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# A scalable, weak formulation of the continuity constraint across domain boundaries for global ocean eddy-resolving applications

The ocean forecasting community is recently devoting a growing effort towards the prediction of mesoscale processes at global scale. New high-resolution global simulation are able to resolve mesoscale structures in large part of the basin. On the other hand, a realistic representation of mesoscale variability is triggered by the capability of the assimilation schemes to efficiently ingest and combine several observing networks at the same model resolution and requires DA codes to be massively parallelized. One of the main bottlenecks that arises in this case is how to handle long correlations in presence of domain boundaries. Exact and continuous solutions over the halo/overlapping regions of different domains require multiple communications within neighbours that can potentially destroy the scalability of the code.
In this presentation, we treat the continuity restoration over the halo regions by including a new term in the cost function that drives the solution towards the continuous one [1]. This corresponds to relax the strong continuity constraint across the boundaries into a weak formulation and define a maximum allowed discontinuity among different solutions over the same halo regions (i.e. boundary continuity error"). The formulation forces possible boundary discontinuities to be less than a prescribed error, and minimizes the parallel communication compared to standard method. Theoretically, the exact solution is recovered by decreasing the boundary error towards zero. Practically, it is shown that the accuracy increases until a lower bound arises ( minimizer accuracy, mesh, etc).
Results are assessed in term of both scalability and accuracy exploiting a global ocean grid at 1/16° resolution. We also show the benefit of using a global eddy-resolving grid by comparing two experiments with different spatial resolution at assimilation level (1/16°-1/4°) and same resolution at forecast level (1/16°) [1].

[1] Cipollone, A., Storto, A., and Masina, S. (2020), JTECH, 37(10), https://doi.org/10.1175/JTECH-D-19-0099.1

## Which theme does your abstract refer to?

Data assimilation methods (algorithmic developments in variational, ensemble and hybrid DA, covariance modelling, etc)

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