HyspIRI
Coastal and Inland Aquatic Data Products

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HyspIRI Aquatic Data Product Working Group

- **Assembled from the HyspIRI Science Study Group and the coastal/ inland aquatic hyperspectral remotes sensing research community.**
- **Community building exercise. Currently >20 members. We continue to add people.** (kevin.r.turpie@nasa.gov)
- **Discussing a potential suite of coastal/inland aquatic data products and applications that HyspIRI could support.**
- **Teleconferenced to review a strawman list of potential hyperspectral applications compiled from the literature.**
- **This talk provides a snapshot of the discussion and a chance to open the dialogue.**

Aquatic Data Product Guidelines

- **Must support studies of terrestrial or coastal marine aquatic environments.**
- **Must feasibly support one or more science applications given HyspIRI mission characteristics.**

Spatial – **60 m** nadir res, 145 km swath
Spectral – **380-2500 nm** @ 10 nm resolution
Thermal – **8 thermal bands**

Radiometric – 14 bit res, good SNR, 2% pol sens, solar & lunar cal, etc.

Orbital
- 19 day revisit period
- 11am sun sync polar orbit
- 4° tilt

- **Must be shown to be compelling, i.e. :**
  - **Related to HyspIRI mission science questions,**
  - **Supported by the recommendations outlined in the Decadal Survey,**
  - **Demonstrated in publishable scientific research,**
  - **Used in work supporting environmental resource management,**
  - **Feasibly drawn from existing Algorithm Theoretical Basis Documents (ATBD).**

Aquatic Data Product Guidelines

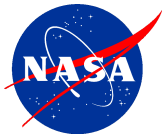
- **Highlight where HyspIRI aquatic observations complement other domestic and international missions.**
  - **High spatial resolution zoom.**
  - **Extend measurements in regions where others missions cannot (e.g., up narrow estuaries, littoral).**
  - **Bridge between PACE and LDCM resolutions for coastal studies.** (PACE SDT Draft Report)

	HyspIRI	PACE	ACE	GeoCAPE	LDCM	Sentinel 2	Sentinel 3	EnMap	PRISMA
Spectral (nm)	380-2500 @ 10 nm 8 TIR	350-800 @ 5 nm 3 SWIR	350-800 @ 5 nm 3 SWIR	345-1100 3 SWIR	6 VNIR 3 SWIR 2 TIR	10 VNIR 3 SWIR	13 VNIR 10 NIR 4 SWIR 4 TIR SAR	420-2450	400-2500 @ 12 nm Pan
Spatial (m)	60	250-1000	250-1000	>200	30 VSWIR 100 TIR 15 (Pan)	10 (4) 20 (6) 60 (3)	300 OLCI 500-1000 SLSTR	30	30 5 (Pan)
Temporal (d)	19	1	1	Geosync	16	3	<2 OLCI 1 SLSTR	>4 possible	>7 possible

