

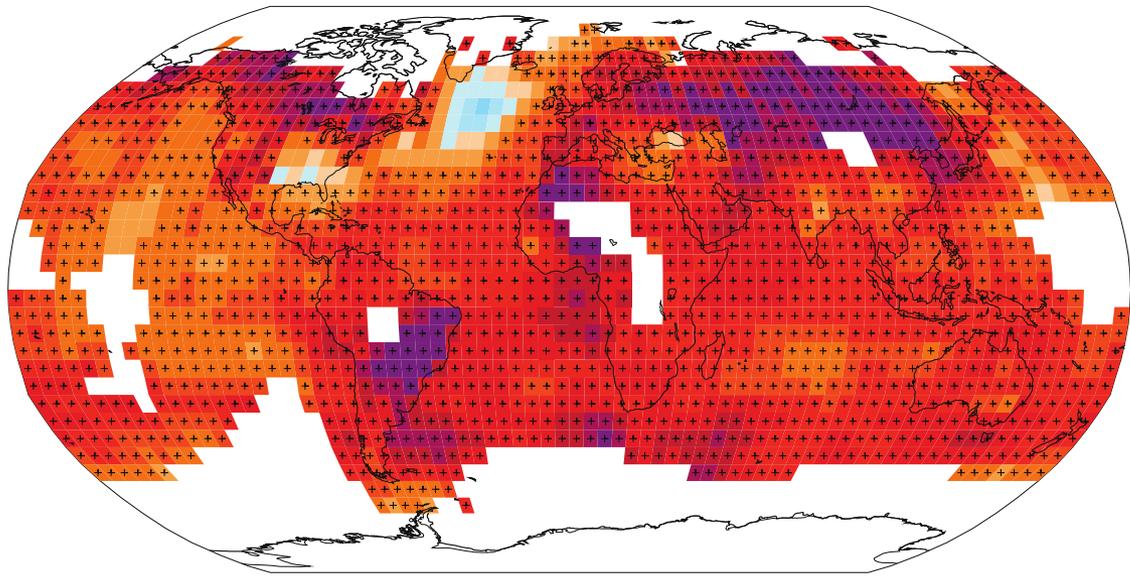
First Smart and Sustainable Development Convention, Nicosia, 9/11/2018

An update of climate change projections for the Mediterranean

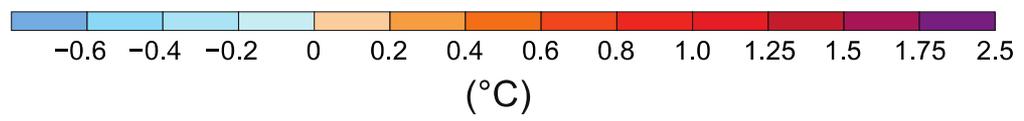
George Zittis, Panos Hadjinicolaou, Jos Lelieveld,
Marina Klangidou, Yiannis Proestos

Observed Climate Change

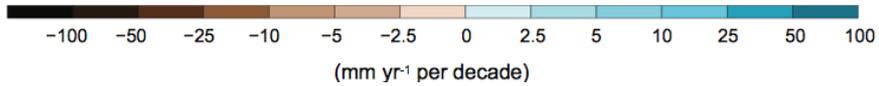
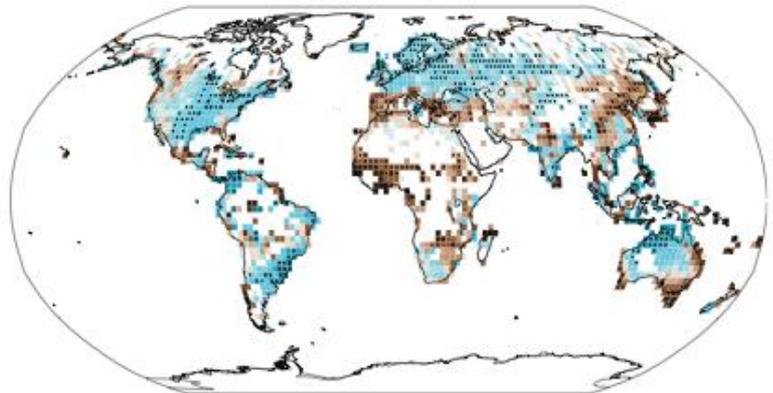
Observed change in surface temperature 1901–2012



- + 1°C since pre-industrial
- CO₂ reached 406 ppm
- Indications this is the warmest period of the last 1500 years
- Last 4 years have been the warmest on record



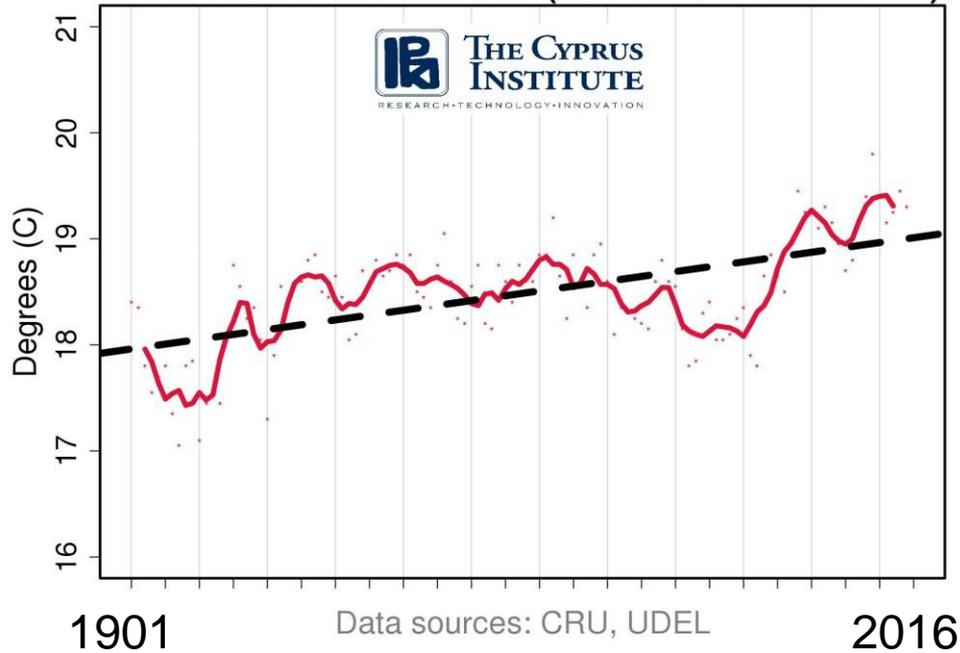
Observed change in annual precipitation over land 1951–2010



Climate Change in our Region

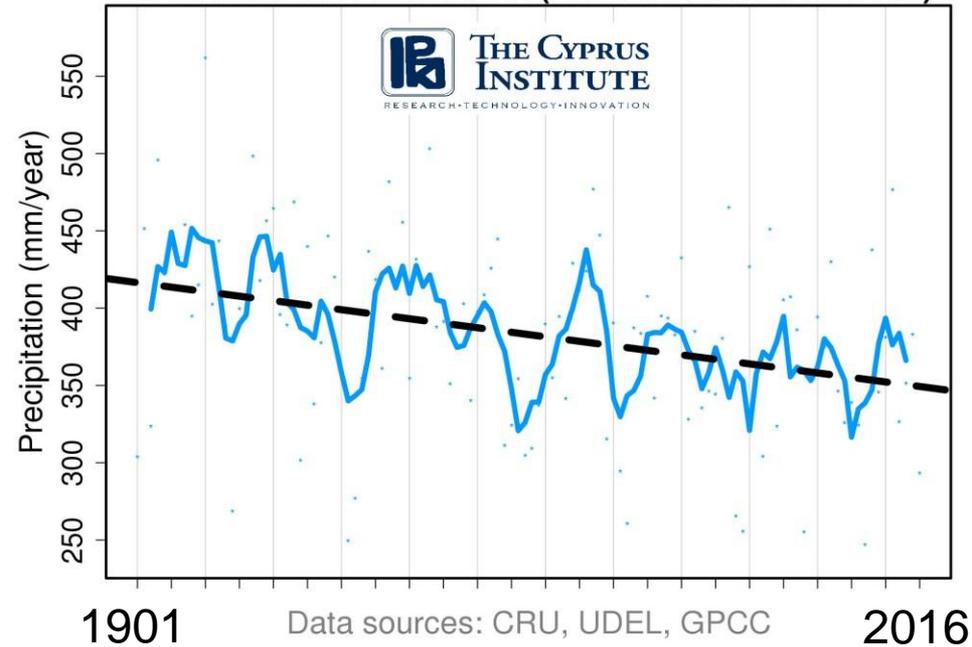
Temperature

MEAN ANN. TEMPERATURE (EAST MEDITERRANEAN)



Precipitation

MEAN ANNUAL RAINFALL (EAST MEDITERRANEAN)

