# Parameterization of Thin Mid-Level Stratiform Clouds

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Thin mid-level stratiform ("altocumulus") clouds have received little attention from either modelers or observational programs, yet these clouds cover large portions of the earth and significantly affect the radiation fields. Since altocumulus are vertically sub-grid scale in general circulation models (GCMs), they have either been neglected or represented implicitly through a "fractional cloudiness" scheme. Such schemes are not suitable for climate modeling because they lack theoretical foundations that indicate their limits of applicability.

The Atmospheric Radiation Measurement (ARM) Cloud and Radiation Testbed (CART) program offers an unprecedented opportunity to greatly improve our ability to parameterize the radiative effects of these important clouds in climate models.

We will develop and test a physically based parameterization for altocumulus layers for use in GCMs. We will make extensive use of ARM-CART measurements and a high-resolution cloud scale numerical model, the University of Utah Cloud Ensemble Model, to increase our understanding of the physical processes that determine the distribution of altocumulus clouds and their effects on the atmosphere. This understanding is necessary to enable development of an altocumulus parameterization based on general physical principles. We will

1. Determine in detail how the large-scale motion field, in combination with the cloud-scale radiative, micro-physical, and dynamical processes, governs the life cycle and structure of altocumulus layers.
2. Determine in detail the effects of altocumulus on the atmosphere, effects that are primarily to modulate the radiation field.
3. Determine the extent to which altocumulus clouds are indeed parameterizable in terms of large-scale processes.
4. Develop and test a vertically sub-grid scale elevated mixed layer model to diagnose altocumulus cloud layer thickness or its tendency within a GCM layer from the large-scale fields.
5. Develop and test a parameterization of altocumulus cloud layer optical properties (liquid water path and effective mean radius) for use in climate models.