LIFE08 ENV/IT/436

# PROJECT ACT

## ADAPTING TO CLIMATE CHANGE IN TIME

# GLOBAL AND REGIONAL CLIMATE MODEL SCENARIOS FOR THE MEDITERRANEAN AREA

A. Toreti

Rome July 2010

*ISPRA Institute for Environmental Protection and Research*

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# OUTLINE

- ✓ Introduction
- ✓ The Mediterranean climate
- ✓ The simulated 20$^{th}$ century: temperature and precipitation
- ✓ The 21$^{st}$ century: temperature and precipitation
- ✓ Conclusions
- ✓ Outlook

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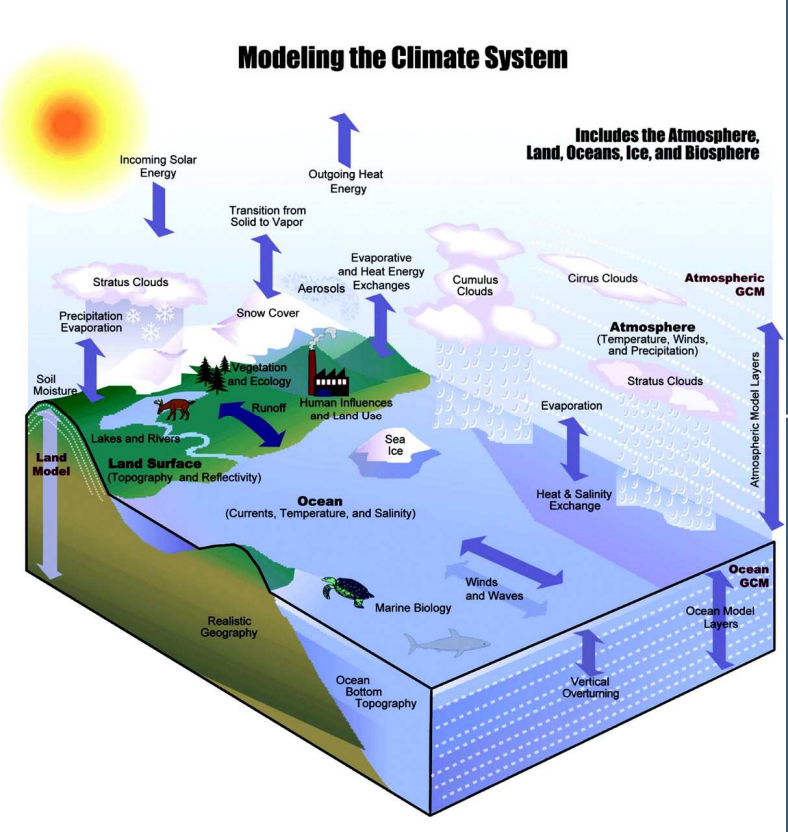
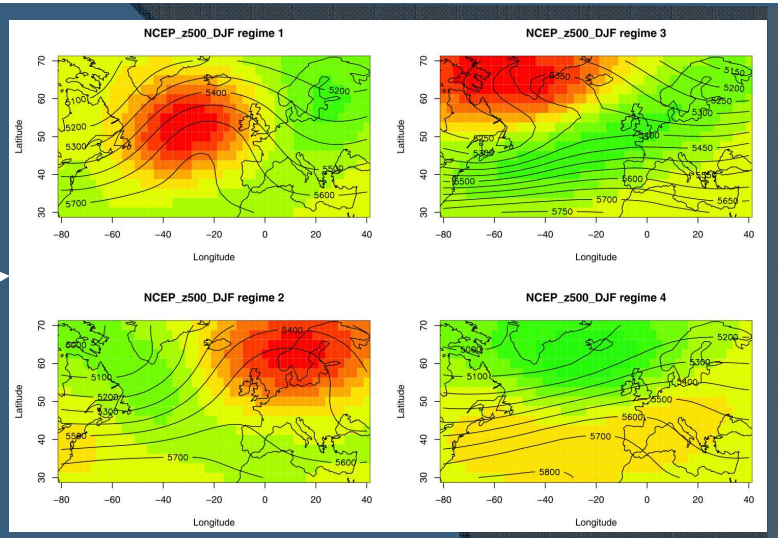
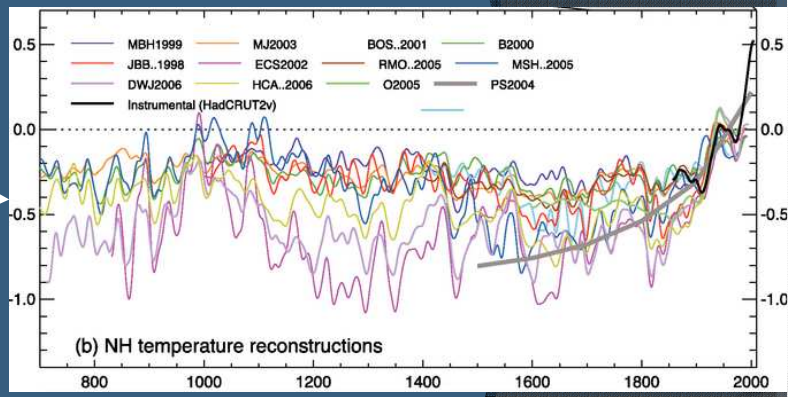
# Introduction




*Source: Karl and Trenberth, 2003*




*Source: Yiou and Nogaj, 2004*




*Source: IPCC, 2007*

The primary tools for predicting future climate are global climate models, which are fully coupled, mathematical, computer-based models of the climate system.

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# Introduction

## The Mediterranean region

*Source: ESA, 2010*

It is a complex region influenced by subtropical processes, mid-latitude dynamics...HOT SPOT of climate change[1]

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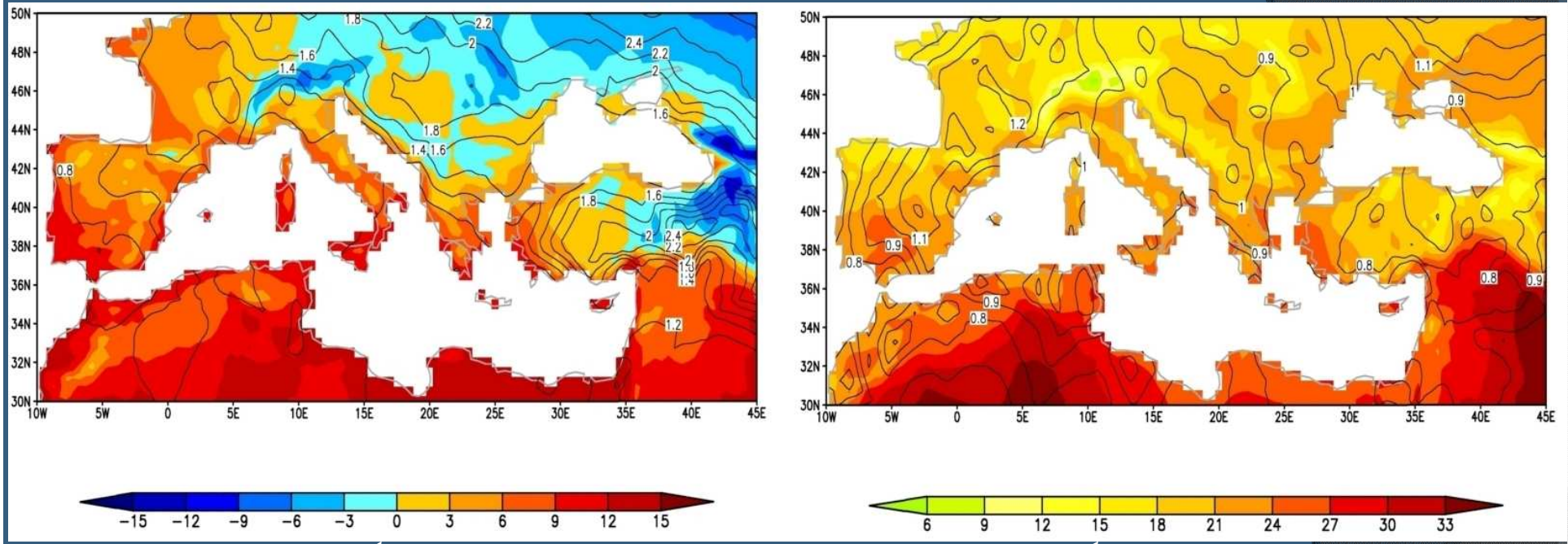
*1 Giorgi, 2006*

# The Mediterranean climate

## Mean Temperature (°C)




*Source: Toreti, 2010*

Winter

Summer

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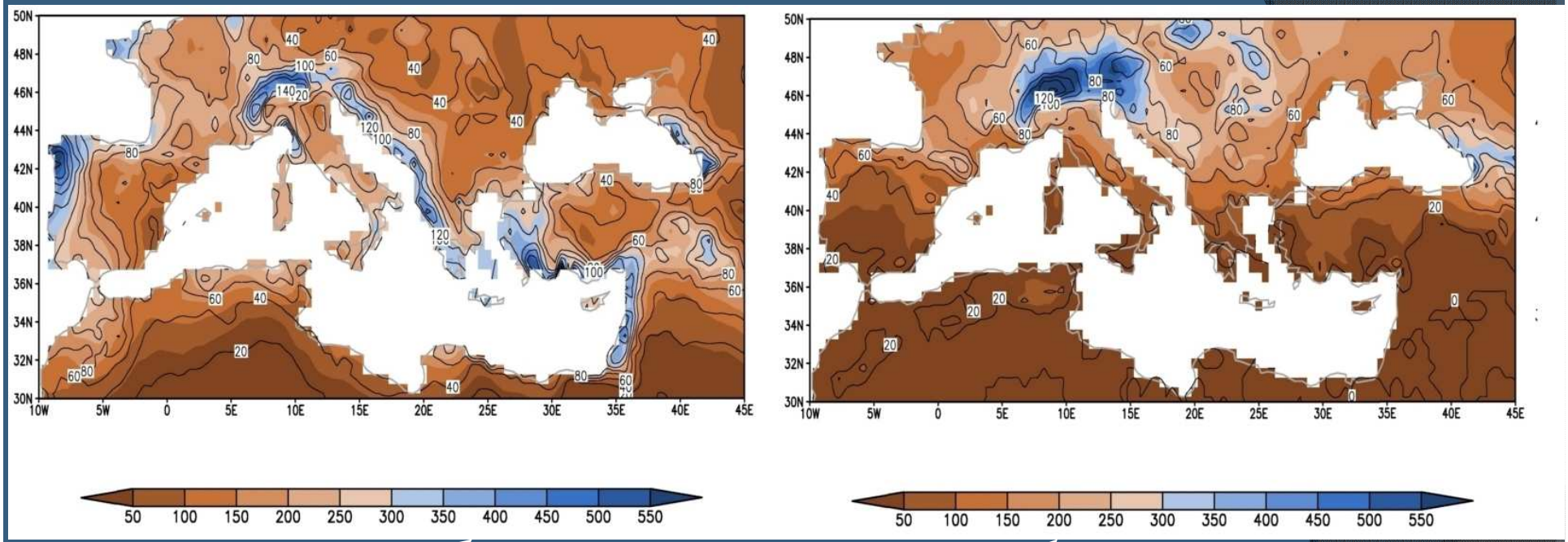
# The Mediterranean climate

