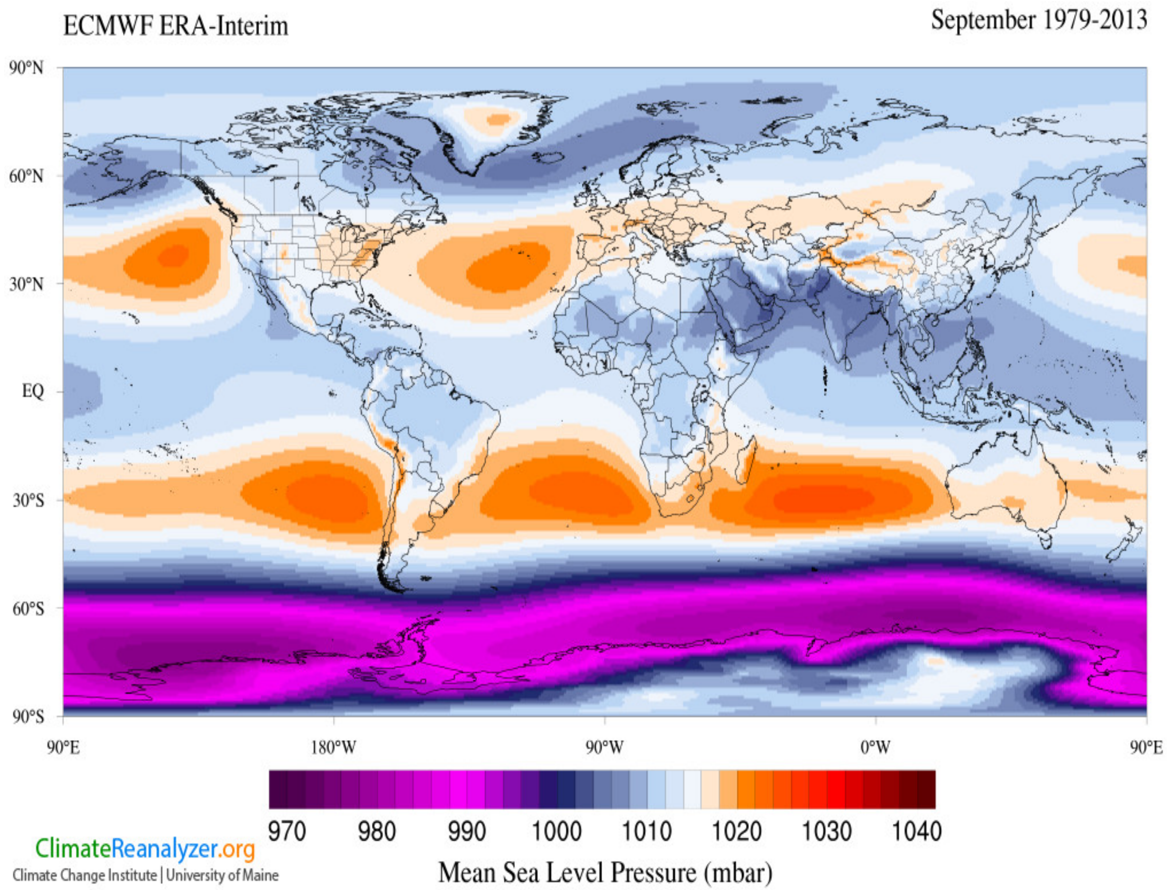
First Training Workshop on Seasonal Forecasting
for MedCOF Participants

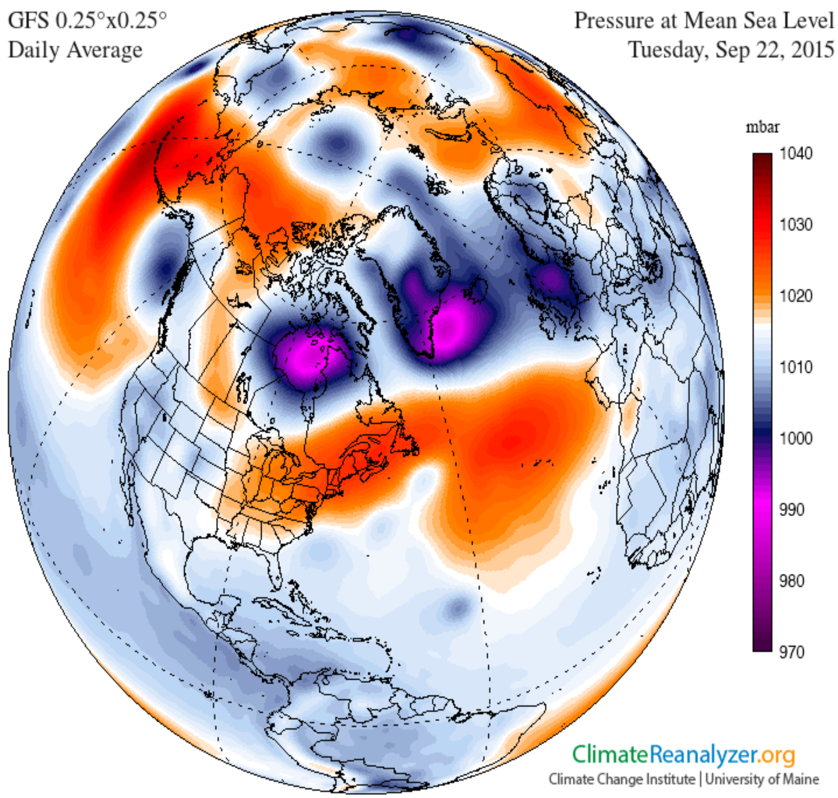
Basic aspects of climate and climate variability over the Mediterranean region

Difference between weather and climate

Climate is what you expect

weather is what you get





CLIMATE: is the long-term pattern of weather in a particular area

How is the Mediterranean climate?

Lionello et al., 2006

The Mediterranean Climate: An Overview of the Main Characteristics and Issues

P. Lionello,[1] P. Malanotte-Rizzoli,[2] R. Boscolo,[3] P. Alpert,[4] V. Artale,[5] L. Li,[6] J. Luterbacher,[7] W. May,[10] R. Trigo,[8] M. Tsimplis,[9] U. Ulbrich[11] and E. Xoplaki[7]

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[6] *Laboratory of Dynamical Meteorology CNRS, Paris, France, Li@lmd.jussieu.fr*
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[9] *National Oceanography Centre, Southampton, UK, Michael.Tsimplis@noc.soton.ac.uk*
[10] *Danish Meteorological Institute, Copenhagen, Denmark, may@dmi.dk*
[11] *Freie Universität Berlin, Germany, ulbrich@met.fu-berlin.de*

Location: 32° - 41° **north** .

All regions are situated along the coast of the Mediterranean Sea

Annual rainfal: relatively low, with at least 65% falling in the winter half of the year.

- primarily from rainfall, averaging 275mm to 900 mm yearly; though in some areas coastal fog and rare light snowfall contribute to the precipitation totals.

Temperature:

Sun intensity is high, especially in inland areas, due to clear, cloudless skies and low humidity; evapotranspiration rates can be twice as high inland, compared to those on the coast.

Summers are warm to hot, and winters are cool but mild, with one month averaging below 15° C; sub-freezing temperatures do not occur more than 3% of the total time.

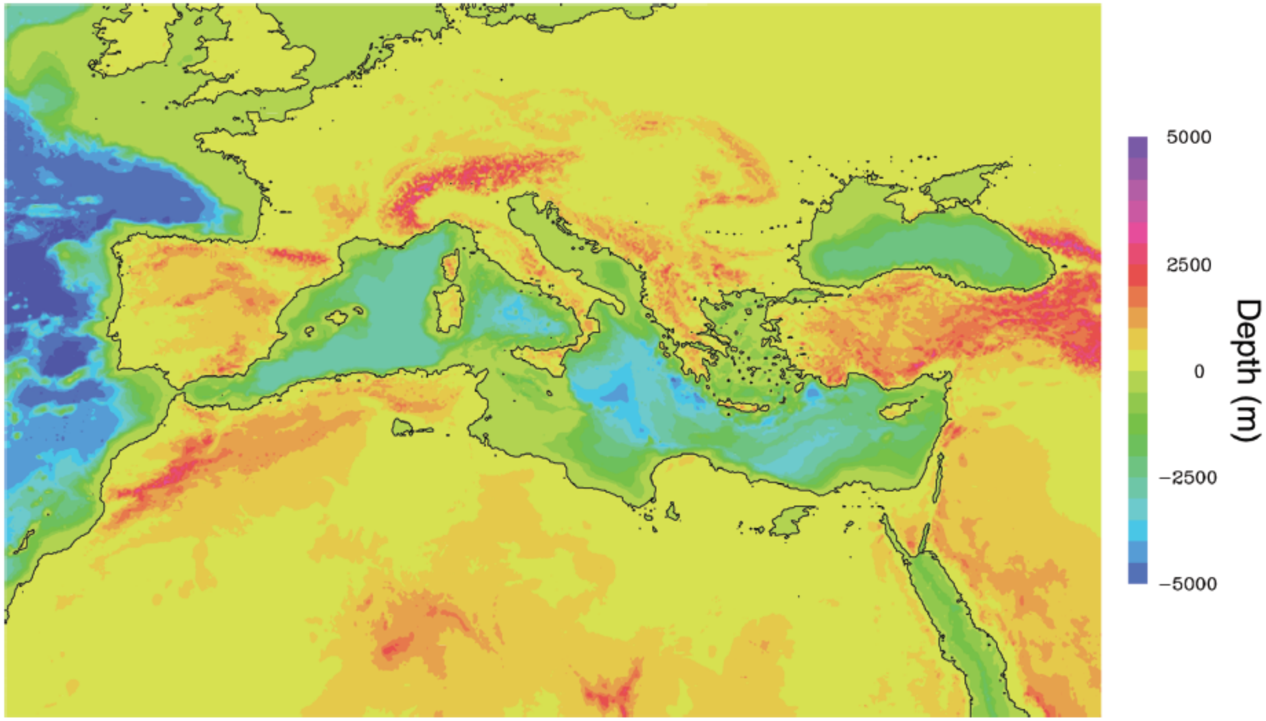


Figure 1: Orography and Sea-depth of the Mediterranean region.

large meridional gradient : from hot and arid regions to humid mountain climate and permanent glaciers in about 2,000 km (Bolle,2003)

High mountain ridges surround the Mediterranean Sea on almost every side.

Mediterranean climate:

Vegetation:

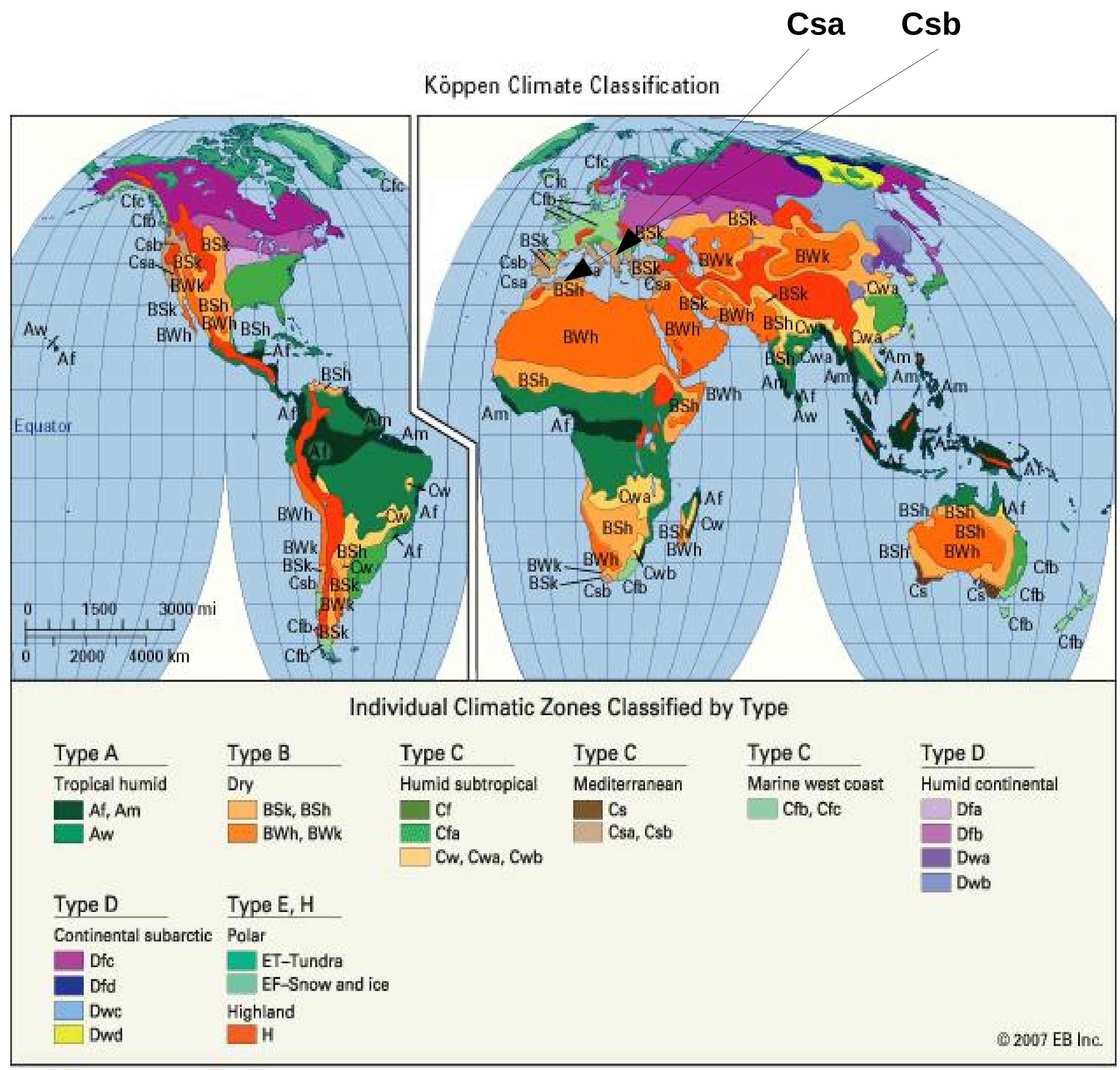
Native vegetation arboreal and plants adapted to climatic stresses of heat and aridity; a well-developed annual and herbaceous (often bulbous) flora is also common.

Native plants often experience a period of summer dormancy, induced by heat and lack of soil moisture, except in some cool, foggy coastal zones.

Soils are generally low in humus, neutral to alkaline in pH, low in biological activity, low in nitrogen and phosphorous, and slow in the decomposition of organic matter; the rugged topography generally leads to a mosaic of old and new soils, with extensive areas of deep alluvial soils (particularly in California), thin soils on slopes due to extensive erosion, and a general susceptibility to erosion, degradation, and desertification.

Events:

Frequent summer and autumn **fires**, brought on by months without rain, serve as a natural means of renewing vegetative growth and of maintaining the health and vitality of the native plant communities.



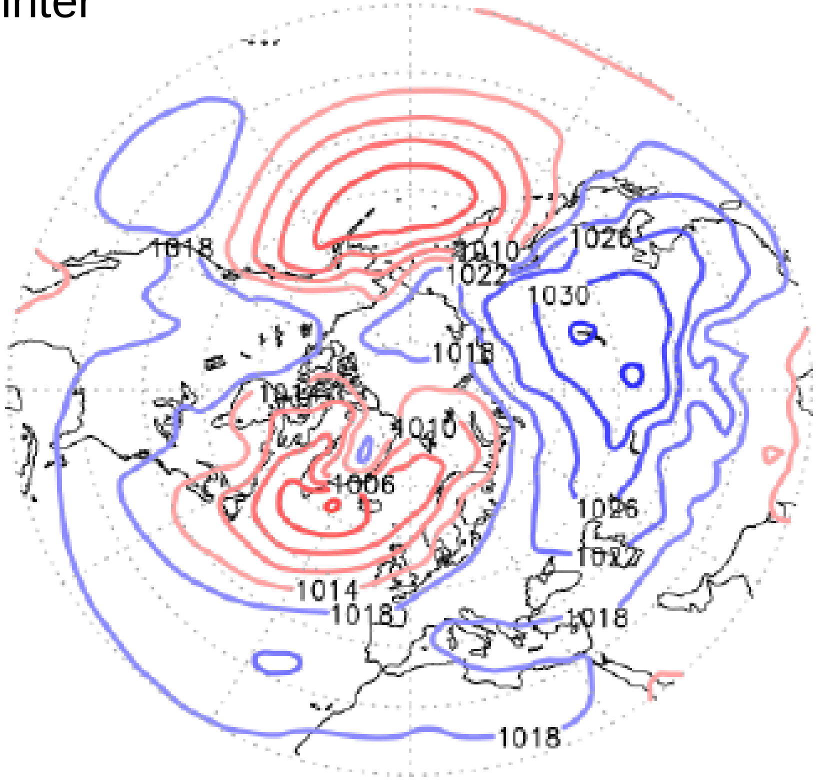
transitional zone,where mid-latitude and tropical variability are both important and compete.

Koppen classification: Maritime West Coastal Climate in the North, while the Southern part is characterised by a Subtropical Desert Climate.

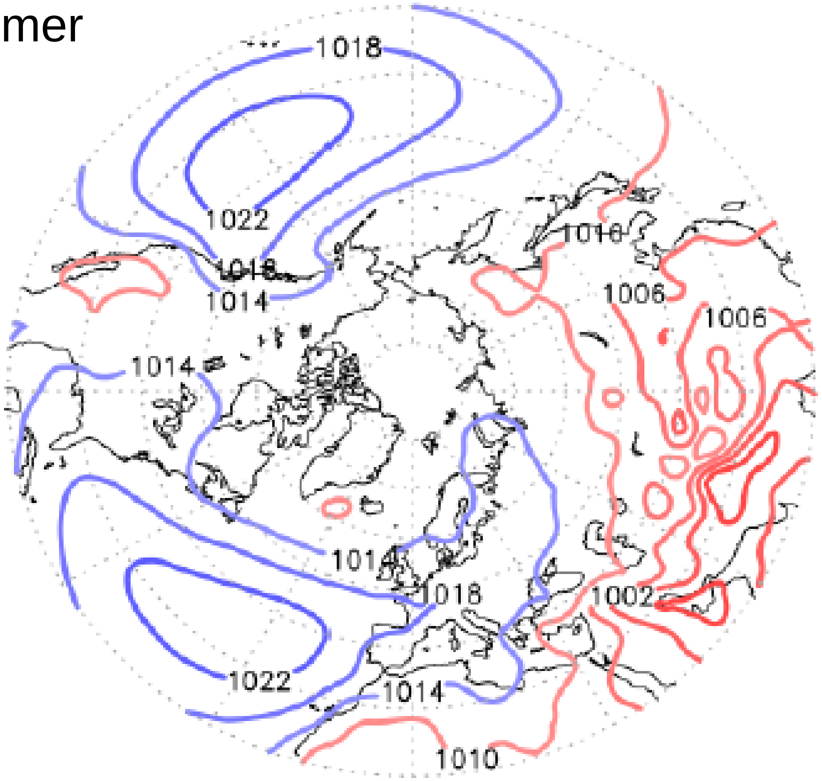
Exposed to the South Asian Monsoon in summer and the Siberian highpressure system in winter.

