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What challenges in remote sensing?

• Patchy and small
  o Mixed pixels
  o Extremely difficult to validate
• Spectral ambiguity
  o Lack of spectral bands
  o Similarity in different types
• Clouds, cloud shadows, sun glint
  o Moving targets
  o Often difficult to mask

What’s an ideal solution?

High spatial, temporal, spectral, and radiometric resolutions – not possible in the near future!
How patchy and small?

- 1 cm² squares

- 0.5 km

- 50µm < Thickness ≤ 200µm
How patchy and small?

Landsat-8 OLI image
**What spatial resolution?**

**Landsat-8 OLI image**

<table>
<thead>
<tr>
<th>Sensor</th>
<th>SNR</th>
<th>Detection Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODIS 1-km</td>
<td>1000:1</td>
<td>0.2% = 2000 m²</td>
</tr>
<tr>
<td>MODIS 250m</td>
<td>200:1</td>
<td>1% = 625 m²</td>
</tr>
<tr>
<td>L8 OLI 30m</td>
<td>50:1</td>
<td>4% = 36 m²</td>
</tr>
</tbody>
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5 km
What spatial resolution?

WV-2 versus MODIS

(a) WV-2 image, 12/8/2009

(b), MODIS FAI image, 12/8/2009

Sargassum slicks caught on WV-2

Bermuda
What spatial resolution?

MSI 10-m resolution
Spectral discrimination?

(a) Water: Chl = 0.14 mg m^{-3}
Green: Chl = 0.8 mg m^{-3}
Red: Sargassum Endmember
All Others: Sargassum

(b) — Tricho

(c) — Ulva

(d) — Syringodium

(e) Plastic Bags
Plastic Bottles
White polyfoam
Grey Styrofoam

(f) — Microcystis
Spectral discrimination?

HICO fingerprints *Sargassum* in the Atlantic
Spectral discrimination?

MODIS fingerprints *Trichodesmium* in the Gulf of Mexico

The spectral curvatures (high-low-high-low-high) are due to PUB and PEB pigments in Trichodesmium. These features will not be detected without combining MODIS ocean and land bands.

In situ $R_{rs}$ of a Tricho bloom

The spectral curvatures (high-low-high-low-high) are due to PUB and PEB pigments in Trichodesmium. These features will not be detected without combining MODIS ocean and land bands.
Spectral discrimination?

MODIS differentiates *Ulva* and *Sargassum*
With *a priori* knowledge

Areal density of *Sargassum* from MODIS observations
What floating algae and materials?

- Macroalgae (*Sargassum* and *Ulva*)
- Microalgae (*Trichodesmium*, *Microcystis*)
- Dead seagrass
- Oil spills (crude and emulsion)
- Garbage (plastics, polyfoam,…)

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