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Anticipating the severity of the fire season in Northern Portugal using statistical models based on meteorological indices of fire danger

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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 region of Portugal characterized by large fire activity.

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 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) and may be viewed as 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/low values of burned area in August.

Using the information obtained by the “combined” model it is possible to calculate the minimum/ maximum value of DSRbu for a given year to be modelled as severe/weak. The probability is then made using a normal distribution of the data series of DSRbu, if the probability is below 20% than the year will be considered as not belonging to that classification. This classification is able to correctly identify 34 out of the 36 years studied.

This results can be of extreme use to forest managers and firefighters when deciding which the best fire preventing measures are and where to allocate the resources.