



Marine ecosystem predictions based on regional ocean modeling

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Q2: Concerning NOAA's key mission element of understanding, predicting, and projecting changes in the Earth System, how can GFDL drive further advances in these areas, including extremes and environmental hazards, through scientific innovation based on observations, theory, and modeling? Where are the strengths, gaps, and new frontiers?

Bringing earth system modeling to a regional scale

- Built with components of ESM4: coupled MOM6 ocean, COBALT ocean biogeochemistry, and SIS2 sea ice models, with forcing from atmosphere and land.
- Targeting 1–10 km resolution to balance representation of shelf scale processes with computational efficiency for running long simulations and many ensemble members.
- Notable additions and improvements:
 - Ocean open boundary conditions for temperature, salinity, velocity, elevation, and generic tracers
 - Tidal forcing at open boundaries and improved explicit simulation of tides within domain
 - COBALT v3 with additional phytoplankton group and variable N:P
- All code freely available and managed on Github. (github.com/NOAA-GFDL/CEFI-regional-MOM6)
- Organized through GFDL-led >100 person mailing list and biweekly virtual meetings with ~30–50 attendees from across NOAA and academia.



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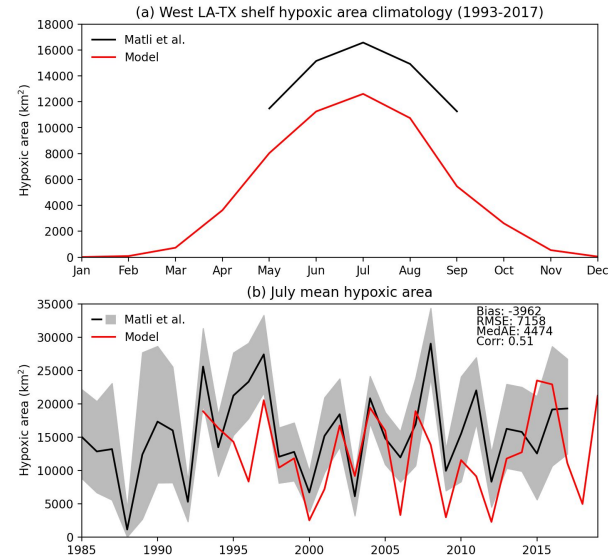
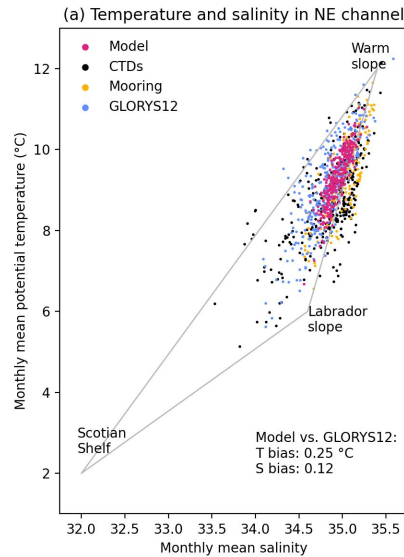
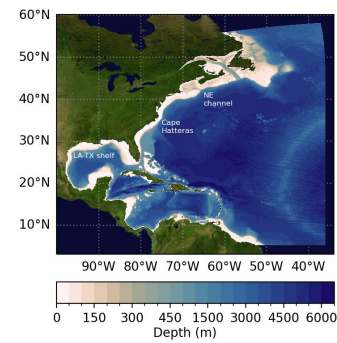


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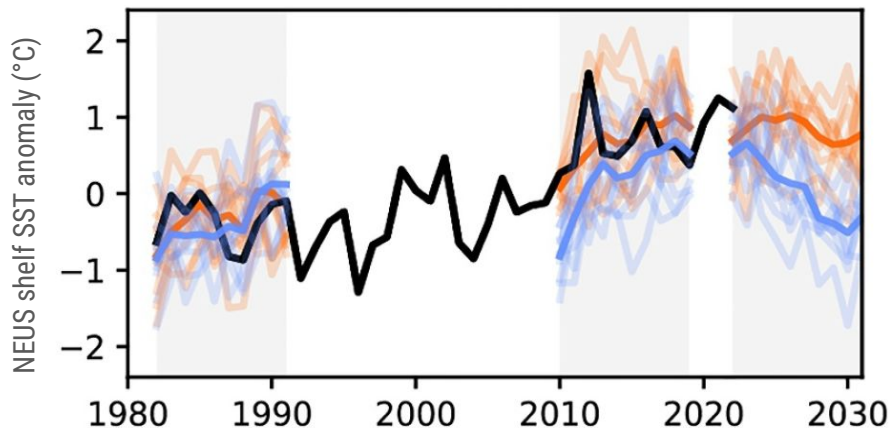
First regional model: 1/12° Northwest Atlantic Ocean (NWA12)

