

# <sup>85</sup>Kr Activity Determination in Tropospheric Air

Andreas Bollhöfer<sup>1</sup>, Martina Konrad<sup>1</sup>, Sabine Schmid<sup>1</sup> and Roland Purtschert<sup>2</sup>

<sup>1</sup>Bundesamt für Strahlenschutz, D-79098 Freiburg, Germany

<sup>2</sup>Climate and Environmental Physics, Physics Institute and Oeschger Centre for Climate Change Research, University of Bern

abollhoefer@bfs.de

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## 1. Project description

Monitoring the tropospheric <sup>85</sup>Kr activity concentrations at Jungfraujoch (JFJ) has started in 1990 and was continued in 2022. Krypton is separated from about 10 m<sup>3</sup> of air continuously collected during one week and sent to the Bundesamt für Strahlenschutz (BfS) in Freiburg i. Br. to measure the <sup>85</sup>Kr activity concentration. Since 2014 the noble gas laboratory at BfS in Freiburg is accredited according to DIN EN ISO/IEC 17025 [1].

The major sources of atmospheric <sup>85</sup>Kr are nuclear reprocessing plants. During the last few decades, the most relevant emitter is the facility in La Hague in France, followed by the facility in Sellafield, UK. Due to its half-life of 10.74 years <sup>85</sup>Kr accumulates in the atmosphere if the release rate from all reprocessing activities exceeds the decay rate of the <sup>85</sup>Kr inventory in the atmosphere. Over the last ten years the baseline <sup>85</sup>Kr activity concentration was rather stable indicating a relatively stagnant global reprocessing capacity.

Krypton-85 emissions to the atmosphere from La Hague are characterized by pulsed releases. The released plumes can be detected at sampling stations located downwind even at distances of a few hundred kilometres (spikes in Figures 1a and b). Amplitude and frequency of activity concentration peaks at Freiburg but also at JFJ are generally highest during periods of high reprocessing activities in La Hague. Above the planetary boundary layer the strength and frequency of such spikes however are reduced compared to stations at lower altitudes. A statistical evaluation of

almost 30 years of <sup>85</sup>Kr data from the JFJ compared to data from Freiburg shows that above baseline <sup>85</sup>Kr activity concentrations are lower at JFJ and, on average, activity concentrations in winter are lower than in summer (the complete dataset is published in [1] and [2]).

The location of the JFJ sampling site for <sup>85</sup>Kr sampling is crucial because of its altitude. Krypton-85 activity concentrations are representative for the northern tropospheric background level and are important for the assessment and quantification of environmental radioactivity and radiation exposure in Germany and Switzerland [3,4].

## 2. Discussion of data collected in 2022

In 2022 the reprocessing activities and emissions from La Hague appear less variable over the year than e.g. in 2021 (Figure 1 a) but total annual emissions are similar. Highest emissions were reported in summer 2022 what is also reflected by the distinct peak measured in Freiburg i. Br. However, at JFJ only marginally elevated values are observed over the same period. This dampening of emission peaks at JFJ compared to Freiburg appears more pronounced than in previous years. Potentially, this could be attributed to a more stable planetary boundary layer during this period.

