Near-term predictions of marine and terrestrial biogeochemistry in CESM

Nikki Lovenduski

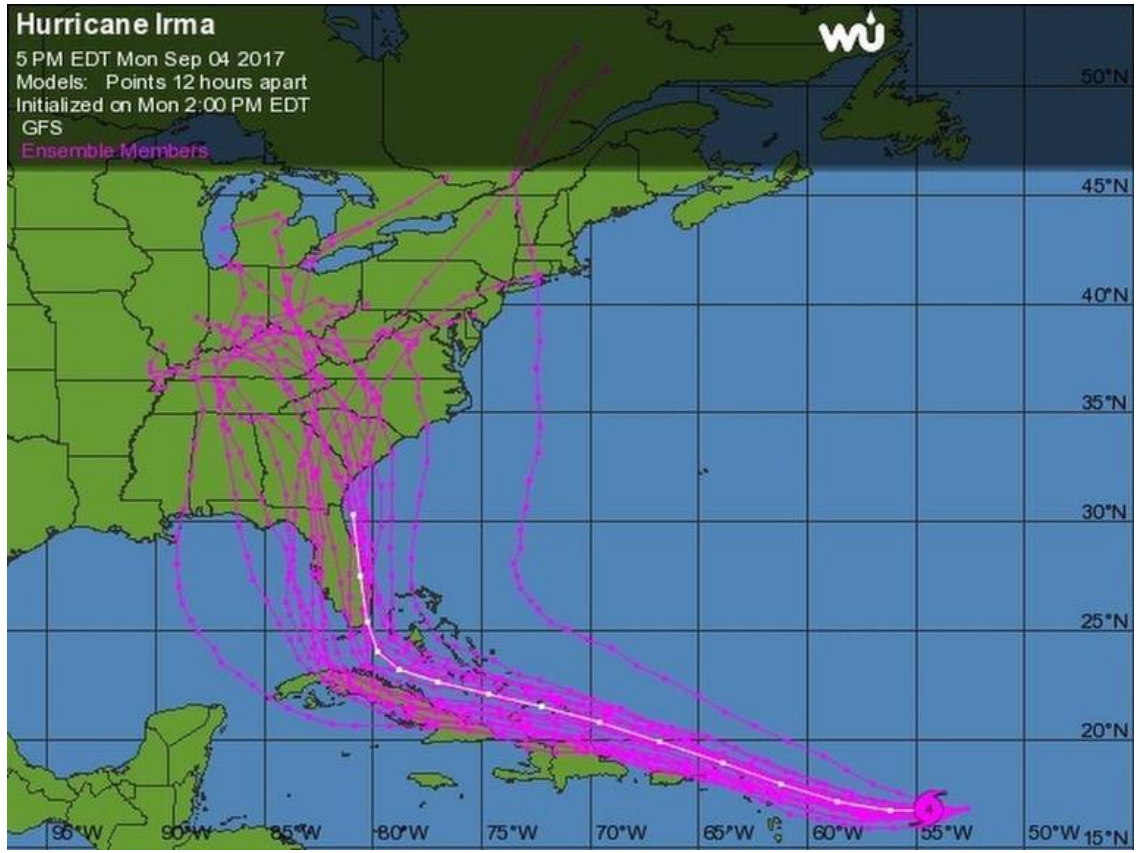
University of Colorado Boulder

thanks to:

Steve Yeager, Kristen Krumhardt, Riley Brady, Gordon Bonan, Danica Lombardozzi, and Keith Lindsay

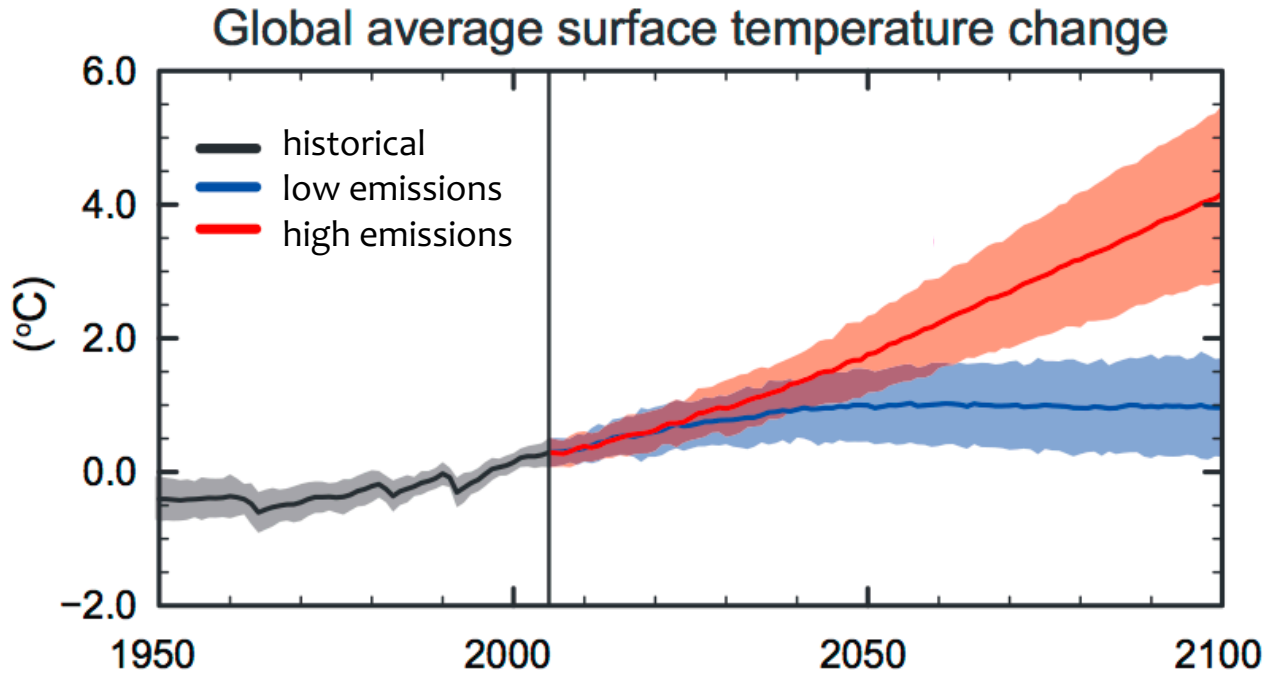
Prediction vs. Projection

Short-term, initialized predictions



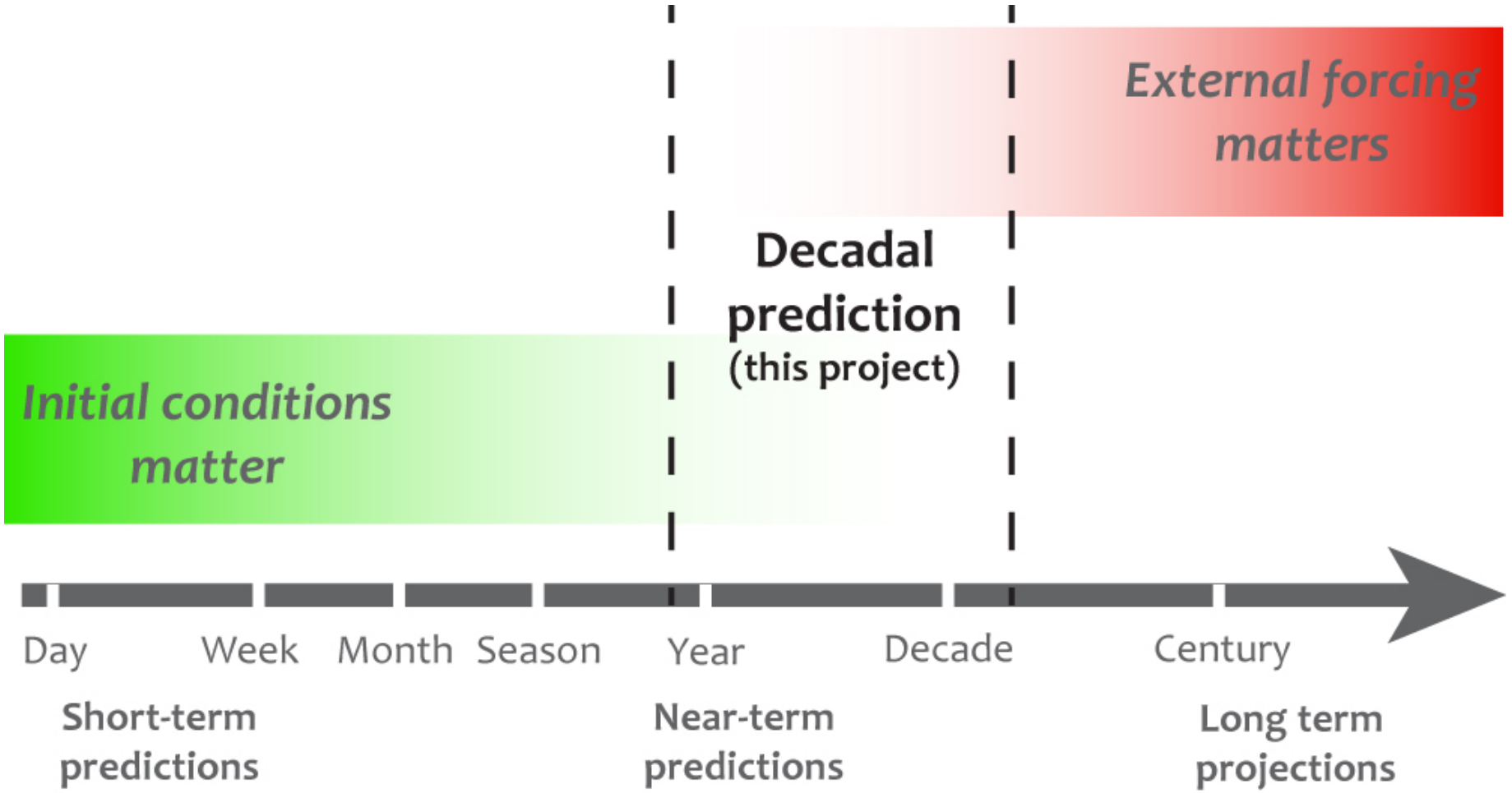
wunderground.com

Long-term, un-initialized projections



IPCC AR5 (2013)

