

Title: Towards parallel time stepping schemes for compatible finite element discretisations of the shallow water equations

Abstract: Compatible finite element methods are a form of mixed finite element method that allow the exact discrete representation of vector calculus identities such as $\text{div-curl}=0$. This is attractive to the numerical weather prediction community as it provides the flexibility to run on non-orthogonal grids, thus avoiding the communication bottlenecks associated with the orthogonal latitude-longitude grid, while retaining the necessary convergence and wave propagation properties required for accuracy. Although the flexibility of the compatible finite element spatial discretisation improves the parallel scalability of the model, it does not solve the parallel scalability problem inherent in the sequential timestepping: we need to find a way to perform parallel computations in the time domain. Exponential integrators, approximated by a near-optimal rational expansion, offer a way to take large timesteps and form the basis for parallel timestepping schemes based on wave averaging. I will describe the progress we have made towards implementing these schemes and designing efficient solvers for the linear systems that arise from combining them with the compatible finite element discretisation.