Argon-37 variability in the low troposphere

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Introduction

Argon-37 is produced in the high troposphere by spallation of argon through $^{40}Ar(n,4n)^{37}Ar$ and by neutron capture, $^{36}Ar(n,\gamma)\ ^{37}Ar$. The resulting natural equilibrium concentration of Ar-37 in the mixed troposphere is about 0.5-1 mBq/m^3_{air}. This value may define the background level for the use of Ar-37 for search area reduction by means of atmospheric Ar-37 measurements in downwind direction of a potential test area in the course of an OSI.

Sampling Location

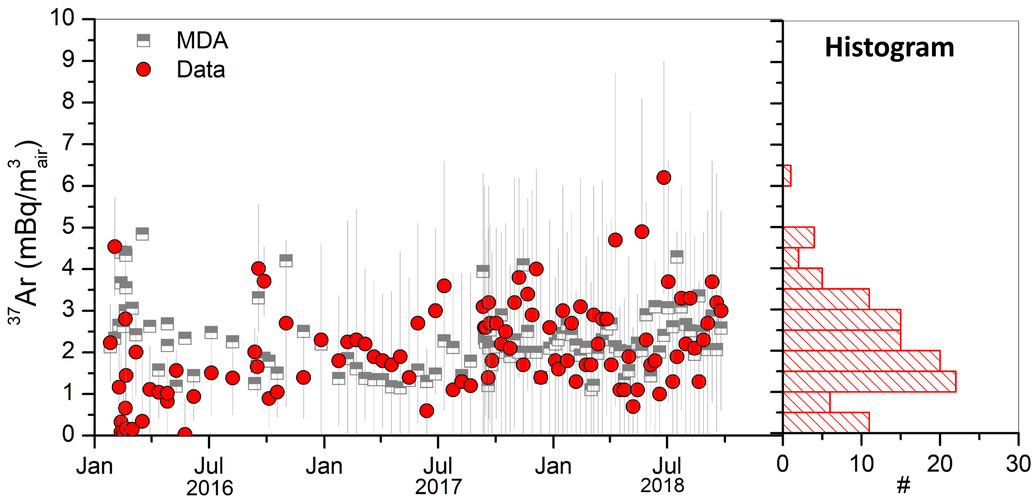
In order to investigate long term atmospheric activity levels of Ar-37, bulk air samples were collected close to the CTBTO IMS Radionuclide station located in Takasaki, Japan.

Methods

In the years 2016-2018 in total 105 samples were taken. Atmospheric air was collected within 30 min in 80 L Tedlar bags and shipped to the University of Bern. Determination of the Ar-37 activity concentration was carried out by Low Level Counting (LLC) in an underground laboratory.

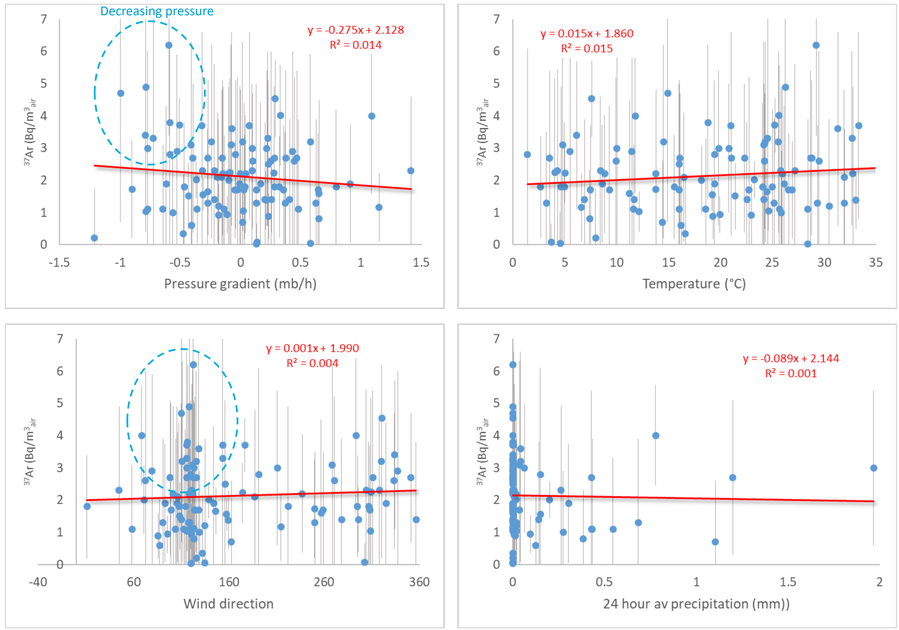
Results

Ar-37 value range between 1-7 mBq/m^3_{air}. MDA was between 1-5 mBq/m^3_{air} depending on sample size and shipping time. Within uncertainties most values agree with the expected natural background in the low troposphere.



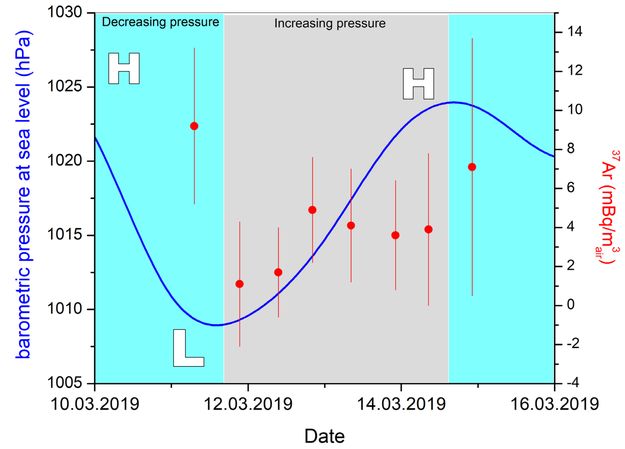
Correlations with Meteo Data (12 h running average)

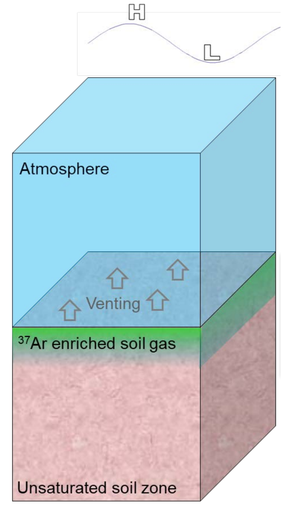
Highest values were observed during barometric lows and wind direction SE. No correlation with temperature and precipitation could be observed.



High Resolution Sampling in 2019

In March 2019 8 samples were collected within 4 days using an automated air sampler developed by CTBTO.





Soil Air Venting

In periods of decreasing barometric pressure Ar-37 enriched soil air with Ar-37 levels of up to 500 mBq/m^3_{air} may escape to the atmosphere.

This process is likely most relevant under conditions of thermal inversion.

Discussion and Conclusions

- Ar-37 values measured in atmospheric air at Takasaki over 3 years show no significantly elevated values above 10 mBq/m^3_{air}
- Slightly elevated values might be attributed to venting of soil air during barometric lows
- Contribution from nuclear facilities cannot be excluded based on the available data but are likely small.