Centro Nacional de Competências para as Alterações Climáticas do Sector Agroflorestal

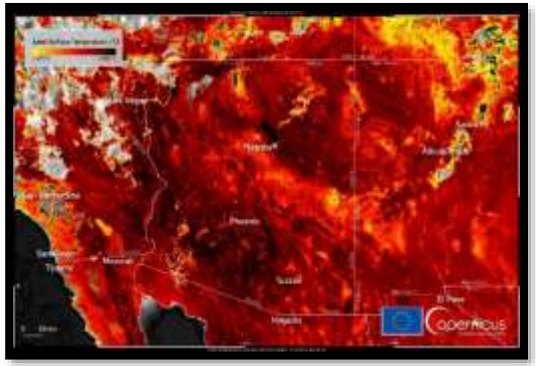
Projeções climáticas ao serviço do futuro da agricultura

João A. Santos & Helder Fraga

utad CITAB inov4agro

CRISE CLIMÁTICA

Secas



Ondas de calor

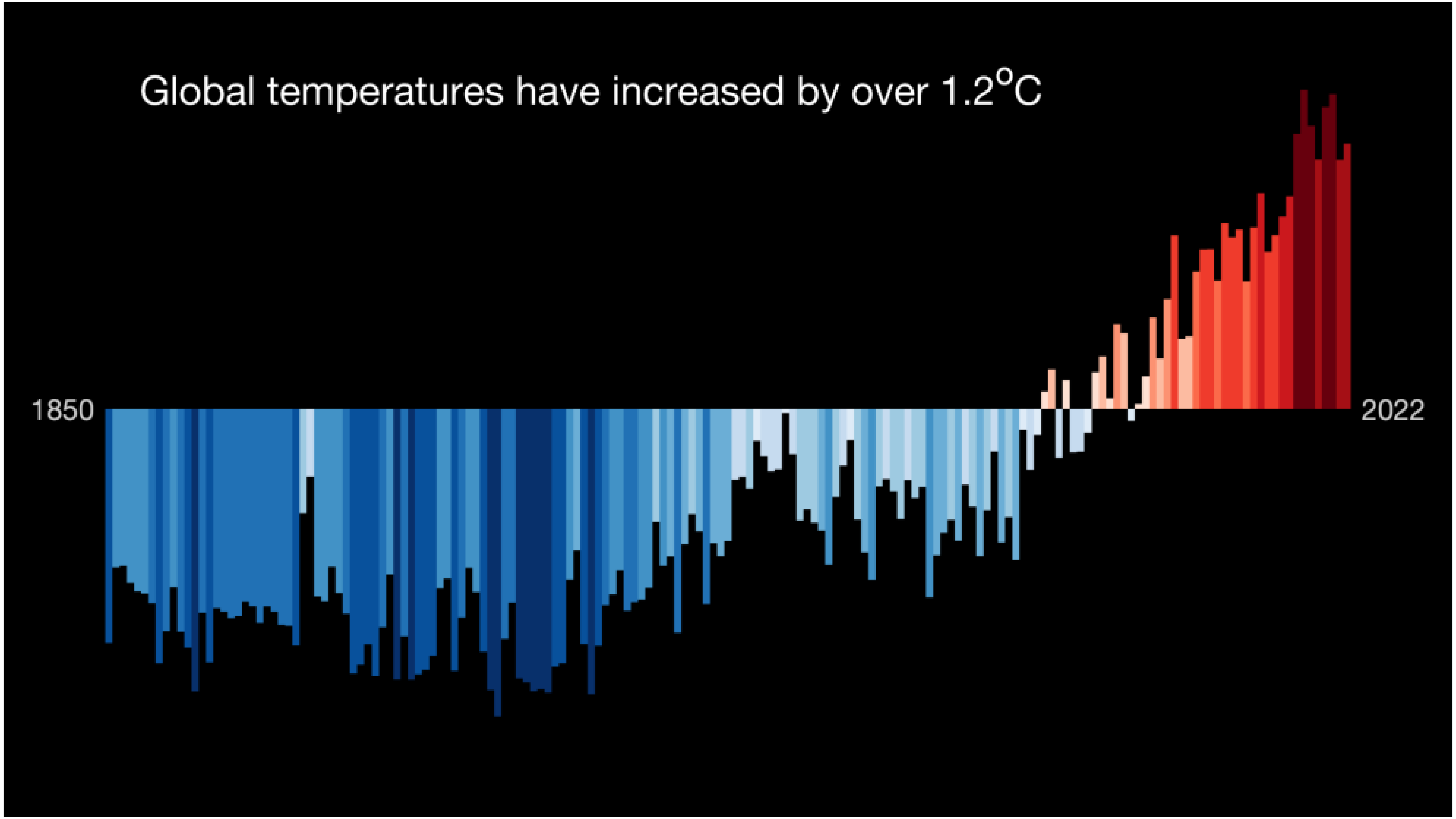
Fogos rurais

Extremos de precipitação

EVENTOS COMPOSTOS & RISCOS EM CASCATA

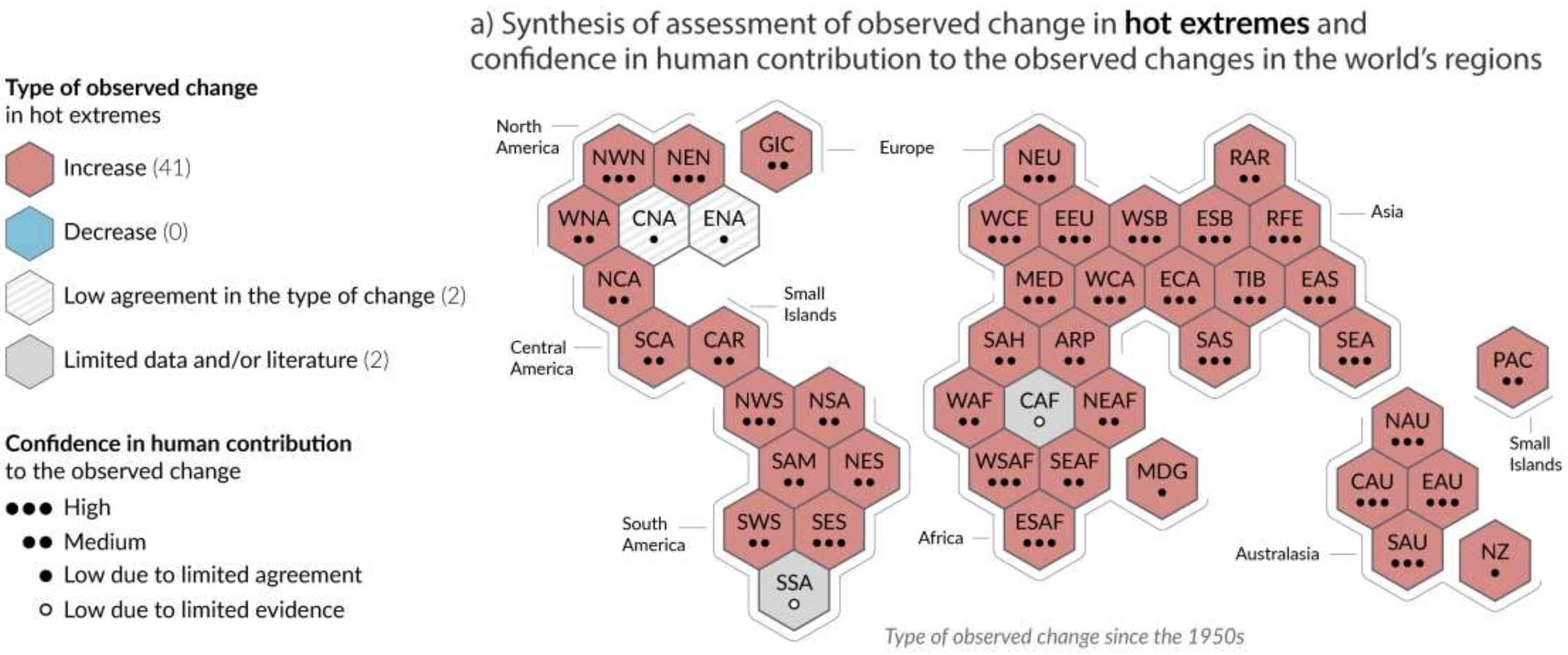
TENDÊNCIAS HISTÓRICAS

Global warming



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

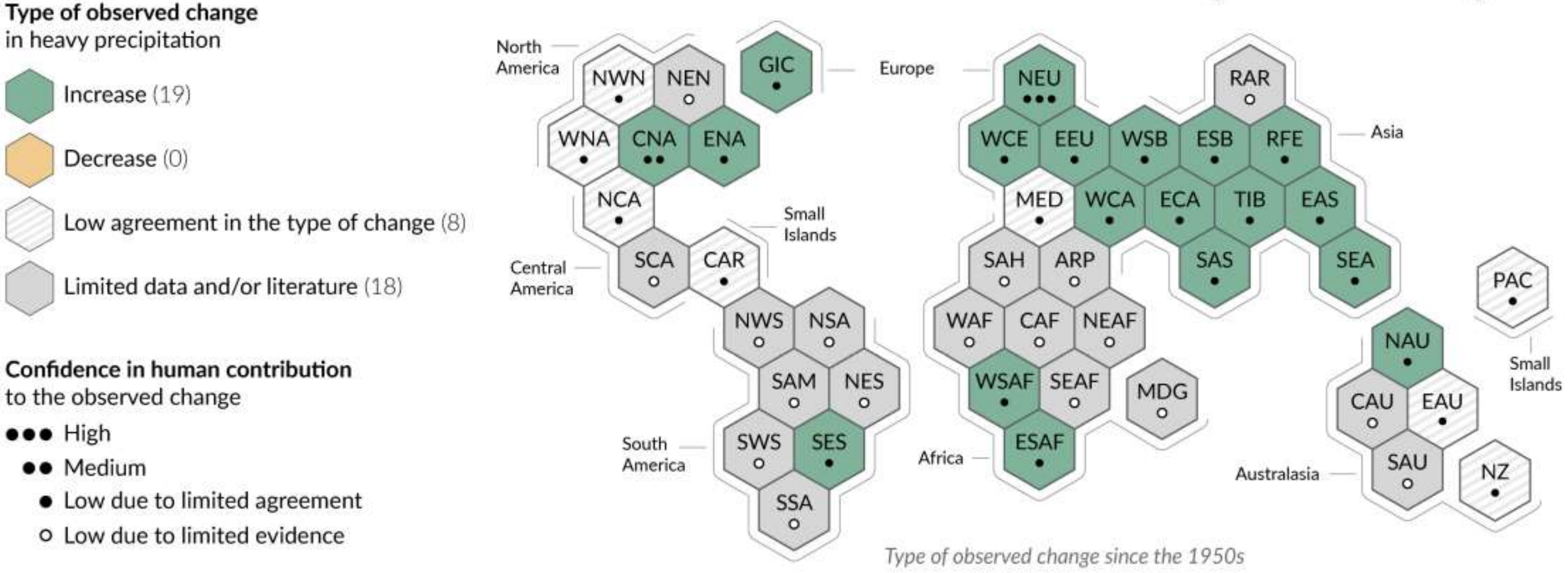
Trends in extreme events



Source: IPCC AR6 WG1 (2021)

