

COASTEPS – First meeting

UIB, Palma, 24-25 May 2018



Universitat
de les Illes Balears

**Permanence and variability of
factors involved in Mediterranean
extreme rainfall events**

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MINISTERIO
DE ECONOMÍA, INDUSTRIA
Y COMPETITIVIDAD



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EUROPEAN UNION
EUROPEAN REGIONAL
DEVELOPMENT FUND
"A way to make Europe"

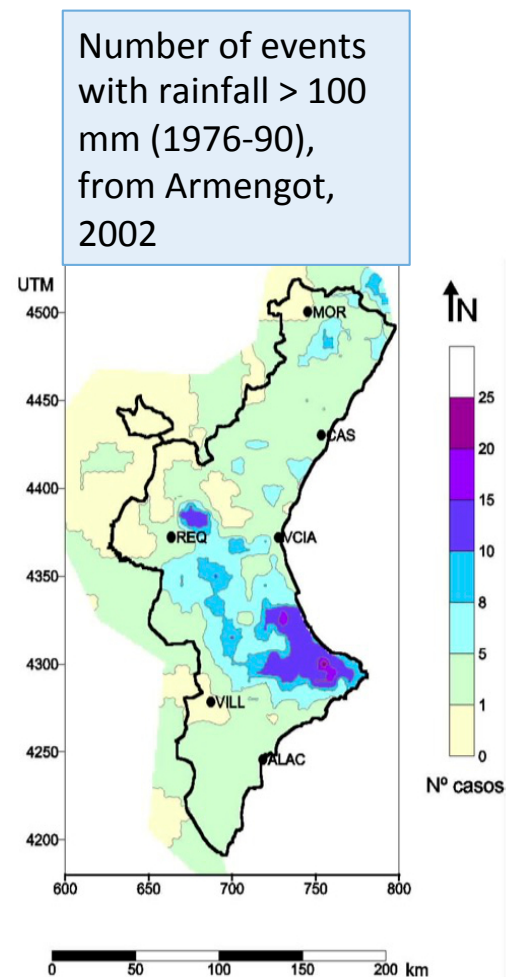
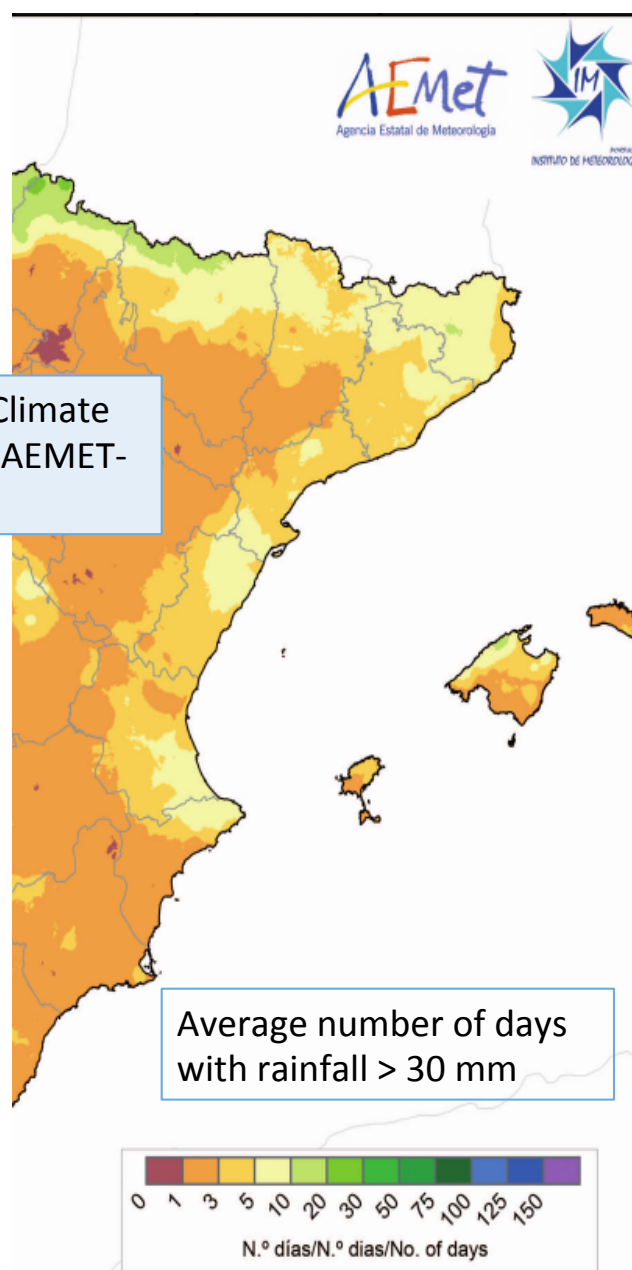
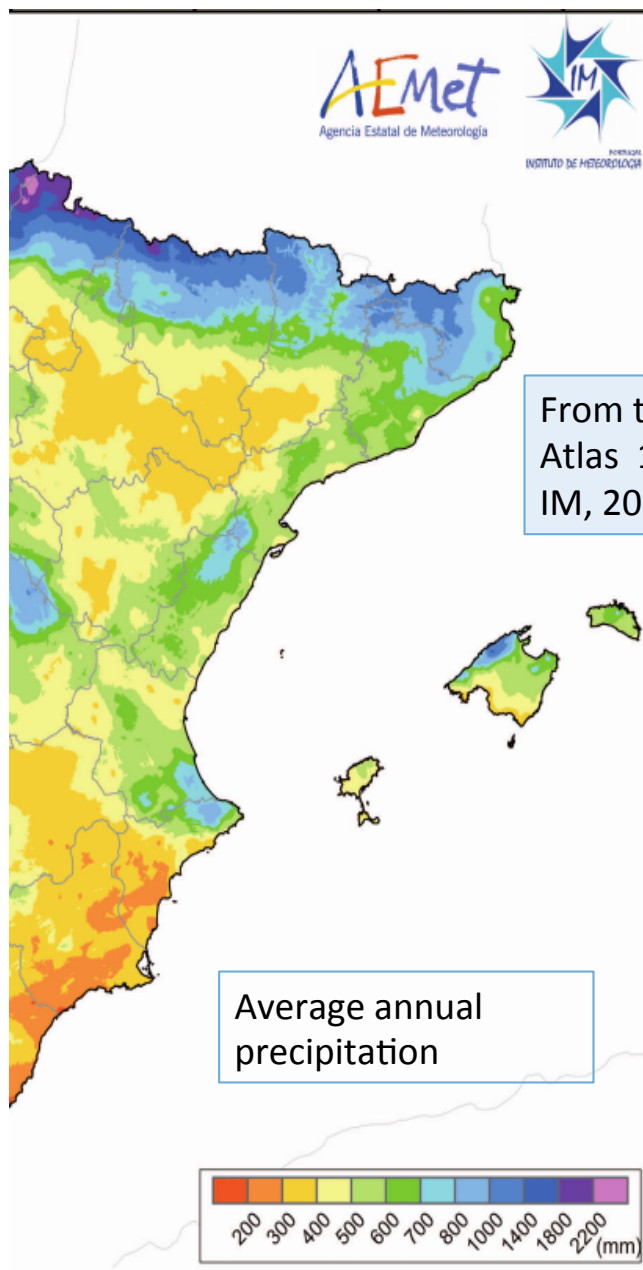
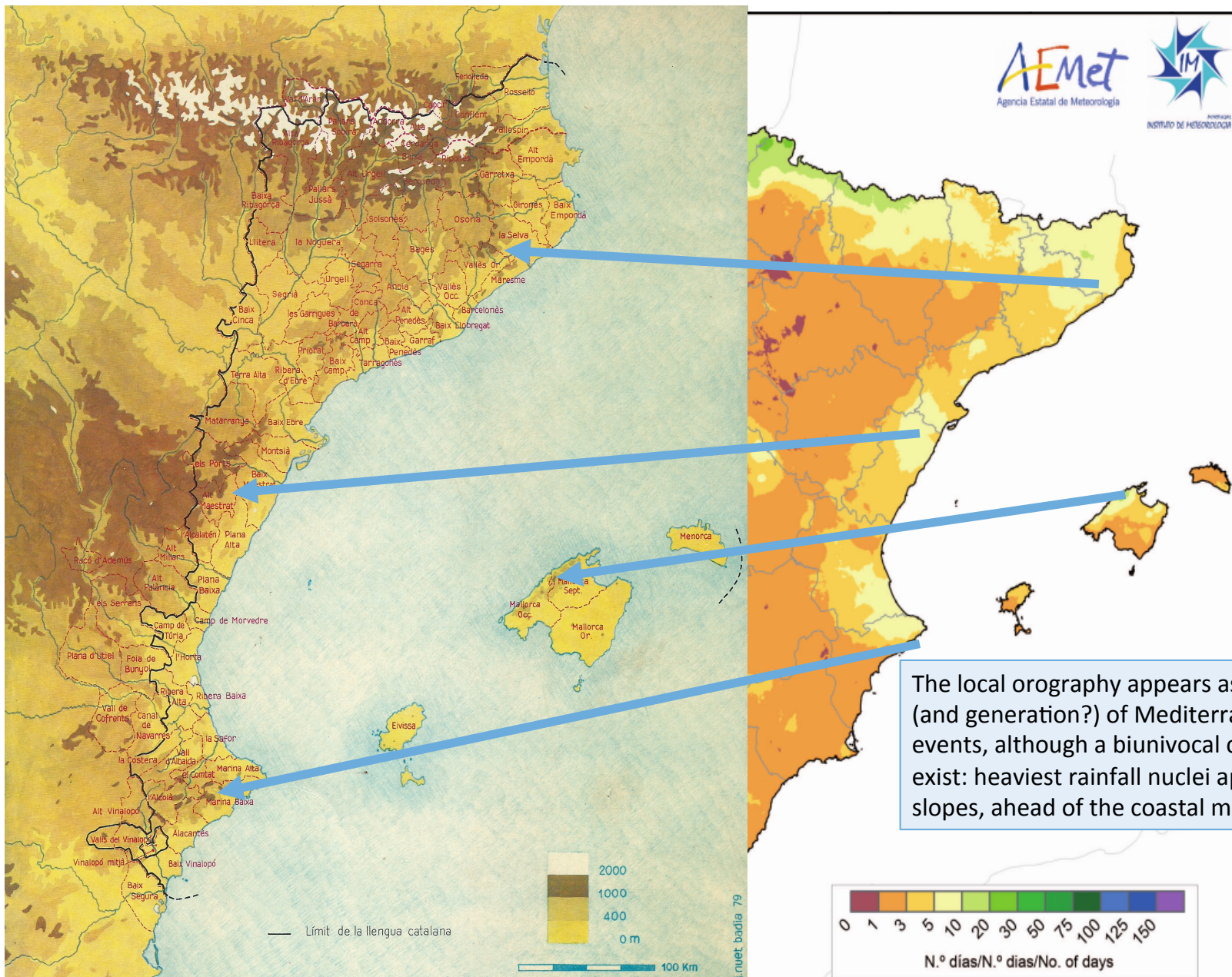
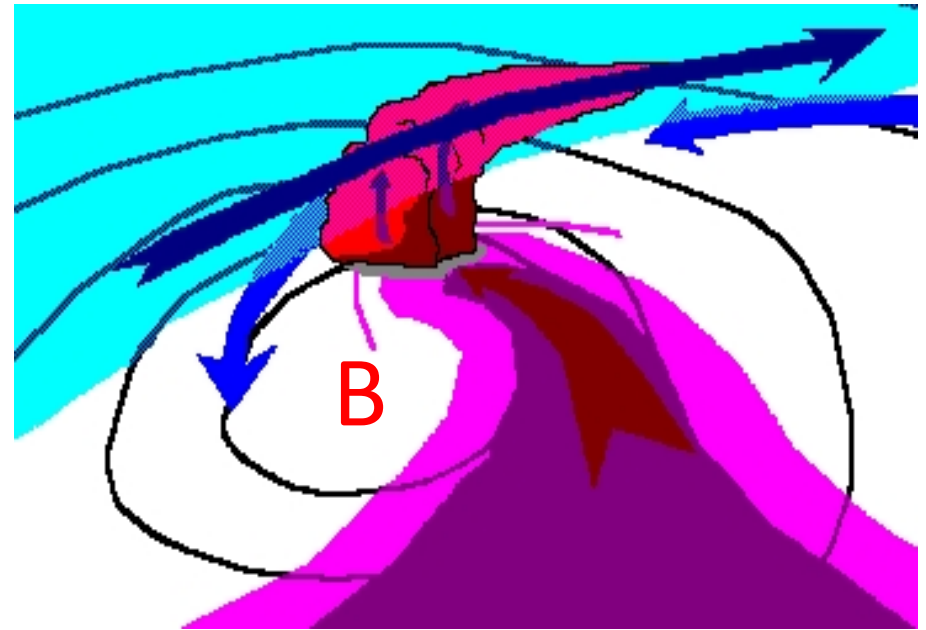


