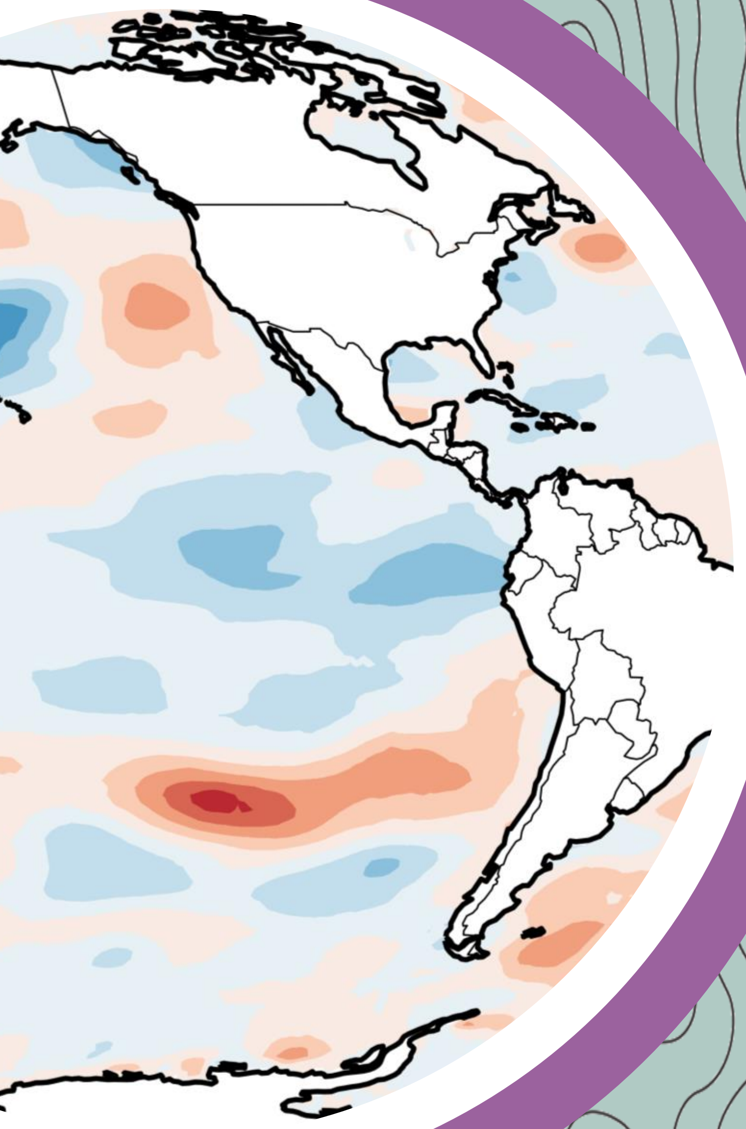


Wind stress contributions to ΔENSO

Jacob Stuivenvolt-Allen, Alexey Fedorov and Minmin Fu

Yale Earth & Planetary Sciences

Atmosphere, Ocean, Climate Dynamics

NCAR

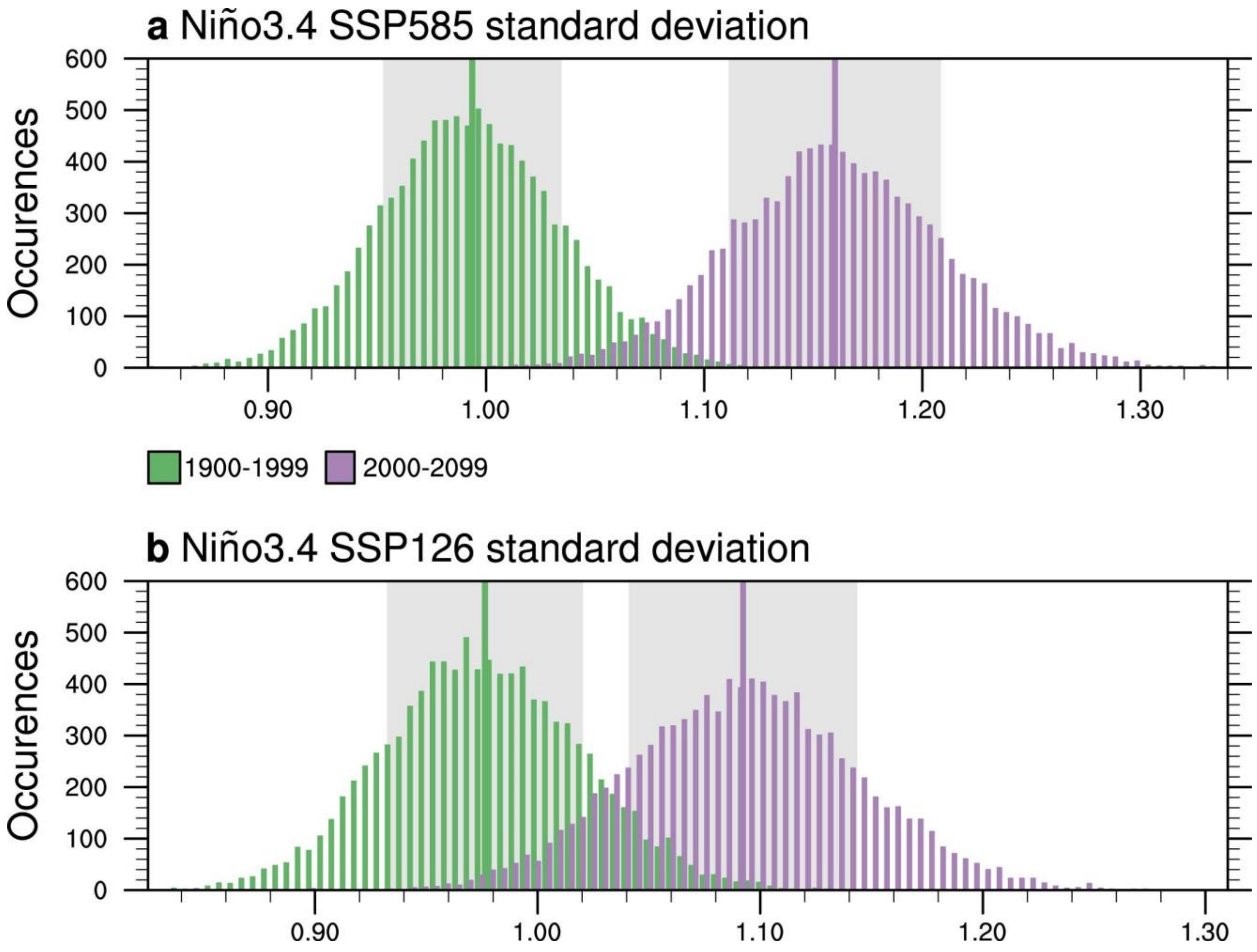
UCAR

"Emerging consensus": on ENSO variability

1 Majority of CMIP6 models agree on increased variability of ENSO SST and precipitation

- **A** Nino 3.4
- **B** EP index
- **C** CP index

