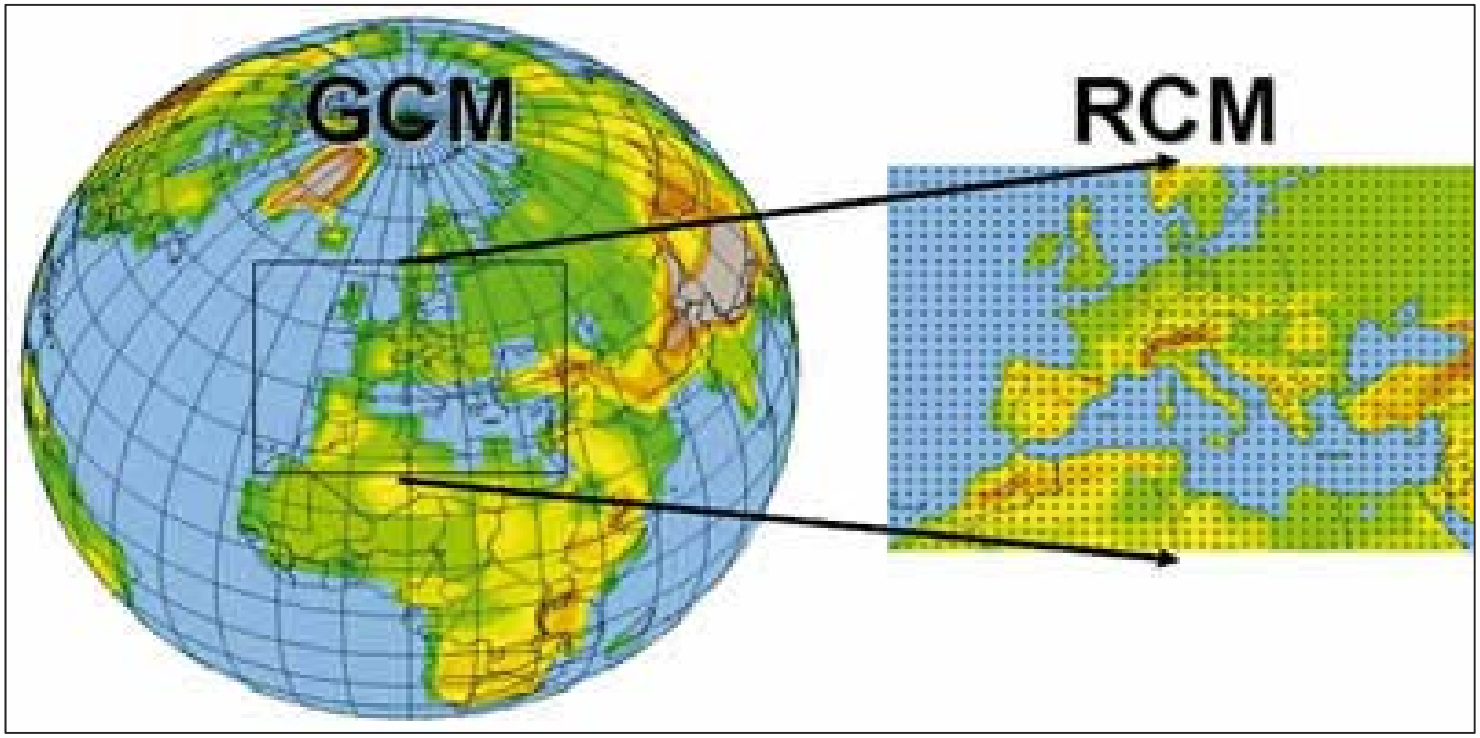
Projection of climate change in Cyprus using a selection of regional climate models

C. Giannakopoulos, G. Lemesios, M. Petrakis, Th. Kopania, N. Roukounakis

National Observatory of Athens, Athens, Greece

Global and Regional Climate Models

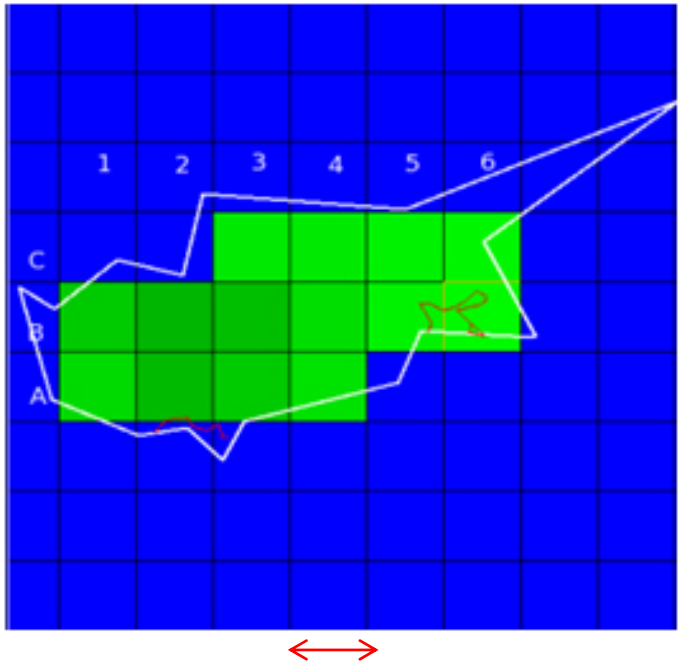


Regional Climate Models

• Regional climate models add further detail to global climate analyses or simulations and study climate processes in more detail than global models allow.

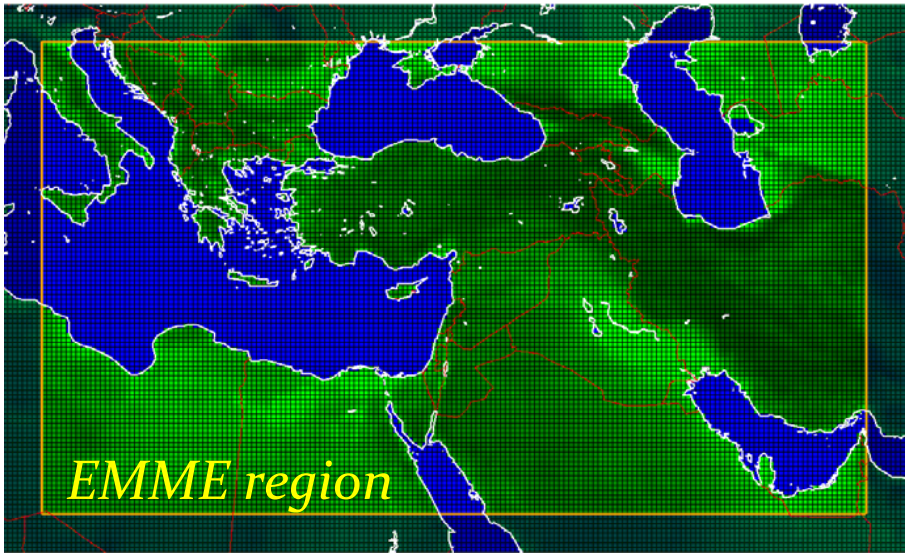
•They are the best available tools so far to study regional or local climate change, as is the case of the island of Cyprus.

