



Hong Kong

6-9 May 2012



Extra-terrestrial Influences on Nature's Risks

Brent Walker

Session Number: **WBR9**



Joint IACA, IAAHS and PBSS Colloquium in Hong Kong
www.actuaries.org/HongKong2012/

Gravitational Influences

Phase Locks & Harmonic Resonances

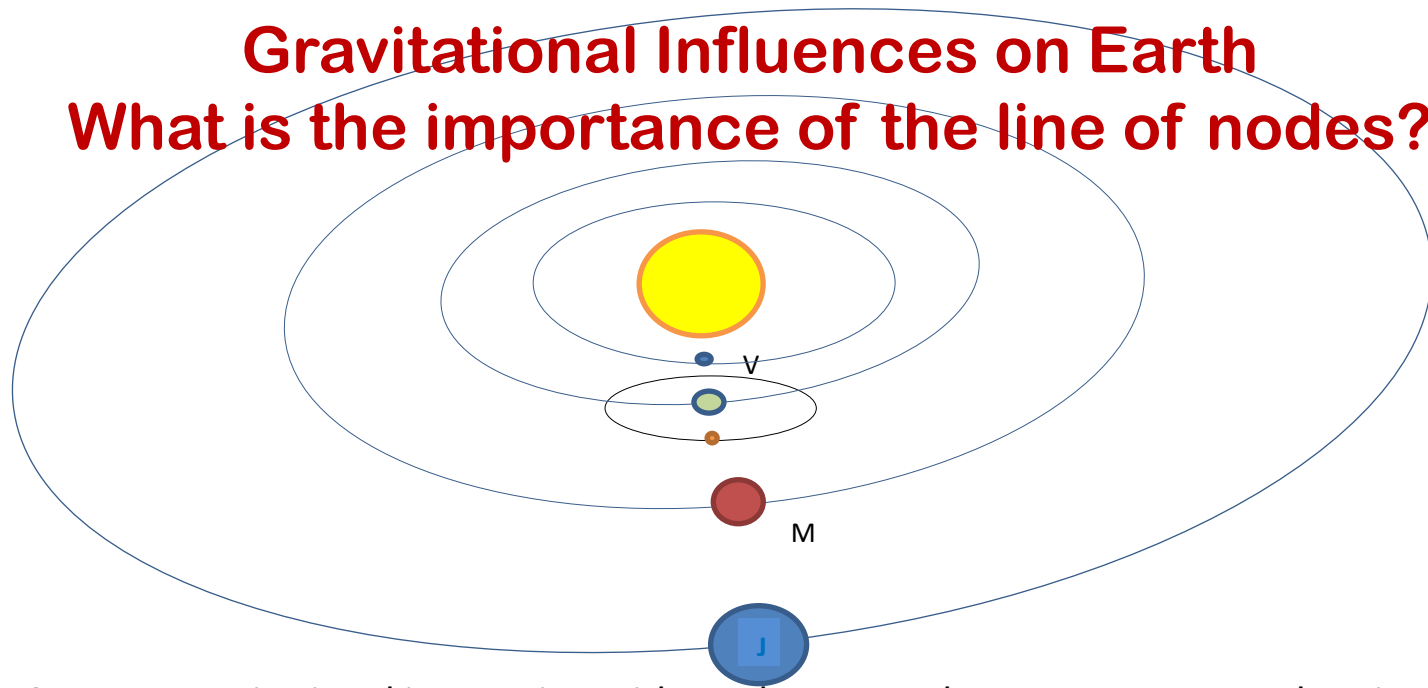
- After billions of years of evolution the solar system is still evolving.
- Tidal forces caused by planetary gravitational influences have caused:
 - a) The moon to be phase locked with Earth - one revolution of the moon occurs each orbit of Earth.
 - b) The orbits of the three closest satellites to Jupiter to be phase locked and in resonance with orbital periods 1:2:4
 - c) Mercury to complete 3 revolutions for every two orbits of the sun.
 - d) Pluto's satellite, Charon to be in geostationary orbit.
 - e) Harmonic or near harmonic resonances between:
 - a) the gas giant planets
 - b) the inner planets.
 - f) A previous harmonic relationship between the orbital periods of the moon, Earth, Mars, Venus and Jupiter. This relationship shows up in the second harmonic of the precision line of nodes of moon's orbit.

Gravitational Influences on Earth

- Earth is the most closely aligned planet to the sun's equator. (.0005 deg. inclination).
- Moon's orbit is inclined 5.145 deg. to Earth's orbit.
- Venus, Mars and Jupiter have orbit inclinations of 3.39 deg., 1.85 deg. and 1.30 deg. to the sun's equator.
- As Jupiter has a mass of 318 times Earth and low orbit inclination it has the greatest gravitational effect on the sun.
- The sun adds an extra 46% to Moon's gravitational "pull" on Earth when in alignment.
- All the planets have (slightly) elliptical orbits.
- Currently Moon's orbit around Earth has a mean perihelion distance of 363,300km and its aphelion distance is 405,500km.

Gravitational Influences on Earth

What is the importance of the line of nodes?



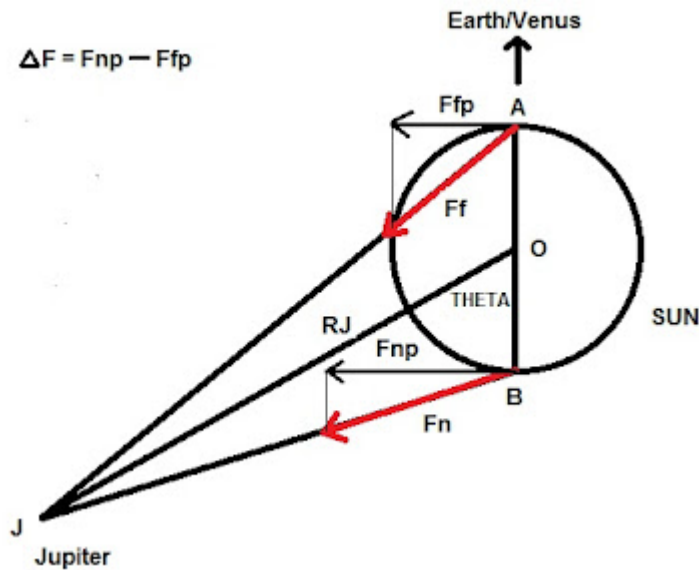
Greatest gravitational interaction with Earth occurs when Venus, Mars and Jupiter are half way between perihelion and aphelion (line of nodes) and are in alignment with Earth and Moon at line of nodes. This happens rarely but varying degrees of alignment occur approximately every 30-35 years.

- These cause greater than average changes in Earth's rotational speed.
- They change the phase of the North Atlantic Oscillation and the Pacific Decadal Oscillation hence change the frequency of El Nino and La Nina weather phenomena.
- Changes in Earth's rotational speed dictate the quantity of deep subsurface heat created, hence change the ensuing frequency of earthquake and volcanic activity.