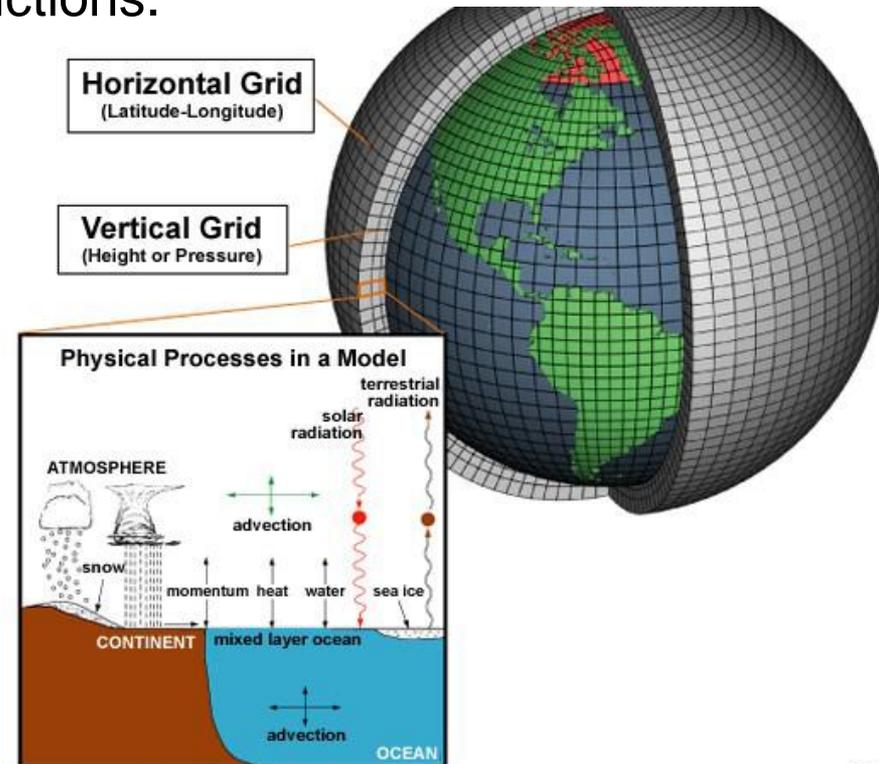


Climate Modeling

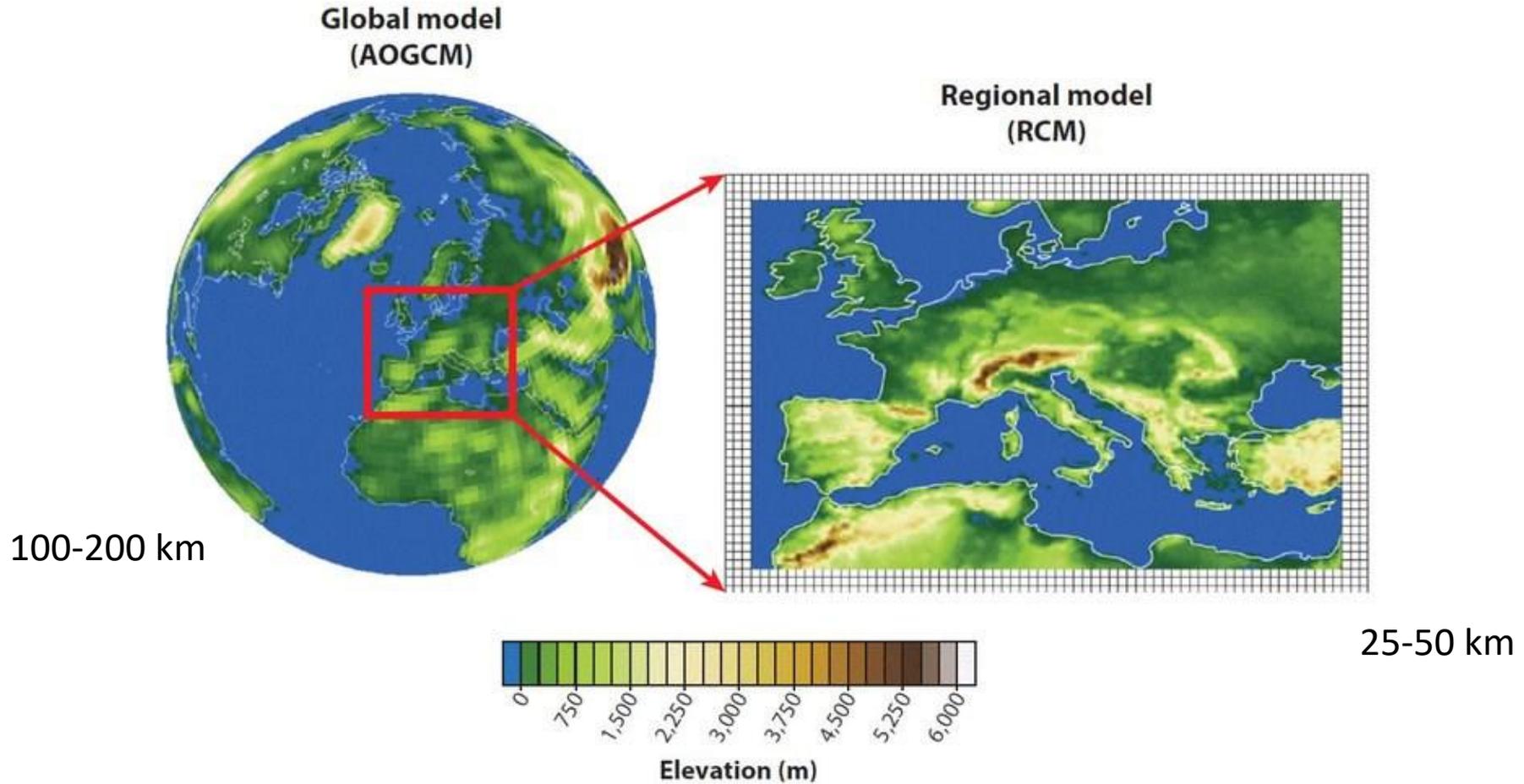
- A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes.
- Climate models are applied, as a research tool, to study and simulate the climate, but also for operational purposes, including monthly, seasonal and interannual predictions.



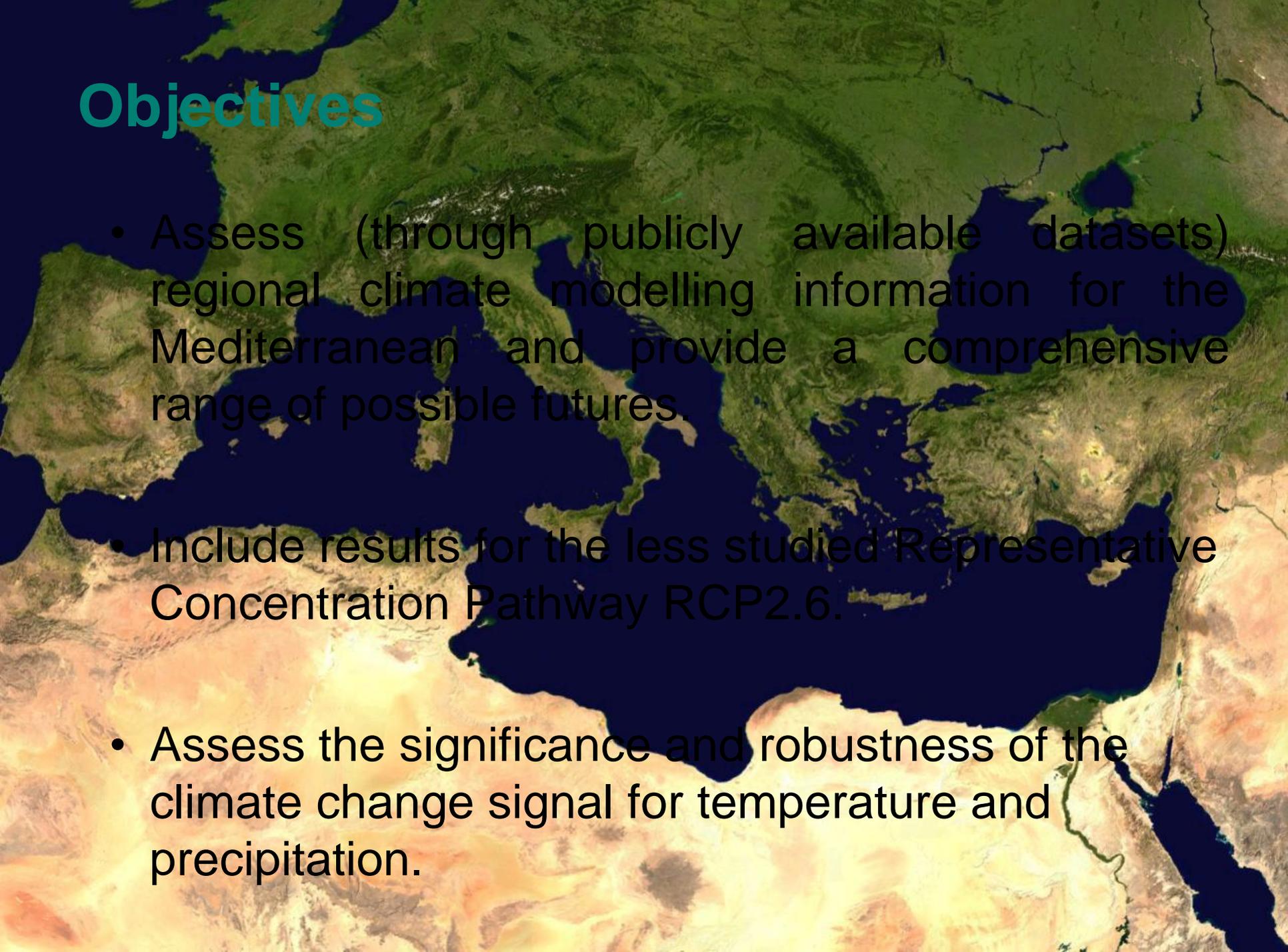
The Cy-Tera HPC facility in The Cyprus Institute



Climate Modeling – Dynamical Downscaling



Objectives

A satellite-style map of the Mediterranean region, showing the sea, surrounding landmasses, and topography. The sea is dark blue, and the land is shown in various shades of green, brown, and yellow, indicating different vegetation and terrain types. The map is centered on the Mediterranean basin, with the Balkans to the north, the Middle East to the east, and North Africa to the south.

