ENSO teleconnections to North America in CMIP5 models: Fidelity to observed relationships and projected changes

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Introduction
The El Niño-Southern Oscillation (ENSO) is the dominant mode of tropical atmosphere-ocean interaction on interannual timescales, with significant impacts on North American seasonal temperature and precipitation. Some studies (e.g., Meehl and Teng 2007, Kug et al. 2010, Stevenson 2012) suggest that ENSO teleconnections may change under global warming. Here we address the following questions:

1) How well do models of the Coupled Model Intercomparison Project Phase 5 (CMIP5) perform in capturing boreal winter (December-February) ENSO teleconnections?
2) What factors influence performance?
3) What are the projected changes of ENSO teleconnections during the 21st century?

Performance in the 20th century climate
- We calculate composites of 300 hPa height normalized by the Niño 3.4 sea surface temperature (SST) anomaly over the Pacific/North American sector during El Niño and La Niña episodes.
- Historical runs (~1850-2005) in CMIP5 models, NCEP/NCAR Reanalysis for observations (1950-2010)
- Models evaluated with Taylor diagram metrics

![Taylor diagrams for Pacific/North American ENSO 300 hPa height teleconnection performance.](image1)

- **High performance models**: pattern correlation greater than 0.6 and RMS difference less than 13 m in both composites, shown in red
- **Low performance models**: shown in blue

What distinguishes high from low performance models?
- The high performance ensemble captures the main El Niño teleconnection features except for the observed negative precipitation anomaly over the Tennessee and Ohio Valleys.
- The low performance ensemble features a weaker and westward shifted Aleutian low anomaly, much weaker northwest North America SAT anomalies, and substantially reduced West Coast precipitation anomalies.
- La Niña teleconnection composites (not shown) largely mirror the El Niño composites.

Projected changes in the 21st century under the RCP8.5 emissions pathway
- For El Niño episodes the high performance ensemble projects a significant increase in equatorial central Pacific SSTs and a strengthening of the teleconnection pattern.
- The low performance ensemble projects an eastward contraction and significant strengthening of equatorial eastern Pacific SSTs and a northeastward shift of the upper tropospheric height pattern.
- For La Niña episodes both the high and low performance ensembles project a zonal elongation and strengthening of the North Pacific/North American positive height anomalies.

![Projected changes in 300 hPa height, SAT, extratropical precipitation, surface temperature (Ts), and tropical precipitation for DJF El Niño episodes in the 21st century under the RCP8.5 emissions pathway.](image2)

References