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Atmospheric Measurement Techniques
Discussions

Interactive comment on "The Passive microwave Neural network Precipitation Retrieval (PNPR) algorithm for AMSU/MHS observations: description and application to European case studies" *by* P. Sanò et al.

P. Sanò et al.

paolo.sano@artov.isac.cnr.it

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We would like to thank Referee#2 for his/her review of our paper and the important comments and suggestions provided. Please, find below our responses to the Referee's comments and the details on how we will address them in the new version of the manuscript.

1. Page 9352, Line 22: I suggest replacing the phrase "with some uncertainties" with "increased uncertainties". I believe that stating "with some uncertainties" implies other

categories are associated with extremely low or no uncertainties, and this representation seems unrealistic.

Authors' Reply: The suggestion is accepted and the change will be performed in the revised manuscript.

2. Page 9352, Line 22: The authors write "In this paper, examples of good agreement of precipitation: : :". I urge the authors to also show instances where the algorithm might not perform well. This information is as important as providing evidence of good algorithm performance. The authors mention larger uncertainties associated with light precipitation, but are there any other obvious systematic deficiencies with the PNPR?

Authors' Reply: We agree with the Referee, it is important to provide instances where the algorithm might not perform well. In addition to the uncertainties associated with the retrieval of light precipitation, there are other deficiencies with the PNPR, and they are mentioned in different parts of the paper. In the definition of the Percentage Confidence Index (Section 2.3 "PNPR flow diagram description", pages 9368 and 9369), the criteria for the evaluation of the index (and therefore of the quality of the retrieval) highlight the most critical cases: in the very cold/dry environmental situations (Table 1), on snow/iced backgrounds (page 9369, lines 11-13), on coastal areas (page 9369, lines 13-14). Moreover there is a general tendency to underestimate the precipitation in correspondence of the pixels at the edge of the scan due to the larger IFOV and the consequent non-uniform beam filling effect (page 9369 lines 19-20). Also in the Summary and Conclusion (page 9380 lines 18-21) these critical cases in the retrieval of PNPR are mentioned. The first case study in Fig.7 shows an example with many deficiencies of the algorithm. In this case study we have found both false alarms (over northern Sardina and central Italy) and misses (over Calabria and northern East Italy) and an underestimation of the intense cells over the Liguria coast. In brief, this case study shows many of the deficiencies of the algorithm and how the Percentage Confidence Index can be used. However, the most critical cases happens in very cold and dry situations, in these conditions the algorithm gives no results and the PCI is

0. Nevertheless, according to the suggestion, we will underline those critical cases in the Conclusion section and a sentence will be added in the revised manuscript to be submitted. Revised version (Section 4 “Summary and conclusions” line 18, pag. 9380): Moreover, as highlighted by the low values the Percentage Confidence Index, other critical cases are represented by the very cold/dry environmental situations, the snow/iced backgrounds, and the coastal areas.

3. Page 9353, Line 5: Change “through” to “thorough” Authors’ Reply: The suggestion is accepted and the change will be performed in the revised manuscript.

4. Page 9354, Lines 25-29: It might be worth mentioning the polarization (H/V) information gained from conical scanning instruments versus the mixed polarization signal from the cross-track scanners.

Authors’ Reply: The suggestion is accepted. A sentence will be added, at the end of the paragraph, in the revised manuscript to be submitted. Revised version (Section 1 “Introduction”, line 28, pag. 9354) It is worth mentioning, however, that polarization (V/H) information from conical scanning instruments provides useful information for surface characterization, screening of not-precipitating area, and precipitation retrieval, which is not available from the mixed polarization signal of cross-track scanning radiometers.

5. Page 9355, Lines 9-14: While the scattering signal is correlated with surface precipitation, there are still large uncertainties related to the scattering signal due to unresolved microphysical issues. Recent publications (e.g" Skoronick-Jackson et al. (2013), Johnson et al. (2012), Kulie et al. (2010)) have highlighted this issue and the need to further understand how different combinations of microphysical features affects high-frequency brightness temperatures.

Authors’ Reply: We agree. A sentence will be added, at the end of the paragraph, in the revised manuscript to be submitted. Revised version (Section 1 “Introduction”, line 14, pag. 9355) However, there are large uncertainties related to the scattering signal

due to unresolved microphysical issues. Recent publications (e.g" Skoronick-Jackson et al. (2013), Johnson et al. (2012), Kulie et al. (2010)) have highlighted this issue and the need to further understand how different combinations of microphysical features affect high-frequency brightness temperatures. For this reason, the precipitation retrieval exploiting high frequencies is complicated by their sensitivity to the highly variable microphysical characteristics of iced hydrometeors (shape, size and density). This issue has of course a significant impact, on light rain and snowfall retrieval. In PNPR this issue is tackled through continuous improvements and refinement of the microphysical parameterization in the cloud-radiation database used in the training phase of the NN.

6. Page 9357, Lines 25-29: Is there any advantage employing a Bayesian approach for conical microwave imaging versus a neural network approach for cross-track sounders? Is the neural network approach better suited for multiple view angles, varying footprint sizes, etc. and other complicating factors associated with sounder data? This is a basic question that might be obvious to some, but not so clear for others. What is the basic reason behind the retrieval approach chosen for the two classes of microwave instruments?

