UNIVERSIDADE DE ÉVORA

Instituto de Ciências da Terra
Institute of Earth Sciences

EaRSLab
Earth Remote Sensing Laboratory

Estudo das condições atmosféricas associadas a incêndios florestais na Ilha da Madeira

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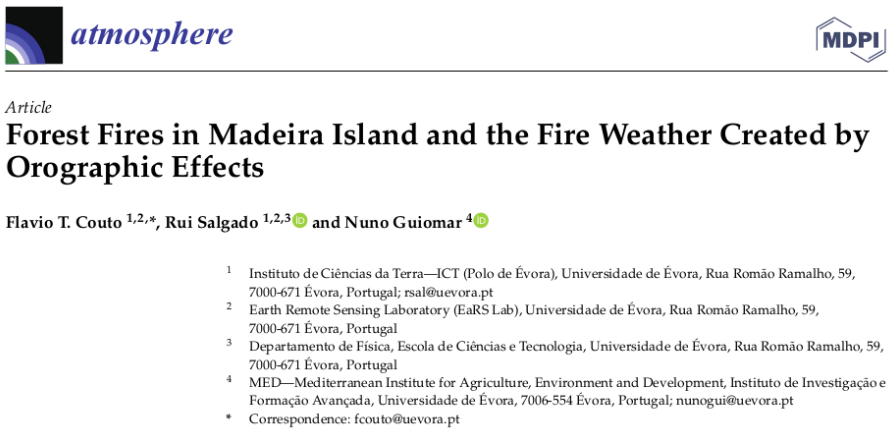
CILIFO
Centro Ibérico de Investigação e Combate aos Incêndios Florestais

FIREPOCTEP

Atmosphere
Fire
Surface
PyroC·pt
Advanced wildfire modelling

OUTLINE



atmosphere MDPI

Article

Forest Fires in Madeira Island and the Fire Weather Created by Orographic Effects

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1. Introduction

Motivation

Forest fires are becoming more and more common and destructive, with several factors affecting their behaviour.

Challenge

Identifying **fire weather conditions** exacerbated by **local effects** at the surface may be useful for specific regions, where fire danger can be directly linked to these factors.

Goal

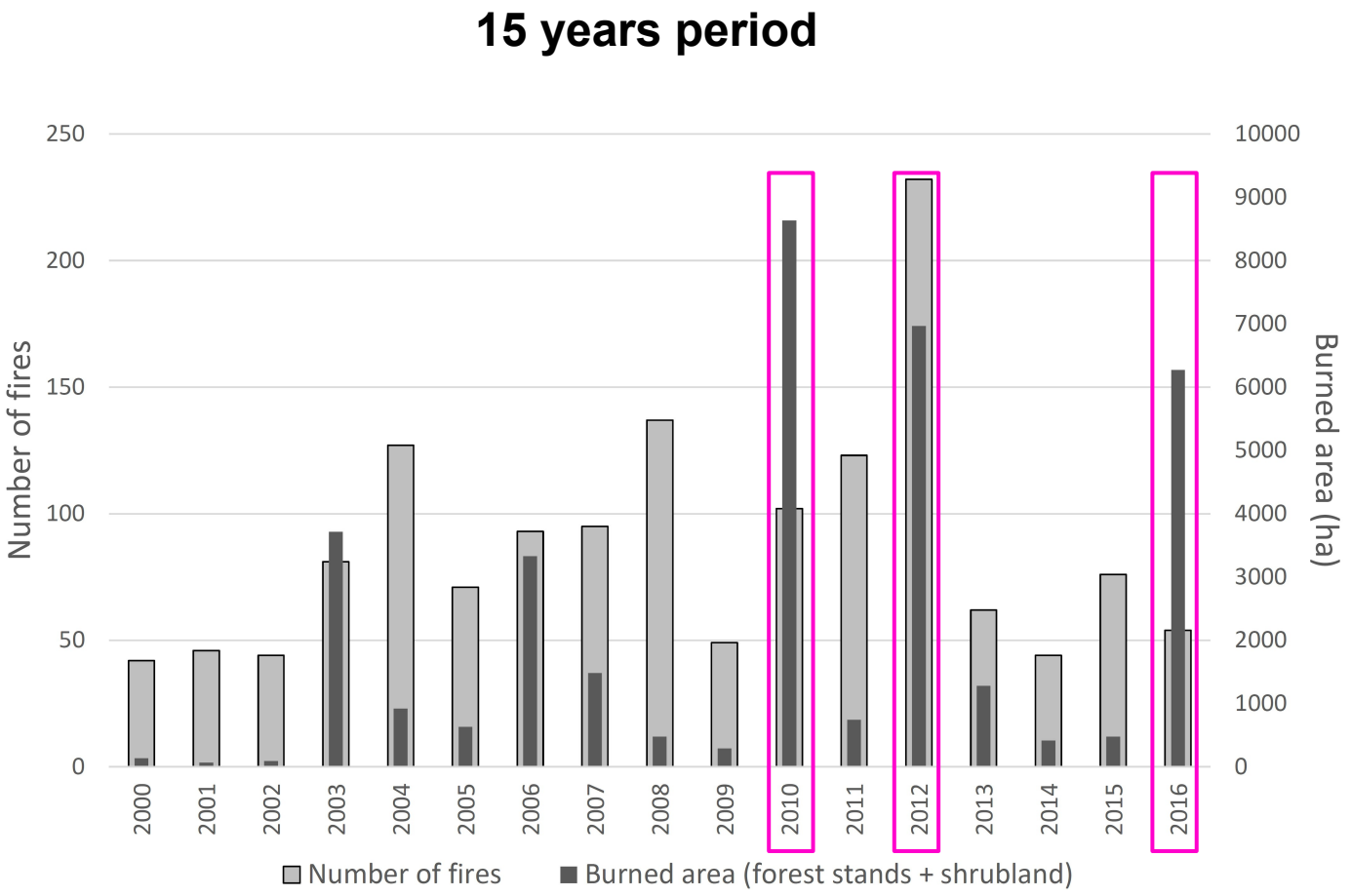
Under the CILIFO framework, namely in the context of **characterization of meteorological environments that favour the evolution of significant large and extreme fires**, this study aims to identify the atmospheric conditions associated with forest fires that have occurred in complex terrain landscapes of Madeira Island using convection-permitting simulations.