Gravitational Influences Planets on the Sun

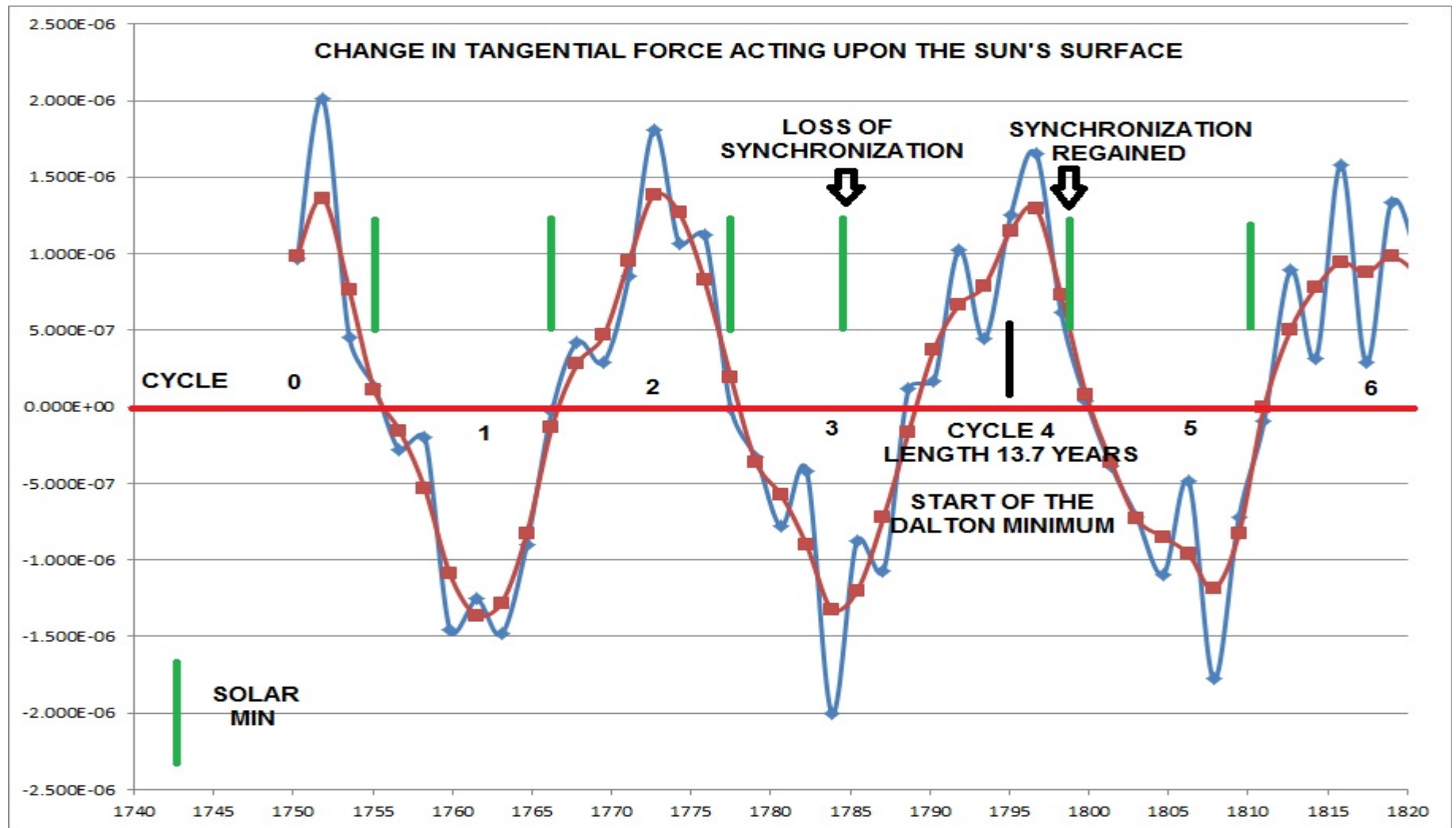
- Greatest gravitational effects on the sun occur when the gas giants are in alignment at line of nodes but with Saturn on the opposite side of the sun to the other three. Orbit inclinations of Saturn, Uranus and Neptune are 2.49 deg., 0.77 deg. and 1.77 deg. So it is not so necessary for Uranus to be near line of nodes as it is for Saturn and Neptune.
- Alignment of gas giants at lines of nodes can only rarely happen as Neptune has a 165 year orbit. Partial line-ups well away from their lines of nodes can occur every few hundred years. Even partial line-ups can cause solar grand minimums.
- The depth of solar grand minimums could be related to the degree of line-up (in all three dimensions).
- Jupiter's gravity acting on the tidal bulge on the sun caused by Venus and Earth appears to dictate the timing of most solar cycles through changes in the rotation rate of the outermost plasma of the sun.
- The 3.39 deg. orbit inclination of Venus and the distance of Jupiter to the sun are significant influences on these cycles.
- When Saturn, Uranus and Neptune add their gravitational pull to that of Jupiter it seems that the timing of solar cycles can be disrupted.

Gravitational Influences of the Planets on the Sun - Ian Wilson's Latest Research (April 23, 2012)

