

Changes in Earth's Magnetic Field are a main cause of Volcanism, Earthquakes, HGFA-seismicity & Global Warming

Please also read : [Part 1](#) of my Climate Hypothesis

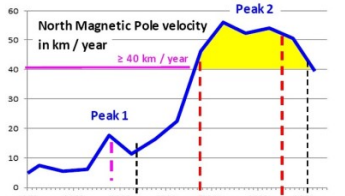
Abstract : by **Harry K. Hahn / Germany - 11.10.2023** - **Note :** This document is not allowed for commercial use !!

Changes in Earth's Magnetic Field seem to be a main cause of Volcanic-Eruptions on Earth ! These changes (or disturbances) in Earth's Magnetic-Field can be caused either by internal processes which take place near the Core-Mantle-Boundary (CMB), or they can be caused by external events which are strong geo-magnetic-storms caused by solar wind (space-weather). The maximum impact on volcanism, of the geomagnetic-changes caused by internal processes seems to be around +/-30%, and the maximum impact of the external events seems to be around +/-20%. There is a correlation of geo-magnetism, HGFA-seismicity, volcanism and global warming. First the geomagnetic-changes (-disturbances) seem to cause earthquakes, especially in High-Geothermal-Flux-(HGF)-areas (e.g. mid-ocean-ridges etc.), then with a delay of 1-2years Volcanism (& hydrothermal-activity, mainly in submarine-areas) is increasing, which then rises the Ocean-Heat-Content (->El-Nino-events), and eventually accelerates Global-Warming. → Please also read my **Study-1** which explains the causes of the El-Nino-events between 1997 and 2023 !

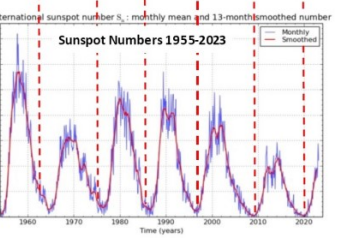
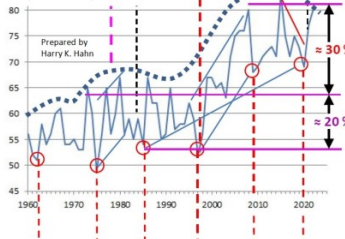
We can see a sharp rise and an elevation of the global-volcanic-activity (active volcanos per year) since around 1997, just after the sharp acceleration of the North-Magnetic Pole-shift (Pole-wander) began, around 1-2 years before. The chart of the -Worldwide Active Volcanos per Year- clearly follows a very similar trend as the chart of the North-Magnetic-Pole-Velocity (N-MPV), if a smoothed chart of the -Active Volcanos/Year- is considered (indicated by the dotted (symbolic) line above the chart). This trend is also visible if we look at Volcanism in very different regions (like South-America, Indonesia, SW-Pacific etc.).

The velocity of the North-Magnetic-Pole-shift (N-MPV) was <20km/yr before 1990 (for the last 400 years !), and it increased to >45km/yr in 1997 ! In just 7 years it more then doubled ! This fast North-Magnetic-Pole-shift is caused by an interference/interaction between two large lobes (blobs) of negative -magnetic-flux near the Earth's core-mantle-boundary (CMB), as Satellite-data of ESA's Swarm-mission showed. This fast North-Magnetic Pole-shift, which can be explained by big shifts of either fluids or electric-charge near the CMB, is a onetime-event which has increased global-volcanism by around 30% between ~1997 & 2015 (see charts), probably caused by increased pressure inside Earth's mantle, as a result of increased dynamical-processes near the CMB. Since around 2016 the N-MPV has decreased from over 50 km/yr to below 40km/yr and is further

Global Volcanism is correlated with the North-Magnetic Pole-shift & Solar Cycles

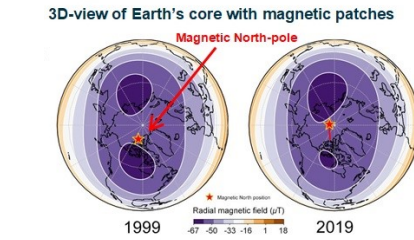
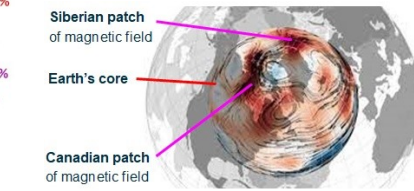


Worldwide active Volcanos 1960-2022 (volcanos / year)

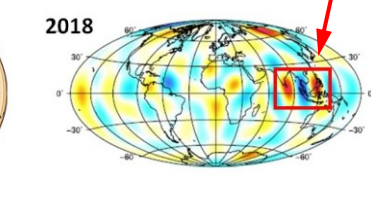
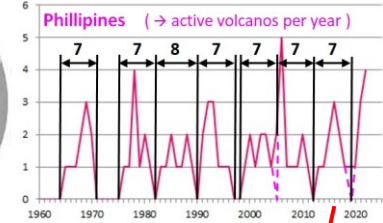


decreasing, which means that the geomagnetic-effect of the N-MPV on global volcanism will disappear in the near future ! Another effect which must be mentioned here : Strong magnetic-acceleration-patterns (magnetic-waves) which are located along the equatorial regions of the CMB, and which move around Earth's outer-core with a 7-year period seem to influence Volcanism too. The -number of active volcanos- in the Phillipines which oscillates with a ~7-year period between 0 and ~3 may be the proof for that. Further there is a clear correlation of sunspot-(solar-cycle)-minimas and Lows in the chart of the -Active Volcanos per year- which shows that Earth's Volcanism is clearly influenced by strong geomagnetic-storm-periods, or by the missing of such storm-periods ! During sunspot-minimas global volcanism clearly decreases by around +/-20%! Further the chart of -Total Volcanic Eruptions per year- and strong geomagnetic-storms from 1800–2023 shows that there are sharp increases in volcanic-eruptions visible, shortly after strong geomagnetic-storm-periods !

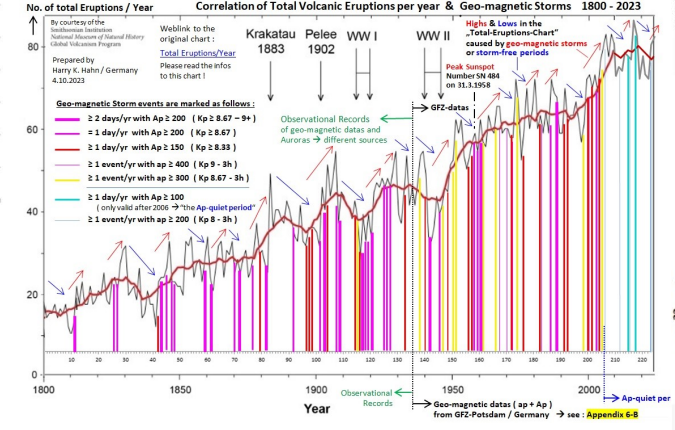
The North-Magnetic Pole-shift is caused by the interaction of 2 magnetic blobs near Earth's core



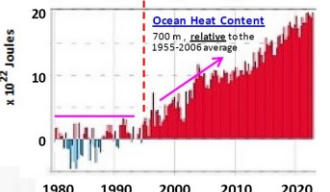
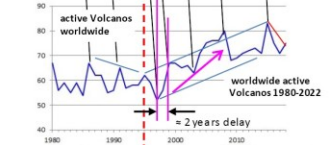
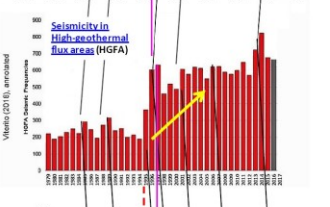
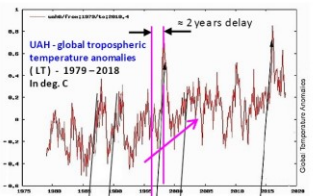
Magnetic acceleration pattern with 7yr-period causes periodic volcanism in the Phillipines ?



Correlation of Total Volcanic Eruptions with strong Geomagnetic storm-periods between 1800 and 2023. Eruptions rise sharply 1-2yr after geomagnetic storms

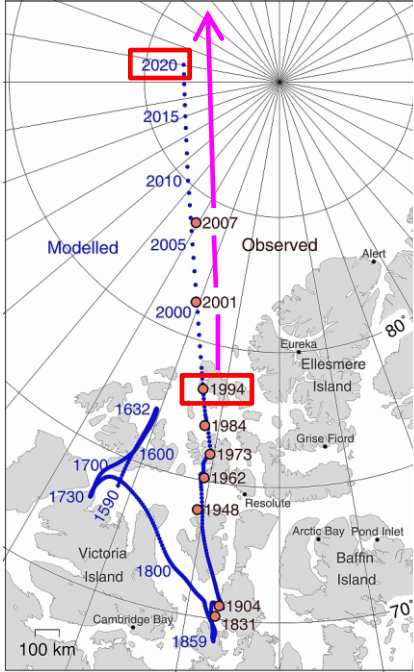


Volcanism correlates with seismicity in HGF-areas and Global Warming

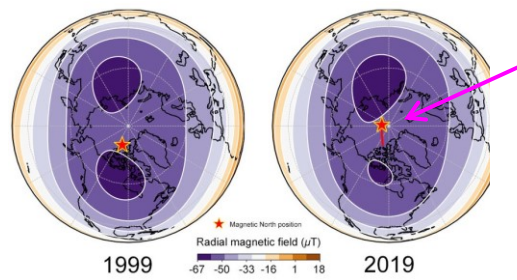


The fast shift of the North-Magnetic-Pole seems to be responsible for increased Volcanism & increased Global Warming from ≈ 1997 - 2023

North magnetic pole positions 1590-2020



Siberian patch of magnetic field
 Earth's core
 Canadian patch of magnetic field
 3D-view of Earth's core with magnetic patches



Tug between two magnetic blobs - A change in the circulation pattern of flow deep under Canada has caused a patch of magnetic field at the core-mantle-boundary to be stretched out. This weakened the Canadian patch and resulted in a fast magnetic pole shifting towards Siberia

Changes in Earth's magnetic field seem to be the main cause of volcanic eruptions on Earth!

The chart of the **Worldwide Active Volcanos per Year** clearly follows a **very similar trend** as the chart of the **North Magnetic Pole Velocity (N-MPV)**, if we consider a smoothed chart of the **Active Volcanos / Year** (dotted line in the chart) → see charts below on the Left.

We can see a sharp rise & elevation of the global volcanic-activity since around 1997 just after the sharp acceleration of the North Magnetic Pole-shift began, around 1-2 years before.

Beside internal processes near the **CMB** inside of Earth, there are also external events that clearly influence Earth's magnetic field and with it Earth's volcanism. These are **Geomagnetic storms**!

(Note: A small number of volcanic eruptions may also be triggered by tidal forces caused by the Sun & Moon, which are responsible for a certain percentage of earthquakes (→ see **Appendix 2**).

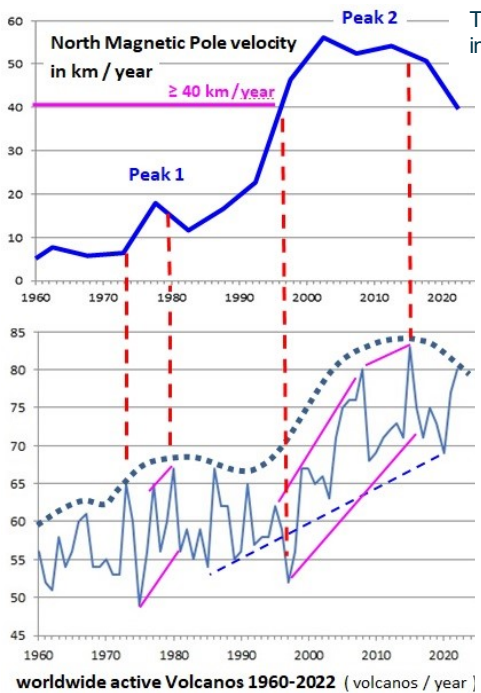
The fast shift of the North-magnetic-pole is caused by an elongating blob inside Earth's mantle

For some years now, scientists have been puzzled over the fast acceleration and fast shift of the **north magnetic pole** towards Siberia (Russia). Thanks, in part, to **ESA's Swarm satellite mission**, scientists are now more confident in the theory that **magnetic blobs** deep below Earth's surface which interact with each other are at the root-cause of this fast magnetic pole-shift.

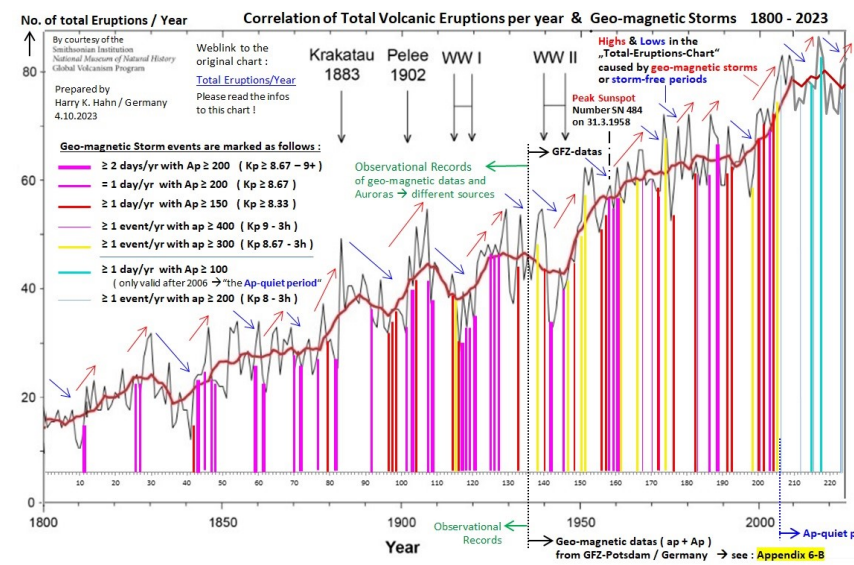
Satellite data showed that the position of the north magnetic pole is determined largely by a balance, or interference/interaction between two large lobes (blobs) of negative-magnetic-flux near the **core-mantle-boundary (CMB)**, deep underneath of Canada.

Note: The North-Magnetic-Pole has moved 12° towards NNW in just 26 years (1994-2020) which corresponds to the enormous distance of ≈ 1300 km in 26 years! The 400 years before it hasn't even had 25% of this velocity! It is clear that this has also caused fast mass-flows inside Earth!

→ see map on the left → The text above was partly extracted from this : [ESA-news article](#)



Strong Geo-magnetic storms caused by solar-wind also cause periods of increased Volcanism on Earth

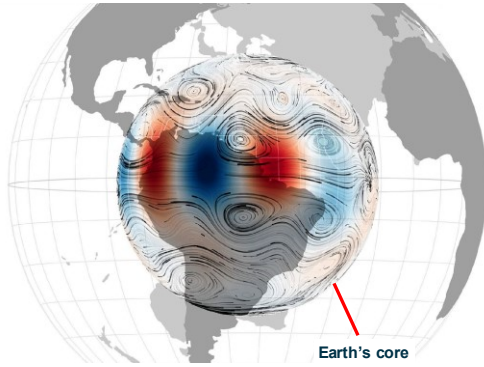


A number of studies indicate that there is a correlation of **Geomagnetic storms** with strong earthquakes, which then trigger volcanic-activity → see [weblinks on page 4](#) → see also **Appendix-3**. I have created a Chart which indicates this correlation of Geomagnetic Storms with the worldwide Volcanic Eruptions/year for the time period 1800 - 2023 (→ see big image + explanation in **Appendix-1**)

How does this correlation work? The **currents** generated by **solar winds** in the **ionosphere** cause magnetic-field-fluctuations on the Earth's surface, inducing electrical currents (**telluric currents**), which penetrate deep into the Earth, and in the presence of **Earth's magnetic field**, generate **electromagnetic-(Lorentz-)force** in the **conductive crust**, which can trigger the release of **stress-strain-energy** and can cause earthquakes and fractures in **Earth's crust**, which result in increased **-volcanism & -hydrotherm. activity**

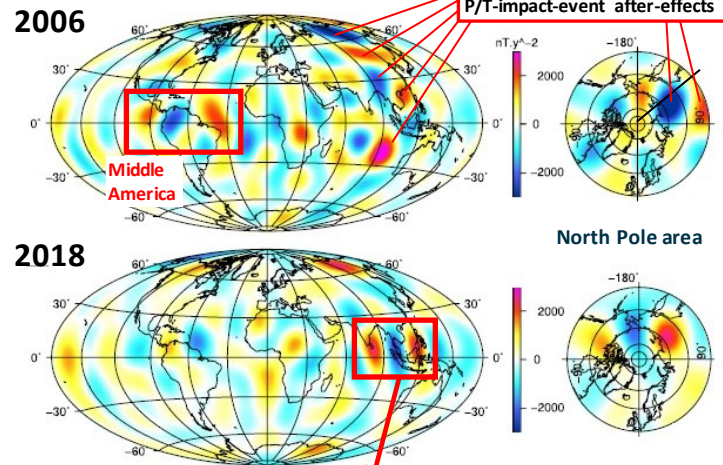
Short-term variations in Earth's Volcanism seem to be caused by Magnetic-Waves with periods of a few years, emitted from Earth's Core

In the chart of the **worldwide active volcanos per year** we can also see **shortterm variations** in the range of around $\approx 2-12$ years, beside the longterm trend caused by the N-MPV. **These shortterm variations in volcanic activity seem to be connected to shortterm changes of Earth's magnetic field**, caused by changing magnetic-acceleration-patterns located near the **core-mantle-boundary (CMB)**. Especially the strong magnetic pattern in the equatorial region (under Indonesia/Phillipines) **must be metioned here**. This pattern with a **7-year periodicity** seems to oscillate synchron with the Phillipine-volcanism (\rightarrow see image)

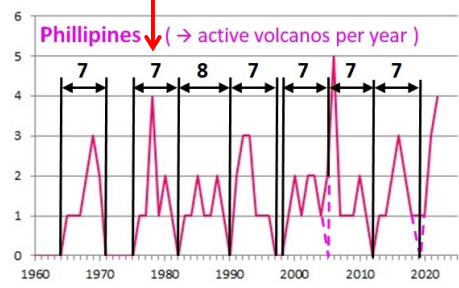


Scientists have discovered a completely **new type of magnetic wave that moves over the outermost part of Earth's outer core every seven years** and propagates westward at up to 1500 km a year. These magnetic waves that **oscillates every seven years** are caused by Earth's rotation, and these waves align in columns along the axis of rotation. The motion and magnetic field changes associated with these magnetic waves are strongest near the equatorial region of the core. (**The volcanism in the Phillipines may indicate these waves !**) The research indicates **magneto-Coriolis waves with an approximate seven-year period**. The question of the existence of similar magnetic waves that oscillate at different periods, however, remains. \rightarrow also read **Appendix-2** regarding this **7-year period** (H.K.Hahn) The magnetic waves are likely to be triggered by disturbances deep within Earth's fluid core, possibly related to buoyancy-plumes. \rightarrow see **News Article** about the results of ESA's swarm mission, which is mapping Earth's magnetic field,

Vertical down core magnetic field acceleration as estimated by the MCM model (Ropp et al. 2020) ; mapped at the CMB for the years 2006 and 2018



Note the nearly precise 7 year long volcanic-activity cycles in the Phillipine-Islands (close to Indonesia)



Extracts from the study: Rapid Variations of Earth's Core Magnetic Field

Evidence of fast variations in the **Earth's core-field** are seen both in magnetic observatory and satellite records. The observed magnetic field above the Earth's surface results from the contribution of numerous sources located inside the Earth, such as the core and the lithosphere, or outside the Earth, such as the ionosphere and magnetosphere, which are influenced by **space-weather** (\rightarrow solar wind related to the **Solar-cycle**).

Note : The dominant contribution to Earth's magnetic field is by far the magnetic field generated in Earth's core.

The Earth's magnetic field has longer time-changes, including millennial and longer Periods. The shortest changes reach sub-daily periods, in link with the rotating fluid dynamics of the fluid core. The changes observable at Earth's surface are currently between the upper limit of around 100 years and the lower limit of a few years duration.

