НЕХАОТИЧЕСКИЕ, ГЛОБАЛЬНО СИНХРОННЫЕ МЕЖДУГОДОВЫЕ ВАРИАЦИИ В КЛИМАТИЧЕСКОЙ СИСТЕМЕ И ИХ ПРИЧИНЫ

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PREFACE

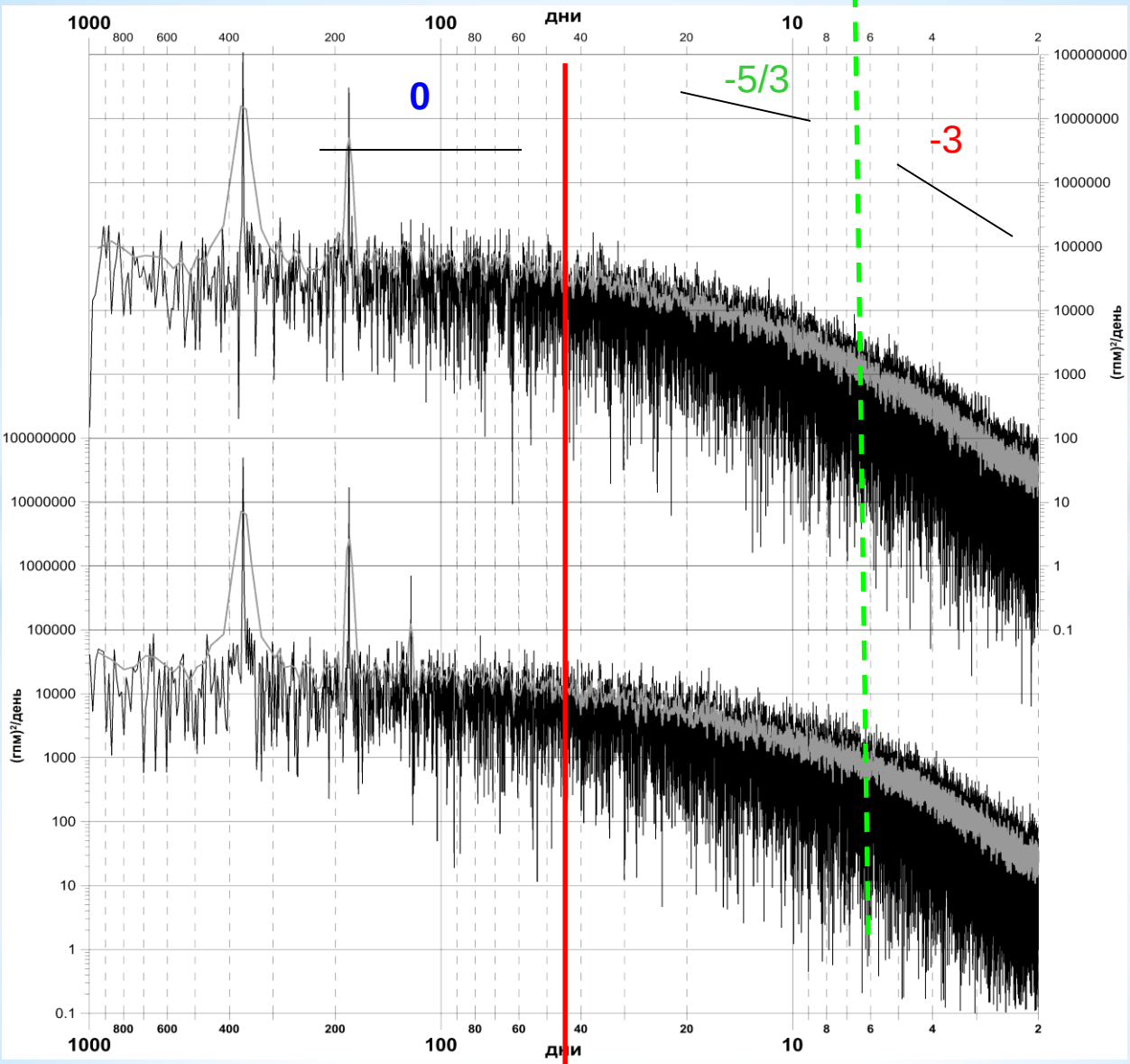
After seminal researches of Ed Lorenz almost all meteorologists agree that weather variations are chaotic, i.e. they are unstable and unpredictable for more or less distant future.
Moreover, the same opinion is widely accepted for climate variations.

Our **aim is to discuss another opinion that climate variations can be nonchaotic at least partly even if their shapes are very complex (strange in mathematical terms).**

