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The role of regional SST warming variations in the drying of Meso-America in future climate projections

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This paper addresses several hypotheses designed to explain why AOGCM simulations of future climate in the third Coupled Model Intercomparison Project (CMIP3) feature an intensified reduction of precipitation over the Meso-America (MA) region. While the drying is consistent with an amplification of the subtropical high pressure cells and an equatorward contraction of convective regions due to the "upped ante" for convection in a warmer atmosphere, the physical mechanisms behind the intensity and robustness of the MA drying signal have not been fully explored. Regional variations in sea surface temperature (SST) warming may play a role. First, SSTs over the tropical North Atlantic (TNA) do not warm as much as the surrounding ocean. The troposphere senses a TNA that is cooler than the tropical Pacific, potentially exciting a Gill type-response, increasing the strength of the North Atlantic subtropical high. Second, the warm-ENSO-like state simulated in the eastern tropical Pacific could decrease precipitation over MA, as warm ENSO events are associated with drying over MA.

We use the International Centre for Theoretical Physics (ICTP) AGCM to investigate the effects of these regional SST warming variations on the projected drying over MA. First we apply the change in SSTs (SRES A1B - Climate of the 20th Century experiment (A1B-20C)) from the ensemble average of the CMIP3 models to determine if the ICTP AGCM can replicate the future drying. Then we test the effects of 1) removing the reduced warming over the TNA, 2) removing the warm-ENSO-event like pattern in the eastern tropical Pacific, and 3) applying uniform SST warming throughout the tropics. The ICTP AGCM can reproduce the general pattern and amount of precipitation over MA. Simulations in which the CMIP3 A1B-20C ensemble average SSTs are added to climatological SSTs show drying of over 20% over the MA region, similar to the CMIP3 ensemble average. Replacing the relatively cooler SSTs over the TNA excites a Gill response consistent with an off-equatorial heating anomaly, showing that the TNA relative cooling is responsible for about 16% (31%) the drying in late spring (early summer). The warm-ENSO-like SST pattern over the eastern Pacific also affects precipitation over the MA region, with changes of 19% and 31% in MMJ and JJA. Our work highlights the importance of understanding even robust signals in the CMIP3 future scenario simulations, and should aid in the design and analysis of future climate change studies over the region.