MODELING DEEP EQUATORIAL CIRCULATION

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Abstract

Observations show that there are significant zonal currents near the equator below the thermocline, the so called equatorial deep jets. The dynamics of these currents are unknown. In this study, the origin of the equatorial deep jets is explored through a series of numerical experiments.

High resolution thermohaline spin up experiments were undertaken to investigate the thermohaline hypothesis of equatorial deep jets. It is found that the deep circulation strongly depends on the deep stratification. If this is unrealistically weak, an alternating jet structure and strong deep upwelling near the equator can be generated. This strong upwelling can result in an extra meridional overturning cell near the equator in the meridional mass transport streamfunction. The lack of stratification in the deep ocean is a generic deficiency of large scale circulation models which employ insulating bottom boundary conditions. The deep stratification can be improved greatly by using a Newtonian bottom boundary condition for temperature. The resulting streamfunction is more realistic and the deep equatorial overturning cell and alternating jets disappeared. It is the bottom boundary condition rather than the size of the vertical diffusion coefficient that is more important in determining the deep stratification and deep equatorial flow. Even though we cannot completely rule out the thermohaline forcing hypothesis of the equatorial deep jets (because thermohaline spinup experiments with very low explicit diffusion have not been carried out to investigate the dynamics of thermohaline circulation in a low diffusive regime), it is improbable that the deep jets are purely thermohaline in origin.

High resolution, low diffusion wind-forced equatorial models were next run to investigate whether subthermocline mean equatorial currents can be generated via

instabilities of the surface currents and wave-wave interactions. It is found that if eddy diffusion coefficients for momentum and heat are low enough, there are significant subthermocline time-mean currents. These currents are connected to low latitude western and eastern boundary subsurface currents. The eddy processes (Reynolds stress divergence) are found to be as important as the parameterized sub-grid processes (explicit diffusion).