But the change is markedly different across different models



Cai et al. 2022

Where do models diverge?

Deser et al. 2012, Captondi et al. 2006, Capatondi et al. 2020, Chen et al. 2021 and many more…

The “***sauce***” of known model biases/uncertainties:

A B C …. Z

ENSO positive/negative feedbacks!

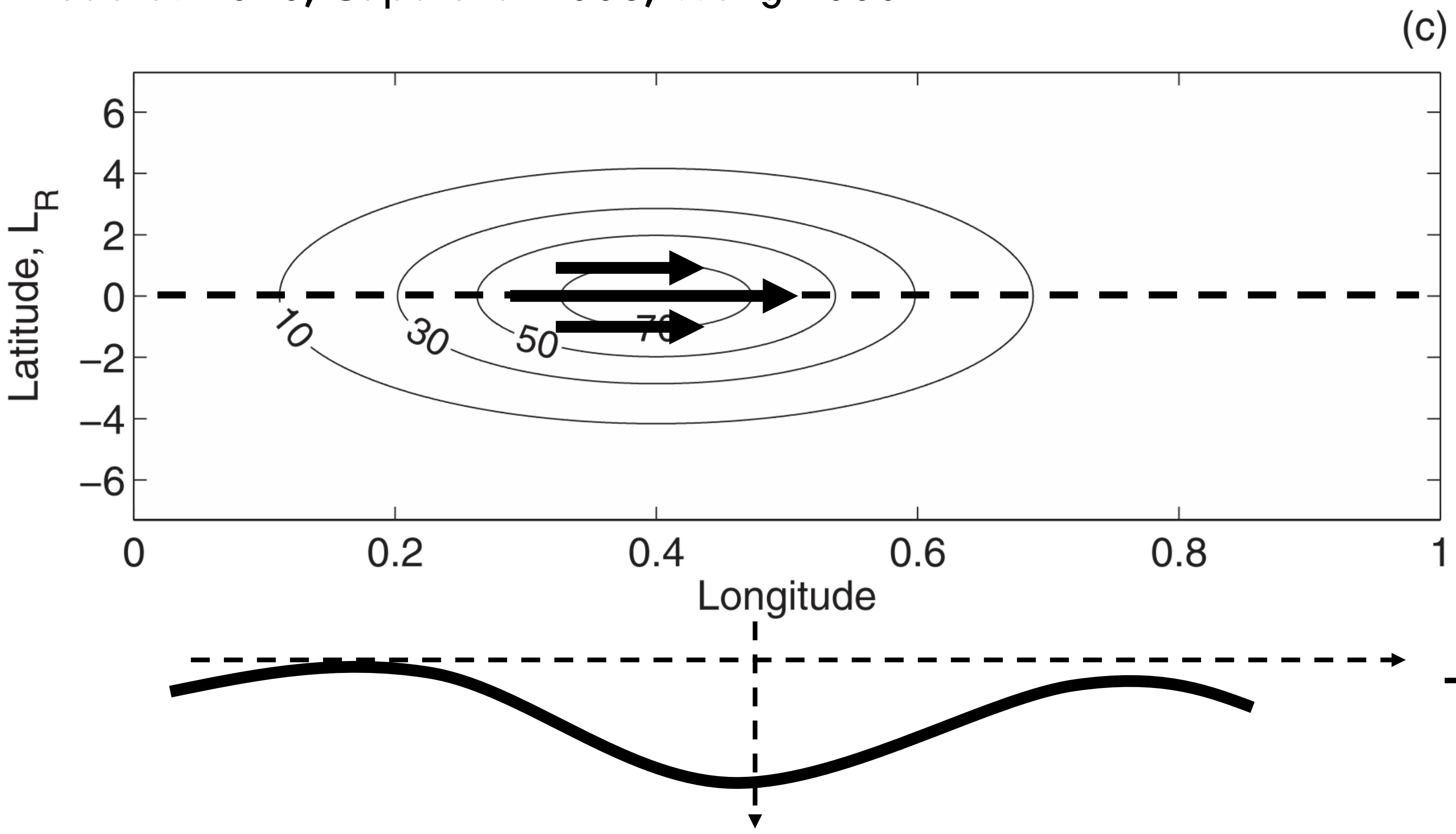
Are there unifying features across models that explain the spread in projected ENSO statistics?

