Refining *Karenia brevis* Detection: An Assessment of Ensemble Imagery Products for Operational Forecasting

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**OBJECTIVE**

Evaluate the effectiveness of ensemble satellite imagery products at detecting *K. brevis* blooms compared to chlorophyll anomaly satellite imagery products.

**RESULTS**

**HAB DETECTION: PERCENT BETTER THAN ANOMALY OR ENSEMBLE PRODUCT**

![HAB Detection: Percent Better Than Anomaly or Ensemble Product](image)

**REFERENCES**


**CO-AUTHOR SPEAK**

Karen Kavanaugh; Katie Derner

![Figure 1: Study region map, highlighting the bloom initiation area offshore SW Florida from Pinellas to Collier counties.](image)

**METHODS**

**Study Region**

- Coastal southwest Florida from Pinellas to Monroe counties, including Florida Bay and Florida Keys region.
- Focus on bloom initiation area offshore from approximately Tampa to Cape Romano.
- Bays and inland waterways excluded due to satellite imagery resolution.

![Figure 2: Analysis of chlorophyll anomaly and ensemble imagery products along with in-situ *K. brevis* water samples.](image)

**CONCLUSIONS**

As of September 2015, the full ensemble product, incorporating the chlorophyll anomaly, spectral shape ensemble, and backscatter ratio ensemble has been generated for operational use by the HAB-OFS and analyzed in conjunction with the chlorophyll anomaly imagery. The combined analysis of these products provides enhanced *K. brevis* detection and monitoring, and should be particularly useful in analysis of the *K. brevis* initiation area from Tampa to Cape Romano, outside of the Florida Bay and Florida Keys region. Future work for consideration includes analysis of the ensemble imagery in other forecast regions, such as northwestern Florida and Texas, and the use of ensemble products with new satellite imagery products as they become available.

**FIGURES**

- Figure 1: Study region map, highlighting the bloom initiation area offshore SW Florida from Pinellas to Collier counties.
- Figure 2: Analysis of chlorophyll anomaly and ensemble imagery products along with in-situ *K. brevis* water samples.
- Figure 3: (a) The full and backscatter ensemble products enhanced the chlorophyll anomaly at SW Florida from approximately Tampa to Cape Romano. (b) Ensembles did not completely eliminate false positives in the FL Bay and FL Keys region, but HAB flags were smaller.
- Figure 4: Ensemble image from 27/6/13. While the spectral shape 490nm ensemble product helps with definition, it tends to overestimate more often than the other ensemble products. The backscatter and full ensemble flags better refined *K. brevis* bloom boundary detection.
- Figure 5: Percentage of images for which either the chlorophyll anomaly alone or the ensemble product was evaluated to be more effective at identifying the presence or absence of *K. brevis* blooms. While the spectral shape 490nm ensemble product performed the best over the chlorophyll anomaly alone, the backscatter and full ensemble products were more effective in reducing false positives, discerning between blooms of *K. brevis* and blooms of other species, especially in coastal areas outside of the FL Bay and FL Keys region. Despite enhanced specificity gained through ensemble products, both the backscatter and full ensemble mixed blooms that were flagged by the chlorophyll anomaly 20.6% of the time, highlighting the continued importance of examining the chlorophyll anomaly in addition to the ensemble.

**ASSESSMENT**

- **Imagery Assessment**
  - Compared chlorophyll anomaly and ensemble MODIS Aqua imagery.
  - Clear, cloud-free images from April 2010 – December 2013 (~100 images).
  - Manual imagery analysis of each ensemble product validated using *K. brevis* water samples (~50,000 cells/L) collected up to 3 days before and after each image date.
  - Only ensemble flags greater than 5x5 pixels considered.
- **Ensemble Products** (see Figure 2)
  - Spectral shape at 490nm: accounts for changes in the Rrs spectral shape at 490nm combined with the chlorophyll anomaly algorithm.
  - Backscatter ratio *b*<sub>bs</sub>: accounts for differences in particulate backscatter (*b*<sub>bs</sub>) spectra between *K. brevis* blooms and non-*K. brevis* blooms combined with the chlorophyll anomaly algorithm.
  - Full ensemble: includes the above ensemble products and the chlorophyll anomaly algorithm.

**DISCUSSION**

While the chlorophyll anomaly alone has proven effective in highlighting areas of high chlorophyll, using this product in conjunction with other algorithms in ensemble imagery products enhances *K. brevis* bloom detection capabilities and forecasting skill. The ensemble imagery evaluation underscored several benefits favoring the use of ensemble imagery, including:

1. Increased specificity in determining the spatial extent of *K. brevis* bloom location/boundaries.
2. Reduction of false positives alongshore southwest Florida from Pinellas to Monroe counties, primarily in the main bloom initiation area extending approximately from Tampa to Cape Romano.
3. Decreased tendency toward over-prediction compared to the chlorophyll anomaly alone, and
4. Improved identification of correct rejections outside the Florida Bay and Florida Keys area.

While there are several benefits to including the ensemble imagery products for operational use, analysis also highlighted the continued examination of the chlorophyll anomaly alone in addition to the ensemble products.

**ACKNOWLEDGEMENTS**


**NOTES**