•Their typical horizontal resolution is 25kmx25km



Regional Climate Model used

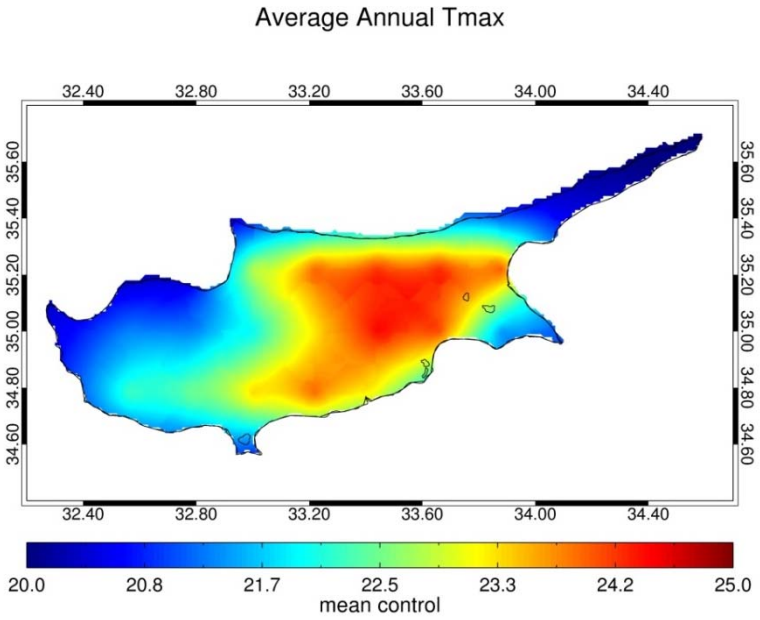
The main model used in our climate projections is the **PRECIS** regional climate model; the domain of the PRECIS runs covers the East Mediterranean and Middle East. Cyprus lies in the centre of this domain. PRECIS is run by the Cyprus Institute.



Regional climate model data

- The daily projections used in the present study, are derived from the PRECIS regional climate model (RCM).
- Region of interest is the island of Cyprus in the East Mediterranean.
- Horizontal resolution of 25km and 19 vertical levels, employing the IPCC SRES A1B emissions scenario (intermediate emissions scenario).
- The control run represents the base period 1961-1990 and is used as reference for comparison with future projections of 2021-2050.

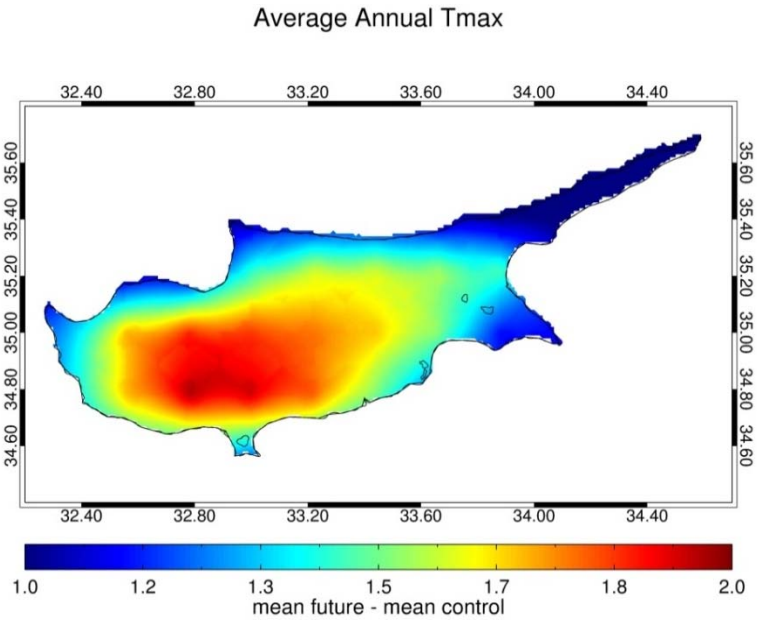
Mean Annual Maximum temperature 1961-1990



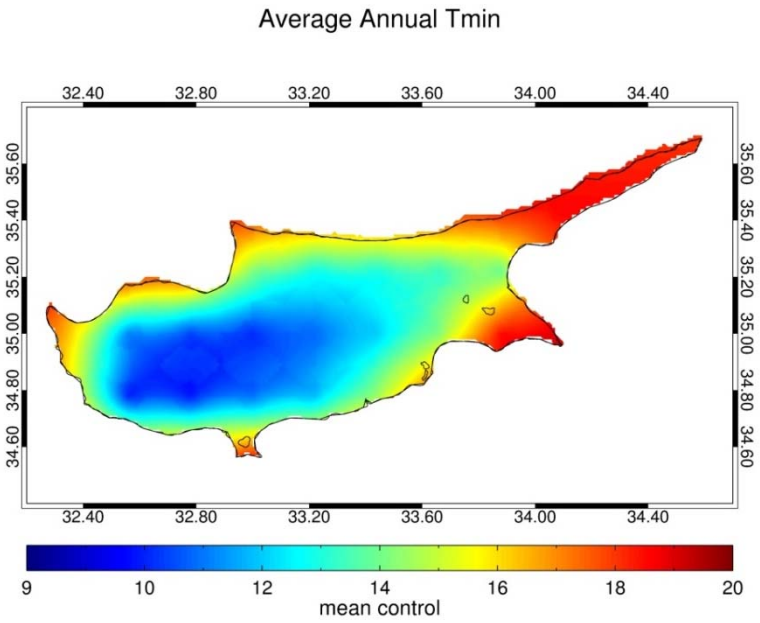
the average annual maximum temperature (TX) ranges from about 20-21C in higher elevation/coastal areas to about 25C in lowland and continental areas

Differences in mean annual maximum temperature: future (2021-2050) - control

Changes in average annual maximum temperature range from 1.0C at the eastern and northern coasts to 2.0C in higher elevation and continental areas



