SUMMER CONVECTION IN THE VOSGES - BLACK FOREST REGION / COPS PRELIMINARY INVESTIGATIONS

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Abstract: As a preliminary investigation for the COPS experiment, a serie of 10 rainy days from last summer was studied with the Méso-NH model, initialized and forced with the ECMWF and ARPEGE analysis. In most cases, the results are not very sensitive to the type of analysis and the model succeeds reasonably well in reproducing the observed precipitation In the few cases for which the sensitivity to the analysis is significant, the model performance is quite poor. It seems that a discrepancy between the ECMWF and ARPEGE-driven simulations could be an indicator of low predictability.

Keywords: *COPS, convection, orography, predictability*

1. INTRODUCTION

The Convective and Orographically-driven Precipitation Study (COPS) will take place in June/July/August 2007 in south western Germany and eastern France, in a region of moderate orography which includes the Vosges and Black Forest mountains. This field experiment is strongly motivated by the poor performance of numerical weather prediction models to accurately forecast quantitative precipitation. As a preliminary investigation, prior to COPS, a serie of 10 rainy days from last summer was selected and studied with the Méso-NH model. The objective was to gain some insight into predictability of convective events which are expected during COPS.

2. NUMERICAL SETUP

The numerical simulations were conducted with the French research model Méso-NH (Lafore et al., 1998) Three interactively 1-way nested domains were used with horizontal mesh sizes of 32, 8 and 2 km. The area corresponding to the coarsest domain is presented in Fig. 1(a) together with the location of the nested domains. The topography of the innermost domain, centered over the COPS area, is shown in Fig. 1(b). Subgrid-scale convection is parameterized for horizontal resolutions of 32 and 8 km by a mass-flux convection scheme, whereas for the inner grid with mesh size of 2 km, convection is assumed to be explicitly resolved.

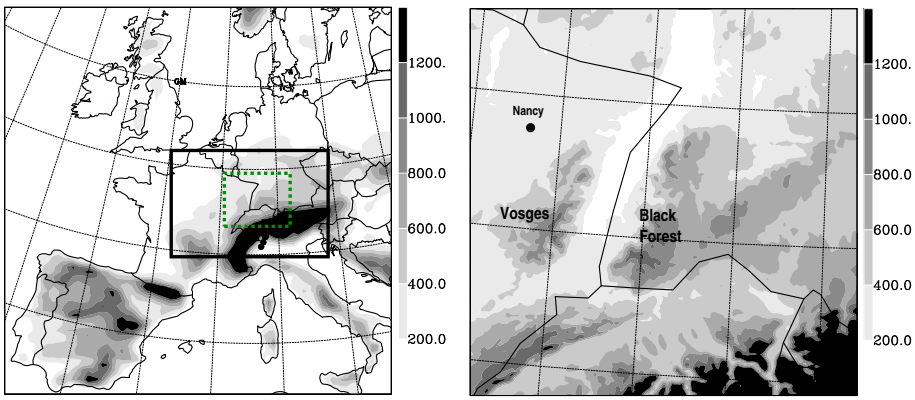

Figure 1: (a) Geographical domains used for the nested simulations. The outer frame shows the 32 km grid-mesh model domain and its topography (m). The location of the 8 km (2 km) grid-mesh domain is indicated by the solid (dashed) square. (b) Topography (m) of the 2 km grid-mesh model.

The initial and boundary conditions were taken either from the ECMWF or ARPEGE analysis. All simulations were integrated over a period of 30h, starting at 00 UTC. The 10 selected days correspond to the rainiest days of summer 2006 over the COPS region.

3. RESULTS

3.1 Overview

Figure 2 presents for each day the time evolution of the simulated precipitation rate (mm.h^{-1}, averaged over the high-resolution domain) and compares the results obtained with the two sets of analysis. In order to get a rough idea of the quality of each simulation, correlation coefficients have been computed between the observed and simulated precipitation accumulated over 24h from 06 UTC to 06UTC the next day. Because of an easier access to data, only the French surface stations have been considered so far. About 180 stations are included in the domain.

