********** Application form **********

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Title of presentation:

Development of a quasi-3D multi-scale modeling framework: motivation, basic algorithm and preliminary results

Abstract:

A quasi-3D multiscale modeling framework (Q3D MMF), which combines a global climate model (GCM) with a quasi-3D cloud resolving model (Q3D CRM), is an attempt to include three dimensional cloud effects in a GCM without necessarily using a global CRM. The horizontal domain of the Q3D CRM consists of two perpendicular sets of channels crossing at the center of a GCM grid cell, each of which includes only a few grid-point arrays. Through coupling this CRM 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.

As a step in developing the Q3D MMF, we have constructed a prediction algorithm for the Q3D CRM applying a 3D anelastic vector vorticity equation model to the Q3D network of grid points. Since the channels of grid network are very narrow it is crucial to have a proper lateral boundary condition. Based on trials of many different ways, the lateral boundary condition is implemented through assigning the values in such a way that the large-scale information is obtained from the GCM and the distribution of the smaller scale in the normal direction to the channel is assumed to be periodic. The perpendicular channels are coupled only through basic prognostic variables averaged over channel segments to avoid singularity at the intersection.

To evaluate the newly developed Q3D CRM in an efficient way, idealized experiments have been performed for a small domain. In these tests, the Q3D CRM is applied with only two grid-point arrays in each channel and only one pair of channels. Then, the ratio of the number of grid points used for prediction in the Q3D and 3D CRMs is 3%. Comparing the simulation 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 including the vertical distributions of cloud water and precipitants, vertical transports of potential temperature and water vapor, and the variances and covariances of dynamical variables.

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