



A study of intense rainfall events in Madeira Island using numerical Models

Flavio Couto (1), Rui Salgado (1,2), Hari Prasad (2), M. Joao Costa (1,2)

(1) Physics Department, University of Evora, Portugal (couto.ft@gmail.com; rsal@uevora.pt), (2) Geophysical Centre of Evora, Portugal

Located in Atlantic Ocean, the Madeira Island is the largest island of the Madeira archipelago, with surface area about 737 km², an approximately E–W elongated form and a maximum altitude of 1861m. This archipelago is a volcanic complex, with peculiar relief and climate as described by many researchers. In recent times, intense rainfall events in Madeira Island have occurred, resulting in several economical and social damages. Nowadays, the use of well defined dynamics and different physical processes in high resolution numerical models are becoming popular to predict the isolated heavily extreme rainfall episodes. These type of events that may be predicted by the high resolution numerical weather prediction models, basically depend on the design of the model, especially choice of the domain size, horizontal and vertical grid resolution, time step and usage of different physical processes. Therefore, this study aims at analyzing the main characteristics associated to the intense precipitation events in Madeira Island using numerical simulations. In this study we used the Weather Research Forecasting (WRF-ARW) model developed and distributed through the National Center for Atmospheric Research (NCAR), as well as the MESOscale Non-Hydrostatic model (MESO-NH) jointly developed by Météo-France and the Laboratoire d' Aérologie.

Initial and boundary conditions are obtained from the European Centre for Medium-Range Weather Forecasts (ECMWF) forecast models. The events were simulated using nested grids in a two-way interactive mode, in which the inner most domain, at a resolution of 1km, cover the Madeira island. Models configuration included state of art microphysical schemes for stratiform clouds and explicit precipitation. Convection schemes were activated in the coarser models.

Several real cases of intense precipitation in Madeira Island were studied, in particular, the case observed on 02nd February 2010, when the Madeira Island was hit by a intense rainfall, responsible by some points of flooding and the disaster on February 20, 2010. The disaster caused more than 40 deaths, several missing and wounded people, as well as a vast range of material losses, including the destruction of houses, industries, roads, bridges and several thousands of vehicles. Initial analysis of these events suggests that the localized heavy rainfall is the product of the features of synoptic scale to local scale. Meteorologically, in the disaster case, there were several factors which contributed to this heavy rainfall event. This included the high latitude block over Greenland and the southward shift of the westerlies. In both cases is clearly possible verify the great influence of a local factor, showing that the application of numerical simulation is very efficient for meteorological studies.

The results confirms the ability of high resolution non hydrostatic mesocale models in accurately simulated heavy precipitation events over isolated mountains and allows to quantify the effect of the orography on the precipitation. The results suggest some mechanisms of the generation of high precipitation over the Madeira as some relations between the large scale flow, the atmospheric hydro and thermal structure, the topography and the precipitation.