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Possible link between solar activity and tropospheric circulation over Europe

Hana Kapolková (1) and Radan Huth (2)

(1) Slovak Hydrometeorological Institute, Bratislava, Slovakia , (2) Institute of Atmospheric Physics ASCR, Praha, Czech Republic

Relationships between solar activity and the atmosphere has been often studied in the past, especially the influence of solar particles on processes in upper atmosphere. However, the influence of solar activity on the troposphere is still being discussed, as the possible mechanism, responsible for the transport of solar signal from the stratosphere to the troposphere, is not fully understood. There exist indications, that it may happen through down-ward propagation from the stratosphere to the troposphere, which is possible to occur in winter. Several studies were aimed at correlations between solar activity and ground based climatic elements. Another way, how to study these relationships, is to correlate solar activity with data of tropospheric circulation.

As a representative of the tropospheric circulation, we chose the Hess-Brezowsky synoptic classification based on the sea level air pressure, prevailing wind flow and location of main pressure centers. The proxy data on solar activity represents Wolf number, which is an index calculated from the counts of sunspots and is directly connected to the 11-years long solar cycle. We classified solar activity to low, moderate and high according to quartiles and tertiles of Wolf number. The analysis was carried out on the monthly basis, from the 1th January, 1881 to the 31th December, 2010 and contains extended winter (December to March) and extended summer (June to September).

We calculated relative frequency of synoptic types under different solar conditions and compared it to long-term mean relative frequency. Statistical significance of the changes in distribution of synoptic types in time was tested by using of the Monte Carlo simulation. We conducted two separate analysis for winter months and summer months and compared the results to evaluate the possibility that the link between solar activity and tropospheric circulation is happening through the down-ward propagation from the stratosphere to the troposphere.