The sensitivity of the AROME simulations on the Gard case to synoptic forcing

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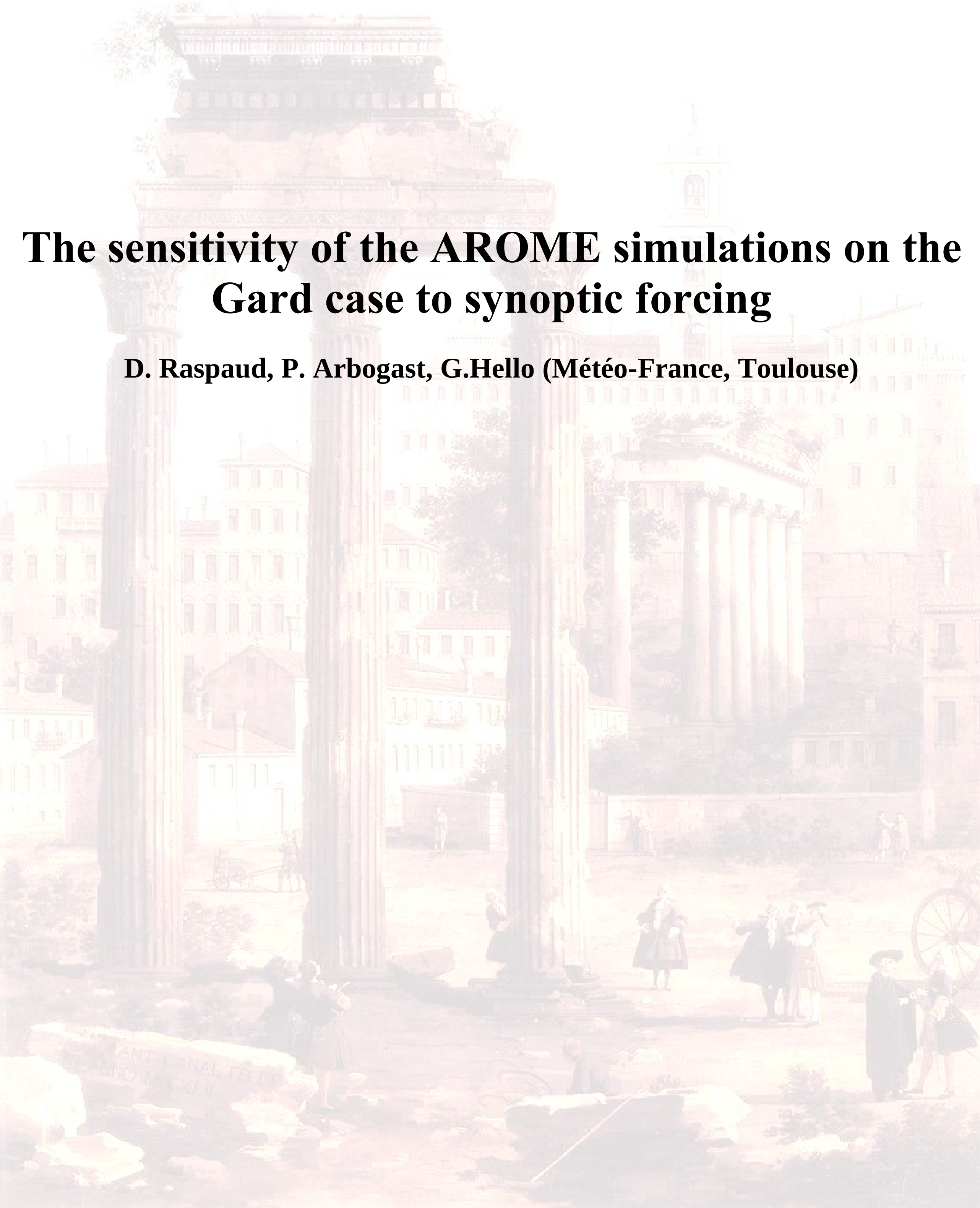