- Model development and evaluation documented with a 27-year reanalysis-forced simulation.
- Evaluation includes exact comparison with indicators in NOAA Fisheries' State of the Ecosystem reports.
- Working with NEFSC through CEFI to include model data in these reports.

Ross et al., GMD, 2023 (doi.org/10.5194/gmd-16-6943-2023)



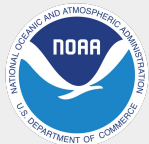
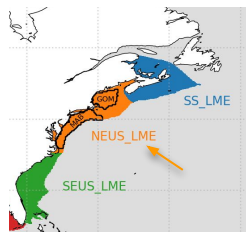
First-of-its-kind downscaled decadal ocean prediction system



Selected [SPEAR](#) and [downscaled NWA12](#) temperature anomaly predictions for the Northeast U.S. Shelf compared with observations

Koul et al., GRL, 2024
(doi.org/10.1029/2024GL110946)

- NWA12 forced by GFDL's SPEAR global decadal predictions.
- > 5000 years of retrospective forecasts to build confidence.
- Next decade: predicted transient AMOC strengthening and southward Gulf Stream shift.
- Global model (SPEAR) predicts a shelf cooling, but downscaled solution with improved shelf resolution and skill predicts only a warming pause.

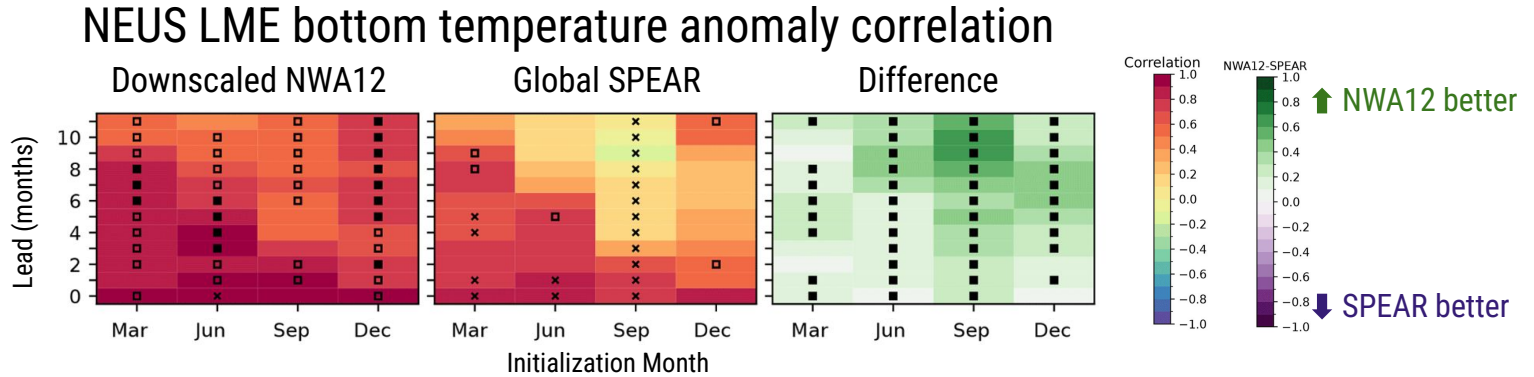


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Improved seasonal prediction skill in the Northeast U.S. LME



- NWA12 model forced by GFDL's SPEAR global seasonal predictions.
- Downscaling improves prediction skill for the Northeast U.S. LME, a region where global models typically struggle.
- Downscaling improved coastal advection, re-emergence, and Gulf Stream trends.

