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Improvement of LAPS wind analysis by including background error statistics

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1. Introduction

The NOAA Earth System Research Laboratory's Local Analysis and Prediction System (LAPS) has been ported and used in many numerical weather forecast centers around the world. LAPS is a mesoscale meteorological data assimilation tool that employs a suite of observations to generate a realistic, spatially distributed, time-evolving, three-dimensional representation of atmospheric features and processes (McGinley et al. 1991; Albers 1995; Birkenheuer 1999). The system has been consistently producing favorable and realistic meteorological analyses (with initial diabatic and cloudy atmospheric conditions) and ensuing forecasts. Over the years, LAPS has continued to evolve and upgrade to include more and better schemes and capabilities.

Currently, the background at each grid point is given an "observation" increment of zero with an appropriate constant weight corresponding to the background error (Albers 1995). This study describes new work that has been done to include an ensemble-based estimate of background error statistics and to improve the weighting of the model background information in the LAPS data assimilation system. With appropriate background covariances retrieved from the ensemble method, the wind analysis is verified by comparing the current LAPS analysis that has constant weighting of background errors (CON) with this upgraded LAPS analysis designated VAR. Both the CON and VAR analyses are then compared with the withheld Radiosonde Observations (RAOBs).

2. Time-phased model ensemble system

The background error statistics are calculated from a set of model forecasts initialized at different times, but validated at the same time. This set of forecasts forms a time-phased ensemble system (Fig. 1), and can capture "flow-dependent" (time-evolving) background error statistics (Lu et al. 2007). Although both error variance and covariance for all forecast variables can be calculated using these ensemble members, we currently only ingest background wind error variance in the LAPS data assimilation system to see if wind analysis is improved.

3. Experiment design

The LAPS domain (1250 km × 1050 km) encompasses the states of Colorado, Wyoming, and portions of South Dakota, Nebraska, Kansas, Oklahoma, New Mexico, Arizona, Utah, Idaho, and Montana (Fig. 2). LAPS employs a wide range of observational datasets to construct its diagnoses, including surface observations from regional surface network, surface aviation observations, Doppler radar volume scans, wind and temperature RASS profiles, satellite visible data, multispectral image and sounding radiance data, and automated aircraft observations.

Validation of the LAPS diagnoses required comparing it with meteorological data which are not used in the LAPS analyses. In this study, LAPS data are extracted from the LAPS grid point horizontally nearest the independent seven RAOBs stations (Fig. 2). And data at the same 10 vertical levels between LAPS and RAOB are used for the validation. LAPS validations were performed for assimilations at every 00 and 12 UTC from 15 to 30 March 2007.

4. Verification results

Wind speed and wind direction biases (differences) between both LAPS analyses (CON and VAR) and the withheld RAOBs at each observation point are computed for every 00 and 12UTC from 15 to 30 March 2007 respectively. Then these biases are averaged for the whole period at each RAOB location.

The verification did show a significant improvement of the wind direction analysis for most pressure levels, especially at lower levels (Fig. 4). Wind direction below 500 hPa in the VAR experiment showed less bias than in the CON experiment. Figs. 4a, c, and e showed that the bias in VAR was less than or similar to CON in the low-elevation areas. In the high-elevation areas, the wind direction was also improved especially in the lower-levels (Figs. b, d, f, and g). The range of improvement for wind direction is between approximately 6 % and 8 %. That improvement is well above 10 % for the ABR (Fig. 4e), UNR (Fig. 4f), and RIW (Fig. 4g).

The verification also showed an improvement of the wind speed analysis in lower levels (Fig. 3). The analysis for wind speed at mid- and upper-levels showed a mixed picture. The analysis showed little mid-level improvement, due possibly to the lack of observation at these levels.

5. Conclusions

The wind direction analyses were improved overall by ingesting background error statistics. On the other hand, the wind speed analyses with ingested background wind variance were improved at some levels but deteriorated at others. To further verify the benefit of incorporating these background error statistics in the LAPS, we are currently conducting forecast experiments and verifying forecast improvement.

References

Albers, S. C., 1995: The LAPS Wind Analysis. *Wea. Forecasting,* **10,** 342-352.

Birkenheuer, D., 1999: The effect of using digital satellite imagery in the LAPS moisture analysis. *Wea. Forecasting*, **14,** 782-788.

Lu, C., H. Yuan, B. E. Schwartz, and S. G. Benjamin, 2007: Short-range numerical weather prediction using time-lagged ensembles. *Wea. Forecasting*, **22,** 580-595.

