How does biogeochemical process uncertainty impact estimates of living marine resources in the Bering Sea?

Kelly A. Kearney[1,2], Wei Cheng[1,3], Albert Hermann[1,3]

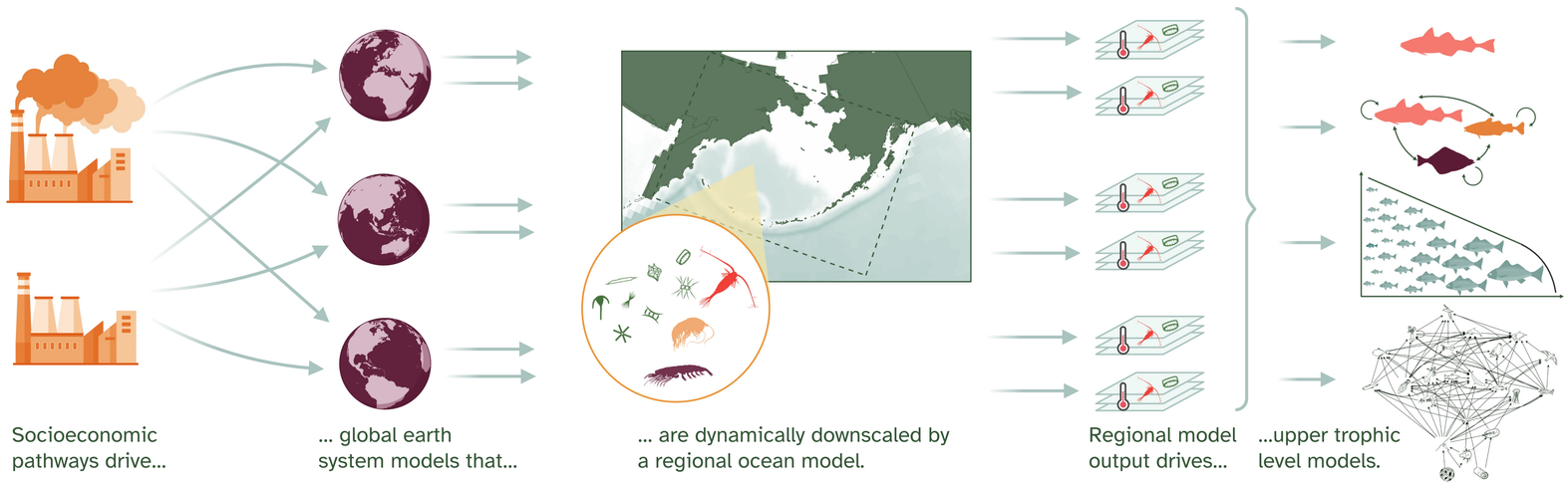
[1] University of Washington, CICOES, Seattle, WA, USA
[2] NOAA Alaska Fisheries Science Center, Seattle, WA
[3] NOAA Pacific Marine Environmental Laboratory, Seattle, WA, USA

Correspondence: kelly.kearney@noaa.gov

Highlights

- Shelf nutrient concentrations are strongly influenced by each model's ecosystem dynamics, recursively impacting the entire ecosystem.
- Ratios between new and regenerated production vary widely between models.
- The relative magnitude of spring and fall blooms is strongly model-dependent, as are regional spatial variations.

Ensemble-based end-to-end models consider many sources of uncertainty...