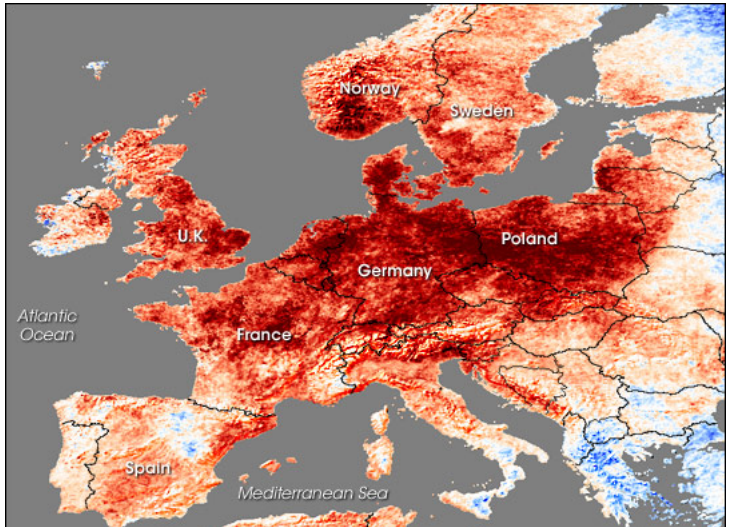
Decadal prediction



adapted from Meehl et al. (2009) and Boer et al. (2016)

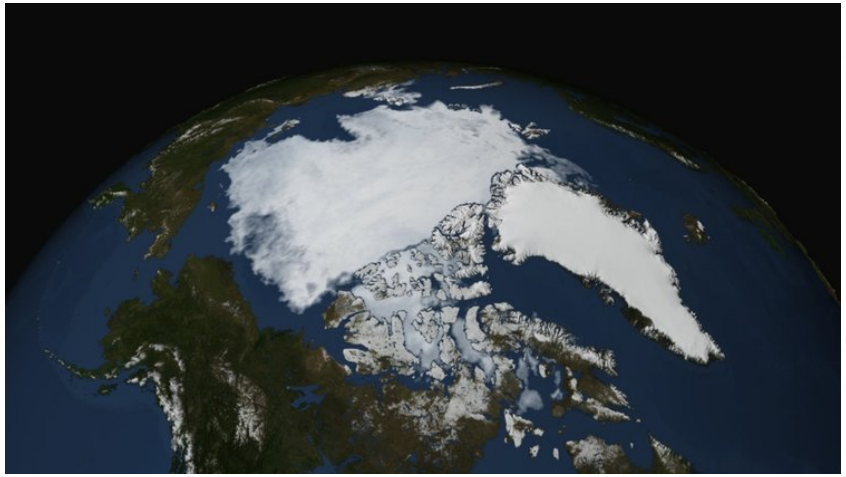
What are we successfully predicting?

European heat waves



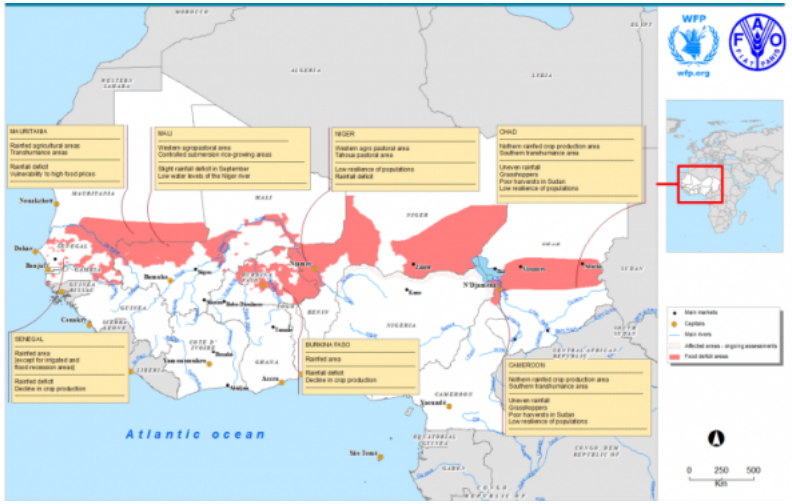
Sutton and Hodson (2005)

Sea ice extent



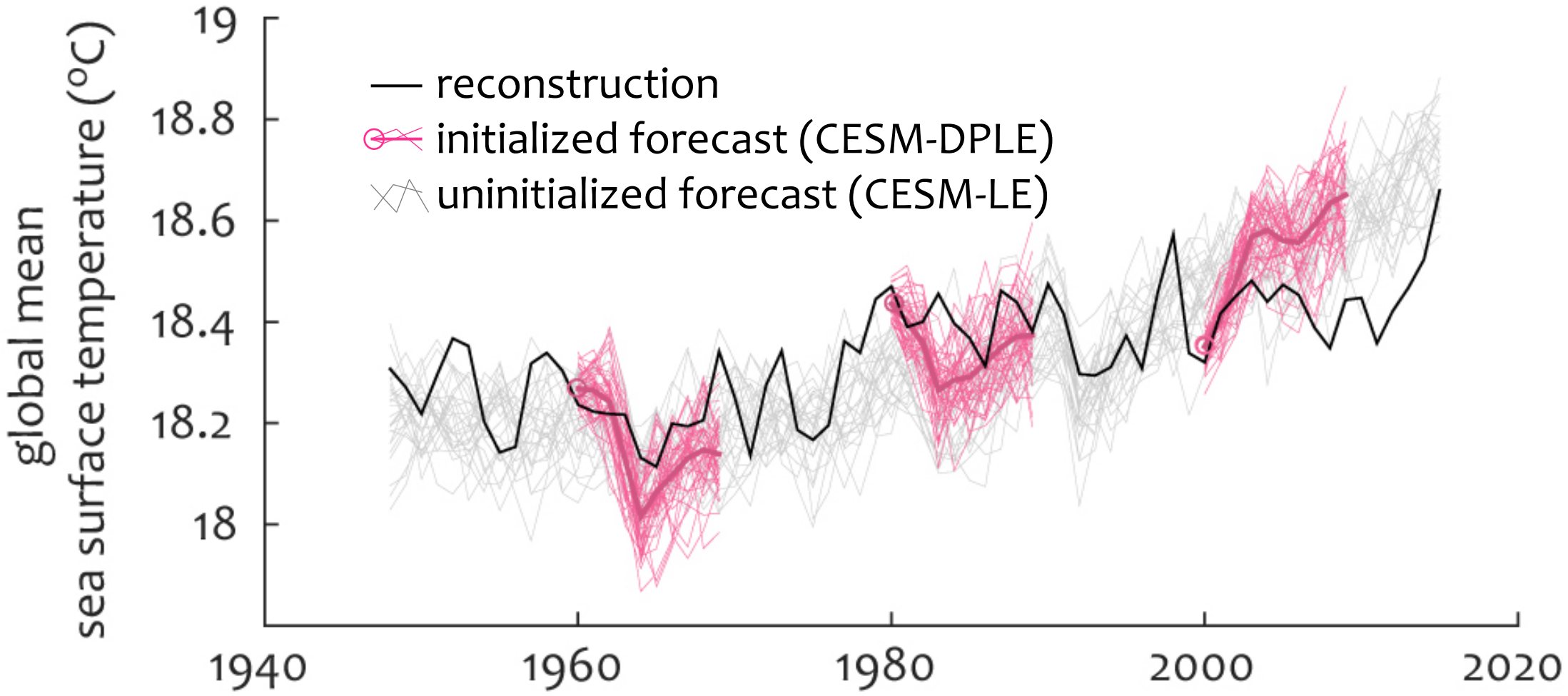
Blanchard-Wrigglesworth et al. (2011)

Sahel precipitation



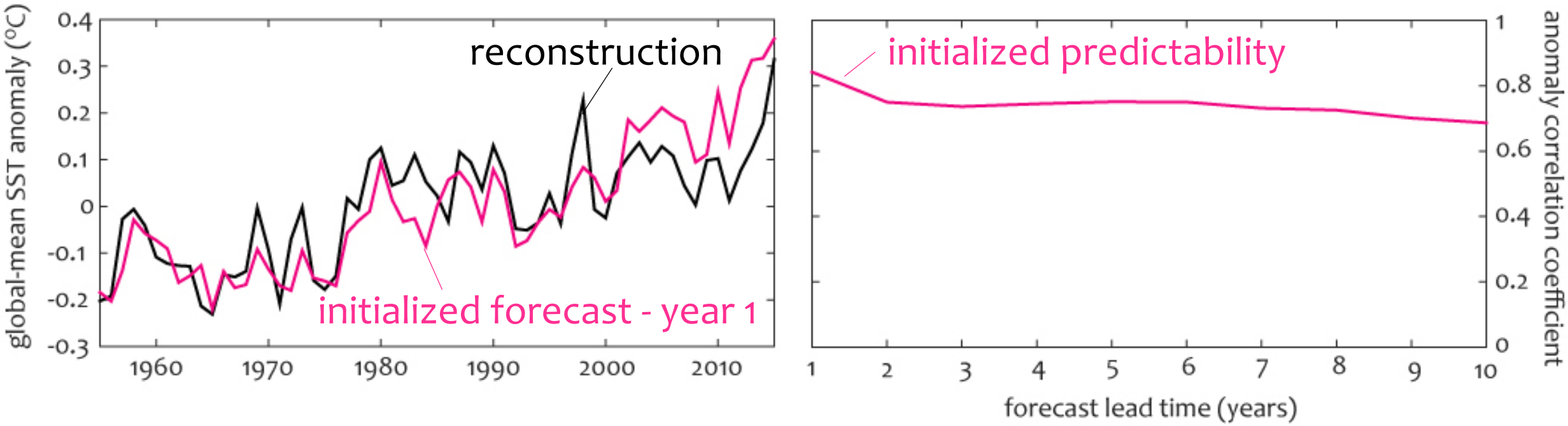
Maroon et al. (in prep.)

