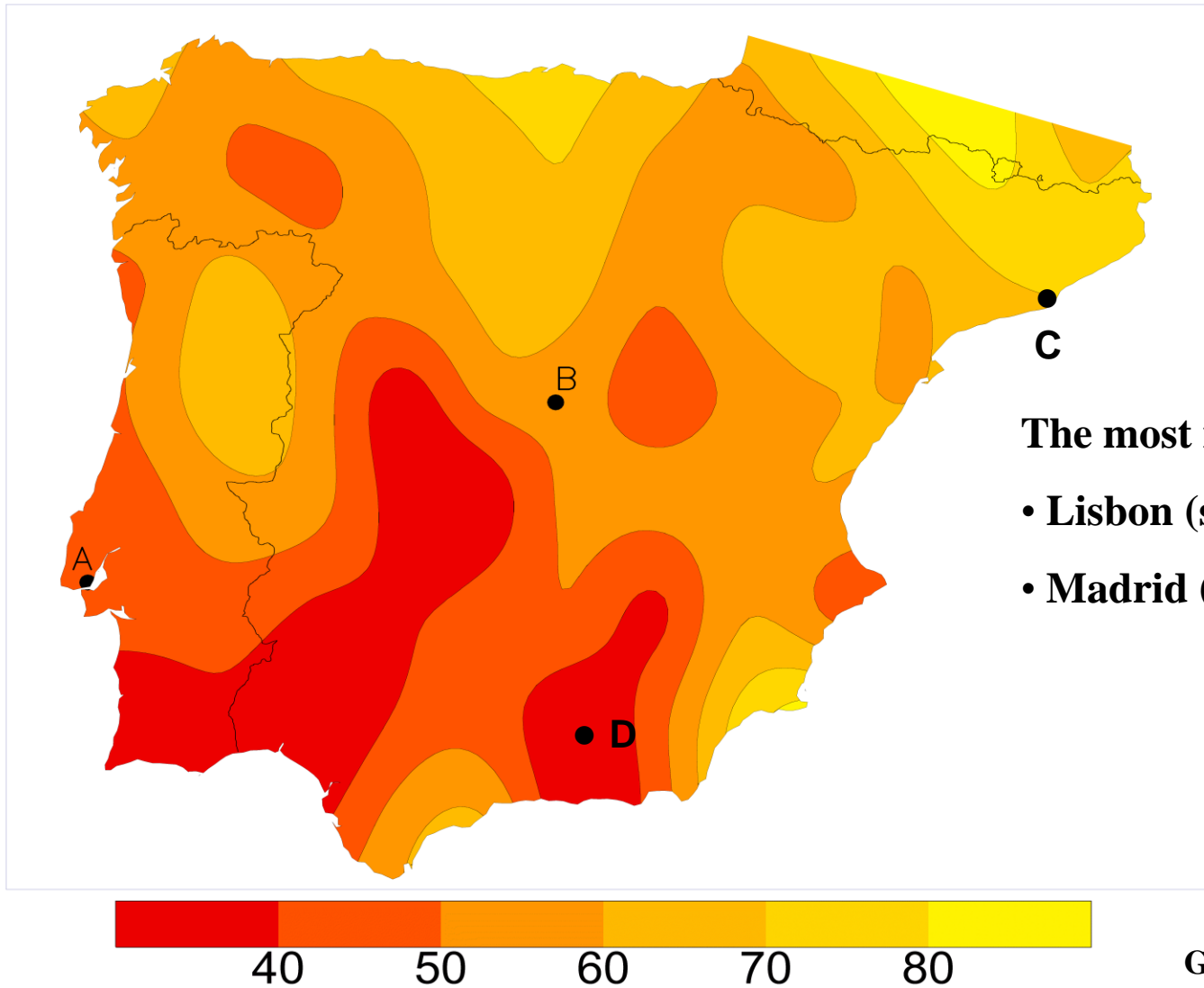


Increasing risk of droughts in the Mediterranean under climate change

Ricardo Machado Trigo
(IDL, University of Lisbon)

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

Accumulated precipitation in Iberia between Oct. 2004 and Sept 2005

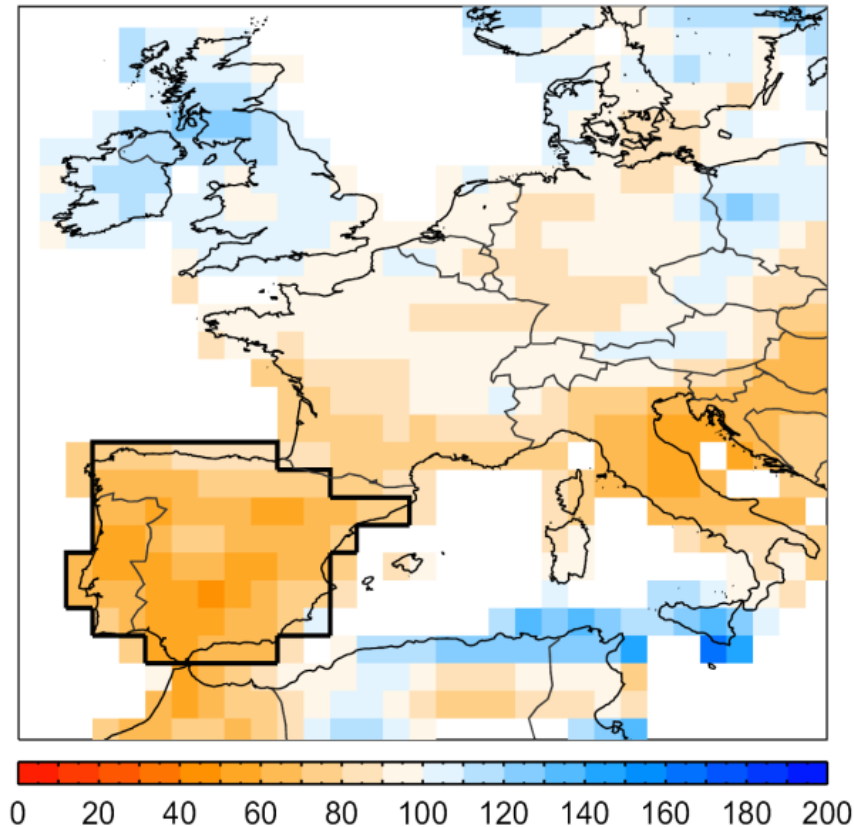


The most intense drought:

- **Lisbon (since 1865)**
- **Madrid (since 1859)**

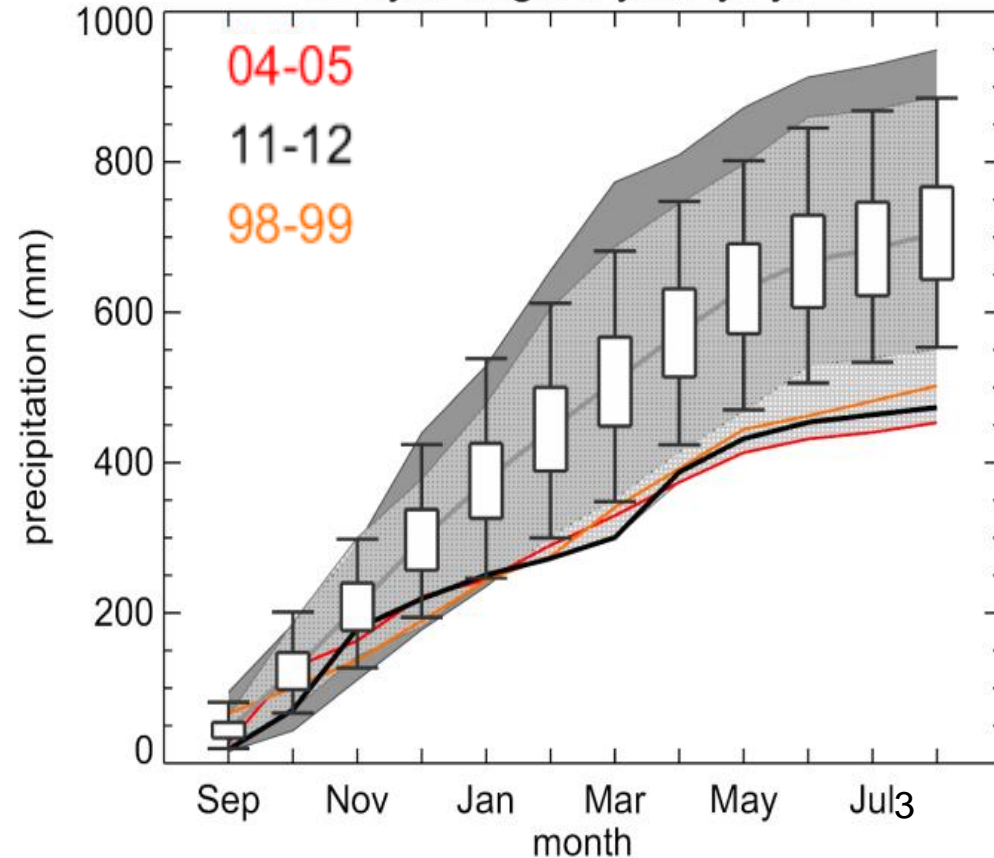
2. Another major **2011-2012 drought** in **IBERIA**?

Sep 2011-Aug 2012

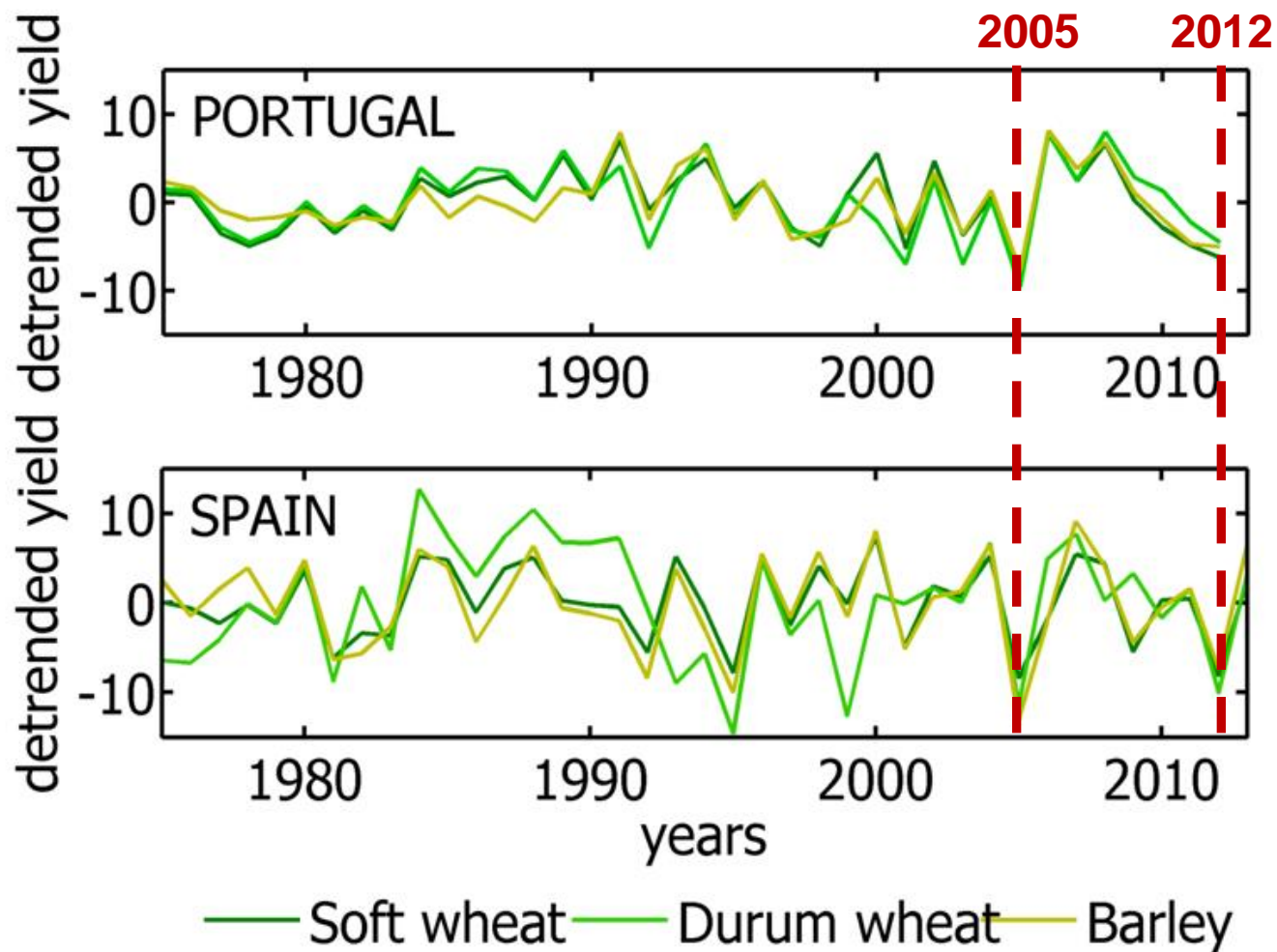


Trigo et al. (2013)

