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Atmospheric Measurement Techniques Discussions

Interactive comment on "Opportunistic validation of sulfur dioxide in the Sarychev Peak volcanic eruption cloud" *by* S. A. Carn and T. M. Lopez

Anonymous Referee #2

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General Comments

As noted by the authors, the use of ground-based measurements to validate satellite-based measurements is challenging. The measurements are fundamentally different. A pixel from the satellite measurement is a (virtually) instantaneous spatial average of the SO2 concentration. The ground-based measurements are instantaneous within the field-of-view (FOV) of the instrument but the FOV is so small, relative to the dimensions of the plume/cloud, that the instrument must travel some distance to cover the cloud. If the distribution of SO2 within the cloud is uniform over space and time then the comparison of satellite- and ground-based SO2 estimates is straightforward. However, if the SO2 distribution varies over the spatial scale of a satellite pixel and/or the time

scale of the ground-based survey then the comparison is problematic.

The authors' discussion, together with the FLYSPEC data plotted in Figure 3 and 4, indicate that the SO2 distribution was variable in both time and space. The south-bound FLYSPEC survey (Figs. 3b and 4a) suggests that P1 was the best characterized of the OMI pixels because the FLYSPEC results are fairly constant over the time and distance required to traverse this pixel (I'm not sure why the average of the FLYSPEC measurements over P1 is greater than any of individual measurements, however). The north-bound survey results (Figs. 3c and 4b) indicate that P1 and P2 were well-characterized by FLYSPEC, but this apparent uniformity may be the result of saturation of the instrument more that uniformity in the SO2 cloud. Assuming that the north-bound measurements were not saturated, we have good characterizations of the cloud at the spatial scale of P1 acquired approximately :50 before and 1:30 after the OMI overpass. The temporal change between the south- and north-bound results appears to be uniform over the survey stations (Fig. 3b vs. 3c). We can calculate the gradient of SO2 abundance vs. time and predict the abundance at the time of the overpass. Given the time symmetry of the P1 surveys, relative to the overpass time, the average of the south- and north-bound results is a good prediction of the OMI result (8.2 and 3.5 DU, respectively, giving a relative difference of 134%).

The average abundance over the south-bound survey of P2 was closest to the corresponding OMI result, but the steep slope of the FLYSPEC plot in Fig. 4a tells us that cloud was poorly-characterized at the scale of P2. We should, therefore, view the FLYSPEC/OMI comparison with caution. As noted above, P1 is the best characterized by the FLYSPEC data provided that the instrument did not saturate on the north-bound survey. Please verify that the FLYSPEC measurements were NOT saturated!

I think that this paper will have great value as a discussion of the difficulties of comparing ground- and satellite-based retrievals of SO2 abundance. I also think that further analysis can be done to the FLYSPEC data to better characterize spatial and temporal changes. For example, Figure 4 shows the combined changes in FLYSPEC with loca-

tion (relative to pixel boundary) and time. A 2-D plot with location and time on different axes would be interesting as we could determine if the change was dominated by the spatial or temporal gradient. Another approach might be to plot histograms of the FLY-SPEC results within pixel boundary to determine how well that pixel is described by the mean of the histogram (i.e. compare the mean to the mode). This analysis could exonerate the south-bound results for P2!

Technical Issues

Figure 1 This figure is difficult to interpret. At the very least you should add arrows pointing out the various data sets. With the current perspective (point of view), it is not readily apparent that the CALIPSO data are show in profile – and it is difficult to distinguish the CALIPSO data from the OMI data. Given that Figure 2 is a nice display of the CALIOP results, and the MODIS data do not play a large role in your analysis, Figure 1 could be deleted.

Figure 3 The pixel boundaries in Figure 3d are very hard to see. This figure (3d) does not add much to the discussion, so you might delete it if this means that Figs 3a-c could be made larger.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 3861, 2011.