CHARACTERISATION OF THE EVOLUTION OF CONVECTIVE PROCESSES IN THE EBRO BASIN (NE SPAIN)

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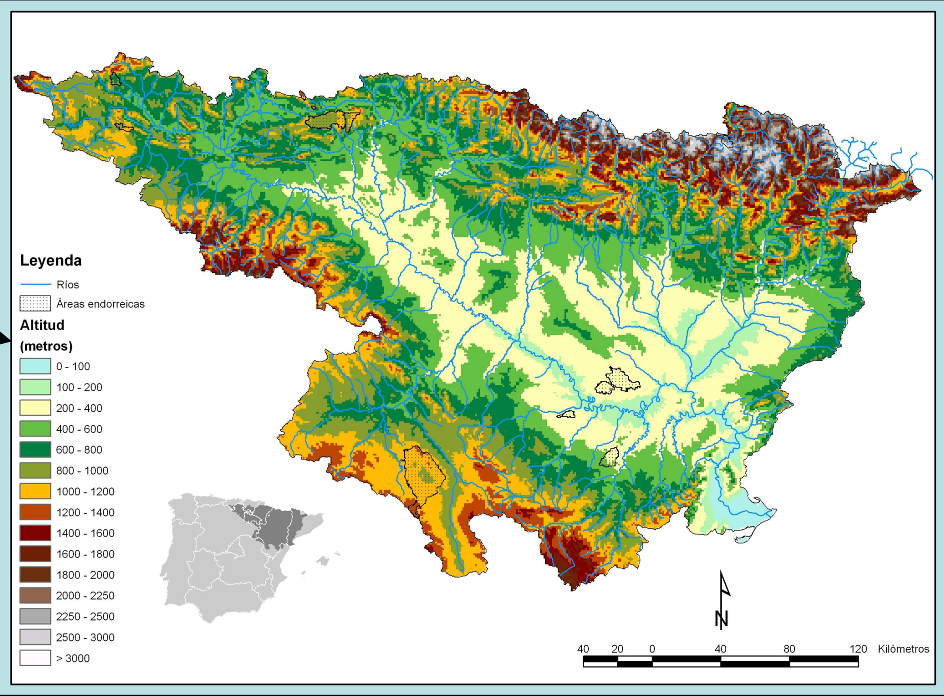
THE EBRO BASIN



The Ebro Basin covers 17% of the total surface of the Iberian Peninsula and is located at its northeast. It is a Mediterranean Basin limited by the Pyrenees to the north, the mountain systems bordering the Central Plateau to the southwest and the Mediterranean mountain ranges to the east. This isolated nature provided by the high mountains, its peaks ranging from 1500 to 3400 m, along with its location between the Bay of Biscay and the Western Mediterranean Sea, give the convective processes in the basin most peculiar characteristics: The Ebro Basin is the area of Spain registering more lightning strokes a year, where forms of severe weather such as heavy rainfall, large-sized hail and even tornadoes reaching up to F3 category can happen yearly. It harbours a population of around 3 million inhabitants, mainly living around the river Ebro or its main tributaries. However, the persons present in high mountain areas any weekend or in summertime could number several thousand.

METHODOLOGY

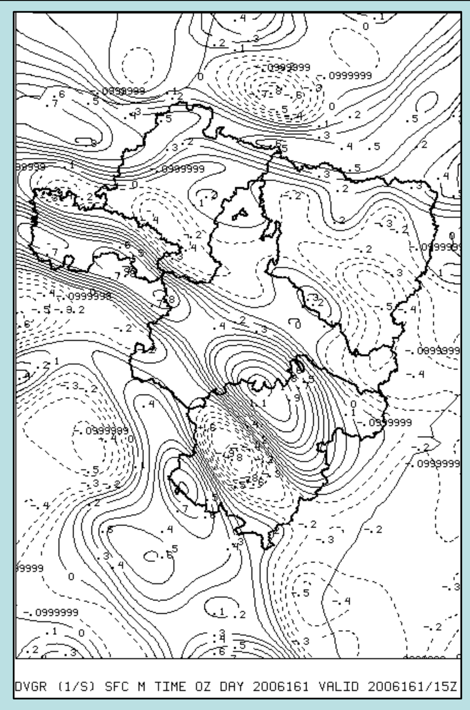
A characterisation is made of the ingredients needed for the occurrence of convective processes and the possible ways for their evolution in terms of severity and distribution over the different areas of the basin. As a **case study**, all the days in which convection was present during the year **2006** are taken into consideration, identifying them by the presence of lightning strokes over the basin. Then, through the evolution of these lightning strokes, radar and satellite images, the life of the different cells is followed. Finally, by means of a study of specific numerical model derived outputs valid for the noon of the day of convection (from HIRLAM-INM 0.2 & 0.5), those ingredients are evaluated. These derived outputs include:

Synoptic factors:
- -differential vorticity advection at 300/500 hPa levels
- -thickness advection at 500/1000 hPa levels
- -lift and subsidence through the Hopkins-Q vector

Thermodynamic factors:
- -TT index
- -K index
- -temperature at 500 hPa

Air mass factors:
- -humidity convergence at 850 and 925 hPa
- -temperature advection at 850 and 925 hPa

Other factors:
- -low level wind convergence
- -mid-high level diffluence
- -anticyclonic to cyclonic curvature change at 500 hPa



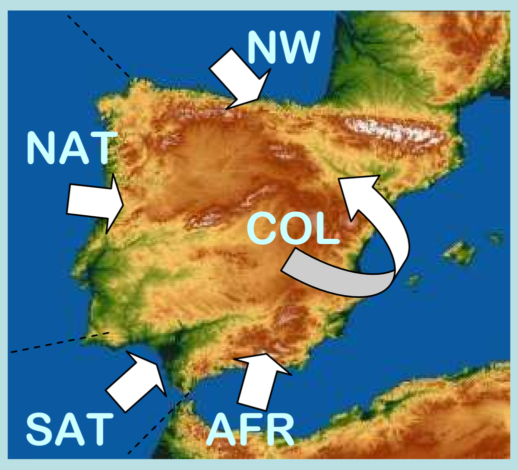
Ex.: Derived output for low level convergence

CLASSIFICATION OF CONVECTIVE PROCESSES

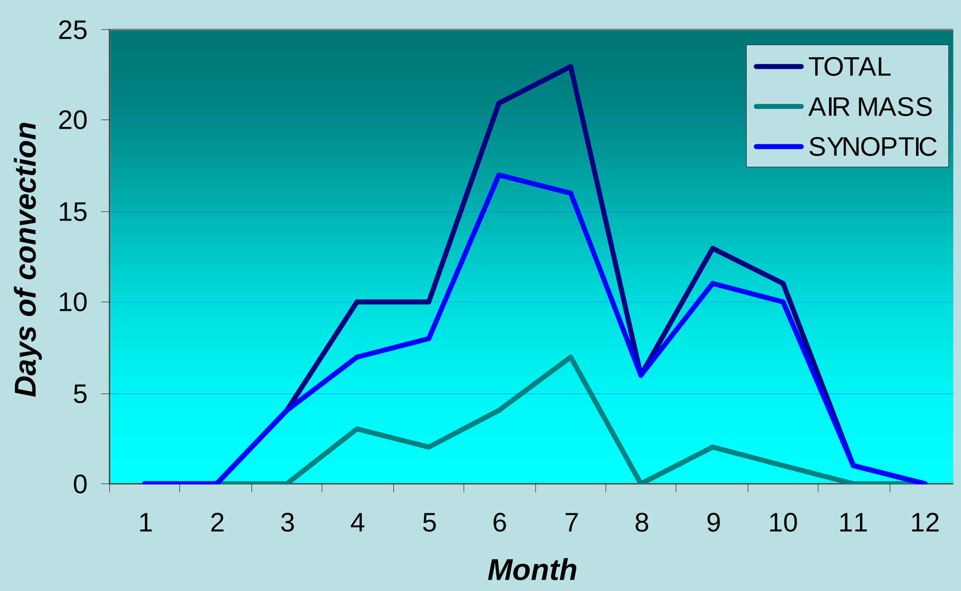
The classical distinction between air mass storms and those of synoptic origin is adopted. Air mass storms remain with little or no translation at all near their formation areas, whereas synoptic-originated storms use to travel many Km during their lifetime.