Figura 44.3: Frecuencia absoluta de casos de más de 100 mm/día en la Comunidad Valenciana en el período 1976-90 [13].

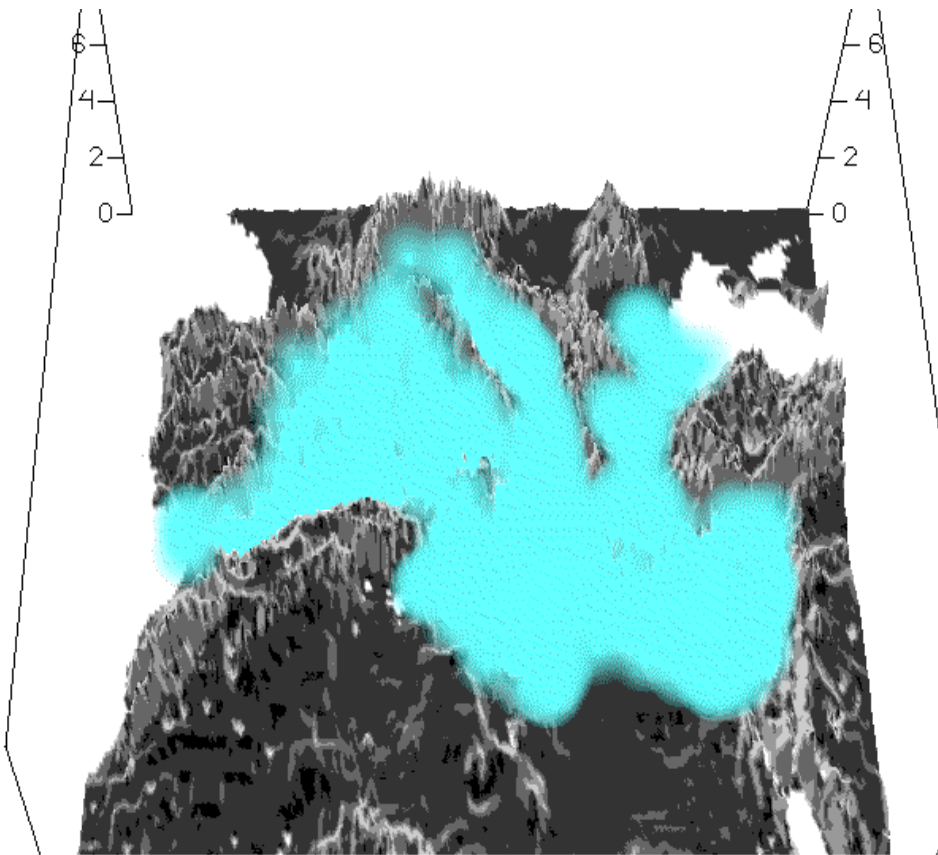


The Mediterranean basin is a bucket, a cooking pot, able to be filled by a warm and humid air-mass

This air-mass can be mobilized and directed to particular zones by local circulations, namely cyclonic circulations



A cyclone centre (even when it is small and weak) can organize the Mediterranean air-mass flow, forming a “small atmospheric river”, towards a zone with upwards forcing (produced by coast + orography or by wind convergence: a frontal line, a convective outflow boundary, ...)
The “Mediterranean river” feeds the rainfall and contributes to instability, providing heat and humidity



Heavy rain → Weak/moderate/intense Cyclone?, Close Cyclone?