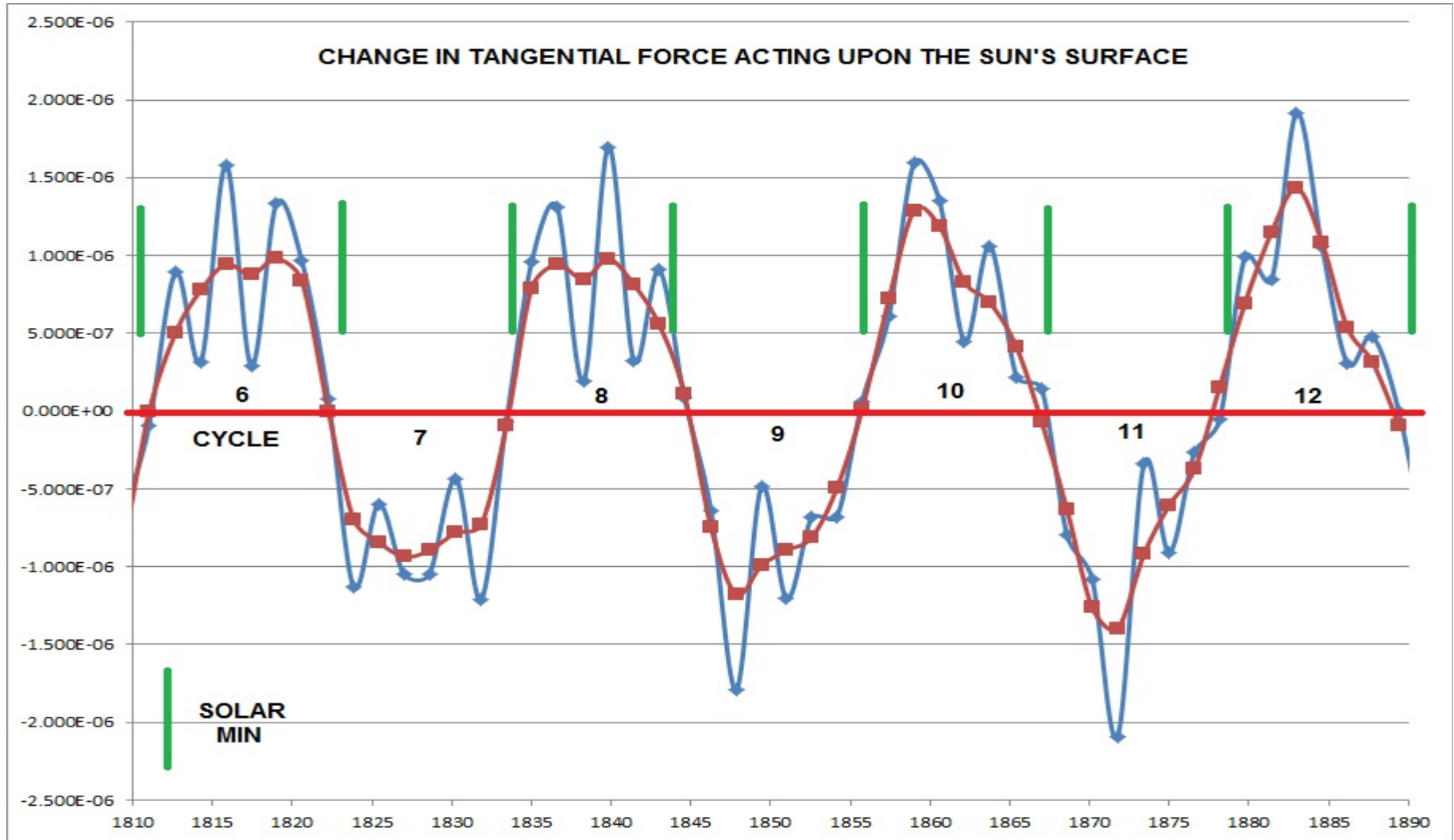


- “Whenever the Sun's sunspot cycles were weak, as in the later parts of the 19th century and the first 40 years of the 20th century (i.e. cycles 13 through 17), the rotation velocity of the layer in the convective region of the Sun changed direction PRIOR TO the date of solar sunspot maximum”.
- “Whenever the Sun's sunspot cycles were strong, as in the last 60 years of the 20th century (i.e. cycles 18 through 23), the rotation velocity of the layer in the convective region of the Sun changed direction AFTER the date of solar sunspot maximum”.

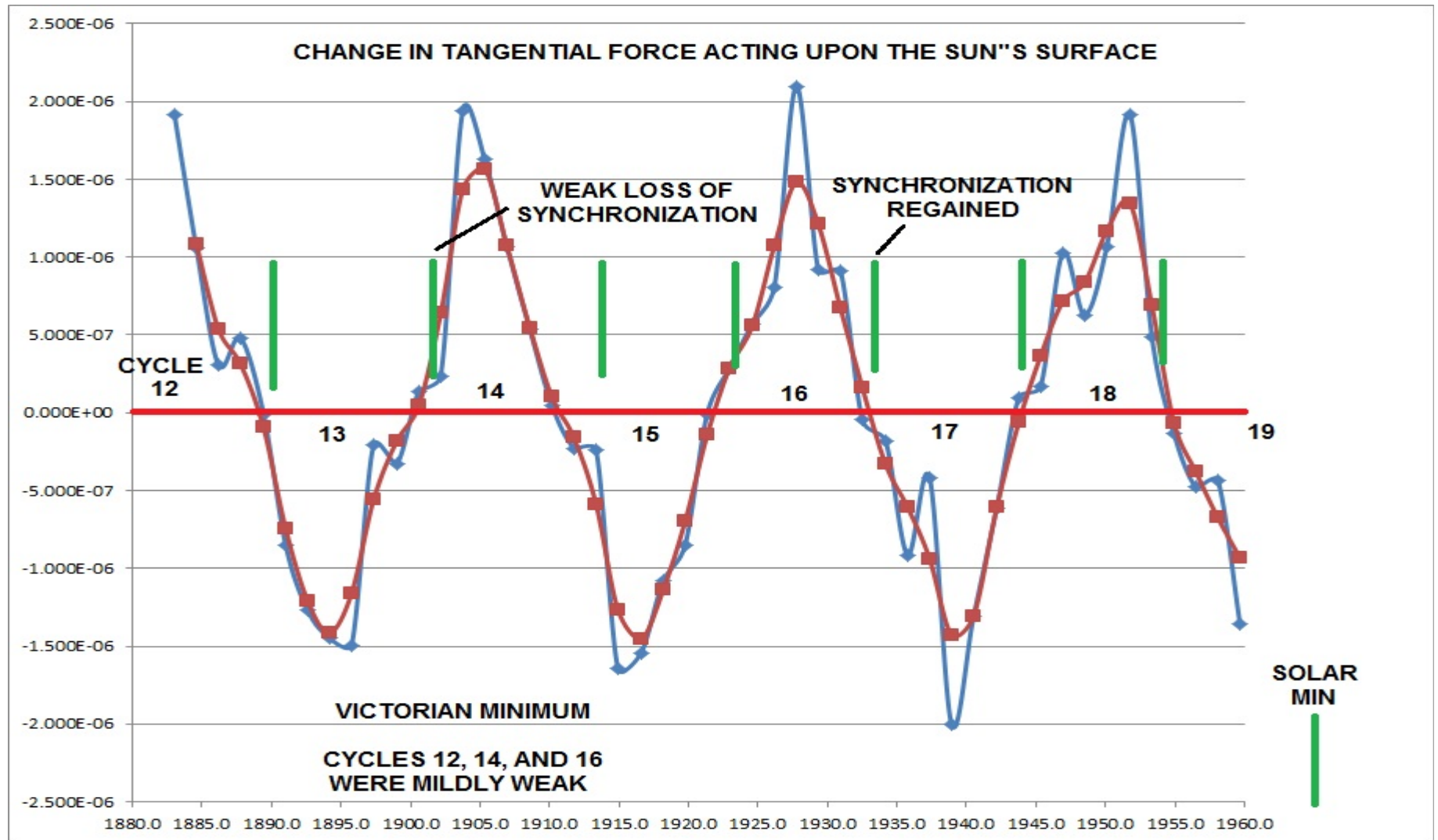
Gravitational Influences Planets on the Sun



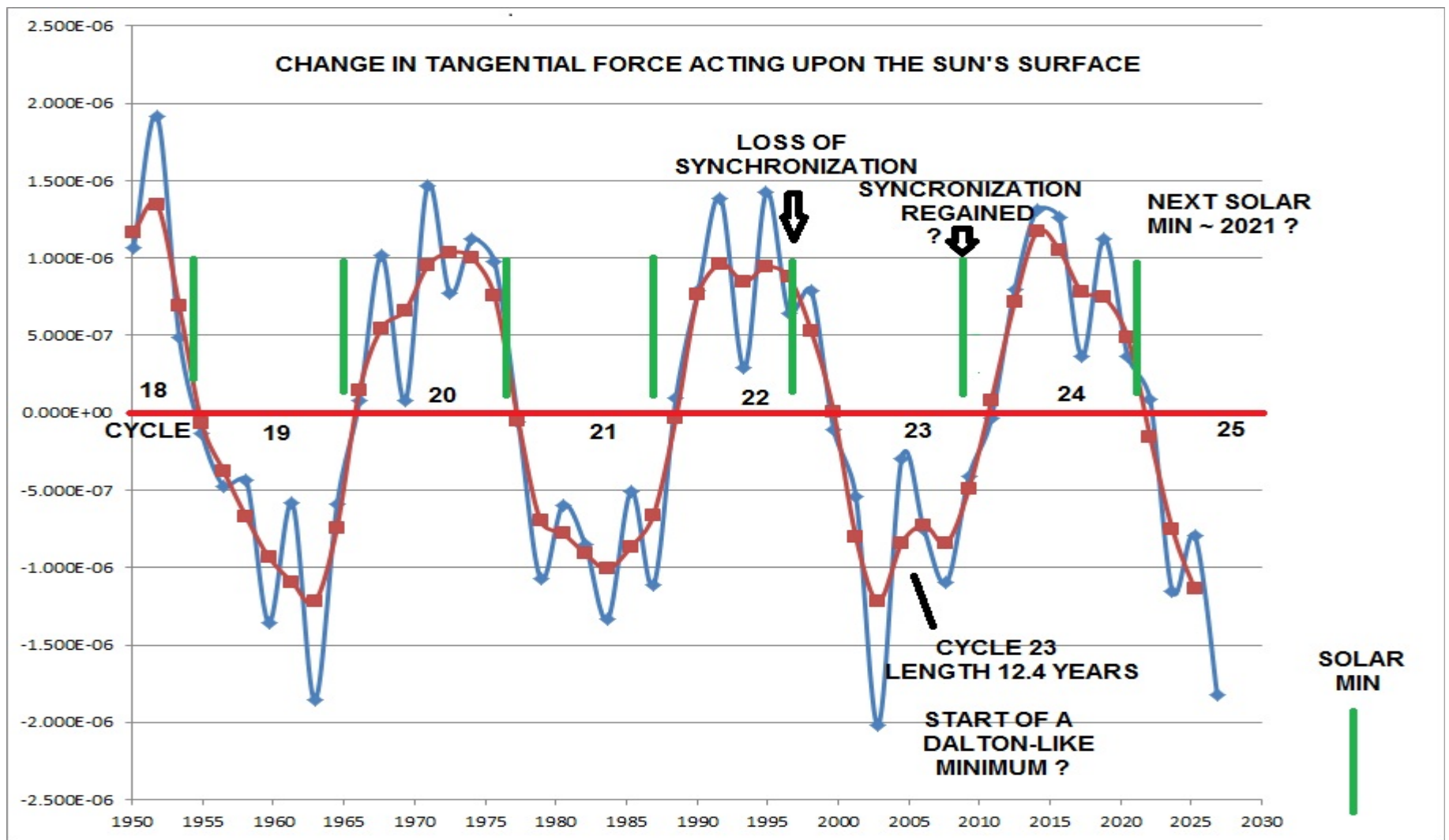
Gravitational Influences Planets on the Sun



