A two-moment microphysics scheme in SAM: Initial results
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Background
The cloud resolving model that represents subgrid processes in the CSU multi-scale modeling framework (MMP) has a relatively simple representation of cloud microphysics. This scheme is fast, but it does not allow for the explicit representation of freezing/melting of hydrometeors, size sorting of falling precipitation and aerosol effects on clouds (also known as aerosol indirect effects).

Objective
We add a more complex representation of microphysical processes (Morrison et al 2005, as described below) as an option in SAM, and we compare its behavior with that of default SAM in three cloud regimes (drizzling stratocumulus, precipitating shallow cumulus and deep convection). The new microphysical scheme should enable SAM to represent aerosol effects on clouds and to more faithfully simulate the vertical structure of clouds and precipitation.

Model Description (SAM)
We use the System for Atmospheric Modeling (SAM 6.6.4) (Khairoutdinov & Randall 2003), an anelastic model with bulk microphysics and prognostic equations for liquid–ice static energy $\beta = C_f T + g z - L_f (q_r + q_i) - L_v (q_r + q_i)$, total water (vapor–cloud) and precipitating water. Phases of condensed water are diagnosed from temperature. When applied (only for KWAJEX here), radiation computations used the scheme from CAM3.

MOR Microphysics
This scheme (Morrison et al 2005) explicitly represents the mass mixing ratios and number concentrations of cloud water, cloud ice, rain, snow and graupel, along with the mass mixing ratio of water vapor. The transformations between these species are represented in the diagram below. Prognostic equations for each of these species are solved (for 12 in total vs. 3 for SAM).

Conclusions
- High SAM autoconversion threshold shuts off drizzle.
- MOR runs have thicker cloud, less entrainment and a stronger cloud base buoyancy flux than SAM.

Deep Convection: KWAJEX
The KwaJalein experiment (KWAJEX) observed conditions around KwaJalein (on the eastern edge of the West Pacific warm pool) from July–Sept. 1999.

Cloud Resolving Model (CRM) Setup
2D Runs w/ $N_u = 128x128$, $\Delta x=50$km and $\Delta z=25$km in troposphere. Time-varying forcings supplied by Minghua Zhang: Prescribed LHF/SHF, large-scale horizontal advection/vertical motion. Interactive radiation using CAM3.0 scheme.

Microphysics Setup
SAM: Prescribed SST=299.8K, large-scale horizontal advection/vertical motion. Interactive radiation using CAM3.0 scheme.

Timeseries, 51-day Time-avg. Profiles

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