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Atmospheric Measurement Techniques Discussions

Interactive comment on "Automatic volcanic ash detection from MODIS observations using a back-propagation neural network" *by* T. M. Gray and R. Bennartz

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Reply to Reviewer #2 Comment dated Aug 31st, 2015

We thank the reviewer for her/his valuable comments. Below please find a detailed response to all reviewer comments.

1. This paper aims to assess the ability to identify volcanic ash plumes and assess co-incident SO2 concentrations by training a neural net on four thermal IR metrics provided by MODIS. This is a valuable pursuit, given the global nature of MODIS observations and the well-known relationships between volcanic plume properties and the thermal

IR bands used. Some additional work assessing more quantitatively the uncertainties in the MODIS training data, and maybe also the HySplit runs, would add considerable value to this study (see Notes 4 and 5 below).

RESPONSE: Thank you. For a detailed response on additional quantitative evaluations, please see our response to points 5-7. (Comparing with the earlier comments by Reviewer #2 (dated Aug 21st, 2015) we believe the points the reviewer is referring to above are actually points 5-7 rather than 4-5. The reviewer seems to have interspersed new comments in the current version leading to a slight discrepancy between the two versions of her/his review.)

2. P2, lines 20-23. Just some perspective on this point: Although CO2 concentrations might be reduced due to ocean fertilization, this also depends heavily on the degree to which the iron in the ash is soluble, and on whether iron is the limiting nutrient in the water. Volcanoes can also be CO2 sources.

RESPONSE: Thank you for this detailed insight. We feel that this information is might not need to be included in the paper, since the paper's main focus is much more technical.

3. P2, lines 26-28. Again for perspective, it is possible that even the much larger number of smaller volcanic eruptions could have a cumulative climate effect by adding sulfate to the stratosphere (e.g., Solomon et al., Science 333, p.866, 2011).

RESPONSE: We will add this reference.

4. P3, line 11. Given the stratosphere-oriented discussion of the previous paragraph, it might be better to say: ". . .the presence of ash in the troposphere can significantly. . ."

RESPONSE: We will change this accordingly

5. P3, lines 22-23. It might be worth mentioning the estimated uncertainty in the ash concentration derived from HySplit. I'd expect HySplit to produce reasonable indication

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of ash plume location, but maybe not as good a constraint on concentration. Actually, I think you are mainly using ash location from HySplit in this study. Also, more could be reported about the data used to characterize the eruption occurrences for initializing the HySplit runs. (I do see that some qualitative discussion of the uncertainties in the plume characterization applied to HySplit is given toward the end of the Discussion section.)

RESPONSE: Point well taken. If accepted for AMT, we will discuss these issues in more detail in a revised version.

6. P5, lines 7-8. How good is the HYSPLIT model aerosol concentration over 30 km in the vertical? I guess this bears on the more general question in Point 5 above.

RESPONSE: (See 5.) We will address this issue of accuracy of HySPlit in more detail..

7. P5, lines 28-29. For this technique to be generally useful, the uncertainties in the MODIS-derived volcanic ash discrimination used to train the neural net need to also be assessed. One way might be to compare the results with those from MISR, which has information about aerosol type based on differences in ash vs. sulfate particle size and shape. Such analysis is presented for a series of Mt. Etna eruptions by Scollo et al. (JGR 117, doi:10.1029/2011JD016625). SO2 discrimination could be validated using the uv detections from the OMI instrument (e.g., Yang et al., JGR 112, doi:10.1029/2007JD008825). MODIS also has an ice-detection channel at 1.38 microns that might be helpful here.

RESPONSE: We agree these are highly valuable comparisons. However, given the limited nature of our study, we would prefer to address those in future publications. The test cases selected for this current study were all visually inspected in much detail. Even though, this does not constitute a formal quantitative assessment of the MODIS accuracy, we believe we have correctly identified all plumes and the contingency tables as well as interpretation of individual neural network retrievals we present in the paper do allow to assess the overall accuracy of the retrieval. IN future studies, we would like

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to expand on our current results and address the accuracy for a wider range of scenes and also compare to additional data sources.

8. P6, line 18; Figures 1-4. You might explain the color scales associated with the right-side images in Figures 1-4. Also, it might be helpful to the make the ash and SO2-rich-ash detections more visible in Figure 1; if there are essentially no detections, then perhaps the caption could say so, so the reader doesn't struggle to find the signals in these plots.

RESPONSE: If, we will change the revised manuscript as per the reviewer's suggestions.

9. P7, lines 23-27. In Figure 3, the ash detection (upper right panel) seems clearer than the SO2 detection (lower right panel), yet the discussion here seems to suggest the opposite.

RESPONSE: We believe we have stated this correctly. The point we wanted to make here is that the SO2-rich area (lower right image), even though smaller, is better delineated from the clouds than the just the ash (upper right image)

10. P7, lines 30-32. It is difficult to see the brown color in the RGB image of Figure 4. Also, in line 32, I think you mean "corroborating" rather than "collaborating" here.

RESPONSE: We will change this to 'corroborating'. The brownish color appears in the upper right corner of the MODIS false-color RGB.

11. P9, lines 6-10. For this approach to be used operationally, false-positives as well as false-negatives need to be characterized, and screened if possible. Too many of either error type would limit operational use. This might be worth mentioning.

RESPONSE: If, we will change the revised manuscript as per the reviewer's suggestion.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 8753, 2015.