



5th International Conference on Meteorology and Climatology of the Mediterranean
Istanbul (Turkey), 2-4 March 2015

EXTENSION OF MEDITERRANEAN SUMMER TOWARDS SPRING

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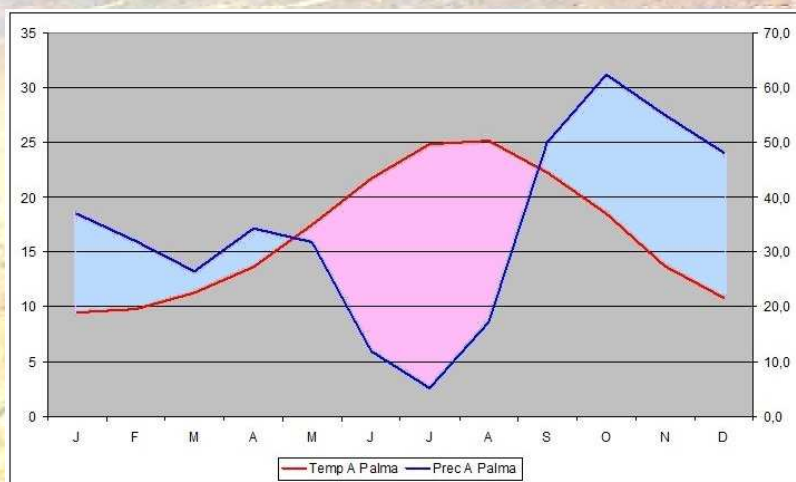
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- **Mediterranean climate ↔ dry summer ↔ tropical circulation in summer?**
- **Near surface warming in the Iberian-West-Mediterranean area**
 - **Singularity of May-June (MJ) → expansion of summer towards spring**
- **Relationship between local near surface temperature & 500-GH**
 - **Singularity of MJ**
- **Regional distribution of the 500-GH tendencies**
- **500-GH main structures in MJ,**
 - **their tendencies,**
 - **attribution to near surface temperature trend**
- **Are the observed MJ Iberian-Western-Mediterranean singularities compatible or manifestation of an expansion of the tropical belt in this region, this season?**

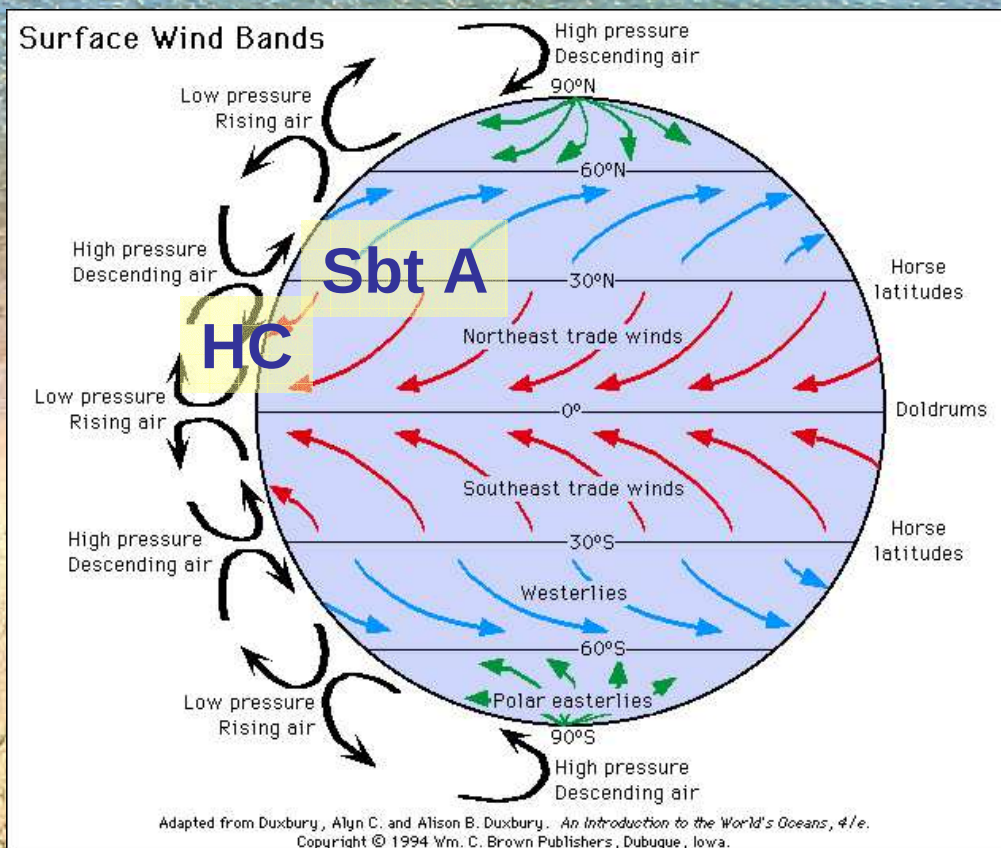


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Mediterranean climate ↔
Köppen Cs type ↔ temperate,
not arid, with dry summer