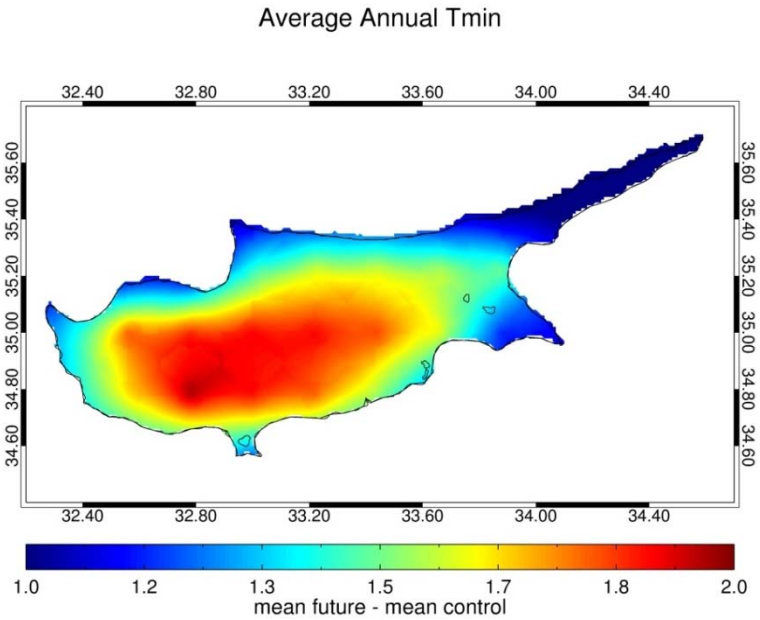
Mean Annual Minimum temperature 1961-1990



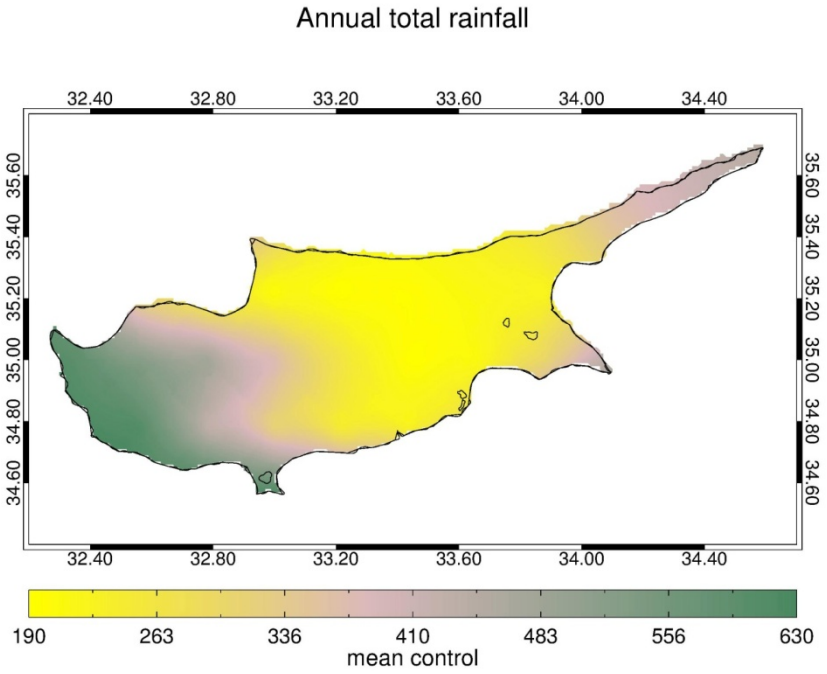
The average annual minimum temperature ranges from about 10C in higher elevation areas to about 20C in coastal areas

Differences in mean annual minimum temperature: future (2021-2050) - control

Changes in average annual maximum temperature range from 1.0C at the eastern and northern coasts to 2.0C in higher elevation areas

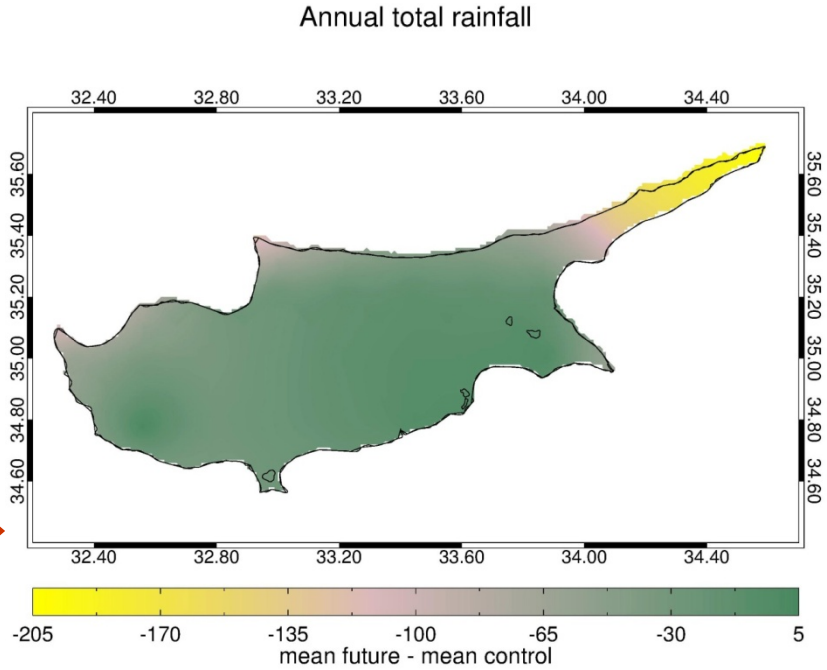


Total Annual Precipitation 1961-1990



The maximum precipitation falls over western coastal areas and higher elevation areas.

Differences in Total Annual Precipitation : future (2021-2050) - control



All northern coasts, especially Karpasia peninsula, are expected to receive less annual total precipitation in the future. Other parts of Cyprus appear to have minor decreases

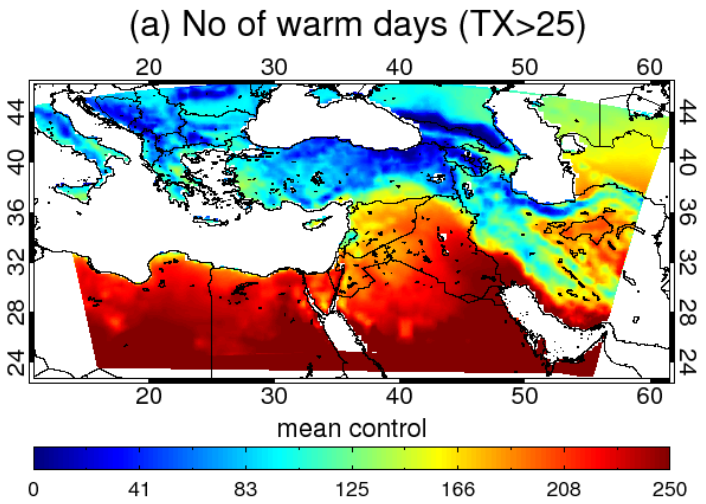
Extreme Climate Events - Indices

We defined the “present-day” period as 1961–1990 and “future” as the time period from 2021–2050 and computed differences in climate indices between these two periods

