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Mixed layer modes of the two-gyre system

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The coupling of the upper mixed layer with the thermocline is investigated in a planetary geostrophic model. Assuming that submesoscale instabilities lead to a rectified effect of geostrophic eddies on the (late winter) mixed layer depth D, and that the mesoscale eddy field is stronger where the thermocline (depth G) is larger, a parameter (r) coupling D to G is identified. Inclusion of this parameter in the Pedlosky and Young (1983) model leads, given an idealised wind forcing, to two modes, each valid over both subtropical and subpolar gyres. One has a mixed layer of uniform depth, the other a mixed layer deepening westward with a maximum in the subpolar gyre. The latter mode is particularly interesting as it displays an "overlapping" between the surface and subsurface gyres (i.e., an expanded subpolar gyre at the surface and an expanded subtropical gyre at depth), cross-gyre exchange, asymmetry between subduction and obduction, as well as Eastern boundary jets. It is suggested that this mode is relevant to the structure of the North Pacific thermocline.

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