Sensitivity of precipitation forecasts to cumulus parameterizations of the October 2007 Flash Flood in the Valencia Region (Eastern Spain)

I. Gómez[1], F. Pastor[1] and M. Estrela[2]

Laboratorio de Meteorología-Climatología. Unidad Mixta CEAM-UVEG.
[1] Fundación Centro de Estudios Ambientales del Mediterráneo. Programa de Meteorología-Climatología. igor@ceam.es
[2] Departament de Geografia Física. Universitat de València.

Introduction and objectives

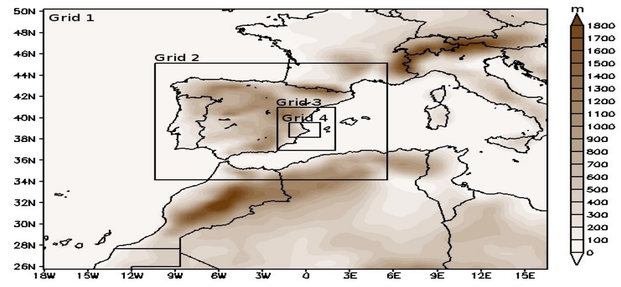
A torrential rain event took place on 11-12 October 2007 in the Valencia region. The synoptic situation prior to and during the event was an easterly winds advection across the Western Mediterranean, along with the presence of a cold pool aloft over the East of the Iberian Peninsula. Precipitations affected the whole Valencia Region but with special impact on coastal areas to the center-south of the region, mainly during the first half of the 12th of October. In this rain event, some stations recorded more than 400 mm in 24 hours. The aim of this work is to analyse the sensitivity of the Regional Atmospheric Modeling System (RAMS) forecasted precipitation to the different cumulus parameterizations implemented by the model. To do this, a series of numerical simulations using RAMS have been performed. The evaluation of the model results has been made in terms of the total amount of accumulated precipitation produced as well as its spatial/time distribution.

Model Setup and sensitivity experiments

Six different sensitivity experiments have been carried out with the Regional Atmospheric Modeling System (RAMS) (Pielke et al., 1992; Cotton et al., 2003) version 6.0, using the cumulus paramerization schemes supplied by RAMS in the three outer grids: Kuo scheme (Molinari, 1985) and Kain-Fritsch (KF) scheme (Kain and Fritsch, 1993; Castro et al., 2002). These simulations have been performed using two-way interactive nested grids at increasing horizontal grid spacings of 40.5, 13.5, 4.5 and 1.5 km, respectively. Vertical discretization consists of a 45-level stretched vertical coordinate with a 30 m spacing near the surface increasing gradually up to 1000 m near the model top at 16 000 m. The atmospheric boundary and initial conditions are obtained from National Centre for Environmental Prediction (NCEP) global Final Analyses (FNL), available every 6 h at 1x1 degree resolution. Simulations of 48 hours are run for each experiment, starting at 00 UTC on 11 October 2007 and finishing at 00 UTC on 13 October.

