Geophysical Research Abstracts, Vol. 7, 09196, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09196

Formation of precipitation in intense tropical Hector thunderstorms

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This is a modelling study to evaluate the relative importance of various precipitation and glaciation mechanisms in intense tropical thunderstorms. The development of precipitation, both by warm rain processes and via accretion processes involving the ice phase are essentially intimately linked and cannot be interpreted in isolation; glaciation in natural storm clouds seems to be dependent on the spectrum of large rain drops (Blyth and Latham 1993; Hobbs and Rangno 1985; Koenig 1963).

Previous researchers have suggested that in multi–thermal storms, ejection of small ice particles from Hail can occur during the collection of liquid water drops in the temperature regime -3 to -8C(the Hallett-Mossop (H-M) process (Hallett and Mossop 1974)). Cycling of this process in many storm cases is responsible for rapid glaciation and a sharp increase in the intensity of the modelled clouds; latent heat is released during the freezing of supercooled rain drops as they collect the ice splinters.

The combined use of a cloud-resolving model with bulk 3-phase microphysics parameterisations and a particle, size-resolved explicit microphysics model has enabled the evaluation of the H-M process in intense cumulus clouds. Central to the assumptions in the model are issues of whether ice multiplication is efcient in intense thunderstorms.

Griggs and Choularton (1986); Heymsfield and Mossop (1984) have made detailed laboratory measurements which together might suggest that ejection of ice splinters would not be efficient in intense tropical convective updrafts under high ice-liquid accretion rates.

The model case studies are based on a typical day of an intense tropical island thunderstorm, Hector which occurs everyday over the Tiwi Islands, North Australia. These storms have wide significance to in the earths atmosphere, and a wide variety of feedbacks are possible (Keenan et al. 1989).

Sensitivity tests to the microphysical inputs of Hector are performed with the two models. They include, varying the number of cloud droplets activated at cloud base, varying the number of primary ice nuclei and varying the H-M process.

The feedbacks on the storm are sometimes complex as the microphysics can affect storm dynamics quite significantly. The implications from the results of varying aerosol input in the model for the development precipitation in mixed-phase clouds will be discussed.

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