Name of research institute or organization:

Bundesamt für Strahlenschutz, Freiburg i.Br.
Climate and Environmental Physics, University of Bern

Title of project:

^{85}Kr Activity Determination in Tropospheric Air

Project leader and team

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Project description:

Monitoring of tropospheric Kr-85 activity concentrations at Jungfraujoch (JFJ) continued in 2011. Krypton is separated from about 10 m^3 of air continuously collected during one week and sent to the Bundesamt für Strahlenschutz in Freiburg i.Br. for measuring the Kr-85 activity concentration.

The major sources of atmospheric Kr-85 are nuclear reprocessing plants that are characterized by a pulsed release behaviour. The resulting plumes can be detected at sampling stations located in downwind direction even at distances of a few hundred kilometres (spikes in Figure 1). Above the planetary boundary layer the amplitude and frequency of such spikes are reduced compared to stations at lower altitude (Figure 1). Due to a half life of 10.76 years Kr-85 accumulates in the atmosphere. Since the start of massive reprocessing it has created a baseline that is characterized by a continuous mean increase rate of about 0.03 Bq/m^3 per year during the past four decades. It has reached a maximal value of about 1.50 mBq/m³ at the stations located at mid northern latitudes (Figure 1, Inset). Recently a trend reversal has been observed and more Kr-85 of the atmospheric inventory decays than is released globally [1-3]. This implies that the world wide reprocessing activities are not increasing any longer as reflected by the release data of La Hague (Figure 1, red areas). At present the major emission source of Kr-85 into the atmosphere is the nuclear reprocessing plant in La Hague and most of the high values could be traced back to La Hague by atmospheric dispersion calculations. Additionally, the data show a high correlation between the measured Kr-85 activity concentrations at Jungfraujoch and even more pronounced at Freiburg and the published releases of the NRP La Hague (Figure 1).

During the nuclear disaster in Fukushima in 2011, among other mainly aerosol bounded radionuclides such as I-131, I-132, Cs-134 and Cs-137, large amounts of radioactive noble gases (mainly Xe-133, half life = 5.24 d) were released to the atmosphere and distributed over the whole Northern Hemisphere. These releases have not significantly affected the Kr-85 values measured in Freiburg and at Jungfraujoch (Figure 1). This is due to the lower source term of Kr-85 compared to Xe-133 and the high Kr-85 background in the atmosphere (see above). As a consequence the activity concentrations of Xe-133 as well as those of the aerosol bound radionuclides I-131, Cs-134 and Cs-137 measured with high volume samplers showed elevated values at

several trace analysis stations in Europe in the weeks after the accident. In addition, the gaseous compound of I-131 was observed at enhanced activity concentrations [4,5]. During the weeks after the Fukushima event the weekly samples collected at the Jungfraujoch were not only analysed for Kr-85 but also for Xe-133 activity concentrations (Figure 2).

The location of the Jungfraujoch sampling site is crucial because of its altitude. The data are representative for the northern tropospheric background level and are important for the assessment and quantification of environmental radioactivity and radiation exposure in Switzerland.

