Review of the HyspIRI White paper

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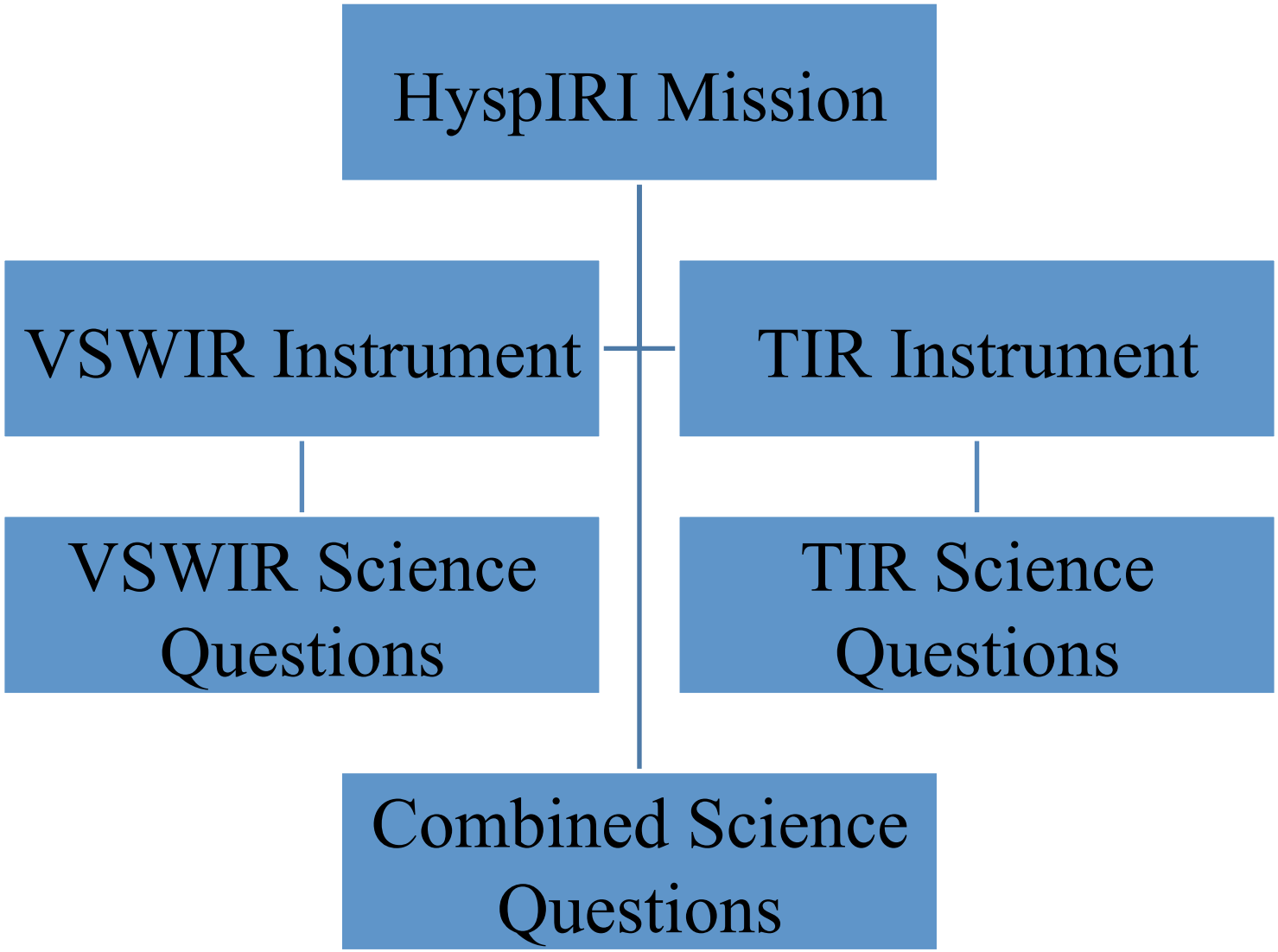
Pre Formulation Guidance

- **Key Guidance from HysplRI 2012 Pre-Formulation Review:**
  - **[*i.2*]** Complete a draft science objectives white paper specifying the value of the individual science measurements and the potential science return of individual instruments on separate platforms.

