



NOAA OCEAN ACIDIFICATION PROGRAM

Dynamically Downscaled Regional Projections of Ocean Acidification in the Main Hawaiian Islands



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Tobias Friedrich, Brian Powell, Chris Sabine, Guangpeng Liu, Jacob Gunnarson, Malte Stuecker

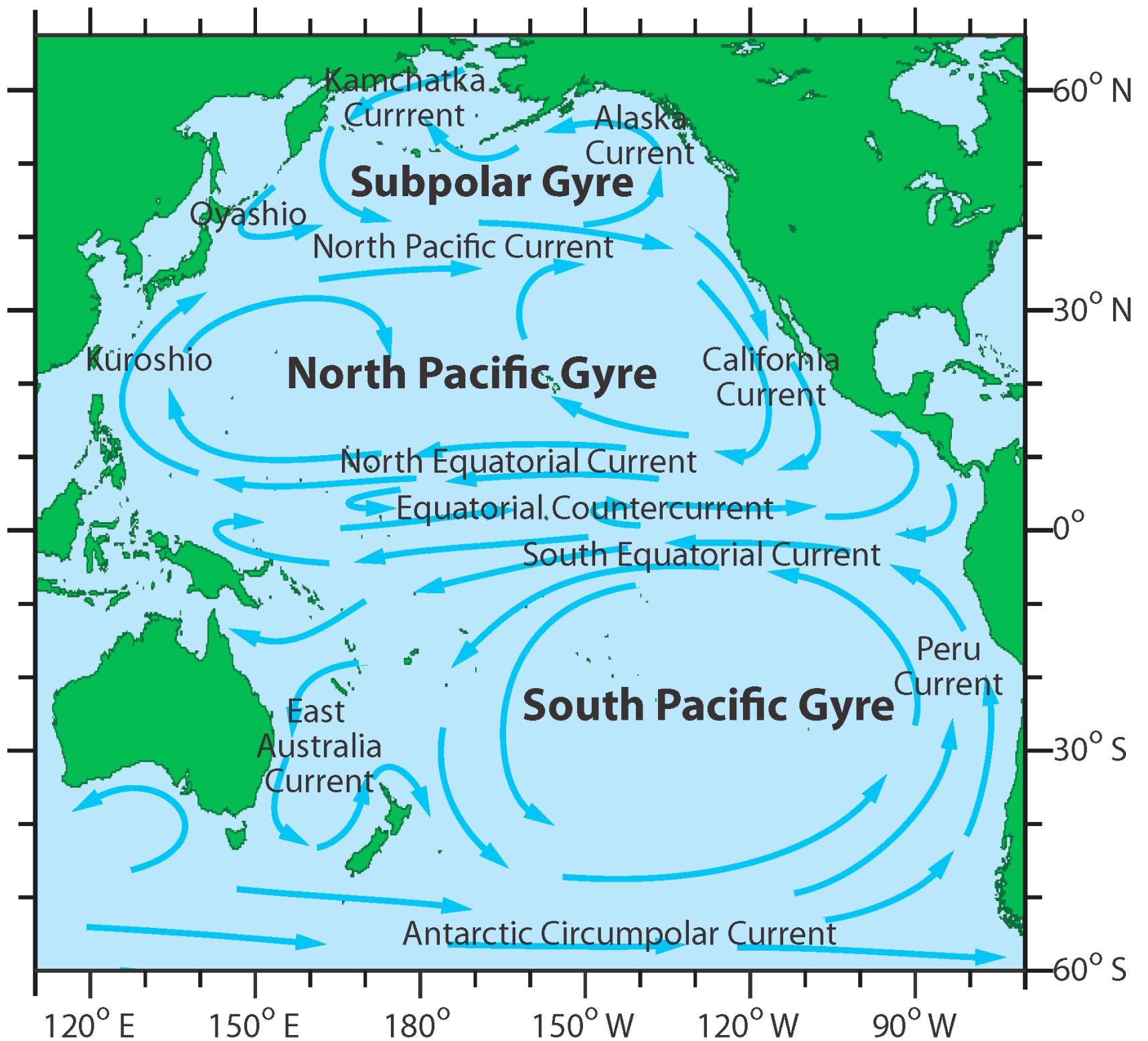


UNIVERSITY of HAWAI'I at MĀNOA

Ke Kulanui o Hawai'i ma Mānoa

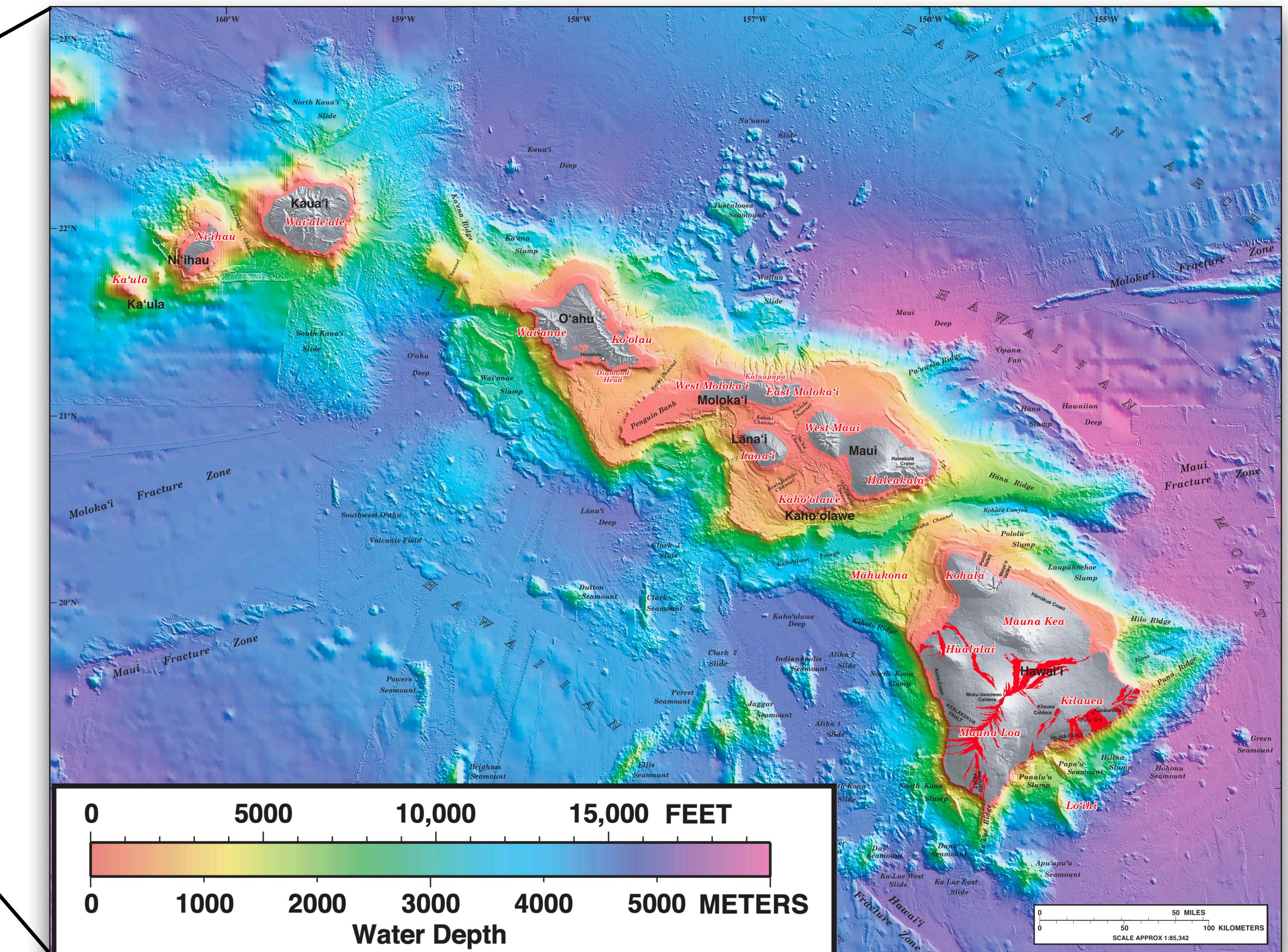
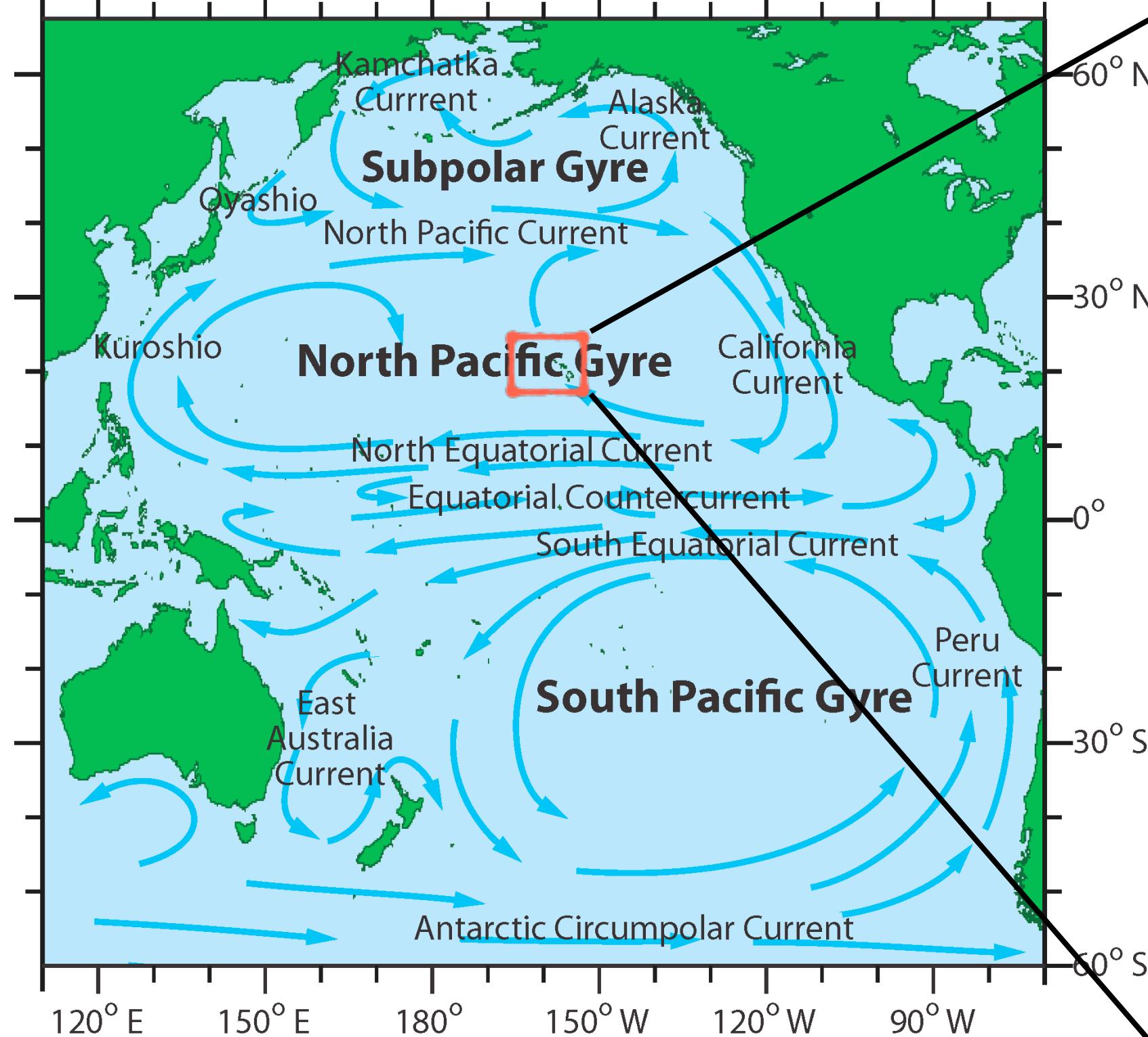


Main Hawaiian Islands



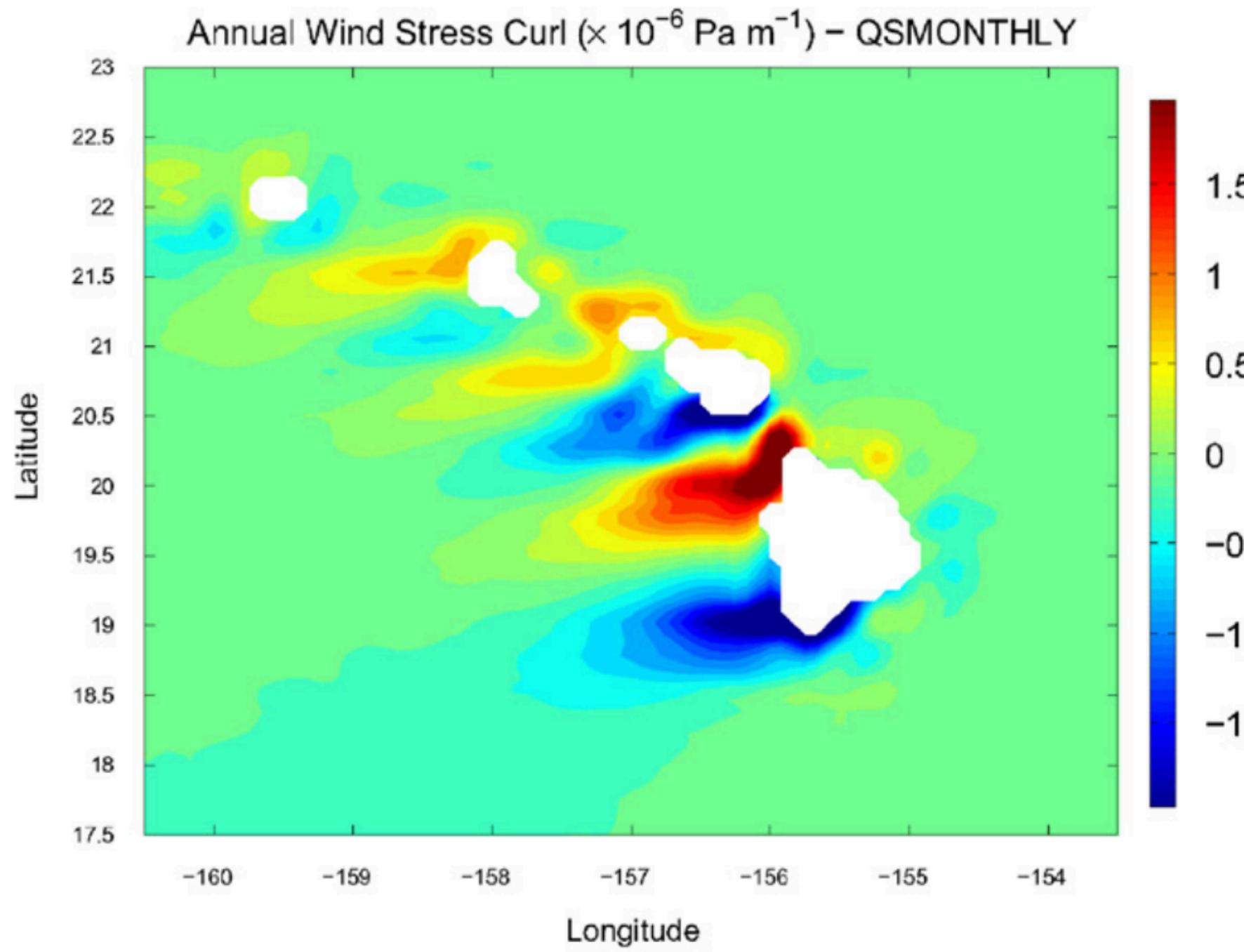
Oceans of Data Institute, <https://oceantracks.org>

