

Permanent and changing factors in extreme Mediterranean precipitation events

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MINISTERIO
DE ECONOMÍA, INDUSTRIA
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COASTEPS
CGL2017–82868–R



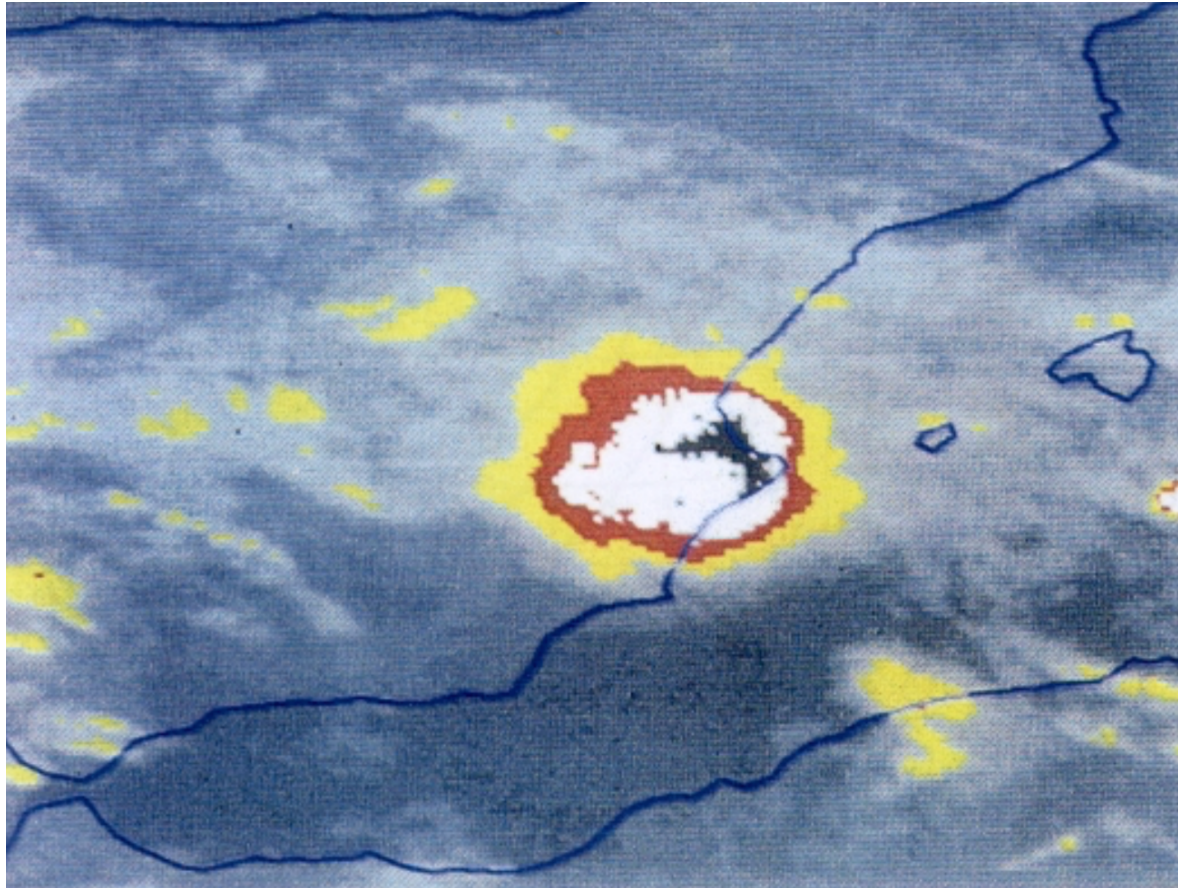
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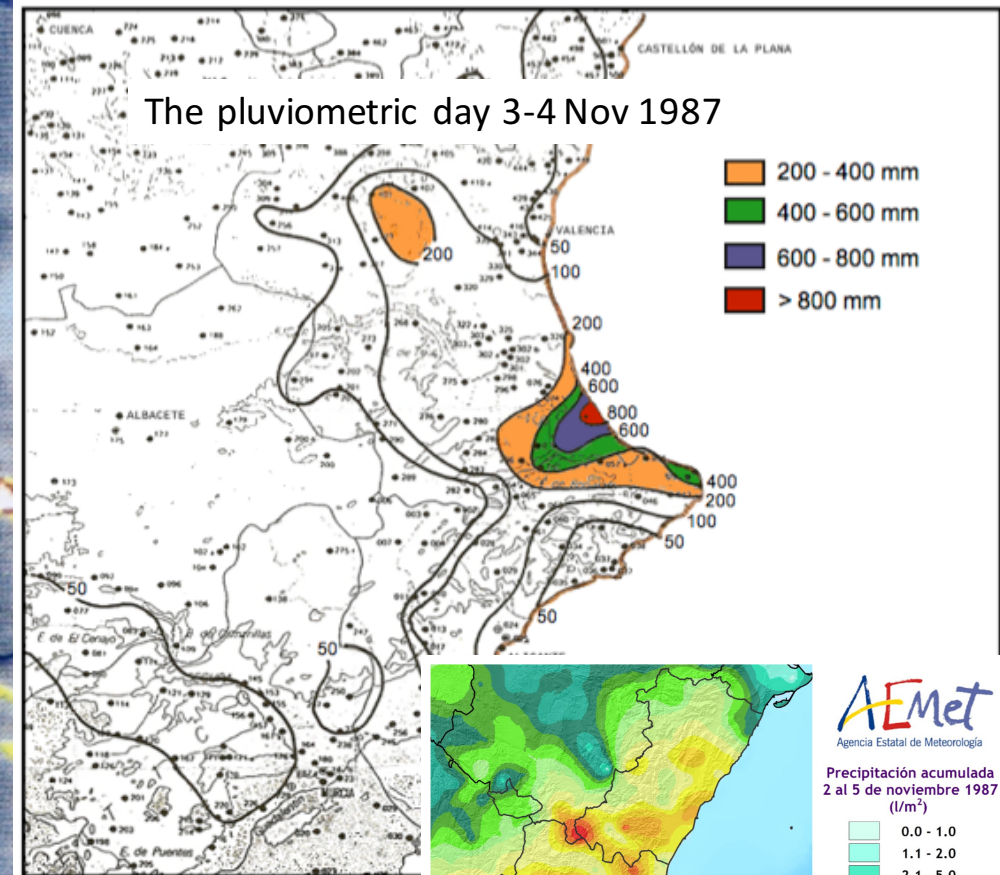
A very extreme event, the Oliva-Gandia case

