HyspIRI Preparatory Airborne Science: Investigations of Volcanic Phenomena

Vincent Realmuto, Jet Propulsion Laboratory, California Institute of Technology

Chad Deering, Michigan Technological University

Paul Lundgren, Jet Propulsion Laboratory, California Institute of Technology

David Pieri, Jet Propulsion Laboratory, California Institute of Technology

Michael Ramsey, University of Pittsburgh

Greg Vaughan, United States Geological Survey

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Government sponsorship acknowledged.

Five Investigations Focused on Active Vents of Kilauea Volcano

Halemaumau Crater, Kilauea Summit Caldera
SO_2 emissions up to 2500 metric tonnes/day since 2008

Puu Oo Vent and Southeast Rift Zone
SO_2 emissions and episodic surface activity since 1983

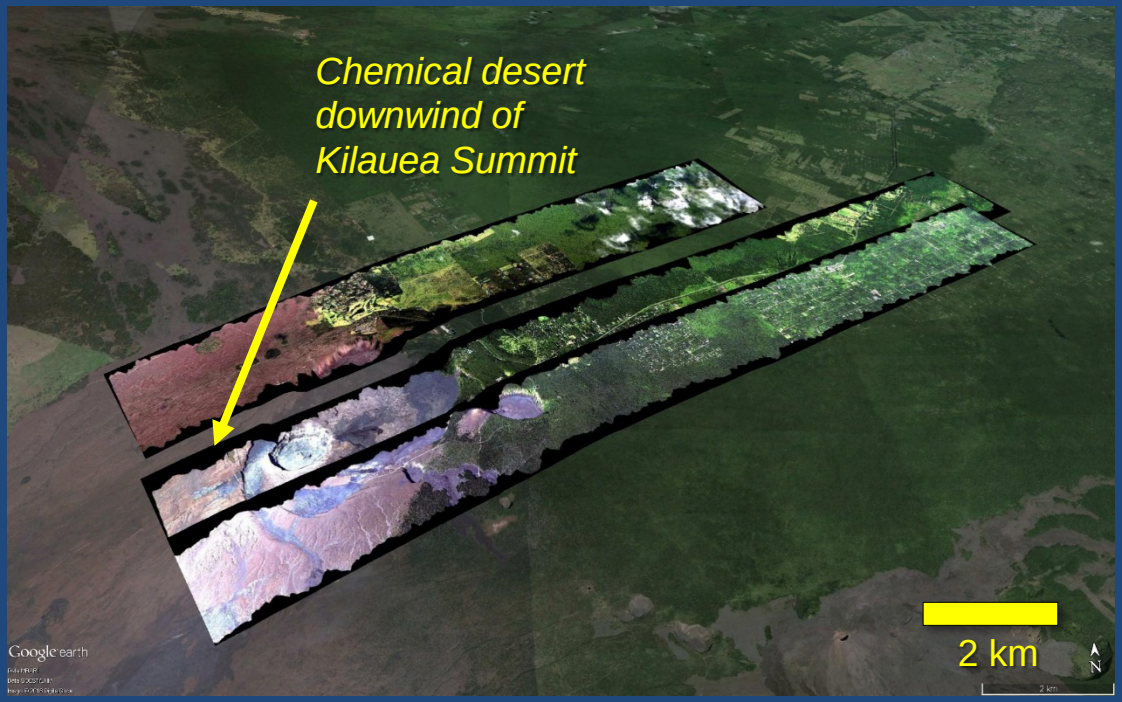
Understanding Basaltic Volcanic Processes by Remotely Measuring the Links between Vegetation Health and Extent and Volcanic Gas and Thermal Emissions using HyspIRI-like VSWIR and TIR Data

Chad Deering, Michigan Technological University

R. Greg Vaughan, USGS Astrogeology Science Center

Isabella Mariotto, Michigan Technological University

Jessica McCarty, Michigan Tech Research Institute



In Situ Validation of Remotely Sensed Volcanogenic Emissions Retrievals using Aerostats and UAVs

David Pieri, Jet Propulsion Laboratory, California Institute of Technology

Andres Diaz, University of Costa Rica

Florian Schwandner, University of California – Los Angeles

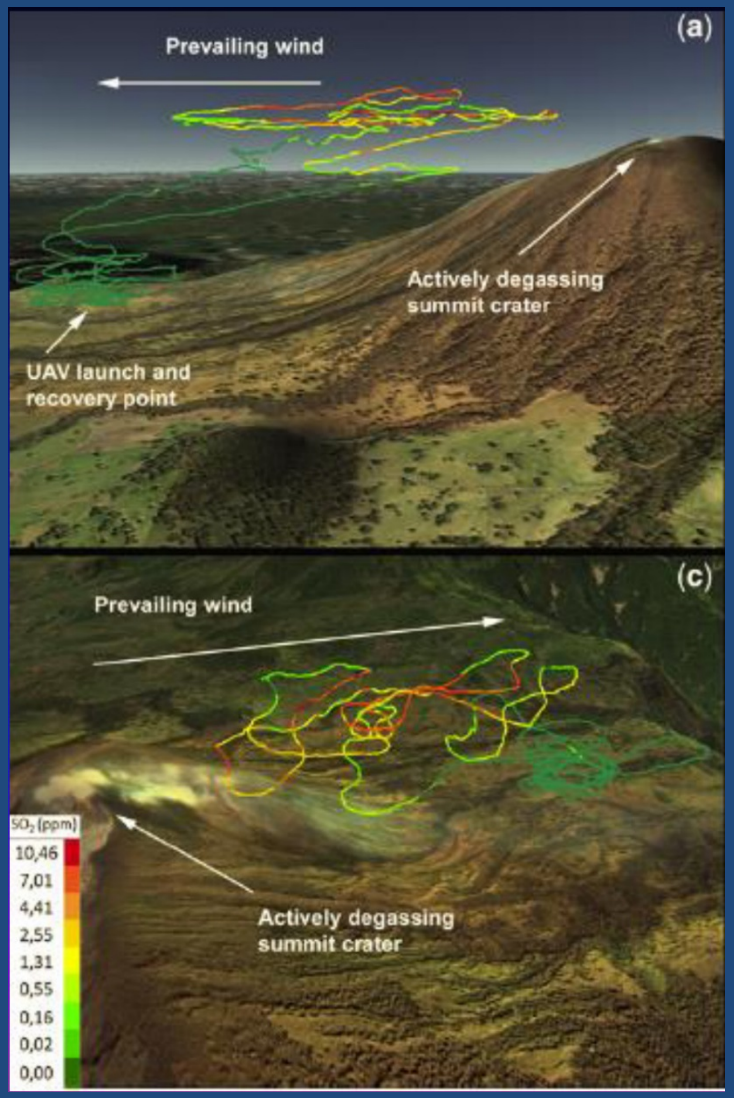
Lance Christensen, Jet Propulsion Laboratory, California Institute of Technology

Geoffrey Bland, NASA Goddard Space Flight Center, Wallops Flight Facility

Peter Mouginis-Mark, University of Hawaii – Manoa

Matt Fladeland, NASA Ames Research Center

Fabrizia Buongiorno, Istituto Nazionale di Geofisica e Volcanologia (Italy)



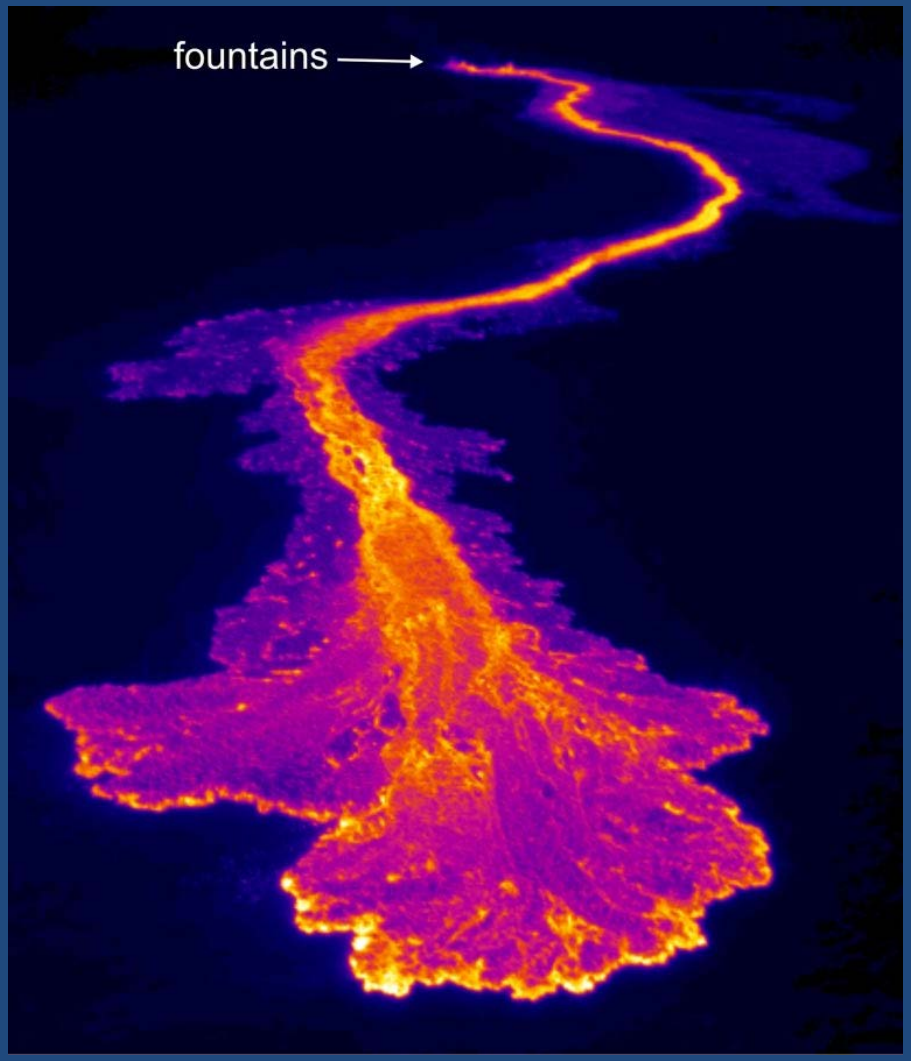
Quantifying Active Volcanic Processes and Mitigating their Hazards with HyspIRI Data

