HyspIRI Preparatory Airborne Science: Investigations of Volcanic Phenomena

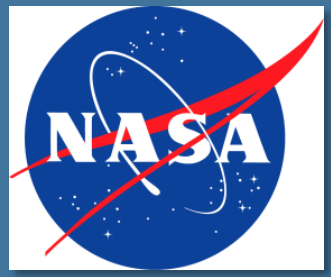
Vincent Realmuto, Jet Propulsion Laboratory, California Institute of Technology

Chad Deering, Michigan Technological University

David Pieri, Jet Propulsion Laboratory, California Institute of Technology

Michael Ramsey, University of Pittsburgh

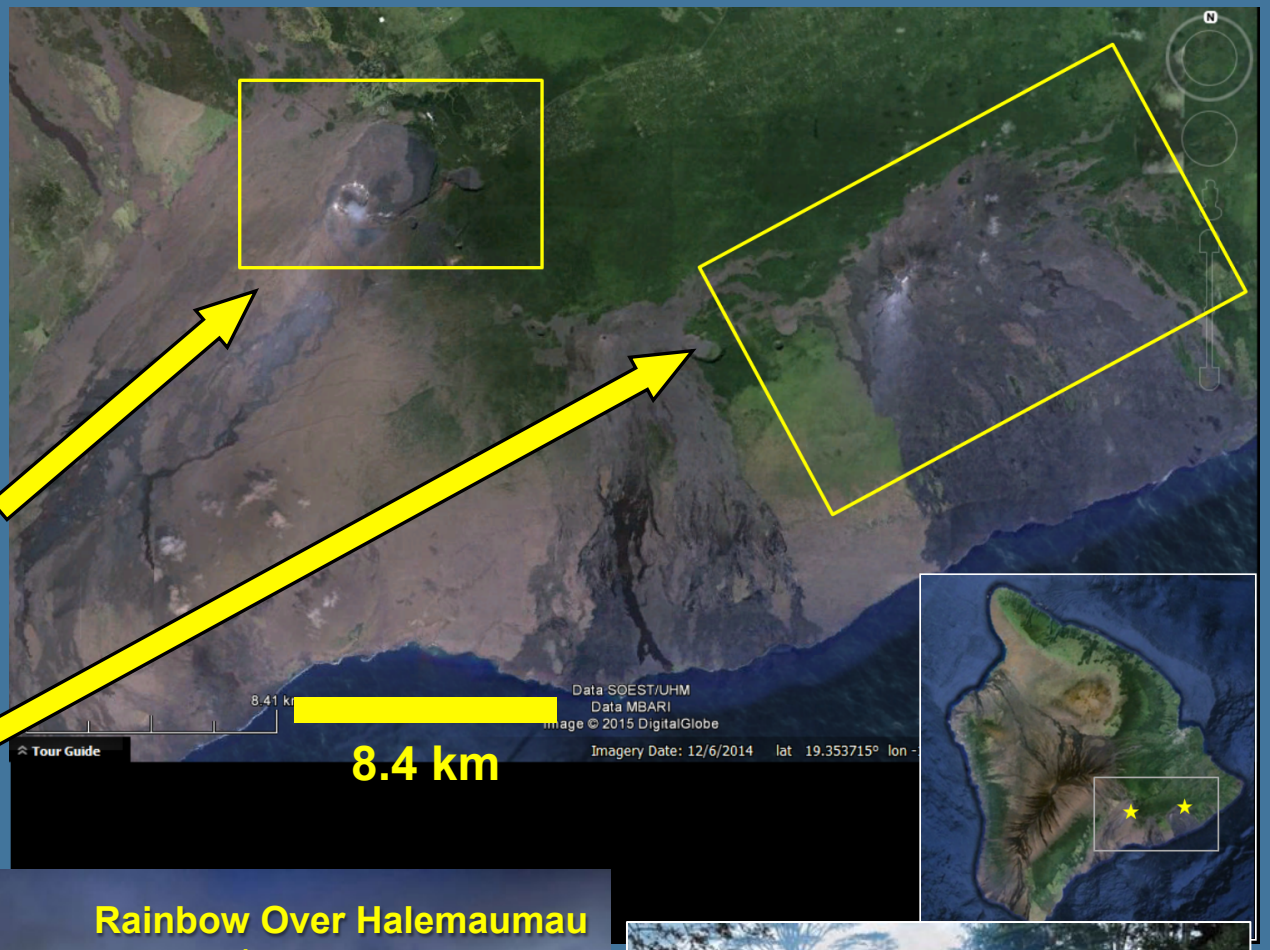
Greg Vaughan, United States Geological Survey



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



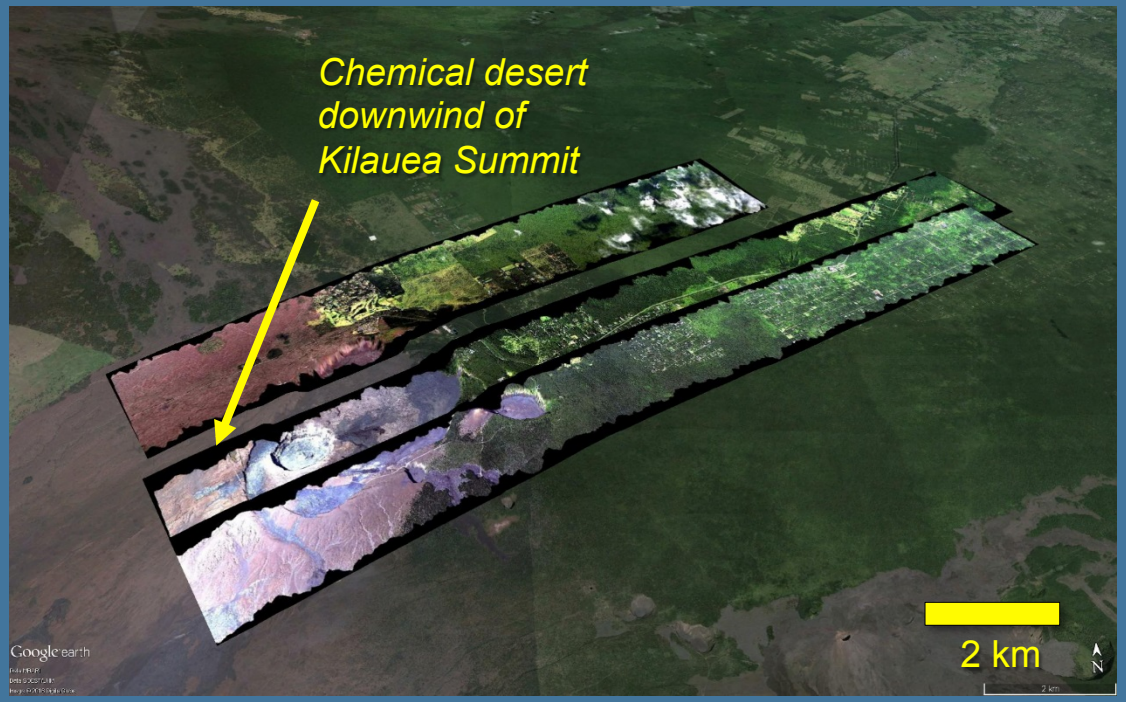
Understanding Basaltic Volcanic Processes by Remotely Measuring the Links between Vegetation Health and Extent and Volcanic Gas and Thermal Emissions using HyspIRI-like VSWIR and TIR Data

Chad Deering, Michigan Technological University

R. Greg Vaughan, USGS Astrogeology Science Center

Isabella Mariotto, Michigan Technological University

Jessica McCarty, Michigan Tech Research Institute



Understanding Basaltic Volcanic Processes by Remotely Measuring the Links between Vegetation Health and Extent

Objectives:

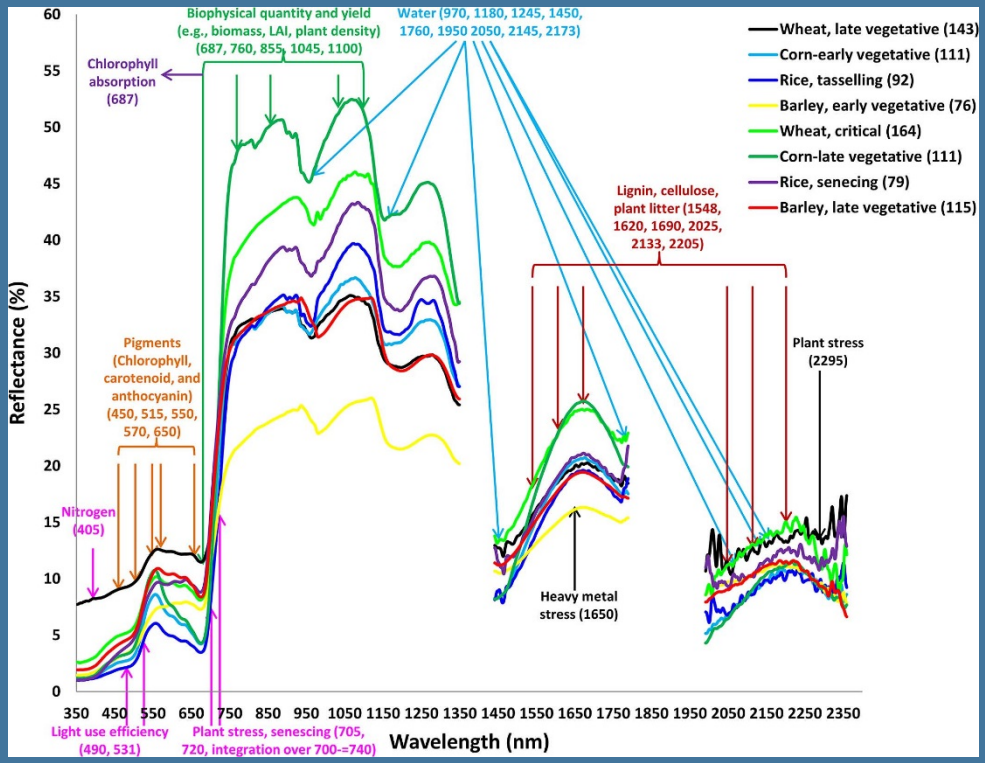
- Quantify the effects of volcanic gas and thermal emissions on the surrounding landscape
- Characterize the spatial and temporal relationships between vegetation cover, surface temperature, and gas (SO_2, H_2S, CO_2) emissions
- Evaluate the performance of hyperspectral vs. multispectral vegetation indices in monitoring the health of vegetation

Measuring radiant temperature at active fumarole site (photo courtesy of USGS-HVO)

Understanding Basaltic Volcanic Processes by Remotely Measuring the Links between Vegetation Health and Extent

Approach:

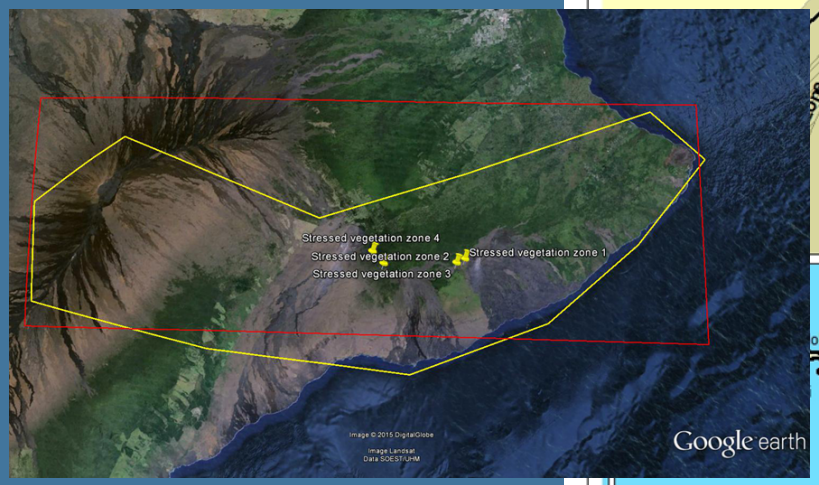
- Make diffuse H_2S and CO_2 measurements and map local vegetation cover
- Develop hyperspectral vegetation indices (HVI) and hyperspectral narrow bands (HNB)
- Develop hyperspectral libraries
- Develop plant stress gradient models
- Generate surface temperature maps
- Create and test automated change detection algorithms

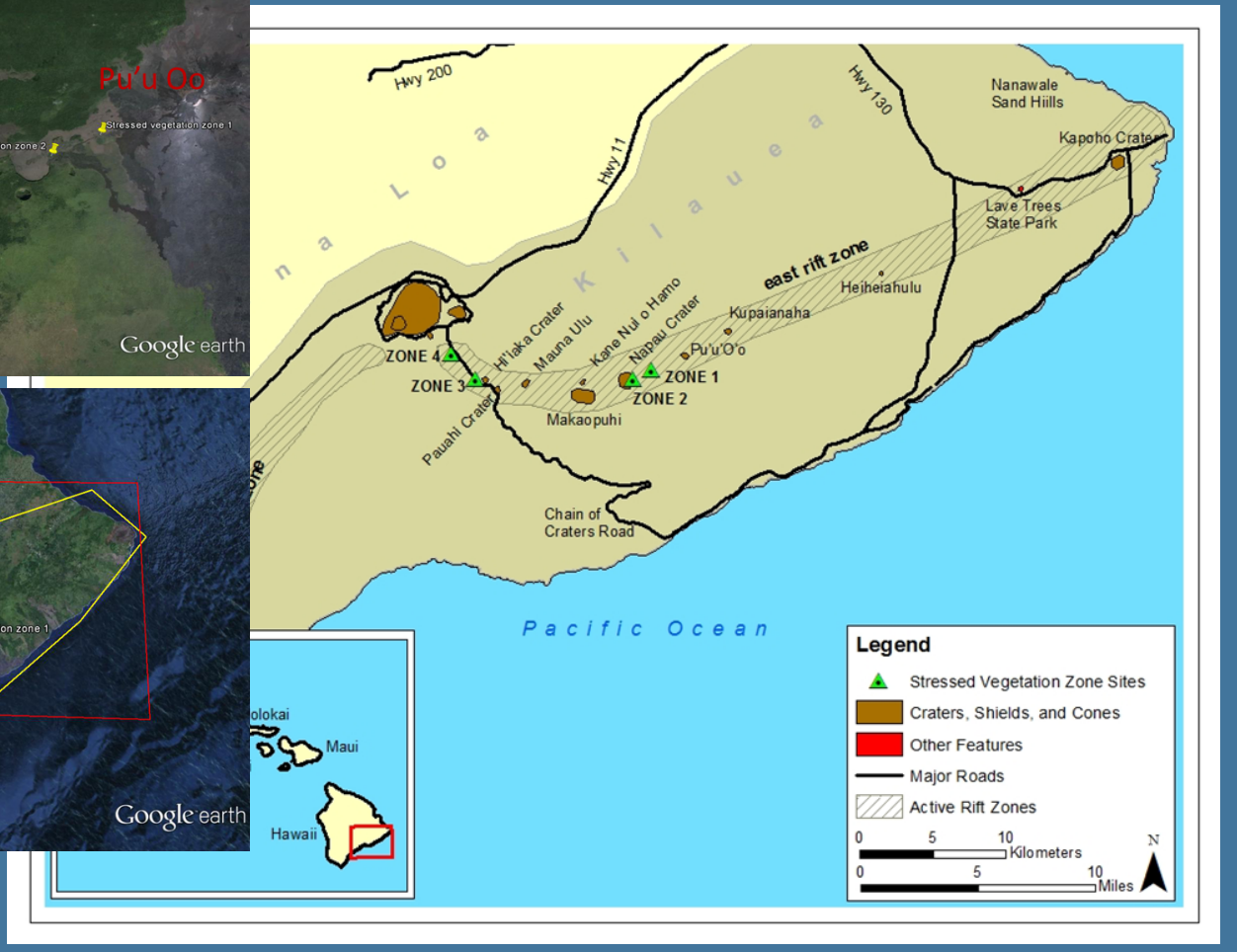


Hyperspectral narrow bands (HNB) describing plant physiology and stress. Hyperspectral vegetation indices (HVI) are based on sets of contiguous HNB's (Thenkabail et al., 2013)

Understanding Basaltic Volcanic Processes by Remotely Measuring the Links between Vegetation Health and Extent

Investigation Sites:





