Future activation of an Indian Ocean El Niño in the High Resolution CESM

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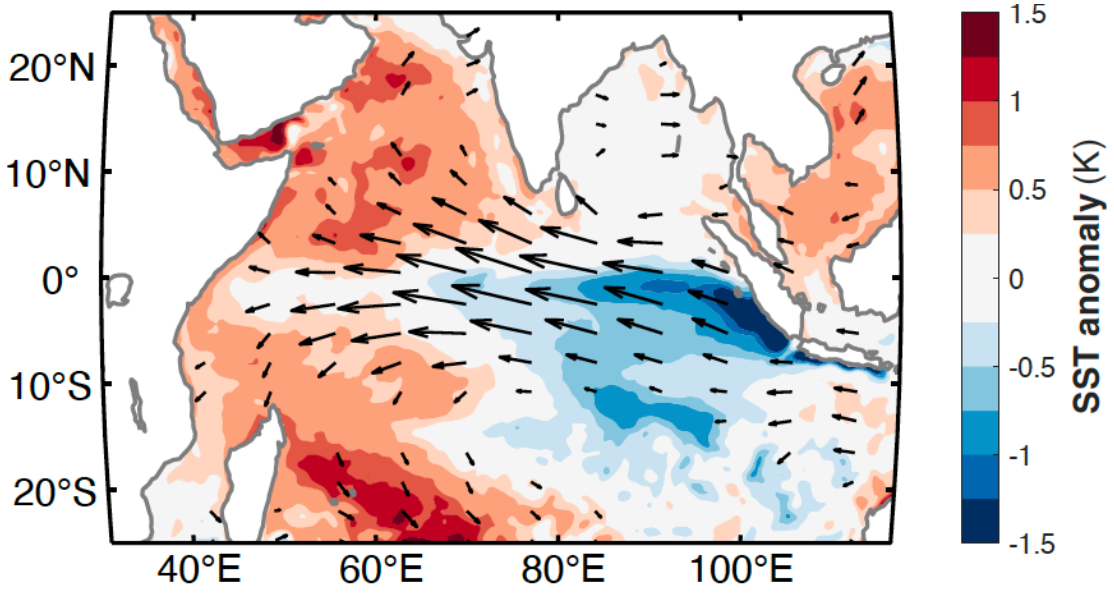
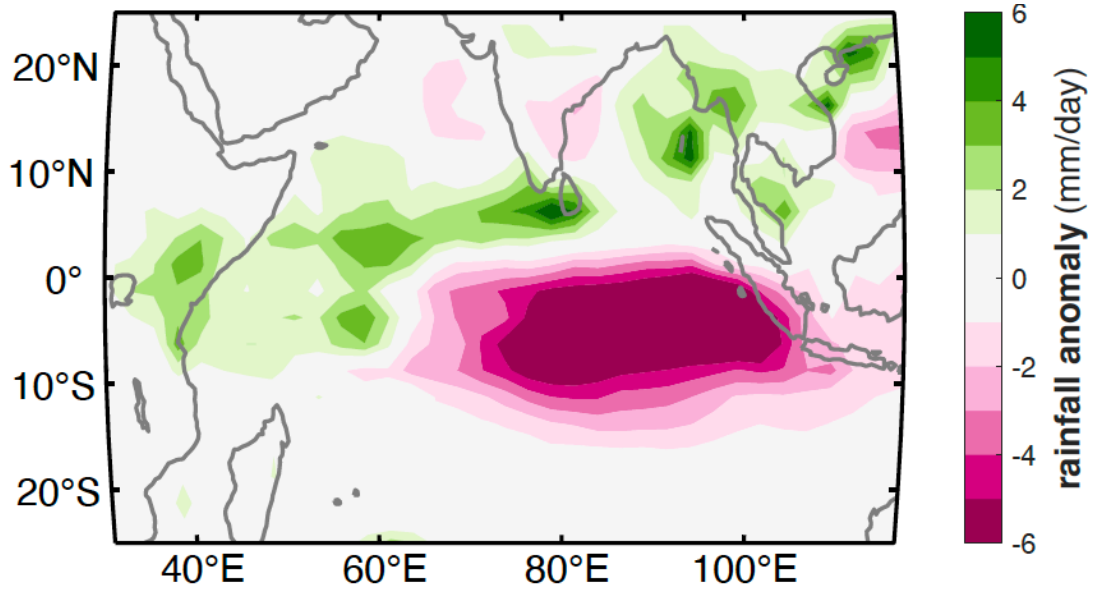
Record breaking cooling pattern in the Indian Ocean during SON 2023



