Abstract

In this study, the 2-km grid spacing simulation with the Morrison microphysics is employed to investigate the warm-rain microphysical properties in Typhoon Usagi (2013) over the ocean, including raindrop size distribution (RSD), source-sink of raindrop concentration and water vapor budget in the inner-core and outer region during different developing stages. The model reasonably reproduced the track, intensity, and overall structure of Usagi. The simulated RSD shows a rapid increase in small-size raindrops concentration but a decrease in large-size ones with the storm development. There exist two levels (5.25 and 1.25 km height) with the maximum number concentration of raindrops. The ice-related microphysics at higher levels starts prior to the warm-rain processes at lower levels. Larger raindrops formed by self-collection in the inner-core suffer from significant breakup, and raindrops outside the eyewall do not experience evident breakup but show comparable evaporation as the inner-core region. Results indicate that the dominant terms in water vapor budget are the horizontal moisture flux convergence (HFC) and local condensation (Cond). The evaporation from underlying ocean surface is small in the inner-core region, but accounts for ~ 40% of the HFC in outer region during the intensification and decaying stages. Water vapor in the outer region is obtained equally through the local cloud evaporation and inward transport from the environment. Moreover, an earlier starting of cloud microphysics in the inner-core region is evident during the intensification stage, and the continuous decreasing of condensation in the outer region may imply the beginning of storm weakening.