Main Hawaiian Islands

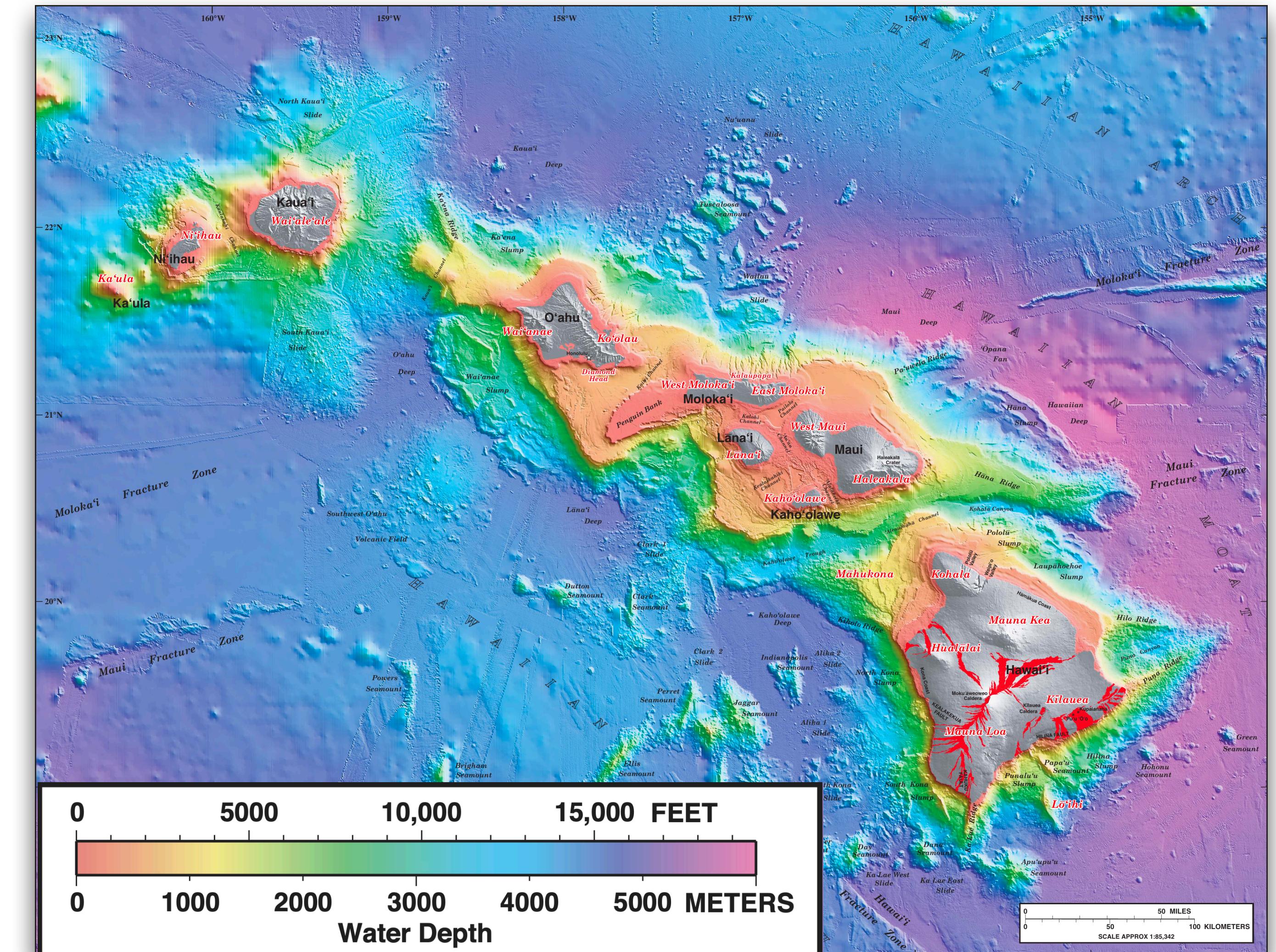


Eakins et al, <https://pubs.usgs.gov/imap/2809/>

Main Hawaiian Islands

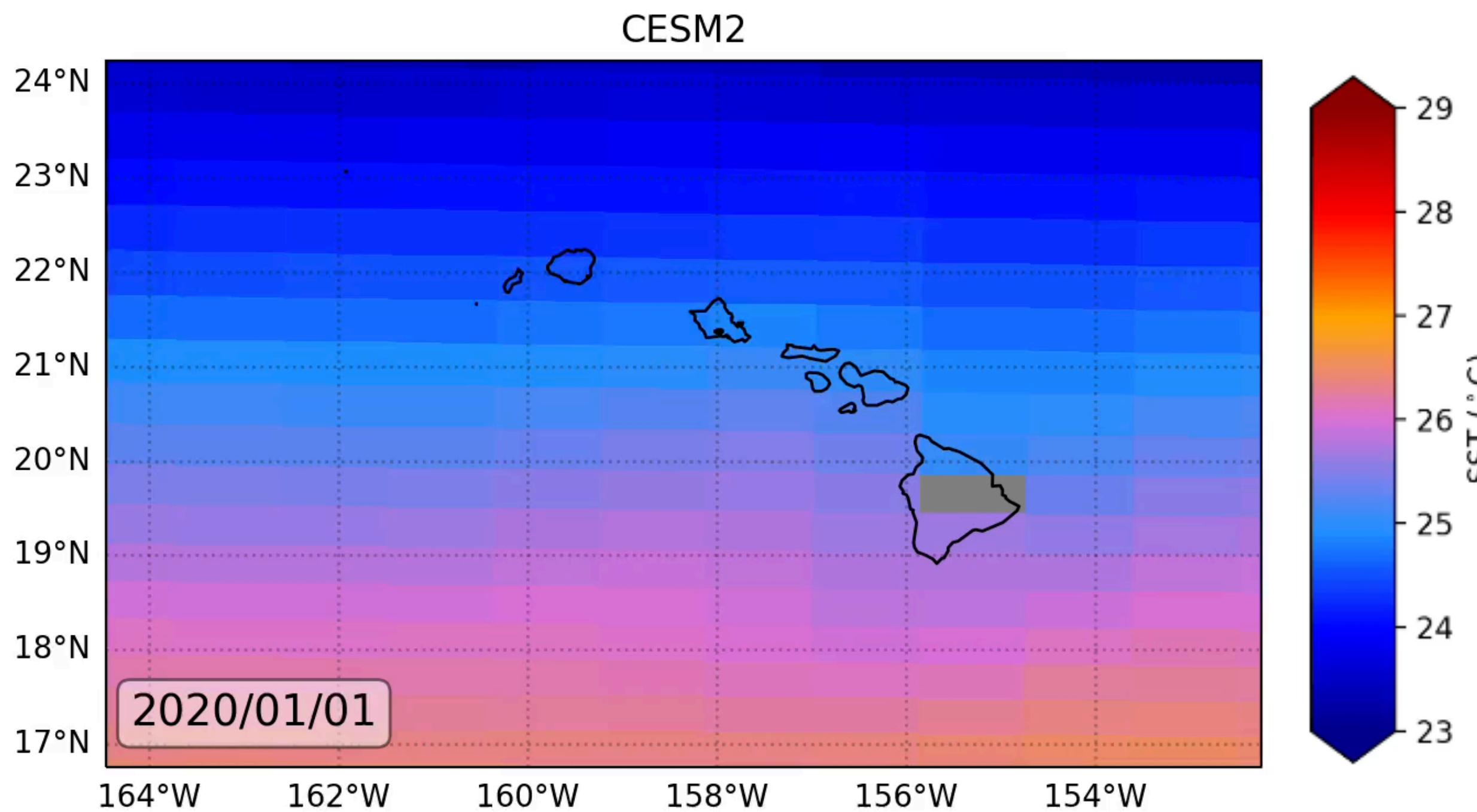


Calil et al. 2008, Deep Sea Research II

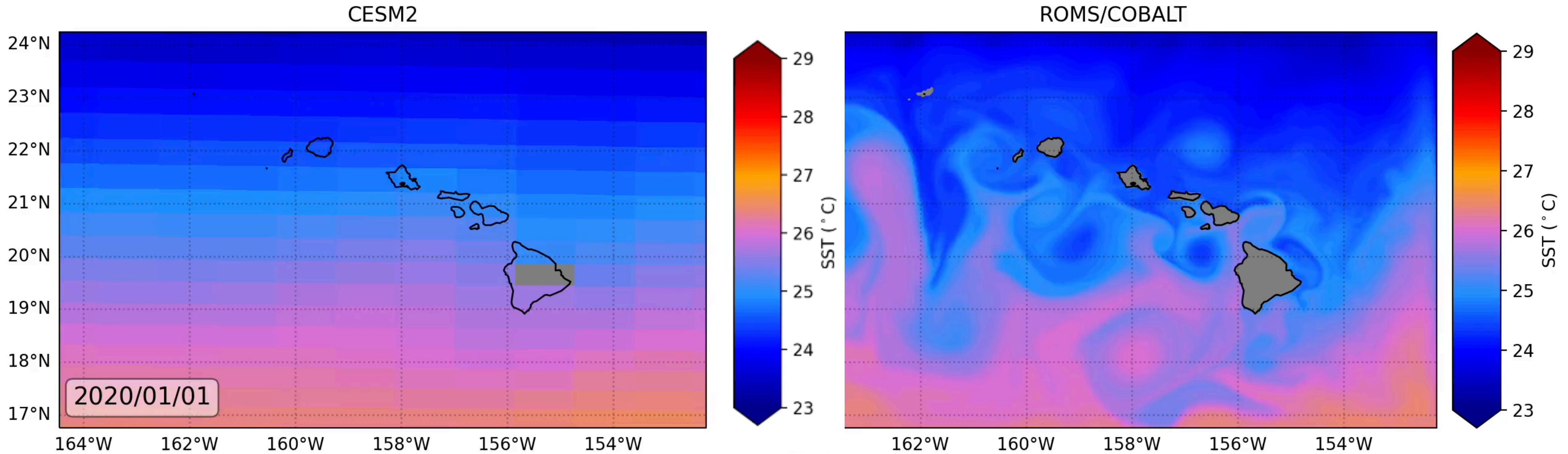


Eakins et al, <https://pubs.usgs.gov/imap/2809/>

Dynamical downscaling of MHI domain



Dynamical downscaling of MHI domain



Friedrich et al. 2024: Submesoscale-permitting physical/biogeochemical future simulations for the main Hawaiian Islands, accepted

Liu et al. 2023: Climate downscaling for regional models with a neural network: A Hawaiian example

