HORIZONTAL RESOLUTION IN MESOSCALE WIND MODELLING:
RELATION WITH COMPLEX TOPOGRAPHY

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Abstract

The weather of the southeast of Spain is characterized by the synoptic scale and the local effects, mainly, the influence of the Atlantic Ocean, the Mediterranean Sea and the local topography.

In this study, one year of numerical mesoscale simulation over this area has been made with different horizontal resolutions. The data obtained from the simulation have been compared with the ones recorded at the meteorological masts, located in a valley centered in the simulation area.

The simulation with coarse resolution cannot reproduce the different physical effects that occur in the valley. However, higher horizontal resolutions allow a better representation of the local effects.

Objectives

The purpose of this study is to analyze the behavior of the mesoscale model regarding the taken horizontal resolution. The results for each resolution are compared with data recorded in the different met towers located in the region of interest.

Methods

The mesoscale model has been run using NCEP/NCAR reanalysis data as initial and boundary conditions, with six nested grids starting with a horizontal resolution of 30 km, in the coarse grid. The maximum horizontal resolution is 1.2 km, and the temporal resolution of the different simulations is 1h. Three different horizontal resolutions have been included in the analysis: 15 km, 2.5 km, and 1.2 km.

Ten minutes data from 11 meteorological towers were analyzed and filtered. Subsequently, data were averaged hourly to make them comparable with the outputs of the mesoscale model.

Data from the three grids have been compared among them, and with the data recorded in the met towers. This was done using a bilinear interpolation considering the four nearest model’s nodes to each mast. As a result, it was created a virtual hourly time series at each met mast location. These virtual time series were compared with the actual data recorded by the meteorological masts.

Results: comparison between model horizontal resolutions

The elevation (altitude above sea level) for the met tower location in each grid is shown in table 1. The correlation coefficients obtained between the virtual time series for each one of the considered grids are shown in table 2.

![Image](1793x926 to 2153x2304)

Figure 2: Frequency rose for met. tower 1 (left panel), met. tower 7 (center panel) and met. tower 11 (right panel). The black line corresponds to data from the met. tower, red thick, medium and thin lines correspond to data from 15km, 2.5km and 1.2km model grids, respectively.

![Image](1800x1800 to 2178x2324)

Figure 4: Hourly MAE values among model simulations and met. towers. Horizontal axis indicates met. tower and vertical axis indicates time of the day.

![Image](1815x3150 to 2549x3410)

Figure 5: Monthly MAE values among model simulations and met. towers. Horizontal axis indicates met. tower and vertical axis indicates month of the year. Yellow square indicates month with less than 90% data availability in the met. tower.

![Image](1876x1544 to 2335x3198)

Figure 6: Shows a comparison between the predictions and the recorded data at met. Tower 2, for each final considered grid (15 km., 2.5 km. and 1.2 km, respectively). Each square shows the percentage of data on which the prediction is made at a certain wind speed bin. It can be seen as the model predictions for high wind speeds are underestimating the real values recorded by the mast. For the remaining wind speed bins, the worst prediction results are obtained for the resolution of 15 km, while the resolutions of 2.5 km. and 1.2 km. show quite similar results.

Conclusions

Three mesoscale model wind simulations with 15 km, 2.5 km and 1.2 km horizontal resolution grids has been analysed and compared with met towers measured data.

- Correlation coefficients between 15 km model simulation and met tower measured data are poor, higher model resolutions (2.5 km and 1.2 km) improve these values. Also, MAE, RMSE and BIAS are better in the higher model resolutions (2.5 km and 1.2 km).
- 15 km model simulation can not achieve a good representation of the diurnal cycle.
- Wind rose frequencies are better represented by higher model resolutions (2.5 km and 1.2 km).
- There is an increase in the summer monthly bias values obtained between the 15 km model resolution and the met towers data that is not observed in the higher model resolutions (2.5 km and 1.2 km).
- Wind speed peaks are not well simulated by the model, even in the higher model resolutions (2.5 km and 1.2 km).

References