

Future Rainfall Projections



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The Water Tribune, Expo Zaragoza 21.- 23.7. 2008

Outline

- Motivation
- Global Climate Models and Scenarios
- Global Precipitation Change
- Regional Precipitation Change
- Downscaling
- Summary

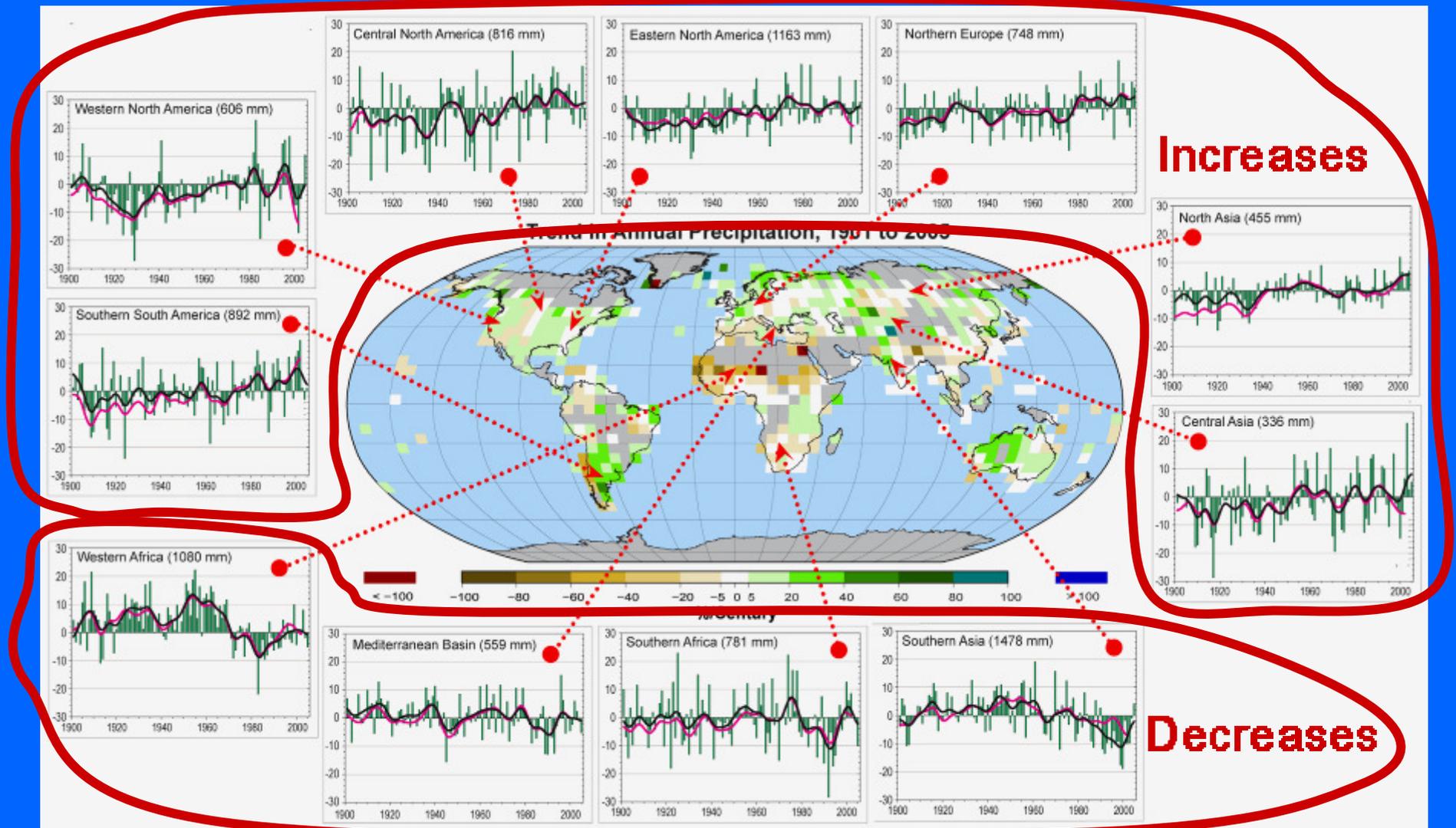
Motivation

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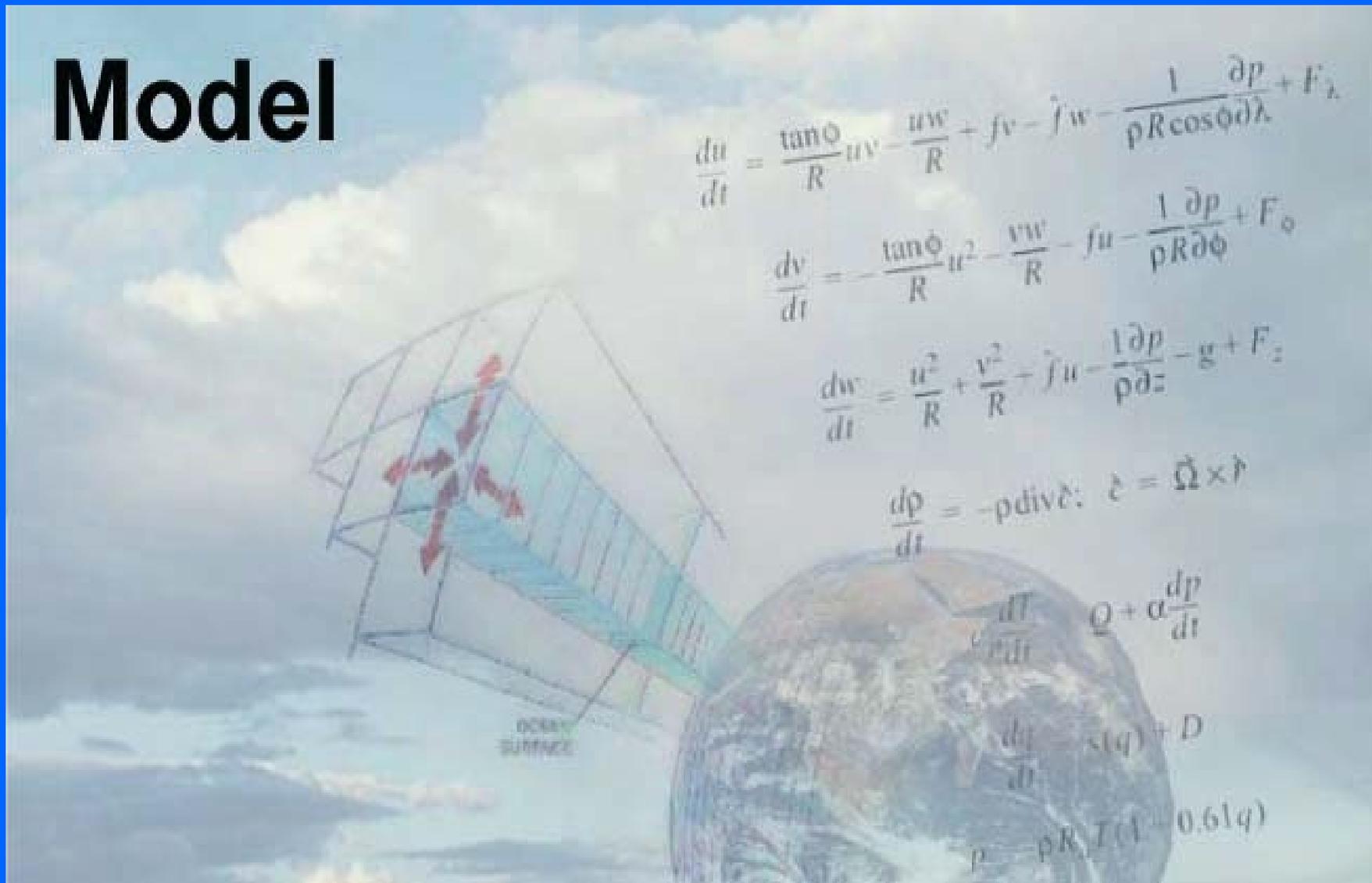
Annual Anomalies for Precipitation