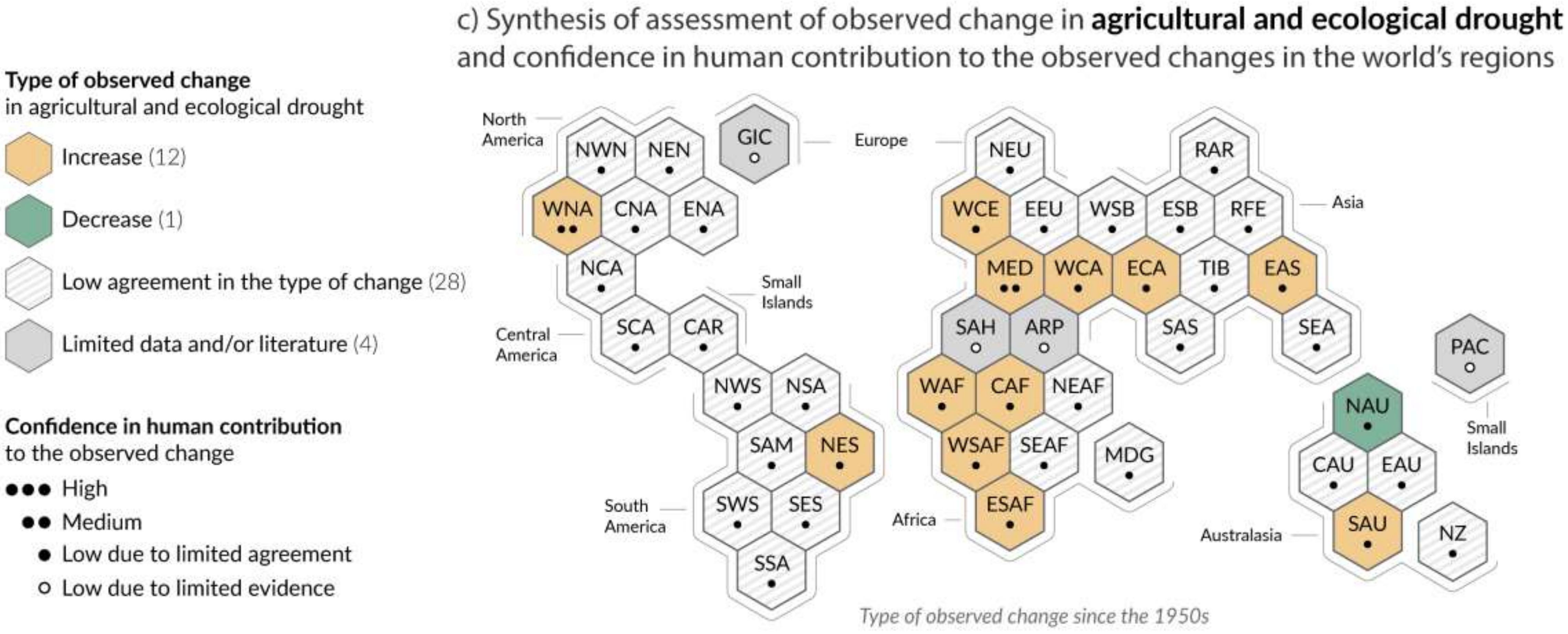
Trends in extreme events

b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions



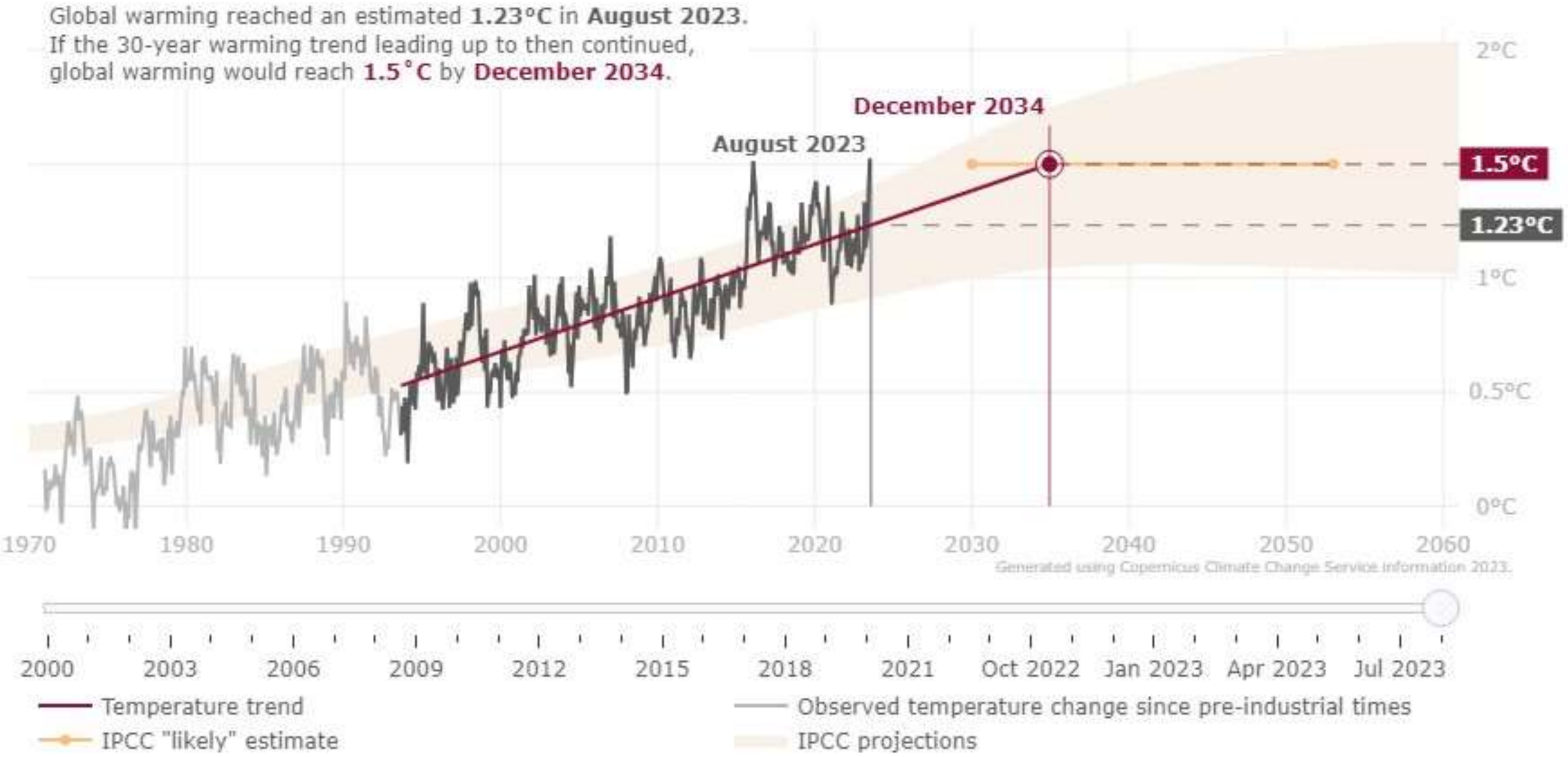
Source: IPCC AR6 WG1 (2021)

Trends in extreme events



Source: IPCC AR6 WG1 (2021)

