



NOAA CoastWatch Seminar Series, Oct.13, 2022

Climate change impacts on the ocean: compound extreme events along the U.S. West Coast and global ocean memory



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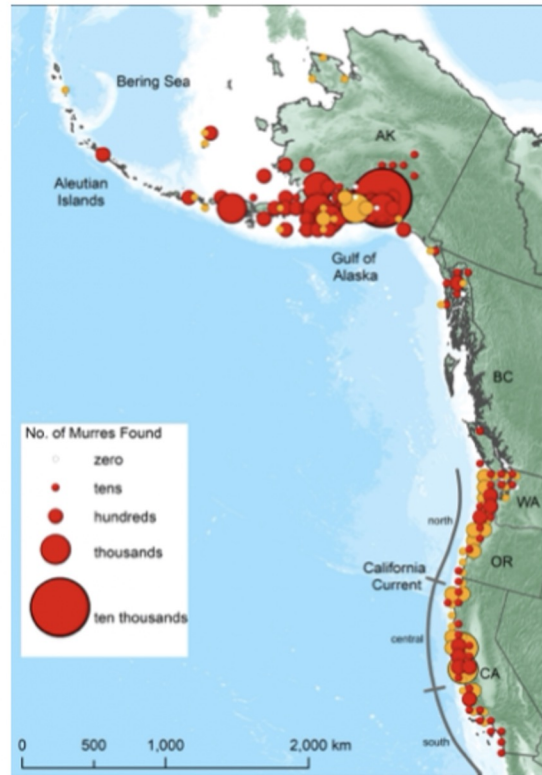
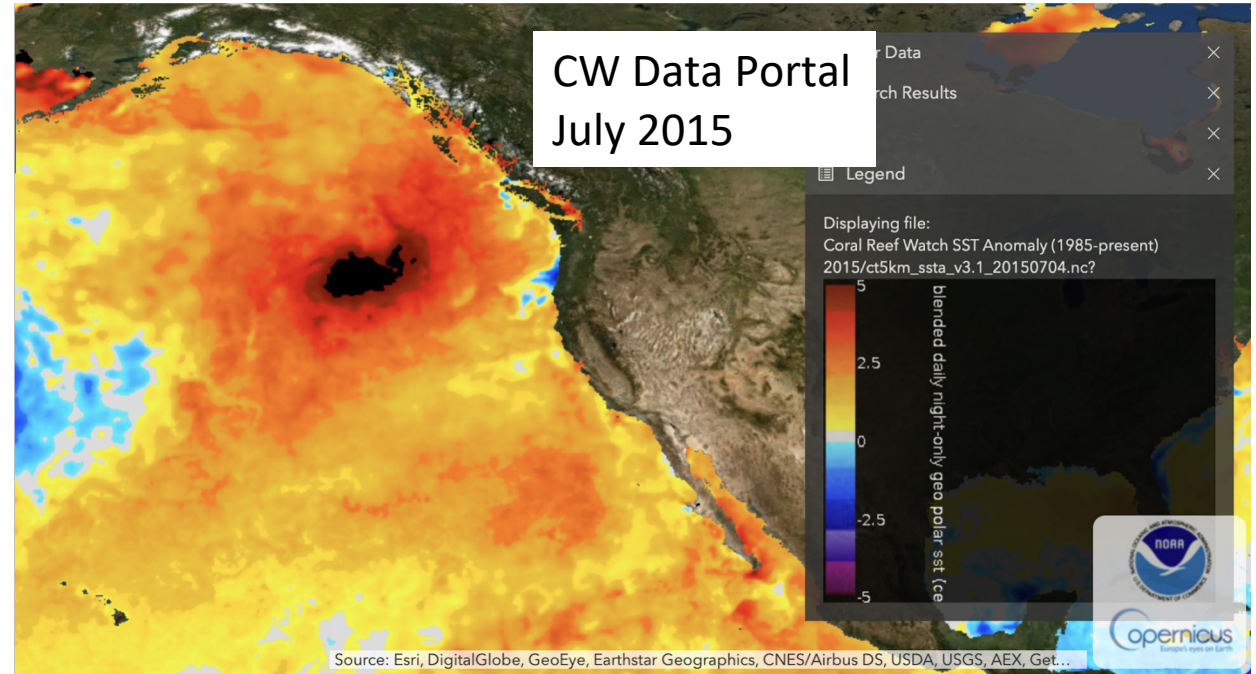
Bryan Black

University of Arizona; Tucson, AZ

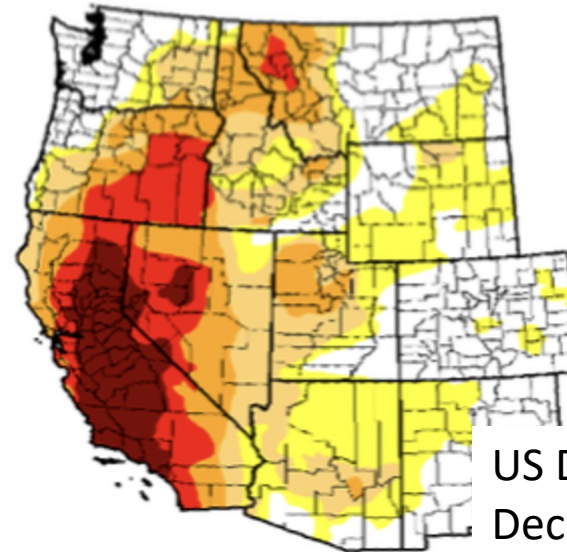
Dillon J. Amaya

*Physical Sciences Laboratory; Boulder,
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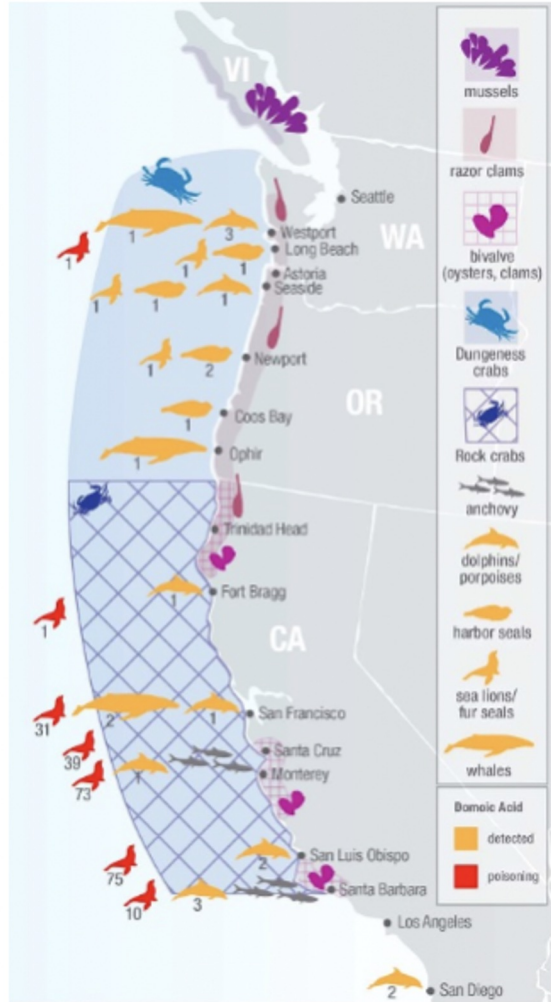
The "Blob" and exceptional drought in 2013-2016



