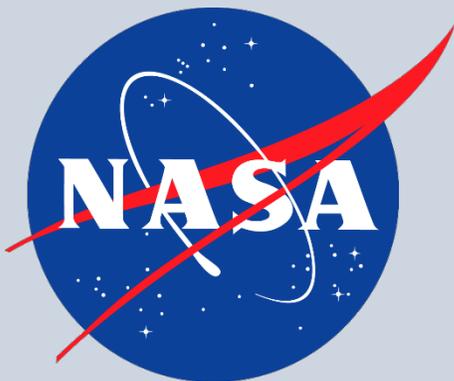


# **The Design and Testing of Information Products: An Early Collaboration Between Scientists and Emergency Managers**

**Vincent J. Realmuto,  
Jet Propulsion Laboratory,  
California Institute of Technology**



*© 2018, California Institute of Technology.  
Government sponsorship acknowledged.*

## The Design and Testing of Information Products for Decision Support (DS) Present Challenges to NASA-Sponsored Scientists

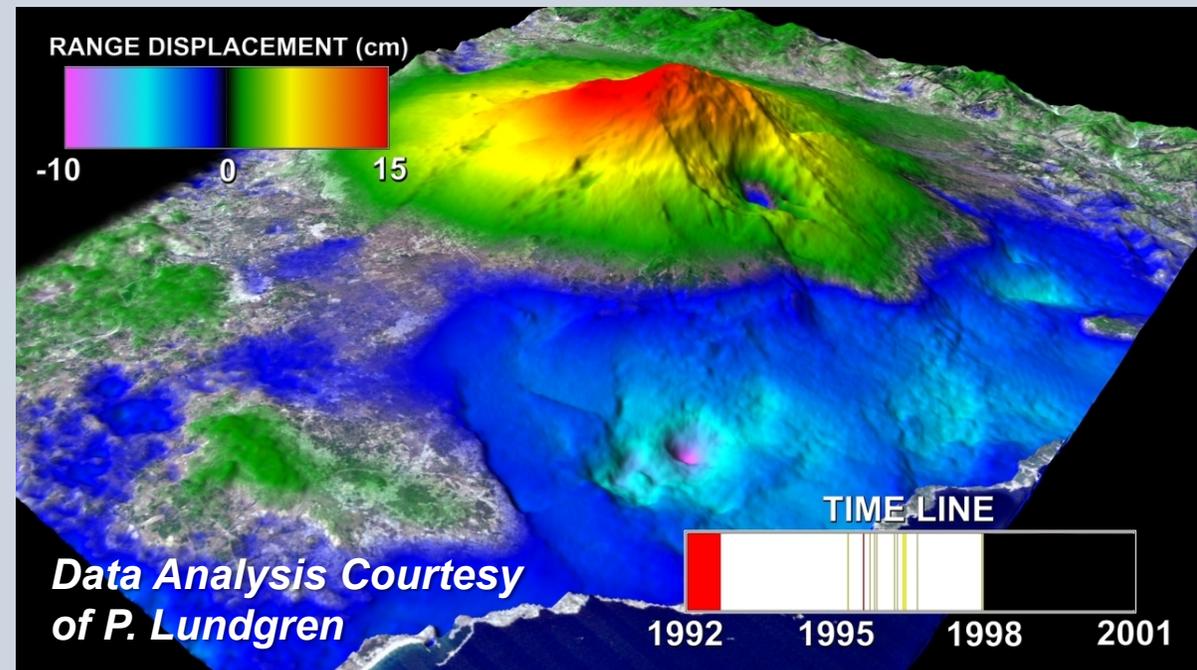
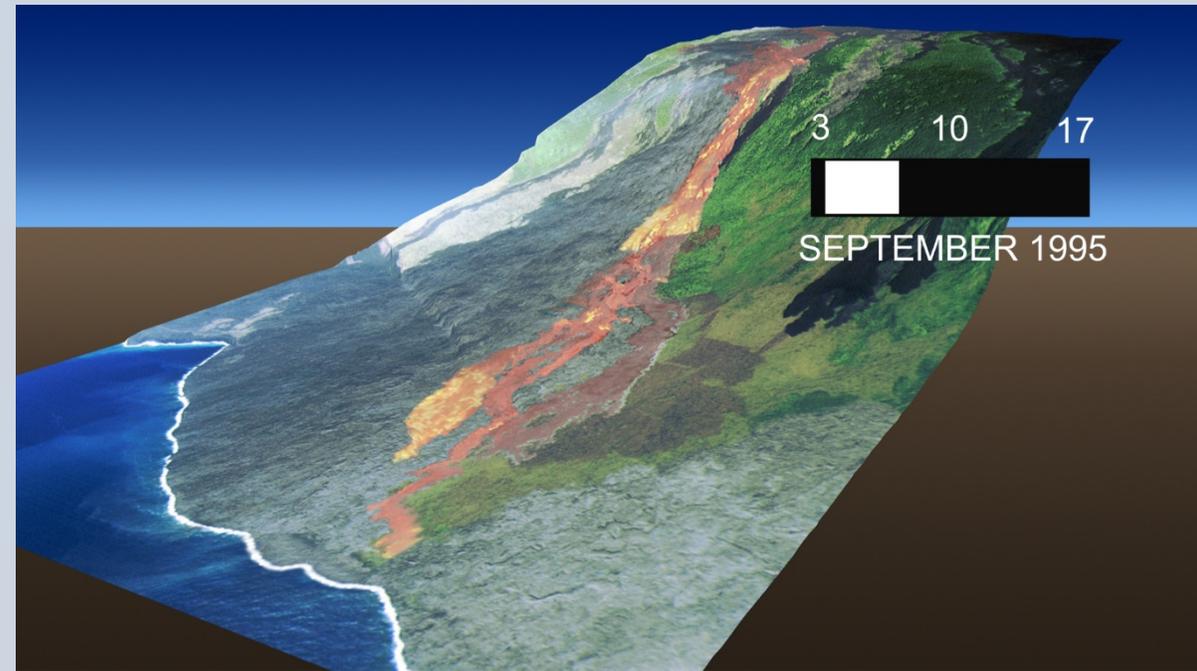
- Many Scientists do not have the Perspectives of the Emergency Management (EM) Agencies that would use the DS Products
- Funding is Focused on Fundamental Research and Publication of Results