1. Summary

The Gard case is a case of a severe mesoscale convective event. The forecast skill for such an event at fine scale is known to be very dependent on the knowledge of the initial conditions (Ducrocq *et al.*, 2002). Therefore, the interaction between the synoptic forcing and the response of the mesoscale forecast is studied. The uncertainties in the initial and coupling conditions of the synoptic forcing are modelled by an ensemble system generated within the ARPEGE model. Then a "downscaling" is applied from the ARPEGE ensemble towards an AROME ensemble with an intermediate step using an ALADIN ensemble.

2. Methodology

2.1 The ensemble

Several ensemble members are defined at synoptic scale (within the ARPEGE model) by the perturbations of the magnitude and/or the localisation of the key features of the synoptic scale dynamics at the initial stage of the simulations. These perturbations are computed by making corrections of the potential vorticity field that can be inverted in order to recover wind and temperature fields. Such a method is used currently at Météo-France in order to correct the initial conditions of a forecast (see Hello and Arbogast (2004) for a concrete application). Here, the tool is used in an unusual way, as the goal is not to correct an erroneous initial state but to model some kind of uncertainties at the synoptic scale. So a small ensemble of 8 members is built. The initial dispersion of the ARPEGE ensemble is shown in figure 1. The dispersion of the ensemble is a little bit greater than what would give a usual ensemble computed with singular vectors. But one can argue that the initial perturbations of this ARPEGE ensemble are not thought to optimally grow over a time period and thus can have greater values at initial time.

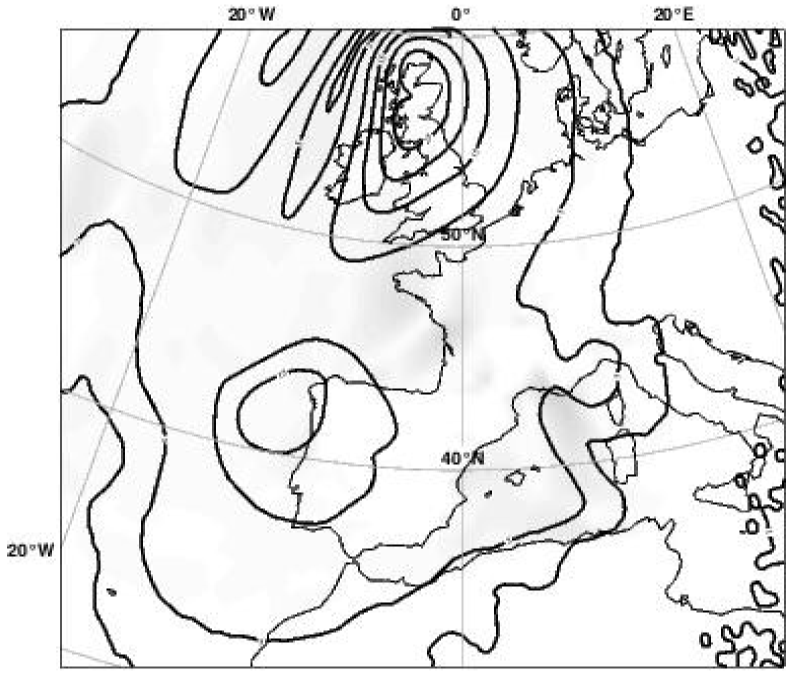

Figure 1: The characteristics of the ARPEGE ensemble on the initial state (08 of September 12UTC 2002). In plain lines, the standard deviation of the geopotential at 500 hPa (m) every 5 meters. In shading mode, the standard deviation of the intensity of the wind field at 950 hPa (maximum value of 2 m/s)

Then the ARPEGE model is run for a 18 hours forecast starting from the 8th of September 2002 at 12UTC. We obtain then 8 different forecasts. These forecasts are then used to initialize and couple the ALADIN model. The ALADIN model configuration used is the one currently in operation at Météo-France. The ALADIN forecasts obtained are then used to initialise and couple the AROME model (at AROME nominal resolution i.e. 2.5 km, for details about AROME see in newsletters 25 and 27 the related articles). Figure 2 shows the nested models ALADIN and AROME..

