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Hypoxia forecasts as a tool for Chesapeake Bay fisheries

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Hypoxia Forecasts as a tool for Chesapeake Bay Fisheries

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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?

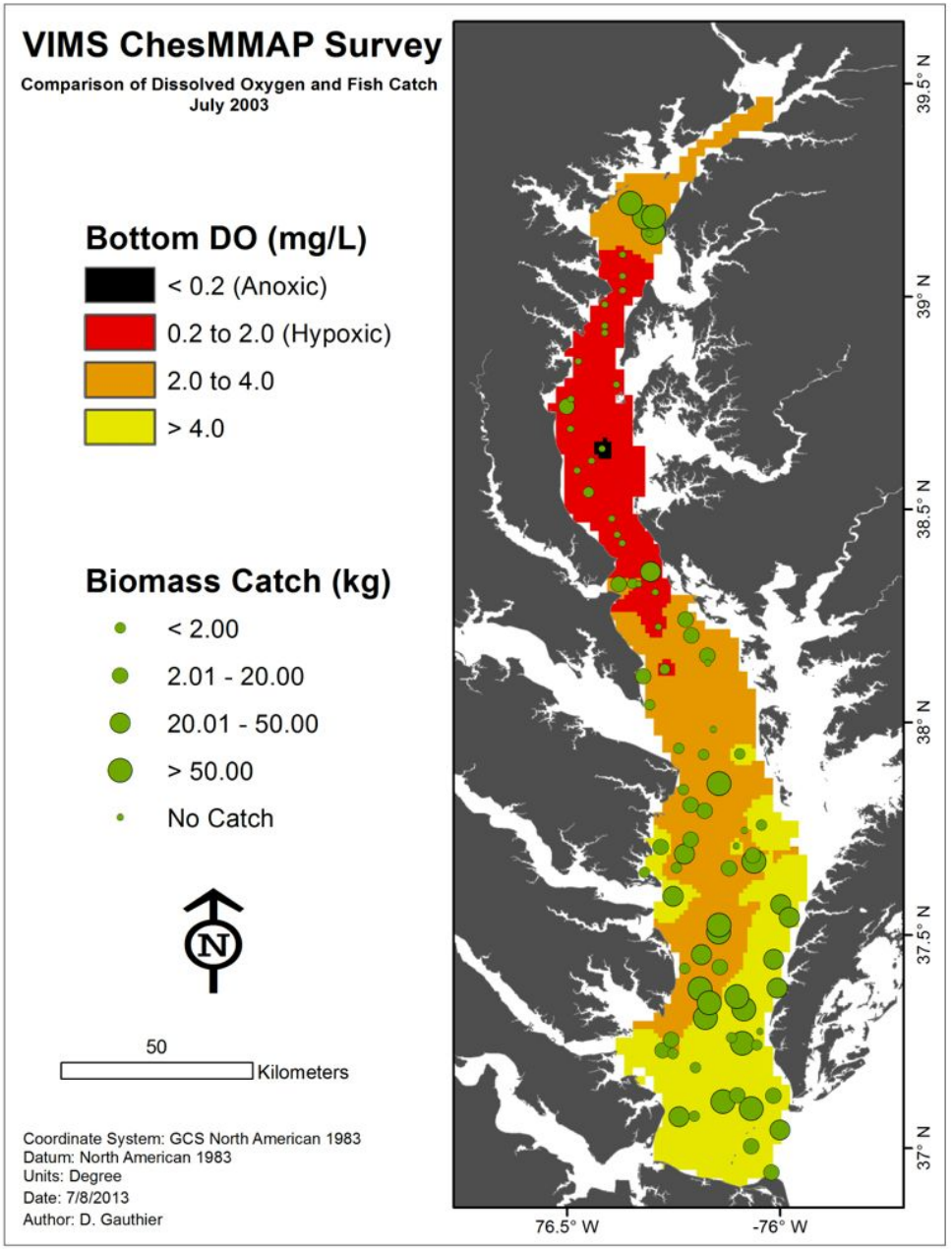
The Chesapeake Bay:

- 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:

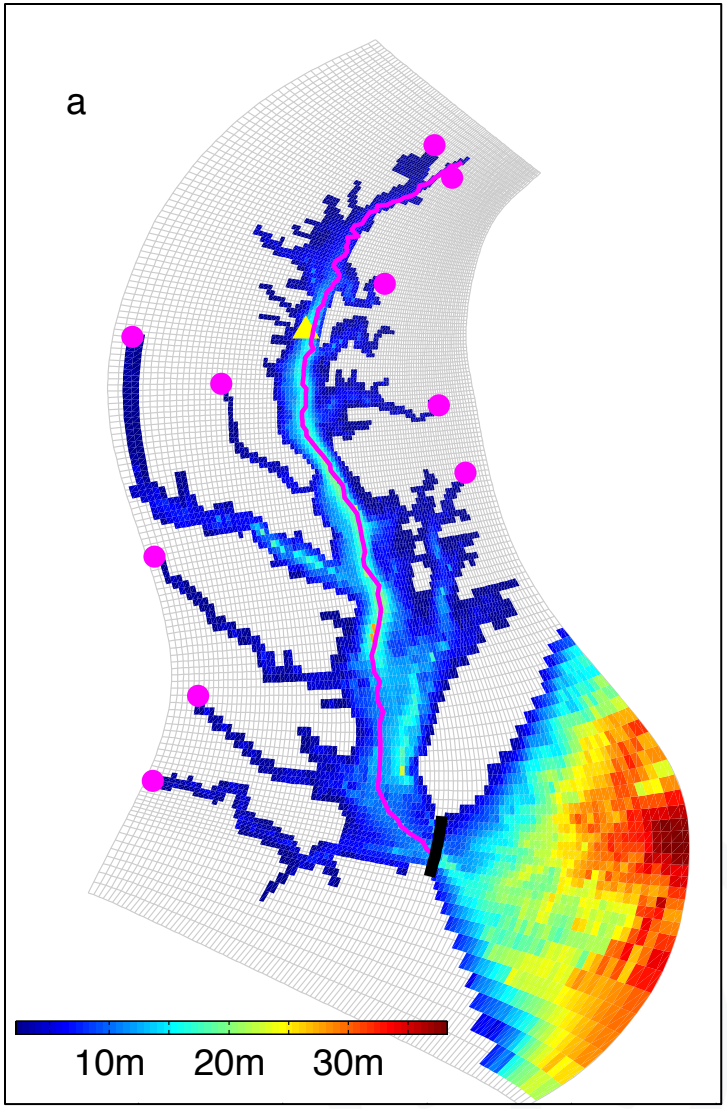
- Excessive nutrient run-off → algal blooms → algal decay → dead zones at bottom of the Bay
- Occur in summer: Warmer temperatures and less mixing
- Impact ecological resources in Bay, particularly demersal fish (low catches where DO < 3 mg/L)