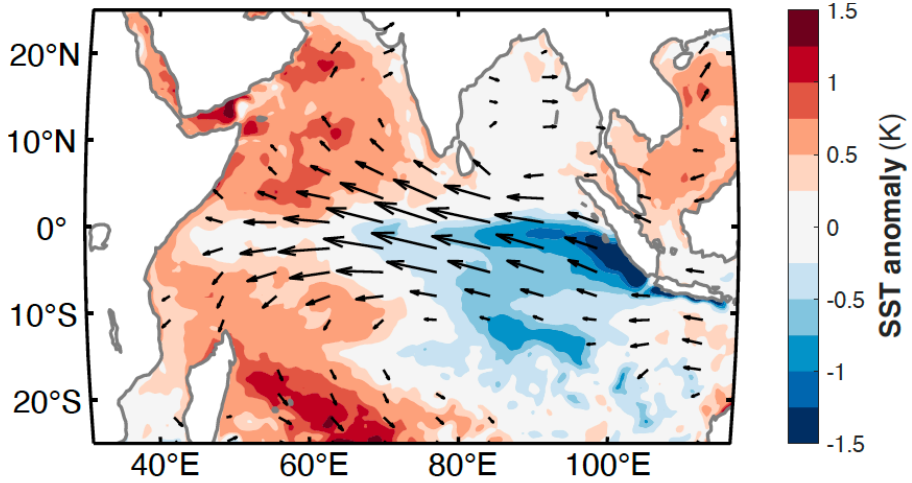
OISST (25 km resolution)
ERA5 surface winds (850 hPa)

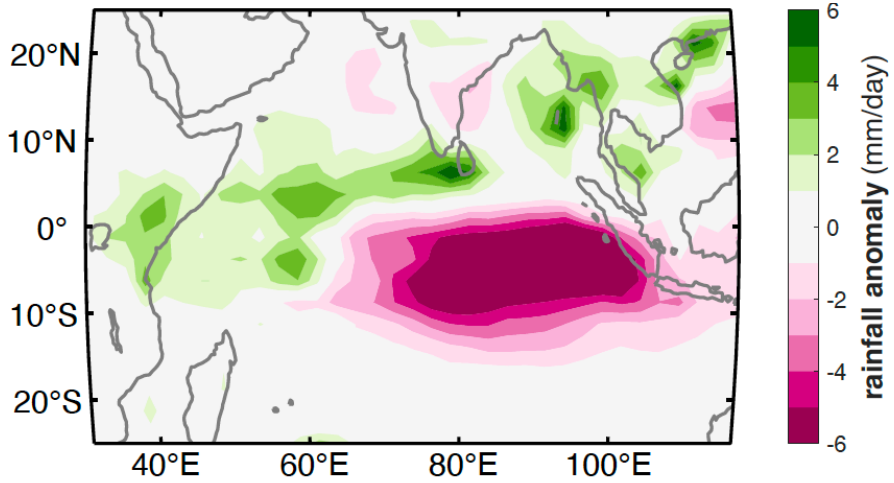


GPCP v2.3 precip.

