Assimilation high-resolution winds from Doppler lidar with lateral boundary optimization

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1. Introduction

Monitoring severe weather such as wind shear and clear air turbulence is important for aviation safety. A dynamical downscaling using a limited-area model (LAM) is one of the effective techniques to make the high resolution forecast data because this will be able to save computational cost by choosing small forecast domain. The dynamical downscaling is generally forced with initial condition and lateral boundary condition (LBC) derived from a coarse-resolution global circulation models, so that the error growth in a LAM is dominated by the LBC when the forecast domain is small. In order to extend the forecast lead time for the small domain, lateral boundary optimization (LBO) scheme through LETKF have been proposed and assessed how effective this scheme would be for three cases with sea-breeze fronts.

2. Experimental design

Observing system simulation experiments for high-resolution winds from simulated Doppler lidar have been performed with the Japan meteorological agency nonhydrostatic mesoscale model (JMA-NHM) at a horizontal resolution of 400 m and 15 minutes update cycle. A “nature run” is generated from the downscaling from the mesoscale objective analysis data by JMA (10-km grid spacing). The ensemble downscaling forecast experiments are performed by using the JMA operational one-week ensemble prediction system (EPS) and the total ensemble forecasts have 21 members. LBO is designed to correct the lateral boundary for whole forecast period using LETKF. Here the ensemble mean state is modified but ensemble perturbations are kept from the JMA-EPS downscaling results.

3. Results

The results indicate that the LBO improved the forecast significantly, in particular, the forecast error of wind speed with the LBO at 1-hour forecast is smaller than that without the LBO at 15 minutes forecast. The assimilation of Doppler lidar with the LBO is a promising approach for the very short-range forecast (1-hour at most) with narrow domain such as the aviation weather.

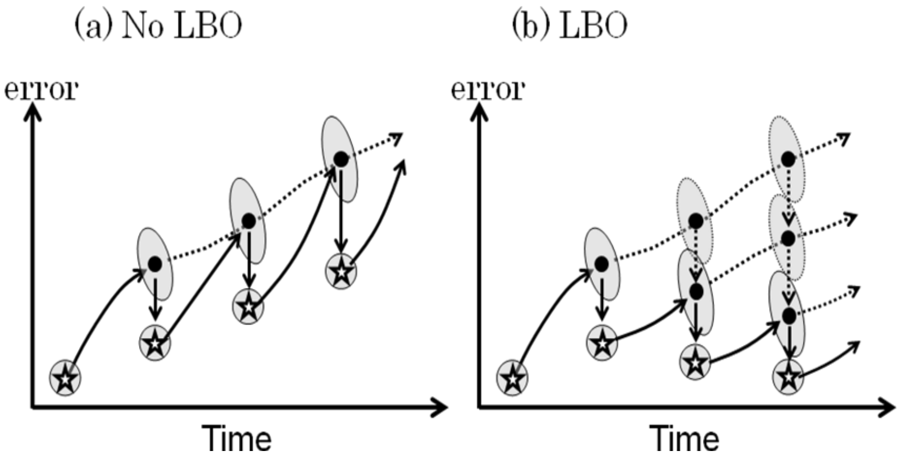

FIG. 1. Schematic of LBO. (a) No LBO and (b) LBO. X axis represents forecast time and y axis is forecast error. Star and filled circle indicate analysis (initial condition) and forecast (first guess), respectively. Solid arrows represent trajectory for ensemble mean of forecast and dotted lines trajectory for ensemble mean of LBC. Gray ellipses denote ensemble spread for each analysis and forecast state.

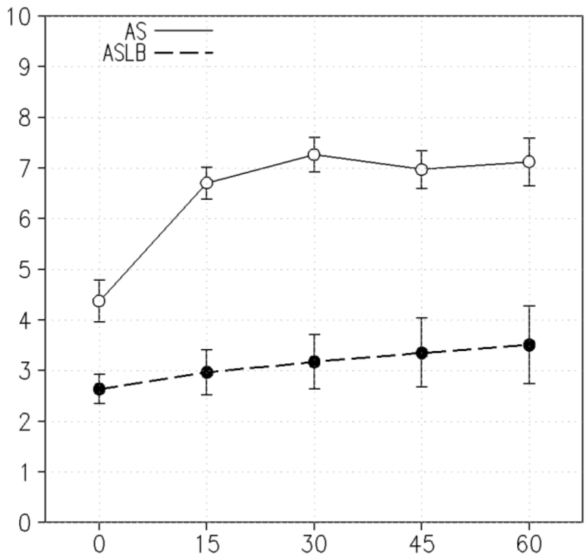

Fig. 2. The ensemble averaged normalized error growth by the experiment without assimilation. Filled and open circles indicate the experiment without LBO (AS) and with LBO (ASLB). Vertical axis of circle indicates one-standard deviation. X axis is forecast length from analysis for 0-60 minutes.