

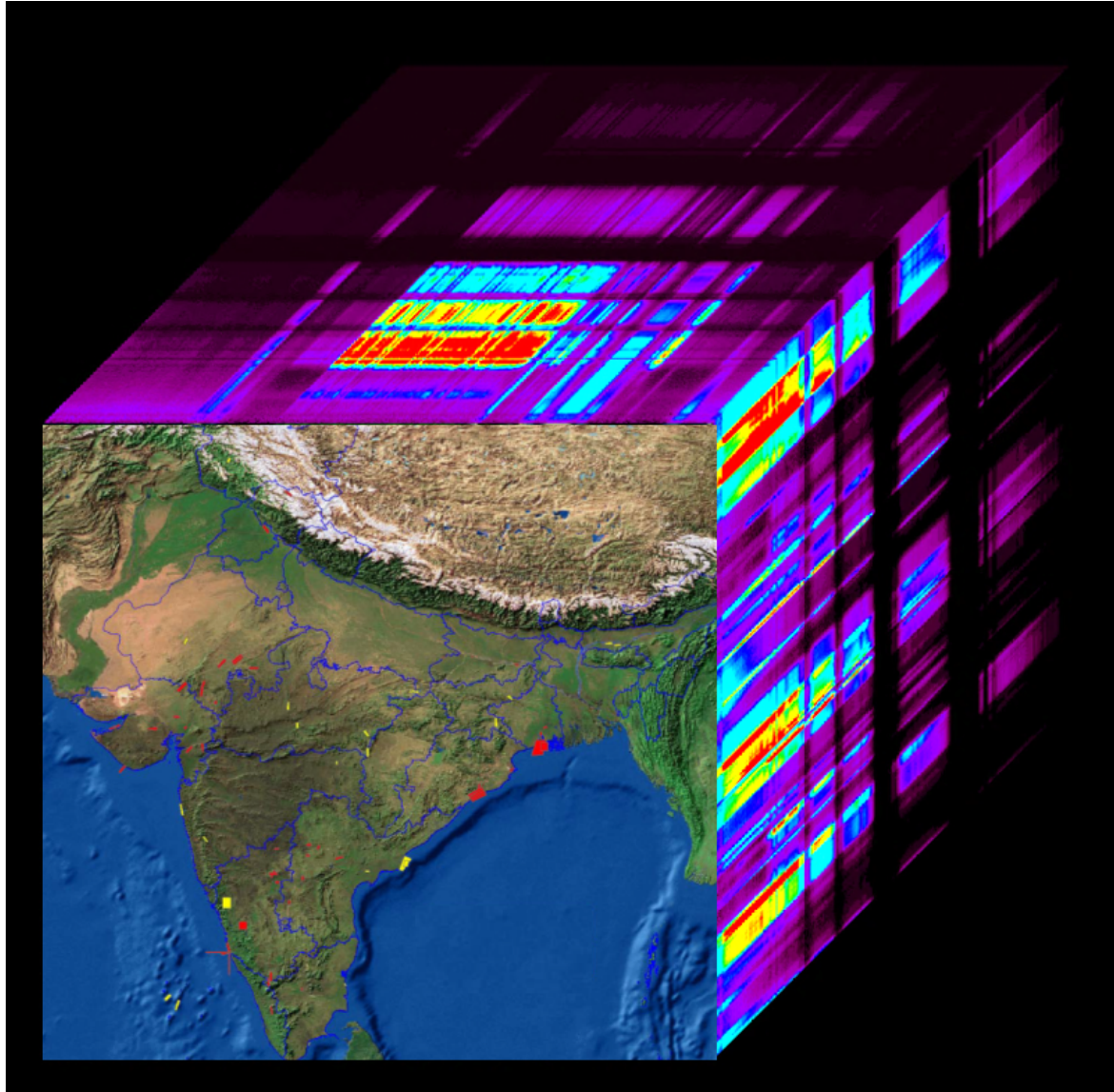
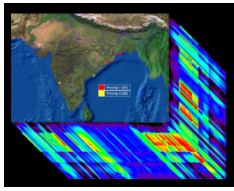
Overview of the AVIRIS-NG Campaign in India and the Diversity of New Environments Measured with Relevance to HypsIRI

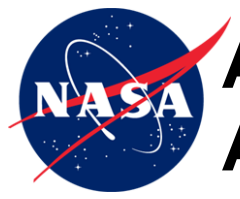
Robert O. Green and The Campaign Team

Jet Propulsion Laboratory, California Institute of Technology



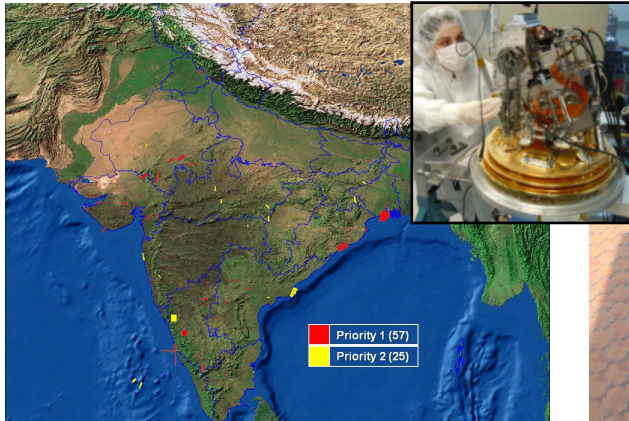
NASA and ISRO Joint AVIRIS-NG Campaign in India





AVIRIS-NG NASA and ISRO Airborne Campaign in India

This joint airborne campaign will provide the first of their kind high fidelity imaging spectroscopy measurement of a diverse set of Asian environments for science and applications research.



57 diverse science sites approved for measurement



Pre campaign Science Meeting Sept 2015

The campaign enables new scientific and applications research in these unique environments:

- Natural ecosystems
- Water resources, snow and ice
- Geology and natural hazards
- Coastal and inland waters, coral reefs
- Agricultural lands and urban areas

This joint science and applications could lead to a future joint space mission to provide routine access to this class of measurement for both nations.

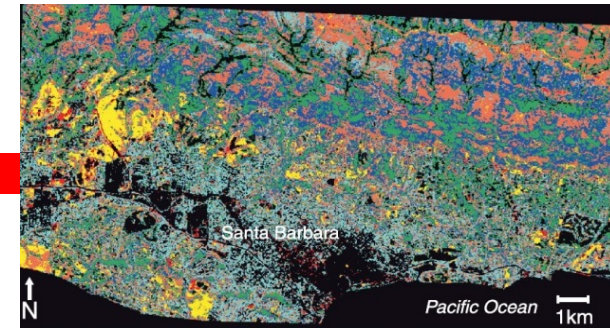


ISRO B-200 Aircraft at NRSC

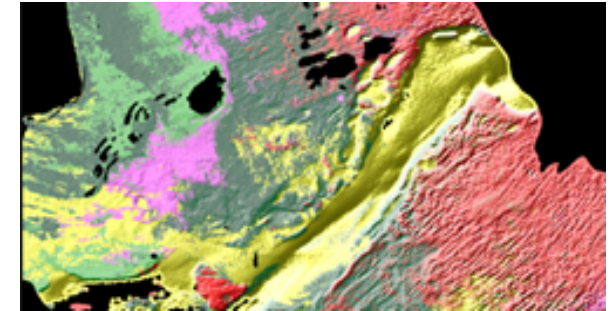
AVIRIS-NG being shipped.



