Advances in knowledge 10 years after the torrential rains in Madeira Island (Portugal)

Rui Salgado, Flavio T. Couto, and Maria Joao Costa
Instituto de Ciências da Terra, Universidade de Évora, Evora, Portugal (rsal@uevora.pt)

On February 20, 2010, Madeira island was affected by a tragic event of extreme precipitation. The event was marked by huge economical damage estimated in millions of euros, and more than 40 deaths. Before the event, there were not many studies about severe precipitation in Madeira, which were highly motivated after 2010. This work intent is to show some advancements in knowledge of heavy precipitation events (HPE) in Madeira found in the last decade. The Meso-NH model was used with a rather complete parametrization package of several physical processes occurring in the atmosphere and configured into different dimensions. In order to explore the meridional water vapour transport, the total precipitable water field was extracted from the Atmospheric Infrared Sounder (AIRS) data products. In the first set of simulations, the experiments were performed with three horizontal nested domains (9 km, 3 km, and 1 km resolution). The results for the winter 2009-2010 raised two questions about the topic. First, associated with the large scale environment, and the second one linked to orographic effects. In the first case, apart from a cyclone affecting the island, it was identified the presence of atmospheric rivers (ARs) coupled to frontal systems transporting tropical moisture toward the island. For the orographic effects, the simulations at 1km resolution showed maximums of accumulated precipitation in the highlands. Subsequently, the analysis of the precipitation in Madeira highlands over a 10-year period showed dry summers and the highest rainfall amounts in the winters, although with some significant events occurring also in autumn and spring seasons. Furthermore, it was found that tropical moisture transported through the ARs may reach the island with different intensities and orientation during the winter seasons. However, for the 10 winter periods, the ARs were not the sole factor producing HPE in Madeira. In the second set of simulations, the model was configured with a larger domain of 2.5 km resolution and an inner domain of 0.5 km resolution. All the significant events in autumn 2012 were simulated confirming the orographic effect in the accumulated precipitation. The most interesting result found was the occurrence of maximums values in different regions over the island. For example, over the highlands in the central peaks and southern/northern slopes, or in the coastal plain at lowlands. From the simulations it was possible to explain the causes for the distinct rainfall patterns, and the atmospheric environments associated. The variations in the configuration of the ambient flow, jointly with the orographic forcing may produce convection in distinct regions of the island, resulting in different rainfall patterns. Ten years later, the advances in the understanding of significant precipitation in the Madeira is evident. The results show how different events may occur, since the formation or enhancement of the precipitation over the island is totally dependent on the geographic aspects.
and atmospheric conditions associated with each precipitating event.