- Assess (through publicly available datasets) regional climate modelling information for the Mediterranean and provide a comprehensive range of possible futures.
- Include results for the less studied Representative Concentration Pathway RCP2.6.
- Assess the significance and robustness of the climate change signal for temperature and precipitation.

CORDEX data (www.cordex.org)

- Resolution: 50-km
- Variables: Precipitation + Temperature (mean, max, min)
- Time resolution: Annual/Seasonal (from monthly averages)
- 3 future scenarios: RCP2.6, RCP4.5, RCP8.5
- 4 CORDEX Domains (EURO, MENA, AFRICA & MED)
- A blend of 188 experiments

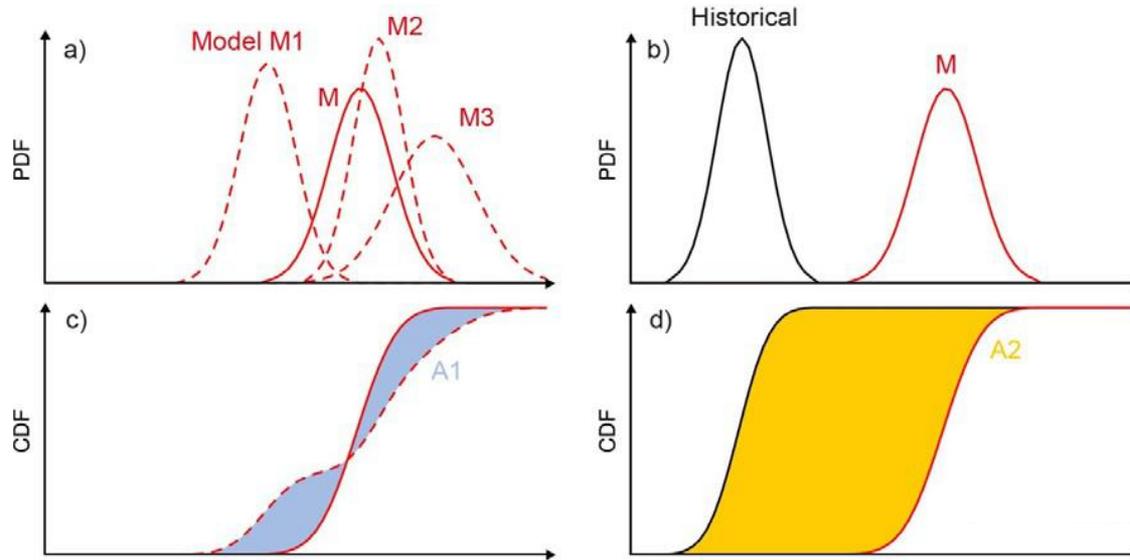
Time Periods:

CTL: 1986-2005

MID: 2046-2065

END: 2081-2100

Robustness



Knutti and Sedlacek (2012)

Robustness:
 $R = 1 - A1/A2$

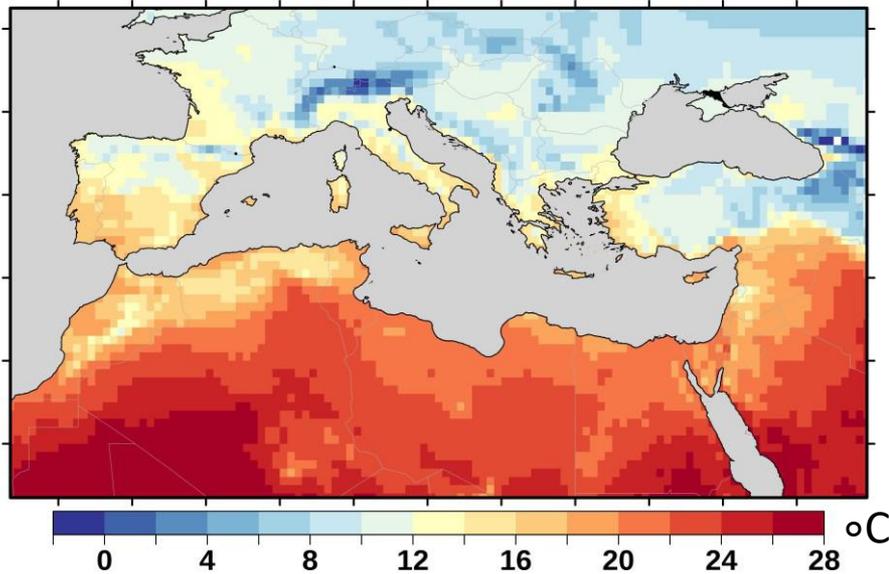
- $R=1$: perfect agreement
- $R \approx 0$: model spread is comparable to the signal
- $R < 0$: the spread is much larger than the signal

Significance

For a particular future period, a change is considered significant when its signal is larger than the interannual variability of the control historical period (as in IPCC AR5).

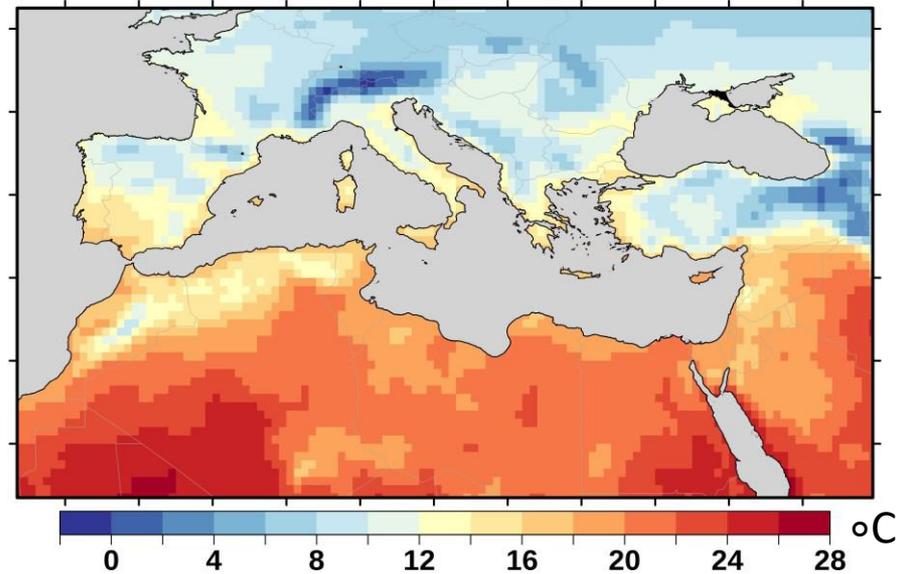
Historical simulations (Temperature)

2-M TEMPERATURE / CRU / 1986-2005



OBSERVATIONS

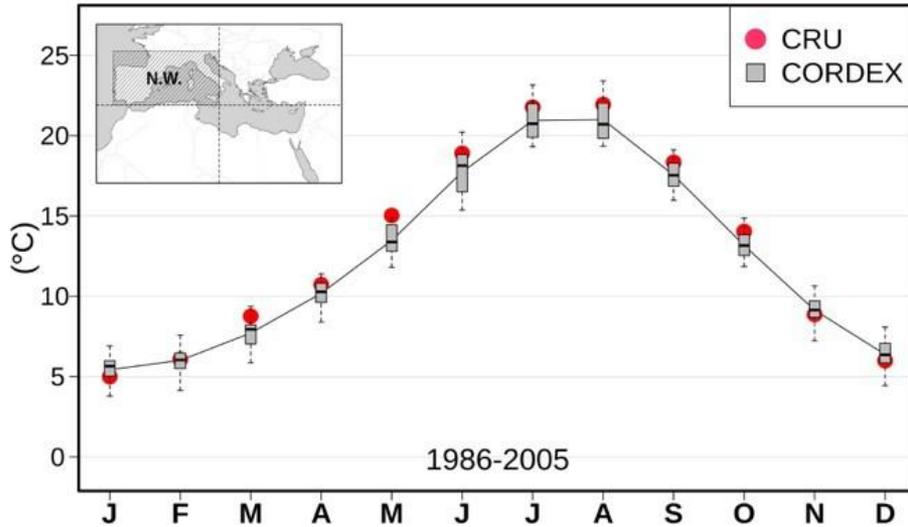
2-M TEMPERATURE / CORDEX ENS. / 1986-2005



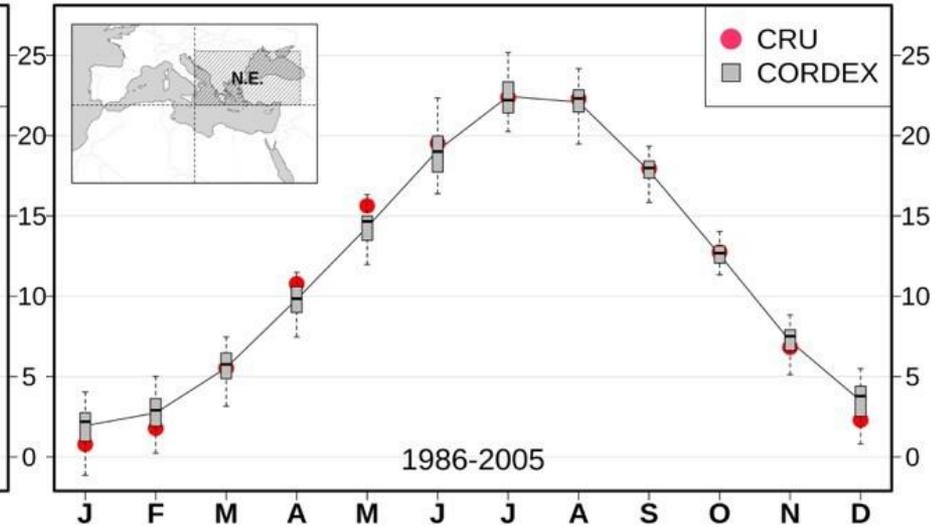
MODEL ENS. MEAN

Historical simulations (Temperature)

