Climate change in the Mediterranean area, climate modelling and downscaling

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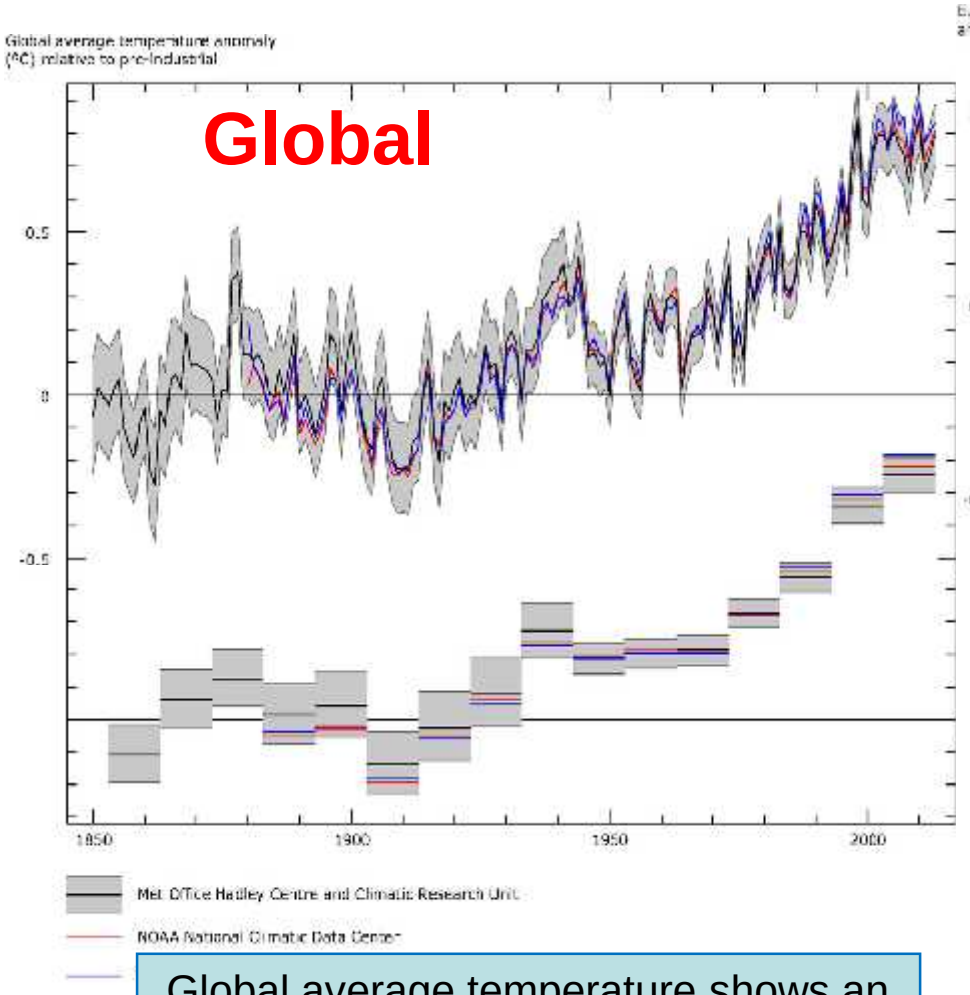
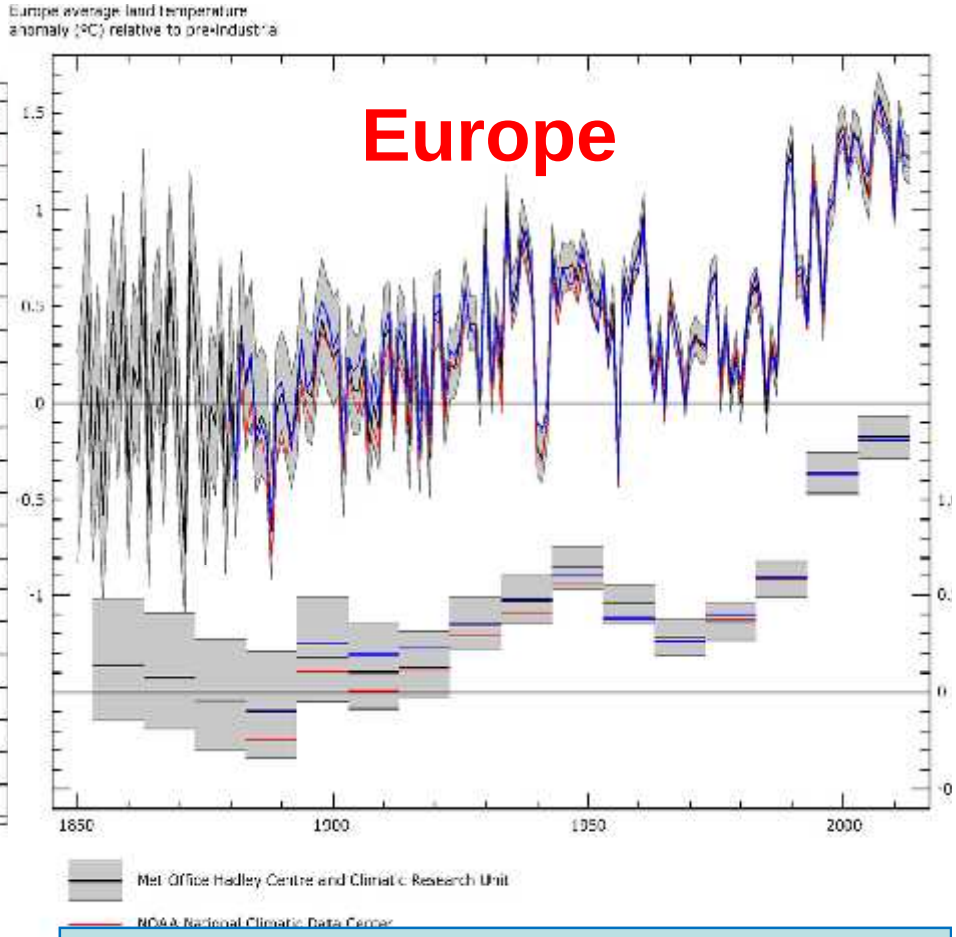
Outline of presentation

- Historical observations of climate trend
- Climate models and simulations of future climate changes
- Projection of climate change for the Mediterranean and North Tunisia

Historical observations of Temperature

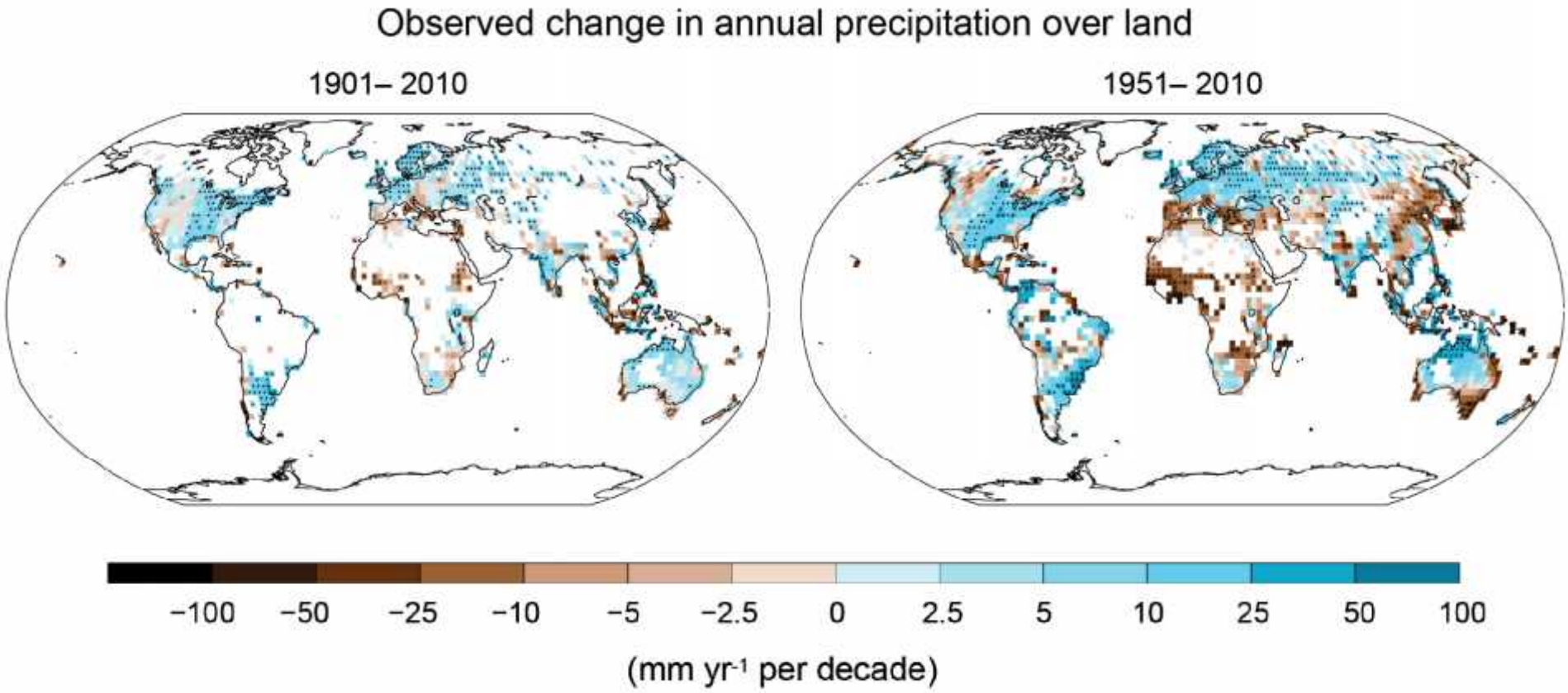


Global average temperature shows an increase equal to 0.85 [0.65-1.06] °C during the period 1880-2012.



The average surface temperature for Euro-Mediterraneum for the last decade (2004-2013) is 1.3 C greater than pre-industrialal level. The warmest recorded decade.

Historical observations of Precipitations

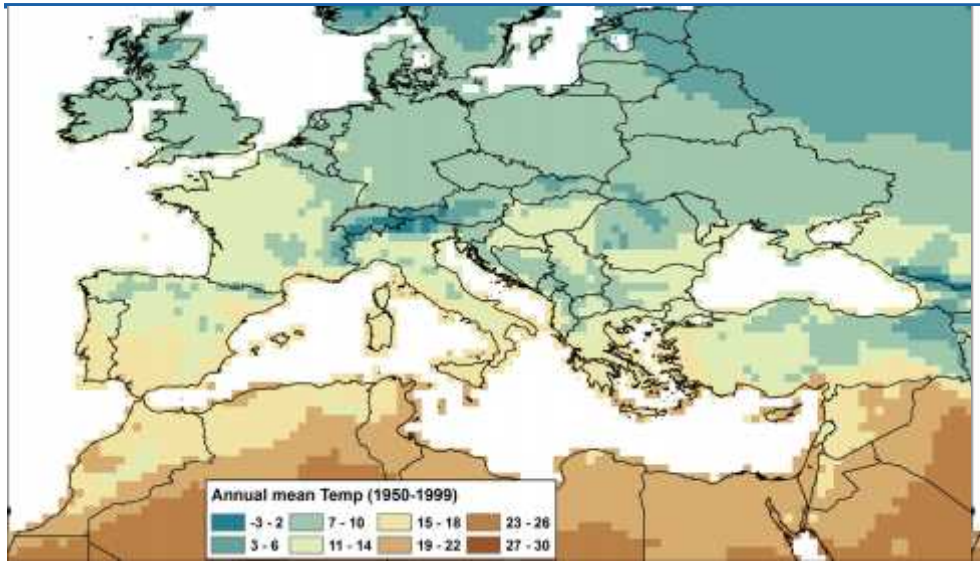


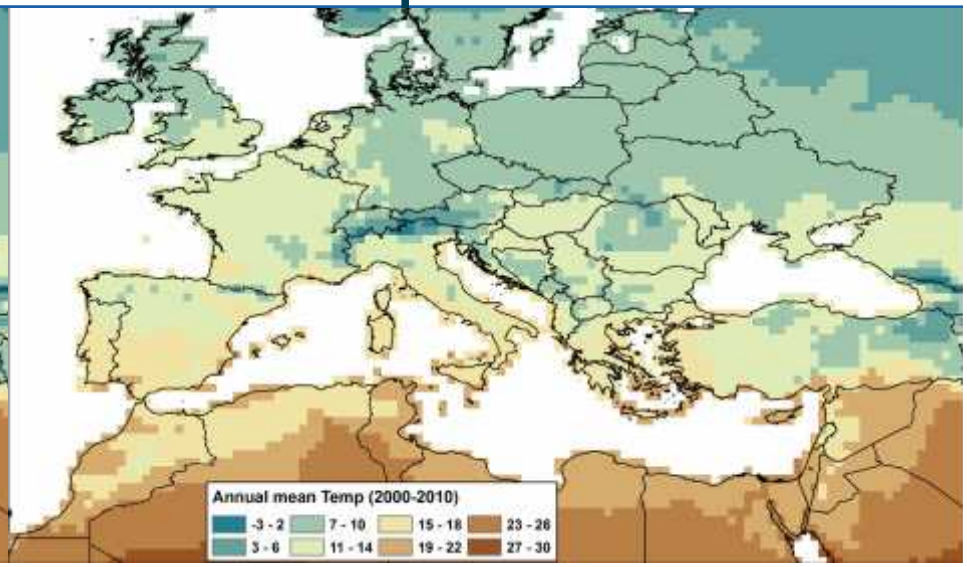
At medium-high latitudes, precipitation increase from 1901
Medium confidence level before 1951, high confidence level after 1951

