KSU VPCA Spectral decomposition CyanoHAB and Green algae from:

• AERONET-OC184
• MTRI hyperspectral spectrometer

MTRI data: M. Sayer; AERONET data: Tim Moore; NOAA CI: Lake Erie HAB bulletin
NASA HSI2 based Multivariate approaches to Chl a estimation (U. Cincinnati, U. Alabama)

• 2 slide summary

• 1-3m resolution Hyperspectral NASA HSI2 data from Harsha Lake

• Work by Min Xu, and Hongxing Liu, et al. presenting two approaches to high spatial resolution modeling of Chl a
  • Geographically adaptive modeling
  • Multivariate ensemble modeling

Geographically adaptive models for Chl-a estimation

- HSI2 data of Harsha Lake, Oct 5, 2015
- Calibrate empirical algorithms for different regions or local areas of the image
- Significantly improve the Chl-a estimation accuracy by 33-47% compared with the best traditional empirical method (global model).

Models performance evaluated by 10 checking points

<table>
<thead>
<tr>
<th></th>
<th>0-8μg/L</th>
<th>8-16μg/L</th>
<th>16-20μg/L</th>
<th>Overall</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>3.22</td>
<td>1.48</td>
<td>2.75</td>
<td>2.48</td>
<td>0.882</td>
</tr>
<tr>
<td>Regional</td>
<td>1.49</td>
<td>1.61</td>
<td>1.91</td>
<td>1.65</td>
<td>0.950</td>
</tr>
<tr>
<td>Local</td>
<td>0.94</td>
<td>1.52</td>
<td>1.71</td>
<td>1.31</td>
<td>0.970</td>
</tr>
</tbody>
</table>

Chl-a distribution by locally adaptive models

Harsha Lake, in situ data, and GCPs overlaid on HSI2 image stripes, Oct 5, 2015

Multi-model ensemble for *Chl-a* retrieval

- Sentinel-2A satellite data of Harsha Lake, Oct 7, 2016
- The optimally weighted ensemble and a spectral partition guided ensemble method
- Spectral space partition rules built by the Classification and Regression Tree method
- Considerably better prediction ability of the ensemble than that of all individual empirical algorithms in the ensemble.

**Optimally weighted ensemble method (OWEM):**

\[
Chl-a = 0.48 \times (70.75 \times 2BDA - 58.45) + 0.32 \times (266.93 \times 3BDA + 11.68) + 0.20 \times (179.18 \times NDCI + 10.82)
\]

**Spectral space partition guided selection method (SSPGSM):**

- **CART**
  - Test pixel \( X_i \)
  - \( B6 \leq 0.41 \)
  - \( B6 \leq 0.29 \) True
  - \( B6 \leq 0.45 \) False
  - Algorithm 2
  - \( B5 \leq 1.3 \)
    - True
    - Algorithm 2
    - False
    - Algorithm 2
    - \( B4 \leq 1.25 \)
      - True
      - Algorithm 2
      - False
      - Algorithm 2
      - \( B3 \leq 2.33 \)
        - True
        - Algorithm 2
        - False
        - Algorithm 2
        - Algorithm 3

**Models’ performance**

<table>
<thead>
<tr>
<th>Methods</th>
<th>( r )</th>
<th>RMSE (μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDCI</td>
<td>0.83</td>
<td>4.70</td>
</tr>
<tr>
<td>3BDA</td>
<td>0.84</td>
<td>4.57</td>
</tr>
<tr>
<td>2BDA</td>
<td>0.88</td>
<td>4.50</td>
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<tr>
<td>OWEM</td>
<td>0.95</td>
<td>4.07</td>
</tr>
<tr>
<td>SSPGSM</td>
<td>0.97</td>
<td>3.57</td>
</tr>
</tbody>
</table>


Chl-a distribution by spectral partition guided ensemble