



# Assessment of the Eastern Gulf of Mexico Harmful Algal Bloom Operational Forecast System: A Comparative Analysis of Forecast Skill and Utilization from 2004 to 2012



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## INTRODUCTION

Blooms of the toxic dinoflagellate, *Karenia brevis*, occur nearly every year in coastal regions of the Gulf of Mexico (GOMX) causing potential impacts on public health, ecosystems, and regional economies<sup>(1,2)</sup>. To aid early bloom identification and response efforts, in 2004 NOAA transitioned a successful demonstration forecast system for harmful algal blooms (HABs) from research to operational status with coverage along the Gulf coast of Florida.

NOAA's GOMX HAB Operational Forecast System (HAB-OFS) issues weekly bulletins that serve as decision support tools for coastal resource managers, federal and state agencies, and academic institutions. In order to continually improve the HAB-OFS, bulletin utilization and forecast skill are evaluated regularly. From May 1, 2004 to April 30, 2012, 697 total forecasts were issued for the eastern GOMX resulting in a total of 1623 bloom days spanning 17 confirmed HAB events<sup>(2)</sup>. Assessment results will be applied to improve HAB forecasts in both the eastern and western GOMX (Texas), which became operational in 2010.

## METHODS

### Bulletin Forecasts

- Bulletin forecasts consisted of four components: Transport, Intensification, Respiratory Impacts, and Potential for Bloom Formation associated with the bloom. See [Table 1](#) for descriptions.

### Assessment

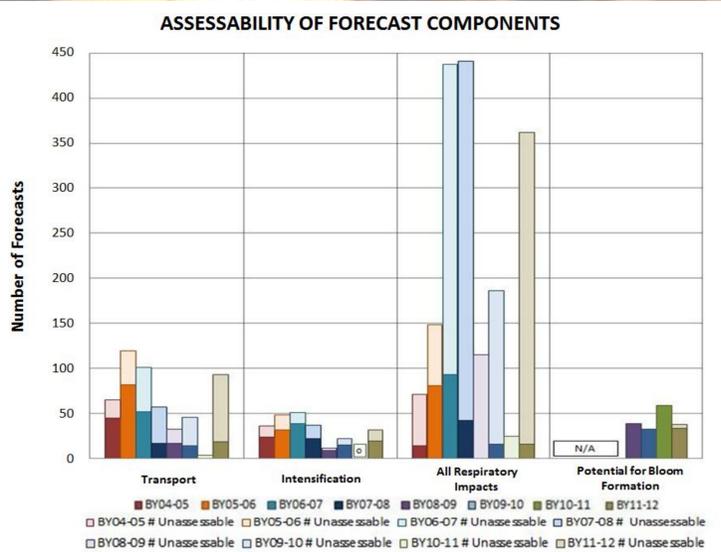
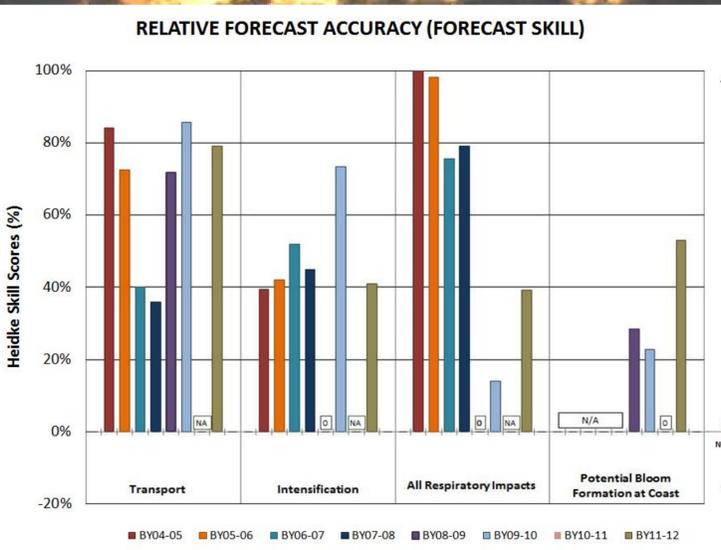
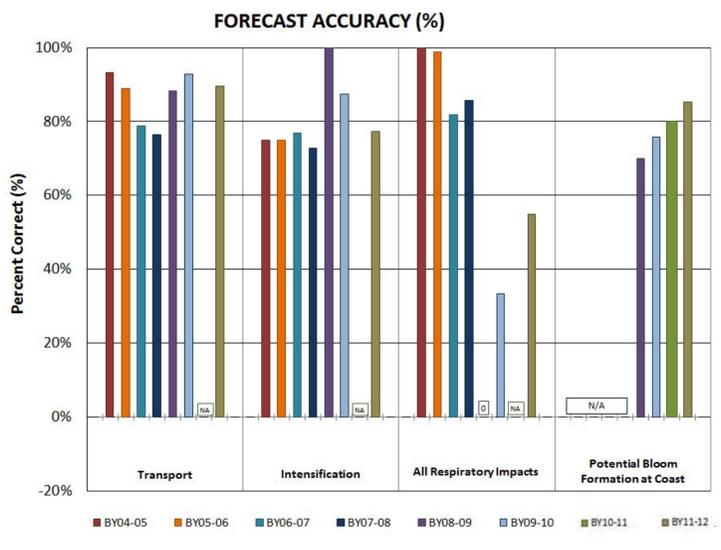
- Forecasts were evaluated for accuracy and usability each week based on the following post-bulletin data.
  - Bulletin Utilization: Media or public health reports, sampling response, written/ telephone responses or inquiries, etc.
  - Transport and Intensification: Satellite imagery and/or *in situ* sample data.
  - Respiratory Impacts: Observations of slight to high respiratory irritation within the forecast area (county) as reported by state agencies, lifeguards, research institutions, and the public.
- Assessment data was grouped by bloom year (BY), e.g. May 1 YYYY to April 30, YYYY.
- Some assessment data is subjective and a lack of reporting confirming a forecast does not necessarily mean that forecast was inaccurate or the bulletin was not utilized.