Mediterranean Climate: within the Northern hemisphere climate

winter



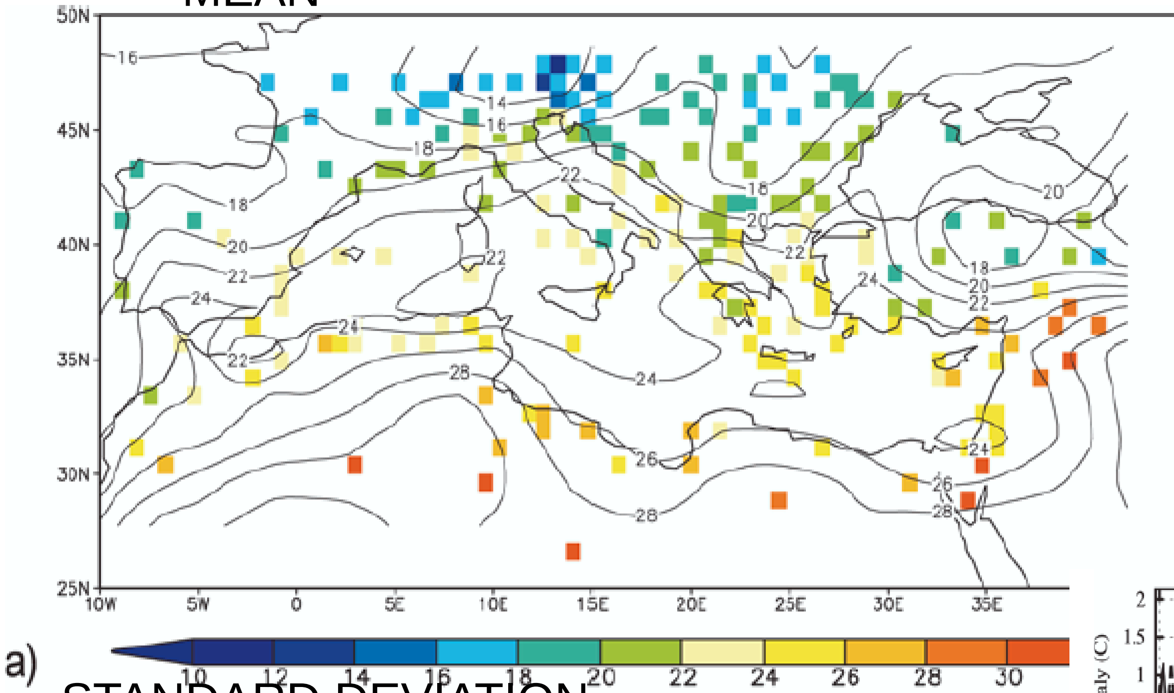
summer



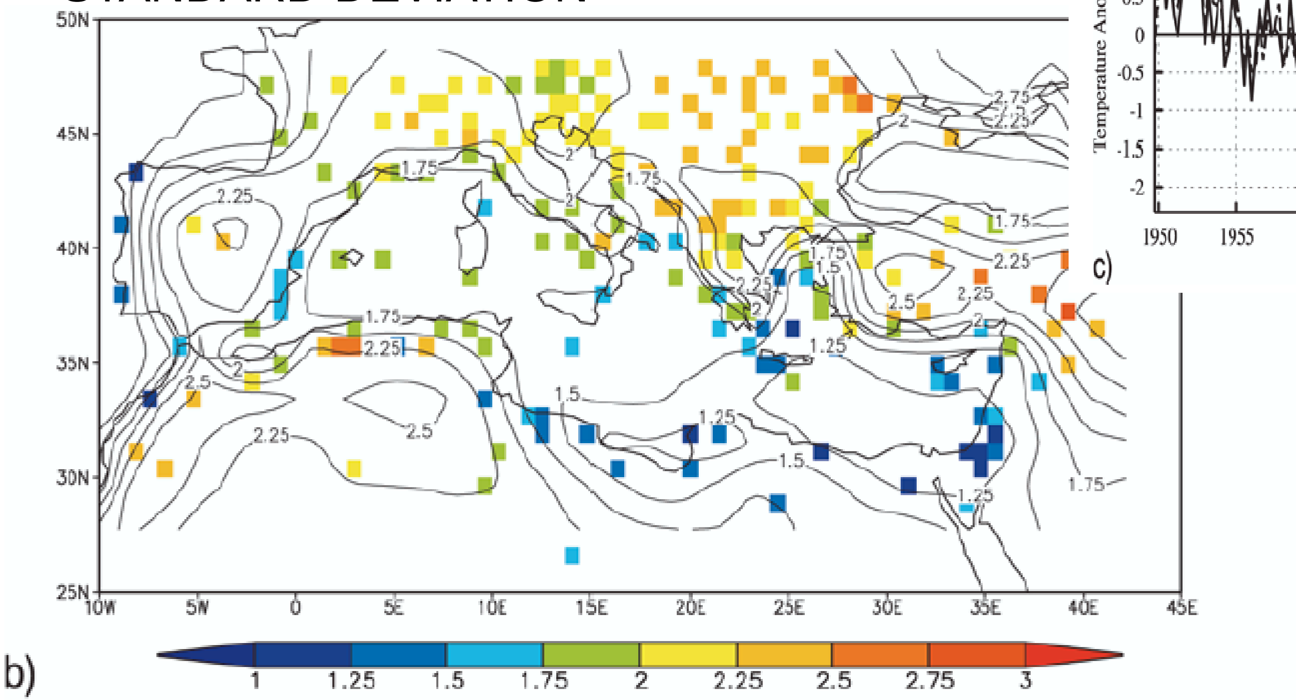
Mean Sea Level Pressure

Poleward extension and expansion of the subtropical anticyclone over the oceans bring subsiding air to the region in summer, with clear skies and high temperatures. When the anticyclone moves Equator-ward in winter, it is replaced by traveling, frontal cyclones with their attendant precipitation.

MEAN

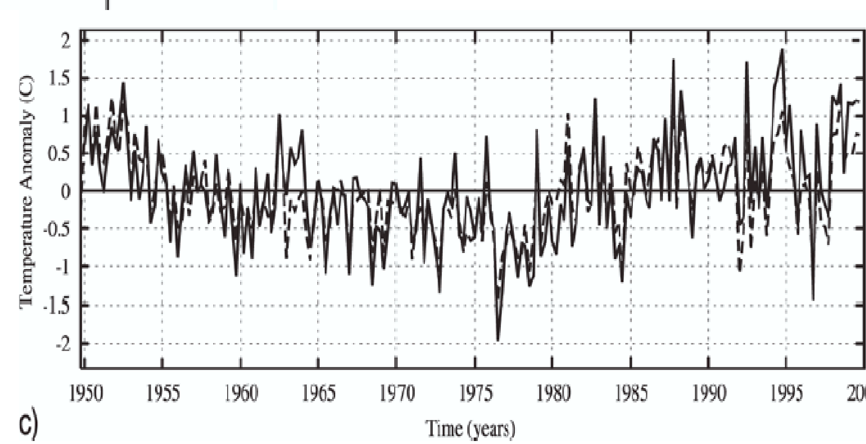


STANDARD DEVIATION



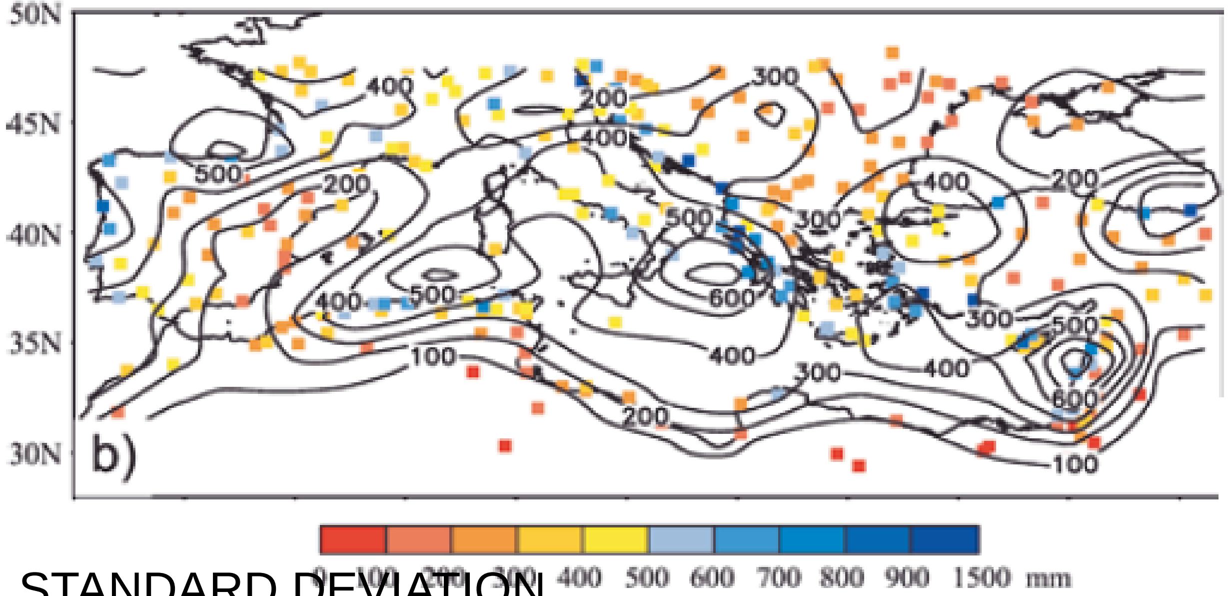
TEMPERATURE

JJAS



Xoplaki et al 2004

MEAN



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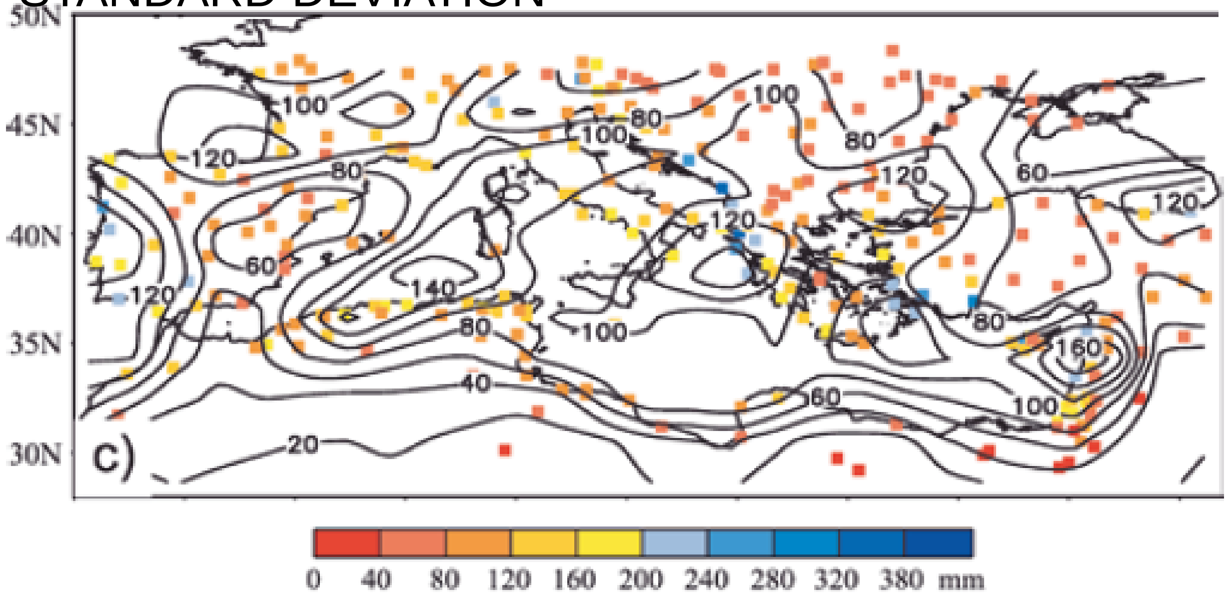
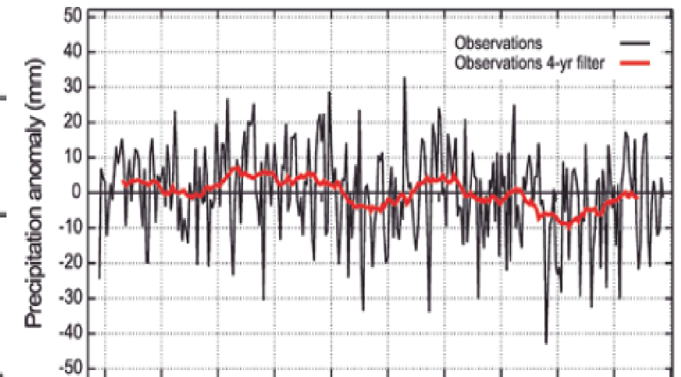
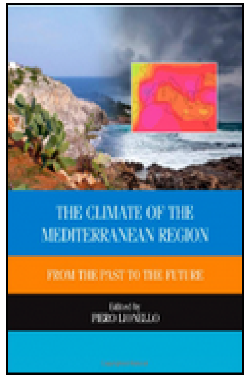


PRECIPITATION
ONDJFM

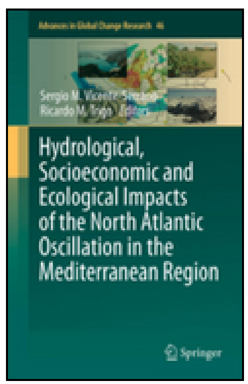


Books

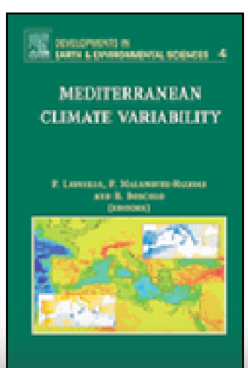


The climate of the Mediterranean region: from the past to the future
2012 , Elsevier Insights, 592pp, ISBN: 978-0-12-416042-2 , Ed. Lionello P.

Aschmann, 1973, Bolle, 2003; Lionello et al 2006



Hydrological, Socioeconomic and Ecological Impacts of the North Atlantic Oscillation in the Mediterranean Region
2011, Advances in Global Change Research, Volume 46, 1-8, DOI: 10.1007/978-94-007-1372-7_1, Eds: Serrano, S.M.V., Trigo, R. M



Mediterranean Climate Variability
2006, Elsevier, Amsterdam, ISBN: 0-444-52170-4, 438 pp, Eds: Lionello P., P. Malanotte-Rizzoli and R. Boscolo

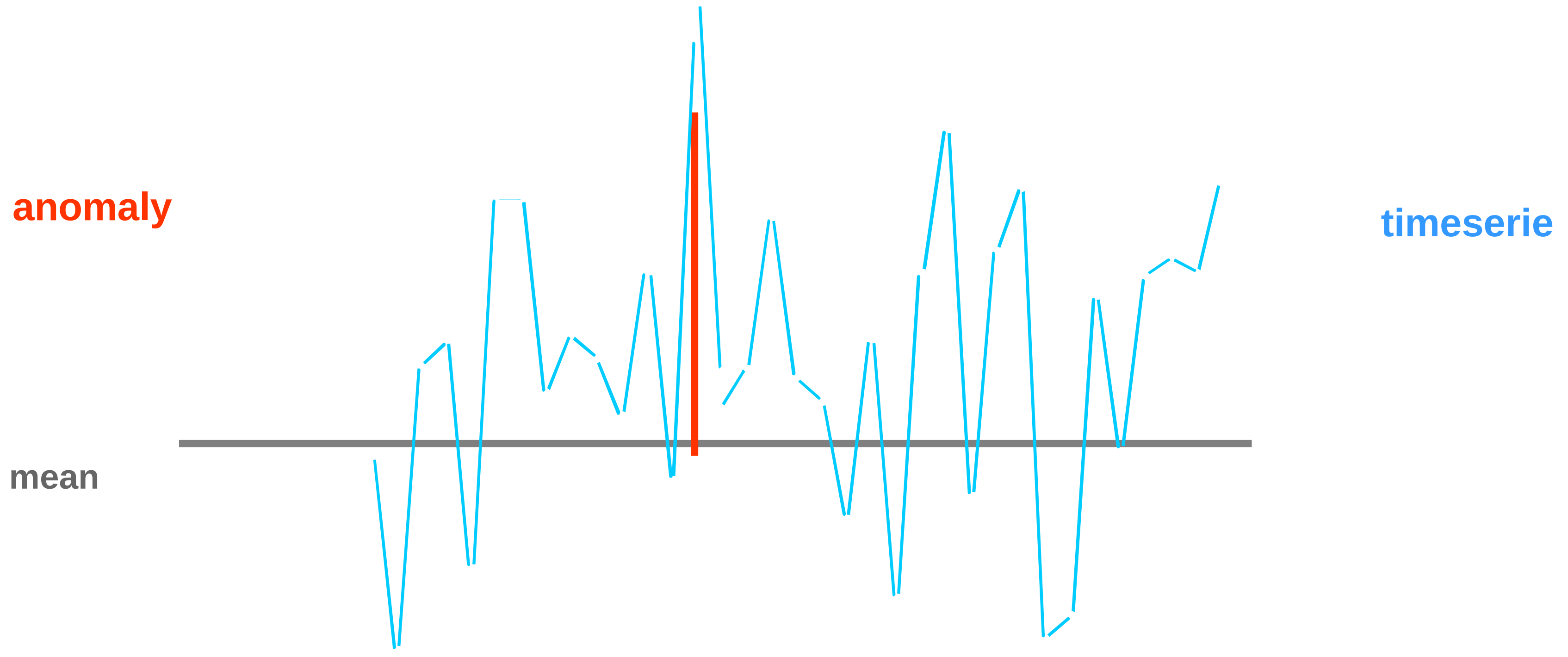
How is the Mediterranean climate variability?

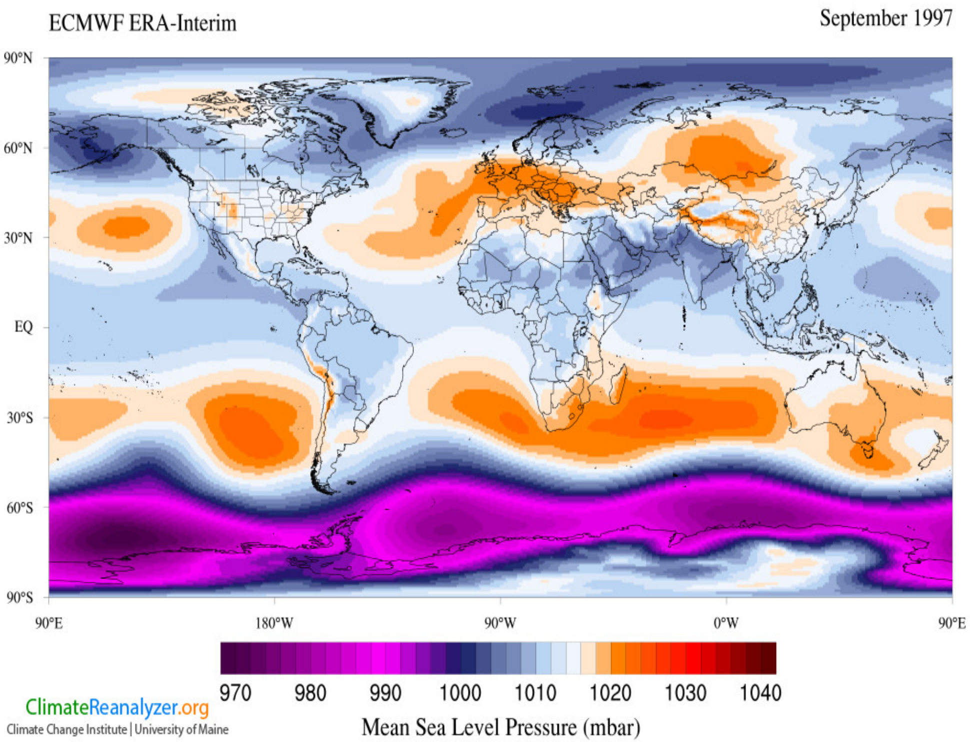
What are climate anomalies? A measure of the climate variability

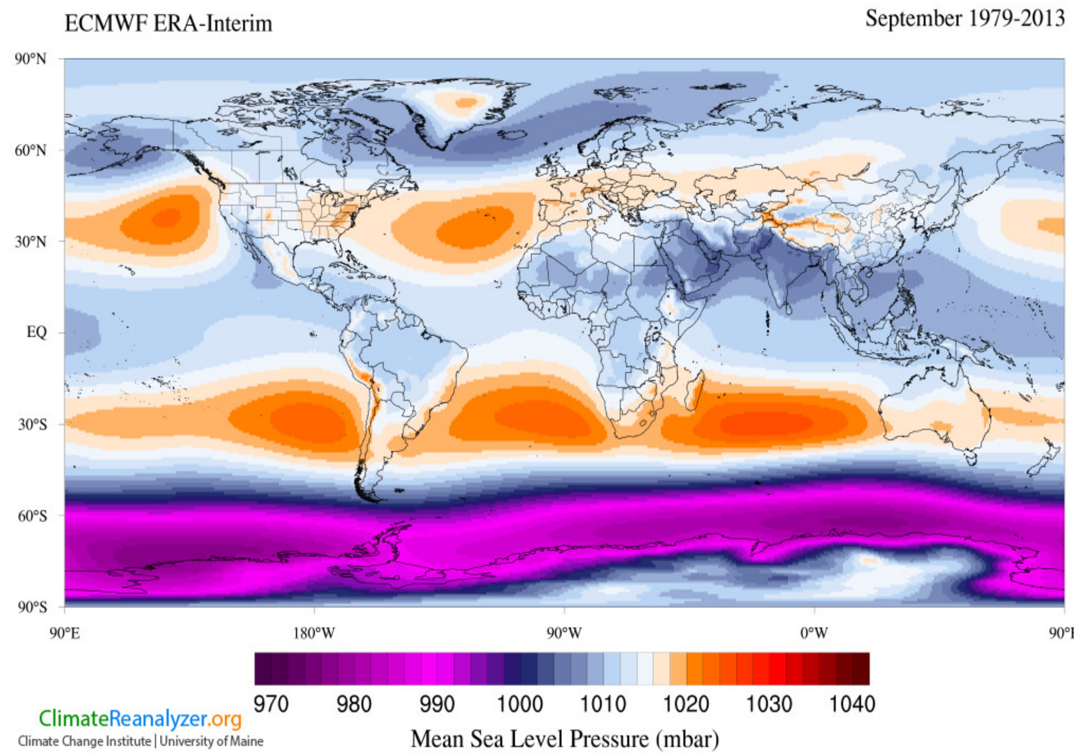
Rich data base that gives a unique opportunity for reconstruction of climate (including extremes) in past historical and recent instrumentally developed times.

