Journal of Atmospheric and Solar-Terrestrial Physics 72 (2010) 951–970

Contents lists available at ScienceDirect

Journal of Atmospheric and Solar-Terrestrial Physics

journal homepage: www.elsevier.com/locate/jastp

Empirical evidence for a celestial origin of the climate oscillations and its implications

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ARTICLE INFO

Article history:
Received 7 October 2009
Received in revised form
6 April 2010
Accepted 12 April 2010
Available online 15 May 2010

Keywords:
Planetary motion
Solar variability
Climate change
Modeling

ABSTRACT

We investigate whether or not the decadal and multi-decadal climate oscillations have an astronomical origin. Several global surface temperature records since 1850 and records deduced from the orbits of the planets present very similar power spectra. Eleven frequencies with period between 5 and 100 years closely correspond in the two records. Among them, large climate oscillations with peak-to-trough amplitude of about 0.1 and 0.25 °C, and periods of about 20 and 60 years, respectively, are synchronized to the orbital periods of Jupiter and Saturn. Schwabe and Hale solar cycles are also visible in the temperature records. A 9.1-year cycle is synchronized to the Moon's orbital cycles. A phenomenological model based on these astronomical cycles can be used to well reconstruct the temperature oscillations since 1850 and to make partial forecasts for the 21st century. It is found that at least 60% of the global warming observed since 1970 has been induced by the combined effect of the above natural climate oscillations. The partial forecast indicates that climate may stabilize or cool until 2030–2040. Possible physical mechanisms are qualitatively discussed with an emphasis on the phenomenon of collective synchronization of coupled oscillators.

1. Introduction

Milankovic (1941) theorized that variations in eccentricity, axial tilt, and precession of the orbit of the Earth determine climate patterns such as the 100,000 year ice age cycles of the Quaternary glaciation over the last few million years. The variation of the orbital parameters of the Earth is due to the gravitational perturbations induced by the other planets of the solar system, primarily Jupiter and Saturn. Over a much longer time scale the cosmic-ray flux record well correlates with the warm and ice periods of the Phanerozoic during the last 600 million years: the cosmic-ray flux oscillations are likely due to the changing galactic environment of the solar system as it crosses the spiral arms of the Milky Way (Shaviv, 2003, 2008; Shaviv and Veizer, 2003; Svensmark, 2007). Over millennial and secular time scales several authors have found that variations in total solar irradiance and variations in solar modulated cosmic-ray flux well correlate with climate changes: see for example: Eddy, 1976; Hoyt and Schatten, 1997; White et al., 1997; van Loon and Labitzke, 2000; Bond et al., 2001; Kerr, 2001; Douglass and Clader, 2002; Kirkby, 2007; Scafetta and West, 2005, 2007, 2008; Shaviv, 2008; Eichler et al., 2009; Soon, 2009; Meehl et al., 2009; Scafetta, 2009, 2010. Also the annual cycle has an evident astronomical origin.

The above results suggest that the dominant drivers of the climate oscillations have a celestial origin. Therefore, it is legitimate to investigate whether the climate oscillations with a time scale between 1 and 100 years can be interpreted in astronomical terms too.

Global surface temperature has risen (Brohan et al., 2006) by about 0.8 and 0.5 °C since 1900 and 1970, respectively. Humans may have partially contributed to this global warming through greenhouse gas (GHG) emissions (IPCC, 2007). For instance, the IPCC claims that more than 90% of the observed warming since 1900 and practically 100% of the observed warming since 1970 have had an anthropogenic origin (see figure 9.5 in IPCC, AR4-WG1). The latter conclusion derives merely from the fact that the climate models referenced by the IPCC cannot explain the warming occurred since 1970 with any known natural mechanism. Therefore, several scientists have concluded that this warming has been caused by anthropogenic GHG emissions that greatly increased during this same period. This theory is known as the *anthropogenic global warming theory* (AGWT).

However, the anthropogenic GHG emissions have increased monotonically since 1850 while the global temperature record has not. Several oscillations are seen in the data since 1850, including a global cooling since 2002: see Fig. 1. If these climate oscillations are natural, for example induced by astronomical

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doi:10.1016/j.jastp.2010.04.015

oscillations, they would determine how climate change should be interpreted (Keenlyside et al., 2008). In fact, during its cooling phase a natural multi-decadal oscillation can hide a global warming caused by human GHG emissions or, alternatively, during its warming phase a natural oscillation can accentuate the warming. If the natural oscillations of the climate are not properly recognized and taken into account, important climate patterns, for example the global warming observed from 1970 to 2000, can be erroneously interpreted. Indeed, part of the 1970–2000 warming could have been induced by a multi-decadal natural cycle during its warming phase that the climate models used by the IPCC have not reproduced.

The IPCC (2007) claims that the climate oscillations are induced by some still poorly understood and modeled internal dynamics of the climate system, such as the ocean dynamics. However, the oscillations of the atmosphere and of the ocean, such as the Pacific Decadal Oscillation (PDO) and the Atlantic Multidecadal Oscillation (AMO), may be induced by complex extraterrestrial periodic forcings that are acting on the climate system in multiple ways. Indeed, the climate system is characterized by interesting cyclical patterns that remind astronomical cycles.

