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# Understanding inter-annual variability of burned area in Portugal using statistical models based on meteorological indices of fire danger

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According to officials statistics, about 3/5 of the total forested surface of Portugal has burnt during 1980-2011. Like in other regions of Mediterranean Europe, climate and weather are major drivers of fire activity in Portugal. The aim of the present study is to assess the role played by meteorological factors on inter-annual variability of burned area over a forested region of Portugal that is characterized by large fire activity. Although covering 18% of the Portuguese territory, the chosen region represents 43% of the total burned area in August during the study period.

Monthly cumulated values of burned area in August are obtained from the fire database of ICNF, the Portuguese authority for forests. The role of meteorological factors is characterized by means of Daily Severity Rating, DSR, an index of meteorological fire danger, which is derived from meteorological fields as obtained from ECMWF Interim Reanalysis.

The study area is characterized by the predominance of forest, with high percentages of maritime pine and eucalyptus, two species with high flammability in summer. The time series of recorded burned area in August during 1980-2011 is highly correlated (correlation coefficient of 0.93) with the one for whole Portugal.

First, a normal distribution model is fitted to the 32-year sample of decimal logarithms of monthly burned area. The model is improved by introducing two covariates:(1) the top-down meteorological factor (DSRtd) which consists of daily cumulated values of DSR since April 1 to July 31 and may be viewed as representing the cumulated stress on vegetation due to meteorological conditions during the pre-fire season; (2) the bottom-up factor (DSRbu) which consists of the square root of the mean of the squared daily deviations (restricted to days with positive departures of DSR from the corresponding long term mean 1980-2011) and may be viewed as representing the contribution of days characterized by extreme weather conditions favoring the onset and spreading of wildfires. Three different statistical models are then developed: the “climate anomaly” model, using DSRtd as covariate, the “weather anomaly”, using DSRbu as covariate, and the “combined” model using both variables as covariates. These models are used to define background fire danger, fire weather danger and combined fire danger, respectively quantifying the contribution of DSRtd, DSRbu and both covariates to increasing or decreasing the probability of having extremely high or extremely low values of burned area in August.

Results obtained with the “climate anomaly” model put into evidence the importance of the long-term pre-fire season conditions on the inter-annual variability of burned area, and the added value that is brought by a continuous monitoring of weather conditions during the pre-fire season. However, as expected, the short-term meteorological conditions in August have a key role on the inter-annual variability of burned areas, which may be assessed with the results of the “weather anomaly” model. The combined model, that takes both results into account, is able to correctly forecast the severity level for 25 out of the 32 years studied.