IB hydrological year yr-yr+1

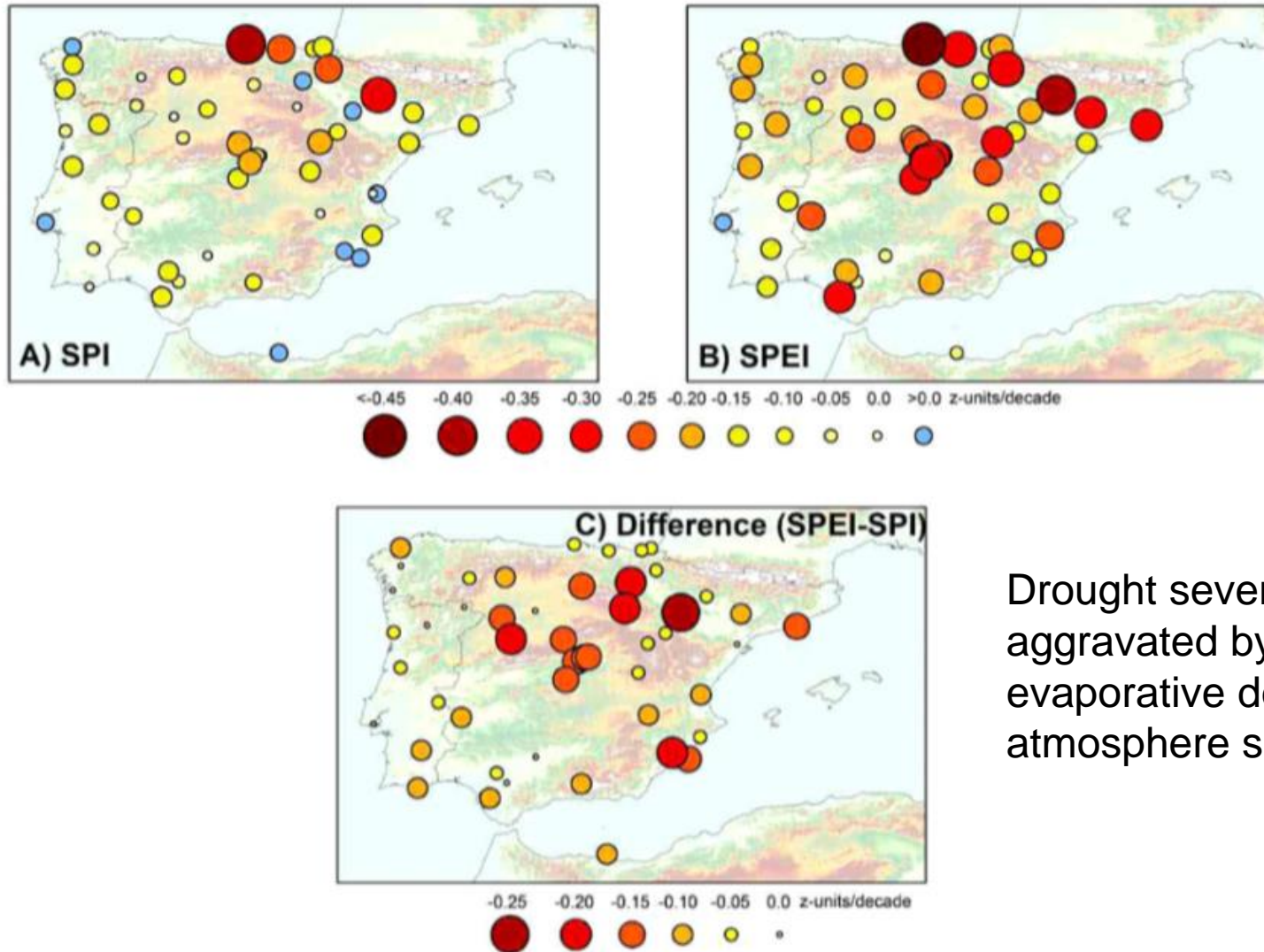


Detrended time series of **wheat** and **barley** yields for Portugal and Spain



(Gouveia et al. 2016)

3. Evidence of increasing drought severity caused by temperature rise in southern Europe (1960-2010)



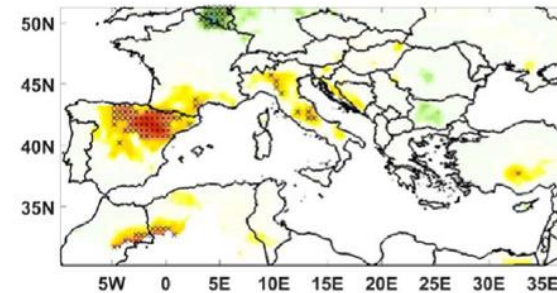
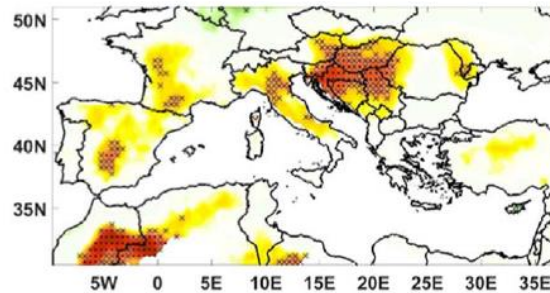
Drought severity has been aggravated by greater evaporative demand by the atmosphere since 1960s.

4. Impact of dryness in the occurrence of **heatwaves**

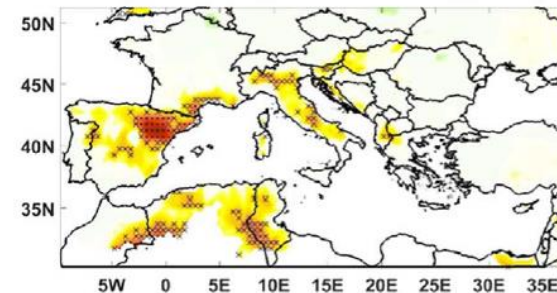
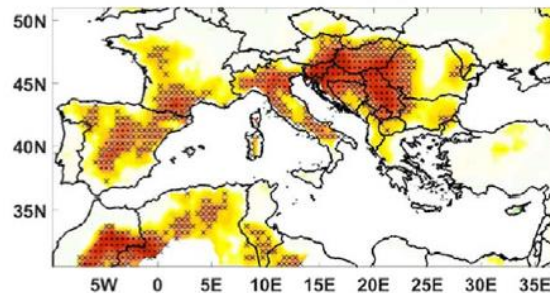
NHD