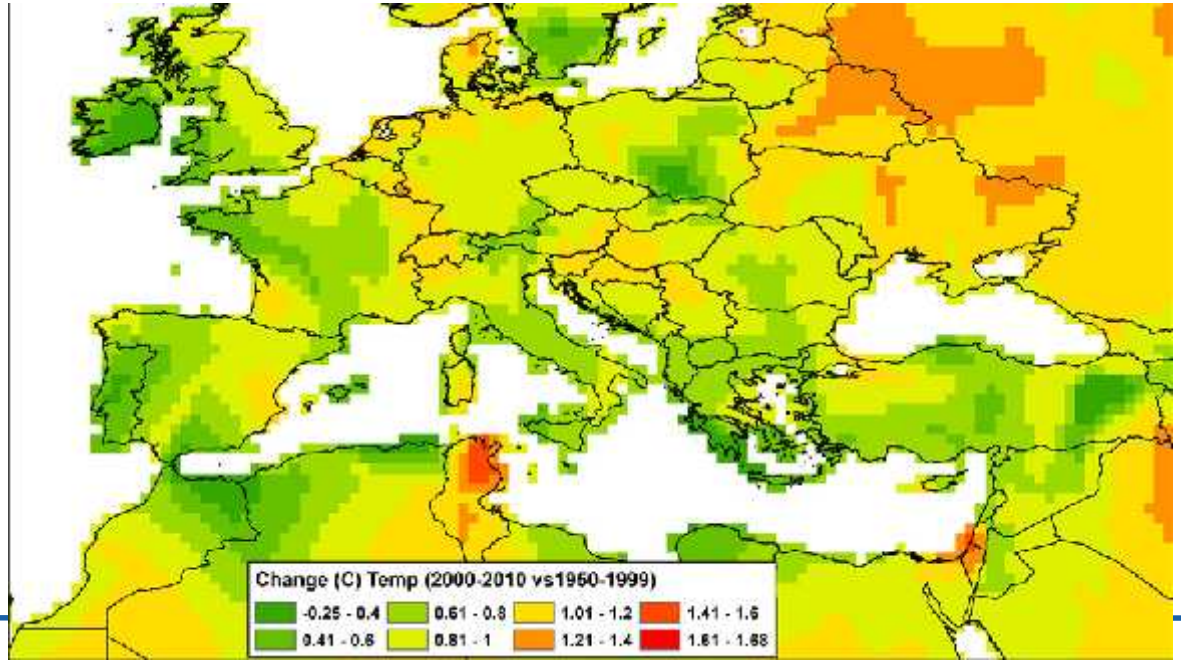
- **Strong precipitation events increased in North America and Europa**
- **Drougth tendency in Sahel, Mediterraneum, Southern Africa and East Asia**

Period 1900-2000:
- **North Europe +10-40%**
- **South Europe up to 20% less precipitation**

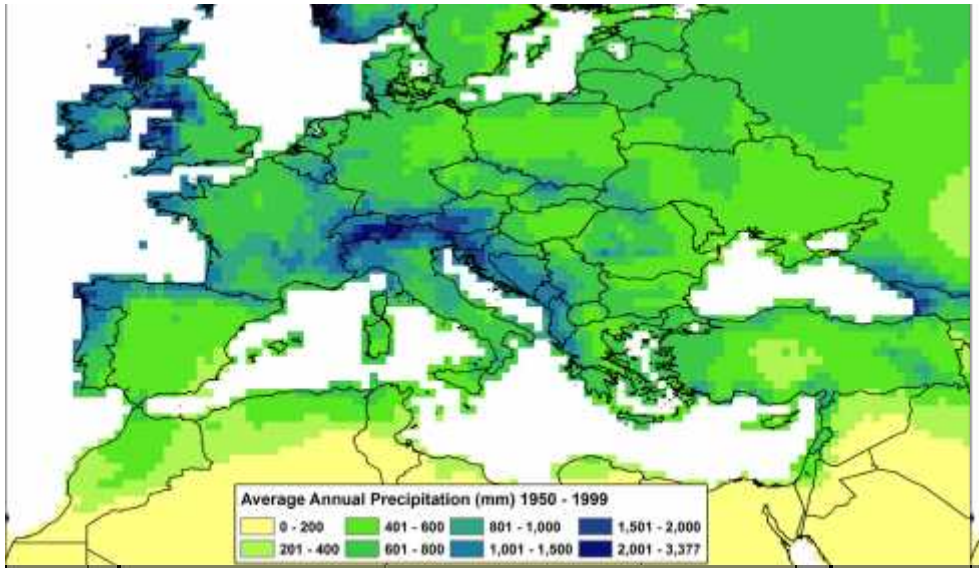
Recent Med climate trend: Temperature

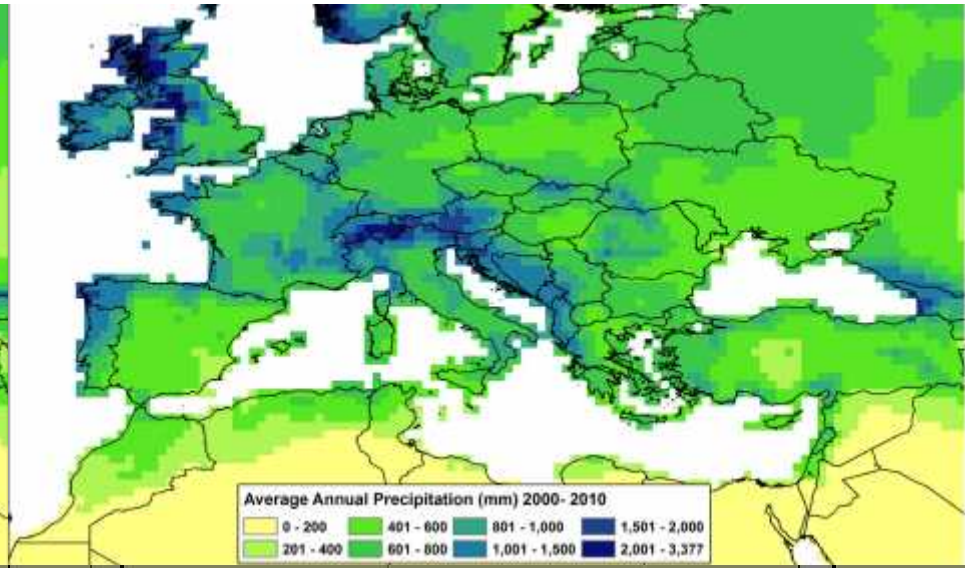


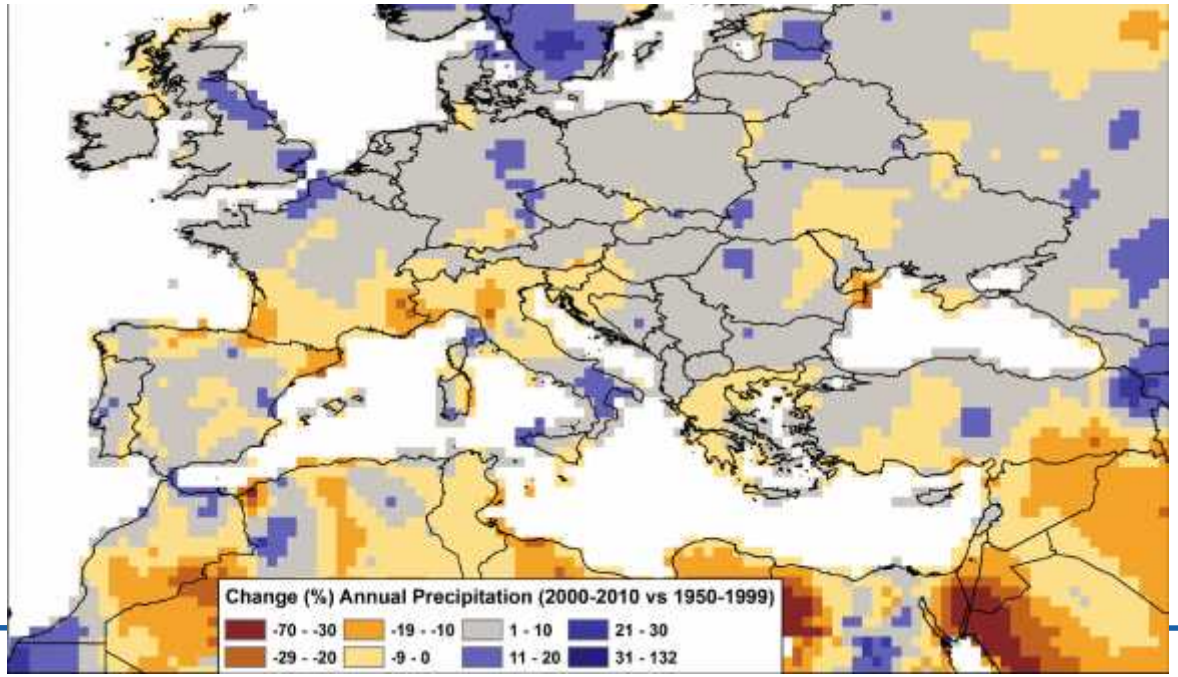




Recent Med climate trend: CRU - Precipitation







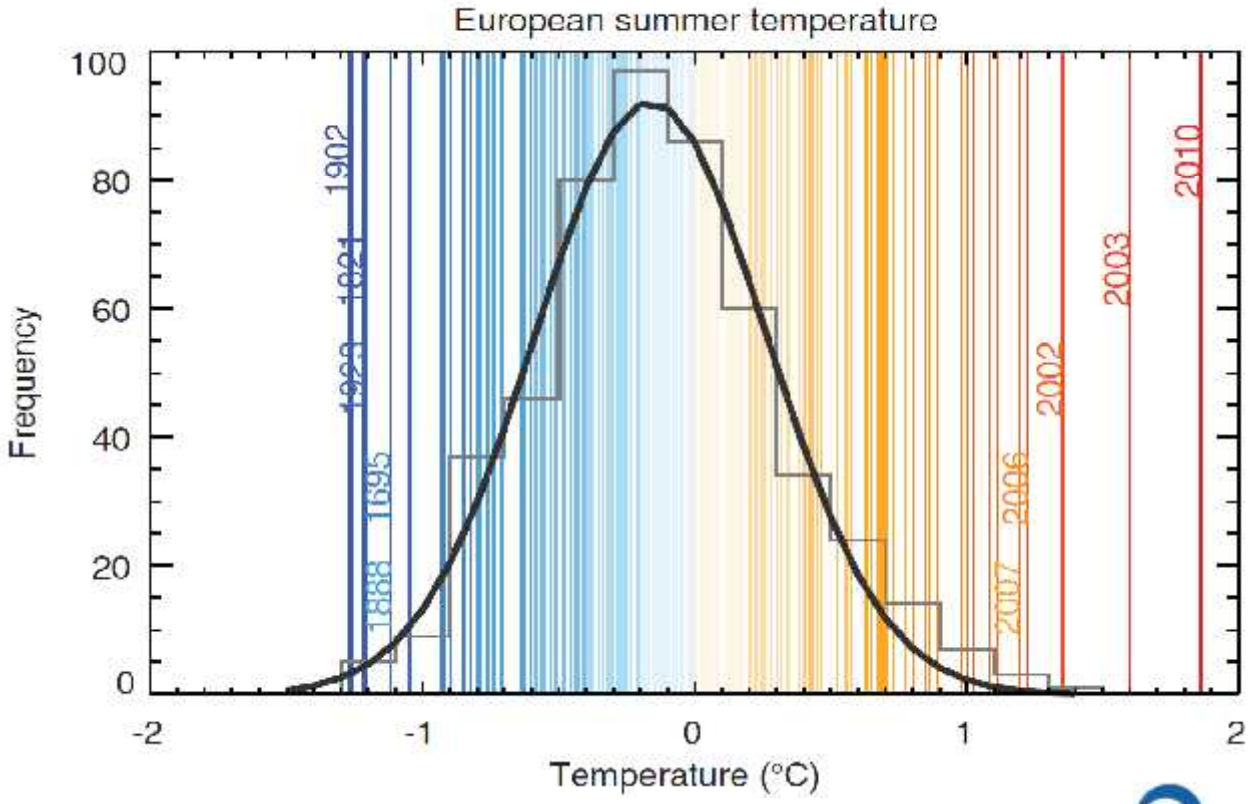
Recent Med climate trend: Extreme events

- In Europe extreme wam events have become more frequent, while extreme cold events have become less frequent

- From 1880 the average length of heat waves has doubbled in western Europe, while the frequency of hot days has tripled.