Community Earth System Model Decadal Prediction Large Ensemble



CESM-DPLE described in Yeager et al. (2018)
CESM-LE described in Kay et al. (2015)

Is global-mean SST predictable?



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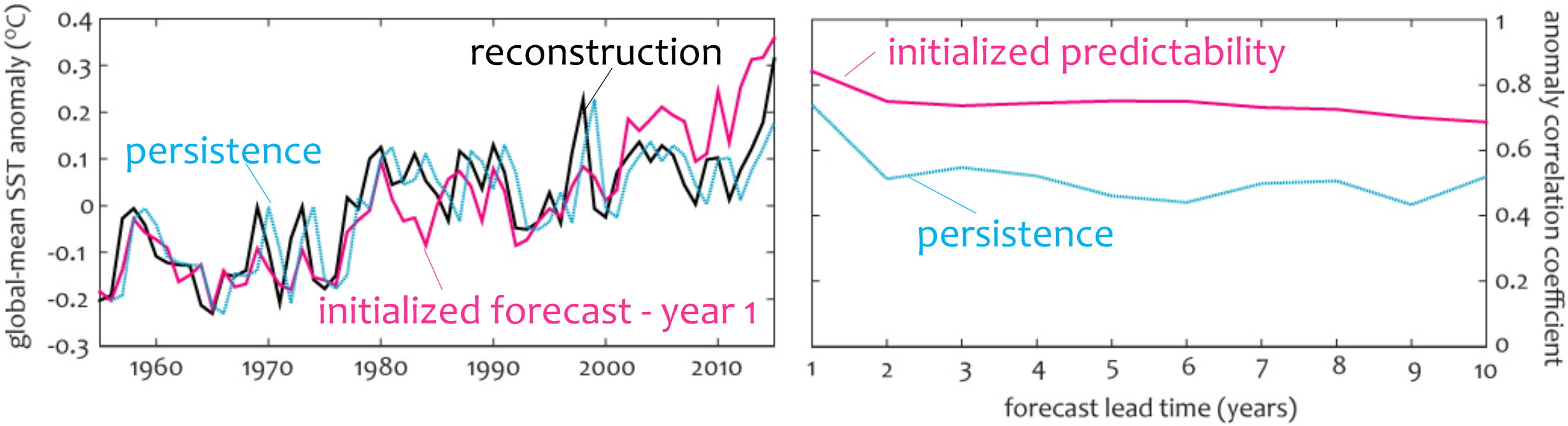

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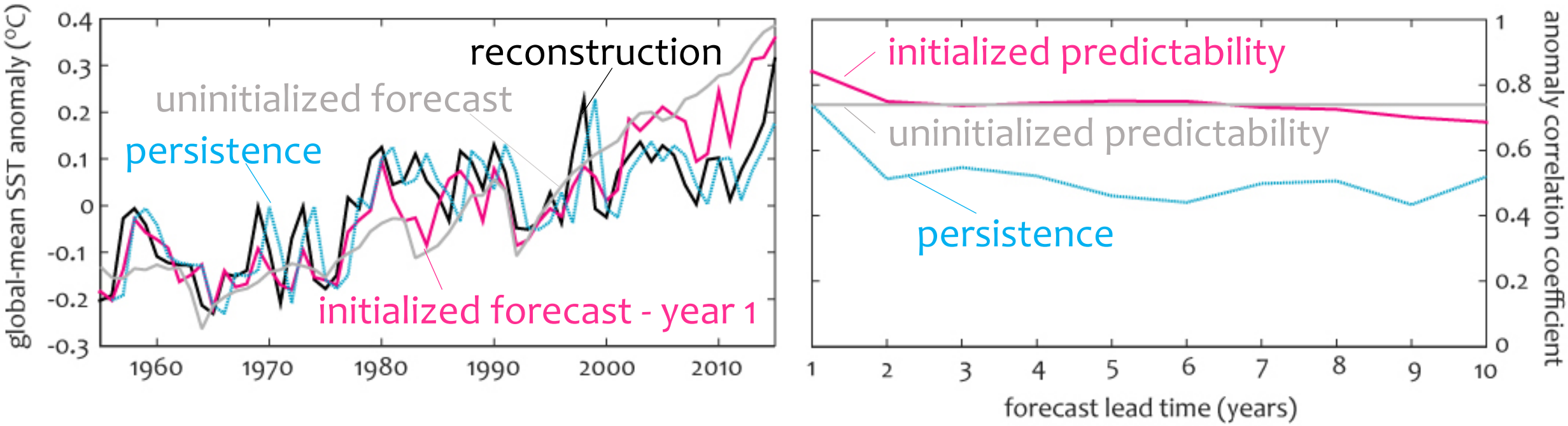
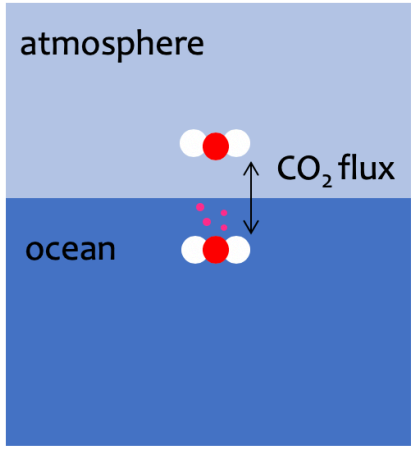


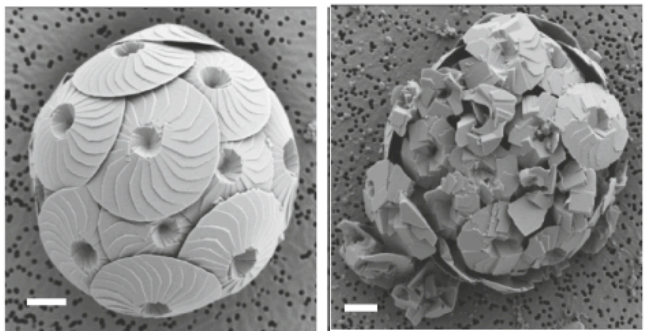
Biogeochemical variables of interest

Air-sea carbon flux



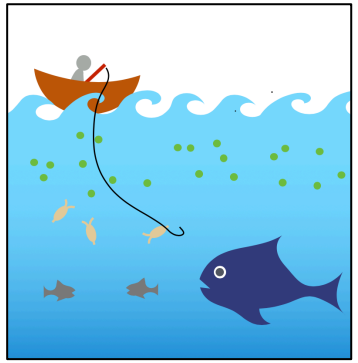
Lovenduski et al. (2019)

Ocean acidity



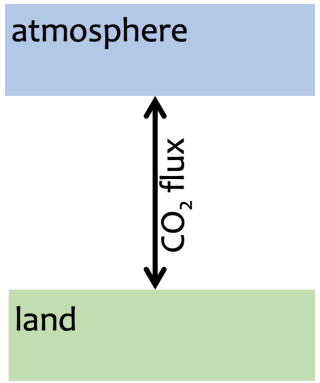
Brady et al. (in review)

Marine phytoplankton



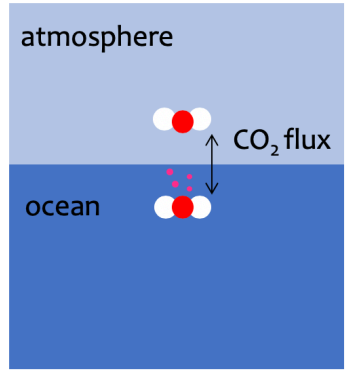
Krumhardt et al. (in prep.)

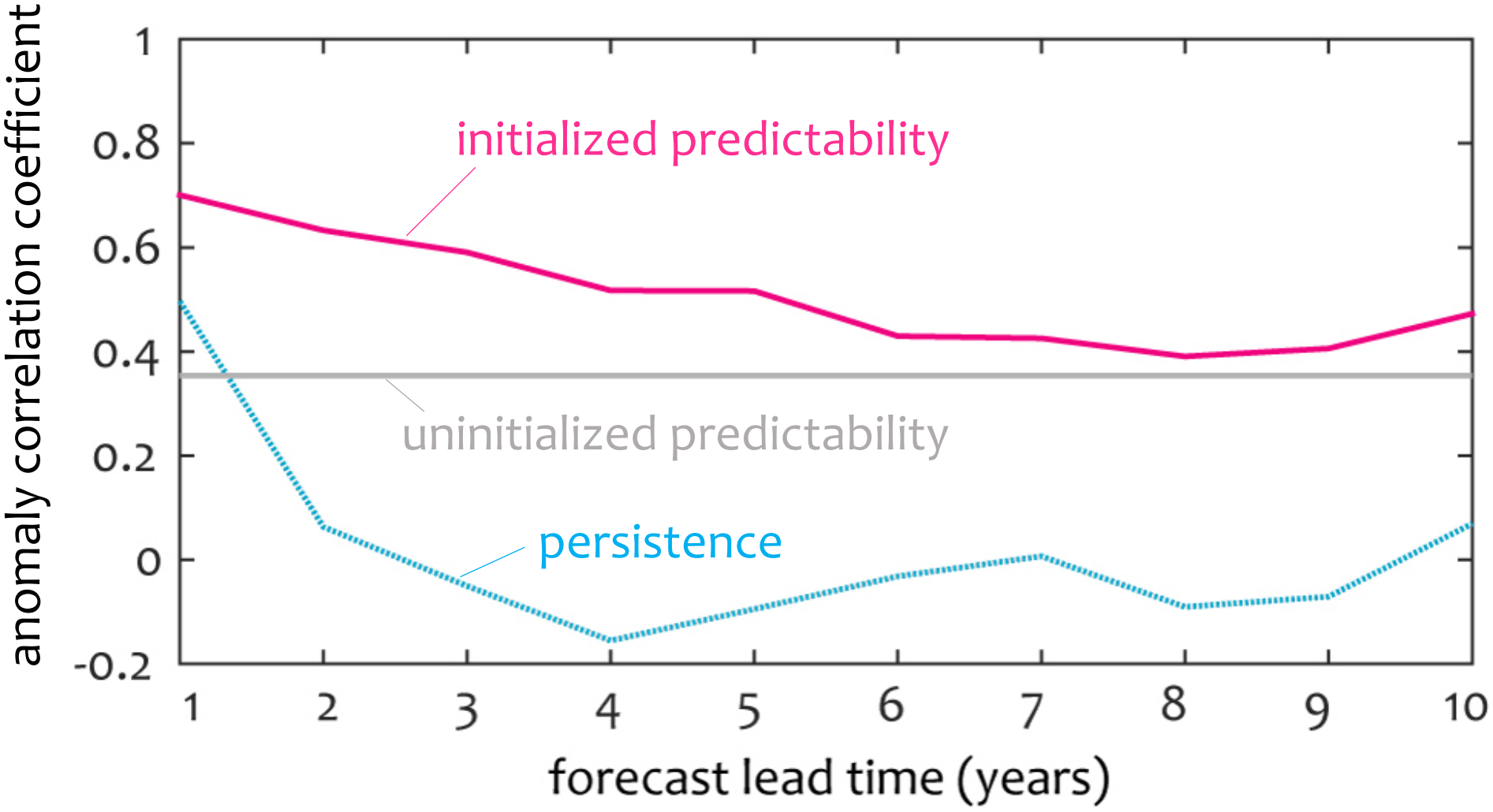
Terrestrial carbon fluxes



Lovenduski et al. (in review)

