Global Change and Hydrology

On the importance of hydrological observation

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TERENO Kick-Off-Workshop

September 22nd, 2008

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Water and Global Change

- In the next decades, water will be **a major driving force** in changing and shaping our European environment and its ecosystems.
- Water is the **key factor** for sustaining food, feed and biomass production for energy consumption (e.g. bio-based economy).
- The water cycle will be strongly **affected by climate change** but the extent and impact on ecosystems functioning and services are only roughly known.
- Increasing hydrological extremes, such as floods and droughts, may lead to severe economic and societal impacts.

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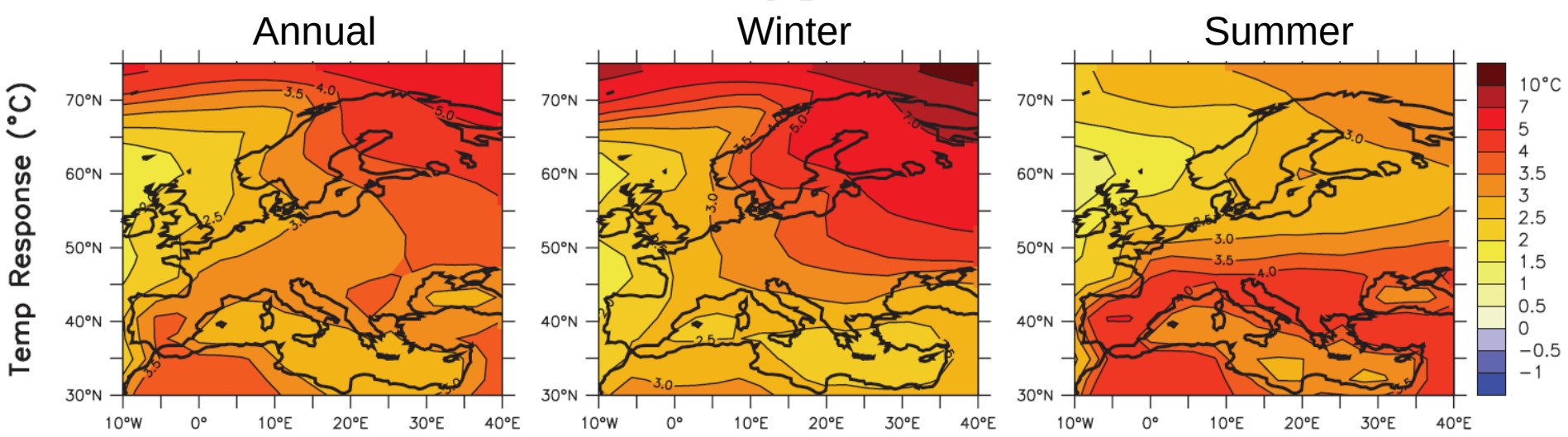
IPCC Report 2007 – Regional Climate Projections

Temperature change projection for Europe (21 models)
(change between 1980 to 1999 and 2080 to 2099)



- Temperature will increase in all parts of Europe
  - Scandinavia and East Europe, especially during winter season in
  - Mediterranean region, especially during summer season in the
- Temperature variability will increasing