## The NASA Applied Sciences (Applications) Program

- Promotes and Supports Collaborations between Scientists and Managers to develop DS systems
- End Goal is to Transfer the DS System to the Management Agency for Sustained Operation and Maintenance
- Level of End-User Support (Including In-Kind) is a Criterion for Evaluating Applications Proposals

## EM Agencies Must be Convinced of Value of DS Products to Commit the Necessary Resources

- Assessment of Value is Difficult to Complete in the 3 to 6 Month Period of Proposal-Writing

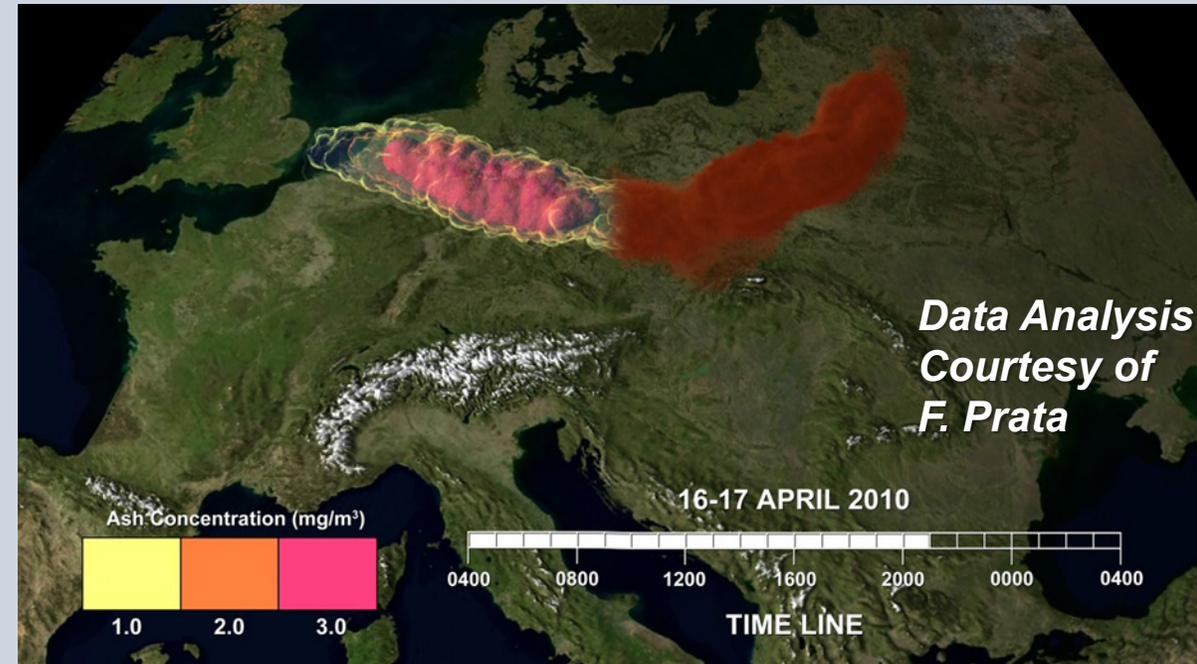
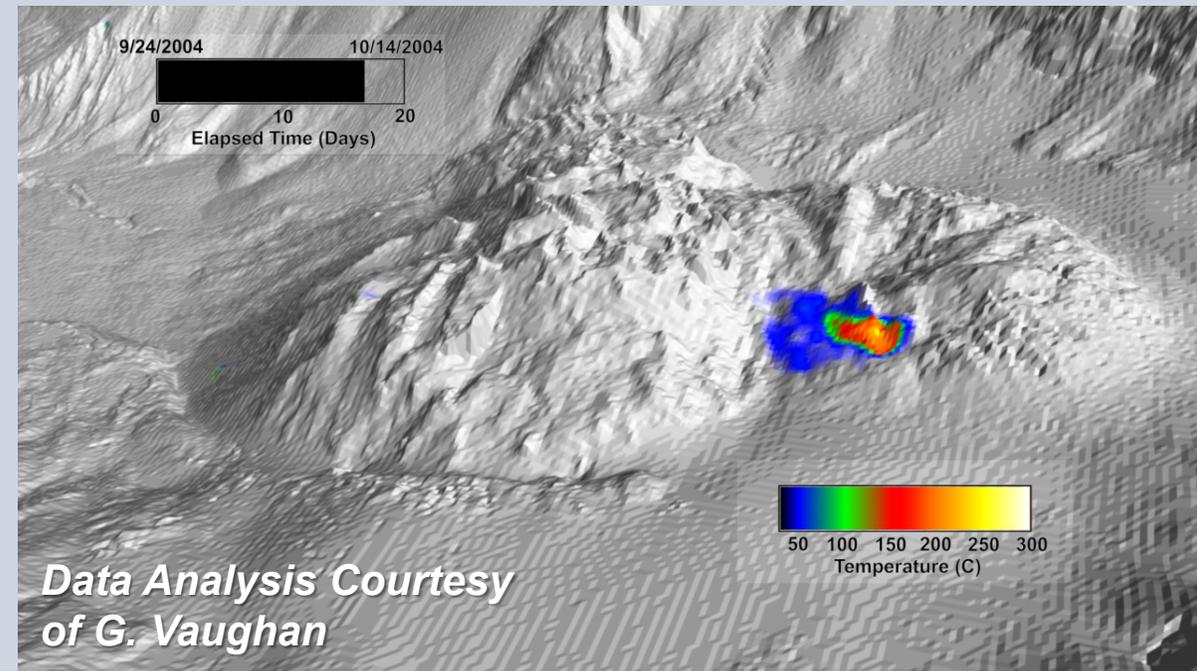


## To Maximize the Value of DS Products, the EM Agency Should:

- Define the specifications for the products
- Interact (Iterate) with NASA Scientists and Engineers Designing the Product Generation System
- Approve and Certify the Final Versions of the Products

