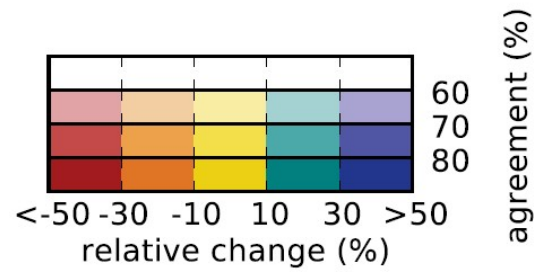
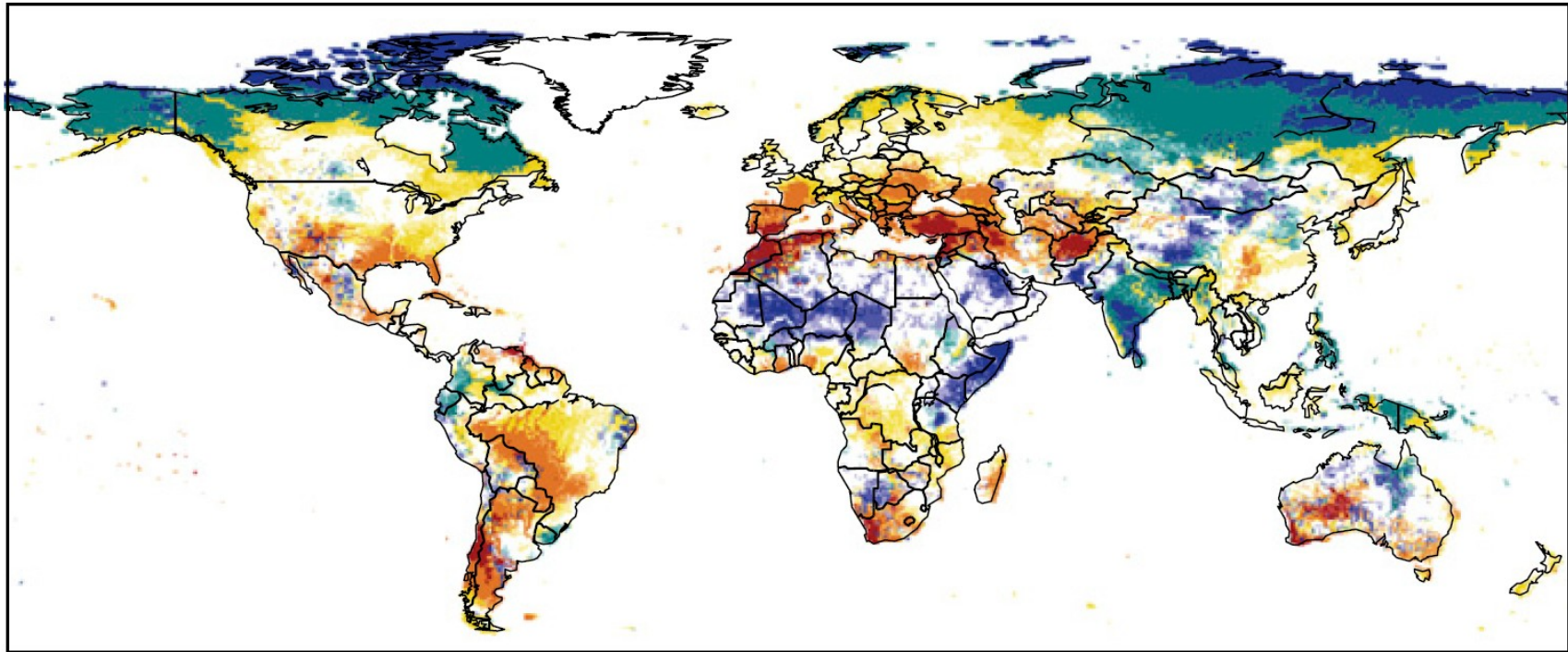


# Global assessment of water policy vulnerability under uncertainty in water scarcity projections

P. Greve, T. Kahil, T. Schinko, J. Mochizuki, Y. Satoh, P. Burek, R. Burtscher, S. Langan, E. Byers, M. Flörke, S. Eisner, N. Hanasaki, Y. Wada

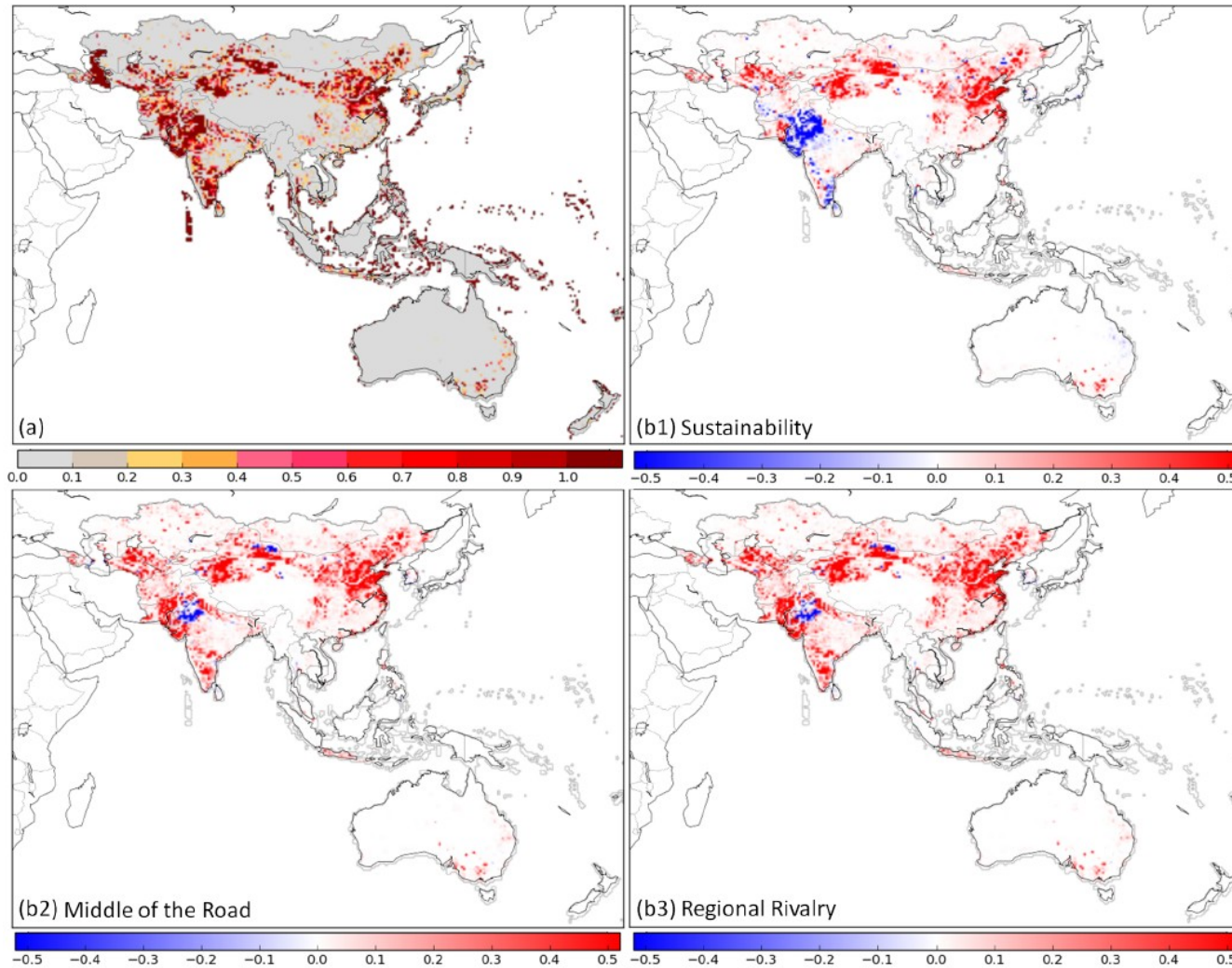
EGU 2017  
HS5.9/CL2.17/CR6.9/NH1.9  
Mon, 24 Apr

water supply

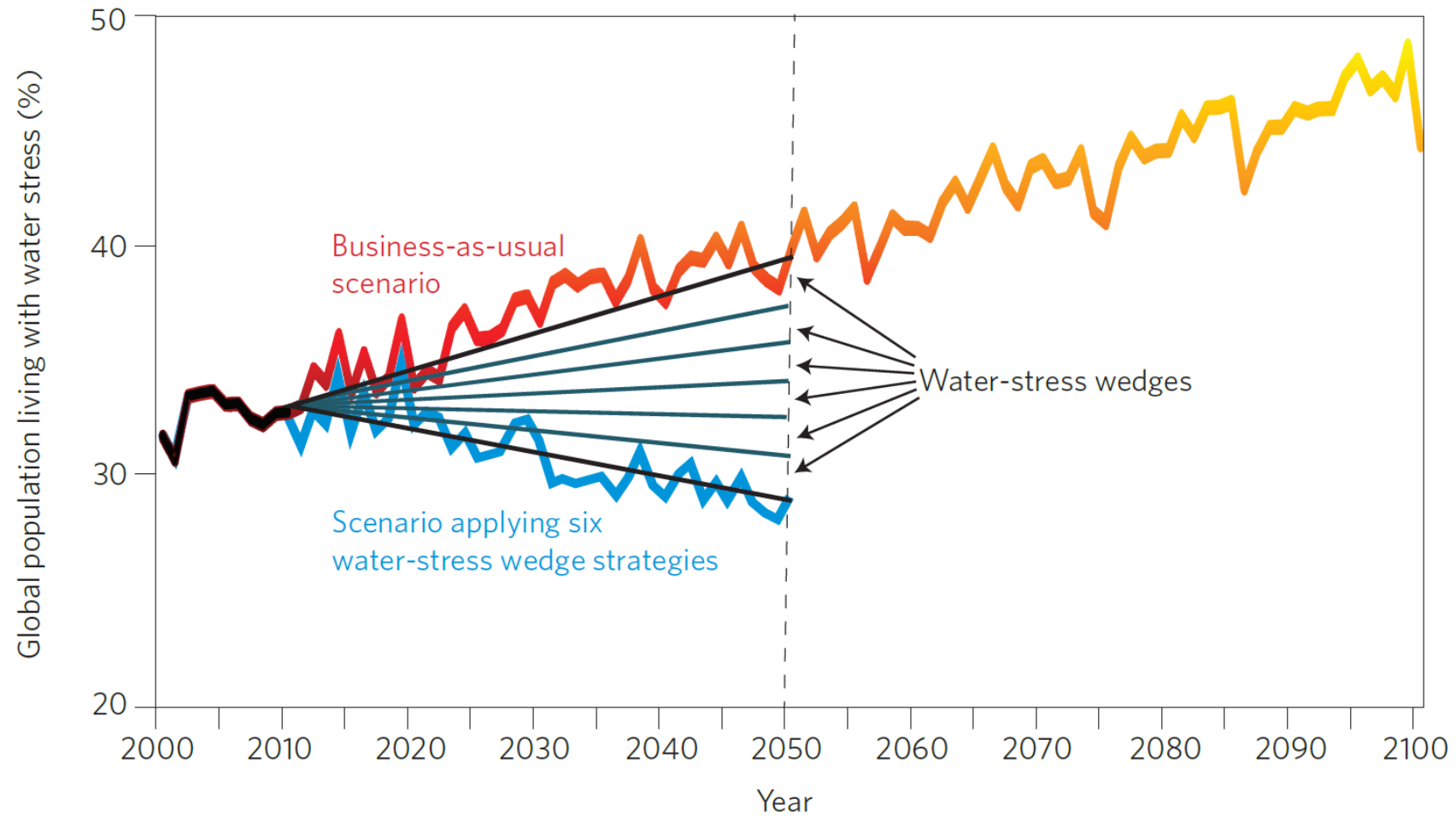


# Water scarcity

$$\frac{\text{water demand}}{\text{water supply}}$$



## Policy actions



Wada et al., NGeo, 2014



## Water scarcity is projected to change

- What is the associated **uncertainty**?
- How does this **uncertainty change**?
- What are the most important **sources of uncertainty** (model and scenario uncertainty)?

Resulting policy implications?

## Water scarcity is projected to change

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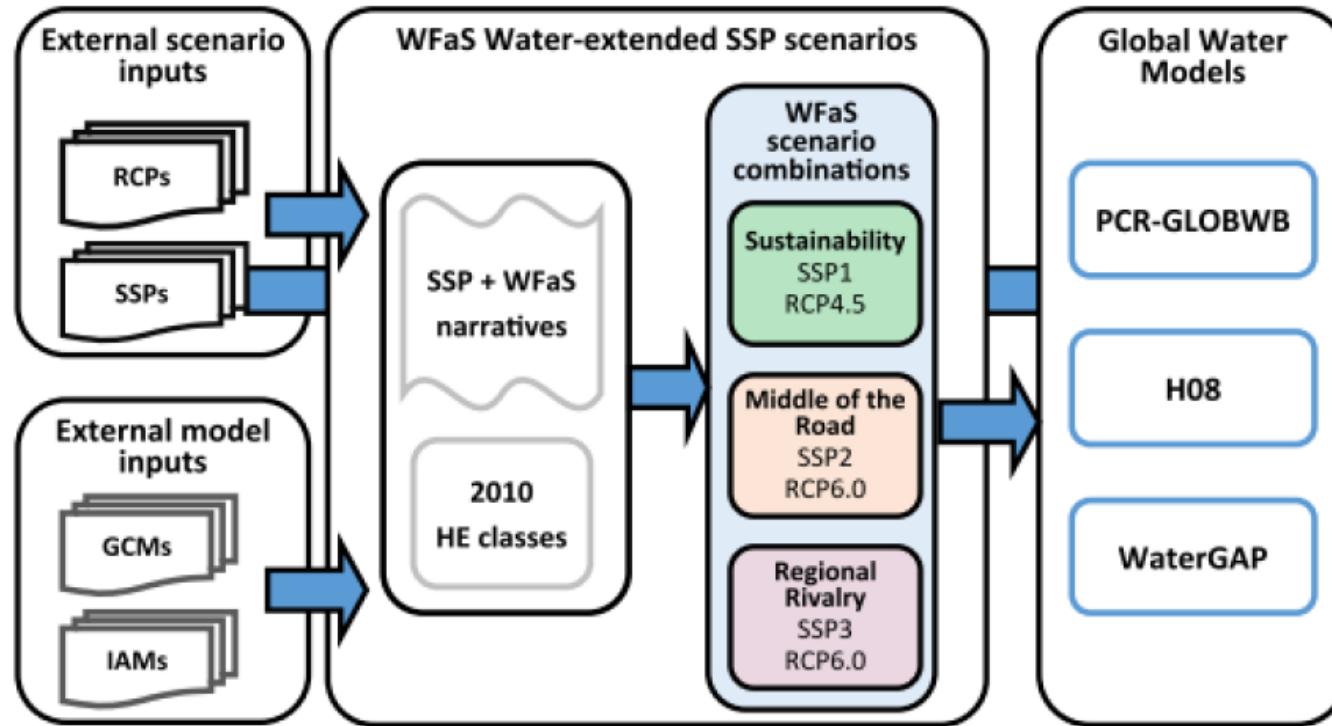
Resulting policy implications?

## Water scarcity is projected to change

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## Resulting policy implications?

