O FUTURO DA ÁGUA NA AGRICULTURA MEDITERRÂNEA FACE ÀS ALTERAÇÕES CLIMÁTICAS

João Andrade Santos *et al*.

Sociedade de Geografia de Lisboa
Lisboa, Portugal

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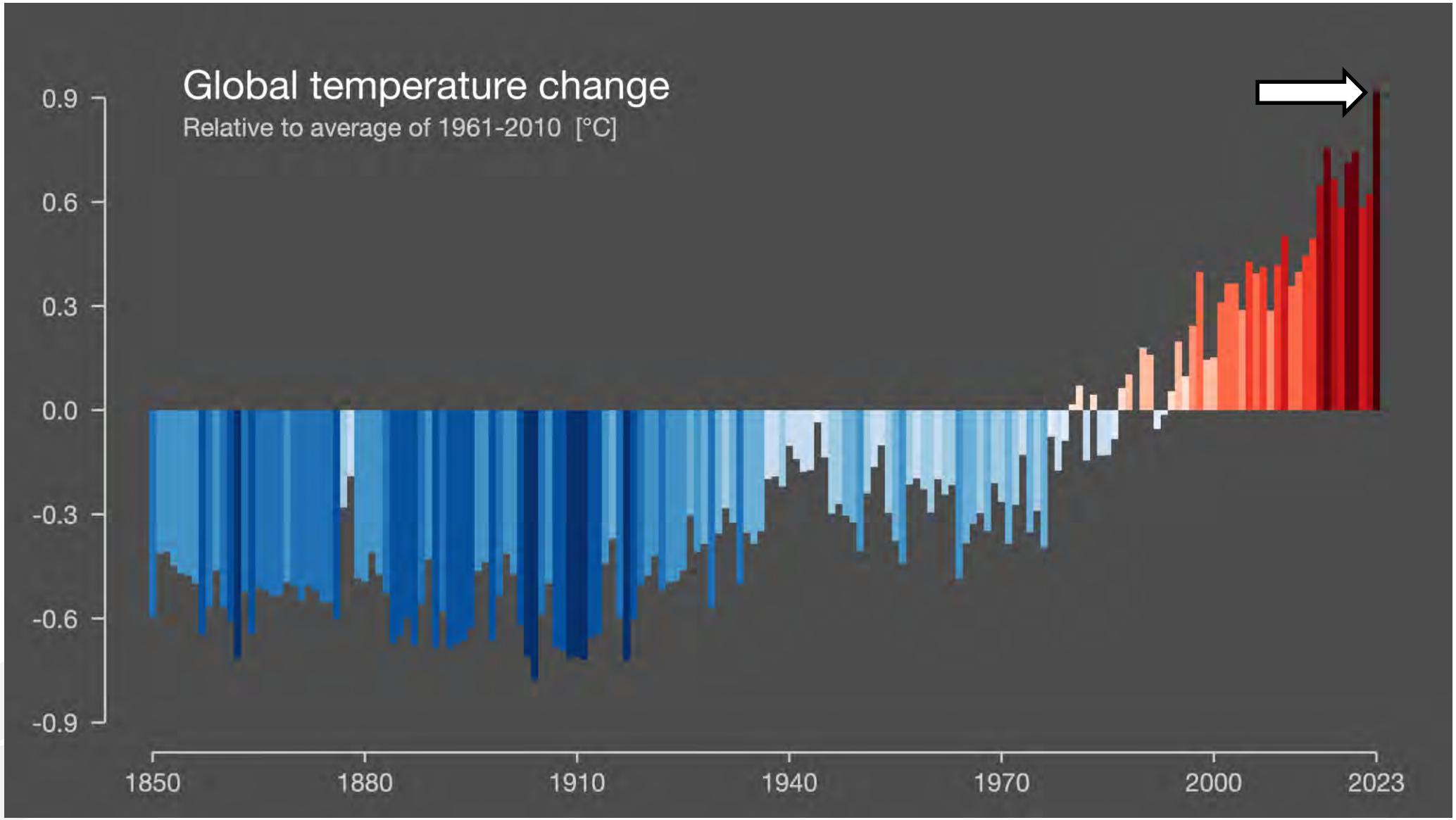
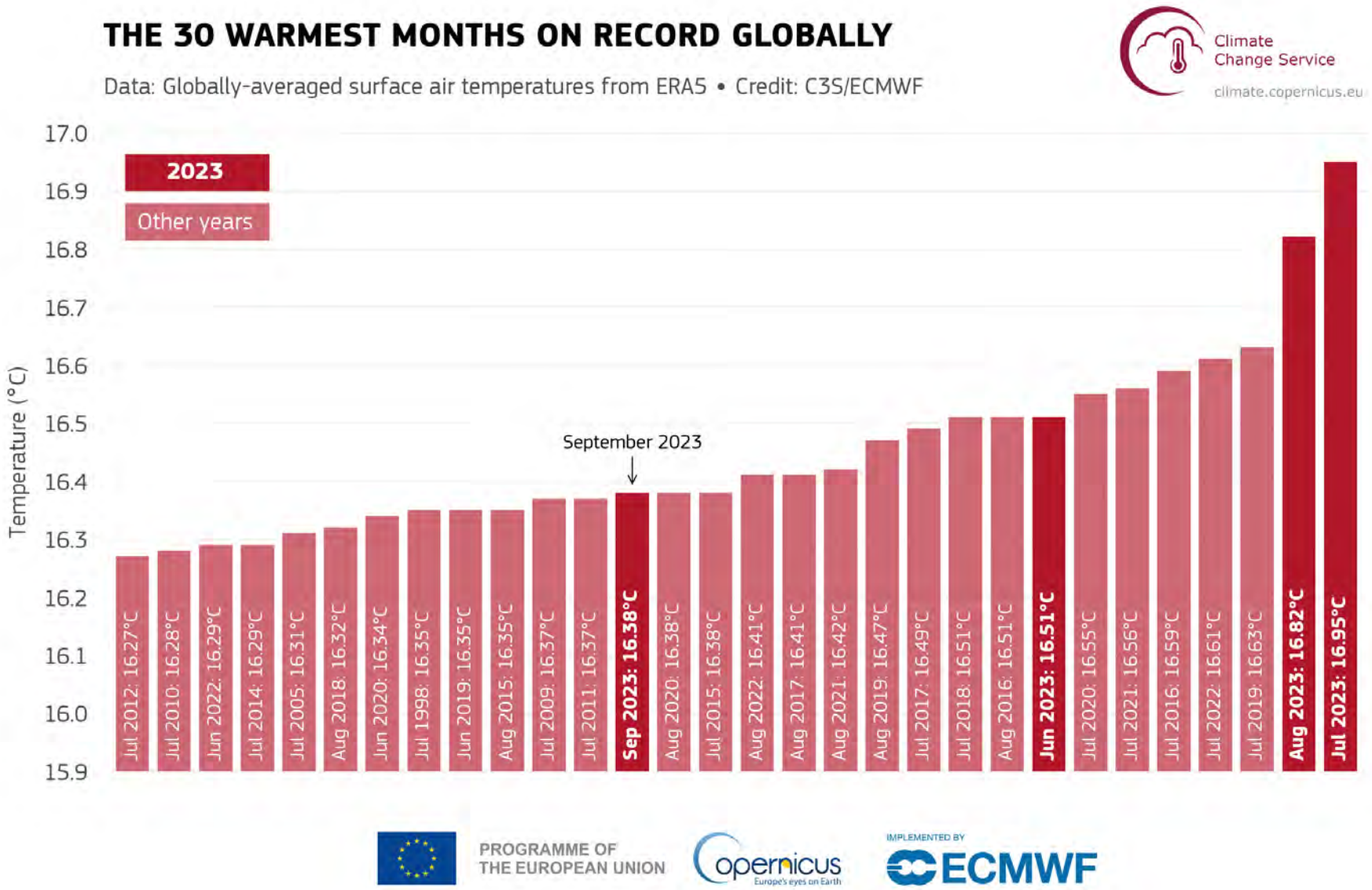
Climate emergency: a global threat

Climate emergency: a global threat



Graphics and lead scientist: Ed Hawkins, National Centre for Atmospheric Science, University of Reading.
Data: Berkeley Earth, NOAA, UK Met Office, MeteoSwiss, DWD, SMHI, UoR, Meteo France & ZAMG

Climate emergency: a global threat



Historical trends

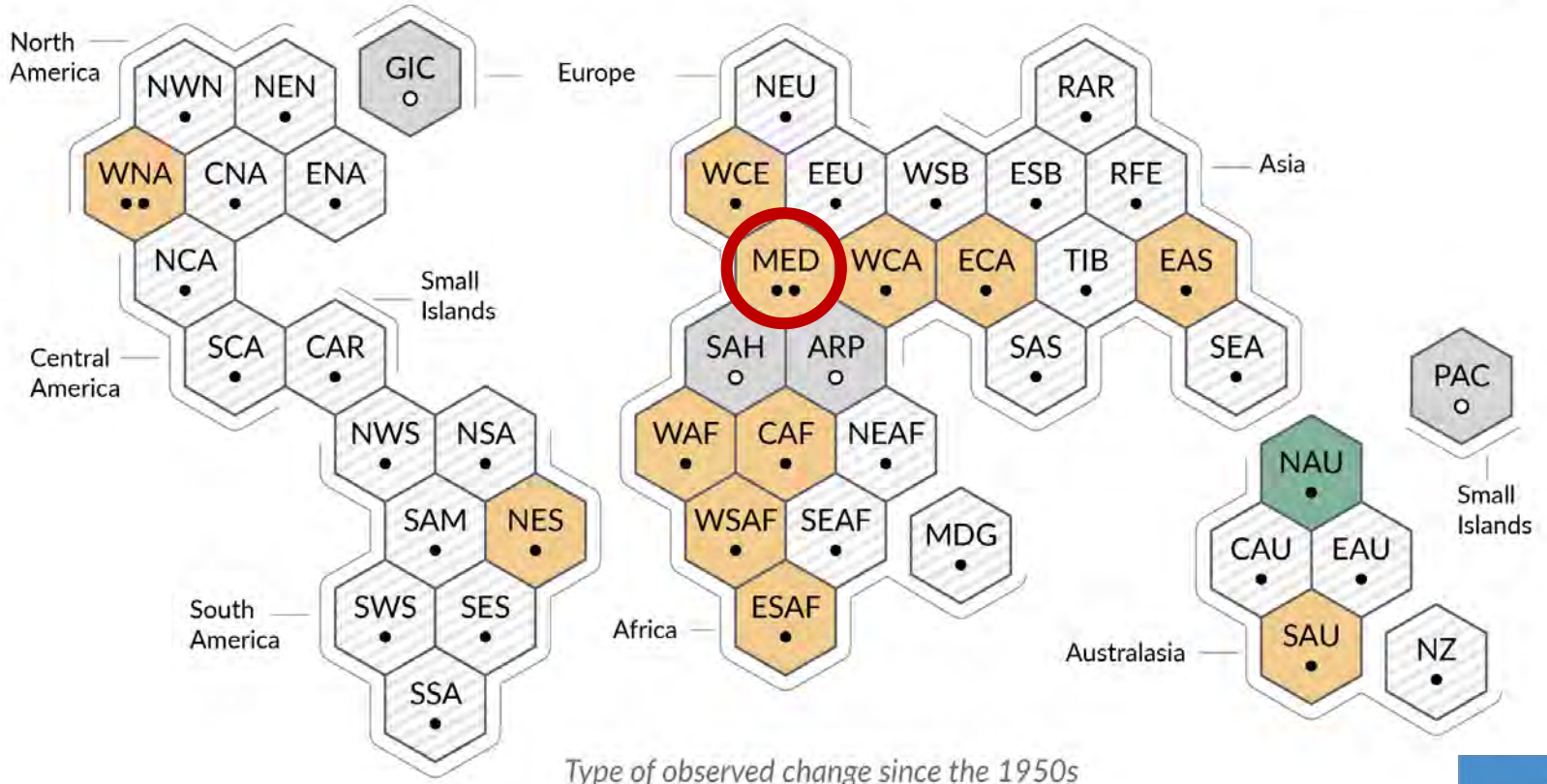
c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in agricultural and ecological drought

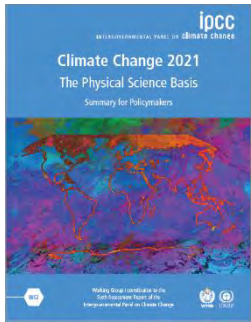
- Increase (12)
- Decrease (1)
- Low agreement in the type of change (28)
- Limited data and/or literature (4)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



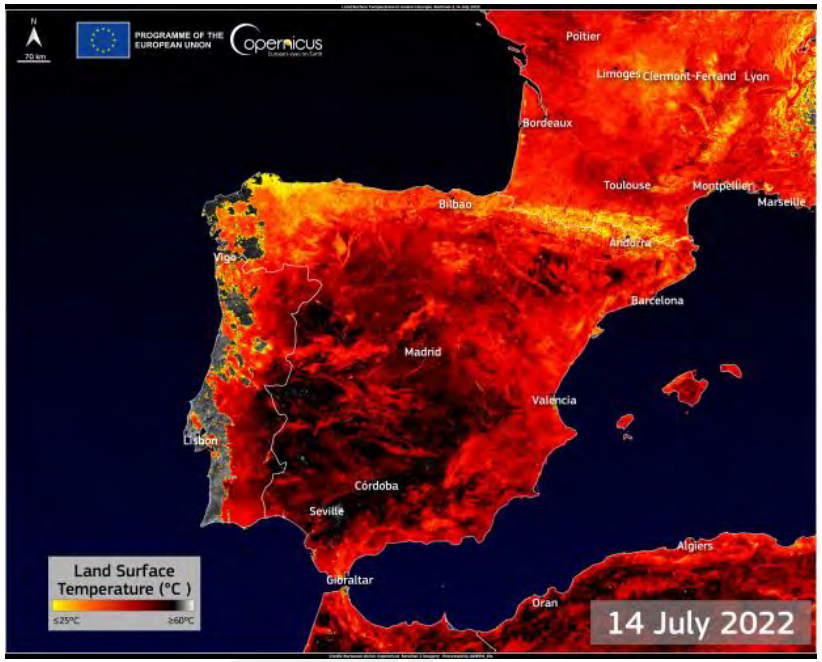
Type of observed change since the 1950s



Source: IPCC AR6 WG1 (2021)

Weather & climate extremes

We are witnessing more frequent and intense…



Compound Events & Cascading Risks

Impacts

Losses in agriculture attributed to extreme events:

FAO estimates for 2008-2018

- Droughts: 37 000 million USD (82% of all drought-related losses)
- Floods: 21 000 million USD (19% of all flood-related losses)
- Storms: 19 000 million USD (18% of all storm-related losses)
- Wildfires: 1 000 million USD (1% of all fire-related losses)
- Pests & diseases (difficult to assess)

Climate change: the physical basis

The physical basis

A doubling in CO_2 concentration will lead to global warming of approximately 5–6°C

Svante Arrhenius (1859-1927)
Nobel Prize in Chemistry

Climate is warming as CO_2 levels are rising

Guy Stewart Callendar (1898-1964)

