Incremento das secas e ondas de calor no sul da Europa: duas faces da mesma moeda

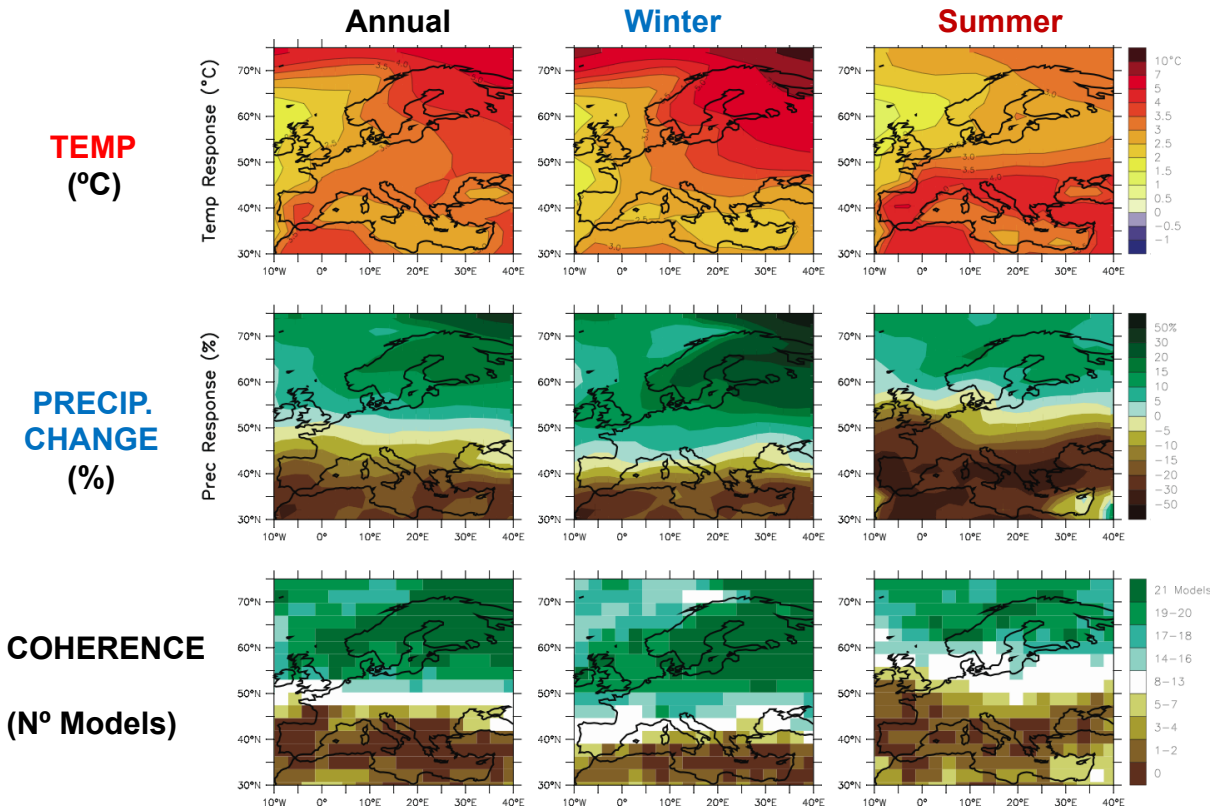
Ricardo Machado Trigo

(IDL, University of Lisbon)

Agradecimentos:

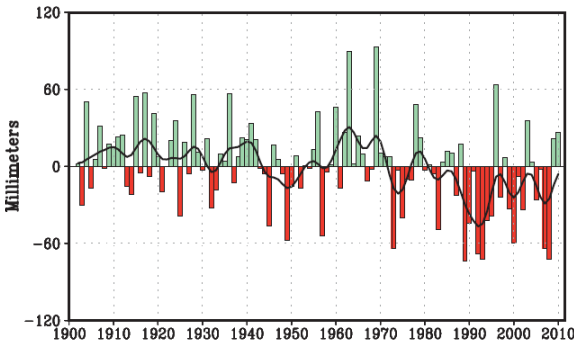
David Barriopedro, Ricardo Garcia Herrera, Celia Gouveia, Malik Amraoui, Erich Fischer, Juerg Luterbacher, Elena Xoplaki, Pedro Sousa

IPCC - Temperature and Precipitation changes over Europe (A1)

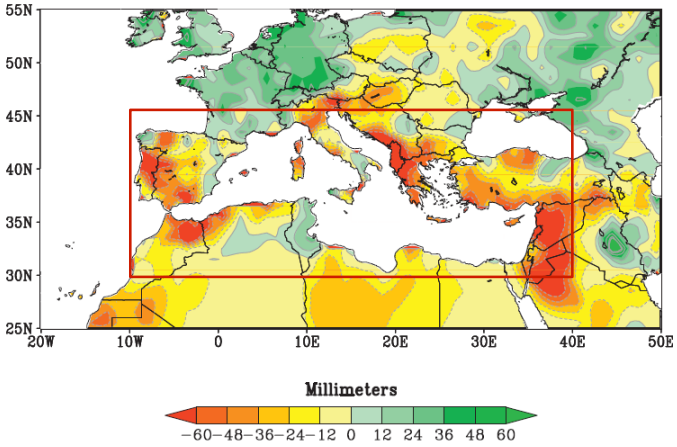


Observed precipitation changes in the Mediterranean (1902-2010)

Winter (NDJFMA) Precipitation variability for the Mediterranean area (red line)

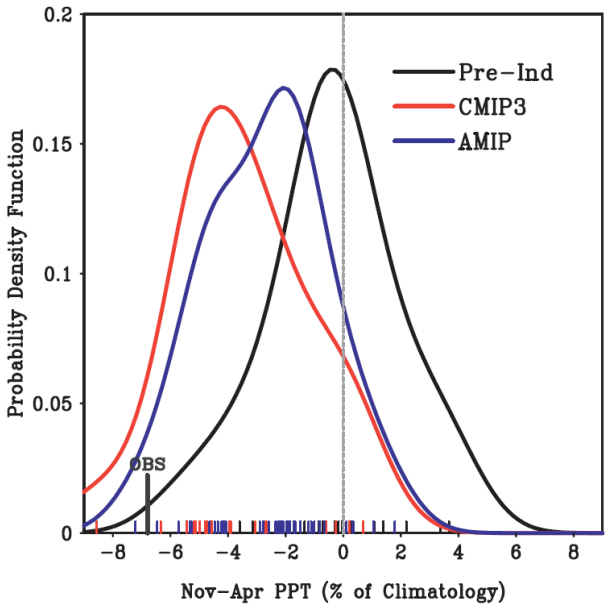


Observed change of winter Precipitation (1971:2010) – (1902:1970)



Hoerling et al. (2013)

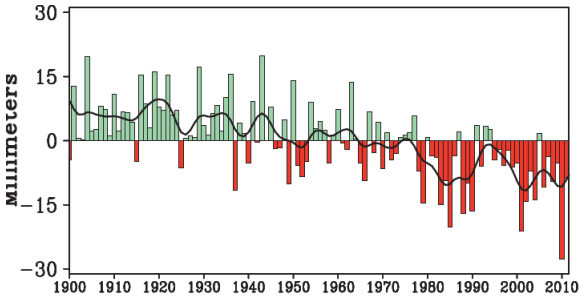
Modeled precipitation changes in the Mediterranean (1902-2010)

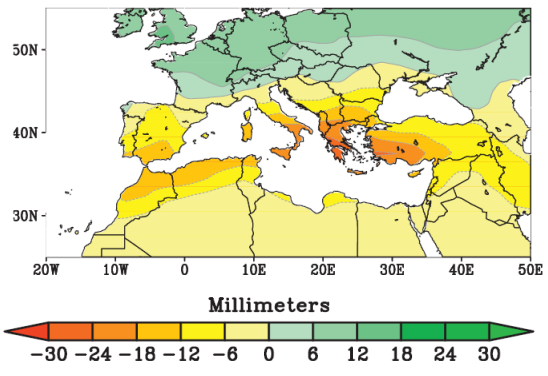


Probability distribution functions for the 1971-2010 minus 1902-1970 period anomalies of winter precipitation.