Climate variability ⇐⇒ alteration of the climate components

Climate variability ⇐⇒ deviation from the mean (background state) of the characteristics variables of the climate system

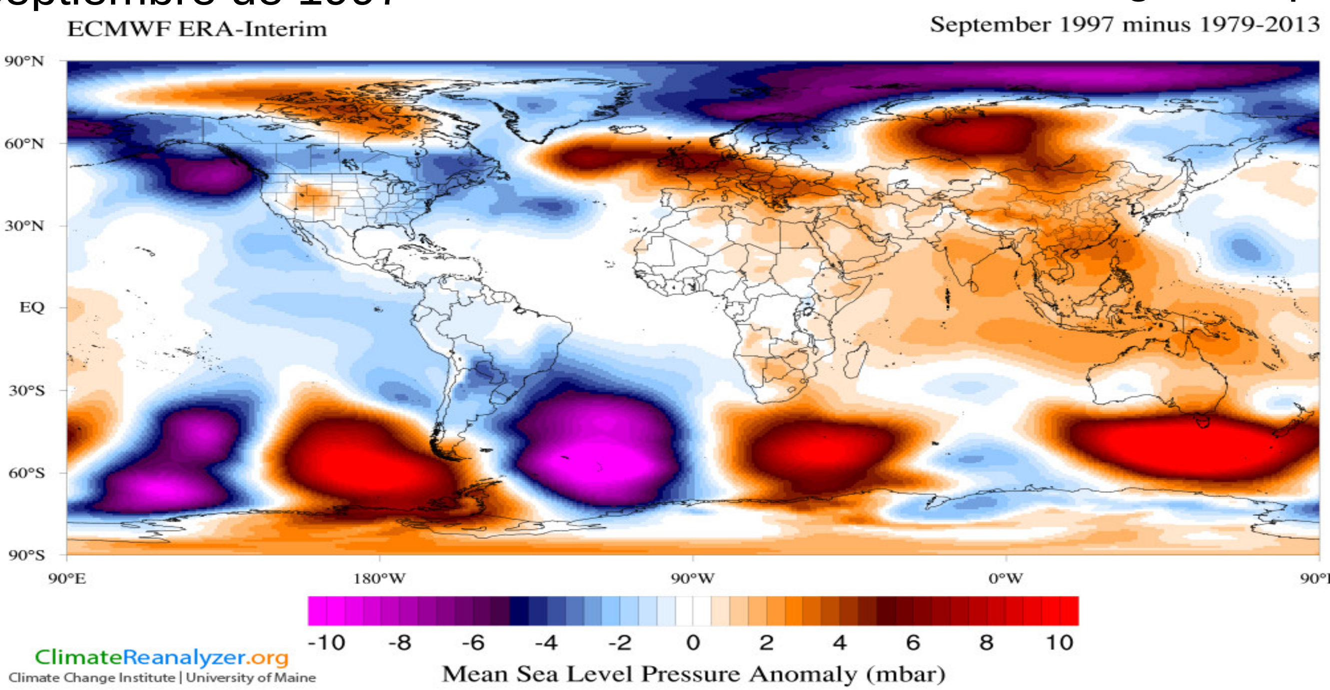






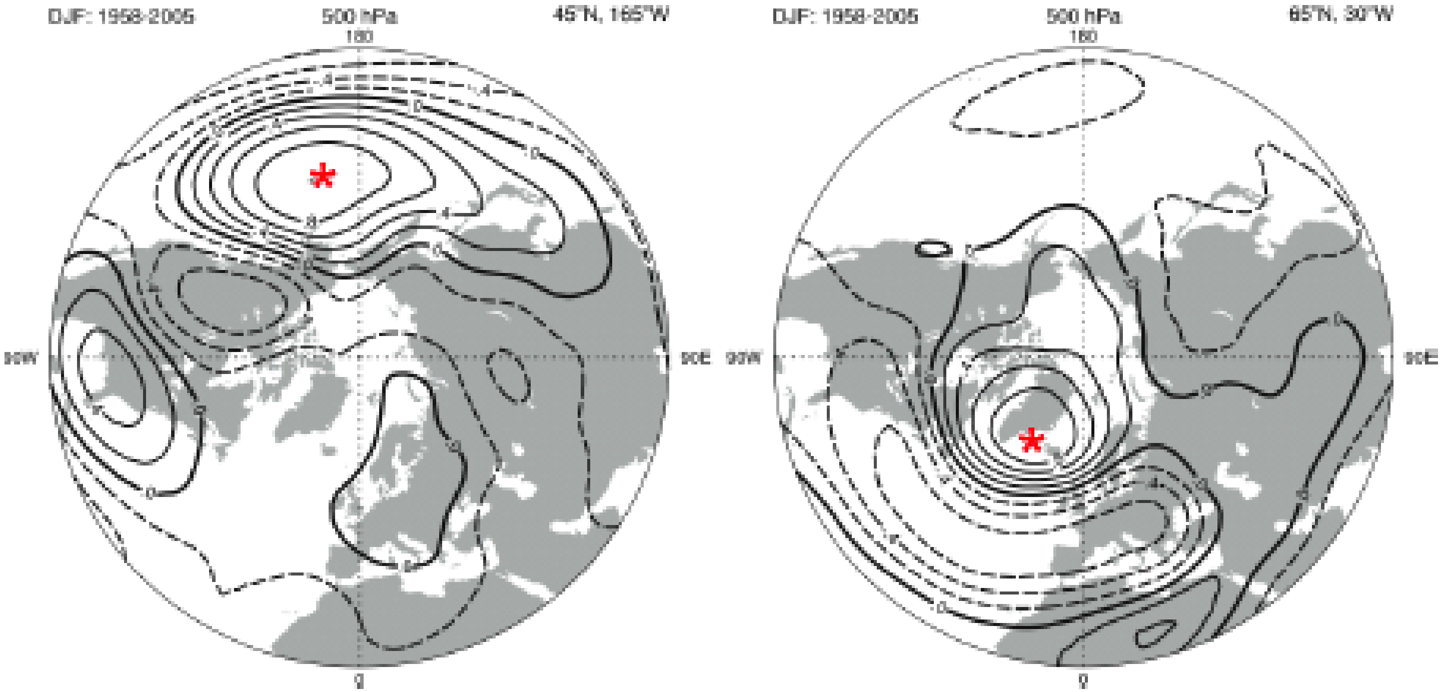
Septiembre de 1997

Climatological september



What are teleconnections?

One definition of Teleconnection Pattern : Regional or planetary-scale pattern of correlated **climate anomalies** in different regions of the world

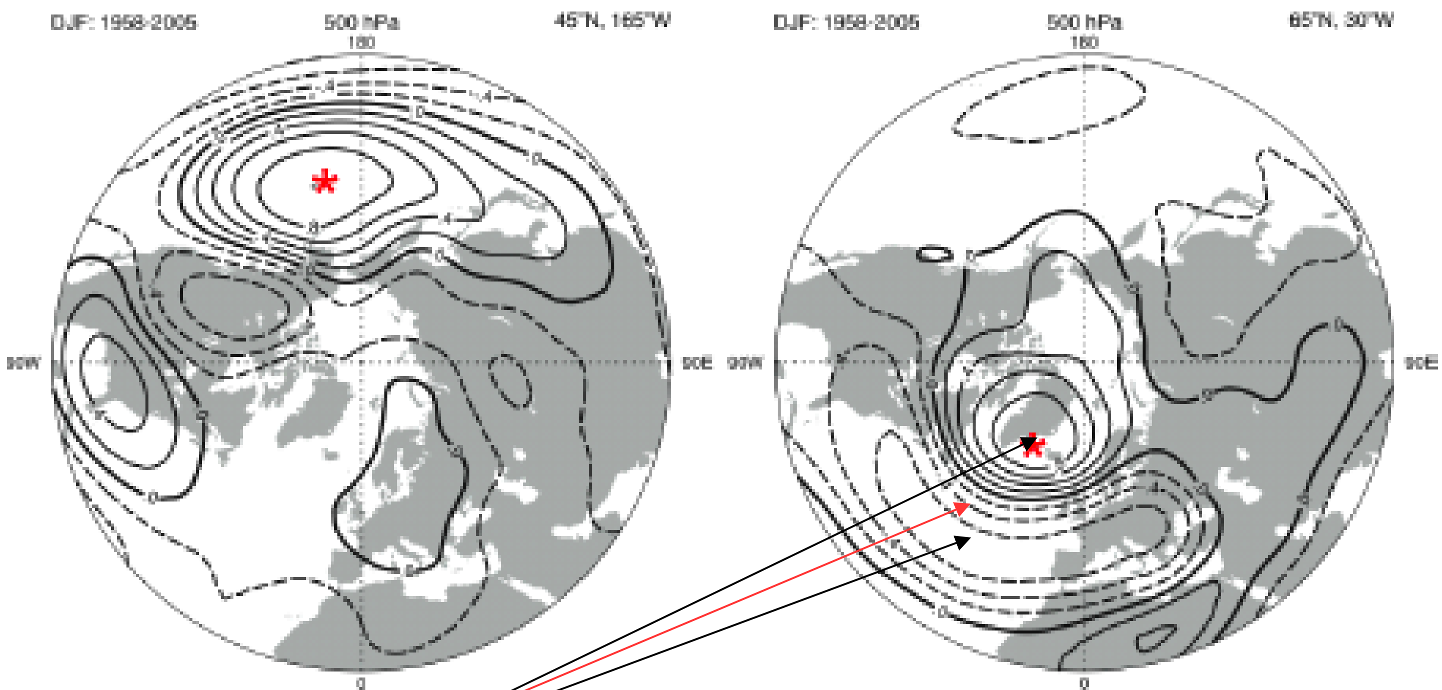


IPCC: from Hurrell et al (2003)

- Walker (1932) used correlation analysis to find the dominant teleconnection patterns, including the NAO.

One point correlation map: correlation between the time serie of DJF 500 hPa (58-05) geopotential height at the * and all the other timeseries from all the other points

Teleconnection patterns define the low frequency variability of the atmosphere and the ocean. They reflect **large scale changes in the atmosphere and ocean** impacting over large areas in rainfall, temperature. They can be the responsible actors in the anomalous meteorological patterns that takes place at the same time in remote regions



-**Center of action:** points in which the connection is extreme. A teleconnection pattern can have several centers of action.

-**Nodes**: points where there is no teleconnection(cero-isoline)

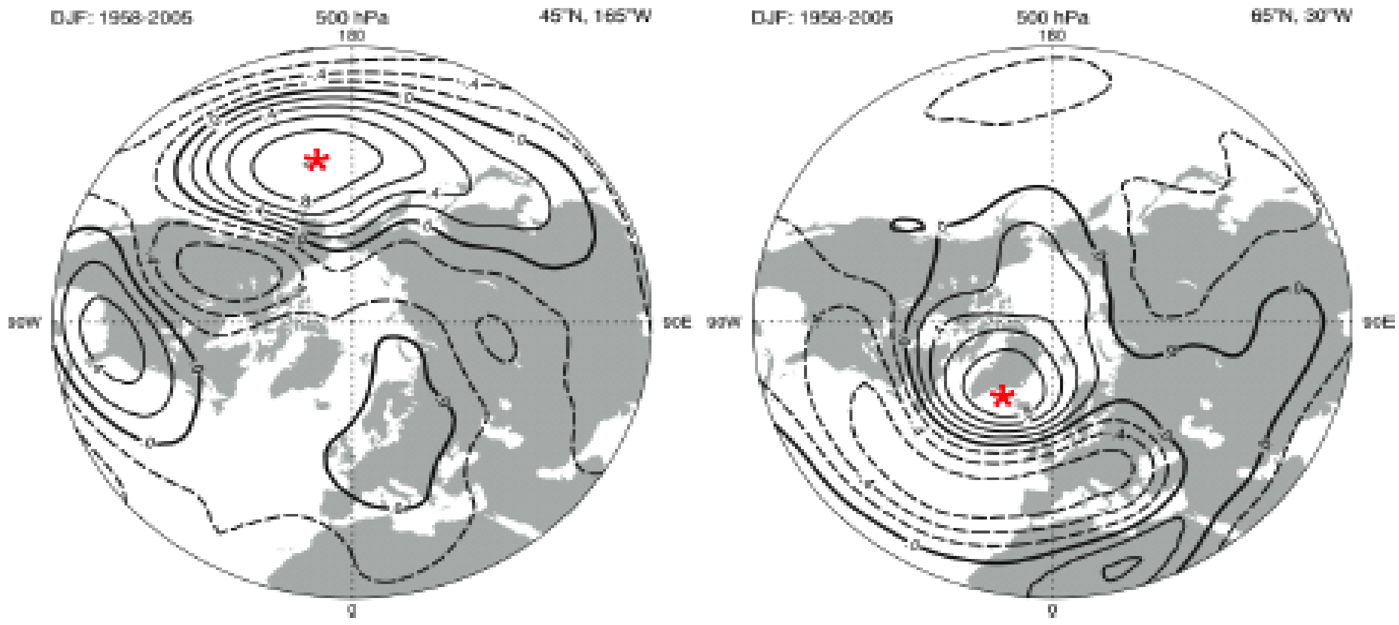
Wallace and Gutzler, 1981; Hoskins and Karoly, 1981

Major atmopheric teleconnection patterns are two :

1-**zonally symmetric global see-saw between polar and temperate latitudes**

Best in sea level pressure More due to internal variability

2-**regional patterns at mid tropospheric levels** . The horizontal scale and spatial projection reflects the steady linear response to a thermal or orographic forcing



IPCC: from Hurrell et al (2003)

Climate variability over the Mediterranean

The climate of the Mediterranean region is to a large extent forced by **planetary scale patterns.**

The role of the Mediterranean Sea itself as source of moisture and the subsequent eastward advection by the atmospheric circulation imply a more complex picture for the Eastern Mediterranean (Corte-Real et al.,1995; Dunkeloh and Jacobeit, 2003; Xoplaki et al., 2004),

NAO: determines a large and robust signal on winter precipitation, which is anti-correlated with NAO over most of the **western Mediterranean** region (Hurrell, 1995; Dai et al., 1997; Rodo et al., 1997; Xoplaki, 2002; Trigo et al., 2004)

Summer NAO

EA pattern: explains more rainfall than NAO

The **central Mediterranean** the **Scandinavian pattern** has a strong influence (e.g. Xoplaki, 2002).

ENSO: different influence depending on the season

Winter : in relation to extreme events (Pozo-Va zquez et al., 2001). Stronger in the Eastern Mediterranean (Yakir et al., 1996 & Price et al., 1998). higher/lower than normal precipitation in Israel have been shown for El Niño/La Niña years. In the west is not clear (Rodó et al., 1997; Rodo´ , 2001; Mariotti et al.,2002a)

The relation is weak (García Serrano et al., 2010)

Spring: relation not statitionary on time (Mariotti et al., 2002a López Parages & Rodríguez de Fonseca, 2012; Lopez-Parages et al., 2014, 2015). Negative relation: Niño related to decreasing rainfall

Fall: Non stationary on time. Different depending of the decades. Strong

Indian ans West African Monsoons (ISM and WAM):

Influence of dry summers in the eastern Mediterranean and the ISM **(Rodwell and Hoskins (1996)**

Influence of the West African Monsoon (Ziv et al., 2004)

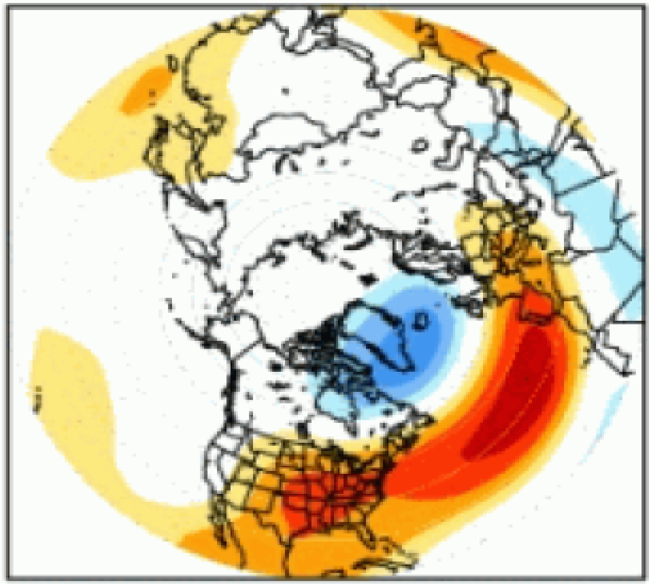
Atlantic Niño

Influence on **summer**

Subtropical North Atlantic (TNA)

Influence on **spring** (ENSO) and **winter**

NAO

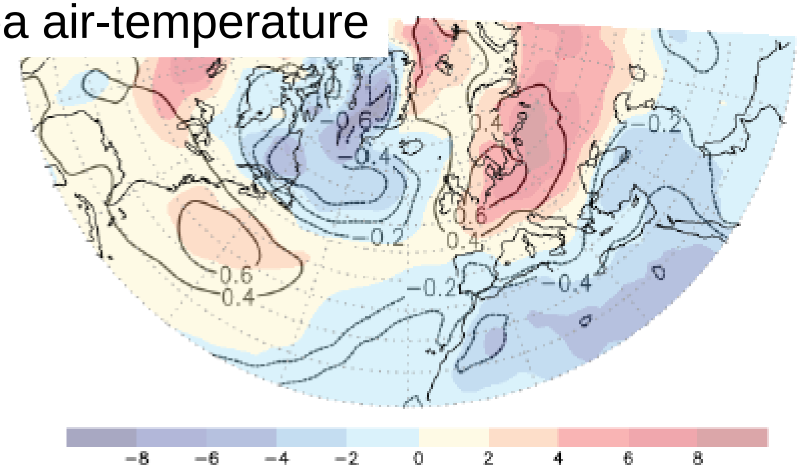


Main Teleconnection patterns over the Mediterranean

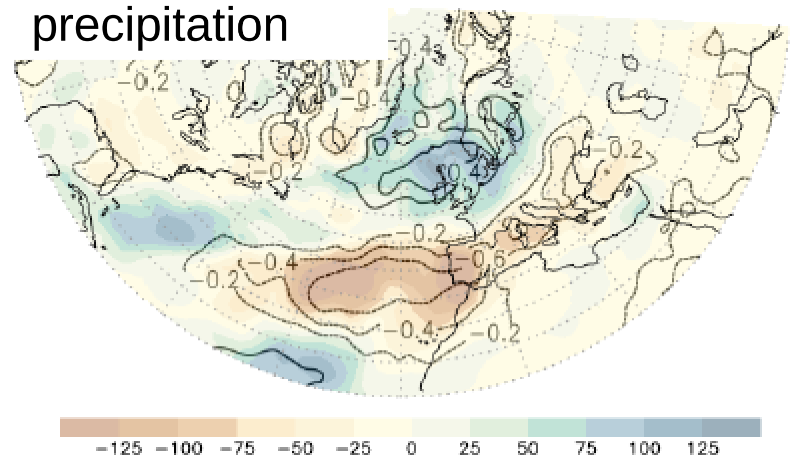
Hurrell, 1995; Dai et al., 1997; Rodo et al., 1997; Xoplaki, 2002;
Trigo et al., 2004; Rodríguez-Fonseca et al., 2006

North Atlantic Oscillation: over the Mediterranean: colder and drier during positive NAO.
Stronger influence on precipitation than on temperature.
Asymetric influence on maximum and minimum temperature (Trigo et al., 2002). It does not explain sum

sea air-temperature



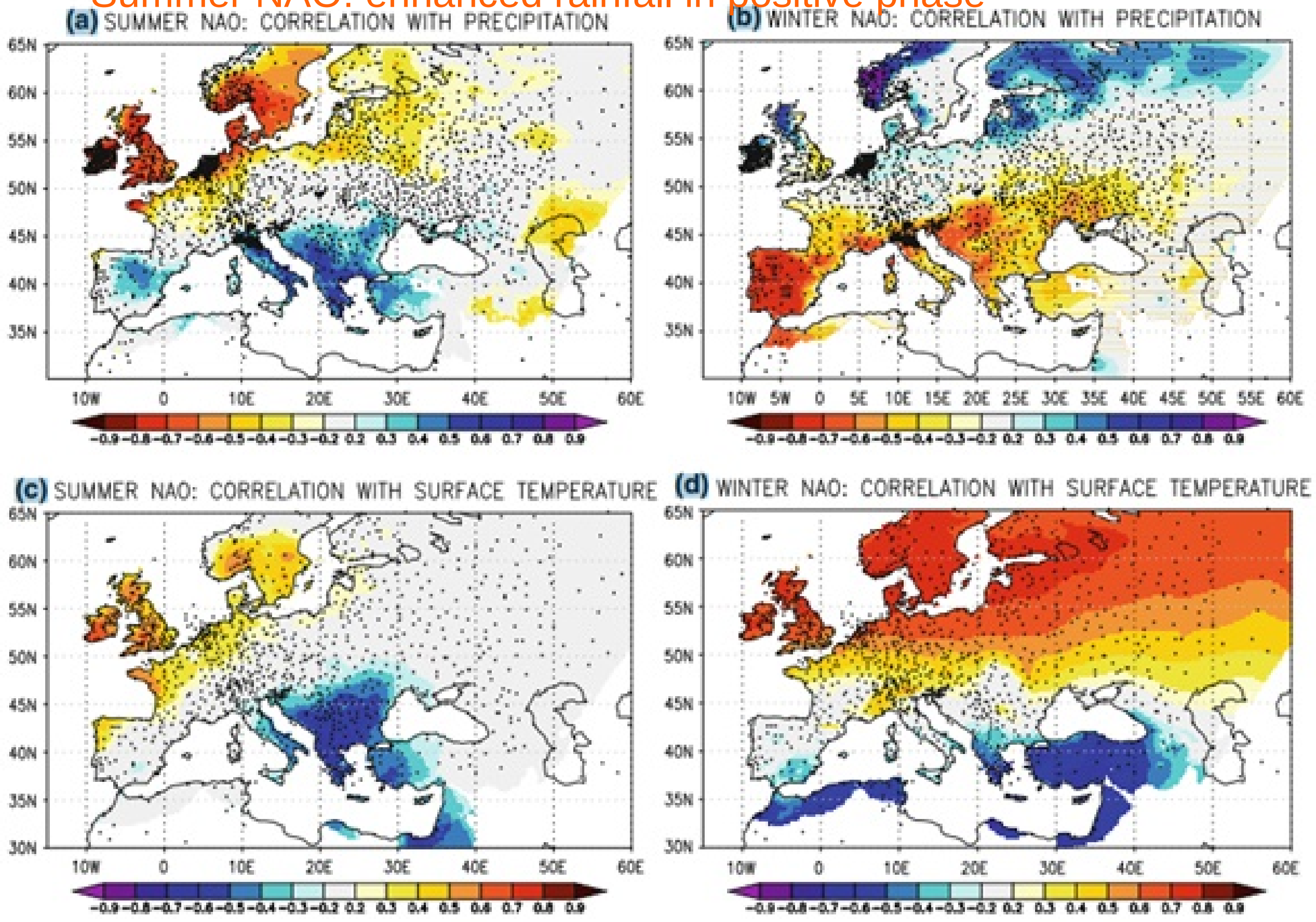
precipitation



Nao influence (correlation map) on the sea air-temperature and precipitation.
From González-Reviriego (2015)

Winter NAO: supressed rainfall in positive phace

Summer NAO: enhanced rainfall in positive phase



Related with an hemispheric upper-level circulation that (in + phase) includes a prominent trough centered over the Balkans, which leads to mid-tropospheric cooling and increased potential instability in the region.

