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The 11-year solar radiation rhythm and the North Atlantic Oscillation during the last two centuries

Heiko Brunck (1) and Frank Sirocko (2)

(1) Johannes Gutenberg-Universität Mainz, Institut for Geosciences, Mainz, Germany (brunckh@uni-mainz.de), (2) Johannes Gutenberg-Universität Mainz, Institut for Geosciences, Mainz, Germany (sirocko@uni-mainz.de)

The study is based on a historical chronology of freezing events in central Europe during the last 230 years (river Rhine (Sirocko et al. 2012), Baltic Sea (Koslowski and Glaser, 1999) and Lake Constance (Dobras, 1983)). These regions display both significant similarities with extremely cold winters in central Germany for the years 1799, 1830, 1895, 1929, 1940, 1942, 1947, 1956 and 1963, as well as regional differences in timing and severity of cold winters. The statistical analysis of all 92 historical freezing events showed that 80 events occurred during a negative NAOwinter phase. The bootstrap test defined the results as extremely significant.
To understand the climatic forcing behind the freezing chronology the NAO data set was smoothed by a three point running mean filter and compared with the 11- year cyclicity of the sunspot numbers. A complete NAO cycle can be observed within each solar cycle back to 1960 and from 1820 to 1900. From 1900 to 1960 the correlation between the Sun and NAO was weak. This on/off mode becomes visible only in the smoothed NAO data, when time intervals longer than “normal” weather observations are analysed. Statistical test for the coherence of the entire 230 years are insignificant. However, the relation is highly significant, if only the intervals from 1960 to 2010 and 1830 to 1900 are analysed.
The phase correlation can be explained by temperature variations up to +-2.5°C in time series of stratospheric air temperature at 40 km height, where ozone is formed by ultraviolet solar radiation. Advanced analysis of sea surface temperatures from reanalysis data (ECMWF Data Archiv, 2013) between 30° – 40°N and 65° – 75°N indicate similar temperature variations in phase with the solar activity. Consequently, the 11 year solar periodicity is related to various parts of the Earth/Ocean/Atmosphere system and not only to the stratospheric signal. However, the NAO is the dominating mediator to implement a solar component into the European winter extremes.

References

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