Methods – Hypoxia forecast model

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)

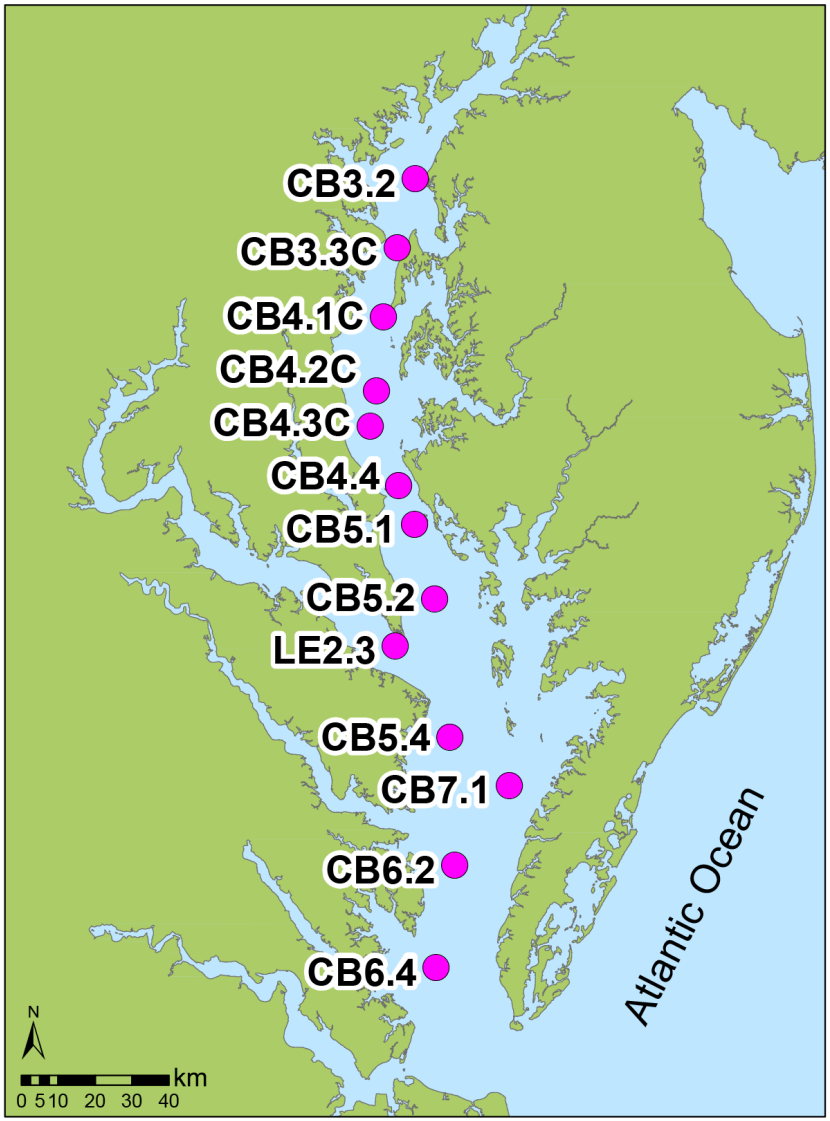


Methods – Evaluate with long term cruise data

Available data:

- Models were assessed by monthly data (semi-monthly in summer) at multiple locations throughout Bay from 1985-present.