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

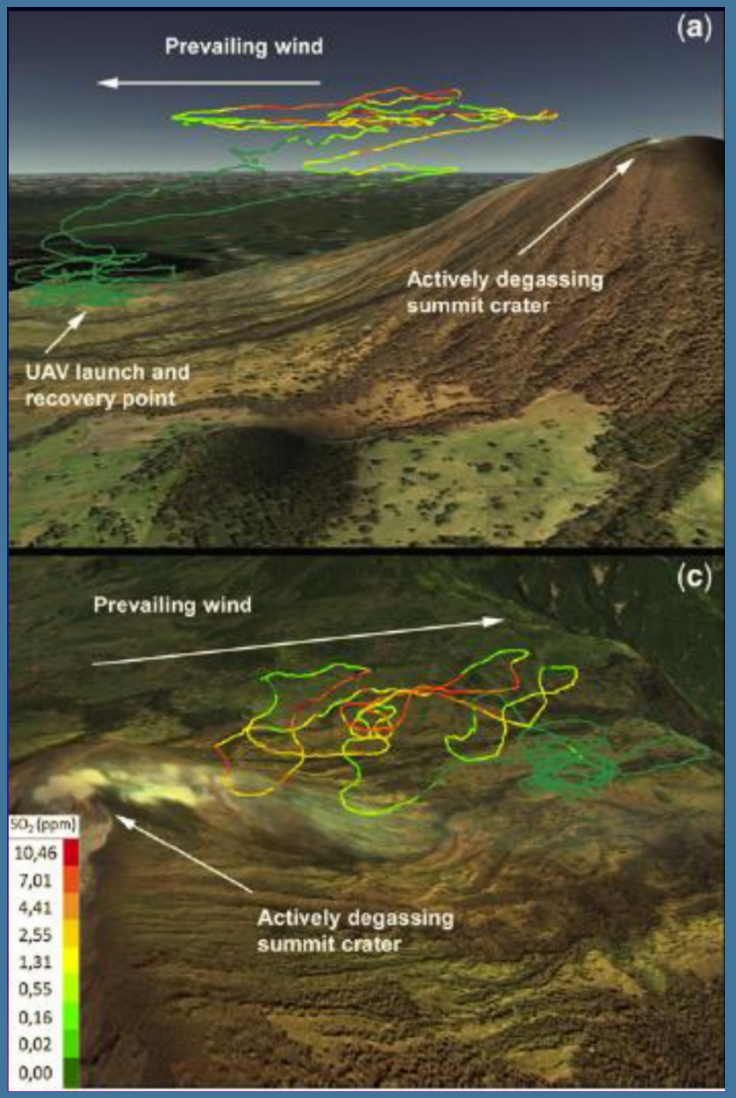
Lance Christensen, Jet Propulsion Laboratory, California Institute of Technology

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

Peter Mouginis-Mark, University of Hawaii – Manoa

Matt Fladeland, NASA Ames Research Center

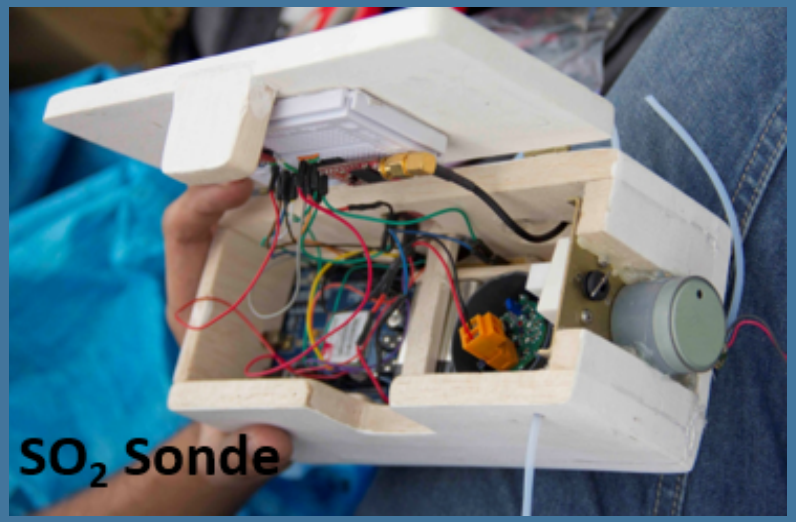
Fabrizia Buongiorno, Istituto Nazionale di Geofisica e Volcanologia (Italy)



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

Objectives:

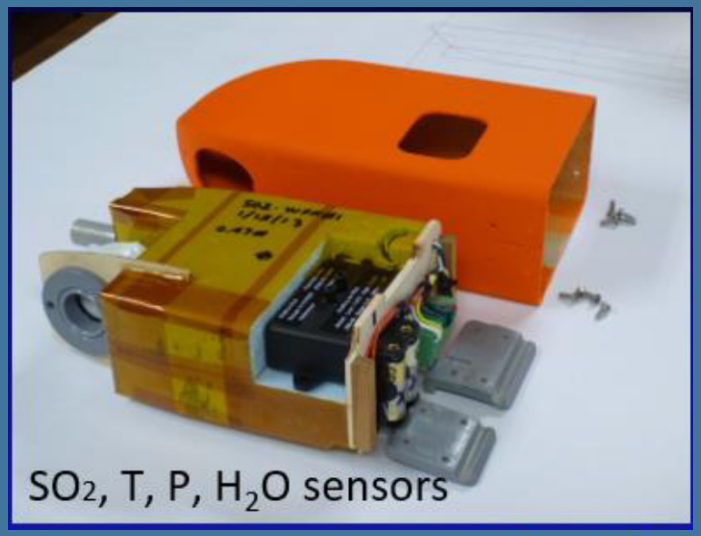
- *In situ* validation of ER2-based MASTER/HyTES and AVIRIS gas and aerosol retrievals using free-flying UAV-based, aerostat-based, and ground instrumentation
- Characterize the near surface extent, distribution, constituents, and dispersion characteristics of gas and aerosol emissions from Kilauea Volcano, e.g. SO_2 hydrolysis
- To improve accuracy of local SO_2 and CO_2 flux estimates using *in situ* airborne data
- Improve approaches to statistical representation of UAV data



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

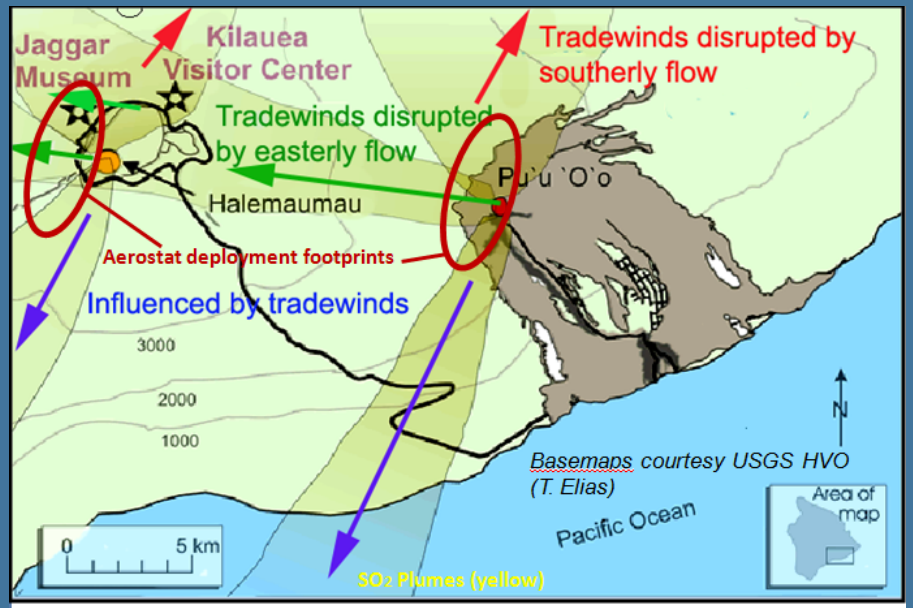
Approach:

- Deploy Dragon Eye UAVs, aerostats, and ground devices to Kilauea (SO_2, CO_2; mass spectrometer; nephelometer).
- Conduct science activities that support ER2 and other remote sensing observations (gas/aerosol detects, T, P, H_2O profiles).
- Conduct science activities and analyses accessible to *in situ* observations
- Proceed with archival activities to take advantage of the JPL/NASA AVA

