Session: B3 Oral presentation

Dynamics and forcing of interannual regional steric sea level variability

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Variations in sea level represent both a valuable index of climate as well as a potential threat to coastal communities; hence, they are the subject of great attention and interest. Accurate interpretation of sea level records and reliable prediction of future sea level changes ultimately require that the governing processes be understood. To first order, year-to-year sea level changes in most regions of the ocean are known to comprise steric variations arising from local density fluctuations within the water column; the dynamical causes of such regional steric changes have yet to be fully resolved, however. Therefore, to further elucidate the nature of sea level variability, we investigate the processes contributing to interannual variations in steric height and diagnose the underlying dynamics, focusing in particular on the importance of mixing processes as well as the relative roles of local and remote forcing mechanisms. Toward this end, we use an estimate of the ocean state over 1993-2004 produced by the ECCO ("Estimating the Circulation and Climate of the Ocean") group. The estimate represents a solution to the MIT general circulation model fit to observations using advanced optimization techniques. Exploiting the solution's dynamical consistency, closed steric height budgets are computed from time series of monthly-averaged model output, thus attributing steric anomalies completely and consistently in terms of advective and diffusive oceanic transports as well as surface fluxes of buoyancy. We find that interannual steric changes are generally due more to advective and diffusive ocean transport processes than to local air-sea buoyancy exchanges. Steric anomalies due to diffusive processes, which can be quite large in the extratropics, are almost entirely due to sub-grid-scale processes parameterized via the schemes of Gent-McWilliams and Redi, while much smaller contributions from Laplacian diffusion and non-local K-profile parameterized vertical mixing are evident in a few regions (e.g., near western boundary currents). Regarding steric changes deriving from advective processes, the influence of local Ekman dynamics appears to be large in many regions. Results of a series of sensitivity experiments - designed to separate the dynamical influences of variable winds and surface buoyancy fluxes on the transports - will also be presented and discussed. These results inform efforts to model regional sea level variability, potentially shedding light on discrepancies evident among model projections of future sea level changes. The role of Gent-McWilliams and Redi eddy fluxes reveals the necessity of parameterizing mixing processes properly, even on relatively short interannual timescales. The evident importance of local Ekman dynamics suggests that local winds are a critical determinant of steric height. Moreover, interannual sea level appears not to be predictable on the basis of oceanic memory alone.