The impact of the use of a more conservative SL scheme for convective cases

Météo-France stay report

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1 Introduction

Sometimes the development of the convective cells can lead to hazardous events such as strong winds, lightnings, heavy rainfalls, hails or even tornadoes.
The present stay had two distingue objectives:

- to analyze the statistical characteristics of convective cells for a given period which was chosen due to the Leger's simulations;
- to evaluate the impact of the use of a more conservative SL scheme on the AROME simulations for specific cases.

2 The statistical characteristics of the convective cells size and intensity

In order to explore the statistical characteristics of the convective cells, the data used were provided by the simulations carried out by J. Leger described in *Evaluation de la prévision de situations orageuses avec des simulations AROME à l'échelle kilométrique* for a period of 43 days, between 1st of June and 30th November 2012.

2.1 The experiments set-up for the statistics period

The AROME integration was performed for all 43 days, starting from 00 UTC, with the output at every 15 minutes and Δt=45s. The domain used, called FRAMINI (Fig.1), was smaller than the operational one.

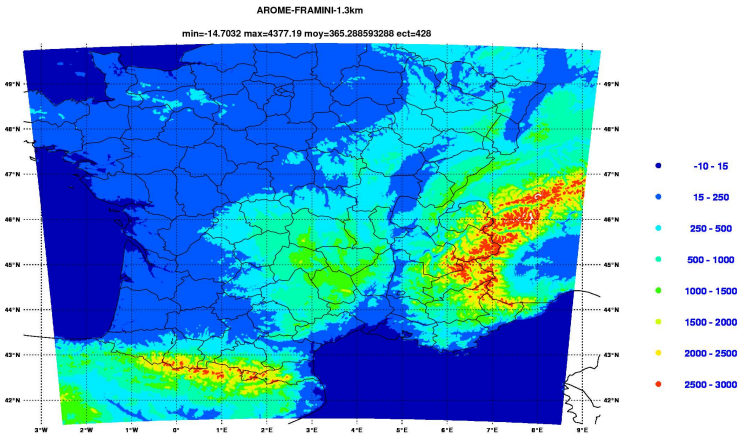

Figure 1: FRAMINI domain

Three types of experiments had been done for every day by varying the horizontal resolution and the number of vertical levels. They are labeled as following: **673I - 1.3kmL90**, **673U - 2.5KmL60** and **673T - 2.5KmL90**.

2.2 The statistics computation

The statistics were computed at the time of maximum amount of simulated precipitation (noted with tmax), at 1h before (noted with tmax-1) and 1h after (noted with tmax+1) and also at 3h before and 3h after (not shown), taking account of the two reflectivity thresholds: 30dbZ and 40dbZ.
The results of the statistics are presented in the figures bellow.

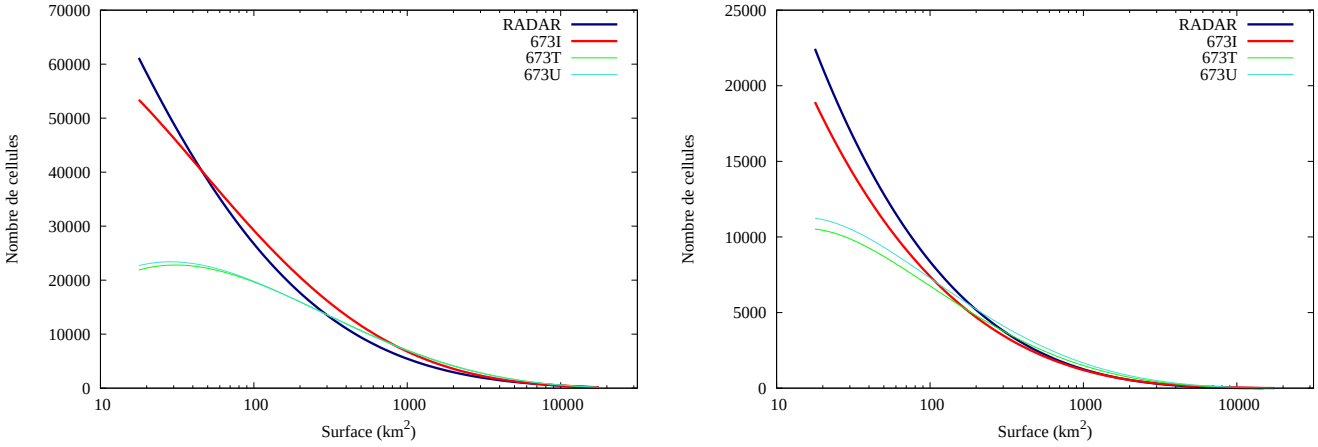

Figure 2: Distribution of the cell size (area) on the following classes logarithmic base: [10;31], [31;100], [100;316], [316;1000], [1000;3162], [3162;10000] and [10000;31622] at tmax; left - 30dbZ and right - 40dbZ

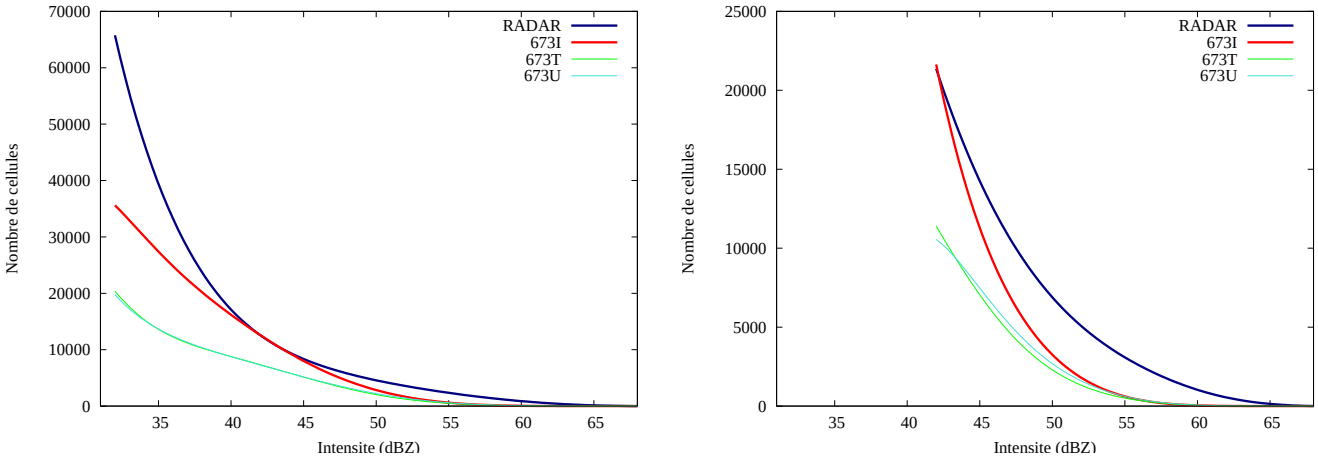

Figure 3: Distribution of the maximum intensity of cells at tmax; left - 30dbZ and right - 40dbZ

