HyspIRI Preparatory Airborne Campaign

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Jet Propulsion Laboratory, California Institute of Technology

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HyspIRI Decadal Survey Mission

Key Science and Science Applications
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 impact
Geology and resources: Global distributions of surface mineral resources and improved understanding of geology and related hazards

Mission Urgency
The HyspIRI 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 2500 nm in 10 nm bands
- 60 m spatial sampling
- 19 days revisit
- Global land and shallow water

Thermal Infrared (TIR):  
- 8 bands between 4-12 μm
- 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 and stable
Payload: VSWIR Imaging Spectrometer, TIR Imaging radiometer, and IPM-Low Latency subsets
Full Mission option: Baseline mission mature with Aerospace Independent Cost Estimate ($493M to $647M in FY12$)
Options for Technology/Science ISS Demonstration:
Submitted for VSWIR and TIR with IPM Studies for instrument on separate platforms:
Draft Science whitepaper underway
Summary: The HyspIRI mission measurement requirements and baseline instruments approach are mature and stable with good heritage, low risk and modest cost. Now exploring a range of instrument and data options to save cost, per guidance letter.
Overview

- R&A HyspIRI Preparatory Airborne Campaign
  - science team with 14 PIs
  - Delivered Level 1 and Level 2 data products
- Ecosystems, Seasonal, Climate, Coastal, Urban, Resources
- 6 zones, 3 seasons, 2 years

Objective: Advance HyspIRI Mission Science and Algorithm Readiness

- Ecosystem composition, function, biochemistry, seasonality, structure, and modeling
- Coastal ocean phytoplankton functional types, habitat
- Urban land cover, temperature, transpiration
- Surface energy balance
- Atmospheric characterization and local methane sources
- Surface geology, resources, soils, hazards
HyspIRI Preparatory Airborne Studies

- Harvard/Paul Moorcroft - Linking Terrestrial Biosphere Models with Imaging Spectrometry Measurements of Ecosystem Composition, Structure, and Function
- UC Santa Barbara/Dar Roberts - HyspIRI discrimination of plant species and functional types along a strong environmental-temperature gradient
- UWI/Philip Townsend - Measurement of ecosystem metabolism across climatic and vegetation gradients in California for the 2013-2014 NASA AVIRIS/MASTER airborne campaign
- UC Davis/Susan Ustin - Identification of Plant Functional Types By Characterization of Canopy Chemistry Using an Automated Advanced Canopy Radiative Transfer Model
- Sonoma State/Matthew Clark - Spectral and temporal discrimination of vegetation cover across California with simulated HyspIRI imagery
- NRL/Bo-Cai Gao - Characterization and Atmospheric Corrections to the AVIRIS-Classic and AVIRISng Data to Support the HyspIRI Preparatory Airborne Activities
- USGS/Bernard Hubbard - Using simulated HyspIRI data for soil mineral mapping, relative dating and flood hazard assessment of alluvial fans in the Salton Sea basin, Southern California
- UC Riverside/George Jenerette - Assessing Relationships Between Urban Land Cover, Surface Temperature, and Transpiration Along a Coastal to Desert Climate Gradient
- NEON/Thomas Kampe - Synergistic high-resolution airborne measurements of ecosystem structure and process at NEON sites in California
- UC Santa Cruz/Raphael Kudela - Using HyspIRI at the Land/Sea Interface to Identify Phytoplankton Functional Types
- Bubbleology/Ira Leifer - Hyperspectral imaging spectroscopic investigation of California natural and anthropogenic fossil methane emissions in the short-wave and thermal infrared
- UMD/Shunlin Liang - Characterizing surface energy budget of different surface types under varying climatic conditions from AVIRIS and MASTER data
- RIT/Jan van Aardt - Investigating the impact of spatially-explicit sub-pixel structural variation on the assessment of vegetation structure from HyspIRI data
- UNV/Wendy Calvin - Energy and Mineral Resources: Surface composition mapping that identifies resources and the changes and impacts associated with their development
HyspIRI Airborne Preparatory Mission

Jet Propulsion Lab: Ian McCubbin, Robert Green, Simon Hook, Marco Hernandez, Sarah Lundeen, Scott Nolte, Chuck Sarture

NASA Dryden: Stu Broce, Tim Moes, Dean Neeley, Tim Williams

NASA Ames: Rose Dominguez, Jeff Myers, Dennis Gearherdt, Bob Billings, Kent Dunwoody

NASA Headquarters Woody Turner
HyspIRI Airborne Preparatory Mission

F130410t01  San Francisco Bay Area, CA
F130411t01  Santa Barbara, CA
F130412t01  Southern California Box no MASTER
F130419t01  Southern California Box
F130502t01  Lake Tahoe Box, MASTER calibration, Soda Straw, Landsat 8 Delta Overpass
f130503t01  Ivanpah, Mtn Pass and Yosemite-NEON, CA
F130522t01  Southern California Box
F130604t01  Tahoe Box, CA
F130606t01  Santa Barbara, CA
F130607t01  Bay Area Box, CA
F130612t01  NEON/Yosemite Box
F130626t01  NEON/Yosemite Box
f130913t01  Rim Fire Portion of NEON/Yosemite Box, CA
f130918t01  Ivanpah Calibration Experiment
F130919t01  Lake Tahoe Box
F130924t01  Southern California Box
HyspIRI Airborne Preparatory Mission
AVIRIS and MASTER on ER-2 with 3 Seasonal Flights in 2013 and 2014
Datasets to Simulate Future HyspIRI Satellite Flights Over California Based from NASA Dryden