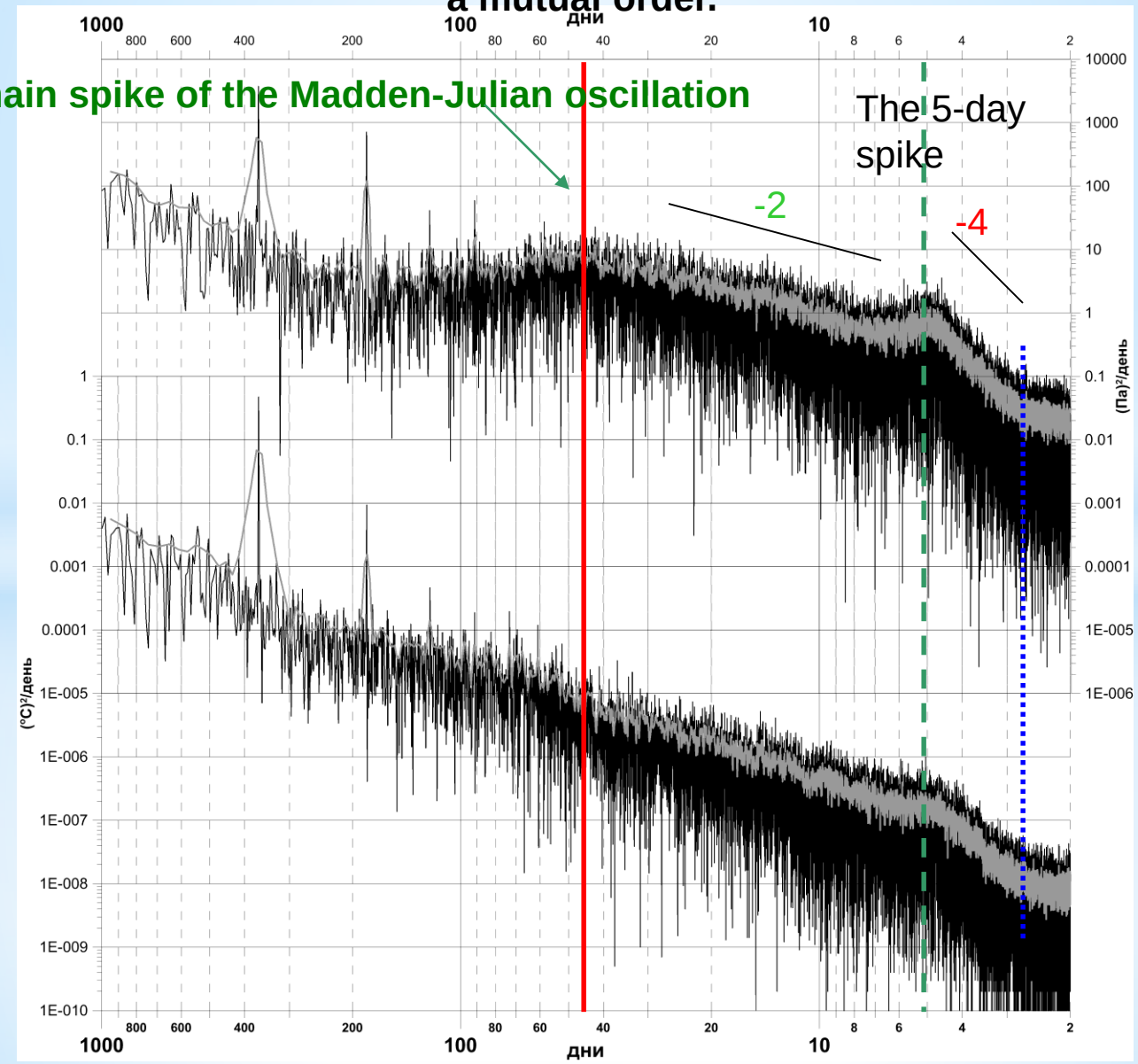
Power spectrum as a signature of chaos

Because the climate is a many dimensional dynamical system it is impossible to use Lyapunov's exponents to conclude either weather/climate variations are chaotic or nonchaotic.
The only shapes of the power spectra of these variations can be used for this purpose.
One can consider variations to be chaotic if the shapes of their power spectra are continuous .
If these shape are not continuous (discrete in their character) these variations can not be chaotic. Instead, they are mutually ordered and self-adjusted with each other.
The typical power spectrum of nonchaotic variations consists of innumerable peaks and bands of increased energy superimposed on an apparent continuous background. It has been proven in the dynamical system theory that the re-distribution of these peaks at the frequency axis forms a self-similar structure. It means any zoom of a part of such a spectrum reveals a peak re-distribution of the same character that is inherent to the whole spectrum.

Real extratropical weather spectra of the zonal indices of the H500 and H500/1000 for the Northern Hemisphere. These spectra are obviously continuous and smooth excepting the annual peak and its superharmonics.

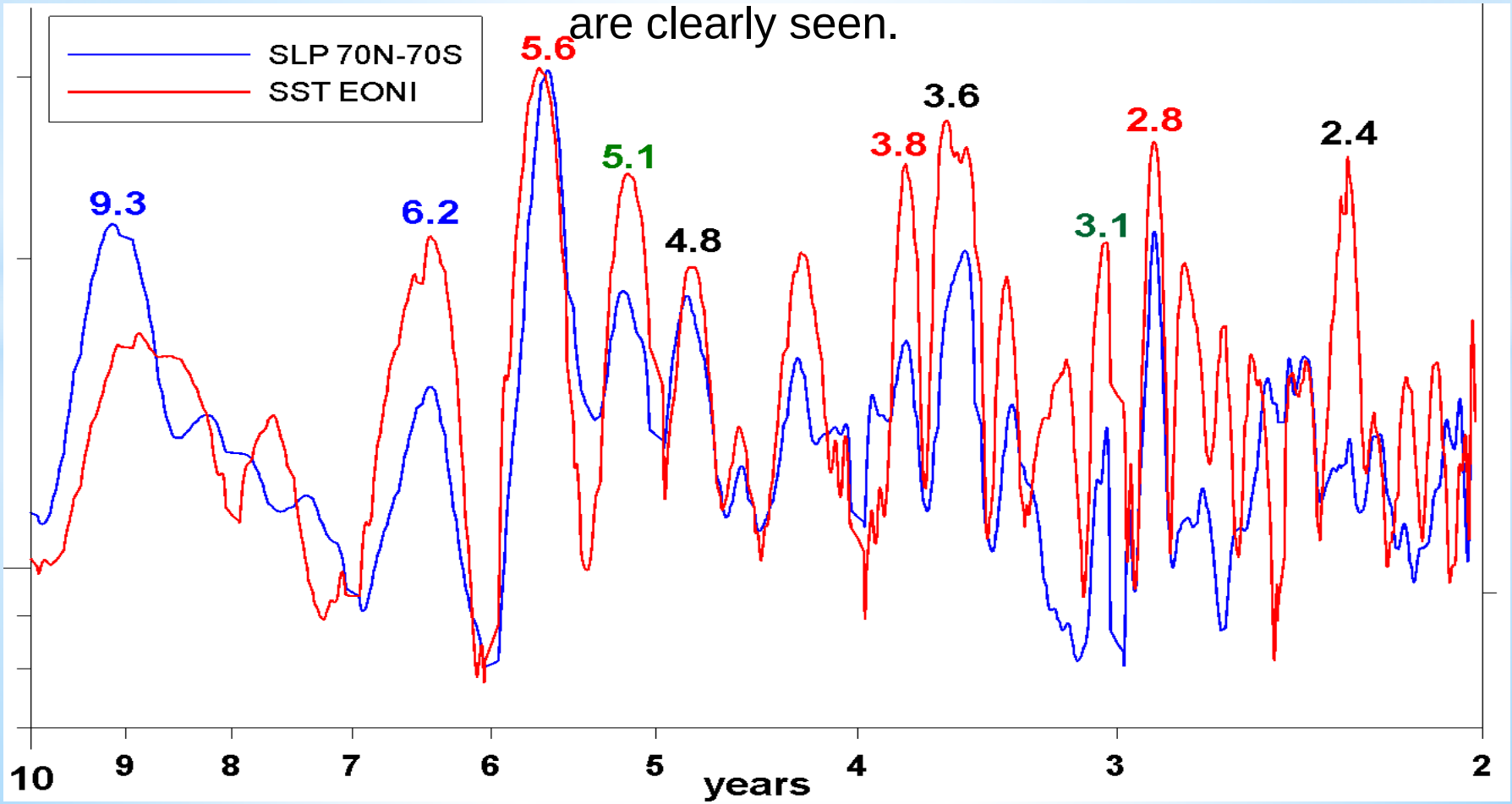


Real tropical weather spectra (of the extended Southern oscillation and El-Nino indices). These spectra also are continuous, but with some spikes evidencing the existence of a mutual order.