2.1. Study Region

Madeira is a Portuguese island located in the North Atlantic Ocean at 32°75 N and 17°00 W. It is the largest island of the archipelago with approximately 740 km^2, with an east-west elongated form, and a central mountain chain characterised by deep valleys, cliffs, and peaks up to above 1800 m in the eastern region.

Forest fires may be observed in the island during the summertime.

2.2. Case Studies (Historical Events)



Annual distribution of the number of fires and burned area affecting forest stands and shrubland between 2000 and 2016.

The years **2010**, **2012** and **2016** stand out clearly from the remaining years, with more than 6000 ha of burnt forests and shrubland.

These three years were then selected to be analysed in terms of **fire weather conditions**.

The events occurred in the following periods:

Episode 1: 12-13 August 2010

Episode 2: 18-19 July 2012

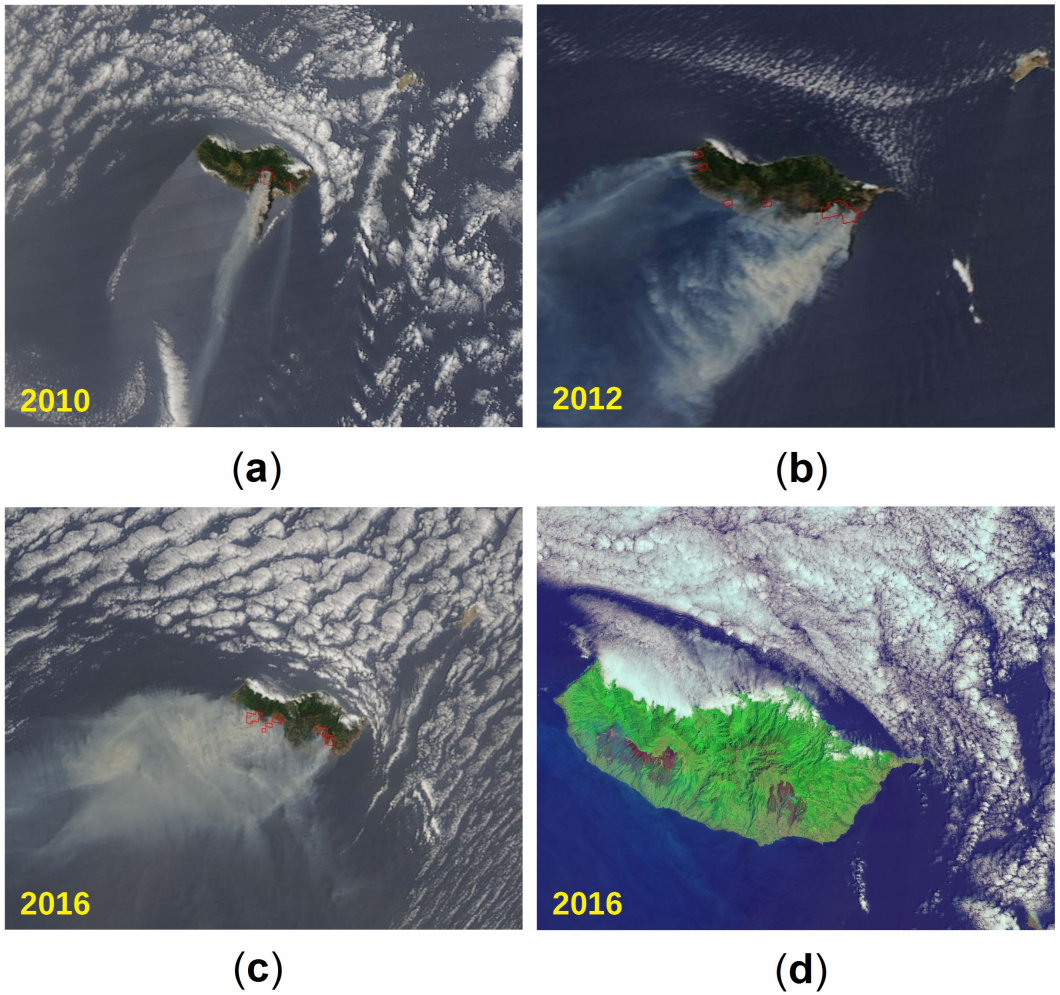
Episode 3: 08-10 August 2016

Fires occurred mainly in the Madeira **highlands**, namely over the central part of the island in the eastern peak.

Forest fires in the **extreme west** and **southern slope regions**, and in larger extension in the **extreme east** of the island.

Fires in the **southern slope** and affected the foothills of the island, namely the wildland-urban interface near the Funchal city in the south-eastern region,

Caused three fatalities, more than 300 houses destroyed, a thousand displaced people.

