Near-term predictions of ocean biogeochemistry in the Community Earth System Model

Nikki Lovenduski

University of Colorado Boulder

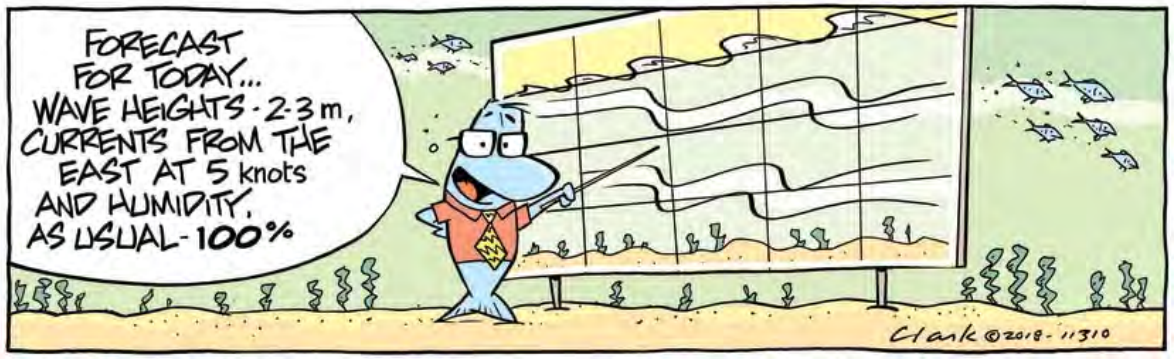
With contributions from

Riley Brady, Geneviève Elsworth, Kristen Krumhardt,

Keith Lindsay, Matt Long, Sam Mogen, Steve Yeager

Why predict ocean biogeochemistry?

Reliable near-term predictions of ocean biogeochemistry can aid in resource management decision-making



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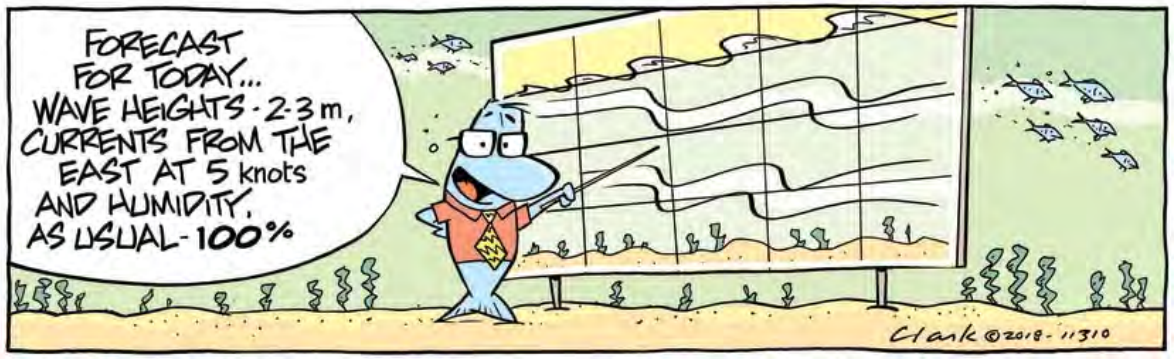
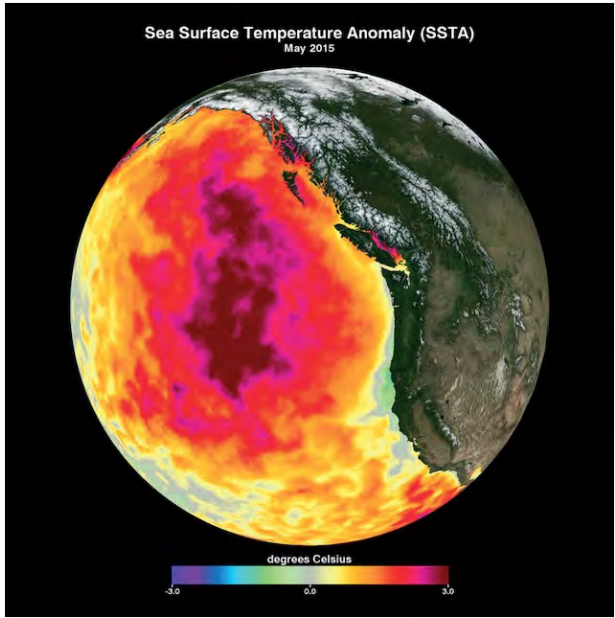


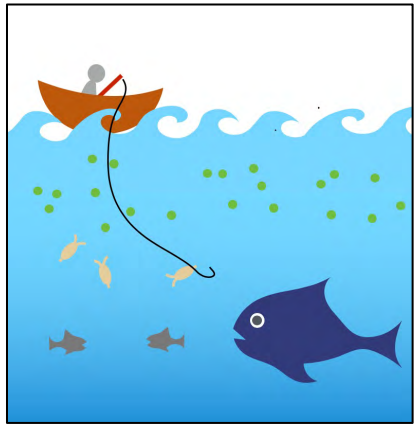
Near-term predictions can enable scientific discovery and process-based understanding of the biogeochemical system

Get ready to measure - here comes the Blob!