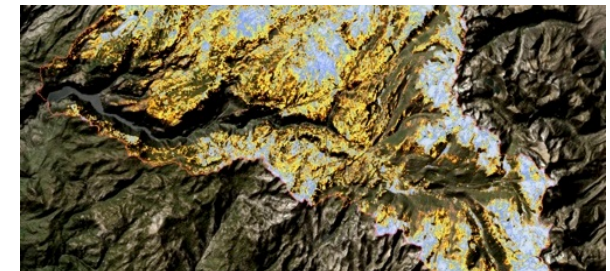
Ecosystem and Agriculture



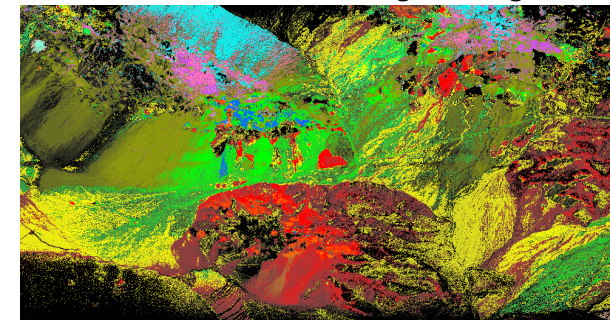
Asian Coastal Waters & Coral



Dust and Black Carbon on Snow & Ice

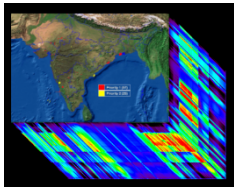


New Geological Regimes

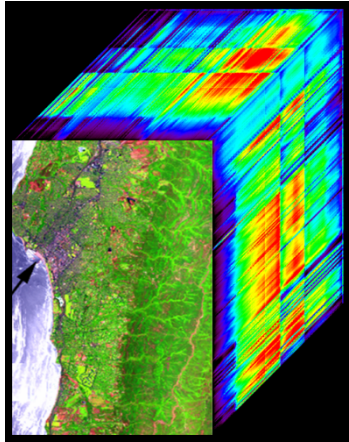




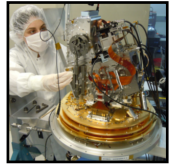
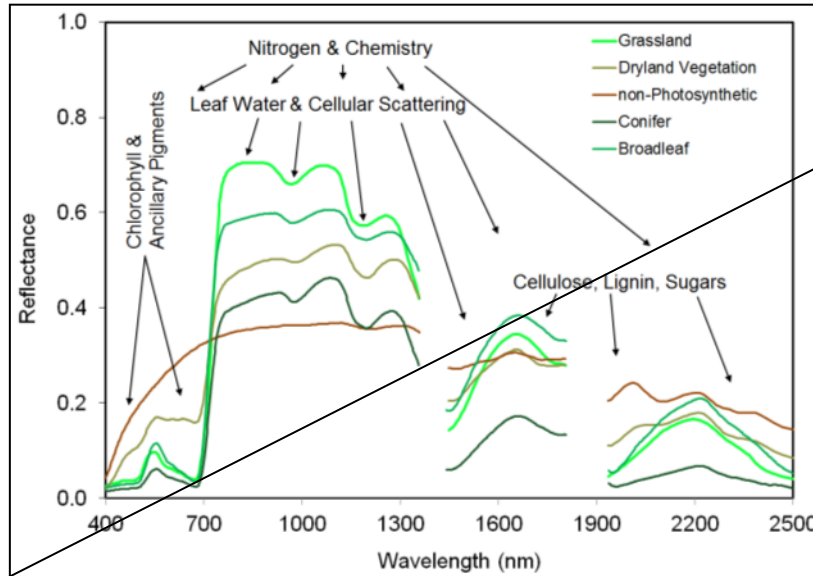
Imaging Spectroscopy: Ecosystem Example



Calibrated
Image Cube



≥ 100 's of Parallel Spectrometers



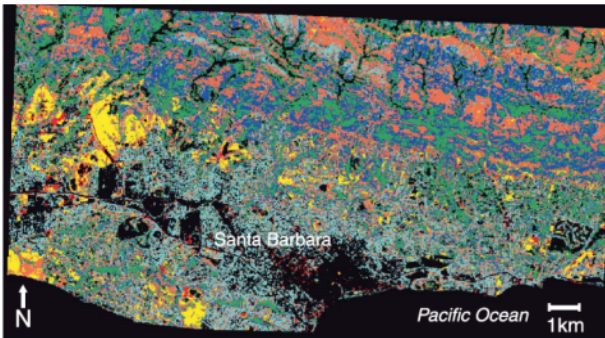
Area Array Detector

Spectrometer

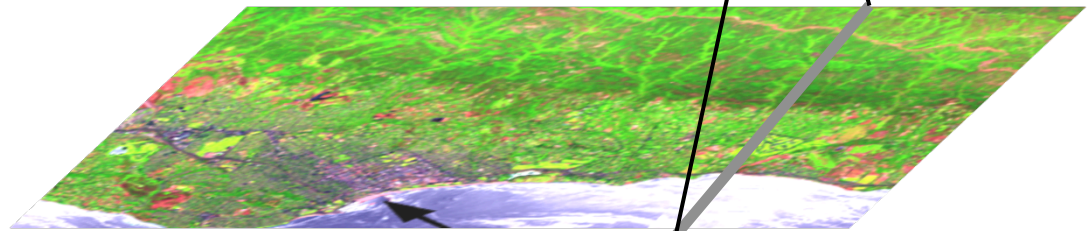
Telescope

Slit

Ecosystem composition,
function, chemistry, etc.



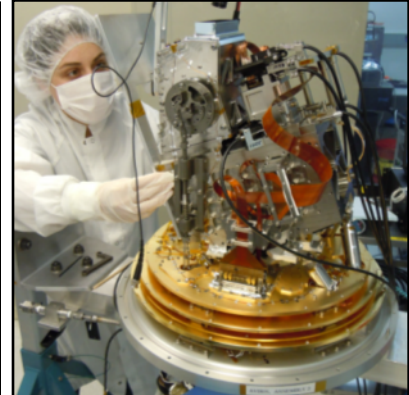
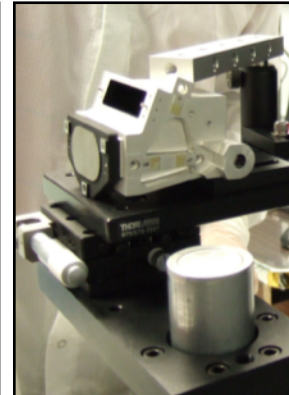
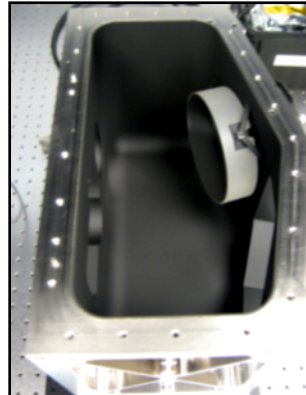
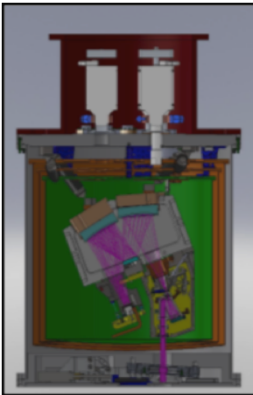
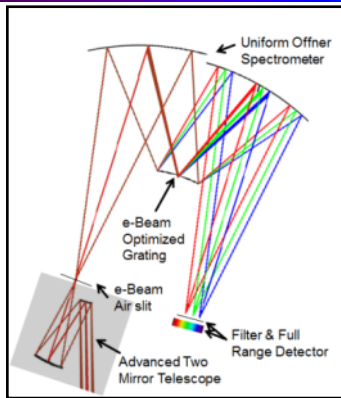
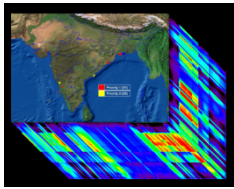
- Adenostoma fasciculatum
- Ceanothus megacarpus
- Arctostaphylos spp.
- Quercus agrifolia
- Grass
- Soil





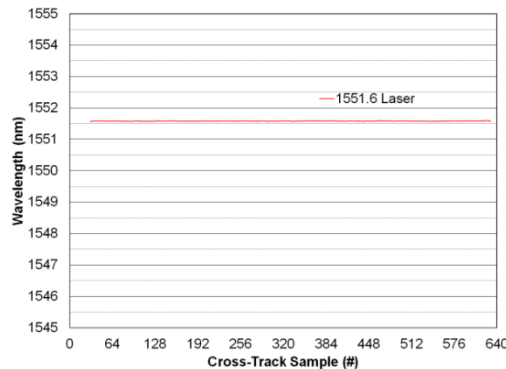
AVIRIS Next Generation 2014

NASA Earth Science and Science Applications

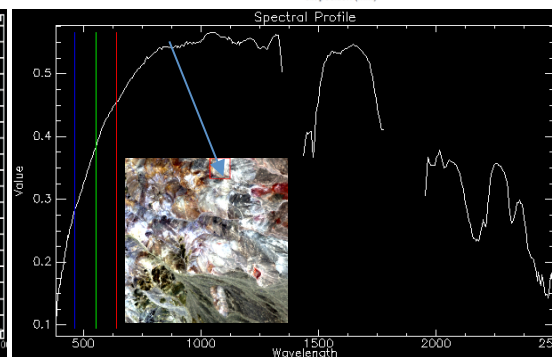
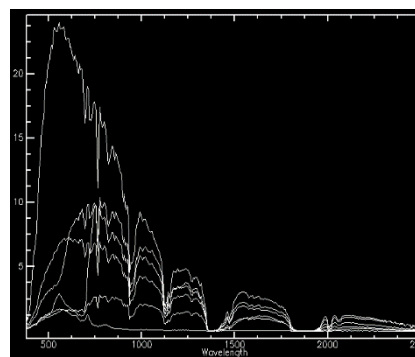
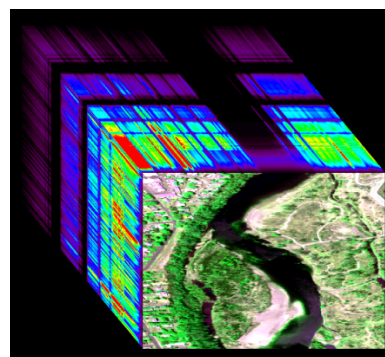
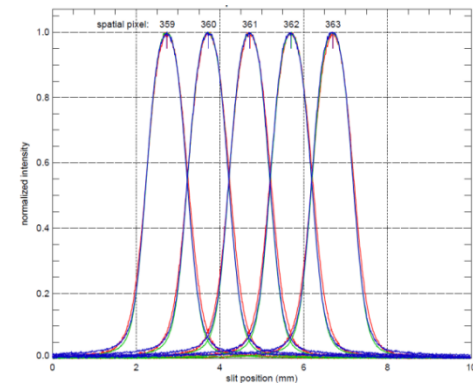


- Designed to exceed existing instruments in the spectral, spatial, radiometric and uniformity domains
- Uses 21st century space elements: design, grating, slit, mounts, alignment/calibration