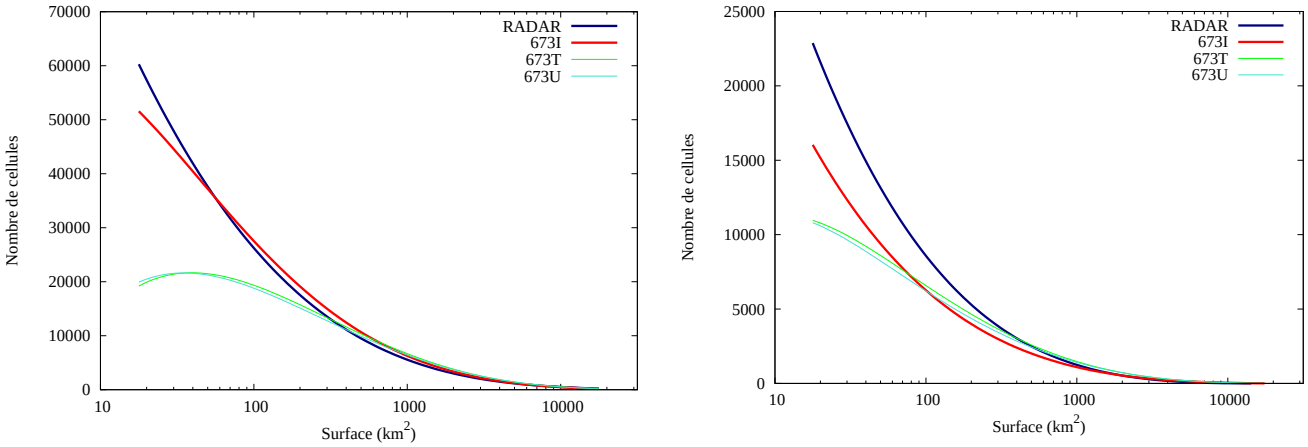

Figure 4: Distribution of the cell size (area) on the following classes logarithmic base: [10;31], [31;100], [100;316], [316;1000], [1000;3162], [3162;10000] and [10000;31622] at tmax+1; left - 30dbZ and right - 40dbZ

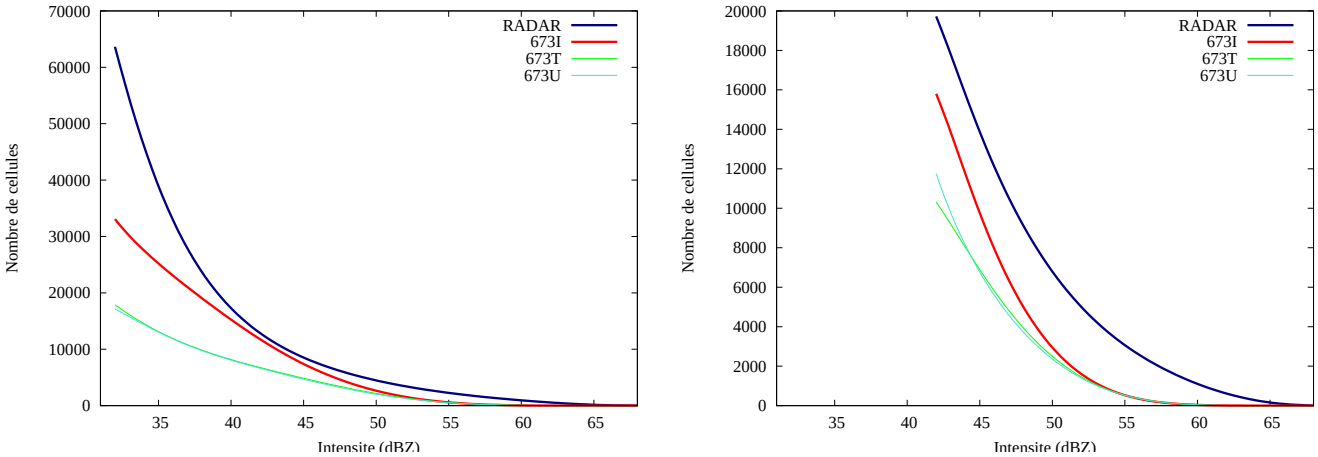

Figure 5: Distribution of the maximum intensity of cells at tmax+1; left - 30dbZ and right - 40dbZ

