Values and advantages of HyspIRI for remote sensing of aquatic environments

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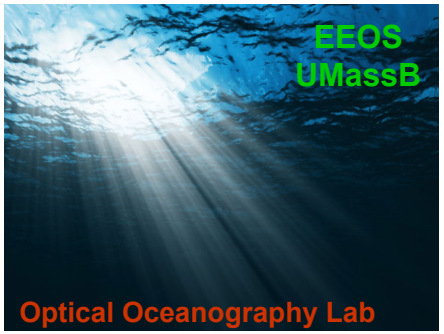
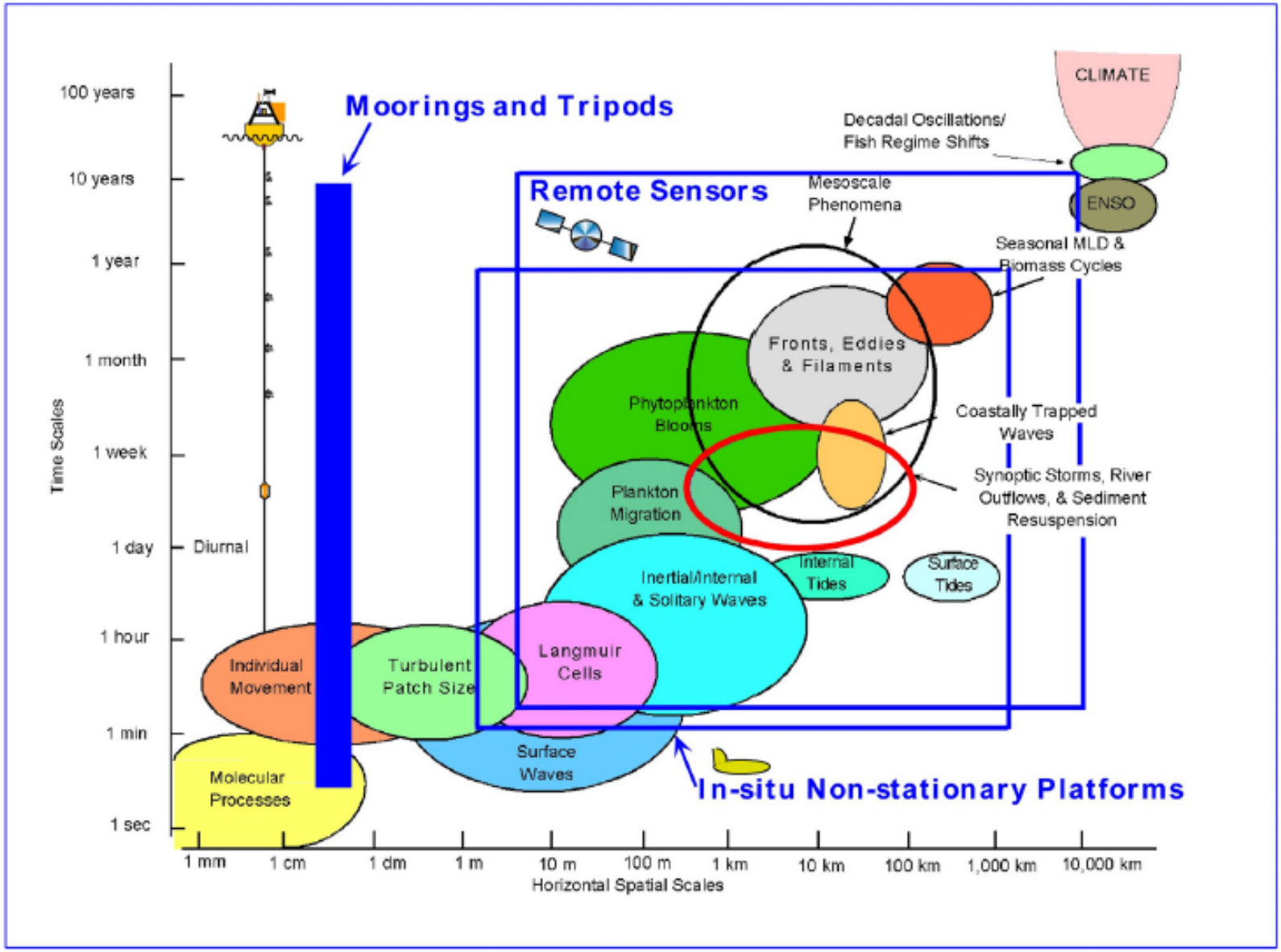


NASA HyspIRI Products Symposium, DC, May 16-17, 2012

Processes



(Dickey et al 2006)

A dream remote sensor to study those processes:

High spatial resolution

High temporal resolution

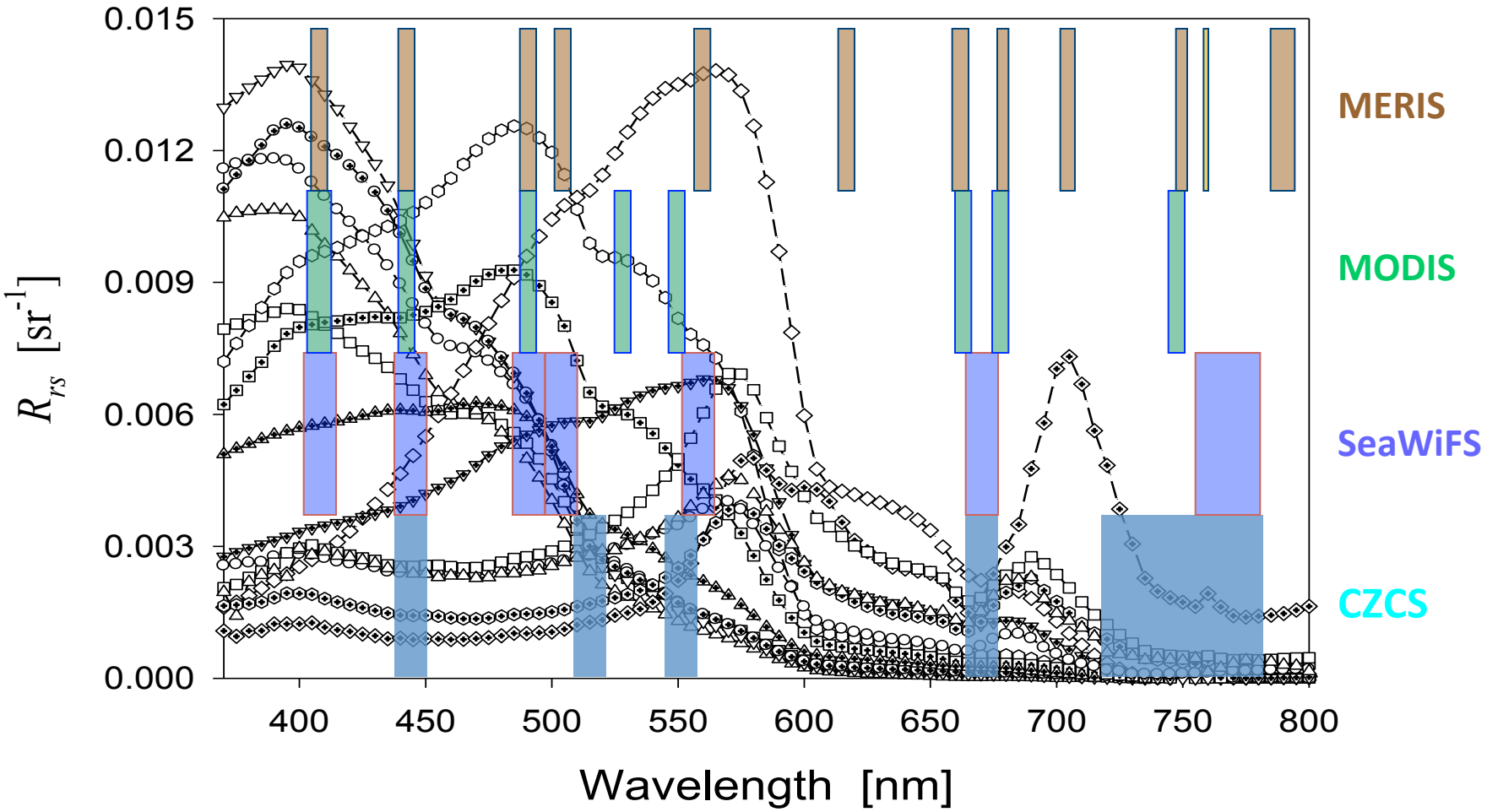
High spectral resolution

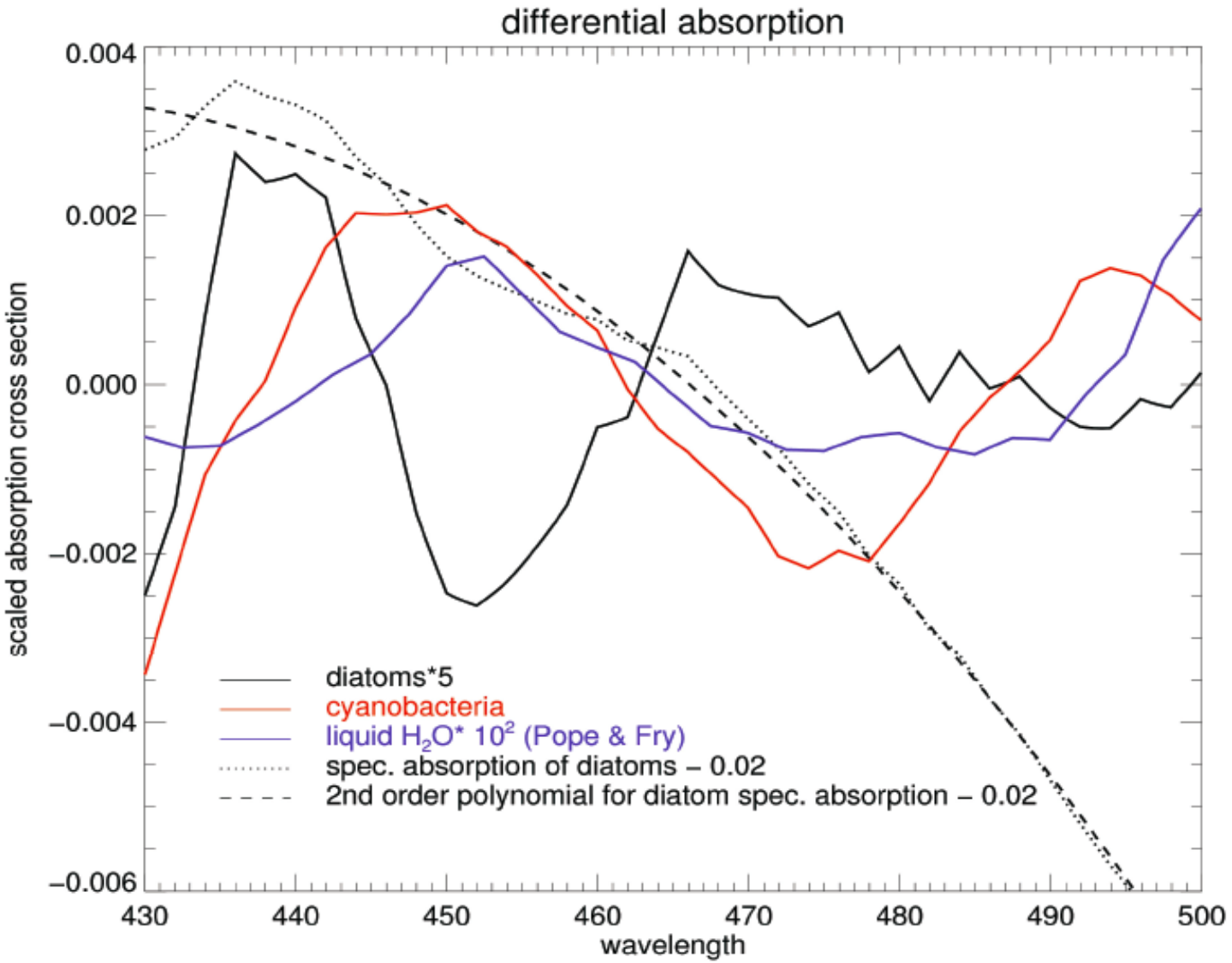
High signal-to-noise ratio

Not feasible!

Some specs of HyspIRI

Name	Spectral bands (VISNIR)	Spatial Resolution (m)	Revisit time (day)
HyspIRI	hyperspectral	60	19

