Influence of the West African monsoon on the summer Mediterranean climate

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Introduction and Aim

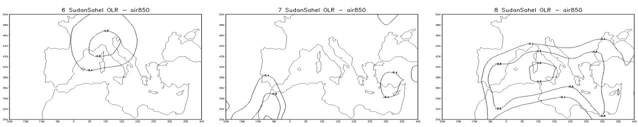
The West Africa monsoon (WAM) is strongly linked with atmospheric circulation in the region up to the southern Mediterranean (Med) coast (*Chen 2005, Semazzi & Sun 1997*). The aim of the work is to analyze the influence of the WAM on the summer Med climate and to single out the dynamical features of this teleconnection, focusing on the mechanisms leading to the occurrence of anomalously warm summers and heat waves.

Data and Method

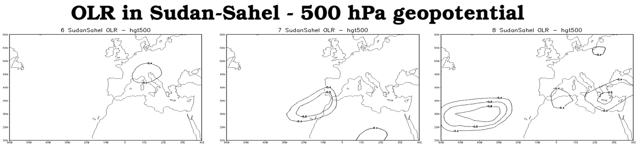
We use rainfall data from CMAP, NOAA OLR data and atmospheric variables from NCEP-DOE reanalysis 2 dataset (*http://www.cdc.noaa.gov/*). We analyze the correlation between the WAM and the Med using correlation analysis and Singular Value Decomposition (SVD) analysis (*Wilks 2006*), on monthly and daily time scale, in the period 1979-2006. We study the dynamics of the teleconnection using composite analysis.

Monthly Analysis

Correlation Maps
OLR in Sudan-Sahel - 850 hPa air temperature



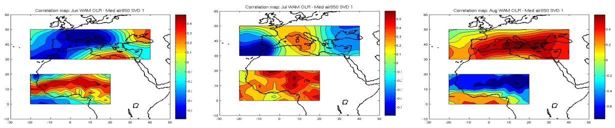
OLR in Sudan-Sahel - 500 hPa geopotential



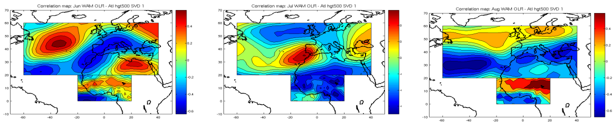
OLR-T 1st mode	SCF	r(ECs)
June	.51	.63
July	.47	.66
August	.76	.75

OLR-hgt 1st mode	SCF	r(ECs)
June	.40	.69
July	.47	.74
August	.60	.71

SVD Analysis
West Africa OLR – Med 850 hPa air temperature



West Africa OLR – Med 500 hPa geopotential



Significance: n=28, r95=0.37, r99=0.48

Correlation Analysis: enhanced convective activity in West Africa, represented by OLR, has significant correlation with positive 850 hPa air temperature anomalies in the Med and with positive 500 hPa geopotential anomalies in the subtropical Atlantic and the Med basin from June to August.

SVD Analysis: from June to August the 1st SVD mode relates positive anomaly in convective activity in West Africa to a positive 850 hPa air temperature anomaly in the Med basin, and to a 500 hPa geopotential pattern leading to northward deflection of the Atlantic flow and increased stability in the Med, with a sizable squared covariance fraction (SCF).

Daily Analysis

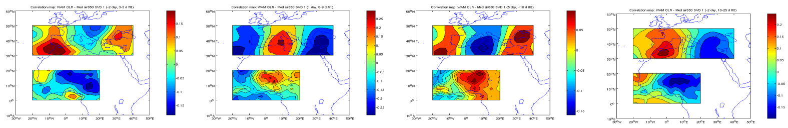
The coupling between the WAM and the summer Med climate exists → Does the WAM lead the Med or viceversa?

We repeat the SDVA with daily data, from June to August, with a lead/lag time of 5 days, filtering the data around the AEWs periods (3-5 days, 6-9 days), the synoptic (<10 days) and the intraseasonal (10-25 days) variability (*Sultan et al 2003*).

