Long-term observations of Beryllium-7 and Sodium-22 in ground-level air

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Beryllium-7 (^{7}Be) and Sodium-22 (^{22}Na), two relatively long-lived cosmogenic radionuclides, are useful tracers for tropospheric circulation and stratosphere–troposphere exchange (STE). This presentation synthesises multi-decadal variability, seasonal patterns, and recent trends in atmospheric ^{7}Be and ^{22}Na concentrations, based on a dataset of surface observations from Switzerland.

The dataset comprises weekly measurements of high-volume air filters (approximately 100,000 m³/week) at six monitoring sites, with time series extending up to 30 years. The primary objective of this monitoring network is to detect anomalous increases in artificial gamma-emitting isotopes, such as ^{137}Cs, ^{134}Cs, ^{131}I, ^{106}Ru and others. Concurrent measurements of the natural radionuclides provide valuable insight into the origin and characteristics of the observed air masses.

As expected, the long-term variations in ^{7}Be and ^{22}Na concentrations reflect the dependence of their production rates on the solar cycle. The monitoring stations are situated at mid-latitudes near a major mountain range (the Alps), a geographic setting that gives rise to a distinct annual cycle. Notably, ^{7}Be and ^{22}Na concentrations are approximately twice as high during summer months compared to winter. Evidence of enhanced STE in spring and early summer is provided by elevated concentrations ^{22}Na and the ^{7}Be/^{22}Na ratio. Superimposed on the annual cycle are short-term fluctuations, typically lasting two to four weeks. We explore the relationship between these variations and prevailing synoptic-scale weather patterns.

Recent observations suggest that atmospheric ^{7}Be and ^{22}Na concentrations confirm a more vigorous vertical mixing of the troposphere due to global warming. However, a significant challenge in interpreting the ^{7}Be and ^{22}Na signals is the correct accounting of washout during rain events, which itself will be influenced by climate change. This last point will be illustrated by daily measurements of radionuclides as well as weather variables at one station.