# Importance of terrain representation in simulating a stationary convective system for the July 2017 Northern Kyushu Heavy Rainfall case

Tetsuya Takemi
Disaster Prevention Research Institute, Kyoto University, Japan
Email: takemi@storm.dpri.kyoto-u.ac.jp

## Abstract

Stationary convective systems are one of the major extreme-rain-producing storms. From a statistical point of view, Tsuguti and Kato (2014) examined warm-season heavy rain events in Japan and suggested that there is a topographical influence on the generation of stationary rain events. Unuma and Takemi (2016) examined stationary meso-□scale convective systems, called as quasi-stationary convective clusters (QSCCs), during the warm season and mentioned that the locations of QSCC occurrence correspond to regions with high elevation.

An extreme, damaging rainfall occurred in northern Kyushu in July 2017. This case produced extreme rainfalls in northern Kyushu and spawned damaging floods and landslides. The case developed under influences of a stationary front: during the southward movement of the Baiu front the heavy rainfall occurred. Among the raingauge stations, the heaviest rainfall was measured at the Asakura station: the maximum accumulated rainfalls for 24, 48, and 72 hours were 545.5 mm (by 1140 JST 6 July), 600.5 mm (by 1040 JST 7 July), and 616.0 mm (by 0600 JST 7 July), respectively, all of which are the highest records at the station.

Whether such an extreme rainfall is quantitatively captured by numerical models is a challenging issue. We investigate the influences of terrain representation in simulating a stationary convective system and the resulting heavy rainfall for this case by conducting a series of 167-m-resolution numerical experiments. The model used is the Weather Research and Forecasting (WRF) model Version 3.6.1. Two-way nesting was used to set four computational domains: the outermost domain (Domain 1) covers most of the Japanese islands at the 4.5-km horizontal grid, the second domain (Domain 2) Kyushu Island at the 1.5-km grid, the third domain (Domain 3) the northern half of

Kyushu Island at the 500-m grid, and the innermost domain (Domain 4) focuses northern Kyushu at the 167-m grid. The model topography was generated with a coarser-resolution digital elevation model (DEM) dataset and a higher-resolution DEM dataset. The topography in Domain 1 and 2 was generated with the global DEM data having a horizontal grid spacing of 30 arc-seconds (about 1 km) (referred to as G30) provided by the United States Geological Survey, while the topography in Domain 3 and 4 was created with the 50-m horizontal resolution DEM data provided by the Geospatial Information Authority of Japan (referred to as GSI); this GSI dataset is a digital version of the GSI maps created by ground-based measurements. To examine the sensitivity to the choice of the elevation dataset, we used the G30 data to create the model topography not only in Domain 1 and 2 but also in Domain 3 and 4 and conducted sensitivity experiments.

By employing the high-resolution elevation dataset as well as a double-moment cloud microphysics scheme, the control experiment successfully reproduced the stationary, linear-shaped convective system and the associated heavy rainfall. When the model terrain was created by a coarser-resolution elevation dataset, the 167-m-resolution experiment underestimated the accumulated rainfall, because of discretely developing convection and weaker intensities of the rainfall. These impacts of the terrain representation were confirmed to be robust through conducting another experiments with a different microphysics scheme.

The sensitivity experiments demonstrated that the representation of model terrain is critically important in reproducing stationary convective systems and quantitatively the resulting heavy rainfall in convection-resolving simulations at a $O$(100 m) grid spacing.

This work has been published in Takemi (2018).

**References:**

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