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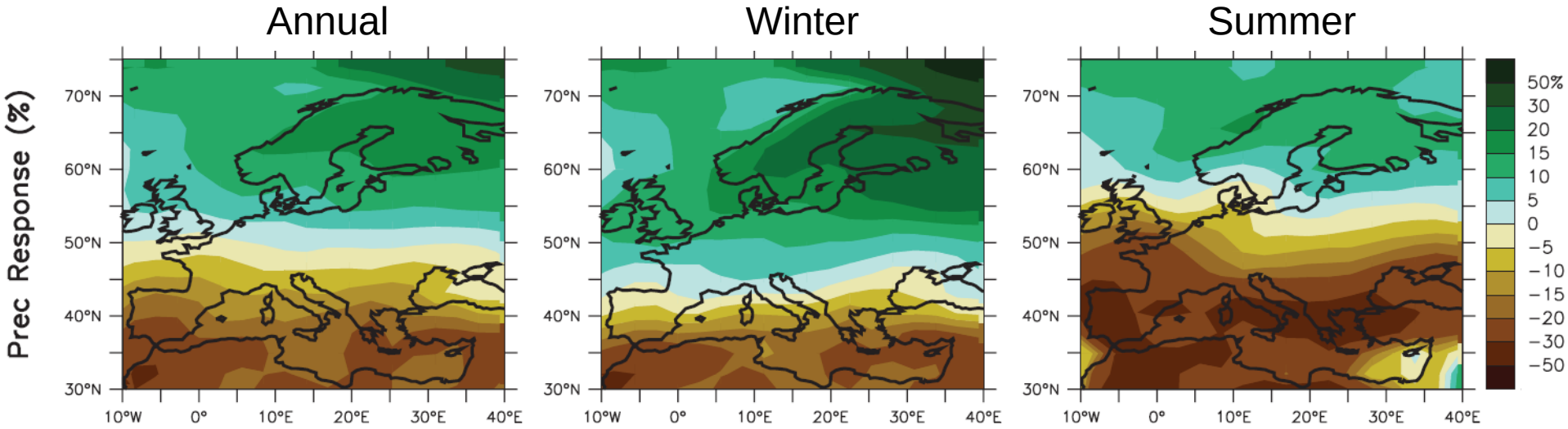
IPCC Report 2007 – Regional Climate Projections

Precipitation change projection for Europe (21 models)
(change between 1980 to 1999 and 2080 to 2099)



- Precipitation will increase Northern Europe
- Precipitation will decrease in the Mediterranean region
- Precipitation variability will increase

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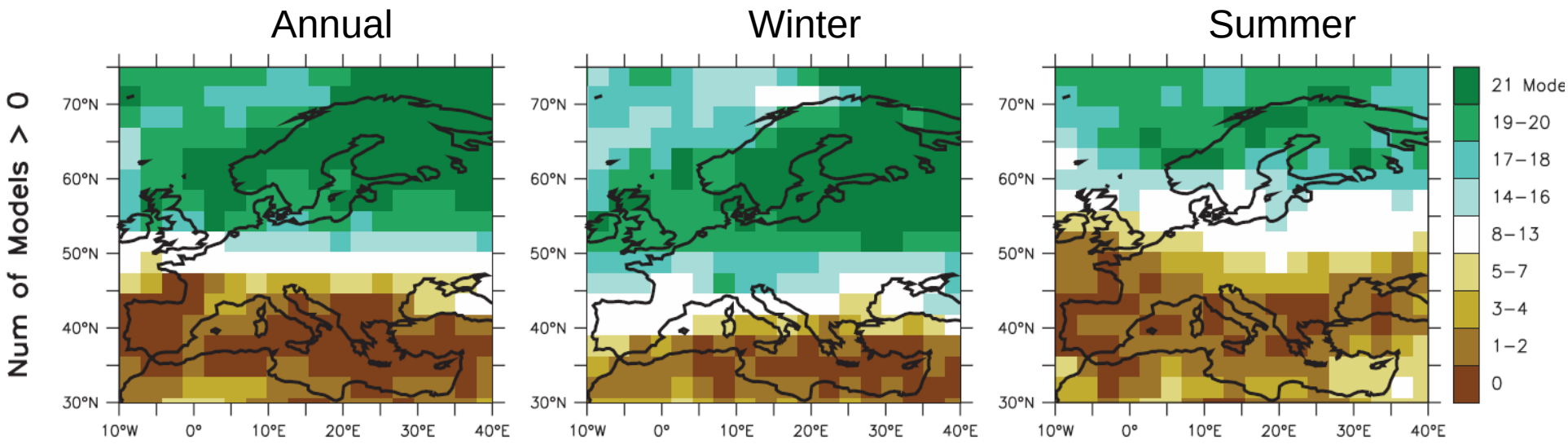
IPCC Report 2007 – Regional Climate Projections