Michael Ramsey, University of Pittsburgh

Andrew Harris, Univesité Blaise Pascal (France)

I. Matthew Watson, University of Bristol (UK)

Matthew Patrick, USGS Hawaiian Volcano Observatory



IR image of Kilauea flow: Matt Patrick (HVO)

Quantifying Active Volcanic Processes and Mitigating their Hazards with HyspIRI Data

Mapping the Composition and Chemical Evolution of Plumes from Kilauea Volcano: Preparing for the Use of HyspIRI Data to Monitor the Impact of Volcanic Plumes on Air Quality

Vincent Realmuto, Jet Propulsion Laboratory, California Institute of Technology

Florian Schwandner, University of California – Los Angeles

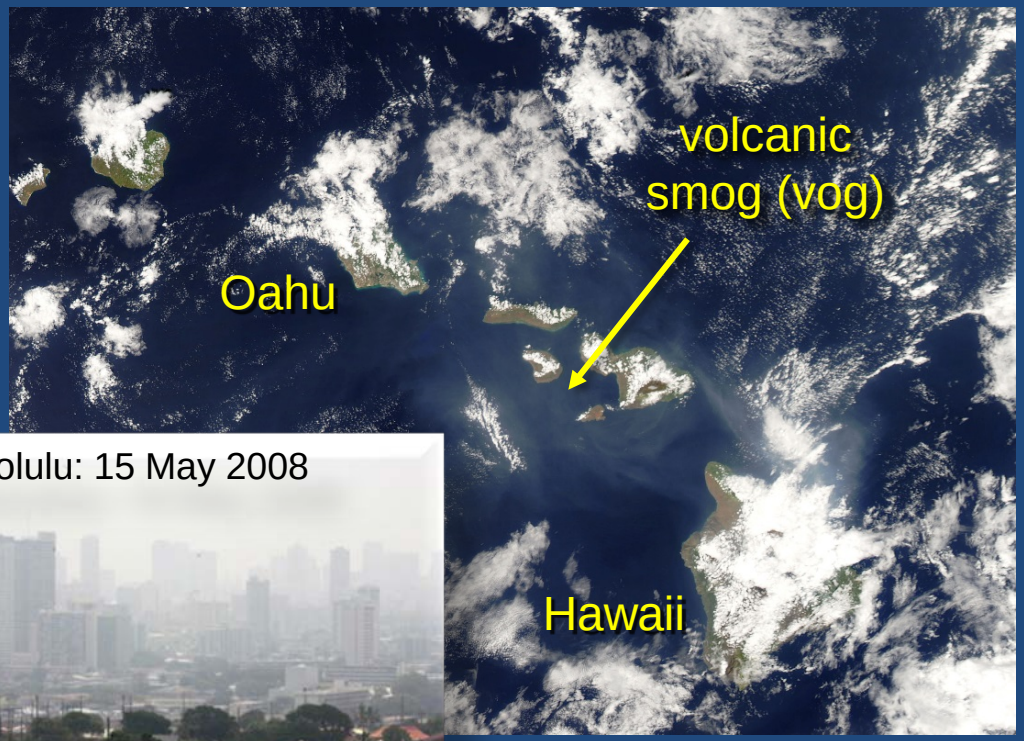
Steven Businger, University of Hawaii – Manoa

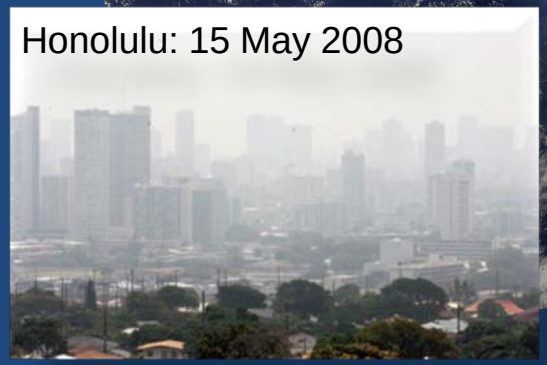
A Sutton, USGS Hawaiian Volcano Observatory

Tamar Elias USGS Hawaiian Volcano Observatory

Keith Horton, Flyspec, Inc.

MODIS RGB: 9 May 2008
Kona (SW) Wind Conditions





Developing an Automated Volcanic Thermal Alert Algorithm using Moderate Spatial Resolution VSWIR and TIR Data: Implications for the Future HyspIRI Mission

R. Greg Vaughan, USGS
Astrogeology Science Center

Moses Milazzo, USGS
Astrogeology Science Center

Jason Laura, USGS
Astrogeology Science Center

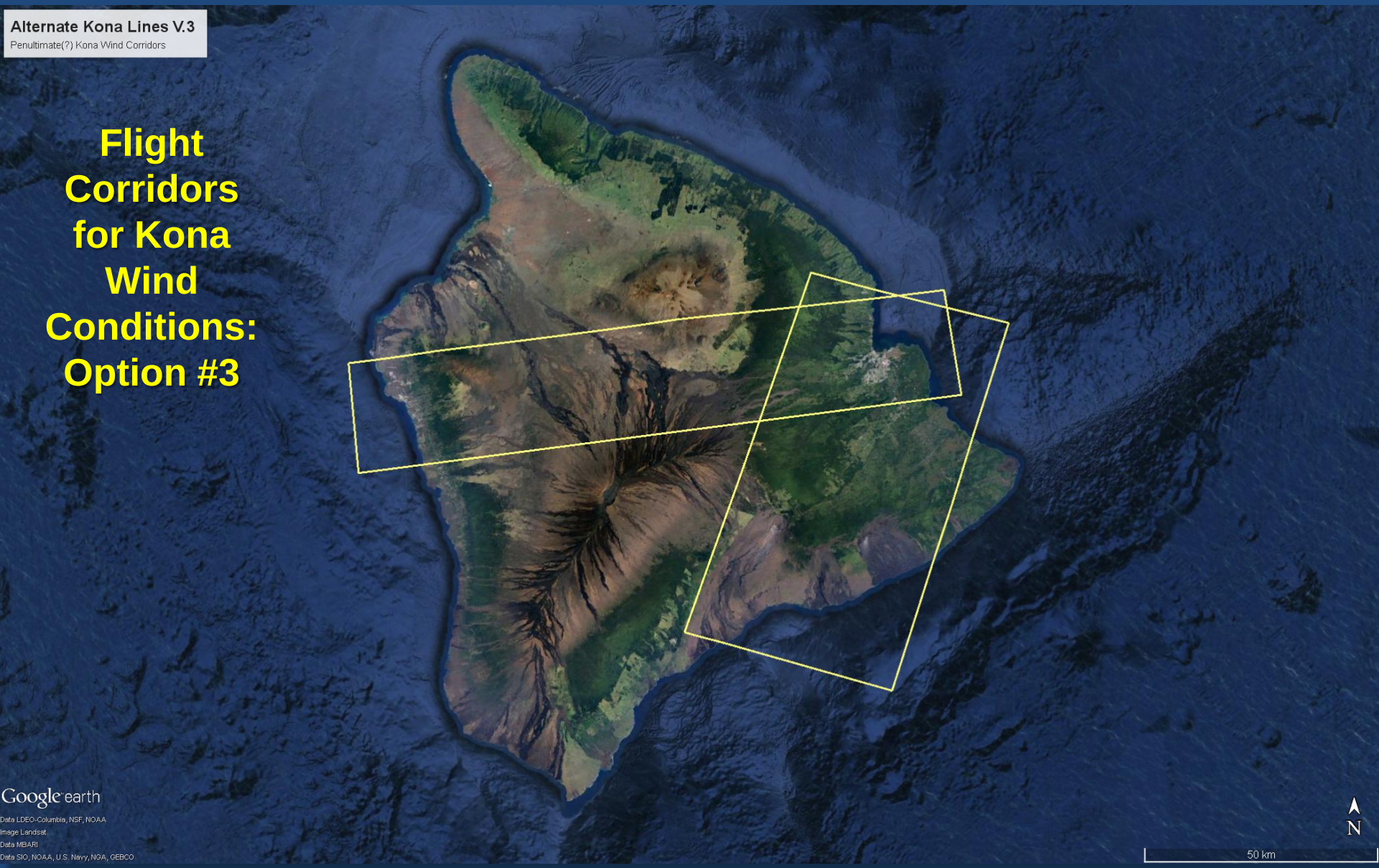
Matthew Patrick, USGS
Hawaiian Volcano Observatory

