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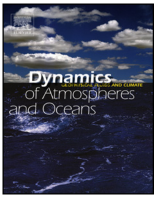

On the influence of physical parameterisations and domains configuration in the simulation of an extreme precipitation event

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ABSTRACT

At daybreak and late morning of 18th of February 2008 Lisbon and Setúbal have been under the influence of a heavy rain event. This period was simulated by two operational WRF model set ups running for Portugal at the University of Aveiro in two different horizontal and vertical resolution and physical parameterisations. These two model configurations were tested for the described precipitation event in terms of microphysics and cumulus parameterisation and also in their domain configuration setup. Results suggest that the combination of cumulus and microphysics schemes is very important in the prediction of the amounts of precipitation. A small change in domain resolution has more impact in the spatial patterns of precipitation rather than in the amounts predicted.

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1. Introduction

The choice of physical parameterisations has important impacts on the results of numerical weather prediction models, more expressive when assessing local variables. Among them, the precipitation amount and intensity are examples of this type of variables which can have potential social and economic impacts, as with the case study presented here. During the morning of 18th February 2008, records of precipitation amounts in Lisbon and Setúbal are included in the high percentiles of the time series for both places.

In spite of the increasing computer power in recent years, the validation of model precipitation amounts and affected regions show that this meteorological variable is still difficult to simulate and predict with accuracy (Rakesh et al., 2009; Wenshi et al., 2000; Wang and Seaman, 1997). Additionally to the parameterisation choices, the prediction skills of the precipitation amounts, as well as its spatio end temporal patterns, is also dependent on the season of year, weather system, domain configuration and the accuracy of the physiographic databases available. Model skills of precipitation variables will be also depend on the climatological vs. event studies.

Several authors have focused their attention on simulated precipitation sensitivity to changes in the cumulus, microphysics, radiation, planetary boundary layer and domain resolution settings using mesoscale meteorological models. The majority of the examples found in the literature include mostly the MM5 (WRF model predecessor) and WRF models applied to the North Atlantic basin and the Iberian Peninsula (Fernández et al., 2007; Awan et al., 2011; Argüeso et al., 2011; Soares et al., 2012; Jerez et al., 2013).

Clouds condensation processes are parameterised through the microphysical schemes (or previously named grid-scale precipitation scheme), which are responsible for removing the excess of the atmospheric moisture directly resulting from the dynamically driven forecast wind, temperature, and moisture fields. Hence, the amount and regions where precipitation occurs depend on the chosen physical parameterisations and the so called model-scale variables important for this phenomenon, namely horizontal and vertical wind speed, potential temperature and the water mixing ratios (Jacobson, 1999).

These same models have been assessed in climate and long term runs. Awan et al. (2011) have tested different physical parameterisations of both MM5 and WRF models with respect to surface temperature and precipitation over the Alpine region in a long term simulation. They indicate that the WRF model is more sensitive than the MM5 to the selected set of parameterisations. They have also shown the model skill dependence on the season of the year, concluding that results are less accurate during summer time, where the PBL and radiation schemes choices have more impact on the results, whereas during the winter the skill is more dependent on the microphysics and cumulus schemes.

Concerning the region of interest in the present study, Portugal as part of the Iberian Peninsula, relevant climatological experiments with MM5 and WRF are found in the literature. Medium term regional climate simulations with MM5 over the Iberian Peninsula were carried out by Fernández et al. (2007) and Jerez et al. (2013). Jerez et al. (2013) increased the simulation period from 5 to 30 years and the horizontal resolution from 45 to 30 km. Both studies test the MM5 sensitivity to the model parameterisations focusing on changes of the microphysics, cumulus, planetary boundary layer (Fernández et al., 2007, have also tested the long wave radiation scheme). Both studies refer that the Kain–Fritsch cumulus scheme was found to produce unrealistically high summer precipitation. Despite the differences on the forcing fields data (NCEP Reanalysis vs ECMWF ERA Interim data), in both cases the Kain–Fritsch scheme allowed better representation of the intensity of precipitation events, which concerns the model settings and results analysis of the work to be discussed here.

Similar studies performed with the Weather Research and Forecasting–Advance Research WRF (WRF-ARW, Skamarock et al., 2008), the successor of the MM5 model, are found in the literature. Recently, the WRF was applied over the Iberian Peninsula by Argüeso et al. (2011) and Soares et al. (2012) through the application of two nested domains with similar horizontal grid resolution (D1: 30/27 km and D2: 10/9 km). Soares et al. (2012) analysed the nested domain model results over the entire Iberian Peninsula whereas Argüeso et al. (2011) use the model results to evaluate the capability to reproduce the defined regions over Southern Spain. Both authors show an improvement of the model skill with the dynamical downscaling. Argüeso et al. (2011) performed a sensitivity study with 8