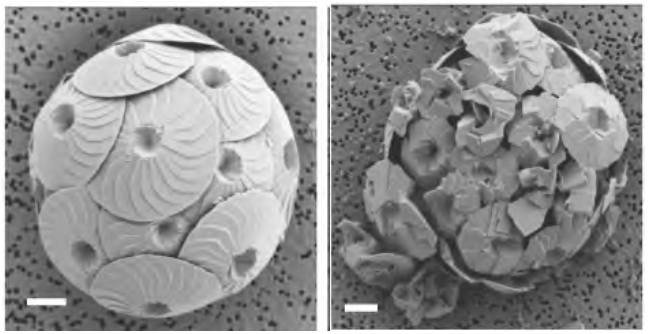


Ocean biogeochemical variables of interest

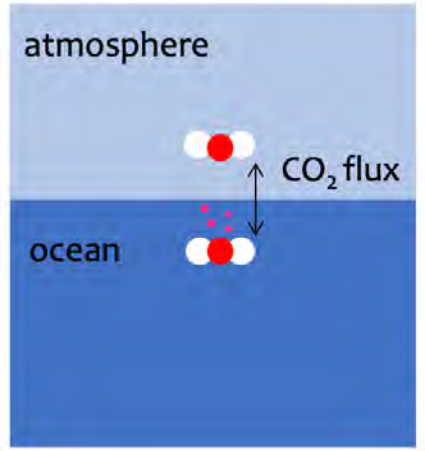
Marine phytoplankton



Ocean acidity

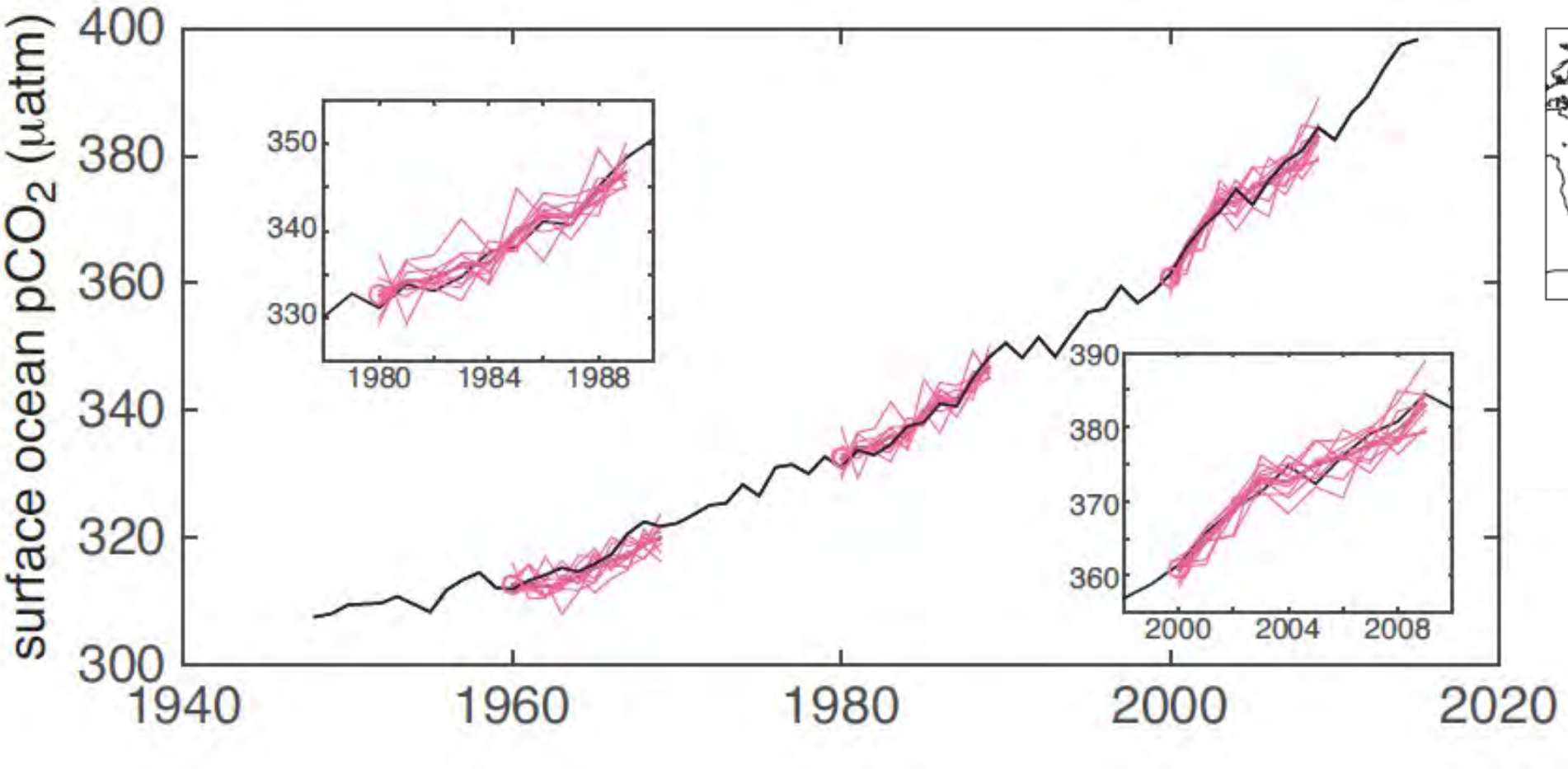


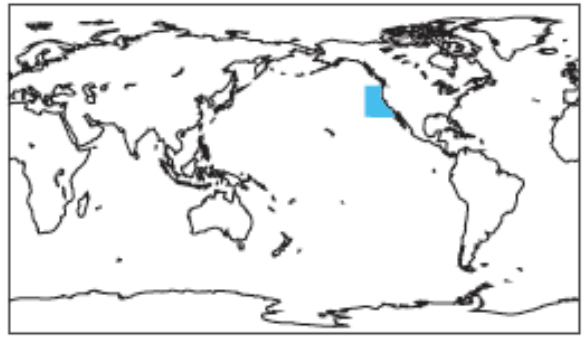
Air-sea carbon flux



Unique aspects of ocean biogeochemical prediction

1. We have BIG trends to worry about





Unique aspects of ocean biogeochemical prediction

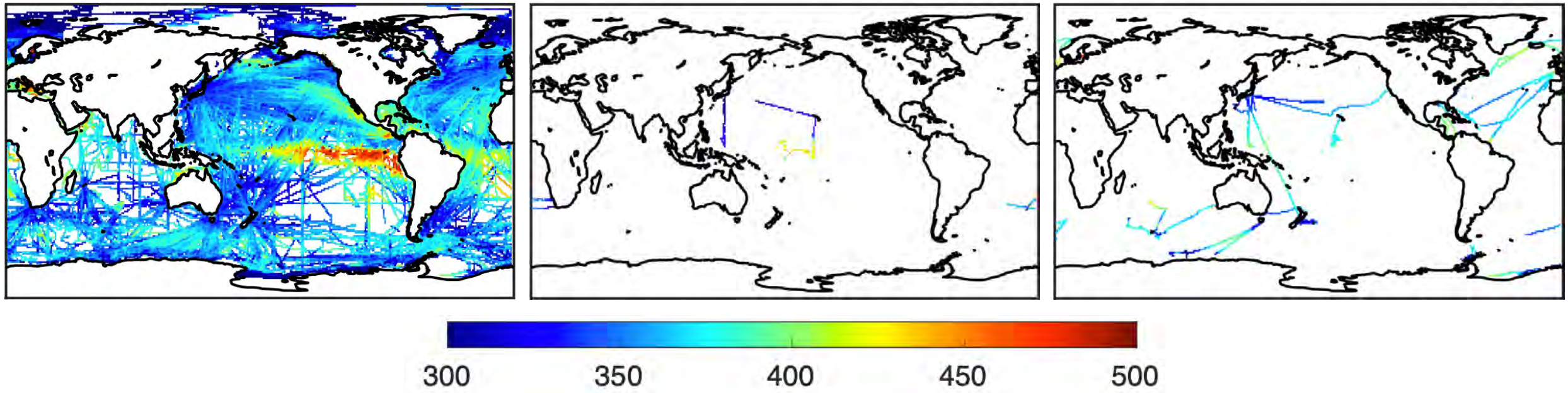
2. We have almost no observations

surface ocean pCO_2 (μatm)