Note : Strong magnetic acceleration patterns are mainly located at the CMB along the equatorial regions, or at all latitudes in between the longitude-lines 90° & 120° East. Strongest accelerations are often seen under Indonesia or Central (Middle) America. These acceleration patterns have a footprint at the Earth's surface that is very large.

The strong patterns between 90° & 120° E and in the North-pole area may be a result of the PTI (\rightarrow see below, H.Hahn)

The magnetic field induced in the conductive crust and in Earth's mantle by time varying external fields remains the major problem that makes it difficult to derivate accurate core magnetic field models, because both contributions overlap over a large range of spatial and temporal scales. Ambiguities (interferences) may also remain at the decadal period of the solar cycle (and its harmonics), and at the strong semi-annual & annual periodicities caused by ionospheric & external fields, in order to achieve a better model \rightarrow Weblink to this **Study**

The **Pacific-LLSVP & African LLSVP**, two big structures inside Earths mantle near the **CMB**, which are characterized by slow (seismic) shear wave velocities, may also influence the magnetic acceleration patterns. These two big **LLSVP**-structures are probably the result of the hypothetical **Permian-Triassic Impact (PTI)**, and therefore they must be **rich in iron- & carbonatites** which are very good **conductors**, and therefore react to magnetic fields. (see **Study**)

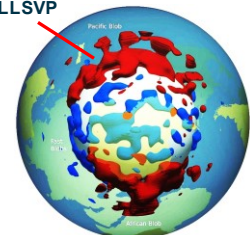
Note : The trajectory of the hypothetical **PTI-Impactor** was roughly following a **path between 90° & 120° E, N \rightarrow S**, when it impacted in Siberia. Thats why the strong magnetic patterns visible between 90° & 120° E, especially in the Northern-hemisphere may be the result of the primary- & secondary impacts (Harry K. Hahn) \rightarrow see **Appendix-5** For more info about the **PTI** please read **Part 1 & Part 2** of my **PTI-hypothesis**. (or alternative: **Part 1 & Part 2**)



Sometimes Earth's magnetic field changes rapidly -the fieldlines inside Earths mantle jerk (wave) suddenly every 3 - 12 years. This is caused by hydromagnetic waves emitted from Earth's core. \rightarrow see : **ESA-article**

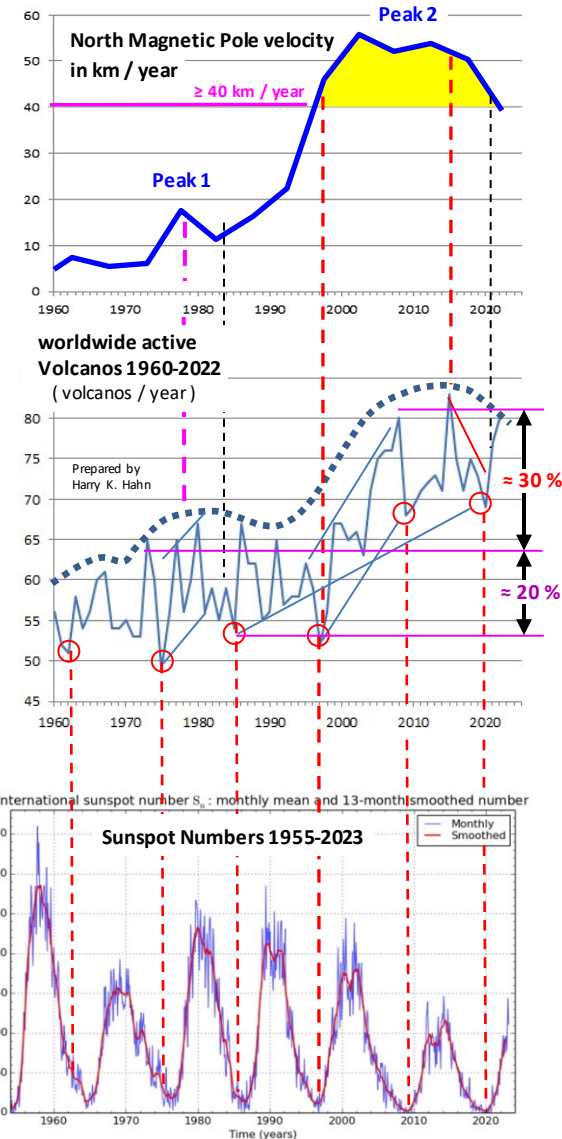
Pacific LLSVP

3D-view of the two big **LLSVPs** located near the **CMB** in Earth's mantle, the **Pacific LLSVP** and the **African LLSVP** \rightarrow see **Appendix-5**



Volcanism is correlated to geo-magnetism, HGFA-seismicity, solar-cycles & global warming

A comparison the 3 charts below indicates that **volcanic activity is influenced by a longterm geo-magnetic effect, the MPV, and by shortterm geo-magnetic effects, like the the sunspot cycle (=space weather-activity)** The chart of the **Worldwide Active Volcanos per Year** clearly follows a very similar trend as the chart of the **North Magnetic Pole Velocity (N-MPV)** if we consider a smoothed chart of the **Active Volcanos/Year** (dotted line) When the **MPV** reached the wide **Peak 2** with ≥ 40 km/year we can see a **sharp rise & elevation of the volcanic activity**. If we look at the chart of the **worldwide active volcanos per year** we clearly see **sharp rises of activity in the years 1997-99, 2003-07, 2014-15 & 2020-22** interrupted by two drops caused by **sunspot cycle** minimas Note that we had **El Ninos** events with increased **Sea Surface-temperatures** in the years **97/98, 2003-05, 2007**



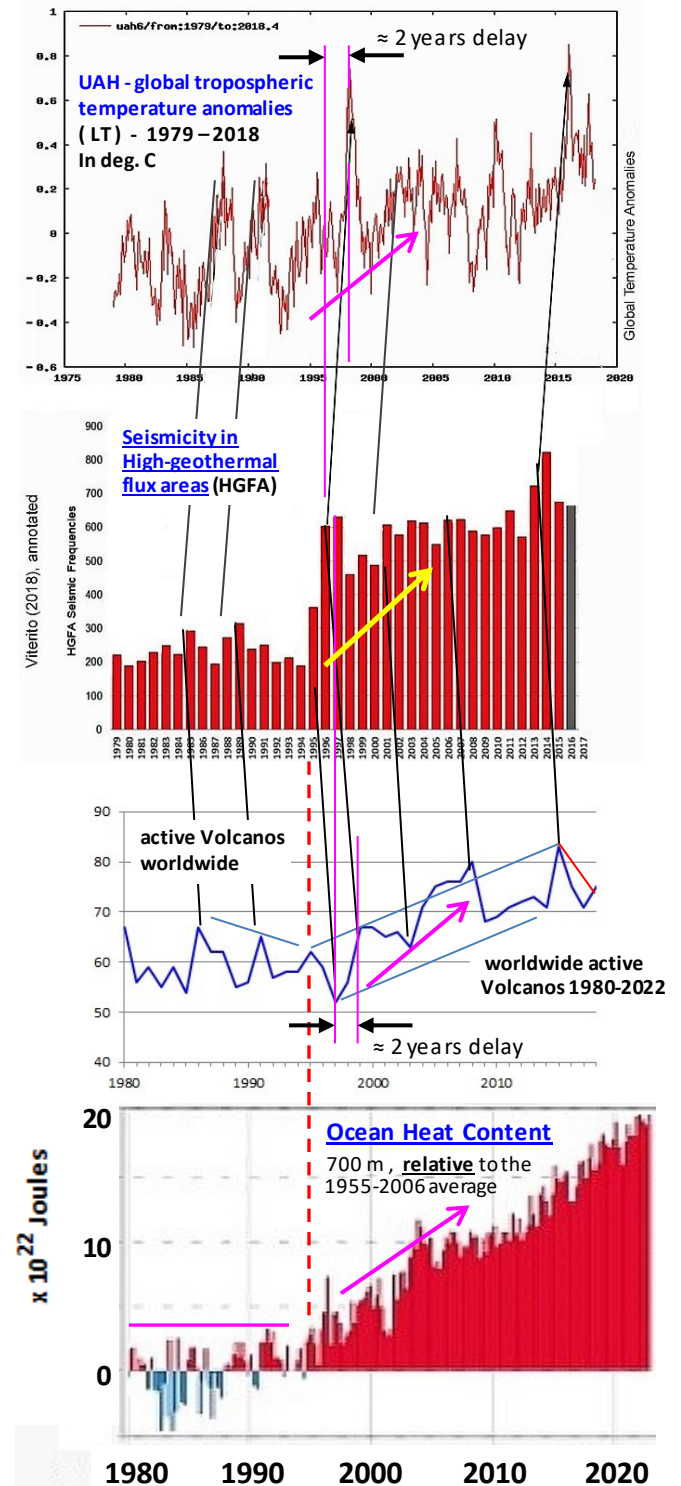
2014-16 and a **new El Nino** episode just started in ≈ 2022 . The impact of the high MPV on Volcanism is $\approx 30\%$ and that of solar cycles $\approx 20\%$ Further some studies show a clear **correlation of seismic activity in High-geothermal-flux-areas (HGFA) and the Global Warming** of the last few decades (see: [Study & Study-update](#)) \rightarrow see charts \rightarrow **HGF-areas** are all **mid-ocean-ridge-areas** and **geothermically** active areas (\rightarrow see map in [Appendix 3](#)) It is important to note that there is a **delay of around 2 years** between the seismic activity and the reaction of the global climate-system. (see charts on the right).

There is also a **delay of ≈ 2 years** noticeable **between the seismic-activity in the HGF-areas and the global volcanism** (in the chart represented by **active volcanos per year**) \rightarrow see charts on the right. This delay can be explained by the time needed for magma and/or hydrothermal fluids to rise from Earth's mantle and Earth's crust to the surface, after new fractures have opened up in Earth's crust, caused by increased seismicity resulting from the mentioned geo-magnetic effects. (magnetic pole-speed & geomagnetic storms) Further it's important to note that **the distinct jump in seismic activity to a higher level in the HGF-areas**, which we see in the chart in the years **1995-1997**, was followed by a strong increase in the growing-rate of the **Ocean Heat Content** since around 1996 and followed by a strong peak in **global tropospheric-temperature-anomalies** (\rightarrow see charts on the right).

Here are weblinks to infos & studies that also indicate such correlations:

- 1.) - [Correlation between solar activity and large earthquakes worldwide](#)
- 2.) - [A solar-terrestrial effect influences volcanism & global seismic activity](#)
- 3.) - [Correlation of geomagnetic anomalies with earthquakes & solar storms](#)
- 4.) - [Volcanic eruptions are correlated with Solar Activity](#)
- 5.) - [Links of Volcanic Eruptions to Solar Activity and Solar Magnetic Field](#)

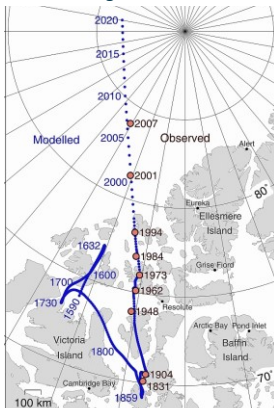
More weblinks to similar studies under [References](#) (see last pages)



The numbers of "Active Volcanos / year" in many world-regions & worldwide clearly increased when the North-Magnetic-Pole-velocity peaked

The pole-shift is caused by 2 magnetic-blobs inside of Earth
 A change in the circulation-pattern of flow deep under Canada has caused a patch of magnetic field at the core-mantle-boundary to be stretched out. This weakened the magn.-field-patch under Canada and caused the magnetic-pole-shifting towards Siberia

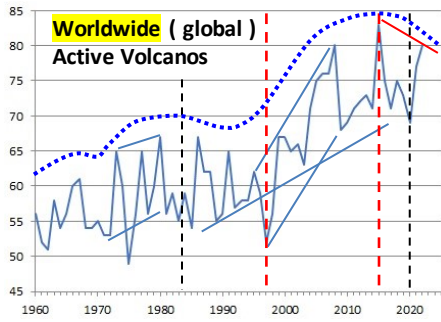
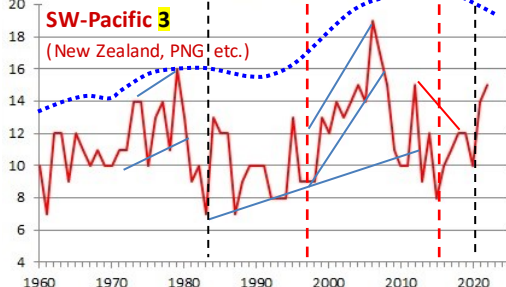
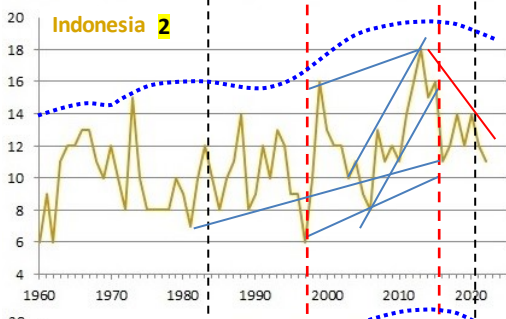
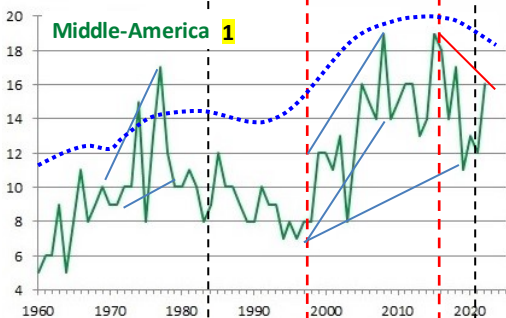
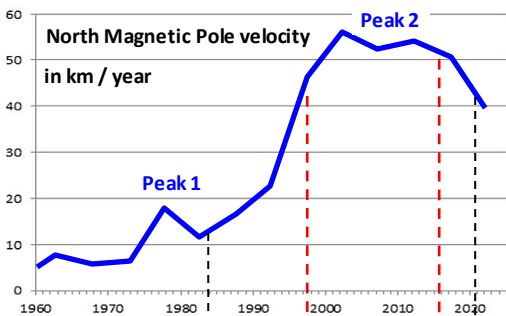
North-Magnetic Pole Shift



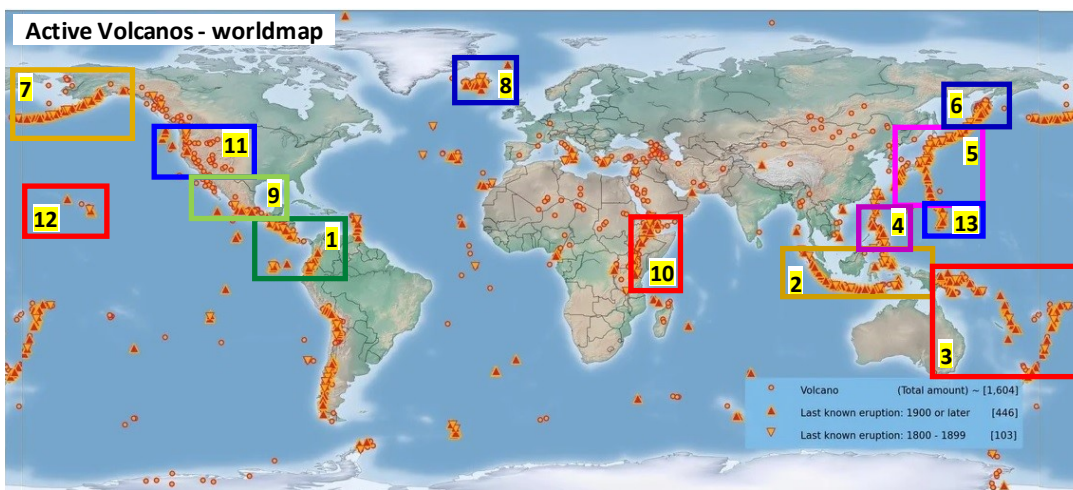
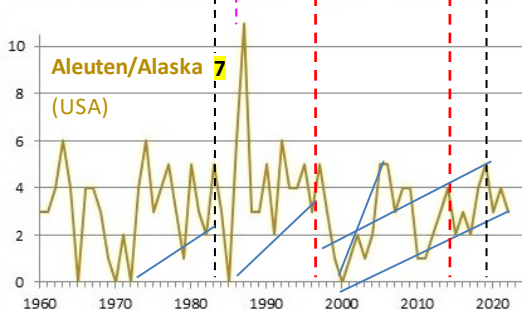
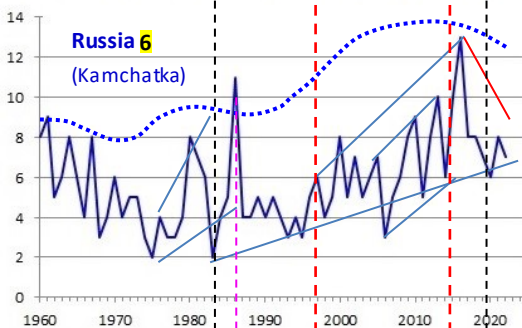
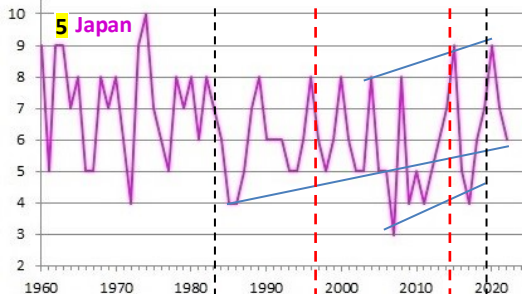
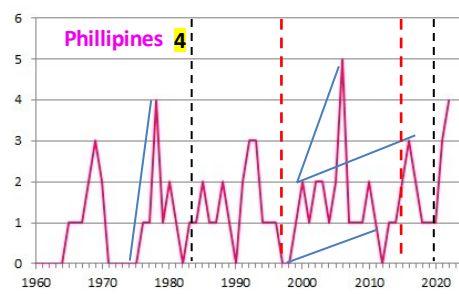
The chart of the **Worldwide Active Volcanos per Year** (see below) clearly follows a very similar trend as the chart of the **North Magnetic Pole Velocity (N-MPV)** if a smoothed chart of the **Active Volcanos/Year** is considered (dotted line over the chart (symbolic)). Increased Volcanic activity on Earth as well as increased Seismic-activity in **HGFA-areas** and increased **Ocean Heat Content** must be linked to increased **geo-magnetic**-changes in **Earth's outer core**, which resulted in the fast shifting of the north-magnetic pole towards Siberia.

When the **N-MPV** reached the wide **Peak 2** with ≥ 40 km/year we can see a sharp rise & elevation of the volcanic activity during the time of the **Peak-2-formation**, not only in the "worldwide"-Chart but also in many other charts which only show the active volcanos/year of selected world-regions, like Middle-America, Indonesia, SW-Pacific & Russia (Kamchatka). This means that we really look at a global phenomenon here !

