How do you capture the global issue of water?

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Water issues from the viewpoint of Nature

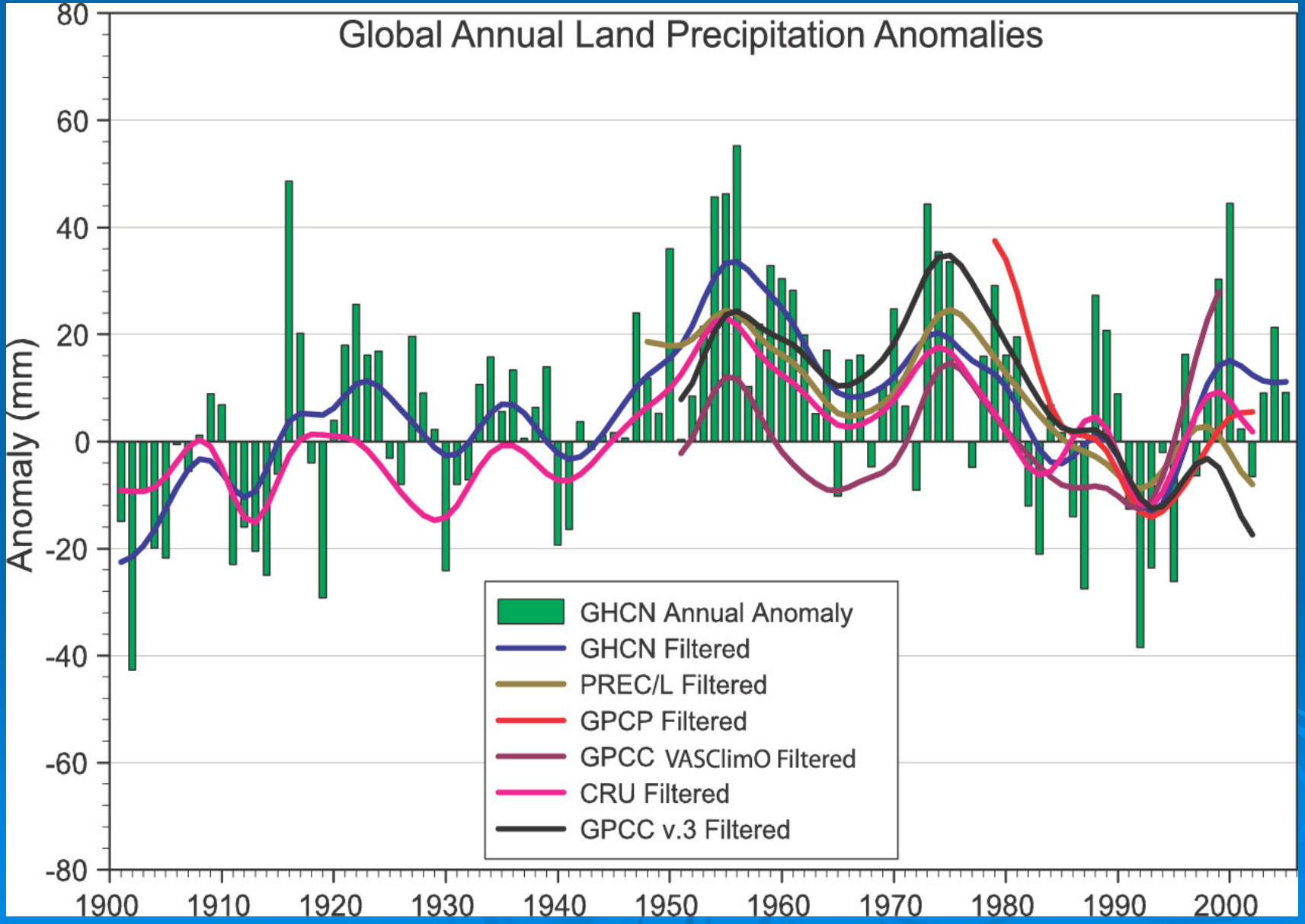
- A complex cycle
- Gas, liquid, solid phases all critical
- Interactions with other natural systems
- Strongly controlled by human society