Laszlo Kestay, USGS
Astrogeology Science Center

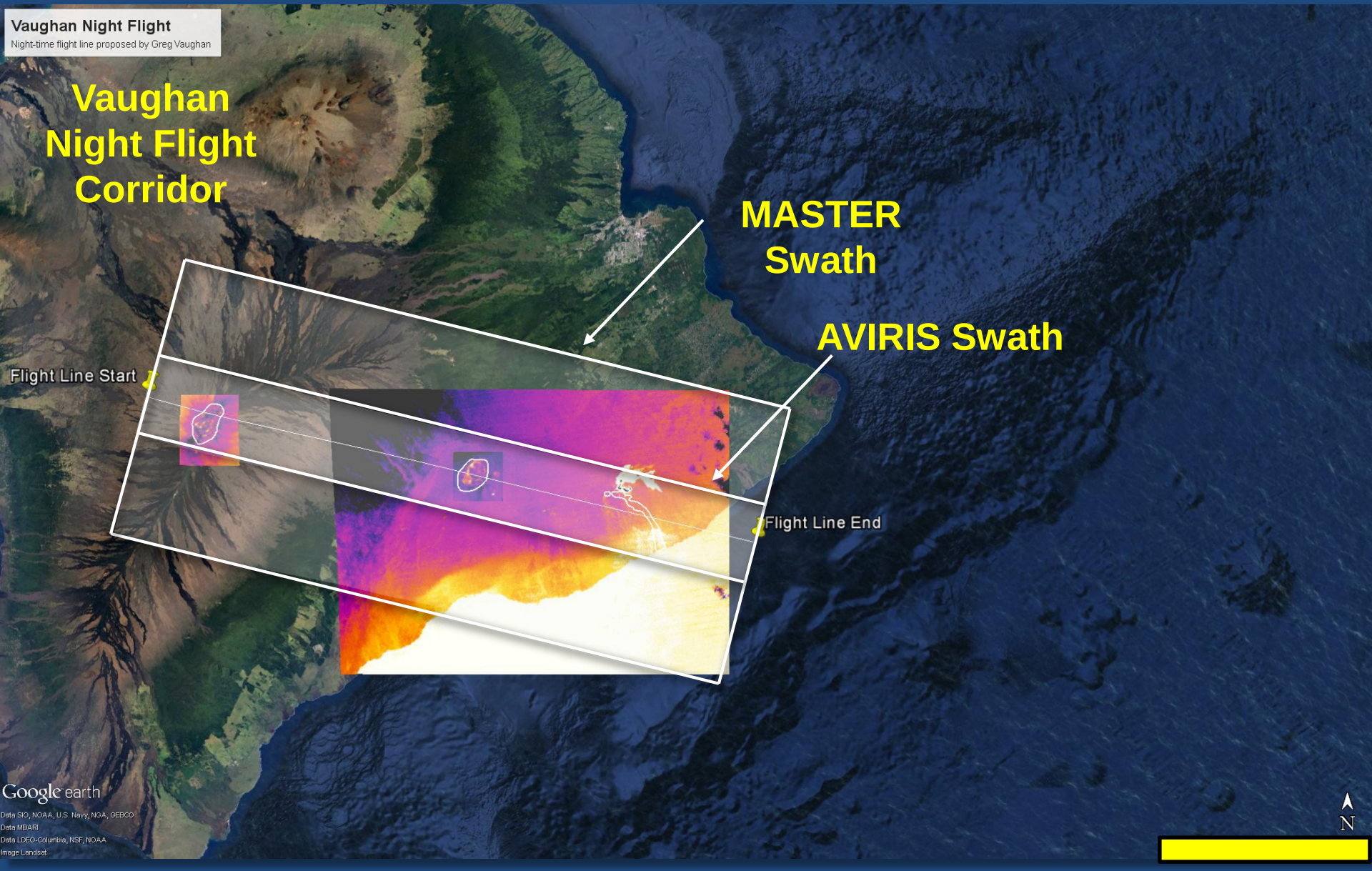
Realmuto Flight Planning
Flight Corridors for Trade Winds Conditions
Legend
Flight Corridors for Trade Wind Conditions
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
Data LDEO-Columbia, NSF, NOAA
Data MBARI
N
50 km

50 km

Flight Corridors for Kona Wind Conditions: Option #3



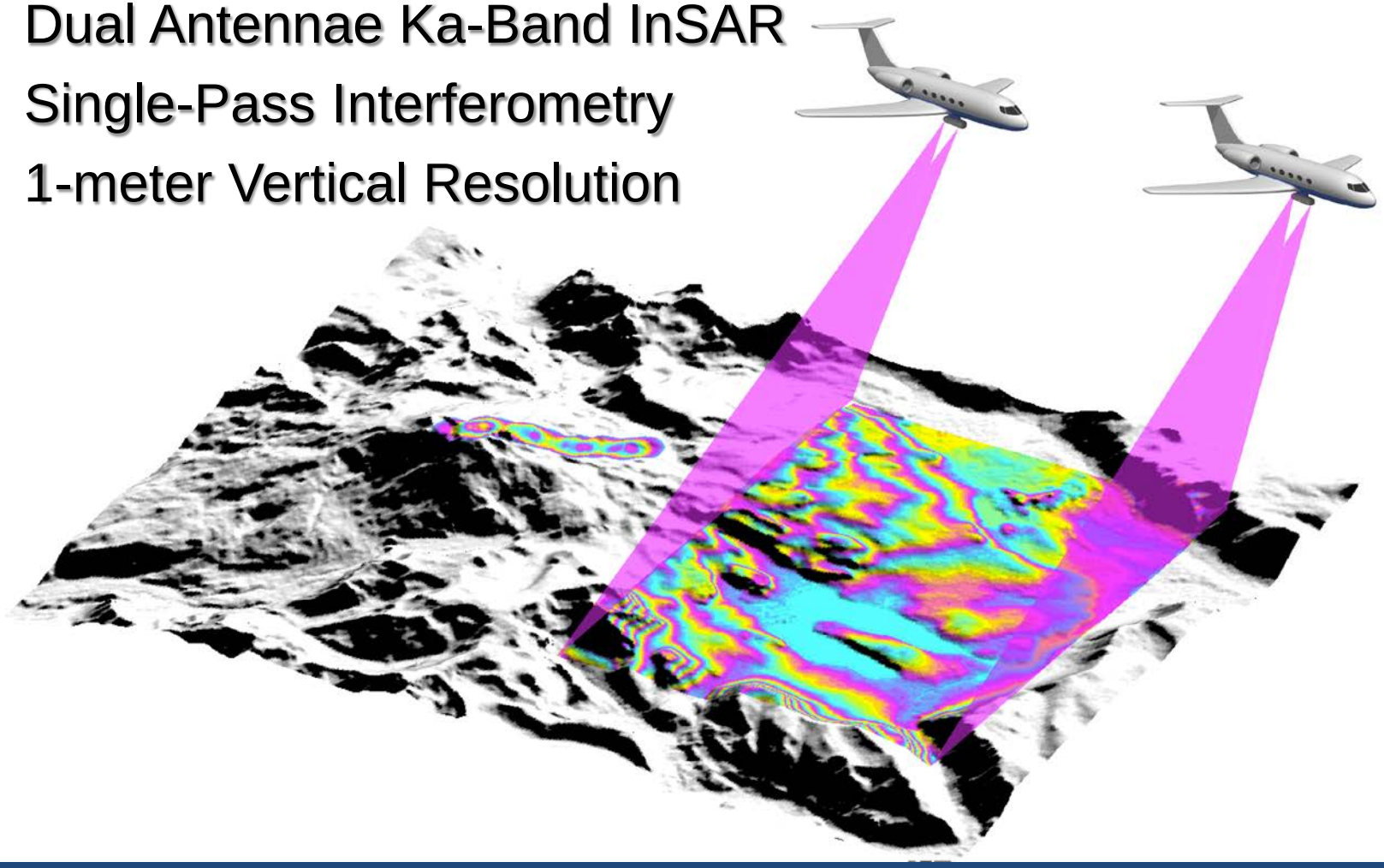
50 km


Vaughan Night Flight
Night-time flight line proposed by Greg Vaughan
Vaughan Night Flight Corridor
MASTER Swath
AVIRIS Swath
Flight Line Start
Flight Line End
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data MBARI
Data LDEO-Columbia, NSF, NOAA
Image Landsat
N
30 km

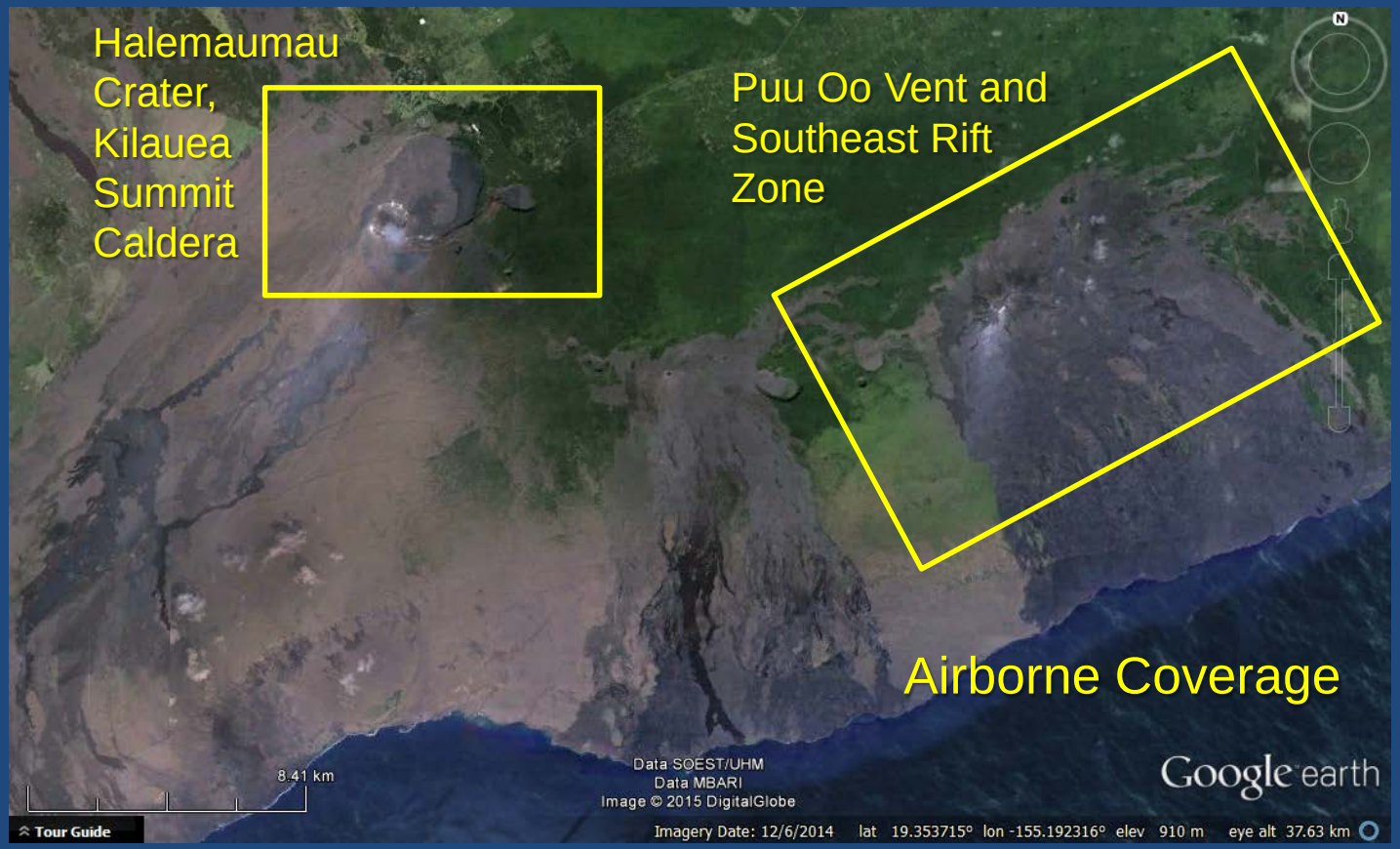
Paul Lundgren (JPL): Topography Change

Glacier/Land Ice Surface Topography Interferometer (GLISTIN-A):