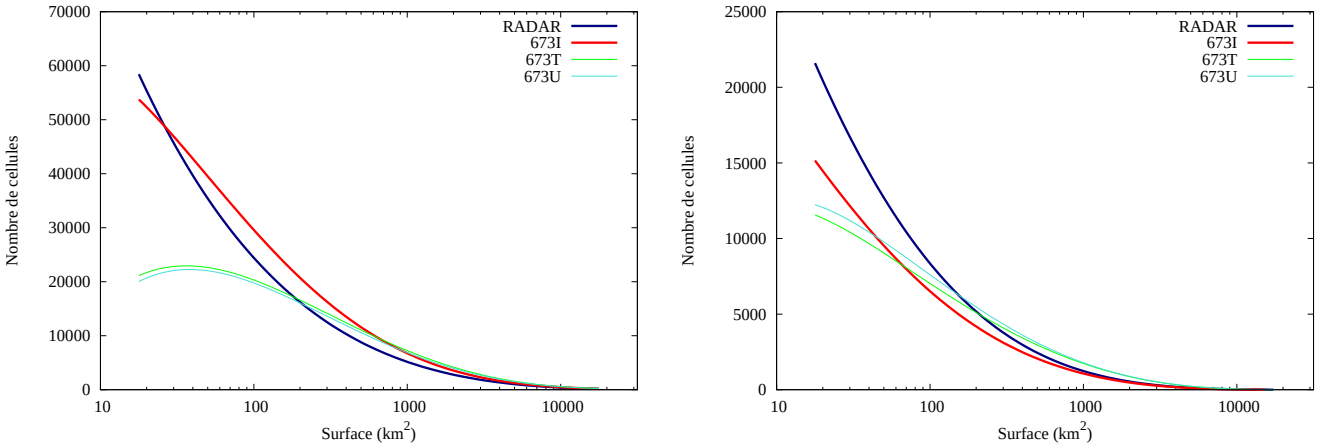

Figure 6: Distribution of the cell size (area) on the following classes logarithmic base: [10;31], [31;100], [100;316], [316;1000], [1000;3162], [3162;10000] and [10000;31622] at tmax-1; left - 30dbZ and right - 40dbZ

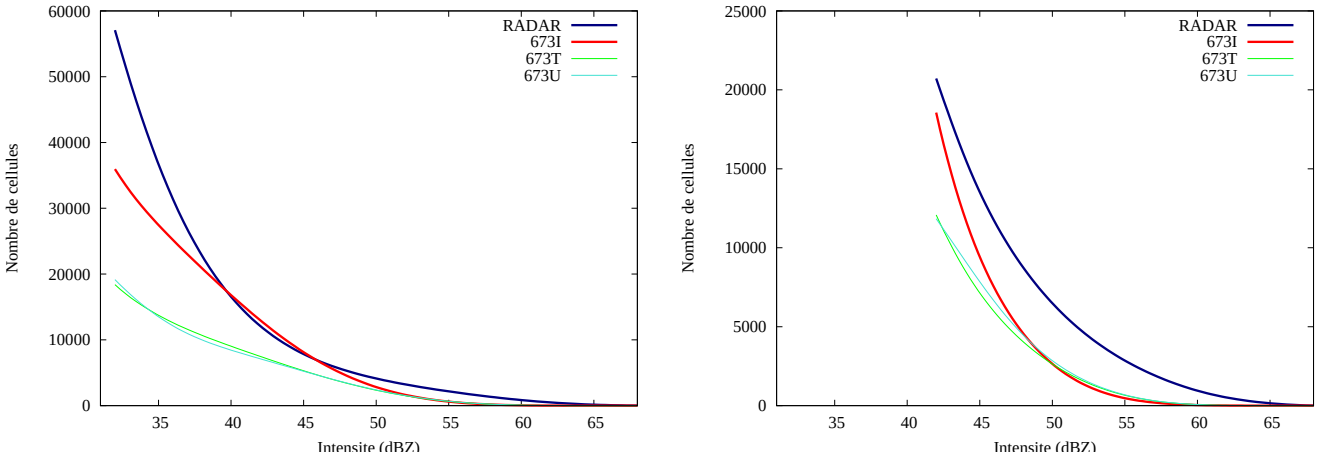

Figure 7: Distribution of the maximum intensity of cells at tmax-1; left - 30dbZ and right - 40dbZ

Conclusions

The analysis of the graphs show:

- for tmax, the reference experiment 1.3kmL90, underestimates the number of cells whose maximum intensity is lower than 40dbZ or higher than 45dbZ and it is almost similar with RADAR between these two thresholds (a slight opposite effect is noticed at tmax-1);
- for tmax+1, all the experiments underestimate the number of cells;
- both the experiments with the horizontal resolution at 2.5km, but with different number of vertical levels, underestimate the number of cells and also the size of them;
- for the cell reflectivity threshold 30dbZ, the reference experiment 1.3kmL90 overestimates the cell size.

3 The impact of the use of a more conservative SL scheme for two convective cases

To asses the impact of the use of a more conservative SL scheme we have chosen two cases: 21 June and 04 July 2012. Several simulations were performed using same domain as before, FRAMINI, varying the horizontal resolution, the number of vertical levels and SL scheme:

- the operational set-up: REF, 67XE - 2.5kmL60 and 67XF - 1.3kmL90;
- the more conservative SL scheme, SLmod: 850R - 2.5kmL60 and 850S - 1.3kmL90;
- the more conservative SL scheme without horizontal diffusion for 5 water species, NoSLHD: 850Z - 2.5kmL60 and 8512 - 1.3kmL90.

In order to evaluate the differences between the 6 simulations, for those two convective cases, we used different diagnoses like simulated radar reflectivity at 1500m, 24 hours cumulated precipitation. Also, the diurnal precipitation variation was analyzed.

