IMPROVING THE HEAVY RAINFALL FORECAST BY ASSIMILATING RETRIEVED MOISTURE AND RADAR DATA: PERFORMANCE AND VALIDATION WITH REAL CASES

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ABSTRACT

Moisture information plays an important role in the convective initiation and heavy rain prediction. This study examined the effect of assimilating S- and Ka-band dual-wavelength-retrieved water vapor data with radial wind and reflectivity data. The S-PolKa vertical profile of humidity, which provides environmental information before precipitation occurs, was obtained at low levels and thinned into averaged and four-quadrant profiles. The retrieved moisture information was assimilated by two different strategies: (1) assimilation of water vapor data with radar data for the entire 2 h and (2) assimilation of water vapor data in the first hour, and radial velocity and reflectivity data in the second hour. By using the WRF local ensemble transform Kalman filter data assimilation system, three real cases of the Dynamics of the Madden-Julian Oscillation Experiment were examined through a series of experiments. The results revealed that assimilating additional water vapor data more markedly improved the analysis at the convective scale than assimilating radial wind and reflectivity data alone, leading to more significant improvements in the rain forecast compared with assimilating radar data only. In addition, the strategy of assimilating only retrieved water vapor data in the first hour and radial wind and reflectivity data in the second hour achieved the optimal analysis with which to launch the very short-term forecast, resulting in the most improvement of rain forecast compared with other experiments. Furthermore, assimilating moisture profiles into four quadrants achieved more accurate analysis and forecast. Overall, our study demonstrated that the humidify information in nonprecipitation areas is critical for further improving the analysis and forecast of convective weather systems. Besides the S-PolKa-retrieved water vapor, the impact of assimilating radar-retrieved refractivity that carries moisture information near the surface and is available in both precipitation and nonprecipiation is investigated in our ongoing works. The preliminary results in two real cases of the Terrain-influenced Monsoon Rainfall Experiment/Southwest Monsoon Experiment reveal that with the additional refractivity assimilation, more precise moisture corrections and stronger southwesterly wind were obtained, leading to the better forecasting of both light and heavy rain during 6 h.

REFERENCES

Ellis, S. M., and J. Vivekanandan, 2010: Water vapor estimates using simultaneous dual-wavelength radar observations. Radio Sci., 45, 1–15, https://doi.org/10.1029/2009RS004280.

Fabry, F., C. Frush, I. Zawadzki, and A. Kilambi, 1997: Extraction of near-surface index of refraction using radar phase measurements from ground targets. IEEE Antennas Propag. Soc. AP-S Int. Symp., 4, 2625–2628, https://doi.org/10.1109/aps.1997.625552

Feng, Y. C., H. W. Hsu, T. M. Weckwerth, P. L. Lin, Y. C. Liou, and T. C. C. Wang, 2021: The spatiotemporal characteristics of near-surface water vapor in a coastal region revealed from radar-derived refractivity. Mon. Weather Rev., 149, 2853–2874, https://doi.org/10.1175/MWR-D-20-0425.1.

Tsai, C. C., S. C. Yang, and Y. C. Liou, 2014: Improving quantitative precipitation nowcasting with a local ensemble transform Kalman filter radar data assimilation system: Observing system simulation experiments. Tellus, Ser. A Dyn. Meteorol. Oceanogr., 66, https://doi.org/10.3402/tellusa.v66.21804.

Keywords: SPol-Ka-retrieved water vapor assimilation; radar-retrieved refractivity assimilation; radar assimilation, heavy rain.