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INTERNATIONAL CONFERENCE ON RADIATION
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Interrelation between the beryllium-7 specific activity in the surface air and North Atlantic Oscillation based on their wavelet coherence

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The natural radionuclide beryllium-7 (Be-7) is produced in the upper levels of the atmosphere and is transported to the surface on carrier aerosols. Therefore, among other factors, the abundance of Be-7 in the surface air is governed by the rate of its production and large-scale air transport. The North Atlantic Oscillation (NAO) index, which quantifies the surface sea-level pressure difference between the Subtropical (Azores) High and Subpolar low, exerts large effects on precipitation and circulation patterns in Europe. With an aim to look closely into the interrelations between the Be-7 specific activity in the surface air, sunspot number (as a proxy for the production signal), and NAO index, this paper investigates their long-term time series over 28 years, between February 1987 and December 2014.

The Be-7 specific activity was recorded in Vienna (48.22 °N; 16.35 °E; 193 m a.s.l.), Austria, and stored in the Radioactivity Environmental Monitoring databank (REMdb) that is created and supported by the European Commission-Joint Research Centre in Ispra, Italy. The sunspot number (SN) data were downloaded from SILSO (Royal Observatory of Belgium, Brussels, Belgium), while the NAO records were retrieved from the Climate Prediction Centre of the National Oceanic and Atmospheric Administration, USA. Since the temporal resolution of the Be-7 measurements varied between six and eight days, they were first linearly interpolated into an array of weekly data, and then, the daily SN and NAO data were averaged into weekly records to match the Be-7 data. Next, Pearson's correlation analysis and wavelet transform were used to analyse the time series.

The low Pearson's correlation coefficients between the Be-7 specific activity in the surface air and SN (-0.15207) on one hand, and the NAO index and SN (0.13512) on the other hand, imply a lack of direct linear interrelations between these variables. The Pearson's correlation coefficient between the Be-7 specific activity in the surface air and NAO index is even lower (-0.05904). However, the Be-7 specific activity wavelet spectrum shows a pronounced annual period, and looking further into the link between the Be-7 specific activity and NAO index at this characteristic periodicity, reveals a prominent pattern. Specifically, the wavelet coherence levels between these two parameters show variations that seem to be in agreement with the 11-year solar cycle: the coherence increases as the sunspot number transitions between its extremes, and it decreases around the maxima and minima in sunspot number. Further, phase difference shows that at the one-year periodicity, the Be-7 specific activity always lags behind the NAO index. The phase difference ranges between 2 and 6 months; it reaches the minimum around the solar activity extremes, and the maximum in-between.

These findings imply that, although weak, the signature of sunspot number can be seen in the wavelet coherence level between the Be-7 specific activity and NAO index.