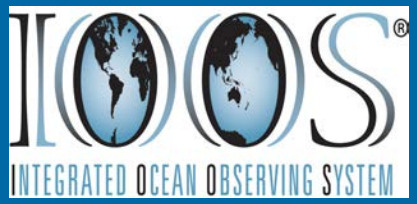
Evaluating water quality in the Chesapeake Bay using water quality models from both the government and academia.

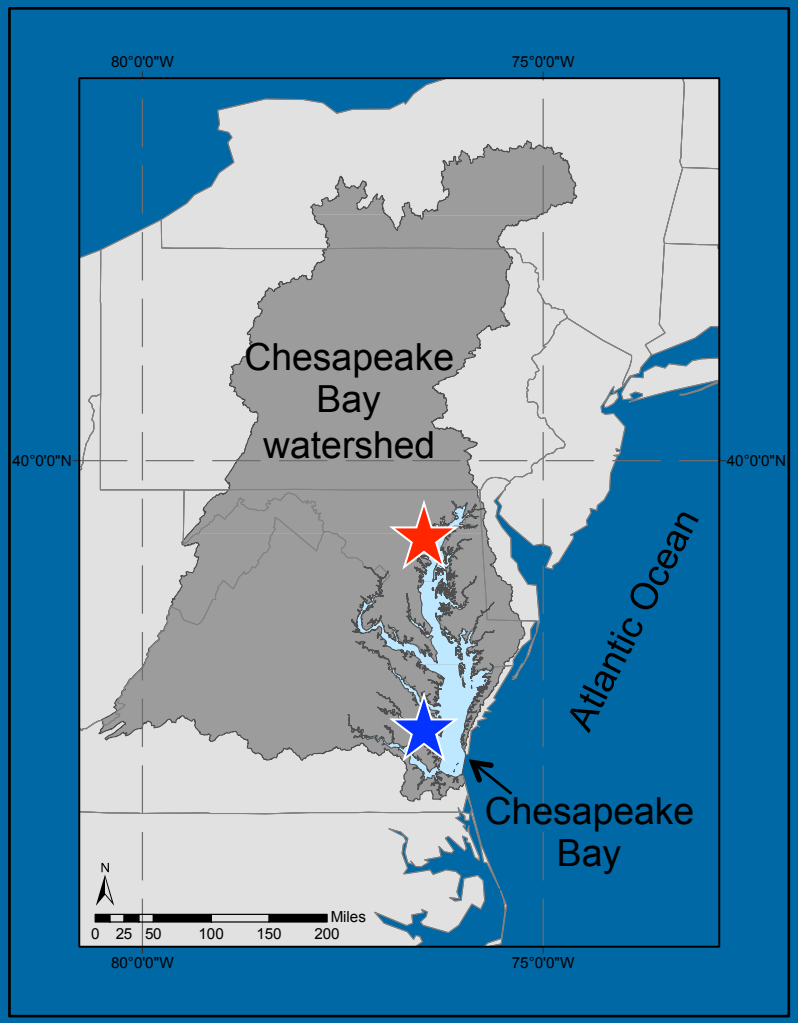
Isaac (Ike) Irby, PhD/MPP Candidate

Advisor: Marjorie Friedrichs

Coastal Ocean Modeling Testbed: Chesapeake Bay Estuarine Hypoxia



Chesapeake Bay



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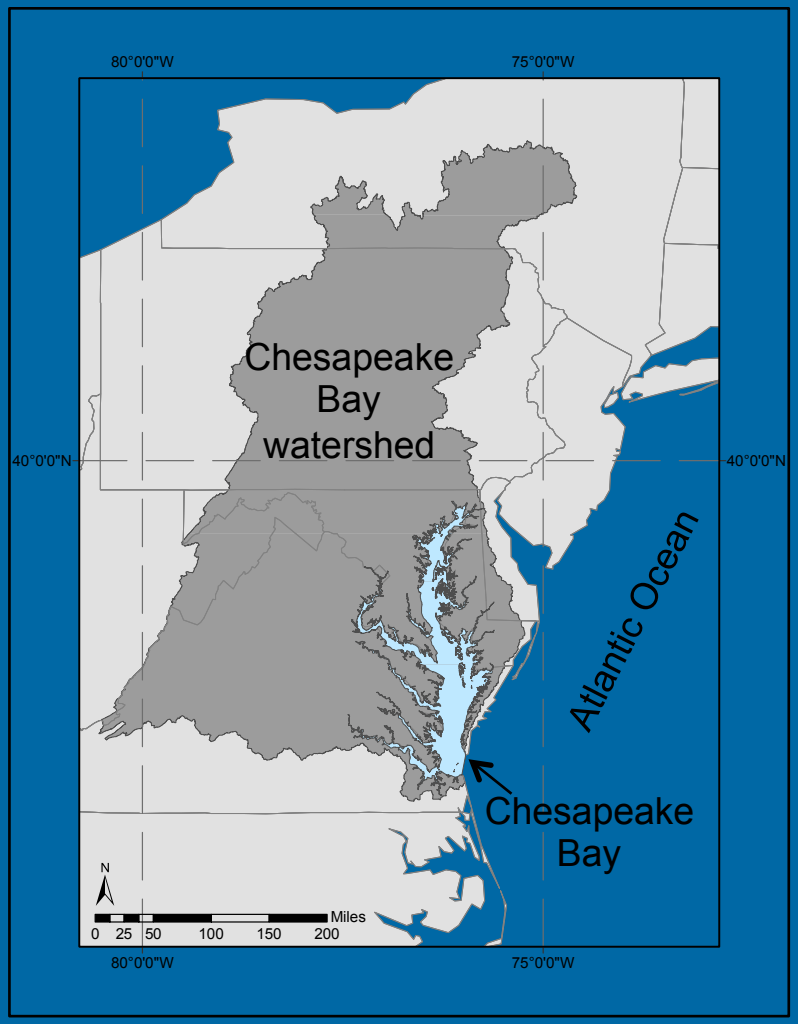
1940-2015 75 Years

Chesapeake Bay



- Water Quality Issues
- Regulatory Actions
  - Dissolved Oxygen
- Modeling Efforts
  - Government
  - Academia

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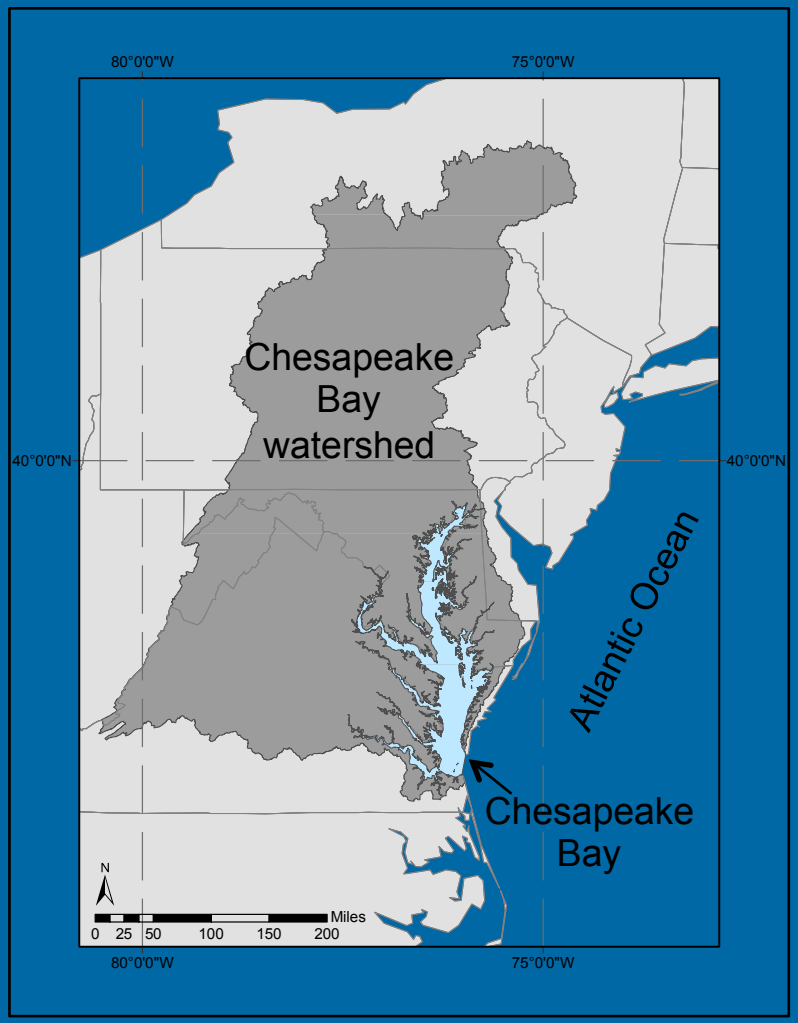
Chesapeake Bay



Long term research goal:

Repeat the regulatory water quality modeling process used to define nutrient loading regulations with an academic model

- **Assess skill of regulatory and academic models**

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Prior Research

Challenges associated with modeling low-oxygen waters in Chesapeake Bay: a multiple model comparison

Isaac D. Irby[1], Marjorie A. M. Friedrichs[1], Carl T. Friedrichs[1], Aaron J. Bever[2], Raleigh R. Hood[3], Lyon W. J. Lanerolle[4,5], Ming Li[6], Lewis Linker[7], Malcolm E. Scully[8], Kevin Sellner[9], Jian Shen[1], Jeremy Testa[6], Hao Wang[3], Ping Wang[10], and Meng Xia[11]