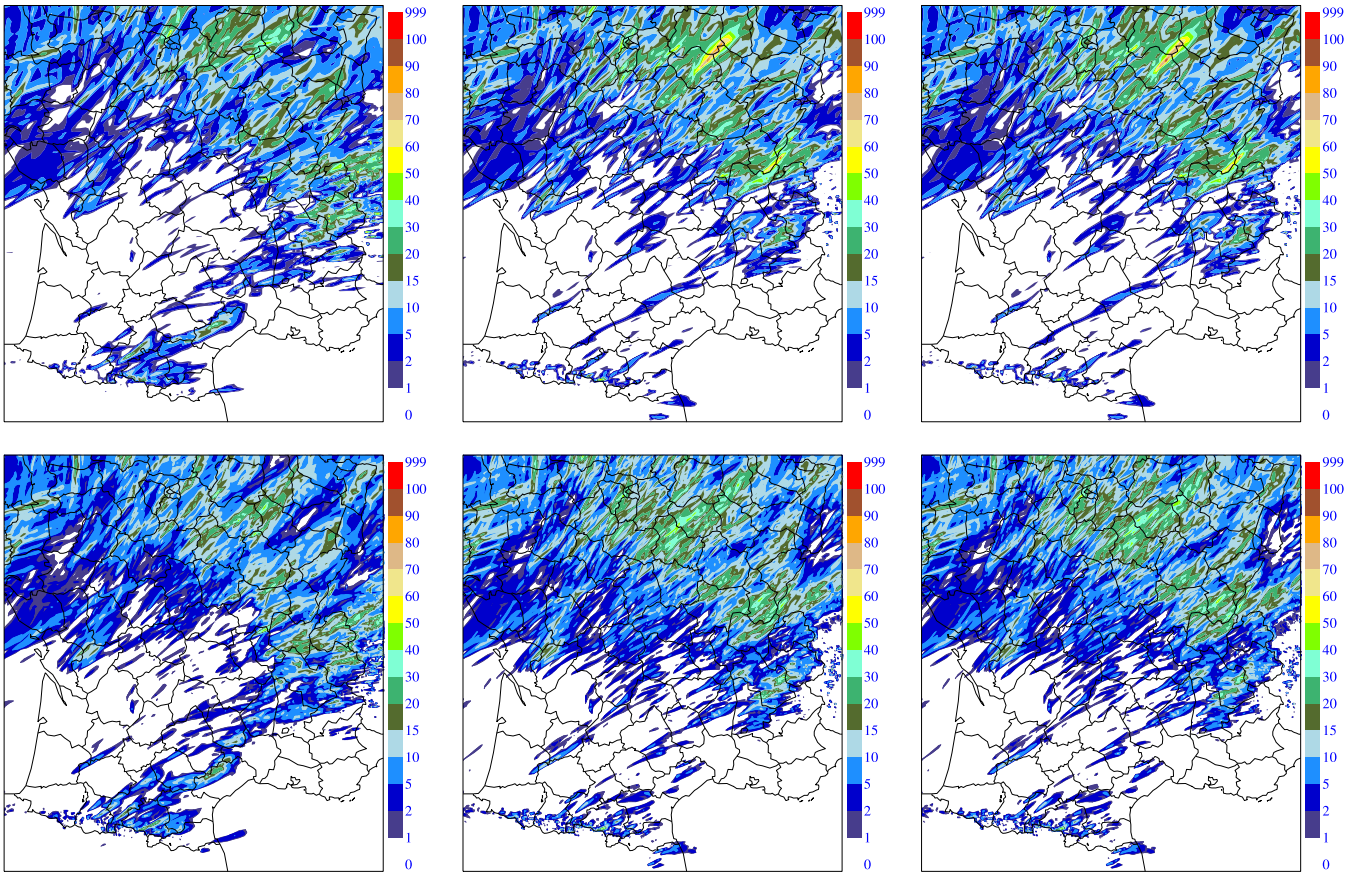

Figure 8: 21June2012, AROME cumulated precipitation - 24h; up (2.5kmL60): left - 67XE, middle - 850R and right - 850Z ; bottom (1.3kmL90): left - 67XF, middle - 850S and right - 8512

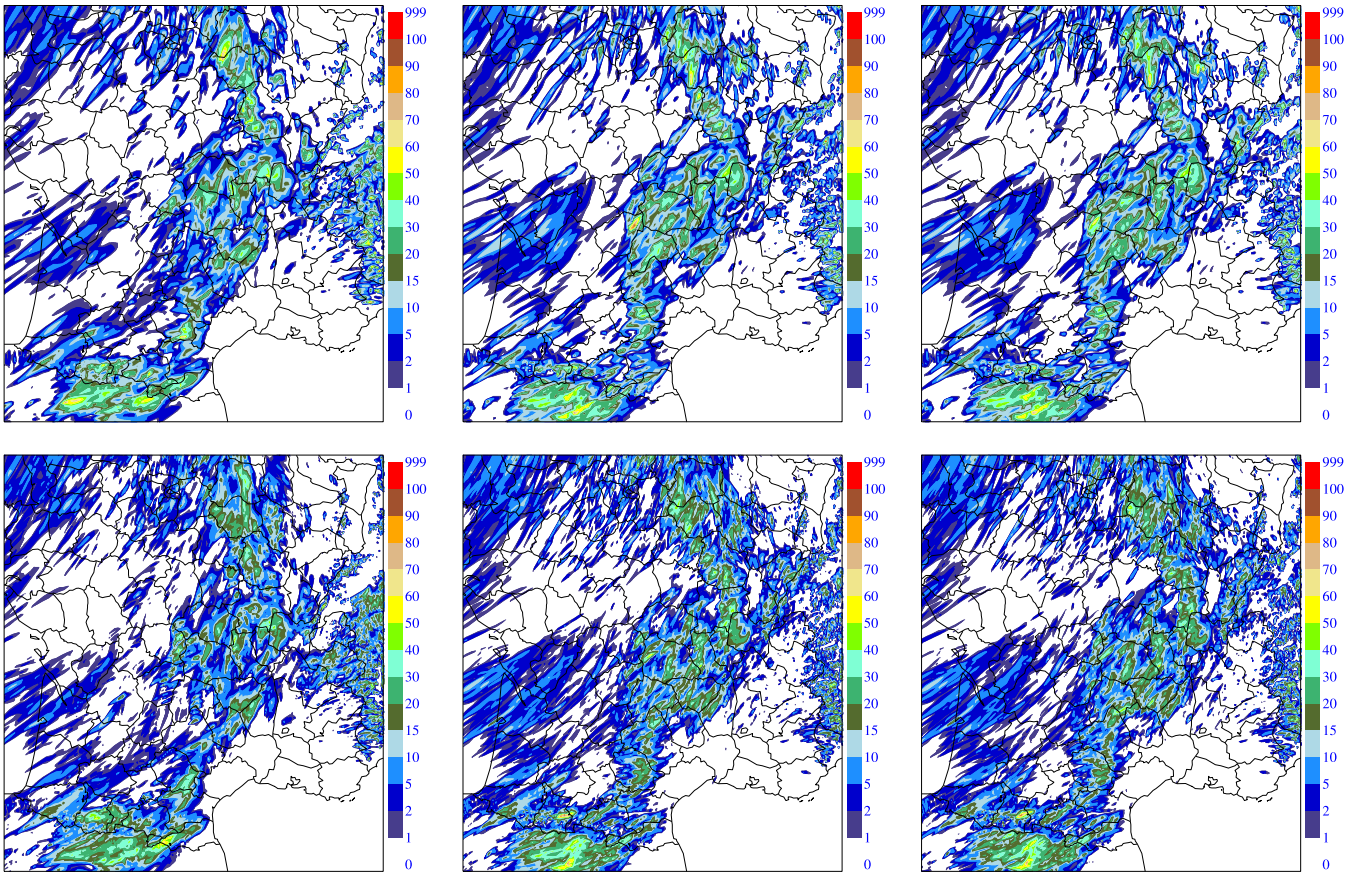

Figure 9: 04July2012, AROME cumulated precipitation - 24h; up (2.5kmL60): left - 67XE, middle - 850R and right - 850Z ; bottom (1.3kmL90): left - 67XF, middle - 850S and right - 8512