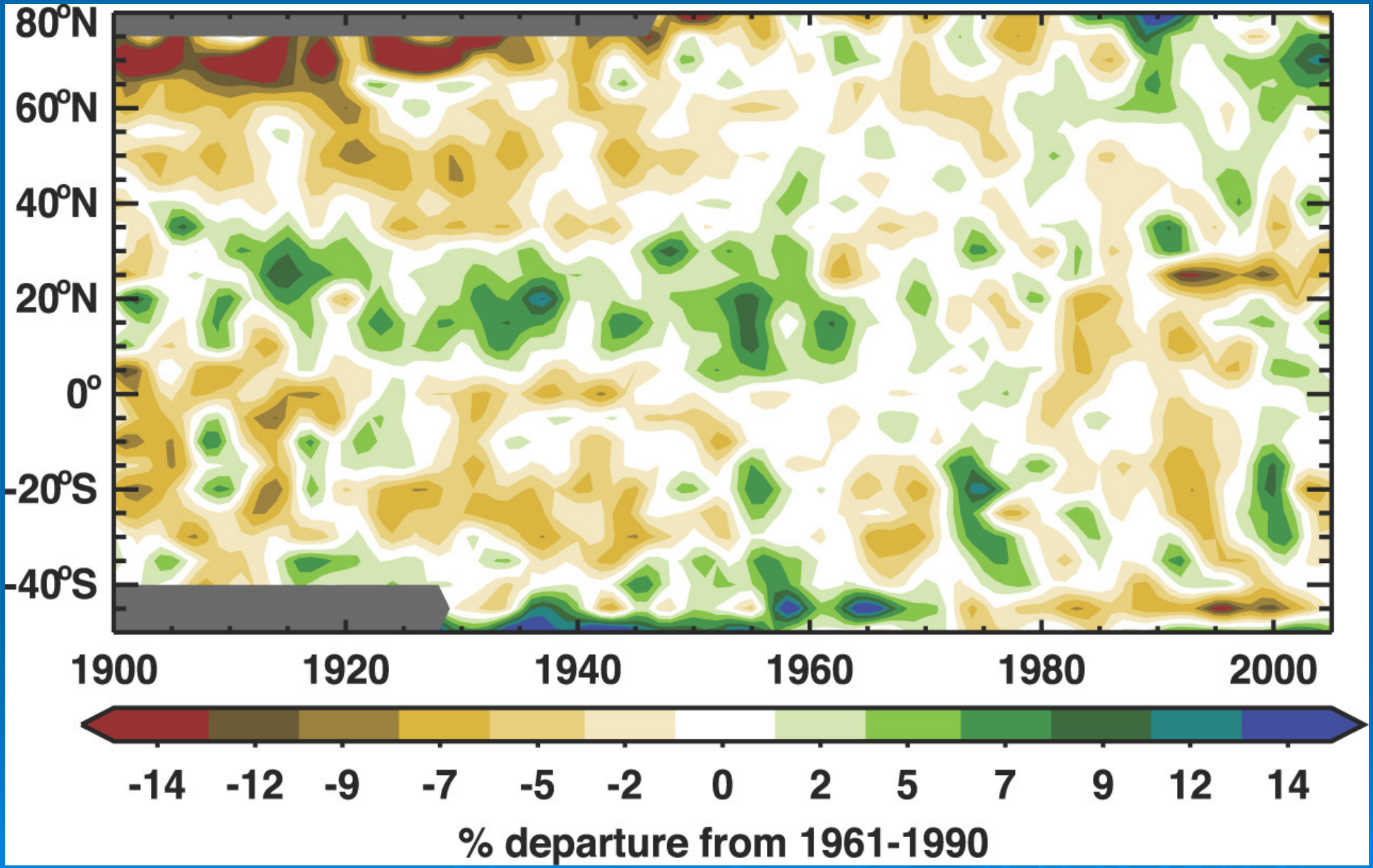
- *Water cycle change far less certain than temperature changes, but probably as or more important*

