Geophysical Research Abstracts
Vol. 19, EGU2017-11802, 2017
EGU General Assembly 2017

Understanding Southern Ocean SST Trends in Historical Simulations and Observations

Yavor Kostov (1), David Ferreira (2), John Marshall (3), and Kyle Armour (4)

(1) University of Oxford, Oxford, United Kingdom, (2) University of Reading, Reading, United Kingdom, (3) Massachusetts Institute of Technology, Cambridge, MA, United States, (4) University of Washington, Seattle, United States

Historical simulations with CMIP5 global climate models do not reproduce the observed 1979-2014 Southern Ocean (SO) cooling, and most ensemble members predict gradual warming around Antarctica. In order to understand this discrepancy and the mechanisms behind the SO cooling, we analyze output from 19 CMIP5 models. For each ensemble member we estimate the characteristic responses of SO SST to step changes in greenhouse gas (GHG) forcing and in the seasonal indices of the Southern Annular Mode (SAM). Using these step-response functions and linear convolution theory, we reconstruct the original CMIP5 simulations of 1979-2014 SO SST trends. We recover the CMIP5 ensemble mean trend, capture the intermodel spread, and reproduce very well the behavior of individual models. We thus suggest that GHG forcing and the SAM are major drivers of the simulated 1979-2014 SO SST trends. In consistence with the seasonal signature of the Antarctic ozone hole, our results imply that the summer (DJF) and fall (MAM) SAM exert a particularly important effect on the SO SST. In some CMIP5 models the SO SST response to SAM partially counteracts the warming due to GHG forcing, while in other ensemble members the SAM-induced SO SST trends complement the warming effect of GHG forcing. The compensation between GHG and SAM-induced SO SST anomalies is model-dependent and is determined by multiple factors. Firstly, CMIP5 models have different characteristic SST step response functions to SAM. Kostov et al. (2016) relate these differences to biases in the models' climatological SO temperature gradients. Secondly, many CMIP5 historical simulations underestimate the observed positive trends in the DJF and MAM seasonal SAM indices. We show that this affects the models' ability to reproduce the observed SO cooling. Last but not least, CMIP5 models differ in their SO SST step response functions to GHG forcing. Understanding the diverse behavior of CMIP5 models helps shed light on the physical processes that drive SST trends in the real SO.