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Real-time weather forecasting in the Western Mediterranean Basin: An application of the RAMS model

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ABSTRACT

A regional forecasting system based on the Regional Atmospheric Modeling System (RAMS) is being run at the CEAM Foundation. The model is started twice daily with a forecast range of 72 h. For the period June 2007 to August 2010 the verification of the model has been done using a series of automatic meteorological stations from the CEAM network and located within the Valencia Region (Western Mediterranean Basin). Air temperature, relative humidity and wind speed and direction of the output of the model have been compared with observations. For these variables, an operational verification has been performed by computing different statistical scores for 18 weather stations. This verification process has been carried out for each season of the year separately. As a result, it has been revealed that the model presents significant differences in the forecast of the meteorological variables analysed throughout the year. Moreover, due to the physical complexity of the area of study, the model presents different degree of accuracy between coastal and inland stations. Precipitation has also been verified by means of yes/no contingency tables as well as scatter plots. These tables have been built using 4 specific thresholds that have permitted to compute some categorical statistics. From the results found, it is shown that the precipitation forecast in the area of study is in general over-predicted, but with marked differences between the seasons of the year. Finally, dividing the available data by season of the year, has permitted us to analyze differences in the observed patterns for the magnitudes mentioned above. These results have been used to better understand the behavior of the RAMS model within the Valencia Region.

1. Introduction

The Regional Atmospheric Modeling System (RAMS) has been implemented within a real-time forecasting system over the Western Mediterranean Basin, precisely in the area delimited by the Valencia Region (Fig. 1). This area exhibits a relevant interest from a meteorological point of view, as it is particularly sensitive to certain severe weather events. Among them, we must highlight episodes of forest fires (Gómez-Tejedor et al., 1999) and heat waves (Miró et al., 2006; Gómez and Estrela, 2010; Gómez et al., 2013) in the summer. In addition, during the late summer and autumn, episodes of torrential rains are also common over this region (Millán et al., 1995; Estrela et al., 2002; Millán et al., 2005). Finally, during the cold period of the year, the Valencia Region is affected by low temperatures, mainly related to the entrance of northerly Arctic air, entrance of north-easterly continental polar air or anticyclonic situations (Millán et al., 2005; Estrela et al., 2010).

The sensitivity of the Valencia Region to climate hazards encouraged us to design and develop a meteorological real-time forecasting system for this area (Gómez and Estrela, 2010). Severe weather events in the Valencia Region has been studied at the CEAM (Centro de Estudios Ambientales de Mediterráneo; Mediterranean Center for Environmental Studies) Foundation,

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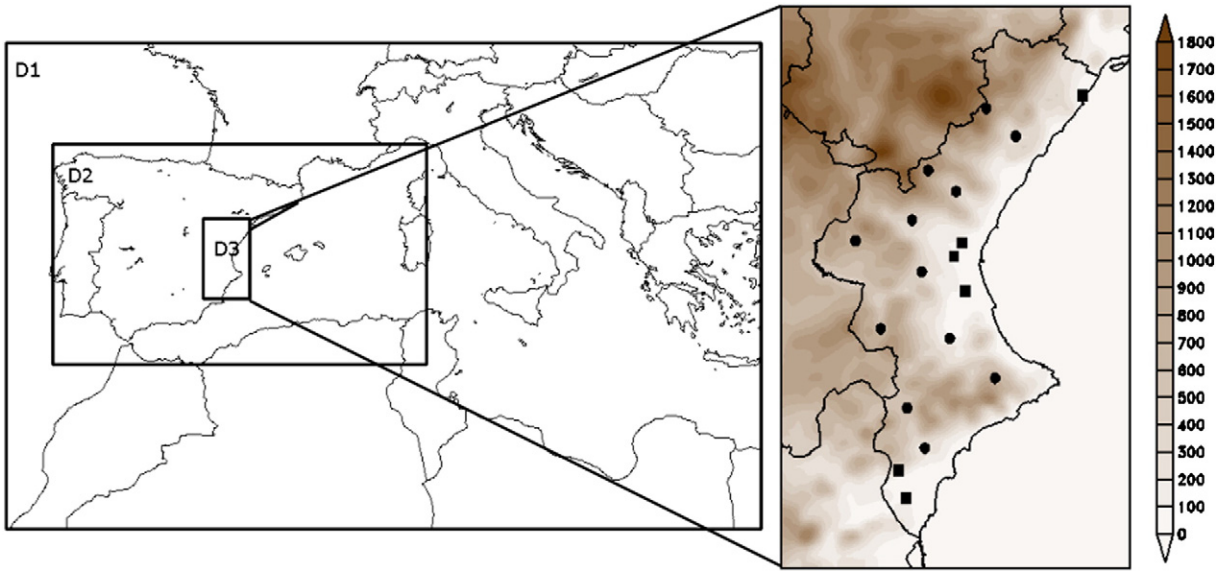

