Impact of the complexity of the land-surface model on convective precipitation forecasts

Bogumił Jakubiak[1], Richard Hodur[1] and Mikołaj Sierżęga[2]

[1]Interdisciplinary Centre for Mathematical and Computational Modelling,University of Warsaw

[2]Faculty of Mathematics, University of Warwick

e-mail: jakubiak@icm.edu.pl

1. INTRODUCTION

ICM is testing the NOAH land-surface model coupled in the mesoscale numerical prediction model COAMPS^{TM}, being explored operationally at University of Warsaw. Results of precipitation forecasts obtained from research version of COAMPS with the NOAH-LSM model included (LSM run) are compared to the results of the control operational set-up with a simple one-layer SLAB model (nolsm run). First tests are concentrated on qualitative, visual examination and comparisons have been done of both runs against 1h precipitation accumulations estimated from 15 minutes radar reflectivity data. We developed also some quantitative measures using a fully automated, object oriented CRA method.

2. CRA VERIFICATION METHOD

To verify the results of both cases of the COAMPS model run, the CRA method proposed by [Ebert and McBride, 2000] was implemented. A contiguous rain area (CRA) is defined as a region bounded by a selected rain rate contour in the forecast and in observations. The location error is determined using pattern matching technique. The forecast field is horizontally translated over the observed field until the best match is obtained. The location error is then simply the vector displacement of the forecast. The example of this technique is presented on Fig. 1. Paired observed and forecasted precipitation events are recognized and the forecasted object is shifted to the position of the observed one. After this, a number of statistics are evaluated.

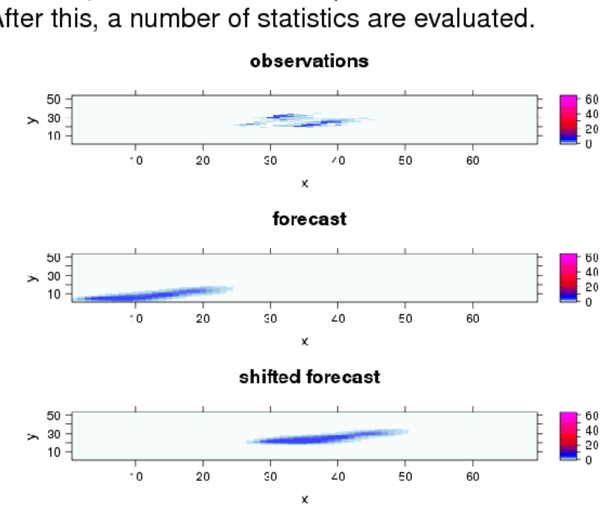

Figure 1: *Precipitation objects matching in CRA method*

3. RADAR OBSERVATIONS

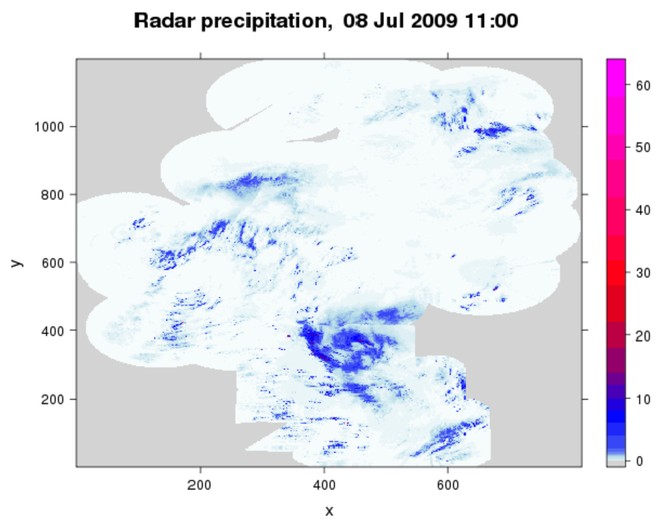

Figure 2: *1h precipitation totals, 8 Jul 2009, 11:00*

Primary radar observations used in our study consist of 15 minutes reflectivity data on 500 m CAPPI level collected from all radars operated in the area of Baltic Sea catchment. After some corrections these data are integrated into 1h precipitation accumulations using standard Z-R relationship. To facilitate comparisons estimated precipitation observations are converted to the projection and resolution of the model.

