Full-chemistry Volcanic Fog Forecast over Hawaii

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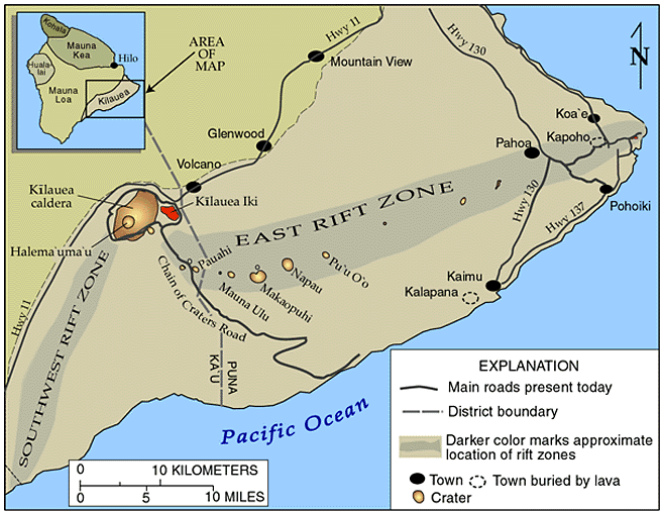
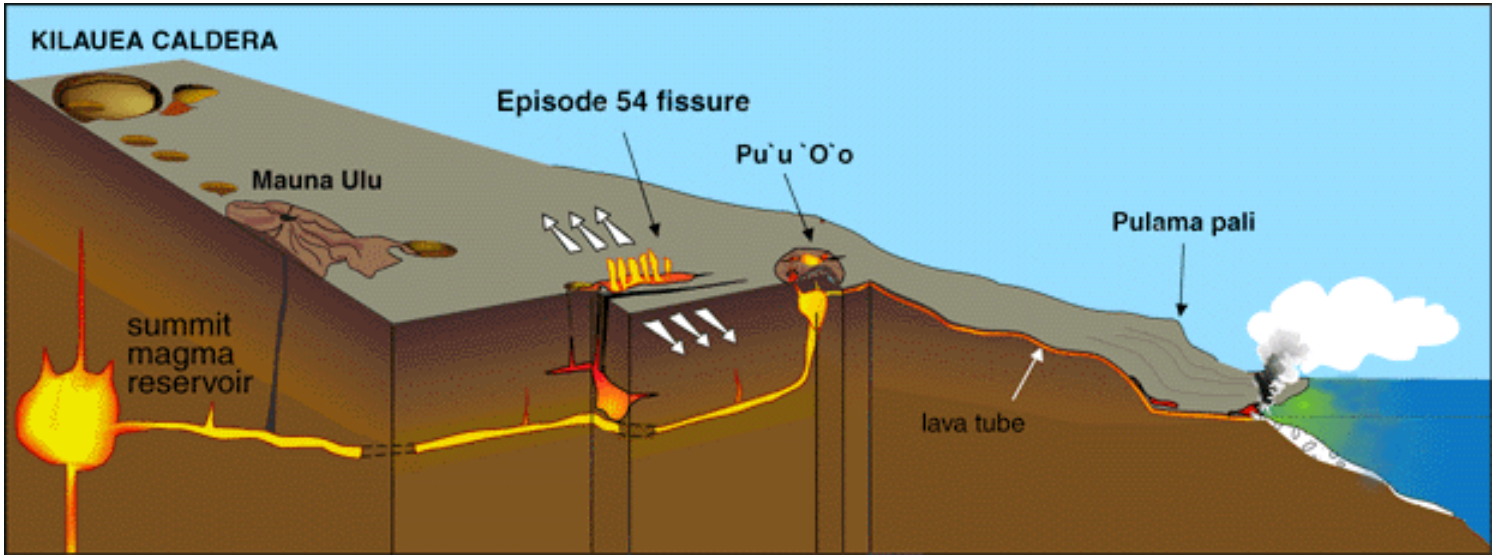
A pulse of magma moving through Kīlauea's east rift zone

Kilauea Volcano over the Hawaii Island



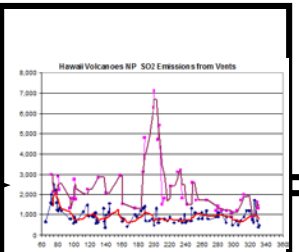


(Source: Hawaiian Volcano Observatory: http://hvo.wr.usgs.gov)

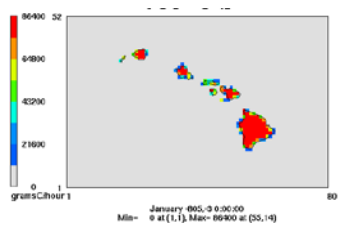
Methodology for Modeling Volcanic Emissions