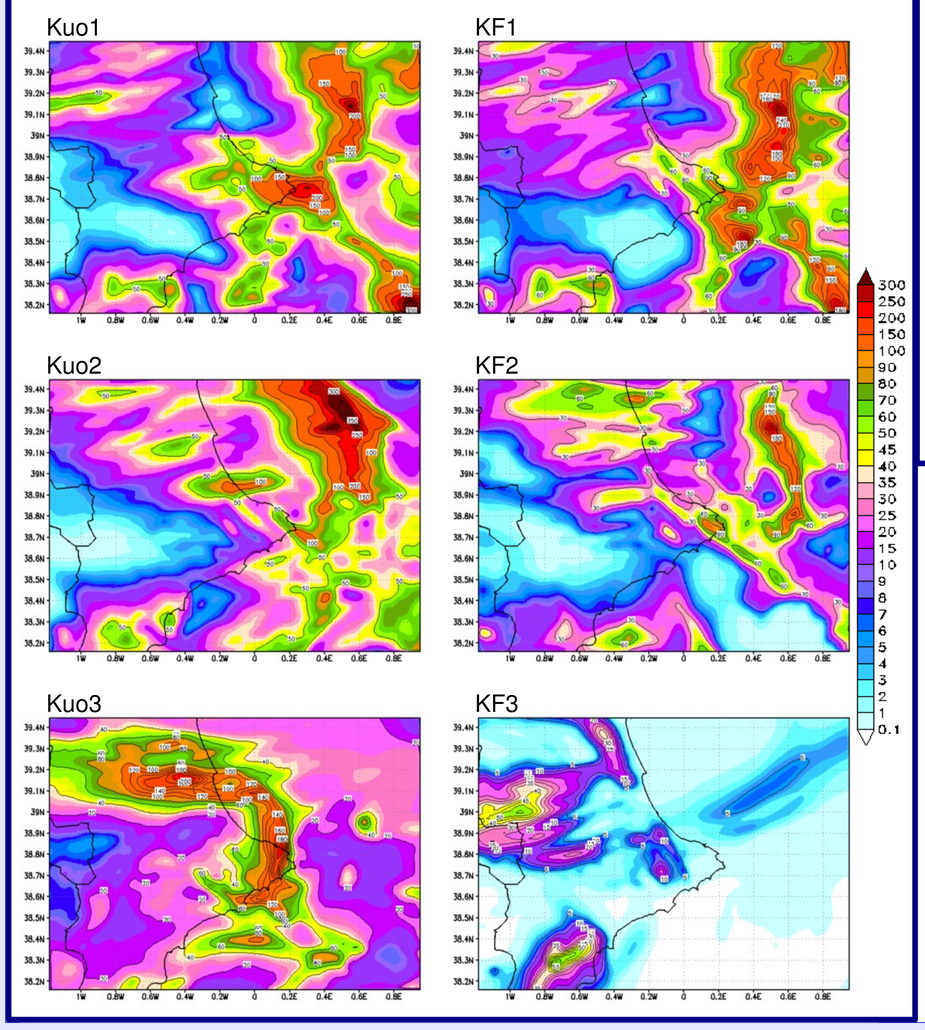
Experiment*	Grid 1	Grid 2	Grid 3
Kuo1	Kuo	-	-
Kuo2	Kuo	Kuo	-
Kuo3	Kuo	Kuo	Kuo
KF1	KF	-	-
KF2	KF	KF	-
KF3	KF	KF	KF

*No cumulus parameterization on Grid 4.

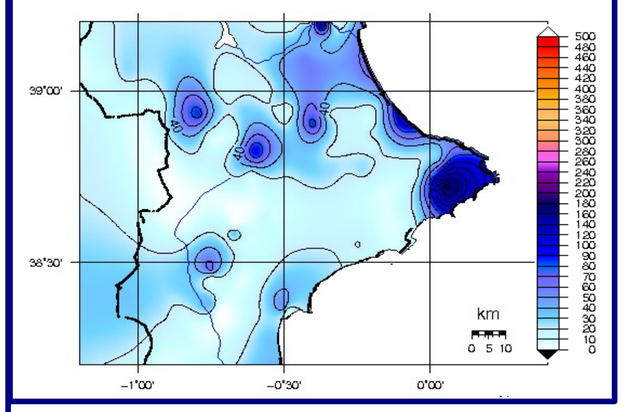


Results

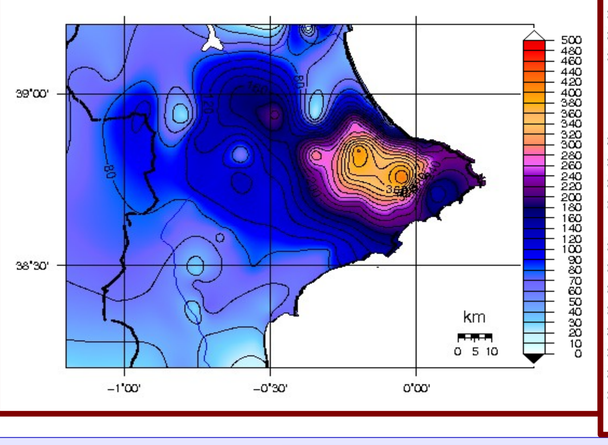
11 October 00 UTC–12 October 00 UTC accumulated rainfall, in mm (RAMS)



