# Case study of a heavy rainfall event in Amami Island on 20 October 2010

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## 1. Introduction

On 20 October 2010, a heavy rainfall was observed in Amami Island, located in southern Japan. Figure 1 shows the horizontal distribution of daily accumulated Radar-Raingauge analyzed rainfall on 20 October 2010, which is estimated by meteorological Radar and calibrated using surface rain gauge observations. Areas with accumulated rainfall more than 200 mm are found widely over Amami Island, and the maximum value exceeds 800 mm. The daily accumulated rainfall of 622.0 mm was observed at the Naze meteorological observatory. This heavy rainfall caused serious disasters in Amami Island.

In this study, the characteristics of environmental fields and the development and maintenance mechanisms of precipitation systems inducing the heavy rainfall are examined from observations and numerical simulations results.

## 2. Supply of water vapor to Amami Island

Figure 2 shows the surface weather map at 09 LST (= UTC + 9 hours) on 20 October 2010. A stationary front is analyzed in an east-west direction in the vicinity of Amami Island. The center of Typhoon Megi with the minimum pressure of 945 hPa is located south of Taiwan. This synoptic pattern suggests the inflow of low-level humid air to the vicinity of Amami Island.

The 950 hPa-level water vapor flux field depicted from JMA mesoscale objective analysis data (MA) at 09 LST on 20 October 2010 are shown in Fig. 3. Water vapor flux larger than 300 g $m^{-2}$ $s^{-1}$ is found east of Amami Island. Air with the specific humidity larger than 16 g $kg^{-1}$ was transported to Amami Island by strong easterly winds (not shown).

Vertical profiles of horizontal wind speed observed by the boundary layer radar at Naze are shown in Fig. 4. Easterly winds at a speed more than 16 m $s^{-1}$ are predominant below a height of 2000 m, between 1000 LST and 1500 LST, when precipitation systems strongly developed over Amami Island. These results indicate that low-level humid air from the east continuously flowed into Amami Island to develop and maintain the precipitation systems.

## 3. Terrain effect of Amami Island

The numerical model used in this study is the nonhydrostatic model (JMA-NHM, Saito et al., 2007) developed by the Japan Meteorological Agency (JMA). A double-moment bulk-type cloud microphysics scheme predicting the specific humidity of 6 water species (water vapor, cloud water, cloud ice, rain, snow, and graupel) and the number concentrations of 3 water species (cloud ice, snow and graupel) is employed. In this study, the JMA-NHM has a horizontal resolution of 1 km with 1000 x 800 grid points (1 km-NHM). The initial and boundary conditions of 1 km-NHM are produced from 3 hourly available MA with a horizontal resolution of 5 km. The initial time of 1 km-NHM is 1800 LST on 19 October 2010 and the forecast time is 30 hours (Fig. 5).

The 1 km-NHM (Fig. 6a) succeeds in producing regions of heavy rainfall, the location and distribution of which are similar to the observations (Fig. 1). Moreover, the simulated maximum daily rainfall agrees with the observations as well. To examine the terrain effect of Amami Island on the development and maintenance of the precipitation systems, a sensitivity experiment in which the topography of Amami Island is replaced with sea areas is performed. The sensitivity experiment result (Fig. 6b) is different from the control experiment (Fig. 6a). The daily accumulated rainfall near Amami Island is less than that in the control experiment. This result indicates that the terrain of Amami Island affected the development and maintenance of the precipitation systems inducing the heavy rainfall.

## References

Saito, K., J. Ishida, K. Aranami, T. Hara, T. Segawa, M. Narita, and Y. Honda, 2007: Nonhydrostatic atmospheric models and operational development at JMA. *J. Meteor. Soc. Japan*, **85B**, 271-304.

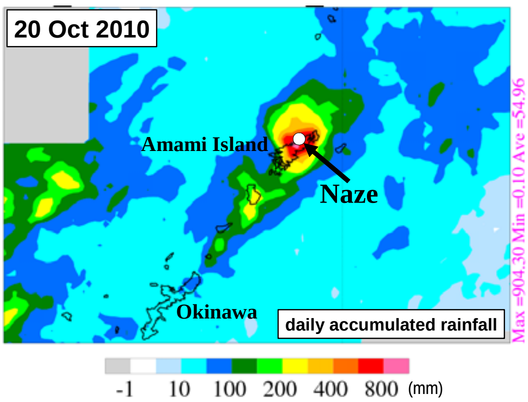


Fig. 1 Horizontal distribution of daily accumulated Radar-Raingauge analyzed rainfall on 20 October 2010.

