Name of research institute or organization:

Bundesamt für Gesundheit; Sektion Umweltschutz, Bern

Title of project:

Aerosols radioactivity monitoring (RADAIR) and DIGITEL

Project leader and team:

Beuret Pierre, project leader
Dr. Sybille Estier, Matthias Müller

Project description:

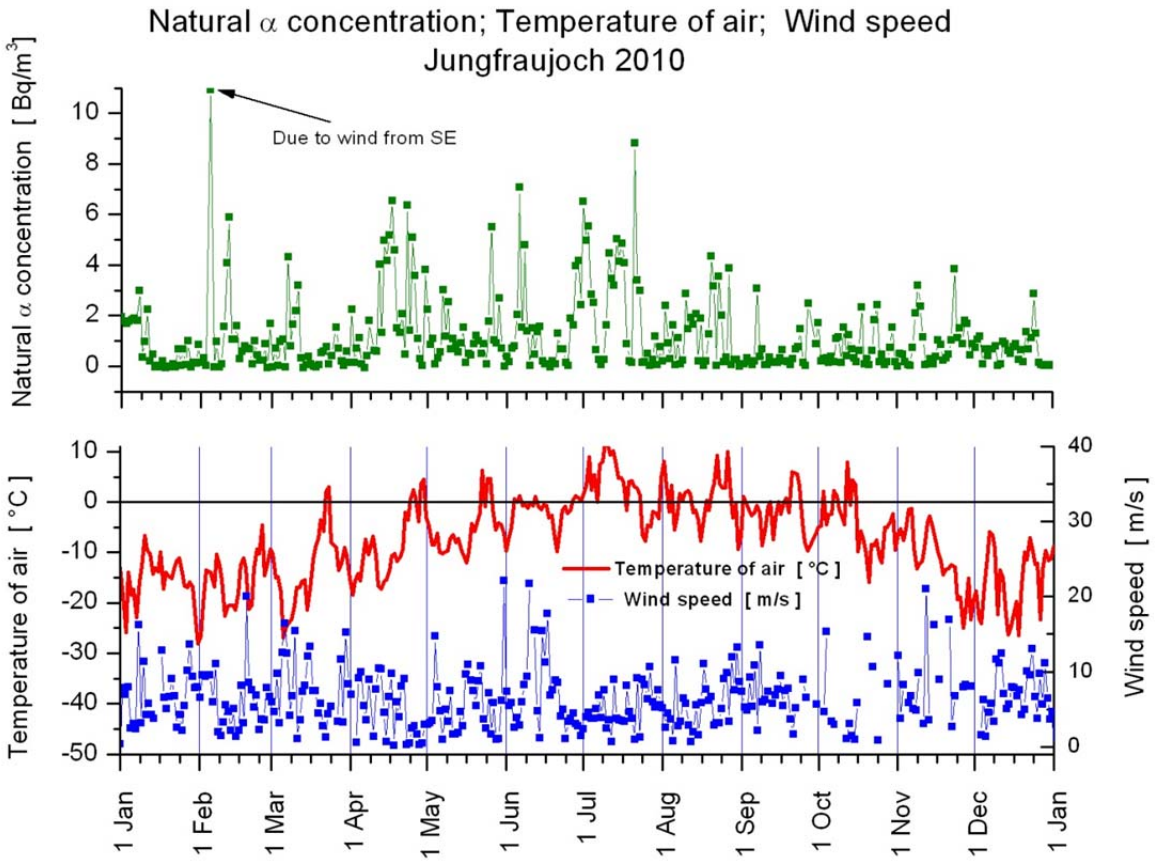
Aerosol Monitoring Station at the Jungfraujoch:
An automatic aerosol radioactivity monitor FHT59S is operated at Jungfraujoch research station by the Swiss Federal Office of Public Health. It has the following particular features:

- Quick detection of any increase of radioactivity in air at the altitude of 3400 m above sea level,
- A detection limit for artificial beta radioactivity as low as 0.1 Bq/m^3. Such a high sensitivity is made possible due to the very low Radon daughter concentration at this altitude.