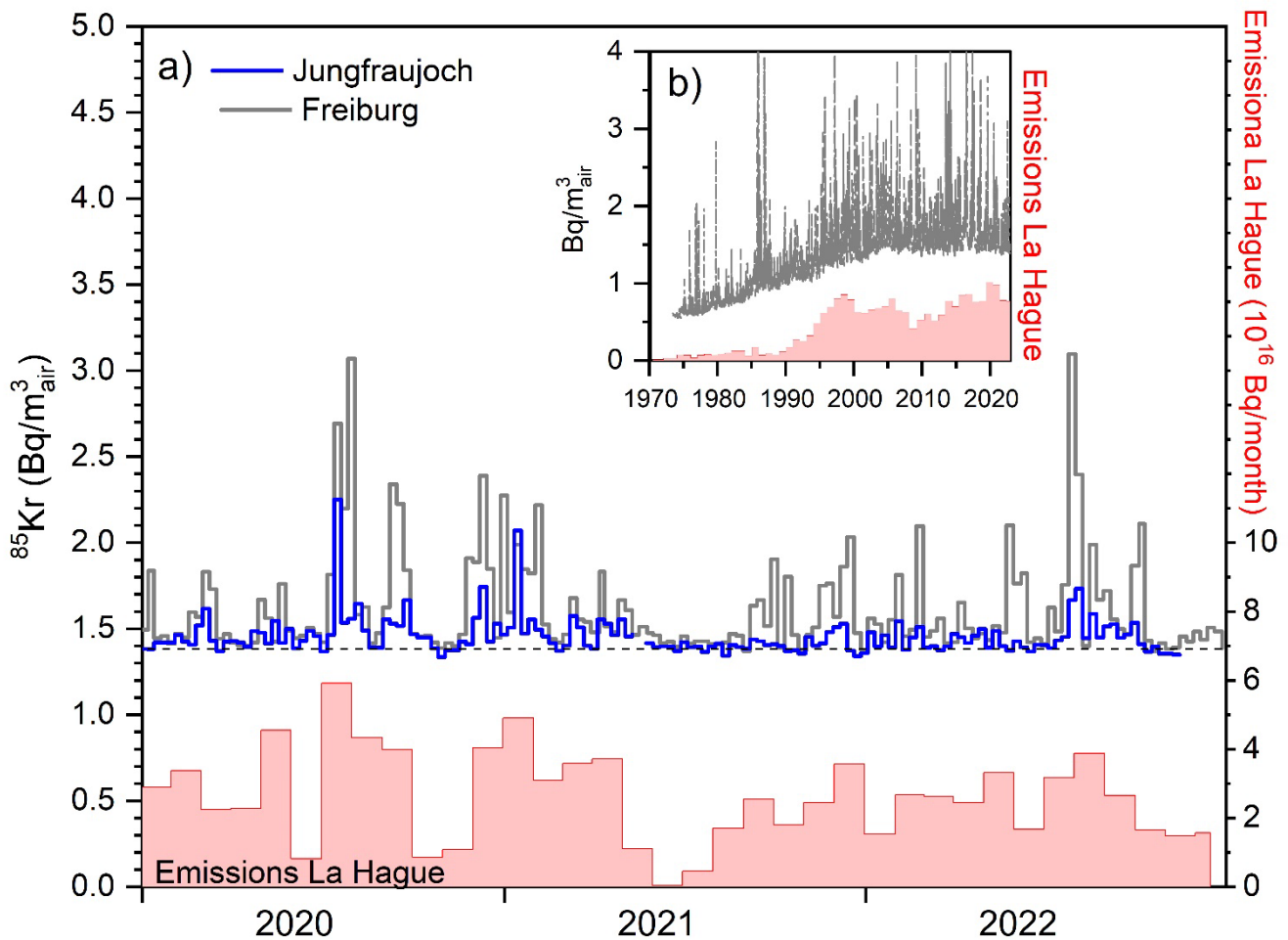


Figure 1. a) Measured atmospheric  $^{85}\text{Kr}$  activity concentrations in weekly air samples, collected at Jungfrauoch (3500 m asl) and Freiburg i. Br. (280 m asl), during the past three years. The red columns represent the monthly emissions from La Hague (data provided by ORANO, 2022). The dotted line represents a baseline activity concentration of approximately  $1.4 \text{ Bq/m}^3_{\text{air}}$ . b)  $^{85}\text{Kr}$  data for Freiburg i. Br. and the yearly emission from La Hague (in arbitrary units) over the last 50 years.

#### References

- [1] Bollhöfer, A., Schlosser, C., Schmid, S., Konrad, M., Purtschert, R. and Kraus, R. (2019) Half a century of Krypton-85 activity concentration measured in air over Central Europe: Trends and relevance for dating young groundwater. *Journal of Environmental Radioactivity* 205-206, 7-16.
- [2] Kersting, A., Schlosser, C., Schmid, S., Konrad, M., Bollhöfer, A., Barry, K., Suckow, A. (2020) Krypton-85 datasets of the northern and southern hemisphere collected over the past 60 years. *Data in Brief* 33, 106522, <https://doi.org/10.1016/j.dib.2020.106522>
- [3] Umweltradioaktivität und Strahlendosen in der Schweiz, Bundesamt für Gesundheit, Abteilung Strahlenschutz, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 (in preparation)
- [4] Umweltradioaktivität & Strahlenbelastung, Deutschland, Jahresberichte 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018-19, 2020, 2021, 2022 (in preparation); Reihe Umweltpolitik; Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit.

#### Internet data bases

<https://data.mendeley.com/datasets/p32bmw6rgs/1>

#### Address

Bundesamt für Strahlenschutz  
 Rosastr. 9  
 D-79098 Freiburg  
 Germany

#### Contacts

Dr. Andreas Bollhöfer  
 Tel.: +49 30 18333 6770  
 e-mail: [abollhoefer@bfs.de](mailto:abollhoefer@bfs.de)