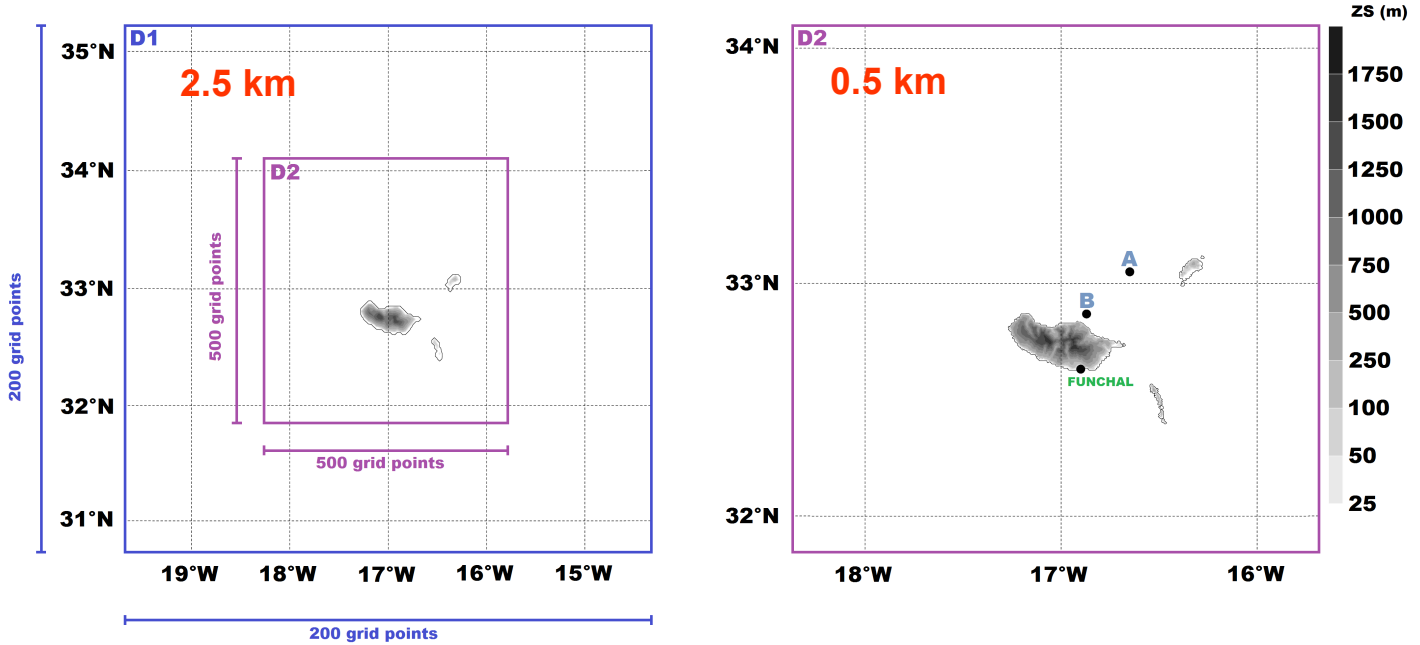


(a) (b)

(c) (d)

2.3. Numerical Simulations and Model Validation

Meso-NH
mesoscale non-hydrostatic model



Standard physical and dynamical configuration

Parametrization	2.5 km	0.5 km
Convection	-	-
Shallow Convection	EDKF	-