The past

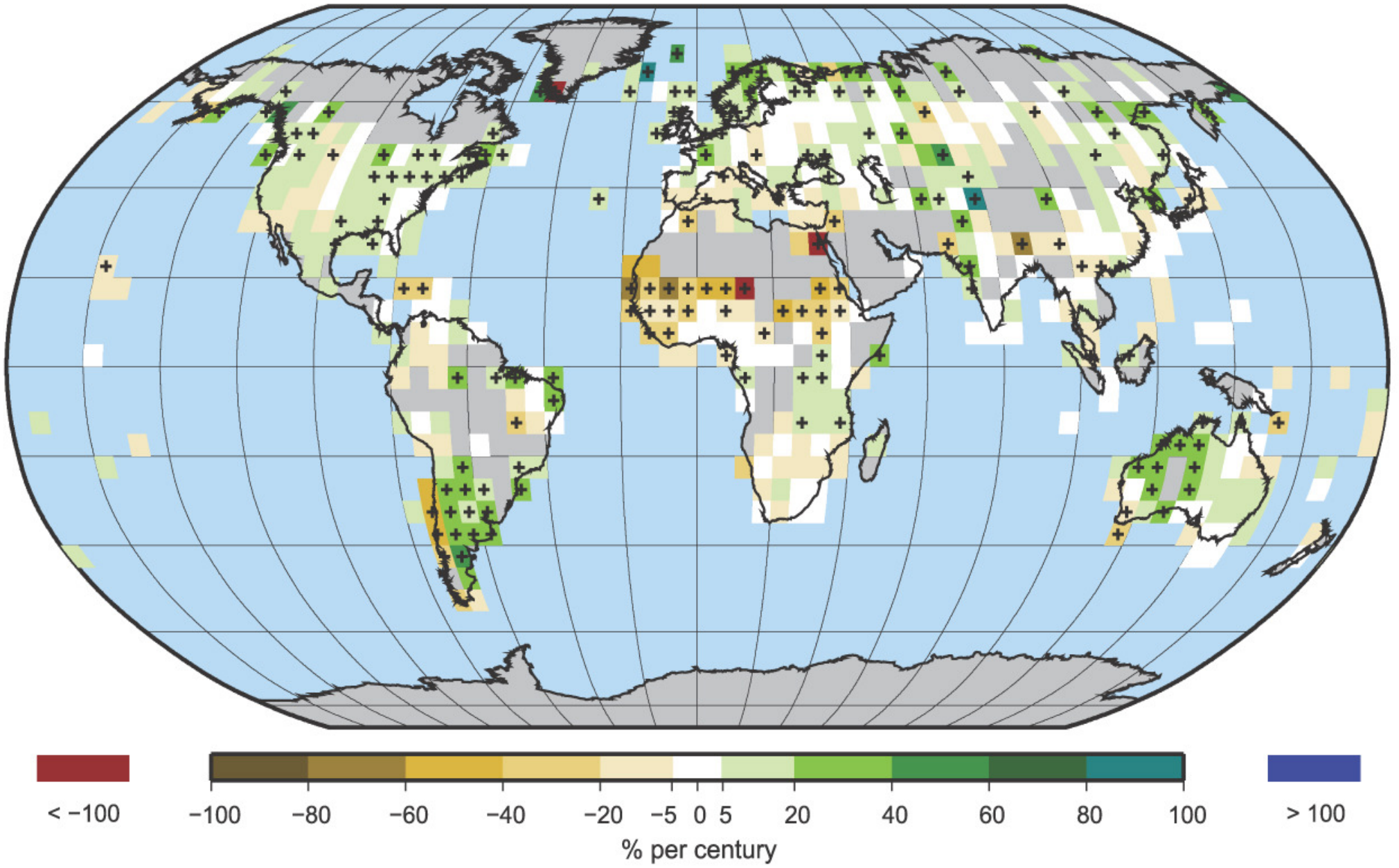
- Difficult to establish human role in regional precipitation variability