During the pluviometric day 3-4 November 1987, **817 mm/24 h** fell at **Oliva** (La Safor, **València**), that is the **absolute record** of rainfall in Spain, in *normalised* 24 h periods

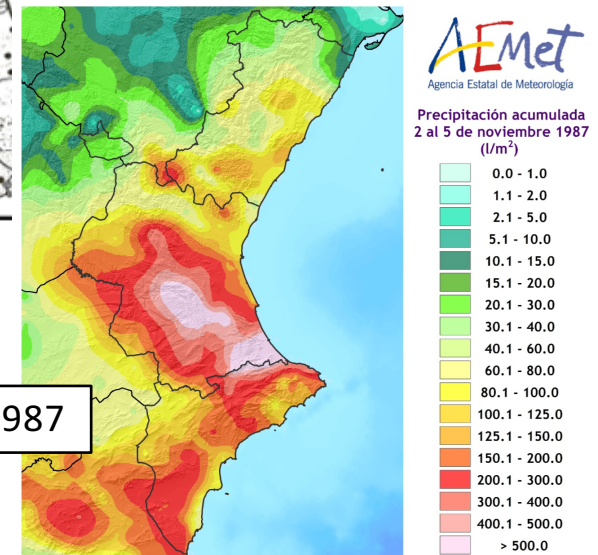


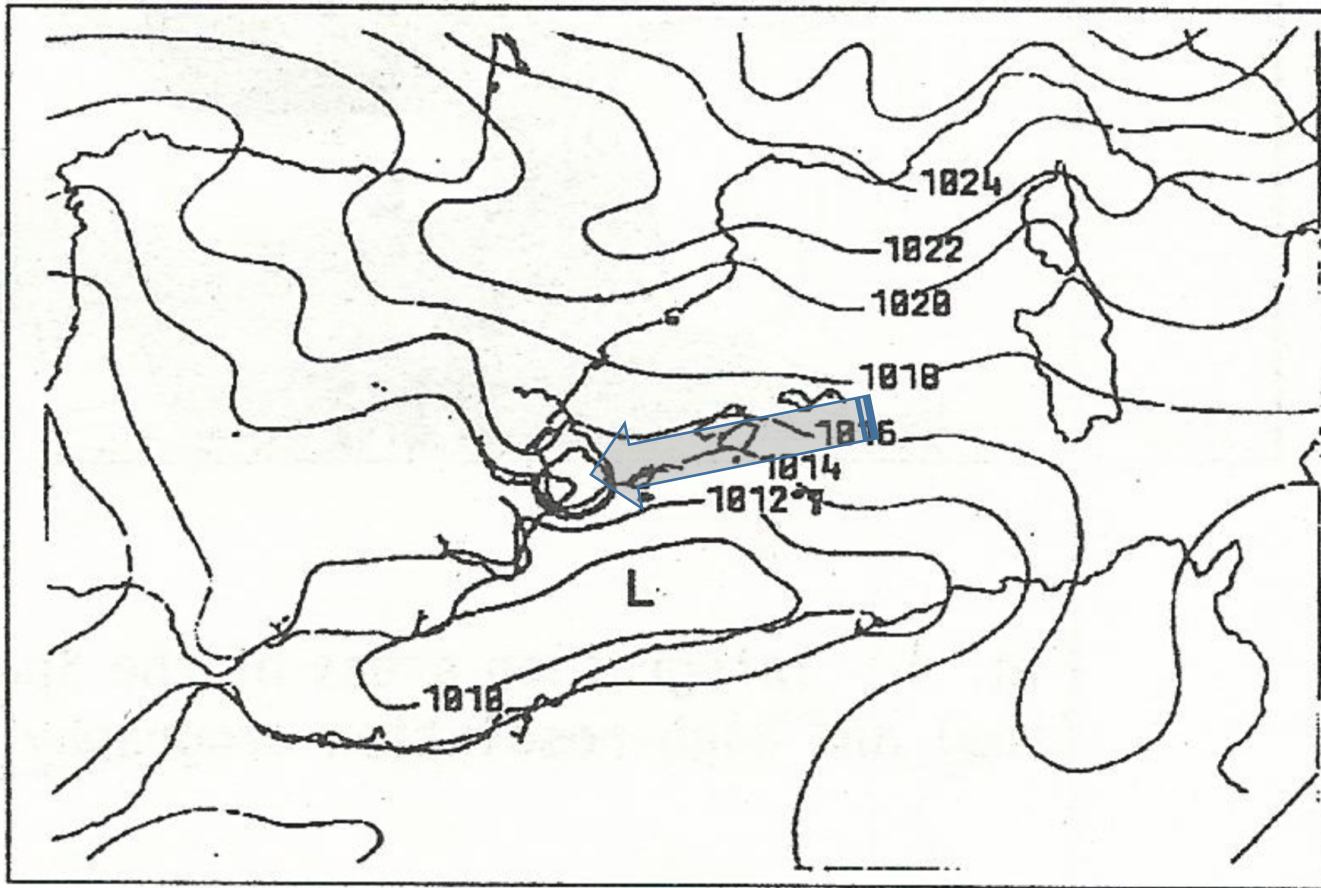


The immediate cause of the event (of the coastal part of the event, at least) was a quasi-stationary **Mesoscale Convective System (MCS)**



The whole event 2-5 Nov 1987





A hand made analysis suggests that the MCS was triggered and sustained by a Mediterranean feeding warm-humid flow

