PhD Defense Announcement
Jingyuan Li
Friday, October 30 at 10:00 a.m.

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Defense
Virtual (Teams link will be sent out)

Post Defense Meeting
Virtual

Committee:
David Thompson (Adviser)
A.R. Ravishankara
Elizabeth Barnes
Daniel Cooley (Statistics)

Quantifying Internal Climate Variability and Its Changes Using Large-Ensembles of Climate Change Simulations

Increasing temperatures over the last 50 years have led to a multitude of studies on observed and future impacts on surface climate. However, any changes on the mean need to be placed in the context of its variability to be understood and quantified. This allows us to: 1) understand the relative impact of the mean change on the subsequent environment, and 2) detect and attribute the external change from the underlying ``noise" of internal variability. One way to quantify internal variability is through the use of large ensemble models. Each ensemble member is run on the same model and with the same external forcings, but with slight differences in the initial conditions. Differences between ensemble members are due solely to internal variability. This research exploits one such large ensemble of climate change simulations (CESM-LE) to better understand and evaluate surface temperature variability and its effects under external forcing.

One large contribution to monthly and annual surface temperature variability is the atmospheric circulation, especially in the extratropics. Dynamical adjustment seeks to determine and remove the effects of circulation on temperature variability in order to narrow the range of uncertainty in the temperature field. The first part of this work compares several commonly used dynamical adjustment methods in both a pre-industrial control run and the CESM-LE. Because there are no external forcings in the control run, it is used to provide a quantitative metric by which the methods are evaluated. The CESM-LE tests the dynamical adjustment methods in the presence of external forcing, which can create biases in the results. This work provides a template through which different methods can be assessed.

A less studied question is how internal variability itself will respond to climate change. Past studies have found regional changes in surface temperature variance and skewness. This research also investigates the impacts of climate change on day-to-day persistence of surface temperature. Results from the CESM-LE suggest that external warming generally increases surface temperature persistence, with the largest changes over the Arctic and ocean regions. The results are robust and distinct from internal variability. We suggest that persistence changes are mostly due to an increase in the optical thickness of the atmosphere due to increases in both carbon dioxide and water vapor. This increased optical thickness reduces the thermal damping of surface temperatures, increasing their persistence. Model results from idealized aquaplanet simulations with different radiation schemes support this hypothesis. The results thus reflect a robust thermodynamic and radiative constraint on surface temperature variability.