Index	Definition
warm days	daily maximum temperature is over 25° C
hot days	daily maximum temperature is over 35° C
frost nights	daily minimum temperature is below 0° C
tropical nights	daily minimum temperature is over 20° C
wet days	daily rainfall rate exceeds 1.0 mm
heavy precip. days	daily rainfall rate exceeds 10.0 mm

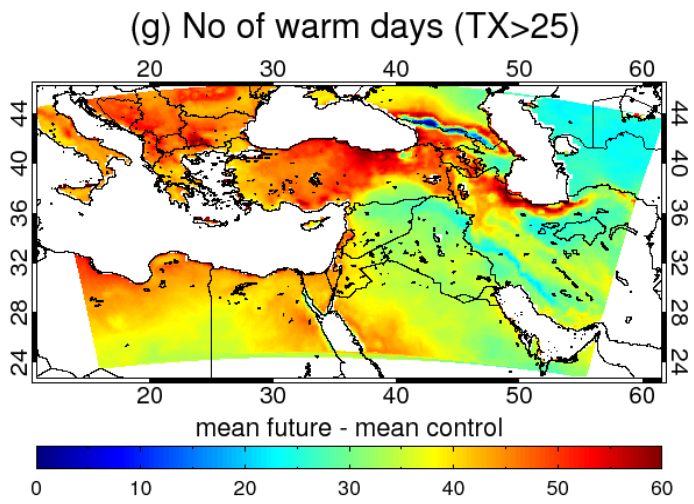
Climate Indices 1961-1990

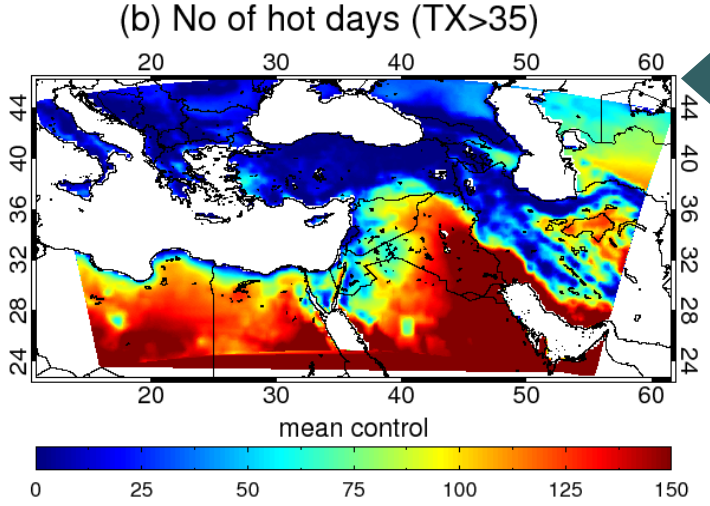
Differences in climate indices: future - control



Annual number of days with TX>25°C ranges from 1 month (in elevated areas) to 3 months in the N-EMME, while in the S-EMME 2/3 of the year can be considered as warm days.

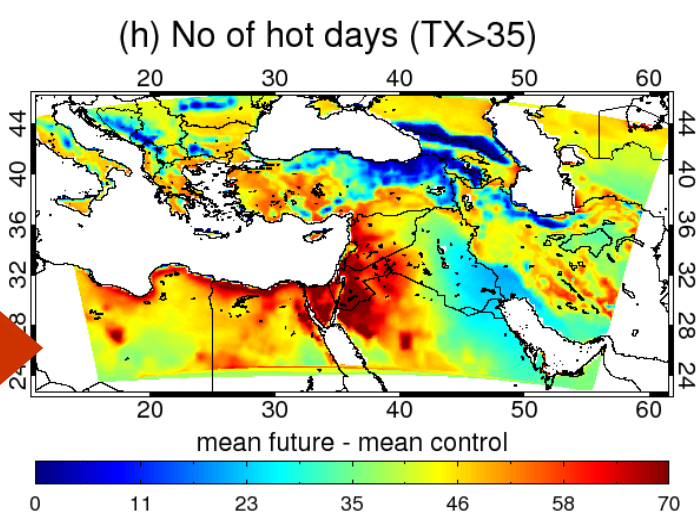
The number of warm days is found to increase in particular in N-EMME by 50-60 additional days/year by the end of the 21st century.



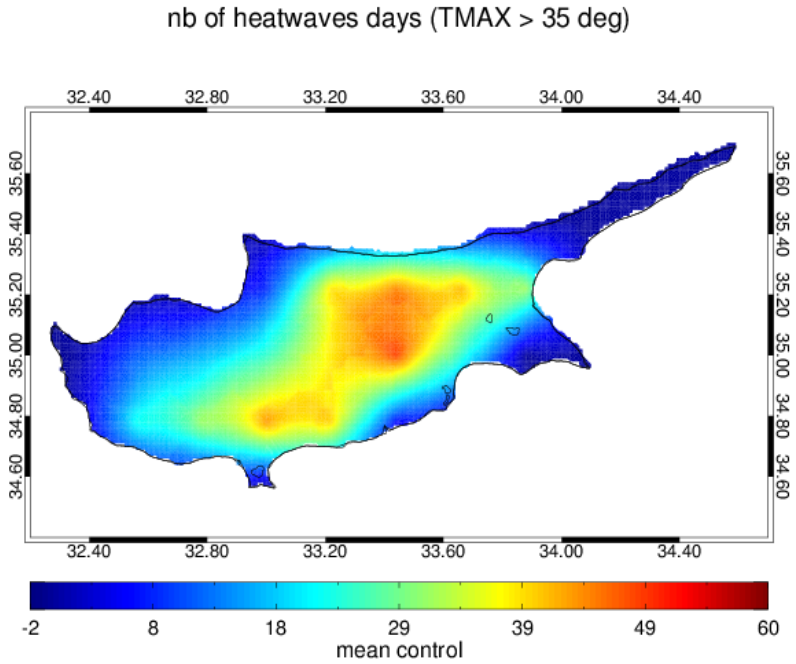


Hot days at a maximum 30-50 days/year in low elevation areas of the N-EMME and less than a month in areas of higher altitudes In the S-EMME, such days are common occurring up to 5 months/year (Gulf region).

Low-elevation and coastal regions in N-EMME are estimated to experience about 1-2 extra months with TX>35°C, while S-EMME are expected to face severe warm conditions with 2 additional months of hot days/year.