## Precipitation (mm)




*Source: Toreti, 2010*

Winter

Summer

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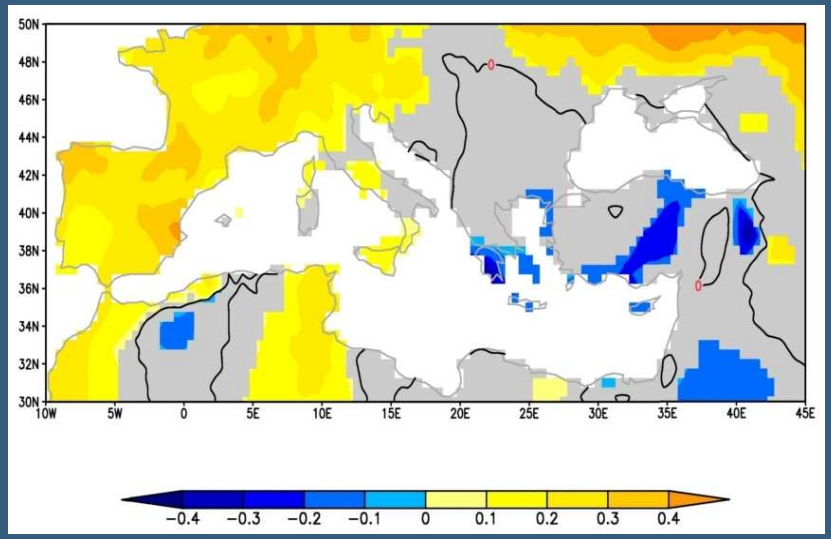
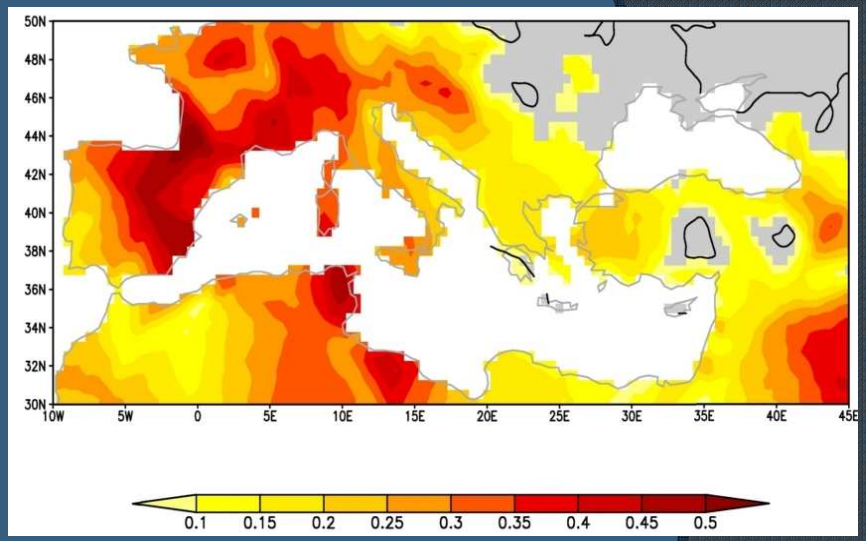
# The Mediterranean climate

## Mean Temperature trend (°C/decade)




*Source: Toreti, 2010*

Winter

Summer

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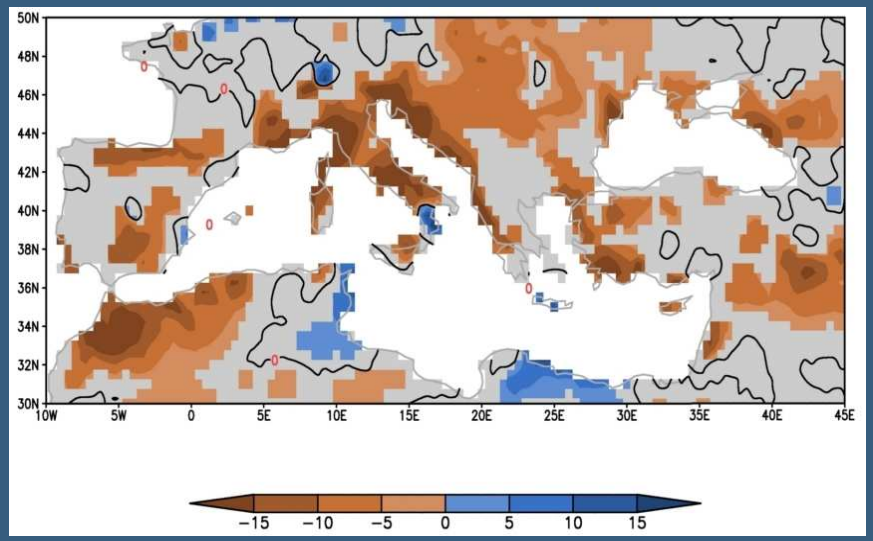
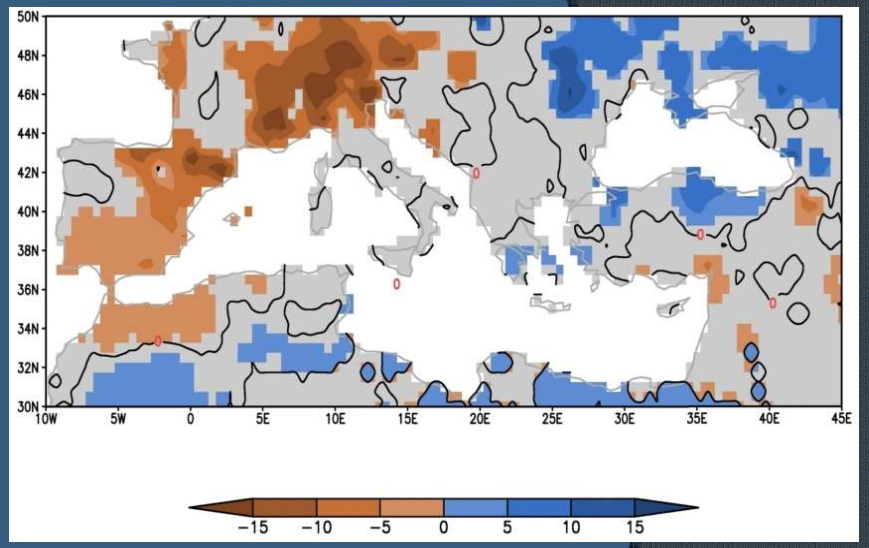
# The Mediterranean climate

## Precipitation trend (mm/decade)




*Source: Toreti, 2010*

Winter

Summer

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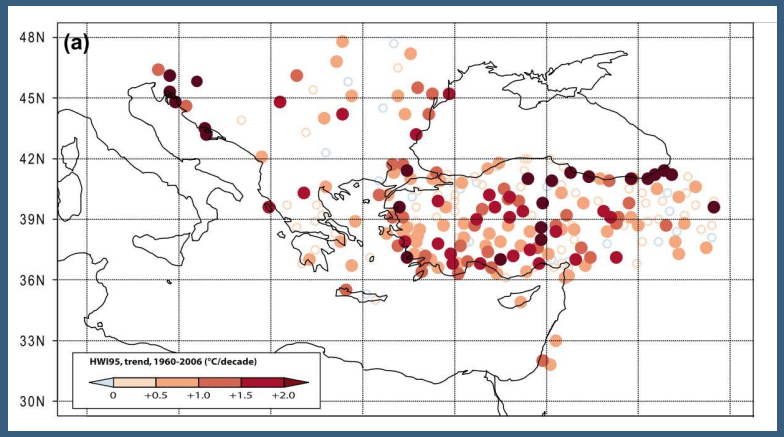
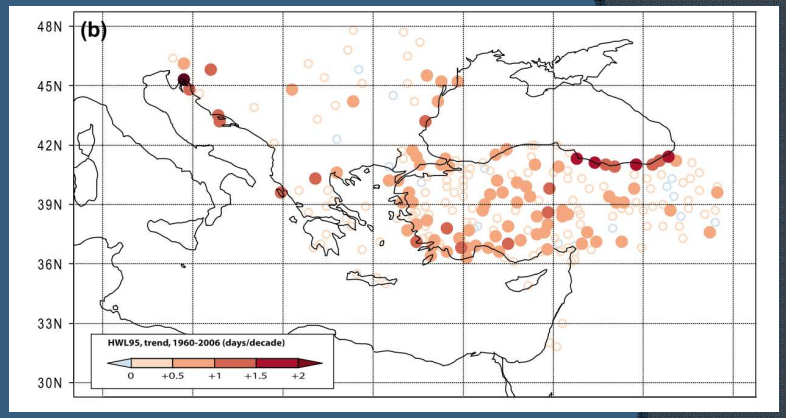
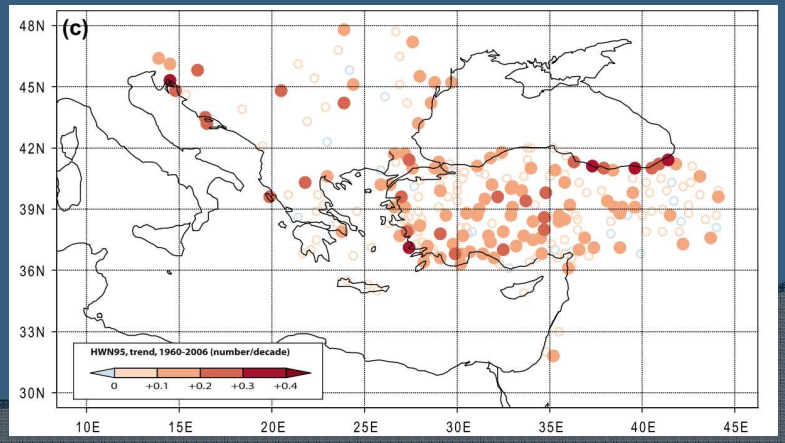
# The Mediterranean climate