Fig. 1. RAMS model domain configuration and orography (m) of the Valencia Region (Domain 3) with the location of the representative coastal and inland CEAM weather stations.

using the Regional Atmospheric Modeling System (RAMS). Besides, RAMS has also been used in the CEAM Foundation within different research projects (Gómez and Estrela, 2010). As a result, the operational forecasting system running over the Valencia Region is based on this mesoscale meteorological model. Taking into account the climatic and physical characteristics of this region, it may be seen that the usage of an atmospheric model operating at a high resolution would be useful as a warning and alert forecasting tool and to simulate the significant local circulations and processes that take place over this region. For the current study, RAMS has been operationally implemented for the whole Valencia Region (Fig. 1) at a 3×3 km grid horizontal resolution. Besides, the model has been running on a daily basis for the period June 2007 to August 2010.

The attention of the current work is mainly focused on the analysis and evaluation of the RAMS high-resolution weather forecasts produced by the operational forecasting system implemented for the Valencia Region. To do this, we have taken advantage of the automatic weather stations from the CEAM network, and located within this area (Corell-Custardoy et al., 2010). Near-surface meteorological observations are compared with the RAMS forecasts in an operational evaluation. Instead of performing a verification of the model for the whole year, the evaluation procedure has been performed by dividing the available information by season of the year. This separation of the data would permit to identify the occurrence and permanence of meteorological processes typical of a concrete season of the year. Besides, this information is truly useful in order to assess the model ability to predict the corresponding atmospheric condition. On the other hand, coastal stations have been isolated from inland ones, to evaluate differences between station locations, as was already done by Gómez et al. (2013).

The paper is structured as follows. Firstly, Section 2 presents the data and the verification methodology. Secondly, Section 3 includes the results. And finally, Section 4 is devoted to the conclusions of this work.

2. Data and verification methodology

2.1. RAMS model

In this study, the RAMS model in its version 4.4 has been used. The following two-way interactive nesting domains (Fig. 1) is adopted. Firstly, Grid 1 covers the southern part of Europe at a 48-km horizontal grid resolution and the Mediterranean. Secondly, Grid 2 covers the Iberian Peninsula and the western Mediterranean with a grid resolution of 12 km. Finally, a high resolution domain (3 km) (Grid 3) includes the Valencia Region. In the vertical, a 24-level stretched scheme has been selected, with a 50-m spacing near the surface increasing gradually up to 1000 m near the model top at 11 000 m. A summary of the horizontal and vertical grid parameters is provided in Table 1. Although the number of vertical levels does not permit a so high model top, this grid configuration has been selected looking for a compromise between the model being able to simulate the most significant local circulations over this region in a time where the forecast is useful and the computational resources available when the model was implemented that way. Nevertheless, as only surface variables are analysed in the

Table 1
Rams model settings for the three simulation grids: number of grid points in the x, y and z directions (nx, ny and nz), horizontal grid spacing (dx) and timestep (t).

Grid	nx	ny	nz	dx (m)	t (s)
1	83	58	24	48,000	60
2	146	94	24	12,000	30
3	78	126	24	3,000	10