Western Mediterranean cyclones and heavy rain – statistical approach

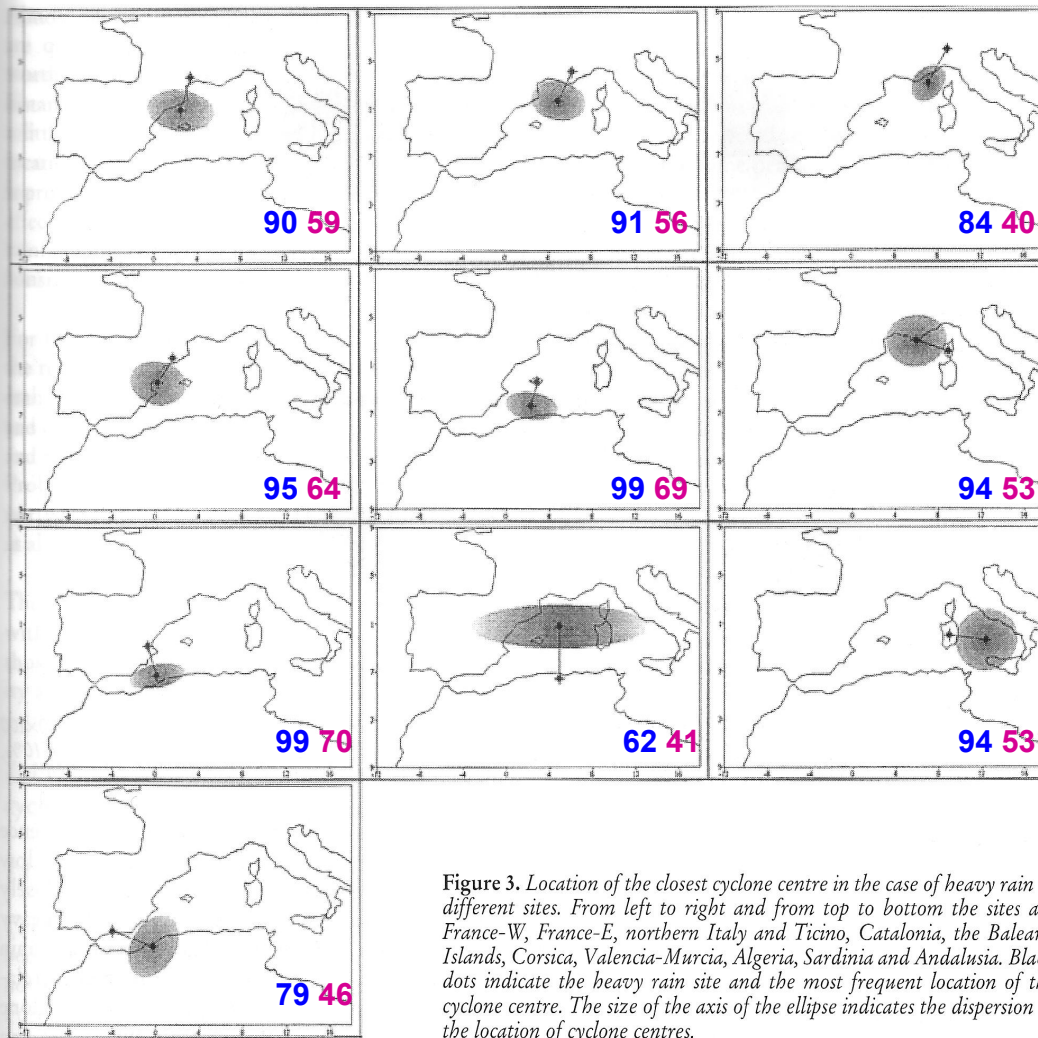


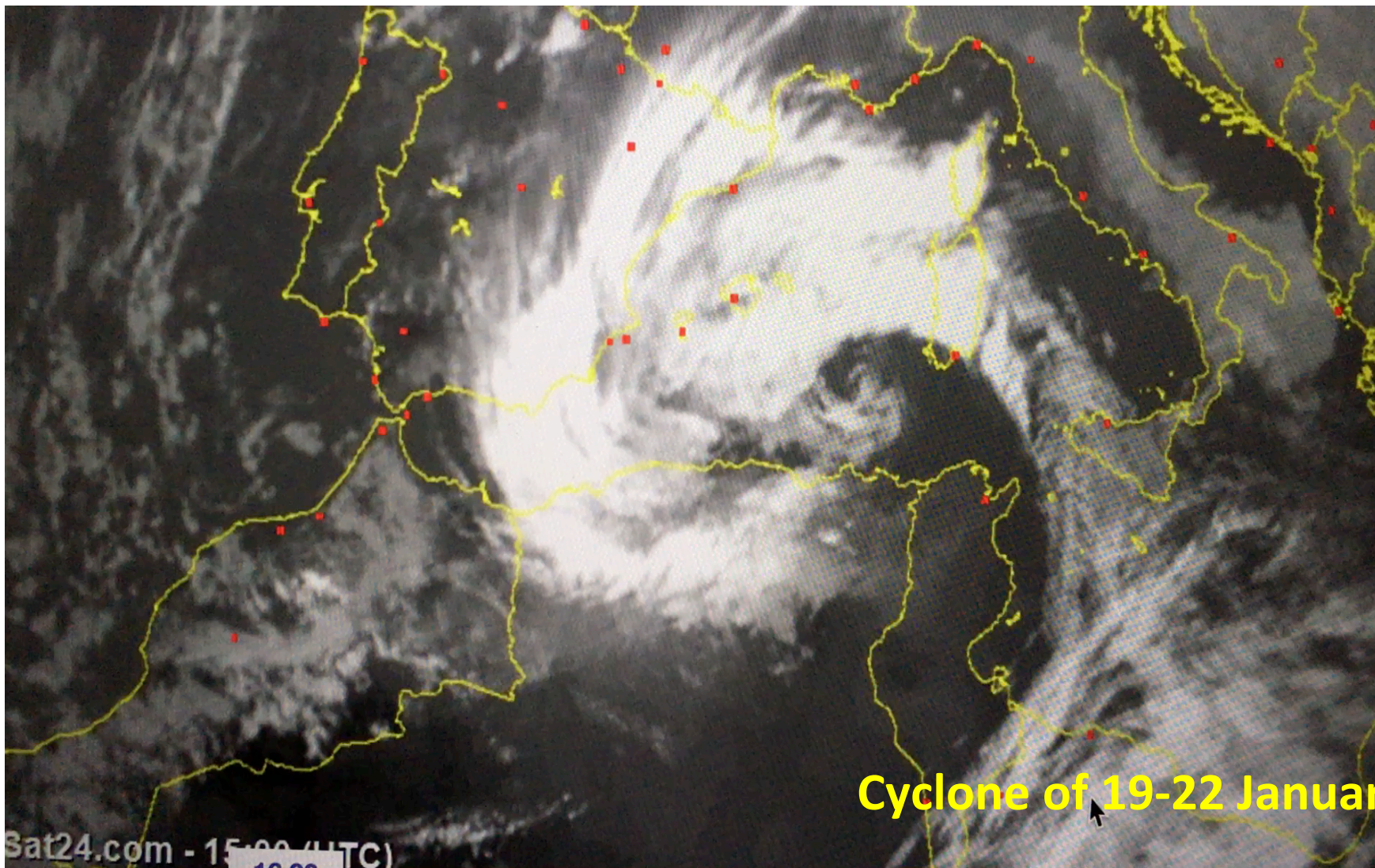
Figure 3. Location of the closest cyclone centre in the case of heavy rain at different sites. From left to right and from top to bottom the sites are France-W, France-E, northern Italy and Ticino, Catalonia, the Balearic Islands, Corsica, Valencia-Murcia, Algeria, Sardinia and Andalusia. Black dots indicate the heavy rain site and the most frequent location of the cyclone centre. The size of the axis of the ellipse indicates the dispersion in the location of cyclone centres.

% of heavy rain events (60 mm/day) with a cyclone at < 600 km

% random events with a cyclone at < 600 km

All cyclones (weak, moderate or intense, shallow or deep, are included)

Jansà et al., 2001



Cyclone of 19-22 January 2017

Sat24.com - 15:00 (UTC)
16:00



Pluviometric day of 3
November 1987: 817 mm/24 h
at Oliva (La Safor, València),
absolute record of rainfall in
Spain, in 24 h

Superrécord de Oliva de 3-4 de noviembre de 1987

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RAFAEL ARMENGOT SERRANO

Ex predictor en Delegación territorial (DT) en Valencia, Agencia Estatal de Meteorología (AEMET)

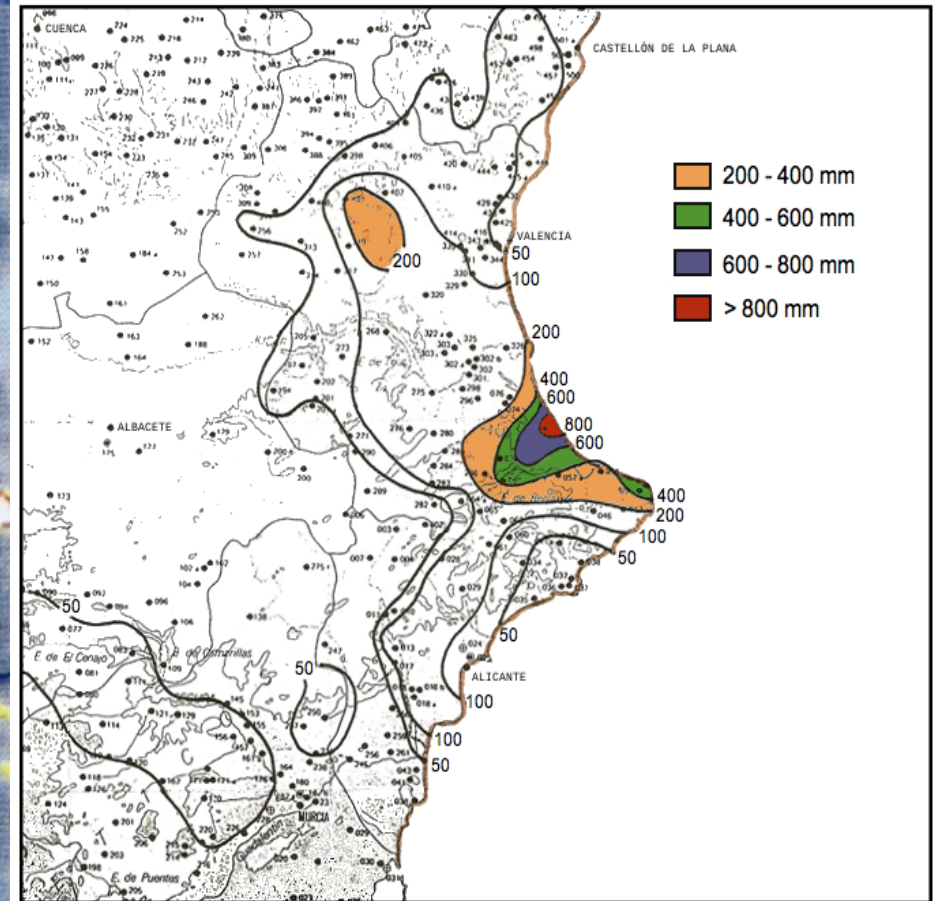
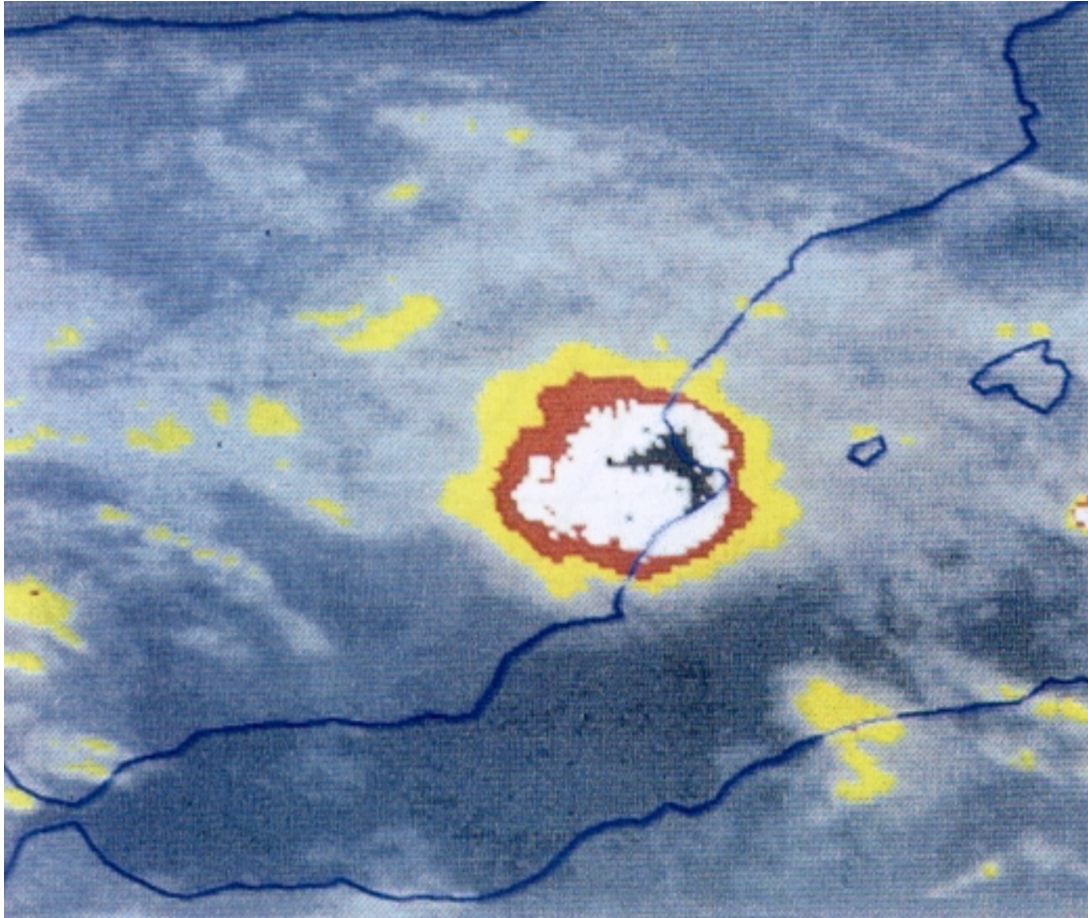
JUAN SIMARRO GRANDE

DT en Valencia, AEMET

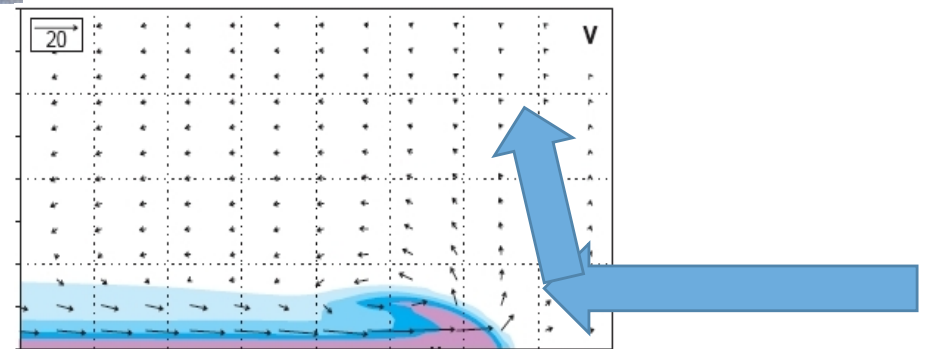
ALFONS CALLADO I PALLARÉS Y MARC COMPTE ROVIOLA