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2013 Dates:
1. Mar 20 - April 22
2. May 22 - June 10
3. Fall Flights
   A. Sept 9 – 20
   B. Oct/Nov TBD

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
George Jenerette/University of California, Riverside
Thomas Kampe/National Ecological Observatory Network
Raphael Kudela/University of California, Santa Cruz
Ira Leifer/University of California, Santa Barbara
Shunlin Liang/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
AVIRIS image cube and Level 1a, 1b and 2 spectra. The reflectance spectra (L2) will be used to address the full range of science objectives including ecosystems and climate.

MASTER image cube. Temperature information is shown as color intensity and mimics topography and composition (emissivity) information is shown as color. Red areas are composed of minerals with high silica such as urban areas. Water and heavily vegetated areas are dark indicating they are cooler. HyspIRI temperature and composition information are key to addressing a range of objectives.
April 10, 2013 – San Francisco Bay - 6.5 hours
UCSC and Ames Team on R/V Martin in
Monterey Bay – Sonoma State in Bay Area
UCD in Sacramento Delta

Field Spectra and Photos
from Sonoma State and Wisconsin

R/V Martin used by UCSC/Ames Ocean
Remote Sensing Team at Monterey Bay
April 11, 2013 – Santa Barbara Box - 4.1 hours
Landsat 8 Under-flight over Los Angeles

NASA/NOAA UCSB Plumes and Blumes
Cruise in SB Channel During Overflight

AVIRIS Data

511 957 1562 2177

MASTER Data
April 19, 2013 – Southern California Box
7.6 hour Flight Time
Plus: AirMSPI

May 3, 2013 Yosemite and NEON Box
4.3 hours of Flight Time and ASO Overflight
Plus: NAST-I, SHIS, AirMSPI, & NAST-M
May 2, 2013 – Lake Tahoe Box
Landsat 8 Under-flight over CA Delta and SF Bay
4.4 hour Flight Plus: NAST-I, SHIS, & AirMSPI

AVIRIS Data

MASTER Data

ASTER/MODIS Airborne Simulator Browse Imagery
Level-2 Data
2 May 2013
Flight #13-041-00 Track #6 of 16

0.63um (R5)
1.64um (R12)
3.75um (R30)
11.33um (R48)
Key Science and Application Event 2013

- Unexpectedly, HyspIRI preparatory campaign has captured a large portion of the RIM fire area before it burned. This highlights the need for HyspIRI-like routine global coverage.

- Fire is a key science and application area for HyspIRI.
  - Fuels: Species-type, dry biomass, and canopy moisture
  - Burning: temperature and emissions
  - Post fire: severity and recovery

VSWIR: Spectroscopy Coverage

RIM Fire 2 Sep 2013
~250,000 acres or 1000 km^2

TIR: Land Surface Temperature

Yosemite Valley
As part of the HyspIRI Preparatory Airborne Campaign, AVIRIS obtained VSWIR spectroscopic coverage of the full RIM fire area on the 13th of September.

VSWIR spectroscopy is used to measure fuels (species-type, water, dry biomass, etc.), hot fire temperature, smoke properties, severity and recovery processes.
AVIRIS data:  http://aviris.jpl.nasa.gov

- Via the quicklook locator
- Via dedicated ftp location
- Via hard disk all data
HyspIRI Airborne Preparatory Mission
2014 Nominal Campaign Dates

– Spring Mar 24 – Apr 23

– Early Summer May 27 – June 6

– Late Summer Aug 18 – 29

– Fall Sept 15 – Oct 17
Recent Topics

• Possible investigation of non contemporaneous VSWIR and TIR data sets
• Must continue accommodate the range of actual illumination and observation geometries
  – This is true for all satellite data even LandSat
  – Is true for 20 years of AVIRIS measurement
  – It is expected that there will be boundaries between flight lines in radiance and reflectance.
  – Product algorithms that account for illumination and observation geometries should not have boundaries.
• In data processing we are going to work to add cloud masks
• How best to simulate HyspIRI spatial properties
  – Currently offer the location of every spectrum to allow range of sampling approaches to be used.
  – We will work to support the consensus approach
Illumination and Observation
Illumination and Observation

Vegetation mapped cleanly across scene boundaries

- *Phragmites* (*phau*)
- *Spartina alterniflora* (*spal*)
- *Spartina patens* (*sppa*)
- *Vigna luteola* (*vilu*)

AVIRIS Vegetation Spectra

D. Roberts, UCSB
Summary

• The HyspIRI preparatory airborne campaign is off to a very strong start with airborne and field work proceeding in 2013
• The data collected to date are available as level 1 and level 2 products for both AVIRIS and Master
• The Autumn 2013 flights will commence as soon as feasible
• We are looking forward to 2014
• The science team is working to address the science and HyspIRI simulation and fulfill both the NASA HyspIRI Mission concept and R&A objectives