2016 HyspIRI Mission Concept Study:
Combined VSWIR, TIR and IPM With Current Technology

Robert Green, Simon Hook, Bill Johnson, Michael Mercury and HyspIRI Team

HyspIRI Workshop 2016
Contents

- Science Summary
- Mission Concept Lineage
- 2016 Concept Overview
- Orbit + Coverage
- HyspIRI Payload (VSWIR, TIR, IPM)
- Spacecraft
- Telecom link
- MOS/GDS
- Conclusion
HyspIRI Science Summary

HyspIRI Science

- **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

Preparatory airborne campaigns have been advancing and refining science, applications, algorithms, and processing

Mission Concept Lineage

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

• **Implementation options:**

  **Original HyspIRI Baseline (2012)**
  VSWIR 60 m / 19 day
  TIR 60 m / 5 day
  3-5 years

  **SmallSat Free-Fliers (2015)**
  VSWIR 30 m / 16 day
  TIR 60 m / 4 day
  2 years
  Meets SLI Rqt’s

  **Updated HyspIRI Baseline (2016)**
  VSWIR 30 m / 16 day
  TIR 60 m / near 4 day
  3-5 years
  Meets SLI Rqt’s
2016 Concept Overview

- **2016 Mission Concept Goal**
  - Update the HyspIRI mission concept baseline to use the latest developments in instrument, spacecraft and ground systems.
  - Use only existing technology
    - PHyTIR, ECOSTRESS and CWIS have brought the latest TIR and VSWIR to $\geq$ TRL 6
    - IPM based on Space cube 2.0 $\geq$ TRL 6
    - Flight system, Ground System and Science Data System all use existing technology

![SLI Swath Dyson (CWIS)](image1)

![PHyTIR](image2)
Orbit and Coverage

504 km Sun Synchronous Orbit (10:30 AM LMTDN)

• 16 day global coverage for VSWIR

• 4 day near-global coverage for TIR
  – Full coverage in 5 days
HyspIRI Payload

• VSWIR
  – 2x CWIS Dyson spectrometers
  – 185 km swath
  – 30 m resolution
  – 83 kg
  – 100 W

• TIR
  – PhyTIR Demo on ECOSTRESS
  – 518 km swath
  – 60 m resolution
  – 48 kg
  – 170 W

• IPM
  – Four Card Flight Unit
  – 5 x 7 x 9 inches
  – 5.8 kg
  – 20 watts (typical)
Spacecraft Payload Capability

- Solutions from various multiple vendors can accommodate payload (CBE):
  - 137 kg
  - 290 W
  - 450 Gb / orbit
  - 400 GB onboard storage (7 nominal orbits worth of storage)
- Pointing (3 sigma):
  - 36 arcsec knowledge
  - 6 arcsec/frame stability
  - 0.25 deg control
Telecom Link

• 1 Gbps Ka-Band single polarization link using QPSK modulation
• Uses Ka Modulator (KAM) and Solid State Power Amplifier (SSPA) developed for NISAR Program (Launch in 2020)
• 2 axis gimbal to maximize downlink time per orbit
MOS/GDS + Onboard Compression

• MOS/GDS
  – HyspIRI preparatory campaign data system experience
  – Ka Band being planned on NiSAR (Launch in 2020)
  – Uses ground stations operated by KSAT through the NEN in Svalbard and Antarctica
    • Ka-band already in use at those locations
  – 10 minutes of ground station access each orbit
  – 600 Gb per orbit capability
    • 450 Gb orbit average data volume

• Onboard Processing
  – 4:1 Fast lossless compression (Klimesh, Kiely, Yeh)
  – Cloud screening using 0.45 and 1.25 µm channels (Thompson et al.)

• Ground processing
  – HyspIRI airborne preparatory campaign pipeline demonstrated
Conclusion

• 2016 HyspIRI Mission Concept:
  – VSWIR: 16 day / 30 m
  – TIR: near 4 day / 60 m

• Enabled by:
  – Onboard data compression and cloud screening
  – Proven Ka-Band link to ground

• Builds upon:
  – ECOSTRESS EV-I selected instrument
  – SLI Dyson spectrometer design published in Optical Engineering
  – HyspIRI Airborne Preparatory Campaign