Piatt et al., 2020



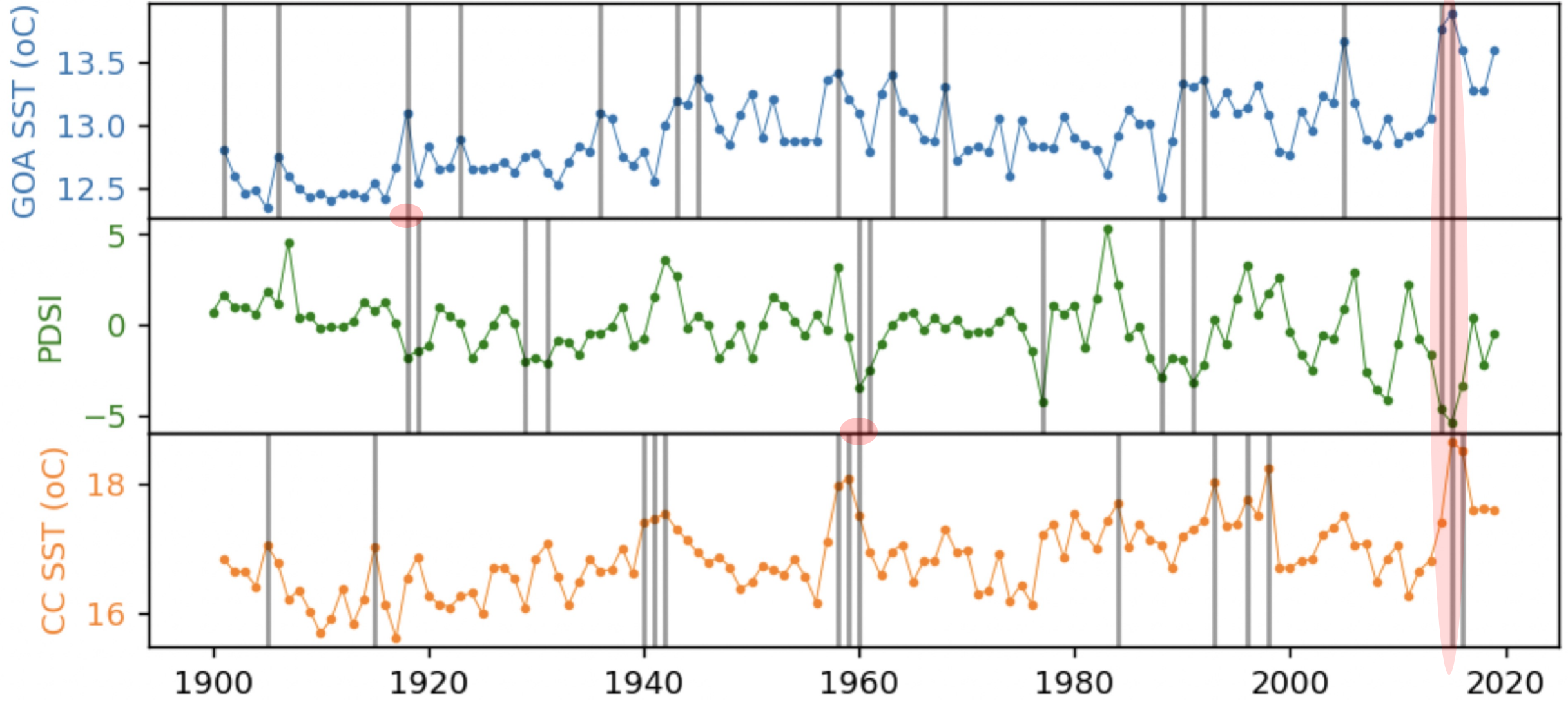
US Drought Monitor
December 2015



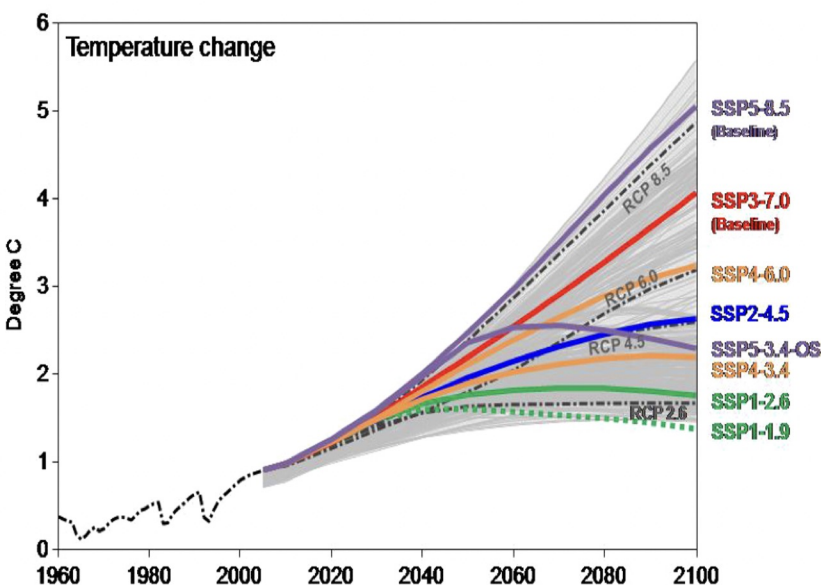
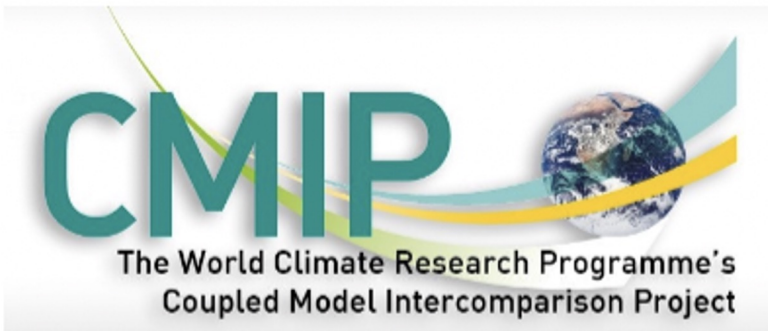
McCabe et al., 2016