- **Title of Whitepaper:**
  - **The Hyperspectral Infrared Imager (HysplRI) – Instrument Configuration Options and Science Impacts**

Science Questions



TIR Overarching Science Questions

•TQ1. Volcanoes and Earthquakes
– How can we help predict and mitigate earthquake and volcanic hazards through detection of transient thermal phenomena?
• TQ2. Wildfires
– What is the impact of global biomass burning on the terrestrial biosphere and atmosphere, and how is this impact changing over time?
• TQ3. Water Use and Availability
– How is consumptive use of global freshwater supplies responding to changes in climate and demand, and what are the implications for sustainable management of water resources?
• TQ4. Urbanization/Human Health
– How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?
• TQ5. Earth surface composition and change
– What is the composition and thermal property of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?

Pros and Cons of Platform Configurations

Question	Description	Together	Separate
TQ1	…		
TQ2	…		
TQ3	How is consumptive use of global freshwater supplies responding to changes in climate and demand, and what are the implications for sustainable management of water resources?	Pros: • Coincident VNIR data for calculating ET • Coincident data for calculating cloud-mask during daytime Cons: • VNIR data do not cover full swath	Pros: • VNIR data do not need to be coincident for ET calculation • Alternate VNIR source could be full swath (better for cloud detection) Cons: • Alternate VNIR source must be sufficiently close in time to TIR data
TQ4	…		
TQ5	…		

CQ1. Coastal Ocean, and Inland Water Environments

CQ1. Coastal Ocean, and Inland Water Environments	VSWIR and TIR instruments bore-sighted (HyspIRI)	VSWIR and TIR separated by < 3 minutes	VSWIR and TIR separated by < 1 week	VSWIR and TIR separated by > 1 year
What are the feedbacks between climate and habitat structure, biogeochemical cycling, biodiversity, and ecosystem productivity of shallow aquatic habitats?	✓	✓	1	2
What are the ecological linkages of landscape-scale ocean-atmosphere interactions including the hydrologic cycle, aerosol production and transport, and cloud radiative forcing?	✓	✓	✓	2
How are small-scale processes in shallow benthic habitats related to changes in functional community types (coral reefs, submerged aquatic vegetation and floating aquatic vegetation), productivity, and biogeochemical cycling including material fluxes and water quality?	✓	✓	✓	2
How can these observations be used to guide the management and utilization of resources in the shallow aquatic environment?	✓	✓	1	2
What are the seasonal expressions and cycles for terrestrial and shallow aquatic ecosystems, functional groups and diagnostic species?	✓	✓	✓	2
What is the susceptibility and likely response in the context of changes in climate, land use, and disturbance?	✓	✓	✓	2

At < 1 week separation general relationships can be examined but specific relationships cannot, e.g. surface temperature to chlorophyll content.
At > 1 week separation loss of general relationships.

CQ2. Wildfire, Fuel and Recovery

CQ2. Wildfire, Fuel and Recovery	VSWIR and TIR instruments bore-sighted (HyspIRI)	VSWIR and TIR separated by < 3 minutes	VSWIR and TIR separated by < 1 week	VSWIR and TIR separated by > 1 year
How does the timing, temperature and frequency of fires affect long-term ecosystem health?	✓	✓	✓	1
How does vegetation composition and fire temperature impact trace gas emissions?	✓	✓	✓	2
How do fires in coastal biomes affect terrestrial biogeochemical fluxes into estuarine and coastal waters and what is the subsequent biological response?	✓	✓	✓	3
What are the feedbacks between fire temperature and frequency and vegetation composition and recovery?	✓	✓	✓	1
How does vegetation composition influence wildfire severity?	✓	✓	✓	4
On a watershed scale, what is the relationship of vegetation cover, soil type, and slope to frequency of debris flows?	✓	✓	✓	5
How does invasive vegetation cope with fire in comparison to native species?	✓	✓	✓	✓

Need VSWIR and TIR within a few weeks to relate any changes in vegetation composition to fire temperature
Need VSWIR and TIR data within a few weeks of the fire accurately estimate emissions
Need VSWIR and TIR data within a few weeks to trace fire to fluxes and response
Need VSWIR and TIR data in same season to tie temperature to severity
Need VSWIR and TIR data within a few weeks to tie cover to moisture (debris flows)