If we look at the chart of the "Worldwide active volcanos per year" we clearly see sharp rises of activity in the years 1997-99, 2003-07, 2014-15 & 2020-22. We also see these sharp rises of volcanic activity in the same time-periods in the other mentioned world-regions. **Note**: The **geo-magnetic** change that is going on inside of Earth is influenced by shortterm **geo-magnetic** fluctuations caused by the **solar-cycles** (see page 4)



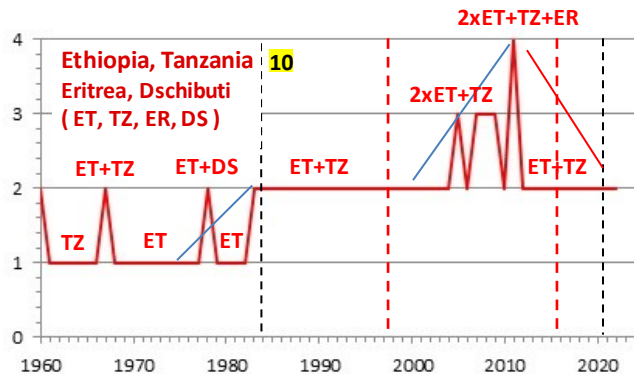
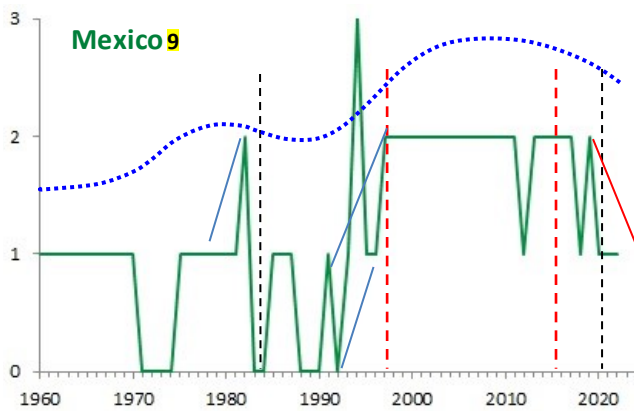
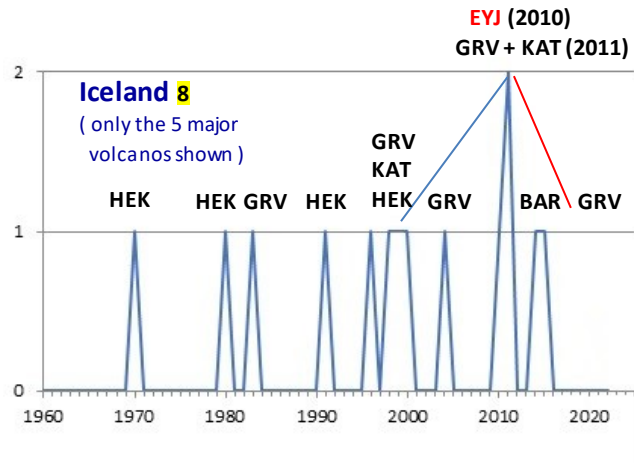
→ **Note**: the datas of the active volcanos/ per region & globally are available in **Table 1 in Appendix 6-A**



This worldmap shows the worldwide Active Volcanos. Volcanos that have been active between 1800 & 1899 are indicated by **yellow-triangles**. Volcanos that have been active 1900 or later are indicated by **red-triangles**
 → The number of active-volcanos/year, located in the areas marked on the map, are shown in the diagrams

The numbers of "Active Volcanos / year" in other world-regions also show increased activity in the time period 1997 - 2015

→ **Note** : the datas of the active volcanos/ per region are available in **Table 1** in Appendix **6-A**



In four other world-regions we can also see increased volcanic activity **within the time-period 1997 – 2015**. These regions are : **Iceland, Mexico, Ethiopia+Eritrea & the Mariana Islands**. This again indicates a global phenomenon !

In the timeperiod 1997-2015 the **North Magnetic Pole-Velocity curve** reached a very high peak with a velocity of 40 km/year. The process which has caused this fast pole shift, a dynamic flow pattern inside of Earth's mantle, must be responsible for this global phenomenon of increased volcanism, increased seismicity in HGF-areas and increased global warming (→increase in ocean heat content)

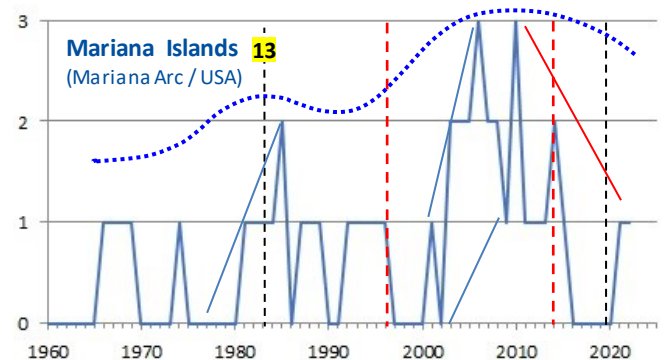
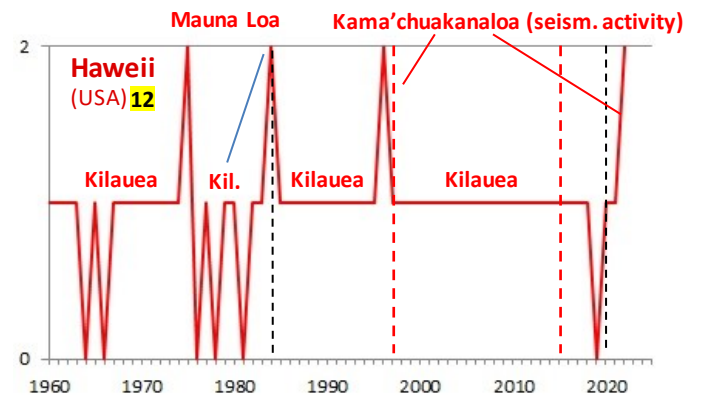
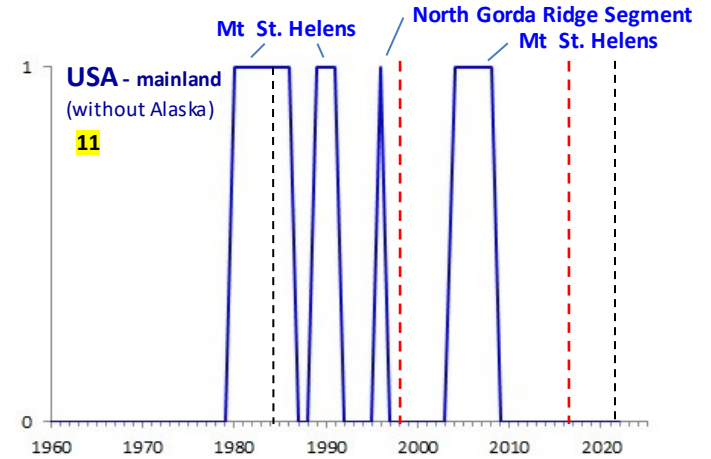
In Iceland the volcano **Eyafjallajökull** became active in **2010** after 190 years pause and the rising magma caused a big crustal displacement and a big eruption that disrupted air-traffic over NW-Europe for 6 days because of huge ash-emissions. The volcano **Katla** was active in **1999** and in **2011** after >40 years pause. And in **2021** a new eruption occurred at **Fagradalsfjall** volcano near the plate boundary in Reykjanes after 815 years pause.

Mexico had two constantly active volcanos without a pause from **1997 to 2011**. Before the year 1997 in average only one volcano was active per year (except in 1994 when 3 volcanos were active and in 1982 when 2 volcanos were active)

Volcanism in the Ethiopia-Tanzania-Eritrea region reached a peak with **4** active volcanos in **2011**. It's most active time was from **2005 to 2011**

At the **Kilauea** volcano in Hawaii the **longest major eruption in history** occurred from **1983 to 2018**

Volcanism in the Mariana Islands had a peak-time between **2003 and 2008** with **2-3** active volcanos. In the Mariana Islands new submarine lavaflows were found in 2015 together with a number of new hydrothermal vents on the ocean ground.

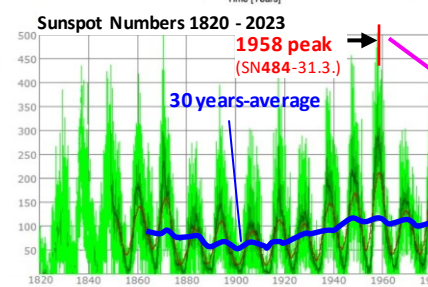
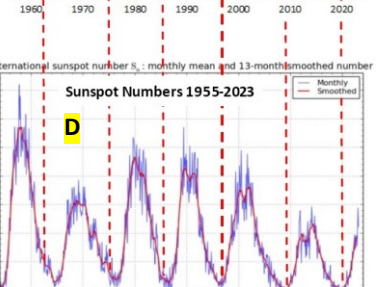
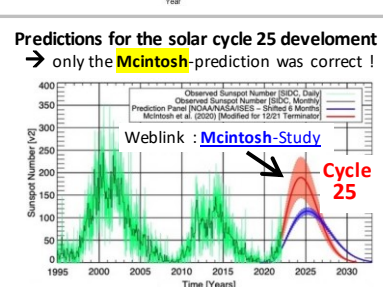
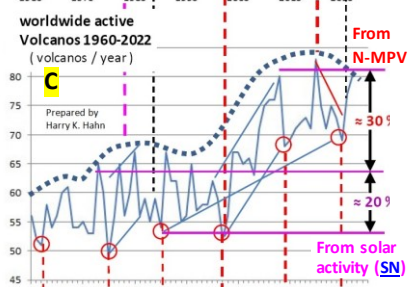
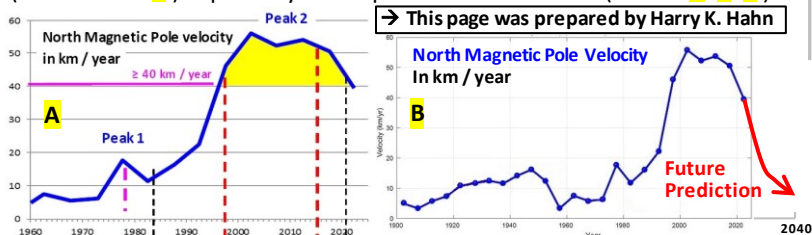


Sunspot-minimas reduce the worldwide active volcanos and the OHC ! → To predict World's climate we must predict the future solar-activity !

As shown on page 4 there is a clear correlation between geo-magnetism, solar-cycles, HGFA-seismicity, Volcanism & Global Warming. The geo-magnetic-changes near the Earth's core-mantle-boundary, which have caused the fast shift of the North Magnetic Pole, have an impact of $\approx +30\%$ and Geo-magnetic Storms caused by solar-cycles have an impact of $\approx +/- 20\%$ on Global Volcanism, as Chart C (& A+D) indicate. Changes in Geo-magnetism & Solar-cycles are responsible for $\geq 40\%$ of Global Warming ! See also my Study-1 !

The same flow-patterns (mass streams) inside of Earth's mantle, which cause the fast North Magnetic Pole Shift (N-MPV) (see chart A+B) are also responsible for increased Worldwide Volcanic Activity (chart C) and increased seismic- & geothermal-activity in HGF-areas on Earth, which caused the increased Ocean-Heat-Content (OHC) & the Global Warming (→ see Chart Y) especially in the period 1997 to 2023 (charts A+C+Y)

→ This page was prepared by Harry K. Hahn



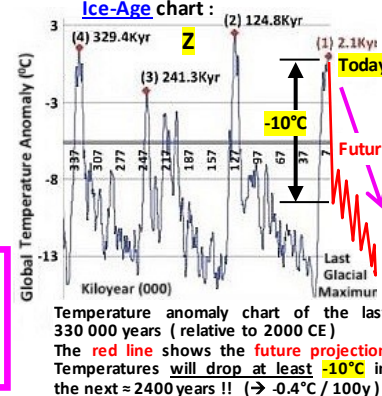
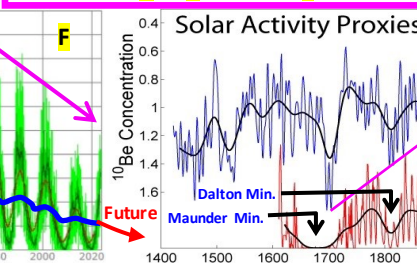
Prediction of future Solar-Activity Volcanic Activity & Global Warming:

In the Chart B we can see that the velocity of the North Magnetic Pole dropped below 40 km/year in ≈ 2022 and it will in all probably drop to ≤ 10 km/year in ≈ 2040 and then it will probably stagnate for many decades

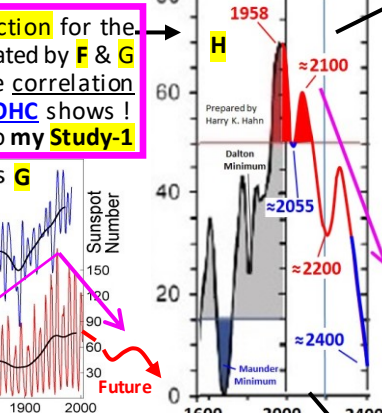
This means the contribution of the N-MPV of $\approx 30\%$ to Global Volcanism (& to geo-thermal activity + OHC) will disappear in ≈ 10 -20 years (Chart A-C)

11000 years ago the solar activity (average sunspot number (SN) was as high as today (see Chart E) → see Ref. Period 1. But the Sun can only hold this high level of activity for ≈ 120 -150 years ! Therefore since 1958 (max. SN-peak) we are on the way to a considerable lower level of solar activity with an average ≤ 40 SN (see E & H). This corresponds to a cooler world climate, as the Dalton Minimum 1790-1830

The Chart H shows my future prediction for the solar activity & SN. This is also indicated by F & G. We go to a cooler (SN)-climate as the correlation between geo-magnetic Ap-Index & OHC shows ! see Charts X & Y (& chart Z) see also my Study-1



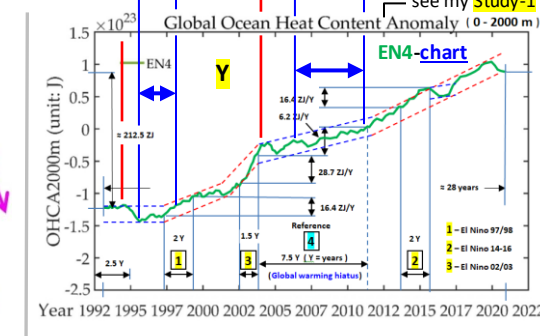
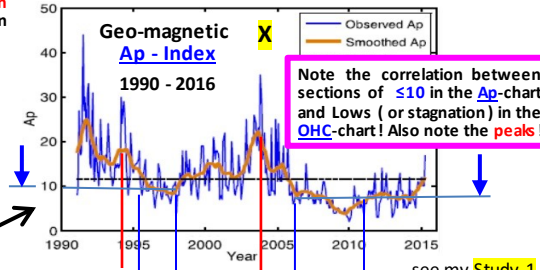
Temperature anomaly chart of the last 330 000 years (relative to 2000 CE) The red line shows the future projection. Temperatures will drop at least -10°C in the next ≈ 2400 years !! (→ $-0.4^\circ\text{C}/100\text{y}$)



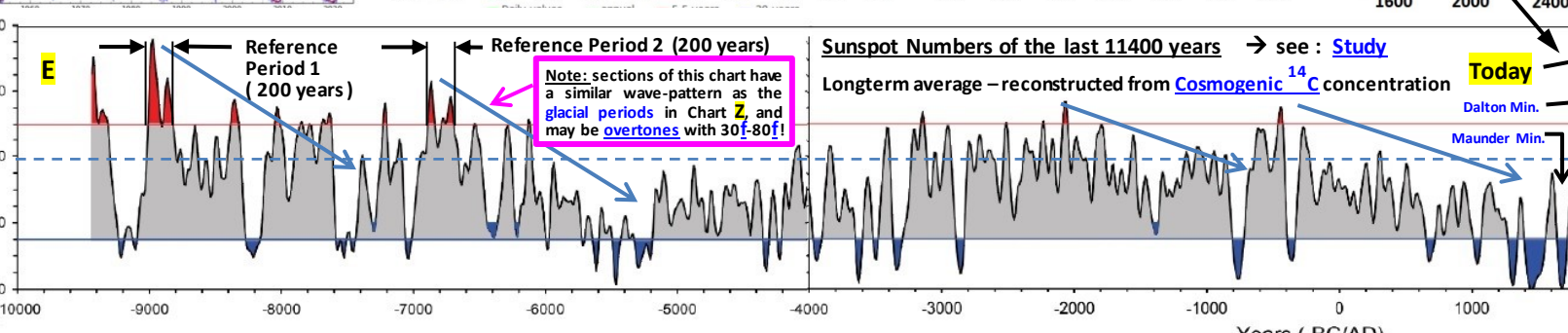
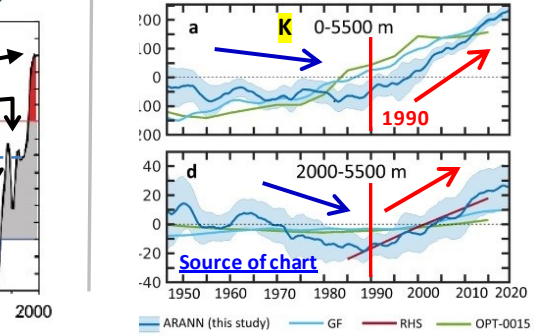
The Ocean Heat Content in the depth-ranges 0-5500 m and 2000-5500 m did not increase in the time-period 1950-1990 !! (see chart K) Note : It actually dropped in that time-period especially in the depth-range 2000 - 5500 m !!

This can mean only one thing: The ocean water was heated from below, from the ocean-floor, in particular → from the HGF-areas ! in the time ≈ 1995 -2023. (→ see Chart K) Otherwise the quick warming of water in depths >2000 m can't be explained !

If heated from the surface (caused e.g. by increased air-temperature), then the ocean water would have needed decades if not centuries to heat up in depths 2000-5500 m !!



Ocean Heat Content in 0-5500 & 2000-5500m



Appendix 1-A : Chart which shows the Correlation of Total Volcanic Eruptions per year & Geo-magnetic Storms in the time-period 1800 - 2023

Explanation to the Chart :

1.) To the visible correlation :

There is a clear correlation visible in the chart, of **sharp rises (highs)** in the "Total Volcanic Eruptions" with the **occurrence of strong geomagnetic storms** (solar storms) indicated by colored lines under the chart.

Shortly after the occurrence of a strong geomagnetic storm (period) ,or with a delay of 1-2 years, there is a sharp increase in the number of volcanic eruptions visible ! (**Highs**) (indicated by **red arrows**)

On the other hand there is a clear correlation visible in the chart of decline-periods (**lows**) in the chart, which correlate with phases where no or very less geo-magnetic storms occurred. (indicated by **blue arrows**)

This correlation is strong and clearly visible in the chart !

