Compatible finite element methods for numerical weather prediction on moving meshes.

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We present recent work on integrating optimal-transport-based mesh movement into a compatible finite element shallow water model. This work has been motivated by the need for numerical weather prediction models to resolve fine scale features without incurring the cost of having a fine grid resolution over the entire globe. Compatible finite element methods are a type of mixed finite element method (where different finite element spaces are used for different fields) where the divergence of the velocity space maps on to the pressure space. This necessitates the use of div-conforming finite element spaces for velocity, such as Raviart-Thomas and Brezzi-Douglas-Marini, and discontinuous finite element spaces for pressure. Cotter and Shipton (2012) demonstrated that compatible finite element discretisations for the linear shallow water equations satisfy the basic conservation, balance and wave propagation properties listed in Staniforth and Thuburn (2012). The linear equations dictate our choice of finite element spaces; we then need to construct stable and accurate advection schemes to solve the nonlinear equations. This is complicated by the presence of the mesh velocity in the equations. In this talk we will describe our mesh movement approach and present the latest results from integrating it into our shallow water model.