- Dual Antennae Ka-Band InSAR
- Single-Pass Interferometry
- 1-meter Vertical Resolution



Topographic Change



Preparing for the Use of HyspIRI to Monitor the Impact of Volcanic Plumes on Air Quality

Vincent J. Realmuto
Jet Propulsion Laboratory

Co-Investigators and Collaborators

F. Schwandner, NPP/JPL

A.J. Sutton, USGS-HVO

T. Elias, USGS-HVO

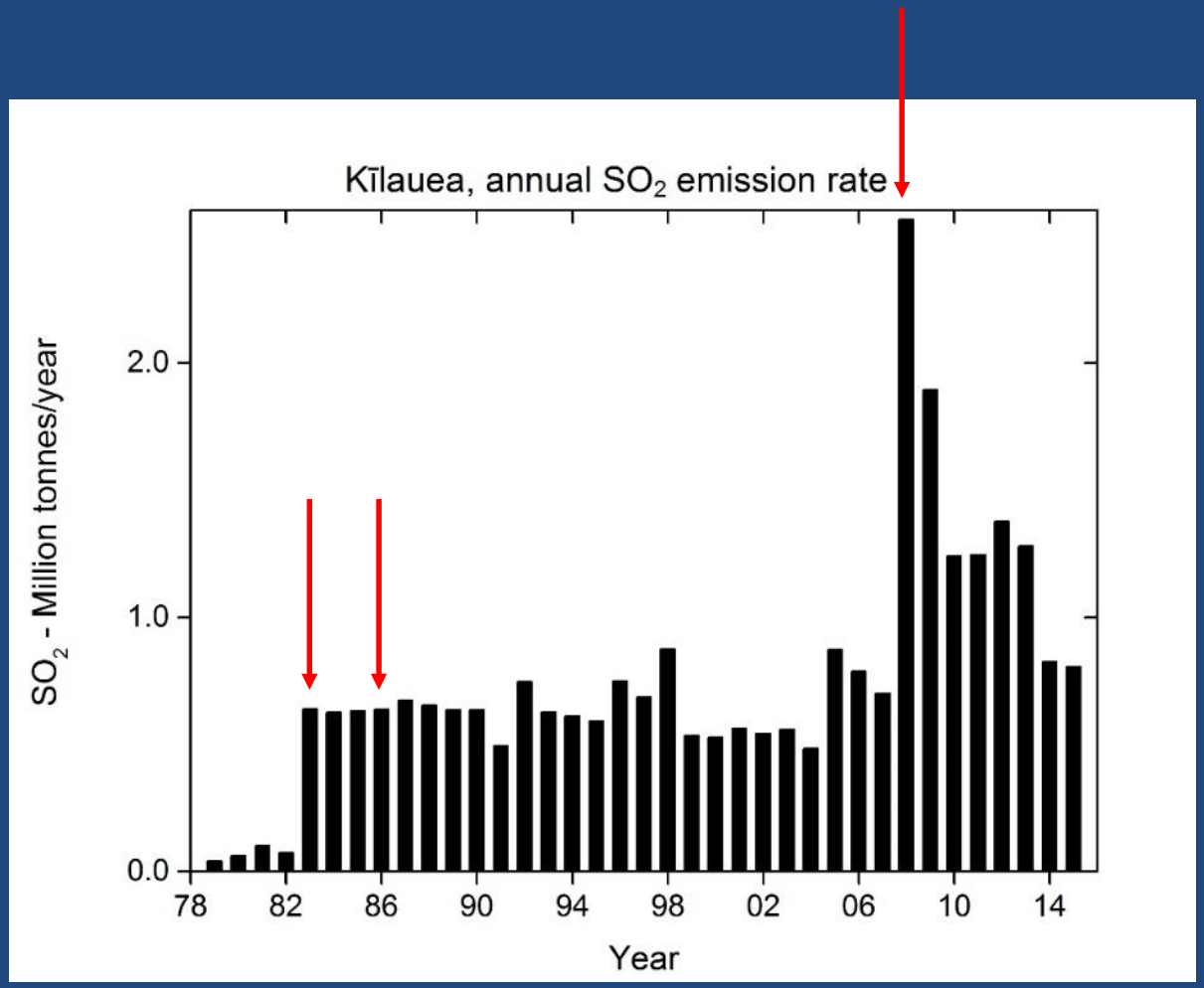
S. Businger, UH-Manoa

K. Horton, FlySpec, Inc.

Experimental Method

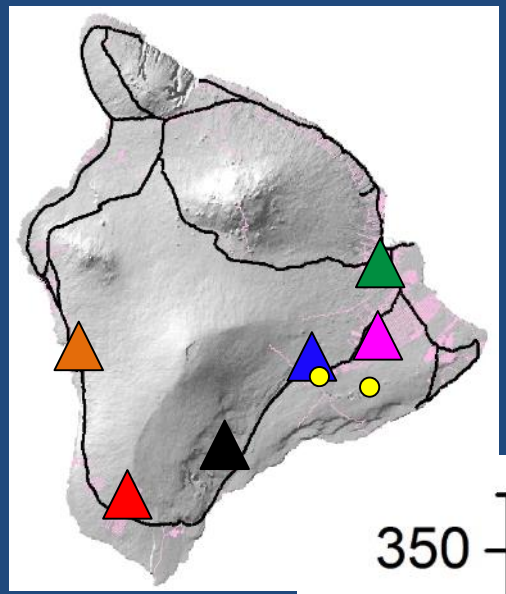
- Airborne remote sensing to map the initial concentrations of sulfur dioxide (SO_2) from Kilauea Volcano and conversion of SO_2 to sulfate (SO_4) aerosols
- Validate our maps with ground-based measurements and contemporaneous satellite data
- Input our maps into the UH VMAP Vog Model to demonstrate improvements to the forecasting skill of the model.

Kīlauea Annual SO_2 Emissions: Record Punctuated by East Rift and Summit Eruptions



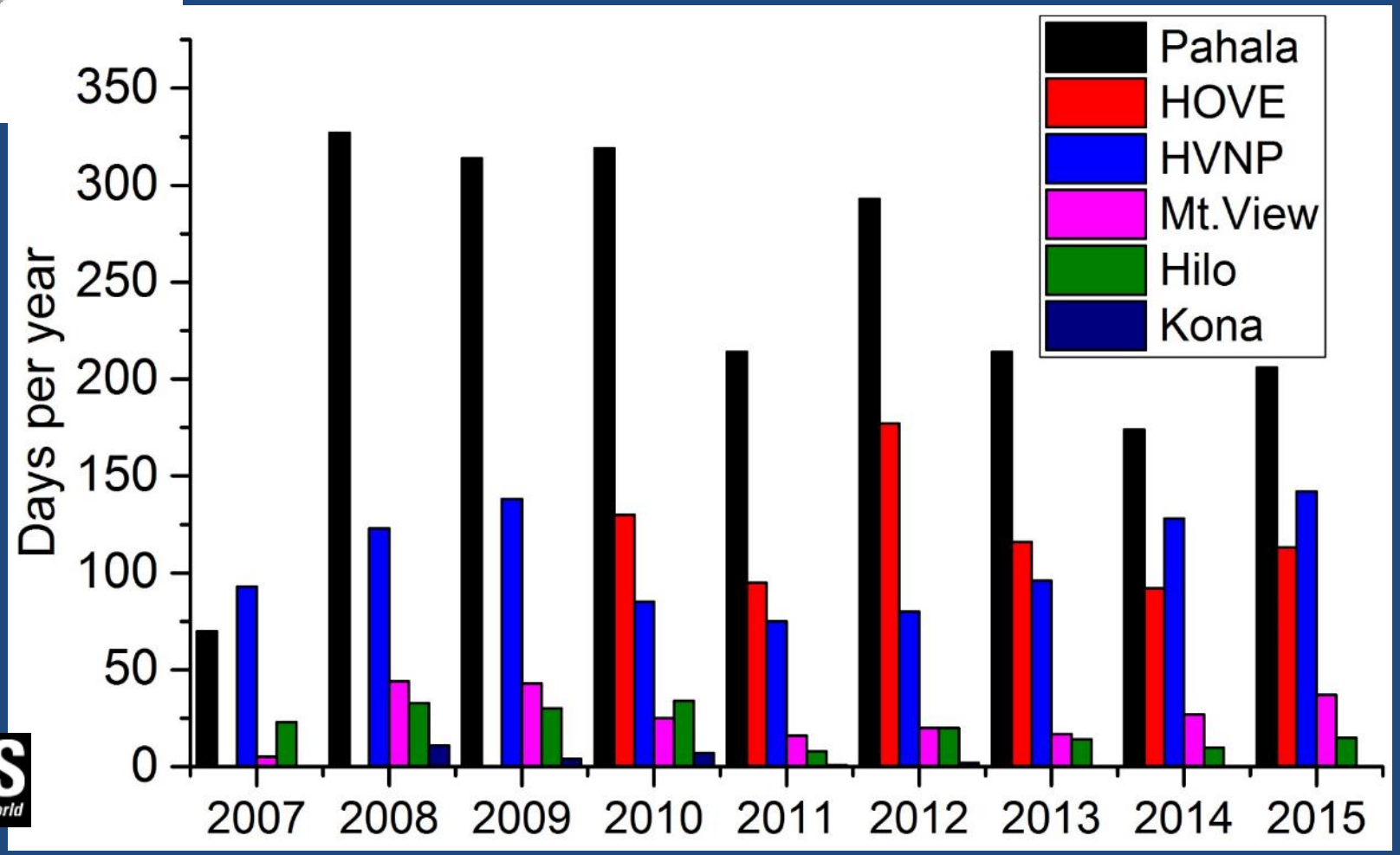
USGS
science for a changing world

Days with SO_2 in Excess of Health Standard (75 ppb)



