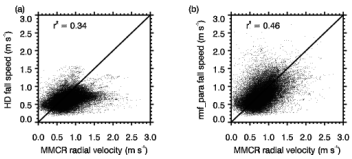
Parameterization of Riming Intensity and Its Impact on Ice Fall Speed Using ARM Data

Research Highlight

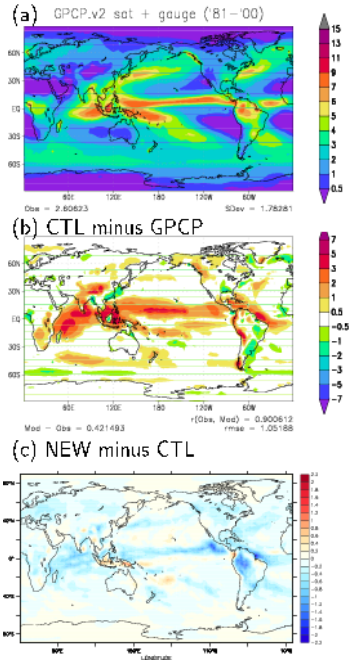
Riming within mixed-phase clouds can have a large impact on the prediction of clouds and precipitation within weather and climate models. The increase of ice particle fall speed due to riming has not been considered in most general circulation models (GCMs), and many weather models only consider ice particles that are either unrimed or heavily rimed (not a continuum of riming amount). Using the Atmospheric Radiation Measurement (ARM) Climate Research Facility data set at the Southern Great Plains (SGP) site in the United States, a new parameterization for riming is derived, which includes a diagnosed rimed mass fraction and its impact on the ice particle fall speed. When evaluated against a vertical-pointing Doppler radar for stratiform mixed-phase clouds, the new parameterization produces better ice fall speeds than a conventional parameterization.

The new parameterization is tested in the recently developed Geophysical Fluid Dynamics Laboratory (GFDL) atmospheric model (AM3) using prescribed sea surface temperature (SST) simulations. Compared with the standard (CTL) simulation, the new parameterization increases ice amount aloft by ~20–30% globally, which reduces the global mean outgoing longwave radiation (OLR) by ~2.8 Wm#2 and the top of atmosphere (TOA) short-wave absorption by ~1.5 Wm#2. Global mean precipitation is also slightly reduced, especially over the tropics.

A new ice fall speed parameterization considering riming impact has been derived and evaluated using an ARM SGP data set. The new parameterization compares better with observed fall velocity than a conventional parameterization and extends its usage for mixed-phase clouds. The new parameterization is tested in the GFDL AM3 model and produces a comparable climatology with the CTL simulation. It also improves the physical basis for using a fall velocity larger than a conventional parameterization in the current AM3.



(a) Scatter plot of the observed Doppler velocities from the MMCR against the ice fall velocities derived using the Heymsfield and Donner (1990) formula. (b) Same as (a), but shows the ice fall velocities derived using Eq. 4 with RMF_para.



Annual long-term mean precipitation in mm day-1 for: (a) GPCPv2, (b) CTL minus GPCPv2, and (c) NEW minus CTL.

Reference(s)

Lin Y, DJ Leo, and BA Colle. 2010. "Parameterization of riming intensity and its impact on ice fall speed using ARM data." Monthly Weather Review, , . ACCEPTED.

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Working Group(s)

Cloud Life Cycle