Biogeosciences
doi: 10.5194/bg-13-2011-2016

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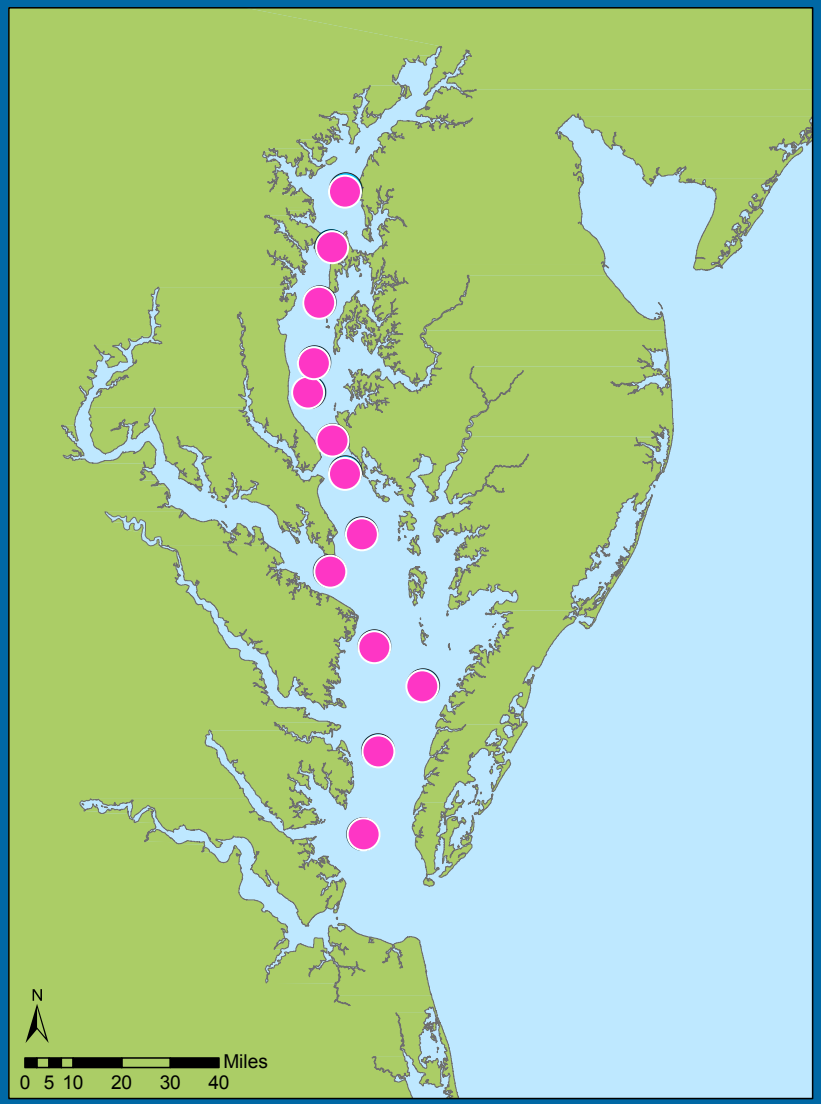
Prior Research



8 Water Quality Models

13 Observation Stations

2004 – 2005

- **All models exhibited skill in simulating seasonal DO variability**
  - **Independent of BGC complexity**
  - **Physical processes (wind-mixing, advection, solubility) influence seasonal DO cycle**

What about interannual variability?
What about the rest of the Bay?

Biogeosciences
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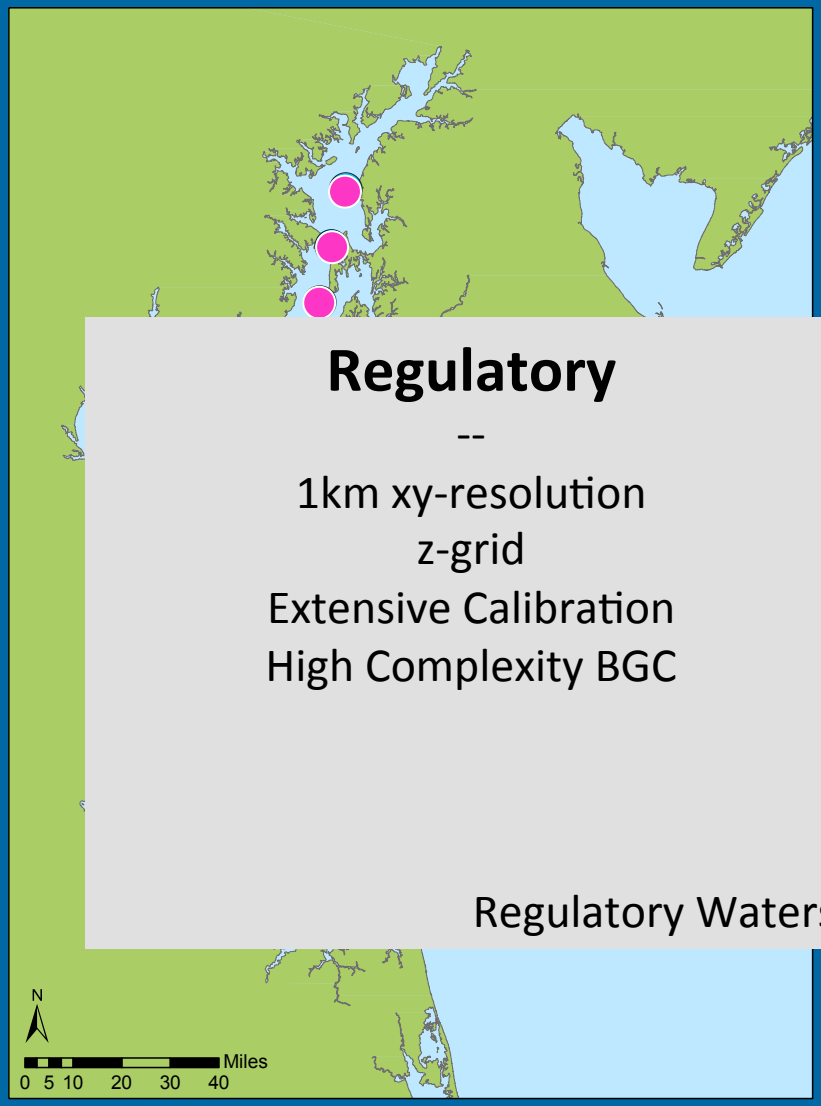
Current Research



Models

Regulatory: CH3D-ICM

Academic: ChesROMS-ECB

Regulatory	Academic
--	--
1km xy-resolution	1.8km xy-resolution
z-grid	sigma-grid
Extensive Calibration	Community Model
High Complexity BGC	Intermediate Complexity BGC

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Regulatory Watershed Model Forcing

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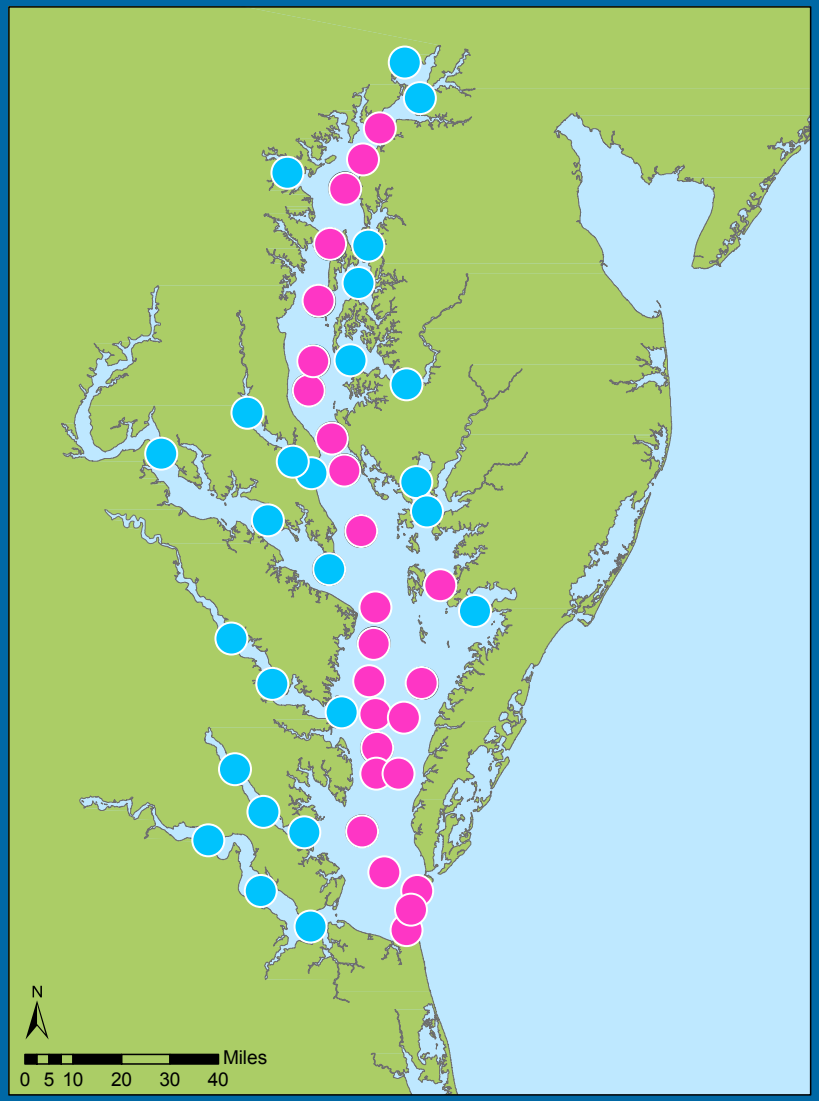
1940-2015 75 Years