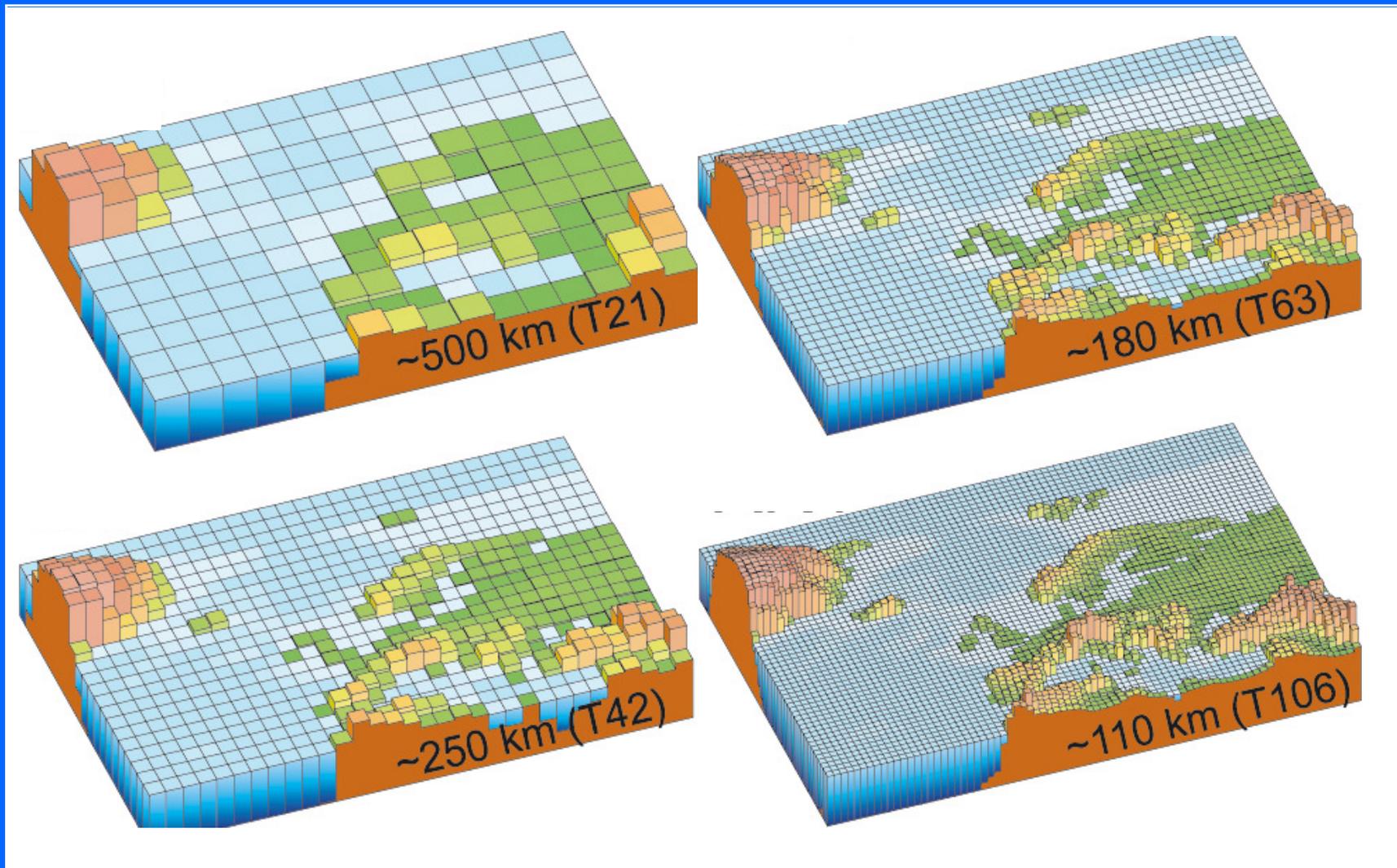
Global Climate Models and Scenarios

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Model



The model equations are solved on a grid with a resolution of ca. 300 x 300 km



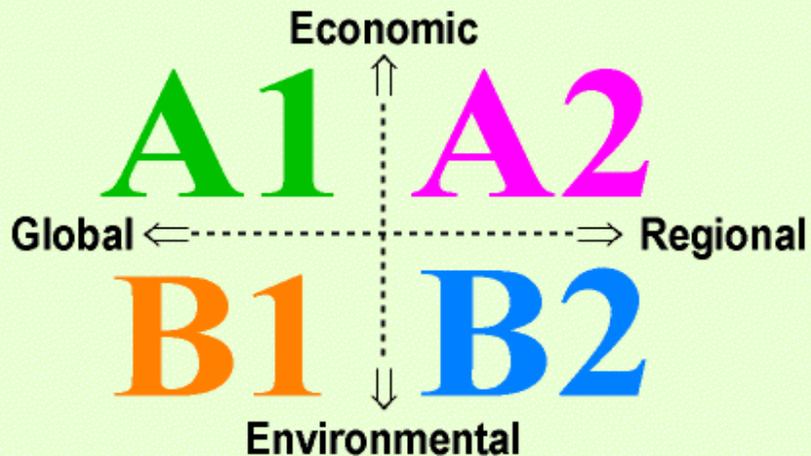
The different horizontal resolutions in a global climate model

(IPCC 2007)

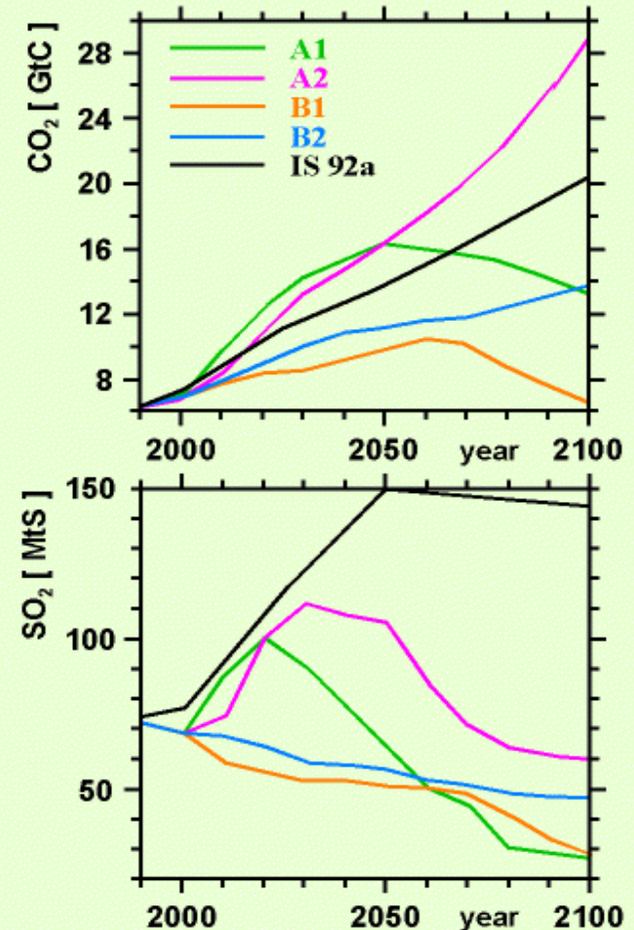
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A New Set of IPCC Emissions Scenarios (SRES Scenarios)

- A1** A world of rapid economic growth and rapid introduction of new and more efficient technology.
- A2** A very heterogeneous world with an emphasis on family values and local traditions.
- B1** A world of "dematerialization" and introduction of clean technologies.
- B2** A world with an emphasis on local solutions to economic and environmental sustainability.
- IS 92a** "business as usual" scenario (1992).



