

# Inability of Tropical Pacific Temperature Gradients in Explaining Observed TOA Radiation Trends

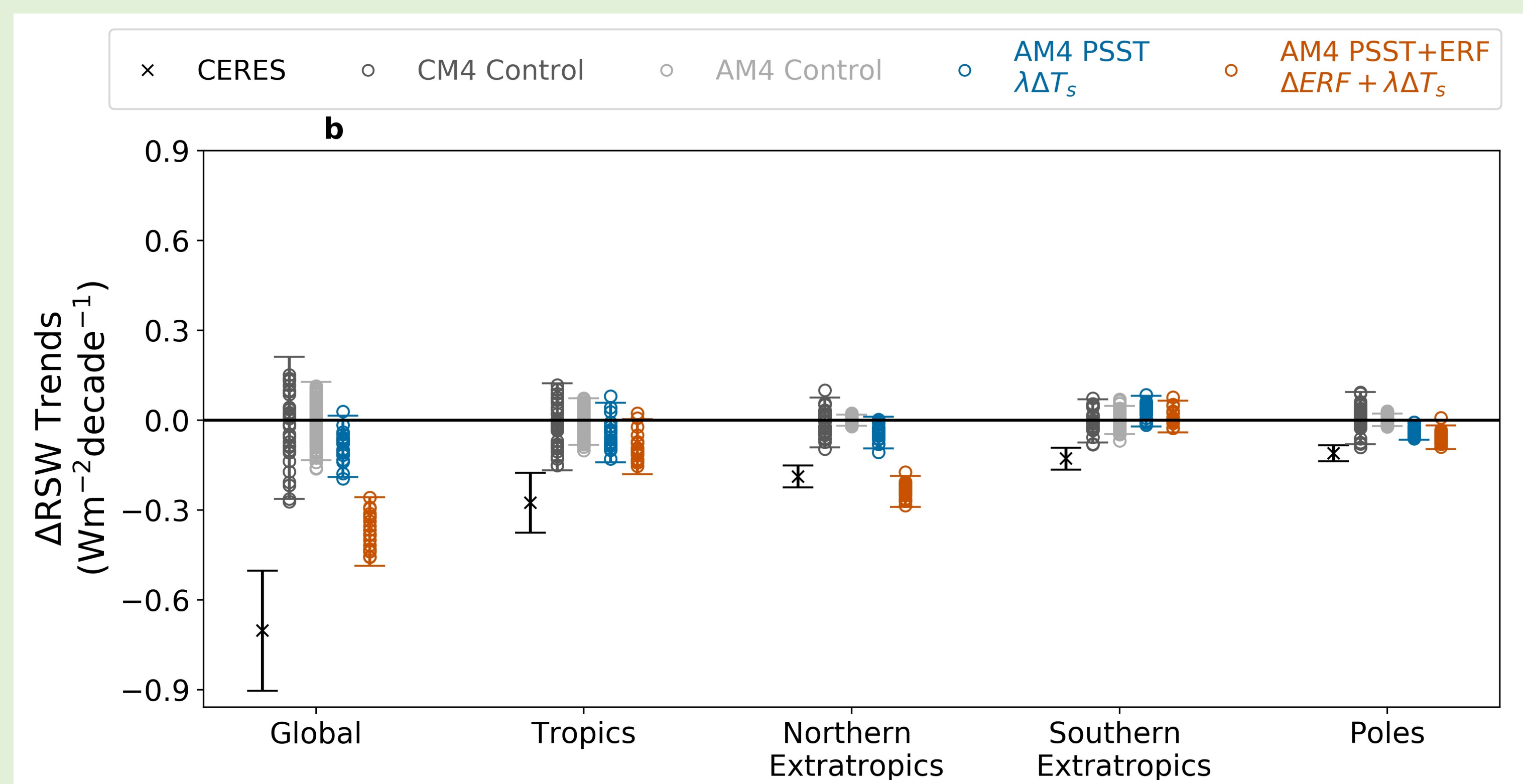
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## Can East-West SST gradients in the tropical Pacific explain recent TOA radiation trends?