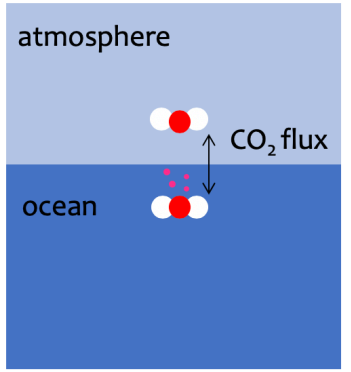
Globally integrated air-sea CO_2 flux





Lovenduski et al. (2019)

Air-sea CO_2 flux predictability

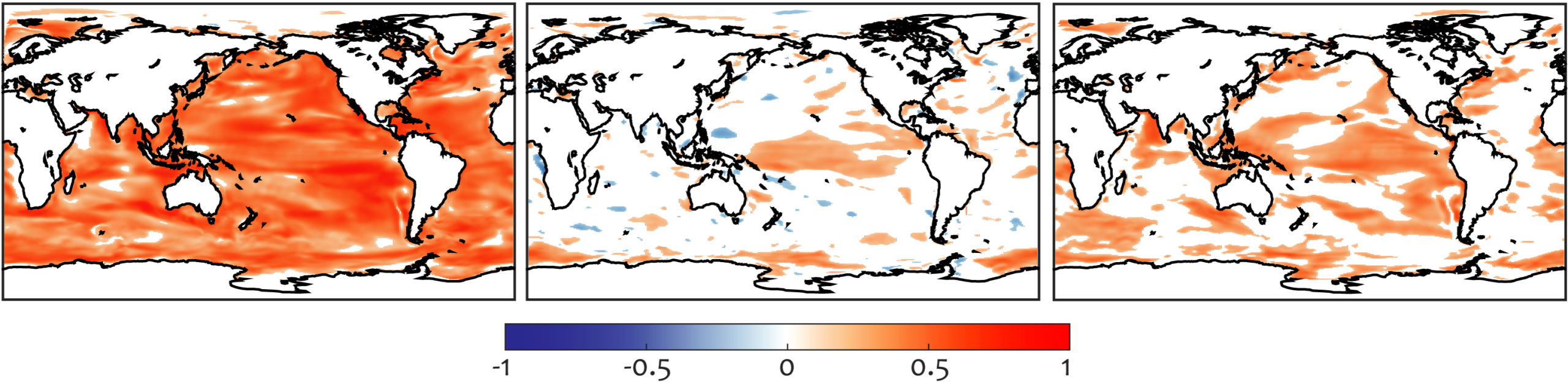


Forecast lead year 1

Initialized forecast

Uninitialized forecast

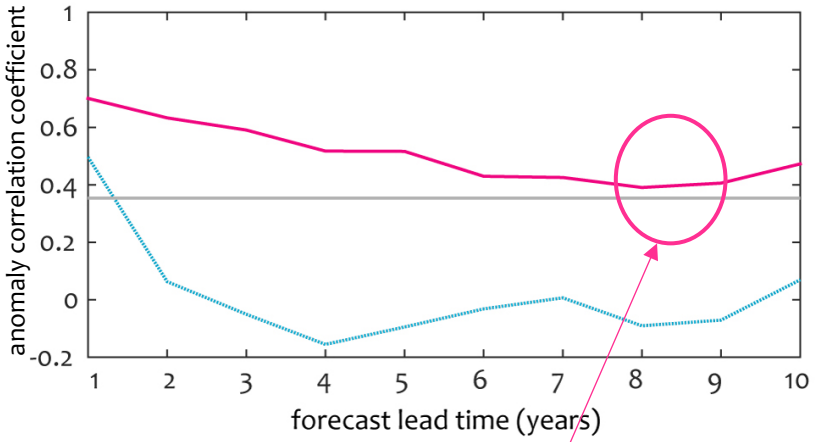
Persistence forecast



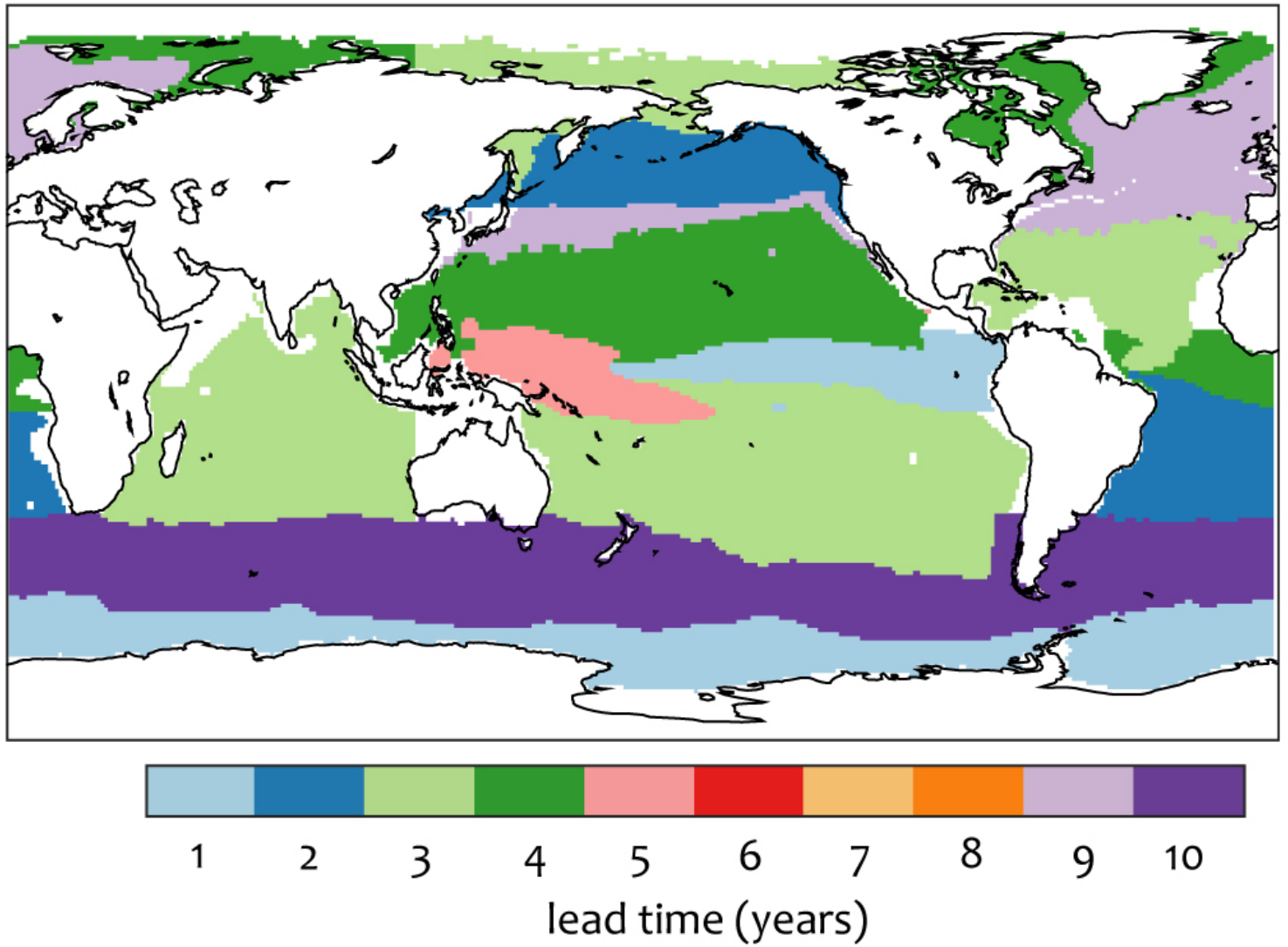
Lovenduski et al. (2019)

