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New developments and diagnostics related to the mass flux convective parameterization in the NEMO ocean model

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Ocean convective events are triggered by vertical density instabilities, e.g., following significant surface heat loss at dusk or upon sea-ice formation. They have a significant impact on the vertical distribution of ocean heat, salt, and biogeochemical content, most frequently in its shallowest few hundreds of meters, but also occasionally much deeper. The representation of such events within ocean models requires a specific treatment adapted to vertically nonlocal processes, since most turbulent closure schemes are based upon Boussinesq-derived diffusivity coefficients and are thus fundamentally local. Consequently, different methods have been employed for making vertical diffusion schemes also accounting for convection. Past examples used in NEMO include, e.g., adding a nonlocal term in the diffusivity parameterization (e.g., K-profile) or simply enhancing the vertical diffusivity.

Another more recent example is the mass-flux convective (MFC) scheme, which has recently been adapted for the NEMO ocean model and can be used as a convective complement to any diffusion-only scheme (e.g., scaled from turbulent kinetic energy). The MFC scheme allows generating subgrid-scale buoyancy-driven convective plumes which can reach down to 2000m depth in extreme cases. Within the plumes, physical quantities of interest (e.g., temperature, salinity) are vertically transported independently from the large-scale model dynamics, at velocities which can exceed by far anything permitting by it (up to 20 cm s^{-1}) implying fast, deep-reaching vertical mixing. Hence, in addition to local fluxes associated with small, diffusion-related eddies, the large-scale model solution can also be affected by nonlocal convective fluxes associated with large eddies produced by the MFC scheme.

In this talk, we present new developments and tests related to the MFC parameterization. Namely, we introduce the application of this scheme to passive biogeochemical tracers, as well as turbulent kinetic energy and model dynamics (i.e., ocean velocities). Results over 1D configurations illustrating the impact of these novelties are presented. Finally, we also show first results over a NEMO global 1/4° configuration involving previously unexplored convection-prone conditions,

such as sea-ice formation.