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The exceptional fire season of summer 2003 in Portugal

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From a meteorological perspective, the early August 2003 heatwave was characterized by very high maximum and minimum temperatures, extremely low humidity levels and relatively intense wind speed. These conditions triggered the most devastating sequence of large fires ever registered in Portugal. The estimated total burnt area was about 450.000 ha, including 280.000 ha of forest. The outstanding total burnt area value corresponds to roughly 5% of the Portuguese territory, and represents approximately twice the previous maximum observed in 1998 ($\sim$220.000 ha), and about four times the long-term average observed between 1980 and 2004. The main aims of this work are twofold, namely: to evaluate the exceptionality of summer 2003 fire season in Portugal using a wealth of fire scars information obtained on the ground and with satellite images retrieved from AVHRR, MODIS, and Landsat; and, (b) to characterize the atmospheric circulation patterns and anomalous weather characteristics over Portugal that led to such an extreme fire season. In particular, to assess, when and where, the low tropospheric temperatures did surpassed observed historical maxima.

The wildland fire database consists of: (1) relevant information about each fire occurred in Continental Portugal between 1980 and 2004, provided by the Portuguese forest Service, DGF); burnt areas maps for the summer 2003 in Portugal identified by the authors using (2) MODIS; (3) Landsat; and, (4) NOAA-AVHRR, satellite imagery. The meteorological dataset consist of: daily time series of NCEP/NCAR reanalysis database, for the entire 1980-2003 period, namely sea level pressure (SLP); 500 hPa geopotential height (Z_{500}); 850 hPa level temperature (T_{850}); maximum air temperature at 2 m (T_{x2} and T_{n2}); and zonal and meridional wind components at 10 m (U10m

and V10m); surface meteorological data observed on 50 ground stations covering the entire Portuguese territory, provided the Portuguese Meteorological Institute (IM).

Given the outstanding value of area burned during the 2003 summer, particularly in August, we decided to investigate in detail the spatial and temporal characteristics of this particular fire season. This extreme event is putted into perspective, analyzing the intra- and inter-annual variability in relation with the correspondent variability of summer burned area between 1980 and 2004. In contrast with other years, the location of the summer 2003 largest concentration of burned area in central Portugal, whereas the second most important cluster of burned area occurred in the mountains of the south-western part of the country. In these regions the size of the total BA values fall considerably above what had been experienced in the past whereas the remaining districts (located in the centre and north) with a higher record of large fires, the average area burned in 2003 is either smaller or roughly of the same magnitude as that previously observed. In addition, the vast majority of area burned in the summer of 2003 had not been affected by fire during the previous decade.

The temporal evolution of the total area burned throughout the 2003 fire season is essentially determined using the two distinct data sets based on satellite platforms (MODIS and AVHRR); however, all four (DGF, MODIS, AVHRR and Landsat) techniques can provide the end-of-summer BA for the entire 2003 fire season.

In order to characterize the thermal structure of the synoptic heatwave we used the 850 hPa temperature field (T_{850}). The temperature and geopotential anomalies with respect to the corresponding 15 day climatology further emphasise the amplitude of this extreme event. We have also analysed, on a daily scale, how exceptional was the tropospheric temperature for the entire summer 2003. However, since the most important sequence of days to trigger the ignition of large fires was probably concentrated between the 1^{st} and the 3^{rd} of August, thus we took special attention to the period from the 29^{th} of July to the 4^{th} of August.

The evolution of the heatwave described using low troposphere data is hampered by the low temporal and spatial resolution of NCEP/NCAR reanalyses dataset. In fact, the daily temporal resolution does not allow the characterisation of the daily cycle, namely differences between day and night time, whereas the spatial resolution (2.5º lat by 2.5º lon), not allowing for the incorporation of any local or regional atmospheric circulation features, particularly those related to topography. Therefore we decided to characterize in greater detail the evolution of the heatwave using data from a considerable number of stations from the Portuguese Meteorological Institute (IM) concerning the evolution of both maximum and minimum temperatures, surface relative humidity and the wind (direction and intensity) anomaly fields for the same period.

Following a previous work (Pereira et al., 2005) we have concentrated our efforts exploring the fact that the extent of BA in Portugal is strongly related with occurrence of very intense dry spells and days of extreme synoptic situations. The circulation patterns and weather conditions at surface and at higher levels during the summer 2003 heat wave present noteworthy differences in relation to the extreme synoptic situations associated with the occurrence of large wild land fires, identified in Pereira et al. (2005).

As may be inferred from this work, the new satellite data, which is available a few hours after the daily satellite overpasses, allows an almost real time fire activity monitoring which may be used to inform both fire managers and the public, to support personnel and equipment redeployment activities, and to prioritise post-fire mitigation of damages and losses.

Reference

Pereira M.G., R. M. Trigo, C. C. da Camara, J. M. C. Pereira, S. M. Leite, 2005.Synoptic patterns associated with large summer forest fires in Portugal. Agricultural and Forest Meteorology, in press.