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Analysis of meteorological and solar activity descriptors to study solar-terrestrial relations

S. Kodermaz (1), F. Stel (2), M. Messerotti (3,1)

(1) Dept. of Physics, University of Trieste, (2) OSMER-ARPA FVG Regional Meteorological Observatory, (3) INAF-Astronomical Observatory of Trieste

The Sun provides a significant energy input to the Earth atmosphere. Such an energy input varies by different amounts on various time scales according to specific wavelength bands. The solar energy flux variations are small compared to the total amount of the incoming energy, but they could play an important role in the global energetic balance and in the terrestrial climate. In fact, there are evidences that the Sun had been the major driver of Earth's climate and paleoclimate in the past. Anyway, due to the complex nonlinear coupling of the Sun's emission with the atmosphere system, it is challenging to clearly identify and quantify the solar contribution to climate and weather.

A possible approach consists in a cross analysis of solar activity descriptor and climate descriptor time series, in the attempt to point out the solar influence. To achieve this goal, in this work we used observational and model-generated data sets. In particular, solar irradiance data and meteorological data. Therefore, important topics such as study of the causes of solar variability, paleoclimate indicators and GCR modulation, which are fundamental anyway, have not been taken in account.

The correlation tests have not led to any significant conclusion, while Fourier analysis has revealed frequency components that could be related with the solar activity. However, doing a Fourier analysis, the temporal information is lost. This limitation has been overcome by wavelet analysis, which has provided some qualitative results of significance, although not quantitative. Finally, the multi-scale analysis performed by Empirical Mode Decomposition has proved to be an efficient methodology to decompose a signal, to achieve a time-frequency analysis through Hilbert Transform, and it has led to some quantitative results of significance, which would prompt some possible future developments.