A Bulk Parameterization of Giant Cloud Condensation Nuclei

Contributors
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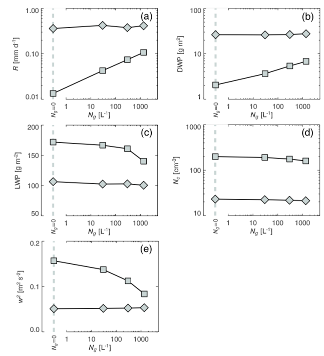
Research Highlight

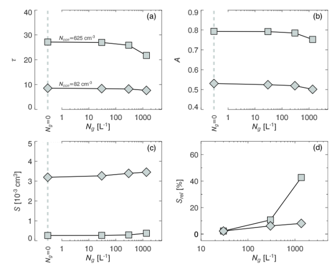
A parameterization for giant cloud condensation nuclei (GCCN), suitable for use in bulk microphysical models, has been developed using precise representations of the condensational growth of aerosol particles in the subcloud layer. The formulation uses an observationally-based GCCN distribution function and directly observable parameters of GCCN, such as concentration and the shape of the aerosol spectra. The parameterization naturally couples to wind speed-dependent parameterizations of sea salt flux from the ocean surface.

The behavior of the GCCN parameterization in a large-eddy simulation (LES) framework is consistent with simulations employing explicit, size-resolving microphysical methods. The parameterization properly represents the sensitivity of cloud, drizzle, and turbulence for both polluted and clean background cloud condensation nuclei (CCN) environments. Adding GCCN to a polluted background environment enhances precipitation formation; while adding GCCN to the clean case changes little, except to slightly enhance the robust precipitation processes already in place. Cloud radiative properties indicate the parameterization captures the climatically important aerosol indirect (cloud mediated) effects consistent with previous bin-model LES studies of GCCN.

Our new parameterization of GCCN can be incorporated into current bulk microphysical models and is suitable for mesoscale, numerical weather prediction (NWP), and large-scale models. The new GCCN parameterization has been verified against bin microphysical LES results; realistically affects the precipitation process in both polluted and clean background environments; and captures the aerosol indirect effect, important for the large-scale radiation balance.



Mean quantities as a function of GCCN concentration for polluted (squares) and clean (diamonds) background CCN conditions.



Radiative quantities as a function of GCCN concentration for polluted and clean background CCN conditions shown in (a) optical depth; (b) albedo; (c) susceptibility; and (d) susceptibility relative to the control simulations without GCCN.

Reference(s)

Mechem, D. B., and Y. L. Kogan, 2007: A bulk parameterization of giant CCN. J. Atmos. Sci., conditionally accepted.

Working Group(s)

Cloud Modeling