Current Research



Models

Regulatory: CH3D-ICM

Academic: ChesROMS-ECB

Years

2001 – 2005

~16 Profiles/Station/Year

Stations

50 Observation Stations

- **25 Mains Stem**
- **25 Tributary**

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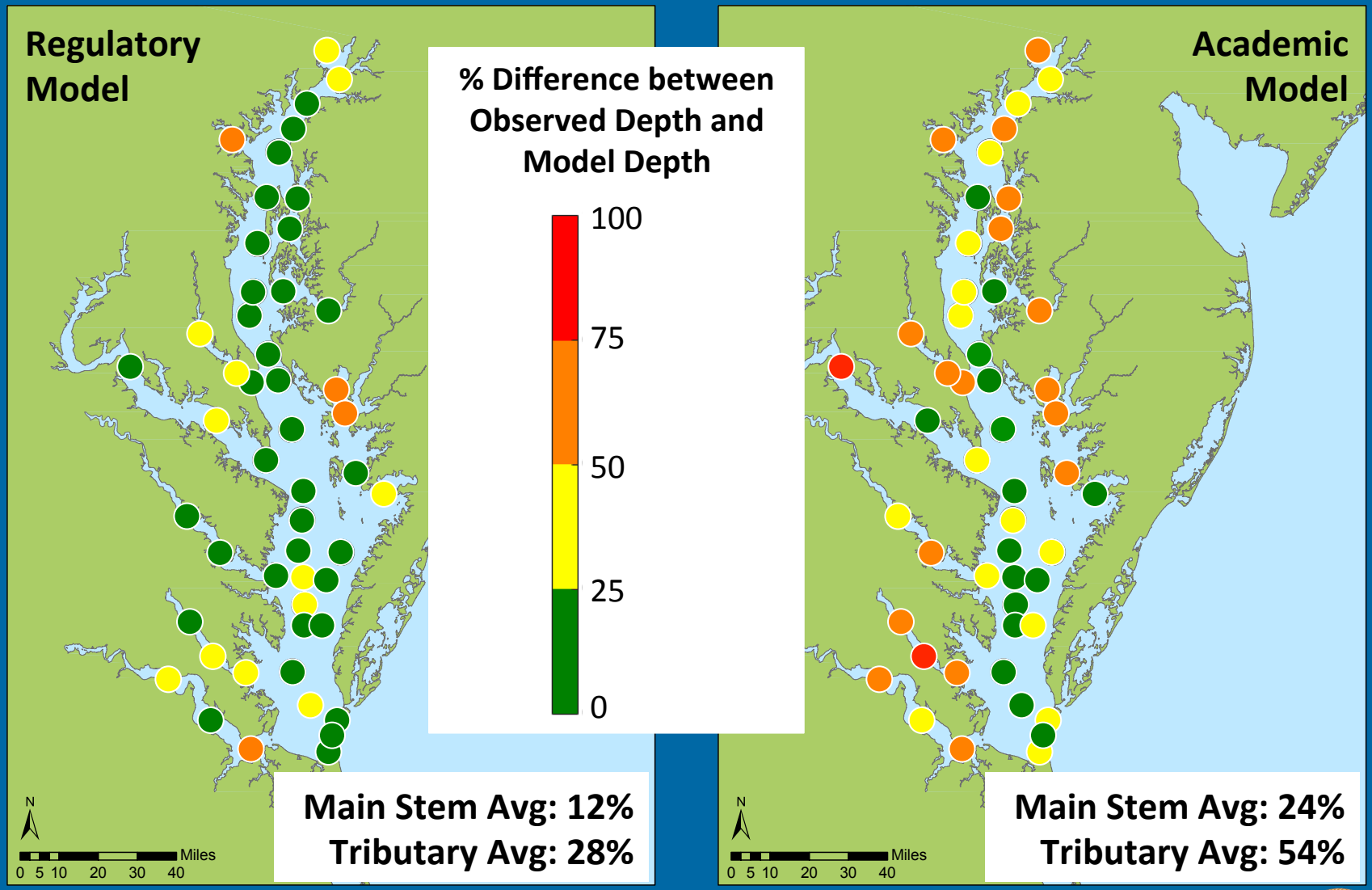
1940-2015 75 Years

Current Research



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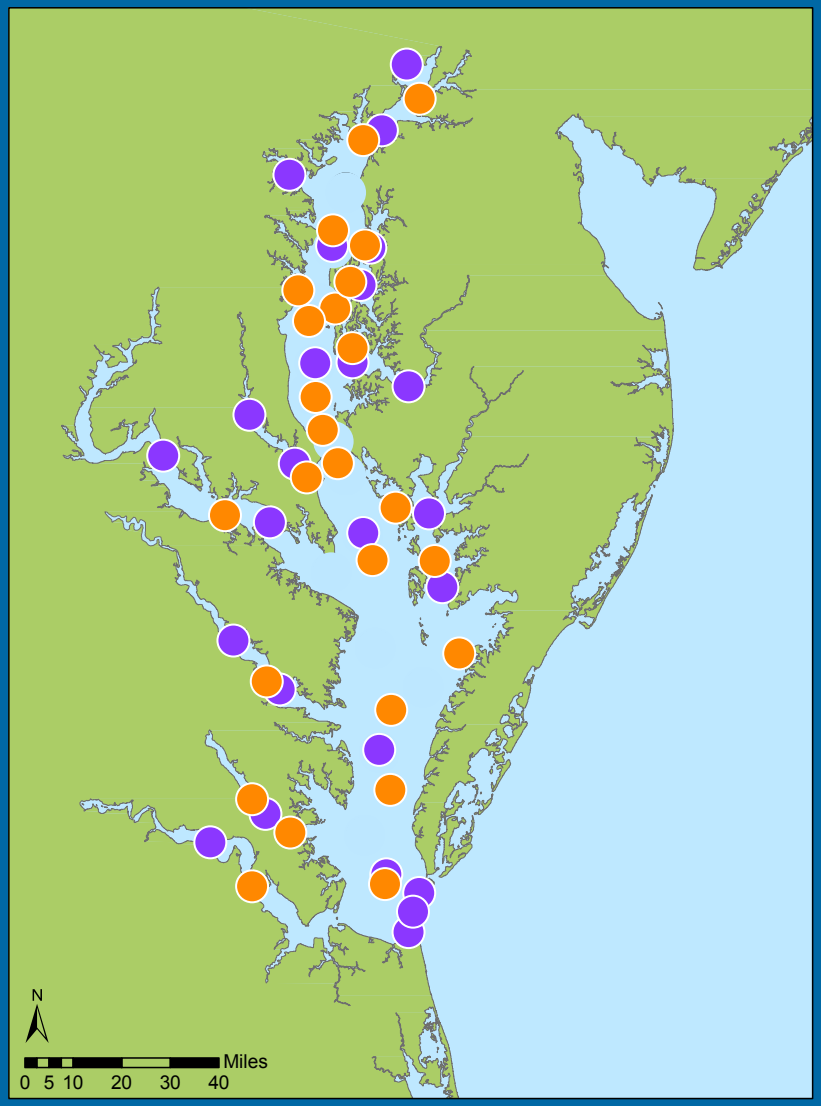

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25 Calibration Stations

25 No-data Stations

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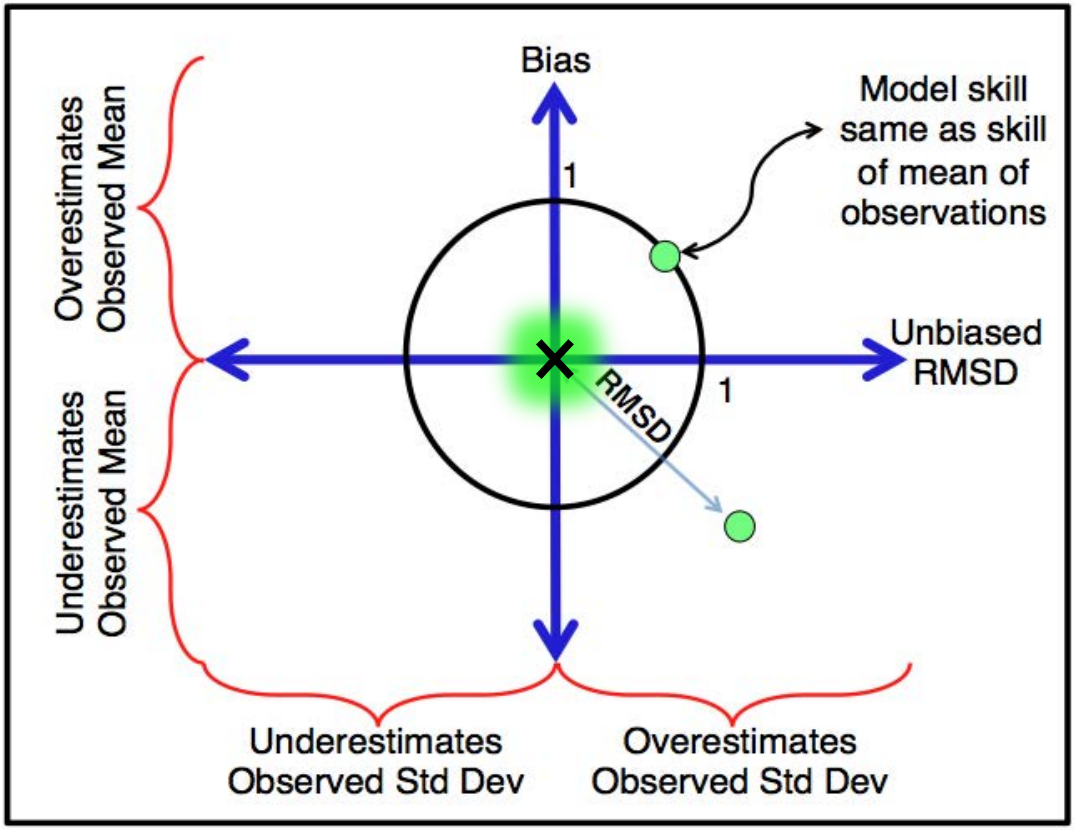
1940-2015 75 Years