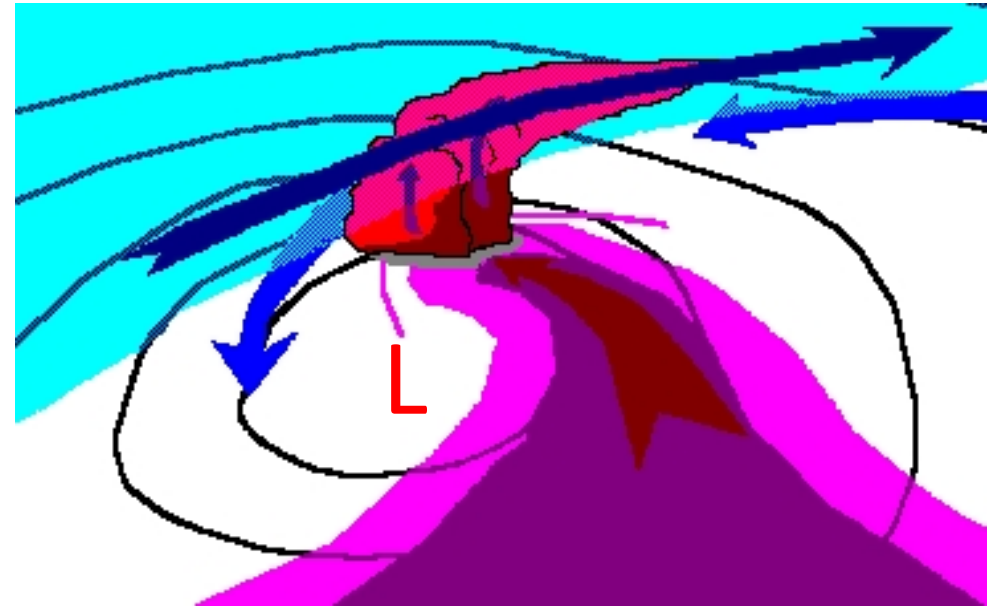
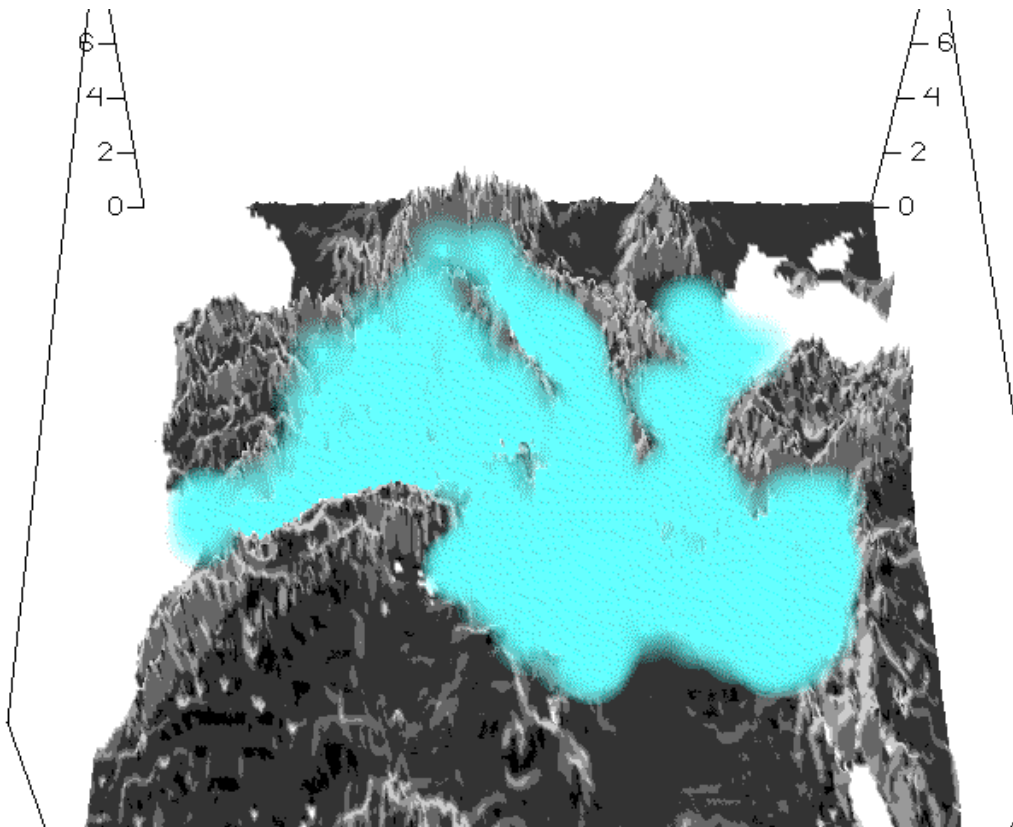
The Mediterranean flow (limited and well defined) was at its time organised by a moderate low pressure centre (L)



The local orography would also have played a significant role in the triggering and organising of the MCS, but note that the main rainfall maximum was coastal

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 → feeding flow → cyclone?

