Scientific Animation: Techniques for the Visualization of Time-Series Earth Science Data

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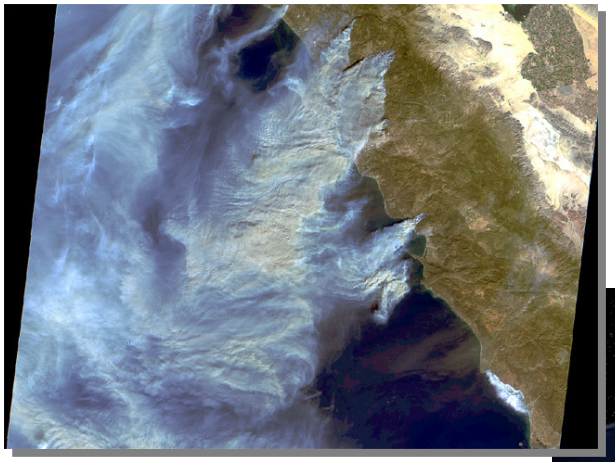
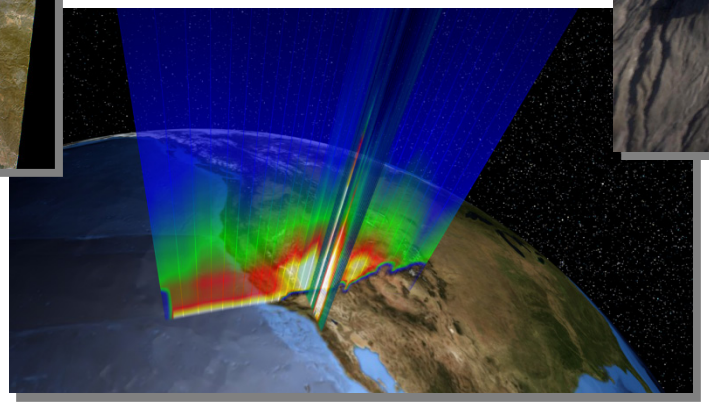
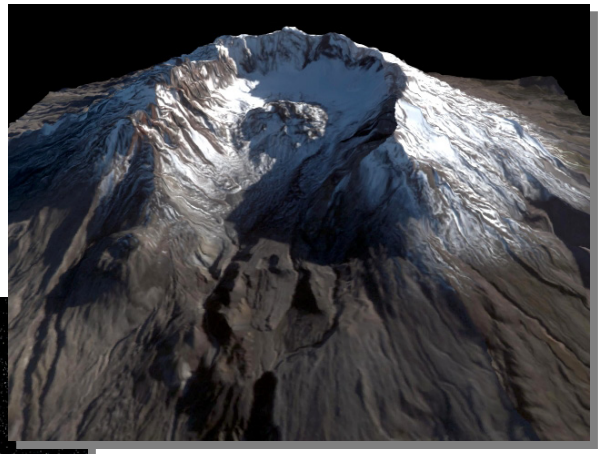
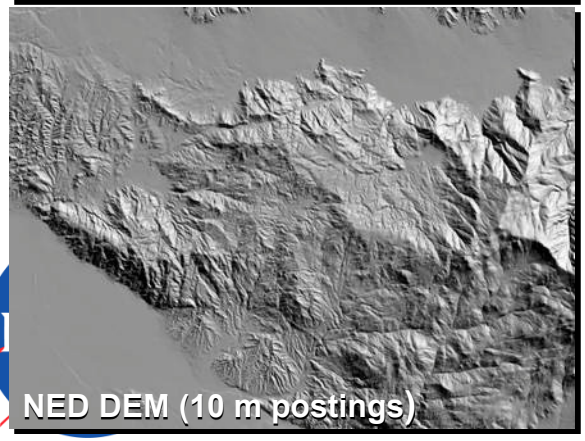
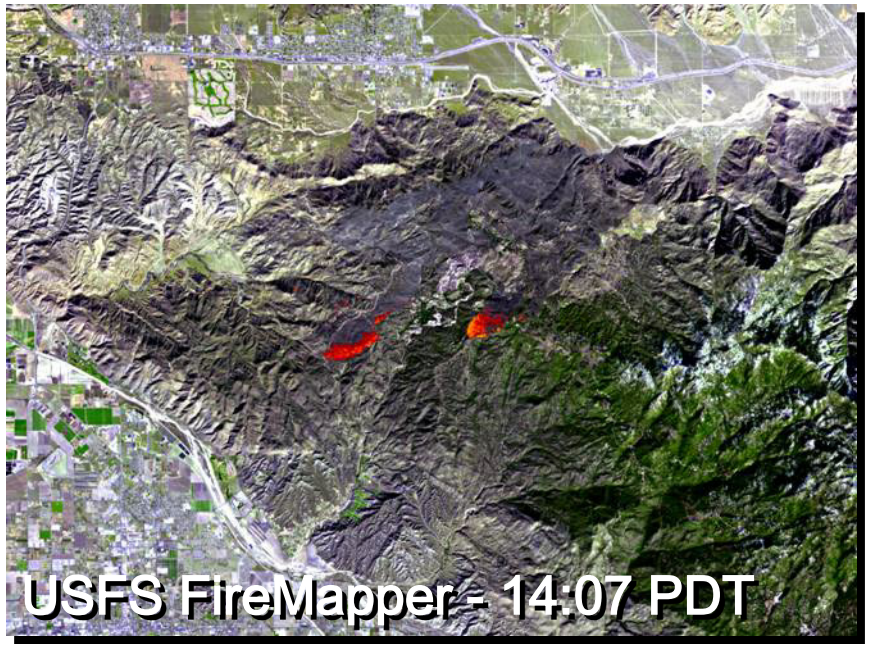


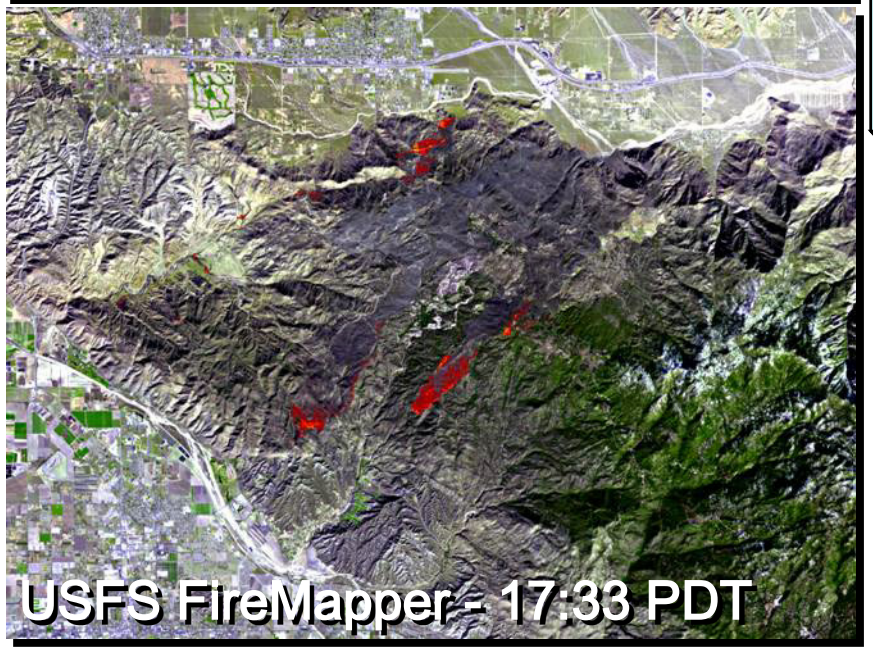




Esperanza Fire, San Jacinto Mountains, 26 October 2006



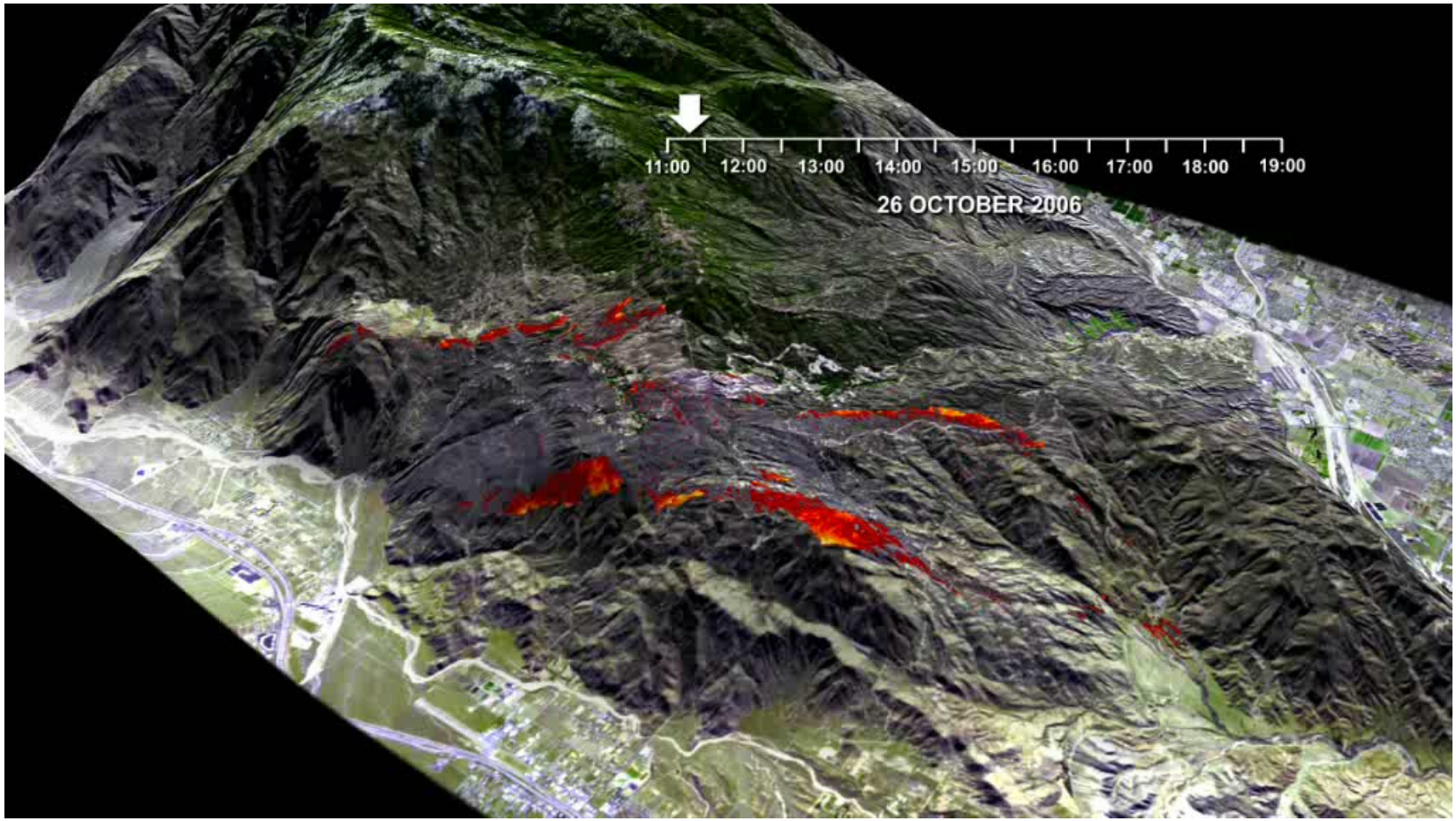




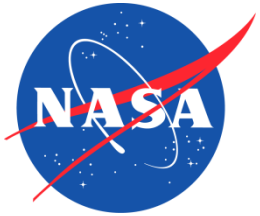
2-D Shape Morph

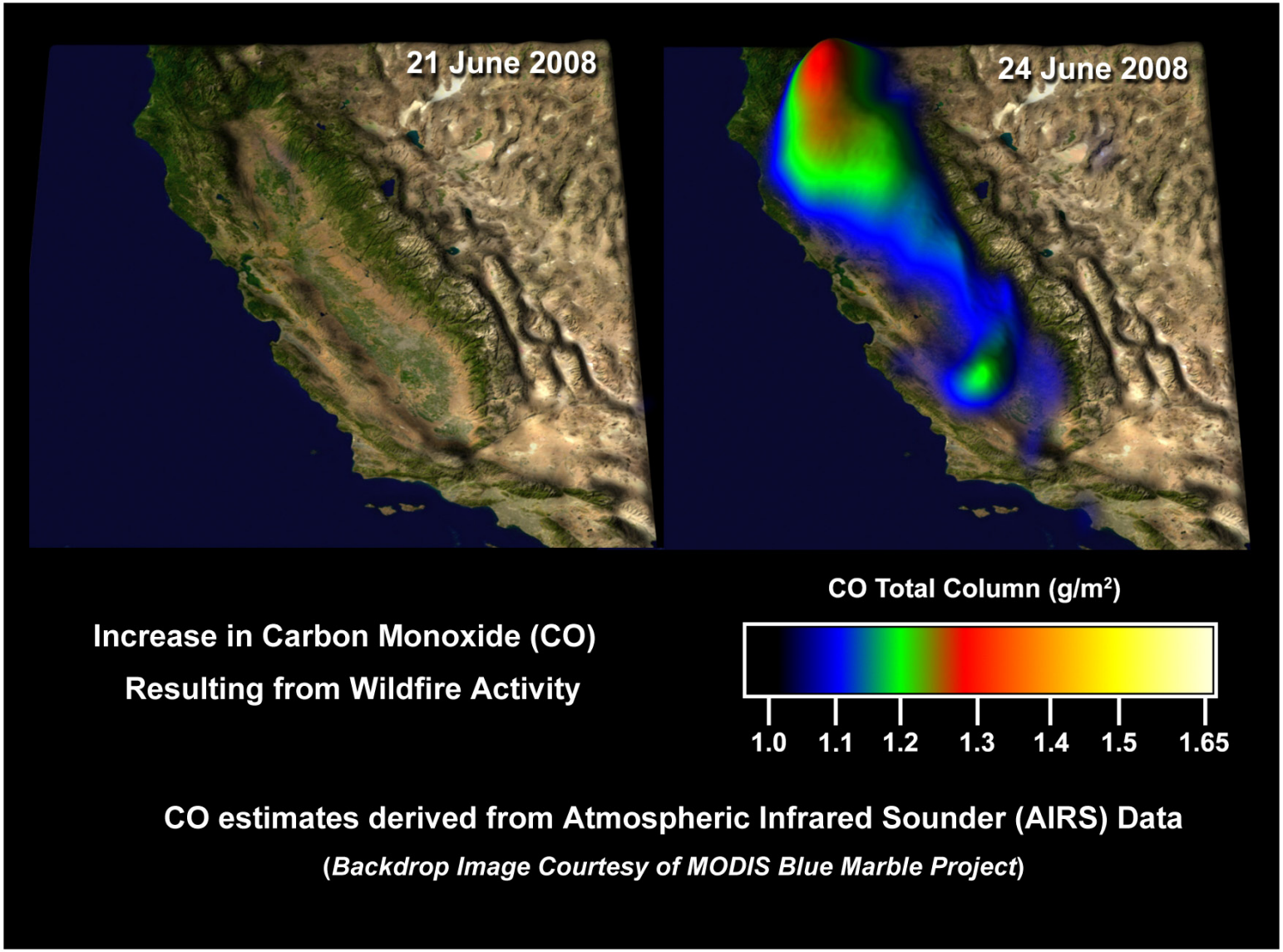
- Interpolate Positions of Flame Fronts
- Five FireMapper Scenes

Visualization of Earth Science Data



Esperanza Fire, San Jacinto Mountains, 26 October 2006



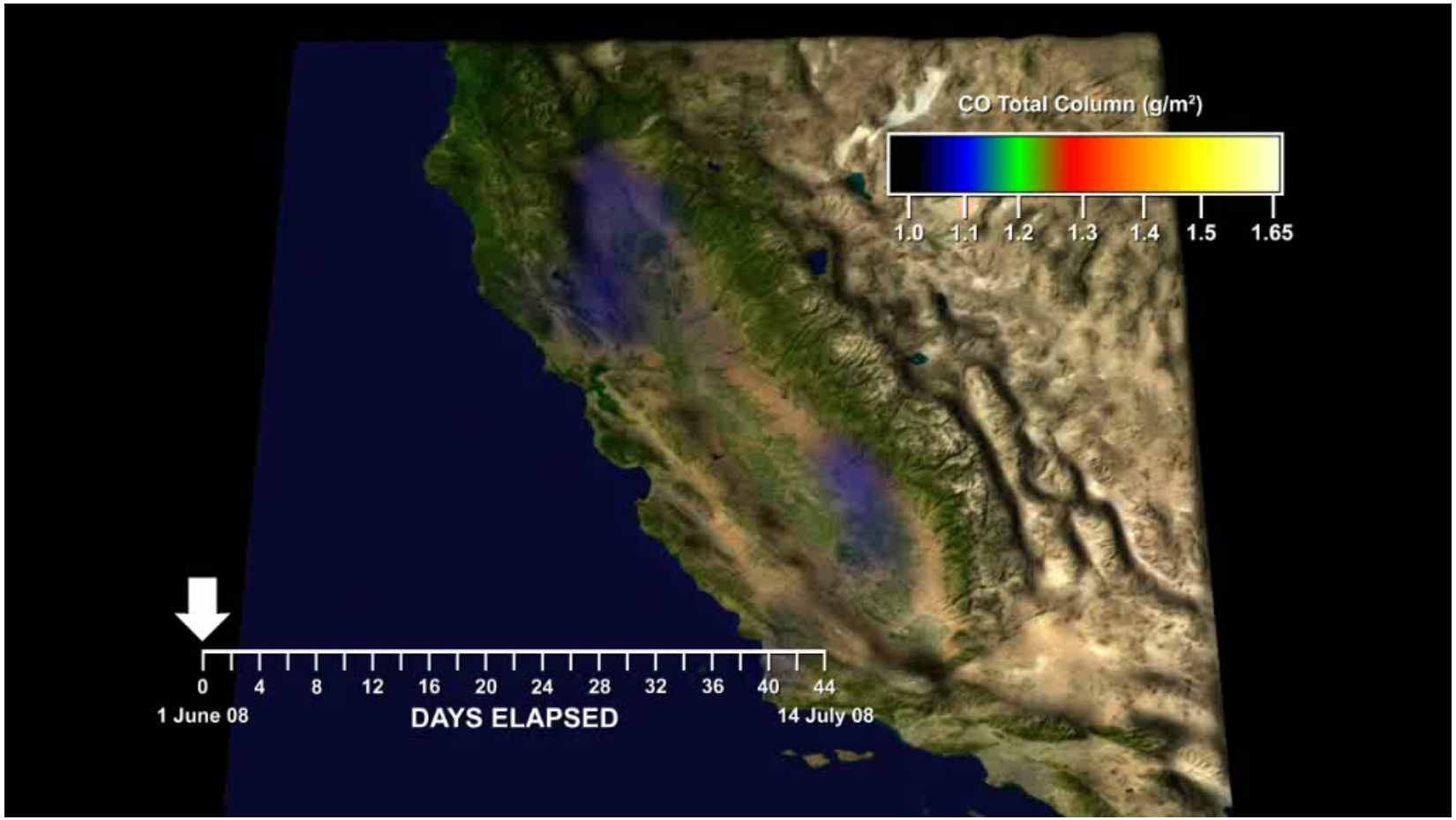


AIRS L2 CO Total Column Estimates

- 3-Day Running Average + Interpolation for Smooth Transitions Over Time
- Height of Feature Corresponds to CO Concentration

