Geophysical Research Abstracts
Vol. 16, EGU2014-2677, 2014
EGU General Assembly 2014

The composite-tendency RAW filter in semi-implicit integrations

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The time discretization in weather and climate models introduces truncation errors that limit the accuracy of the simulations. Recent work has yielded a method for reducing the amplitude errors in leapfrog integrations from first-order to fifth-order. This improvement is achieved by replacing the Robert–Asselin filter with the RAW filter and using a linear combination of the unfiltered and filtered states to compute the tendency term. In the present work we apply the composite-tendency RAW-filtered leapfrog scheme to semi-implicit integrations. A theoretical analysis shows that the stability and accuracy are unaffected by the introduction of the implicitly treated mode. The scheme is tested in semi-implicit numerical integrations in both a simple nonlinear stiff system and a medium-complexity atmospheric general circulation model, and yields substantial improvements in both cases. We conclude that the composite-tendency RAW-filtered leapfrog scheme is suitable for use in semi-implicit integrations.