Western Mediterranean cyclones and heavy rain – statistical approach

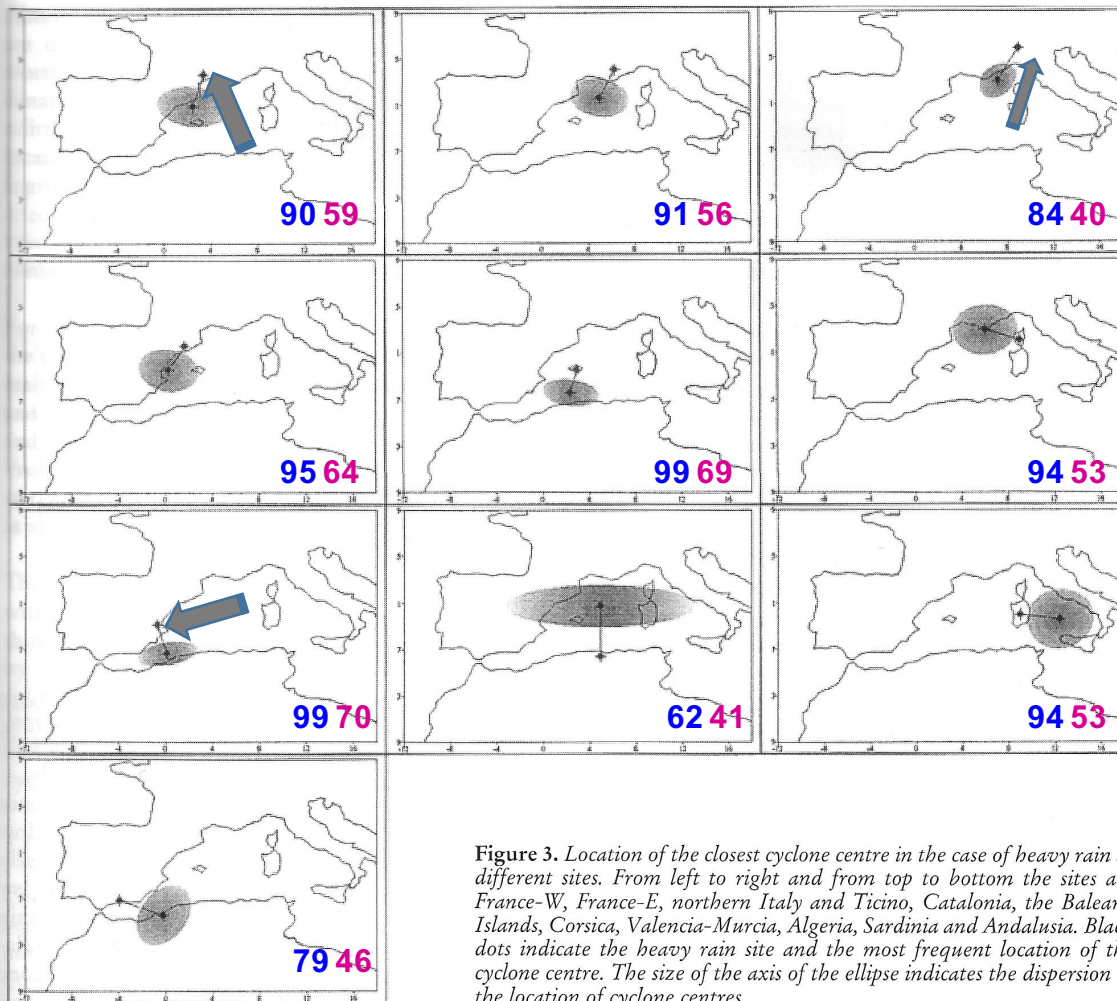


Figure 3. Location of the closest cyclone centre in the case of heavy rain at different sites. From left to right and from top to bottom the sites are France-W, France-E, northern Italy and Ticino, Catalonia, the Balearic Islands, Corsica, Valencia-Murcia, Algeria, Sardinia and Andalusia. Black dots 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)

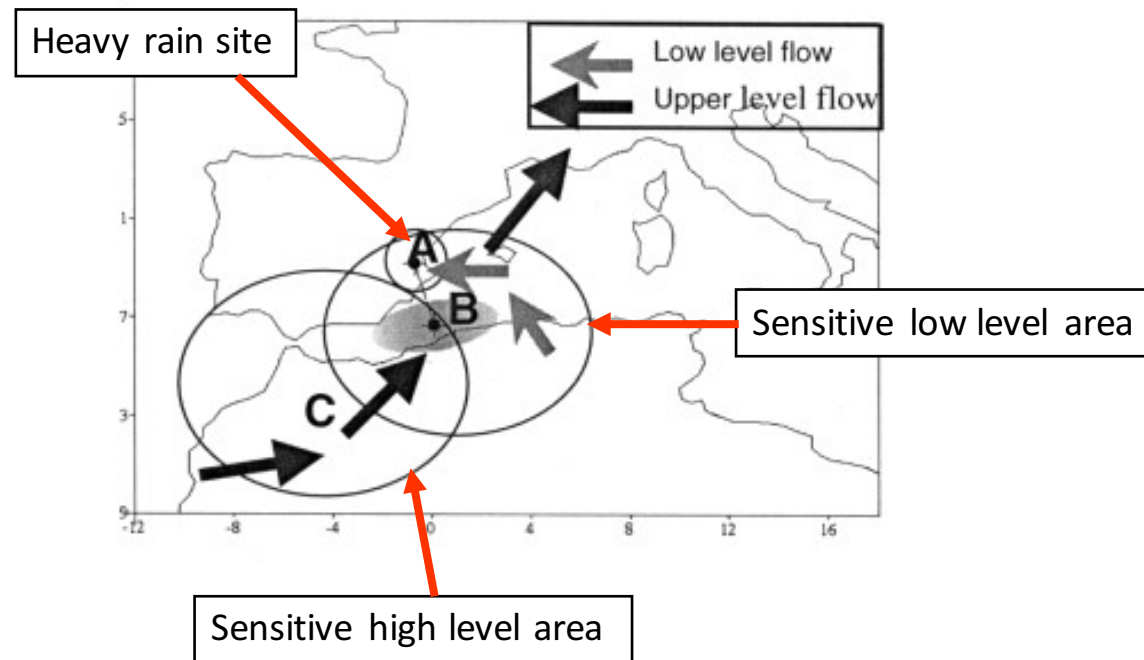
Jansà et al., 2001

A chain of factors:

Low level Mediterranean warm/humid flow against coast/mountains or convergence lines (producing MCS or convective, even no convective heavy rain)

← **low level cyclone** organising the low level flow (coming from lee effect or upper level dynamics)

← **upper level cut-off low** or open trough organising upper level flow → lee depression and/or ascending air (upper level divergence)