Spectral X-track Uniformity > 95%

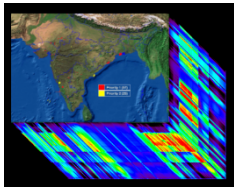


Spectral IFOV Uniformity > 95%



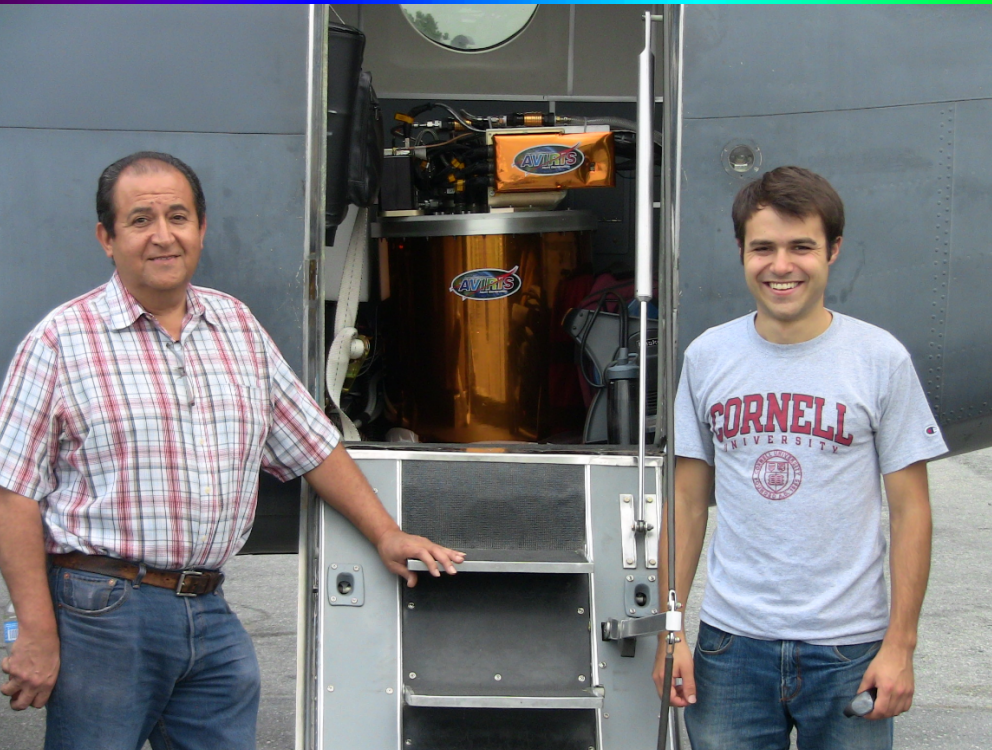
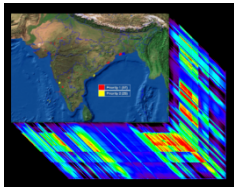


ISRO B200 Aircraft



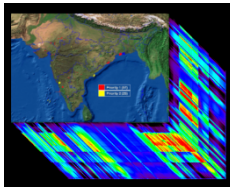


AVIRIS-NG on US B200 King Air August 2015



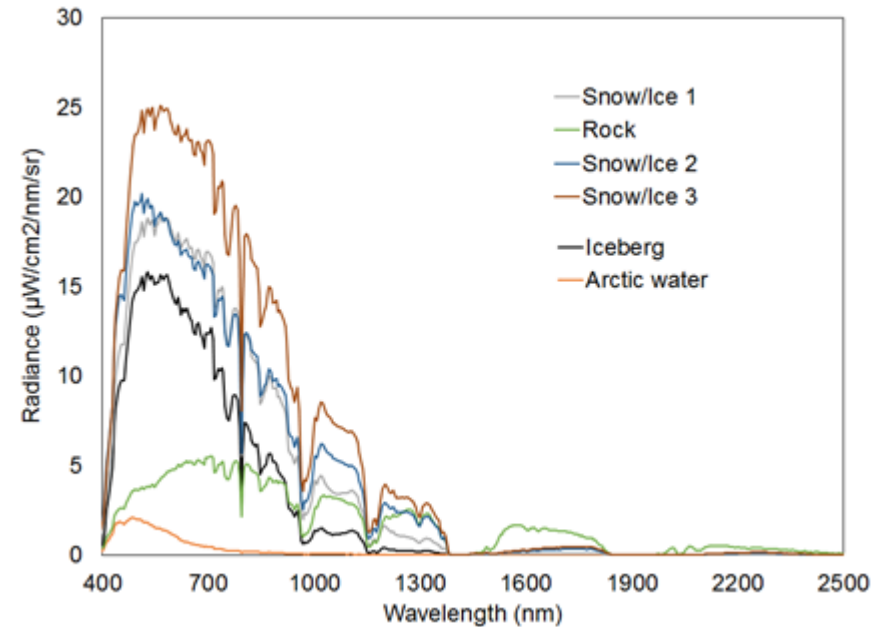
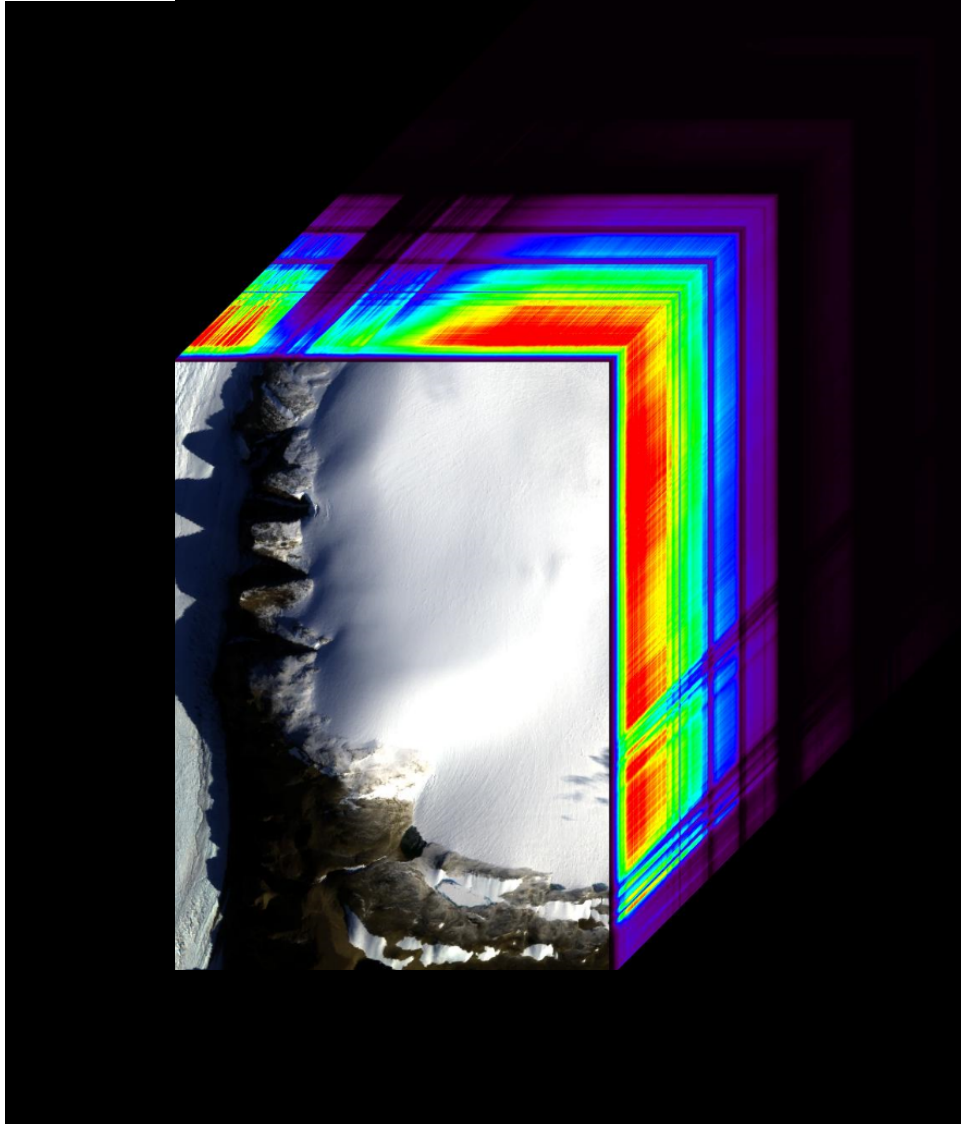
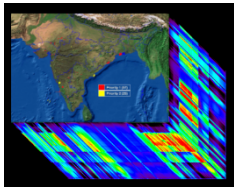