Quarterly Journal of the Royal Meteorological Society

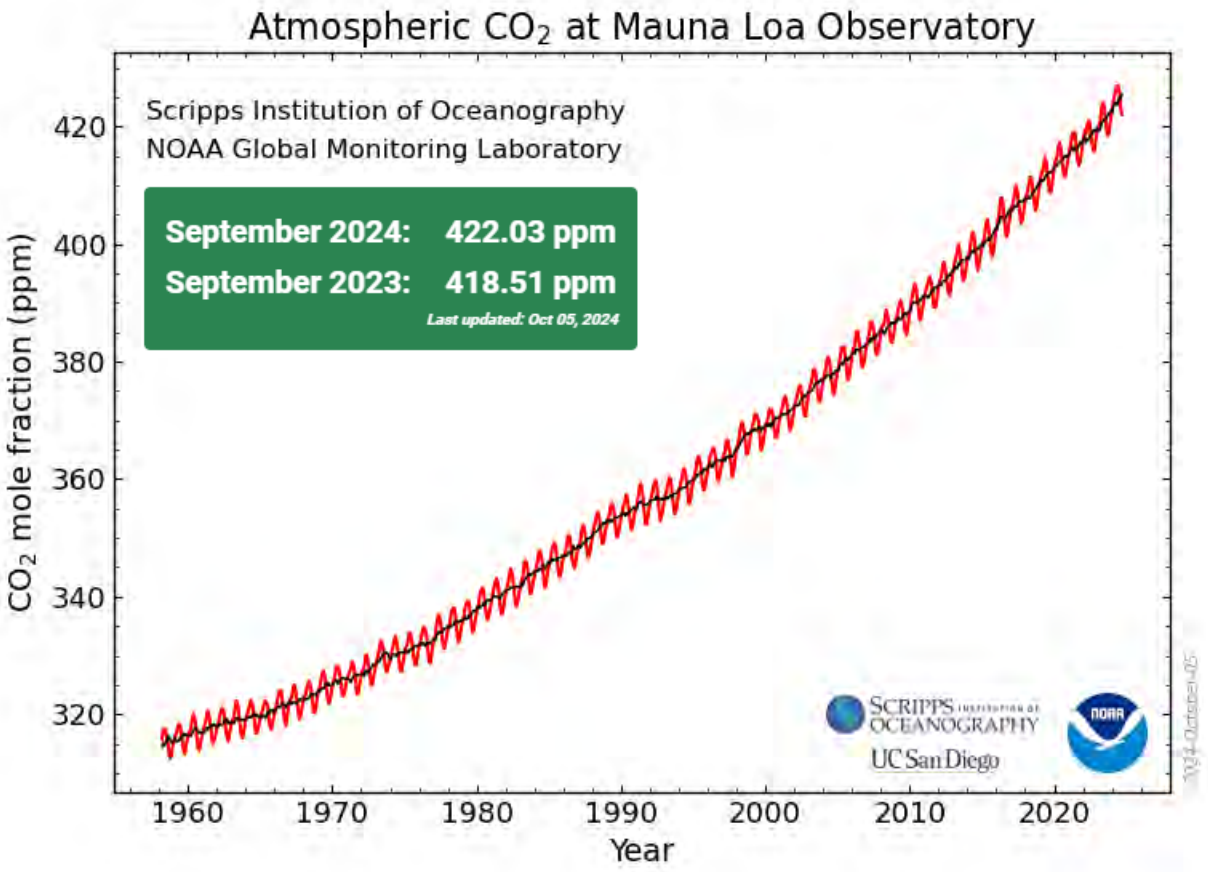
Article

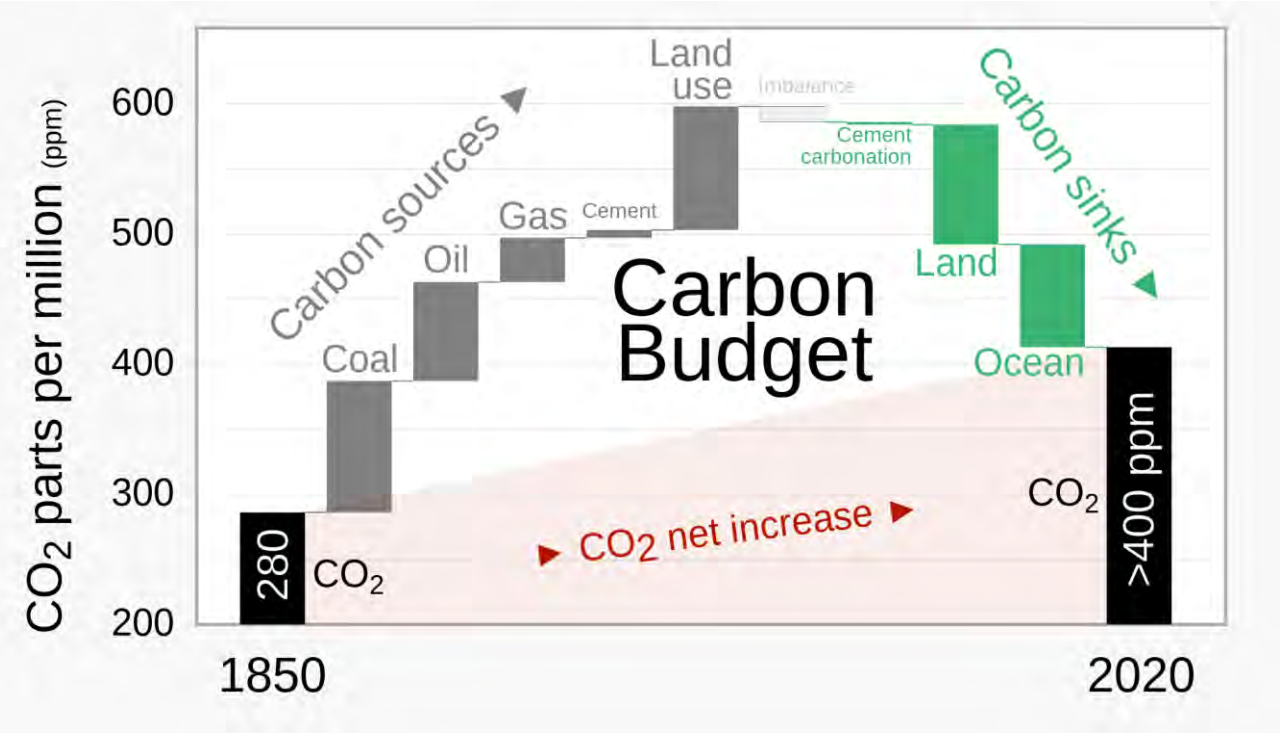
The artificial production of carbon dioxide and its influence on temperature

G. S. Callendar

First published: April 1938 | https://doi.org/10.1002/qj.49706427503 | Citations: 433

The physical basis



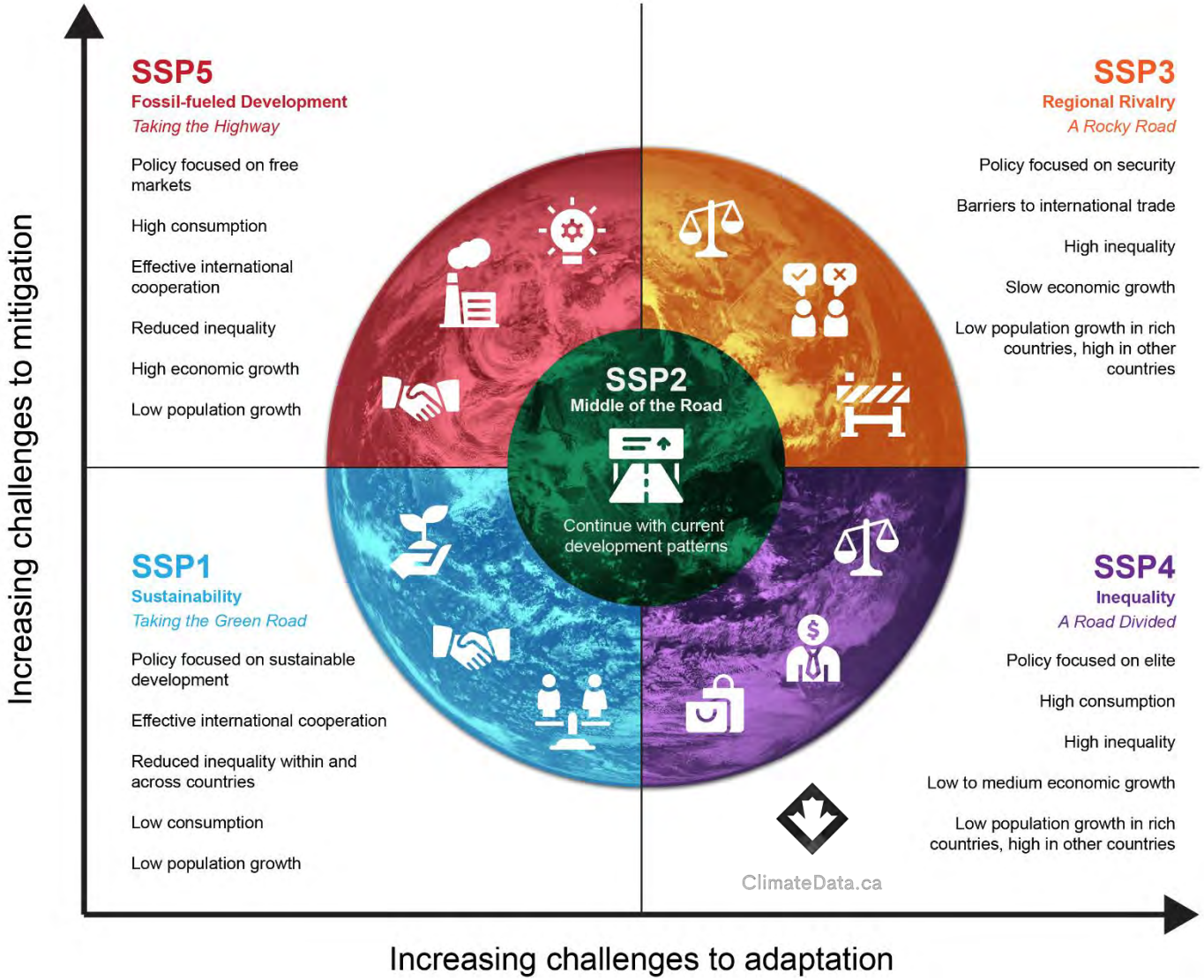


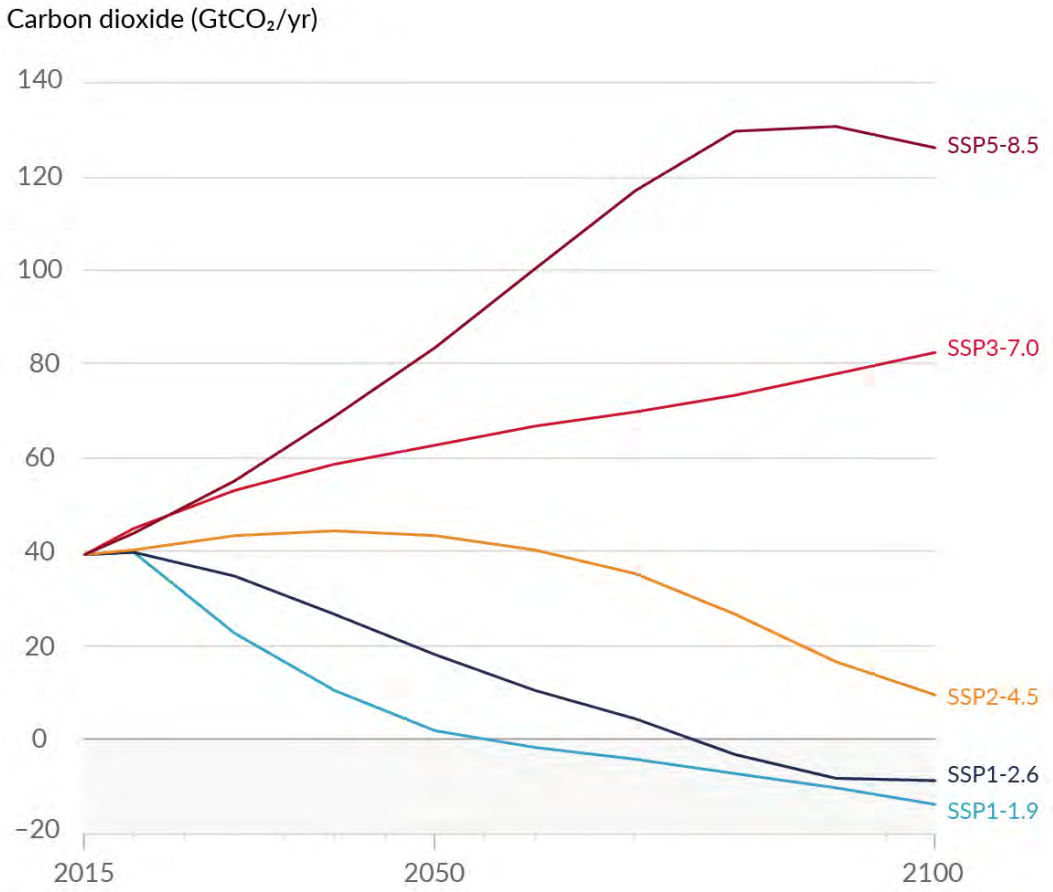
GCP's *Global Carbon Budget 2021*
(Friedlingstein *et al.* 2021)

Climate change: scenarios & projections

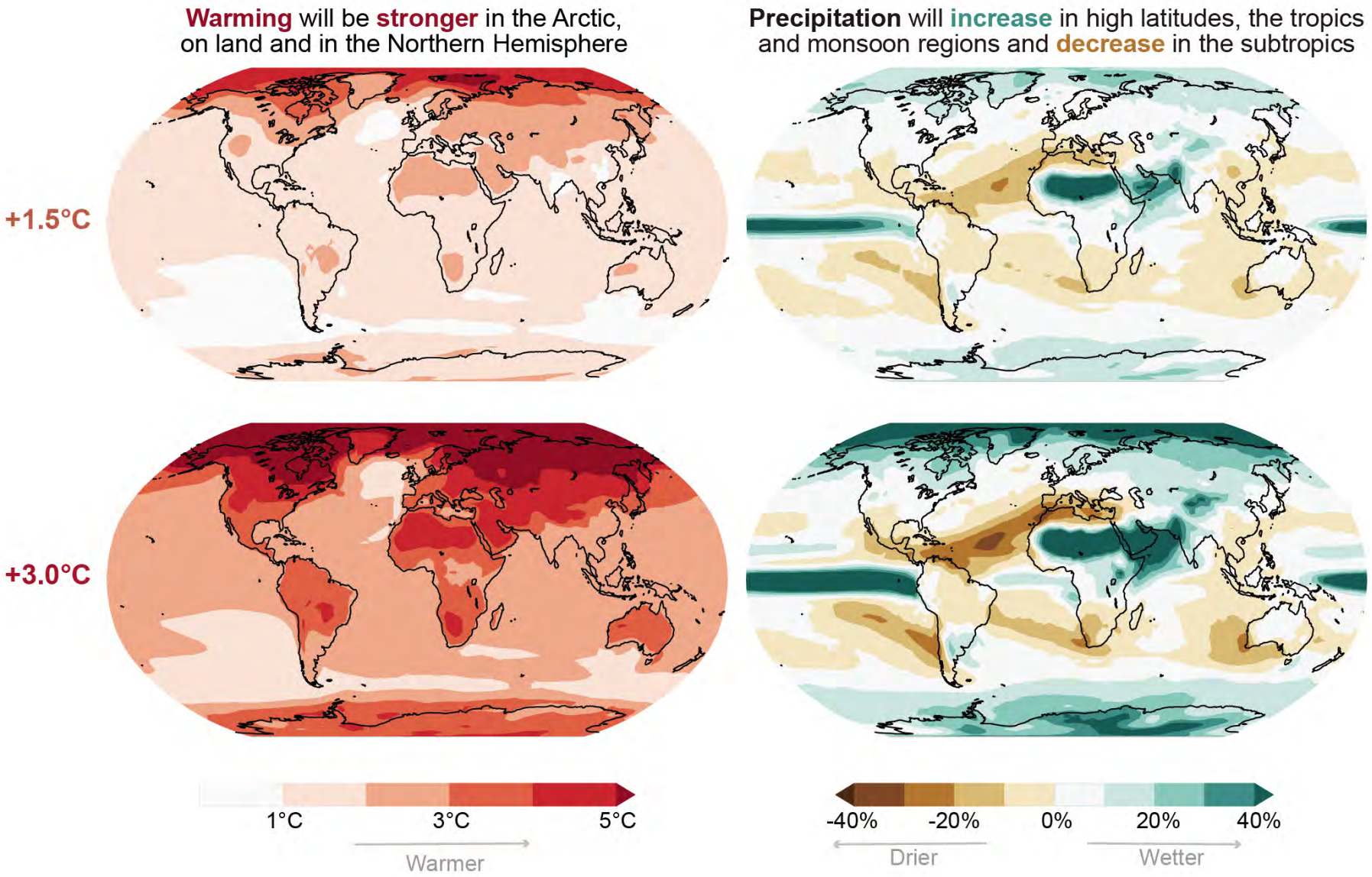
GHG scenarios

Shared Socio-economic Pathways (SSPs)