MODIS Blue Marble Background + GLOBE DEM (1 km postings)

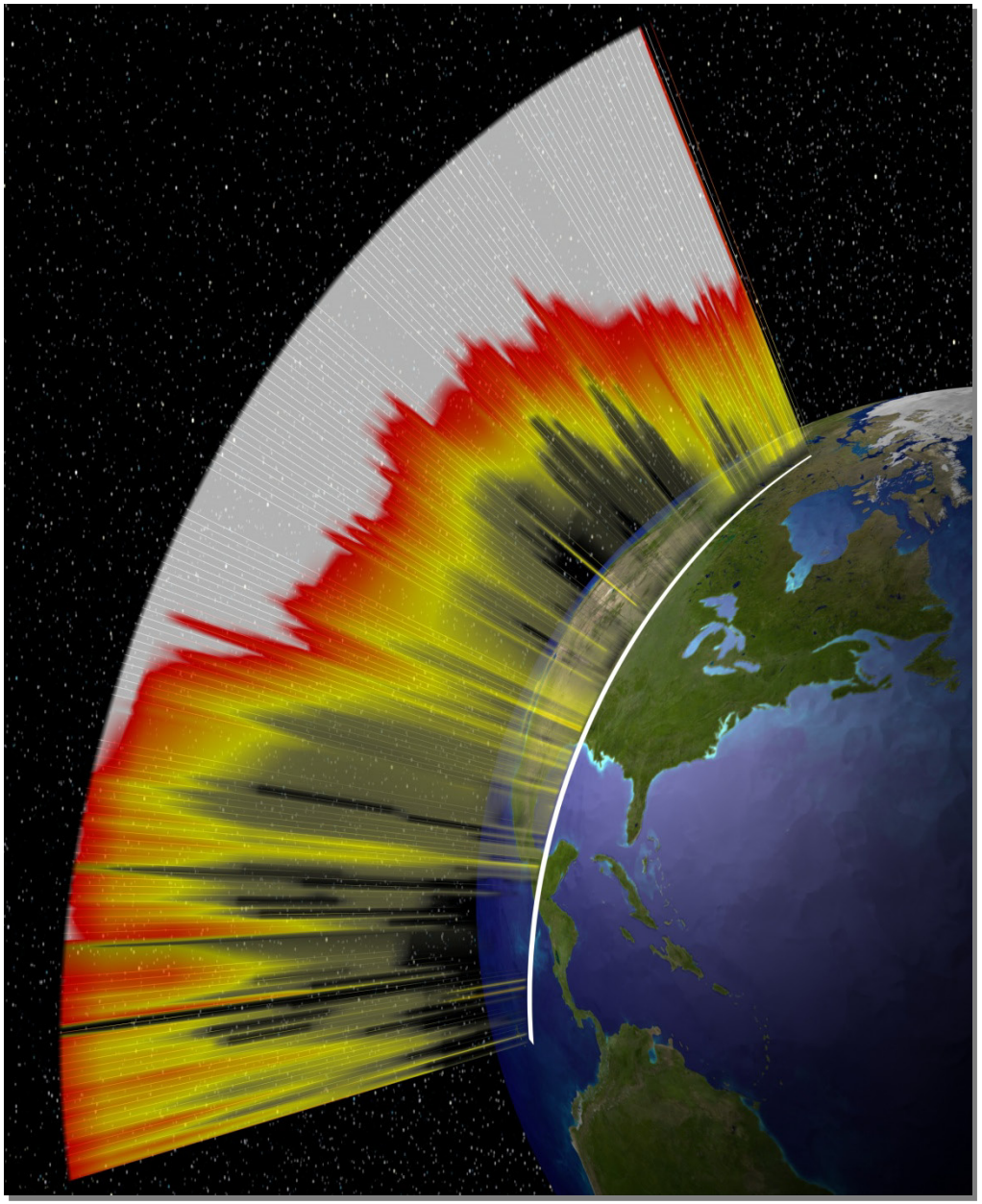
Visualization of Earth Science Data

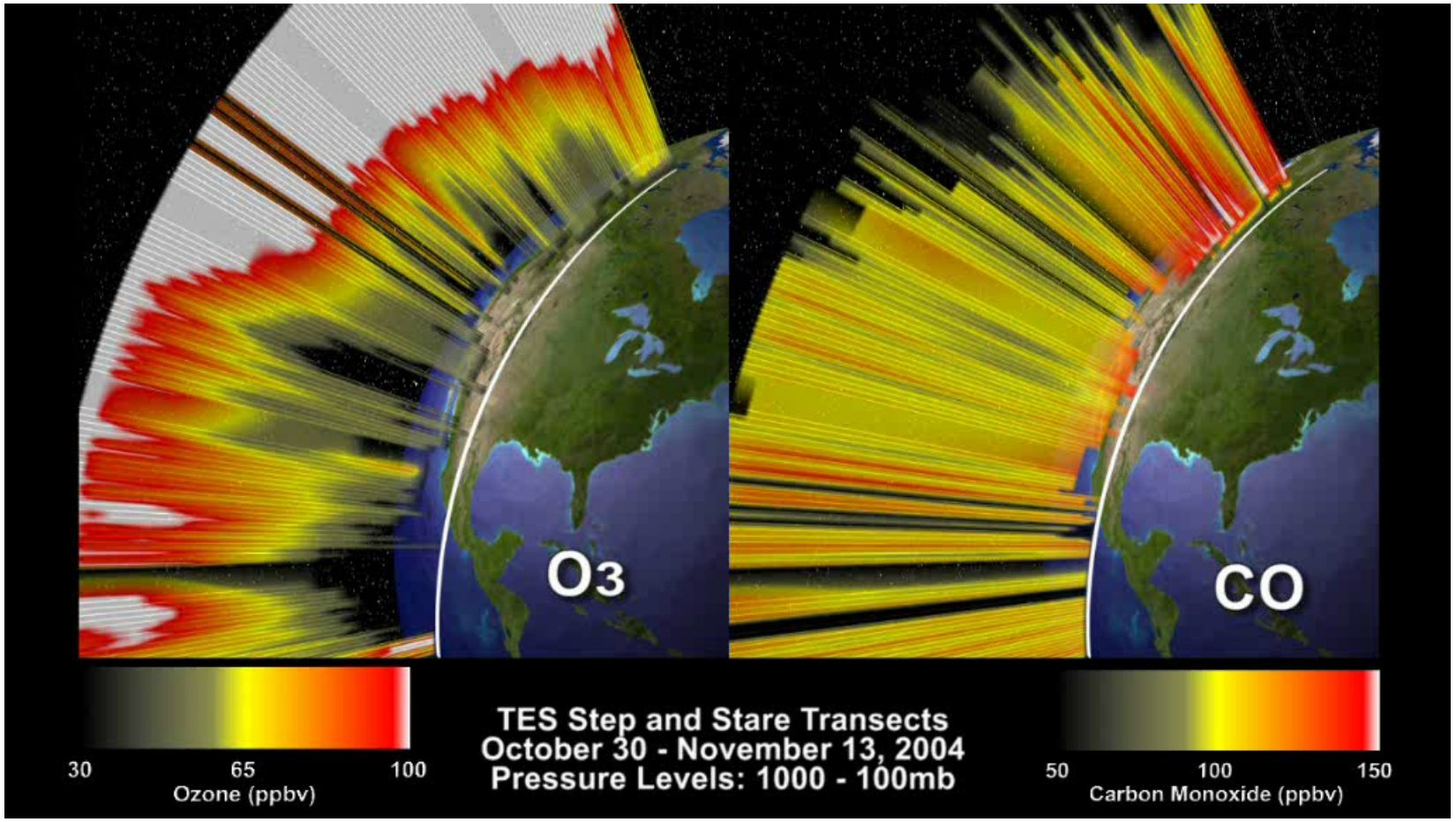


Increase in CO Due to California Wildfires
1 June – 14 July 2008
(*AIRS data processing by C. Thompson*)

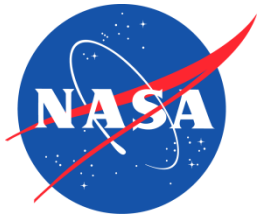
TES: Houston/AVE 2004 Campaign
Special Observation (Step & Stare) Mode

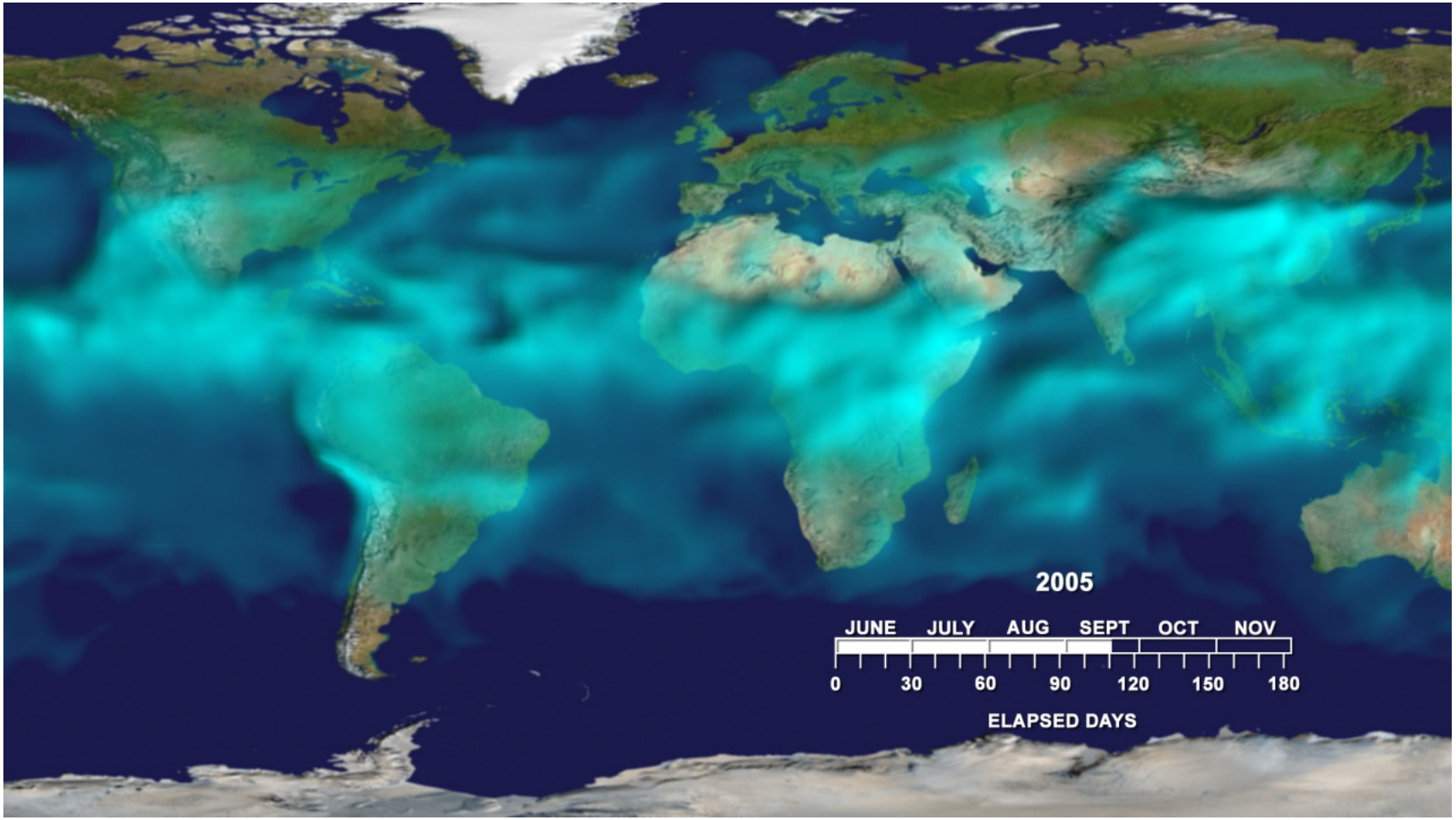
- L2 Retrievals from Sea Level (1000 mb) to ~ 18 km (100 mb)
- Nine Transects Collected Over Two Week Period
- Linear Interpolation Used to Create Continuous Time-Series
- MODIS Blue Marble Background





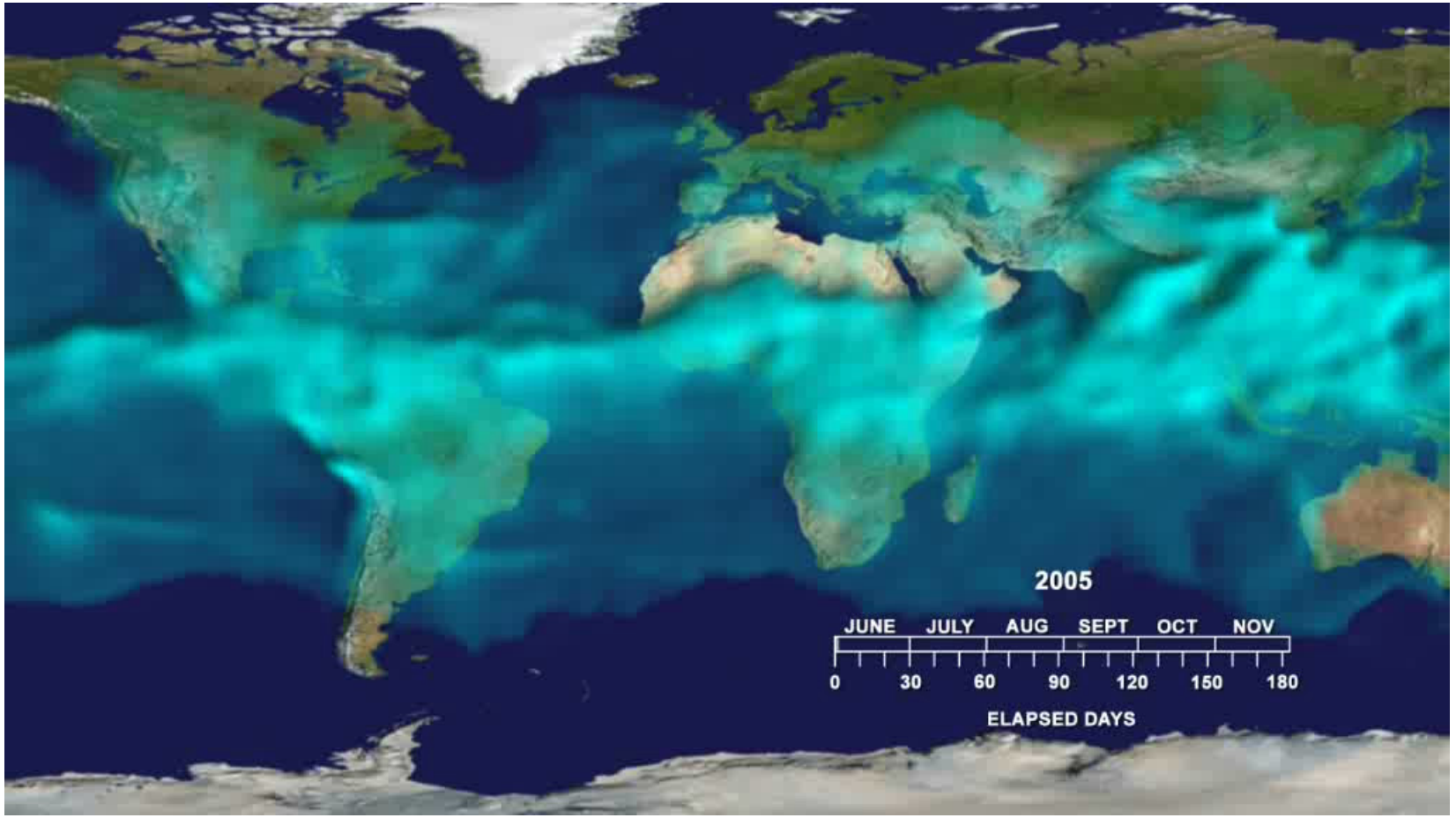
TES: Houston/AVE 2004 Campaign



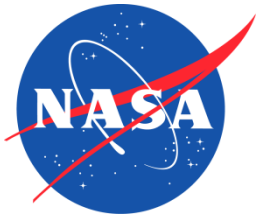


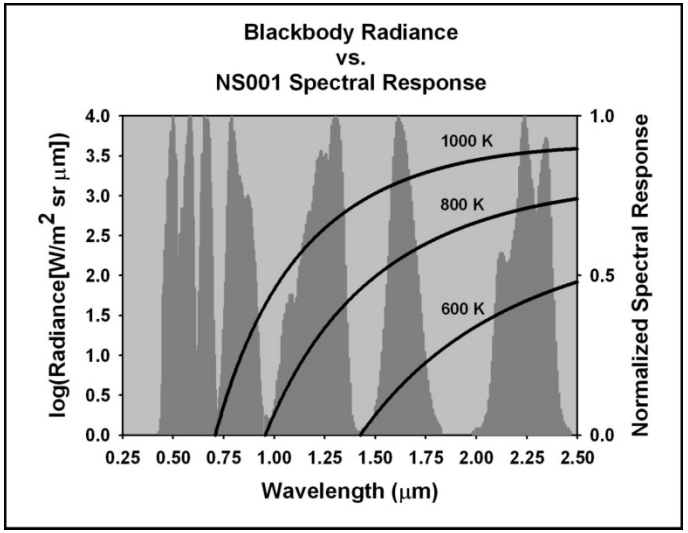
AIRS: L3 Water Vapor Visualization
1 June – 30 November 2005