## Heat Waves in the eastern part of the region




*Source: Kuglitsch et al., 2010*

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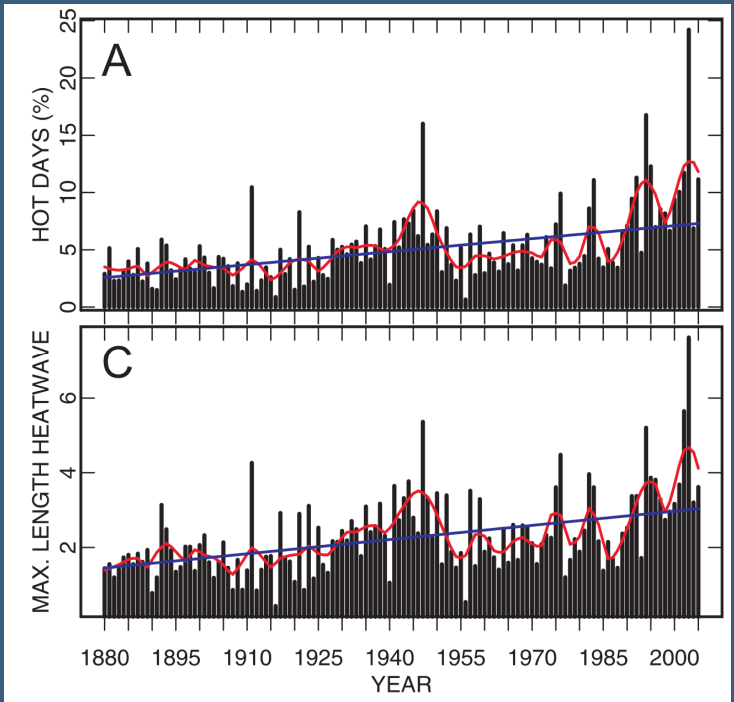
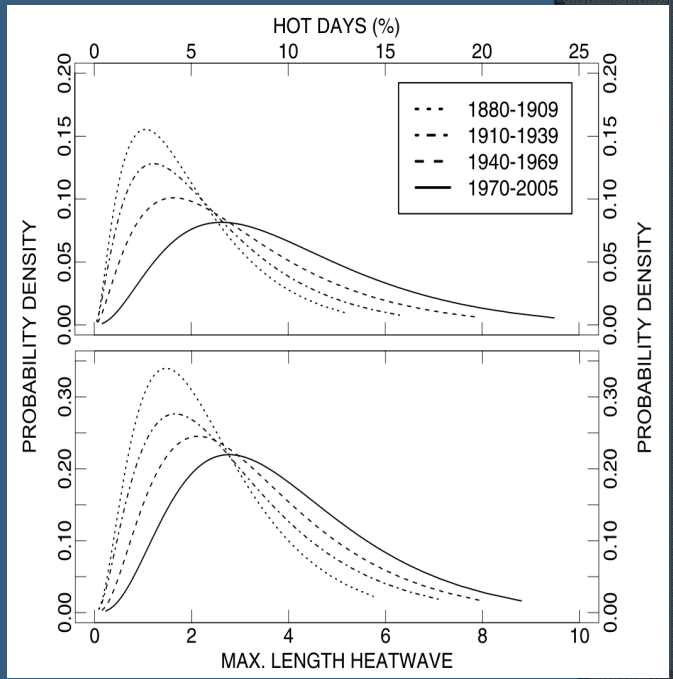
# The Mediterranean climate

## Heat Waves in the western part of the region




*Source: Della-Marta et al., 2007*

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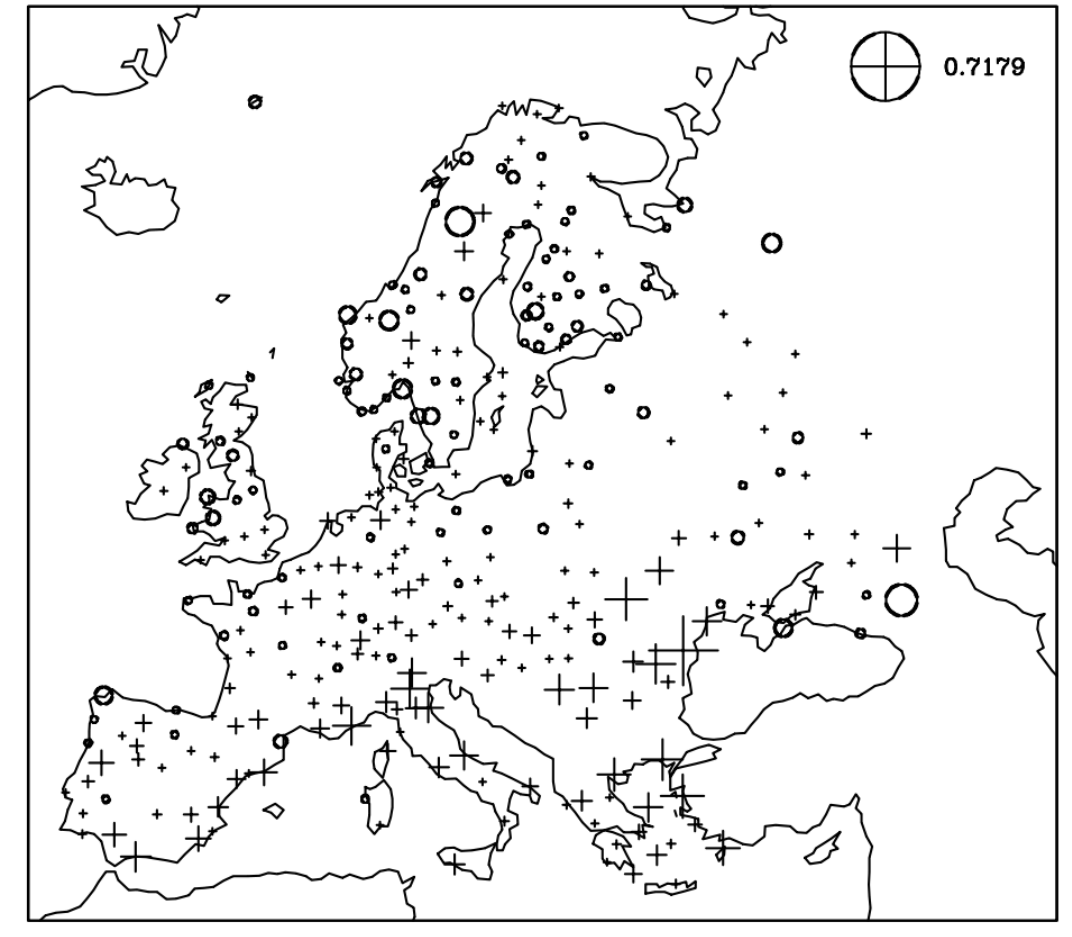
# The Mediterranean climate




*Source: Haylock and Goodess, 2004*

Winter (DJF) Consecutive Dry Days. Linear trend (days/year).

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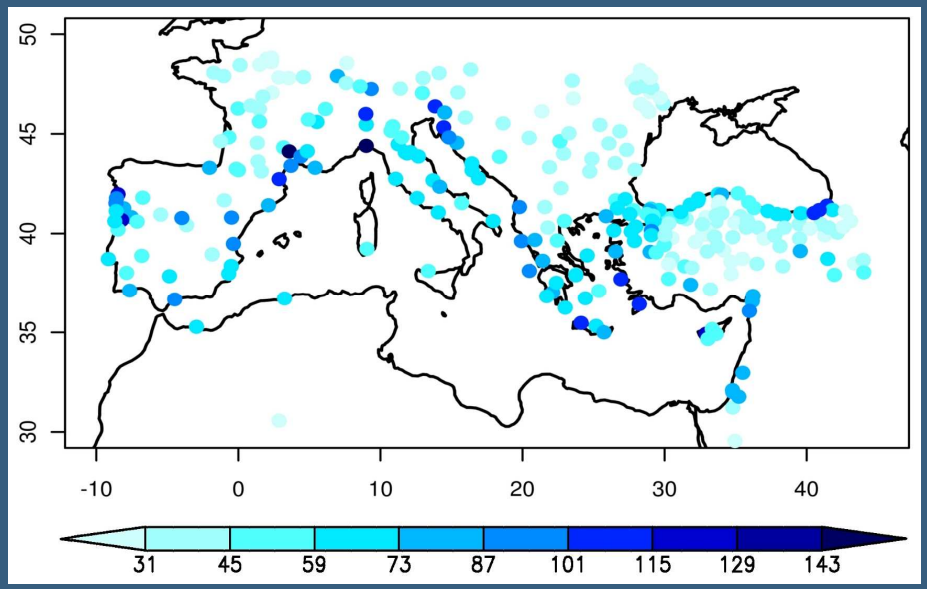
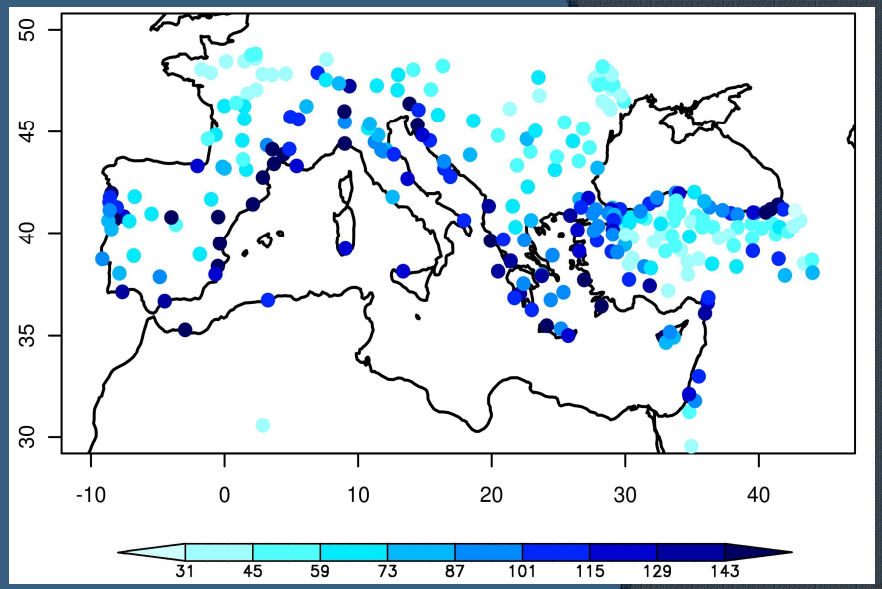
# The Mediterranean climate