### Motivation

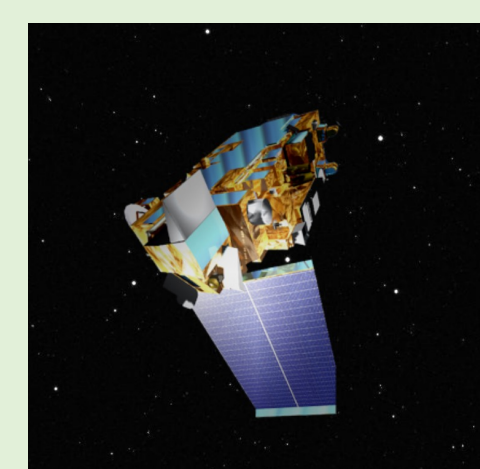
Observations show a large decrease in tropical reflection of sunlight in the 21<sup>st</sup> century (negative trend). Why?



### Method

#### Radiative response

- AM4 PSST: Prescribed observed SSTs and sea-ice (AMIP)
- 2001–2020, 20 realizations, fixed forcing



CERES EBAF  
satellite  
observations

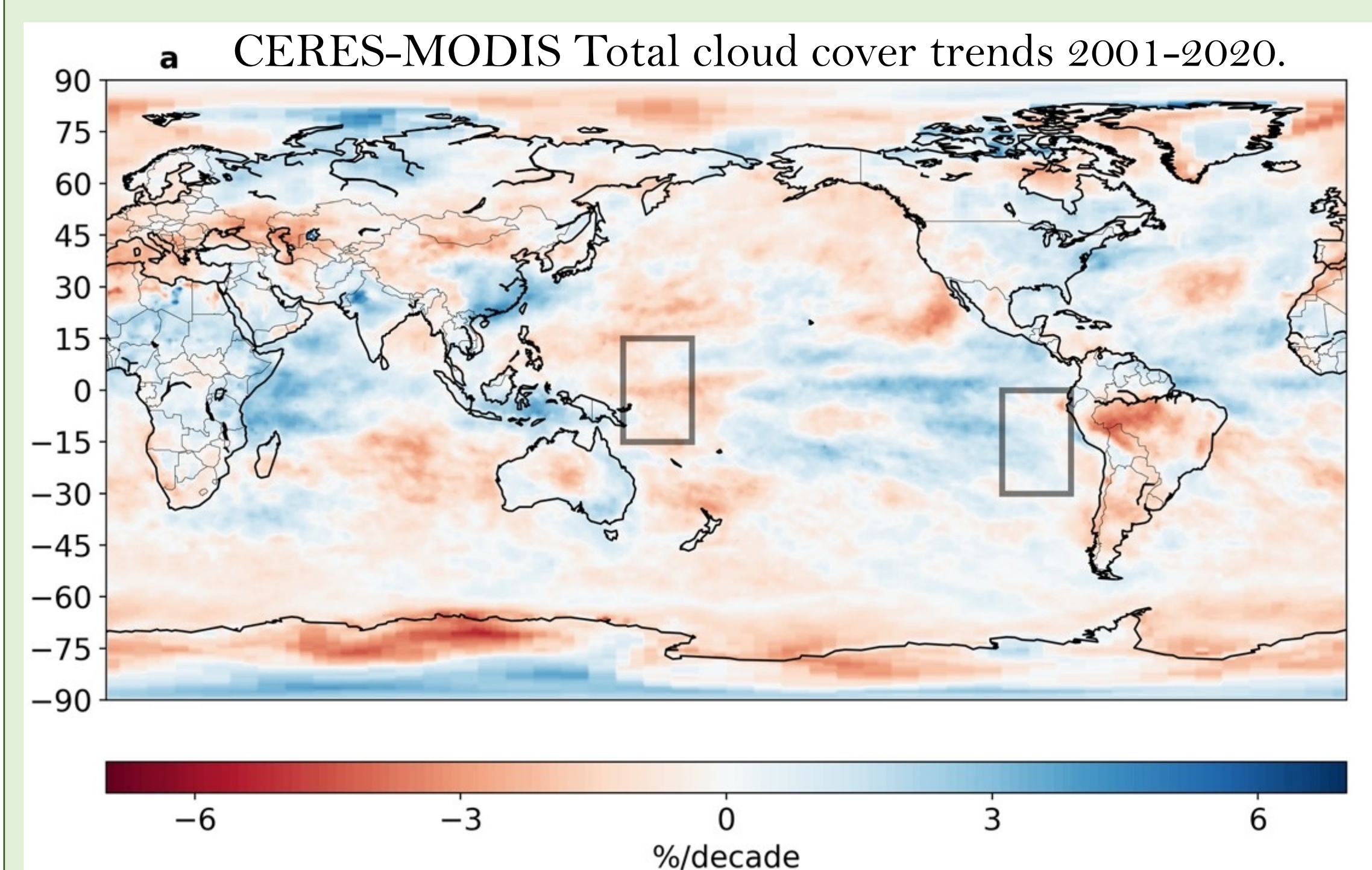
$$\Delta R = \Delta ERF + \lambda \Delta T_s + \epsilon$$