Global temperature trend monitor

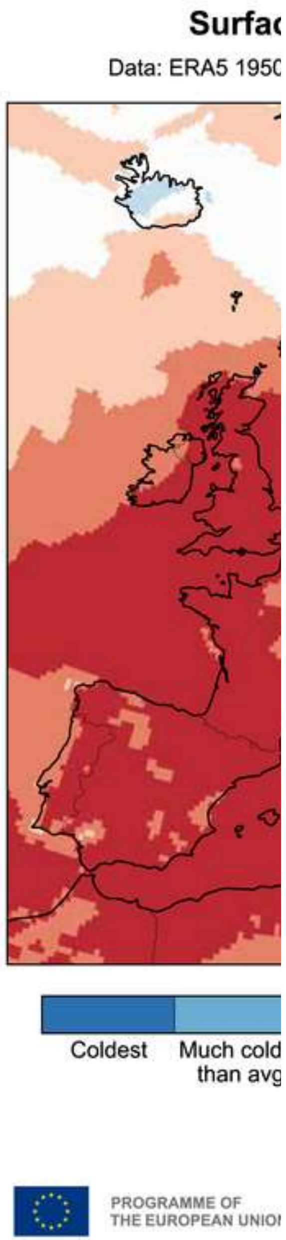


European Commission

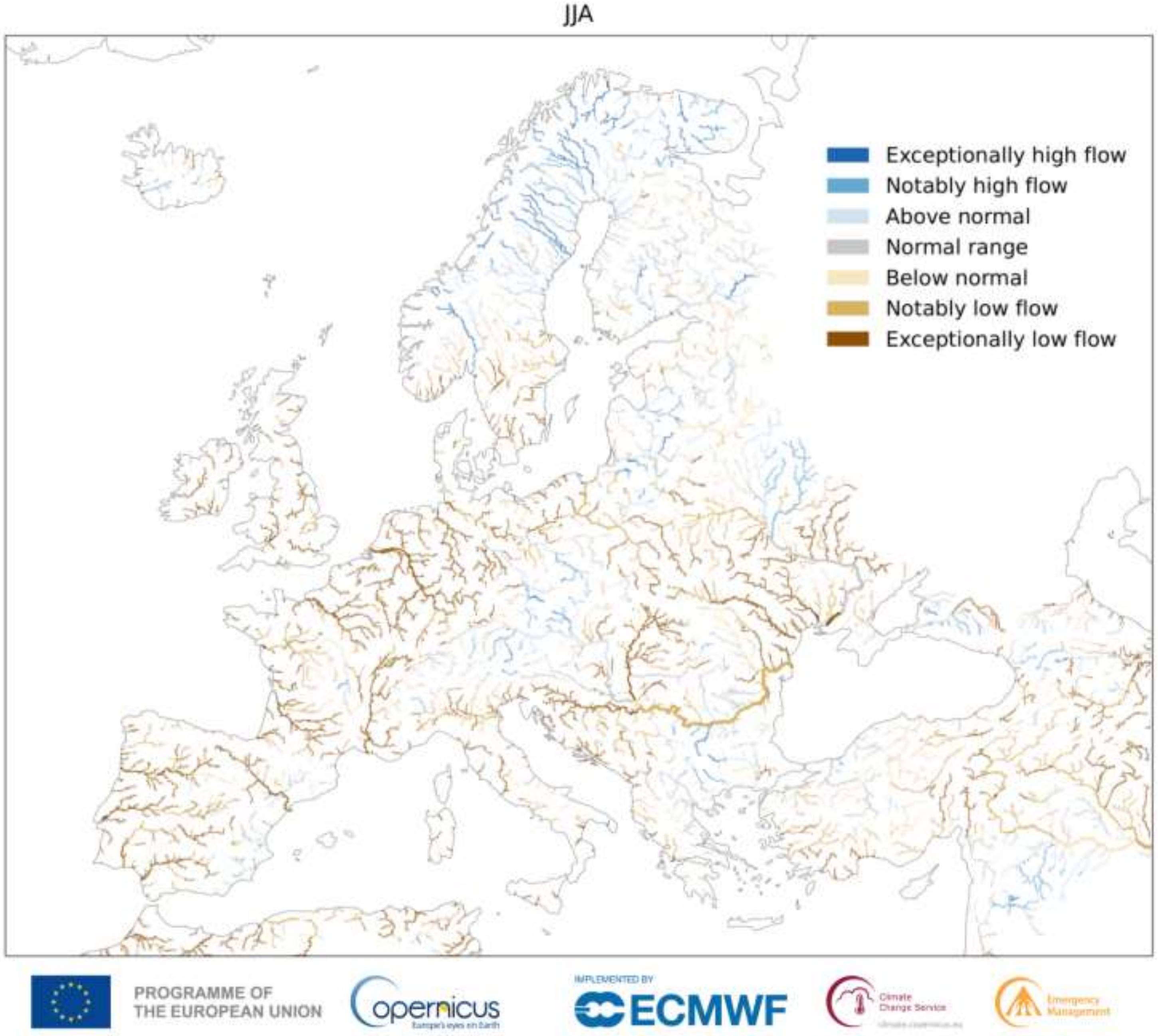
opernicus
Europe's eyes on Earth

IMPLEMENTED BY ECMWF

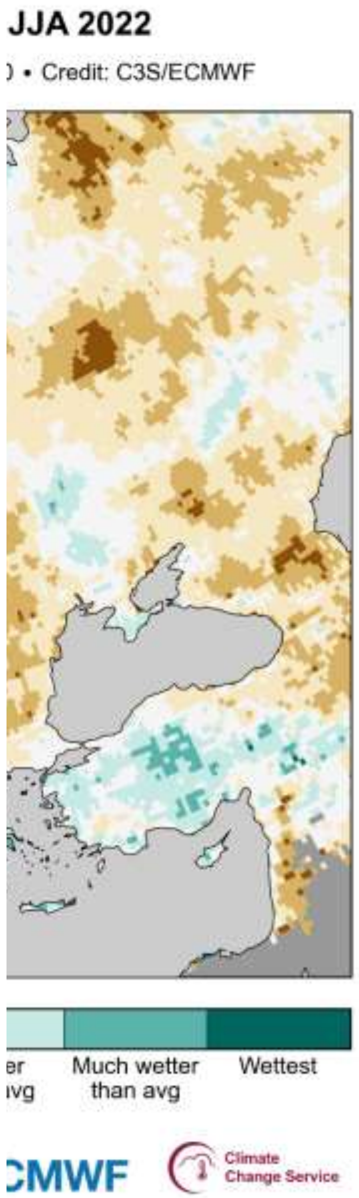
Climate Change Service



Surfac
Data: ERA5 1950
Coldest
Much cold than avg
PROGRAMME OF THE EUROPEAN UNIO

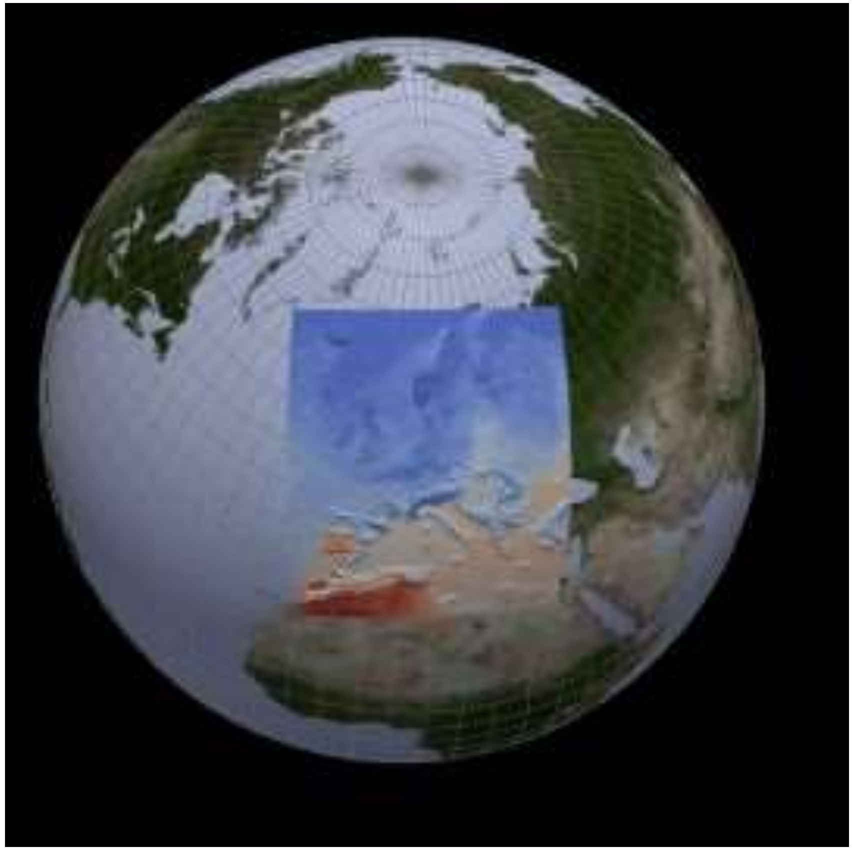


JJA
Exceptionally high flow
Notably high flow
Above normal
Normal range
Below normal
Notably low flow
Exceptionally low flow
PROGRAMME OF THE EUROPEAN UNION
opernicus
IMPLEMENTED BY
ECMWF

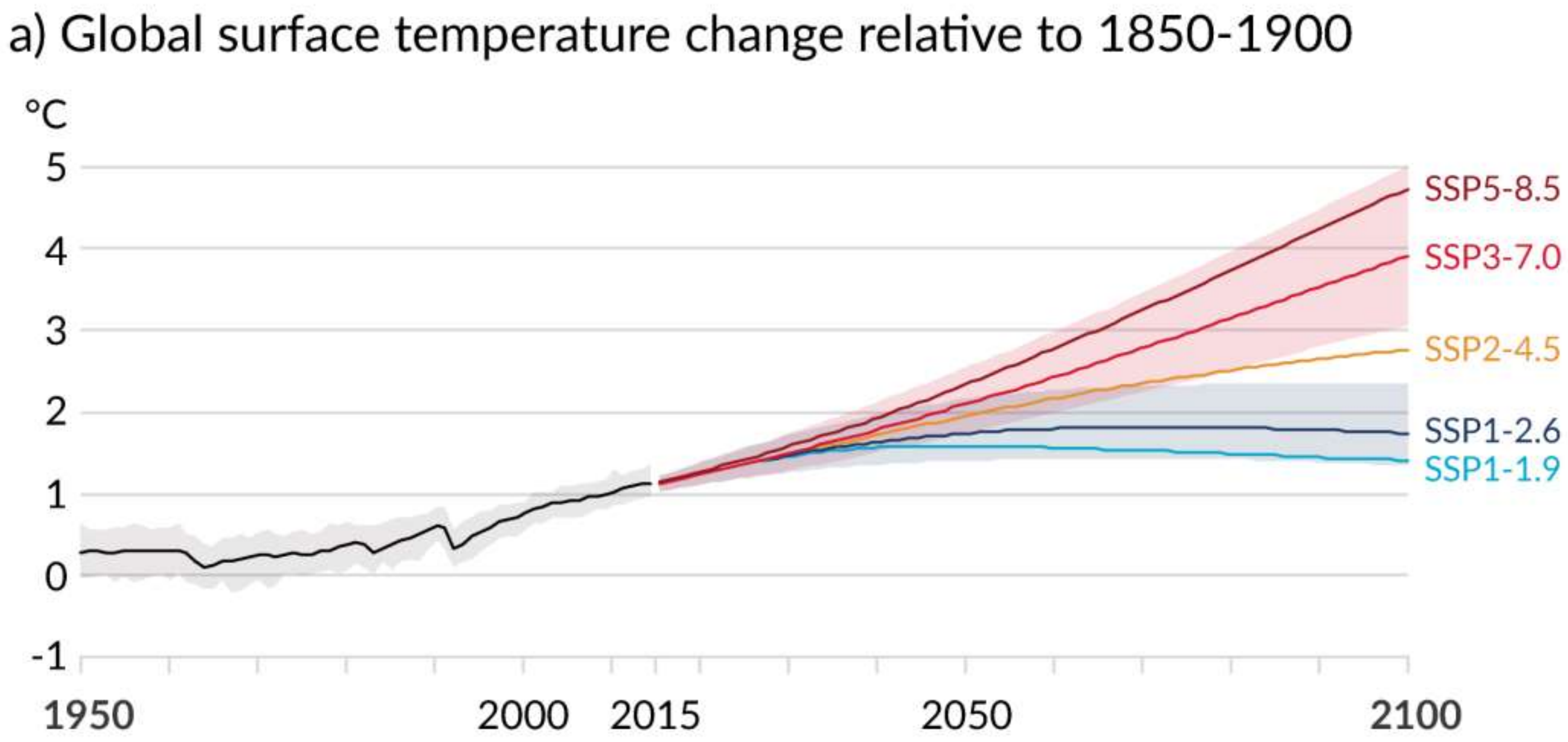


JJA 2022
• Credit: C3S/ECMWF
Much wetter than avg
Wettest
CMWF
Climate Change Service

PROJEÇÕES CLIMÁTICAS

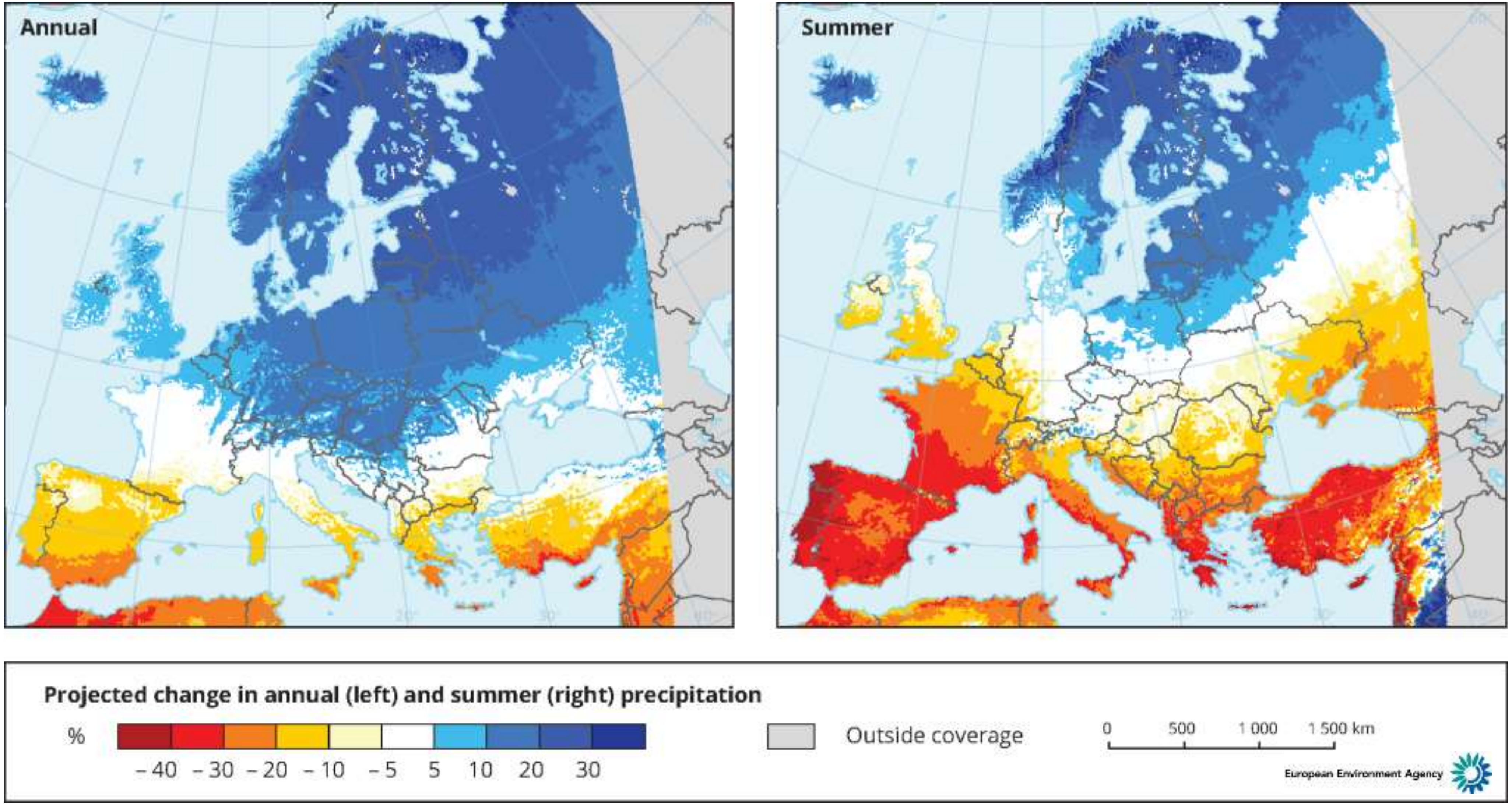


Climate change projections: global mean temperature

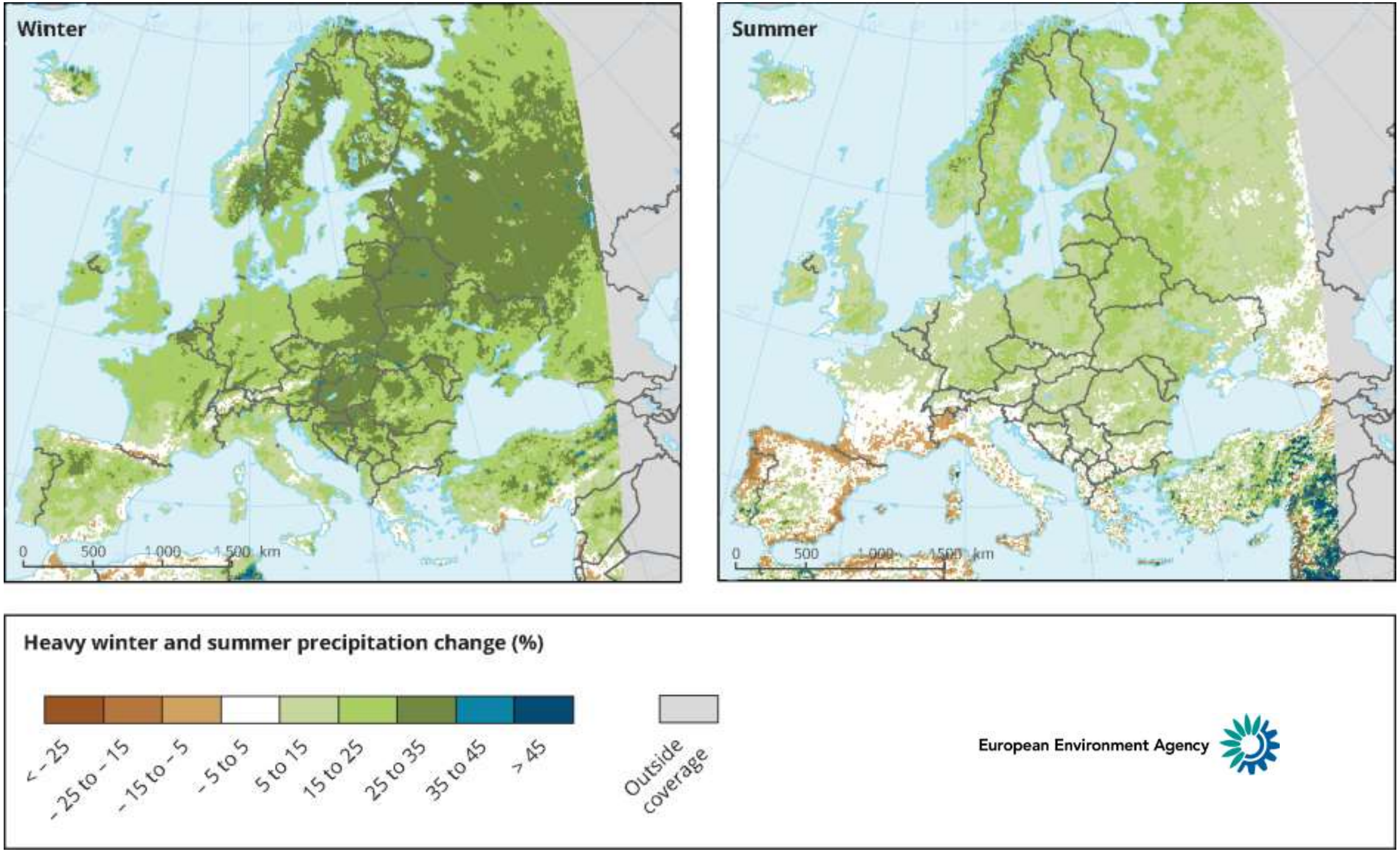


Source: IPCC AR6 WG1 (2021)

