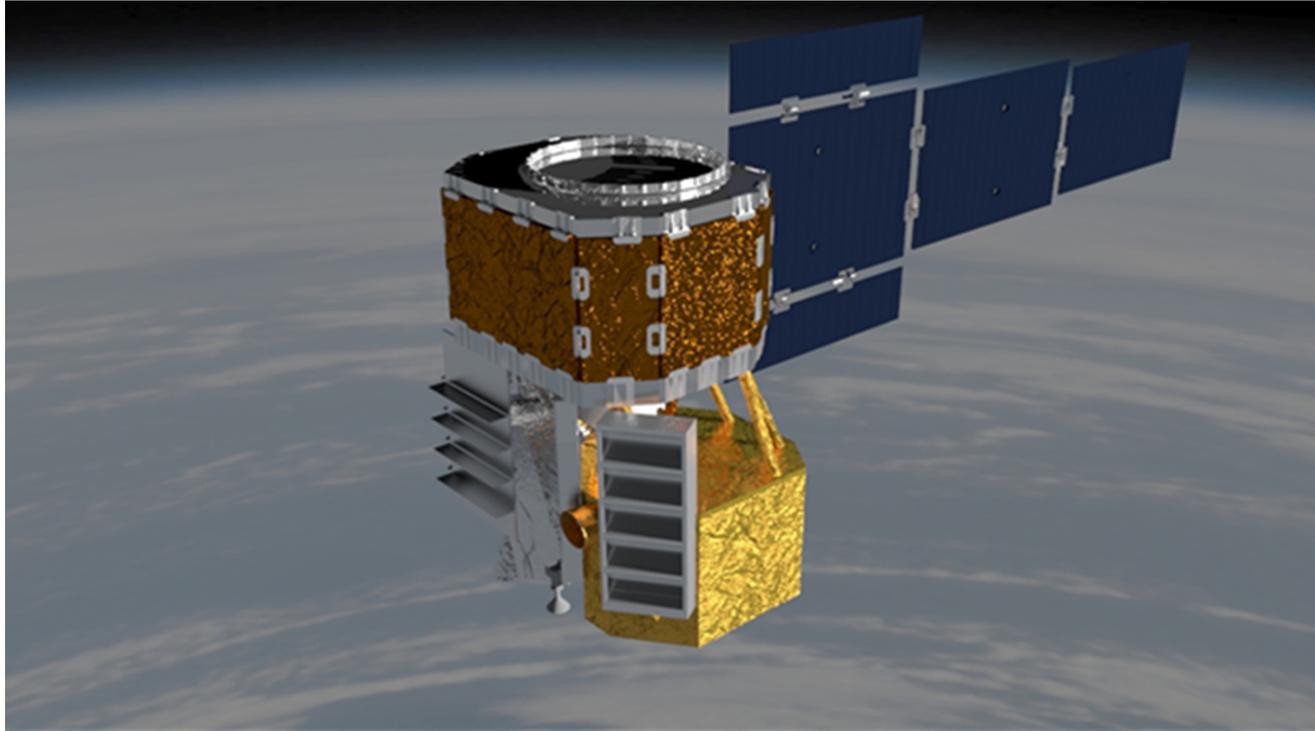


9th HypsIRI Science and Applications Workshop



Overview and Update



Woody Turner

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Earth Science Division

NASA Headquarters

October 18, 2017



HypsIRI



HyspIRI Objectives and Approach

Key Global Science and Applications Research

Climate: Ecosystem biochemistry, condition & feedback; spectral albedo; carbon/dust on snow/ice; biomass burning; evapotranspiration

Ecosystems: *Global* biodiversity, plant functional types, physiological condition, and biochemistry including agricultural lands

Fires: Fuel status; fire frequency, severity, emissions, and patterns of recovery *globally*