US B200 Aircraft





AVIRIS-NG Radiance Image Cube of the Edge of the Greenland Ice sheet

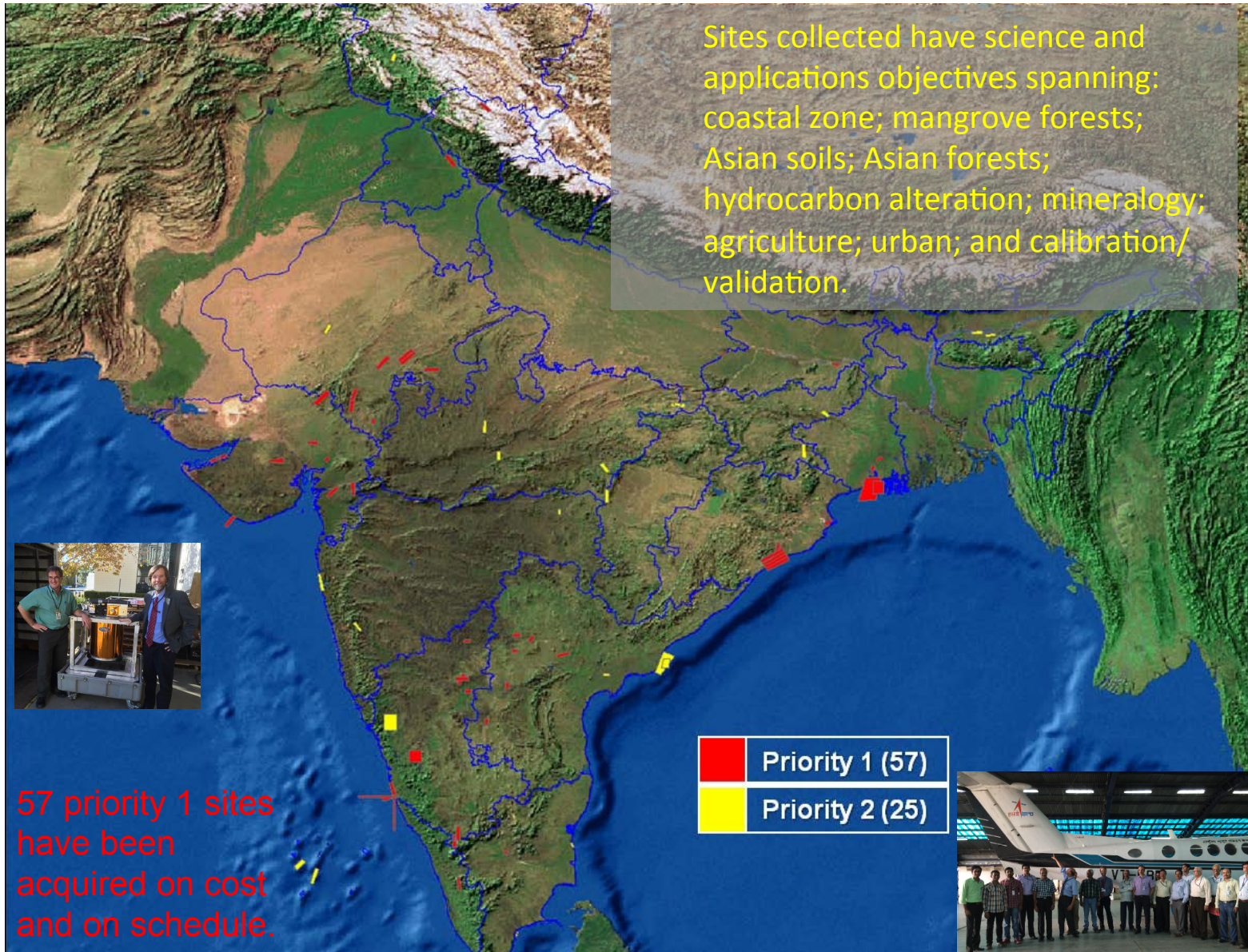
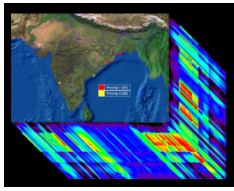


AVIRIS-NG radiance image cube acquired near the edge of the Greenland ice sheet. Radiance spectra were extracted for a number of targets in the full flight line. The radiance spectra will be atmospherically corrected and used to generate the higher level products: grain size, melt state, impurities, etc.



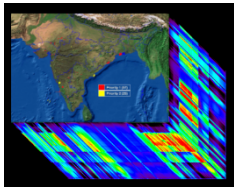
NASA ISRO Imaging Spectroscopy Campaign

17th of December 2015 to 8th of March 2016





NASA AVIRIS-NG Installed on the ISRO B200 Aircraft



- 11 Dec 2015, AVIRIS-NG is installed on the ISRO B200 and is cooling down to operational temperatures ($\sim 150\text{K}$).
- AVIRIS-NG Imaging Spectrometer
 - Spectral: 380 to 2510 nm @ 5 nm
 - Radiometric: $\geq 95\%$ calibration with high SNR
 - Spatial: 2 to 8 m sampling

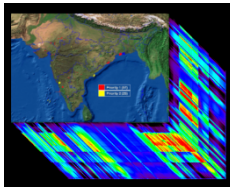
AVIRIS-NG Installed 11 Dec 2015

AVIRIS-NG in the hanger prior to installation





Tarmac Calibration Target NRSC Hyderabad

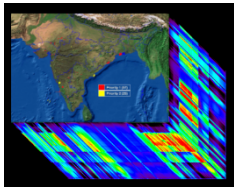


- NRSC hanger where AVIRIS-NG is being install in the ISRO B200 Aircraft
- Local calibration validation site.





AVIRIS-NG Radiometric Calibration in Hyderabad



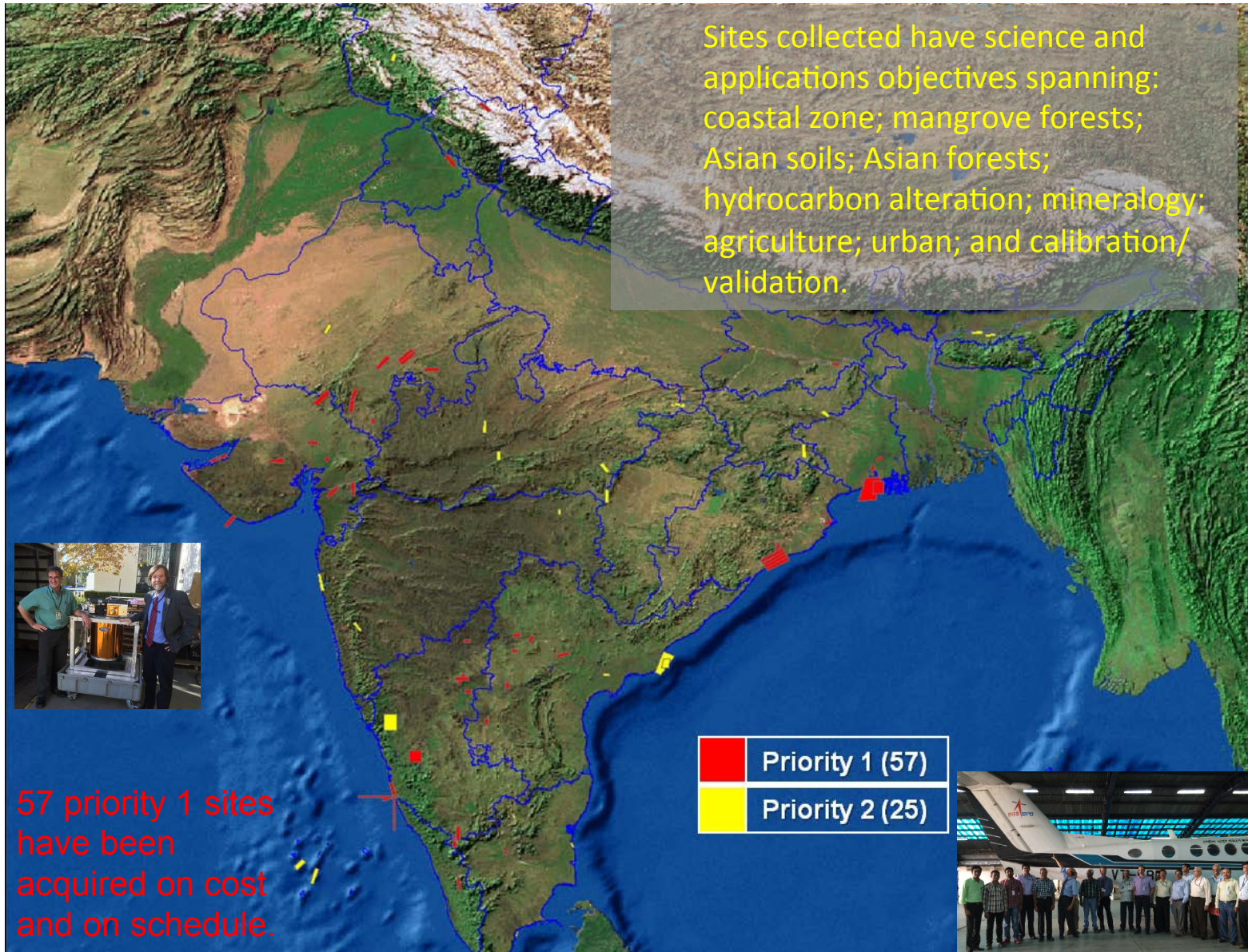
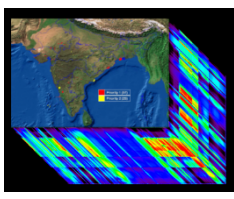
During the week of January 11th, 2016 the AVIRIS-NG team (Ernesto Diaz, Peter Sullivan, and Andrew Thorpe) acquired NIST traceable radiometric calibration and flat-field measurements for AVIRIS-NG at the Hyderabad hanger while the aircraft was undergoing routine maintenance.

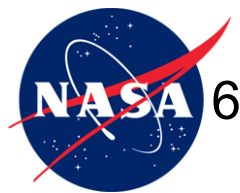




NASA ISRO Imaging Spectroscopy Campaign

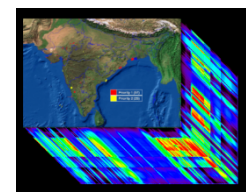
17th of December 2015 to 8th of March 2016





The First 13 of 57 AVIRIS-NG Data Sets

65 flight lines (~2 TB) processed to L1 and L2 and delivered back to ISRO in two weeks



AVIRIS-NG Data Portal 2014-2015

Please note that the locator tool is only compatible with Mozilla Firefox, Google Chrome, and Safari web browsers.

