



# Alternative historical realizations of tropical sea surface temperature and their influence on regional and global climate

Flavio Lehner<sup>\*1,2</sup>, Yan-Ning Kuo<sup>1</sup>, Adam Phillips<sup>2</sup>, Matt Newman<sup>3,4</sup>, Sang-Ik Shin<sup>3,4</sup>, Clara Deser<sup>2</sup>, Isla Simpson<sup>2</sup>



<sup>1</sup>Department of Earth and Atmospheric Sciences, Cornell University, Ithaca, USA <sup>2</sup>Climate and Global Dynamics Laboratory, National Center for Atmospheric Research, Boulder, USA

<sup>\*</sup>[flavio.lehner@cornell.edu](mailto:flavio.lehner@cornell.edu)

<sup>3</sup>CIRES, University of Colorado Boulder, Boulder, USA <sup>4</sup>NOAA Physical Sciences Laboratory, Boulder, USA

## Synopsis

### Issue:

- We can study the pattern effect using AMIP simulations with observed SSTs, but this represents just one of many possible historical SST realizations.
- Large ensembles (LEs) with coupled models offer many realizations but can contain SST biases in trend and variability.

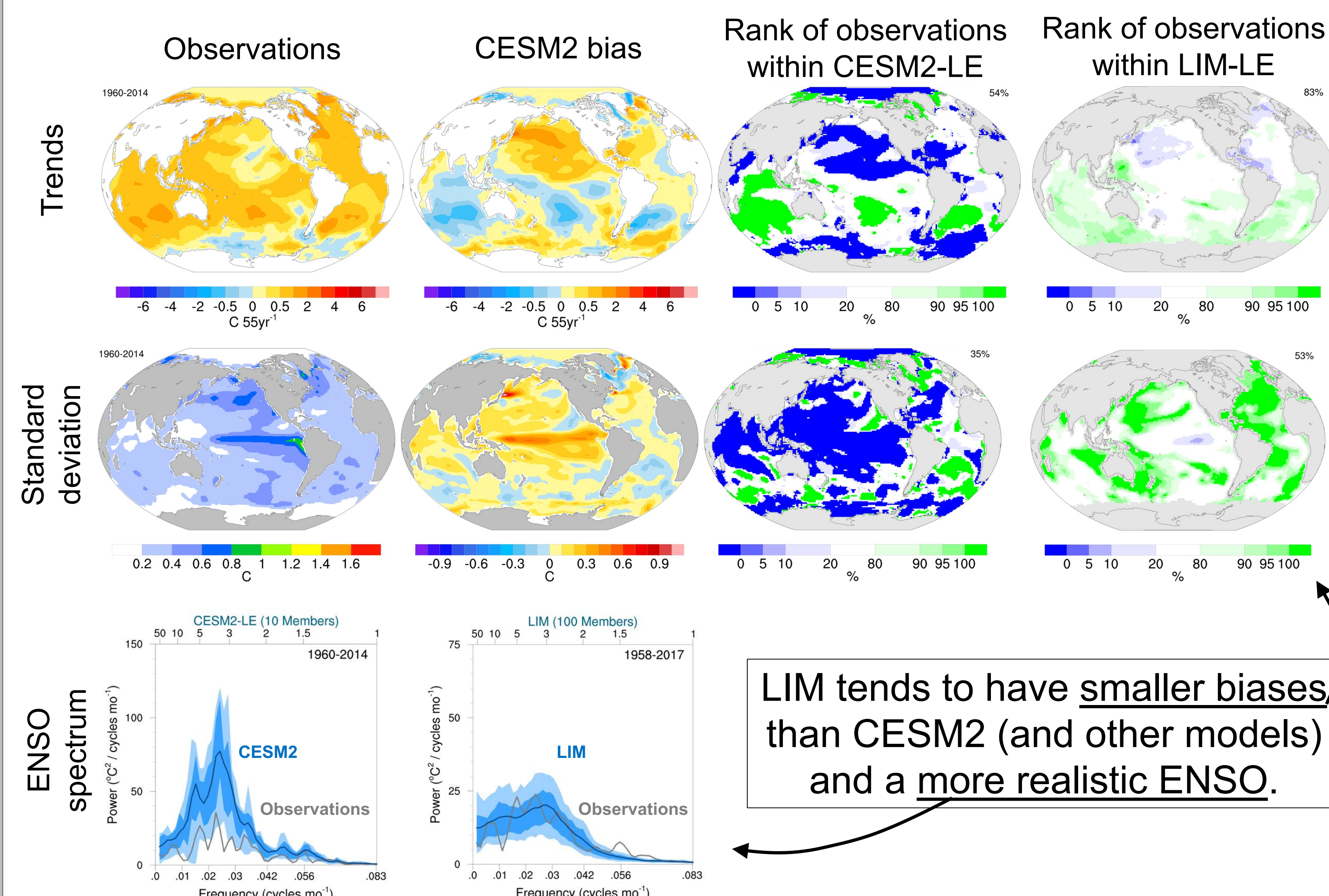
### Approach:

- CAM6 simulations with synthetic but realistic SSTs generated by a **Linear Inverse Model (LIM-LE)** trained on observations (ERSSTv5).
- We chose end members in terms of long-term trends in Nino3.4 from the LIM-LE and conduct 10-member CAM6 ensembles with a TOGA setup.

### Results:

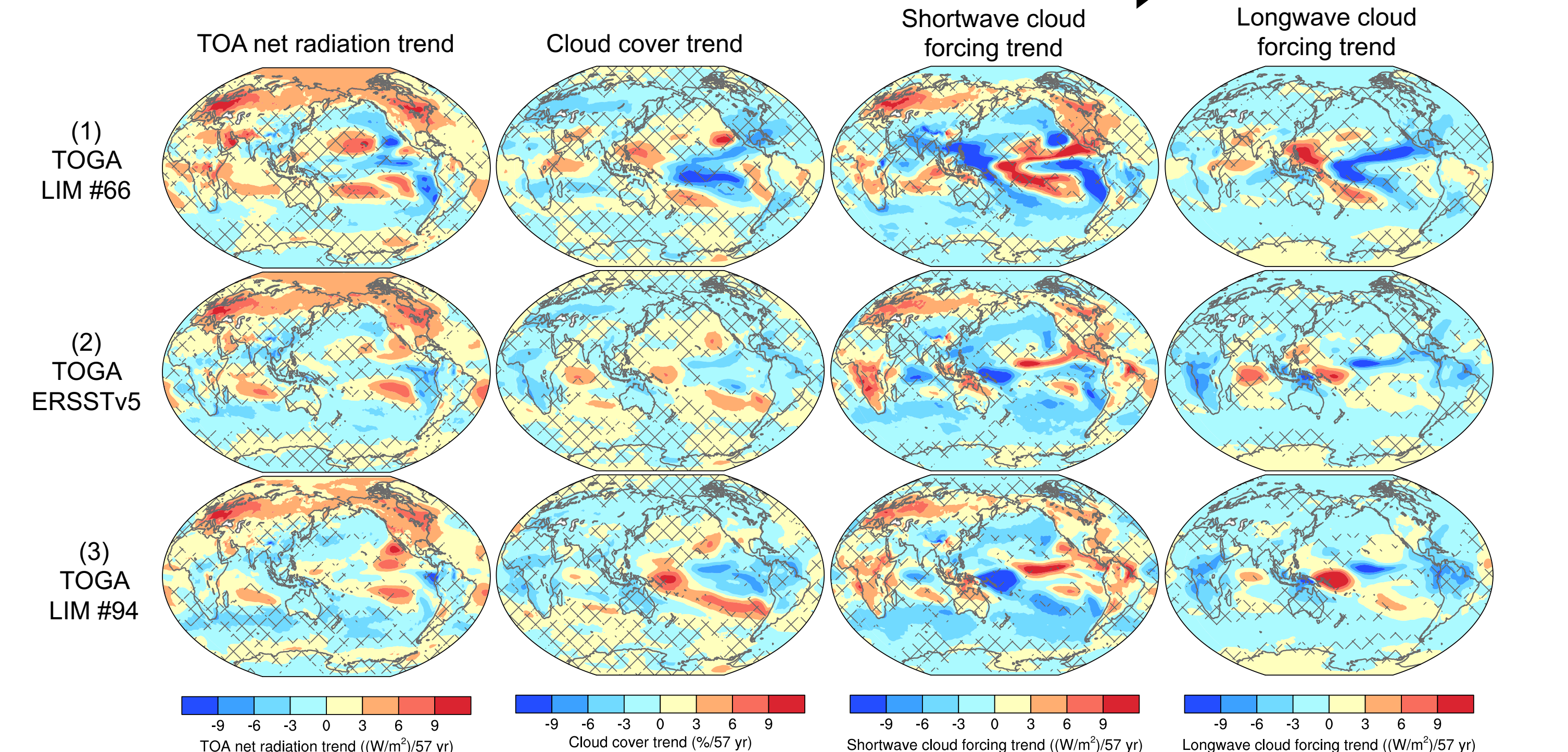
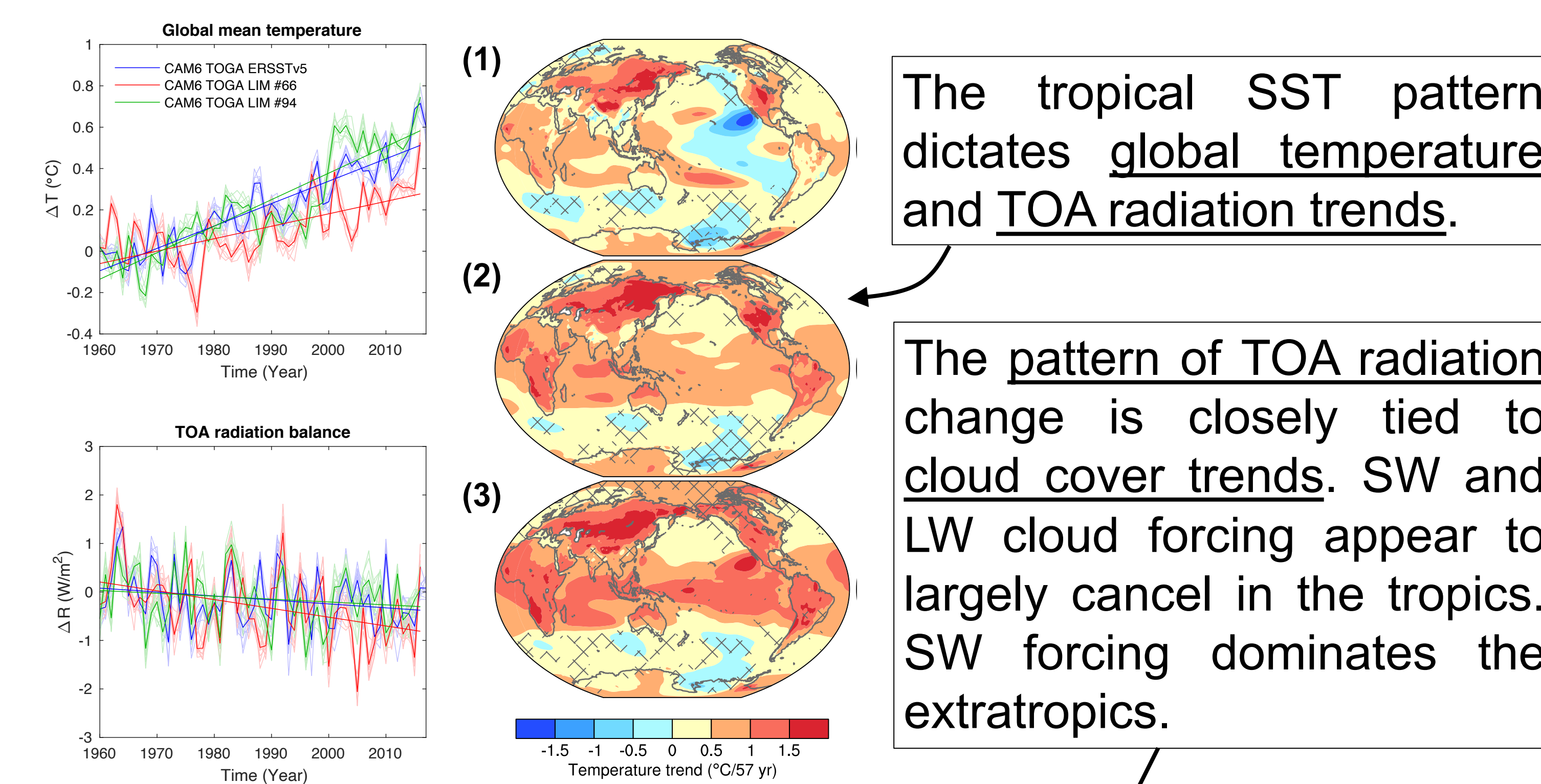
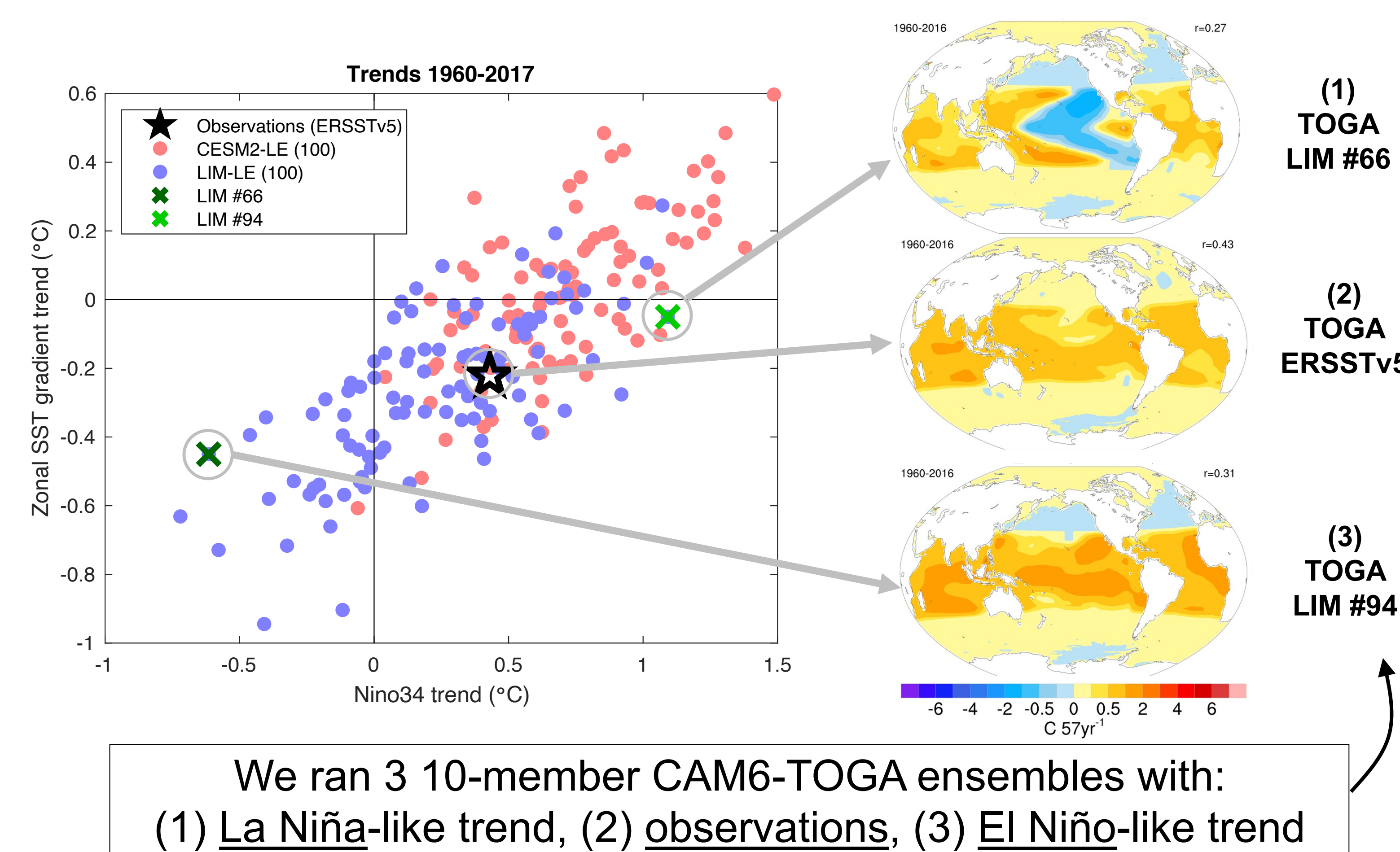
- Divergent tropical SST trends dictate global temperature and radiation patterns through cloud forcing.
- Regional precipitation trends show varying degrees of sensitivity to either Nino 3.4 trends or the general forced response (GHGs, aerosols).