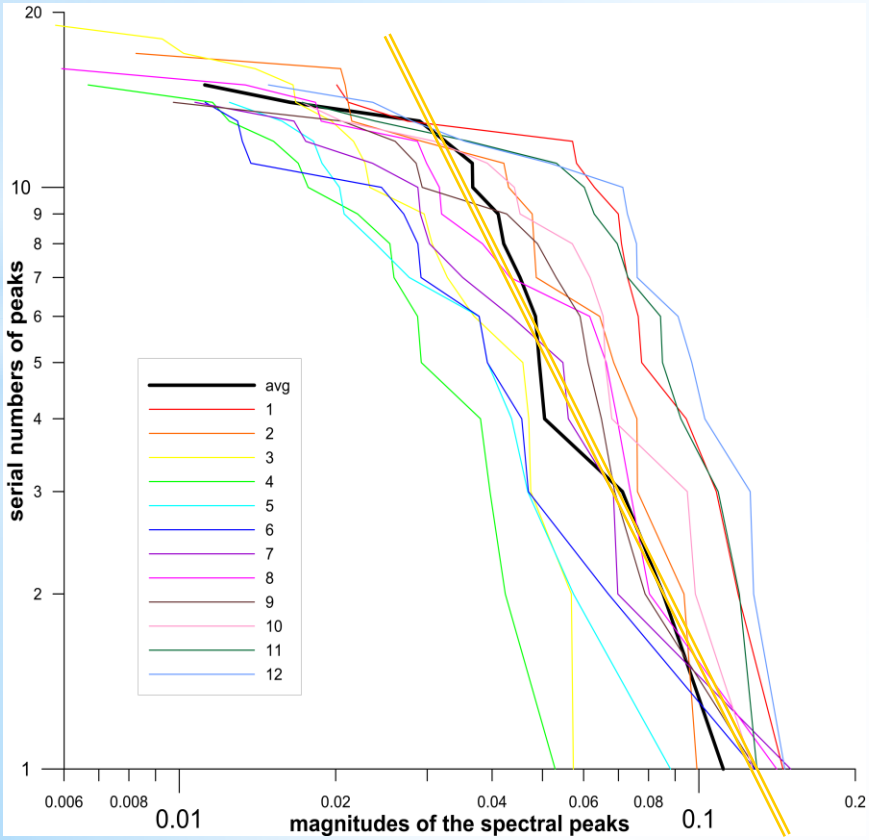


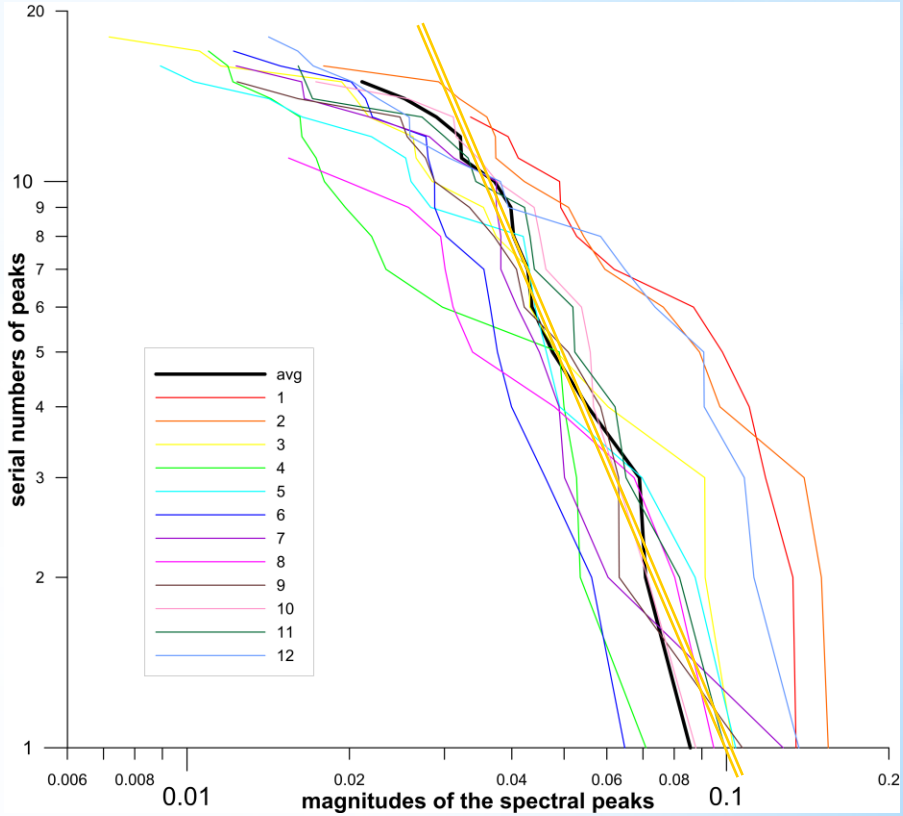
Power spectra of the interannual climate variations <u>mapped</u> at the annual period

Blue - the sea-level pressure over the ±70 latitude belt and
red - an extended SST index (El-Nino).
Subharmonics of the Chandler wobble in the Earth's pole motion, and superharmonics of the Luni-Solar nutation and the Sun-spot cycle are clearly seen.