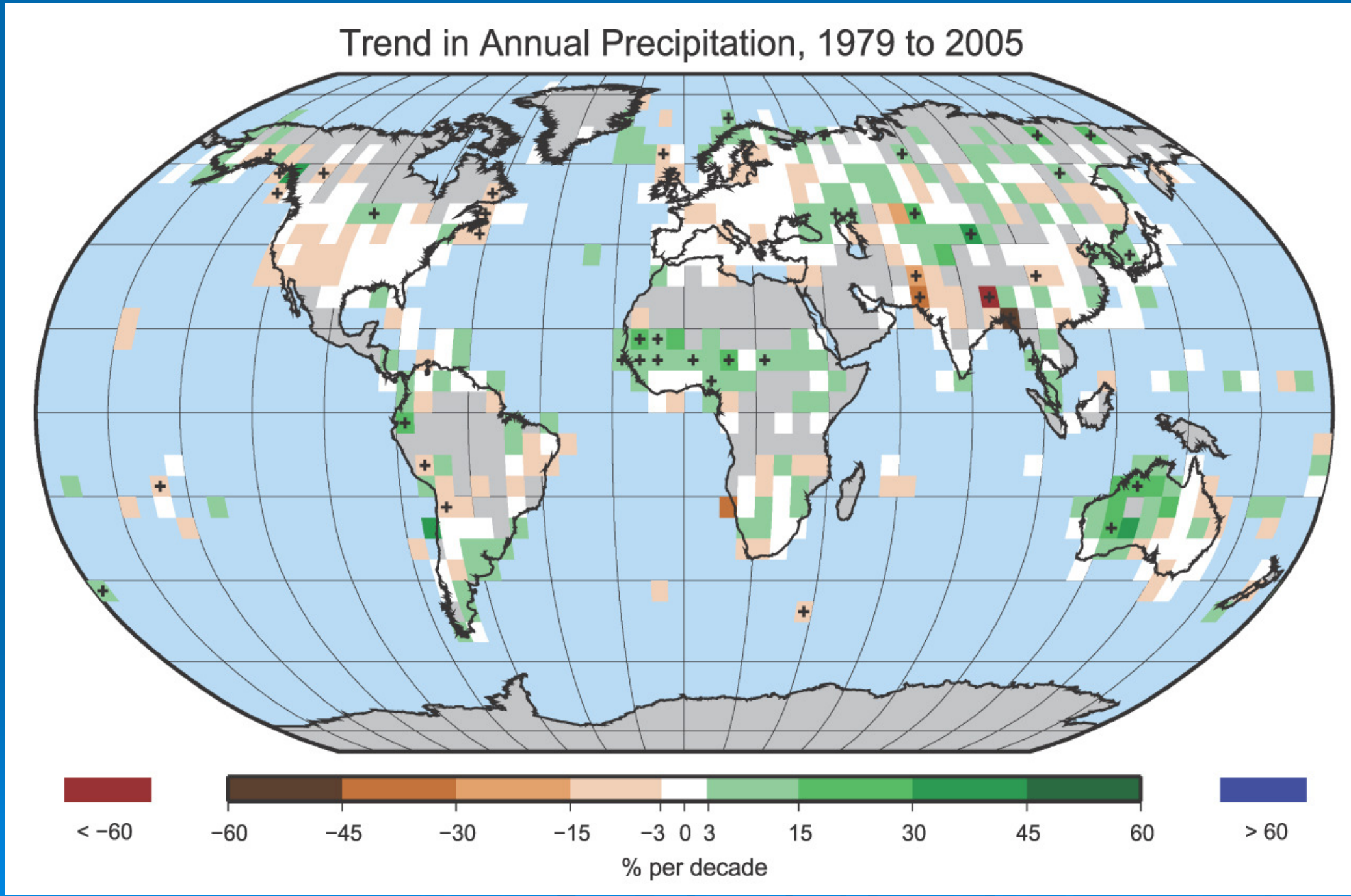
Variability and uncertainty in 20th century records




80°N
60°N
40°N
20°N
0°
-20°S
-40°S
1900
1920
1940
1960
1980
2000
-14
-12
-9
-7
-5
-2
0
2
5
7
9
12
14
% departure from 1961-1990