1970-2021

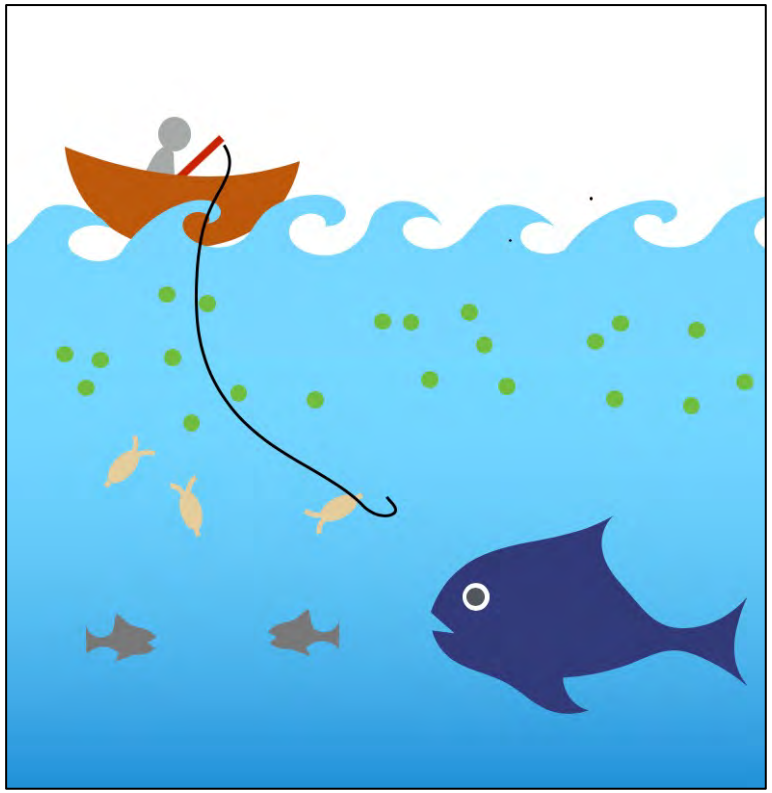
January 1989

January 2016

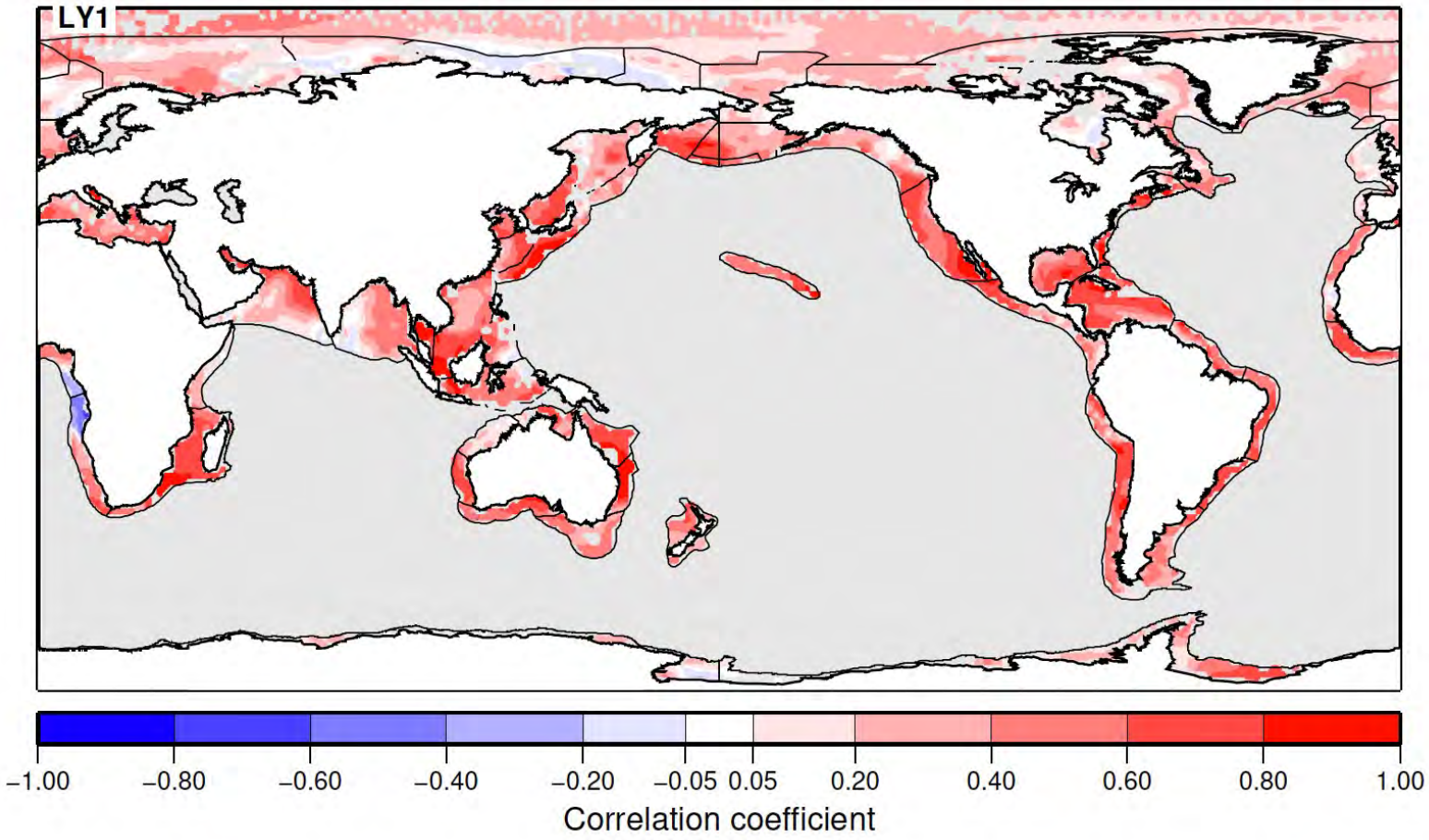


Bakker et al. (2016), Sabine et al. (2013)