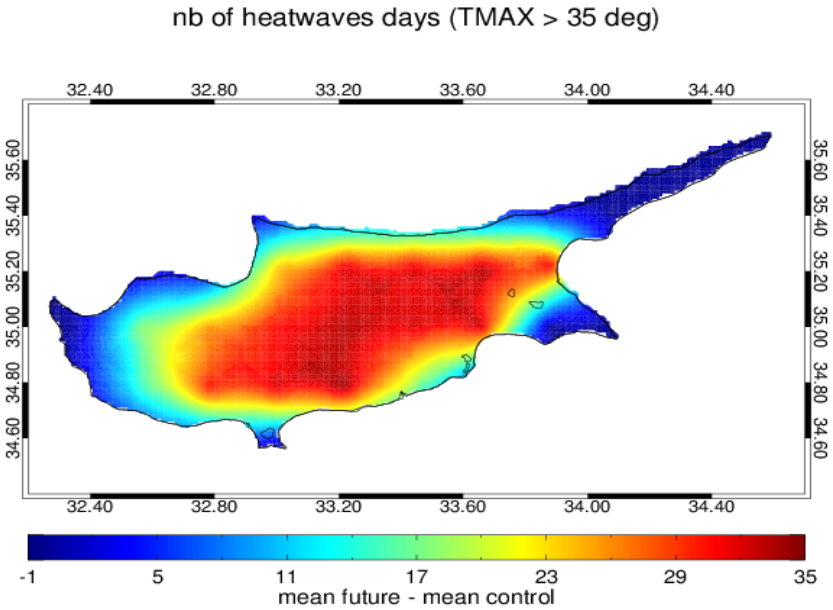
Hot days 1961-1990



Differences in hot days: future (2021-2050) - control

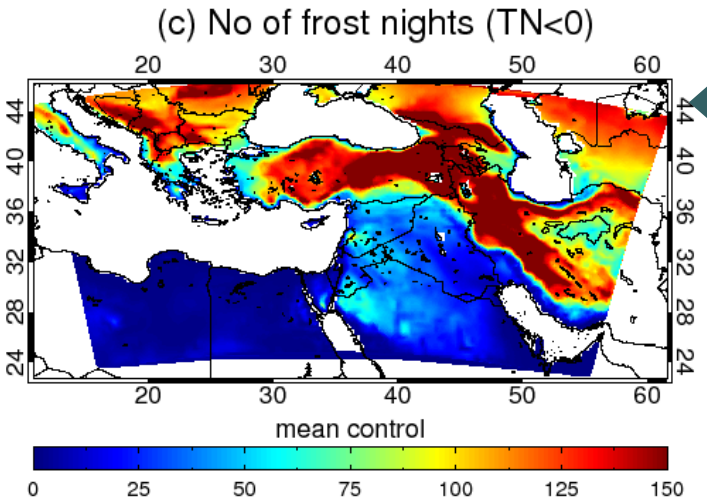
In Cyprus the continental lowlands have close to two months temperatures above 35C. This decreases gradually as we approach the coastline

Low-elevation continental regions in Cyprus are estimated to experience about 1 extra months with TX>35ºC, while coastal regions will see much smaller changes in the near future.



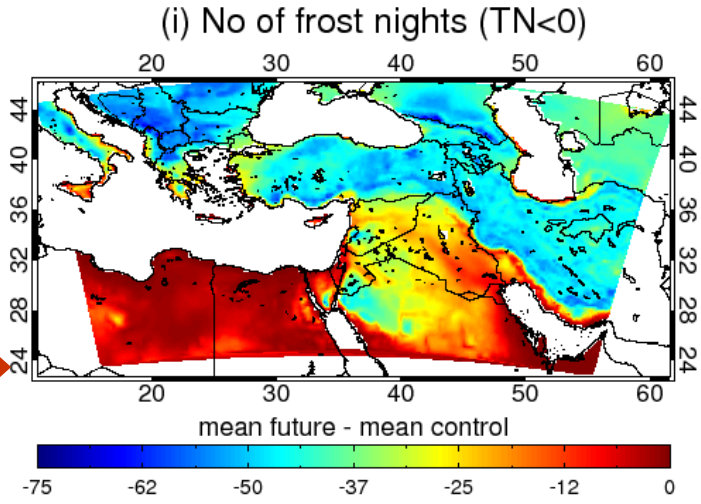
Climate Indices 1961-1990

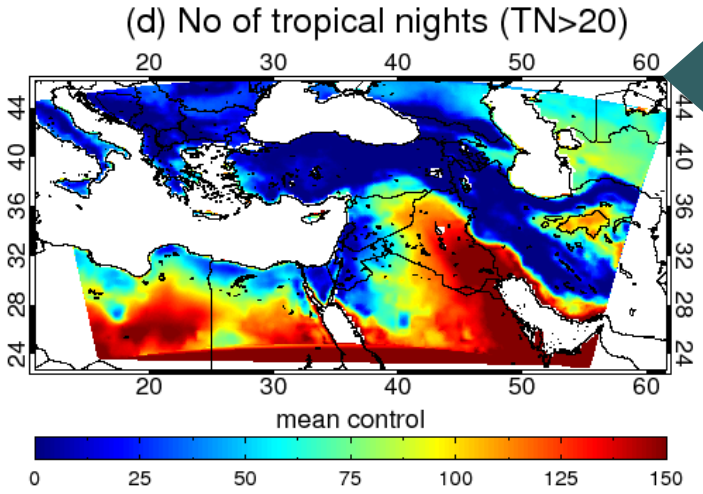
Differences in climate indices: future - control



Continental (above 36°N) and high-altitude areas experience up to 150 frost days/year, while in the south the annual number of frost days does not exceed 20 days/year.

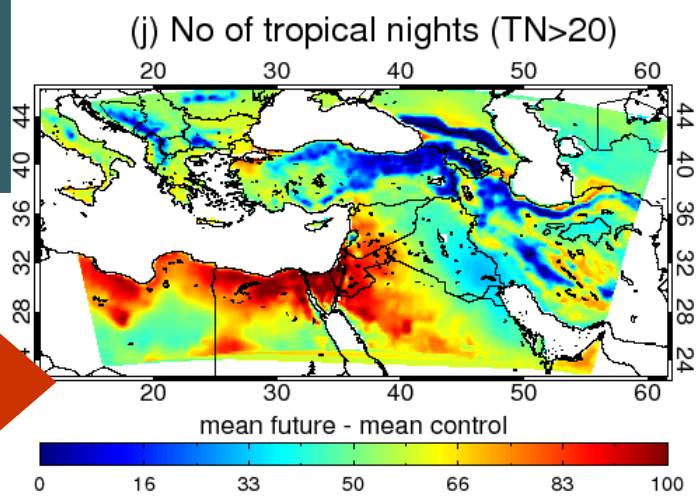
The number of frost days is found to decline within a range of 1-2 months of fewer frost days/year (in high-latitude continental and high-altitude locations).