CO₂ and SO₂ emissions

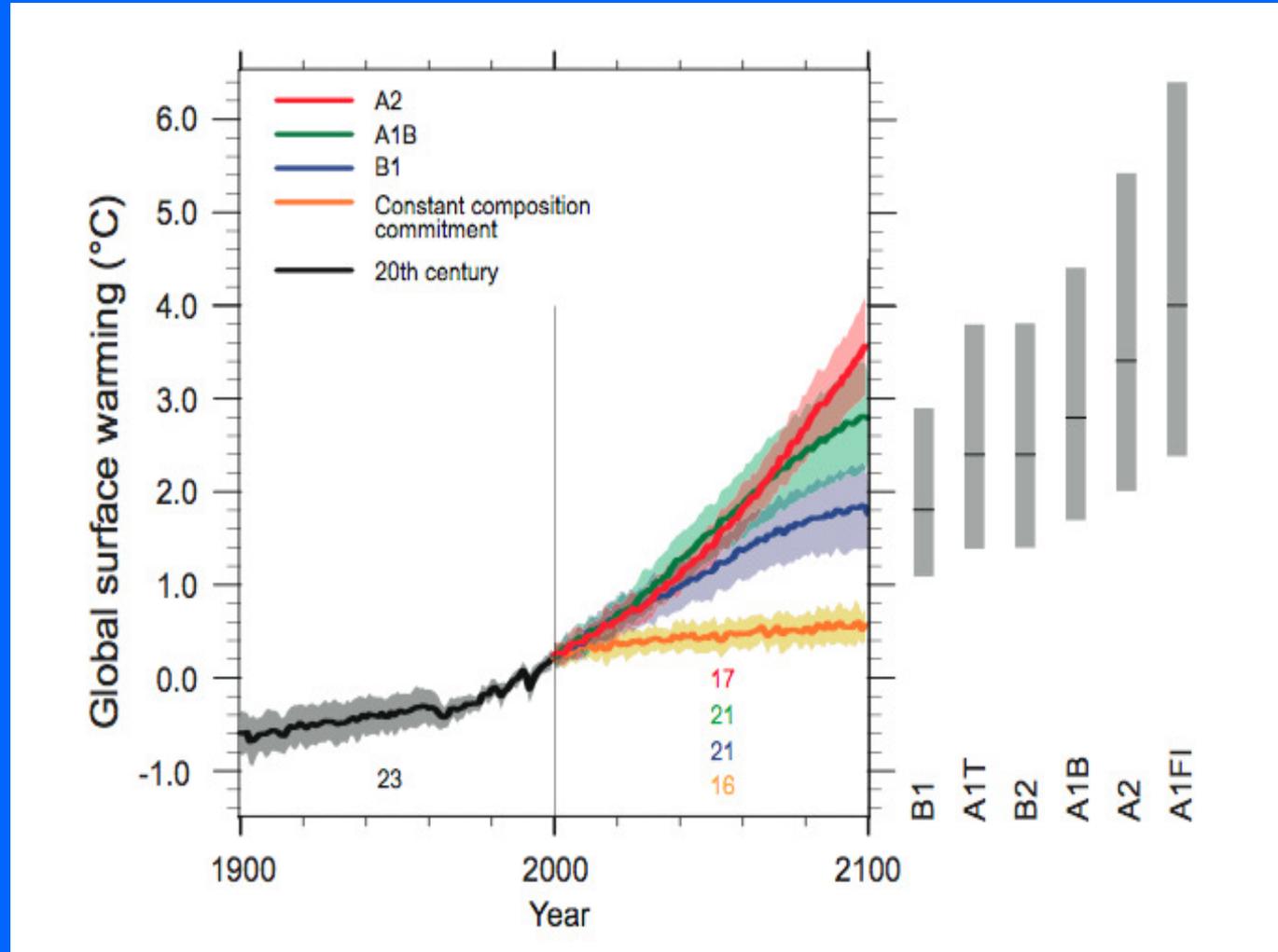


Global Precipitation Projections

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Projections of Future Temperature Changes in Climate

Best estimate for low scenario (B1) is 1.8°C (*likely range is 1.1°C to 2.9°C*), and for high scenario (A1FI) is 4.0°C (*likely range is 2.4°C to 6.4°C*).

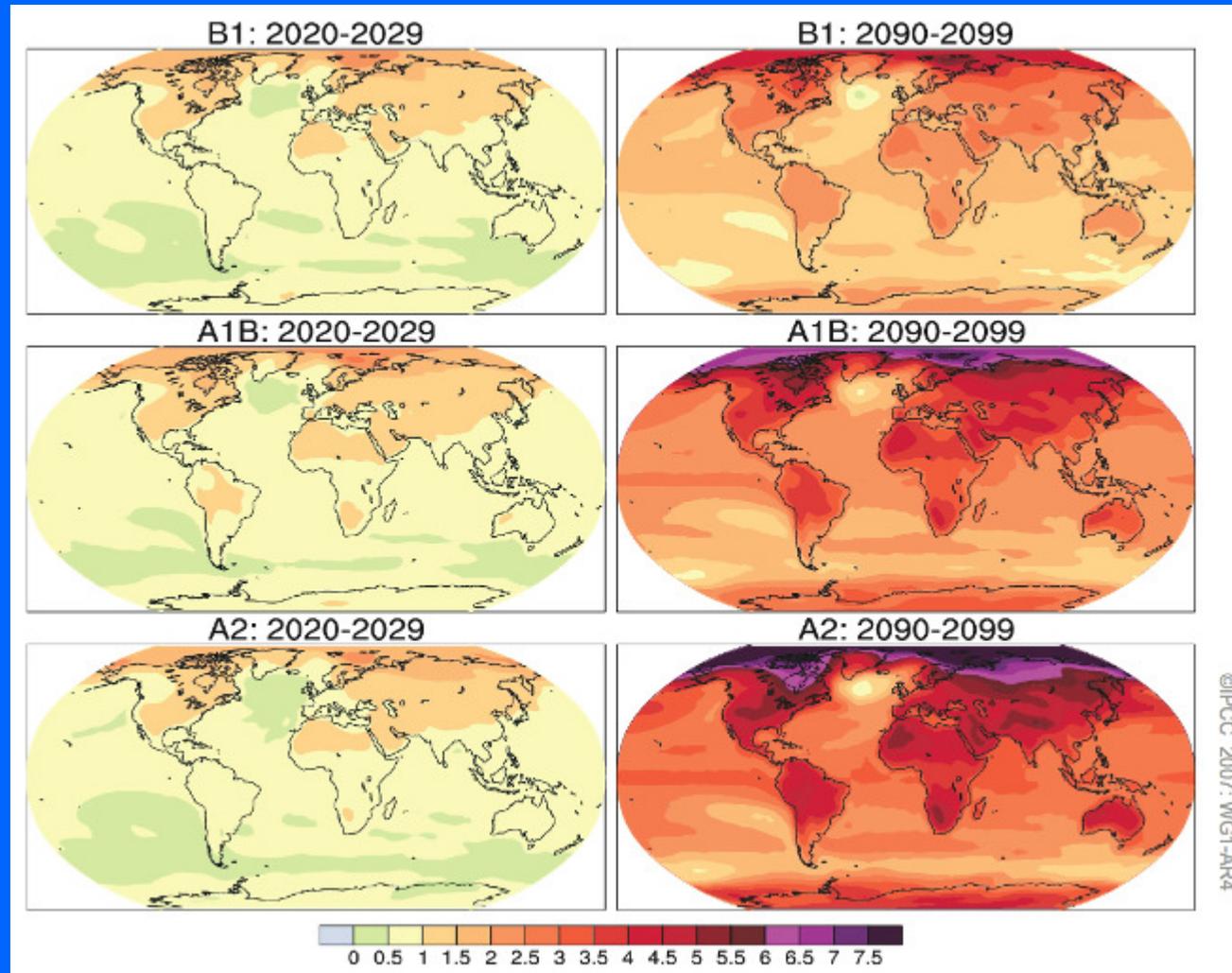


Projections of Future Changes in Climate

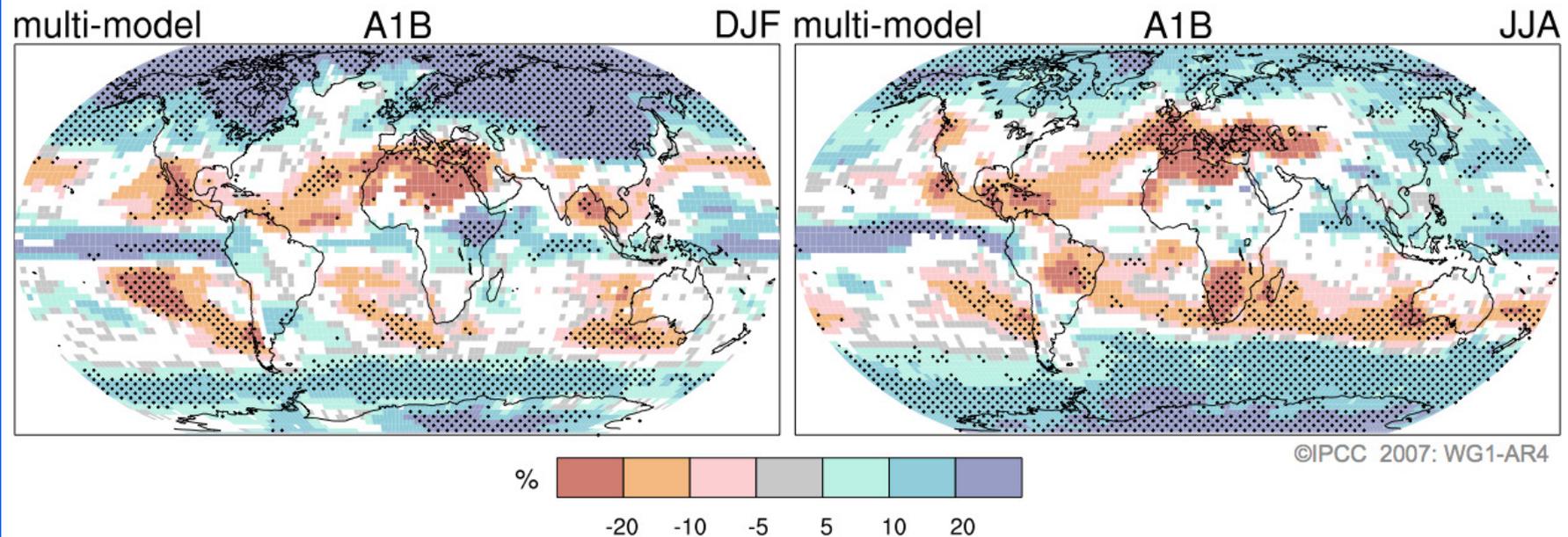
Projected warming in 21st century expected to be