In-Situ SO_2 Measurement

Daily web update



Pre-processor



Emission Processing

Hawaiian Volcano Observatory

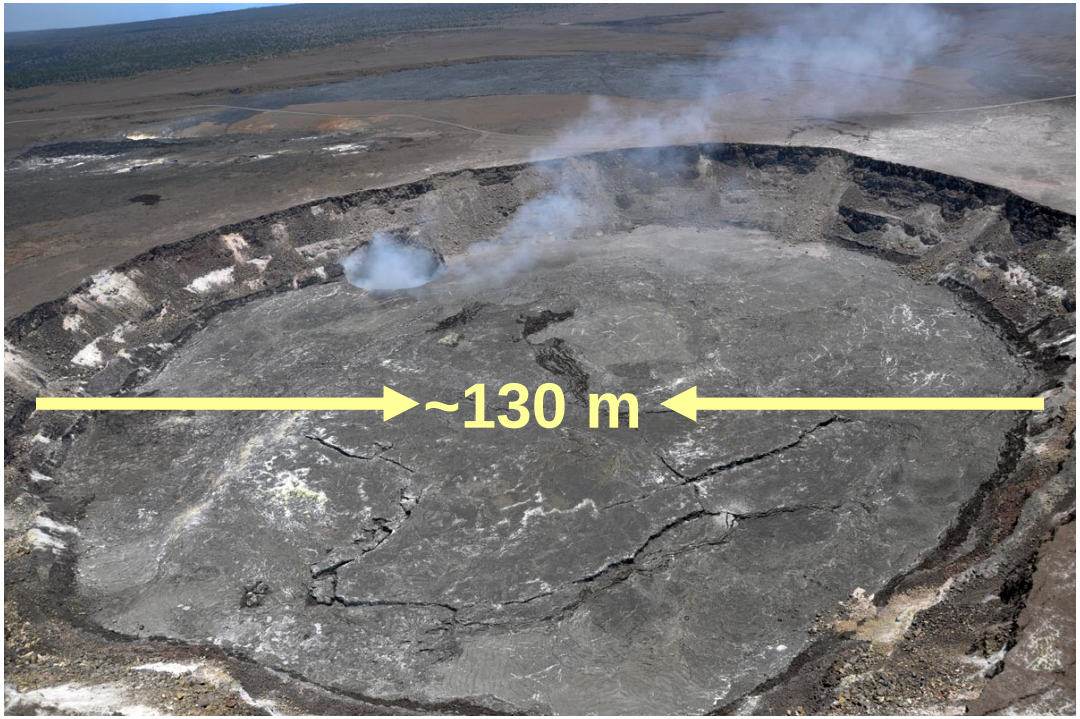
NOAA Air Resources Lab

- SO_2 measurement
  Correlation Spectrometer (COSPEC);

- Simple plume rise:
  Distributed from ground to 100 m above;

