

Numerical Experiment of Cloud Overseeding for Mitigating Extreme Rainfall from a Localized Thunderstorm in an Urbanized area

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Localized thunderstorms can produce intense rainfall over short periods, increasing the risk of flash flooding in urban areas. As extreme precipitation events are expected to intensify with increasing global temperatures, the combined effects of climate change and rapid urbanization may further intensify flood risks. These growing risks highlight the need to explore alternative mitigation strategies that complement conventional flood-management measures. One potential approach is cloud over seeding, which seeks to modify cloud microphysical processes to reduce or redistribute localized extreme rainfall. This study aims to investigate the potential of numerical cloud over seeding to mitigate localized extreme rainfall using the Weather Research and Forecasting (WRF) model with the Morrison double-moment microphysics scheme. A selected localized thunderstorm event will first be simulated under control conditions and characterized to identify potential seeding levels within its mixed-phase region based on temperature and supercooled cloud water distributions. Cloud over seeding will be represented by artificially enhancing the effective ice nuclei concentration using the Meyers et al. (1992) formulation with a prescribed enhancement factor ($\beta = 10^{11}$). Sensitivity experiments will then be conducted by varying the seeding altitude and horizontal extent. Each over seeding simulation will be compared with the control simulation to assess changes in precipitation. Changes in cloud properties will also be examined to identify the processes associated with the simulated rainfall responses. Ultimately, this study seeks to identify cloud over seeding configurations that may reduce or redistribute localized extreme rainfall and improve understanding of how enhanced ice nuclei concentrations influence convective cloud development and precipitation processes.

Keywords: Cloud over seeding, localized thunderstorms, extreme rainfall, Weather Research and Forecasting (WRF) model, Morrison double-moment microphysics, ice nuclei