McGinley, J. A., S. C. Albers, and P. A. Stamus, 1991: Validation of a composite convective index as defined by a real-time local analysis system. *Wea. Forecasting*, **6,** 337-356.

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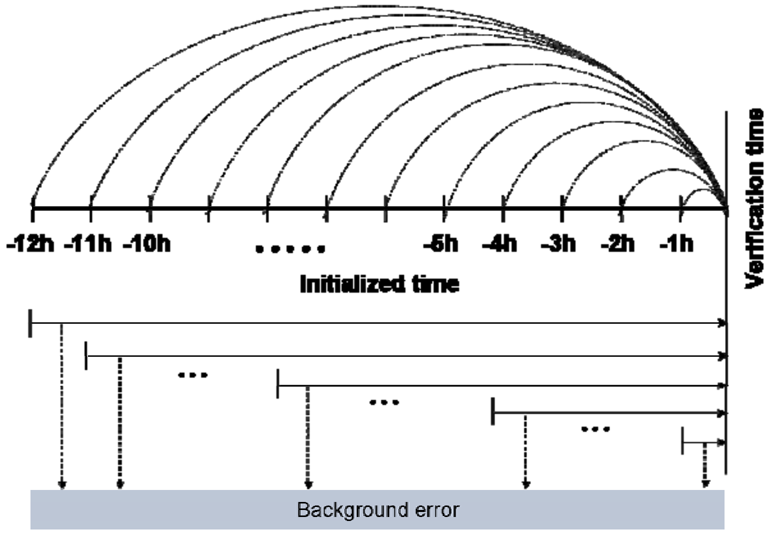

Fig. 1 Schematic illustration of time-lagged ensemble method for estimating error covariance. In this figure, forecasts within a 12-h cycle are considered for the ensemble member pool.

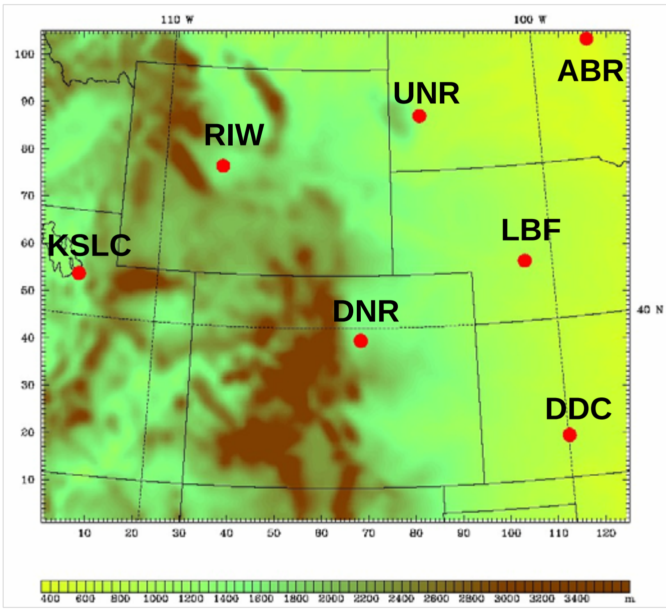

Fig. 2 The LAPS domain encompasses CO, WY, and portions of the surrounding states. Data used for validation include seven RAOBs (red points and their name).

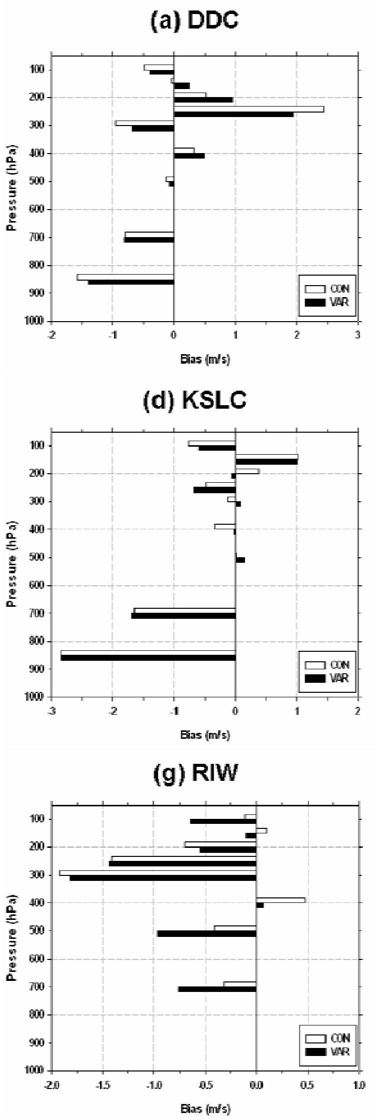

Fig. 3 Wind speed bias (LAPS-RAOB) for 7 RAOB points. Black bar is "VAR" experiment (LAPS analysis with ingested background wind variance as the weighting). White bar is "CON" experiment (LAPS analysis with constant weighting of background errors).

