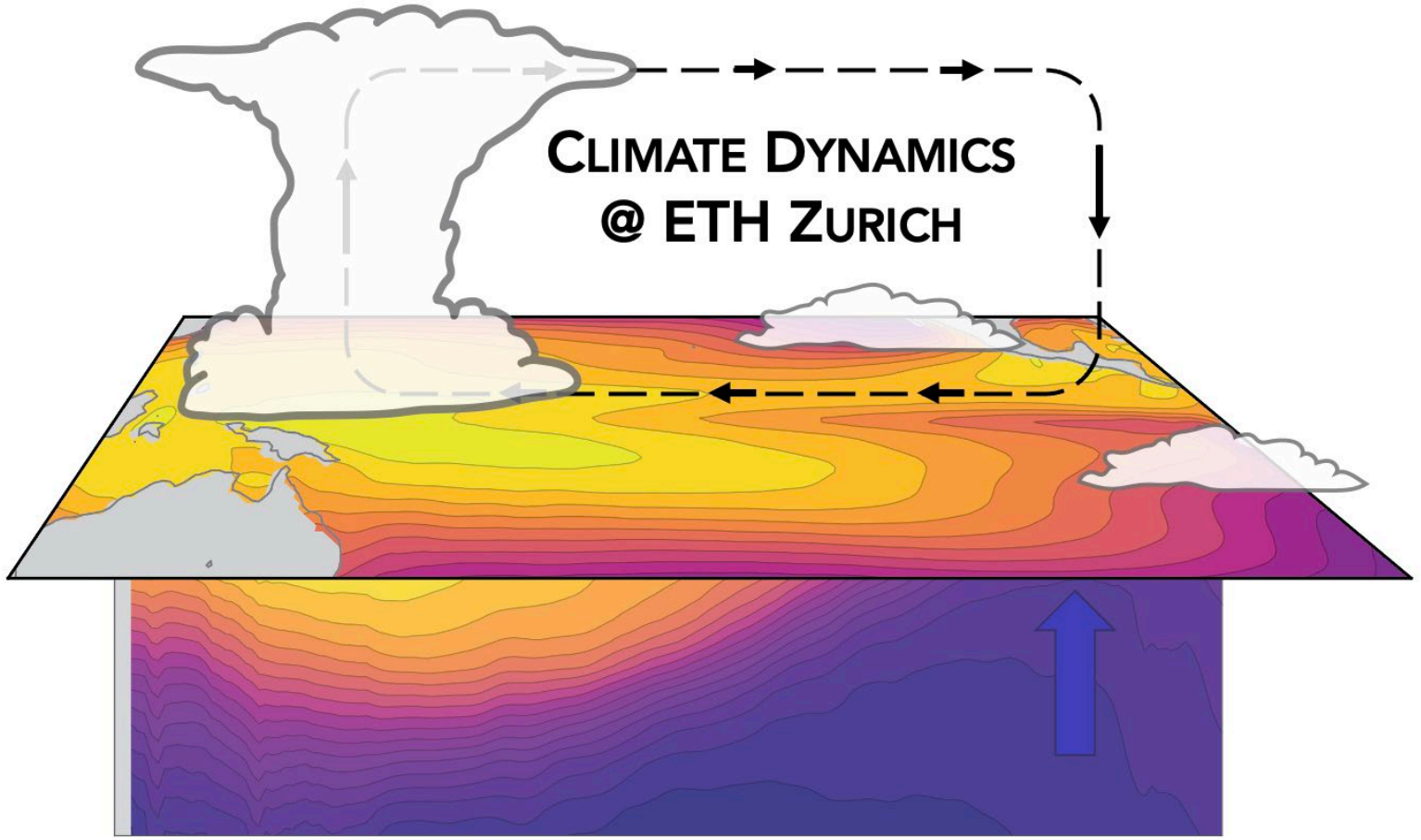
ETH zürich

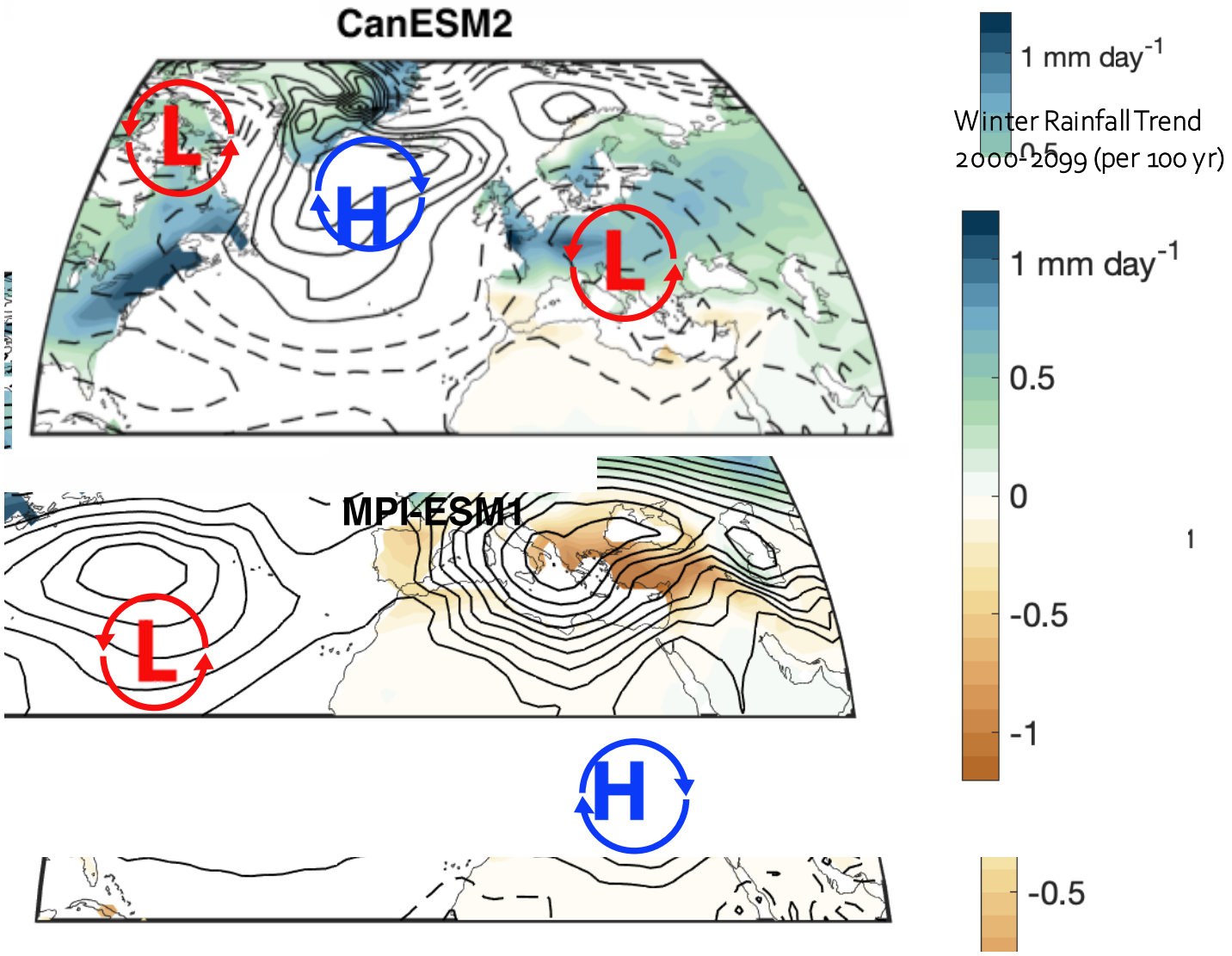



# Climate Dynamics Group

Prof. Robb Jnglin Wills; Postdocs: Clarissa Kroll; PhDs: Joas Müller, Nora Fahrenbach, Zhenghe Xuan

