

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

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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 2021. Krypton is separated from about 10 m<sup>3</sup> of air continuously collected during one week and sent to the Bundesamt für Strahlenschutz 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]. The data are also used for scientific studies on the dispersion and transport of air masses, e.g. the inter-hemispheric exchange [5]. The known temporal <sup>85</sup>Kr activity evolution in the atmosphere is the basis for dating groundwater on timescales of decades [1, 5, 6]

## 2. Discussion of data collected in 2021

In 2021 the reprocessing activities and emissions from La Hague show high values in the winter months and a distinct minimum in the summer, when the emissions decreased by over one order of magnitude (Figure 1 a). This pattern is mirrored in the measured values at JFJ and Freiburg i. B. In summer 2021 the values at both stations converged towards the current northern hemisphere baseline activity concentration of ~1.4 Bq/m<sup>3</sup><sub>air</sub>. The data may even indicate a slightly decreasing trend of the <sup>85</sup>Kr baseline what was already observed in 2020 (Figure 1b).

The increase of the emissions in late 2021 is much more visible in Freiburg i.B than at JFJ where the peaks are significantly dampened. This is in contrast to the situation in late summer 2020 when both stations show a similar pattern. Our observation reflects the more stable planetary boundary layer in winter inhibiting contaminant transport to higher altitudes. In the future and with regard to a changing climate the comparison of <sup>85</sup>Kr activity concentrations at both stations provide therefore some potential to investigate changes of the stability of the atmospheric air column in the Swiss Alps.

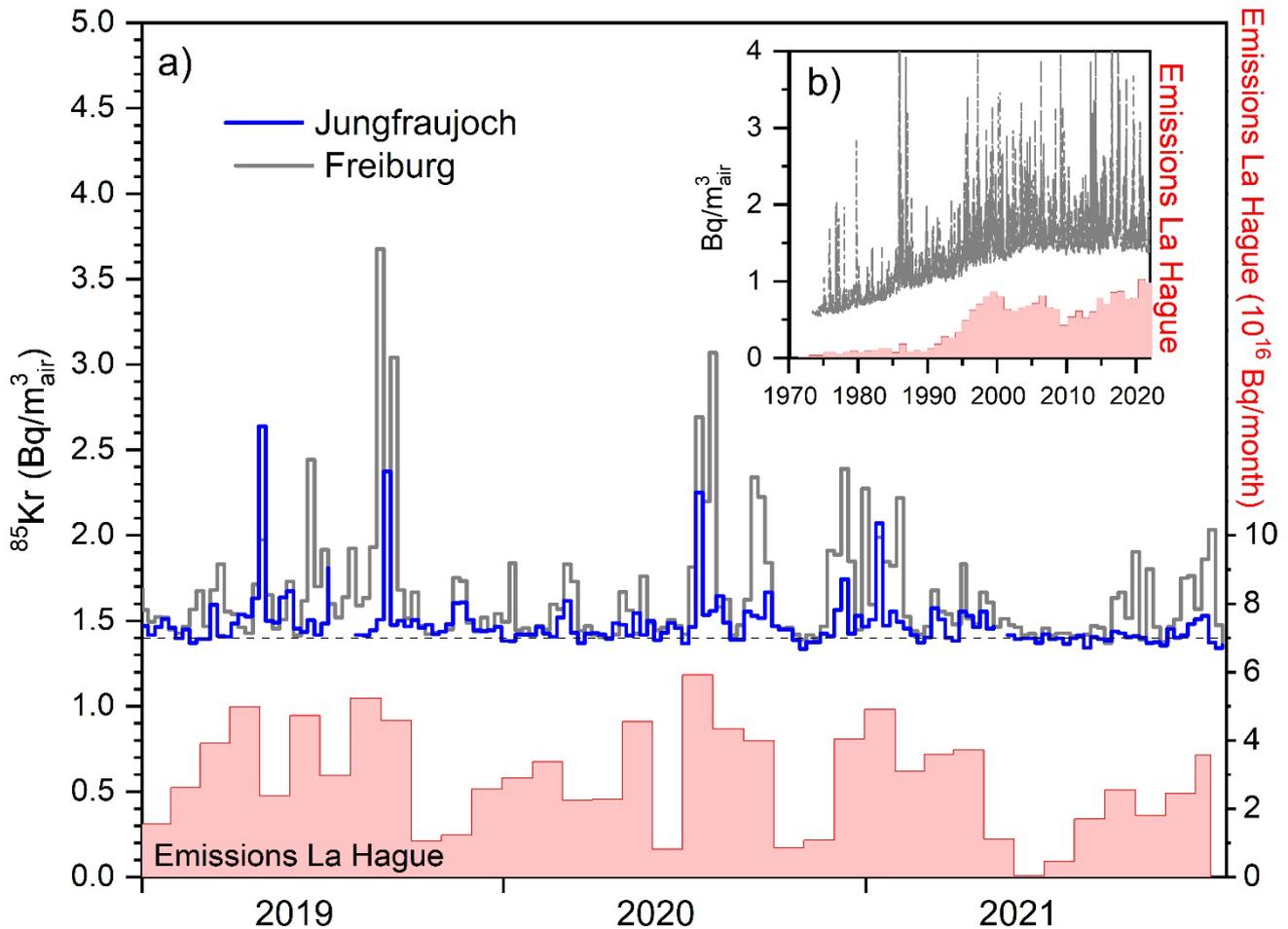


Figure 1. a) Measured atmospheric  $^{85}\text{Kr}$  activity concentrations in weekly air samples, collected at Jungfrauoch (3500 m asl) and Freiburg i. Br. (280 m asl), during the past three years. The red columns represent the monthly emissions from La Hague (data provided by ORANO, 2021). The dotted 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

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## Internet data bases

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

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