11-13-2013

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Recommended Citation
Irby, I. D.; Friedrichs, M.; Feng, C.; and Friedrichs, C. "Skill assessment of multiple models in the Chesapeake Bay". 11-13-2013. Chesapeake Bay Program Tidal Monitoring and Analysis Workgroup, Annapolis, MD.

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Skill Assessment of Multiple Models in Chesapeake Bay

CERF - 2013

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Project Objective

• Statistically compare output from four Chesapeake Bay (estuarine) models:
  – three ROMS models, varying biological complexity
  – biologically sophisticated CBP regulatory model

• How well do they reproduce the mean and seasonal variability of:
  – temperature, salinity, stratification, dissolved oxygen, chlorophyll-a, and nitrate.
## Models Utilized

<table>
<thead>
<tr>
<th>Models Utilized</th>
<th>CH3D-ICM (CBP model)</th>
<th>ChesNENA</th>
<th>ChesROMS - BGC</th>
<th>ROMS - RCA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nutrients Simulated</strong></td>
<td>N, P, Si</td>
<td>C, N</td>
<td>N</td>
<td>N, P, Si</td>
</tr>
<tr>
<td><strong>Biogeochemical Sediment Component</strong></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Number of Algal Groups</strong></td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Horizontal Resolution</strong></td>
<td>0.25 - 1km²</td>
<td>~ 1km²</td>
<td>~ 1km²</td>
<td>~ 1km²</td>
</tr>
<tr>
<td><strong>Vertical Grid</strong></td>
<td>z: ~ 5ft</td>
<td>σ: 20 layers</td>
<td>σ: 20 layers</td>
<td>σ: 20 layers</td>
</tr>
</tbody>
</table>
Compare simulations at 10 main stem stations for ~16 cruises in 2004
Model Skill Assessment via Target Diagrams

Model skill same as skill of mean of observations

Bias

1

RMSD

1

Model	
  Skill	
  Assessment	
  via	
  Target Diagrams

Underestimates
  Observed Mean

Overestimates
  Observed Mean

Underestimates Observed Std Dev

Overestimates Observed Std Dev

Observed Mean

Observed Mean

Overestimates

Underestimates

Unbiased RMSD
Overall skill of all four models (temporal+spatial variability):

- are **highest** in terms of Temperature
- are **similar** to each other in terms of T, S, stratification and DO
- are **different** in terms of chlorophyll and nitrate
All models consistently underestimate both the mean and seasonal variability of stratification, particularly at the northern stations.
Skill for surface chlorophyll & nitrate varies significantly between models
Despite underestimation of stratification & varying performance between models for chlorophyll and nitrate, models still reproduce mean and seasonal variability of DO similarly well, particularly at southern stations.
Conclusions & Implications

• Models with lower biological complexity and resolution achieve similar skill scores as CBP model in terms of seasonal variability along the main stem of Chesapeake for T, S, DO and stratification
  → More confidence in CBP model predictions of seasonal variability,
  → Models do not necessarily need to perform well in terms of stratification, chlorophyll, or nitrate in order to reproduce mean and seasonal variation of DO

• All models reproduce bottom DO better than variables that are primary influences on DO (stratification, chlorophyll, nitrate)
  → This is because seasonal DO variability is sensitive to temperature (solubility effect), and the models reproduce temperature very well
  → Modeled DO simulations may be very sensitive to any future increases in Bay temperature

Future Work: Similar analyses for interannual 25 year run