NHN

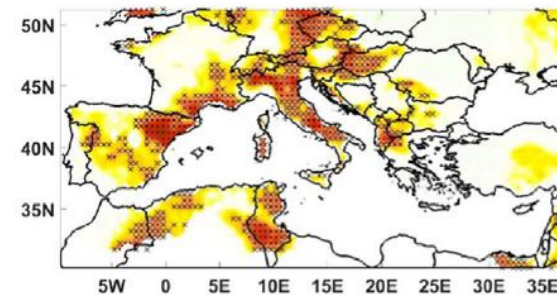
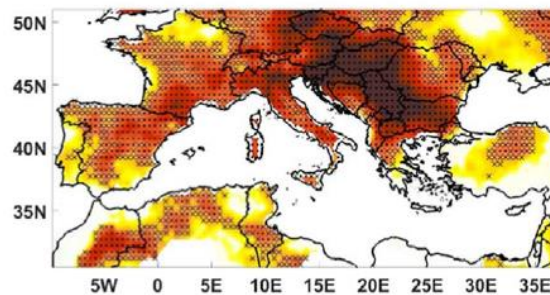
SPEI-6 May



SPEI-6 June



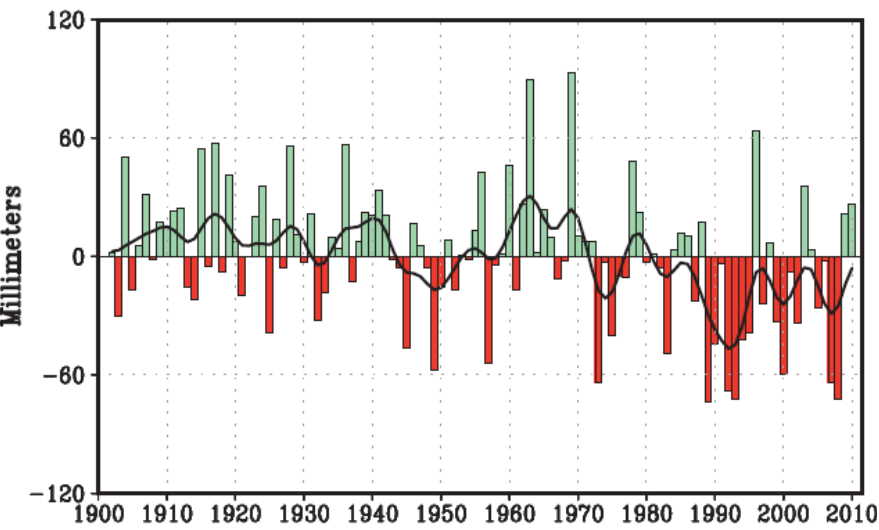
SPEI-6 July



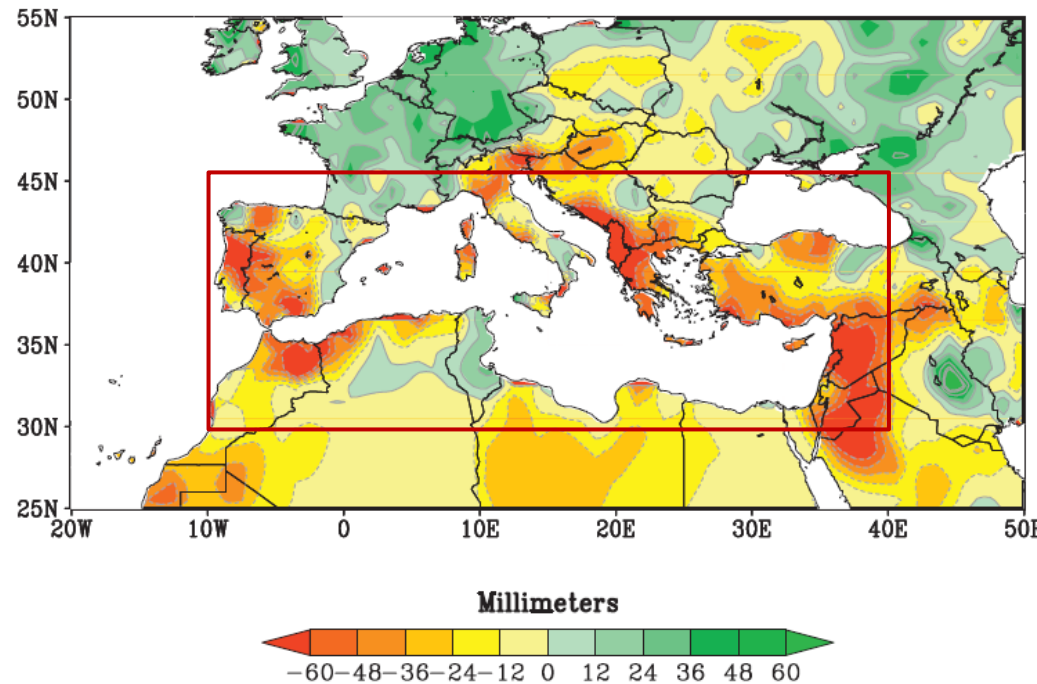
(Russo et al. 2019)

5. Observed precipitation changes in the Mediterranean (1902-2010)

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



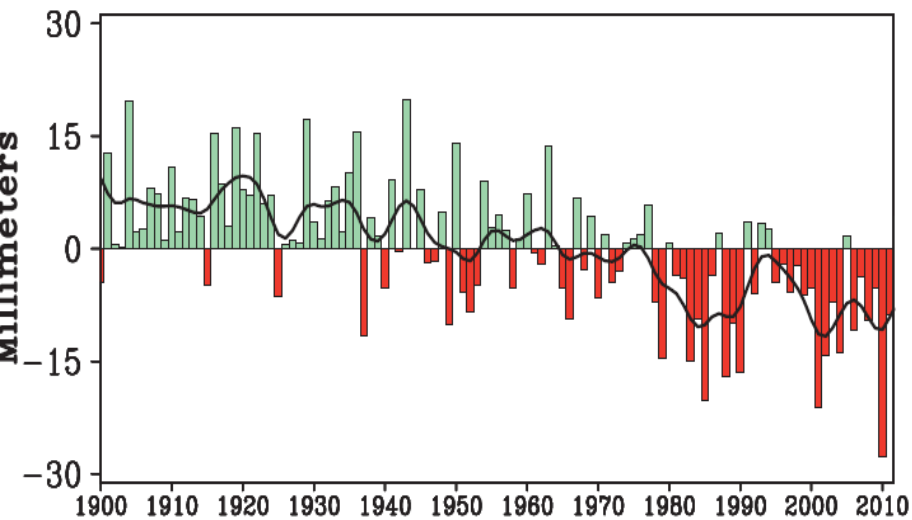
Observed change of winter Precipitation
(1971:2010) – (1902:1970)



Hoerling et al. (2012)

