Multi Resolution Variational Data Assimilation Schemes With Application to a Realistic Ocean Model.

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The convergence of variational data assimilation algorithms for high dimensional non-linear systems is an important issue. The approach currently in use in most of the operational applications is known as Multi-Incremental 4D-Var or Perturbed Gauss Newton (PGN) where the inner problem of the Gauss Newton algorithm is solved with a succession of reduced resolution / simplified physics approximations of increasing complexity of the original problem. However this algorithm is known to converge toward a minimum that is different from that of the original problem. As a result of this the number of iterations has to be limited in order to avoid the risk of divergence.

By controlling the error made between successive approximations one can derive a more robust algorithm that will converge toward the original minimum provided the right conditions are fulfilled. These conditions can easily be verified and the additional cost is modest compared to PGN. Applying this algorithm to the outer iteration of the Gauss Newton algorithm instead can bring a further improvement by reducing the risk of getting stuck in a local minimum.

These algorithms are part of recent developments of the NEMOVAR system, which is a state-of-the-art variational data assimilation system dedicated to NEMO the European ocean community model. NEMOVAR is used in two major operational centres in its 3D-Fgat configuration.
The general NEMOVAR framework and the different algorithms will be presented, they will be applied to realistic ocean configurations and their relative merits will be compared. Moreover difficulties related to the specificities of the ocean will be discussed since both algorithms requires the use of operators allowing to project system states from one resolution to another, which could be delicate for ocean applications due to complex boundaries