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The effects of ice-phase microphysics on tropical cyclone formation in Lokalmodell (LM) simulations

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Release of latent heat is an essential process for the growth and the longevity of tropical cyclones. In addition, for the maintenance of storms, the formed condensate must be removed from the vortex area before it may be evaporated in subsaturated air.

Willoughby et al. (1984) and Lord et al. (1984) simulated ice phase effects in tropical cyclones using an axisymmetric nonhydrostatic model with a cloud parameterization scheme including five categories of hydrometeors. They found that the existence of the ice phase forces downdrafts outside of the eyewall. These downdrafts are generated by the withdrawal of latent heat due to melting of falling graupel. Wang (2002) investigated the impact of the ice phase in a threedimensional nonhydrostatic model. He found a slight decrease of intensity due to the existence of ice. Furthermore, spiral bands in the tropical cyclone are forced by downdrafts which are produced by melting of graupel.

In our present work within the context of SFB 641 'Die troposphärische Eisphase', we investigate effects of the ice phase on tropical cyclogenesis with the LM (Lokalmodell) of the DWD (Deutscher Wetterdienst). In our experiments, we assume a circular symmetric low in gradient wind balance as initial state. 21 buoyancy elements with increased moisture and temperature are placed at the centre of the low. Moreover, we used for comparison of the results different moisture background profiles (a constant profile with RH=70%, in addition, we distinguished between 'dry' and 'wet' Jordan profiles, as in Willoughby et al.(1984)). LM computations are performed with a warm-rain microphysical scheme and a cloud microphysical scheme that additionally includes two categories of ice, namely floating cloud ice and precipitating snow.

We found that the initial state described above turns out to be sufficient for modelling tropical cyclogenesis. The initial vortex strength threshold for cyclogenesis depends on whether the ice phase is included in the microphysical cloud scheme or not. A lower initial pressure is needed in order to initiate tropical cyclogenesis when ice processes are included. This is due to the fact that cooling of the boundary layer through downdrafts caused by melting of snow hinders the development in the simulations with two categories of ice included. Another result is the fact that the constant moisture profile shows a more vigorous storm development than in those experiments with wet and dry Jordan profiles. The last result is still under examination.