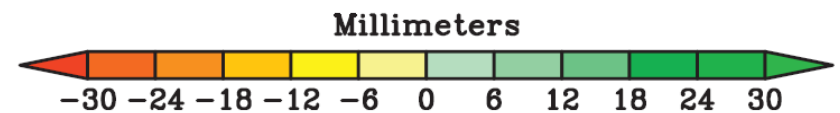
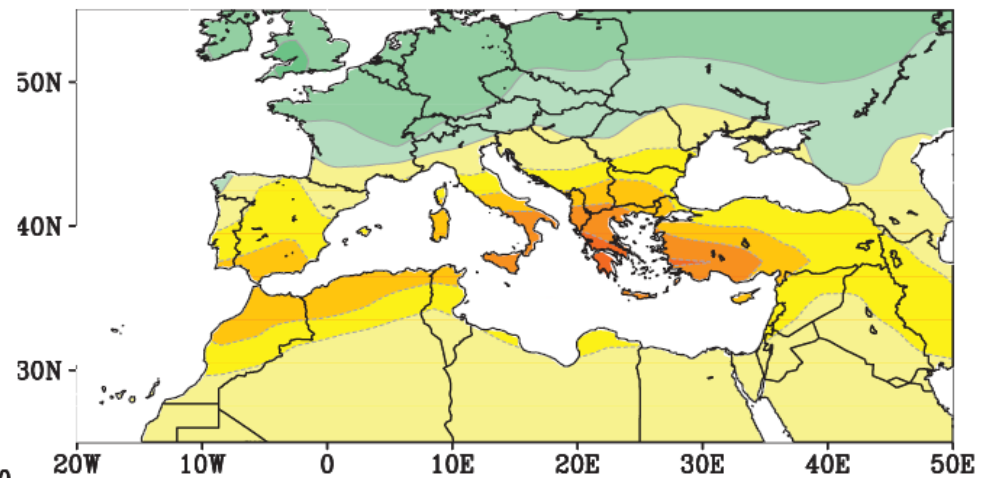
Modeled precipitation changes in the Mediterranean (1902-2010)

CMIP



Hoerling et al. (2012)

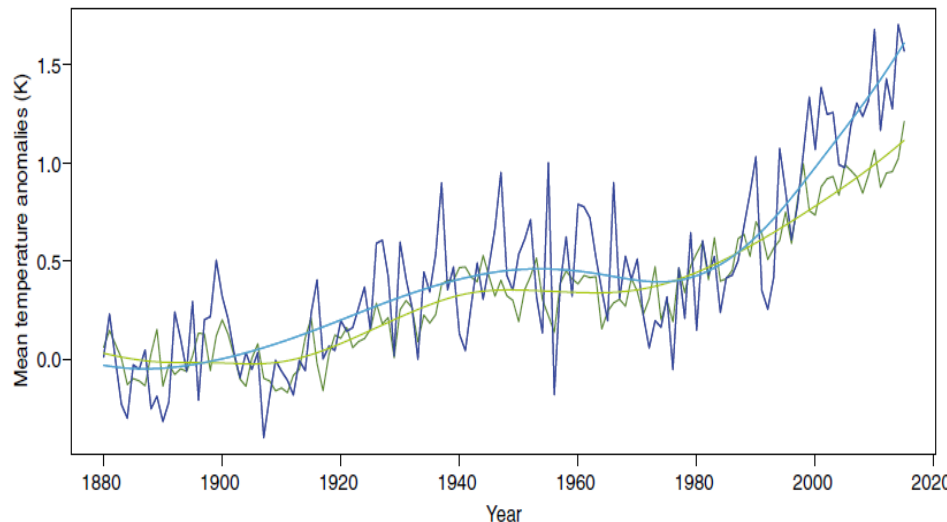
Modelled change of winter Precipitation
(1971:2010) – (1902:1970)



(Cramer et al., 2018)

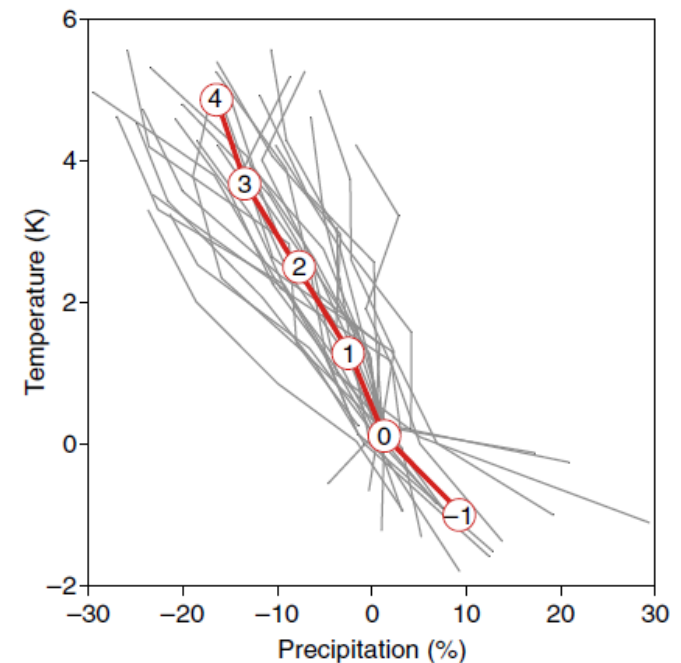
Climate change and interconnected risks to sustainable development in the Mediterranean

Wolfgang Cramer^{1*}, Joël Guiot², Mariana Fader³, Joaquim Garrabou^{4,5}, Jean-Pierre Gattuso^{6,7},



Future warming in the Mediterranean region is expected to exceed global rates by 25%.

For each 1 °C of global warming, mean rainfall will probably decrease by about 4% in much of the region, particularly in the south.