Winter (ONDJF) extreme precipitation. Return Levels (mm)




*Source: Toreti et al., 2010*

5-year

50-year

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# The simulated 20th century

Mean Temperature: biases (°C,1980-1999)

| | *min* | *median* | *max* |
|---|---|---|---|
| *DJF* | -4.6 | -1.1 | 2.1 |
| *MAM* | -3.1 | -1.1 | 1.5 |
| *JJA* | -2.8 | 0 | 4.2 |
| *SON* | -3.5 | -1.6 | 1.0 |

*Adapted from IPCC, 2007*

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# The simulated 20th century

Precipitation: biases (%, 1980-1999)

| | *min* | *median* | *max* |
|---|---|---|---|
| *DJF* | -8 | 8 | 67 |
| *MAM* | -23 | 15 | 80 |
| *JJA* | -53 | 8 | 65 |
| *SON* | -32 | -9 | 31 |

*Adapted from IPCC, 2007*

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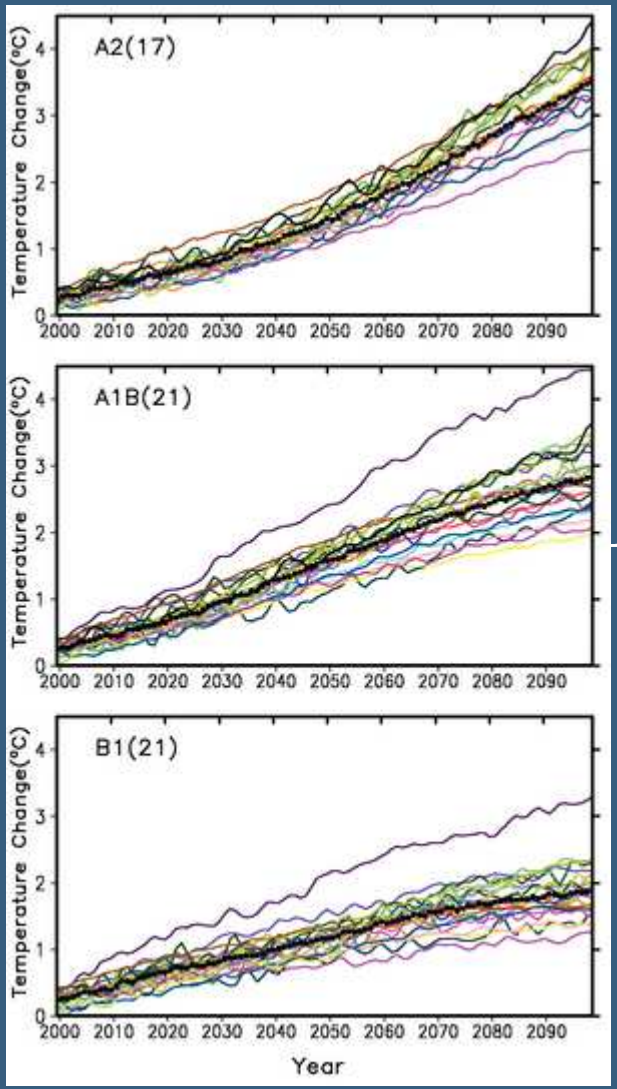
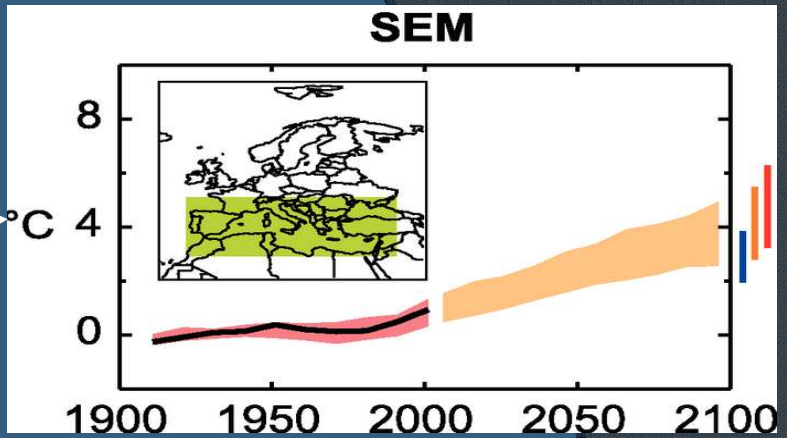
# The 21st century: temperature




Source: IPCC, 2007




| | min | median | max |
|---|---|---|---|
| DJF | 1.7 | 2.6 | 4.6 |
| MAM | 2.0 | 3.2 | 4.5 |
| JJA | 2.7 | 4.1 | 6.5 |
| SON | 2.3 | 3.3 | 5.2 |

*A1B, 2080-2099 wrt 1980-1999.*

*Adapted from IPCC, 2007.*

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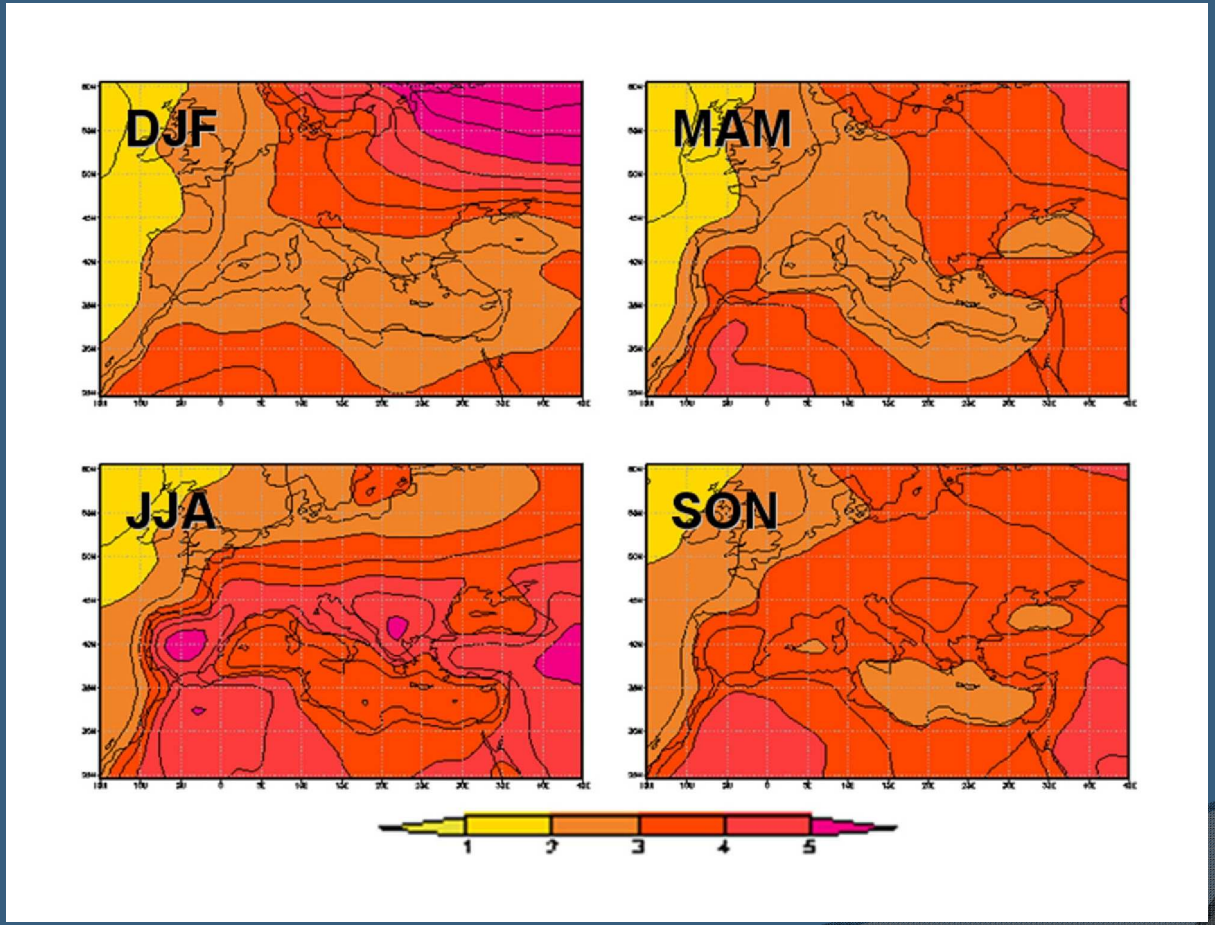
# The 21st century: temperature

A1B, 2071-2100 wrt 1961-1990 (°C)