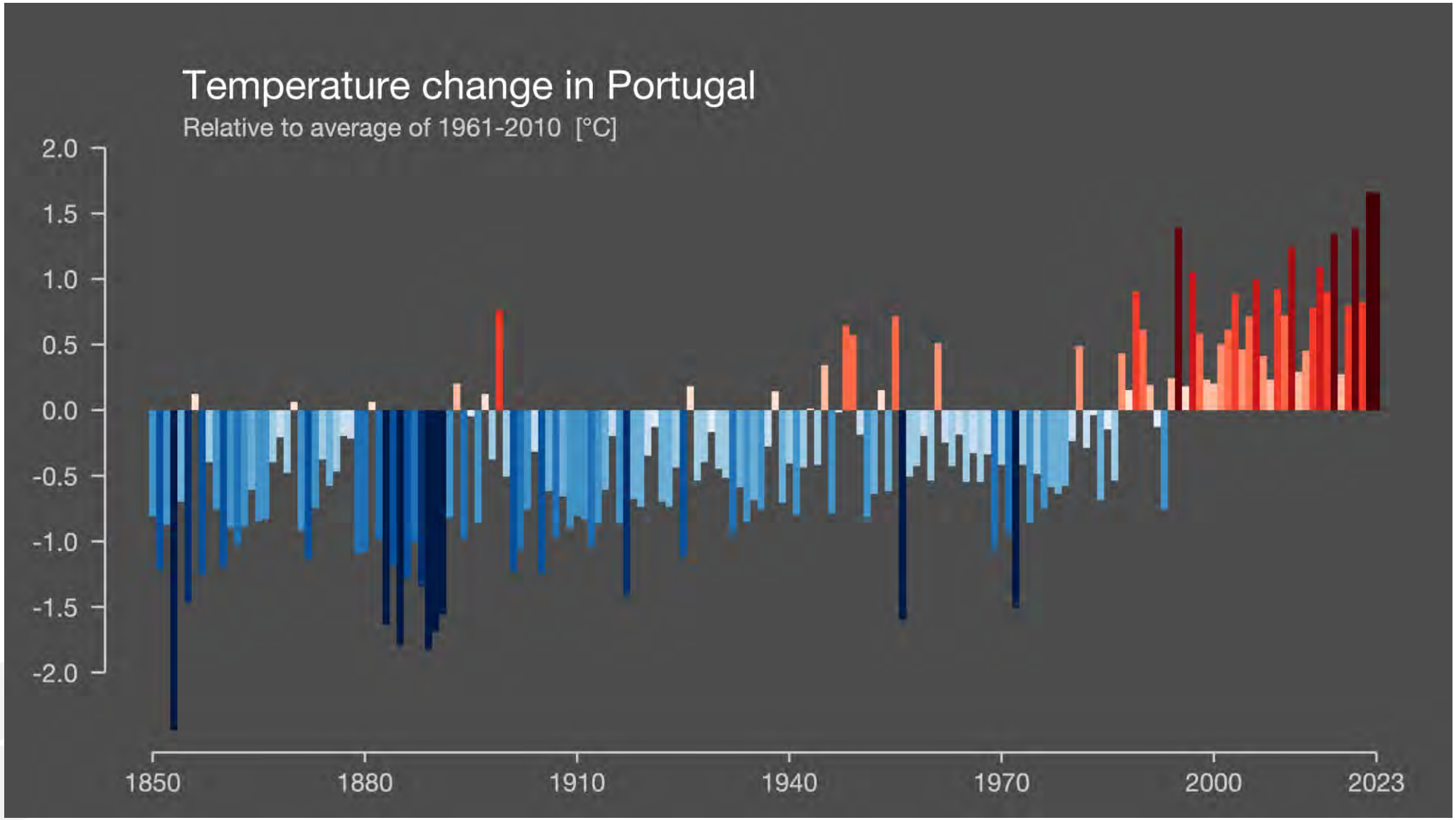
Climate emergency: a global threat



Source: IPCC AR6 WG1 (2021)

Climate change: Portugal

Historical warming trend



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Climate change: Portugal

Climate model ensemble

Acronym	Name
IPSL-CM6A-LR	Institut Pierre-Simon Laplace Earth System Model—Coupled Model version 6A—Low Resolution
MPI-ESM1-2-HR	Max Planck Institute Earth System Model Version 1.2—High Resolution
MRI-ESM2-0	Meteorological Research Institute Earth System Model Version 2.0
UKESM1-0-LL	UK Earth System Model 1.0 Low Resolution
CNRM-CM6-1	Centre National de Recherches Météorologiques - Climate Model Version 6.1
MIROC6	Model for Interdisciplinary Research on Climate, version 6

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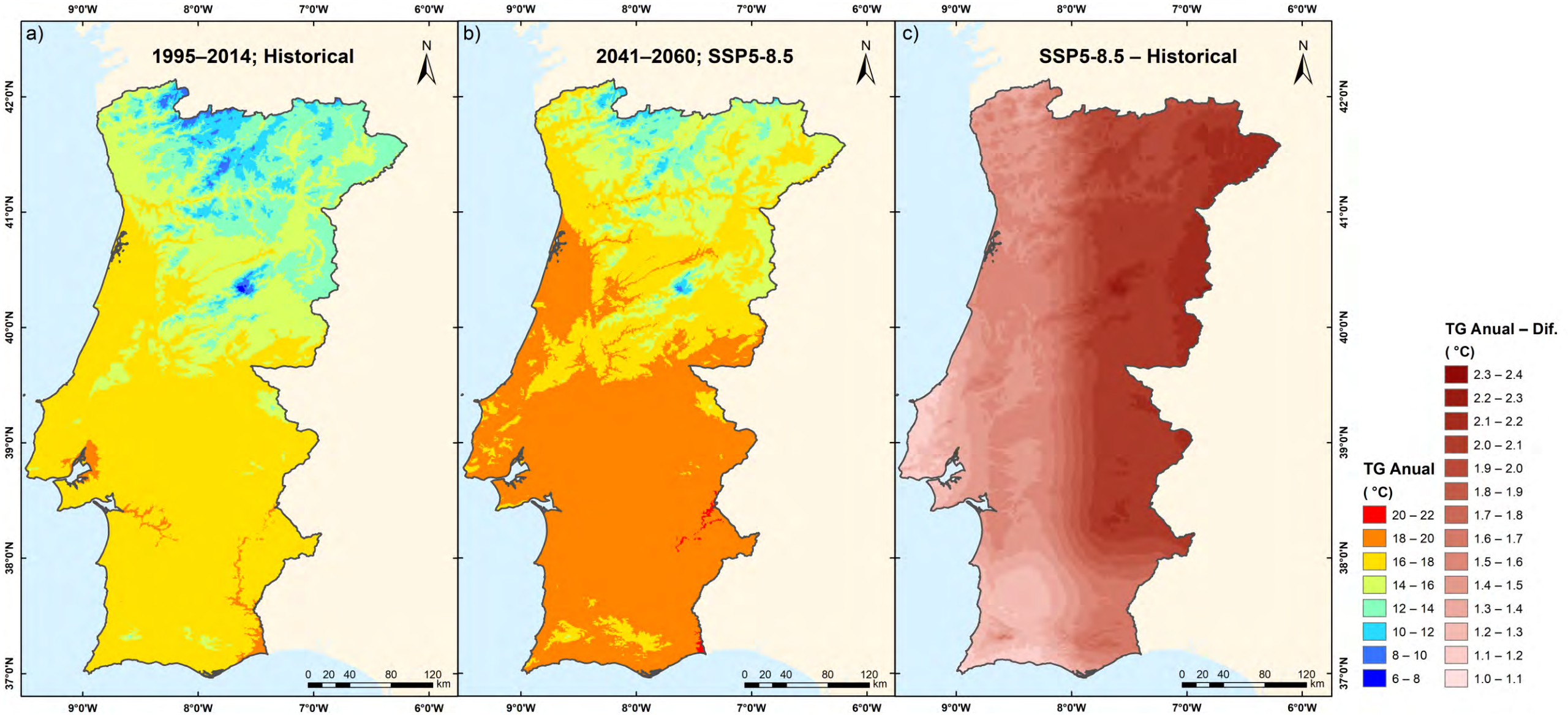
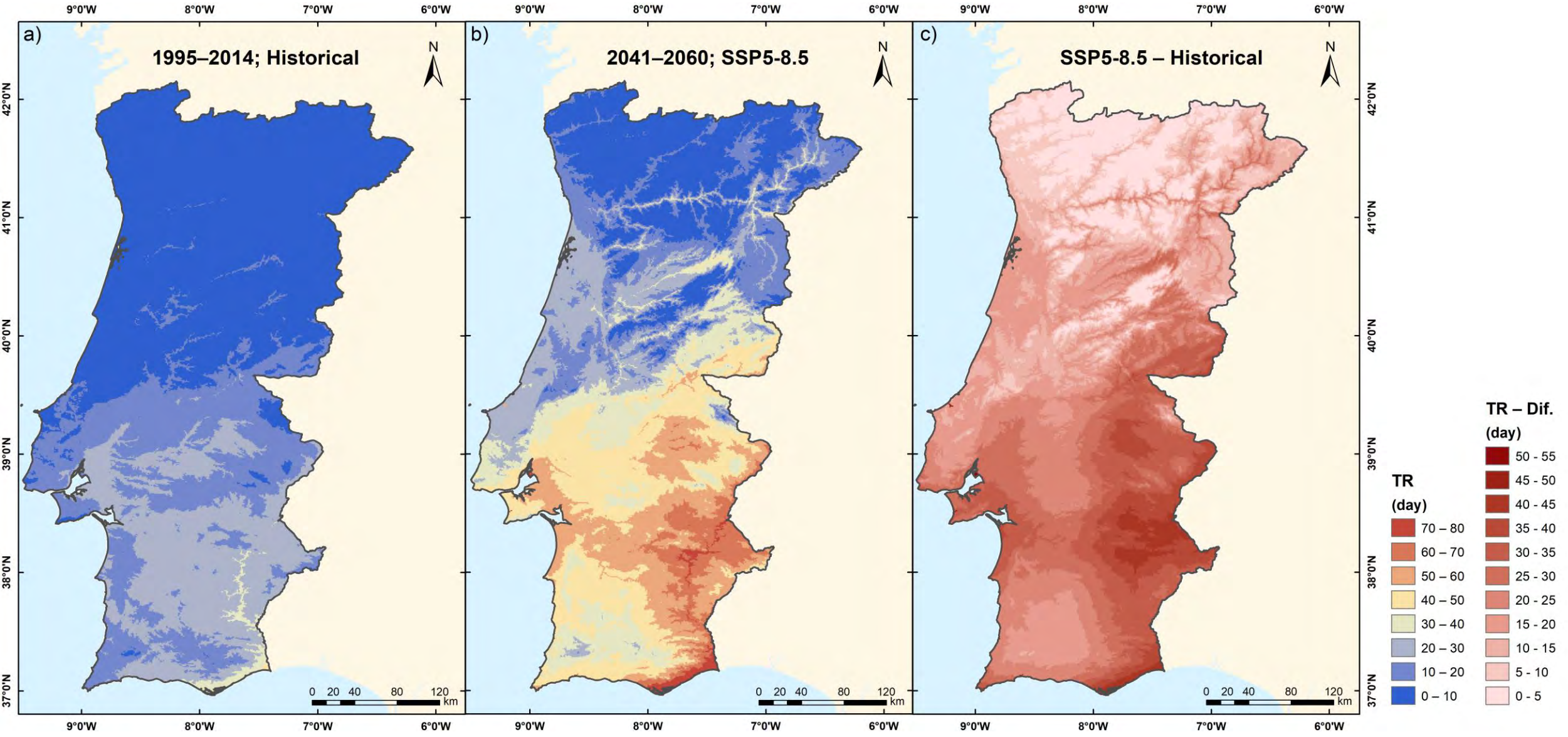
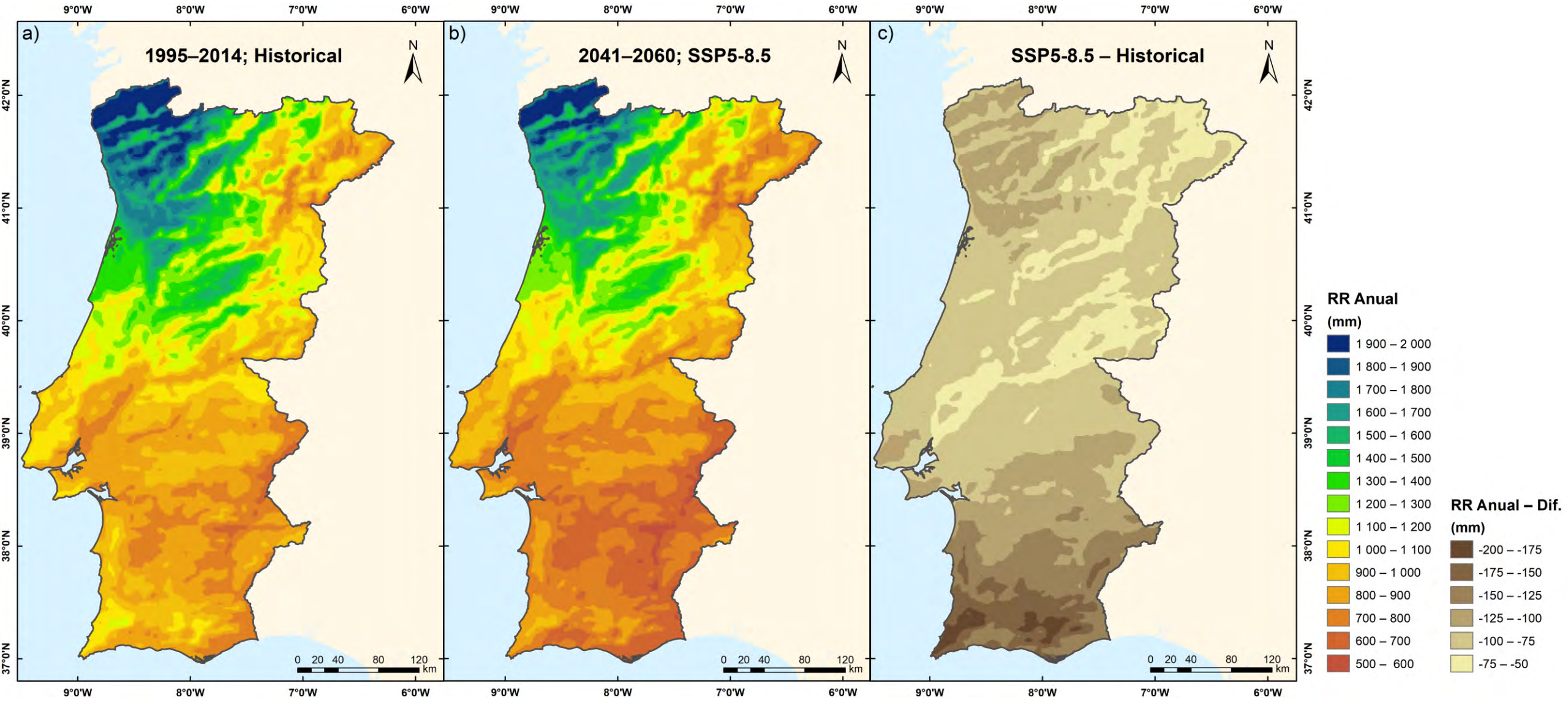
Projections of annual mean temperature