Air-sea CO_2 flux

Initialization beats other forecast methods until…

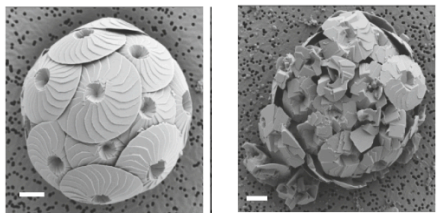


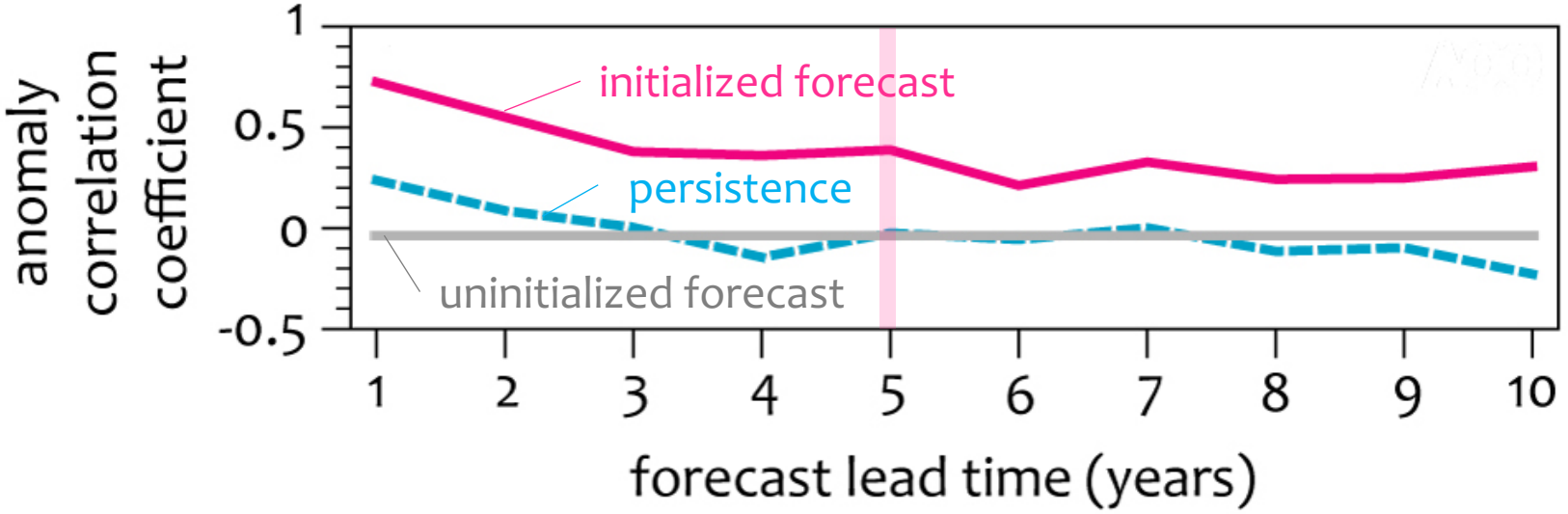
When does the initialized forecast drop below the persistence or uninitialized forecast?



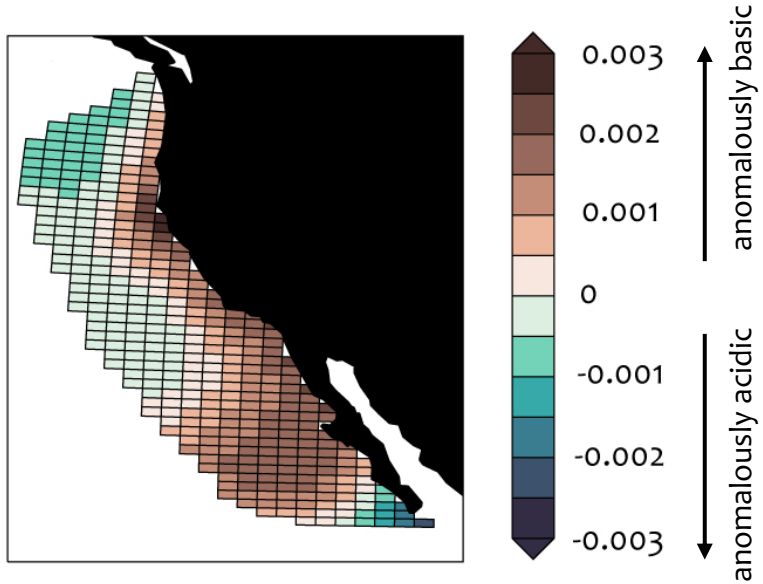
Lovenduski et al. (2019)

Ocean acidification in the California Current



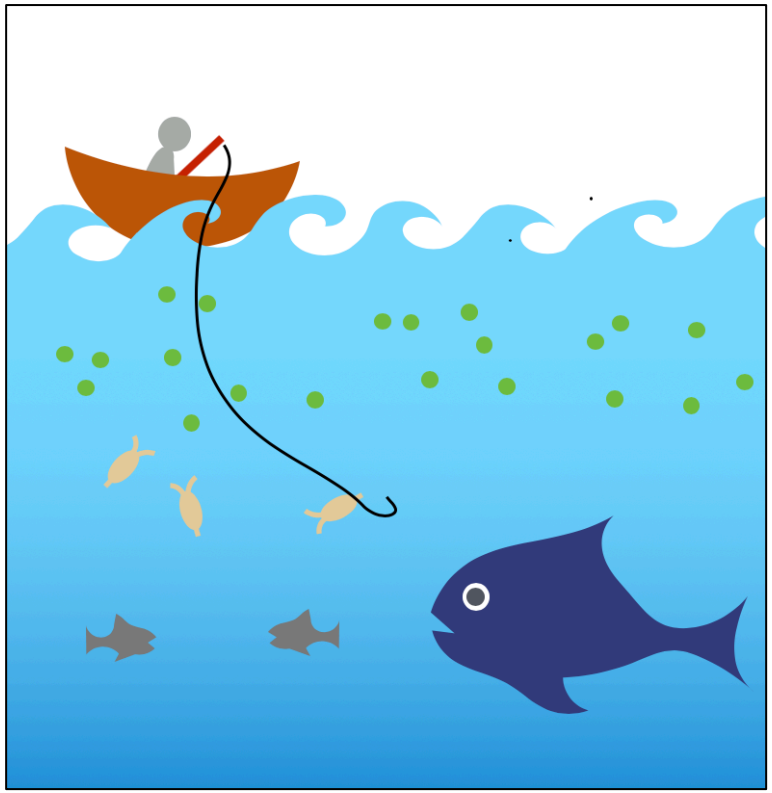


we made a forecast for 2020 !

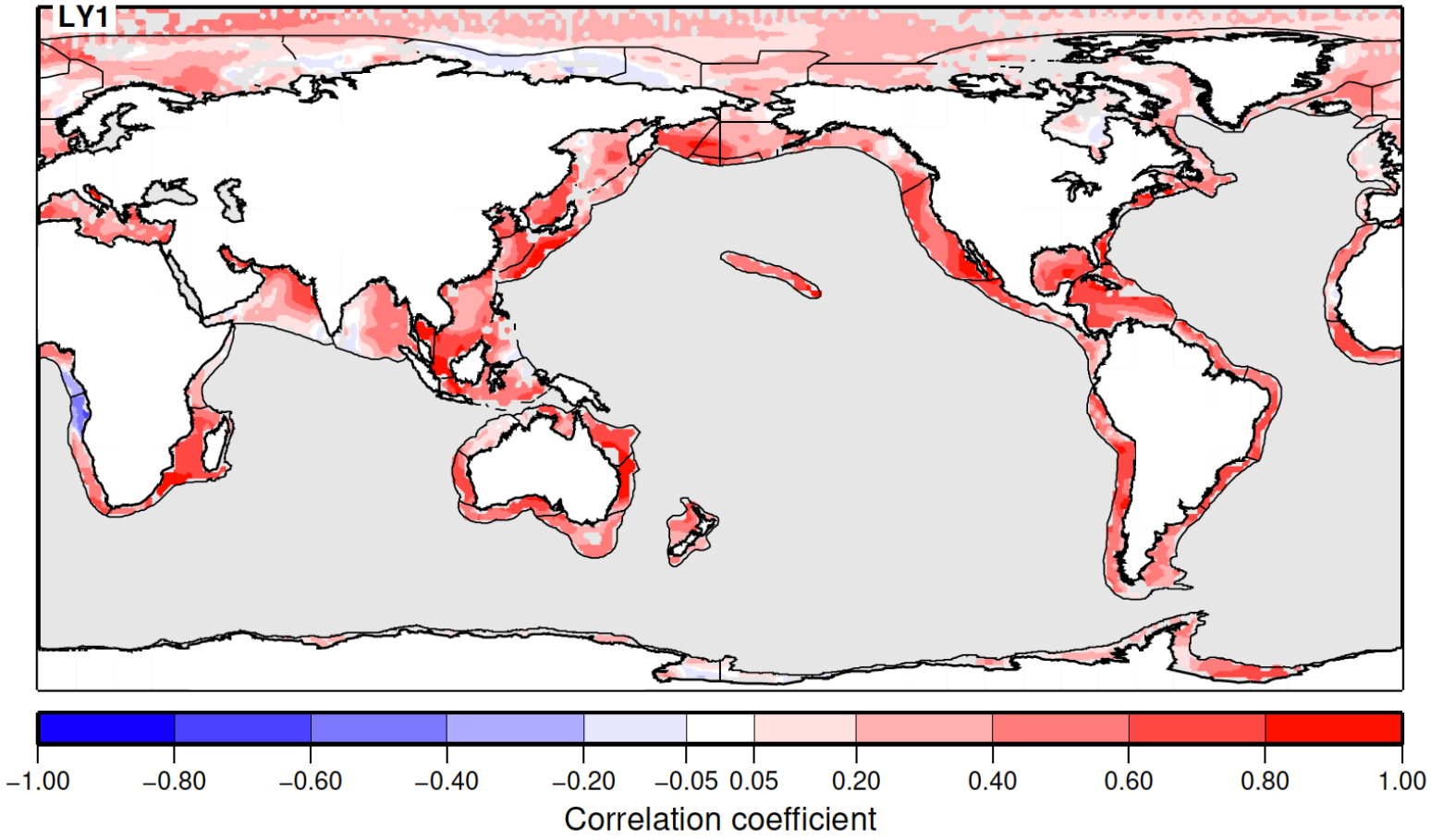


Brady et al. (in review)

