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The Large-Scale Ocean Dynamical Effect on uncertainty in the Tropical Pacific SST Warming Pattern in CMIP5 Models

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This study investigates how intermodel differences in large-scale ocean dynamics affect the tropical Pacific sea surface temperature (SST) warming (TPSW) pattern under global warming, as projected by 32 models from phase 5 of the Coupled Model Intercomparison Project (CMIP5). The largest cause of intermodel TPSW pattern differences is related to the cloud–radiation feedback. After removing the effect of cloud–radiation feedback, we find that differences in ocean advection play the next largest role, explaining around 14% of the total intermodel variance in TPSW pattern. Of particular importance are differences in climatological zonal overturning circulation among the models. With the robust enhancement of ocean stratification across models, models with relatively strong climatological upwelling tend to have relatively weak SST warming in the eastern Pacific. Meanwhile, the pronounced intermodel differences in ocean overturning changes under global warming contribute little to uncertainty in the TPSW pattern. The intermodel differences in climatological zonal overturning are found to be associated with the intermodel spread in climatological SST. In most CMIP5 models, there is a common cold tongue bias associated with an overly strong overturning in the climatology simulation, implying a LaNiña–like bias in the TPSW pattern projected by the MME of the CMIP5 models. This provides further evidence for the projection that the TPSW pattern should be closer to an El Niño–like pattern than the MME projection.