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Impact of surface temperature biases on climate change projections of the South Pacific Convergence Zone and tropical cyclone activity.

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The main characteristics of South Pacific (SP) climate (e.g. South Pacific Convergence Zone (SPCZ), Tropical Cyclones (TC)) are poorly represented in global coupled simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5), with trademark biases such as the tendency to form a “double Intertropical convergence zone”, an equatorial cold tongue that extends too far westward. Such biases limit our confidence in projections of the future climate change for this region in CMIP5 models. Previous studies (Li et al. 2015, 2016, Huang and Ying 2015) have shown that these present-day biases also distort their projected SST patterns and suggest methods to correct such biases. Here we use a downscaling strategy based on a regional atmospheric model (WRF) that accurately captures the SPCZ present-day climatology and TC activity on the SP region to explore how the present-day biases and their corrections via an emergent constraint approach affect the future SPCZ and its cyclonic activity. We show that while the equatorial western Pacific projected rainfall increase is robust in our experiments and CMIP5, correcting the projected CMIP5 SST changes yields a considerably larger drying ($\sim$25%) than without correction ($\sim$1%) in the southwestern Pacific. The correction yields stronger projected SST gradients, which lead to more humidity convergence reduction in the SPCZ. Finally, our bias-corrected set of experiments yields a clear reduction of the cyclogenesis (-55%) and TC occurrence (-48%) over the basin, while those changes are not statistically significant in the simulations witho ut. Analysis of cyclogenesis indices indicates that this is caused by stronger vertical wind shear, in response to an equatorial shift of the South PacificConvergence Zone in response to the stronger SST gradients due to the correction. These results are not sensitive to the model physical parameterizations. Therefore, our study demonstrates that projected CMIP5 SST biases can strongly hamper the reliability of SPCZ and TCs projections.