The cosmogenic ^{7}Be and ^{22}Na as atmospheric tracers in Finland

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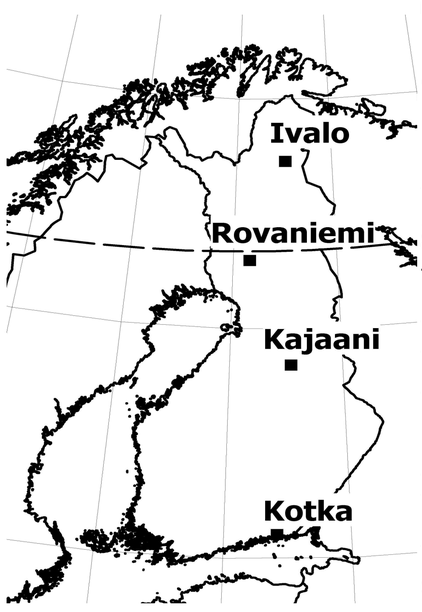
Materials and Methods

In Finland, Radiation and Nuclear Safety Authority (STUK) monitors airborne radioactivity in surface air. Monitoring stations are located in different parts of the country, three stations above the Arctic Circle. The air is sampled by pumping air through a filter where aerosols are collected, the filter is changed on weekly basis. The filter is measured with an HPGe detector in a low background environment for 3 days to determine concentrations of gamma emitting radioisotopes. The sampling station locations are shown in Fig.1.



The purpose is to monitor anthropogenic radioisotopes. In nominal operation natural radionuclides such as cosmogenic ^{7}Be and ^{22}Na are seen as well. The galactic cosmic rays produce cosmogenic isotopes in the upper atmosphere in the spallation process with atmospheric O, N and Ar. In theory, the surface air ^{7}Be and ^{22}Na concentrations follow the cosmic ray flux (or Solar cycle).

Fig 1. Locations of the surface air radioactivity sampling stations where the data ^{7}Be/^{22}Na has been collected.

Results and Discussion

In our studies the longest time series of ^{7}Be surface air concentrations is from Rovaniemi where the sampling started 1987. The time series of ^{7}Be and ^{22}Na concentrations in surface air from Rovaniemi, Ivalo and Kotka has been analyzed for periodicities using the wavelet analysis method.

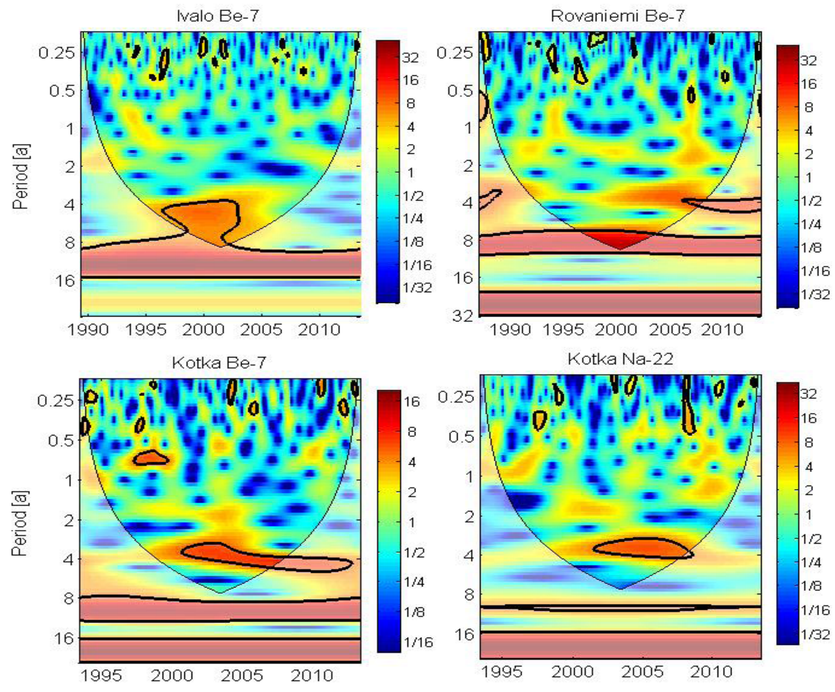


Fig. 2. Results of the wavelet analyses of ^{7}Be and ^{22}Na time series

Several periodicities can be observed in fig.2 ranging from 4-(14) years. In coherence analyses these periodicities were found to in coherence with AO/NAO, ENSO teleconnection indices. The data from Kotka station provides an opportunity to compare periodicities found in ^{7}Be and in ^{22}Na.

The intraseasonal periodicities in ^{7}Be surface air concentrations from Ivalo, Rovaniemi and Helsinki was also studied . Other studies have found 20-30 day periodicities in surface air ^{7}Be concentrations that were linked to Solar rotational period. In our studies shown in fig. 3, an intermittent period of 45-90 days was found. This was speculated to be caused by meridional wind oscillations (MWO) and/or Arctic Oscillation (AO).

