

Using Satellite Observations to Evaluate the AeroCOM Volcanic Emissions Inventory and the Dispersal of Volcanic SO₂ Clouds in MERRA

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Overview

AeroCom Volcanic Emissions Inventory is used as a volcanic input to climate models by describing the:

- Daily SO₂ Emission for a given volcano
- Estimate of the Cloud Top Altitude

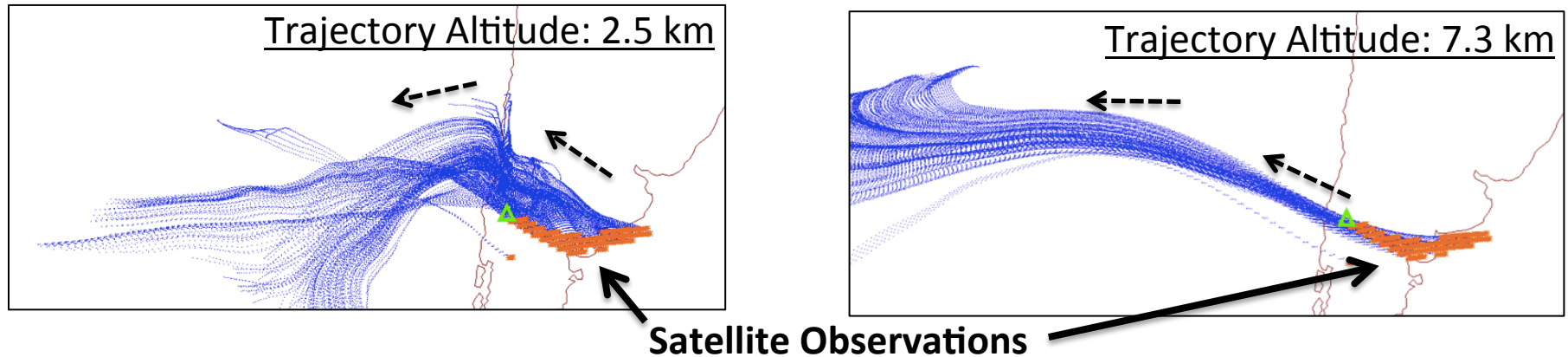
Extends back to 1930s, but most of the detailed information extends to the satellite remote sensing period, back to 1979.

*In select case studies, large differences have been observed between the Modern-Era Retrospective Analysis for Research and Applications (**MERRA**) and SO₂ observations from the Ozone Monitoring Instrument (**OMI**)*

Shown to better understand the nature of these differences:

- Comparison of AeroCom Inventory vs. MERRA input
- Aerocom Cloud Top Estimates vs. Back Trajectory Height Estimates
- MERRA Simulated SO₂ dispersal vs. OMI Observed SO₂ dispersal

Emission altitude and timing can be estimated from *back trajectories from observations*



The Trajectory Transport Test:

A trajectory has successfully described the transport of an SO₂ measurement if it arrives within a minimum distance of the volcano.

The *Distance of Closest Approach*

$$r^*(\theta, t^*)$$

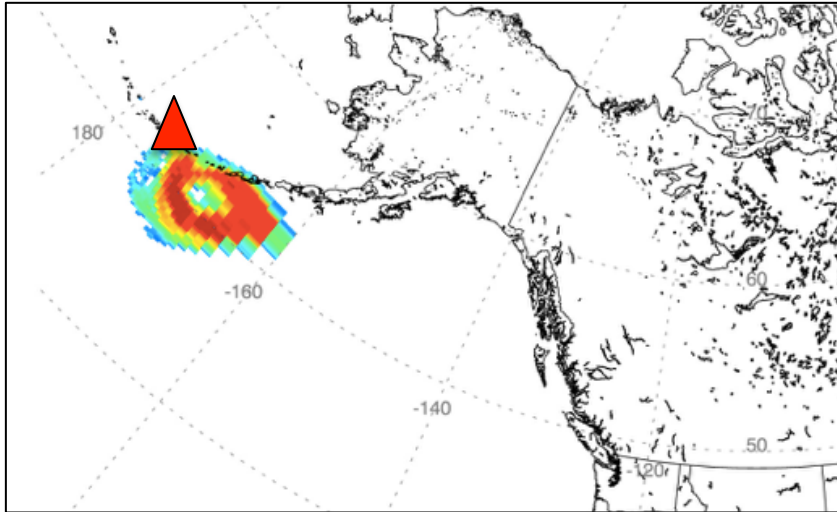
θ - the theta height of that trajectory

t^* - is the time of closest approach

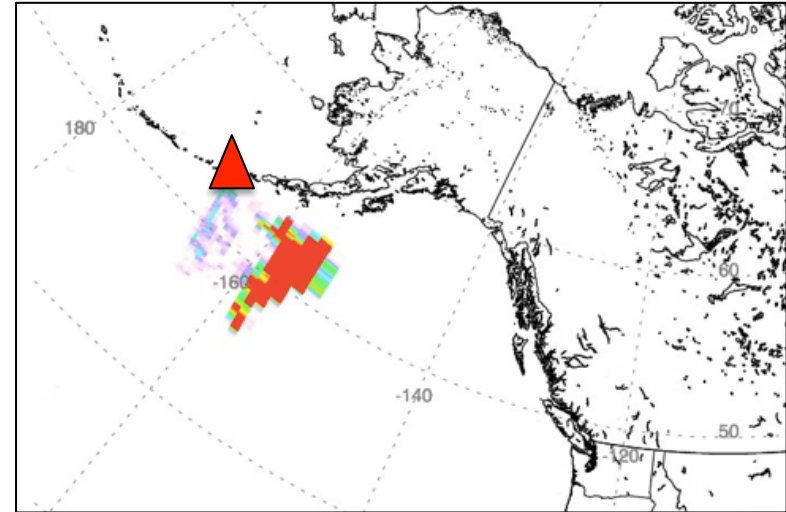
Derive Emission Probability Distribution Functions (PDFs) from those trajectories that arrive within a minimum distance of the volcano

SO₂ Explosive Eruption Case Studies:

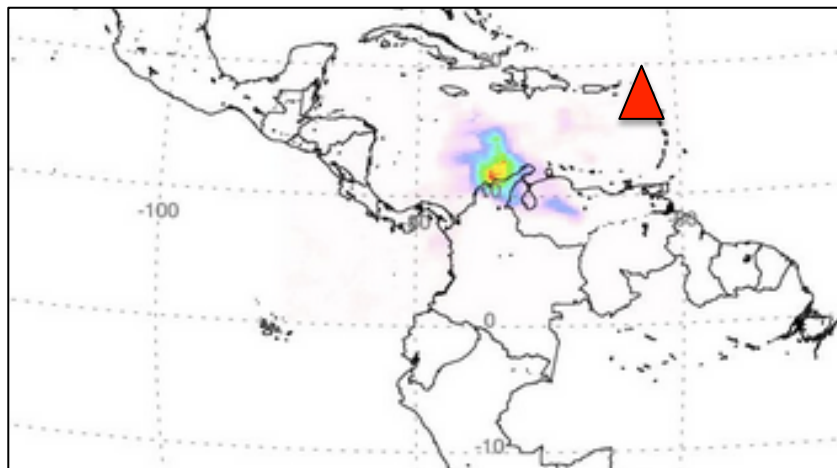
Kasatochi 2008



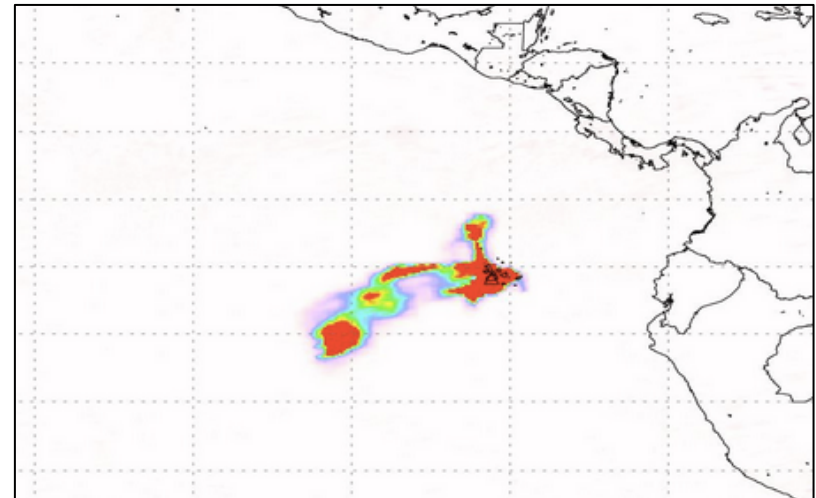
Okmok 2008



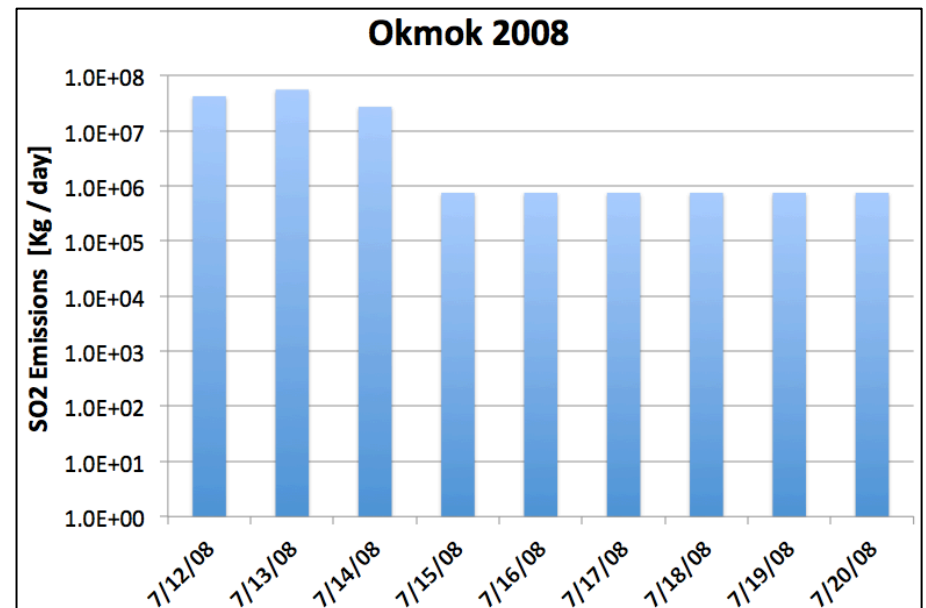
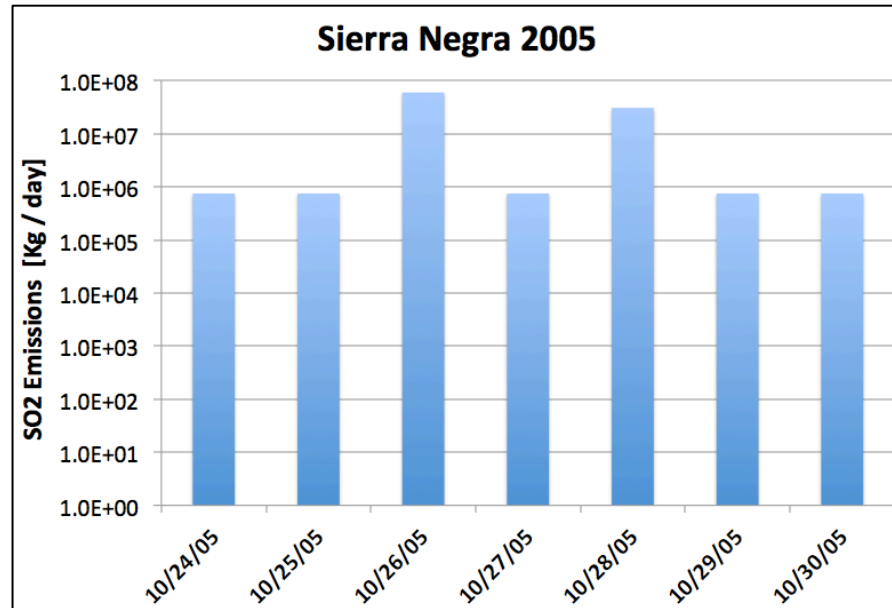
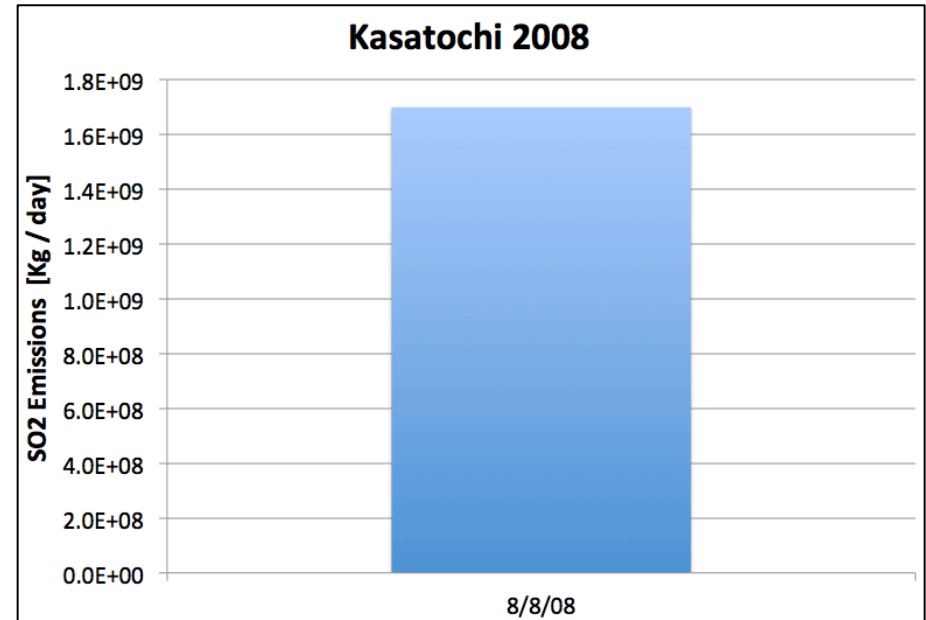
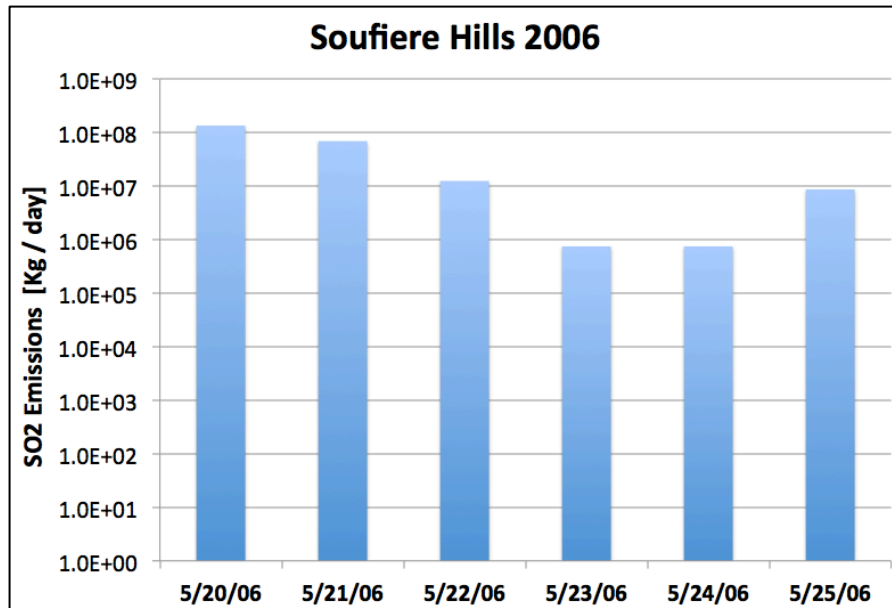
Soufriere Hills 2006