Main Teleconnection patterns over the Mediterranean: The EAST ATLANTIC PATTERN

The **EA** (East Atlantic) pattern plays an important role (Krichak et al., 2002; Fernandez et al., 2003).

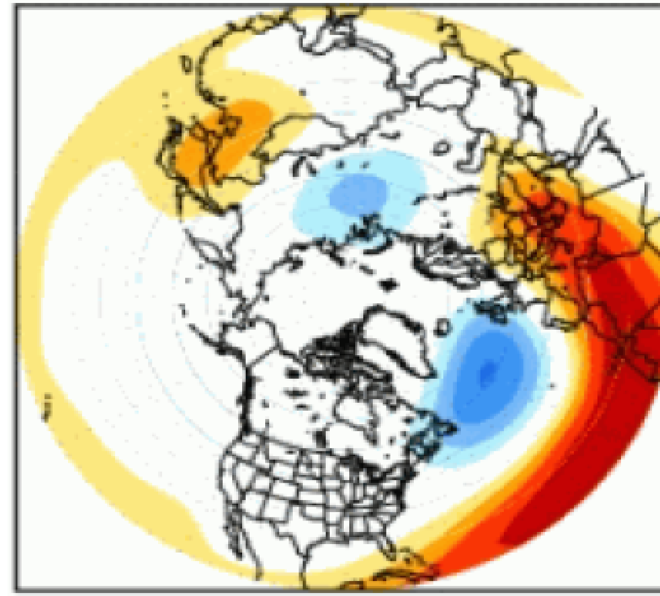
In general, EA describes much of the precipitation anomalies in the whole basin that cannot be ascribed to the NAO (Quadrelli et al., 2001)

Mediterranean rainfall variability in summer has been shown to be related with the EA Jet pattern (Dünkeloh and Jacobeit, 2003)

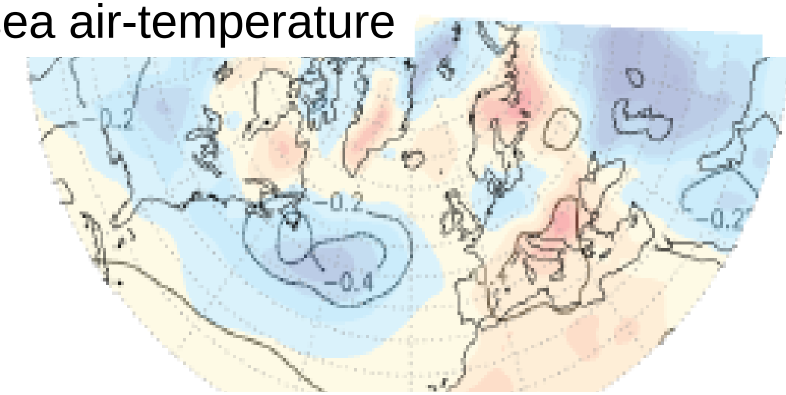
In winter, EA impact is stronger than NAO one (Saénz et al., 2001; Frías et al.,2005)

EA cannot be extended to the eastern part of the basin (Hasanean, 2004)

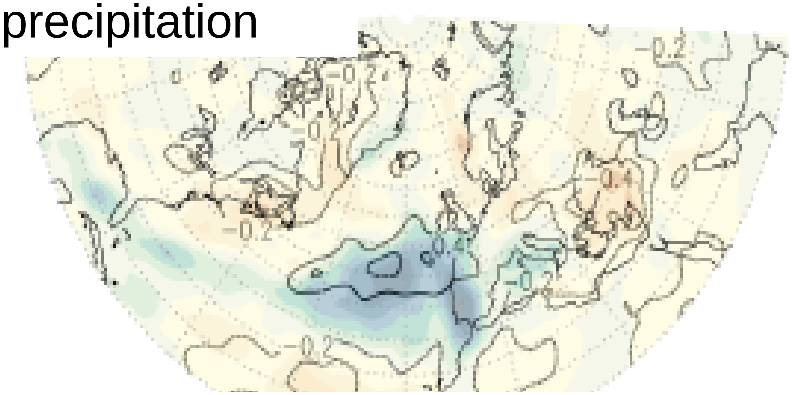
EA



sea air-temperature



precipitation

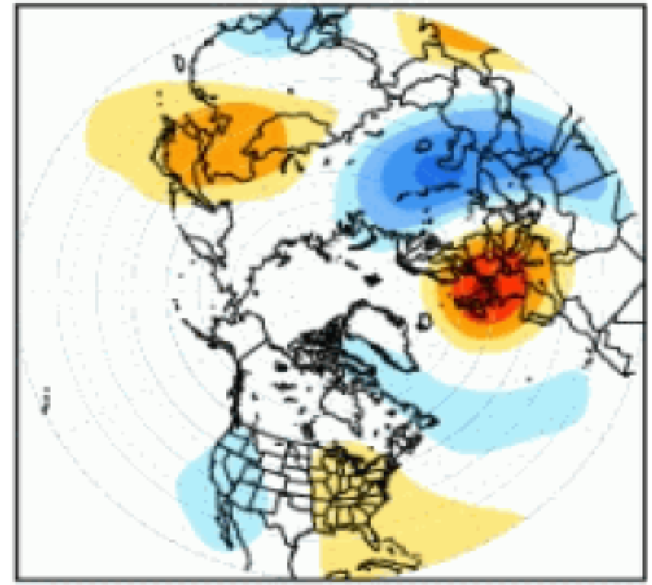


EA influence (correlation map) on the sea air-temperature and precipitation

From González-Reviriego (2015)

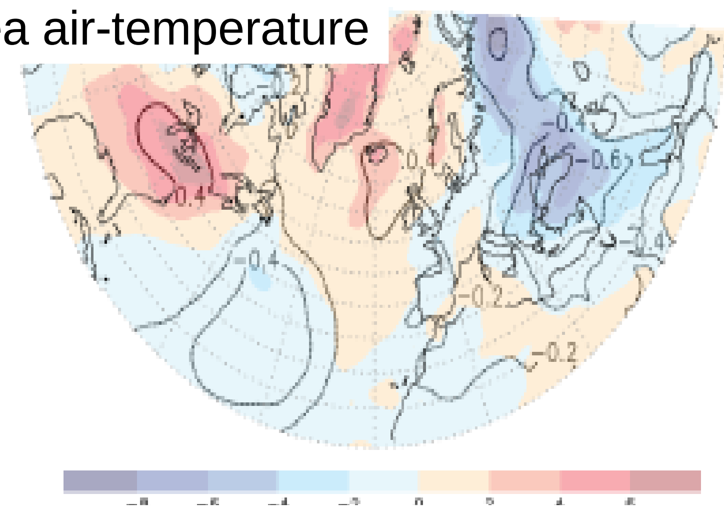
Main Teleconnection patterns over the Mediterranean:
: The EAST ATLANTIC /WEST RUSSIAN PATTERN

EATL/WRUS

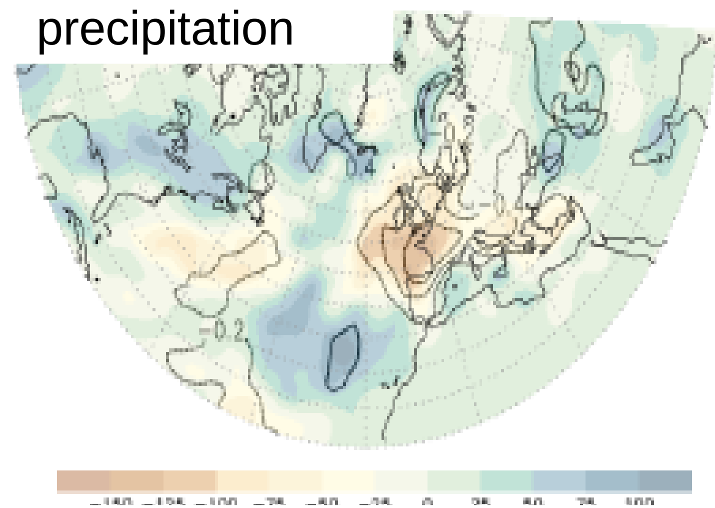


Relation to ENSO? Alpert et al., 2006

sea air-temperature



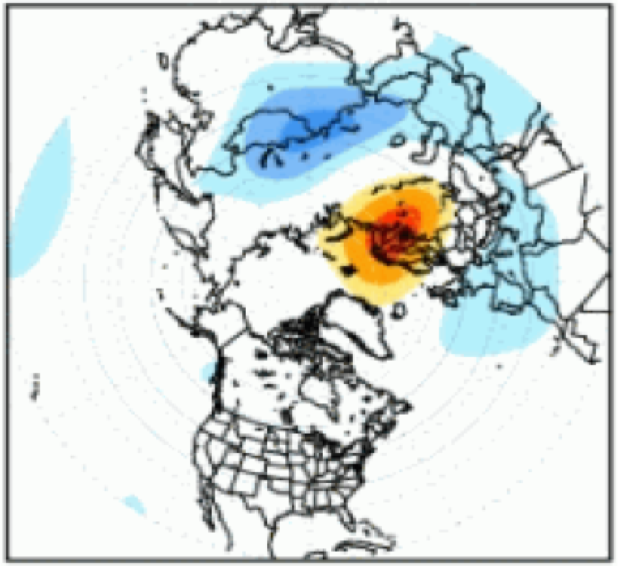
precipitation



EAWR influence (correlation map) on the sea air-temperature and precipitation
From González-Reviriego (2015)

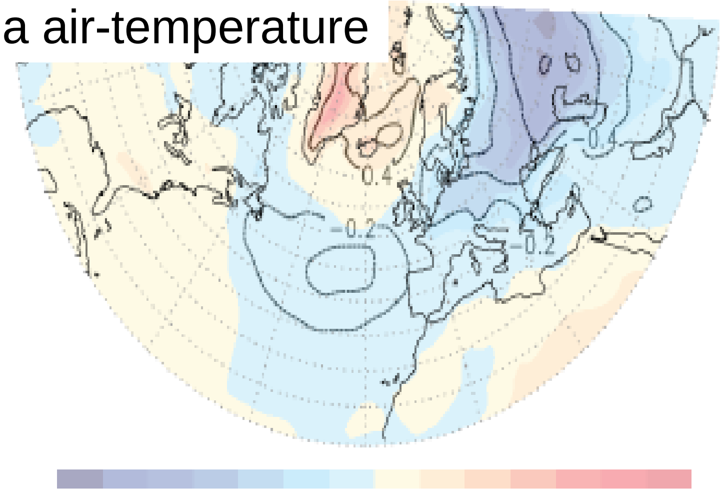
Main Teleconnection patterns over the Mediterranean:
: The SCANDINAVIAN PATTERN

SCAND

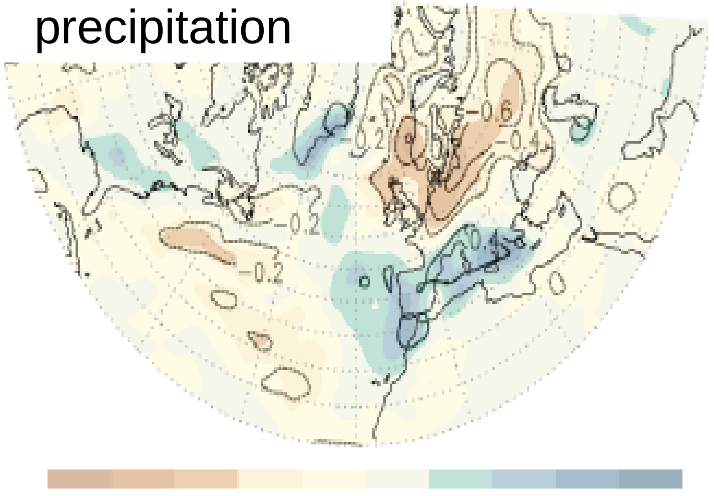


Xoplaki et al., 2002

sea air-temperature



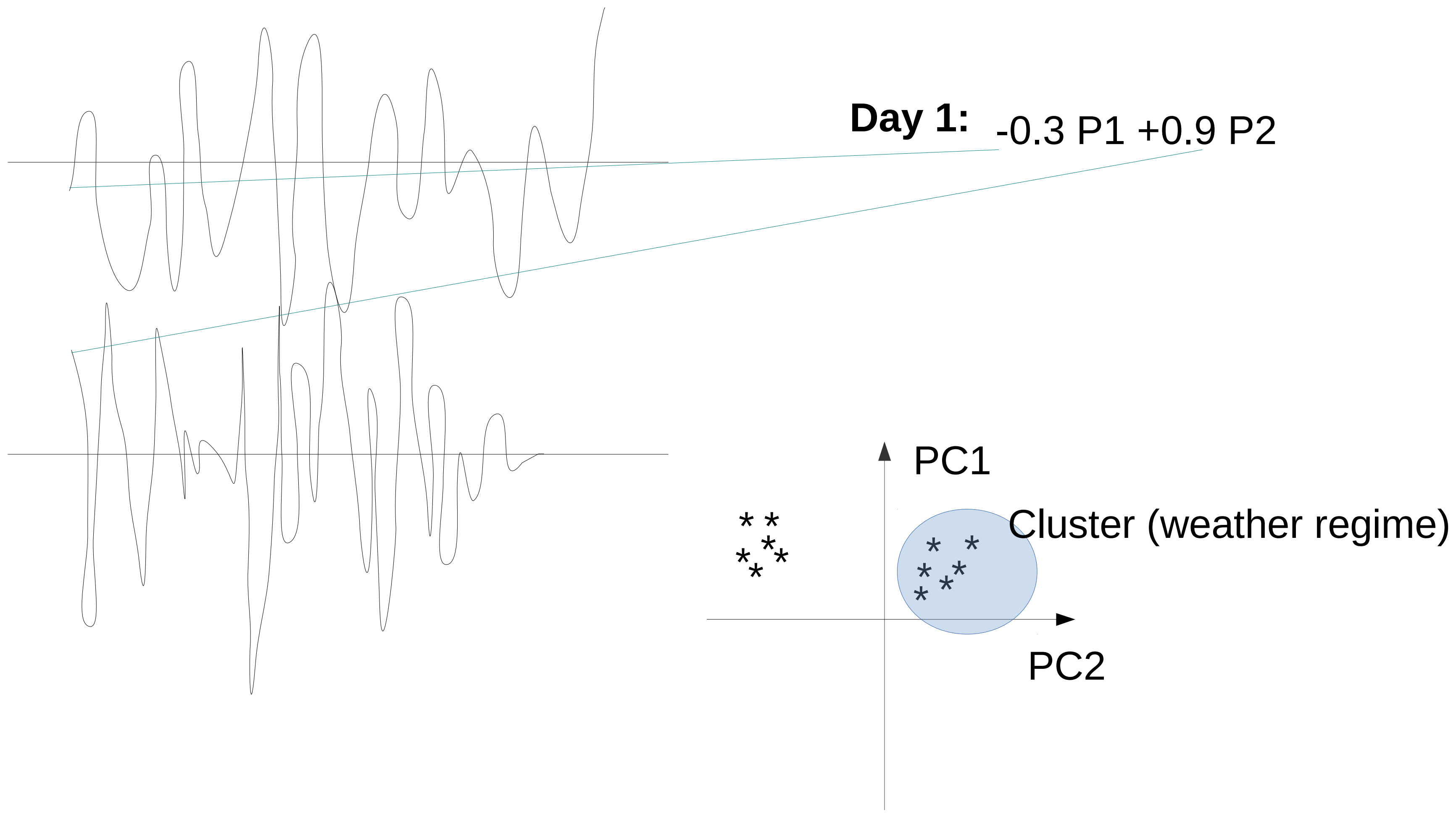
precipitation



SCAN influence (correlation map) on the sea air-temperature and precipitation
From González-Reviriego (2015)

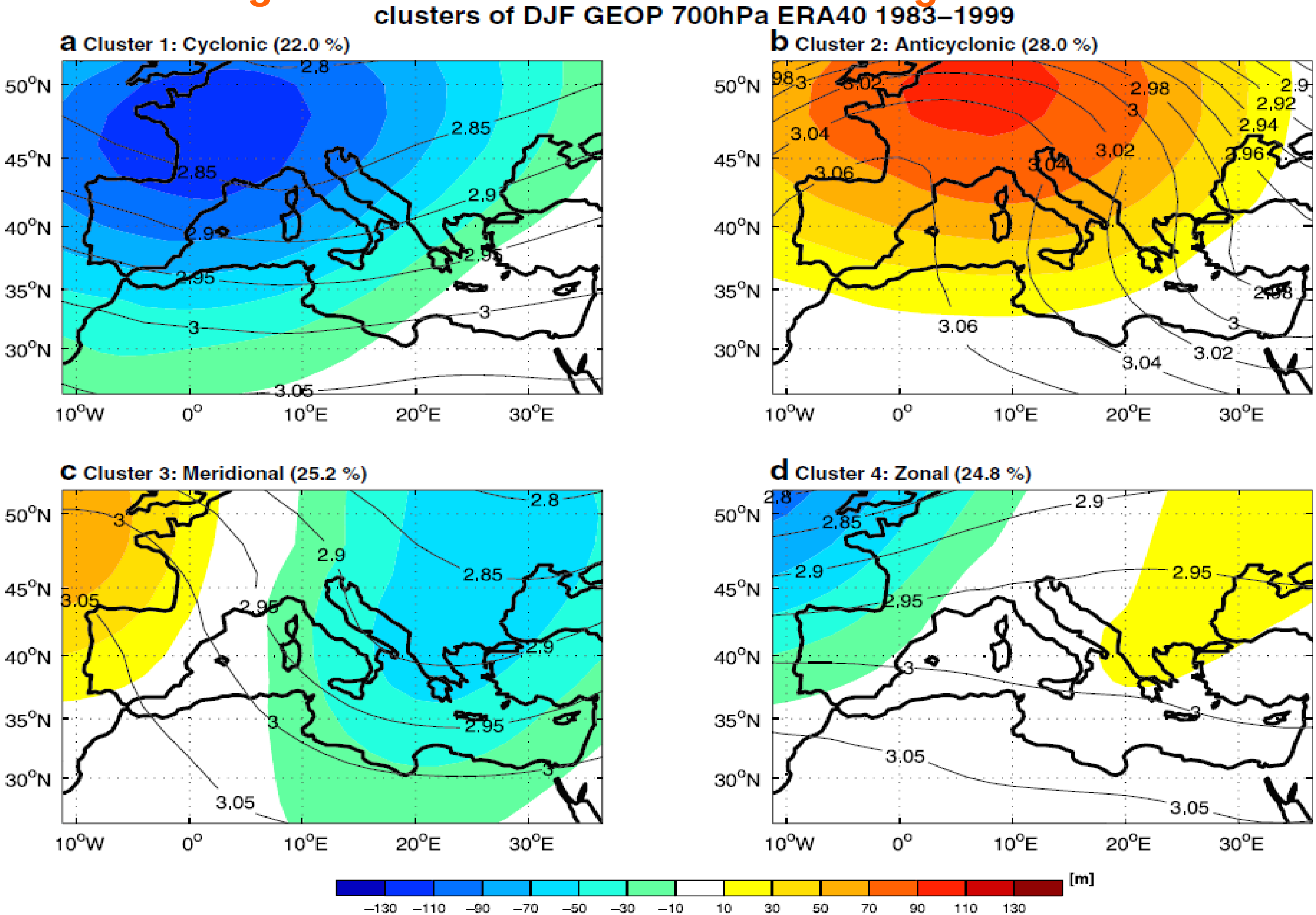
Winter weather regimes over the Mediterranean region:

With the main modes of variability we are able to classify the weather regimes. How?