Hoerling et al. (2013)

CMIP

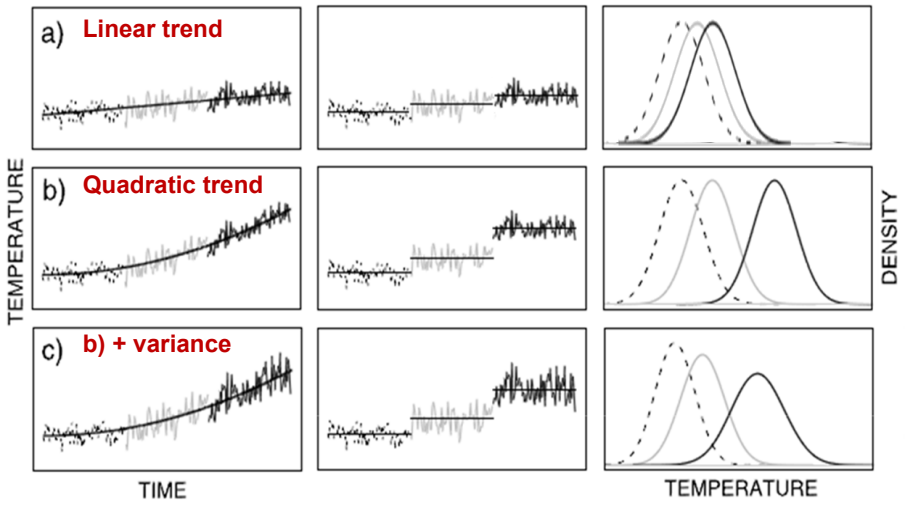




Extreme events in a changing climate

Climate change implies changes in distribution affecting the frequency of extremes.

For extremes, variability is more important than mean!



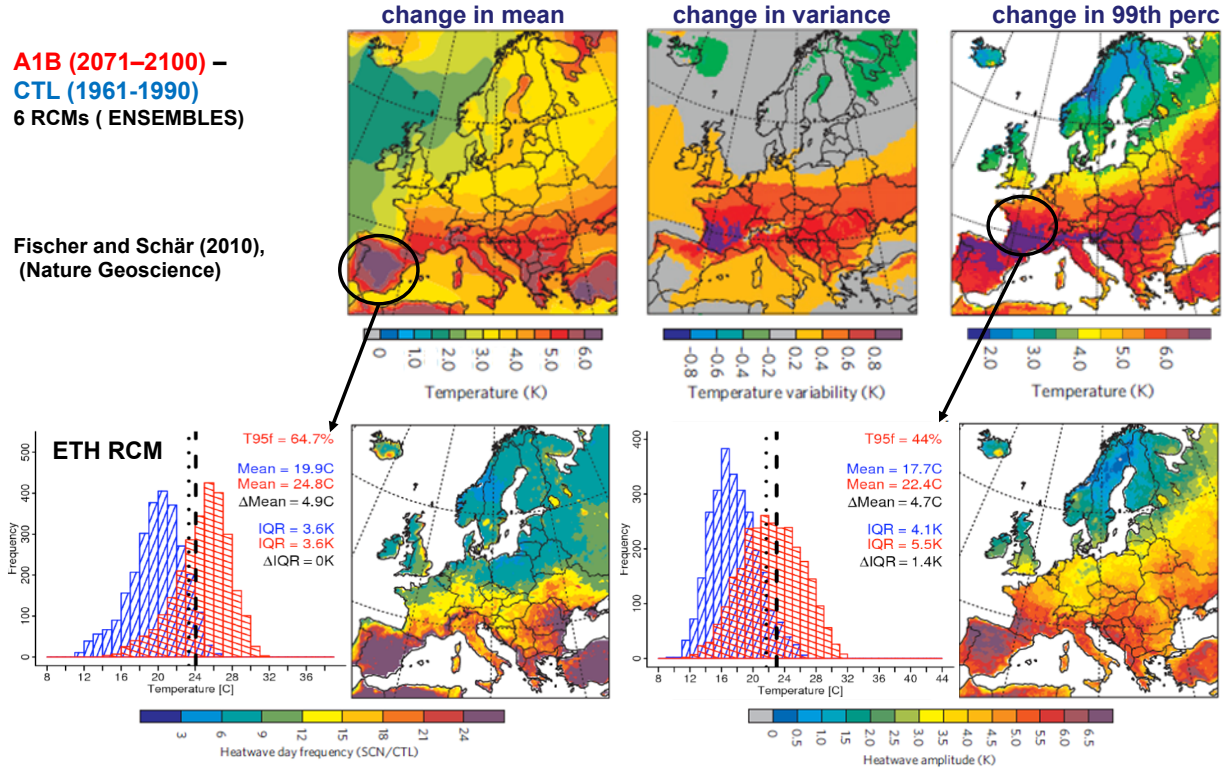
Adapted from Della-Marta et al. (2007)

Future extreme events

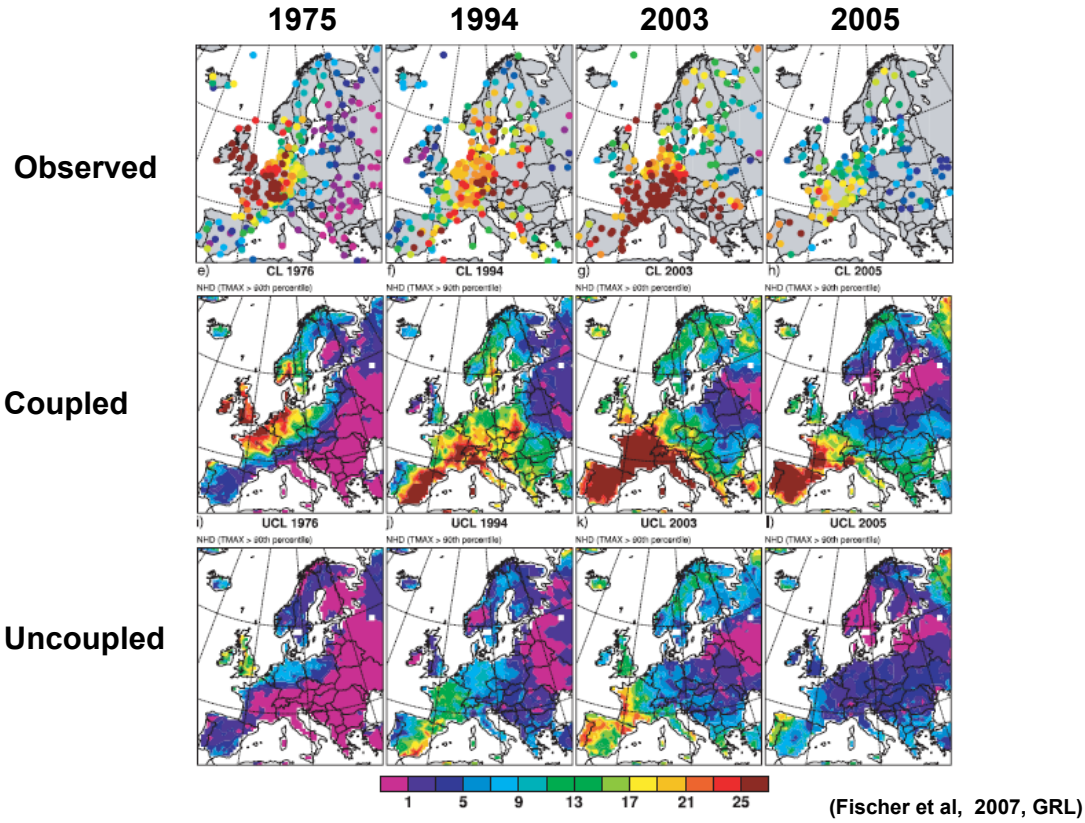
Trend patterns are consistent with climate change scenarios. The largest increases in the frequency (intensity) of heatwaves occur in regions with maximum changes in mean (variability).

