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On Equatorial Dynamics, Mixed Layer Physics and Sea Surface Temperature

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ABSTRACT

We describe a new numerical model designed to study the interactions between hydrodynamics and thermodynamics in the upper ocean. The model incorporates both primitive equation dynamics and a parameterization of mixed layer physics. There is a consistent treatment of mixed layer structure for all physical processes.

In order to study interplay between dynamics and mixed layer physics in the equatorial ocean, we carried out a series of numerical experiments with simple patterns of wind stress and surface heating. In some cases stratification and/or mixed layer physics were suppressed. On the basis of these experiments we reached the following conclusions:

The vertical circulation at the equator is so vigorous that surface heating is essential if stratification is to be maintained for periods longer than a few months. Without stratification to inhibit mixed layer deepening momentum will be mixed uniformly to the main thermocline and the equatorial undercurrent will disappear.

Vertical transfers of momentum due to vertical advection and mixed layer entrainment are essential features of equatorial dynamics. These process influence currents, SST and upwelling rates more than changes in sea surface elevation. Consequently, the overall mass field adjustments of equatorial oceans are more nearly linear than are the currents or SST variations.

The connection between changes in SST and dynamical quantities such as sea surface topography need not be straightforward. For example, increased upwelling will make the mixed layer shallower but will not reduce SST unless it induces increased entrainment of colder water. The influences of upwelling and down-welling on SST are highly asymmetric so that the influence of perturbations cannot be predicted without considering the mean vertical

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velocity.

The asymmetry in the interaction between vertical velocity and mixed layer physics can result in the formation of surface fronts. On the upwelling side of a $w = 0$ line the surface layer is cold and shallow while on the downwelling side it is warm and deep. Differential advection creates a temperature discontinuity at the depth discontinuity. It is suggested that the Galapagos Front has this character.

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