Gravitational Influences Planets on the Sun



Gravitational Influences Planets on the Sun



Gravitational Influences Tidal Heating & Energy Transfers

Io, Jupiter's closest satellite, is the most volcanic body in the solar system because of heating caused by gravitational tidal forces:

- Greatest influence when Calipso and Ganymead are in alignment with Io and Jupiter.
- A “tidal” ridge up to 100 mtrs high ripples across Io.
- Enormous heat is generated within Io.
- Jupiter and Io also form a dynamo causing 400,000 volts of potential to form across Io, and 5 million amps of current to flow through a permanent flux tube between Io and Jupiter.



Gravitational Influences Tidal Heating & Energy Transfers

Moon was volcanic when it was much closer to Earth.

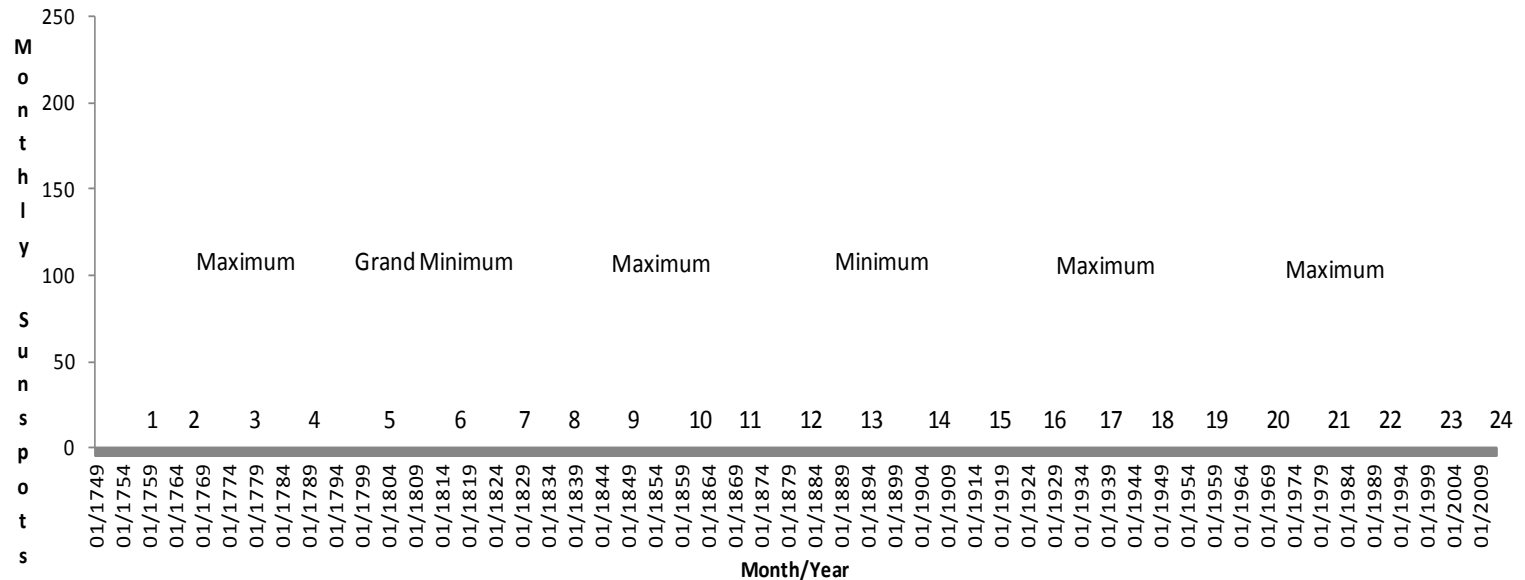
- It currently moves away from Earth at an average of 380 meters per thousand years.
- Earth's rotation slows at an average of 17 milliseconds per thousand years to preserve angular momentum.
- Some lost angular momentum is converted to heat.
- Approximately every 8 minutes a flux tube connects magnetic field lines of the Sun and Earth and allows the transportation of plasma directly into the ionosphere.