- Altitude of the MMR = 5 (5g H_2O/kg dry air) Isosurface
- 3-day running average
- Transparency Gradient between Altitudes of 0 and 3 km
- Luminosity Gradient: Brightness Increases with Altitude



AIRS: Water Vapor Isosurface Sequence



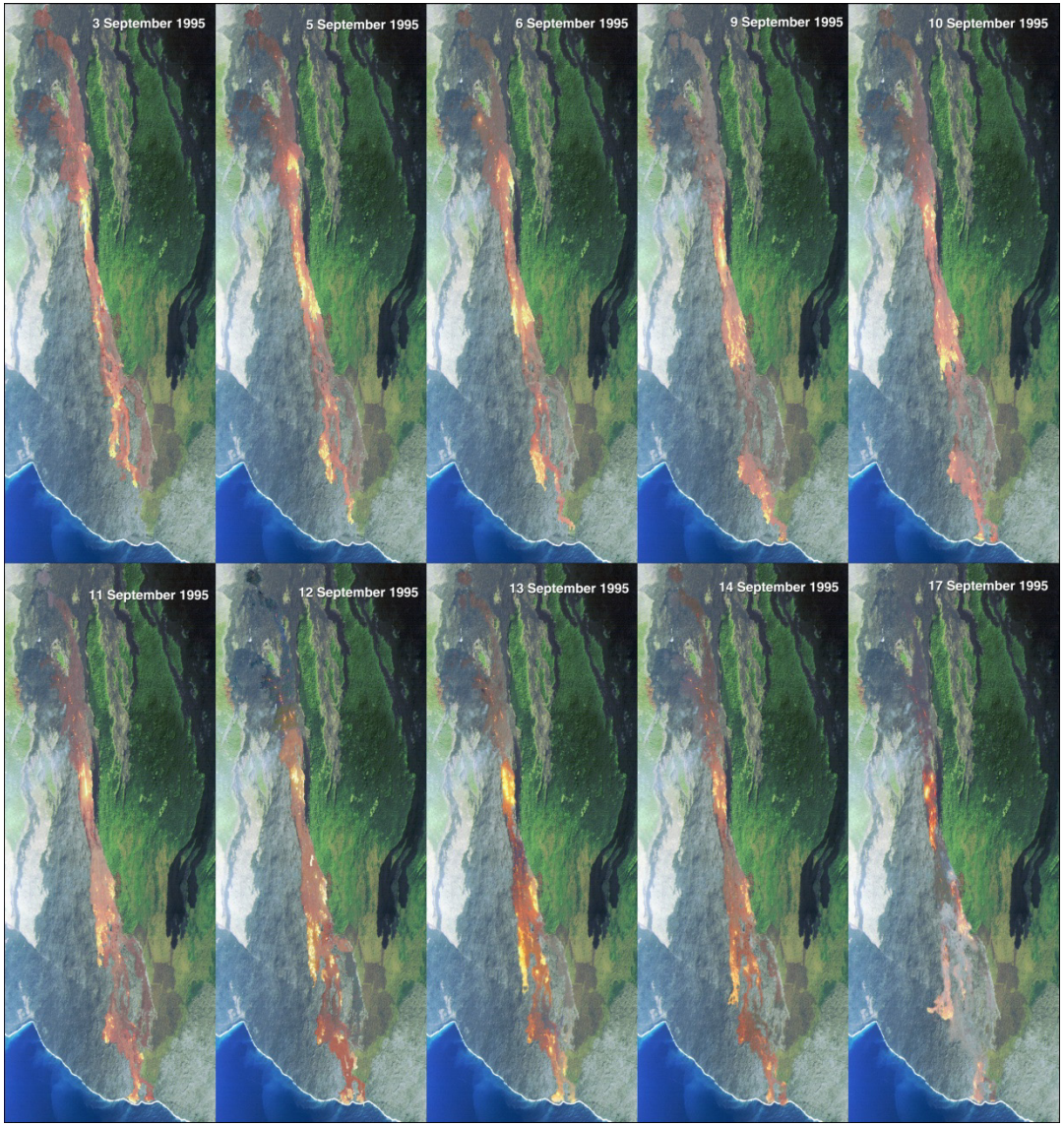


Kamoamoa Flow Field
Kilauea Volcano, HI
3 – 17 September 1995

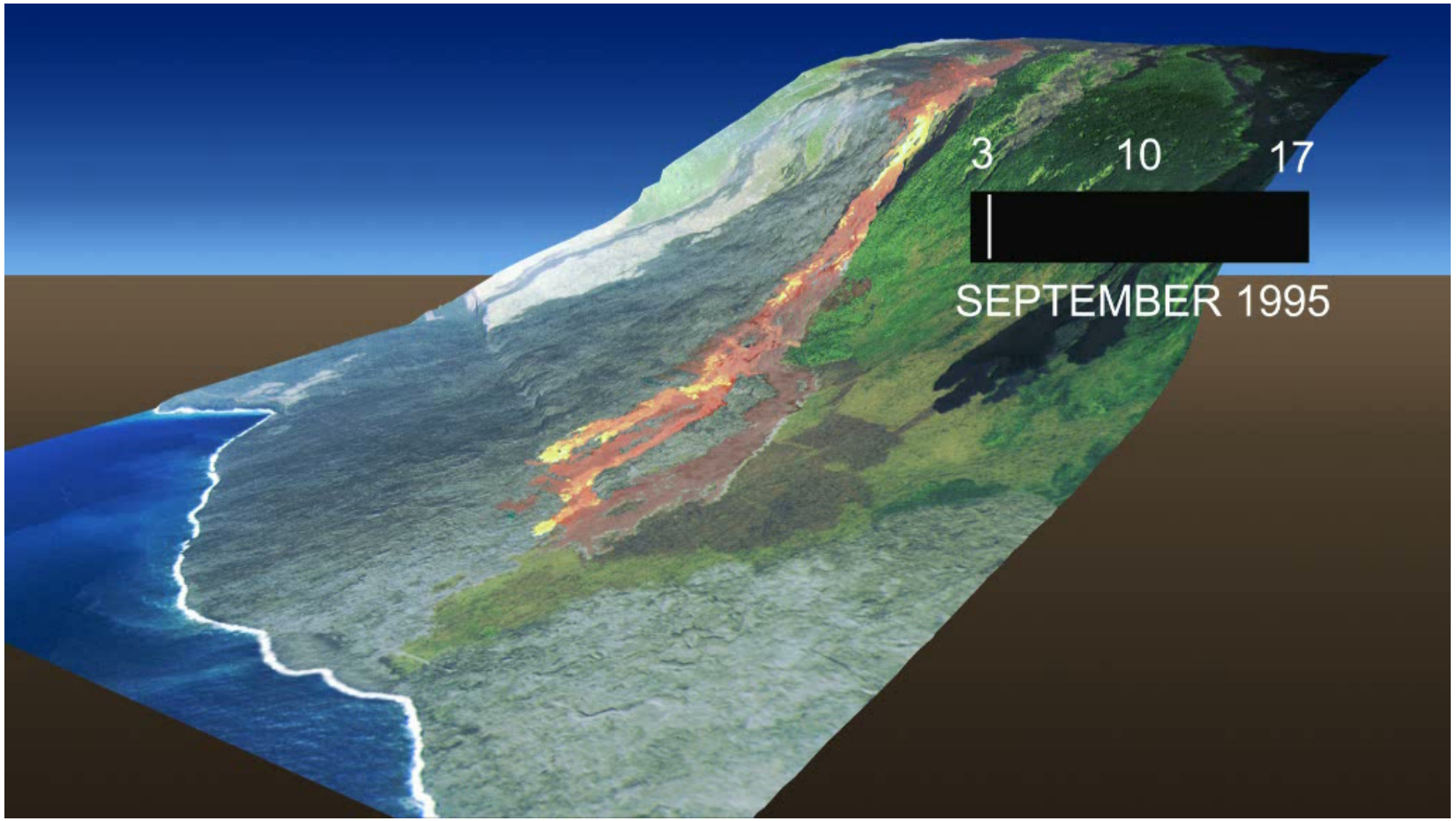
Ten Multispectral Images of Advancing Lava Flows Acquired (from Aircraft) Over 14 Day Period

- 2-D Morphing Used to Interpolate Positions of Flows
- Frame = 30 min of elapsed time

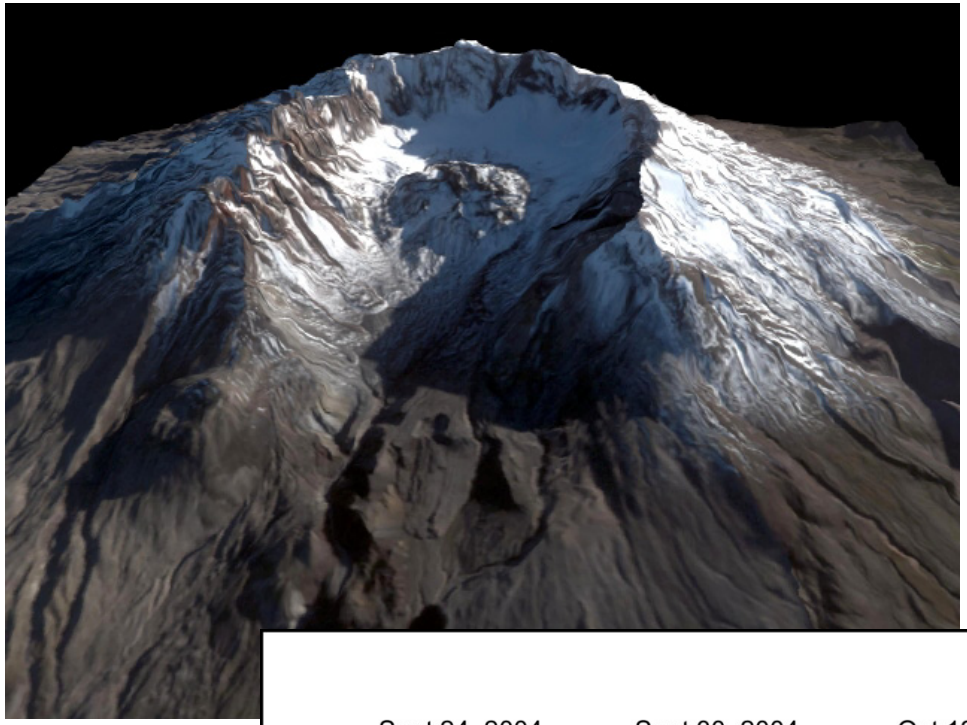
DEM (10 meter spatial resolution)



Visualization of Earth Science Data



Kamoamoa Flow Field, Kilauea Volcano, HI
3 – 17 September 1995



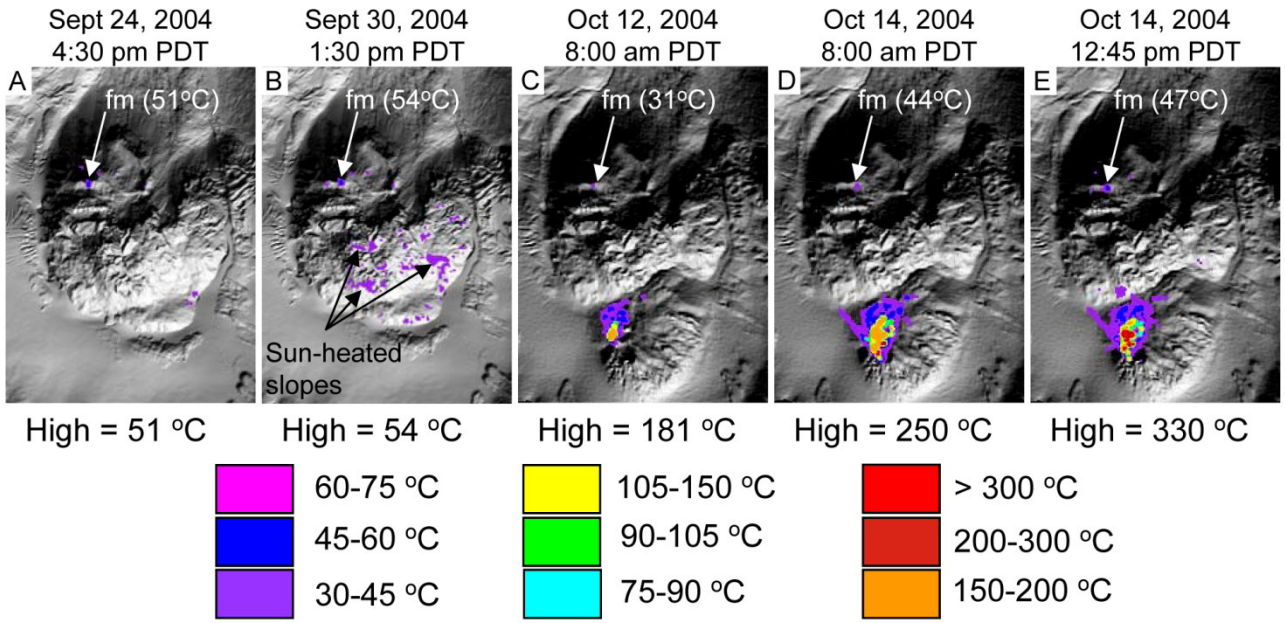
Ground Deformation + Evolution of Hot Spots
Mount St. Helens Volcano

DEM's from Airborne Lidar Surveys (*courtesy USGS and GSFC*):

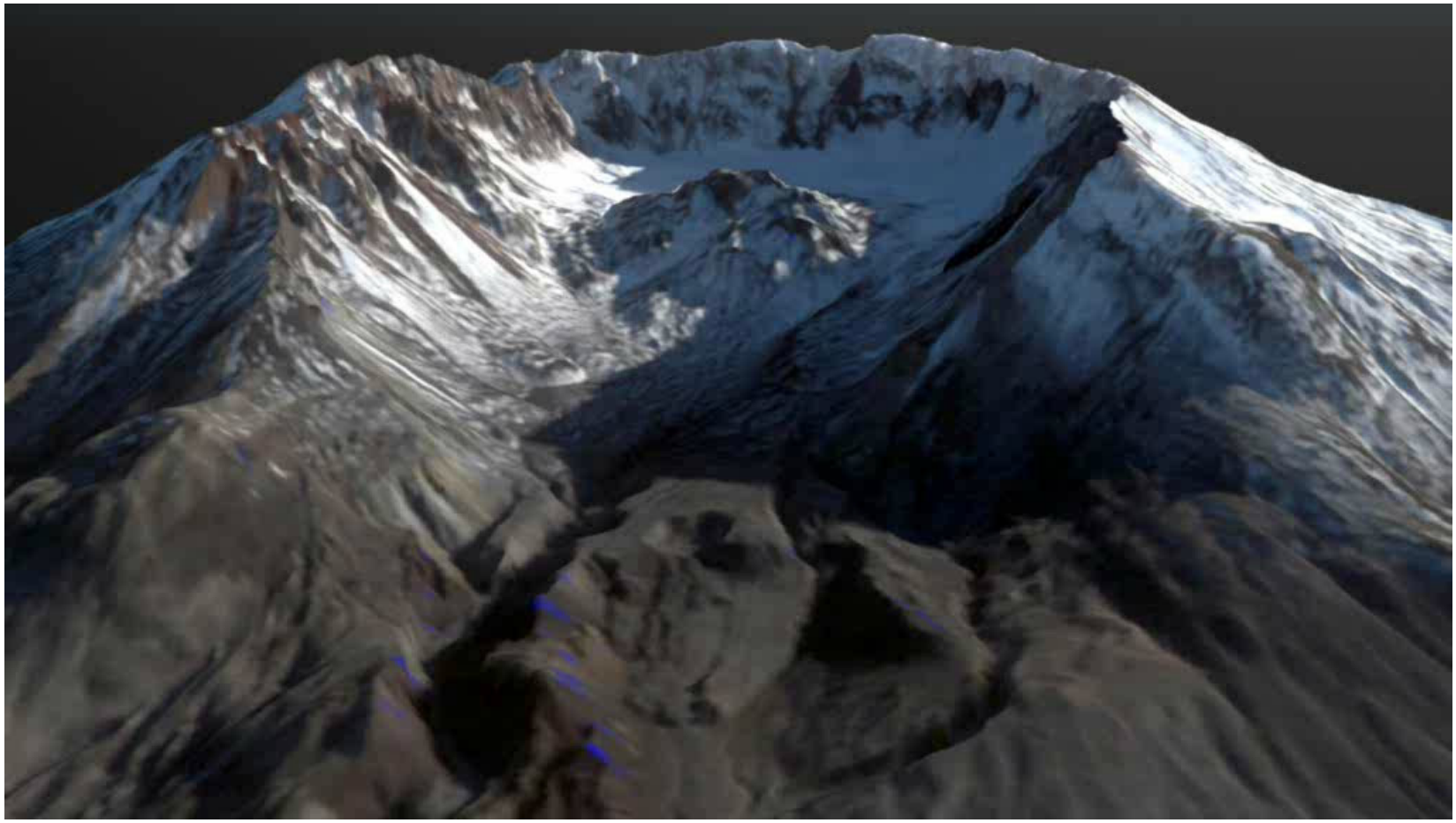
- **September 2003 vs. 14 October 2004**
- **95 meters of Deformation by 14 October**

Thermal Anomalies Derived from Airborne MASTER Surveys

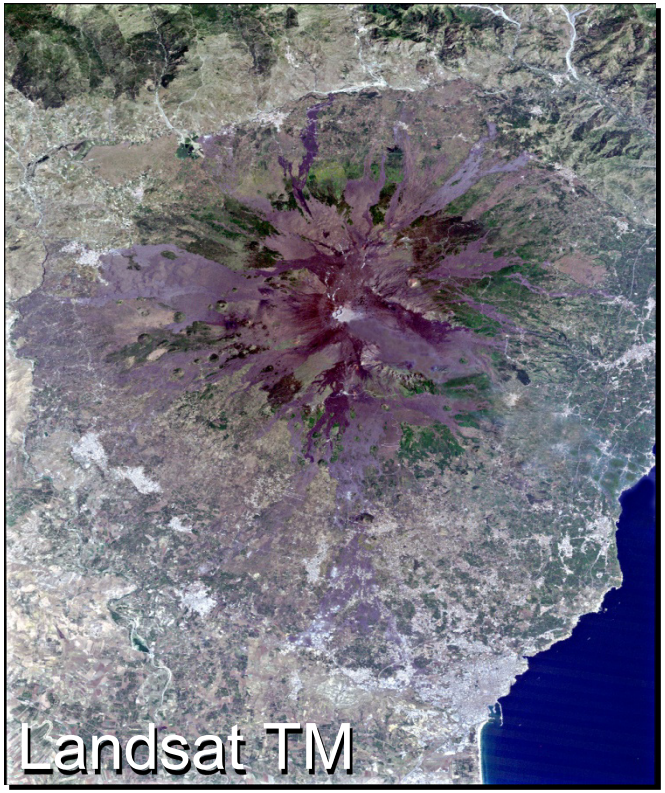
- **Survey Dates: 24 and 30 September 2004; 4 and 14 October 2004**