greatest over land and at most high northern latitudes

and **least** over the Southern Ocean and parts of the North Atlantic Ocean

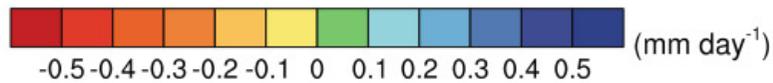
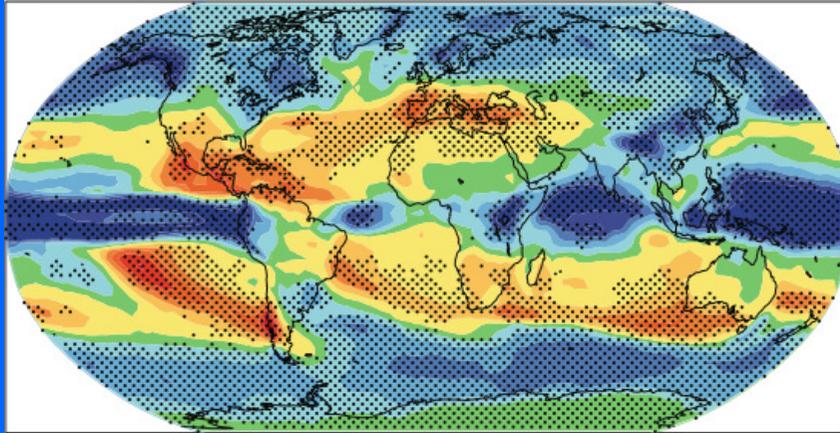


Projected Patterns of Precipitation Changes



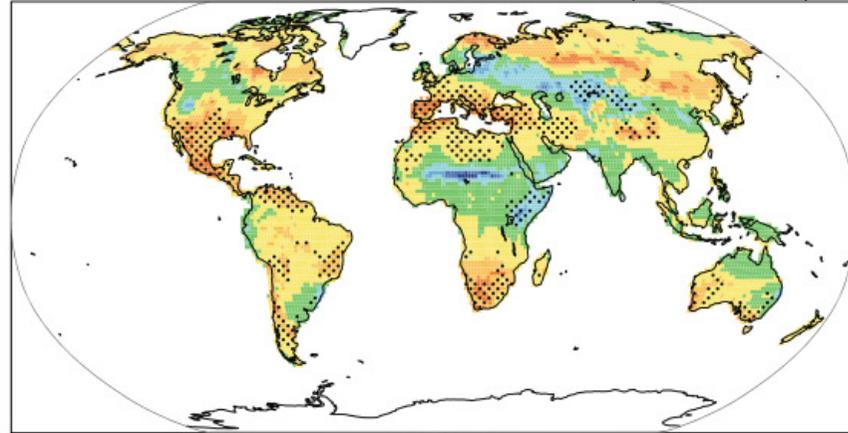
Precipitation Change at the End of the 21st Century for the Medium Scenario (A1b)

a) Precipitation

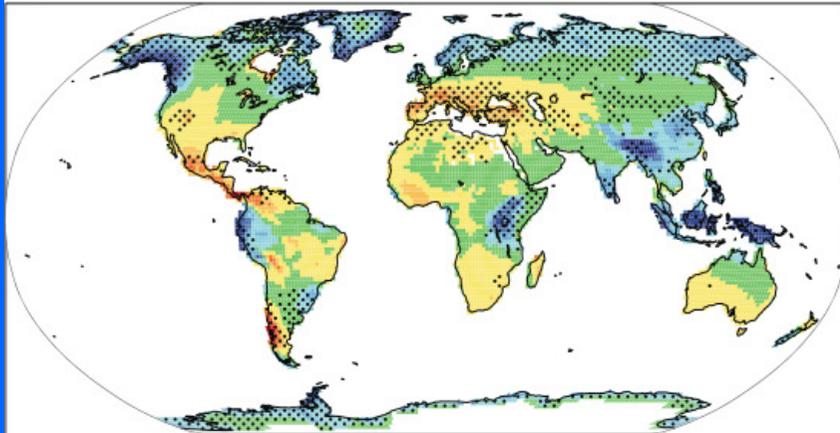


b) Soil moisture

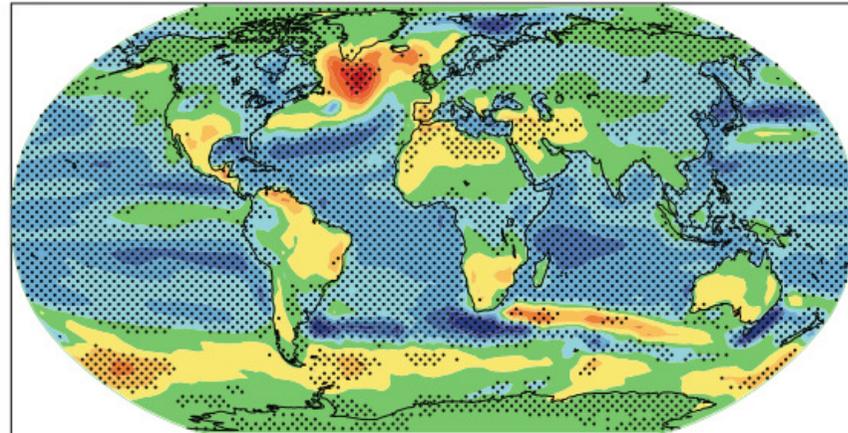
(IPCC, 2007)



