Name of research institute or organization:

Departement Umweltwissenschaften, Universität Basel

Title of project:

Quantifying mountain venting of boundary layer air through Rn-222 measurements

Project leader and team:

Dr. Franz Conen, project leader
Mr. Lukas Zimmermann
Dr. Alastair Williams
Dr. Alan Griffiths
Dr. Scott Chambers

Project description:

Our atmospheric radon-222 (radon) monitoring at Jungfraujoch has two objectives. First, to learn more about mountain venting of boundary layer air and, second, to provide a direct measure for the influence of boundary layer air on the Jungfraujoch station. Latter is useful information for other projects investigating atmospheric constituents, such as greenhouse gases or aerosols. The first objective is currently pursued on the data set of 2010 and 2011 and a publication is in preparation. The second objective seems compromised since February 2013 by continued contamination of the sample air. This is evident in the severalfold increase, compared to the previous years, in the lowest 10 % of radon concentrations measured each month (Fig. 1).

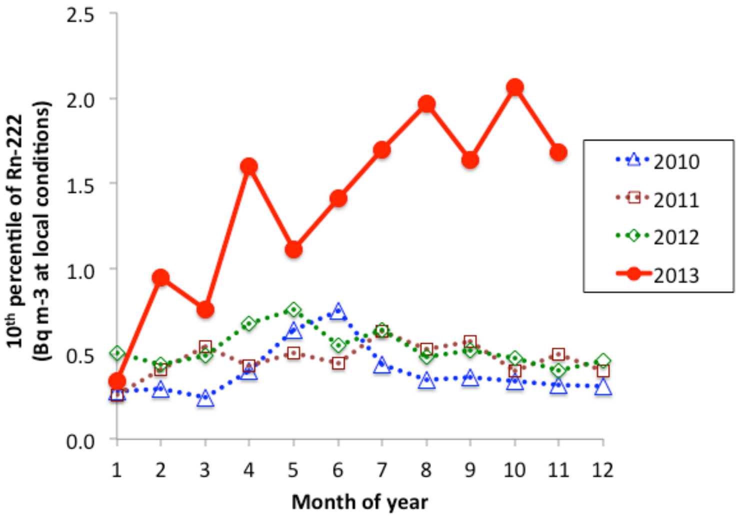

Figure 1. 10th percentile of monthly radon concentrations measured at Jungfraujoch during the past four years.

Our radon monitor is situated in the cavern at the south-eastern end of the research station. Before the research station was built, a cavity had been cut into the steep face of the rock. The cavity was somewhat larger than the building erected. This left at the south-eastern side of it a space between building and rock which was closed off to the outside with a brick wall, providing an additional room used for some time as a shelter for sheep and as a storage room. The cavern extends into a narrow (about 1 m wide) corridor running all the way between the research station and the rock and serving as an emergency escape route. Air sampled for radon analysis is aspired through a L-shaped metal tube (10 cm diameter) piercing through the brick wall, which closes off the cavern. The inlet branch about 0.3 m outside the wall points downwards to prevent precipitation from entering the inlet line. Below the air inlet there is a metal door which is usually closed. Brick wall, metal door and inlet anchoring are not 'gastight'. However, when we first installed the monitor at this location, and during regular maintenance visits, we found that air circulation in the tunnel system is such that there was a pressure deficit of about 5 Pa inside the cavern, compared to the outside atmosphere. Hence, air from the tunnel system (railway tunnel, train station, escape route behind the research station, etc.) did not pass through gaps in the brick wall, or between wall and door to contaminate the sample air. There was always a sensible draught of air entering from the outside through these small gaps. The building of a new visitors' tunnel and work on the storage room on the other side of the research station may have changed the previous circulation pattern. Since the beginning of this year, we see radon peaks which are most likely caused by radon-rich air from the tunnel network being pressed through gaps close to our air inlet. Most of the time, the pattern are too noisy to interpret because of changing wind directions, speeds, changing radon concentrations in the free atmosphere, etc. However, the first three days of March provide an interpretable example (Fig. 2). Weather conditions were calm, average wind speeds around 5 m s^{-1}, with clear sky throughout the entire period.