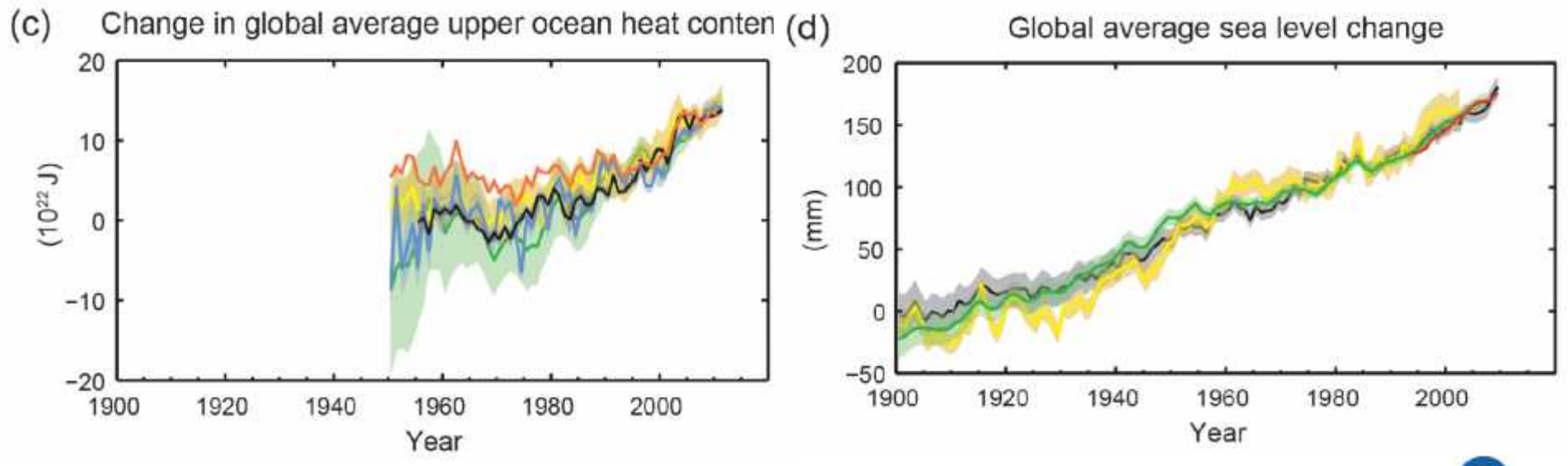
- 5 warmest summer in Europe after 2000, while 5 coldest summer before 1924.

- Increased frequency of events of strong precipitations.



Sea Level Rise

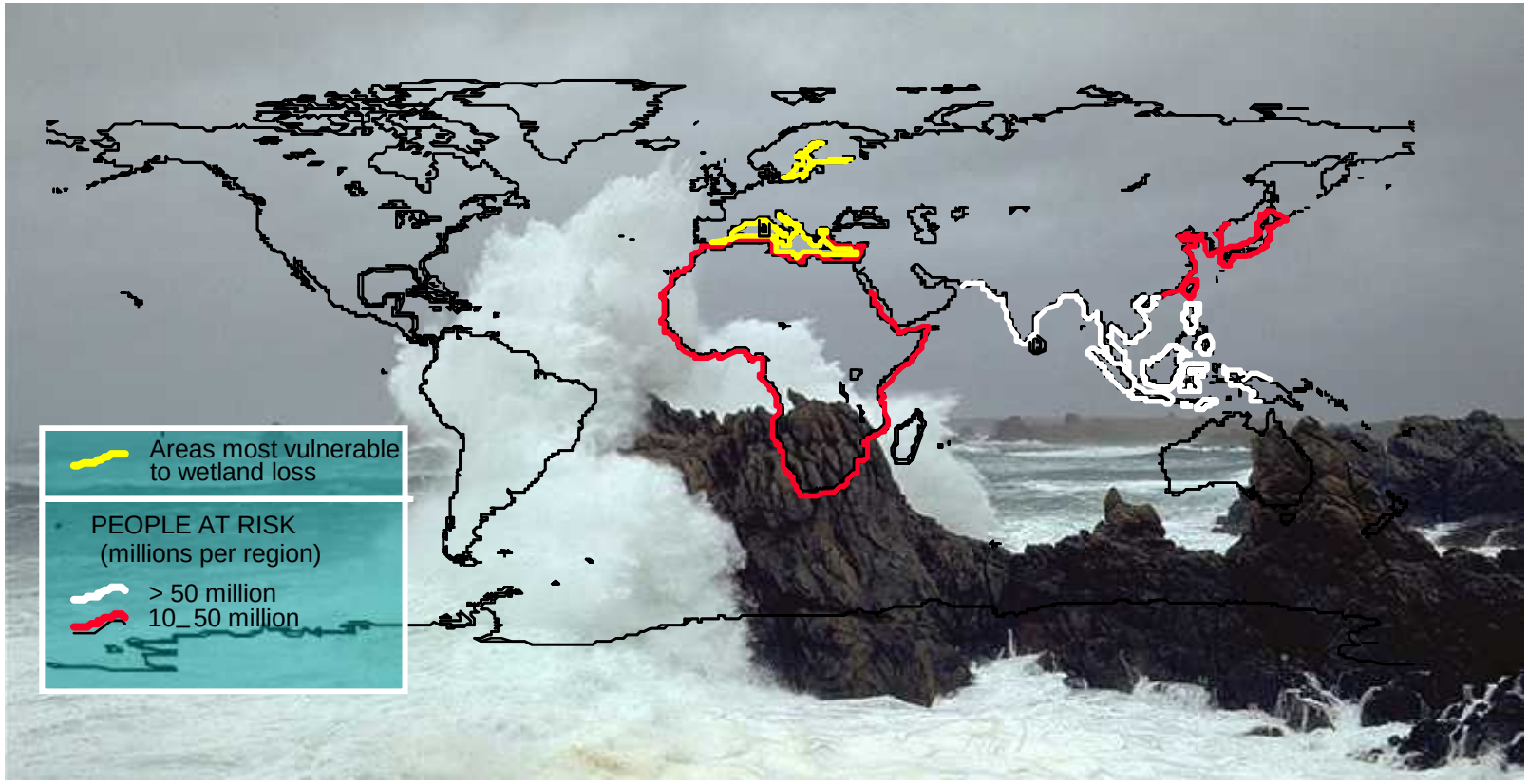
- The oceans have adsorbed up to 80% of the heat added to our planet
- The average temperature of oceans has increased down to a depth of at least 3000 m
- Sea surface is warming at a rate of 0.11 C per decade during 1971-2010.
- Sea warming causes water expansion, and thus sea level rise.
- Glaciers and snowcover are also decreasing, contributing to sea level rise.



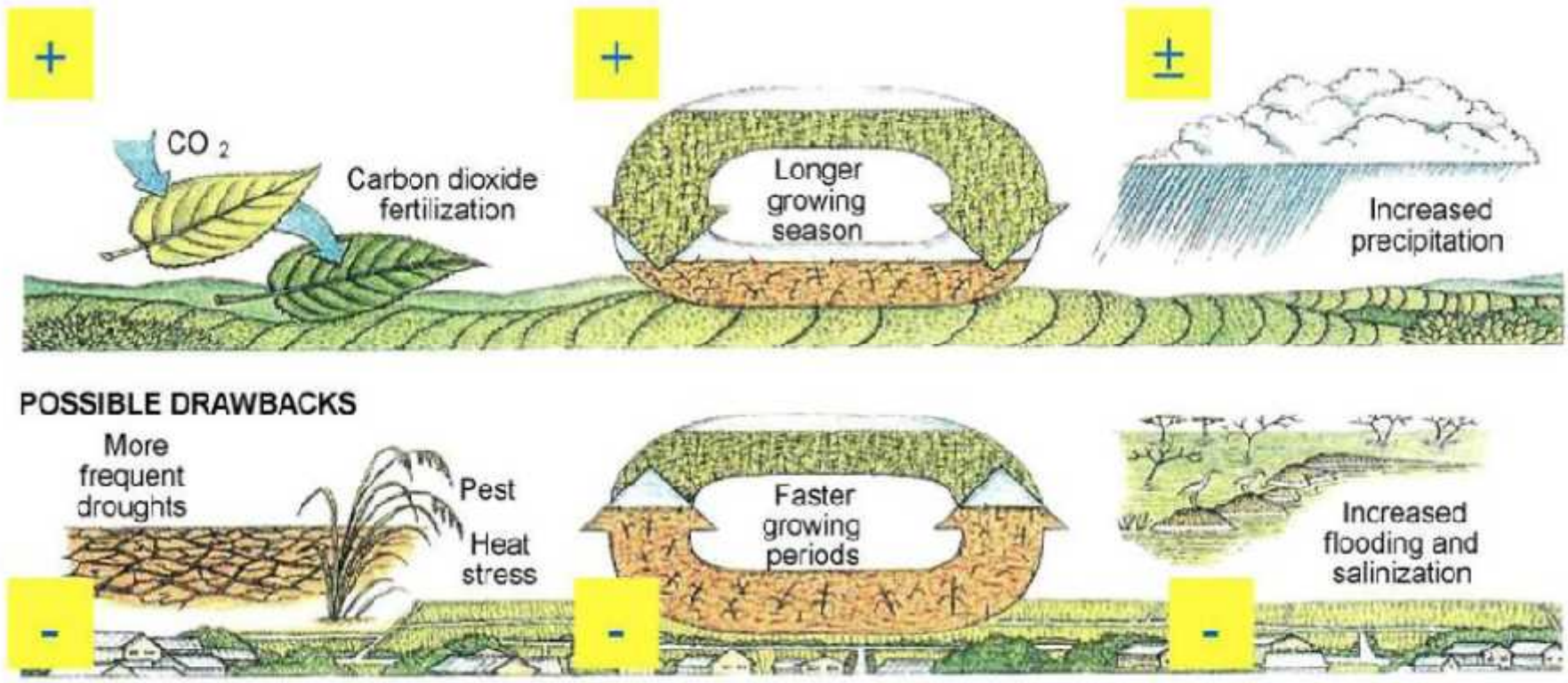
Sea Level Rise

Threats to:

- Coastal development and coastal wetland
- Sea water intrusion into costal aquifer



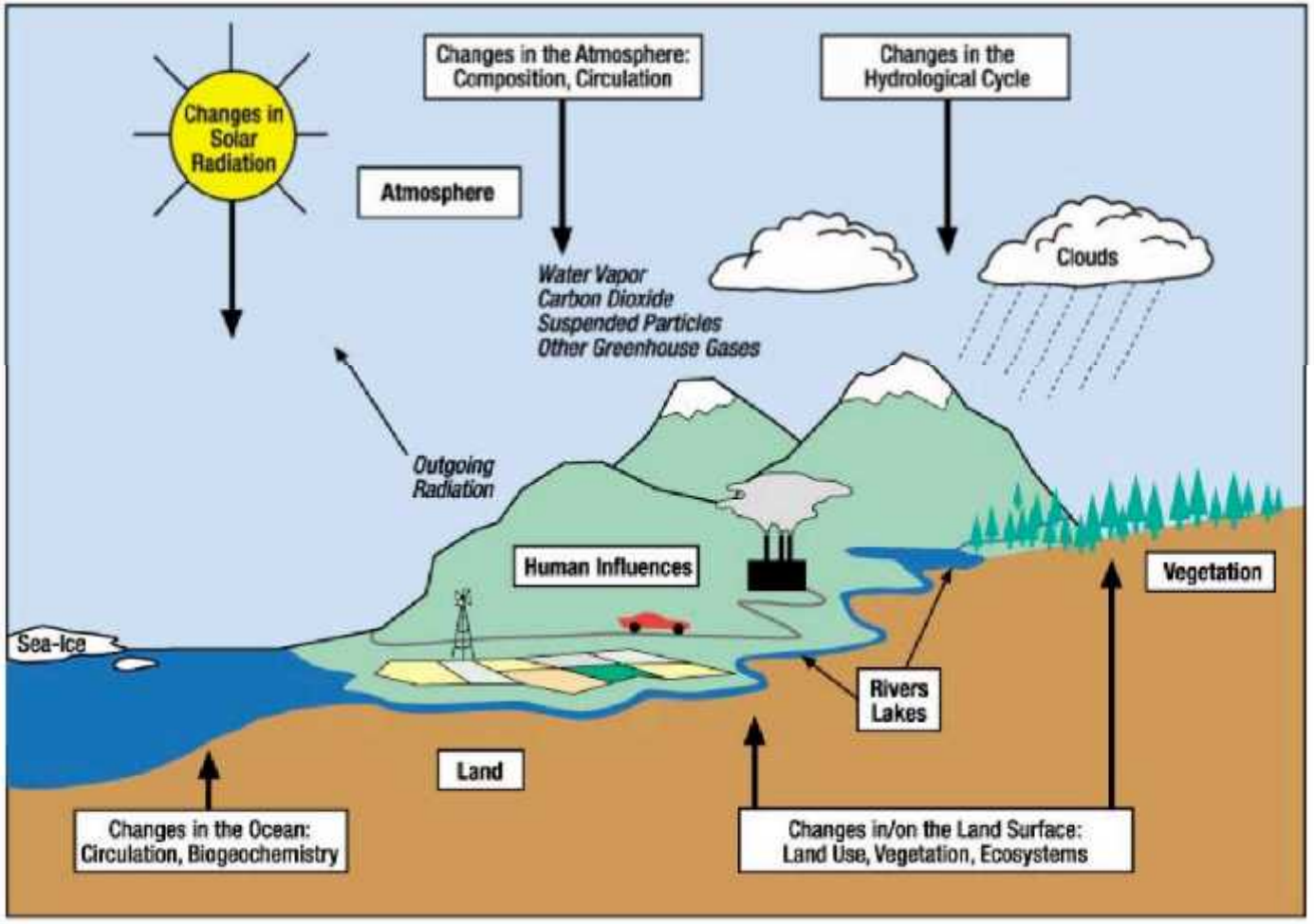
Impact of Climate Change on Crop productivity



Agro-ecosystem processes and a changing climate (from: Bongaarts, 1994).