Ocean acidification indices

pH

Ω_A

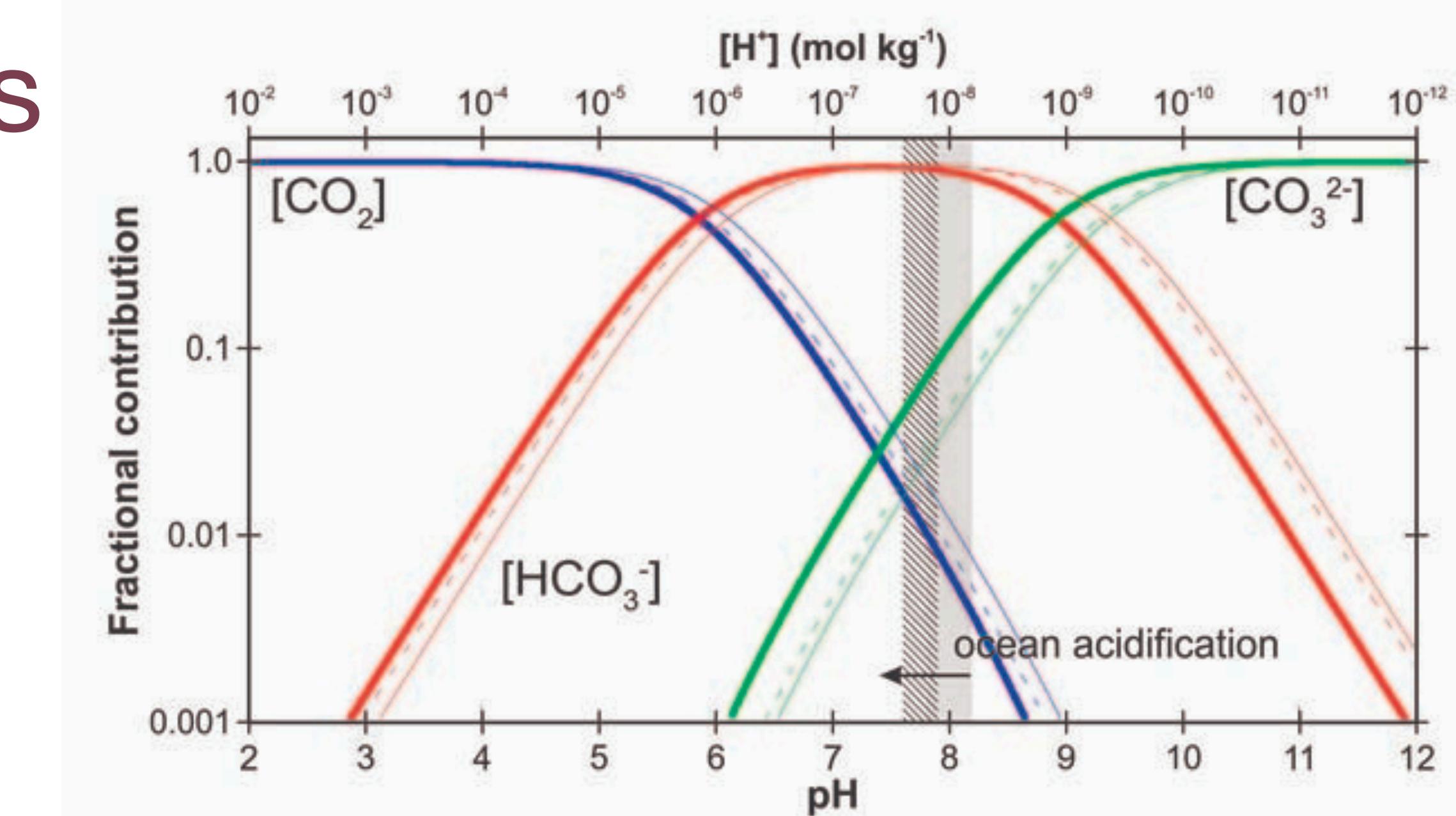
SIR

1. pH ($\sim [H^+]$)

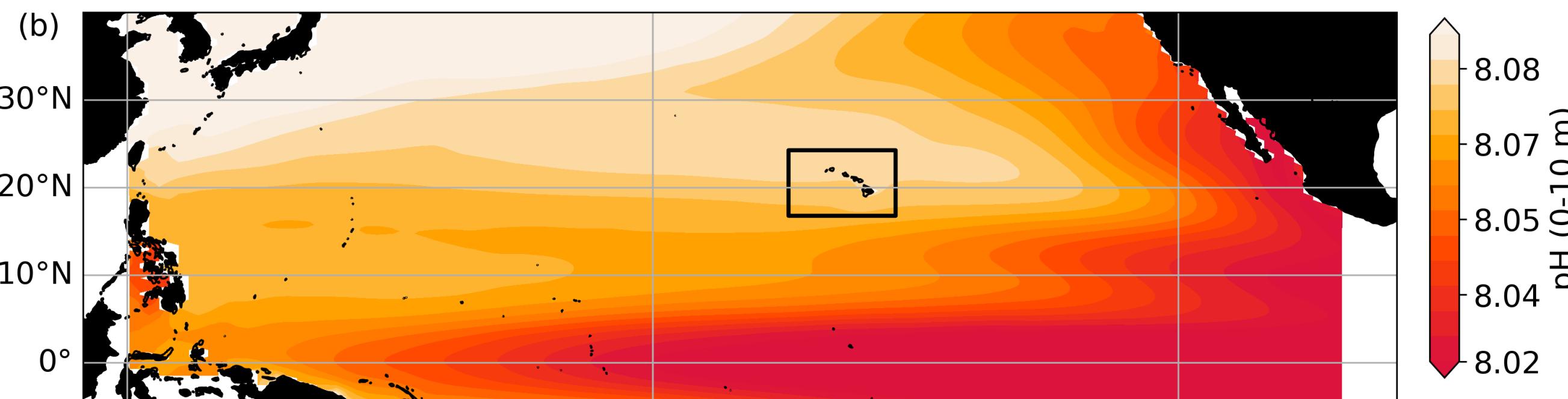
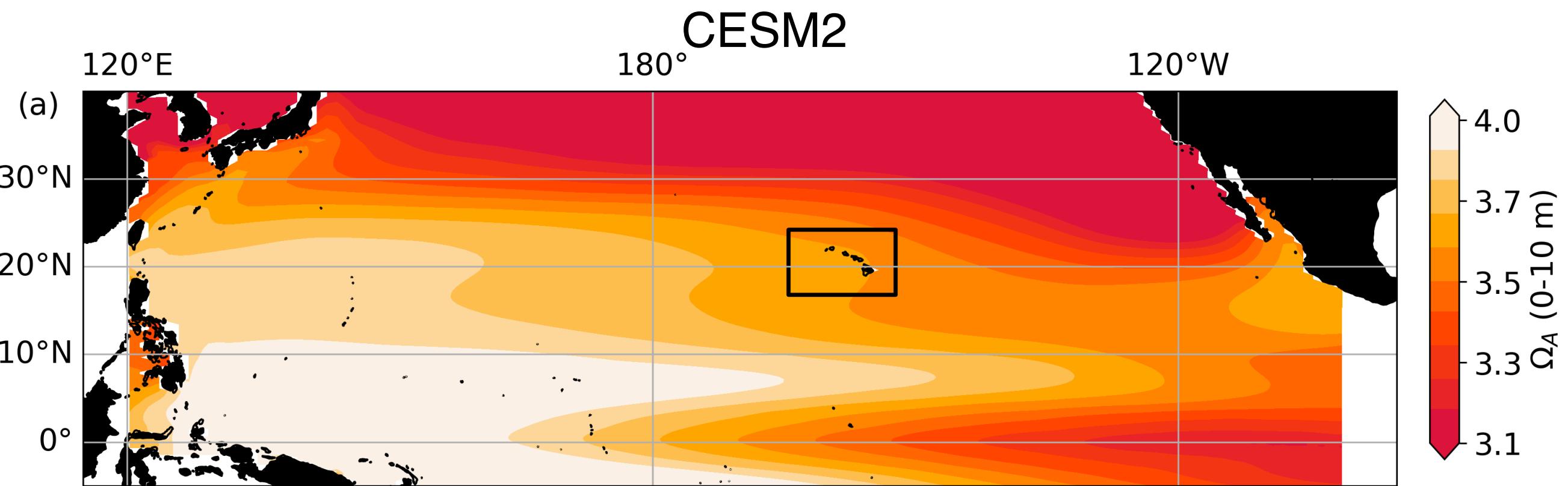
2. Aragonite saturation (Ω_A) ($\sim [CO_3^{2-}]$)

3. Substrate-to-inhibitor ratio (SIR) ($\sim [HCO_3^-]/[H^+]$)

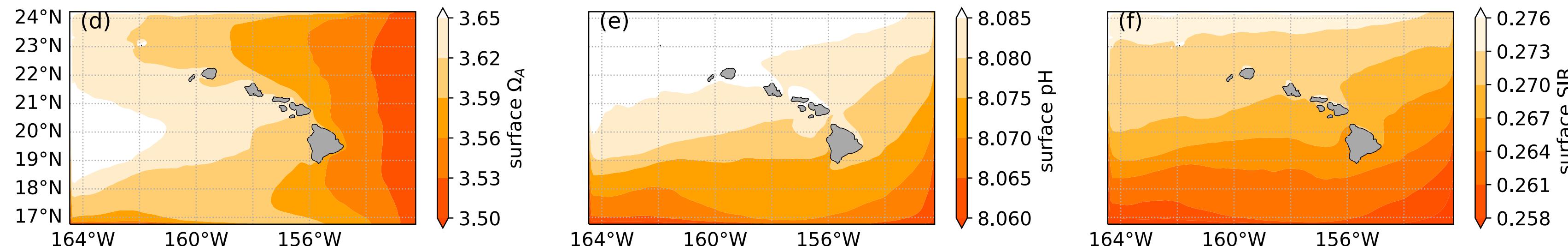
Ingredients: T, ALK, DIC, S



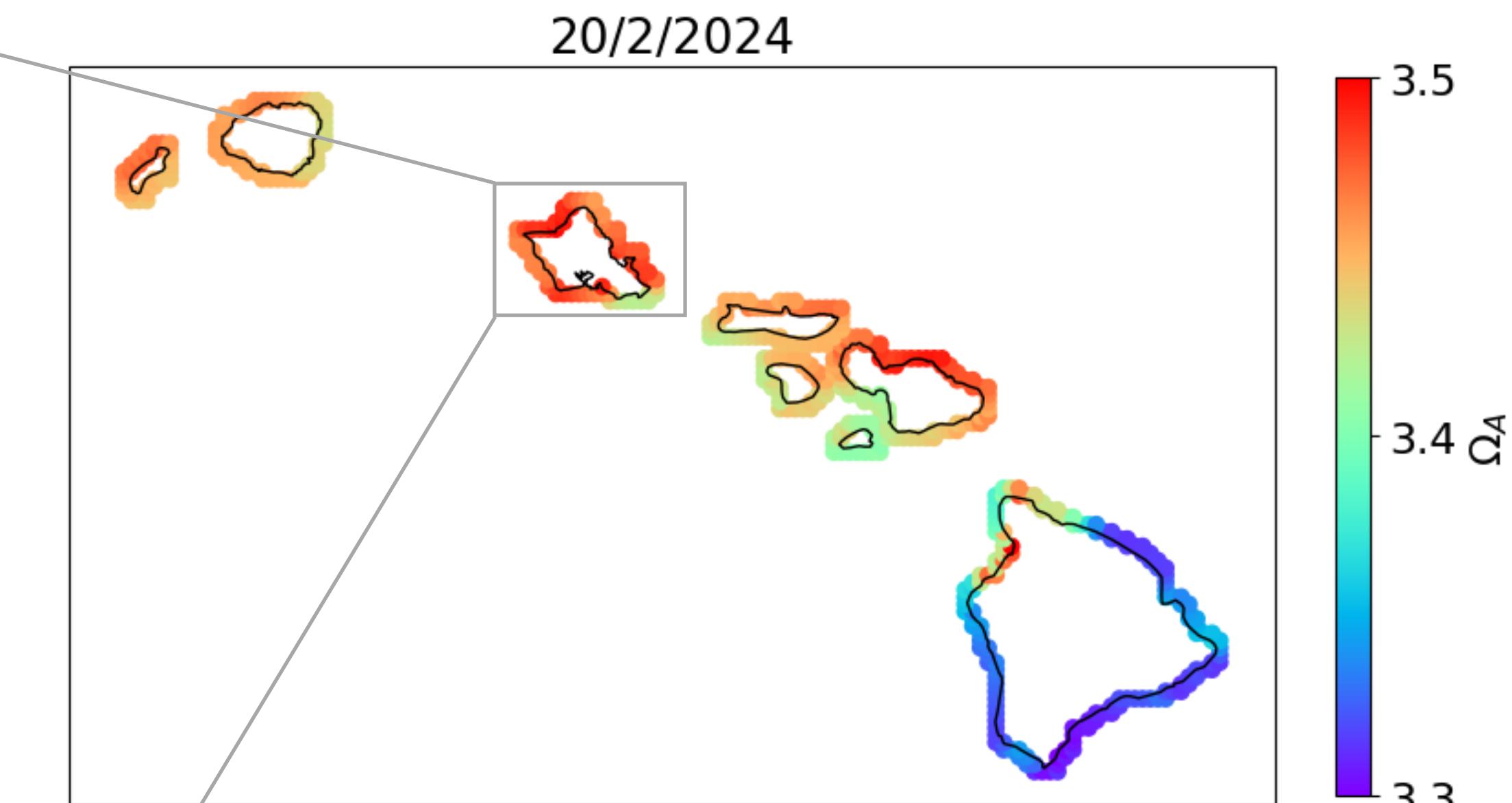
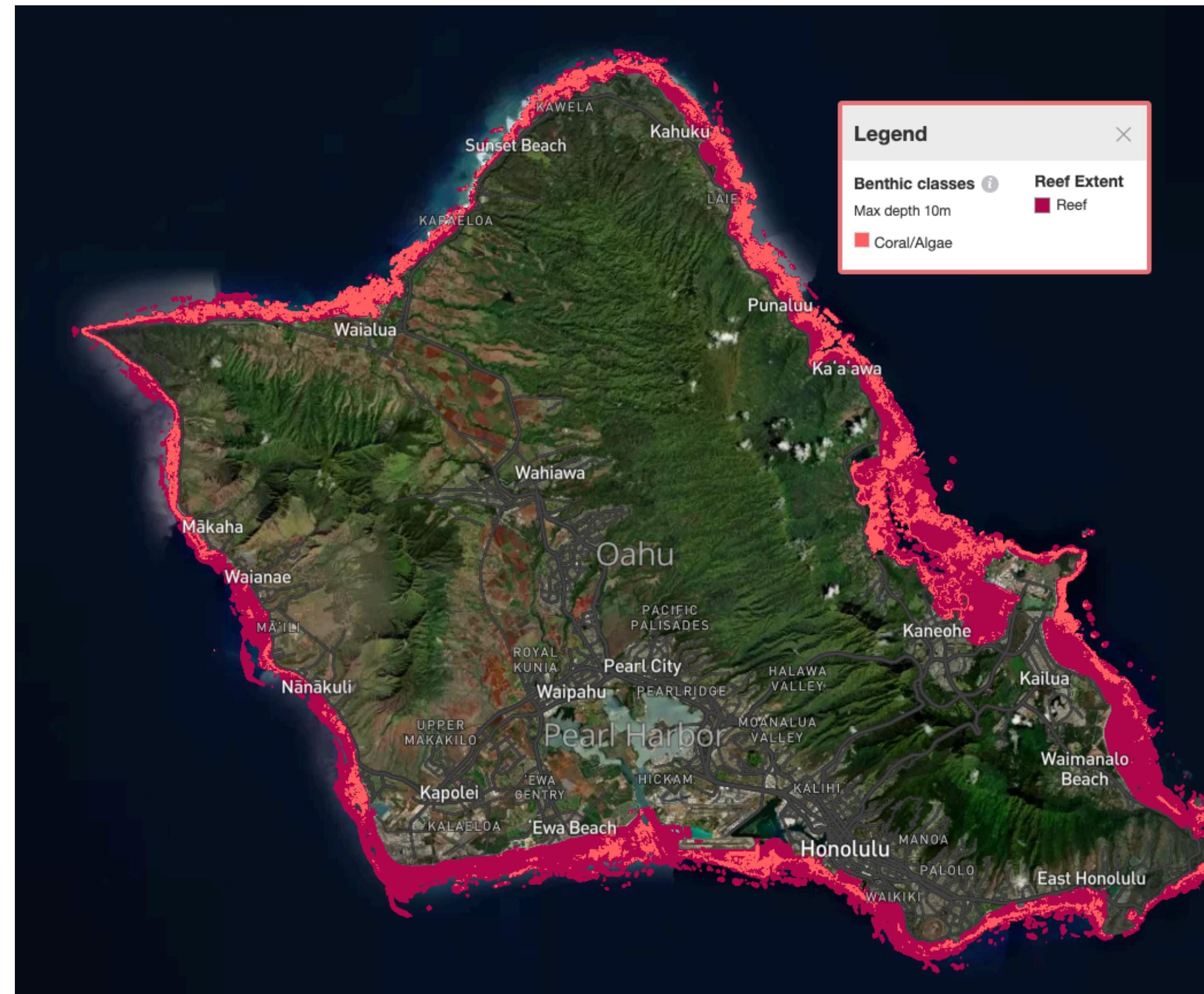
OA indices 2005-2020