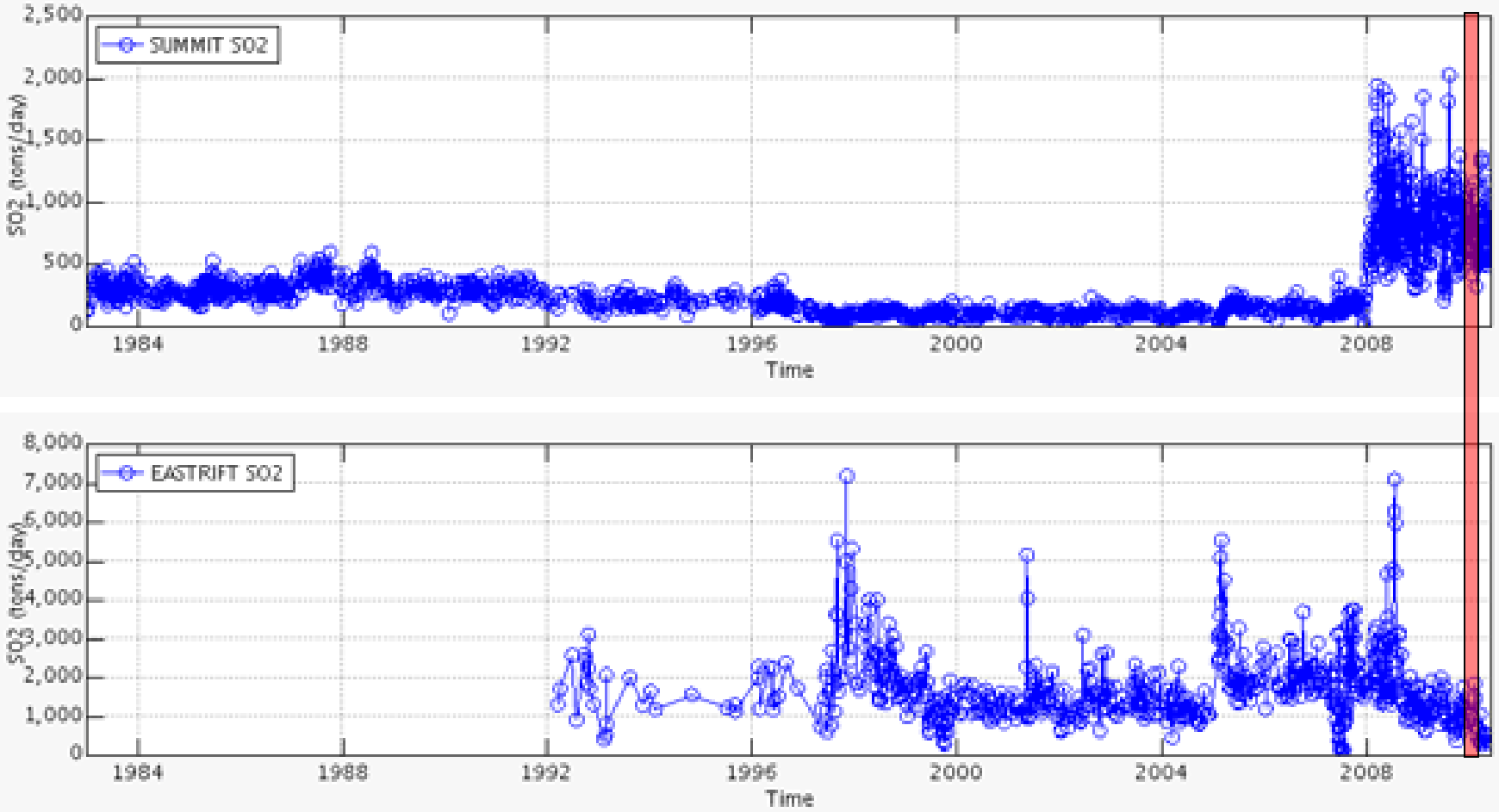
Plume Rise of Volcanic Emissions

Make it simple since we know so little about it…



- **Multiple and moving emitting points;**
- **Emitting point below surface;**
- **Dynamic magma movement;**
- **Difficult to implement plume rise algorithms, such as Briggs (1972).**

Kilauea SO_2 Emissions

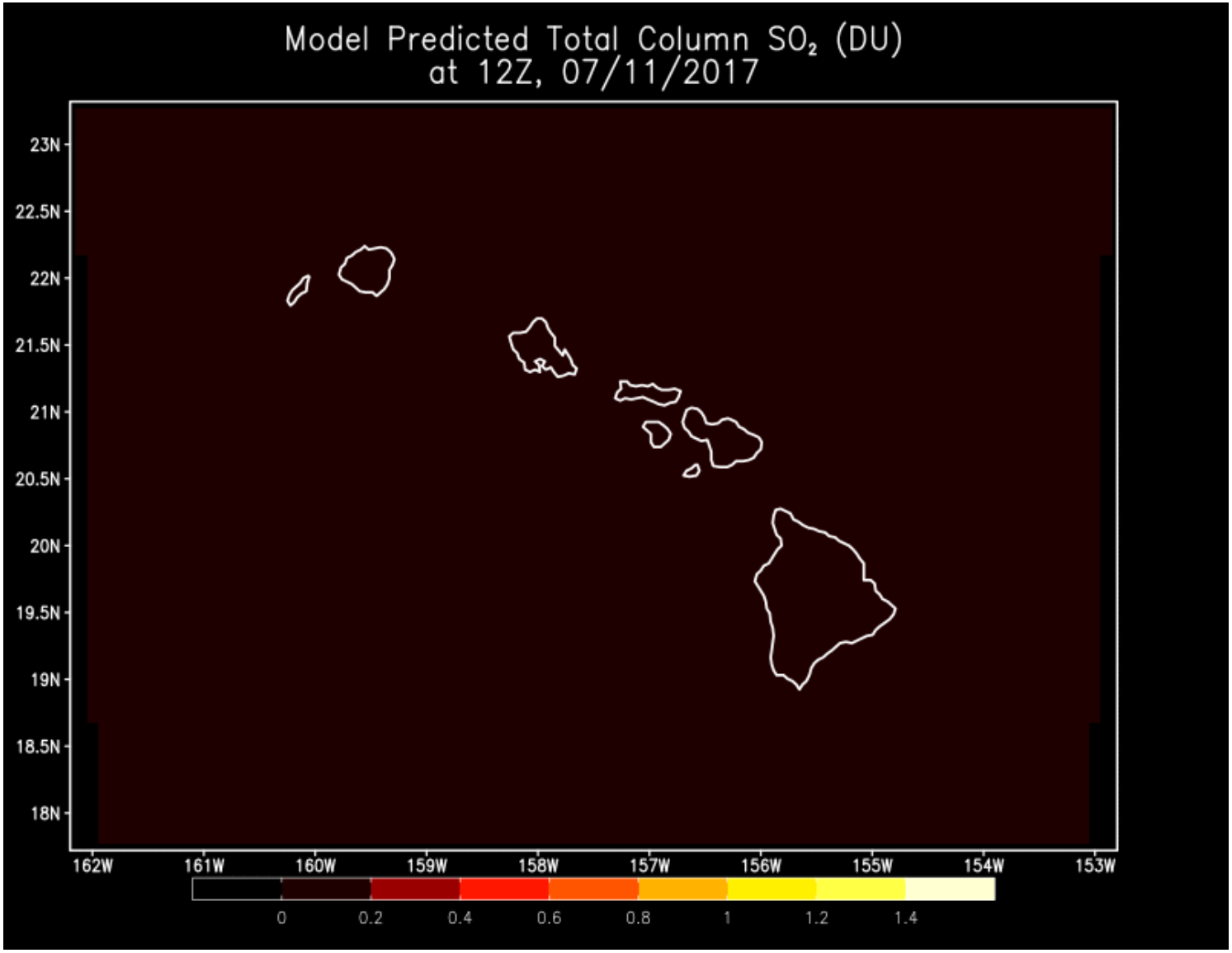


(Source: Hawaiian Volcano Observatory: http://hvo.wr.usgs.gov)

