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Assessment of the numerical efficiency of ocean circulation model : Hycom contribution to the COMODO project

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The French navy hydrographic service uses a modified version of the Hybrid coordinate ocean model (HYCOM) for operational oceanographic applications. In the framework of the COMODO project, a series of test cases has been carried out to measure the numerical efficiency of the model. It addresses a wide panel of oceanic processes (baroclinic eddy, baroclinic jet, coastal upwelling, internal tides) and is useful to examine most of numerical schemes (advection schemes, time stepping, pressure gradient, ...).
The objectives of this study are first to assess the numerical performance of the present model to guide the modelers to make the suitable choices, and second to examine how the performances may be improved in the next years.
We examine the sensitivity of the main choices for Hycom (2th or 4th order advection schemes, and viscosity values) in baroclinic eddy and baroclinic jet test cases. Both test cases are run using increasing resolution. The highest resolution provides a reference for studying the coarser resolutions. In the baroclinic vortex test case, the second order vector form scheme is well performing whereas the 4th order scheme appears to be more accurate in the baroclinic jet test case. This is probably due to the lack of fine scale energy in the baroclinic vortex test case allowing simulations with very tiny dissipation rates.
We focus then on the sensitivity of the performance to vertical coordinate choices. The ability of Hycom to switch between isopycnal coordinate and quasi geopotential coordinate provides useful insights for example on the sensitivity of numerical diapycnal mixing to remapping scheme. This is particularly visible on the internal tide test case. The type of vertical coordinate is also important for potential vorticity structures. The shape of the baroclinic vortex is found to be different in geopotential and isopycnal coordinates. At coarse resolution, the potential vorticity structures seem to be better resolved in isopycnal coordinate.
The change of the time stepping scheme is also a promising improvement. The leap frog scheme used in the standard version may be replaced by a Runge-Kutta time stepping method. First insights are presented here.