# Solar and orbital effects on the terrestrial environment: temperature, ENSO, sea level and ice areas

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## Solar activity and magnetic field effects

### Terrestrial temperature T (black),sea level (blue) and wavelet of T

Zharkova&Vasilieva, 2023aa, Natural Sciences, vl. 15, N9, Sept 2023

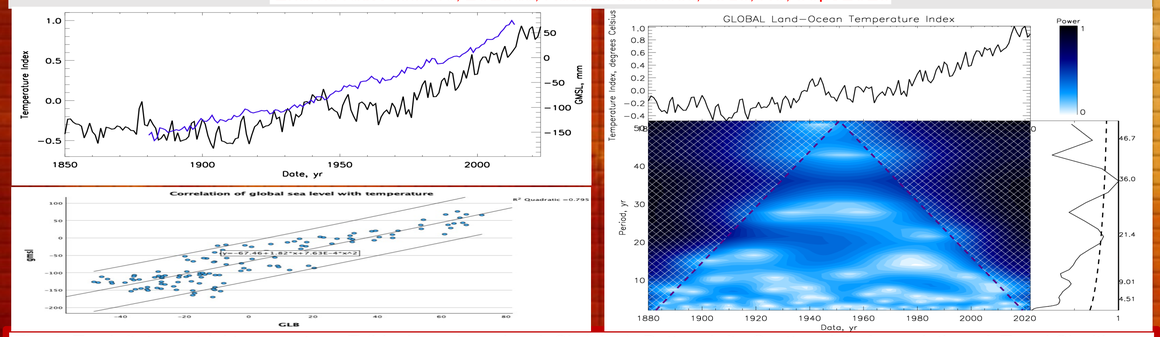



Fig. 1. Top left terrestrial temperature T (black) and sea level SL (blue). Bottom left: Scatter plot of correlation of T and Sl with correlation coefficient of 87%. Top right: T temporal variations, Bottom right –wavelet (left) with the dashed line showing the Cone of Influence. The global wavelet spectrum of T (solid black line) (right) with the dashed line showing 95% confidence interval.

It was shown there is a clear 21.4 years period in the temperature variations, that exactly equal to the period of oscillations derived from the summary curve of two largest eigen vector of SBMF (Zharkova et al, 2015, 2023a). The other period of 36 years can be linked to the local or external conditions which require the further investigation. Hence, the oscillations of T and SL go in line with the oscillations of the summary curve of SBMF.

### Wavelet spectra of the ice areas in Arctics (left) and Antarctic (right)

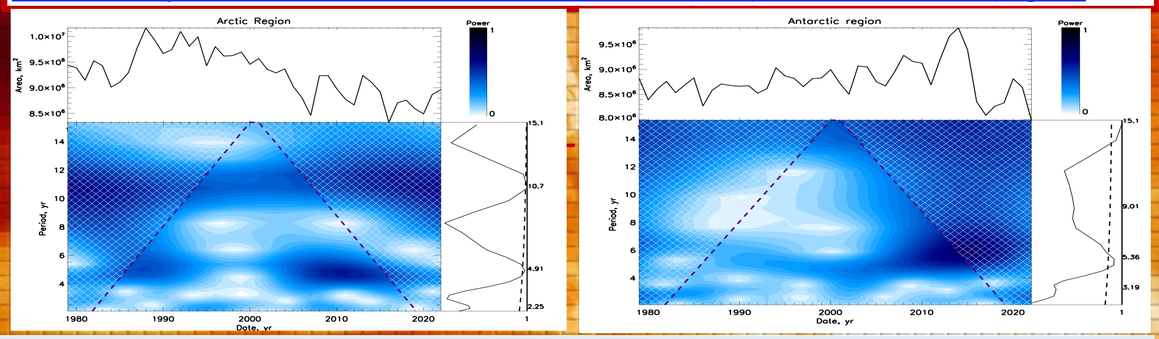



Fig. 2 Wavelet spectra of the ice areas in Arctic (left) and Antarctica (right) with dashed line showing the Cone of Influence. The solid black lines present the global wavelet spectra while the dashed line here shows the 95% confidence interval.

It can be seen that the ice area coverage in Arctics reveals a clear period of 10.7 years, which is exactly the averaged period of solar activity defined by the averaged sunspot numbers and by the modulus summary curve (Zharkova et al, 2023). The other period of 4.91 in Arctic ice area variations can be caused by some local or external conditions, which need to be identified yet.
The variations of Antarctica ice area don't show any links to solar activity periods revealing only the periods 5.36 and 15.1 years.