Skill Assessment

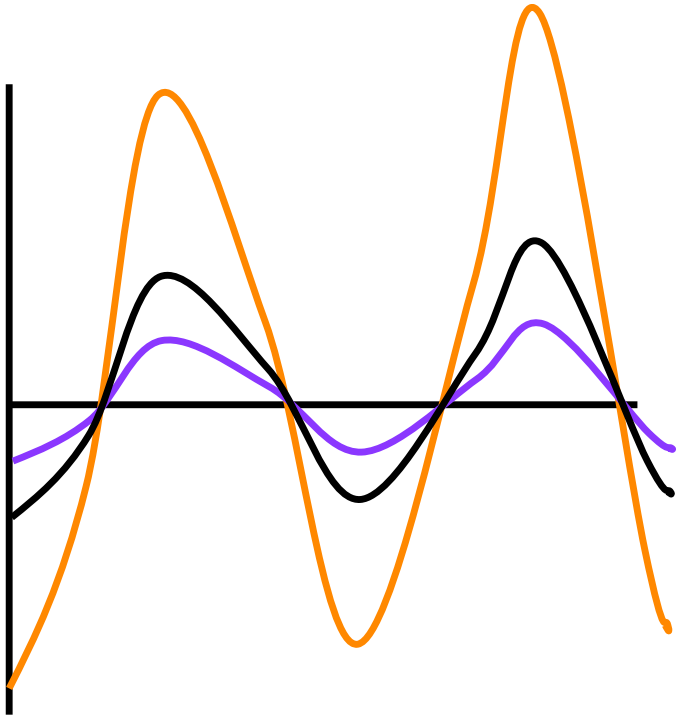
Target Diagram

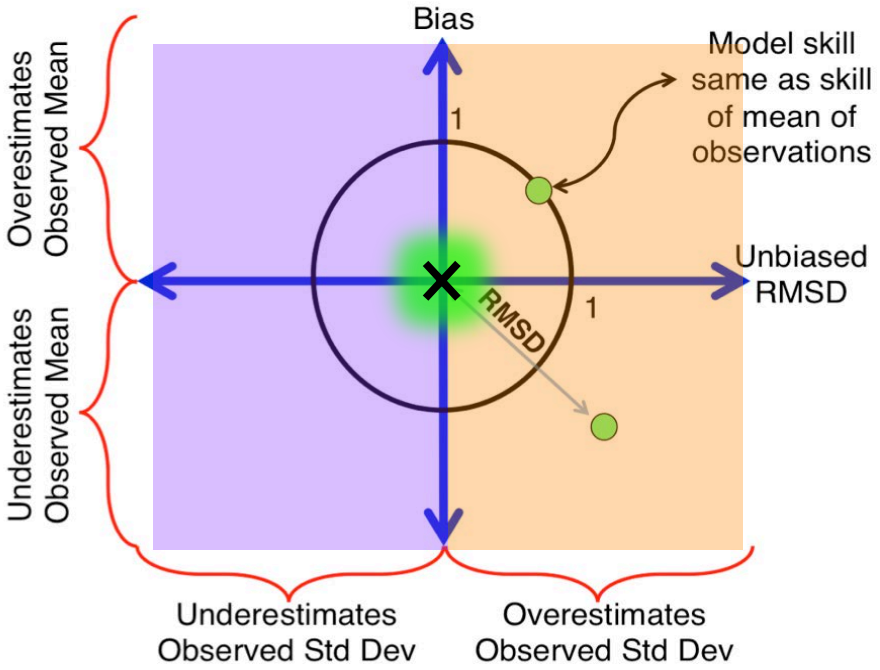
***Normalized**



Skill Assessment

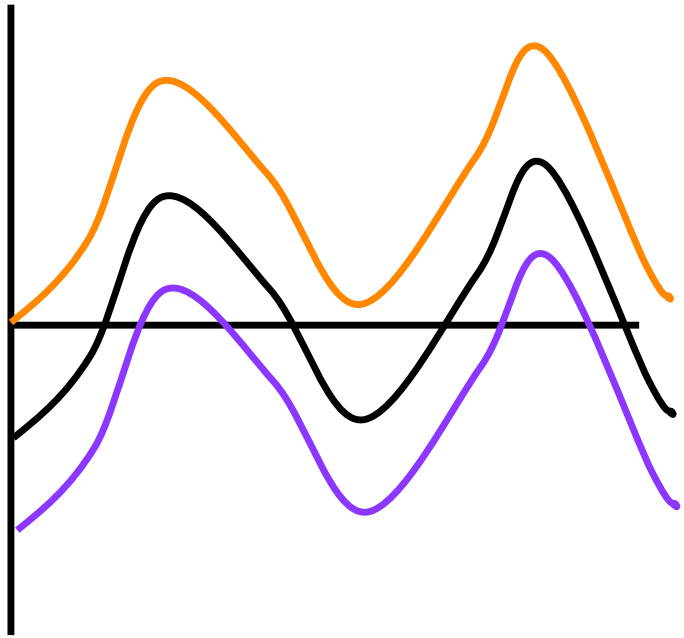
Target Diagram

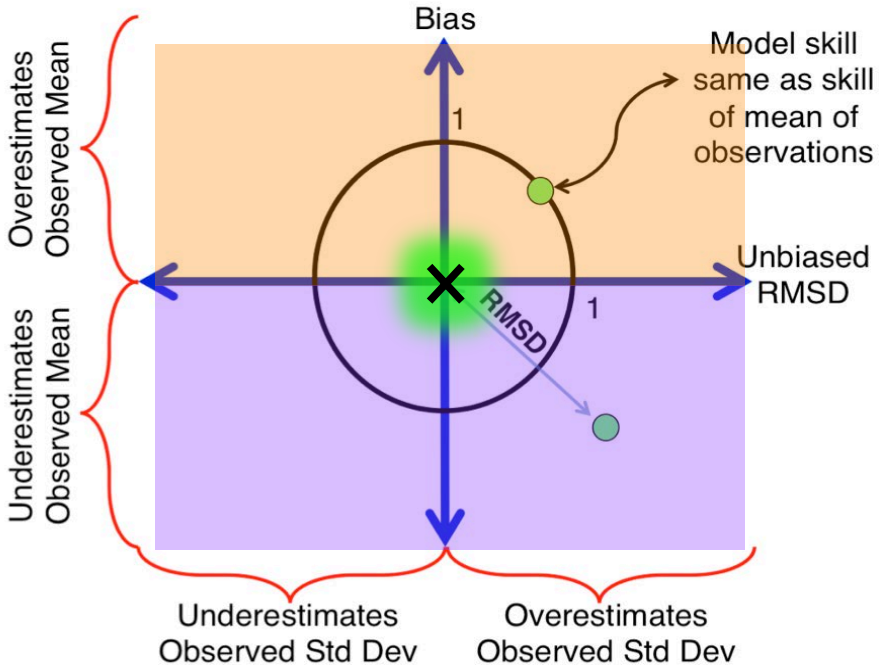




Skill Assessment

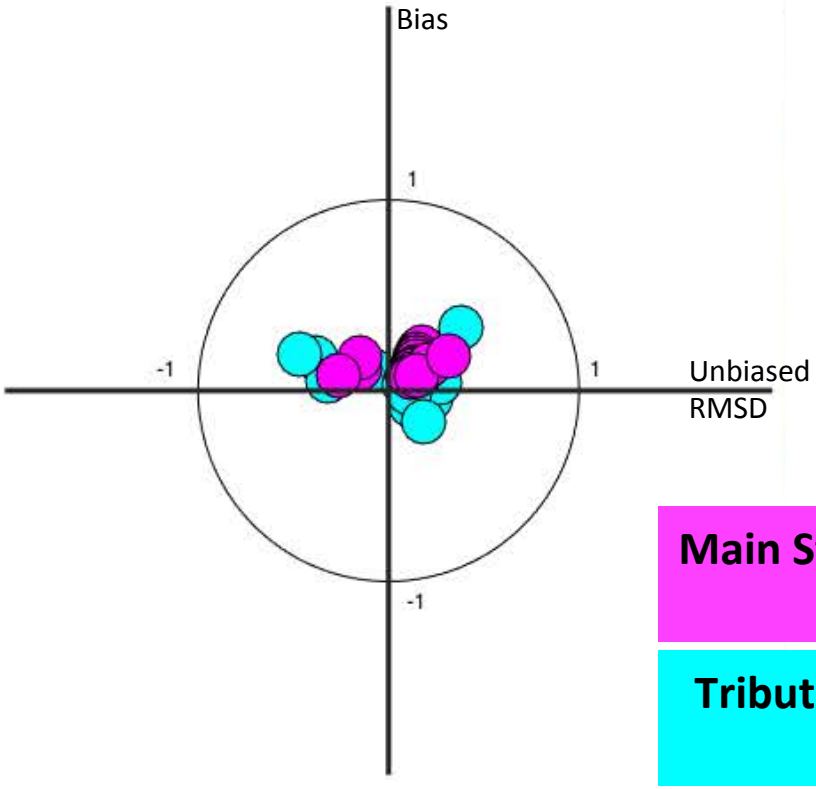
Target Diagram



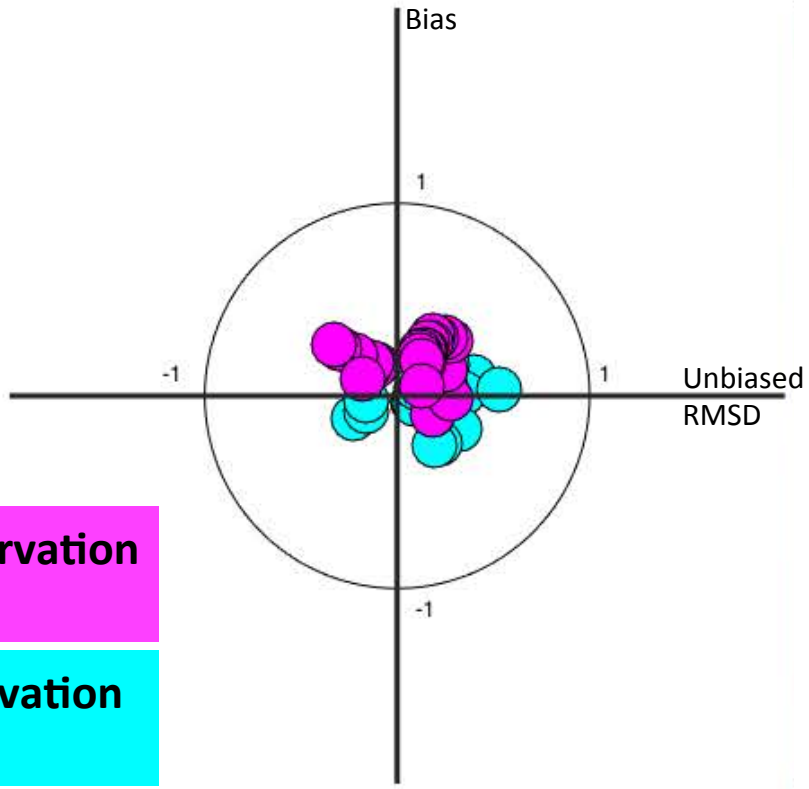


Bottom Temperature