*Source: Giorgi and Lionello, 2008*

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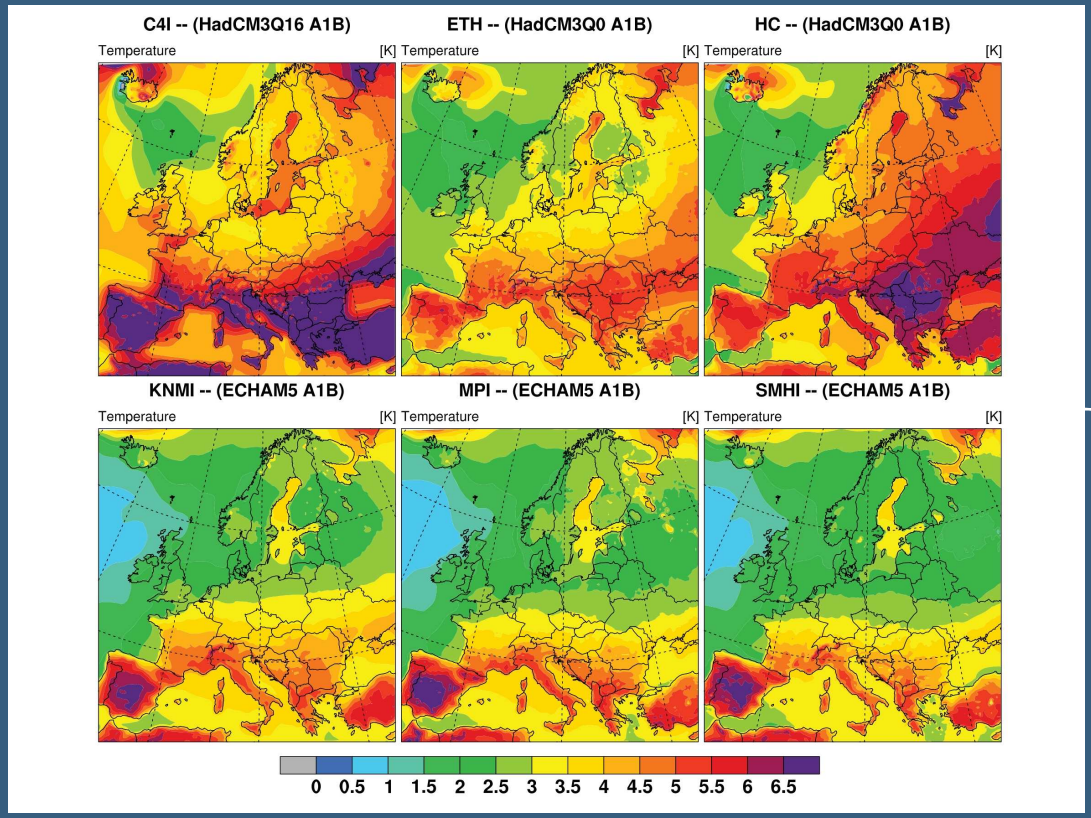
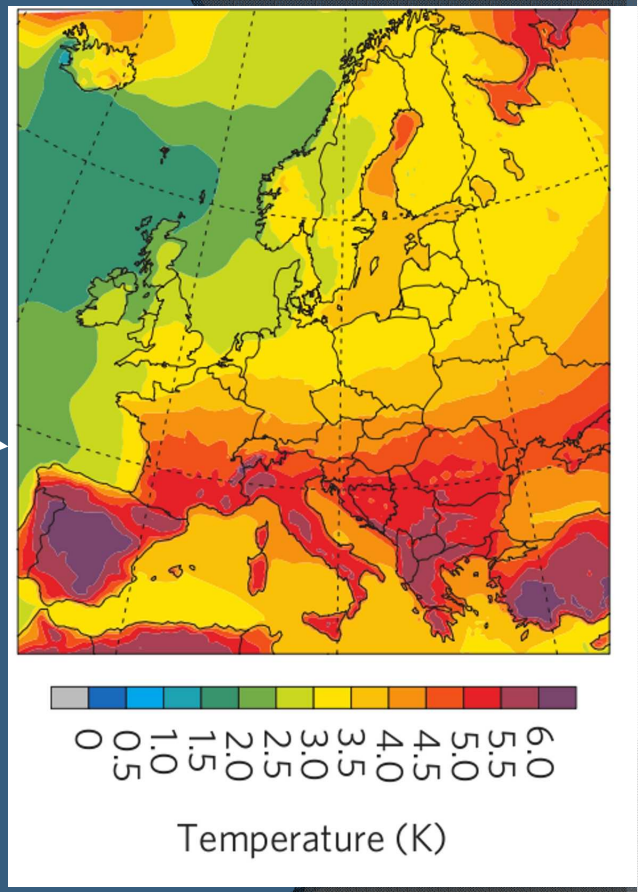
# The 21st century: temperature




*Source: Fischer and Schär, 2010*




RCMs: summer (JJA) mean temperature. 2071-2100 wrt 1961-90 (A1B).

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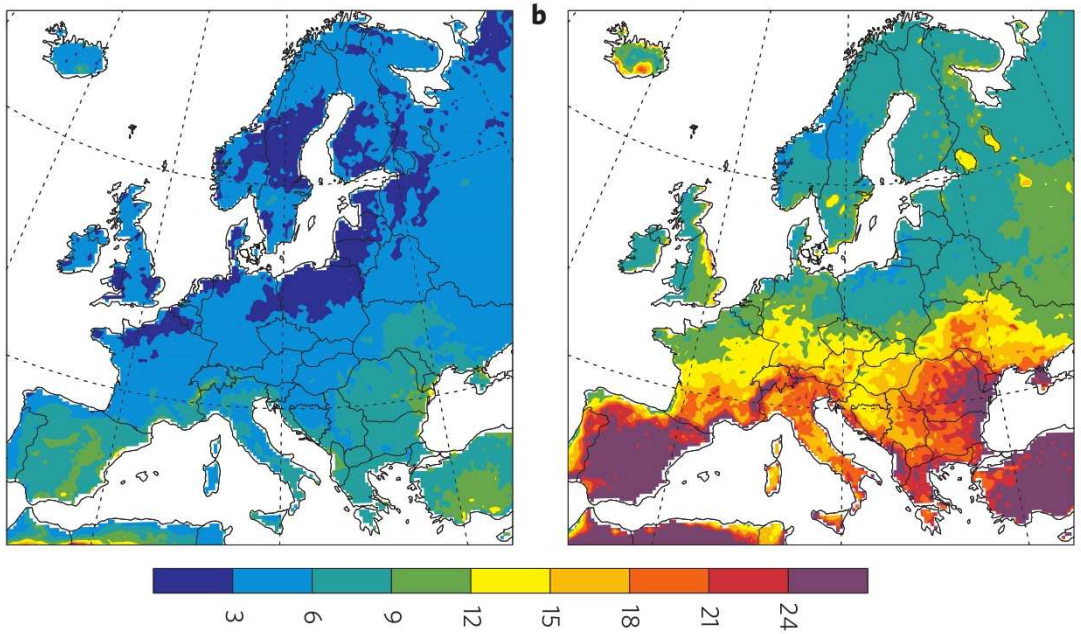
# The 21st century: temperature

2021-2050 2071-2100




*Source: Fischer and Schär, 2010*

Heat wave frequency (days) wrt 1961-1990. 6-RCM ensemble.

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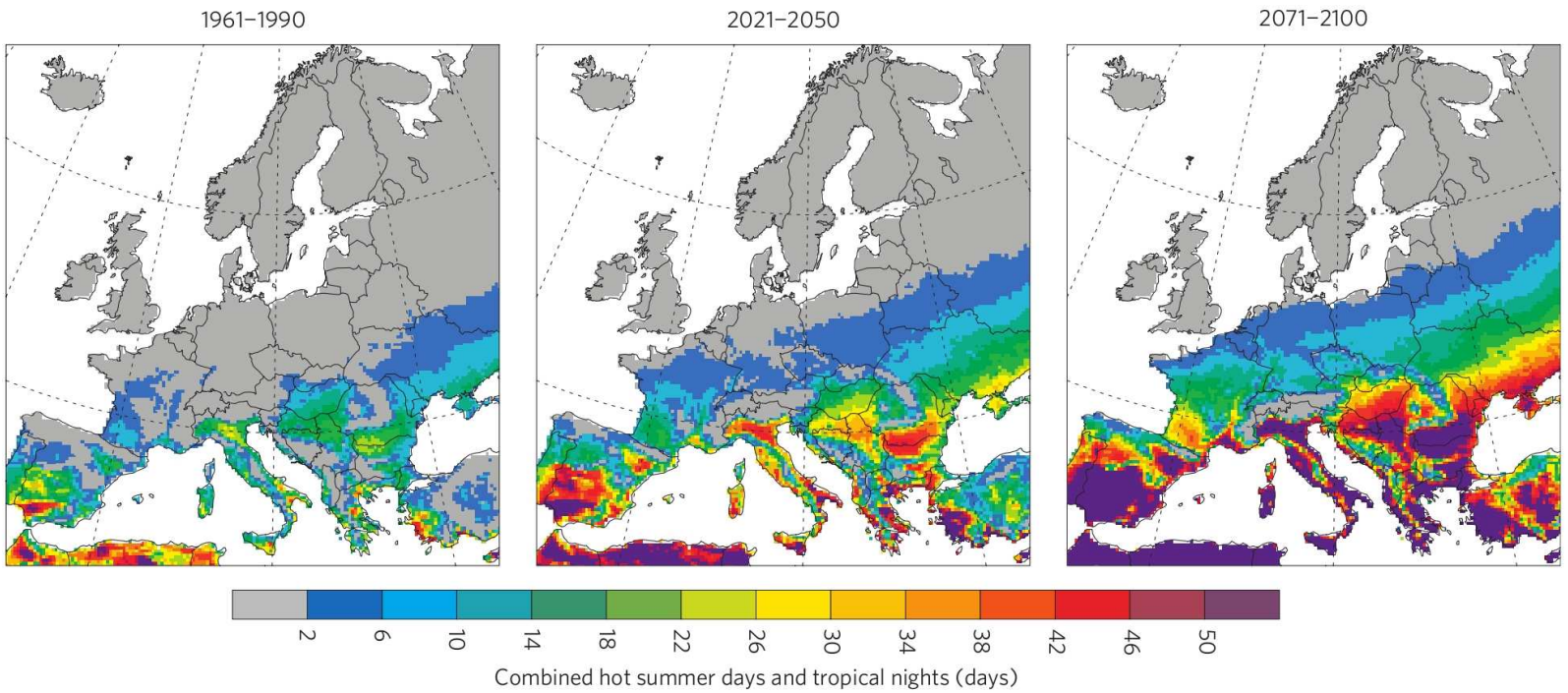
# The 21st century: temperature




*Source: Fischer and Schär, 2010*

Summer days with Tmax > 35 °C and Tmin > 20 °C.
6-RCM ensemble, A1B.