Predictable plankton

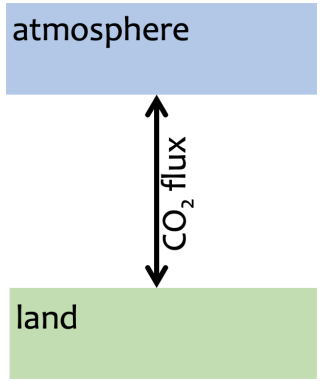


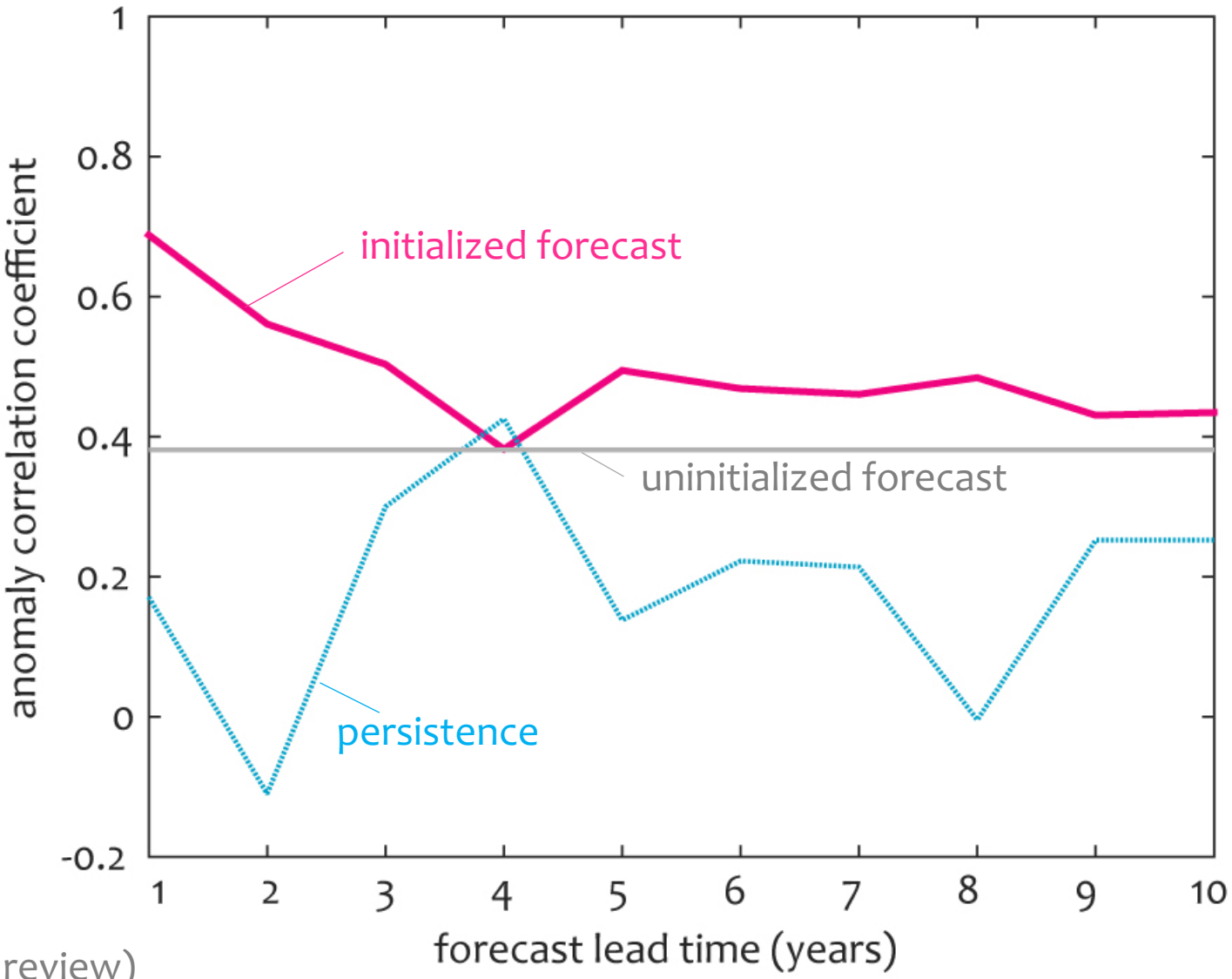
Net Primary Production -- Forecast lead time: 1 year



Krumhardt et al. (in prep.)

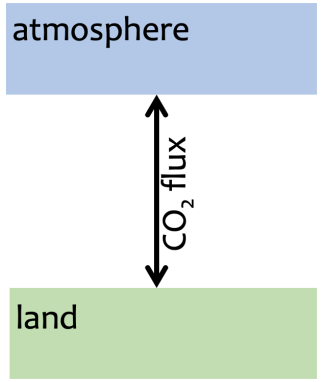
Globally-integrated NEP



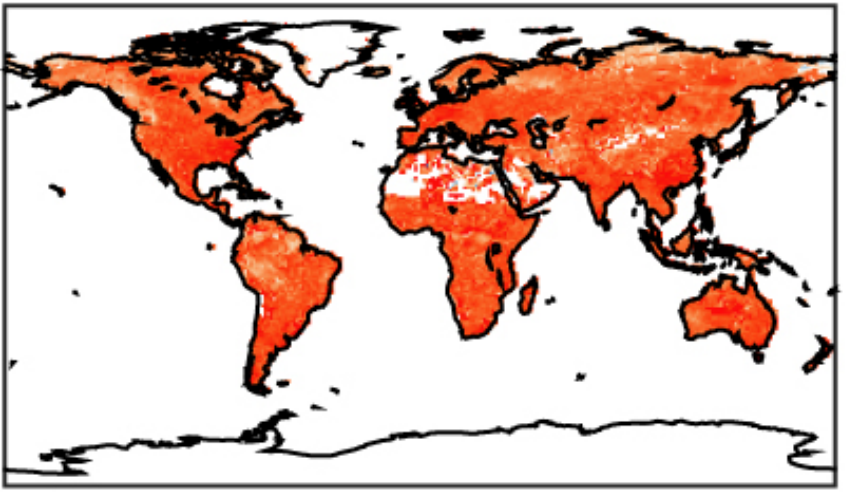


Lovenduski et al. (in review)