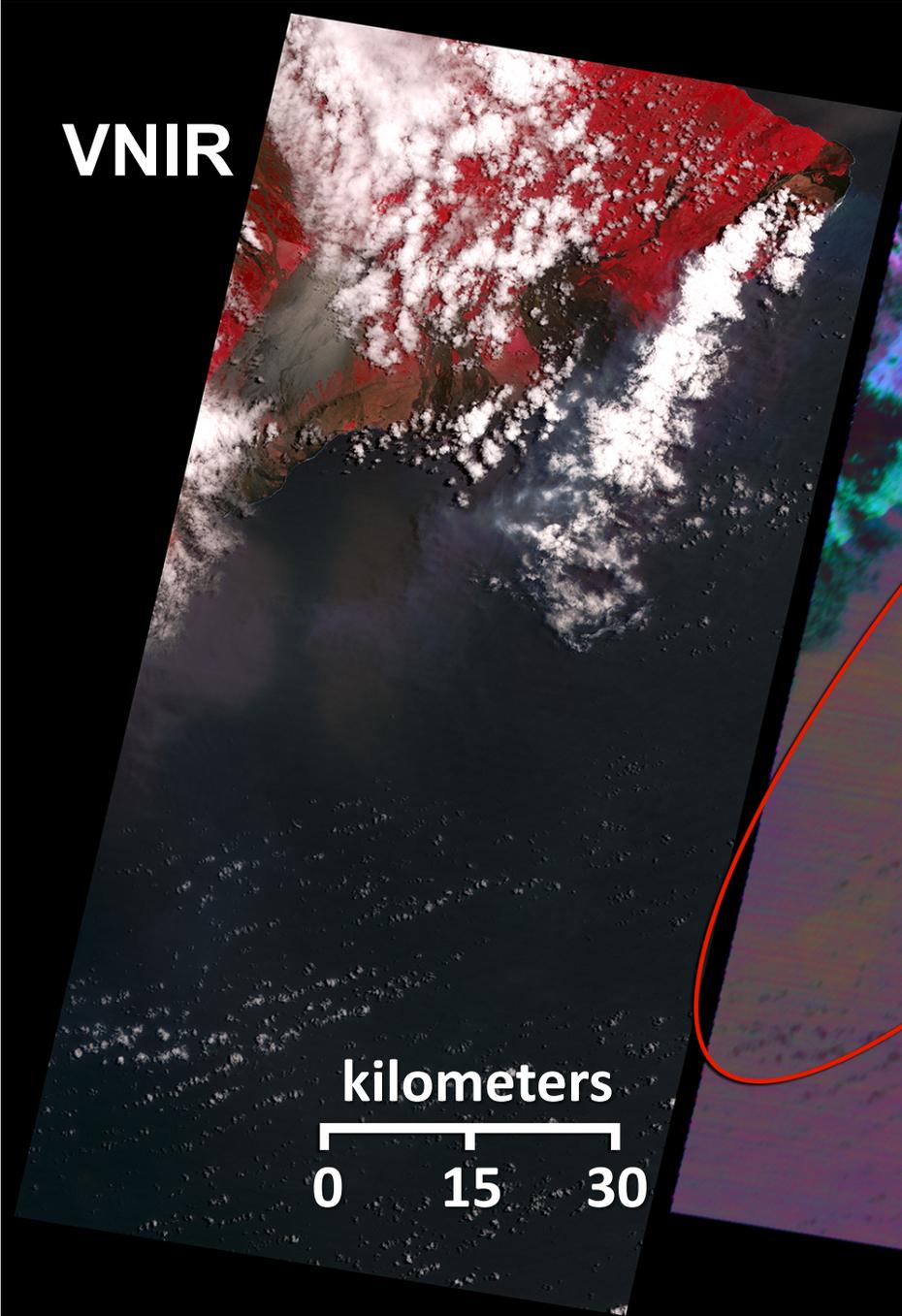
## Base Collaborations on Retrospective Case Studies of Past Events

- Difficult to Collaborate in the Midst of an Emergency
- Design DS Products to Inform Decisions that Were Made During the Event
- Promote Focus on Retrospective Studies by Targeting Applications