Name of research institute or organization:

Departement Umweltwissenschaften, Universität Basel

Title of project:

Baseline characterisation of air masses using radon-222

Part of this programme:

ICOS

Project leader and team:

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

Project description:

The purpose of this project is to continuously monitor the influence of the planetary boundary layer on air masses at Jungfraujoch. It is achieved through high-precision measurements of radon, which is a direct indicator of recent land contact. Our radon measurements support the interpretation of other atmospheric observations at the station. Here we show an example of its usefulness in the context of our second project at Jungfraujoch, which is about ice nucleating particles (INPs) active at moderate supercooling (e.g. at -8 °C or warmer, INP_{-8}).

Previous studies have shown that rainfall events drive the aerosolisation of biological INPs from vegetated land surfaces into the first tens of metres of the planetary boundary layer (e.g. Conen et al., 2017; https://doi.org/10.5194/acp-17-11065-2017). However, it is at much greater height that biological INPs catalyse ice formation in clouds and trigger precipitation. A possible link between rainfall on vegetated land and the concentration of INPs at cloud height can be investigated at Jungfraujoch, but not by measuring INPs alone. An enhanced concentration of INPs at that height on a particular day can equally well result from a greater influence of boundary layer air.

Our observations so far show little correlation between INP_{-8} and radon for days not preceded by a day with substantial rainfall in larger parts of Switzerland (white dots in Figure 1). However, it looks like the upper bound of INP_{-8} on such days increases with the influence of boundary layer air (i.e. larger radon values). Ten days in our record were preceded by at least one day with abundant rainfall in larger parts of Switzerland (pink dots in Figure 1). On about half of these days INP_{-8} concentrations were above the upper bound of INP_{-8} concentrations observed on other days with similar boundary layer influence. Thanks to the combination of INP_{-8} measurements with radon data we can conclude that rainfall-driven increases of INP_{-8} concentration do sometimes extend to a height where INP_{-8} can affect moderately supercooled clouds.

Open access to daily updated data from this project is provided through our website (http://radon.unibas.ch/) since the beginning of the measurements. In addition, raw data is now also processed at the Laboratoire des Sciences du Climat et de l'Environnement, Gif sur Yvette, according to the same protocol as data from similar instruments within ICOS-RI and made available through this channel (https://www.icos-ri.eu/).

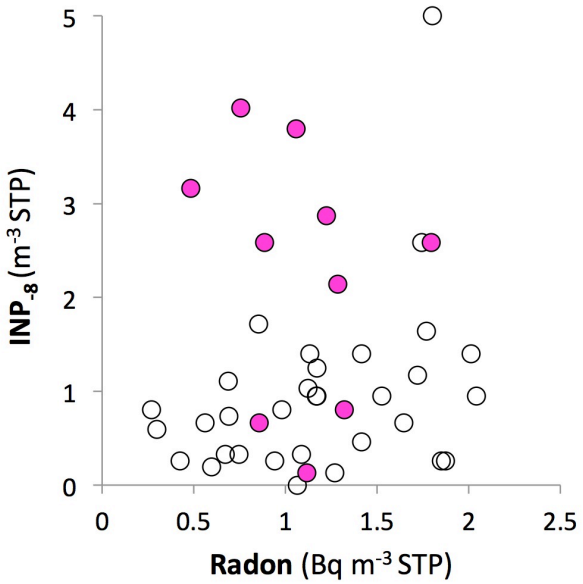

Figure 1. Concentration of INP_{-8} versus radon-222 (24-hour samples, starting midnight). Samples were collected at Jungfraujoch during two periods in spring and summer 2016 (21.05.-15.06. and 01.08.-21.08). Radon values are averages of fourty-eight 30-min counting intervals. INP_{-8} were determined on sections of quartz-fibre filters used to gravimetrically determine PM_{10} loads and were generously provided by NABEL (Empa/BAFU). Different colours indicate values observed on days either preceded (pink) or not preceded (white) by a day with substantial rainfall in larger parts of Switzerland. The allocation to either category was based on the text of the monthly climate reports of MeteoSwiss (http://www.meteoswiss.admin.ch/home/climate/present-day/climate-reports.html).

Key words:

Land influence, radon-222, tracer, application

Internet data bases:

http://radon.unibas.ch/
http://www.ansto.gov.au/ResearchHub/OurResearch/environmentresearch/Research/IsotopesinClimate/AtmosphericMixing/index.htm
http://www.gl.ethz.ch/research/bage/icos-ch/jungfraujoch.html

Collaborating partners/networks:

Australian Nuclear Science and Technology Organisation (ANSTO), Sydney Australia
Laboratory of Atmospheric Chemistry, Paul Scherrer Institute, Villigen, Switzerland
Laboratory for Air Pollution/Environmental Technology, Swiss Laboratories for Material Science and Technology (Empa), Dübendorf, Switzerland

Scientific publications and public outreach 2017:

Conference papers

Imhof, S., M. Steinbacher and F. Conen, Large-scale CO_2 flux estimated from CO_2 and ^{222}Rn measurements on Jungfraujoch, 15th Swiss Geoscience Meeting, Davos, Switzerland, November 17-18, Abstract booklet Session 12, 486, 2017.

Theses

Imhof, S., Abschätzung des schweizerischen CO_2 Flusses mit der Radon-Tracer-Methode anhand von gemessenen CO_2- und Radonkonzentrationen auf dem Jungfraujoch, BSc thesis, University of Basel, 2017.

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