6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Towards parallel in time methods for numerical weather prediction.

Jemma Shipton[1], Colin Cotter[1], Beth Wingate[2] and Martin Schreiber[2]

[1] Department of Mathematics, Imperial College London, South Kensington Campus, London, SW7 2AZ, jshipton@ic.ac.uk

[2] College of Engineering, Mathematics and Physical Sciences, Harrison Building, Streatham Campus, North Park Road, Exeter, EX4 4QF

Keywords: *asymptotic parareal, parallel-in-time, rational approximation of exponential integrators, shallow water equations*

We present recent work on a parareal algorithm for solving the rotating shallow water equations. These equations are the simplest to exhibit behaviour relevant for atmospheric modelling and as such are often used as a test bed for new numerical algorithms.

The parareal algorithm has two ingredients: a cheap integrator (the coarse propagator) and a more accurate integrator (the fine propagator). The convergence rate, and hence efficiency, of this scheme is strongly affected by the accuracy of the coarse propagator. Our approach follows that of [1] where it was shown that averaging the nonlinear terms over some fast oscillations includes the effects of near-resonances, essential for accuracy and hence convergence. A key component of this scheme is the computation of the exponential of the linear operator corresponding to the fast linear waves in the system. Here we use the rational approximation approach of [2]. This requires the solution of an elliptic problem for each term. The method is highly parallelisable as each term can be computed separately, but the solution of each term must be efficient, scalable and fast. In this talk, we describe how we construct a coarse propagator and present the latest results from various test cases.

REFERENCES

[1] Haut, T. and Wingate, B. *An asymptotic parallel-in-time method for highly oscillatory PDEs.* SIAM Journal on Scientific Computing, 36.2 (2014), A693-A713

[2] Haut, T. et al *A high-order time-parallel scheme for solving wave propagation problems via the direct construction of an approximate time- evolution operator.* IMA Journal of Numerical Analysis, 36(2) (2015), 688-716