### Frequency of volcanic eruptions vs the summary curve of eigen vectors of SBMF,

**Vasilieva&Zharkova, 2023**, Global Journal of Science Frontier Research: A Physics and Space Science, Volume 23 Issue 3, 22-34 read it

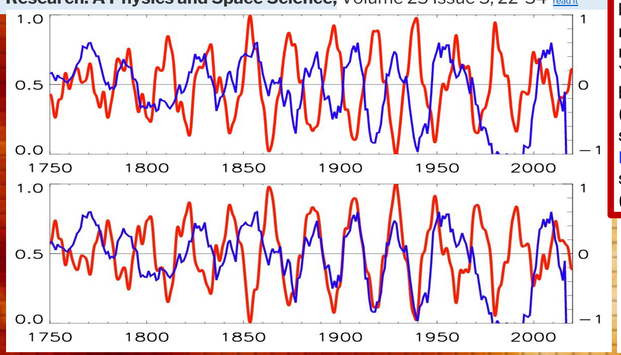
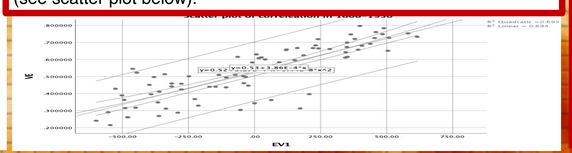


**Fig. 3** Top plot: The summary curve of eigen vectors (EV) of the solar background magnetic field {Zharkova et al 2015} (red curve) normalised by its maximum (the right Y-axis) versus the averaged normalised frequency of volcanic eruptions (VEs) (blue curve) (the left Y-axis). Bottom plot: the volcanic eruption (VE) numbers (left Y-axis, blue line) versus the inverted summary curve of eigen vectors (EV1) (the right Y-axis, red line) with positive magnitudes corresponding to southern polarity and negative to the northern one.

**Fig. 4.** Correlation coefficients between frequencies of VEs and summary curve of EVs are 0.23 for 1750-1868 and 0.82 for > 1868 (see scatter plot below).



## Orbital effects of the Sun and Jupiter

### Solar irradiance increase owing to solar inertial motion and terrestrial temperature trend

(Zharkova& Vasilieva, 2023a, Natural Sciences, vl. 15, N9, Sept 2023)

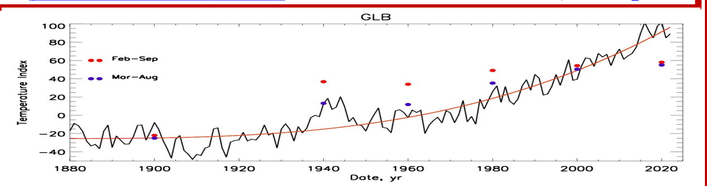



**Fig. 5.** The measured terrestrial temperature (black line) and averaged temperature (red line) versus the total solar irradiance (TSI) affected by SIM in the spring- summer months as per the legend on the plot.

### El Nino and Southern Oscillation (ENSO) vs ocean temperature

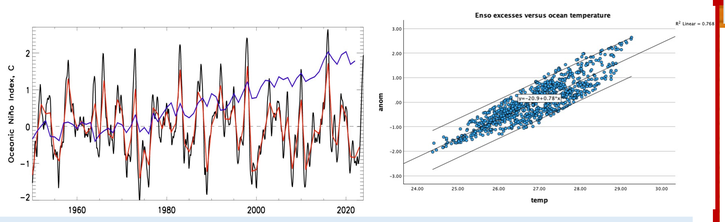



**Fig. 6.Left:** ENSO index variations (black and red lines) vs the ocean temperature. Right: scatter plot of correlation of the ENSO index with the ocean temperature (correlation coefficient r=0.87).

### Wavelet analysis of ENSO (Zharkova&Vasilieva, 2024, Natural Science Vol.16 No.4, April 25 https://doi.org/10.4236/ns.2024.164004)