### Statistical Analysis

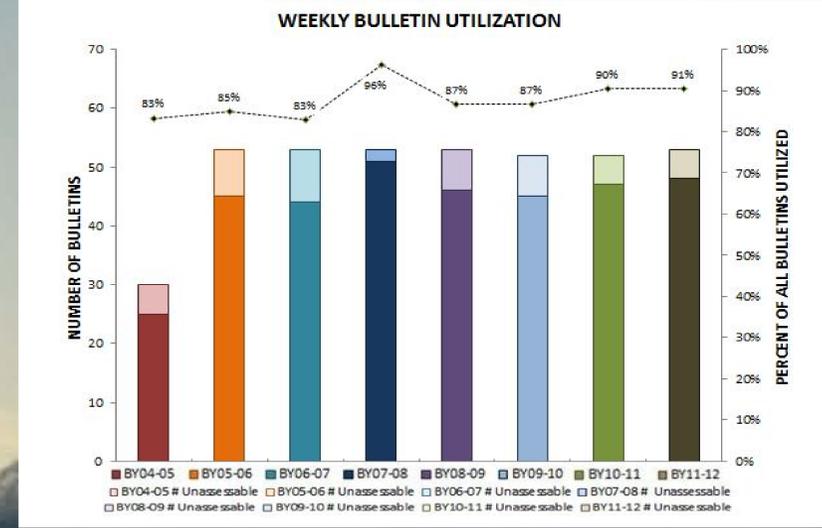
- Assessability- % of forecasts with sufficient evidence to be adequately evaluated
- Forecast Accuracy- % of correct forecasts out of the total # of assessable forecasts
- Relative Forecast Accuracy- *Heidke Skill Score*- Proportion of correct forecasts relative to the # of correct forecasts that could be made by random chance. This is reported as a range between -100% and 100%, with a score over 0% indicating improvement over random chance at predicting an event<sup>(3)</sup>.
- Bulletin Utilization- reported as % where at least one bulletin was utilized per week