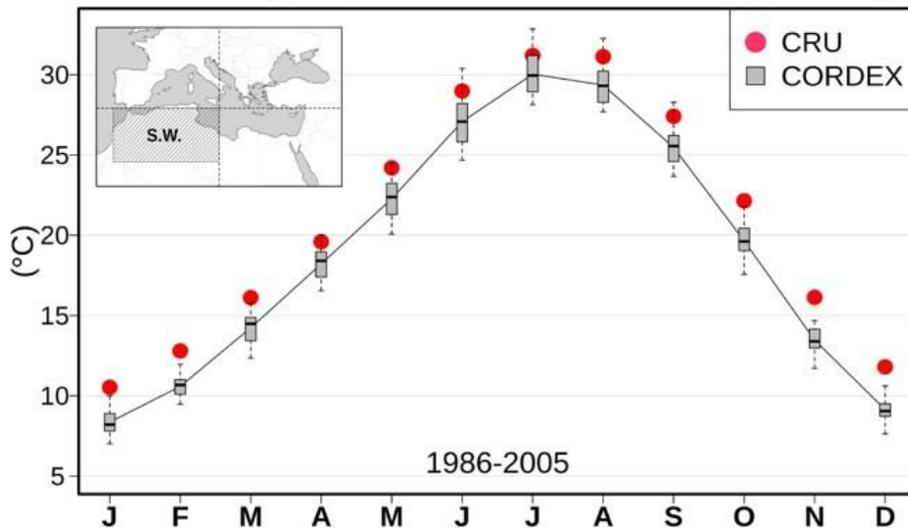
Mean monthly temperature N.W. Mediterranean (land only)



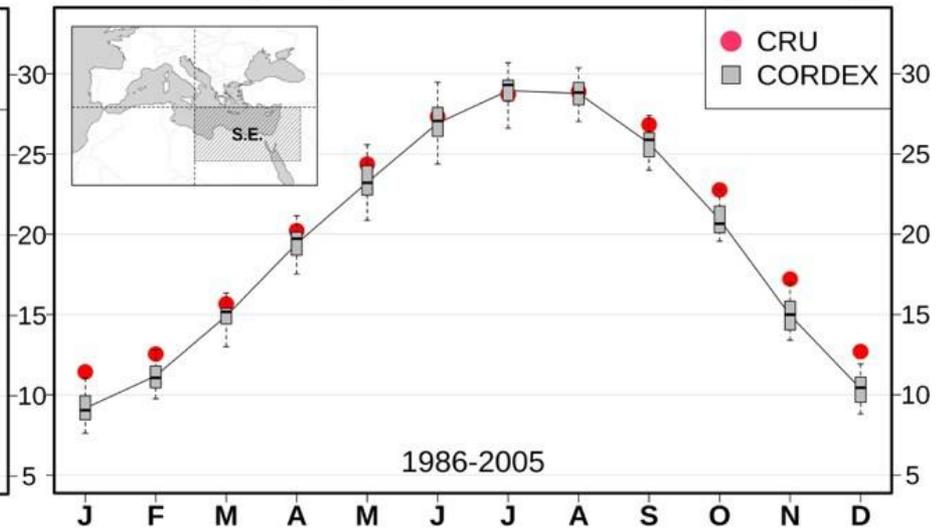
Mean monthly temperature N.E. Mediterranean (land only)



Mean monthly temperature S.W. Mediterranean (land only)

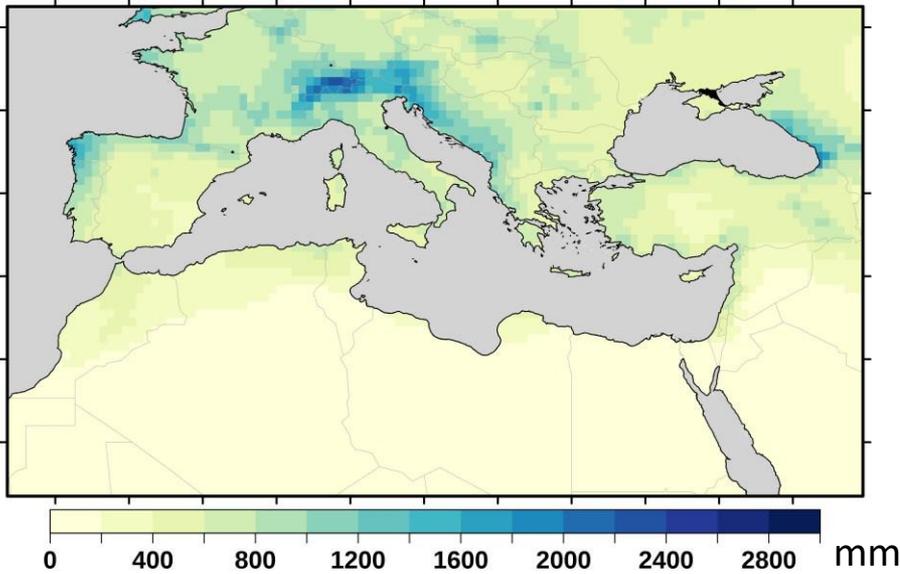


Mean monthly temperature S.E. Mediterranean (land only)



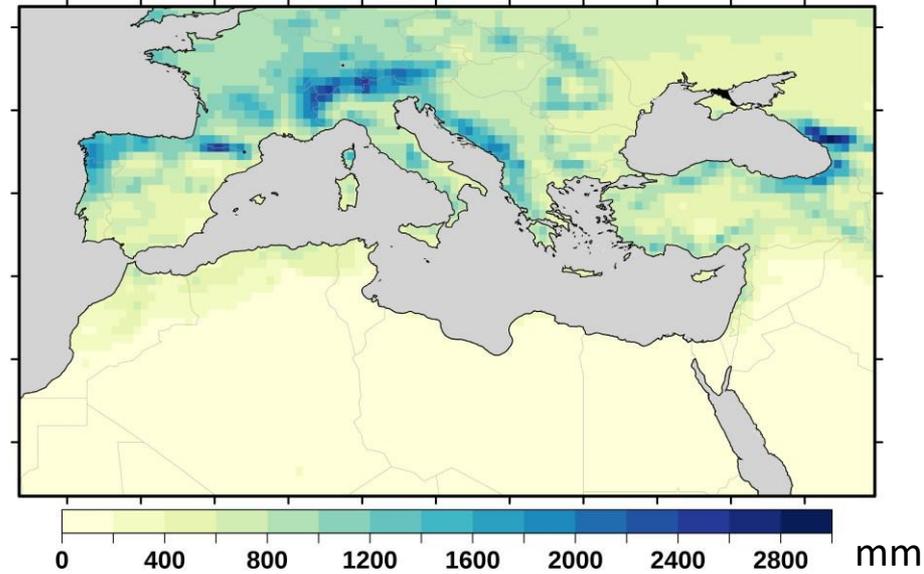
Historical simulations (Precipitation)

PRECIPITATION / CRU / 1986-2005



OBSERVATIONS

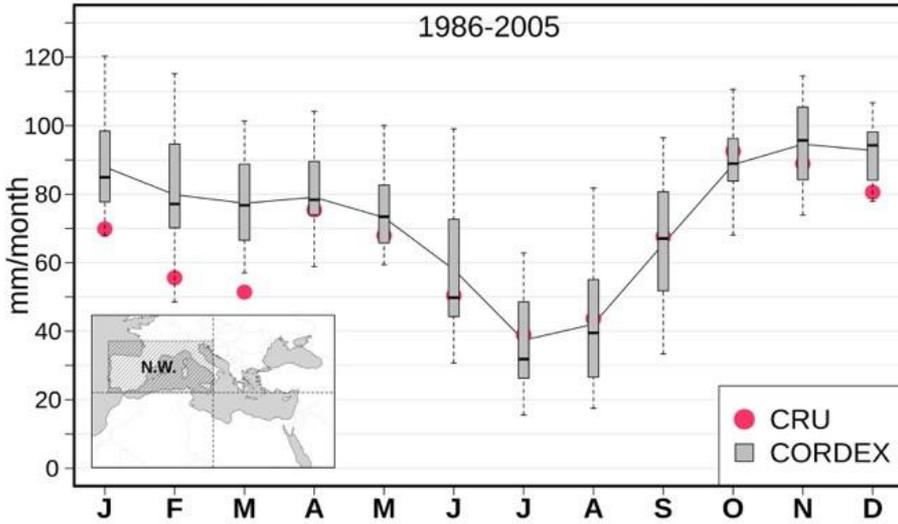
PRECIPITATION / CORDEX ENS. / 1986-2005



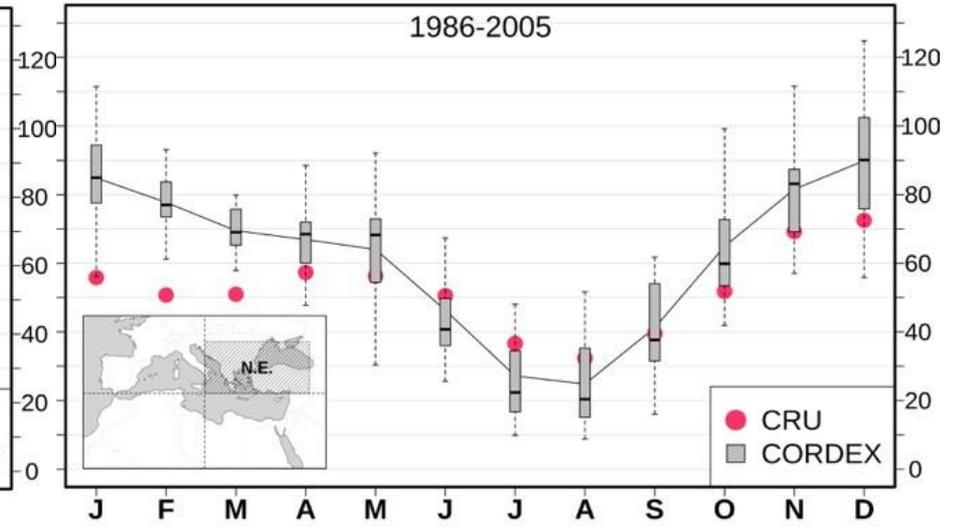
MODEL ENS. MEAN

Historical simulations (Precipitation)