A1B (2071–2100) – CTL (1961-1990)
6 RCMs (ENSEMBLES)

Fischer and Schär (2010), (Nature Geoscience)



Spring droughts: Land-Atmosphere coupling

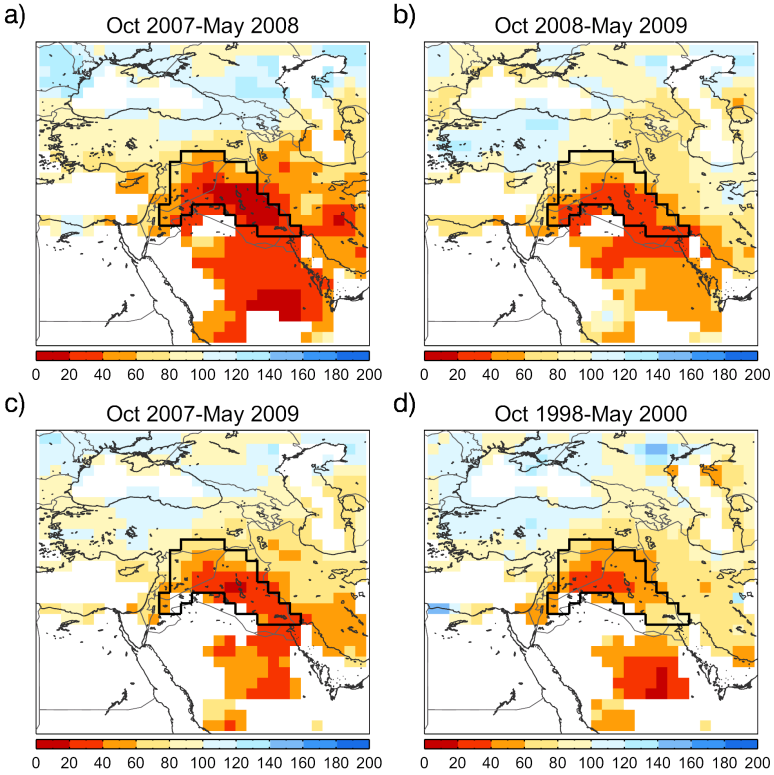


(Fischer et al, 2007, GRL)

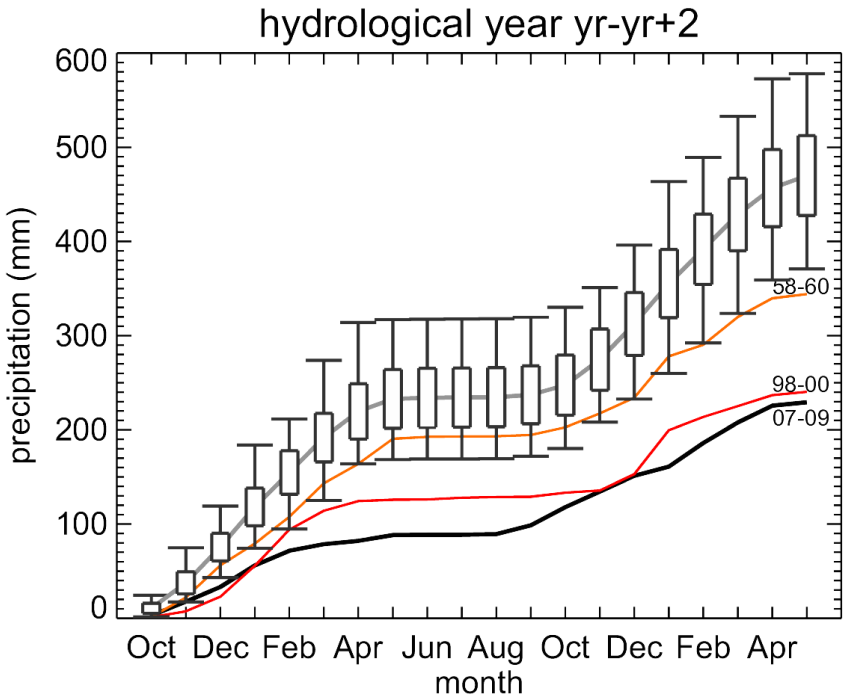
Drought Case-studies

1. The intense **2007-2009** drought in the Fertile Crescent

Accumulated monthly precipitation (expressed in percentage relative to the 1940-2009 normals) during the hydrological years



(Trigo et al., 2010)

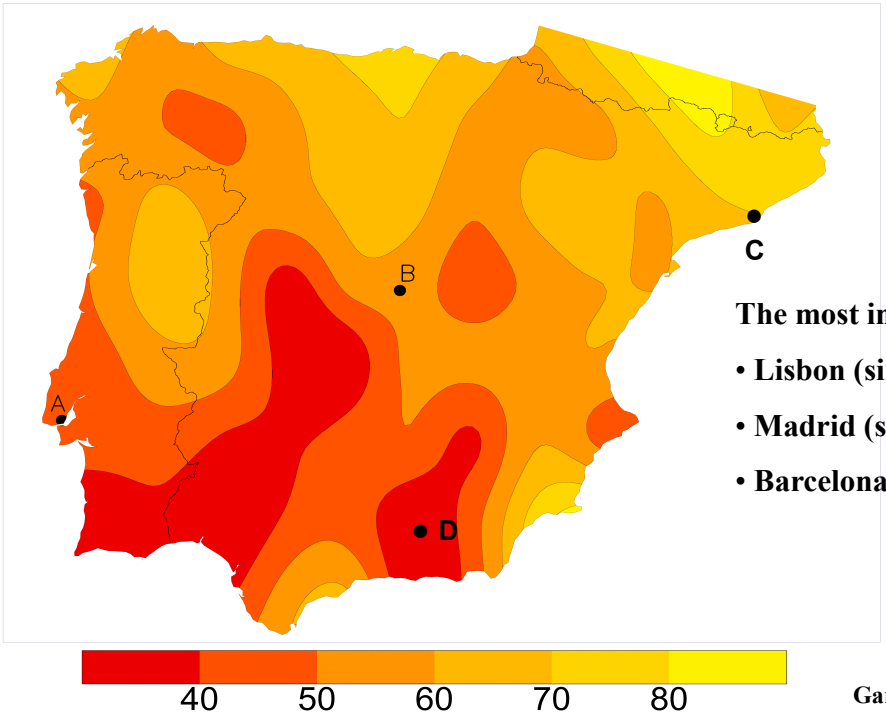


Accumulated monthly precipitation averaged over the FC during two consecutive hydrological years (from October yr to May yr+2).

Drought
Case-studies

2. The outstanding **2004-2005** drought in **IBERIA**

Accumulated precipitation in Iberia between Oct. 2004 and Sept 2005
(% relative to the average for the period 1961-1990)

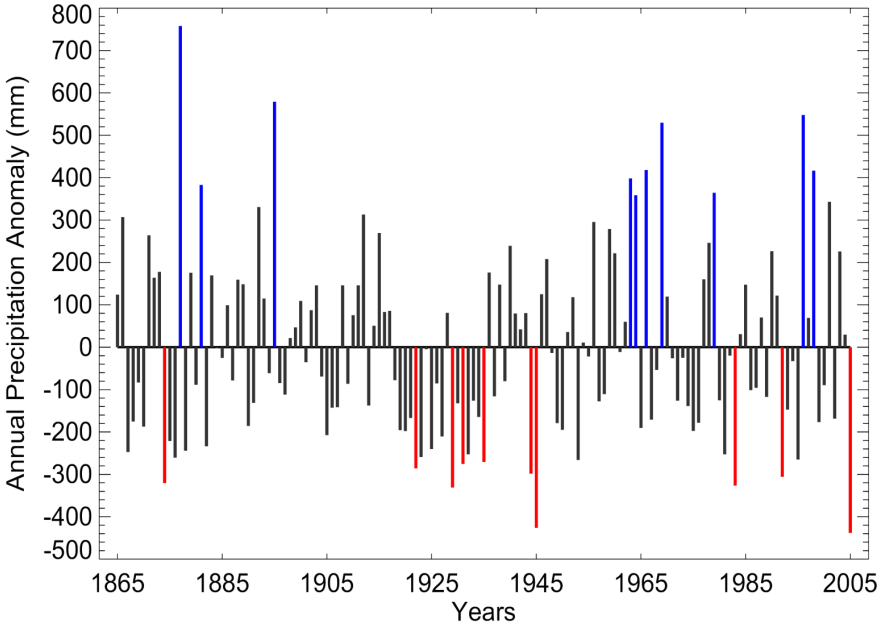


The most intense drought:

- **Lisbon (since 1865) A**
- **Madrid (since 1859) B**
- **Barcelona (since 1941) C**

Garcia-Herrera et al. (2007)

Detailed analysis for Lisbon (1865-2005)

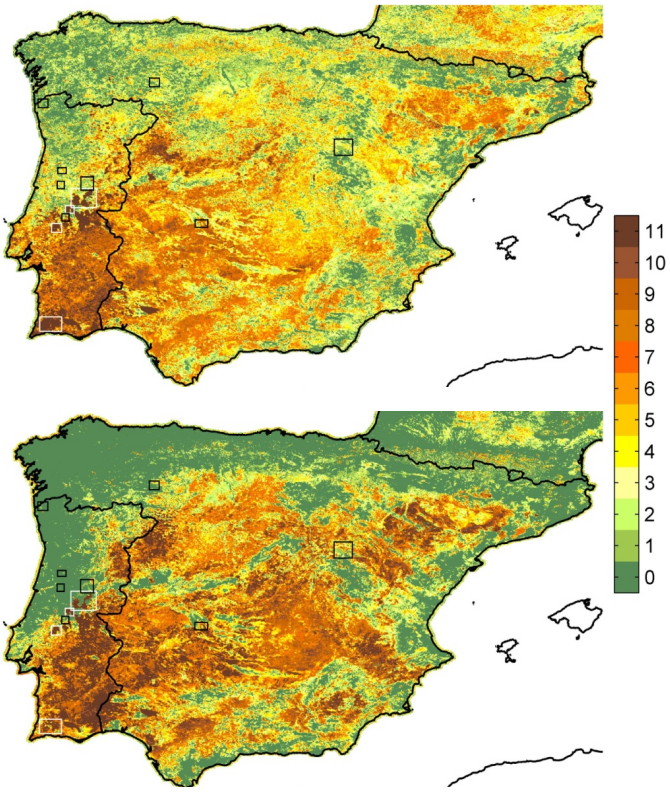


Blue: Ten wettest years

Red: Ten driest years

Trigo et al. (2006) BAMS

Drought 2005

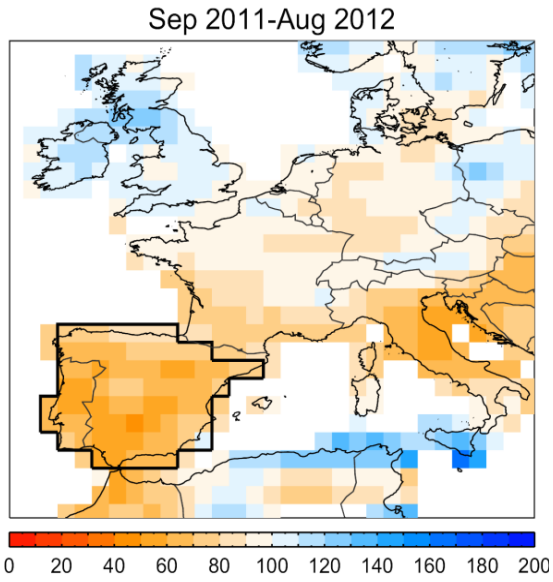


Number of months between September 2004 and July 2005 characterised by an **NDVI** anomaly values below -0.025

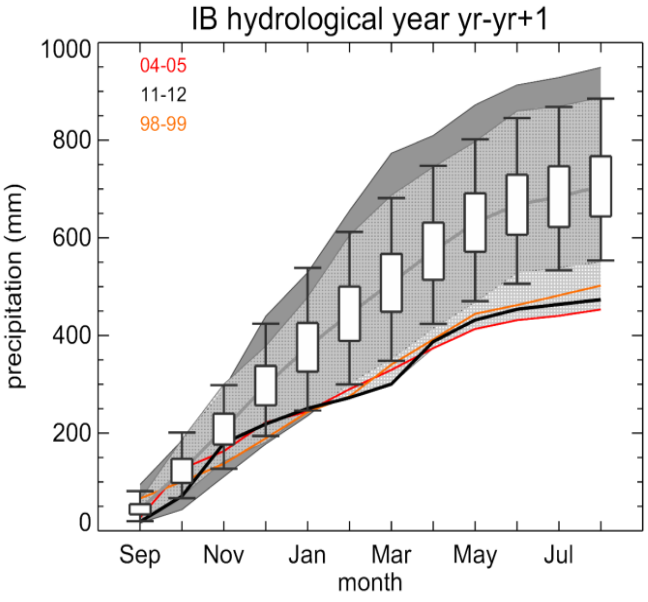
NDDI anomaly values above 0.25. White boxes correspond to the 2003 fire scars and black boxes to the 2005 fire scars.

Drought
Case-studies

3. Another major **2011-2012** drought in **IBERIA?**



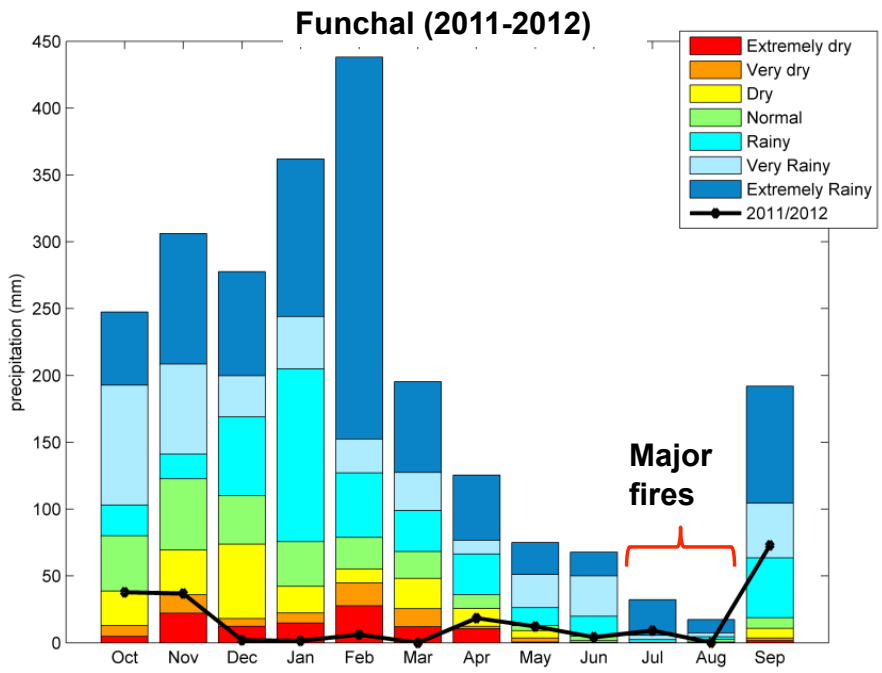
Accumulated monthly precipitation (expressed in percentage relative to the 1940-2010 normals) during the hydrological year



Trigo et al. (2013)

Drought in Madeira

IPMA (2012)