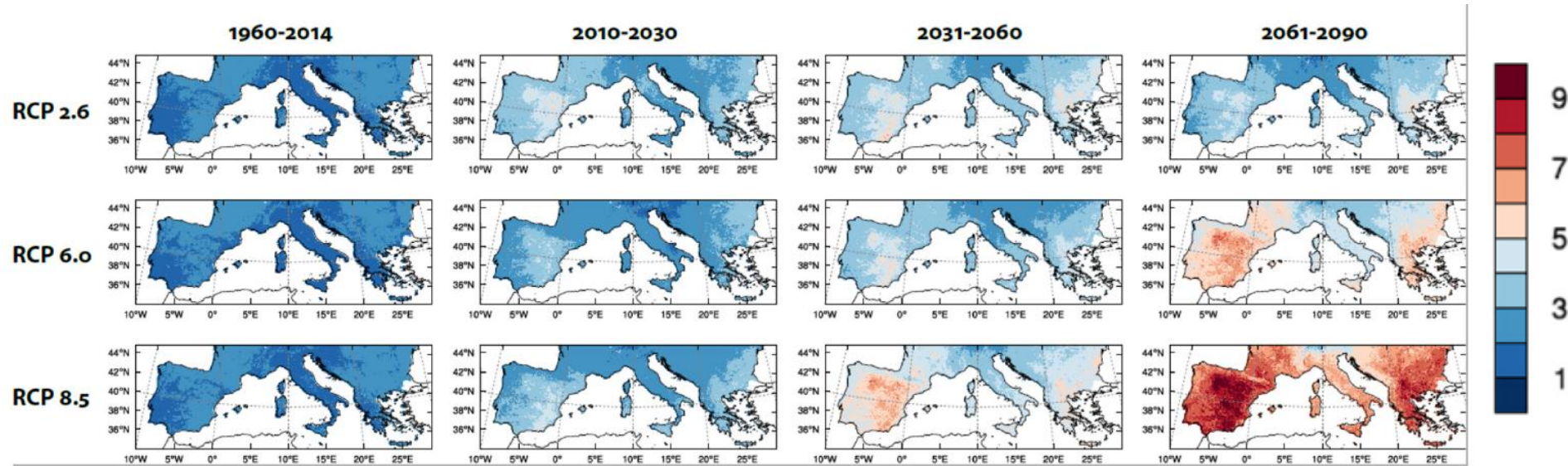
Review Article

Challenges for drought assessment in the Mediterranean region under future climate scenarios



Yves Tramblay^{a,*}, Aristeidis Koutroulis^b, Luis Samaniego^c, Sergio M. Vicente-Serrano^d, Florence Volaire^e, Aaron Boone^f, Michel Le Page^g, Maria Carmen Llasat^h, Clement Albergel^f, Selmin Burakⁱ, Maxime Cailleret^j, Ksenija Cindrić Kalin^k, Hendrik Davi^l, Jean-Luc Dupuy^j, Peter Greve^m, Manolis Grillakisⁿ, Lahoucine Hanich^{o,p}, Lionel Jarlan^g, Nicolas Martin-StPaul^l, Jordi Martínez-Vilalta^{q,r}, Florent Mouillot^e, David Pulido-Velazquez^z, Pere Quintana-Seguí^f, Delphine Renard^v, Marco Turco^u, Murat Türkeş^v, Ricardo Trigo^w, Jean-Philippe Vidal^x, Alberto Vilagrosa^y, Mehrez Zribi^g, Jan Polcher^z

Multi-model ensemble mean drought duration (month/years)

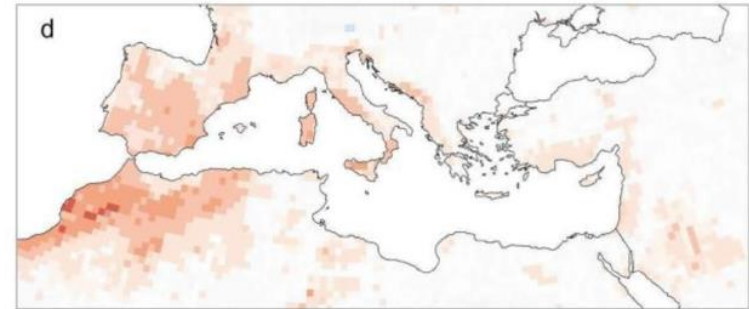


(Trambley et al., 2020)

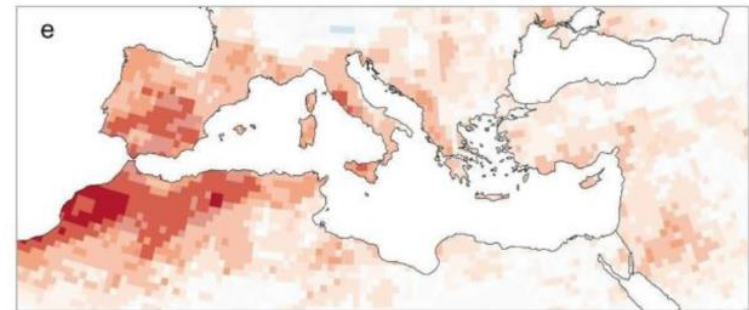
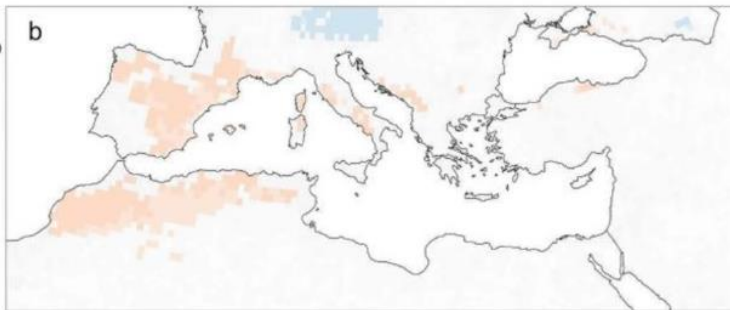
SPI6

SPI48

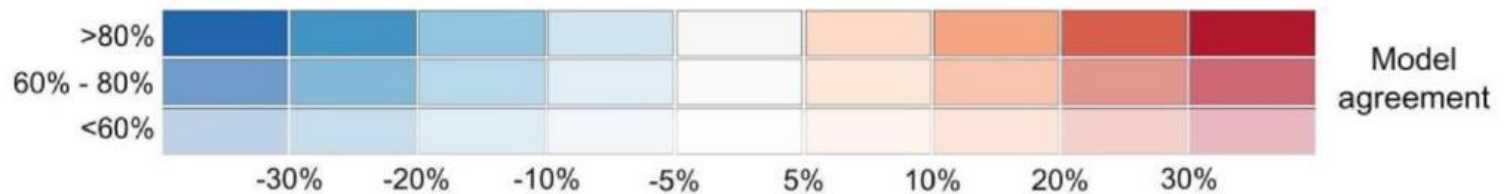
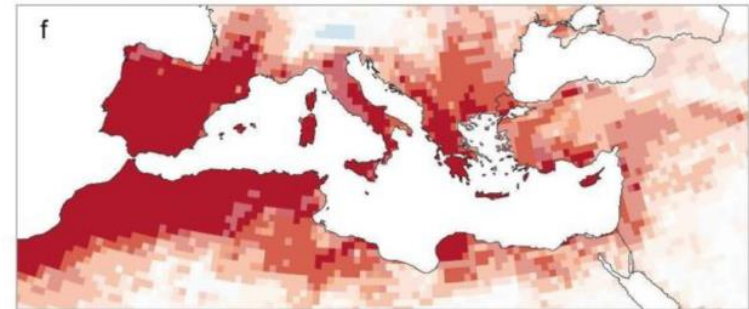
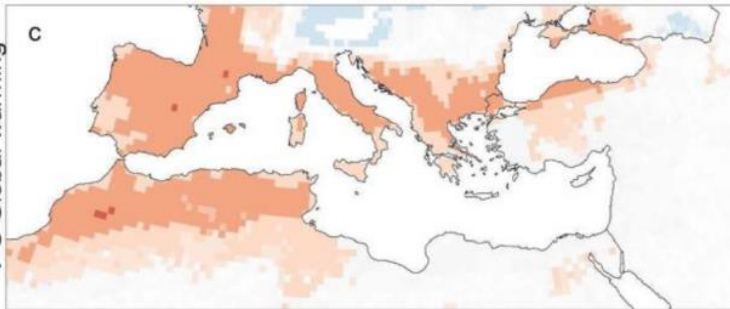
1.5°C