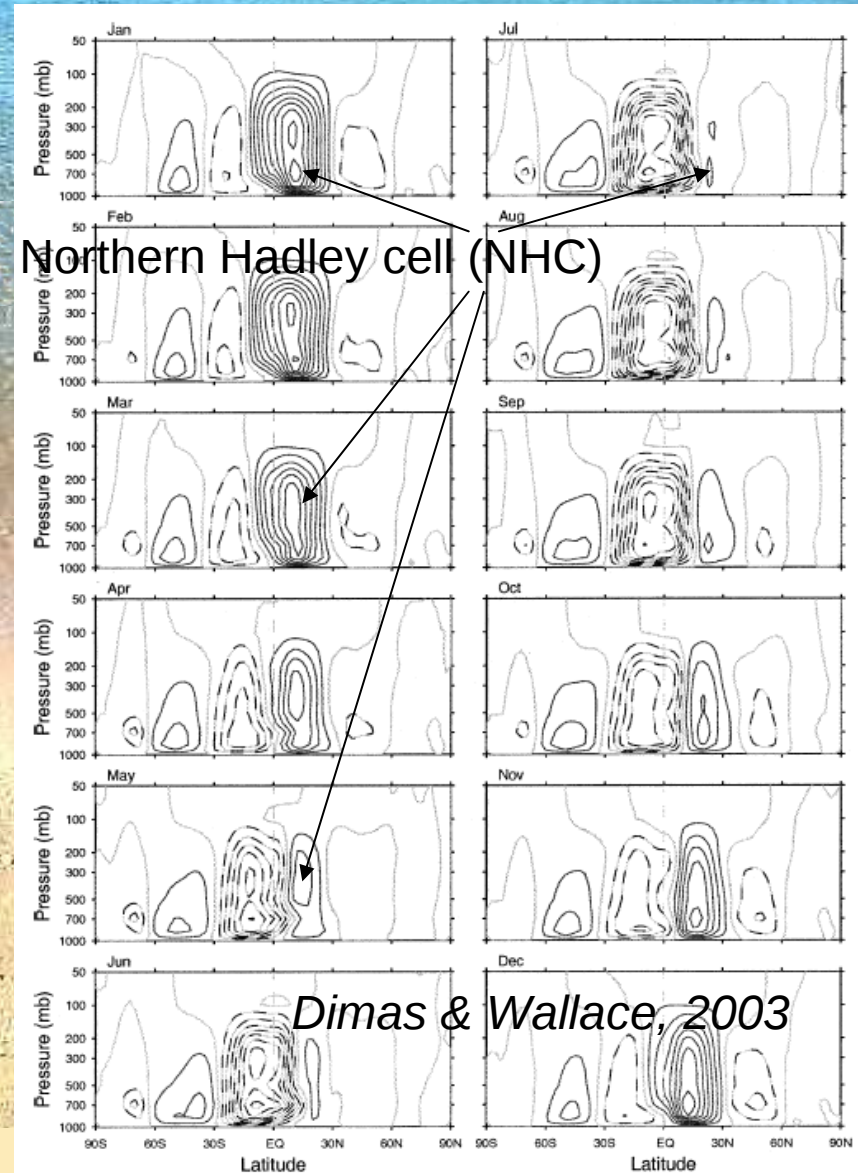
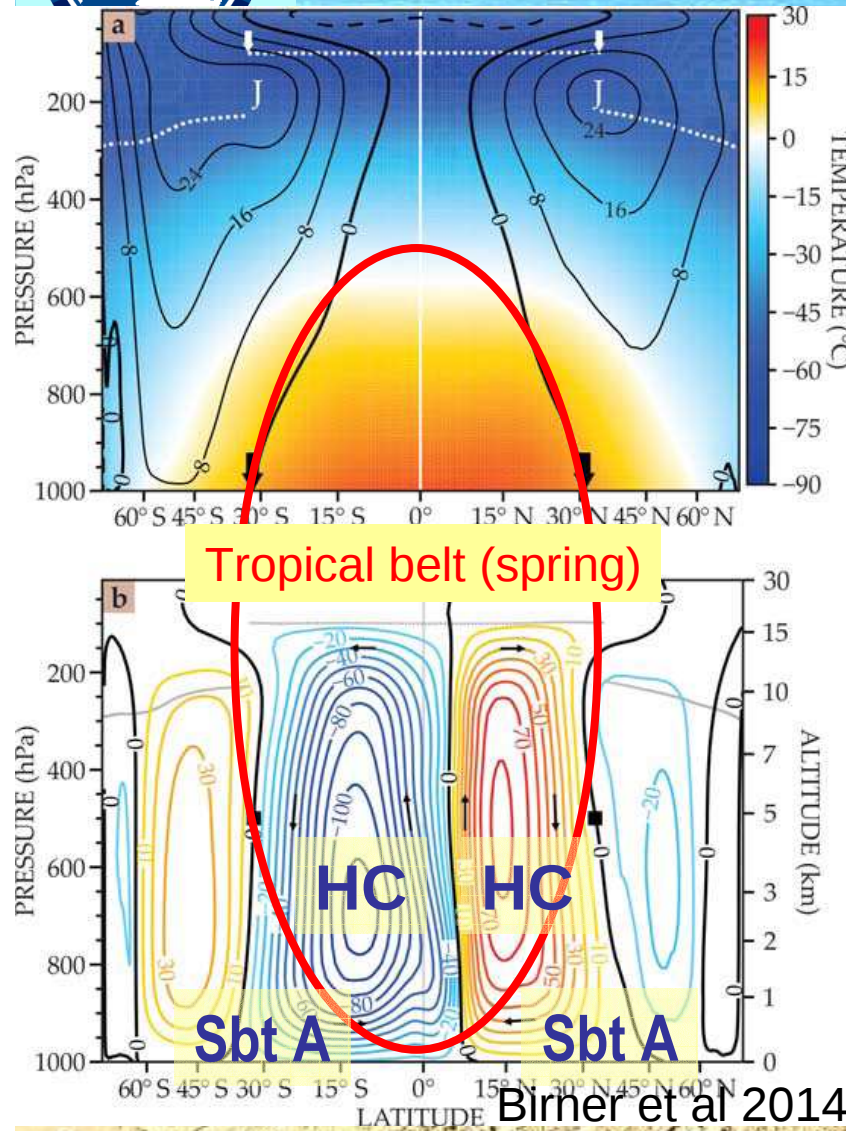
Is the seasonal polar wards shifting of
the tropical circulation (HC, Sbt A) the
Mediterranean summer key?





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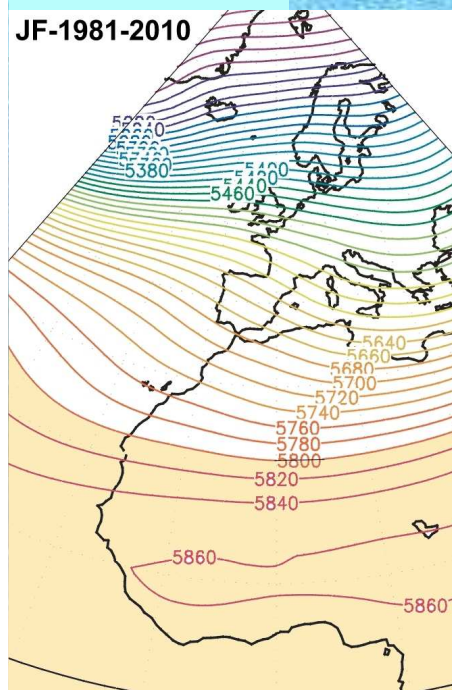
HC / low level Sbt A: vanish in
summer as planetary belt features



