

Introducing time parallelisation within data assimilation using parareal

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Four dimensional variational data assimilation (4DVAR) methods, in their incremental formulation, are based on optimization algorithms which require the integration of the forward and adjoint versions of the original model in order to compute its gradient. For their use on parallel computers, these models are classically parallelized only on the spatial dimension and this is a limiting factor on the maximum number of computing cores that can be used. We here present a novel approach of introducing additional time parallelisation using the parareal method. This approach is used here for the integration of the forward model. We use a modified version of the inexact conjugate gradient method where the matrix-vector multiplication is supplied through the parareal algorithm. The use of this inexact conjugate gradient and the associated convergence conditions allows to determine precisely the stopping criterion of the iterations of the parareal method. The results are demonstrated by considering a one dimensional shallow water model. They are presented in terms of the accuracy (in comparison with the original exact conjugate gradient) and in terms of the number of required iterations of the parareal algorithm.

HAL link to the paper : <https://hal.inria.fr/hal-03540480/>