the solar power over all wavelengths per unit area incident on the Earth's upper atmosphere. It is measured perpendicular to the incoming Sunlight. The solar constant is a conventional measure of mean TSI at a distance of one astronomical unit (AU), Kopp and Lean (2011), Krivova et al. (2007), Lean (1989), Scafetta and Willson (2014), Solanki et al. (2013), Steinhilber et al. (2009).
- **Direct Normal Irradiance** (DNI), or *beam radiation*, is measured at the surface of the Earth at a given location with a surface element perpendicular to the Sun.[6] It excludes diffuse solar radiation (radiation that is scattered or reflected by atmospheric components). Direct irradiance is equal to the extraterrestrial irradiance above the atmosphere minus the atmospheric losses due to absorption and scattering. ("Solar irradiance - Wikipedia") Losses depend on time of day (length of light's path through the atmosphere depending on the solar elevation angle), cloud cover, moisture content and other contents. The irradiance above the atmosphere also varies with time of year (because the distance to the Sun varies), although this effect is generally less significant compared to the effect of losses on DNI, Nonnenmacher et al. (2014).
- **Diffuse Horizontal Irradiance** (DHI), or *Diffuse Sky Radiation* is the radiation at the Earth's surface from light scattered by the atmosphere. It is measured on a horizontal surface with

radiation coming from all points in the sky excluding *circumsolar radiation* (radiation coming from the Sun disk). There would be almost no DHI in the absence of atmosphere.

- **"Global Horizontal Irradiance** (GHI) is the total irradiance from the Sun on a horizontal surface on Earth," (“Solar irradiance - Wikipedia”). It is the sum of direct irradiance (after accounting for the solar zenith angle of the Sun *z*) and diffuse horizontal irradiance:
- **"Global Tilted Irradiance** (GTI) is the total radiation received on a surface with defined tilt and azimuth, fixed or Sun-tracking." GTI can be measured or modeled from GHI, DNI, DHI, (“What Is Solar Irradiance? 10 Things You Must Know - Gokce Capital”). It is often a reference for photovoltaic power plants, while photovoltaic modules are mounted on the fixed or tracking constructions, Gueymard (2009), (“Solar irradiance - Wikipedia”).
- **Global Normal Irradiance** (GNI) is the total irradiance from the Sun at the surface of Earth at a given location with a surface element perpendicular to the Sun, Fligge and Solanki (2000).

"The Earth facing the sun always receives 410 x 10^{18} Joules each hour!" (“Scholars - demos.library.tamu.edu”) A one-percent increase means 410 x 10^{16} Joules **per hour**! In comparison, the total amount of energy that humans **use in a year** is 410 x 10^{18} Joules, (Harrington, 2015). Hence the increase per hour when compared to human energy use per year is significant.

Current theories indicate that global warming due to anthropogenic-forcing causes solar radiation to bounce from the different layers of the Earth’s atmosphere. If this theory is correct, Earth should be receiving less and not more solar irradiance at ground level. However, this heat bouncing from surface to clouds and back preventing its reach of higher atmosphere that, therefore, is getting colder.

Geomagnetic Field

Earth’s magnetic shield is losing strength, Fig. 16; therefore, the mirror effect is weakening (Katoh et al. 2023 and Sugo et al. 2023), allowing solar entire spectrum irradiance but specially gamma rays to reach Earth’s surface at increasing levels, Christl et al. (2004). Bodner Research Web and EPA Radiation Basics have excellent graphics based on classical understanding of solar radiation.