Coral reef and coastal habitats: *Global* composition and status

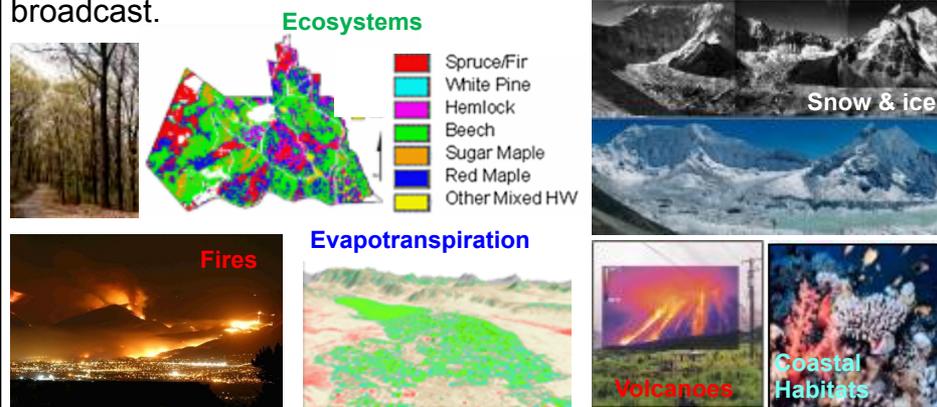
Volcanoes: Eruptions, emissions, regional and *global* impacts

Geology and resources: *Global* distributions of surface mineral resources and improved understanding of geology and related hazards

Applications: Disasters, EcoForecasting, Health/AQ, Water

Global Mission Urgency

The HypsIRI science and applications objectives are critical today and uniquely addressed by the combined imaging spectroscopy, thermal infrared measurements, and IPM direct broadcast.



Measurement

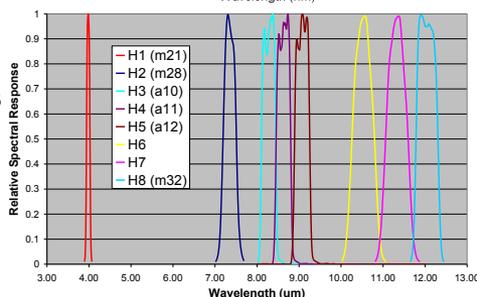
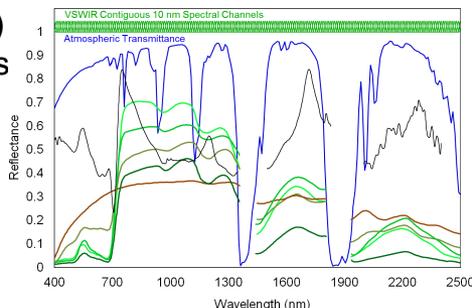
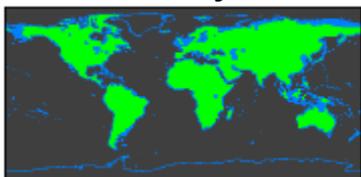
Imaging Spectrometer (VSWIR)

- 380 to 2510nm in ≤ 10 nm bands
- 30 m spatial sampling
- 16 days revisit
- Global land and shallow water

Thermal Infrared (TIR)

- 8 bands between 4-12 μ m
- 60 m spatial sampling
- 5 days revisit; day/night
- Global land and shallow water

IPM-Low Latency data subsets



Mission Concept Status

Level 1 Measurement Requirements: Vetted by community at workshops and in literature (many refereed journal articles)

Payload: VSWIR Imaging Spectrometer, TIR Multi-spectral Radiometer, and Intelligent Payload Module (IPM)

Original 60 m option: Mature

ISS options: VSWIR & TIR Mature, ECOSTRESS EVI selected

Separate Smallsat Mission option: VSWIR and TIR solutions developed with TEAM I/X

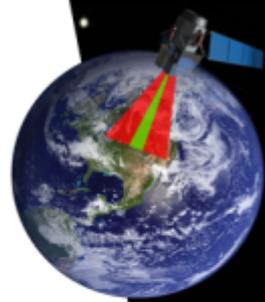
2016 Option: HypsIRI VSWIR evolved to 30 m and 16 day global revisit. Requires F/1.8 Dyson spectrometer architecture and other current technologies.