2.0°C

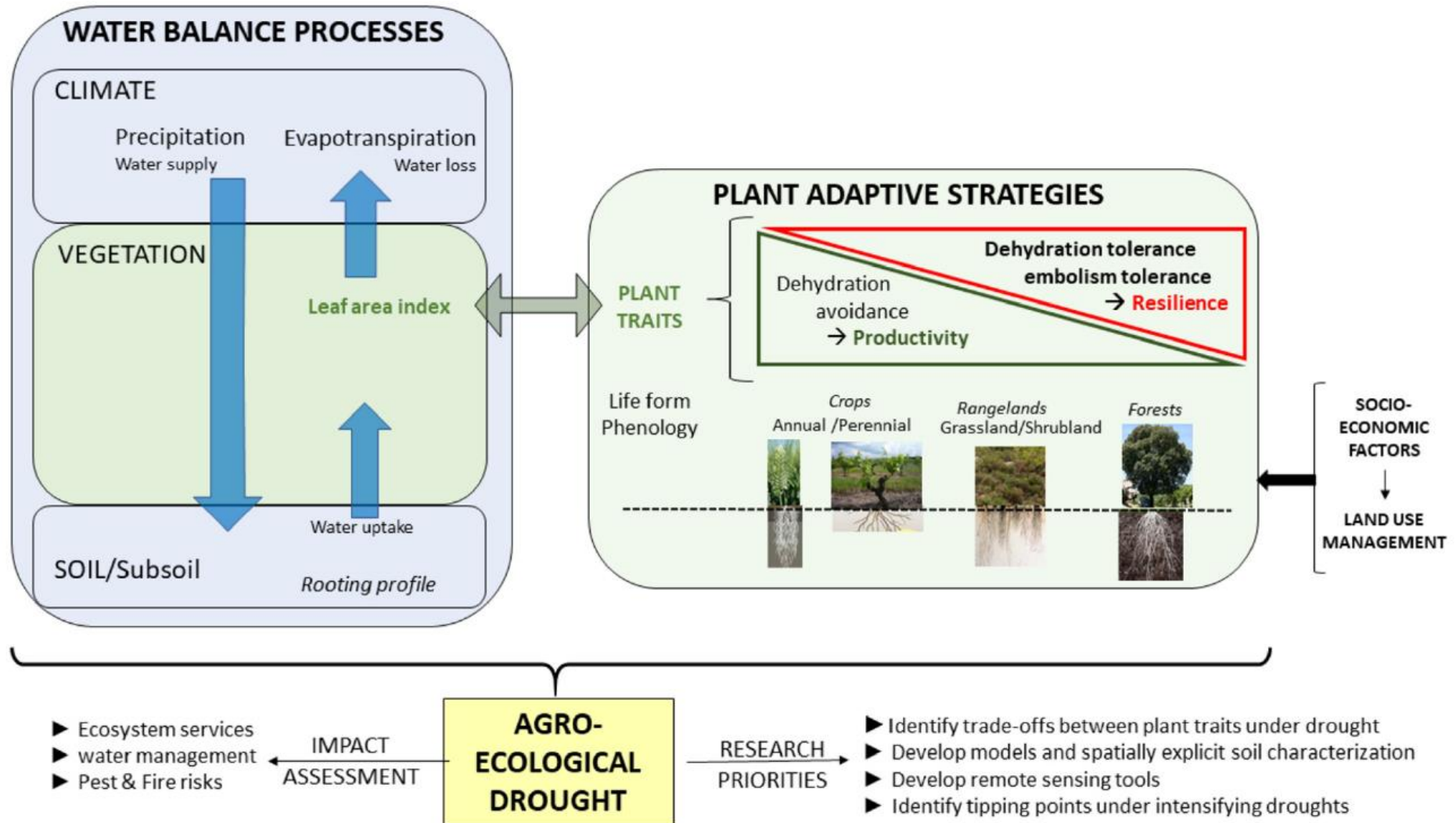


4.0°C



(Trambley et al., 2020)

Change in time under severe & extreme drought (SPI < -1.5)



(Trambley et al., 2020)

Thanks!

ResearcherID: B-7044-2008

Scopus Author ID: 6603764342

FCT

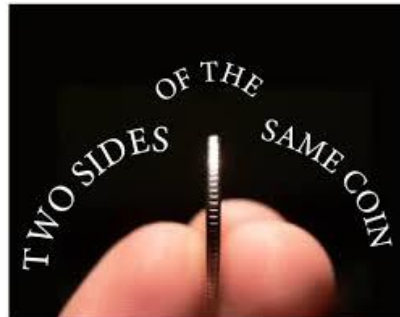
Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR



Indecis
Sectorial Climate Services

Droughts → Heatwave

Can we consider that **droughts** and summer **heatwaves** are two sides of the same coin?