In order to test either the above climate variations are chaotic or nonchaotic the relationship between the amplitudes of spectral peaks and these peak serial numbers must be considered (Feudel et al., 2006).
A linear character of this relationship evidences that the interannual climate variations are **strange but not chaotic.**





Conductors
of the interannual climate variations

All of the peaks in the climatic power spectra shown above are localized at the subharmonics 2:1, 3:1,… of the 14-month period of **the Chandler wobble** in the Earth's pole motion, the superharmonics of the 18.6-year period of **the Luni-Solar nutation** of the Earth's rotation axis, and the 22-year period of **the Hale's heliomagnetic cycle** as well.
These external periodicities are powerless, and so they must be considered as the climate dynamic **conductors** **but not drivers.**

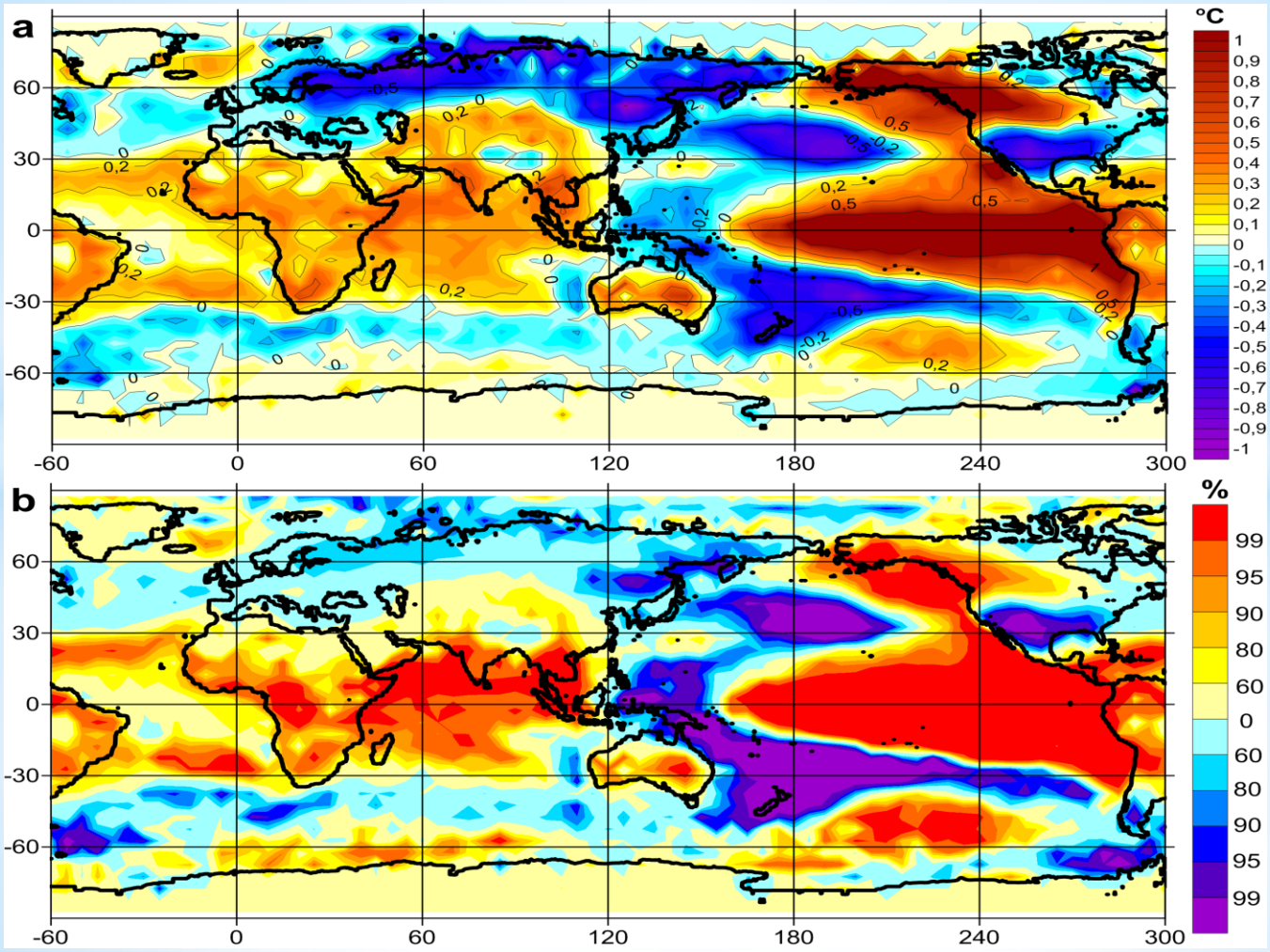
As a result of these periodicities conducting,

the climate dynamics turn out to be **globally synchronized.**

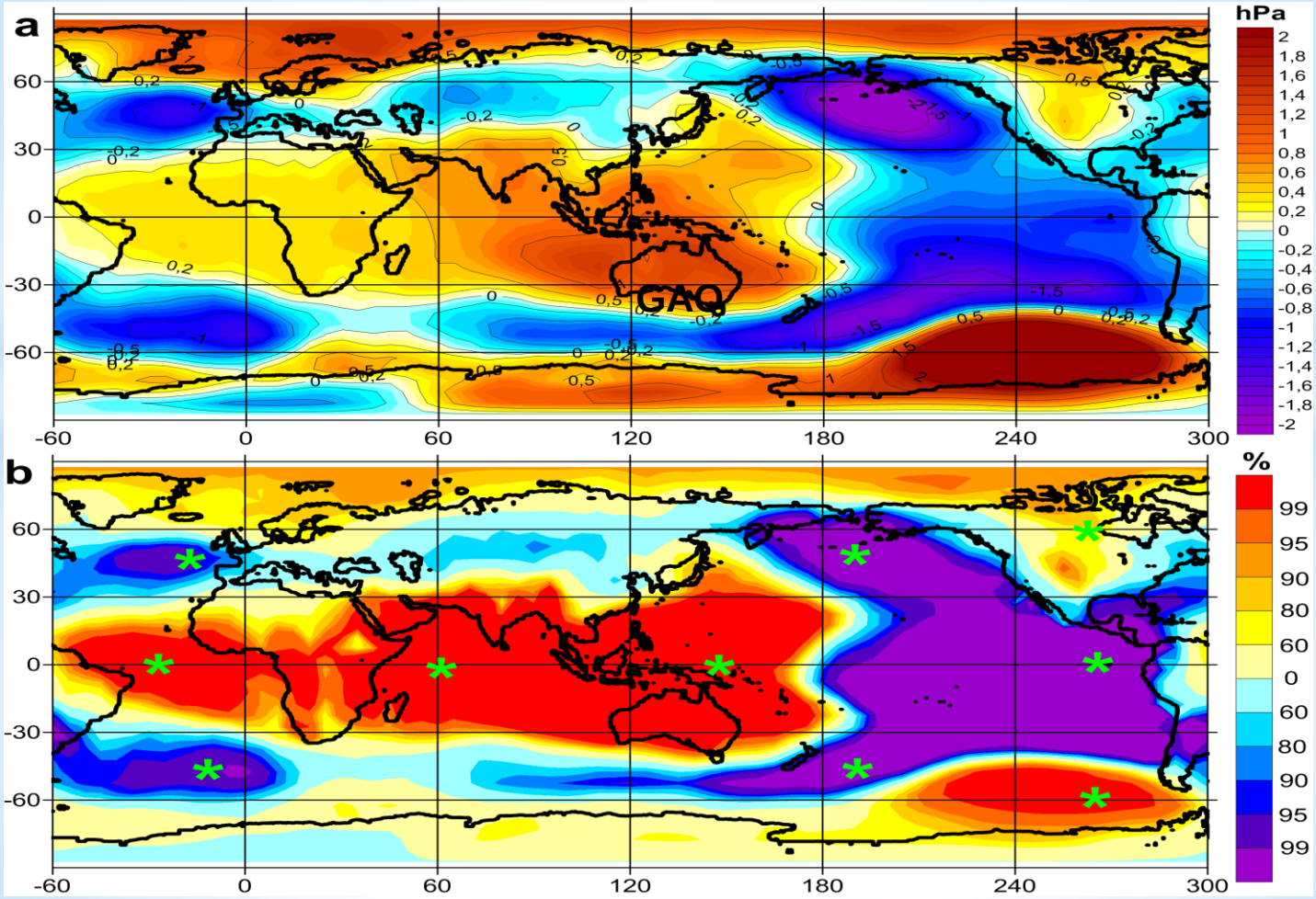
As a result, these variations form a spatial structure of the global scale.
We call this structure