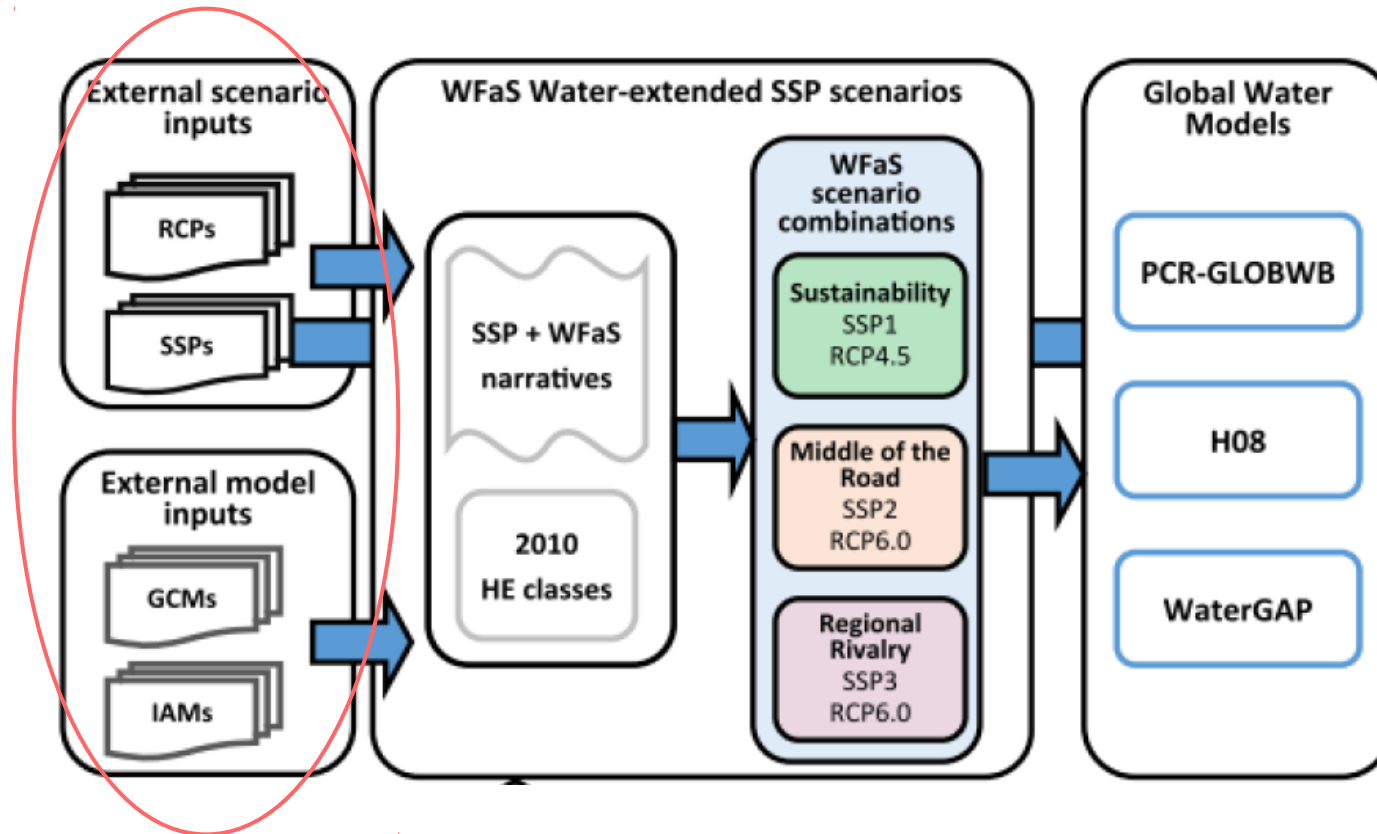




5 Global Climate Models (GCMs) to force

3 Global Hydrological Models (GHMs) under

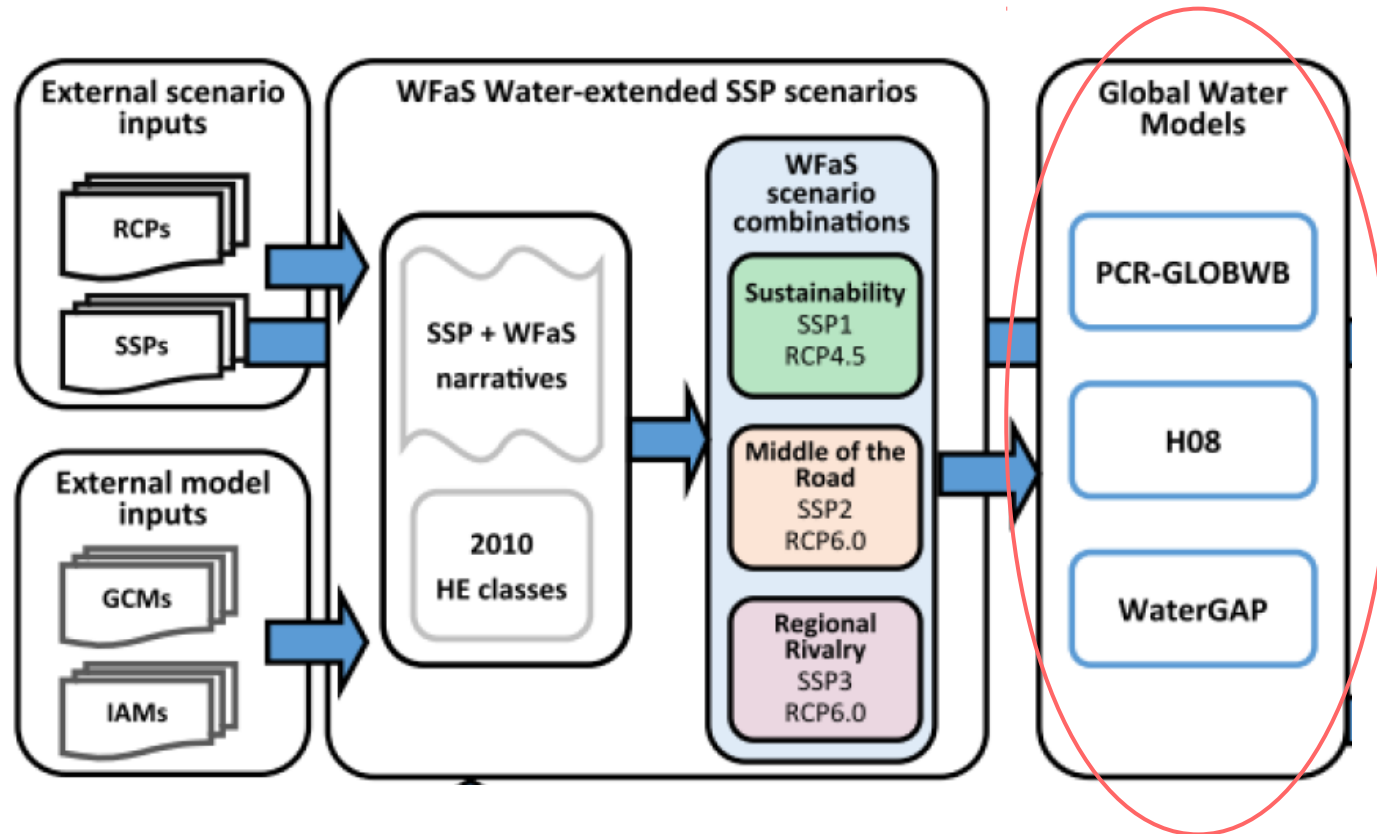
3 different water scenarios



**5 Global Climate Models (GCMs) to force**

**3 Global Hydrological Models (GHMs) under**

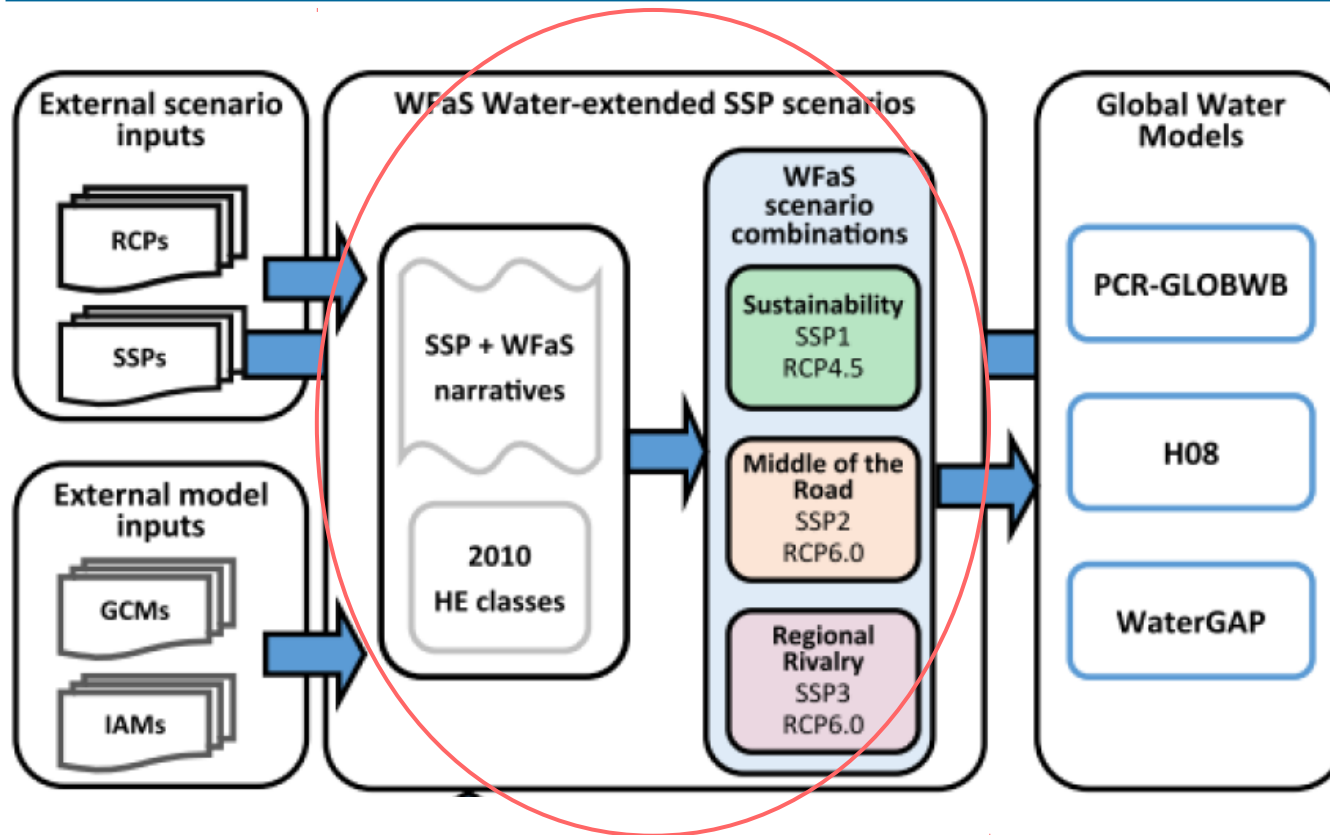
**3 different water scenarios**



**5 Global Climate Models (GCMs) to force**

**3 Global Hydrological Models (GHMs) under**

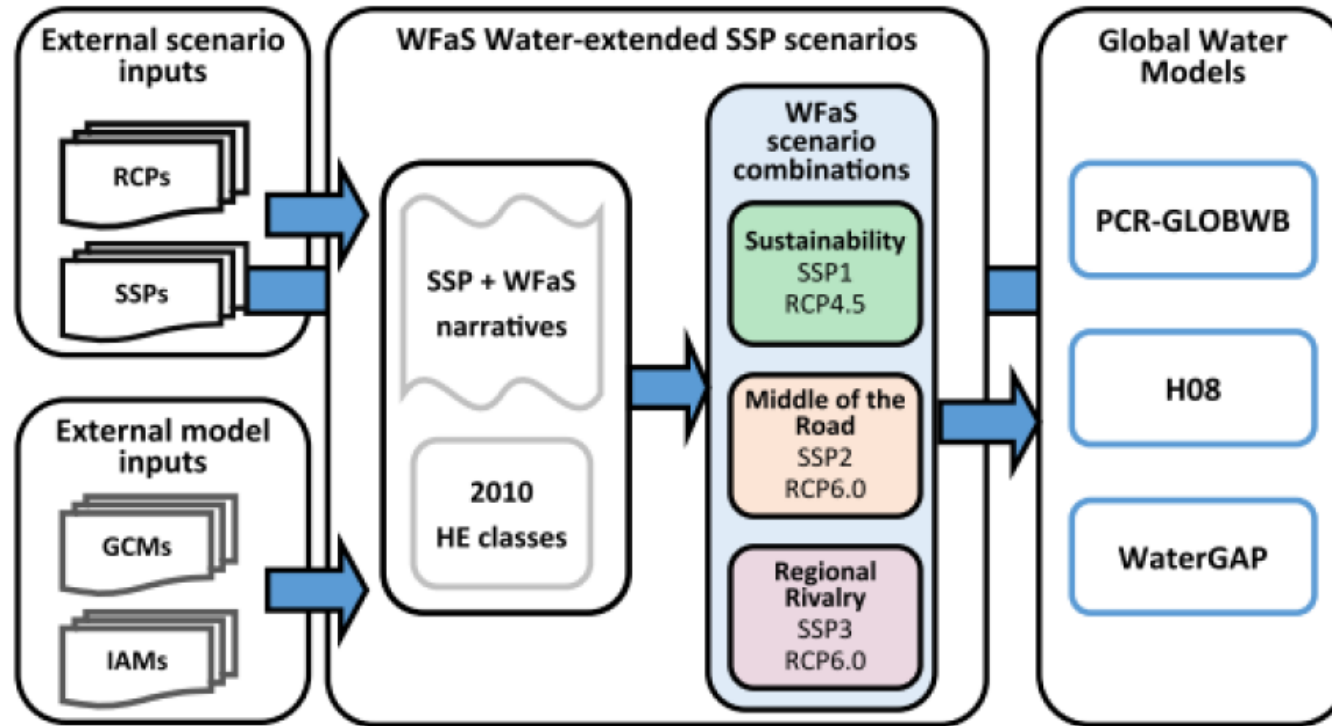
**3 different water scenarios**



**5 Global Climate Models (GCMs) to force**

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**3 different water scenarios**



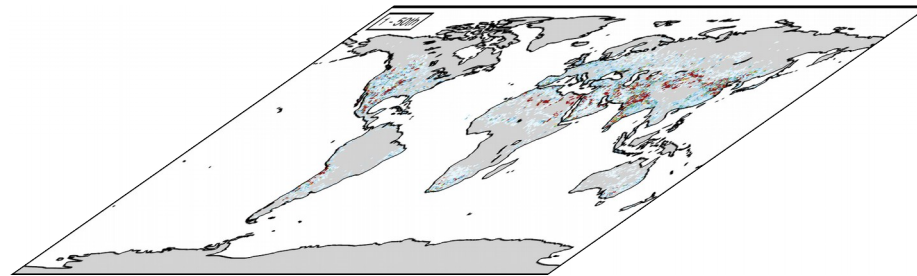
**5 Global Climate Models (GCMs)** to force