D USYS

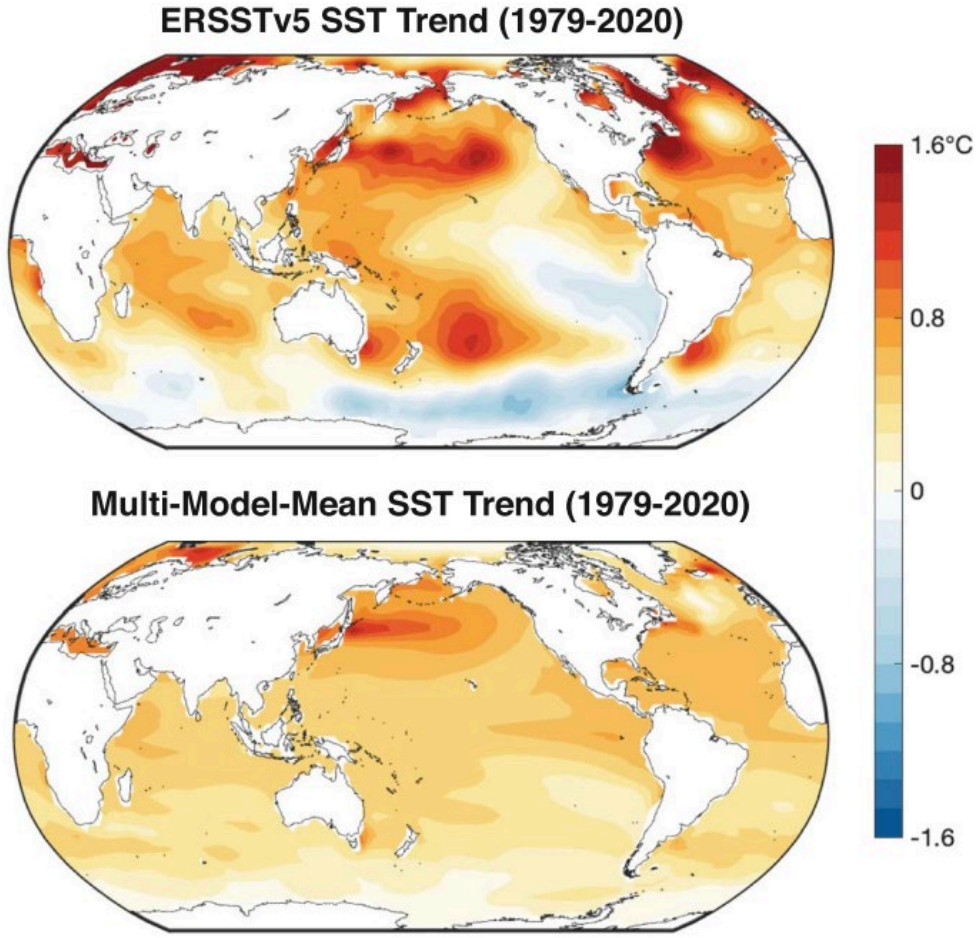
# What We Work On: Constraining future changes in the large-scale atmospheric circulation and regional climate