Rojas et al 2013

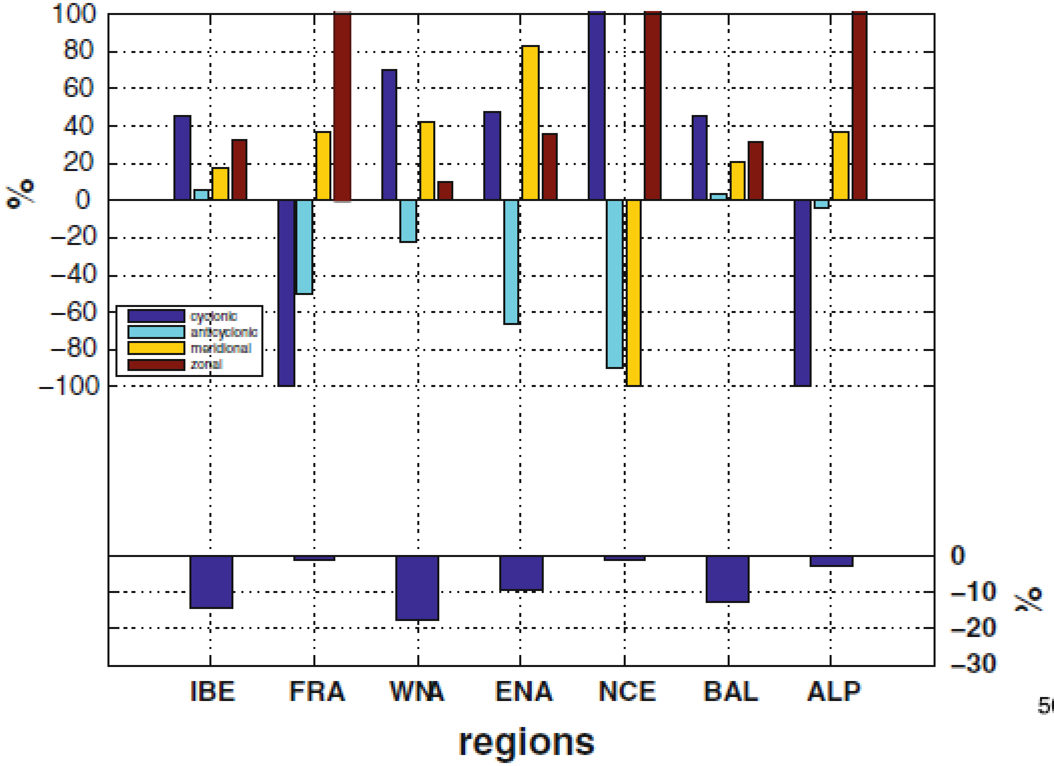
Winter weather regimes over the Mediterranean region:



Climatological (1983–1999) four weather regimes prevailing over the Mediterranean during winter (December–January–February) in terms of geopotential height at 700 hPa (Z700 contours in km). Coloured areas represent the Z700 anomalies (in m) with respect to the climatological fields.

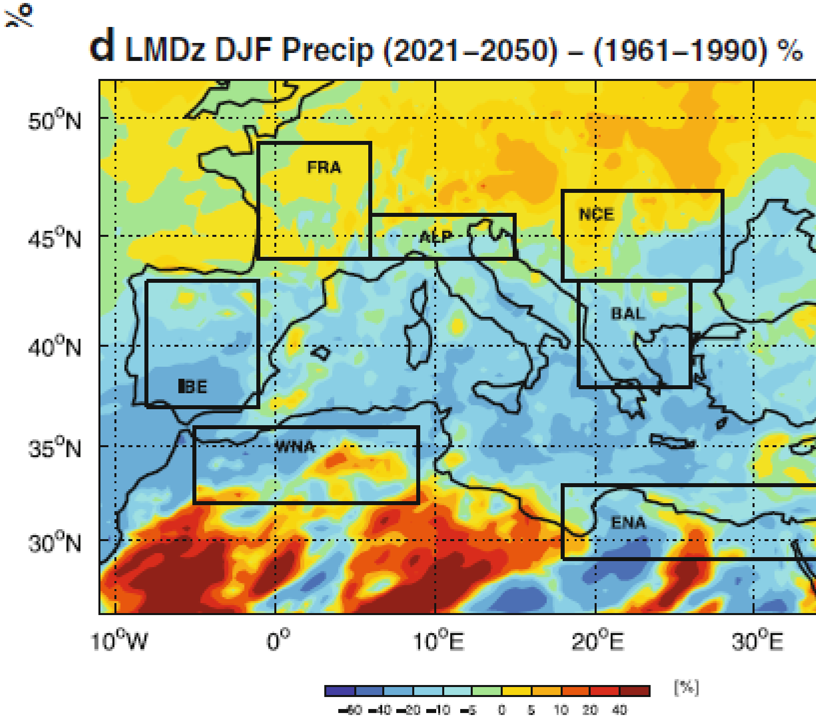
Rojas et al 2013

Winter weather regimes over the Mediterranean region:



Contributions of the weather regimes to rainfall amounts

Rojas et al 2013



Regional precipitation changes for seven regions indicated in Right pannel.
Blue bars (bottom) % precipitation change, 4 colored bars (top) relative contribution of each regime change to precipitation decrease. Negative bar indicates that change in that particular regime contributes to more precipitation to the region


Predictability: from interanual to decadal
The role of the ocean

El Niño de 2015 will be comparable to 1997-98!!!!

The Washington Post (WP Com... (US) | https://www.washingtonpost.com/blogs/capital-weather-gang/wp/2015/08/21/forecast-models-are-now-calling-fo

tarted https://www.faceboo... American Meteorol...

Capital Weather Gang

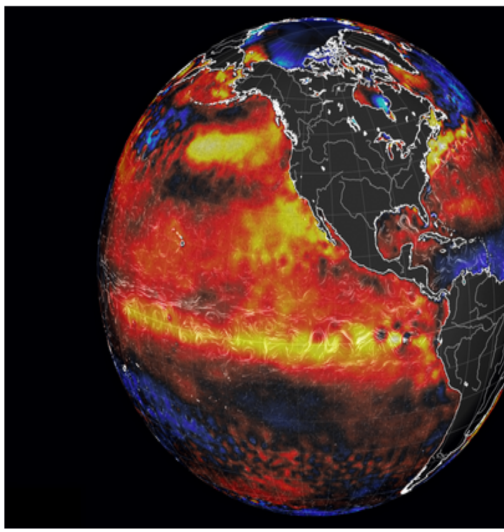
Forecast models are now calling for this El Niño to be the strongest on record

A | 70

Earn up to a $500 BONUS Capital One 360

By Angela Fritz August 21 Follow @angelafritz

ROSENTHAL AUTO

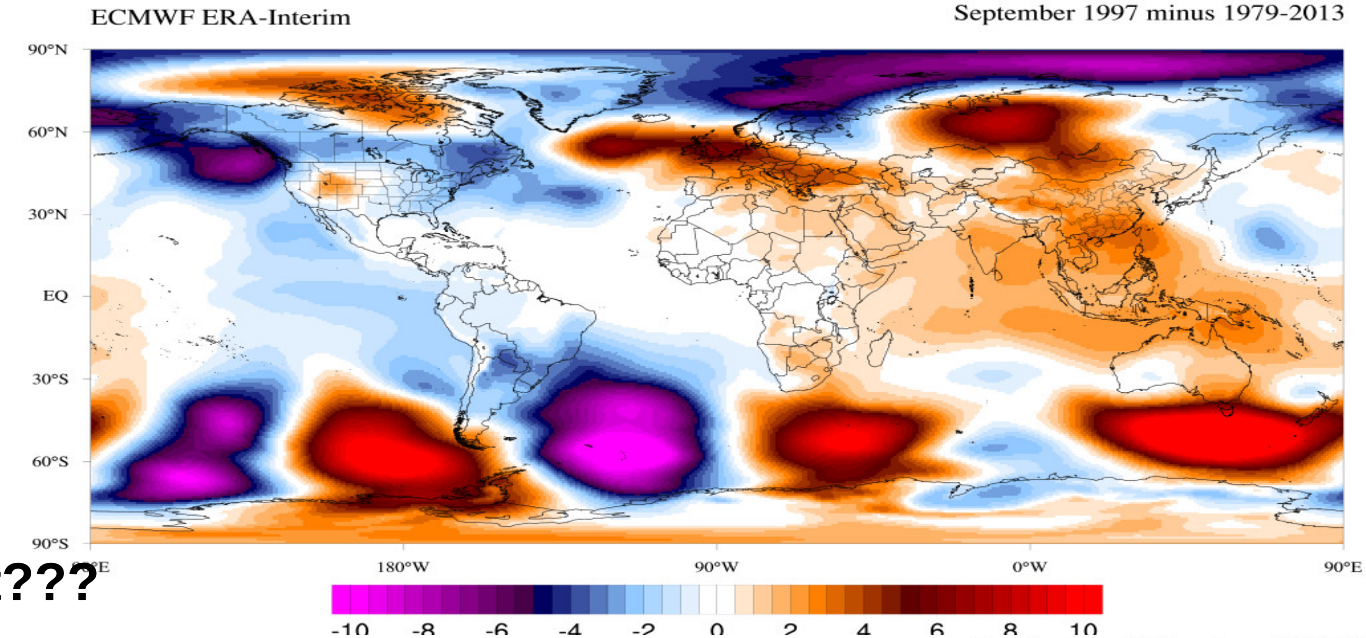


Forecast models are now suggesting that this El Niño could be stronger than th 1997-1998. (earth.nullschool.net)

News > World > Australasia Frontpage >

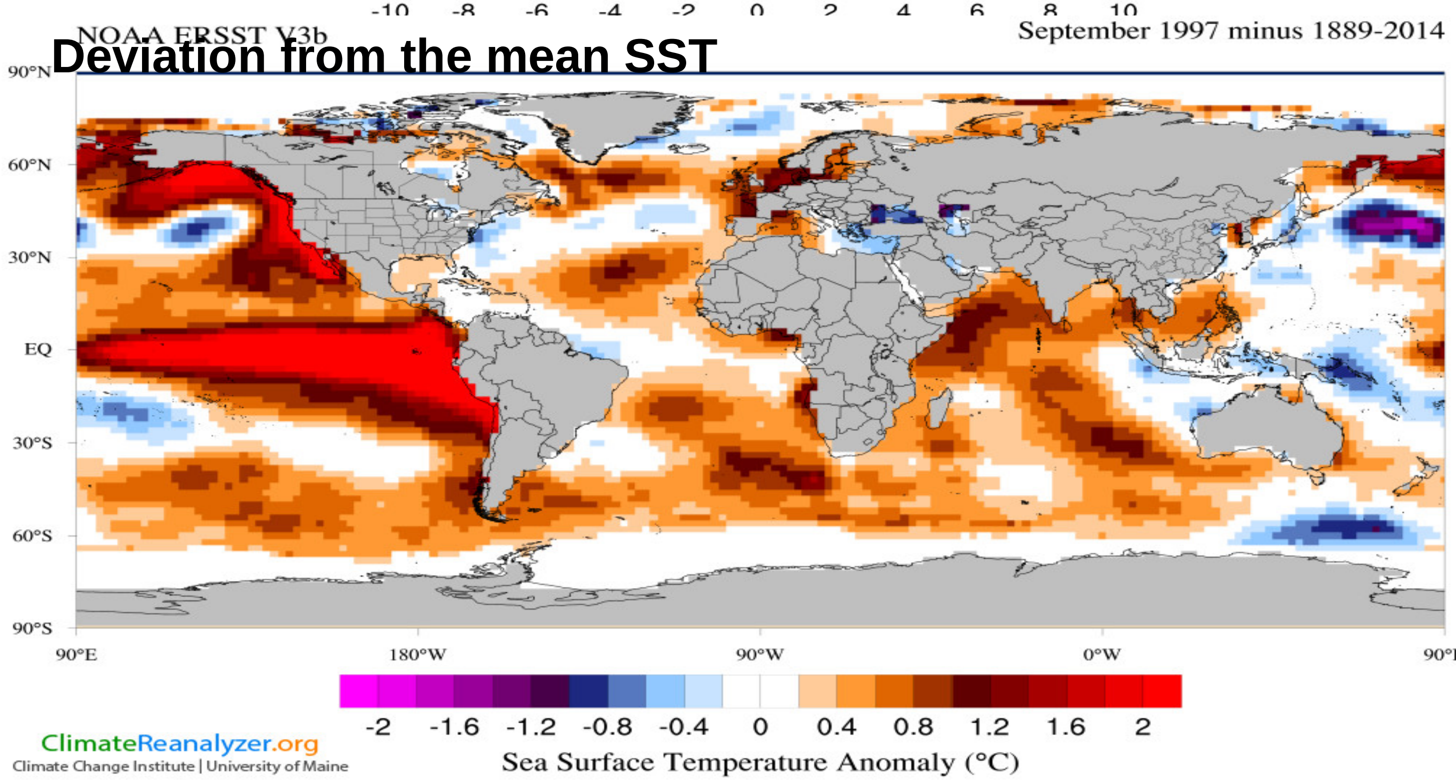
El Nino arrives in the Pacific Ocean and its effects could be 'substantial' – but what does it mean for the UK and the rest of the world?

Deviation from the mean SLP

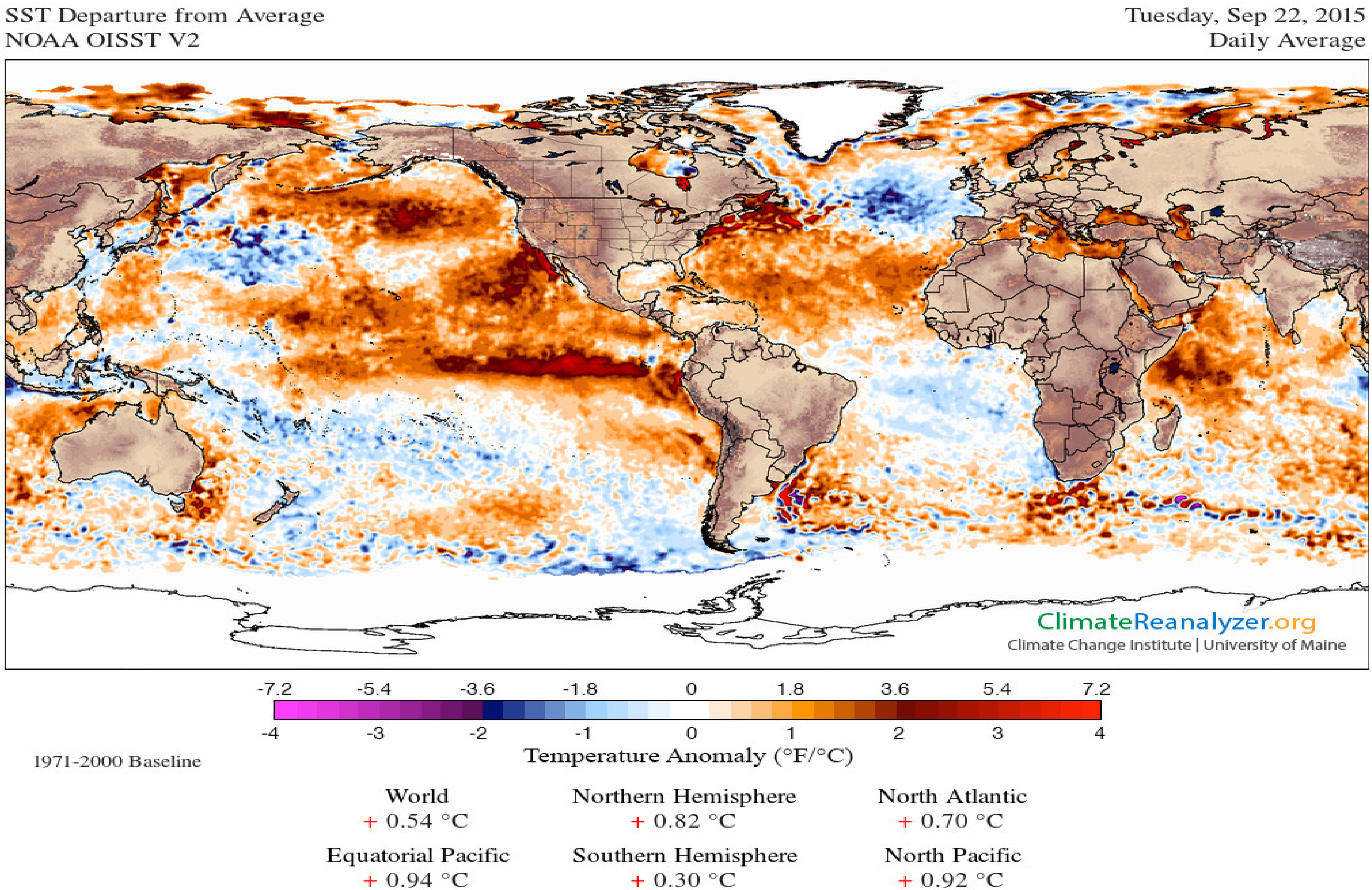


cause- effect???

Deviation from the mean SST



Why a 3 C of oceanic warming is important?



How much heat can be realeased beause of a 1C?

$$\Delta E = m \cdot C_p \cdot \Delta t$$

$$C_p = 410^3 \, JKg^{-1} \cdot C^{-1}$$

E= 5 10 ^{11} J by 1º C

E= 15 10 ^{12} J by 3 ºC in the first 300 m of the ocean

Application: Climate Services

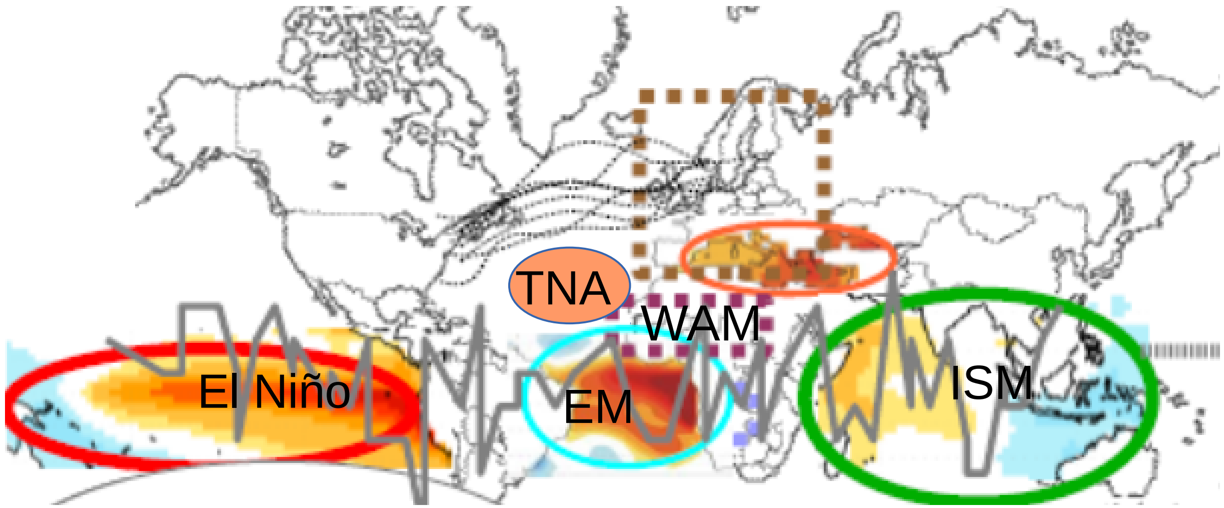
There is predictibility from seasons before and, from information from SST variability we can mitigate the effects od take advantages...