GLOBAL ATMOSPHERIC OSCILLATION

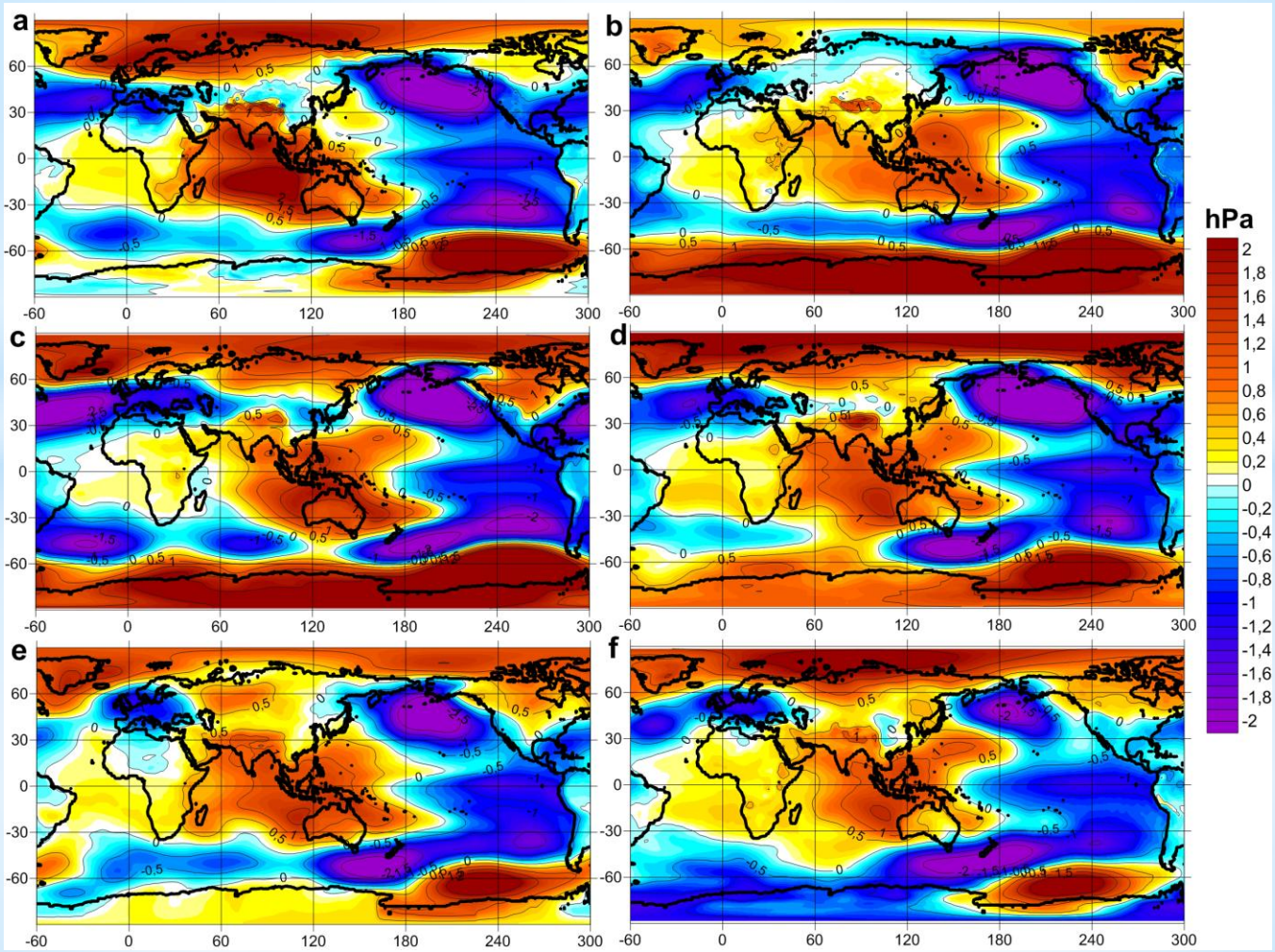
Global Atmospheric Oscillation (upper) as seen on mapping of the sea-surface temperature difference between 23 El Ninos and 25 La Ninas and the map of the *t-Student* test (below)