Proposal Opportunities on Recent Emergency Events
- NASA Support of EM Personnel Leading to Transfer of Responsibility for DS Product to Agency



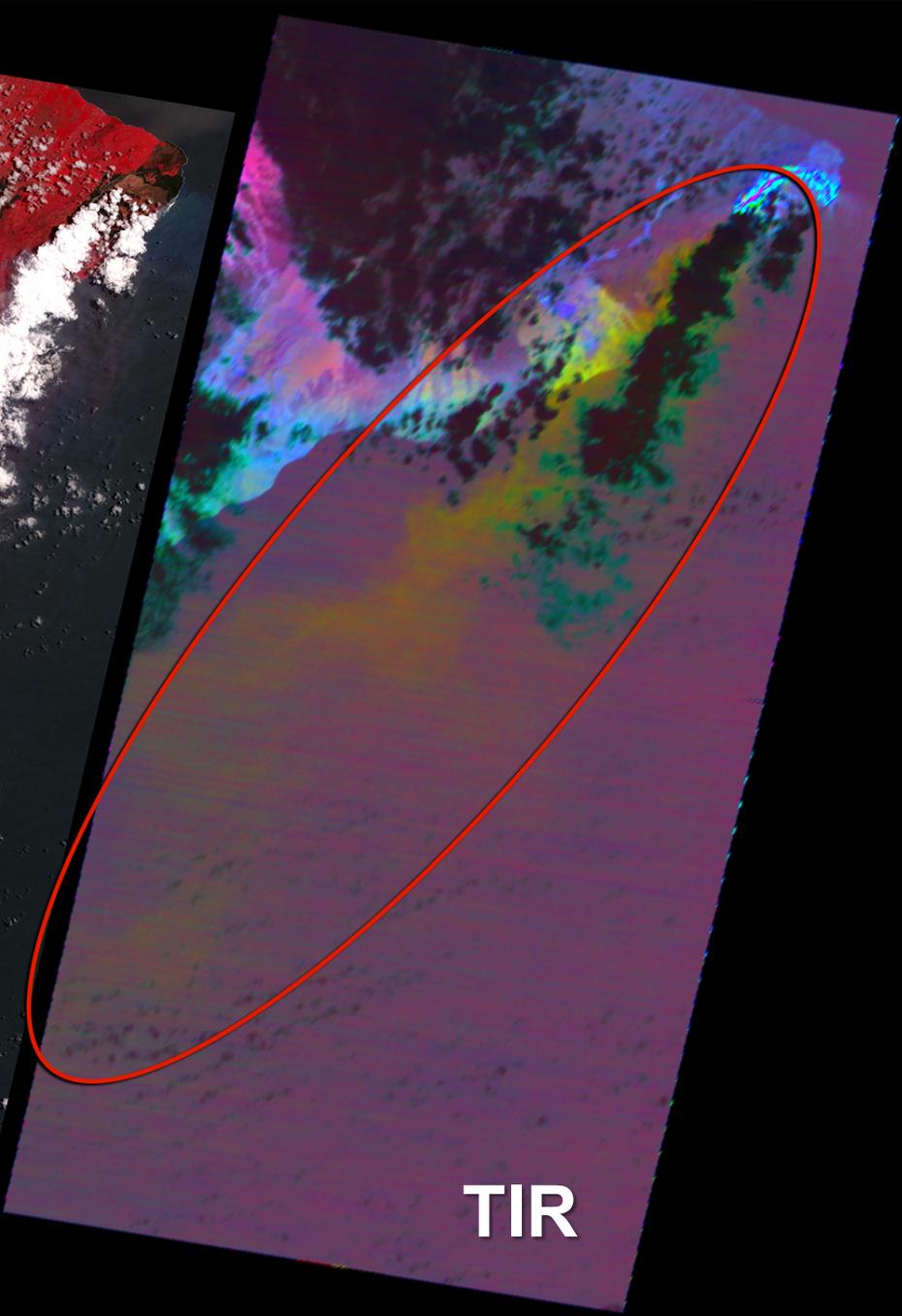
**Example: Low-Latency Mapping  
of SO<sub>2</sub> Emissions with Thermal  
Infrared (TIR) Remote Sensing**