Note : Because the geo-magnetic storms first trigger earthquakes, and with a certain delay of up to $\approx 1-2$ years the volcanic eruptions follow, the rises (peaks) follow with a slight delay after the geo-magnetic storms (storm periods)

2.) Geo-magnetic storm datas :

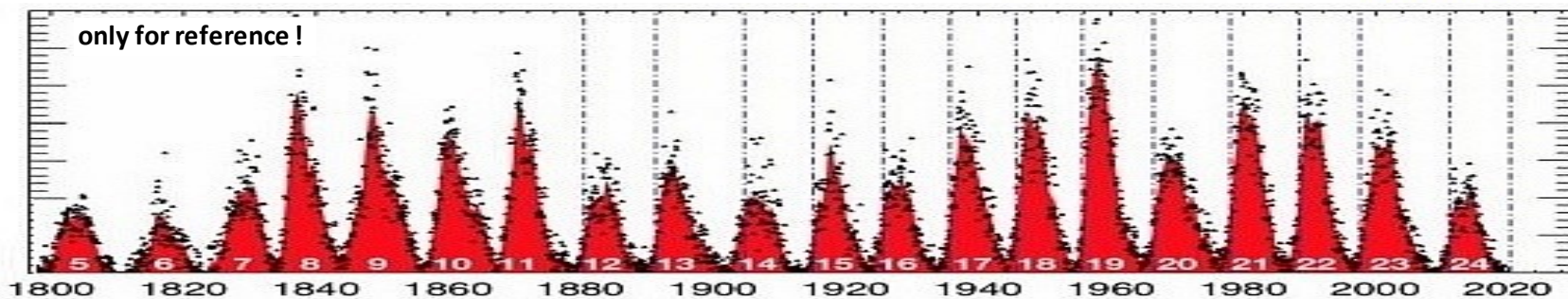
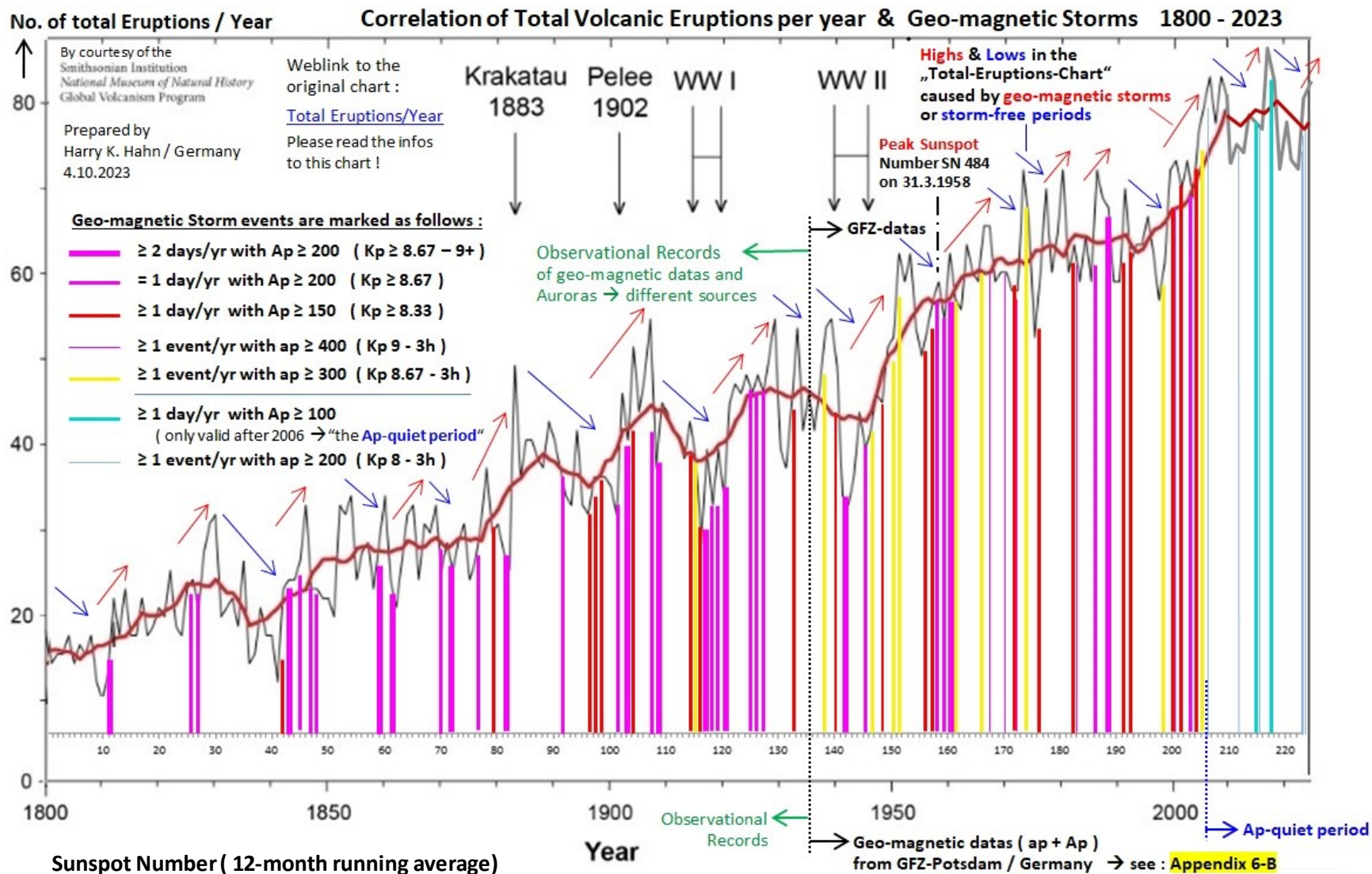
→ see **Tables 6B & 6C** in Appendix

3.) Volcanic Eruptions datas :

→ see **Table 6A** in the Appendix

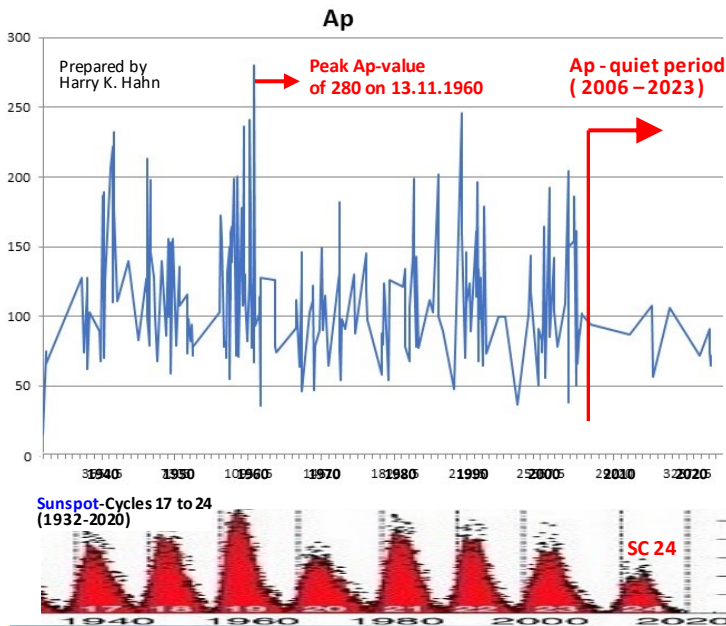
→ Also read the informations of the **Smithsonian Institution !**

see : [Total Eruptions/Year](#)



Appendix 1-B: Prediction of future Solar Cycles and Solar Activity

Because there is a correlation of **geomagnetic storms** with earthquakes, volcanism and **hydrothermal activity**, and **Global Warming** (→ see page 4&7) we must predict the solar cycles:



Geo-magnetic Storm Chart :

The chart is showing all days with at least one 3h –ap-value ≥ 200

The **Ap-value** (sum of ap1 to ap8) of these days is shown in the chart

It is clearly visible in the chart that **Since 2006 no days with higher Ap-values occurred anymore !!**

Since 2006 only two days with an Ap-value slightly > 100 occurred !!

WARNING !! :

This fact is a clear **warning-sign** that the Sun has switched to a **lower general activity !!**

This has a **cooling effect on the World's Climate in the future !!**

Here theories for **longterm predictions of solar cycles:** „**A mathematical model of the sunspot cycle...**“

The model presented here is an attempt to produce a more quantitative prediction of monthly **sunspot-number forecasts** and increase the granularity of the shape of future solar cycles. The model is based primarily on a **Tidal Torque theory** proposed by Ian Wilson (2011) and **two Jovian harmonics** that account for the positioning of three Jovian planets.

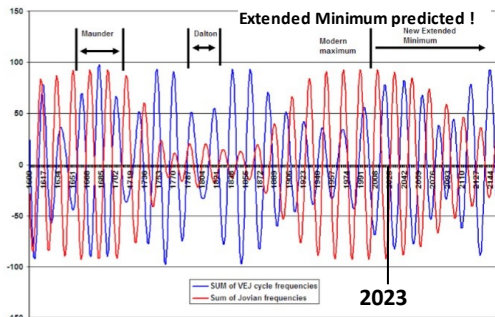


Fig.: The blue line is the interference contribution pattern for the sum of the two Venus–Earth–Jupiter (VEJ)-frequencies (19.528, 22.14), and the red line is the interference contribution for the sum of two Jovian frequencies (19.585, 21.005) to the polarity-adjusted sunspot model for the years 1600 to 2100.

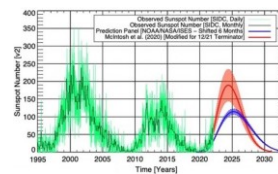
The periods of destructive interference during solar minimums and constructive interference during the solar maximum can be seen by inspection of these two interference patterns. At times either the VEJ or Jovian cycles can dominate.

Wilson's theory proposes that periodic alignments of Venus and the Earth on the same or opposite sides of the Sun produce temporary solar tidal bulges. Jupiter's gravitational force acts on these bulges and either **speeds up or slows down the rotation of the Sun's plasma**, leading to changes in **solar activity**. The frequency of these alignments on the same side of the Sun is 22.14 yr. Wilson also shows that the strength of the tidal force depends on the heliocentric latitude of Venus and the mean distance of Jupiter from the Sun, and that **when these forces are weakest, solar minimums occur**. This happens approximately every 165.5 yr. The frequency to produce a 165.5 yr beat with 22.14 yr is 19.528 yr. These two frequencies of Venus–Earth–Jupiter (VEJ) interactions are a principle basis for the model. → **Weblink to this Study**

Other studies which are based on the Tidal Torque Theory: → **Weblinks : Study1 , Study2 , Study3 , Study4**

Prediction of the next solar cycle : → **Weblink to McIntosh's Study**

This theory of **Scott McIntosh** allows to predict one solar cycle precisely in advance. A relationship was found between the temporal spacing of the terminators of the 11yr-sunspot- & 22yr-magnetic cycles and the magnitude of (future) sunspot cycles.



1-C: Correlation of Geomagnetic Storms with Global Warming

As described on the previous page there is a clear correlation visible in the chart, of sharp rises (highs) in the “**Volcanic Eruptions**” –worldwide, with the occurrence of mainly strong **Geomagnetic-Storms (solar storms)**, → indicated by colored lines under the Chart → see on the right

Because these **Geomagnetic Storms** probably first trigger earthquakes, mainly in the **HGF-areas**, and then with a certain delay of $\approx 1-2$ years the volcanic eruptions follow, the rises (peaks) in the “**Volcanic Eruptions-chart**” follow with a slight delay after the **geo-magnetic storms (storm periods)**.

Since ≈ 2006 it is noticeable that geo-magnetic storms are considerable weaker and they are rarer. These weaker geomagnetic storms are indicated by blue lines under the chart.

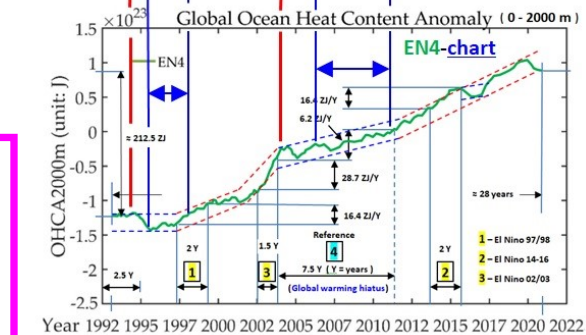
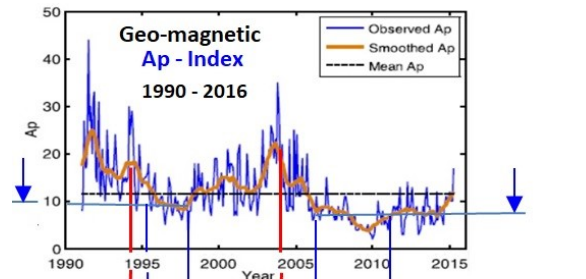
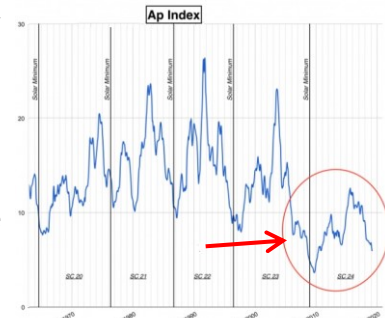
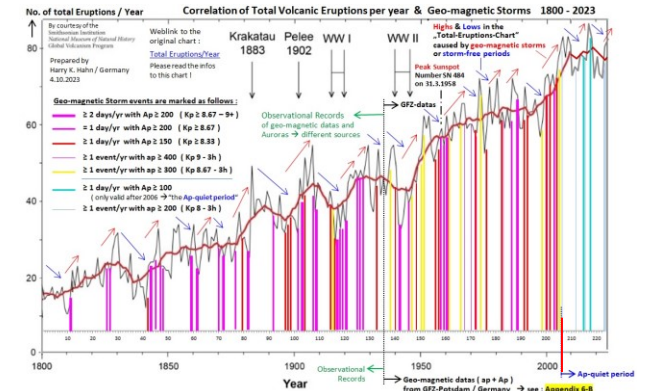
In the chart which shows the geomagnetic **Ap-index**, which measures the daily average storm-activity, we can see that **there is considerable less activity visible after 2006** (→ see Ap-chart on the right and below !)

Geo-magnetic storm-activity is effecting the World's Climate :

The two charts on the right, the **Ap-Index** and the **Ocean-Heat-Content (→ EN4-chart)** of the last ≈ 30 years indicate that there is a **correlation of geomagnetic storm-activity with the Warming of the Ocean water (0-2000m)**, described by the **Ocean Heat Content**.

Geomagnetic storm-activity causes earthquakes, mainly in **HGF-areas** (e.g. the **mid-ocean-ridges**), which then causes increased **volcanism & hydrothermal-vent-activity**, mainly in **submarine areas**, and heats-up the ocean water in this way.

It is clearly visible in the two charts that there is a **correlation of lows with AP-values below 10 (the top chart) with stagnation-periods (or lows) in the Ocean-Heat-Content chart**. And correlation of at least one major peak in the Ap-chart with a clear peak in the OHC-chart



Appendix 2 : Earthquakes caused by tidal forces (gravitational forces)

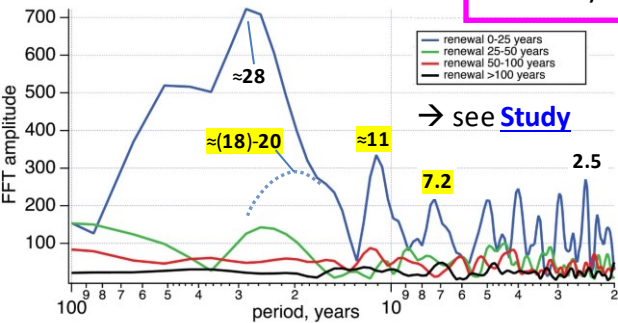
Different statistical tools indicate that earthquakes are organized in time according to certain renewal intervals. These intervals (time periods) between earthquakes with the highest probability of their appearance are represented in the **Fourier Power Spectra** and in the **Schuster Spectra** by the highest peaks in the Spectra (→ see the diagrams further below)

There is a high correlation between **tidal events** (tidal forces) caused by the moon and sun.

I want to contribute here an example of a powerful earthquake which surely was triggered by a maximal tidal stress amplitude. The **M 7.6 Gölcük-earthquake** from **17.8.1999** in Turkey which occurred just **6 days after the solar eclipse from 11.8.1999**. Note that the **core-shadow** (→gravity force vectors of moon and sun in line) moved ≈ **20 minutes** precisely along the **North Anatolian fault**, probably the crucial fact here !



Satellite map of Turkey with tectonic fault lines

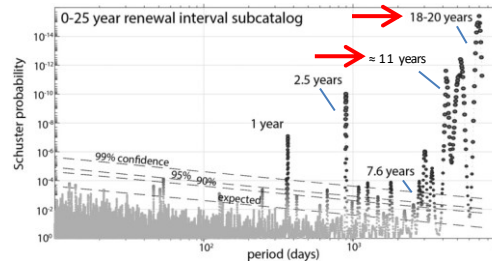


Fourier spectra results - complementary to the Schuster spectra

Time series of annual earthquake productivity for different renewal interval subcatalogs. Indicating power at frequencies which are also identified in the Schuster-spectra. For example the strong peaks at 2.5, 7.2, 11 & 20 years and other resolved peaks at 3, 4, 5 and 28 years (for the **1-25 year** catalog)

and tectonic earthquakes, and earthquakes in the **mid-ocean-ridge-areas** (=HGF-areas). Tidal stress caused by Sun & Moon, is superimposed on tectonic-stress and plays a triggering role for such earthquakes. Strong earthquakes (≥M7), such as the 2011 Tohoku-Oki-earthquake often occur near the maximal tidal stress amplitude. The **M 7.6 Gölcük-earthquake** from 17.8.99 in Turkey which occurred just 6 days after a **solar-eclipse** was also caused by maximal tidal stress ! Beside daily- and ≈14-day-tidal periodicities which are caused by Earth's rotation and by the moon's orbit-period, there is also one longterm tidal periodicity caused by the **18-20 year peak** in the Schuster-(Fourier-) Spectra This periodicity probably is caused by the **18 year Saros-period**. Because after a **solar-eclipse** Earth, Sun & Moon reach the same geometry, after one **Saros-period** and a similar **solar-eclipse** (tidal event) follows. →**Studies** about tidal triggers: **Study1, Study2, Study3**

Note: The strong **11-year peak** in the spectra is caused by the **11-year solar-cycle**. And the big **7.2 year peak** & other peaks with shorter periods (e.g. 2.5) probably are caused by the described **magnetic waves** emitted from **Earth's core**. Changes in **Earth's magnetic field** caused by these factors trigger **earthquakes+ volcanism**

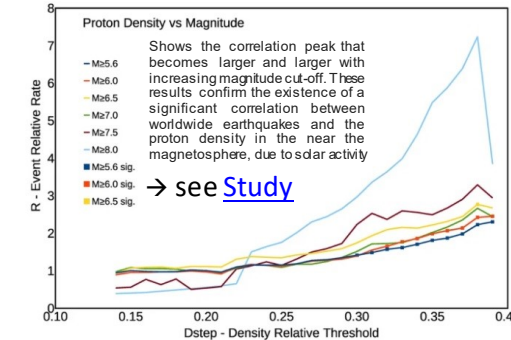


Schuster spectra for 1-25 year subcatalog of earthquakes

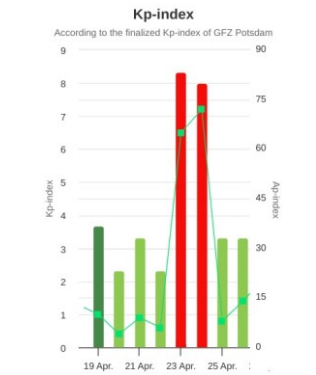
The logarithmic diagram of the Schuster probability for the subcatalog of earthquake events with the renewal interval of 1-25 years shows a number of strong peaks. For example at 1, 2.5, 7.6 and 18-20 years periods (with >99% confidence)

Appendix 3: Earthquakes (& Volcanism) caused by Geomagnetic storms

Large earthquakes occurring worldwide have long been recognized to be non-Poisson distributed, so involving some **large scale correlation mechanism**, which could be **internal** &/or **external** to the Earth. **Clear correlation was found between increased proton density, during solar-cycle maximas & during geomagn. Storms (solar storms), and the occurrence of earthquakes with magnitude > M 5.6.**



Plots of the Event Relative Rate R as a function of the normalized proton density, and for the condition 1Dy BT (earthquakes occurring within 24 h from the value of density decreasing below the threshold value). Colour indicates different linear cut-off magnitudes in the catalogue

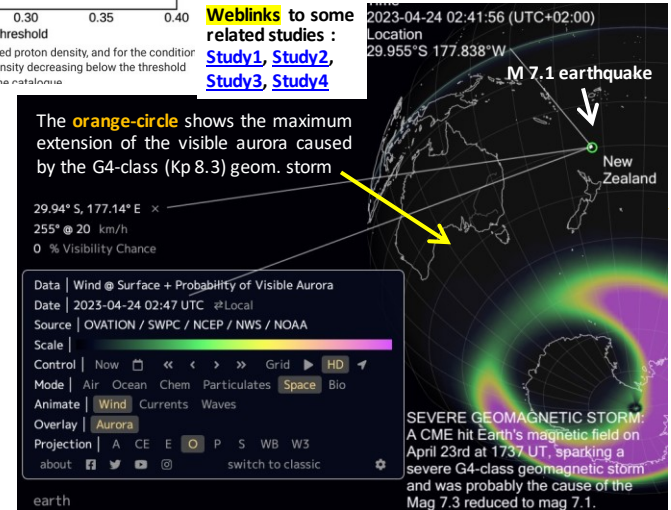


Kp-index of the geomagnetic storm on 23.4. to 24.4.2023

The currents generated by solar winds in the ionosphere cause magnetic field fluctuation on the Earth's surface, inducing electrical currents, which penetrate into the Earth and, in the presence of Earth's magnetic field, generate electromagnetic (Lorentz) force, which can trigger the release of stress strain energy and can cause earthquakes and fractures in Earth's crust.