Preparatory airborne campaigns: Measurements used to advance and refine science, applications, algorithms, and processing

Current Decadal Survey: >25 HypsIRI-related Dec. Sur. RFI



Workshop Overview



HyspIRI

- **Tuesday**

- *Status of HypsIRI Mission Concept*
- *Science Talks across Disciplines (including results from airborne campaigns and Decadal Survey papers)*

- **Wednesday**

- *Science Talks*
- *AVIRIS-NG in India Campaign Update*
- *Poster Session*
- *ECOSTRESS Talks*

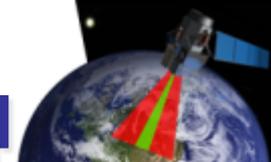
- **Thursday**

- *Talks on Managing HypsIRI Data and Product Generation*
- *Mission Concept Studies*
- *Related Sensor Talks*
- *Decadal Survey Town Hall Inputs*



Overall FY16 Progress

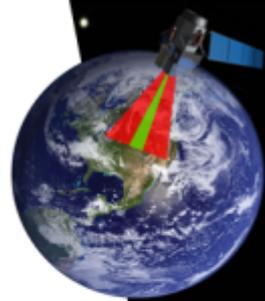
2016 Guidance Memo Actions Completed



Guidance Memo Actions	Status	Summary of Actions Taken
<p>1. Continue to build broad community understanding and support by conducting science and applications workshops and data product symposia.</p>		<p>Symposium held in June at GSFC Workshop and Airborne Meeting in October at Caltech Two oral sessions, 38 abstracts received for AGU session in December 2016 >15 HypSIIRI-related Decadal Survey RFI2 inputs</p>
<p>2. Continue to conduct HypSIIRI data product generation and benchmarking with airborne and satellite data.</p>		<p>Completed 4th year Western US HypSIIRI data set; Algorithms advancing Routinely generating L1 and L2 from VSWIR and TIR data FY16 start of Volcano and Coral Reef campaign in Hawaii Small aircraft tests: IPM/spectrometer data throughput (GSFC)</p>
<p>3. Continue to carry out instrument mission trade studies, including smallsat and ISS opportunities, to provide lower cost and more adaptable instrument and/or mission approaches, including risk reduction concepts.</p>		<p>Refined and updated ISS and smallsat options Full 2016 HypSIIRI baseline mission study with VSWIR (30m/16 day revisit), TIR (60m/5 day revisit), and IPM; Informed by ECOSTRESS and VSWIR studies</p>
<p>4. Continue to explore options to ensure the HypSIIRI VSWIR and TIR instruments meet the Sustainable Land Imaging measurement requirements, including compatibility with heritage data product resolutions.</p>		<p>Evolved VSWIR concept to 30 m sampling and 16 day revisit HypSIIRI airborne VSWIR convolved to Landsat bands ECOSTRESS demonstrating TIR for SLI VSWIR-Dyson F/1.8 meets SLI requirements (Mouroulis et al. journal article)</p>
<p>5. Utilize the ECOSTRESS mission development for HypSIIRI risk reduction.</p>		<p>Using ECOSTRESS to advance the TRL of key components of the HypSIIRI baseline: optics, detector, cryocoolers and science algorithms; TIR related airborne and ground validation efforts including use of HyTES for TIR validation</p>
<p>6. Continue to engage potential international and domestic partners in addressing opportunities to lower the cost of a potential mission while maintaining Level 1 mission requirements.</p>		<p>AVIRIS-NG campaign in India with possibilities for future partnerships Participation in EnMAP science advisory group Participation in International Space Science Institute (ISSI) Workshop on Imaging Spectroscopy</p>
<p>7. Prepare materials updating the National Research Council's 2017 Earth Science Decadal Survey effort on the status and value of a HypSIIRI mission and provide the NRC with options for accomplishing the mission.</p>		<p>Web-based HypSIIRI comprehensive development report Participation in Decadal Survey November white papers and May RFI 12 White papers, November 2015 >15 RFI2 responses, May 2016</p>
<p>8. Refine and update the HypSIIRI comprehensive development report that documents and provides broad access for the NRC and others to the work completed by the HypSIIRI team.</p>		<p>The comprehensive development report has been updated The HypSIIRI website has been updated to support NASA and NRC efforts</p>