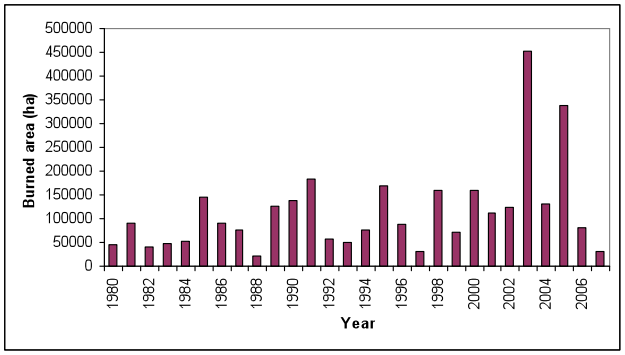
Heatwave Case-studies

1- The summer **2003** heatwave in **Iberia/western Europe**

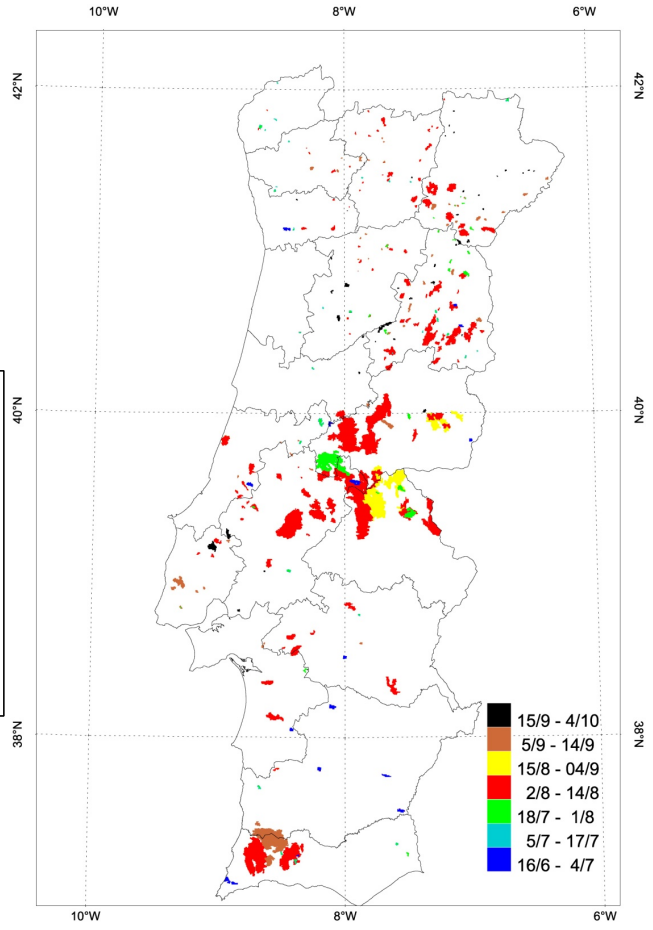
Record burned area

Total burnt area**: 450.000 ha**

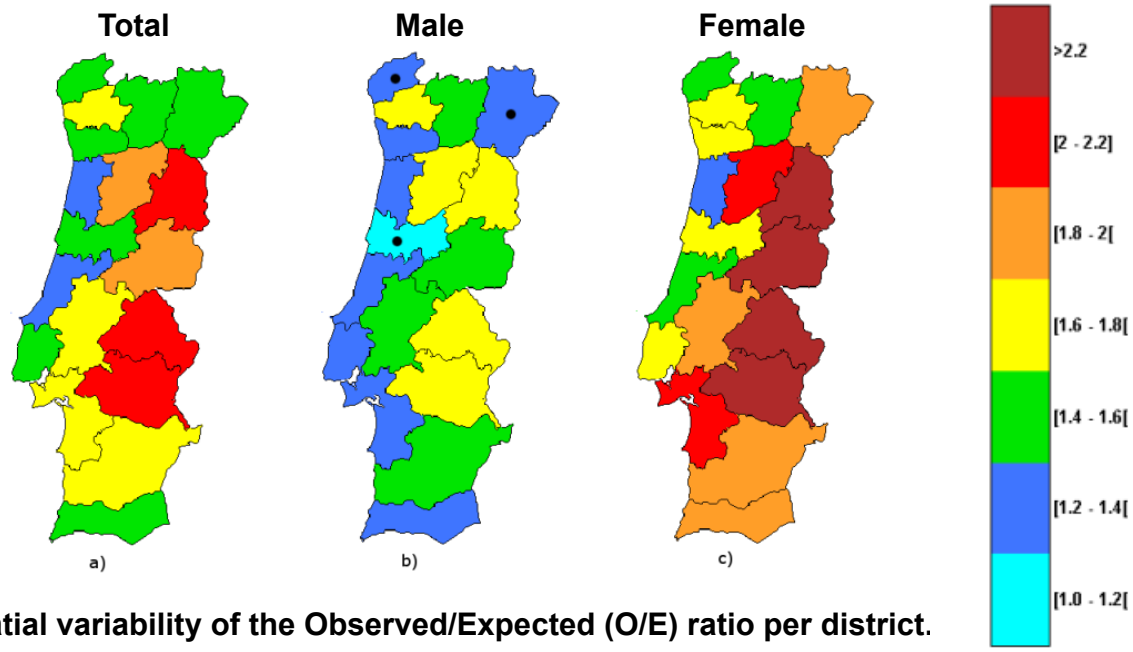
Mostly during the **first 2 weeks of August (red colour)**



Garcia-Herrera et al. (2010)



Mortality per District and Gender

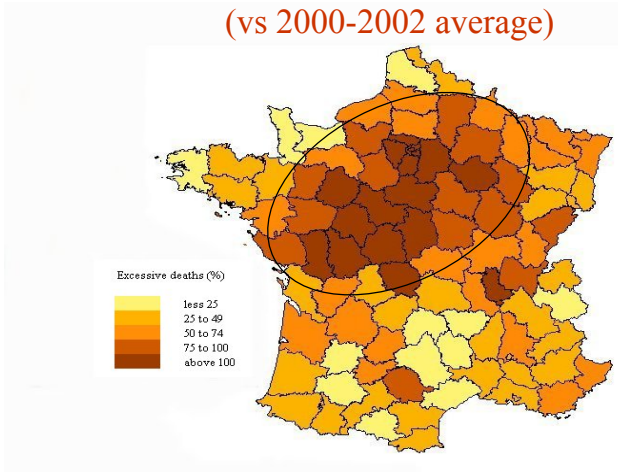


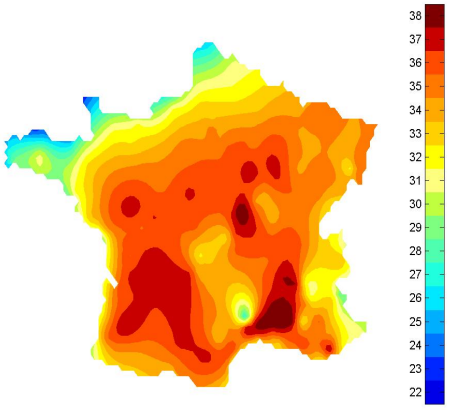
Spatial variability of the Observed/Expected (O/E) ratio per district.

Trigo et al. (2010)

Tmax 1-15 August 2003

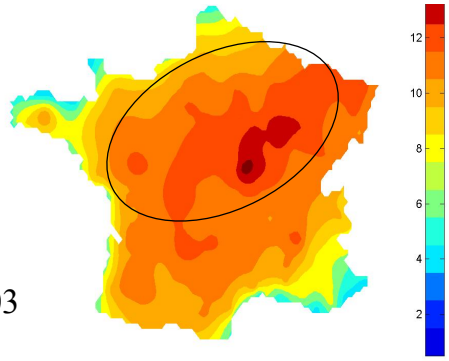
Excessive mortality 1-15 August
(vs 2000-2002 average)





(**Trigo et al., 2005, GRL**)

Tmax anomaly 1-15 August 2003

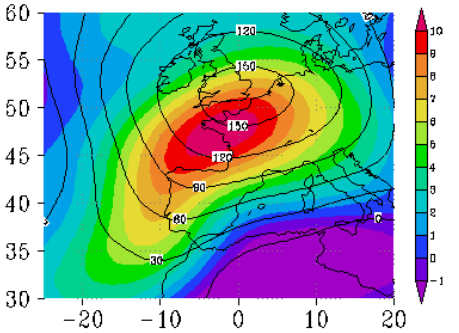


• Processes associated with heat waves may change from region to region. Key processes in Europe include:

• 1) relative high pressure systems (**blocking events**);

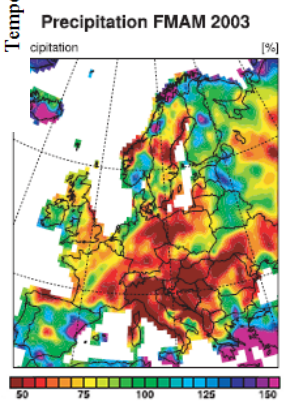
• 2) **deficit of accumulated precipitation** during winter-spring months;