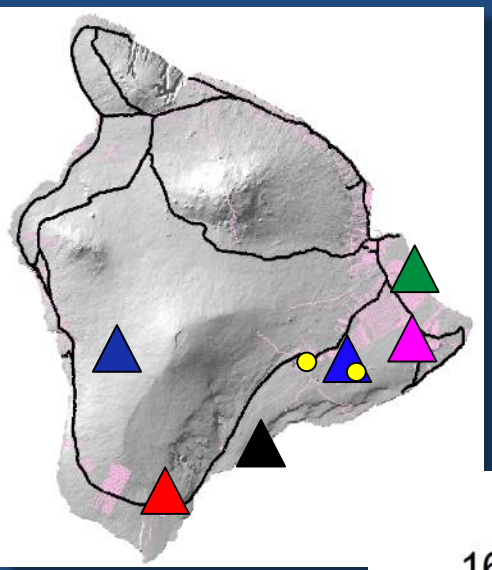
Trade Wind Flow

Data courtesy of Hawaii State Department of Health and NPS



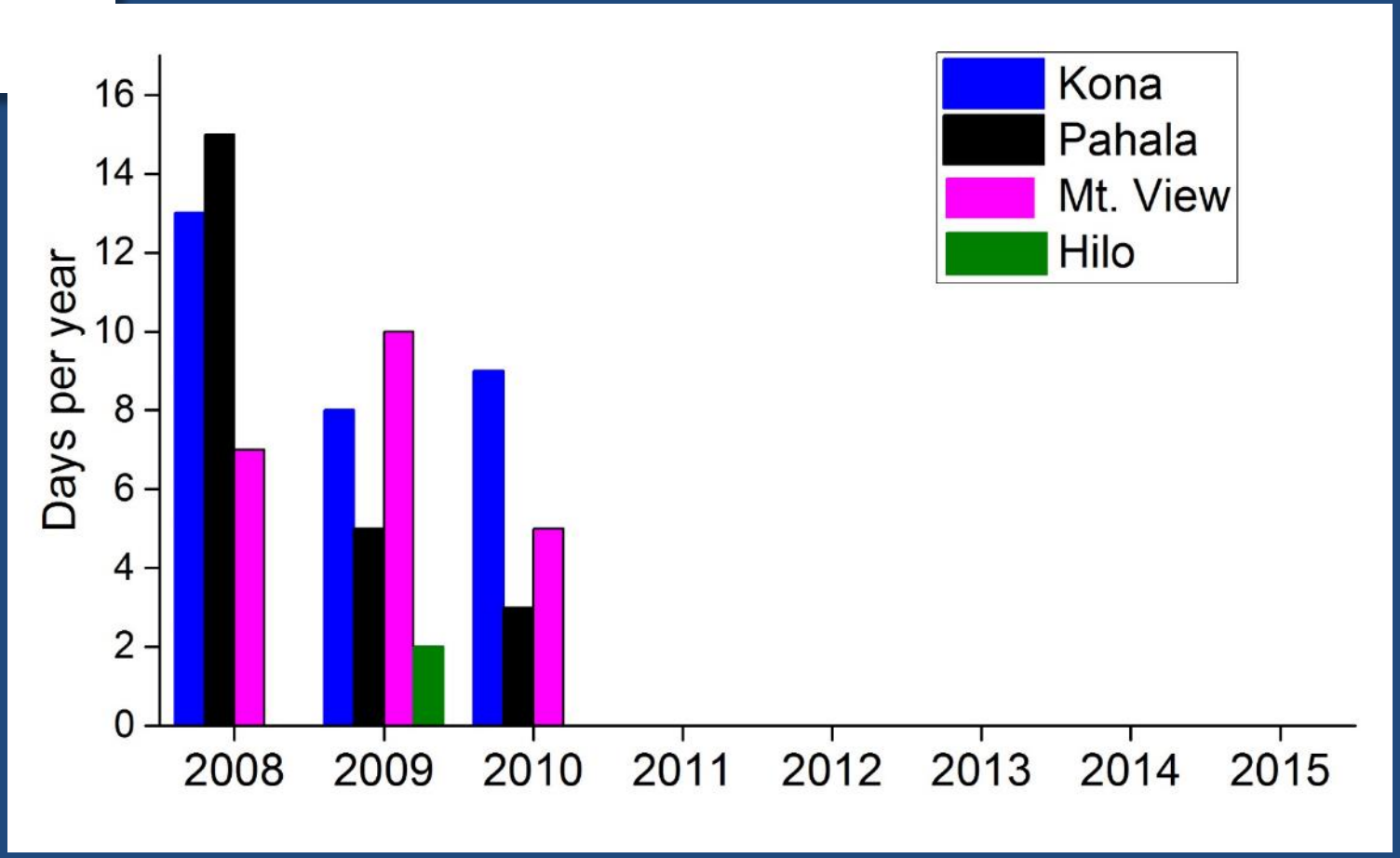
USGS
science for a changing world

Days with $PM_{2.5}$ in Excess of Health Standard (35 µg/m^3)



Trade Wind Flow

Data courtesy of Hawaii State Department of Health and NPS



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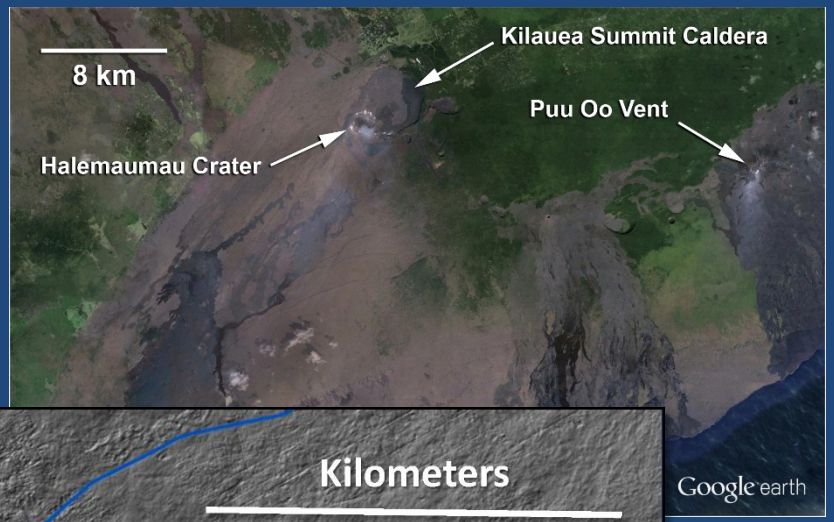
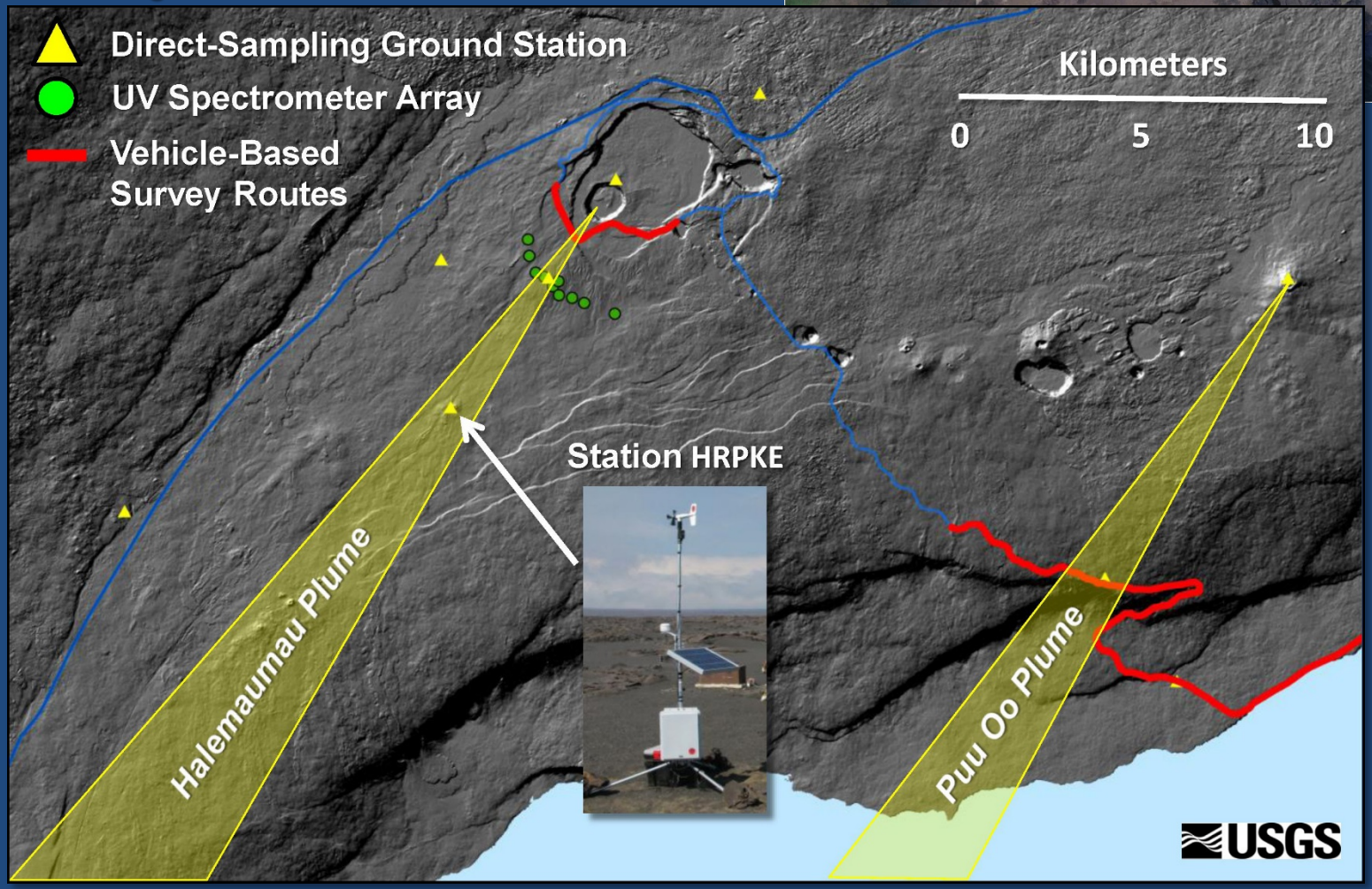
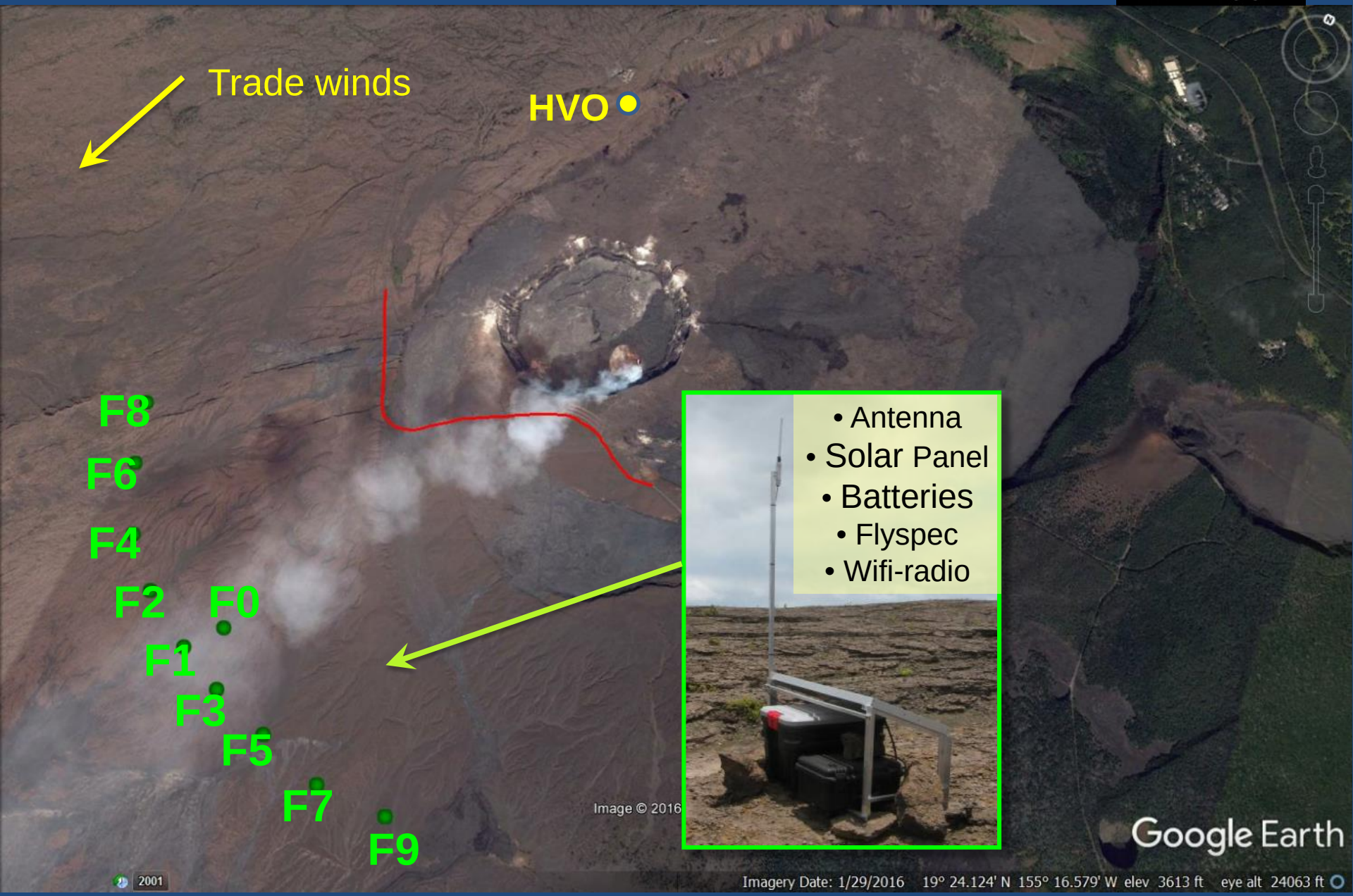
USGS-Hawaii Volcano Observatory Gas Geochemistry Network

