A high-resolution multi-purpose particle tracking framework for coastal areas near Japan

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A comprehensive and multi-purpose particle tracking framework using latest high resolution velocity field in the coastal regions near Japan is developed.
The particle tracking system uses accurate fourth order Runge-Kutta method and implements random-walk based diffusivity, and is built-in the recent versions of MRI.com (an OGCM developed in Meteorological Research Institute, Japan Meteorological Agency) and kinaco (a non-hydrostatic ocean model developed in Atmosphere and Ocean Research Institute, University of Tokyo) for *on-line* use. Each particle is able to store up to seven arbitrary properties (such as size, age, exposed temperature, orientation, mass and buoyancy, etc.) and record the history of them.

The code is effectively parallelized (using MPI and OpenMP hybrid technique) and allows ~$O(10^{10})$ particles on modern massive-parallel supercomputers, and is also ported to GPU architecture using CUDA language.

This particle tracking framework has no particular target in a priori, and can be applied to various purposes for both physical oceanography (from large scale tracking of water masses to small scale modeling of suspended sediment matter or frazil ice crystals) and ocean biogeochemistry (tracking of trace elements, Laglangian modeling of plankton and detritus, individual based modeling of fishes and marine resources), only by defining appropriate properties and inserting a few lines of code that manipulats them corresponding to the particular target use.

In the presentation, we will introduce an application of this framework to the tracking of passive particles scattered in the coastal areas near Japan using velocity field provided by the latest very high resolution ocean modeling (~300 m mesh). Each model particle records its trajectory and the history of exposed environment, and can be interpreted as eggs or larvae (before acquiring swimming ability) of species of corresponding spawning areas and seasons as well as the tracers for small scale water mass exchanges.

Keywords: Particle tracking system