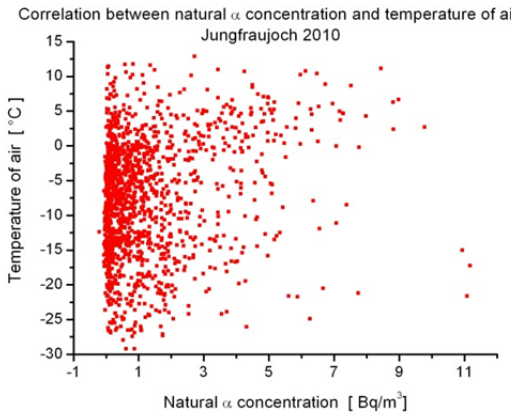
Comments on the measurement performed in 2010:
Graph 1, part a) shows the natural alpha radioactivity, the temperature of the external air and the speed of the wind during the period January 1, 2010 to December 31, 2010. The correlation between the natural alpha radioactivity and the temperature of the external air and the speed of the wind are depicted on graph 1, parts b) and c) respectively. These figures show that:

- Alpha radioactivity - Radon daughter products - is transported mainly up to the Jungfraujoch by air masses from the lowlands;
- The highest values are usually observed from April to August due to greater thermal air movement in summer than in winter (see Graph 1a and b);
- When the main winds blow strongly, the natural radioactivity decrease due to the dilution in the air (see Graph 1a and c);
- Graph 1d shows that the geographical distribution of the natural α concentration is strongly correlated with the two directions of the main winds.

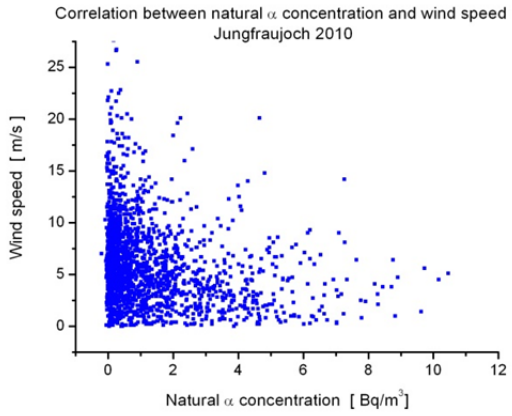
a)


Natural α concentration; Temperature of air; Wind speed
Jungfraujoch 2010
Natural α concentration [Bq/m3]
Due to wind from SE
Temperature of air [°C]
Wind speed [m/s]
Temperature of air [°C]
Wind speed [m/s]
1 Jan
1 Feb
1 Mar
1 Apr
1 May
1 Jun
1 Jul
1 Aug
1 Sep
1 Oct
1 Nov
1 Dec
1 Jan

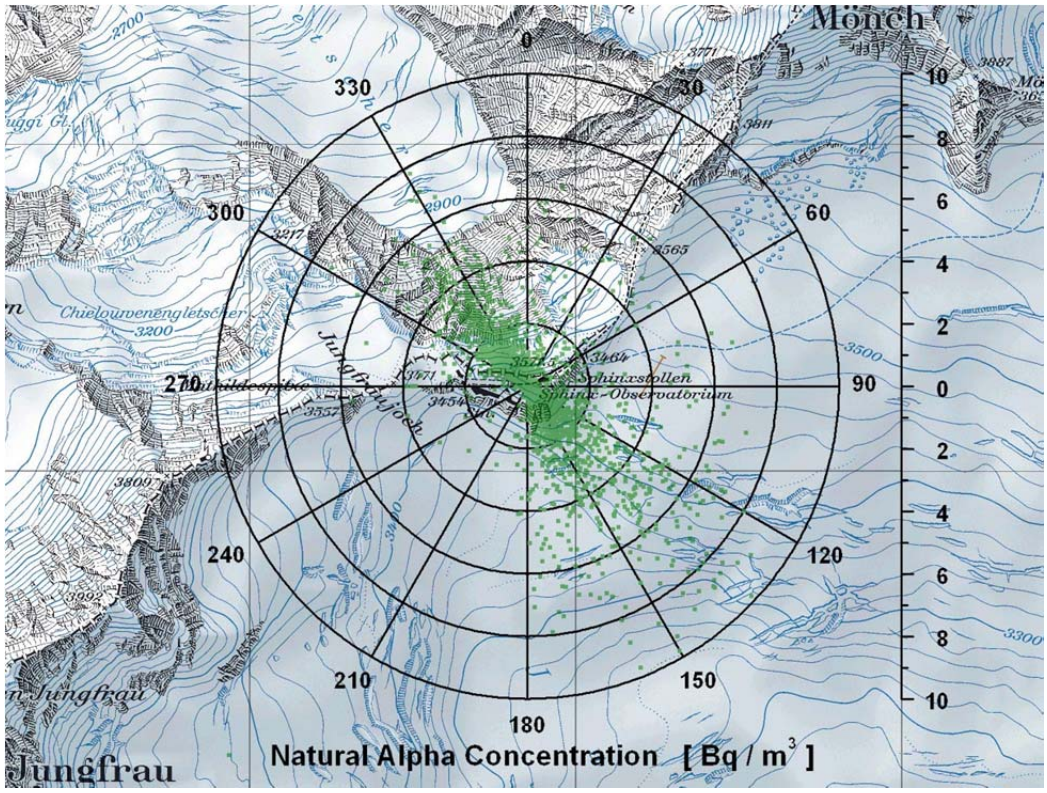
b)