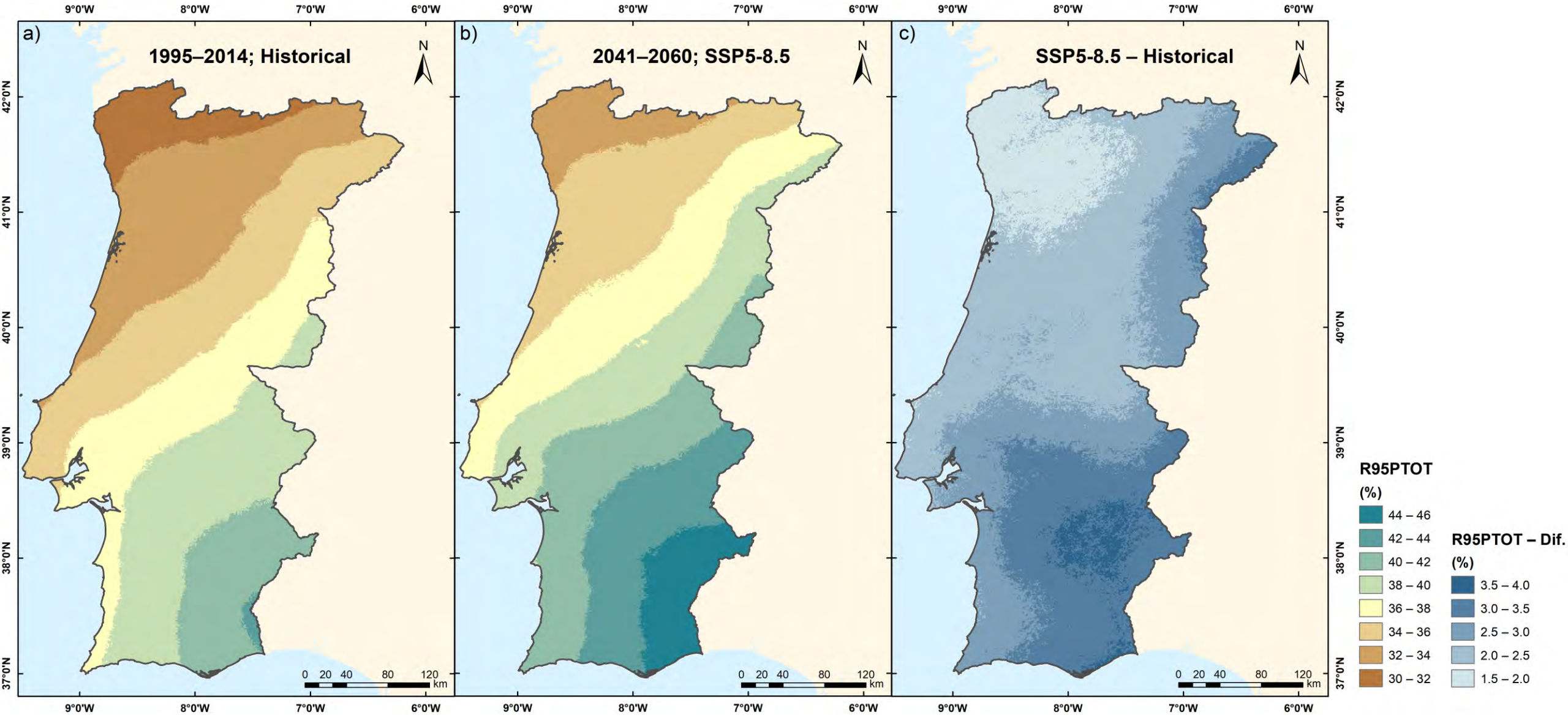
Projections of tropical nights



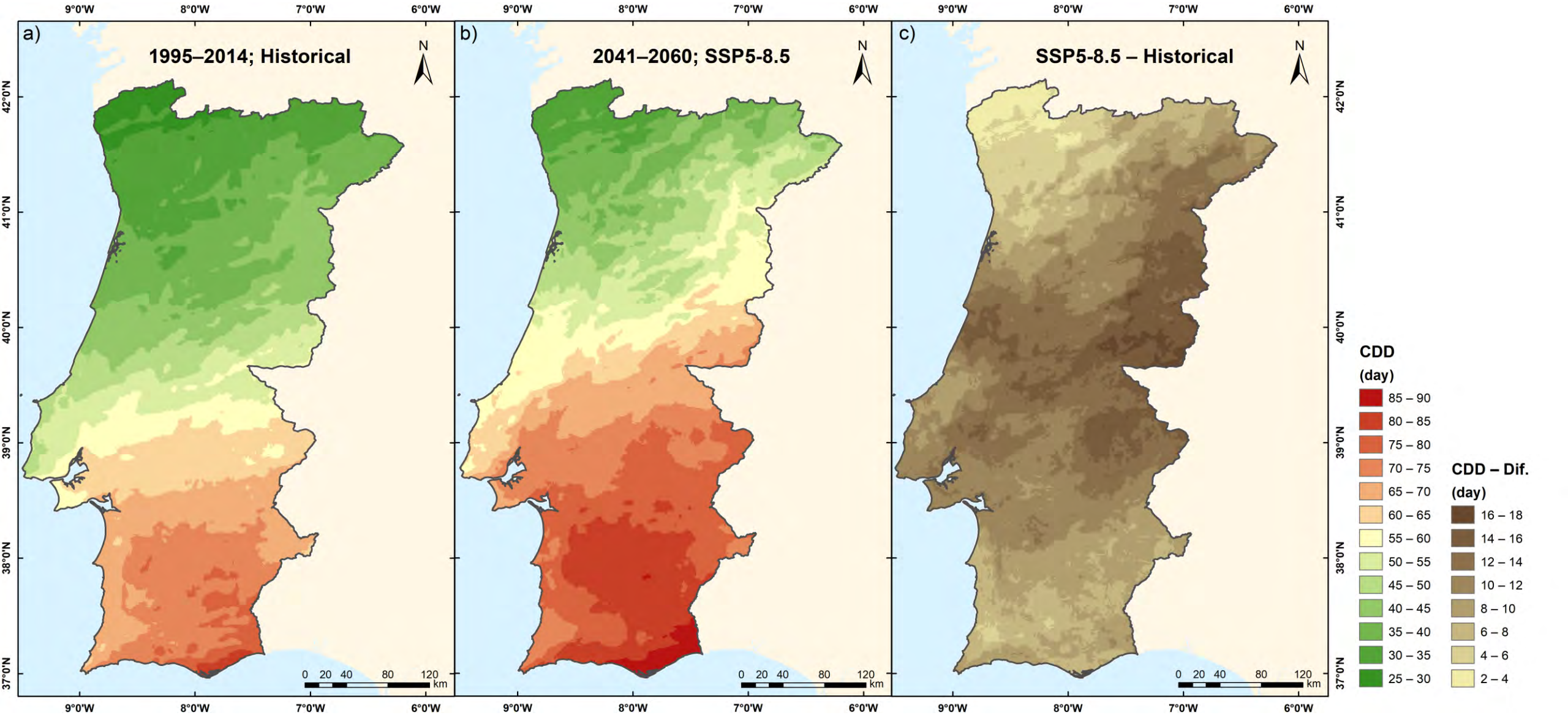
Projections of total annual precipitation



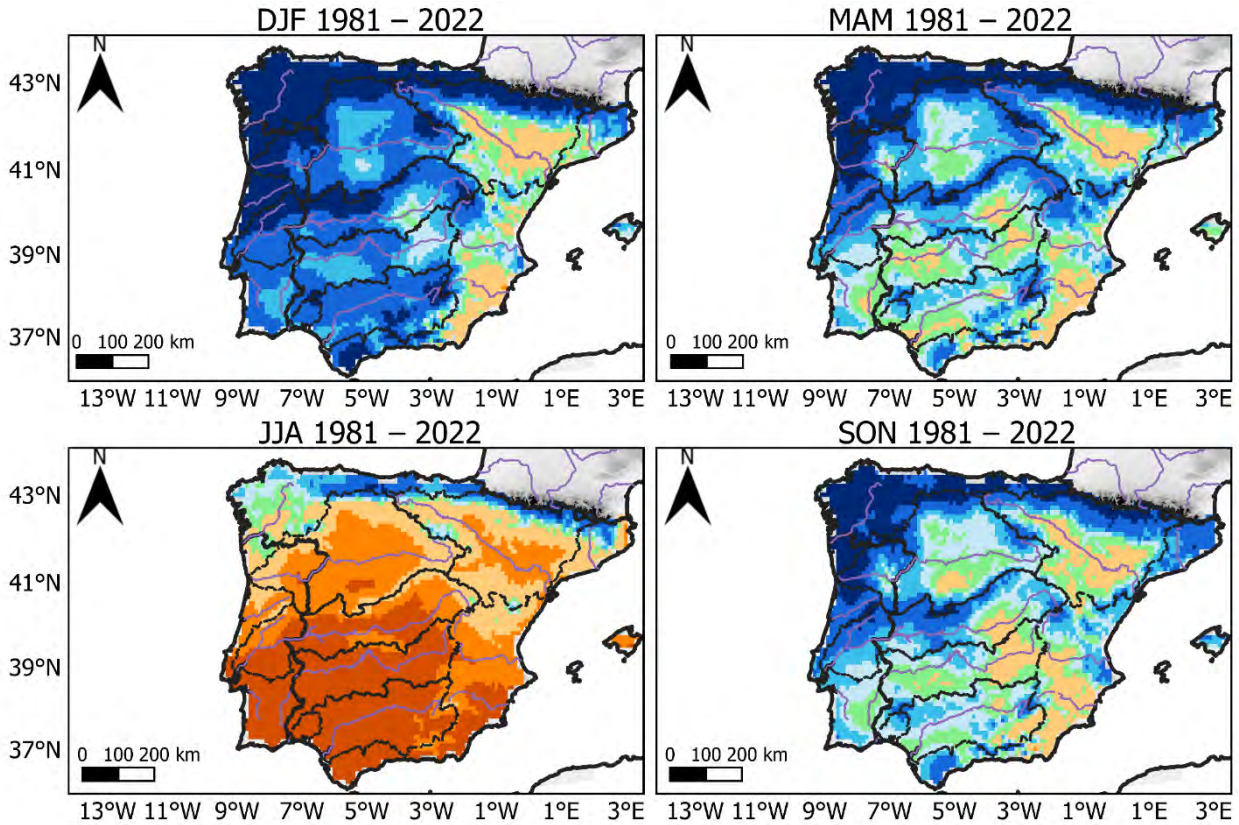
Projections of extreme precipitation events



Projections of dry periods

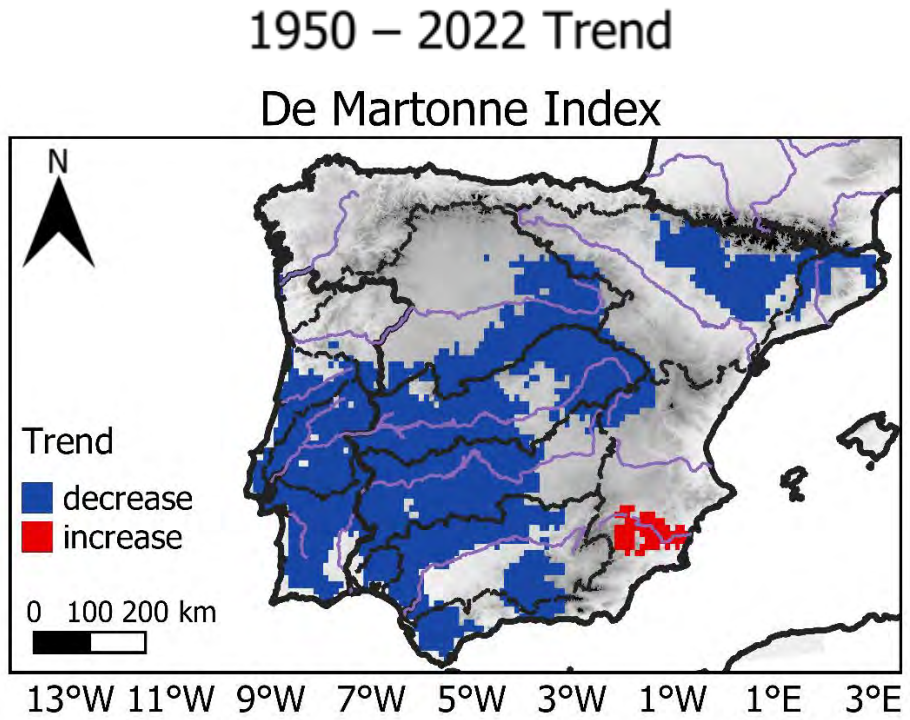


Current aridity conditions and trends



DMI (mm/ºC)

- Hyper-arid (<= 5)
- Arid (5 – 10)
- Semi-arid (10 – 20)
- Mediterranean (20 – 24)
- Semi-humid (24 – 28)
- Humid (28 – 35)
- Very humid (35 – 55)
- Extremely humid (> 55)

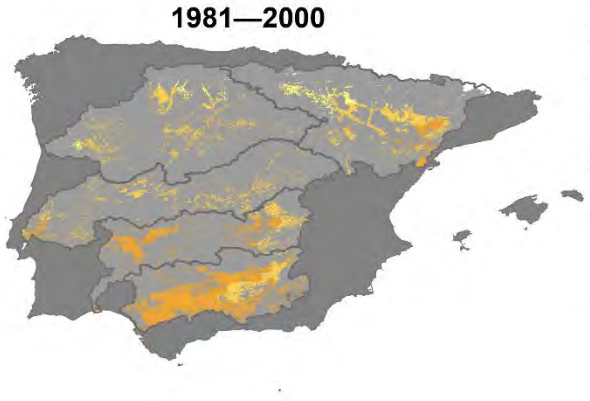


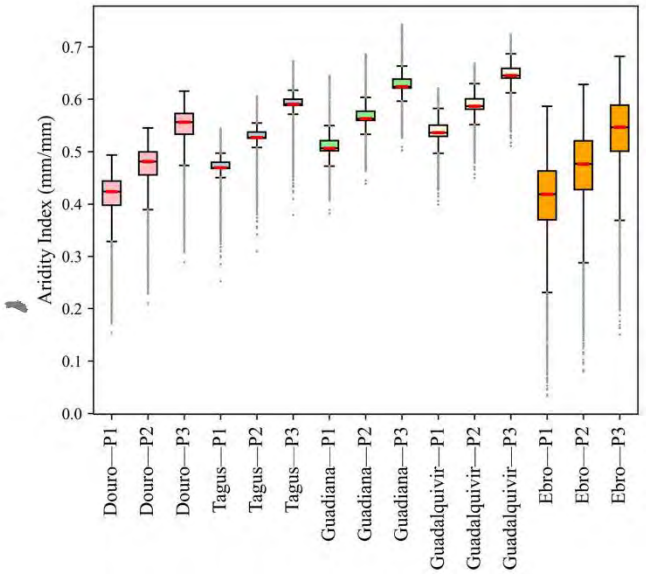
For a period d (months): $\mathrm{DMI} = \dfrac{\frac{12}{d}P}{T+10}$

Claro, A.M.; Fonseca, A.; Fraga, H.; Santos, J.A, (2023). Susceptibility of Iberia to Extreme Precipitation and Aridity: A New High-Resolution Analysis over an Extended Historical Period. Water, 15, 3840.