Effective Radiative Forcing

- AM4
- 2001–2020 Forcing

Internal variability

- AM4 Control, 100 realizations
- CM4 Control, 32 realizations
- Pre-industrial Forcing



West Pacific and East Pacific boxes are based on Andrews & Webb, 2018 metric. Results are insensitive to a different metric (Burls & Fedorov, 2014)

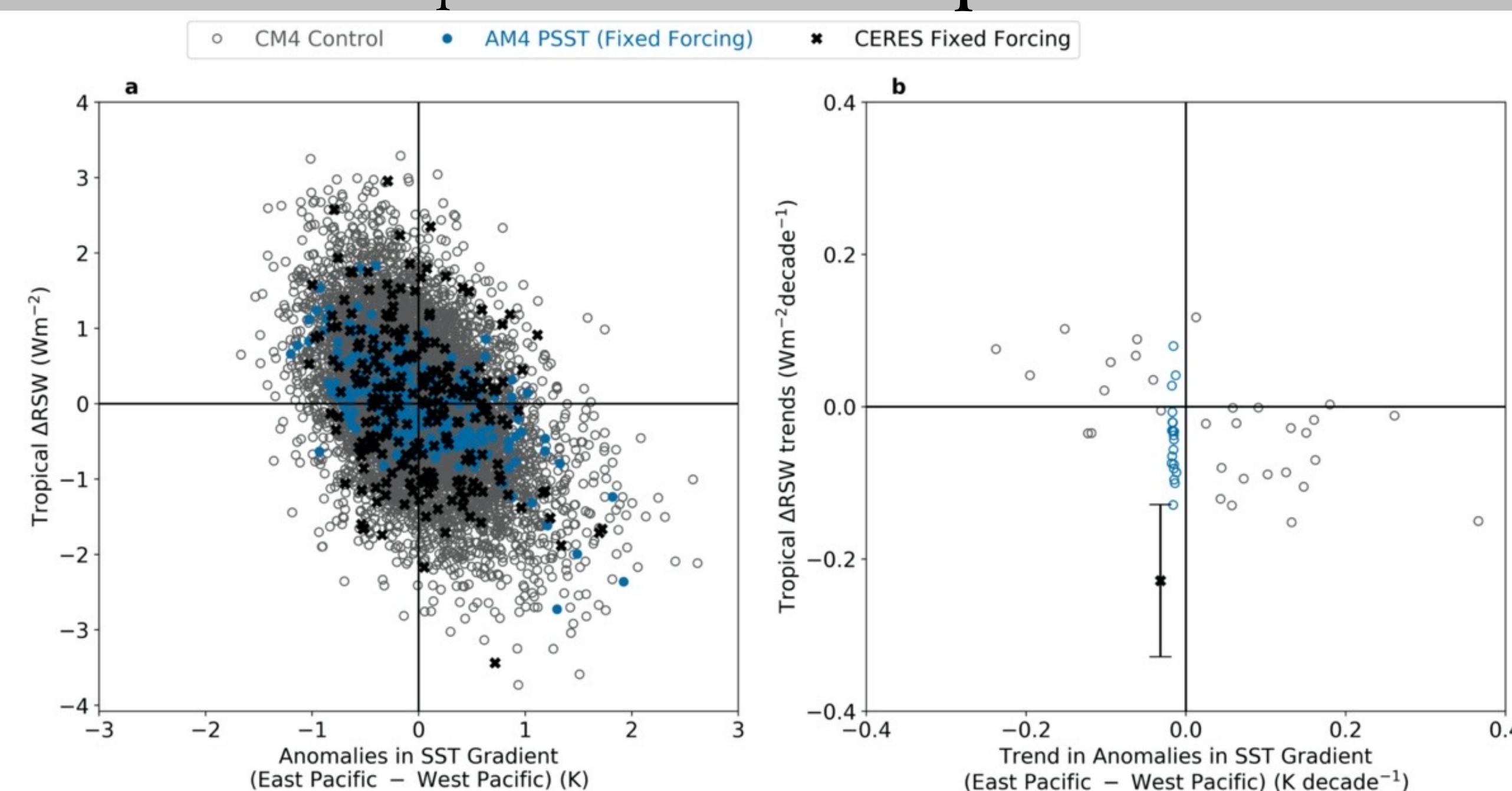
### References

Raghuraman, Shiv Priyam, David Paynter, and V. Ramaswamy. "Anthropogenic forcing and response yield observed positive trend in Earth's energy imbalance." *Nature Communications* 12.1 (2021): 1–10.  
Raghuraman, Shiv Priyam, David Paynter, Raymond Menzel, and V. Ramaswamy. "Forcing, feedbacks, cloud-masking, and internal variability in the cloud radiative effect satellite record." Under Review.