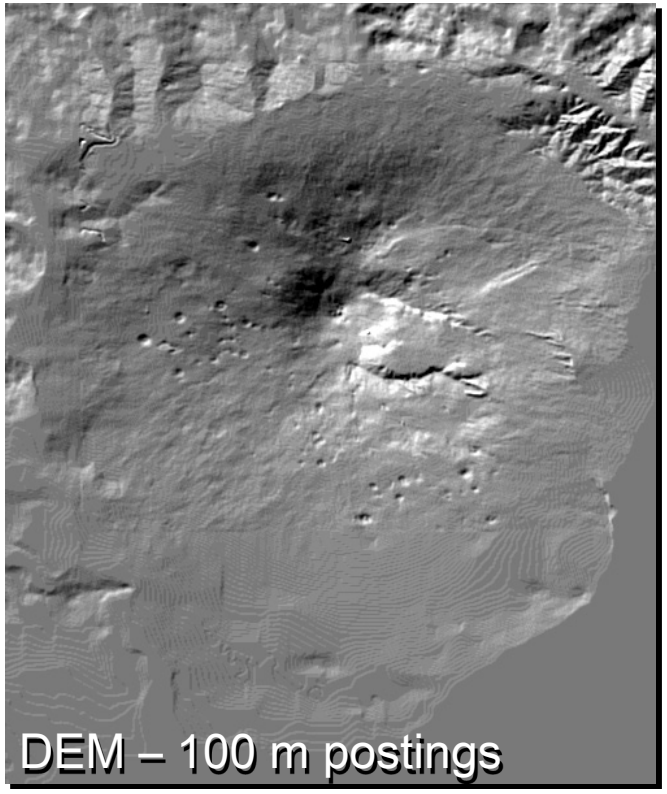


Vaughn et al., 2005



Ground Deformation + Evolution of Hot Spots
Mount St. Helens Volcano





Negative Displacement Sequence

Positive Displacement Sequence

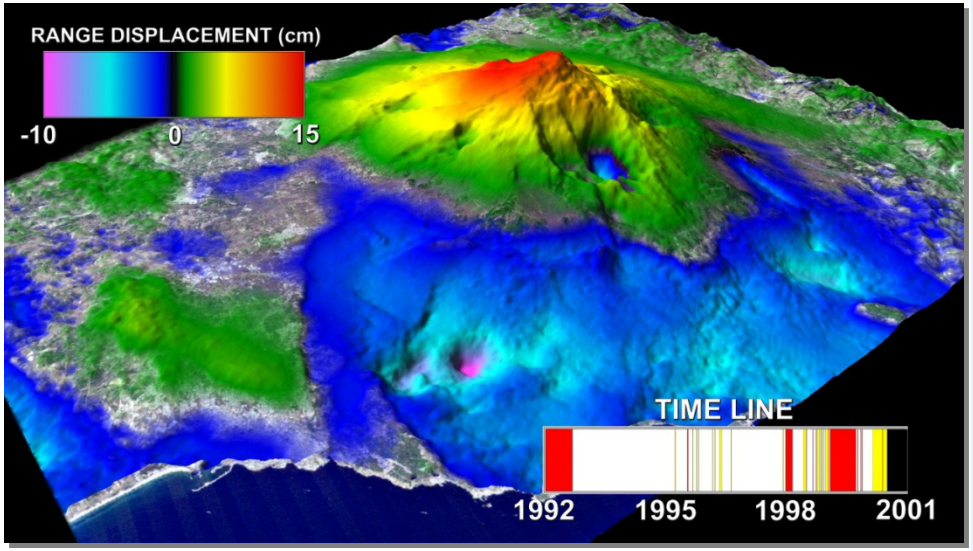
Ground Deformation at Mount Etna Volcano

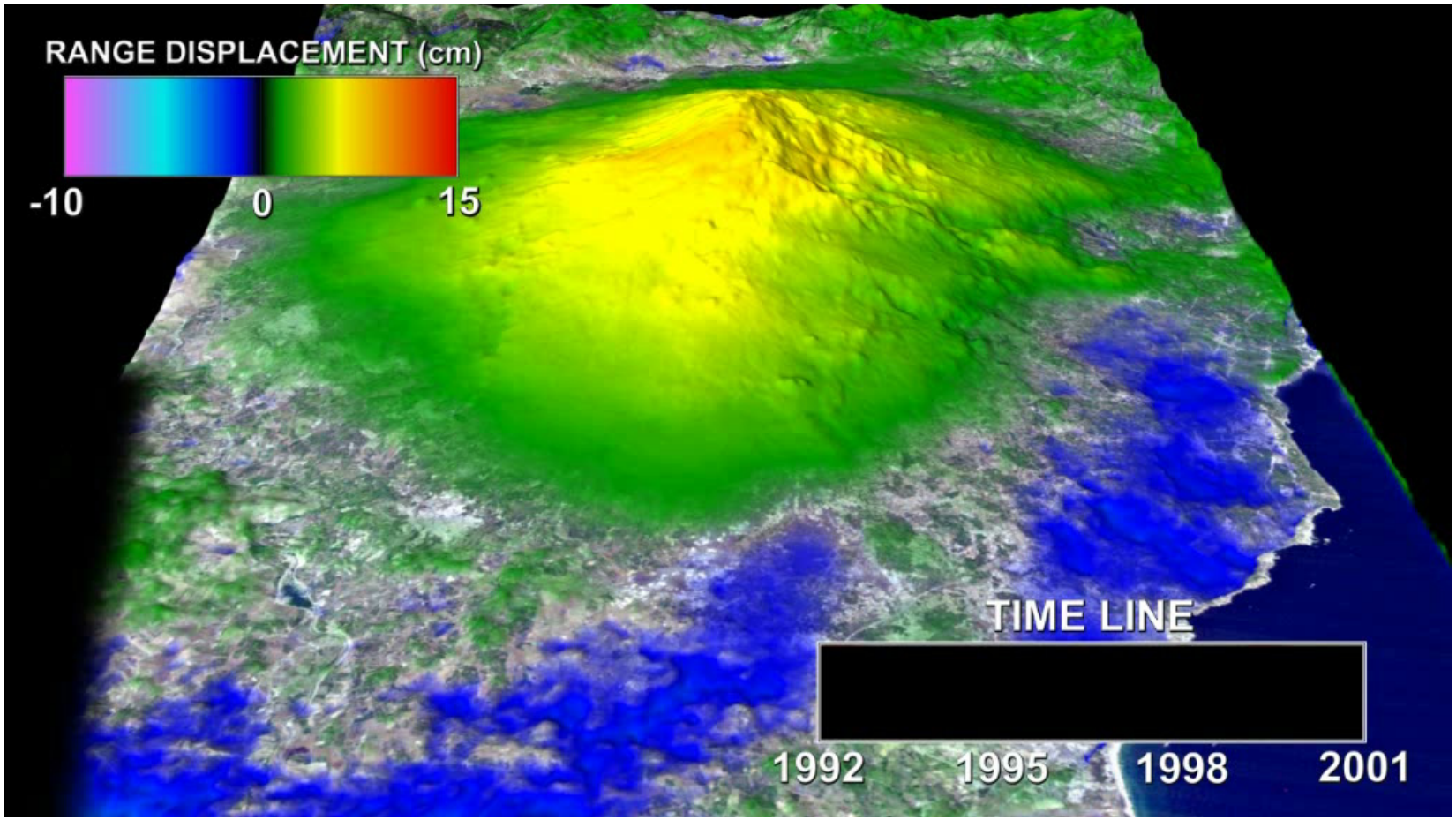
(*data courtesy of P. Lundgren, JPL*)

Deformation Derived from Radar Interferometry

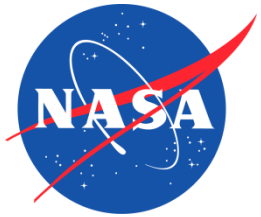
- **Eight-year Record of ERS SAR Data: 86 Interferograms**
- **Interpolated Sequence of Displacement Maps (> 3000 frames)**

Red and Yellow Bars on Time Line Signify High and Moderate Levels of Eruption Activity

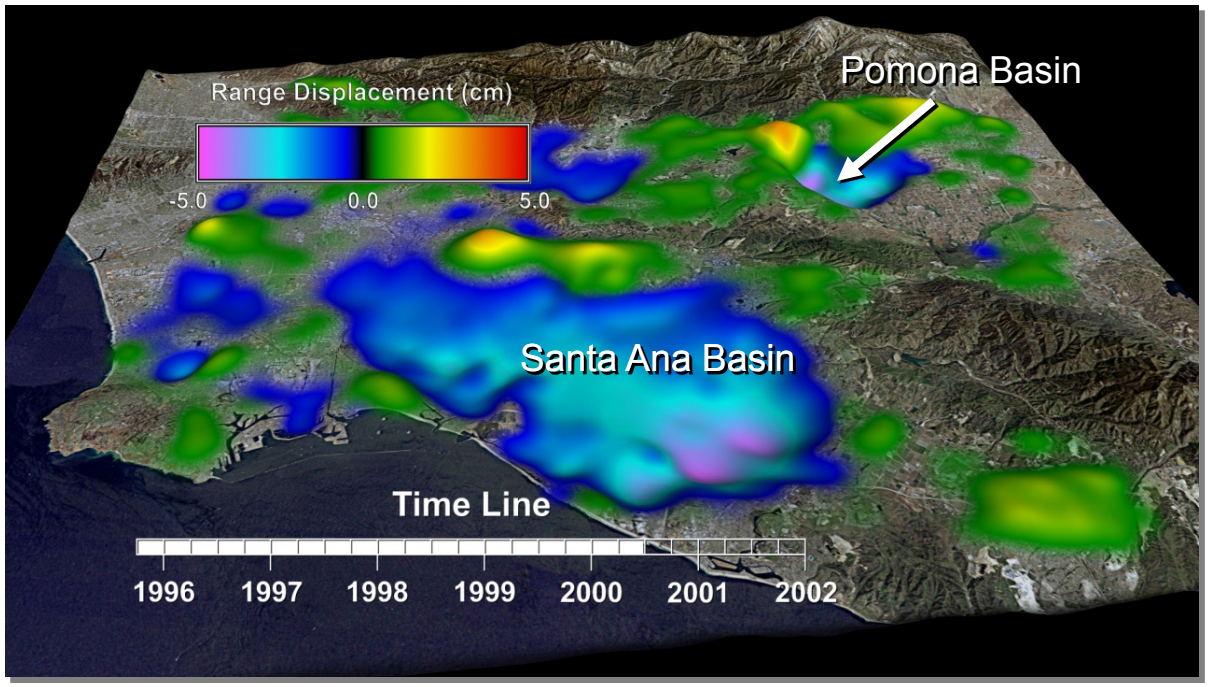




Ground Deformation at Mount Etna Volcano
(data courtesy of P. Lundgren, JPL)



Visualization of Ground Deformation Related to Southern California Ground Water Basins



Deformation Time-Series Derived from Radar Interferometry

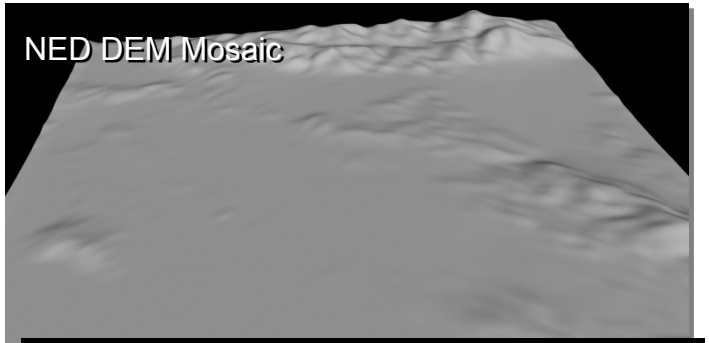
Sequence of 42 Interferograms Generated from ERS-1/ERS-2 Data

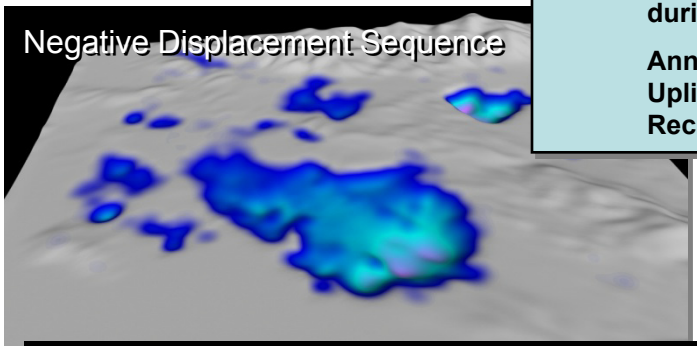
2270 Animation Frames Produced by Linear Interpolation Between Pairs of Interferograms

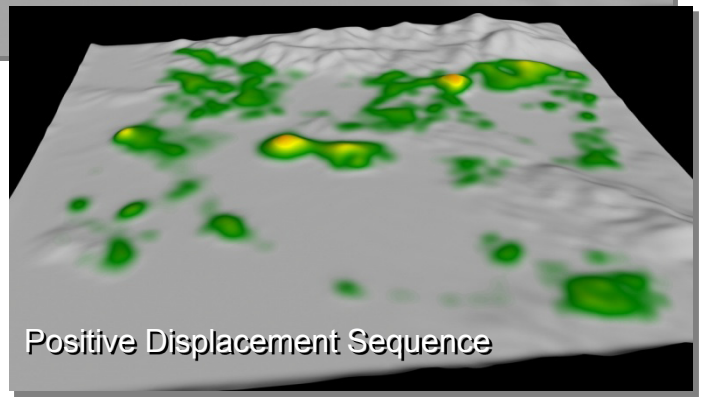
Ground Water-Related Deformation Observed on Two Different Time Scales

Net Subsidence of the Santa Ana and Pomona Basins Over 6-yr Study Period Attributed to Compaction of Sediments during Discharge

Annual Fluctuations in Subsidence and Uplift Due to Seasonal Discharge and Recharge of Ground Water Basins







INSAR data courtesy of P. Lundgren, Jet Propulsion Laboratory

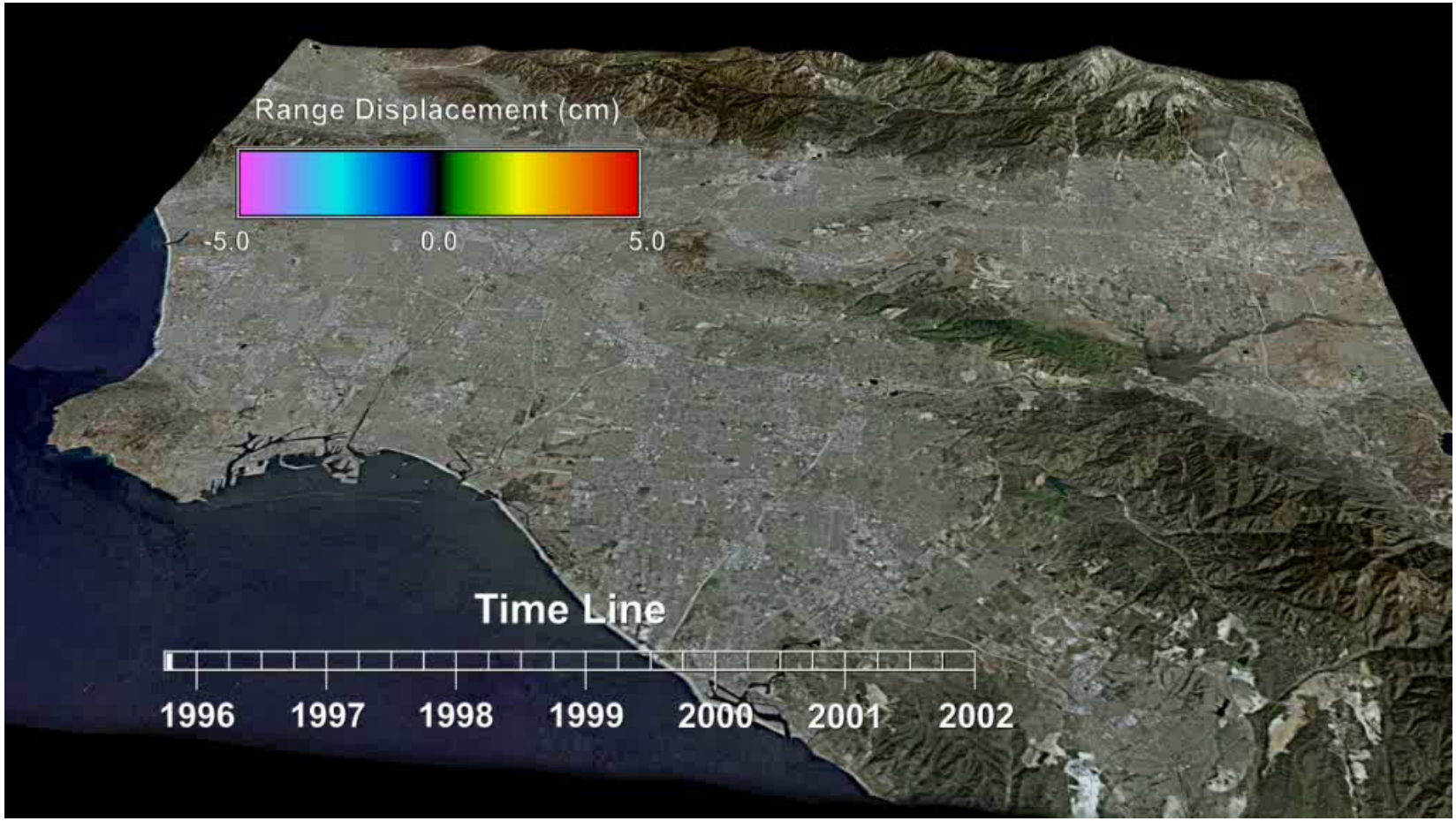
References:

Lanari et al., Geophysical Research Letters, V.31, L23613, doi:10.1029/2004GL021294, 2004

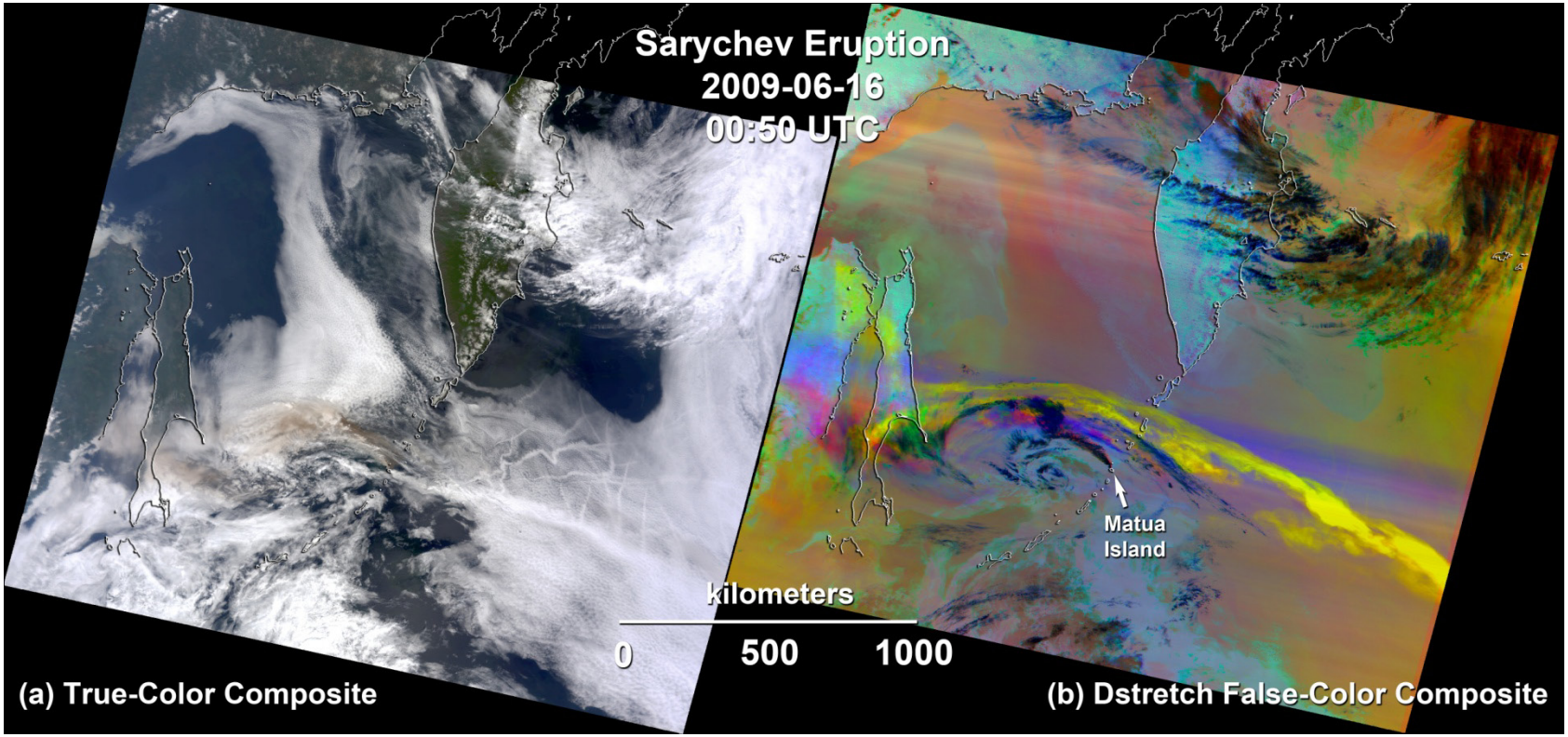
Argus et al., Journal of Geophysical Research, V.110, B04401, doi:10.1029/2003JB002934, 2005

King et al., Journal of Geophysical Research, V.112, B03409, doi:10.1029/2006JB004448, 2007

Jet Propulsion Laboratory
California Institute of Technology

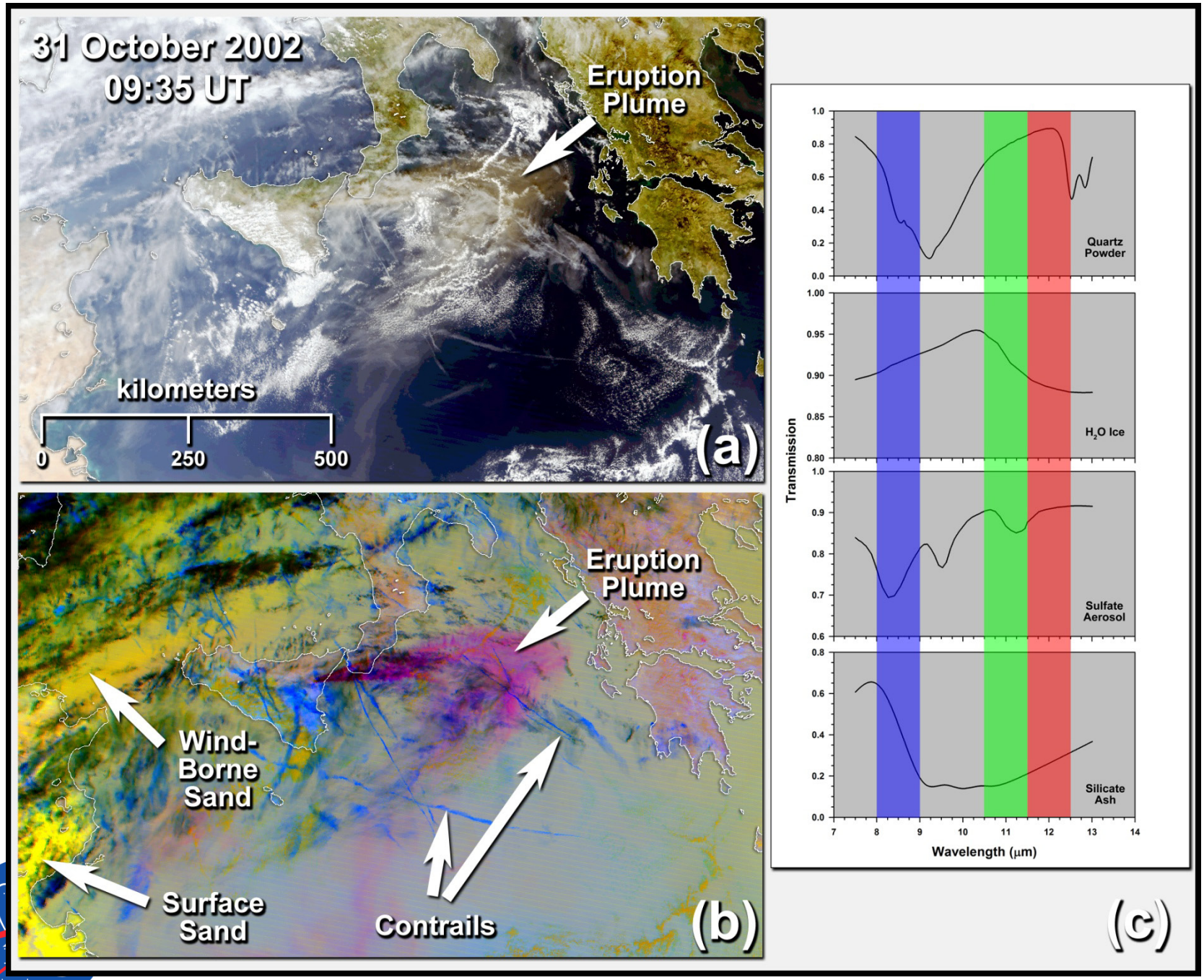


Southern California InSAR Time Series

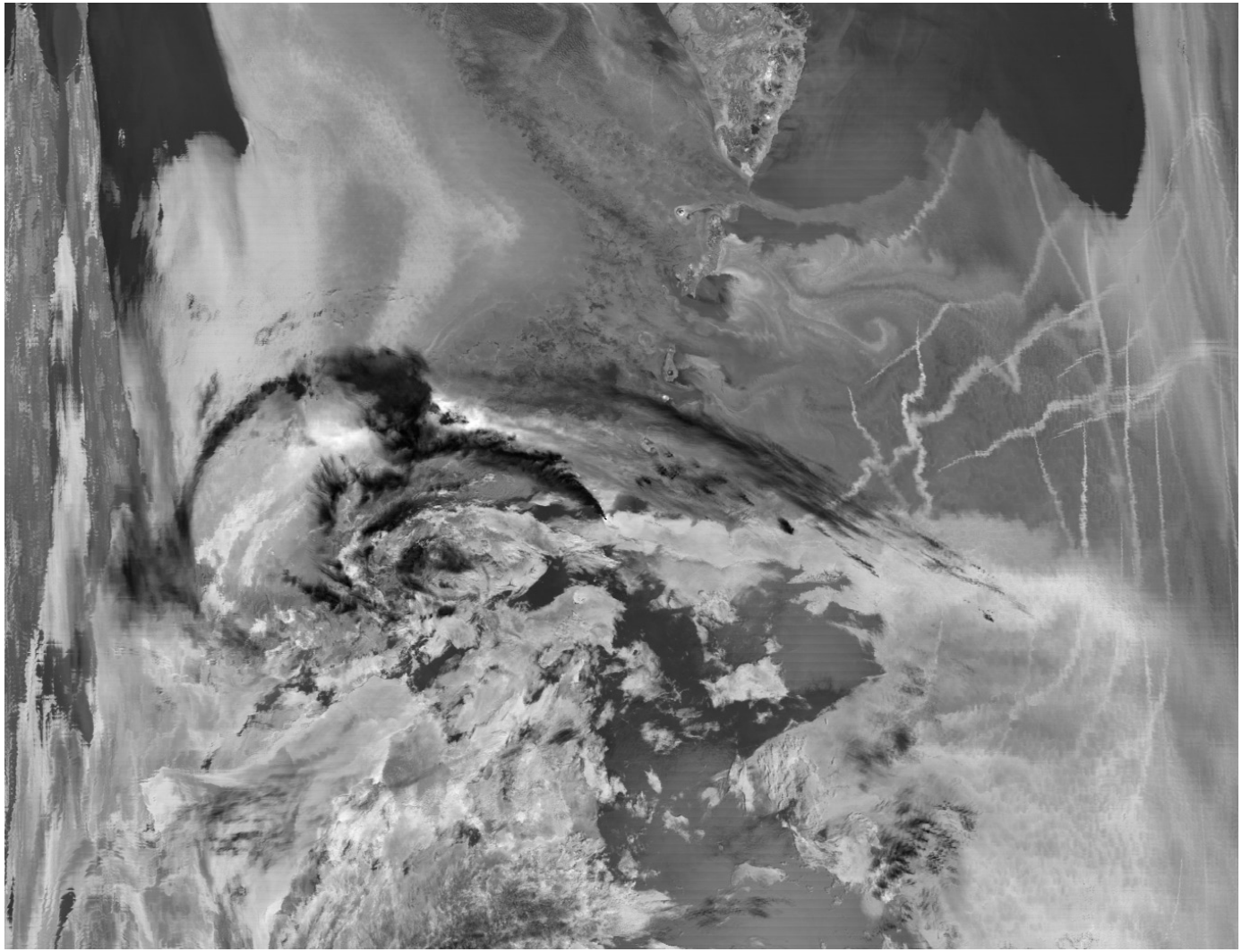


Multispectral Analysis of Volcanic Plumes
Sarychev Peak Eruption
Matua Island, Kuril Islands, Russia

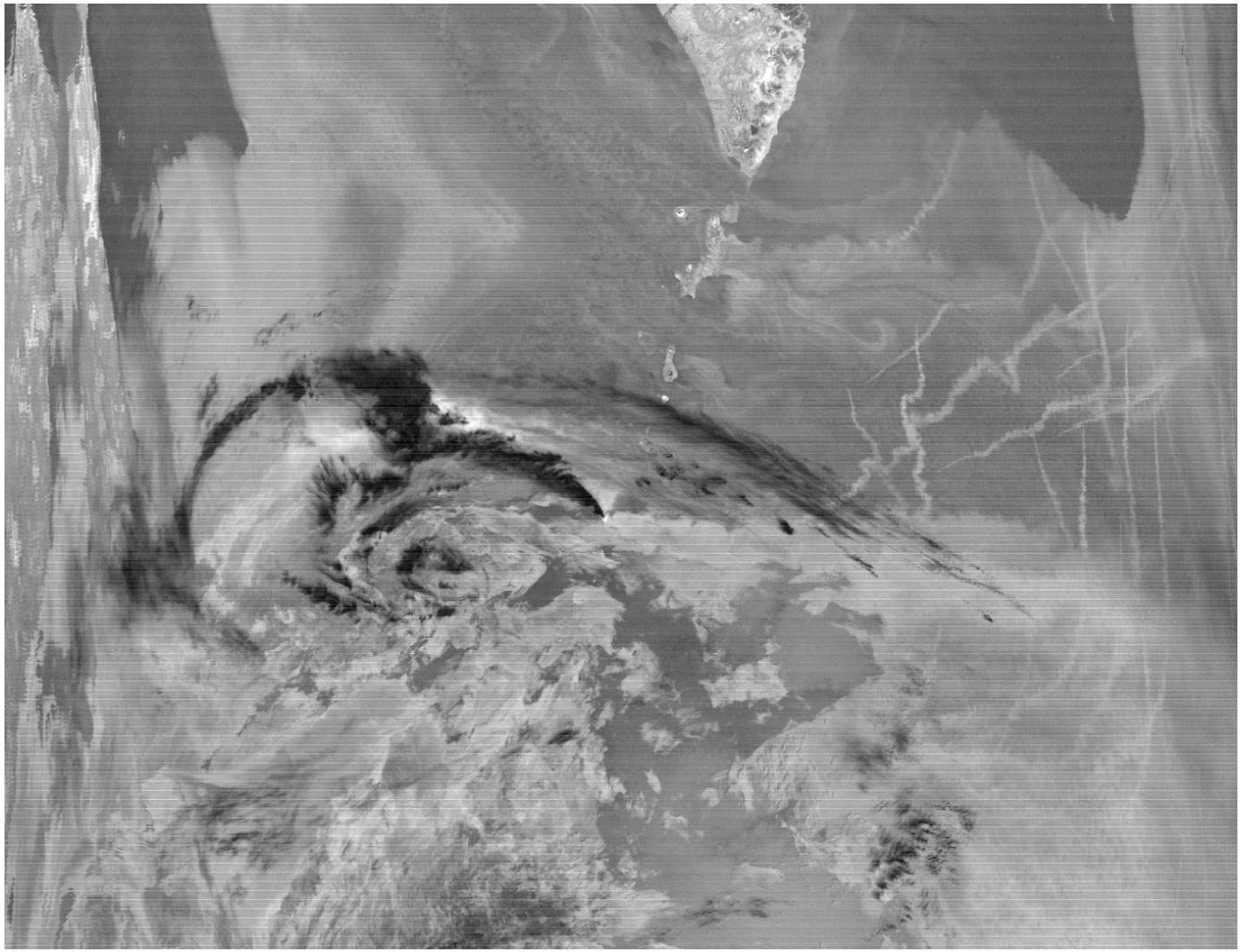
NASA


31 October 2002
09:35 UT
Eruption Plume
kilometers
0
250
500
(a)
Eruption Plume
Wind-Borne Sand
Surface Sand
Contrails
(b)
Transmission
Quartz Powder
H_2O Ice
Sulfate Aerosol
Silicate Ash
Wavelength (μm)
(c)