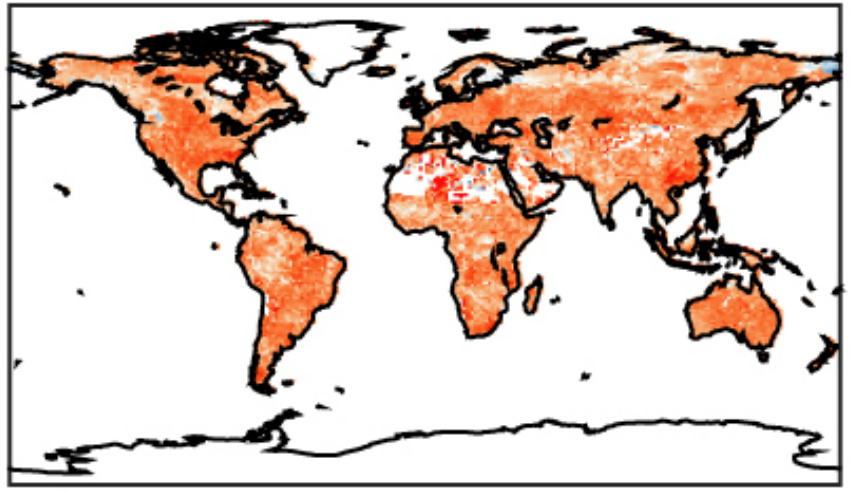
Net ecosystem production predictability



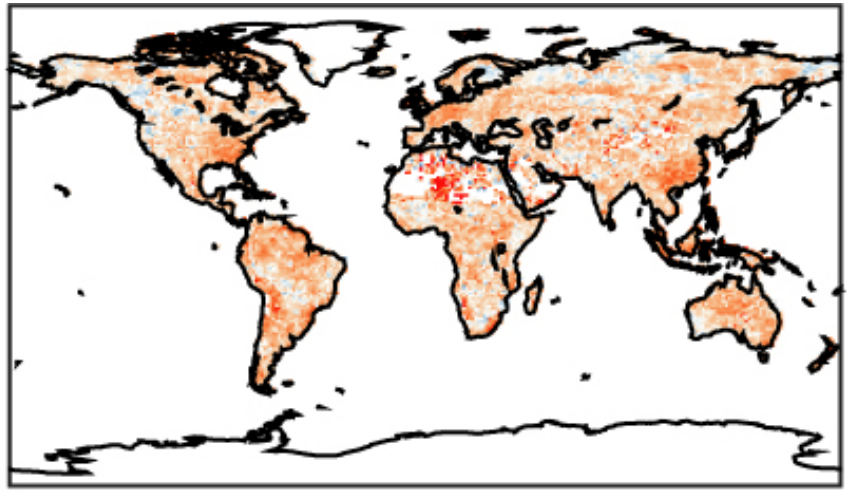
Forecast lead time: 1 year



Forecast lead time: 2 years

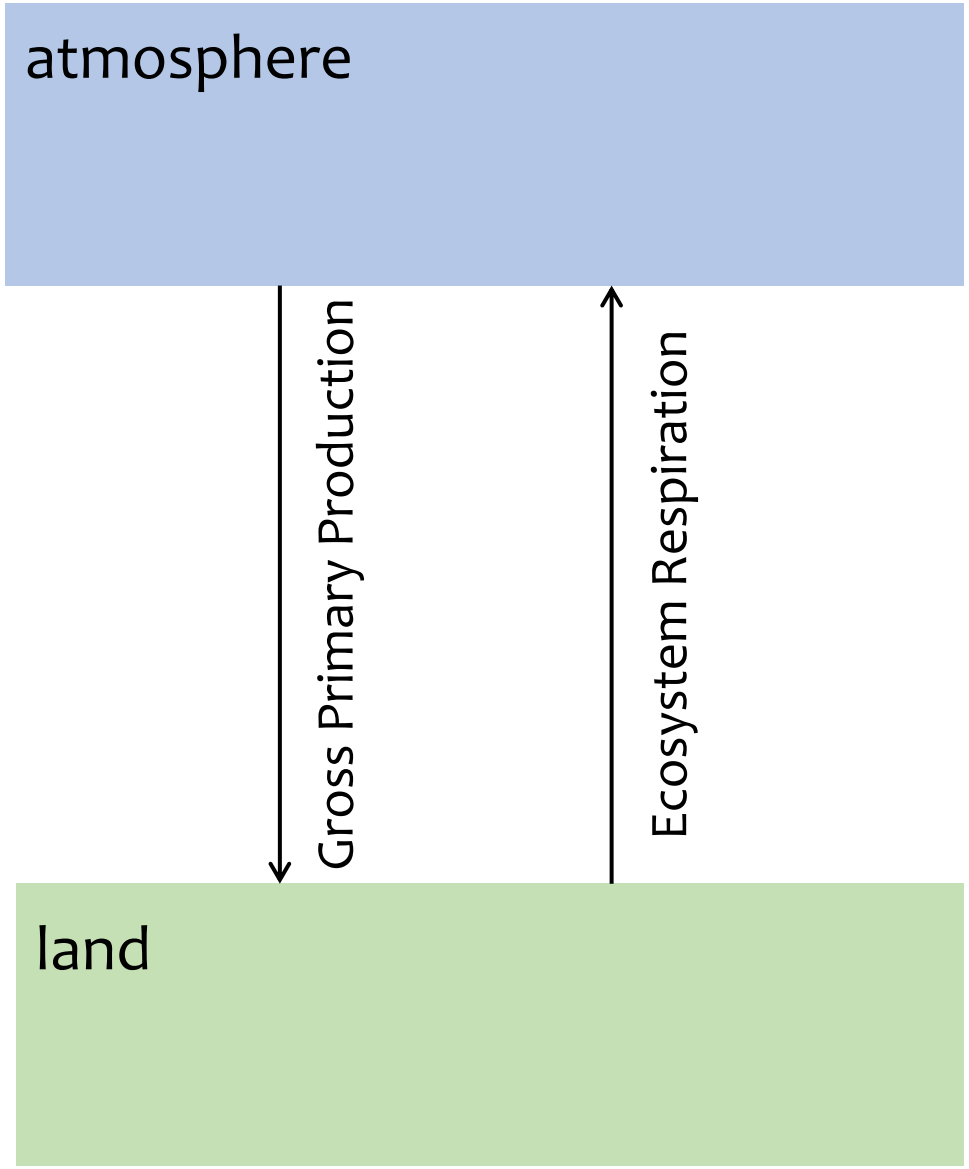


Forecast lead time: 3 years

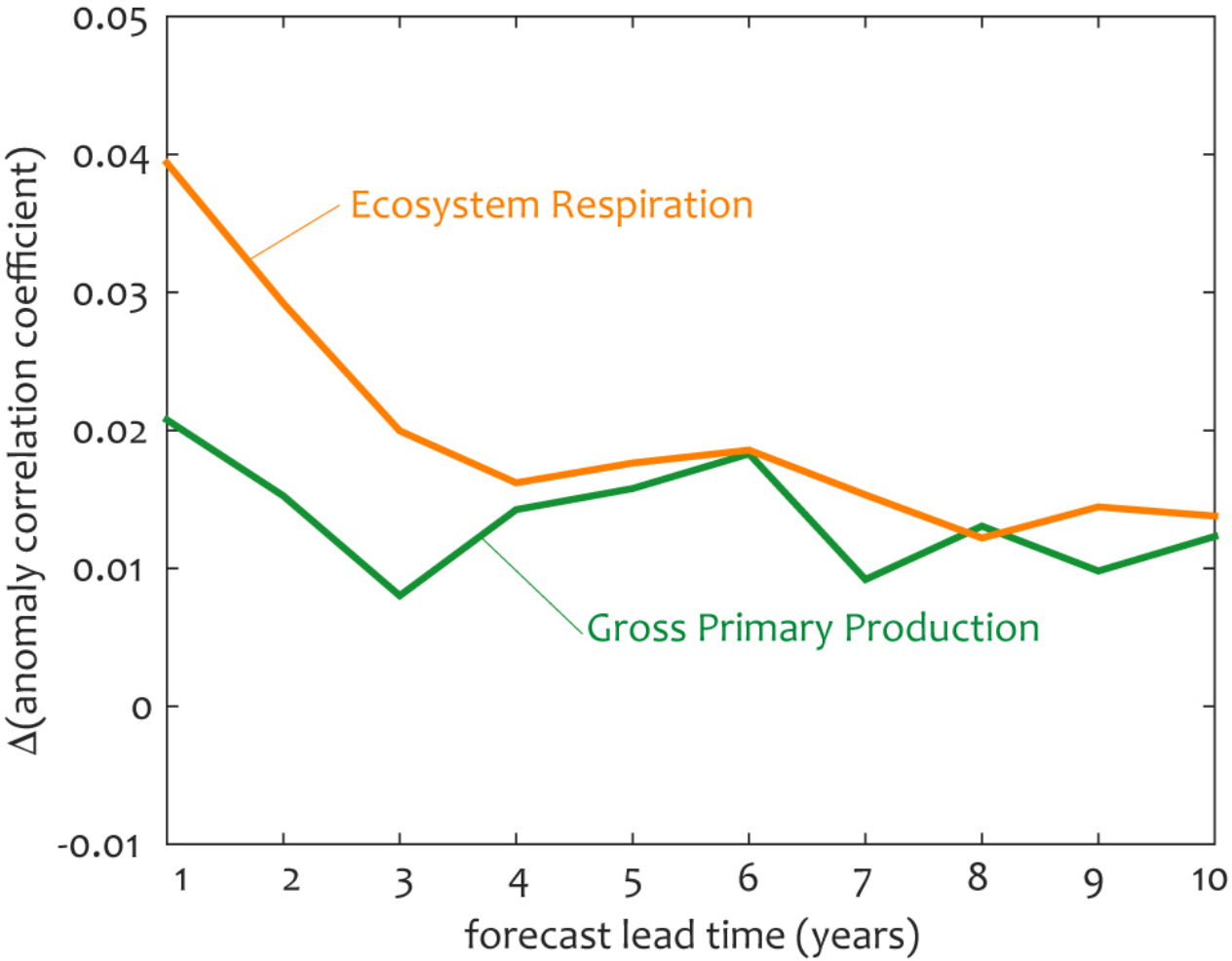


Lovenduski et al. (in review)

Terrestrial carbon fluxes

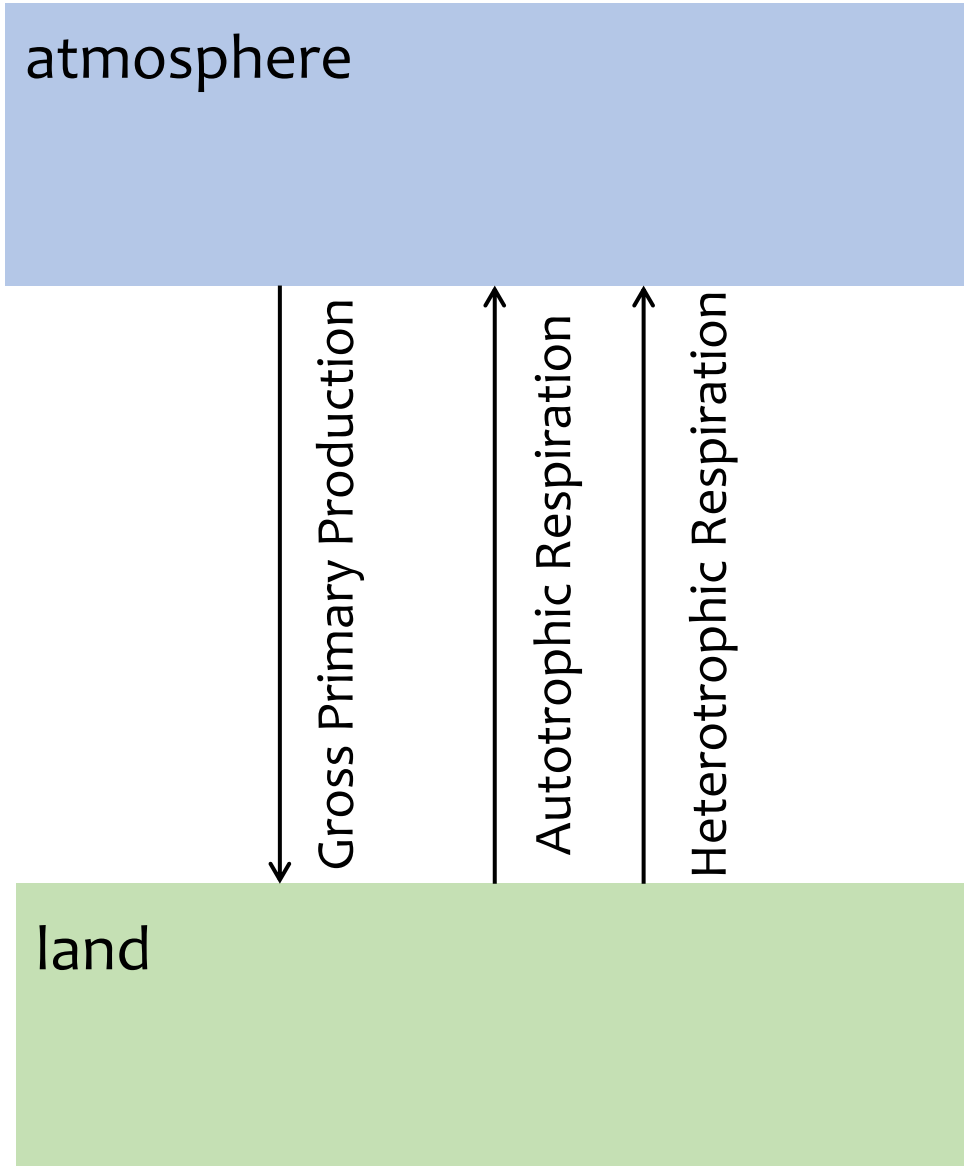


Globally-integrated



Lovenduski et al. (in review)