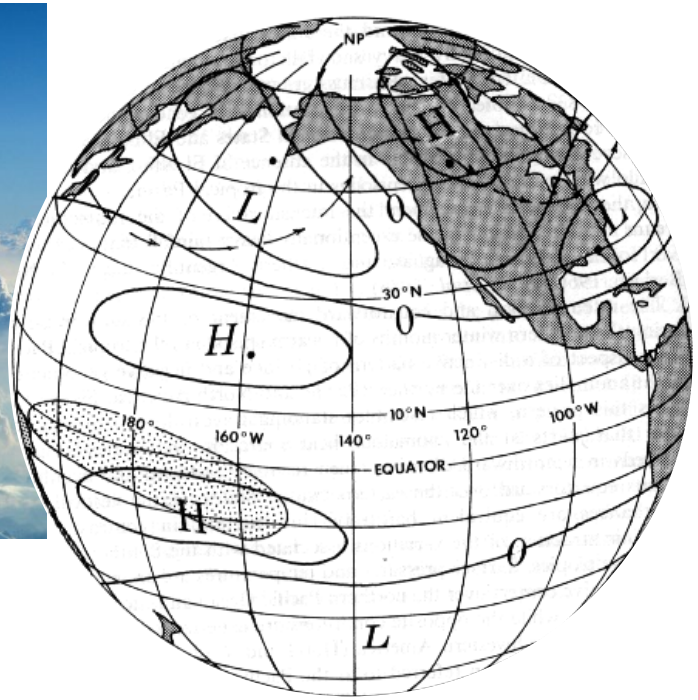



Contours: Winter sea-level pressure trends, 2000-2099

Analysis of CanESM2 and MPI-ESM1 Large Ensembles

# What We Work On: The role of the ocean in shaping the atmospheric circulation and climate

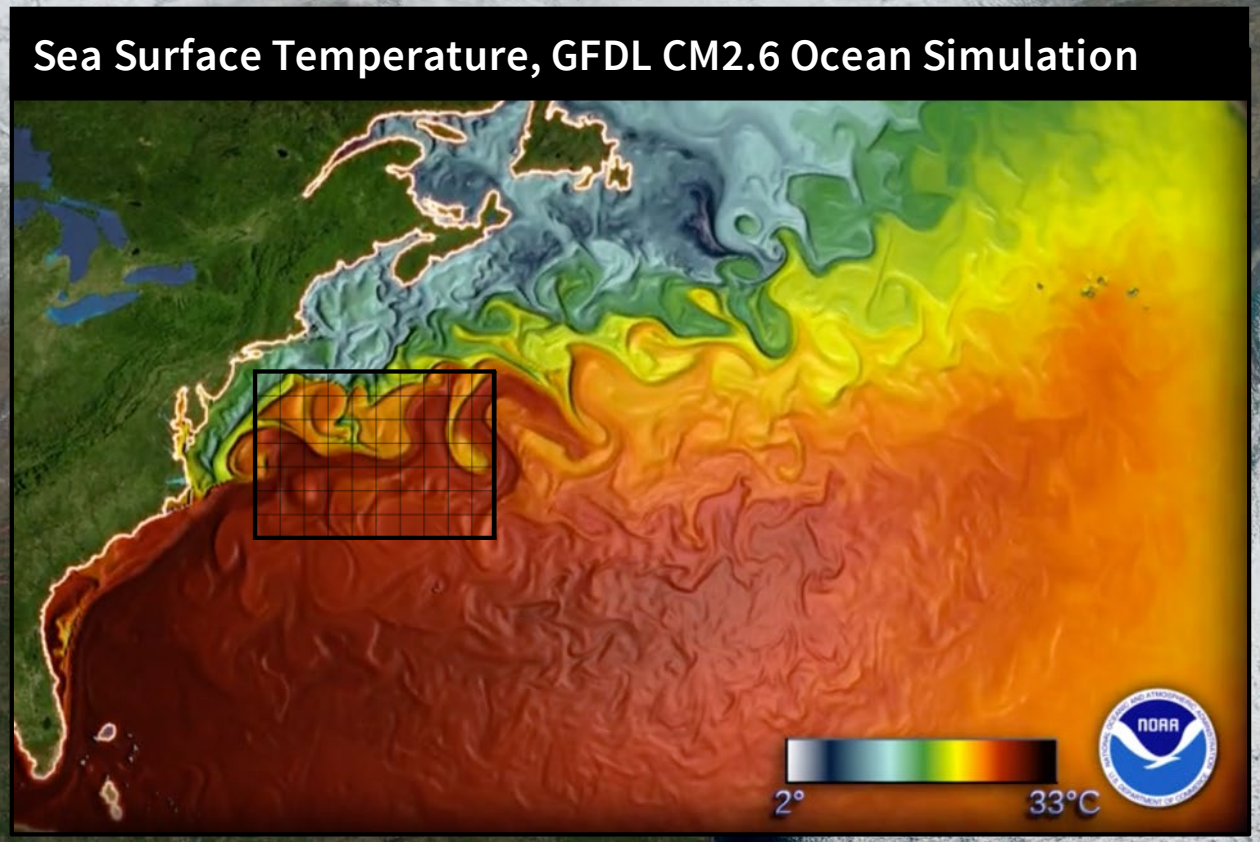


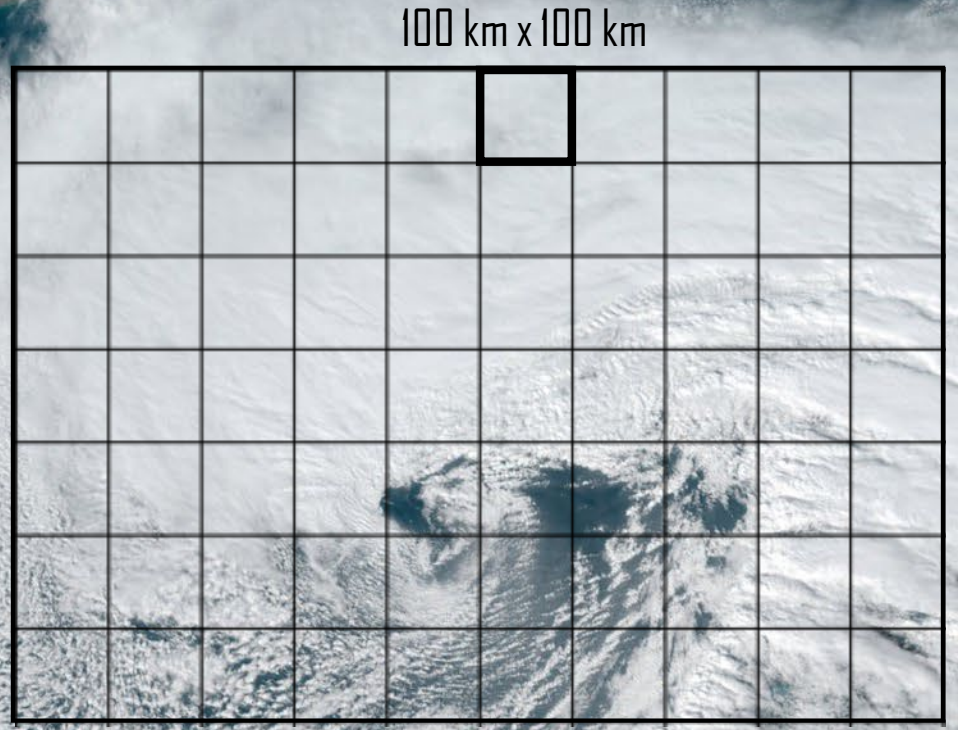




Sea-surface temperature (SST) patterns in the tropics influence the distribution of deep convection and modify Rossby waves propagating throughout the globe.

However, SST pattern have been changing differently in the real world than climate models. We don't know why yet, but this could bias regional climate projections globally.