Such co-occurrences are rare across the instrumental history 1900-2019

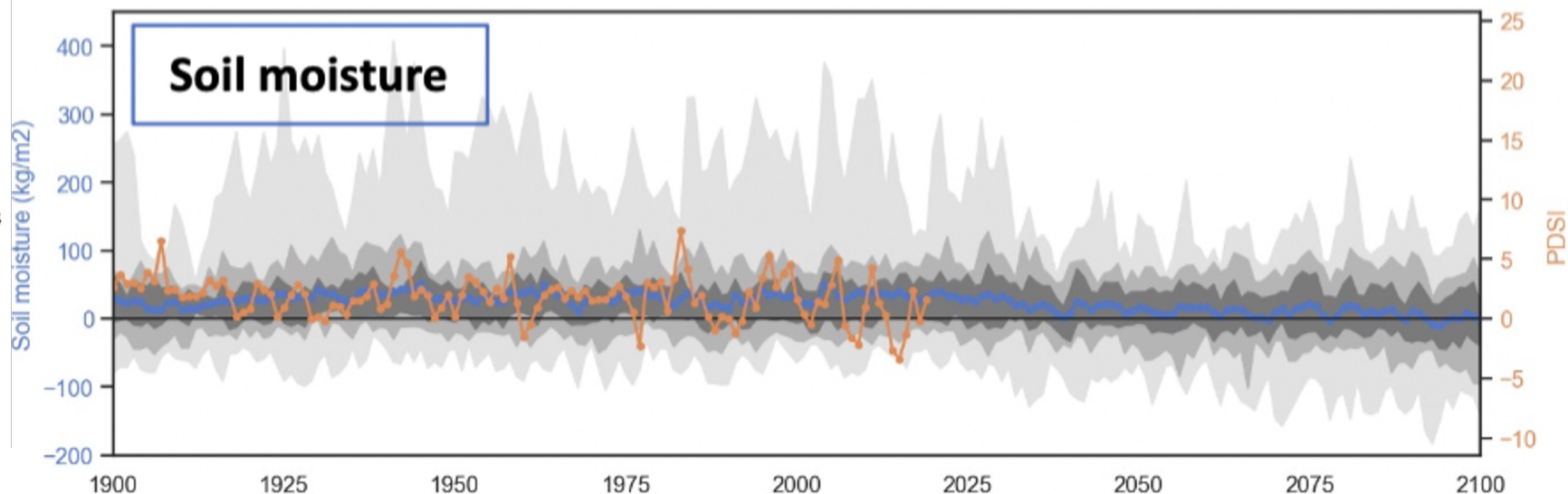
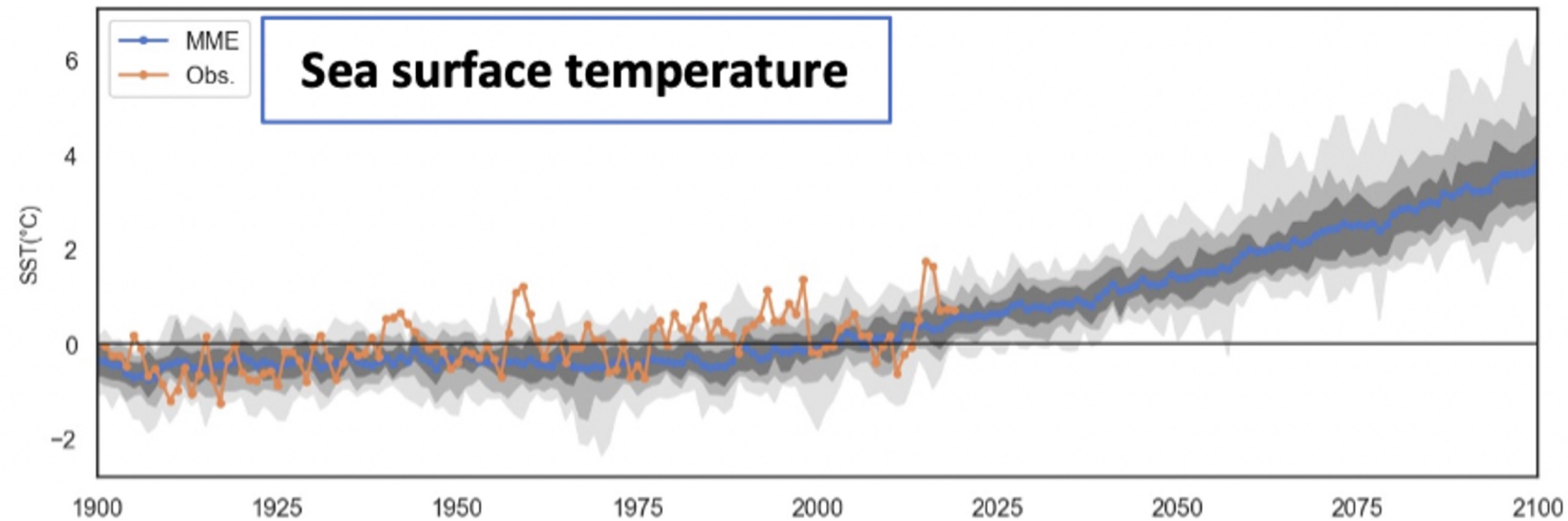
2013-2014 2014-2015