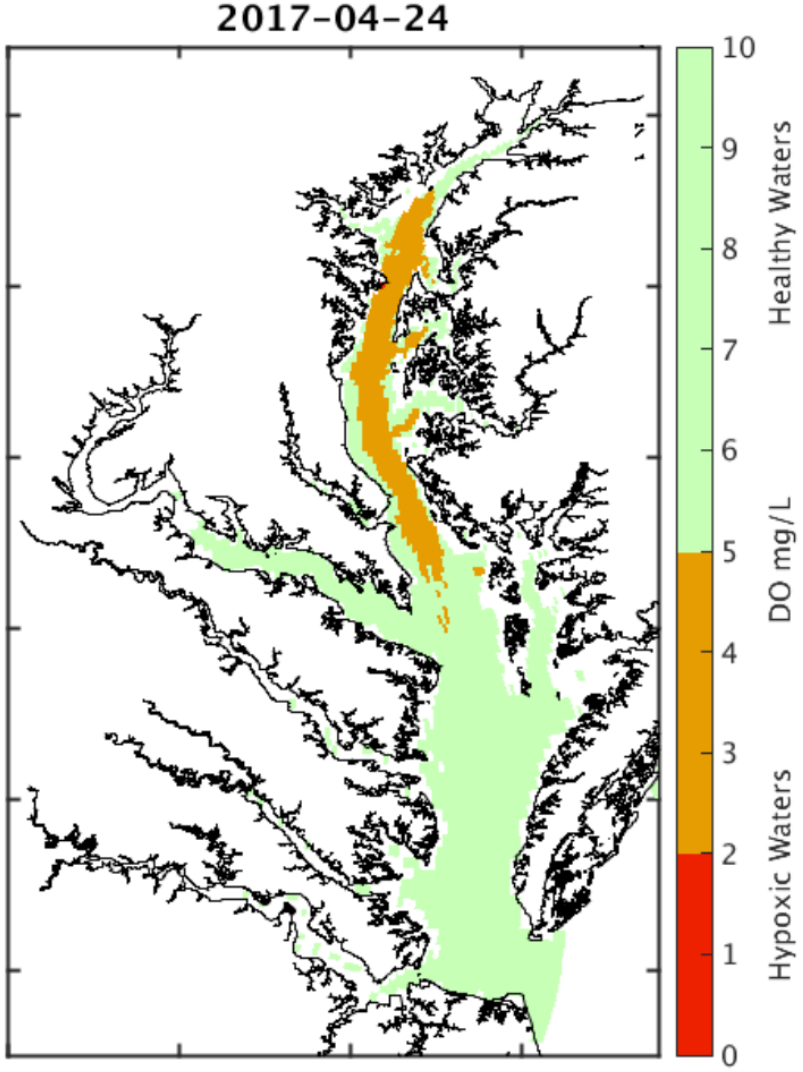
- Data includes S, T, DO and multiple other ecological parameters.



Chesapeake Hypoxia Forecast Tool

http://www.vims.edu/research/topics/dead_zones/forecasts/cbay/index.php

Yesterday's Oxygen Nowcast



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

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

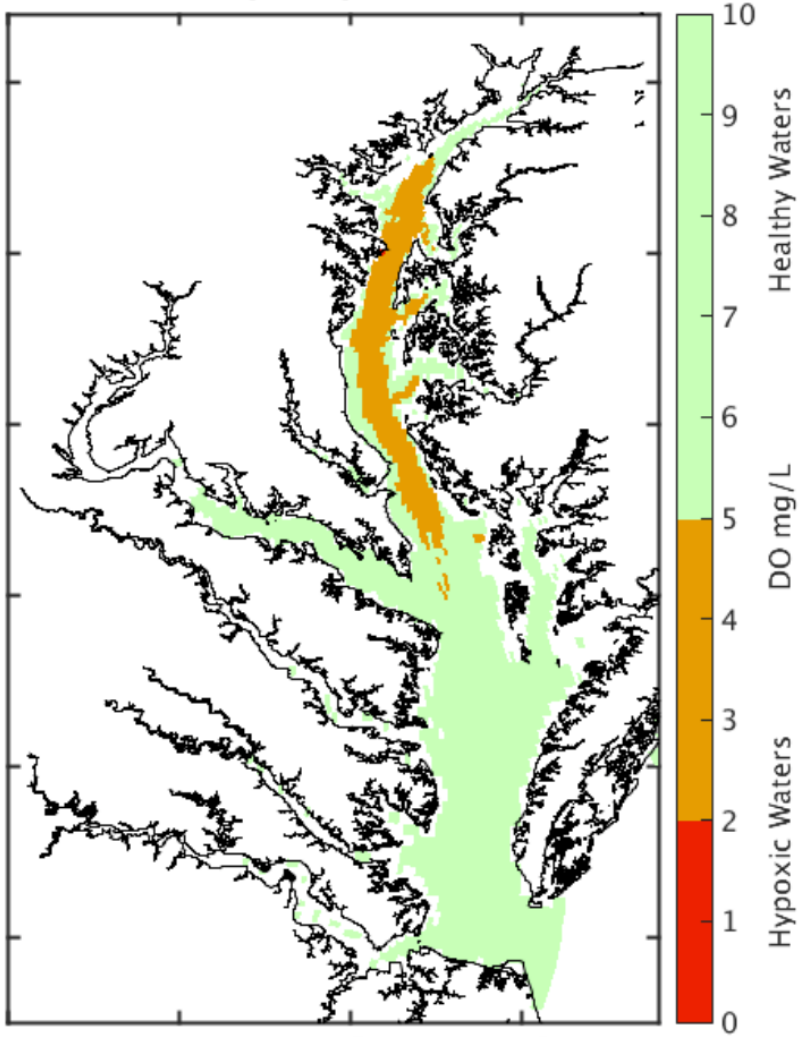
Red → Very low bottom oxygen
= Bad bottom water
= No bottom fish or crabs