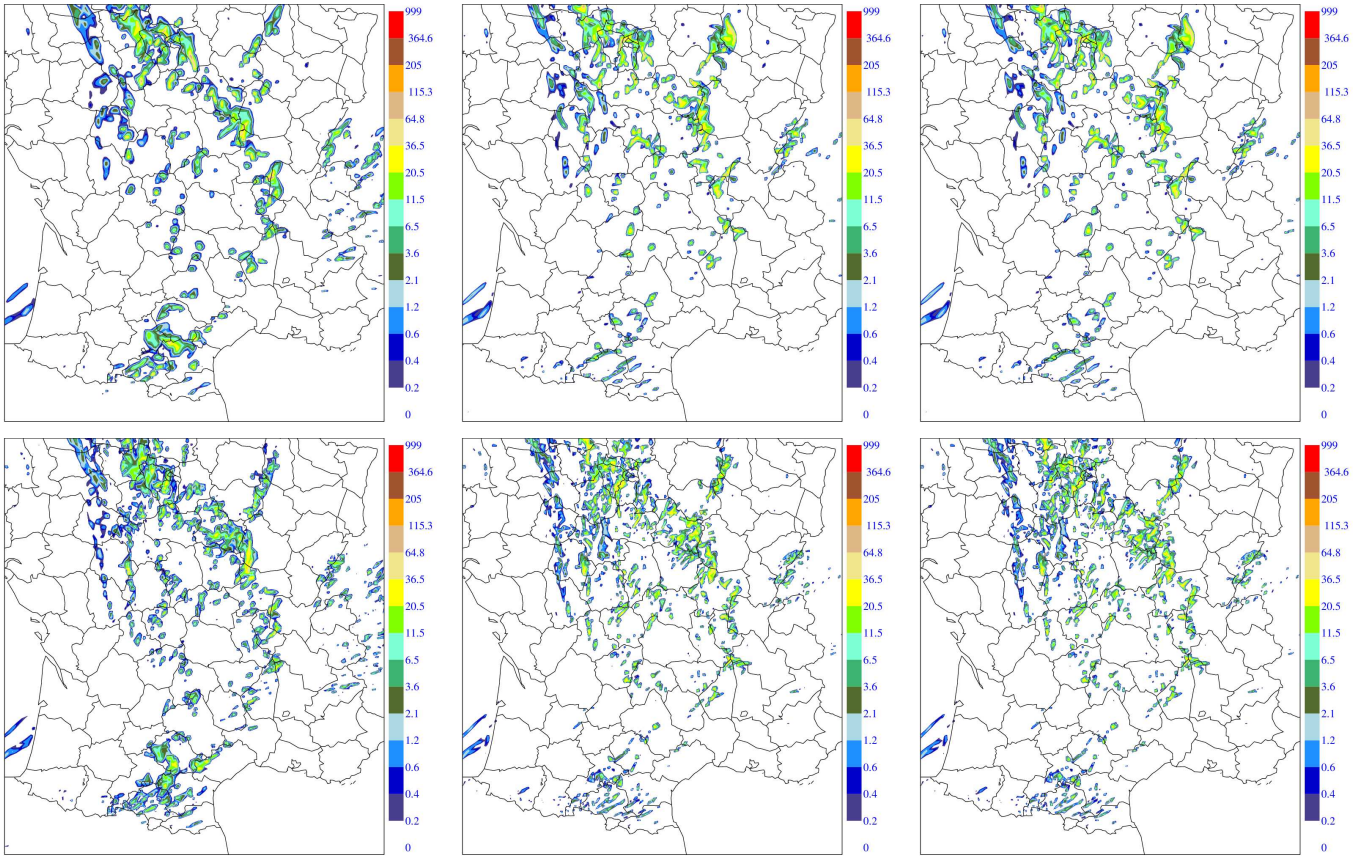

Figure 10: Simulated radar reflectivity field at 1500m, 21June2012, up (2.5kmL60): left - 67XE, middle - 850R and right - 850Z ; bottom (1.3kmL90): left - 67XF, middle - 850S and right - 8512