Correlation between natural α concentration and temperature of air
Jungfraujoch 2010
Temperature of air [°C]
Natural α concentration [Bq/m3]

c)


Correlation between natural α concentration and wind speed
Jungfraujoch 2010
Wind speed [m/s]
Natural α concentration [Bq/m3]

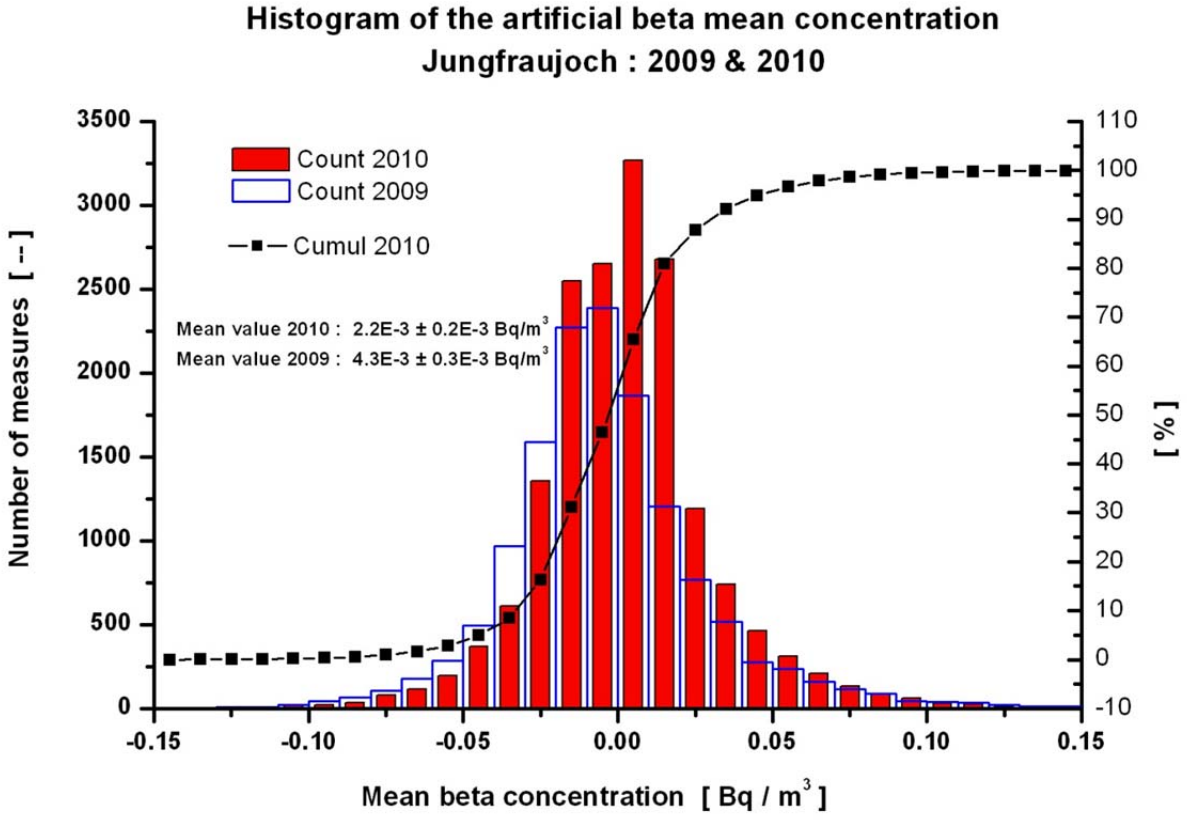
d) Geographical distribution of the natural α concentration



Graph 1

Graph 2 shows the net beta radioactivity in aerosol for 2010 (and 2009). Note that the net beta radioactivity concentrations cannot be measured directly and are calculated automatically by the monitor by applying an α/β-compensation technique (see below for more details).