Number of models out of 21 that project increases in precipitation for Europe



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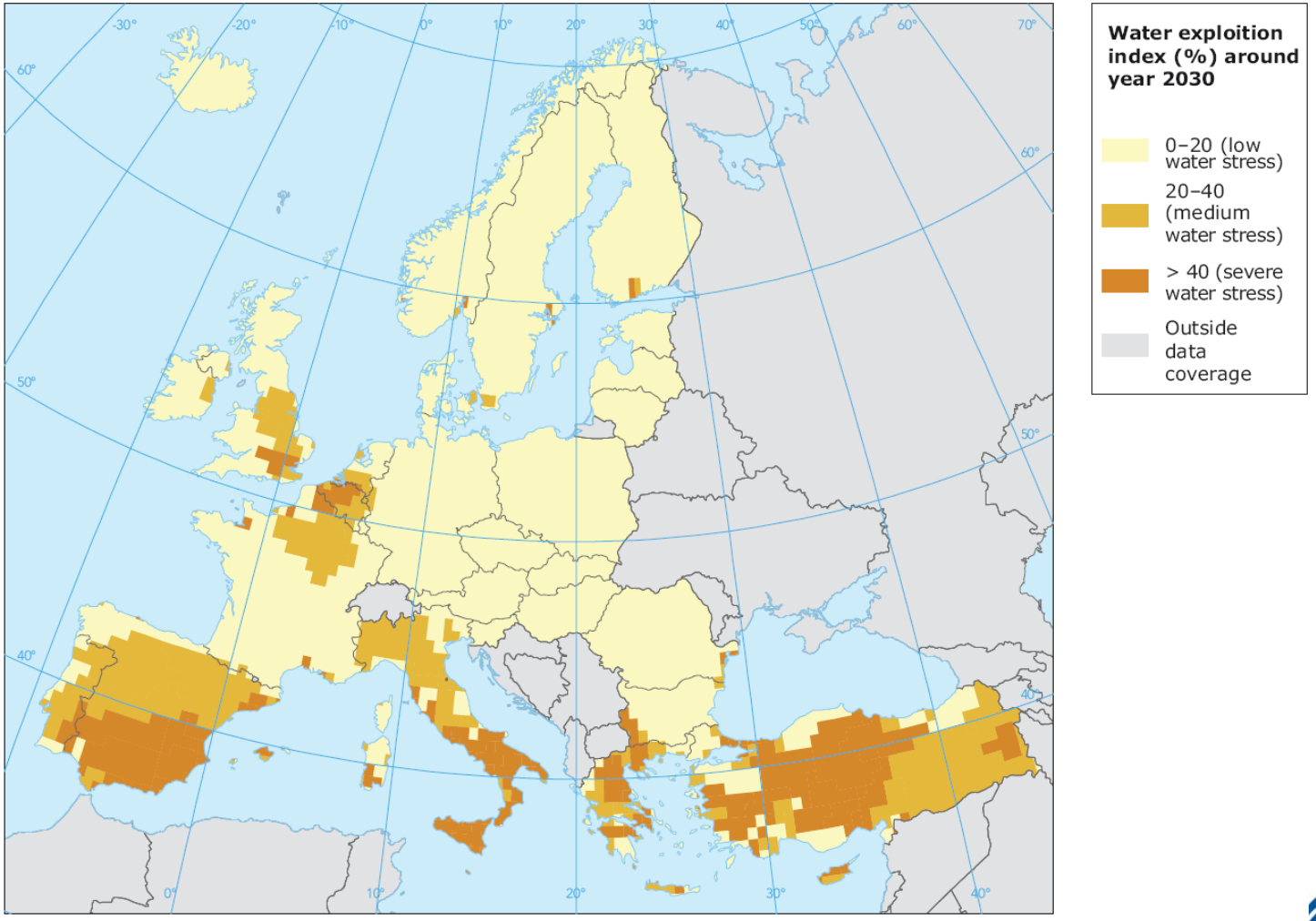
EEA Third Environmental Assessment Report

Water stress in European river basins under a base-line scenario by 2030



Note: The water exploitation index is the percentage of available water resource abstracted each year.

Source: EEA, 2005b.