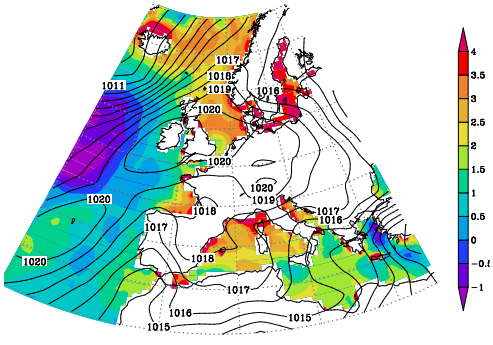
• 3) anomalously **warm SSTs**



Blocking pattern

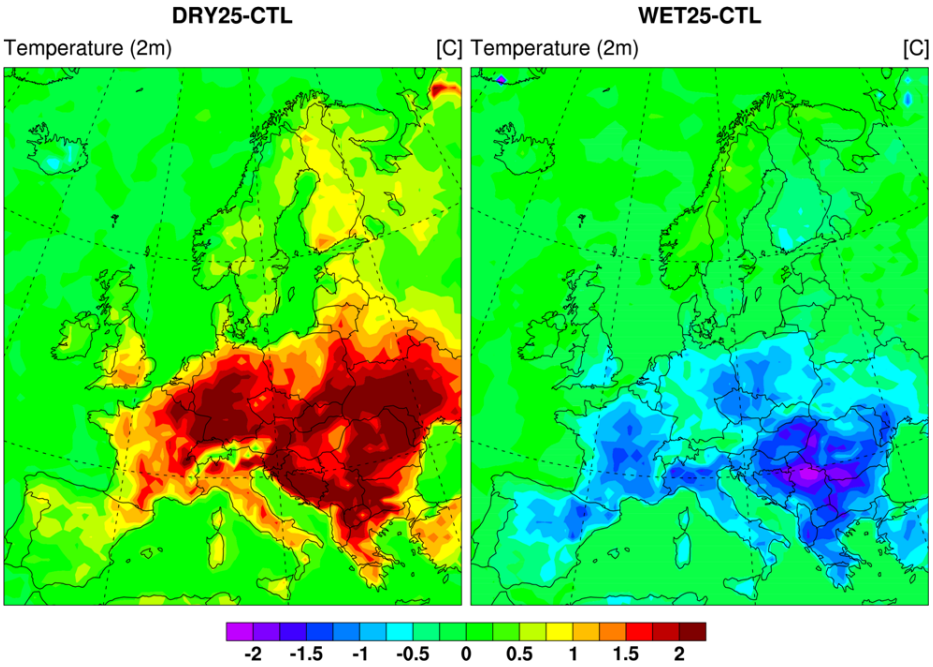
2003





High SST anomalies

Deficit of accumulated precipitation

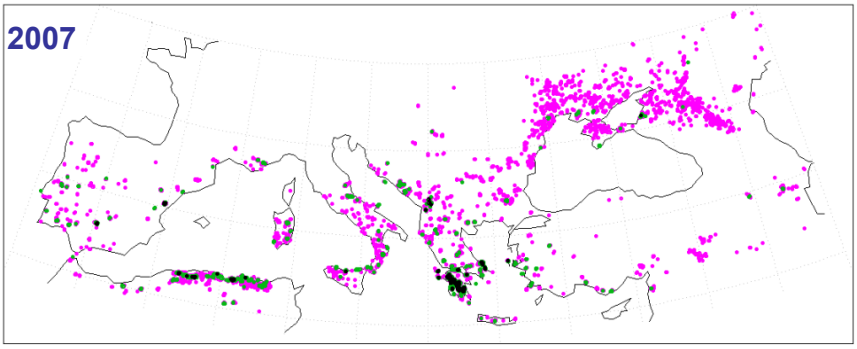


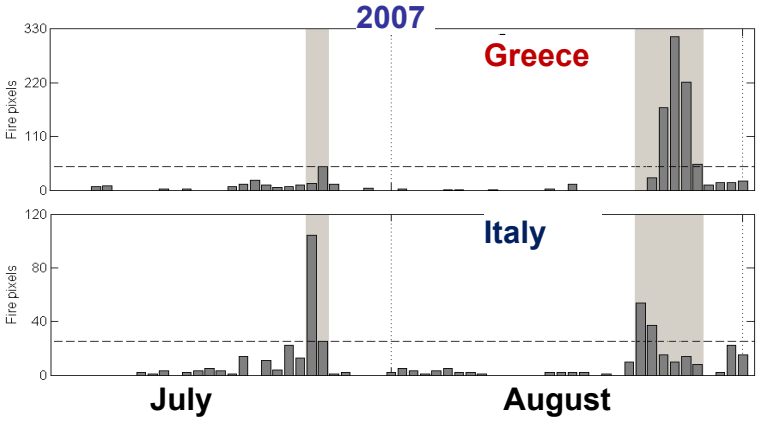
Simulated summer temperature (at 2m) anomalies ***due to spring soil moisture perturbation*** *in (**a**)* ***DRY25-CTL*** *and (**b**)* ***WET25-CTL*** *experiments (CHRM regional climate model). The anomalies were averaged for summer (JJA) 2003 wrt to a model climatology 1970-2000* ***(Fischer et al. 2007)***

Heatwave Case-studies

2)The summer 2007 heatwave in **central Mediterranean**

Fire pixels over Southern Europe during **July-August of 2007**.
Less than 2 hours (**magenta**), 2-10 hours (**green**), above 10 h (**black**)



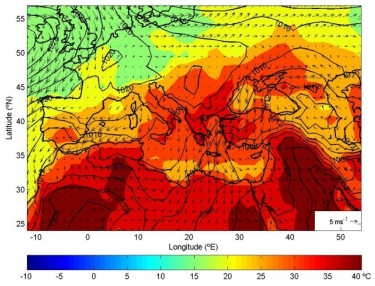


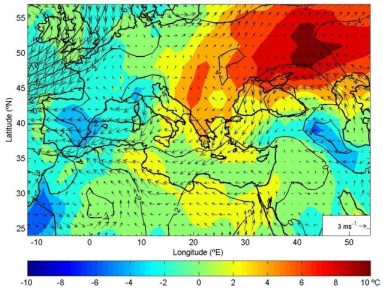
Amraoui et al. (2013)