- No artificial beta concentration above the detection limit was observed;
- As shown in the histogram below, some 95 percent of the beta concentrations recorded in 2010 were below 0.08 Bq/m^3.
- The histogram recorded for 2010 is rather symmetric; this shows that the automatic compensation technique was good. Note that even if the histogram recorded for 2009 is slightly less symmetric (for weak natural activities, the calculated beta radioactivity was slightly overcompensated) than the one recorded for 2010, the compensation technique can however be generally considered as adequate.
- When the alpha concentration decreases quickly, the compensation technique can't follow. Some values are therefore greater than 0.1 Bq/m^3.



Graph 2

For normal situations, i.e. with no artificial radioactivity in the air, the net Beta radioactivity at the Jungfraujoch, calculated using the Alpha-Beta compensation technique, is less than 0.1 Bq/m^3. At the top of Europe, a radiation incident causing an increase of the artificial beta radioactivity in the atmosphere of as low as 0.1 Bq/m^3 could therefore be detected.

Automatic α/β-compensation: this technique applied by our aerosol monitoring stations is based on the simultaneously measurements of gross Alpha (A_G) and gross Beta (B_G) radioactivity of the aerosols collected on a filter. The net (artificial) Beta radioactivity (B_N) is then calculated by the following formula: $B_N = B_G - f \times A_G$. The constant factor α/β (f) can be adapted either by the software program or by the operator. Note that since 2009, the post compensation was not applied any more; but the factor α/β (f) is periodically adjusted for each monitor.

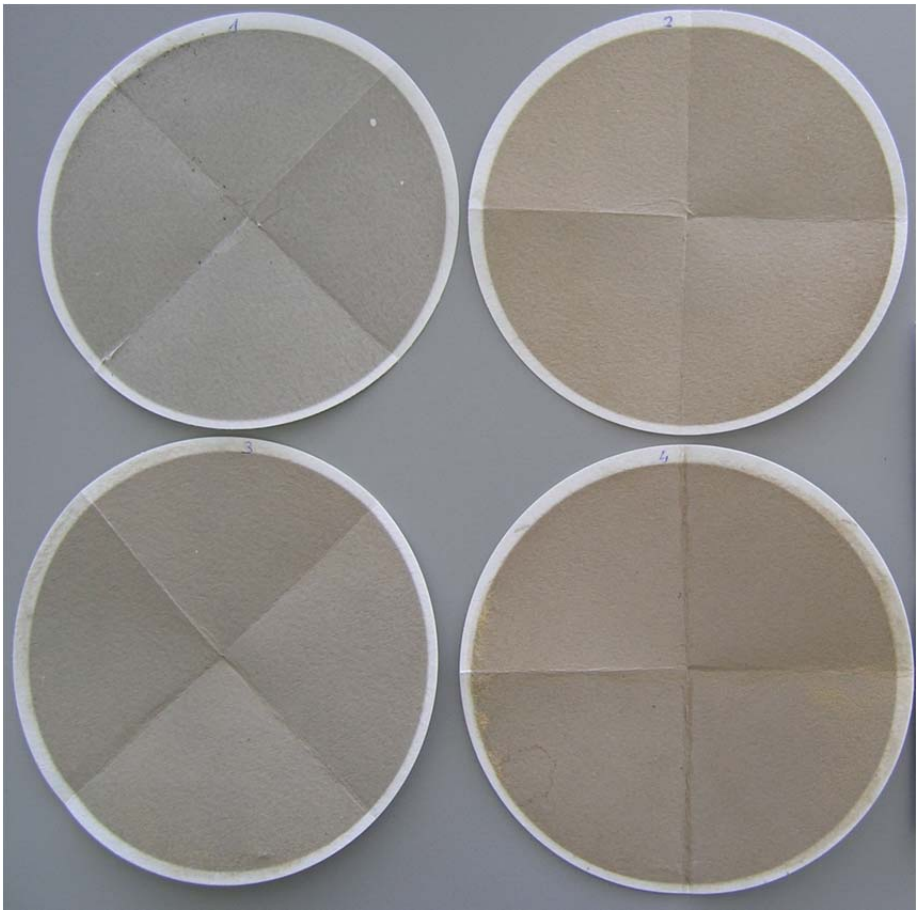
Comments on technical aspects:
With the new computer and the high speed line (ADSL) for faster data transmission, no major breakdown of the aerosol monitor was registered in 2010.

In order to avoid any power cut, the monitor was equipped with an Uninterruptible Power Supply.

