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FLOW DECOMPOSITION FOR VELOCITY DATA ASSIMILATION

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Ocean observational current data are usually acquired from limited number of stations in domains with open boundaries and contain various errors or noises. It is an important task for physical oceanographers to establish (or to reconstruct) a realistic and complete velocity field from sparse and noisy data.

From a mathematical point of view, the reconstruction requires solving a least square problem without or with a priori information (limit) on the circulation characteristics. An a priori limit can be formulated as a set of inequalities that the solutions should satisfy, as a dynamical model applied to the description of circulation dynamics or hypotheses on statistical properties of reconstructed field.

Without knowing statistical weights and without using ocean numerical models, a kinematical method is proposed for reconstructing a velocity field from noisy and sparse data. For a three-dimensional incompressible flow, two scalar functions, toroidal and poloidal potentials, satisfy Poisson equations with the vertical vorticity and vertical velocity as the sources terms, respectively.

In this talk, a new set of basis functions is introduced for reconstructing the ocean circulation in a domain with open boundaries. These functions are the eigenfunctions of Laplacian operator with homogeneous mixed conditions. With known velocities along the open boundary, the mixed boundary conditions are accurate. With unknown velocities along the open boundary, a parameterization scheme is proposed for obtaining approximate open boundary conditions from data. In general, the reconstruction is reduced to linear and nonlinear regression models for known and unknown velocities along the open boundary, respectively. For the latter (without data on the open boundary), the velocity inside the domain and along the boundaries are simultaneously determined.

References

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