A hierarchical modeling study of the interactions among turbulence, cloud microphysics, and radiative transfer in the evolution of cirrus clouds

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This proposal uses a hierarchy of cloud resolving models to address the following science issues of relevance to CRYSTAL-FACE:

- What ice crystal nucleation mechanisms are active in the different types of cirrus clouds in the Florida area and how do these different nucleation processes influence the evolution of the cloud system and the upper tropospheric humidity? How does the feedback between supersaturation and nucleation impact the evolution of the cloud?
- What is the relative importance of the large-scale vertical motion and the turbulent motions in the evolution of the crystal size spectra? How does the size spectra (through gravitational fallout and sublimation) impact the life-cycle of the cloud and stratospheric dehydration?
- What is the nature of the turbulence and waves in the upper troposphere generated by precipitating deep convective cloud systems? How do cirrus microphysical and optical properties vary with the small-scale dynamics? How do turbulence and waves in the upper troposphere influence the cross-tropopause mixing?

Two different models will be used in this study:

- 2-D hydrostatic model with explicit microphysics that can account for 30 size bins for both the droplet and crystal size spectra. .
- Large-eddy simulations (LES) with options for bulk and explicit microphysics.

By using these models we will be able to in detail study both, cloud microphysics and the effects of cirrus clouds on the radiative transfer, as well as dynamical effects of intermediate eddies on the evolution of cirrus clouds and mixing processes.

In addition to the modeling, the PIs expect to be involved in the planning and design of the experiment, and Curry expects to participate in the field experiment. Such connections between modeling groups and the field observation groups are critical for obtaining a data set that is useful for forcing and evaluation of the models.