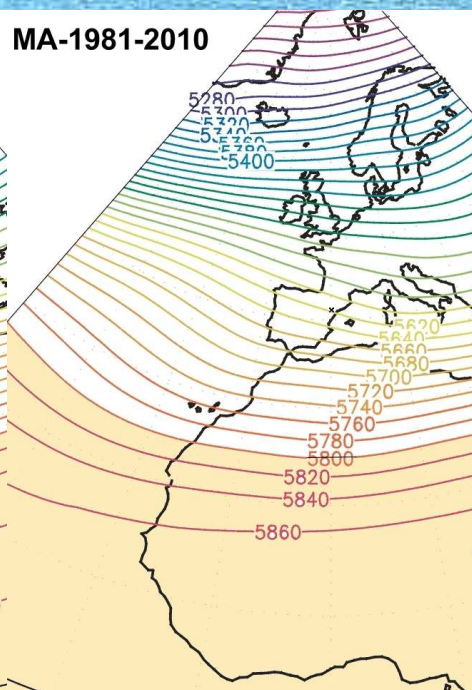


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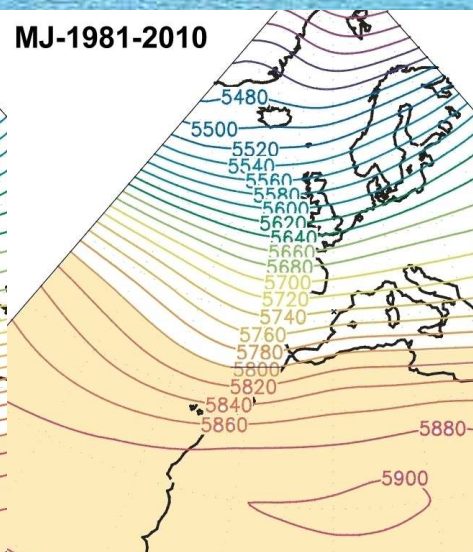
JF-1981-2010



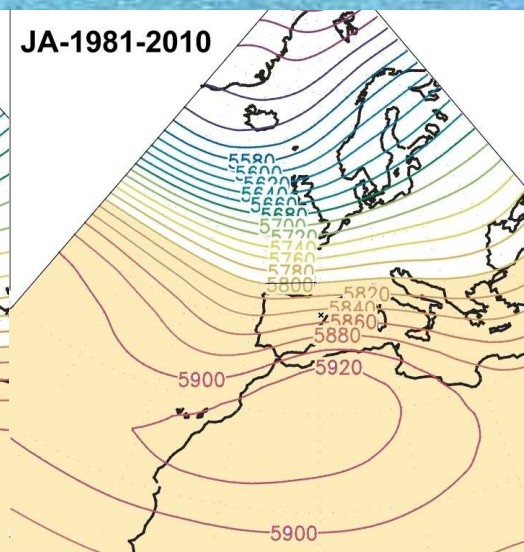
MA-1981-2010



MJ-1981-2010

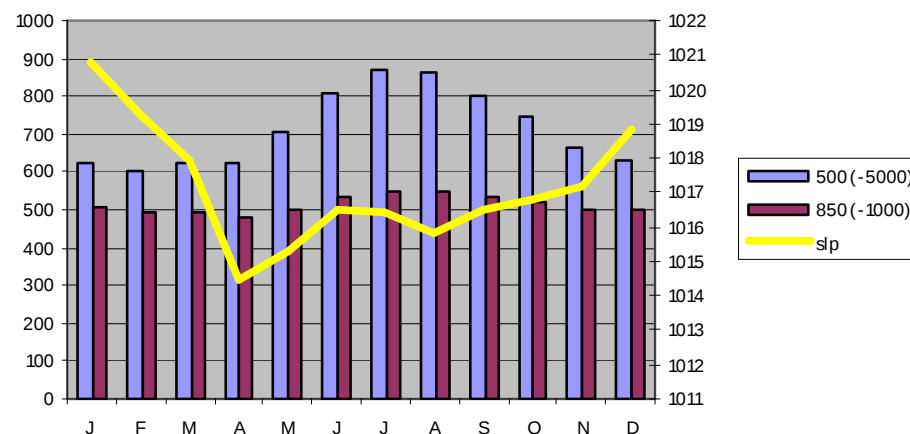


JA-1981-2010



**500 hPa geopotential height -500-GH-
could become an indicator of
Mediterranean summer and tropical
belt presence -5800 m?**