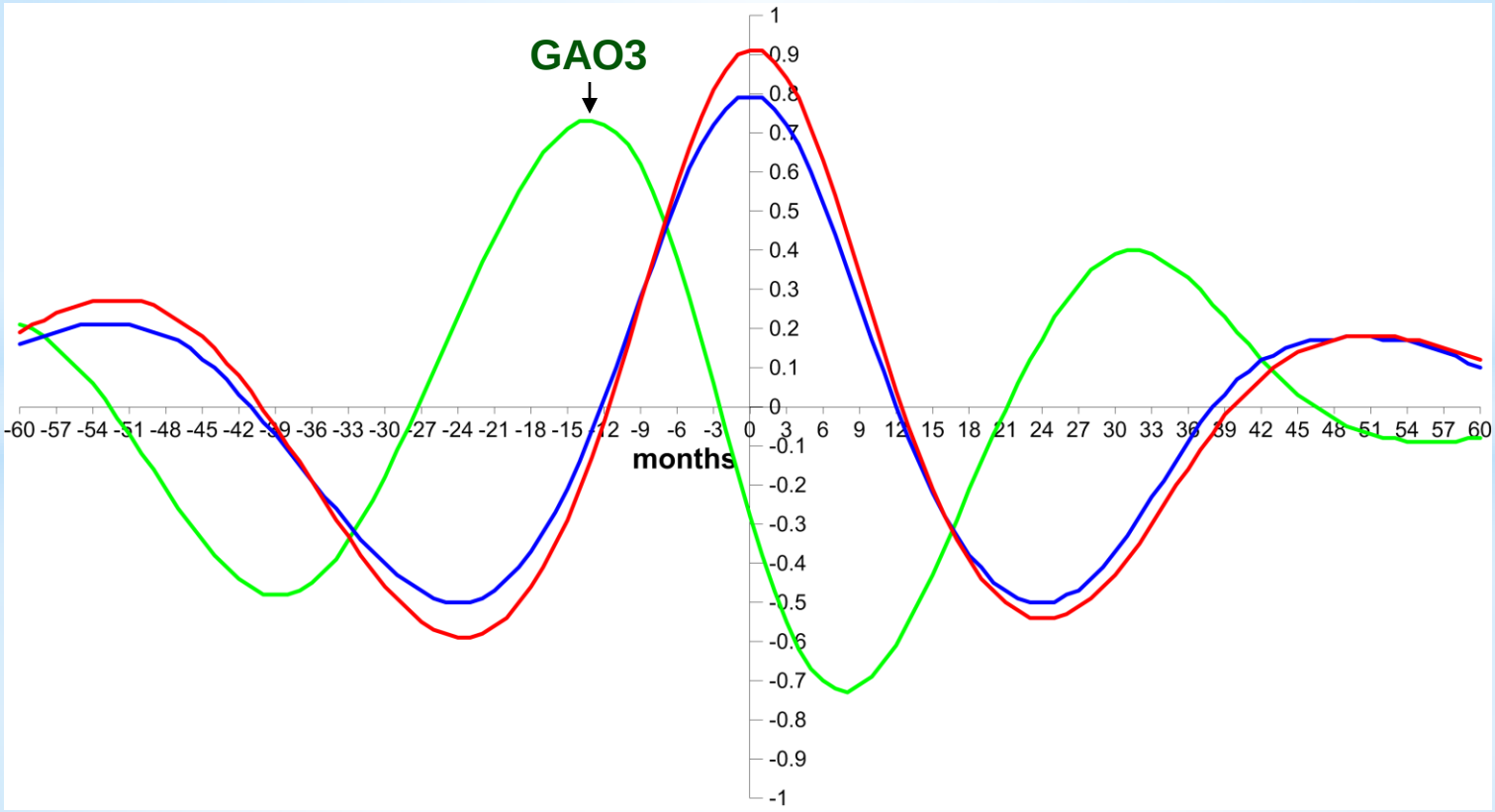
Global Atmospheric Oscillation (upper) as seen in the map of the sea-level pressure difference between 23 El Ninos and 25 La Ninas and its map of the *t-Student* test (below)



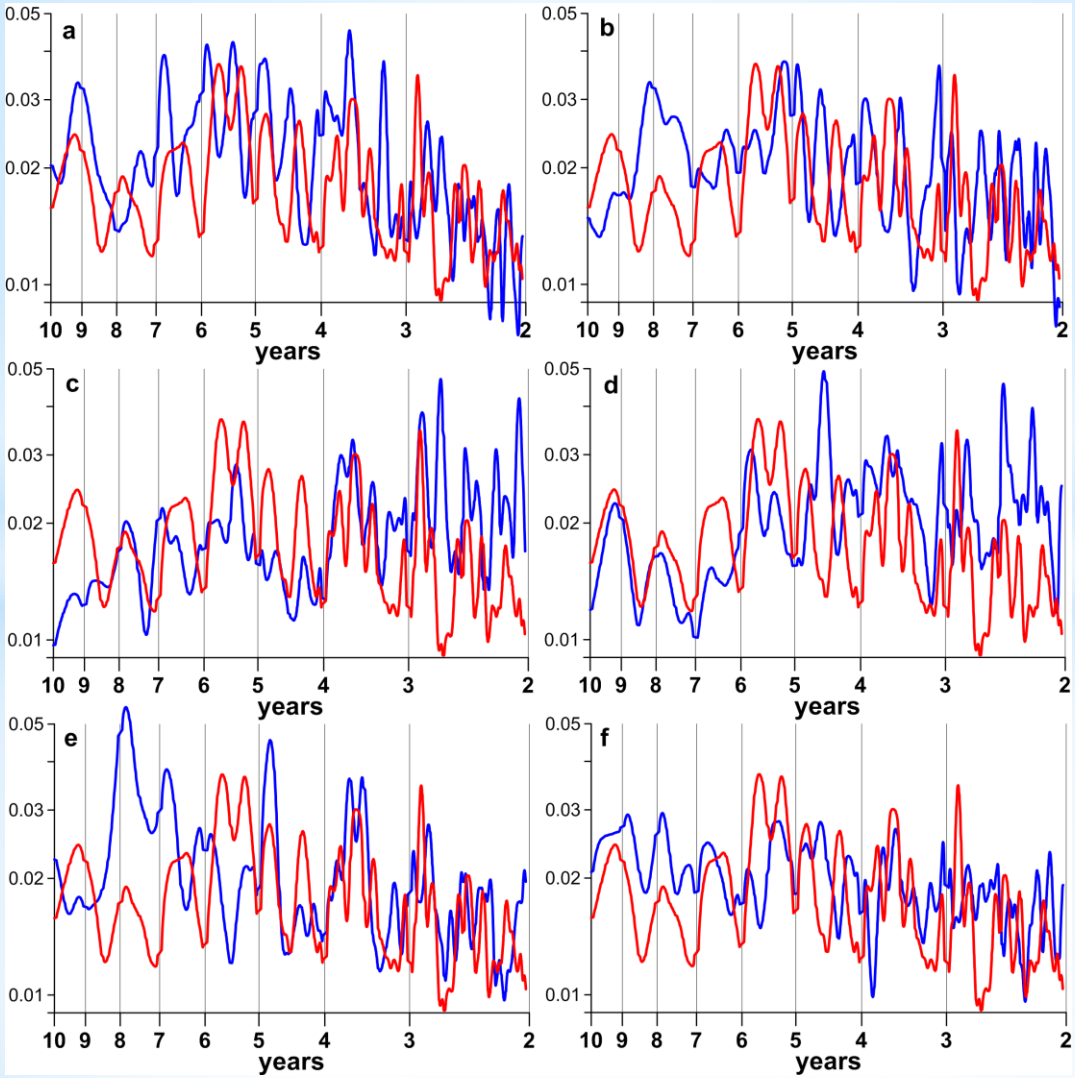
GAO as seen in six from the best CMIP5-models