CQ3. Volcanoes and Surface Signatures

CQ3. Volcanoes and Surface Signatures	VSWIR and TIR instruments bore-sighted (HyspIRI)	VSWIR and TIR separated by < 3 minutes	VSWIR and TIR separated by < 1 week	VSWIR and TIR separated by > 1 year
What do comparisons of thermal flux and SO2 emission rates tell us about the volcanic mass fluxes and the dynamics of magma ascent?	✓	✓	1	1
Does pressurization of the shallow conduit produce periodic variations in SO2 flux and lava dome surface temperature patterns that may act as precursors to explosive eruptions?	✓	✓	1	1
Can measurements of the rate at which lava flows cool allow us to improve forecasts of lava flow hazards?	✓	1	1	1
Does the temperature and composition of volcanic crater lakes change prior to eruptions?	✓	✓	2	2
How does vegetation composition influence wildfire severity? Do changes in the health and extent of vegetation cover indicate changes in the release of heat and gas from crater regions?	✓	✓	3	3

If obtaining thermal flux from a combination of VSWIR and TIR data need near simultaneity of measurements. If have high saturation MIR band as on HyspIRI-TIR then simultaneity is not required

Need near simultaneity to ensure that lake color relates to a specific temperature

Need near simultaneity to be able to relate changes in temperature to changes in vegetation

CQ4. Ecosystem Function and Diversity

CQ4. Ecosystem Function and Diversity	VSWIR and TIR instruments bore-sighted (HyspIRI)	VSWIR and TIR separated by < 3 minutes	VSWIR and TIR separated by < 1 week	VSWIR and TIR separated by > 1 year
How can we enhance phenological & stress characterization through synergy between reflective and emitted radiation with higher frequency temporal sampling?	✓	✓	✓	1
How is energy partitioned between latent and sensible heat fluxes as a function of different plant types and fractional cover and how does this impact hydrology?	✓	✓	✓	2
How is physiological function affecting water and carbon exchange expressed at the ecosystem scale, especially seasonal down-regulation due to environmental stress factors?	✓	✓	✓	3
What is the vegetation phenological response to seasonal and interannual changes in temperature and moisture due to climate change and how does this response vary at the community/species level?	✓	✓	✓	4
What are the feedbacks between changes in canopy composition, mortality and retrieved canopy temperatures resulting from disturbances (e.g., disease, moisture deficiency, insect attack, fire, land degradation, fragmentation) in natural and managed ecosystems?	✓	✓	✓	5
How do climate-induced temperature and moisture changes impact the distribution and spread of invasive and native species?	✓	✓	✓	5

Phenology and stress are closely tied, but since phenology usually follows stress so need to examine if <1week is adequate.
Near simultaneity required to match fluxes to fractional cover
Near simulataneity required to match water-carbon exchange
Need data in same season to match interannual changes to phonological response
Need near simultaneity between composition and temperature

CQ5. Surface Composition and Change

CQ5. Surface Composition and Change	VSWIR and TIR instruments bore-sighted (HyspIRI)	VSWIR and TIR separated by < 3 minutes	VSWIR and TIR separated by < 1 week	VSWIR and TIR separated by > 1 year
What is the composition of the exposed terrestrial surface of the Earth?	✓	✓	✓	✓
How does the surface mineralogy and soil composition relate to the plant physiology and function on the terrestrial surface of the Earth?	✓	✓	✓	✓
How is the composition of exposed terrestrial surface responding to anthropogenic and non anthropogenic drivers (desertification, weathering, disturbance e.g. logging, mining)?	✓	✓	✓	1
How do types and distributions of altered rocks define regional trends in hydrothermal fluid flow for magmatic arcs and tectonic basins, better define hydrothermal deposit models, and assist in the discovery of new economic deposits?	✓	✓	✓	✓
How do regional trends of minerals and shale thermal maturity within basins better define depositional models and assist in the discovery of new hydrocarbon reserves?	✓	✓	✓	✓