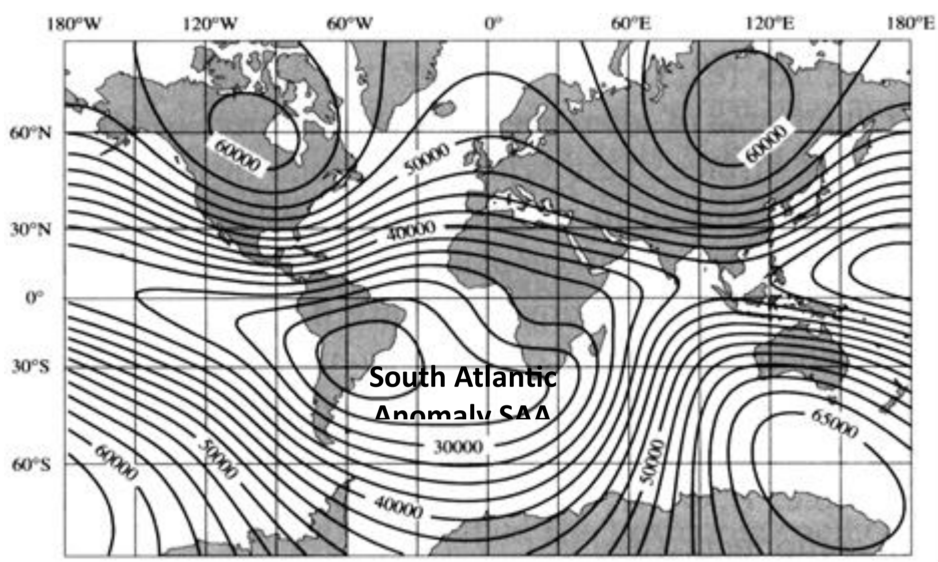

Figure 16. Total magnetic field nano Tesla (nT) showing one SAA anomaly.

However, very recent scientific insights have shed new light on how the Geomagnetic field protects Earth from electron showers, Gubbins et al. (2006), Gubbins (1987).

Earth's Magnetic Field (EMF) and its electrical current are related. Both are essential in protecting Earth from the Sun and Intergalactic weather. Disturbance of EMF during a polarity excursion or reversal (secular variation – intensity, and declination – dislocation) affects its electrical component, both of which are essential in maintaining atmospheric integrity. The cause of a polar excursion or reversal is from within Earth's core mantle, De Santis and Qamili (2015). The visibility of northern and southern lights at the equator will be one of the signs that the reversal has taken place. The others are more ominous.

The magnetic field is about 80% dipolar and 20% non-dipolar. For the last 100 years the EMF has been decreasing and currently is 20% weaker and weakening. If a reversal occurs, it is expected that the EMF will become 20% dipolar and 80% non-dipolar or more complicated. The last time this happened was approximately 780,000 years ago around the era when Homo Erectus appeared after the last ice planet earth condition. The population of human ancestors crashed between 800,000 and 900,000 years ago during an ice age. Estimates based on a model published 31st August 2023, by a team of international scientists calculate that there were only 1,280 breeding individuals, a decline of 98.7% of the ancestral Neanderthal population during a bottleneck that lasted roughly 117,000 years, Fig. 17. This is a time not only of ice planet but also 80% non-dipolar EMF. The ice covered globe shaped oceans and land masses that we see today.

