Notes for *Changes in ENSO amplitude under climate warming and cooling*

Introduction

- Lots of research on whether ENSO will strengthen in the future
- Little agreement between models on whether ENSO will strengthen or weaken
- Studies addressed disagreement and explained it
- Goal is to determine what changes to ENSO amplitude happen under global warming/cooling and why.

Experiments with CESM

- Describes model setup
- Added uniform extra heat to ocean to simulate global warming, subtracted for cooling
- Control simulation

Changes in ENSO amplitude under climate warming and cooling

- Calculated SST anomaly standard deviation across the pacific
- Selected ENSO events based on whether SSTA in the Niño3 box exceeds 1 STD.
- Found significant increase in maximum ENSO sea temperature during global warming

Dominant dynamic and thermodynamic processes for ENSO amplitude changes

Mixed layer heat budget analysis

- Used existing equation to measure strength of different heat transfer feedbacks that contribute to ENSO
- Calculated MLTA (mixed layer temperature anomaly) on model output during ENSO events
- Transfer of heat between the ocean and the air contributes the most
- Found that perturbation has a greater impact on thermodynamic damping than mean state differences.

Zonal Advective Feedback

- Horizontal transfer of heat is stronger in warming simulation and weaker in cooling simulation
- Greater interlocking of wind speed anomalies with ocean current anomalies under global warming

Meridional advective feedback

- Weakened surface ocean currents in global warming
- Weaker currents allow for strengthened wind advection feedback

Thermocline feedback

- Equation to represent strength of thermocline feedback
- Used linear regression to compare strength of thermocline feedback with SST anomaly
- Global warming strengthens terms in equation, increasing thermocline feedback

Ekman feedback

- Stronger currents caused by increased temperatures reduce eastern pacific upwelling

Thermodynamic damping

- Changes in the temperature difference between the ocean and the atmosphere
- Affects heat transfer between ocean and atmosphere

Changes in Bjerknes linear stability index

- Used different equation to measure changes to ENSO stability under forcing
- Decreased stability in warming simulation leads to higher ENSO amplitude

Summary

- Higher temperatures cause currents to vary more in the pacific during ENSO
- Stronger current change causes thermocline to vary more during El Nino
- Weakened equatorial winds allow heat to transfer horizontally more
- All of these changes add up to decreased ENSO stability and higher amplitude