Geophysical Research Abstracts
Vol. 13, EGU2011-8292, 2011
EGU General Assembly 2011

Assessing uncertainty of solar signals in the tropospheric temperature field

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The estimation of the 11-year solar cycle signal into the observed temperature field of the Earth's atmosphere has seen many efforts by the scientific community in the last decade. Indeed, the availability of a large amount of good-quality data and the high solar activity make the last 50 years an ideal period for the seeking of relationships between Sun variability and climate. While the solar impacts on the stratosphere are now relatively well understood, particularly in the tropics, the low signal-noise ratio in the troposphere is still a massive obstacle to any attempt to detect the Sun-related decadal variability. Nevertheless, several authors estimated a peak-to-peak solar signal of about 0.1°C in the mean global surface temperature, with the largest contribution coming from the mid-latitudes of both hemispheres. The most widely used statistical tool for this purpose is the multiple linear regression (MLR), which aims to maximize the fraction of the total variance of a predictand (e.g., global temperature) explained by linear relationships with a limited number of predictors (usually ENSO, volcanic aerosols, solar variability and a linear trend), supposed to be the main physical forcings. Different variants of the MLR have been proposed, with different implementations of time-lags, but still this method presents important shortcomings. For instance, the presence of a strong correlation between two predictors in a sub-period of the dataset can lead to a wrong estimation of the factors and therefore to a higher uncertainty.

In this work we show to what extent the choice of the predictors can change the estimation of the solar sensibility of the temperature during the last 5 solar cycles, by using the NCEP/NCAR monthly reanalysis. The focus is on the troposphere of the Northern Hemisphere, where the quality of the data is better, but also global data from different surface-based datasets are analyzed. We provide estimations of the uncertainty ranges of the solar coefficients by mean of a resampling procedure; our aim is to determine where, and in which seasons, the Sun is more likely to have had an influence on the decadal scale variability.