ROMS/COBALT



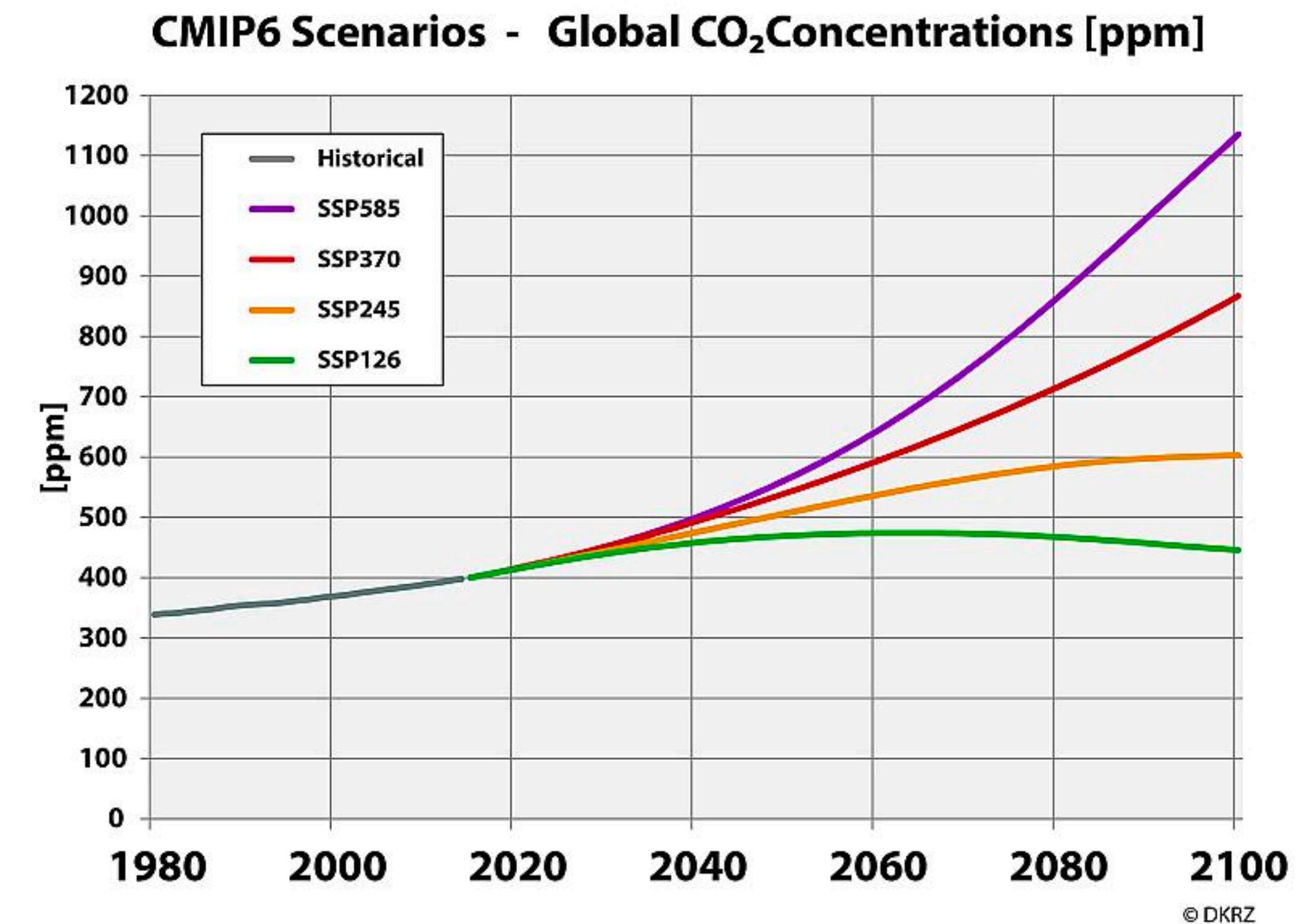
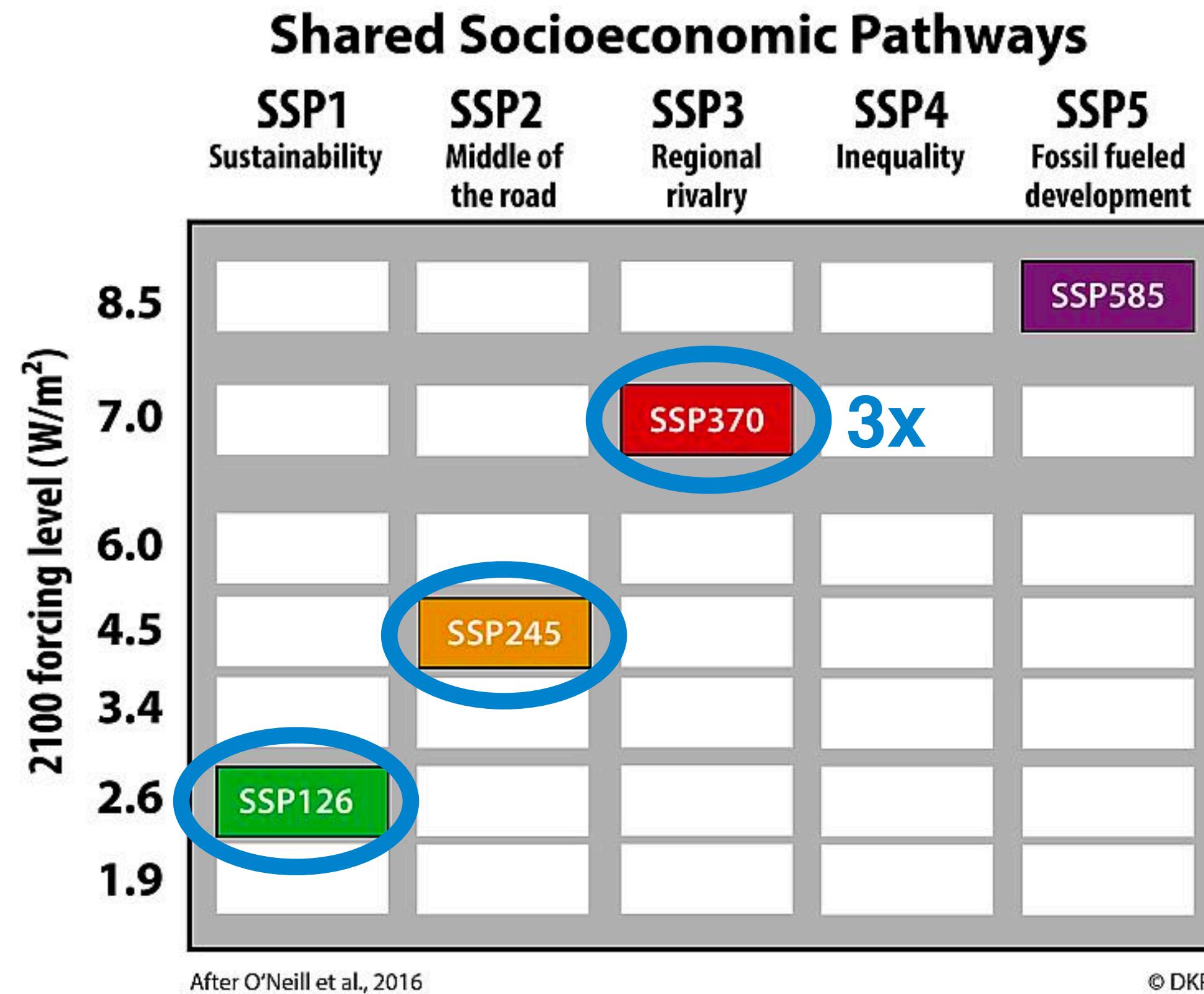
Fringing coral reefs