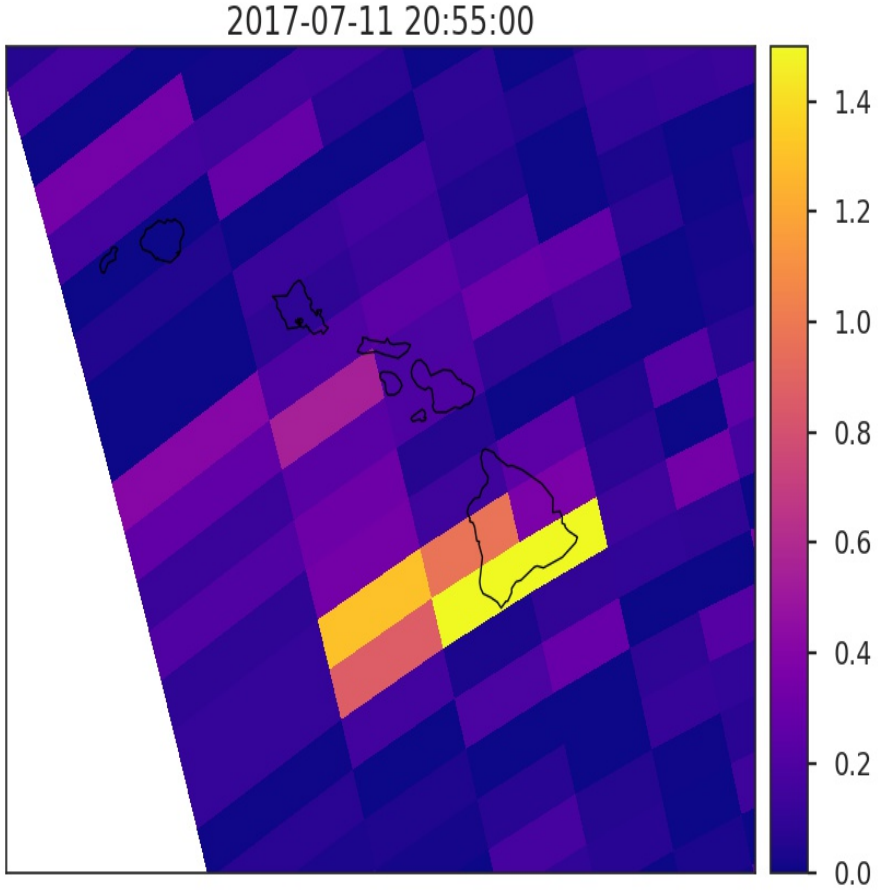
Model Configurations

- **Volcano SO2 emissions:**
  - Summit Emissions: 650 - 800 tons/day;
  - East Rift Zone: ~400 tons/day;

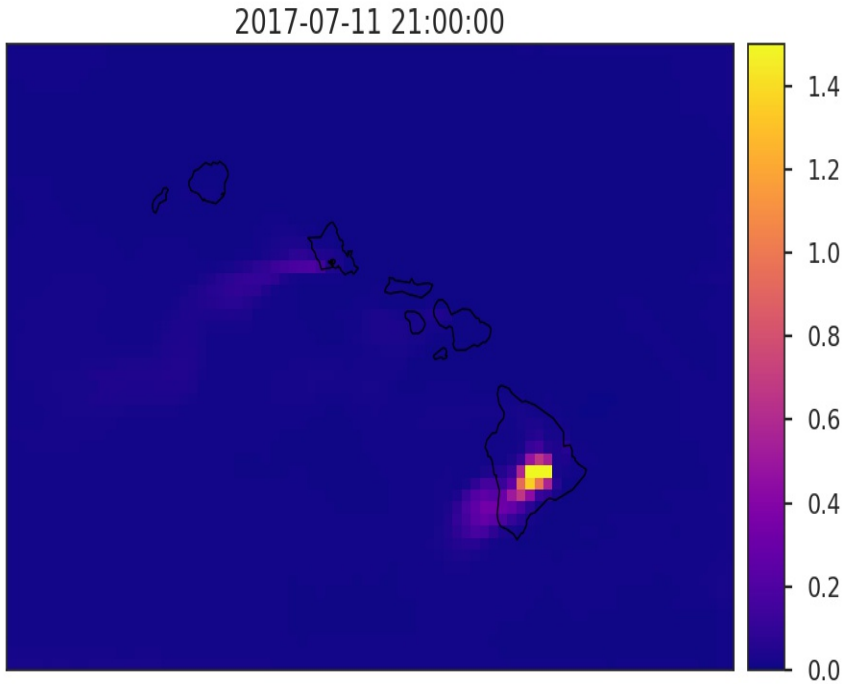
- **Model (National Air Quality Forecast Capability (NAQFC))**
  - CMAQ 5.0.2 CB05-AQ-AERO6 gas, aqueous and aerosol chemistry
- **NAQFC's Hawaii Domain**
  - 80 x 52 grid cells (All islands and surrounding water)
- **Horizontal resolution:** 12x12 km^2
- **Vertical level:** 35 layers
- **Meteorological inputs**
  - NAM(NMM-B) 12 km
- **Lateral boundary conditions**
  - GEOS-Chem precursors with Hilo monthly mean ozonesonde