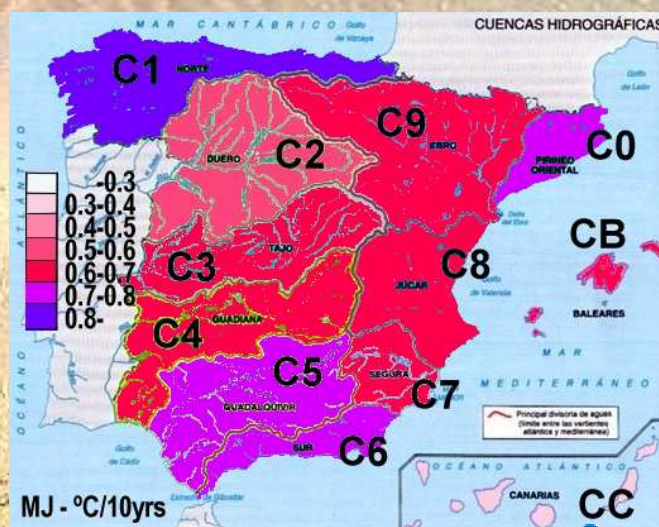
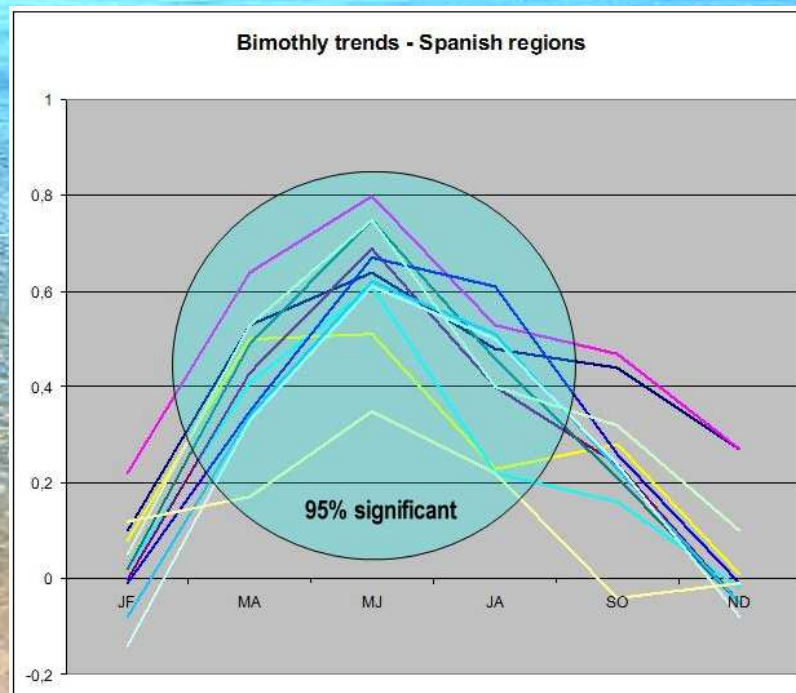
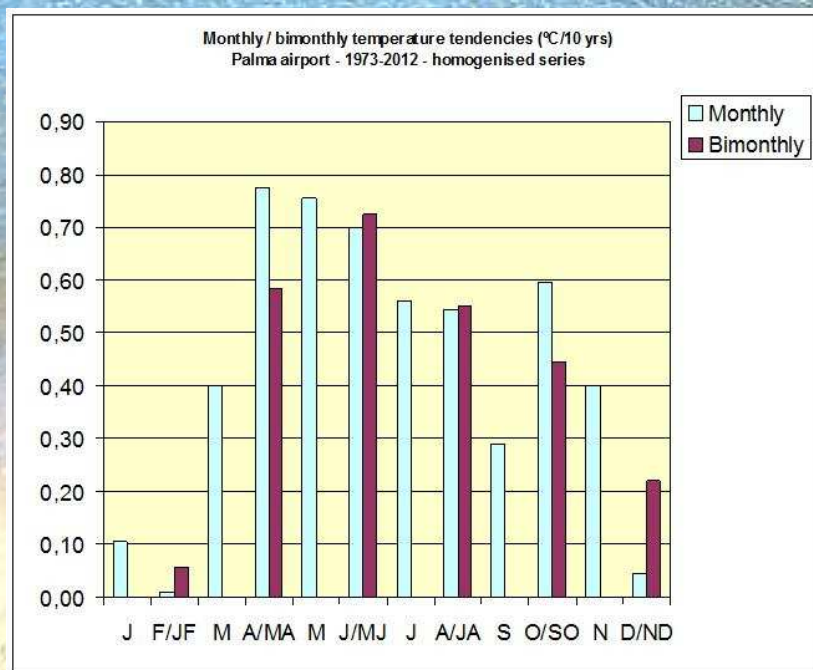
**SLP, 850-GH, 500-GH
Palma, 1981-2010**





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Near surface warming

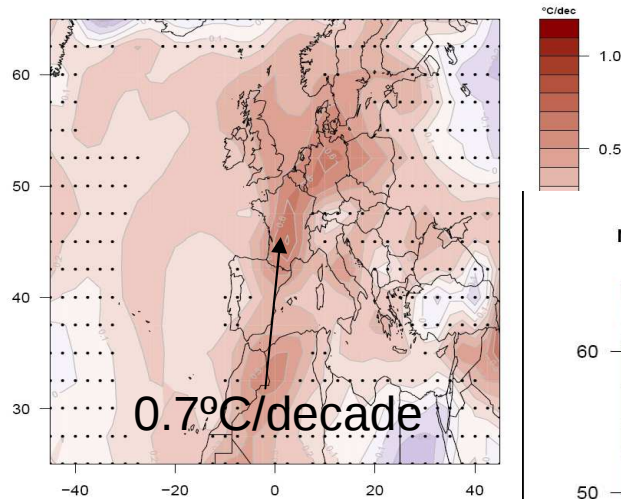




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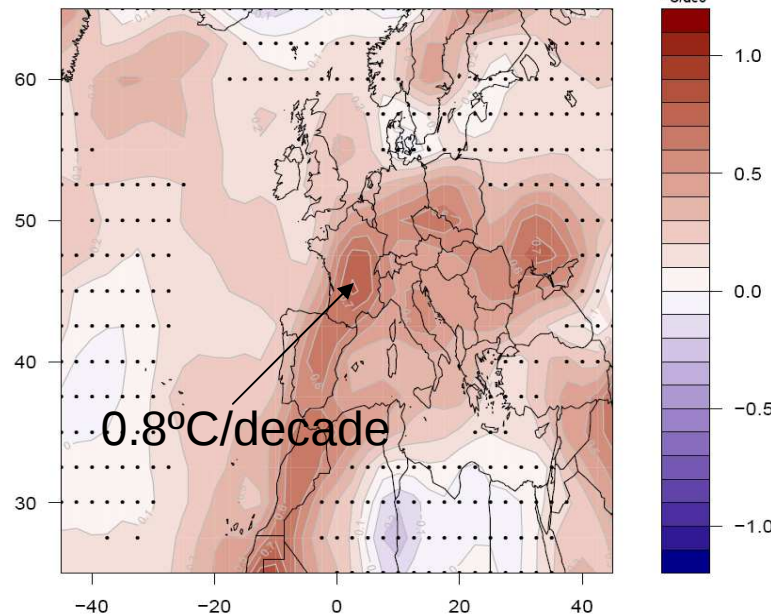
Near surface warming (NCEP/NCAR reanalysis)

NCEP REANALYSIS. MA T (sigma == 0.995) TREND (1973 - 2012)



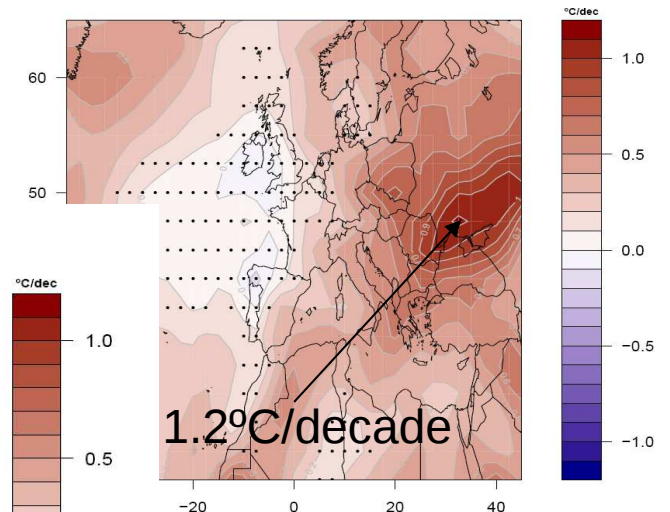
Dots indicate trends not significant at the 95% level