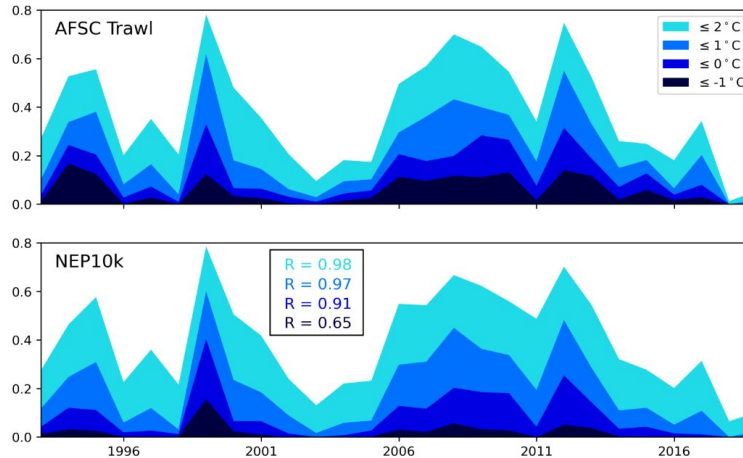
Ross et al., Ocean Science, 2024 (doi.org/10.5194/os-20-1631-2024)

A growing suite of regional models and applications

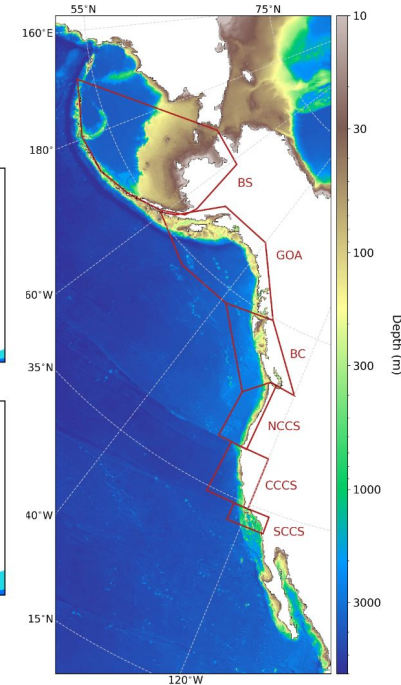
- Development and evaluation paper for 10 km Northeast Pacific Ocean model under review.
- Ability to accurately simulate Bering Sea cold pool (right) a product of collaboration with PMEL.

Drenkard et al., GMD, 2024
(doi.org/10.5194/gmd-2024-195)

Bering Sea cold pool index



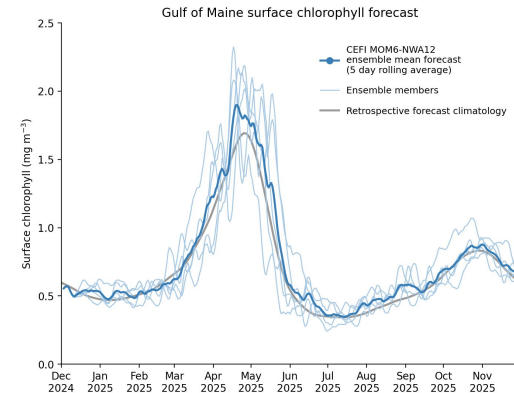
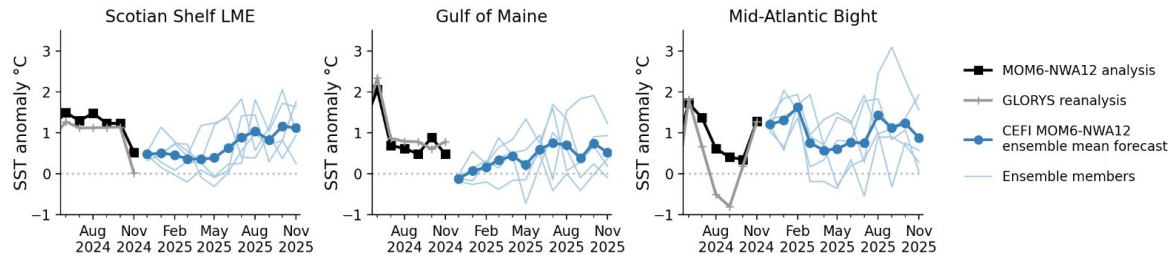
NEP10k



A growing suite of regional models and applications

- Additional model domains and downscaled predictions and projections with partnerships: Charlie Stock Q3 tomorrow.
- Ongoing development includes even higher resolution, improved benthic biogeochemistry, and workflows for regularly delivering updated predictions and projections.

Dec. 2024 test run of regularly updated seasonal predictions



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