HyspIRI

DRAFT PRELIMINARY Level 1 Requirements

NASA Earth Science and Applications Decadal Survey

Overview

Beginning in January 2007 a Mission Concept effort for HyspIRI Mission has been under way with involvement of NASA HQ, JPL, GSFC, and a broad Science Study Group and the 2008 workshop, 2009 workshop, 2010 symposium.

With the call of the NASA Earth Science and Applications Decadal Survey this team has worked to develop a end-to-end concept for implementation of the HyspIRI Mission.

Based on this effort and with input from SSG and the relevant communities a set of Level 1 Requirements and Success Criteria have been develop in accordance with the required NASA process.

The Level 1 Requirements are a NASA Headquarters Document and provide an important basis for tracking the progress and judging the success of HyspIRI.
HyspIRI Science Study Group
(Selected by NASA Program Science Leadership)

- Request list from authors
1.0 Scope

2.0 Science Definition
   2.1 Baseline Science Objectives
   2.2 Science Instrument Summary Description

3.0 Project Definition
   3.1 Project Organization and Management
   3.2 Project Acquisition Strategy

4.0 Performance Requirements
   4.1 Science Requirements
   4.2 Mission and Spacecraft Performance
   4.3 Launch Requirements
   4.4 Ground System Requirements
   4.5 Mission Data Requirements

5.0 NASA Mission Cost Requirement Program Requirement
   5.1 Cost
   5.2 Cost Management and Scope Reduction

6.0 Multi-Mission NASA Facilities

7.0 External Agreements

8.0 Public Outreach and Education

9.0 Special Independent Evaluation

10.0 Waivers

11.0 Approvals and Concurrences
Draft Preliminary

HyspIRI

Visible to Short Wavelength Infrared Imaging Spectrometer and Thermal Infrared Imager (HyspIRI) Decadal Survey Earth Science and Applications Mission

Level 1 Requirements and Mission Success Criteria

Version X.8.0
Date: August 27, 2010

Owner: NASA Decadal Survey HyspIRI Program Executive and Program Scientist

Draft Preliminary
2.2. *Science Objectives*

The HyspIRI Project will implement an earth observation space mission designed to collect and deliver global surface spectral reflectance, remote sensing reflectance over shallow water, thermal emissivity and surface temperature imaging measurements that will enable science and applications users to advance the current understanding of the Earth’s ecology, biogeochemistry, biodiversity, coastal and inland water research, geology, natural hazards, hydrology, climate, climate change impact and adaptation, and studies of the carbon cycle [NRC DS].
4. Performance Requirements

4.1 Science Requirements

The science objectives in Section 2.2 can be achieved by either the baseline or minimum science mission requirements listed here, but the baseline mission provides substantially more value to NASA and the Earth Science Community.

- **4.1.1 Requirement: Baseline Science Mission**

  - The scientific requirements that must be achieved in order to fully satisfy the baseline science objectives.

  - a) VSWIR
  - b) TIR
  - c) Combined
Level 1 Requirements

VSWIR

- a) To address the Decadal Survey and community identified science and application questions related to terrestrial and coastal ocean ecosystem composition, function, and change as well as surface composition (DS113-115), the baseline science mission shall provide global mapping measurements of the surface reflectance or remote sensing reflectance for shallow water regions across the solar reflected spectrum from 380 to 2500 nm at ≤10 nm sampling at the specified signal-to-noise ratio and accuracy with >95% spectral/spatial uniformity at ≤60 m nadir spatial sampling with <20 day revisit to provide >60% seasonal and >80% annual coverage of the terrestrial and shallow water regions of the Earth for at least three years with a subset of measurements available near-real-time for designated science and applications.
**Level 1 Requirements**

**Benchmark Radiances**

![Radiances Graph]

- 0.01 reflectance (z45)
- 0.05 reflectance (z45)
- 0.25 reflectance (z23.5)
- 0.50 reflectance (z23.5)

**Required SNR**

![SNR Graph]

- SNR 0.01 Reflectance (z45) 60m
- SNR 0.05 Reflectance (z45) 60m
- SNR 0.25 Reflectance (z23.5) 60m
- SNR 0.50 Reflectance (z23.5) 60m

**Uniformity Requirement**

- Depiction
  - Grids are the detectors
  - Dots are the IFOV centers
  - Colors are the wavelengths