Pre-Formulation Review

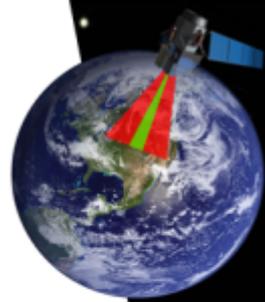


HypIRI

- FY2016 funding level from 2016 guidance = \$2.36M
 - *Included \$360,000 over guide request for simulated HypIRI TIR scene*
- Requested FY2017 funding of \$2.6M
 - *\$2M in guide*
 - *\$600,000 over guide for IPM, TIR, and VSWIR detector work*
- Draft 2017 guidance memo with Eric Ianson with a target release date of end October
- Plan for FY2018 is to receive 6 months of FY2018 funding with future continuation determined by the outcome of the NRC Decadal Survey



Technical Progress in FY2016



HypSIPI

- Refined and benchmarked atmospheric correction and cal/val algorithms
- VSWIR-Dyson F/1.8 prototype has been running at cryogenic temperatures for 9 months; it can be scaled to support 30 m and 16 day revisit; full characterization, calibration and acquisition of relevant spectra achieved
- Tracking ECOSTRESS development and identifying those components that advance the HypSIPI TRL and those components requiring further work for HypSIPI
- Updated full HypSIPI concept with Team-X study for combined VSWIR, TIR, and IPM at VSWIR 30 m and 16 day revisit; TIR uses ECOSTRESS maturing technology; Ka band and lossless compression (4x for VSWIR/3x for TIR) with cloud screening allows downlink of all VSWIR and TIR data
- Testing VSWIR and TIR with latest lossless compression algorithm; now a Consultative Committee for Space Data Systems (CCSDS) standard
- IPM demonstrated 4.8 Gbps composite ingest rate on 8 Low Voltage Differential Signal (LVDS) lines, which is likely method to tap data from SWIR; 1.7 Gbps throughput for Level 1 Radiometric (L1R) correction previously demonstrated, but should shortly demonstrate 4.8 Gbps L1R and L1 Geometric Correction
- Comprehensive report summarizing multi-year effort of HypSIPI concept study team reviewed and made available for web distribution through the HypSIPI website: <http://hypsipl.jpl.nasa.gov/comprehensive-development-report>