Chesapeake Hypoxia Forecast Tool

http://www.vims.edu/research/topics/dead_zones/forecasts/cbay/index.php

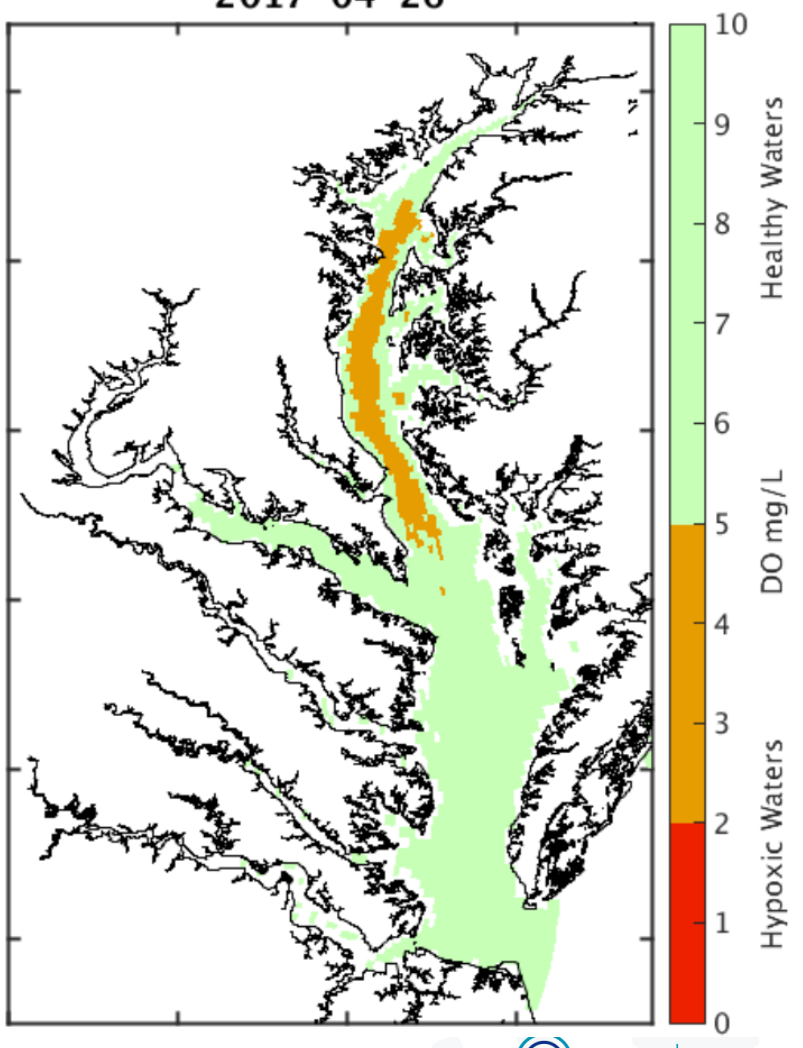
Yesterday's Oxygen Nowcast

2017-04-24



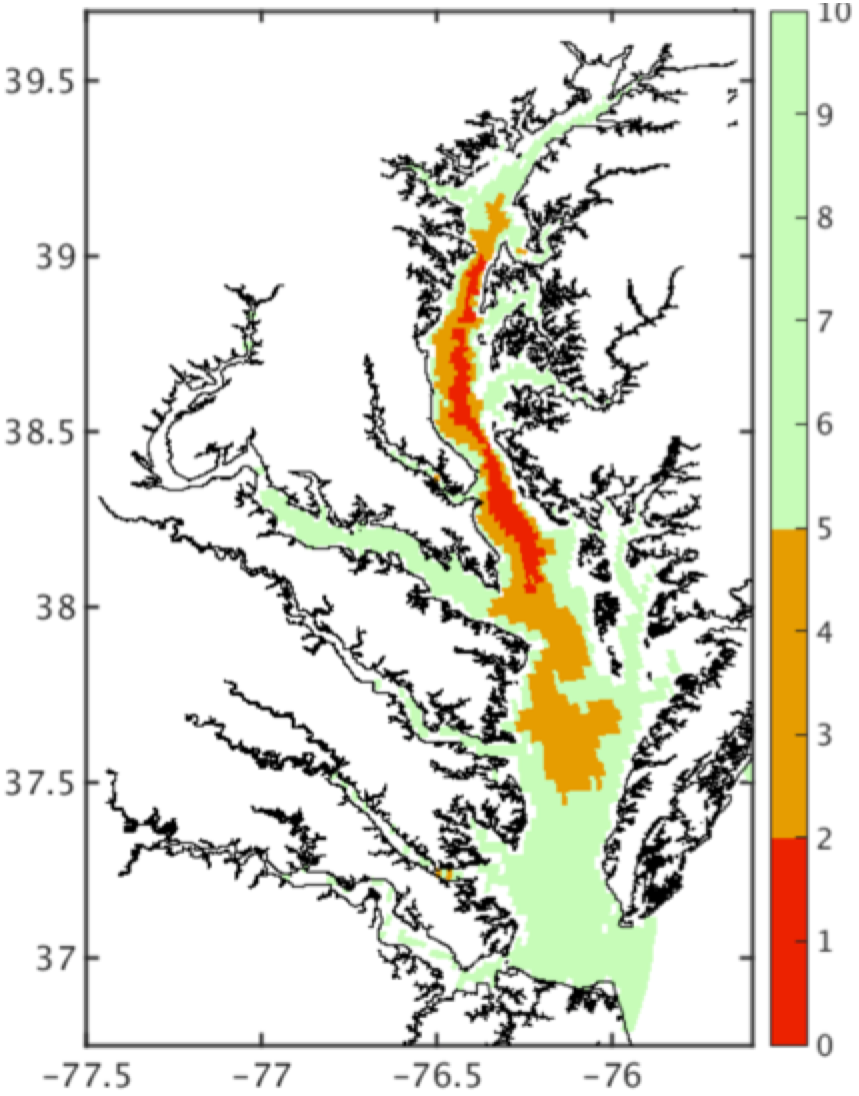
Yesterday's Oxygen Forecast

2017-04-26