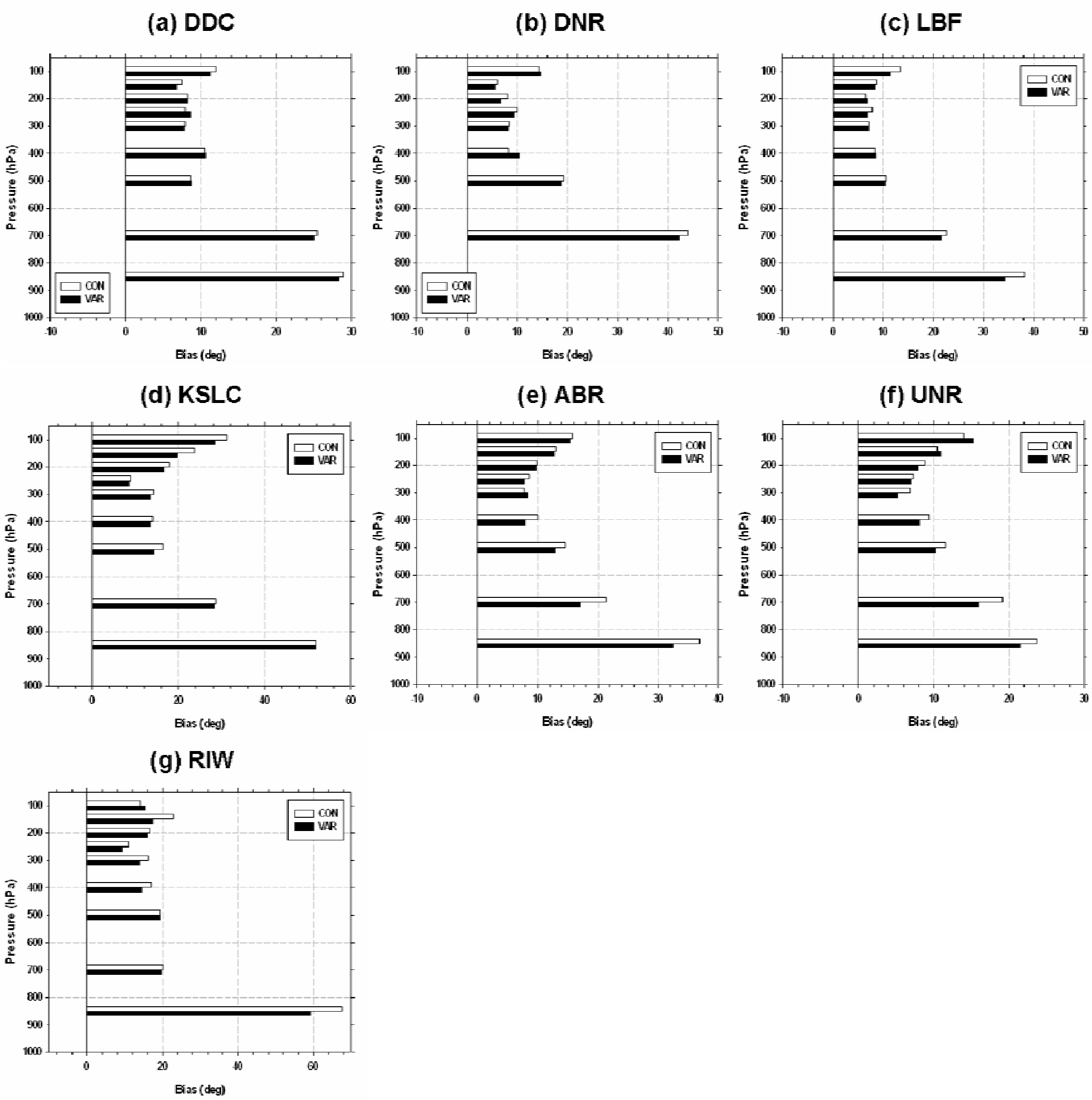

Fig. 4 Wind direction bias (LAPS-RAOB) for 7 RAOB points. Black bar is "VAR" experiment (LAPS analysis with ingested background wind variance as the weighting). White bar is "CON" experiment (LAPS analysis with constant weighting of background errors).