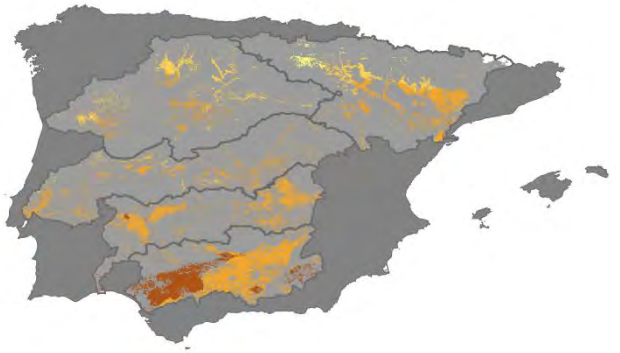
Future aridity

1981—2000

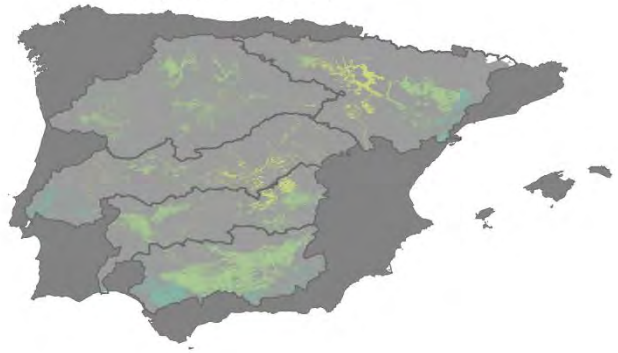




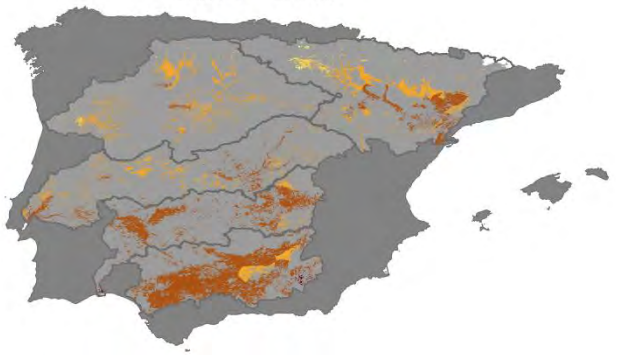
2041—2060



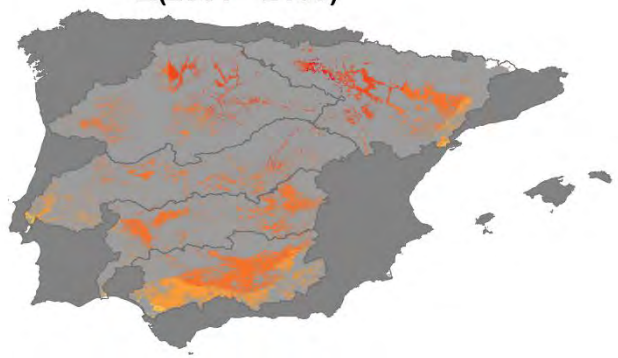
Δ(2041—2060)

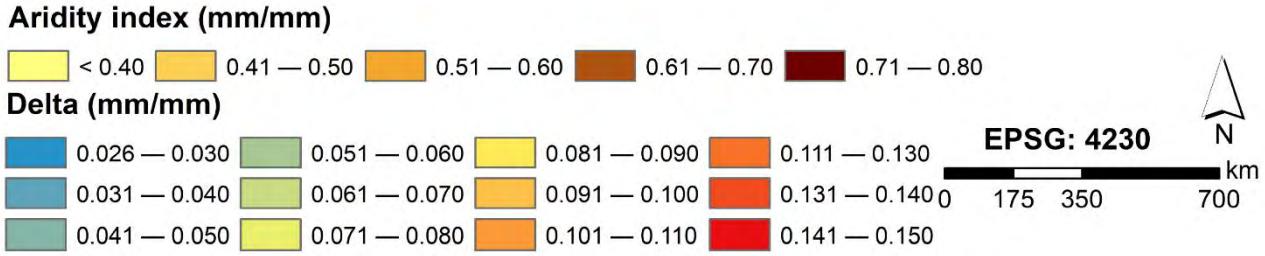


2081—2100



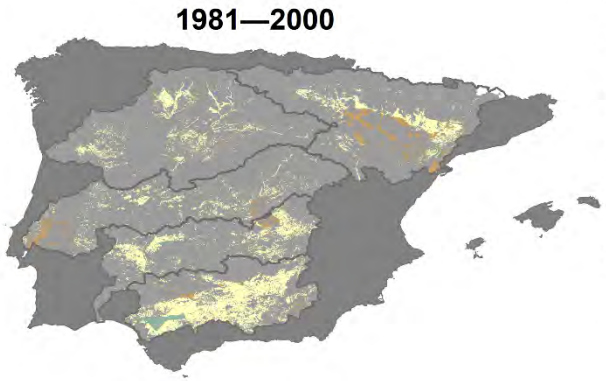
Δ(2081—2100)

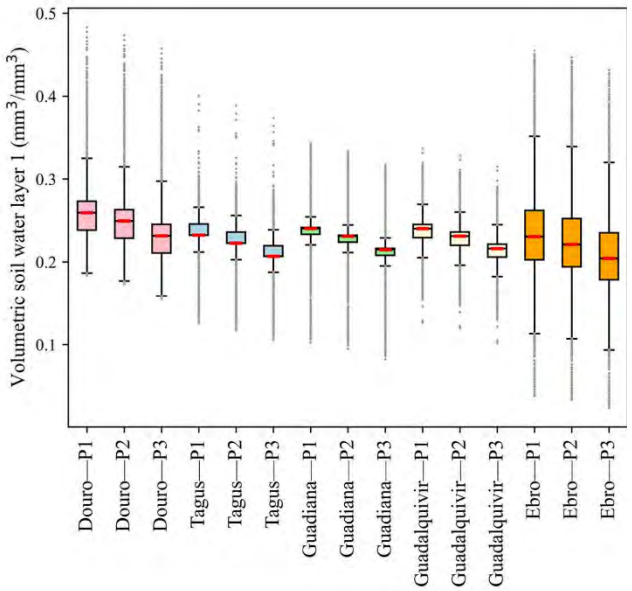


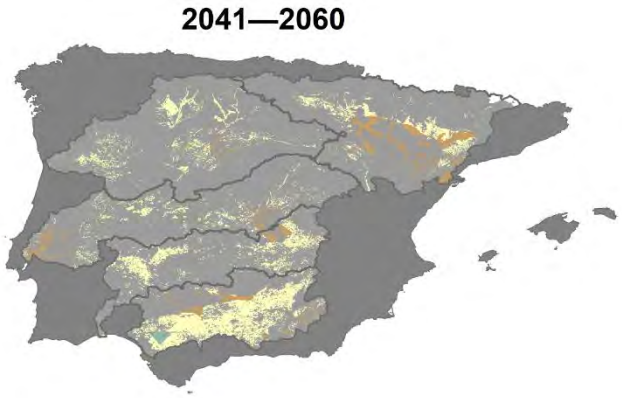


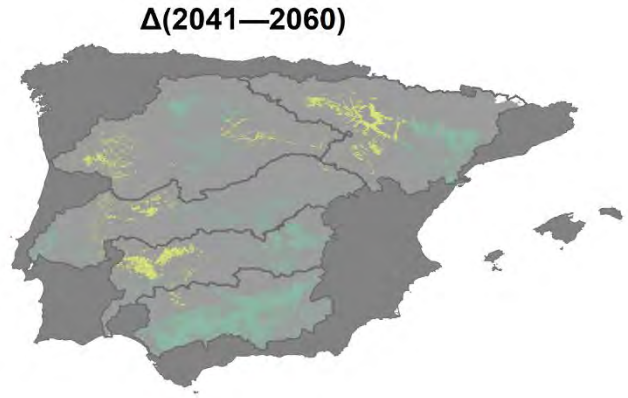
Fonseca, A., Andrade, C., & Santos, J. A. (2022). Agricultural Water Security under Climate Change in the Iberian Peninsula. *Water*, *14*(5), 768.

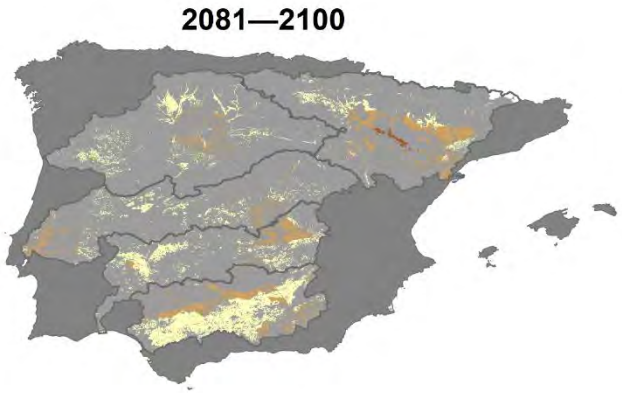
Future soil water content

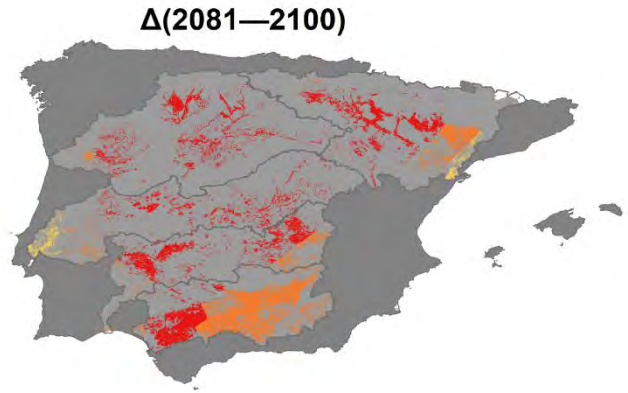


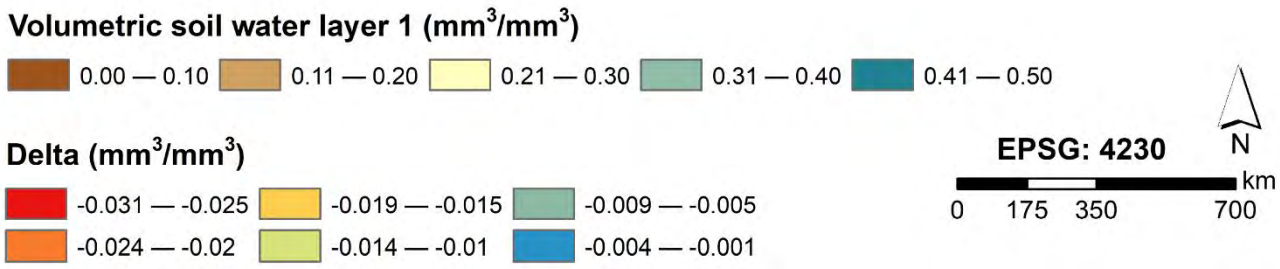






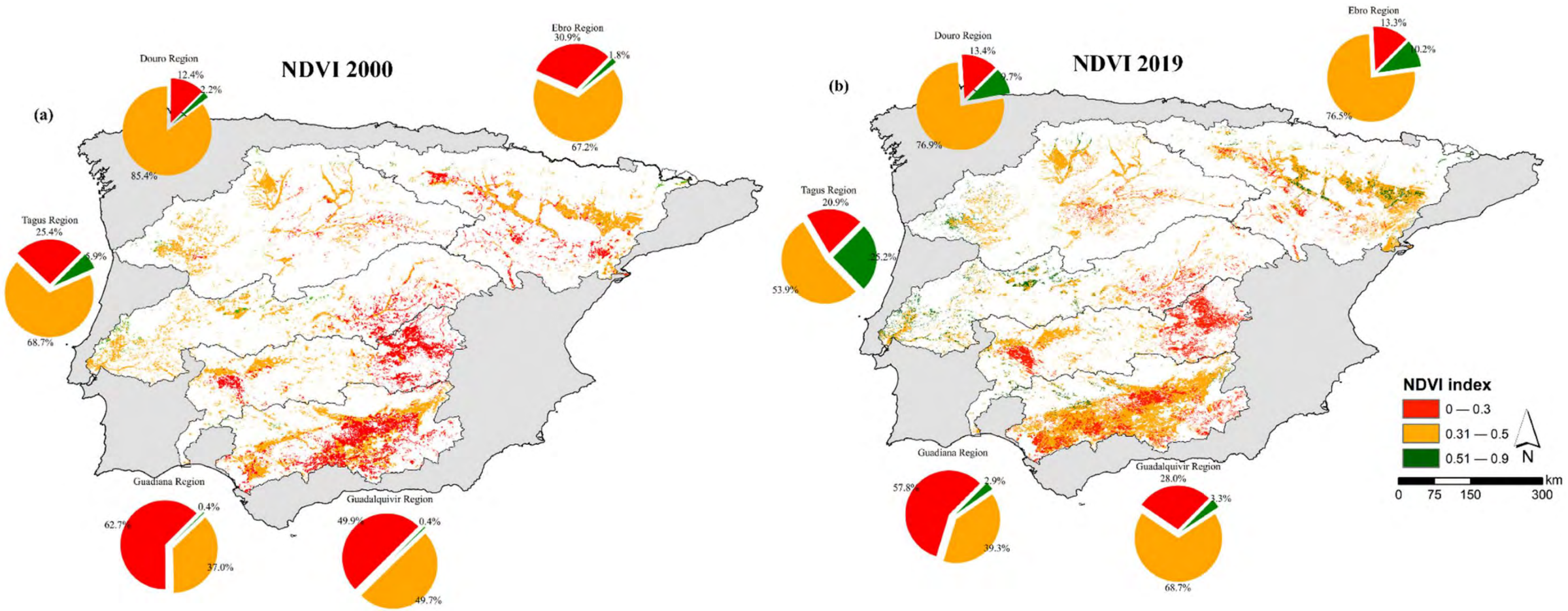






Fonseca, A., Andrade, C., & Santos, J. A. (2022). Agricultural Water Security under Climate Change in the Iberian Peninsula. *Water*, *14*(5), 768.