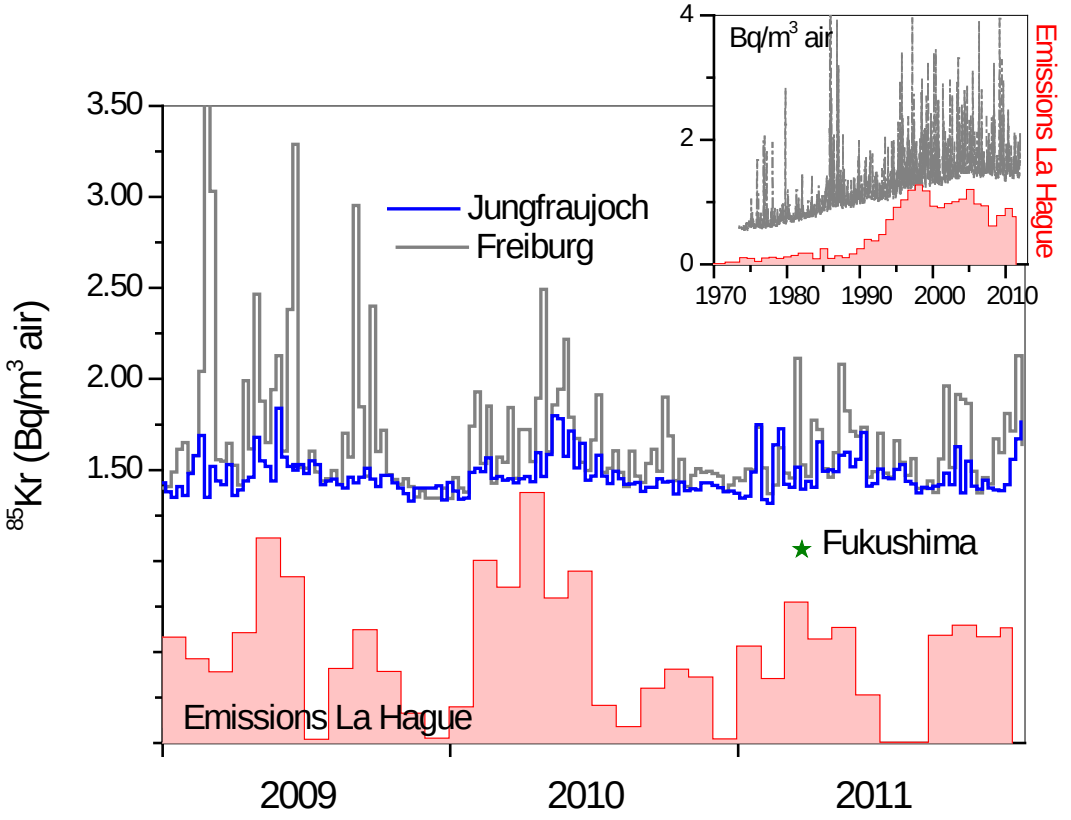

Figure 1. *Measured atmospheric ^{85}Kr activity concentrations in weekly air samples, collected at Jungfraujoch (3500 masl) and Freiburg i. Br. (280 masl), during the last three years. Inset: Values for Freiburg i. Br. over the last 35 years. The red columns represent the monthly emissions from La Hague in arbitrary units (the order of magnitude is 10^{16} Bq Kr-85 per month). The start date of the Fukushima disaster in March 2011 is indicated by the green star.*

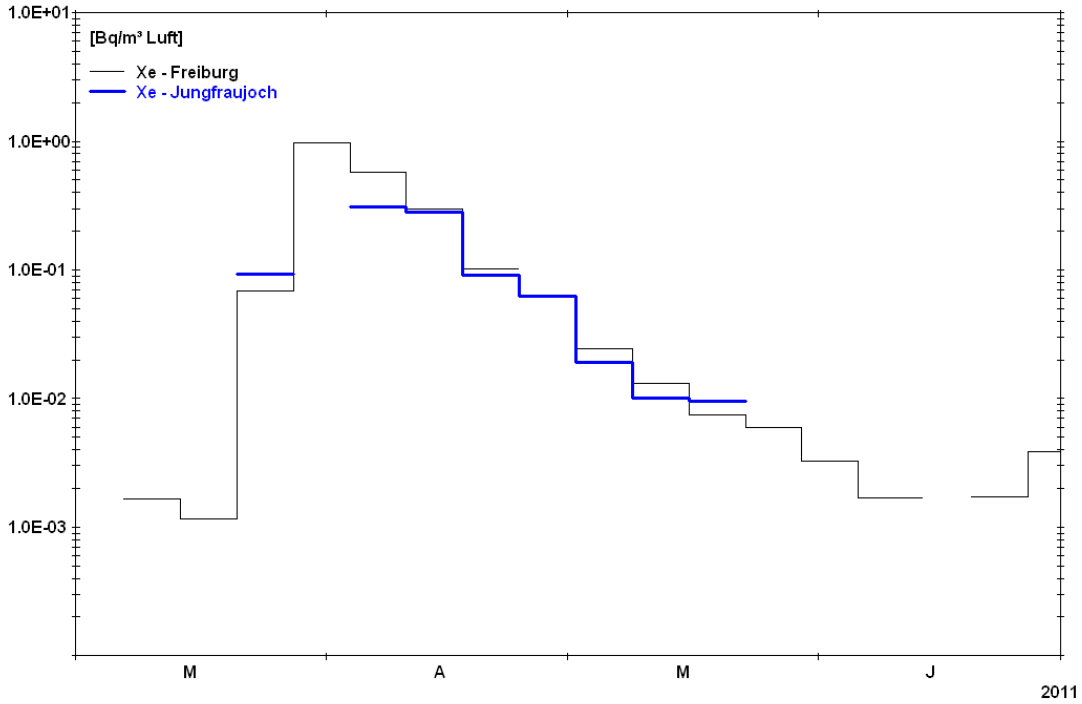

Figure 2. *The atmospheric activity concentration of Xe-133 in weekly samples collected at Jungfraujoch (3500 masl) and Freiburg i. Br. (280 masl), in March to June 2011. The "Fuksuhima peak" is clearly seen at both stations.*

Key words:

Krypton, ^{85}Kr, radioactivity in air, reprocessing plants

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Scientific publications and public outreach 2011:

[1] Umweltradioaktivität und Strahlendosen in der Schweiz, Bundesamt für Gesundheit, Abteilung Strahlenschutz, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011 (in preparation)

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