Fisheries

agronomy

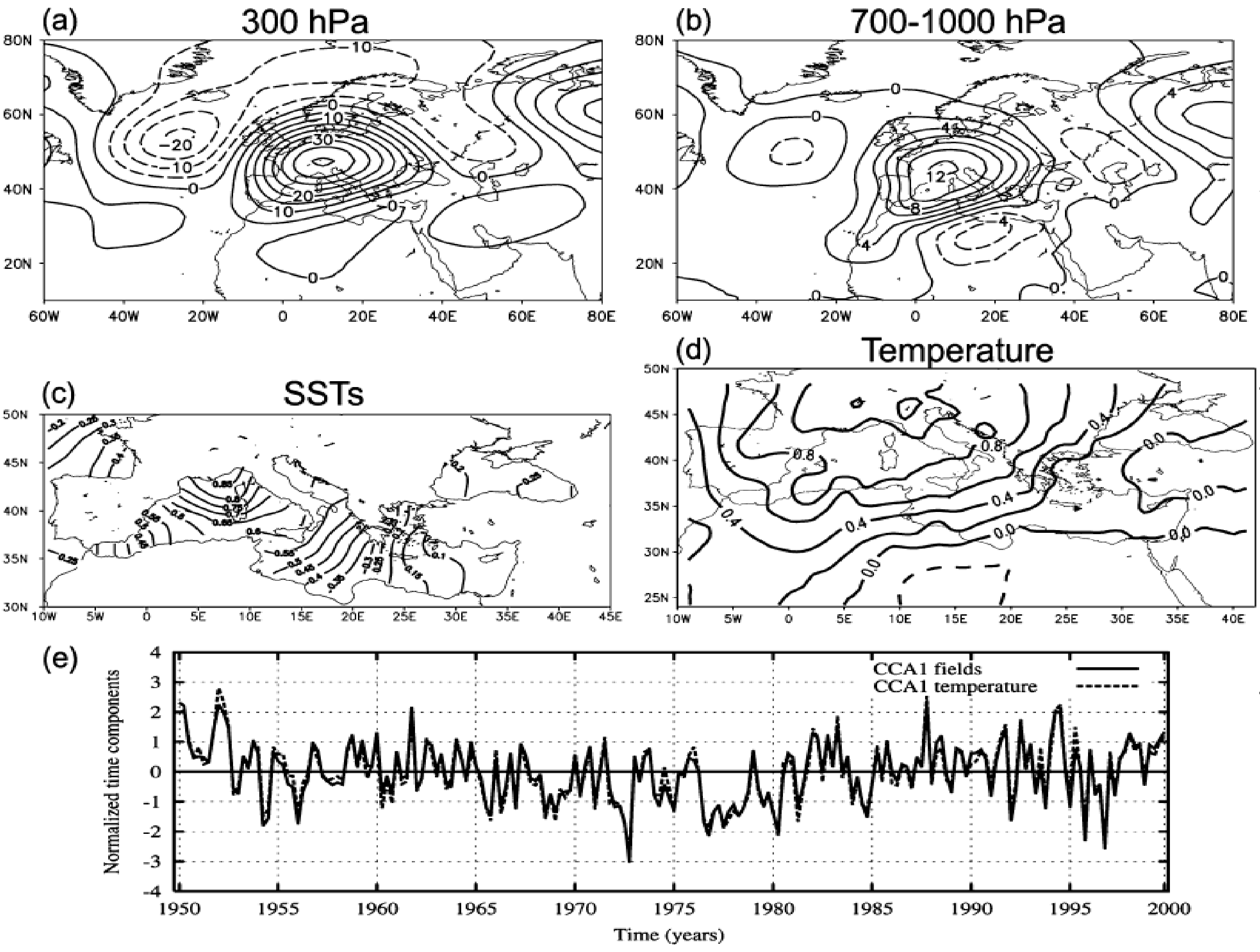
health

Principal regions and months that give seasonal predictability in Mediterranean



En	Feb	Mar	Abr	May	Jun	Jul	Ago	Sep	Oct	Nov	Dec
Internal Ciclones TNA MED	El Niño + TNA MED	El Niño + TNA MED	El Niño + TNA	EM	EM	EM ISM WAM	EM ISM WAM	EM ISM WAM MED	TNA El Niño MED	TNA El Niño MED	Internal Ciclones TNA MED

Mediterranean summers : connected with a main mode, characterized by strong positive geopotential anomaly covering large parts of Europe including the Mediterranean area, associated with blocking conditions, subsidence, stability, a warm lower troposphere, small pressure gradients at sea level as well as above-normal Mediterranean SST (Xoplaki et al., 2003)



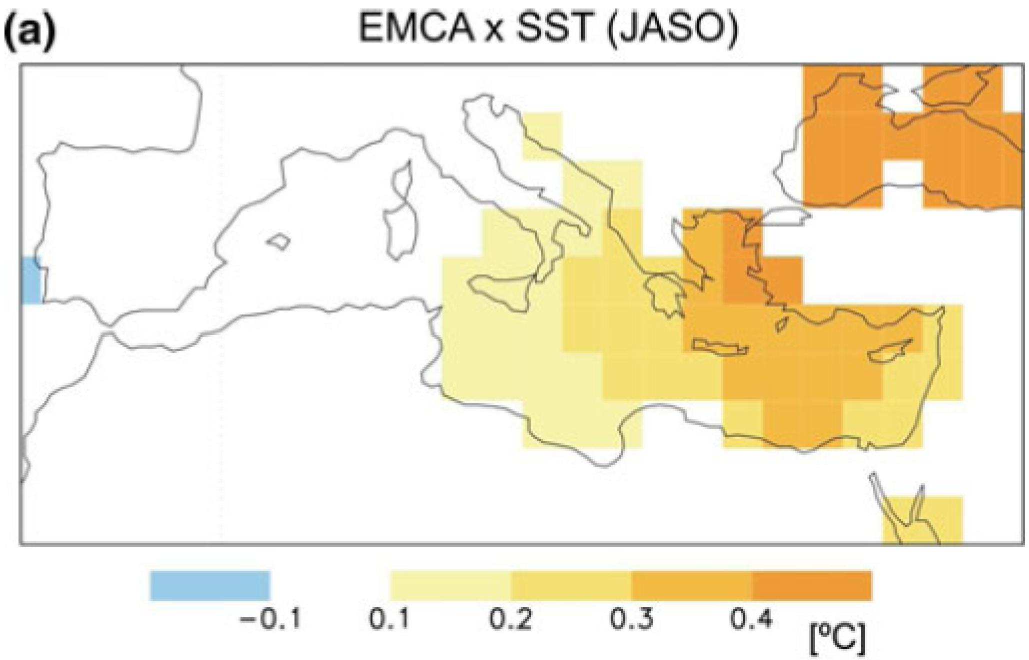
Western Mediterranean SSTs:

Warmer Mediterranean summers characterize the 1950s, 1980s and 1990s and cooler summers were prevalent from the mid-1960s to the mid-1970s.

Significant warming of 0.05 C/decade over the 1980 to 1999 period.

For the whole twentieth century, significant upward trend is of the order of 0.05 C/ Decade.

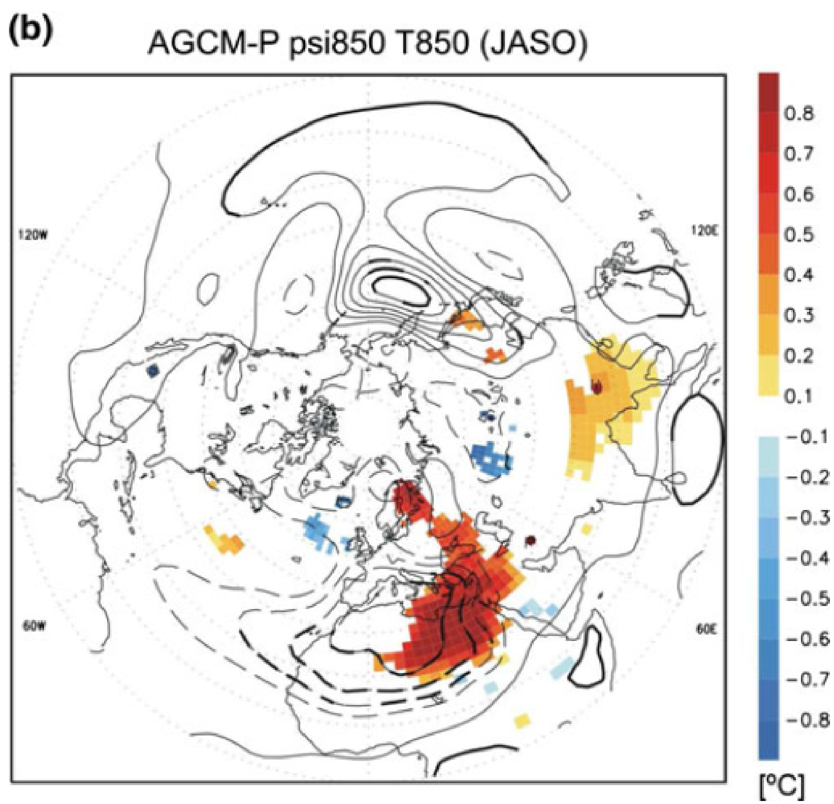
Relation to AMO (Guemas et al 2015) which increases predictability

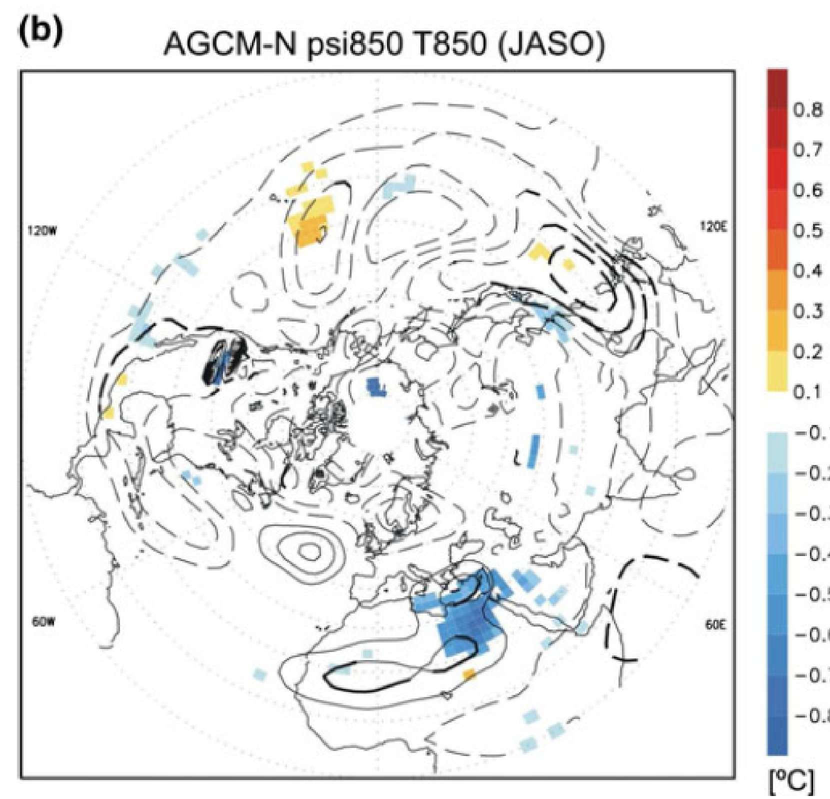


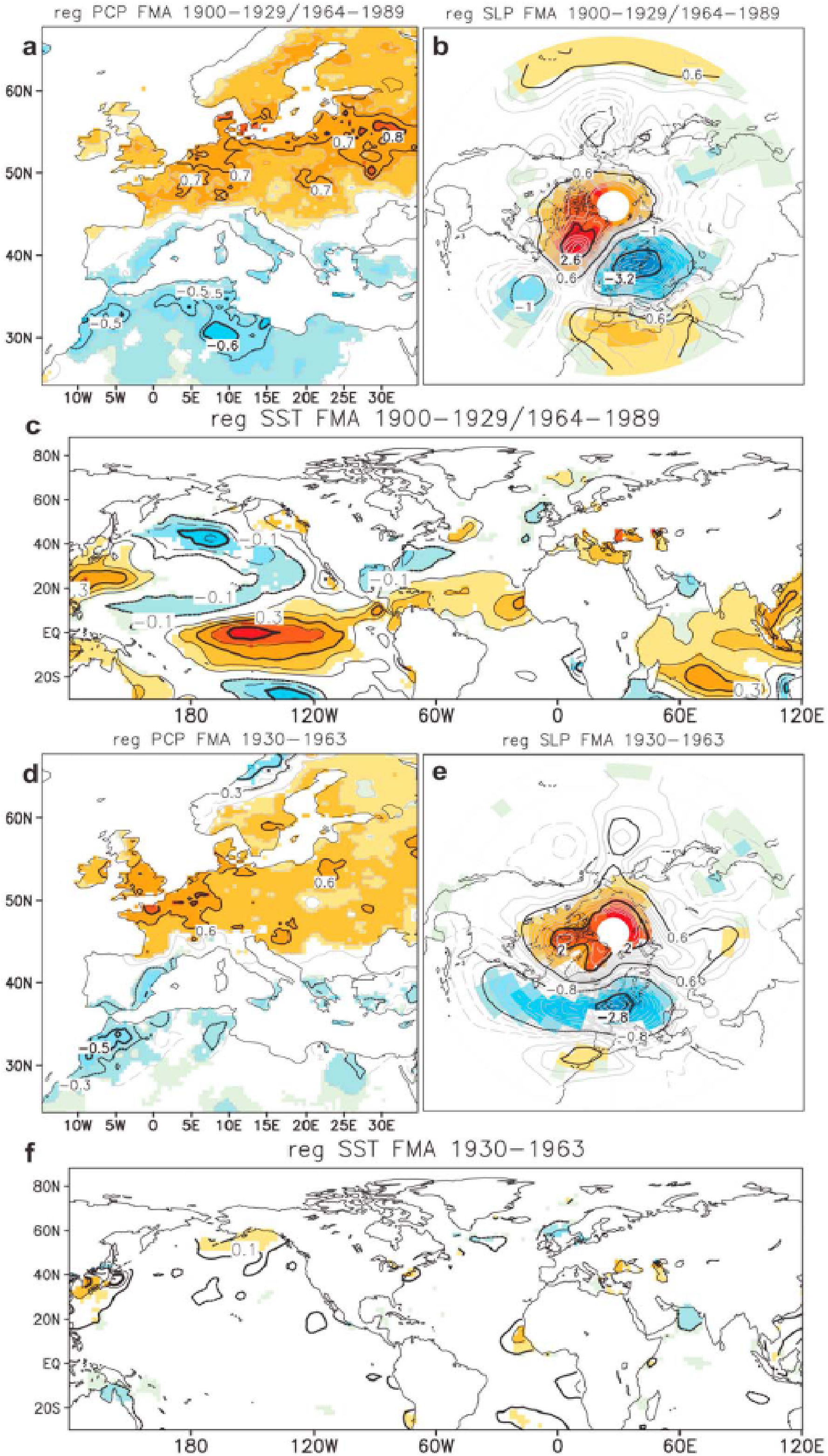
García -Serrano et al 2013
Xoplaki et al., 2003
Li , 2006

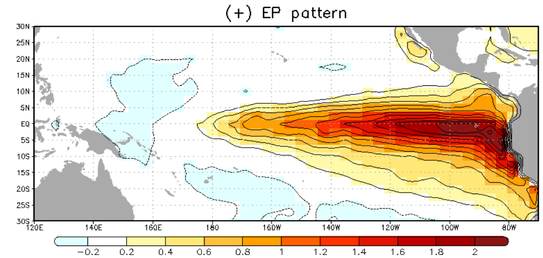
The western Mediterranean warming is related to higher summer-fall temperatures

The **eastern Mediterranean** SST is abe to initiate a global atmospheric teleconnection during wintertime









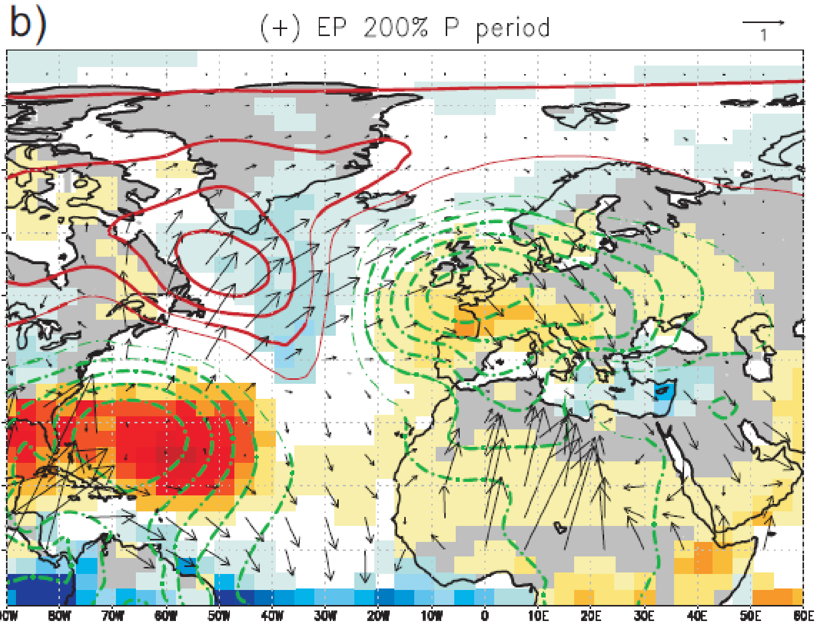
SPRING
observational analysis: increase of rainfall . Relation to negative NAO. Non stationary influence

López-Parages et al, 2012 , GRL

Aplication to climate services: this relation has been found in the Lugo maize crop yield, which increases under a Niño

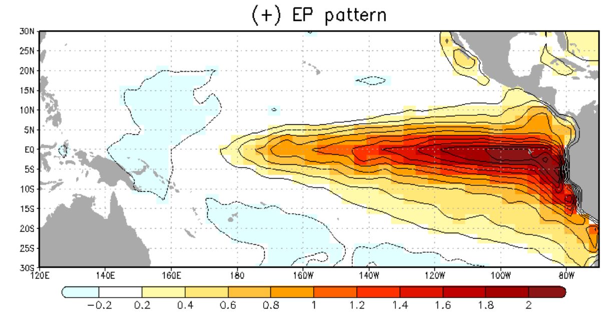
Capa et al (2013), Agricultural and forest meteorology

SPRING
Models

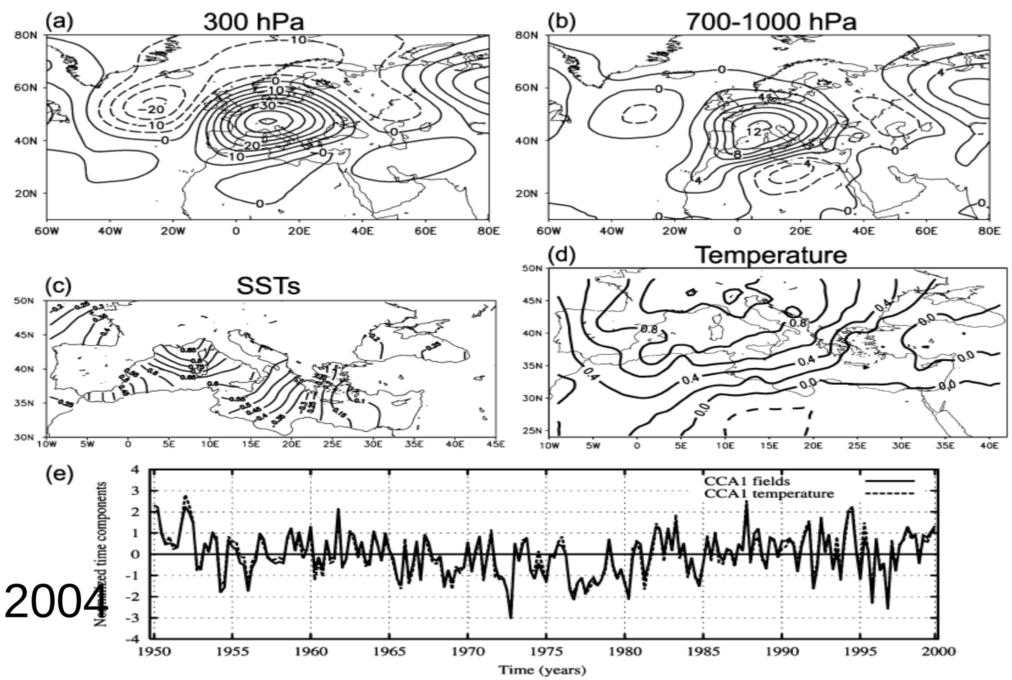


shaded: rainfall (increment in orange)
Contours: SLP
Arrows: Wave Activity Flux

The strong El Niño produce an increase of rainfall in the north of Spain and central Europe in spring

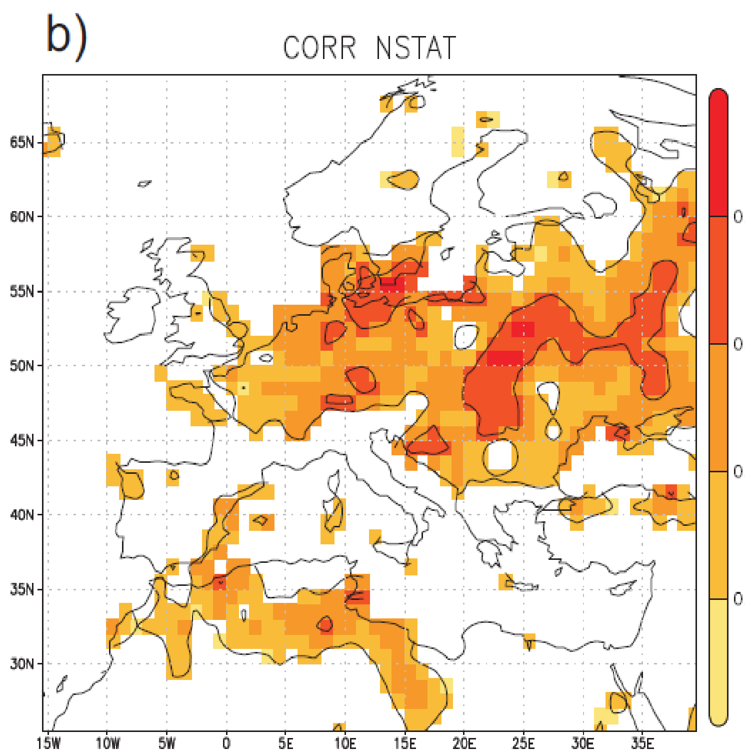


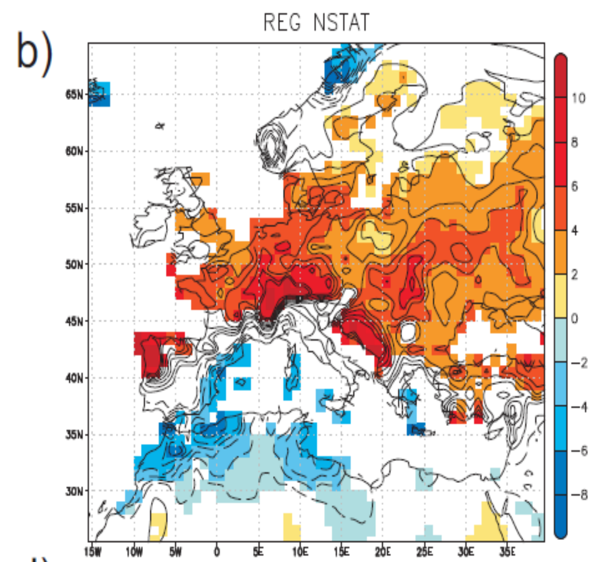
López Parages et al. (2015)

