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SHORT ARTICLE

Stardust component in tree rings

E. Kasatkina[a], O. Shumilov[a,*], N.V. Lukina[b], M. Krapiec[c], G. Jacoby[d]

[a]*Institute of North Industrial Ecology Problems, Kola Science Center RAS, P.O. Box 162, 184209 Apatity, Russia*
[b]*Centre for Forest Ecology and Productivity RAS, 117997 Moscow, Russia*
[c]*Polish Geological Institute, Carpatian Branch, 31-560 Cracow, Poland*
[d]*Tree-Ring Laboratory, Lamont-Doherty Earth Observatory, NY 10964, USA*

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Abstract

Tree-ring series collected from different parts of Arctic (Fennoscandia, Kola Peninsula and Northern Siberia) are investigated by means of the multi-taped method (MTM) of spectral analysis. Results of spectral analysis allow us to select the main periods of solar variability (22-, 30–33- and 80–90-year solar cycles) in Kola and Fennoscandia tree-ring chronologies. Besides it was found that only periodicities of around 20 years are present in Siberian and Stockholm series, respectively. With respect to 11-year periodicity, which is the most prominent one in sunspot number spectrum (Schwabe cycle) it may be said that it hardly appeared in Arctic tree-ring series. Although the 22-year cycles in climatic records are perceivable (it is also evident from our and other results), any physical mechanisms by which a reversal in the solar magnetic field could influence climate are still missing. To our mind, a potential cause of this phenomenon seems to be a variation of stardust flux inside the solar system. The most recent observations in frame of the DUST experiment on board the Ulysses spacecraft have shown that stardust level inside of the solar system was trebled during the recent solar maximum (Landgraf et al., 2003. Penetration of the heliosphere by the interstellar dust stream during solar maximum. Journal Geophysical Research 108, 8030). It is possible that the periodic increase of stardust in the solar system will influence the amount of extraterrestrial material that rains down to the Earth and consequently down to the Earth's atmosphere and may affect climate through alteration of atmospheric transparency and albedo.

Keywords: Solar cycles; Interstellar dust; Tree-ring chronologies; Climate; Cosmic rays; Solar radiation

Introduction

An existence of low-frequency variability in climatic parameters seems to be connected to solar cycles. The most expressed periodicities are: 11-year (Schwabe), 22-year (Hale), 33-year (Bruckner) and 80–100 (Gleissberg) cycles. The main heliophysical factors acting on climate, biosphere and atmospheric state are solar irradiance (Reid, 1991; Lean et al., 1995; Douglass and Clader, 2002), intensity of solar and galactic cosmic rays (relativistic particles with energies $>500\,\mathrm{MeV}$) influencing the cloud cover of the atmosphere (Tinsley et al., 1989; Shumilov et al., 1996; Svensmark and Friis-Christensen, 1997; Palle and Butler, 2001; Carslaw et al., 2002, Kasatkina and Shumilov, 2005) and UVB-radiation (Haigh, 1996).

The 11-year and 80–90 solar cycles are apparent in solar radiation and as well in galactic cosmic ray variations (Tinsley et al., 1989; Lean et al., 1995;

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*Corresponding author.
E-mail address: oleg@aprec.ru (O. Shumilov).

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Svensmark and Friis-Christensen, 1997; McCracken et al., 2001). At the same time, the bidecadal Hale cycle, related to a reversal of the main solar magnetic field direction is practically absent in either solar radiation (Lean et al., 1995) or in galactic cosmic ray variation (Webber and Lockwood, 1988). Besides we cannot identify any physical mechanisms by which a reversal in the main solar magnetic field direction could influence climate. However, the 22-year cycle has been identified practically in all regional climatic and temperature records all over the world (D'Arrigo and Jacoby, 1991; Plaut et al., 1995; Cook et al., 1997; Hoyt and Schatten, 1997; Baliunas et al., 1997; Rigozo et al., 2002; Gusev et al., 2004). In contrast, the 11-year solar cycle is not easily detectable in climate records worldwide and where a signal is apparent it is often preserved with lower amplitudes compared with those of the 22-year cycle (Molinari et al., 1997; White et al., 1997). The other 80–90-year solar cycle is less commonly preserved in climatic records (Stocker, 1994). The 33-year (Bruckner) solar cycle, the physical nature of which currently remains unknown, has only been identified in a limited number of regions: Northern Finland (Stocker, 1994), Chile (Roig et al., 2001), Mexico (Mendoza et al., 2001) and North America (Scuderi, 1993; Dean et al., 2002).