**3 Global Hydrological Models (GHMs)** under

**3 different water scenarios** provide global estimates of

water supply and water demand → **water scarcity (dem/sup)**



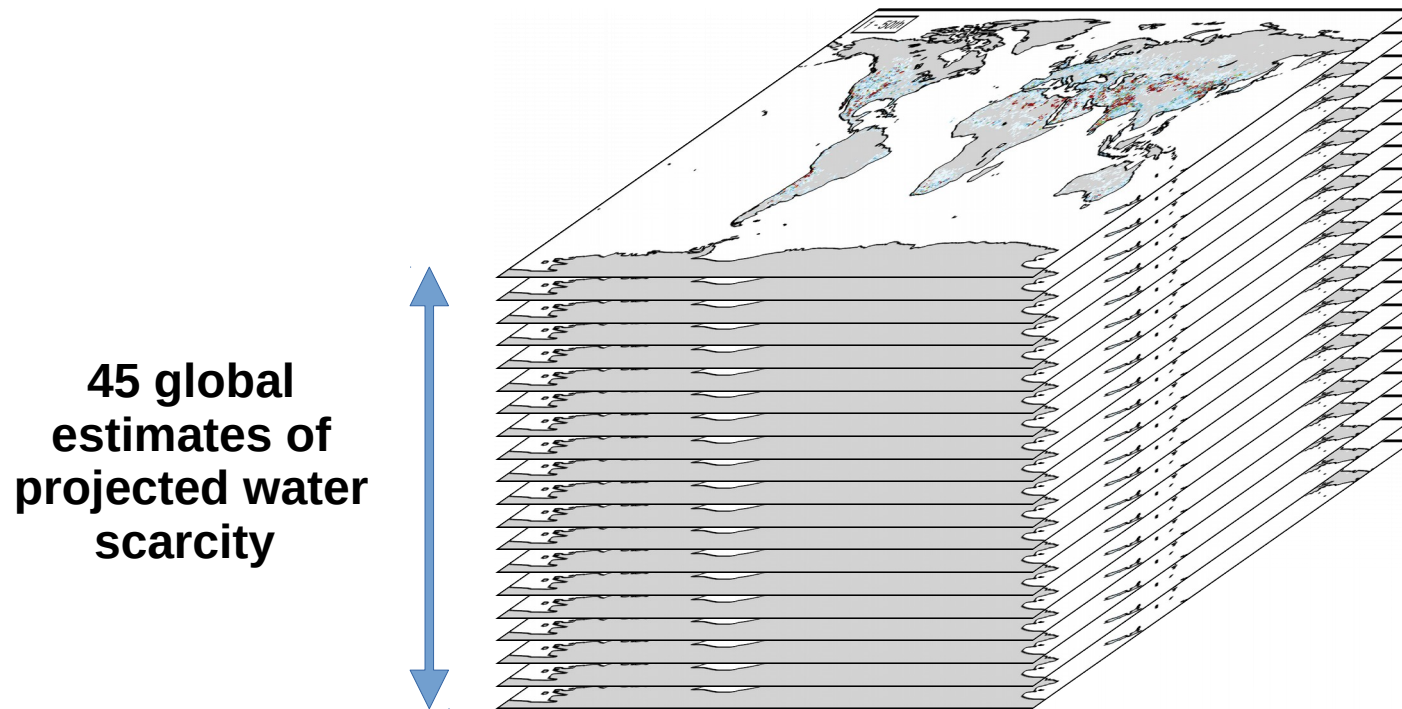


**5 Global Climate Models (GCMs)** to force

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water supply and water demand → **water scarcity (dem/sup)**



**5 Global Climate Models (GCMs)** to force

**3 Global Hydrological Models (GHMs)** under

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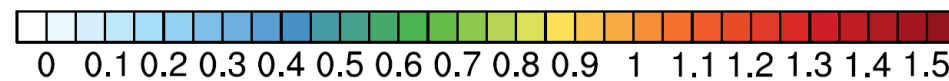
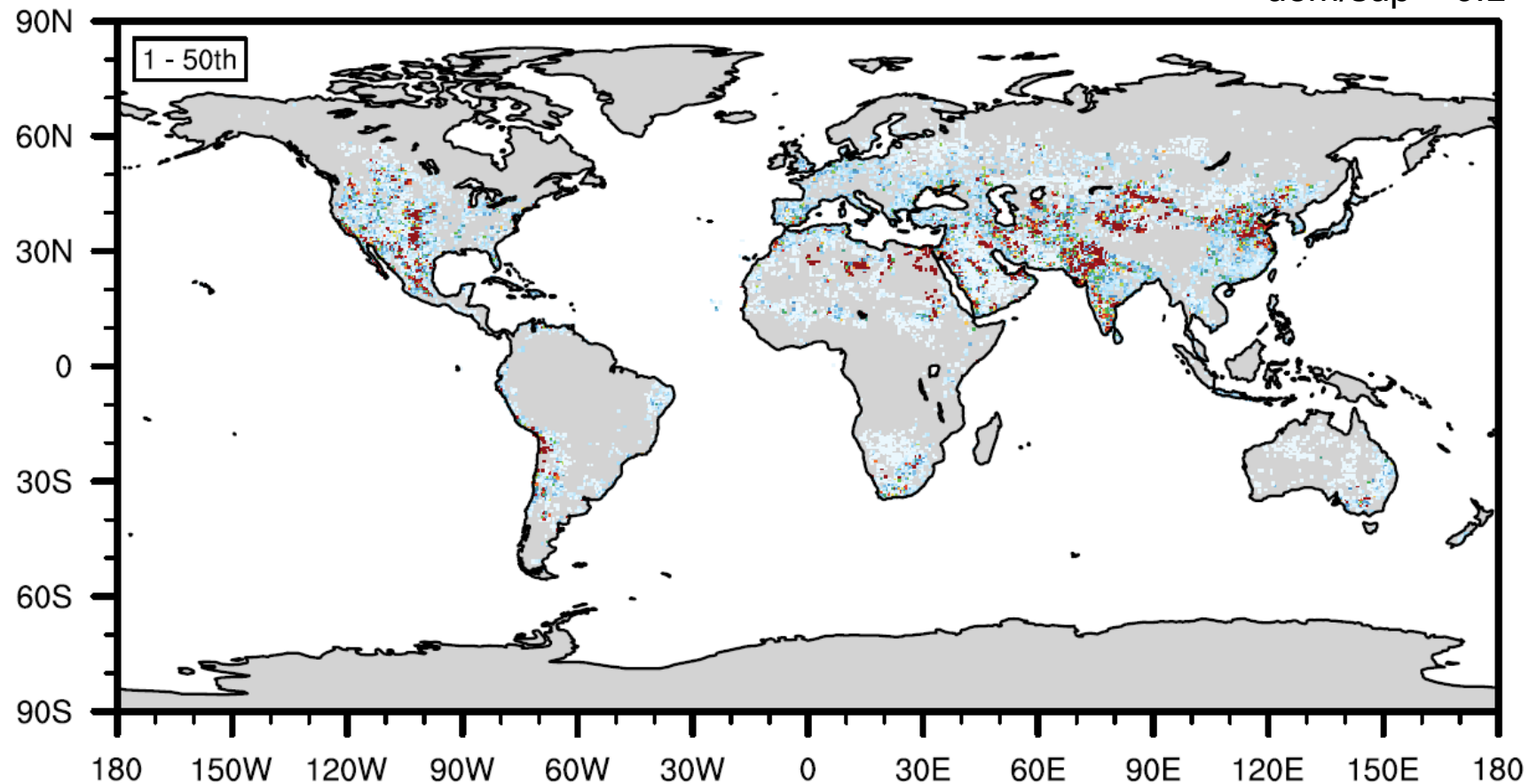
water supply and water demand → **water scarcity (dem/sup)**

# Water scarcity projections

median water scarcity

2006-2015

dem/sup > 0.1

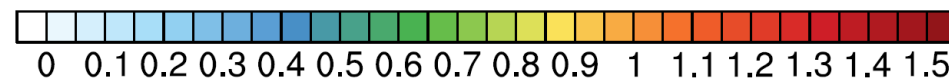
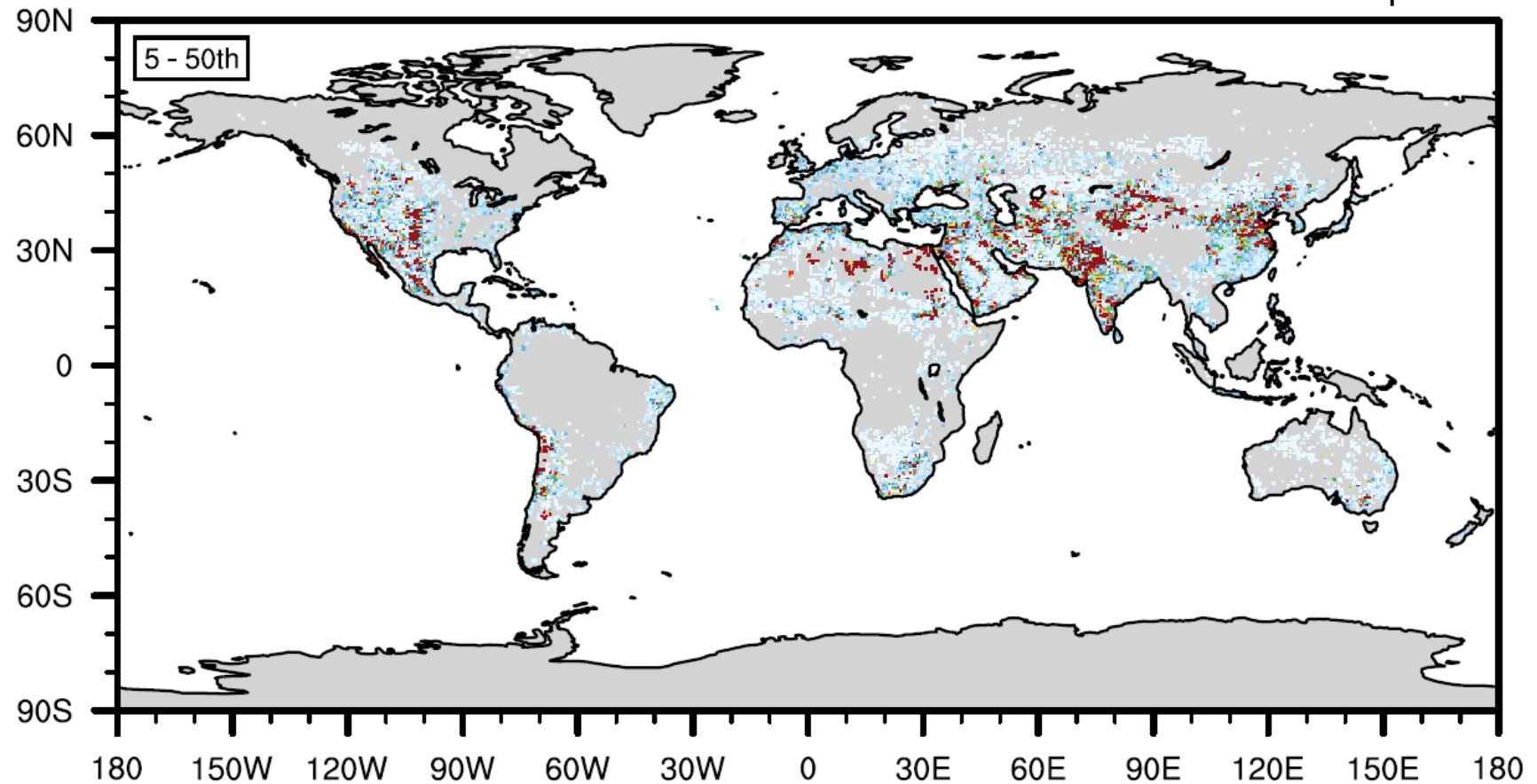


# Water scarcity projections

median water scarcity

2046-55

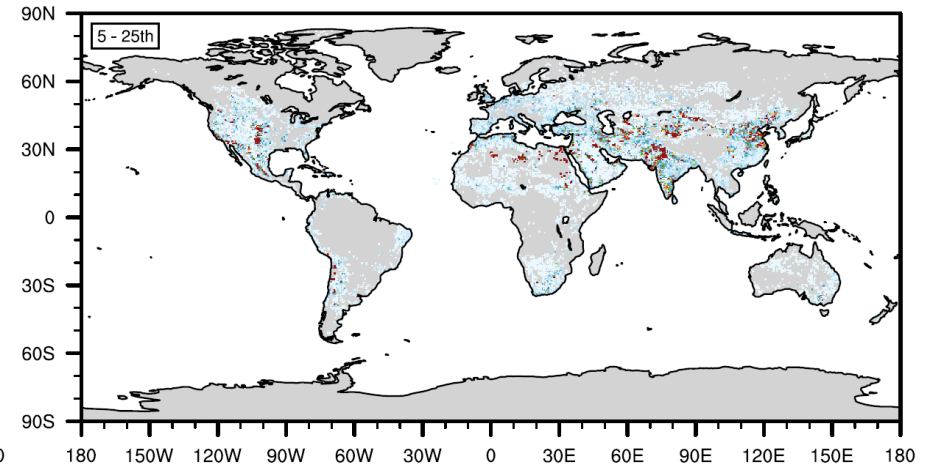
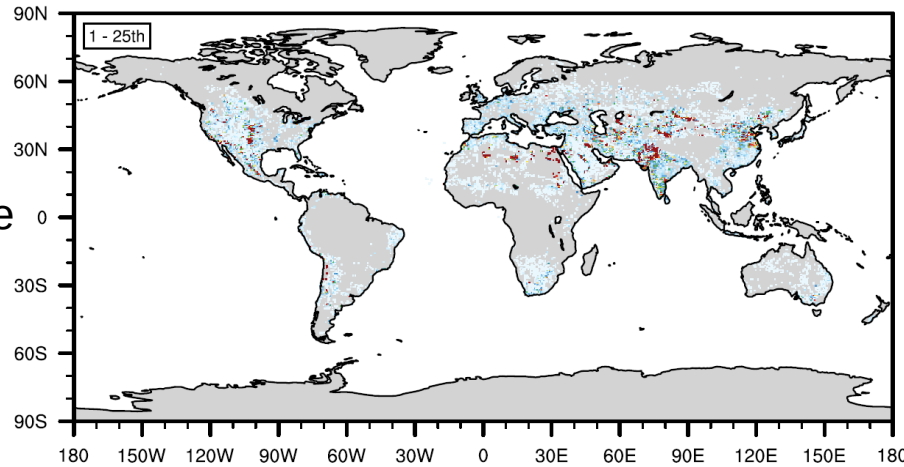
dem/sup > 0.1



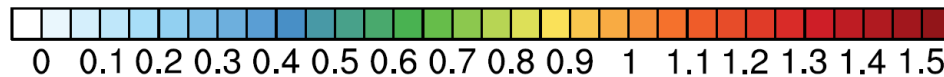
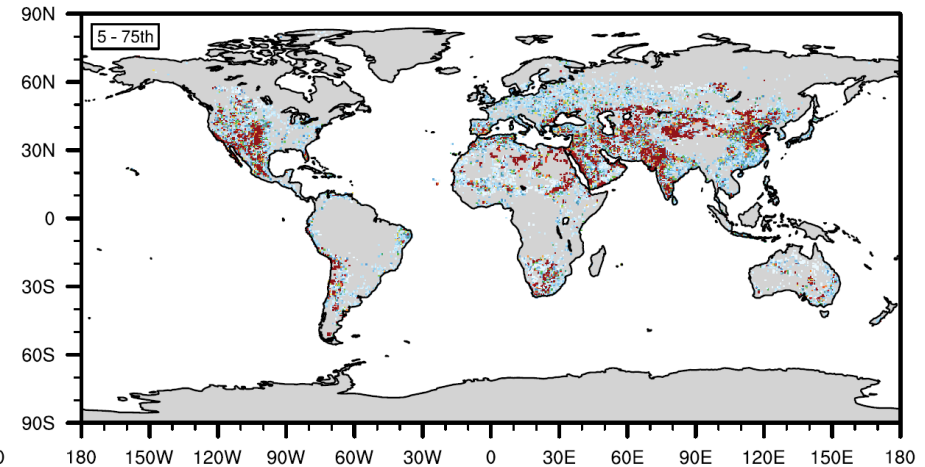
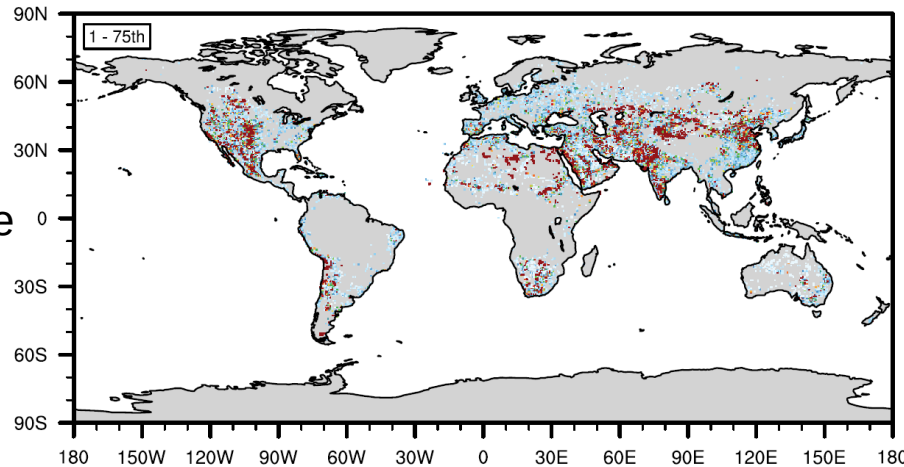
2006-2015