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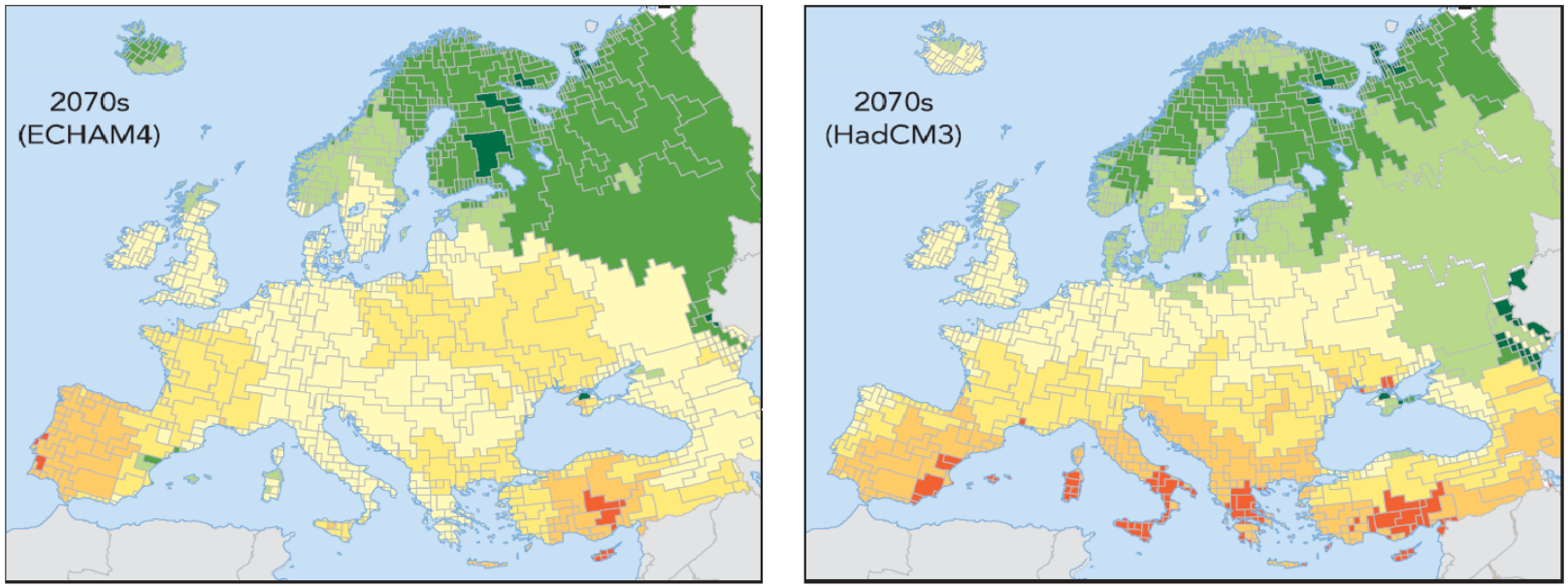
EEA Report 2007 – Climate change and water adaption issues

Change in average annual river discharge in Europe (2070 versus 2000)



Note: Note that larger changes in seasonal averages are expected in some regions.

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Key uncertainties in evaluating the effect of climate change on hydrology (IPCC, 2007)

- Substantial uncertainty remains in trends of hydrological variables because of large regional differences, gaps in spatial coverage and temporal limitations in the data.
- There are very limited direct measurements of actual evapotranspiration over global land areas.
- Difficulties in the measurement of precipitation remain an area of concern in quantifying the extent to which global and regional-scale precipitation has changed.
- Historical records of soil moisture and stream flow are often very short and available for only a few regions.
- The availability of observational data restricts the types of extremes that can be analyzed. The less frequent the event, the more difficult it is to identify long-term changes.

