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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of Total Water Vapour in the Arctic Using Microwave Humidity Sounders" *by* Raul Cristian Scarlat et al.

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We want to thank the anonymous referee for their work. We appreciate the direct and specific comments which address incomplete or unclear formulations on our part. Hopefully the answers below can address the referee's concerns and, after integration into a revised version of the manuscript can be accepted as satisfactory.

General comments

"1) It was not clear that Fig. 5 was not actually a pixel count of the bottom panels on Fig 4, which according to the caption is just an example from 1 day. I think Figs 4 and 5 should be comparable. Perhaps keep the contents of Fig. 4 (the example is nice) and add additional panels for the "new" and "original" algorithms where instead of TWV, the

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pixels show the frequency of time that a retrieval is possible (perhaps for both January and July 2007-2009). This will provide the spatial context for Fig. 5."

This is a good suggestion. Figure 5 was supposed to show the difference in coverage area as a pixel count between the original and the new method for the whole temporal range we used (2007-2009). We will change Figure 4 to include the panels as you describe.

"2) You have not explained the domain over which you counted the pixels shown in Fig. 5. I'm assuming that this is the same as was plotted in Fig. 4 (âĹij north of 50âŮęN) and if so it includes large regions of the north Atlantic and Pacific. It is likely then that a large number of newly-retrievable pixels are found outside the Arctic, which artificially inflates the percent increases reported in Section 3.1. Are you recommending that your method be applied in the north Atlantic and north Pacific too? If I understand correctly, the new algorithm is actually fairly limited in the more southerly parts of the map when averaged over time and these limitations are apparent also in Fig. 4. In addition to quantifying the improvement in coverage from the new algorithm, it would be interesting to know how close to total coverage is represented by the new algorithm. I recommend carefully defining the domain over which you recommend that algorithm be applied, explain this, and then use this domain to calculate all the results in Section 3."

Both the original and the New method are only limited in their coverage by the water vapor content of the atmosphere. We apply them over the entire northern hemisphere at latitudes above 50 N, because the average atmospheric water vapor content at these latitudes is usually low enough for the methods to function. We will change the wording in the manuscript to reflect that the domain covers the entire polar region above 50 N, including the land masses of North America, Greenland and the northern regions of the Pacific and Atlantic Oceans.

"3) I am confused about how to interpret the validation of the retrievals in comparison

to the ECMWF data. This is for two main reasons: (3a) The ECMWF data are highly dependent on the model, especially at high latitudes, and are thus normally the type of data that is being validated. Therefore, it seems odd to conclude that the retrieval with the smallest systematic difference compared to ECMWF is the best retrieval. This is further confused by the fact that the ECMWF product likely assimilated the same/or similar data to that used in the retrievals. I realize you need a benchmark for comparison, so perhaps this can be resolved by tweaking the wording. What can you conclude through such a comparison?"

We agree that this comparison does not represent a validation because ECMWF is not an independent source for TWV data. We will change the wording to reflect that the testing done represents a comparison and not a validation effort for the presented methods. In this context the results show how well do the methods match with the benchmark of ECMWF TWV data which is often used in literature. The conclusion is that the Neural Network is the method that is closest to the model data when considering only the open water regions. Even though the AMSU-B method is not as close to the benchmark ECMWF data over open water, it is the only method that can also work over sea ice and land.

"(3b) AMSU-B new and AMSU-B orig are valid over different spatial areas and I assume the same is true for NN and RSS AMSR-E. I don't see where it is explained what spatial areas are averaged for the ECMWF data, but I know that it cannot apply to all four satellite algorithms at the same time. Therefore, it is not possible to isolate systematic differences in retrievals (which is interesting) to biases tied to spatial gaps (which was already established earlier in the section)"

For the inter-comparison in Figure 8 and Figure 9 top, we used the largest common domain for all three methods and collocated ECMWF data for this area. In essence the comparison for all methods against ECMWF is made over the ice-free open ocean where the RSS and Neural Network methods can work. This is why in the bottom panel of Figure 9 only the New AMSU-B retrieval mean value is compared to collo-

cated ECMWF data because only this retrieval method and the model have valid data over all surface types (ocean, sea ice, land). Wherever the AMSR-E methods are discussed together with the AMSU-B retrievals the domain is the ice-free ocean. When the AMSU-B Original and New are compared to each other or to ECMWF, the domain is the entire Northern Hemisphere above 50N. The language in the revised version will clarify this aspect.

Specific comments:

"Section 2.8: What data set do you use to find the sea ice concentration?"

We used the ARTIST Sea Ice (ASI) algorithm which provides daily high resolution (6.25km) sea ice concentration data. The AMSU-B New TWV retrieval routine checks the ASI value for each pixel before deciding which module to use. We will add this information to the revised manuscript.

"P17L5-13: You have addressed the emissivity difference between 183 and 150 GHz for the ocean component. Why not also develop an analogous correction for the sea ice so that this bias is corrected across the whole Arctic domain?"

For the ocean surface there are reliable forward models which can be used to calculate the upward microwave emissivity, for example the RTTOV model which was used in this manuscript. Applying the same correction technique for sea ice would be difficult because the corresponding forward models for sea ice emissivity are not as mature as the open ocean models. Also, the nature of the variables required for parametrizing the sea ice microwave emissivity present an obstacle by themselves. Snow cover, sea ice type, snow water content are all parameters which are still difficult to obtain at our current level of development.

"P4L22: “This assumption is false when switching” to “This is a poor assumption when using”. The sentence is a bit odd anyway. Do you mean that the 183 triplet is used with 150 up to 2 kg/m2 after which one of the 183 bands is saturated and uncertainty

increases?"

Yes, this is what we meant to express. We will edit that sentence accordingly.

"P16L16: You mean for the channels used for retrievals in the mid-range of TWV?"

Yes, mid-TWV refers to the channel selection that can retrieve in the range of 2-6 kg/mˆ2 which is the mid-range for the complete 0 to 14kg/mˆ2 of the method. The references to all modules and corresponding TWV ranges will be clarified by using one unitary naming convention (X – extended range, M – mid-range, L – low TWV range) and a table that shows which modules and parameters correspond to which range of retrievable TWV values.

We agree with all your other comments and we will implement them as is in the revised version of the manuscript.

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