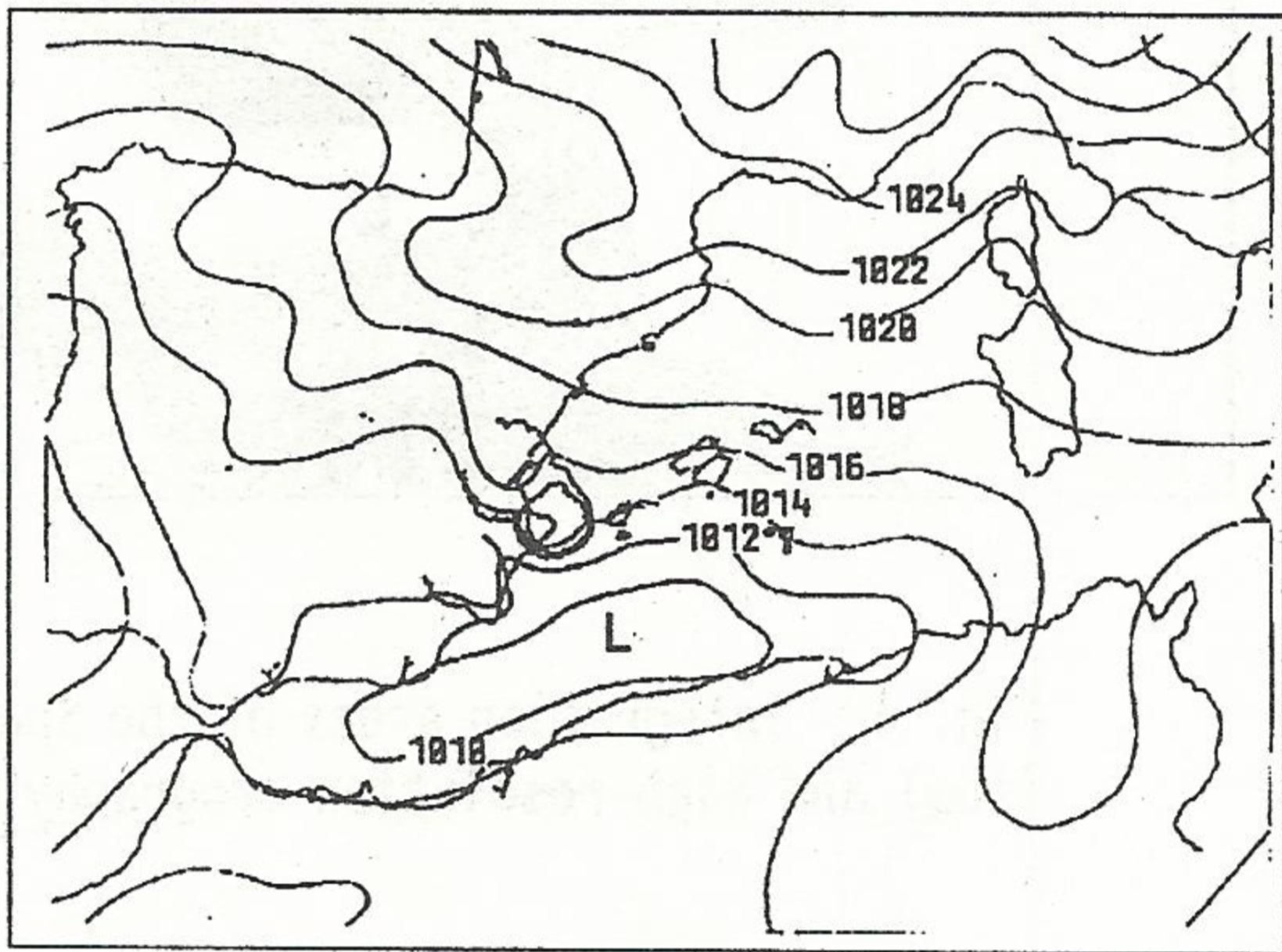
DT en Cataluña, AEMET

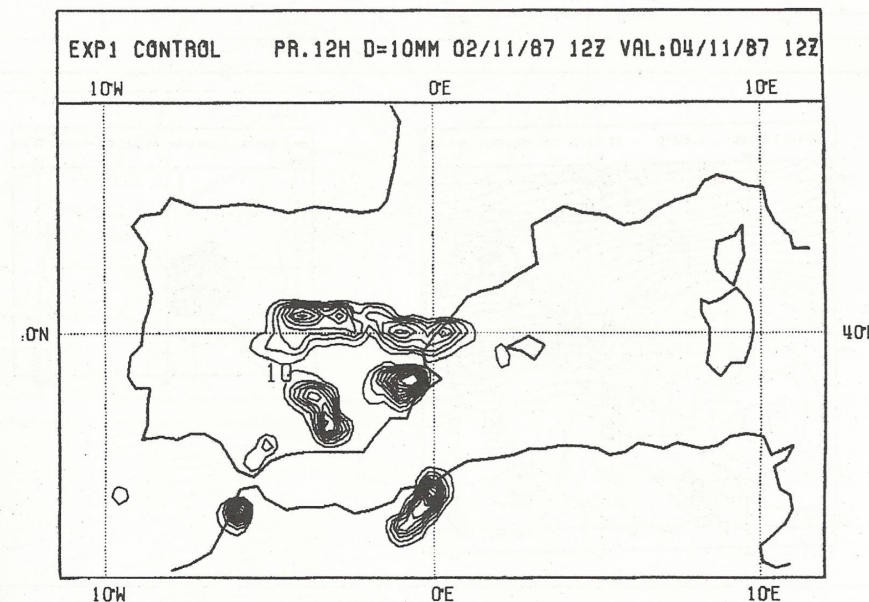
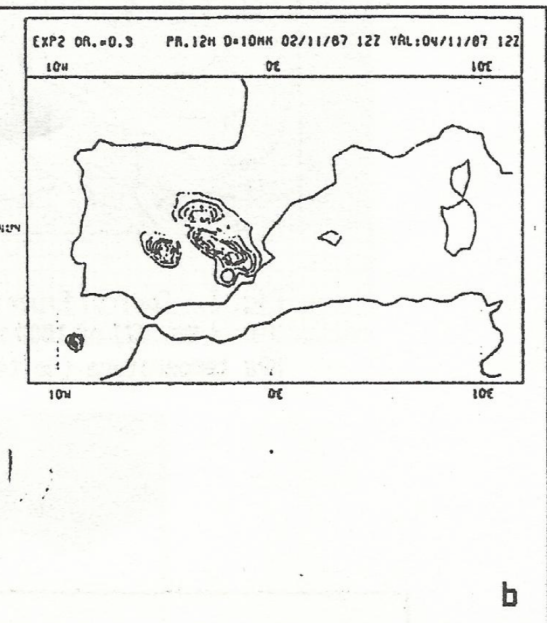
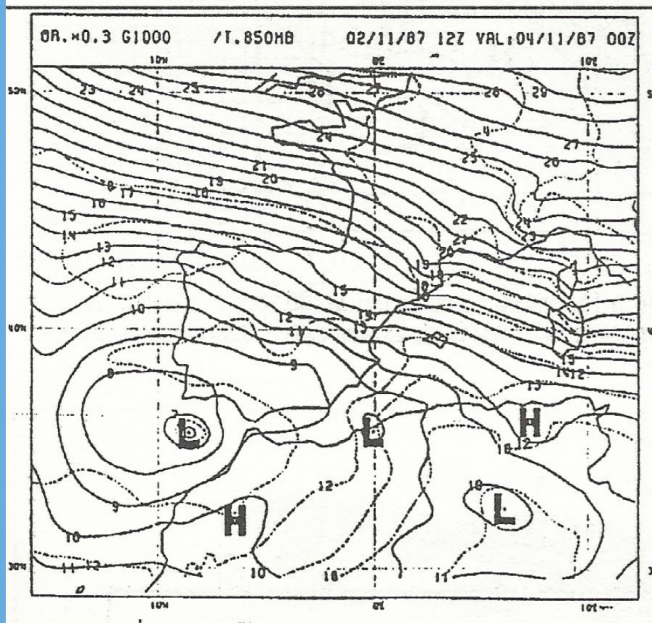
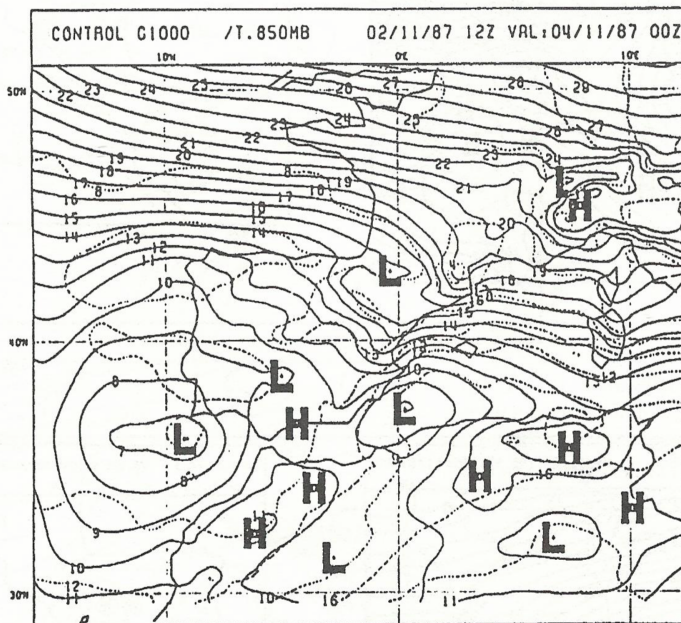




The satellite images suggest a quasi-stationary Mesoscale Convective System (MCS), continuously reactivated from the sea, supposedly by interaction between a Mediterranean atmospheric river and the outflow from the already existent MCS