NCEP REANALYSIS. MJ T (sigma == 0.995) TREND (1973 - 2012)



Dots indicate trends not significant at the 95% level

NCEP REANALYSIS. JA T (sigma == 0.995) TREND (1973 - 2012)



Dots indicate trends not significant at the 95% level

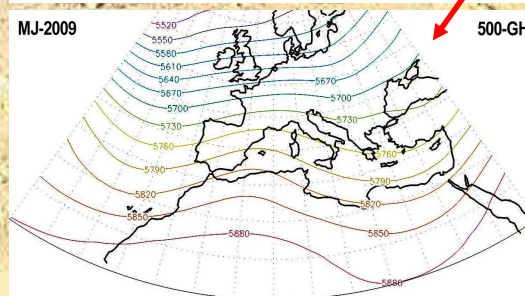
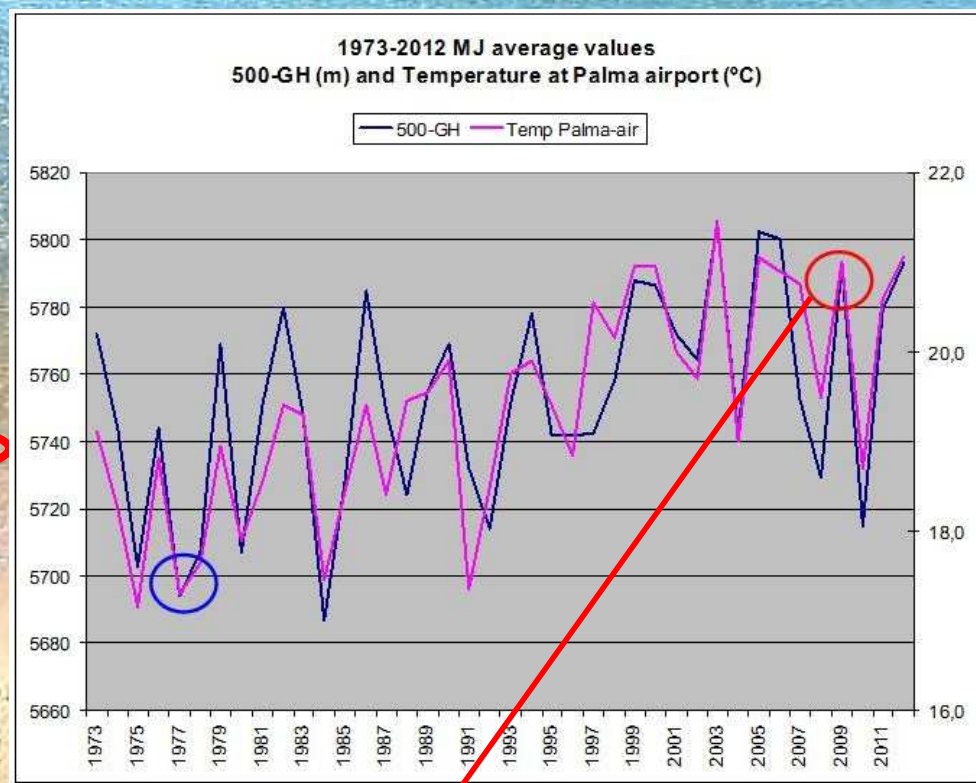


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Relationship between **local** near surface temperature & 500-GH

	TMP TND	500- GH TND	R
JF	0,06	3,7	0,30
MA	0,58	11,9	0,63
MJ	0,72	12,2	0,84
JA	0,55	6,5	0,69
SO	0,45	2,6	0,66
ND	0,22	-5,1	0,34
Year	0,43	5,3	0,77

95% level of confidence



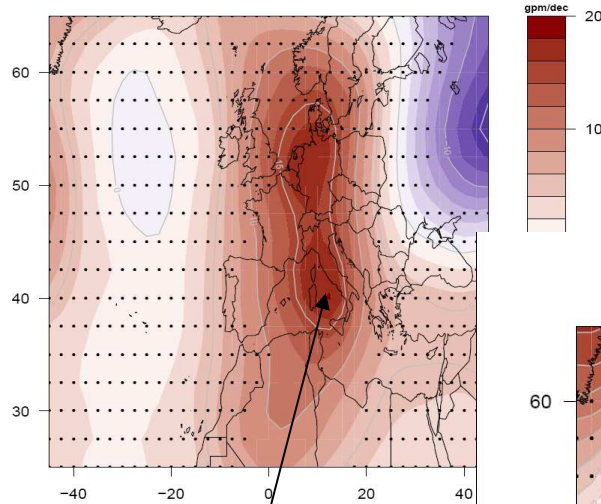
Universitat
de les Illes Balears



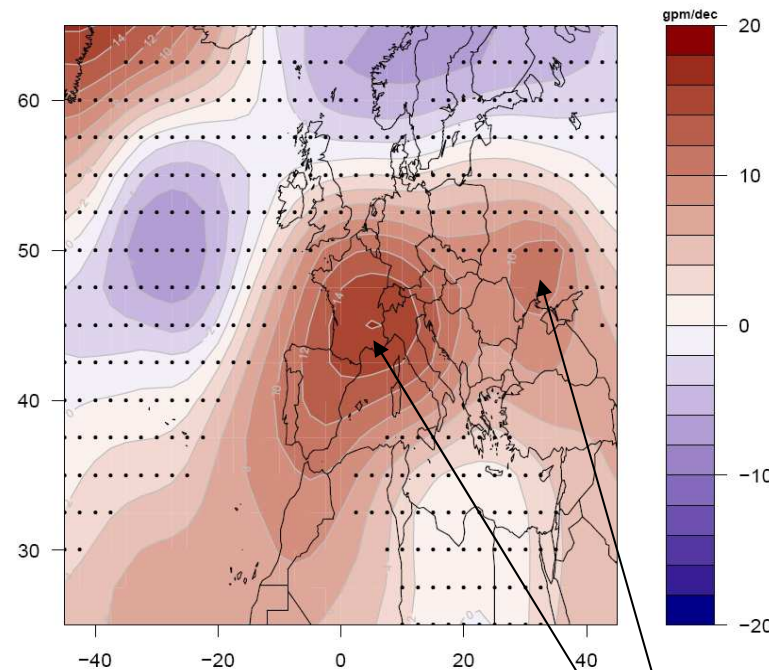
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Regional distribution of the 500-GH tendencies