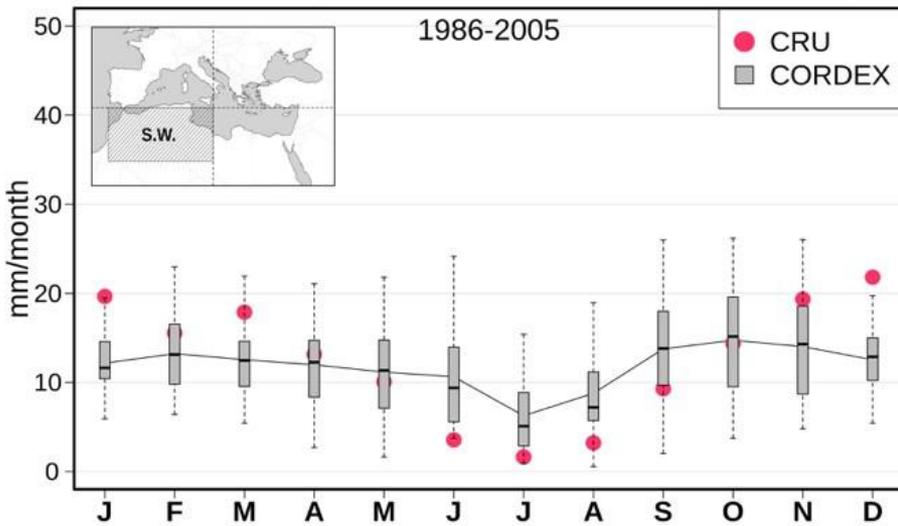
Monthly precipitation N.W. Mediterranean (land only)



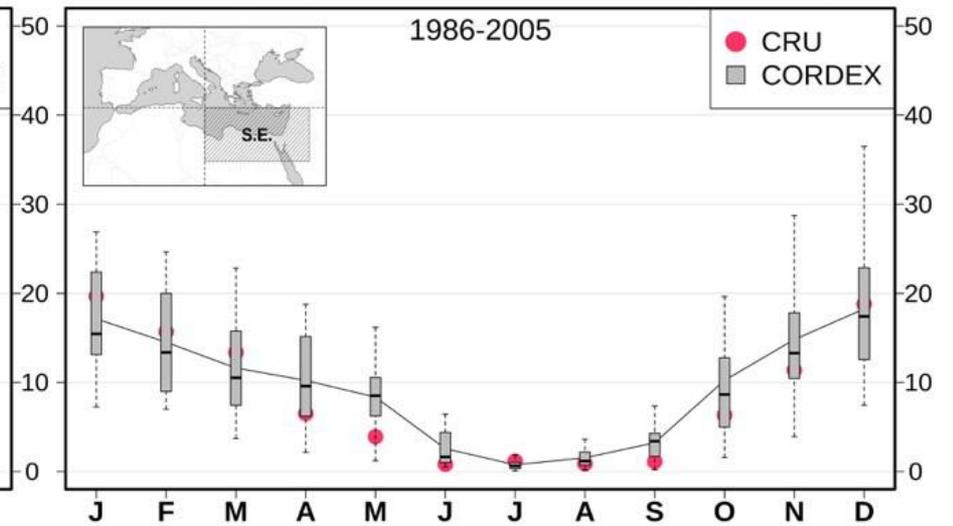
Monthly precipitation N.E. Mediterranean (land only)



Monthly precipitation S.W. Mediterranean (land only)



Monthly precipitation S.E. Mediterranean (land only)



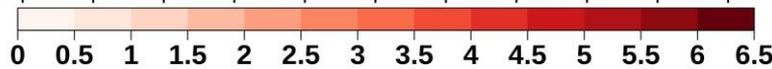
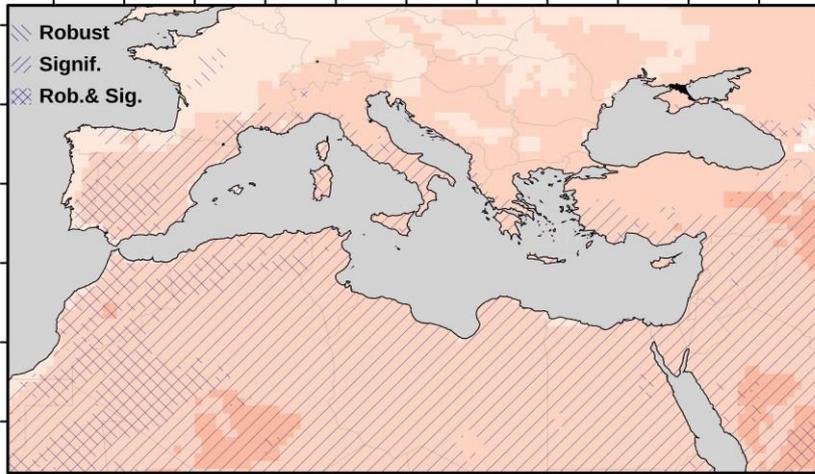
Temperature changes (relative to 1986-2005)

RCP2.6

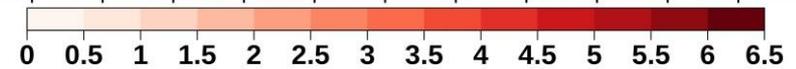
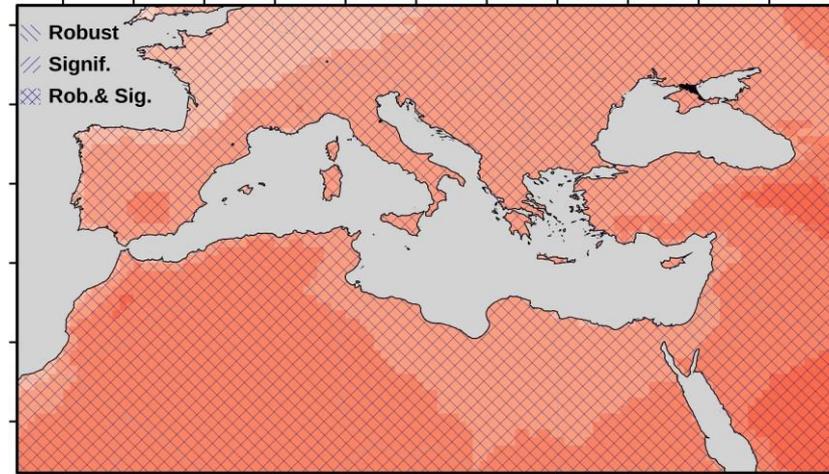
RCP8.5

MID
21st

2-M TEMPERATURE CHANGE MID-CTL (RCP2.6)

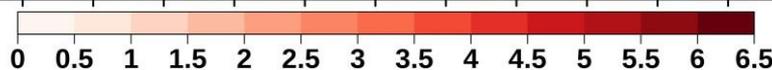
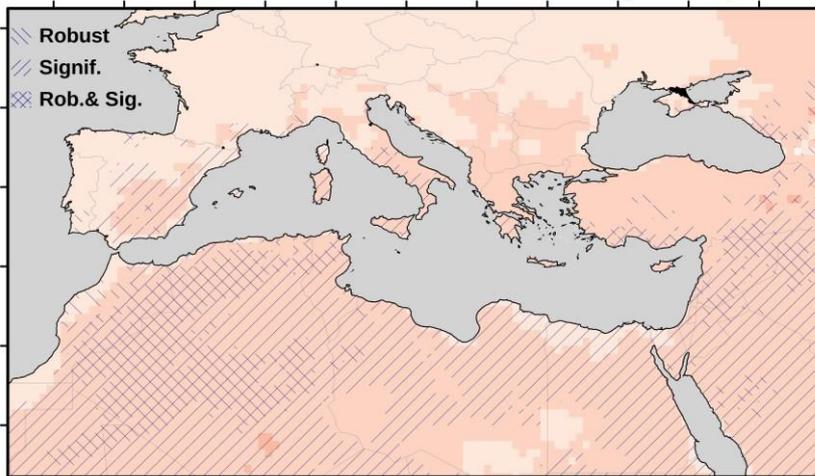


2-M TEMPERATURE CHANGE MID-CTL (RCP8.5)

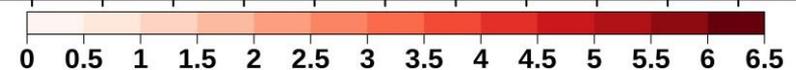
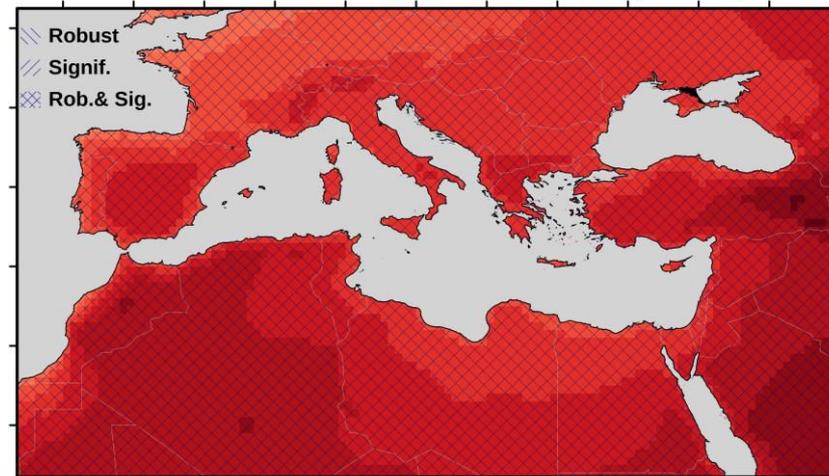