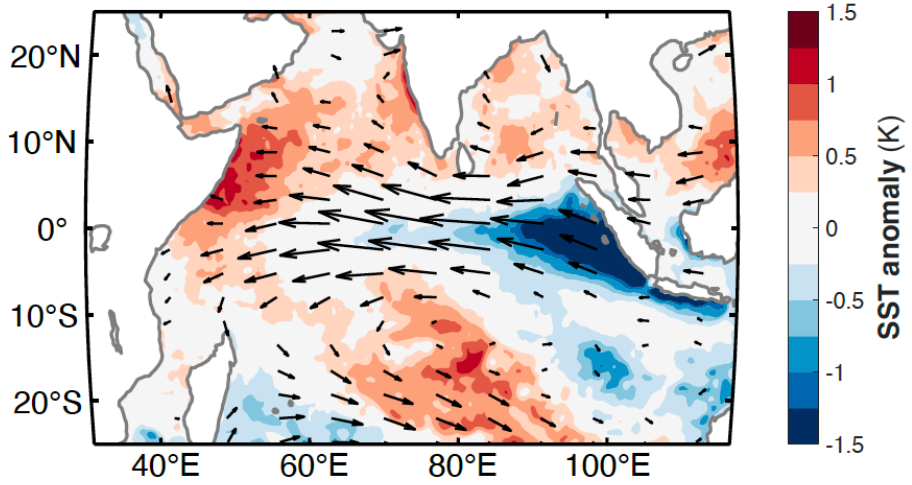
Very rare events, only 2 occurred in the last 40 years