Model Predicted Total Column SO_2 (DU)
at 12Z, 07/11/2017
23N
22.5N
22N
21.5N
21N
20.5N
20N
19.5N
19N
18.5N
18N
162W
161W
160W
159W
158W
157W
156W
155W
154W
153W
0
0.2
0.4
0.6
0.8
1
1.2
1.4

OMPS SO_2 Total Column (DU)

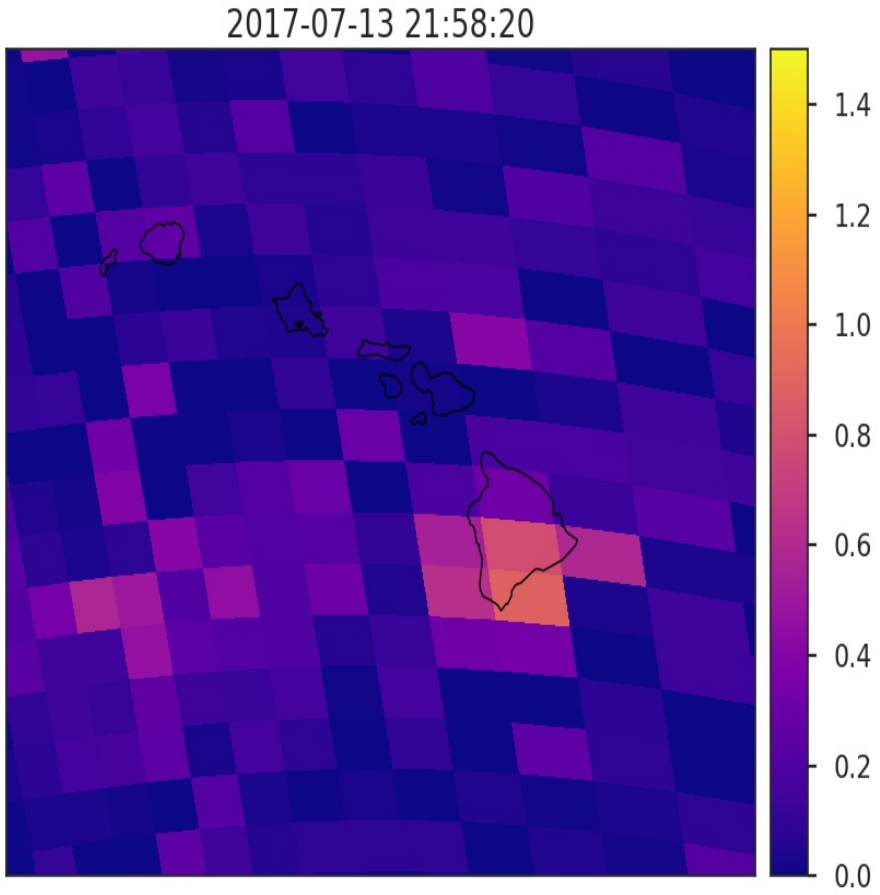


Model SO_2 Total Column (DU)

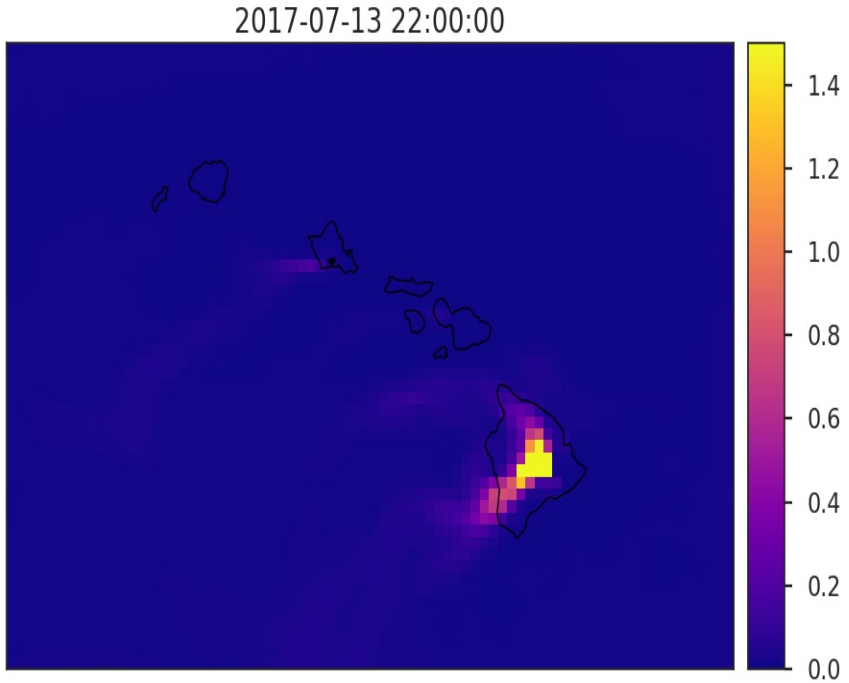


(OMPS SO_2 data is downloaded from NASA retrievals, https://so2.gsfc.nasa.gov)

