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A characteristic mapping method for incompressible hydrodynamics on a rotating sphere

We present a semi-Lagrangian method for diffeomorphism approximation and its application to incompressible hydrodynamics on the sphere. The method approximates the flow of a velocity field using a spatio-temporal discretization formed by a composition of submaps. This technique substitutes the effects of spatial refinement with the operation of composition by adaptively growing the temporal discretization. In turn, the method has the capacity of accurately and sparsely representing the generation of fine scales globally using only a linear increase in the degrees of freedom. The design and analysis of the method is presented and supported through numerical experimentation on some canonical geophysical flows.