Numerical experiments for weather modification in arid and semi arid regions

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The United Arab Emirates (UAE) launched the UAE Research Program (UAEREP) for Rain Enhancement Science in order to promote scientific advancement and the development of new technology. In the project "Advanced Study on Precipitation Enhancement in Arid and Semi-Arid Regions," which was one of the three projects awarded the UAEREP prize in 2016, the authors plan to apply the cloud seeding model (Hashimoto and Murakami, 2016) to the assessment of seedability and to the evaluation of cloud seeding effects, after necessary modifications (Hashimoto, Murakami and Haginoya, 2017) and new developments.

At first for this purpose, we investigate performances of the model in terms of reproducibility of seasonal distributions of cloud and precipitation in the arid and semi-arid regions in the UAE and its sensitivity to grid spacing. Hindcast numerical simulations have been conducted throughout one year (from February 2015 to January 2016) with 5- and 1-km horizontal resolutions. The model shows a good performance in both of the 5- and 1-km horizontal resolutions after some modifications for land surface parameters. Hindcast simulations are extended to finer resolution up to 200 m for 30 days in September 2015. The seasonal or monthly distributions of accumulated precipitation amount are roughly the same among the different resolutions. However, with finer resolution, finer structures appear in the precipitation distributions, especially over desert areas for spring and summer seasons, where the precipitation is mainly brought by small-scale cloud systems generated by thermal convections. Since microphysical features of a cloud such as the mass and number concentration of cloud droplets is dependent on the fine-scale dynamics, finer grid spacings are required for assessment of seedability and planning of seeding experiments, although it is still unclear what is the resolution fine enough to obtain robust results.

To perform numerical seeding simulations, a hygroscopic seeding scheme has been incorporated in the bulk microphysics framework of our model. This scheme is based on a lookup table (LUT) which is able to represent the number concentration of nucleated droplets as a function of updraft velocity and number concentrations of two types of cloud condensation nuclei (CCN); ammonium-sulfate (AS) and sodium chloride (SC) particles. Using the LUT-based hygroscopic seeding scheme, we are performing test simulations, which show the enhancement of rainwater production is dependent not only on a seeding rate but also on dilution of SC particles during the transportation from the seeding point to the cloud base.

Acknowledgement

References

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