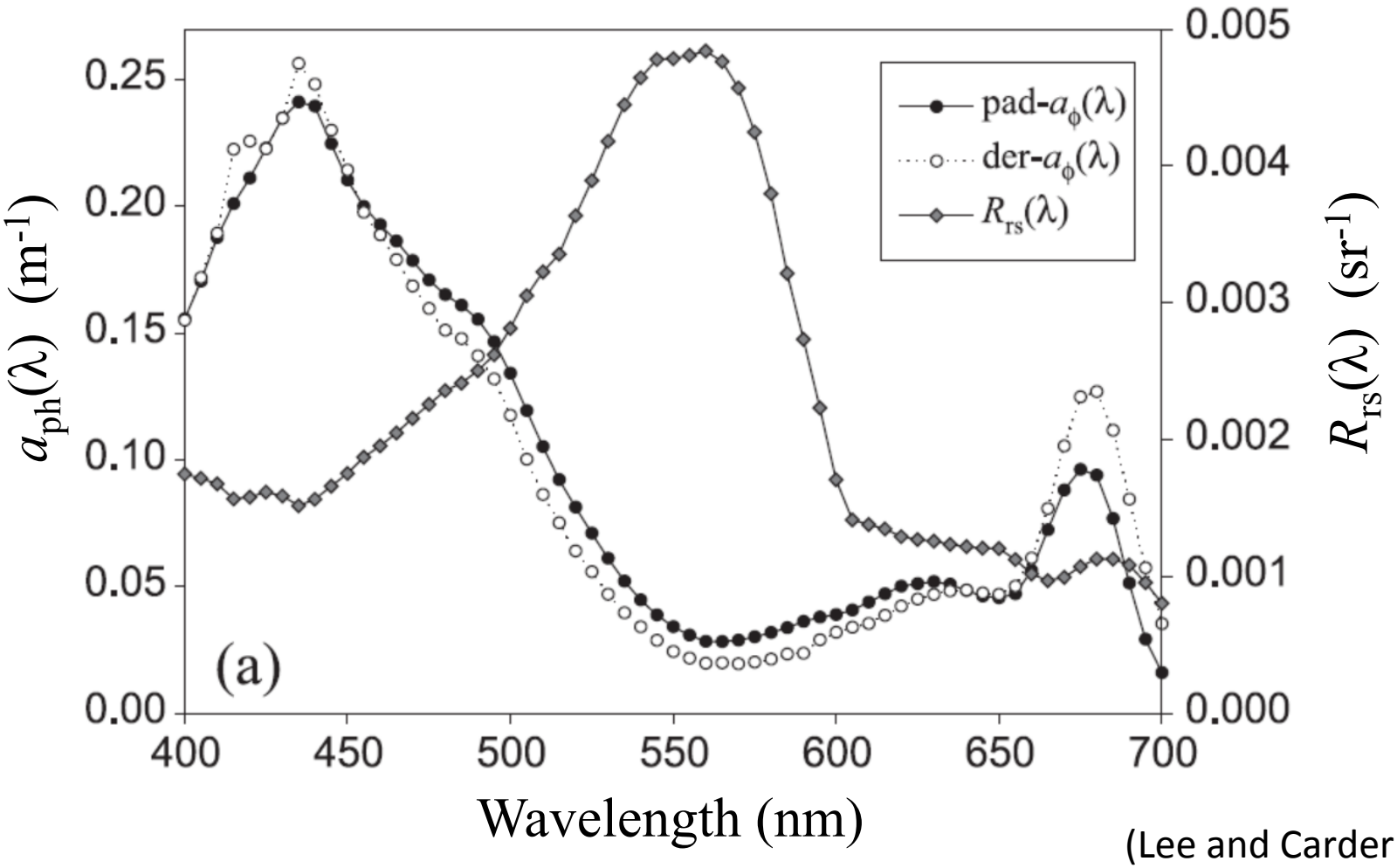




(Bracher et al 2009)

Derivative technique demands hyperspectral measurement.

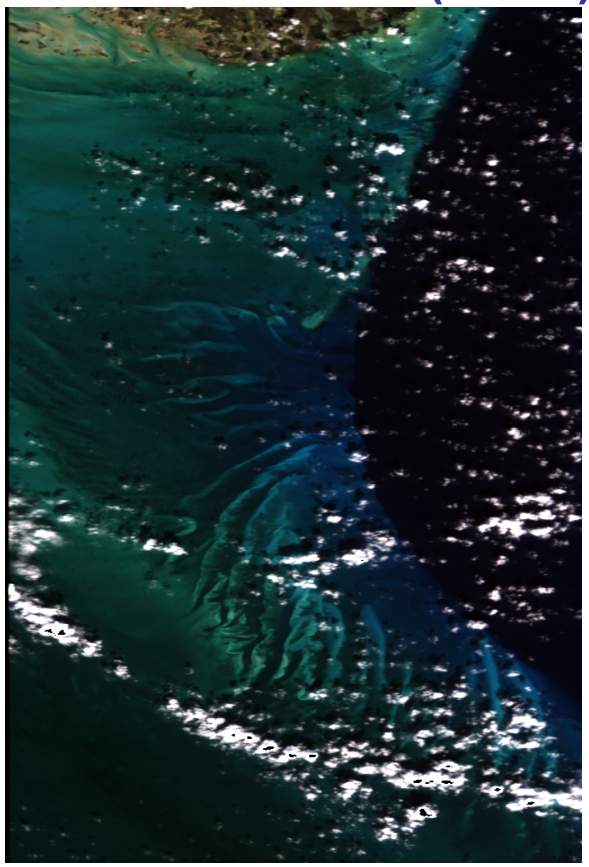
Method to retrieve hyperspectral phytoplankton absorption is now available.



(Lee and Carder 2004)

Name	Spectral bands (VISNIR)	Spatial Resolution (m)	Revisit time (day)
HyspIRI	hyperspectral	60	19

100 m resolution (HICO)



1000 m resolution (MODIS)

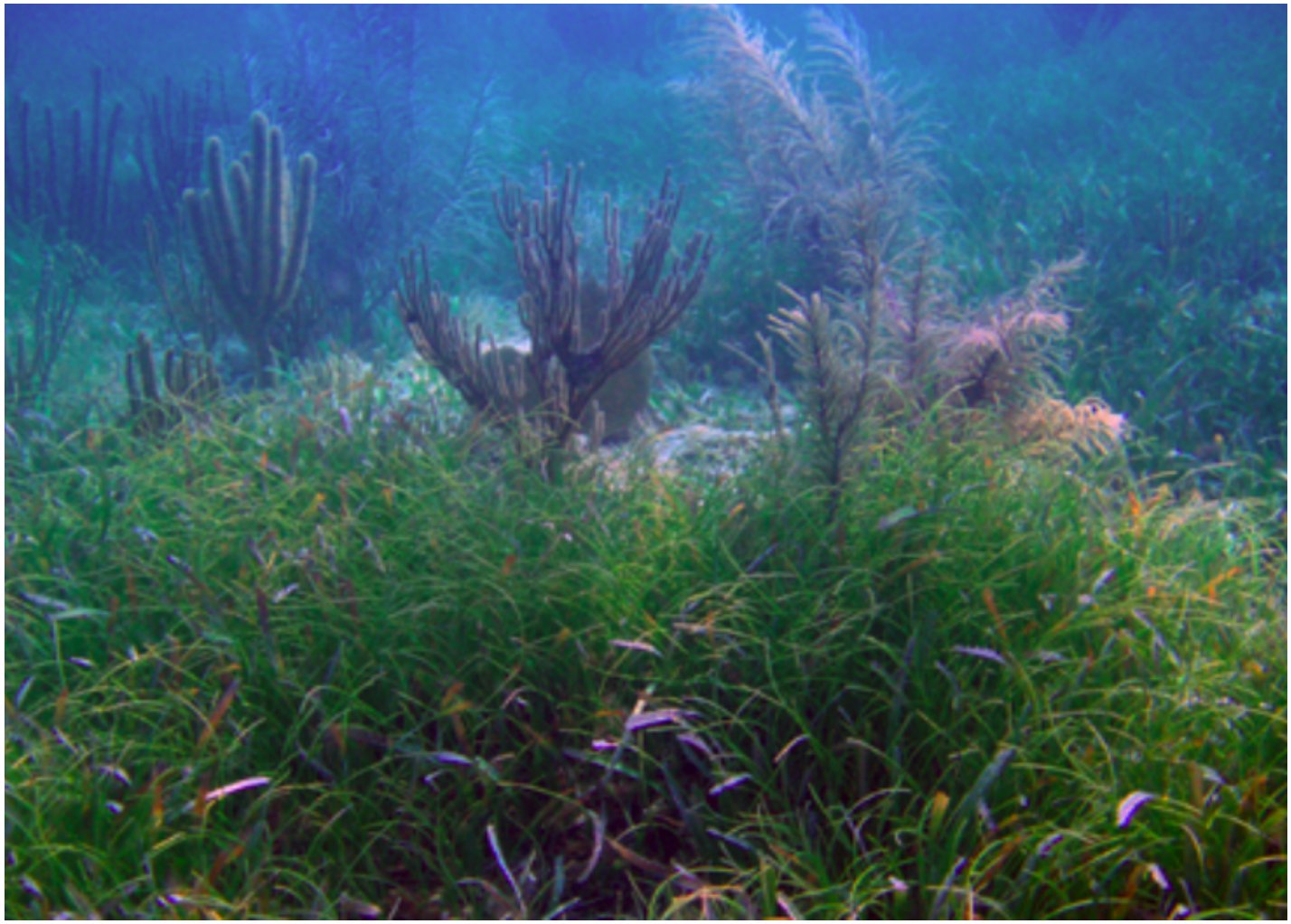
High spatial resolution is required to differentiate coastal/near-shore substrates!

Some specs of HyspIRI

Name	Spectral bands (VISNIR)	Spatial Resolution (m)	Revisit time (day)
HyspIRI	hyperspectral	60	19

Is a 19-day temporal resolution making data useful for studying aquatic environment?

aquatic environment



19 day revisit is still good for slowly changing environment.