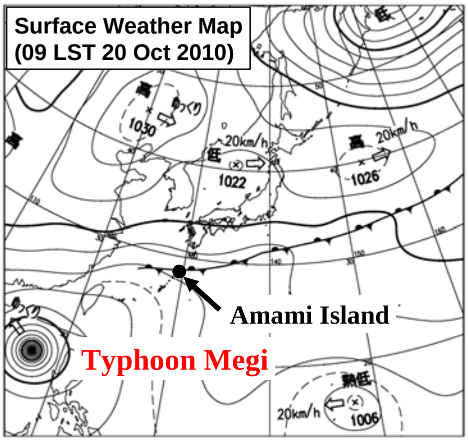


Fig. 2 Surface weather map at 09 LST on 20 October 2010.

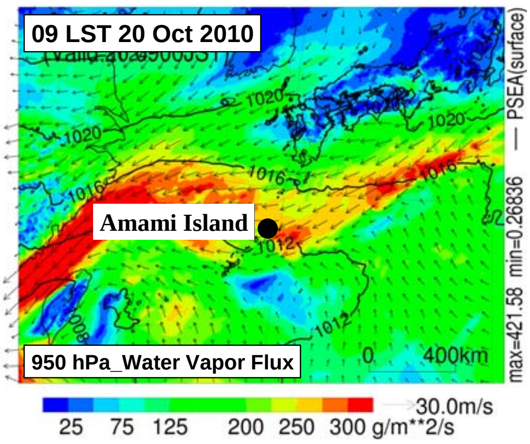


Fig. 3 950 hPa-level water vapor flux field and horizontal winds depicted from MA at 09 LST on 20 October 2010.

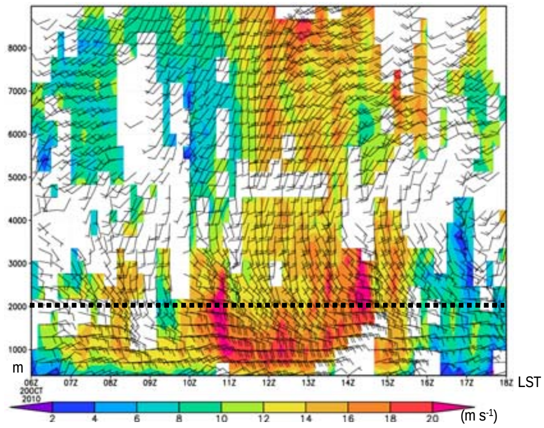


Fig. 4 Vertical profiles of horizontal wind speed (shaded) observed by the boundary layer radar at Naze from 0600 LST to 1800 LST on 20 October 2010. Half-barb means 5 m s$^{-1}$ and Full-barb means 10 m s$^{-1}$. The black dashed line shows the height of 2000 m.

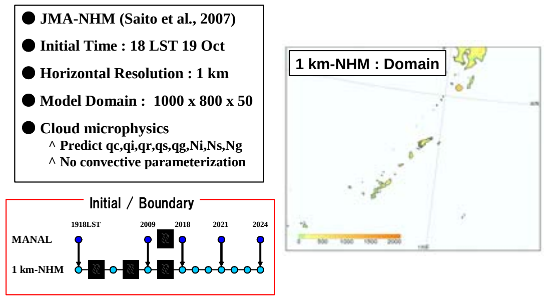


Fig. 5 Numerical experiment design and calculation domain of 1 km-NHM.

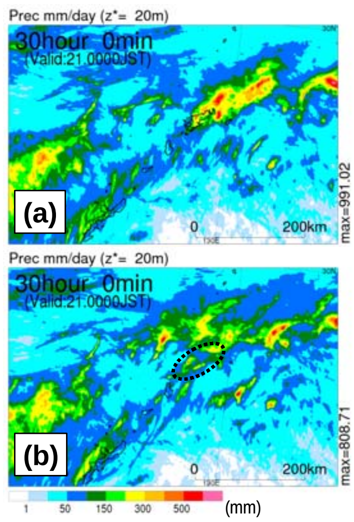


Fig. 6 Same as Fig. 1, but simulated by 1 km-NHM. (a) the control experiment and (b) the sensitivity experiment in which the topography of Amami Island is replaced with sea areas. The dashed circle in (b) shows the location of Amami Island.