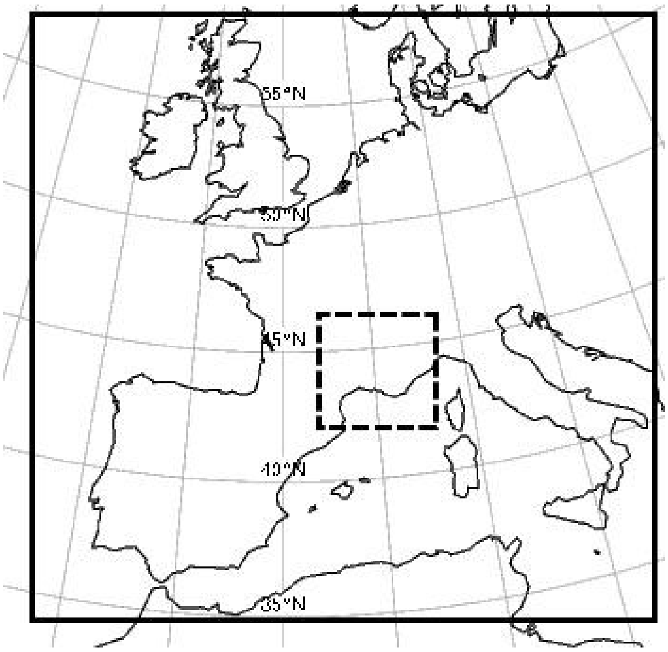

Figure 2: The nested ALADIN-AROME domains. The geographical domain covered by the ALADIN simulations is depicted in plained lines as the one covered by the AROME simulation is in dashed lines.

2.2 The Gard case

This case as been thoroughly studied as it is was a catastrophic flash-flood event over the southeast part of France. The reader can find more details on this case in Delrieu *et al.* (2004). The period that is considered in this study is starting on the 8 of September at 12UTC, to end on the 9 of September at 06UTC. On the 8 of September at 12UTC the convection has already started. The event is characterised by the large size of the area touched by heavy precipitation and also by important values of the cumulated rainfall: more than 300 mm of rain in 24 hours over the 'Gard' area (figure 3).

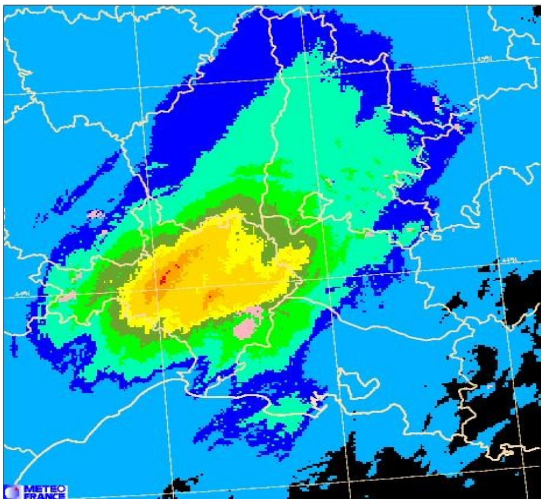

Figure 3: Cumulated rainfall over the Gard region in 24 hours from the 8 of September 12UTC to the 9 of the September 12UTC. In light green values between 50 and 100 mm, in khaki values between 100 and 150 mm, in yellow values between 150 and 200 mm, in light orange values between 200 and 300 mm, in dark orange values between 300 and 400 mm and in red values between 400 and 500 mm.

3. Results

3.1 The ALADIN ensemble

The dispersion of the ensemble at the regional scale is examined with the help of the standard deviation of the geopotential field at 500 hPa and of the intensity of the wind field at 950 hPa. This dispersion is considered after 18 hours of forecast (figure 4).

