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The time mean ocean dynamics as viewed from the mass-weighted averaging of equations in isopycnal coordinates

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Oceanic motions are highly constrained by stratification and rotation. Advective fluxes of mass, tracers, momentum and energy are closely related to the distribution of potential density and potential vorticity. Here, the perspective of time mean ocean dynamics obtained by mass-weighted averaging the equations of motion in potential density coordinates is reexamined, emphasizing its handling of stratification and rotation constraints.
This framework exhibits unambiguously the fact that the time mean flow inherits the stratification constrait through the averaging process : mean and rectified advective fluxes of mass, tracers, horizontal momentum and energy across potential density surfaces are explicitly bound up by the diabatic effects, and vanish for instantaneous ideal flow. In such a limit case, horizontal momentum and energy can only be redistributed across potential density surfaces via mean and rectified non-advective fluxes involving the pressure field and the potential density surfaces slopes (form drag). The inherited rotation constraint is not as clearly exhibited, and some manipulations are required to identify it. By discussing both the equations for time mean potential vorticity and eddy enstrophy, we can obtain a useful rewriting of the equations, highlighting the effects of the rotation constraint on mean and rectified advective fluxes.