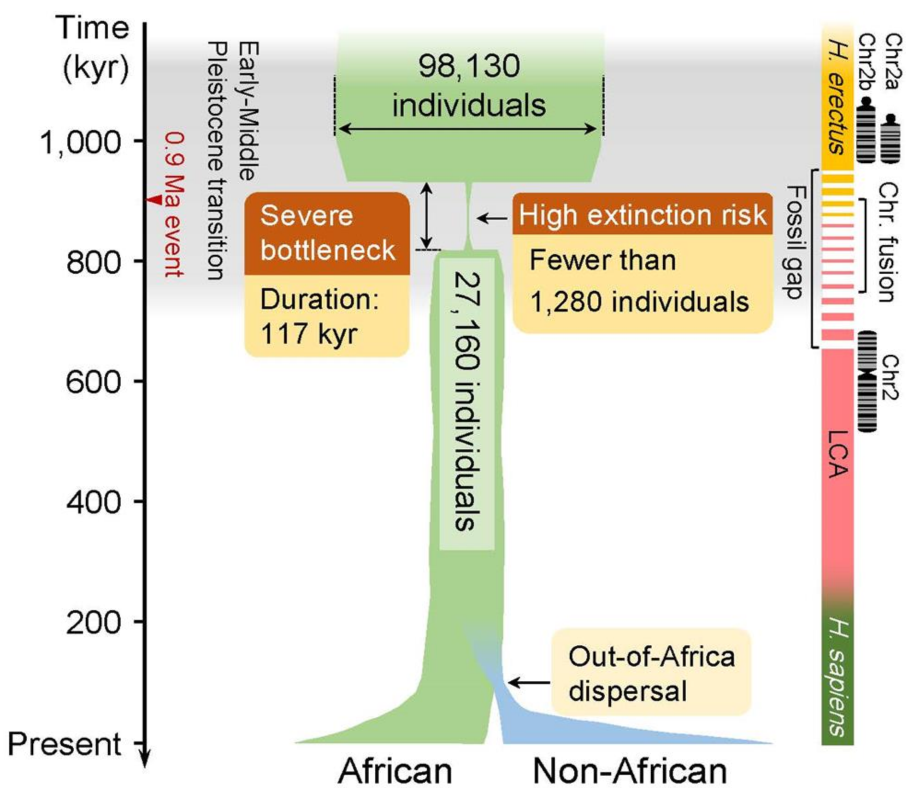

Figure 17. African hominin fossil gap and the estimated time period of chromosome fusion, shown on the right. Credit: Science

High values of EMF protect Earth differently than low values of EMF. High values of EMF, Snowball and Muscheler (2007) argued, reinforce the Solar system shield hence low density of galactic cosmic rays penetrating the solar system and in turn Earth's shield. Likewise, high values of Earth's EMF reinforce Earth's shield, Usoskin and Kovaltsov (2008). These researchers were looking at high energy galactic and sun rays, specially betta, gamma and x rays.

Otherwise, a decrease in solar and Earth's EMF intensities would allow a higher penetration of galactic cosmic rays to Earth protective shield and eventually to Earth's surface warming mainly the waters but also the land. Warm water enhances the formation of low-lying clouds leading to increased greenhouse feedback forcing while at the same time tropospheric cooling (Christl et al. 2004) and Svensmark (1998).

Furthermore, on a long-time scale, Dergachev et al. (2021), Gallet et al. (2005), and Pavón-Carrasco (2008) studied and proposed a link between centennial-scale cooling episodes (Gallet et al. 2005) and a strong decrease of EMF activity, reinforcing the findings of Wollin et al. (1971) - Magnetism of the earth and climatic changes , Bucha (1976 and 1978) - Variations of the geomagnetic field, the climate and weather, De Santis et al. (2012).

More than one percent radiation from the sun at atmospheric and Earth surface levels in terms of insolation has catastrophic effects on the amount of energy that clouds, oceans and land receive and reflect with the resultant effects on the climate, Fig. 17.

The Earth facing the sun always receives 410 x 10^{18} Joules each hour! A one-percent increase means 410 x 10^{16} Joules per hour! In comparison, the total amount of energy that humans **use in a year** is 410 x 10^{18} Joules, (Harrington, 2015).

