What do SMILEs tell us about ENSO projections?

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Introduction and Aims

- It is important to understand whether the ***El Niño Southern Oscillation (ENSO)*** will change under increasing greenhouse gas emissions due to its widespread impacts
- Previous work finds a diverse range of projections of ENSO variability
- Differences between the projections of ENSO variability in individual modes have been linked to the pattern of mean-state warming across the tropical Pacific (SST gradient), with projections of this pattern also inconsistent between different studies

Without large ensembles, previous studies were forced to rely on long time averages to robustly evaluate changes in ENSO variability. By using 14 ***single model initial-condition large ensembles (SMILEs)***, we can separate the forced response of ENSO variability from internal variability.

This study aims to:

1. Evaluate the time evolution of ENSO statistics
2. Assess future ENSO pattern changes
3. Investigate the tropical Pacific SST gradient response to warming
4. Determine whether there is a relationship between projected ENSO variability and the tropical Pacific SST gradient response in climate models

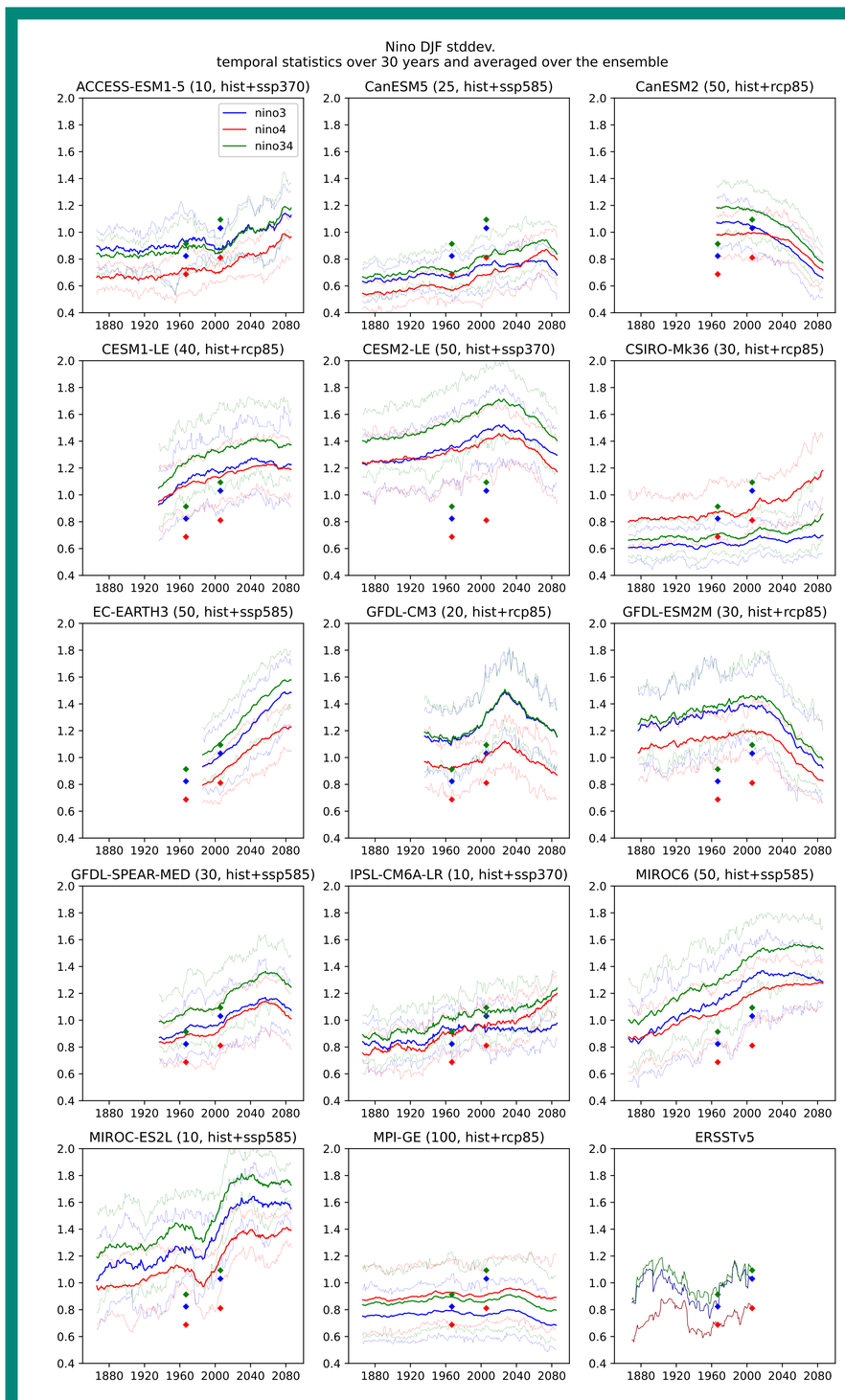

Figure 1: Time series of Niño3, Niño3.4 & Niño4 variability for DJF in each SMILE and observations.