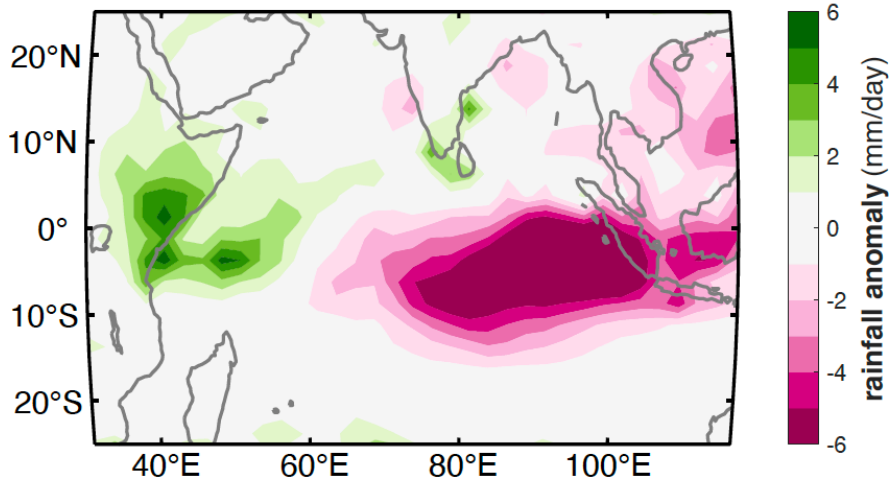
SON 2023





SON 1997

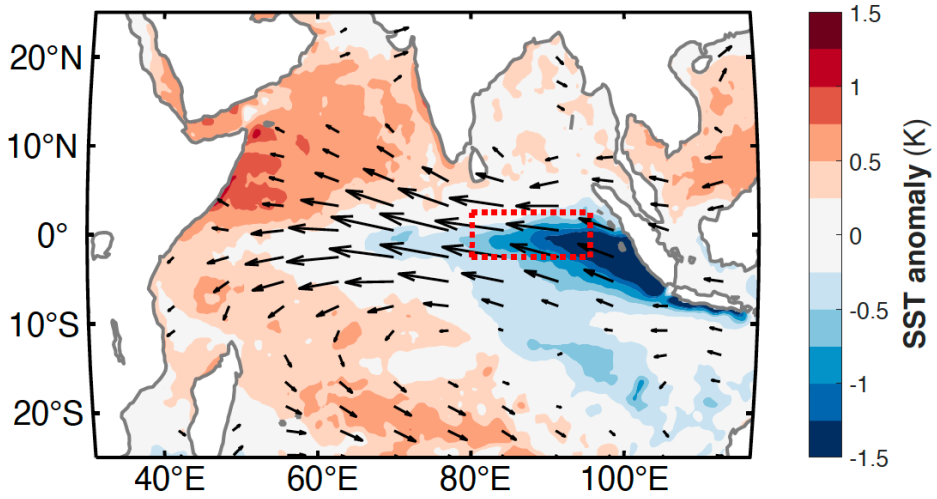


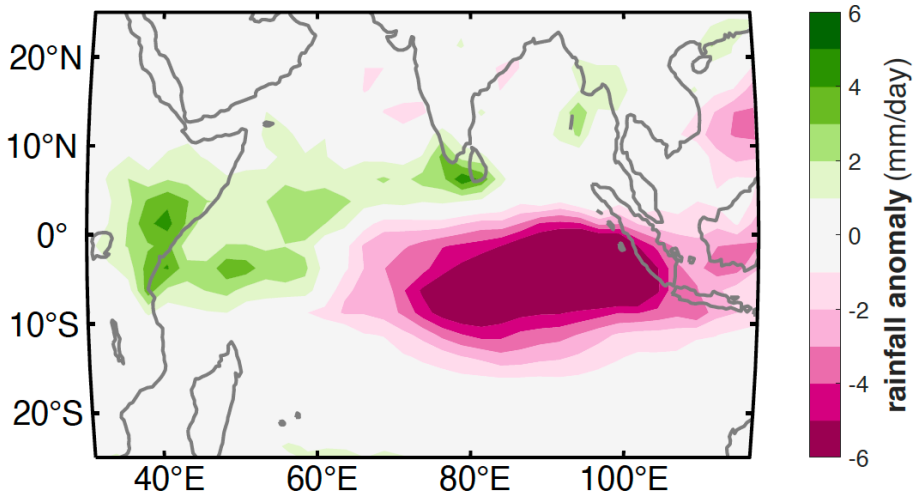


Two types of “dipole” events in the Indian Ocean

Equatorial / Basin wide

composite of
2 events since 1982
3σ events





Was the 2023 event a result of climate change?