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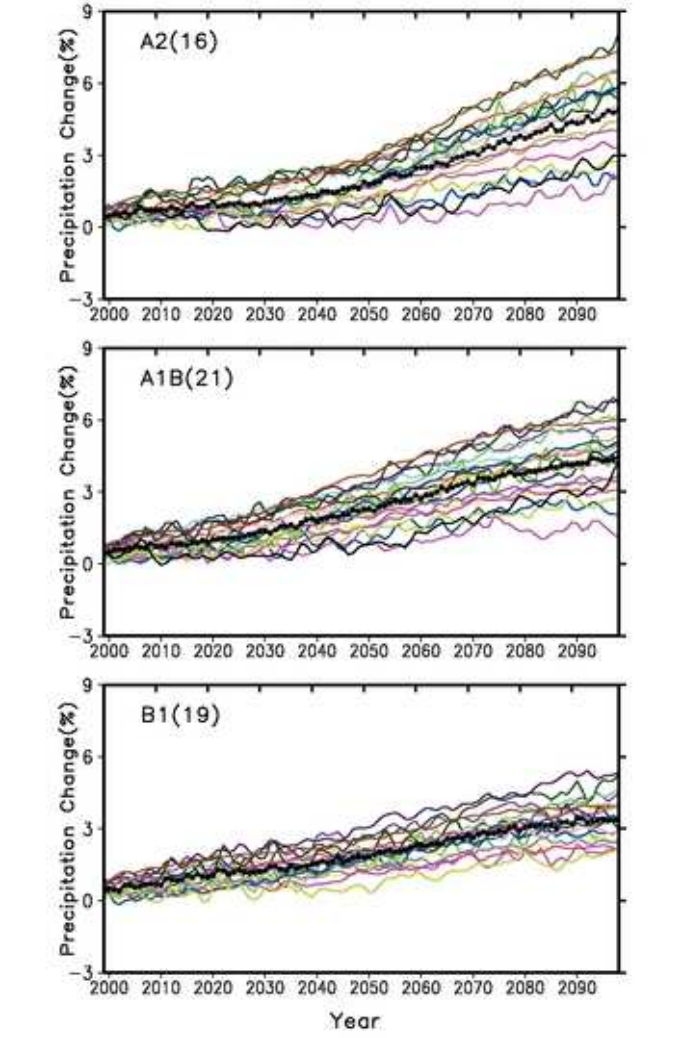
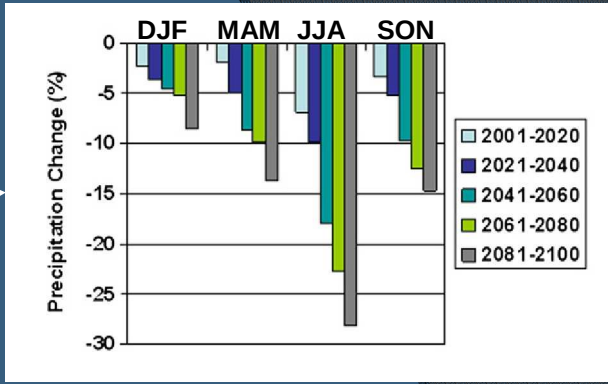
# The 21st century: precipitation




Source: IPCC, 2007




Source: Giorgi and Lionello, 2008

| | min | median | max |
|---|---|---|---|
| DJF | -16 | -6 | 6 |
| MAM | -24 | -16 | -2 |
| JJA | -53 | -24 | -3 |
| SON | -29 | -12 | -2 |

*A1B, 2080-2099 wrt 1980-1999.*

*Adapted from IPCC, 2007.*

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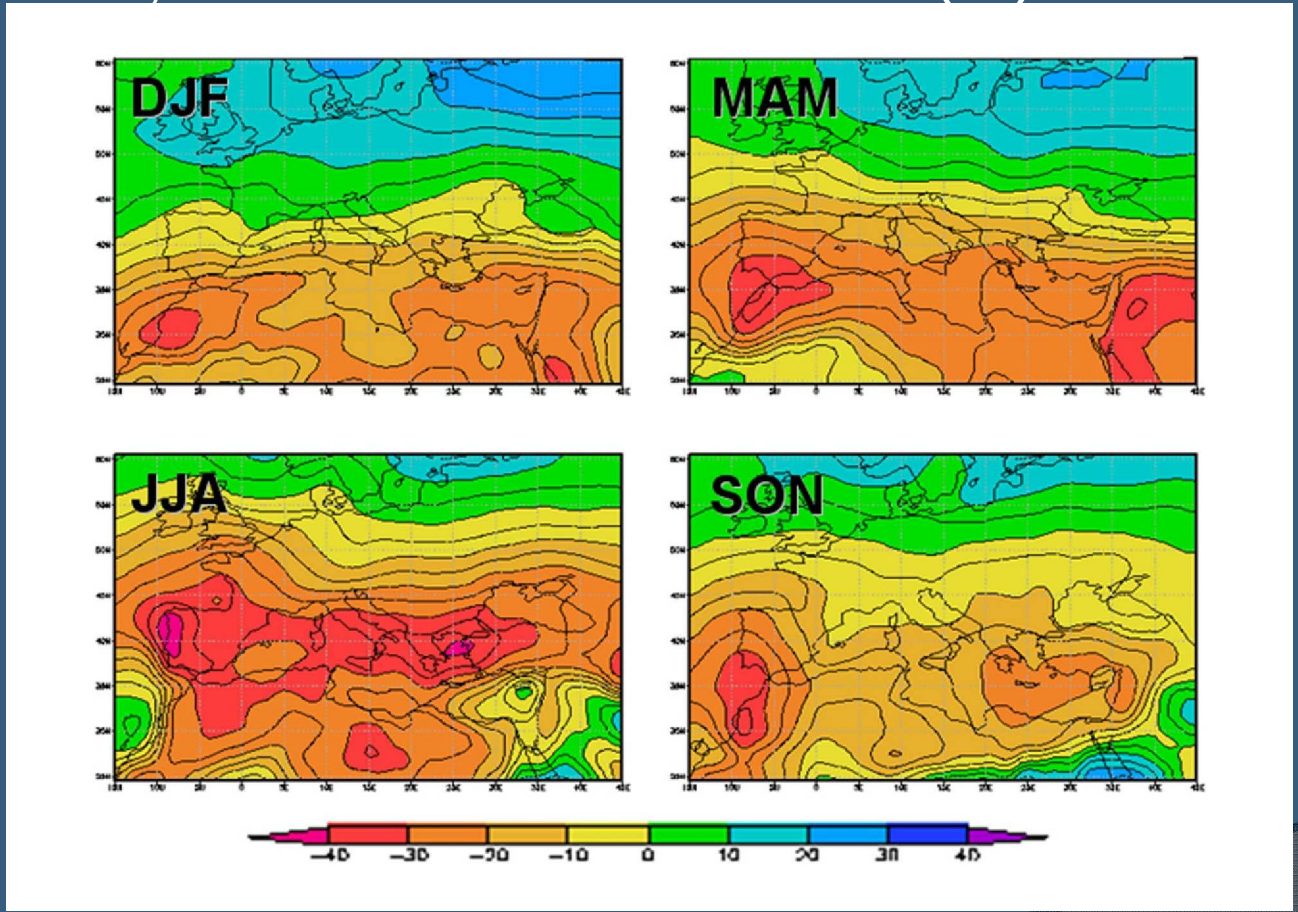
# The 21st century: precipitation

A1B, 2071-2100 wrt 1961-1990 (%)




*Source: Giorgi and Lionello, 2008*

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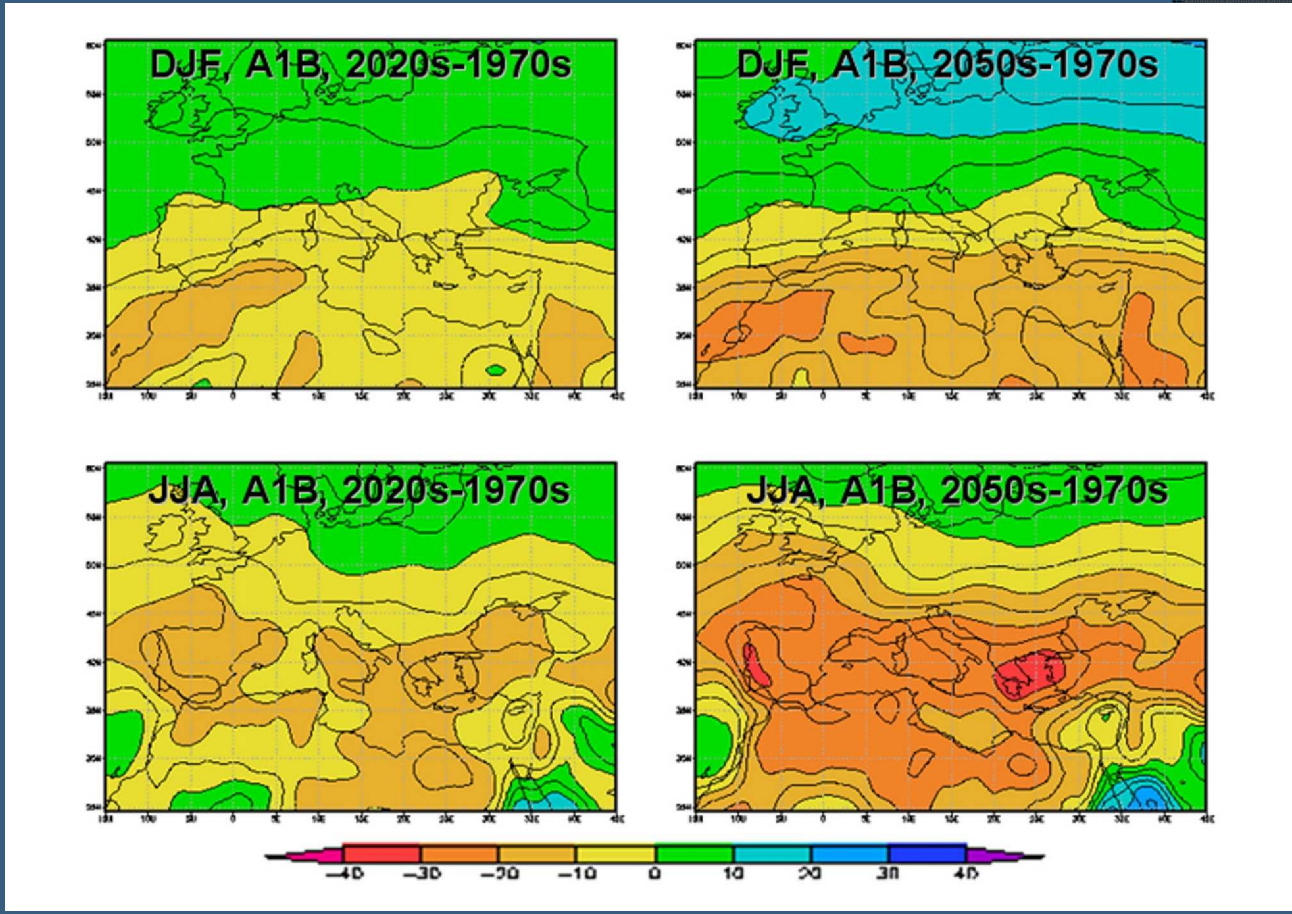
# The 21st century: precipitation




*Source: Giorgi and Lionello, 2008*

Winter and Summer precipitation changes (% of 1961-1990 value).