2046-2055

25<sup>th</sup> quantile



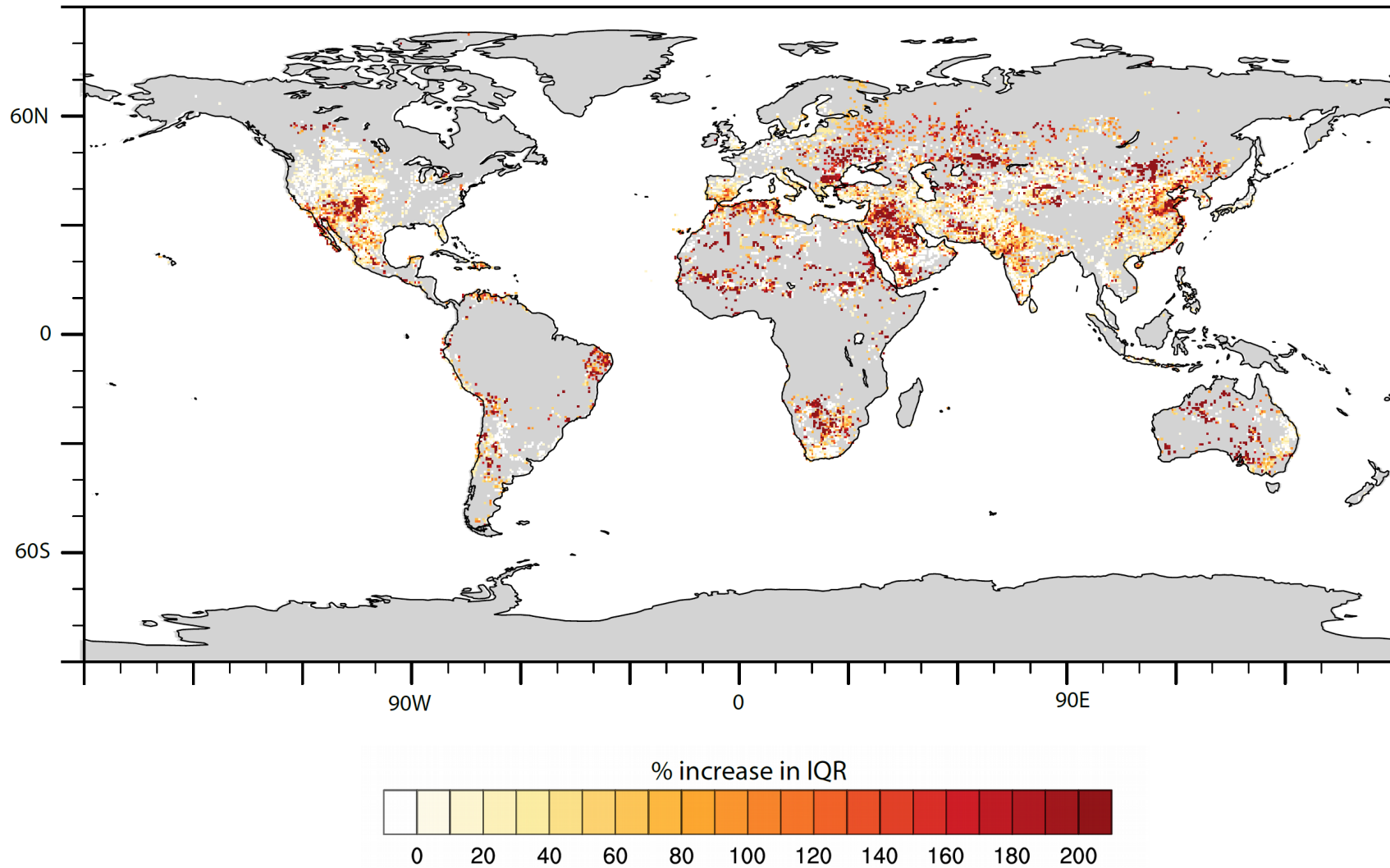
75<sup>th</sup> quantile





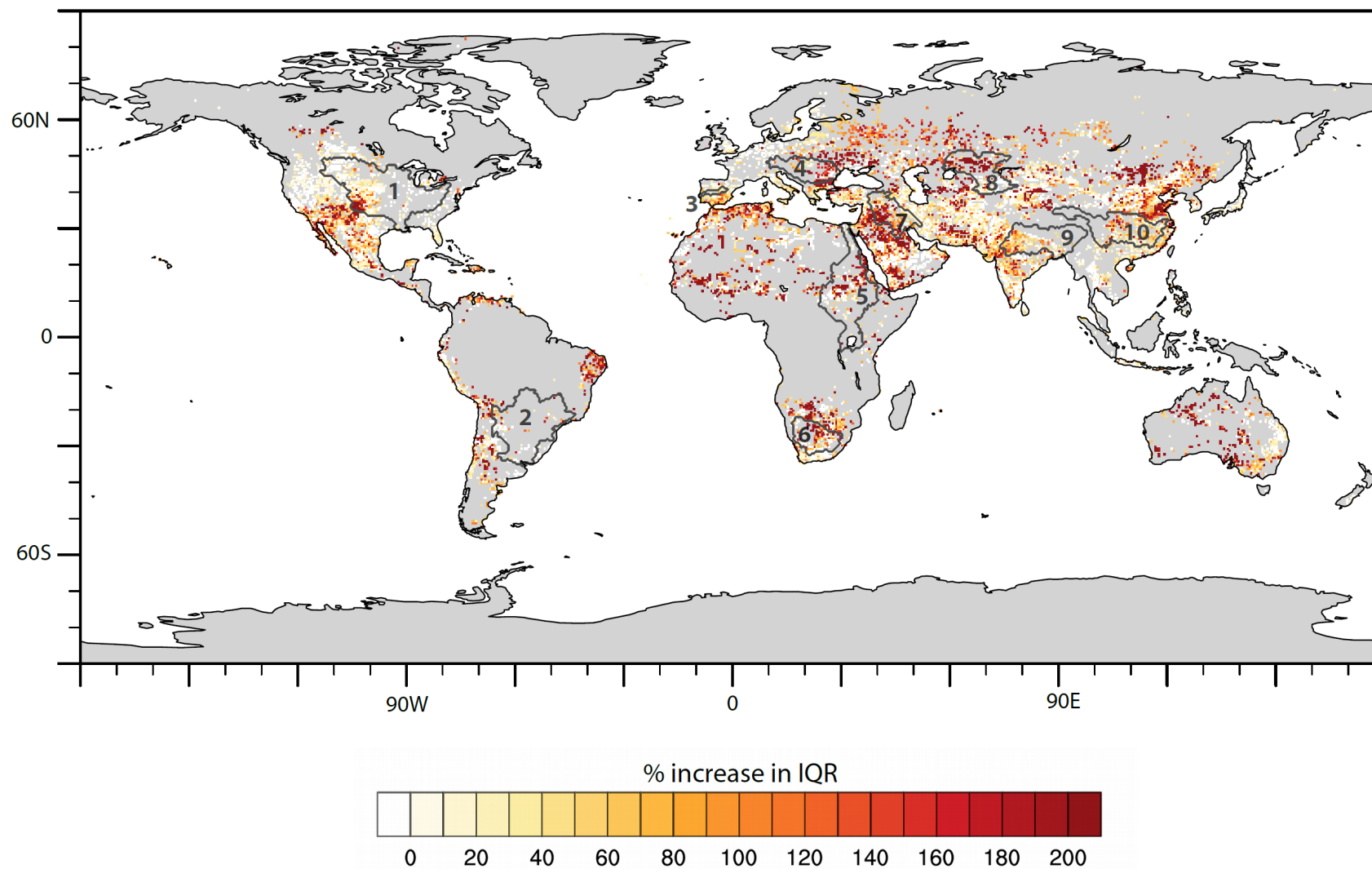
# Changes in uncertainty

2006-2015 to 2046-2055

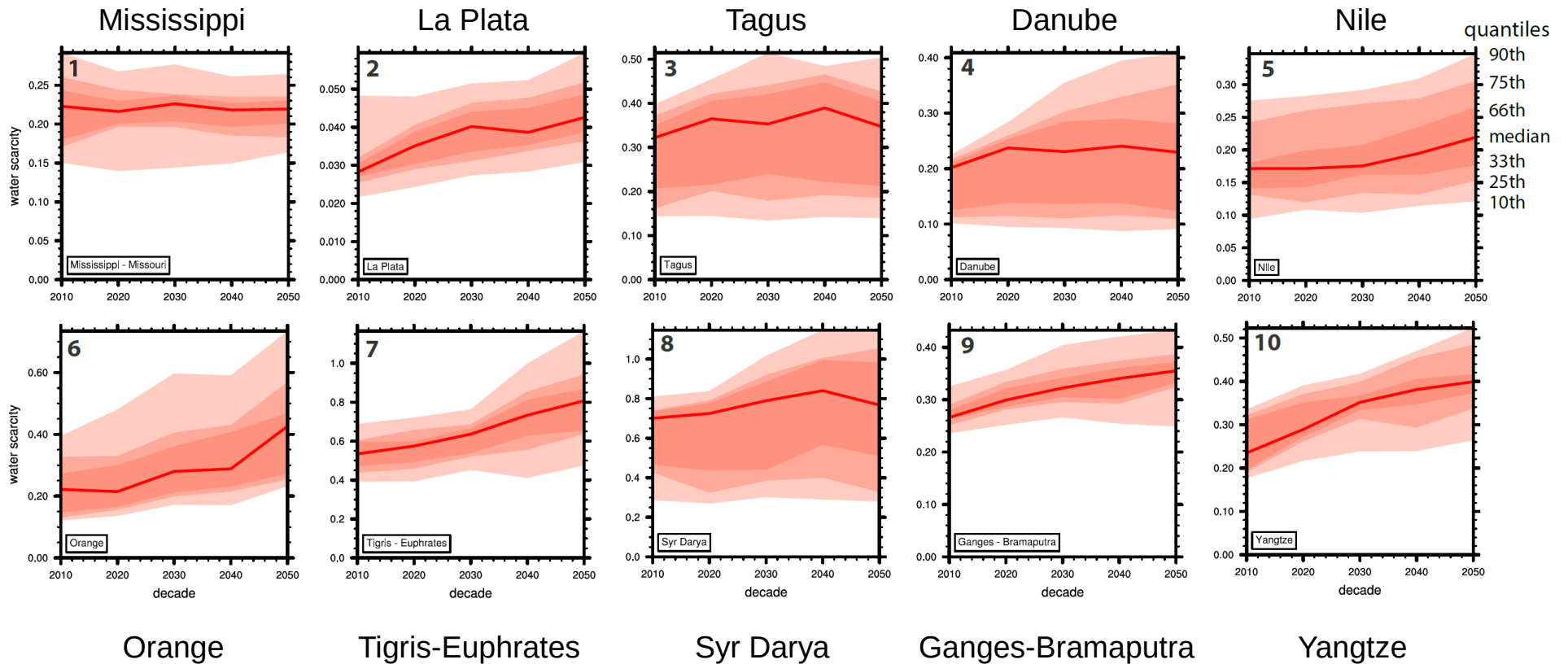
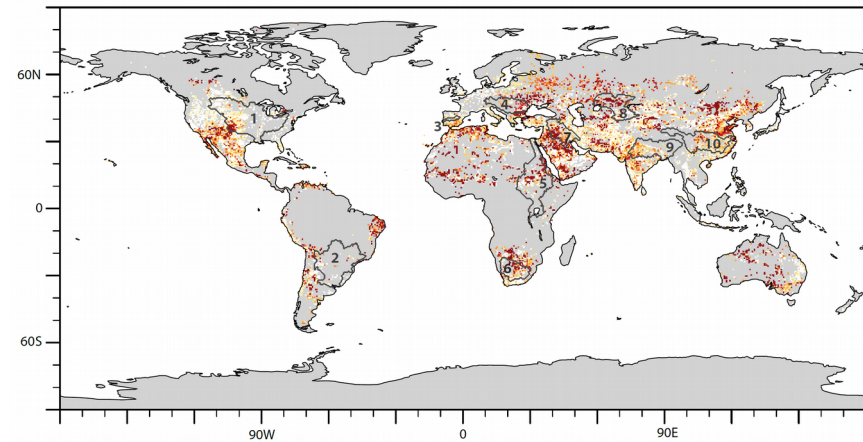