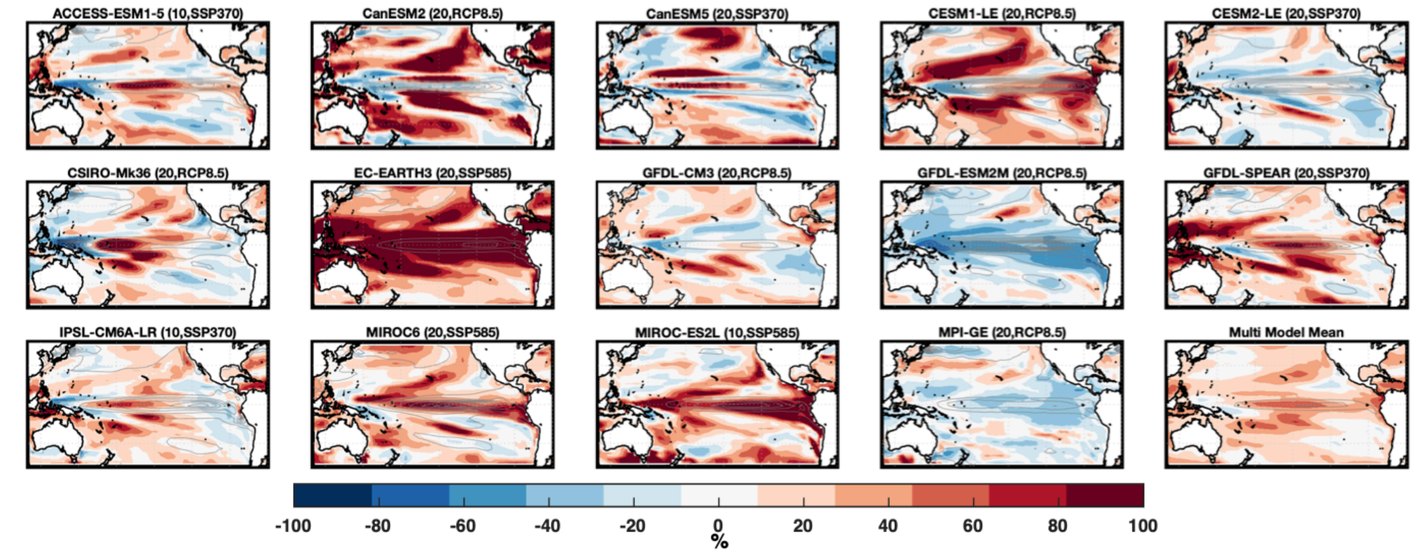

Figure 2: Spatial pattern of relative change in interannual variance between the late 21st century (2071-2100) simulations and the historical (1951-1980) period.