Emergence of an equatorial mode of climate variability in the Indian Ocean

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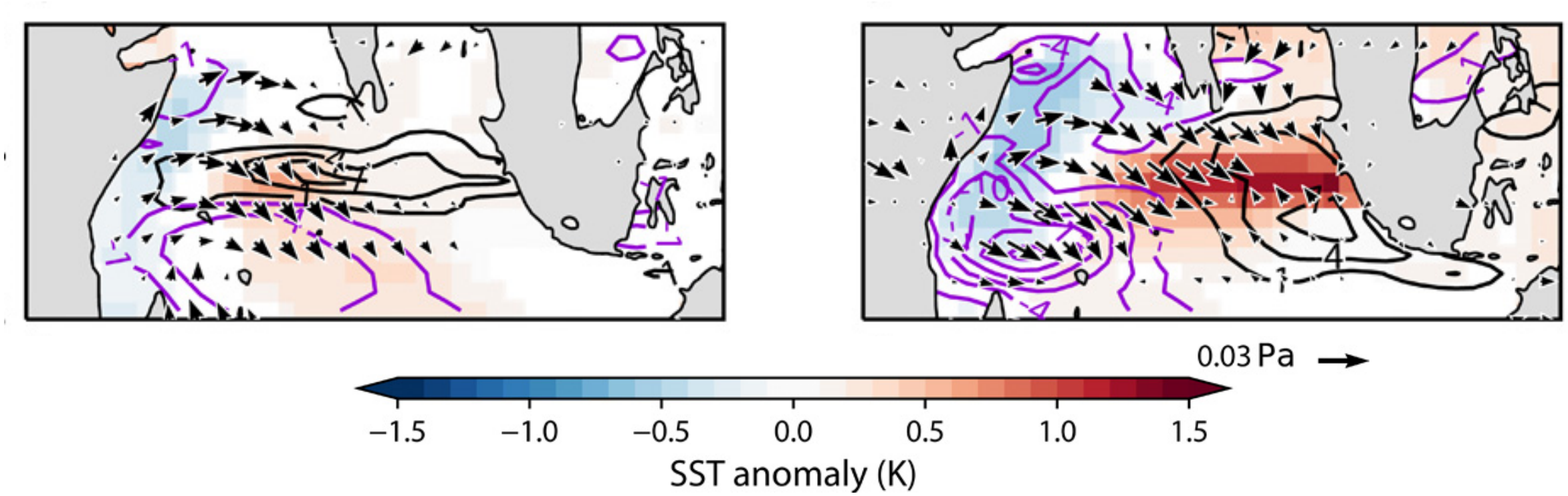
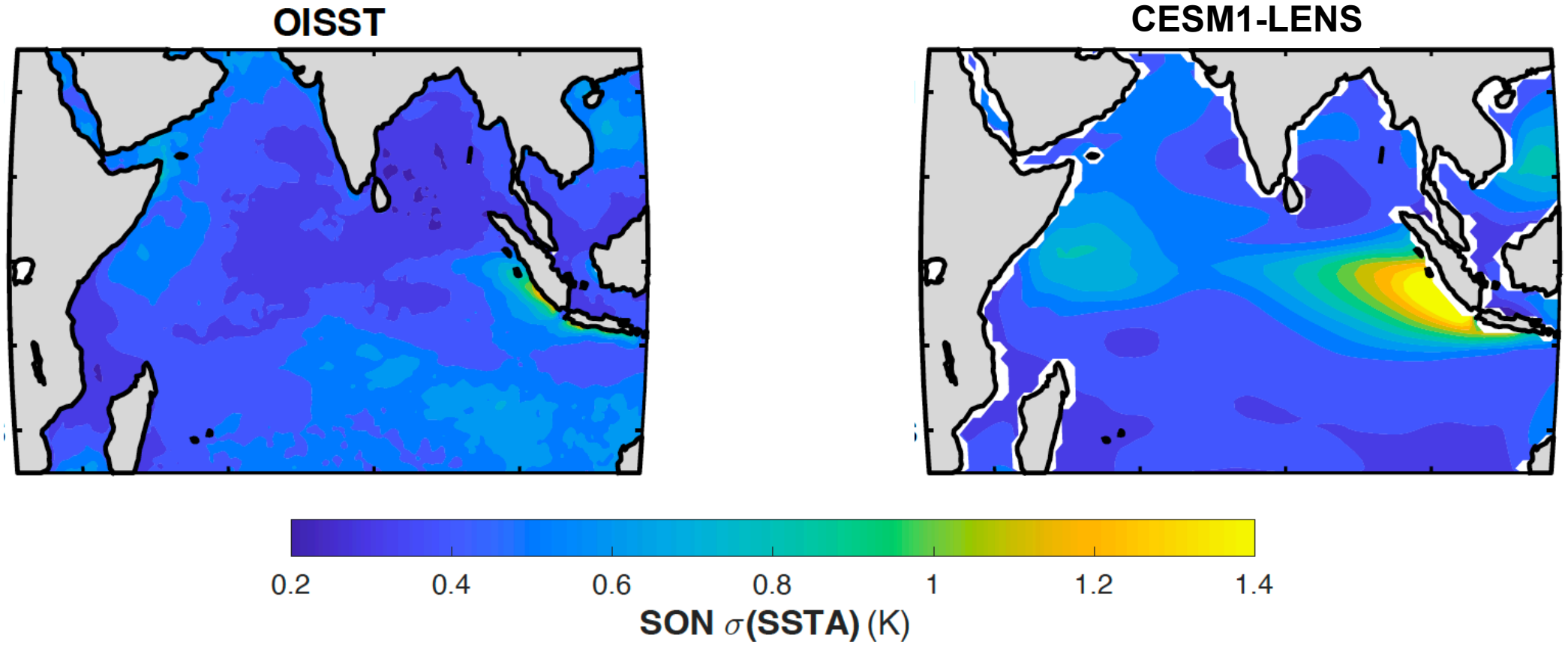
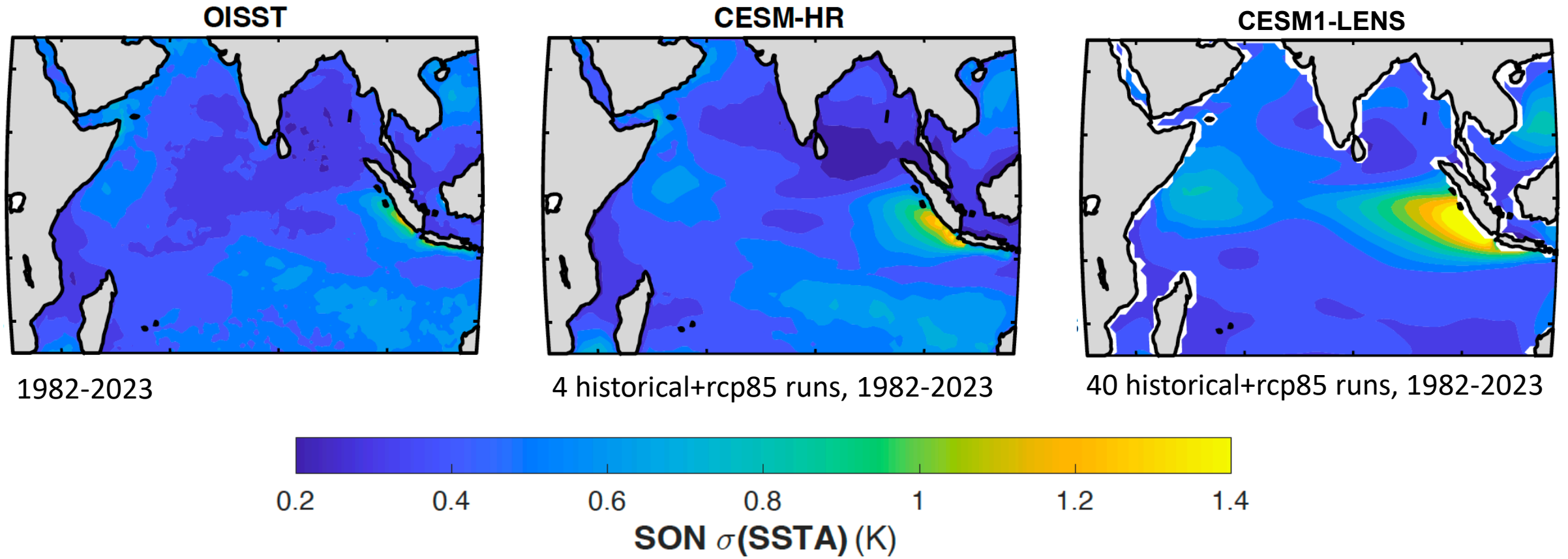