The map below shows the **aurora australis** caused by a **G4-geomagnetic storm on 23.4.2023** & the location of a **M 7.1 earthquake** in the **Kermadec-Arc** that occurred ≈ **7 hours after the start of the storm**. The probability for **>M7 earthquakes** in this 8h-period was only **1 : 180**

Weblinks to some related studies : **Study1, Study2, Study3, Study4**

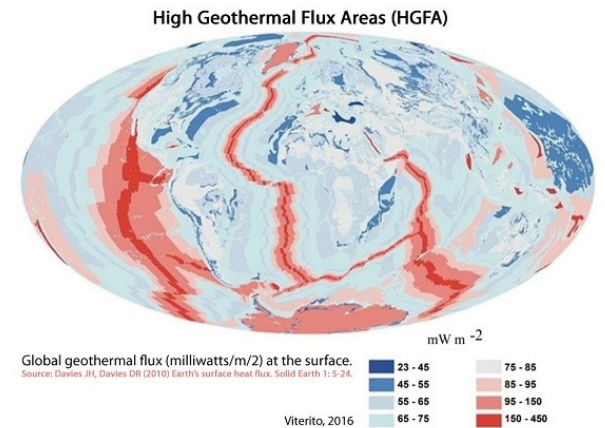


Appendix 4: High Geothermal Flux Areas (HGFA) – World Map

Note :

HGF-areas are all **mid-ocean-ridge-areas** and the **geo-thermally active areas**

(→ see map)

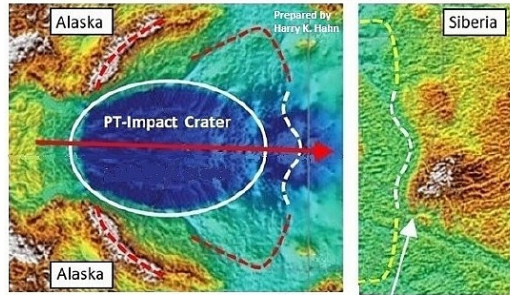


Global geothermal flux (milliwatts/m²) at the surface. Source: Davies JH, Davies DR (2010) Earth's surface heat flux. Solid Earth 1: 5-24. Viterito, 2016

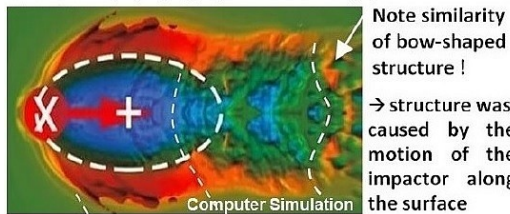
Appendix 5 : To the probable cause of the Pacific-LLSVP & African-LLSVP inside of Earth's mantle

There are two large structures noticeable in Earth's mantle, the **Pacific-LLSVP** & the **African LLSVP**, which are characterized by slow (seismic) shear wave velocities and which in all probability consist of much hotter material (~4000°K) than the surrounding mantle material (~2000°K). These two large LLSVP's extend laterally and vertically for thousands of kilometers from the core-mantle boundary (CMB). There is strong indication that the hypothetical **Permian-Triassic Impact (PT-I)** and the ejecta that was caused by this enormous impact-event are responsible for the formation of these two big LLSVPs inside of Earth's mantle. (see study: **Part 1**)

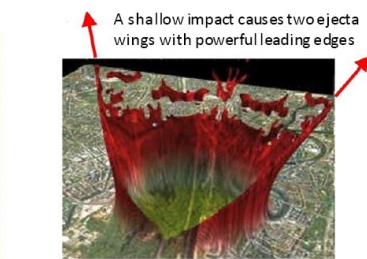
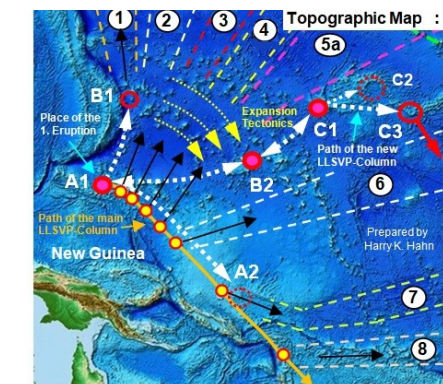
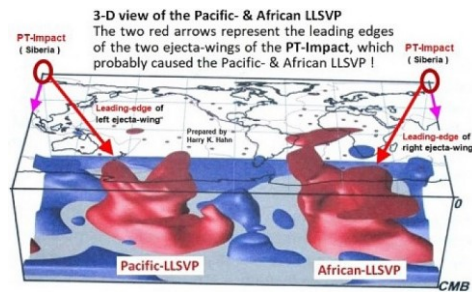
The Ø 1270 x 950 km Permian-Triassic Crater



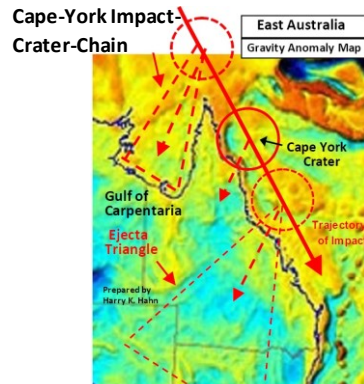
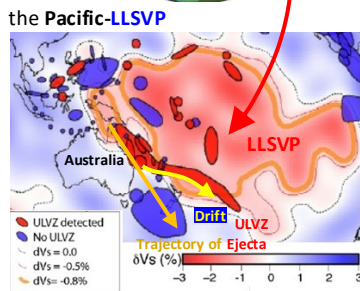
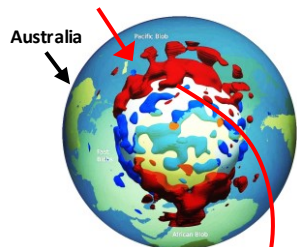
PT- crater topography (symmetrical image)



Note similarity of bow-shaped structure!
→ structure was caused by the motion of the impactor along the surface



3D-view of the two big LLSVPs located near the CMB in Earth's mantle, the Pacific LLSVP and the African LLSVP



In all probability the powerful Ejecta-masses of the leading-edges of the two ejecta-wings of the PT-I together with large secondary impactors descended deep into Earth's mantle and caused the 2 LLSVP's.

Because the impactor that caused the PTI was either a carbon- & iron-rich-asteroid or -comet we can assume that the two LLSVPs caused by the PTI-ejecta also contain a considerable share of Iron and Carbon in the form of various minerals, for example in the form of molten carbonate minerals (→ that have an electrical conductivity that is exceeding the one of any mantle-phase → see Study).

Therefore the Pacific-LLSVP & African LLSVP may also influence the magnetic acceleration patterns near the CMB and the North-pole-shift, described on the first pages of this study, because the LLSVPs are probably rich in iron- & carbonatites which are very good conductors, and therefore react to magnetic fields & telluric-currents caused by Earth's magnetic field & by strong geomagnetic-storms (solar wind).

Note : The trajectory of the hypothetical PTI-Impactor was roughly following a path North to South between the longitudes 90° & 120° E, when it impacted in Siberia. That's why the strong magnetic patterns visible between 90° & 120° E near the CMB (as described on page 3), especially in the Northern-hemisphere may be the result of the primary- & secondary-impacts of the PTI !

The 2D-map of the Pacific-LLSVP on the left shows that especially the ULVZ at the core mantle boundary (CMB) within the Pacific-LLSVP is mainly orientated along the path where the leading edge of the left ejecta wing of the PTI probably impacted. Because this ULVZ has a distinct chemical signature there is a high probability that the ULVZ is a direct result of ejecta of the PTI which descended to the CMB in this area. This path where the leading-edge of the left-ejecta wing of the PTI impacted is noticeable on a gravity-anomaly-map as a chain of large secondary-craters (→ see image on the bottom left)

The powerful Ø 320 km Cape-York secondary-Impact (CYC) probably formed a channel in Earth's mantle which connected the Pacific-LLSVP / ULVZ that was caused by the PTI with the surface. Through this channel in the mantle ≥ 8 large-scale magma eruptions probably occurred over the last ~200 Ma, which are probably responsible for a number of big LIP's on the Pacific Plate (e.g. the Ontong LIP).

→ see explanation in : **Part 1** and **Part 2** of my PTI-hypothesis. (alternative links : **Part 1** & **Part 2**)

More info about my PT-I Hypothesis [here](http://www.permiantriassic.de) : www.permiantriassic.de or here www.permiantriassic.at

The topographic-map on the left shows the path of the source of the mentioned magma eruptions, which is part of the Pacific-LLSVP (→ the yellow dots on the orange arrow). Today it is probably located in the area of the Fiji-islands. **Note** : There is a high probability that another such large-scale magma eruption (as described in **Part 1** of my PTI-hypothesis) will take place probably somewhere in the surrounding area of the Fiji-islands. The trigger for such a large-scale eruption, which can cause a large LIP, may be an extreme seismic-shock-wave that runs through Earth's mantle. Such an extreme seismic shock-wave can be caused by a large asteroid-impact. For example the Chicxulub-Impact in Mexico which killed the Dinosaurs ≈ 66 million years ago probably triggered a global seismic shock-wave of > RS-magnitude 12, that was 1000 times more powerful than the strongest earthquake ever measured (RS-magnitude 9). The massive eruption that caused the Deccan-Traps, a large LIP in India at the same time ≈66 million years ago, probably was triggered by the global seismic shockwave of the Ø 180 km Chicxulub Impact.

Appendix 6-A : Table 1 : worldwide Active Volcanos / & -Eruptions per year - Datas from the [Smithsonian Volcanism Program](#) (left side of table)

→ active volcanos per year were separated into selected regions (right side of table) → **to see all volcanos of a certain year clic on the year** (left column)

Year	Eruptions Started (New)	Eruptions Ended	Eruptions Total	Volcanos Active (globally)	Countries	VEI <= 2	VEI 3	VEI 4	VEI 5	VEI 6
1960	35	18	58	56	20	26	9	0	0	0
1961	32	25	56	52	21	27	5	0	0	0
1962	29	21	52	51	17	24	5	0	0	0
1963	40	27	64	58	20	31	8	0	1	0
1964	29	29	58	54	21	27	1	1	0	0
1965	34	27	60	56	24	27	6	1	0	0
1966	35	32	63	60	23	24	9	2	0	0
1967	43	31	66	61	24	37	6	0	0	0
1968	32	29	58	54	22	24	7	1	0	0
1969	32	29	57	54	22	30	2	0	0	0
1970	34	25	57	55	23	28	6	0	0	0
1971	32	28	56	53	20	27	5	0	0	0
1972	30	22	55	53	22	25	5	0	0	0
1973	41	29	69	65	21	35	5	1	0	0
1974	27	32	64	60	19	22	4	1	0	0
1975	23	16	52	49	22	21	1	1	0	0
1976	29	23	61	56	23	27	1	1	0	0
1977	39	35	73	65	26	35	4	0	0	0
1978	25	22	58	56	22	23	2	0	0	0
1979	32	24	65	60	22	28	4	0	0	0
1980	41	36	74	67	25	31	9	0	1	0
1981	29	24	60	56	24	22	5	2	0	0
1982	32	35	64	59	22	27	3	1	1	0
1983	32	24	58	55	20	25	6	1	0	0
1984	33	29	64	59	23	28	5	0	0	0
1985	27	25	60	54	25	22	5	0	0	0
1986	41	38	75	67	28	32	6	3	0	0
1987	32	23	64	62	23	29	3	0	0	0
1988	27	30	64	62	24	23	4	0	0	0
1989	25	26	57	55	24	23	2	0	0	0
1990	30	27	60	56	22	23	6	1	0	0
1991	37	29	67	65	27	31	4	0	1	1
1992	27	24	61	57	24	24	2	1	0	0
1993	27	28	60	58	24	25	1	1	0	0
1994	33	27	62	58	22	28	4	1	0	0
1995	33	36	65	62	29	29	4	0	0	0
1996	35	26	61	59	23	29	6	0	0	0
1997	26	25	56	52	23	22	4	0	0	0
1998	32	23	59	56	24	27	5	0	0	0
1999	39	31	70	67	26	34	4	1	0	0
2000	39	38	75	67	29	34	4	1	0	0
2001	33	36	70	65	26	27	6	0	0	0
2002	41	34	74	66	25	36	3	2	0	0
2003	29	32	65	63	25	24	5	0	0	0
2004	49	42	81	71	27	41	7	1	0	0
2005	46	38	83	75	28	39	7	0	0	0
2006	44	41	86	76	29	39	4	1	0	0
2007	36	38	81	76	29	30	6	0	0	0
2008	45	39	86	80	28	36	6	3	0	0
2009	31	31	75	68	25	28	2	1	0	0
2010	33	37	77	69	24	21	10	2	0	0
2011	36	36	76	71	28	31	2	2	1	0
2012	41	38	81	72	27	36	5	0	0	0
2013	37	42	80	73	29	29	7	1	0	0
2014	41	33	79	71	31	30	8	3	0	0
2015	44	40	90	83	31	37	5	2	0	0
2016	36	45	86	75	28	30	6	0	0	0
2017	33	31	74	71	29	26	6	1	0	0
2018	37	32	80	75	28	31	6	0	0	0
2019	27	29	75	73	28	22	3	2	0	0
2020	28	25	74	69	29	22	4	2	0	0
2021	34	31	83	77	30	31	1	1	1	0
2022	33	35	85	80	28	32	1	0	0	0
2023 <small>(7.9.23)</small>	16	17	66	65	28					

Active Volcanos per year - separated into selected regions														
Indonesia	Ecuador, Colombia Guatemala Costa Rica, El Salador Nicaragua	Papua New Guinea New Zealand Tonga, Australia Samoa, Vanuatu	Japan	Russia (Kamchatka)	Aleuten + Alaska (USA)	Phillipines	Indonesia + Phillipines	Iceland (5 major volcanos) BAR, EYJ, GRV, HEK, KAT	Mariana Islands (USA)	North- America (USA with- out Alaska)	Hawaii	Mexico	all others	Ethiopia, Tanzania Eritrea, Dschibut
6	5	10	9	8	3	0	6	0	0	0	1	1	11	2
9	6	7	5	9	3	0	9	0	0	0	1	1	10	1
6	6	12	9	5	4	0	6	0	0	0	1	1	6	1
11	9	12	9	6	6	0	11	0	0	0	1	1	2	1
12	5	9	7	8	4	0	12	0	0	0	0	1	7	1
12	8	12	8	6	0	1	13	0	0	0	1	1	6	1
13	11	11	5	4	4	1	14	0	1	0	0	1	8	1
13	8	10	5	8	4	1	14	0	1	0	1	1	7	2
11	9	11	8	3	3	2	13	0	1	0	1	1	3	1
10	10	10	7	4	1	3	13	0	1	0	1	1	5	1
12	9	10	8	6	0	2	14	1	0	0	1	1	5	1
10	9	11	6	4	2	0	10	0	0	0	1	0	9	1
8	10	11	4	5	0	0	8	0	0	0	1	0	13	1
15	10	13	9	5	4	0	15	0	0	0	1	0	5	1
10	15	14	10	3	6	0	10	0	1	0	1	0	-1	1
8	8	10	7	2	3	0	8	0	0	0	2	1	7	1
8	13	13	6	4	4	1	9	0	0	0	0	1	5	1
8	17	14	5	3	5	1	9	0	0	0	1	1	9	1
8	12	11	8	3	3	4	12	0	0	0	0	1	4	2
10	10	16	7	4	1	1	11	0	0	0	1	1	8	1
9	10	13	8	8	5	2	11	1	0	1	1	1	8	1
7	11	9	6	7	3	1	8	0	1	1	0	1	8	1
10	10	10	8	6	2	0	10	0	1	1	1	2	7	1
12	8	7	7	2	5	1	13	1	1	1	1	0	8	2
10	9	13	6	4	3	1	11	0	1	1	2	0	7	2
8	12	12	4	5	0	2	10	0	2	1	1	1	4	2
10	10	12	4	11	6	1	11	0	0	1	1	1	8	2
11	10	7	5	4	11	1	12	0	1	0	1	1	8	2
14	9	9	7	4	3	2	16	0	1	0	1	0	10	2
8	8	10	8	5	3	1	9	0	1	1	1	0	7	2
9	8	10	6	4	5	0	9	0	0	1	1	0	10	2
12	10	10	6	5	2	2	14	1	0	1	1	1	13	2
10	9	8	6	4	6	3	13	0	1	0	1	0	7	2
13	9	8	5	3	4	3	16	0	1	0	1	1	8	2
12	7	8	5	4	4	1	13	0	1	0	1	3	10	2
9	8	12	6	3	5	1	10	0	1	0	1	1	11	2
9	7	9	8	5	3	1	10	1	1	1	2	1	10	2
6	8	9	6	6	5	0	6	0	0	0	1	2	7	2
10	8	9	5	4	3	0	10	1	0	0	1	2	12	2
16	12	13	6	5	1	1	17	1	0	0	1	2	8	2
13	12	12	8	8	0	2	15	0	0	0	1	2	7	2
12	11	14	6	5	1	1	13	0	1	0	1	2	9	2
12	13	13	5	7	2	2	14	0	0	0	1	2	7	2
10	8	13	5	5	1	2	12	0	2	0	1	2	10	2
11	12	15	8	6	2	1	12	1	2	1	1	2	8	2
9	16	14	5	7	5	2	11	0	2	1	1	2	8	3
8	15	19	5	3	5	5	13	0	3	1	1	2	7	2
13	14	17	3	5	3	1	14	0	2	1	1	2	11	3
11	19	15	8	6	4	1	12	0	2	1	1	2	7	3
12	14	11	4	8	4	1	13	0	1	0	1	2	7	3
11	15	10	5	9	1	2	13	1	3	0	1	2	8	2
14	16	10	4	5	1	1	15	2	1	0	1	2	12	4
16	16	15	5	8	2	0	16	0	1	0	1	1	5	2
18	13	9	6	10	3	1	19	0	1	0	1	2	7	2
15	14	12	7	6	4	1	16	1	2	0	1	2	5	2
16	19	8	9	10	2	2	18	1	1	0	1	2	11	2
11	18	10	5	13	3	3	14	0	0	0	1	2	7	2
12	14	11	4	8	2	2	14	0	0	0	1	2	13	2
14	17	12	6	8	4	1	15	0	0	0	1	1	9	2
12	11	12	7	7	5	1	13	0	0	0	0	2	14	2
14	13	10	9	6	3	1	15	1	0	0	1	1	9	2
12	12	14	7	8	4	3	15	0	1	0	1	1	12	2
11	16	15	6	7	3	4	15	0	1	0	2	1	12	2

Ethiopia +Tanzania
Tanzania
↓
Tanzania
Tanzania
Ethiopia +T

Appendix 6-B : Table 2 : Geo-magnetic-storm days → All days with an 3h – ap-value > 200 are listed from 1932 to mid-2023

→ datas from the GFZ-Potsdam → weblink to GFZ-homepage : <https://kp.gfz-potsdam.de/>