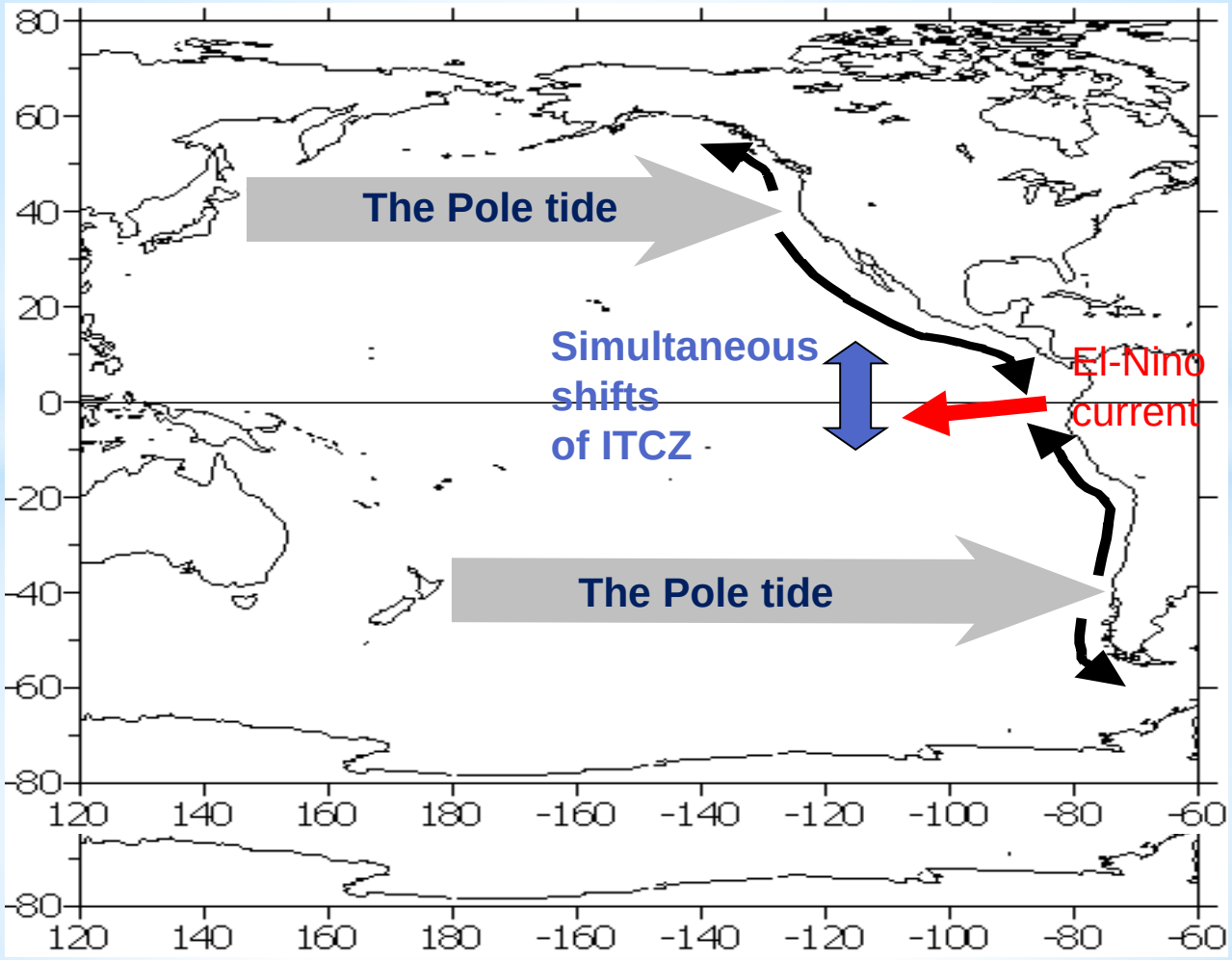
Cross-correlations between GAO-indices (GAO1, GAO2, GAO3) and an El Nino-index (EONI).
GAO3 can be used to predict El Nino with one year lead time!



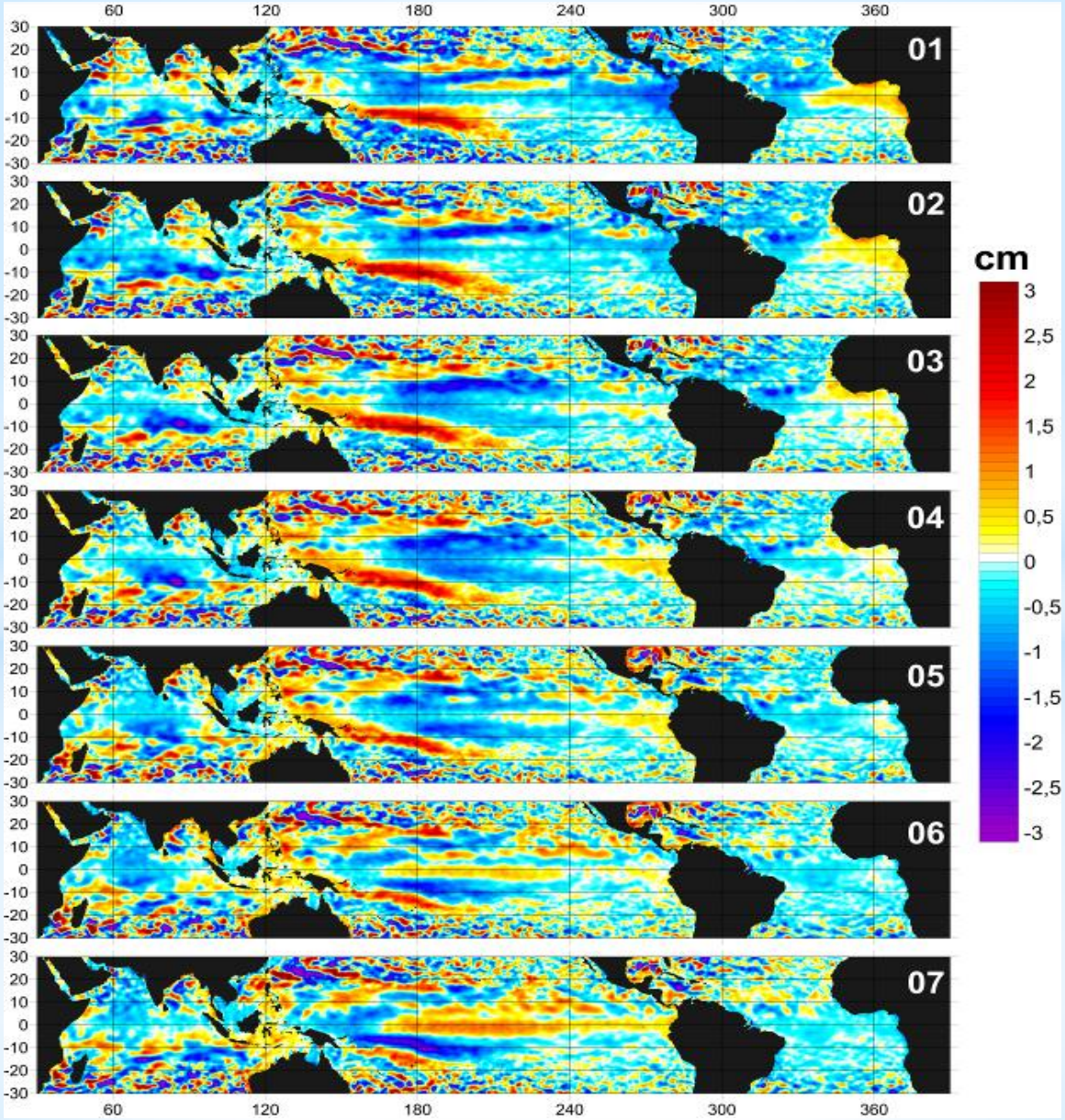
A comparison of the real GAO spectrum (red) with some CMIP5-model spectra (blue). All of the modeled peaks are localized at combinational harmonics of the annual period.