Sierra Negra 2005

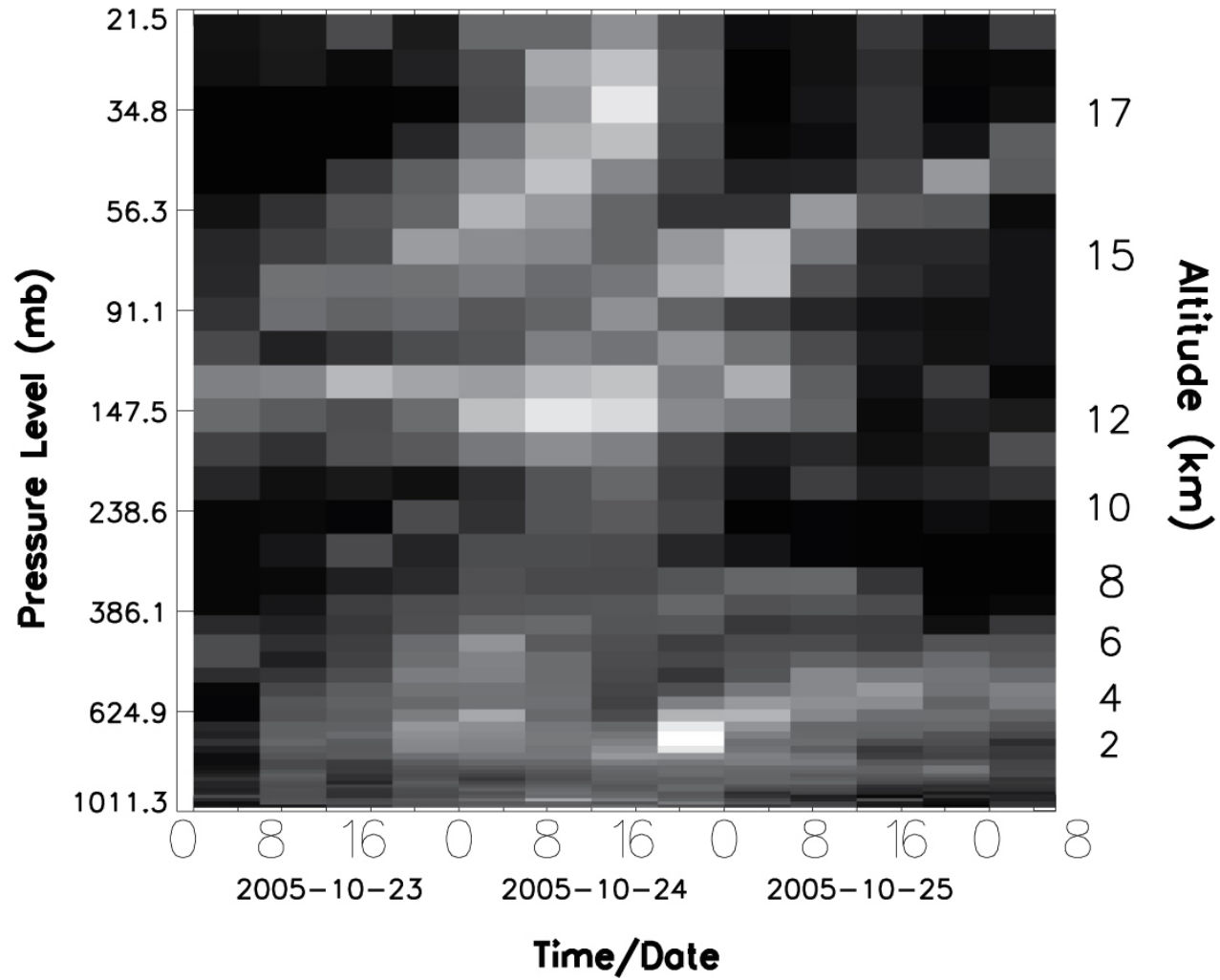


AeroCom Volcanic Emission Inventory: *Select Cases*



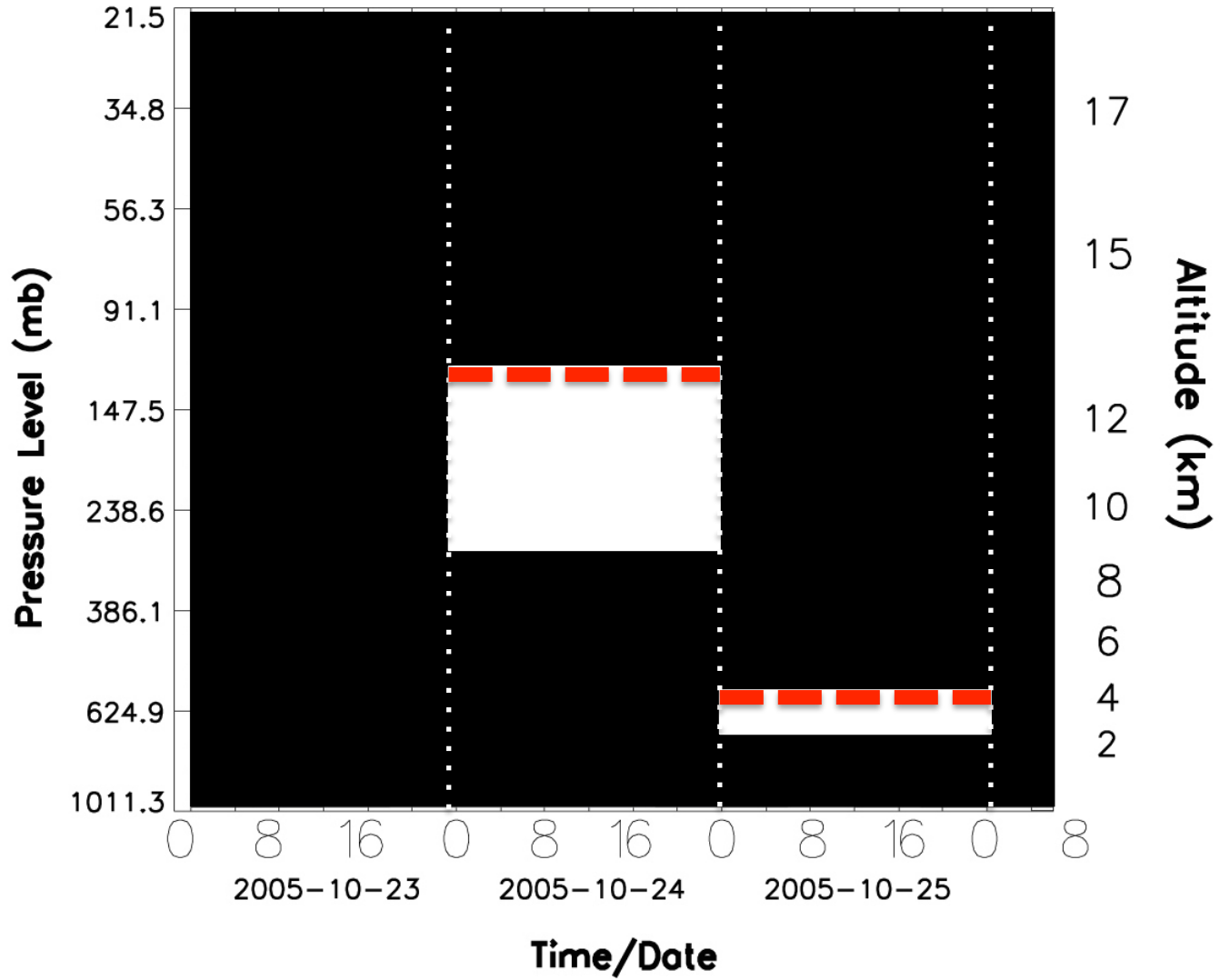
How well do the derived height profiles compare to those assumed in the GEOS-5/GOCART MERRA Run?

