EnKF Data Assimilation of Canadian Radar for a Lake-Effect Snowstorm in 2015

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The data assimilation of Radar data using the Ensemble Kalman Filter (EnKF) method has demonstrated considerable benefits to the short-term forecasts of the high-resolution NWP model.

However, until now:

- Most of studies are based on U.S. NEXRAD data. How is performance using Canadian Radar data?
- Most of studies focus on the summer convection cases (e.g. tornado). What is the impact on the simulation of a winter snowstorm case like a lake-effect snowstorm.

This research addresses both questions through a case study of an Ontario-lake-effect snowstorm in 2015.
Objectives

- To examine the capability of the Canadian radar data assimilation using EnKF to improve the short-term numerical forecasts of a lake-effect snowstorm.

- To investigate whether any numerical method leads to even better short-term numerical forecasts of a lake-effect snowstorm.

- To identify whether reflectivity or radial velocity in the radar data contributes more to the improvement of the numerical forecasts of a lake-effect snowstorm.
Methods and Data

- WRF-ARW, Version 3.4.1;
- Planetary boundary layer: MYNN;
- Microphysics: New Thompson scheme;
- Long Wave: Rapid Radiative Transfer Model;
- Short Wave: Goddard scheme.
- ICs/BCs: NCEP/RAP model output

- DA method: EAKF by the Data Assimilation Research Testbed (DART) system
- Canadian radar from King City, ON (WKR)
- Obs: Ref and Vr
- DA time window: 07Z-09Z Jan 26, 2015
- Cycle interval: 10 minutes
- 30 ensemble members
- Diabatic Digital Filter (DDFI) implemented every cycle every member
- Initial perturbation generated by WRFDA 3DVAR
Experiment setup

- CTRL: No data assimilation; initialized at 0700 Z.
- EnKF WKR: Assimilate King City (WKR) Canadian radar data.
- EnKF KBUF: Assimilate Buffalo (KBUF) U.S. radar data.
Analysis Results: Mean of Ref_post

0900Z Jan 26, 2015

CTRL

OBS WKR

Bias

EnKF KBUF

EnKF WKR

RMSE

- The EnKF DA of Canadian radar leads to an evident improvement in the analysis results.
More realistic short-term model forecasts are presented as a consequence of Canadian radar DA using EnKF.
Compared with U.S. Buffalo radar, Canadian radar at King City better captures the lower parts of the shallow lake-effect storm.
Radar Lowest Elevation Angle: Over-shooting Issue for Buffalo radar

[Diagram showing radar data for WKR Ref and KBUF Ref, with corresponding WKR Alt and KBUF Alt plots showing different data sets and color scales.]
Diabatic Digital Filter (DDFI)

2-hr valid at 1100Z Jan 26, 2015

- **EnKF WKR with DDFI**
- **EnKF WKR no DDFI**

**Bias**

**ETS**

- DDFI is an effective technology to address the model spin-up problem for the high-resolution simulation.
The Increment of Diabatic Heating after EnKF update

0840Z Jan 26, 2015

Prior Mean | Posterior Mean

Increment | OBS WKR

×10^5 K/s

26.0
21.0
16.0
11.0
6.0
1.0
-2.0
-4.0
Most of the improvement in analyzing and predicting the snowstorm is contributed by the assimilation of the reflectivity. Limited improvement is induced by Vr DA.
Concluding Remarks

- The research shows the beneficial impact of the Canadian radar data assimilation using EnKF method on the numerical analysis and short-term forecasts of the lake-effect snowstorm.

- For the cases of the shallow system like the lake-effect snowstorm, the radar beam overshooting issue could be a concern when the radar data (e.g. U.S. Buffalo site) are assimilated.

- DDFI in the DA cycles demonstrates its capability to lead to a more accurate analyses and short-term forecasts of the lake-effect snowstorm.

- Reflectivity data assimilation contributes more significantly to the improvement in the analyses and short-term forecasts of the lake-effect snowstorm, compared with the data assimilation of radial velocity.
Best wishes,

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