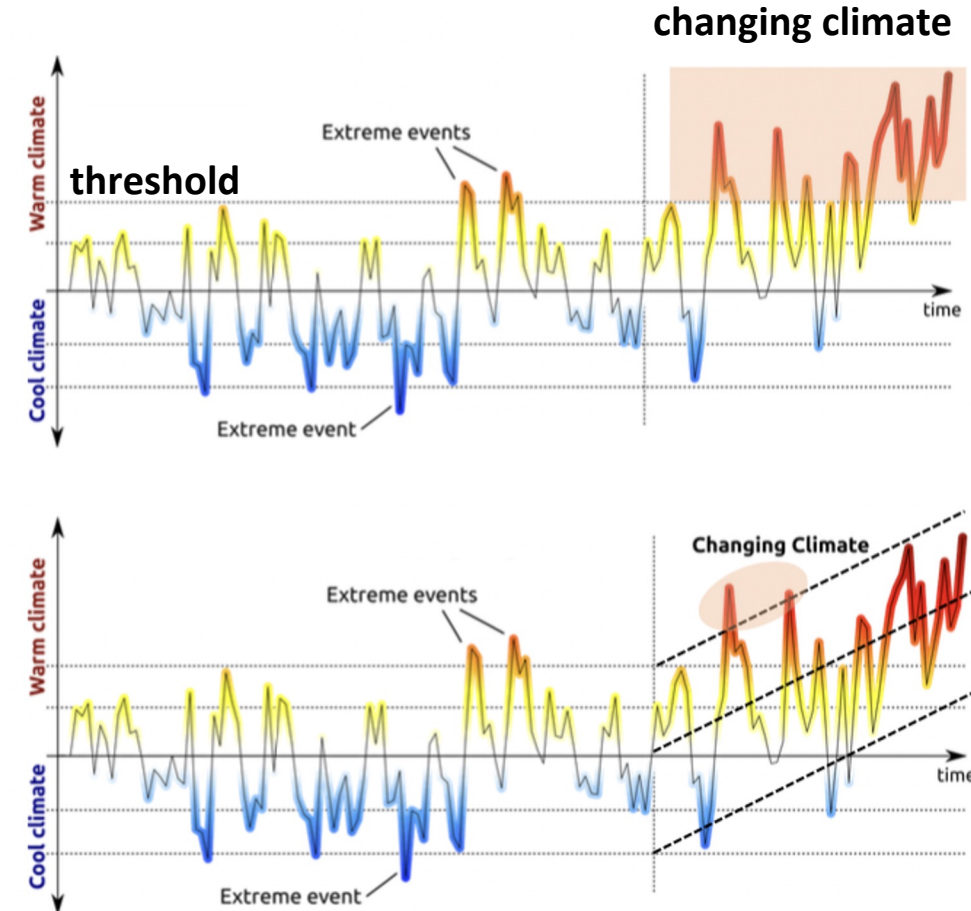
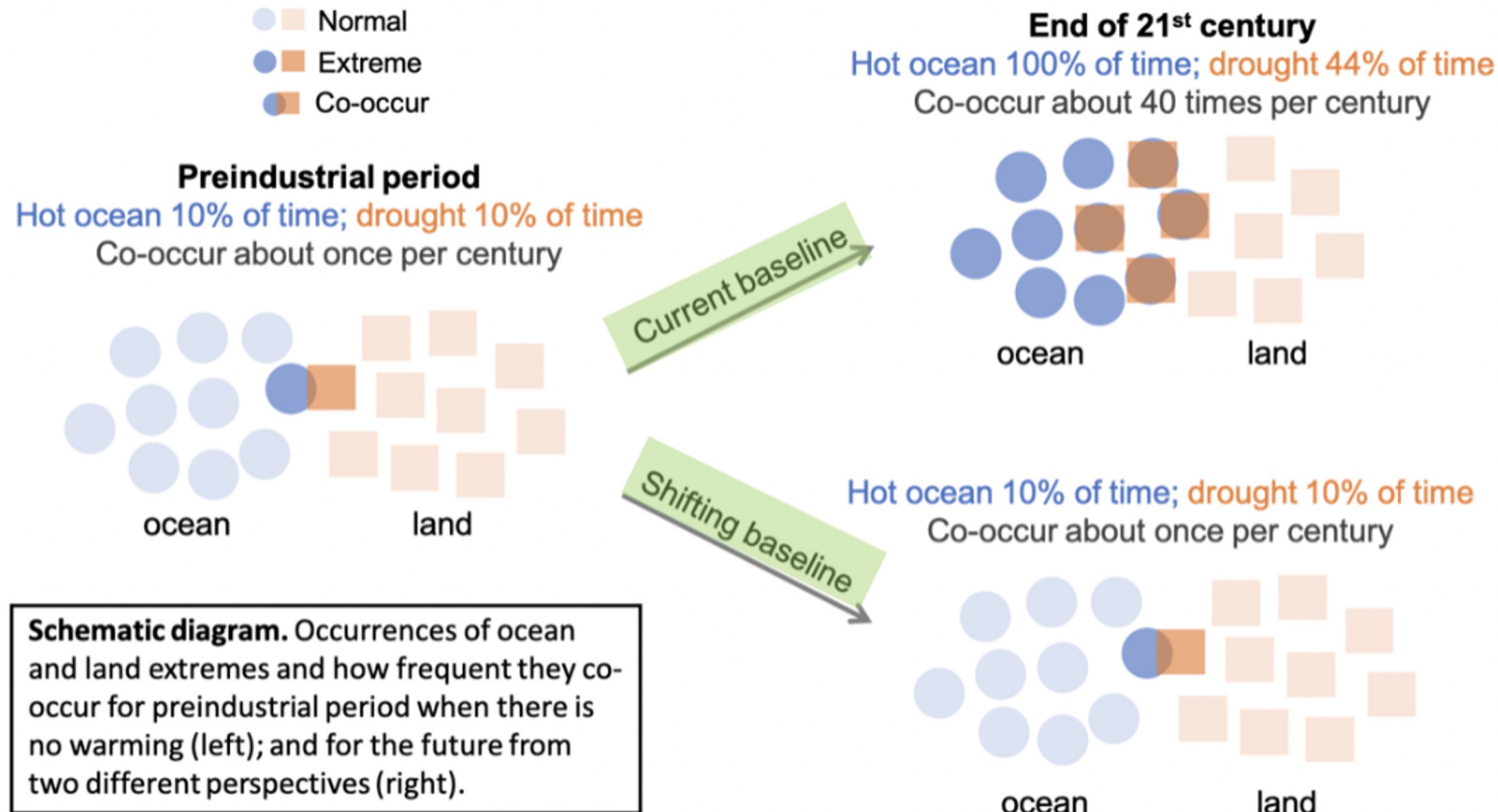
New generation of Earth system model projections