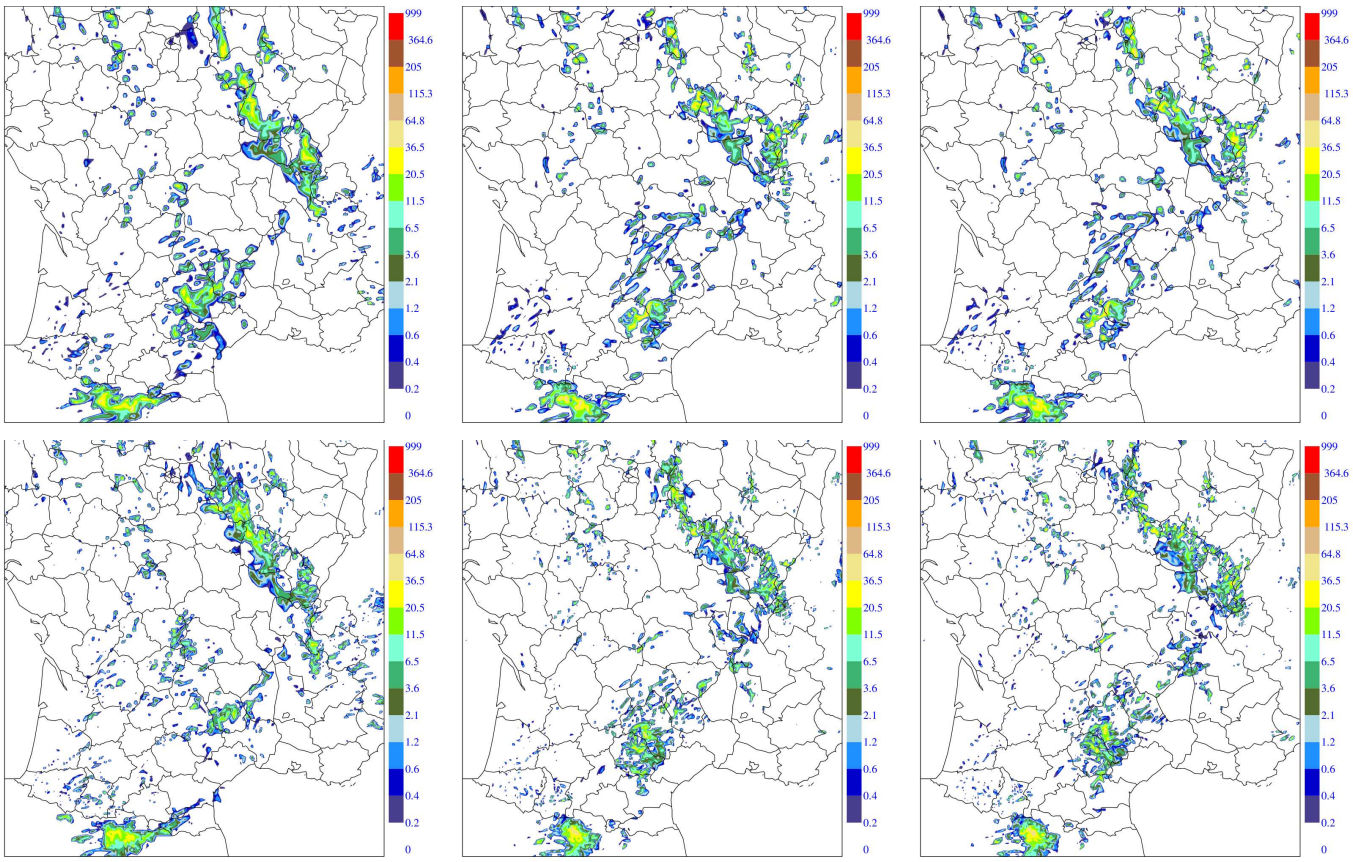

Figure 11: Simulated radar reflectivity field at 1500m, 04July2012, up (2.5kmL60): left - 67XE, middle - 850R and right - 850Z ; bottom (1.3kmL90): left - 67XF, middle - 850S and right - 8512

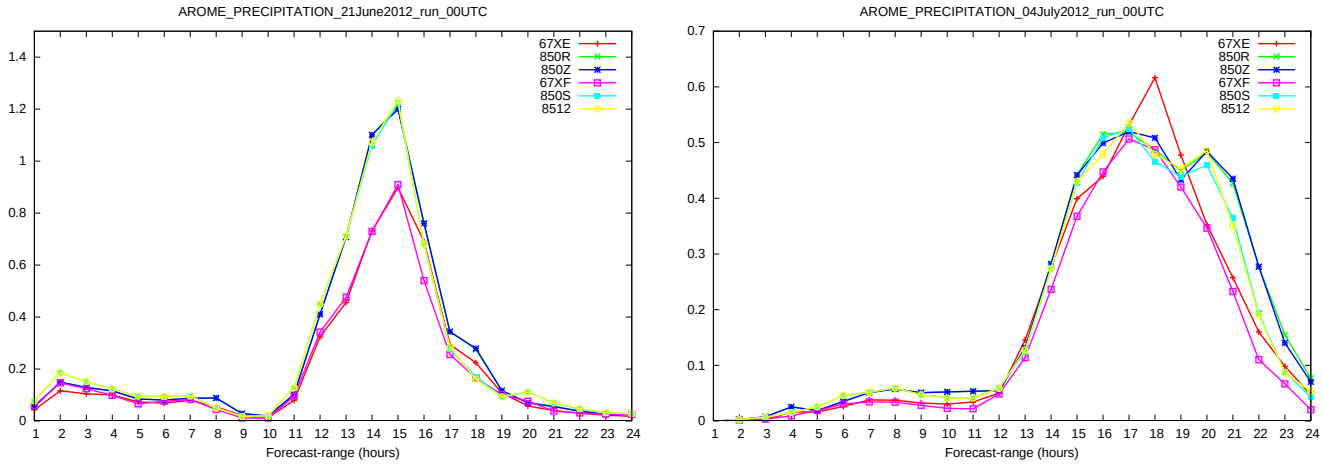

Figure 12: The diurnal variation of precipitation for 21June2012 - left and 04July2012 - right

