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Computation of the deformation spectrum for flows on a sphere
SIAVASH AMELI, SHAWN SHADDEN, UC Berkeley — The most common example of flow on a manifold is flow on a sphere with numerous geophysical examples. In this talk we consider the direct and accurate computation of the nonlinear deformation tensor describing fluid kinematics on manifold surfaces, and in particular efficient computation on spherical domains. We demonstrate that standard spherical coordinate computations are undesirable and instead integration of the singular deformation tensor in Cartesian coordinates restricted to the sphere can be advantageous. This approach yields a set of differential algebraic equations that can be reduced by symmetry to yield differential equations for a 2D flow. We have applied our method to the steady and unsteady flows generated by vortex sets on the sphere as well as geophysical flow models. For the former, we demonstrate that the evolution equations near the vortices can become singular and numerically unstable. To resolve this, we derived an exact solution for the spectral components of the deformation tensor near the vortices, which also enables us to match and validate our numerical solution.

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