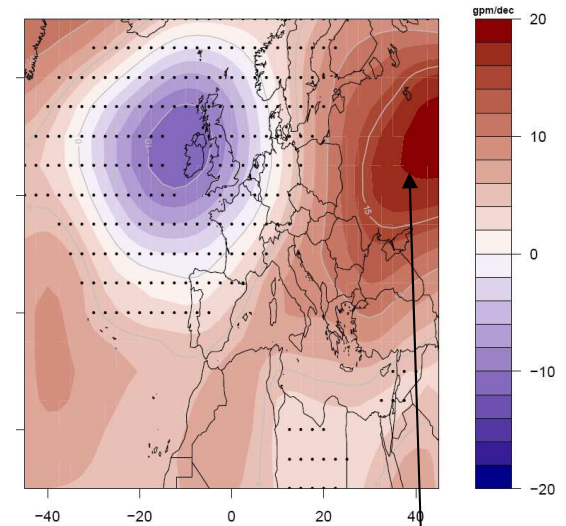
NCEP REANALYSIS. MA H500 TREND (1973 – 2012)



NCEP REANALYSIS. MJ H500 TREND (1973 – 2012)



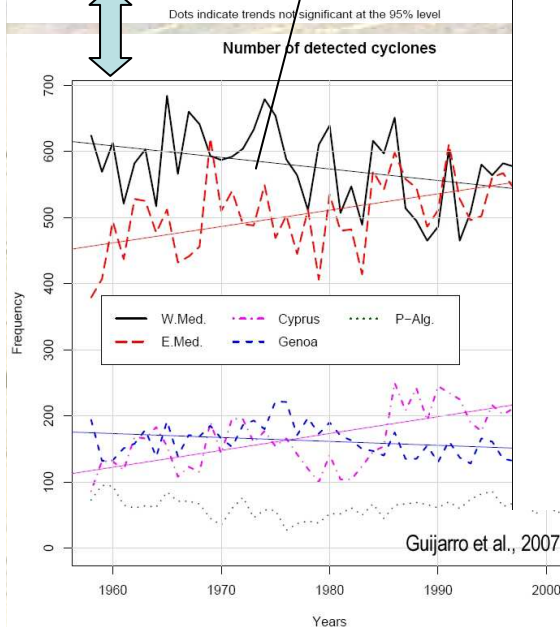
NCEP REANALYSIS. JA H500 TREND (1973 – 2012)



Dots indicate trends not significant at the 95% level

The second ridge
strongly reinforces in JA

MJ 500-GH increasing could be seen as
expansion towards N of the tropical high
500-GH area – Ridge-shaped (or 2 ridges)



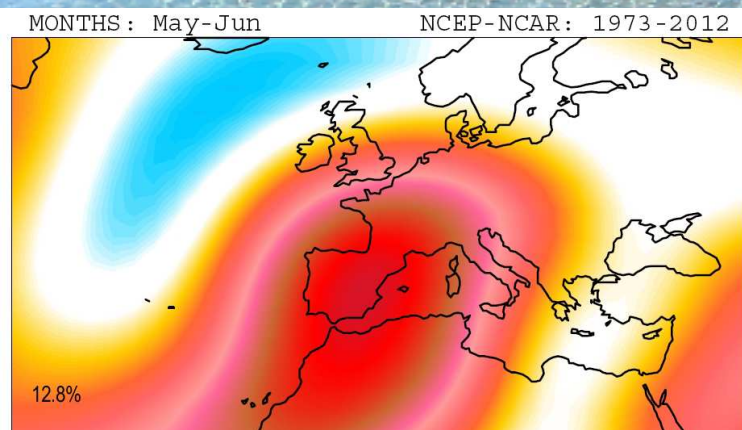


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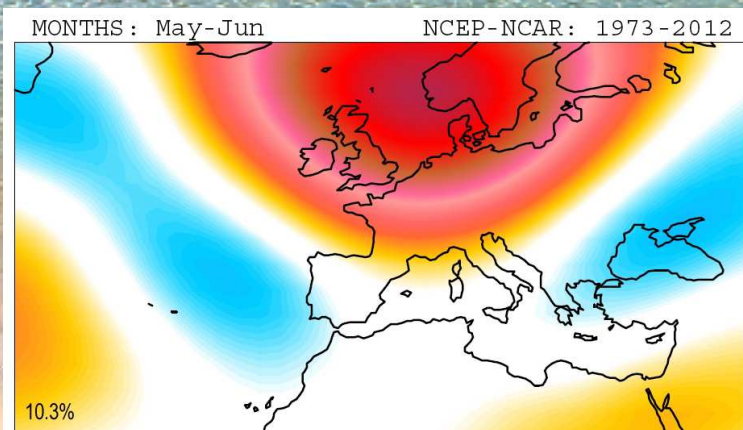
500-GH main structures in MJ,

- their tendencies,
- attribution to near surface temperature trend

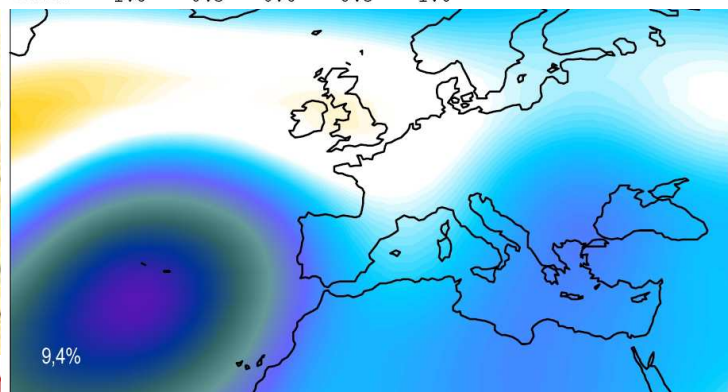
*Identifying main 500-HG patterns, in MJ, through PC analysis (rotated PCs)
10 PCs explain 83% of the variance. First four PCs, by variance explained:*