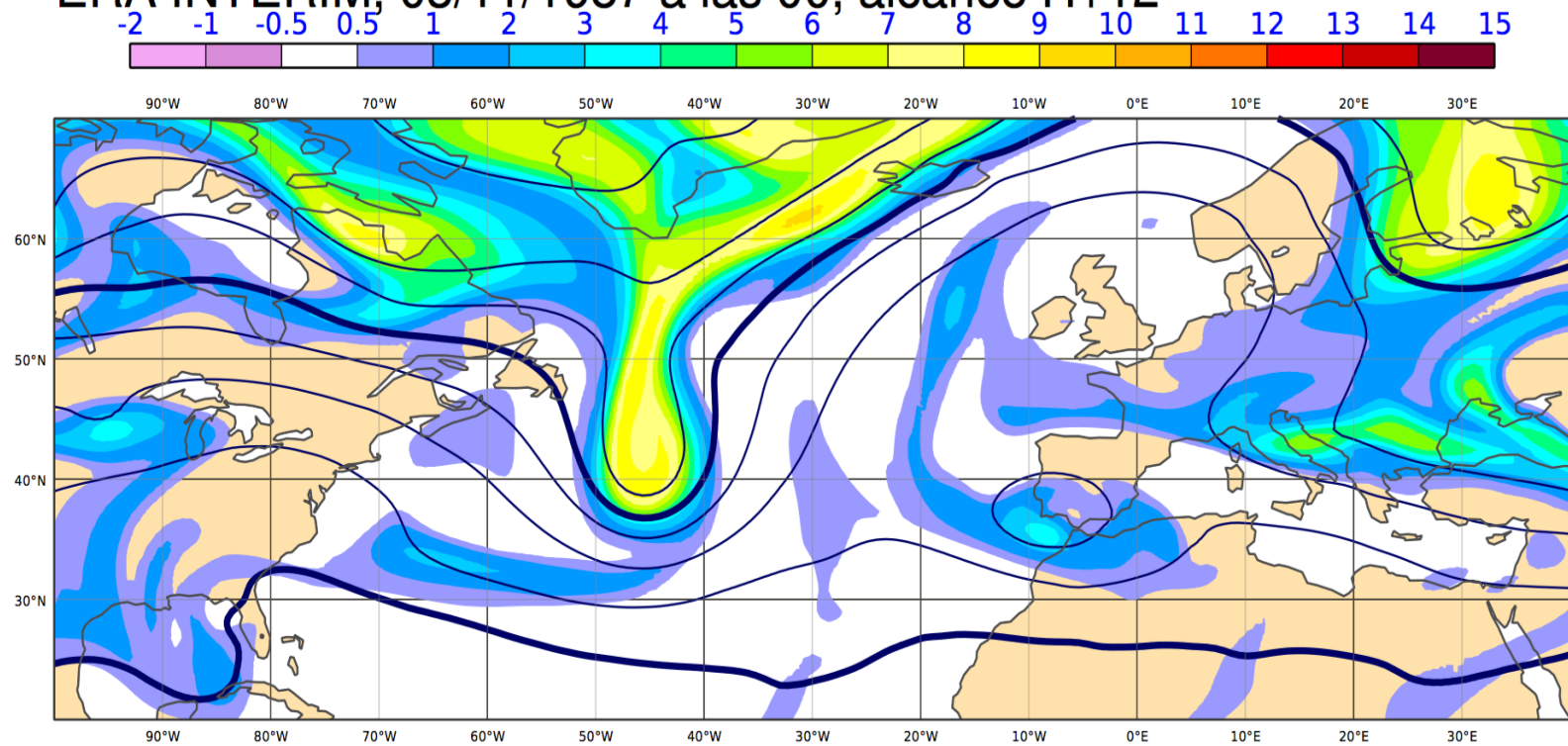
A “prehistoric” numerical experiment (1991):

- “control run”, on the left
- “orography X 0,3 experiment”, above

When the orography is reduced, the Mediterranean low centre becomes weaker and the “atmospheric river” losses organization, with a reduction and de-concentration of the rainfall maximum area.

Through the generation of the Mediterranean low, the north-African orography can even be more important than the local orography for the rainfall maximum generation.

ERA INTERIM, 03/11/1987 a las 00, alcance H+12

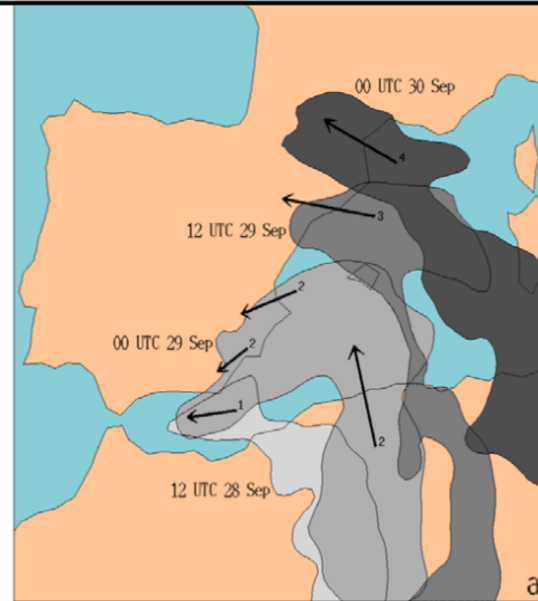
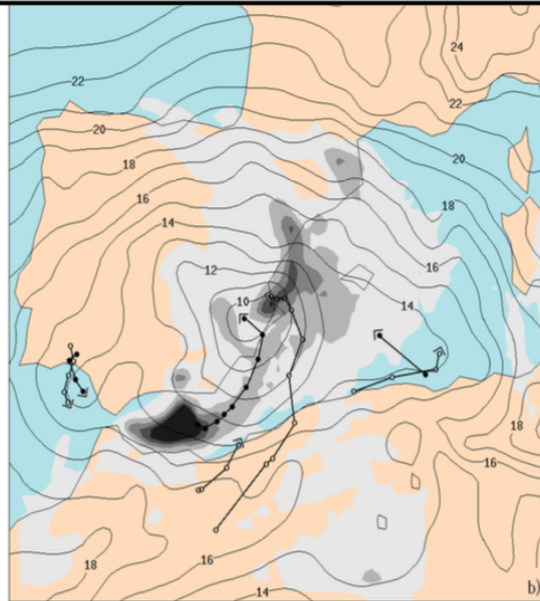


The 300 hPa geopotential high and PV reconstructed maps (through a newly performed simulation, using HARMONIE/AROME) suggest that the low level Mediterranean low centre could be not purely orographic (from Simarro & Armengot, 2018, in press)

In fact, deep high level throughs or cut-off lows can be key factors in heavy Mediterranean rainfall generation:

- they can directly force upward motion
- they can contribute to low level Mediterranean cyclone generation
- they can provide or intensify convective instability

**CONTROL
SIMULATION**

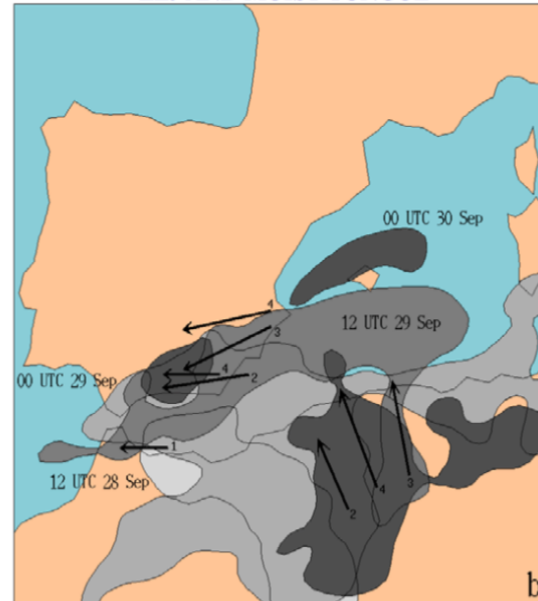
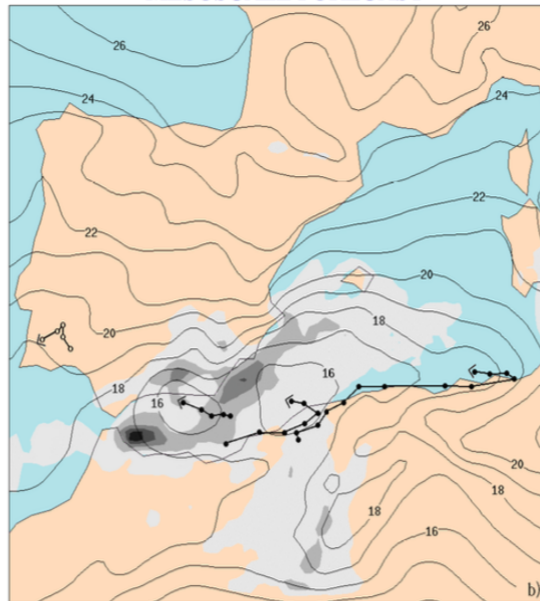


**DYNAMICAL
CONTROL of PRECIP**

MESOSCALE FORECAST

LLJ AND MOIST TONGUE

**S^0_0
FIRST GROUP**

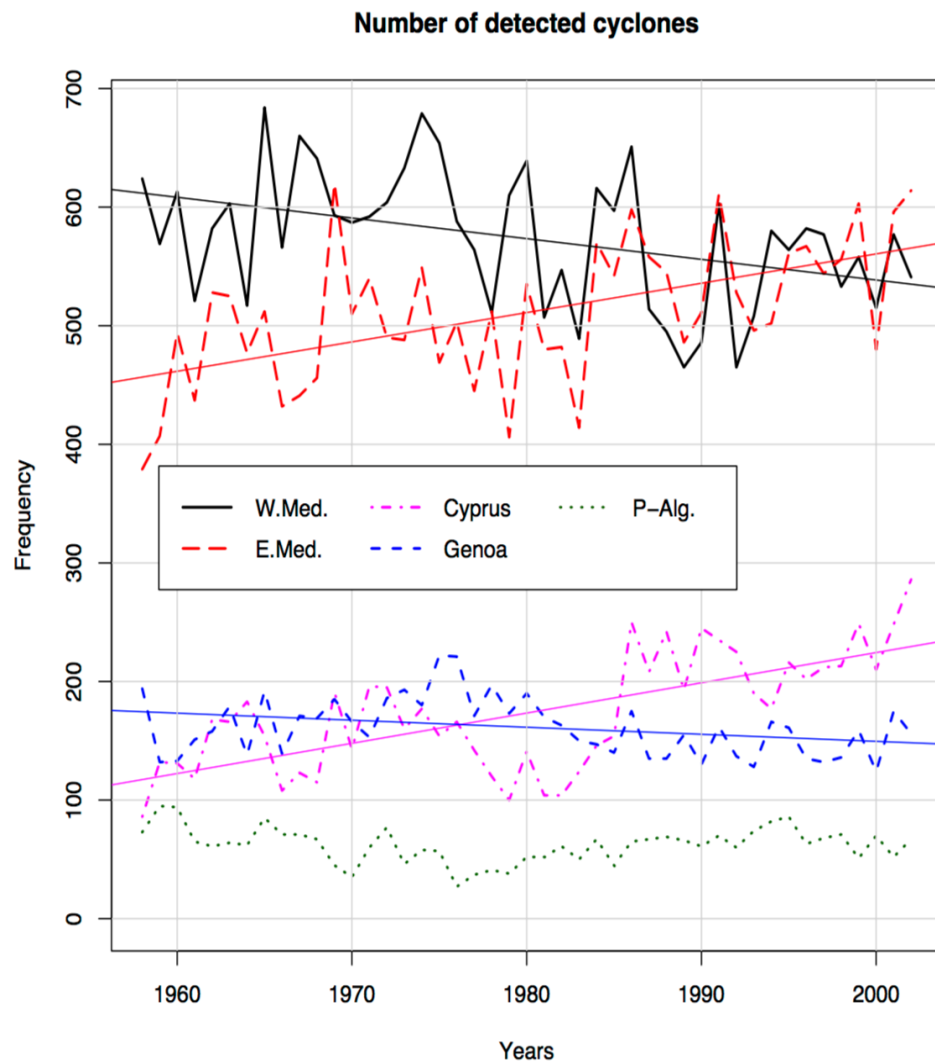


Experiments by Romero et al., 2001 show that changes in the location and shape of the high level disturbance affect the low level cyclone and so the feeding low level airflow and the location and intensity of the rainfall