Significance: n=inf, r95=0.14, r99=0.18, r99.9=0.23

OLR-T850 1st mode SCF

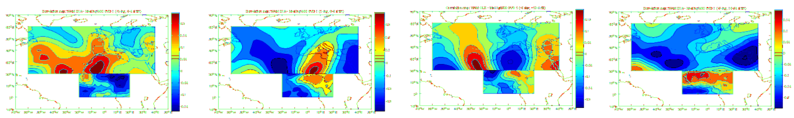
filter	OLR leads (days) -5	-4	-3	-2	-1	0	T leads (days) 1	2	3	4	5
3-5	0.19	0.28	0.20	**0.29**	0.22	0.26	0.22	0.23	0.22	0.22	0.25
6-9	0.28	0.26	0.29	0.36	0.34	0.33	**0.43**	0.41	0.30	0.35	0.43
<10	0.31	0.32	0.32	0.36	0.29	0.25	0.27	0.35	0.34	0.32	**0.39**
10-25	0.36	0.43	0.51	**0.54**	0.47	0.42	0.41	0.38	0.40	0.45	0.47



filt 3-5 | filt 6-9 | filt <10 | filt 10-25

OLR-hgt500 1st mode SCF

filter	OLR leads (days) -5	-4	-3	-2	-1	0	hgt leads (days) 1	2	3	4	5
3-5	0.29	0.35	0.23	**0.36**	0.23	0.35	0.26	0.26	0.25	0.28	0.28
6-9	0.32	0.30	0.36	0.32	0.32	0.32	**0.39**	0.38	0.31	0.29	0.29
<10	0.32	0.26	**0.36**	0.33	0.27	0.27	0.32	0.33	0.34	0.29	0.23
10-25	**0.43**	0.37	0.35	0.31	0.29	0.35	0.38	0.37	0.34	0.30	0.30

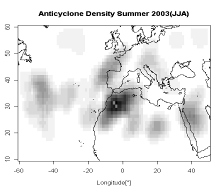


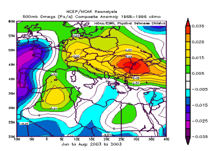
On the basis of the explained covariance → WAM leads Med when the data are 3-5 and 10-25 days filtered, and Med leads WAM when the data are 6-9 days filtered. Mixed results comes from the analysis of the synoptic variability. The significant OLR signal is located in the Sudan-Sahel region, the air temperature anomaly in the Med and the significant geopotential signal in the subtropical belt.

Case Study: Summer 2003

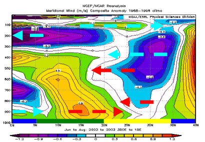
Analysis of the dynamical features show a clear WAM-Med linkage.

We hypothesize that an anomalously warm summer in Mediterranean is due to the reinforcement and widening of the meridional Hadley circulation driven by a strong WAM. This is when the Libyan anticyclone is more intense and shifts northward.

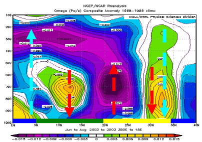




500 hPa omega 2003 anomaly



10W 15E vwnd 2003 anomaly



10W 15E omega 2003 anomaly

Hadley Circulation and **Saharan Heat Low Circulation**

Conclusions

✓**A correlation exists between the WAM and the summer climate in the Mediterranean.**

✓**The WAM leads the Med summer climate on the AEWs time scale and on intraseasonal time scale with a 2-5 days lead time.**

✓**The WAM affects the meridional Hadley circulation and the North African circulation, influencing the occurrence of summer hot spells in the Med.**

References

•*Chen 2005 J Climate 18 2943*
•*Semazzi & Sun 1997 Int J Climatol 17 581*
•*Sultan et al 2003 J Climate 16 3389*
•*Wilks 2006 Academic Press*