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Atmospheric patterns for wildfires caused by lightning in Castile and León, Spain

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Castile and León, Spain, is the third largest region in Europe, with $94225\ km^2$, and has a forest area of nearly $50000\ km^2$. Every year an average of 1,800 wildfires scorch forests in this region and 8% of these fires are ignited by lightning during thunderstorms. Lightning plays an important role in devastating fires that burn large areas. Critical fire-weather conditions are the prime ingredients needed to fuel a fire that may rage for long periods of time. The land area affected by this type of fire is generally larger than in the case of fires with a different origin because storms often bring with them strong and erratic winds making the extinction of the fire more difficult. Most summer storms occur in mountainous regions and during the night, thus contributing to larger affected areas.

The Group for Atmospheric Physics (GAP) at the University of León (ULE), Spain, is currently engaged in a research Project cooperating with the Center for the Defense against Fire (CDF) of the Regional Government in Castile and León. The final aim is to develop a forecast model for fire risk based on the identification of the meteorological situations that may lead to convective phenomena including storms with lightning.

The project has several stages. Firstly, we focus on identifying the patterns of the synoptic and mesoscale atmospheric circulation in the affected areas during wildfire days caused by lightning, from 1985 to 2006. The database contains 376 days that caused 973 wildfires, with affected land areas between 1 and 5000 hectares. Gridded data from the National Centers for Environmental Prediction (NCEP), with a $2.5^o \times 2.5^o$ latitude-longitude resolution, are used. The study area comprises the domain from 30^o N to 60^o N and from 30^o W to 10^o E. The selection of a group of independent variables representative of the state of the atmosphere will supply -by means of a clustering procedure- a synoptic and mesoscale meteorological categorization of the atmospheric characteristics of these days. The Principal Component Analysis (PCA) will be applied previously to extract the most important components of the initial variables and to explore the joint space and time variations in the data set.

In this preliminary study, a subjective classification of the atmospheric patterns has been carried out corresponding to the fire days in the province of León ($15500\ km^2$), the one most severely affected in Castile and León, with 326 fires in 161 days. The variables used have been sea level pressure and 500-hPa geopotential height. An additional objective classification was carried out. Using the time steps as variables and the grid points as observations, we have used the PCA (in T-mode) to isolate groups of time steps with similar patterns. The results obtained enable us to describe the characteristics of the various synoptic environments. However, it seems obvious that a forecast model based on the results of cluster analysis classification requires a more complete set of independent variables obtained from a group of fields, such as geopotential height, relative humidity or horizontal component of wind. This classification will be the next stage in the present research Project.