The event concerned by the experiments is 28-29 of September, 1994

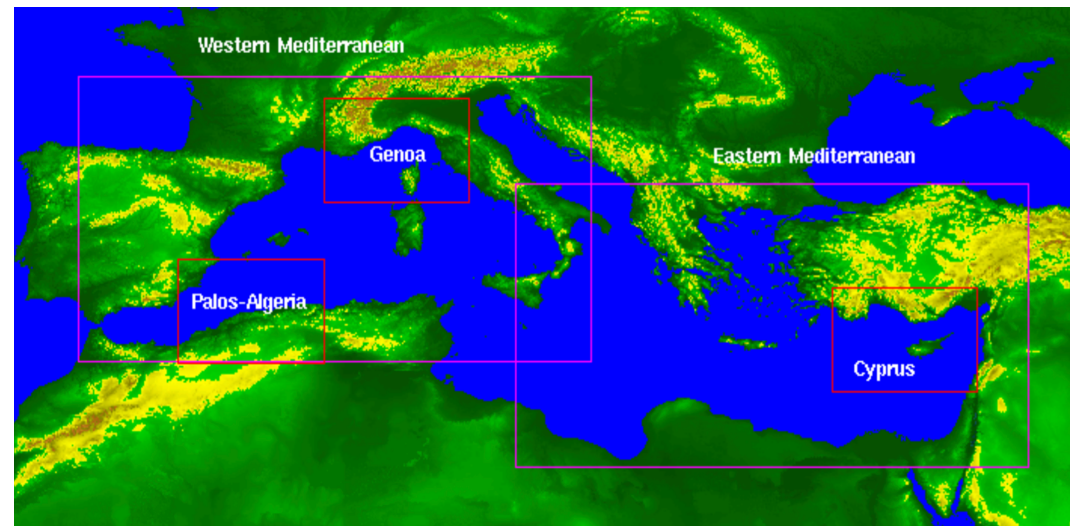
In the S^0_0 experiments the trough analysed (at the Western Iberian Peninsula - control simulation-) has been smoothed

<i>Factor involved in extreme Mediterranean rainfall events</i>	<i>Uncertainty of its short range forecasting</i>	<i>Possible tendencies in frequency and intensity attributable to climate change</i>
Local and regional orography	No uncertainty (forcings associate to orography can reduce uncertainty)	No changes foreseen!
Well located surface Mediterranean cyclone (organizer of an efficient feeding inflow)	The accuracy in forecasting these cyclones depends on the relevance of the cyclogenetic factors involved (the orographic factors give better predictability than the baroclinic factors)	Observed tendencies indicate a decrease in the frequency of the Genoa cyclones, for instance, but not in the Palos/Algerian cyclone frequency. A weakening of the average NW-ly flow in the Western Mediterranean can reinforce the same idea
Cut-off low or deep through at high level (not far from the heavy rain site and mostly located to the SW)	Although most upper level low are roughly predictable at present, their details are difficult to be accuracy forecast	There are some indications of regional decreasing of the medium/high level geopotential to the west of Spanish Mediterranean areas. The contrary occurs in the Genoa area. Changes in cut-off low frequencies can be guessed
High SST (favouring high temperature and humidity of the inflow)	SST changes are not specially dramatic in the short term	SST is warming at a rate that is comparable to the low level air temperature warming



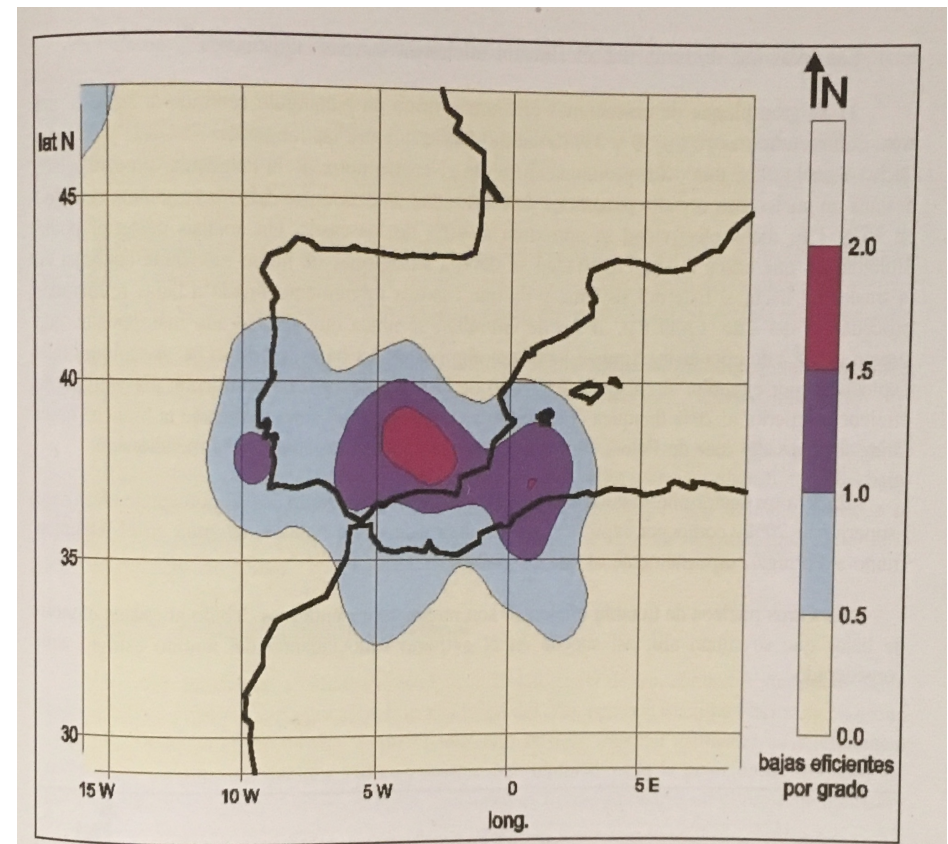
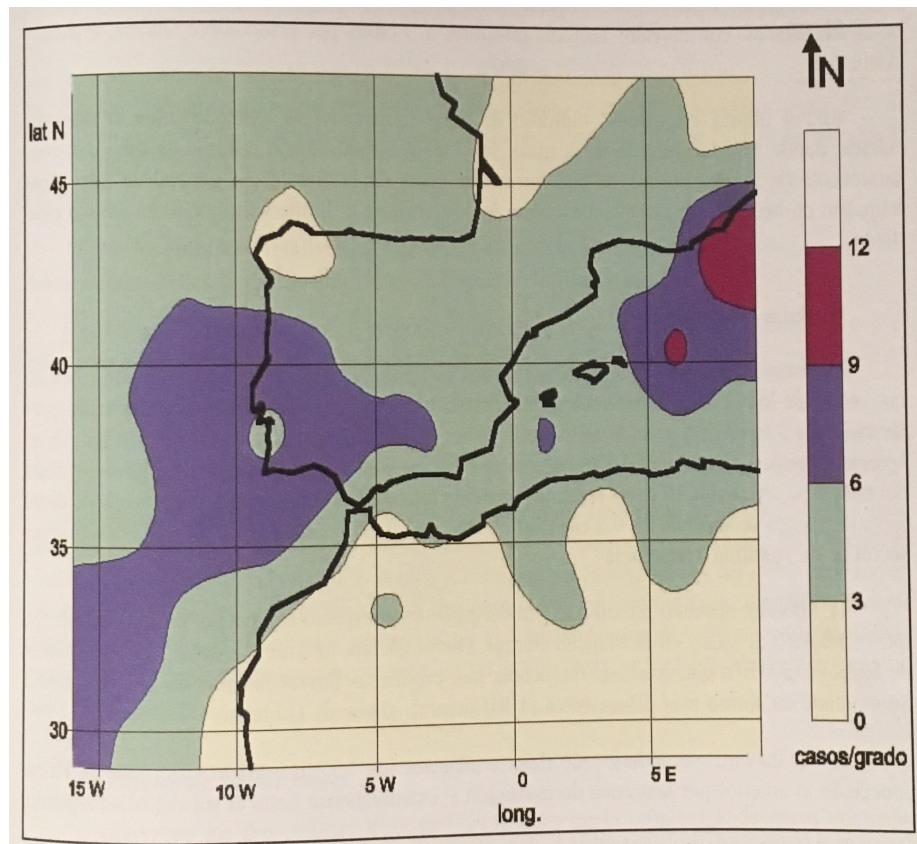
Observed tendencies on the frequency of some surface Mediterranean cyclones

(1957-2002 , from Guijarro et al, 2006)



Observed frequency of all cut-off lows (left) and of the cut-off most probably related to heavy rain in Valencia area

(1976-1990 , from Armengot, 2002)