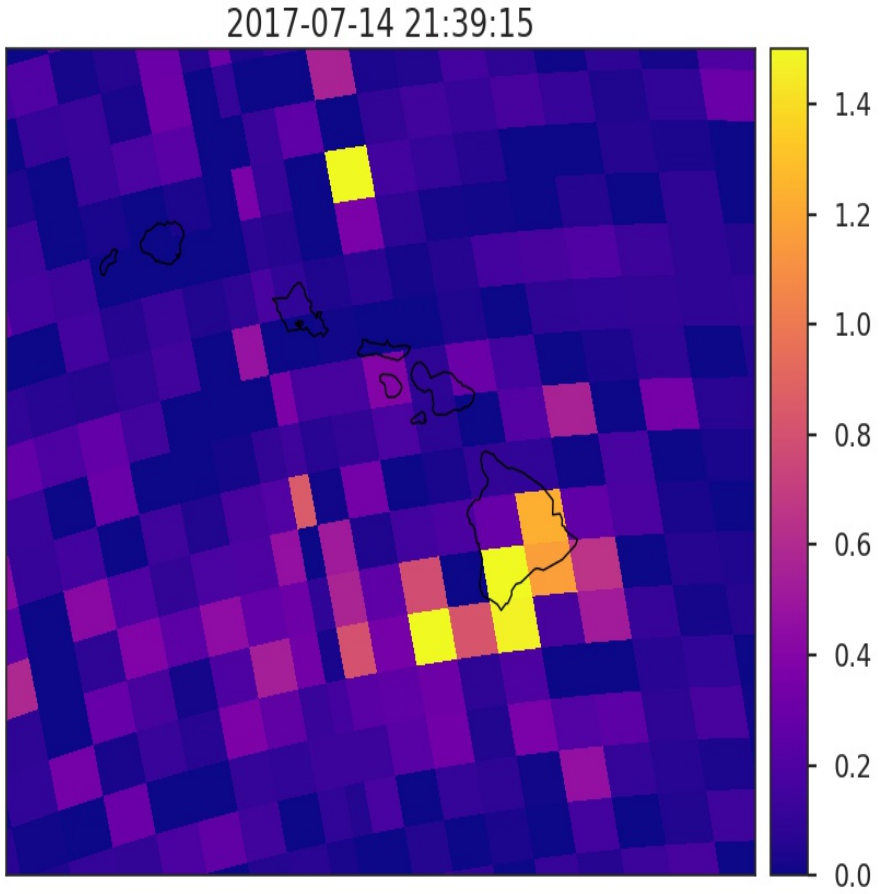
OMPS SO_2 Total Column (DU)



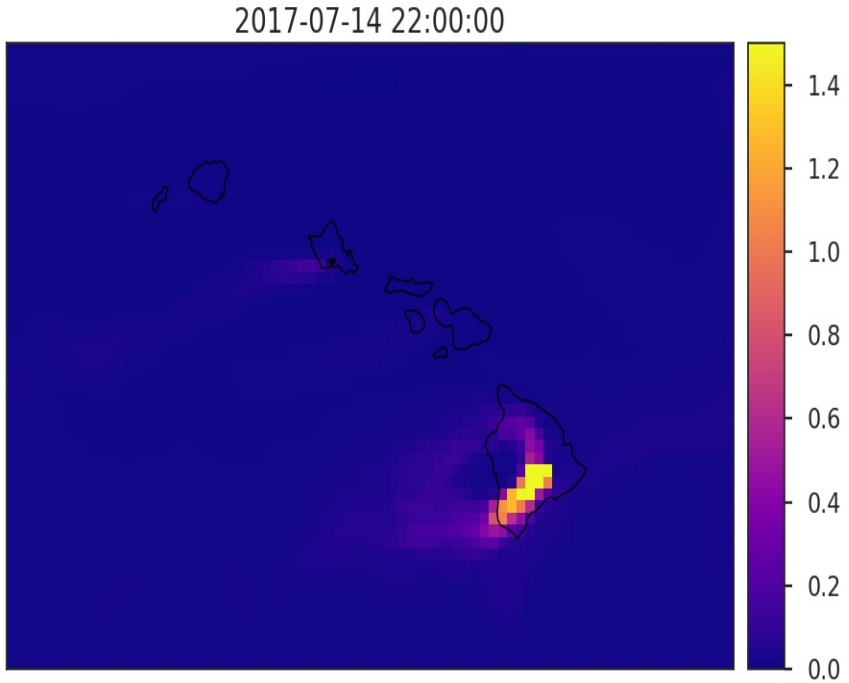
Model SO_2 Total Column (DU)