YYYY	MM	DD	days	days_m	Bsr	dB	Kp1	Kp2	Kp3	Kp4	Kp5	Kp6	Kp7	Kp8	ap1	ap2	ap3	ap4	ap5	ap6	ap7	ap8	Ap	SN	F10.7obs	F10.7adj	D
1932	5	29	149	149.5	1357	24	2.333	3.000	2.667	4.333	6.667	7.000	6.667	7.667	9	15	12	32	111	132	111	179	75	17	-1.0	-1.0	2
1932	5	30	150	150.5	1357	25	7.000	8.000	6.333	3.000	2.667	3.667	4.333	3.000	132	207	94	15	12	22	32	15	66	17	-1.0	-1.0	2
1937	4	28	1944	1944.5	1424	10	7.000	8.000	8.000	7.333	6.667	6.667	5.000	5.333	132	207	207	154	111	111	48	56	128	248	-1.0	-1.0	2
1937	8	22	2060	2060.5	1428	18	1.333	6.000	8.000	7.667	5.667	3.000	4.333	2.333	5	80	207	179	67	15	32	9	74	172	-1.0	-1.0	2
1938	1	17	2208	2208.5	1434	4	6.667	6.333	6.667	6.333	8.333	7.667	4.667	6.333	111	94	111	94	236	179	39	94	120	183	-1.0	-1.0	2
1938	1	22	2213	2213.5	1434	9	5.667	7.333	8.333	8.333	6.667	7.000	5.333	4.333	67	154	236	236	111	132	56	32	128	203	-1.0	-1.0	2
1938	1	25	2216	2216.5	1434	12	4.000	2.667	1.667	4.667	6.000	7.333	8.667	8.333	27	12	6	39	80	154	300	236	107	157	-1.0	-1.0	2
1938	1	26	2217	2217.5	1434	13	8.333	6.333	4.333	4.667	4.000	4.333	4.000	2.000	236	94	32	39	27	32	27	7	62	127	-1.0	-1.0	2
1938	5	11	2322	2322.5	1438	10	2.667	2.667	2.000	2.333	2.000	7.667	8.667	8.667	12	12	7	9	7	179	300	300	103	248	-1.0	-1.0	2
1939	10	13	2842	2842.5	1457	17	5.000	5.667	6.333	4.000	3.667	5.667	7.667	8.000	48	67	94	27	22	67	179	207	89	142	-1.0	-1.0	2
1939	10	15	2844	2844.5	1457	19	6.667	8.000	6.667	3.333	3.333	4.667	4.000	3.000	111	207	111	18	18	39	27	15	68	122	-1.0	-1.0	2
1940	3	24	3005	3005.5	1463	18	6.333	6.000	5.000	4.333	8.000	9.000	9.000	8.333	94	80	48	32	207	400	400	236	187	192	-1.0	-1.0	2
1940	3	25	3006	3006.5	1463	19	8.667	8.333	8.333	8.000	7.000	4.667	6.667	8.000	300	236	236	207	132	39	111	207	184	168	-1.0	-1.0	2
1940	3	29	3010	3010.5	1463	23	2.667	1.667	2.333	5.000	5.000	8.333	8.000	8.333	12	6	9	48	48	236	207	236	100	163	-1.0	-1.0	2
1940	3	30	3011	3011.5	1463	24	8.667	8.333	8.333	8.000	7.333	7.667	7.000	5.667	300	236	236	207	154	179	132	67	189	143	-1.0	-1.0	2
1940	3	31	3012	3012.5	1463	25	7.000	5.333	4.667	8.333	8.000	7.667	6.000	6.333	132	56	39	236	207	179	80	94	128	142	-1.0	-1.0	2
1940	4	3	3015	3015.5	1464	1	8.000	8.000	7.000	4.667	4.667	5.000	6.333	3.667	207	207	132	39	39	48	94	22	98	108	-1.0	-1.0	2
1940	4	25	3037	3037.5	1464	23	4.667	8.000	4.000	1.667	2.333	5.000	6.667	6.667	39	207	27	6	9	48	111	111	70	93	-1.0	-1.0	2
1940	6	25	3098	3098.5	1467	3	4.667	7.000	5.333	7.333	8.333	7.667	7.333	5.333	39	132	56	154	236	179	154	56	126	180	-1.0	-1.0	2
1941	3	1	3347	3347.5	1476	9	3.000	6.333	8.000	8.000	8.667	9.000	8.667	7.000	15	94	207	207	300	400	300	132	207	77	-1.0	-1.0	2
1941	7	5	3473	3473.5	1480	27	6.333	6.333	8.667	8.667	9.000	8.667	6.667	7.667	94	94	300	300	400	300	111	179	222	78	-1.0	-1.0	2
1941	8	4	3503	3503.5	1482	3	5.000	7.000	6.000	5.667	8.333	6.667	6.333	6.667	48	132	80	67	236	111	94	111	110	155	-1.0	-1.0	2
1941	9	18	3548	3548.5	1483	21	2.000	6.667	8.333	8.667	8.667	8.667	8.667	8.667	7	111	236	300	300	300	300	300	232	233	-1.0	-1.0	2
1941	9	19	3549	3549.5	1483	22	8.667	9.000	8.667	7.333	4.000	5.000	7.333	4.000	300	400	300	154	27	48	154	27	176	220	-1.0	-1.0	2
1942	3	1	3712	3712.5	1489	23	3.333	2.667	8.000	8.000	7.333	5.667	6.667	6.667	18	12	207	207	154	67	111	111	111	212	-1.0	-1.0	2
1943	8	31	4260	4260.5	1510	4	7.000	8.333	7.333	7.333	7.667	7.000	6.333	4.667	132	236	154	154	179	132	94	39	140	0	-1.0	-1.0	2
1944	12	16	4733	4733.5	1527	18	4.000	3.667	4.333	6.000	8.000	8.333	5.000	3.000	27	22	32	80	207	236	48	15	83	53	-1.0	-1.0	2
1946	2	7	5151	5151.5	1543	4	3.667	2.000	4.000	8.333	7.667	8.000	7.000	8.000	22	7	27	236	179	207	132	207	127	182	-1.0	-1.0	2
1946	2	8	5152	5152.5	1543	5	8.667	7.667	7.333	7.000	5.667	5.667	4.000	3.000	300	179	154	132	67	67	27	15	118	170	-1.0	-1.0	2
1946	3	24	5196	5196.5	1544	22	8.000	7.667	5.000	5.667	7.333	8.000	3.333	5.333	207	179	48	67	154	207	18	56	117	123	-1.0	-1.0	2
1946	3	25	5197	5197.5	1544	23	7.667	7.333	7.333	7.667	8.333	8.667	7.667	7.667	179	154	154	179	236	300	179	179	195	92	-1.0	-1.0	2
1946	3	28	5200	5200.5	1544	26	5.000	6.000	8.333	8.667	8.667	8.667	8.333	8.000	48	80	236	300	300	300	236	207	213	100	-1.0	-1.0	2
1946	4	23	5226	5226.5	1545	25	3.667	4.000	5.333	6.000	6.333	7.667	7.667	8.667	22	27	56	80	94	179	179	300	117	102	-1.0	-1.0	2
1946	4	24	5227	5227.5	1545	26	8.333	7.333	6.667	6.333	4.333	6.667	4.667	3.333	236	154	111	94	32	111	39	18	99	97	-1.0	-1.0	2
1946	7	26	5320	5320.5	1549	11	3.667	4.000	3.000	3.667	3.333	3.333	8.667	8.000	22	27	15	22	18	18	300	207	79	200	-1.0	-1.0	2
1946	7	27	5321	5321.5	1549	12	8.667	8.667	9.000	6.667	5.333	3.667	3.667	2.333	300	300	400	111	56	22	22	9	152	285	-1.0	-1.0	2
1946	9	22	5378	5378.5	1551	15	3.667	8.333	7.667	8.667	9.000	8.333	7.000	6.000	22	236	179	300	400	236	132	80	198	168	-1.0	-1.0	2
1946	9	23	5379	5379.5	1551	16	7.333	7.667	8.000	6.333	7.000	8.000	6.000	6.667	154	179	207	94	132	207	80	111	146	222	-1.0	-1.0	2
1947	3	3	5540	5540.5	1557	15	7.000	5.000	6.667	7.000	6.333	5.667	8.333	8.000	132	48	111	132	94	67	236	207	128	156	0.0	0.0	2
1947	4	17	5585	5585.5	1559	6	3.667	3.667	1.667	1.667	6.333	6.667	8.667	8.333	22	22	6	6	94	111	300	236	100	110	156.8	158.1	2
1947	7	17	5676	5676.5	1562	16	1.000	0.667	0.667	2.000	1.333	7.000	8.000	7.667	4	3	3	7	5	132	207	179	68	283	271.0	280.0	2
1948	3	15	5918	5918.5	1571	15	5.667	8.333	8.000	7.333	6.333	7.000	7.667	5.000	67	236	207	154	94	132	179	48	140	194	146.1	144.6	2
1948	10	18	6135	6135.5	1579	16	8.333	6.667	5.333	3.667	3.667	4.000	5.333	7.333	236	111	56	22	22	27	56	154	86	252	167.4	166.0	2
1949	1	25	6234	6234.5	1583	7	8.667	8.000	6.667	4.333	5.000	6.000	8.333	8.333	300	207	111	32	48	80	236	236	156	205	184.9	179.3	2
1949	1	26	6235	6235.5	1583	8	8.333	8.000	7.000	5.667	5.000	5.000	4.667	4.000	236	207	132	67	48	48	39	27	100	181	178.4	173.0	2
1949	5	12	6341	6341.5	1587	6	2.000	2.000	7.333	7.333	8.333	8.667	8.333	7.000	7	7	154	154	236	300	236	132	153	102	136.8	139.7	2
1949	5	13	6342	6342.5	1587	7	8.000	7.333	3.333	2.000	5.333	3.333	1.000	2.333	207	154	18	7	56	18	4	9	59	85	126.1	128.8	2
1949	10	15	6497	6497.5	1592	27	6.000	6.000	7.333	8.000	7.333	7.333	8.333	7.667	80	80	154	207	154	154	236	179	156	212	189.0	187.8	2
1950	2	20	6625	6625.5	1597	20	2.333	2.667	1.667	2.333	3.000	5.000	8.667	8.333	9	12	6	9	15	48	300	236	79	269	208.6	204.0	2
1950	8	19	6805	6805.5	1604	11	5.667	4.333	5.667	6.333	8.000	8.333	7.667	8.000	67	32	67	94									

1952	4	21	7416	7416.5	1627	1	2.667	3.333	4.000	4.000	8.333	8.000	7.000	6.333	12	18	27	27	236	207	132	94	94	88	89.3	90.3	2
1952	5	27	7452	7452.5	1628	10	8.000	5.667	4.667	5.333	4.333	5.333	5.667	5.000	207	67	39	56	32	56	67	48	72	61	86.7	89.1	2
1952	6	30	7486	7486.5	1629	17	5.333	8.000	7.667	7.000	3.667	2.333	1.667	2.333	56	207	179	132	22	9	6	9	78	108	101.9	105.3	2
1956	2	25	8821	8821.5	1679	2	0.667	6.000	8.333	7.333	6.667	6.667	6.667	3.333	3	80	236	154	111	111	111	18	103	211	0.0	0.0	2
1956	4	27	8883	8883.5	1681	10	8.667	8.667	7.667	7.667	6.667	6.667	7.000	5.667	300	300	179	179	111	111	132	67	172	129	137.1	139.0	2
1956	5	16	8902	8902.5	1682	2	5.333	7.333	7.667	7.000	8.333	7.667	7.000	7.667	56	154	179	132	236	179	132	179	156	173	156.0	159.6	2
1956	9	2	9011	9011.5	1686	3	5.000	7.667	8.000	6.667	4.667	4.000	4.000	3.000	48	179	207	111	39	27	27	15	82	224	179.4	182.5	2
1956	9	8	9017	9017.5	1686	9	1.000	1.000	3.667	5.333	8.333	8.000	6.000	3.333	4	4	22	56	236	207	80	18	78	222	203.4	206.3	2
1957	1	21	9152	9152.5	1691	9	1.667	3.333	3.667	3.667	4.667	5.667	7.667	8.667	6	18	22	22	39	67	179	300	82	251	226.1	219.0	2
1957	1	22	9153	9153.5	1691	10	8.333	6.667	6.333	4.667	4.000	4.000	3.000	2.333	236	111	94	39	27	27	15	9	70	273	228.7	221.6	2
1957	3	2	9192	9192.5	1692	22	6.000	8.333	8.333	7.000	6.667	5.333	6.333	6.667	80	236	236	132	111	56	94	111	132	232	183.1	180.0	2
1957	6	30	9312	9312.5	1697	7	3.000	6.333	5.333	7.667	8.000	8.000	8.000	8.333	15	94	56	179	207	207	207	236	150	289	265.0	273.9	2
1957	7	2	9314	9314.5	1697	9	1.667	1.000	2.667	4.667	8.000	6.333	5.667	2.333	6	4	12	39	207	94	67	9	55	275	242.0	250.2	2
1957	9	3	9377	9377.5	1699	18	6.667	6.333	6.333	7.333	8.000	8.667	6.000	4.667	111	94	94	154	207	300	80	39	135	269	273.5	278.1	2
1957	9	4	9378	9378.5	1699	19	3.667	4.667	2.333	2.667	8.333	9.000	8.000	8.333	22	39	9	12	236	400	207	236	145	245	247.5	251.6	2
1957	9	5	9379	9379.5	1699	20	8.333	8.667	6.667	5.000	4.667	4.000	5.333	6.000	236	300	111	48	39	27	56	80	110	242	237.5	241.3	2
1957	9	13	9387	9387.5	1700	1	7.667	8.333	8.667	8.667	7.000	6.000	4.000	4.000	179	236	300	300	132	80	27	27	160	357	268.5	271.7	2
1957	9	23	9397	9397.5	1700	11	8.000	8.667	7.667	7.667	7.667	6.667	6.667	5.000	207	300	179	179	179	111	111	48	164	379	295.2	297.1	2
1957	9	29	9403	9403.5	1700	17	4.000	5.333	5.000	4.333	8.000	8.667	8.333	8.000	27	56	48	32	207	300	236	207	139	343	257.0	257.7	2
1958	2	11	9538	9538.5	1705	17	9.000	8.333	8.667	8.333	8.000	5.333	6.000	6.000	400	236	300	236	207	56	80	80	199	242	230.1	224.2	2
1958	5	31	9647	9647.5	1709	18	2.333	4.000	2.000	3.333	4.333	6.333	7.667	8.000	9	27	7	18	32	94	179	207	72	256	209.0	214.9	2
1958	6	29	9676	9676.5	1710	20	7.000	8.000	6.667	5.333	7.667	6.333	4.333	2.667	132	207	111	56	179	94	32	12	103	283	220.0	227.4	2
1958	7	8	9685	9685.5	1711	2	3.000	2.667	7.333	7.667	8.333	9.000	8.667	8.667	15	12	154	179	236	400	300	300	200	290	232.0	239.8	2
1958	9	4	9743	9743.5	1713	6	5.000	4.333	3.333	3.667	7.333	8.667	8.333	8.333	48	32	18	22	154	300	236	236	131	340	256.5	260.8	2
1958	9	5	9744	9744.5	1713	7	8.000	7.667	4.333	4.000	3.333	3.667	5.667	3.000	207	179	32	27	18	22	67	15	71	292	233.5	237.3	2
1959	3	27	9947	9947.5	1720	21	7.333	7.667	8.333	6.667	8.333	8.333	7.667	6.333	154	179	236	111	236	236	179	94	178	252	246.7	245.7	2
1959	5	12	9993	9993.5	1722	13	7.000	6.667	6.667	5.667	6.667	8.333	5.333	4.667	132	111	111	67	111	236	56	39	108	391	266.3	271.8	2
1959	7	15	10057	10057.5	1724	23	4.333	5.000	8.000	8.667	8.667	9.000	8.667	8.667	32	48	207	300	300	400	300	300	236	249	245.0	253.1	2
1959	7	17	10059	10059.5	1724	25	3.333	4.333	3.333	3.667	3.333	8.333	8.667	8.333	18	32	18	22	18	236	300	236	110	273	240.0	247.9	2
1959	7	18	10060	10060.5	1724	26	8.000	7.667	8.000	5.667	4.667	7.000	4.667	6.000	207	179	207	67	39	132	39	80	119	276	231.0	238.6	2
1959	8	16	10089	10089.5	1726	1	4.333	4.333	6.667	7.333	8.333	8.000	6.667	7.333	32	32	111	154	236	207	111	154	130	222	201.2	206.3	2
1959	8	17	10090	10090.5	1726	2	7.667	8.333	6.667	6.333	5.333	7.000	5.000	5.333	179	236	111	94	56	132	48	56	114	235	224.2	229.8	2
1959	11	28	10193	10193.5	1729	24	6.000	8.000	7.333	6.667	4.333	3.667	4.000	4.000	80	207	154	111	32	22	27	27	82	214	230.2	224.0	2
1960	3	31	10317	10317.5	1734	13	4.333	4.667	5.000	7.667	6.667	8.000	7.667	8.333	32	39	48	179	111	207	179	236	129	187	182.5	182.3	2
1960	4	1	10318	10318.5	1734	14	8.667	8.667	7.000	8.000	8.333	8.667	8.667	7.333	300	300	132	207	236	300	300	154	241	218	201.4	201.3	2
1960	4	30	10347	10347.5	1735	16	6.667	6.667	5.667	5.667	8.667	9.000	8.000	7.000	111	111	67	67	300	400	207	132	174	142	161.2	163.7	2
1960	5	8	10355	10355.5	1735	24	3.333	6.333	6.667	7.333	8.000	8.333	6.333	6.667	18	94	111	154	207	236	94	111	128	191	168.2	171.4	2
1960	7	15	10423	10423.5	1738	11	3.000	3.667	3.667	5.000	6.333	7.333	7.667	8.000	15	22	22	48	94	154	179	207	93	149	146.0	150.8	2
1960	7	16	10424	10424.5	1738	12	8.333	6.667	5.667	5.000	4.333	5.333	4.667	4.000	236	111	67	48	32	56	39	27	77	187	144.0	148.8	2
1960	9	4	10474	10474.5	1740	8	3.667	4.667	6.667	6.000	6.667	6.000	6.667	8.000	22	39	111	80	111	80	111	207	95	106	142.3	144.6	2
1960	10	6	10506	10506.5	1741	13	6.000	8.000	7.333	8.000	8.000	8.333	8.333	8.667	80	207	154	207	207	236	236	300	203	130	132.7	132.5	2
1960	10	7	10507	10507.5	1741	14	9.000	8.667	7.667	7.667	7.333	7.000	5.667	6.000	400	300	179	179	154	132	67	80	186	160	144.7	144.4	2
1960	11	12	10543	10543.5	1742	23	2.000	1.000	2.000	1.667	5.000	6.000	7.667	8.000	7	4	7	6	48	80	179	207	67	164	169.8	166.3	2
1960	11	13	10544	10544.5	1742	24	8.667	8.667	9.000	9.000	8.667	8.333	8.000	6.333	300	300	400	400	300	236	207	94	280	173	182.0	178.1	2
1960	12	1	10562	10562.5	1743	15	6.333	8.000	6.667	5.000	5.333	6.000	5.667	6.000	94	207	111	48	56	80	67	80	93	105	138.2	134.3	2
1961	7	13	10786	10786.5	1751	23	0.333	1.000	0.667	6.333	8.000	8.333	7.667	6.333	2	4	3	94	207	236	179	94	102	122	141.0	145.7	2
1961	7	14	10787	10787.5	1751	24	4.667	3.000	6.667	8.333	7.333	6.667	6.333	4.000	39	15	111	236	154	111	94	27	98	160	136.0	140.5	2
1961	7	27	10800	10800.5	1752	10	4.000	4.333	8.333	8.333	6.000	5.333	6.333	7.333	27	32	236	236	80	56	94	154	114	75	111.0	114.4	2
1961	9	30	10865	10865.5	1754	21	2.000	3.000	1.667	1.667	2.000	0.333	4.667	8.000	7	15	6	6	7	2	39	207	36	74	100.4	100.6	2
1961	10	1	10866	10866.5	1754	22	8.667	8.333	7.000	7.667	4.667	2.000	2.000	2.333	300	236	132	179	39	7	7	9	114	64	98.4	98.6	2
1961	10	28	10893	10893.5	1755	22	2.333	2.333	5.000	6.333	8.000	8.000	8.667</														