SO₂ Emission Height-Time PDF

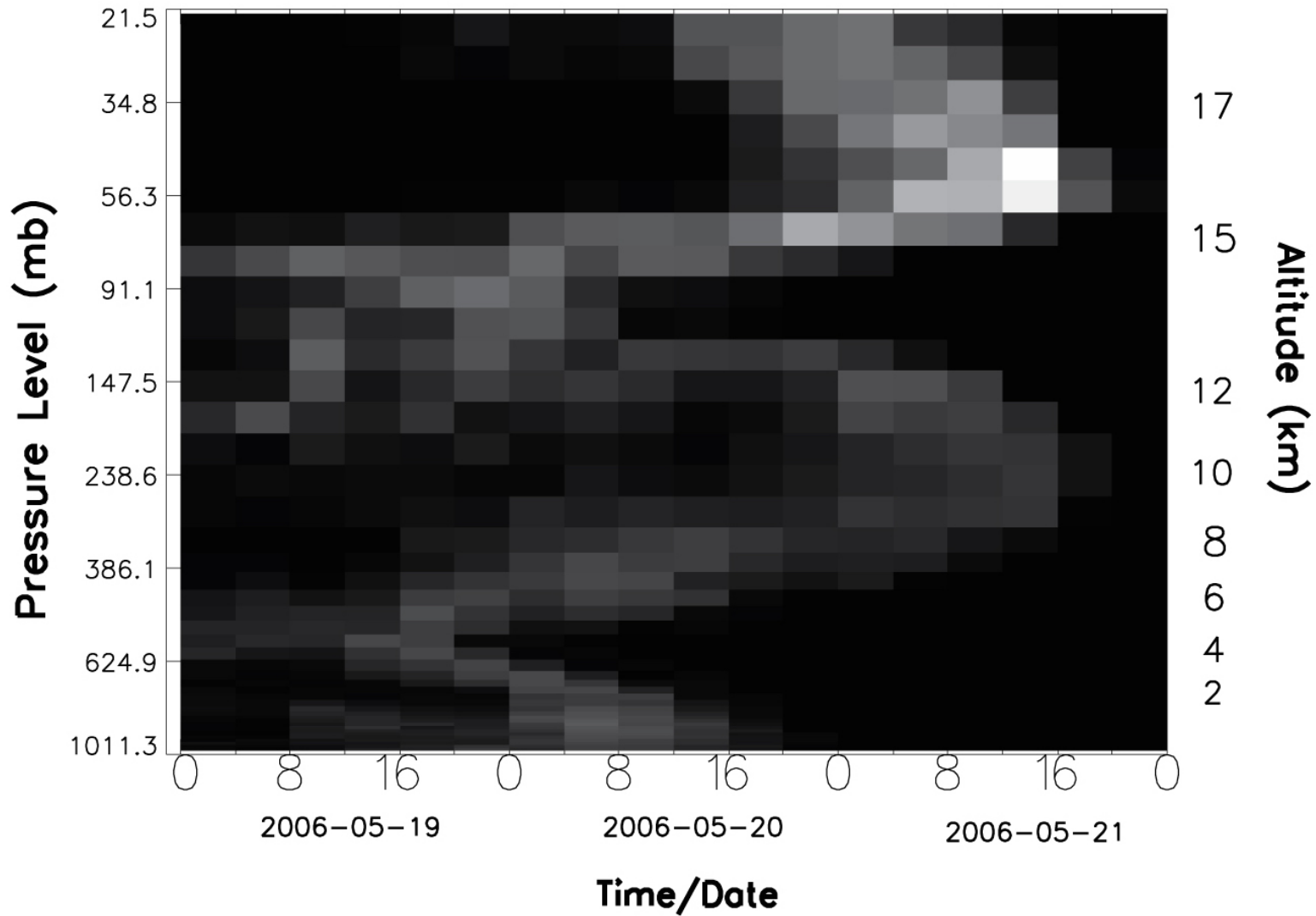


Sierra Negra

GOCART SO₂ Emissions

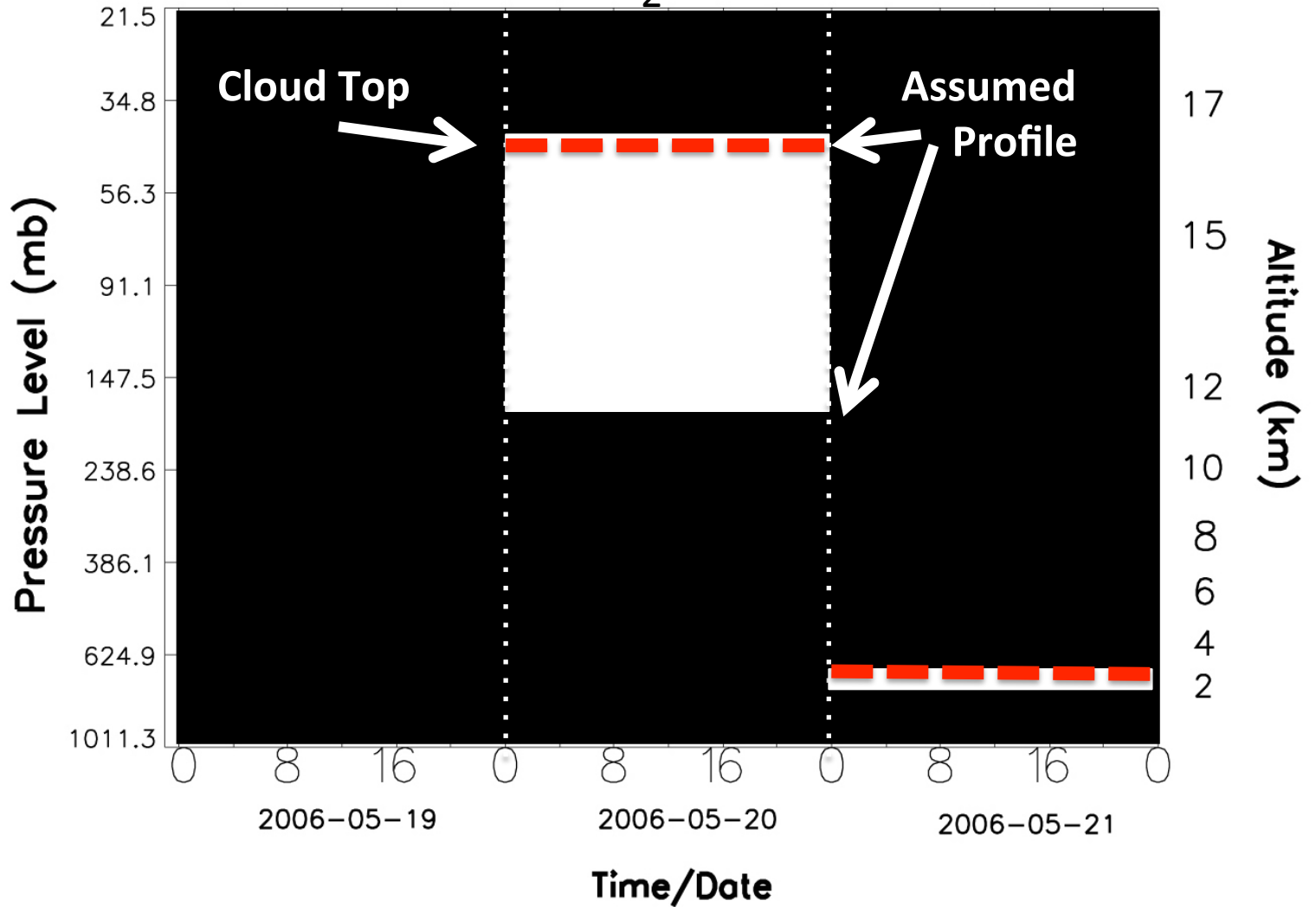


SO₂ Emission Height-Time PDF

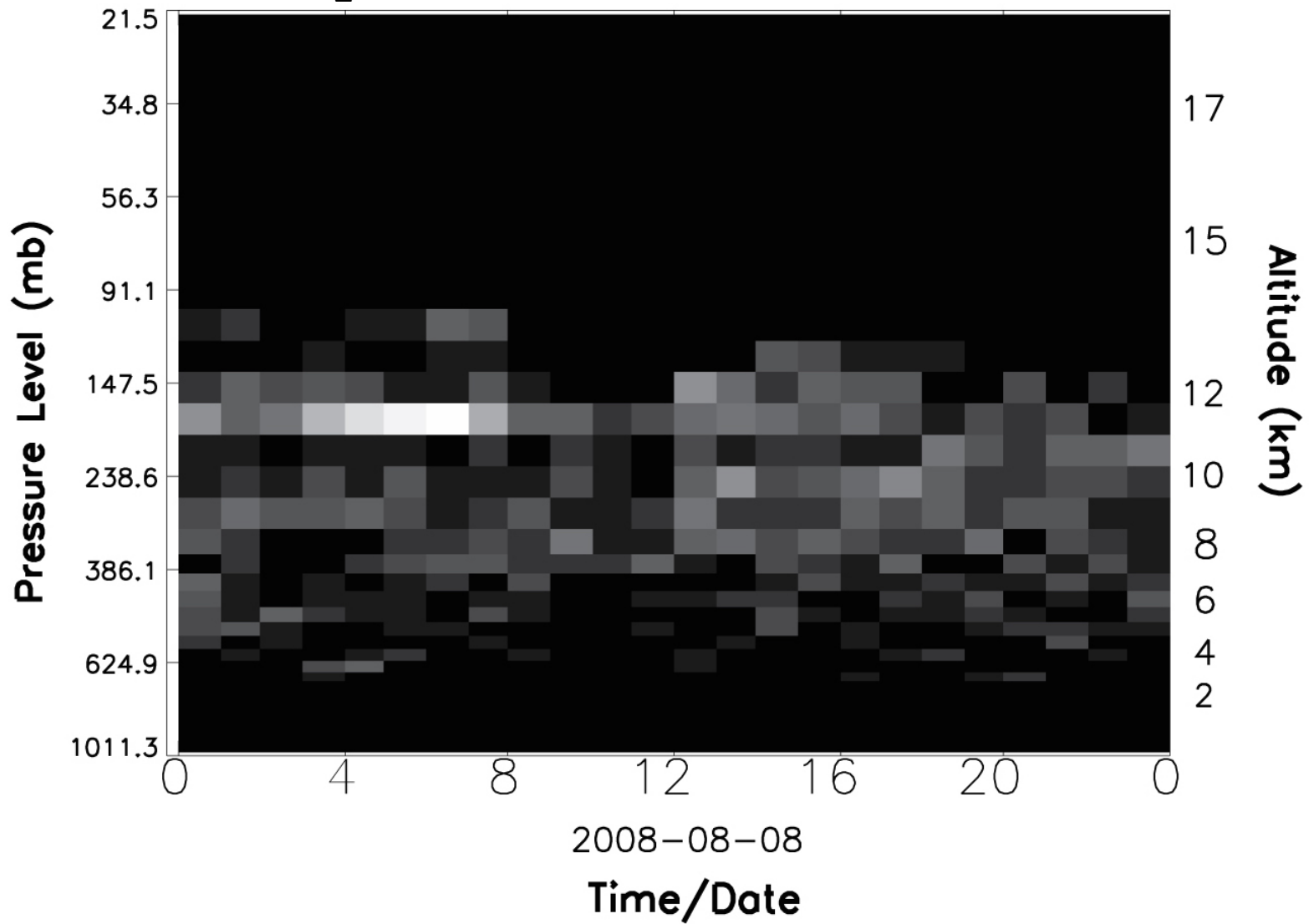


Soufriere Hills

GOCART SO₂ Emissions