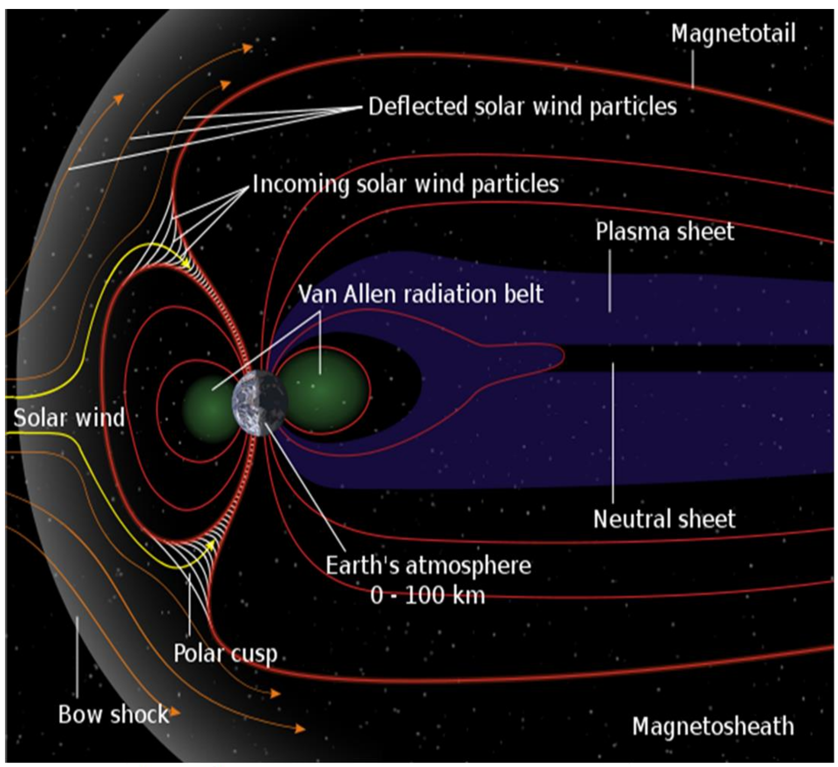

Figure 17. Earth's magnetic field in space. Credit NASA

Polar ozone depletion

Both, anthropocentric effects on climate change and increased solar irradiance and insolation due to a weakened geomagnetic shield are climate change drivers with feedback and forcing mechanisms that interrelate and affect Earth overall average temperature.

Some solar radiation bounces off of our upper atmosphere while the rest travels downward. Some of that radiation is absorbed by the air and the ground. The remainder of the radiation reflects off the surface of the Earth. Most of that escapes into space, but some of it is reabsorbed by the atmosphere creating a greenhouse effect that warms our surface to temperatures greater than what could be achieved without it, ("Without ozone, the Earth might get a lot colder - Phys.org").

The ozone layer, critical for blocking ultraviolet radiation from the sun, is also critical to Earth's climate. In short, we have not always had an ozone layer. "Before the emergence of life, ozone was essentially non-existent in our atmosphere," ("Scientists Reveal What Would Happen if The Ozone Layer Vanished"). Earth spent billions of years with only a minimal ozone layer as oxygen was scarce or non-existent. Molecular oxygen, when it appeared, played little role in climate but a major role in creating the ozone layer which did and does affect Earth's climate.

Deitrick et al. (2023) observes that recent complex research models varying the amount of ozone in the upper atmosphere and allowed to reach equilibrium has a warming effect on Earth's surface temperatures by approximately 3.5 Kelvin (- 273 Centigrade or - 460 Fahrenheit). In this model, if ozone were to disappear, Earth would be in snowball or ice planet condition.

The primary effect of a lack of ozone would be a cooling of the upper atmosphere, which could not hold on to much moisture causing the stratosphere to be dryer and much colder. A reverse of the greenhouse feedback loop. In fact, the anthropogenic and natural greenhouse effects on Earth would be diminished or disappear. Earth would continue to receive greater amounts of sun insolation and radiation because of the weaker geomagnetic field, De Santis et al. (2013).

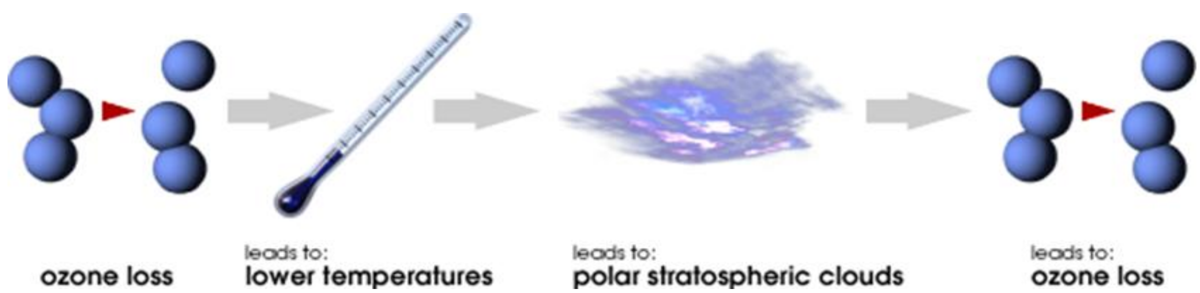

Figure 18. Ozone atmospheric reactions. Courtesy of Mark R. Shoeberl, NASA, GSFC

Deitrick (2023) states that the lack of ozone and the resulting cooling of the stratosphere would also destabilize that layer of the atmosphere preventing the formation of clouds, Fig. 18. This would force clouds to only appear at lower and higher altitudes. Jet streams would be strengthened near the equator, while others near the poles would be weakened. ("Scientists Reveal What Would Happen if The Ozone Layer Vanished") This scenario portrays drastic consequences for seasonal weather patterns at all latitudes.

