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Application of Latent Heat Nudging in Aladin model

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Abstract. Latent heat nudging was chosen as precipitation assimilation technique in slovene operational numerical model. The system was set up and evaluated subjectively on a typical prefrontal situation when NWP models are known to have problems with correct precipitation simulation. First results are encouraging.

1 Introduction

Various methods are available for assimilation of radar reflectivity measurements into a NWP model. They can be roughly divided into three classes: initialization methods, nudging methods and variational assimilation. All methods were thoroughly reviewed in the scope of COST 717 project. At the moment none of the methods is clearly superior; each method has advantages and disadvantages. A well known technique - Latent Heat Nudging (Jones and Macpherson, 1997) – has been chosen for implementation in Slovene operational NWP model ALADIN. Despite its robustness this technique has generally positive impact on model forecasts' scores which lasts several hours ahead.

Latent heat nudging (LHN) is a method of forcing NWP model with observed precipitation rate. In this case the model is forced with heat released by observed precipitation. Since generally only two-dimensional observations are available some kind of heating profile should be prescribed. There are two possibilities: idealised profiles or scaled model profiles. Manobianco et al. (1994) and Jones and Macpherson (1997) have chosen the second possibility. This implementation of LHN has followed their ideas.

LHN was found to be useful in mid latitudes. In studies of winter cyclogenesis the impact of assimilation was noted far beyond assimilation period (impact on surface pressure 30 h into forecast) (Chang and Holt, 1994). Some authors report dramatic impact on quality of precipitation forecasts (Wang and Warner, 1988), others have found smaller yet noticeable positive impact in general (Jones and Macpherson, 1997), with occasional larger benefits (Macpherson, 2000).

Slovenia is quite challenging area for any precipitation assimilation technique. Due to its position between Alps and Mediterranean mesoscale cyclones and convective systems are frequent and various in shape and origin. A typical case with prefrontal convection was chosen for very first attempt of LHN in Slovenia.

2 Case study

During 20 August 2003 a through has moved from western Europe towards the Alps. Prefrontal convection was triggered in prevailing south-westerly flow. Due to (among others) differences in model and real topography control model run cannot resolve topography-induced precipitation systems correctly. Usually (as in this case) strong unrealistic explicit convection is triggered on model ridges (Fig. 1 center). LHN is able to reduce unrealistic precipitation maxima and more realistically position centers of precipitation systems.

Impact of LHN lasts hours into model integration in this case. However also drawbacks appear later - explicit, model-resolved unrealistic convection appears later in the integration (Fig. 2). 3 h after end of LHN forcing instability that was artificially kept in the model starts to release. Therefore forcing window should be carefully chosen.

3 Conclusion

LHN has a positive impact on shape and time of appearance of precipitation systems in this particular case. Of course more extensive and qualitative study has to and will follow. First of all, optimal nudging time window will be chosen. The second question that remains is shape of heating profile in "dry" points, i.e. in points where there are precipitation detected by radar and none are simulated by numerical model.

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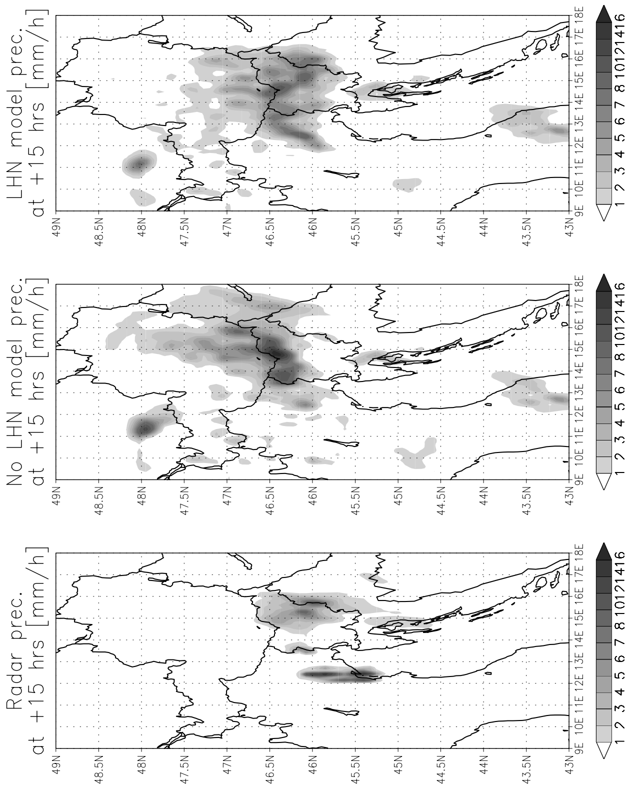

Fig. 1. Radar-derived precipitation (left), control model run (center) and LHN run (right). 20 August 2003, 15 UTC.

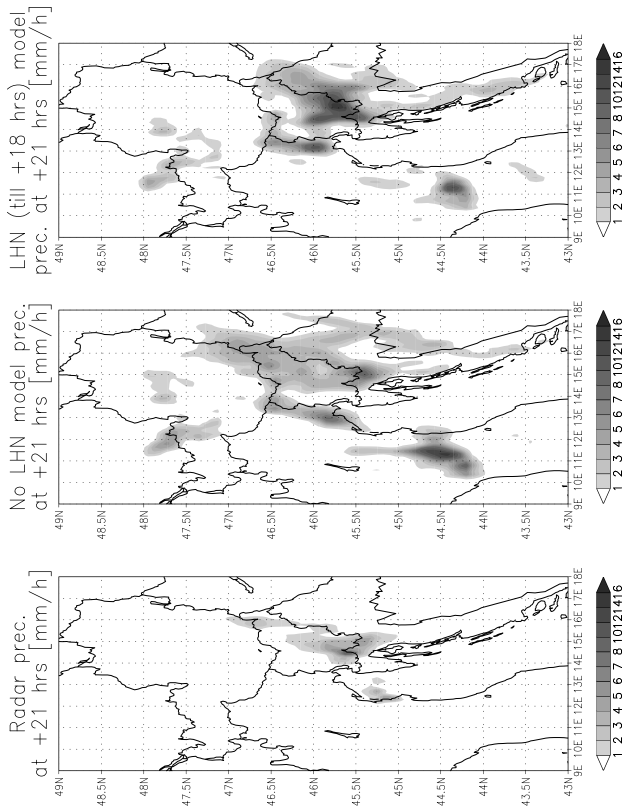

Fig. 2. Radar-derived precipitation (left), control model run (center) and LHN run (right). 20 August 2003, 21 UTC.

Search for near-by points might be unpractical due to computation efficiency and only one "climatological" profile seems to be to rigid. A solution will be looked for somewhere in-between.

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