END
21st

2-M TEMPERATURE CHANGE END-CTL (RCP2.6)

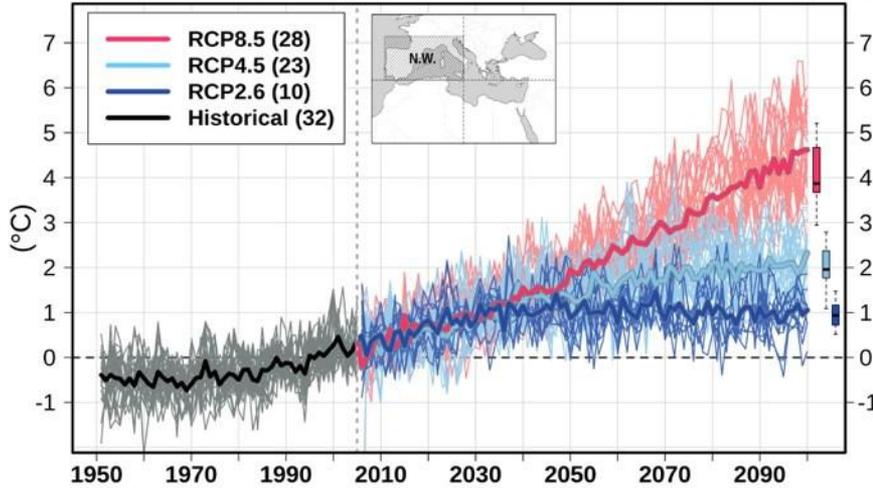


2-M TEMPERATURE CHANGE END-CTL (RCP8.5)

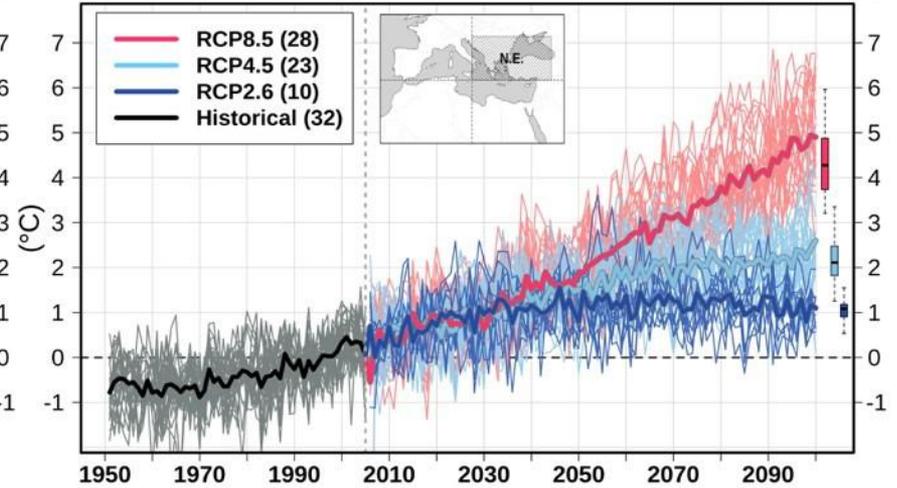


Temperature changes (relative to 1986-2005)

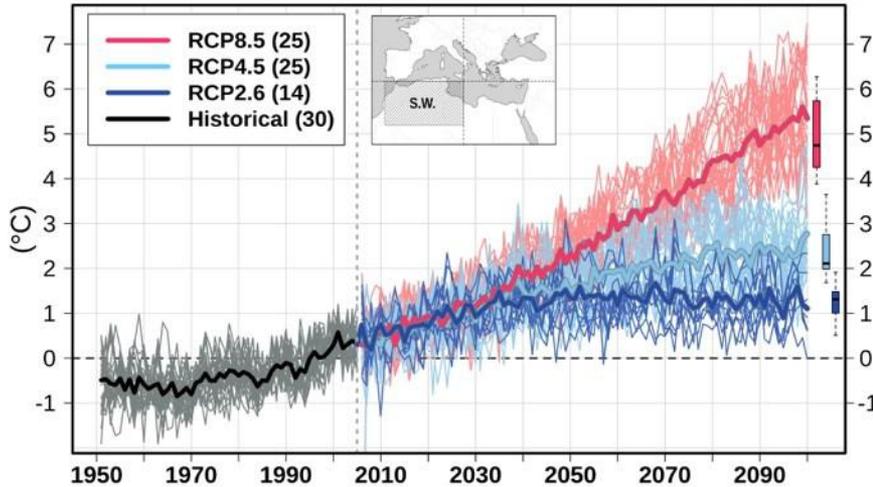
Mean annual temperature change N.W. Mediterranean (land only)



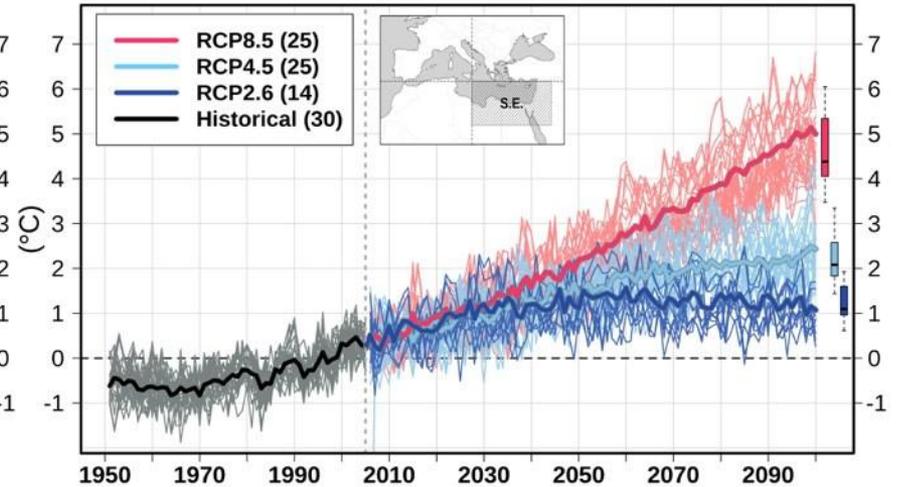
Mean annual temperature change N.E. Mediterranean (land only)



Mean annual temperature change S.W. Mediterranean (land only)



Mean annual temperature change S.E. Mediterranean (land only)



- Stronger warming projected for the southern Mediterranean

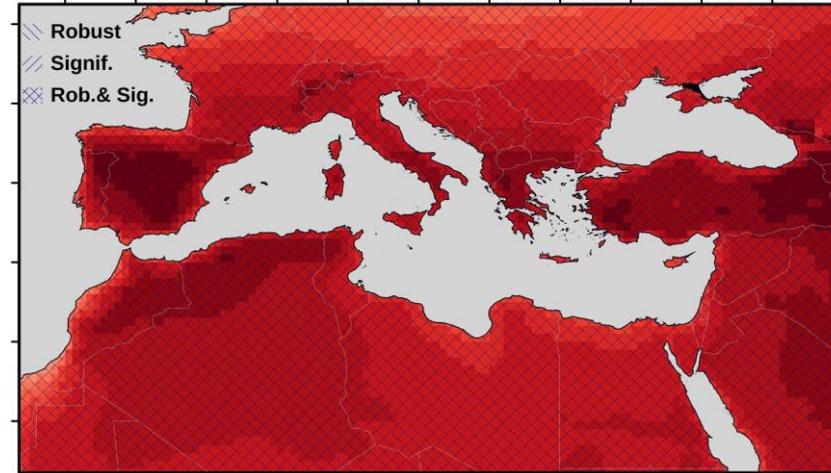
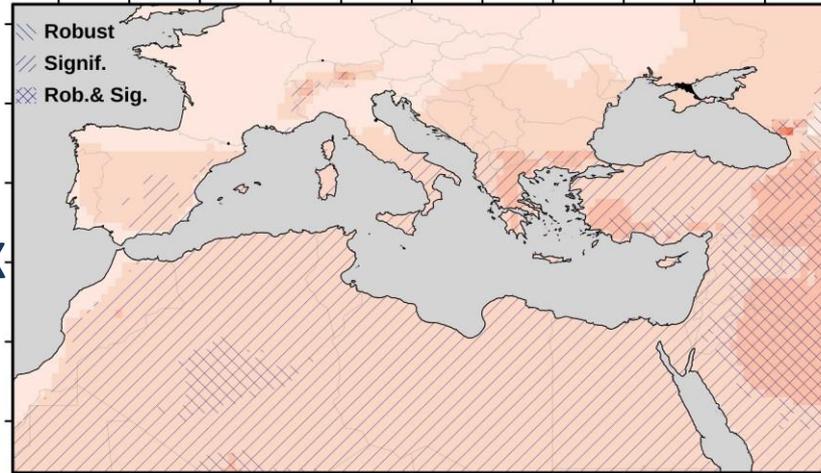
Seasonal temperature changes (relative to 1986-2005)