Climate Modeling

The climate system

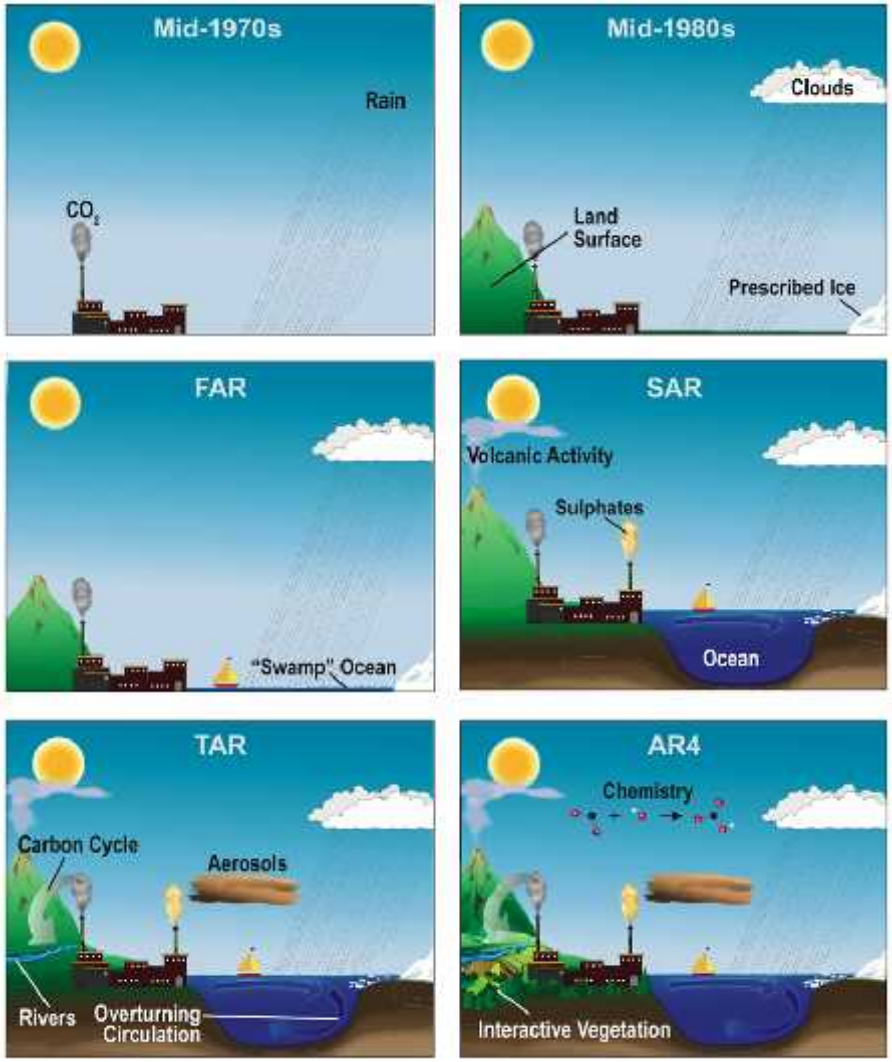


Climate Modeling

Reproducing the climate system

Increasing complexity

Climate models are a lot like weather forecast models, but include interaction among ocean, land surface, and sea ice, changes in atmospheric constituents (GHG), etc



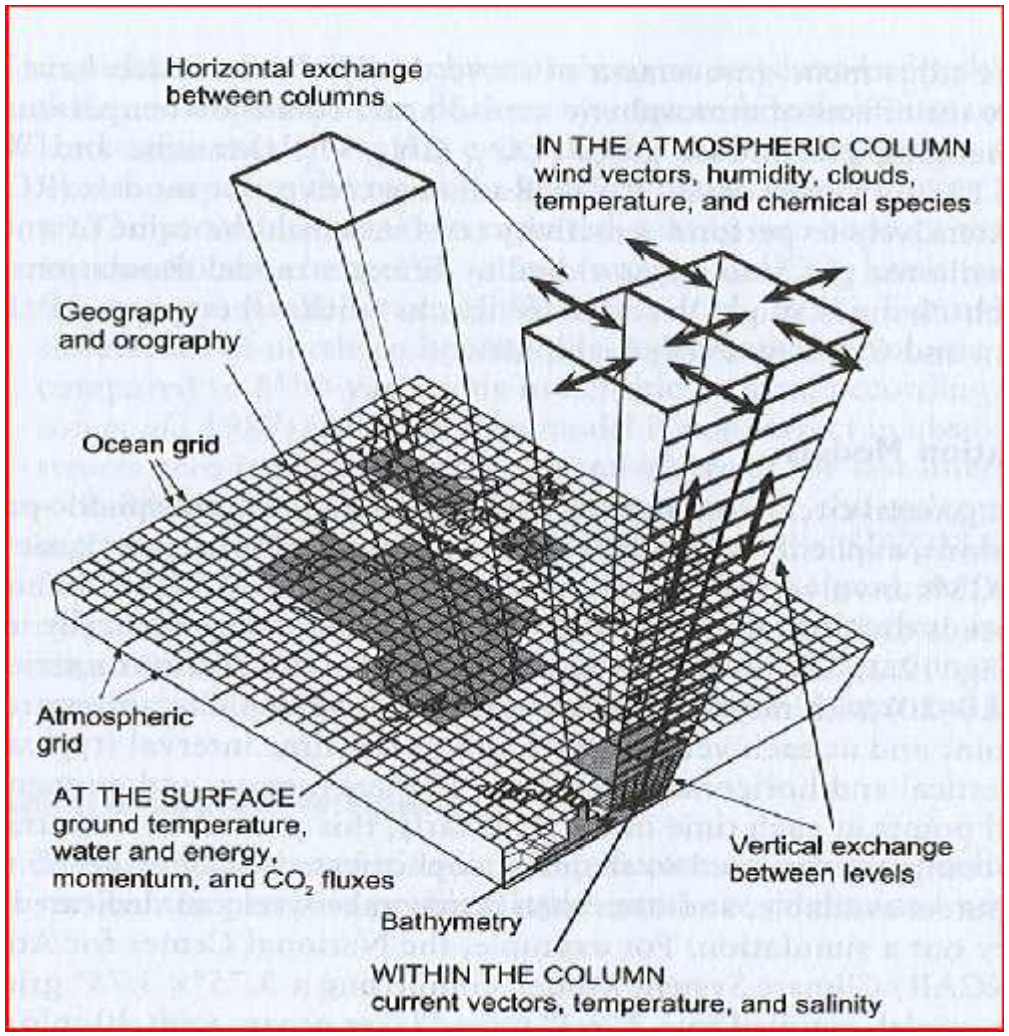
Climate Modeling

Reproducing the climate system

Horizontal and vertical flux distribution among soil and atmospheric layers

The earth system simulated as one system (Global Circulation Models, GCM)

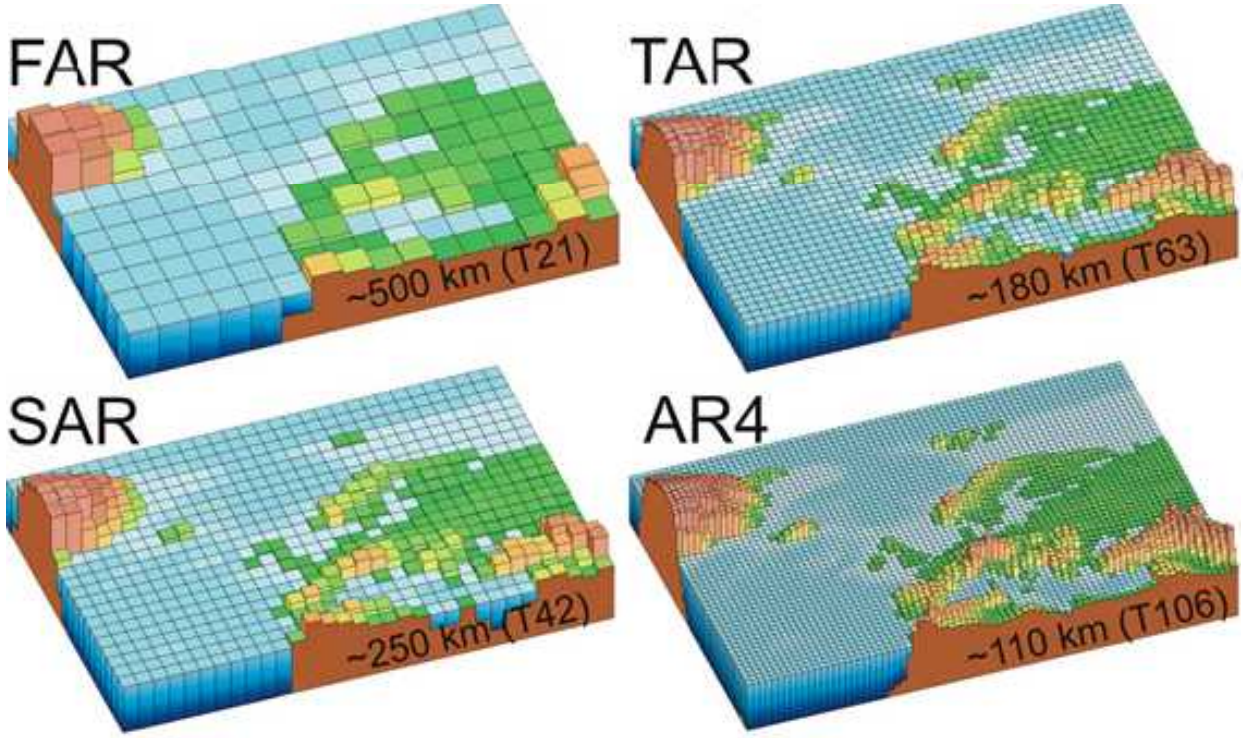
Computing demand increases inversely with cube of horizontal resolution



Climate Model Development

Reproducing the climate system

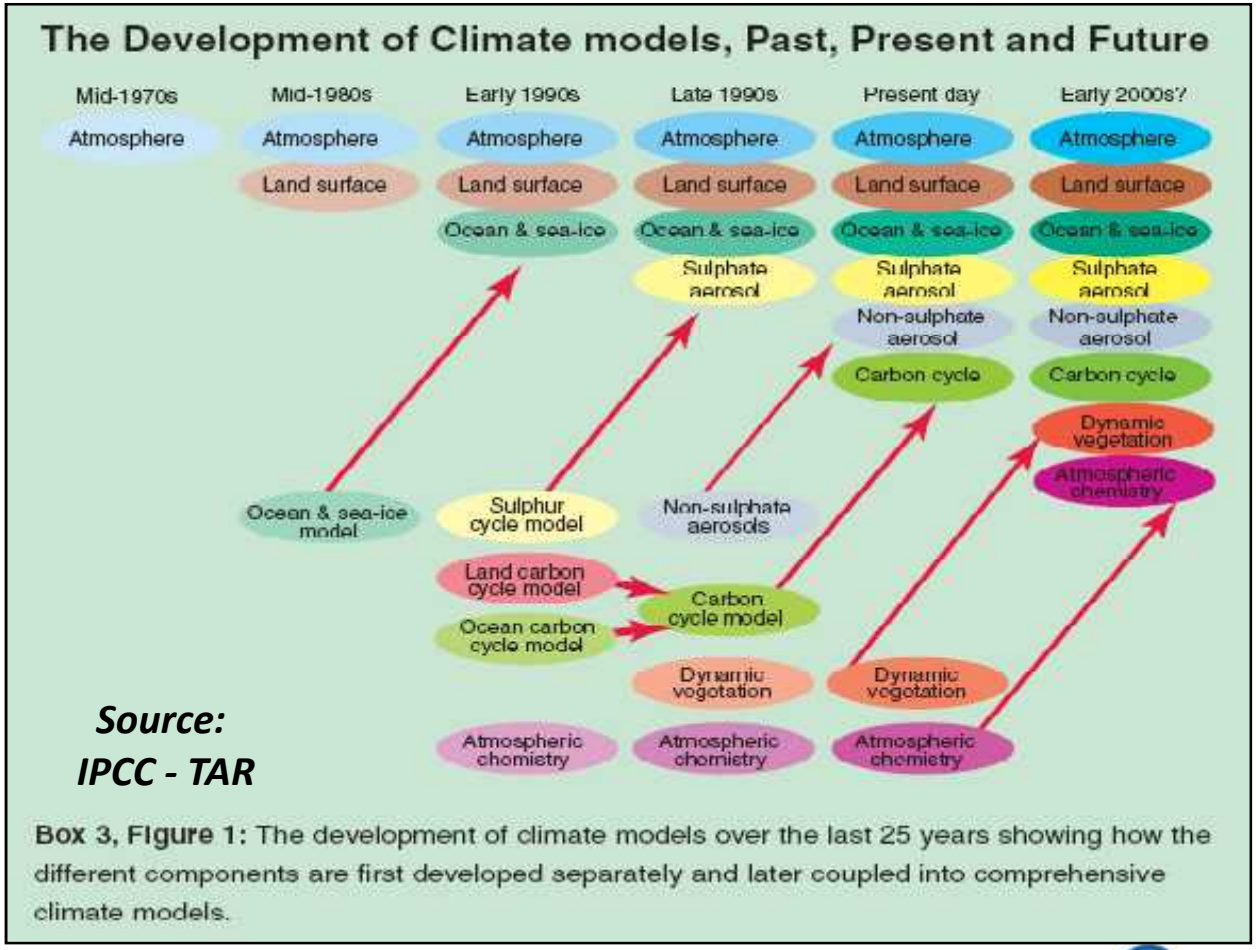
Resolution of GCM has increased over time



Climate Model Development

Different components have been added in climate models to represent more accurately the complexity of climate systems