- Comprehensive Network of Direct-Sampling Ground Stations, UV Spectrometer Array, and Vehicle-Based Spectrometer Surveys
- SO_2 Emission Measurements Used to Initialize the Univ. Hawaii Vog Model

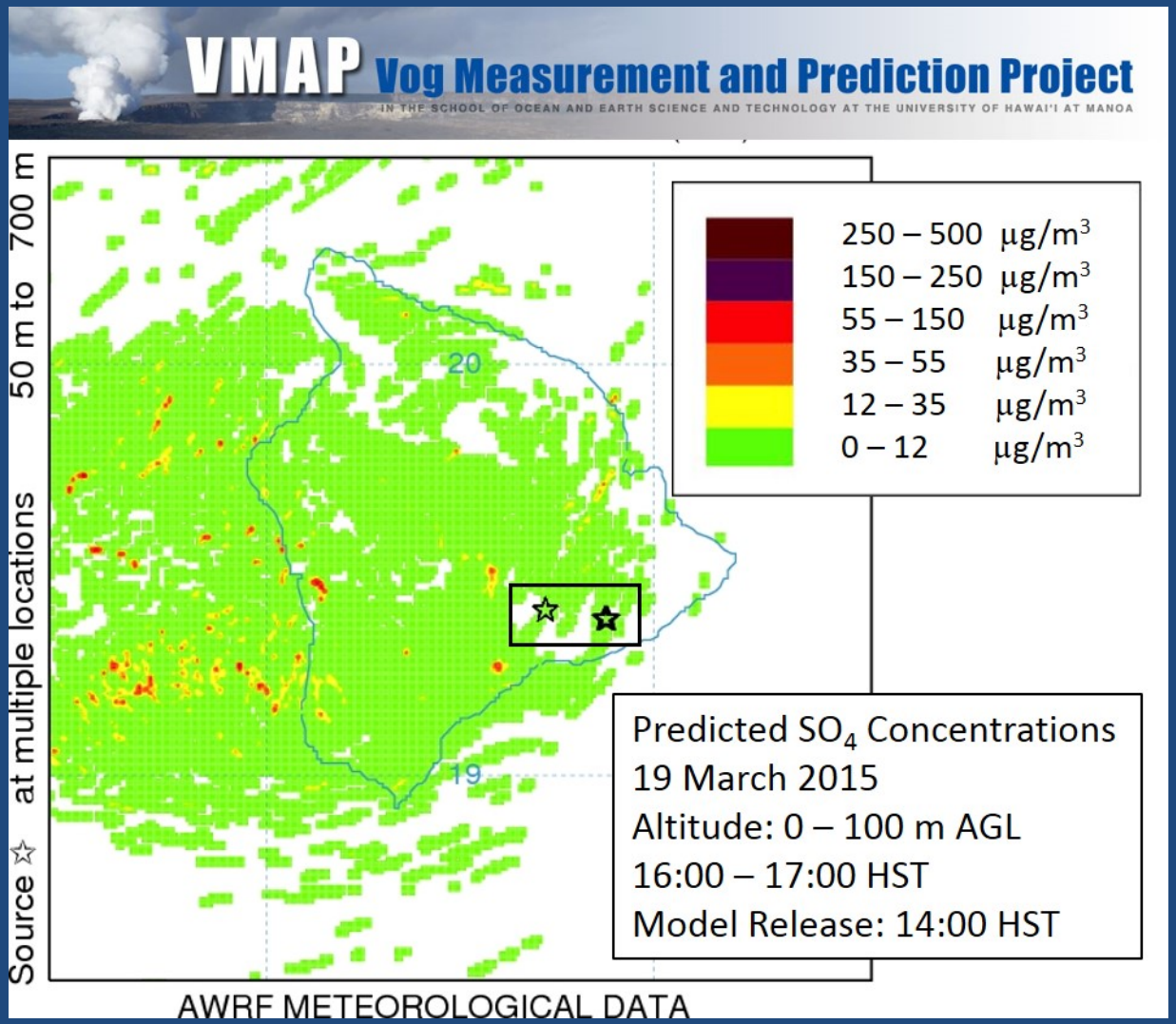





Trade winds
HVO
F8
F6
F4
F2
F0
F1
F3
F5
F7
F9
• Antenna
• Solar Panel
• Batteries
• Flyspec
• Wifi-radio
Image © 2016
Google Earth
2001
Imagery Date: 1/29/2016 19° 24.124' N 155° 16.579' W elev 3613 ft eye alt 24063 ft

UH VMAP Project: Hourly Forecasts of $PM_{2.5}$

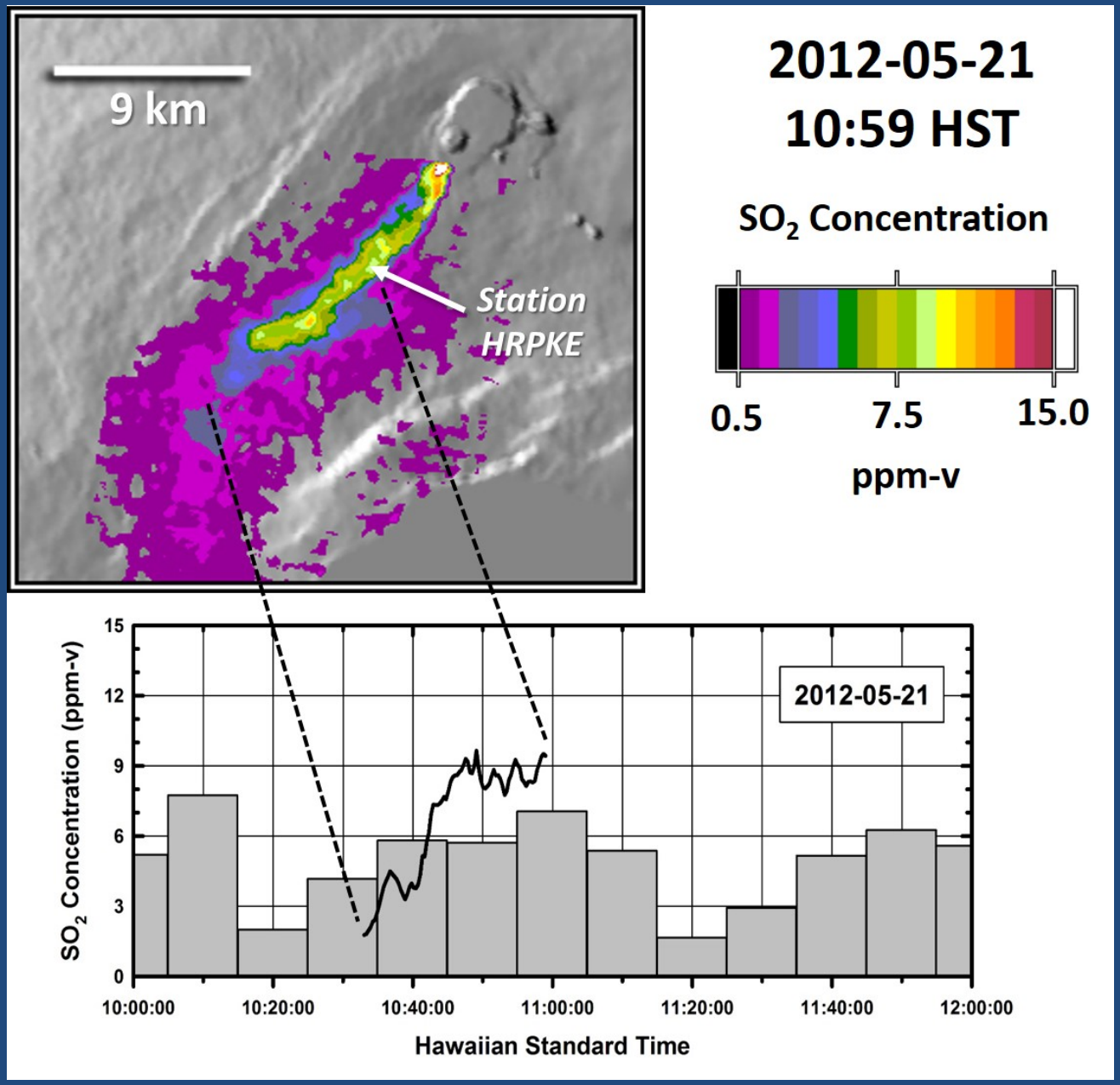
- Initialized by HVO Measurements of SO_2 Emission Rate
- Prediction Skill (Training) via Comparison with DOH Stations
- High Resolution of Model Domain (1 km Grid Spacing) + Sparse DOH Network = Most of the Forecast Field <u>Cannot be Validated</u>