Deitrick's (2023) computer generated model scenario, although possible in geological time scale, is not probable in near or far future. Furthermore, the model generated 3.5 Kelvin scenario of an atmosphere without ozone is suspect since the solar system vacuum is estimated to be 10 Kelvin. The vacuum between galaxies is estimated to be as low as 3 Kelvin. However, the model is useful in establishing that ozone is a critical factor that affects Earth's temperature and climate.

The ozone – climate relation is complex as the ozone affects the climate and the climate affects the ozone. Temperature, humidity, winds, and the presence of other chemicals in the atmosphere influence ozone formation, and the presence of ozone, in turn affect those atmospheric constituents.

Stratosphere ozone absorbs ultraviolet rays and upwelling infrared radiation from lower atmosphere (troposphere) and generates heat, increasing temperature. Conversely, decreased ozone in the stratosphere results in lower temperatures. Observations show that over recent decades, the mid to upper atmosphere (from 30 to 50 km above the Earth's surface) has cooled by 1 to 6 degrees Centigrade (2 to 11 degrees Fahrenheit). This has taken place at the same time that greenhouse gas amounts in the lower atmosphere (troposphere) have risen. A paradox of two linked phenomena.

The stratospheric cooling depletes ozone in a feedback loop. The more ozone destruction in the stratosphere, the colder it would get, and the more ozone depletion would occur. ("NASA GISS: Research Features: Ozone and Climate Change") The deepest ozone losses over both the Artic and Antarctic result from special conditions that occur in the winter and early spring. Scientists explain these special conditions - as winter arrives, a vortex of winds develops around the pole and isolates the polar stratosphere, ("NASA GISS: Research Features: Ozone and Climate Change").

Chemical reactions on the surfaces of ice crystals in the clouds release active forms of chlorofluorocarbons (CFCs), ("Tango in the Atmosphere: Ozone and Climate Change - NASA Earth Observatory"). Ozone reacts with the CFC's and depletion begins, and the ozone "hole" appears. "In spring, temperatures begin to rise, the ice evaporates, and the ozone layer starts to recover," ("NASA GISS: Research Features: Ozone and Climate Change").

When temperatures drop below -78 degrees Celsius (-109 degrees Fahrenheit), thin clouds form ice, nitric acid, and sulphuric acid mixtures, Fig. 19.

This year, 2023 the ozone hole appeared earlier due to the 2022 eruption of the Hunga Tonga-Hunga Ha'apai volcano eruption that injected 150 megatons amount of water vapor into the stratosphere. The water vapor formed the ice clouds with nitric, sulphuric acid, and CFC's. This year hole compares with the ozone depletion hole in the year 2000. Higher-than-usual 2023 temperatures at the lower atmosphere due to greenhouse emissions are expected to continue.

Scientists now believe that greenhouse gases in the lower atmosphere are retaining the heat that would normally warm the stratosphere, hence the paradox of hot below and colder above.