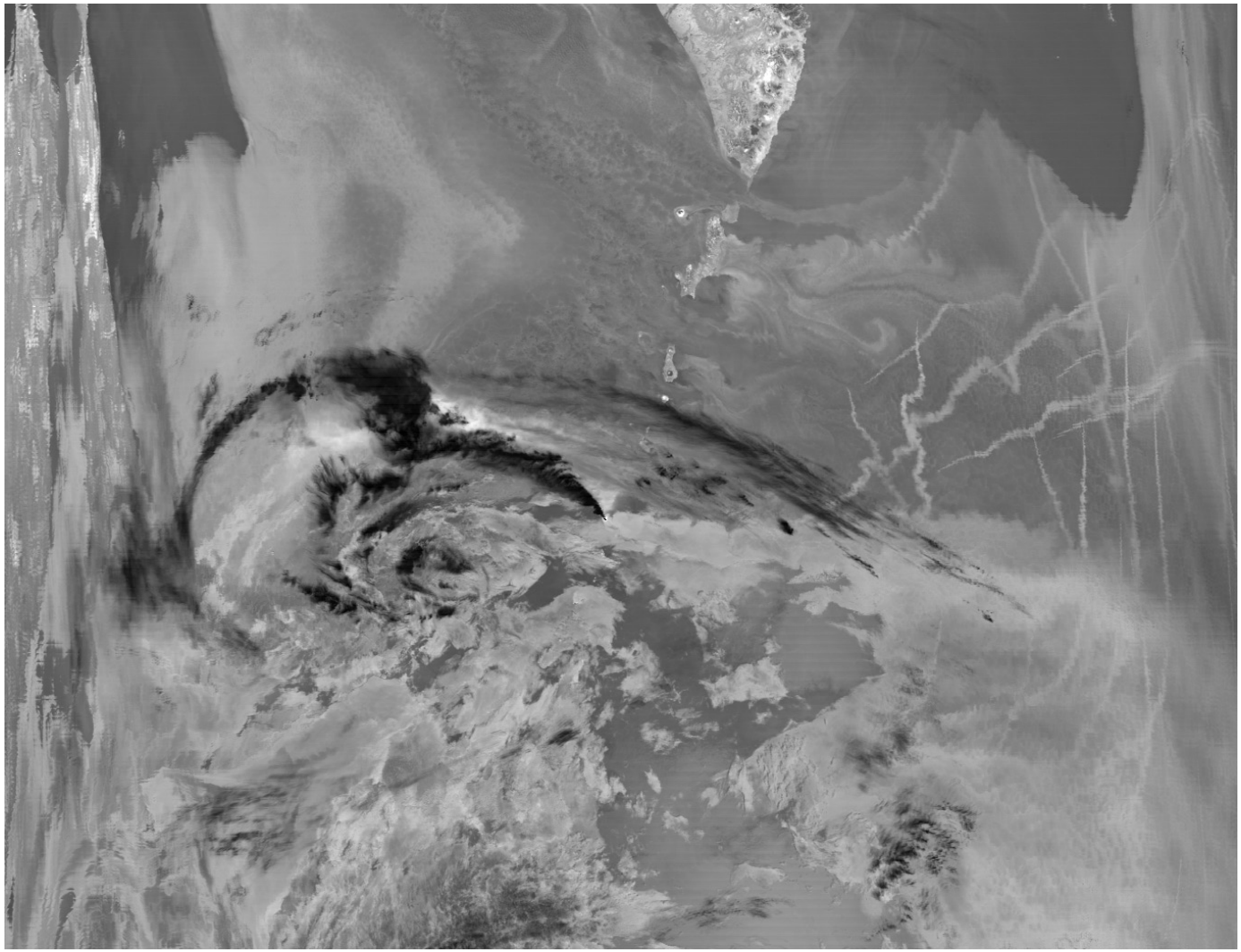
Band 20: 3.66 – 3.84 μm



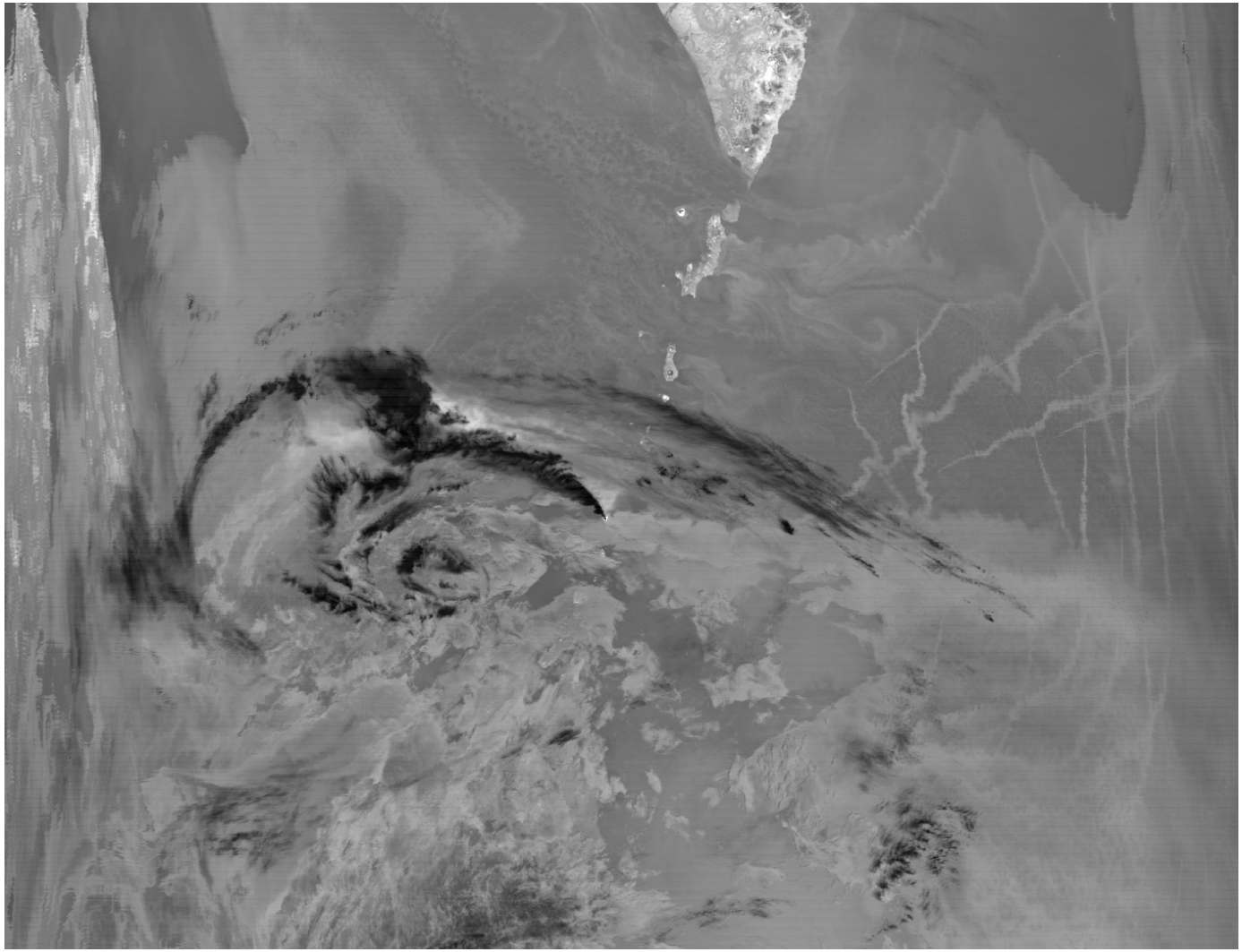
Band 21: 3.929 – 3.989 μm

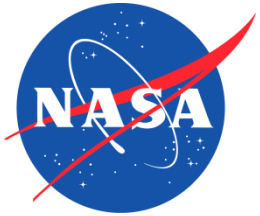


Band 22: 3.929 – 3.989 μm

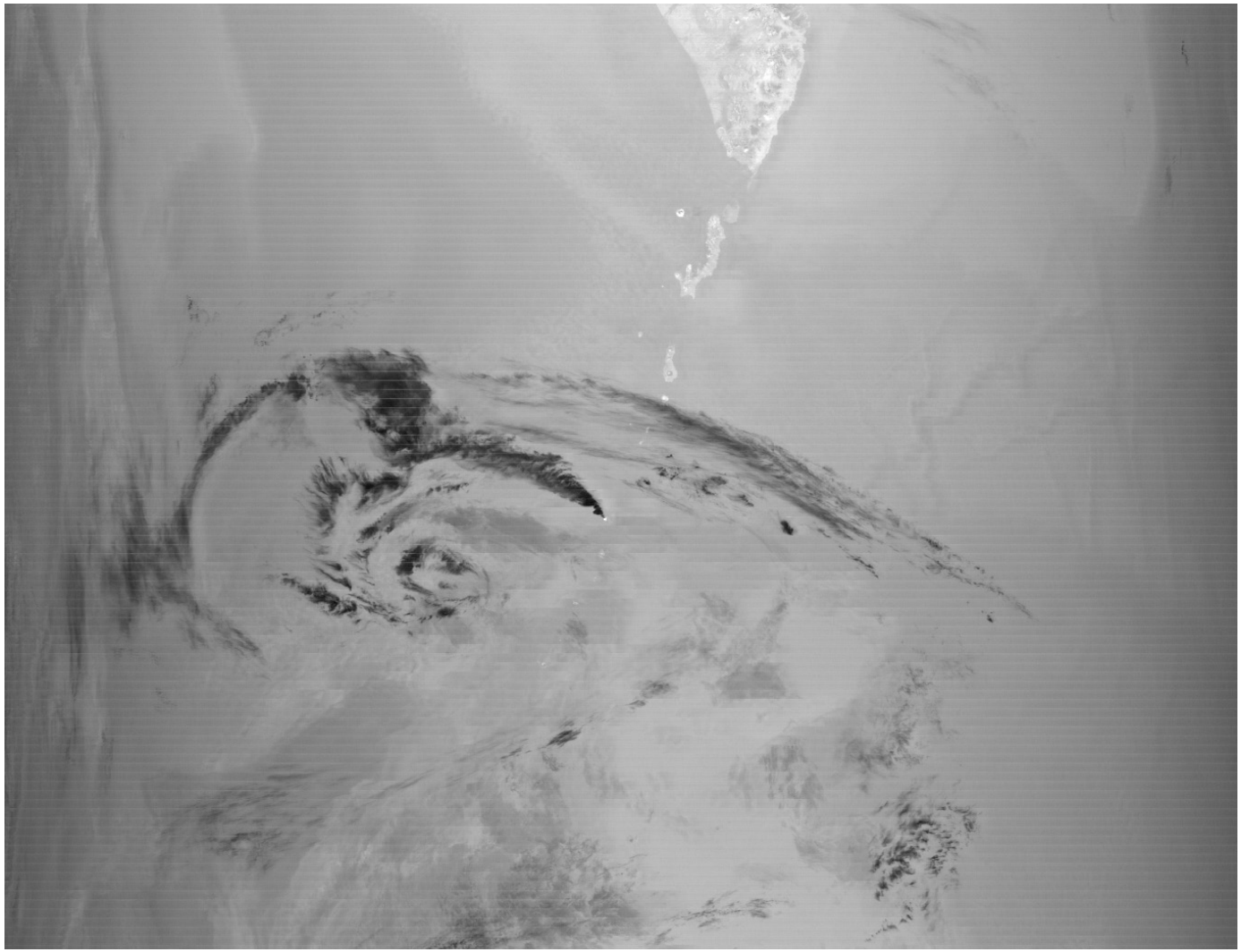


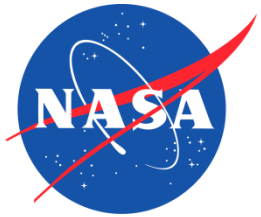
Band 23: 4.020 – 4.080 μm



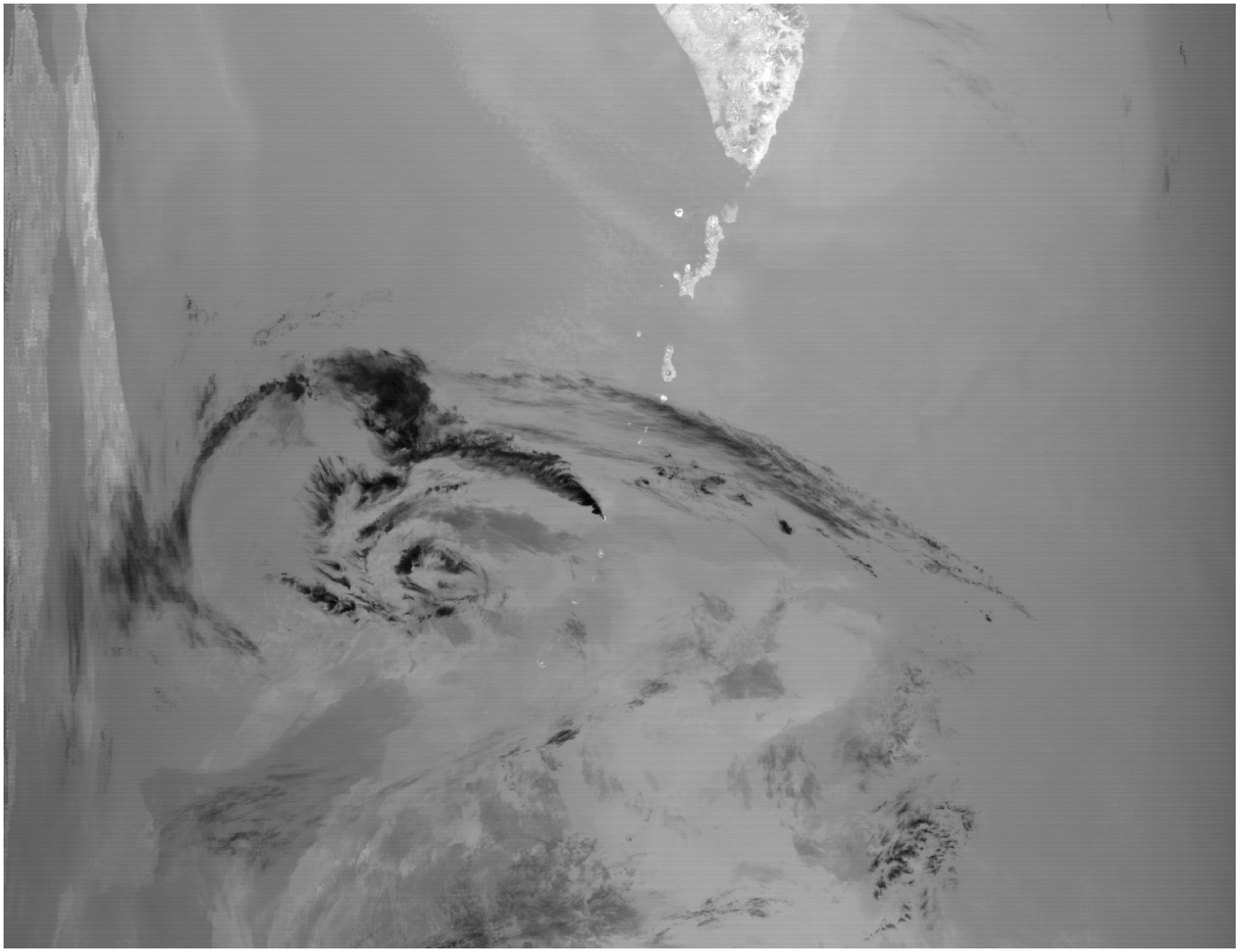


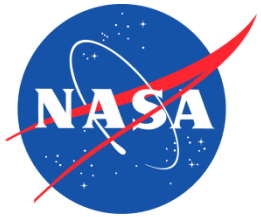
Band 24: 4.433 – 4.498 μm



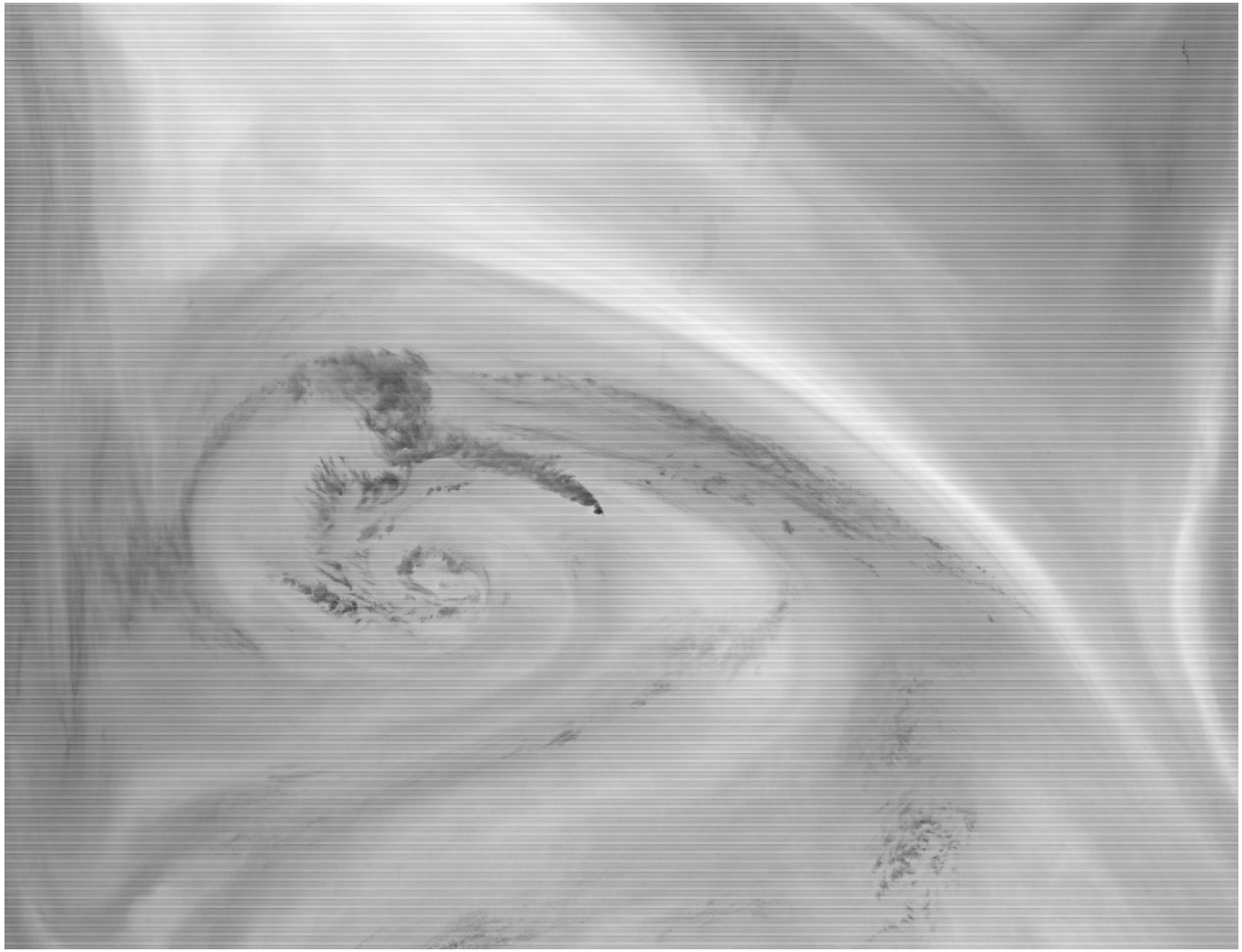