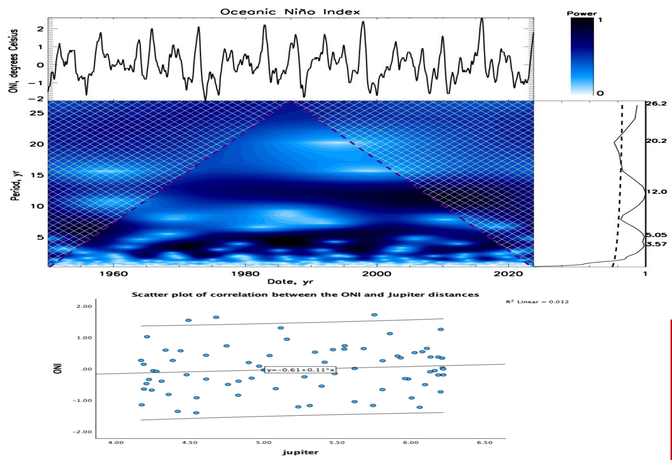



**Fig. 7. Left -** Top plot: The ONI/ENSO index variations. Middle plot: the wavelet spectrum of ENSO, black dashed line defines the Cone of Influence (COI). Bottom plot: scatter plot of correlation of ENSO with distance Earth-Jupiter (r=0.12). **Right-** Top plot: wavelet power. Bottom plot: Global wavelet spectrum integrated over time (black solid line) and 95% confidence interval (black dashed line).

It can be clearly seen that the dominant periods in ENSO index are 5 and 12 years. The first one can be linked with the local tectonic plate condition change while the period of 12 years is linked to gravitational forces caused by revolution of Jupiter around the Sun with correlation of 12%.

### Correlation of ENSO index and frequency of underwater volcanic eruptions

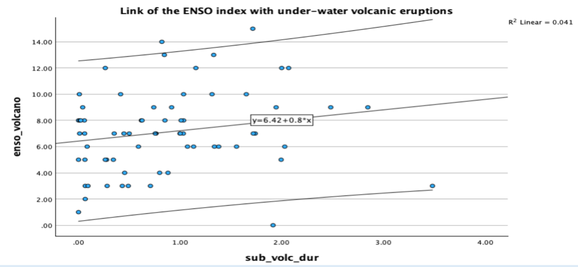



**Fig.8.** The scatter plot of correlation of the ENSO index and frequency of underwater volcanic eruptions (r=0.25).

**Frequency volcanic eruptions vs distance between Earth and Jupiter** Zharkova& Vasilieva, 2023a, Natural Sciences, vl. 15, N9, Sept 2023

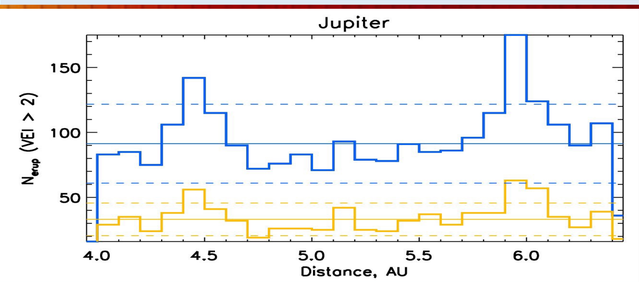



**Fig.9.** The frequencies of volcanic eruptions depending on E-J distances for all volcanos (blue line) and those in the ENSO area (yellow line). There are two maxima at the distances 4.5 au when Jupiter is colsest to Earth and 6 au when the Sun is closest to Earth

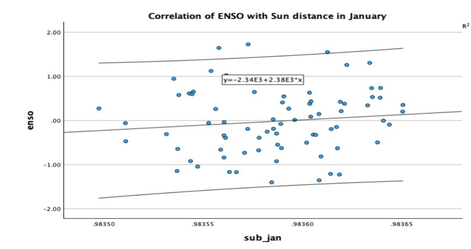



**Fig.10.** The scatter plot of correlation of the ENSO index and the Sun-Earth distances in January owing to SIM (r=0.15).

**Link with solar activity**

- **GLB terrestrial temperature and sea leval have clear 21.4 year period associated with solar ctivity and summary curve of SBMF**
- **Frequencies of volcanic eruptions have also dominant period of 21,4 years with maxima occurring in even cycles when the dominant polarity of is southern**
- **Ice area variations in Arctic have a main period of 10.7 years, or solar activity defined by sunspots or modulus summary curve**
- **ENSO index has a strong correlation (87%) with ocean temperature**
- **Link with orbital motion**
- The key period derived from ENSO index was 12 years linked to gravitation forces from Jupiter
- Terrestrial temperature in the past two centuries presented by IPCC follows the TSI variations caused by SIM
- The Jupiter when at 4.5 au and Sun at 6 au in its SIM cause the increase of general and underwater volcanic eruptions
- Underwater volcanic eruption shown very close (25%) correlation with the ENSO index increase higher for January when Sun is closest to Earth