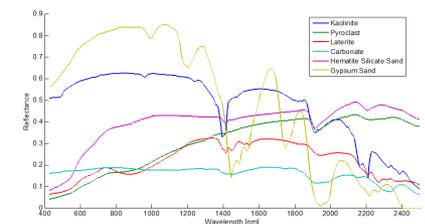
ECOSTRESS



VSWIR-Dyson



VSWIR-Dyson Test Lab Spectra



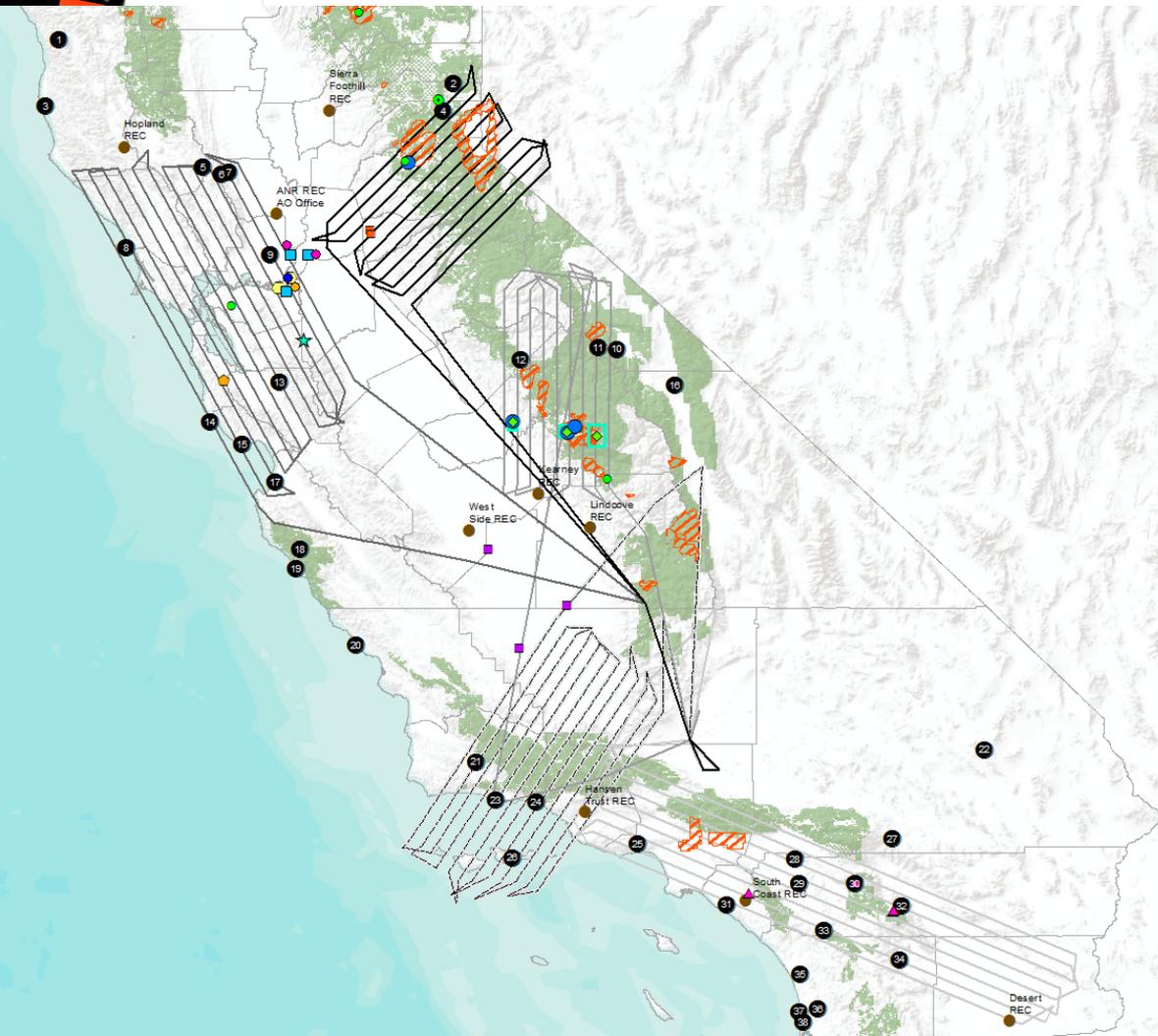


HypIRI Airborne Preparatory Mission

3 Seasonal Flights Over 5 Boxes/Soda Straw in 2013, 2014, 2015
To Simulate HypIRI Satellite Imagery - **Complete**



ER-2	AVIRIS	AVIRIS	MASTER	MASTER
Altitude	Resolution	Swath	Resolution	Swath
65,000 ft	20 m	12 km	50 m	35 km



PI TEAM:

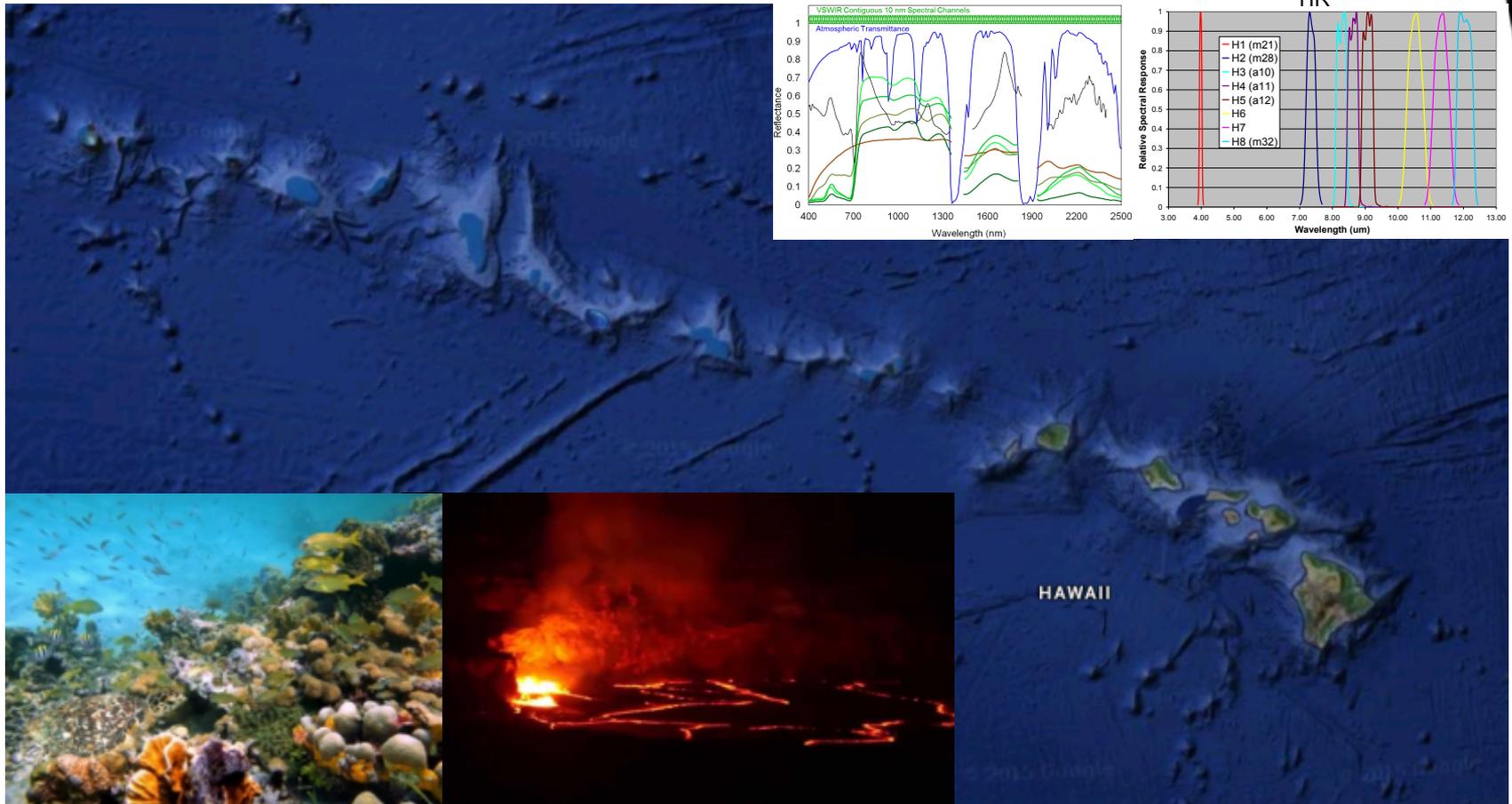
- Wendy Calvin/University of Nevada - Reno
- Matthew Clark/Sonoma State University
- Bo-Cai Gao/Naval Research Laboratory
- Bernard Hubbard/U. S. Geological Survey
- Darrel Jenerette/University of California, Riverside
- Thomas Kampe/NEON
- Raphael Kudela/University of California, Santa Cruz
- Ira Leifer/University of California, Santa Barbara
- Dongdong Wang/University of Maryland
- Paul Moorcroft/Harvard University
- Dar Roberts/University of California, Santa Barbara
- Philip Townsend/University of Wisconsin-Madison
- Susan Ustin/University of California, Davis
- Jan van Aardt/Rochester Institute of Technology