# What We Work On: What are the role of mesoscale and convective processes in large-scale dynamics?

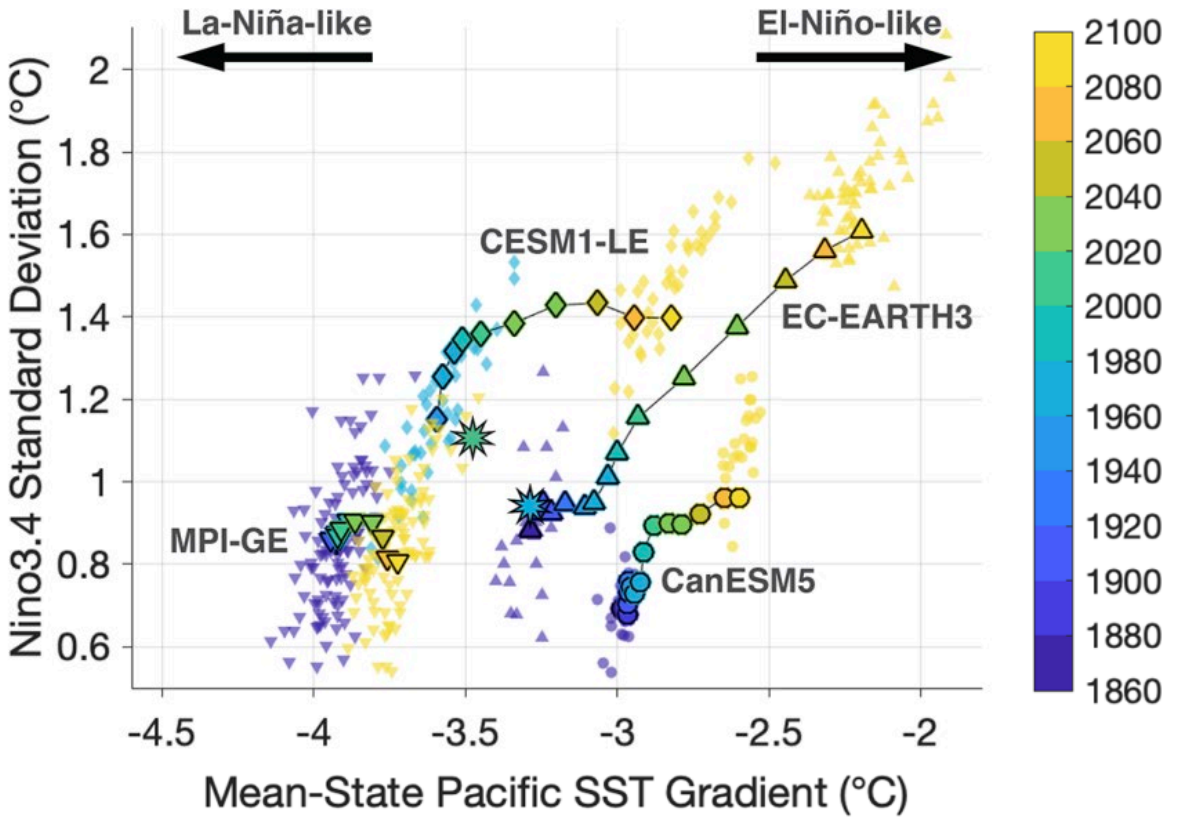


# Maher et al. 2023: The future of the El Niño-Southern Oscillation: Using large ensembles to illuminate time-varying responses and inter-model differences

**In this paper:**

- El Niño-Southern Oscillation (ENSO) amplitude, pattern, and seasonality changes under historical and future anthropogenic forcing, based on climate model large ensembles
- Model-to-model differences in ENSO responses
- El-Niño-like changes in the mean climate and its relationship with ENSO variability

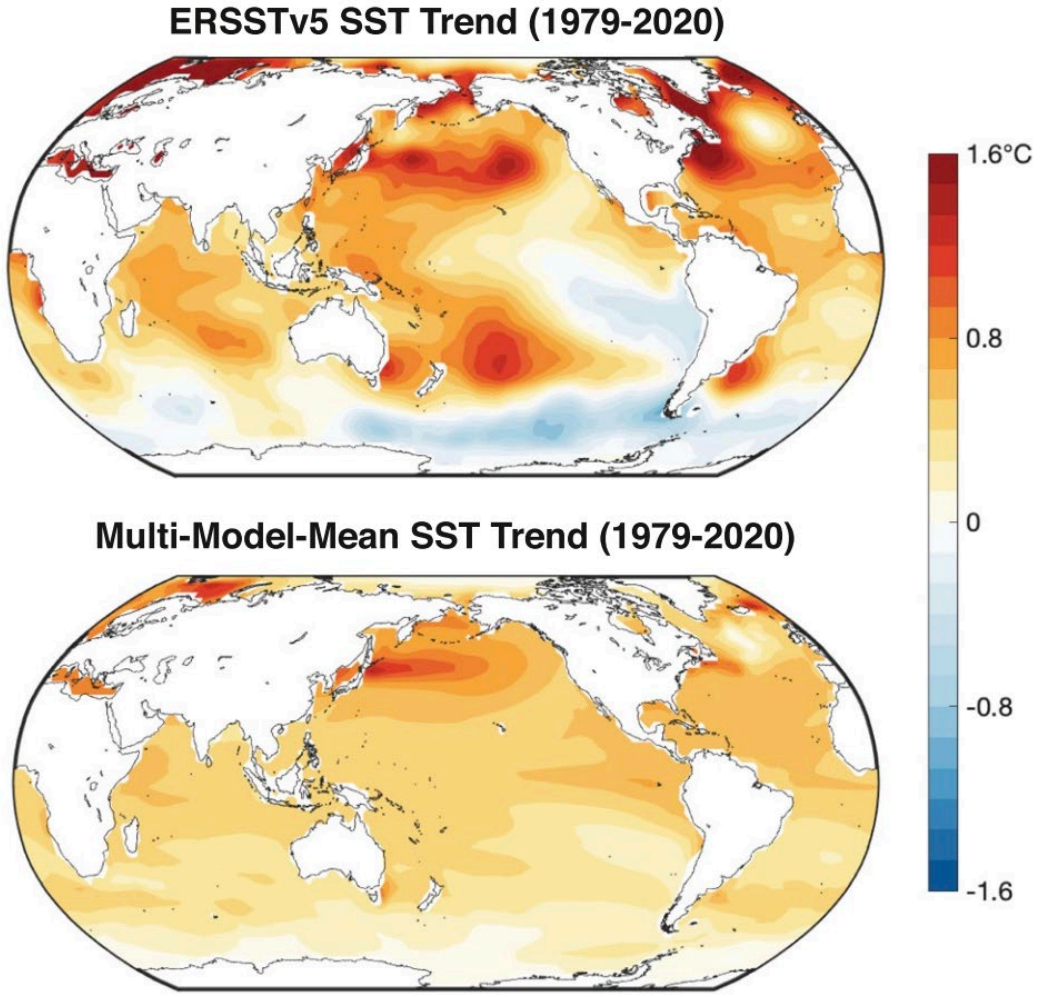



Maher, N., R.C. Jnglin Wills, P. DiNezio, J. Klavans, S. Milinski, S.C. Sanchez, S. Stevenson, M.F. Stuecker, and X. Wu: The future of the El Niño-Southern Oscillation: Using large ensembles to illuminate time-varying responses and inter-model differences. Earth System Dynamics, 14, 413-431, https://doi.org/10.5194/esd-14-413-2023.