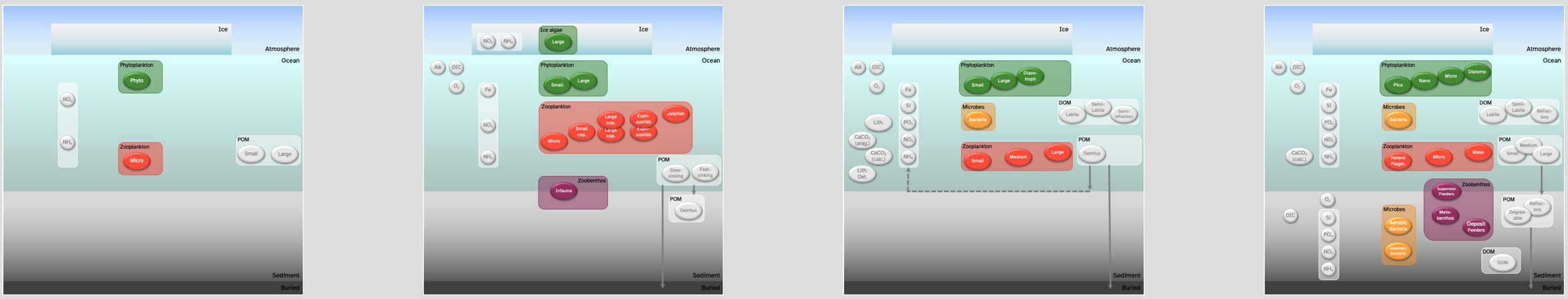
... but rarely those related to regional biogeochemistry. Is this a problem?

The experiment

We couple different biogeochemical models to an identical ROMS ocean and ice model. The simulations span 1990–2020 and use reanalysis-based surface and boundary forcing.

We then assess how key biological metrics — those typically used to force upper trophic level models — vary between simulations.

Models are designed and tuned for different scientific objectives and priorities



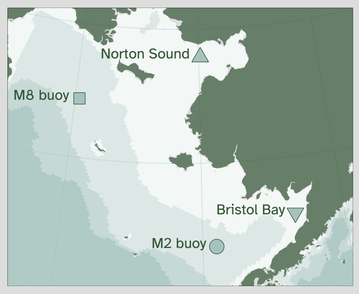
A) Banas et al., 2009 NPZ: Prioritizes simplicity and clarity, tuned to the Bering Sea shelf spring bloom.

B) BESTNPZ: Emphasizes zooplankton and zoobenthos for use with fisheries applications, tuned and validated with focus on the southeastern Bering Sea shelf.

C) COBALT: Prioritizes capturing global patterns in nutrient distribution, primary production, mesozooplankton production, and carbon export, not specifically tuned to coastal regions like the Bering Sea.

D) ERSEM: Designed for coastal applications , includes a mature benthic model, tuned to capture global coastal dynamics

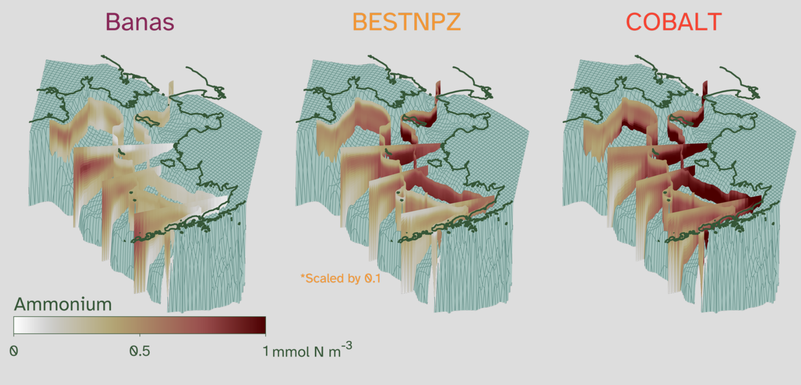
How do these different approaches affect common metrics?



← Map
30-year median metrics were extracted at 4 locations to highlight north/south and cross-shelf gradients.

Nutrient and phytoplankton concentration →
Annual mean values (in 2000, an average sea-ice year) along the 40-m and 70-m isobaths and selected cross-shelf transects. Nutrient values on the shelf are controlled by feedbacks within the biogeochemistry more than by the initial or boundary conditions, leading to the large differences seen between models.

Animation



↓ Net primary productivity: The magnitude, phenology, and relative size of the spring versus fall bloom and the spatial variation between the inner and middle shelves vary considerably between models.

↓ Zooplankton productivity: Like primary production, secondary production varies both spatially and temporally between models.

↓ f-ratio: The spring bloom in the Banas model is driven primarily by new production; BESTNPZ and COBALT show the opposite pattern, favoring regenerated production for most of the year.