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Predictability of an intense precipitation event using the WRF model

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Orography may play an important role in disturbing synoptic scale systems through an exchange of energy and momentum with the mesoscale. This will be depend on the presence and a combination of factors such as atmospheric stability, direction of the main flow when encounters the mountain and the presence of water vapor and wind shear.

In the morning of the 20th of February of 2010 an extreme precipitation event occurred over the Madeira Island. This event triggered several flash floods and mudslides in the southern parts of the Island, resulting in 42 confirmed deaths, 100 injured and at least 8 people still missing. These extreme weather conditions were a result of weather frontal system moving northeastwards associated to a depression centered in the Azores archipelago. This storm was one in a series of such storms that affected Portugal, Spain, Morocco and Canary islands causing flooding and strong winds. These storms have been bolstered by an unusually strong sea surface temperature gradient across the Atlantic Ocean.

In this study, the WRF model is used to evaluate the intensity and predictability of this extreme precipitation event over the Madeira island. It is also evaluated the synoptic/orographic nature of the precipitation, as well as the sensitivity of the model to horizontal resolution and cumulus parametrization. Two WRF nest configurations were applied to the Madeira Island. One is that used in the operational forecasts shown at the Clim@UA (http://climetua.fis.ua.pt/) site, which consists of two nested domains, the parent domain (D1) with a 25 km horizontal resolution and the child domain (D2) with 5 km horizontal resolution. In the other configuration, a third domain (D3) with horizontal resolution of 1 km, was nested into domain D2. In total, 13 simulations were performed.

These simulations were divided into four groups. The first group is a single two nested WRF run forced by the GFS 6 hour analysis fields). The second group consists of nine runs forced by GFS forecasts differing in their starting date. These two sets of runs were performed over the two nested domains. A third group is formed by two runs with three nested domains, both starting at the same time and using different cumulus parametrization schemes. At last, the fourth group is formed by a single run, with three nested domains but with flattened island topography.

Results points to orography as the principal cause of the simulated precipitation event; also that horizontal resolution is important to simulate local precipitation but not as such to simulated area-averaged precipitation. The choice of using or not cumulus parameterization is not relevant to simulated precipitation during this particular event.