Regulatory Model



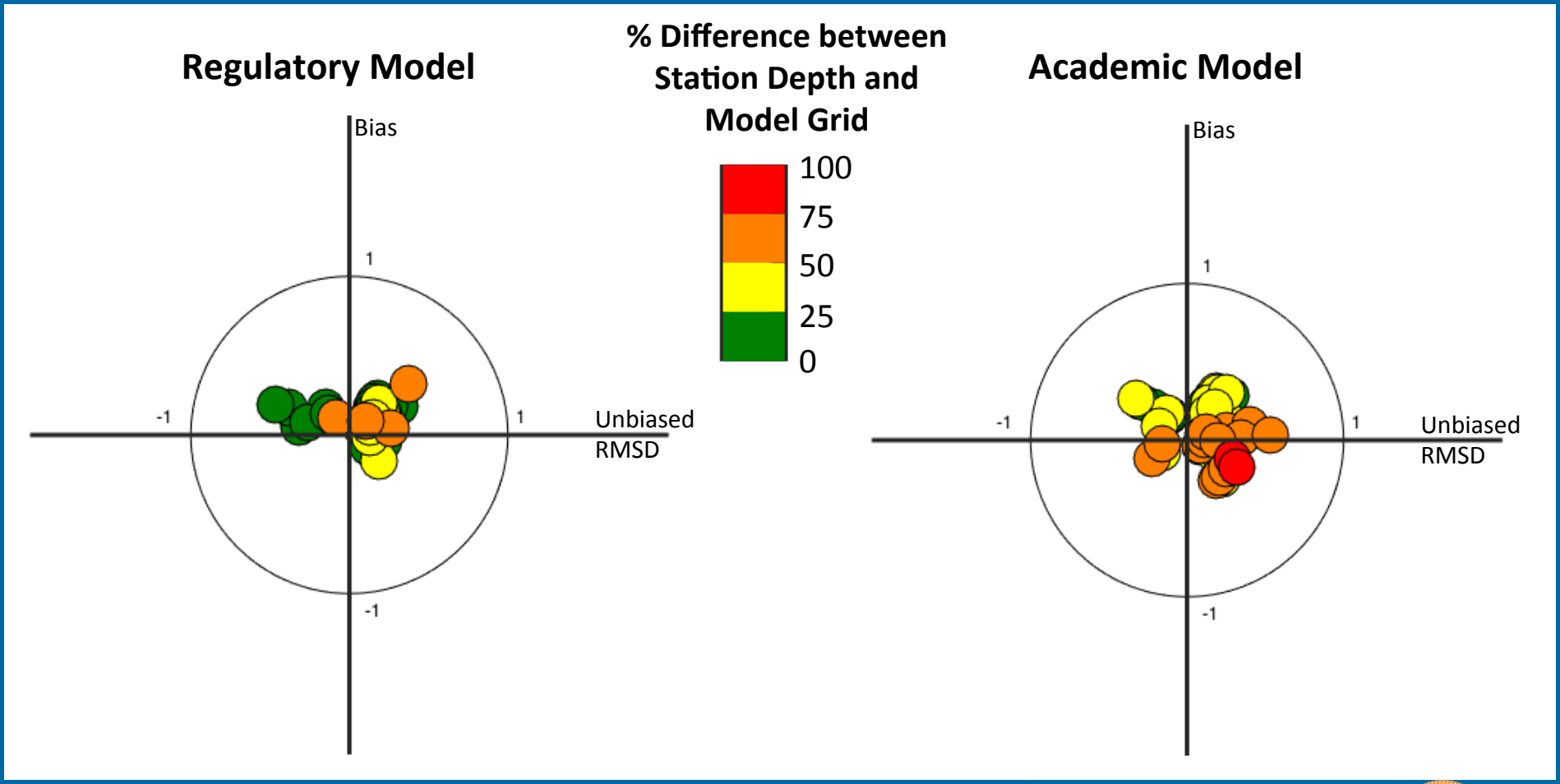
Academic Model



Main Stem Observation Stations

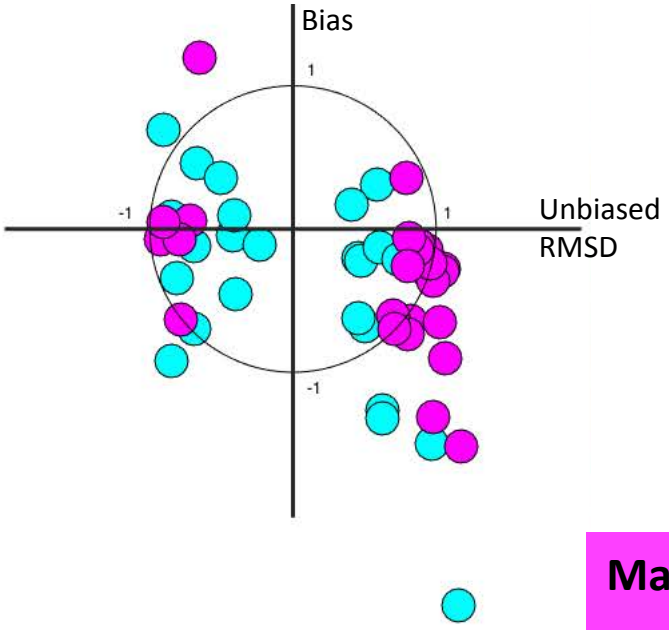
Tributary Observation Stations

Bottom Temperature

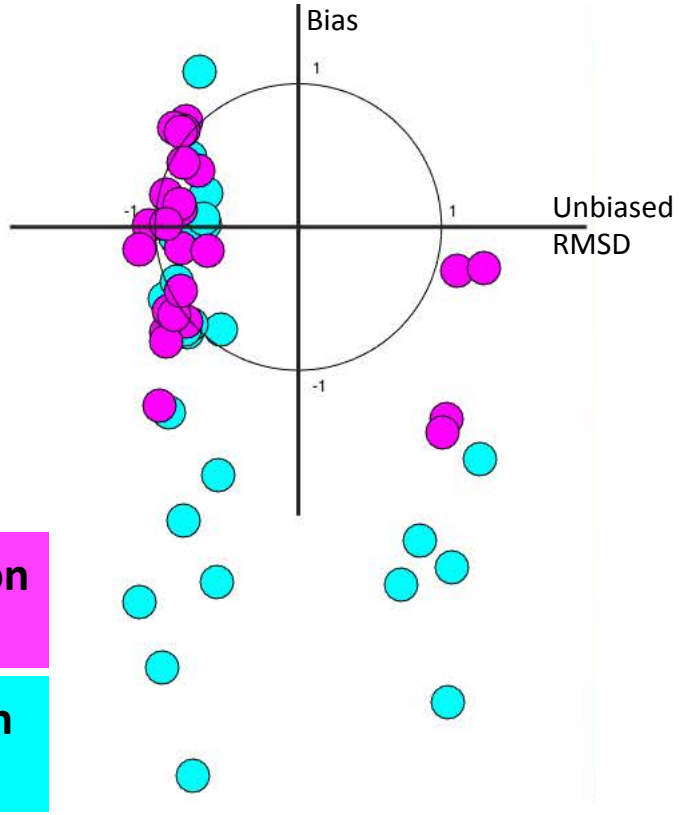


Bottom Salinity

Regulatory Model



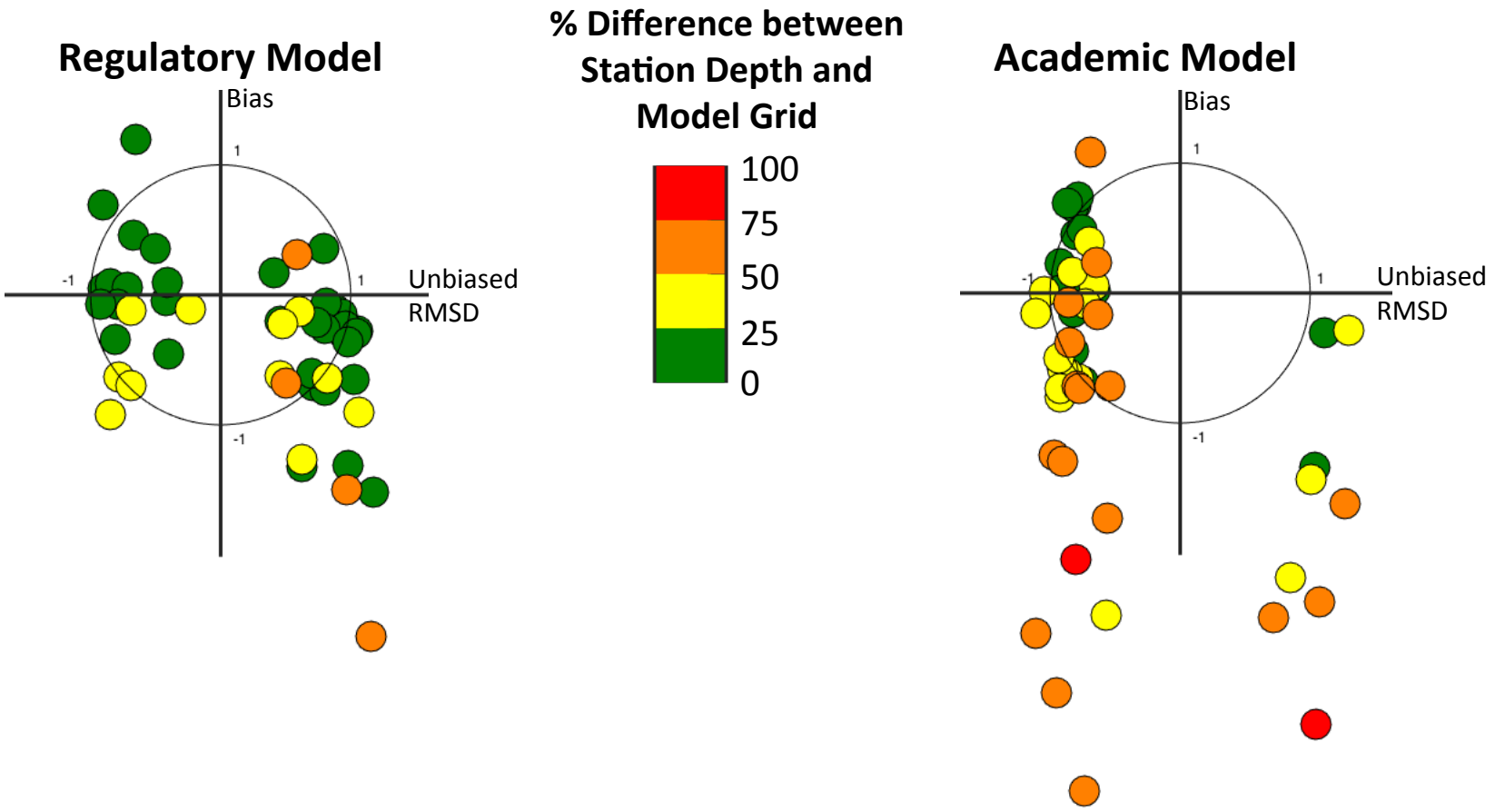
Academic Model



Main Stem Observation Stations