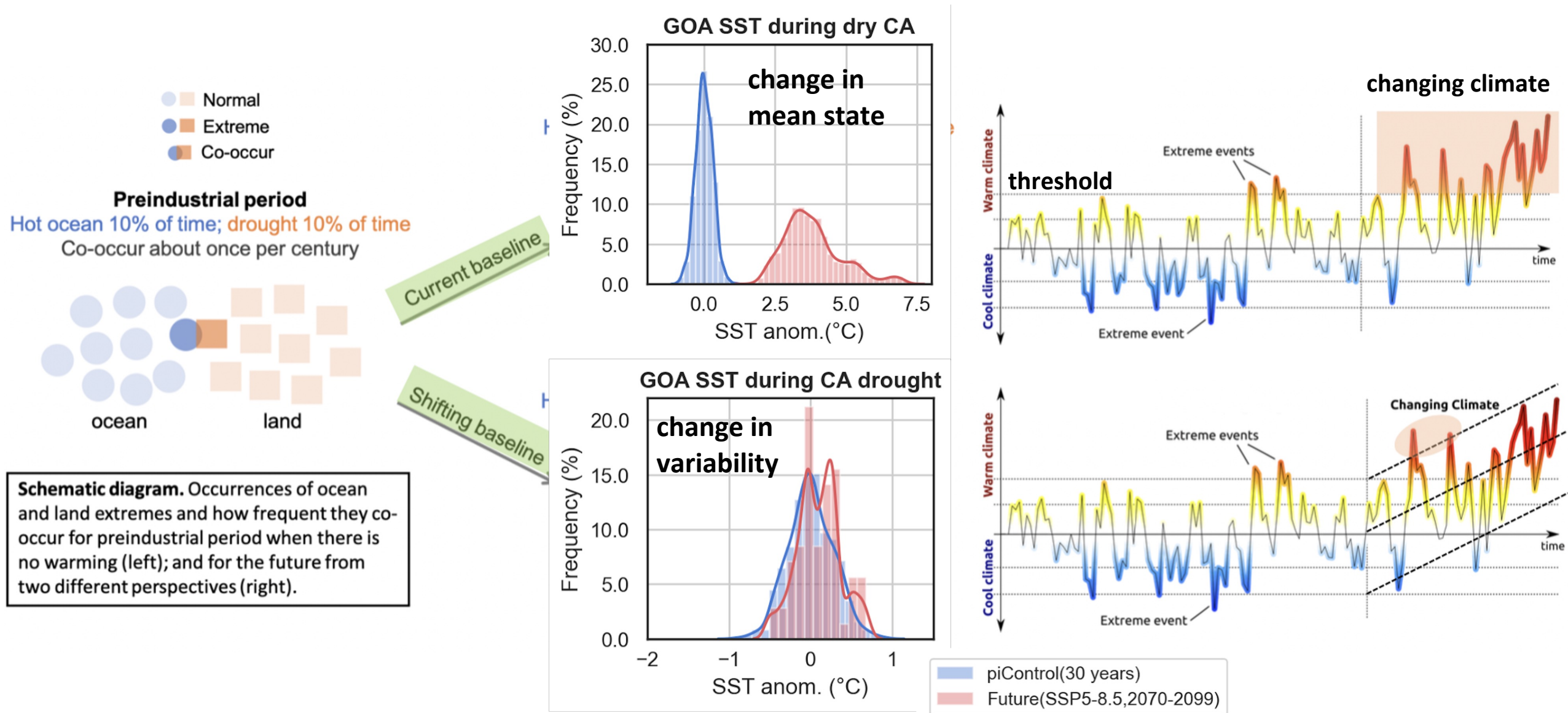
O'Neill et al., 2016



Future change of compound extremes from two perspectives



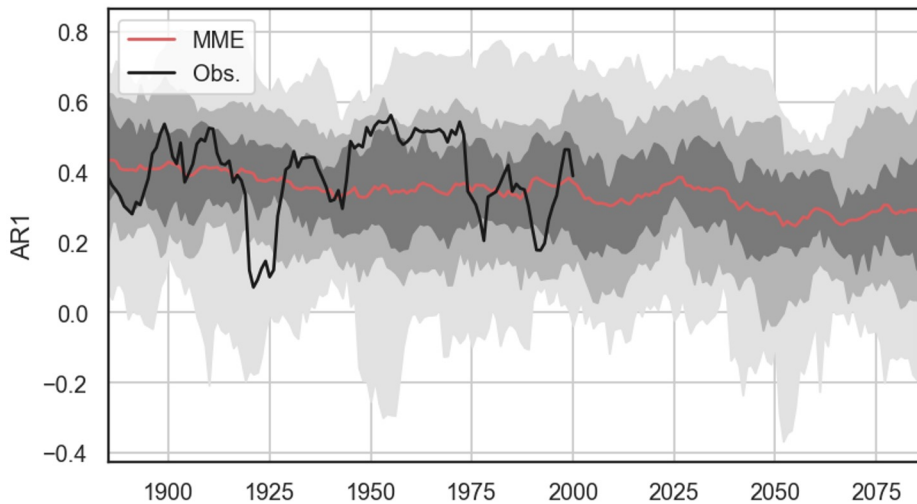
Future change of compound extremes from two perspectives



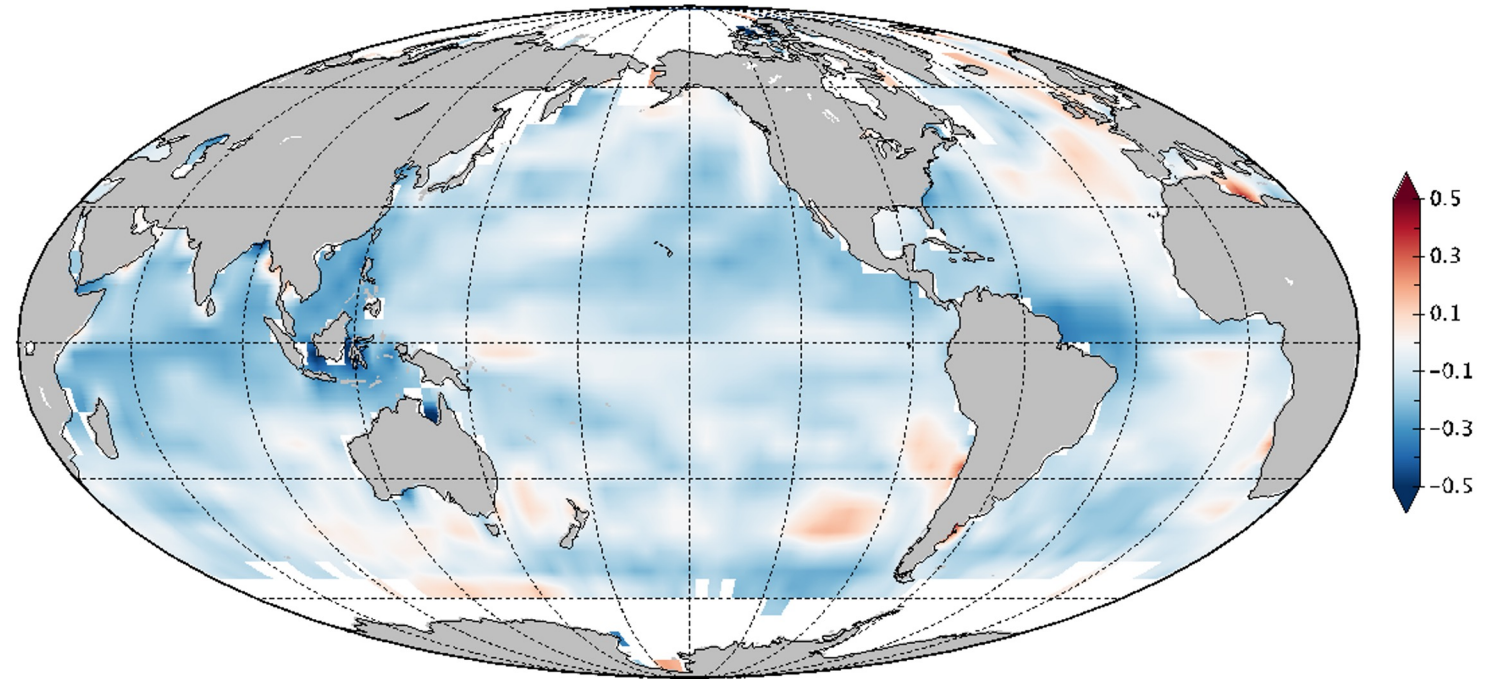
Shi, H., García-Reyes, M., Jacox, M. G., Rykaczewski, R. R., Black, B. A., Bograd, S. J., & Sydeman, W. J. (2021). Co-occurrence of California Drought and Northeast Pacific Marine Heatwaves Under Climate Change. *Geophysical Research Letters*, 48(17), e2021GL092765.