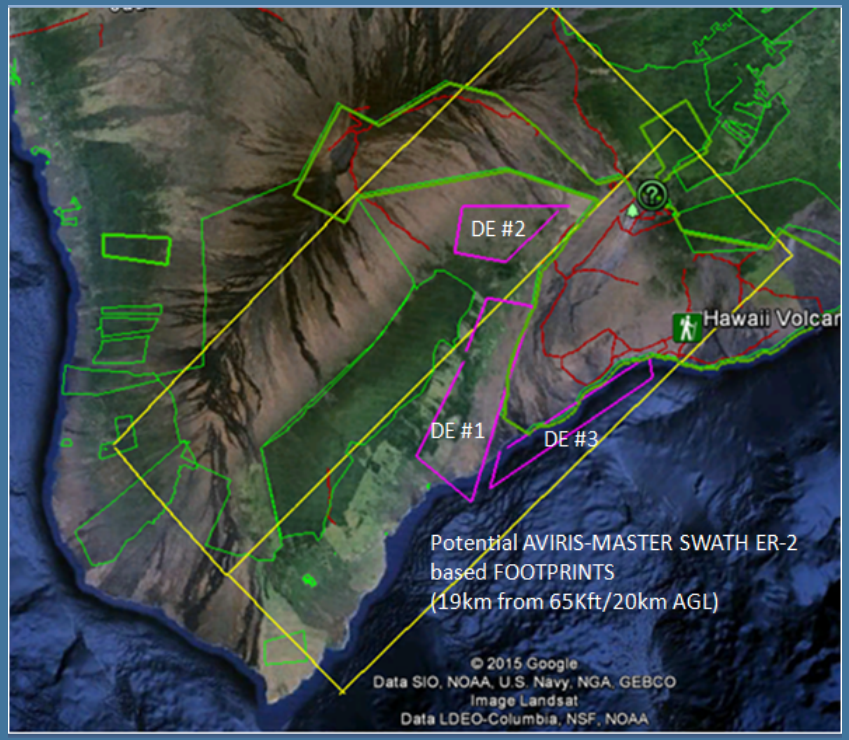


In Situ Validation of Remotely Sensed Volcanogenic Emissions Retrievals using Aerostats and UAVs

Investigation Sites:



Candidate near-vent deployment ellipses for tethered aerostats in SO_2 plumes



Aerostat Lift Sites: Red Ovals

UAV Flight Operation Sites: Purple
ER-2 Ground Swath: Yellow

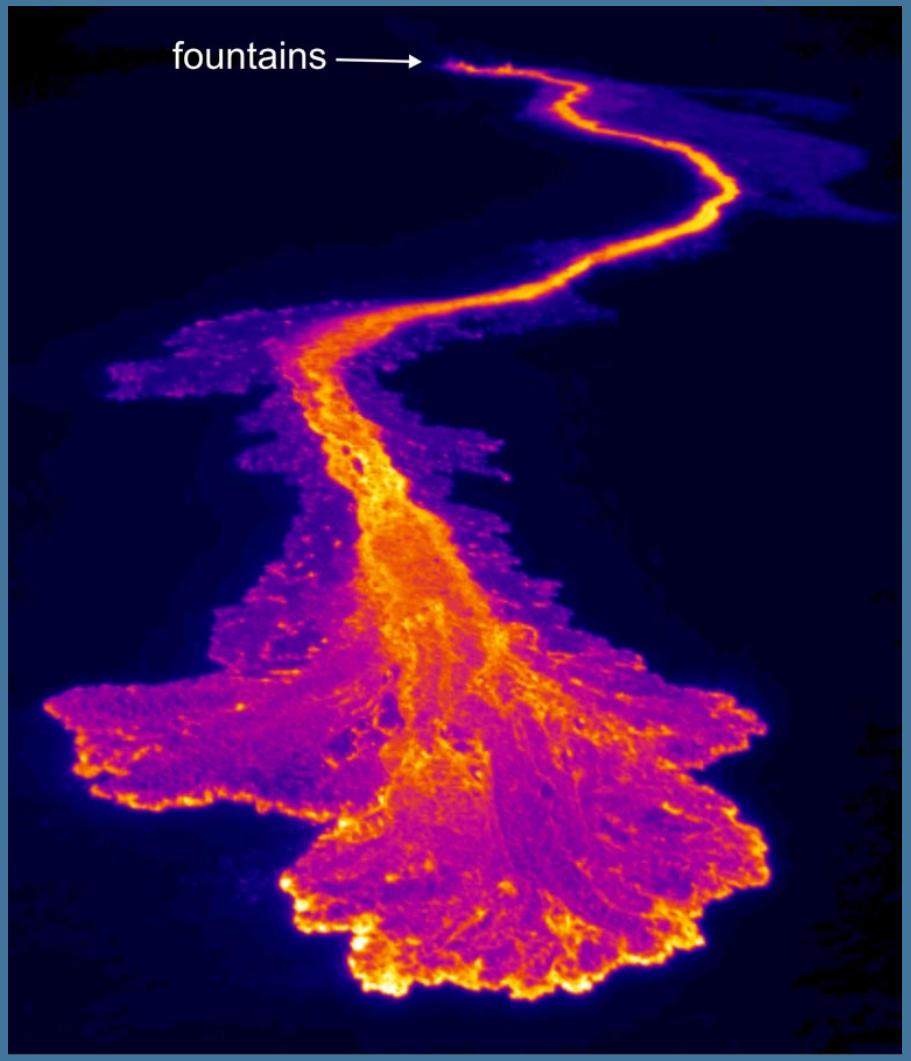
Quantifying Active Volcanic Processes and Mitigating their Hazards with HyspIRI Data

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

Objectives:

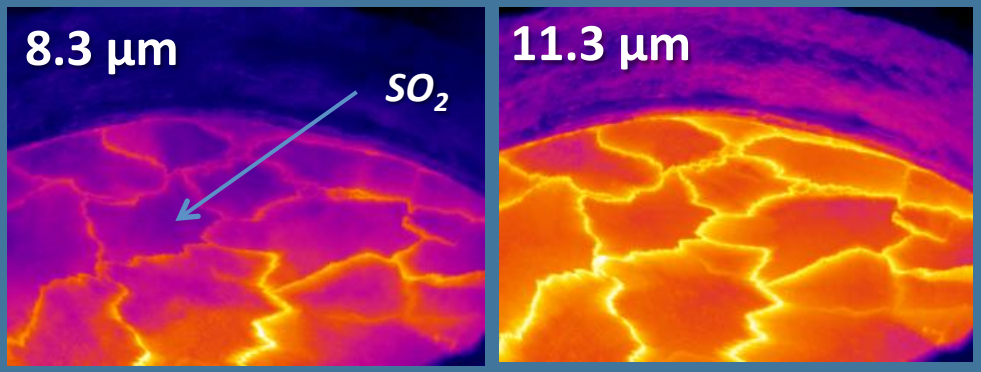
- Quantify the magnitude of temperature-dependent emissivity change for active basaltic surfaces using *in situ* field and laboratory IR data
- Determine the accuracy of high-temperature emissivity extraction at potential HyspIRI spatial resolutions and its impact on modeling of flow advance

