Torrential Rainfall Responses of Typhoon Fitow (2013) to Radiative Processes: A Three-Dimensional WRF Modeling Study

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The three-dimensional Weather Research and Forecasting (WRF) model is used to conduct sensitivity experiments of Typhoon Fitow in 2013 during its landfall. Surface rainfall and heat budgets as well as the vertical profiles of stability and vertical velocity are analyzed to examine physical processes responsible for radiative effects on rainfall. The inclusion of radiative effects of liquid clouds suppresses radiative cooling in liquid cloud layers via reducing outgoing radiation to ice cloud layers, whereas it enhances radiative cooling in ice cloud layers through trapping less radiation from liquid cloud layers. The enhanced radiative cooling decreases from ice cloud layers to liquid cloud layers. The suppressed stability and vertical mass convergence increase. Thus, heat divergence is weakened to warm the atmosphere, which reduces net condensation and rainfall. The inclusion of radiative effects of ice clouds suppressed radiative cooling by reducing outgoing radiation. The suppressed radiative cooling reduces from ice cloud layers to liquid cloud layers and the suppressed instability and vertical mass convergence decreases when radiative effects of liquid clouds are present. As a result, heat divergence is strengthened to cool the atmosphere, which increases net condensation and rainfall. The suppressed radiative cooling increases temperature and reduces net condensation and rainfall when radiative effects of liquid clouds are absent.

Keywords: Radiative effects, cloud and heat budget