Search for Data Products

[INSTRUCTIONS](#)

Flight Acquisition Parameters

Year	<input type="text" value="2014"/>	AND	Year	<input type="text" value="2016"/>
Month	<input type="text" value="1"/>	AND	Month	<input type="text" value="12"/>
Day	<input type="text" value="1"/>	AND	Day	<input type="text" value="31"/>
Pixel Size	<input type="text" value="0.1"/>	AND	Pixel Size	<input type="text" value="8.10"/>
Rotation	<input type="text" value="-90"/>	AND	Rotation	<input type="text" value="90"/>
Solar Elev	<input type="text" value="0"/>	AND	Solar Elev	<input type="text" value="90"/>
Solar Azimuth	<input type="text" value="0"/>	AND	Solar Azimuth	<input type="text" value="360"/>

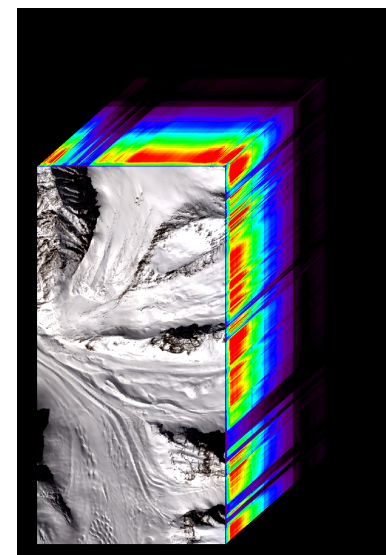
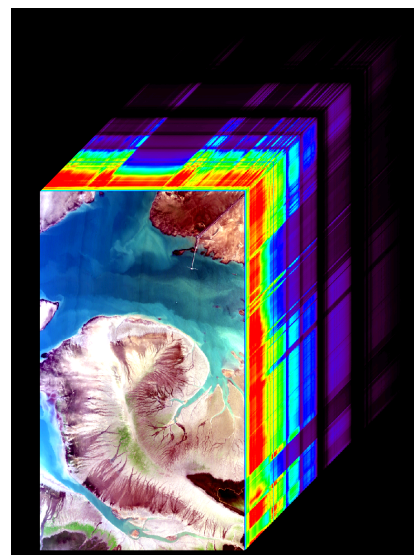
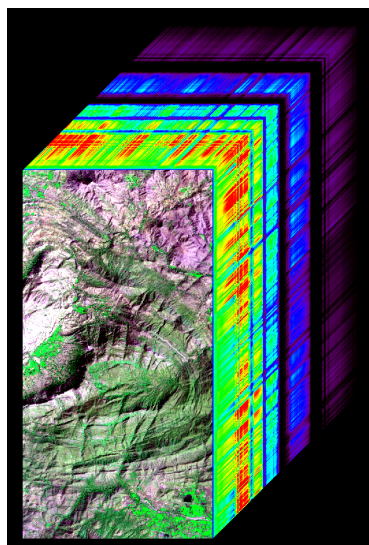
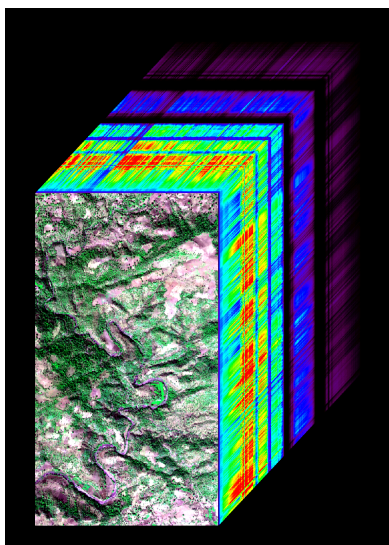
Pixel size unit is meters. Rotation, Solar Elevation, and Solar Azimuth are degrees.

Flight Name	CONTAINS	<input type="text" value=""/>
Site Name	CONTAINS	<input type="text" value="India"/>
Comments	CONTAINS	<input type="text" value=""/>
Investigator	CONTAINS	<input type="text" value=""/>

Data Products Filter

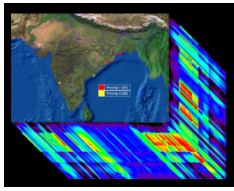
Filter results to include ONLY the checked data product(s)

(?)

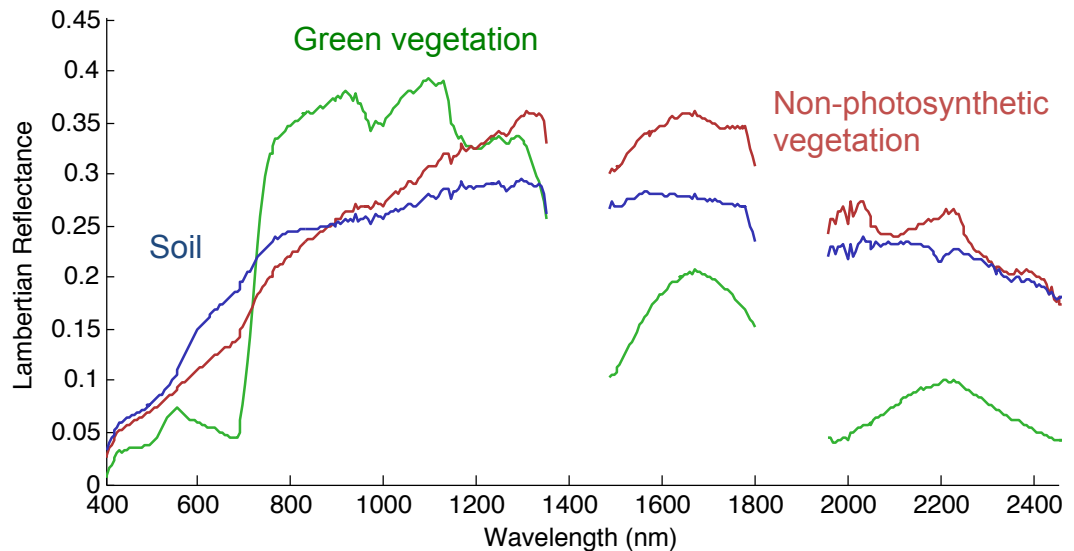
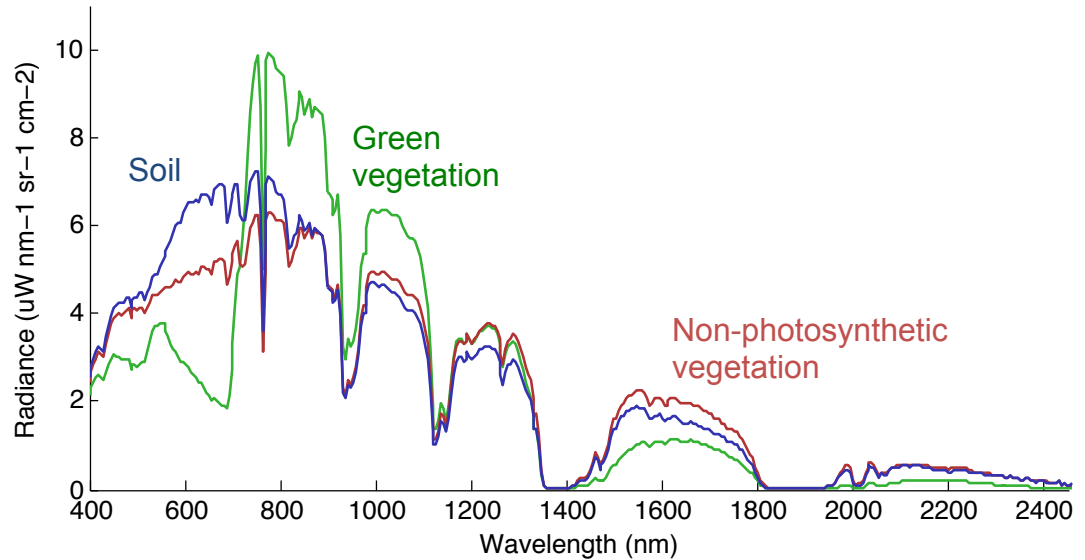




L1 & L2 spectra (typical)



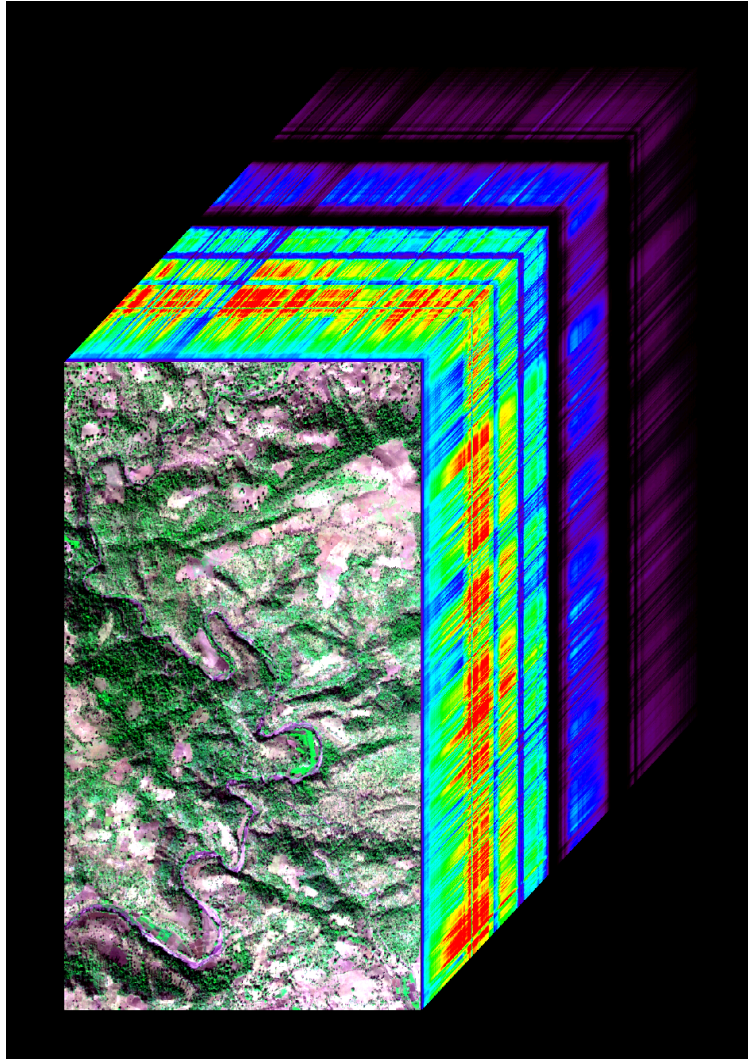
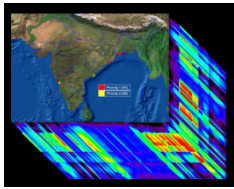
Radiance & reflectance for three surface types in a Feb 3 flight line