Deployment of V.2.5 multispectral FLIR in Hawaii

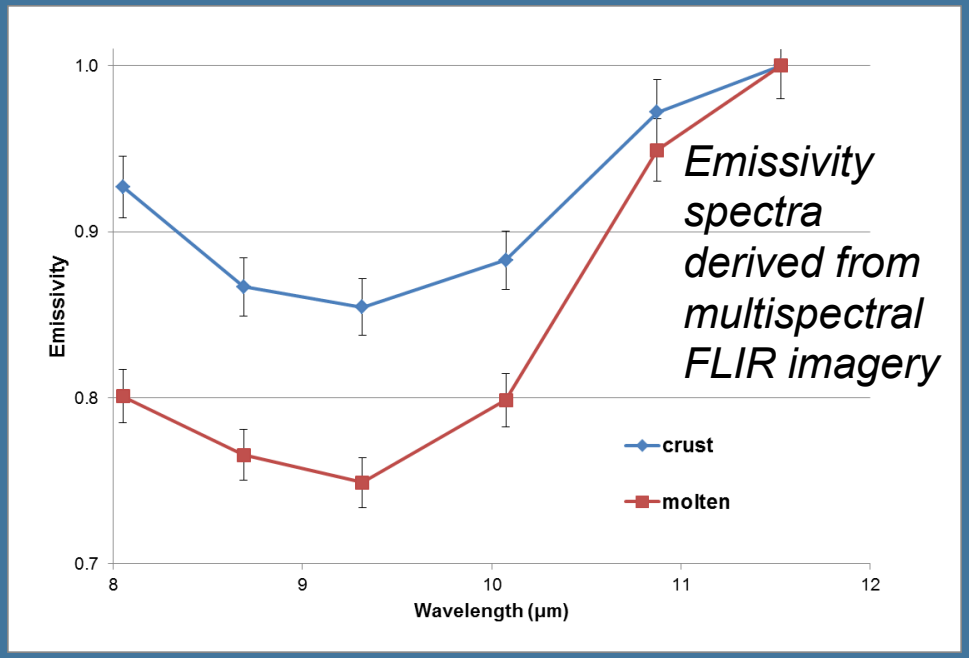
Quantifying Active Volcanic Processes and Mitigating their Hazards with HyspIRI Data

Approach:

- The airborne data will be forward-modeled using a quantitative resampling methodology
- Ground-based multispectral TIR data will be acquired with new FLIR-based instrument
- The combined data will be used to validate a correction approach for thermally-mixed HyspIRI data using VSWIR and TIR data
- Results will be input into flow modeling to better monitor and predict future volcanic hazardous phenomena

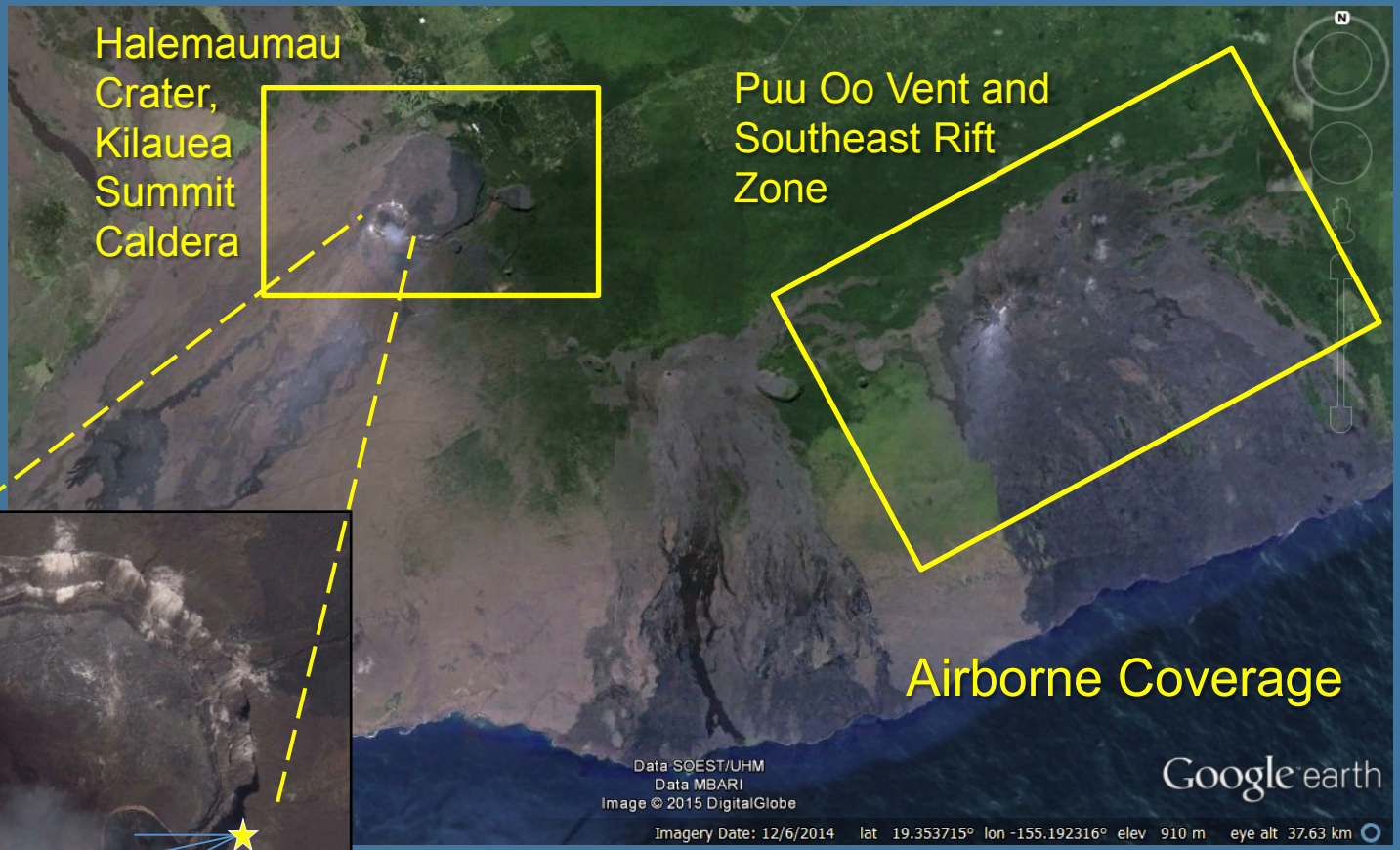


FLIR filter images of Halemaumau Crater lava lake



Quantifying Active Volcanic Processes and Mitigating their Hazards with HyspIRI Data

Investigation Sites:



Proposed Location of new FLIR system at Halemaumau during overflights

Mapping the Composition and Chemical Evolution of Plumes from Kilauea Volcano: Preparing for the Use of HysplRI 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

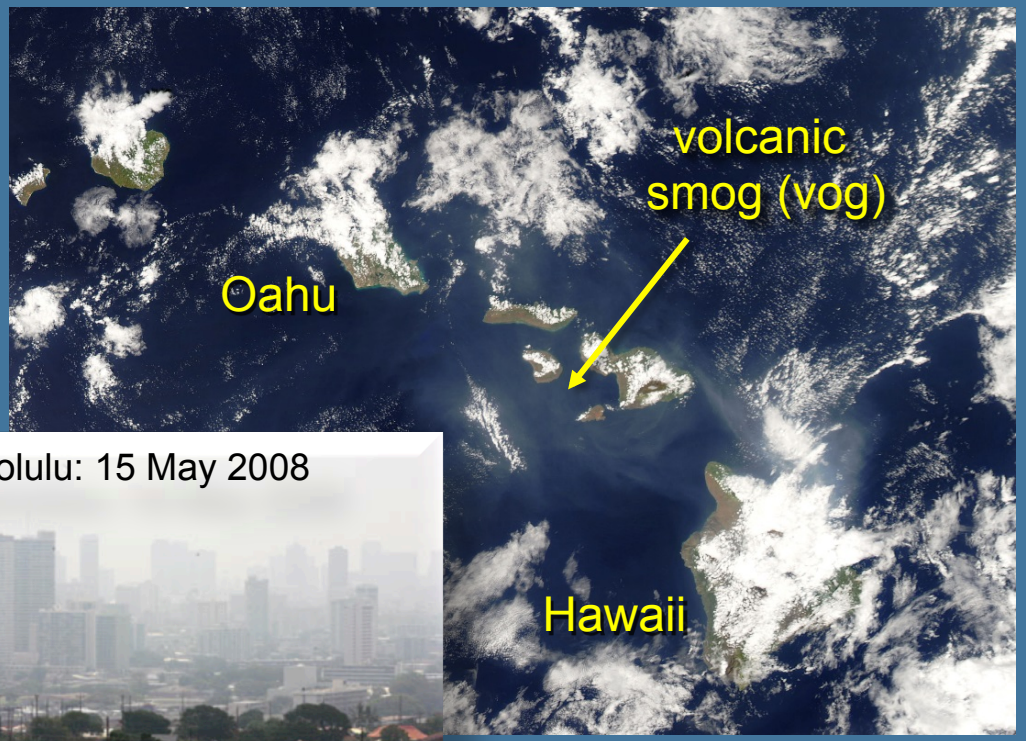
Steven Businger, University of Hawaii – Manoa

A Sutton, USGS Hawaiian Volcano Observatory

Tamar Elias USGS Hawaiian Volcano Observatory

Keith Horton, Flyspec, Inc.