16 – 30 AUG 2007

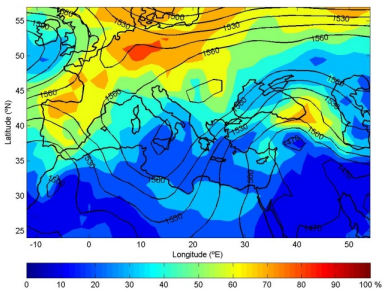
Composite | Anomaly

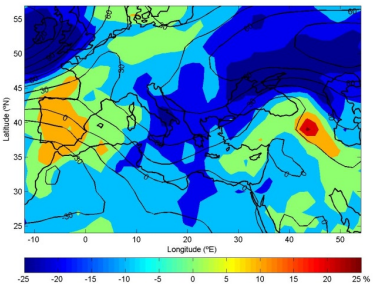
SLP
T 2m
Wind



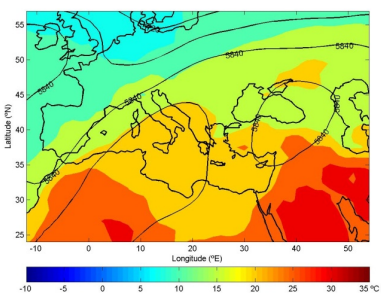


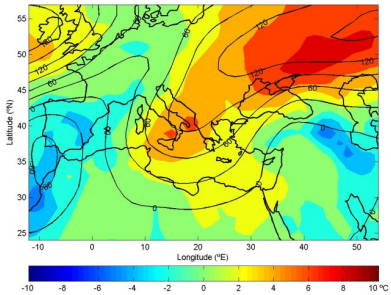
Z850
RH850





Z500
T850





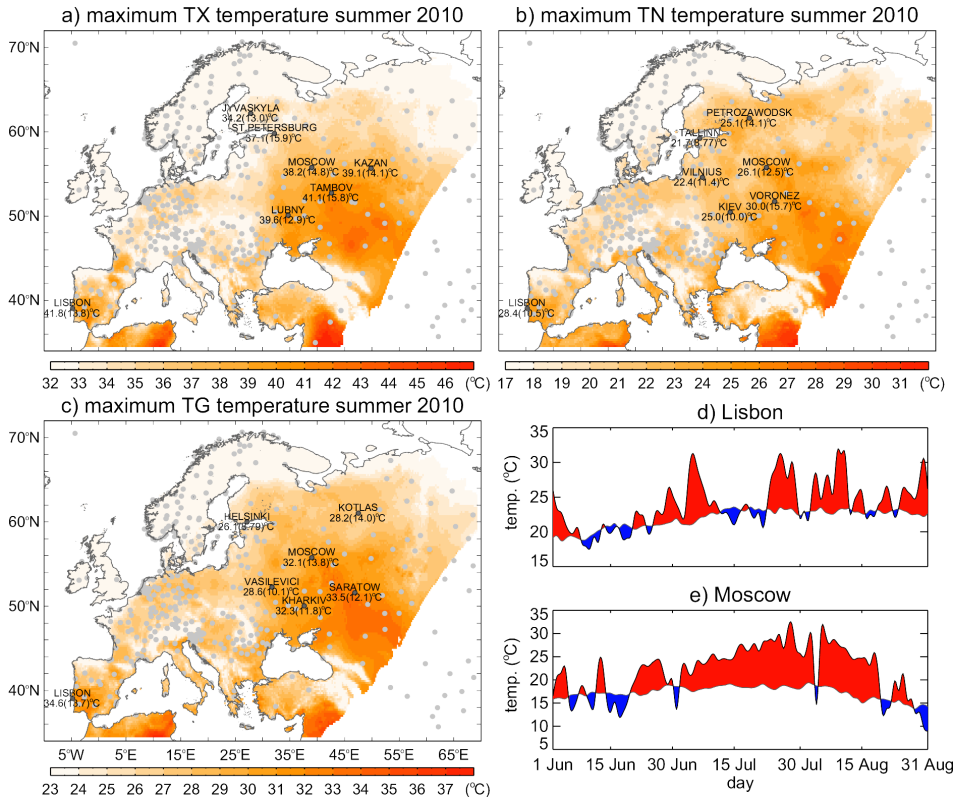
Amraoui et al. (2013)

Heatwave Case-studies

3) The summer **2010** heatwave in **Russia / Black sea**

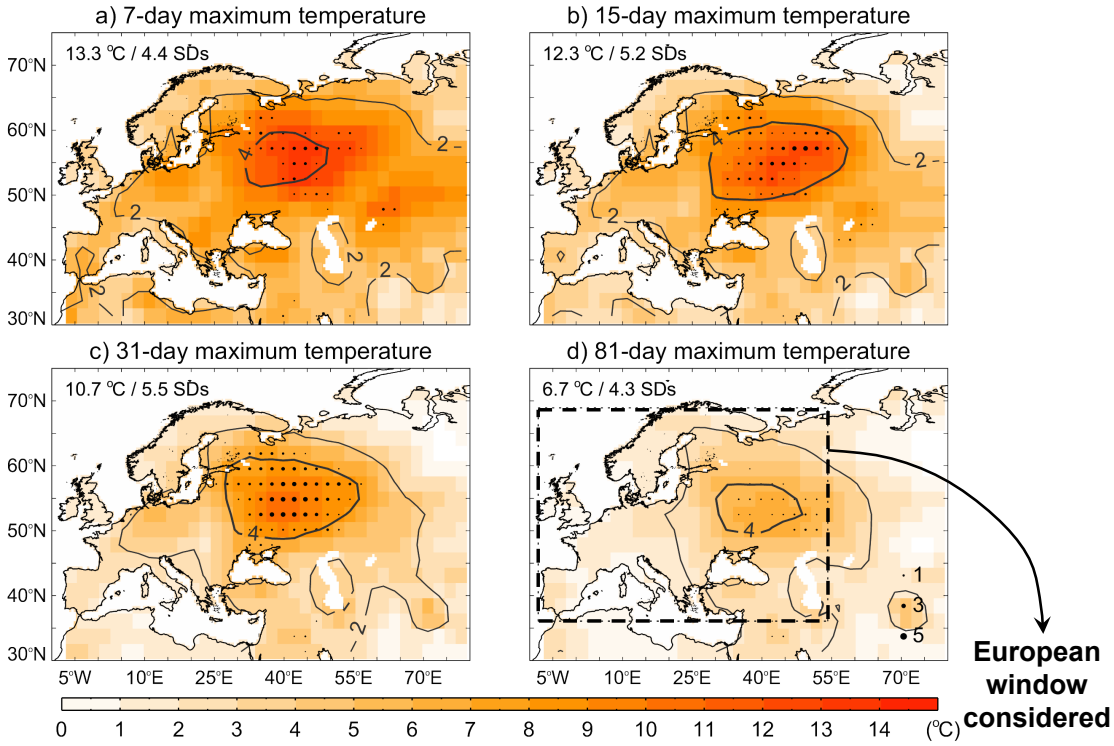
Record breaking temperatures in Eastern Europe

ECA&D and **E-OBS** gridded temperature

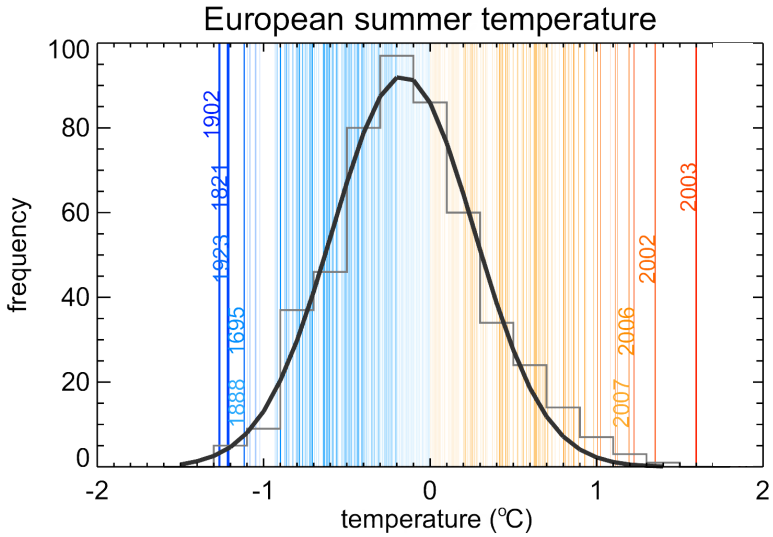


(Barriopedro et al. 2011, SCIENCE)

The 2010 heatwave at different temporal scales



The impact of summer 2010 heatwave in Europe



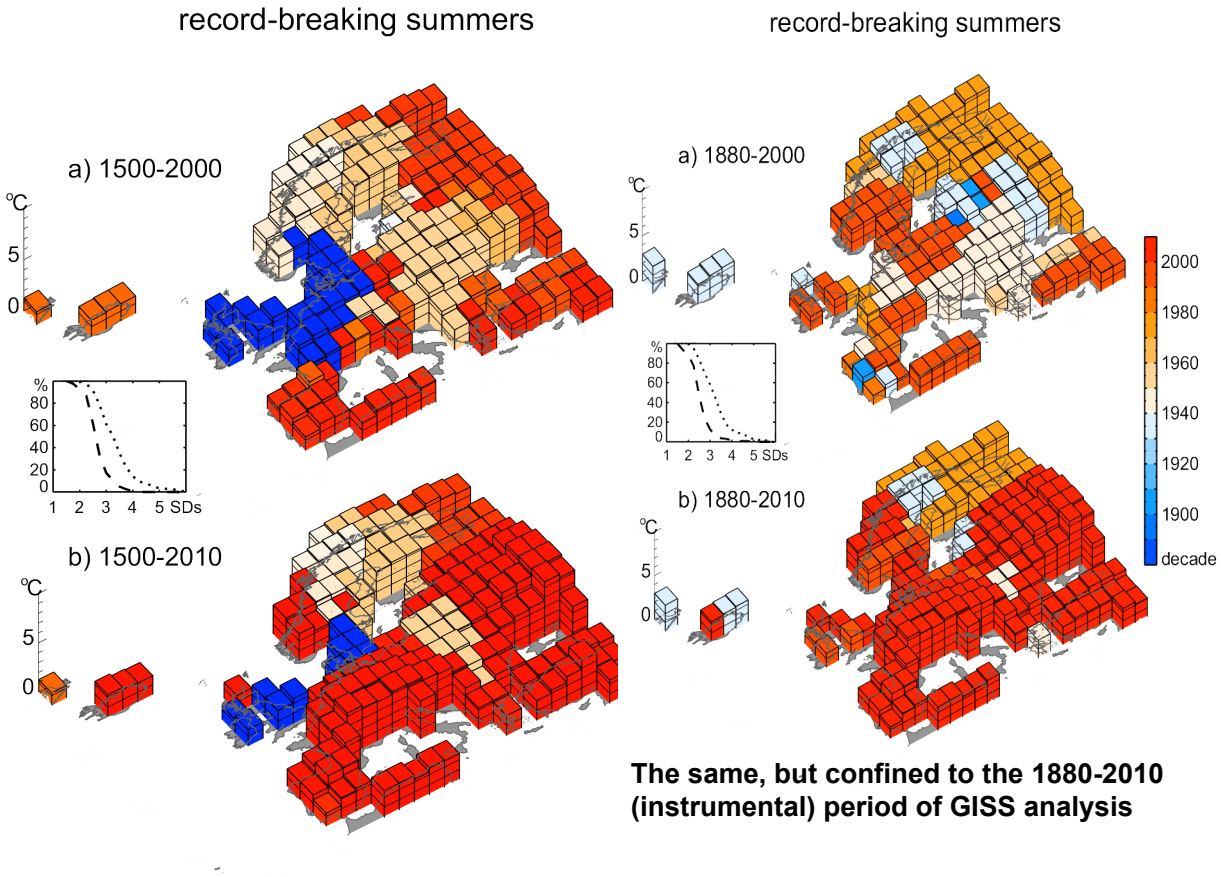
Frequency distribution of European summer land temperature (°C) for the 1500-2010 period (vertical lines).