Authors’ Reply: The use of a Bayesian approach for cross-track scanning radiometer measurements is problematic because of the changing view angle and footprint size across the scan, and the concomitantly changing atmospheric path, introducing view angle-dependent errors in the Radiative Transfer Equation Modeling System (RMS) calculations. This is unlikely the case for conical scanners where RMS-generated errors are consistent across the scan passage and thus easily detected as systematic errors when conducting validation checks. When view-angle dependent errors enter retrievals, they complicate how systematic error should be expressed and impose a reduced confidence in formulating Bayesian probabilities. It is this confidence issue that motivates a turn to a neural network approach when using cross-track scanner data (at the expense of moving away from a pure physics-based solution). Moreover, all the different viewing angles and footprint sizes need to be taken into account in the

RTM calculations and the size of the a-priori database used in the Bayesian approach becomes much larger than that used for a conical-scanning radiometer, and difficult to handle in the framework of quasi-real time applications. We also would like to point out (as done in the response to Reviewer 1) that in the Bayesian approach to optimize the efficiency of the retrieval a compromise between the processing time and the search radius is necessary, especially for near real time applications. In fact, the Bayesian approach requires processing all the database elements for each pixel. Alternatively the NN approach, using the database only in the training phase, provides an immediate response without requiring compromises between processing time and quality of the retrieval.

To clarify this point a sentence will be added to section 1 (Introduction) of the revised manuscript to be submitted. Revised version (Section 1 "Introduction", line 29, pag. 9357) The motivation for using a neural network algorithm for AMSU/MHS cross-track scanning radiometers stems from the geometry of radiometers measurements. These are less manageable for a Bayesian solver because the changing viewing angle across a scan passage, and the concomitantly changing atmospheric path, introduce viewing angle-dependent errors in the Radiative Transfer Equation Modeling System (RMS) calculations (see Mugnai et al. (2013b)).

7. Page 9360, Lines 4-5: The UW-NMS model reference seems dated. Are there any updates to the model since 1992? Any recent references that apply updated versions of this model? Readers might be concerned if the database is populated with this particular model versus other community models. But this issue can be resolved by including newer references where this model was applied more recently.

Authors' Reply: According to the suggestion, newer references will be included in the revised manuscript to be submitted. New references to be included in the revised manuscript: Tripoli, G. J. and Smith, E. A. Introducing Variable-Step Topography (VST) coordinates within dynamically constrained Nonhydrostatic Modeling Systems (NMW), part 1: VST formulation within NMS host model framework. Dynamics of Atmospheres

and Oceans, Volume 66, 2014, pp.28-57. Tripoli, G. J. and Smith, E. A. Introducing Variable-Step Topography (VST) coordinates within dynamically constrained Nonhydrostatic Modeling Systems (NMW), part 2: VST performance on orthodox obstacle flows. Dynamics of Atmospheres and Oceans, Volume 66, 2014, pp.10-27.

8. Section 2.2: The authors include a very detailed description of the NN approach used in this study. I originally thought the level of specificity was too great, but after reading the manuscript for the second time, I appreciate the level of detail provided. The main purpose of this paper was to introduce this retrieval algorithm, so I lean toward keeping the details provided in their current form. Authors' Reply: Thank you very much for the positive feedback.

9. Page 9364, Line 25: "constrain" should "constraint".

Authors' Reply: The suggestion is accepted and the change will be performed in the revised manuscript.

10. Page 9367, Line 13: Is the TB < 50K or TB > 400K frequently applied to reject observations? Or are these criteria rarely applied?

Authors' Reply: These criteria are frequently applied. The quality control (TB < 50K or TB > 400K) of input data to retrieval algorithms is currently performed in order to reject measurement errors (telemetry errors) that result in not-physical brightness temperatures. It often happens that along the scan pixels are associated with unrealistic TBs, leading sometimes to the need to remove the entire scan line. In Ferraro et al. (1998) an analysis of the quality control screens is presented, and in Surussavadee et al. (2012) a recent application of the criterion is shown. According to the suggestion, the following references will be included in the revised manuscript to be submitted.

Ferraro, R. R., Smith, E. A., Berg, W., and Huffman G. J.: A screening methodology for passive microwave precipitation retrieval algorithms, J. Atmos. Sci., vol. 55, no. 9, pp. 1583–1600, 1998. Surussavadee, C., Blackwell, W.J., Entekhabi, D. and Leslie, R.V.:

A global precipitation retrieval algorithm for SUOMI NPP ATMS, IGARSS 2012, IEEE International Geoscience and Remote Sensing Symposium, Munich, 2012.

11. Page 9371, Line 16: Is the same analysis presented in Panegrossi (2013) using the four case studies? Or was the focus of the Panegrossi (2013) paper substantially different?

Authors' Reply: In Panegrossi et al. (2013) the validation study of the two algorithms, CDRD and PNPR, developed at CNR-ISAC for conical scanning and cross-track radiometers, respectively, is presented. The goal is to evaluate the performance of the two algorithms, respect to ground measurements, and their consistency in the evaluation of the surface precipitation for 19 different typologies of meteorological events over the European area, selected among the H-SAF Precipitation Product Ground Validation dataset. The paper does not provide a detailed description of the two algorithms nor of the four case studies reported in this manuscript, as it is primarily oriented to the statistical evaluation of the results, for the 19 precipitation events, and to assess their improvement over previous releases of H-SAF PMW precipitation products. (See also Answer to Referee 1: Major)

(Panegrossi et al., 2013 is attached)

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/7/C4400/2015/amtd-7-C4400-2015-supplement.zip

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Interactive comment on Atmos. Meas. Tech. Discuss., 7, 9351, 2014.