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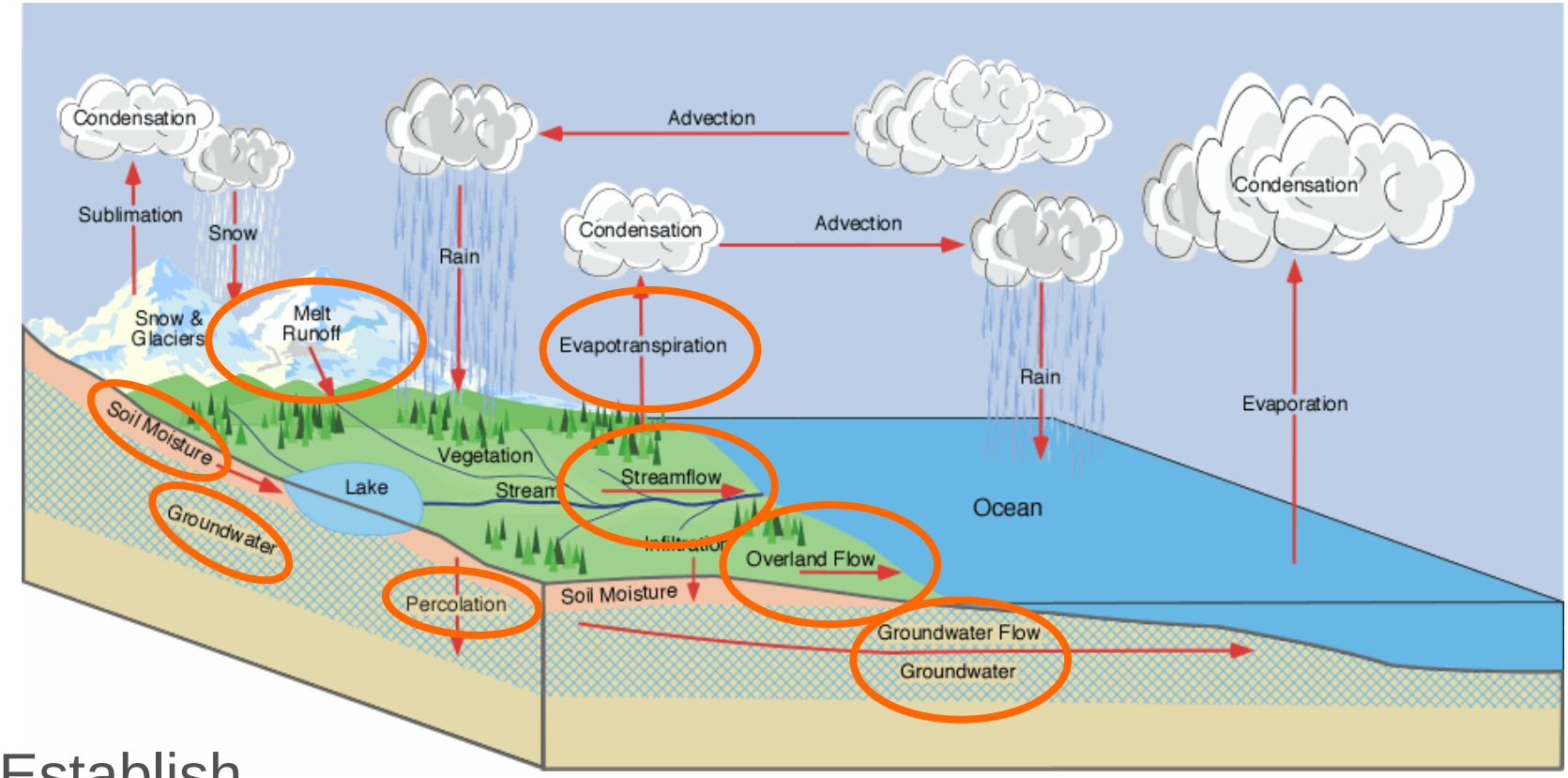
How do these changes translate in terms of European water resources and its hydrological system?