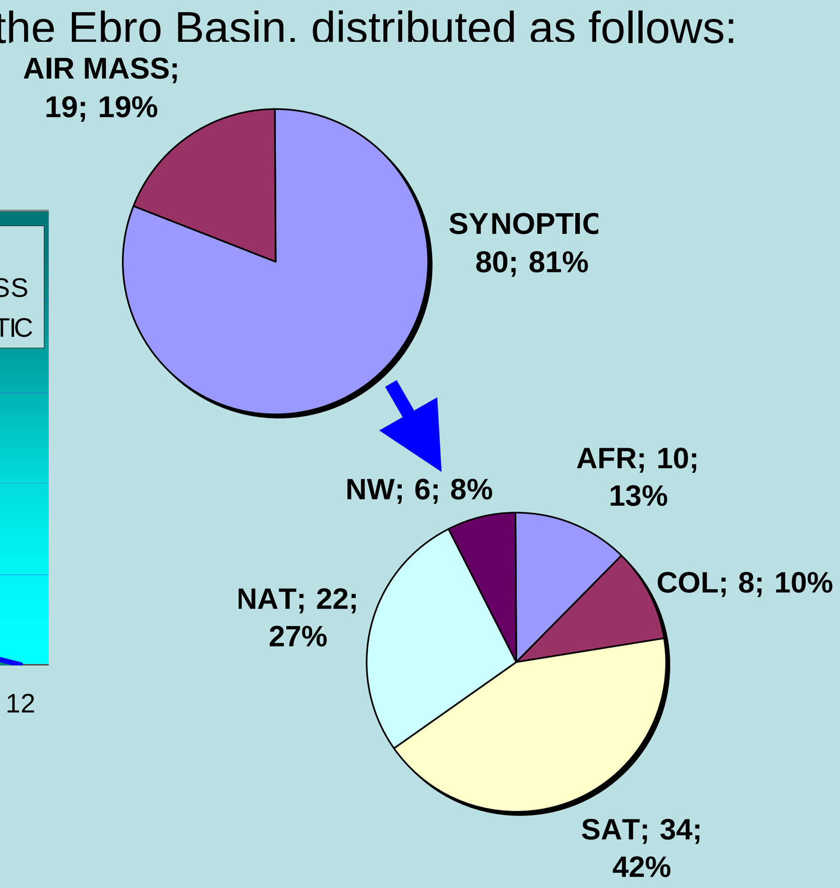
Another classification for the synoptic-originated convective processes is established in terms of the provenance of the flux at mid-high levels (500 hPa). The established types are:

AFR: Southern flux with trajectory over Northern Africa
SAT: South-western flux of Atlantic origin
NAT: Western flux of Atlantic origin
NW: North-western flux coming from the Bay of Biscay
COL: Cut-off low at mid-high levels



In 2006 there were 99 days of convection in the Ebro Basin, distributed as follows:



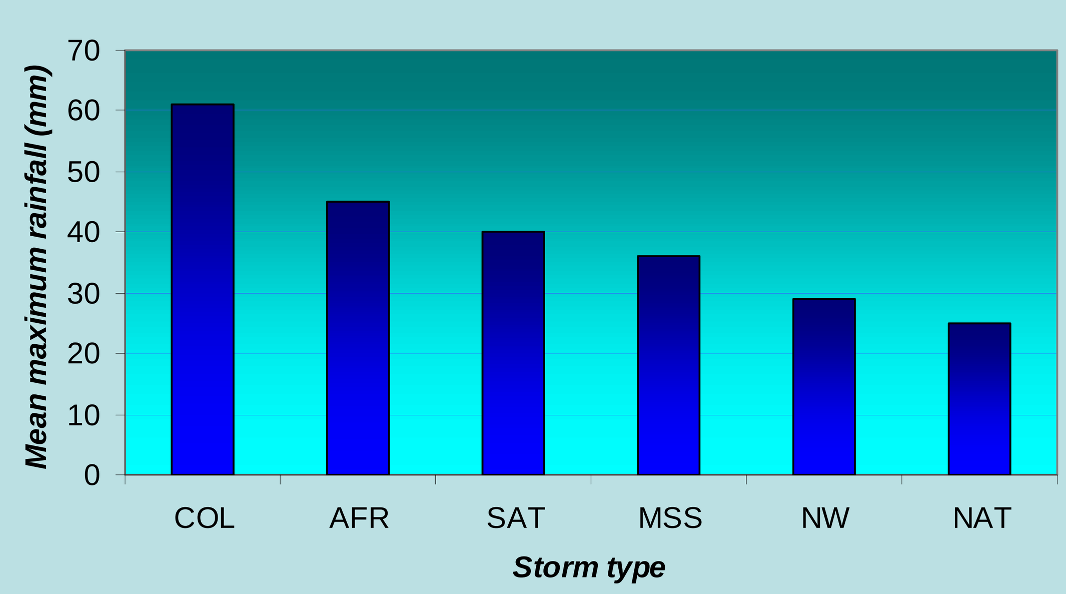


RESULTS

The factors considered are evaluated for each day with convection in terms of their positive or negative contribution to the convective processes (+2 to -2). The final results for each type appear in the following table:

TYPE	FACTORS					
	SYNOPTIC	THERMO-DYNAMIC	AIR MASS 925 hPa	AIR MASS 850 hPa	LOW LEVEL CONVERGENCE	DIFFLUENCE-CURVATURE
AIR MASS	**0.1**	**0.3**	**0.1**	**0.0**	**0.9**	**-**
SYNOPTIC	**0.3**	**0.4**	**0.3**	**0.1**	**0.6**	**0.5**
SYN-AFR	0.2	0.3	-0.1	-0.1	0.4	1.0
SYN-SAT	0.3	0.3	0.5	0.2	0.2	0.6
SYN-NAT	0.3	0.4	0.3	0.0	0.7	0.4
SYN-NW	-0.2	0.4	-0.2	-0.1	1.0	0.3
SYN-COL	0.2	0.2	0.0	-0.1	0.3	0.3

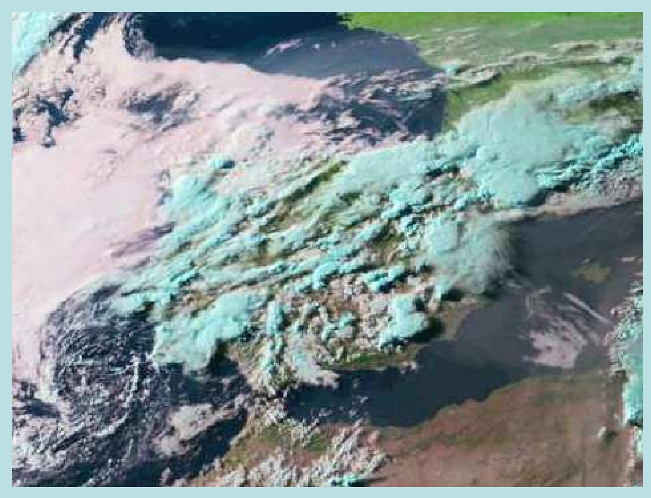
MEAN MAXIMUM DAILY RAINFALL PER STORM TYPE



CONCLUSIONS

Air-mass convection
- Obviously favoured by low level convergences, thus it appears normally over or near mountain areas.
- Thermodynamic factors are of importance (well represented by the indices).
- Ageostrophic circulations as revealed by the Q-vector contribute to the focalisation of convection.
- Air mass factors relatively more important at 925 hPa than at 850 hPa.
- Significant role of humidity convergences.
- Can also cause important amounts of rainfall.

Air mass convection



Synoptic (AFR) convection

Synoptic-originated convection
- Synoptic factors are significant in Atlantic situations (SAT-NAT). In NW these factors tend to inhibit convection as it starts in the troughs' central or rear sectors.
- Thermodynamic factors are of relevance in flows from the 4th quadrant (NAT-NW) due to the mid-level cold air mass advected over the basin.
- Air mass factors are also more important near the surface than slightly upper. These are especially high in SAT situations due to humidity convergences in the subtropical Atlantic flow. This effect disappears when the flow travels over Northern Africa.
- Low level convergences are generally the main factor for convection, especially for NW and NAT situations as Atlantic masses find Mediterranean air. In COL, SAT and AFR situations the upper level situations prevail over local convergences and convection might start in other places.
- High level diffluence and curvature are generally important, mainly in AFR and SAT situations with very long trajectories.
- COL situations (those prone to cause heavy precipitation episodes) don't show high values for their factors, probably because of their degree of maturity when they reach the basin.