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Atmospheric Measurement Techniques Discussions

Interactive comment on "Detecting cloud contamination in passive microwave satellite measurements over land" *by* Samuel Favrichon et al.

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The authors would like to express their gratitude for the reviewing done on the paper "Detecting cloud contamination in passive microwave satellite measurement over land". A detailed response to the reviewer comments on behalf of all authors can be found below.

RESPONSE TO REVIEWER COMMENTS

This manuscript describes a Neural Network(NN)-based method of detecting clouds from passive microwave observations. The NN is trained using co-located SEVERI

cloud classifications and GMI observations. This method has several properties that make it useful for a variety of applications: the NN performs well over land, where physical methods of detecting clouds are more difficult than over water due to the more variable and heterogeneous surface, and the NN outputs a cloud probability metric that can be thresholded to screen more clouds (at the expense of increasing false detections) depending on the application. I have a few minor comments that pertain to describing the method and its skill in more detail. There are also some recommended technical corrections but none of these issues are major and the manuscript should be acceptable for publication after these revisions.

Minor Comments: 1. On page 3, there are some additional microwave imaging radiometers that could be included in your list. WindSat would fall into the group with channels < 40 GHz, and TMI could be listed under those with channels < 90 GHz.

R. The mentioned MW imagers were not initially targeted for possible applications of our methodology, but given their frequency ranges and incidence angle our models should be applicable with minor differences. We are adding them as suggested.

2. Section 2.3 - I'm interested in the detail of how SEVIRI was mapped to GMI. Was the 36 GHz footprint of GMI used, or some other channel? The higher frequency (smaller) footprints might result in more homogeneous scenes for training but could also misrepresent the cloud type in the larger footprints.

R. The GMI data used is the 1C-R product, which provides GMI measured brightness temperatures with both low-frequency and high-frequency channels projected to a common scan centre position. This scan position is consistent with the resolution of the 89 GHz channel (4 km x 4km). The resolution of the 166 and 183 GHz channel is also close, while the coarser lower frequency channels are remapped to this resolution. As this common scan position is used to search for matches with the SEVIRI data, we can say that we are collocating at the resolution of the 89 GHz (and above) channels. Certainly, for the clouds not homogeneous at the scale of tens of kilometres the lower

the frequency the more likely the mismatch between the observed radiances and the SEVIRI cloud type. This adds some level of noise in the relationship between cloud types and radiances, and it is better explained now in the revised manuscript.

3. Is there a reason that most of class 7-10 clouds are classified as class 8 by the NN? It seems as though these can't be distinguished from each other by the MW but are still being detected - you could group these classes together and training and confusion matrix would be more diagonal. I see these are excluded from the training altogether later, which is also logical since these optically thin ice clouds shouldn't have much impact on microwave brightness temperatures, and in fact any detection may be via correlation to upper level humidity inferred from the Tbs near 190 GHz.

R. A possible explanation for the overrepresentation of class 8 as the predicted cloud type in figure 3, is that it is close to the average cloud cover for classes 7-10. The "meanly thick semitransparent cloud" corresponding Tb distribution possibly lies at the intersection of the "thin semitransparent" and "thick semitransparent" clouds ones. Nevertheless it is difficult to know which phenomenon leads to the distinction between cloud types. As seen in section 4.3 some cloud types are indeed difficult to detect, however they may share similar properties with other cloud types that led to this classification.

4. Table 4: I think a measure of skill that evaluates the NN detection to random chance, such as the Heidke Skill Score, would be helpful here. For example, it is stated on Page 11 that the detection of classes 7-8-11 is similar to a random assignment, so there is no skill, while presumably, the detection of opaque clouds has higher skill. It would be helpful to see this for all classes to evaluate the relative detection capability.

R. Following the reviewer suggestion we computed the Heidke Skill scores. The results are displayed in the table. The scores falling below 0.1 for class 7 and 11 illustrate well the lack of skill of our classifiers for these 2 classes. As we wanted a detection performing well for multiple frequency ranges and as the cloud types description covers

Cloud Type	All channels	Channels (<100GHz)	Channels (<40GHz)	Mean Scores
2	0.28	0.19	0.16	0.21
3	0.36	0.22	0.18	0.25
4	0.43	0.25	0.19	0.30
5	0.45	0.25	0.20	0.30
6	0.46	0.27	0.22	0.32
7	0.26	0.13	0.09	0.16
8	0.30	0.15	0.12	0.19
9	0.41	0.23	0.19	0.28
10	0.39	0.20	0.16	0.25
11	0.23	0.09	0.06	0.13

a continuum of possible cloud cover, the inclusion of class 8 along with the 2 previously mentioned made sense. These 3 classes indeed have the lowest skill score among all the cloud type.

Although we found the exercise of interest, we are not convinced that it shows anything particularly different from the analyses already included in the paper, so we prefer not to include them in the revised manuscript to not further complicate the discussion.

Technical Corrections and Typographical Errors: Page 2, Line 2: "spatial resolution" is erroneously repeated Page 2, Line 8: "frequencies" should be "frequency" Page 2, Line 23: "miss-interpreted" should be misinterpreted C2Page 3, Line 2: "80's" should be "1980s" Table 1: The 36 GHz channel on GMI is centered at 36.64 GHz (to avoid conflict with the Ka band radar) Page 3, Line 16: "similar" should be "constant" in this context, I think Page 4, Line 10: "emissivities" should be "emissivity" Page 6, Line 4: for GMI, the level 1C product is internally calibrated (other sensors are intercalibrated to it), so I don't think "corrected" is needed here Page 8, Line 5: "situation" should be "situations" Page 14, Line 12: "miss classified" should be "misclassified"

R. Technical suggestions and typographical errors corrected in the revised