Land use changes & water use

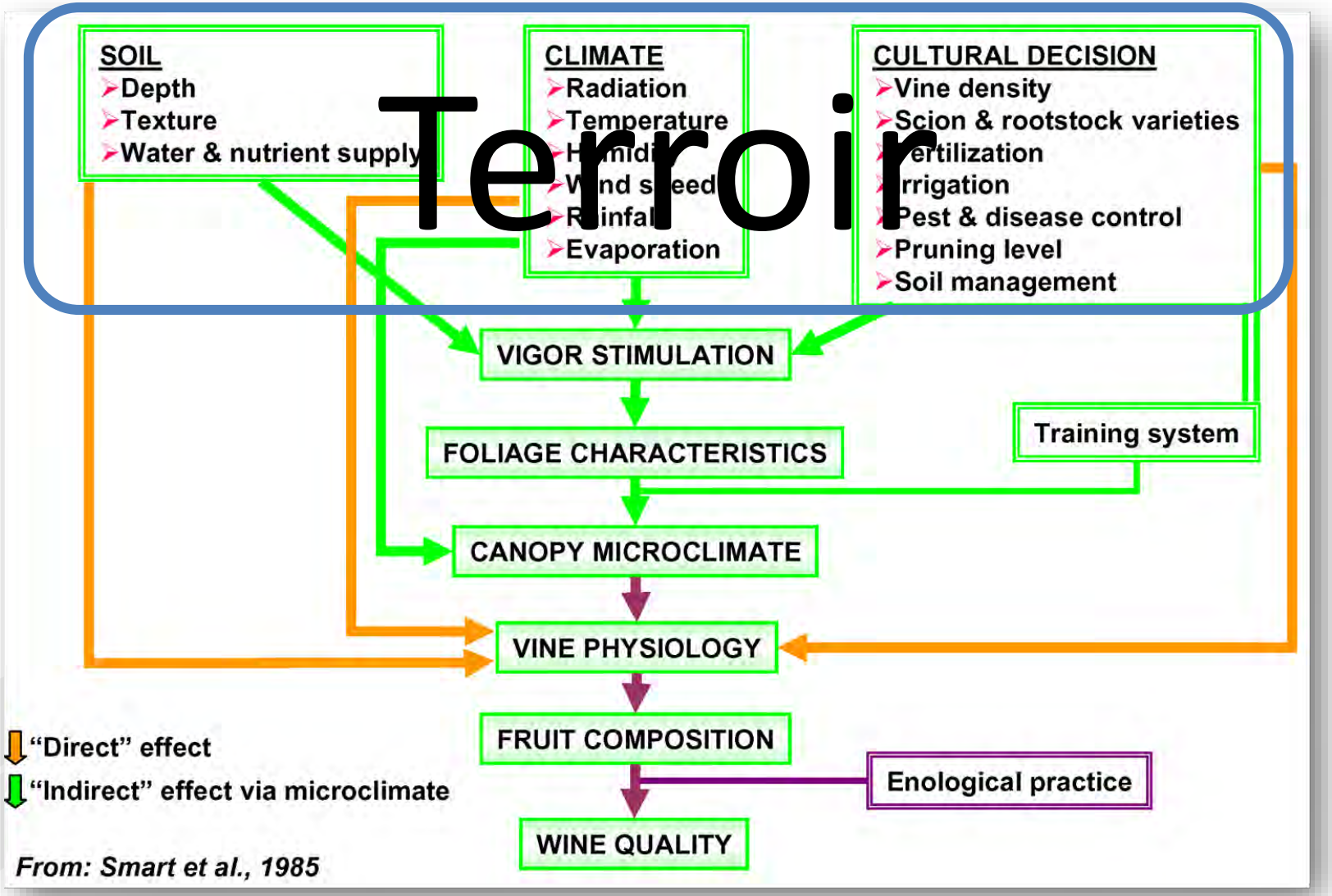


Normalized difference vegetation index (NDVI) in water-dependent areas in the Iberian Peninsula, for the years (**a**) 1990 and (**b**) 2020. Pie charts show the percentage of area evolution from one period to another.

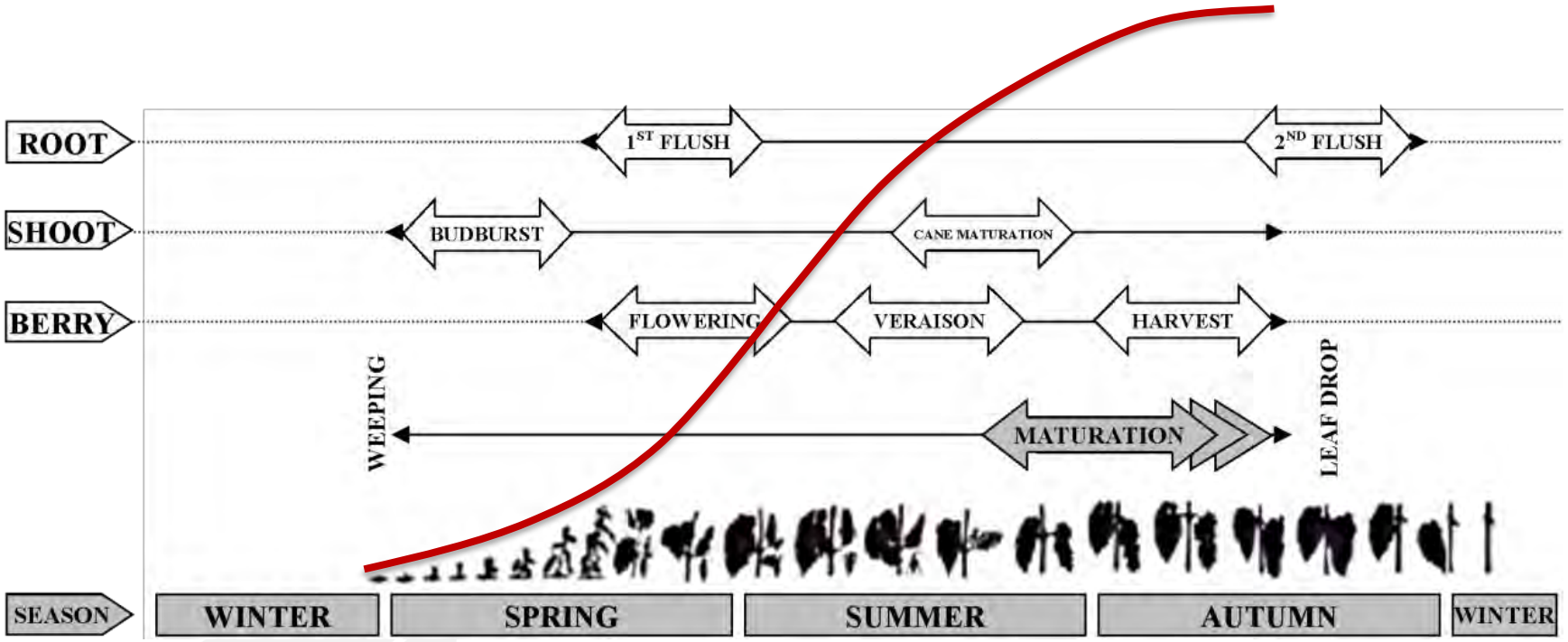
Climate change adaptation: local & sectorial responses

Viticulture

Grapevine forcing factors

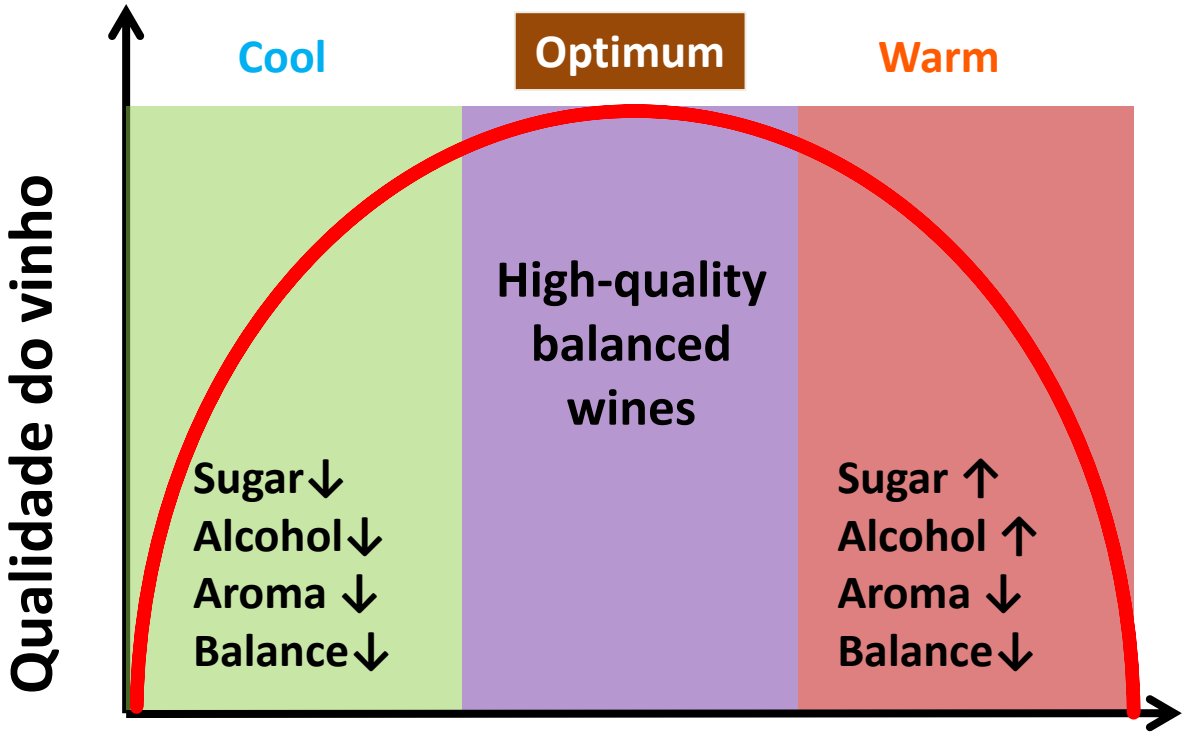


Climate factors vs. physiological



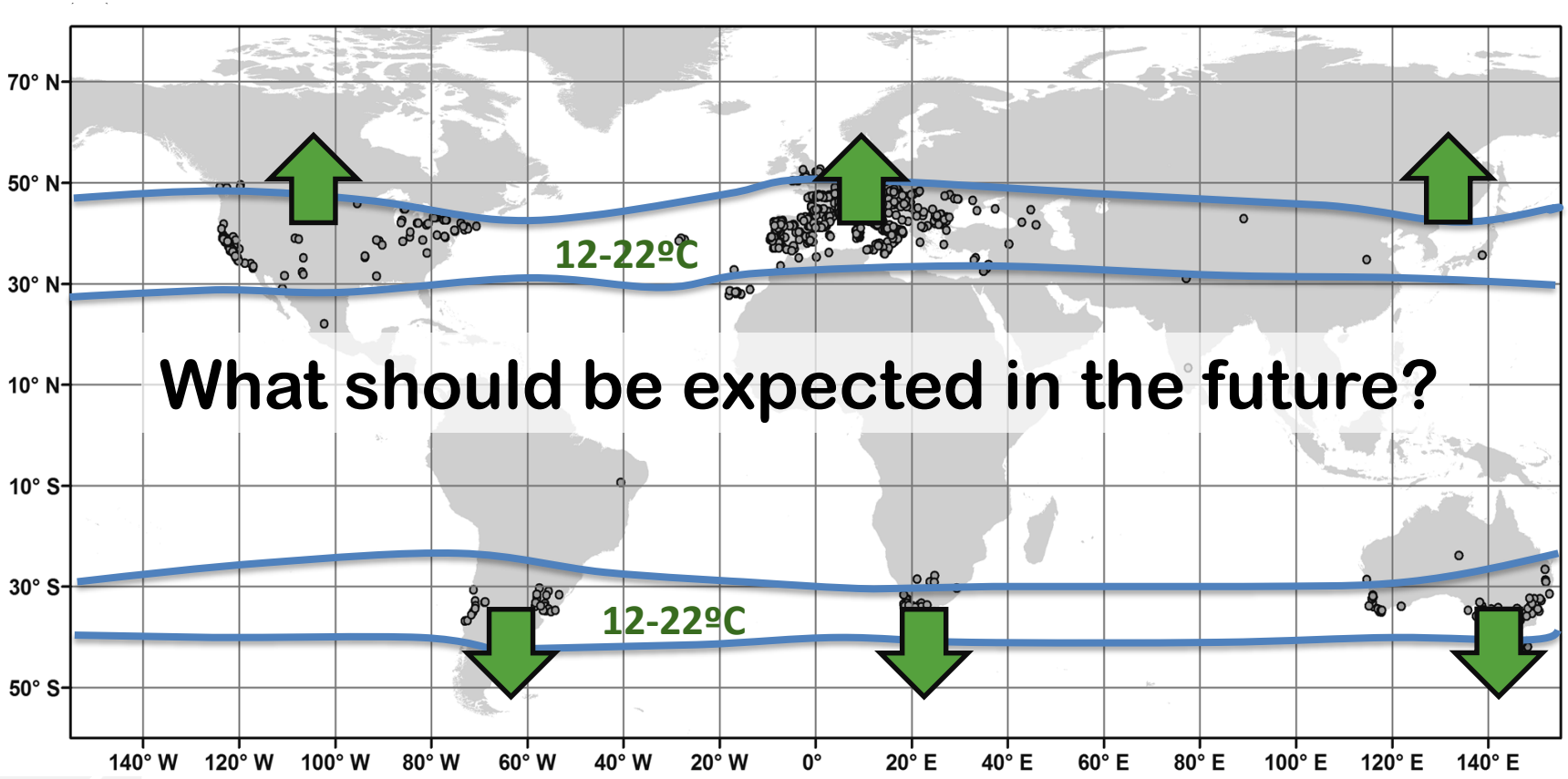
Temperature accumulation above 7°C (growing degree-day)