Predictable plankton

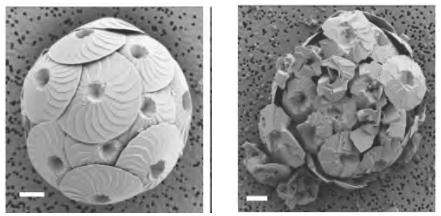


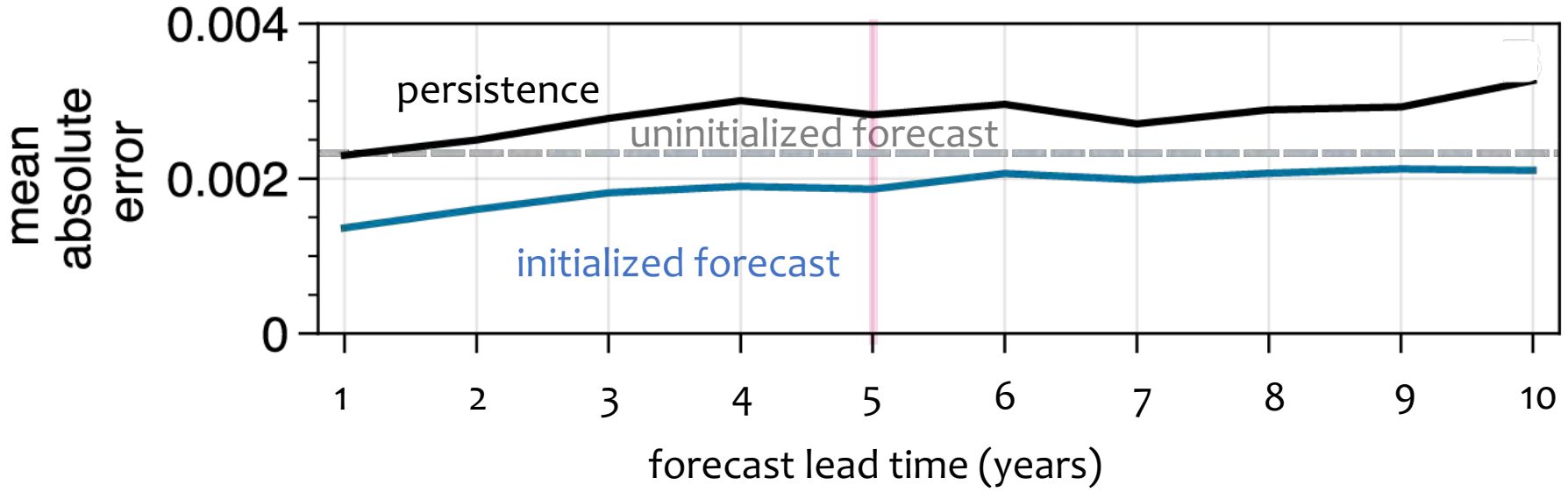
Net Primary Production -- Forecast lead time: 1 year



