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Florida International University
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Doctoral Dissertation Defense

Abstract

Evaluating Changes to Natural Variability on a Warming Globe in CMIP5 Models

by

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Global mean surface temperatures (GMST) warmed in the early 20th century, experienced a mid-century lull, and warmed again steadily until 1997. Observations at the turn of the 21st century revealed another period of quiescent warming of GMSTs from 1998 to 2012, thus prompting the notion of a global warming "hiatus". The warming hiatus occurred concurrently with steadily increasing atmospheric greenhouse gas concentrations, sea level rise, and retreating arctic sea ice. The occurrence of the warming hiatus suggests that natural variability continues to be a contributor to modern climate change and implies that energy is rearranged or changed within the climate system. Much of the scientific research conducted over the last decade has attempted to identify which modes of natural variability may be contributing to the GMST signal in the presence of anthropogenic warming. Many of these studies concluded that natural variability operating in the global oceans were the largest contributors to GMST. What remains unclear is how oceanic variability and its contribution to GMST may change on a warmer globe as greenhouse gas concentrations continue to rise.

Our research includes diagnostic analyses of the available observational surface temperature estimates and novel state-of-the-art climate model experiments from the fifth phase of the Coupled Model Intercomparison Project (CMIP5). Our analyses seek to understand changes to natural variability and utilize simulations forced with observed pre-industrial and historical greenhouse gas emissions in combination with several future warming simulations. We quantify the probability of similar "hiatus-like" periods occurring on a warmer globe. To that end, employ various metrics and detrending techniques including EOF decomposition, running climatologies, along with linear and nonlinear trends to elucidate how natural variability changes over time. We also examine the changing influence of natural modes of variability with respect to the anthropogenic radiative forcing over different regions on the globe. Results suggest that natural variability for much of the global oceans decreases as the radiative forcing increases in the future warming scenarios.

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