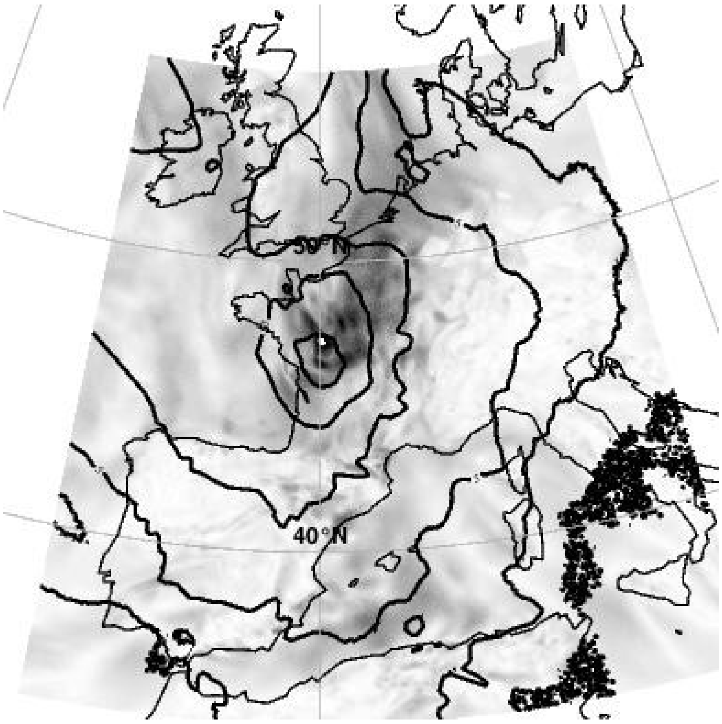

Figure 4: The dispersion of the ALADIN ensemble after 18 hours of forecast. In contouring mode is displayed the standard deviation of the geopotential at 500 hPa every 5 meters. In shading mode the standard deviation of the wind field at 950 hPa is displayed (black is for 6 m/s).

The ALADIN ensemble amplified the dispersion given by the ARPEGE ensemble especially for the low level wind. Apart from that fact, the location of the maximum of dispersion is the same as the one depicted by the ARPEGE ensemble, on the Northern part of France, and is related to a front that crossed this area during the night of the 8th of September.

3.2 The AROME ensemble

The dispersion of the regional ensemble is furthermore amplified in the AROME ensemble. The standard deviation of the ensemble for the wind field on the AROME domain reaches its maximum value of 6 m/s in many places with important geographical extent as this value is not reached in the same area, as with the ALADIN ensemble. This increase could be due to a downscaling effect together wih the impact of the convection, which is explicitly described at the AROME scale, on the low-level wind. Figure 5 shows the cumulated rainfall of the different AROME forecasts from the 8th of September 12UTC to the 9th of September 06UTC. The first remark is that the location of the event is the same on each simulation. In the reality, this event was located more south and east over the 'Gard' area (figure 3). So, the AROME ensemble was not able to catch correctly the localisation of the event. This can be due to the fact that the dispersion of the synoptic ensemble is not large enough, considering this specific aspect (only 8 members and the perturbations are done on too few features of the ARPEGE analysis) and, that this specific aspect may also be sensitive to finer scale forcing that can not be present in the ARPEGE ensemble. The second point that can be infer from figure 5 is, that the experiments are very different, considering the intensity and the geographical location of the event. For example, there is more than 150 mm on

18 hours as a maximum difference inside the ensemble. This last point shows the extreme sensitivity of the strength of this event to the skill of the initial condition at synoptic scale.