c) Runoff



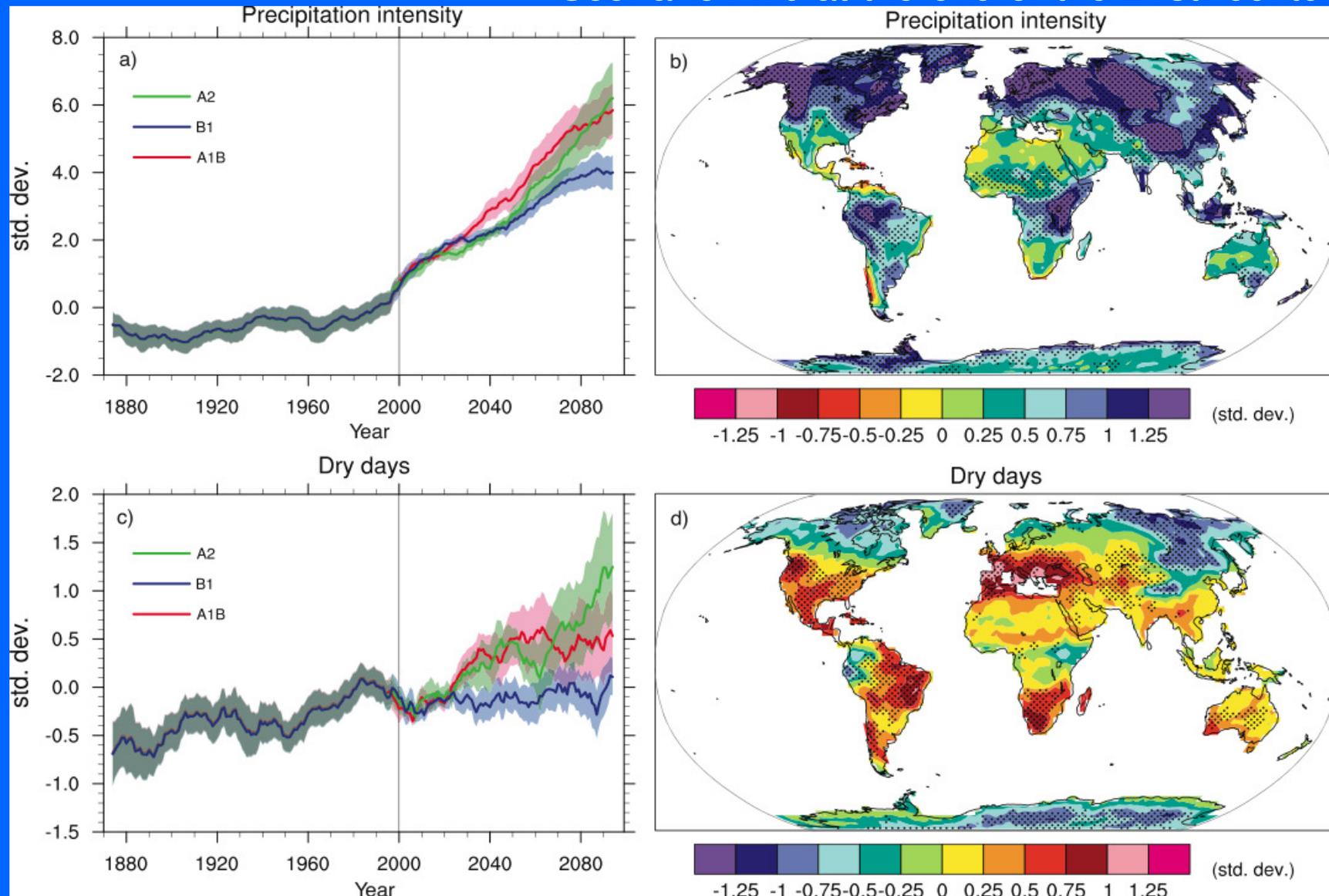
d) Evaporation



Various hydrological parameters for Scenario A1b at the end of the 21. century

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Scenario A1b at the end of the 21st. century



The precipitation intensity and the number of dry days (IPCC, 2007)

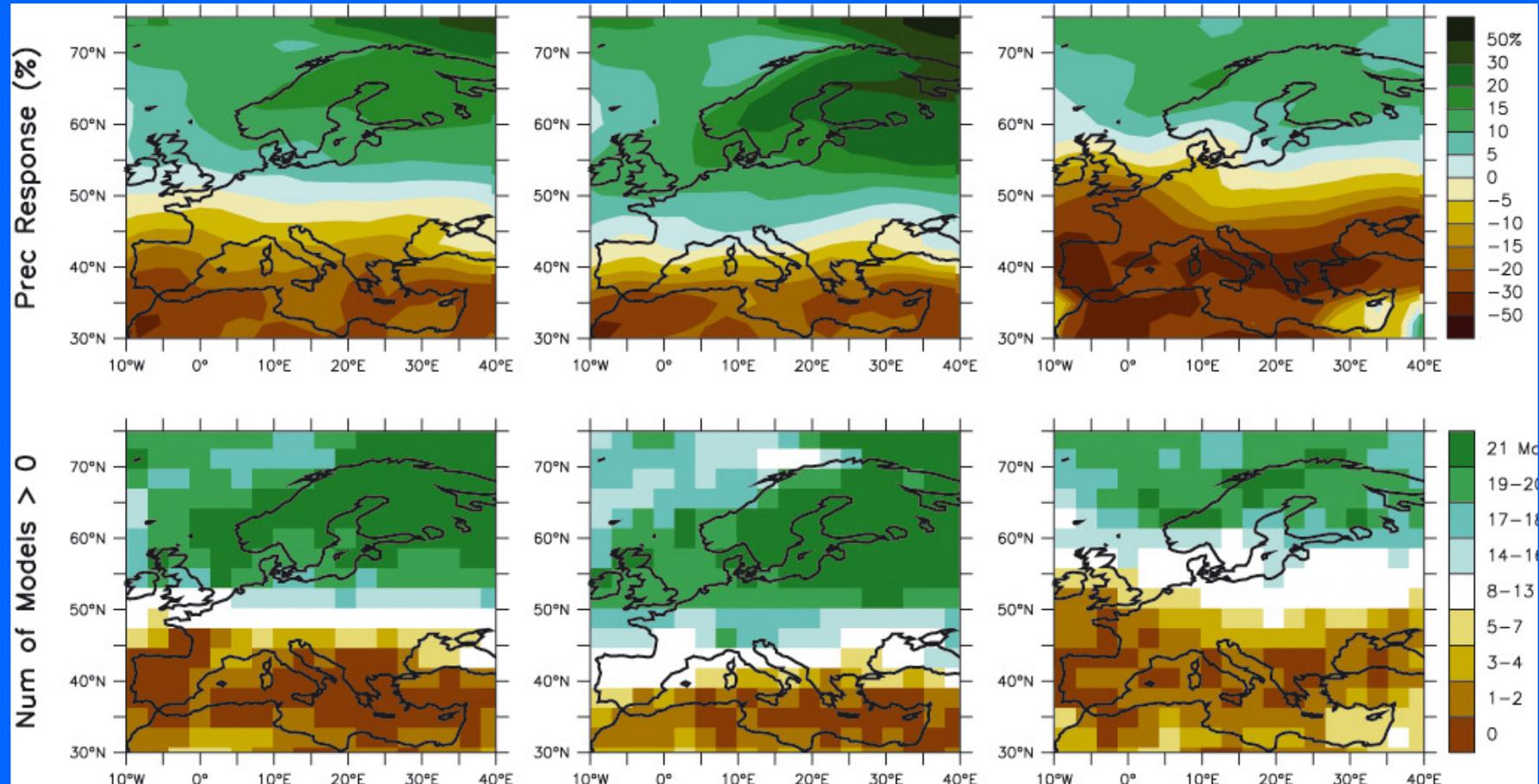
Regional Precipitation Change

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Annual

DJF

JJA

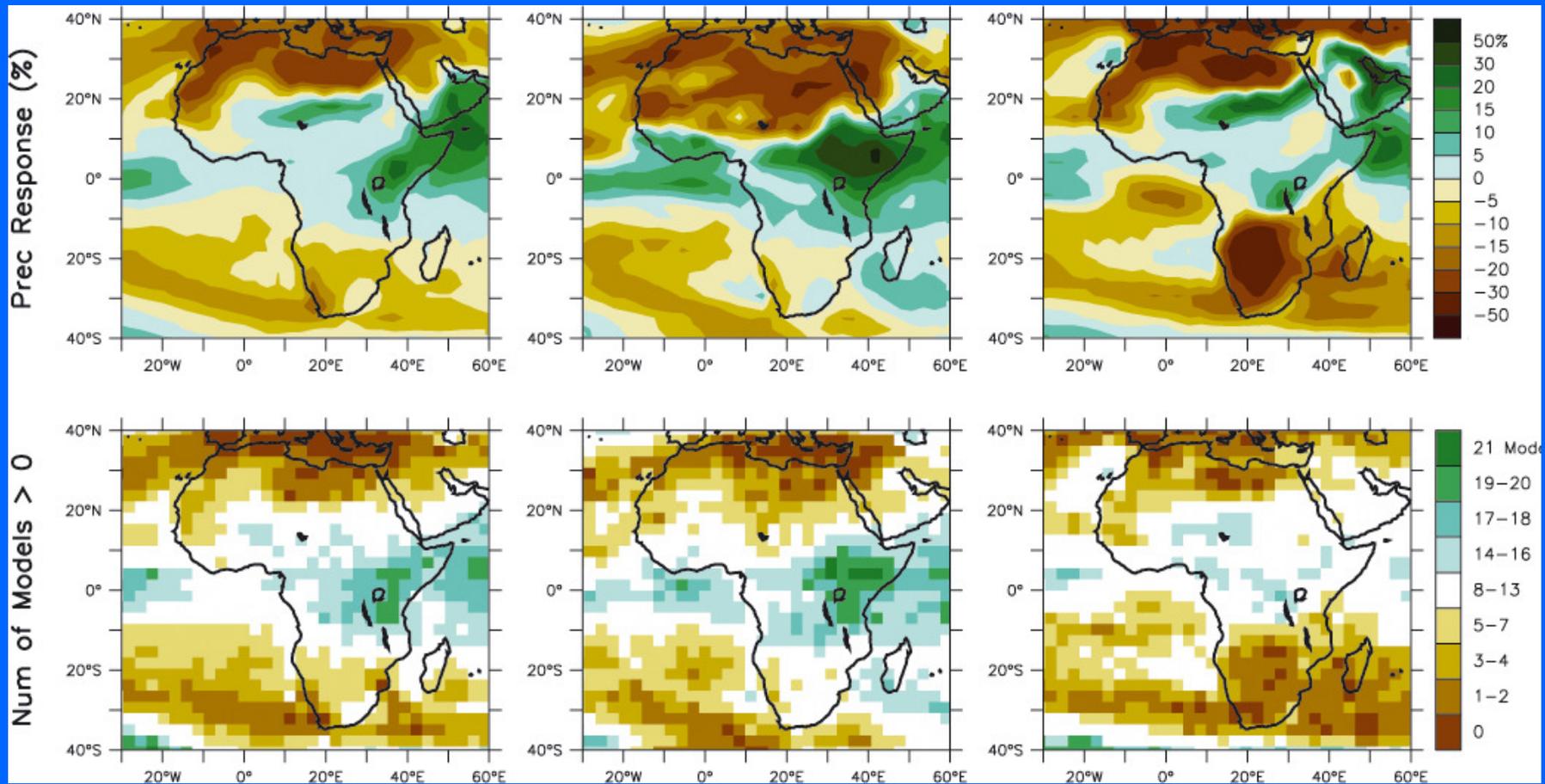


Precipitation changes (top) Europe for 2080 to 2099, Scenario A1b, bottom: number of models that project increases in precipitation, from IPCC 2007