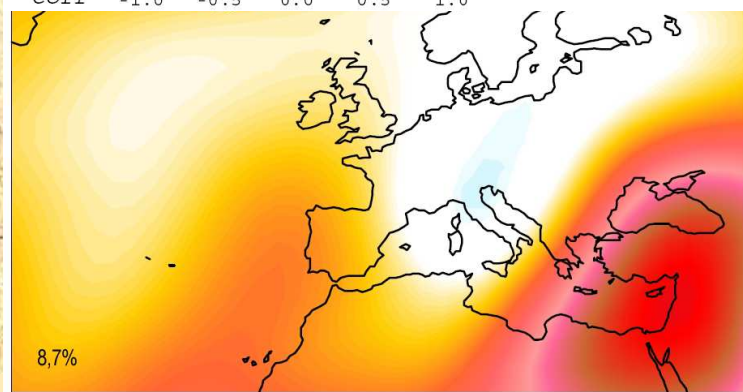
rotPC 1 Z500
corr -1.0 -0.5 0.0 0.5 1.0



rotPC 2 Z500
corr -1.0 -0.5 0.0 0.5 1.0



rotPC 7 Z500
corr -1.0 -0.5 0.0 0.5 1.0



rotPC 9 Z500
corr -1.0 -0.5 0.0 0.5 1.0

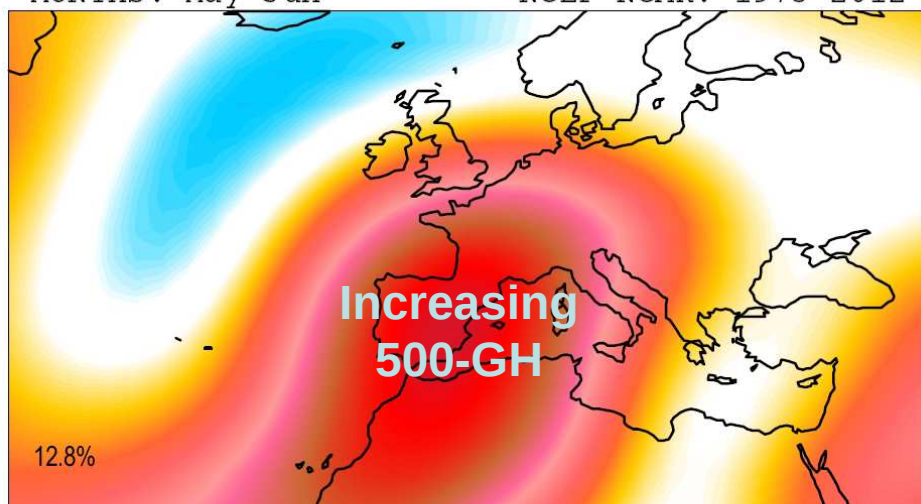


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Two PCs present important trends along time in their scores In other cases the score trends are much weaker

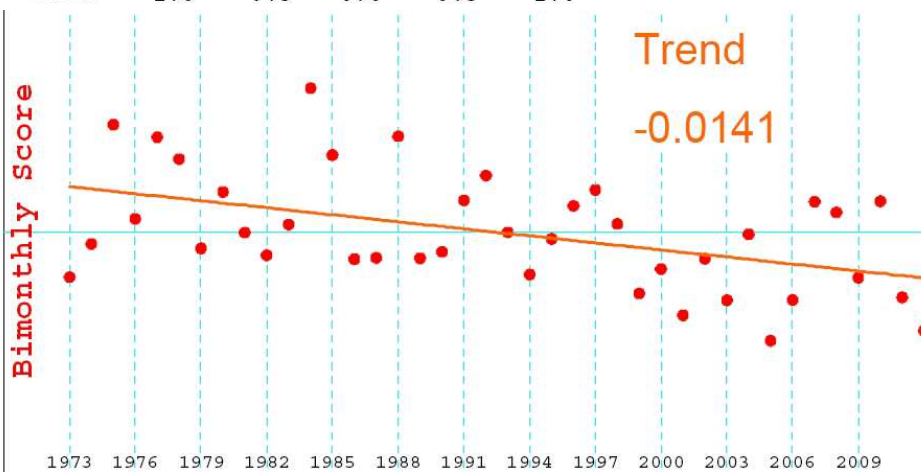
MONTHS: May-Jun

NCEP-NCAR: 1973-2012



rotPC 1
corr -1.0 -0.5 0.0 0.5 1.0

Z500



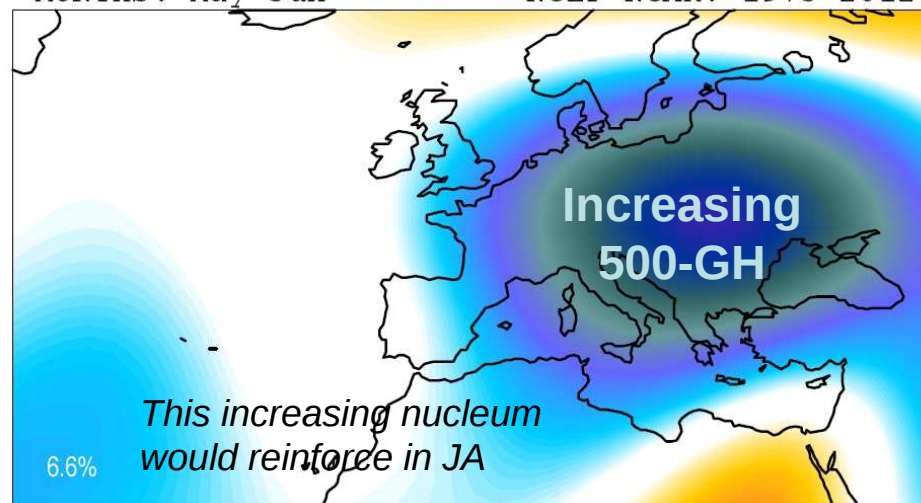
Z500

rotPC 1 TIME SERIES

Agencia Estatal de Meteorología

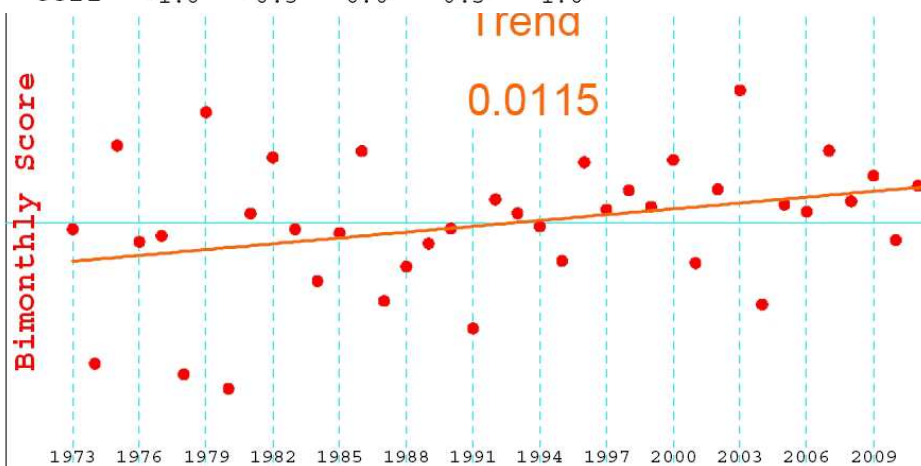
MONTHS: May-Jun

NCEP-NCAR: 1973-2012



rotPC 8
corr -1.0 -0.5 0.0 0.5 1.0

Z500



Z500

rotPC 8 TIME SERIES

Institut Mediterrani d'Estudis Avancats



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A multi lineal regression model have been obtained to describe the local MJ average temperature at Palma-airport as a function of the scores of the 10 main rotated PCs