Sunspot Activity

Solar Influences Data Centre

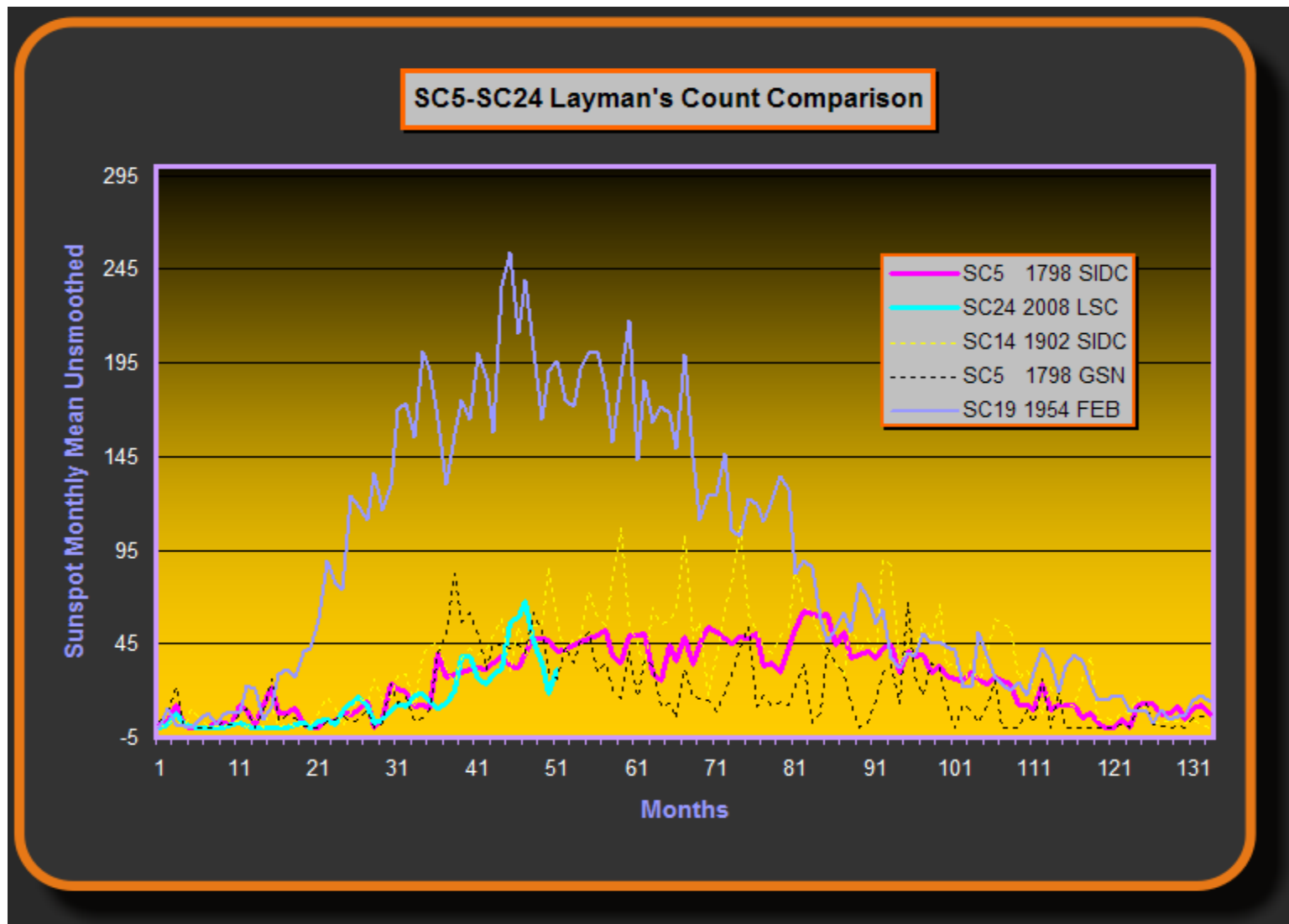
Monthly Sunspot Activity - SIDC data



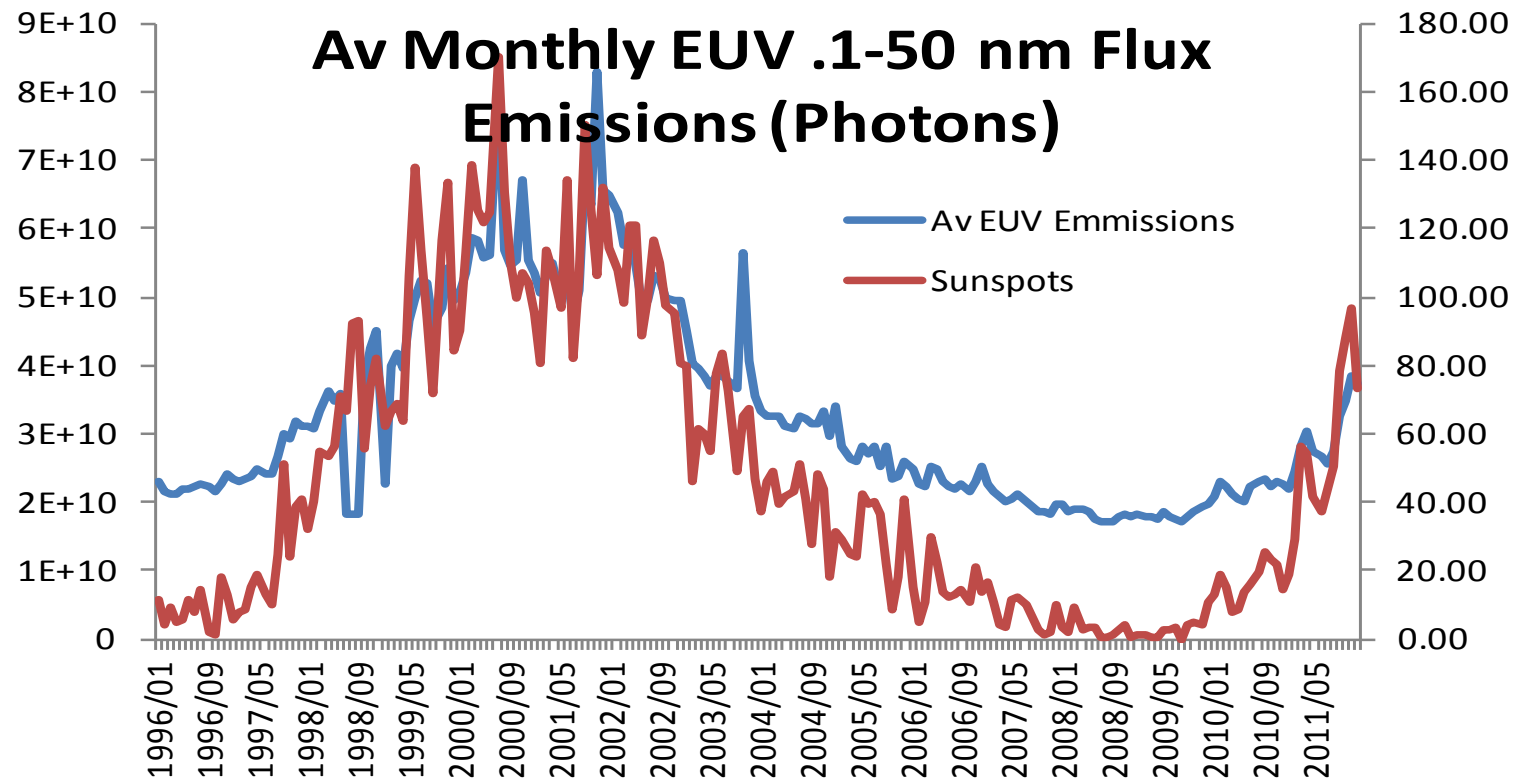
1 Counting changed in 1954, which increases count by approximately 22%.