# Changes in uncertainty

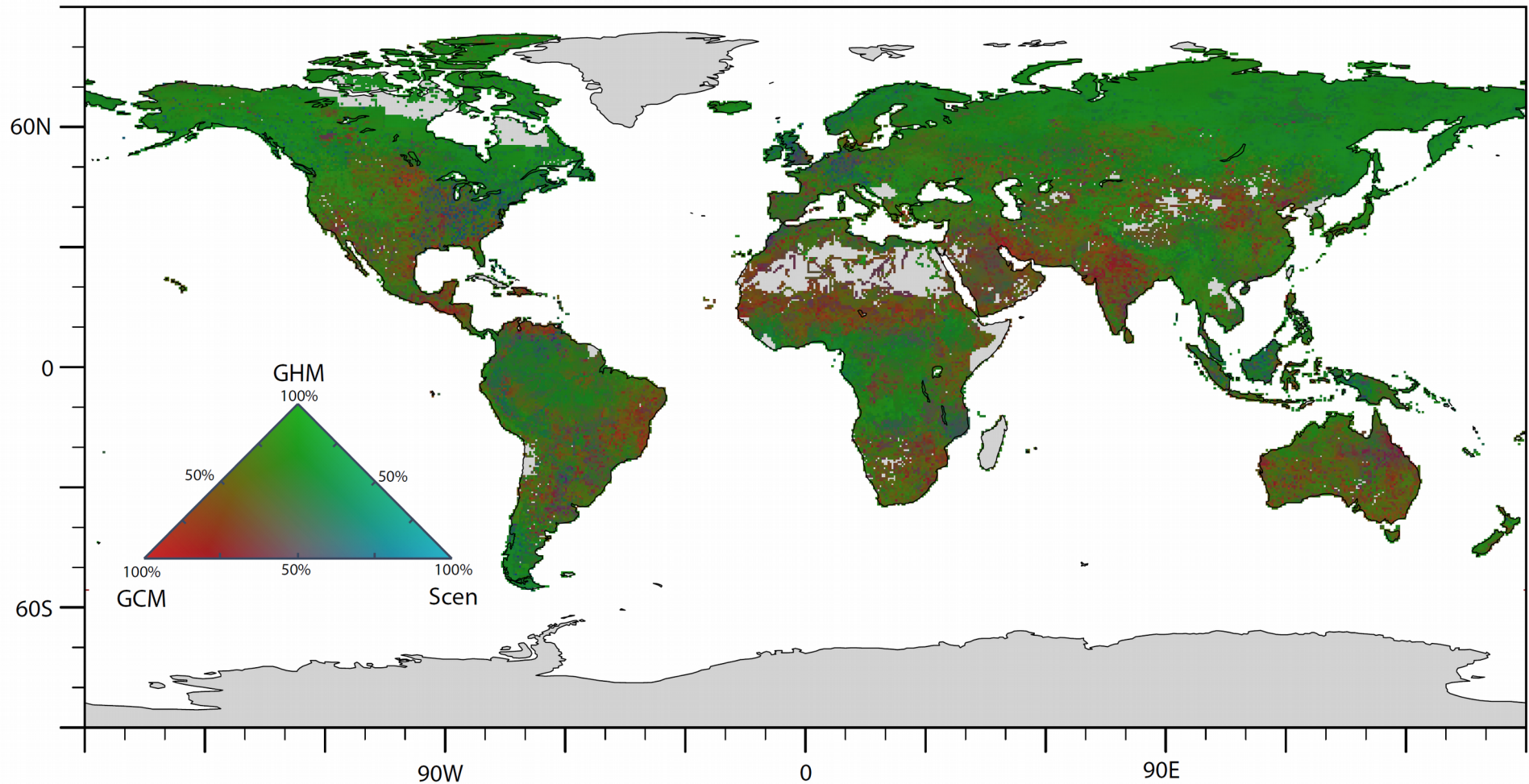
2006-2015 to 2046-2055



# Changes in uncertainty



2046-2055

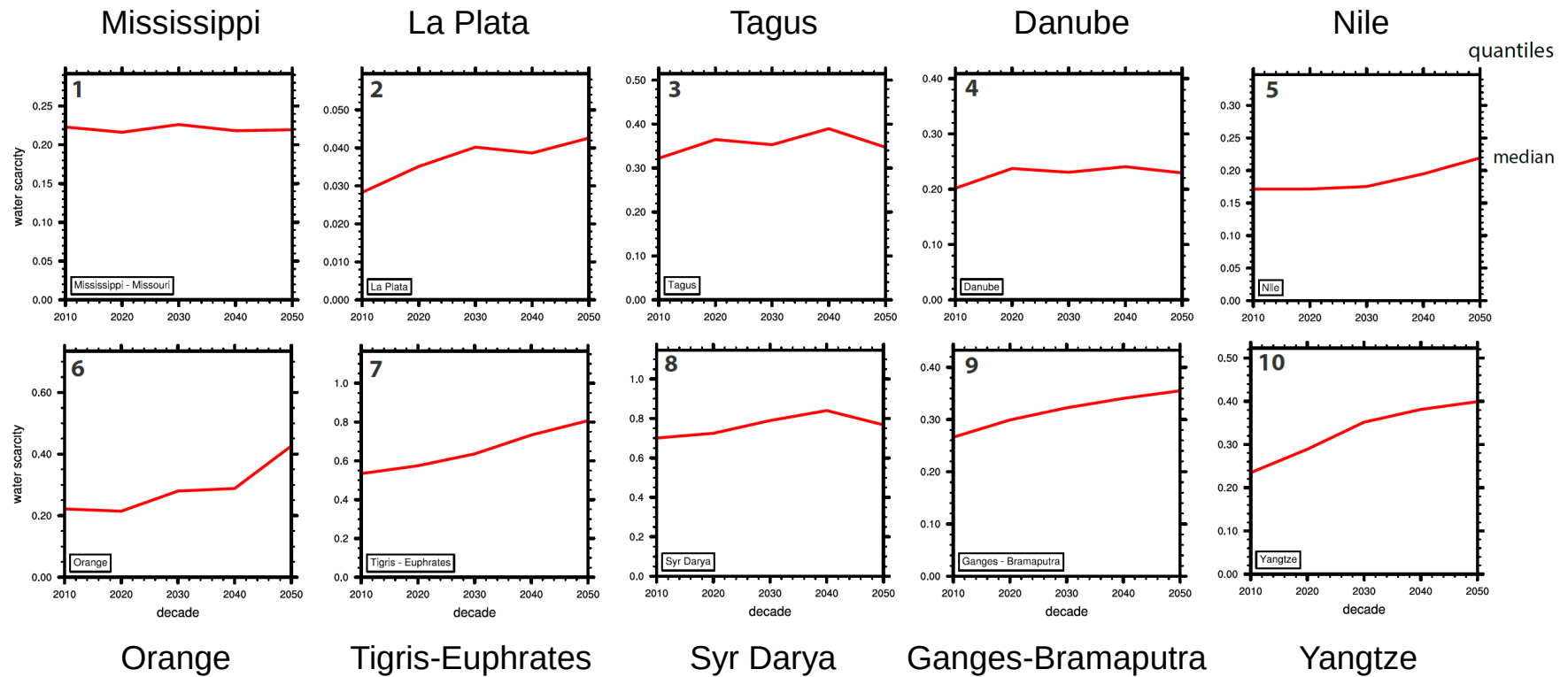


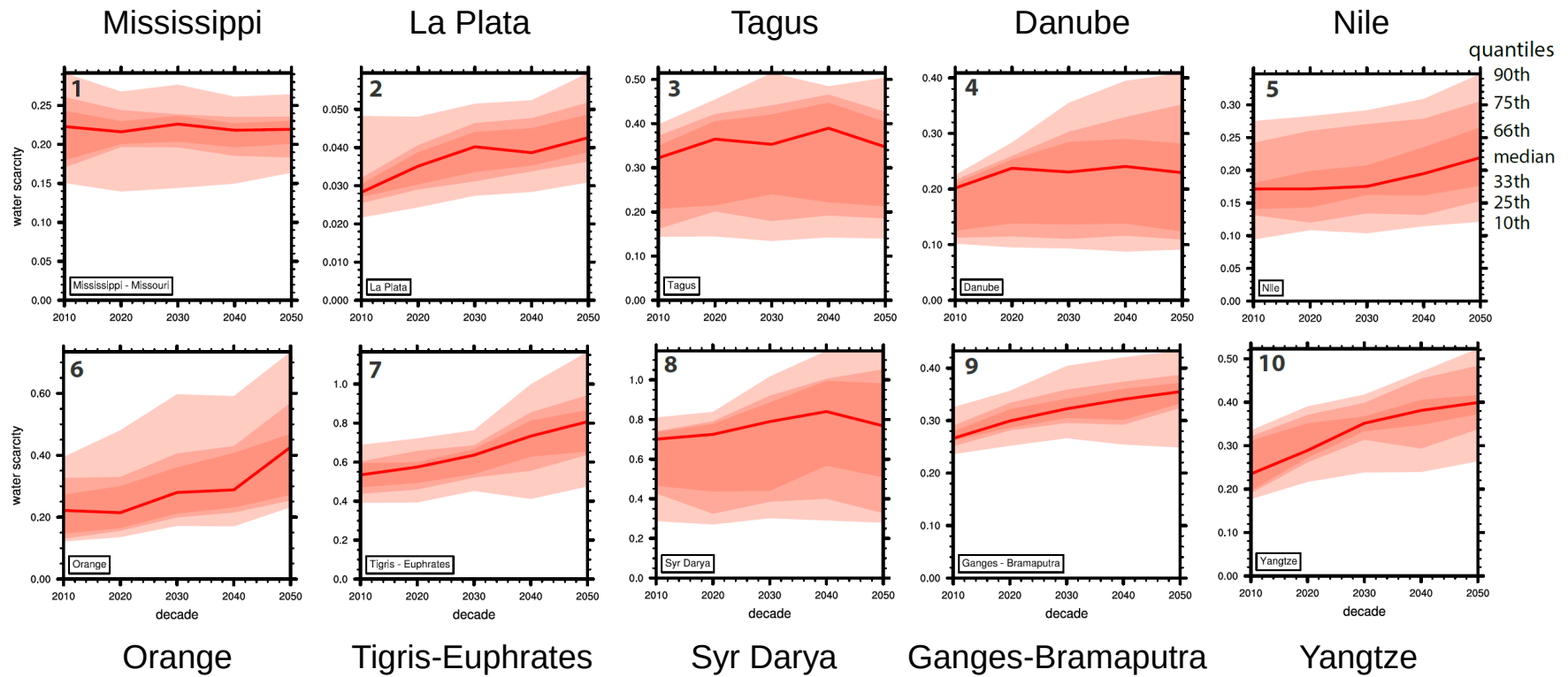
- **Global Hydrological Models (GHM)** are the main source of uncertainty in most regions
- **Climate Models (GCM)** are the main driver of uncertainty in many subtropical regions
- Uncertainty stemming from **water scenarios (Scen)** is less important

# Policy implications



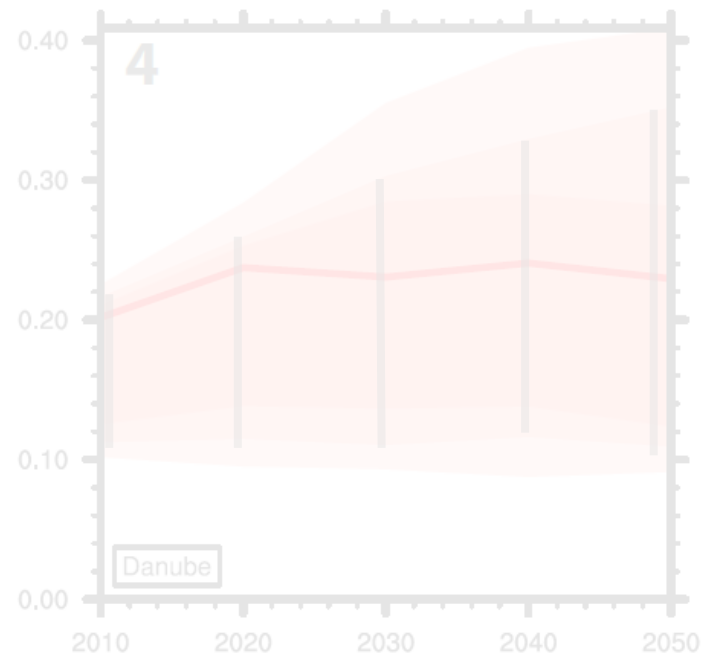
# Policy implications





# Clustering

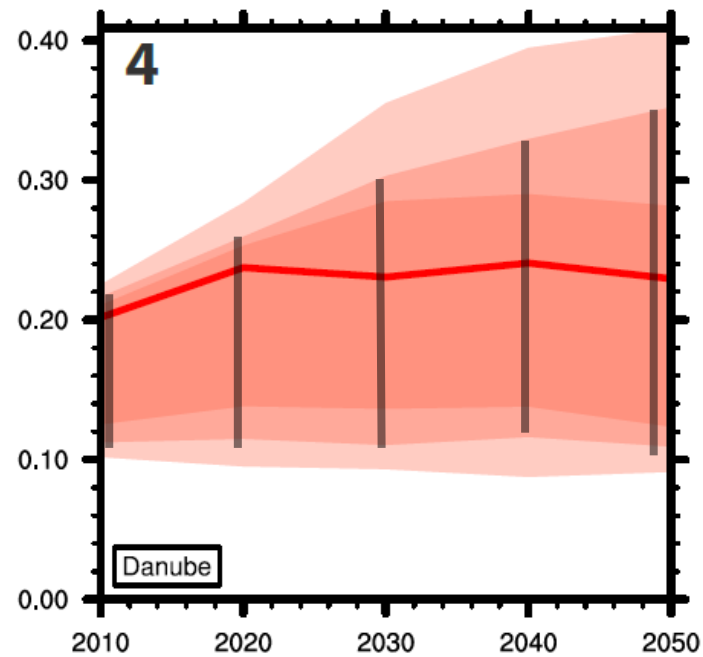
Identify regions of similar changes in uncertainty



Identify regions of similar changes in uncertainty

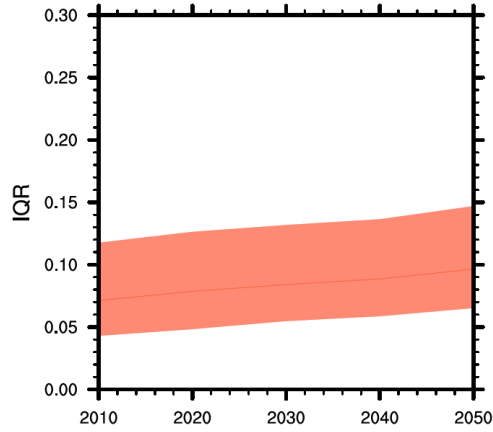
**Characteristics:**  
(at every gridpoint)

