Cloud and Precipitation Property Sensitivity to Volcanic Aerosol Downstream of Marine Volcanoes

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Question: Is there a difference in cloud and precipitation properties using CloudSat when high and low aerosol concentrations are present downstream of marine volcanos?

Introduction

- Mace and Abernathy (2016) found the clouds that exist within the volcanic plume have higher cloud fraction and grow deeper than clouds outside of the plume [1]
- Volcanos release sulfur dioxide into the atmosphere and it can affect the microphysics of clouds downstream of these volcanos by oxidizing into a sulfate aerosol[2]
- The different microphysics create a difference in the AOD (aerosol optical depth) [2]
- Kilauea annually emits between 0.3 and 1.1 million tons of sulfur dioxide[3]
- When aerosol levels are high due to the volcano plume, it is visible on Worldview as a light blue film, as shown in this photo:

Image 1: Shows the aerosol plume downstream of Kilauea on June 29th, 2014

Methods

- We only analyze data during daytime
- From MERRA-2, use the 1 hour time averaged single level diagnostics (M2T1NXSLV), to find the 850 mb winds closest in time to the cloudsat overpass. Use the location 2 degrees South and 2 degrees East from the volcano to get the wind vector that will orient the sample area downstream from the volcano. The sample area is a rectangle with a short side (500 km) and the long side (1500 km) oriented along the wind vector. The cloudsat track that crosses the sample area is used to analyze the aerosol optical depth.
- The aerosol optical depth comes from the MODIS Joint Atmosphere Product (MYDATML2).
- The cloudsat radar reflectivity comes from 2B-GEOPROF.P1_R05

Results

Red arrows indicate CloudSat Overpass.

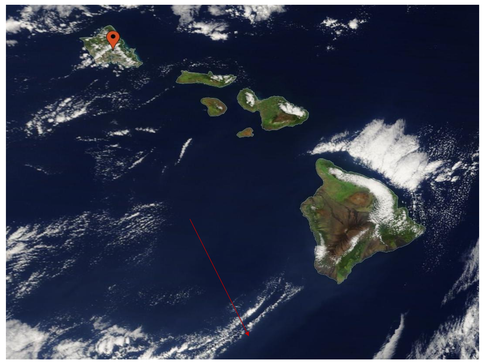

Image 2: Shows the Worldview image of Kilauea on March 19th, 2014, with no plume visible.

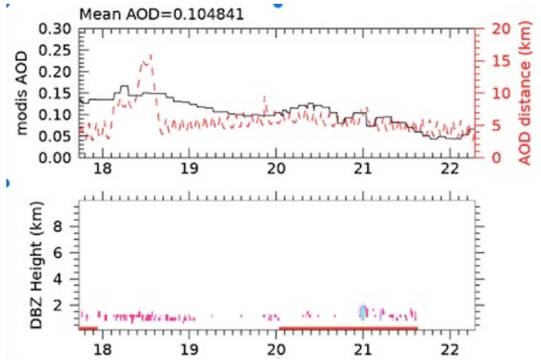

Figure 1: Shows DBZ Height and AOD of clouds downstream of Kilauea on March 19th , 2014, with a low overall AOD

In Figure 1 and Image 2, there is volcanic activity downstream from Kilauea. In the image, there is a distinct aerosol plume on Worldview. When compared with the CloudSat information from the same day, Aerosol Optical Depth (AOD) is low. The cloud fraction is higher in the plume than downstream of adjacent Islands consistent with Mace and Abernathy (2016).

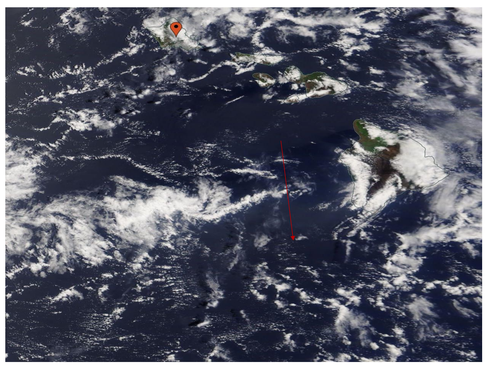

Image 3: Shows the aerosol plume downstream of Kilauea via Worldview on June 6th, 2014

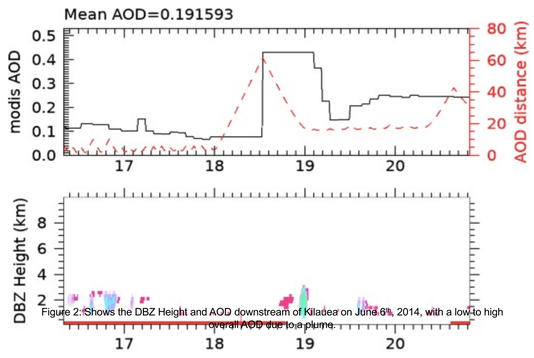

Figure 2: Shows the DBZ Height and AOD downstream of Kilauea on June 6th, 2014, with a low-to high overall AOD due to a plume.

In Figure 2 and Image 3, there is volcanic activity with Kilauea and this is evident in the Worldview image and in the AOD results. The AOD changes from low to high around the 18.5 N latitude line. Clouds in the plume have a higher AOD which is consistent with Mace and Abernathy (2016)

Analysis

In both Figures 1 and 2, there was a CloudSat overpass, as indicated. In Figure 1, there is less AOD than Figure 2 because CloudSat did not pass as near Kilauea as in Figure 2. Both images show a plume from Kilauea, however, Figure 2 and Image 3 show a noticeable difference in AOD as CloudSat passes into the plume. This is consistent with the findings in the Mace and Abernathy (2016) because the downstream aerosol plumes have higher cloud fractions and grow deeper when compared to outside of the plume.

Bibliography

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