**VNIR**

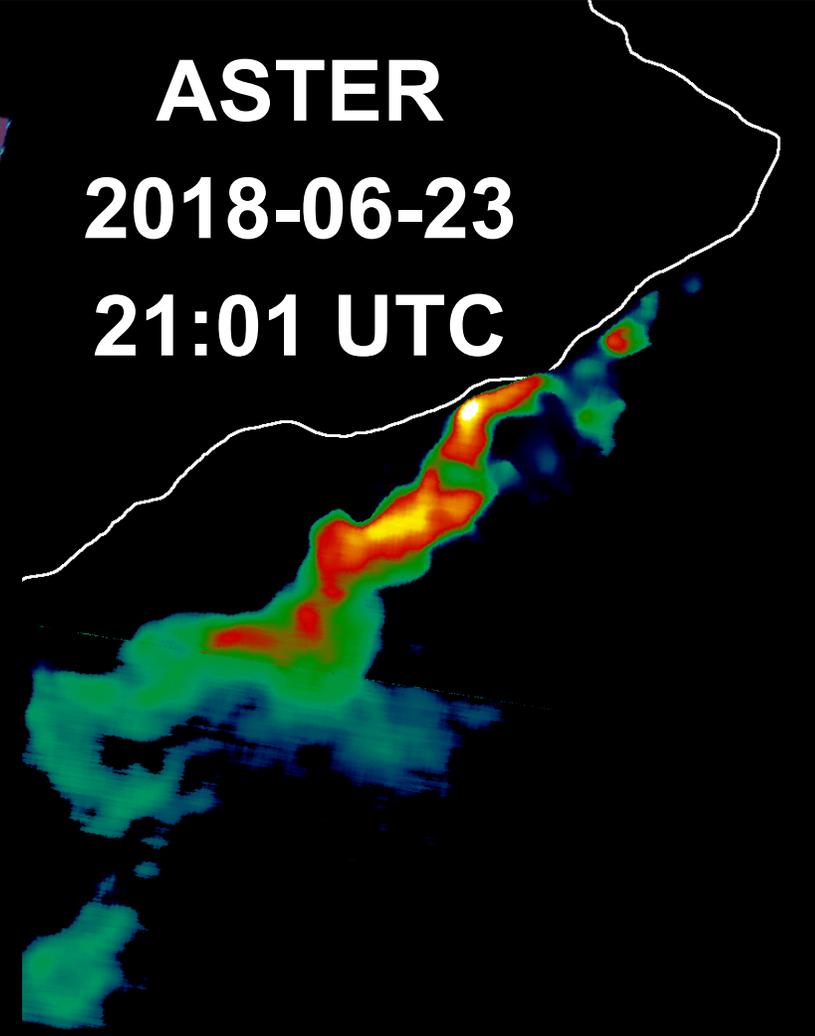


**kilometers**  
0 15 30

**TIR**



**ASTER**  
**2018-06-23**  
**21:01 UTC**



**SO<sub>2</sub> Column (g/m<sup>2</sup>)**  
0 15 30

# Plume Tracker: A Menagerie of Widgets!



The screenshot displays the PLUME TRACKER (V.2.2.8c) application window. The interface is organized into several sections, each with a title and associated input fields or buttons:

- Radiance at the Instrument:** Contains a button labeled "IRAD Image" and an empty text input field.
- Sensor Description:** Contains three input fields: "Sensor Zenith", "Spec. Resp. File", and "No. of Channels:", each preceded by a button with the same label.
- Optional Input Files:** Contains three input fields: "DEM", "Latitude", and "Longitude", each preceded by a button with the same label.
- Action Menu:** Contains three buttons labeled "Begin", "Help", and "Exit".