NASA HypSIRI Volcano and Coral Reef Airborne Campaign



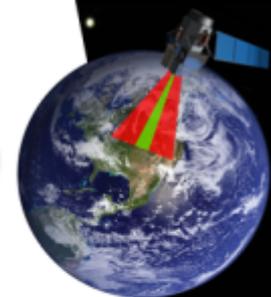
HypSIRI

- EV-S CORAL campaigns in 2016-2017 with PRISM imaging spectrometer
- HypSIRI Preparatory Airborne Activities and Associated Science: Coral Reef and Volcano Research
 - 10 investigations selected with data acquisition in early 2017
 - Test Level 1 and 2 products for VSWIR and TIR HypSIRI-type measurement
 - Advance maturity of higher level products and related algorithms





38 Abstracts Submitted to AGU Session



HySPIRI

- Two oral sessions allocated by AGU

AGU FALL MEETING

San Francisco | 12–16 December 2016

SEARCH KEYWORDS

SEARCH SECTIONS AND FOCUS GROUPS

SEARCH CONVENER/AUTHOR NAME

LOGIN

GC029:
Earth Science Results from New Imaging Spectroscopy Measurements around the Globe

Session ID#: 13023

Session Description:

In 2015/16, advanced airborne imaging spectrometers operated by NASA and other agencies pursued science campaigns spanning new and diverse environments worldwide. Regions included Greenland, India, the Southern Ocean, the South Pacific, United States, Europe and elsewhere. This session will present salient new results from these diverse investigations. It will highlight algorithmic advances, challenges and opportunities related to regional diversity, preparing for new capabilities from orbital imaging spectrometers such as EnMAP and future missions with full global coverage. Submissions will demonstrate new measurements for land, ocean, cryosphere, and atmosphere science. Examples include: terrestrial ecosystem function, health, and biodiversity; ocean, coastal, benthic and inland water properties; urban land cover condition; snow and ice climate and water resource factors; measurement of the atmosphere including local methane sources; and surface geology related to resources, soils, and hazards. We will also examine calibration, algorithms, and field methodology ensuring continued consistency in global Earth system science.

Primary Convener:

David R Thompson, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States

Conveners:

Robert O Green, Jet Propulsion Laboratory, Pasadena, CA, United States, **Elizabeth Middleton**, NASA Goddard Space Flight Cen., Greenbelt, MD, United States and **Thomas H Painter**, NASA Jet Propulsion Laboratory, Pasadena, CA, United States

Cross-Listed:

- A - Atmospheric Sciences
- B - Biogeosciences
- C - Cryosphere
- OS - Ocean Sciences

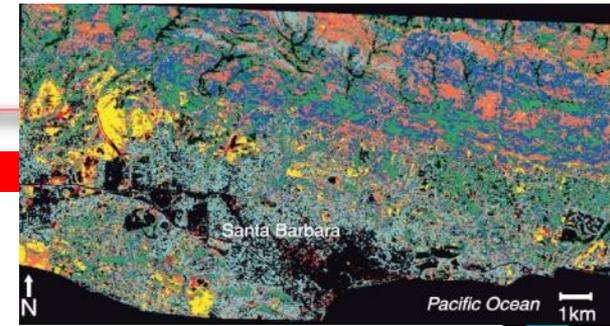
Index Terms:

- 0410 Biodiversity [BIOGEOSCIENCES]
- 1615 Biogeochemical cycles, processes, and modeling [GLOBAL CHANGE]
- 1632 Land cover change [GLOBAL CHANGE]
- 1635 Oceans [GLOBAL CHANGE]