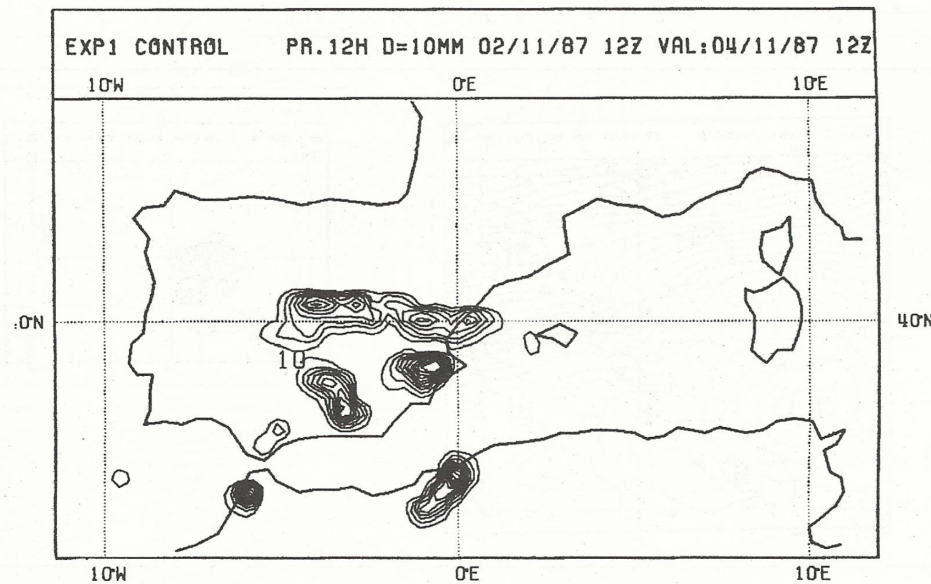
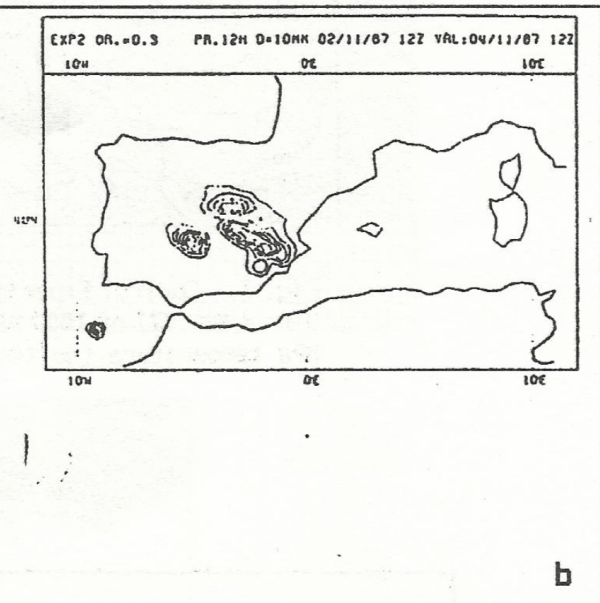
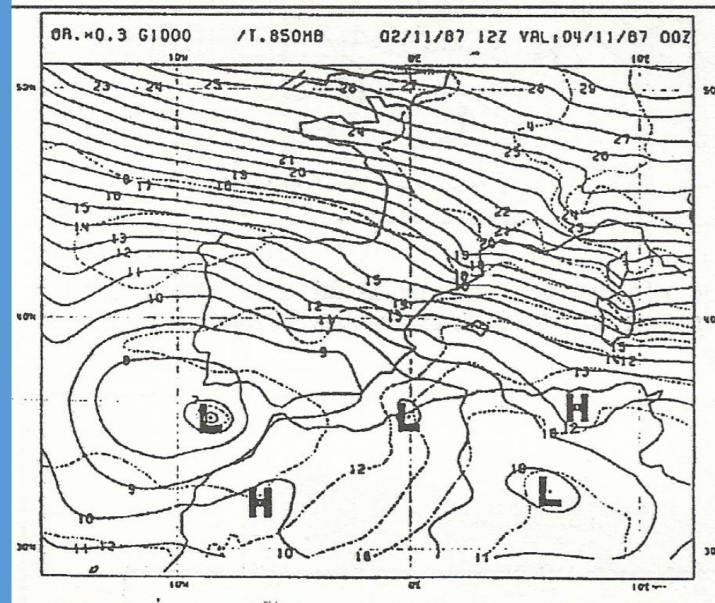
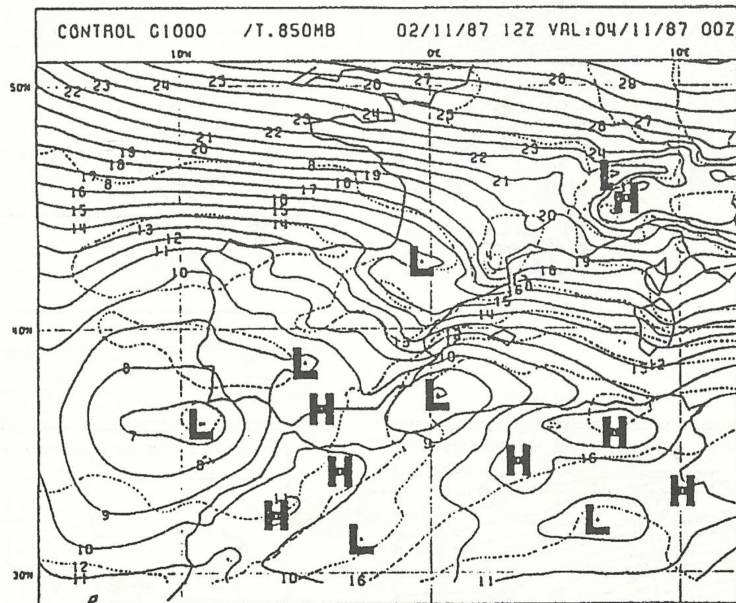
Some experiments on predictability:

- Old experiment, with INM/LAM/ECMWF model, 0.455 ° lat x lon
Sensitive experiment, orography x 0.3 [Jansa et al., 1991)

- Revisiting the cases from present:

- Deterministic experiment with mesoscale model
(AEMET/Harmonie/Arome), 2.5 km lat x lon (initiated with ERA-Interim)
[Simarro & Armengot, 2017]

- Probabilistic experiment with the multimodel/multianalyses ensemble
AEMET-gamma-SREPS, 2.5 km lat x lon [Callado & Compte, 2017]

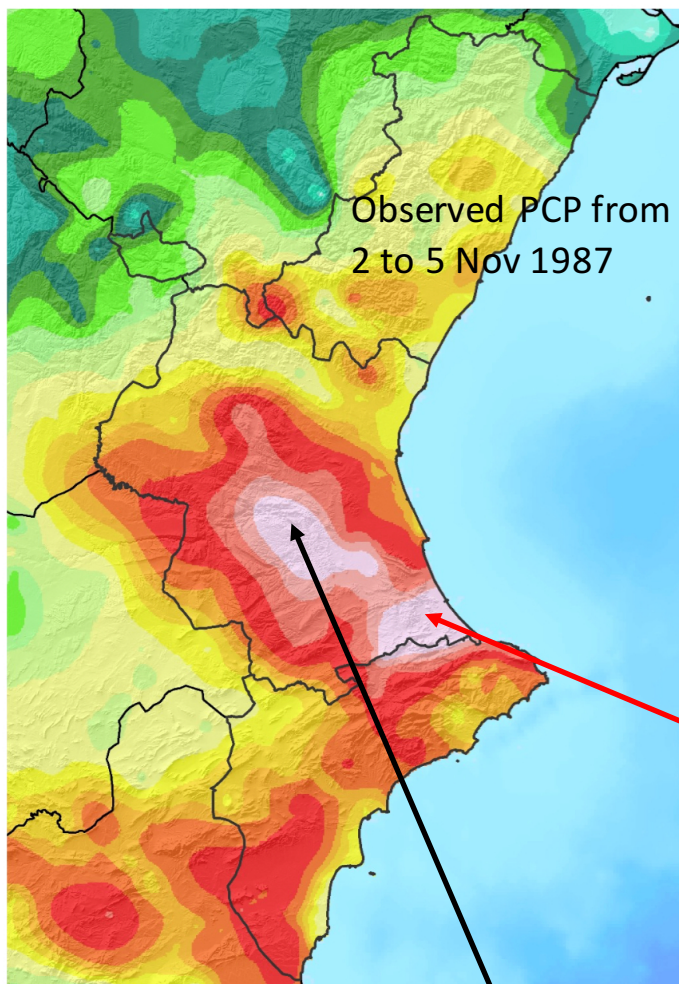


A “prehistoric” numerical experiment (1991):