Establish
a network of
hydrological observatories: NOHA

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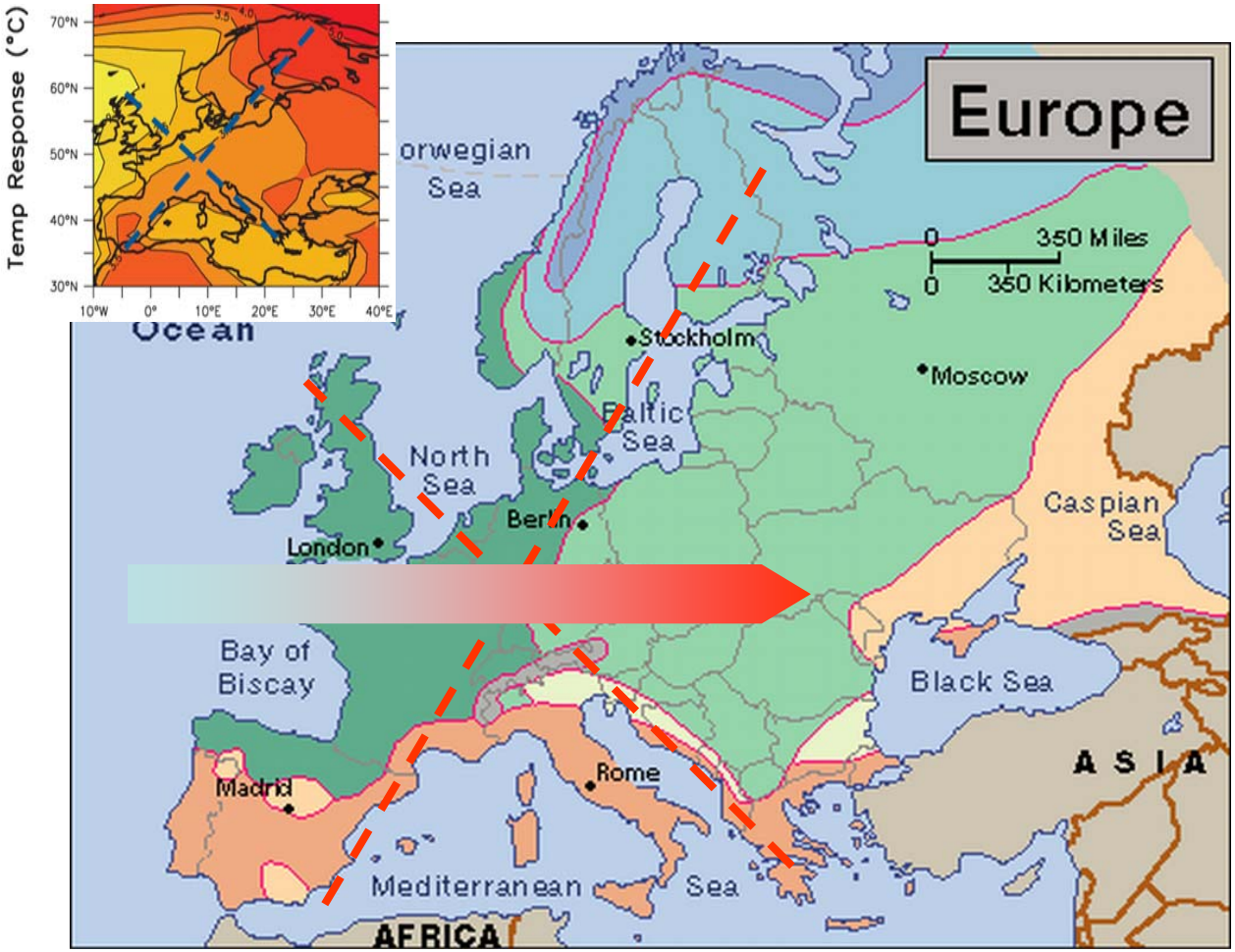
NOHA Transects of hydrological observatories

IPCC Report 2007:
Temperature change projection



European climate zones

- Semiarid
- Subtropical dry summer
- Humid subtropical
- Humid oceanic
- Humid continental
- Subarctic
- Tundra
- Highland

NOHA Transects of Hydrological Observatories

Oceanic-Continental Gradient

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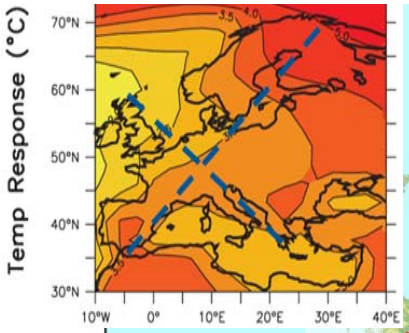
The planned Hydrological Observatories of NOHA