Krumhardt et al. (2020)

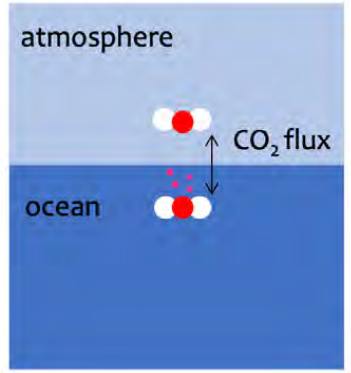
Ocean acidification in the California Current



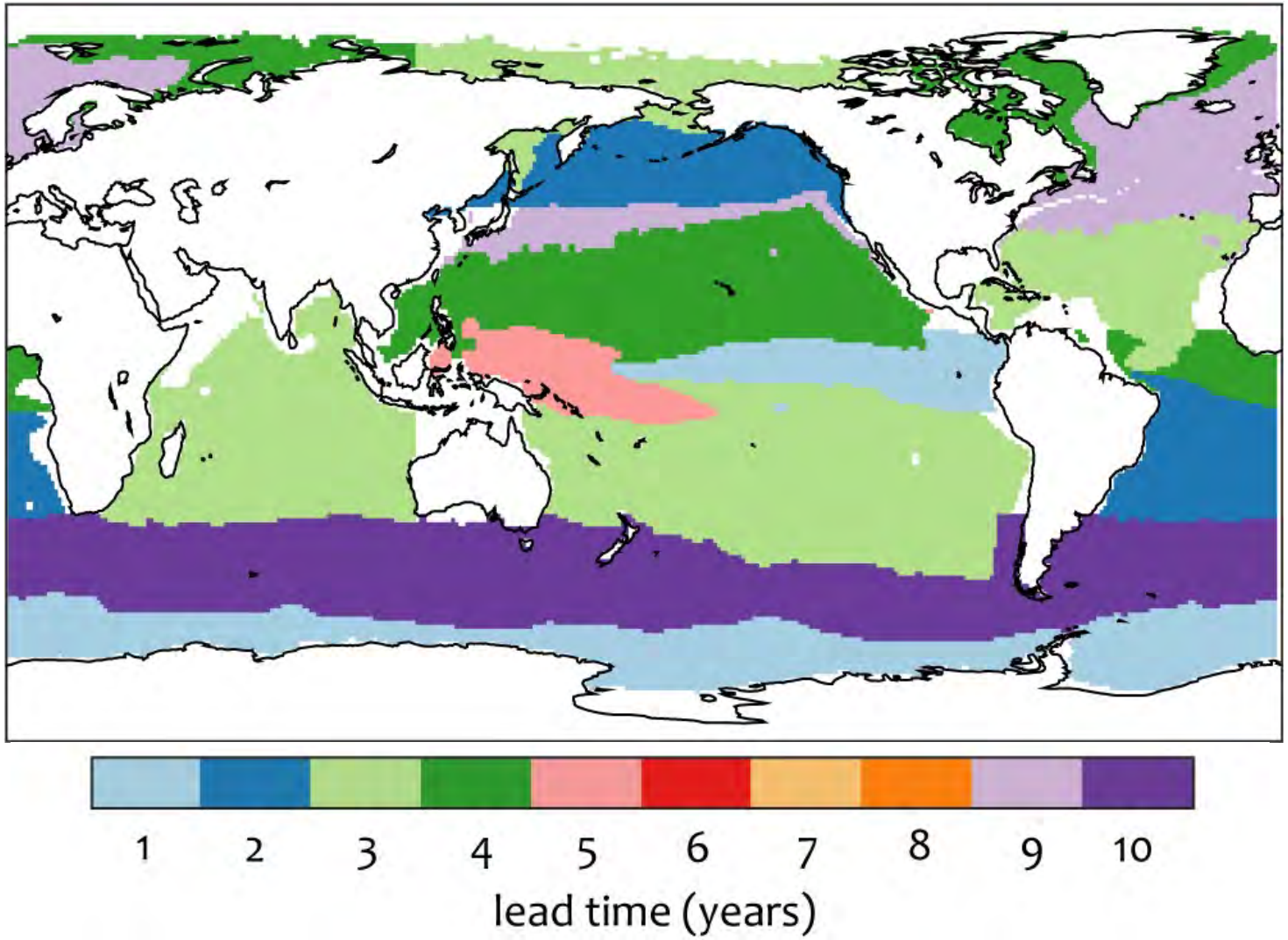


Brady et al. (2020)