4 km horizontal resolution
~ 500 coastal grid cells

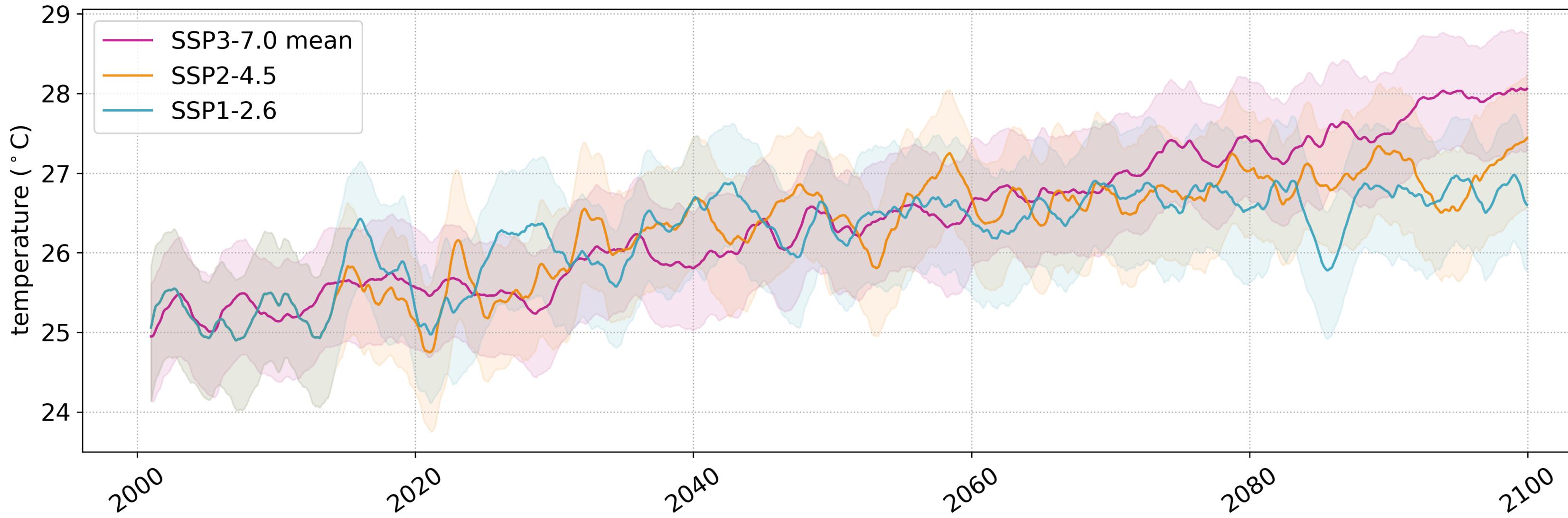
Source: <https://allencoralatlas.org/>

CMIP6 combined scenarios

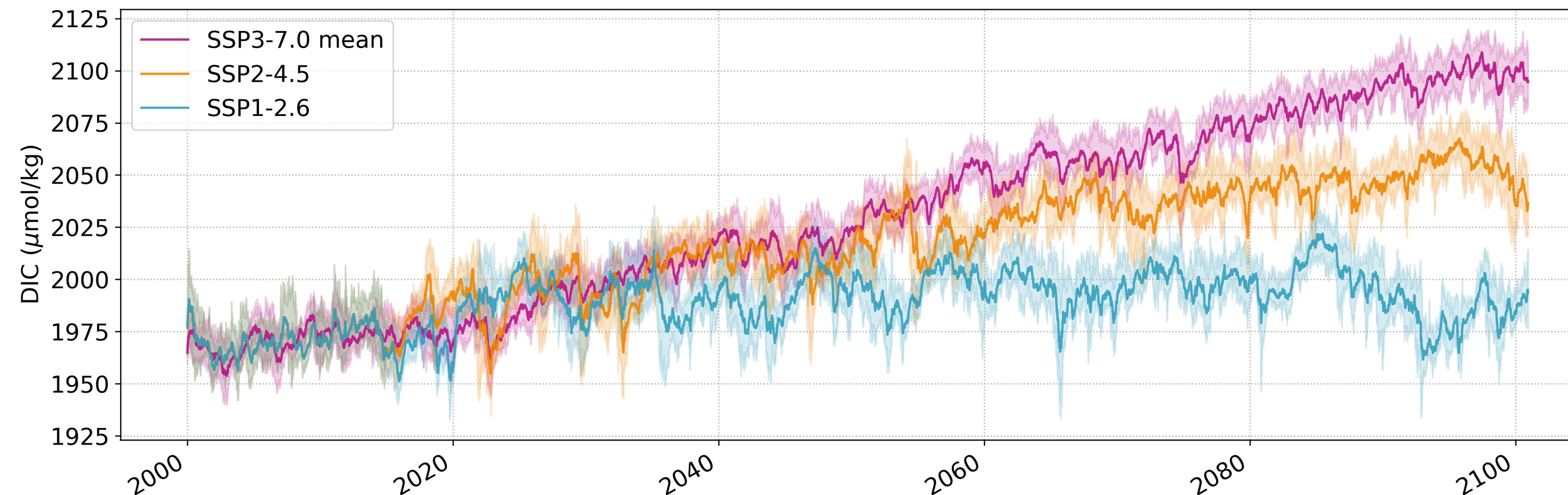


Temperature and DIC trends

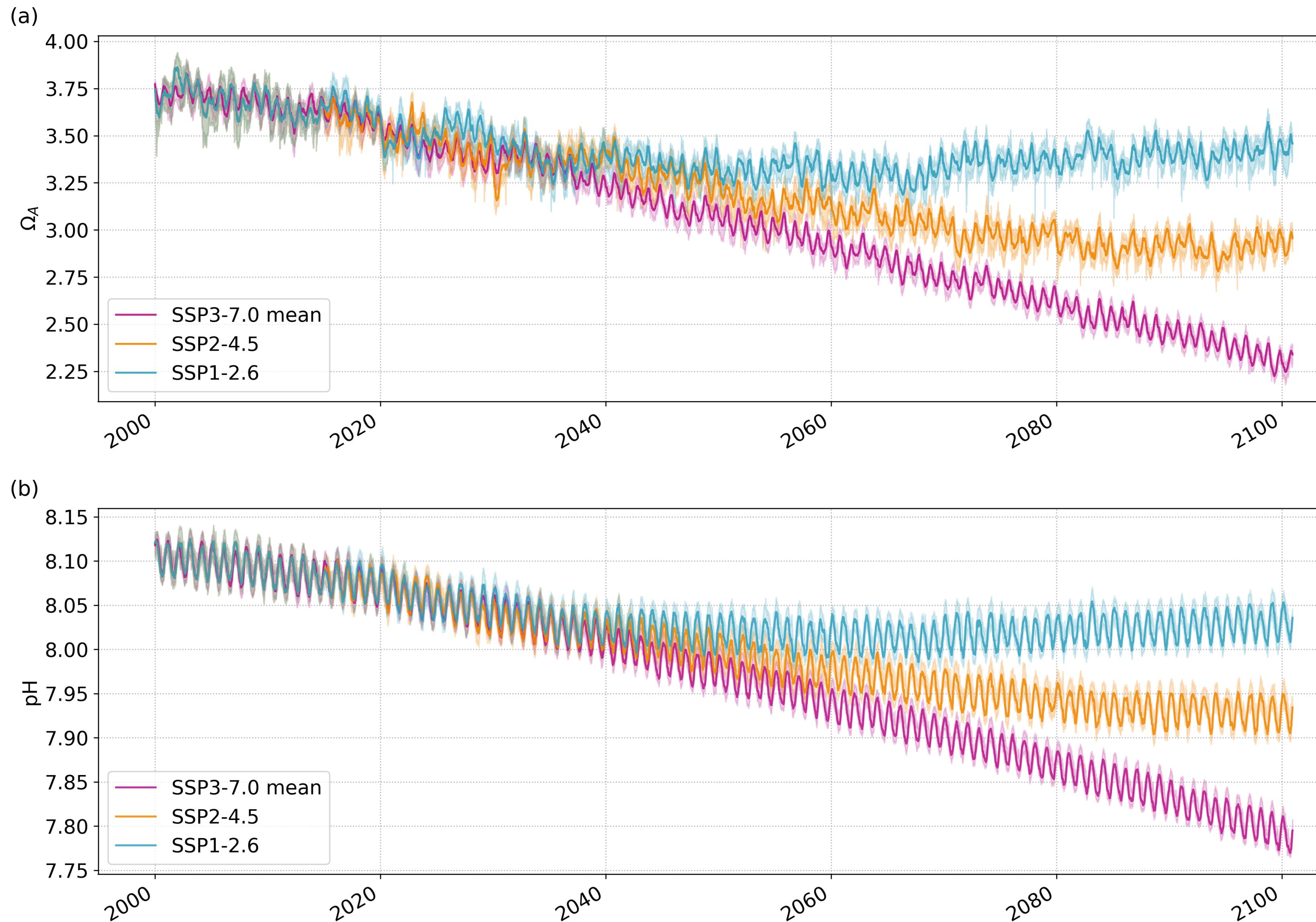
(a)



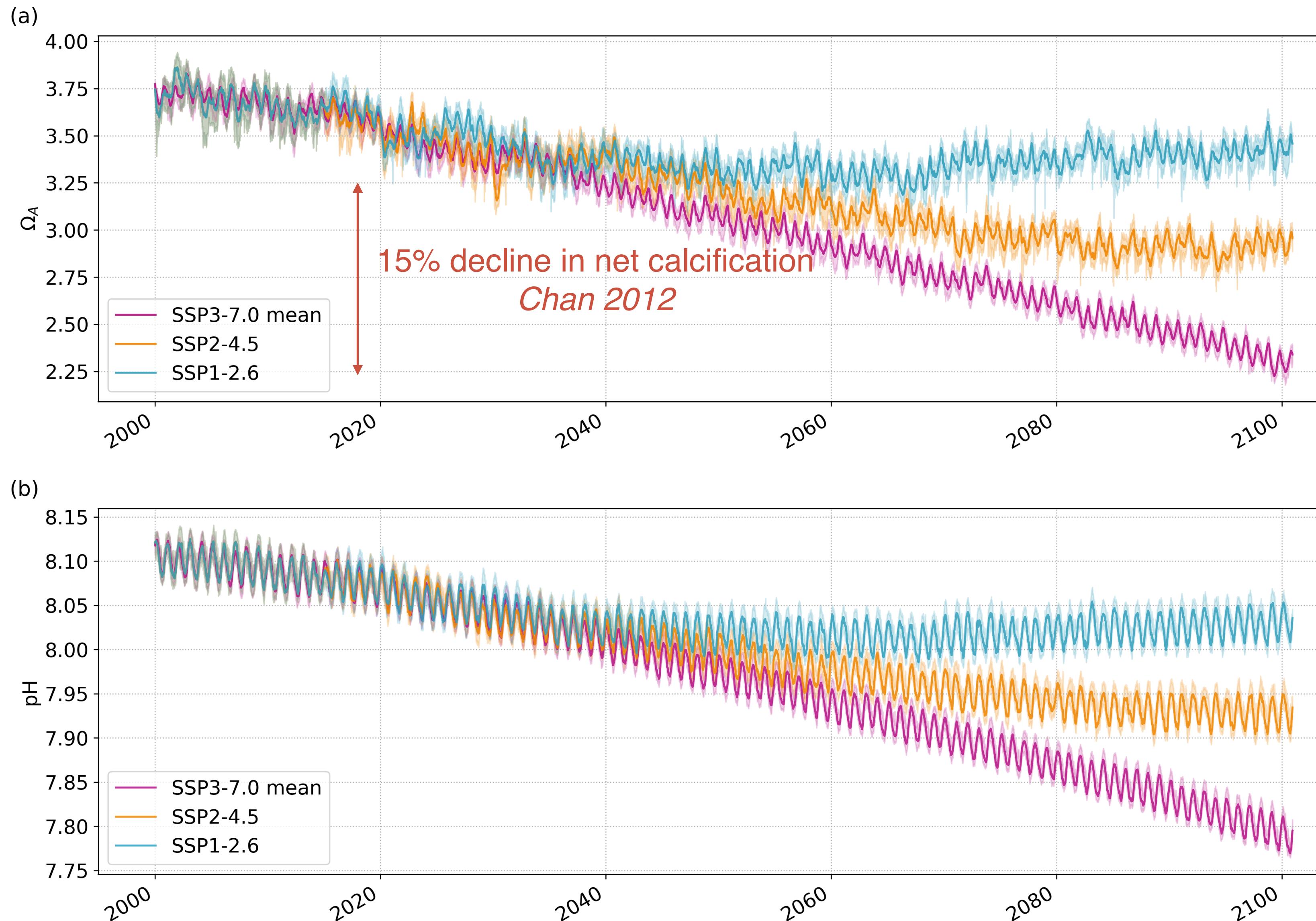
(b)



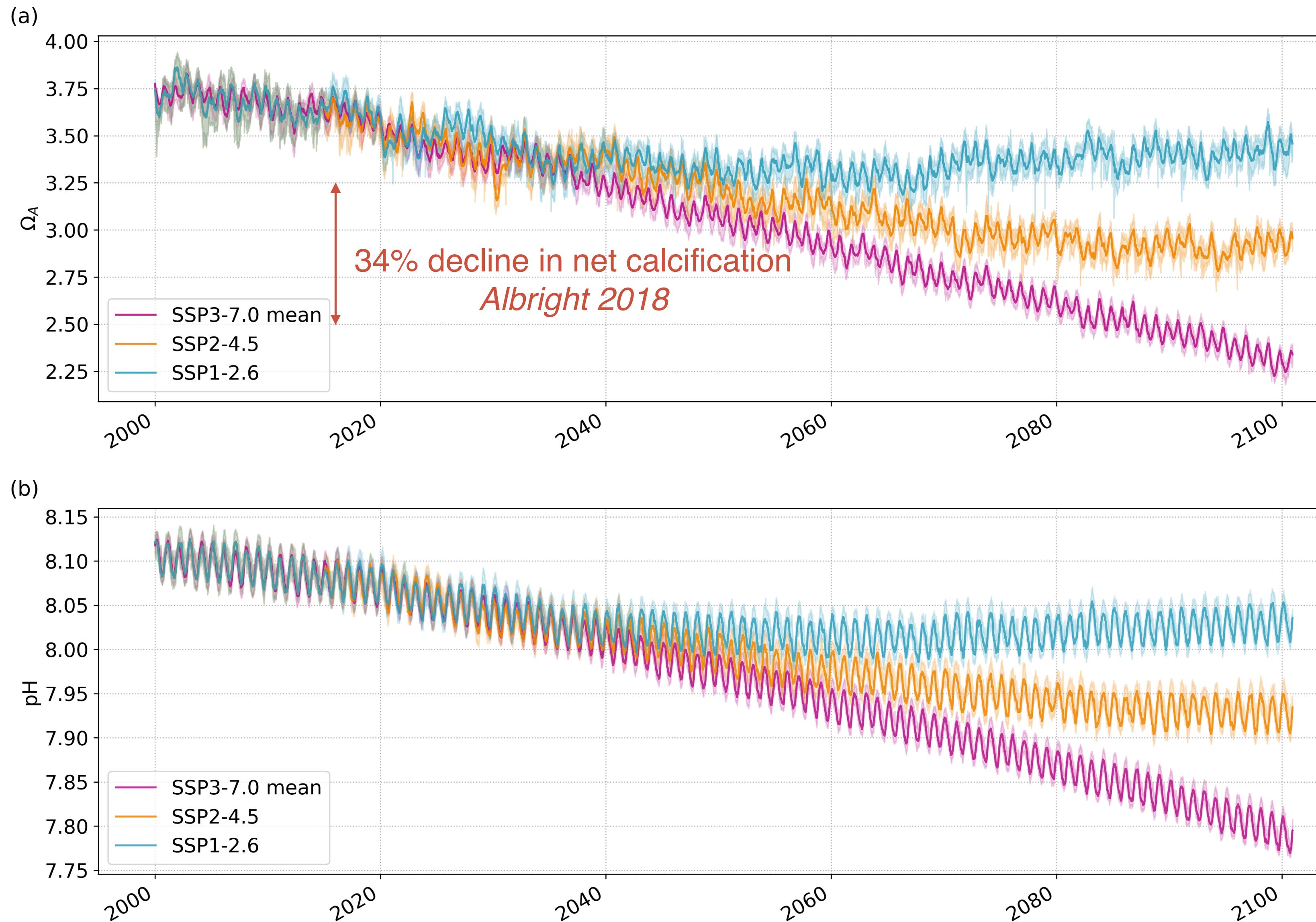
CMIP6 coastal trends for ocean acidification



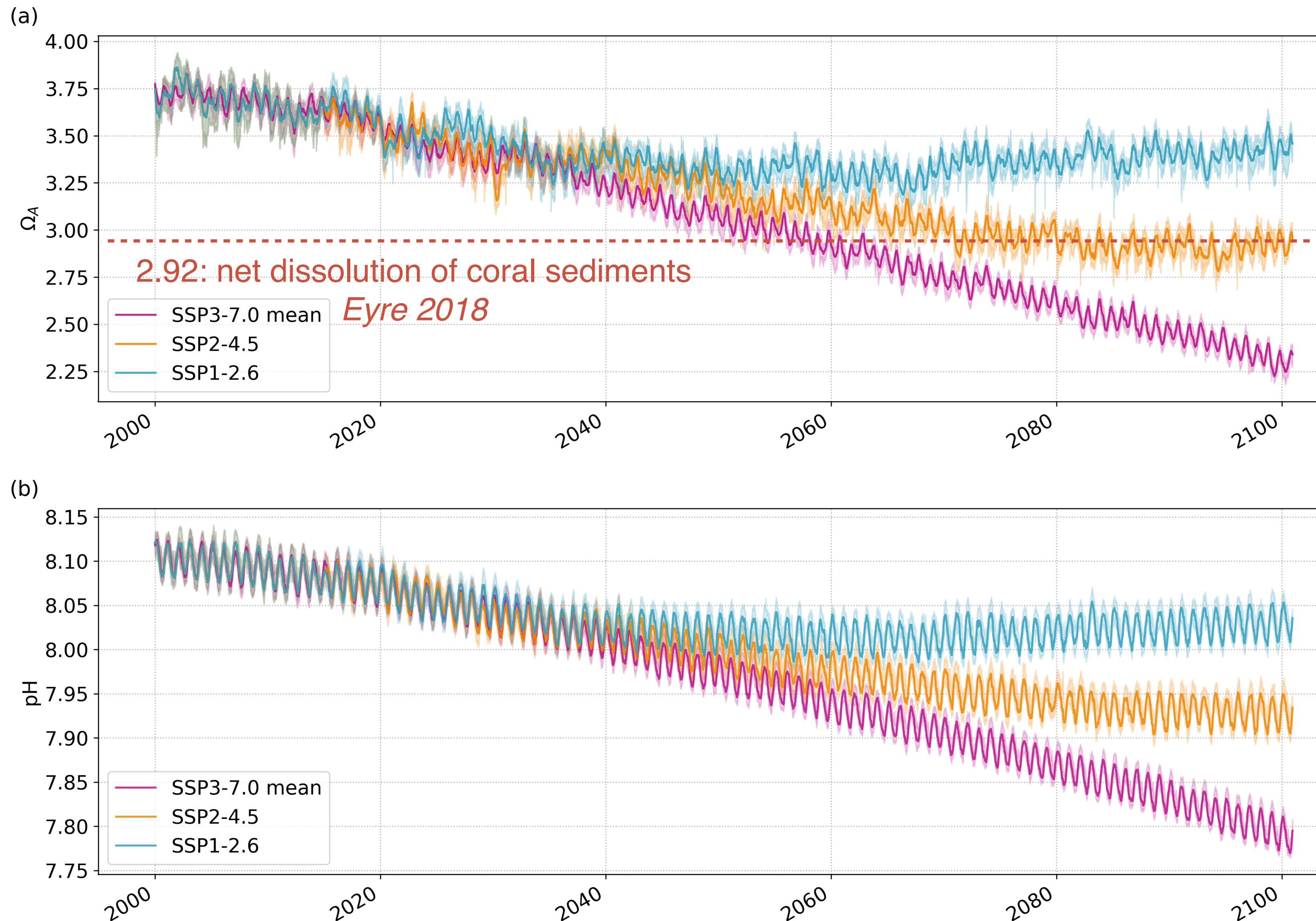
CMIP6 coastal trends for ocean acidification