Turbulence	1D	3D
Cloud microphysics	ICE3	ICE3

Horizontal dimension: Two nested domains.

D2.5km: 200x200 grid points.
D0.5km: 500x500 grid points.

Vertical dimension: 50 levels.

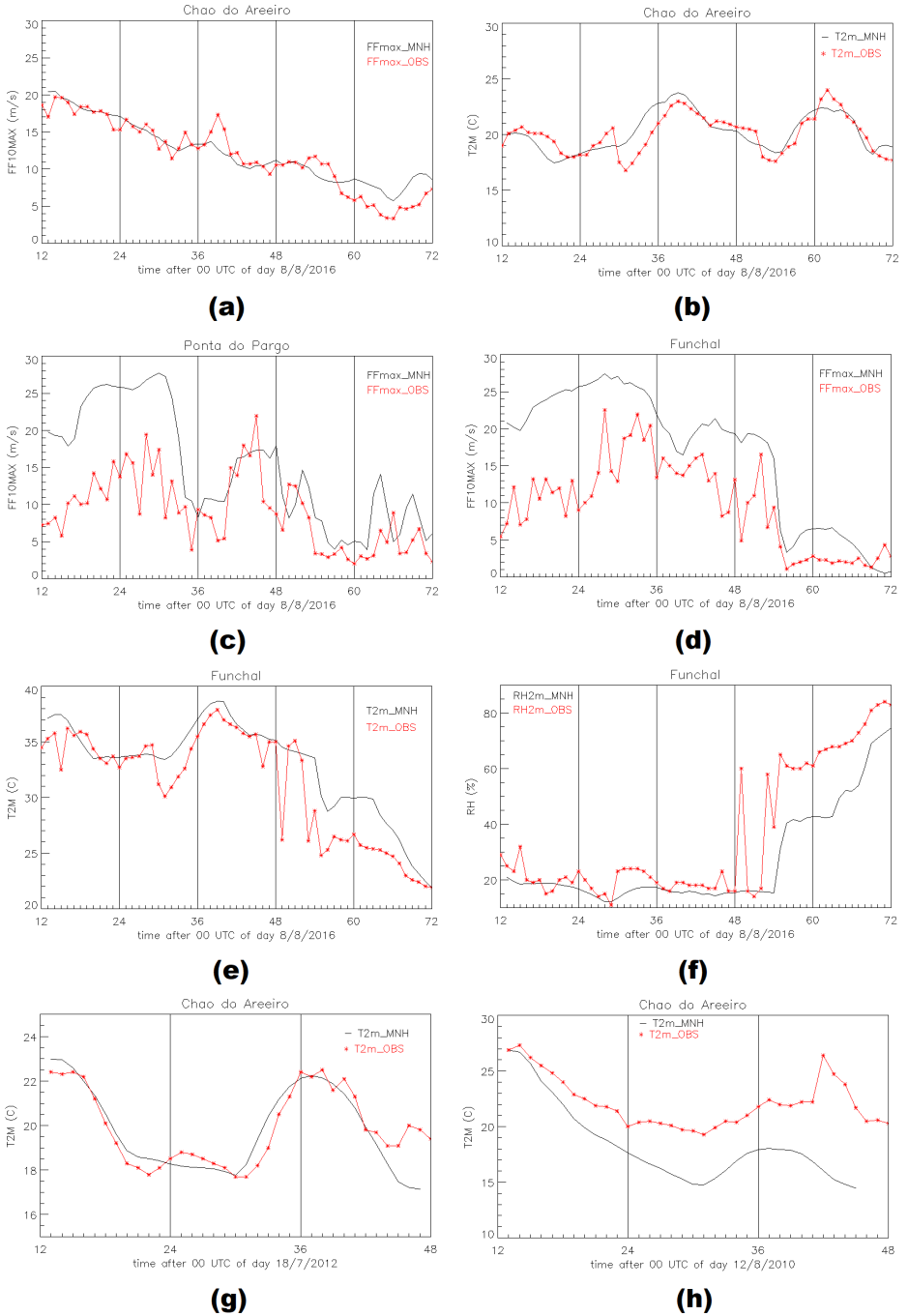
Initial fields: ECMWF analysis updated each 6 h.