Grey bars represent the distribution for the 1500-2002 period with a Gaussian fit in solid line.

Multiproxy temp [Luterb. (2004)] 1500-2002
Temperature [GISS NASA] 2003-2010

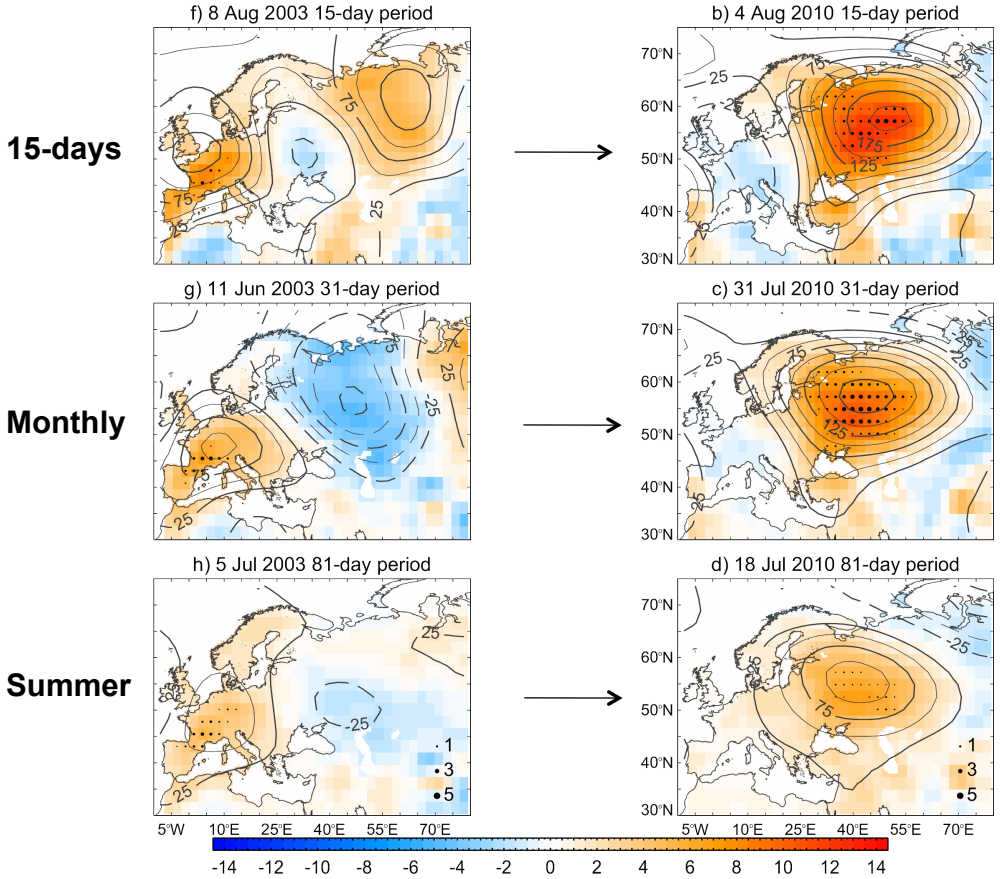
Barriopedro et al. (2011, SCIENCE)

Spatial distribution of the hottest European summers since 1500



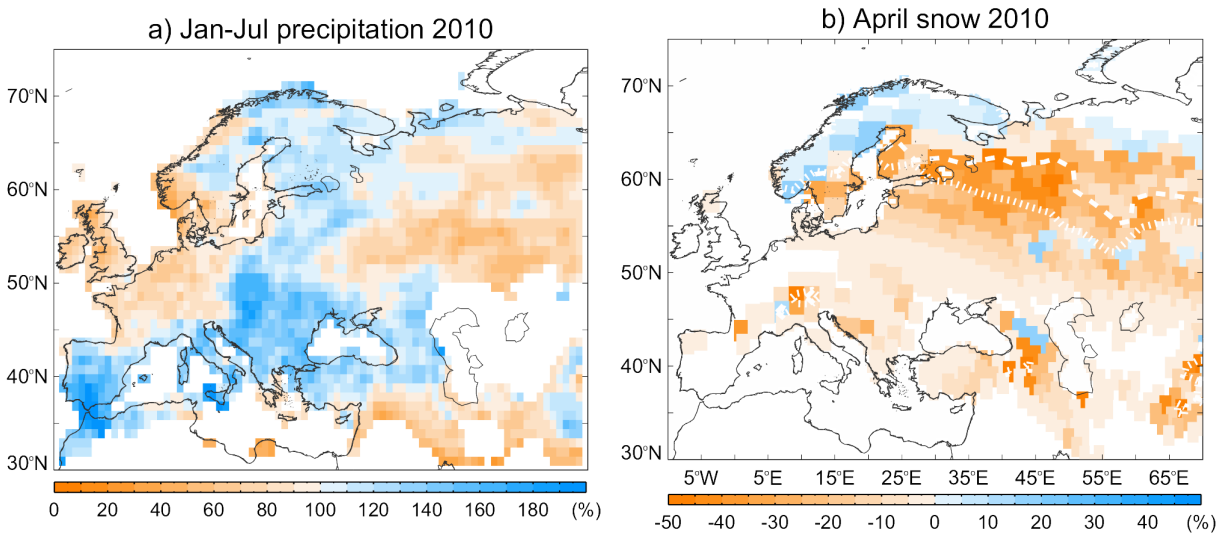
The same, but confined to the 1880-2010 (instrumental) period of GISS analysis

Comparing 2003 and 2010 heatwaves at various scales



The 2010 summer: potential mechanisms

Deficit of January-to-July 2010 accumulated precipitation and **early spring snow cover disappearance** in western-central Russia.



a) Precipitation departures (in % of 1970-1999) for January-July 2010 and gridpoints with mean precipitation above 20 mm month^{-1}. Source: GPCC; b) Anomalies in the percentage of snow covered areas for April 2010. The dashed (dotted) white line indicates the April 2010 (climatological mean) location of the snow cover line. Source: NOAA visible charts & RUCL.

Summary

1. The Western (Eastern) Europe **heatwave** of summer of 2003 (2007) was **exceptional at the monthly/seasonal**, but also at the **weekly and daily scales.**
2. The **Eastern Europe heatwave** of summer of **2010** was even more outstanding than 2003/2007 at the weekly-monthly-seasonal scales**.**
3. Usually heatwaves are associated to intense **blocking circulation** pattern. However, **Winter/Spring drought conditions** have exacerbated the strength of both summer heatwaves**.**
4. The **Mediterranean basin is getting drier** and **drought frequency is bound to increase during the 21st Century**.
5. A large number of Regional Climate Models predict **2003 type of events frequently by mid 21st Century** while the **outstanding 2010 event is less likely to repeat**.

Obrigado!
Thanks!