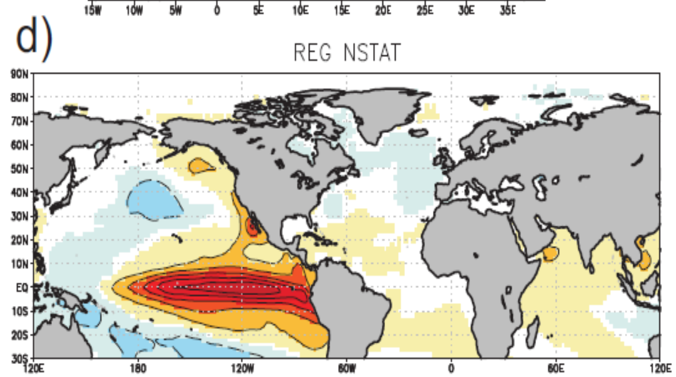


Xoplaki et al 2003,2004

Aplication: Modelo estadísitico **S4CAST** (SST-based Statistical Seasonal Forecast)

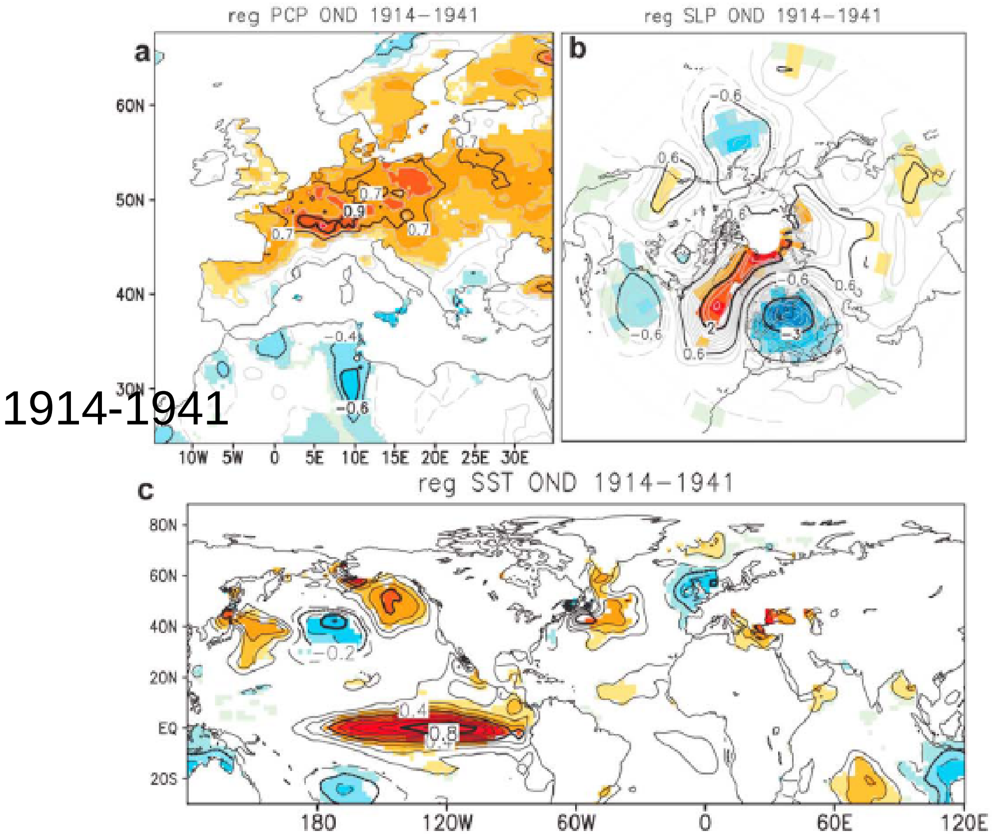






Significant correlation between observations using just El Niño

Suarez and Rodríguez de Fonseca, 2015



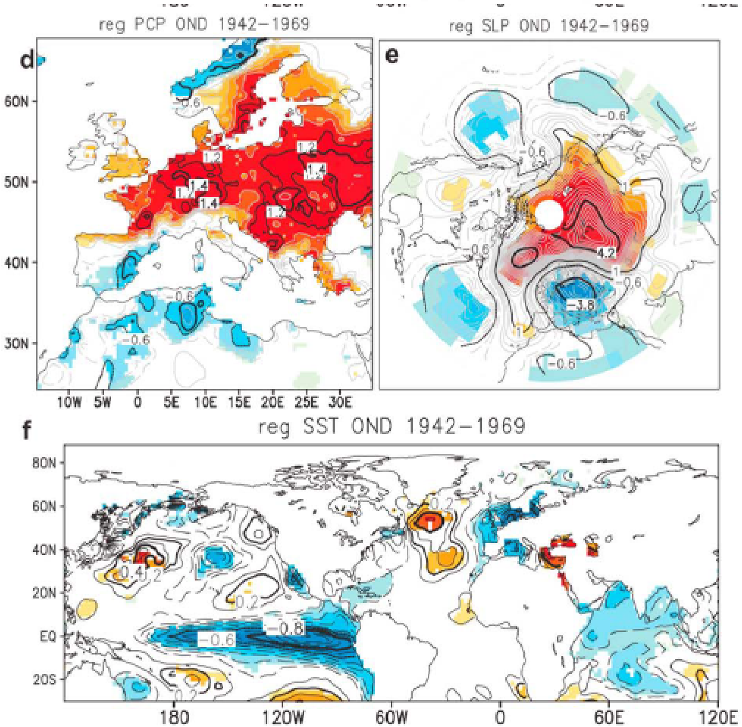
FALL

observational analysis: increase or decrease of rainfall depending on decades.

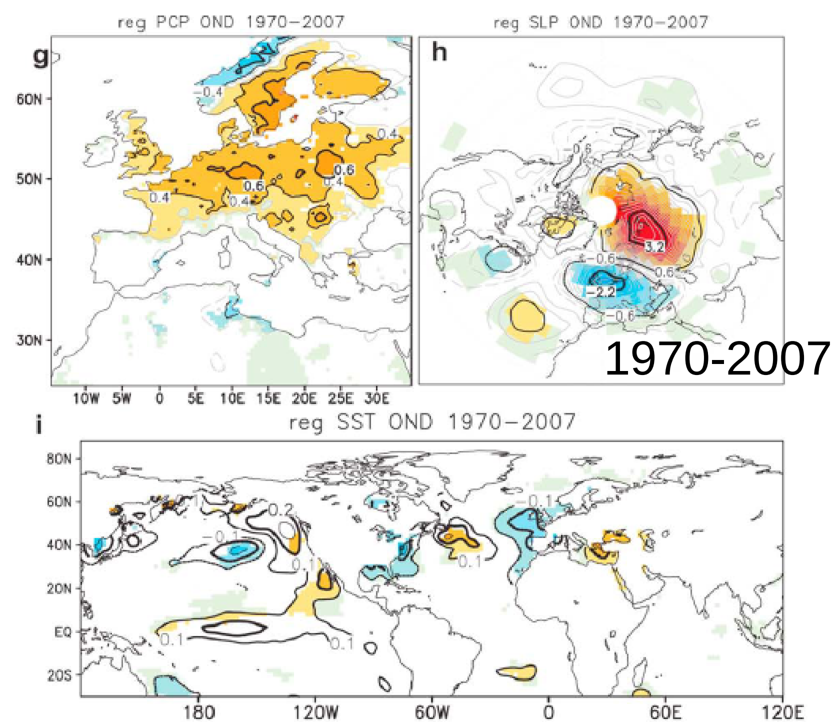
Relation to NAO.

Non stationary influence

López-Parages et al, 2012 , GRL



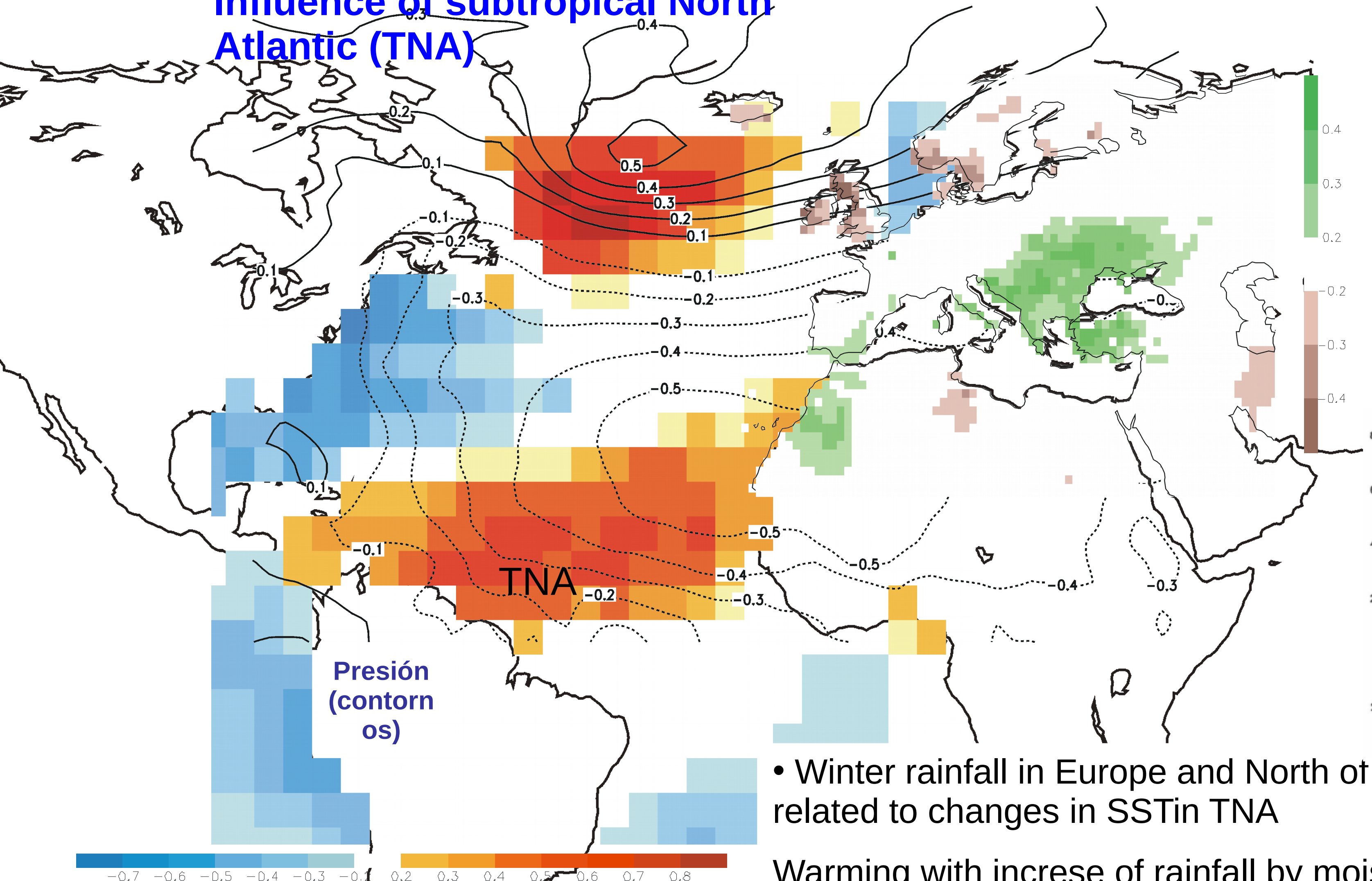
1942-1969

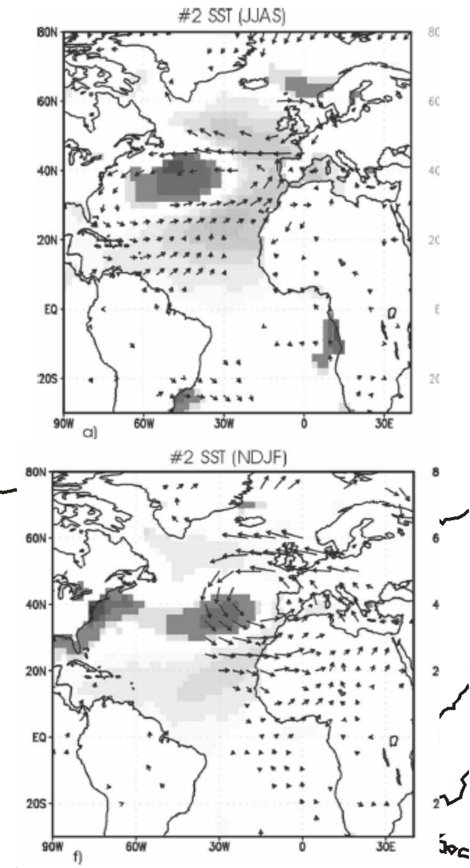


WINTER

Rodríguez-Fonseca & Castro, 2002
Polo et al, 2005; Garcia -Serrrano et al 2008
Rodríguez-Fonseca et al, 2006

Influence of subtropical North Atlantic (TNA)





Presión (contornos)

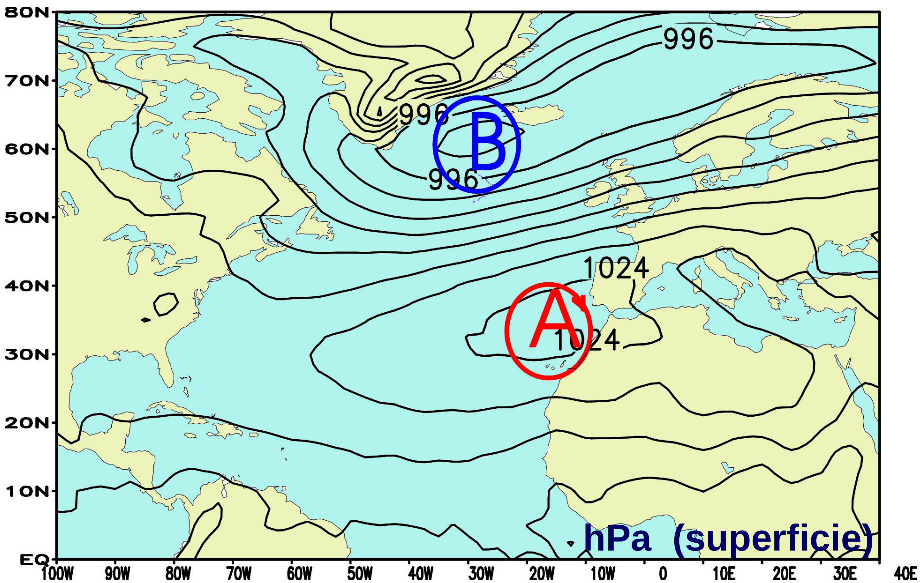
Sombreado(temperatura de la superficie del mar)

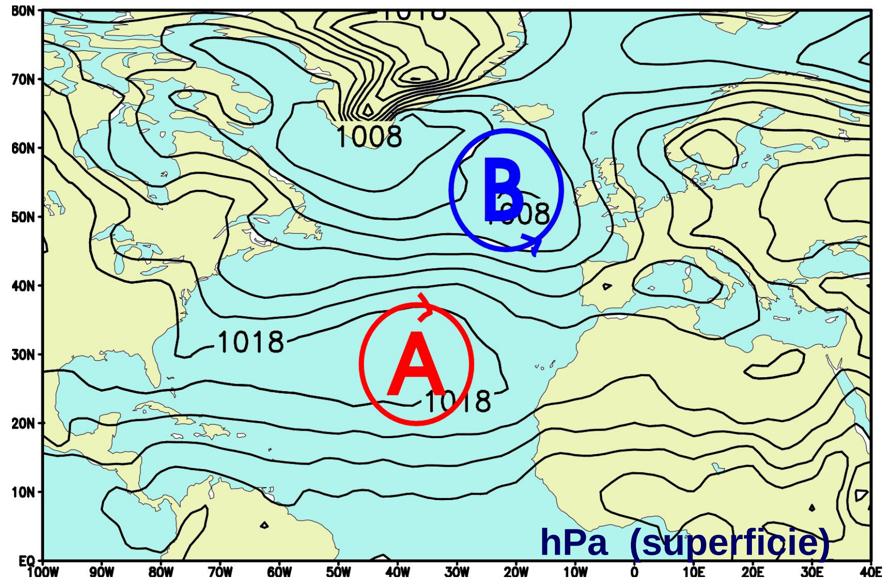
- Winter rainfall in Europe and North of Africa is related to changes in SSTin TNA

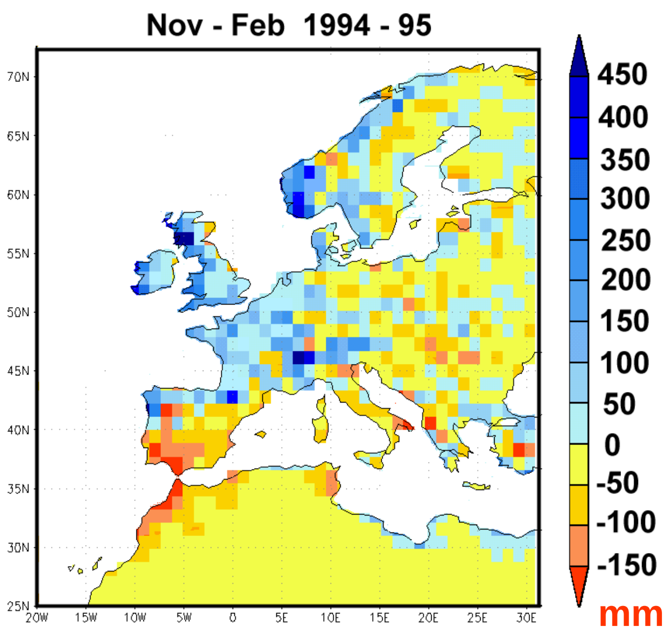
Warming with increse of rainfall by moisture advection

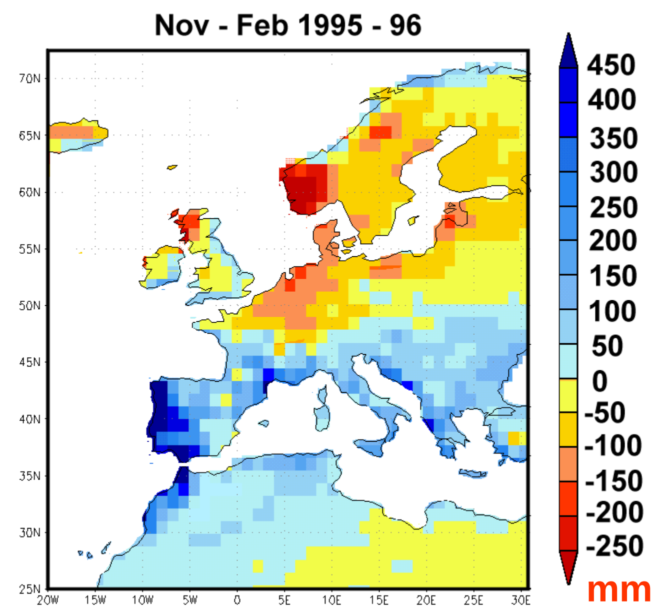
Influence on wheat

Capa et al. 2015









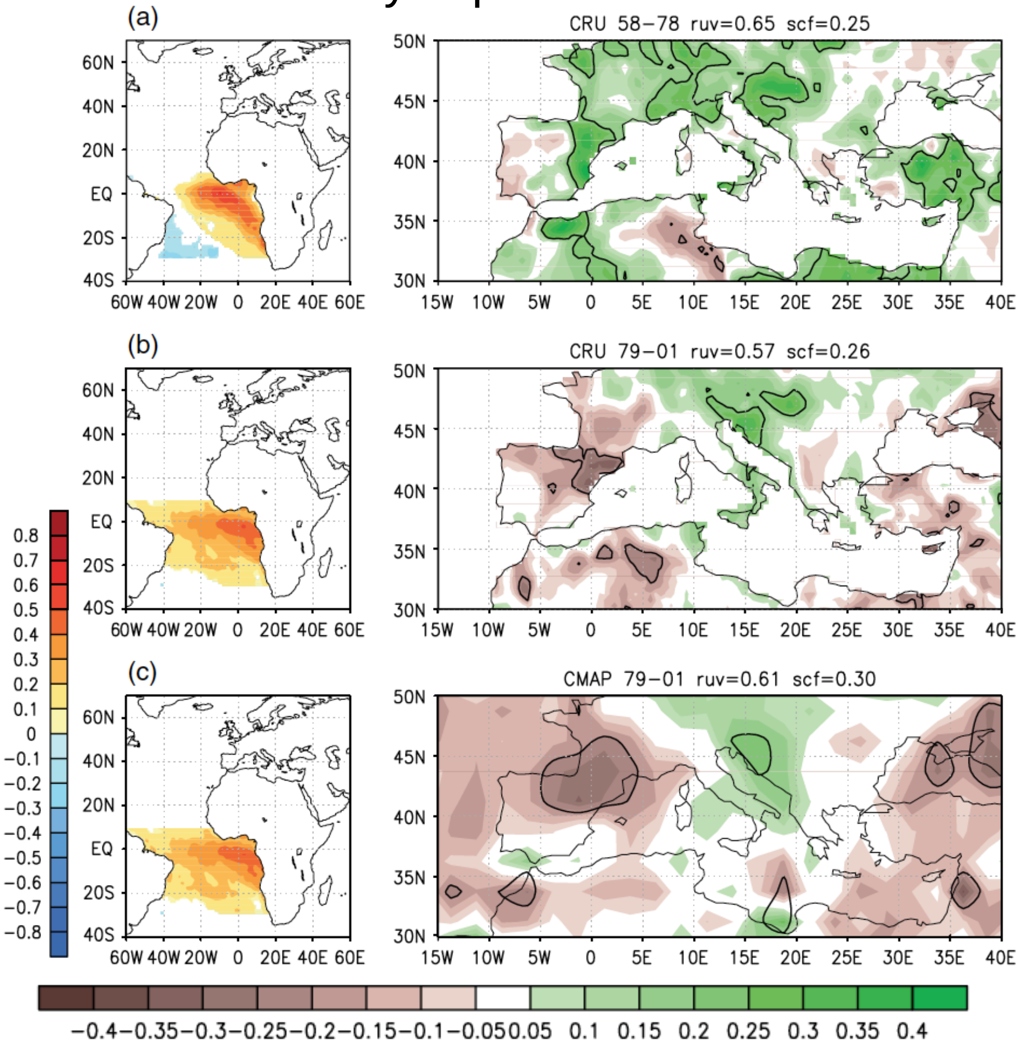
Losada et al., 2007

Example: 1995-96

Verano: Atlantic Niño.