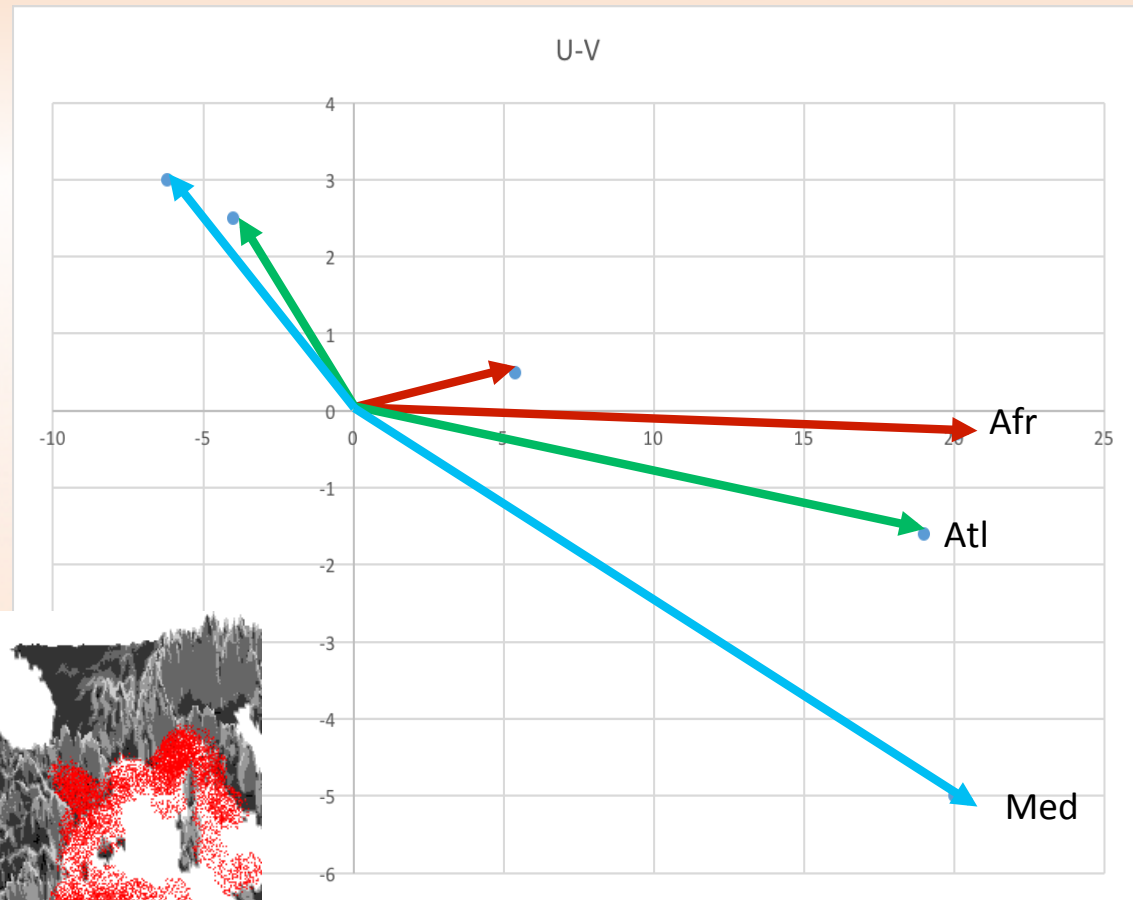
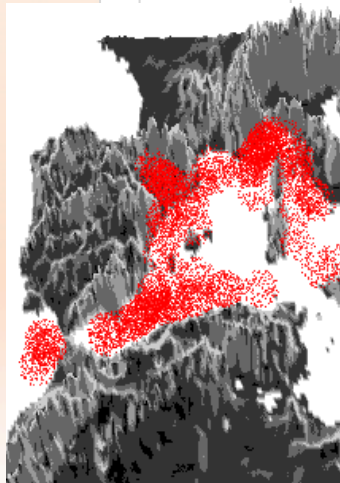


Average vectorial winds and vectorial tendencies (x 100),

at 700 hPa, per regions (1979-2016: ERA-Interim)



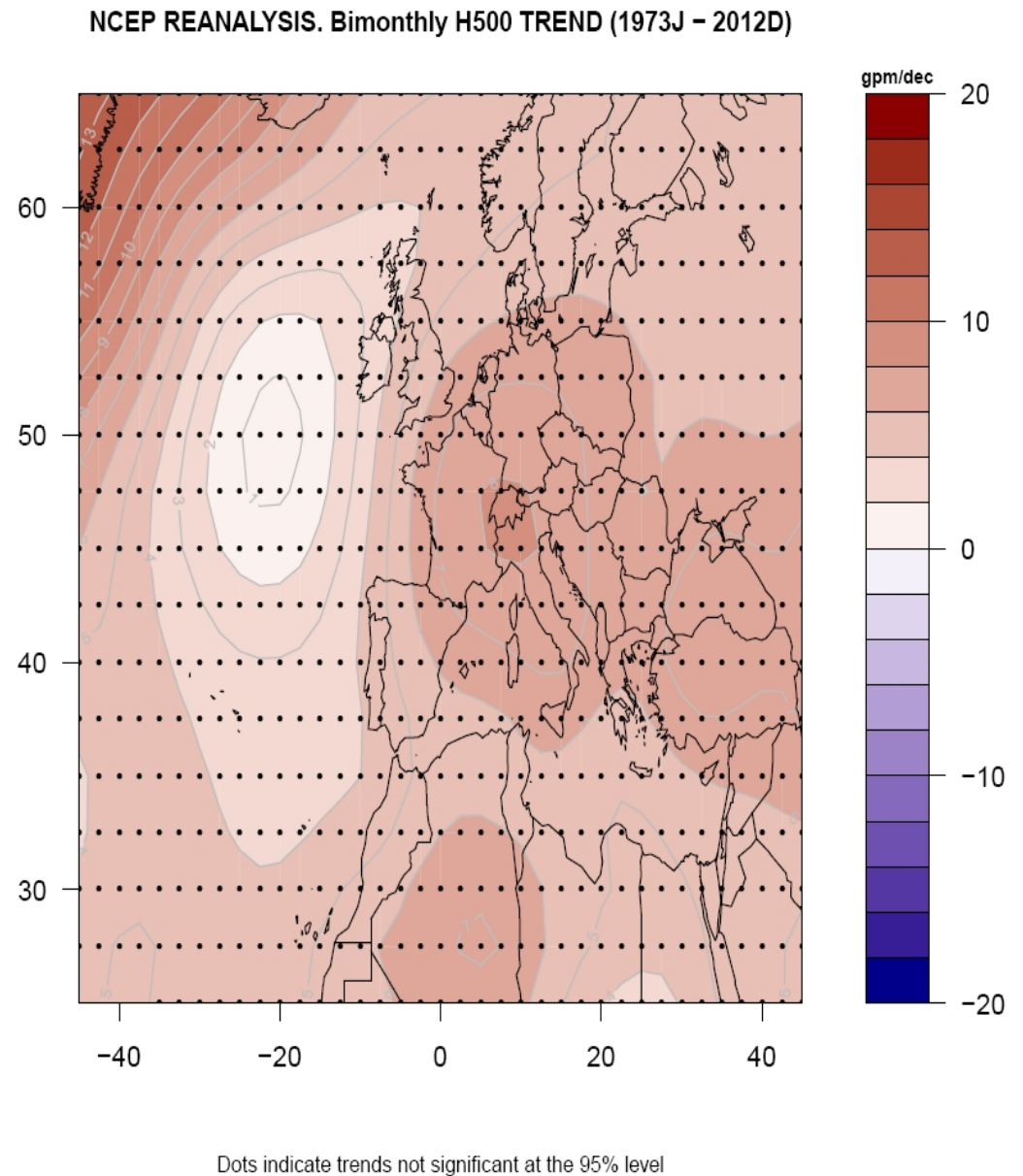
It can be not significant or not very stable, but the reanalyses show a tendency of the regional 700 hPa winds to become slightly more southerly (less northerly), favouring even more lee-lows in the Palos-Algeria zone



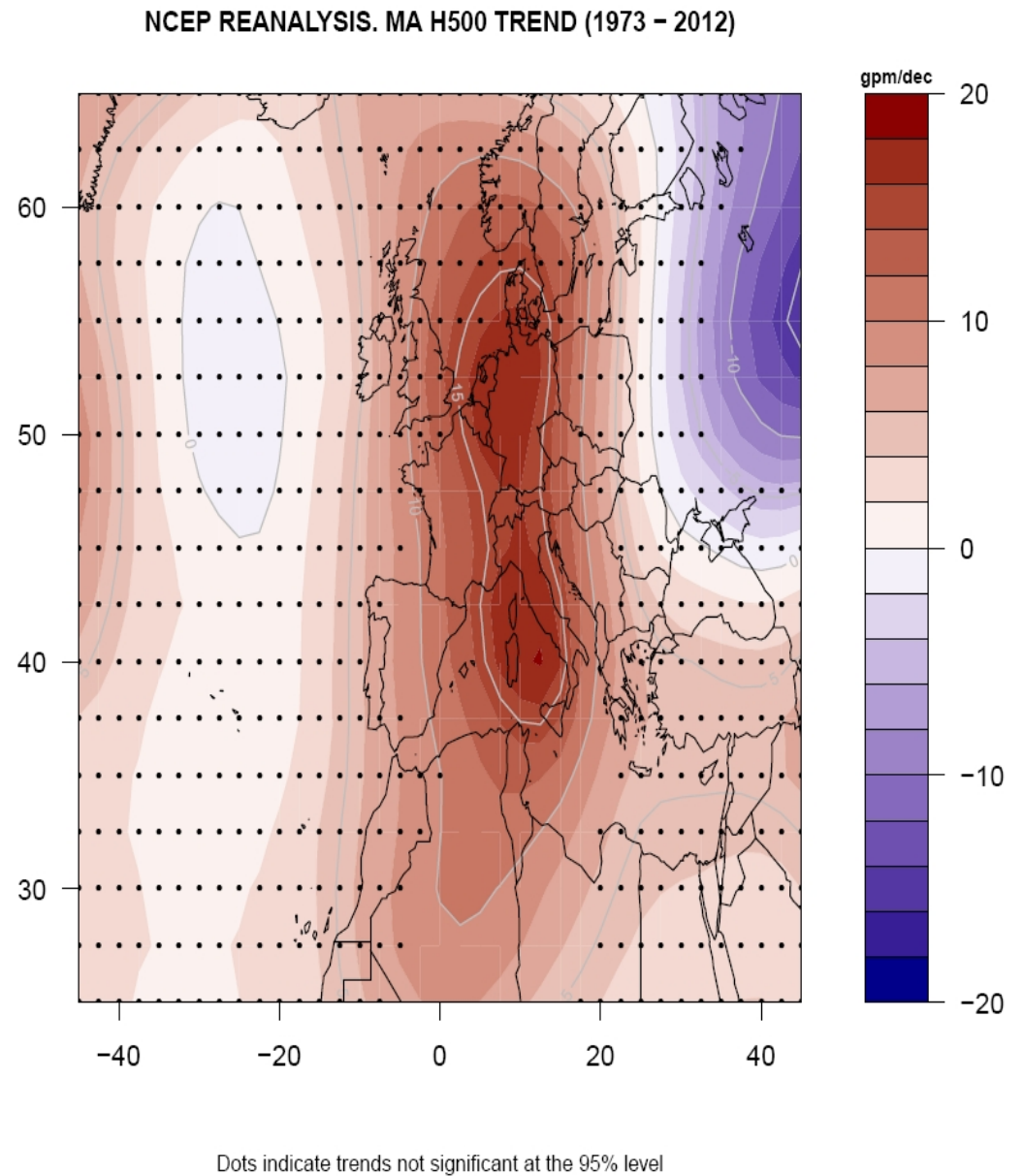
Relative frequency of lee-lows, at present

