## Appendix 4. The HAB Forecast System for the Gulf: Recommended Improvements

### Background

The Harmful Algal Bloom (HAB) Forecast System provides nowcasts and forecasts of *Karenia* bloom location and impact in the Gulf of Mexico. Currently analysis is performed separately for the eastern Gulf of Mexico and the western Gulf of Mexico. A bulletin is produced for managers in order to provide information that will aid in guiding sampling, monitoring, and response strategies. Forecasts of HAB impact are provided to the public. The bulletin for managers, sent by email, includes an analysis of field measurements, satellite imagery, and models. The Forecast System, while emphasizing *Karenia* "red tide", also will respond to other potential HAB events. The system became operational for the eastern Gulf of Mexico in September 2004.

The key forecasts are:
1) Nowcast location and extent
2) Forecast location and extent (out 2-4 days)
3) Forecast respiratory impact
4) Forecast intensification
5) Forecast and identification of initial HAB

All the forecasts need validation in order to provide uncertainty, capture errors in the input and forecast models, and identify areas needing improvement. In addition, the models require location information in order to achieve accurate forecasts.

### Recommended improvements

Significant improvements in HAB Forecasts can be achieved with the HABIOS addressing the areas to follow.

*Location Data* A HAB Field is created as a key part of the forecasts. The location data are interpreted to create the HAB Field, and the quality is limited by the resolution of the available data. Location information can be the equivalent of "presence/absence" or "medium/low/background".

1) Resolution of HABs along and near the coast. In order to forecast and nowcast HABs, the most critical lack of information is the location of the HABs required to initialize the nowcast/forecast models. The current combination of satellite and cell counts can identify general areas of HABs, but cannot provide details at the coast at resolutions better than 10-50 km $d^{-1}$. This is insufficient for many of the public health requirements. Areas with critical public health concerns may require 1-4 km $d^{-1}$.
2) Near-real time respiratory irritation. Forecasting is simply more effective if the variable being forecast is also being measured.
3) Resolution of HABs at key sites in or near estuaries in order to forecast HABs at shellfish beds. Current capabilities allow forecasts of the presence of blooms immediately outside estuaries, but lack the information to produce the necessary targeted forecasts within estuaries.

4) Location of HABs offshore at critical initiation/transport sites. As HABs sometimes appear near the coast without detection by satellite, some mechanism is needed to locate these blooms.

*Validation* All forecasts require validation in order to identify errors, uncertainties, and areas for improvement.

1) Locations, as described above. Several of the forecasts (transport, extent, area, and intensification) can be met by the same location data as collected for initialization.
2) Respiratory irritation data. The presence and absence of respiratory irritation/impact must be available at the resolution required. A target would be tracking movements with errors not more than 10 km $d^{-1}$ and forecasting critical beaches.
3) Shellfish toxin levels. Access to shellfish closures that are documented by tissue samples would aid in validation of forecasts over these areas.
4) Human health data. This should include poison center information, hospital admission data, and emergency room visit data, among other.

*Models* Transport models involve a combination of HAB fields and circulation models. Respiratory irritation models involve HAB-aerosol fields with near-shore wind/sea breeze models. As different models can be effective and uncertainties exist in these, a combination of ensemble forecasts, confidence bounds, and real-time model assessment are needed.

1) Standard forms for circulation models. As HAB transport models must blend HAB fields with circulation models, the currents from circulation models must be in standard formats and have identified uncertainties, so that they can be easily interpreted and implemented.
2) Real-time circulation model comparison. Circulation models need to be compared in real-time with observed currents in standard locations in order for forecasters to evaluate the potential value of each model for the current event.
3) Characterization of uncertainty in winds from the forcing meteorological models. This characterization would include the wind forecasts themselves, which are necessary for some models, as well as the impact of the uncertainty on the circulation models.
4) Biological "model" transformation. Usable biological models are conceptual, a mechanism needs to be established to transform these into heuristic forms that can be implemented and incorporated into forecasts, such as for initiation and intensification. This would also allow for new models on dissipation or seasonal forecasts.
5) Bloom Initiation models. Currently there are no applicable models for bloom initiation for the Florida panhandle and Texas. This is a research topic, but may not be considered as a research priority at this time.
6) Public health models.