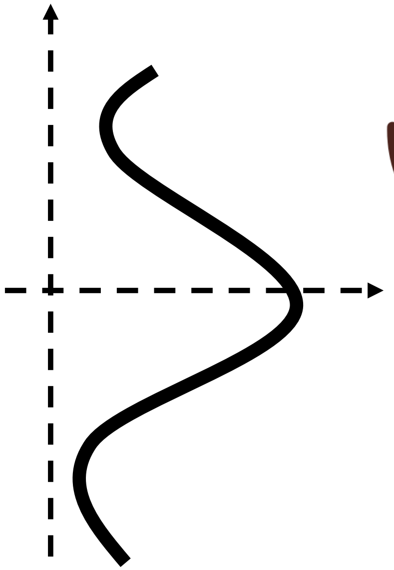
Where do models diverge?

Westerly wind forcing

The distribution of wind stress about the equator matters for ENSO

Fedorov 2010, Capatondi 2006, Wang 2000





Wider wind-stress anomaly

→ Stronger, lower frequency ENSO

Longer wind-stress anomaly → Weaker, higher frequency ENSO

ENSO in observations and models

Can the shape and characteristics of wind stress explain the projected changes in ENSO?

Increased SST variability

Changes to ENSO frequency?

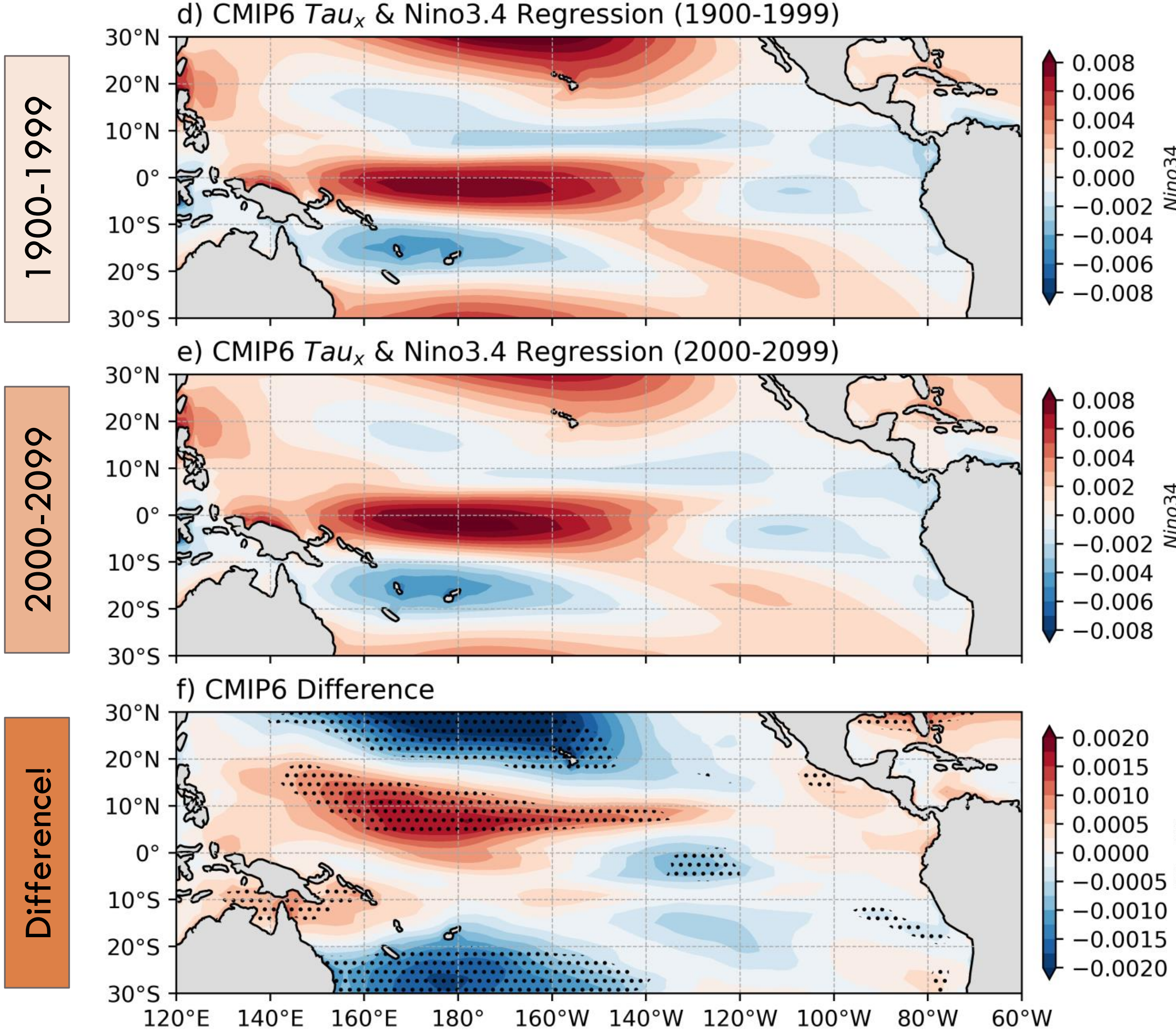
Changes to ENSO skewness?

