Influence of ENSO on entry stratospheric water vapor in coupled chemistry-ocean CCMI and CMIP6 models

Ohad Harari, Chaim Garfinkel, and Shlomi Ziskin
Hebrew University of Jerusalem (ohad.harari@mail.huji.ac.il)

The connection between the dominant mode of interannual variability in the tropical troposphere, El Niño Southern Oscillation (ENSO), and entry of stratospheric water vapor, is analyzed in a set of the model simulations archived for the Chemistry-Climate Model Initiative (CCMI) project and for phase 6 of the Coupled Model Intercomparison Project. While the models agree on the temperature response to ENSO in the tropical troposphere and lower stratosphere, and all models also agree on the zonal structure of the response in the tropical tropopause layer, the only aspect of the entry water vapor with consensus is that La Niña leads to moistening in winter relative to neutral ENSO. For El Niño and for other seasons there are significant differences among the models. For example, some models find that the enhanced water vapor for La Niña in the winter of the event reverses in spring and summer, other models find that this moistening persists, while some show a nonlinear response with both El Niño and La Niña leading to enhanced water vapor in both winter, spring, and summer. A moistening in the spring following El Niño events, perhaps the strongest signal in observations, is simulated by only half of the models. Focusing on Central Pacific ENSO versus East Pacific ENSO, or temperatures in the mid-troposphere as compared to temperatures near the surface, does not narrow the inter-model discrepancies. Despite this diversity in response, the temperature response near the cold point can explain the response of water vapor when each model is considered separately. While the observational record is too short to fully constrain the response to ENSO, it is clear that most models suffer from biases in the magnitude of interannual variability of entry water vapor. This bias could be due to biased cold point temperatures in some models, but others appear to be missing forcing processes that contribute to observed variability near the cold point.