Towards a long-term high-resolution regional reanalysis over Japan by using NHM-LETKF

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Abstract

We are investigating the feasibility of regional reanalysis covering Japan and its surrounding area with a 5-km grid spacing over ~60 years (Fukui et al., 2018). Such long-term high-resolution reanalysis datasets are expected to be useful for various purposes, such as researching past extreme events, monitoring local responses on the climate change, and developing schemes to apply meteorological data. The regional reanalysis system that we are developing consists of the JMA's nonhydrostatic model (NHM) nested in JRA-55 (equivalent to a 55 km gird spacing) and the local ensemble transform Kalman filter (LETKF). The NHM-LETKF is optimized for long-term regional reanalysis in terms of first guesses, lateral boundary perturbations and the ensemble size. The assimilated data are limited to the conventional observations, such as surface pressure observations and radiosonde observations, in order to keep the consistency of the reanalysis in quality throughout the entire reanalysis period, which enables us to detect signals of climate change and to compare past extreme events.

Towards a long-term reanalysis, regional reanalysis experiments covering one summer (August 2014) and one winter (January 2016) were conducted. We assessed the system, paying special attention to its reproducibility of precipitation. Dynamical downscaling experiments were also conducted to validate the values of the regional reanalysis.

First, we confirmed that the system worked stably for the experimental period, using the JMA's operational Mesoscale Analysis (MA), where the observations with satellites and radars as well as the conventional observations are assimilated. The root mean square differences (RMSD) to MA for mean sea level pressure were ~0.9 hPa on average

and stable over the period. The RMSDs were comparable to the RMSDs of JRA-55 and significantly smaller than the RMSDs of the dynamical downscaling experiment.

Then, the simulated precipitation over the Japan islands were verified using the JMA's precipitation data (R/A), which are based on radar observations calibrated with rain gauge observations. The bias scores of the regional reanalysis are stable, whereas those of JRA-55 were gradually smaller for higher precipitation in both season. The threat scores of the regional reanalysis is higher in both seasons than those of JRA-55 and the dynamical downscaling experiments. The higher-resolution model resolved better not only the topography but also mesoscale phenomena, such as vortex over the Japan sea in winter and typhoons. The assimilation of the conventional observations improved some individual mesoscale phenomena that were difficult to simulate with dynamical downscaling where no observation was assimilated, although the difficulty remained in simulating of the phenomena over the area where observations are sparse, such as the ocean to the south of the Japan islands.

Acknowledgement:

This study was funded by the social and scientific priority issues (Theme 4) to be tackled by using post K computer of the FLAGSHIP2020 Project (ID: hp150287, hp160230, hp170246, hp180194) and JSPS KAKENHI Grant Number 16H04054. This work was done as part of a joint research project between Tohoku Univ. and MRI The experiments were partly conducted with the supercomputing resources at Cyberscience Center, Tohoku Univ. and the ES under the Strategic Project with Special Support.

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