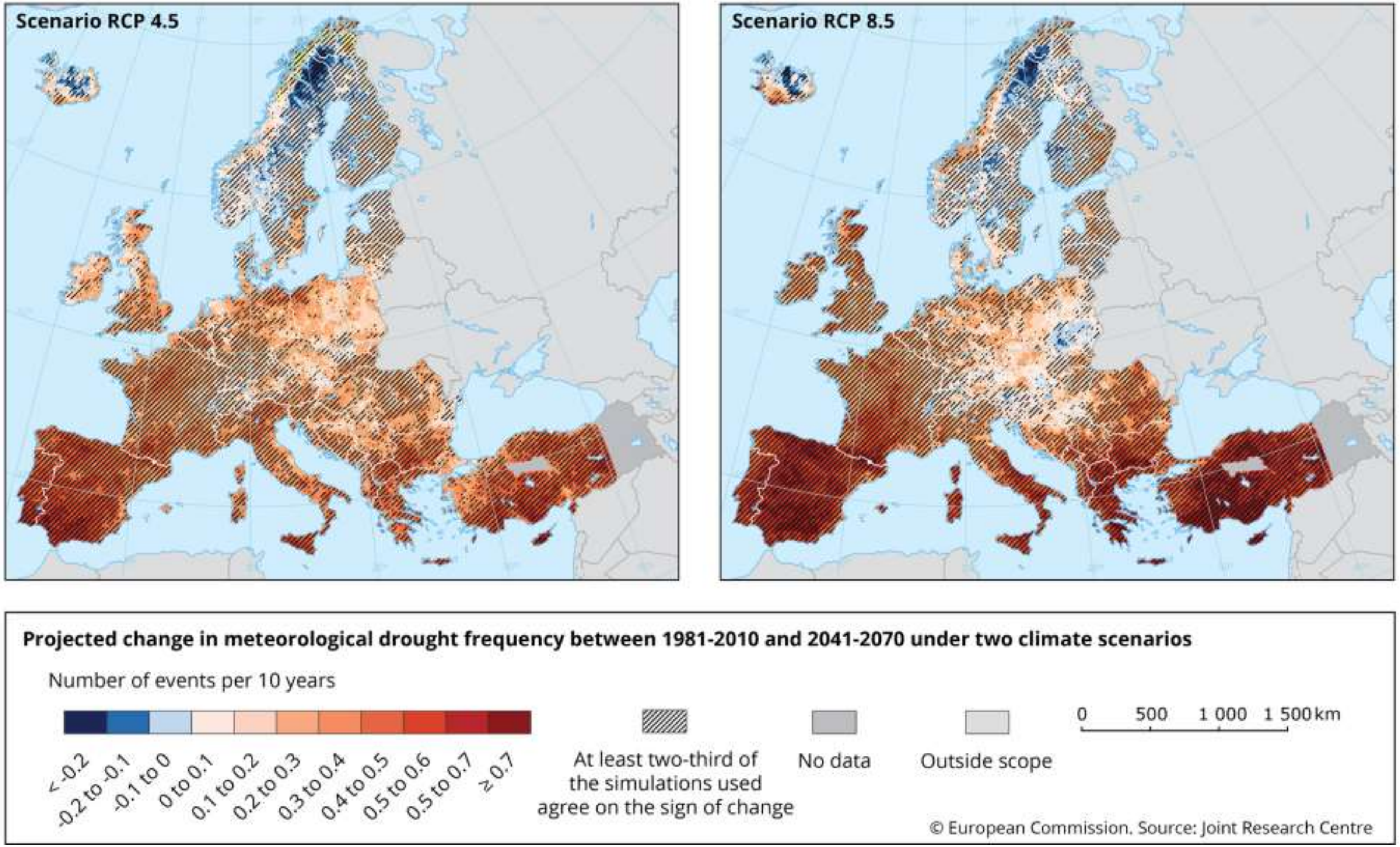
Climate change projections: precipitation



Climate change projections: heavy precipitation

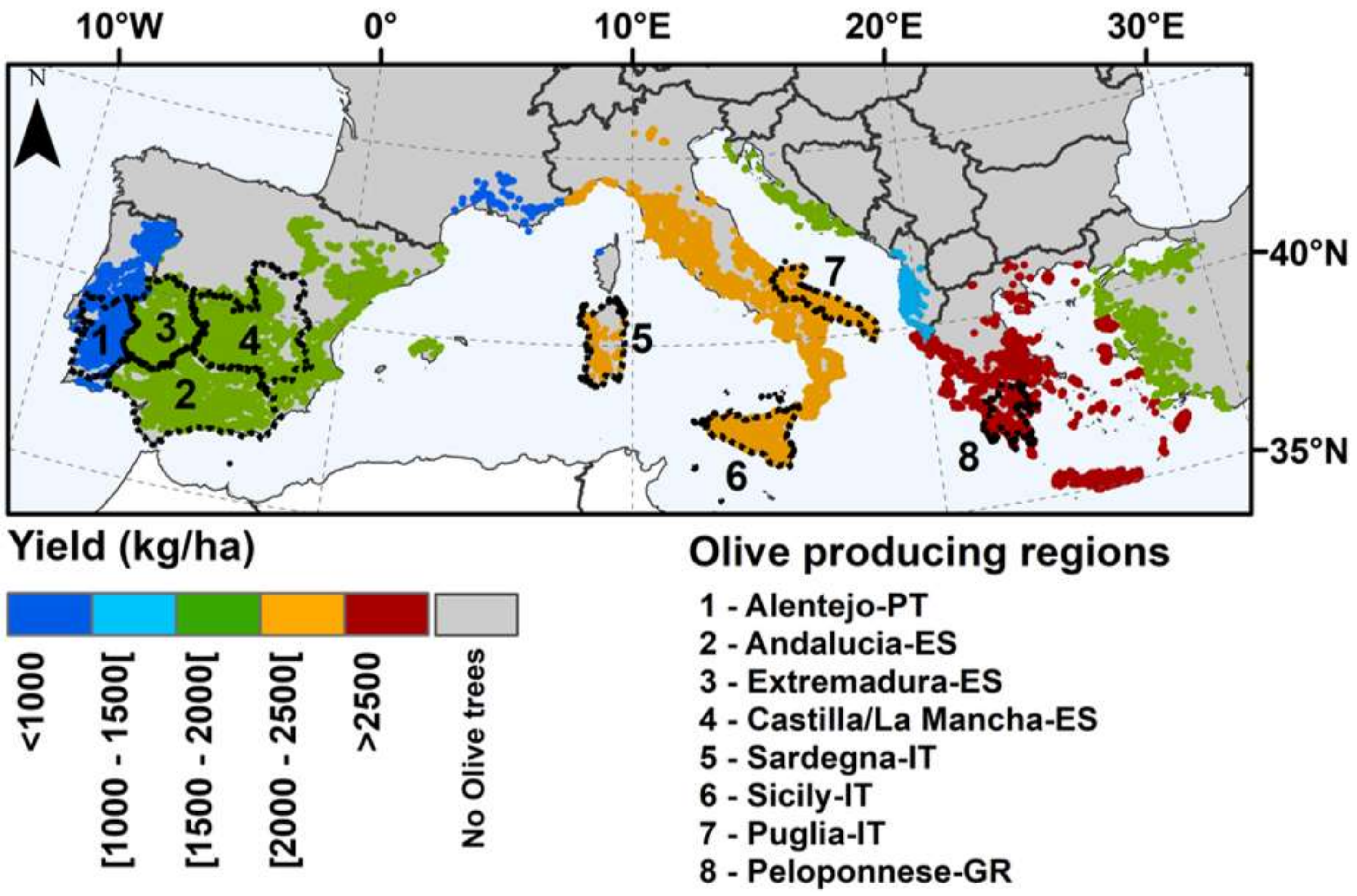


Climate change projections: droughts



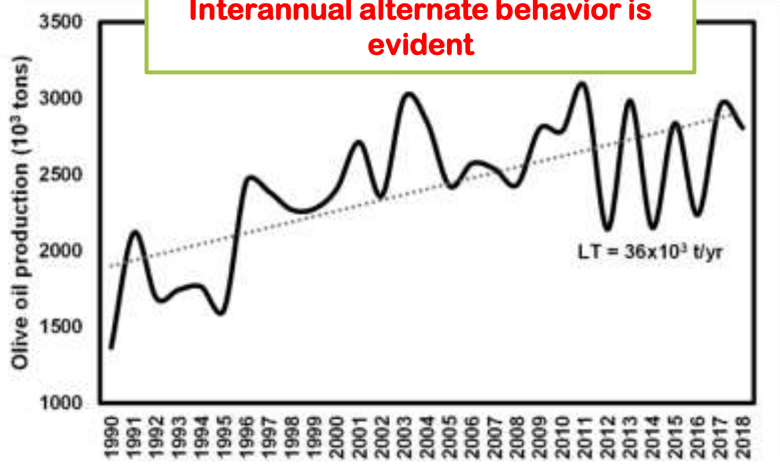
CLIMATE PROJECTIONS FOR OLIVES

Olive yield in Southern Europe



Increasing linear trend over the past 30 years

Interannual alternate behavior is evident



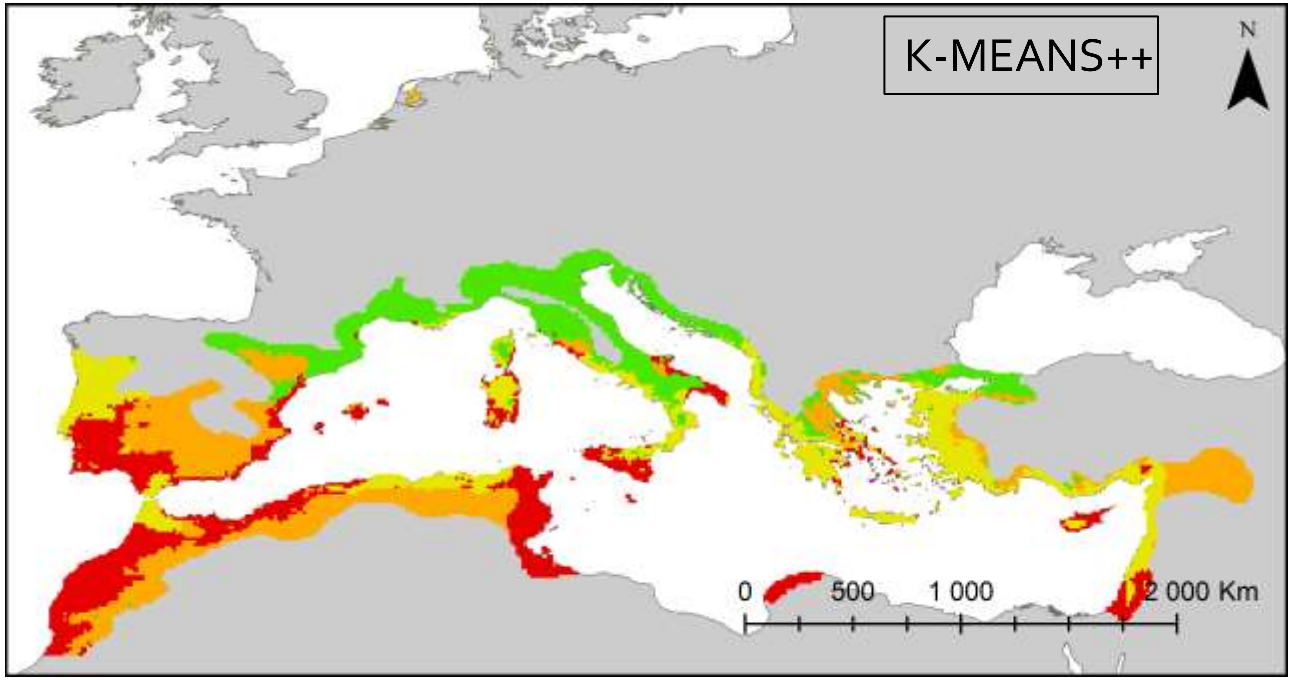
EUROSTAT DATA:

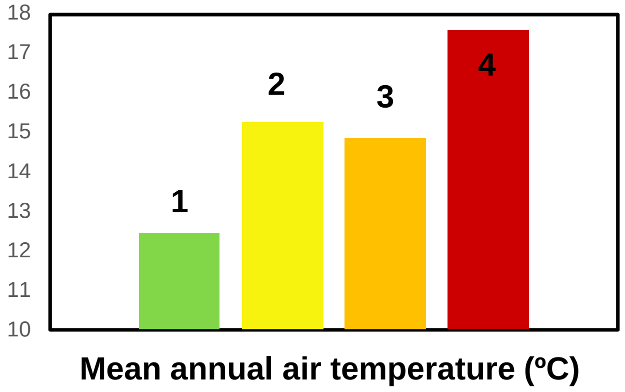
Higher yields in Greece, Italy, Spain.