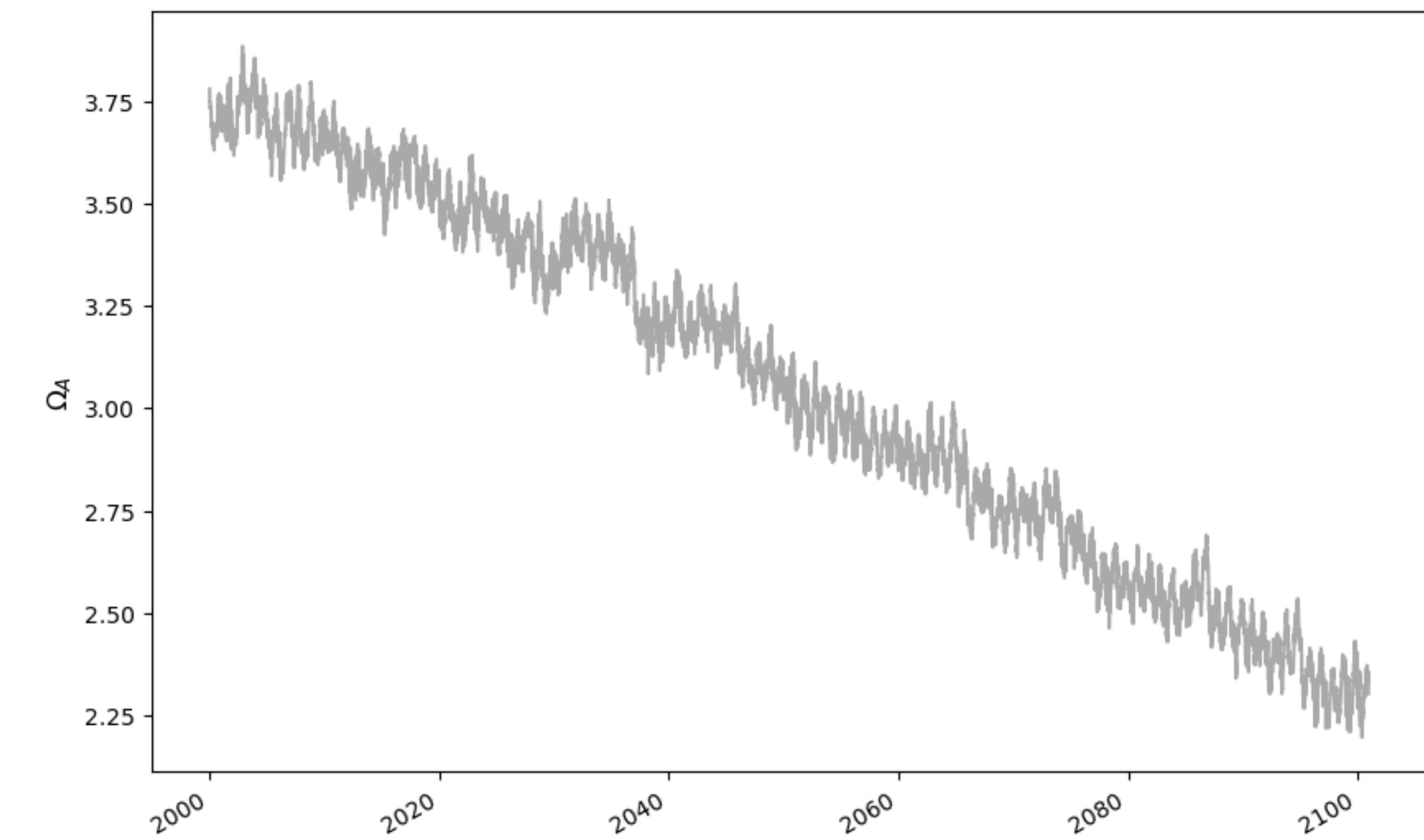
CMIP6 coastal trends for ocean acidification



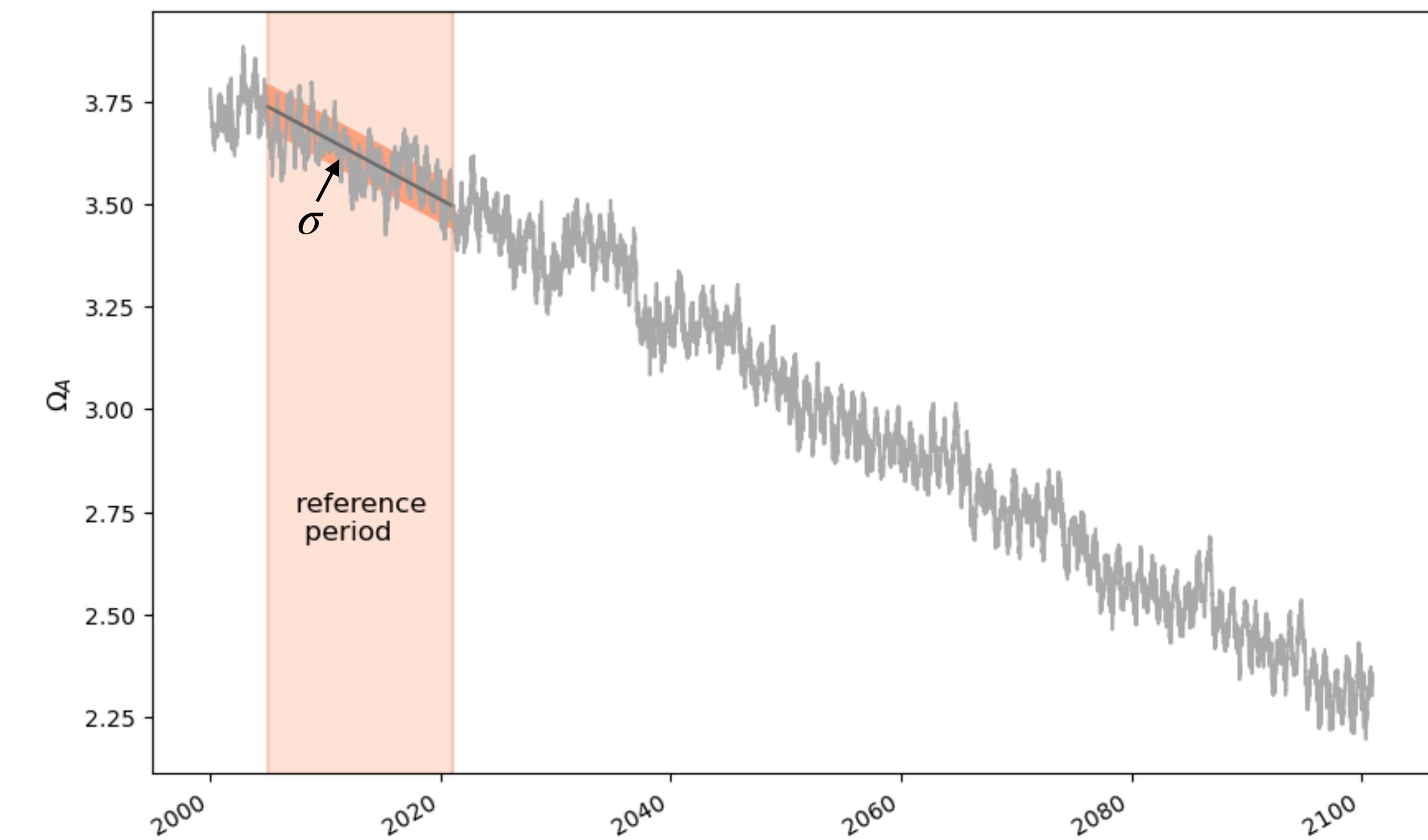
CMIP6 coastal trends for ocean acidification



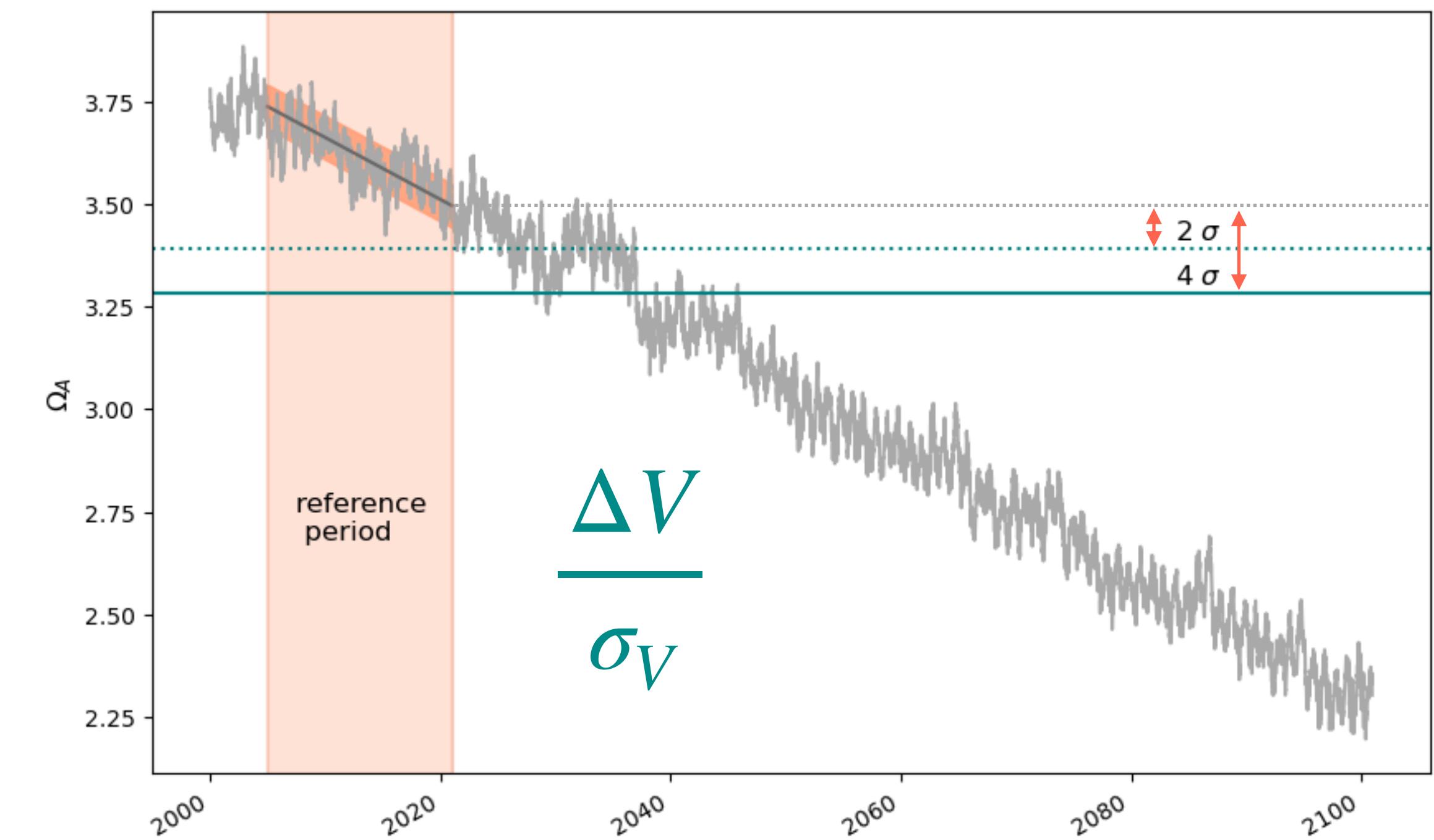
Novelty: departure from historical variability