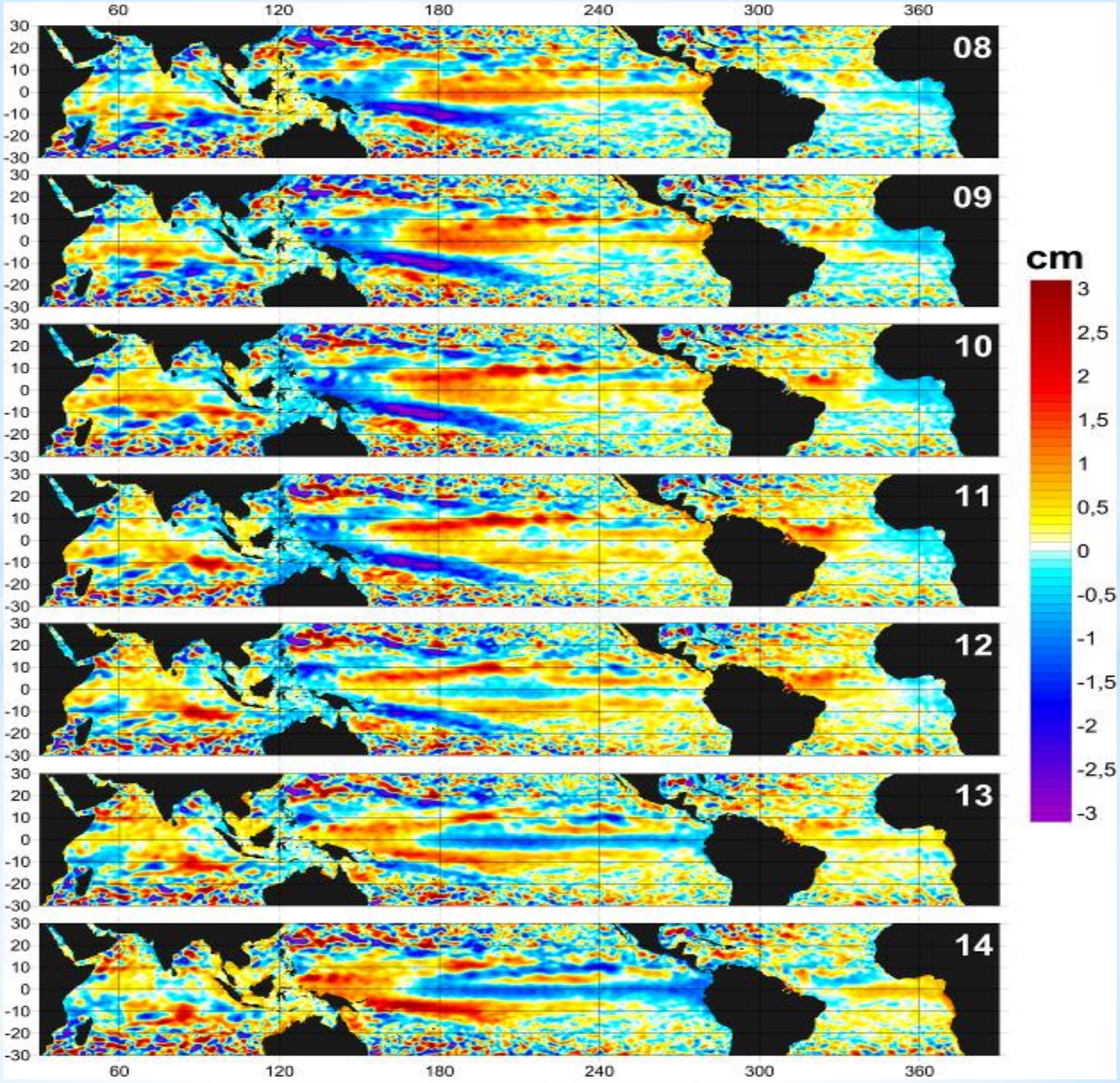
A possible explanation of the Chanler wobble (Pole tide) role in the El-Nino excitation



Satellite sea-level altimetry during the first sevel months of the El-Nino generating



Satellite sea-level altimetry during the first sevel months of the El-Nino suppressing



CONCLUSIONS

1. Variations of the extratropical weather are fully chaotic.
2. Variations of the tropical weather are chaotic,
   but with a mutual order.
3. Interannual climate variations are nonchaotic
   because these variations are conducted by three more
   external periodicities with **incommensurate** periods
   in addition to the annual Sun-induced heating.
4. The interannual climate variations form a global scale spatial
   structure called **GAO** as a result of these conductor actions.
5. **GAO** includes **ENSO** with their temporal rhythms within itself.
6. There is a possibility to predict **ENSO** for one year ahead.
7. Present-day climatic models are not capable to catch temporal
   variations of **GAO**. By this reason, these is no ENSO
   predictability excepting very short-term one.