1968	6	11	13311	13311.5	1845	10	7.000	8.000	7.000	6.333	6.667	5.000	5.667	4.333	132	207	132	94	111	48	67	32	103	123	142.1	146.5	2
1968	10	31	13453	13453.5	1850	17	4.667	4.333	5.000	7.333	8.000	8.000	7.000	6.000	39	32	48	154	207	207	132	80	112	140	161.9	159.5	2
1968	11	1	13454	13454.5	1850	18	5.333	3.000	2.667	6.000	8.333	8.000	7.000	8.333	56	15	12	80	236	207	132	236	122	126	155.7	153.3	2
1969	2	2	13547	13547.5	1854	3	0.000	0.000	1.667	2.000	2.000	4.667	8.000	6.667	0	0	6	7	7	39	207	111	47	136	143.2	139.1	2
1969	3	24	13597	13597.5	1855	26	8.000	6.333	6.667	7.000	5.333	3.333	1.667	1.667	207	94	111	132	56	18	6	6	79	207	196.6	195.5	2
1969	9	30	13787	13787.5	1862	27	8.000	7.000	6.333	6.667	6.000	4.000	5.333	2.667	207	132	94	111	80	27	56	12	90	140	136.6	136.9	2
1970	3	8	13946	13946.5	1868	24	4.333	5.000	5.667	5.000	7.333	8.000	9.000	8.333	32	48	67	48	154	207	400	236	149	167	175.3	172.8	2
1970	4	21	13990	13990.5	1870	14	3.667	4.000	5.000	5.667	6.000	6.667	8.333	7.000	22	27	48	67	80	111	236	132	90	91	125.0	126.3	2
1970	8	17	14108	14108.5	1874	24	5.333	8.667	8.000	6.000	5.333	6.667	5.333	5.333	56	300	207	80	56	111	56	56	115	140	147.9	151.6	2
1970	12	14	14227	14227.5	1879	8	3.667	6.000	8.333	5.000	4.333	3.000	4.333	5.333	22	80	236	48	32	15	32	56	65	120	159.5	154.5	2
1972	6	18	14779	14779.5	1899	20	8.333	7.333	7.000	6.333	7.000	7.333	6.000	4.000	236	154	132	94	132	154	80	27	126	135	144.2	148.9	2
1972	8	4	14826	14826.5	1901	13	5.667	8.333	7.000	4.000	5.333	4.000	6.667	9.000	67	236	132	27	56	27	111	400	132	120	141.9	146.0	2
1972	8	5	14827	14827.5	1901	14	8.333	8.333	7.000	7.333	7.667	8.667	7.333	5.667	236	236	132	154	179	300	154	67	182	132	142.4	146.5	2
1972	8	9	14831	14831.5	1901	18	4.667	6.667	6.667	8.333	4.000	4.333	3.333	3.333	39	111	111	236	27	32	18	18	74	84	120.4	123.7	2
1972	9	14	14867	14867.5	1902	27	6.667	8.000	4.667	1.333	1.667	3.333	4.000	3.333	111	207	39	5	6	18	27	18	54	52	98.2	99.3	2
1972	11	1	14915	14915.5	1904	21	7.667	8.000	7.667	6.333	5.333	2.000	4.667	4.000	179	207	179	94	56	7	39	27	98	106	131.9	129.9	2
1973	4	1	15066	15066.5	1910	10	4.000	2.667	3.000	4.000	5.333	7.667	8.333	7.667	27	12	15	27	56	179	236	179	91	92	115.0	115.0	2
1974	7	6	15527	15527.5	1927	12	6.667	8.333	8.667	6.000	7.333	6.333	5.000	3.000	111	236	300	80	154	94	48	15	130	132	117.5	121.5	2
1974	9	16	15599	15599.5	1930	3	8.000	7.667	6.000	6.667	6.333	2.667	2.667	2.000	207	179	80	111	94	12	12	7	88	96	100.9	102.0	2
1976	3	26	16156	16156.5	1950	20	4.333	7.333	8.000	7.333	8.000	8.000	7.000	5.667	32	154	207	154	207	207	132	67	145	54	84.5	84.1	2
1976	4	1	16162	16162.5	1950	26	6.333	8.333	8.333	8.333	6.000	4.333	3.333	2.667	94	236	236	236	80	32	18	12	118	33	79.7	79.6	2
1976	5	3	16194	16194.5	1952	4	8.333	7.667	6.667	7.000	5.333	4.333	3.667	2.333	236	179	111	132	56	32	22	9	97	36	70.7	71.9	2
1978	4	30	16921	16921.5	1979	2	3.333	2.667	2.000	5.000	6.667	8.000	3.667	4.667	18	12	7	48	111	207	22	39	58	106	179.4	182.1	2
1978	5	1	16922	16922.5	1979	3	2.667	4.667	5.667	5.333	7.333	4.333	6.667	8.333	12	39	67	56	154	32	111	236	88	120	178.5	181.3	2
1978	7	4	16986	16986.5	1981	13	6.000	3.667	4.000	4.000	7.667	8.000	3.667	6.000	80	22	27	27	179	207	22	80	80	68	113.5	117.3	2
1978	8	28	17041	17041.5	1983	14	4.333	7.333	8.333	7.667	8.000	6.333	4.667	5.000	32	154	236	179	207	94	39	48	124	81	105.6	107.7	2
1978	9	29	17073	17073.5	1984	19	4.333	6.667	7.667	8.000	8.000	6.667	3.667	1.667	32	111	179	207	207	111	22	6	109	173	147.7	148.2	2
1979	4	3	17259	17259.5	1991	16	3.000	2.333	2.667	2.667	2.667	5.333	6.667	8.000	15	9	12	12	12	56	111	207	54	191	194.2	194.2	2
1979	4	25	17281	17281.5	1992	11	7.667	8.000	7.667	7.000	7.000	5.000	5.667	5.667	179	207	179	132	132	48	67	67	126	120	170.5	172.6	2
1981	4	13	18000	18000.5	2019	1	8.000	8.333	7.667	5.667	6.333	5.667	5.667	5.000	207	236	179	67	94	67	67	48	121	284	253.4	254.9	2
1981	7	25	18103	18103.5	2022	23	4.333	5.667	6.667	4.333	8.333	8.333	7.667	7.667	32	67	111	32	236	236	179	179	134	304	251.6	259.5	2
1981	7	26	18104	18104.5	2022	24	8.000	6.667	6.000	5.000	5.667	5.667	4.000	3.333	207	111	80	48	67	67	27	18	78	294	264.6	272.9	2
1982	3	1	18322	18322.5	2030	26	2.333	2.333	3.333	4.667	6.333	7.000	4.667	8.000	9	9	18	39	94	132	39	207	68	242	235.5	231.3	2
1982	3	2	18323	18323.5	2030	27	8.000	7.667	6.667	7.333	6.000	5.333	4.667	4.000	207	179	111	154	80	56	39	27	107	250	232.2	228.2	2
1982	7	13	18456	18456.5	2035	25	4.667	5.667	5.000	4.333	4.333	8.333	8.667	9.000	39	67	48	32	32	236	300	400	144	288	244.5	252.7	2
1982	7	14	18457	18457.5	2035	26	9.000	7.667	6.667	7.000	6.000	7.000	6.667	6.000	400	179	111	132	80	132	111	80	153	292	260.6	269.3	2
1982	9	6	18511	18511.5	2037	26	8.000	8.333	8.333	8.333	8.667	7.333	7.000	6.333	207	236	236	236	300	154	132	94	199	199	169.4	172.1	2
1982	9	22	18527	18527.5	2038	15	7.667	8.333	8.000	7.667	6.667	6.000	4.333	5.333	179	236	207	179	111	80	32	56	135	134	145.2	146.2	2
1983	1	10	18637	18637.5	2042	17	7.333	8.333	7.000	5.000	3.333	2.667	2.333	3.000	154	236	132	48	18	12	9	15	78	114	149.1	144.2	2
1983	2	5	18663	18663.5	2043	16	7.333	8.000	7.333	7.333	7.333	6.000	7.000	6.667	154	207	154	154	154	80	132	111	143	118	158.7	154.3	2
1983	5	24	18771	18771.5	2047	16	4.000	4.000	3.000	2.667	4.667	8.000	7.667	6.667	27	27	15	12	39	207	179	111	77	148	136.9	140.4	2
1984	11	16	19313	19313.5	2067	18	7.667	8.000	7.000	6.667	6.333	5.333	5.667	5.000	179	207	132	111	94	56	67	48	112	13	72.3	70.7	2
1985	4	21	19469	19469.5	2073	12	8.333	7.333	8.000	5.667	4.667	5.667	4.333	3.667	236	154	207	67	39	67	32	22	103	21	77.1	77.9	2
1986	2	8	19762	19762.5	2084	8	7.000	7.000	7.333	6.667	8.000	7.667	9.000	8.667	132	132	154	111	207	179	400	300	202	65	96.9	94.3	2
1986	2	9	19763	19763.5	2084	9	8.667	7.667	5.333	4.667	5.000	6.333	5.333	4.000	300	179	56	39	48	94	56	27	100	56	95.1	92.6	2
1986	9	12	19978	19978.5	2092	8	5.333	8.667	7.333	5.667	4.333	4.000	4.667	4.667	56	300	154	67	32	27	39	39	89	0	67.9	68.8	2
1988	4	3	20547	20547.5	2113	10	2.667	2.667	5.000	4.667	1.667	4.333	8.000	4.333	12	12	48	39	6	32	207	32	48	116	127.6	127.6	2
1989	3	13	20891	20891.5	2126	3	6.000	7.667	8.667	8.333	8.333	8.333	8.667	9.000	80	179	300	236	236	236	300	400	246	210	256.0	253.0	2
1989	3	14	20892	20892.5	2126	4	9.000	7.667	7.667	5.667	5.000	5.333	7.667	7.333	400	179	179	67	48	56	179	154	158	235	266.7	263.8	2
1989	9	19	21081	21081.5	2133	4	6.667	8.000	7.000	5.000	4.000	3.000	2.667	1.333	111	207	132	48	27	15	12	5	70	194	195.3	197.0	2
1989	10	20	21112	21112.5	2134	8	2.333	3.000	4.333	6.667	7.667	7															

1991	7	9	21739	21739.5	2157	14	3.333	4.667	8.000	7.000	8.000	7.333	6.667	5.667	18	39	207	132	207	154	111	67	117	248	194.1	200.6	2
1991	7	13	21743	21743.5	2157	18	4.667	5.000	6.667	7.000	8.000	8.667	6.000	7.333	39	48	111	132	207	300	80	154	134	192	195.7	202.3	2
1991	10	28	21850	21850.5	2161	17	5.333	5.333	4.667	6.333	7.667	8.333	5.333	5.667	56	56	39	94	179	236	56	67	98	302	271.0	267.5	2
1991	10	29	21851	21851.5	2161	18	7.667	8.333	8.000	6.333	4.667	6.000	7.000	5.333	179	236	207	94	39	80	132	56	128	339	272.5	268.8	2
1991	11	1	21854	21854.5	2161	21	5.333	3.333	5.333	5.333	6.667	8.000	8.333	7.000	56	18	56	56	111	207	236	132	109	292	230.2	226.8	2
1991	11	8	21861	21861.5	2162	1	2.667	3.000	4.000	4.000	6.667	6.667	7.667	8.667	12	15	27	27	111	111	179	300	98	208	200.4	196.7	2
1991	11	9	21862	21862.5	2162	2	8.333	8.333	7.333	6.667	6.000	5.000	5.333	4.333	236	236	154	111	80	48	56	32	119	195	197.4	193.6	2
1992	2	26	21971	21971.5	2166	3	3.333	3.333	3.667	3.667	4.000	6.333	8.000	6.667	18	18	22	22	27	94	207	111	65	281	252.9	248.0	2
1992	5	10	22045	22045.5	2168	23	5.333	6.333	8.000	8.667	8.333	7.667	8.000	7.333	56	94	207	300	236	179	207	154	179	93	124.4	126.9	2
1992	8	23	22150	22150.5	2172	20	7.667	8.000	6.333	3.000	4.333	2.333	4.000	3.667	179	207	94	15	32	9	27	22	73	51	110.7	113.2	2
1994	4	17	22752	22752.5	2195	1	6.667	8.333	8.333	7.000	4.667	3.000	3.000	3.333	111	236	236	132	39	15	15	18	100	29	81.8	82.5	2
1995	4	7	23107	23107.5	2208	5	4.000	5.667	6.000	5.333	7.000	8.000	7.333	6.000	27	67	80	56	132	207	154	80	100	0	70.5	70.7	2
1996	10	23	23672	23672.5	2229	3	7.333	5.667	3.667	3.333	1.667	3.000	2.333	2.000	154	67	22	18	6	15	9	7	37	0	70.5	69.8	2
1998	5	4	24230	24230.5	2249	21	6.000	8.667	8.333	5.667	6.000	3.667	2.333	3.000	80	300	236	67	80	22	9	15	101	96	121.1	123.2	2
1998	8	27	24345	24345.5	2254	1	8.000	8.000	7.667	6.667	6.667	6.667	7.000	6.333	207	207	179	111	111	111	132	94	144	131	135.0	137.8	2
1998	9	25	24374	24374.5	2255	3	7.667	8.000	8.333	7.000	6.333	5.667	2.667	2.333	179	207	236	132	94	67	12	9	117	149	138.5	139.2	2
1999	9	22	24736	24736.5	2268	14	3.000	2.000	2.000	2.667	5.000	3.667	6.000	8.000	15	7	7	12	48	22	80	207	50	89	140.4	141.5	2
1999	10	22	24766	24766.5	2269	17	7.000	7.667	8.000	5.333	4.667	4.333	5.667	3.333	132	179	207	56	39	32	67	18	91	124	160.3	158.8	2
2000	4	6	24933	24933.5	2275	22	1.667	4.333	2.667	2.333	3.333	6.667	8.333	8.333	6	32	12	9	18	111	236	236	82	165	177.7	178.1	2
2000	4	7	24934	24934.5	2275	23	8.667	6.000	6.000	4.000	4.000	4.333	3.667	3.667	300	80	80	27	27	32	22	22	74	143	174.9	175.4	2
2000	5	24	24981	24981.5	2277	16	8.000	7.667	6.000	5.667	5.000	5.000	6.000	4.333	207	179	80	67	48	48	80	32	93	183	189.4	194.3	2
2000	7	15	25033	25033.5	2279	14	3.000	3.667	4.667	4.333	8.000	8.667	9.000	8.667	15	22	39	32	207	300	400	300	164	213	213.1	220.1	2
2000	9	17	25097	25097.5	2281	24	4.667	4.000	2.333	3.000	4.000	4.667	5.333	8.333	39	27	9	15	27	39	56	236	56	154	181.5	183.2	2
2001	3	31	25292	25292.5	2289	3	6.667	8.667	8.667	6.333	7.000	8.000	8.333	7.333	111	300	300	94	132	207	236	154	192	300	245.6	245.3	2
2001	4	11	25303	25303.5	2289	14	3.000	2.333	2.000	2.000	3.667	8.000	7.667	8.333	15	9	7	7	22	207	179	236	85	173	159.6	160.3	2
2001	11	6	25512	25512.5	2297	7	8.667	8.667	7.000	5.000	5.333	6.667	6.333	6.333	300	300	132	48	56	111	94	94	142	232	237.4	233.2	2
2001	11	24	25530	25530.5	2297	25	3.333	5.333	8.333	7.000	7.667	7.333	3.000	4.667	18	56	236	132	179	154	15	39	104	111	173.0	168.6	2
2002	5	23	25710	25710.5	2304	16	2.667	2.667	2.000	6.667	7.667	8.333	5.000	3.333	12	12	7	111	179	236	48	18	78	211	180.3	184.8	2
2003	5	29	26081	26081.5	2318	9	4.000	3.667	3.667	3.000	7.000	7.667	8.333	8.333	27	22	22	15	132	179	236	236	109	89	137.8	141.6	2
2003	10	29	26234	26234.5	2323	27	4.667	4.000	9.000	8.000	7.667	7.667	8.667	8.667	39	27	400	207	179	179	300	300	204	250	291.7	287.7	2
2003	10	30	26235	26235.5	2324	1	8.667	7.333	5.333	4.667	5.000	7.000	9.000	9.000	300	154	56	39	48	132	400	400	191	250	271.4	267.6	2
2003	10	31	26236	26236.5	2324	2	8.333	7.667	7.333	6.667	7.333	4.667	4.000	4.333	236	179	154	111	154	39	27	32	116	239	248.9	245.2	2
2003	11	4	26240	26240.5	2324	6	3.000	3.000	6.333	7.000	2.667	2.000	3.333	2.667	15	15	94	132	12	7	18	12	38	64	560.9	551.6	2
2003	11	20	26256	26256.5	2324	22	1.000	3.667	6.333	6.333	7.667	8.667	8.667	8.000	4	22	94	94	179	300	300	207	150	111	175.2	171.0	2
2004	7	25	26504	26504.5	2333	27	7.000	7.333	6.333	7.667	7.333	8.000	7.333	7.333	132	154	94	179	154	207	154	154	154	94	156.2	161.1	2
2004	7	27	26506	26506.5	2334	2	8.333	7.667	7.333	8.000	8.667	8.333	6.333	6.000	236	179	154	207	300	236	94	80	186	90	118.1	121.8	2
2004	11	7	26609	26609.5	2337	24	1.667	3.000	0.667	3.333	3.000	4.667	6.333	8.000	6	15	3	18	15	39	94	207	50	101	129.6	127.2	2
2004	11	8	26610	26610.5	2337	25	8.667	8.667	8.333	7.000	5.000	2.667	4.333	5.333	300	300	236	132	48	12	32	56	140	92	124.1	121.7	2
2004	11	9	26611	26611.5	2337	26	5.667	6.000	5.000	6.000	7.000	6.667	8.667	7.000	67	80	48	80	132	111	300	132	119	84	140.9	138.1	2
2004	11	10	26612	26612.5	2337	27	7.667	8.333	8.667	8.333	7.333	6.333	5.333	4.333	179	236	300	236	154	94	56	32	161	52	104.6	102.6	2
2005	1	21	26684	26684.5	2340	18	3.333	2.000	2.333	2.333	2.667	6.667	8.000	7.333	18	7	9	9	12	111	207	154	66	69	113.5	109.9	2
2005	5	8	26791	26791.5	2344	17	6.000	5.333	3.667	6.000	8.333	7.667	5.333	3.667	80	56	22	80	236	179	56	22	91	67	101.3	103.2	2
2005	5	15	26798	26798.5	2344	24	5.667	5.667	8.333	7.667	4.000	4.000	5.000	5.000	67	67	236	179	27	27	48	48	87	56	103.0	105.2	2
2005	8	24	26899	26899.5	2348	17	2.667	3.333	6.333	8.667	7.333	6.667	6.333	4.333	12	18	94	300	154	111	94	32	102	70	98.6	100.7	2
2005	9	11	26917	26917.5	2349	8	6.333	7.000	7.667	6.333	7.000	5.333	6.000	4.667	94	132	179	94	132	56	80	39	101	58	109.7	111.1	2
2006	12	15	27377	27377.5	2366	9	8.333	7.667	6.667	5.667	6.000	4.000	4.000	3.667	236	179	111	67	80	27	27	22	94	21	88.2	85.4	2
2012	3	9	29288	29288.5	2437	3	4.667	6.333	8.000	7.333	6.667	5.667	3.000	2.333	39	94	207	154	111	67	15	9	87	110	145.5	143.5	2
2015	3	17	30391	30391.5	2477	26	2.000	4.667	5.667	5.333	7.667	7.667	7.333	7.667	7	39	67	56	179	179	154	179	108	38	114.3	113.2	2
2015	6	22	30488	30488.5	2481	15	1.000	3.333	4.333	3.000	4.667	5.333	8.333	5.333	4	18	32	15	39	56	236	56	57	56	246.9	255.0	2
2017	9	8	31297	31297.5	2511	14	8.000	4.667	4.333	5.000	8.333	7.333	6.333	4.667	207	39	32	48	236	154	94	39	106	88	116.8	118.5	2
2021	11	4	32815	32815.5	2567	20	6.333	5.667	7.000	7.667	5.667	3.6															

Appendix 6-C: Table 3: List of Geo-magnetic Storms in the time period 1800 – 2023 , mainly based on observational reports (visible Auroras etc.)

