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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Surface-to-mountaintop transport characterised by radon observations at the Jungfraujoch" *by* A. D. Griffiths et al.

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We are grateful to the reviewer for their comments which have been used to improve the manuscript. Detailed responses are given below.

Response to specific comments

1. in Sect. 2.4.1 : the method is for anabatic mountain winds , how are non-anabatic winds recognized? Please clarify it and give more interpretation on Fig. 2

Non-anabatic winds are not directly measured by the method, but we can infer their presence. Our primary measurement is radon concentration, which we assume to be a reliable and quantitative tracer of land-surface influence. This is a robust assumption

based on many studies, some of which we cite in the introduction. Next, our method allows us to detect days which are likely to be influenced by anabatic winds – roughly speaking, we look for days which have a sinusoid-like diurnal cycle and call these 'anabatic days'. Although less robust than our previous assumption (that radon is a tracer of land influence) this assumption is still relatively reliable, based on our results and others. All days not classified as anabatic are, by our definition, 'non-anabatic', and sometimes have relatively high radon concentrations despite the absence of anabatic winds. Irrespective of classification, periods of low radon concentration mean that the air being sampled is most likely representative of unperturbed free tropospheric background values, whereas high radon concentrations on non-anabatic days likely correspond to periods where non-anabatic winds are important.

We now augment the present discussion of Fig. 3 with a discussion of this.

2. also in Sect. 2.4.1, a run with the steps 5 and 6 could loss an input set for a diurnal composite, which could lead to an inaccurate estimation and the higher radon level in the last period in Fig. 3.

Yes, this may well partly explain the result in Fig. 3. As the main use of the "anabatic radon" diagnostic was to identify a threshold (grey bar in the revised Fig. 3.) we are not so concerned with the behaviour of the anabatic radon diagnostic for the highest ranks, but we have mentioned this point at the end of Sect. 2.4.1.

3. Why are the diurnal changes in radon at Bern so high in Fig. 5? Which impact could the diurnal changes at Bern exert the estimations of anabatic winds?

As an inland site, Bern has land fetch for all wind directions, and radon emissions from the ground are roughly constant. As a result, the main driver of diurnal changes in near-surface radon concentrations is the boundary layer mixing depth, h. Radon increases at a rate $\sim 1/h$ during the night and then drops the next day during the period of boundary layer growth due to the entrainment of comparatively low radon

air from the residual layer or free atmosphere. The largest diurnal variations in radon concentrations are observed on days with the largest variation in mixing depth, which typically occur on clear-sky days in summer when daytime convection is strongest and nocturnal cooling the most rapid. Such conditions usually correspond to days with anabatic winds (e.g. days 1–50 in Fig. 5).

The large diurnal changes mean that it is not useful to define a representative radon concentration for "boundary-layer air". This is the main reason we have not normalised the Jungfraujoch radon concentration by some function, e.g. the daily minimum, of the Bern radon concentration. Instead, we use the Jungfraujoch radon concentration as a direct indicator of the land surface influence function (or footprint) which is equivalent to assuming that radon emissions are constant from land. With the recent improvement in radon emission estimates, it would make sense in a future study to take spatial and temporal variations into account.

A discussion of this appears in the revised Sect 3.1.

4. The Sects of 3.4 and 3.5 are a little beyond the topics of manuscript. Please shorten them.

Another reviewer suggested removing Sect 3.5. We have done so, leaving the question of aerosol scavenging to be dealt with in more detail in a future study.

The editorial corrections have been incorporated into the revised version.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 18083, 2014.