Below we analyze new evidence of bidecadal variations in Arctic and their possible extraterrestrial origin.

Data and method

For analysis, we used 14 tree-ring records from three sites distributed longitudinally over a large part of Arctic (Kola Peninsula, Northern Lapland and Northern Siberia). Tree-ring data (*Pinus sylvestris* L.) were sampled in Northern Lapland (40 km from Sodankyla; 67°22′N, 26°38′E; 2 series), Kola Peninsula (67°33′–68°36′N; 31°45′–34°58′E; 11 series), which were collected up to date and Northern Syberia [(Taymir region, 72°30′N, 105°10′E; *Larix gmelinii* (Rupr.) Kuzen (Jacoby et al., 2000)]. The samples were cross-dated and ring widths were measured using standard dendrochronological techniques and COFECHA (Holmes, 1983) and ARSTAN (Cook and Kairiukstis, 1990) programs. Most of the series begin in the 1700s, the longest one begins in 1524. All data series were spectrally analyzed with help of a multi-taped method (MTM) (Thomson, 1982) in order to look for solar activity signals.

Results and discussion

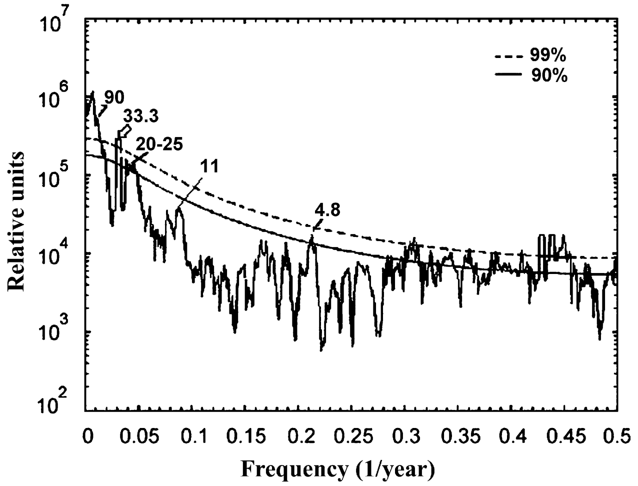

Fig. 1. Example of MTM-spectrum of tree-ring record with clearly impressed solar cycles from Kola Peninsula, Apatity (67.5N, 33.5EE), 1601–2000. The lower and upper lines represent 90% and 99% confidence limits.

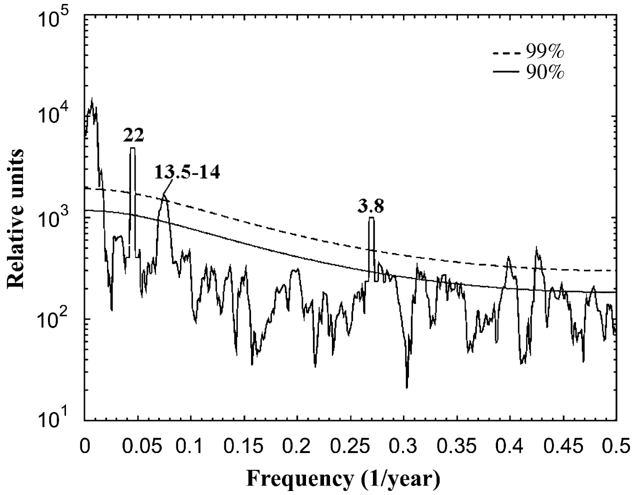

Fig. 2. The same as in Fig. 1, but for Northern Siberia, Taymir (72.5N, 105.2E), 1581–1997.

MTM spectral analysis revealed 4–7, 11, 22, 33, 66, 80–100 year periodicity with 90% (or higher) confidence level for Kola and Lapland series (Fig. 1). However, by the method used, no cycles at significant level were found in Siberian (Fig. 2) and Stockholm (Fig. 3) tree-ring records with exception of the 22-year one. Peaks between 4 and 7 year may be related to the North Atlantic Oscillation (NAO) (Mokhov et al., 2000) together with other peaks corresponding to solar cycles. As noted earlier, the periods of 11-year and 80–90-year solar cycles were identified in variations of solar irradiance and galactic cosmic rays. These periods are also evident in climatic variations. There are several reasons to consider the 33-year cycle observed in Kola and Lapland series to be of a solar origin. For example, it was discovered in variations of magnetic index (Ap) and as well as in sunspots, although it was very unstable (Gonzalez et al., 1993). This period seems to be