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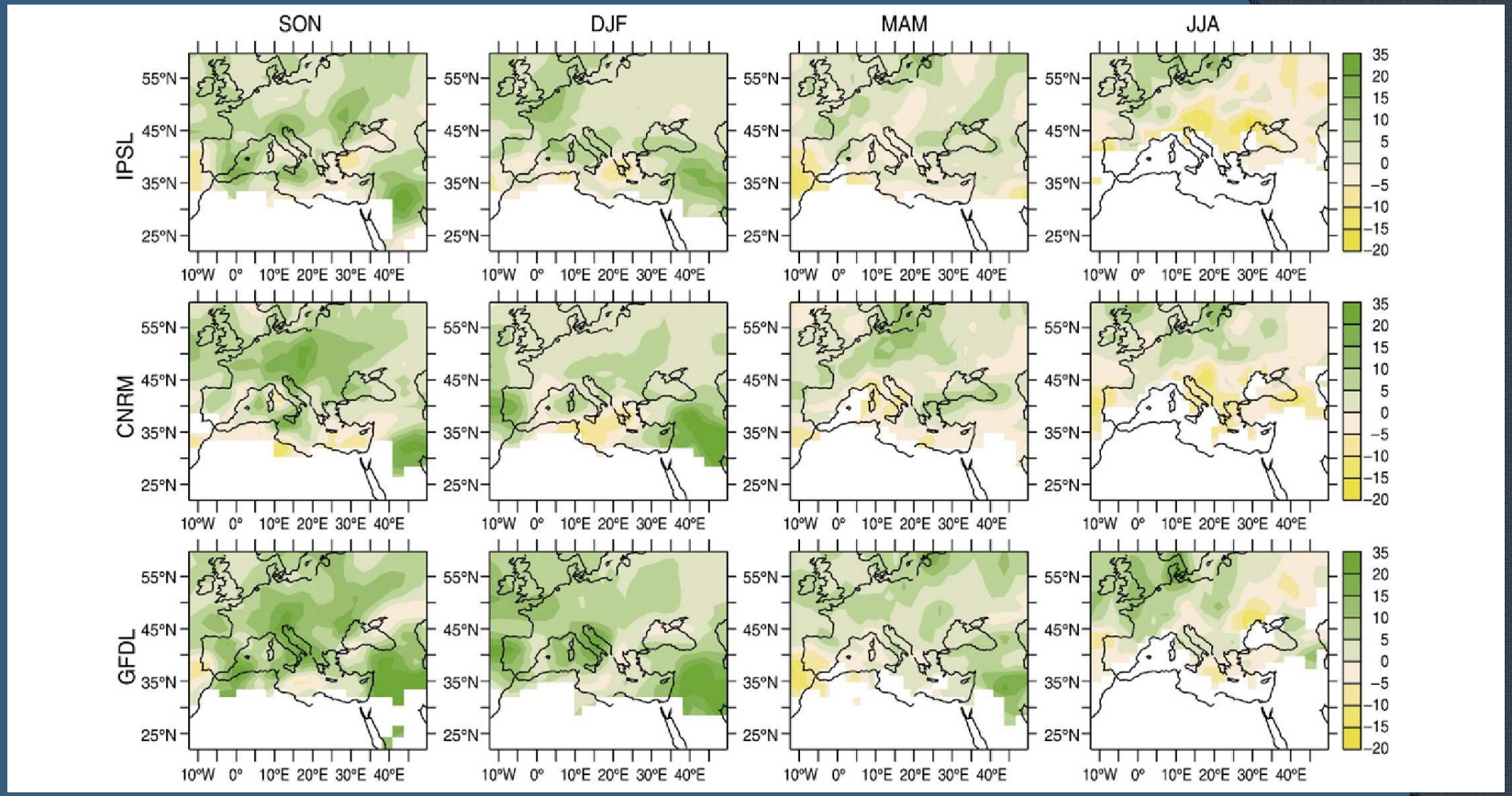
# The 21st century: precipitation




*Source: Goubanova and Li, 2007*

30-year return level of extreme precipitation. 2070-2099 (A2) wrt 1970-1999 (mm/day).

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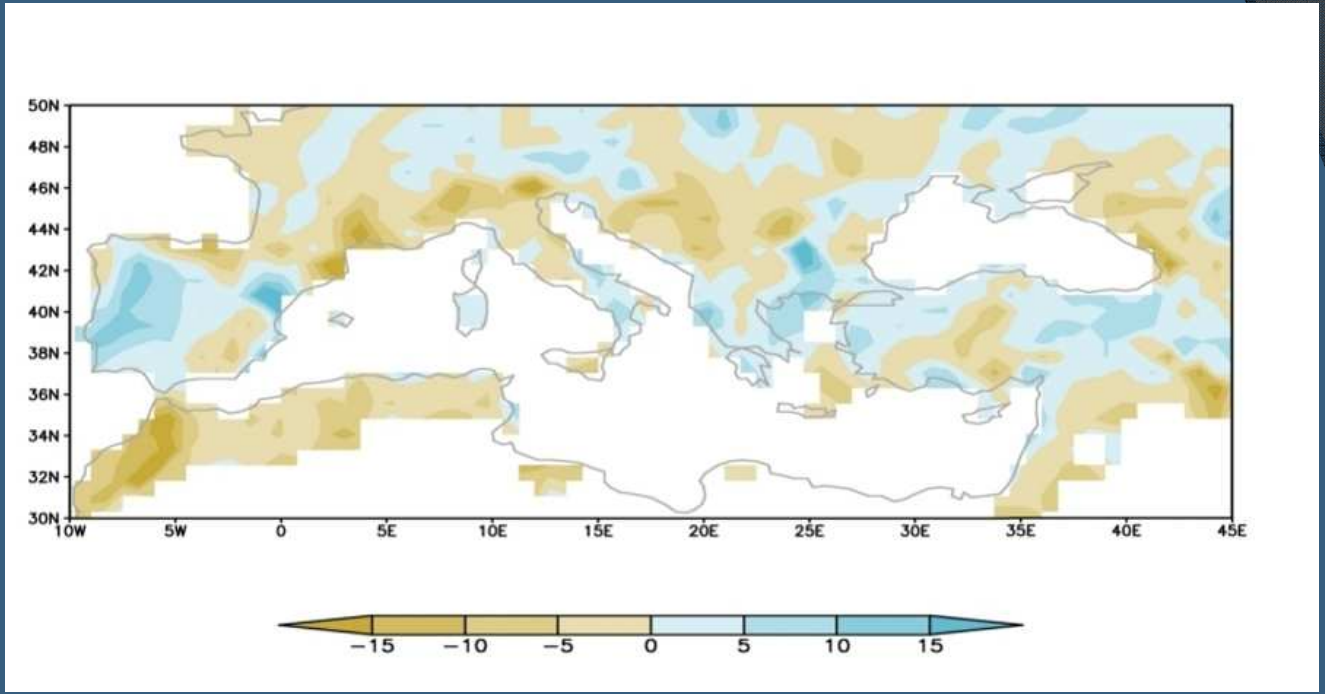
# The 21st century: precipitation




*Source: Toreti et al., 2010*

5-year return level (mm). A1B scenario, 2031-2050 wrt control run.

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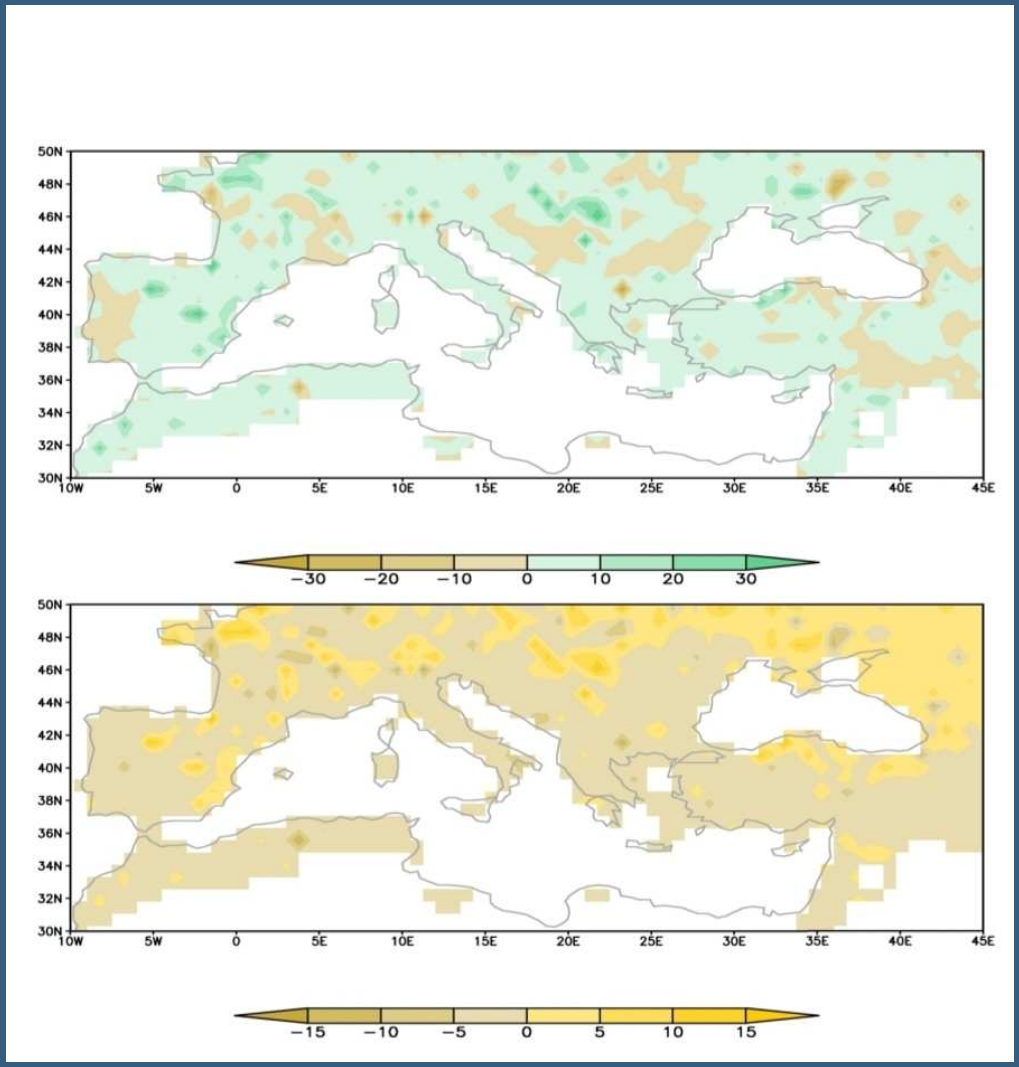
# The 21st century: precipitation




Fraction of total winter precipitation due to extreme events (%)

Number of extreme precipitation days (days)

*Source: Toreti et al., 2010*

A1B, 2031-2050 wrt control run

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# Conclusions

✓ The Mediterranean region is and will be more exposed to climate change

✓ Climate projections show an increase of the mean temperature in all seasons.