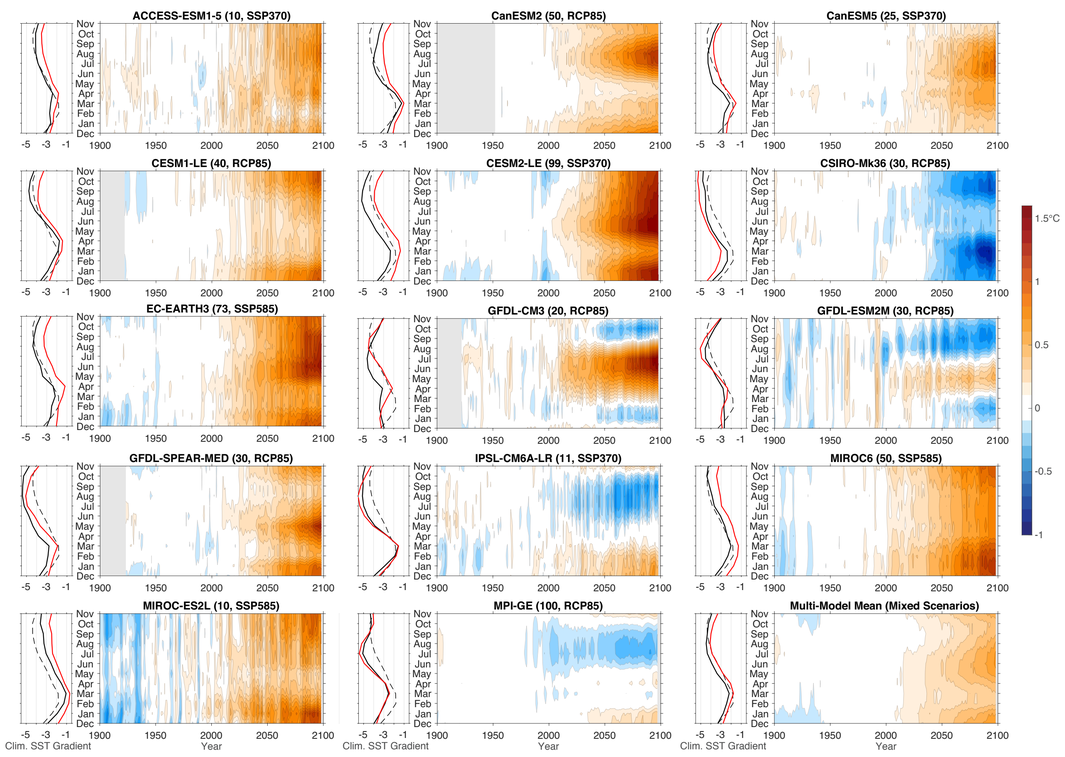

Figure 3 Ensemble-mean Pacific SST gradient climatology, the difference between the eastern equatorial Pacific (90–150W, 5S–5N) and the western equatorial Pacific (120E-180, 5S–5N).

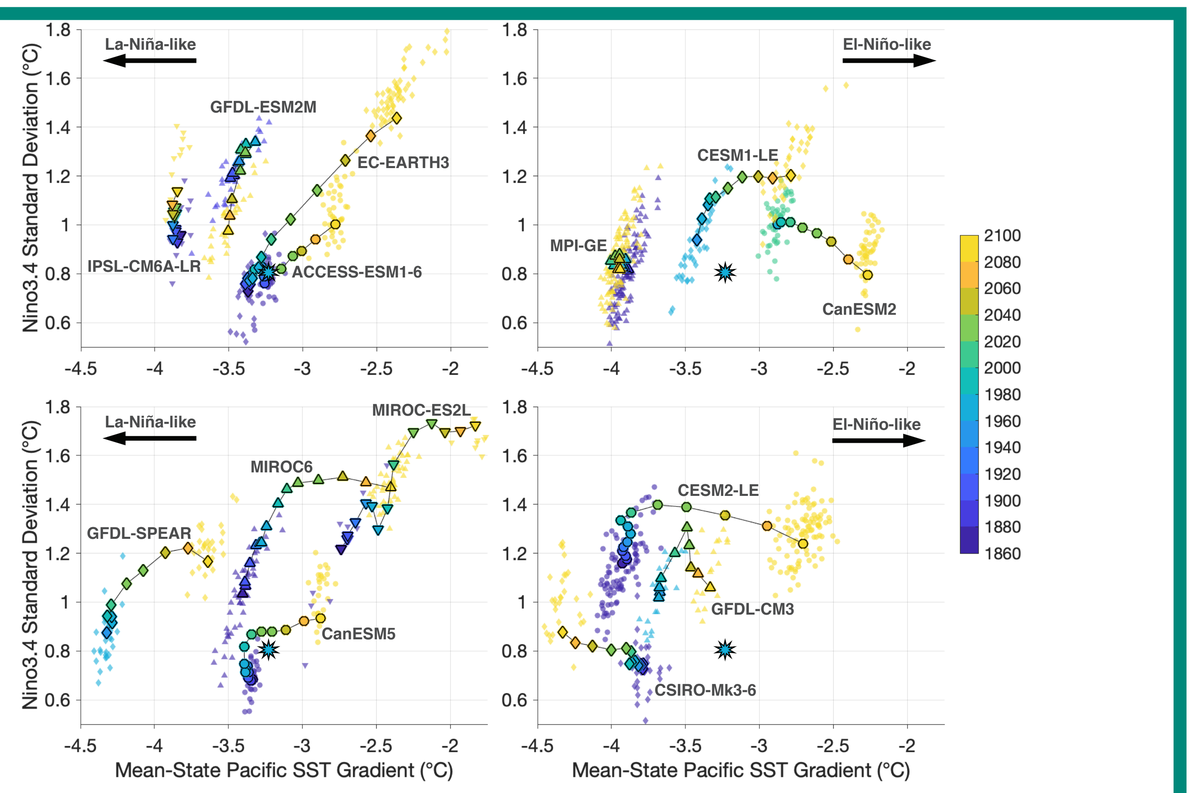

Figure 4 Time evolution of the ensemble-mean and 30-year-running-mean annual-mean climatologies of the Pacific SST gradient climatology (x-axis) and Niño3.4 variance (y-axis).

Key points

1. Models differ in their time-evolution of ENSO SST variability (Figure 1).
2. The pattern change also differs between models with the multi-ensemble mean projecting an increase ion ENSO variability, El Niño-like warming, and more variability in the Central Pacific (Figure 2).
3. Most models project El Niño-like warming, although some models project the opposite. Individual models are different in their longitude and season of maximum warming in the tropical Pacific (Figure 3).
4. Tropical Pacific SST gradient changes are linked to ENSO variability. This response is time-dependent. ENSO variability first increases, then the Pacific SST gradient weakens as ENSO variability plateaus or decreases. This response is found in many models but not all (Figure 4).

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