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Category: Ocean and Atmospheres

Paper ID: 57-OOA-A1644

Title: Numerical Simulation of Record-Breaking Heavy Rainfall in Continuous Development of Mesoscale Convective Systems for 18-Day over Korea in 1998 Summer

Abstract: The 18-day long lasting heavy rainfall events occurred over the Korean Peninsula from 31 July to 17 August in 1998. During this period, the extremely westward extended subtropical high over the western North Pacific and the nearly stationary continental low over northern China established strong quasi-stationary baroclinicity in East Asia, so that temperature gradient was much intensified to the west of Korea and strong southwesterly flows developing between the two pressure systems transported sufficient moisture over Korea. The development of consecutive heavy rainfall events was highly related with the variation of the synoptic-scale motion. Synoptic-scale vertical motion was largely generated by the diabatic heating to intensify ageostrophic motion in the upper branch of the secondary circulation across the upper-level jet. The indirect circulation decreased intensity of the upper-level jet and increased warm advection and temperature gradient to the south of the upper-level jet axis. The upper-level jet moved to the south because the maximum temperature gradient line moved southward, and then convective activities were intensified again. Thus, the direct circulation was induced due to the convection south of the upper-level jet that was re-intensified and moved northward in the area of increased cold advection due to increased ageostrophic motion. As the indirect and direct circulation repeated, consecutive heavy rainfall with meridional variation took place over Korea for 18 days. A record breaking heavy rainfall event of 619 mm/day at Kangwha on August 5 occurred during the 18-day heavy rain period. In the case, convective storms evolved continuously in the upstream side of the existing mesoscale convective systems, and moved toward downstream. To investigate the evolution mechanism of mesocale convective systems responsible for the heavy rainfall, the experiments of a mesoscale model with two model domains of 30 and 10 km horizontal grid spacings on the 40 vertical sigma levels were conducted. In the 10 km resolution, the simulated 12-hour accumulated rainfall amounts agreed well with observation in terms of rainfall pattern and timing but weak rain intensity. In the simulation, the strong 850 hPa convergence zone over the Yellow Sea provided a favorable condition for the initiation of convective storms. The equivalent potential temperature contrast was intensified across the rain band over the convergence zone. New convective storms evolved in the convergence zone on the upstream of the major rain area, and then moved eastward along the rain band. The individual convective storms were newly initiated with intervals of 1-2 hours and horizontal scale of about 50km at the entrance of the convergence zone in concordance with the tip of a moist tongue. The storms developed in the maximum convergence area and then moved eastward rapidly with life time scales of 3 to 6 hours. This consecutive development, movement, and decay of convective storms resulted in a narrow heavy-rain band, and consequently heavy rainfall in their mature stages.

Presentation Mode: Oral

Keywords: Mesoscale Convective Systems, Heavy Rainfall, Convergence Zone

Status: Pending.

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