Synthesizing coral $\delta^{18}O$ with high-resolution ocean models to explore mechanisms of Indo-Pacific oceanic exchange through the Indonesian Throughflow

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The Indonesian Throughflow (ITF) serves as an important oceanic teleconnection for Indo-Pacific climate, altering heat and buoyancy transport from the Pacific to Indian Oceans. For example, equatorial Pacific wind forcing transmitted through the ITF impacts interannual to interdecadal Indian Ocean thermocline depth and heat content, with implications for preconditioning Indian Ocean Dipole events. Yet the modulation of Indian Ocean thermal properties at seasonal timescales is still poorly understood. Here we synthesize coral $\delta^{18}O$ records, instrumental indices (El Niño Southern Oscillation (ENSO), Asian Monsoon, etc.), and simulated ocean variability (e.g. heat content, mixed layer depth, sea surface salinity (SSS), sea surface temperature) from state-of-the-art NEMO ocean model hindcasts to explore drivers of variability from seasonal to multi-decadal timescales. All coral sites are located within main ITF pathways (Makassar and Lombok Straits) and are influenced by monsoon-driven South China Sea surface waters during boreal winter that obstruct surface ITF flow and reduce heat transport to the Indian Ocean. Makassar and Lombok Strait coral $\delta^{18}O$ co-varies with simulated SSS, subsurface heat content anomalies (50-350m) and mixed layer depth at the coral sites as well as in the eastern Indian Ocean. Notably, the variability in these coral and model responses reveals sensitivity to phase changes in ENSO, the Interdecadal Pacific Oscillation and the East Asian Winter Monsoon in the mid- to late-20th century. These results collectively suggest that the paleoproxy records are capturing important features of regional hydrography and climate-driven Indo-Pacific exchange, including responses to regional monsoon variability. Such proxy-model comparison is thus critical for understanding the drivers of Maritime Continent and eastern Indian Ocean variability related to changes in ITF oceanic teleconnections over the 19th and 20th centuries.