- (i) initial IQR
- (ii) decade-to-decade changes in IQR



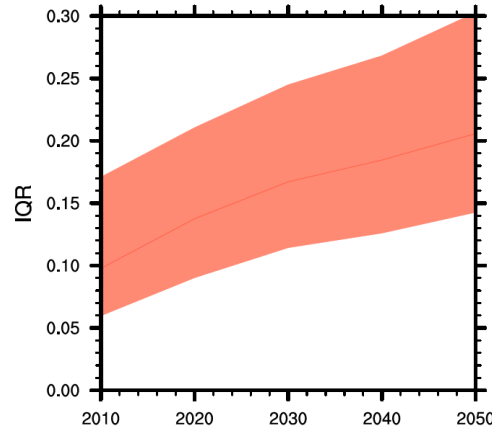
## Cluster 1

small IQR + small change



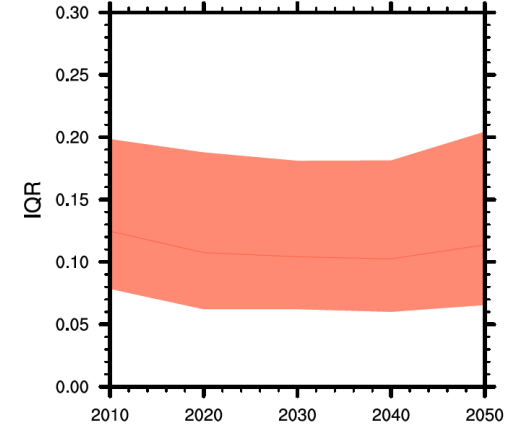
## Cluster 2

small IQR + medium change



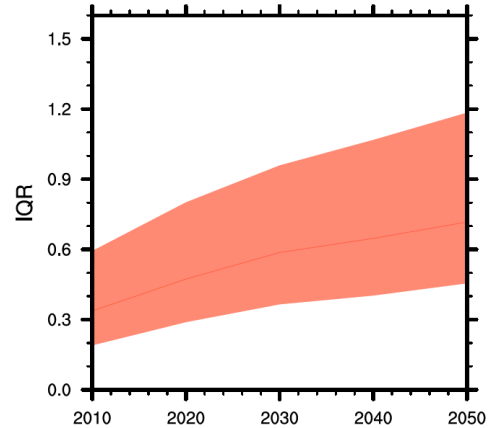
## Cluster 3

small IQR + stable change



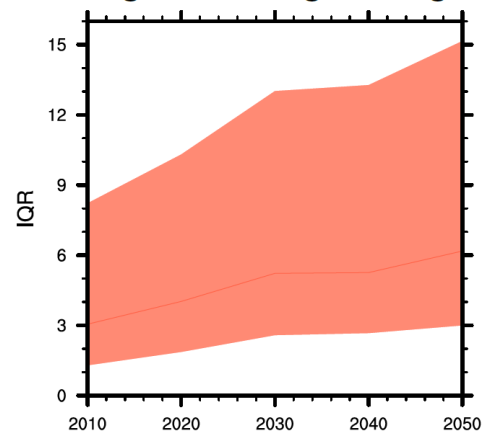
## Cluster 4

medium IQR + large change



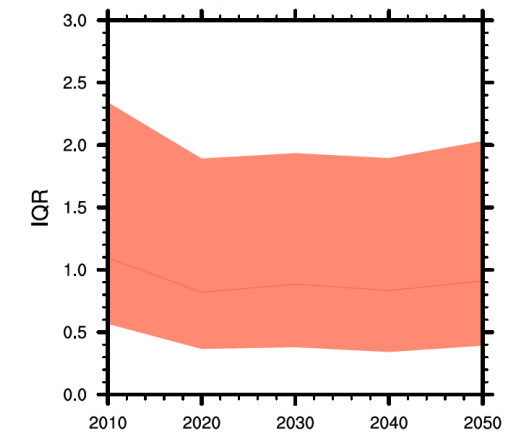
## Cluster 5

large IQR + large change



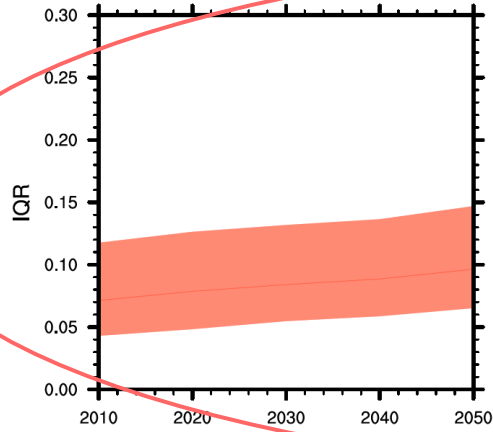
## Cluster 6

medium/large IQR + stable change



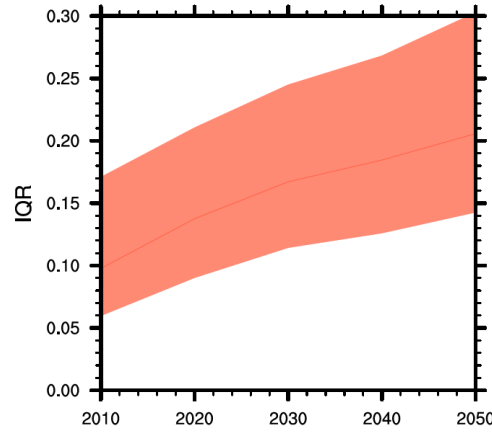
## Cluster 1

small IQR + small change



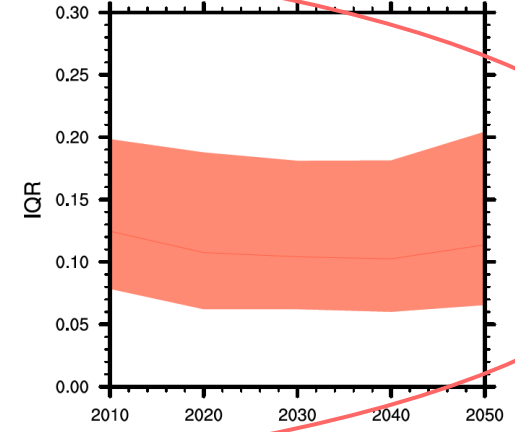
## Cluster 2

small IQR + medium change



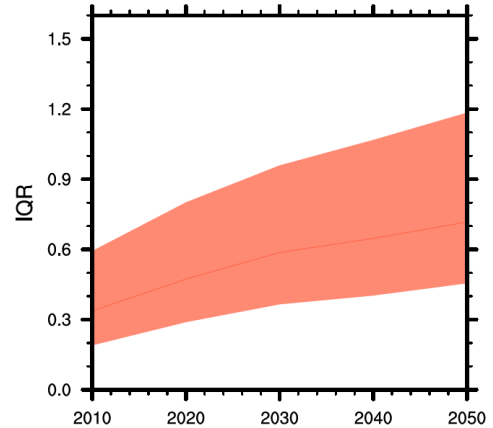
## Cluster 3

small IQR + stable change



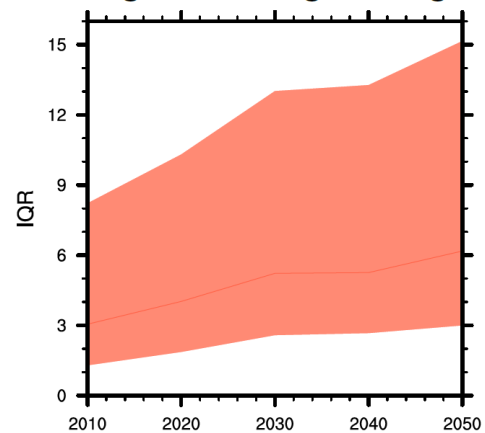
## Cluster 4

medium IQR + large change



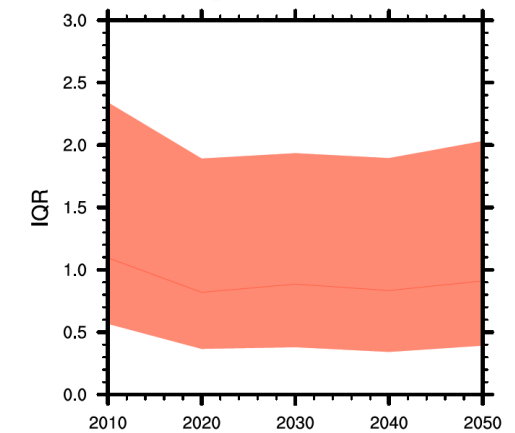
## Cluster 5

large IQR + large change



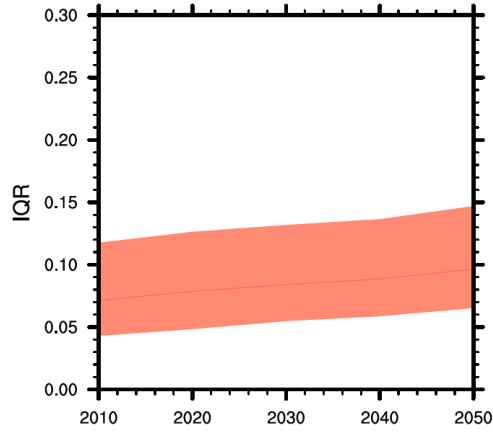
## Cluster 6

medium/large IQR + stable change



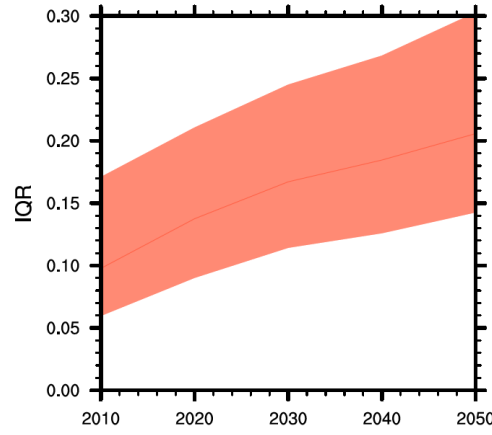
## Cluster 1

small IQR + small change



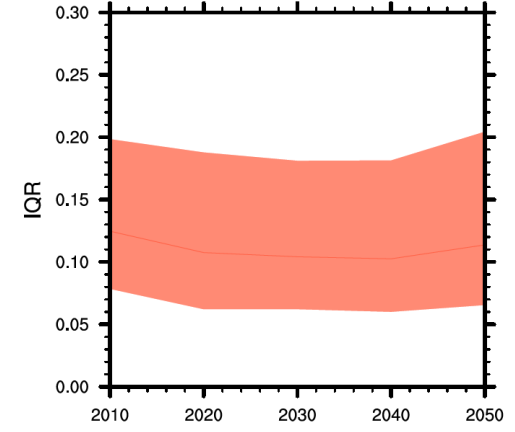
## Cluster 2

small IQR + medium change



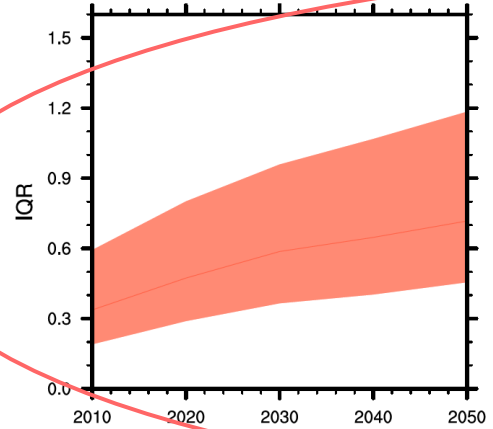
## Cluster 3

small IQR + stable change



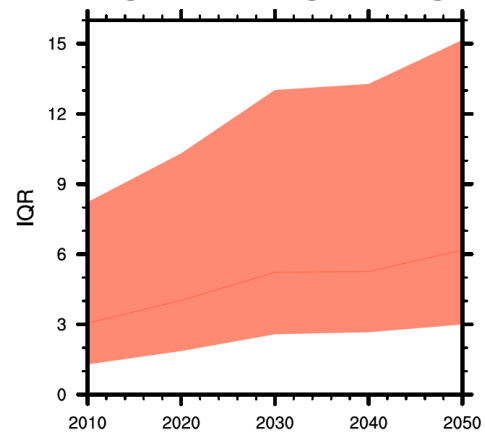
## Cluster 4

medium IQR + large change



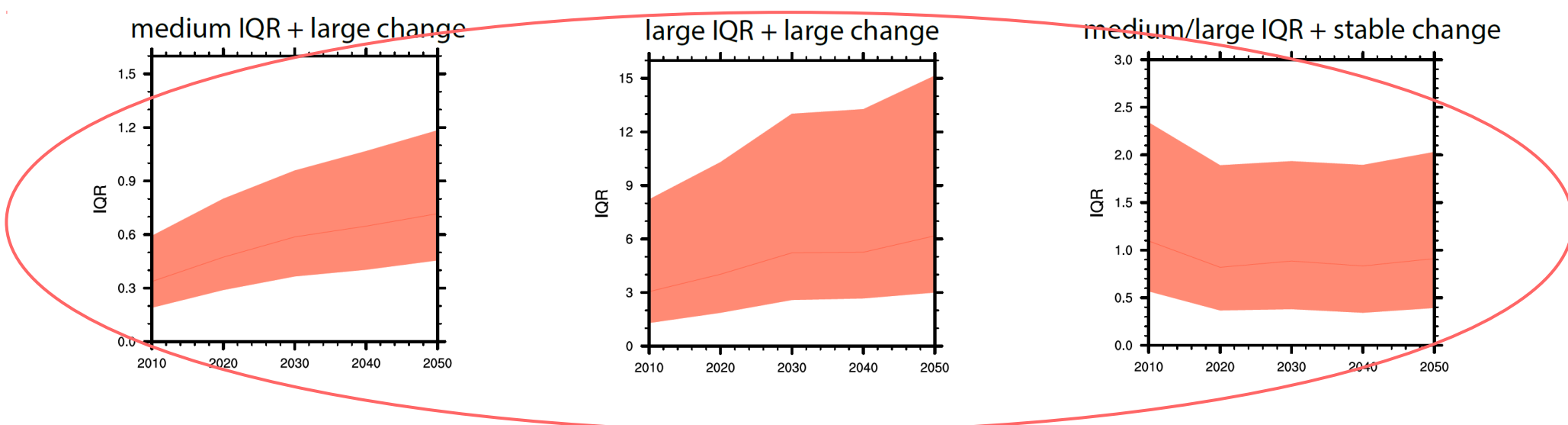
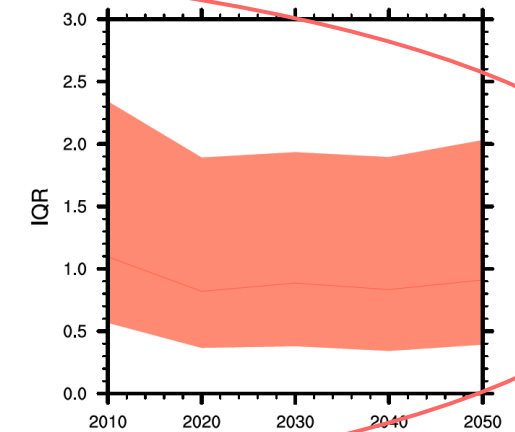
## Cluster 5