Is the activation of the equatorial mode an artifact of an overly active IO in models?



CMIP-class models simulate too strong variability

CESM-HR simulates more realistic levels of variability



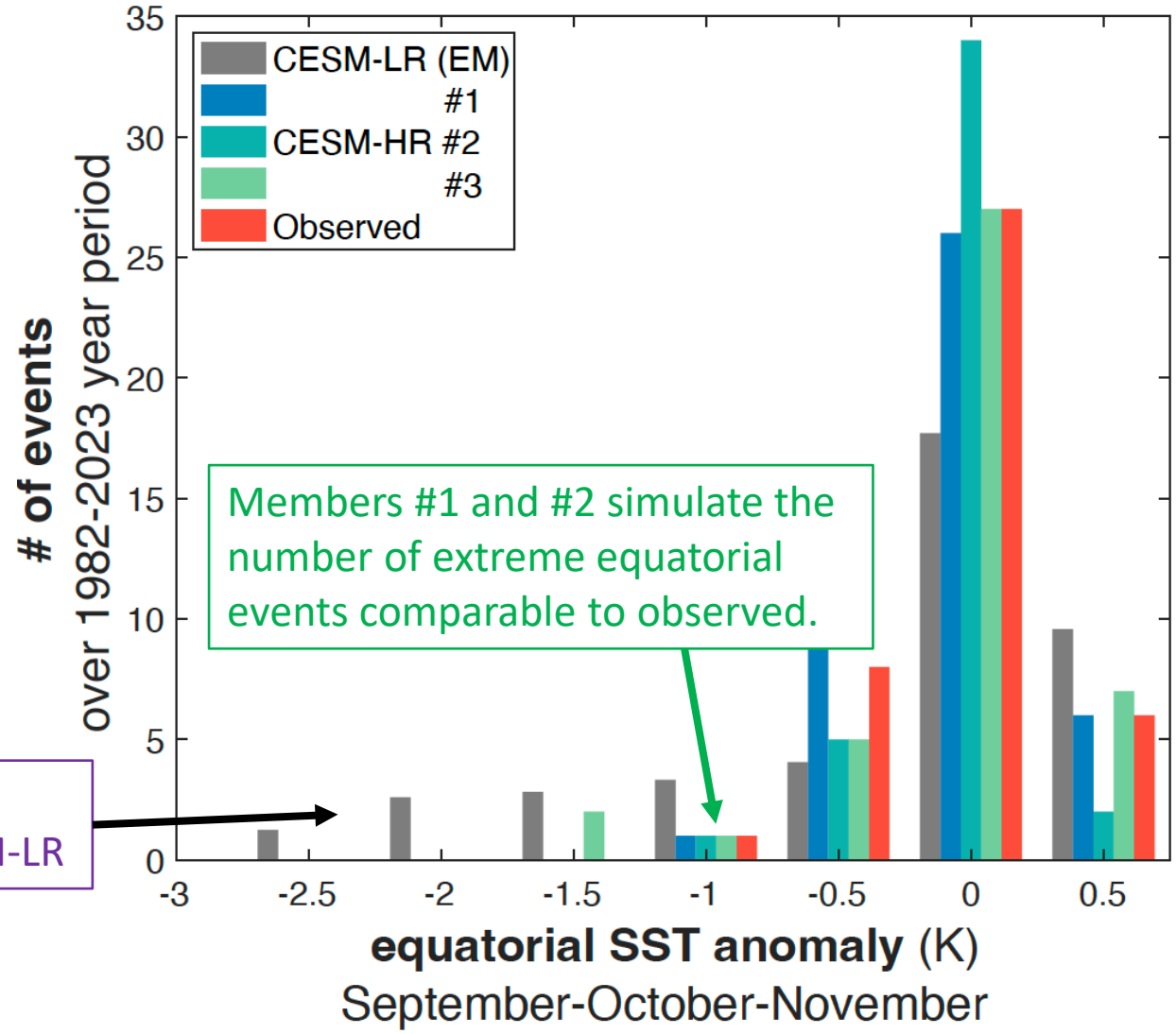
1982-2023

4 historical+rcp85 runs, 1982-2023

40 historical+rcp85 runs, 1982-2023

Improvement due to more narrow, realistic coastal upwelling

CESM-HR simulates equatorial events with realistic amplitude and frequency

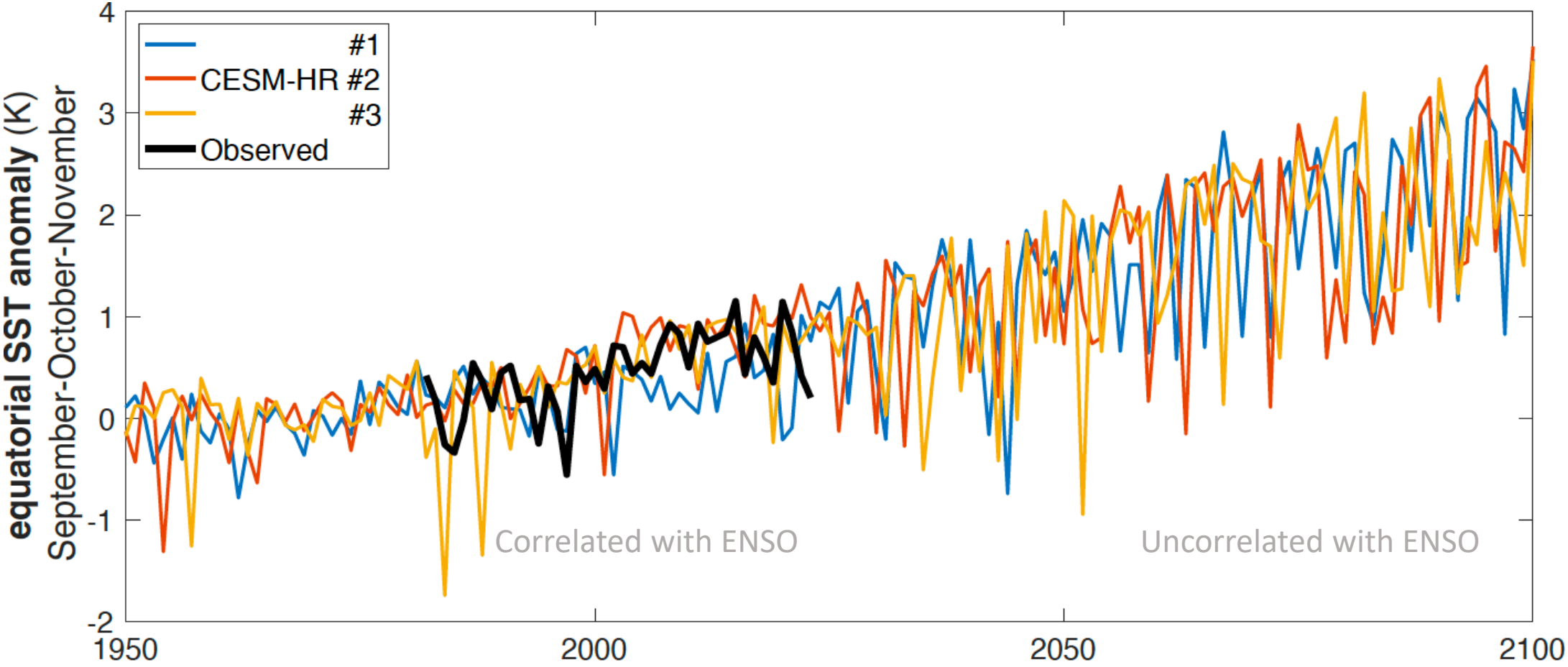


Too many, too strong equatorial events in CESM-LR

Members #1 and #2 simulate the number of extreme equatorial events comparable to observed.

The distribution for member #1 (blue) is identical to the distribution of observed variability (red).

CESM-HR predicts an increase in frequency of equatorial events



Conclusions

- **Increasing horizontal resolution in CESM1 improves simulation of IO climate variability:**
  - Realistic frequency and amplitude of equatorial events.
- **High resolution CESM1 predicts large increase in climate variability in the IO:**
  - Active by mid-century under high emission scenario,
  - Increasing frequency of rainfall extremes in teleconnected regions.