2 Counting now includes specks which couldn't have been seen 18th and 19th Centuries.

Comparison of sunspot activity - Cycle 24 with others

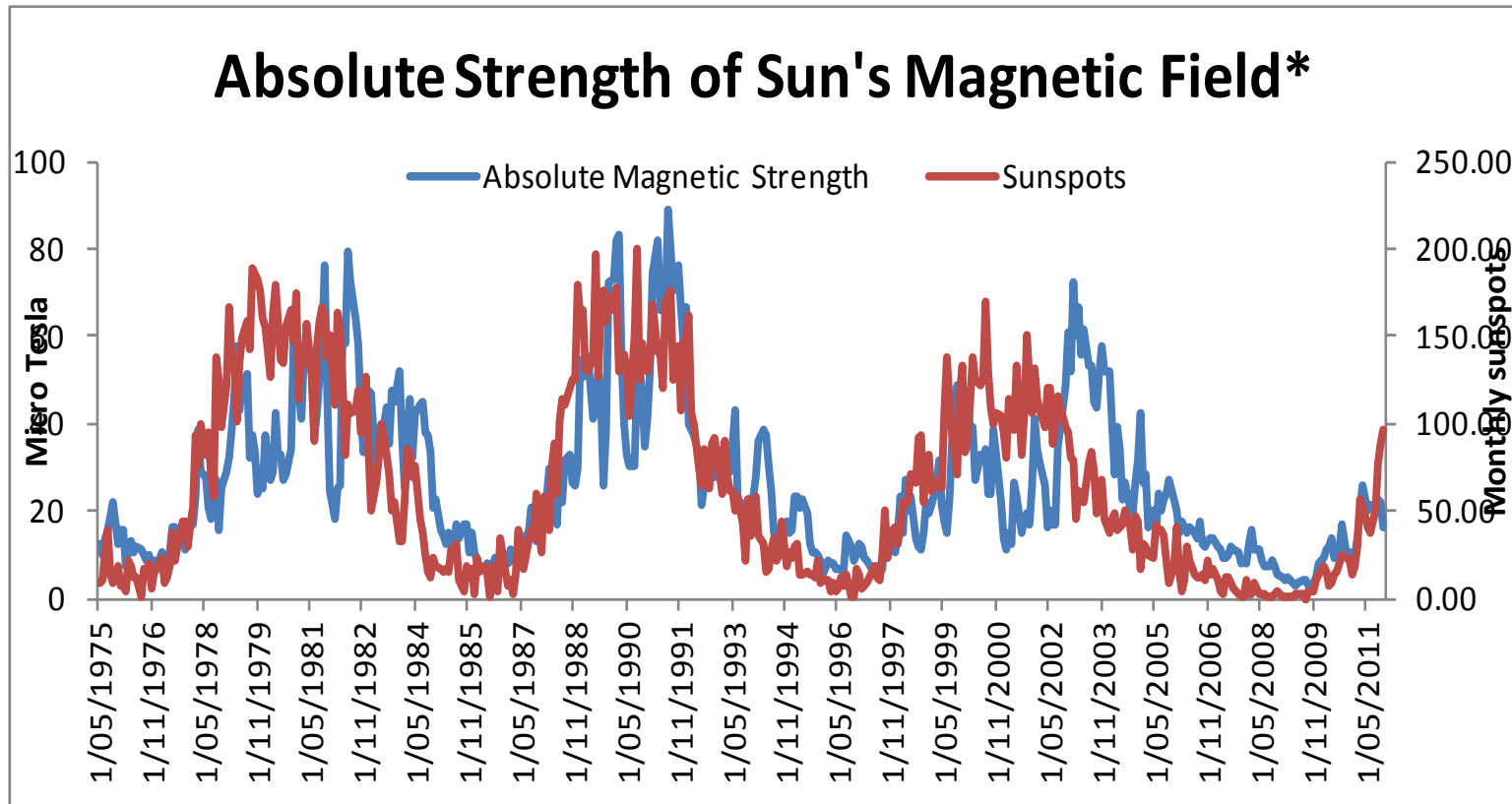


Most solar wavelengths do not change much - but EUV does



- 1 Extreme Ultraviolet includes UVB and UVC
- 2 These emissions affect the temperature of the upper atmosphere and the ozone layer.
- 3 Extreme weather results when these emissions remain low too long.

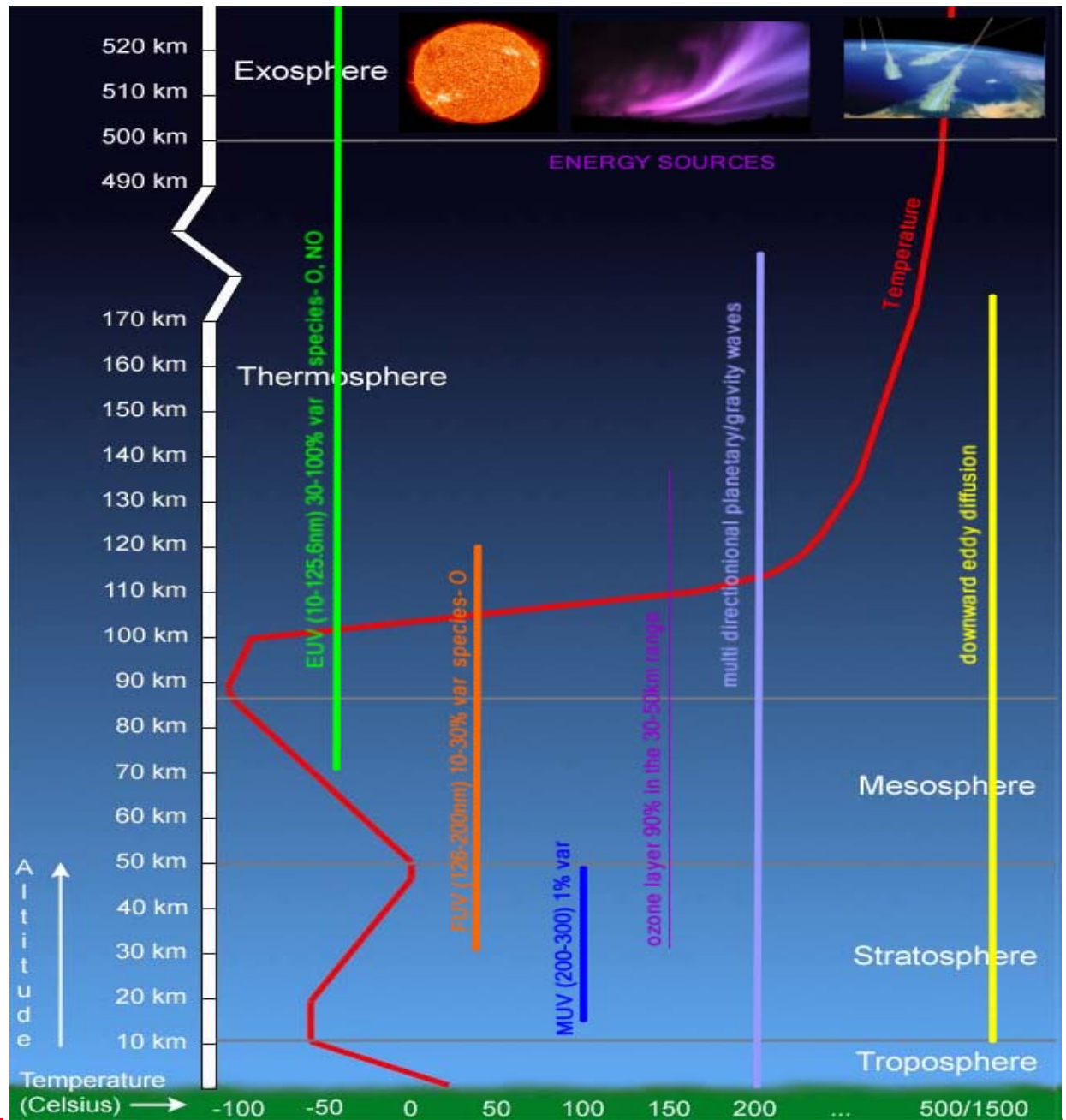
The Sun's magnetic field changes significantly



- 1 Normal sunspots increase the magnetic field.
- 2 Unipolar sunspots do not increase the magnetic field and can reduce it.
- 3 Many unipolar spots at present.
- 4 Sun's magnetic field is frothy at edge of solar system allowing passage of cosmic rays.

