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Climate change projection with reduced model systematic error over tropical Pacific

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The tropical Pacific is a major driver of the global climate system. Climate models, however, have difficulties in realistically simulating the region: typically, they have a too pronounced equatorial cold tongue, an erroneous double inter-tropical convergence zone (ITCZ), and poorly represent of ocean-atmosphere interaction. These errors introduce large uncertainties into climate change projections. Here we assess the impact of these errors by performing climate change projections with an interactive model ensemble (SUMO) that has a reduced tropical Pacific error.

SUMO consists of one ocean model coupled to two atmospheric models, which only differ in their representation of atmospheric convection. Through optimal coupling weights, synchronization of the atmospheric models over tropical Pacific is enhanced and there the simulation of climate is dramatically improved: The model realistically simulates the equatorial cold tongue, a single ITCZ, and the Bjerknes positive feedback. SUMO also simulates interannual variability better than the two individual coupled ocean-atmosphere models (i.e. based on the two different atmospheric models).

Global warming predicted by SUMO lies between that of the two individual coupled models. However, the projections for the tropical Pacific differ markedly. SUMO simulates a weakening of the zonal SST gradient, while the two individual coupled models simulate a strengthening. The weaker zonal SST gradient leads to around 20% weakening of the Walker Circulation, and there is an increase of precipitation over the entire tropics. In contrast, the two individual coupled models simulate an eastward shift of the Walker Circulation, and enhancement of precipitation over the western Pacific. The differences are related to the representation of ocean-atmosphere interaction. This underscores the importance of improving the simulation of tropical Pacific to reduce uncertainties in climate change projection.