Forced response

Multi-model ensemble mean of Niño 3.4 regression onto zonal wind stress anomalies

Asymmetric change (about the equator) of wind stress anomalies related to ENSO

CMIP6: Historical and SSP585



CMIP6

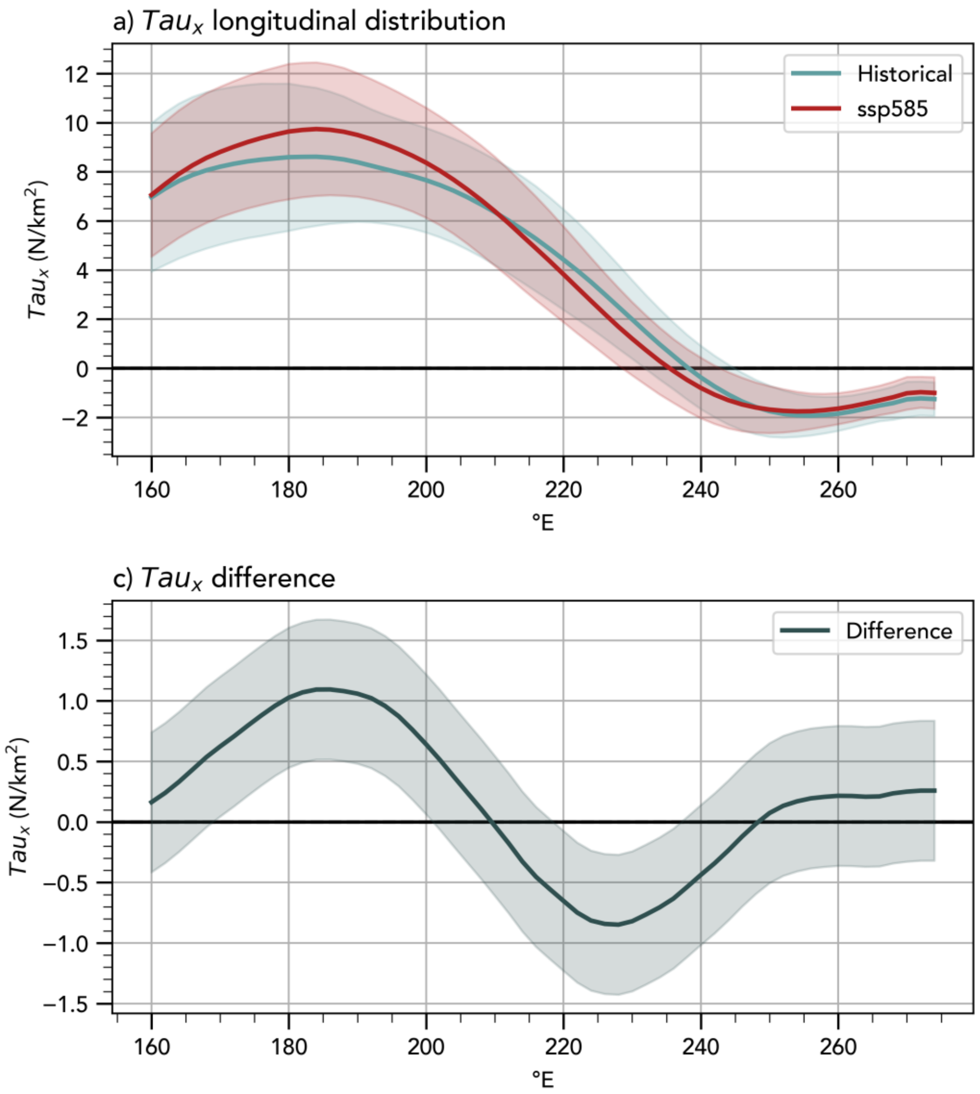
How to quantify the change in wind-stress structure?

Westward shift

Magnitude increase

Increased "width" across the equator

5°S-5°N Average across the pacific basin



Niño 4 lon average

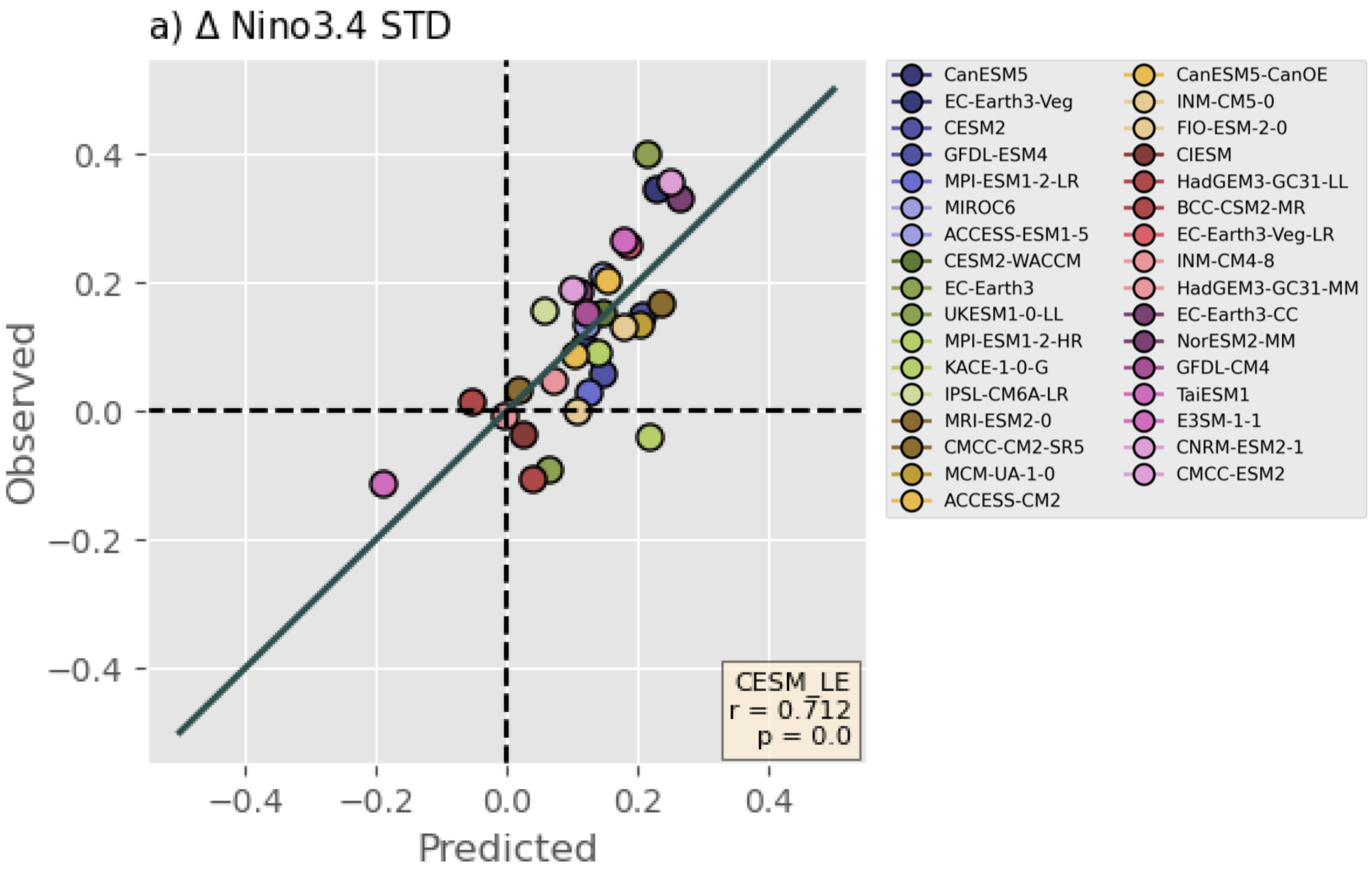
CMIP6

Across models, it seems to be important!

Westward shift

Magnitude increase

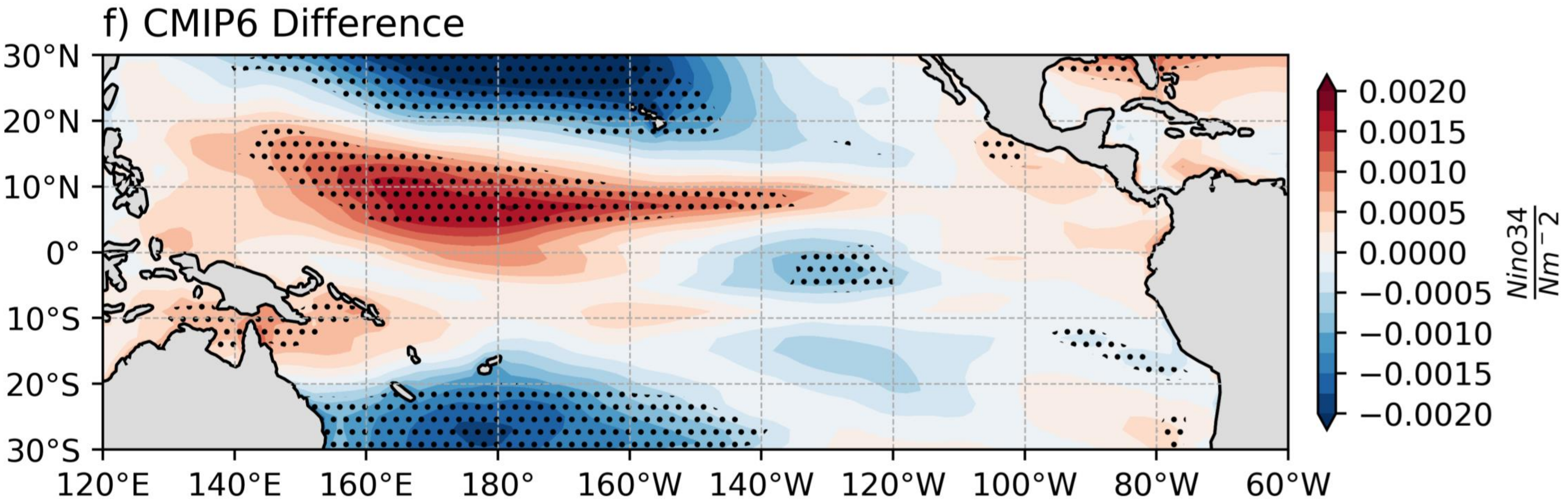
Increased “width” across the equator



CESM Workshop

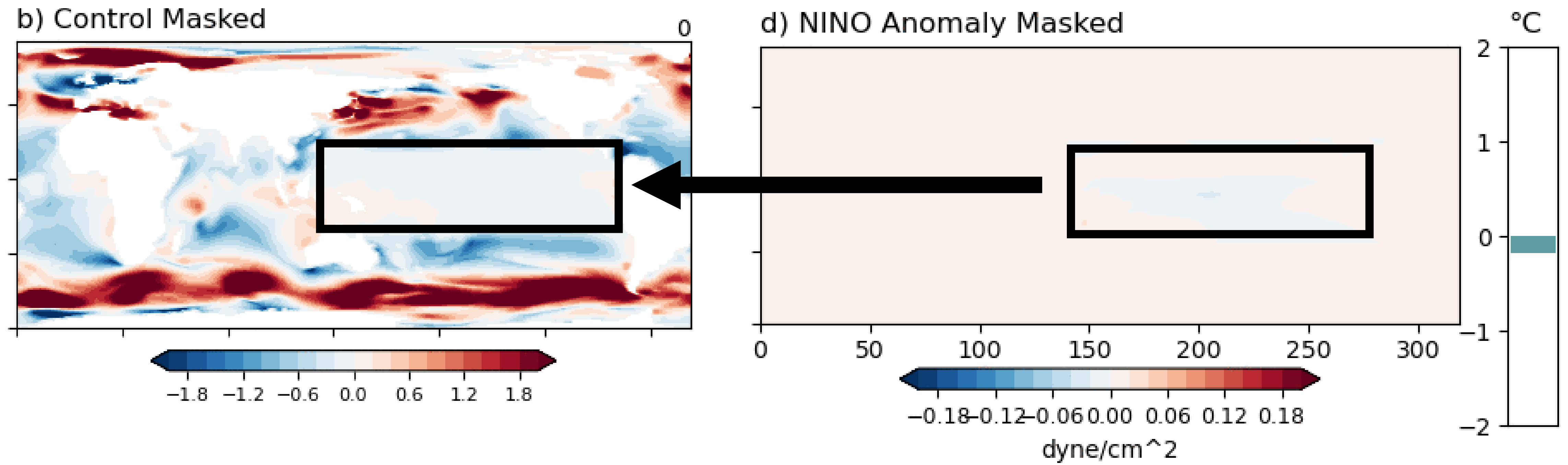
Can we simulate this?

If we add this change in the structure of wind stress to CESM, can we observe an increase in Niño 3.4 standard deviation?



Wind stress override

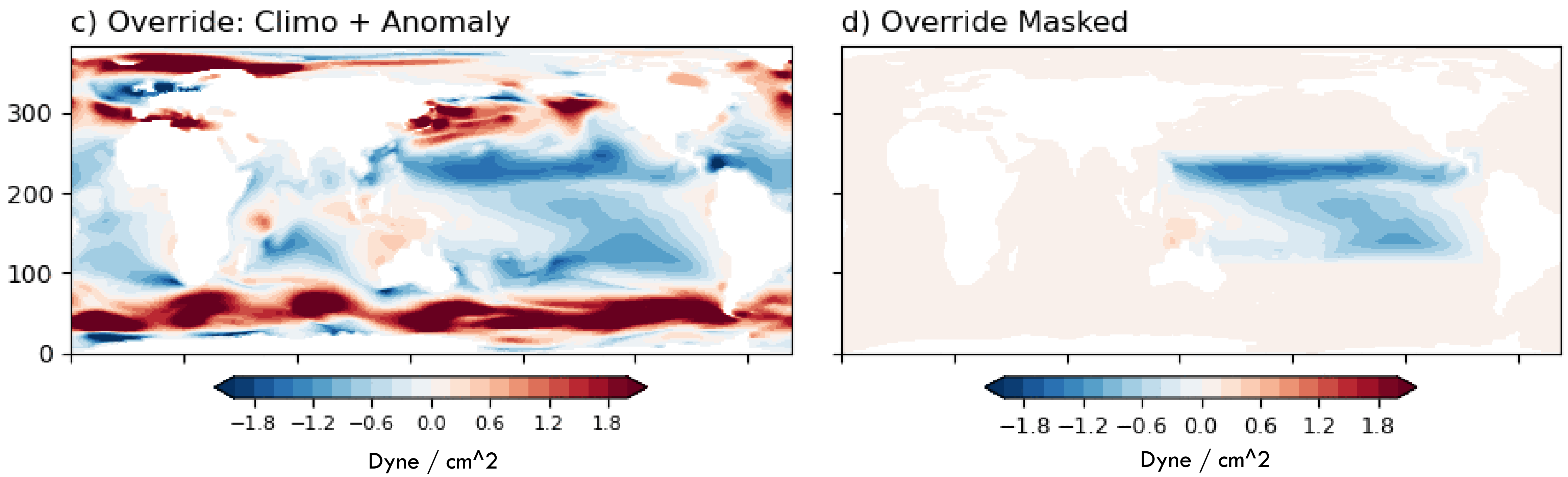
CESM2.1: B1850 branched from the piControl



Step 1:	Daily wind-stress values from control
Step 2:	Daily Niño 3.4 anomaly from control

Wind stress override

25°S through 25°N across the Pacific



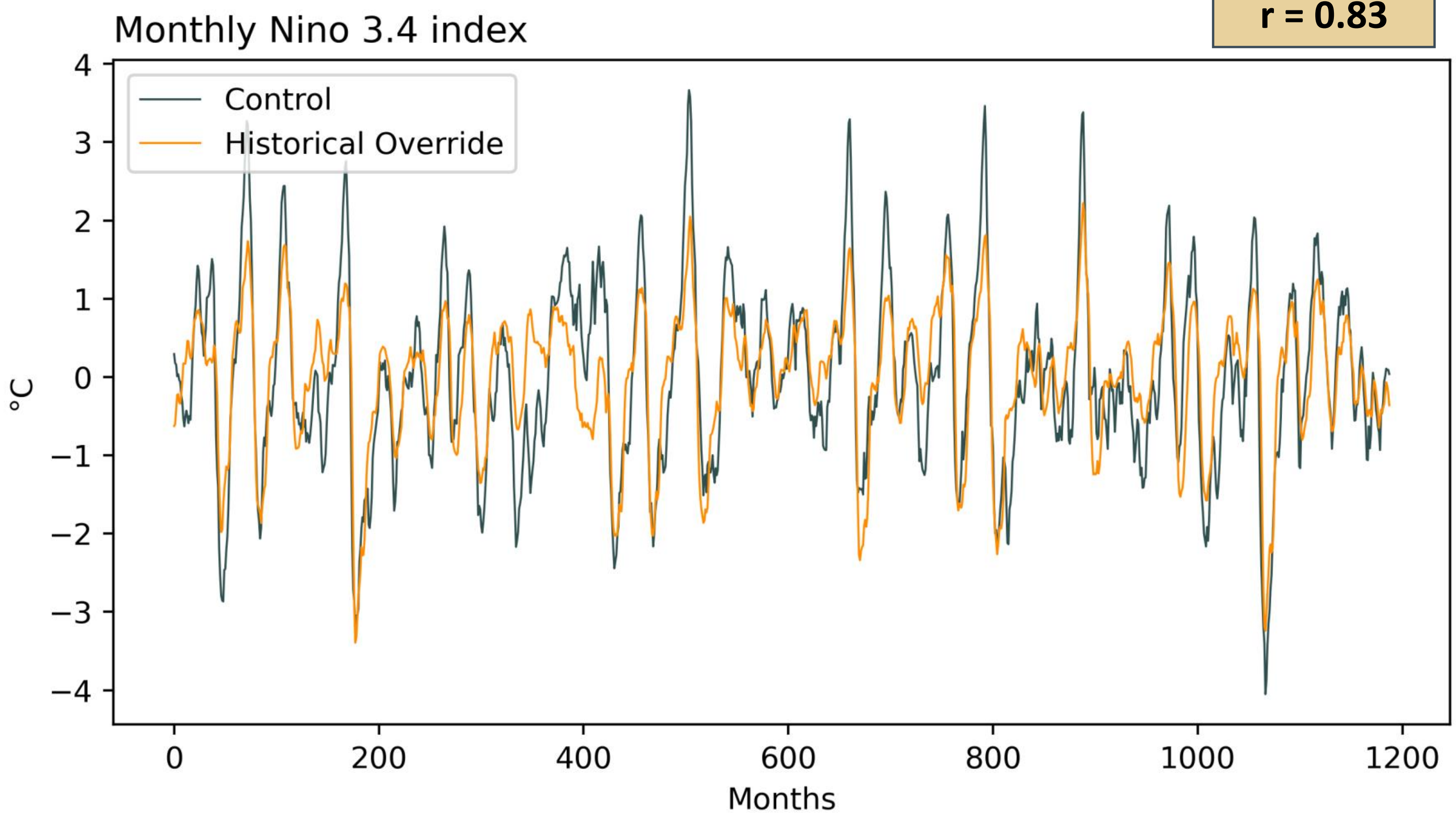
Step 1:	Daily wind-stress values from control
Step 2:	Daily Niño 3.4 anomaly from control
Step 3:	Climatology (tropics only)
Step 4:	Historical and SSP 585 override

Expectations

El Niño anomaly strength is reduced

The result: Two simulations of ENSO without marked differences in interannual variability.

r = 0.83

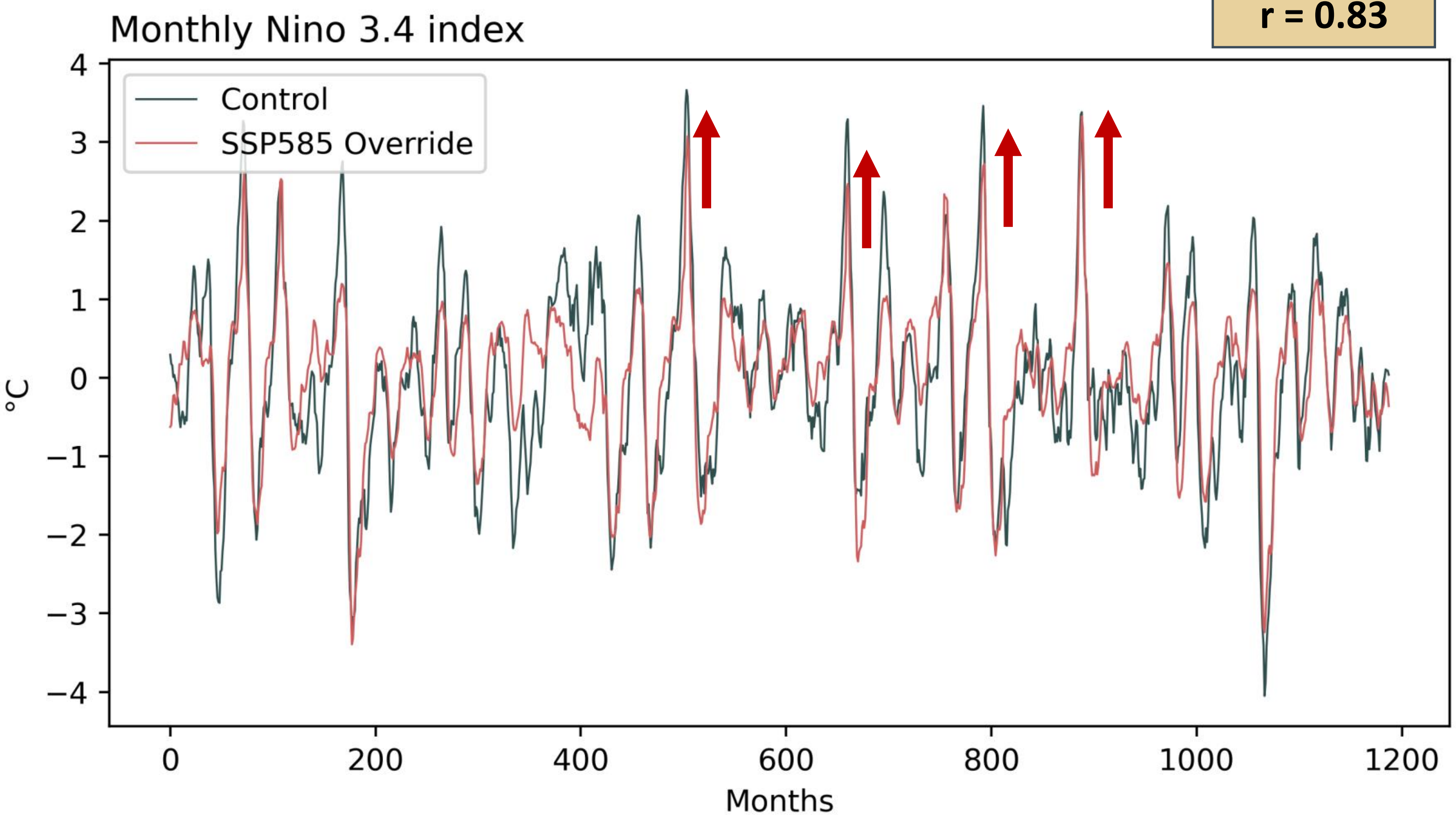


El Niño anomaly strength is reduced

CAUTION : NOT A RESULT

The expectation: ENSO standard deviation will be markedly higher from imposed wind-stress anomaly alone

r = 0.83



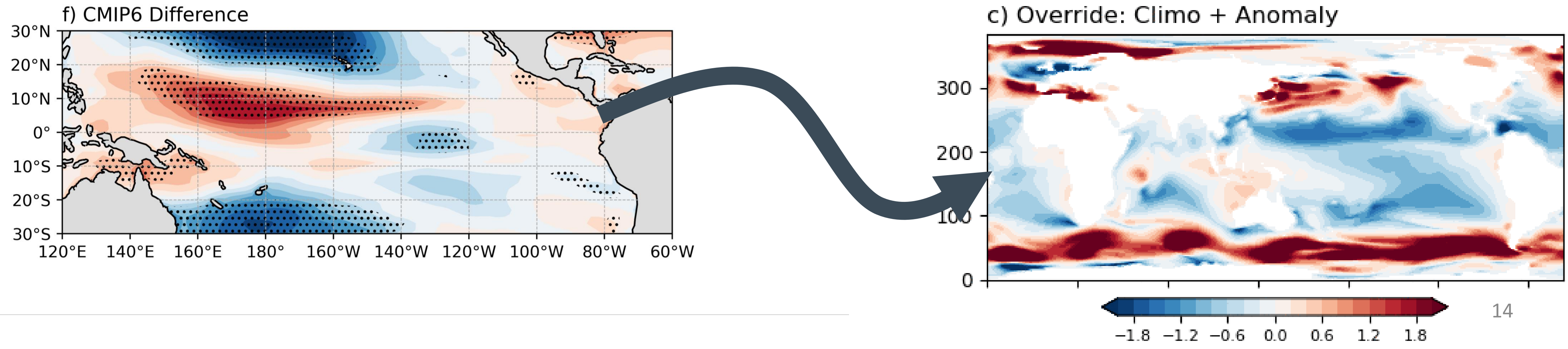
Conclusions and next steps

Expectations

The structure and shape of wind-stress can explain inter-model differences in ENSO statistics in CMIP6

CESM2 experiments will allow us to analyze this hypothesis without internal and model variability

Chugging along:



Thanks to NCAR/UCAR! Questions?