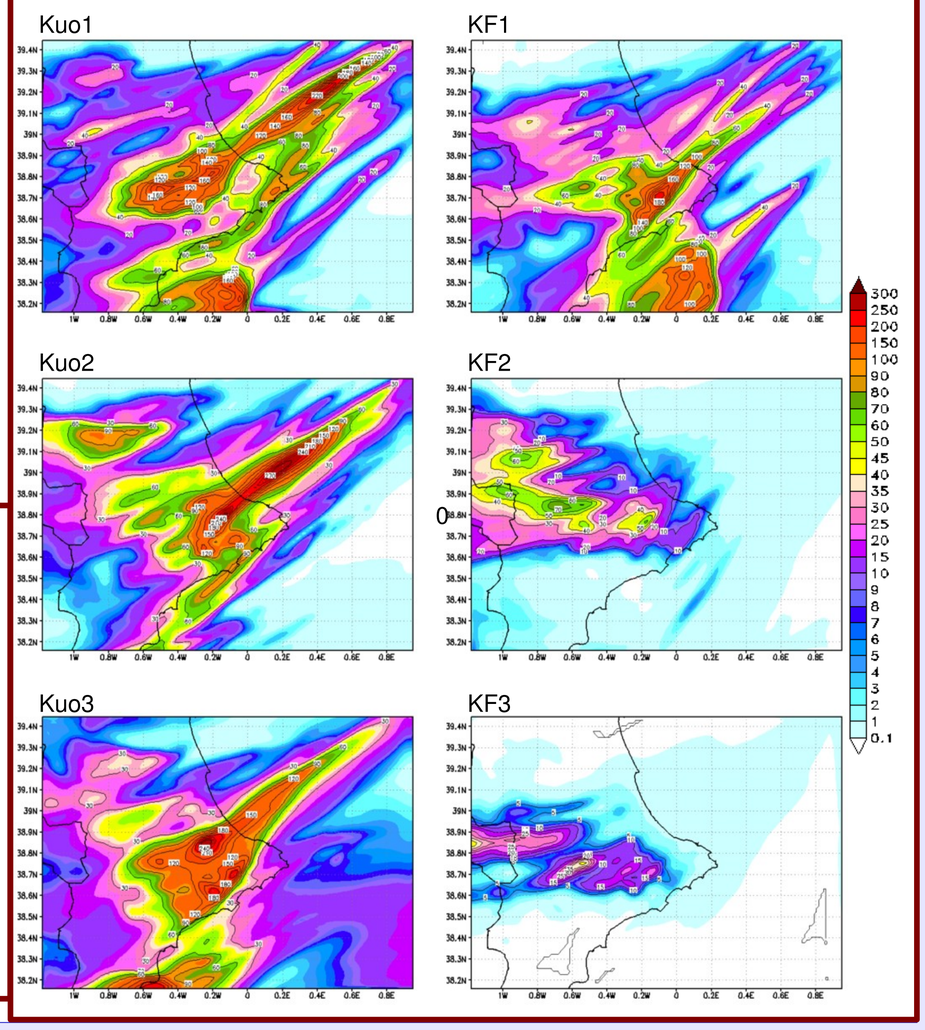
11 October 00 UTC – 12 October 00 UTC observed



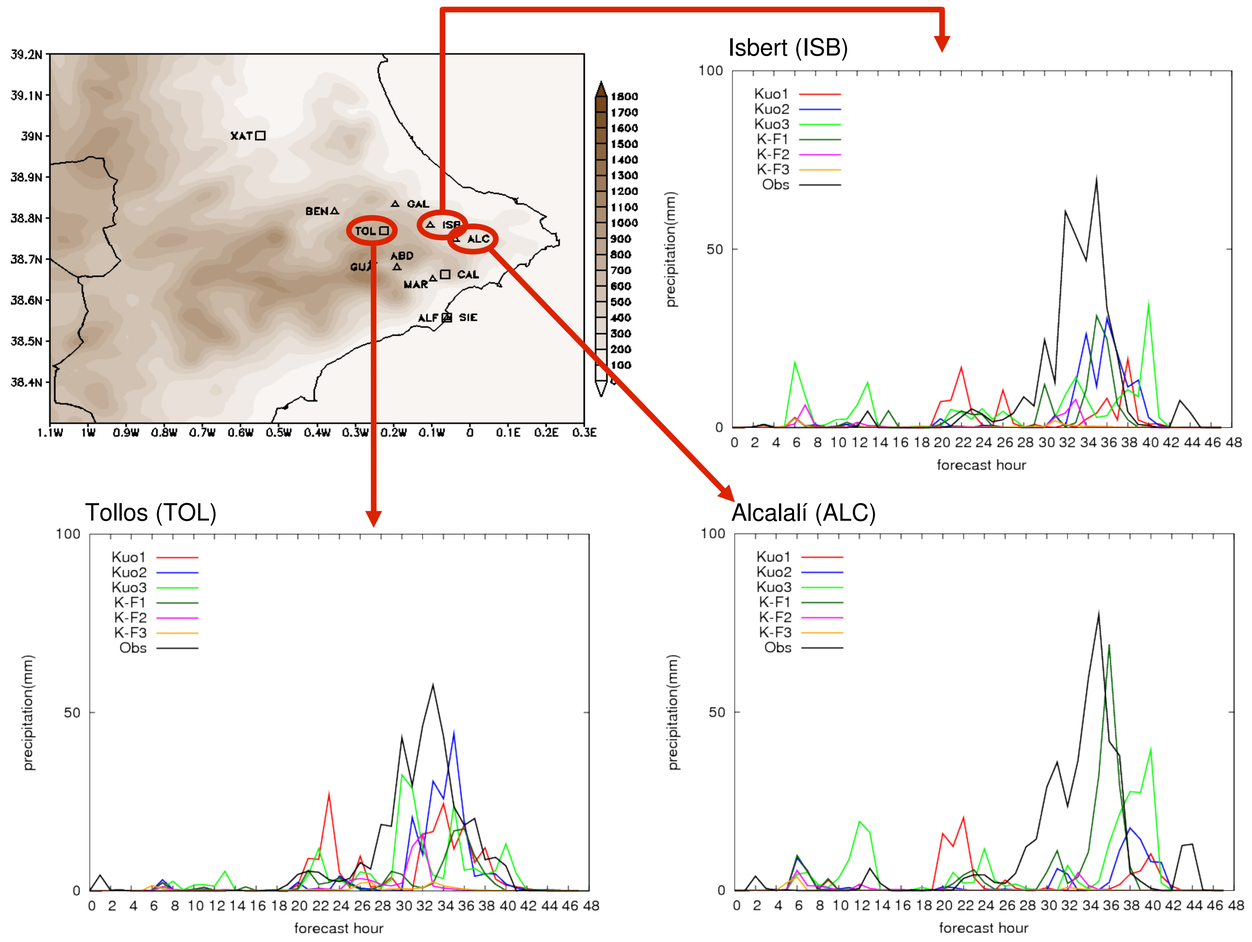
12 October 00 UTC – 13 October 00 UTC observed



12 October 00 UTC–13 October 00 UTC accumulated rainfall, in mm (RAMS)



Time Evolution



Conclusions

Several numerical simulations of an extraordinary rain event have been run, each one modifying the cumulus parametrization schemes activated in the simulation grids. We have analysed the model results on the inner model grid, centred in the rain area and showing the highest spatial resolution, by considering the 24 h accumulated precipitation and the hourly evolution against observations for each of the experiments. From this analysis, it is clear that cumulus parametrization has a significant impact on precipitation forecast in RAMS model:

- Kuo1: it captures well the location and amount of rain on the first day of simulation with a slight displacement and underestimation of amounts on second day. It produces more precipitation than that observed for the last part of 11 October. For 12 October it reproduces quite well the hourly distribution of precipitation but with low records.
- Kuo2: on the first day Kuo2 moves the location of precipitation to the north over the sea. On the second day the maximum amount of precipitation forecasted exceeds 240 mm, while actual values were over 400 mm, but rainfall location is better for this day. This simulation reproduces quite well the hourly distribution of precipitation but with records below those observed.
- Kuo3: correctly captures the rainfall area on both days, with the peak precipitation slightly moved to the north for the first day, but with somewhat lower values, mostly for the second day (240 vs 400 mm). It produces more precipitation than observed levels with a peak centred around midday for 11th October for the area of maximum precipitation.
- KF1: it shows the bulk of precipitation displaced to the south-east over the sea while it correctly locates the rainfall area on the second day but still predicting less than 50% of the maximum rain. It reproduces quite well the hourly distribution of precipitation but with records below the observed ones, with a pattern in general similar to the one obtained for Kuo2.
- KF2: it strongly under-predicts precipitation values and does not locate the rainfall area correctly.
- KF3: KF scheme activated on the three coarser grids produces very low precipitation, far from that observed both days, while the rainfall area is moved inland from observed locations. Besides, the hourly distribution of precipitation is not well reproduced in shape or in rainfall records, as for KF2.

In summary, KF1 seems to better capture precipitation maximum intensity peaks despite its poor achievement in accumulated totals. Although Kuo3 show the best performance in location and total accumulation of precipitation, its hourly distribution performance is worse than KF1 and Kuo2.

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