Science questions:

Table 1: Overarching Thematic Science Questions

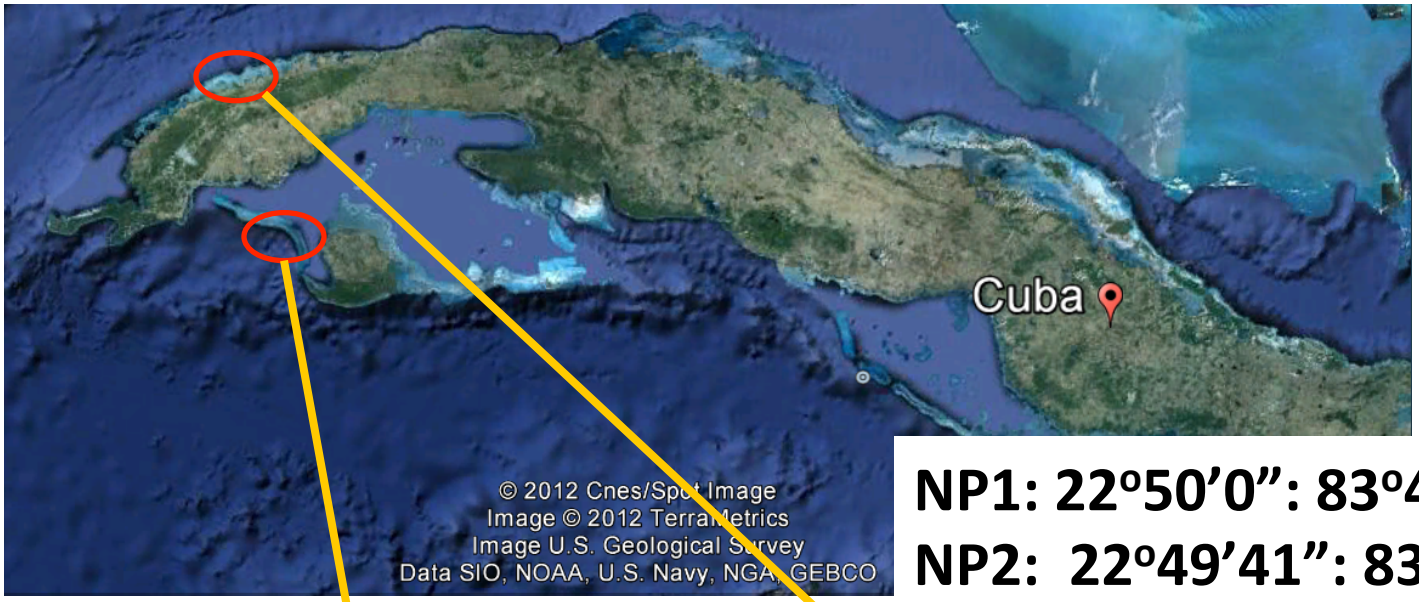
Question #	Area	Question	Lead and Co-Lead
VQ1	Pattern and Spatial Distribution of Ecosystems and their Components	What is the global spatial pattern of ecosystem and diversity distributions, and how do ecosystems differ in their composition or biodiversity?	Roberts, Middleton
VQ2	Ecosystem Function, 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?	Gamon
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?	Ollinger
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?	Asner, Knox
VQ5	Ecosystem and Human Health	How do changes in ecosystem composition and function affect human health, resource use, and resource management?	Townsend, Glass
VQ6	Earth Surface and Shallow-Water Substrate Composition	What is the land surface soil/rock and shallow-water substrate composition?	Green, Dierssen
TQ1	Volcanoes and Earthquakes	How can we help predict and mitigate earthquake and volcanic hazards through detection of transient thermal	Abrams, Freund

In addition to substrate type …

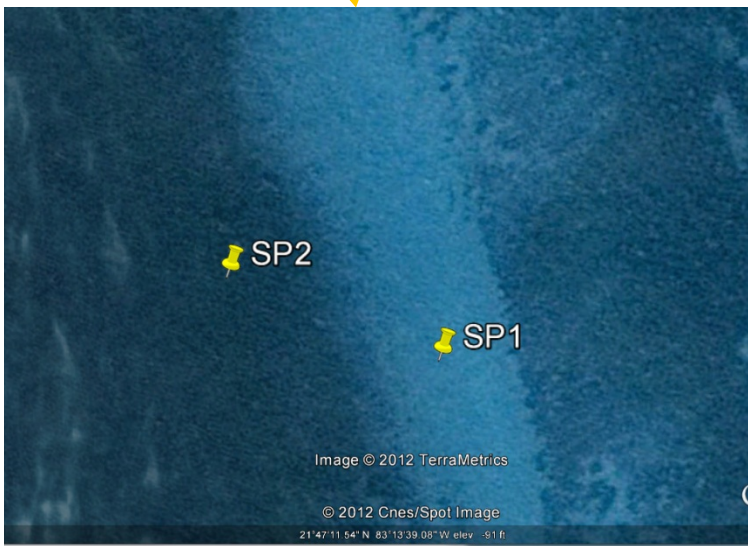
Do we have adequate database of bottom topography in the littoral zone?

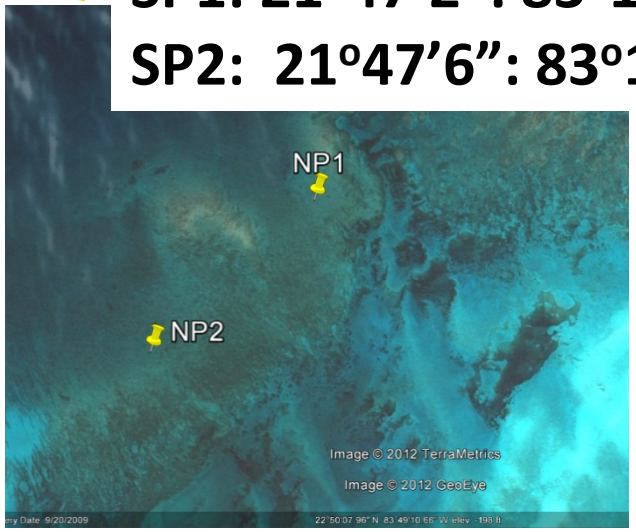
How bottom topography change due to drastic events?

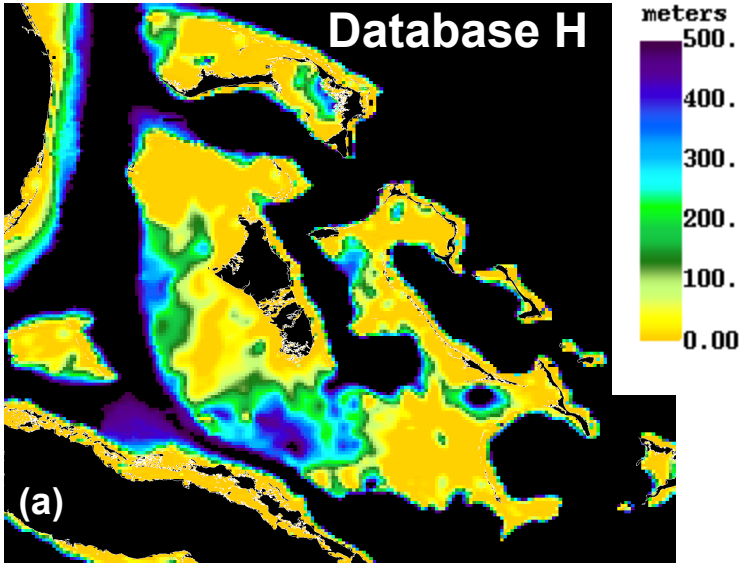
Examples of inadequate topography information:

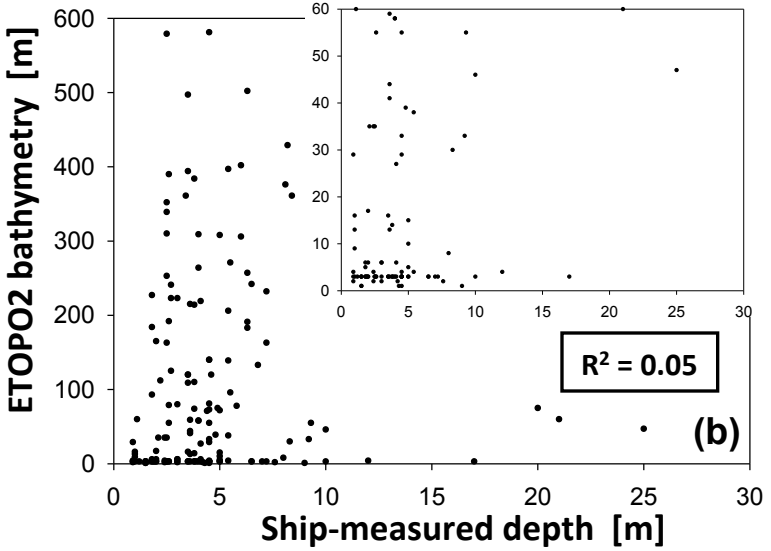


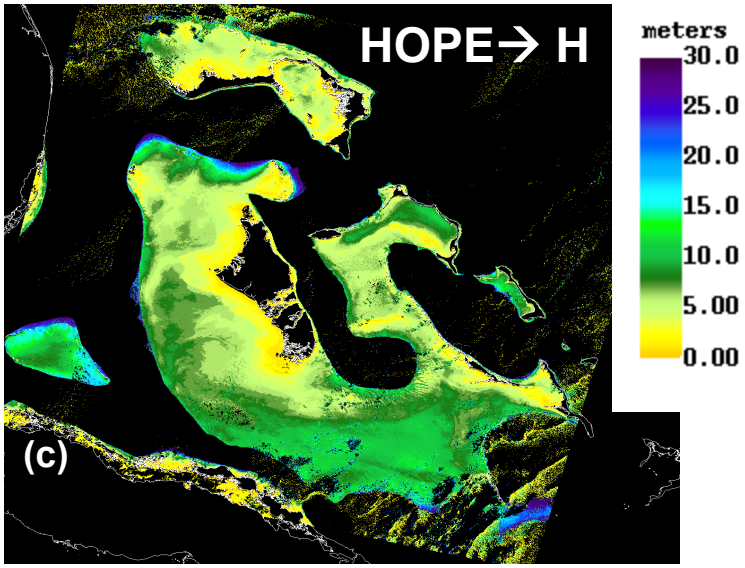
NP1: 22°50’0”: 83°49’2”; 120 ft
NP2: 22°49’41”: 83°49’23”: 58 ft
SP1: 21°47’2”: 83°13’37”; 110 ft
SP2: 21°47’6”: 83°13’49” 220 ft

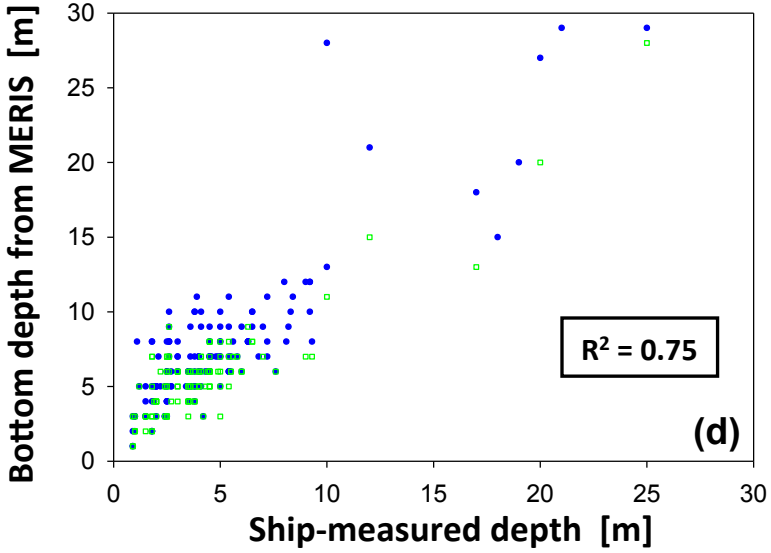






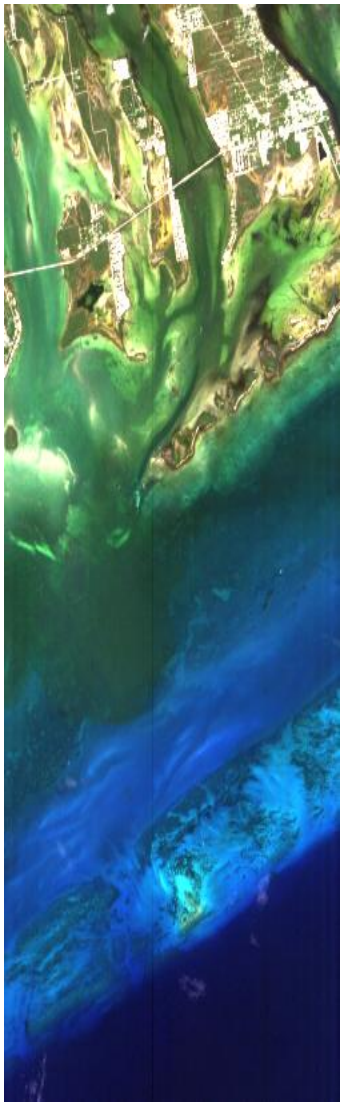




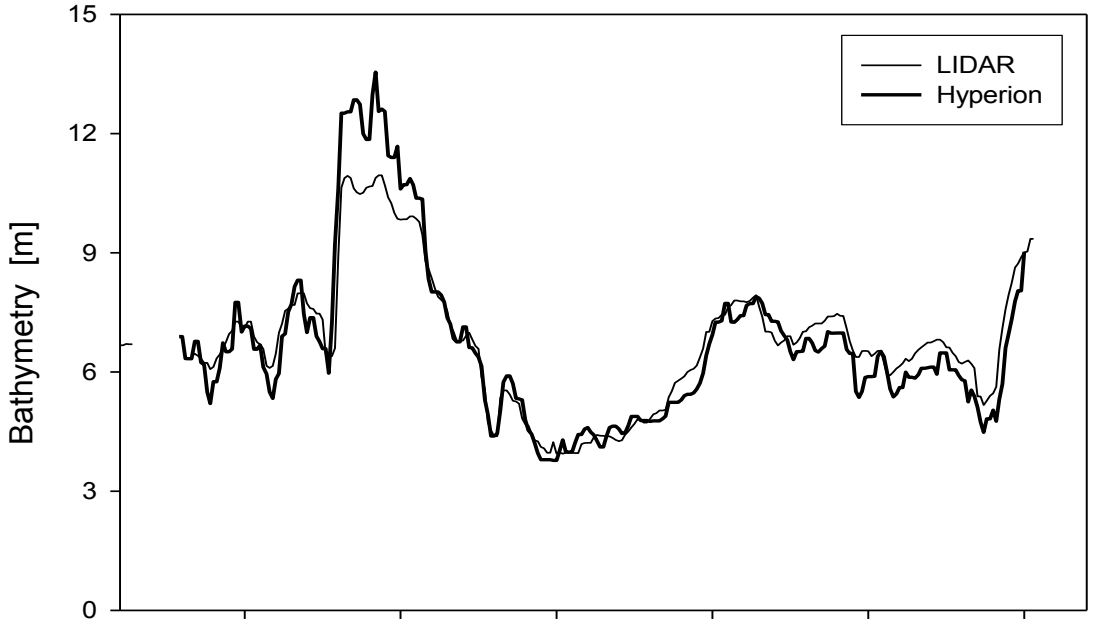


300 m spatial resolution is still very coarse …

(*Lee et al,* 2010, EOS)