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

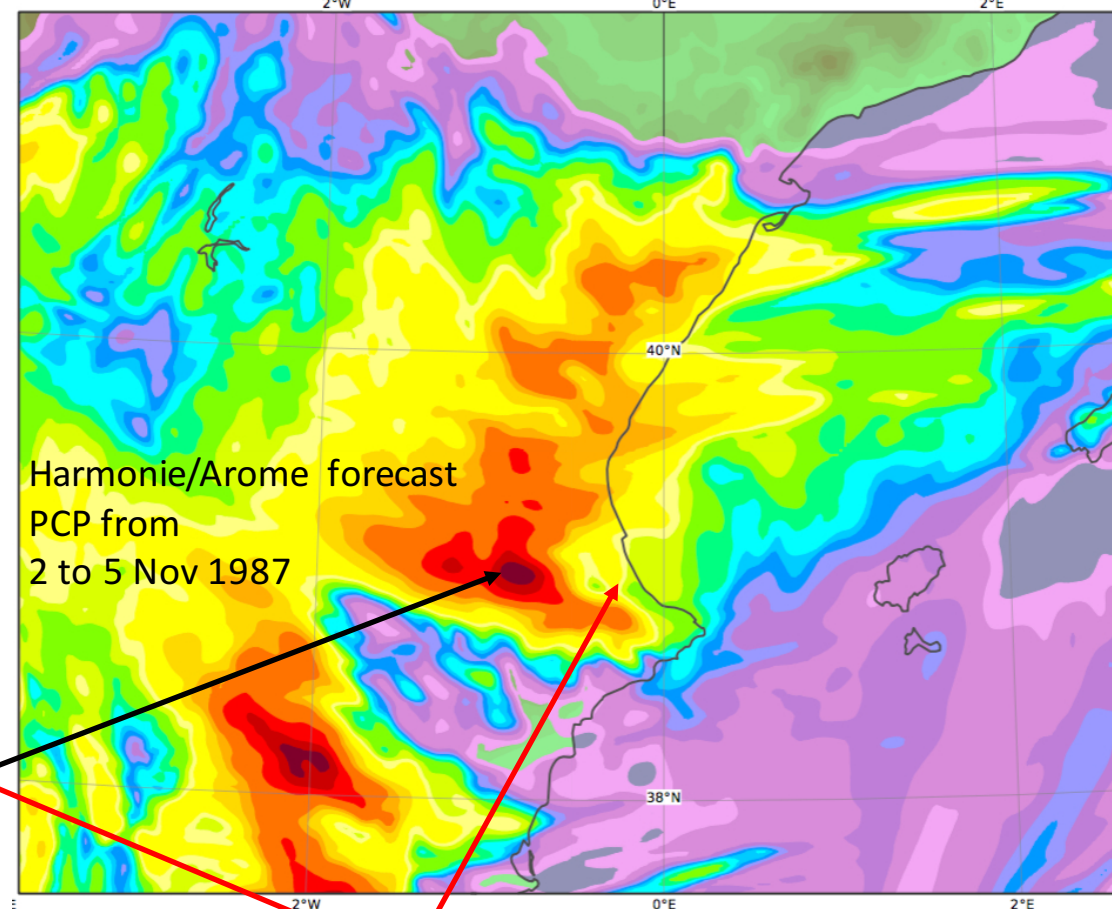
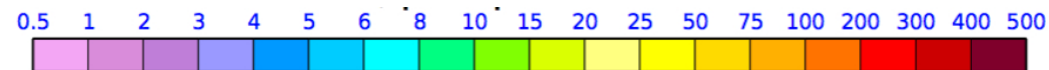
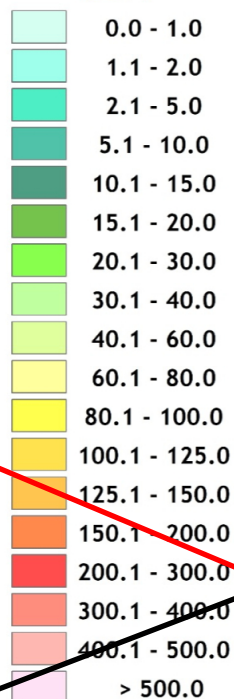
When the orography is reduced, the Mediterranean low centre becomes weaker and the “atmospheric river” losses organization, with a reduction and de-concentration of the rainfall maximum area.

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.



AEMet
Agencia Estatal de Meteorología

Precipitación acumulada
2 al 5 de noviembre 1987
(l/m²)



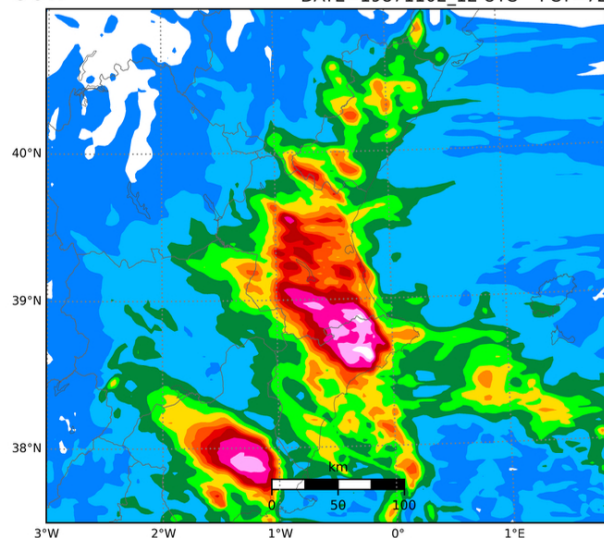
A probably more orographic nucleus is much better forecast than the more coastal nucleus

Improving the deterministic model quality the predictability of extreme orographically induced maximum rainfall increases, but the predictability of other (coastal) rainfall maximum does not increase so much.

**AccPcp max
60h**

AEMET-gSREPS
NMBRS=12

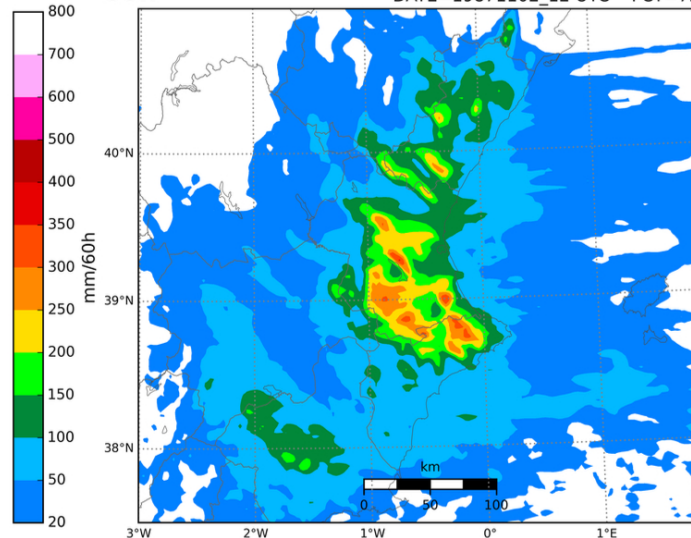
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**AccPcp upper quartile
60h**