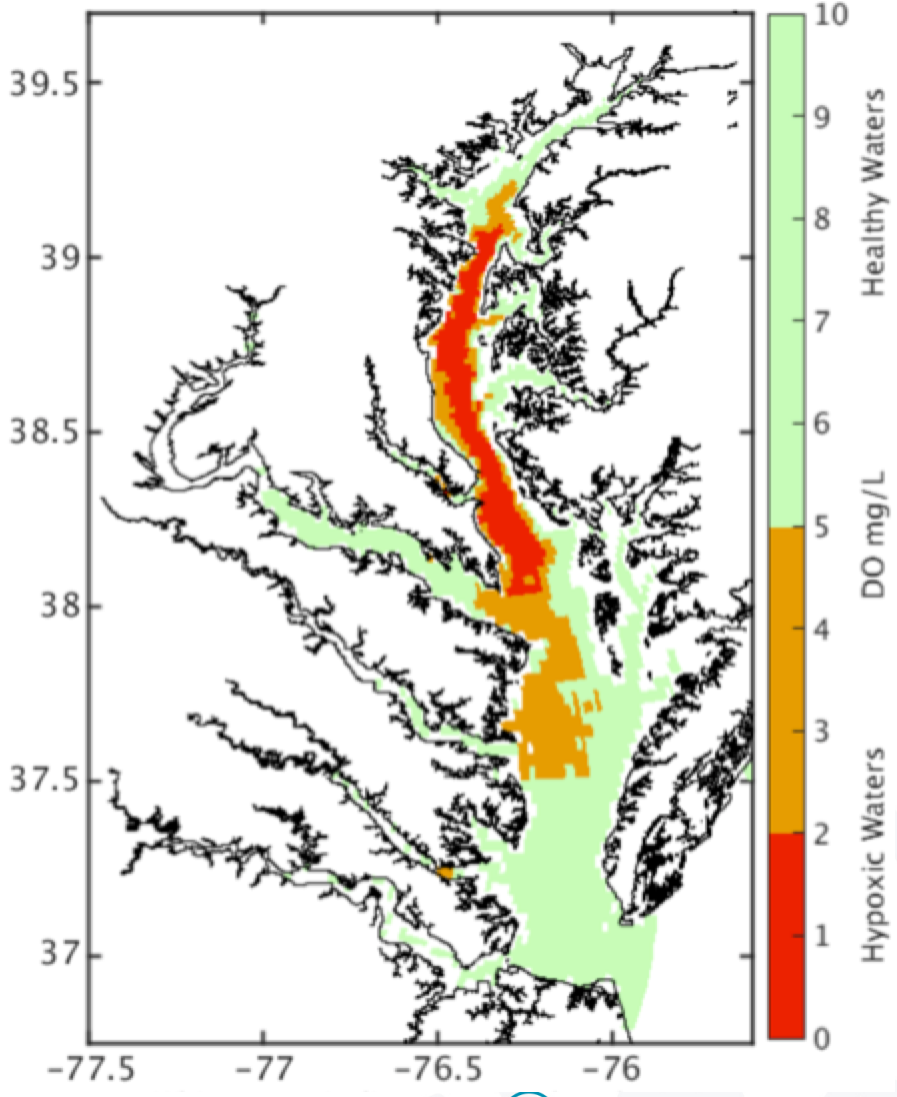


Chesapeake Hypoxia Forecast Tool

1 June 2016 Oxygen Nowcast



3 June 2016 Oxygen Forecast



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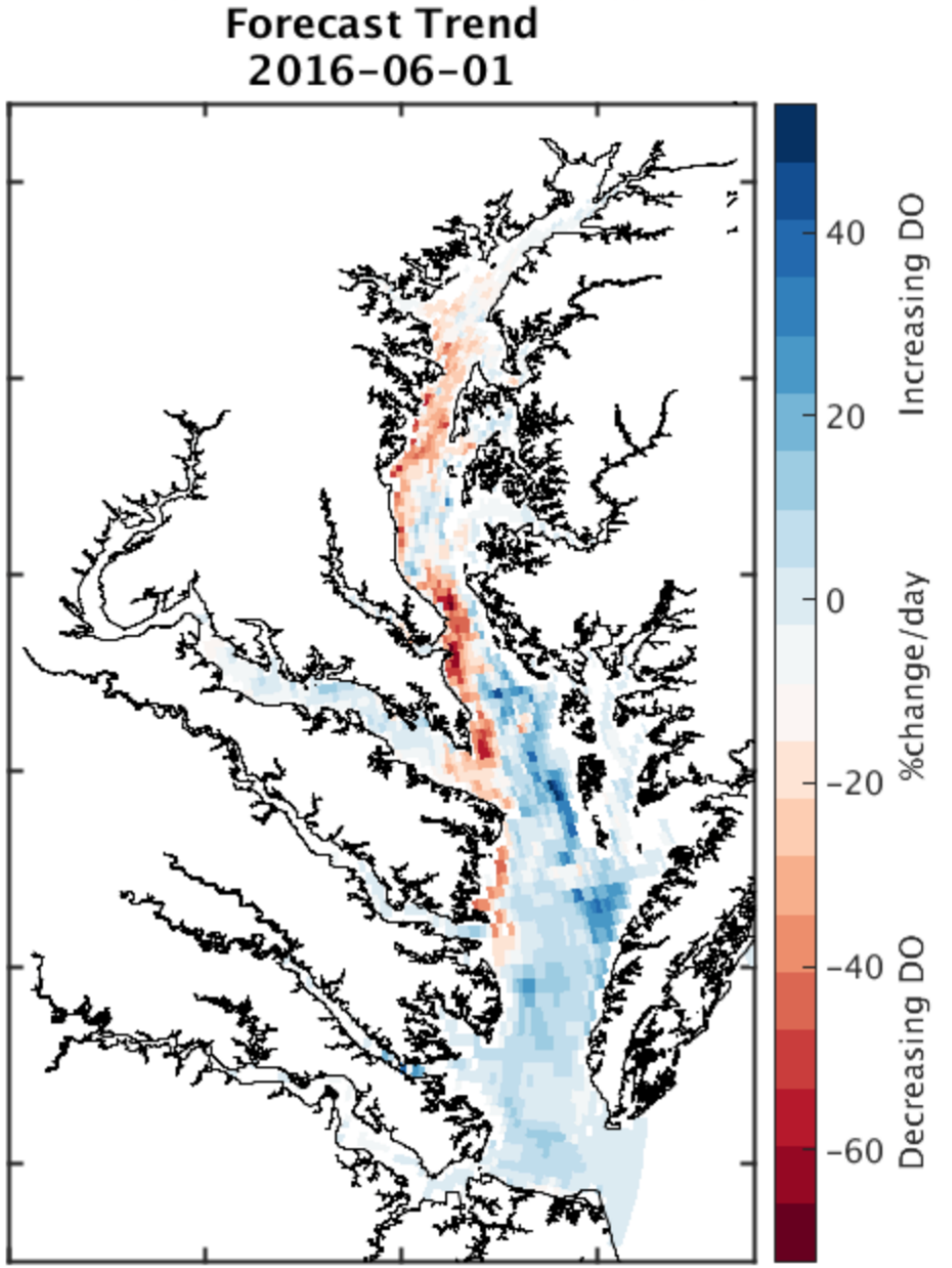
Chesapeake Hypoxia Forecast Tool