Forecast Component	Definition	Forecast	Data Used
Transport	Direction bloom is likely to migrate	<ul style="list-style-type: none"> <li>North</li> <li>South</li> <li>No Change</li> </ul>	<ul style="list-style-type: none"> <li>NWS forecasted winds</li> <li>Ekman Transport</li> </ul>
Intensification	Expected change in bloom concentration	<ul style="list-style-type: none"> <li>Increase</li> <li>Decrease</li> <li>No Change</li> </ul>	<ul style="list-style-type: none"> <li>NWS forecasted winds</li> <li>K. brevis samples</li> <li>MODIS AQUA imagery</li> </ul>
Respiratory Impacts	Potential level of respiratory impacts caused by bloom	<ul style="list-style-type: none"> <li>None</li> <li>Very low</li> <li>Low</li> <li>Moderate</li> <li>High</li> </ul>	<ul style="list-style-type: none"> <li>NWS forecasted winds</li> <li>K. brevis samples</li> <li>MODIS AQUA imagery</li> </ul>
Potential for Bloom Formation at the Coast	A forecast of conditions that are favorable for bloom formation	<ul style="list-style-type: none"> <li>Favorable</li> <li>Unfavorable</li> </ul>	<ul style="list-style-type: none"> <li>NWS forecasted winds</li> <li>Ekman Transport</li> </ul>

**Table 1:** Definitions of forecast components for the Florida region, the data required, and the selection for each component.



**Figure 1.** (from top) Percent correct forecasts (of total assessable), Heidke skill score (of assessable), and the assessability of forecast components.



**Figure 2.** Bulletin utilization (percent) where at least one bulletin is utilized each week.

## CONCLUSIONS

### Greater User Feedback and Information is Required to Assess Forecast Accuracy and Bulletin Utilization

- Respiratory Impact Forecasts have the lowest confirmation percentage and require the greatest amount of information from users and the public to assess.
- BY05-06 respiratory forecasts were 54% assessable (greatest), while BY08-09 and BY10-11, where there was no bloom, both had 0% assessable forecasts.
- An average of 85% of respiratory irritation forecasts could not be confirmed per bloom year.
- Potential for Bloom Formation had the greatest percentage of assessable forecasts (99% average). These forecasts require a minimal amount of user feedback to assess and are primarily confirmed through MODIS AQUA imagery and *in situ* cell counts.

### All Bulletin Components are Forecast with High Accuracy and Skill

- Respiratory impact forecasts had the highest accuracy and skill, but the forecasts are biased toward the observation due to a general lack of impact reporting and because a report of "no impacts" cannot confirm the complete absence of impacts in a bloom region.
- Potential Bloom Formation at the Coast also had a high amount of skill (>20%) but the forecast is also subject to a number of false alarms. This may be attributed to the overall deficiency in understanding of specific factors that lead to bloom formation. Without knowing if a bloom has formed offshore or not, the forecast is restricted to predicting the potential for an unknown bloom that may have formed offshore to form at the coast based on physical oceanography.

### Bulletins Successfully Assist Users

- Overall bulletin utilization where at least one bulletin was utilized per week was >87% each bloom season.
- In an effort to increase year-over-year bulletin utilization and further CO-OPS ability to address specific user needs, social media and outreach programs were initiated in BY12-13. These efforts will allow CO-OPS to incorporate a greater amount of feedback from a broader audience which will be used as guidance for improving HAB-OFS products moving forward.

### Results Will Guide Future Forecasting and Skill Assessment

- The results of this comparative analysis will be used as guidance in improving the HAB-OFS program in the future. Using these results, operating procedures for each component will be analyzed in an effort to improve accuracy, assessability, and utilization.

### References

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 (3) Doswell, C.A., Davies-Jones, Robert, & Keller, D.L. (1990). On summary measures of skill in rare event forecasting based on contingency tables. *Weather and Forecasting*, 5, 576-585.

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