Changes in rainfall

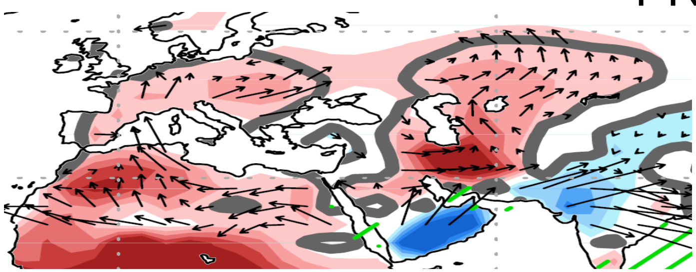
Non stationary impact. Before the 1970's it was related to more rainfall in westermost and eastern most Med
After the 1970's is related to less rainfall



Losada et al., 2010

Changes in temperature

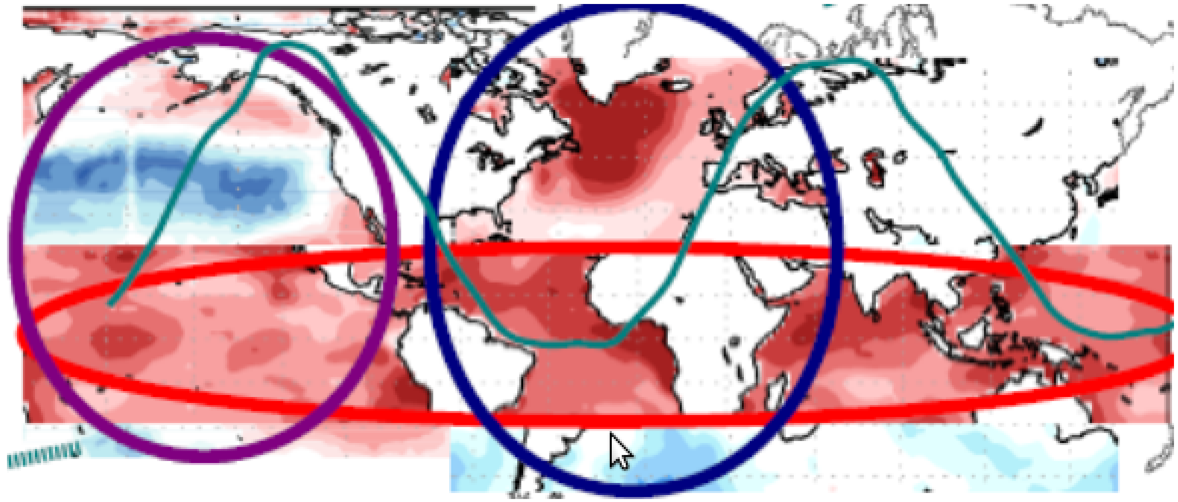
PRESENT

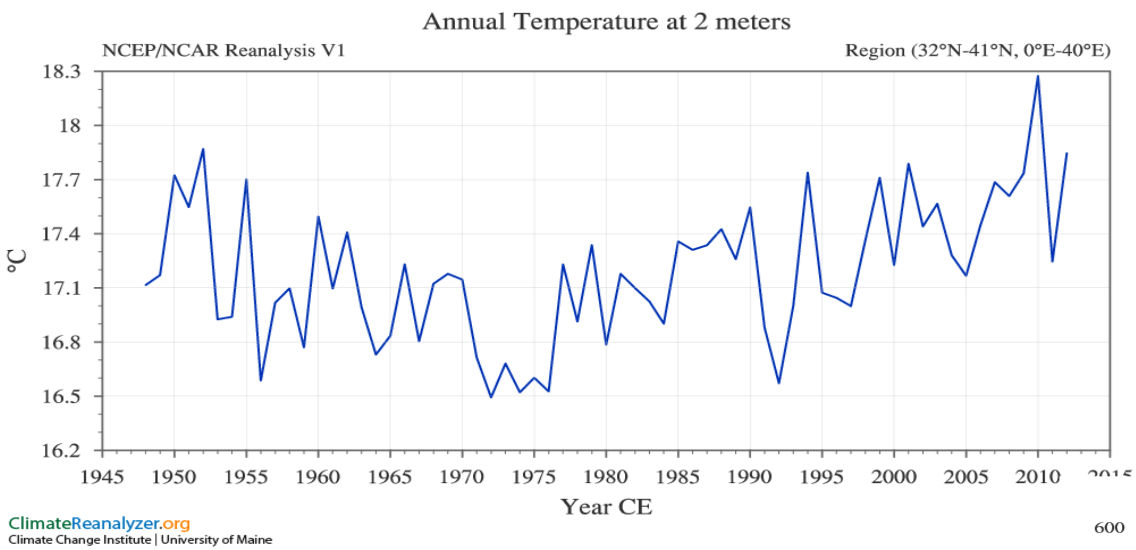


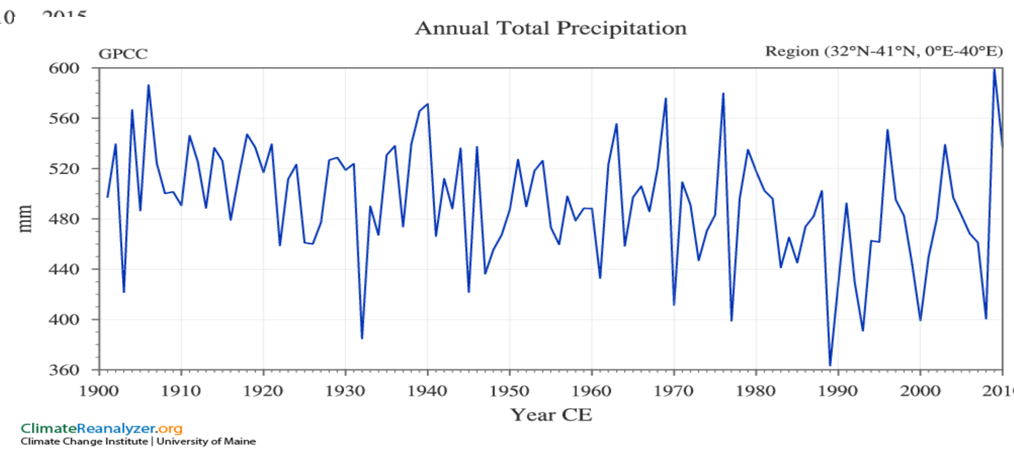
Increase in summer temperatures

Mohino and Losada, 2015

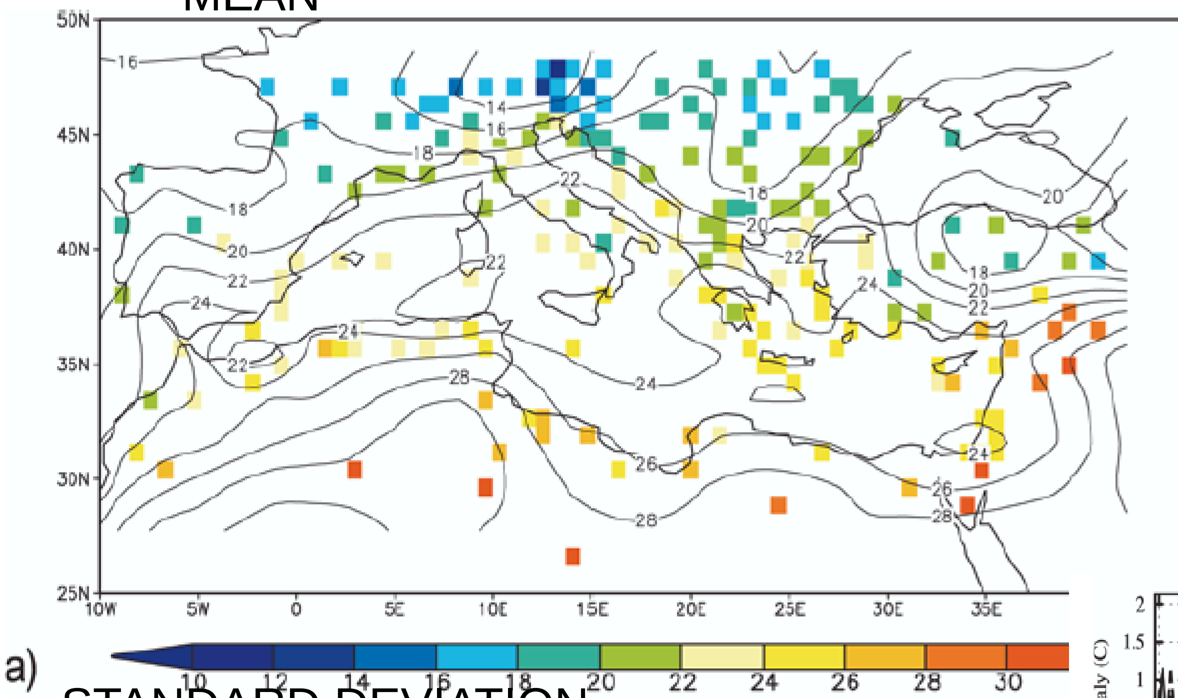
Decadal Variability: periodicities from 40 years



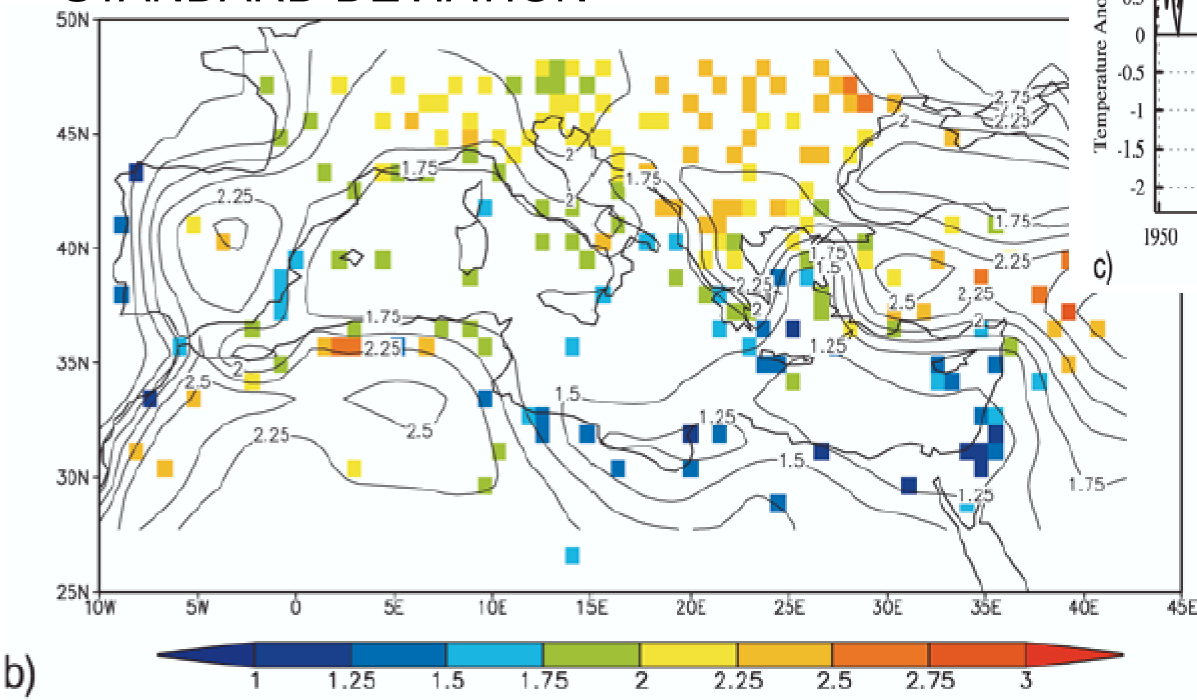




MEAN

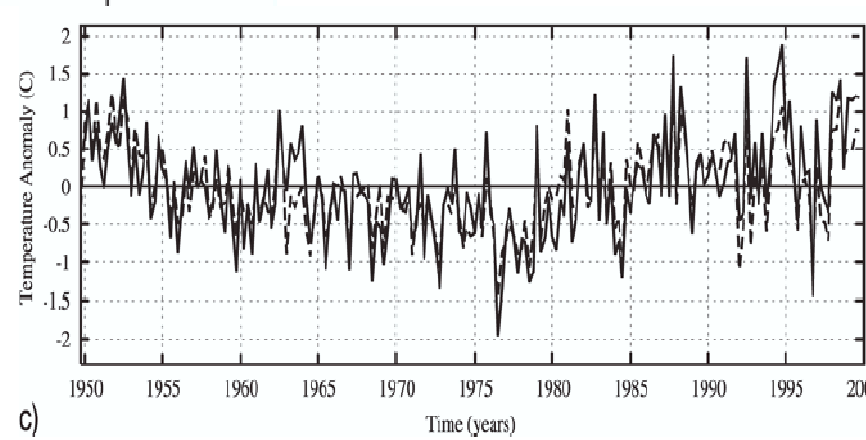


STANDARD DEVIATION



TEMPERATURE

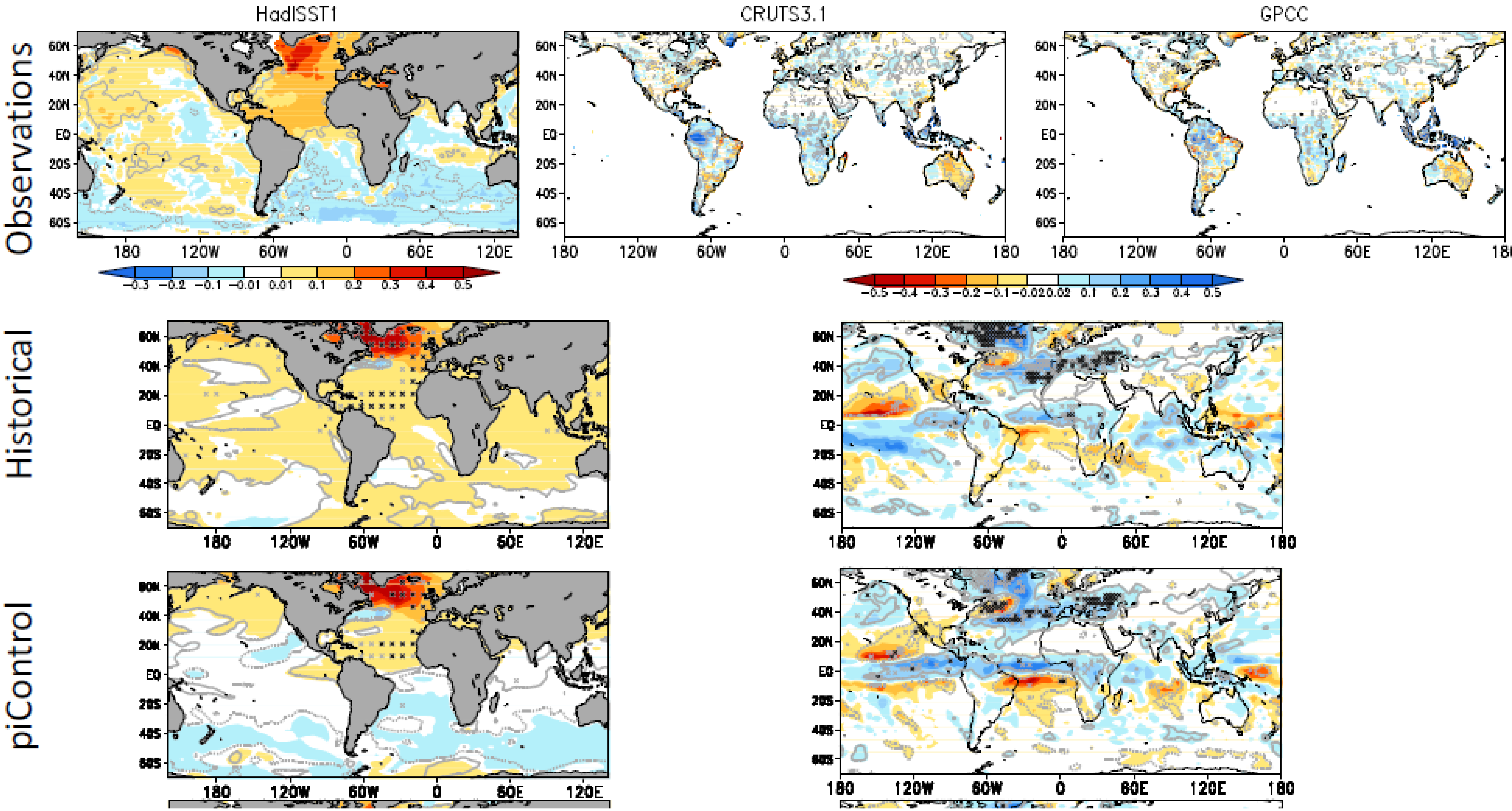
JJAS



Xoplaki et al 2004

AMO

Decadal Variability influence on rainfall

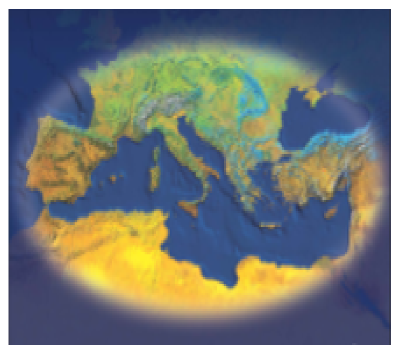


Villamayor & Mohino, 2015

Guemas et al (2015): AMO influence increases predictability

Strong signal over the Mediterranean

Med - CLIVAR
Mediterranean CLImate VARiability and Predictability



MedCLIVAR (*) serves as a scientific network to promote better communication among different scientific disciplines and to develop a multidisciplinary vision of the evolution of the Mediterranean climate through studies that integrate atmospheric, marine, and terrestrial climate components at time scales ranging from paleoreconstructions to future climate scenarios. The program deals with scientific issues including past climate variability; connections between the Mediterranean and global climate; Mediterranean Sea circulation and sea level; feedbacks on the global climate system; regional responses to greenhouse gases, air pollution, and aerosols, as well as regional impacts of climate change.

MedCLIVAR has contributed to scientific progress, new scientific synthesis, the education of a new generation of scientists, and the promotion of awareness of the interdisciplinary nature of regional climate change. To ensure future progress, MedCLIVAR aims to continue acting as a neutral forum in which analysis and prioritization of scientific issues are achieved through open discussion and cooperation is strongly promoted.

NEWS

15-10-2015

European Geosciences Union General Assembly 2016 Vienna, Austria, 17–22 April 2016

session CL4.05
The climate of the Mediterranean region: from basic science to impacts

Conveners: Piero Lionello, Andrea Toreti, Marta Marcos

Deadline for receipt of abstracts:
13 Jan 2016, 13:00 CET