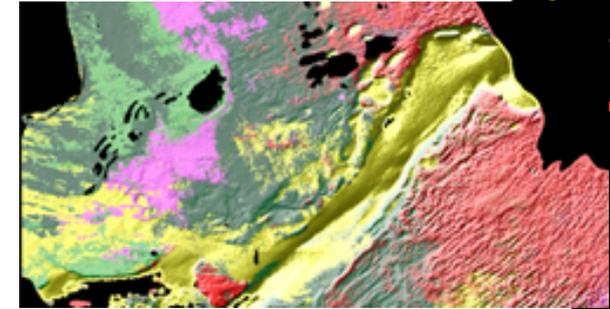


AVIRIS-NG NASA and ISRO Airborne Campaign in India

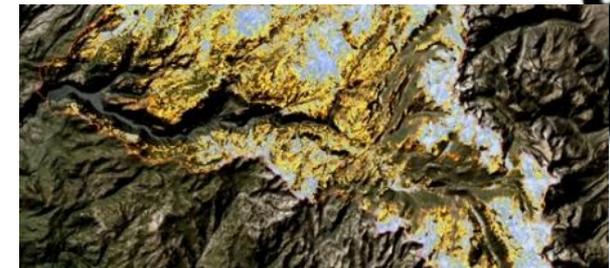
Ecosystem and Agriculture



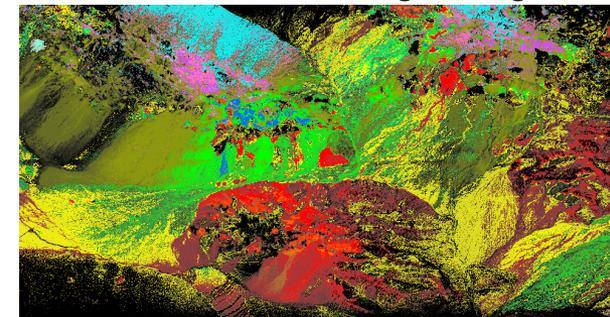
Asian Coastal Waters



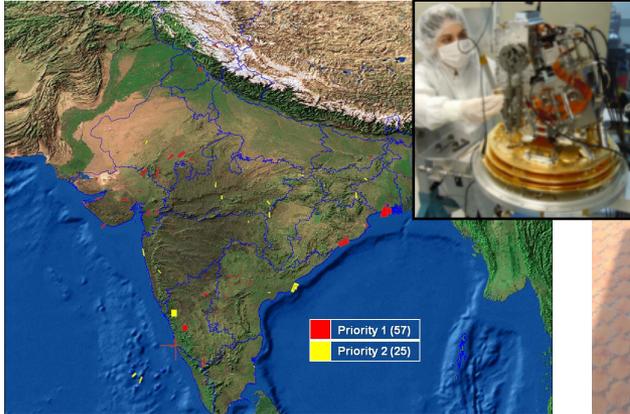
Dust and Black Carbon on Snow & Ice



New Geological Regimes



This joint airborne campaign is providing first-of-their-kind high fidelity imaging spectroscopy measurements of a diverse set of South Asian environments for science and applications research.



57 diverse science sites measured



Pre campaign Science Meeting Sept 2015

ISRO B-200 Aircraft at NRSC



AVIRIS-NG being shipped.



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

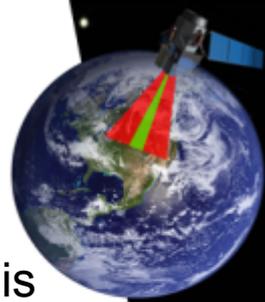
- Natural ecosystems
- Water resources, snow and ice
- Geology and natural hazards
- Coastal and inland waters, coral reefs
- Agricultural lands and urban areas

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.

https://avirisng.jpl.nasa.gov/cgi/flights.cgi?step=view_all_flights = Quicklooks

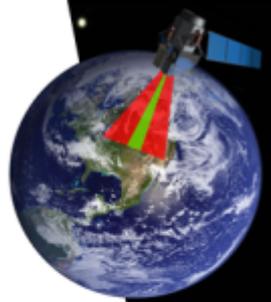


Critical Take Aways



HypIRI

- HypIRI-enabled science and applications are unique and urgent in this period of climate change.
- The technologies are ready for HypIRI now.
 - ECOSTRESS is maturing the TIR capability for a subset of HypIRI-TIR bands.
 - The F/1.8 VSWIR-Dyson is maturing the VSWIR solution for 30 m and 16 day revisit.
- The HypIRI mission concept team and science study group is supporting the current Decadal Survey.
- There are potential international partnership opportunities at multiple levels.
- The JPL and GSFC HypIRI Mission Concept team has performed exceptionally well. The team is committed to supporting NASA in FY17 and in the future as appropriate to achieve the HypIRI science and applications research objectives.



HySPIRI

THANK YOU