## Large trends in TOA radiation in spite of neutral warming pattern trend

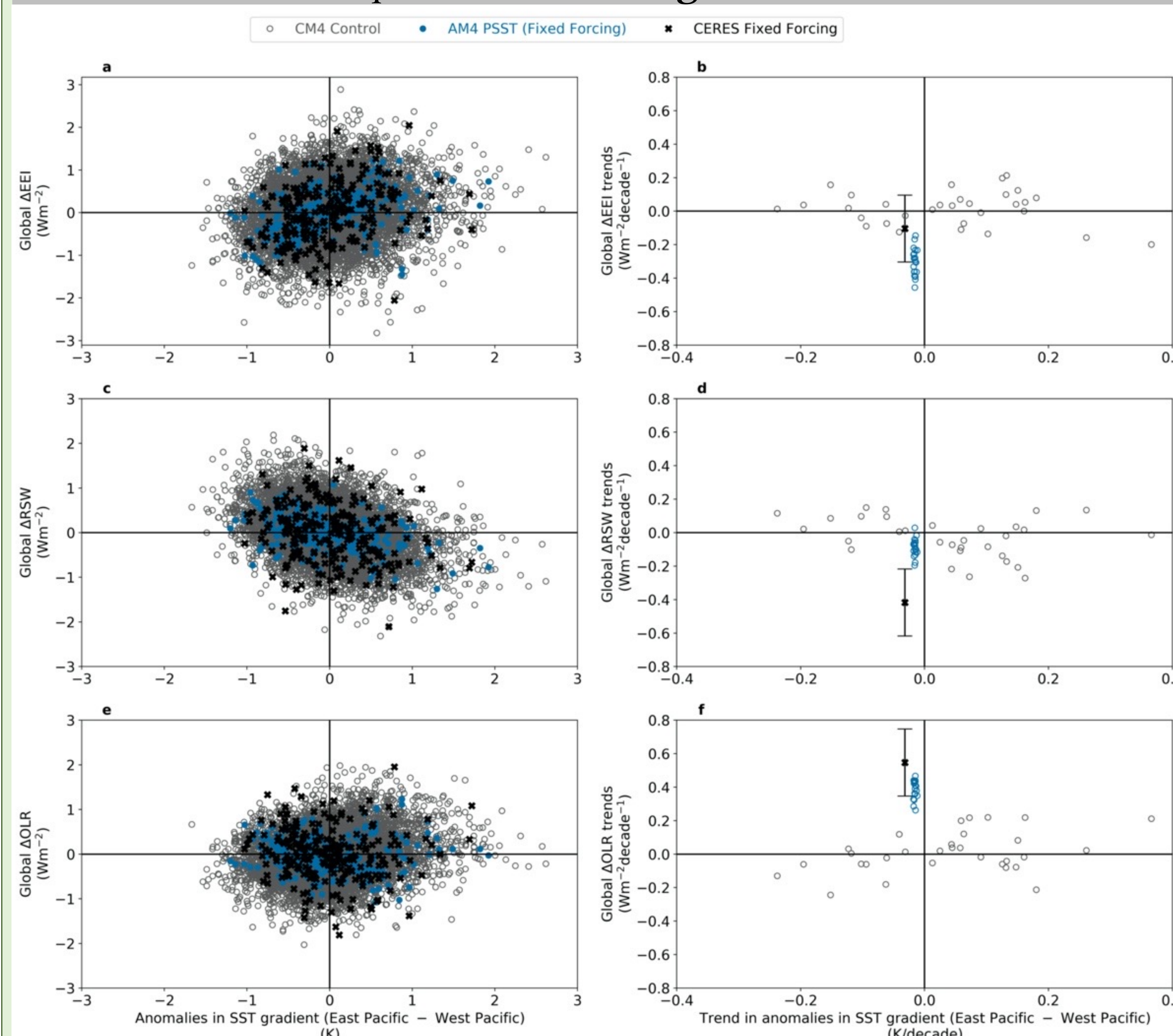
### Results

#### Influence of pattern effect on **tropical** SW radiation

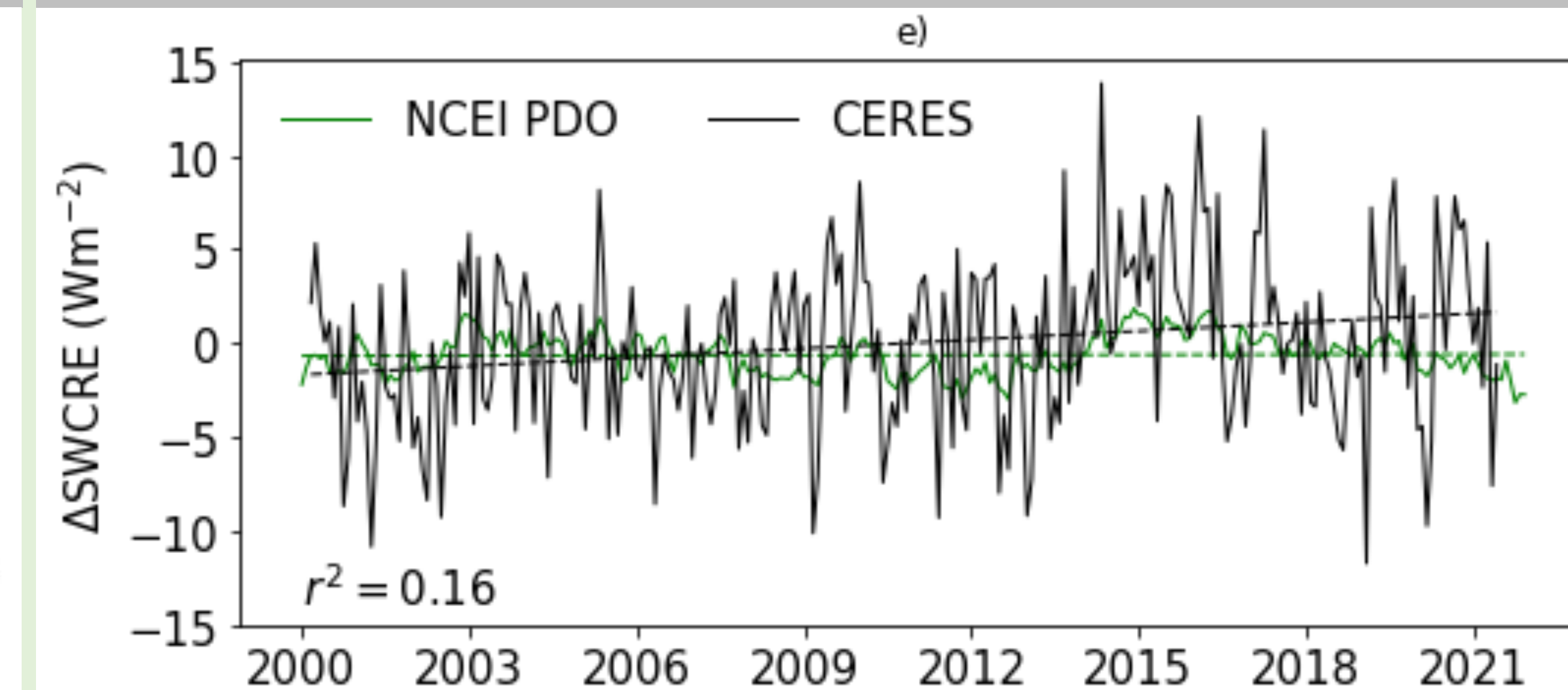


- Tropical RSW decreases as the East Pacific warms more than the West on a monthly-interannual basis, as predicted by the pattern effect hypothesis.
- At decadal timescales there is a neutral warming pattern yet there is a large decrease in RSW, contrary to the hypothesis.
- Atmospheric noise: Large range of tropical RSW trends despite giving the model the same AMIP SST pattern in each realization (contains ENSO, E-W SST, PDO, etc.).

