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Changes in ENSO amplitude under climate forcings

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The response of ENSO amplitude to climate warming and cooling is investigated using the Community Earth System Model, in which the warming and cooling scenarios are designed by adding heat fluxes of equal amplitude but opposite sign onto the ocean surface, respectively. Results show that the warming induces an increase of the ENSO amplitude but the cooling gives rise to a decrease of the ENSO amplitude, and these changes are robust in statistics. A mixed layer heat budget analysis finds that the increasing (decreasing) SST tendency under climate warming (cooling) is mainly due to an enhancement (weakening) of dynamical feedback processes over the equatorial Pacific, including zonal advective (ZA) feedback, meridional advective (MA) feedback, thermocline (TH) feedback, and Ekman (EK) feedback. As the climate warms, a wind anomaly of the same magnitude across the equatorial Pacific can induce a stronger zonal current change in the east (i.e. a stronger ZA feedback), which in turn produces a greater weakening of upwelling (i.e. a stronger EK feedback) and thus a larger thermocline change (i.e. a stronger TH feedback). In response to the climate warming, in addition, a slowdown of the subtropical cells will result in a narrower meridional width of SST anomaly around the equator and thus a stronger MA feedback. And vice versa for the cooling case. Bjerknes linear stability (BJ) index is also evaluated for the linear stability of ENSO, with significantly larger (smaller) BJ index found for the warming (cooling) case.