EFFECT OF THE ASSIMILATION OF 3D RADAR REFLECTIVITY DATA ON A VERY-SHORT RANGE FORECAST OF HEAVY CONVECTIVE RAINFALLS

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I. INTRODUCTION

Present high resolution NWP models are capable of generating detailed precipitation fields. However, the observed and forecasted precipitation amounts usually differ in their positions, intensities and time evolutions. Inaccurate initial conditions, which result in inappropriate triggering of convective processes, belong to the reasons of errors in forecasts.

The improvement of the initial conditions can be performed by the assimilation of suitable data containing information on the development of precipitation processes in the atmosphere into a NWP model. In this contribution the assimilation of radar reflectivity data is used to initialize convective processes in the model with a high horizontal resolution.

II. PRESENTATION OF RESEARCH

Several methods of the radar reflectivity assimilation into the NWP model with a high horizontal resolution are presented and their impact on the accuracy of precipitation forecast is evaluated. The data are assimilated into the non-hydrostatic NWP model COSMO (Doms and Schaettler, 1999), which is integrated with the horizontal resolution of 2.8 km. The model uses explicit expression of cloud and rain processes and the parameterization of the precipitation processes includes water vapour, cloud water, rain, ice, snow and graupels.

The radar reflectivity is measured by two Czech radars, Skalky and Brdy, and reflectivity values in 27 vertical levels (CAPPI 1000, 1500, …, 14000 m a.s.l.) with the horizontal resolution of 1 km are available every 10 minutes.

The considered assimilation methods are based on the correction of the model water vapour mixing ratio (WVC) which depends on the difference between the model precipitation and observed precipitation derived from radar data (Falkovich et al., 2000; Sokol and Rezacova, 2006). The applied methods differ in the radar data that are used. They use either standard 2-dimensional precipitation fields (WVC 2D) derived from radar reflectivity or 3-dimensional precipitation data (WVC 3D), which include vertical profiles of radar-derived precipitation. The latent heat nudging method (LHN; Macpherson, 2001), which is the option of the COSMO model and which uses 2-dimensional precipitation field serves as the reference method.

The assimilation methods are tested for cases with heavy convective precipitation, which produced local flash floods. All selected cases were observed in the Czech territory because this area is well covered by available data. The assessment of the methods is focused on a very short range forecast of precipitation. The evaluation is performed subjectively "by eye" and also by more objective approaches that belong to so called "fuzzy" methods (Ebert, 2007; Rezacova and Sokol, 2007).

III. RESULTS AND CONCLUSIONS

The results confirm that the assimilation of radar reflectivity data significantly improves the forecast of heavy convective precipitation. In case when the forecast without assimilation is good then the assimilation improves the locations of the storms and precipitation amounts. If the model without assimilation does not forecast convective precipitation then the assimilation of radar data, containing first indications of a future storm, usually triggers the development of the storm and consequently improves the precipitation forecast.

The results show that the LHN and CWV methods yield comparable results when the forecast of the model without the assimilation is good. If the model does not forecast precipitation and observed precipitation during the assimilation period is small then the LHN has problems to develop storms and significantly underestimates precipitation. An example when CWV yields significantly better forecast than LHN is shown in Fig. 1. It also confirms that the assimilation can significantly improve the original forecast by the model without the assimilation.

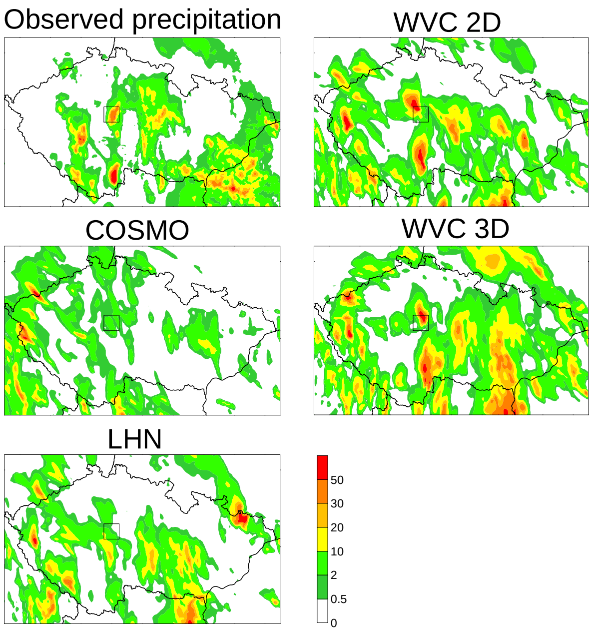

FIG. 1: An example of the forecasts by the model without the assimilation (COSMO) and by the LHN, WVC 2D and WVC 3D assimilation methods. The forecast is focused on the storm located in the indicated square and 3-h accumulated precipitation on 13 July 2002 1700 UTC is shown.

Preliminary results show that the inclusion of vertical reflectivity profiles can improve the precipitation forecast in comparison with the forecast obtained by the assimilation of 2-dimensional data.

IV. AKNOWLEDGMENTS

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V. REFERENCES

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