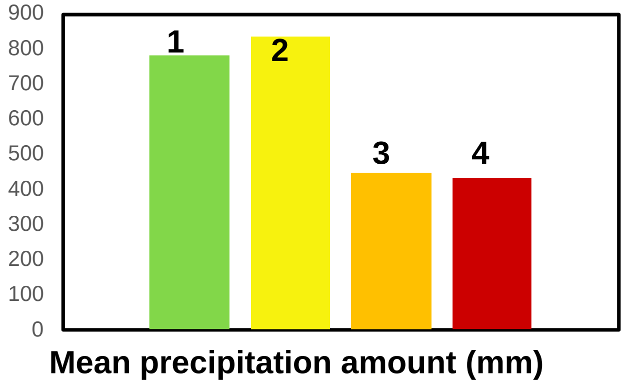
Lower yields in Portugal and southern France

Helder Fraga; Joaquim G. Pinto; Francesco Viola; João A. Santos. "Climate change projections for olive yields in the Mediterranean Basin". *International Journal of Climatology* 40 (2020): 769-781. https://doi.org/10.1002/joc.6237.

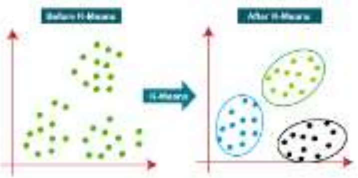
Olive climatology







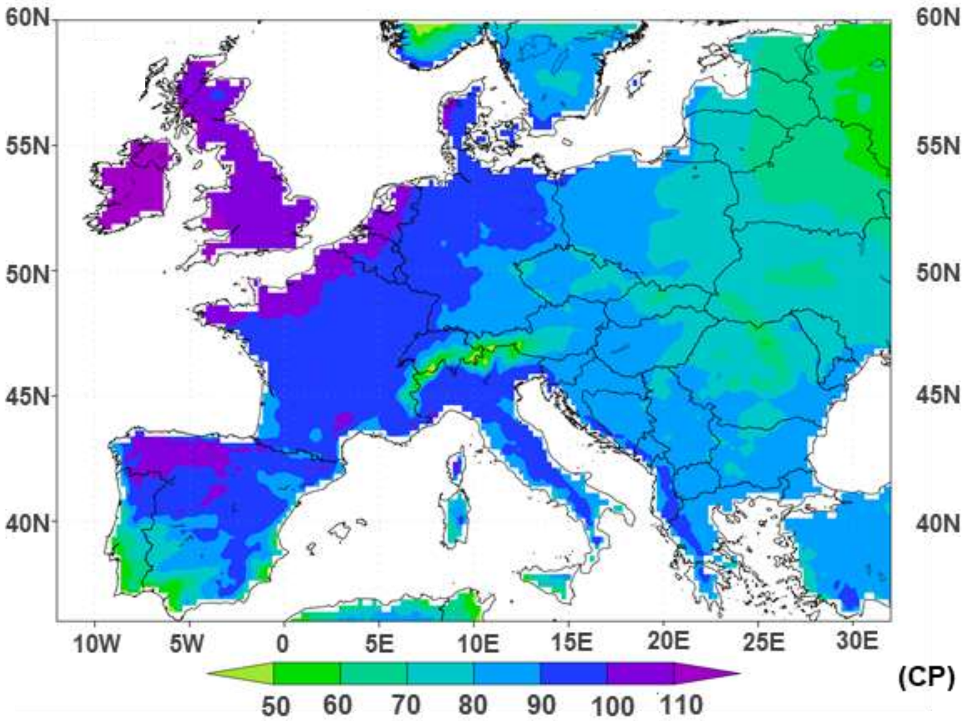
Bioclimatic Indices
mean annual air temperature
mean diurnal air temperature range
isothermality
temperature seasonality
mean daily maximum air temperature of the warmest month
mean daily minimum air temperature of the coldest month
annual range of air temperature
mean daily mean air temperatures of the wettest quarter
mean daily mean air temperatures of the driest quarter
mean daily mean air temperatures of the warmest quarter
mean daily mean air temperatures of the coldest quarter
annual precipitation amount
precipitation amount of the wettest month
precipitation amount of the driest month
precipitation seasonality
mean monthly precipitation amount of the wettest quarter
mean monthly precipitation amount of the driest quarter
mean monthly precipitation amount of the warmest quarter
mean monthly precipitation amount of the coldest quarter

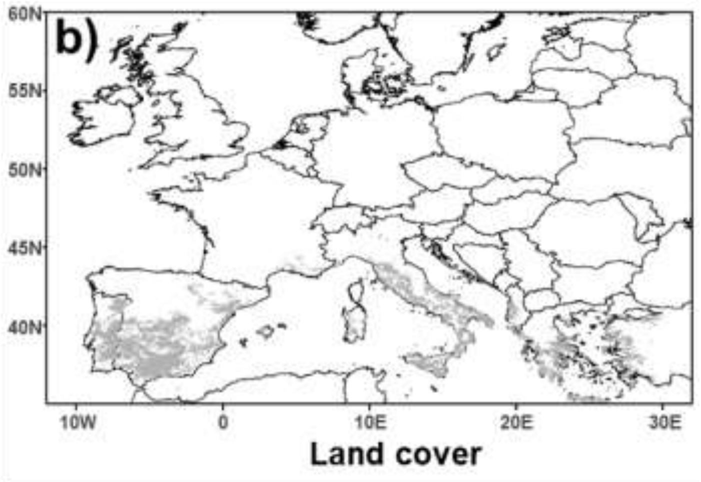


*Fraga et al. In preparation

Chilling conditions

- Chilling portions



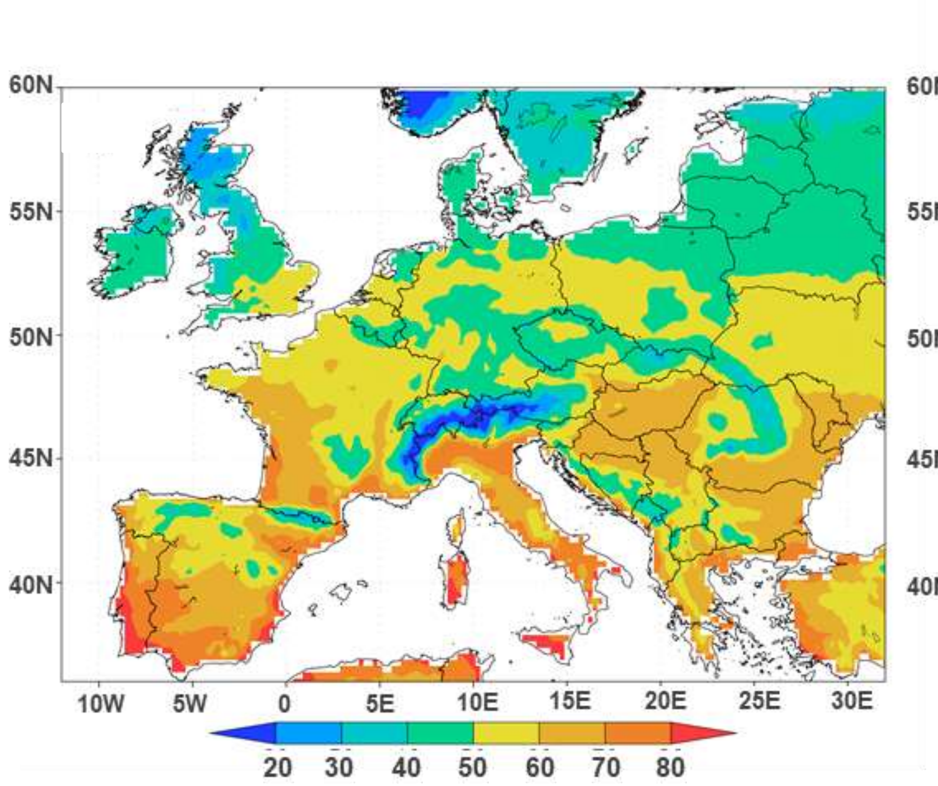


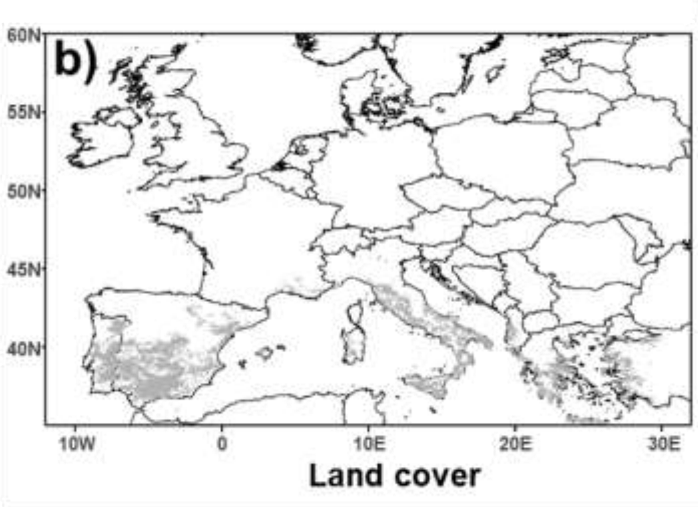
Olive trees stay in areas of **maximum 90-100 CP**

Fraga, H., Pinto, J.G. & Santos, J.A. Climate change projections for chilling and heat forcing conditions in European vineyards and olive orchards: a multi-model assessment. *Climatic Change* **152**, 179–193 (2019). https://doi.org/10.1007/s10584-018-2337-5