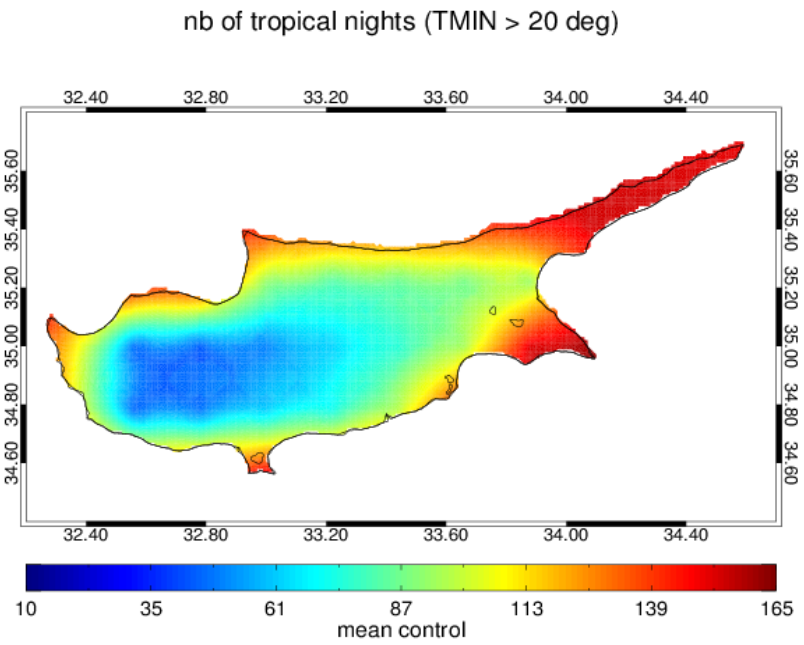


Tropical nights (TN>20°C) are rare (up to 1 month/year) in the northern EMME, whereas in the south occur typically 1-2 months and more than 3 months/year around the Persian Gulf.

The change in the number of tropical nights translates to 1-2 additional months of tropical nights/year in the north and to 3 additional months in the southern EMME by the end of the 21st century.

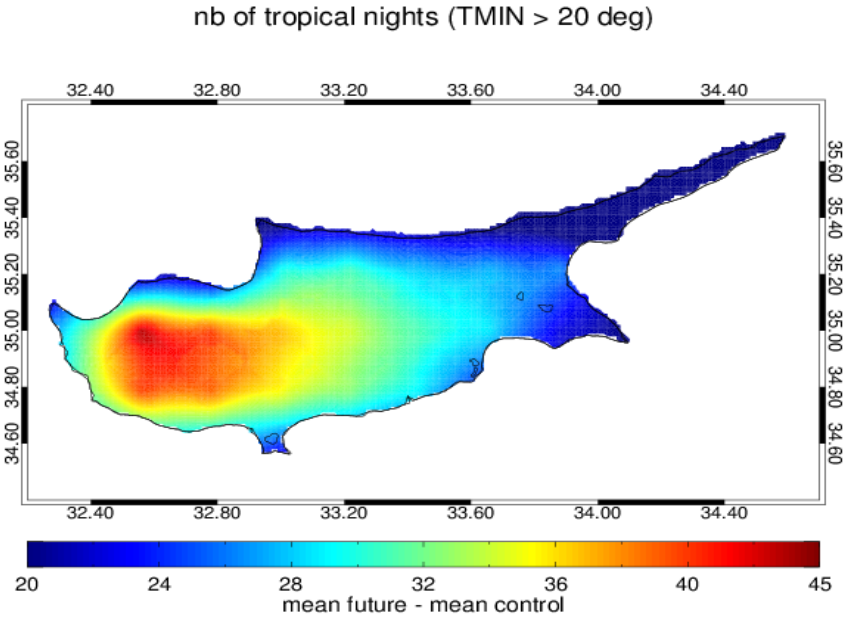


Tropical Nights 1961-1990



In the present climate, coastal regions have more than two months with Tmin>20°C but the higher elevation areas have less than 1 month.

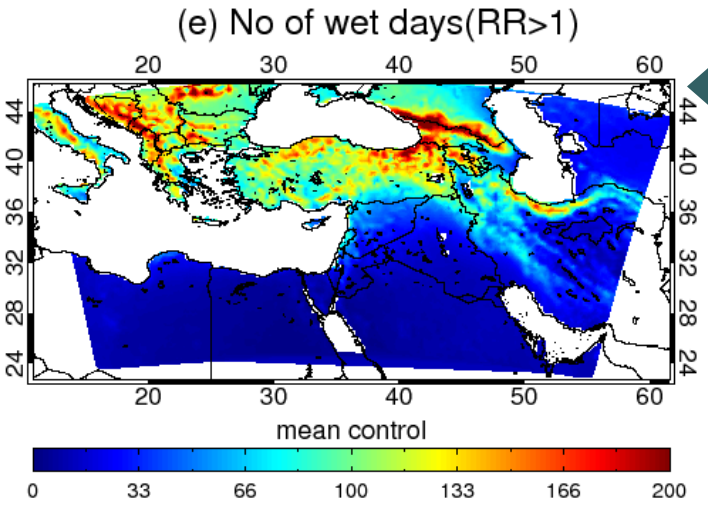
Differences in tropical nights: future (2021-2050) - control



In the near future, the western part and the higher elevation areas will see increases of 1 month while smaller increases will be evident in the rest of the island.

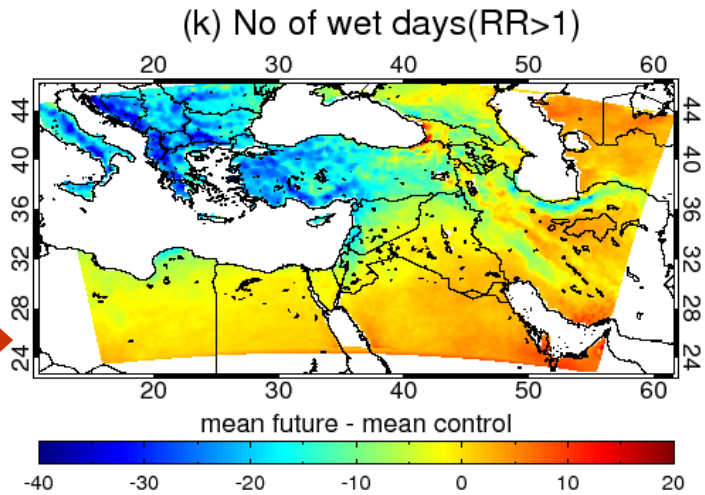
Climate Indices 1961-1990

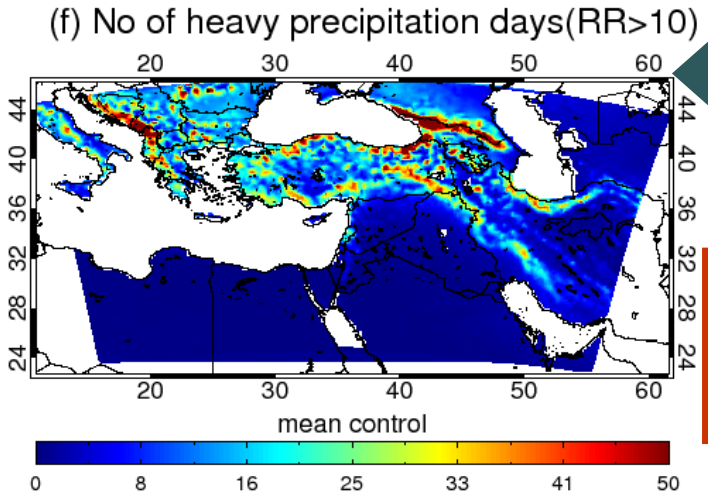
Differences in climate indices: future - control



The number of wet days ranges from 200 days/year in high altitudes and approximately 100 days/year in N-EMME to less than 40 days/year in S-EMME.