4. References

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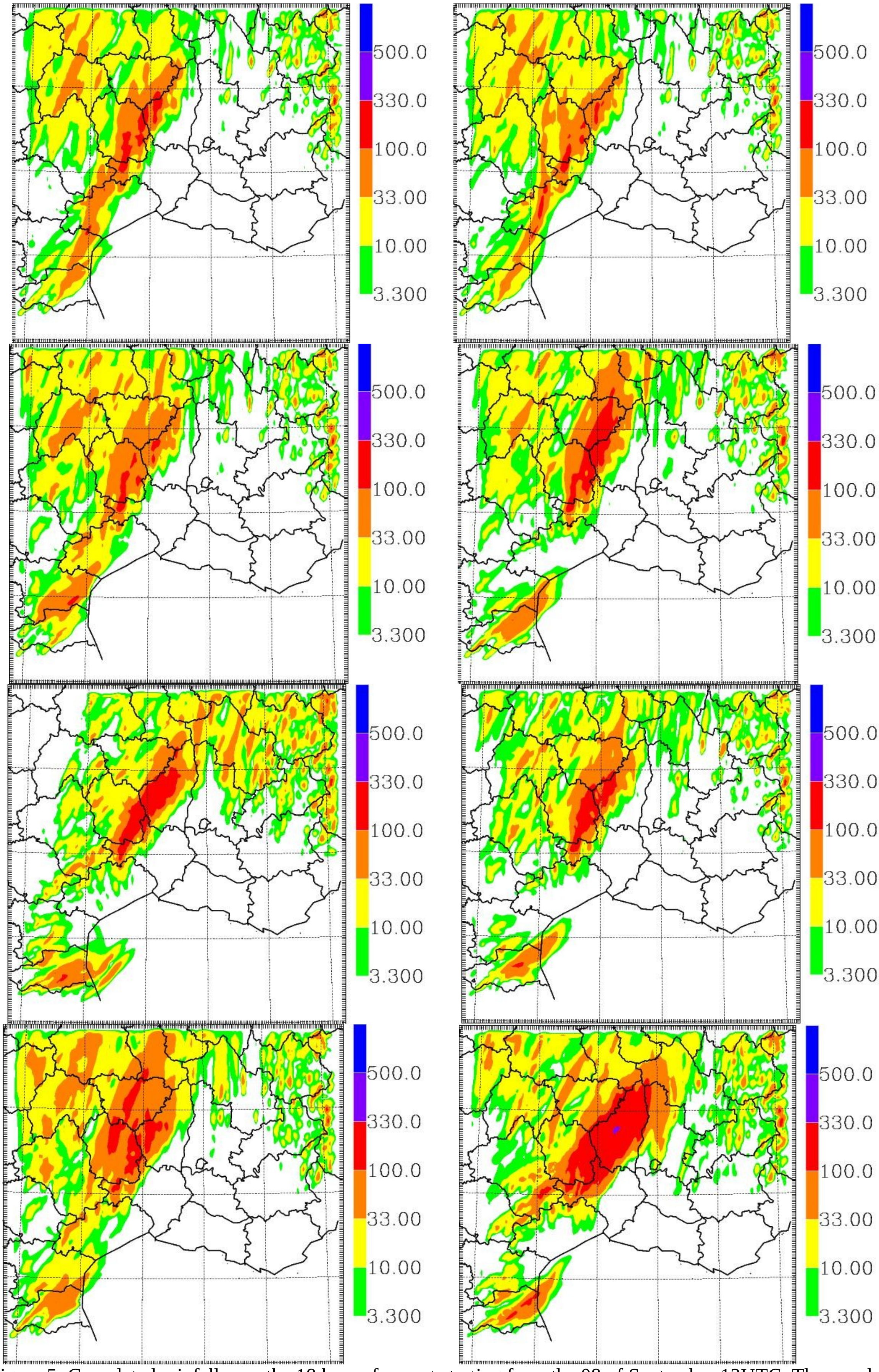

Figure 5: Cumulated rainfall over the 18 hours forecast starting from the 08 of September 12UTC. The panels are showing the different AROME forecasts of the ensemble.

CONTENTS