Heat conditions

- Growing degree hours

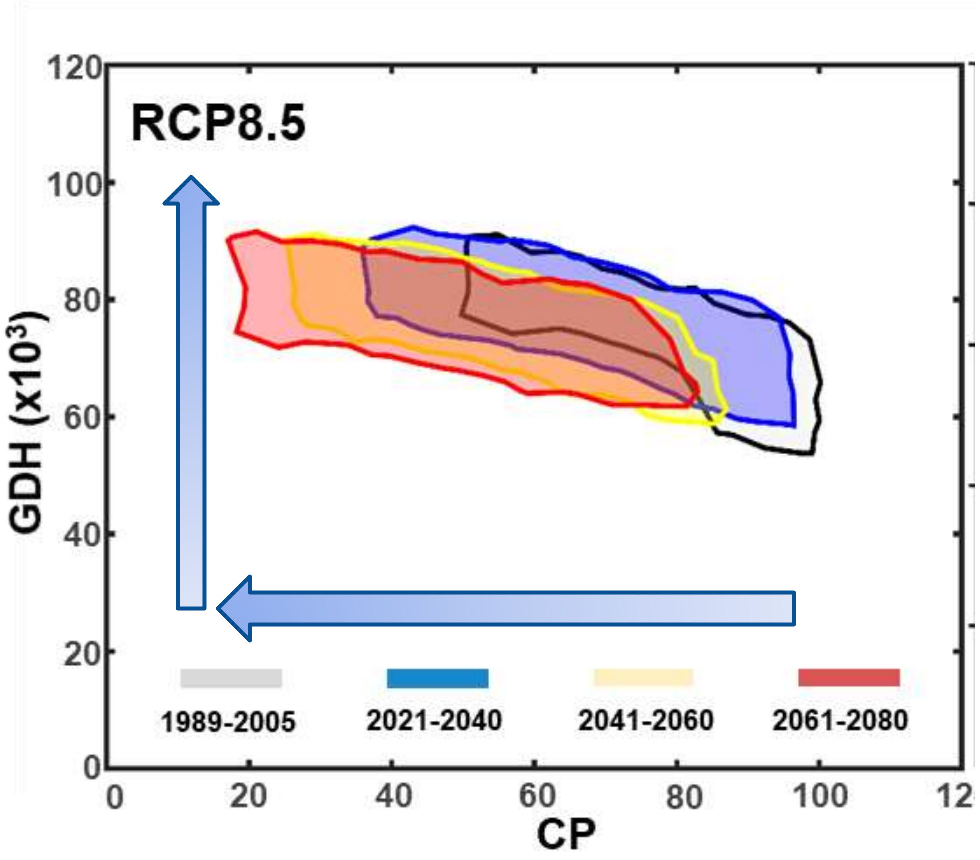




Olive trees stay in areas of **minimum 50 GDH**

Fraga, H., Pinto, J.G. & Santos, J.A. Climate change projections for chilling and heat forcing conditions in European vineyards and olive orchards: a multi-model assessment. *Climatic Change* **152**, 179–193 (2019). https://doi.org/10.1007/s10584-018-2337-5

Future conditions for heat and chill



The 2 future scenarios behave similarly until 2050

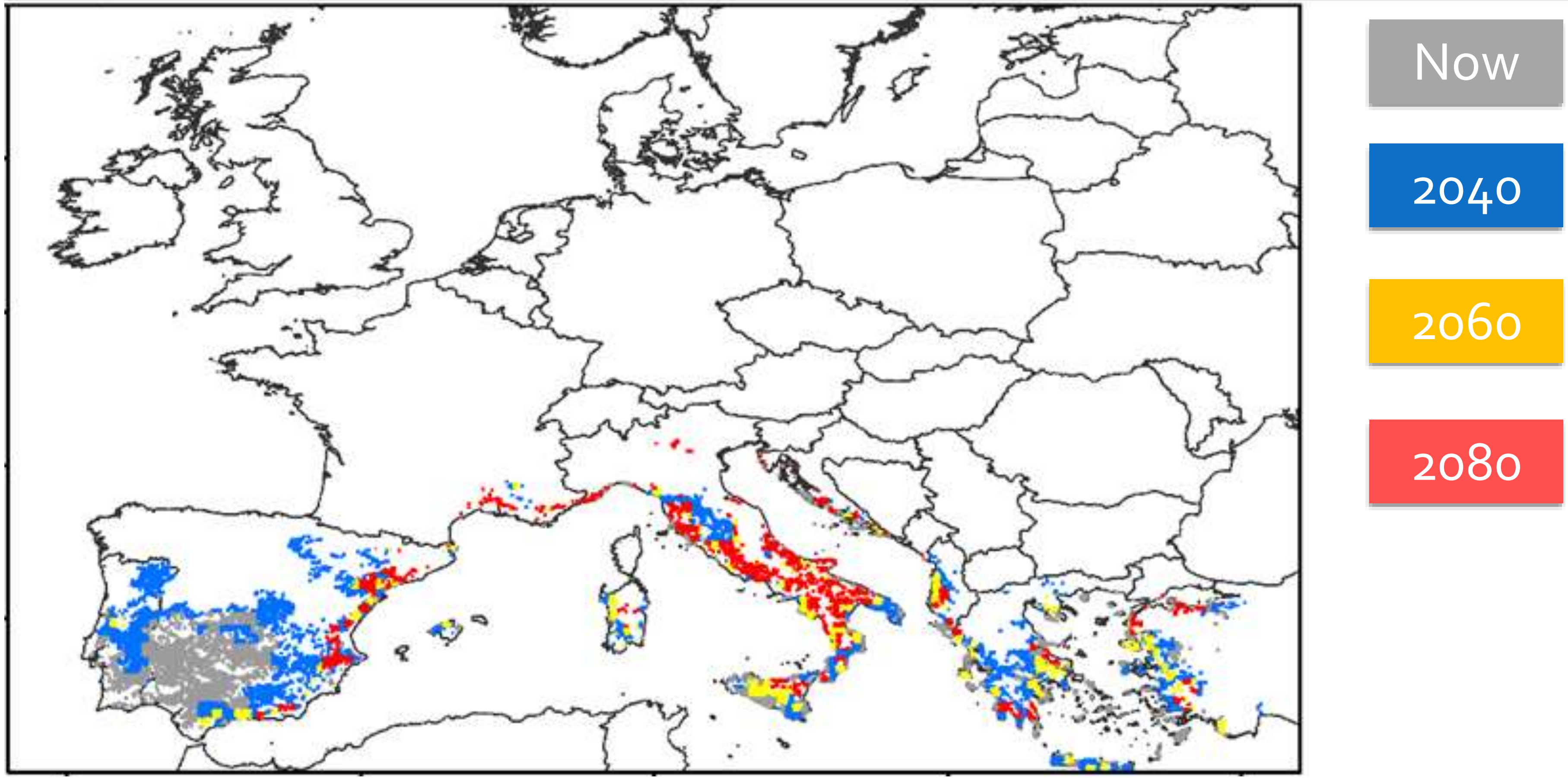
Chill will tend to decrease and forcing increase

This may lead to several problems; chill decrease may lead to problems with flowering and fruit set. And heat increase may lead to phenological advances.

Fraga, H., Pinto, J.G. & Santos, J.A. Climate change projections for chilling and heat forcing conditions in European vineyards and olive orchards: a multi-model assessment. *Climatic Change* **152**, 179–193 (2019). https://doi.org/10.1007/s10584-018-2337-5

Future conditions for heat and chill

When is the last time period where you have similar Chill-heat conditions as you have today?



Fraga, H., Pinto, J.G. & Santos, J.A. Climate change projections for chilling and heat forcing conditions in European vineyards and olive orchards: a multi-model assessment. *Climatic Change* **152**, 179–193 (2019). https://doi.org/10.1007/s10584-018-2337-5

Olive tree dynamic modelling

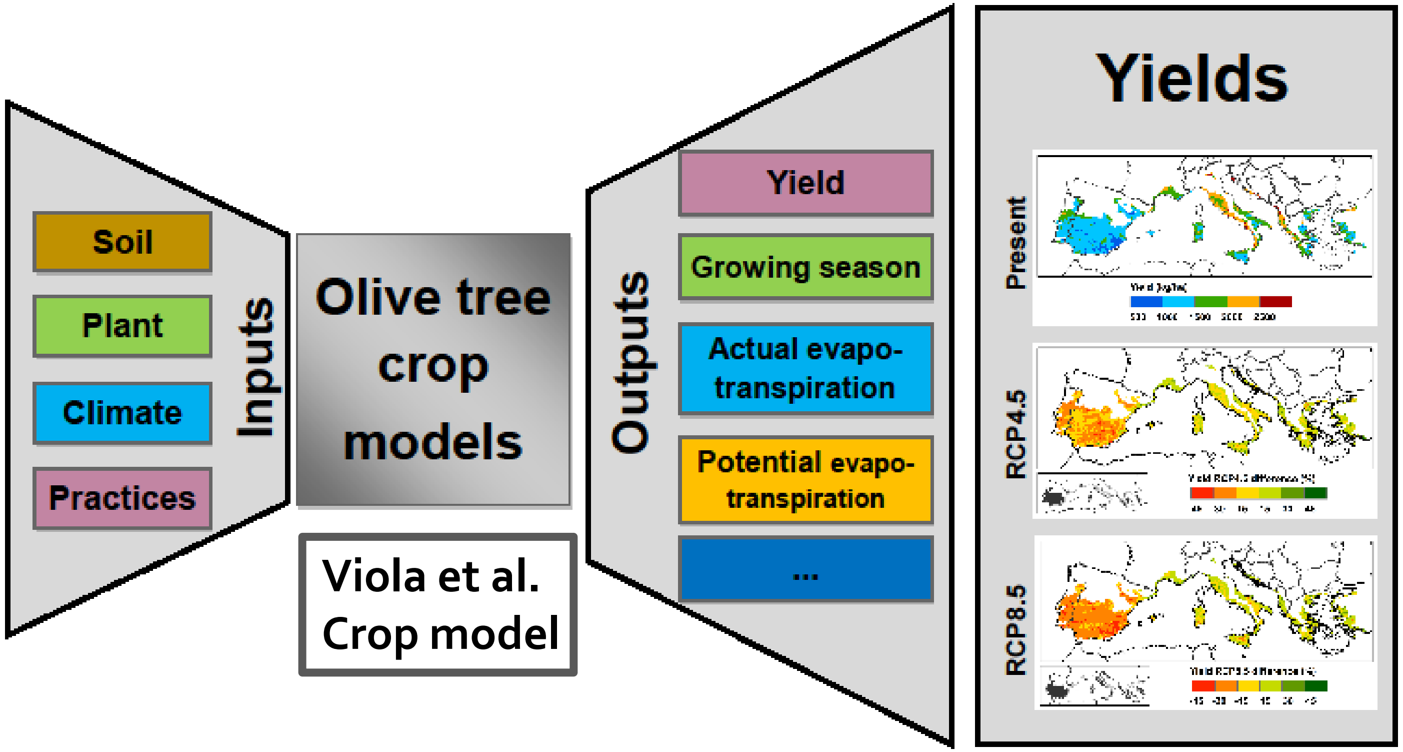
Tested in Italy and Portugal: R^2 ~= 0.75

Harmonized World Soil Dataset (HWSD)

Optimised for Olive trees using field data

4 Regional climate models from Euro-Cordex

Common cultural practices and management

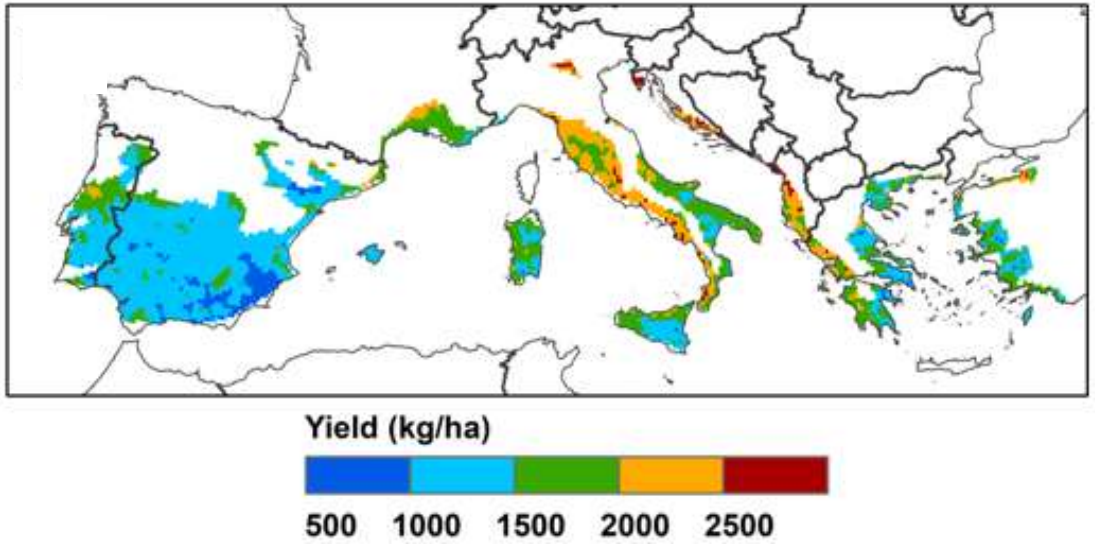


Viola et al. 2012. Olive yield as a function of soil moisture dynamics. Ecohydrology

Helder Fraga; Joaquim G. Pinto; Francesco Viola; João A. Santos. "Climate change projections for olive yields in the Mediterranean Basin". *International Journal of Climatology* 40 (2020): 769-781. https://doi.org/10.1002/joc.6237.

Yield (current climate)

(1985-2005)



Higher yields at higher latitudes

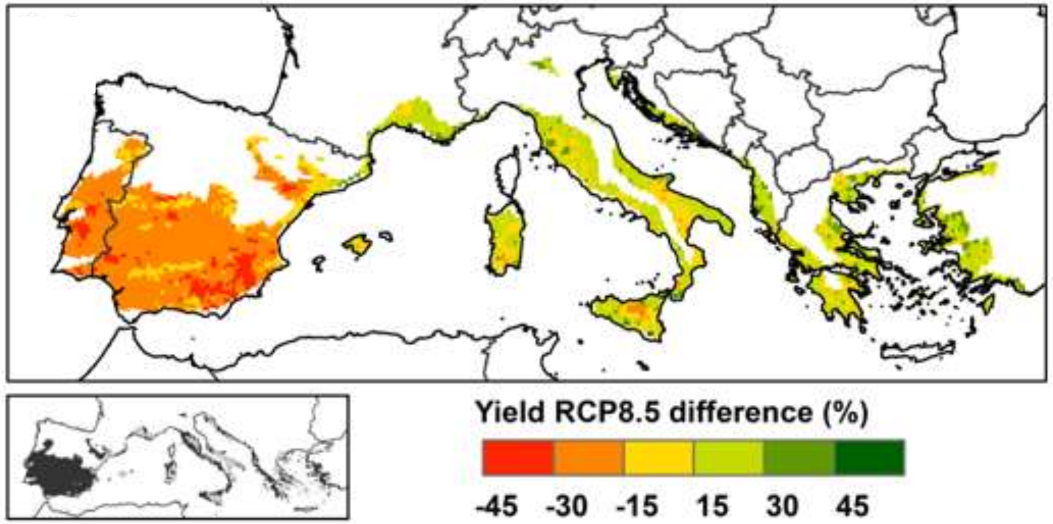
Lower yields in southern Italy and southern iberia

Good agreement with real yield

Helder Fraga; Joaquim G. Pinto; Francesco Viola; João A. Santos. "Climate change projections for olive yields in the Mediterranean Basin". *International Journal of Climatology* 40 (2020): 769-781. https://doi.org/10.1002/joc.6237.

Yield (Future climate RCP8.5)

(2041-2070)



Two opposite behaviors

Strong decrease in yield in Iberia up to -45%

Weak increase elsewhere 15%

Helder Fraga; Joaquim G. Pinto; Francesco Viola; João A. Santos. "Climate change projections for olive yields in the Mediterranean Basin". *International Journal of Climatology* 40 (2020): 769-781. https://doi.org/10.1002/joc.6237.

Main results

Iberia	Elsewhere in southern Europe
• Strong decrease in yields • Severe water stress • Extreme heat may threaten quality	• Small higher yields • Water stress offset by CO_2 increase

Helder Fraga; Joaquim G. Pinto; Francesco Viola; João A. Santos. "Climate change projections for olive yields in the Mediterranean Basin". *International Journal of Climatology* 40 (2020): 769-781. https://doi.org/10.1002/joc.6237.

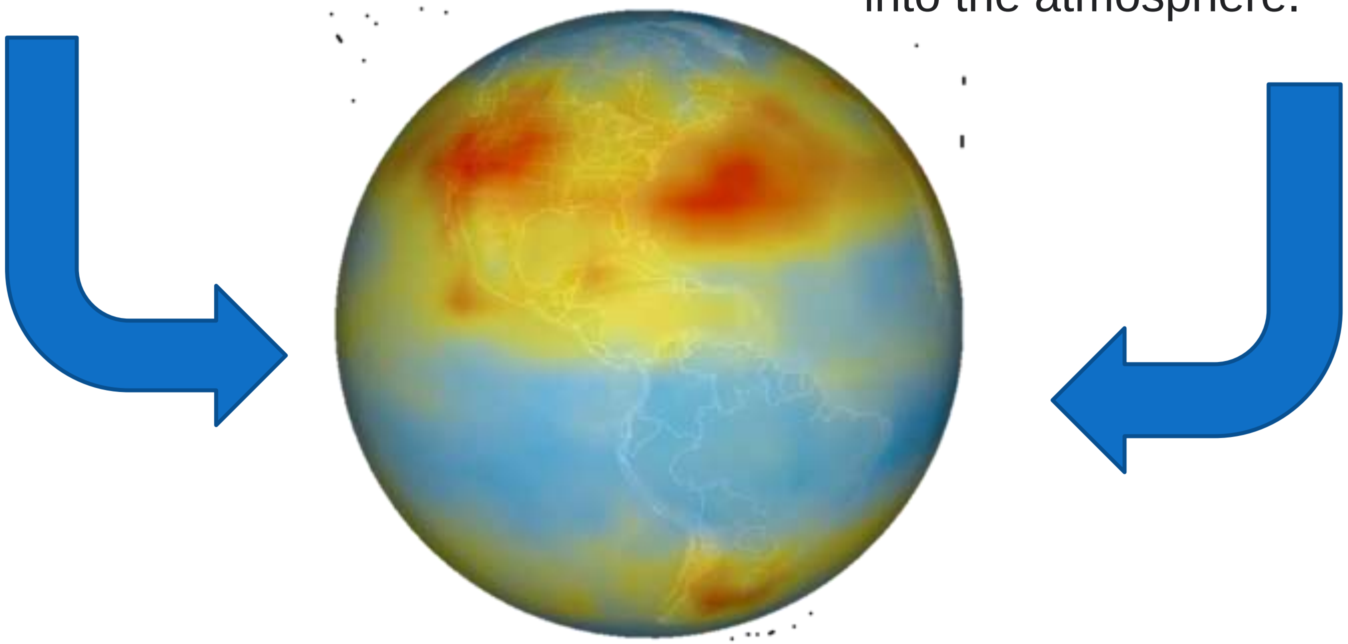
How can we fight climate change?

1 . ADAPTATION

Adaptation can be understood as the process of **adjusting to the current and future effects of climate change.**

2 . MITIGATION

Mitigation means making the impacts of **climate change less severe by preventing or reducing the emission of greenhouse gases** (GHG) into the atmosphere.



Short-term

Short-term measures:

Irrigation

Management

Foliar protectors

Pruning techniques should be focused

Irrigation requirements could increase on average by **10-50% per decade in the**

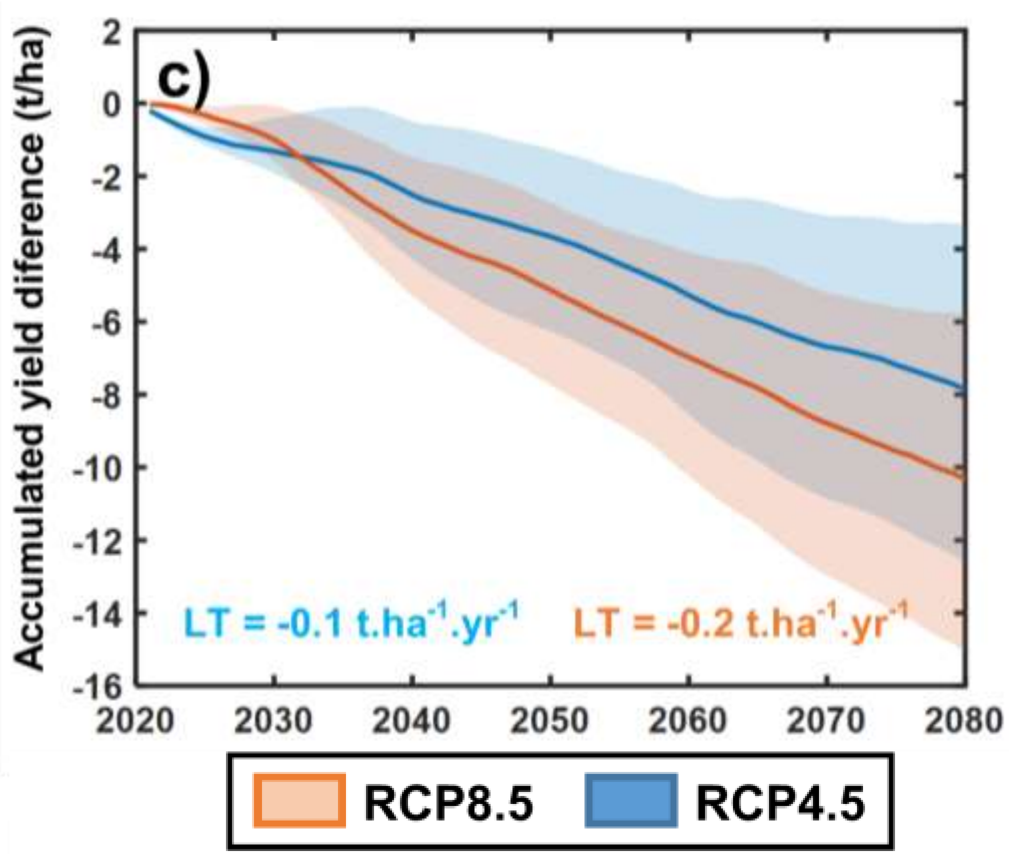
One strategy is that application of spray compounds that could mitigate the negative effects of excessive heat and sunburns. **kaolin clay particles** reduce canopy temperature, heat stress and sunburn impacts. It resulted in alleviating the negative effects of drought stress. Additionally, kaolin clay has also shown protective properties against pests and diseases. On the other hand, spraying olive trees with copper may also give protection against frost.

source of energy.

Fraga, H.; Moriondo, M.; Leolini, L.; Santos, J.A. Mediterranean Olive Orchards under Climate Change: A Review of Future Impacts and Adaptation Strategies. Agronomy 2021, 11, 56.

Projections for rainfed orchards in the future

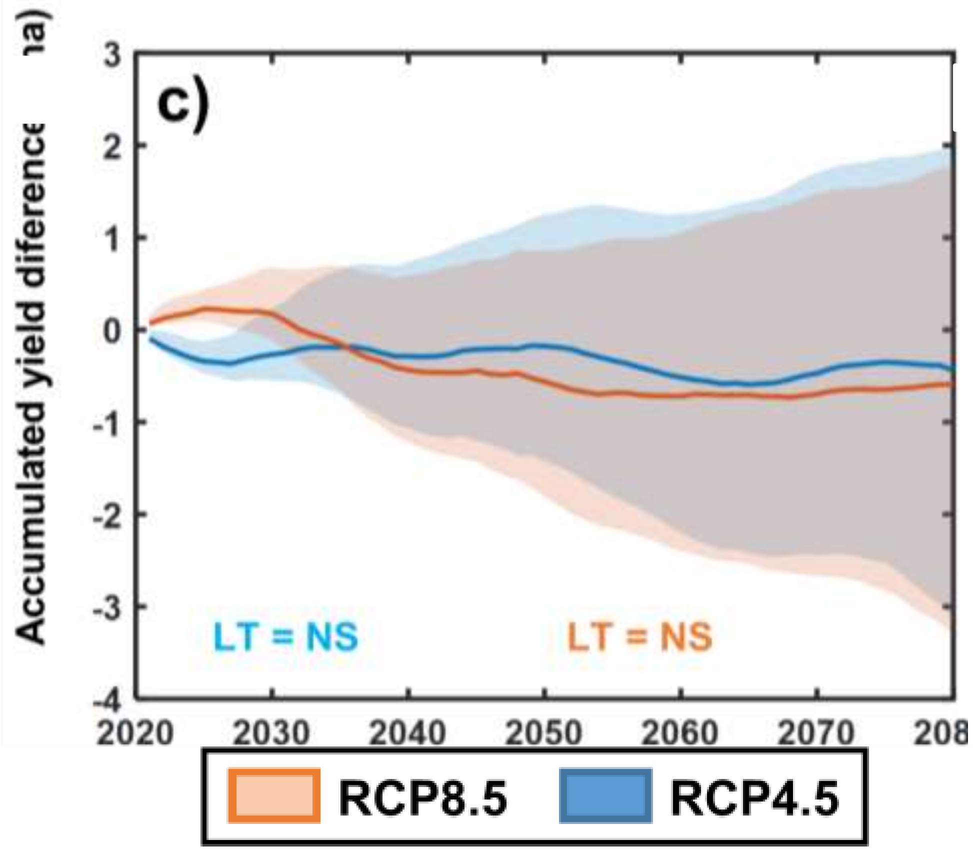
Rainfed olive orchards



Fraga, Helder; et al ."Olive tree irrigation as a climate change adaptation measure in Alentejo, Portugal". *Agricultural Water Management* 237 (2020): 106193.

