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Comment on amt-2022-173

Anonymous Referee #3

Referee comment on "Volcanic cloud detection using Sentinel-3 satellite data by means of neural networks: the Raikoke 2019 eruption test case" by Ilaria Petracca et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-173-RC3, 2022

The Authors present a neural network technique to detect volcanic ash clouds by combining visible and thermal infrared channels of moderate resolution spectroradiometers.
A neural network trained on MODIS imagery acquired during the Eyjafjallajökull eruption in 2010 is applied to two pairs (nadir and oblique view) of SLSTR images of the Raikoke eruption that occurred in 2019.
The neural network method is compared to the classic brightness temperature difference (BTD) method and the accuracy of the two methods is evaluated against manually classified pixels. The results show a reasonable performance of the NN method in detecting ash clouds in nadir view, whereas I have some perplexities about its performance in the oblique view, as it seems to me that the NN underperforms for a fairly thick ash plume which I would expect to be easily detectable.
All in all, I think the paper can be published with minor revisions, although I recommend careful proofreading by a native English speaker, as the quality of the written English does not look impeccable to me.

MAIN COMMENT

I think that the extension of the NN approach to oblique view needs further investigation. What are the typical values of the viewing angles sampled in the oblique view and how do they compare to those of the nadir view? If the air mass sampled in the oblique view is much bigger than that sampled in nadir view, the difference in the slant optical depth may translate to a npticeable difference in top-of-atmosphere signal levels. Furthermore, if there is a large difference in the observed scattering angles you may be also sampling different ranges of (weather and ash) cloud phase functions, which also may lead to significant differences in the signal levels in

VIS/NIR channels.
In this case, it looks far from obvious to me that the NN can still be applied reliably to oblique view
situations that are probably not covered in the training set.
Therefore, I would recommend studying the sensitivity of the NN detection to the observation angle
by generating synthetic top-of-atmosphere spectra of VIS/NIR radiance and thermal brightness temperature
for a typical liquid water, ice and ash cloud. In my opinion, the results presented in the paper
do not allow to draw reliable conclusions on the robustness of the NN method to off-nadir observations.

DETAILED COMMENTS

- P1, L15, spaceborne sensors acquired data -> satellite data

- P1, L19, The classification of the clouds and of the other surfaces -> A classifications of clouds and other surfaces

- P1, L22, foster the robustness of the approach, which allows overcoming -> allow to extend the approach to SLSTR, thereby overcoming

- P2, L42, to detect the volcanic cloud -> to detect volcanic clouds

- P2, L43, you can remove "problem" after detection

- P2, L43, lies on -> relies on

- P2, L44. There is no such thing as "water vapour clouds". I guess you mean "liquid water clouds"

- P2, L49, region -> regions

- P2, L59, procedures described -> described procedures. Plus, is "among" really what you mean, or do you mean "in addition to"?

Does "described" refer to Prata et al. (2001b) and Corradini et al. (2008,2009)?

- P3, L70, statistical -> statistically

- P3, L71. Is this real time capability really an advantage of the NN approach? Isn't the BTD method also in near real time, given that it involves taking a difference? Furthermore, in an emergency scenario is there really such a big advantage in correctly detecting a few more ash pixels than the BTD method?

- P3, L85-86, either "a vertically ascending cloud" or "vertically ascending clouds"

- P4, L103, "water vapour" -> "liquid water"

- P4, L107. At what angles does SLTR dual view observe?

- P4, L109-110. I don't understand the use of "since" here. What do you mean when you say that the feasibility of the method was confirmed for high latitudes "since" your study area is at medium-high latitudes.

-P8, L159-160. How is each percentage in the confusion matrix computed? Furthermore, overall accuracy is not a particularly informative parameter. Given that the main focus is on ash, it may be useful to provide statistics on the task of ash detection (probability of detection, false alarm ratio, critical success index).

-P8, L166. What do you mean by "commission" and "omission" errors? I guess one is "false detection" and the other is "missed detection", but it is not clear which is which.

-P9, Figure 5. If I look at panel a, it seems to me that on the edges of the plume there are quite a few pixels that the NN classifies as "cloud ice". Do you have an idea why this happens?

-P11, L186, emphasizes -> shows

-P11, L198-199, "even if some pixels are misclassified as ash on land". For such a thick ash cloud I would indeed expect that there is hardly any information in the signal to distinguish ash over land from ash over sea or cloud. Does it really make sense to introduce such a fine distinction between ash classes? What do you gain from that?

-P11, L199, less false positives -> fewer false positives. On top of that, are they really false positives? Doesn't the BTD detect fewer ash pixels compared to the NN?

-P11, L206, water vapour cloud -> liquid water cloud

-P11, L213, aerial trails -> aircraft condensation trails

-P11, L214. What causes the BTD method to give false positives over contrails?

-P11, L218, "produces good results". I would say "reasonable". The ash cloud looks so thin here that I doubt you have a very good reference to compare your results against. How does the BTD approach perform for this image?

-P12, Fig. 7(a). Here the NN seems to detect a much smaller portion of the plume compared to what happens in the nadir image.
Interestingly, a large fraction of the ash cloud is again classified as cloud ice (see my previous comment about Fig. 5).
Do you have any explanation for this apparently systematic tendency to confuse ash with cloud ice? Again, how does the BTD
approach perform for this case?

-P12, L220, "this is due to the opacity of the volcanic cloud". Why is the opacity of the volcanic cloud a problem for the NN detection?
I would expect a more opaque cloud to provide a better contrast against weather clouds.
Even visually, the plume in image (a) looks easier to detect than the faint plume in image (c).

-P13, L249, matching -> agreement

- P14, Table 4. How would such a table compare to a similar one for BTD vs MPM?

- P16, L286, includes also -> also includes