# Plume Tracker: A Menagerie of Widgets!

Describe Atmospheric Profile (v.9.2)

Temperature Units: Celsius

Pressure Units: mb

H2O Conc. Units: Rel Humid (%)

O3 Conc. Units: Vol Mixing Ratio (ppmv)

Climatology Profile: US Standard

H2O Scaling Factor: 1.00000

O3 Scaling Factor: 1.00000

CO2 Mixing Ratio (ppm-v): 390.000

Tropopause Height (km): 10.0000

Plume Height (km): 6.00000

Plume Thickness (km): 1.00000

Max SO2 Conc (mg/m3): 10.0000

Surface Temperature (K): Calculate

Accept Cancel Help

AST\_20120521\_205939\_DS432\_Index

Quit

Display Menu Zoom

Current View S1: 0 L1: 0 S2: 649 L2: 511

Plume Tracker Driver (V.4.2.3): [AST\_20120521\_205939\_TIR]

Action Menu

CURRENT SELECTION

STARTING POINT

Line: 386 Sample: 241

Latitude Longitude

ENDING POINT

Line: 386 Sample: 241

Latitude Longitude

PLUME GAS OPTION

Sulfur Dioxide (SO2)

Ammonia (NH3)

Methane (CH4)

RETRIEVAL OPTIONS

Surface Temperature

H2O Factor

O3 Factor

Plume Gas

Hash Table

PANEL MODE

Plume Description  Map Information

Elevation (m): 0.830000 H2O Factor: 0.830000 O3 Factor: 1.10000 LS Misfit: 2.5272E-001

Surface T (K): 324.553 Gas Conc. (ppm-v): 7.71485 Gas Column (g/m2): 8.57140

Emissivity Plot

Misfit: Prediction vs. Observation

BRIGHT TEMP (K): 318, 316, 314, 312, 308, 306, 304, 8

%Δ: 5, 0, -5, 8

Spectrum [1]: ASTER\_Seawater\_Lab\_Spectrum.tab

Action Menu

Max. Emissivity: 0.99

Spectrum Name

ASTER\_Seawater\_Lab\_Spectrum.tab

Emis Spectrum #1 Read From File  
ASTER\_Seawater\_Lab\_Spectrum.tab

	Wavelength	Emissivity	Std Dev
1	8.28731	0.982826	0.000000
2	8.63488	0.983577	0.000000
3	9.07929	0.984710	0.000000
4	10.6592	0.990301	0.000000
5	11.2893	0.990651	0.000000

# Plume Tracker: A Menagerie of Widgets!

Plume Tracker Driver (V.4.2.3): [AST\_20120521\_205939\_TIR]

**Action Menu**

**CURRENT SELECTION**

**STARTING POINT**

Line	Sample
386	241

**Latitude**  **Longitude**

**ENDING POINT**

Line	Sample
386	241

**Latitude**  **Longitude**

**PLUME GAS OPTION**

Sulfur Dioxide (SO<sub>2</sub>)

Ammonia (NH<sub>3</sub>)

Methane (CH<sub>4</sub>)

**RETRIEVAL OPTIONS**

Surface Temperature

H<sub>2</sub>O Factor

O<sub>3</sub> Factor

Plume Gas

Hash Table

**PANEL MODE**

Plume Description  Map Information

**MESSAGES**

Loaded  
x) Loaded  
p  
x) Loaded

Elevation (m)	H <sub>2</sub> O Factor	O <sub>3</sub> Factor	LS Misfit
0.830000	0.830000	1.10000	2.5272E-001

Surface T (K)	Gas Conc. (ppm-v)	Gas Column (g/m <sup>2</sup> )
324.553	7.71485	8.57140

**Emissivity Plot**

**Misfit: Prediction vs. Observation**

**Delta: Prediction vs. Observation**

Pseudo Color Widget

Quit

IDL Tables  Custom Table

B-W LINEAR  
BLUE/WHITE  
GRN-RED-BLU-WHT  
RED TEMPERATURE  
BLUE/GREEN/RED/YELLOW  
STD GAMMA-II  
PRISM  
RED-PURPLE  
GREEN/WHITE LINEAR  
GRN/WHT EXPONENTIAL  
GREEN-PINK  
BLUE-RED  
16 LEVEL  
RAINBOW  
STEPS  
STERN SPECIAL  
Haze  
Blue - Pastel - Red  
Pastels  
Hue Sat Lightness 1