# Wills et al. 2022: Systematic climate model biases in the large-scale patterns of recent sea-surface temperature and sea-level pressure change

## In this paper:

- Observations have different sea-surface temperature and sea-level pressure trends over 1979-2020 than the average climate model simulation, and this can't be explained only by internal climate variability
- Evidence of a systematic bias in the pattern of climate change across state-of-the-art CMIP6 climate models
- Discussion of possible reasons for this trend discrepancy

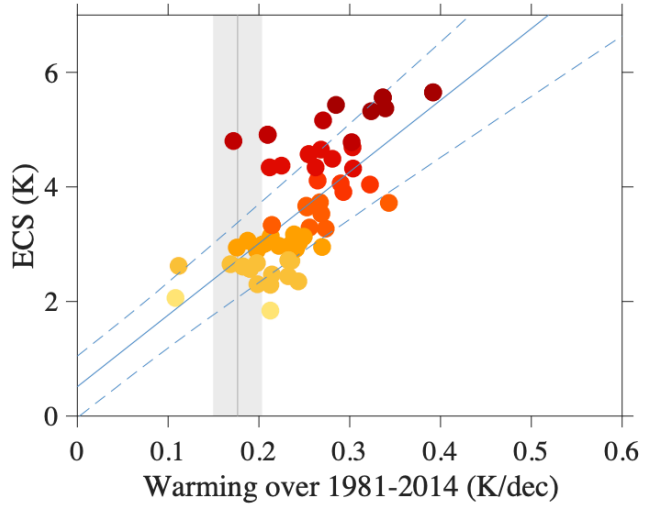


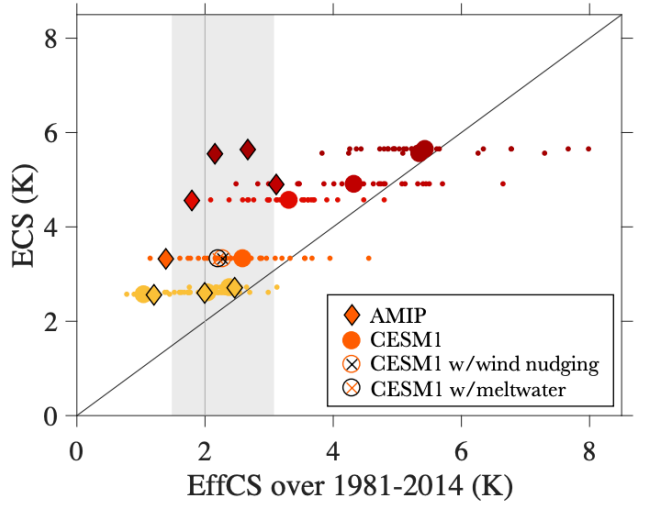

Wills, R.C.J., Y. Dong, C. Proistosescu, K.C. Armour, and D.S. Battisti, 2022: Systematic climate model biases in the large-scale patterns of recent sea-surface temperature and sea-level pressure change. Geophysical Research Letters, 49, e2022GL100011, https://doi.org/10.1029/2022GL100011.

# Armour et al., in review: Sea-surface temperature pattern effects have slowed recent global warming and biased emergent constraints on climate sensitivity

## In this paper:

- Models with higher equilibrium climate sensitivity (ECS) simulate more warming over 1981-2014, offering the potential to constrain ECS based on the observed warming rate
- However, this constraint can't be used to rule out "hot models" that have high ECS, because these models simulate feedbacks consistent with less warming if they use the observed SST patterns
- This means that understanding the reason for the SST pattern bias is also critical for constraining ECS