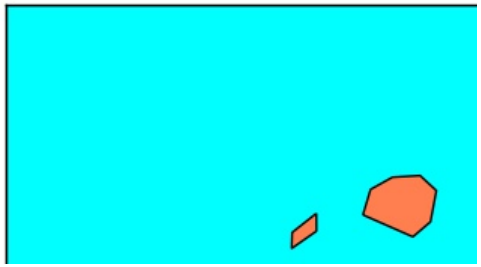
OMPS SO_2 Total Column (DU)



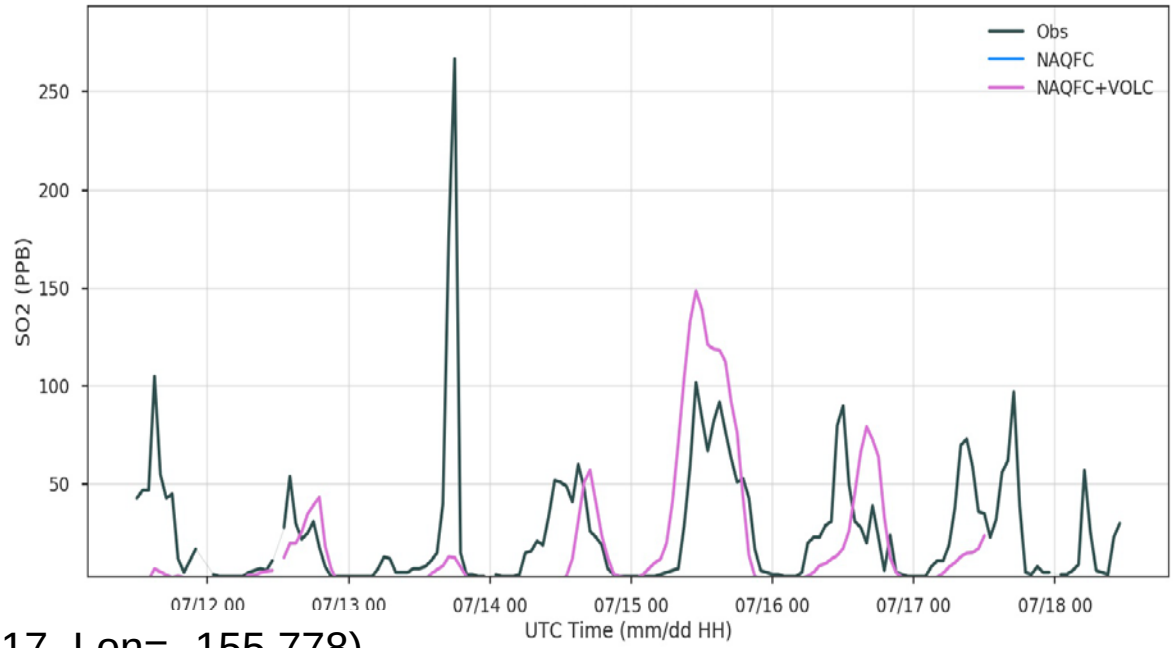
Model SO_2 Total Column (DU)



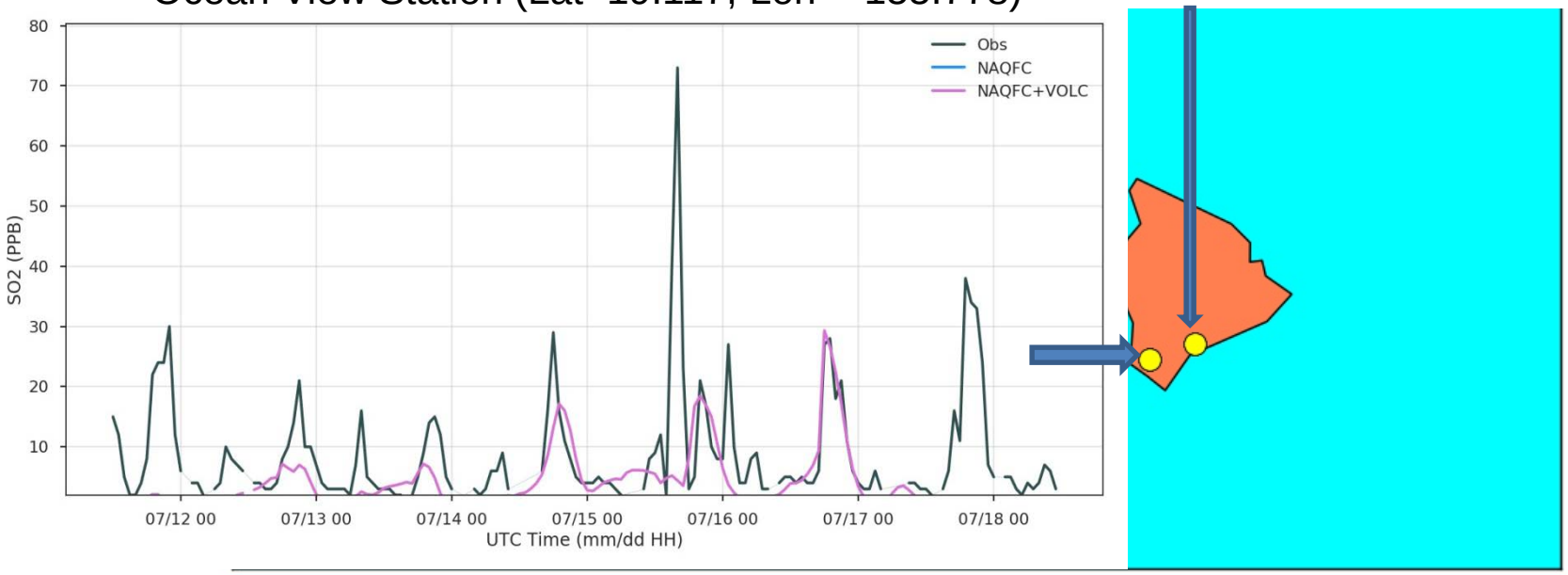
compared to surface SO_2 monitering data