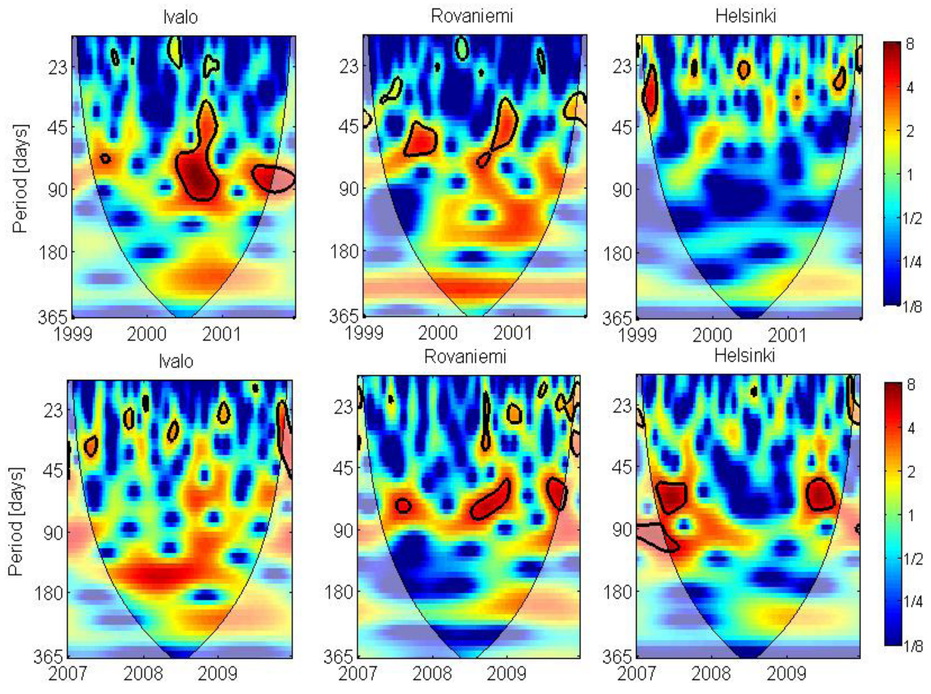


Fig 3. Wavelet analyses of intraseasonal periodicities of Ivalo, Rovaniemi and Helsinki ^{7}Be data.

In the data of Rovaniemi and Kotka ^{7}Be and ^{22}Na were observed simultaneously. In ^{7}Be/^{22}Na ratio there is a distinct annual cycle where low ratios are observed during summer and high ratios during winter. The ^{7}Be/^{22}Na ratio decreases as a function of altitude where low ratios are produced in the upper troposphere and in the stratosphere. Fig 4. panel A shows the annual cycle of ^{7}Be/^{22}Na ratio vs. ^{7}Be, panel B shows the monthly means of ^{7}Be and ^{22}Na. The ^{7}Be/^{22}Na ratio can serve as a complementary method to ^{10}Be/^{7}Be ratio as a tracer and as a radiochronometer.

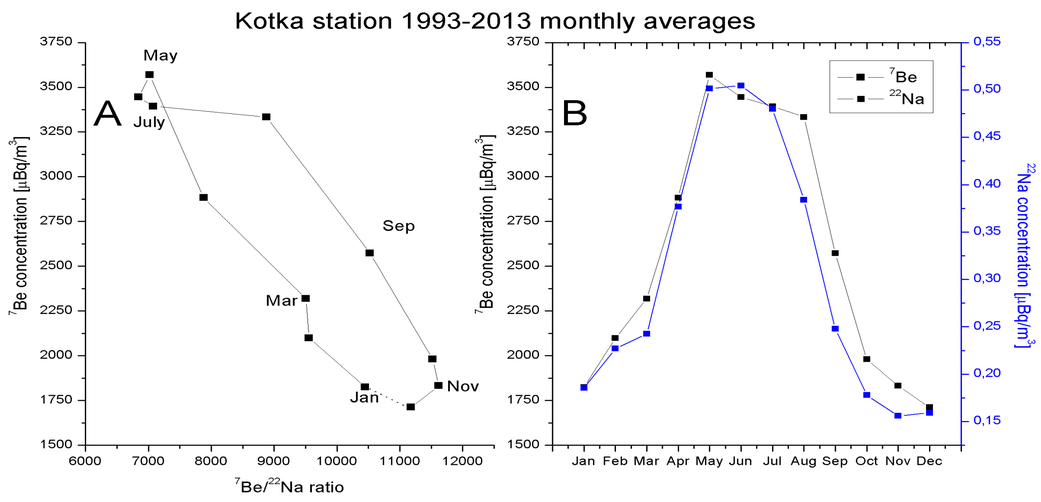


Fig 4. panel A: Annual cycle of ^{7}Be/^{22}Na vs. ^{7}Be, panel B: ^{7}Be and ^{22}Na monthly mean concentrations in surface air.

This poster is a summary of three separate articles. If you are interested in the more detailed analysis, please see

A.-P. Leppänen et al., J.Atm.Sol.-Terr.Phys.,72(13),1036-1043

A.-P. Leppänen et al., J.Atm.Sol.-Terr.Phys., 74, 164-180.

A.-P. Leppänen et al., J.Atm.Sol.-Terr.Phys. 97, 1-10.