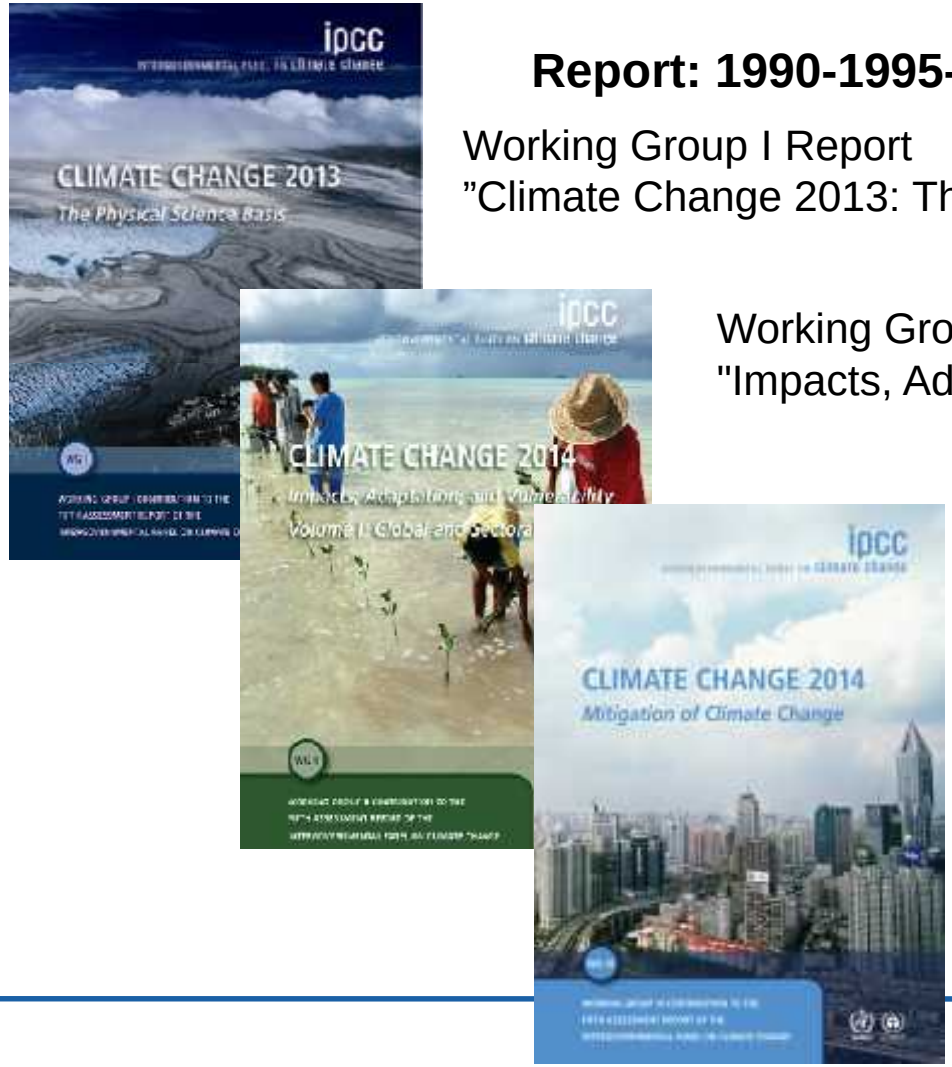
More components are under development, to better understand and simulate the variation of climate (e.g. Oceans)



Box 3, Figure 1: The development of climate models over the last 25 years showing how the different components are first developed separately and later coupled into comprehensive climate models.

1988

United Nations (UNEP & WHO) form the IPCC - Intergovernmental Panel on Climate Change



Report: 1990-1995-2001-2007-2014

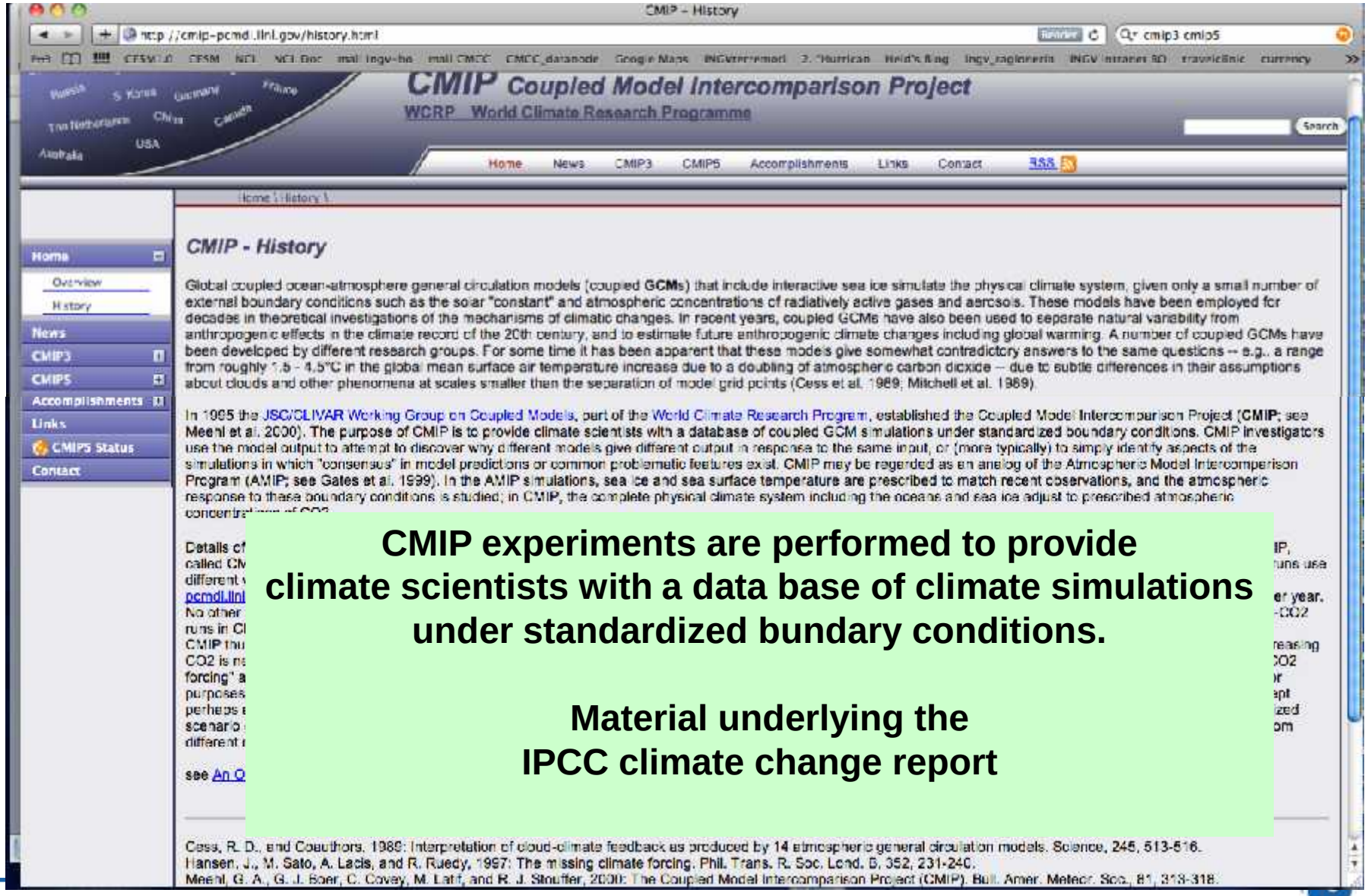
Working Group I Report
”Climate Change 2013: The Physical Science Basis"

Working Group II Report
"Impacts, Adaptation and Vulnerability"

Working Group III Report
"Mitigation of Climate Change"

http://www.ipcc.ch/

Climate Model Development: CMIP dataset

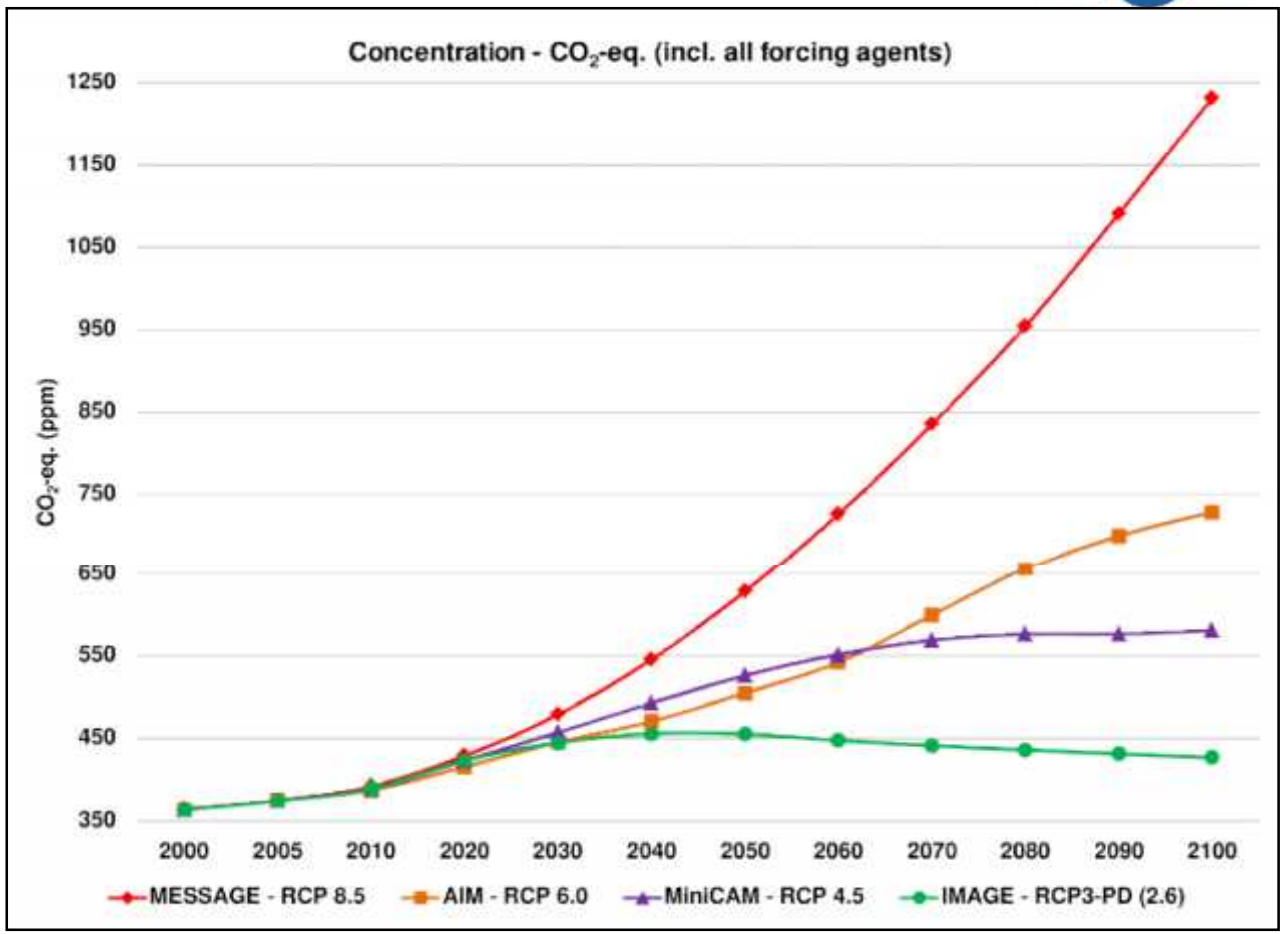


Emission Scenarios

Rapresentative Concentration Pathway (RCP)

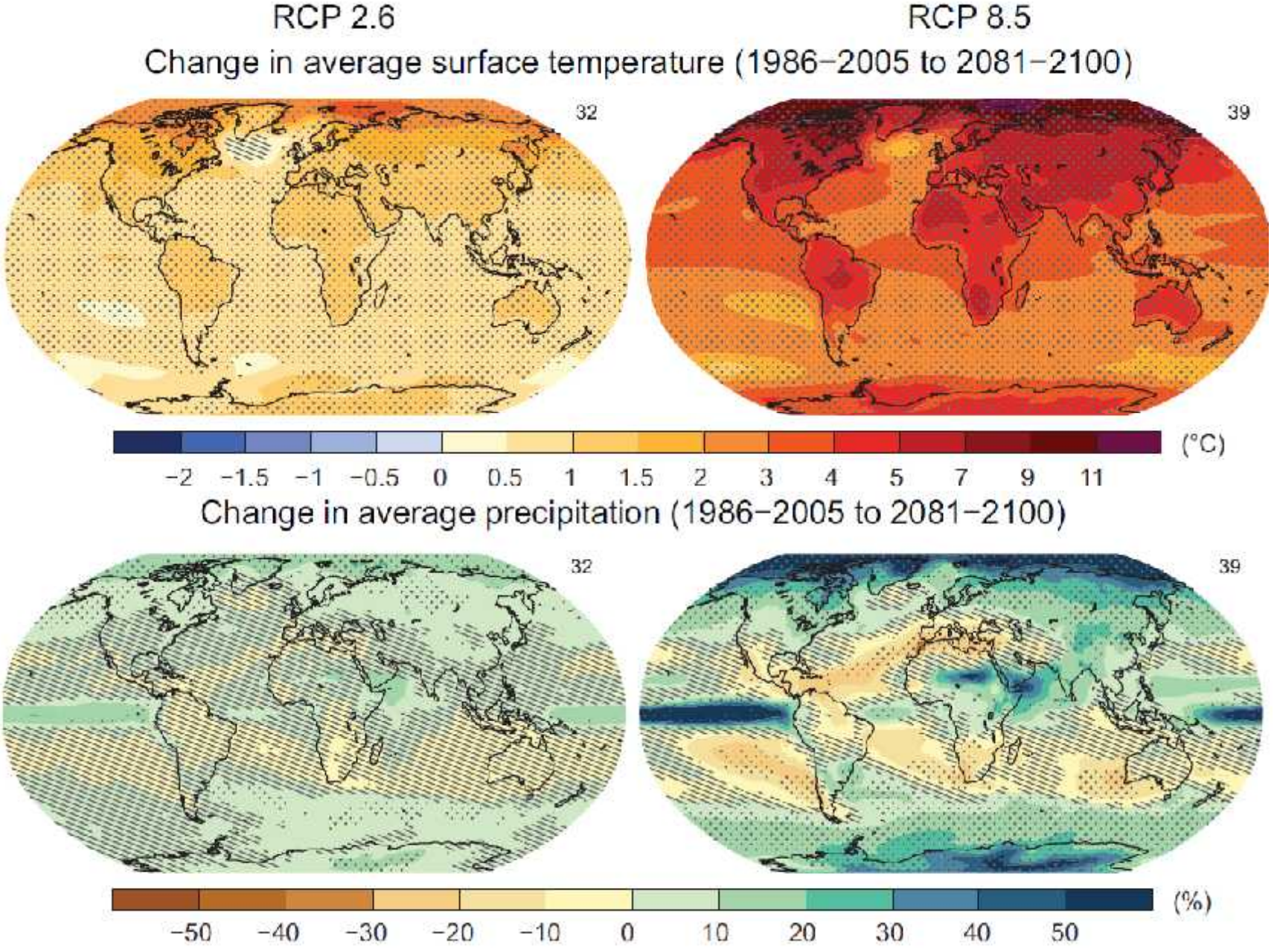
Based directly on the radiative forcing of CO2 concentrations.