Trend in Annual Precipitation, 1901 to 2005



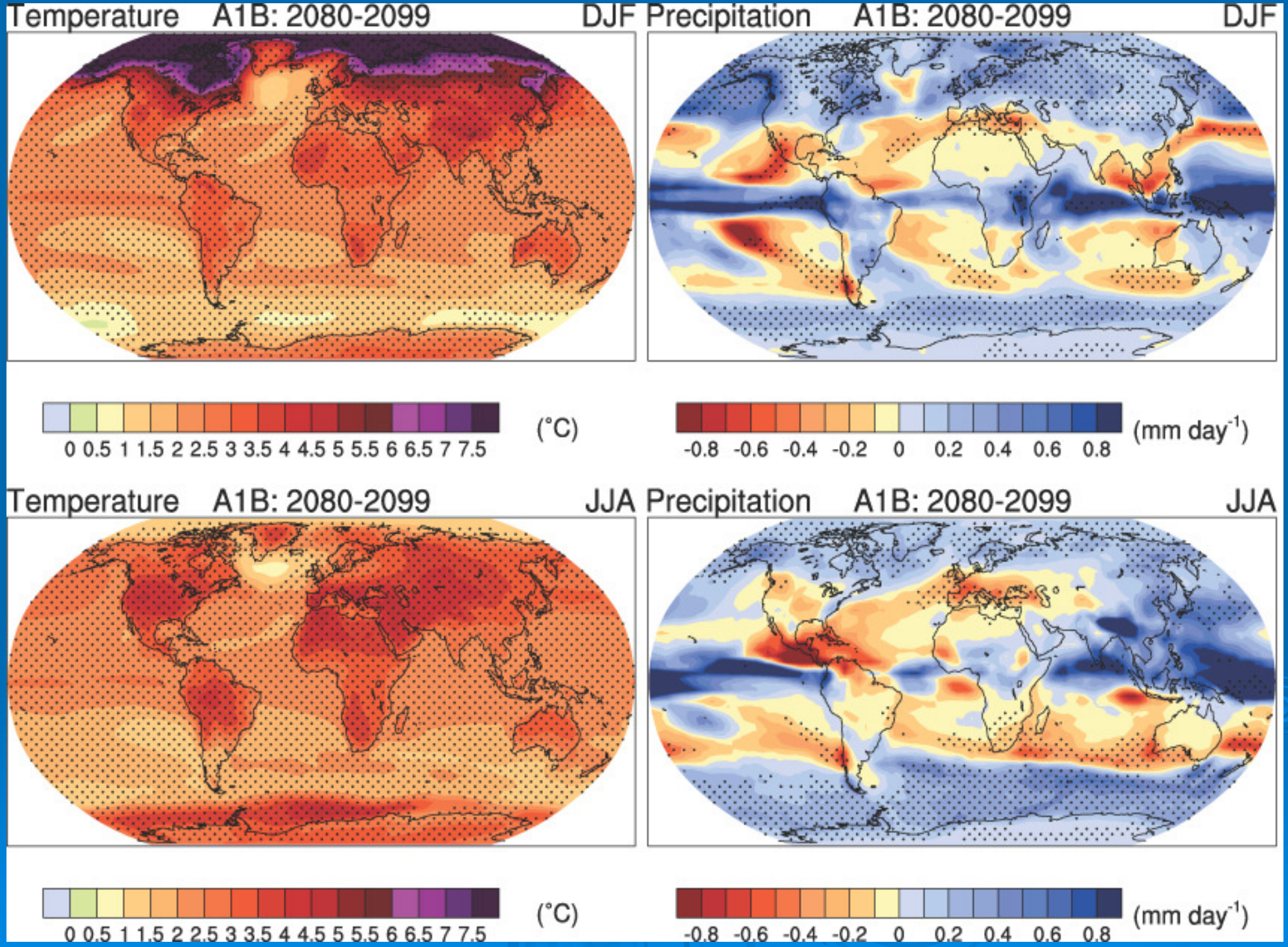

Trend in Annual Precipitation, 1979 to 2005
< −60
−60
−45
−30
−15
−3
0
3
15
30
45
60
> 60
% per decade