Global air-sea CO_2 flux



Initialization beats other forecast methods until…

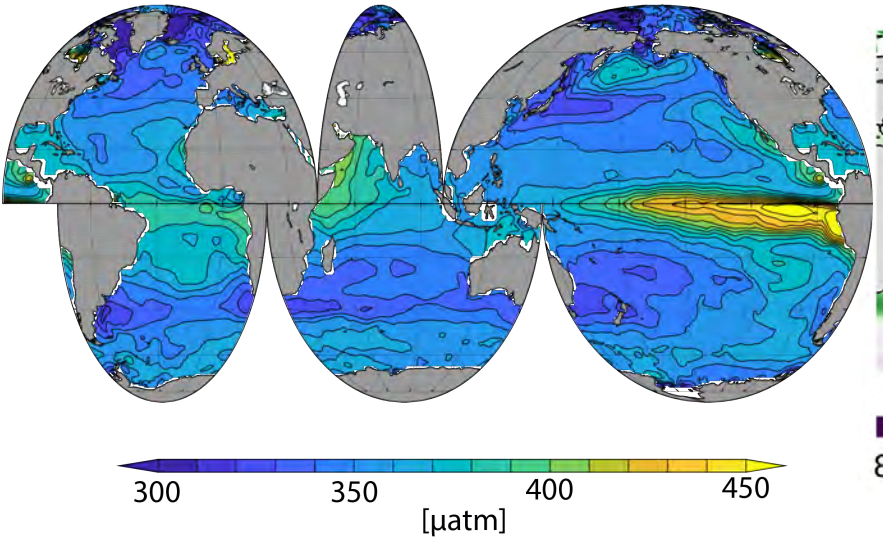


Lovenduski et al. (2019)

New directions in ocean BGC prediction

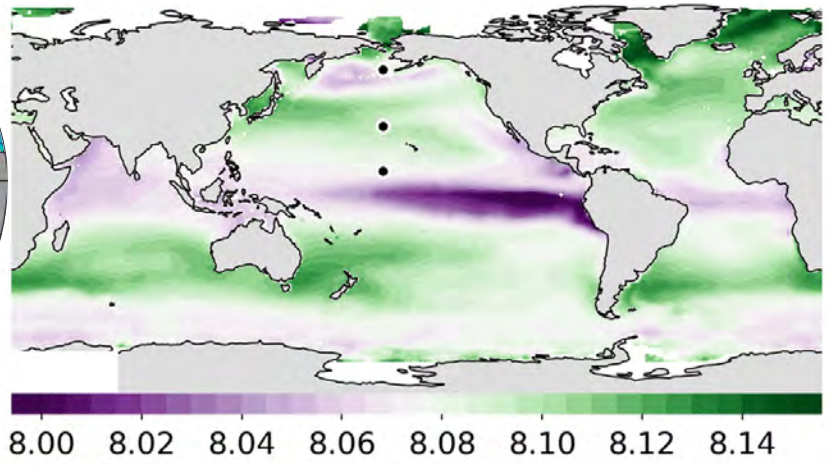
1. We have many more "observations" to assess skill

interpolated surface ocean pCO_2



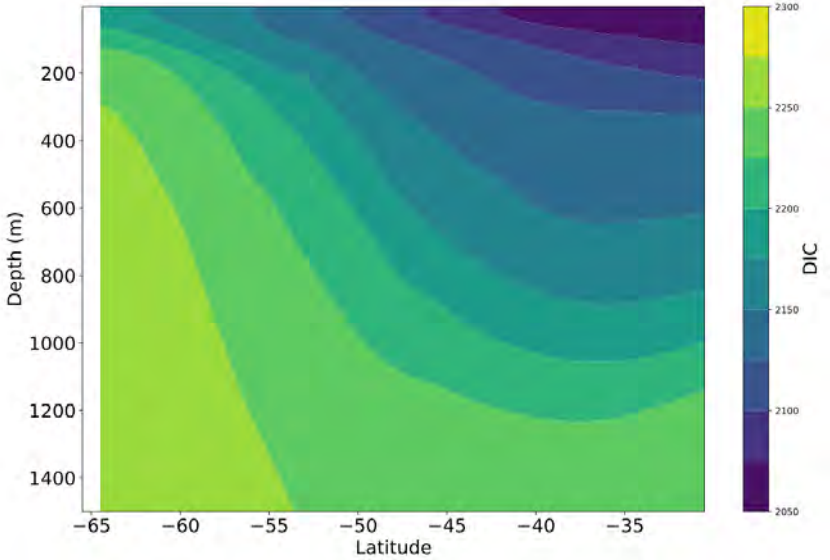
Landschützer et al. (2016)

interpolated surface ocean pH



Gregor and Gruber (2021)

interpolated subsurface carbon

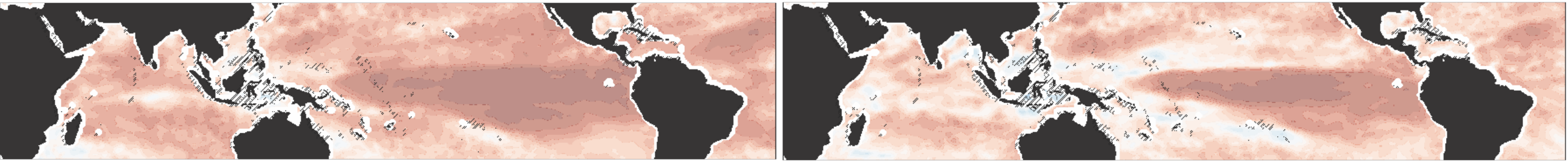


Keppler et al. (in prep.)

