Synthesizing satellite- and surface-based air quality observations during the 2018 Kilauea eruption

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Introduction

Background
- Kilauea Volcano (Big Island, Hawaii)
  - Major SO₂ source in past decades [1]
  - May 3, 2018: new eruption begins
  - Some signs of eruption end in July, but was not recognized at the time (USGS)
  - Vog typical for Big Island western coast, with increased impact during 2018 eruption
  - Data available but needs to be synthesized

Research Questions
- What was the spatial and temporal pattern of volcanic-impacted air quality on the Big Island?
  - Sulfur dioxide
  - Particulate matter
  - Could public satellite and sensor network data have helped track the eruption activity?

Stakeholder Input
- Value to public to conveniently combine and present available data
- Some concerns with satellite data
  - Cloud cover handling; SO₂ height assumption; row anomaly (for OMI)
  - Consistency with the USGS, ground-based emission estimates

Volcanic Air Quality

Datasets Investigated
- Hawaii Department of Health
  - 14 stations
  - Variable coverage PM₂.₅, SO₂
  - 5-, 15-, or 60-min averages
- PurpleAir network (commercial)
  - 68 stations, PM₂.₅ and met
- Satellite (OMI and OMPS)
  - SO₂ column using consistent retrieval algorithm [6]
- Mobile monitoring (Princeton)
  - Multi-species campaign Aug. 5 to 20

Satellite Examples

SO₂ plume as observed from space, driven by trade wind conditions

Spatial and Temporal Trends

DEPARTMENT OF HEALTH NETWORK

Air quality at three stations through early Dec. 2018; volcanic signal seen May to early August

OMI AND OMPS

SO₂ mass evolution from both satellites (circles: individual days; lines: 7-day mean); product from https://so2.gsfc.nasa.gov/index.html

Conclusions and Implications

Main results
- Clear start, evolution, and end to eruption seen in all four observational datasets; satellite measures spatially integrated emissions while surface monitors directly applicable to air quality
- Satellite SO₂ retrievals tracked slowdown in July (especially OMPS) unlike the surface networks; in retrospect, had value as sign of slowing volcano activity
- Air quality significantly impacted during May–July; afterwards, conditions cleaner than normal
- 7-day mean OMPS SO₂ consistently higher than from OMI

Future work
- Model SO₂ dispersion patterns with STILT and estimate daily SO₂ emissions

Satellite Examples

Comparison

Comparison to DustTrak instrument (where driven within 10 km of monitoring station)

SATELLITE COMPARISON

• Most OMPS readings above 1:1 line; through trends consistent for both
• Results used lower tropospheric (3 km center altitude) profile
• OMI: PBL assumption 4.3x higher
• OMPS: PBL assumption 3.2x higher
• Number of quality controlled results (April through August)
  - 131 results for OMI, 104 for OMPS
  - 90 for both

Bibliography


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