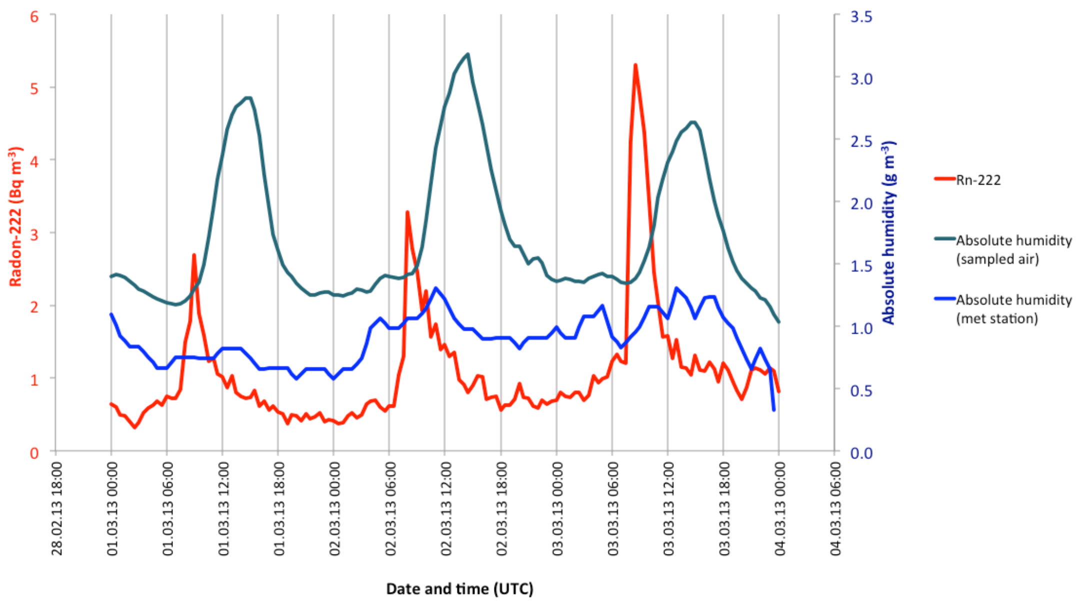

Figure 2. Diurnal pattern of radon concentrations and absolute humidity in the same stream of air sample (sampled air), which was most likely contaminated by air from inside the tunnel system. For comparison is shown the absolute humidity derived from a met station not influenced by vented tunnel air (based on services of MeteoSwiss). (Note: the offset between the absolute humidity values 'sample air' and 'met station' is probably due to an imprecision of relative humidity and temperature measurements in the sampled air. These parameters are recorded for instrumental diagnostics and are not well calibrated. However, this does not affect the overall pattern of absolute humidity derived from these measurements.)

The first train of the day enters at 08:10 hours (UTC + 1) the lower end of the extended tunnel system at Eigergletscher (2320 m). On its 40 minutes journey to the Jungfraujoch station (3454 m) it passes gates, which are closed all night and also between trains. These gates are in place to prevent the chimney effect to develop into strong winds inside the tunnel and in the underground train station and visitors area at Jungfraujoch. Overnight the gates are closed for 15 hours. During this time, radon will accumulate in the tunnel system. This radon-rich air may partially be vented through gaps near our air inlet and cause the peaks in radon concentrations observed when train traffic starts in the morning (Fig. 2). During the day, when several trains pass the gates every hour, the tunnels get vented and radon concentrations inside the tunnels decrease. The up to 5'000 visitors a day increase humidity in the tunnel system where they walk around to get to the attractions. The increase in absolute humidity observed in the sample air until early afternoon and the decrease towards the end of the visitor hours at 16:30 hours indicates continued contamination with air from the tunnel system. The absolute humidity determined from data at the Sphinx observatory (based on services of MeteoSwiss) is smaller and does not follow the same diurnal pattern (Fig. 2).

In June we had a close look at other possible reasons for sample air contamination, in particular at leaks in the inlet line. However, we did not identify anything that could possibly explain our observations this year. It is unfortunate that additional construction has changed the ventilation pattern and has led to a (probably) continued contamination of the sample air. Hence, we will either have to look for another location of the radon monitor, or at least extend the inlet line and relocate the air inlet.

Key words:

Atmospheric transport and mixing; planetary boundary layer; free troposphere; radon; tracer

Internet data bases:

http://umweltgeo.unibas.ch/
http://radon.unibas.ch/

Collaborating partners/networks:

Dr. Ernest Weingartner, Aerosol Physics Group, PSI, Villigen

Scientific publications and public outreach 2013:

Refereed journal articles and their internet access

Xia, Y., F. Conen, C. Alewell, Total bacterial number concentration in free tropospheric air above the Alps, Aerobiologia, **29**, 153-159, doi: 10.1007/s10453-012-9259-x, 2013.
http://link.springer.com/article/10.1007%2Fs10453-012-9259-x#page-1

Address:

Departement Umweltwissenschaften
Universität Basel
Bernoullistrasse 30
CH-4056 Basel

Contacts:

Franz Conen
Tel.: +41 61 267 0481
Fax: +41 61 267 0479
e-mail: franz.conen@unibas.ch
URL: http://umweltgeo.unibas.ch/team/personen-ugw/profil/person/conen/