For 7 of the 10 selected days, precipitation results are not very sensitive to the type of analysis but significant discrepancies occur for June 27, August 3 and 15. For these three days, correlation coefficients which are mostly above 0.5 for the other days drop dramatically. At first sight, it seems that a discrepancy between the ECMWF and ARPEGE-driven simulations could be an indicator of a poor predictability of the situation.

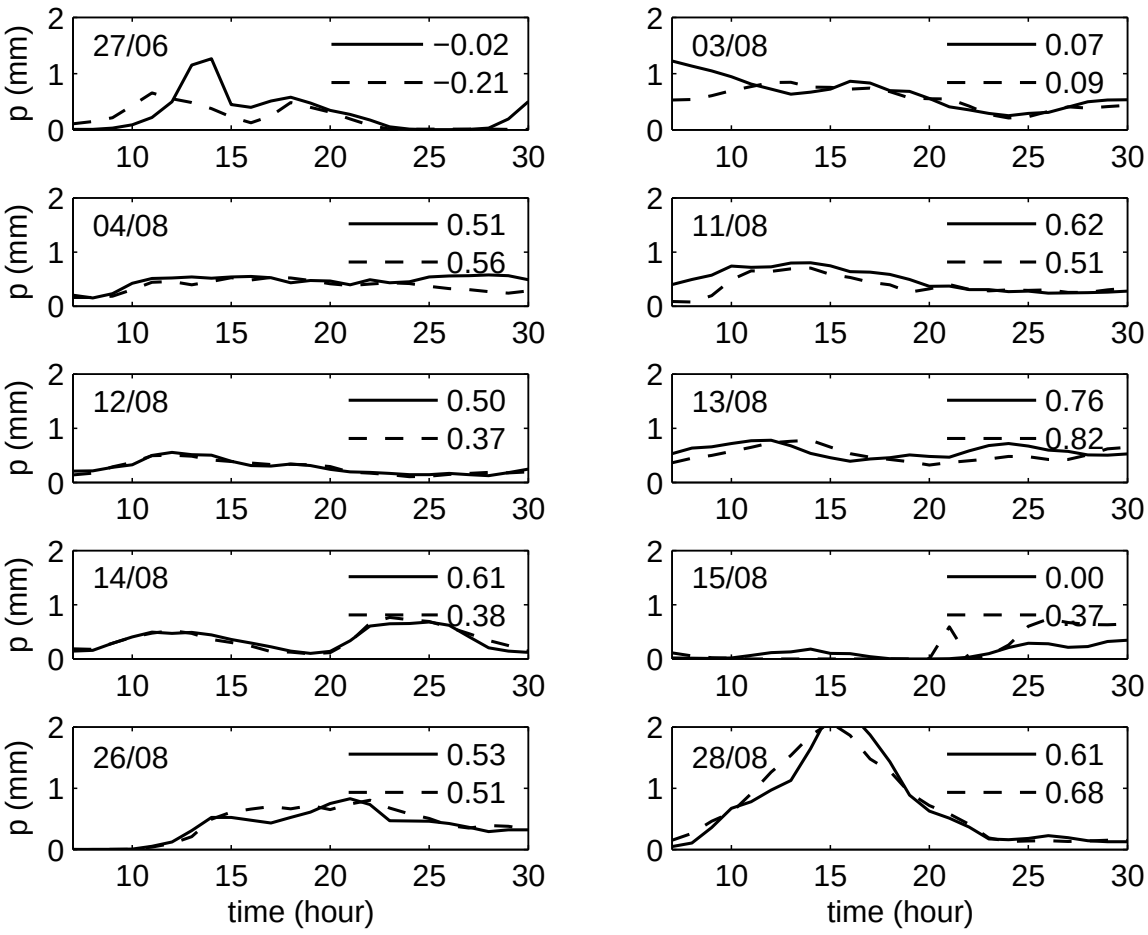

Figure 2: Time evolution of the spatially averaged precipitation rate (mm.h^{-1}) for the 10 selected days: simulations driven by ECMWF analysis (solid line) and ARPEGE analysis (dashed line). The correlation coefficients are reported on the top right corner of each plot.

