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Towards a suite of test cases and a pycomodo library to assess and improve numerical methods in ocean models

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The COMODO group (http://www.comodo-ocean.fr) gathers developers of global and limited-area ocean models (NEMO, ROMS_AGRIF, S, MARS, HYCOM, S-TUGO) with the aim to address well-identified numerical issues. In order to evaluate existing models, to improve numerical approaches and methods or concept (such as effective resolution) to assess the behavior of numerical model in complex hydrodynamical regimes and to propose guidelines for the development of future ocean models, a benchmark suite that covers both idealized test cases dedicated to targeted properties of numerical schemes and more complex test case allowing the evaluation of the kernel coherence is proposed.

The benchmark suite is built to study separately, then together, the main components of an ocean model : the continuity and momentum equations, the advection-diffusion of the tracers, the vertical coordinate design and the time stepping algorithms. The test cases are chosen for their simplicity of implementation (analytic initial conditions), for their capacity to focus on a (few) scheme or part of the kernel, for the availability of analytical solutions or accurate diagnoses and lastly to simulate a key oceanic processus in a controlled environment.

Idealized test cases allow to verify properties of numerical schemes
advection-diffusion of tracers,
- upwelling,
- lock exchange,
- baroclinic vortex,
- adiabatic motion along bathymetry,
and to put into light numerical issues that remain undetected in realistic configurations
- trajectory of barotropic vortex,
- interaction current - topography.
When complexity in the simulated dynamics grows up,
- internal wave,
- unstable baroclinic jet,
the sharing of the same experimental designs by different existing models is useful to get a measure of the model sensitivity to numerical choices (Soufflet et al., 2016). Lastly, test cases help in understanding the submesoscale influence on the dynamics (Couvelard et al., 2015).

Such a benchmark suite is an interesting bed to continue research in numerical approaches as well as an efficient tool to maintain any oceanic code and assure the users a stamped model in a certain range of hydrodynamical regimes. Thanks to a common netCDF format, this suite is completed with a python library that encompasses all the tools and metrics used to assess the efficiency of the numerical methods.

References
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