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Using Circulation Weather Types to model the distribution of extreme fire days in Portugal

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Rural fires are a major problem in Portugal, with serious impacts at the social, economic and environmental levels. A better understanding of the fire regime and of the role played by meteorological conditions on the occurrence of extreme events is especially important when defining fire management and prevention policies and when assessing expected changes on the fire regime associated to different scenarios of future climate.

Fire activity in Portugal during the 15-year period 2004-2018 is characterized based on daily values Fire Radiative Energy (FRE), i.e. of energy released by fire events, as derived from the Fire Radiative Power (FRP) product. This product is operationally disseminated by EUMETSAT Satellite Application Facility on Land Surface Analysis (LSA SAF) and uses information provided every 15 minutes by the SEVIRI radiometer on-board Meteosat Second Generation (MSG) series of geostationary satellites operated by EUMETSAT.

Weather conditions are characterized by means of daily Lamb circulation weather types (CWTs) as derived from sea level pressure fields covering the same period. Daily values of surface pressure were extracted from the ERA Interim reanalysis dataset (Dee et al., 2011) generated by the European Centre for Medium-Range Weather Forecasts (ECMWF). Daily CWTs are grouped into 8 directional (NE, E, SE, S, SW, W, NW and N) associated to the cardinal and intercardinal directions of the geostrophic flow, and 2 rotational types (cyclonic and anticyclonic) according to the two signs of geostrophic vorticity.

The distribution of daily FRE is long tailed with 5% of fire days (i.e. days where there is a recorded release of FRE by wildfires in Portugal) accounting for 69% of the total FRE. The vast majority (96%) of these extreme fire days takes place from July to October (with 62% occurring in August) and the remaining 4% of events are evenly distributed in March and June. On the other hand, 66% of the released energy in extreme days is associated to directional types NE (36%) and E (30%) that occur in 62% of the extreme days (but only in 28% of all fire days and 18% of all days).

Results above suggest using a Generalized Pareto (GP) distribution to model the statistical distribution of daily FRE using the “peaks-over-threshold” (POT) approach and then assess the impacts of CWTs on the parameter of scale of obtained distribution. Daily values of the decimal logarithm of FRE are adequately modelled by a GP distribution with a negative shape parameter, indicating that exceedances of energy are upper limited, and the model is further improved when the scale parameter depends on CWTs.

Obtained models may be used to generate synthetic distributions of daily FRE using time series of CWTs derived from observed or reanalyzed fields of surface pressure or from simulated fields of present and future climate.

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