Quantitative Prediction of Typhoon Precipitation Using the Tiling Domain Technique of a Cloud-Resolving Model

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1. Introduction

When a typhoon approaches and lands the Japanese Islands, the Korean Peninsula, Taiwan and other coastal regions, it brings often a large amount of precipitation. The orography and mid-latitude baroclinic zone strongly enhance the precipitation of typhoon over lands. This occasionally results in a huge disaster. The recent global models or large-scale prediction systems have been advanced to predict more accurate track of typhoon. A high resolution and cloud-resolving model, however, is necessary for a quantitative prediction of typhoon precipitation when it approaches orography.

For numerical studies and accurate prediction of high-impact weather systems, a cloud-resolving model named the Cloud Resolving Storm Simulator (CReSS) has been developed at our research center of Nagoya University (Tsuboki and Sakakibara, 2002, 2008). In the present study, we developed a new technique to perform a long-term typhoon prediction using a parallel computer. The objective of the present study is the development of the technique for the CReSS model and to apply it for quantitative predictions of typhoon precipitation.

2. The cloud-resolving model and tiling domain technique

CReSS is a non-hydrostatic and compressible model designed for parallel computers. Convection is explicitly calculated and the cloud microphysics is represented by a bulk scheme. For a high-resolution and long-term simulation of typhoons, we developed a new technique of simulation using the cloud resolving model, which is named tiling domain (TD) technique. This

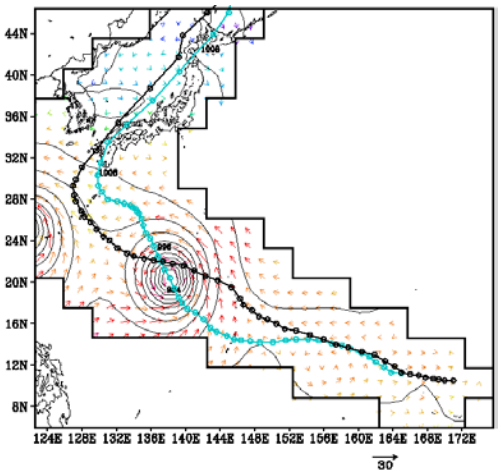

Fig. 1. Computation domain of the simulation experiment of T0416 and T0418. Initial pressure (contour lines) and horizontal wind (arrows) at 00 UTC August 25, 2004 are displayed within the domain. The blue and black lines are best tracks of T0416 and T0418, respectively.

enables us to use a non-rectangular shaped domain along the typhoon track and to perform a high-resolution and long-term simulation of typhoon.

3. Simulation Experiments of Typhoon

In the present study, the TD technique was applied for simulation experiments of the typhoons T0418, T0416 and T0423 in 2004 to make quantitative predictions of the intense precipitation of typhoons over Japan. The horizontal resolutions and periods are 4 km and two weeks for T0418 and T0416, and 2 km and 4 days for T0423. The simulated precipitation was compared with observation and the performance of the technique was evaluated. In the experiment of T0416 and T0418, 94 domain tiles which are basic unit to compose the computational domain were used along the tracks (Fig. 1). The regional objective analysis data of the Japan Meteorological Agency were used for initial and boundary conditions.

At the initial time, T0416 already developed while T0418 was not generated yet. Around 2 days from the initial time, T0418 formed and both typhoons moved almost along the best tracks. T0416 approached the southern Kyushu at 120 h and T0418 approached the western Kyushu at 312 h from the initial time (Fig.2) in the simulation. The locations of typhoon centers are almost same as those of observation. The enhancements of rainfall due to the Kyushu topography are successfully simulated and rainfall intensity is comparable with the observation for the both typhoons. In Fig.2, the southerly is intense in the southern Kyushu and precipitation is enhanced there. The central pressure of T0418 was correctly simulated. The rainbands and eyewall are also simulated well. The result indicates that the TD technique is useful for the quantitative prediction of typhoon precipitation.

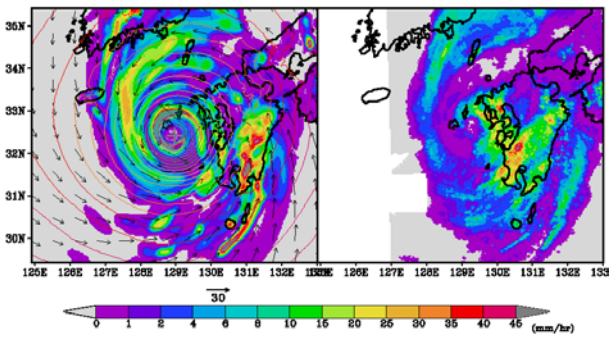

Fig. 2. Simulated (left) and observed (right) rainfall distributions of T0418 at 312 h (00 UTC Sept. 7, 2004) from the initial time.

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References

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