HEAVY RAINFALL FORECASTS IN MEDITERRANEAN SPAIN: SENSITIVITY TO MODEL INPUT DATA RESOLUTION

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Introduction

The study investigates, from a statistical aproach, the quality of numerical model forecasts of heavy rainfall in Mediterranean Spain (Figure 1) as function of model input data resolution.

For that purpose, 165 heavy rainfall events during the period 1984-93 are simulated with a standard mesoscale model (HIRLAM) at 0.3 degrees horizontal resolution. Input data used to nest the HIRLAM model is obtained by gridding ECMWF ERA T106 spectral analysis, available at 00, 06, 12 and 18 UTC, into a mesh with **1^0**, **2^0** and **3^0** resolution. Therefore, three sets of 165 simulations are performed by using these varied resolution input data sets, with the simulations extending from 00 to 06 UTC next day. An aditional set of simulations is considered based on the 1^0 resolution analyses except that less frequent 30-h apart boundary conditions are used (**1^0 + 30h**). This strategy allows to assess the relative role of the small dynamical structures of the flow as compared to the action of the complex orography of the region.

The performance of the 4 sets of experiments for predicted total precipitation is evaluated for the **whole of Mediterranean Spain** using the Relative Operating Characteristic (ROC) curves (Mason 1982), which combine Probability of Detection (POD) and False Alarm Rate (FAR) indexes. Observed precipitation at model grid points is derived from homogeneous and complete daily rainfall registers at 410 stations (Romero et al. 1998; Figure 1). As a further refinement of the study, the **subdomain spatial variability** is examined, and for 1^0 resolution the study is particularized for six **major rain bearing flow regimes** (atlantic flow, cold front passage, southwestern disturbance aloft, southern disturbance aloft, southeastern disturbance aloft and northerly flow).

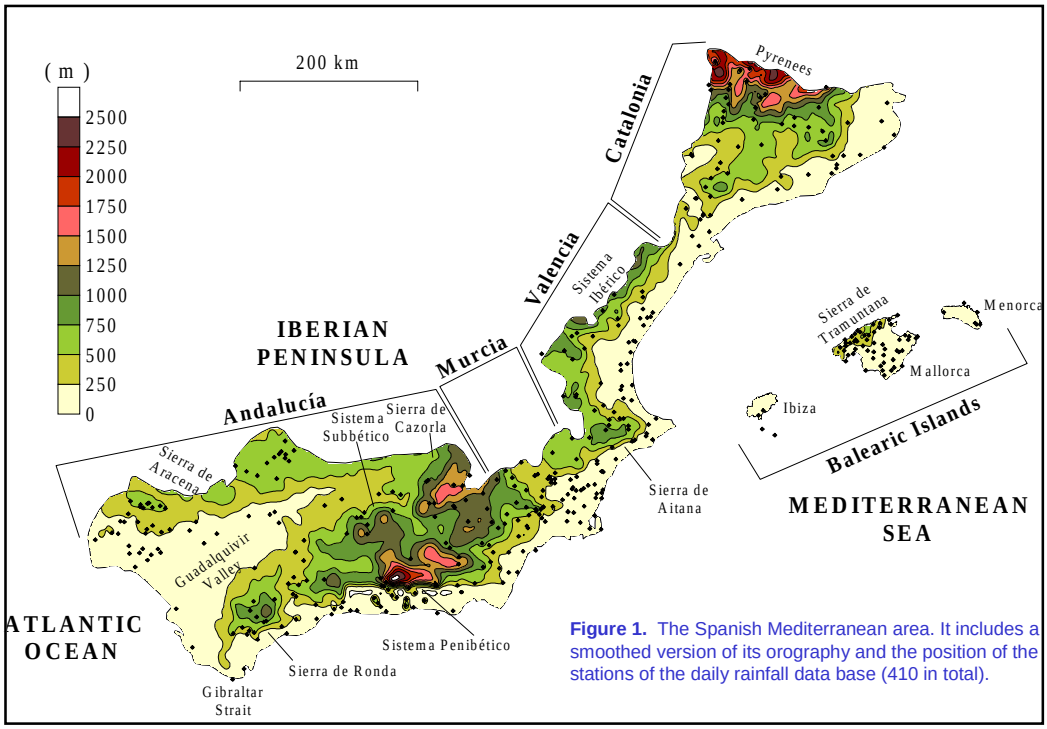


Figure 1. The Spanish Mediterranean area. It includes a smoothed version of its orography and the position of the stations of the daily rainfall data base (410 in total).

Whole of Mediterranean Spain

The performance of the 4 sets of simulations for predicted accumulated precipitation is evaluated for all heavy rainfall days and the whole of Mediterranean Spain (408 model grid points over that domain).

Precipitation thresholds are 0, 1, 2, 4, 8, 16, 32 and 64 mm. The False Alarm Rate (FAR) and the Probability of Detection (POD) varies from values near 1 for small thresholds to 0 for the higher ones.

Table 1. Area values under the ROC curves.

Resolution	1^0	2^0	3^0	1^0 + 30 h
Area	0.817	0.816	0.814	0.804

RESULTS: No significant improvement is observed by initializating the HIRLAM model with high (in space and/or time) resolution meteorological data.

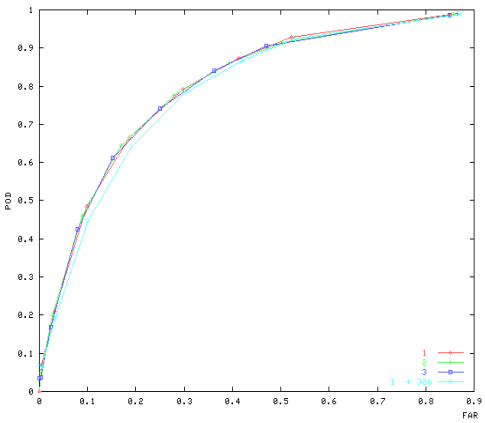
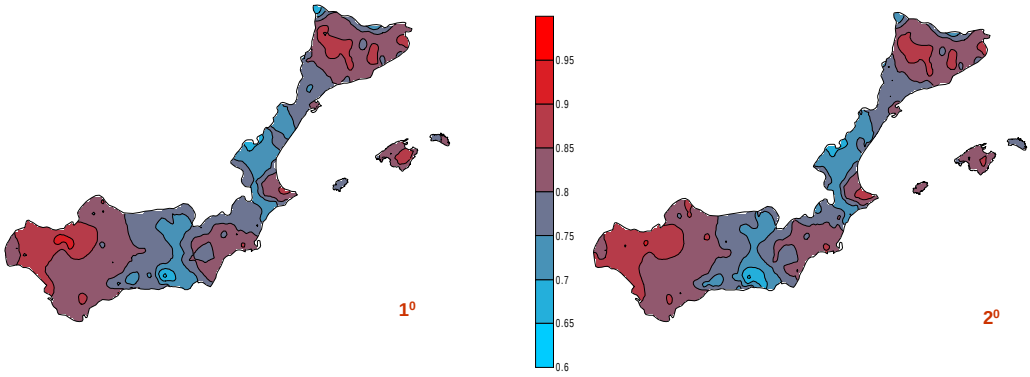


Figure 2. ROC curves for 1^0, 2^0, 3^0 and 1^0 + 30h experimental data sets.

Subdomain spatial variability

The performance of the 4 sets of simulations is regionally evaluated by computing the ROC curves for each of the 408 model grid points over Mediterranean Spain.



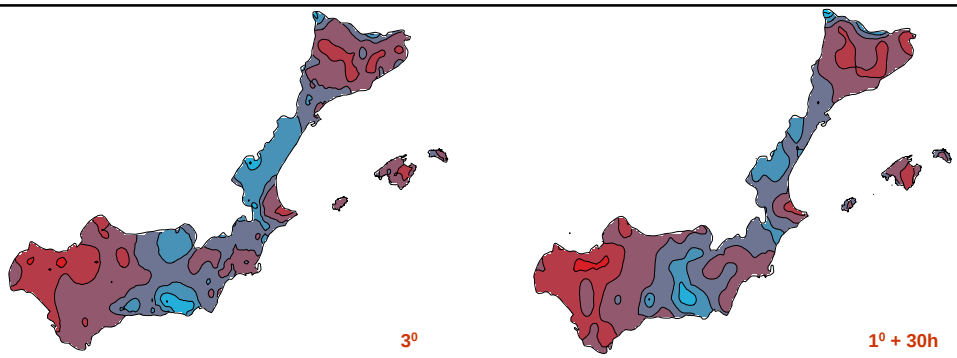


Figure 3. Spatial distibution of area values under ROC curves for the 4 sets of experiments (**1^0**, **2^0** , **3^0** and **1^0 + 30h)**.

RESULTS: There are not important differences among the 4 sets of simulations. The model shows higher skill over Catalonia, central and western Andalucía, the Balearics and some areas of the Southeast. On the contrary, model skill is relatively low over eastern Andalucía, northern Valencia and the spanish-french border.

Major rain bearing flow regimes

Finally, the performance of the forecast system (in this case only for 1^0 input data resolution) is particularized for six rain bearing flow regimes that affect Mediterranean Spain (Romero et al. 1999; Sotillo et al. 2002).

The 165 heavy rainfall days are then subdivided as belonging to one of the following flows types:

Atlantic flow (**A**), 53; cold front passage (**C**),11; southwestern disturbace aloft (**SW**), 31; southern disturbance aloft (**S**), 30; southeastern disturbance aloft (**SE**), 19; and finally notherly flow (**N**), 21.

Table 2. Area values under the ROC curves for the six major rain bearing flow regimes (for 1^0 input data resolution).

A	C	SW	S	SE	N
0.816	0.836	0.802	0.835	0.739	0.835

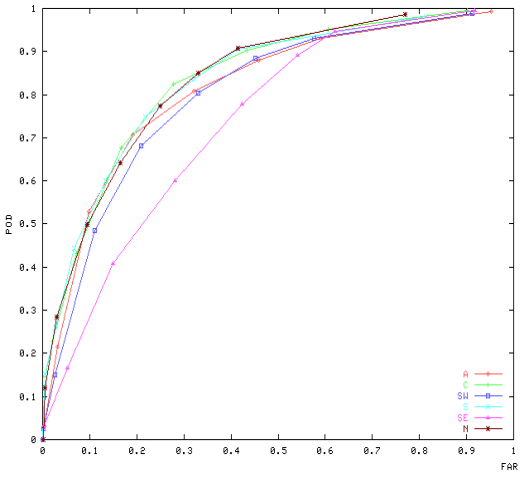
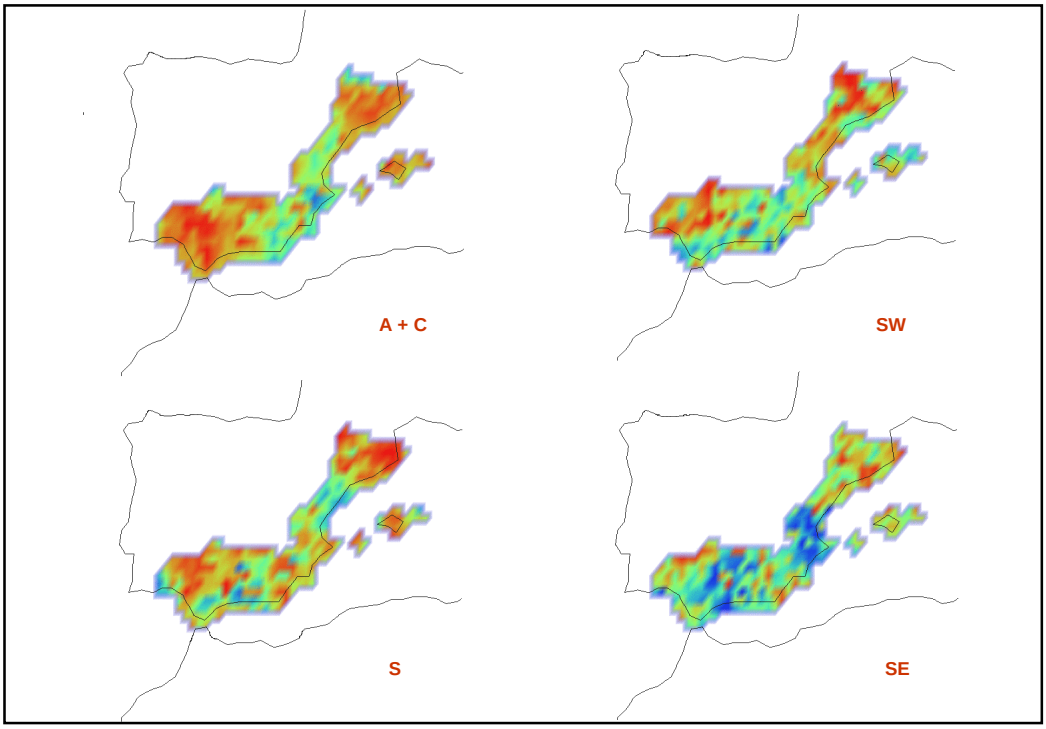


Figure 4. ROC curves for the six major rain bearing flow regimes (for 1^0 input data resolution).



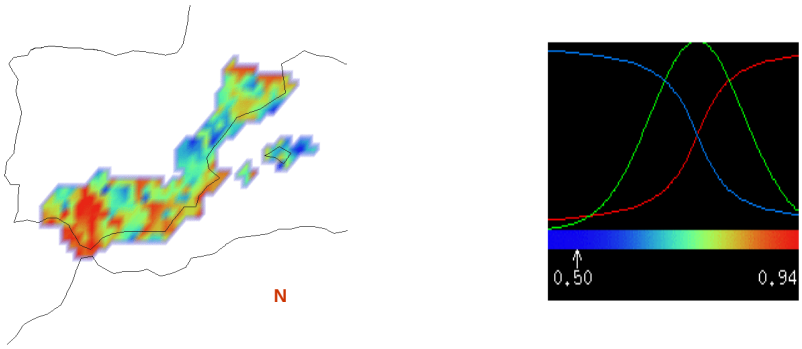


Figure 5. Spatial distribution of area values under ROC curves for the major rain bearing flow regimes.

RESULTS: For Atlantic flows and cold fronts crossing the Iberian Peninsula, the forecast skill is better over Catalonia, western Andalucia and the Balearic Islands. Similar results are obtained for southwestern and southern lows. For these regimes, the model exhibits the worst performance over areas of Valencia and the Southeast.

On the other hand, with southeastern disturbances aloft the predictability is generally lower than for other regimes. Northerly flows appear to offer a good model skill for all areas except the Balearic Islands and most of Valencia.

Conclusions

The results show, for the considered resolution range, that there is no appreciable improvement in model skill when higher spatial or temporal resolution data is used to nest the model. This suggests that the role of the orography for the heavy precipitation control overcomes the dynamical action induced by subsynoptic features embedded in the circulation.

On the other hand, an accentuated spatial variability is found in the domain, with an overall tendency for better forecasts in the west and north of the region and over highlands. This is consistent with the higher ROC area values obtained for Atlantic and notherly flows, as these are flow types quite influencial for rainfall enhancement in the above areas.

References

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