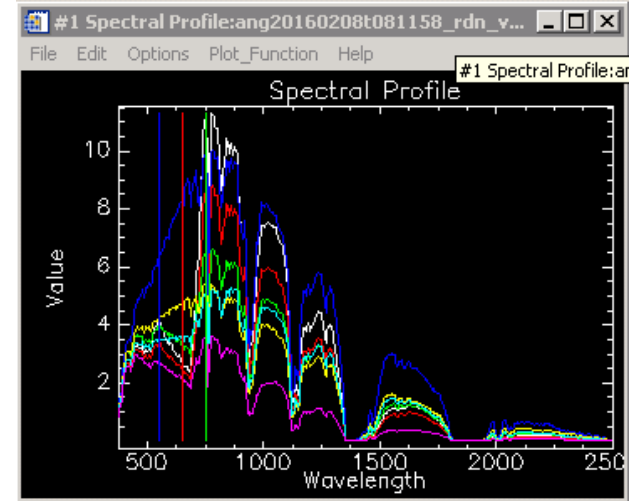


AVIRIS-NG Imaging Spectroscopy

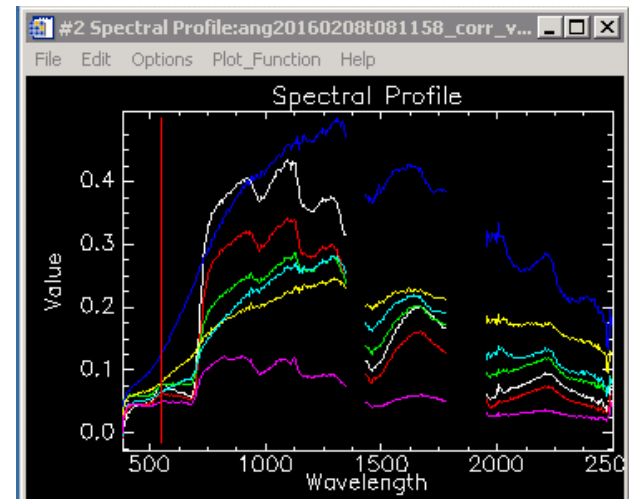
Forestry: Shoolpaneshwar, Gujarat, India



L1 Radiance ($\mu\text{W}/\text{cm}^2/\text{nm}/\text{sr}$)



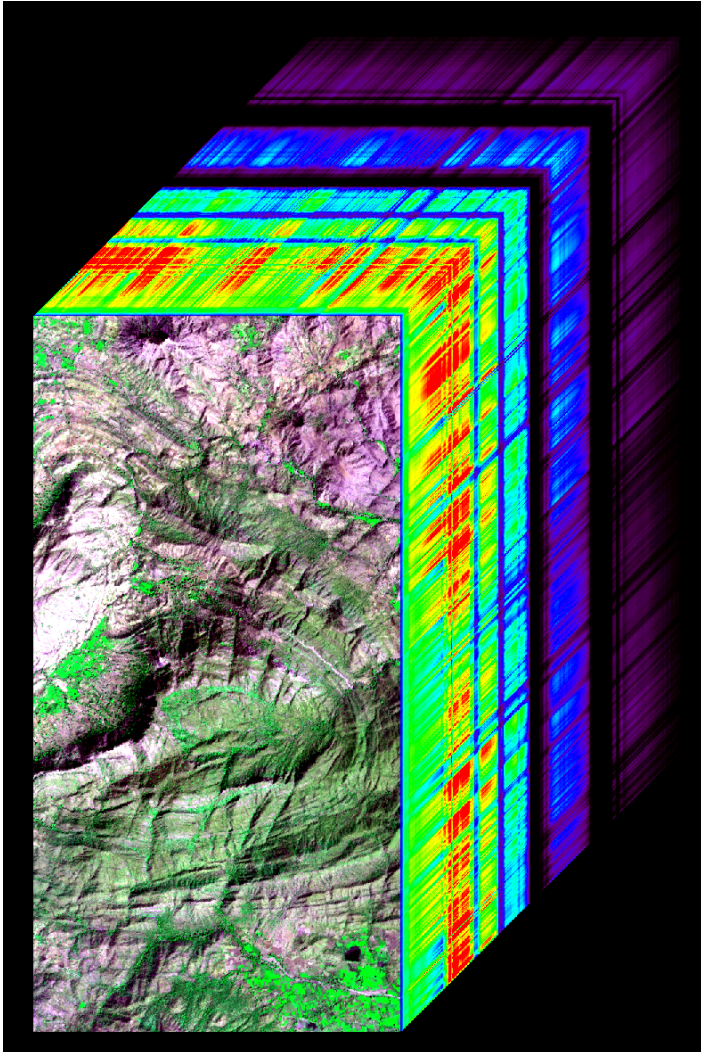
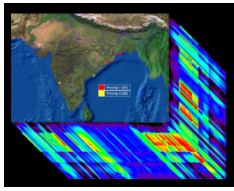
L2 Reflectance



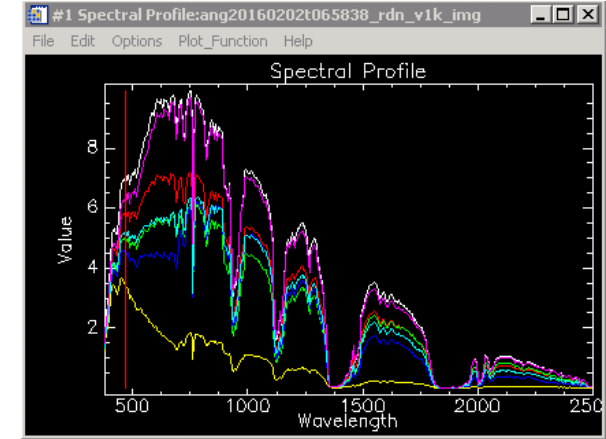


AVIRIS-NG Imaging Spectroscopy

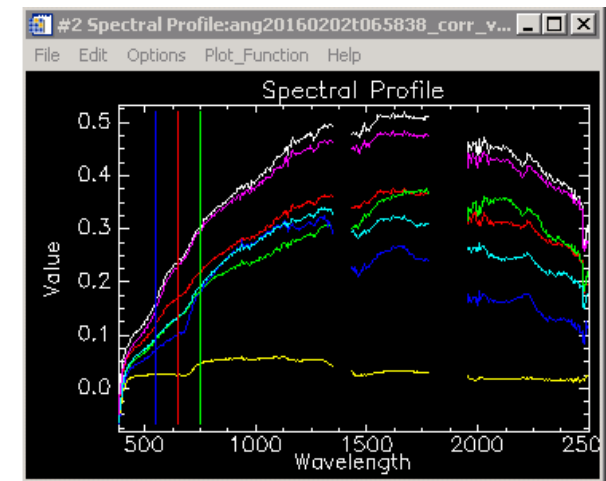
Geology: Ambaji, Gujarat, India



L1 Radiance ($\mu\text{W}/\text{cm}^2/\text{nm}/\text{sr}$)



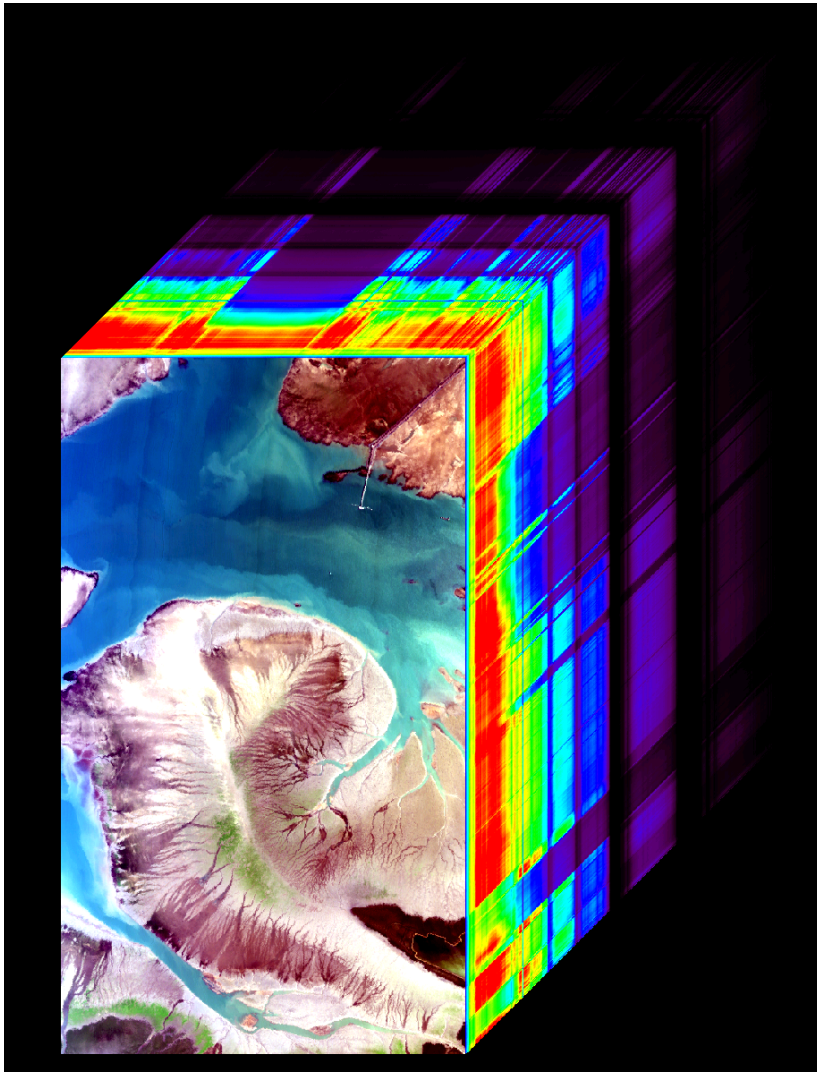
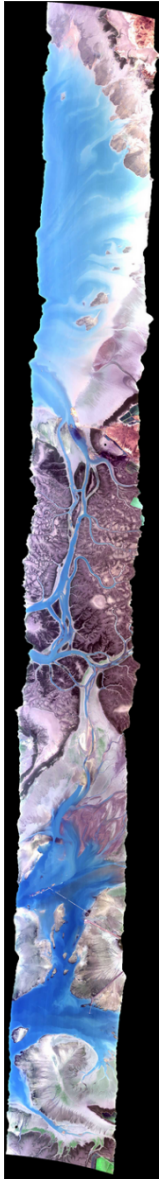
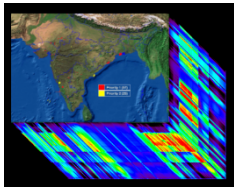
L2 Reflectance