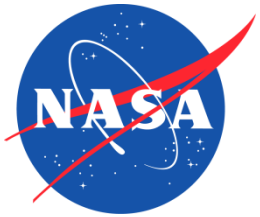
Band 25: 4.482 – 4.549 μm



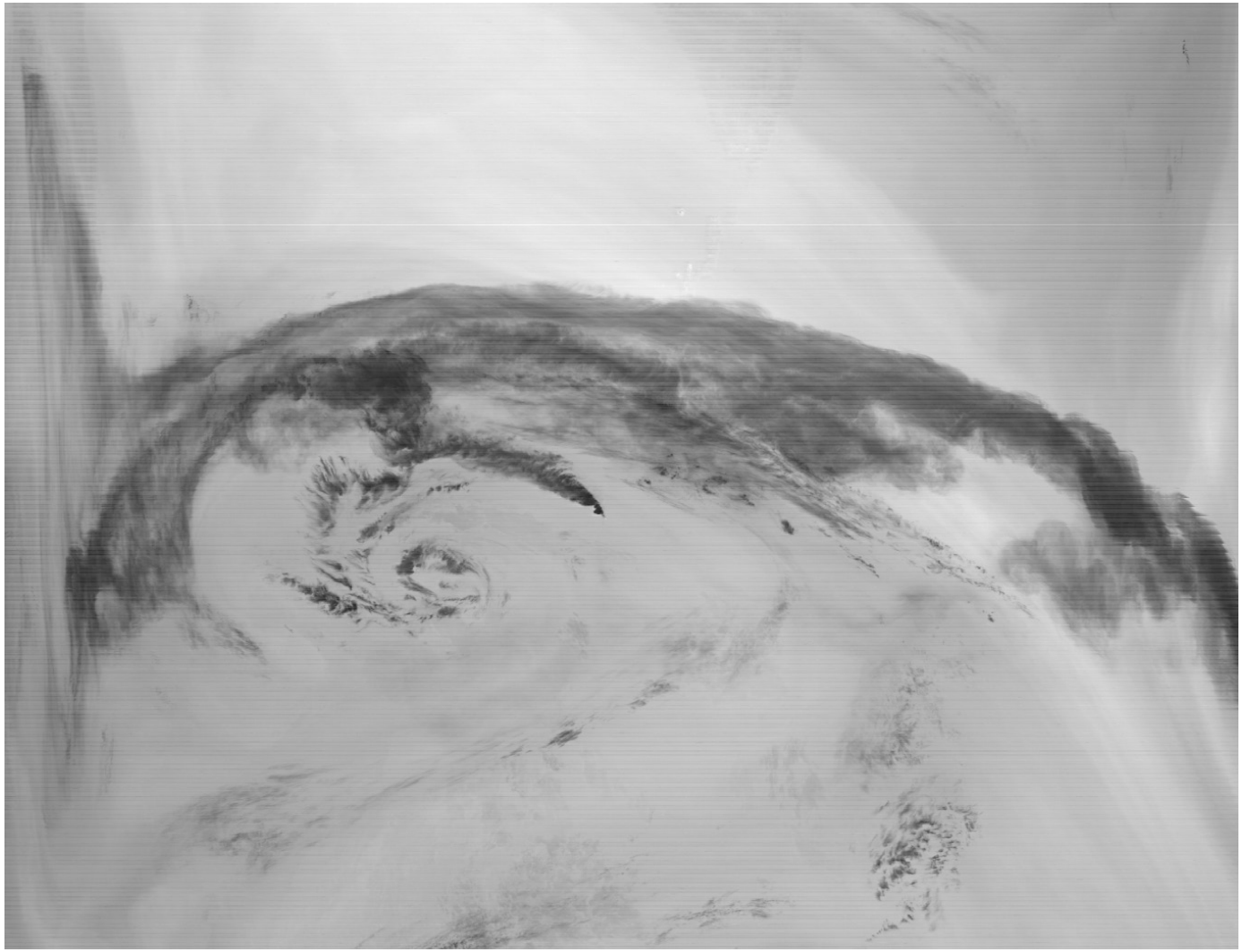


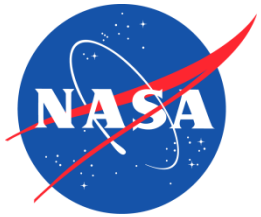
Band 27: 6.535 – 6.895 μm



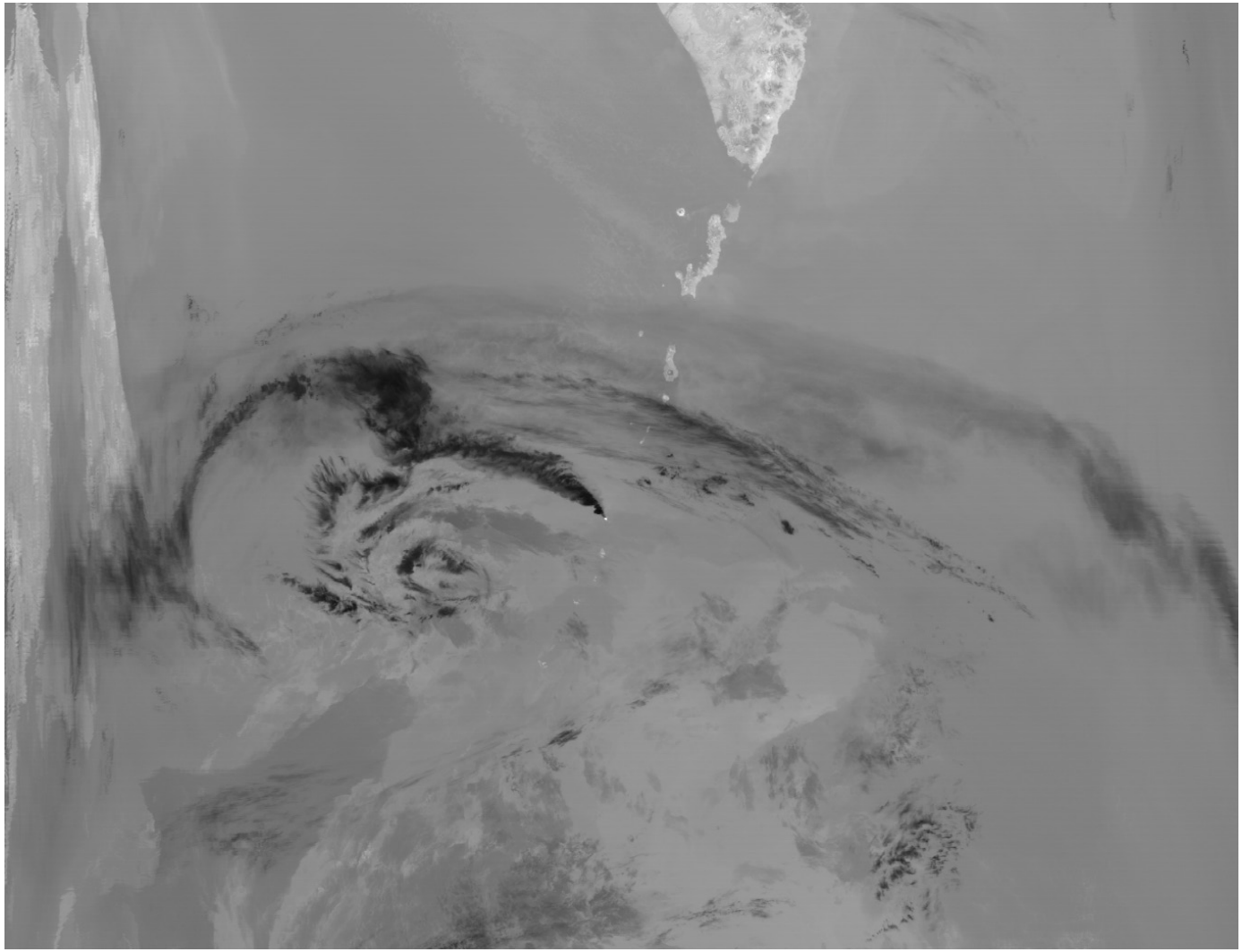


Band 28: 7.175 – 7.475 μm

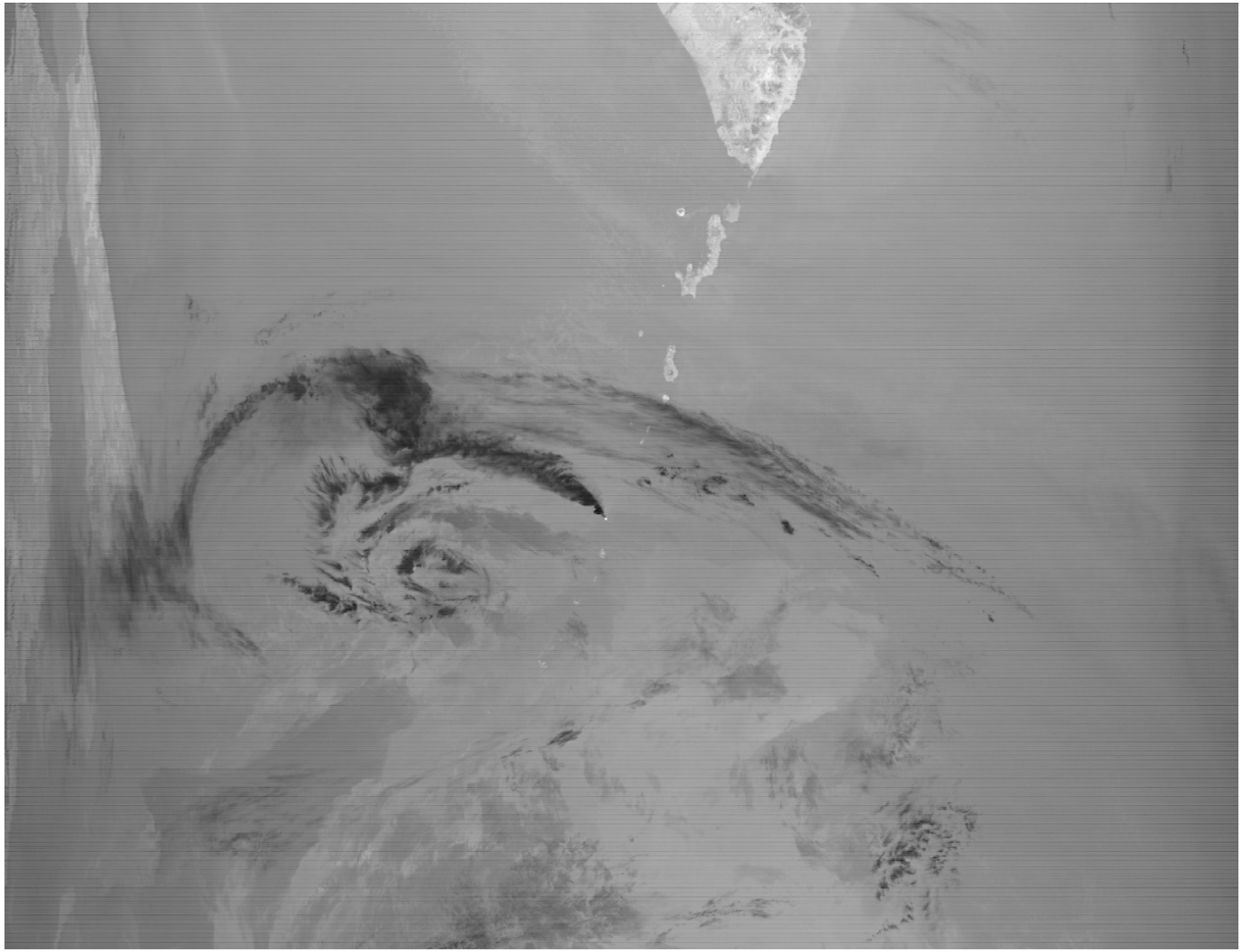




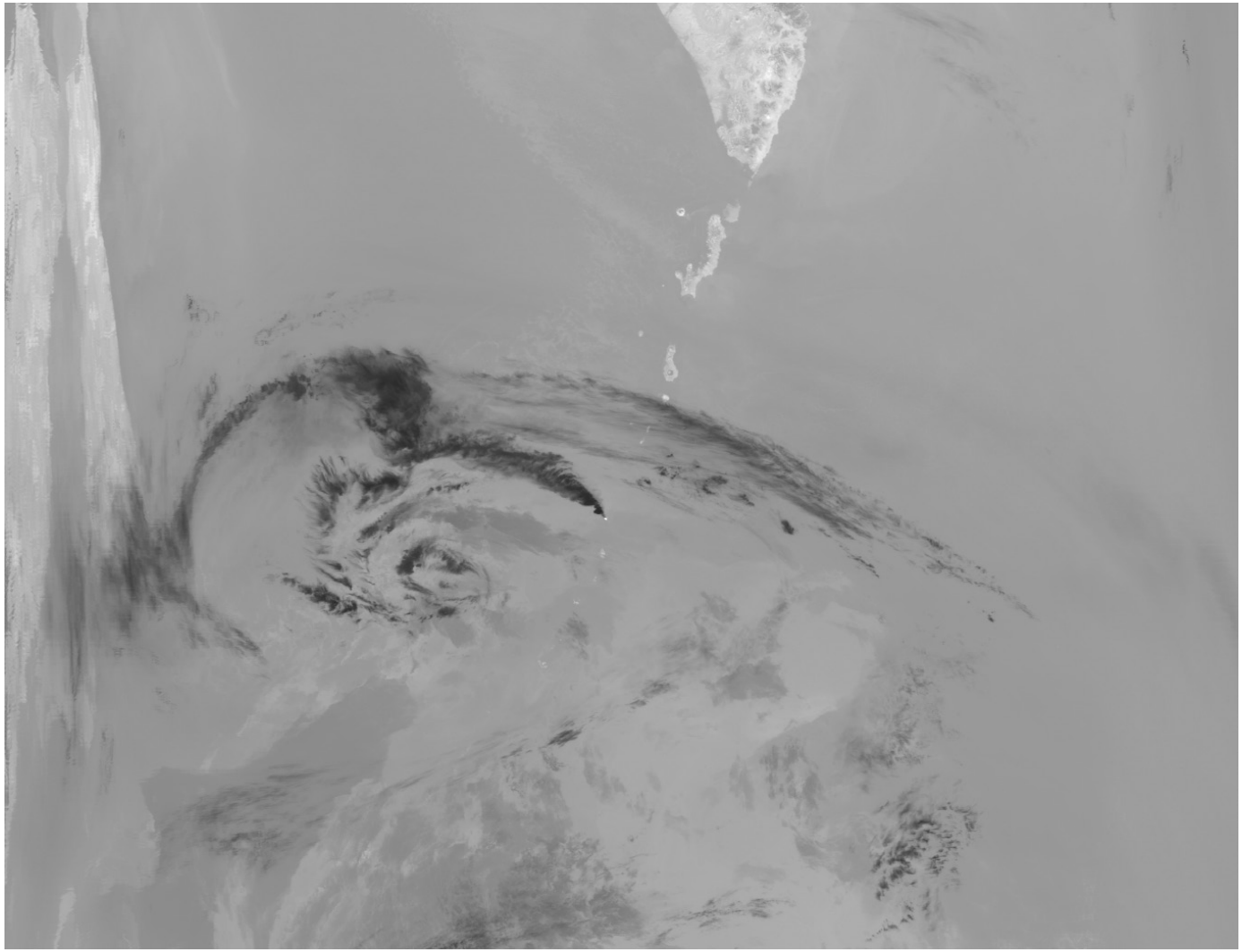
Band 29: 8.400 – 8.700 μm



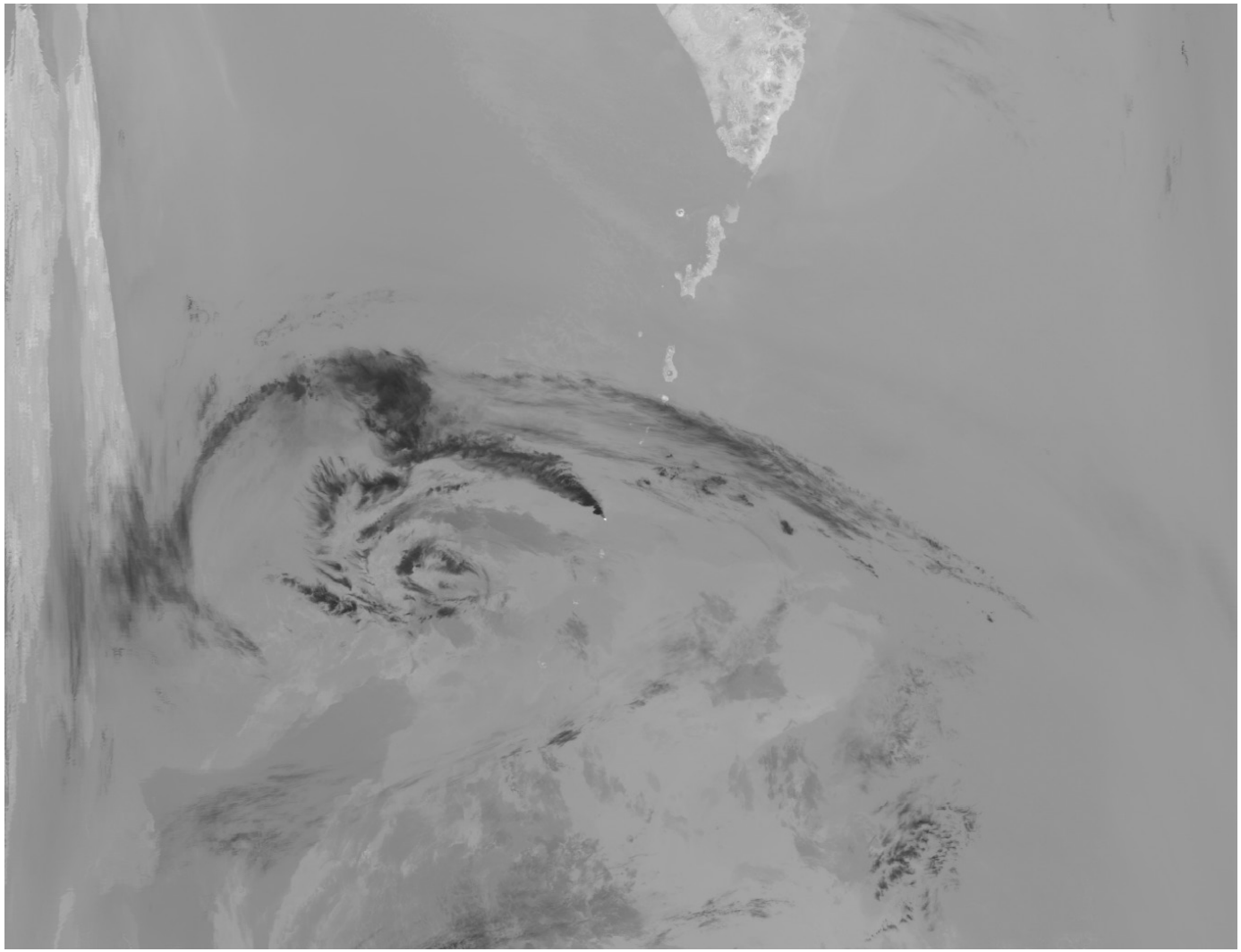
Band 30: 9.580 – 9.880 μm



