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Time lag between the tropopause height and ⁷Be activity concentrations on surface air

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The objective of this study is to define the time-lag between the elevation of tropopause and the concentration of ⁷Be in near surface air. The concentration of ⁷Be at surface air has been determined in the region of Thessaloniki, Greece at 40°N, over 52 weekly measurements covering the year 2009, a year of a deep solar minimum and of maximum concentration of ⁷Be, where any fluctuation due to meteorological and seasonal variations are easily revealed.

Sampling of ⁷Be aerosols was carried out by Staplex high-volume air sampler with glass-fiber filters, and a regulated airflow rate of 1.7-1.92 m³ min⁻¹ (60-68 ft³ min⁻¹). The length of each collection period was 24 h. All samples were measured for ⁷Be activity using an HPGe detector (42% relative efficiency). The tropopause height time series of daily values was obtained from the NCEP/NCAR Reanalysis data.

The positive correlations between the monthly activity concentrations of ⁷Be and the tropopause height (0.94, $p < 0.0001$) as well as between ⁷Be concentrations and the temperature T (°C) ($R = 0.97$, $p < 0.001$), confirm that the increased rate of vertical transport within the troposphere, has as a result the descent to surface of air masses enriched in ⁷Be. However, the ⁷Be concentration levels in near surface air are not expected to respond immediately to the change of elevation of the tropopause. The calculation of time lag is the next step in understanding the atmospheric procedures behind the correlation. This step will also reveal information about radioactive aerosols movement in the atmosphere's transfer cycles.

The time lag was found by holding the same column of data for ⁷Be and calculating the correlation coefficient (R) for each new column of daily data of the tropopause height. The new columns are created by going back in time with a step of one day waiting for the best correlation in order to find how many days we have to wait until the concentration of ⁷Be responds to the elevation of the tropopause height.

The correlation coefficient (R) between ⁷Be and the tropopause height was successively calculated for different time lags starting with lag equal to zero. The analysis of the daily data revealed that the time delay between the elevation of tropopause and ⁷Be concentrations in surface air is about 3 days. The most striking feature of the data is the four day plateau (including the day of the measurement and the three previous days) revealing persistence in the state of the atmosphere.

In order to test our results and confirm that the correlation depends on the successive waves of air masses of a four day period a cumulative index should be calculated.

The results improved as the correlation coefficient hits a peak in the first calculation at 0.47 and 0.46 in the second one. This indicates that the time lag is 2 to 3 days as the first two calculations refer to the correlation between the ⁷Be concentrations and 4 day average (3 previous days and the day we measured ⁷Be) measurements of tropopause heights. .

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