RCP2.6

RCP8.5

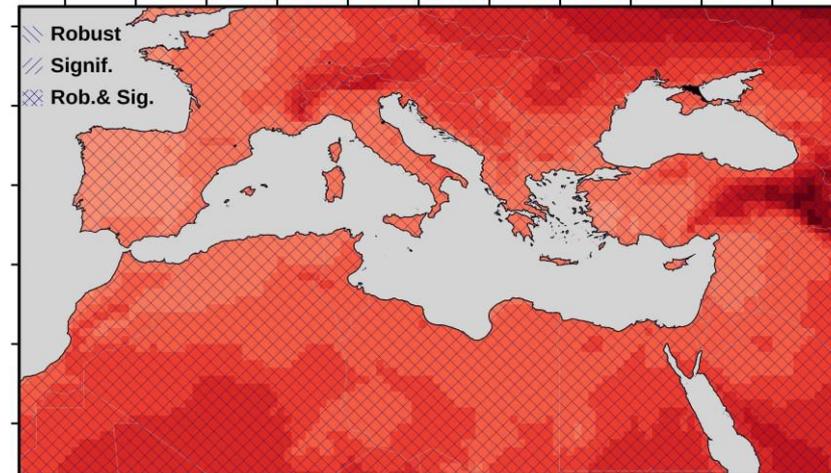
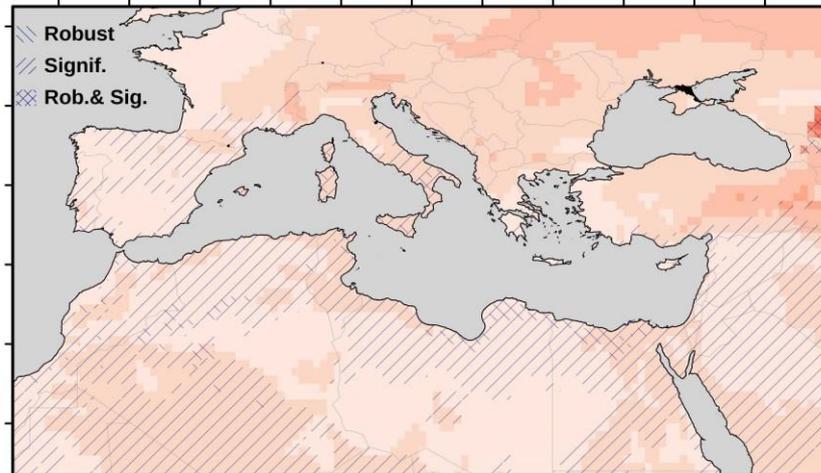
JJA MAX. 2-M TEMPERATURE CHANGE END-CTL (RCP2.6)

JJA MAX. 2-M TEMPERATURE CHANGE END-CTL (RCP8.5)



DJF MIN. 2-M TEMPERATURE CHANGE END-CTL (RCP2.6)

DJF MIN. 2-M TEMPERATURE CHANGE END-CTL (RCP8.5)



JJA
TASMAX

DJF
TASMIN

Precipitation changes (relative to 1986-2005)

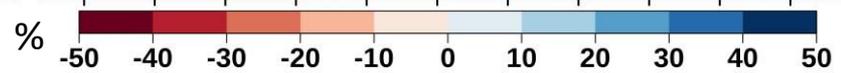
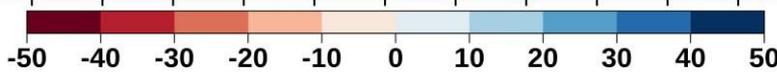
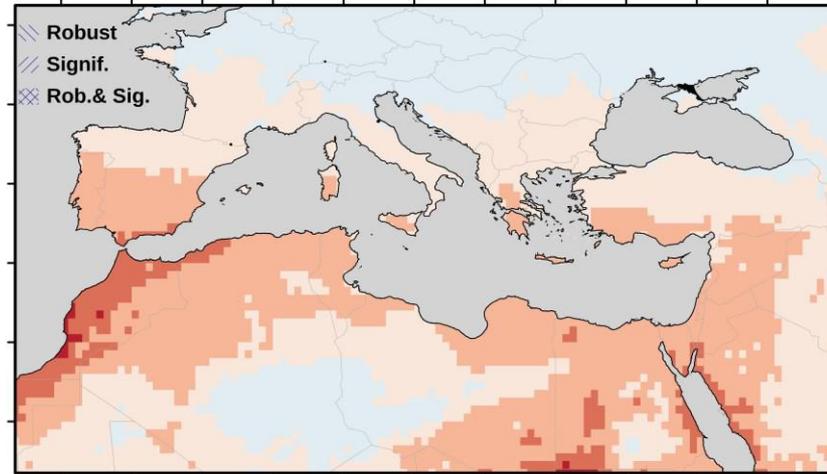
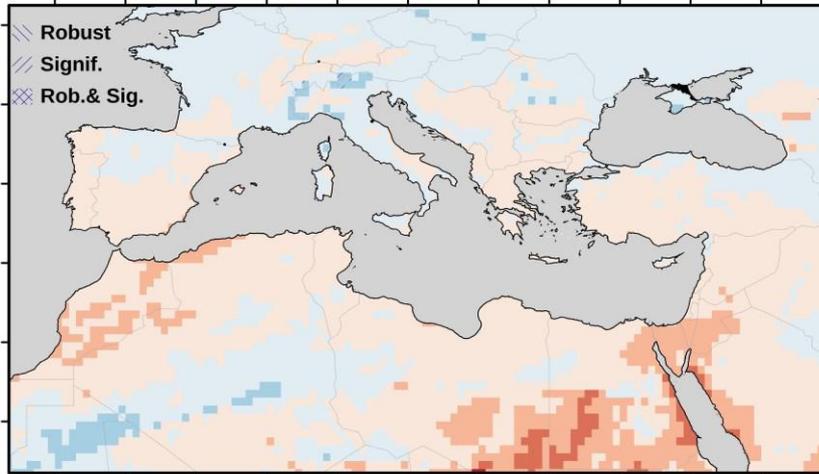
RCP2.6

RCP8.5

**MID
21st**

PRECIPITATION CHANGE MID-CTL (RCP2.6)

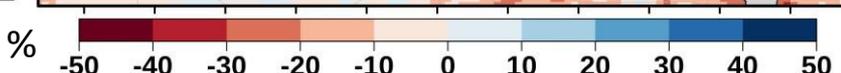
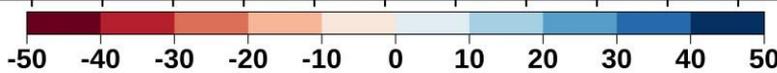
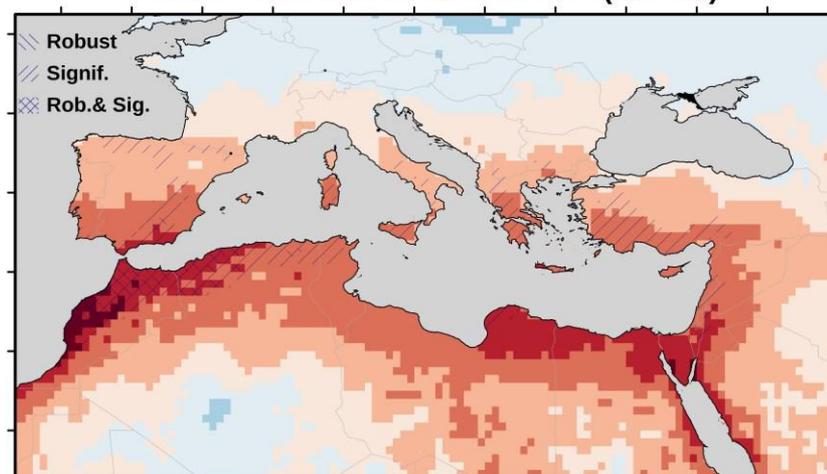
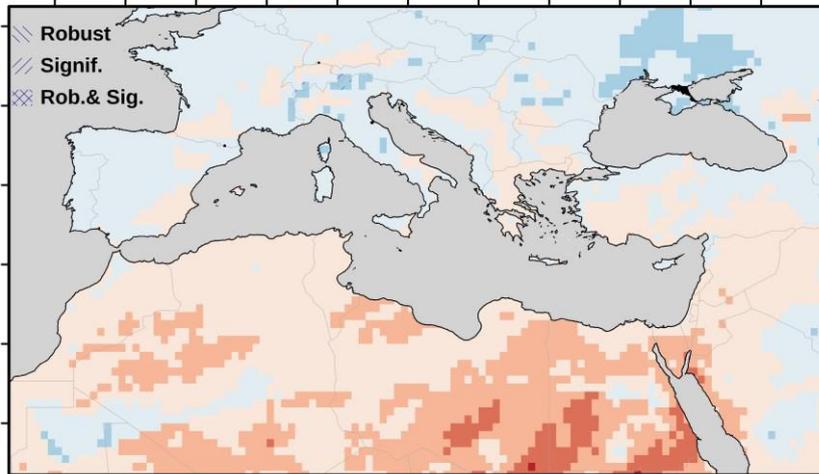
PRECIPITATION CHANGE MID-CTL (RCP8.5)



