Atmospheric Rivers in a Hierarchy of Climate Simulations: Resolution Sensitivity and Impacts of Global Warming

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The western U.S. receives precipitation predominantly during the cold season when storms approach from the Pacific Ocean. The snowpack that accumulates during winter storms provides about 70-90% of water supply for the region. Associated with the warm sector of extratropical cyclones over the Pacific Ocean, atmospheric rivers (ARs) provide enhanced water vapor transport from the tropics. Upon landfall in the mountainous terrain along the U.S. west coast, ARs produce heavy precipitation that accounts for 25 – 50% of annual precipitation in the western U.S. Due to the narrow structure of the ARs and the complex terrain along the west coast, simulations of ARs and the associated precipitation are sensitive to model resolution. Using a suite of idealized aqua-planet simulations and AMIP simulations at resolutions ranging from 30km to 240km, we investigate the sensitivity of simulated AR frequency to model resolution and dynamical core. The impacts of global warming on ARs are investigated using CMIP5 models to evaluate the thermodynamical and dynamical contributions to changes in the frequency of ARs making landfall in western North America and Europe. We identified an emergent constraint for AR frequency changes using the observed position of the jet stream that works particularly well for the North Atlantic ARs.