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Superparameterization and mesoscale dynamics

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Representation of convection and cloud processes is the most uncertain aspect of numerical modeling of weather and climate. Horizontal grid spacing around 1 km is required to resolve gross features of deep convection and even higher resolution is needed for shallow clouds. Only recently cloud-resolving (or convection-permitting) resolutions became feasible for the continental-scale numerical weather prediction (NWP) using nonhydrostatic models. For climate, cloud-resolving modeling of atmospheric general circulation is in its infancy, with the first global cloud-resolving simulation (only 10-day long) recently completed in Japan. As far as traditional climate models are concerned, a different approach was recently proposed by this author to include elements of cloud physics in large-scale models of weather and climate. The cornerstone is to apply a two-dimensional (2D) cloud-resolving model in each column of a large-scale model to represent small-scale and mesoscale processes and couplings among them. This approach was termed the Cloud-Resolving Convection Parameterization (CRCP) and has since been often referred to as the "superparameterization". This paper will show that a similar approach can be used in mesoscale modeling, with models featuring horizontal gridlength in the 10 to 50 kilometers range. In such a case, convective-scale processes (such as individual convective clouds or convective drafts within mesoscale systems) are resolved by the 2D superparameterization models, whereas mesoscale processes (e.g., convective organization into mesoscale systems) are treated by the mesoscale model. To illustrate this point, results from idealized simulations of organized convection developing in the mean GATE environment will be presented at the conference. The overall conclusion is that the superparameterization approach seems a valuable approach for mesoscale models with horizontal gridlength in the range of 10 to 50 km, such as in regional climate or NWP models.