Prolonged MHW? Ocean memory decline!

Lag 1-year autocorrelation, $A(1)$, of SST anomalies in the California Current shows an interesting decline over time



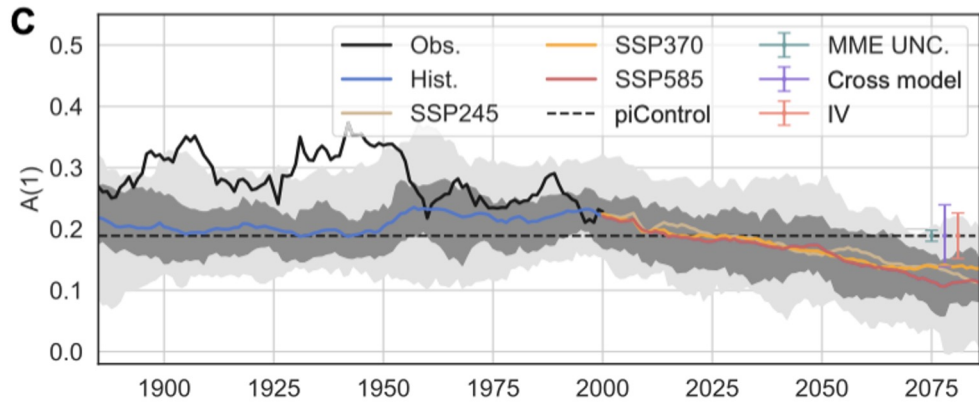
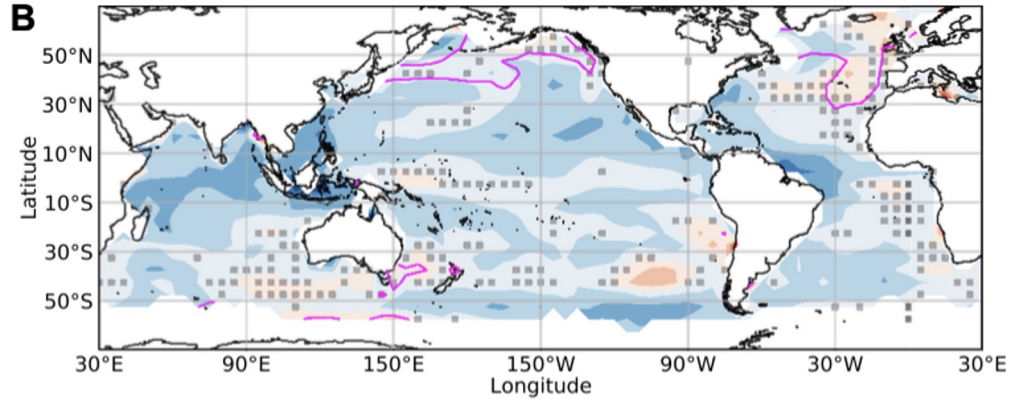
Declining ocean memory between the present and the end of the 21st century



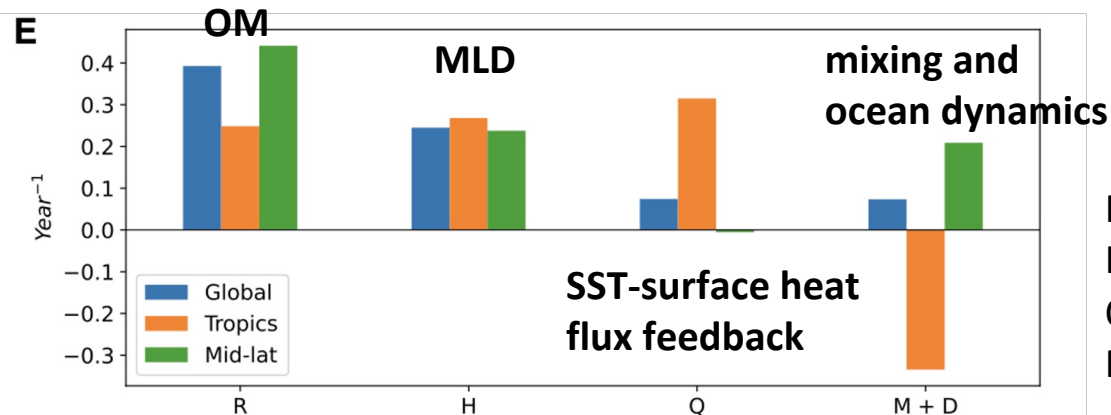
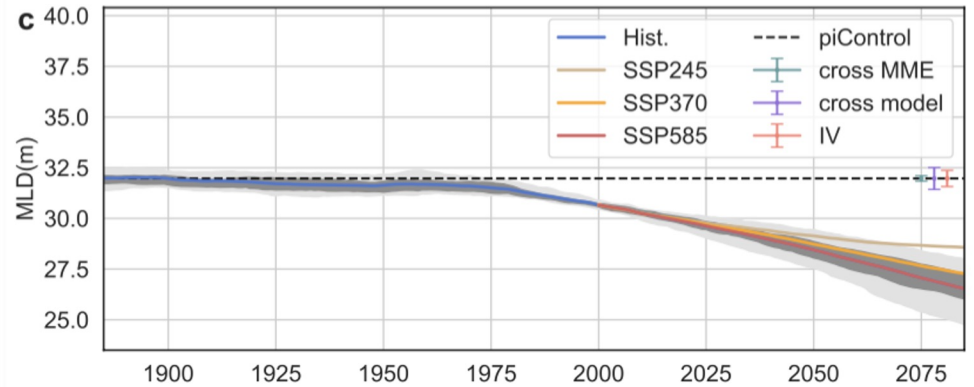
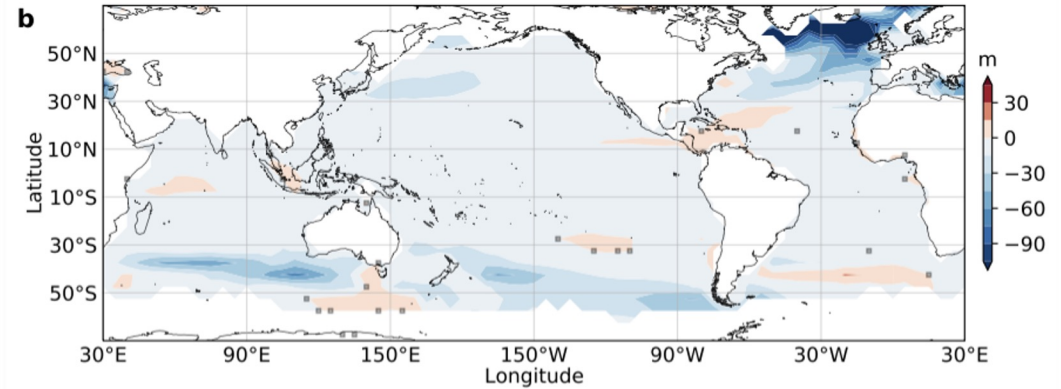
<https://www.eurekalert.org/news-releases/951784>