Hyperion image



(*Lee et al*. JARS, 2007)

Some specs of ocean-targeting sensors

Name	Spectral bands (VISNIR)	Spatial Resolution (m)	Revisit time (day)
CZCS	4	900	~2
SeaWiFS	6	1100	~2
MODIS	8	250, 500, 1000	~2
MERIS	12	300, 1200	~2
OCM-2	9	360	~2
GEO-CAPE	hyper	375	0.12
ACE	Hyper+Lidar	250?	~xx
HyspIRI	**hyperspectral**	**60**	**19**

Only HyspIRI could resolve fine coastal/littoral zone variations!

Name	Spectral bands (VISNIR)	Spatial Resolution (m)	Revisit time (day)
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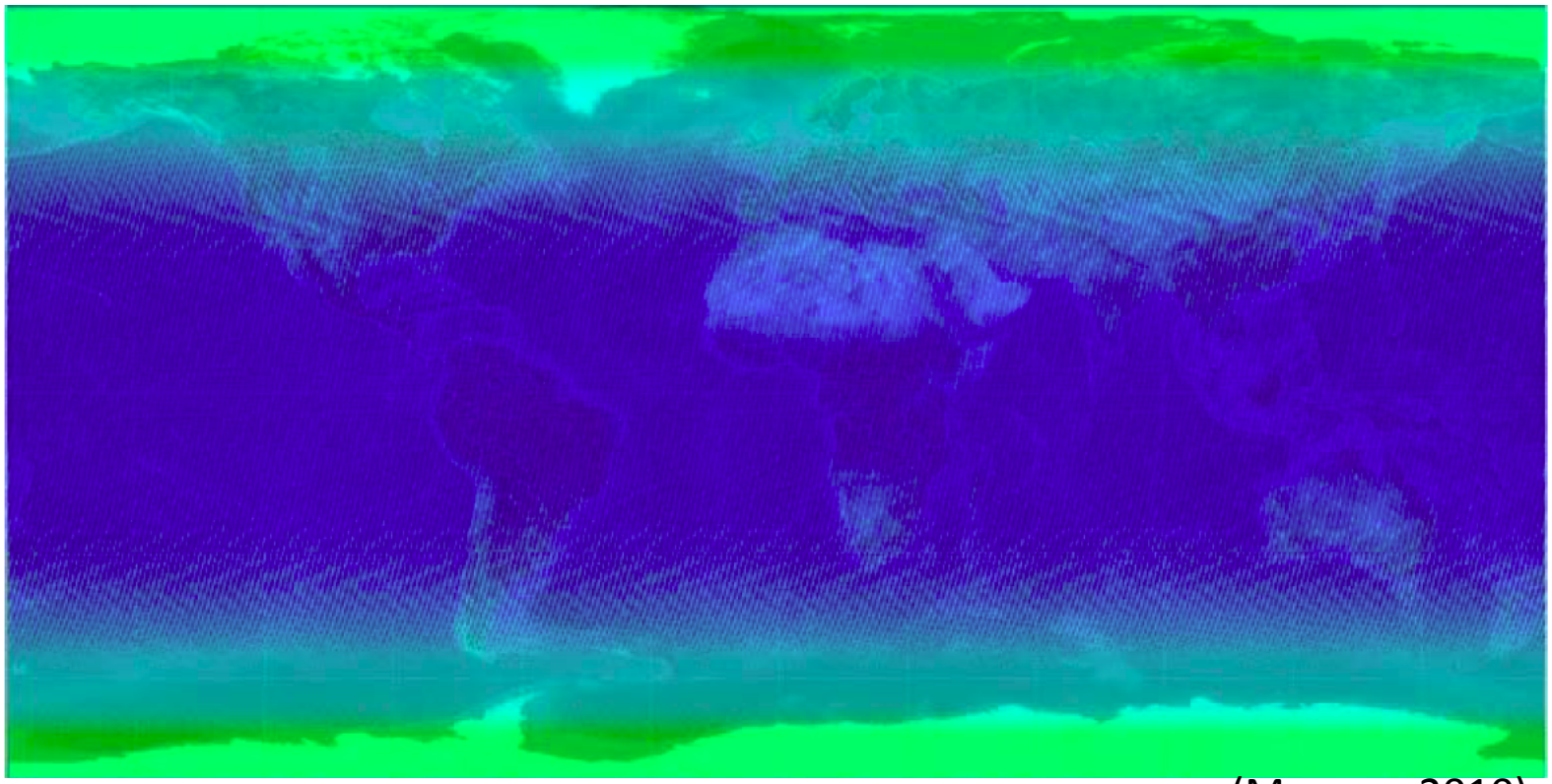
VSWIR Coverage after 19 days

