Super-parameterization: Global context for cloud-scale processes

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Abstract

Representation of cloud-scale processes is the most uncertain aspect of global climate and weather modeling. This is because large-scale models can resolve only mesoscale dynamics at best, and all small-scale processes have to be parameterized. At the same time, however, cloud processes are hypothesized to play a major role in weather and climate through the impact of atmospheric aerosols on nucleation and growth of cloud particles, precipitation formation mechanisms, and cloud-radiation interactions. Arguably, the situation would be much improved if a global cloud-system-resolving model, with horizontal grid increment of about 1 km, is used. However, such models are not expected to be practical before the end of this decade and alternative approaches are needed. One possibility is to apply a 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 it has since been often referred to as the "super-parameterization". A climate model with super-parameterization is two to three orders of magnitude more costly than traditional climate models, but at the same time it is two to three orders of magnitude less expensive than a cloud-system-resolving global model. Super parameterization has been applied to idealized problems, such as the large-scale organization of tropical convection, and also to the Community Atmospheric Model of NCAR's Climate System Model. This

presentation will illustrate application of the super-parameterization to the clouds in climate problem and will discuss very recent advancements of this modeling approach.