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Heat budget analysis of the Tropical Pacific Ocean - comparing two approaches for use in climate model evaluation

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Accurate diagnosis of the ocean heat budget in climate simulations is often avoided because of the high demands of computing time and memory storage needed to calculate and save all necessary terms in the ocean heat balance. An alternative approach that strives to isolate the effects of thermodynamical and dynamical processes without requiring a full budget analysis has been proposed in previous studies with demonstrated insight into the mechanisms of longer term upper ocean heat content variability and change. Rather than the standard "fixed depth" estimation of the ocean heat content commonly applied in data and model analysis, the technique relies on the depth of a specific isotherm †("isothermal approach"). This method attempts to isolate heat content changes above that isotherm into contributions due to isotherm deepening/shoaling associated with dynamical heat redistribution (via horizontal advection, diffusion and vertical entrainment) and warming/cooling of the layer related to anomalous air-sea heat fluxes. This in turn allows us to infer the role of these processes in the heat content variability. The goal of the current study is to assess the viability of this method for future use in climate simulation studies focused on the ocean heat content changes, with the particular application of the Tropical Pacific. Using results from Ultra-High Resolution Coupled Climate Simulations project, part of the Grand Challenge Program at Lawrence Livermore National Laboratory, we calculate the full ocean heat budget in the Tropical Pacific upper ocean layer and compare the resulting dynamical and thermodynamical terms to those derived by the "isothermal approach". This comparison will identify conditions where the isothermal dynamical/thermodynamical partitioning yields similar results to the full budget analysis. Relevant observations will also be used to examine the quality of the high-resolution simulation of ocean heat content changes, and analysis of the Tropical Pacific ocean heat content in the CMIP3 simulation is being performed in parallel.