Terrestrial carbon fluxes



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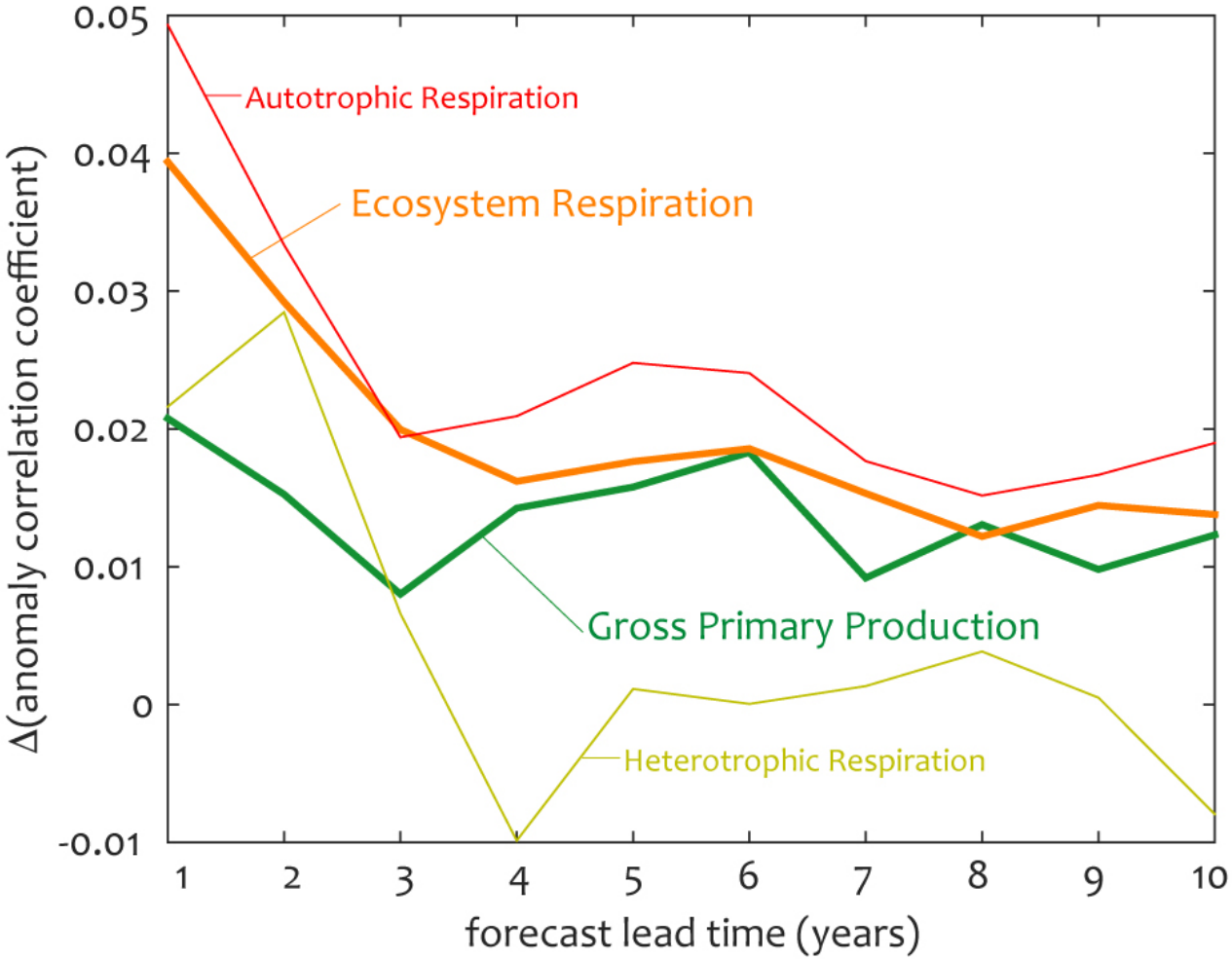
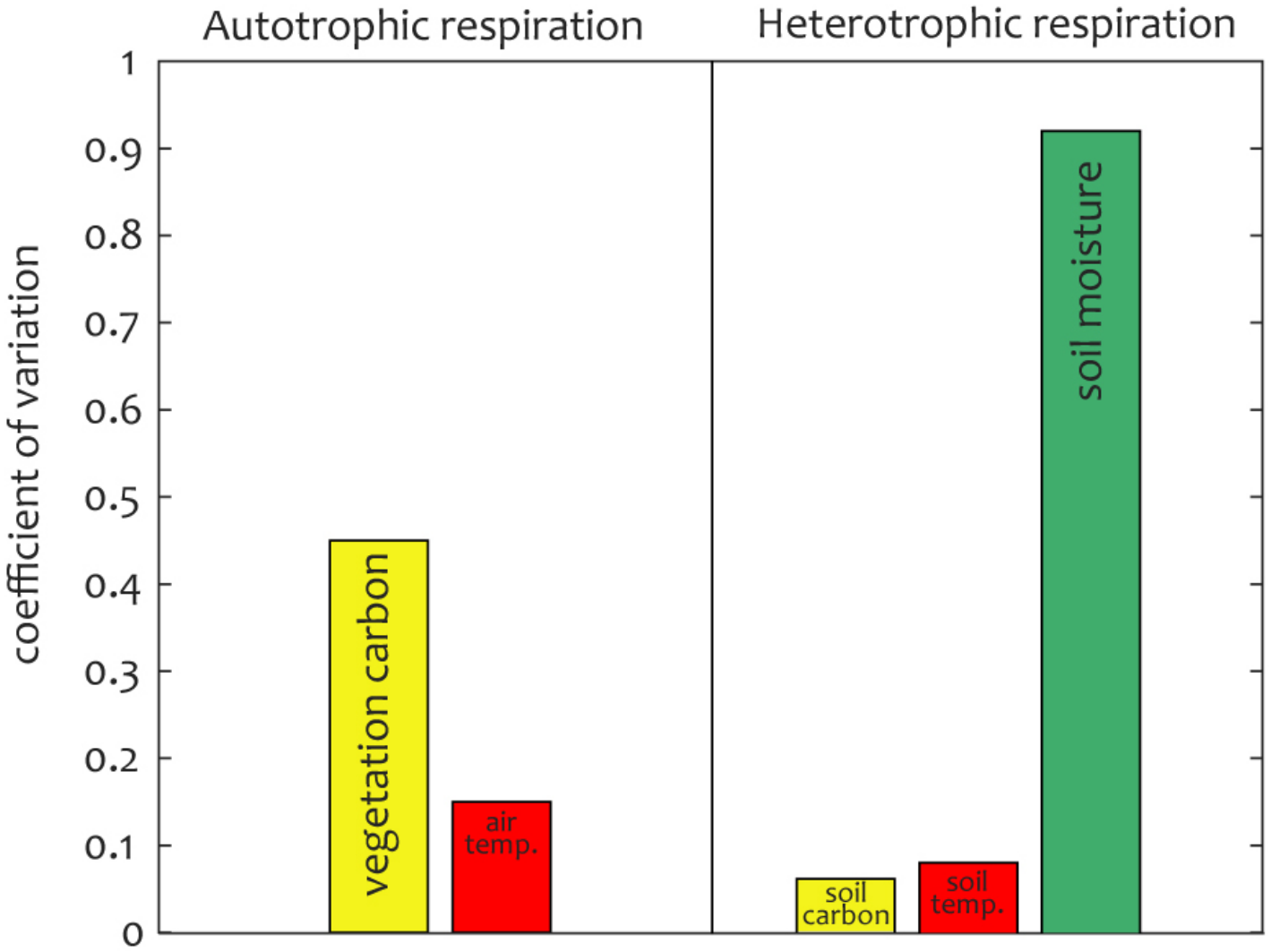
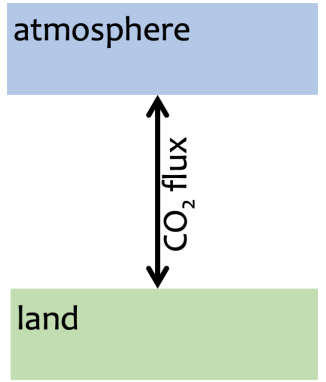


Lovenduski et al. (in review)

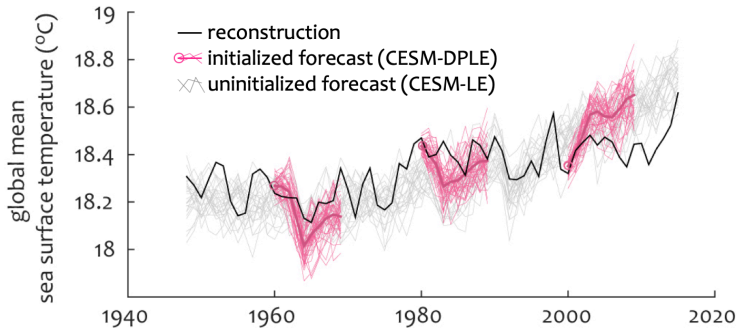
What's the most important quantity to initialize?

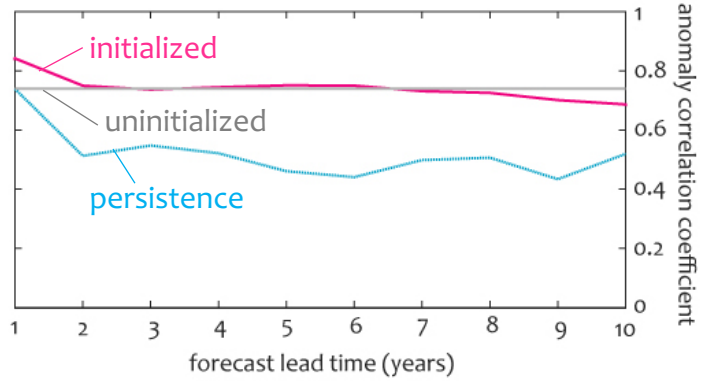


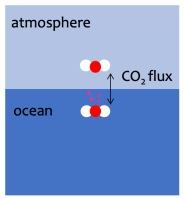


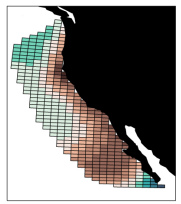
Lovenduski et al. (in review)

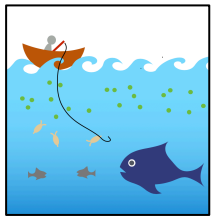
Conclusions

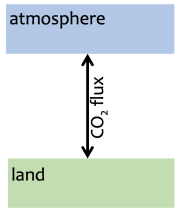












A novel set of decadal prediction simulations allows exploration of marine and terrestrial biogeochemistry

The importance of initialization is assessed via comparison with persistence and uninitialized forecasts

Initialization may allow us to predict marine and terrestrial biogeochemical variables with several years lead time