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Sensitivity of WRF model simulations to parameterizations of depositional growth of ice crystal during the landfall of Typhoon Fitow (2013)

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The uncertainty in ice nucleation process is still large, yet the torrential precipitation associated with the landfall of typhoon is strongly contributed by stratiform rainfall, which is mainly from of the ice-phase clouds. This study investigates the parameterization scheme of growth of ice crystal proposed by Zeng et al. (2008) under the assumption that the ice crystal concentration is proportional to the mass of ice crystal. Sensitivity tests reveal that the simulations with Zeng scheme are especially sensitive to the ice nuclei concentration. Zeng schemes with high ice crystal concentration simulate anomalously large rain rate, weak intensities and abnormal tracks, and it is directly related to the over-production of ice nuclei concentration that severely affects cloud ice and other microphysical fields mainly through the depositional growth of cloud ice from cloud water. Shen et al. (2014) scheme works better than Zeng scheme by changing radius of base ice crystal from 0 to 40 μm and reducing sensitivity of the depositional growth of cloud ice from cloud water on the ice nuclei concentration. But Shen parameterization schemes simulate the number of ice crystals anomalously large as those in Zeng parameterization schemes, since both Zeng and Shen schemes use Fletcher (1962) equation in the parameterization of ice crystal concentration. When DeMott et al. (2010) ice crystal concentration parameterization is applied to Zeng parameterization scheme, the anomalously large rainfall is significantly weakened, further indicating that Zeng parameterization schemes with high ice crystal concentration poorly simulate typhoon primarily due to the over-nucleation of ice in Fletcher parameterization.