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Modeling and Observational Study of Drizzle Production in Stratocumulus Clouds over the Southern Ocean

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LONG TERM GOALS

Testing and refinement of drizzle parameterization for conditions typical for stratocumulus cloud layers over the Southern Ocean.

OBJECTIVES

The objective is to study the drizzle production in marine stratocumulus under conditions of high winds and heavy drizzle typical for the Southern Ocean. The CIMMS drizzle parameterization will be tested and generalized for use under these conditions.

APPROACH

The study involved numerical simulations using the CIMMS LES model with explicit (spectral) formulation of aerosol and cloud drop size-resolving microphysics, as well as observational analysis of data from the Southern Ocean Cloud Experiment.

WORK COMPLETED

The graduate student hired under this Grant used the CIMMS LES model to investigate the dependence of marine boundary layer clouds on surface winds. The CCN spectra produced under various surface wind conditions have been analyzed and a series of 2D sensitivity experiments performed. Both the concentration and the mean radius of the accumulation mode, as well as the sea-salt portion of the spectra have been varied in the sensitivity tests.

RESULTS

Cloud microstructure (characterized by drop concentration) depends in a complex way on surface winds which affect the ambient CCN spectra. The investigation of these effects required a substantial modification of the CIMMS LES model. In the performed sensitivity experiments we initially specify an environment with sea-salt aerosols well mixed in the boundary layer. Several results look especially interesting. First, we found that depending on the mean radius and concentration of the accumulation, as well as the sea-salt mode the large and giant sea-salt nuclei formed by surface winds may increase the drop concentration, as well as drizzle amount (Fig. 1). Secondly, the sink of large CCN due to activation and drizzle washout can be quantified and the magnitude of the source of CCN needed to maintain a stable stratocumulus cloud layer can be assessed from the performed LES simulations.

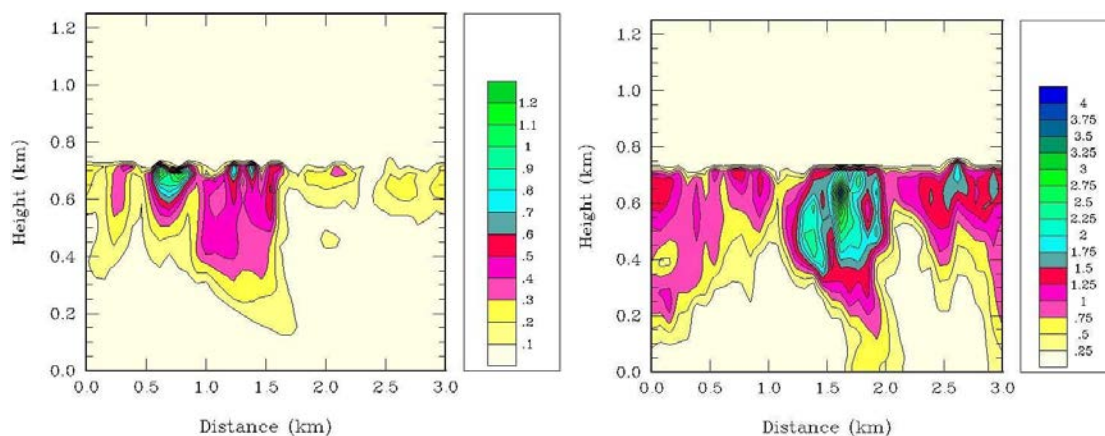


Fig. 1. Isolines of drizzle rates (mm/day) in a vertical cross-section at two hours into a simulation in environments with non sea-salt (left) and added sea-salt (right) CCN spectra.

RELATED PROJECTS

The ASSERT Grant is related to the parent ONR grant “LES Modeling of Aerosol and Drizzle Effects in Marine Stratocumulus” (N000149610687).