For example, surface temperature records are characterized by decadal and bi-decadal oscillations which are usually found in good correlation with the (11-year) Schwabe and the (22 year) Hale solar cycles (Hoyt and Schatten, 1997; Scafetta and West, 2005; Scafetta, 2009). However, longer cycles are of interest herein.

Klyashtorin and Lyubushin (2007) and Klyashtorin et al. (2009) observed that several centuries of climate records (ice core sample, pine tree samples, sardine and anchovy sediment core samples, global surface temperature records, atmospheric circulation index, length of the day index, fish catching productivity records, etc.) are characterized by large 50–70 year and 30-year periodic cycles. The quasi-60 year periodicity has been also found in secular monsoon rainfall records from India, in proxies of monsoon rainfall from Arabian Sea sediments and in rainfall over east China (for example see the following works and their references: Agnihotri et al., 2002; Sinha et al., 2005; Goswami et al., 2006; Yadava and Ramesh, 2007). Thus, several records indicate that the climate is characterized by a large quasi-60 year periodicity, plus larger secular climatic cycles and smaller decadal cycles. All these cycles cannot be explained with anthropogenic emissions. Errors in the data, other superimposed patterns (for example, volcano effects and longer and shorter cycles) and some chaotic pattern in the dynamics of these signals may sometimes mask the 60-year cycle.

A multi-secular climatic record that shows a clear quasi-60 year oscillation is depicted in Fig. 2: the G. Bulloides abundance variation record found in the Cariaco Basis sediments in the Caribbean sea since 1650 (Black et al., 1999). This record is an indicator of the trade wind strength in the tropical Atlantic ocean and of the north Atlantic ocean atmosphere variability. This record shows five 60-year large cycles. These cycles correlate well with the 60-year modulation of the global temperature observed since 1850 (the correlation is negative). On longer time scales, periods of high G. Bulloides abundance correlate well with periods of reduced solar output (the well-known Maunder, Spörer, and Wolf minima), suggesting a solar forcing origin of these cycles (Black et al., 1999).

Patterson et al. (2004) found 60–62 year cycles in sediments and cosmogenic nuclide records in the NE Pacific. Komitov (2009) found similar cycles in the number of the middle latitude auroras from 1700 to 1900. Cycles of about 60 years have been detected in the number of historically recorded meteorite falls in China from AD 619 to 1943 and in the number of witnessed falls in the world from 1800 to 1974 (Yu et al., 1983). Ogurtsov et al. (2002) found a 60–64 year cycle in ^{10}Be, ^{14}C and Wolf number over the past 1000 years. The existence of a 60-year signal has been found in the Earth's angular velocity and in the geomagnetic field (Roberts et al., 2007). These results clearly suggest an astronomical origin of the 60-year variability found in several climatic records.

Interestingly, the traditional Chinese calendar, whose origins can be traced as far back as the 14th century BCE, is arranged in

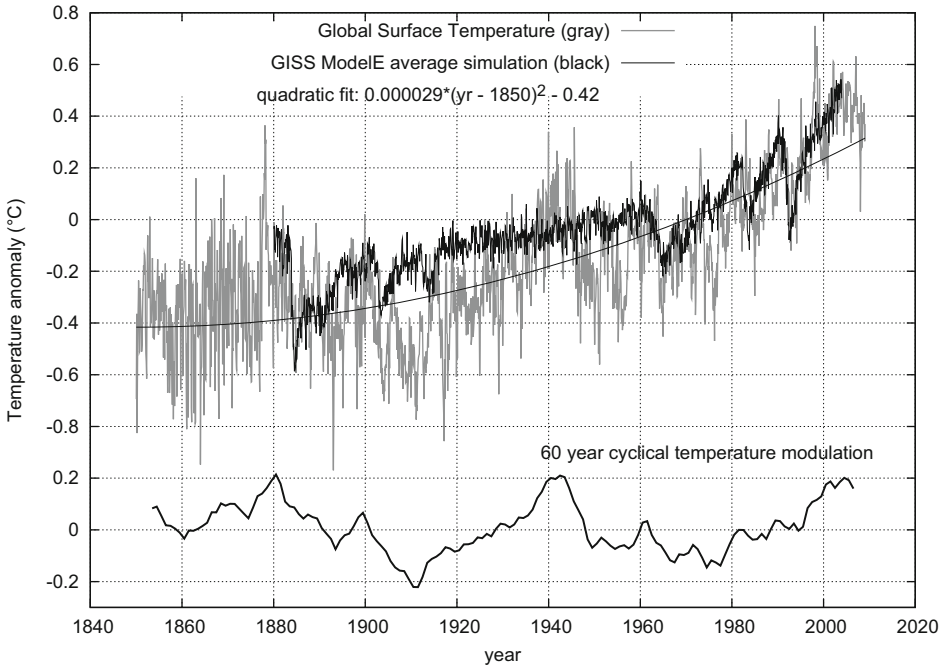

Fig. 1. Top: global surface temperature anomaly (gray) (Brohan et al., 2006) against the GISS ModelE average simulation (black) (Hansen et al., 2007). The figure also shows the quadratic upward trend of the temperature. Bottom: an eight year moving average smooth of the temperature detrended of its upward quadratic trend. This smooth reveals a quasi-60 year modulation.