THE DECADAL FLUCTUATIONS IN THE EARTH'S ROTATION AND IN THE CLIMATE CHARACTERISTICS

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ABSTRACT. Close correlations are found between the decades-long variations in the length of the day (LOD), variations in the rate of the westward drift of the geomagnetic eccentric dipole, and variations in some key climate parameters i.e. anomalies in the type of the atmospheric circulation, the hemisphere-averaged air temperature, the increments of the Antarctic and Greenland ice sheet masses, and the PDO.

This presentation outlines recent progress towards a better understanding of the causes of these relationships. The constraints put on the processes in the Earths interior by the decadal fluctuations of the Earth's rotation are discussed. We proposed that there is a spin-orbit coupling between the Earth's rotation rate and its motion together with the Sun about the barycentre of the solar system. Evidence in favour of this hypothesis is presented.

1. INTRODUCTION

It is well known that fluctuations in the Earth's LOD have components with characteristic time scales of the order of several decades. The origin of these decadal fluctuations of the Earth's rotation velocity are usually attributed to the Earth's core-mantle coupling. Support for this hypothesis comes from the fact that it could explain why there is a close correlation between the decadal fluctuations in the Earth's rotation and the variations in the rate of the westward drift of the geomagnetic eccentric dipole. It is reasonable to assume that the observed changes could be produced by the redistribution of angular momentum between the Earths fluid core and mantle. However, we contend that the empirical evidences and facts demand that this generally accepted assumption should be revised.

2. THE EMPIRICAL EVIDENCE

Figure 1 shows that the observed changes in the specific mass of the Antarctic ice sheet closely correspond to the specific mass variations that are needed to explain the "decadal" fluctuations in LOD. However, this correspondence is only a qualitative one. The problem is that the amplitude of the observed variations in the specific ice mass is 28 times less than the required amplitude. However, we believe that this discrepancy can be explained by a model that involves the drift of lithosphere over the asthenosphere.

Since the mass of the ice sheets in Antarctic and Greenland depend on the variations in climate, it is reasonable to assume that the decadal fluctuations in the Earth's rotation may also correlate with the fluctuations in the climatic characteristics and indices. Following this line of reasoning, we have found that the atmospheric circulation regimes are well correlated with the changes in the Earths rotation rate.

Figure 2 shows a close relationship between the decadal-long fluctuations in the Earths rotational rate (solid curve), the cumulative sum of anomalies of the circulation form C atmospheric circulation using the Vangengeim's classification (dashed curve), and the ten-year running mean of the anomalies of the Northern Hemisphere air temperature (dotted curve).

Finally, figure 3 shows the relationship between the deviation of the Earth's LOD from its long–term trend and the Pacific Decadal Oscillation (PDO) index. The upper graph shows the PDO reconstruction of D'Arrigo et al. (2001) between 1707 and 1972. The reconstruction has been smoothed with a 15–year running mean filter to eliminate short–term fluctuations. Superimposed on this PDO reconstruction is the instrumental mean annual PDO index (Mantua 2007) which extends the PDO series up to the

year 2000. The lower graph shows the absolute deviation of the Earth's LOD from its long–term trend between 1656 and 2005. The data in this figure has also been smoothed with a 15-year running mean filter. We can see from figure 3 that whenever there are large deviations in the Earth's length of day from its long–term trend, the PDO index is positive. It is important to note that the changes in the LOD precede those in the PDO by about eight years.

Hence, it is possible that the exchange of angular momentum between the Earth's mantle and its liquid core could be responsible for the decadal fluctuations in the Earth's rotation rate. And it could be argued that it is these decadal fluctuations in the Earth's rotation rate that cause the observed long-term changes in the climatic and glaciological characteristics. However, we present new evidence that shows that these tele–connections could also be explained by a spin-orbit coupling mechanism operating between the planets and the Sun that simultaneously affects both the processes in the Earth's core and the Earth's climatic systems.

3. A SPIN-ORBIT COUPLING MECHANISM

A recent paper by Ian Wilson et al. (2008) presents evidence that claims the changes in the Sun's equatorial rotation rate are synchronized with the changes in the Sun's orbital motion about the barycentre of the Solar System. This paper showed that the recent maximum asymmetries in the Solar motion about the barycentre have occurred in the years 1865, 1900, 1934, 1970 and 2007. And as we can see in Figure 4, these years of maximum asymmetry in the Solar motion closely correspond to the points of inflection in the Earth's length-of-day.

Figure 5 shows that, from 1700 to 2000 A.D., on every occasion where the Sun has experienced a maximum in the asymmetry of its motion about the centre-of-mass of the Solar System, the Earth has also experienced a significant deviation in its rotation rate (i.e. LOD) from that expected from the long-term trends. This fact indicates that the changes in the Earth's rotation rate are synchronized with a phenomenon that is linked to the changes in the solar motion about the barycentre of the Solar System.

4. SUMMARY

We have shown that there are strong correlations between the decadal-long variations in the length of the day and variations in certain climate characteristics i.e. the increments of the Antarctic and Greenland ice sheet masses, anomalies of the atmospheric circulation regimes, and changes in the hemisphere-averaged air temperature and the Pacific Decadal Oscillation.

From the empirical data, we argue that there is compelling evidence to support the idea that these correlations are due to a spin-orbit coupling between the Earth's rotation rate and its motion (that it shares with the Sun) about the barycentre of the solar system.