#### Influence of pattern effect on **global** Net, SW, LW



#### Little influence of PDO on Northeast Pacific SWCRE



- Tropical RSW's relation to the E-W SST gradient continues to hold at the global-scale.
- Global and tropical OLR increases as the East Pacific warms more than the West on monthly-interannual timescales, contrary to the pattern effect hypothesis. At decadal timescales there is a neutral warming pattern yet there is a large increase in OLR.
- Northeast Pacific: 1) PDO index and CERES SWCRE are poorly correlated and 2) PDO index's trend is flat while SWCRE's is strongly positive.

### Conclusions and Discussion

- Large decadal decrease in tropical reflection of sunlight is partly due to an underlying SST pattern trend, but it cannot be explained by existing tropical pattern effect theories nor the PDO. Furthermore, although an SST pattern led to decreased reflection, atmospheric stochasticity makes its exact magnitude uncertain.
- On monthly-interannual timescales RSW decreases and OLR increases as the East Pacific warms more than the West. The observed and modeled SW changes are consistent with the pattern effect hypothesis while it is opposite to the hypothesis in the LW.
- Future work needs to address: 1) Why the 2001–2020 SST warming pattern caused tropical RSW to decrease. 2) Why observations have a larger negative trend in RSW than the model for the same SST pattern trend. Is the model underestimating forcing or the response to the underlying SST pattern?