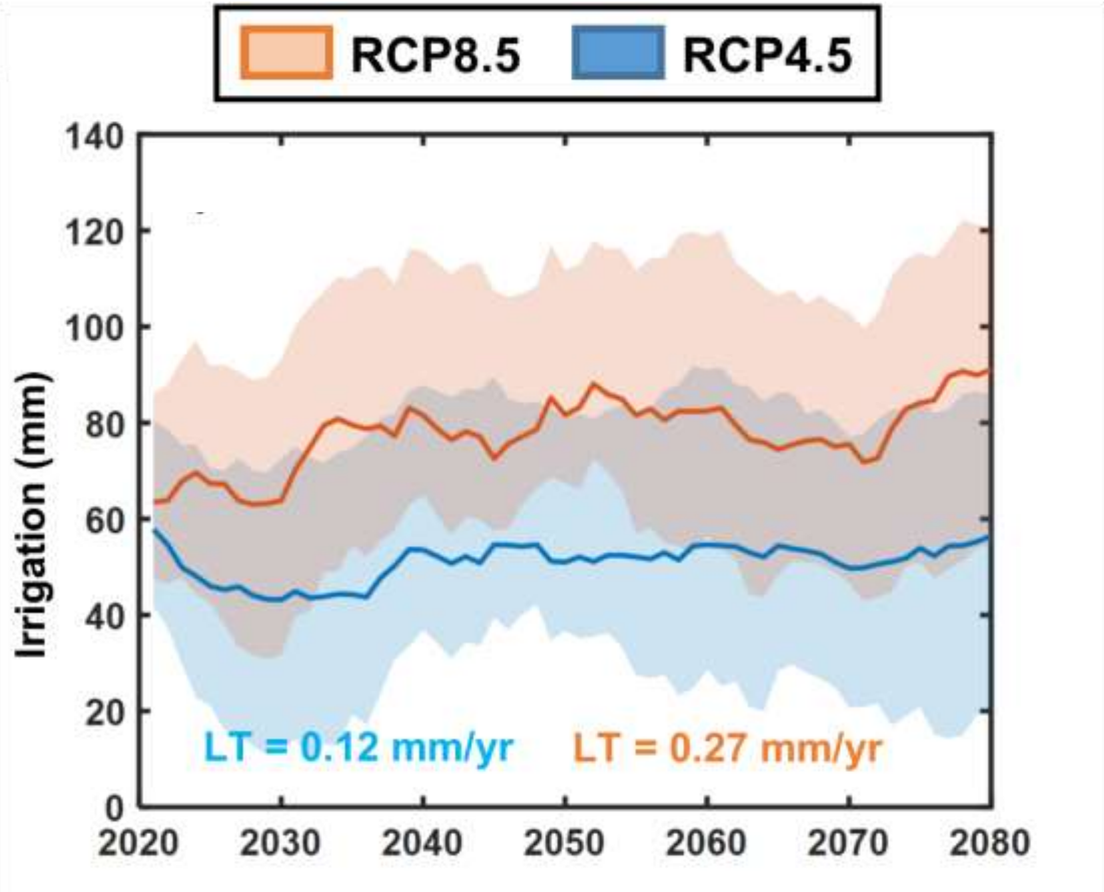
Projections for irrigated orchards in the future

Applying drip irrigation (only at certain water stress level)



Fraga, Helder; et al ."Olive tree irrigation as a climate change adaptation measure in Alentejo, Portugal". *Agricultural Water Management* 237 (2020): 106193.

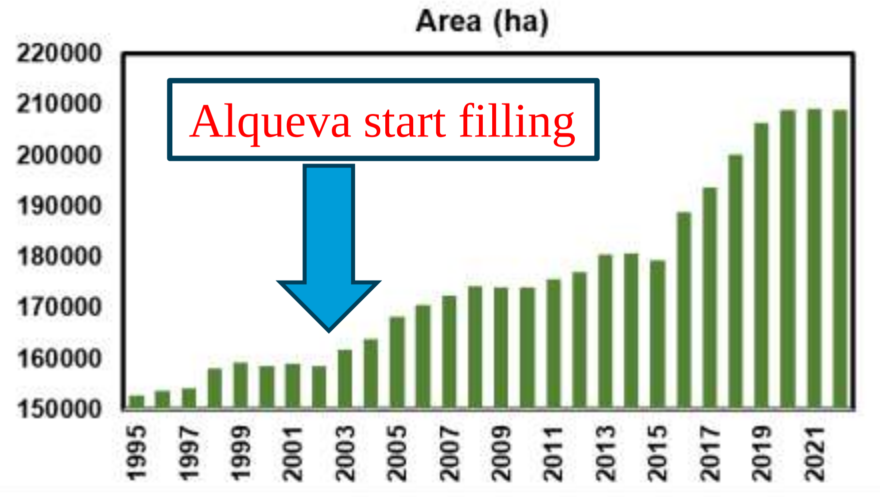
Irrigation needed

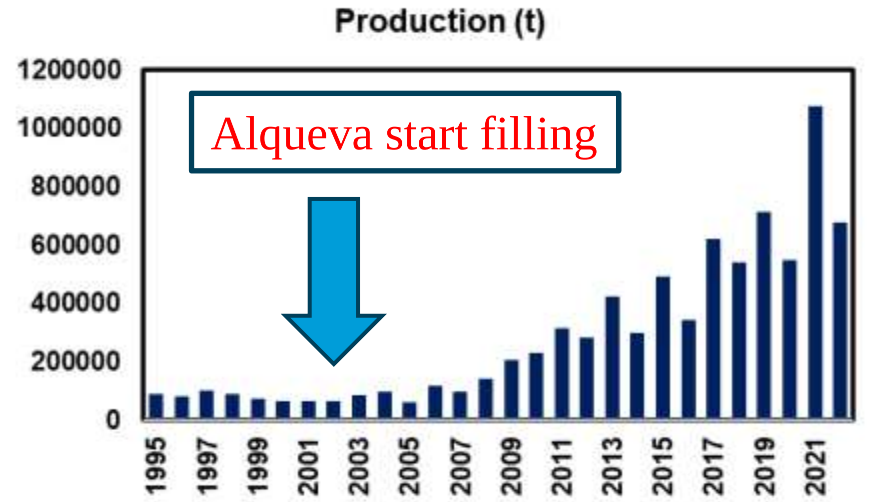


Higher need for irrigation in RCP8.5

Fraga, Helder; et al ."Olive tree irrigation as a climate change adaptation measure in Alentejo, Portugal". *Agricultural Water Management* 237 (2020): 106193.

Alentejo study case: Alqueva





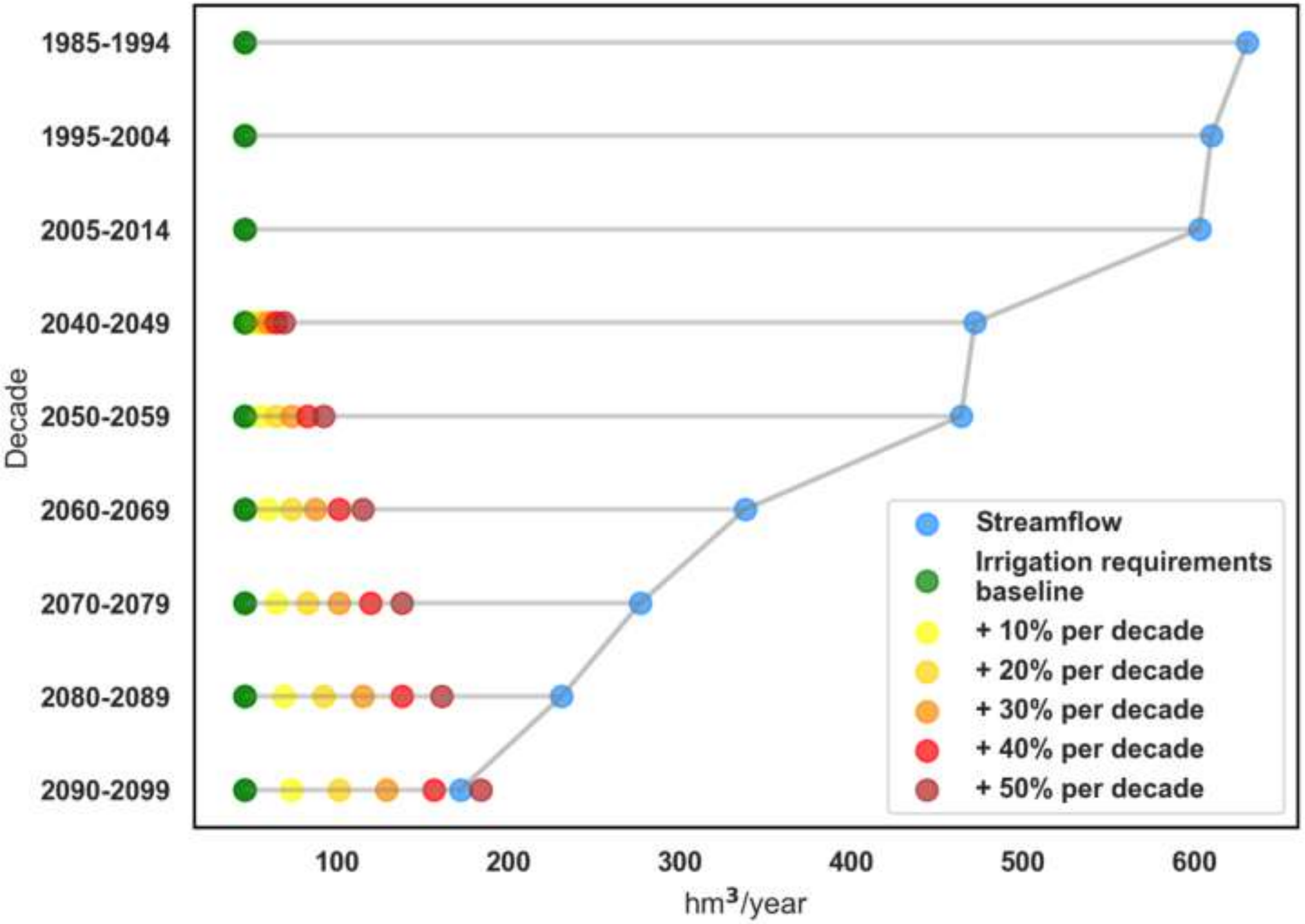
Alqueva Dam

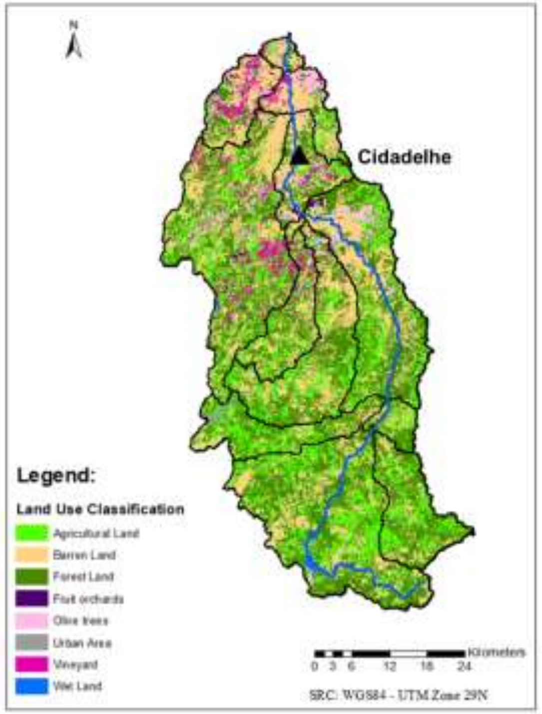
Irrigated olive orchards (%)

2019		51%
2009		32%
2022	**Estimate***	60%

*Portuguese Statistics Institute

Basin streamflow under climate change





Rodrigues, D.; Fonseca, A.; Stolarski, O.; Freitas, T.R.; Guimarães, N.; Santos, J.A.; Fraga, H. Climate Change Impacts on the Côa Basin (Portugal) and Potential Impacts on Agricultural Irrigation. *Water* **2023**, *15*, 2739.

Long-term

Long-term measures:

- relocation
- Varietal selection

Over the centuries olive growers have selected the most adapted varieties for each location and climate. Under future climate change, it is expected that growers **may** need to replace susceptible varieties with more resilient ones. This vast number of varieties (over 2000) can indeed be a valuable resource against climate change. For this reason it is of utmost importance to maintain the vast genetic pool of olive varieties, particularly encourage the use of highly **drought-tolerant** olive varieties. Additionally, the implementation of suitable **breeding systems** is central in this adaptation measure.

Fraga, H.; Moriondo, M.; Leolini, L.; Santos, J.A. Mediterranean Olive Orchards under Climate Change: A Review of Future Impacts and Adaptation Strategies. Agronomy 2021, 11, 56.

Obrigado pela atenção!

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