Annual

DJF

JJA

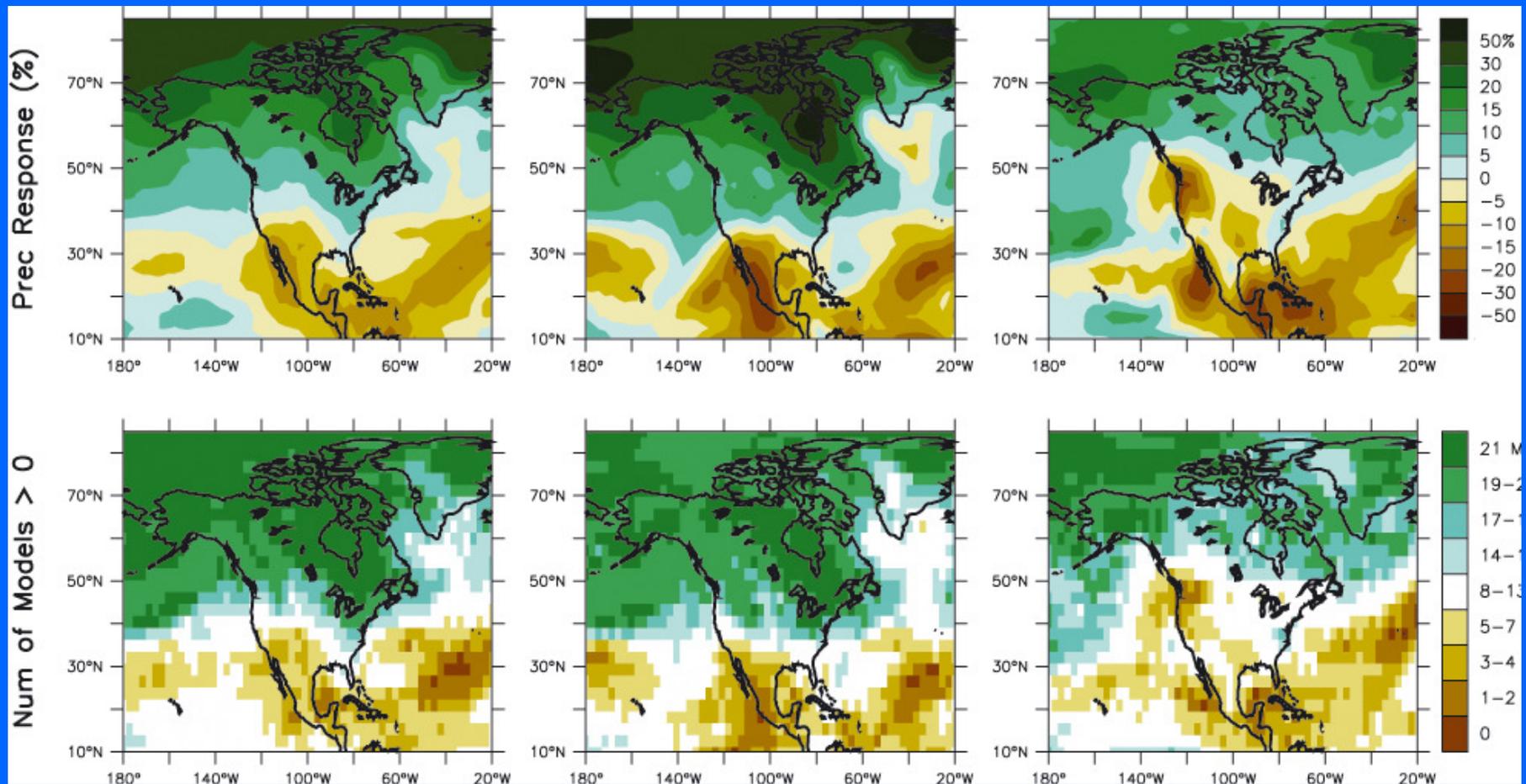


Precipitation changes (top) Africa for 2080 to 2099, Scenario A1b, bottom: number of models that project increases in precipitation, from IPCC 2007

Annual

DJF

JJA

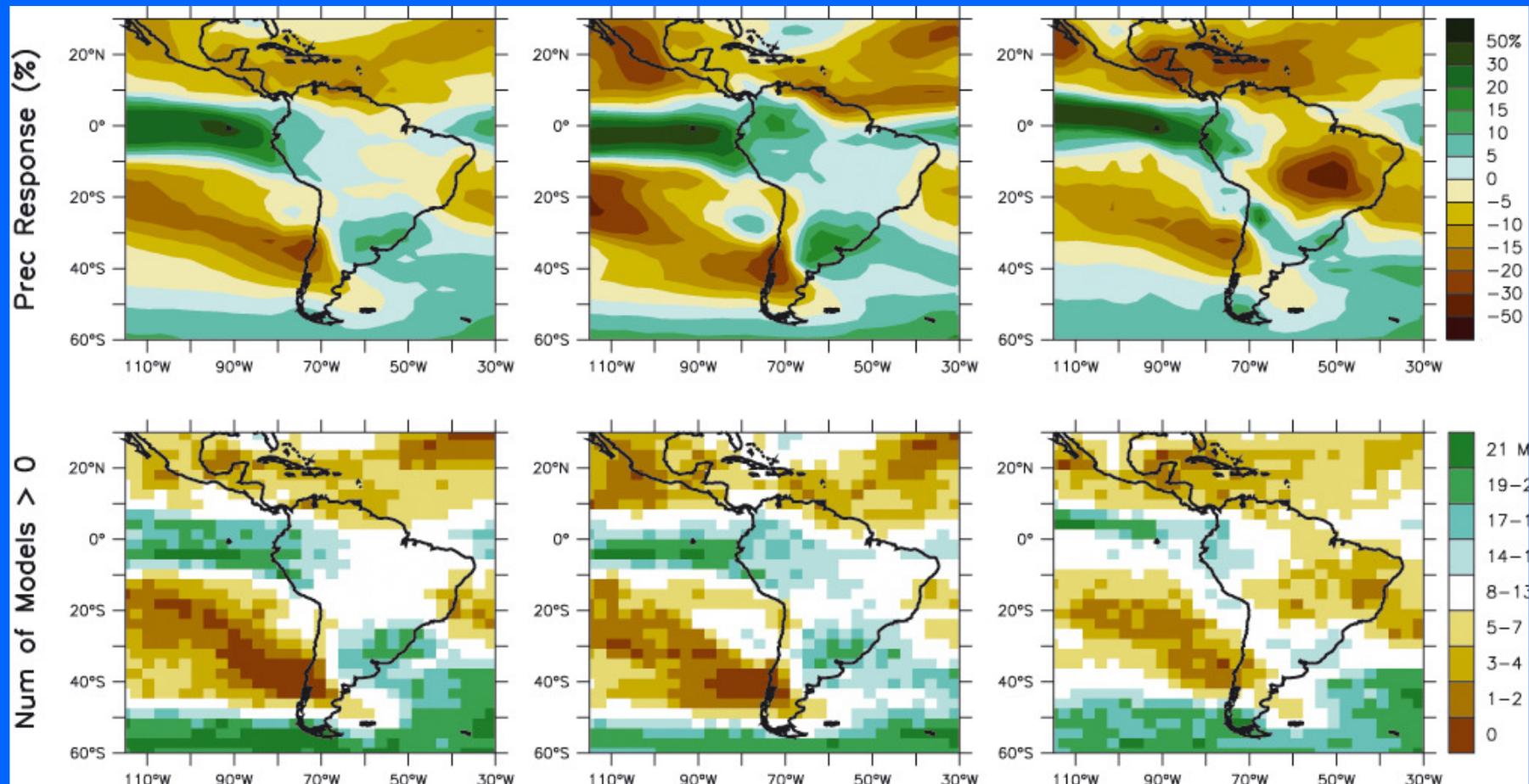


Precipitation changes (top) North America for 2080 to 2099, Scenario A1b, bottom: number of models that project increases in precipitation, from IPCC 2007