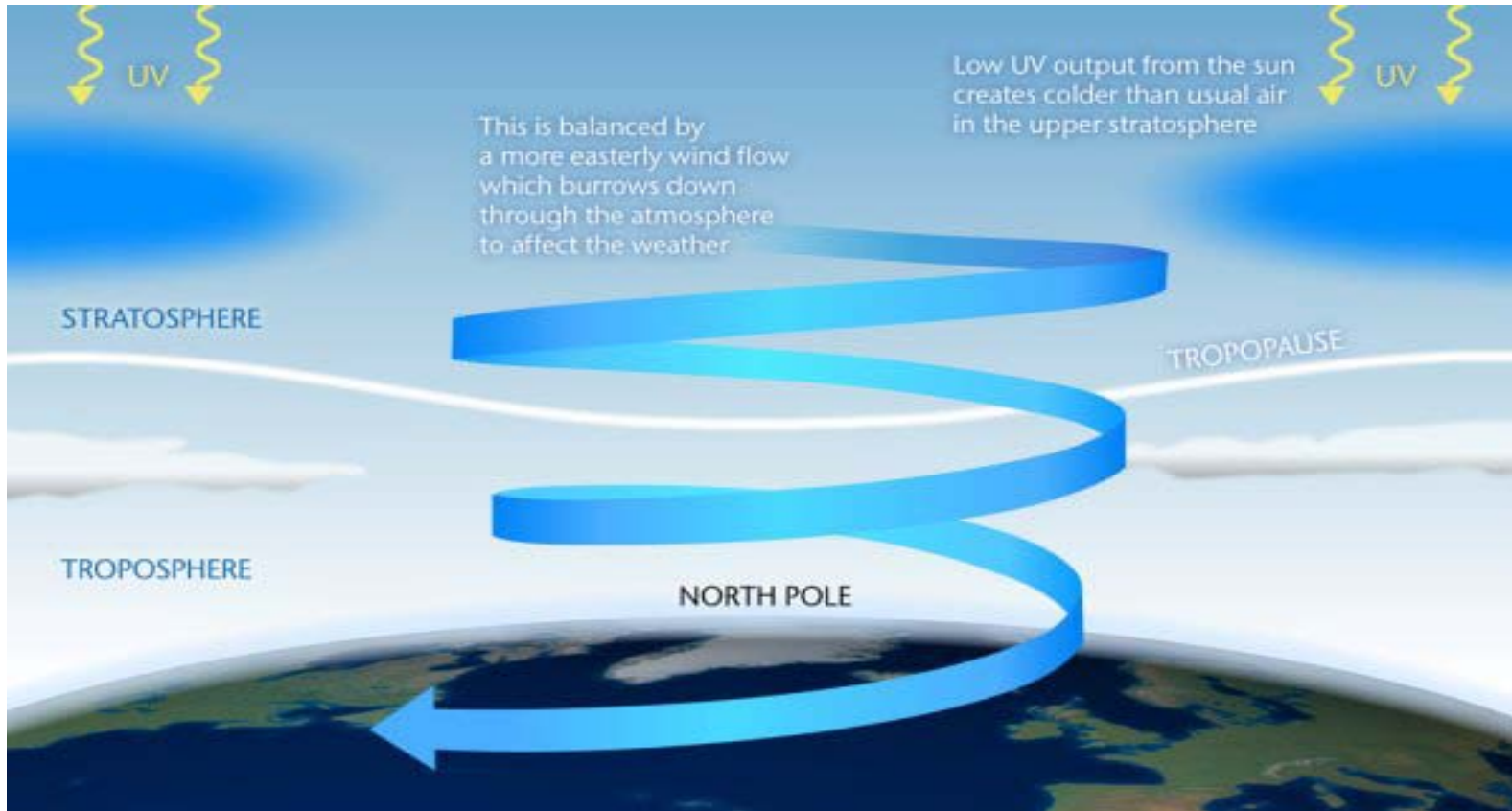
Earth's Atmosphere

- With prolonged weak EUV Earth's upper atmosphere cools.
- NASA reported upper thermosphere 100 deg. cooler in 2010
- Temperature appears to be slowly dropping at lower levels of atmosphere.
- The effects are different by latitude and between Northern and Southern Hemisphere.



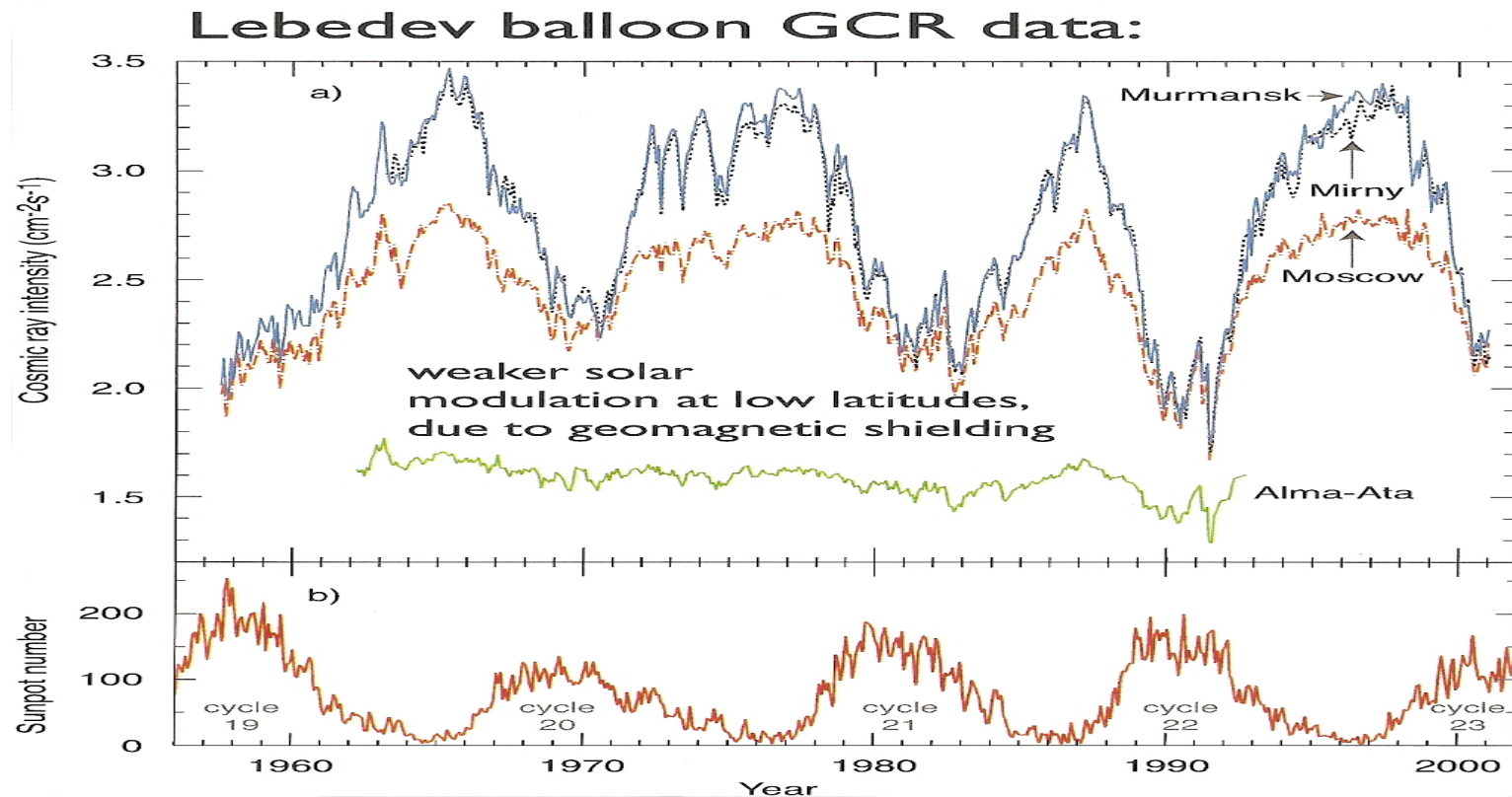
UK Met Office Explanation

- Low EUV output of sun appears to create mini ice-age conditions in Northern Hemisphere.