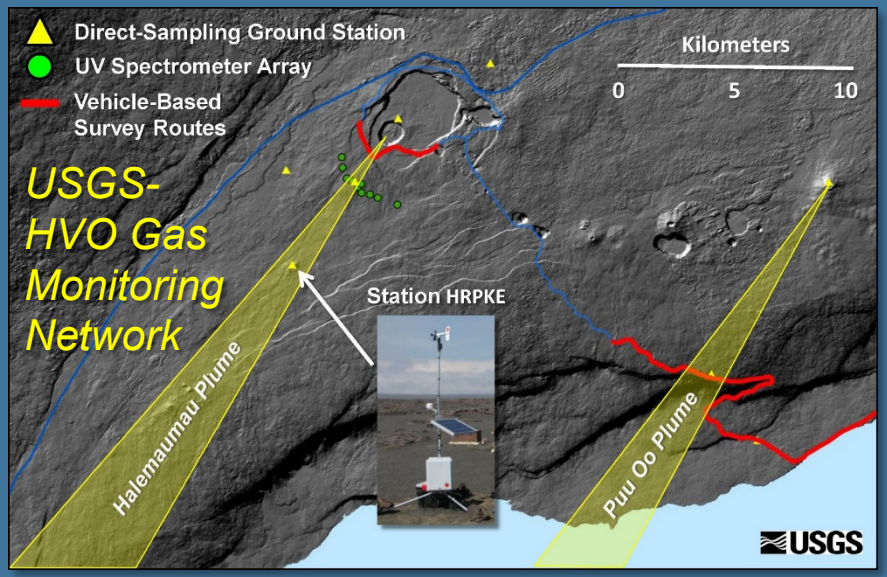
MODIS RGB: 9 May 2008
Kona (SW) Wind Conditions

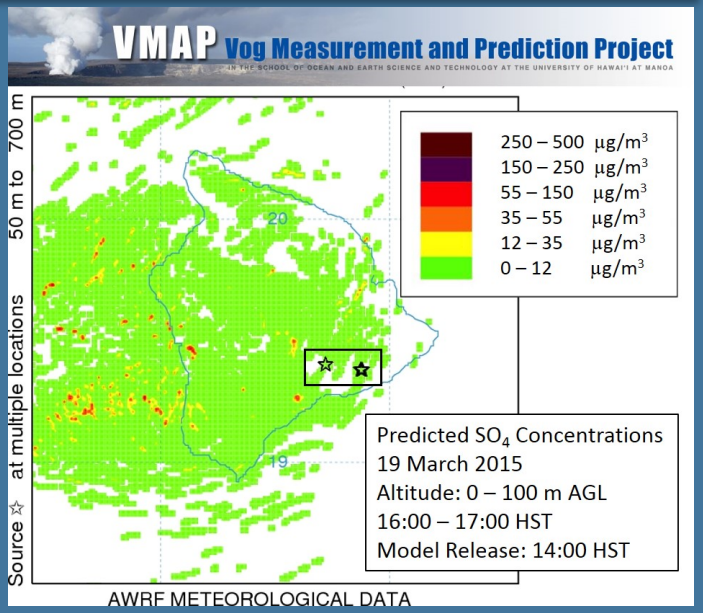


Mapping the Composition and Chemical Evolution of Plumes from Kilauea Volcano

Objectives:

- Prepare for the use of HyspIRI VSWIR and TIR data to monitor the impact of Kilauea SO_2 plumes on air quality in the state of Hawaii
- Map the initial concentrations of SO_2 and the conversion of SO_2 into SO_4 aerosols
- Evaluate the impact of HyspIRI-based SO_2 and conversion-rate estimates on the skill of the VMAP vog forecast model

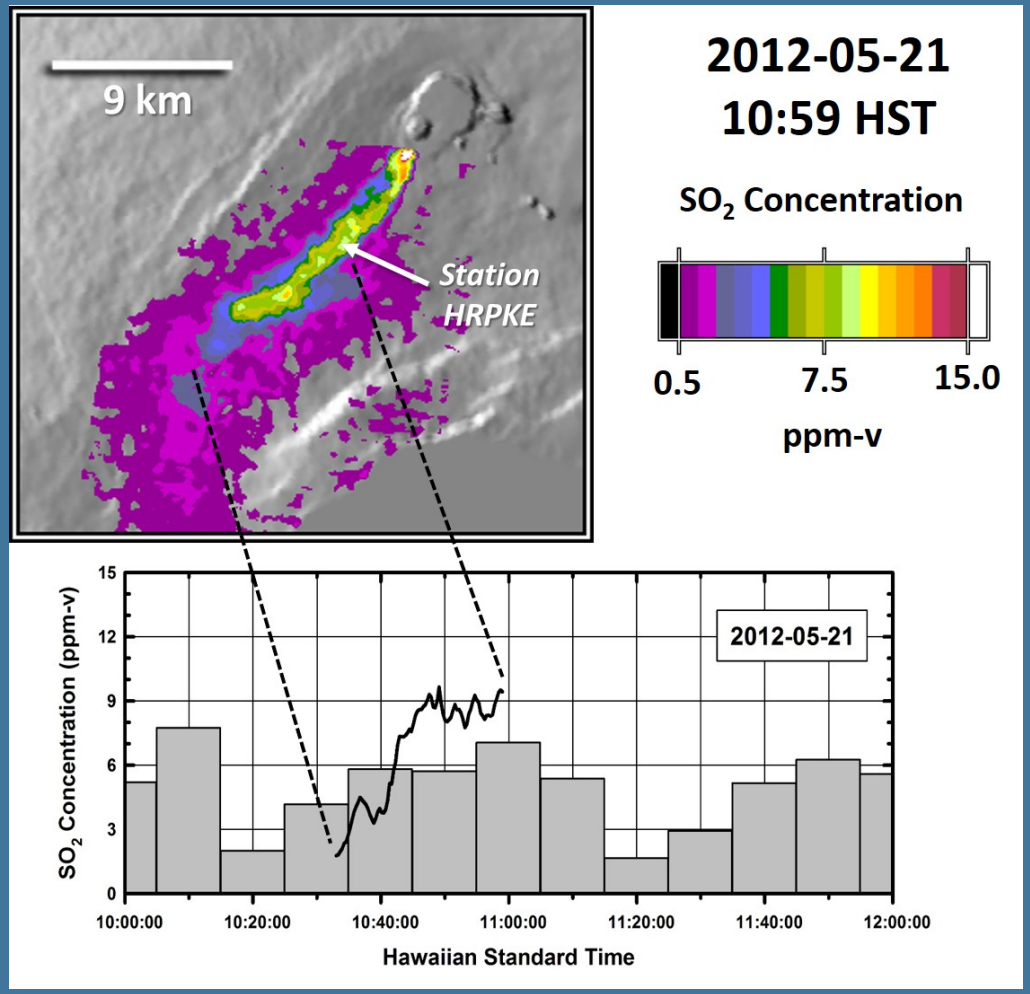




Mapping the Composition and Chemical Evolution of Plumes from Kilauea Volcano

Approach:

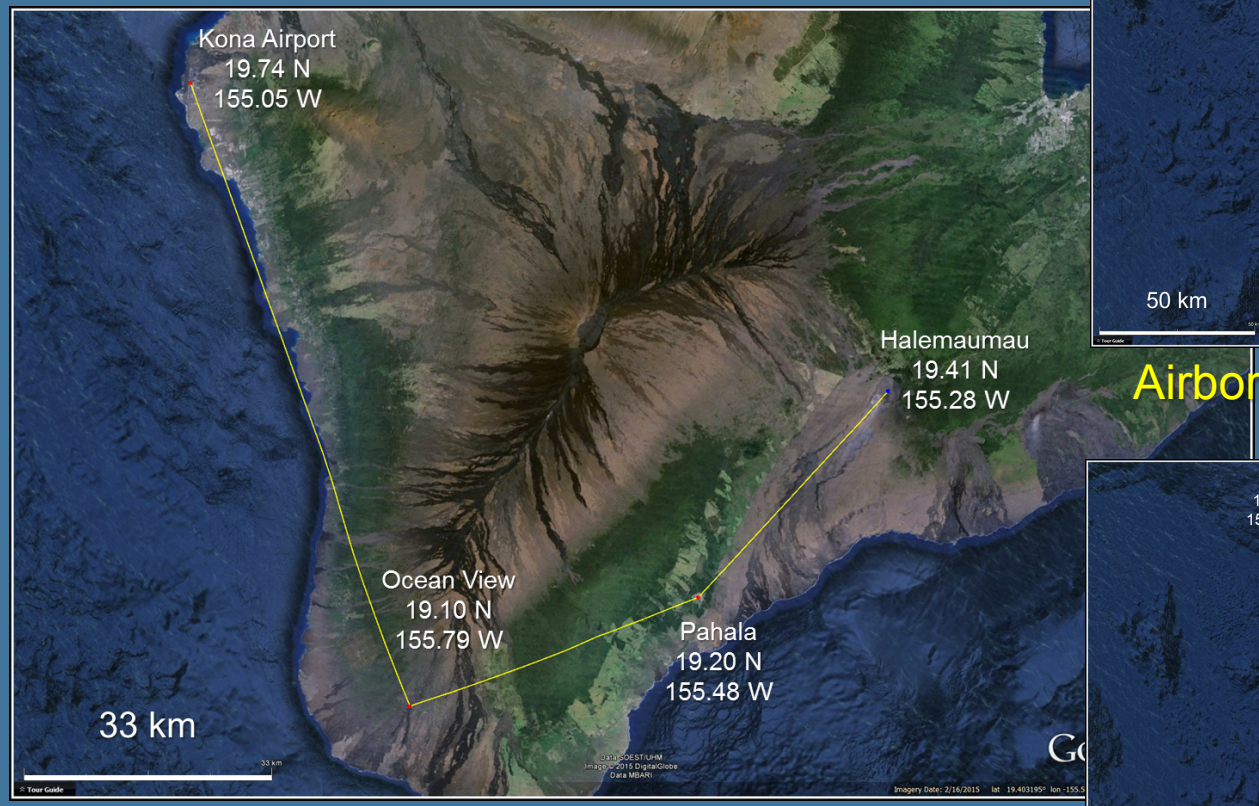
- Collect AVIRIS and MASTER data as analogues for HyspIRI VSWIR and TIR data
- Derive SO_2 concentration estimates from the TIR and SO_4 AOD estimates from the VSWIR
- Validate the retrievals against ground-based measurements collected during deployment
- Evaluate the potential impact of HyspIRI data products on the forecasting skill of VMAP vog model



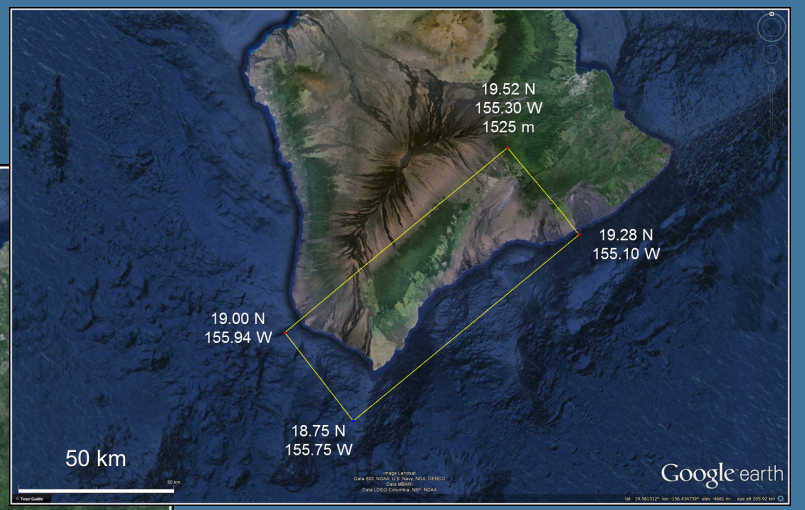
Comparison of ASTER-based SO_2 retrievals to measurements from direct-sampling ground station

Mapping the Composition and Chemical Evolution of Plumes from Kilauea Volcano

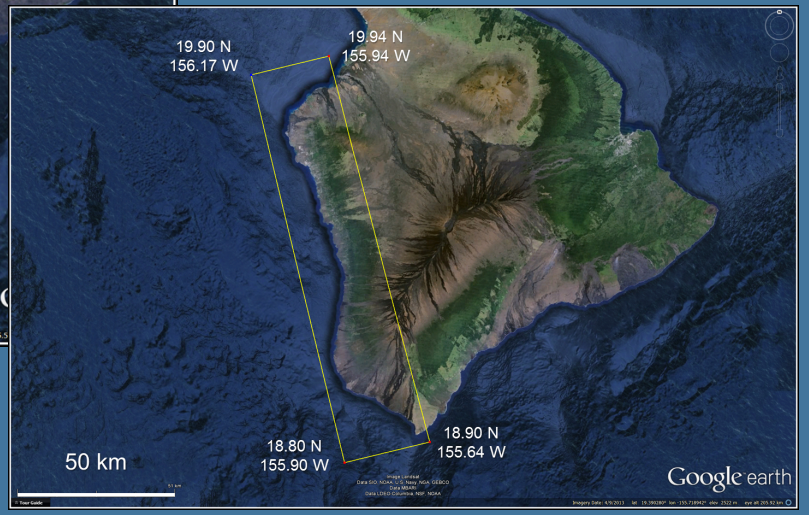
Investigation Sites:



Hawaii Health Department Air Quality Stations trace the route of Kilauea plumes



Airborne Coverage: Southern Box



Airborne Coverage: Western Box

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

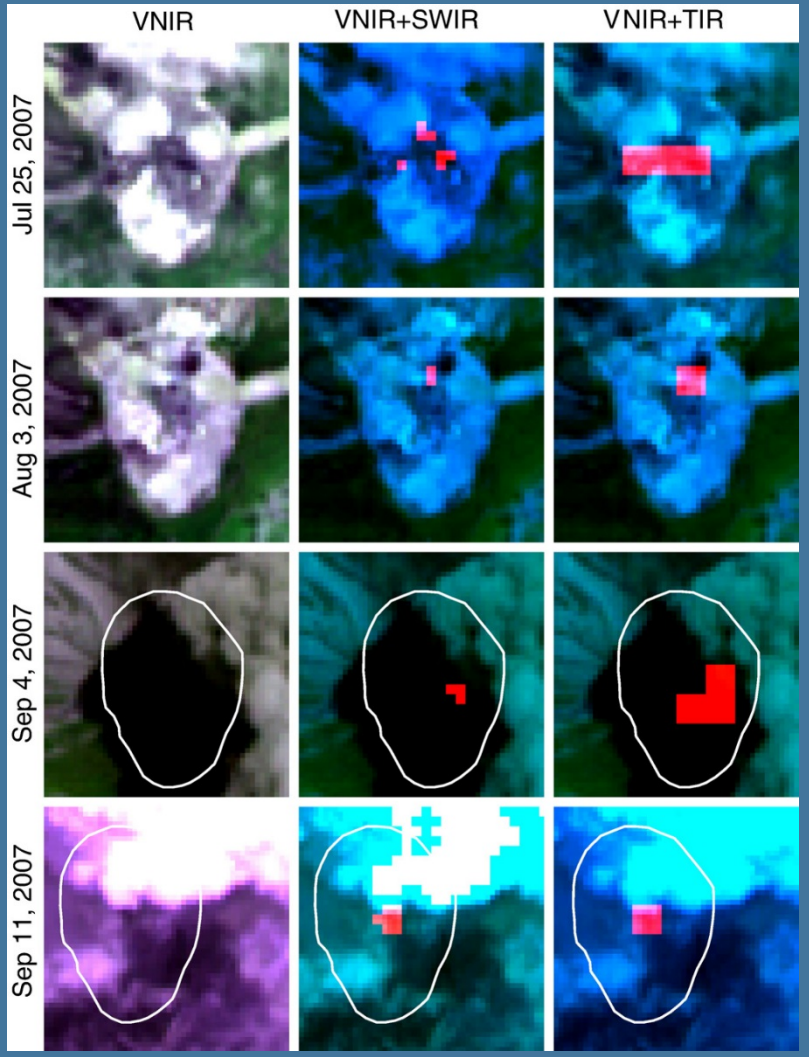
Matthew Patrick, USGS
Hawaiian Volcano Observatory