Primary driver: shoaling of mixed layer depth under warming

Change in A(1) from current to end of 21st century



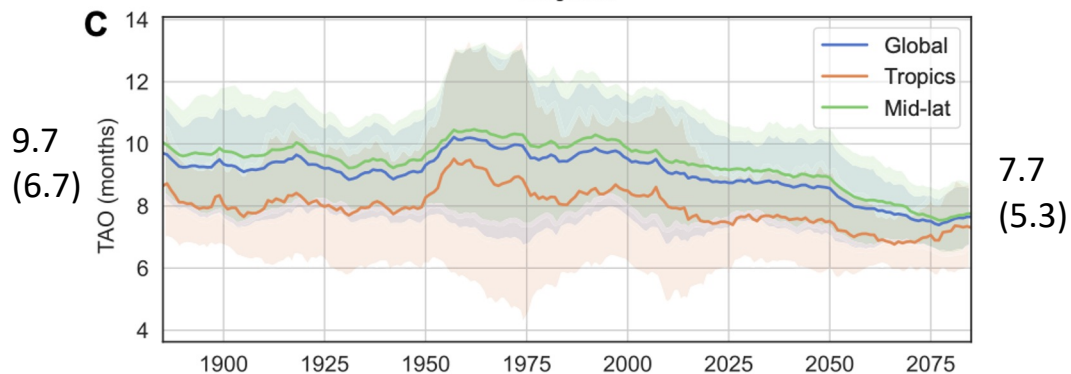
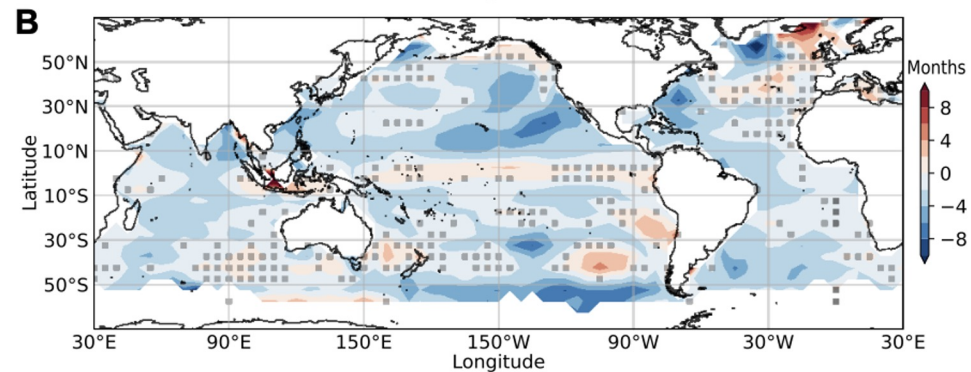
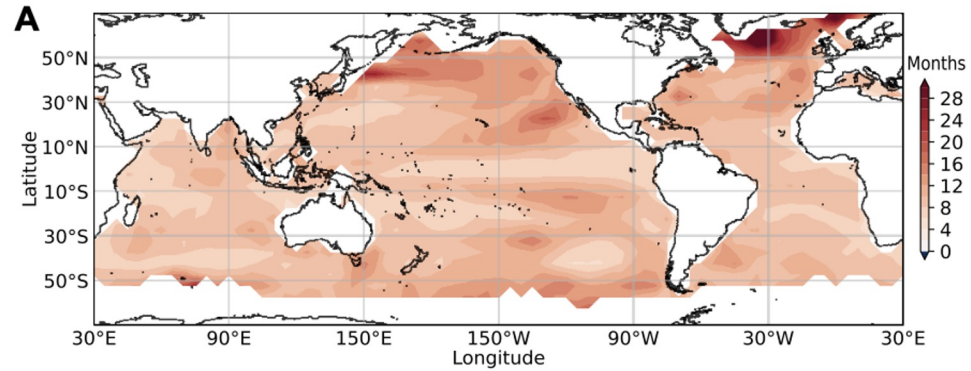
Change in MLD from current to end of 21st century



R: damping rate (inversely related to OM)
H: mixed layer depth
Q: SST-surface heat flux feedback
M+D: mixing and ocean dynamics