3.2 The case of 27 June

Due to the poor results obtained for 27 June, this case was studied in more details. Figure 3 displays the simulated precipitation obtained with both analysis and accumulated from 06 to 12 UTC and from 12 to 18 UTC. These fields can be compared with the rainfall estimate deduced from radar observations of Nancy. According to the radar, an elongated rainband, south-west/north-east oriented moved accross the area in the morning whereas precipitation mainly occurred over northeastern Switzerland in the afternoon. Both simulations succeed in reproducing the precipitation pattern over Switzerland but none of them correctly captured the time evolution of the rain band that crossed over the Vosges and Black Forest. The ARPEGE-driven simulation gives too much precipitation over the Vosges in the morning and the ECMWF-driven simulation too much in the afternoon.

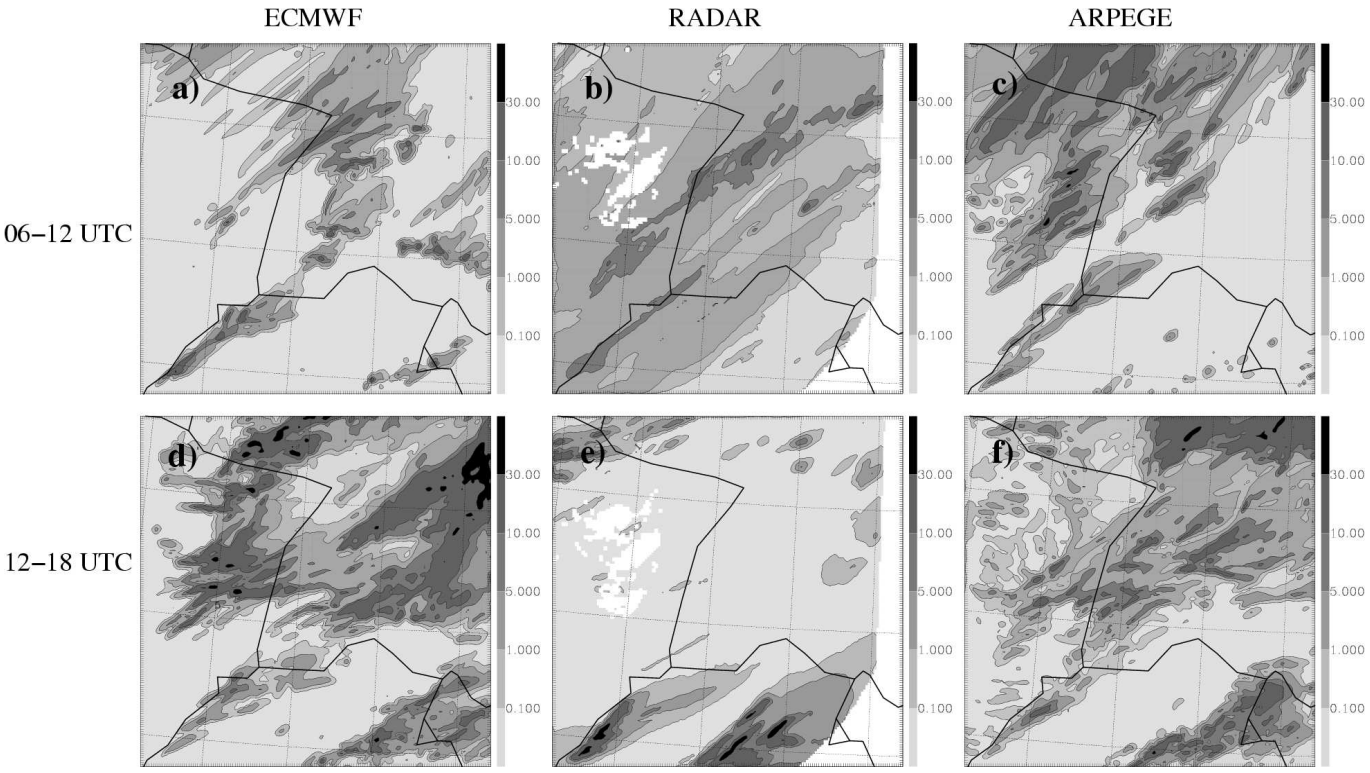

Figure 3: Accumulated precipitation (mm) from 06 to 12 UTC (top) and from 12 to 18 UTC (bottom) on 27 June 2006: computed from the ECMWF and ARPEGE-driven simulations (left and right, respectively) and estimated from the Nancy radar (middle).