Such a configuration was chosen in order to assess the **prevailing weather conditions** encompassing the fire events. The **interactions between the fires and the atmosphere were not taken into account** in the experiments.

2. Study Region, Case Studies and Numerical Modelling

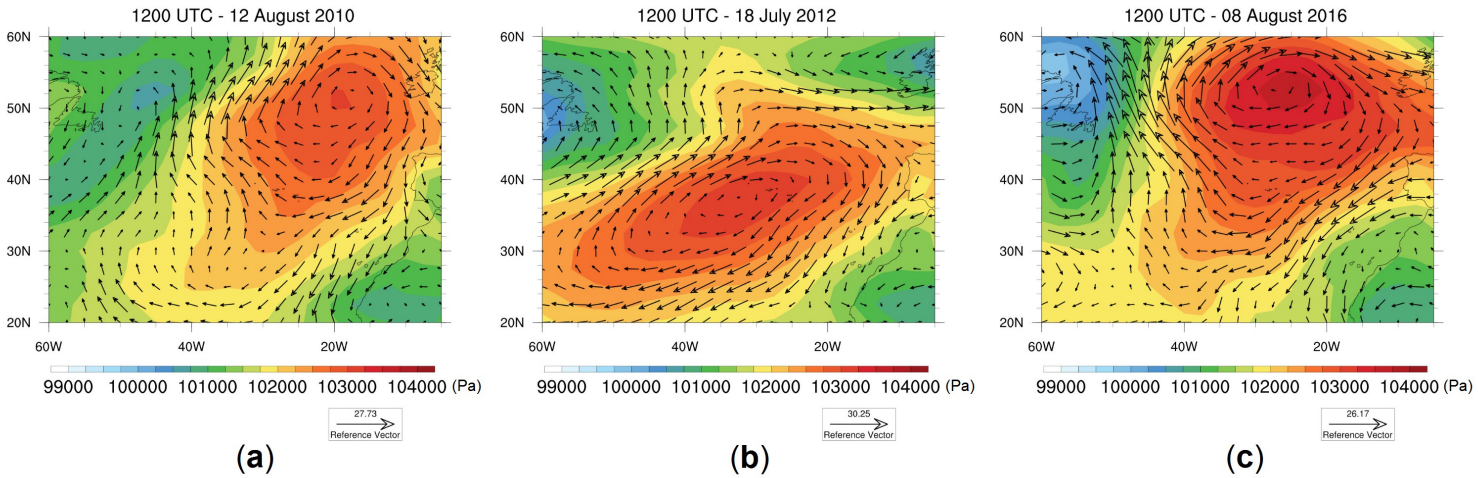
The **model validation** is made from a **point to point comparison** between observed and simulated time series. The meteorological variables verified were wind gusts, wind direction, air temperature at 2 m, and relative humidity at 2 m.

