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Present and future of Extreme El Niño teleconnections over North America in CMIP6 models

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Previous studies did suggest a diversity of the ENSO teleconnection pattern, with an eastward shifted pattern for El Niño relative to La Niña or for “eastern Pacific” (EP) relative to “central Pacific” (CP) El Niño events. Recently, Beniche et al. (in revision) demonstrated that extreme El Niño events (i.e. the strongest EP events, such as those in 1982/83, 1997/98, and 2015/16) were the only events leading to a clear eastward shift of the winter ENSO teleconnection pattern over North America. This specific teleconnection is also associated with reproducible wet (warm) anomalies over the western USA coast (northern USA and Canada). They did however demonstrate it based on the limited observational dataset, and a single AMIP CNRM-CM6.1 ensemble.

The current study aims at evaluating the robustness of these results using the broader AMIP6 and CMIP6 datasets. The specificity of the Extreme El Niño North American winter teleconnection pattern, and its inter-event and inter-member reproducibility, are robust across 23 historical AMIP ensembles (1979-2014). These events are associated with 73% chances of warm conditions over the Northern USA and Canada and 68% chances of wet conditions over the Western US coast across the AMIP ensemble. The stronger reproducibility of the extreme El Niño teleconnections can be explained by a more favourable Signal to Noise (SNR) ratio (mainly due to stronger signal).

We further evaluate the realism of these teleconnections patterns in presence of the systematic biases that are present in CMIP6. We only select CMIP6 models that reproduce Extreme El Niño events based on the precipitation-index of Cai et al. (2014). In agreement with previous studies using CMIP5 (e.g. Bayr et al., 2019), we find that models with stronger cold climatological SST bias are unable to simulate extreme Niño3 rainfall anomaly events. CMIP6 models that reproduce extreme El Niño tropical rainfall reasonably also reproduce the specific extreme El Niño 500 hPa geopotential height and surface temperature winter teleconnection pattern over North America. They however do not reproduce well the specific wet anomalies over the west American coast associated with those events, casting doubt on the CMIP6 ability to project precipitation changes over this region. We end by discussing the relevance of these results for understanding projected changes in ENSO teleconnections over North America in the context of different Shared Socioeconomic Pathways (SSPs) scenarii.