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

Red → Decreasing oxygen
(Degrading bottom water in western Bay)

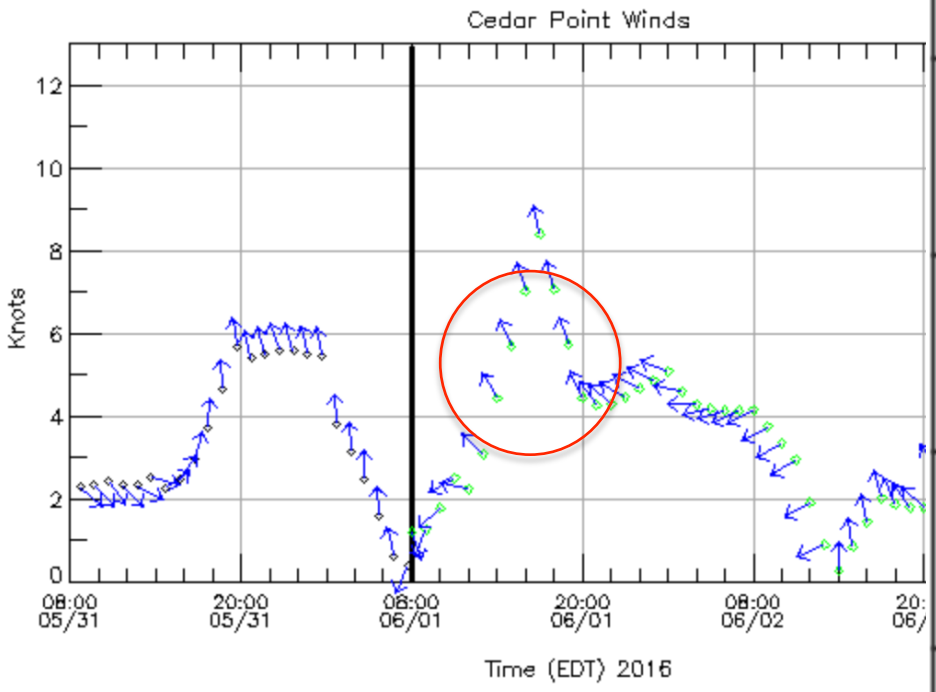


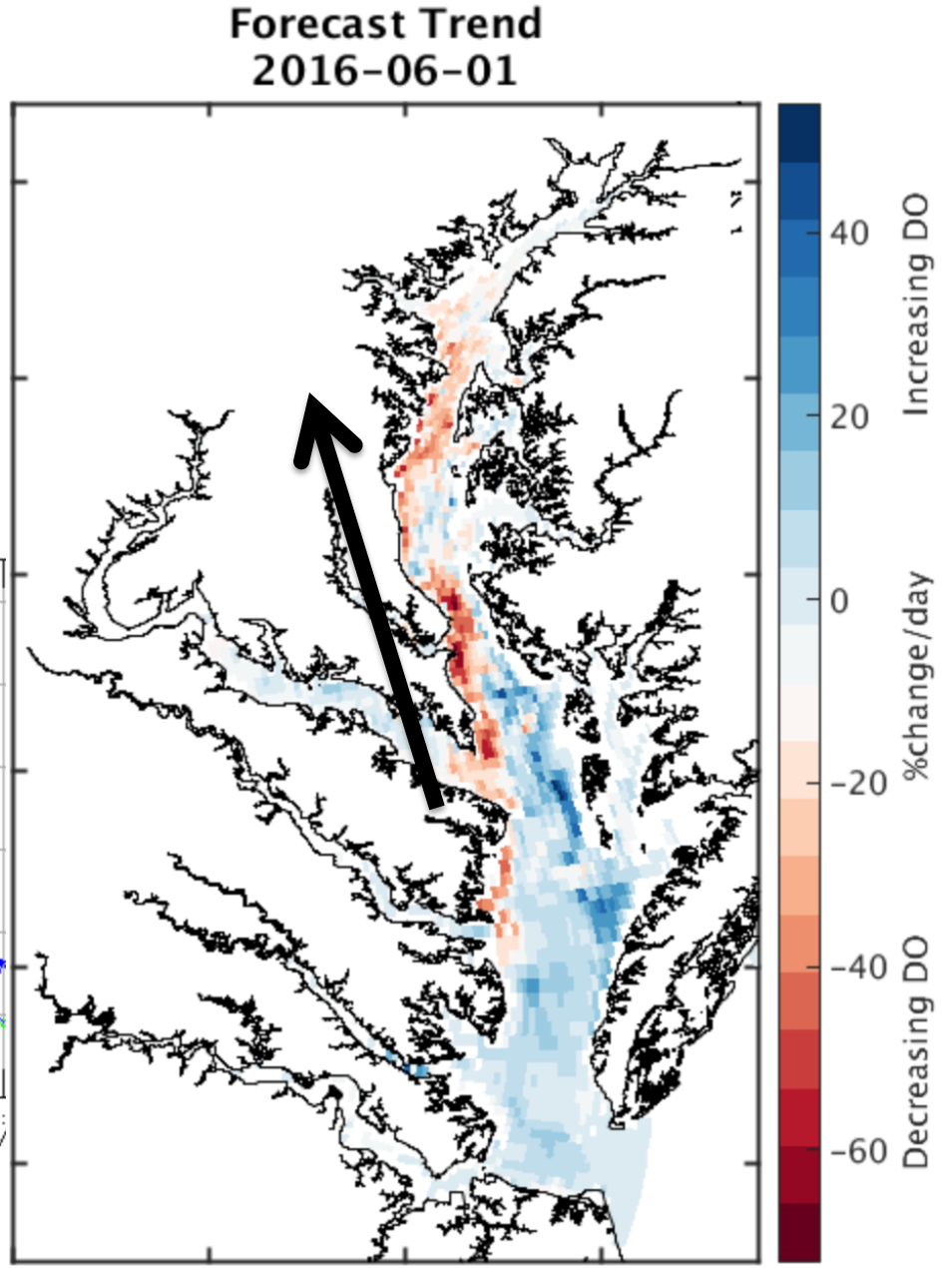
Chesapeake Hypoxia Forecast Tool

SSE wind transports high oxygen surface water to the east, upwells low oxygen water in west

NOAA/National Ocean Service
Chesapeake Bay Operational
Forecast System (CBOFS2)

Observation:
Nowcast:
Forecast Guidance:

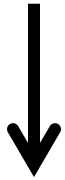




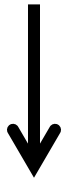