4. SENSITIVITY STUDY

In an attempt to identify some of the factors that could determine the predictability of this event, two types of sensitivity experiments were carried out. The first one intended to address the problem of uncertainty on the synoptic scale. By using a potential vorticity inversion tool (Chaigne and Arbogast, 2000), the upper-level PV anomaly of the ARPEGE analysis of 27 June 2006 00 UTC was modified to obtain a better match with the one of the ECMWF analysis. The second serie of experiments was designed to investigate the role of mesoscale processes and was based upon the lag ensemble method proposed by Hohenegger et al. (2006). The driving simulations (32 km and 8 km) were initialized at 00 UTC while the ensemble members were spun off at 01 UTC (member 1), 02 UTC (member 2) and so on untill 06 UTC (member 6). The ensemble was then integrated to 06 UTC on the next day without any rescaling of the perturbation amplitudes.

Figure 4 presents the time evolution of the hourly precipitation spatially averaged over a domain restricted to the Vosges area for all the simulations. It is quite interesting to note that none of the two methods was able to

significantly alter the results. The ARGEGE-driven simulations are very little sensitive to our modifications of the large scale environment and similarly the ECMWF-driven simulations were not strongly modified by small changes in the mesoscale environment.

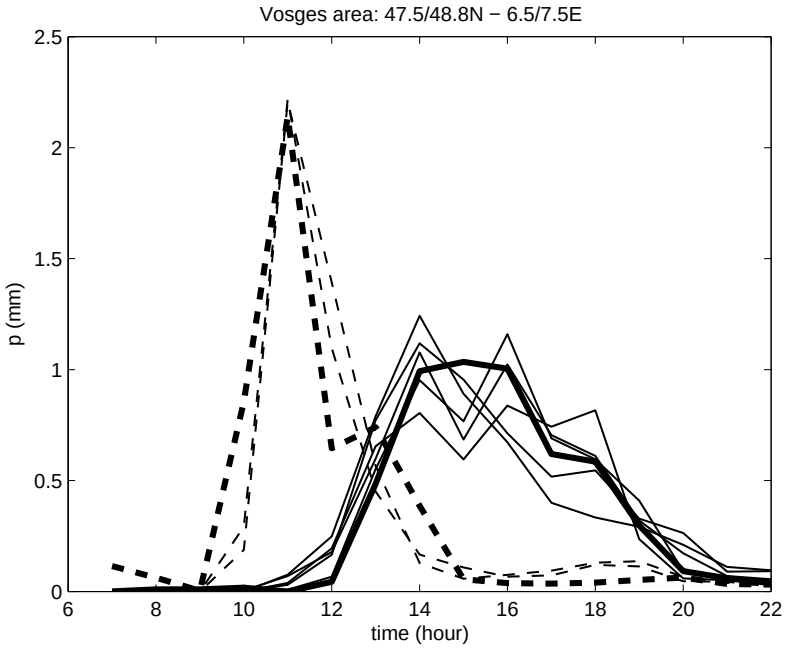

Figure 4: Time evolution of the hourly precipitation (mm) averaged over the Vosges region (solid lines: ECMWF driven simulations; dashed lines: ARPEGE driven simulations; thick lines : control experiments; thin lines : sensitivity experiments).

5. CONCLUSION AND OUTLOOK

A serie of 10 cases of rain episodes over the COPS area has been studied with the Méso-NH model initialized and forced either with ECMWF or ARPEGE analysis. Most often, model results are reasonably good and not very sensitive to the initial analysis. However, in a small number of cases, model performance is very poor and results strongly differ depending upon the type of analysis. The case of 27 June shows that the discrepancy of the results cannot be explained with small uncertainties neither in the synoptic conditions nor in the mesoscale conditions. Future work will involve further investigations on the role of the mesoscale environment. In particular the new potential offered by assimilation techniques at the convective scale will be explored.

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