Climatic suitability vs. wine



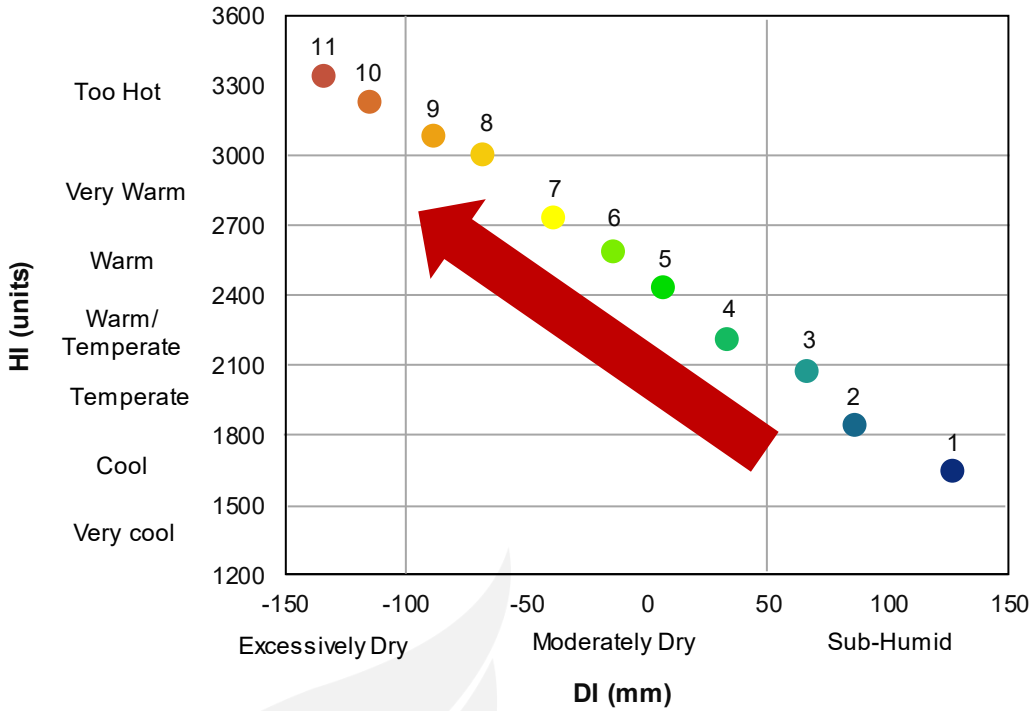
Adapted from Schultz (2005)

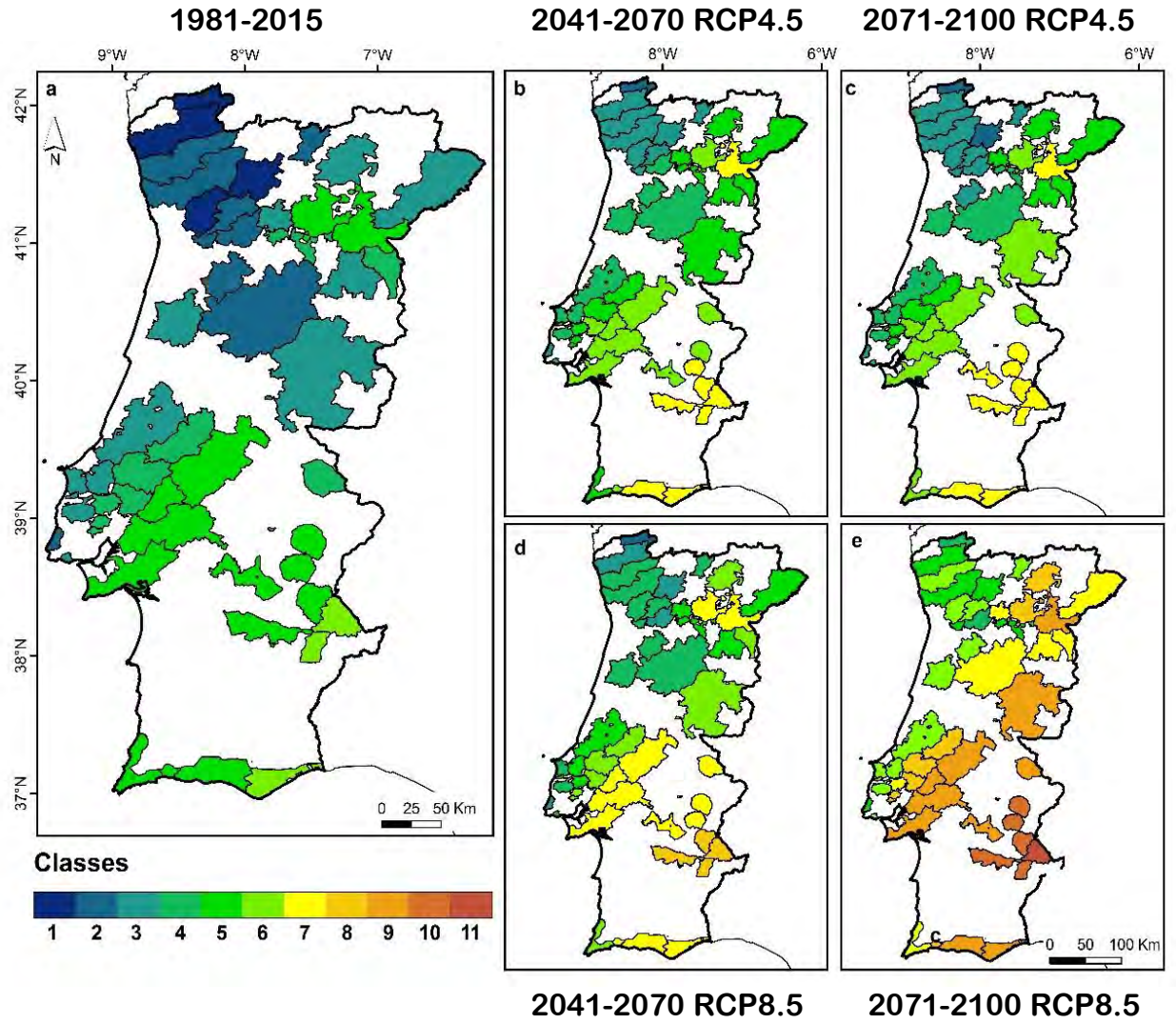
Climatic suitability: present & future



Average growing season temperature

Shifts in agroclimatic classes

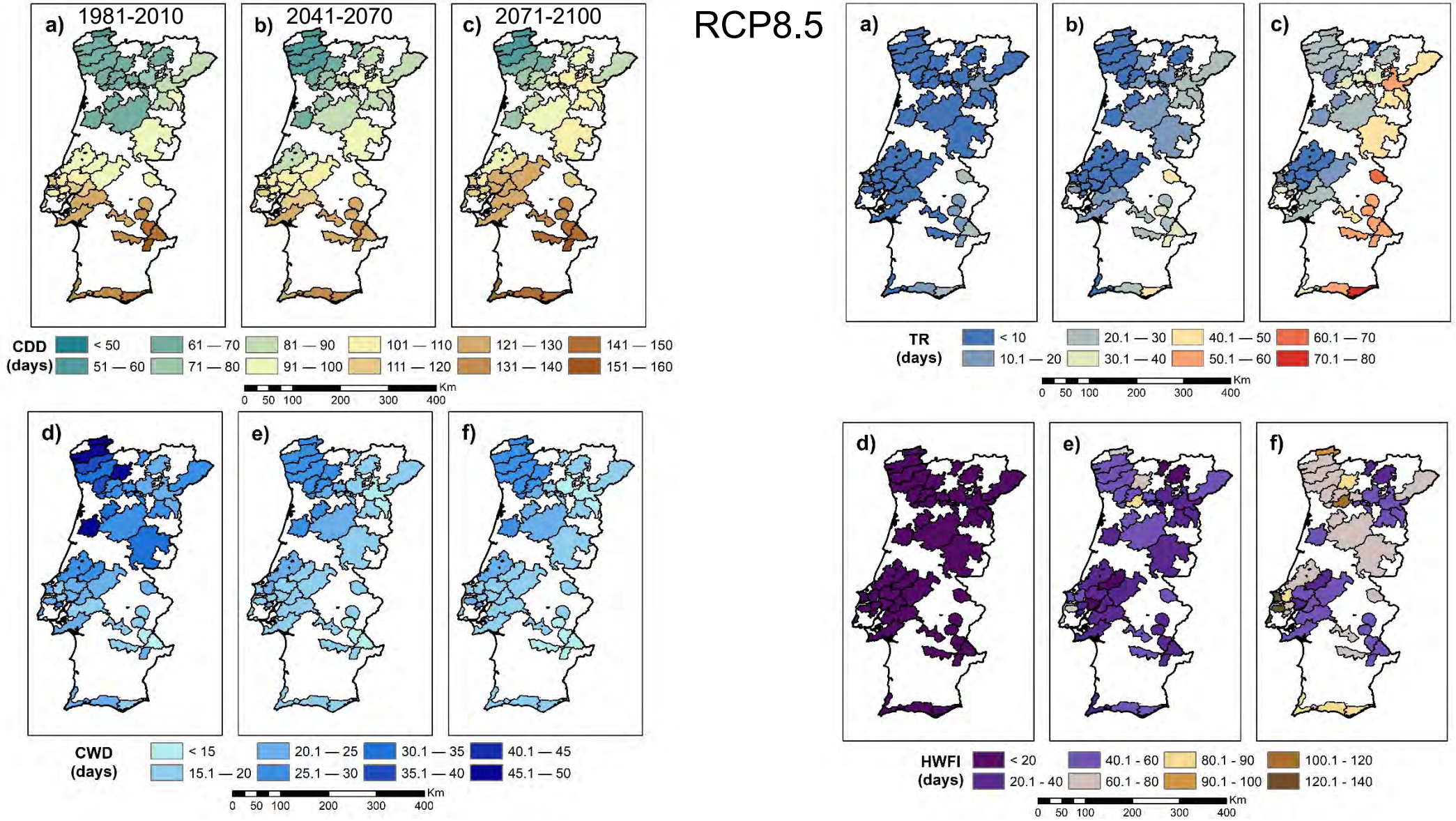




Santos, M.; Fonseca, A.; Fraga, H.; Jones, G. V.; Santos, J. A. (2020). Bioclimatic conditions of the Portuguese wine denominations of origin under changing climates. *International Journal of Climatology*, 40: 927-941

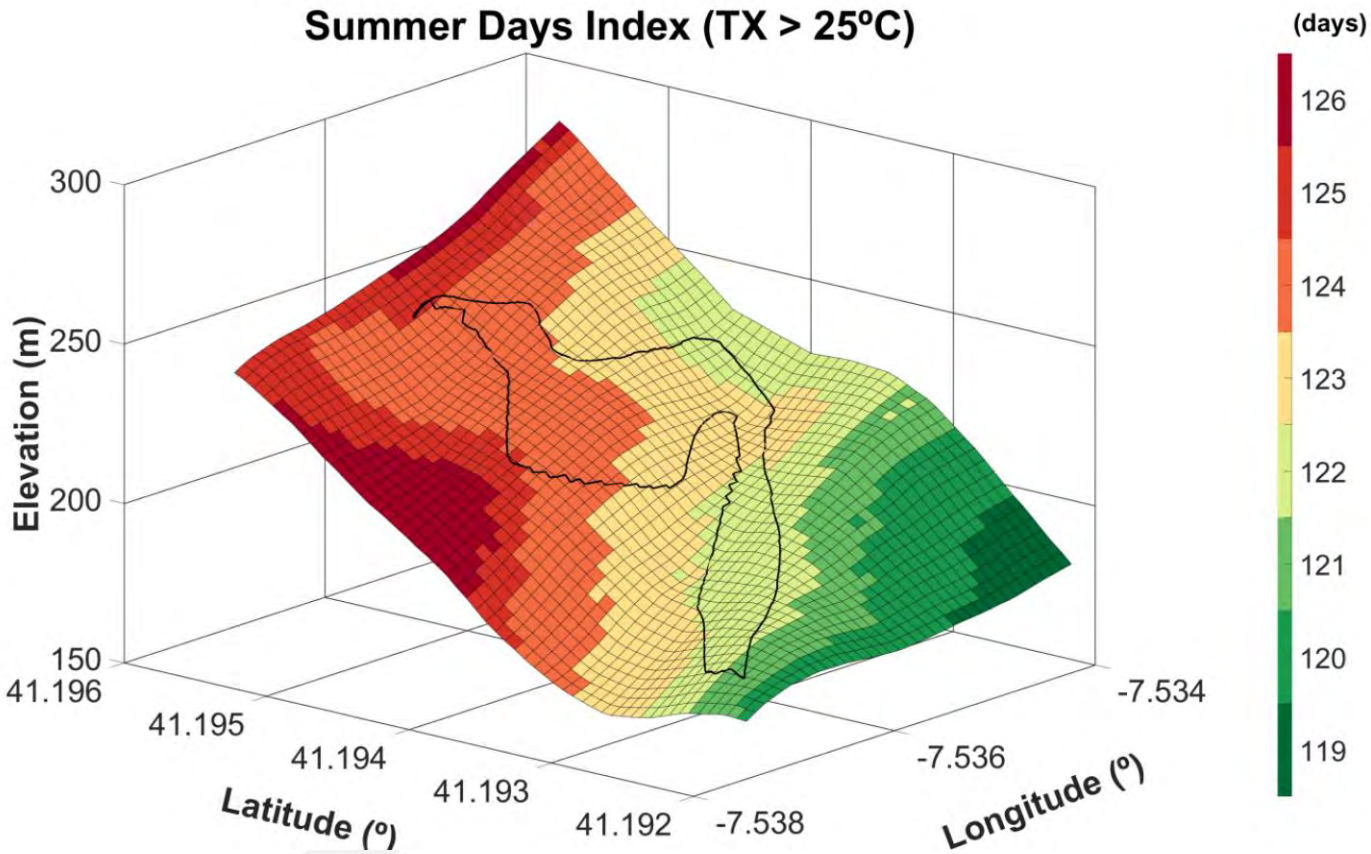
Exposure to extreme events & vulnerability

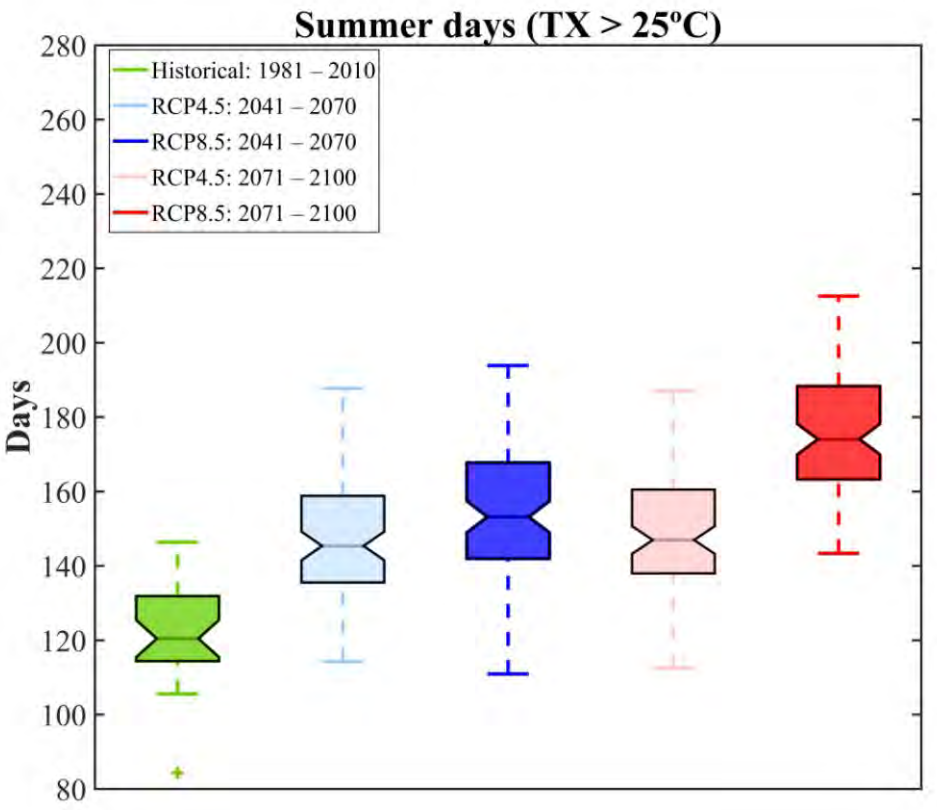
RCP8.5



Fonseca, A., Fraga, H., & Santos, J. A. (2023). Exposure of Portuguese viticulture to weather extremes under climate change. Climate Services, 30, 100357.