Chesapeake Hypoxia Forecast Tool

"Quasi-operational" forecasts

on VIMS website:
http://www.vims.edu/research/topics/dead_zones/forecasts/cbay/index.php



transition



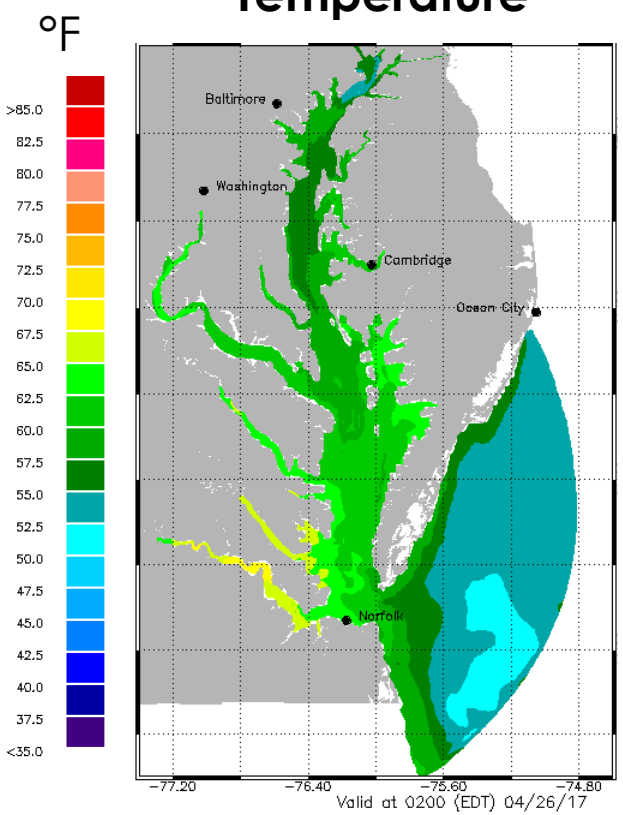
Truly operational forecasts

on NOAA on CBOFS site:
https://tidesandcurrents.noaa.gov/ofs/cbofs/cbofs.html

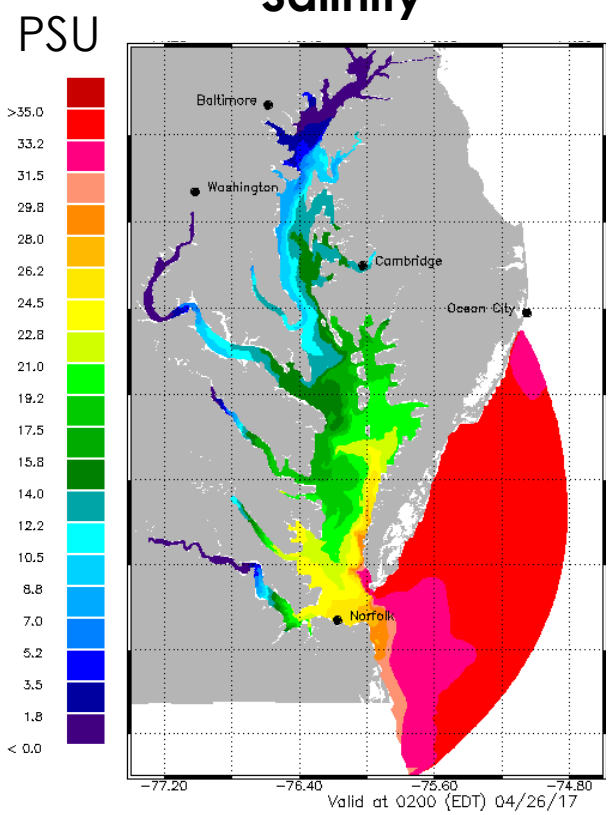
NOAA CBOFS Forecasts

Operational Forecast Site

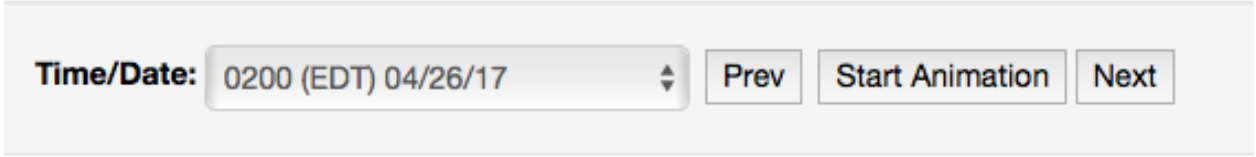
Surface Temperature



Surface Salinity



Ecological Forecasting: oxygen/hypoxia?