Although the annual tendencies can not be significant, ERA-40 indicates **less decreasing of the 500 hPa in the Atlantic areas than in the European (Alpine) ones.** *Higher frequency of Atlantic cut-off lows and lower frequency of Alpine-Genoa cut-off lows can be suggested from that.*

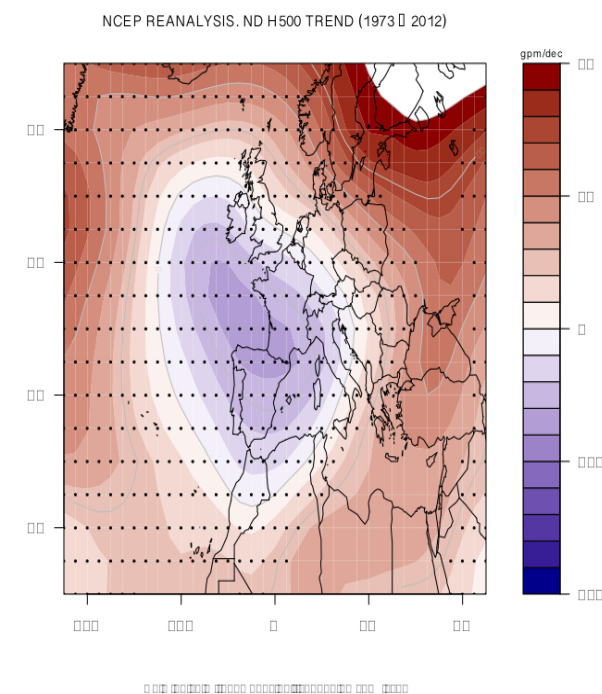
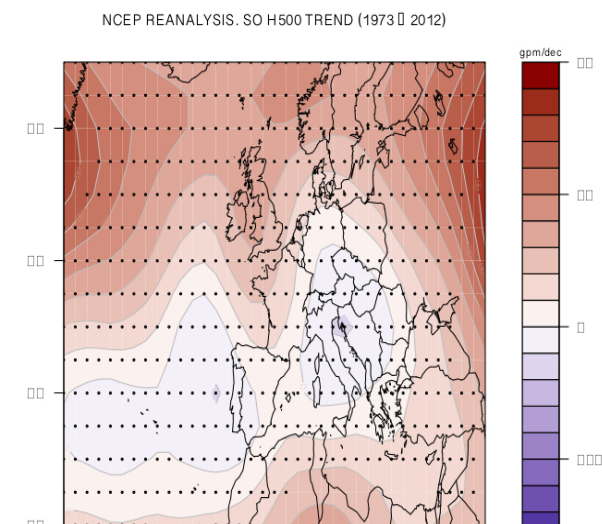
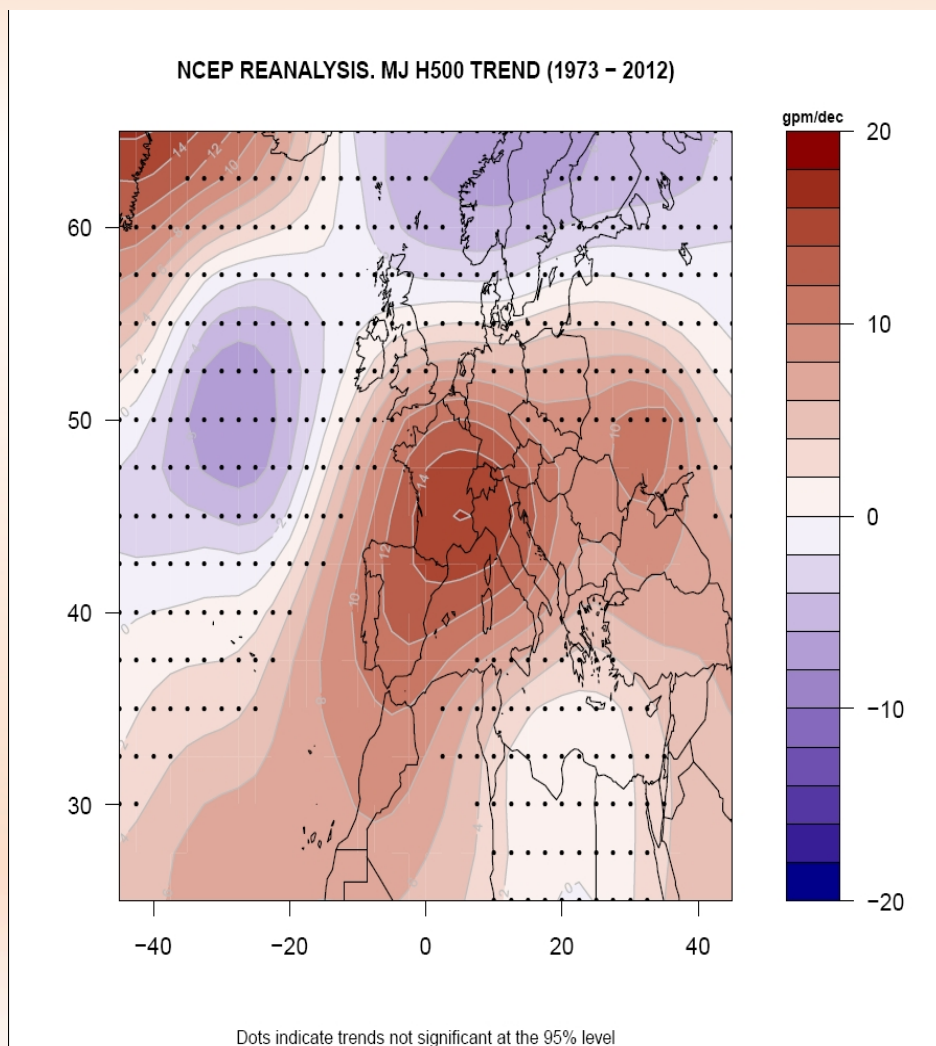
(From Jansa et al., 2017)



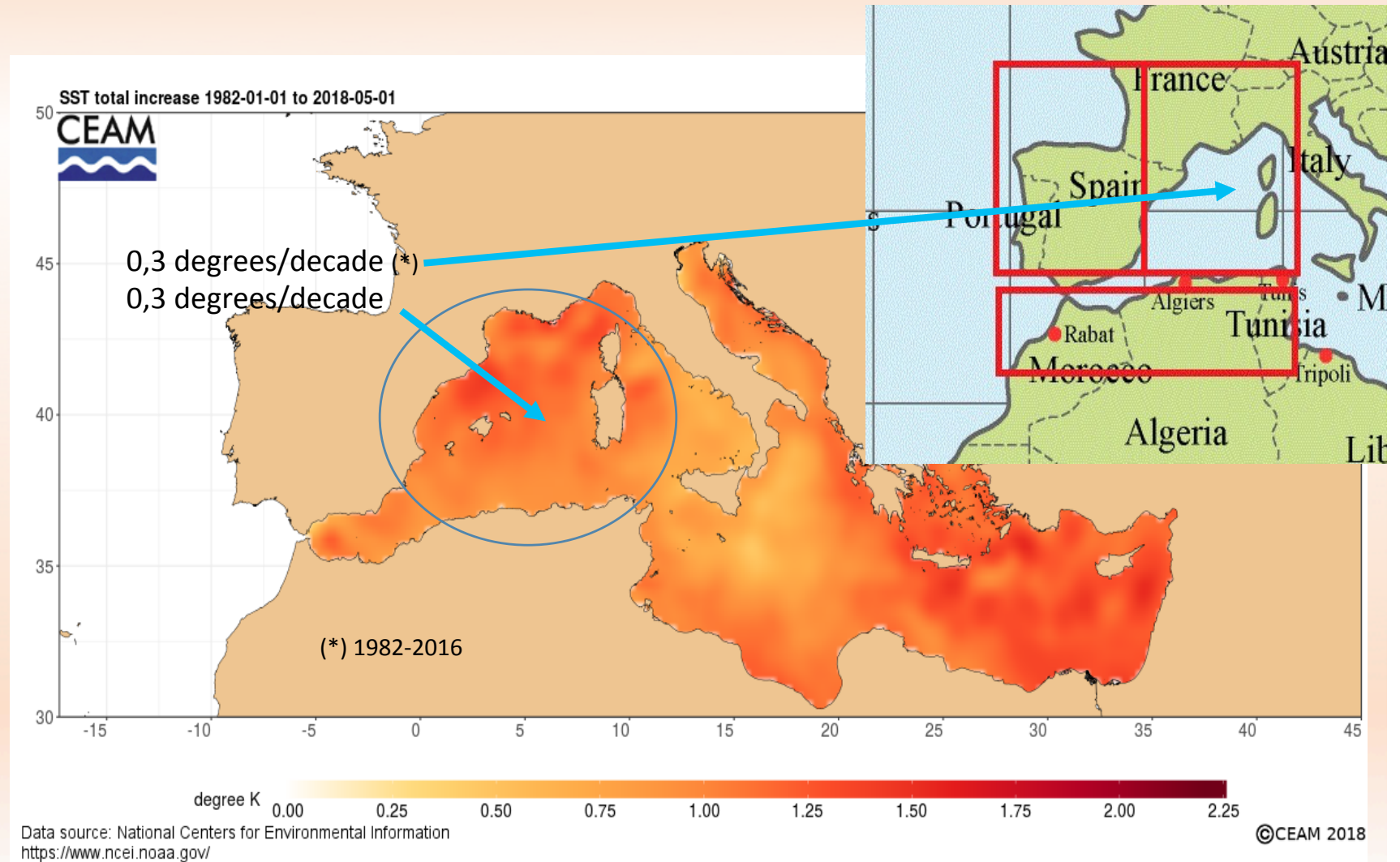
**More clear and more significant
are the geopotential tendencies
In the March-April period, in the
same sense as the annual
tendencies ...**



... but very different distribution of tendencies is observed in May-June. Nothing clear in Autumn.



There is a large increasing, at a similar rate at the low level air-temperature warming





Thanks !!