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Role of vertical velocities in the cooling of the Atlantic cold tongue

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The formation of the Atlantic cold tongue in the eastern equatorial Atlantic is generally viewed as resulting from the equatorial upwelling induced by the divergence of currents on the equator. Vertical velocities resulting from this divergence are thought to be strong enough to bring subsurface cold waters to the surface, thus inducing the rapid seasonal cooling observed. This classical view differs somewhat from what is seen in recent observations and modelling studies. In this presentation, we show that the classical Ekman theory is inappropriate at the equator and that vertical advection is not the main source of cooling in the cold tongue.

Our findings suggest that vertical velocities are instrumental in preconditioning the mixed layers, by bringing the thermocline closer to the surface. South of the equator, the presence of upward vertical velocities results from the existence of a dynamical equilibrium which is broken after the reinforcement of the south-easterlies in May-June, at the beginning of and during the cold season. Because of preconditioned shallower mixed layers, cooling is much easier in the cold tongue than elsewhere and is essentially due to vertical turbulent mixing resulting from the shear of horizontal currents increased by surface wind stress.