Laszlo Kestay, USGS
Astrogeology Science Center

Developing an Automated Volcanic Thermal Alert Algorithm using VSWIR and TIR Data

Objectives:

- Leverage the fine spatial resolution and frequent observations that will be provided by HyspIRI
- Combine VSWIR and TIR measurements
- Improve sensitivity to subtle thermal anomalies
- Incorporate spatial context and temporal variance to minimize false anomalies

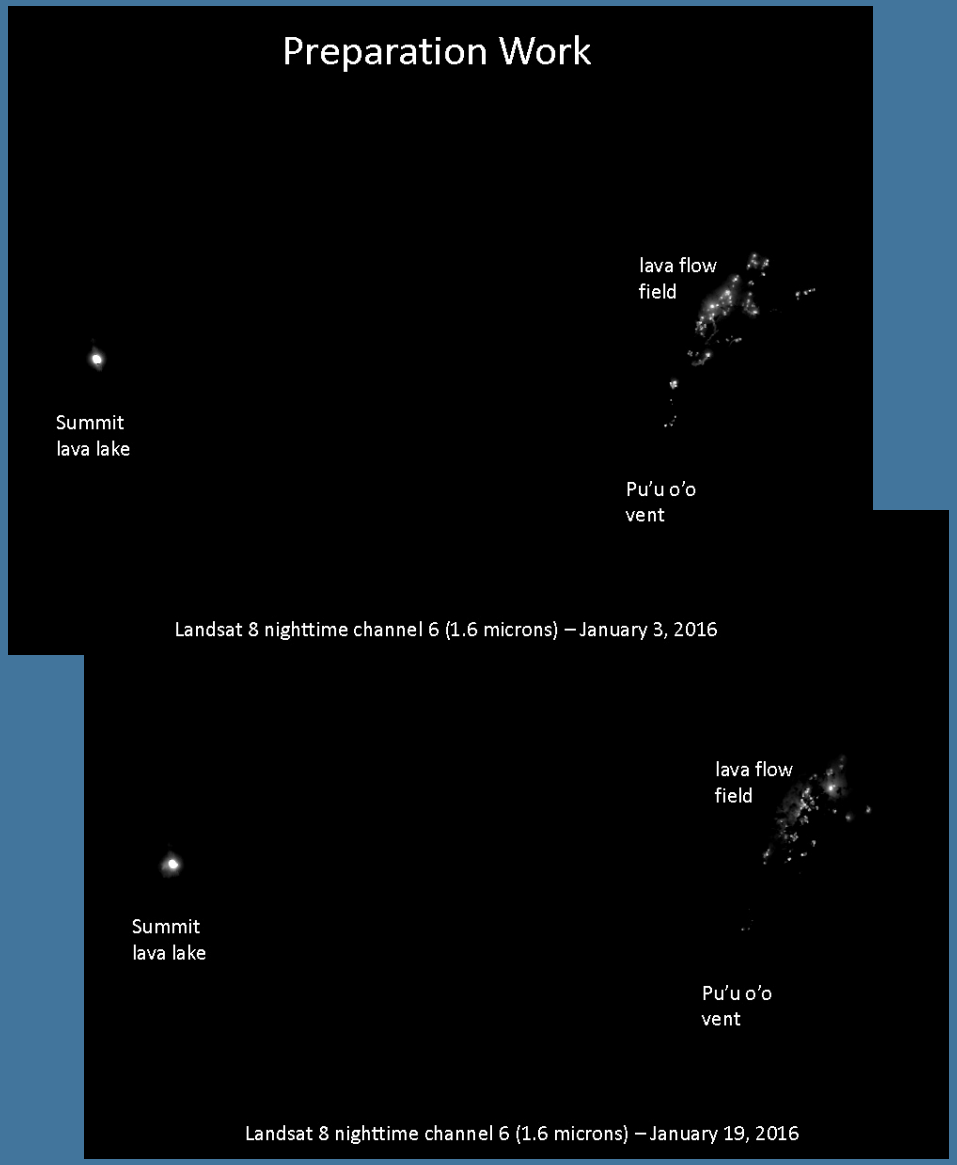


High-temperature features at Oldoinyo Lengai Volcano (Tanzania) identified in ASTER VNIR, SWIR, and TIR data (Vaughan et al., 2008)

Developing an Automated Volcanic Thermal Alert Algorithm using VSWIR and TIR Data

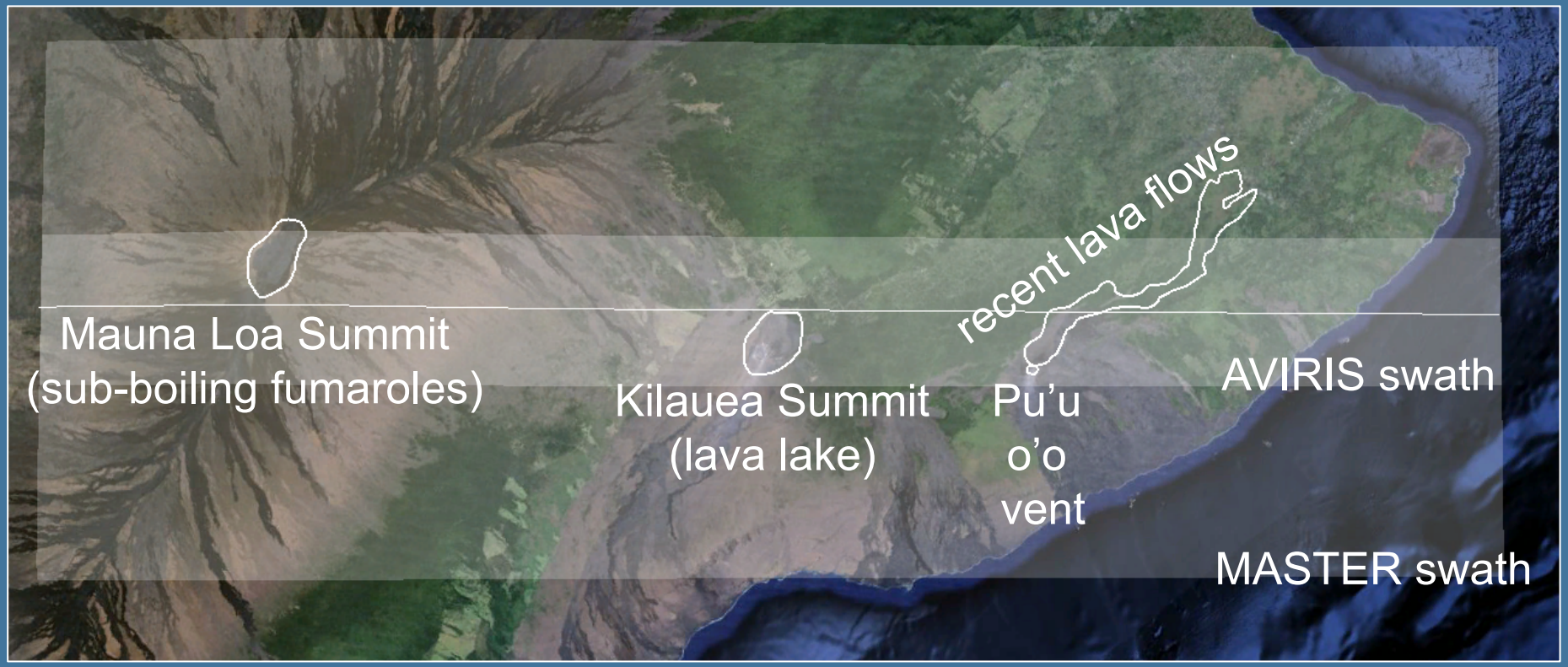
Approach:

- Collect AVIRIS and MASTER data as analogues for HyspIRI VSWIR and TIR data
- Employ archived data (e.g. Landsat 8) to establish temporal background
- Validate the alert algorithm against ground-based measurements collected during deployment
- Evaluate the improvements in performance of HyspIRI alert vs. current operation thermal alters (e.g. MODVOLC)



Developing an Automated Volcanic Thermal Alert Algorithm using VSWIR and TIR Data

Investigation Sites:



Thank You for
Your Attention.