Pahala Station (Lat=19.206, Lon= -155.469)

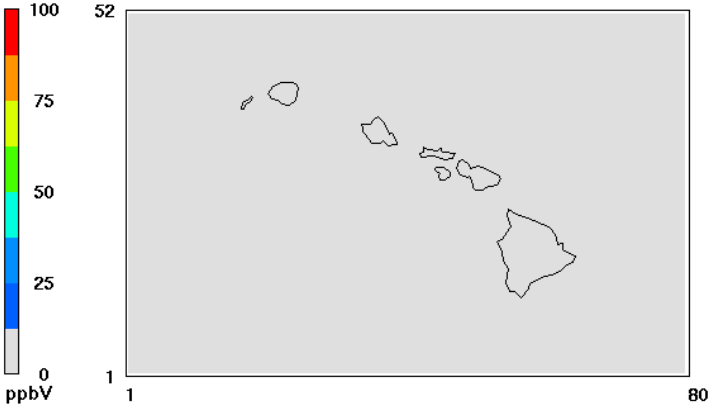


Ocean View Station (Lat=19.117, Lon= -155.778)

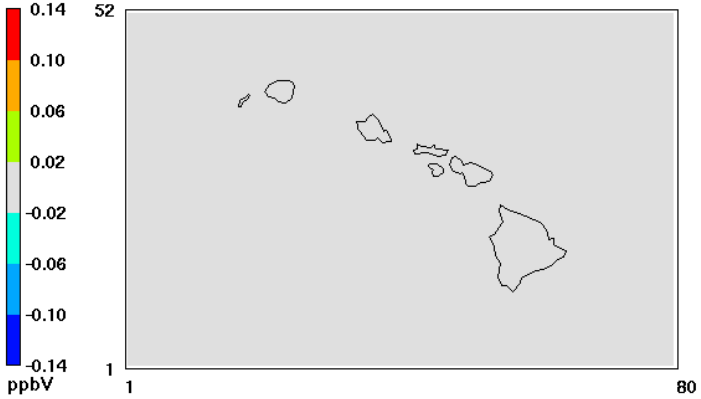


Effects on Air Quality

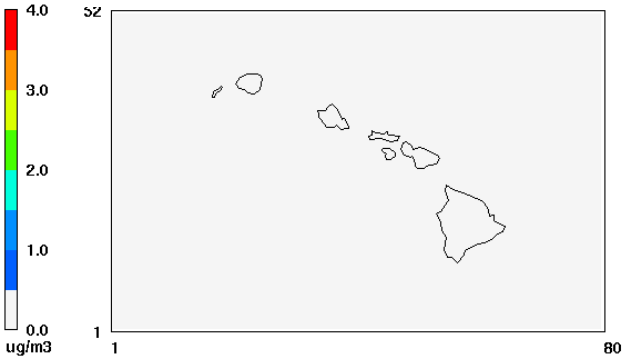
SO_2



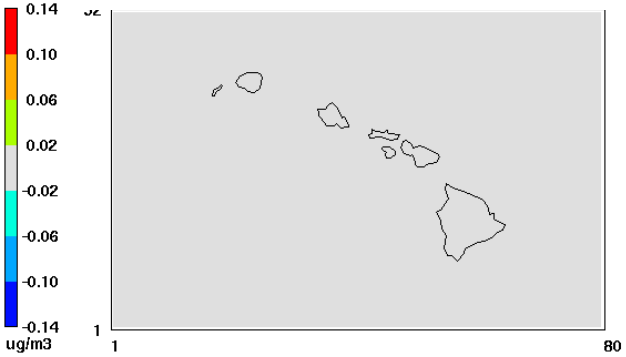
O_3



Sulfate



Nitrate



H_2O_2

Summary

- With the proper volcano SO_2 emission, we have capability to predict the Hawaii SO_2 plume, which is comparable to the surface measurements.
- OMPS SO_2 retrievals are comparable to the model results. After suitable Cal/Val, it can be used to verify/assimilate Hawaii volcano SO_2 concentration or emission.
- There are still uncertainties in the volcano emissions, such as plume heat fluxes etc, which can be adjusted with the proper satellite retrieval, such as FRP.

Future Works

1. Apply the similar OMPS SO_2 product to verify/assimilate the power-plant SO_2 emissions, which is the major SO_2 source over CONUS.
2. As SO_2 is the precursor of sulfate, we should be able see PM2.5 and AOT enhancement in the downstream areas, which can be verified with the VIIRS AOT product.