4. FORECAST MODEL

The numerical model used in our study is the US NAVY COAMPS [Hodur, 1997]. The atmospheric portion of COAMPS represents a complete three-dimensional data assimilation and prediction system comprised of data quality control, analysis, initialization, and forecast model components. The model solves the nonhydrostatic equations in a nested domains of three grids. The outher nest has 193 by 127 gridpoints separated by distance of 39 km ad covering Nord Atlantic and Europe area, the second domain consists of 169 by 217 gridpoints separated by a distance of 13 km and covering the Central Europe region and the finest domain consists of 193 by 175 gridpoints separated by a distance of 4.3 km and covering the area of Poland. The model has 30 vertical levels with variable resolution. The land-surface model, configured with four soil layers is coupled to the atmospheric model. The LSM has 33 parameters: 10 related to the vegetation, and 23 that describe soil properties. The impact of the LSM on a quality of convective precipitation has been tested in medium and fine resolution grids only.

5. RESULTS FOR FINE (4 km) MESH

Table 1: *Counters for maximum precipitation, grid 3a*

case	class	cutoff2	cutoff3	cutoff4
lsm	correct	651	550	480
	overestimated	177	166	166
	underestimated	496	480	461
nolsm	correct	511	456	413
	overestimated	211	205	200
	underestimated	393	377	369

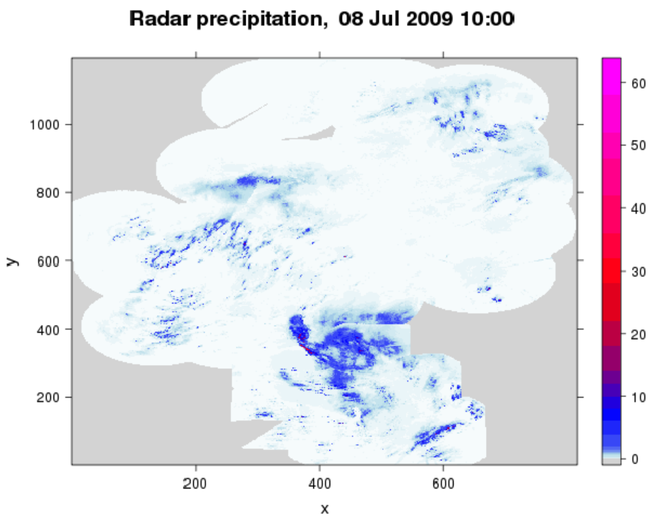

Figure 3: *1h precipitation totals, 8 Jul 2009, 10:00*

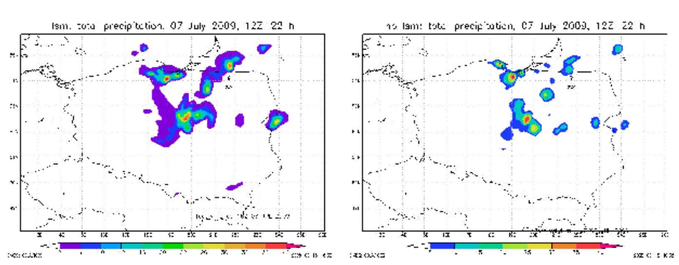

Figure 4: *Precipitation forecast valid on 8 Jul 2009, 10:00, lsm case*

Table 2: *Counters for mean precipitation, grid 3a*

case	class	cutoff2	cutoff3	cutoff4
lsm	correct	1134	1013	929
	overestimated	0	0	0
	underestimated	190	183	178
nolsm	correct	936	872	820
	overestimated	0	0	0
	underestimated	179	166	162

In Table 1 statistics for maximum precipitation are presented. They are divided into the lsm and no lsm cases, each consisits the number of correct, underestimated and overestimated points. Similar statistics, but for mean precipitation accumulation are presented in Table 2.