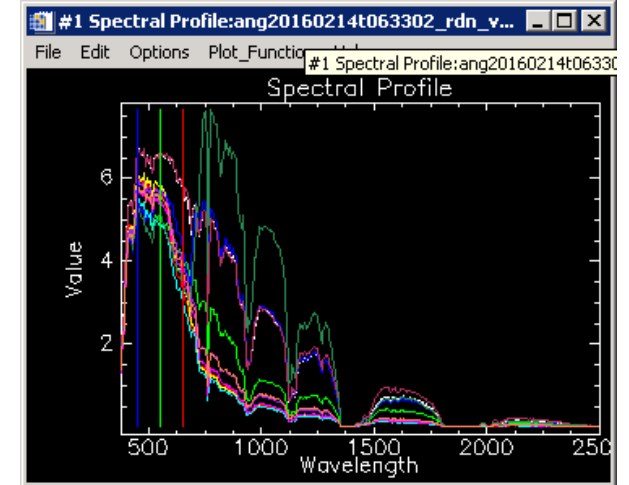


AVIRIS-NG Imaging Spectroscopy

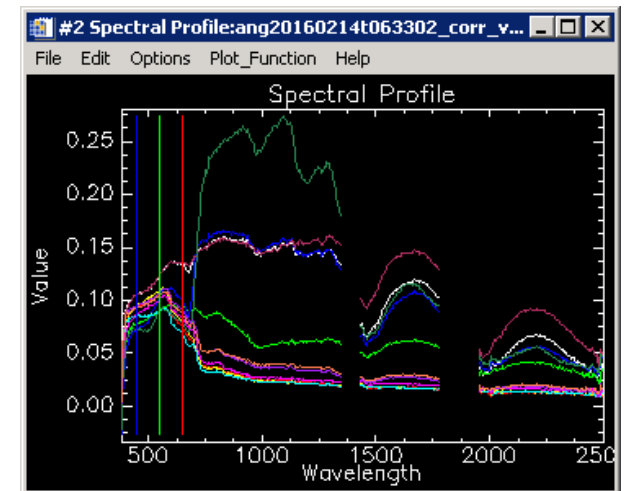
Costal Ocean: Pirotan, India



L1 Radiance ($\mu\text{W}/\text{cm}^2/\text{nm}/\text{sr}$)



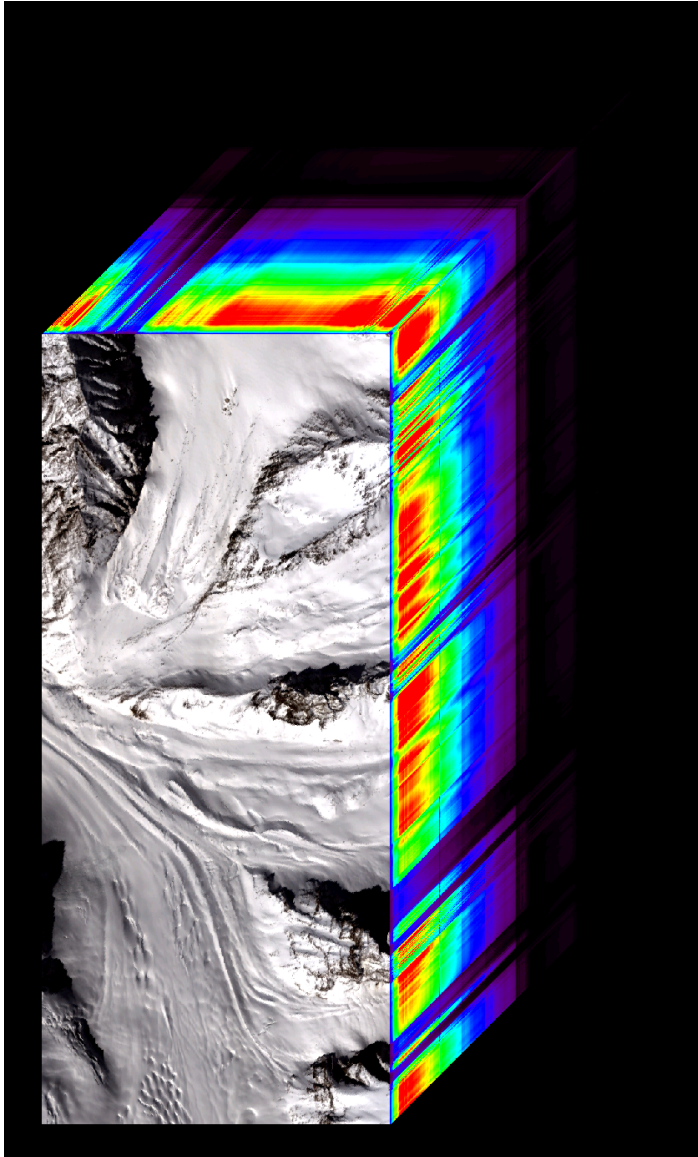
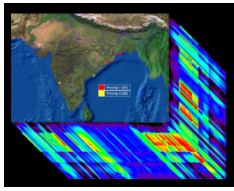
L2 Reflectance



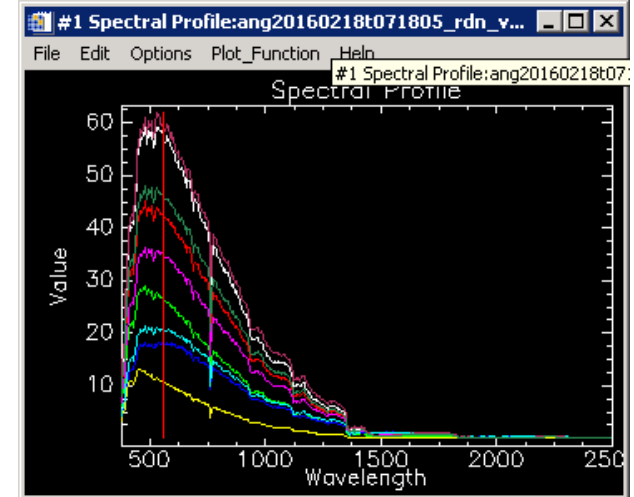


AVIRIS-NG Imaging Spectroscopy

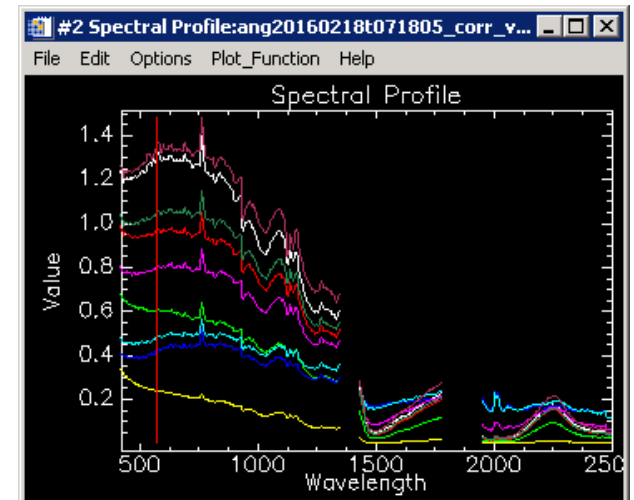
Snow/Ice: Himachal Pradesh, India



L1 Radiance ($\mu\text{W}/\text{cm}^2/\text{nm}/\text{sr}$)

