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Cloud-resolving component in the quasi-3D multi-scale modeling framework

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A quasi-3D multi-scale modeling framework (Q3D MMF), which combines a GCM with a Q3D CRM, is an attempt to include three dimensional cloud effects in a GCM without necessarily using a global cloud-resolving model. The horizontal domain of the Q3D CRM consists of two perpendicular sets of channels crossing at the center of a GCM grid box, each of which includes two grid-point arrays. Through coupling this structure with a GCM, the whole system of the Q3D MMF can converge to a fully 3D global CRM as the GCM's resolution is refined. Consequently, the horizontal resolution of the GCM can be freely chosen depending on the objective of application. However, due to the use of very narrow channels for the cloud-resolving component, its prediction algorithm must be specially designed.

As a step in developing a Q3D MMF, we have first constructed a prediction algorithm for the Q3D CRM applying a 3D anelastic vector vorticity equation model to the Q3D network of grid points. Preliminary tests of the Q3D CRM have been performed for an idealized small domain. Comparing the results with those of the straightforward application of a 3D CRM, it is concluded that the Q3D CRM can reproduce most of the important statistics of the 3D solutions and the MMF based on the Q3D CRM will be a useful framework for climate modeling. This paper presents an outline of the Q3D algorithm and highlights of the results.