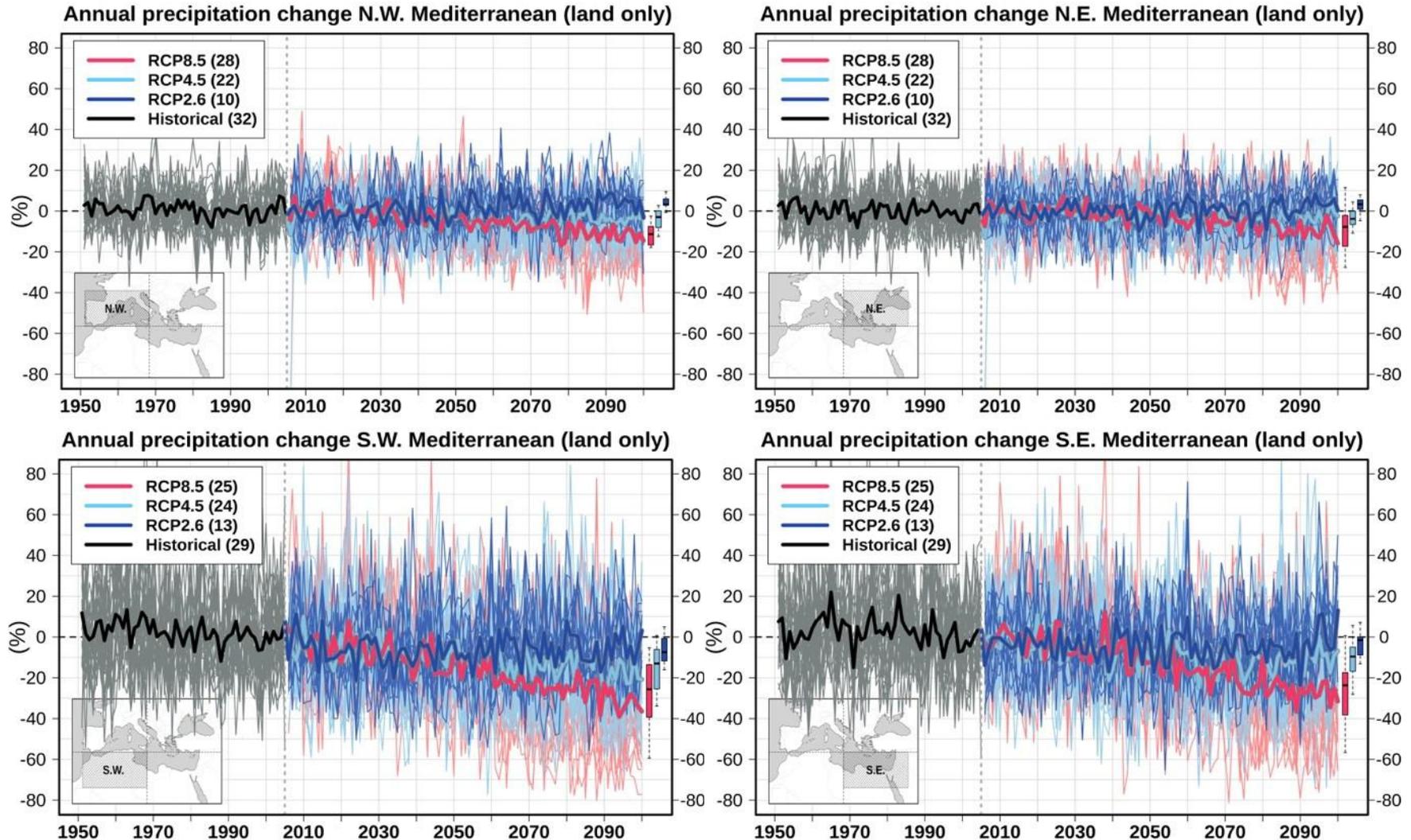
**END
21st**

PRECIPITATION CHANGE END-CTL (RCP2.6)

PRECIPITATION CHANGE END-CTL (RCP8.5)



Precipitation changes (relative to 1986-2005)



- Larger interannual variability and model spread for S. Med.
- Larger decreases projected for S. Med. (even under RCP2.6)

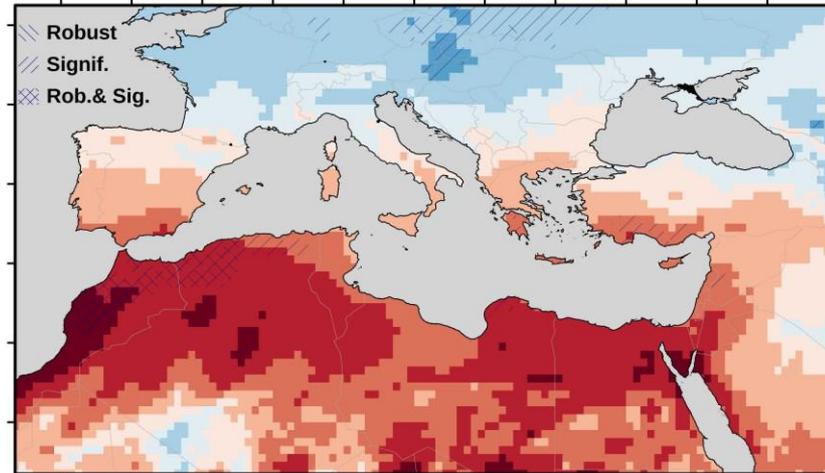
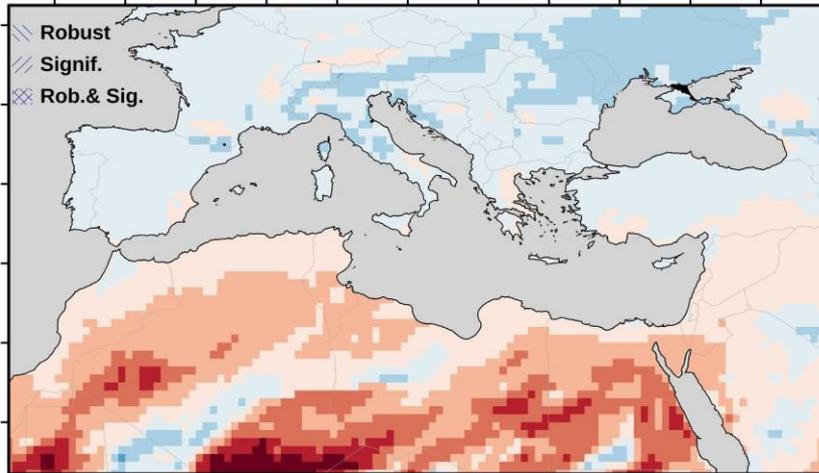
Seasonal precipitation changes (relative to 1986-2005)

RCP2.6

RCP8.5

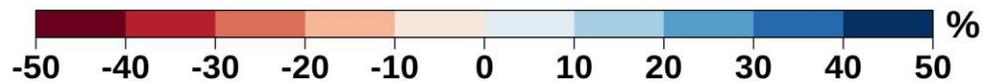
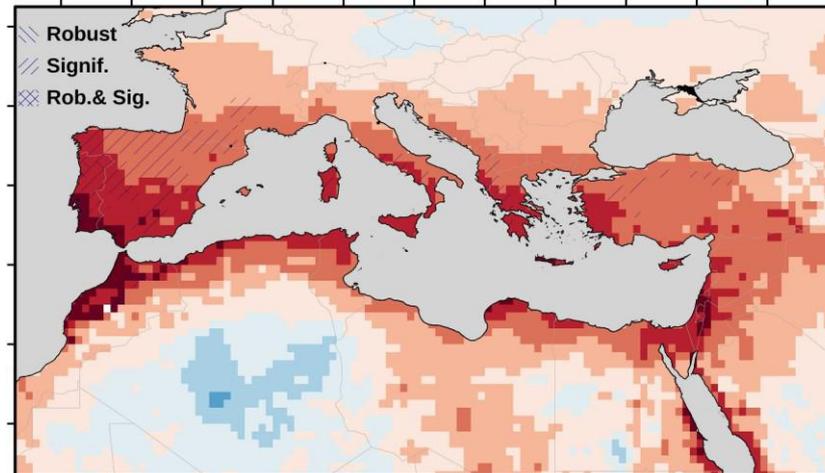
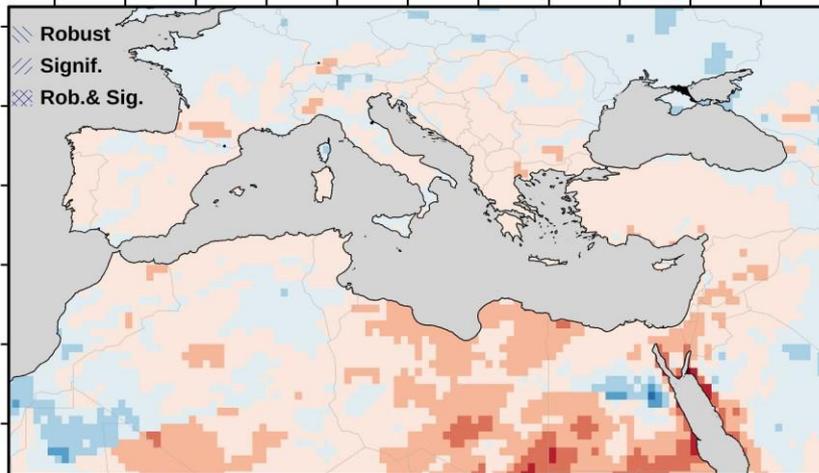
WET SEASON PRECIPITATION CHANGE END-CTL (RCP2.6)

WET SEASON PRECIPITATION CHANGE END-CTL (RCP8.5)



DRY SEASON PRECIPITATION CHANGE END-CTL (RCP2.6)

DRY SEASON PRECIPITATION CHANGE END-CTL (RCP8.5)



PR WET SEASON

PR DRY SEASON

Summary

- Projected warming (from 1986-2005) ranges from 1-5°C for annual temperature.
- The warming is robust/significant (esp. for RCP4.5 & RCP8.5).
- South Med. temperature is projected to increase more.
- Summer warming will likely be much stronger than winter warming.
- Precipitation changes are less robust/significant, however most of the simulations suggest a drying.
- For north (south) Med. precipitation decrease is projected higher for the dry (wet) season.

Acknowledgments



All data providers and groups that performed simulations for the CORDEX initiative and publicly shared their data (EURO-CORDEX, MED-CORDEX, CORDEX-AFRICA and MENA-CORDEX communities).



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Thank you for your attention!