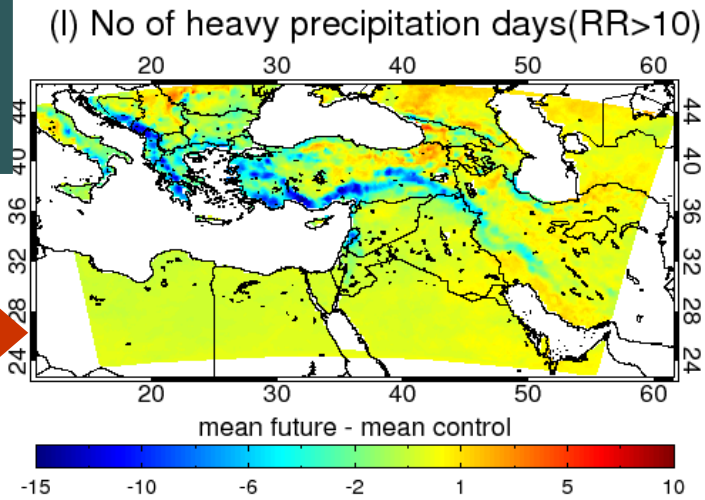
In the N-EMME the number of wet days may decrease by 10-30 days/year.



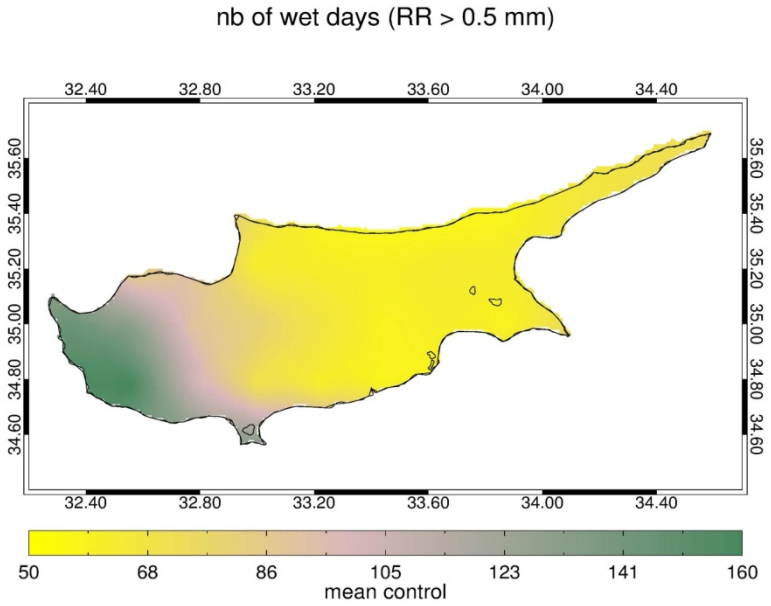


In the W-Balkan Peninsula and other high-elevation areas heavy precipitation occurs maximum 40-50 days/year. Heavy precipitation days are unusual in the S-EMME region.

In N-EMME the number of days with heavy precipitation is likely to decrease in the high-elevation areas by 15 days/year by the end of the 21st century.



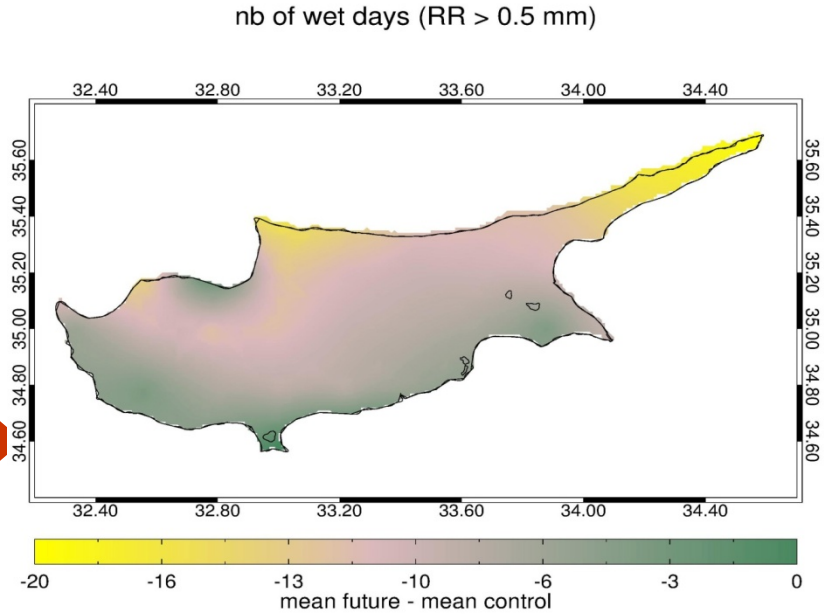
Wet days 1961-1990



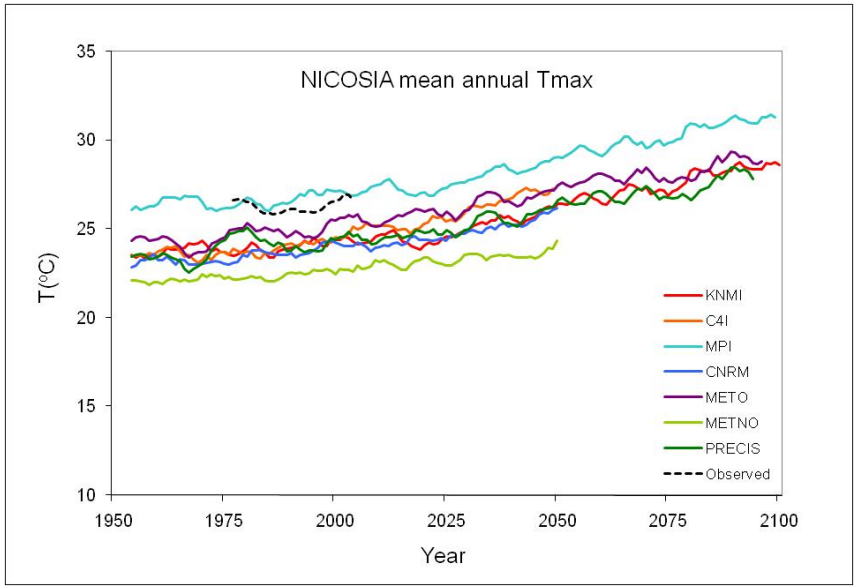
In the present climate, there are more than 5 months of wet days in the western part and higher elevation areas but less than 3 in the eastern part.