General Conclusions

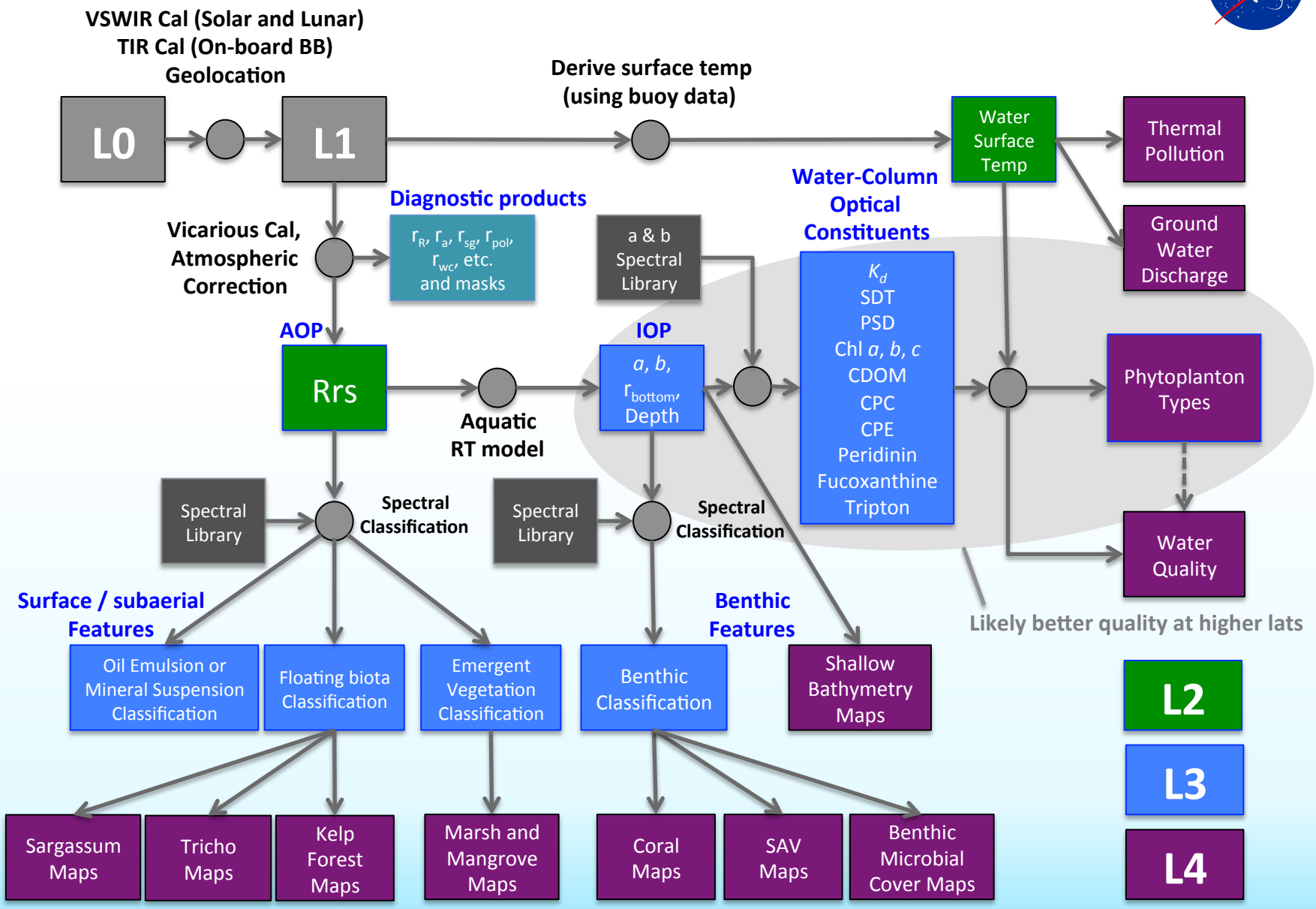
- **Temporal resolution** – Products should be related to targets that change slowly (i.e., seasonally to inter-annually).
- **Spatial resolution** – Targets need to be, on average, >>60 m.
- **Sun Glint** – Quality for some products may be very dependent on latitude and season.
- **Uniqueness** – Emphasize products uniquely supported by the HyprIRI mission.
  - **Applications that combine hyperspectral VSWIR and thermal.**
  - **Small water body hyperspectral or thermal observations at 60 m resolution.**
- **Combined Science Questions** – Applications that make use of both VSWIR and thermal bands would be unique to HyspIRI.
  - **Mapping coral with sea surface temperature.**
  - **Relating water surface temperature with phytoplankton functional types.**
  - **Observing the effects of thermal pollution on benthic and planktonic communities.**

Aquatic A…oduct Hierarchy



LEVEL-2	INTERMEDIATE	FUTHER APPLICATIONS
Remote sensing r…	Absorption (a) Backscatter (b) Bottom reflectance Depth	Determine the impact of thermal pollution to benthic and phytoplankton communities. Mapping trash islands in coastal waters. Mapping natural CH_4 plumes from coastal point sources. Exploring effects of ground water discharges on ecosystems. Mapping mine waste water. Assessing the impact of disturbances (e.g., severe storm) to aquatic ecosystems. Estimate river and estuary output for CDOM and sediment. Mapping coral with sea surface temperature. Measuring water surface temperature with phytoplankton functional types. Establishment of standing stocks. Getting distributions of species or functional types. Determining phenology or seasonal succession. Ecosystem and biogeochem modeling.
Water Surface Te…	Shallow water bathymetry maps	
	Maps	
	Emergent vegetation classification	

Aquatic Applications and Product Hierarchy



THE NEXT STEPS

- **Trace each data product to a science question** (this was already done for a similar list of aquatic products).
- **Find literature support and community input** (identified >90 recent hyperspectral, coastal or inland water papers).
- **Prioritize by maturity and relevance.**
- **Write white paper on candidate suite of aquatic data products.**