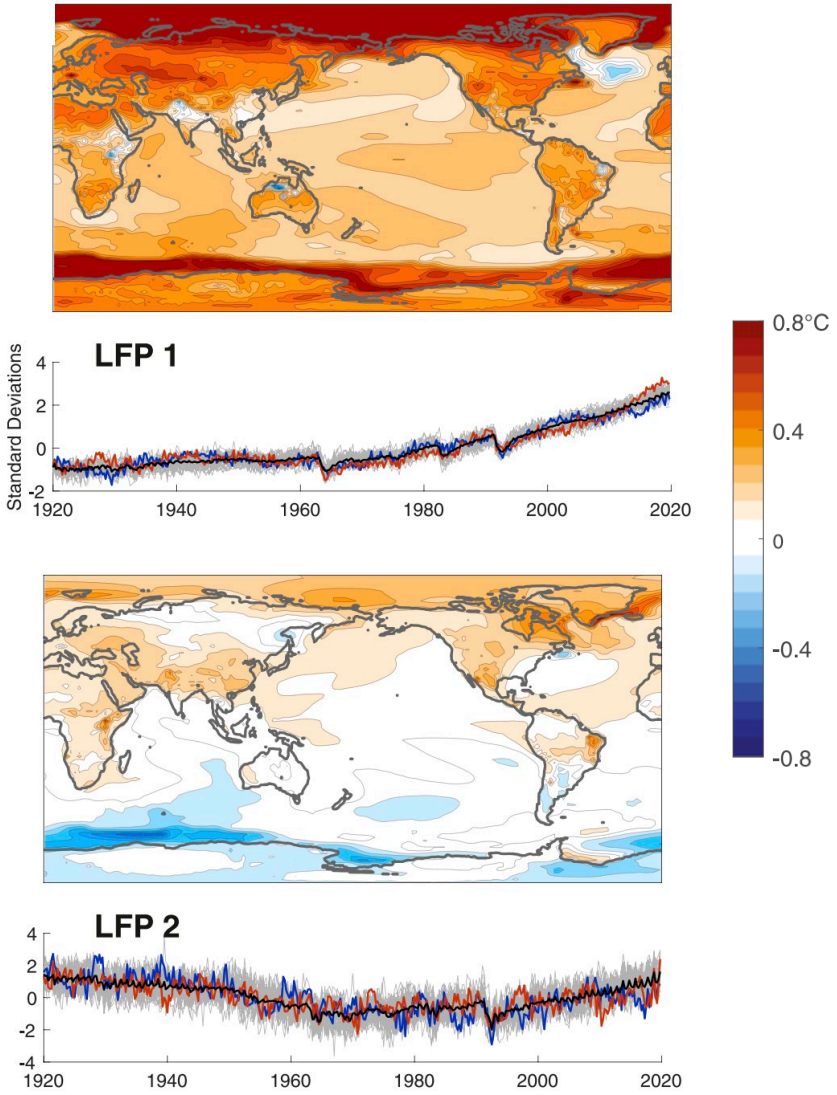




Armour, K.C., C. Proistosescu, Y. Dong, L.C. Hahn, E. Blanchard-Wrigglesworth, A.G. Pauling, R.C. Jnglin Wills, T. Andrews, M.F. Stuecker, S. Po-Chedley, I. Mitevski, P.M. Forster, and J.M. Gregory: Sea-surface temperature pattern effects have slowed recent global warming and biased emergent constraints on climate sensitivity, in review at Proceedings of the National Academy of Science, preprint: http://faculty.washington.edu/karmour/papers/ArmourProistosescu_etal_PNAS2023_submitted.pdf.

# Wills et al. 2020: Pattern recognition methods to separate forced responses from internal variability in climate model ensembles and observations

**In this paper:**

- Pattern recognition methods are presented that identify signals associated with (anthropogenically) forced climate change
- An estimate of the spatiotemporally varying anomalies that are due to forced climate change can be constructed from the identified patterns
- Testing these methods in climate model ensembles, where ensemble members differ only in their phase of internal variability, shows that they can identify the forced response with fewer ensemble members and/or in observations




Wills, R.C.J., D.S. Battisti, K.C. Armour, T. Schneider, and C. Deser, 2020: Pattern recognition methods to separate forced responses from internal variability in climate model ensembles and observations. Journal of Climate, 33, 8693–8719, https://doi.org/10.1175/JCLI-D-19-0855.1.

# Logistics

Presentations 07. December 2023, 10:15-12:00

TA: Zhenghe Xuan