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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Toward unification of the multiscale modeling of the atmosphere" *by* A. Arakawa et al.

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The authors thank Dr. Grabowski for his review of the paper with stimulating comments. There seems to involve, however, rather serious misunderstanding. The objective of subgrid-scale parameterization is to formulate the effects of unresolved eddies. By definition, unresolved eddies have their own closed mass budget with no net mass source or sink that affects the mass budget of resolvable scales. The equations affected by cumulus parameterization are those for predicting the (potential) temperature, the mixing ratios of water substances and possibly the momentum, not the continuity equation. To our knowledge, no cumulus parameterization that works in realistic numerical models modifies the mass budget and, therefore, mass conservation is not an issue. The following paragraph is a slightly expanded version of the relevant comment given in the

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paper: “Here it is important to note that the “cumulus-induced subsidence” is only a hypothetical subsidence. It is a component of the subgrid-scale eddy, which has its own mass budget closed within the same grid cell by definition. This does not mean that the true subsidence is confined within that cell. The true subsidence is the sum of the blue and red vertical arrows in Fig. 5(a), which normally tend to compensate each other. In such a case, the true subsidence occurs in another grid cell, which may well be far away, whose position is determined by the grid-scale dynamics, not by the parameterization. This point is often misunderstood in the literature.” With respect to Dr. Grabowski’s second comment, it should be remembered that one of the basic requirements of the Q3D MMF is that it converge to a 3D CRM. This naturally means that the code structure of the Q3D MMF is likely to be similar to that of a 3D CRM rather than that of the classical GCMs inherited by the prototype MMF.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 3181, 2011.