Previous emission scenarios were based on socio-economic development (SRES)



RCP 2.6 = 2.6 W m^{-2} ⟹ 421 ppm
RCP 4.5 = 4.5 W m^{-2} ⟹ 538 ppm
RCP 6.0 = 6.0 W m^{-2} ⟹ 670 ppm
RCP 8.5 = 8.5 W m^{-2} ⟹ 936 ppm

Climate Model projections: Global



Climate Model projections: EM

Mediterranean:

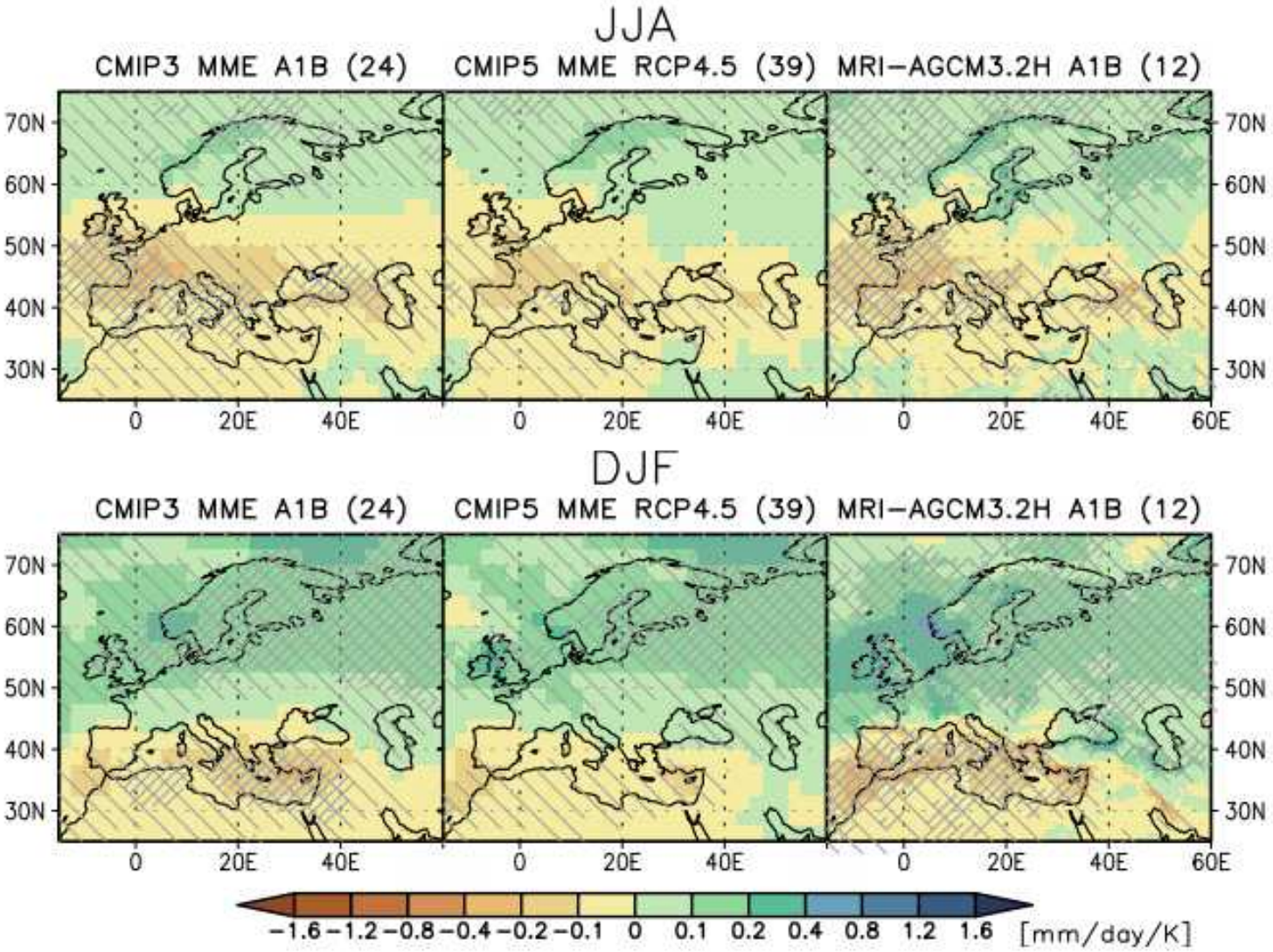
Average temperature increase:

- highest : summer
- lowest : winter

Annual precipitation very likely to slightly decrease during most months of the year

TEMP increase + significant PREC decrease ➔ drought risk will increase

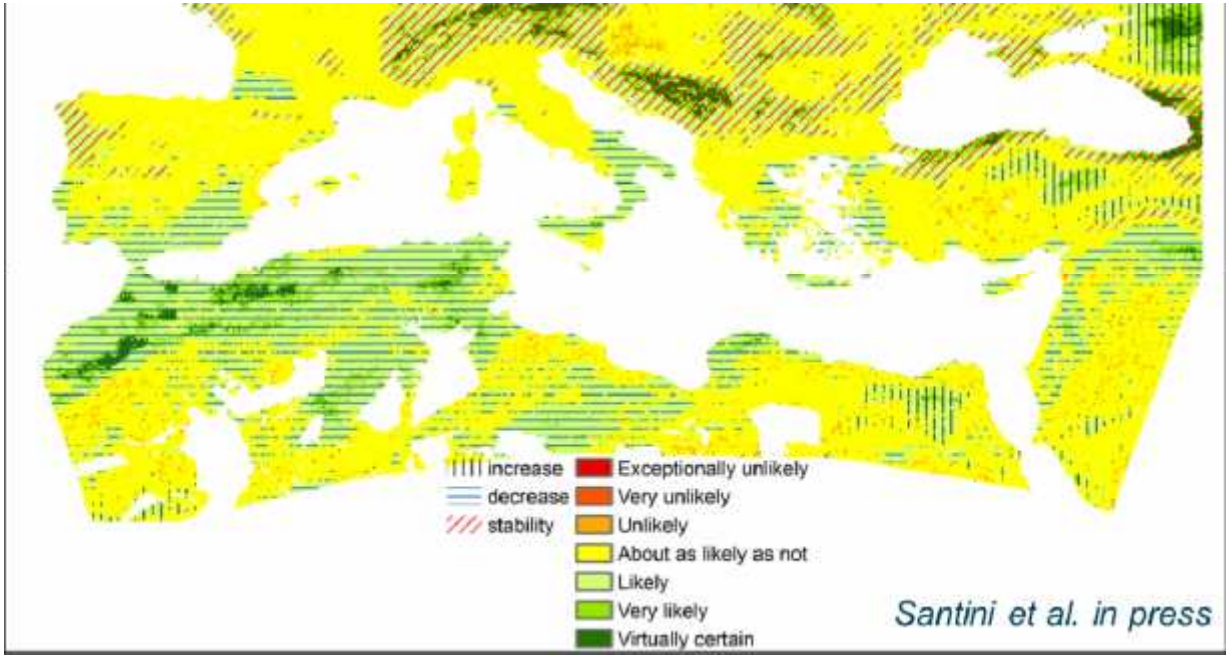
Climate Model projections: EM



Climate Model projections: Impacts in the EM

Higher risks of scarce water availability, especially in the mediterraneum due to:

- More extreme rainfall events will lead to less soil water recharge

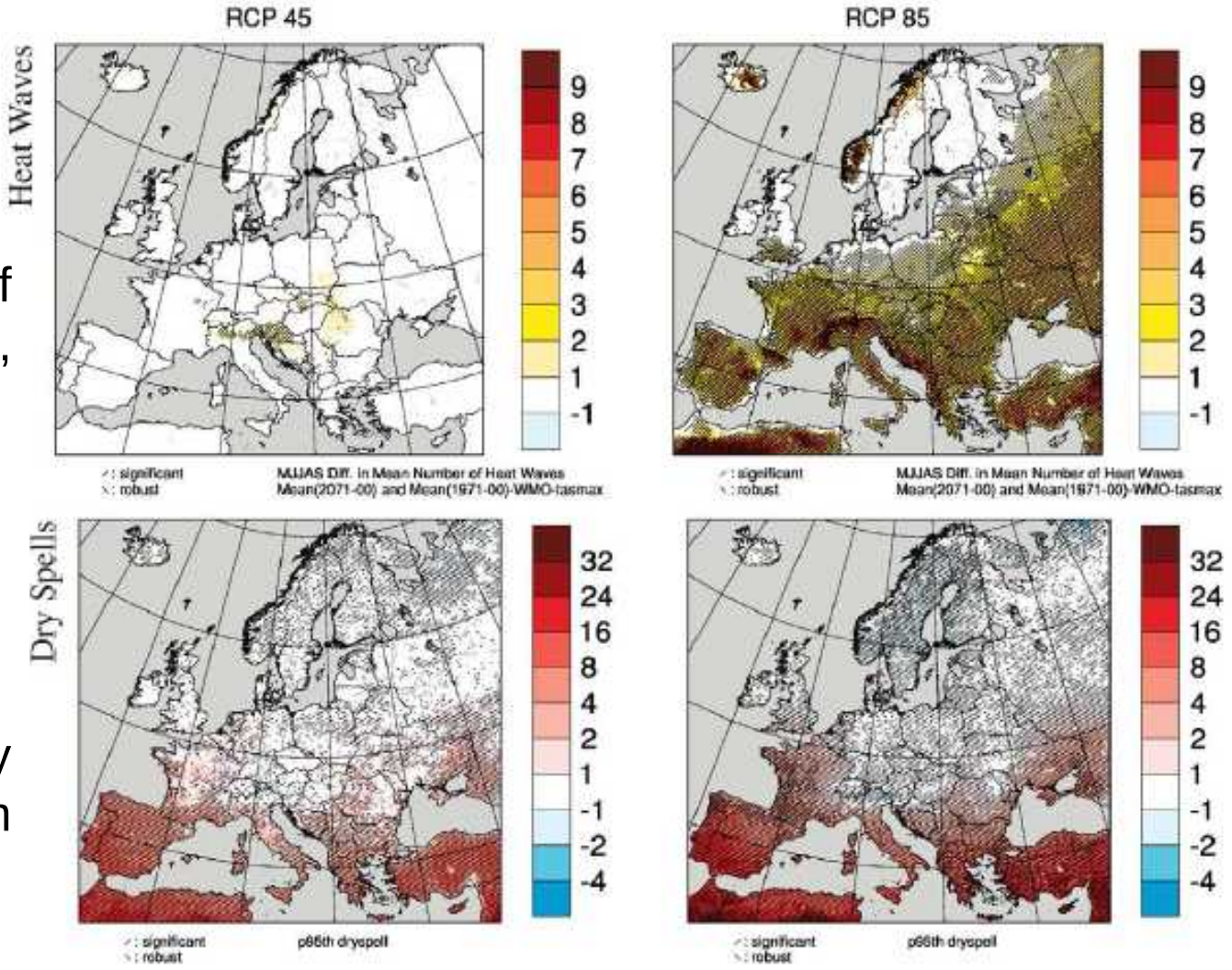


- Increasing vegetation water demand (higher EvapoTranspiration)
- Consequent increase of irrigation requirements
- Higher water conflicts with other sectors (domestic, industrial, etc)

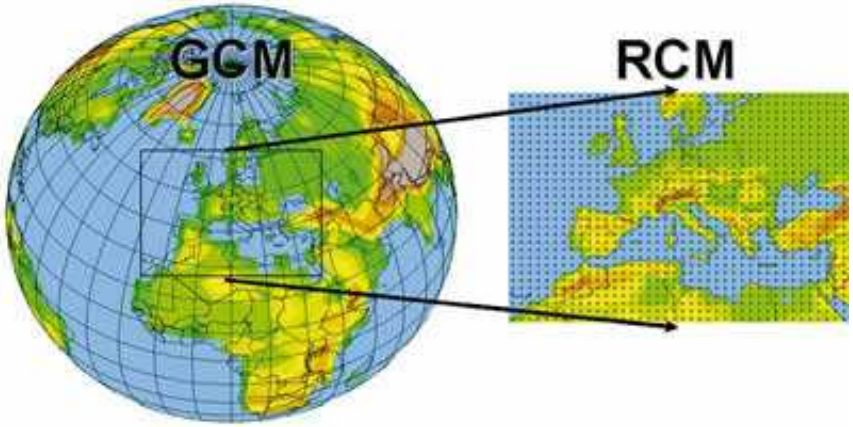
Climate Model projections: Impacts in the EM

Increasing risk of extreme climate events, especially heat waves.

