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Parameter estimation in ocean circulation models: comparison of stochastic perturbation and variational approaches

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With increasing computing resources and data availability, we now have the possibility to develop new data assimilation methods. This study focuses on the use of two different algorithms to estimate parameters linked to bottom friction in ocean general circulation models.

The first method is the simultaneous perturbation stochastic approximation (SPSA). For this approach, the gradient is approximated with a fixed number of cost function measurements, regardless of the dimension of the vector to be estimated. Each cost function is obtained with random perturbations of every component of the parameter vector. Thus, this algorithm is especially interesting in problems with a large number of parameters. The second algorithm is based on a variational approach involving the use of an adjoint code to compute gradients which allow the minimization of the cost function.

For these experiments, we use the HYbrid Coordinate Ocean Model (HYCOM) in barotropic mode (one isopycnal layer). The area includes the Bay of Biscay, the English Channel and the North Sea. The only forcing field is tide which is forced at the boundaries of the domain. The parameter to be estimated is the bottom friction coefficient which determines dissipation due to flows near the bottom. Data used for cost function computation are elevations measured by tide gauges. Criteria considered for the comparison of the two methods are the ability to minimize cost function and the computational cost.