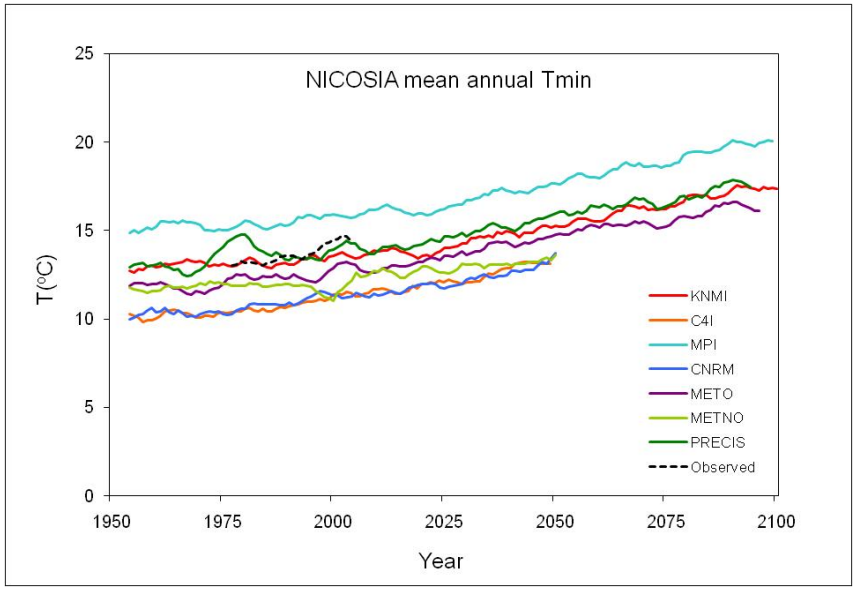
Differences in wet days: future (2021-2050) - control

In the near future , there are greater decreases in the eastern part of the island where we already have drier conditions.



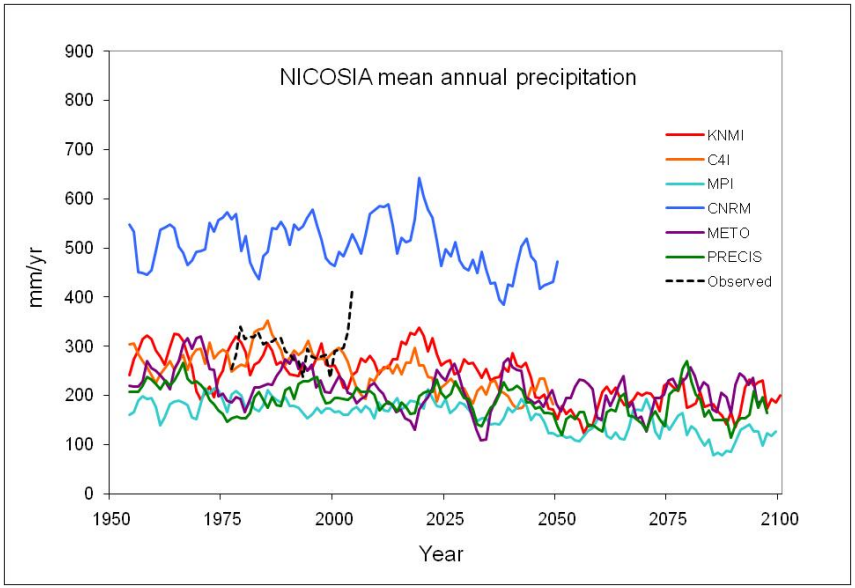
Temperature (Tmax, Tmin) trends

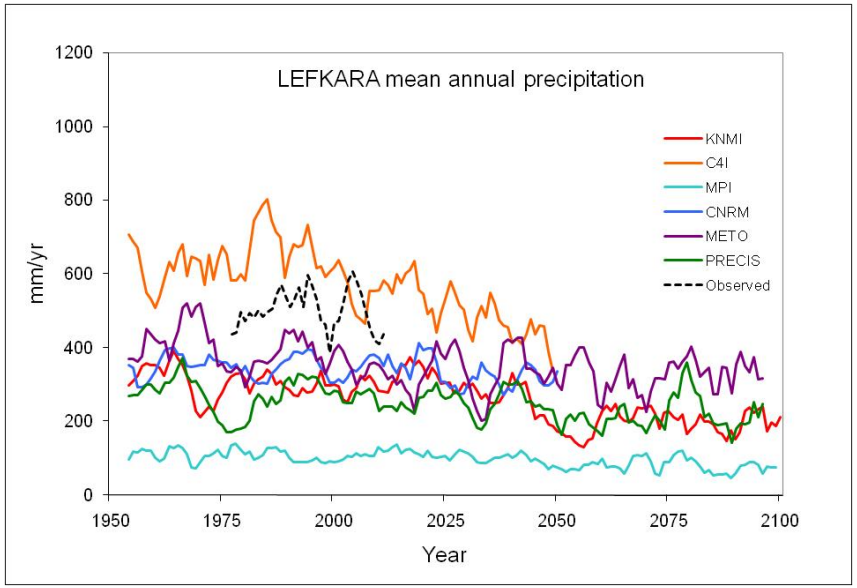




Both Tmax and Tmin show increasing trends (2-4°C increase)by the end of the century for Nicosia with small deviations among models and observations

Precipitation trends





Precipitation show only small decreasing trends in Nicosia but for Lefkara, which is an agricultural site, show more significant precipitation decreases. There are also significant deviations among models and observations showing that the models donot fully succeed to accurately represent the hydrological cycle.

Conclusions

- a continual, gradual and relatively strong warming of about 1 to 2C may occur between the 1961-1990 reference period and the future period 2021–2050, as shown by the annual maximum temperature patterns. Interestingly, in summer the increase of maximum TX will exceed 2.5° C. Hot summer conditions that rarely occurred in the reference period may become the norm by the middle of the 21st century.
- Cyprus projected precipitation changes are quite variable among models. Winter drying will be modest in PRECIS with precipitation decreasing by 15mm or more in higher elevation areas. Throughout the year, Cyprus will be affected by changes in precipitation that may reach 30mm.
- almost one additional month with temperature higher that 35° C is anticipated in the domain of study expect for the coastline where the increase is lower i.e. 5-15 days. The increase in the number of days with TN>25° C (tropical nights) is expected to be approximately 1 month, which is of great since it is highly contribute to the intensification of people discomfort.