EMS Annual Meeting Abstracts
Vol. 16, EMS2019-889, 2019

Effects of mean state of climate models on the response to prescribed forcing: Sensitivity experiments with the SPEEDY general circulation model.

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Understanding how the general circulation of the atmosphere is affected by global warming is one of the grand challenges in climate science. Climate models are a valuable tool to: i) identifying potential mechanism for changes in general circulation, ii) recognizing signals that can be related to external forcing and iii) produce projections for future scenarios. Despite the use of large ensemble of continuosly improving climate models, uncertainty for the extratropical circulation is still large. It is therefore important to understand processes driving the variability of the circulation in climate models and how these processes are affected by model bias. To characterize the effect of models bias on the response to a given forcing, several simulations were performed with the Simplified Parameterizations, primitivE - Equation DYnamics (SPEEDY), an intermediate complexity model developed by International Center for Theoretical Physics (ICTP). Four simulations are performed with a modified orography in order to obtain an atmospheric circulation at mid-latitudes characterized by different mean states and a control climate simulation carried in standard configuration is used as baseline. For each of these experiments, we have studied the climatic response to El Niño Southern Oscillation (ENSO) and to the Atlantic Multidecadal Variability (AMV). All the Sensitivity simulations were performed with a large ensemble (100 members). Results show that indeed the model response is non-negligibly influenced by its mean state and reveal geographic areas where the sensitivity is large. On the other hand, they also show large scale regions of the world where the atmospheric response to ENSO and AMV is unlikely to depend on the atmospheric mean state. We also found that the relationship between changes in the model mean state and the response to the forcing appears to be non linear. These results cam be used to interpret and understand multi-model spread in atmospheric response to aforementioned surface condition.