Need data in same season to see to tie anthropogenic effects to composition

CQ6. Human Health and Urbanization

CQ6. Human Health and Urbanization	VSWIR and TIR instruments bore-sighted (HyspIRI)	VSWIR and TIR separated by < 3 minutes	VSWIR and TIR separated by < 1 week	VSWIR and TIR separated by > 1 year
How do land surface characteristics such as vegetation state, soil moisture, temperature, and land cover composition affect heat and drought, and vector- and animal-borne diseases?	✓	✓	✓	1
What changes can be observed and measured in emissivity's of urban surfaces and how do emissivity's change for different cities around the world as they impact the urban heat island and associated land-atmosphere energy balance characteristics?	✓	✓	✓	2
How does the distribution of urban and peri-urban impervious surfaces affect regional energy balance fluxes, hydrologic processes, biogeochemical fluxes, and what is the response of ecosystems to these changes?	✓	✓	✓	2
What is the status and availability of freshwater resources including snow and ice and how is this related to climate variability, land-use, and population growth?	✓	✓	✓	✓

1 week separation is probably limit to tie temperature and land cover
Beyond 1 year surfaces will have changed

Summary and Conclusions

- Whitepaper is underway
- Need your input on what you see as pros and cons of instruments on different platforms
- Expect to hear more on this over the next year

Leads and Co-Leads for Questions

- VQ1 – Pattern and Spatial Distribution of Ecosystems and their Components
- VQ2 – Ecosystem Function, Physiology and Seasonal Activity
- VQ3 – Biogeochemical Cycles
- VQ4 – Changes in and Responses to Disturbance
- VQ5 – Ecosystems and Human Well-being
- VQ6 – Earth Surface, Snow/Ice, and Shallow Water Benthic Composition
- TQ1 – Volcanoes and Earthquakes
- TQ2 – Wildfire temperature and emissions
- TQ3 – Water Use and Availability
- TQ4 – Urbanization and Human Health
- TQ5 – Surface composition and Change
- CQ1 – Coastal, ocean, and inland aquatic environments
- CQ2 – Wildfire, fuel, and recovery
- CQ3 – Volcanoes and hazards
- CQ4 – Ecosystem Function and Diversity
- CQ5 – Land surface composition and change
- CQ6 – Human Health and Urbanization

Combined Overarching Questions

- CQ1. Coastal Ocean, and Inland Aquatic Environments
  - What is the status of inland and coastal aquatic ecosystems in the context of local and regional thermal climate, land-use change, and other environmental factors?
- CQ2. Wildfire, Fuel and Recovery
  - How are fires and vegetation composition coupled?
- CQ3. Volcanoes and Related Signatures
  - Do volcanoes signal impending eruptions through changes in the temperature of the ground, rates of gas and aerosol emission, temperature and composition of crater lakes, or health and extent of vegetation cover?
- CQ4. Ecosystem Function and Diversity
  - How do species, functional type, and biodiversity composition within ecosystems influence the energy, water and biogeochemical cycles under varying climatic conditions?
- CQ5. Earth Surface Composition and Change
  - What is the composition of exposed terrestrial surface of the Earth and how does it respond to anthropogenic and non anthropogenic drivers?
- CQ6 Human Health and Urbanization
  - How do patterns of human environmental and infectious diseases respond to leading environmental changes, particularly to urban growth and change and the associated impacts of urbanization?

VSWIR Overarching Science Questions

- VQ1. Pattern and Spatial Distribution of Ecosystems and their Components
  - What is the global spatial pattern of ecosystems and diversity distributions and how do ecosystems differ in their composition or biodiversity?
- VQ2. Ecosystem Function, Physiology and Seasonal Activity
  - What are the seasonal expressions and cycles for terrestrial and aquatic ecosystems, functional groups, and diagnostic species? How are these being altered by changes in climate, land use, and disturbance?
- VQ3. Biogeochemical Cycles
  - How are the biogeochemical cycles that sustain life on Earth being altered/disrupted by natural and human-induced environmental change? How do these changes affect the composition and health of ecosystems, and what are the feedbacks with other components of the Earth system?
- VQ4. Changes in and Responses to Disturbance
  - How are disturbance regimes changing, and how do these changes affect the ecosystem processes that support life on Earth?
- VQ5. Ecosystem and Human Health
  - How do changes in ecosystem composition and function affect human health, resource use, and resource management?
- VQ6. Earth Surface, Snow/Ice, and Shallow-Water Benthic Composition
  - What are the land surface soil/rock and shallow-water benthic compositions?