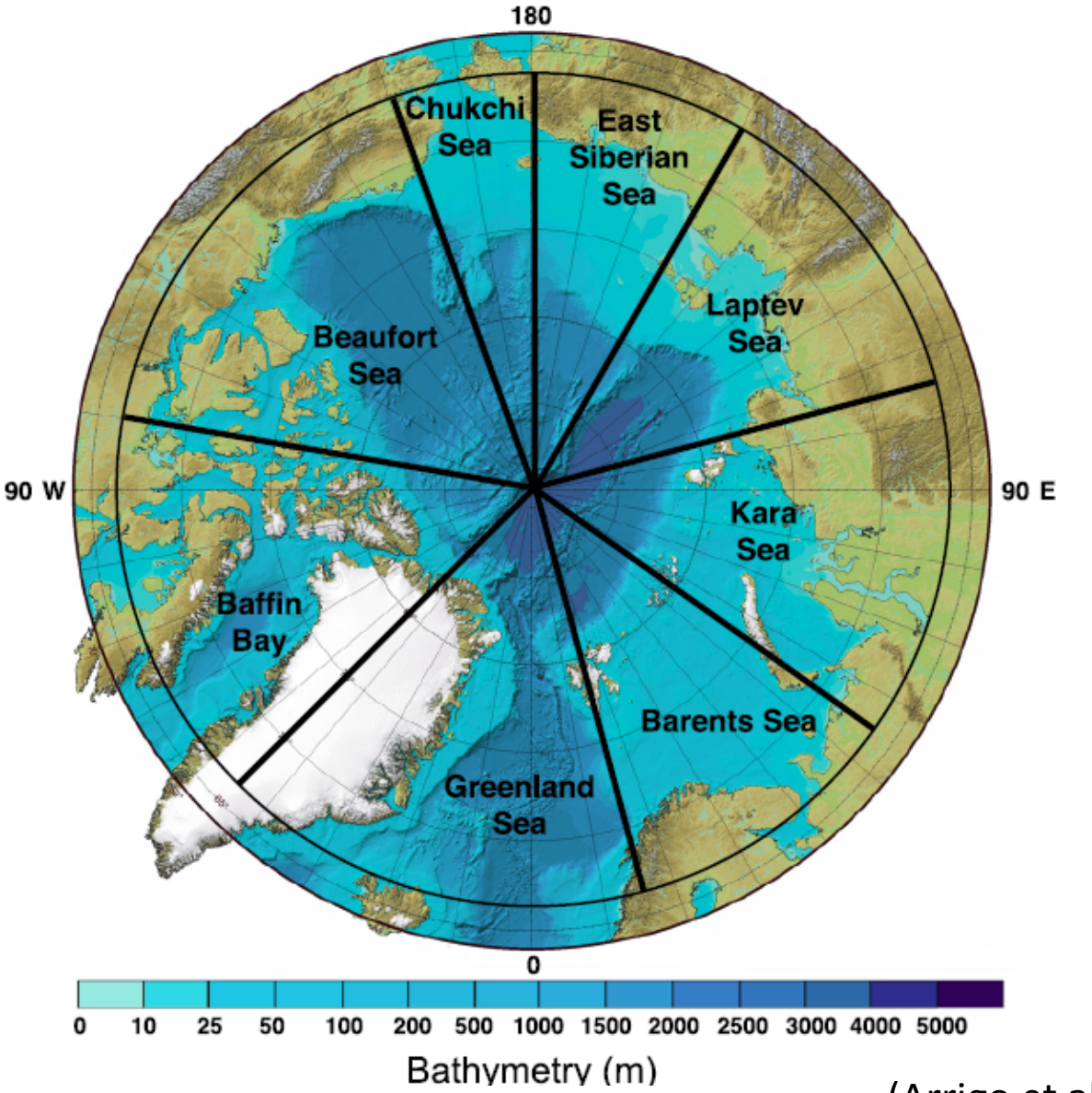


(Mercury 2010)

The current design (150 Km swath) has adequate temporal resolution (~6-7 visits/month) for high-latitude waters.

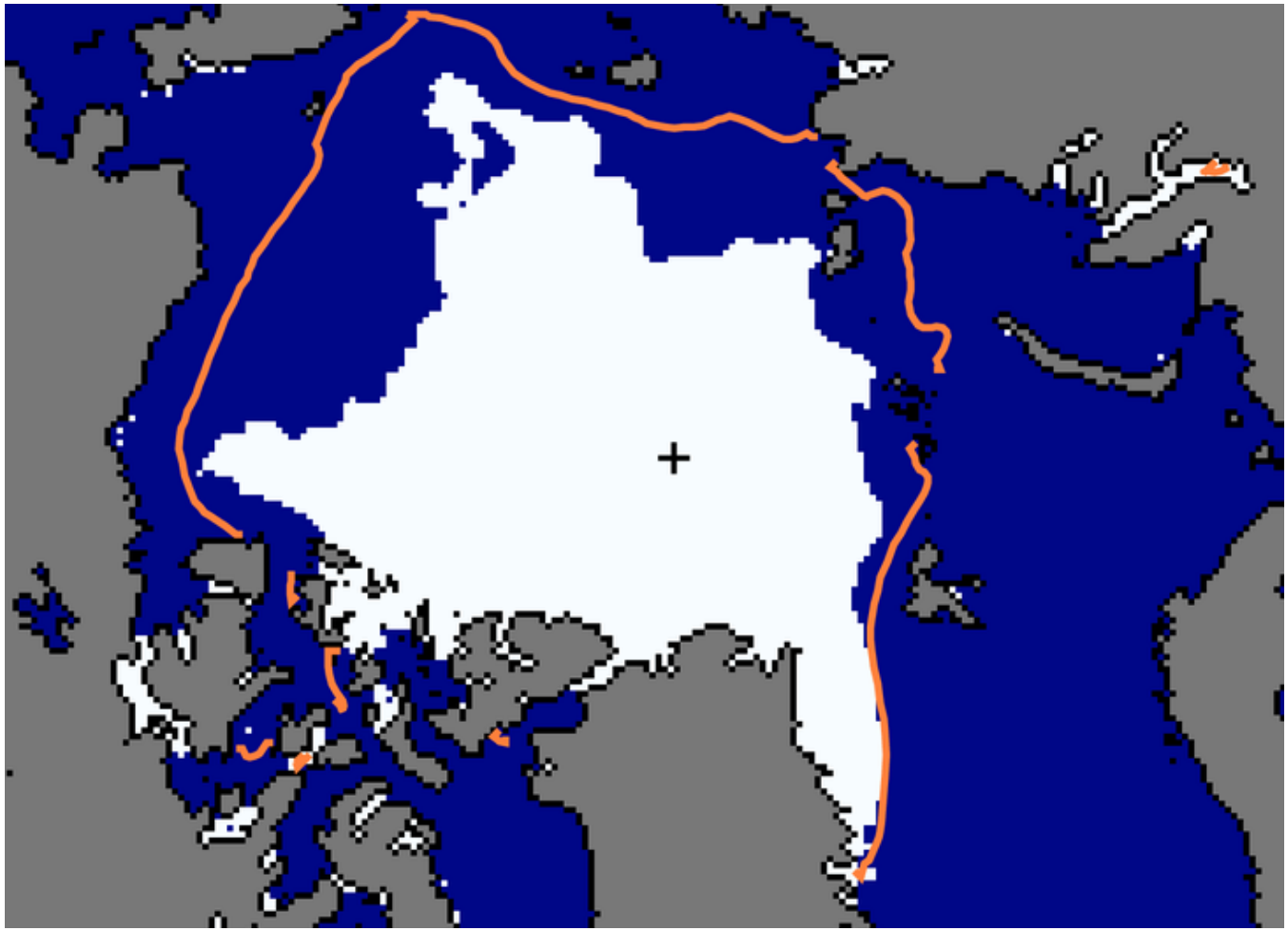
Temporal NOT an issue!

Importance of high-latitude waters



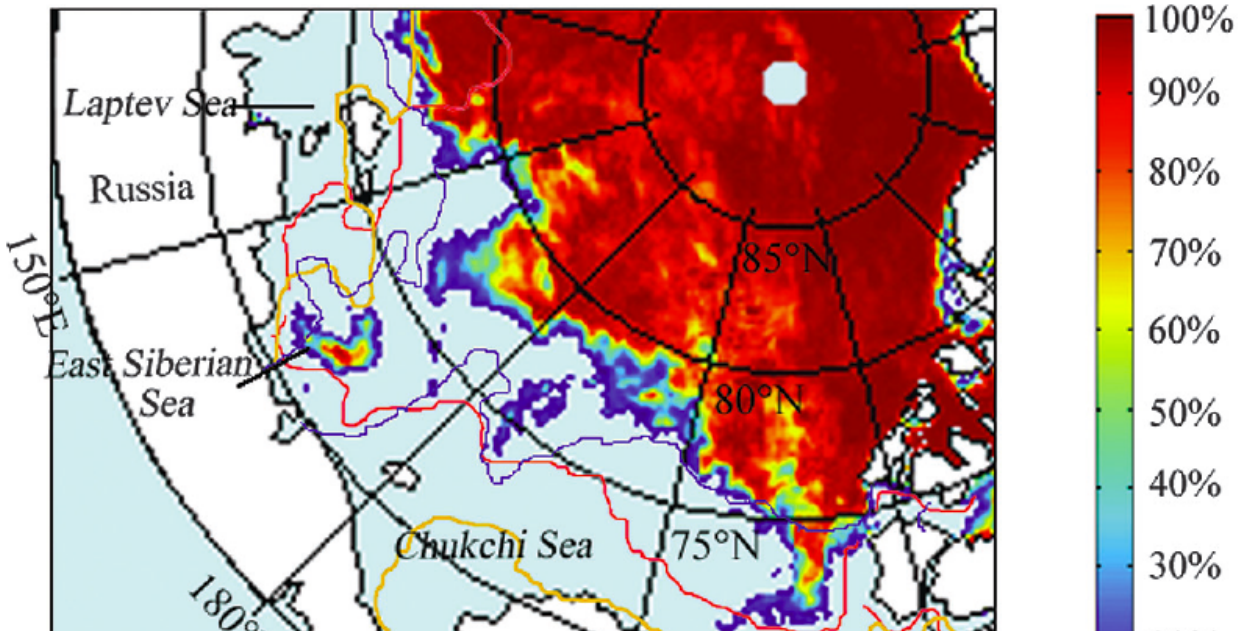
(Arrigo et al 2011)