New directions in ocean BGC prediction

2. We are considering multiple, simultaneous ecosystem stressors

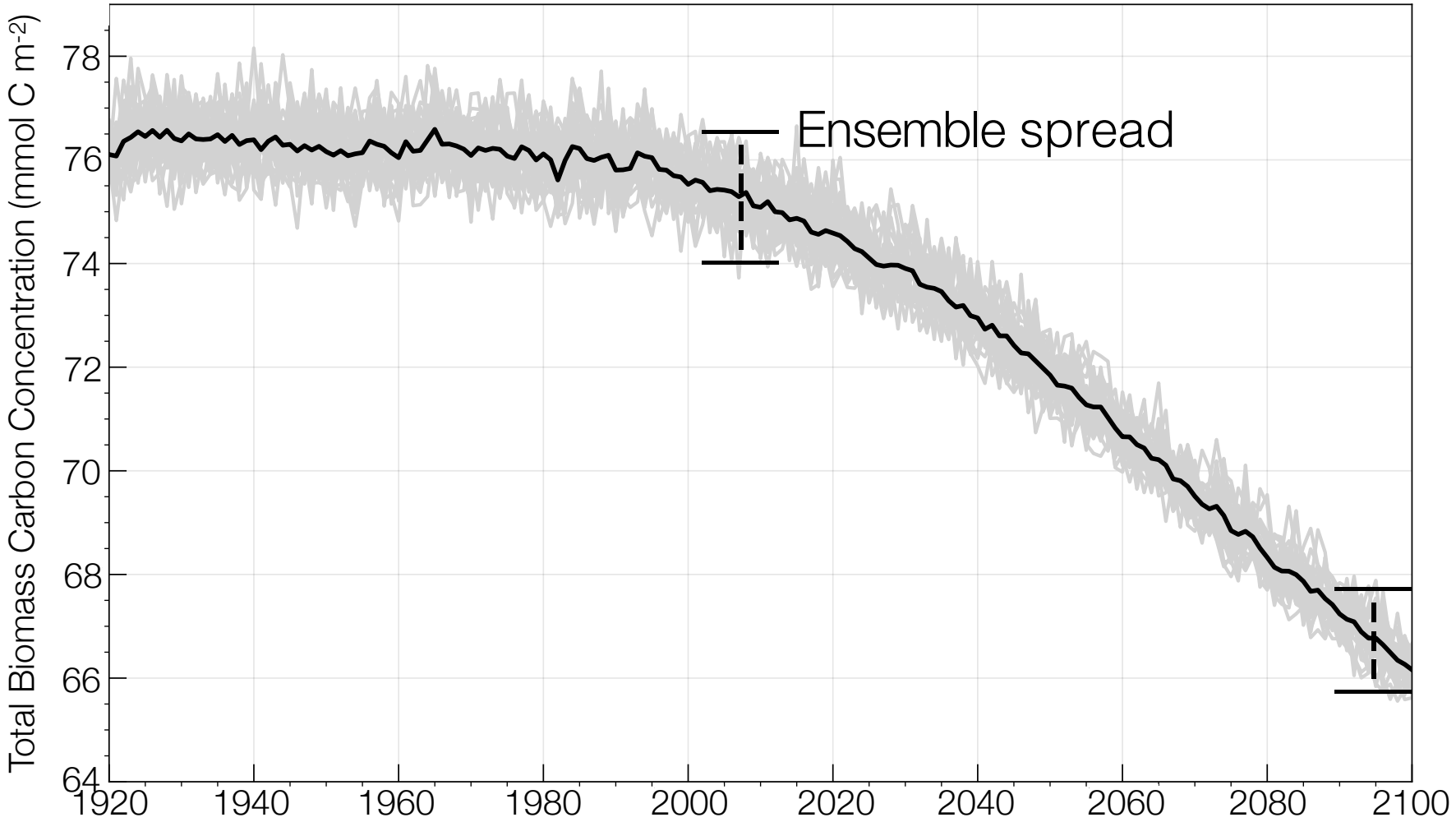
Temperature + Acidity



Mogen et al. (in prep)

New directions in ocean BGC prediction

3. Phytoplankton may become more predictable in the future



Elsworth et al. (in prep.)