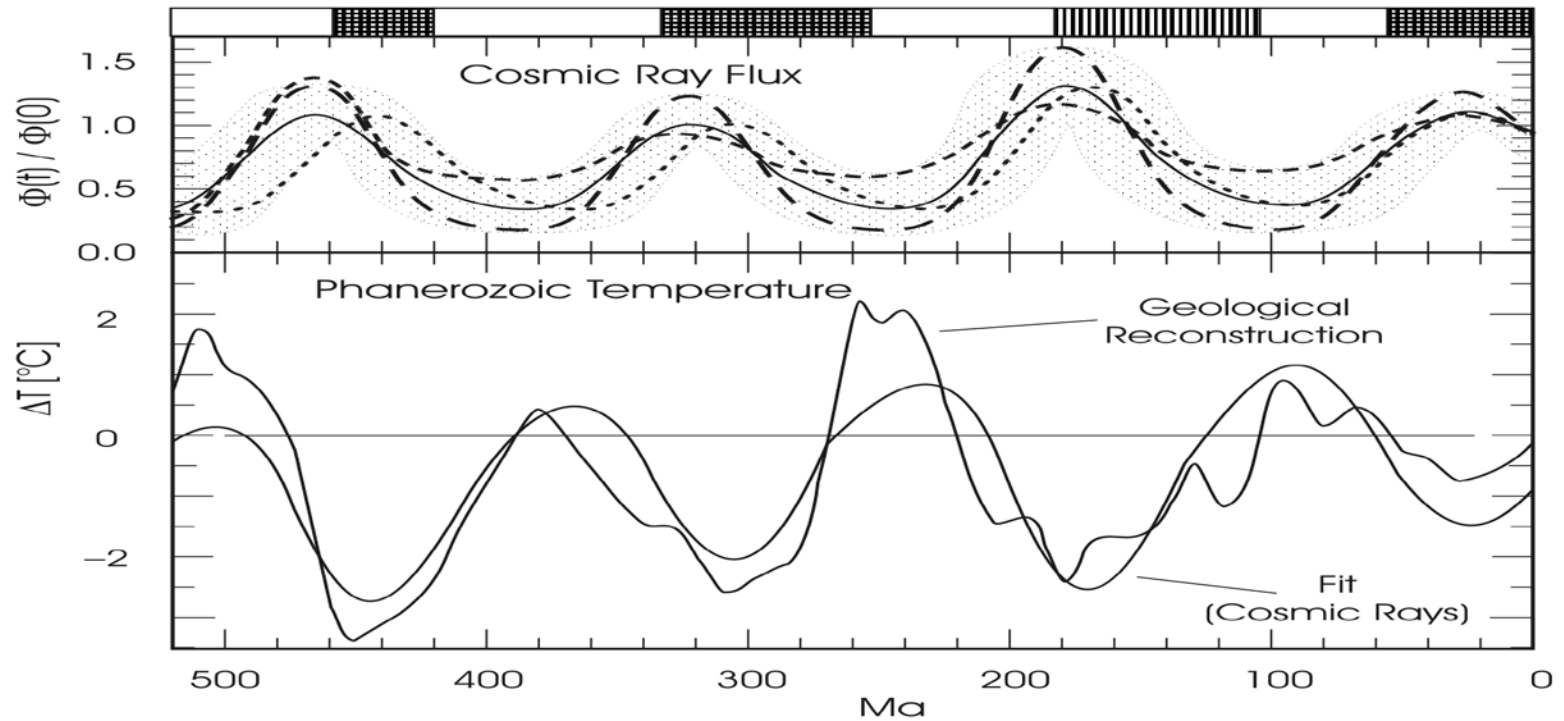
- Low EUV output creates extreme weather events due to greater difference between oceans and upper atmosphere.

Cosmic rays increase volcanic and low depth earthquake activity



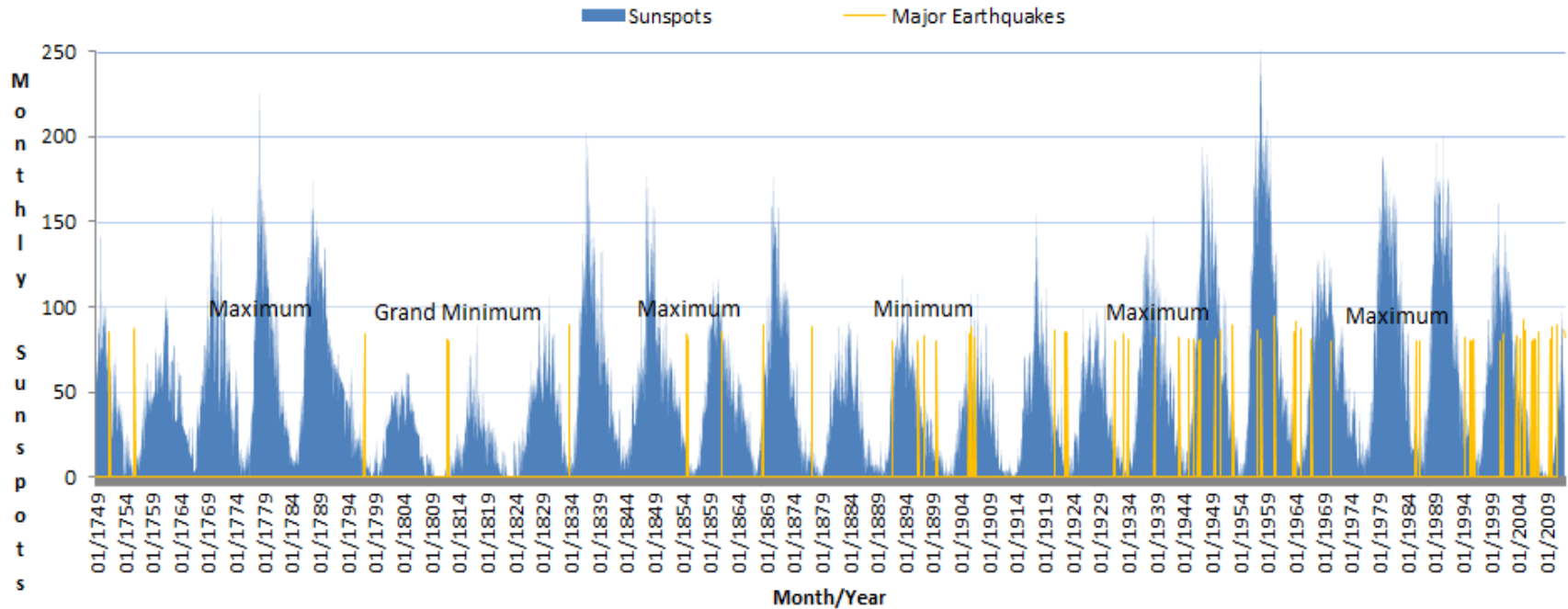
- Cosmic rays produce radiocarbon 14 and beryllium 10 by interaction with oxygen and nitrogen in atmosphere.
- Cosmic rays produce muons (heavy electrons). These can penetrate a few kilometres into Earth's crust particularly at high latitudes.
- Muons weaken the calderas of some volcanoes (incl. extinct ones).

Inverse correlation between cosmic ray flux and global temperature



Great (8+ mag.) Earthquake activity

Monthly Sunspot Activity & Major Earthquakes



- There were 13 great earthquakes from 1958 to 2003.
- There have been 13 great earthquakes from 2003 to-date.
- If you assume randomness this may not be too significant. But physics suggests differently!

Conclusions

- Actuarial models used to predict nature's risks should include inputs from extra-terrestrial factors.
- There is a wealth of data being produced in the space-age that will provide actuaries with predictive tools to assess future changes in many of nature's risks.
- Actuaries should be aware that the risk of natural catastrophes is not normal during a solar grand minimum. Actuaries should also be aware that these not normal periods usually only occur every few hundred years but they do last for decades. This means that the higher incidence of catastrophic events that have occurred in 2010 and 2011 should not be regarded as a random fluctuation but rather as the new normal for a few decades.
- Although research into long term climate change is important for mankind and for the profession, actuaries currently face the considerable threat that they are underestimating the natural risk frequency and severity caused by the new solar grand minimum.