DIGITEL - aerosol sampler

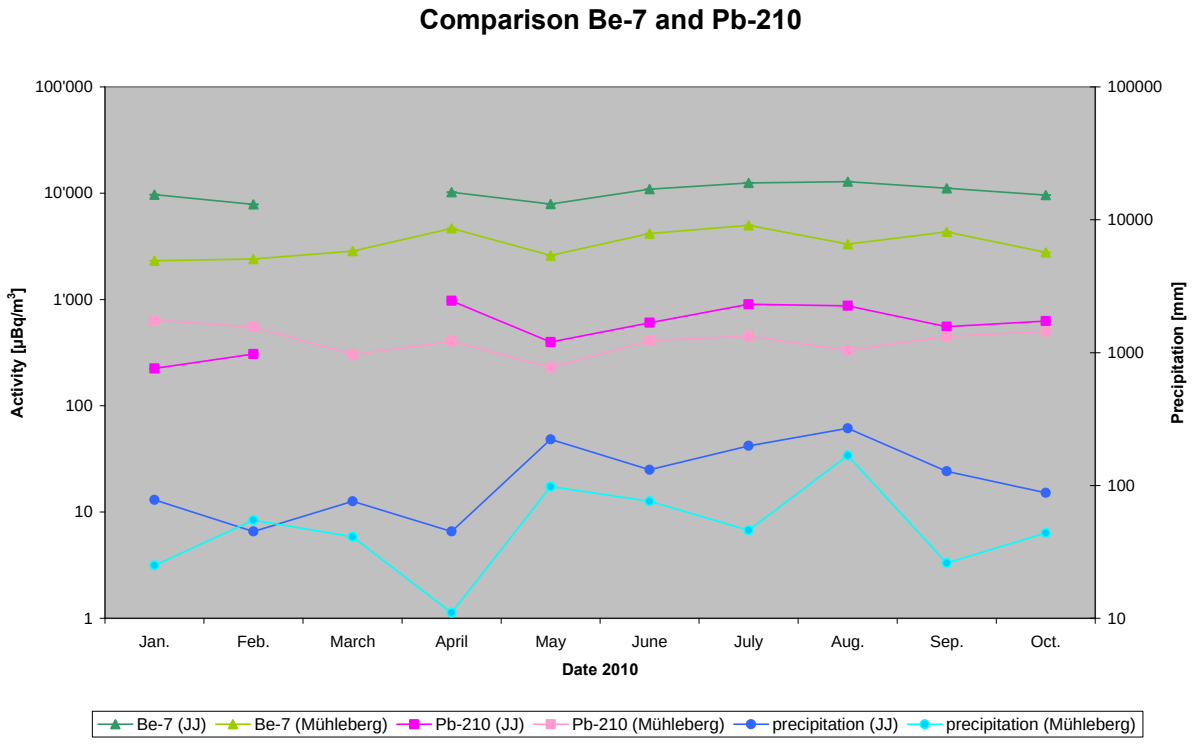
The Digitel DHA-80 High Volume Sampler is an automatic air sampler with a typical air flow rate of 0.6 m^3/min. Aerosols are collected on glass fibre filters of 150 mm in diameter. The pump maintains a constant flow rate independent of dust load on the filter. Filter change intervals are programmed in advance and the sampler is controlled remotely by an internet connection.

The filters are automatically changed once a week and are measured at the end of the month in the laboratory (URA-FOPH, Bern) using a high purity coaxial germanium gamma-ray detector for 1-2 days.



Digitel-filters after the weekly exposures at Junfraujoch

The graph below shows the activity of ^{7}Be and ^{210}Pb at Jungfraujoch ("JJ"; 3450 m AMSL) and Mühleberg (480 m AMSL).



The atmospheric concentrations of the cosmogenic radionuclide ^{7}Be are higher at Jungfraujoch, as, due to the half-live of 53 days and considering a mean residence times of 10-30 days in the troposphere, part of the nuclides decay before arriving at lower altitudes.

The other radioisotope shown in the above figure is ^{210}Pb a long-lived daughter of ^{222}Rn which emanates into the atmosphere from terrestrial sources. During summer convection brings ^{210}Pb to appreciable altitudes and the concentrations at Jungfraujoch are higher than at Mühleberg. In winter the prevalent occurrences of inversion situations often hinders the vertical mixing of radon-222 and its descendants. Consequently the ^{210}Pb concentrations are typically higher at Mühleberg than at Jungfraujoch over this period.

In 2010 the Digitel aerosol sampler had known two breakdowns, namely in March when the changer got jammed and in November due to a pump failure.

Key words:

RADAIR, Digitel, Radon, radioactivity, aerosols, radioisotope,

Internet data bases:

http://www.radair.ch
http://www.bag.admin.ch/themen/strahlung/00043/00065/02239/index.html?lang=de

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