AEMET-gSREPS
NMBRS=12

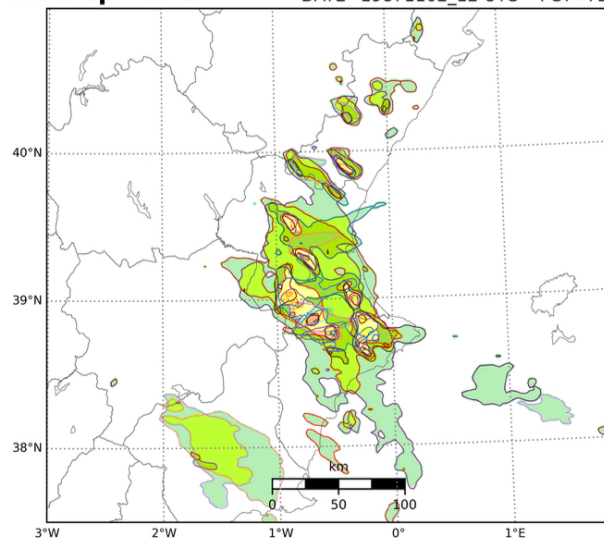
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**AccPcp prob >= 200mm/60h
AccPcp mbrs**

AEMET-gSREPS
NMBRS=12

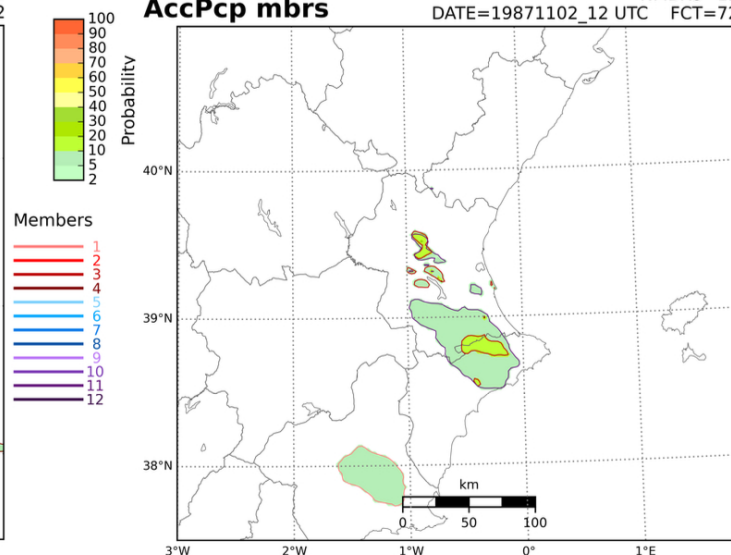
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**AccPcp prob >= 400mm/60h
AccPcp mbrs**

AEMET-gSREPS
NMBRS=12

DATE=19871102_12 UTC FCT=72



A high resolution ensemble forecast can give a rough indication about the probability of an extreme precipitation event, but details are not well caught.

Once more, the most orographically induced nuclei are better forecasted than the coastal ones.

About predictability:

If the upper level, large structures are well forecasted, even old, low resolution models can reproduce well the low level structures associated to extreme precipitation (that is: low pressure centre and feeding flow), at least when the orography plays a role in its generation → an indication about heavy precipitation can also be explicit

Realistic amounts of rainfall, when extreme, are only possible with modern, high resolution models. Even then, not all the convective structures: when the orography is important, the predictability increases.

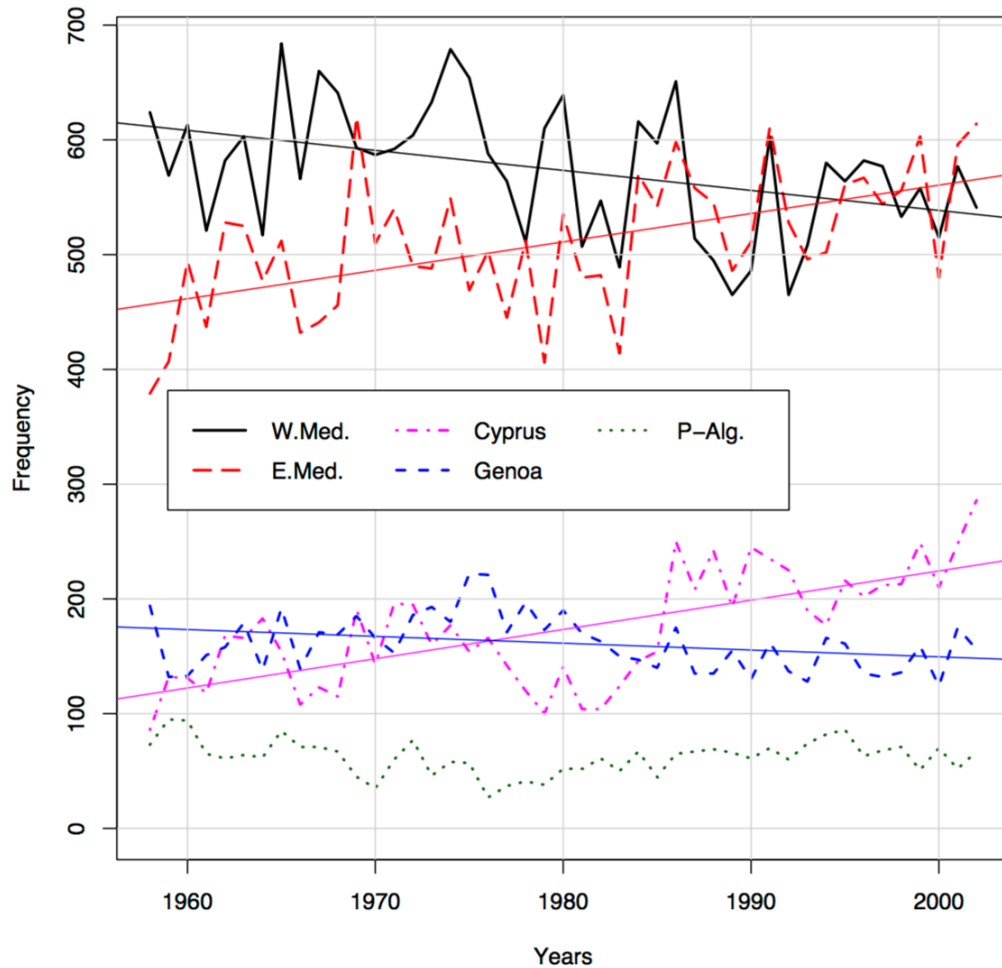
Regarding the case of Oliva, the coastal maximum is not well caught not even by modern models

Long term time evolution of factors favouring extreme precipitation:

Of course, there is no evolution of the orography (considered as a possible factor of triggering precipitation systems and a possible factor of low level cyclonic centres in the Mediterranean)