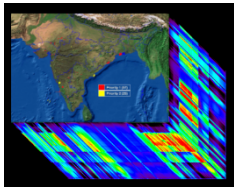


L2 Reflectance

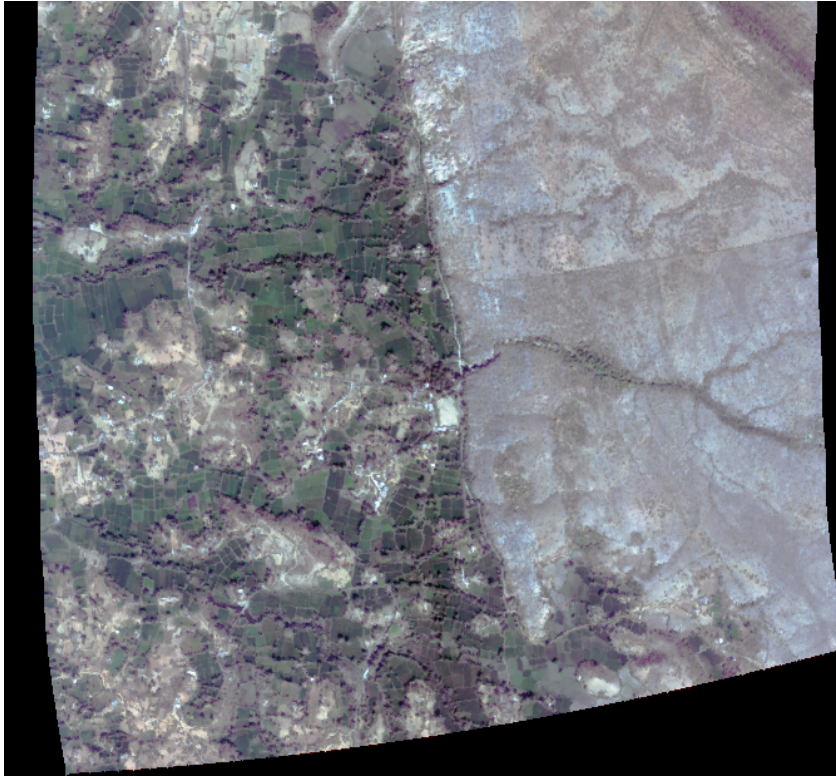




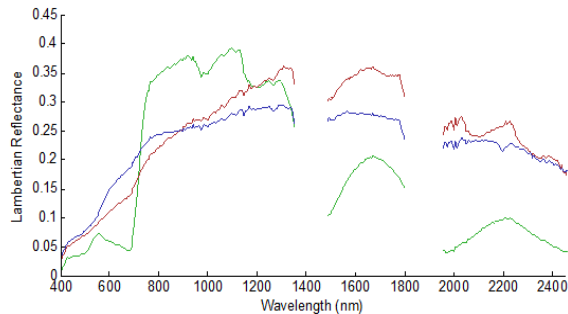
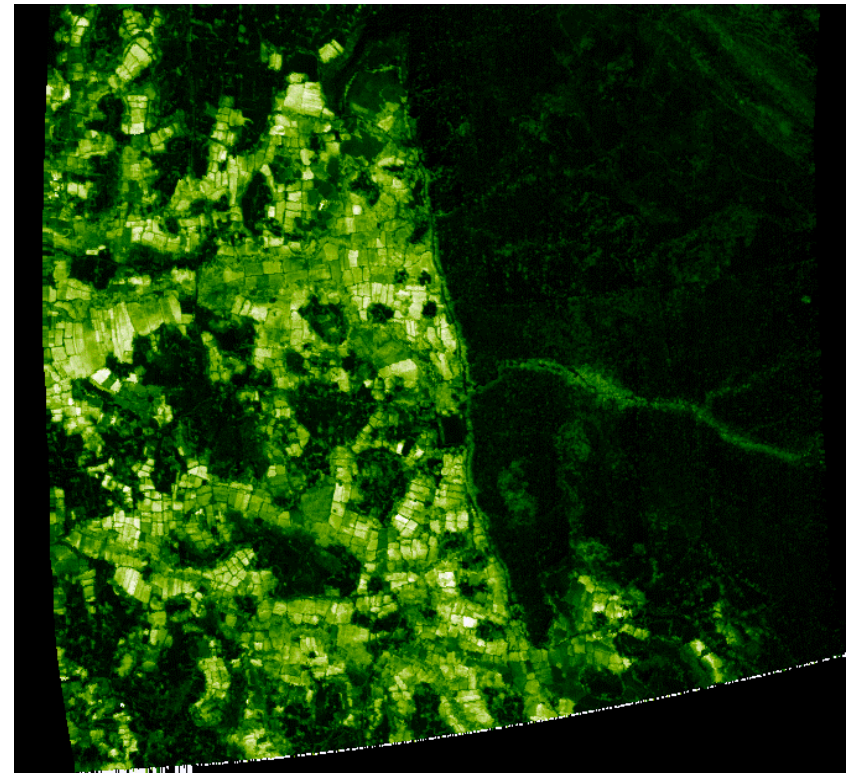
Test of L3 Product Canopy Water Absorption



ang20160203t060655



Equivalent water thickness (EWT)



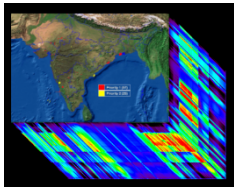
0



4 mm

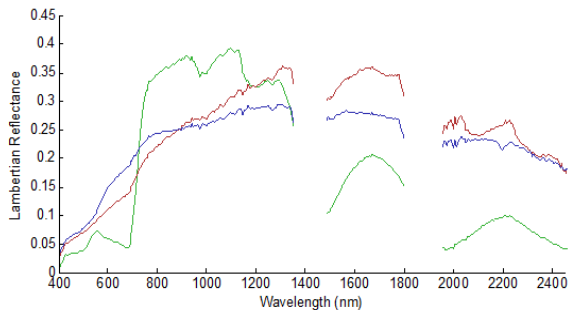
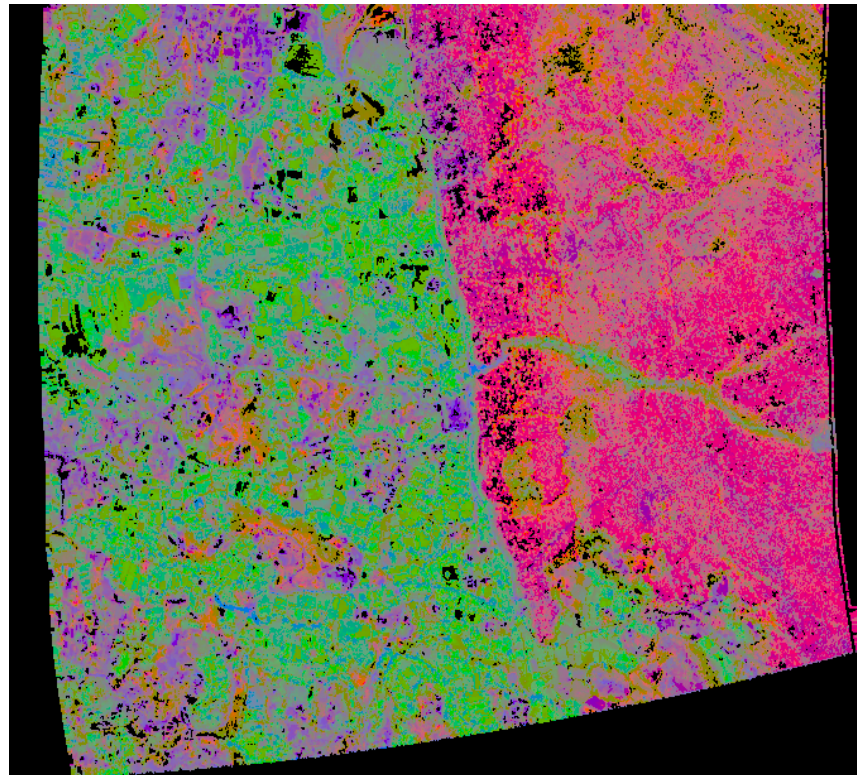


Test of L3 Ecosystem Product



ang20160203t060655

Spectral Mixture Analysis (SMA)



Non-photosynthetic vegetation

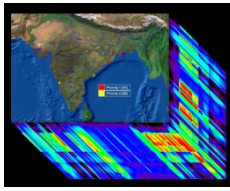
Green vegetation

Substrate (soil, rock, anthropogenic, etc.)

Currently Unmapped



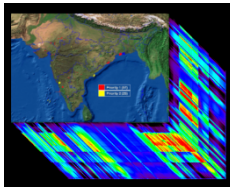
Current Status



- All 317 flight lines for the 57 sites imaged have been received and processed.
- Copies of the L1 and L2 are being shipped back to ISRO.
- Plans are underway to reopen the ROSES opportunity with pathways to establish connections with ISRO researchers.
- Quicklooks can be found at https://avirisng.jpl.nasa.gov/cgi/flights.cgi?step=view_all_flights



This Weeks Status and Update



- AVIRIS-NG was installed on an ISRO B200 aircraft and began measuring science targets in India on the 17th of December 2015 and completed acquisitions on the 8th of March 2016.
- AVIRIS-NG returned safely to JPL on 22 April 2016.
- During the campaign imaging spectroscopy measurements were acquired for all 57 planned sites, 317 flight lines.
- Sites collected have science and applications objectives spanning: coastal zone; mangrove forests; Asian soils; Asian forests; hydrocarbon alteration; mineralogy; agriculture; urban; and calibration/validation.
- All 57 sites have been cleared by MoD with some portions of 30 flight lines redacted.
- The data have been transferred to JPL and are being processed. Upon completion, copies of the L1 radiance and L2 reflectance are being sent to ISRO.
- Quicklook images of AVIRIS-NG India campaign data sets can be found at:
 - https://avirisng.jpl.nasa.gov/cgi/flights.cgi?step=view_all_flights
- **The NASA ROSES opportunity for U. S. investigators to work collaboratively with Indian researchers is planned to be reopened.**
- Weekly telecons continue with ISRO to track the status and processing of all data sets for use by Indian and U.S. researchers.
- There is broad and enthusiastic interest in the joint science and applications research that can be pursued with these first of their kind measurements.