Spring droughts: Land-Atmosphere coupling

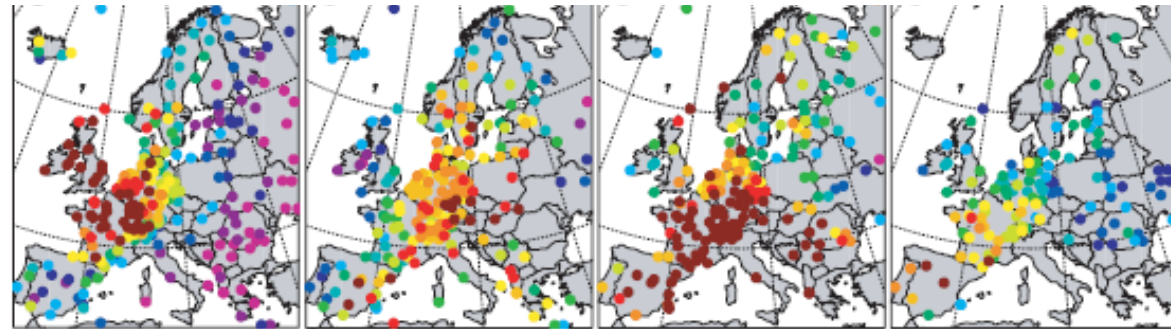
Observed

1975

1994

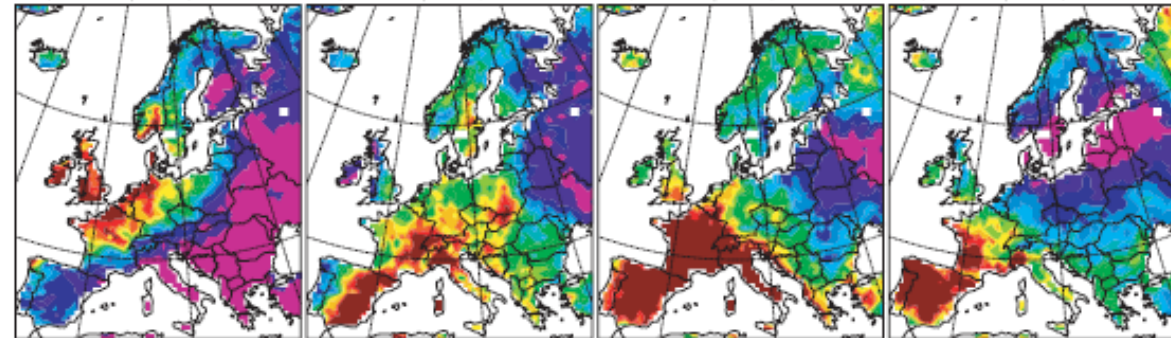
2003

2005



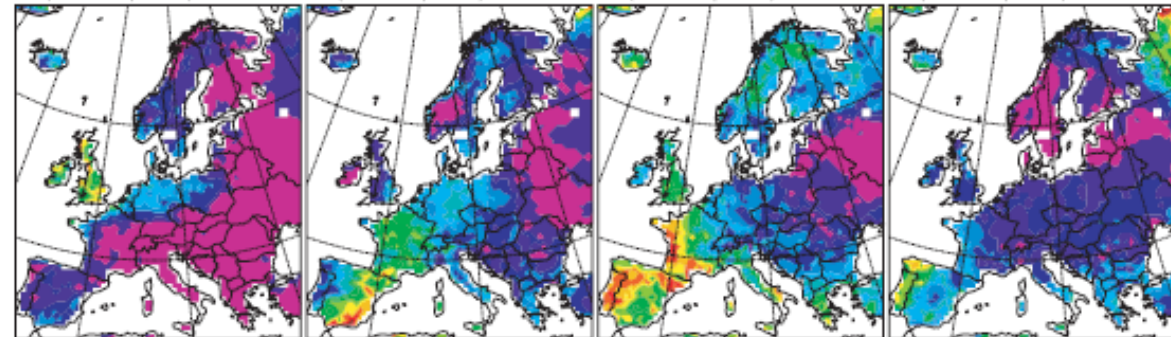
e) CL 1976 NHD (TMAX > 90th percentile)
f) CL 1994 NHD (TMAX > 90th percentile)
g) CL 2003 NHD (TMAX > 90th percentile)
h) CL 2005 NHD (TMAX > 90th percentile)

Coupled



i) UCL 1976 NHD (TMAX > 90th percentile)
j) UCL 1994 NHD (TMAX > 90th percentile)
k) UCL 2003 NHD (TMAX > 90th percentile)
l) UCL 2005 NHD (TMAX > 90th percentile)

Uncoupled



Miralles et al. (2014
Nature Geoscience)

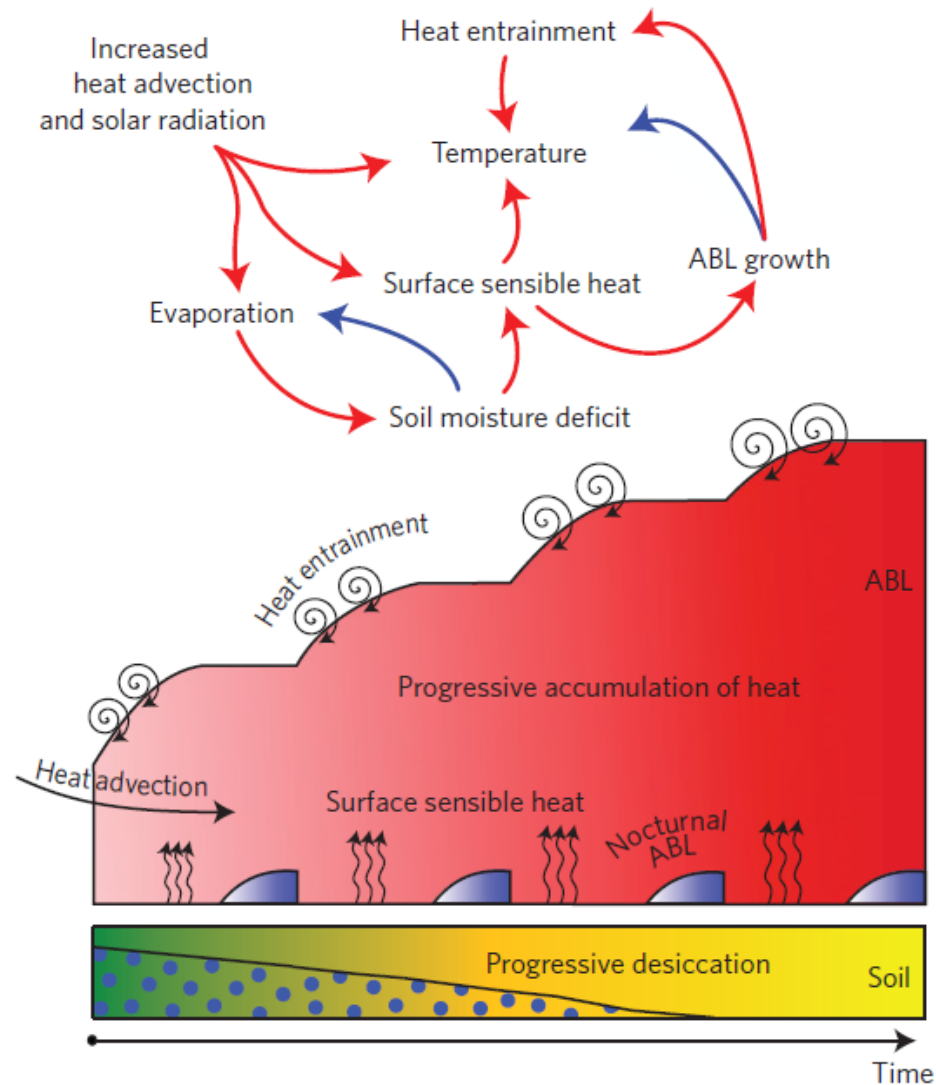


Figure 4 | Land-atmosphere interactions during mega-heatwaves revisited. Representation of the main soil moisture–air temperature interactions in the development of a mega-heatwave. Red and blue arrows represent positive and negative correlations, respectively.