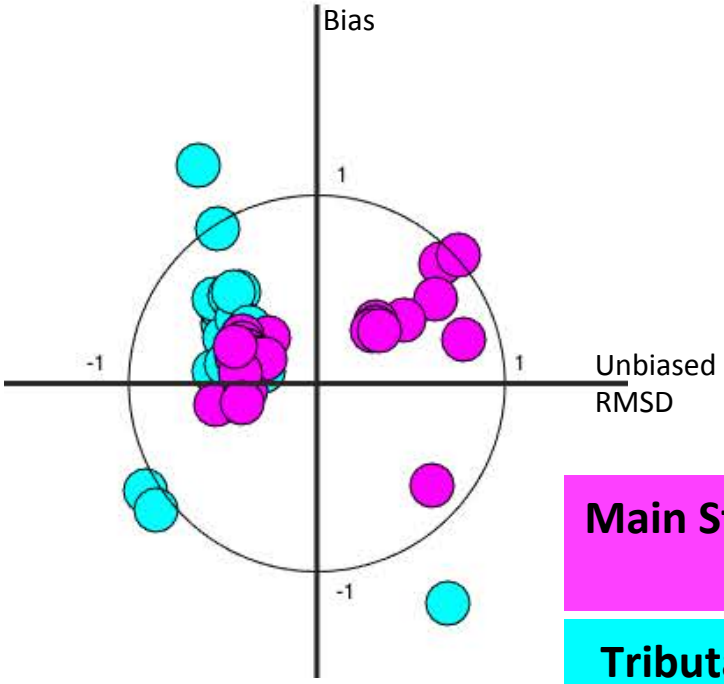
Tributary Observation Stations

Bottom Salinity

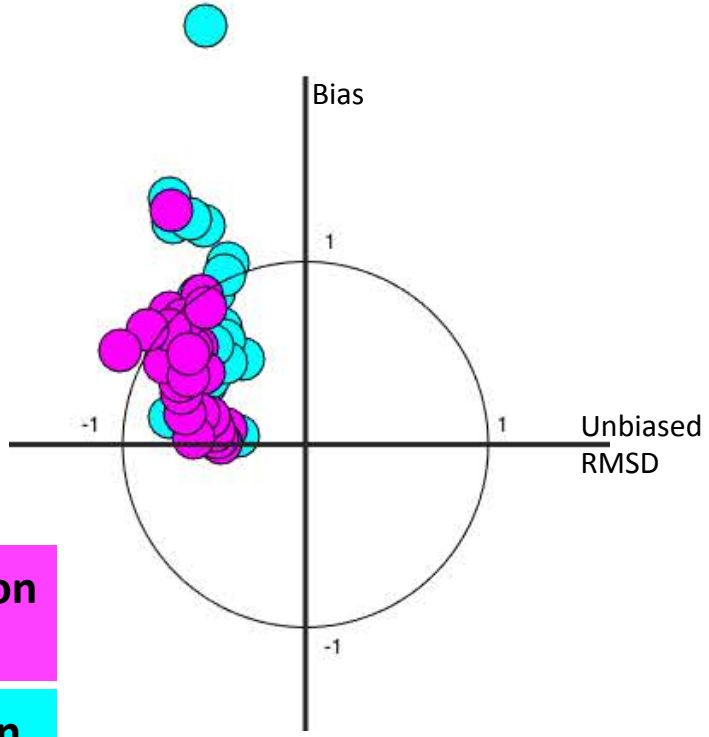


Bottom Dissolved Oxygen

Regulatory Model



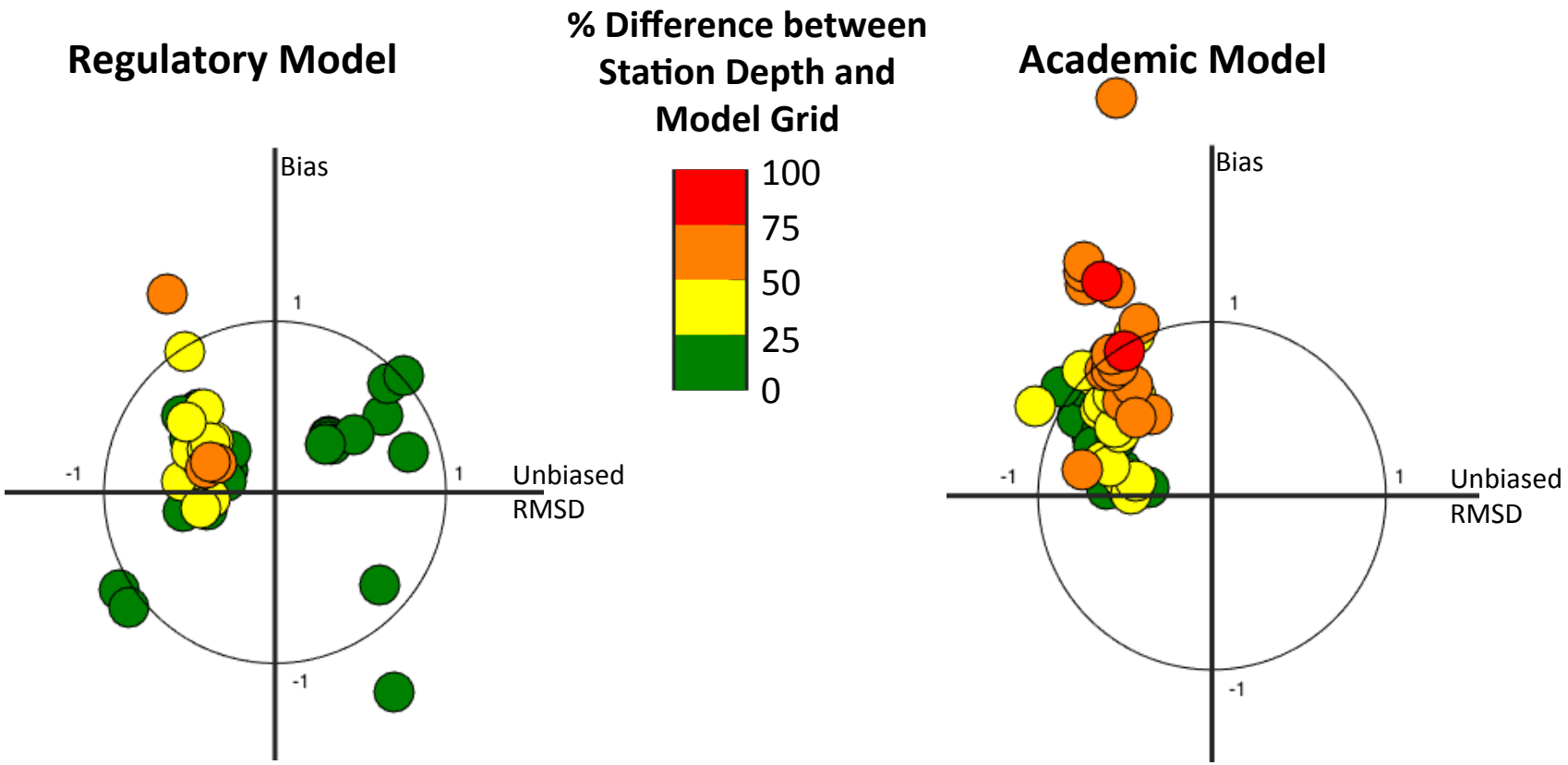
Academic Model



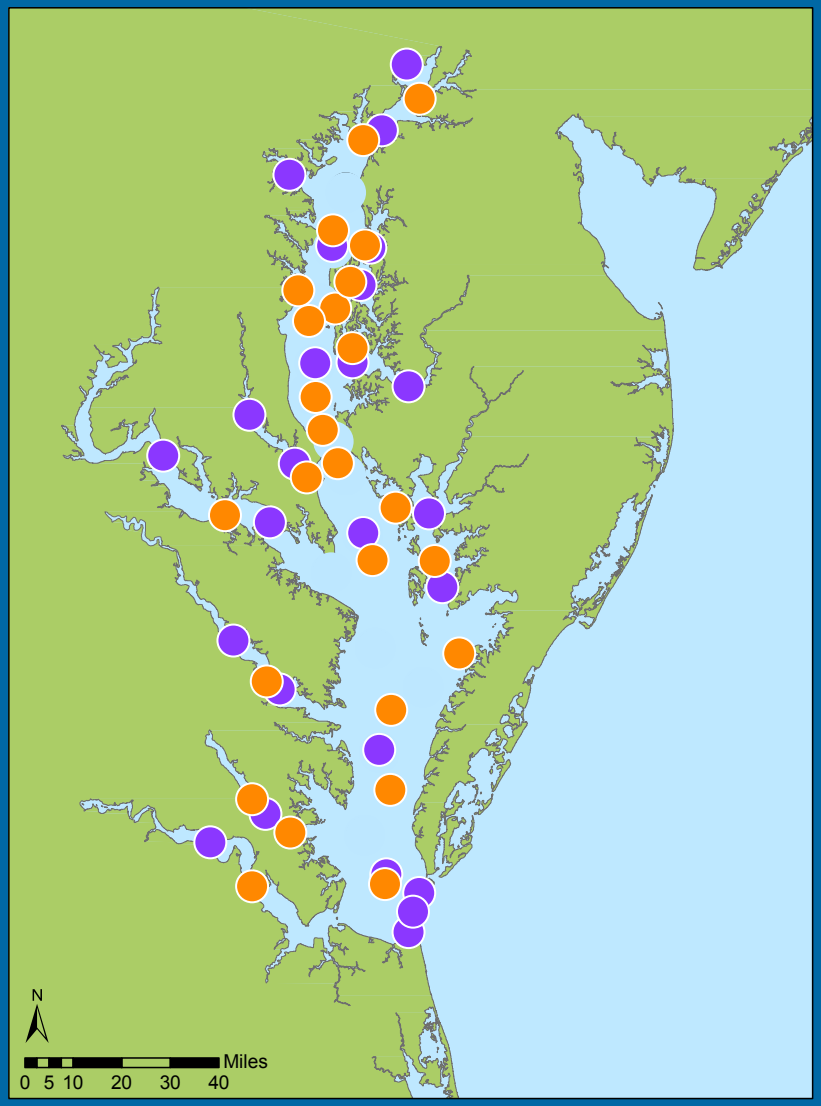
Main Stem Observation Stations

Tributary Observation Stations

Bottom Dissolved Oxygen



Model-Model Comparison