Impact on:
- Human health,
- Agricultural production
- Forest fires especially in the mediterraneum and boreal forests.



Climate Modeling: Downscaling



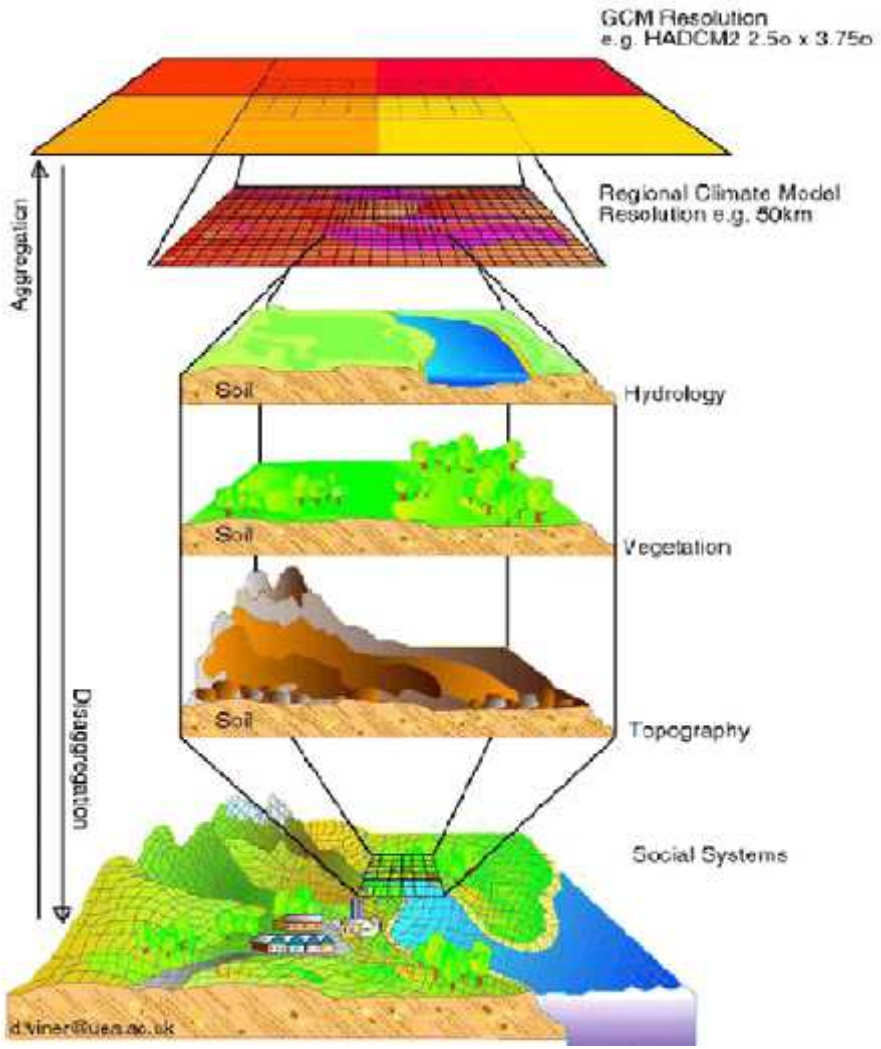
Downscaling indicates an increase of the spatial resolution from GCM.

Needed for climate impact studies

A Regional Climate Model (RCM) is an additional climate model that is run within a Global Circulation Model

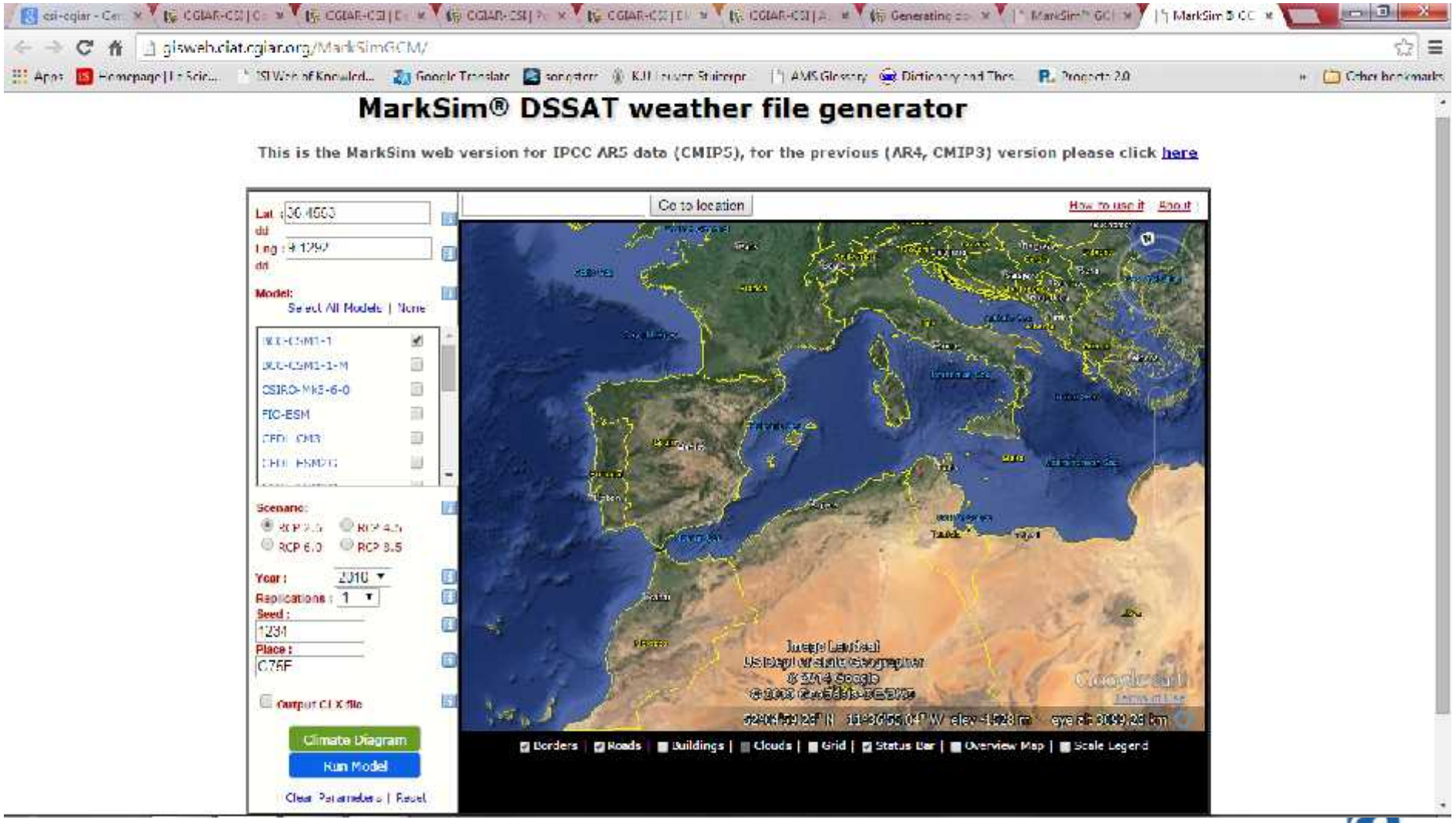
Maintaining consistency with the general atmospheric physical GCM description.

Example: GCM HadCM downscaled with COSMO-CLM RCM



Climate Modeling: Downscaled data

http://gisweb.ciat.cgiar.org/MarkSimGCM/



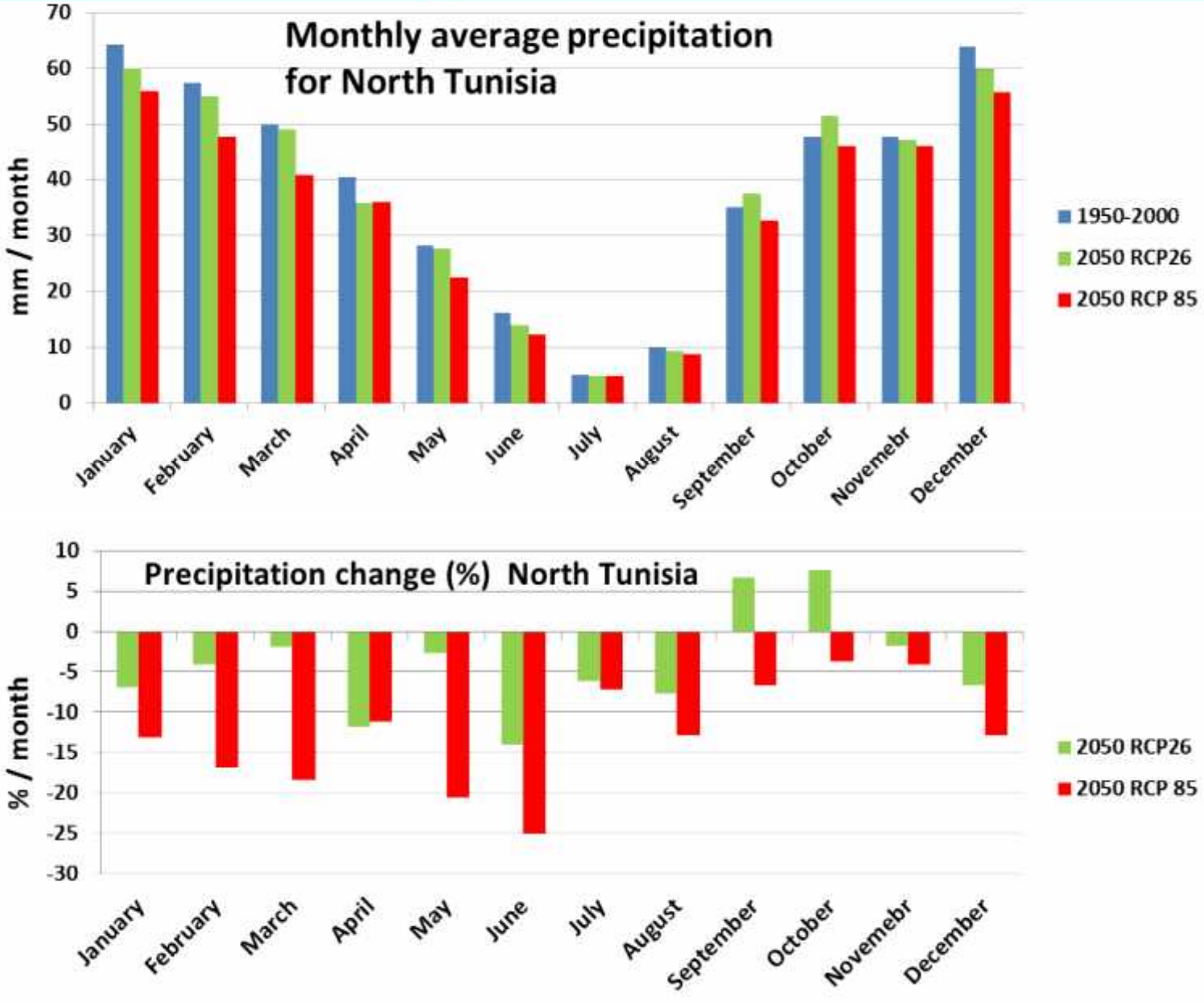
Climate Modeling: communicating the issue

- Climate models have improved in the past few years, and society is now demanding ever more accurate information from climate scientists to study the impacts at smaller scales.

- More (less certain!) knowledge will have to be inserted into climate models, and early results may cause problems in the public understanding of climate change.