Change of ice coverage



National Snow and Ice Data Center

(Cai et al, Science, 2010)



It has been predicted that the Arctic Ocean will sequester much greater amounts of carbon dioxide (CO_2) from the atmosphere as a result of sea ice melt and increasing primary productivity. However, this prediction was made on the basis of observations from either highly productive ocean margins or ice-covered basins before the recent major ice retreat. We report here a high-resolution survey of sea-surface CO_2 concentration across the Canada Basin, showing a great increase relative to earlier observations. Rapid CO_2 invasion from the atmosphere and low biological CO_2 drawdown are the main causes for the higher CO_2, which also acts as a barrier to further CO_2 invasion. Contrary to the current view, we predict that the Arctic Ocean basin will not become a large atmospheric CO_2 sink under ice-free conditions.

Conflicting views of the role of Arctic waters in the carbon cycle.

Sample science questions to waters in this “new frontier”:

Spatial distribution and temporal variations of phytoplankton?

Diversity of phytoplankton?

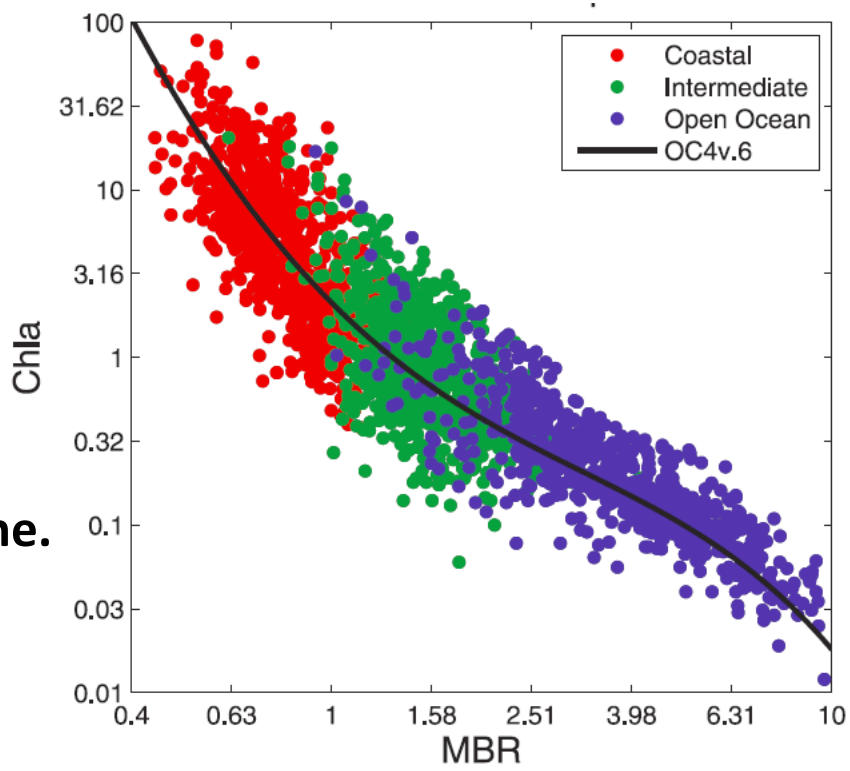
Messenger of climate change?

Contribution to the carbon cycle?

Need long term, large scale, observations: remote sensing!

Issues of sensing high-latitude waters with current ocean-color sensors:

1. software: algorithm

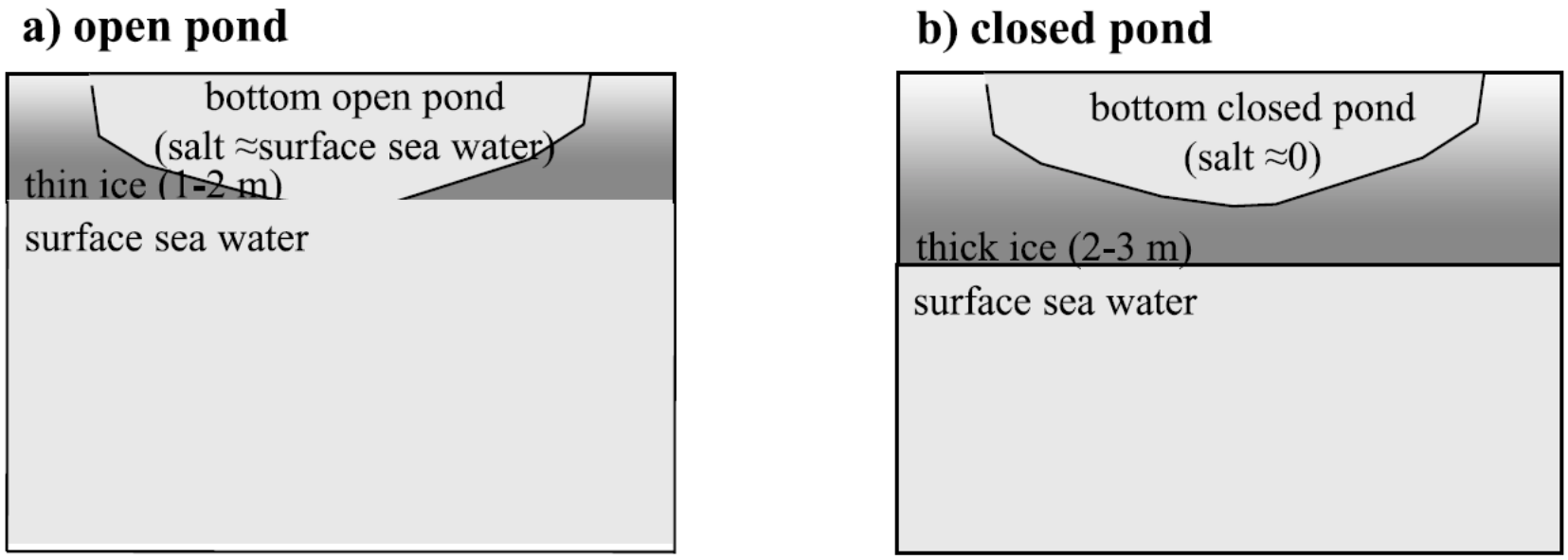


(Szeto et al 2011)

Low/no high-latitude waters;
Large deviation from the regression line.

2. hardware: spatial resolution

Only HyspIRI could resolve fine-scale variations!



(Lee et al 2012)

Past and current ocean-color sensors are unable to sense water constituents in these "new" waters!

Requires a sensor like HyspIRI!

Summary:

The high-spatial resolution and hyperspectral sampling make HyspIRI

1. **unique for near-shore/littoral zone**
2. **unique for high-latitude waters:**
   aquatic environment of "new" frontier.

A tentative list of products for aquatic environment:

Shallow Bottom:

- **Bathymetry**
- **Type of substrates (and status)**

Water Column:

- **Phytoplankton (Chl, functional types)**
- **Colored Dissolved Organic Matter (DOC)**
- **Suspended Particles (POC, Sediments)**

Does it have enough SNR?

Thank you!