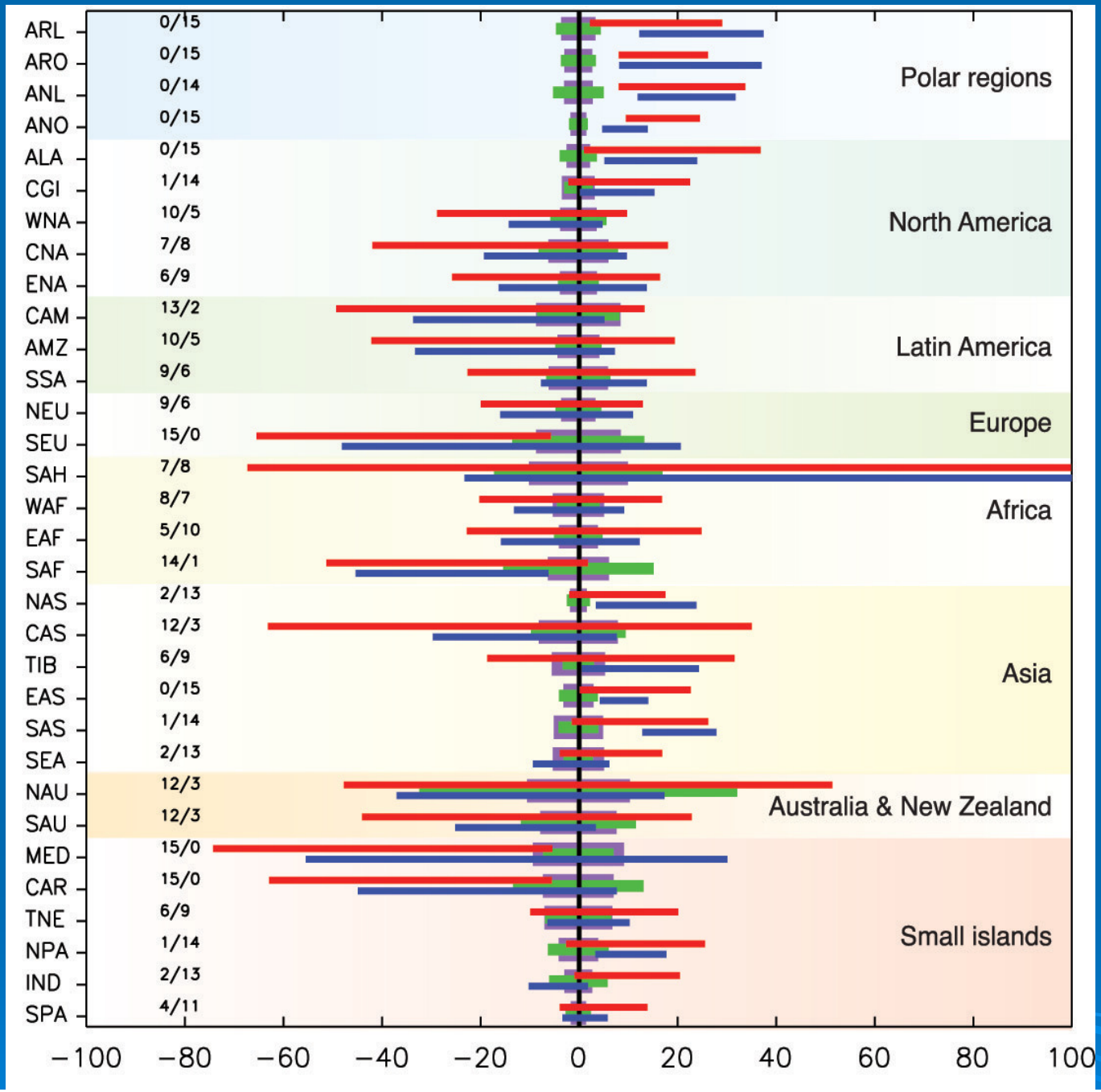
The future

- Predictions uncertain
- Changes spatially variable
- Related to changing circulation and atmospheric water holding capacity

Likely changes

- Increases in extreme precipitation
- Increase in variability
- Wetter polar regions


Temperature A1B: 2080-2099 DJF
Precipitation A1B: 2080-2099 DJF
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5
(°C)
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8
(mm day-1)
Temperature A1B: 2080-2099 JJA
Precipitation A1B: 2080-2099 JJA
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5
(°C)
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8
(mm day-1)