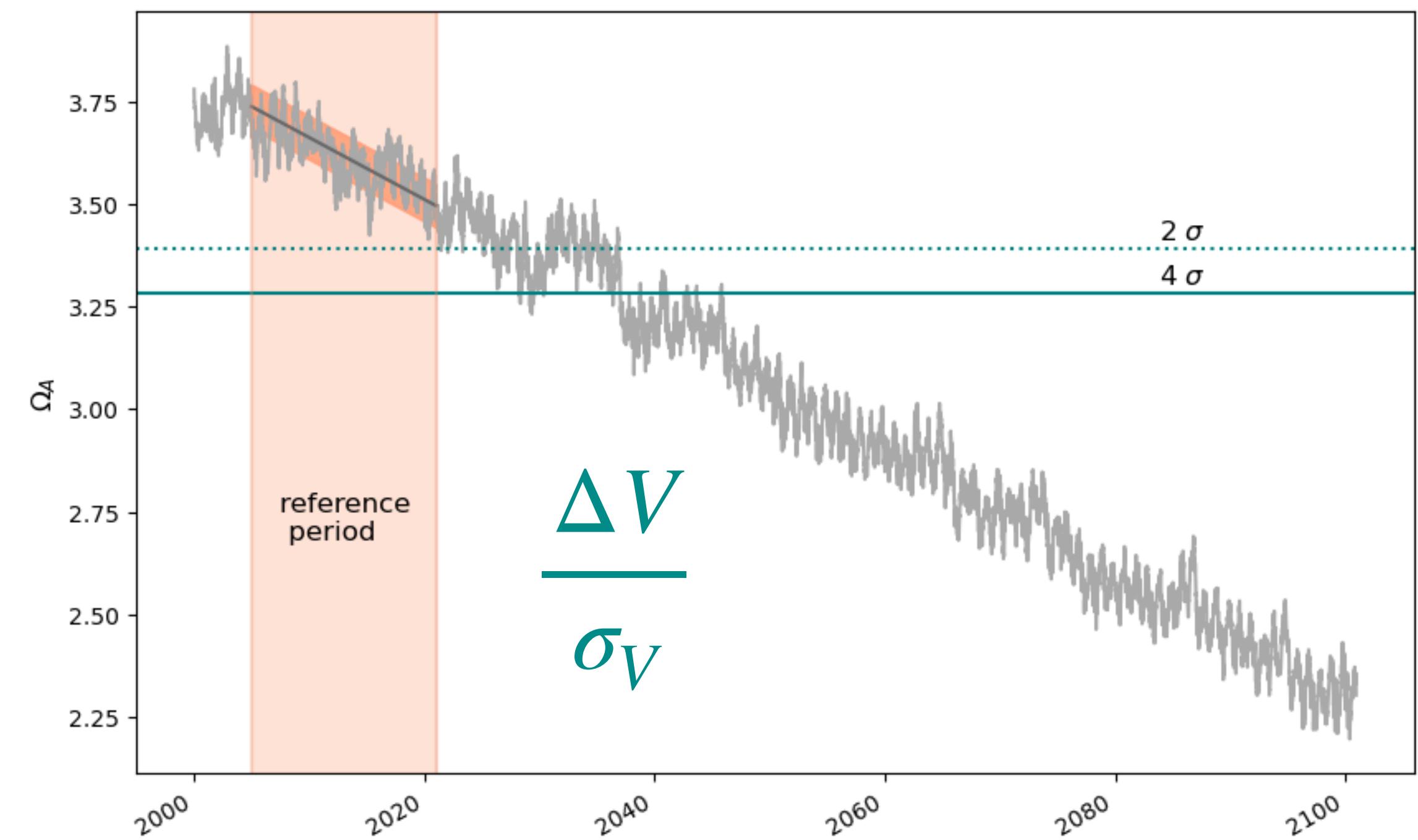
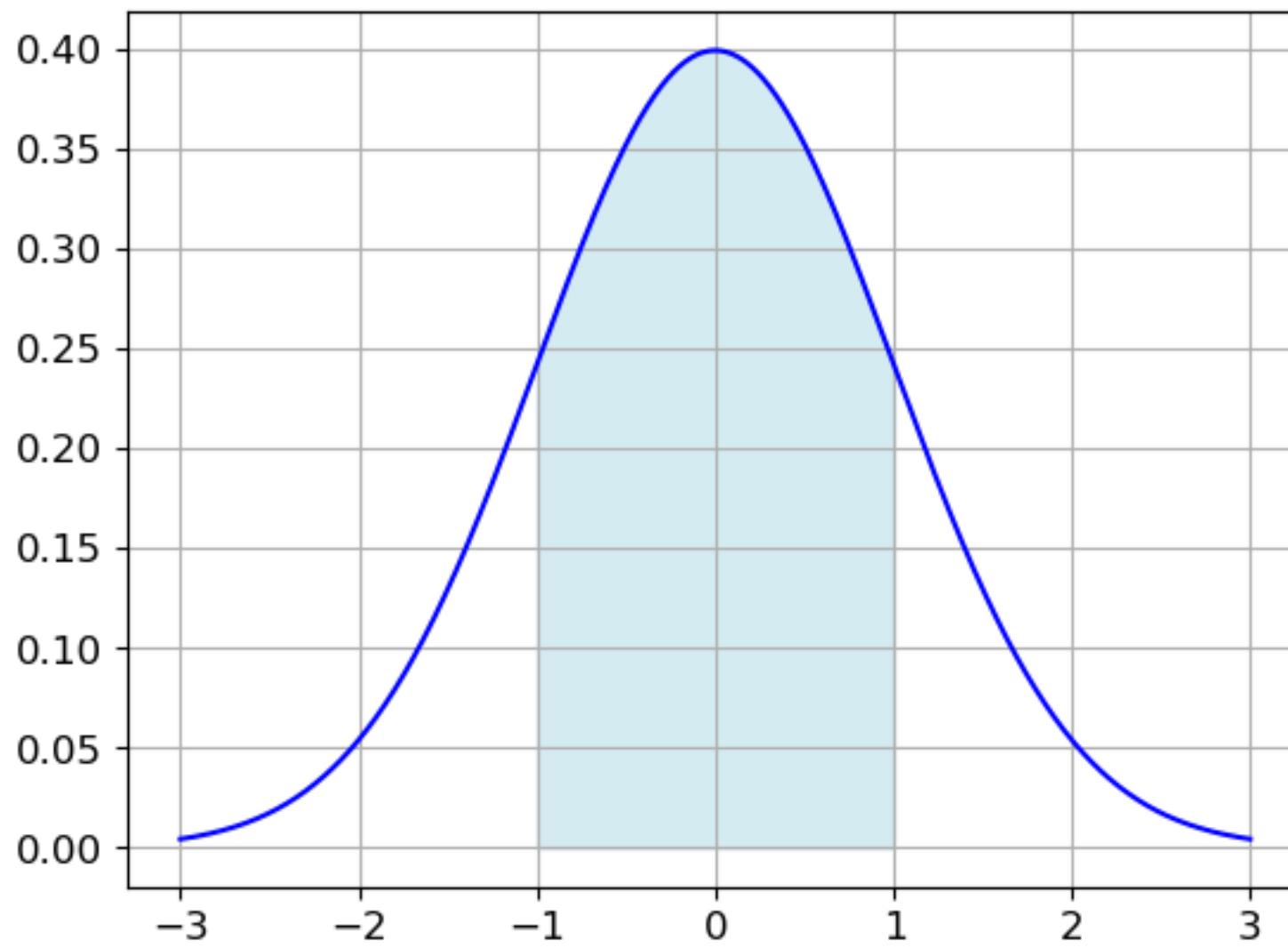
Novelty: departure from historical variability



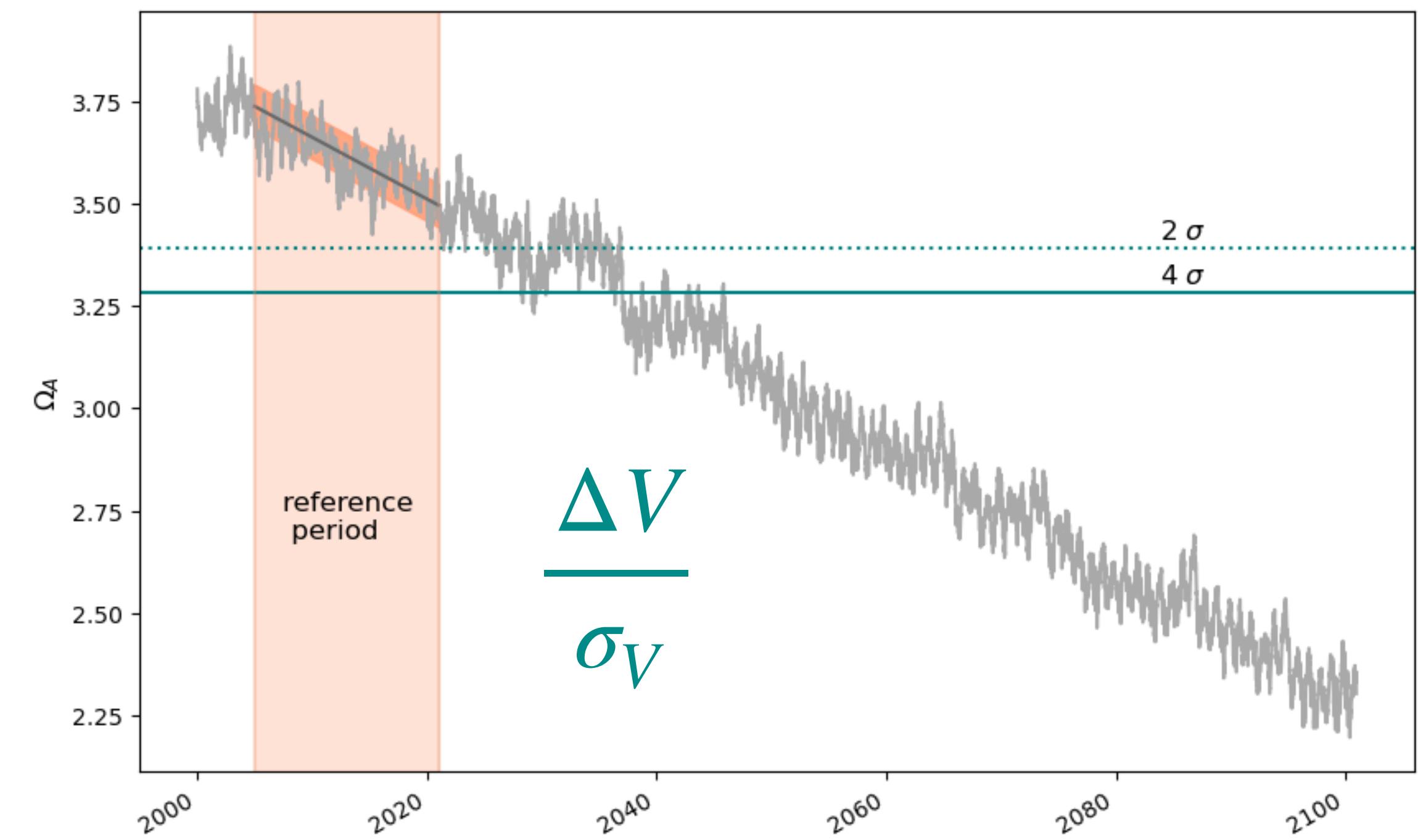
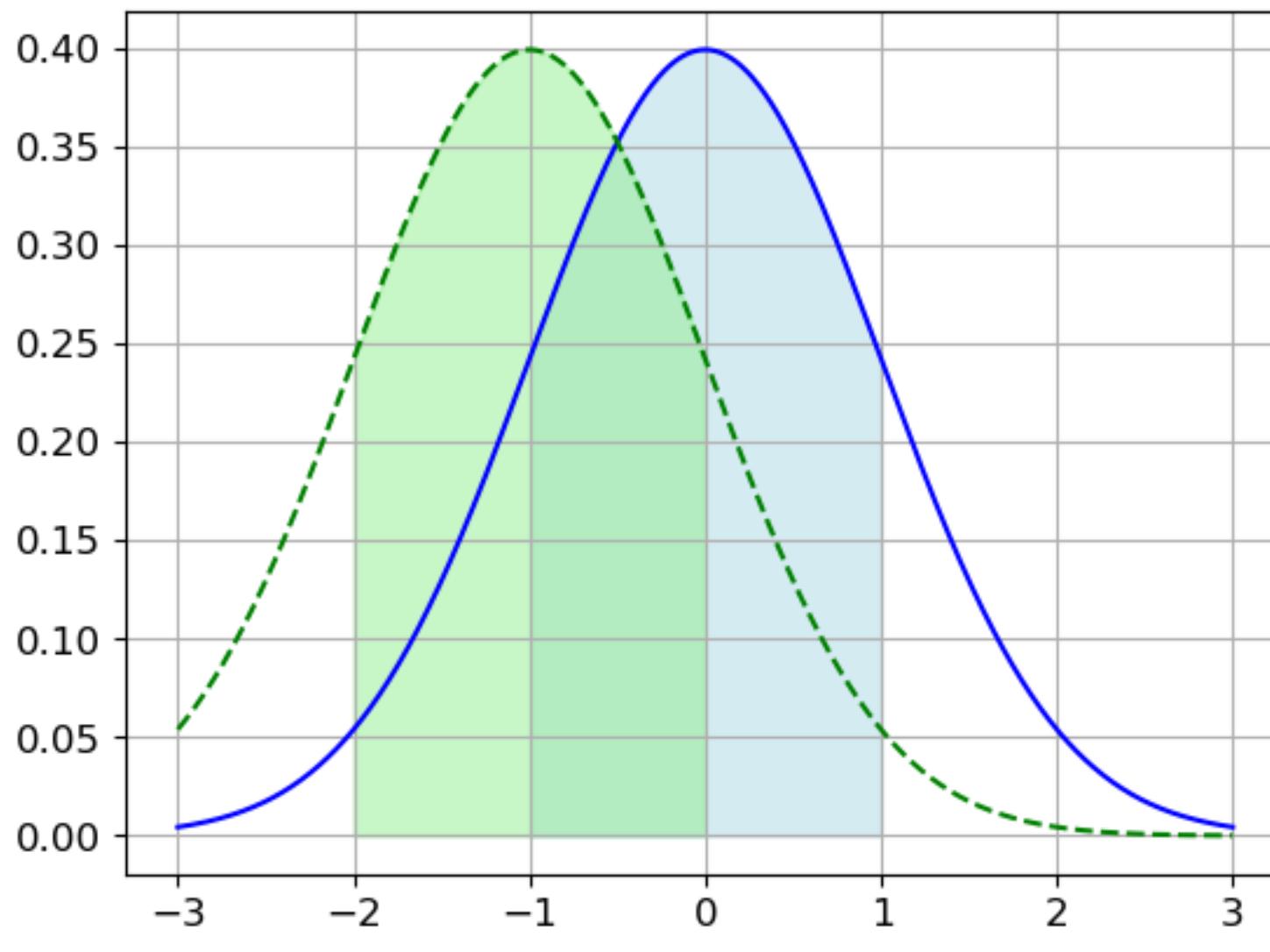
Novelty: departure from historical variability