Plume Tracker Analysis of ASTER TIR Data

SO_2 Retrievals at High Spatial Resolution (90 m) Provide Important Input Parameters for Vog Model

- 2-D Maps of SO_2 Source is Superior to Line Source Model
- Longitudinal Profiles Record the Chemical Evolution of Plume - Constrain SO_2 Loss Rates
- Spatial Resolution of MODIS (1 km) and VIIRS (750 m) TIR Data are Finer than Vog Model (1 km)



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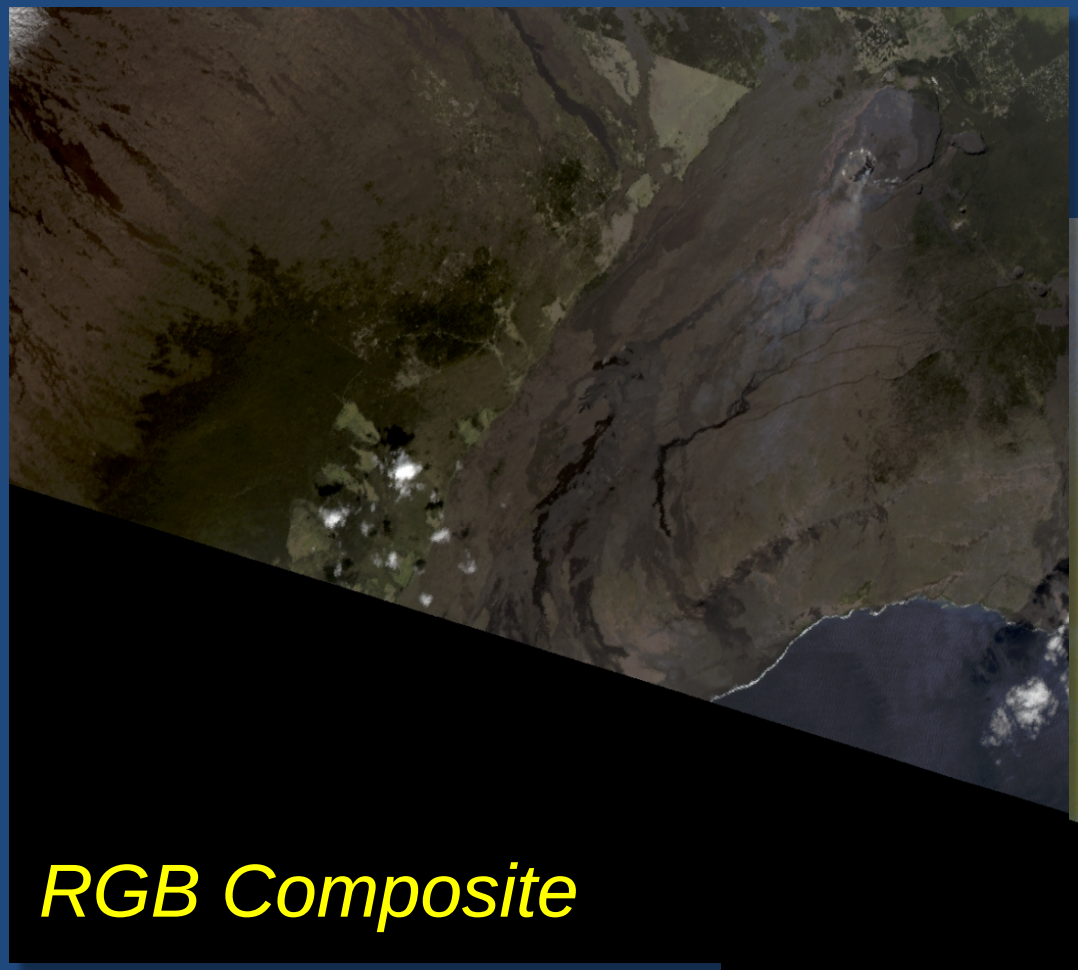
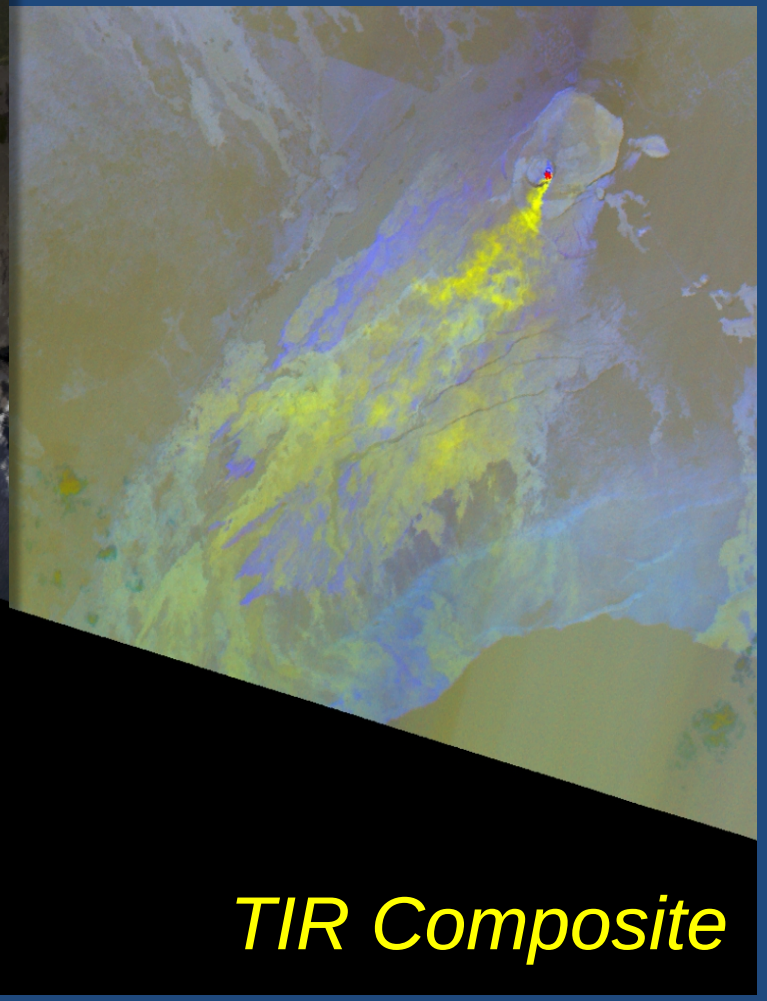
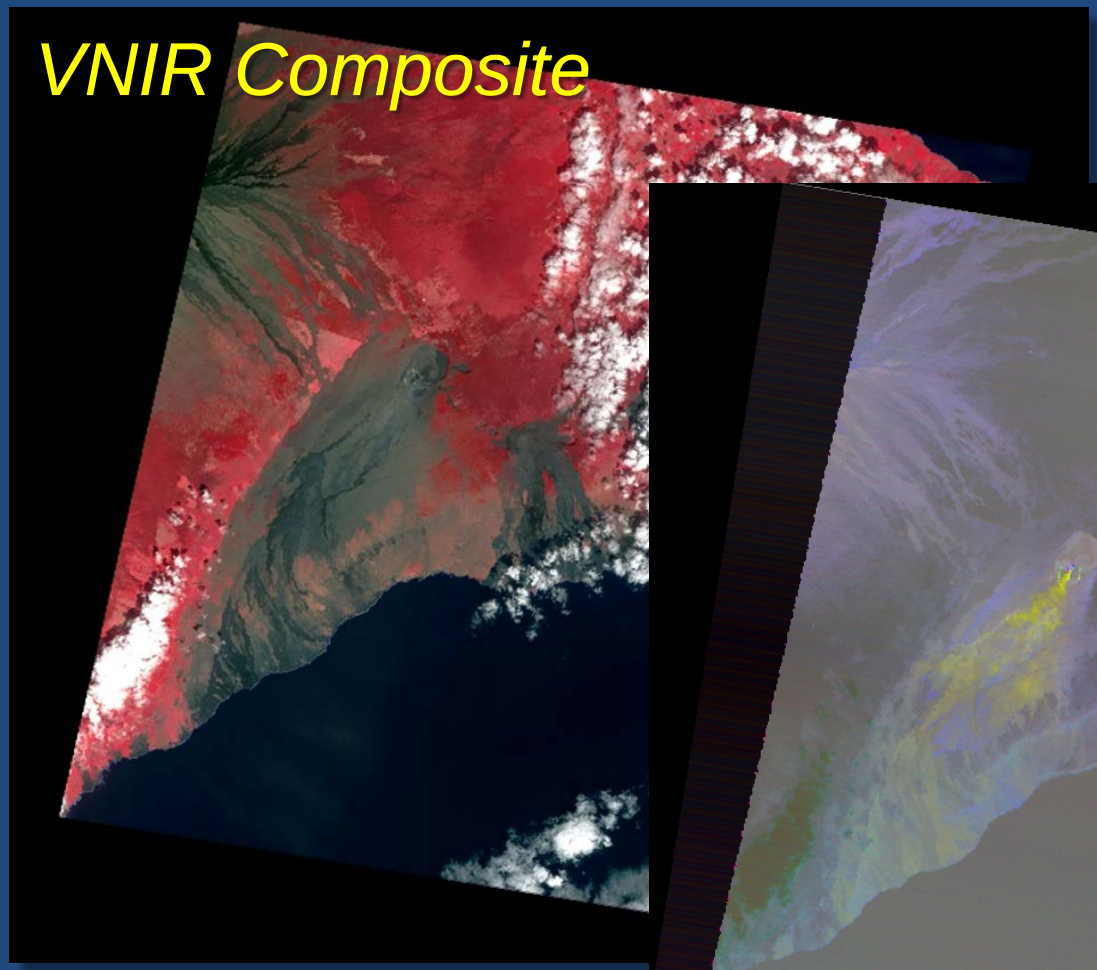
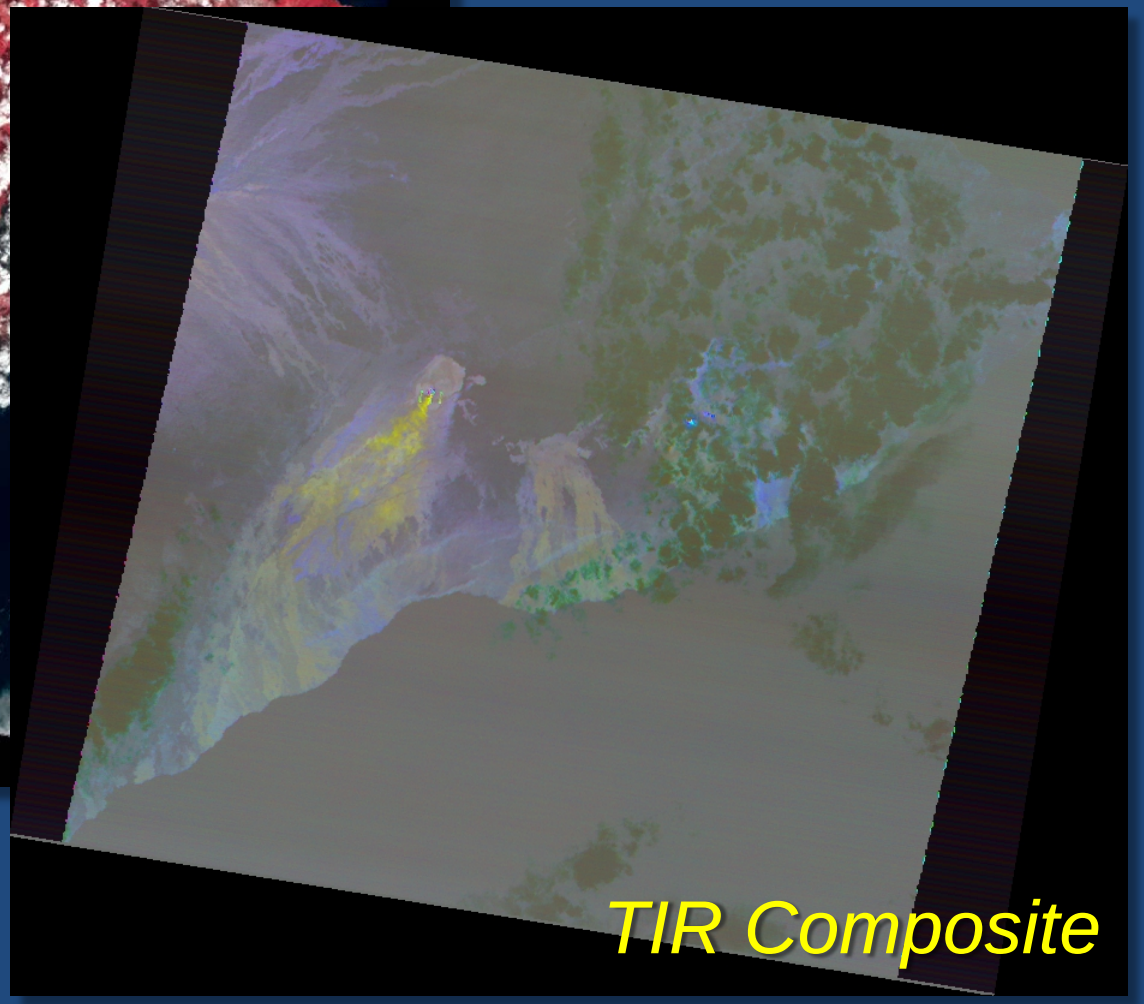




