

The forced response of the climate system: The case of climatic teleconnections

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We frame the forced response of the climate system in terms of an ensemble that represents the so-called snapshot/pullback attractor, and explore the implications and power of this approach. Teleconnections as cross-correlations can be defined in the ensemble-based framework by evaluating the correlations over ensemble members. As a specific example, we studied the teleconnection between the El Niño–Southern Oscillation (ENSO) and the Indian summer monsoon in ensemble simulations from state-of-the-art climate models, the Max Planck Institute Earth System Model (MPI-ESM) and the Community Earth System Model (CESM). We detect an increase in the strength of the teleconnection in the MPI-ESM under historical forcing between 1890 and 2005, which is in contrast with scientific consensus. In the MPI-ESM no similar increase is present between 2006 and 2099 under the Representative Concentration Pathway 8.5 (RCP8.5), and in a 110-year-long 1-percent pure CO₂ scenario; neither is in the CESM between 1960 and 2100 with historical forcing and RCP8.5. This is also a puzzling result inasmuch as the historical forcing is the weakest. Accordingly, we evaluated that the static susceptibility of the strength of the teleconnection with respect to radiative forcing (assuming an instantaneous and linear response) is at least three times larger in the historical MPI-ESM ensemble than in the others.

Keywords: teleconnection, ENSO, Indian monsoon, forced response, trajectory ensemble