IPCC Report 2007:
Temperature change projection



Fyrisan
Karjaanjoki
Tay
Skjern
Zeimena
Bode
Rur
Wisla
Siret
Ammer
Sava
Herault
Upper Guadiana
Candelaro
Kalamas
Andarax

NOHA
Network of Hydrological Observatories in Europe

Hydrological Observatories
- Karjaanjoki (Finland)
- Fyrisan (Sweden)
- Tay (Great Britain)
- Skjern (Denmark)
- Bode (Germany)
- Rur (Germany)
- Ammer (Germany)
- Sava (Slovenia)
- Herault (France)
- Candelaro (Italy)
- Upper Guadiana (Spain)
- Kalamas (Greece)
- Andarax (Spain)

Transects
Rivers
Water bodies

Topography [m]
- < 50
- 50 - 100
- 100 - 200
- 200 - 400
- 400 - 600
- 600 - 800
- 800 - 1000
- 1000 - 2000
- 2000 - 4000
- > 4000

Scale 1 : 20.500.000

Map edit: Dr. H. Bogena
Data bases: U.S. Geological Survey: DGM GTOPO 30

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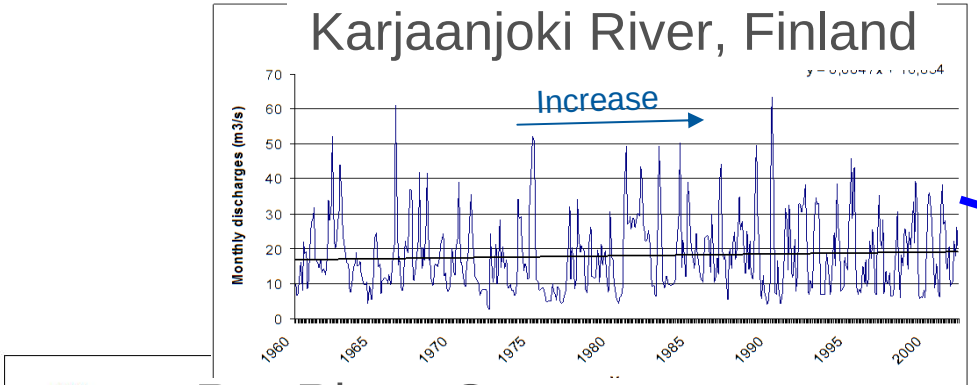
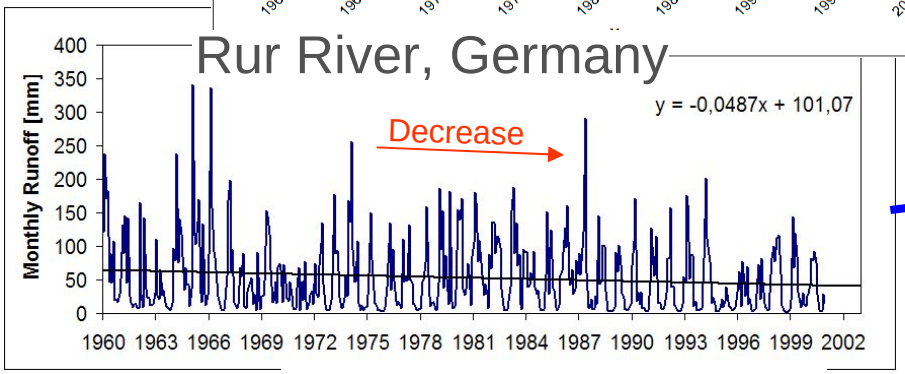
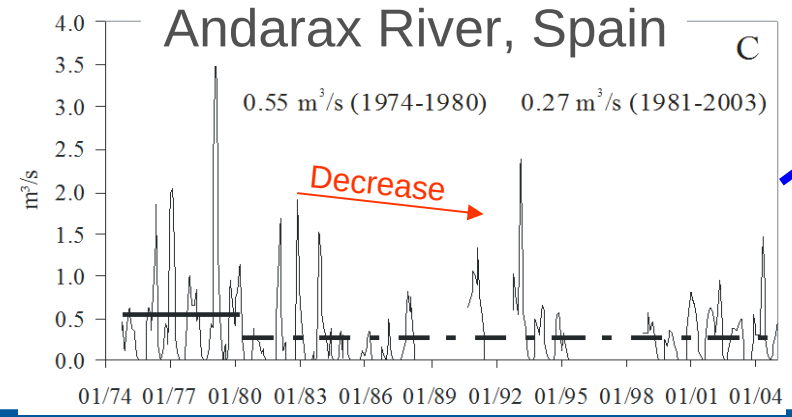
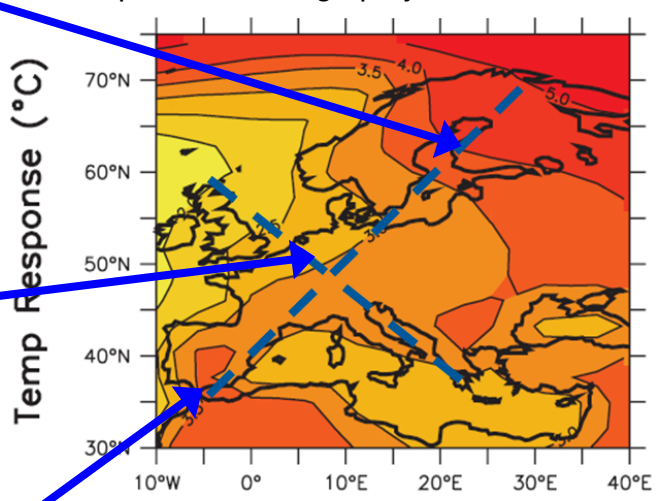
Climate Change effects on the Hydrological Cycle