In the Areeiro station (Fig 5h), the model captures the air temperature behaviour along the period, but with a significant underestimation of the observed values. The higher observed temperatures may be a consequence of the wildfire that occurred precisely in this region, whose effects were not taken into account by the model.



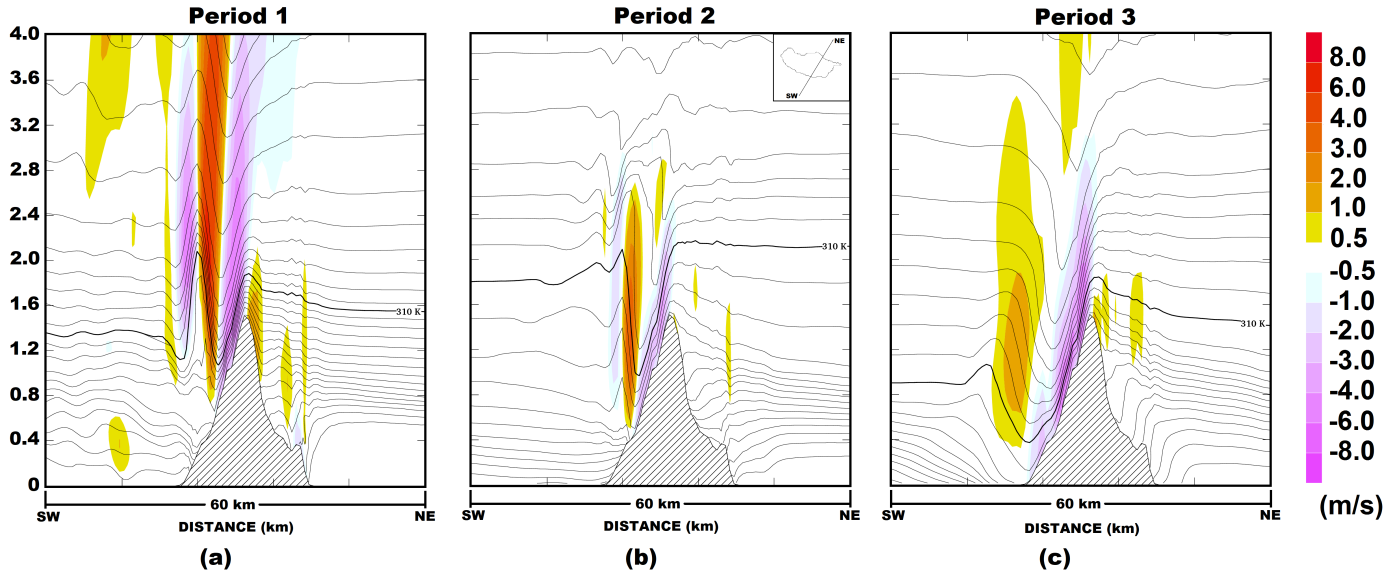
Plots for three different meteorological stations: Areeiro (lat: 32.72, lon: −16.91), Ponta do Pargo (lat: 32.81, lon: −17.26) and Funchal (lat: 32.64, lon: −16.89).

3.1. Synoptic Environment



The **Azores Anticyclone** was the typical synoptic system over the North Atlantic Ocean inducing the north-easterly airflow towards the island in its coastal zones (eastern side). As it remains almost stationary, the fair weather was maintained over the region for several days.

3.2. Mesoscale Environment and Fire Weather Conditions

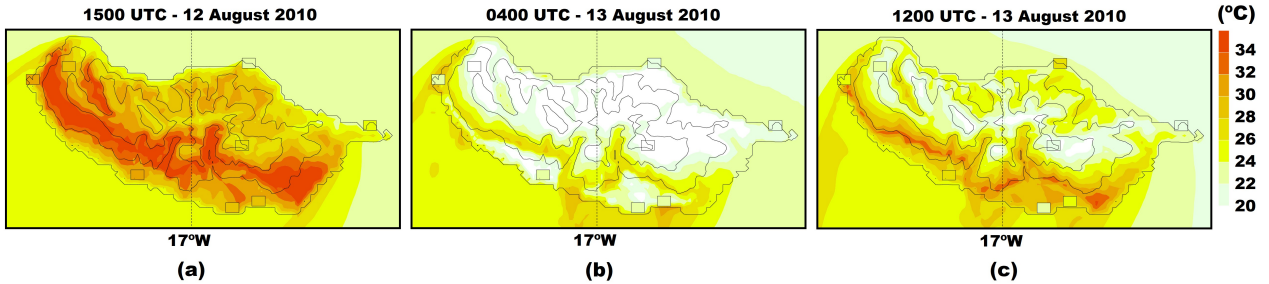


Over the island, the downward motion created by the local orography at the southern slopes was evident from the simulations.