5. REFERENCES

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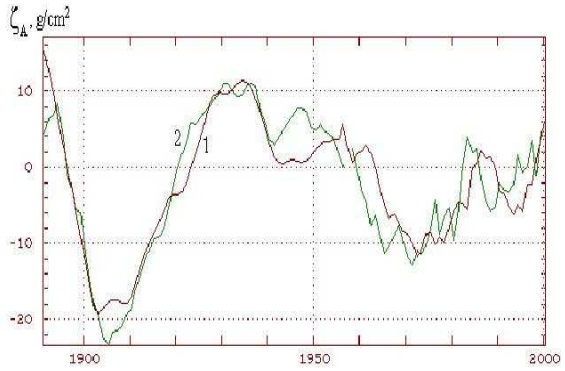

Figure 1: Temporal variations of the specific mass of ice in Antarctica, $g \cdot cm^{-2}$
1 - the theoretical value ; 2 - the empirical value (Sidorenkov et. al. 2005).

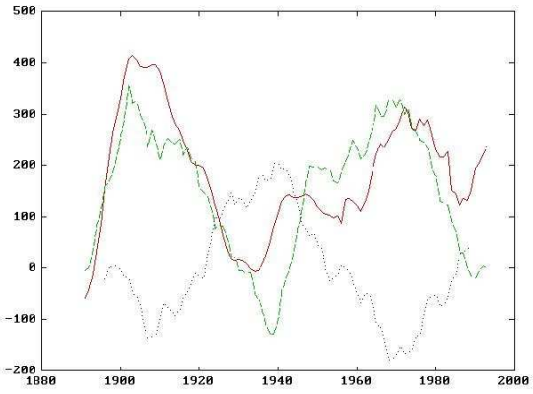

Figure 2: Synchronous changes in the length of day(solid curve), the cumulative sums of anomalies of the circulation form C (dashed curve), and of the ten-year running anomalies of the Northern Hemisphere air temperature (after elimination of a trend and a thousand fold magnification (dotted curve).

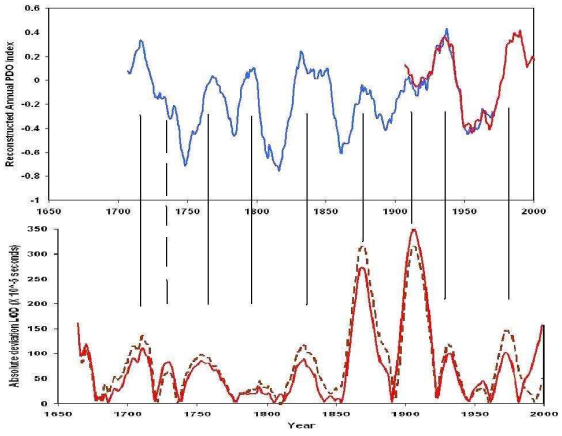

Figure 3: The upper graph shows the PDO reconstruction of D'Arrigo et al. (2001) between 1707 and 1972. The lower graph shows the absolute deviation of the Earths LOD from 1656 to 2005 (Sidorenkov 2005).

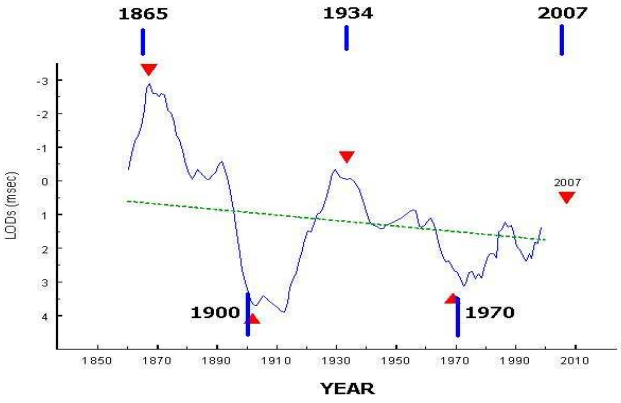

Figure 4: Wilson's asymmetries in the Solar motion (vertical lines); Landscheidt's zero phases in the solar motion (diamonds); tidal slow-down of the Earth's rotation (dashed line)

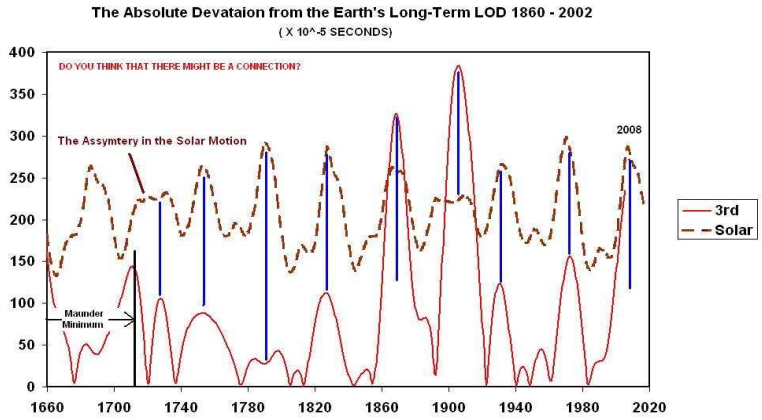

Figure 5: On every occasion where the Sun has experienced a maximum in the asymmetry of its motion about the centre-of-mass of the Solar System, the Earth has also experienced a significant deviation in its rotation rate (i.e. LOD) from that expected from the long-term trends