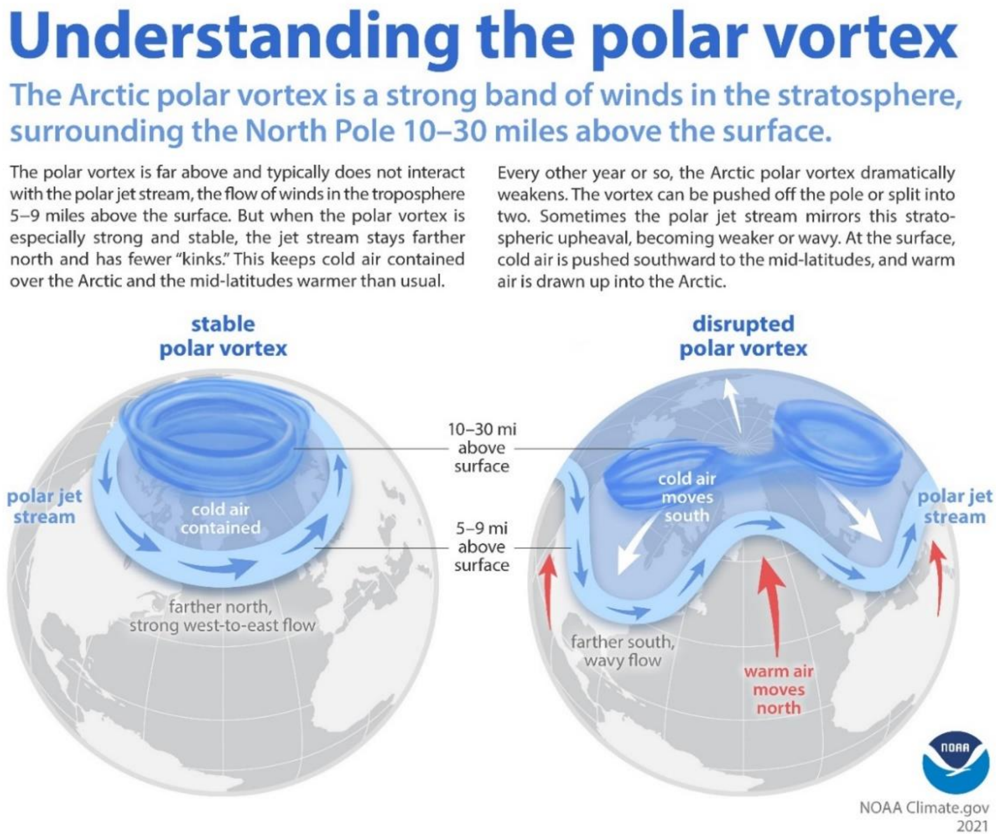

Figure 19. Understanding polar vortex. Courtesy of NOAAClimate.gov 2021

Ozone depletion allows more ultraviolet rays and other solar rays to penetrate the atmosphere and heat Earth's surface, another vicious feedback loop. At some point two critical thresholds will be crossed: Earth becomes much hotter, and the atmosphere becomes much colder. This dichotomy will generate abnormal winds, polar vortices, and jet patters. Scientist caveat applies, we need more data and information on the interaction of the different atmospheric layers. What is certain is that Earth's climate will change, thresholds crossed, and the anthropocentric epoch will follow.

Summary

This article comprehensively reviews multiple factors that may be contributing to climate change beyond just human-caused emissions, including cosmic rays, solar radiation, weakening of Earth's magnetic field, and ozone depletion. It provides significant detail and scientific evidence on each factor. The article discusses complex interrelationships and feedback loops between different climate drivers. It also highlights how factors like ozone depletion and weakened magnetic field may amplify effects of increased solar radiation.

The article research draws on a wide range of scientific studies across multiple disciplines like space physics, atmospheric science, geophysics, etc. and includes numerous references to support key points.

The article proposes that climate change may be progressing towards paradoxical effects of overheating at surface and cooling in upper atmosphere and provides plausible mechanisms for how this could occur.

However, this article's scope is broad, covering many complex topics at a high level, therefore more research is needed to increase the depth of critical interrelationships between factors. The author notes that arguments for cosmic rays and increased solar irradiation having significant climate impact are still speculative and controversial in climate science community. More research is needed to quantify their effects. Likewise, while ozone depletion is discussed, potential impacts of CFC emissions of greenhouse effect are not mentioned, as this is covered in great detail by others.

Conclusions

The Anthropogenic Epoch is when humanity sheer numbers and living patterns adversely affects Earth's systems that cross critical threshold and ushers the new geological epoch because of irreversible patterns of consumption and emissions generation. These patterns are augmented by natural phenomena of which EMF and ozone weakening are mayor players by allowing increased solar radiation to penetrate Earth's shields and increase lower atmosphere greenhouse feedback loops that sizzle Earth while at the same time increasing higher atmospheric cooling that bring space freezing coldness closer to Earth's surface.

Overall, the article reviews lesser-known factors that may be contributing to climate change beyond just greenhouse gas emissions. It highlights the complexity of Earth's climate system and the need to better understand feedback between different components. However, some arguments are still speculative and not widely accepted, so should be considered hypotheses for further research rather than definitive conclusions. Overall, it serves as a thought-provoking review that highlights gaps in current climate change understanding.

Conclusions summarize possible future climate scenarios but do not provide specific recommendations on actions to address factors driving climate change, as recommendations are beyond the scope of this article.

The future appears to be a paradox where the planet jumps from a convection oven frying to an unimaginable freezing, an ice planet condition. Between the sun and space, geological history indicates that the coldness of space is a greater influence.

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