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Lagrangian stochastic models for an operational surface material transport estimation system: A first stage validation for turbulent transport with stochastic and real operational data

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An adequate prediction of Lagrangian material transport at the first layer of the ocean, i.e. transport of pollutants, nutrients, containers, shipwrecked persons, drifted vessels, etc, is one of the most important tasks of the Ocean Operational Systems. In ocean surface, Lagrangian dynamics is due basically to winds and currents. At some operational levels, the estimation of these forcings implies simplifications due to selection of time – space resolutions, missed physics, unresolved scales and errors, which in turn can produce important deviations in the Lagrangian prediction of the transport. On the other hand, a number of studies (e.g., Aref 1984, Samelson 1996) have shown that Lagrangian motion often exhibit chaotic behaviors, even in simple and regular Eulerian flows. Thus, it is necessary in some other way, to model Lagrangian behaviours that can not be well described with available estimated forcings (turbulent transport in this study). In the last fifteen years, the stochastic modelling of transport processes in ocean had been increasingly developed and used. Essentially, stochastic models allow to represent some statistical complex behaviours in space and time and allow modelling of a physical process as a mean component (deterministic) plus a fluctuation. The above is quite adequate for transport process in a geophysical fluid: advection owing to well estimated forcings at some scale and transport effects owing to turbulence.

To date, several stochastic models have shown good applicability in mesoscale ocean ranges (days and dozens of kilometers) and open seas, but operational systems have to respond to questions in submesoscale ranges and coastal seas. Therefore, towards to have more representative and accurate tools, it is considered necessary to evaluate the performance of this type of models in those environments and scales.

In this study, in the framework of Operational Oceanography Systems, it is conducted a first stage validation test of two specific types of the so-called Lagrangian Stochastic Models (LSM): Markovian single particle models (Griffa 1996) and Markovian multiparticle models (Piterbarg 2001). Each of these two types of models helps to respond to two types of specific operational questions: What is Probability Distribution Function of the positions of Lagrangian particles at time t? and What is the specific trajectory of a particle from the knowledge of the positions and velocities of other observable particles?

The validation test was carried out at two levels: first, stochastic flows (Kraichnan 1970, Drummond et al 1982, Haza et al 2007) had been constructed and used to test the models under a variety of controlled and regulated synthetic turbulent conditions; then, an operational exercise realized during ESEOO Spanish Operational Project, was used to test the models under real conditions. The test with stochastic flows was mainly directed to assess the ability of the different models to simulate several levels of turbulent characteristics as temporary memory, spatial correlation, spatial component correlations, etc. The test with real data was conceived as a first evaluation towards identification of necessities for future calibrations in Spanish seas.

References

Aref, H., 1984: Stirring by chaotic advection. J. Fluid Mech., 143, 1–21.

Samelson, R. M., 1996: Chaotic transport by mesoscale motions. Stochastic Modelling in Physical Oceanography, R. J. Adler, P. Müller, and B. L. Rozovoskii, Eds., Birkhauser, Boston, 467 pp, 423–438.

Griffa, A., 1996: Applications of stochastic particle models to oceanographic problems. Stochastic modelling in Physical Oceanography. Eds R.Adler, P. Müller, B. Rozovskii. Birkhauser, Boston, 467 pp, 113-128.

Piterbarg, L.I., 2001: The top Lyapunov exponent for a stochastic flow modelling the upper ocean turbulence. SIAM J. Appl. Math., 62, 3, 777 - 800.

R.H. Kraichnan, 1970: Diffusion by a random velocity field. Phys. Fluids 13, 22.

I. T. Drummond, S. Duane, and R. R. Horgan, 1983: The stochastic method for numerical simulations: Higher order corrections. Nucl. Phys. B220, 119 -136.

Haza A. C., Piterbarg L. I., Martin P., Ozgokmen T. M., Griffa A., 2007: A Lagrangian Subgridscale Model for Particle Transport Improvement and Application in the Adriatic Sea Using the Navy Coastal Ocean Model. Ocean Modelling, (17), 68-91.