- Performing cutting-edge climate science in public could easily lead to misinterpretation, and it will take a great deal of work communicating carefully with the public and policy makers to ensure that the results are used appropriately. (K. Trenberth, 2010)

Climate Modeling: Impact in North Tunisia



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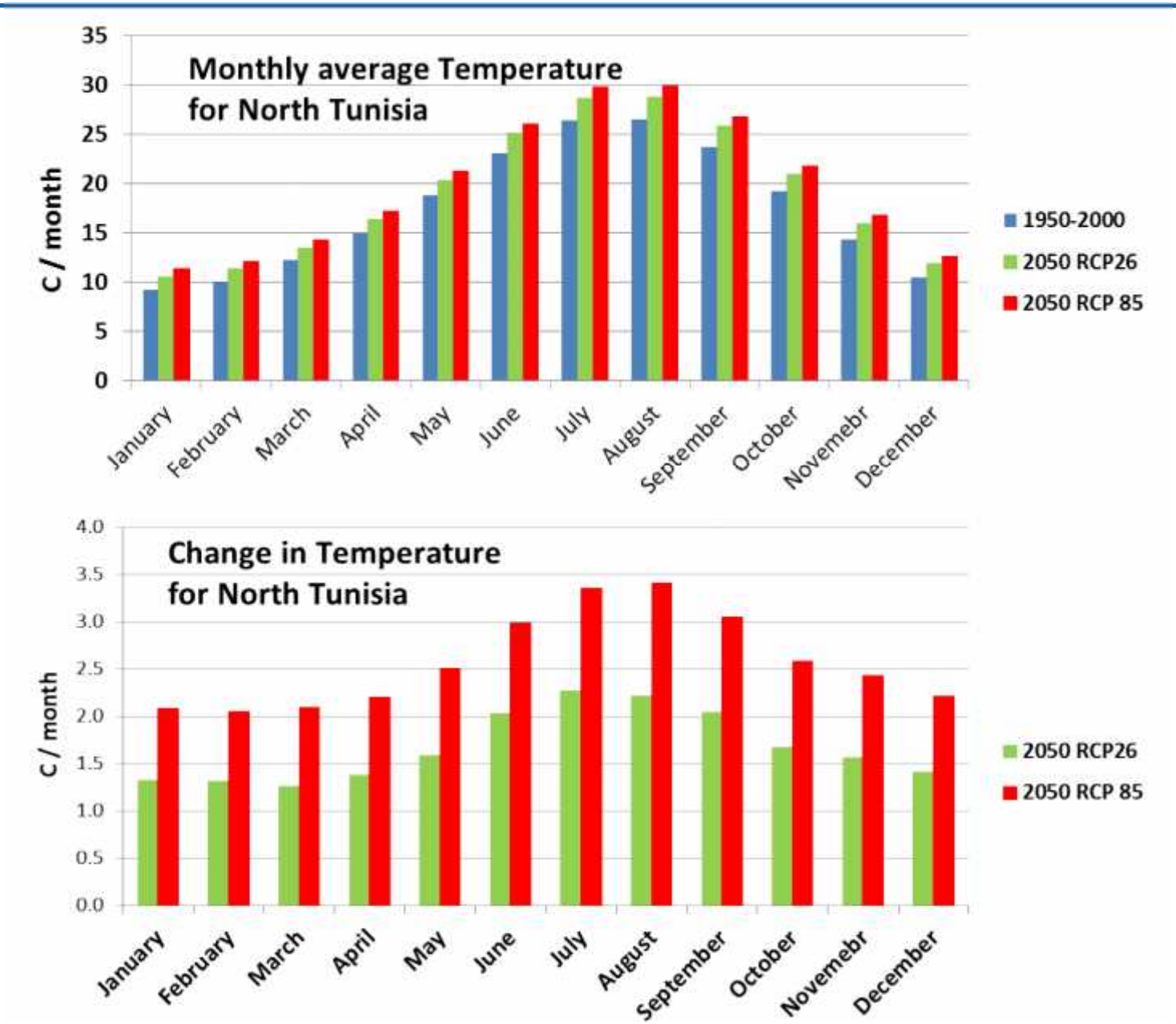

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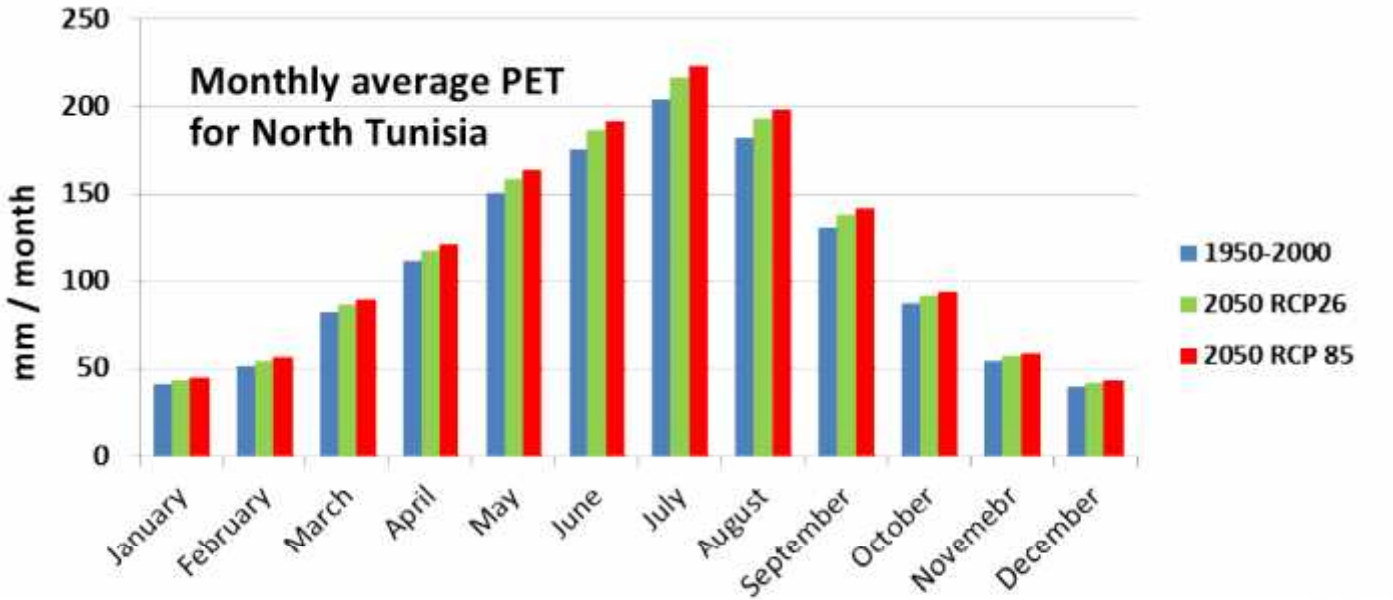

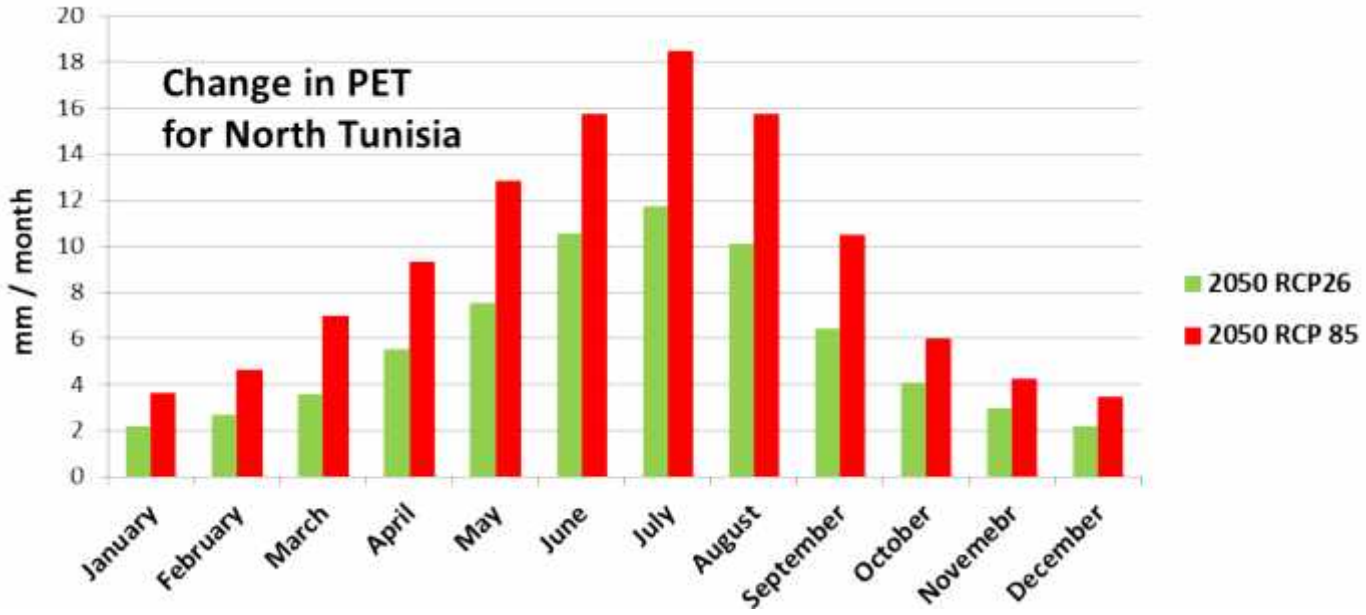

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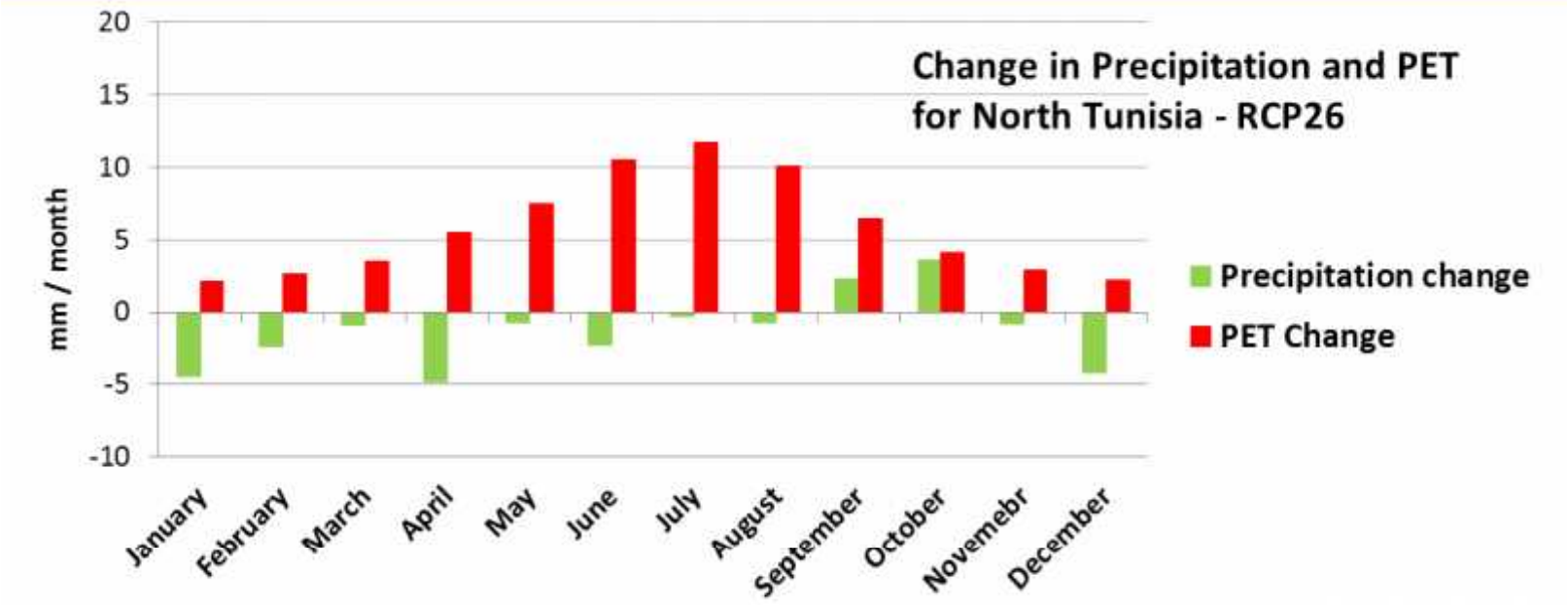

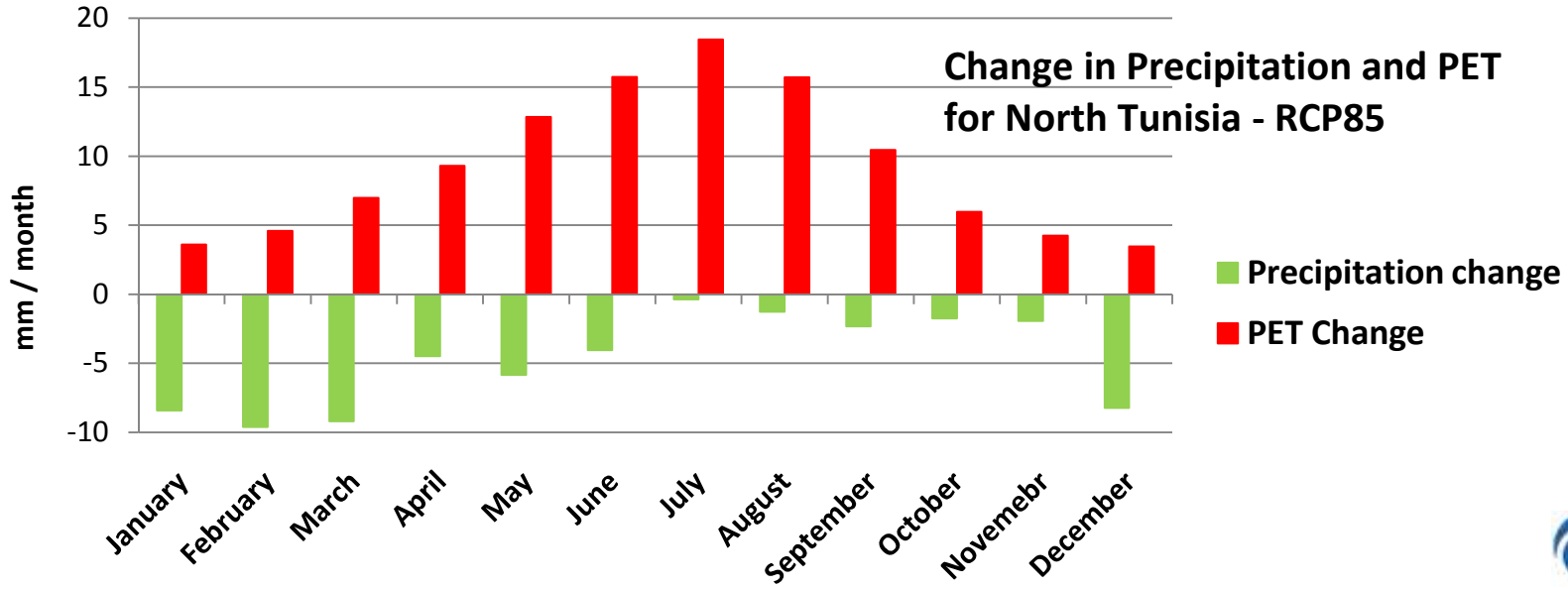

Merci!!