255

Stretch Top

0

Stretch Bottom

1.00

Averaged Results (V.4.0) [5]

**Mean Emissivity Spectrum**

**Misfit: Mean Prediction vs. Observation**

**Delta: Mean Prediction vs. Observation**

**Probability (%)**

**TEMPERATURE (K)**

Mode: 322.488  
Mean: 321.71959 +/- 4.29  Save

**WATER FACTOR**

Mode: 0.800000  
Mean: 0.84999996 +/- 0.0  Save

**OZONE FACTOR**

Mode: 1.30000  
Mean: 1.2500000 +/- 0.00  Save

**Assign** **Cancel**

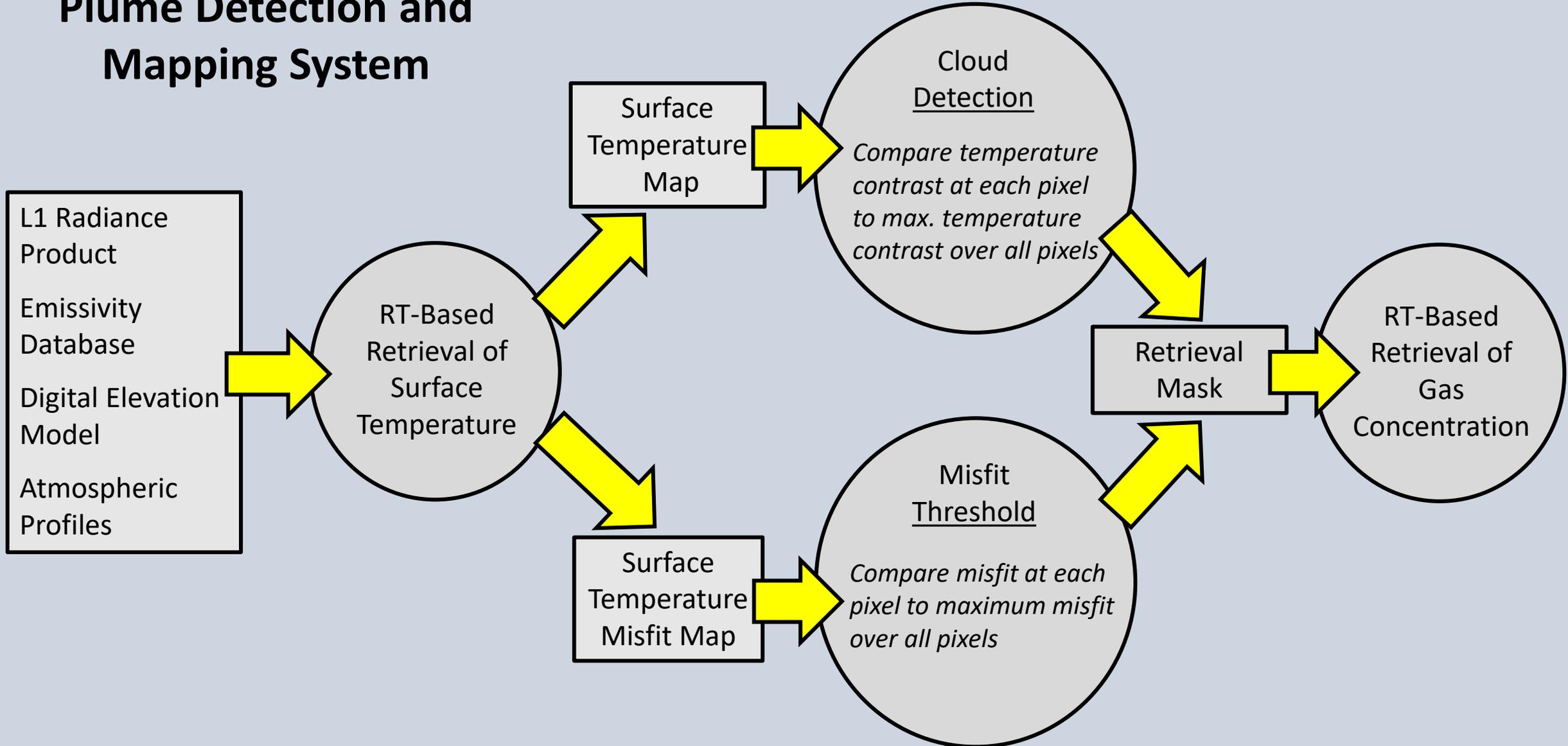
Gas Concentration Map: Zoom Window #3

Quit

Zoom Factor: 4

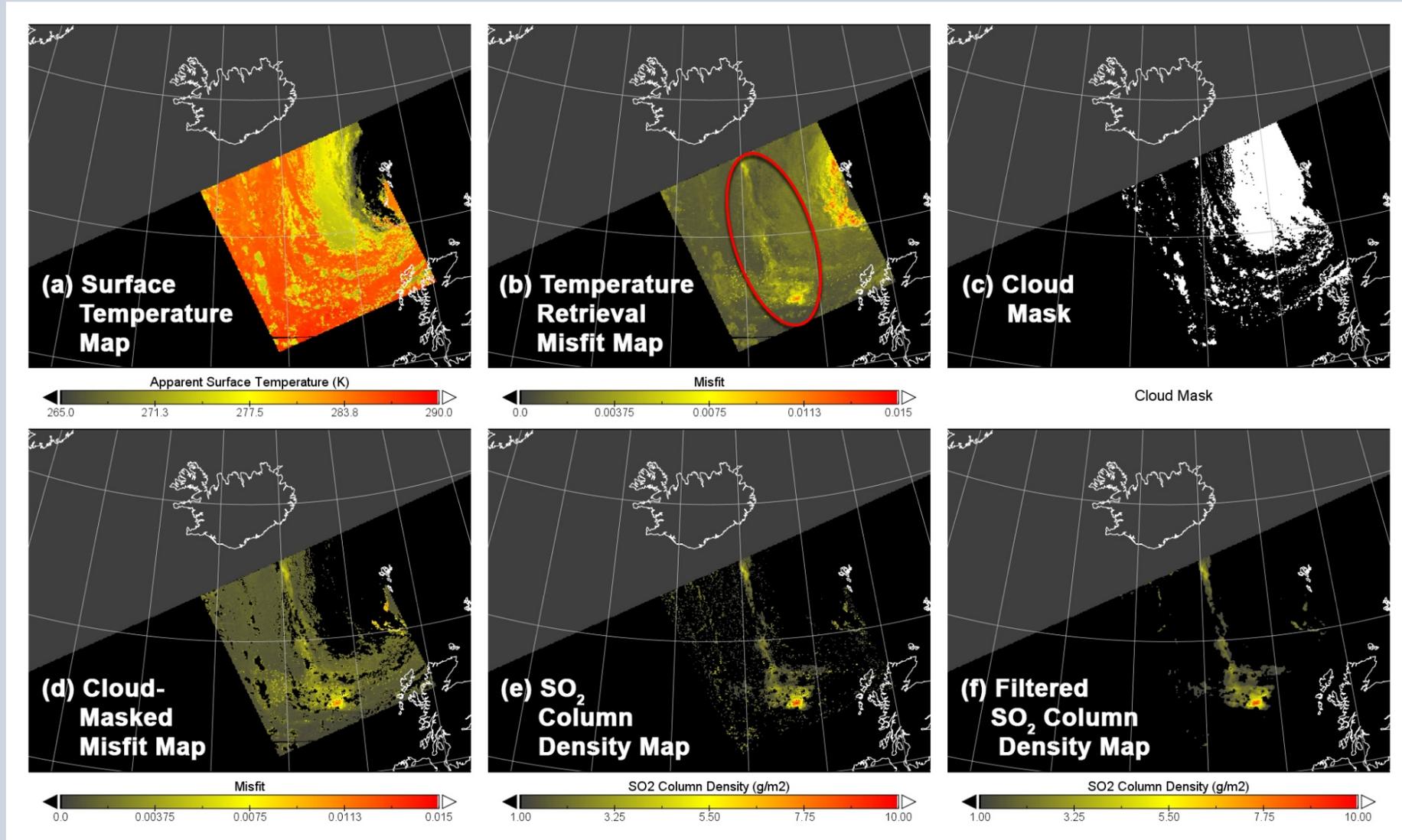
**Current View** S1: 200 L1: 308 S2: 328 L2: 436

# Flow Chart for Automated Plume Detection and Mapping System



# Bardarbunga Volcano (Iceland) / VIIRS-VMAE / 2014-09-05

- Surface temperature estimation does not consider volcanic plumes or met. clouds
- Misfit map shows the locations of plumes (red oval) and met clouds
- Met clouds are identified by comparing apparent surface temperature with air temperature at plume altitude
- Combination of cloud mask and misfit map improves the detection of volcanic plumes
- Estimation of  $\text{SO}_2$  column density is confined to the locations identified by the masked misfit map
- $\text{SO}_2$  map is filtered to minimize the “holes” corresponding to the locations of met clouds.



**Thanks for Your Attention**