large IQR + large change



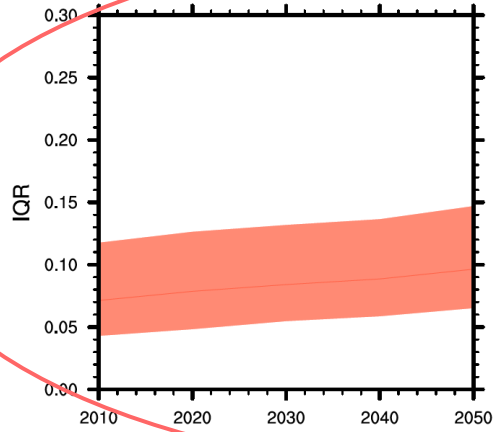
## Cluster 6

medium/large IQR + stable change



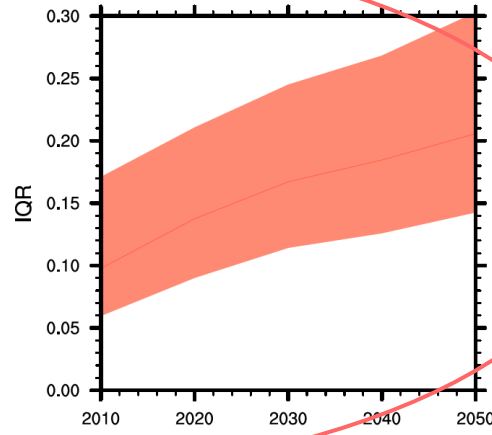
## Cluster 1

small IQR + small change



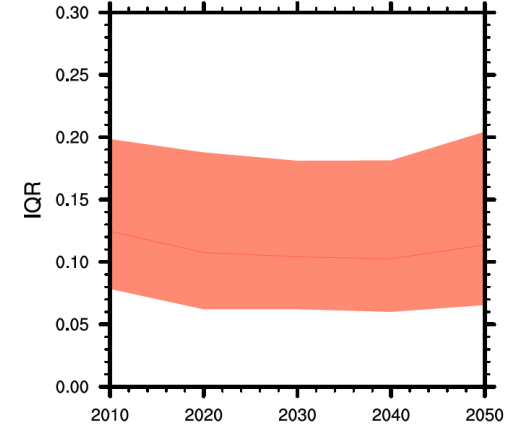
## Cluster 2

small IQR + medium change



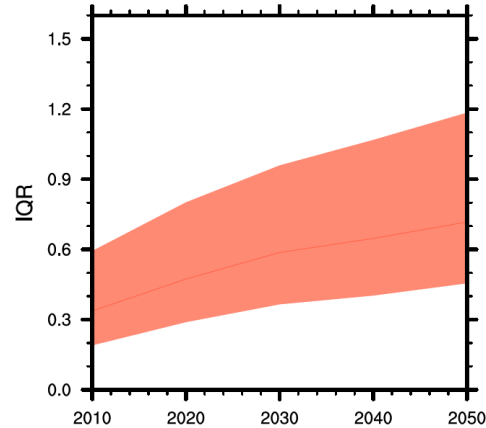
## Cluster 3

small IQR + stable change



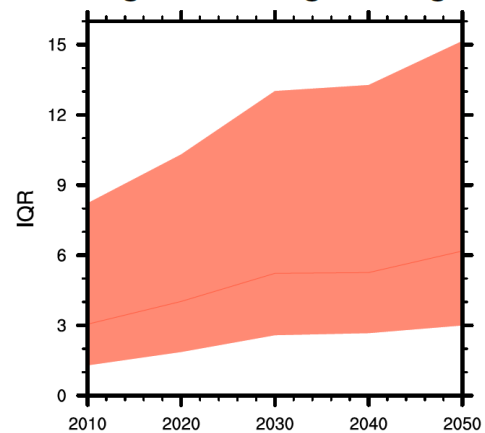
## Cluster 4

medium IQR + large change



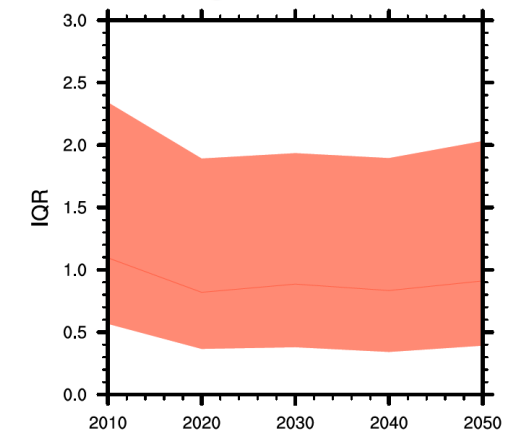
## Cluster 5

large IQR + large change



## Cluster 6

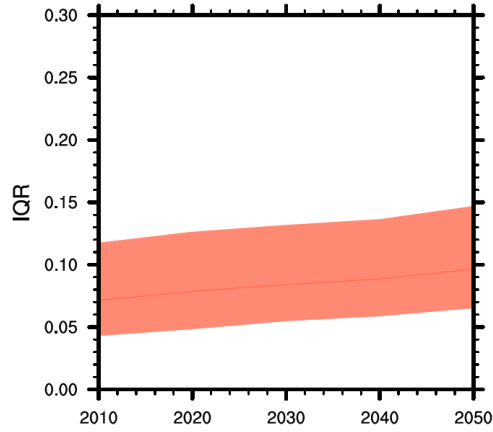
medium/large IQR + stable change





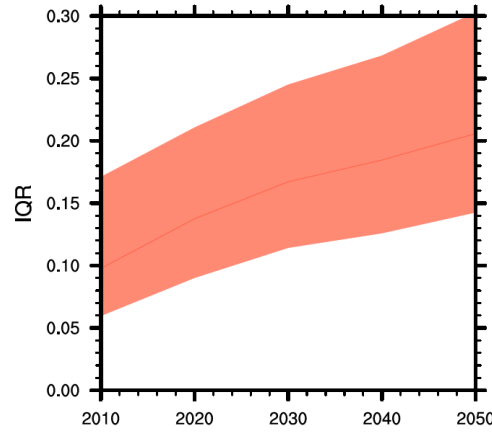
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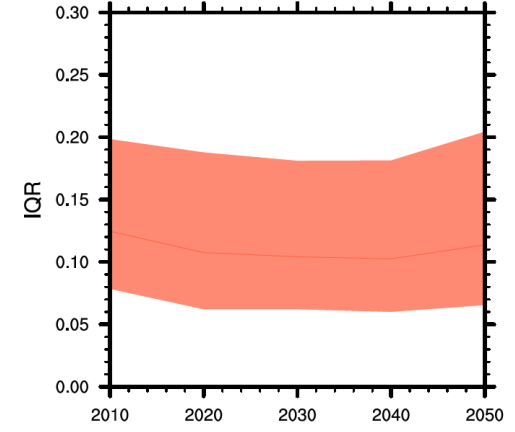
## Cluster 2

small IQR + medium change



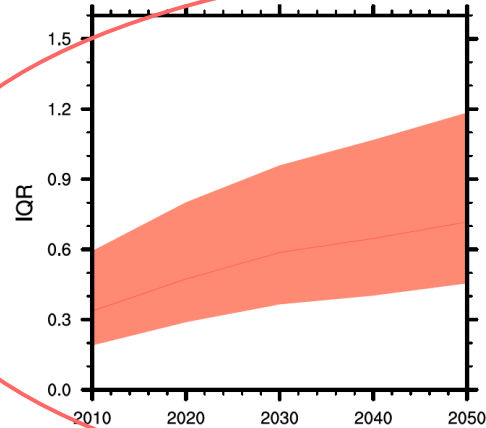
## Cluster 3

small IQR + stable change



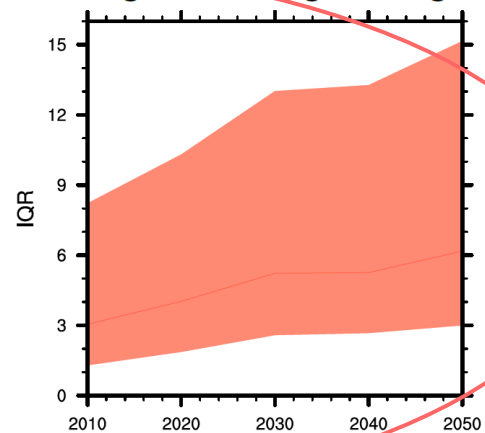
## Cluster 4

medium IQR + large change



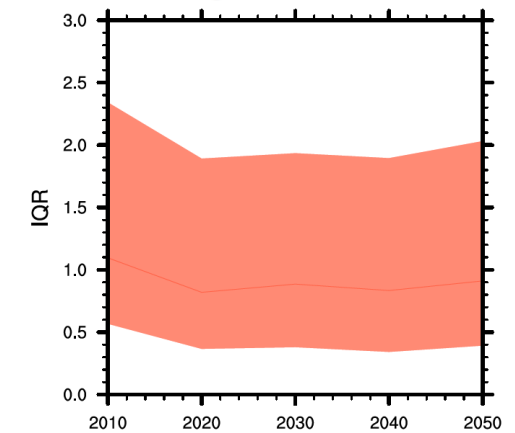
## Cluster 5

large IQR + large change



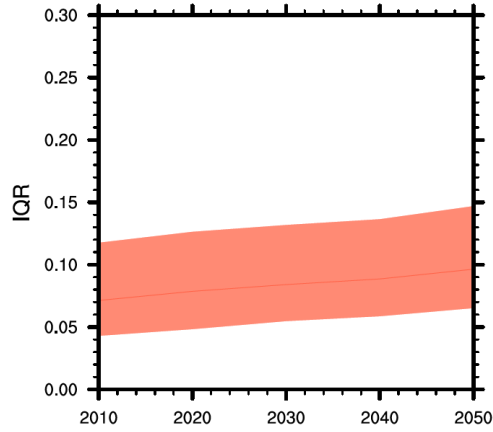
## Cluster 6

medium/large IQR + stable change



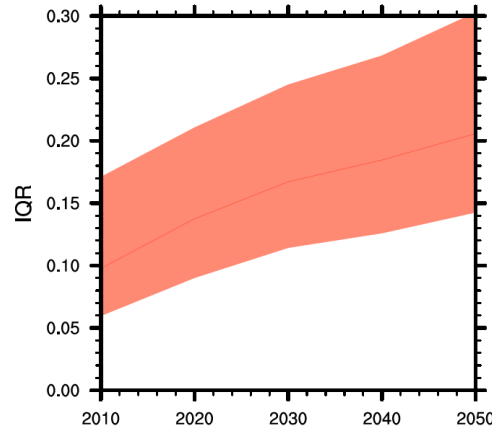
## Cluster 1

small IQR + small change



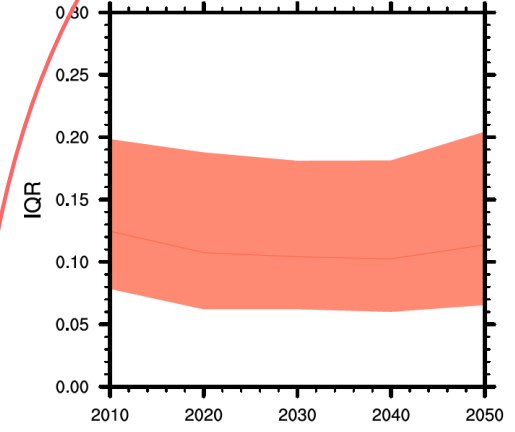
## Cluster 2

small IQR + medium change



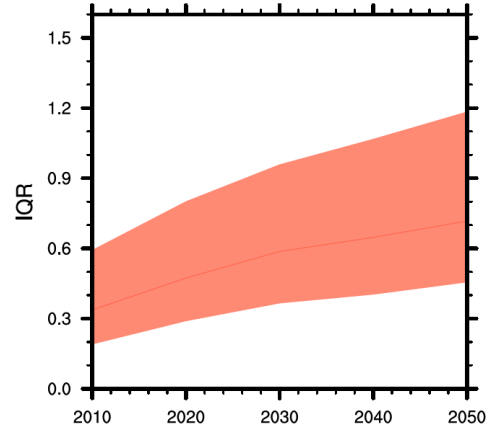
## Cluster 3

small IQR + stable change



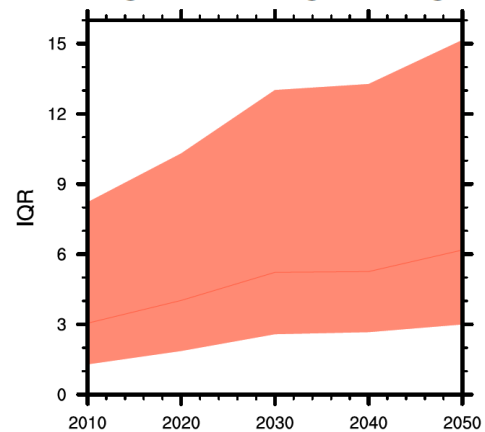
## Cluster 4

medium IQR + large change



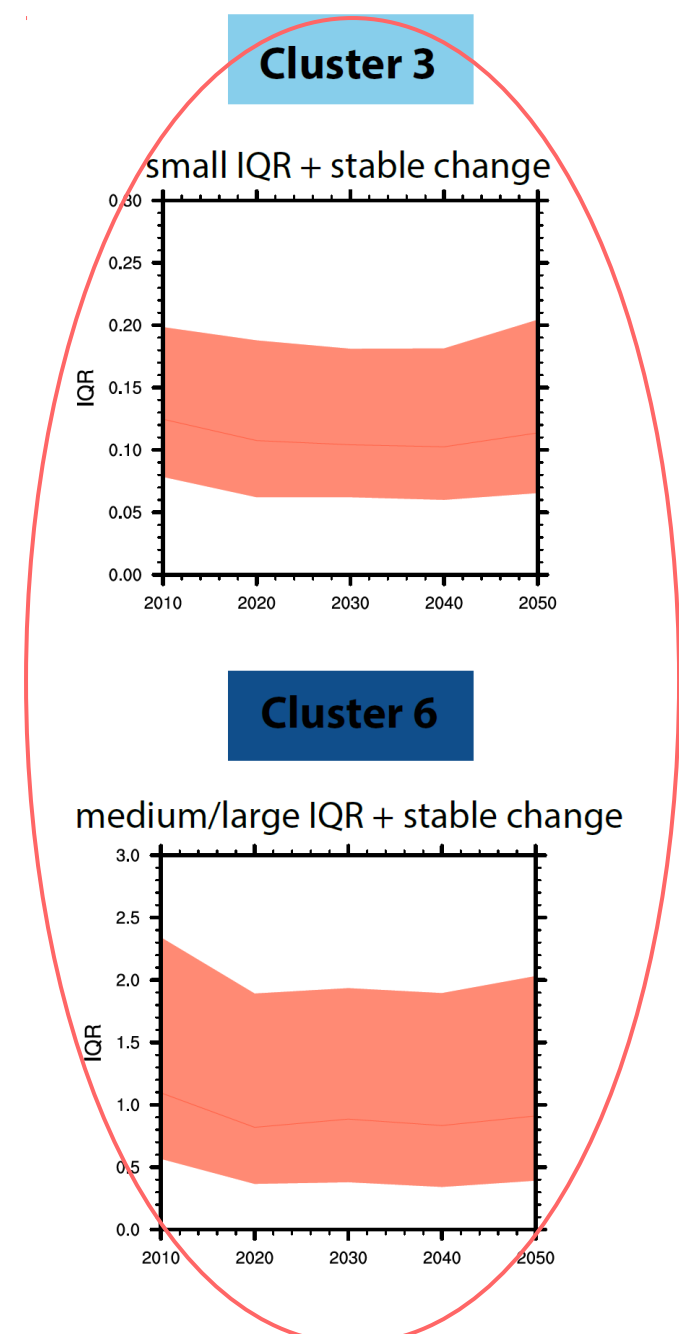
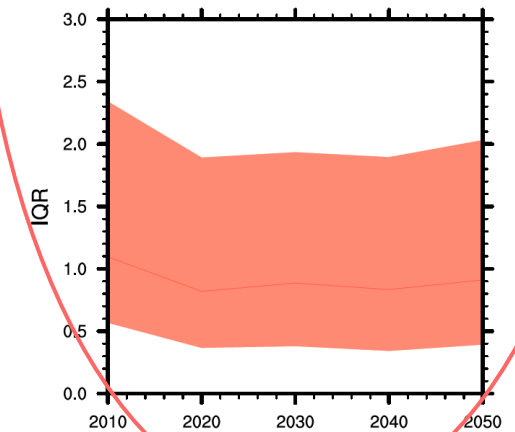
## Cluster 5