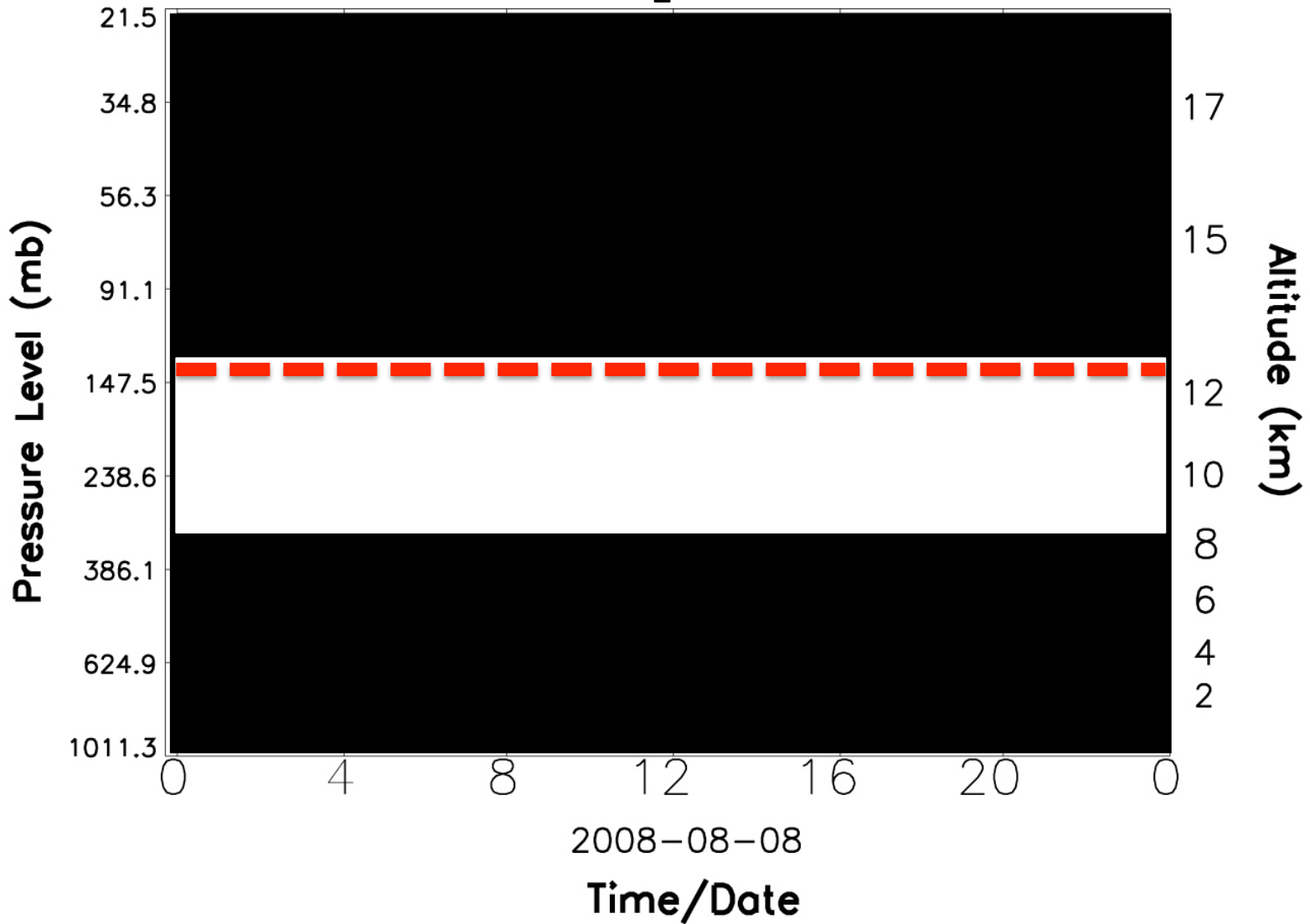


SO₂ Emission Height-Time PDF

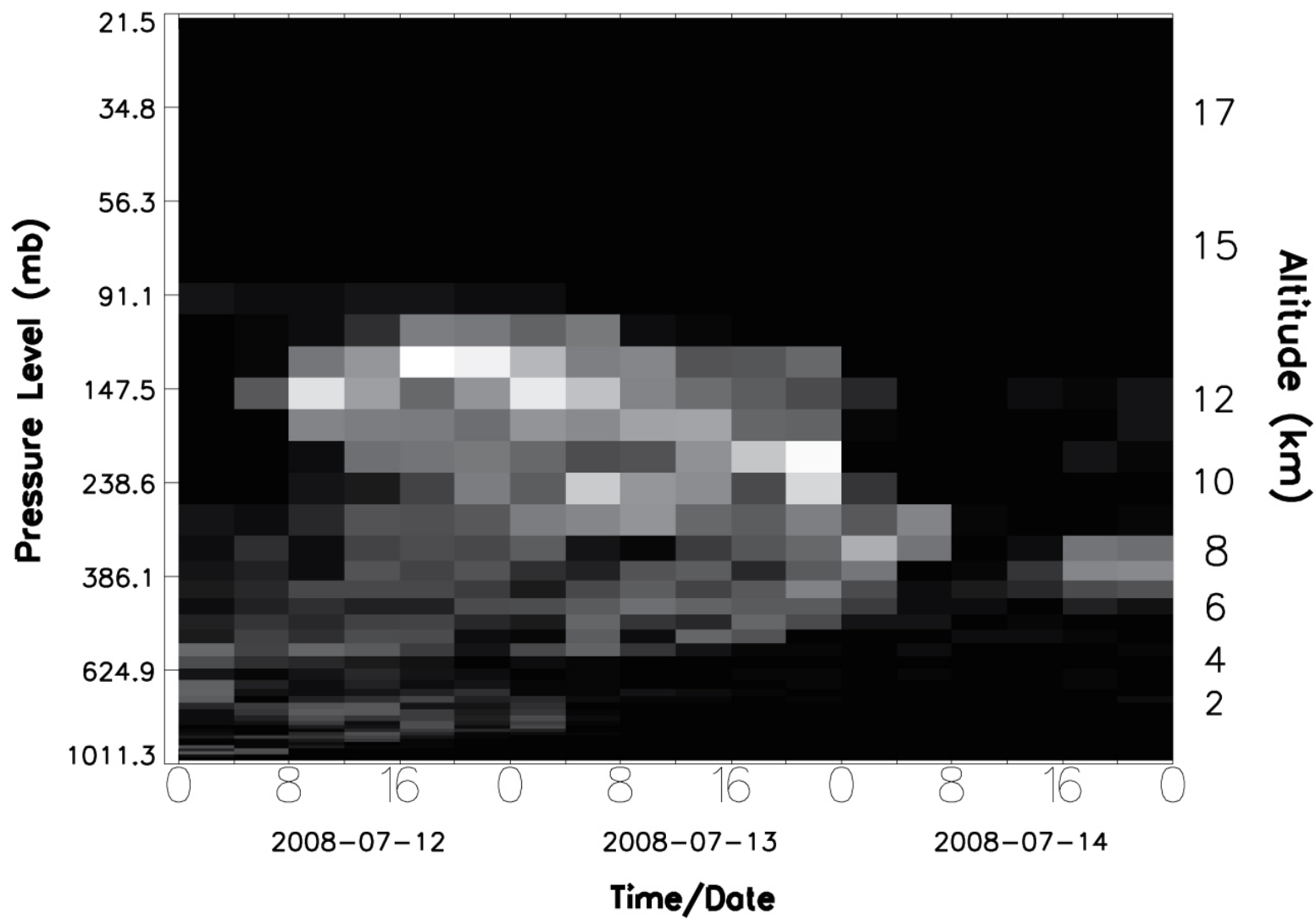


Kasatochi

GOCART SO₂ Emissions

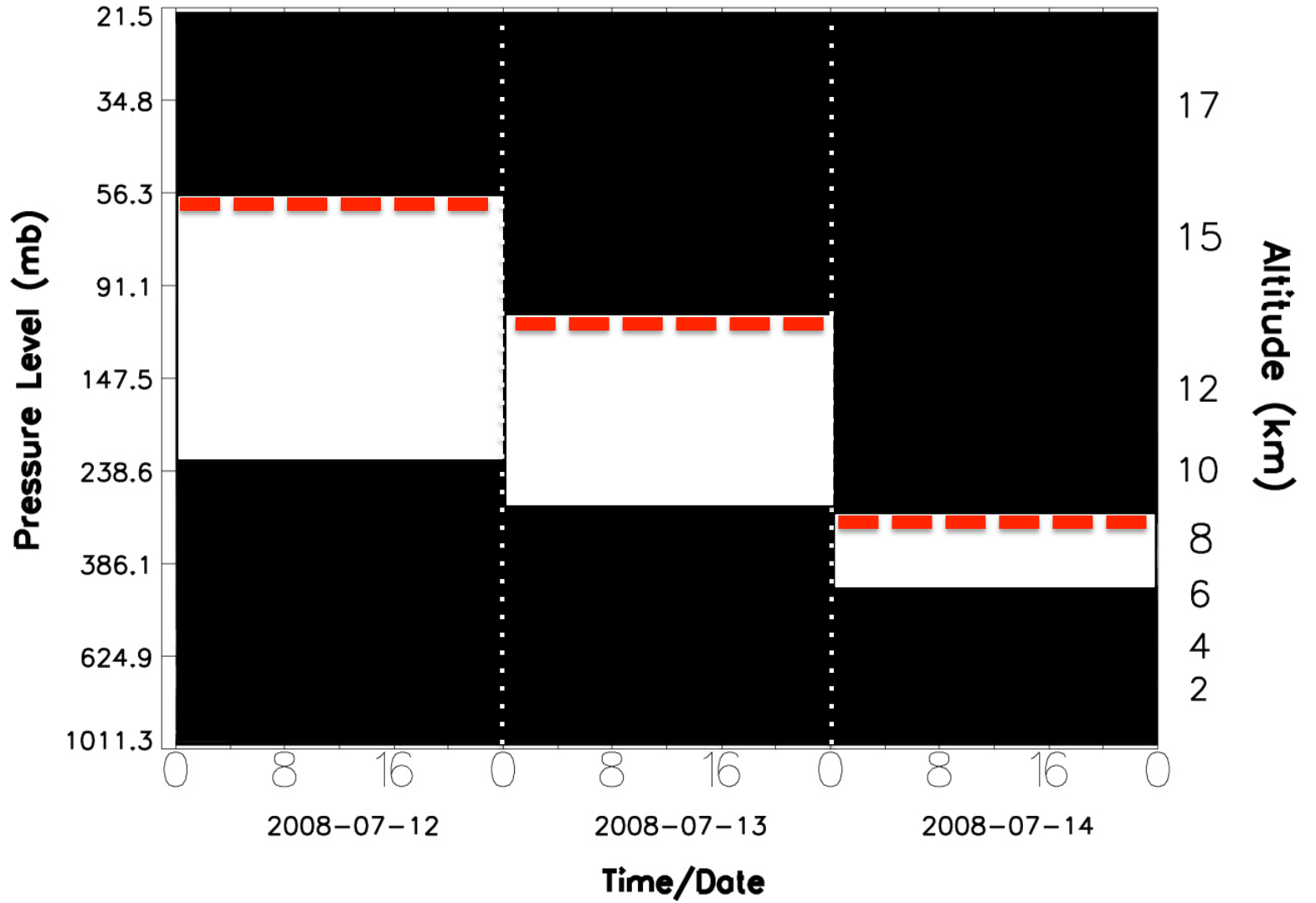


SO₂ Emission Height-Time PDF



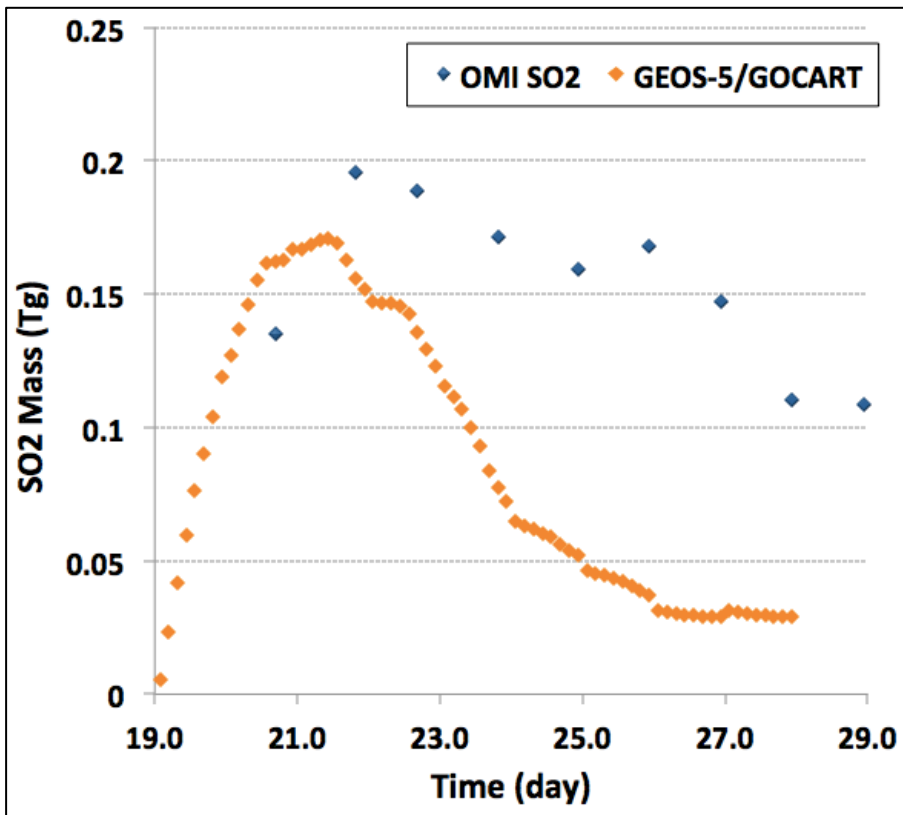
Okmok

GOCART SO₂ Emissions