- Requirement
  - Spectral Cross-Track: >95% cross-track uniformity {<0.5 nm min-max over swath}
  - Spectral-IFOV-Variation: >95% spectral IFOV uniformity {<5% variation over spectral range}
b) To address the Decadal Survey and community-identified science and application questions related to volcanoes, wild fires, water usage, urbanization and surface composition (DS113-115), the baseline science mission shall provide global mapping measurements of the surface radiance, temperature and emissivity with 8 spectral bands from the 3-5 micron and 8-12 micron regions of the spectrum at the specified noise-equivalent-delta-temperature and accuracy at $\leq 60$ m nadir spatial sampling with $\leq 5$ day revisit to provide $>60\%$ Monthly, $>70\%$ seasonal and $>85\%$ annual coverage of the terrestrial and shallow water regions of the Earth for at least three years with a subset of measurements available near-real-time for designated science and applications.
### Specified NEdT

<table>
<thead>
<tr>
<th>Wavelength (microns)</th>
<th>Spectral Bandwidth (microns)</th>
<th>Min Nominal Radiance and Temperature (W/m^2/micron/sr)</th>
<th>Max Nominal Radiance and Temperature (W/m^2/micron/sr)</th>
<th>NEdT at Min Nominal Temperature Kelvin</th>
<th>NEdT at Max Nominal Temperature Kelvin</th>
<th>NEdT at 300 K Kelvin</th>
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<tbody>
<tr>
<td>Band 1</td>
<td>3.98</td>
<td>14 (400 K)</td>
<td>9600 (1400 K)</td>
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<td>Band 2</td>
<td>7.35</td>
<td>0.34 (200 K)</td>
<td>110 (500 K)</td>
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<td>Band 3</td>
<td>8.28</td>
<td>0.45 (200 K)</td>
<td>100 (500 K)</td>
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<td>0.24</td>
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<td>Band 4</td>
<td>8.63</td>
<td>0.57 (200 K)</td>
<td>94 (560 K)</td>
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<td>0.24</td>
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<td>Band 5</td>
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<td>0.68 (200 K)</td>
<td>86 (500 K)</td>
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<td>Band 6</td>
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<td>0.52</td>
<td>0.3</td>
<td>0.18</td>
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</tbody>
</table>

### Notes
- Center wavelength is the average of the max and min wavelengths at the FWHM.
- Spectral bandwidth is the FWHM.
- Minimum nominal radiance is 200K except for 4 um band where it is 400K.
- Maximum nominal radiance is 500K except for 4 um band where it is 1400K.
c) To address Decadal Survey and community-identified science and application questions (DS113-115), requiring combined reflectance, emissivity and temperature measurements, the baseline mission shall provide combined global mapping data sets.
• Threshold (or minimum) scientific requirements (the “science floor”) that are required to scientifically justify performing the mission.
4.1.2 Threshold Science Requirements

a) [VSWIR] To address the Decadal Survey and community identified science and application questions related to terrestrial and coastal ocean ecosystem composition, function, and change as well as surface composition (DS113-115), the baseline science mission shall provide global global mapping measurements of the surface reflectance or remote sensing reflectance for shallow water regions across the solar reflected spectrum from 380 to 2500 nm at ≤10 nm sampling at >80% of the specified signal-to-noise ratio and accuracy with > 90% spectral/spatial uniformity at ≤60 m nadir spatial sampling with <20 day revisit to provide >50% seasonal and >70% annual coverage of the terrestrial and shallow water regions of the Earth for at least two years.
Level 1 Requirements

Threshold Science Requirements

b) [TIR] To address the Decadal Survey and community identified science and application questions related to volcanoes, wild fires, water usage, urbanization and surface composition (DS113-115), the baseline science mission shall provide global mapping measurements of the surface temperature as well as emissivity and surface radiance in 8 spectral bands from the 3-5 micron and 8-12 micron regions of the spectrum at >80% the specified noise-equivalent-delta-temperature and accuracy at ≤60 m nadir spatial sampling with ≤5 day revisit to provide > 40% Monthly, > 60% seasonal and >70% annual coverage of the terrestrial and shallow water regions of the Earth for at least two years.

c) [COMBINED] To address Decadal Survey and community identified science and application questions requiring combined reflectance, emissivity and temperature measurements, the threshold mission shall provide combined global mapping data sets.
Summary

Program Level Requirements (or Level 1 Requirements) are a required gate product:
- KDP-A: Draft
- KDP-B: Updated Draft Baseline
- KDP-C: Baseline Update

In the pre Phase A period of the HyspIRI Mission concept input to the Level 1 Requirements will be requested from the SSG and Community.

The Level 1 Requirements are a NASA Headquarters Document and provide an important basis for tracking the progress and judging the success of HyspIRI.

Questions?
Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer

Multispectral Thermal InfraRed (TIR) Scanner

IPM Low Latency Data

Map of dominant tree species, Bartlett Forest, NH

Soil C:N Ratio

White Mountain National Forest, NH