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Multiscale Dynamics of ENSO Impacts on Coral Proxy Environments: Towards Improving Reconstruction Accuracy

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Oxygen isotope (δ^{18}O) records from tropical coral skeletons are widely used for reconstructing the El Niño/ Southern Oscillation (ENSO). However, data limitations have prevented detailed investigation of the dynamical connection between ENSO variability and δ^{18}O anomalies near sites used for reconstructions, potentially creating large uncertainties. To address this issue, a new, isotope-enabled version of the Regional Ocean Modeling System ("isoROMS") has been developed to simulate seawater oxygen isotope anomalies during historical El Niño and La Niña events at a variety of spatial scales. isoROMS is forced with 20th century (1979-2009) boundary conditions and surface fluxes, in addition to precipitation δ^{18}O from the newly developed isotope-enabled Community Atmosphere Model (iCAM5); it thus functions as an approximate 'reanalysis' of seawater δ^{18}O over the satellite era. The balance of surface and advective/diffusive processes during central and eastern Pacific El Niño events is investigated at sites throughout the tropical Pacific, in order to understand the mechanisms governing the magnitude of individual δ^{18}O excursions in existing proxy records. Budget analysis shows that in many cases impacts on δ^{18}O take place primarily through advective changes, rather than surface fluxes as previously thought. Additionally, mesoscale processes such as tropical instability waves significantly affect temperature and δ^{18}O in some locations, and their importance varies with ENSO phase; this suggests that rectification of such high-frequency variability into the proxy signal may affect estimates of overall ENSO variance. Implications for ENSO estimates using 'pseudoproxy' conversions from instrumental data are discussed.