large IQR + large change

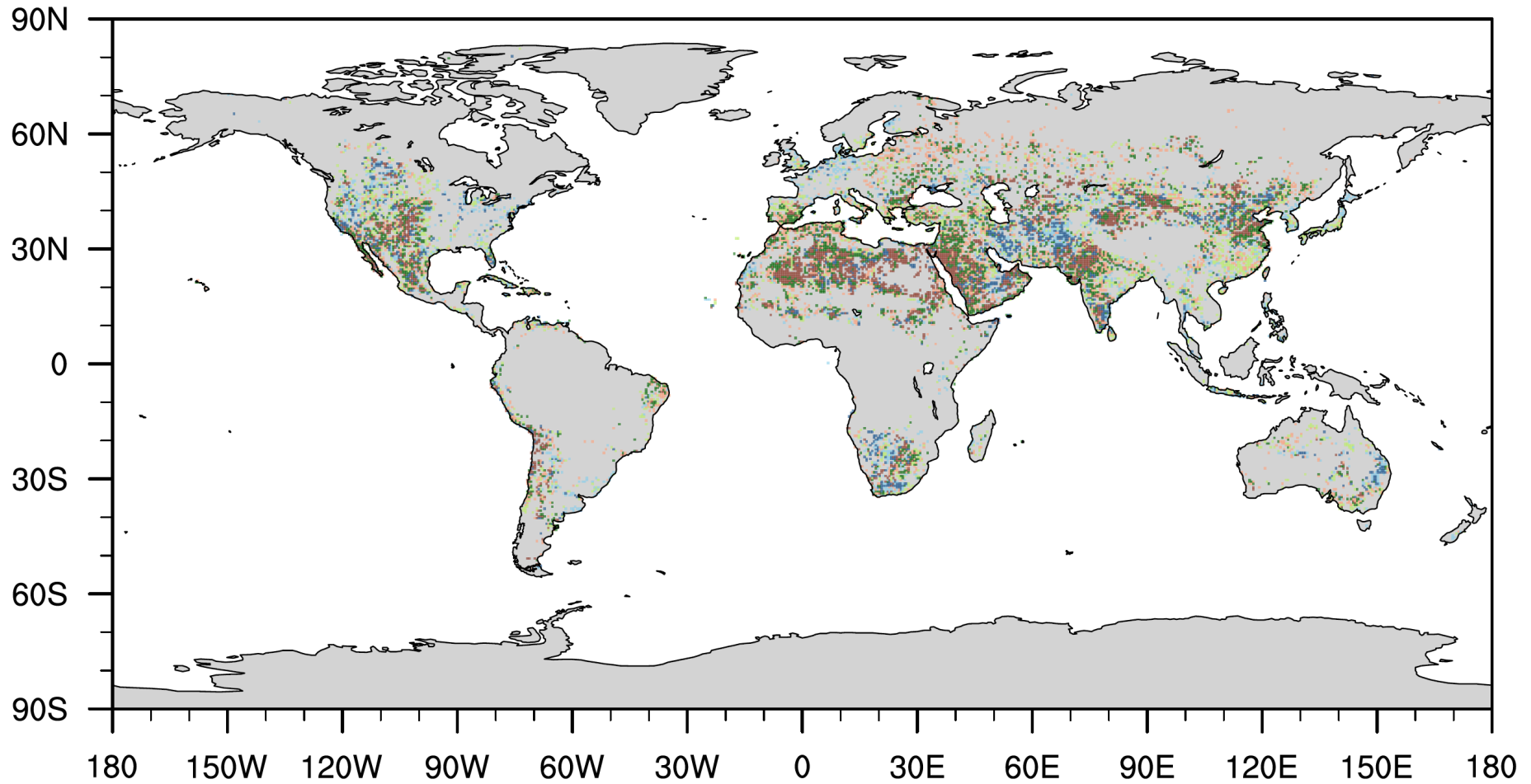


## Cluster 6

medium/large IQR + stable change



# Clustering



**Cluster 1**

**Cluster 2**

**Cluster 3**

**Cluster 4**

**Cluster 5**

**Cluster 6**

small IQR + small change

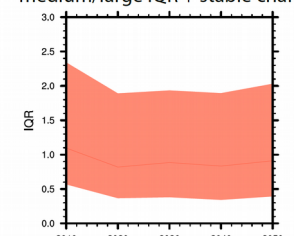
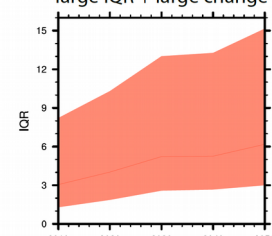
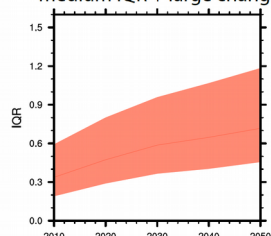
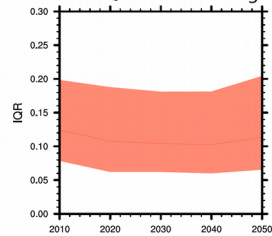
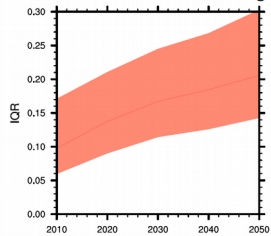
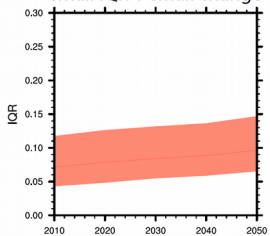
small IQR + medium change

small IQR + stable change

medium IQR + large change

large IQR + large change

medium/large IQR + stable change



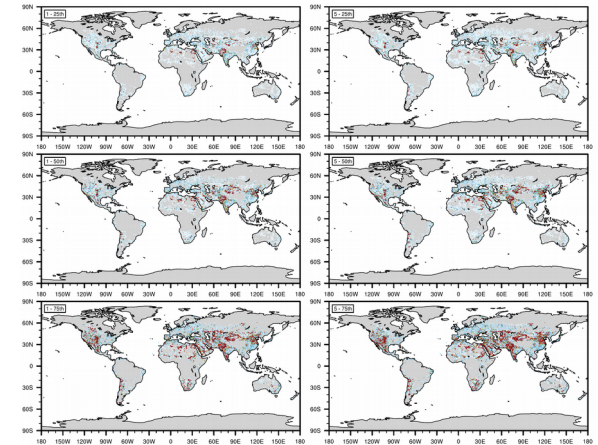
- **Low challenge areas** (Low water stress, low & stable uncertainty)
  - Continue monitoring and periodically review risk and uncertainty related to water scarcity
- **Medium challenge areas** (High water stress, low & stable uncertainty)
  - Transitional changes are needed
  - Immediate action is required
  - Standard decision-making processes such as cost–benefit analysis or MCA
- **Medium challenge areas** (Medium water stress, medium-high (increasing) uncertainty)
  - Start with low/no-regret options tackling the adaptation deficit
  - Iterative decision making processes
  - Robust decision making
- **High challenge areas** (High water stress, high & increasing uncertainty)
  - Transformational changes are needed
  - Immediate action is required
  - Employ adaptive and iterative management and decision frameworks
  - Start from existing adaptation deficit

- **Low challenge areas** (Low water stress, low & stable uncertainty)
  - Continue monitoring and periodically review risk and uncertainty related to water scarcity
- **Medium challenge areas** (High water stress, low & stable uncertainty)
  - Transitional changes are needed
  - Immediate action is required
  - Standard decision-making processes such as cost–benefit analysis or MCA
- **Medium challenge areas** (Medium water stress, medium-high (increasing) uncertainty)
  - Start with low/no-regret options tackling the adaptation deficit
  - Iterative decision making processes
  - Robust decision making
- **High challenge areas** (High water stress, high & increasing uncertainty)
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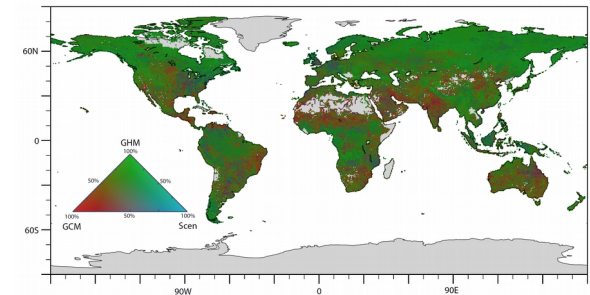
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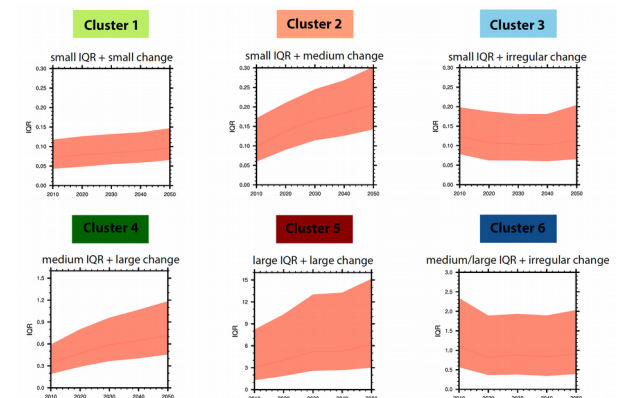
We identified **regions under water scarcity** and associated **uncertainty ranges**



We determined the **relative importance** of individual **sources of uncertainty**



We identified clusters that require **different policy actions** to flexibly and robustly **adapt to water scarcity changes**





## Water research at IIASA – Overview

“Opportunities and constraints for improved water resources management using different lenses and scales”

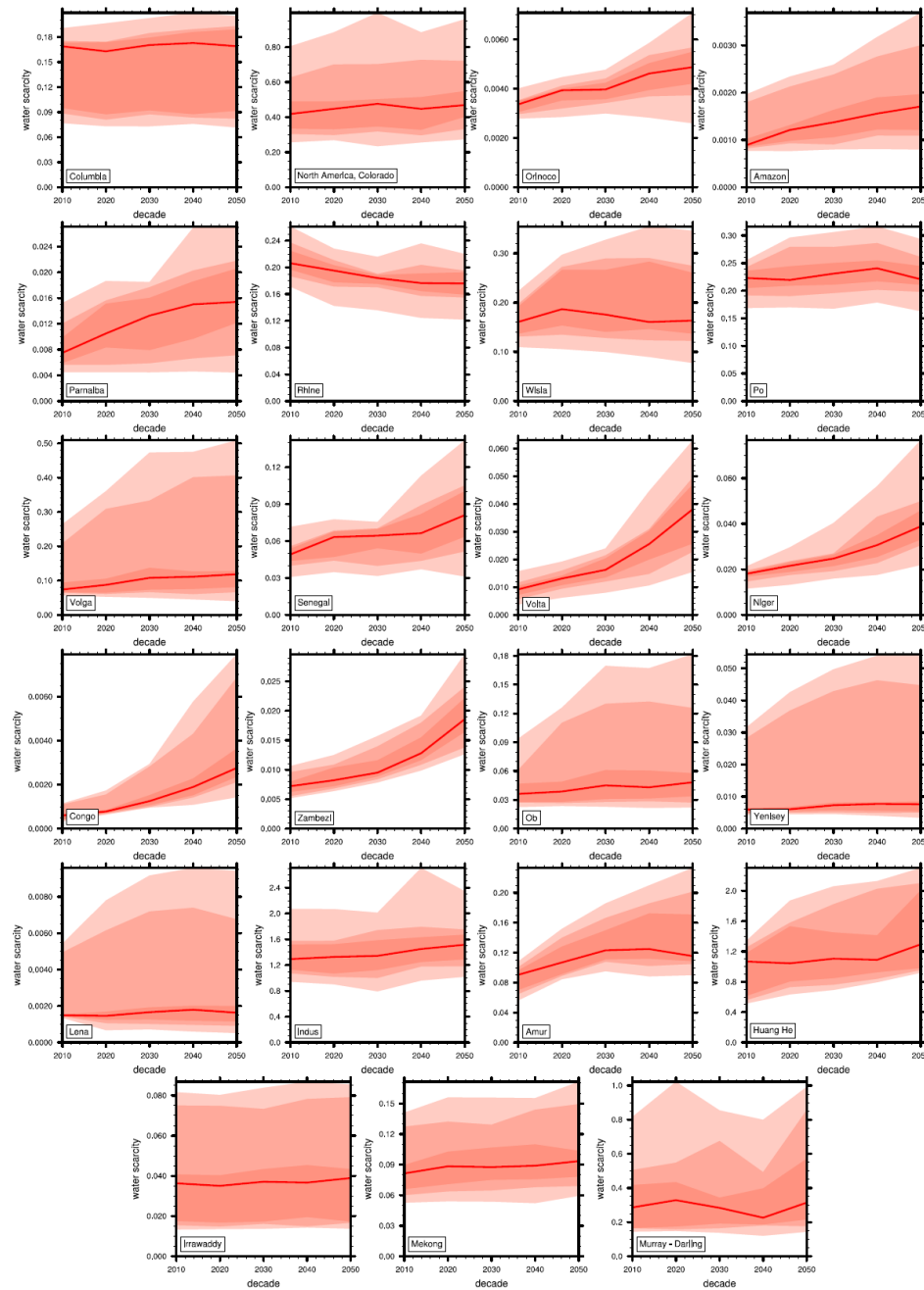
**Simon Langan**

*Tue, 25 Apr, 08:30–09:00, Room B*

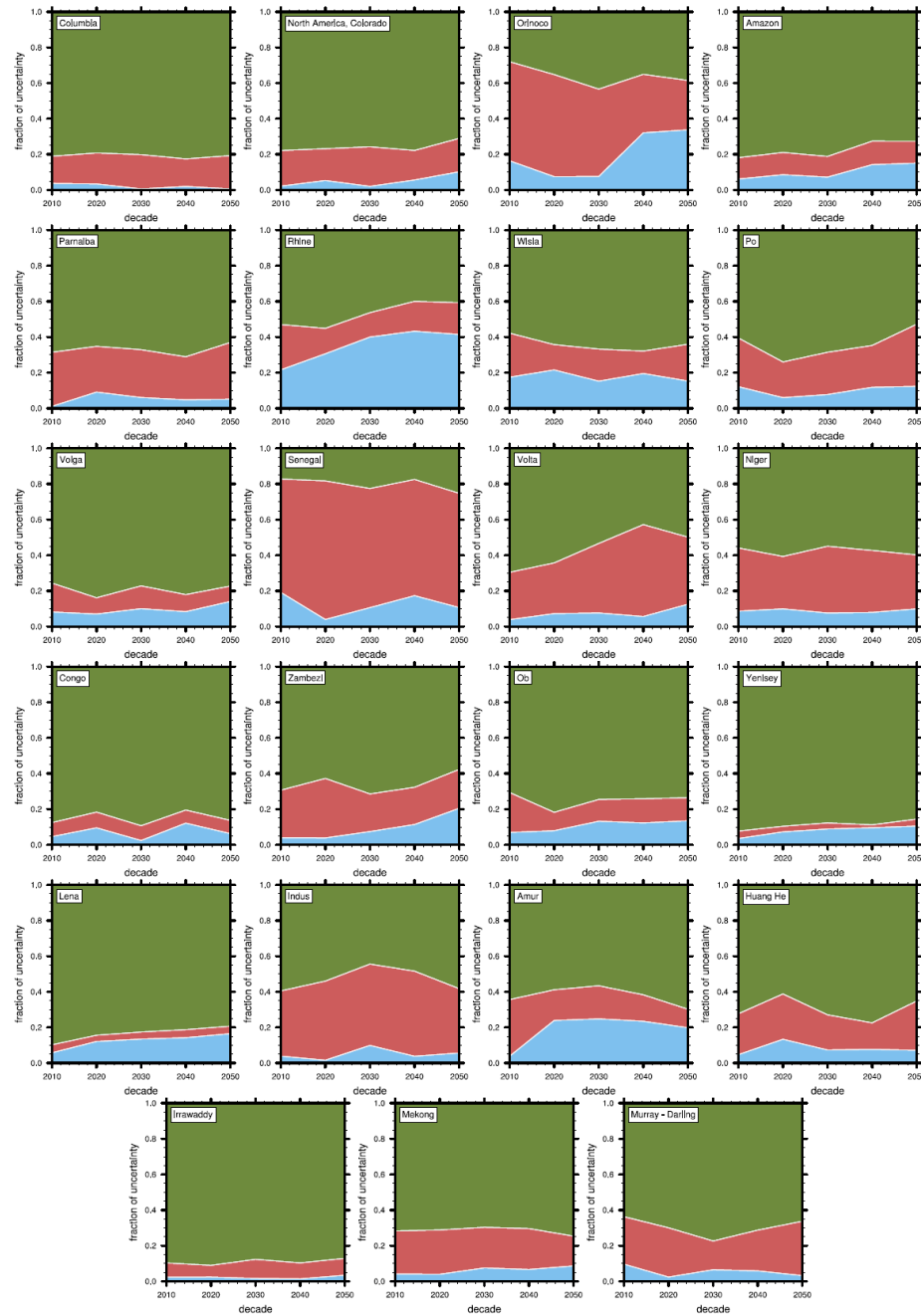
Peter Greve

greve@iiasa.ac.at

# Changes in uncertainty



# Sources of uncertainty



- (i) the average over the variances of all GCMs under each water scenario and for each GHM (**GCM uncertainty**),
- (ii) the average of the scenario-specific variances of the averages over all GCMs for each GHM (**GHM uncertainty**) and
- (iii) the variance of the averages of all GHMs and GCMs within a specific scenario (**scenario uncertainty**).