Formulation and performance of VCAM

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Abstract

Two cube-based atmospheric GCMs have been developed at CSIRO, the Conformal-Cubic Atmospheric Model (CCAM) and, more recently, the Variable Cubic Atmospheric Model (VCAM). CCAM is formulated on the conformal-cubic grid, and employs 2-time-level semi-Lagrangian semi-implicit numerics. On the other hand, VCAM is cast on the highly-uniform equiangular gnomonic-cubic grid and employs a split-explicit flux-conserving approach. The conservative formulation, together with flux-limited advection, is appealing for climate studies and for modelling trace gases. Both models employ reversible staggering for the wind components (McGregor, MWR, 2005), producing good wave dispersion behaviour. Special treatments are employed to handle panel edges and orography; hybrid and non-hybrid vertical coordinates produce similar satisfactory simulations. Both models can be run in variable-resolution mode, employing the Schmidt (1977) transformation.

VCAM avoids the message-passing overheads necessitated by the Helmholtz solver of CCAM. VCAM now only requires infrequent calls (once per time-step) to the wind staggering/unstaggering routine, although message passing during the sub-time-steps is required for calculating pressure gradients.

Comparative model performance will be shown for selected advection tests, aquaplanet simulations, and for AMIP simulations where VCAM and CCAM use the same physics routines.