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How could uncertainty in future ENSO diversity influence assessments of seasonal precipitation anomalies over the 21st century?

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The El Niño-Southern Oscillation (ENSO) is the leading mode of tropical climate variability, with impacts on ecosystems, agriculture, freshwater supplies, and hydropower production spanning much of the globe. Most impact studies use a canonical representation of ENSO, as characterised by sea-surface temperature anomalies (SSTa) in the central-eastern Pacific. However, ENSO shows large differences from one event to another in terms of its intensity, spatial pattern and temporal evolution. For instance, while the 1997/98 El Niño displayed extreme SSTa in the eastern equatorial Pacific, the largest SSTa during the 2002/03 event were weaker and primarily confined to the central equatorial Pacific. These differences in the longitudinal location and intensity of ENSO events, referred to as “ENSO diversity”, are associated with different regional climate impacts throughout the world. The representation of such differences in ENSO spatial patterns in climate models thus strongly influence the skill of impact prediction systems. Here, we exploit the power of single model initial-condition large ensembles (SMILEs) from 14 fully-coupled climate models from both CMIP5 and CMIP6 (totalling over 500 simulations in historical and SSP-RCP scenarios) to examine the system trajectories, and identify future variations in the location and intensity of El Niño and La Niña events. We then quantify how contrasting pathways for ENSO event location, and their associated intensity, could alter seasonal precipitation anomalies throughout the world over the 21st century.