CHARACTERISTICS OF CONVECTIVE PROCESSES IN INLAND NORTHEAST SPAIN

Francisco Espejo[1], Evelio Álvarez[2], Francisco Cortés[3], Cristina Lafragüeta[3]

[1]*AEMET-State Meteorological Agency, Aragon Regional Office, Spain, pespejo@inm.es*
[2]*AEMET-State Meteorological Agency, La Rioja Regional Office, Spain, ealvarez@inm.es*
[3]*SODEMASA, Aragon Regional Government, Spain, beca1zar@inm.es, beca3zar@inm.es*
(Dated: 15 September 2009)

I. INTRODUCTION

The interior of the Northeastern Iberian Peninsula presents some special characteristics regarding convective processes. Due to both the proximity to the Atlantic Ocean and the Mediterranean Sea, the effect of high mountain ranges (the Pyrenees and the Iberian Range), and the presence of a high portion of elevated plateau-like terrain in the latter, convection in this area presents records of frequency and severity in Spain. Especially during the warm season (April-September), storm severity features such as the number of lightning strokes, high maxima of rainfall, severe hail and even F3 tornadoes can be observed in the area.

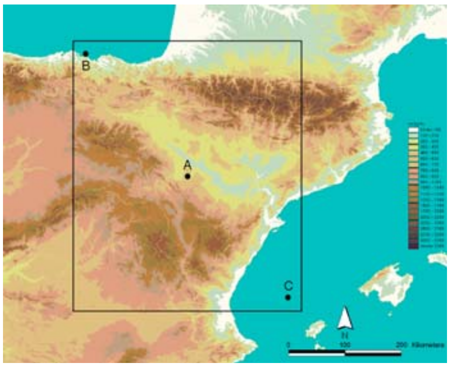

FIG. 1: Area of study.

II. PRESENTATION OF RESEARCH

In this work we follow the line of research presented in ECSS 2007, extending the study period to warm seasons (April-September) between 2002 and 2008. The aim is to characterize the convective processes in the area and to establish their main driving factors.

The first part of the study presents a classification of 26 convection-prone situation types, shown in TABLE I, selected through wind speed and direction in points A, B, C (FIG. 1) at the 500 hPa level.

Vector velocity modulus A	>5 m/s					
<5 m/s	Vector velocity direction	C				
	B	(160,200]	(200,250]	(250,280]	(280,360] [0,30]	(30,160]
AIR MASS	(160,200]	AFR AFR	AFR SAT	AFR W	AFR NW	AFR COL
	(200,250]	SAT AFR	SAT SAT	SAT W	SAT NW	SAT COL
	(250,280]	W AFR	W SAT	W W	W NW	W COL
	(280,360] [0,30]	NW AFR	NW SAT	NW W	NW NW	NW COL
	(30,160]	COL AFR	COL SAT	COL W	COL NW	COL COL

TABLE I: Classification of convective-prone situation types.

Besides, a climatological revision of the study area is carried out using three different parameters for the period considered. FIG. 2 shows the mean number of strokes per Km^2 and warm season (a) and the mean storm days per warm season (b), whereas FIG. 3 shows the seasonal distribution of precipitation maxima (a) and the percentage of summer rainfall to the annual total (b).

As seen in FIG. 2a, the Eastern Iberian Range presents the maximum density of strokes, whereas as for mean storm days FIG. 2b shows two maxima, a relative one coinciding with the maximum of stroke density and an absolute one located in the Pyrenees.

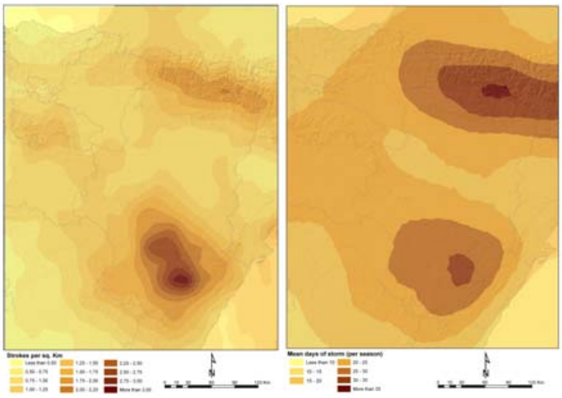

FIG. 2: Climatology of lightning stroke density (a) and days of storm (b) per warm season (April-September).

On the other hand, FIG. 3 shows that in spite of its proximity to the Mediterranean, it is in the summer when the Eastern Iberian Range has more rainfall (a), which seems to be linked to the higher frequency of storms during the warm season (FIG. 2).

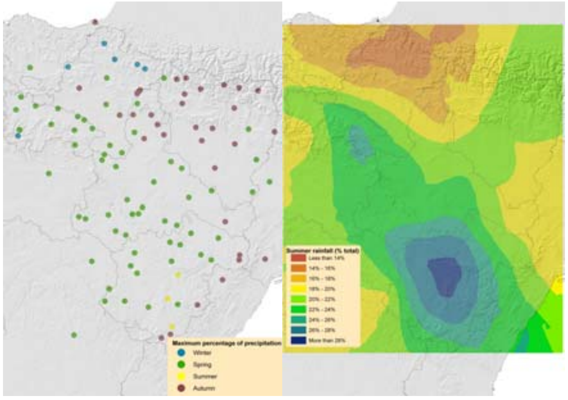

FIG. 3: Seasonal maximum percentage of precipitation (a) and summer rainfall percentage to the annual total (b).

The second part is a systematization of the possible causes of local convection. This has been made using the data from AEMET-HIRLAM 0.5º model, through various parameters involving different factors and levels. A statistical study of the correlation of factors and effects (detected lightning strokes), using logistical regression techniques, has been carried out for the warm season (April-September) between 2002 and 2008 in the region of interest.

The parameters considered are: humidity convergence and wind convergence at low levels, pressure at surface level, instability, geostrofic vorticity advection, differential thickness advection and Q vector divergence (Hoskins). Before regression, variables were tested for colineality and correlation, not detecting any trace of these. Consequently, all variables were included in the analysis.

Regression analysis was carried out in two different ways, considering the 2002-2007 period and validating the results with data of 2008 and, alternatively, considering a random sample of 60% of all possible data (2002-2008) and validating them with the remaining 40%, trying to avoid a possible seasonality in the results.

III. RESULTS AND CONCLUSIONS

In the study period and area considered 847 days of storm were counted which, according to the classification established in TABLE I, the most numerous were SAT-SAT (South Atlantic) situations, followed by Air Mass storms and SAT-W situations (FIG. 4).

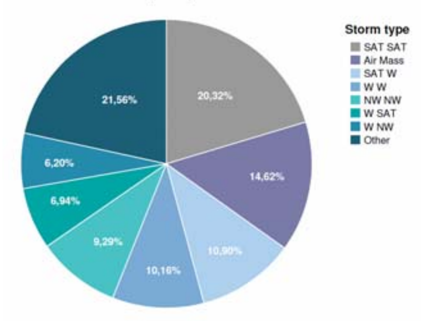

FIG.4: Classification of days of storm according to situation type. April-September 2002-2008.

Besides, we analyzed the mean maximum rainfall associated to each storm type (FIG. 5), being COL (Cutoff Low) and AFR (Northern African) the situations registering more rainfall.

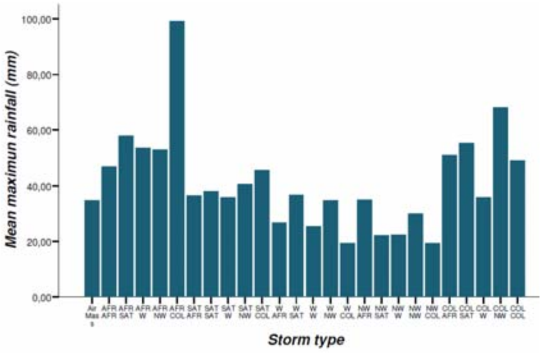

FIG.5: Mean maximum daily rainfall per storm type. April-September. 2002-2008.

The regression models using the two methodologies presented take into account 5 variables: humidity convergence and wind convergence at low levels, pressure at surface level, instability and differential thickness advection. From the statistical analysis, we can conclude that instability is the most important parameter regarding prediction of convective phenomena in the area, followed by humidity convergence and wind convergence, the two latter probably being caused by the confrontation of humid Mediterranean flows with drier and cooler winds in the presence of a ground configuration and a geographic position prone to favour convection.

Both methodologies show similar results in modellization as well as in validation, with a skill score around 85%, as shown in TABLES II and III.

OBSERVED		PREDICTED					
		Selected cases (2002-2007)			Selected cases (2008)		
		Dependent variable		Correct percentage	Dependent variable		Correct percentage
		Storm	Non storm		Storm	Non storm	
Dependent variable	Storm	61184	6038	91.0	11395	1262	90.0
	Non storm	5153	4899	48.7	1071	933	46.6
Total percentage				85.5			84.1

TABLE II: Classification of training sample (2002-2007) and validation sample (2008).

OBSERVED		PREDICTED					
		Selected cases (60%)			Non selected cases (40%)		
		Dependent variable		Correct percentage	Dependent variable		Correct percentage
		Storm	Non storm		Storm	Non storm	
Dependent variable	Storm	43438	4317	91.0	29148	2976	90.7
	Non storm	3705	3491	48.5	2498	2371	48.8
Total percentage				85.4			85.2

TABLE III: Classification of training sample (60%) and validation sample (40%).

Finally, it is noteworthy that the results obtained in this study corroborate and complete the ones obtained in previous studies (Espejo and Álvarez, 2007).

IV. REFERENCES

Álvarez, E., 2001: Climatología de descargas eléctricas. V Simposio Nacional de Predicción, INM.

Buisán, S., Espejo, F., Sanz G. et al., 2009: Characterization of the convective activity in the eastern Iberian Range, Spain. International Conference on Alpine Meteorology.

Buisán, S., Espejo, F., Sanz G. et al., 2009: Convective activity and severe weather in Teruel province, Spain. Description, episodes and possible future trends. I Spain-China Symposium on Geophysical & Geochemical Geosystems.

Doswell, C.A., Brooks, H.E., Maddox, R.A., 1996: Flash Flood Forecasting: An Ingredients-Based Methodology. *Weather and Forecasting*, 11 560-581.

Espejo, F., Álvarez, E., 2007: Characterisation of the evolution of convective processes in the Ebro Basin (NE Spain). 4th European Conference on Severe Storms. ECSS 2007.

Espejo, F., Sanz, R., 2001: El tornado del 28 de agosto de 1999 en Teruel. V Simposio Nacional de Predicción, INM.

Pérez, C., 2005: Técnicas estadísticas con SPSS 12. Aplicaciones al análisis de datos. *Pearson Prentice Hall*, 13 513-542.

Vilar del Hoyo, L., 2006: Empleo de regresión logística para la obtención de riesgo humano de incendios forestales. CDRom XII Congreso Nacional de Tecnologías de la Información Geográfica.