Annual

DJF

JJA

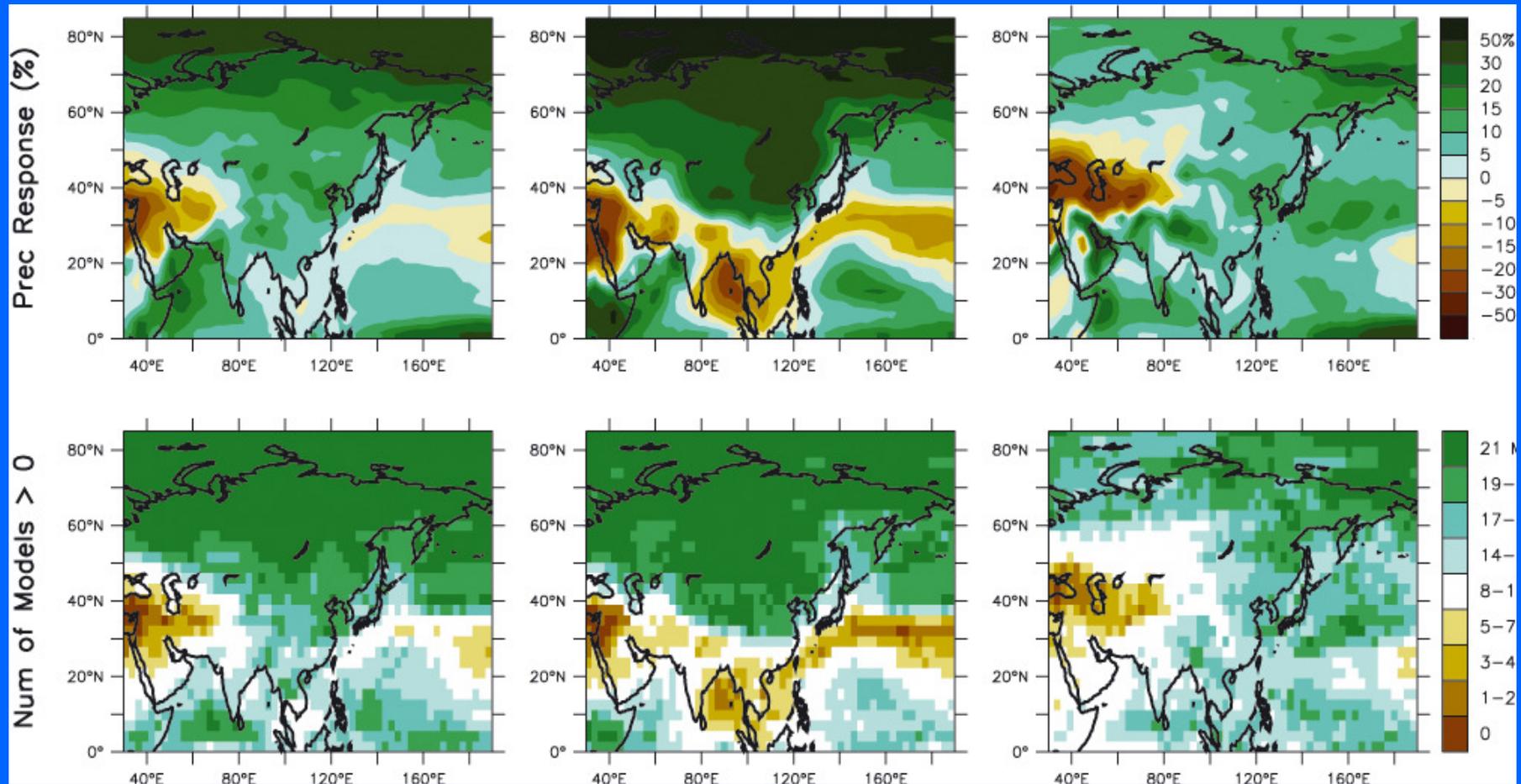


Precipitation changes (top) Central and South America
for 2080 to 2099, Scenario A1b,
bottom: number of models that project increases in precipitation,
from IPCC 2007

Annual

DJF

JJA

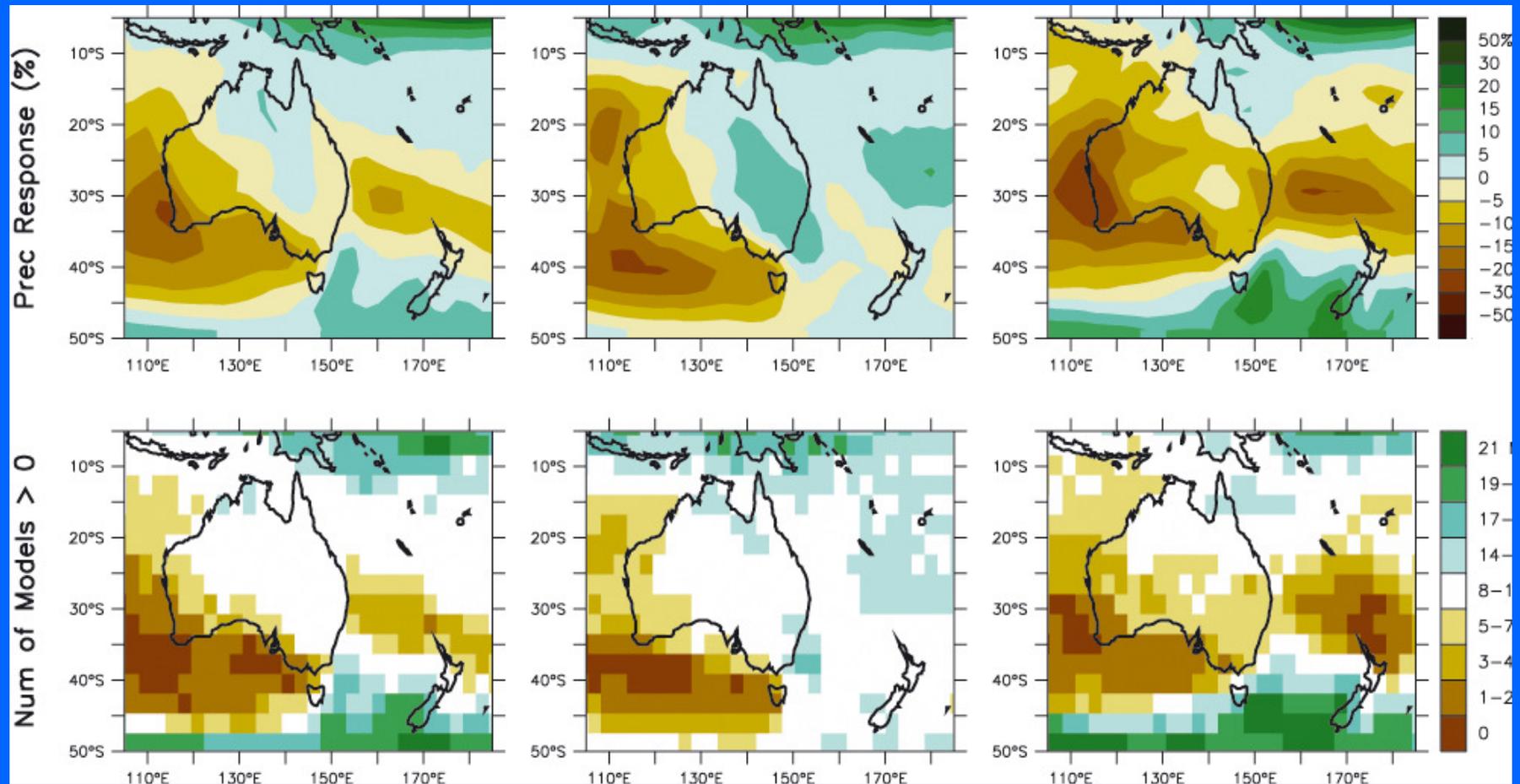


Precipitation changes (top) Asia for 2080 to 2099, Scenario A1b,
bottom: number of models that project increases in precipitation,
from IPCC 2007