3.2. Mesoscale Environment and Fire Weather Conditions

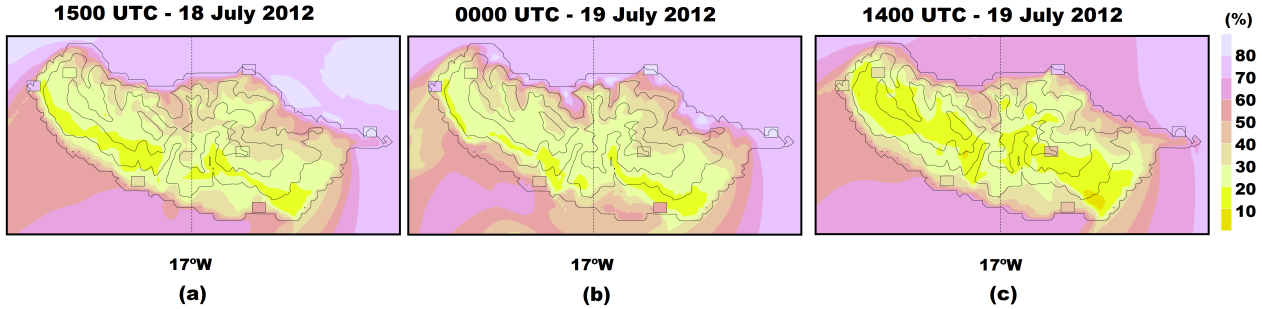
The combined effect of terrain and atmospheric conditions increased fire danger by leading the maximum **temperatures** above 35 °C and **relative humidity** around 20%, exacerbated by **intense gusts**.

Temperature



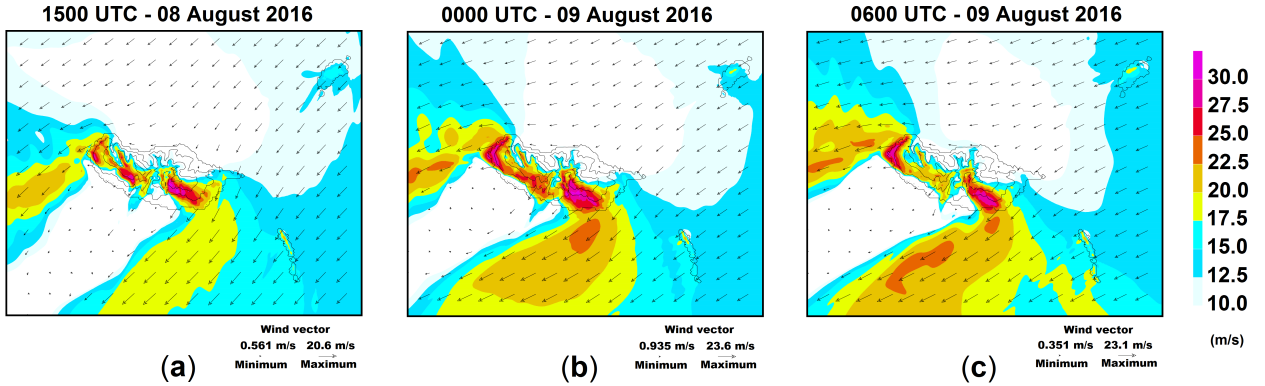
T > 35ºC

Relative humidity



RH < 20%

Wind gusts



WG> 20 m/s

4. Conclusions

The simulations showed that the atmospheric conditions in the southern slopes are driven by the local orography, which intensified the effects of typical anticyclone conditions prevailing over the North Atlantic Ocean.

In general, the model represented well the temperature and relative humidity at surface, despite some local over- or underestimation.

The high-resolution simulations showed fire-prone areas over the island and weather patterns related to high daytime temperatures and sometimes overnight, low humidity, and strong wind gusts that favour fire growth. The absence of precipitation is another factor contributing for this propitious condition to fires over the island.

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