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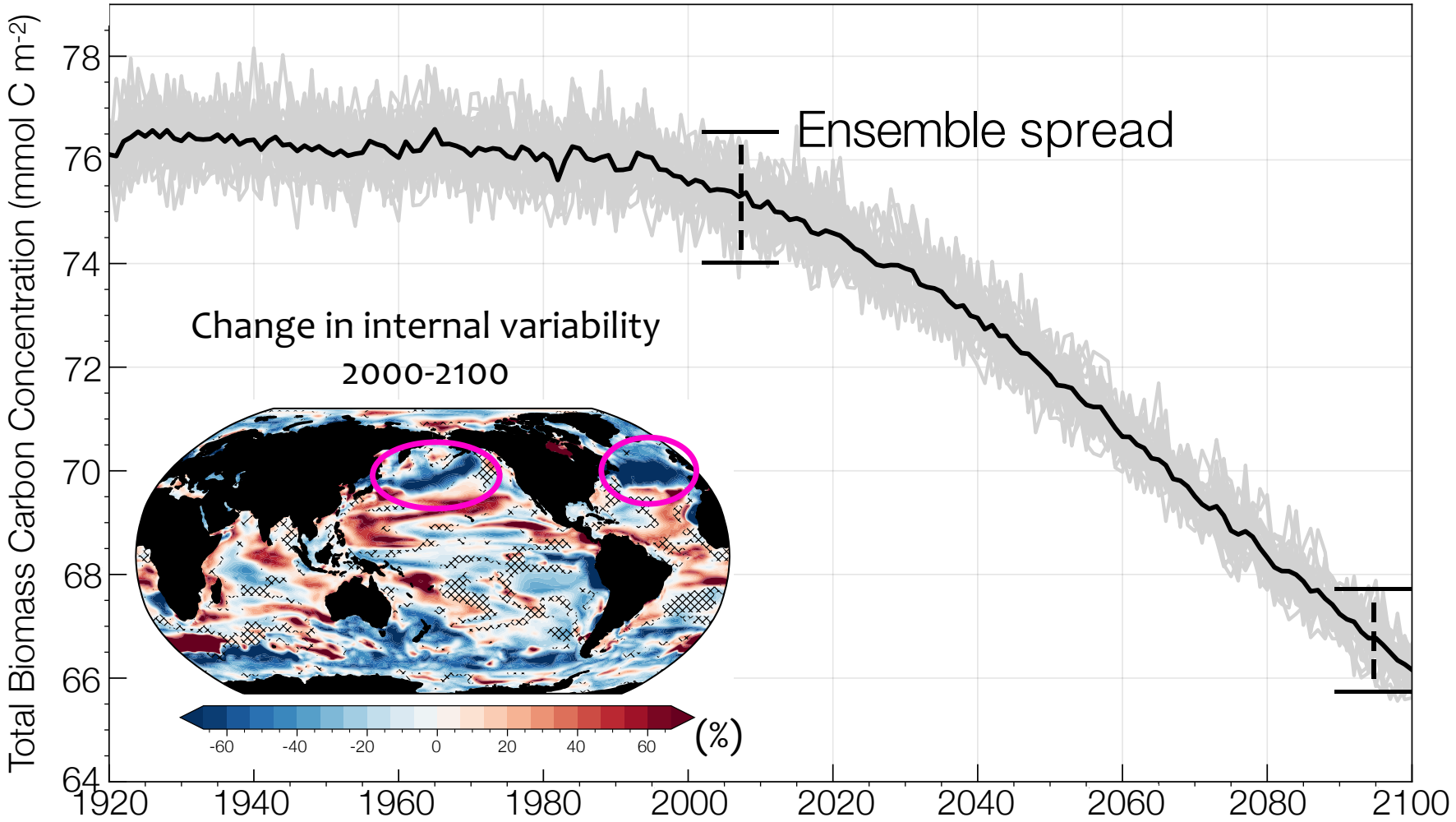
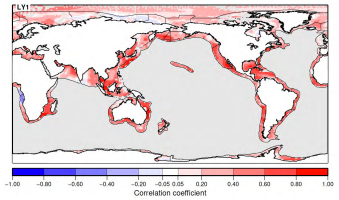
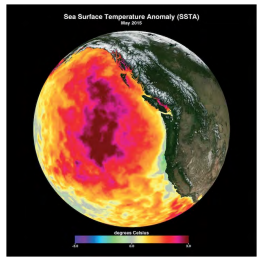


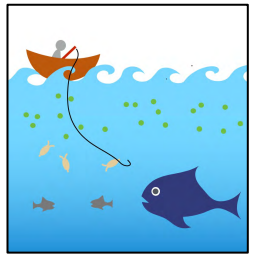
Elsworth et al. (in prep.)

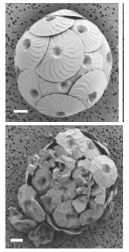
Summary

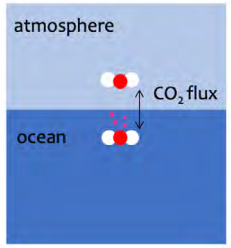




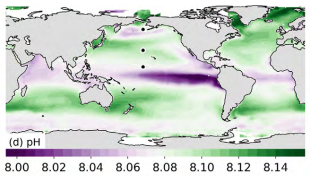
Ocean biogeochemical prediction is an emerging and exciting research field with multiple potential applications and much to be learned.

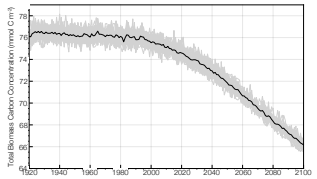






Analysis of near-term predictions with the CESM reveal the potential for predictability in marine phytoplankton, ocean acidification, and ocean carbon absorption.





Future research directions for ocean biogeochemical prediction include real-world skill assessment, a multi-stressor and/or event-based predictability framework, and the possibility of “easier” predictions at the end of the century