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Constraint of the ocean vertical structure by sea level data in an intermediate coupled model of the equatorial Pacific

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An intermediate coupled model (ICM) of the tropical Pacific, designed for El Niño forecasting, is run in forced mode and constrained by sea level data using an Ensemble Kalman Filter (EnKF). Our objective is to document the sea level correction to the model. Forcing winds and sea level data are taken from the SODA reanalysis over 1958-2007. Model errors used to generate the ensemble arise from the uncertainty in wind stress. The vertical ocean structure of the model consists of three baroclinic modes that have independent dynamics in the absence of correction. However, the sea level correction is applied on the multi-varied set of baroclinic modes, which modifies the entire vertical structure of the model and ensures consistency between large zonal and vertical scales. We assess the impact of the assimilation by comparing to independent observations, as well as by computing the hindcast score. We propose an original diagnostic of the model correction, where we analyse the first SVD (Singular Value Decomposition) eigenvectors of the representor (or Kalman gain) matrix. The first eigenvectors are basin scale corrections, with distinct impacts between the baroclinic modes that we interpret in term of the fast wave adjustment and the slow recharge-discharge process of the equatorial Pacific. We also consider the parameter estimation problem for the relative weight of the baroclinic modes, which is here controlled by the wind stress projection coefficients.