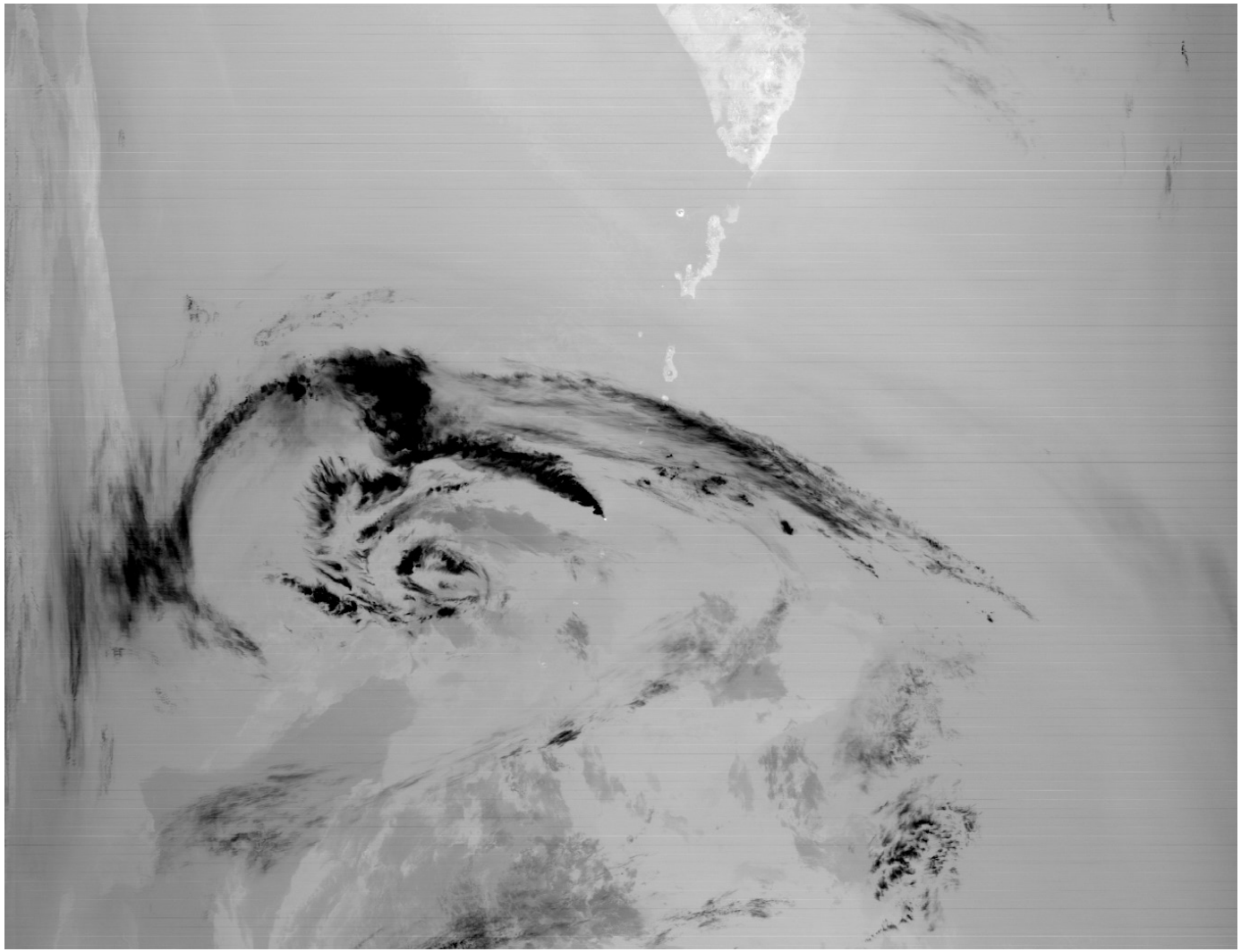
Band 31: 10.780 – 11.280 μm

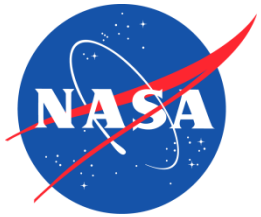


Band 32: 11.770 – 12.270 μm

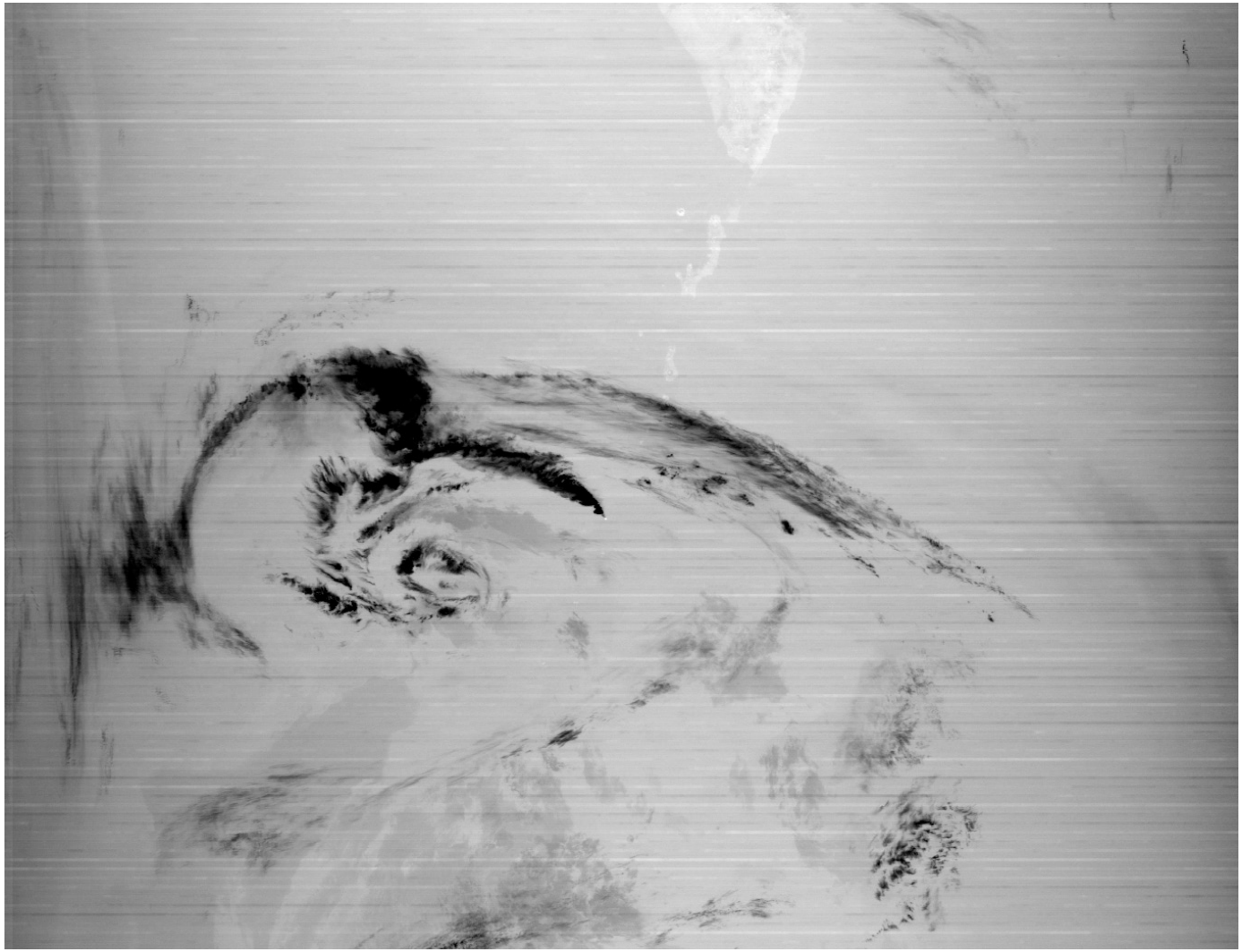


Band 33: 13.185 – 13.485 μm

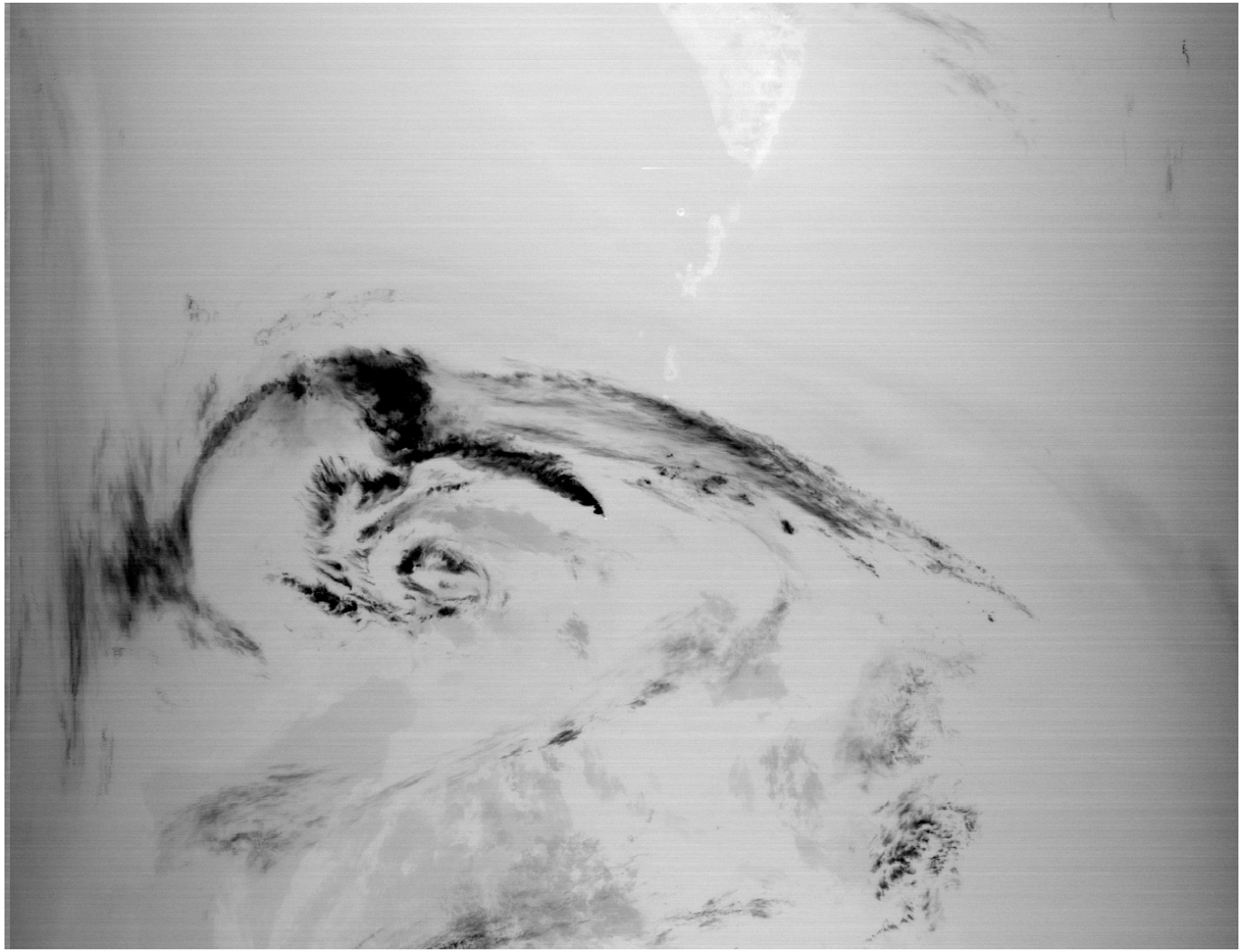




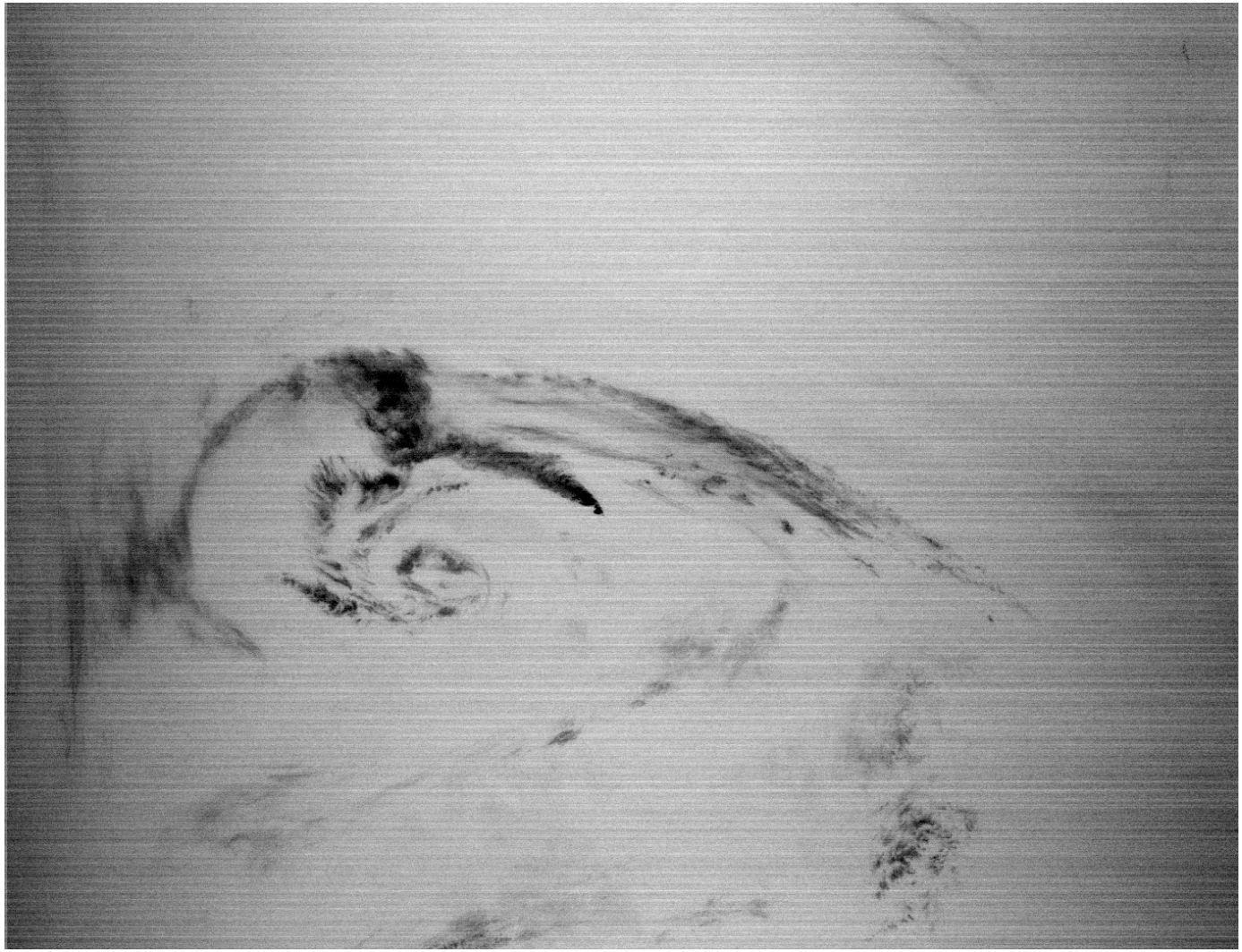
Band 34: 13.485 – 13.785 μm

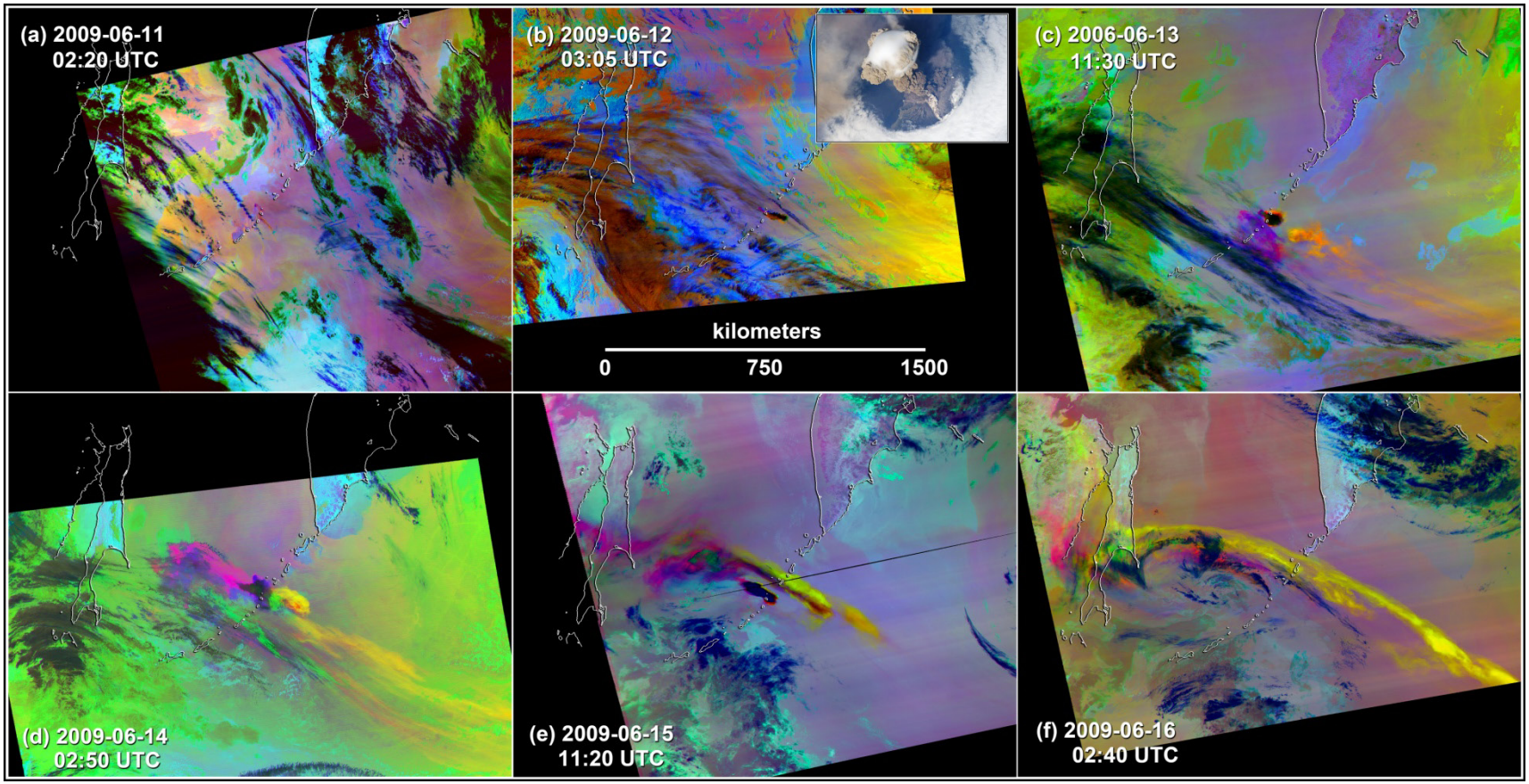


Band 35: 13.785 – 14.085 μm



Band 36: 14.085 – 14.385 μm





Sarychev Time Series
Evolution of SO_2 Clouds