6. RESULTS FOR MEDIUM MESH

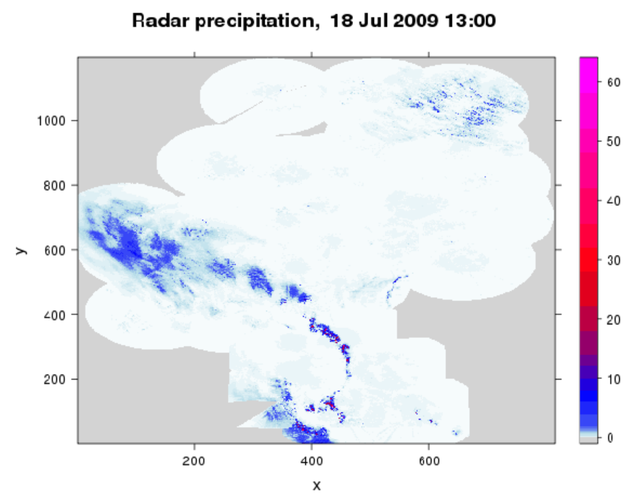

Figure 5: *1h precipitation totals, 18 Jul 2009, 13:00*

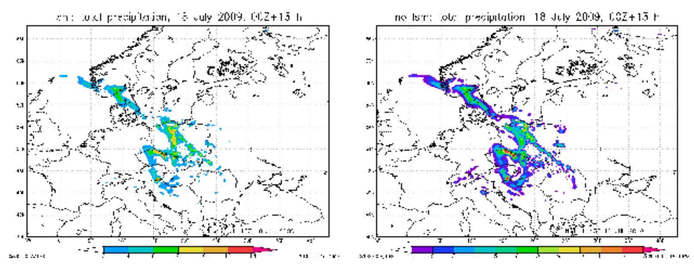

Figure 6: *Precipitation forecast valid on 18 Jul 2009, 13:00, lsm case (right panel) and nolsm case (left panel)*

7. SUMMARY and CONCLUSIONS

The summary of hit rates statistics for the lsm and no lsm cases for medium and fine meshes are presented on Fig 8. From predicted 1h precipitation accumulations maximum and mean precipitation were estimated. Hit rates for a medium grid are better than statistics for a fine mesh. In the medium grid the convection is parameterized using Kain-Fritsch method, in fine grid the convection is computed explicity. Results for lsm runs are better then results for nolsm runs. The improvement of the forecast of convective precipitation is higher for the fine grid.

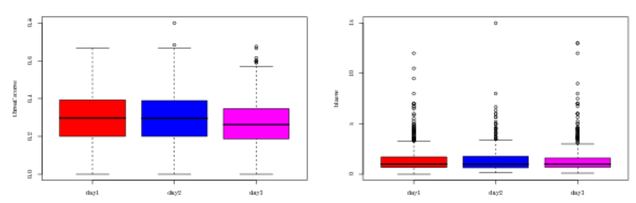

Figure 7: *Threat scores (right panel) and biases (left panel) for July 2009, medium grid*

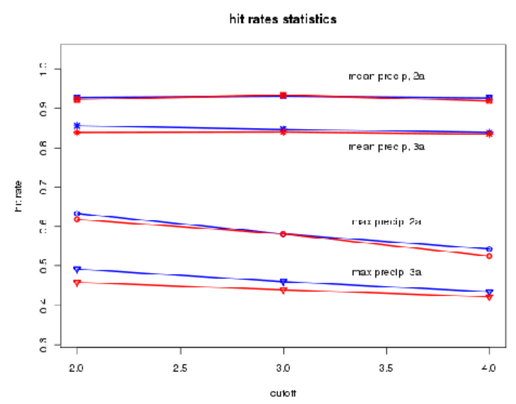

Figure 8: *hit rate statistics from all experiments*

Acknowledgements:

This research was supported by the ONR NICOP grant N00014-09-1-1099, the COST Action 731, and the Innovative Economy grant POIG.01.03.01-00-140/08. Authors acknowledge helpful discussions with Dr Teddy Holt from NRL, Monterey, CA. We used computer resources of ICM, Warsaw University, and radar observations from Baltex Radar Data Centre, Norrkoping, Sweden.

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