MASTER: 20:54 UTC

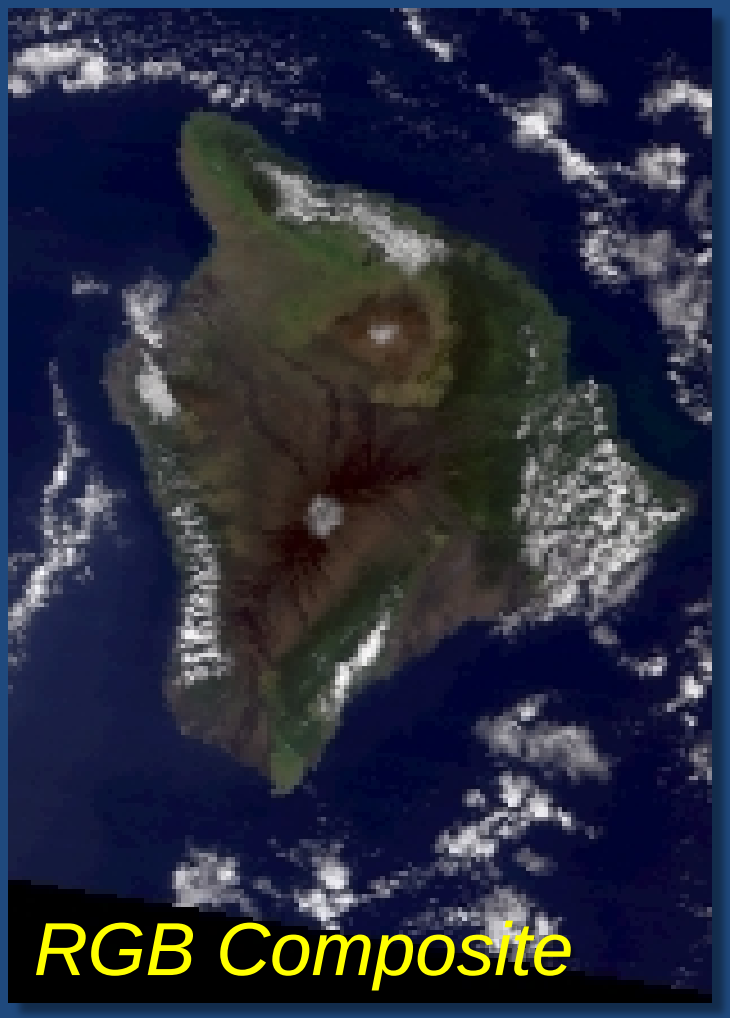
Golden Day: 2017-01-27

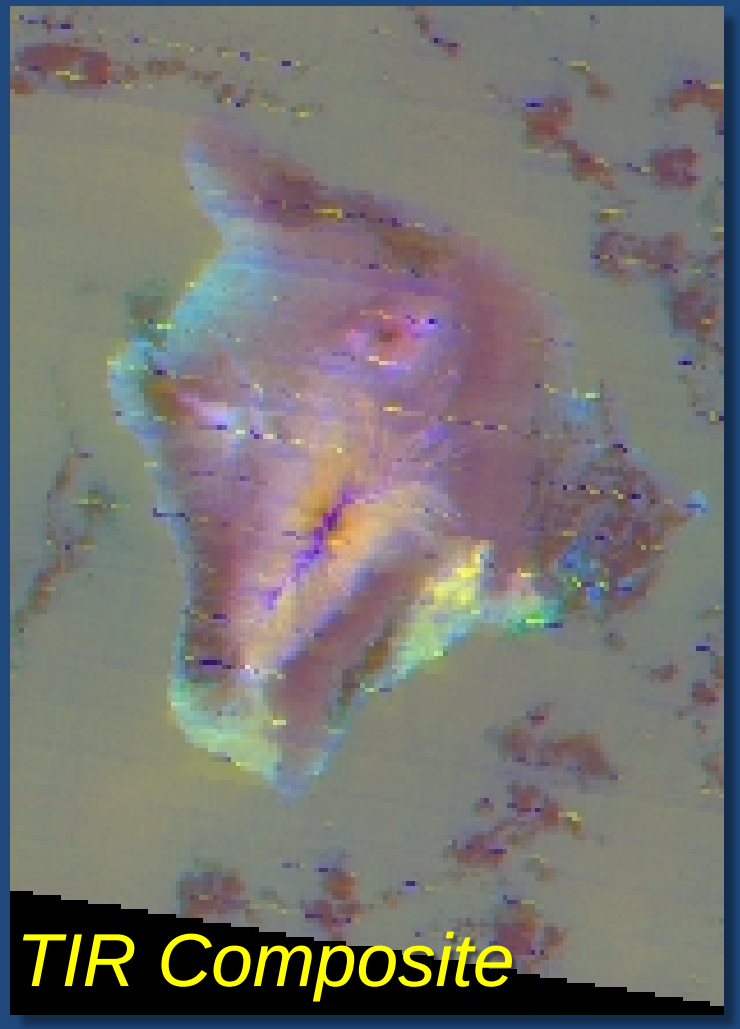




ASTER

Golden Day: 2017-01-27





MODIS-Terra

Thanks for Your Attention!