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

Bogumił Jakubiak, Richard Hodur and Mikolaj Sierżega
1Interdisciplinary Centre for Mathematical and Computational Modelling, University of Warsaw
2Faculty of Mathematics, University of Warwick
e-mail: jakubiak@icm.edu.pl

1. INTRODUCTION

ICM is testing the NOAA land-surface model coupled in the mesoscale numerical prediction model COAMPS™
by exploring operationally at University of Warsaw. Results of precipitation forecasts obtained from research
version of COAMPS with the NOAA-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
forecast 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.

3. RADAR OBSERVATIONS

Radar precipitation, 06 Jul 2009 11:00

Primary radar observations used in our study consist of 15 minutes reflectivity data on 500 m CAPP3 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 2.5t relationship. To facilitate comparisons estimated precipitation ob-
servations 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
the model represents the Noah land surface model (LSM) assimilation and precipitation system comprised of data qual-
ity control, analysis, initialization, and forecast model components. The model solves the nonhydrostatic equations in
a nested domains of three grids. The outer nest has 192 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 192 by 176 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

<table>
<thead>
<tr>
<th>case</th>
<th>class</th>
<th>cutof3</th>
<th>cutof93</th>
<th>cutof94</th>
</tr>
</thead>
<tbody>
<tr>
<td>lsm</td>
<td>correct</td>
<td>651</td>
<td>550</td>
<td>480</td>
</tr>
<tr>
<td></td>
<td>overestimated</td>
<td>177</td>
<td>166</td>
<td>166</td>
</tr>
<tr>
<td></td>
<td>underestimated</td>
<td>496</td>
<td>480</td>
<td>461</td>
</tr>
<tr>
<td>nolsm</td>
<td>correct</td>
<td>511</td>
<td>456</td>
<td>413</td>
</tr>
<tr>
<td></td>
<td>overestimated</td>
<td>211</td>
<td>205</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>underestimated</td>
<td>393</td>
<td>377</td>
<td>369</td>
</tr>
</tbody>
</table>

6. RESULTS FOR MEDIUM MESH

Figure 5: 1h precipitation totals, 19 Jul 2009, 13:00

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
6. 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
Rain-Fritsch method, in fine grid the convection is computed explicitly. 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.

Acknowledgements:
This research was supported by the CNR-MOCOP grant 5000154.69.01, the COST Action 171, and the Innovative Economy grant PG03-1.01.01-00-1403S. Authors acknowledge helpful discussions with Dr. Todd Holt from NRL, Monterey, CA. We used computer resources of ICM, Warsaw University, and radar observations from Baltic Radar Data Centre, Nortegping, Sweden.
E.E. Ebert and J.L. McBride. Verification of precipitation in weather systems: Determination of systematic errors. J.
