THE FIELDS INSTITUTE
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ABSTRACTS 1.2

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A Semi-Lagrangian Double Fourier Method for the Shallow Water Equations

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We describe a numerical method, based on the semi- Lagrangian semi-implicit method, for solving the shallow water equations (SWE) in spherical coordinates. The most popular spatial discretization method used in global atmospheric models is currently the spectral transform method, which generates high-order numerical solutions and provides an elegant solution to the pole problems induced by a spherical coordinate system. However, the standard spherical harmonic spectral transform method requires associated Legendre transforms, which, for problems with resolutions of current interest, have a computational complexity of $\mathcal{O}(N^3)$, where N is the number of subintervals in one dimension. Thus, the double Fourier spectral method, which uses trigonometric series, may be a viable alternative. The advantage of the double Fourier method is that fast Fourier transforms, which have a computational complexity of $\mathcal{O}(N^2 \log N)$, can be used in both the longitudinal and latitudinal directions. In this implementation, the SWE are discretized in time by means of the three-time-level semi-Lagrangian semi-implicit method, which integrates along fluid trajectories and allows large time steps while maintaining stability. Numerical results for the standard SWE test suite are presented to demonstrate the stability and accuracy of the method.