Reduced lead time for persistence-based ocean prediction and other challenges

Current SST damping timescale and its reduction toward the end of 21st century



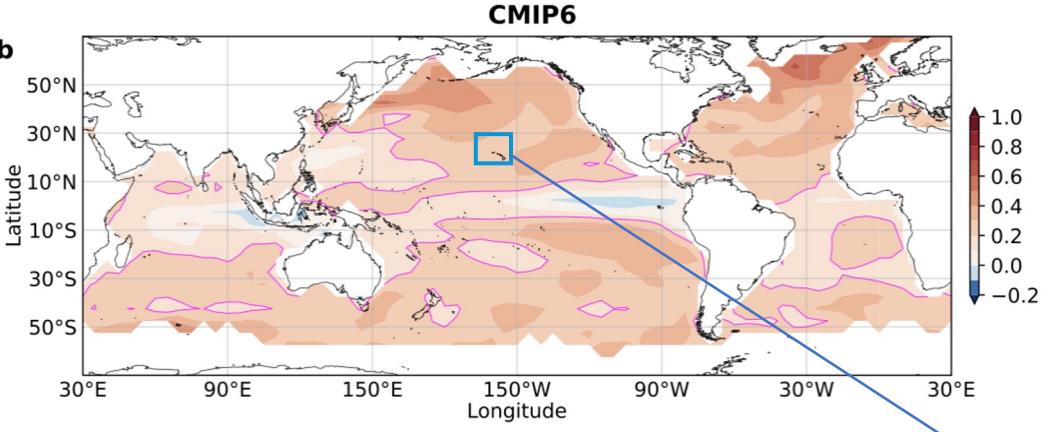
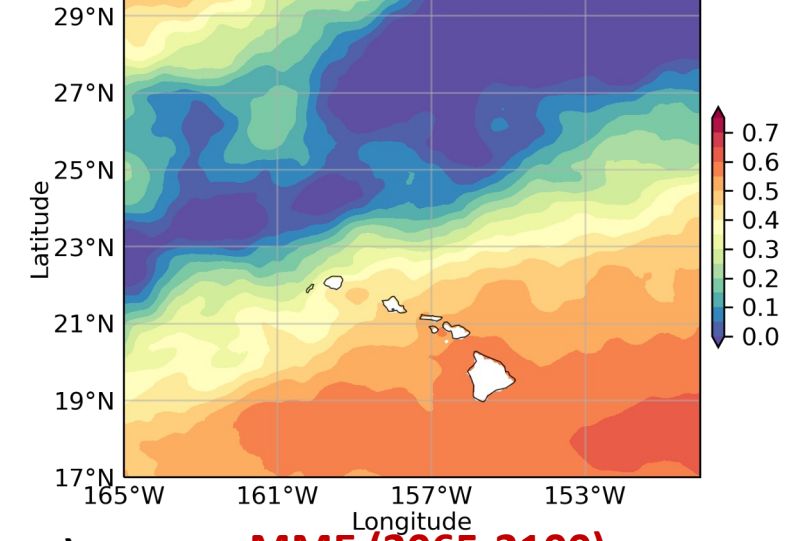
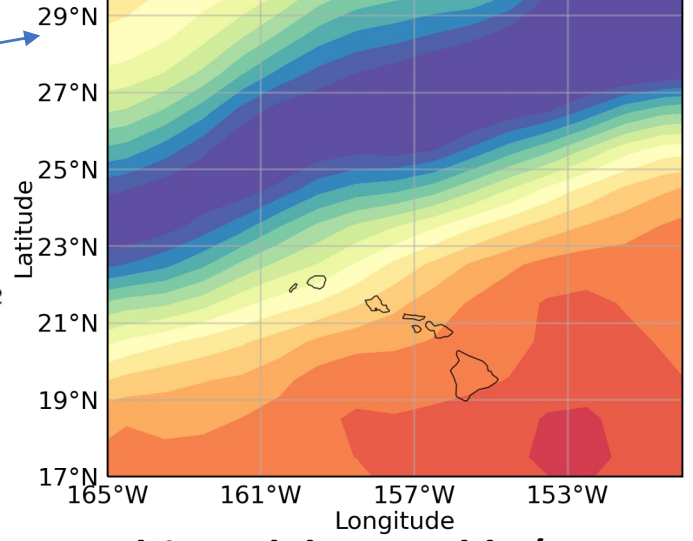
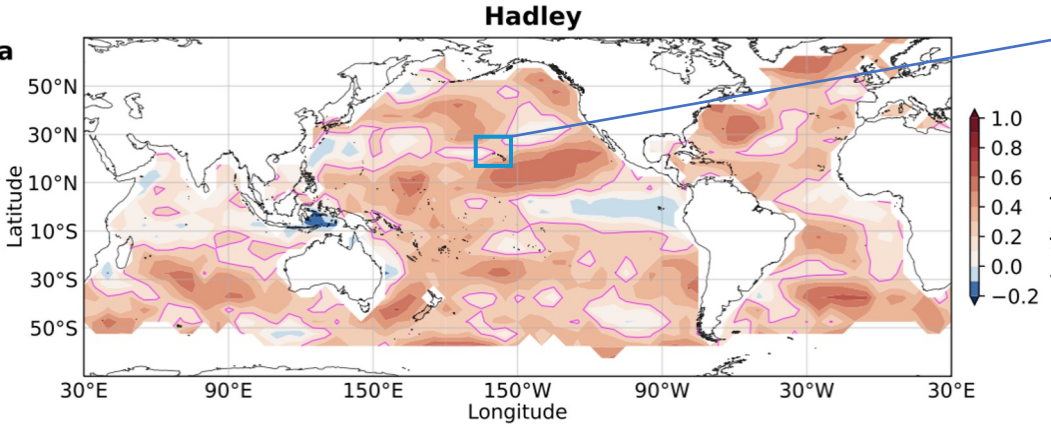
- **MHW prediction and preparation**
 - Altered statistics of temperature extremes, less time to prepare
- **Forecasts over land**
 - Ineffective predictors for temperature, rainfall and extremes
- **Fisheries management**
 - Reduced accuracy in estimates of biological parameters
- **Biology**
 - Diverging impacts on species' populations

Shi, H., Jin, F. F., Wills, R. C., Jacox, M. G., Amaya, D. J., Black, B. A., Rykaczewski R.R., Bograd, S.J., García-Reyes, M. & Sydeman, W. J. (2022). Global decline in ocean memory over the 21st century. *Science Advances*, 8(18), eabm3468.

Moving forward: satellite data to depict accurate regional ocean memory and its future change

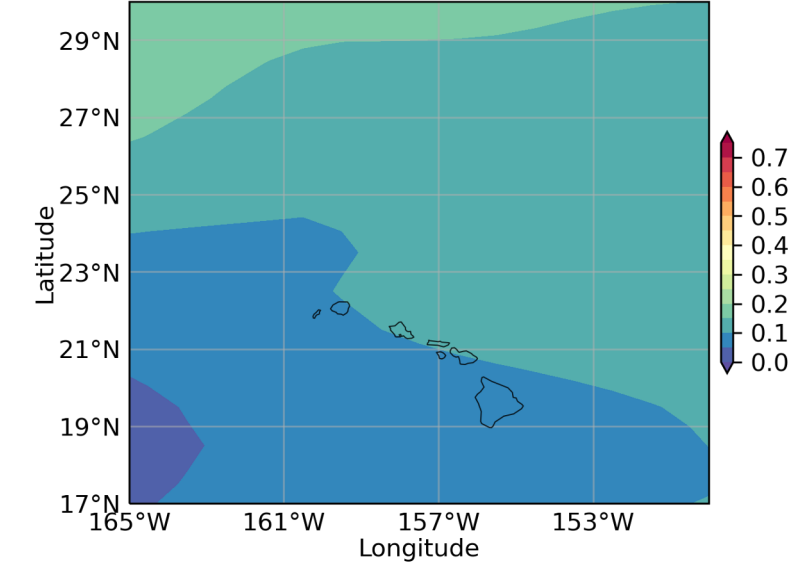
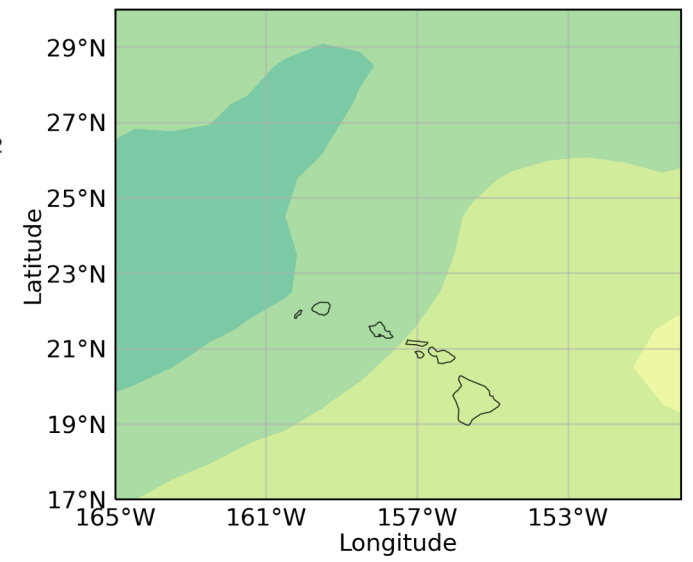
Hadley reanalysis (1985-2020)

Coral Reef Watch (1985-2020)



Multi-model ensemble (1985-2020)

MME (2065-2100)



Thank you for listening! 😊