

## ***Interactive comment on “Characteristics of water-vapour inversions observed over the Arctic by Atmospheric Infrared Sounder (AIRS) and radiosondes” by A. Devasthale et al.***

**Anonymous Referee #1**

Received and published: 5 July 2011

This paper uses AIRS retrievals of water vapour profiles over the Arctic from 2002 to 2010 to characterize water vapour inversions under clear sky conditions. The results are validated with radiosondes from Barrow and SHEBA. It provides a spatial distribution by season of water vapour inversion properties, such as frequency, strength and height, giving a useful climatology. The results should prove useful for modelers wishing to validate their models in the Arctic. It is a sound and well written paper but the authors should address the following questions and comments.

It would be useful to have some discussion about the relationship between temperature and water vapour inversions. To first order one might expect a close correspon-

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dence, particularly in the winter when strong surface based temperature inversions are present. Differences between the temperature and water vapour inversion structures would be a measure of the vertical variation in the relative humidity which may have useful dynamical implications. Since the AIRS retrievals also includes the vertical variation of temperature why did the authors not try to do this comparison? It strikes me that a great value can be added to this paper with relatively little additional work. I would argue that differences in the temperature and water vapour inversions are a more physically powerful constraint for model to validate against instead of the solely water vapour inversion statistics presented here.

Page 15804. Lines 14-18. There are some confusing statements here. Higher water vapour aloft does not imply a downward transport. Subsidence or turbulence may achieve this but it is not necessary. Also connecting higher water vapour aloft to “very” high relative humidity in the lowest troposphere is not a generally valid remark. This section needs to be removed or rewritten.

Page 15808, Line 18. What is meant by “accurate” estimates of WV MRs? Please quote the accepted error limits for AIRS retrievals of water vapour.

Page 15806, Line 9. Please state numerically what the “coarse” resolution is.

Page 15809, Line 23. What grounds or references do you have to back up the claim of homogeneity of water vapour over the Arctic Ocean?

Page 15810, Line 18. I assume you mean “negatively” skewed. Please add this.

Figures 1 and 3. Explain the source of the ring artifact in the inversion strength around the North Pole during the non-summer months. If there are sampling issues then this area should be greyed out.

Figure 3. I assume the noise in the summer months is related to the cloud frequency and poorer statistics. Please explain this.

Figures 6 and 7 are missing a colour scale. Please add one.

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Figure 8 is too small and the lines are not visible. Please replace with a larger version.

I am not convinced that Figures 8a and b has much significance. How do you avoid allowing noise to be counted as an inversion? I think this might be a useful metric of the degree of vertical structure in water vapour but you need to establish a good criterion of when an inversion is deemed real versus an artifact due to measurement noise and uncertainty.

Page 15812, Line 28. WWMR should be WVMR.

Page 15814, Lines 15-17. I am not quite sure what you did here. How do you define the inversion base? Is the base usually the ground? Is the base often above a lower inversion? Wouldn't it be best to always use the ground as the base?

Page 15816, Line 6-7. Although summer inversions are the strongest they are also the least frequent. You mention the frequency in the first conclusion but perhaps these statements should be combined in some way.

Page 15816, Lines 20-25. To properly appreciate the role of partial precipitable water from inversions to the total precipitable water it would be useful to know what the vertical extent of the inversion is. In other words that is the average difference between  $z_1$  and  $z_2$  in Equation 1. This statistic might be more useful than the rather confusing Figure 9.

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 15801, 2011.