IPCC Report 2007:
Temperature change projection



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What is the value of hydrological observatories?

- To improve our understanding of the effect and impact of climate change on the hydrological cycle
- To advance hydrological and terrestrial sciences by integrating and developing novel measurement technologies, e.g. wireless sensor technologies, remote sensing platforms (e.g. Envisat, SMOS Mission, RapidEye) in a multi-scale modeling approach
- To provide high quality multi-temporal multi-scale databases for hydrological and terrestrial modeling in order to assess long-term changes in European ecosystems (natural, agricultural, forest,…)
- To support the implementation and eventual adaptation of management plans and measures based on the European Regulatory Framework related to water (e.g. WFD 2000/60/EC, nitrate directive 91/676/EEC) and agricultural policy (Cross-compliance)

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What are the scientific questions?

- How will climate change affect major hydrological fluxes on the long-term?
- How to better predict e.g. flood and drought risks?
- How do interface processes and feedback mechanisms between different compartments of the terrestrial system (soil, plant, atmosphere, and groundwater) affect long-term predictions of hydrological and atmospheric processes?
- How to adapt our actual management of ecosystem services to the changing hydrological and climatic conditions?
- What will be the effect of climate and man-induced changes on physical-chemical and biological indicators used to assess the status of water bodies?
- How will the expected land use change (e.g. agro-climatic cropping zones, forestation and deforestation) influence the hydrological cycle and especially the water quality of storage systems?
- What will be the socio-economic consequences?

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A new vision for catchment hydrology

- Development of new modelling approaches that not rely on calibration but on a insightful analysis of landscape heterogeneity and process complexity through:
  - Systematic learning from novel hydrological observation data, e.g. remote sensing, geophysical, sensor network data
  - Dedicated hydrological experiments to gain knowledge for new hydrological theories, e.g. large scale labelling and tracer experiments
  - Interdisciplinary measuring programs, incl. Climatology, Geology, Ecology, to embrace new scientific perspectives

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Vision: To predict hydrology from sensing information

Multi-scale Observations using non-invasive and novel Technologies

SMOS

SAR

Weather-Radar

Radio-meter

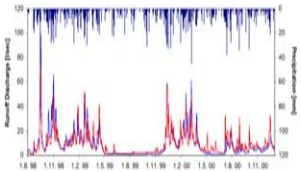
GPR

Hydrological Processes

Evapotranspiration

Soil moisture

Runoff



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