✓ Extreme temperature events show an increase in terms of intensity, duration and frequency.

✓ Seasonal precipitation shows a higher spatial variability. A decrease is evident in most of the Mediterranean areas, especially in summer.

✓ Extreme precipitation events show an increase in the intensity.

✓ *Although many features of the simulated climate change in Europe and the Mediterranean area are qualitatively consistent among models and qualitatively well understood in physical terms*, **substantial uncertainties remain** (IPCC, 2007)

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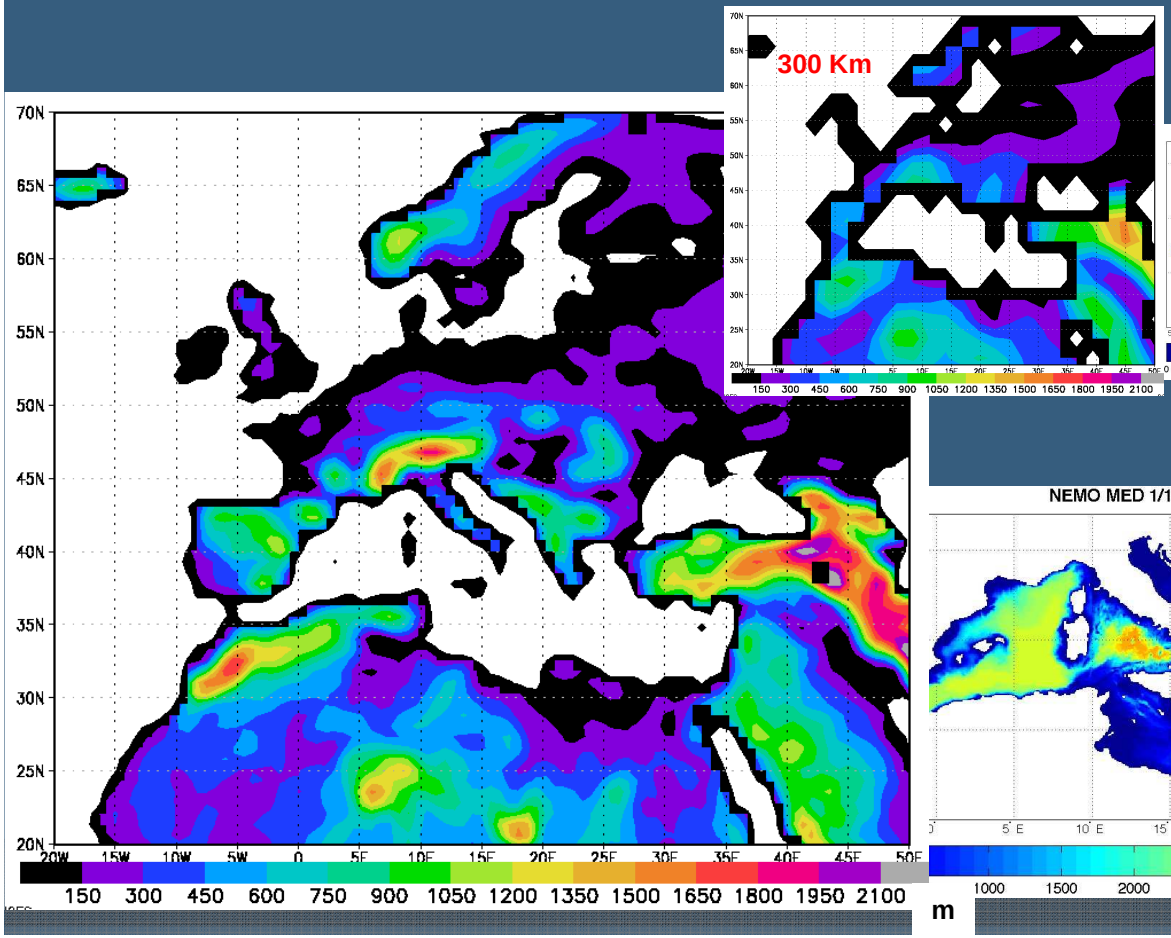
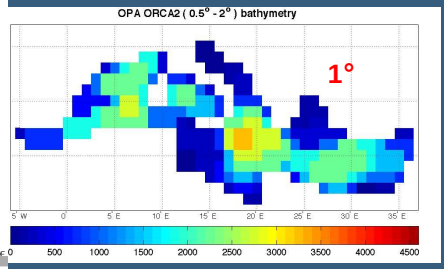
# Outlook

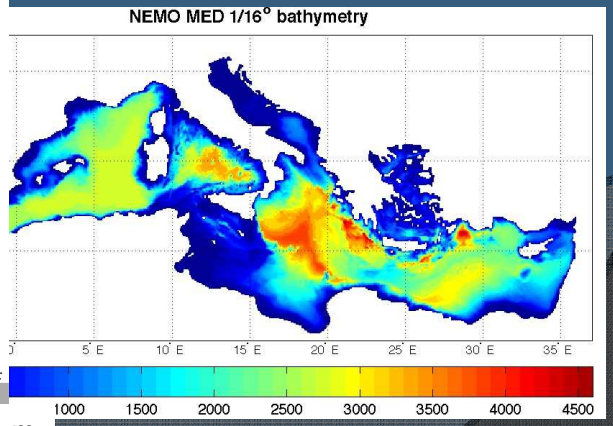
Towards a better representation of the Mediterranean region:

INGV-CMCC GCM




*Source: Gualdi, 2010*

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# Thank you!

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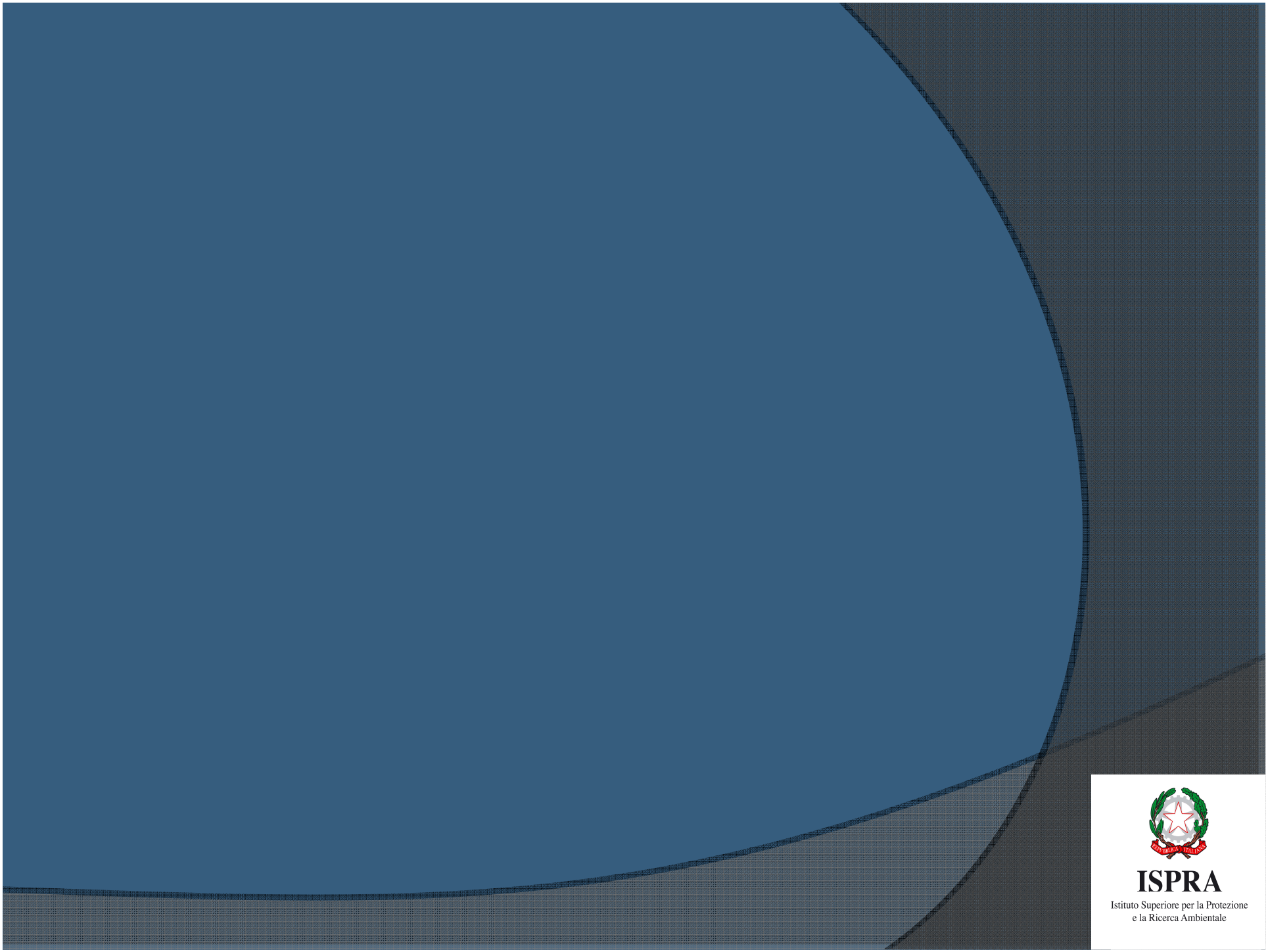

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