- Move from model-data comparison to model-model comparison
  - How similar are the two models?
  - Target now identifies similarity
- Regulatory model "observations" taken as the first hour of every month

25 Calibration Stations
25 No-data Stations

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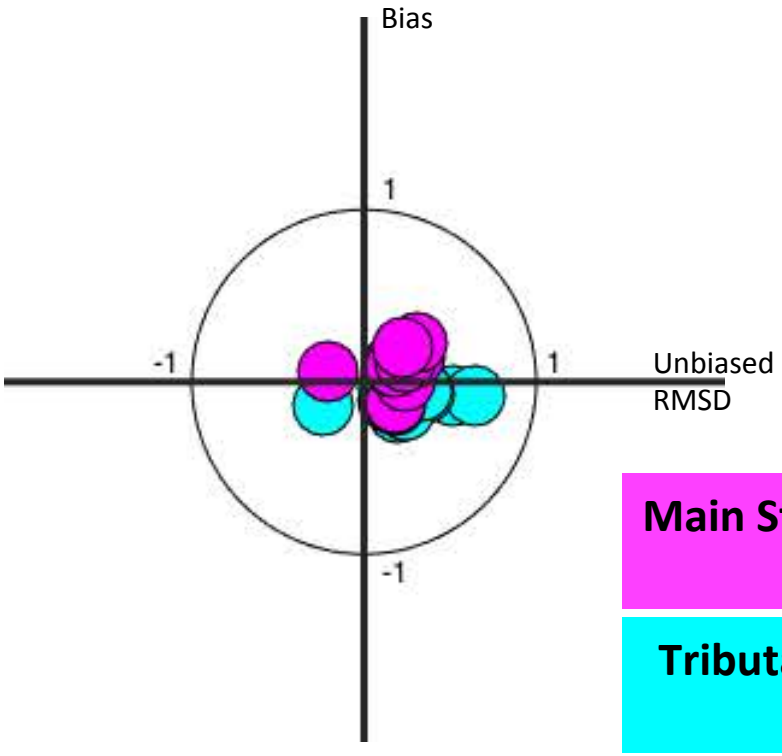
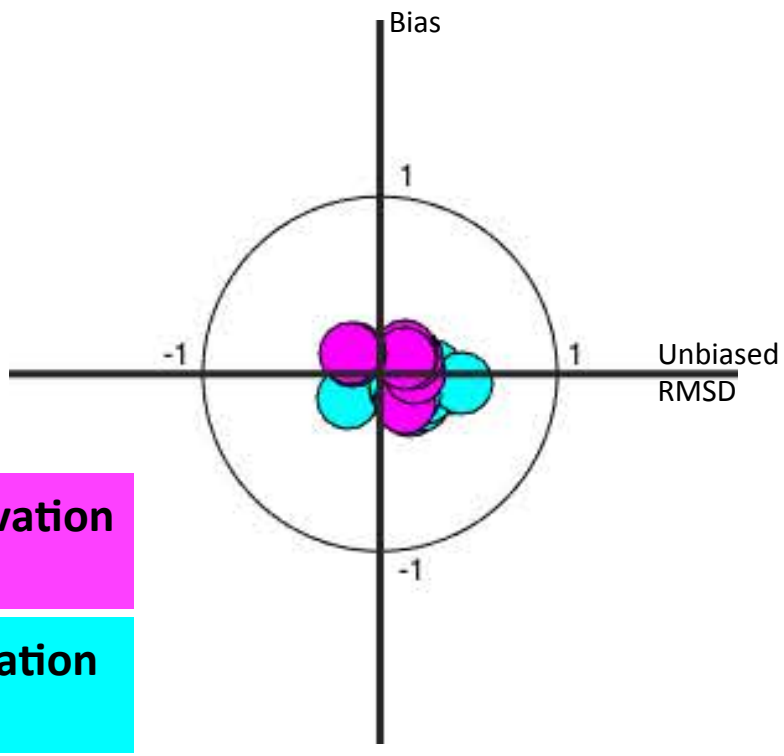
Bottom Temperature