## Benchmarking of synthetic SSTs

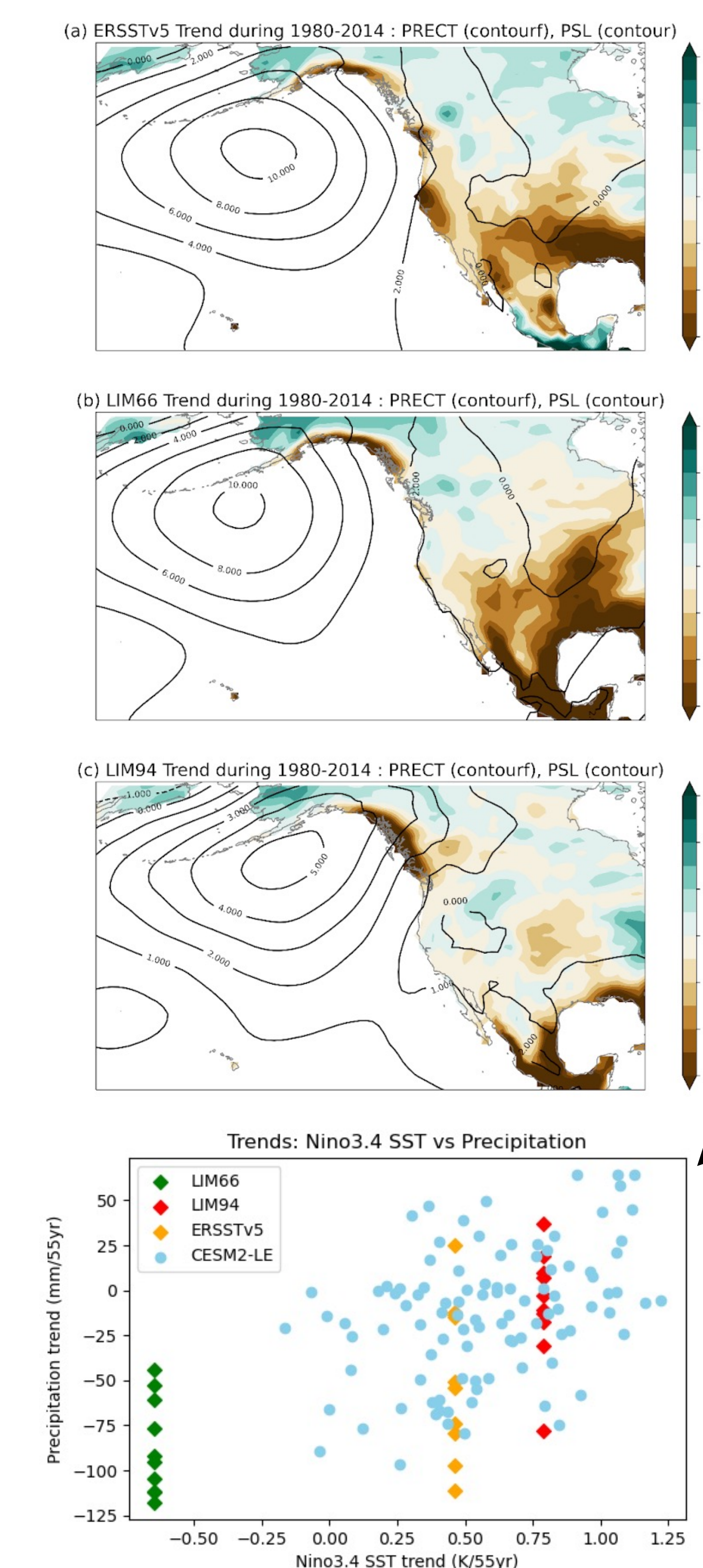


Details of the LIM: Shin et al., 2021, *J. Climate*, doi: 10.1175/JCLI-D-20-0291.1

## Temperature and radiation patterns



## Hydroclimate response patterns



Despite the very different tropical SST forcing, all TOGA ensembles show a similar North Pacific SLP response, overall promoting a precipitation decline over the Western US (atmospheric circulation forced response not as sensitive to SST trend pattern?).

Substantial uncertainty in regional precipitation trends (Southwestern US) from atmospheric internal variability, but ENSO trend vs precipitation trend relationship is consistent between LIM-TOGA and CESM2.

LIM-TOGA produces precipitation trends outside of CESM2-LE, but this is presumably due to different forced response in tropical SSTs. → It remains important to better understand forced tropical SST response.

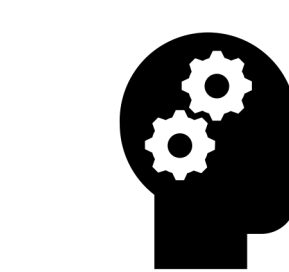
## Data / References / Seeking postdoc



Model output from all 3 TOGA ensembles is on Cheyenne – let us know if you would like to use it.



Kuo et al., in prep., on hydroclimate response pattern



We are looking for a 2-year postdoc to work on related topics (broadly: hydroclimate projections, model evaluation, emergent constraints). Get in touch with Flavio Lehner if interested.