Improved reanalysis and prediction of atmospheric fields over the Southern Ocean by campaign-based radiosonde observations

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1. Introduction

The reanalysis data has large uncertain in the polar regions. The previous study suggested that additional radiosonde observation in high latitude reduced large uncertainty at upper level and improved forecast skill of surface circulations over the not only high latitude (Yamazaki et al., 2015; Inoue et al., 2015) but also over the midlatitude (Sato et al., 2017). Because large uncertainty over the high latitude reached midlatitudes, resulting in error of surface circulations over midlatitudes (Sato et al., 2017). The uncertainty over the Southern Hemisphere in Atmospheric reanalysis is larger than over the Northern Hemisphere because of lack of the observation over the Southern Ocean. However, no previous study has reported the impact of additional radiosonde observation over the Southern Ocean on reanalysis data and weather forecast. In this study, we investigate the impact of additional radiosonde observations by R/V Australia Aurora Australis (AA) on forecast skill of midlatitude cyclone.

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2. Data

2.1 Observation by R/V Aurora Australis

A research cruise by the R/V AA was done over Southern Ocean from 29 October to 4 December 2017 (Fig. 1). During the period, 6-hourly radiosonde observations were conducted over the Southern Ocean. However, these data were not sent to the Global Telecommunication System, implying that we need assimilate additional radiosonde observations into numerical model using data assimilation systems.

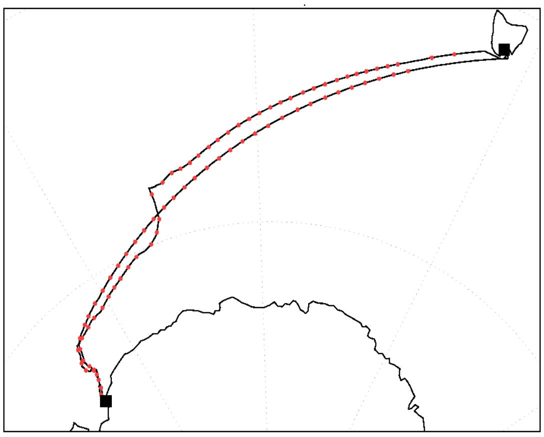

Figure 1 AA tracks and radiosonde points.

2.2. Ensemble reanalysis and forecasts

An ensemble data assimilation system, the so-called ALEDAS2 [*Enomoto et al.*, 2013], is used in this study. The ALEDAS2 is composed of the Atmospheric general circulation model For the Earth Simulator (AFES) and local ensemble transform Kalman filter (LETKF). The AFES with horizontal resolution T119 and L48 vertical levels provides 63-member ensemble forecasts. National Oceanic and Atmospheric Administration daily 0.25° Optimal Interpolation Sea-Surface Temperature (OISST) version 2 was used for ocean and sea ice boundary conditions. The AFES-LETKF experimental ensemble reanalysis version 2 (ALERA2) dataset is produced with ALEDAS2. In this study, we prepared two reanalysis data to investigate the impact of additional radiosonde by R/V AA on weather forecast over the Southern Hemisphere. The first is OSE reanalysis, which assimilated radiosonde data from R/V AA. The other one is CTL, which excluded sounding data from R/V AA. Ensemble forecasts were conducted using two ensemble reanalysis datasets.

3. Synoptic condition over the Australia

To investigate the impact of additional radiosondes on the prediction of surface systems over the mid-latitude in the Southern Hemisphere, we examined a cyclone that passed near Tasmania during early December 2017. On 1 December, the cyclone developed over southeastern Australia, and then headed toward the Tasman Sea. The cyclone with central pressure 980 hPa was located east of Tasmania on 3 December, causing strong precipitation and snowfall over Tasmania. The upper level trough, which influences the development and track of the cyclone, was located above the west part of the surface cyclone. The strong wind around the trough promoted a southward movement of the cyclone. The track of the cyclone in the CTL is similar to the track in the ERA-Interim. We conducted two ensemble forecasts (hereafter OSEf and CTLf) using two reanalysis data (OSE and CTL) as initial conditions.

4. The impact of radiosonde observation by R/V AA on forecasting the midlatitude cyclone

Figure 2 shows predicted ensemble mean sea level pressure for a 2 day forecast initialized by the OSEf and CTLf on 1 December 2017. The predicted mean cyclone was situated at the Tasmania Sea on 3 December 2017 in the OSEf (Fig 2a). The location of cyclone in the OSEf is very similar to position of `observed' cyclone in the OSE reanalysis, with small spread of cyclone position. The OSEf captured location of cyclone over the Tasmania Sea. The results from the same forecast but initialized by the CTL are shown in Fig. 2b. The cyclone in CTLf is located at north part of Tasmania Sea. The CTLf has large spread in position of cyclone, indicating that the cyclone was well predicted in the OSEf but not in the CTLf. These results indicated that the additional radiosonde observations over the Southern Ocean improved weather forecast over the midlatitude in Southern Ocean.

Acknowledgements

To access the CTL and OSE reanalyses and CTLf and OSE forecast simulation data, contact the corresponding author (satokazu@mail.kitami-it.ac.jp). ALEDAS2 and AFES integrations were performed on the Earth Simulator with the support of JAMSTEC. PREPBUFR compiled by the National Centers for Environmental Prediction (NCEP) and archived at the University Corporation for Atmospheric Research (UCAR) is used as the observations (available from http://rda.ucar.edu).

Reference

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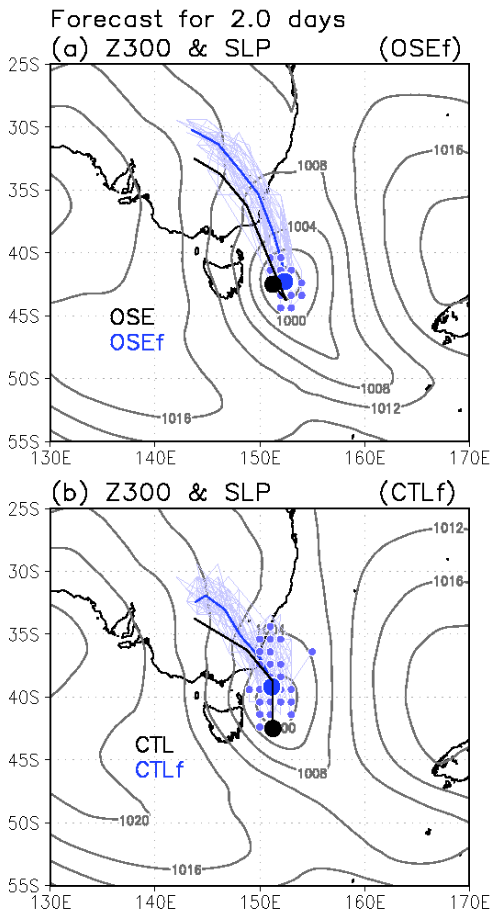

Figure 2 Predicted SLP and cyclone tracks at 00UTC 03 December 2018 in the OSEf (a) and CTLf (b).

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