range of changes from seven pre-TAR AOGCMs for the A2 emissions scenario

range of changes from 15 recent AOGCM simulations for the A2 emissions scenario

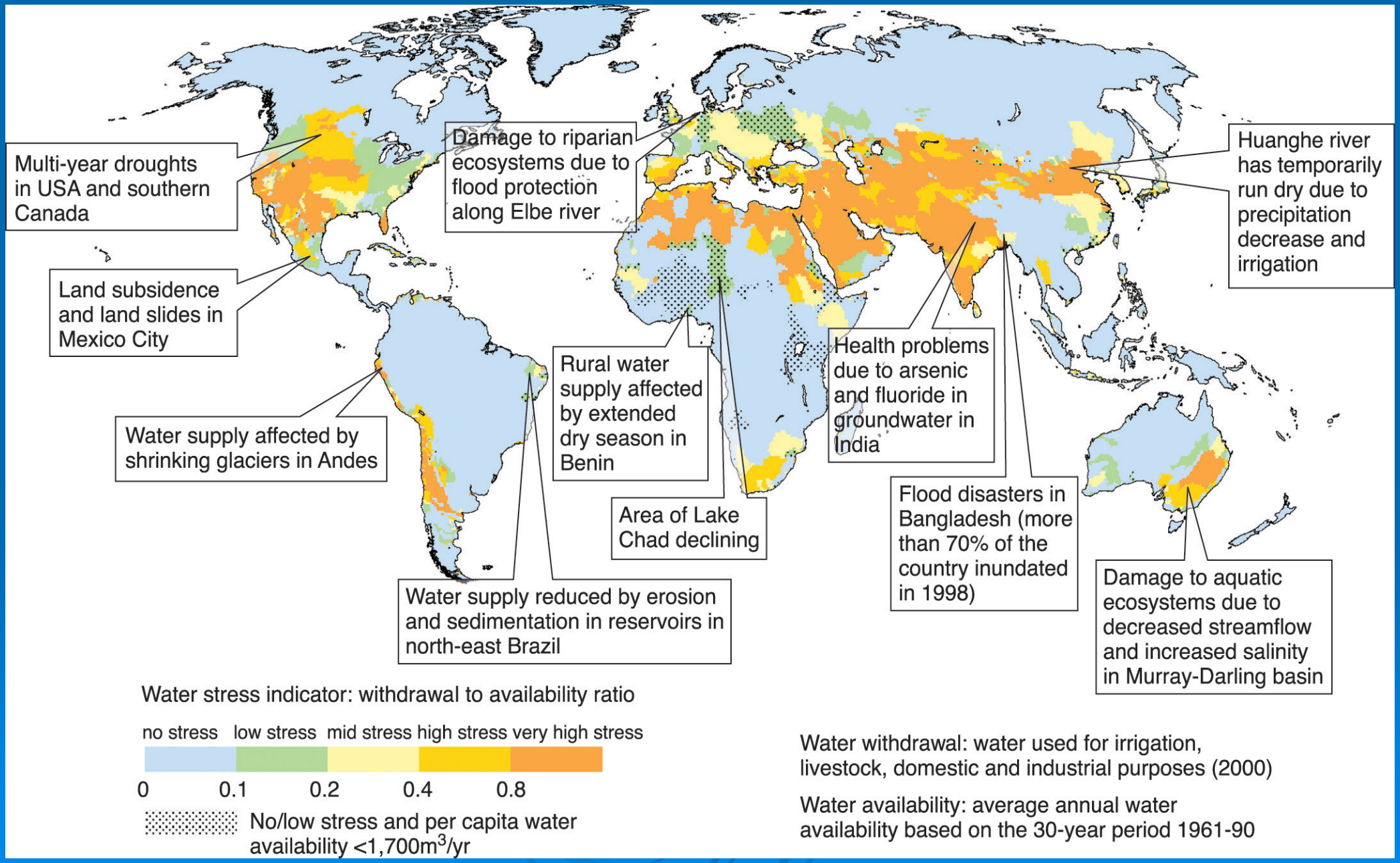
95% confidence limits on modelled 30-year natural variability based on HadCM3 millennial control simulation