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NOAA CBOFS Forecasts

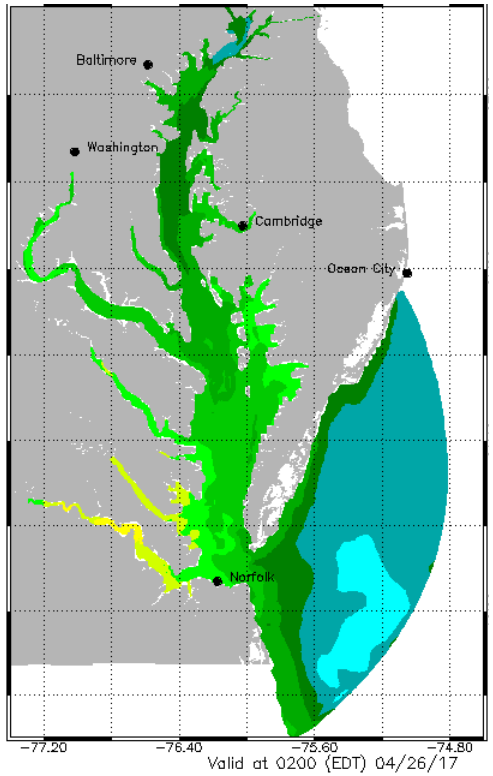
Operational Forecast Site

Developmental Site

Surface Temperature

°F

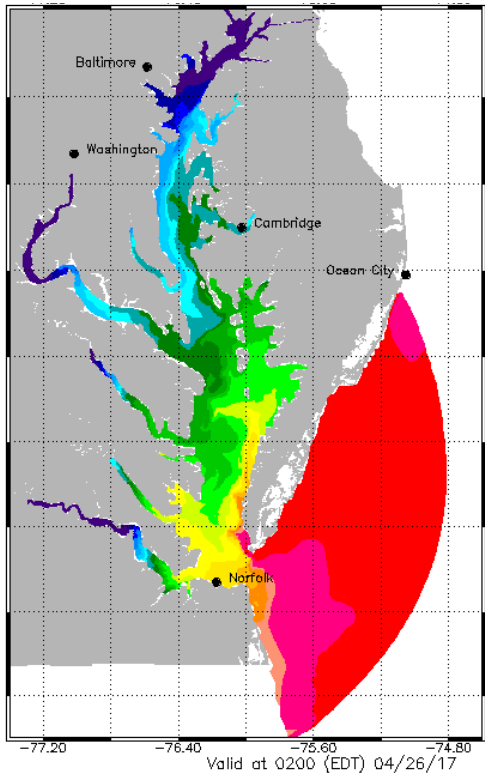
>85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
<35.0



Surface Salinity

PSU

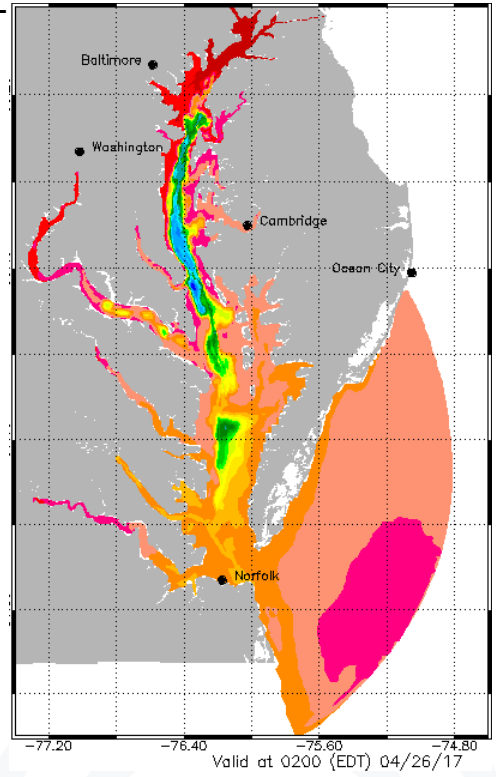
>35.0
33.2
31.5
29.8
28.0
26.2
24.5
22.8
21.0
19.2
17.5
15.8
14.0
12.2
10.5
8.8
7.0
5.2
3.5
1.8
< 0.0



Bottom Oxygen

mg/L

>10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
< 0.0



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Stakeholder Workshop (April 2016, VIMS)

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

Stakeholder Workshop (April 2016, VIMS)

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

Summary

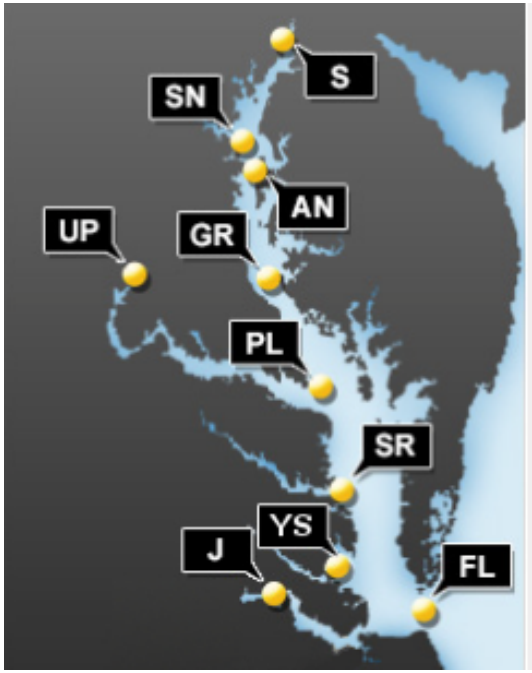
COMT Estuarine Hypoxia Testbed

- 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

Future work:

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



Questions?


NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE