

Importance of simulating coastal biogeochemical processes for projections of ocean acidification on the Bering Sea shelf

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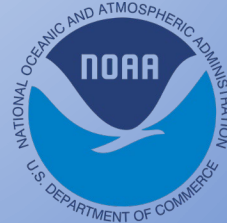
¹ Joint Institute for the Study of the Atmosphere and Ocean, University of Washington

² NOAA Pacific Marine Environmental Laboratory

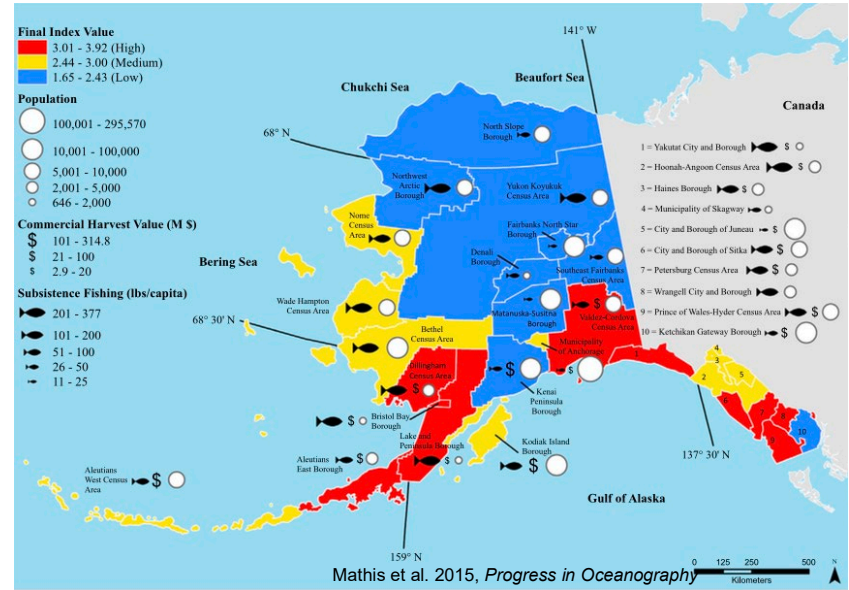
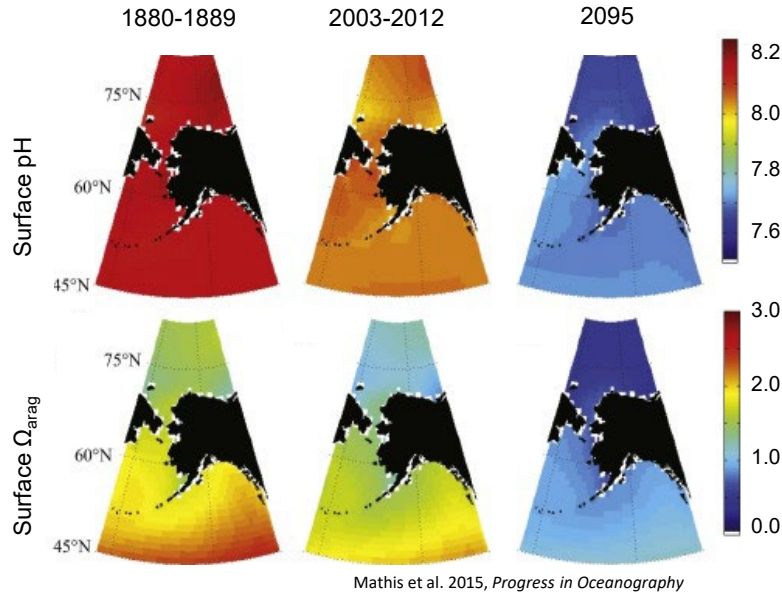
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Ocean Acidification poses a risk to Alaska's fisheries

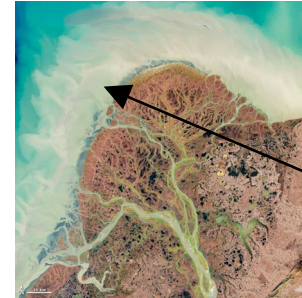
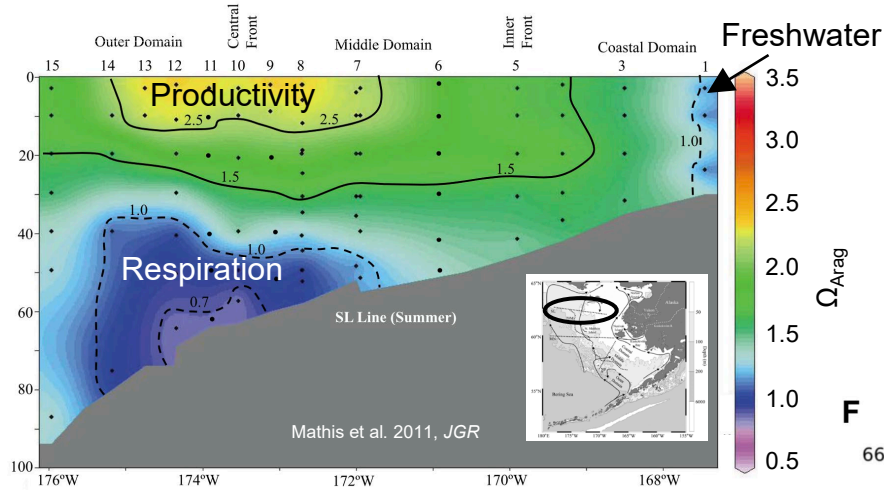


Marine calcifying organisms use Ω_{arag} to build shells and hard parts

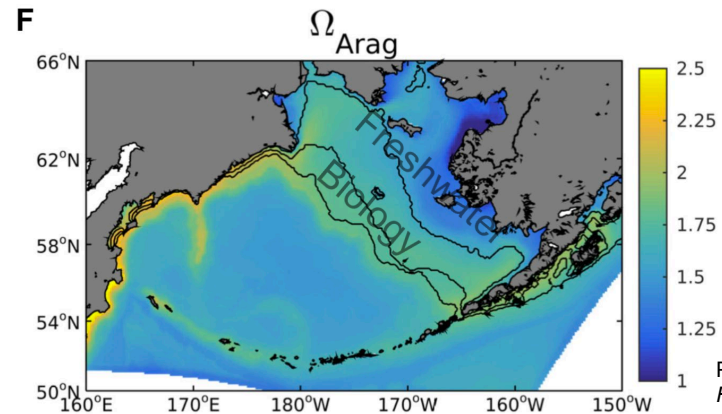
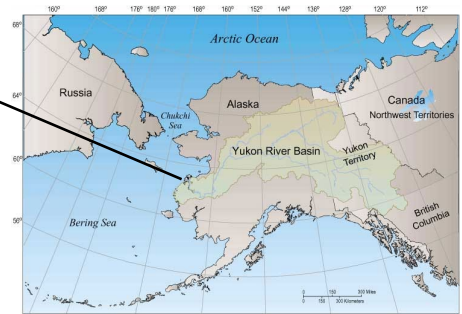
$\Omega_{arag} < 1$ indicates dissolution



Spatial Variability

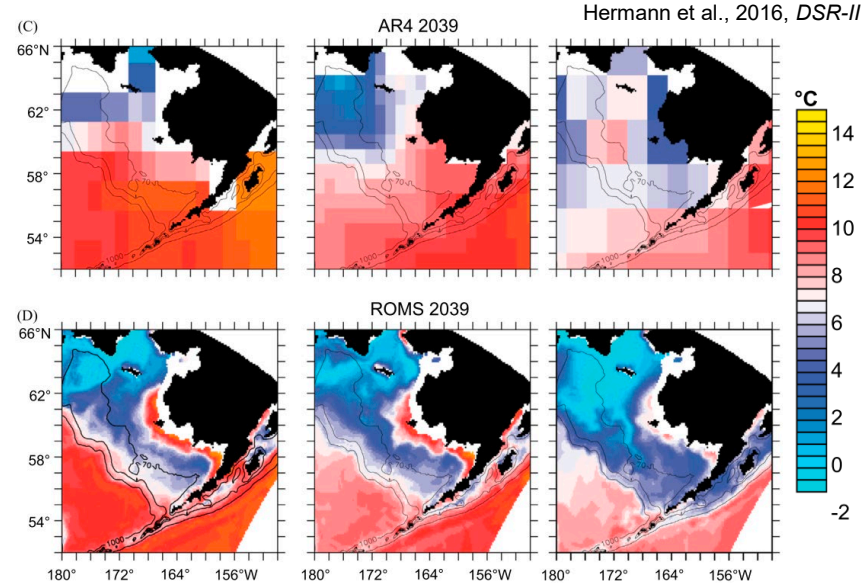
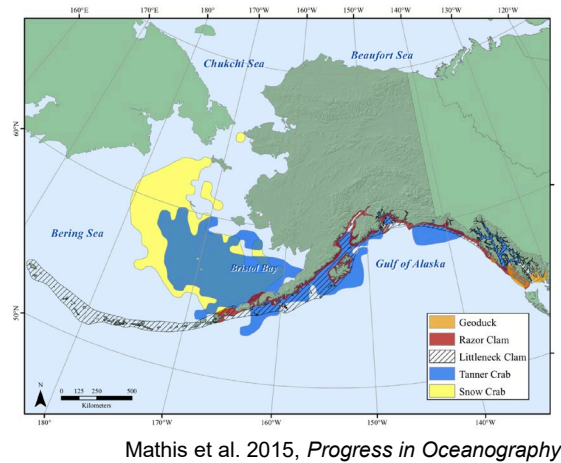
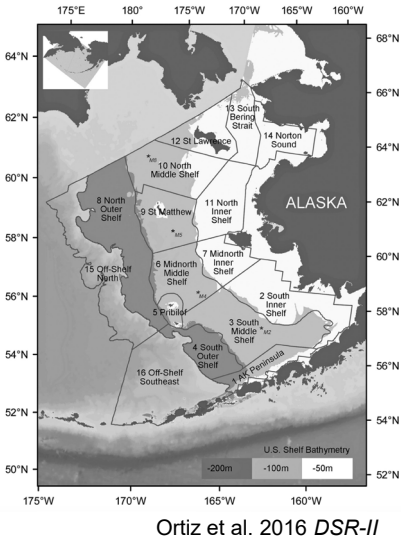


Yukon River delta



Pilcher et al. 2019,
Front. Mar. Sci.

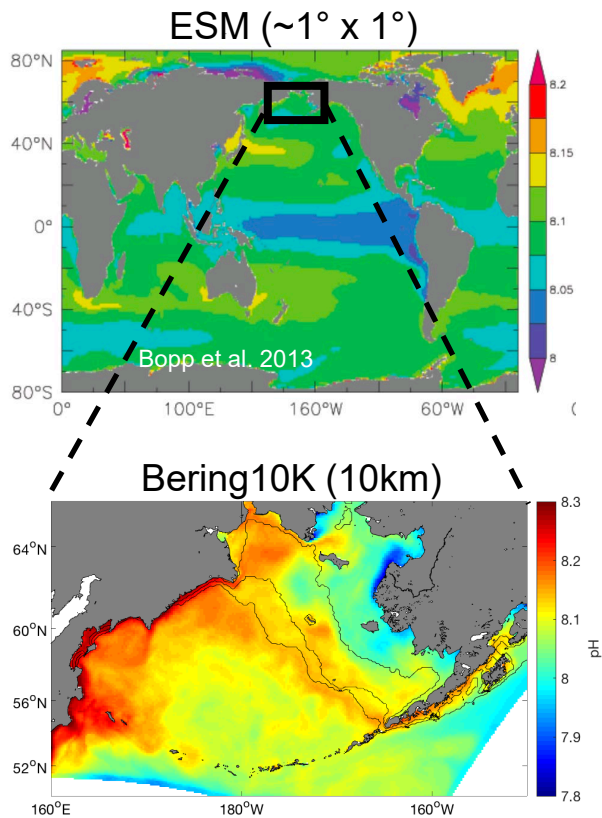
Spatial variability within ecosystem habitats



Bering Sea shelf composed of multiple ecosystem regions

Dynamical downscaling produces climate change projections on a similar spatial scale

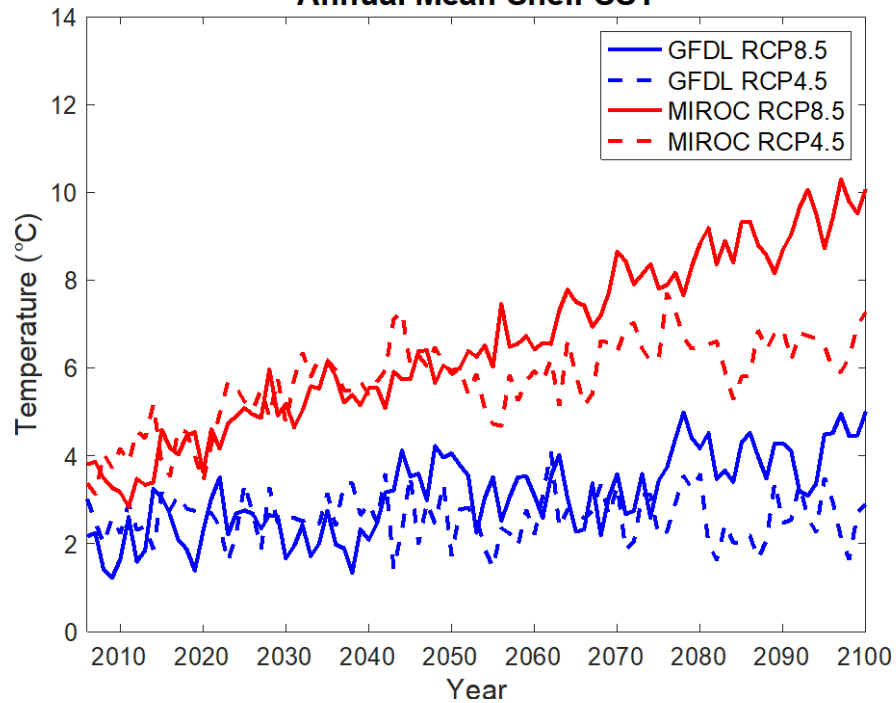
Dynamical Downscaling



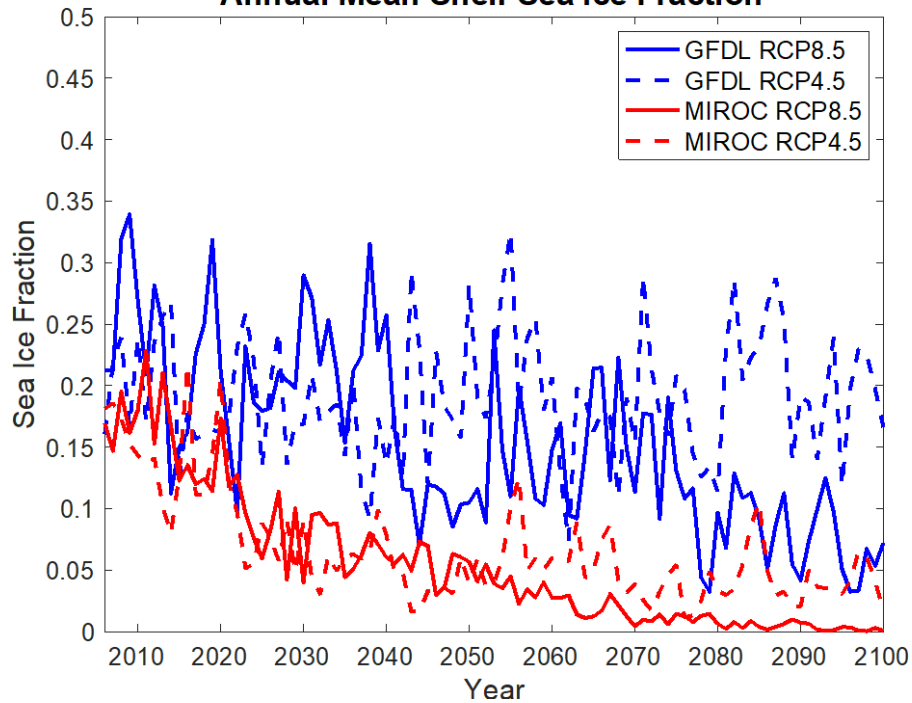
- Bering10K: 10km horizontal resolution with 30 vertical layers
- BEST-NPZ ecosystem (Gibson and Spitz 2011) with recent overhaul by Kearney et al. in review
- Earth System Model provides atmospheric forcing and horizontal boundary conditions
- Each simulation started from year 2006 taken from previous hindcast
- 6 total simulations, using 3 CMIP5 ESMs (GFDL-ESM2M, MIROC, CESM) and 2 emissions scenarios (RCP 8.5, 4.5)

Downscaled physical results

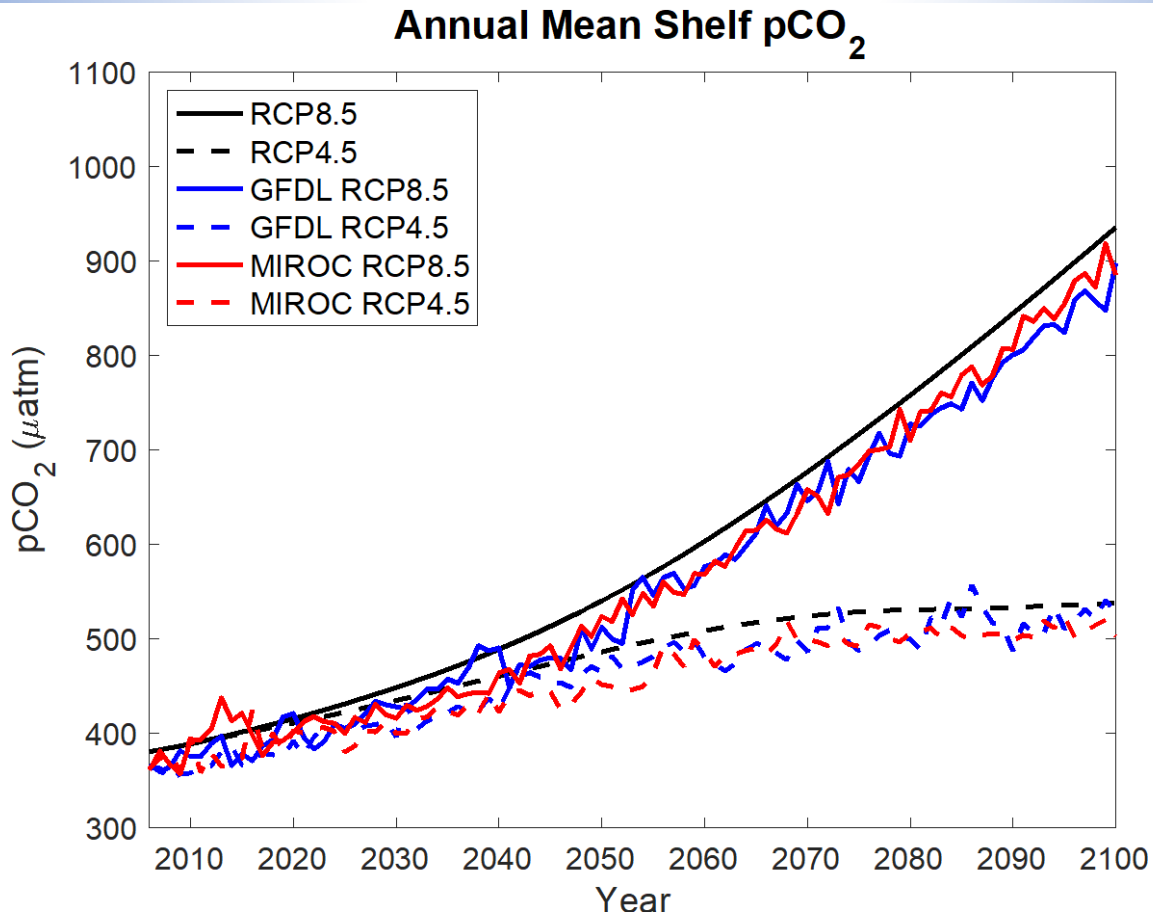
Annual Mean Shelf SST



Annual Mean Shelf Sea Ice Fraction

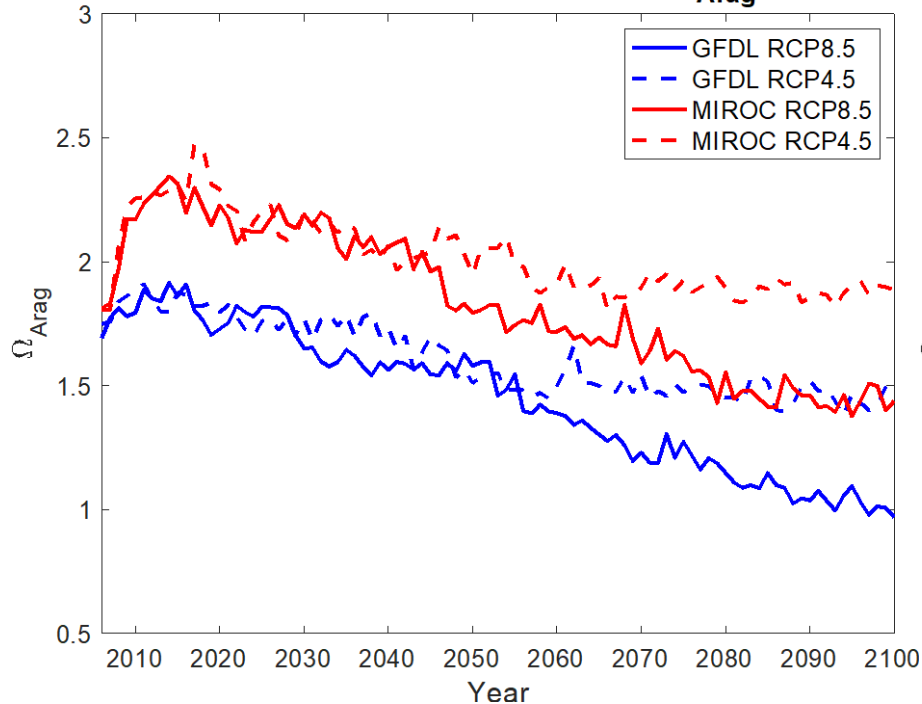


Ocean pCO₂ closely follows atmosphere in all scenarios

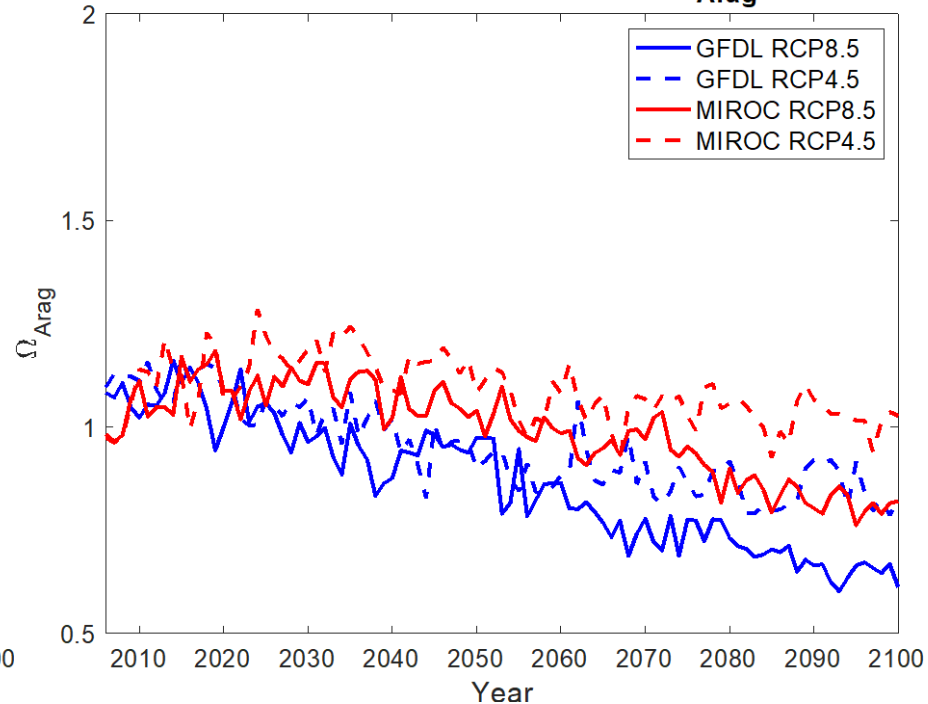


Decreasing surface and bottom Ω_{Arag}

Annual Mean Shelf Surface Ω_{Arag}

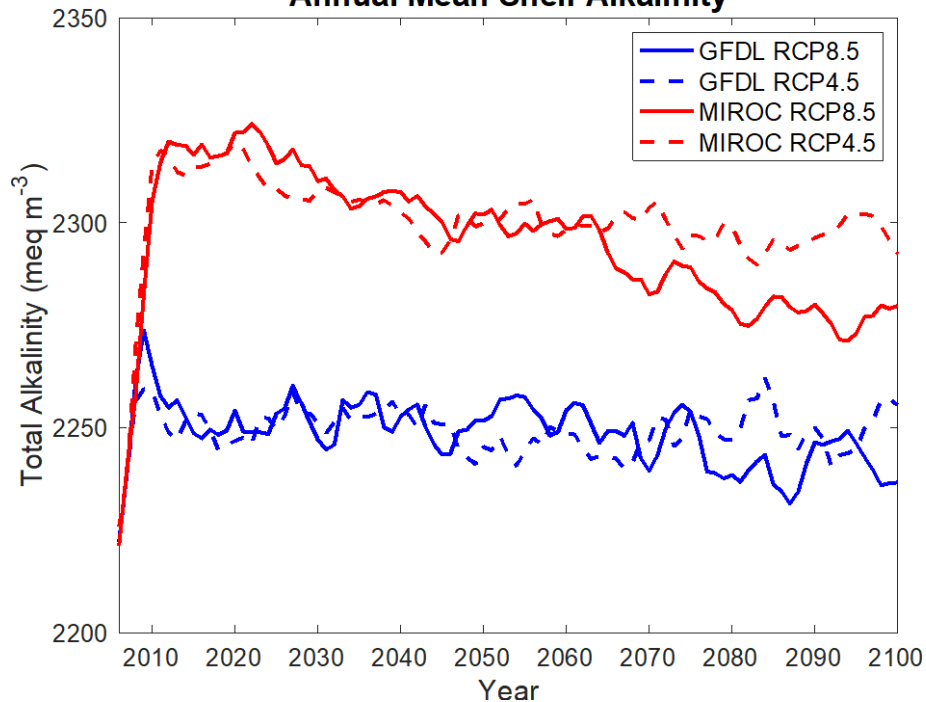


Annual Mean Shelf Bottom Ω_{Arag}

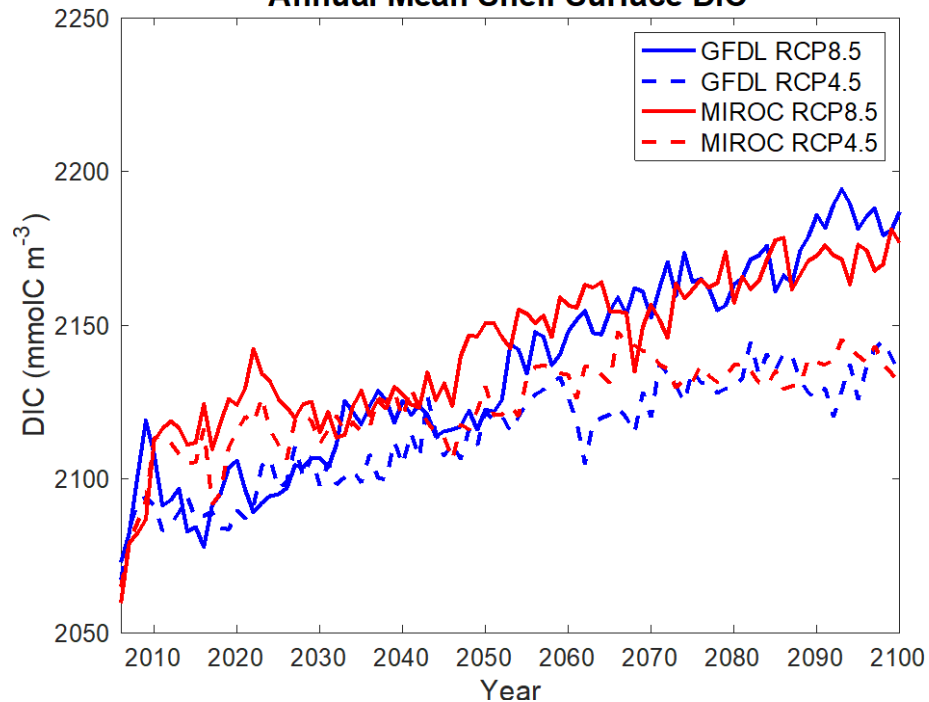


Why is the MIROC model different?

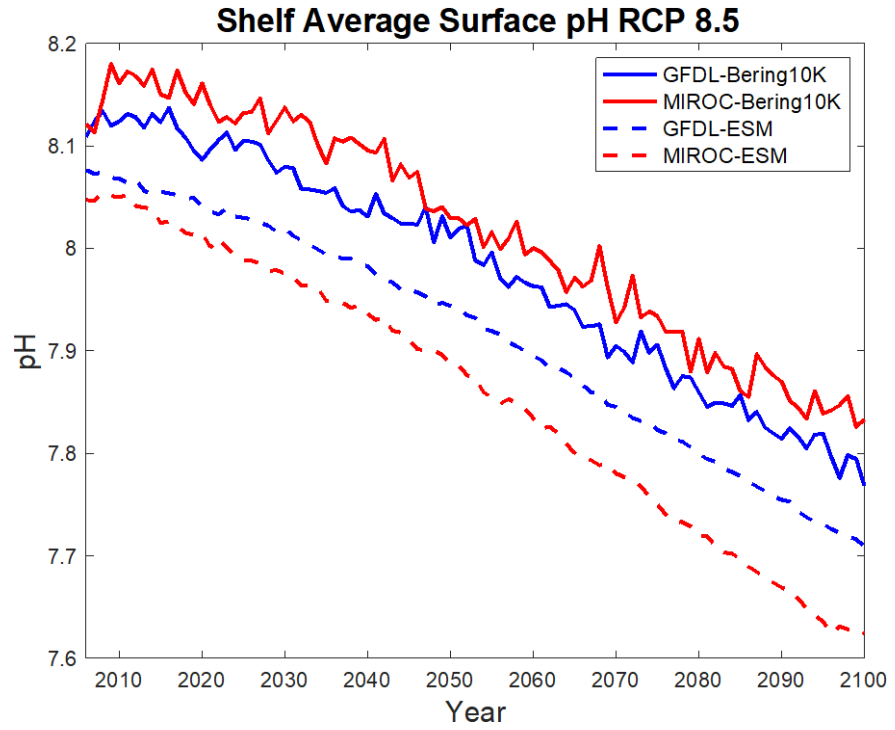
Annual Mean Shelf Alkalinity



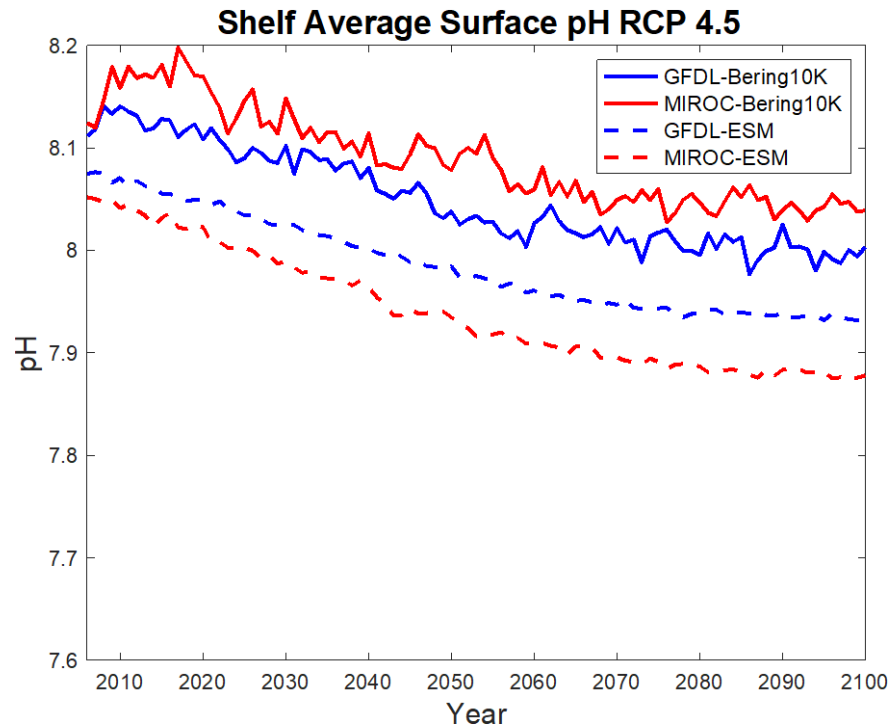
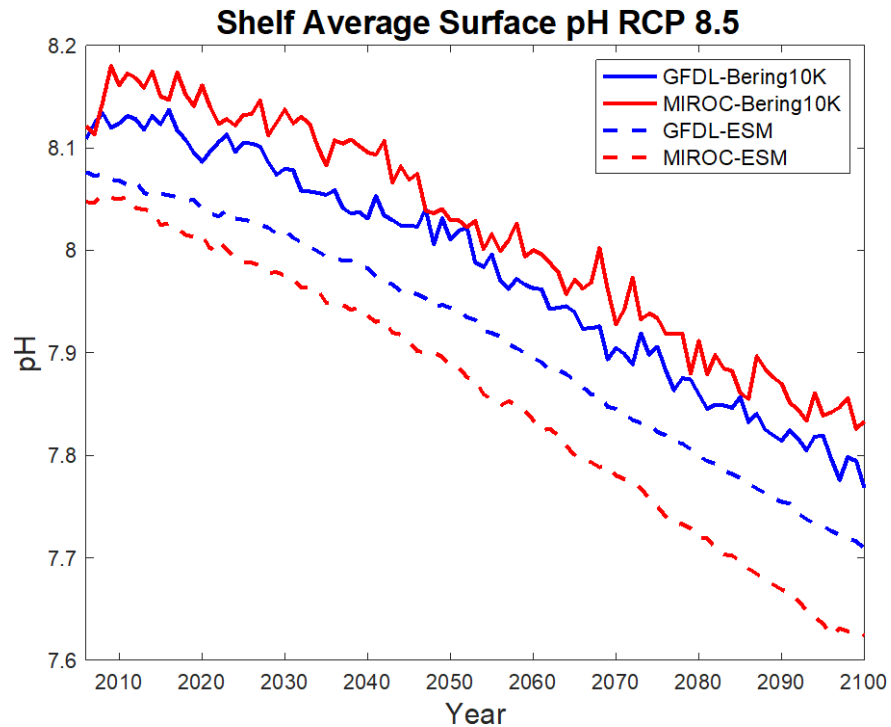
Annual Mean Shelf Surface DIC



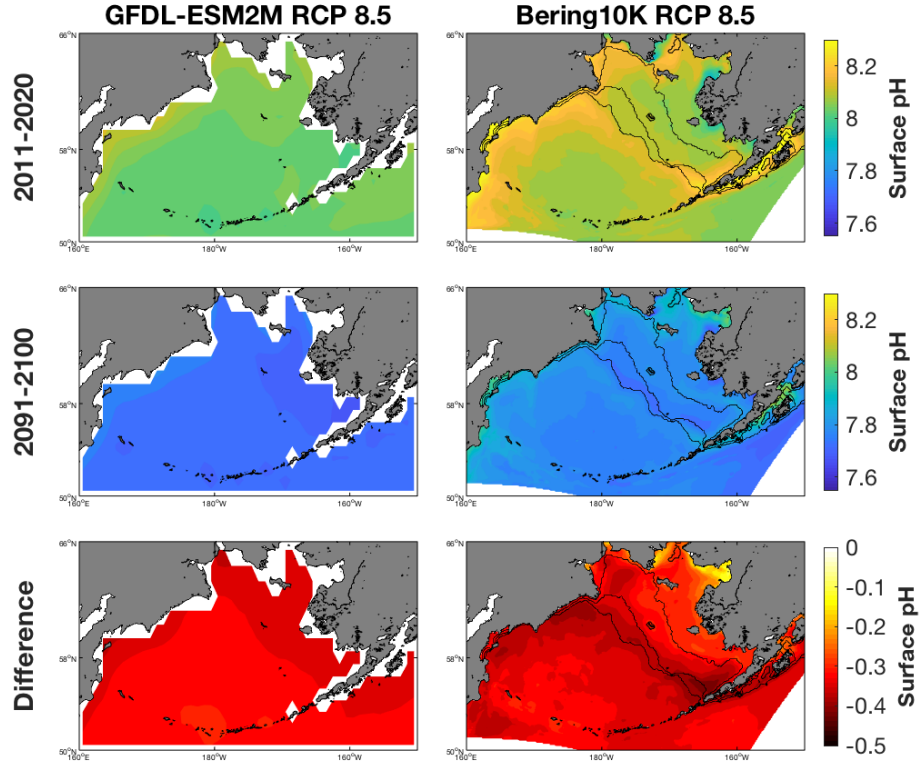
How does the downscaling compare to the ESMs?



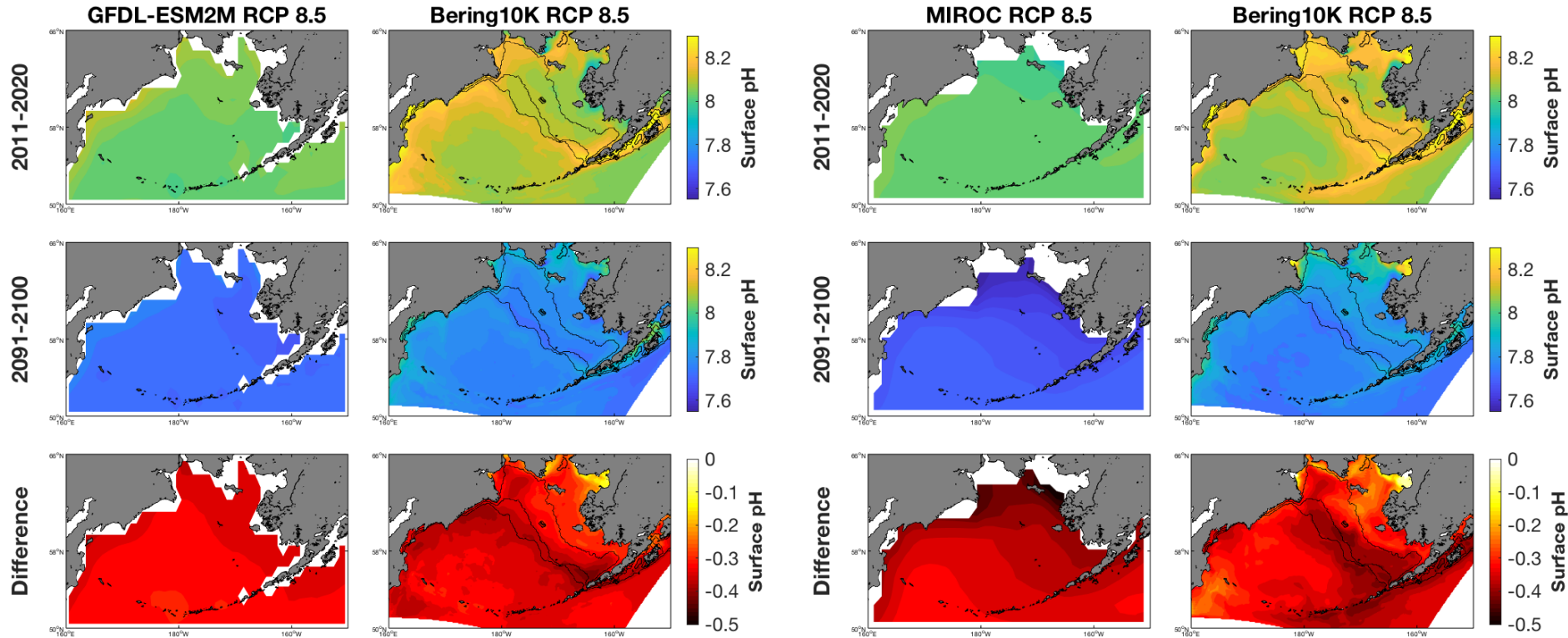
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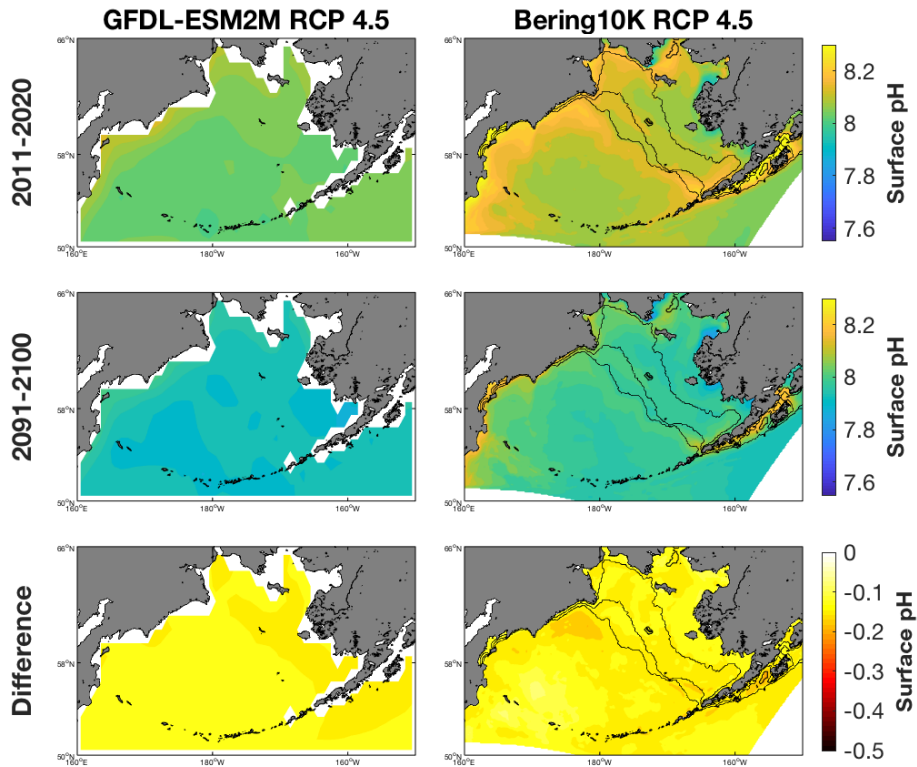
Spatial plots highlight regional differences



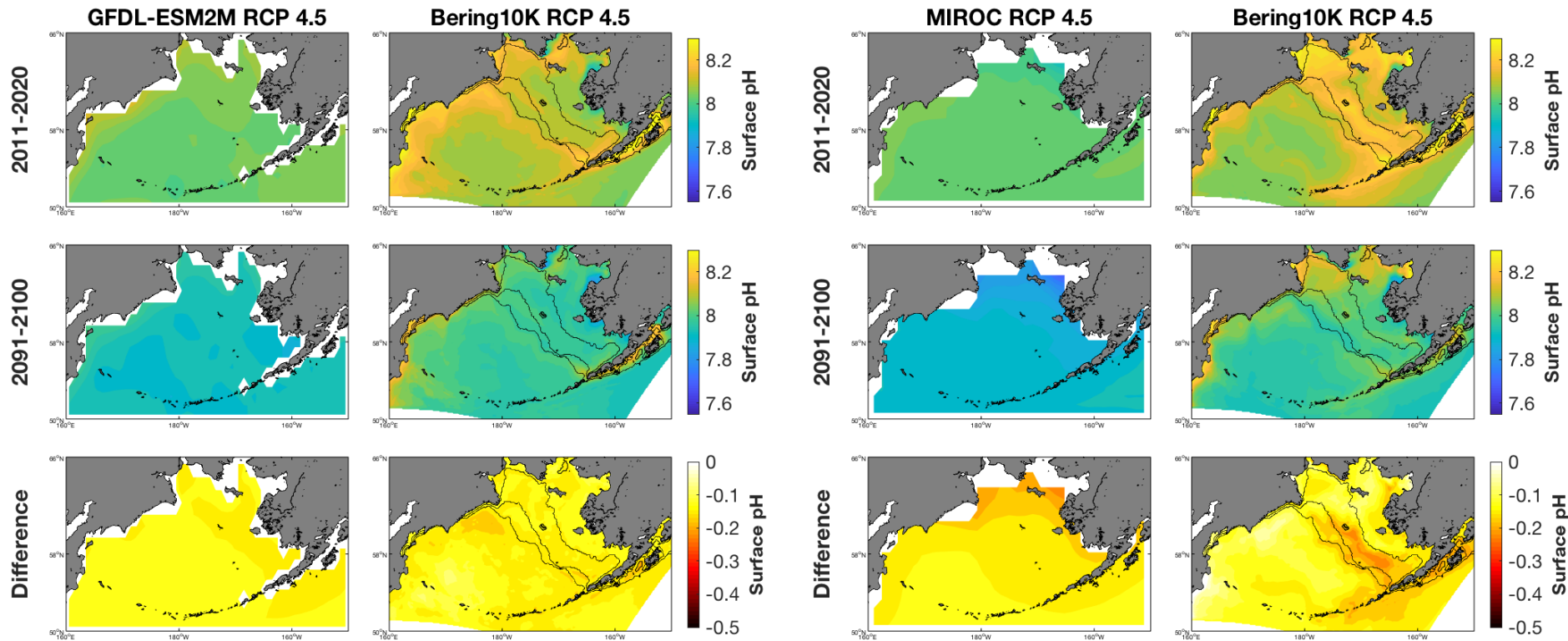
Spatial plots highlight regional differences



Spatial results highlight regional differences

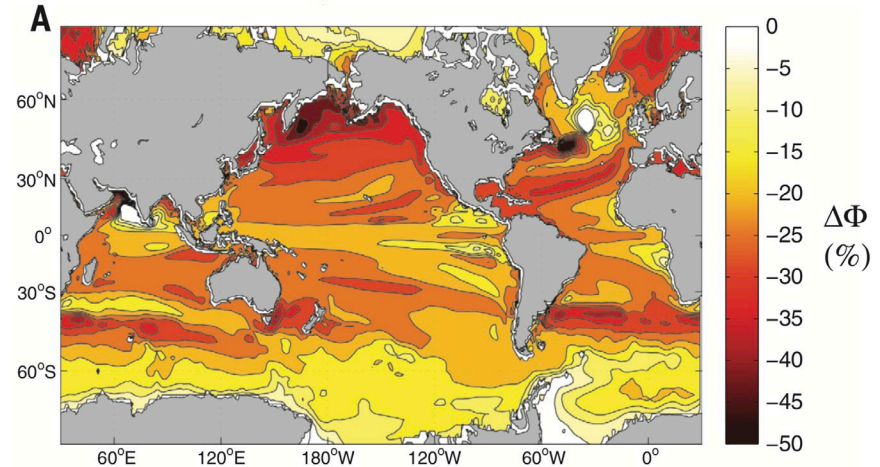
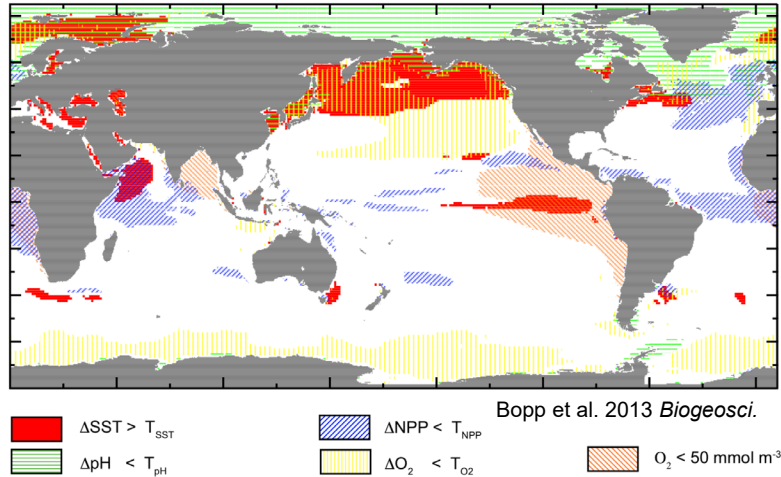


Spatial results highlight regional differences



Next steps

RCP8.5 - 2090s, changed from 1990s



Deutsch et al. 2015 *Science*

- Finish CESM downscaling simulations
- Mechanistic analysis of model differences
- Incorporate oxygen for a multiple stressor analysis

Conclusions

- Rate of change for collective shelf is similar between models, despite differences in physical forcing
- Within shelf though, rates can differ substantially
- SE Bering Sea emerges as a hot spot for OA
- Accurate initial state is critically important for projecting when key thresholds are passed

Questions?

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