Year	month-day(s)	DST-value (in nT)	-dH (nT) from Kakioka	Solar Flare class	Kp-index (before 1932 estimated)	Aurora oval visibility overhead/low-latitude (estimated)	Aurora observation reported from these locations	Effects of solarstorm	Comments	weblinks (more info)		
1811	12-15				9+	≈35°/≈25° (?)	South-& North-Carolina, Havana/Caribbean(?),Jerusalem (?)	possible connection with the strong M7.4-8.6 Intraplate-Earthquake in New Madrid/Missouri (USA) on 16-12-1811	from distant cities & ships (in the Tropics) a Red-Aurora was seen in the night-sky, one day before the big Earthquake	more info (page 46)	more info2 (see Light)	
1826	3-29				9-	≤50° / ≈40°	Manchester		rainbow-like arc aurora, stretching across the midheaven	more info	-	
1827	9-25				9-	≤50° / ≈40°	Charleston, Norfolk, Switzerland Holland, Paris		brilliant bright arc aurora was visible in the northern sky in Charleston, aurora also seen in Central Europe	more info	more info2	
1842	2-24				≈8	≈50° / ≈40°	Alford (Lincolnshire) UK		brilliant aurora with streamers seen in Alford	more info	-	
1843	4-19				9+	≤ 45°/≈23°	Mexico, Scotland	magnetic disturbances measured in Makerstoun Scotland	sporadic aurora observed in Mexico on 19 April 1843 other bright aurora seen on March 20&28 in Manchester	more info	more info2	
1845	12-29				9-	≤50° / ≈40°	Valencia (Spain)		sporadic red aurora observed in Spain on 29 December 1845	more info		
1847	10-24 11-17				9 (24.10)	≈45° / ≈35°	San Fernando (Spain) Cartagena, Coruna (Spain),UK 17.11.	strong magnetic storm reported from Helsinki (23/24.10) at the same time great magnetic disturbances (17.11.)	extraordinary display of aurora borealis observed in Cambridge	more info	more info2	
1848	10-18 11-17	-900 (28.8.)			9	≈45° / ≈35°	Valladolid (Spain) - 18.10. Cartagena, Coruna (Spain),UK 17.11.	strong magnetic storm reported from Helsinki (17/18.11) value of a geomag. Storm from 28/29.8.1848 : -900nT	red bright aurora in NNW, color became white later (18.10.) Aurora arc from NNW to NNE, colors: white, green, yellow 17.11.	more info	more info2	more info3
1859	8-28 9-2 to 9-4	-1760			9+	41° / 20°	Hawaii, Cuba, Mexico, Italy, Washington, London	disabled telegraph network from New York to Washington brilliant radiations of different colored light filled the sky	"Carrington Event", big floods of 1861-62 in California indicate: a strong El Nino may have been caused by the solar-storm !	more info	more info2	
1862	12-14				9+	≈44°/≈34°	Virginia, Gulf States (USA)		brilliant aurora borealis seen by civil war soldiers in Virginia possible bright aurora with streamers seen in the gulf states	weblink1	-	
1870	10 -14 & 24				9-	≈45° / ≈35°	New York, Cleveland, Cincinnati (24.10.)	magn. disturbance reported from Melbourne Observatory (Australia) and on other places in the north. Hemisphere	unusual bright and brilliant aurora was observed on 24.10. in Cleveland & Cincinnati. It lasted two days !	weblink1	-	
1872	2-4/5	-830			9+	≈45°/≈21° - north ≈23° (?) -south	Paris, Havana, Cuba Rio de Janeiro (4.2.)		A possible case of a low latitude sporadic aurora another bright aurora was visible on 18.8.1872	weblink1	more info	more info3
1872	8-18				9-	≈45°/≈35°	New York		the best auroral display that occurred in the present generation	weblink1	-	-
1875	Sept.						Martinique Island (magnetic Phenomena observed)	the telegraph chief at Fort de France/Martinique observed that each of the Sept. 1875 earthquakes was preceded by a marked disturbance of the electric telegraph needles		more info	-	
1877	5-28				9-	≈45°/≈35°	New York	telegraph lines were effected from Boston, Baltimore, Philadelphia & Washington DC	bright wavering aroras with streamers seen in New York arched aurora that moved halfway to the zenith, visible in NY	weblink1	-	
1880	8-12				≈8	≈50° / ≈40°	daytime aurora borealis in USA	disruption of telegraph-lines in Connecticut/USA	Current was induced in lines. Batteries had to be removed.	weblink1	-	
1882	4-16/17 11-17/18				9+ ≈9	42°/≈30° - north ≈40°/30° - south	overhead in Chicago & Goulburn/AU England: aurora crossed sky (16/17.4)	strong disruption of telegraph systems, Telegraph lines between Chicago & Milwaukee worked without batteries	a moon-like aurora crossed sky in England, bright aurora of crimson (red) color seen 60° high in Goulburn/NSW Australia	more info	weblink1	more info2
1892	2-13				9-	≈45°/≈35°	Cleveland, Lousville, Detroit, Milwaukee		Was described as the -most wonderful exposition- ever seen on american soil, visible from Iowa to the Atlantic-coast	weblink1	-	-
1897	4-23 / 7-30 8-19 / 12-20				≈8	≈50° / ≈40°	Williams Bay (USA)	Note: a telegraph operator noticed 22.5.1897 a few seconds before an earthquake an unusual signal on a telegraph device	bright aurora arcs with streamers observed at the Yerkes-Observatory in Williams-Bay (USA) 23.4, 30.7, 19.8. & 20.12.	more info (page1-2)	more info2 (earthquake)	
1898	9-9 & 9-10				≈8	≈50° / ≈40°	reported from Haslemere (UK) Williams-Bay (USA)	disruption of telegraph systems reported from Chicago, Tennessee, Washington by daytime-aurora, Tennessee and Omaha (USA) --> daytime aurora	voltage of ≈ 280 V was induced into the telegraph wires very bright auroras with streamers reported from UK 9.9/10.9. other bright auroras at Williams Bay on 16.1., 14.3, 3.5, 2-15.9.	more info	more info2 (page2-4)	
1899	2-11&15 / 5-1 6-28&29				≈8	≈50° / ≈40°	Williams Bay (USA)		bright aurora arcs with streamers observed at the Yerkes-Observatory in Williams-Bay (USA) 11+15.2, 1.5., 28+29.6.	more info (page5-6)	-	
1901	9-10 9-26				≈6	≈60° / ≈52°	Scotland (10. Sept 1901), Canada, Finland	Remark : The worldwide hot climate in 1901 may indicate an El Nino event in 1901-02	beautiful display of curtains of Aurora borealis observed in Rusnes/Sanday near Kirkwall (Nature Journal No. 1665)	more info		
1902	Oct.				9-	≤50° / ≈40°	Spain (Pyrenees mountains)		pink & red Aurora observed on a few occations	more info		
1903	≈10-30 11-1 (& 7-29)	-531			9+	≈44°/≈34° (north) ≈35°/≈30° (south)	Ireland, Scotland, Chicago, Colorado, overhead Aurora in Duluth & NSW-Australia	disruption of Western Union- & New York telegraph systems & transatlantic sea-cables, swiss street-cars disabled, another strong geom. Storm on 29.7.	Geom. storm during <u>sun</u> cycle minimum measured in France, telegraph disruption in Mexico, Geom. storm reported from East-Asia, in Chicago telegraph lines up to 675 V were measured	more info		
1905	3-2 & 3-3				≈8	≈50° / ≈40°	Chicago & Sioux City (USA)	Electrical disturbances on Chicago- & Sioux City telegraph systems reported		weblink1 (2.3.1905)	-	

1908	9-11				9-	≈45°/≈35°	Washington	disruption of telegraph systems	bright pink-colored (energetic) aurora with streamers, often reaching up to the zenith, observed in Washington	weblink (12.9.1908)	-	
1909	9-24/25	-595		probably ≥X10	9+	≈35°/≈20°	Japan, Maine (USA) (Singapore?)	disruption of telegraph systems in Boston, Chicago, Tennessee and in transatlantic sea-cable reported, disruptions also in telegraph systems in Europe	voltage of up to ≈500 V was induced into the telegraph wires, geomagn. disturbance was compared with events from 1803 & 1882 (it was a daytime aurora in Chicago)	more info		
1915	6-17				9-	≈45°/≈35°	Flagstaff (Lowell Observatory) (Arizona/USA)	eastern telegraph circuits interrupted (USA), only east- & west-cables were effected and these wires were heavily surcharged, electrical disturbances in the western states	bright aurora with streamers observed in Flagstaff, some streamers reached almost to the zenith, was bright for a few hours, aurora reached from 25° west to 45° east	weblink		
1916	8-25/26				≈7	≤50° / ≤40°	Minneapolis,	telephone & telegraph services in the East & West of the USA were seriously disrupted (between Chicago & Minneapolis), 75 V were induced in the cables	bright night-sky in Minneapolis,	weblink		
1917	8-8 8-21				9- ≥6	≈50° / ≈40°	Algonquin/Canada	telegraph & telephone communications to Chicago from Pittsburg, Omaha, Buffalo & Philadelphia stopped.	arc aurora with streamers observed in Algonquin/CA on 21.8 telegraph networks around New York area were disrupted too	weblink	more info	
1918	3-7				9+	≤40°/≤30°	Washington (overhead aurora) Illinois, Tampa/Florida, Texas	telegraph lines from New York to Buffalo were disrupted motors/generators providing electricity were effected too	bright overhead aurora with streamers observed in Washington and Duluth, another bright aurora on 21.3.1918	more info	weblink	more info2
1919	1-31 8-11 10-1				9	≤50° / ≤40°	St. Petersburg (overh. Aurora, 31.1.) Denver (11.8.), New York, Omaha (1.10)	telegraph disruptions along Atlantic seaboard as far south as Georgia & Kansas (11.8.), disruption of telegraph systems in Minnesota & NW-states	31.1.: brilliant flaming auroras were observed in the night 11.8.: in Denver aurora visible in northern sky	weblink		
1920	3-22				9	≤44°/≤34°	New York, Atlanta	disruption of telegraph cables of the American Telegr. Co. Undersea cables were disrupted and stopped working too	flashing and wavering auroras were seen in the northern sky from New York, aurora with streamers seen in Atlanta	weblink		
1921	5-13 to 5-15	-907 +/- 132			9+	≤34° / ≤24° (north) ≈33° / -13° (south)	visible in east-USA, Caribbean, and in Samoa (confirmed !), overhead aurora in California	substantial damage to overhead and underwater telegraph equipment in USA, Europe and in the southern hemisphere, sparked many electrical fires	induced (telluric) ground currents probably were larger than from the 1989 superstorm, Auroras created brightly lit night skies in eastern USA, credible Aurora-report from Samoa	more info	weblink	
1926	1-26 3-9				9	≈45° / ≈35°	Salzburg/Austria (9.3.)	telegraph systems throughout the country were disrupted all over the country down south to New Orleans (26.1.)	120 to 150 V were induced in telegraph cables (USA)-26.1. bright red aurora visible from Austria/Salzburg	weblink	-	
1927	2-24 4-14 7-21 10-12				9- (24.2.) ≥7 (12.10)	≈50° / ≈40° (24.2.)	Geneva/Switzerland (24.2.) Berlin (12.10.)	telegraph systems disrupted, Winnipeg to Montreal 14.4. telegraph systems disrupted, New York to Mid-West 21.7. disruption of telegraph networks in northern states 12.10.	bright red aurora visible from Geneva 100 V were induced into telegraph cables 12.10. disrupted shortwave radio systems to the north, Berlin 12.10. Berlin: glow of Aurora Borealis was visible on 12.10.	weblink	-	
1928	7-7/8		486		9-	≈45°/≈35°	Sydney, Geelong (Australia)	disruption of telegraph system all over USA caused by earth-currents resulting from the geomagnetic storm	7.July.1928 in Sydney: green&blue aurora with bright white streamers against a red glowing sky visible	weblink		
1932	5-29/30				9-	≤45°/≤35°	Cleveland, New Mexico, Geneva	radio- & telegraph systems were disrupted by magn. Storm	two wide bands of pale white light appeared in the sky (photo)	more info	weblink	more info2
1938	1-17 1-22 to 1-25	-336	490/509		8+ 9-	≤ 45°/≈30°	Sicily, Portugal, Bermuda, Southern California	electrical disturbances, short wave radio systems were interfered, 3 geom. Storms, 2 great aurora storms, 4 SSCs	The "Fatima Storm" Jan. 22-25, great Aurora display in Europe, USA & South-Australia, another geom. Storm on 16.4.1938	more info	weblink	
1941	9-18/19		604		9+	≤ 40°/≈20°	Florida (18.9.), Washington, New Mexico	"geomagnetic flash" reported, disruption of telegraph- & short wave radio systems, another magn. Storm on 6. July	18.09.1941, most brilliant aurora display ever seen in Washington (energetic pink aurora), even seen in Florida	weblink	more info	
1943	8-30/31				8+	≈40°/≈30°	Delaware/Ohio	radio communication between Europe and USA was seriously disturbed (3.9.)	brilliant aurora during sunspot-minimum visible at Perkins-Observatory/Ohio, aurora with streamers covered northern sky	more info	weblink	
1946	2-7 3-25 & 3-28	-512 (23.3.)	462		8+ 9-	≈40°/≈30° (north & south)	New York (overhead-7.2.), Scotland Canberra 30.3., Cambridge 28.9.	radio disruption reported from Bombay, Lisbon, Cairo & Singapore, & worldwide on 3.2.(until 15.2.) on 26.3.	brilliant waving overhead aurora seen in New York on 7.2. and 26.7., aurora with bright streamers (colors red & green)	weblink	more info	more info2
1949	1-25/26 5-12	-530(?)	407 (24.1.)	3+ (1949)	9- 9-	≤45°/≤30°	Adelaide (Australia)-12.5.	complete blackout in India shortwave-radio services, shut-down of radio- & Sea-cable communication on 26.1.	24.01.1949 (-dH-value), sudden-commencement-type Storm 12.5.: bright pink aurora seen from Adelaide	more info	more info2	more info3
1950	2-20 3-19				9- 7+	≤45°/≤35°	Sydney (Australia)	disruption of worldwide radio communication (21.2.1950)	red glowing aurora seen from Sydney in the South on 19. March	weblink	-	more info3
1956	2-24				8+	≤ 54°/≈35°	one overhead aurora visible in South-England	strong solar cosmic rays measured during a strong solar proton event	extremely high ground level (telluric current) enhancement auroras visible on 8 nights (low latitude) in South-England (54°)	weblink		
1957	1-21/22 9-13		486 (13.9.)		9- 9-	≤ 54°/≈35°	South-England (13.9.), France (23.1.) Chicago (4.9.), Los Angeles (13.9.)	strong solar storms measured (13.9.), spectacular fade-out of radio signals worldwide (16.4.)	highest auroral activity for at least two centuries (NASA) auroras visible on 30 nights (low latitude) in South-England (54°)	weblink		
1958	2-11	-425	617/472		9	≤ 45°/≈23°	Havana, Los Angeles, New Mexico Washington, across Europe	strong geomagn. storm, most communication systems were disrupted for a few hours, blackout in Toronto, SSC	telegraph cables over the North Atlantic became a 2650V battery, auroras visible on 16 nights in South-England (54°)	more info	weblink	
1960	11-12/13		417		9+	≤40°/≤30°	Western Europe, Atlantic overhead in France	widespread radio disruption	12.11.1960 (-dH-value), active arc aurora with streamers, sometimes brilliant red flaming curtains	weblink	more info	
1967	5-25/26		509		9	≤45°/≤35°	England, Northern France, W-Atlantic, Washington	strong geomagnetic storm measured	25.5.1967 (-dH-value), brilliant aurora bands with streamers colored in red, violet & green	more info	more info2	weblink

1969	3-24				8	≈45°/≈30°	Eastern USA, New York to Louisiana		mostly red aurora with green and yellow colors	weblink1		
1972	8-4	-450 to -486		X20	9	≤45°/≤35°	Illinois to Colorado Bilbao/Spain	disruption of electrical- & communication networks & satellites, DST-value may have surpassed -1600 nT	series of strong solar flares (peak class 20), fastest CME-transit ever recorded, 4 X-flares, strong geom. Induced currents (GICs)	weblink1		
1974	7-5/6				9-	≤50° / ≤40°	Chicago, Ohio, Michigan, Omaha	strong geomagnetic storm measured	brilliant green- & yellow-colored aurora was visible over Chicago	more info	more info2	weblink1
1982	7-13/14	-330	630	3B/X7.1	9	≤45°/≤35°	Bermuda, Sardinia, Malta, Australia Michigan, Ontario, Atlantic, UK	the geom. storm from 13.7. produced a localized (around Japan) short-lived (1.5h) deep depression of geom. H-comp.	13.7.1982 (-dH-value), aurora borealis observed in the Mediterranean region	more info	more info2	
1989	3-13/14	-589	644	X8	9+	≤ 40°/≈20°	Florida, Honduras, Caribbean Wales: overhead aurora	caused the collapse of the Hydro-Quebec Power grid in seconds (protection relays tripped in a cascade), widespread effects on power systems	on 13. March the strongest geom. Storm of the last century struck Earth with intense auroras ,(-dH-value: date : 13.3.), another X4.5-flare was caused 2 days earlier,10. March 89)	more info		
1991	3-24/25 6-5 11-8/9		503		9- 9- 9-	≤45°/≤30°	Texas, Pennsylvania, California (9.11) Graz (Hungary)-24.3.	around half of the energy output of the 1989 event, worst mag. Storm since 1989	24.3.91 (-dH-value), in Northern USA aurora covered whole sky active flaming pulsating aurora seen in Graz (24.3.)	more info	weblink1	.
1992	5-9/10		426		9-	≤55°/≤45°	North Dakota, south. Scotland		9.5.1992 (-dH-value), aurora with bright streamers	more info		
1995	4- 7/8 (10- 18/20)				8 7-	≈50° / ≈40°	Denmark, Northern England & Detroit (18/19.10.);North Dakota, Scotland & Midlands in UK (7.4.)		brightest aurora seen all over the sky in North Dakota 7.4. and all over Scotland down to the english midlands	more info		
1996	10-22/23				7+	≈50° / ≈40°	North Dakota		23.10.1996 - Ap-index 38 & Kp-max=7+ active moving, waving & pulsating Aurora observed in Dakota	more info	more info2	
1998	5-4 9-25	-216 (soho) -207 (soho)			9- 8+	≤50° / ≤40°	Chicago, Detroit, Boston (4.5.) Dakota (USA) in Sept./Oct.		active moving, waving & pulsating Aurora observed in Dakota	more info	more info2	more info3
1999	10-22	-237 (soho)			8	≈50° / ≈40°				more info	weblink3	
2000	4-6/7 7-15 8-11/12 9-17	-321 (soho) -301 -237 (soho) -201 (soho)		X5.7 (14.7.)	9- 9 8- 8+	≤45°/≤35°		minor satellite- & power transformer damage worldwide associated solar particle event was 4.th largest since 1967 (15.7.2000)	DST-value from 14/15. July, G5-storm, "Bastille Day storm"	more info	more info2	weblink1
2001	3-31 4-11	-377 (soho) -251 (soho)	477		9- 8+	≤45°/≤30°	Texas, California, Florida	fast moving CME triggered vivid aurora in Nov. 2001	red aurora visible on 6. April was caused by X20 flare, but the majority of the solar storm missed the Earth	more info	.	
2003	10-29 to 11-2	-353 -383	423		9	≤45°/≤30°	Texas, Mediterranean countries, (South Africa?)	3 strong geom. Storms from 29.10-2.11 ->"Halloween Storm" 12 transformers in South Africa were disabled by the storm	3 geom. Storms between 29.10 and 2.11. overlapped each other DST-values : -151, -353 & -383, storm of a X45 flare missed Earth	more info	weblink1	.
2003	11-20	-533	415 (20.11.)		9-	≤40°/≤25°	Florida, South Australia	extreme radio blackout was caused on 4. Nov. 2003	on 4th of Nov. a powerful X34 flare was detected	weblink1	weblink3	
2004	7-25/26 11-4 to 11-10		460 (7.11.)		8 9-	≤45°/≤35° (25.7.)	25.7.: Michigan, California, New York 7.11.: Alabama, Ohio			weblink1		
2005	5-15		401 (15.5.)		8+	(GFZ-Potsdam data)		big solar storm caused large-scale atmospheric ionization	20. Jan 05			
2013	3-17				7-	(GFZ-Potsdam data)						
2013	6-1				7	(GFZ-Potsdam data)						
2013	10-2				8-	(GFZ-Potsdam data)						
2014	2-19				6+	(GFZ-Potsdam data)						
2015	3-17				8-	(GFZ-Potsdam data)		St. Patrick's Day storm:				
2017	9-8			X8.2	8+	(GFZ-Potsdam data)						
2022	2-3			M1.1	5	(GFZ-Potsdam data)		CME ended up as shock-driving magnetic cloud (MC)	3. February: 39 starlink satellites lost in solar-storm	more info		
2022	9-30				4	(GFZ-Potsdam data)	Tasmania	bright aurora visible in Tasmania		more info		
2023	2-10/11			X1.1	4	(GFZ-Potsdam data)		temporary radio blackout in South America		more info		
2023	2-16/17			X2.2	5	(GFZ-Potsdam data)	New York, Idaho (predicted)	temporary radio blackout on sunlit side of Earth		more info		
2023	2-27				7-	(GFZ-Potsdam data)				-		
2023	3-3			X2.1	4	(GFZ-Potsdam data)		caused a shortwave radio blackout in N- & S-America		more info		
2023	3-24				8	(GFZ-Potsdam data)		see GFZ-data table - Appendix 6-B		-		
2023	4-23/24				8+	(GFZ-Potsdam data)	South Australia,NSW & WA		24. April : bright Aurora visible across southern Australia	more info		

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