Calibration Stations



No-data Stations

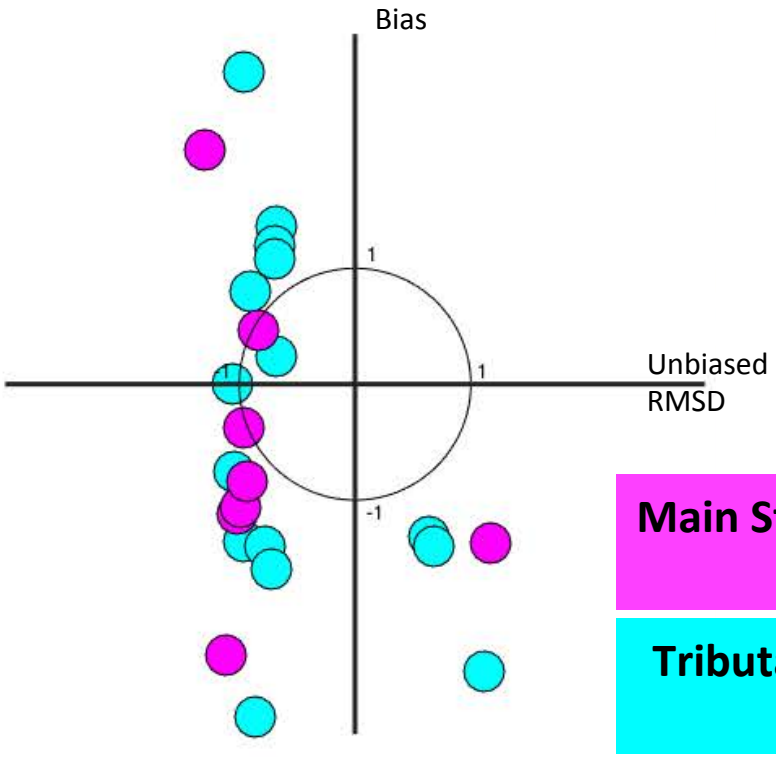


Main Stem Observation Stations

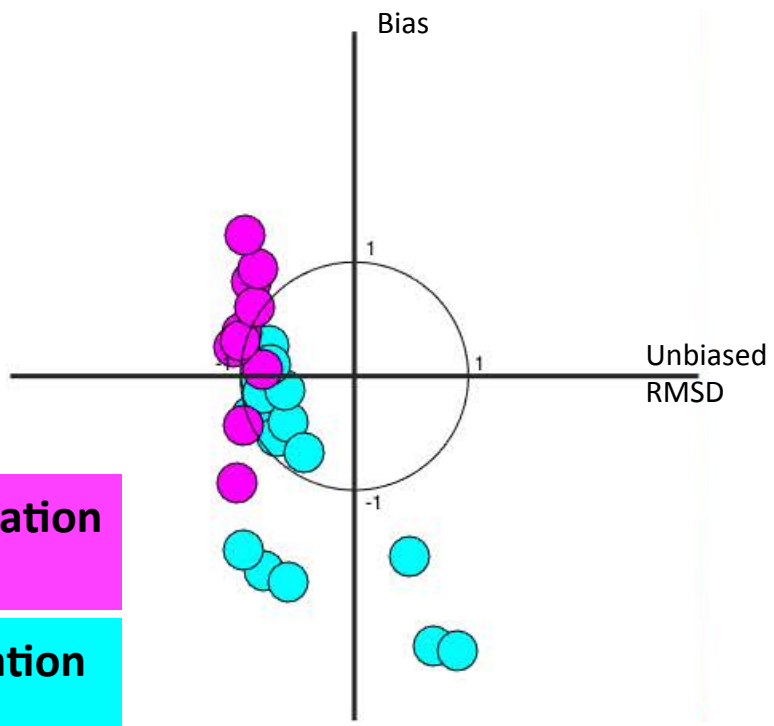
Tributary Observation Stations

Bottom Salinity

Calibration Stations



No-data Stations

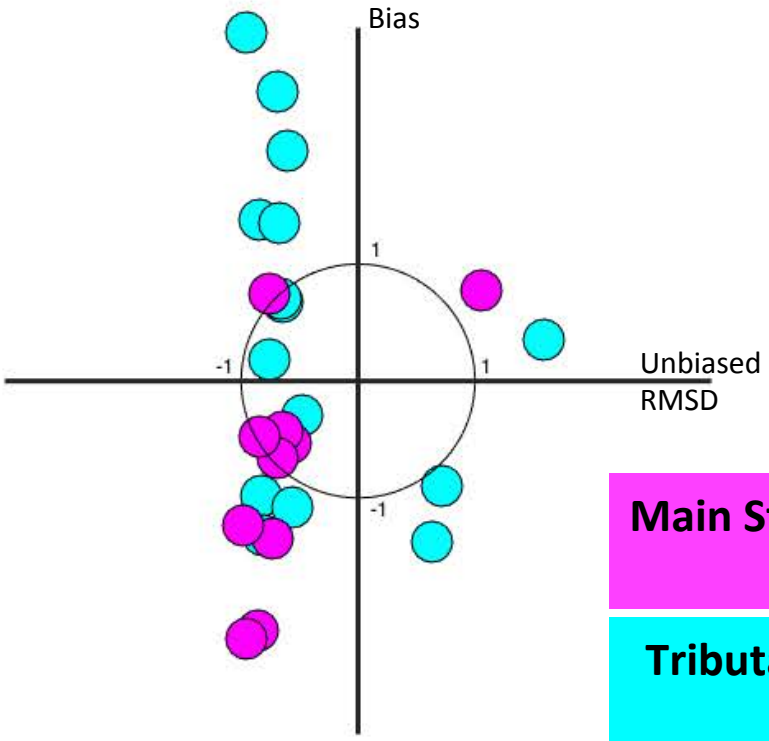


Main Stem Observation Stations

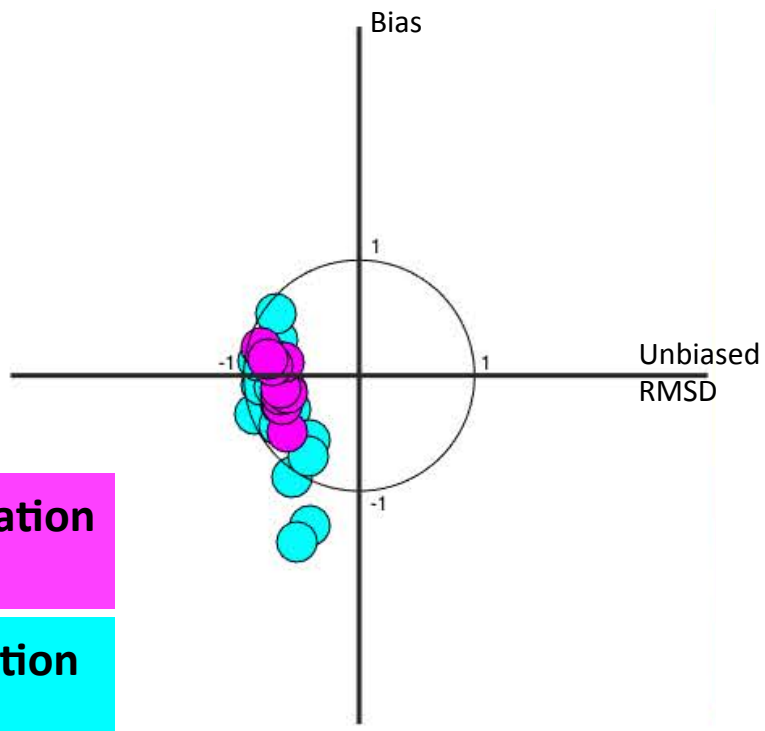
Tributary Observation Stations

Surface Salinity

Calibration Stations



No-data Stations

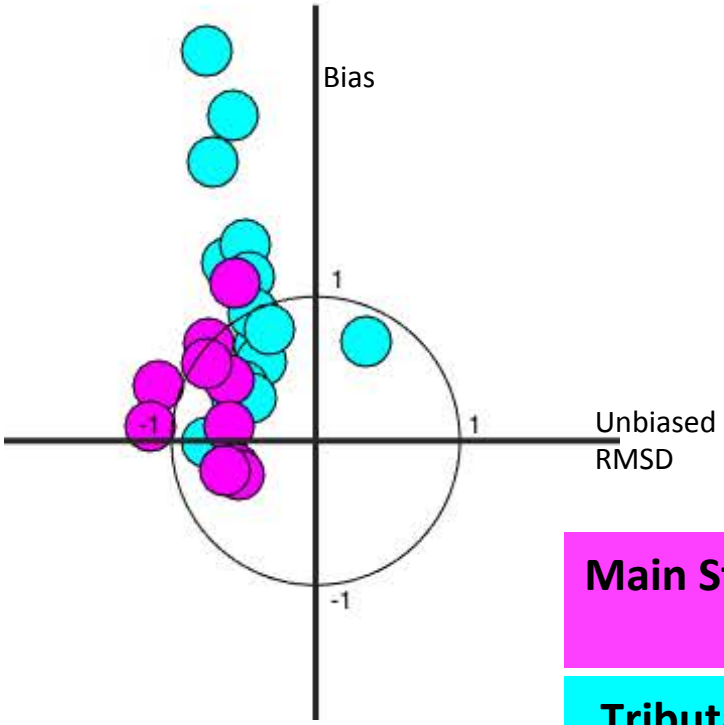


Main Stem Observation Stations

Tributary Observation Stations

Bottom Dissolved Oxygen

Calibration Stations



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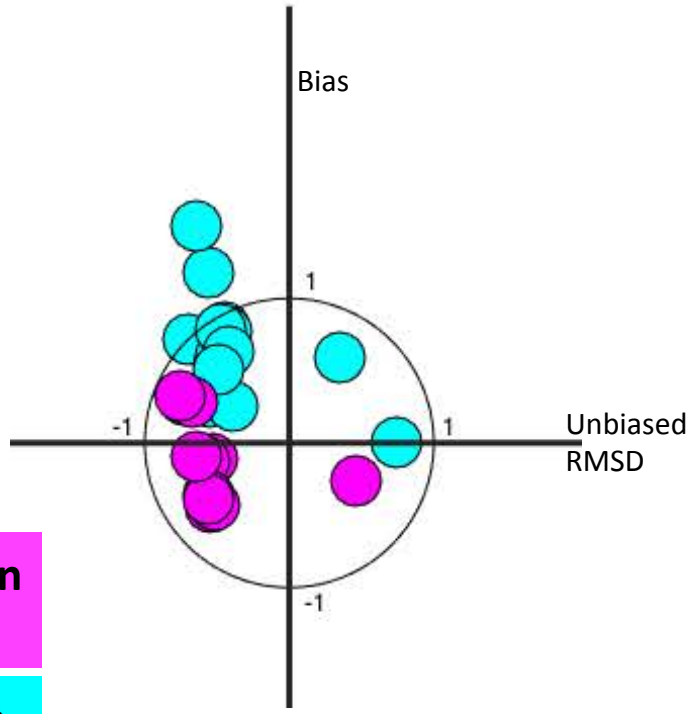

Main Stem Observation Stations

Tributary Observation Stations

Conclusions

- Both models simulate temperature, salinity, and dissolved oxygen along the main stem stations similarly
- The grid bathymetry, as a result of low resolution, of the academic model is a limiting factor in the tributaries
- There is evidence for over-calibration as Model-Model differences are less at locations where there is no data than they are at regulatory model calibration stations

Future Work

- Extend model comparison to 1985 – 2005
- Apply regulatory nutrient reduction
  - Compare dissolved oxygen concentrations between standard run and nutrient reduction run
- Compare models after nutrient reduction

Questions?

Challenges associated with modeling low-oxygen waters in Chesapeake Bay: a multiple model comparison

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