ABSTRACT

Extreme Wildfires in Portugal in a changing climate: Driving weather conditions and air quality impacts

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Under the FIRESTORM project, a close collaboration between the partners University of Aveiro (DAO, CESAM), ADAI (U. Coimbra) and IPMA (Ministério do Mar) was articulated. The three main goals and lines of research of this partnership, developed in several working groups, are summarized as follows: (a) Weather and climate driving conditions of Extreme Fire Events and Periods, (b) Interaction between mesoscale atmospheric flows and the fires, (c) Smoke emission and dispersion modeling for air quality evaluation. This broadly corresponds to Tasks 1, 2 and 5 of the project.

As a starting point useful for all working areas, fire occurrence data was collected and the criteria to define Extreme Fire established. The Portuguese database of rural fires events (1980-2018) was compiled and several corrections were made. For reasons of consistency, fire records with a burnt area of less than 1,0 hectare were excluded. The final list shows 189 734 individual fires that burned 4,6 million hectares between 1980 and 2018, which corresponds to 25,8% and 98,5% of the respective values in the original database.

Regarding Extreme Fire, two definitions were adopted: Extreme Wildfire Events (EWE) and Extreme Wildfire Periods (EWP). EWE classifies individual fires (as recorded in the database) by dimension of the burnt areas. For instance, 77 fires burned more than 5000 hectares each (equivalent to 20% of the total burnt area, 1980-2018), 28 more than 10.000 hectares (12% of the total), and 5 more than 30.000 hectares (4% of the total). The EWP, which is particularly useful in the analysis of changes of weather conditions, identifies the periods (sequence of days) with the largest burnt areas in the territory. By statistical segmentation of the daily time series of burnt area 53 EWP were identified, non overlapping, with an average daily burnt area greater than 3.000 ha. This corresponds to 52.1% of the total area, which burned over 392 days (about 8% of the days of the fire season, June-September).

In the research line (a), a complete and long-term characterization of the weather conditions associated with Extreme Fire is under development, following methodologies well established in the literature. IPMA and ADAI have joined efforts to identify the days that gave rise to major fires, combining meteorological parameters and indicators, and fire risk indexes. The focus falls

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on large-scale circulation patterns (weather typing), drought influence, and daily and sub-daily variation of weather conditions (e.g. maximum temperatures, wind, moisture content in fuels).

Research line (b) seeks to explore less studied fire-atmosphere interaction phenomena, on which evidence suggests direct influence on fire front intensification. On the one hand, different types of discontinuity surfaces in the lower layer of the troposphere (such as breezes, nonspecific confluence and convergence zones, or gust fronts of convective outflows) observed by radar and poorly represented by circulation models. On the other hand, situations of thermal inversion in the vertical profile with local effects on wind intensification and temperature increase in mountainous zones. This will be studied in the Lousã-Estrela mountain system, SW-NE oriented, through a vertical layer more than 1000 meters deep, using four mobile weather stations plus two from IPMA's network.

Third line of research (c), led by the University of Aveiro, aims to study the impact of fire plumes on air quality (namely on CO, $PM_{2,5}$, PM_{10}, O_3, NO_X levels), on visibility impairment and on human exposure. Wildfire emissions were estimated for the October 2017 events and maps were produced to better understand the spatial impact of these emissions. Furthermore, the modelling system WRF-SFIRE-CHEM was selected to numerically simulate the dispersion and chemistry of emitted pollutants. Results from the meteorological model WRF, included in this system, will be compared with those of the AROME model provided by IPMA. Signatures on radar observations will be used to complement smoke dispersion estimations. The first case study in progress refers to the fire complex of Lousã, on the 15th of October 2017, and air pollutants concentration values will be presented and explored.