Dr. Rolf Weller

ALFRED-WEGENER-INSTITUTE
FOR POLAR- AND MARINE RESEARCH
Am Handelshafen 12
D-27570 BREMERHAVEN

☎ (xx471) 4831 - 1508
T-fax: (xx471) 4831 - 1425

email: rweller@awi-bremerhaven.de

18 February 2014

Copernicus Publications

Editorial Support

Manuscript Number: acp-2013-899
Title: "On the variability of atmospheric ^{222}Rn activity concentrations measured at Neumayer, coastal Anatrctica" by R. Weller et al.

Dear Natascha Töpfer,

Please find below our reply to the comments of the reviewers and how we revised our manuscript, including a list of relevant changes. I state that my co-authors concur with submission in its revised form.

Sincerely yours
-Rolf Weller

encls.

Interactive comment on "On the variability of atmospheric ^{222}Rn activity concentrations measured at Neumayer, coastal Antarctica" by R. Weller et al.

Responses to Interactive comment by Referee #1

First of all we thank the referee for his thorough review and his constructive comments and suggestions.

Reply to "Specific comment on the trajectory analysis"

We argue that the spatial and temporal resolution of the presented and discussed backward trajectory analyses are appropriate for our purpose. As stated in our manuscript the underlying meteorological data in high southern latitudes are relatively sparse and thus the accuracy of the calculated trajectories is much more a critical issue compared to the mid latitude northern hemisphere. Higher spatial (and temporal) resolution is thus barely supported by adequate meteorological data sets. This is especially true for the vertical development of a given air parcel trajectory.

Trajectory analyses refer to daily mean ^{222}Rn activity concentrations hence generally trajectories with an arrival time of 12:00 UTC at NM are shown. Additionally we tested 20 days backward trajectories for extremely high concentrations (listed in Fig. 4) for arrival times 00:00, 06:00, 12:00, and 18:00, but just two trajectories were associated with South America (17 Dec. 2003 18:00 starting close from the coast of Argentina at 40°S and for the 02 May 2002 00:00 crossing the tip of Terra Fuego). Note however, that even for the lowest ^{222}Rn activity concentrations one 10 days backward trajectory crossed South America (07 Dec. 2001). Consequently we feel that this kind of analysis is not much conclusive (even when neglecting the enormous spatial uncertainty of such long range transport simulations). At least, we could see no evidence that high ^{222}Rn concentrations at NM are typically associated with air mass transport from northern continents (i.e. especially South America).

Another point is the effect of dispersion. As noted by the referee, peak ^{222}Rn activity concentrations at NM are nearly two orders of magnitude lower compared to typical continental concentrations. Evidently, this is only partly caused by radioactive decay during long range transport. Considering uncertainties of air mass backward trajectory calculations and the effect of dispersion may show a stronger contribution from South America. Even though, we think that assigning NM ^{222}Rn peak activity concentrations in such cases to continental sources (with minor impact from marine emissions) would remain somewhat equivocal.

Finally we agree with referee #1, that the limitations of our backward trajectory approach should be stated more clearly. Respecting revisions are now included in chapter 2.3 and in the Conclusions.

1. [32818 L12] The abbreviation SIE should be defined again in the abstract, consider spelling out in full throughout

The abbreviation SIE is now defined in the Abstract.

2. [32819 L10] Replace "excel" with "exceed"

Corrected.

3. [32819 L13] Replace “On” with “on”

Corrected.

4. [32821 Sect. 2.2] What is the sampling height above ground level? Does it change significantly over the 17 years, e.g with snow accumulation?

Due to snow accumulation the observatory has to be typically jacked up every 2 years and hence the sampling height (inlet) varied between 6 m and 8 m above ground. This is now mentioned in Section 2.1, last sentence.

5. [32822 L21] Explain why a backtrajectory length of 10-days was chosen

We now explain this point in Section 2.3.

6. [32822 L24] Note the spatial and temporal resolution of the meteorological data

This information is now provided in Section 2.3.

7. [32823 L18] “a small fraction” - of what?

… where the vertical heat flux ceased to a small fraction of its surface value (sentence is now completed).

8. [32823 L21] Explain why it makes sense to compare Halley Station to Neumayer; consider including a small map showing all locations mentioned in the paper

Like NM, Halley is a site on the ice shelf with comparable flat surface topography. We include a map with the location of all measuring sites mentioned in the text (Fig.1).

9. [32825 L9] I found the paragraph beginning here to be confusing; perhaps it could be revised to improve clarity.

We clarified this paragraph in the revised version.

10. [32828 L10] The large difference between Dumont d’Urville and Mawson is no longer present with the more recent observations from Mawson (Zhang et al. 2011, Fig. 10)

Thanks for this important note which is now considered accordingly.

11. [32827 L25] Mention whether or not these other studies were from comparable locations

This point is clarified in the revised version.

12. [32833 L5] delete “with intend”

Corrected.

13. [32841 Fig. 4 - 7] Using the same scale on these maps would allow for easier comparison

The figures are roughly in the same scale, except Fig. 6b (now Fig. 7b). But for the latter the used zoom in is necessary to show the details.

Interactive comment on "On the variability of atmospheric ^{222}Rn activity concentrations measured at Neumayer, coastal Antarctica" by R. Weller et al.

Responses to Interactive comment by S. Tagushi

We thank Prof. Taguchi for his comments and in particular for his modelling effort based on our data. We are glad to hear that our ^{222}Rn measurements turn out to be valuable input data for his model. The synergetic potential of modelling and observation was an important motivation for us to establish continuous long-term observations of atmospheric tracers at this remote site.

Reply to specific questions raised by the referee:

1. Does the measurement have temporally suspension during harsh weather ? In Wellar et al. (2008), there is a description on the stopping of the pump when the wind exceed 20m/sec. (Section 2.1 Measurement site and meteorological conditions). Does this affect the Rn measurement?

During harsh weather conditions like blowing snow, only the aerosol sampling devices (high and low volume sampler) are stopped due to the risk of filter wetting by ice crystals, while the ^{222}Rn monitor was operated continuously. Hence we are confident that there is no "bad-weather" bias.

2. How did you evaluate 'local impact' such as the effect of emissions of nunataks around Neumayer? The stations below where photos of them are available on Web may be located on or near nunataks. (1) Sanae/South Africa, 71deg40min25sec S, 2deg49min44sec W, (2) Troll/Norway, 72deg00min07sec S, 2deg32min02sec E, (3) Maitri/India, 70deg45min57sec S, 11deg44min09sec E, (4) Svea/Sweeden, 74deg35sec S, 11deg13min W.

^{222}Rn exhalation from Nunataks (or bare soil areas) constitutes an utterly minor contribution to the ^{222}Rn level at the Neumayer ice shelf station. The nearest two Nunataks are located more than 200 km away, each presenting a rather solid rock peak with very little gravel exposed to the atmosphere.

3. In my simulation, significant contributions from South American continent are predicted at some time. Top five examples are (1) 1995.APR.19 431 mBq/SCM (21.75) (2) 1999.AUG.22 215 mBq/SCM (15.00) (3) 2004.JUN.03 154 mBq/SCM (19.72) (4) 2000.FEB.08 140 mBq/SCM (23.89) (5) 2003.SEP.29 126 mBq/SCM (14.04) Observed concentrations at these days are listed in parenthesis. Did you have any special operation on these days ?

We are not sharing the referee's strong confidence in the model-predicted daily ^{222}Rn activity at NM. Nevertheless, we are not aware of any special operational conditions for the days mentioned above.

4. p32827, line22 fact that 222Rn levels at NM were comparable to the rocky site DDU cast into doubt a significant contributions from ice free regions. Could you suggest any specific reason for your doubt ?

The model results presented in Figs. 1 and 2 of the review are an interesting supplement to our observations! Unfortunately, the NM data from the year considered here (1995) are somewhat less

suitable due the data gaps especially through January, early February and early April. To set the record straight concerning the comparison between NM and DDU discussed in our manuscript: We refer to ice-free regions in Antarctica and we argue (see point 2 above) that their impact is most likely negligible for NM. If such sources would be of relevance, ^{222}Rn activity concentrations at DDU should be considerably higher compared to NM, at least during summer when generally there are comparably large areas of exposed rocky ground in the surroundings of DDU.

List of relevant changes

1**.** Limitations of our backward trajectory approach are stated more clearly. Respecting revisions are included in chapter 2.3 and in the Conclusions.

2. We include a map with the location of all measuring sites mentioned in the text (Fig.1).