Recent development of the moist physics processes in the MSM

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1. Introduction

The Japan Meteorological Agency (JMA) nonhydrostatic model (JMANHM) is used to study a regional climate change in the vicinity of Japan under the framework of the "Projection of the change in future weather extremes using super-high-resolution atmospheric models" supported by the KAKUSHIN Program of the MEXT. The JMANHM has been operationally used with a horizontal resolution of 5 km in the JMA. The system is called Meso-Scale Model (MSM). As one of the main purposes of the MSM is to prevent disaster mainly caused by heavy precipitation, it is important to improve moist physics processes. For the moist physics processes, the MSM adopts a bulk parameterization scheme for cloud microphysics which predicts the mixing ratios of water vapor, cloud water, rain, cloud ice, snow, graupel and the number concentration of cloud ice (Ikawa and Saito, 1991). The Kain-Fritsch (KF) convective parameterization scheme (Kain and Fritsch, 1990; Kain, 2004) is also adopted to represent the effects of subgrid-scale convection because the horizontal resolution of the MSM seems to be too coarse to treat deep convection explicitly.

Concerning the moist physics processes, the MSM has a problem of too excessive precipitation along coastlines due to the overreaction of the KF scheme where the stream with a large amount of water vapor flows into from the southern ocean of Japan (Fig. 1a). Therefore, the improvement of the KF scheme is necessary to reduce the above-mentioned excessive precipitation.

2. Modification of the KF scheme

The KF scheme is based on a one-dimensional entraining/detraining plume model. To suppress too excessive precipitation along coastlines, the mixing rate between an updraft and its environmental air, which is formulated to be in inverse proportion to the radius of the updraft in the KF scheme, is made larger. That prevents a subgrid-scale

convection from growing into the upper altitude and a vertical profile of heating rate becomes closer to that of a higher resolution model which is able to represent convection explicitly without the parameterization. The modification to the KF scheme successfully suppresses too excessive precipitation (Fig. 1b) in a heavy rainfall event (Fig. 1c) and also contributes to improve the quantitative precipitation forecast.

However, that problem is not overcome in essence, therefore we have been investigating the activities of the KF scheme fundamentally with a single column model to improve the forecasts of the MSM.

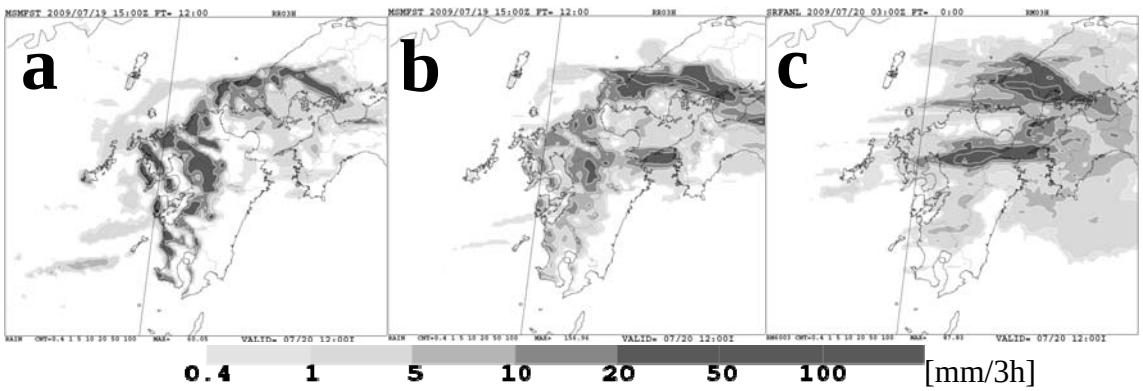

Fig. 1 Improvement of suppressing too excessive precipitation along coastlines. Accumulated Precipitation [mm/3h] of (a) the MSM forecast using the current KF scheme, (b) the MSM forecast using the modified KF scheme, and (c) observation.

References

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