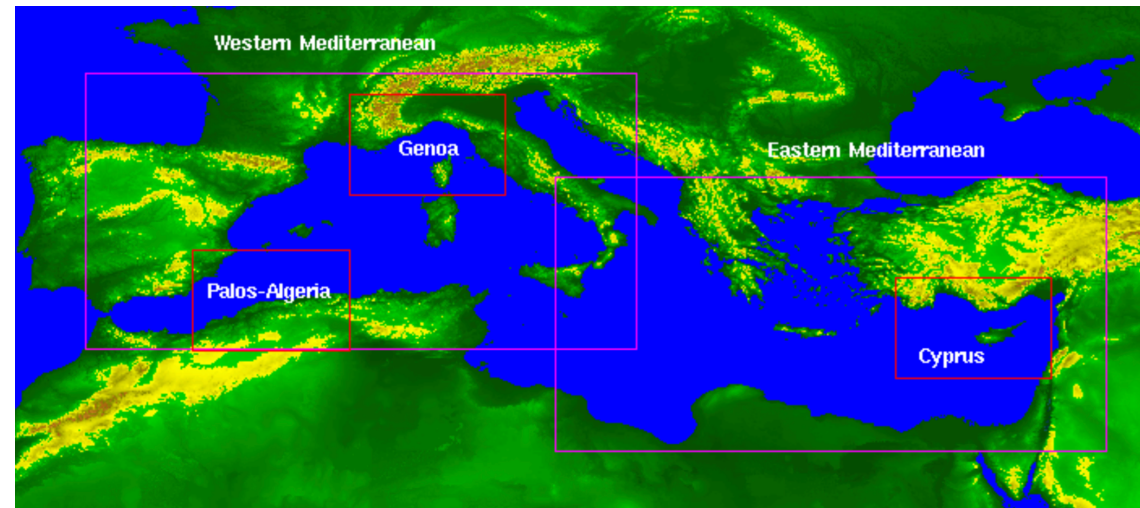
What about the involved low and upper level meteorological systems themselves?

Number of detected cyclones



Observed tendencies on the frequency of some surface Mediterranean cyclones

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

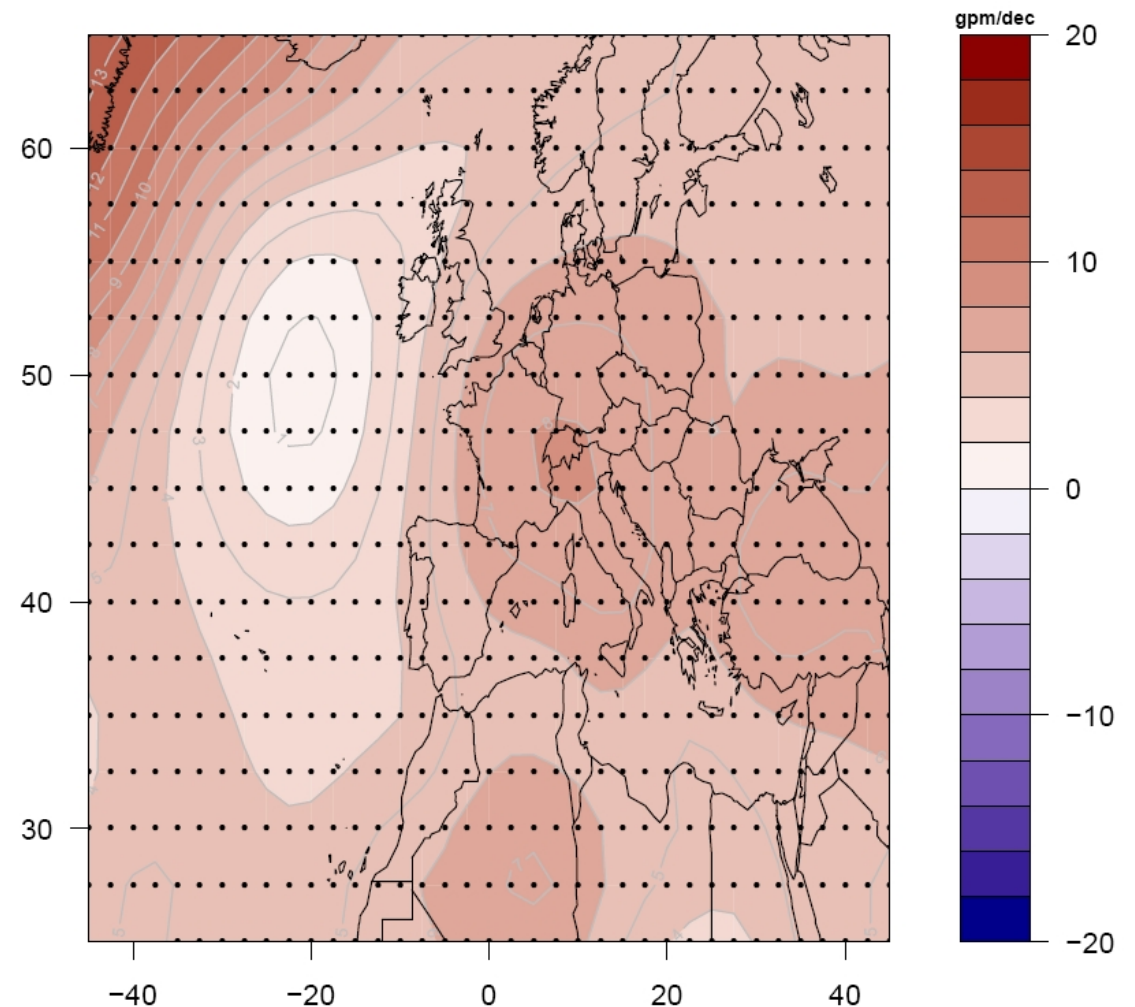


There is no decreasing of the frequency of cyclone centres in the Palos-Algeria region ...

Although the annual tendencies can not be significant, ERA-40 indicates **less increasing of the 500 hPa geopotential in the Atlantic areas than in the European (Alpine) ones**: This can suggest *higher frequency of Atlantic cut-off lows and lower frequency of Alpine-Genoa cut-off lows*.

(Jansa et al., 2017)

NCEP REANALYSIS. Bimonthly H500 TREND (1973J – 2012D)



Dots indicate trends not significant at the 95% level

Neither the low level, nor the upper level meteorological systems involved in extreme rainfall events in the Valencia area have a decreasing frequency with the climate change -> the probability of extreme rainfall in this area could not decrease.

Perhaps it is not the same in other Mediterranean areas.

Thank you!