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BOOK OF ABSTRACTS

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The uniqueness of the beryllium-7 time series in Kista and Vienna over 1987–2014

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Activity concentration of beryllium-7 (Be-7) in the surface air is considered a good tracer of atmospheric processes. Promptly after its production, this radionuclide attaches to aerosols and then subsides to the surface where its concentrations depend on the aerosol removal processes, e.g. precipitation, and atmospheric transport drivers, e.g. temperature and pressure. Our study investigates whether a set of five variables: mean temperature, minimum temperature, maximum temperature, precipitation and atmospheric pressure can account for the Be-7 concentration variability at the surface.

We use the Be-7 activity concentration from the Radioactivity Environmental Monitoring data bank maintained by the Joint Research Centre in Ispra, Italy. We look into two locations, Kista (59.40 °N; 17.93 °E; 16 m a.s.l.) in Sweden and Vienna (48.22 °N; 16.35 °E; 193 m a.s.l.) in Austria, between February 1987 and December 2014, when the sampling was performed on a weekly basis. The meteorological parameters are extracted from the E-OBS gridded climatology, version 15, using bilinear interpolation.

For each location, we perform Factor Analysis. The calculations are done in R, an open-source software for statistical computing and graphics.

Factor Analysis assumes that a given set can be modelled as a linear combination of unobserved uncorrelated factors. Loadings are contributions of each original variable to a factor; variables with high loadings are well explained by the factor. The total data variability has two terms: communality arising from the linear combinations of the factors, and uniqueness not explained by the factors. The model is appropriate if the uniqueness is low. The null hypothesis in Factor Analysis is that the chosen number of factors is sufficient to explain the variability of the data; the hypothesis is rejected if the calculated p-value is less than 0.05.

We perform Factor Analysis by choosing 1, 2 and 3 factors. Results for both locations give similar results.

One factor (F1): Temperatures show very high loadings (greater than 0.98) making F1 identical to a temperature variable in the set. The loading of the Be-7 concentration is 0.39 and 0.68 for Kista and Vienna, respectively. The loadings of precipitation and atmospheric pressure are less than 0.4. With the low Be-7 concentration loading, its uniqueness is large, giving temperature, as a single contributing factor, insufficient to explain well the data's features. This is corroborated by the p-value=0.

Two factors (F1 and F2): The sum of square loadings for F1 is greater than 3 making it significant, unlike F2 (a factor is significant if the sum of square loadings is greater than 1). The Be-7 concentration and temperatures have high loadings for F1, but precipitation has a negligible F1-loading; precipitation has a significant loading for F2, while the pressure has similar loadings for F1 and F2. Although the uniqueness of the Be-7 concentration decreases with two factors, p-value is again very low, essentially zero.

Three factors (F1, F2 and F3): Again, F1 with the highest temperature loadings can be identified as a temperature variable. The loading of atmospheric pressure is the highest for F2. Both F1 and F2 are significant, while F3 is insignificant. Also, we cannot assess the validity of the null hypothesis regarding the use of the 3-factor model, because this model has zero degrees of freedom, thus no p-value can be calculated. Nevertheless, if we look into the uniqueness of the Be-7 concentration, its lowest values are given by this model.

In conclusion, all variables exhibit a variance that cannot be captured by up to 3 factors. Still, the Be-7 concentration seems to be strongly correlated with the temperature variables in all the investigated models. But, the uniqueness of the Be-7 concentration remains high, implying that the chosen set of variables lacks an important observable that could help explain the behaviour of the Be-7 concentration at the surface.

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