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M.A.M. Friedrichs  
*Virginia Institute of Marine Science*

A. J. Bever  
*Virginia Institute of Marine Science*

Carl Friedrichs  
*Virginia Institute of Marine Science*

R.R. Hood

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Hypoxia Forecasts as a tool for Chesapeake Bay Fisheries

Marjorie Friedrichs\textsuperscript{1}, Aaron Bever\textsuperscript{2}, Carl Friedrichs\textsuperscript{1}, Raleigh Hood\textsuperscript{3} & Doug Wilson\textsuperscript{4}

\textsuperscript{1}Virginia Institute of Marine Science
\textsuperscript{2}Anchor QEA
\textsuperscript{3}Univ. of Maryland Center for Env. Science
\textsuperscript{4}Caribbean Wind, LLC
Coastal and Ocean Modeling Testbed (COMT)

Overall COMT Mission:
• To accelerate transition of coastal ocean modeling research advances to improved operational ocean products and services, meeting the needs of a diverse user community

COMT Estuarine Hypoxia Objective:
• To assess the readiness of existing estuarine models for forecasting hypoxia events within the Chesapeake Bay
Motivation – Why Chesapeake Bay?

The Chesapeake Bay:

- Largest estuary in U.S.
- Benefits derived from Bay > $100 Billion annually
- Major anthropogenic impacts threatens Chesapeake’s economic/social services
- Additional impacts of climate change are not yet known
- One of longest & most comprehensive data sets (1985-present)
Motivation – Why focus on hypoxia?

Hypoxic (low oxygen) dead zones:

- Excessive nutrient run-off → algal blooms → algal decay → dead zones at bottom of the Bay
- Occur in summer: Warmer temperatures and less mixing
- Impact ecological resources in Bay, particularly demersal fish (low catches where DO < 3 mg/L)
Chesapeake hypoxia models:

- Multiple model comparison indicated Simple Respiration Model performed as well as more complex models (Irby et al. 2016)
- Apply this to Chesapeake (ChesROMS) grid
- Use same forcing as is used by NOAA’s Chesapeake Bay Operational Forecast (CBOFS) forecasts for physical variables (water level, salinity, temperature)
Methods – Evaluate with long term cruise data

Available data:

- Models were assessed by monthly data (semi-monthly in summer) at multiple locations throughout Bay from 1985-present.
- Data includes S, T, DO and multiple other ecological parameters.
Chesapeake Hypoxia Forecast Tool

Yesterday’s Oxygen Nowcast

2017-04-24

Green → **High bottom oxygen**
= Good bottom water
= Bottom fish and crabs

Orange → **Moderate/low bottom oxygen**
= Poor bottom water
= Fewer bottom fish and crabs

Red → **Very low bottom oxygen**
= Bad bottom water
= No bottom fish or crabs

http://www.vims.edu/research/topics/dead_zones/forecasts/cbay/index.php
Chesapeake Hypoxia Forecast Tool

1 June 2016 Oxygen Nowcast

3 June 2016 Oxygen Forecast
Chesapeake Hypoxia Forecast Tool

**Blue** → **Increasing oxygen**
(Improving bottom water in **eastern** Bay)

**Red** → **Decreasing oxygen**
(Degrading bottom water in **western** Bay)
SSE wind transports high oxygen surface water to the east, upwells low oxygen water in west.
“Quasi-operational” forecasts
on VIMS website:
http://www.vims.edu/research/topics/dead_zones/forecasts/cbay/index.php

transition

Truly operational forecasts
on NOAA on CBOFS site:
https://tidesandcurrents.noaa.gov/ofc/cbofs/cbofs.html
NOAA CBOFS Forecasts

Operational Forecast Site

Surface Temperature

Surface Salinity

Ecological Forecasting: oxygen/hypoxia?

Time/Date: 0200 (EDT) 04/26/17
Workshop summary:

- Attendees included fishermen as well as scientists/educators
- Strong enthusiasm for hypoxia forecasts as complementary tool with other information sources
- Several captains already use real-time observations for planning (e.g., water clarity, temperature, wave heights) and/or short-term model forecasts (e.g., currents from CBOFS)
- Little interest in hypoxia forecasts beyond 2-3 days because of limited trust in detailed weather/wind forecasts beyond 2-3 days
Suggestions for Hypoxia Forecast Tool:

- Oxygen at other depths

- Other variables (winds, salinity, temperature, water clarity, algal blooms)

- Model-data time series at observation station locations

- Historical averages as well as current conditions
COMT Estuarine Hypoxia Testbed

• Identified a simple oxygen model that can be easily used to produce hypoxia forecasts in the Chesapeake Bay

• Developed a “quasi-operational” Hypoxia Forecast Tool that has provided forecasts on VIMS website since Jan. 2016

• We have worked with NOAA NOS to get the oxygen formulation in the operational model and results posted to NOAA's developmental website for the Chesapeake

• Met with Chesapeake Bay Stakeholders to better understand what they are looking for in these forecasts, and the improvements they would like to see in the future
Future work:

Investigating methods for nudging modeled fields to observed high frequency fields ($T, S, DO$) at 10 locations.
Questions?