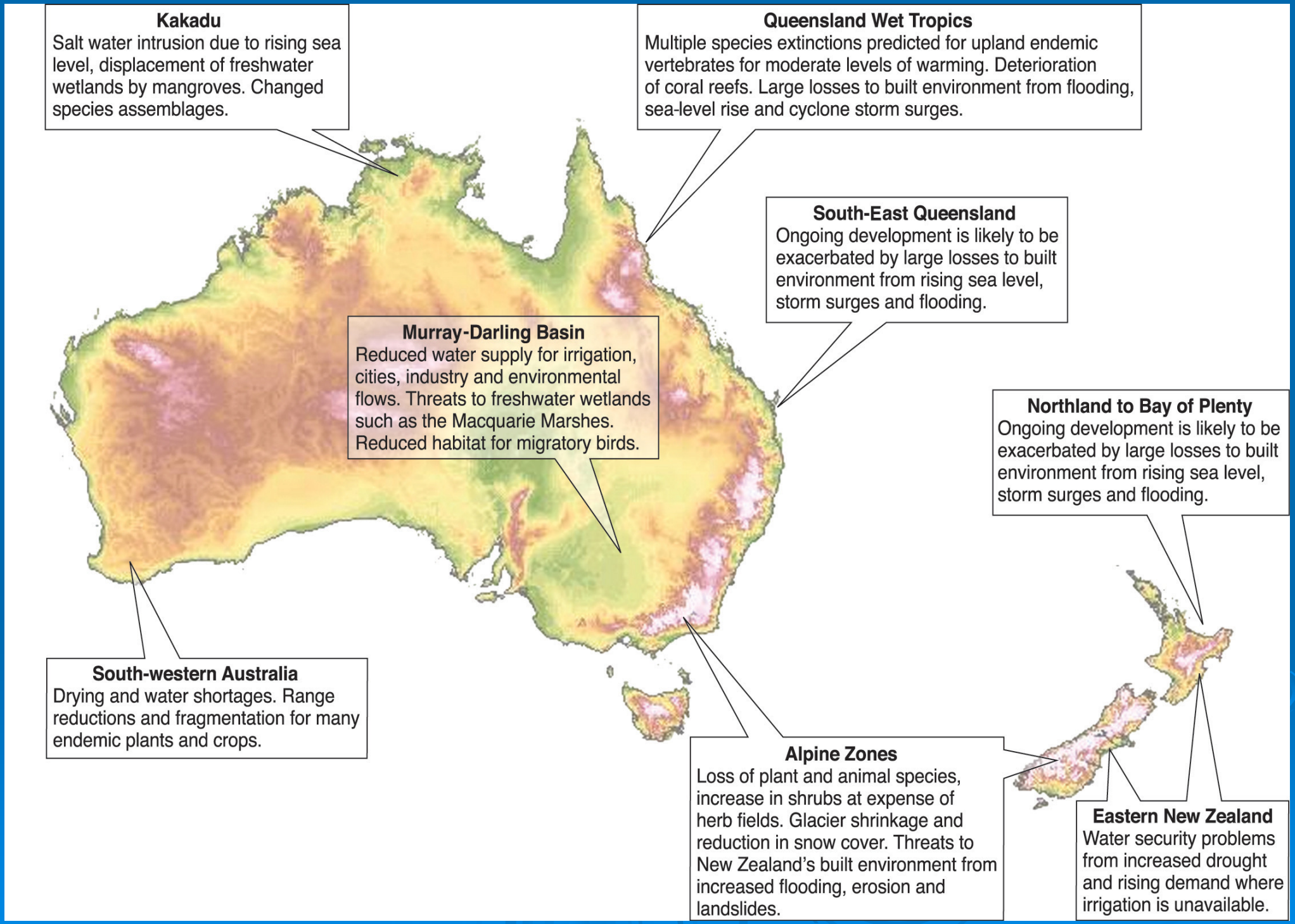
95% confidence limits on modelled 30-year natural variability based on CGCM2 millennial control simulation

The impacts

- Strongly moderated by human society
- Human interaction with the water cycle could be more important than climate change

Global vulnerabilities




Kakadu
Salt water intrusion due to rising sea level, displacement of freshwater wetlands by mangroves. Changed species assemblages.
Queensland Wet Tropics
Multiple species extinctions predicted for upland endemic vertebrates for moderate levels of warming. Deterioration of coral reefs. Large losses to built environment from flooding, sea-level rise and cyclone storm surges.
South-East Queensland
Ongoing development is likely to be exacerbated by large losses to built environment from rising sea level, storm surges and flooding.
Murray-Darling Basin
Reduced water supply for irrigation, cities, industry and environmental flows. Threats to freshwater wetlands such as the Macquarie Marshes. Reduced habitat for migratory birds.
Northland to Bay of Plenty
Ongoing development is likely to be exacerbated by large losses to built environment from rising sea level, storm surges and flooding.
South-western Australia
Drying and water shortages. Range reductions and fragmentation for many endemic plants and crops.
Alpine Zones
Loss of plant and animal species, increase in shrubs at expense of herb fields. Glacier shrinkage and reduction in snow cover. Threats to New Zealand's built environment from increased flooding, erosion and landslides.
Eastern New Zealand
Water security problems from increased drought and rising demand where irrigation is unavailable.

Food and energy

- Small warming good for mid-latitude agriculture
  - But then detrimental
- Irrigated land only 18% of agriculture
  - But produces 50% of grain
  - Future water availability and management important
- Water delivery from glaciers and snow pack likely to decline
- Hydroelectric power future dependent on human society and ecological value

Impacts and mitigation

- Megacities, groundwater dependent cultures, low-elevation islands, glacier- and snow-fed regions
- Socio-economic stress will reduce ability of societies to adapt and mitigate

Conclusions

- Historical and future changes in water cycle uncertain and hard to predict
- But a few changes are likely (more extremes, wetter poles, higher runoff, changing seasonality)
- Pressing need for better models and management