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Issues on numerical weather prediction detected by formation mechanisms of Hiroshima heavy rainfall on 20 August 2014

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On 20 August 2014, heavy rainfall exceeding 200 mm/3hour occurred in Hiroshima, located about 300 km south of a stationary front extending northeastward over the Sea of Japan, and brought some huge landslides that killed 74 peoples. The rainfall was caused by a band-shaped precipitation system with a hierarchical structure consisting of convective cells and band-shaped multi-cell clusters that stagnated for 4 hours. The band-shaped precipitation system had a back-building type formation, as well as the multi-cell clusters, in which new multi-cell clusters successively formed upstream of the pre-existing ones, and consequently extent northeastward with a width of 20˜30 km and a length of about 100 km. Convective cells successively formed under instable atmospheric conditions that were enhanced by the inflows of mid-level colder air and low-level humid air. The colder air was produced through adiabatic cooling due to large-scale updrafts that existed south of the stationary front. The updrafts also brought a humid condition at the middle level that is favorable for the development of convective cells. The humid air was accumulated below a height of 1 km by the effect of Bungo Strait, located just south of Hiroshima. Both the sides of Bungo Strait have terrains exceeding a height of 1 km, which accelerated southerly winds from the Pacific Ocean that took along humid air. The effect of Bungo Strait also produced the upward pressure gradient force to transport humid air upward.

The Japan Meteorological Agency operates Local Model (LM) with a horizontal resolution of 2 km every hour for nine hour forecasts. The forecasts with initial conditions at 18 JST (= UTC + 9hours) 19 August 2014 successfully reproduced the band-shaped precipitation system; those with initial conditions after then, however, produced different features in rainfall amounts and the location of the precipitation system. Even when low-level inflow has the same equivalent potential temperature, rainfall amounts depend on water vapor flux amounts that are changed by wind speed and the 1˜2 degree change of wind direction alters the location of the precipitation system by a few tens kilometers. These indicate that the accuracy of wind speed and direction is necessary for the improvement of heavy rainfall predictions, as pointed out by Kato and Aranami (2005), in addition to the accuracy information of low-level water vapor upstream of the occurrence location of heavy rainfall. In Hiroshima heavy rainfall case, water vapor was accumulated in the lower atmosphere over Bungo Strait, which suggests that boundary layer processes in numerical models should be validated to be improved. Since observations over the sea are necessary to be obtained, the cooperation with different fields of research institutes is important as well as that of meteorology.

Reference

Kato, T., and K. Aranami, 2005: Formation factors of 2004 Niigata-Fukushima and Fukui heavy rainfalls and problems in the predictions using a cloud-resolving model, *SOLA*, **1**, 1-4.

Keywords: heavy rainfall, band-shaped precipitation system, numerical weather prediction model