Annual

DJF

JJA

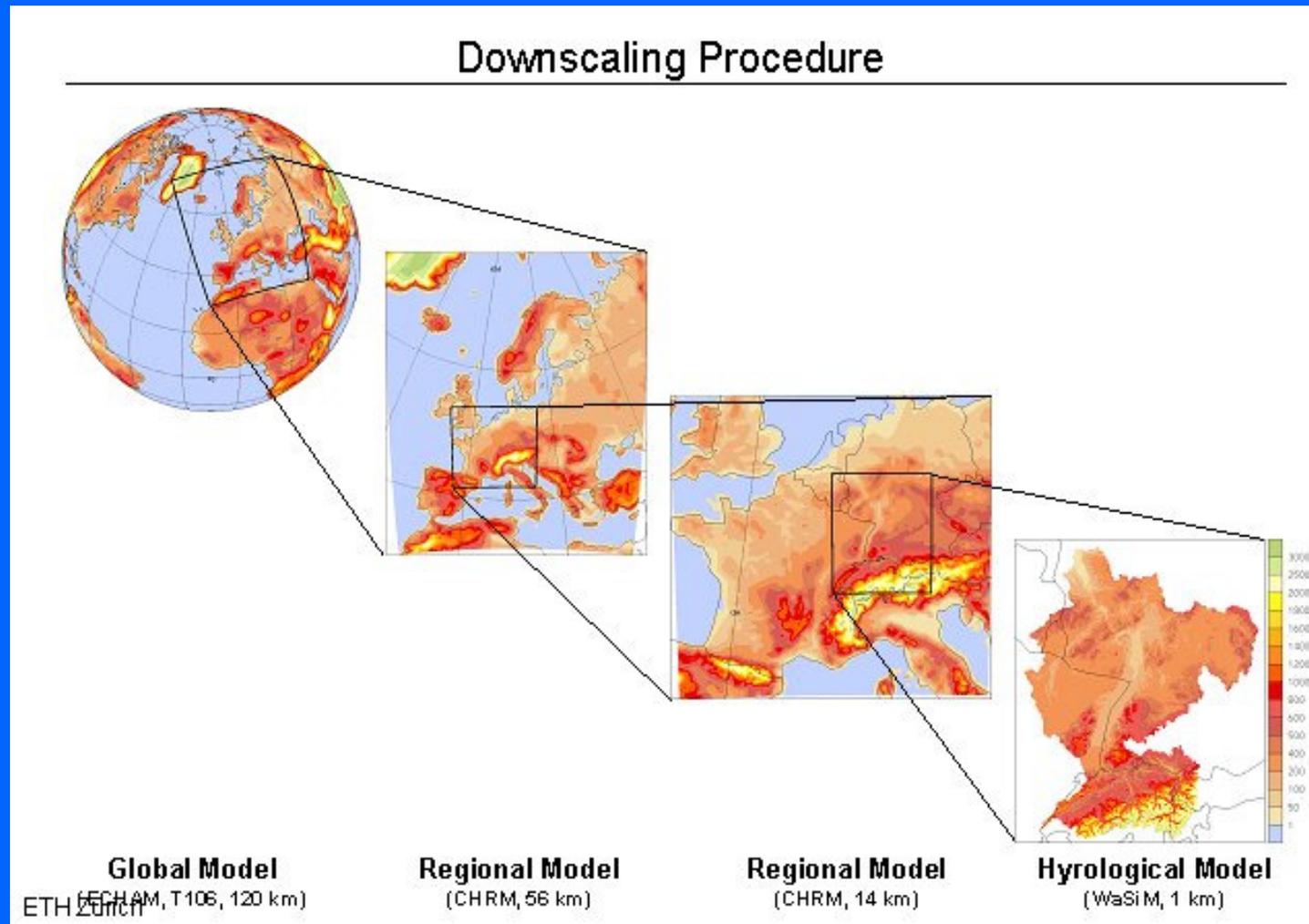


Precipitation changes (top) Australia and New Zealand
for 2080 to 2099, Scenario A1b,
bottom: number of models that project increases in precipitation,
from IPCC 2007

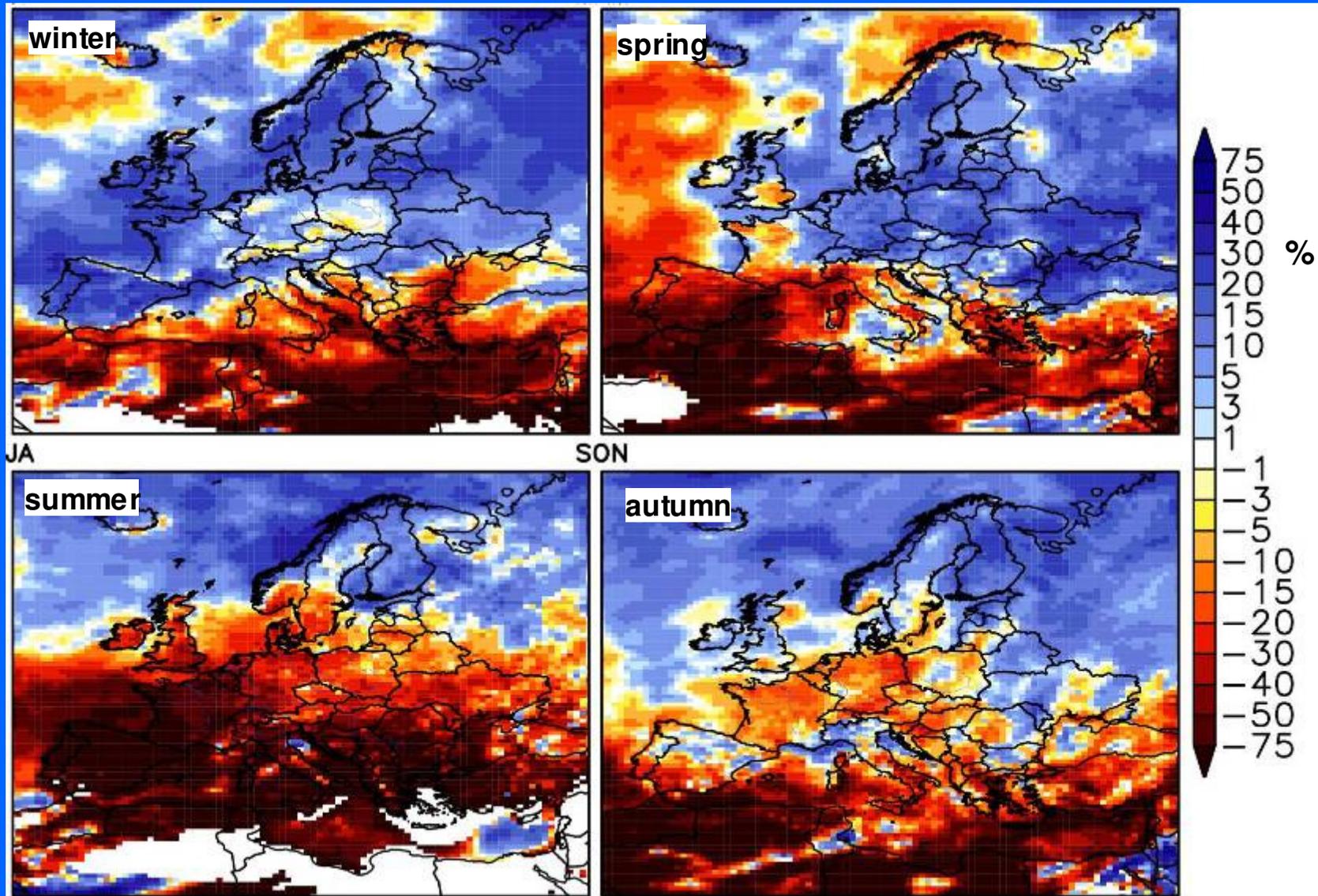
Downscaling

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Dynamische Regionalisierung: Nesting



Several nesting steps: Factor 2 to 4 in increase of resolution



**Europe: precipitation change for the end of the 21. century
in the A1B Szenario, single model result, $\Delta x \sim 10$ km**

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Summary

- In a warmer world, the water holding capacity of the atmosphere is increased.
- This does not lead to an increased precipitation everywhere – the distribution of the precipitation change pattern is quite differentiated.
- Broadly speaking: dry areas become dryer, wet areas become wetter.
- The number of dry days increases.
- The precipitation intensity increases.