Harmful Algal Blooms (HABs) 3 Limitations

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HAB occurrences worldwide

Image from whoi.edu/redtide
What are limitations

Recall operational component: need an answer “today”, not for last year.

Obvious ones? (Should be some insights from the last two weeks)
Limitations

Obvious limitations:
- Clouds
- Sunglint
- Aerosols
- Frequency
- Spectral Bands (algorithm)
- Resolution

Others:
- Algorithm robustness
- Water turbidity
- CDOM
Clouds are a problem and unknown in classification.

Yellow indicates potential HAB, eastern Gulf of Mexico, 2005, worst event in 30 years.

Aug 12
2005 Aug 13
Aug 14

Cloudy area interpreted using “persistence” (from a previous day).

Ambiguous algorithm, requires manual correction.
Sunglint (at 42N a problem for 2 months around solstice).
## Satellite Comparison for HAB applications

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Spatial</th>
<th>Temporal</th>
<th>Key Spectral</th>
</tr>
</thead>
<tbody>
<tr>
<td>MERIS</td>
<td>300 m</td>
<td>OK</td>
<td>good (10 on red edge)</td>
</tr>
<tr>
<td>MODIS high res</td>
<td>250/500 m</td>
<td>1-2 day</td>
<td>4 (1 red, 1 NIR)</td>
</tr>
<tr>
<td>SeaWiFS, MODIS low res</td>
<td>1 km</td>
<td>1-2 day</td>
<td>7-8 (2 in red edge)</td>
</tr>
<tr>
<td>Landsat</td>
<td>30 m</td>
<td>8 or 16 day</td>
<td>4 (1 red, 1 NIR)</td>
</tr>
<tr>
<td>Very high res (IKONOS, etc.)</td>
<td>1-4 m</td>
<td>Variable (must be ordered)</td>
<td>4 (1 red, 1 NIR)</td>
</tr>
</tbody>
</table>

**Comments:**
- Clouds take out 1/2 to 2/3 of imagery
- Sunglint impacts ratio or semi-analytic algorithms
- Minimum resolution, 3 pixels across (2 mixed land/water)
Satellite spectral bands & turbid blooms

Landsat TM

Landsat

MERIS

MODIS

250/500m

SeaWiFS
“Swaths” move around

Full Swath
1150 km

No Coverage
Aug 30

Aug 27
Western Ohio

Aug 28, 2010
All Ohio

Aug 29
Eastern Ohio

Aug 30
Eastern Ohio

Aug 31
All Ohio

Sep 01
Eastern Ohio

Aug 31
All Ohio
Usability right in lakes or at the coast

My experience is that “adjacency” (atmospheric scattering) is not a noticeable beyond the mixed pixel.
Glint as an issue. Mild to Moderate glint can be treated with spectral shape
Spectral shape algorithms are superior for operational use

Derivatives do not depend on the absolute magnitude. They can:

- work without atmospheric correction
- “see” through moderate glint

However, algorithms require a difference, which is influenced by sediment concentration (the degree of influence depends on the bands) (Gordon & Morel, 1983).
Some published shape algorithms

MERIS bands

Oligotrophic Chl-a (SS-560); Hu et al

CI (SS-681); Wynne et al.

MCI (SS-708); Gower et al.
Challenges, no *Karenia* after Hurricane Charley: Optical technique allow ID of diatom bloom, but falsely flagged 2\(^{nd}\) bloom as *Karenia*

Chl (insufficient) anomaly 2\(^{nd}\) der bb/a
Optical methods, while useful, need optically deep, case 1 water. Not the case in Florida Keys.
Algorithm Robustness

Algorithm conceived with radiometry (or developed elsewhere)

Two sources of problem:
1) Algorithm is not valid for the HAB
2) Algorithm will break
   1) satellite limitation
   2) Atmosphere limitation
All of these have been used for HABs. Give two examples of what can “break” or invalidate each (either won’t work, or inappropriate)

1. Chl-a blue:green
2. Chl-a NIR:red
3. FLH
4. anomaly
5. MCI (SS-708)
6. CI (SS-681)
7. Bb/a ratio
8. Brightness
9. Multi-band empirical relationship