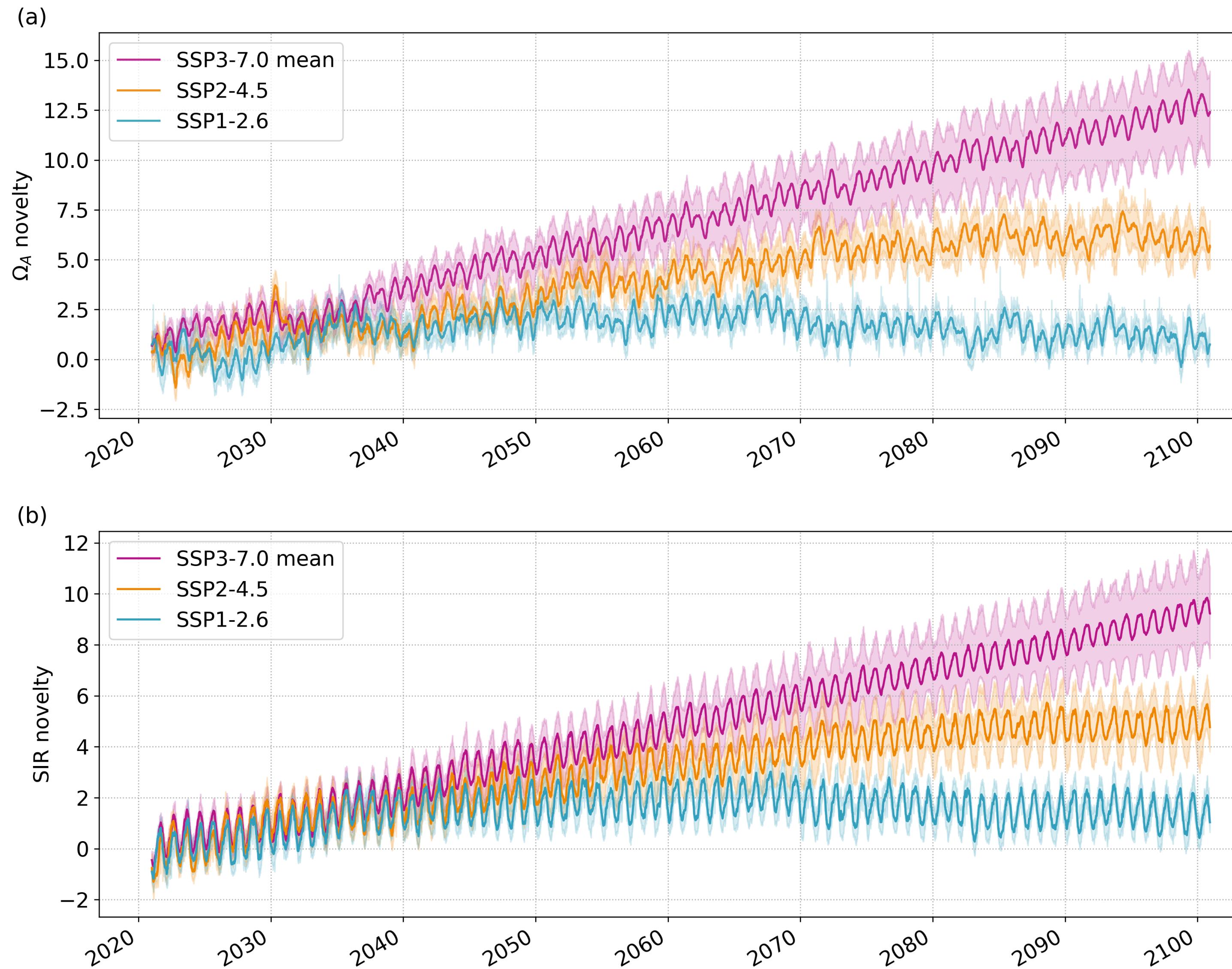
Novelty: departure from historical variability



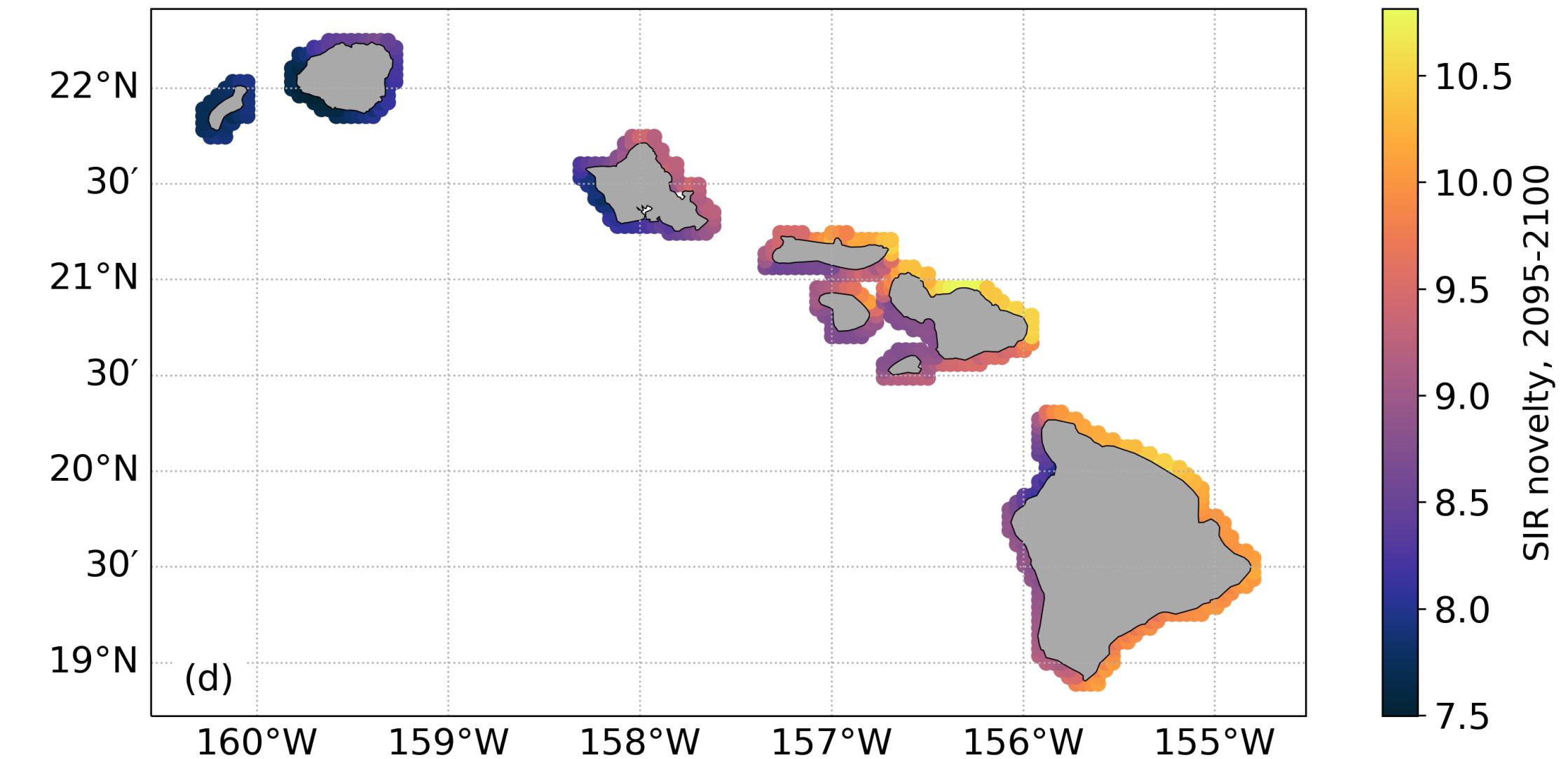
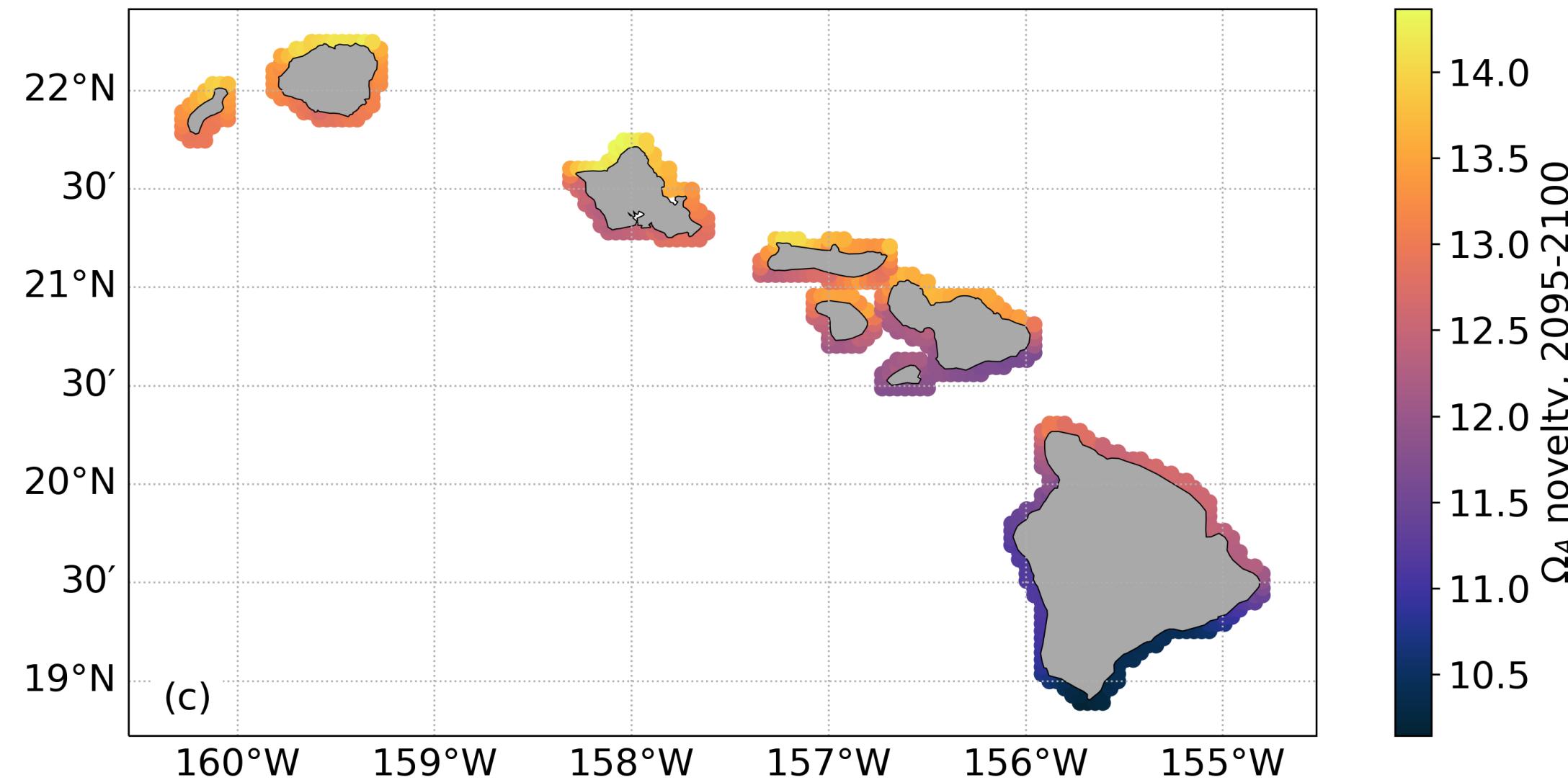
Novelty: departure from historical variability



CMIP6 novelty estimates for MHI coast



Climate novelty along the coast in SSP3-7.0

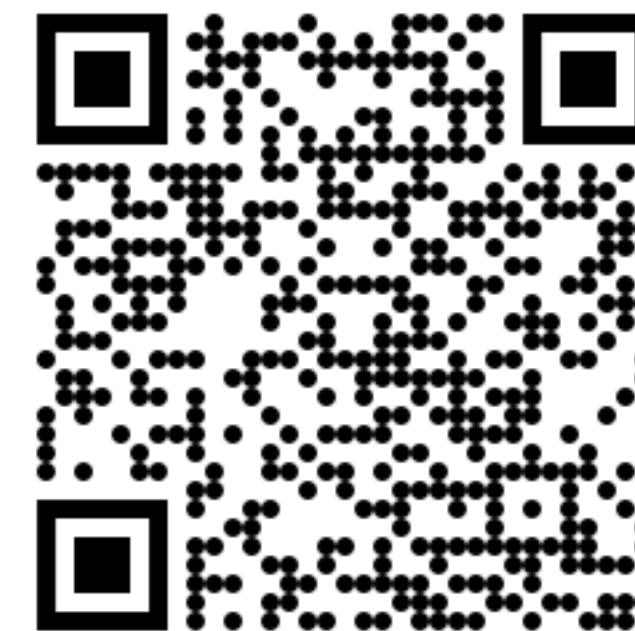


driven by variability in DIC/alkalinity

driven by variability in temperature

Conclusions

- First dynamically downscaled ROMS/COBALT CMIP6 projections for the main Hawaiian Islands
- Unprecedented levels of ocean acidification expected in the next 30 years
- CMIP6 scenarios lead to qualitatively distinct implications for the end of century
- OA anomalies exceeding historical variability by factor 12 in 2100 in SSP3
- Temperature sensitivity of OA indices leads to contrasting spatial patterns of climate novelty
- Contact: hosekova@hawaii.edu



Hošeková et al. 2025,
Journal of Geophysical Research,
<https://doi.org/10.1029/2024JC021903>