Also the contribution to the temperature trend in Palma has been obtained, taking into account the trend of the PCs scores (Note that the 10PCs can explain only part of the total temperature trend, 0,58°C/decade, instead of observed 0,72°C/decade)

$$TPalm=b_0+b_1PC_1+b_2PC_2+b_3PC_3+b_4PC_4+b_5PC_5+b_6PC_6+b_7PC_7+b_8PC_8+b_9PC_9+b_{10}PC_{10}$$

	b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10
Temp cont.	19,38	-2,54	-1,20	0,70	0,66	-0,16	1,08	0,05	1,38	-0,88	0,39
PC-trend		-0,14	0,03	0,09	0,05	-0,04	-0,04	0,05	0,12	-0,07	-0,05
T-trend cont.		0,36	-0,03	0,06	0,03	0,01	-0,05	0,00	0,16	0,06	-0,02

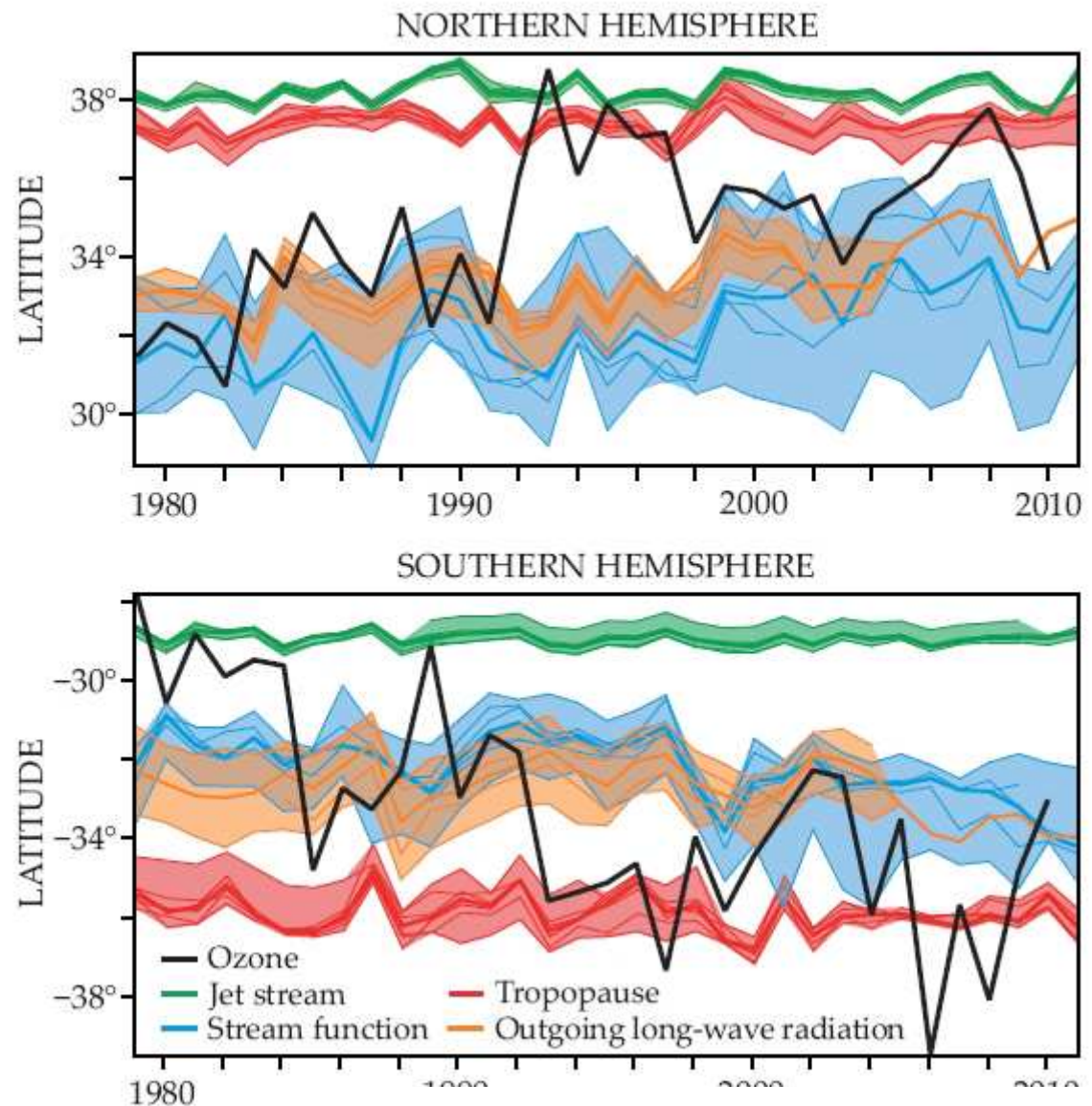


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In the Western Mediterranean and vicinity there is observational evidence of a specially intense warming in the late spring, which suggests an extension of summer towards spring.

Since the mid-2000's, the idea and some evidences of a supposed expansion of the Hadley Cells or, more in general, of the tropical climatological belt, are gaining ground.

Estimated expansion is 2° lat/decade



Adapted by Birtner-et-al-2014, from IPCC-Report-2013



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Although not used in this sense, the 500-GH could provide an alternative or complementary metrics to define the edge of the tropical climatological belt, better than MSLP, for instance, particularly in summer or near summer, when high values of 500-GH are closely associated to warm air, to the tropical warm dome.

The patterns and trends in 500-GH are even better instruments to analyse the expansion of the tropical belt in a limited region and in a limited season.

Our conclusion can be that the intense warming in the Western Mediterranean area and vicinity could be a consequence of a limited expansion of high 500-GH associated to a limited –ridge-shaped- expansion of the tropical climatological area in the zone in MJ.

To the east, at higher latitudes (towards Russia) an analogous phenomenon occurs in JA.



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Thank you for your attention!