Analyzing the Indirect Effects of Volcanically Increased SO_2 on Marine Boundary Layer Clouds Using A-Train

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Mt. Kilauea became active in 2008 emitting a significantly anomalous SO_2 plume. This geological event provides an excellent experimental opportunity to investigate the degree to which low level maritime clouds are influenced by changes in sulfate aerosol. In this study we examine only how the measurements change and infer, based on the measurements, what changes may have occurred to the cloud properties to cause such changes. We find that the changes in measurements from the inactive period to the active period show an *unambiguous decrease* in 94 GHz brightness temperature (Tb), a weak *decrease* in integrated Z, a slight *increase* in 2.1 micron reflectance, and a *nearly constant* reflectance in the mid visible. **This combination of changes suggests that cloud droplet size decreased consistent with the first aerosol indirect effect, yet albedo remained nearly constant because liquid water path decreased proportionally. The role of precipitation in this process is unclear**. For instance, did changes to precipitation play a causal role in the liquid water path changes by modulating the stability of the lower troposphere or are changes to precipitation merely a result of decreased liquid water path? Either way, given a nearly constant cloud fraction, evidence for the 2nd aerosol indirect effect is weak.

Method

This study examined data from 2007 and 2008. Using CloudSat integrated column dBZ, MODIS vis and near IR reflectance, 94 GHz Tb.

Validation of volcanic SO_2 activity from Aura OMI. Data are filtered using the following criteria:

Filtering Criteria

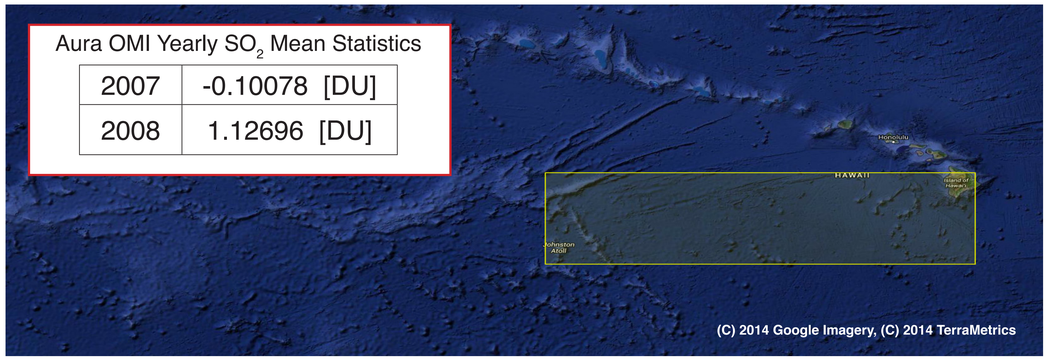
1. Region of interest defined by Eguchi et al. (2011)
2. Daytime data only
3. Cloud tops less than 4 kilometers with no cloud formations above them.
4. CloudSat CPR (1B) cloud mask is applied. Only values > 20 are accepted.

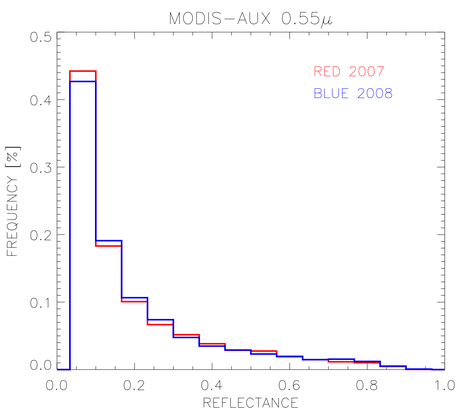
Cloud Fraction Statistics

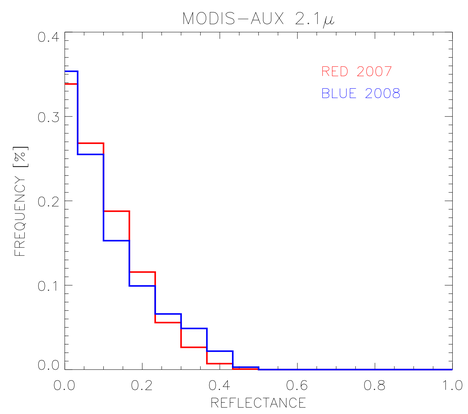
	2007	2008
Mean	54.127%	46.173%
St. Dev	22.03%	20.64%
No. Days	181	179
No. Profiles	21,705	20,205
Ave Profile/Day	120	113

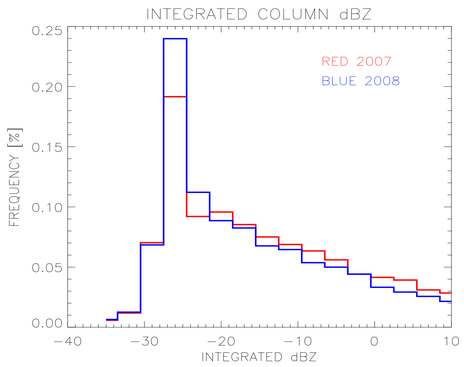
Aura OMI Yearly SO_2 Mean Statistics

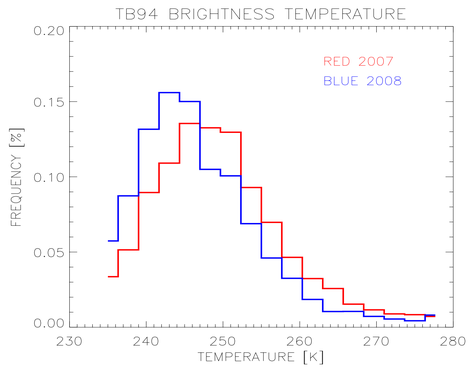
2007	-0.10078 [DU]
2008	1.12696 [DU]











Further Work

Continue the statistical analysis of volcanically active versus inactive years. Focus will be on attempting to understand the changes in LWP and how LWP changes are related to or caused by precipitation changes. Additionally, examine differences in large-scale meteorology from year to year and conduct a series of more rigorous statistical tests proving significance of changes.

References

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