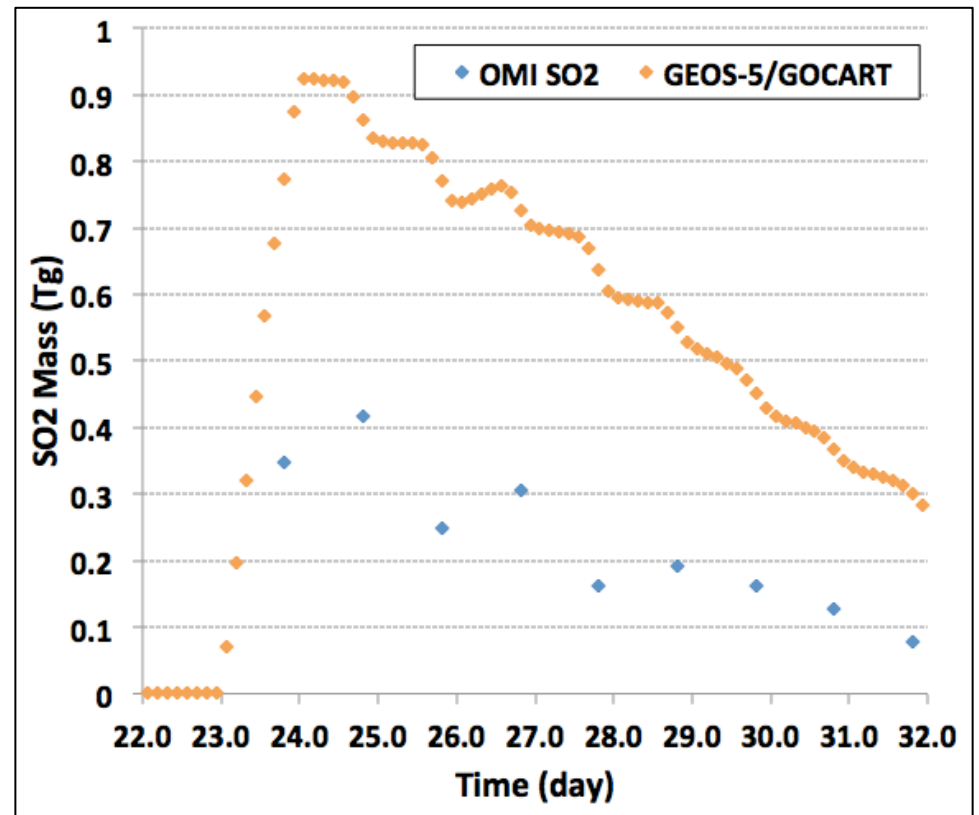


How do satellite observations compare to the simulated SO₂ dispersal?

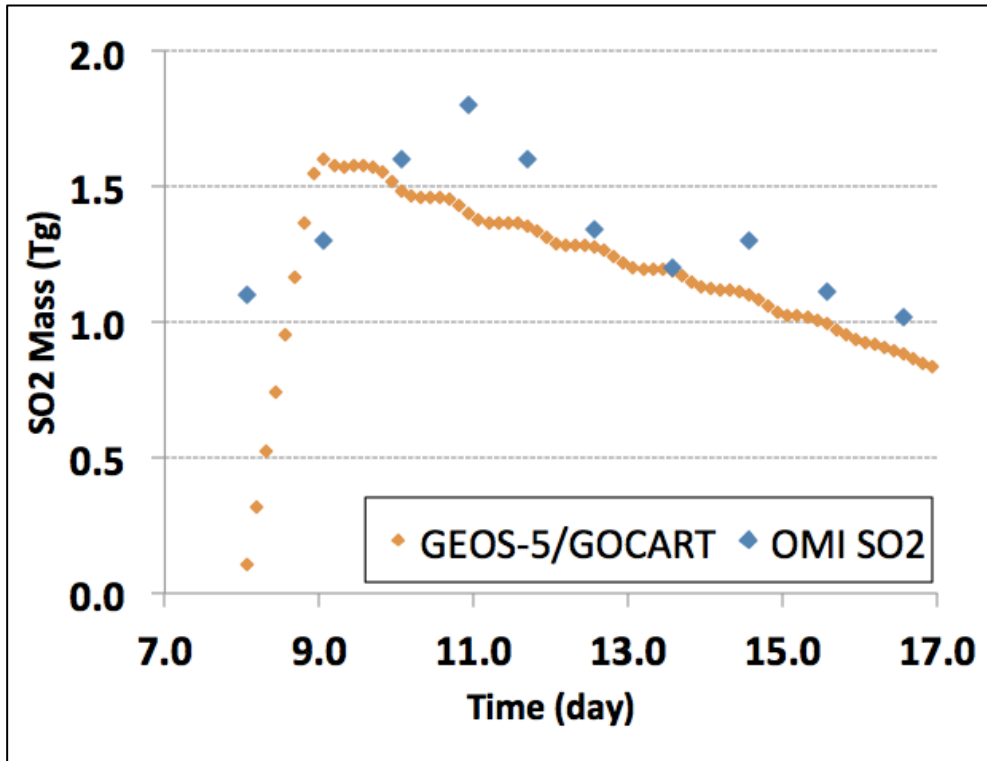
Soufriere Hills



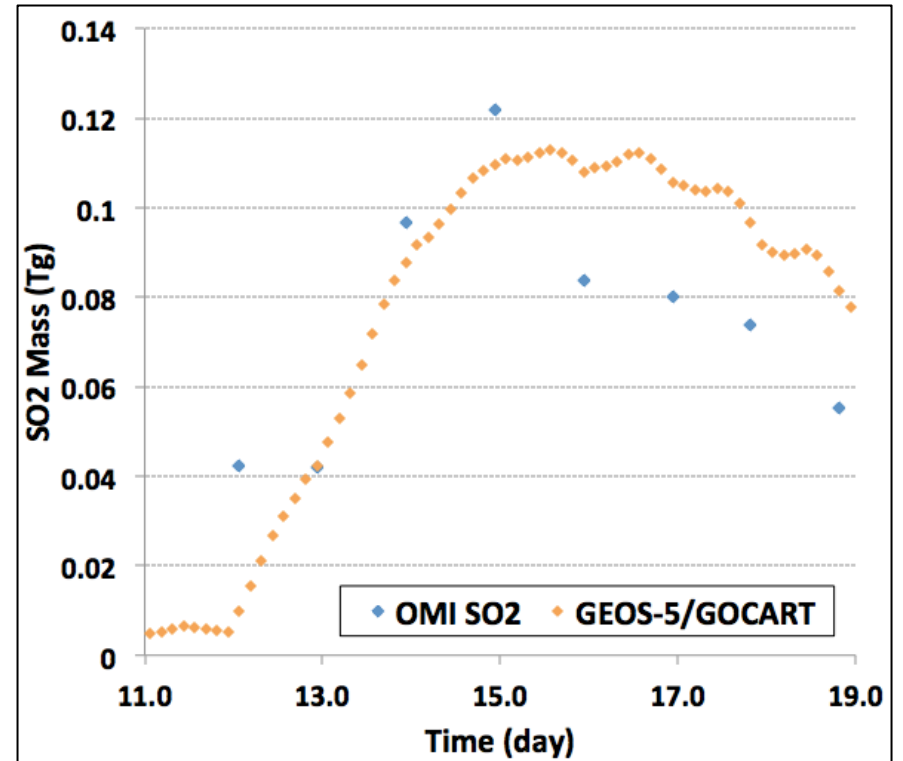
Sierra Negra



Kasatochi



Okmok



Model vs. Satellite: *There is a large disagreement seen in Sierra Negra and Soufriere Hills and better agreement with Kasatochi and Okmok.*

Concluding Remarks

- The assumed profile of $1/3$ the column between cloud top and volcano summit
 - Appears incorrect for several eruptions
 - May be pushing SO₂ into the lower trop creating incorrect dispersal/loss rates in MERRA (Soufriere Hills)
- Comparing dispersal rates of MERRA vs. OMI can be misleading as continuous emission can give the appearance of longer dispersal rates (Sierra Negra)
- Need to more directly compare OMI and MERRA.