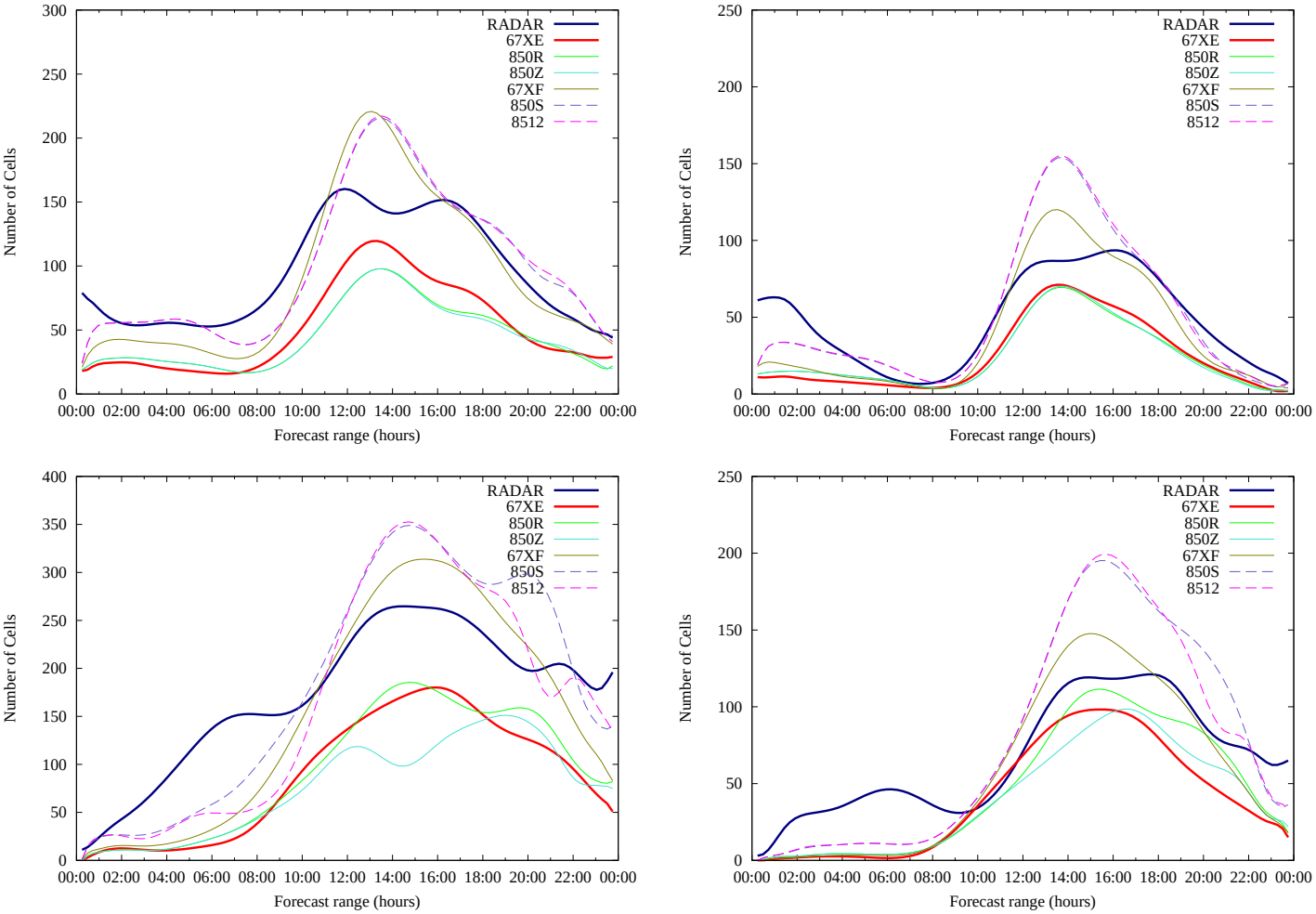

Figure 13: The time evolution of the cells for two thresholds: left - 30dbZ and right - 40dbZ, up: 21June2012 and bottom: 04July2012

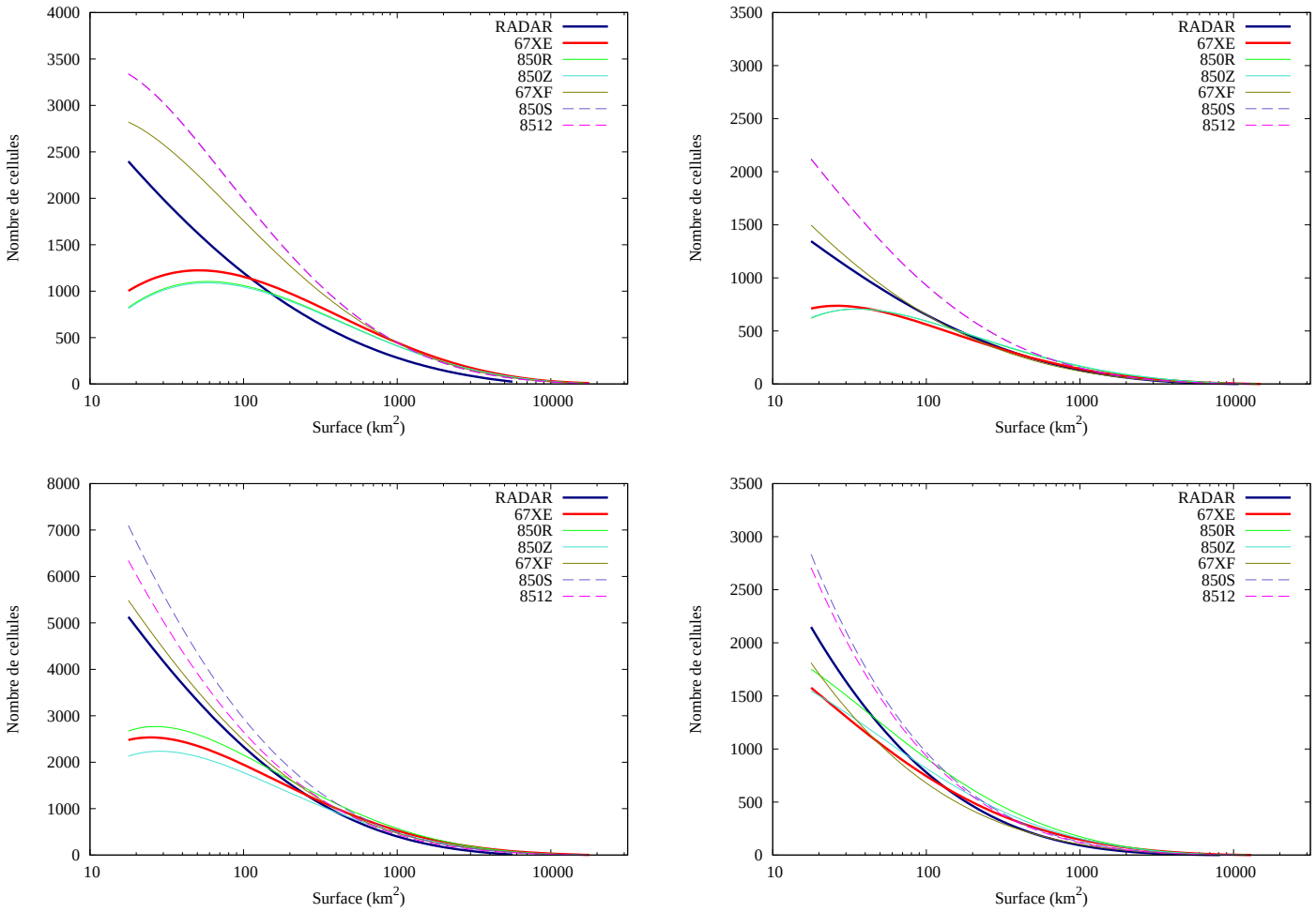

Figure 14: Distribution of the cell size (area) on the following classes logarithmic base: [10;31], [31;100], [100;316], [316;1000], [1000;3162], [3162;10000] and [10000;31622]: left - 30dbZ and right - 40dbZ, up: 21June2012 and bottom: 04July2012