Microclimatic zoning



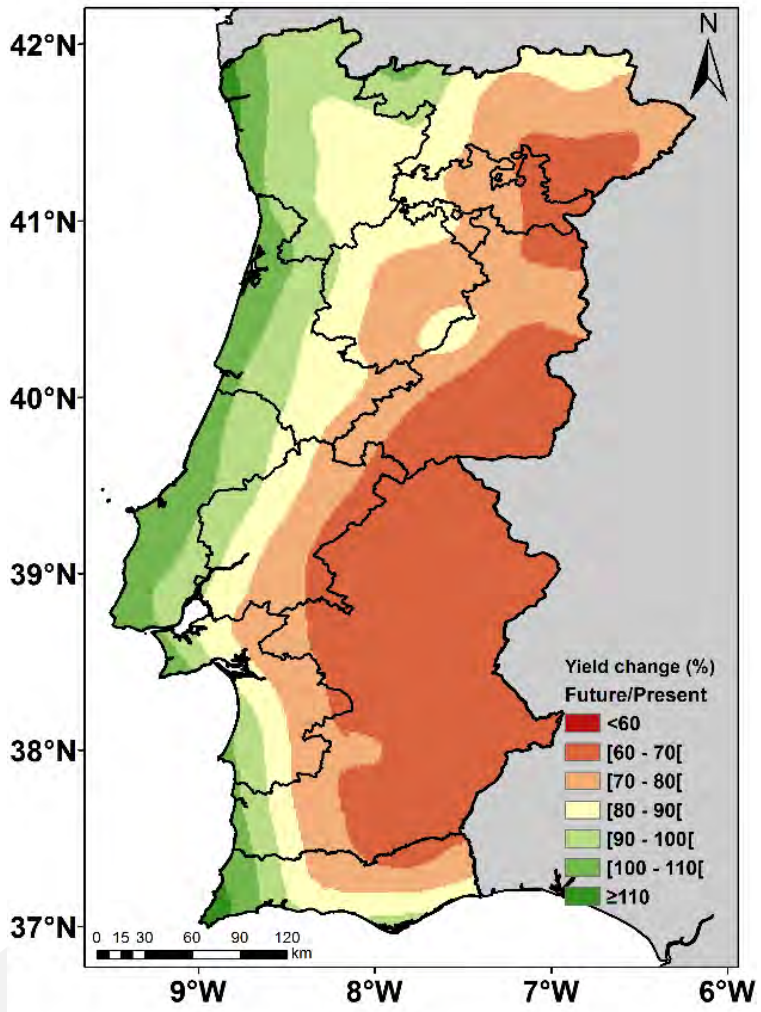


3-member ensemble of GCM-RCM chains

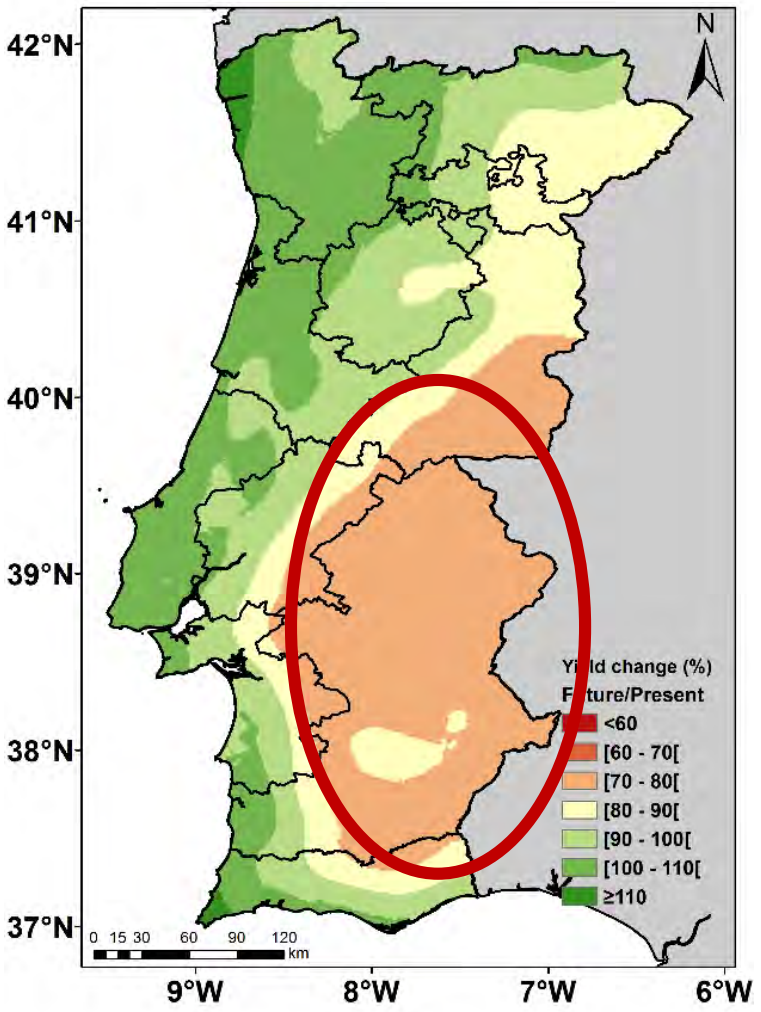
10-m spatial resolution and daily data

André Fonseca, José Cruz, Helder Fraga, Cristina Andrade, Joana Valente, Fernando Alves, Ana Carina Neto, Rui Flores and João Santos (2024). Vineyard microclimatic zoning as a tool to promote sustainable viticulture under climate change. Submitted.

Irrigation as an adaptation strategy



Δ Yield (no irrigation)



Δ Yield (with irrigation)

Fraga, H.; García de Cortázar Atauri, I.; Santos, J. A. (2018). Viticultural irrigation demands under climate change scenarios in Portugal. *Agricultural Water Management*, 196: 66-74

Varietal selection as an adaptation

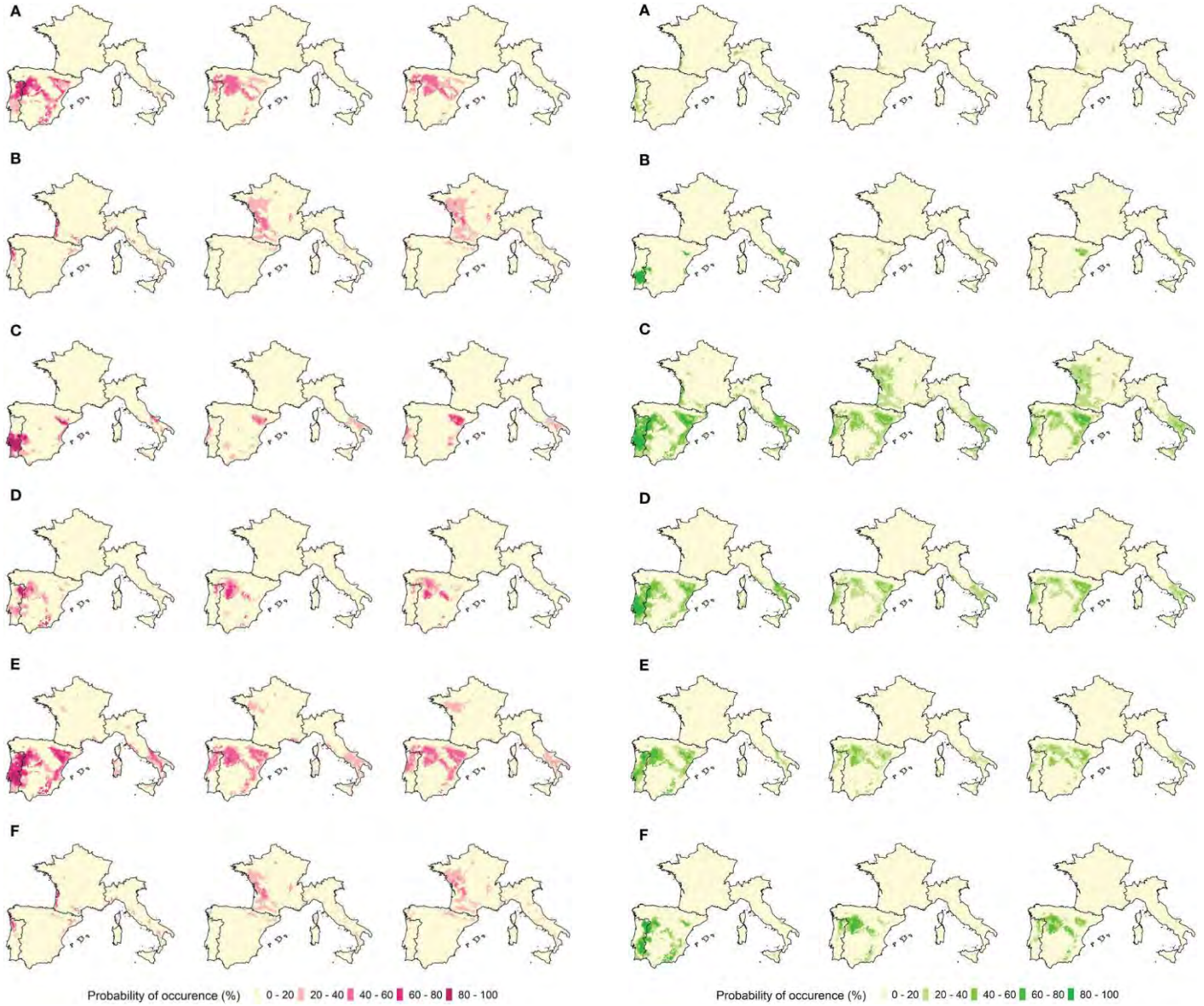
Bioclimatic suitability for red/white varieties:
Bastardo, **Borraçal**, **Castelão**, **Touriga-Franca**, **Touriga-Nacional**, **Vinhão**,

Alvarinho, **Antão-Vaz**, **Arinto**, **Fernão-Pires**, **Malvasia-Fina**, and **Síria**.

Left panels: **Historical distribution of bioclimatic suitability (1989–2005)**

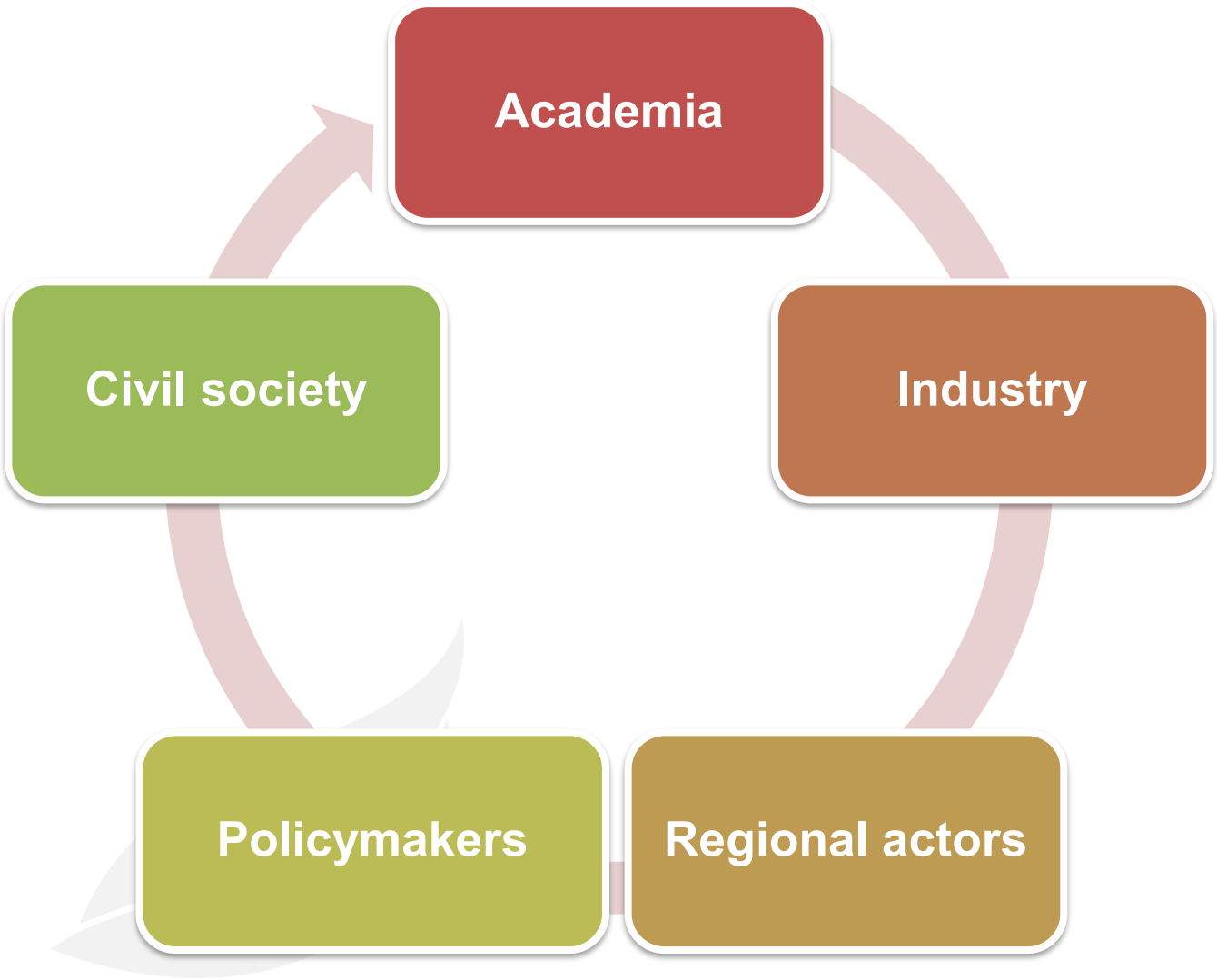
Middle panels: **2021–2050, RCP 4.5**

Right panels: **2021–2050, RCP 8.5**



Adão F, Campos JC, Santos JA, Malheiro AC and Fraga H (2023). Relocation of bioclimatic suitability of Portuguese grapevine varieties under climate change scenarios. Front. Plant Sci. 14:974020.

Climate change adaptation: local & sectorial responses



Climate change adaptation: local & sectorial responses

Thank you!

jsantos@utad.pt

https://www.citab.utad.pt/

FCT - Portuguese Foundation for Science and Technology
Projects: UIDB/04033/2020 & UIDP/04033/2020
https://doi.org/10.54499/UIDB/04033/2020