FUTURE STEPS

- **Determine expected data quality based on error sources :**
  - Radiometric or spectral calibration error
  - SNR
  - Sun glint
- **Develop ATDB for each product, intermediate products, or groups of products.**
- **Implement algorithms and test using similar hyperspectral (thermal) data.**
- **Define Cal/Val Program:**
  - Vicarious calibration
  - Field Data Collection
  - Validation and Accuracy Assessment

- **Cross-calibration with other sensors.**


DISCUSSION

HyspIRI Science Workshop – Aquatic Talks

Tuesday 16 Oct 2012

11:20 AM - Spectral Imaging of Coral Reefs: Inversion, Classification, and Modeling Ecosystem Function - Eric Hochberg.

Wednesday 17 Oct 2012

9:40 AM - Development of Aquatic Coastal and In-Land Water Data Products - Kevin Turpie.

2:00 PM - Assessment of Large Scale Floods Using Imaging Spectroscopy - Praveen Kumar.

2:40 PM - Deriving Inland Water Quality from Hyperspectral Imagery - Els Knaeps.

3:20 PM - Hyperspectral remote sensing in coastal waters: PRISM field validation in Monterey Bay - Kelley Bostrom.

3:40 PM - High Resolution Assessment of Carbon Dynamics in Seagrass and Coral Reef Biomes - Frank Muller-Karger.

HyspIRI Science Workshop – Aquatic Talks

Wednesday 17 Oct 2012 (cont.)

4:00 PM - Hyperspectral Measurements to Predict Marine Phytoplankton Biodiversity in Coastal Regions - Tiffany A.H. Moisan.

4:20 PM - Shallow Coastal Waters of the San Francisco Bay / Sacramento-San Joaquin River Delta - James Dalton.

Thursday 18 Oct 2012

11:00 AM - Assessing bio-optical variability of ocean waters and adjacent coral reefs using hyperspectral satellites - Arnold Dekker.

HyspIRI Science Workshop – Aquatic Posters

5:20 PM Wednesday 17 Oct 2012 – 1 Minute Previews

Directly measure water-leaving radiance in the field with a sky-light-blocked radiometer - Zhongping Lee (POSTER 7)

NASA's Coastal and Ocean Airborne Science Testbed for Satellite Cal/Val - Liane Guild (POSTER 8)

Hyperspectral Image Analysis of Aquatic Vegetation - Alfanso Blanco (POSTER 9)

Sensitivity of Full-Width at Half Maximum (FWHM) and spectral fidelity to inversion retrievals of pigments and Inherent Optical Properties (IOPs) - John Moisan (POSTER 18)

OSPREy Update: Calibration and Validation Sensors for Next-Generation NASA Missions - Stanford Hooker (POSTER 23)

Aquatic Applications and Product Hierarchy

Level-2	Intermediate Diagnostic Data Products	Level-3	Level-4	Further Applic
Remote sensing reflectance (R_{rs})				Determine the impact of thermal pollution to b
Water Surface Temp				Mapping trash islands in coastal waters.
	Rayleigh reflectance			Mapping natural CH_4 plumes from coastal point
	Aerosol reflectance			Exploring effects of ground water discharges on
	Polarization correction			Mapping mine waste water.
	Sun glint			Assessing the impact of disturbances (e.g., seve
	Whitecap reflectance			Estimate river and estuary output for CDOM an
	Masks			Mapping coral with sea surface temperature.
		Absorption (a)		Measuring water surface temperature with phy
		Backscatter (b)		
		Bottom reflectance (ρ_b)		
		Depth	Shallow water bathymetry maps	
		Spectral attenuation coeff Kd(λ)	Phytoplankton Types	Establishment of standing stocks.
		Secchi disk transparency		Getting distributions of species or functional typ
		Particle size distribution		Determining phenology or seasonal succession.
		Chlorophyll a, b, c		Ecosystem and biogeochem modeling.
		CDOM		
		CPC (cyanobacteria)		
		CPE (cyanobacteria)		
		Peridinin (dinoflagelates)		
		Fucoxanthine (diatoms)		
		Tripton (TSM, TSS, FSS, NAP)	Water Quality	
		Oil emulsion or mineral suspension classification		
		Benthic classsification	Coral Maps	
			Benthic Microbial Cover Maps	
			SAV Maps	
		Floating biota classification	Kelp Maps	
			Trichodesmium Maps	
			Sargassum Maps	
		Emergent vegetation classification	Marsh and Mangrove Maps	