Values and advantages of HyspIRI for remote sensing of aquatic environments

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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

<table>
<thead>
<tr>
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<tr>
<td>HyspIRI</td>
<td>hyperspectral</td>
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![Graph showing spectral reflectance](chart.png)

- **R_{rs} [sr^{-1}]**
- **Wavelength [nm]**
- **CZCS**
- **MERIS**
- **MODIS**
- **SeaWiFS**
- **CZCS**
Derivative technique demands hyperspectral measurement.

(Bracher et al 2009)
Method to retrieve hyperspectral phytoplankton absorption is now available.

(Lee and Carder 2004)
High spatial resolution is required to differentiate coastal/near-shore substrates!
### Some specs of HyspIRI

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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.
Table 1: Overarching Thematic Science Questions

<table>
<thead>
<tr>
<th>Question #</th>
<th>Area</th>
<th>Question</th>
<th>Lead and Co-Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>VQ1</td>
<td>Pattern and Spatial Distribution of Ecosystems and their Components</td>
<td>What is the global spatial pattern of ecosystem and diversity distributions, and how do ecosystems differ in their composition or biodiversity?</td>
<td>Roberts, Middleton</td>
</tr>
<tr>
<td>VQ2</td>
<td>Ecosystem Function, Physiology, and Seasonal Activity</td>
<td>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?</td>
<td>Gamon</td>
</tr>
<tr>
<td>VQ3</td>
<td>Biogeochemical Cycles</td>
<td>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?</td>
<td>Ollinger</td>
</tr>
<tr>
<td>VQ4</td>
<td>Changes in and Responses to Disturbance</td>
<td>How are disturbance regimes changing, and how do these changes affect the ecosystem processes that support life on Earth?</td>
<td>Asner, Knox</td>
</tr>
<tr>
<td>VQ5</td>
<td>Ecosystem and Human Health</td>
<td>How do changes in ecosystem composition and function affect human health, resource use, and resource management?</td>
<td>Townsend, Glass</td>
</tr>
<tr>
<td>VQ6</td>
<td>Earth Surface and Shallow-Water Substrate Composition</td>
<td>What is the land surface soil/rock and shallow-water substrate composition?</td>
<td>Green, Dierssen</td>
</tr>
<tr>
<td>TQ1</td>
<td>Volcanoes and Earthquakes</td>
<td>How can we help predict and mitigate earthquake and volcanic hazards through detection of transient thermal</td>
<td>Abrams, Freund</td>
</tr>
</tbody>
</table>
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)
Some specs of ocean-targeting sensors

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<td>CZCS</td>
<td>4</td>
<td>900</td>
<td>~2</td>
</tr>
<tr>
<td>SeaWiFS</td>
<td>6</td>
<td>1100</td>
<td>~2</td>
</tr>
<tr>
<td>MODIS</td>
<td>8</td>
<td>250, 500, 1000</td>
<td>~2</td>
</tr>
<tr>
<td>MERIS</td>
<td>12</td>
<td>300, 1200</td>
<td>~2</td>
</tr>
<tr>
<td>OCM-2</td>
<td>9</td>
<td>360</td>
<td>~2</td>
</tr>
<tr>
<td>GEO-CAPE</td>
<td>hyper</td>
<td>375</td>
<td>0.12</td>
</tr>
<tr>
<td>ACE</td>
<td>Hyper+Lidar</td>
<td>250?</td>
<td>~xx</td>
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Only HyspIRI could resolve fine coastal/littoral zone variations!
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The current design (150 Km swath) has adequate temporal resolution (~6-7 visits/month) for high-latitude waters.

VSWIR Coverage after 19 days

(Mercury 2010)

Temporal NOT an issue!
Importance of high-latitude waters

(Arrigo et al 2011)
Change of ice coverage

National Snow and Ice Data Center
It has been predicted that the Arctic Ocean will sequester much greater amounts of carbon dioxide (CO₂) 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 CO₂ concentration across the Canada Basin, showing a great increase relative to earlier observations. Rapid CO₂ invasion from the atmosphere and low biological CO₂ drawdown are the main causes for the higher CO₂, which also acts as a barrier to further CO₂ invasion. Contrary to the current view, we predict that the Arctic Ocean basin will not become a large atmospheric CO₂ 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
   Low/no high-latitude waters; Large deviation from the regression line.

2. hardware: spatial resolution

(Szeto et al 2011)
Only HyspIRI could resolve fine-scale variations!
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!