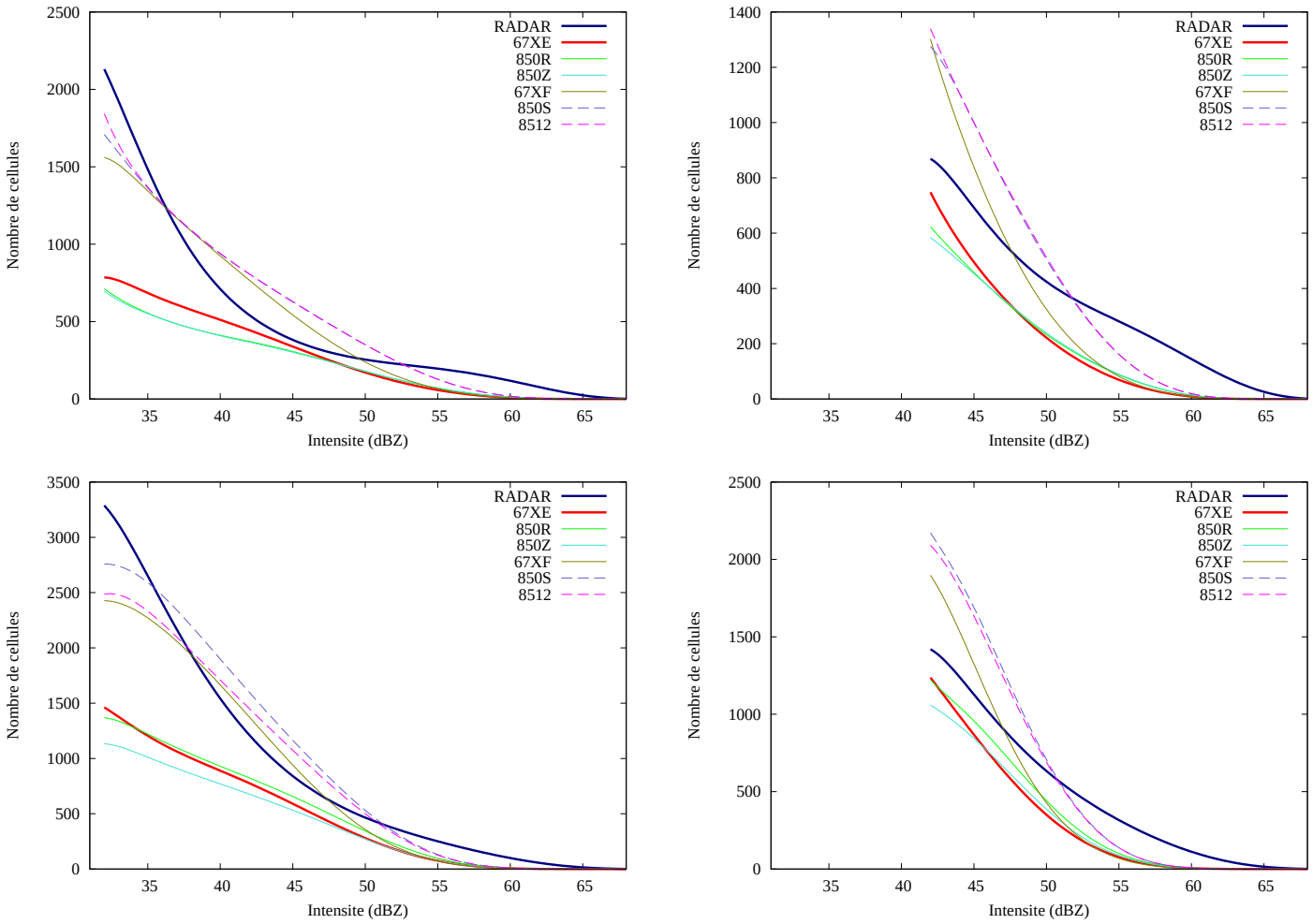

Figure 15: Distribution of the maximum intensity of cells: left - 30dbZ and right - 40dbZ, up: 21June2012 and bottom: 04July2012

Conclusions

- the variation of hourly precipitation shows (fig.12) that, for 21 June, for the more conservative SL scheme, the simulated amount of precipitation is increased; for 04 July, the impact of modifications of SL scheme is slightly different: for 1.3kmL90, we noticed an increase of the amount of precipitations, but for 2.5KmL60, the amount is decrease ;

- compared with radar data, for both days, we observed that the number of convective cells forecasted by the REF at 1.3kmL90 is bigger, fact also confirmed by the simulated radar reflectivity at 1500m (fig.10 and fig.11);

- using a more conservative SL scheme, for 1.3kmL90, the number of convective cells is increased, but the size of them is much smaller compared to the operational set-up (where we noticed an opposite effect: larger cells, but less);

- also, for both days, the experiment with 1.3kmL90 underestimates the number of cells whose maximum intensity is lower than 38dbZ or higher than 53dbZ and overestimates between these thresholds.

Acknowledgements
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References

[1] J. Leger, 2013, *Evaluation de la prévision de situations orageuses avec des simulations AROME à l'échelle kilométrique*

[2] Y. Seity, P. Brousseau, S.Malardel, G. Hello, P. Bénard, F. Bouttier, C. Lac, and V. Masson, 2011, *The AROME-France Convective-Scale Operational Model, MWR, 139, 976-991*;

[3] F. Váňa, P. Bénard, J.F. Geleyn, A. Simon and Y. Seity, 2008, *Semi-Lagrangian advection scheme with controlled damping: An alternative to nonlinear horizontal diffusion in a numerical weather prediction model, Q. J. R. Meteorol. Soc. 134: 523537*