



Internationale Kommission für die Hydrologie des Rheingebietes

International Commission for the Hydrology of the Rhine Basin

**Impact of climate change on the rain, snow and glacier melt components of streamflow of the river Rhine and its tributaries**

**Synthesis report**

Kerstin Stahl, Markus Weiler, Marit van Tiel, Irene Kohn, Andreas Hänsler, Daphné Freudiger, Jan Seibert, Kai Gerlinger, Greta Moretti



Report No. I-28 of the CHR

# Impact of climate change on the rain, snow and glacier melt components of streamflow of the river Rhine and its tributaries

Kerstin Stahl, Markus Weiler, Marit van Tiel, Irene Kohn,  
Andreas Hänsler,  
Daphné Freudiger, Jan Seibert,  
Kai Gerlinger, Greta Moretti

CHR Symposium  
1.+ 2. June 2022  
Olten - Switzerland



Universität  
Zürich<sup>UZH</sup>



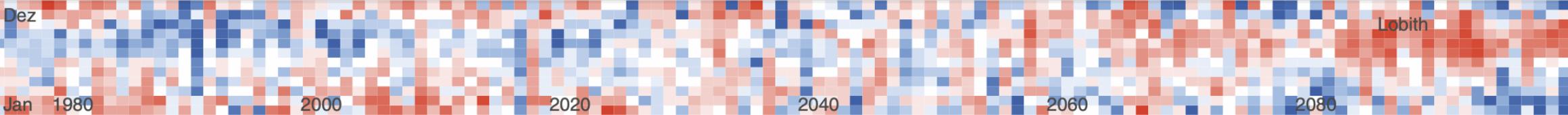
1980

2020

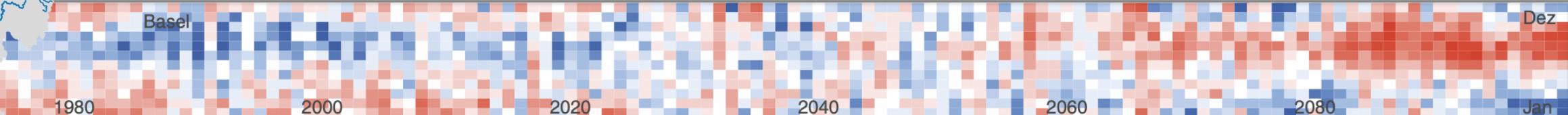
2100

# From warming stripes

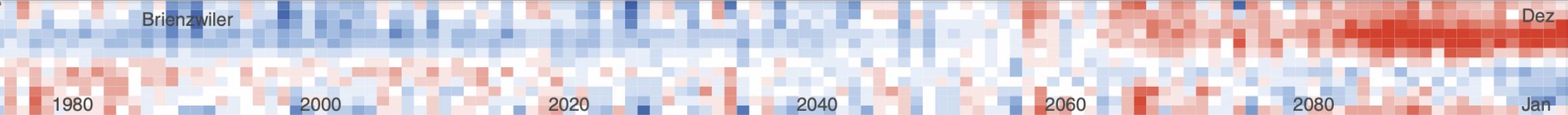
Rhine at Lobith



Rhine at Basel

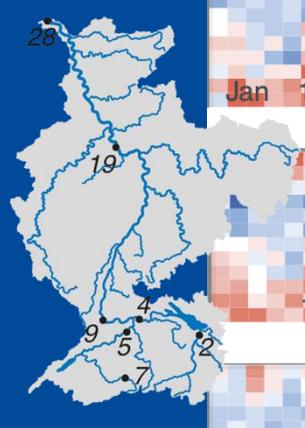


Aare at Brienzwiler



# To wetting/drying squares

Anomalies of simulated monthly streamflow from mean monthly flow  
1974–2100 (ensemble mean)



Rhine Basin  
& Gauges



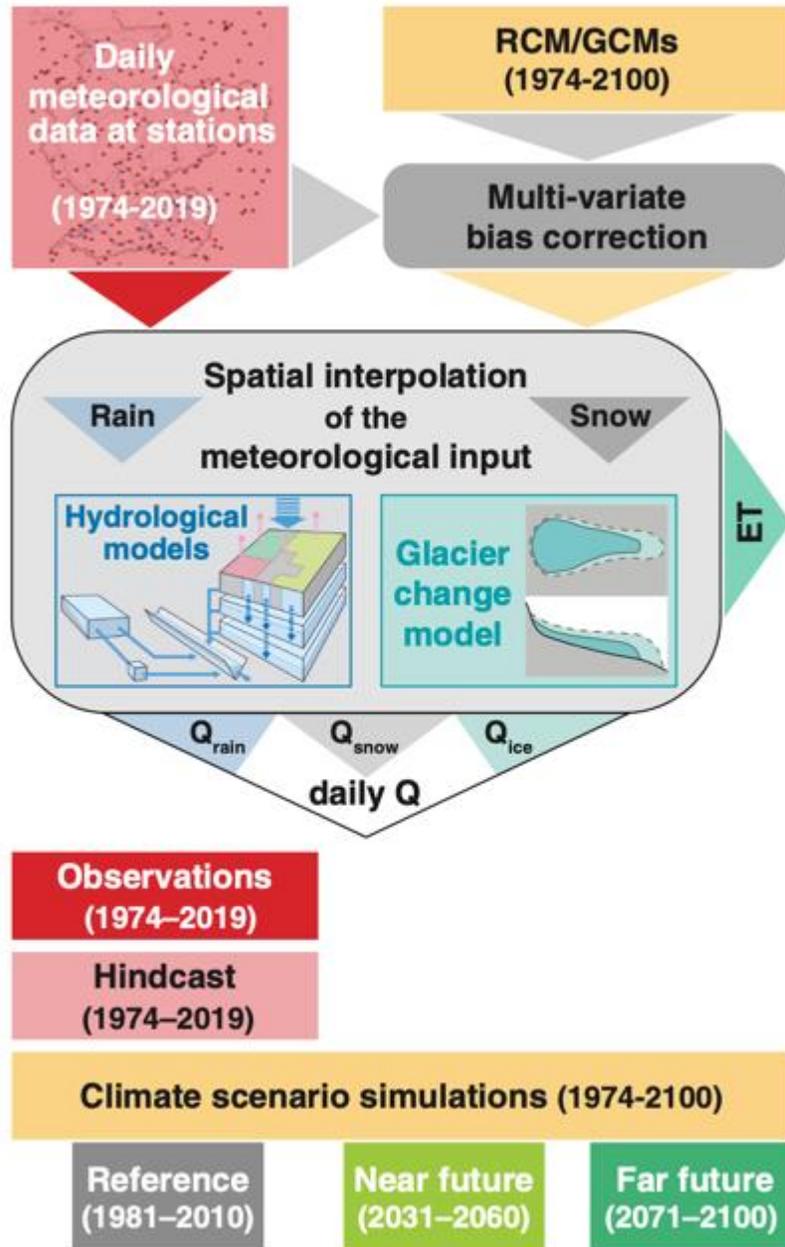
# Objectives

- To model and analyse how streamflow in the Rhine will change in response to future climate projections
- To elucidate the relative roles of the different streamflow components from rain, snowmelt, and ice melt in different sections of the river
- To quantify their contributions to changes in low flow conditions in particular
- To estimate the relevance of these changes for exemplary water uses & restrictions



Navigation on the river Rhine near Oberwesel during the low flow situation in November 2015 (photo: Jörg Belz).

# The model approach



# Modelling the Rhine and its tributaries

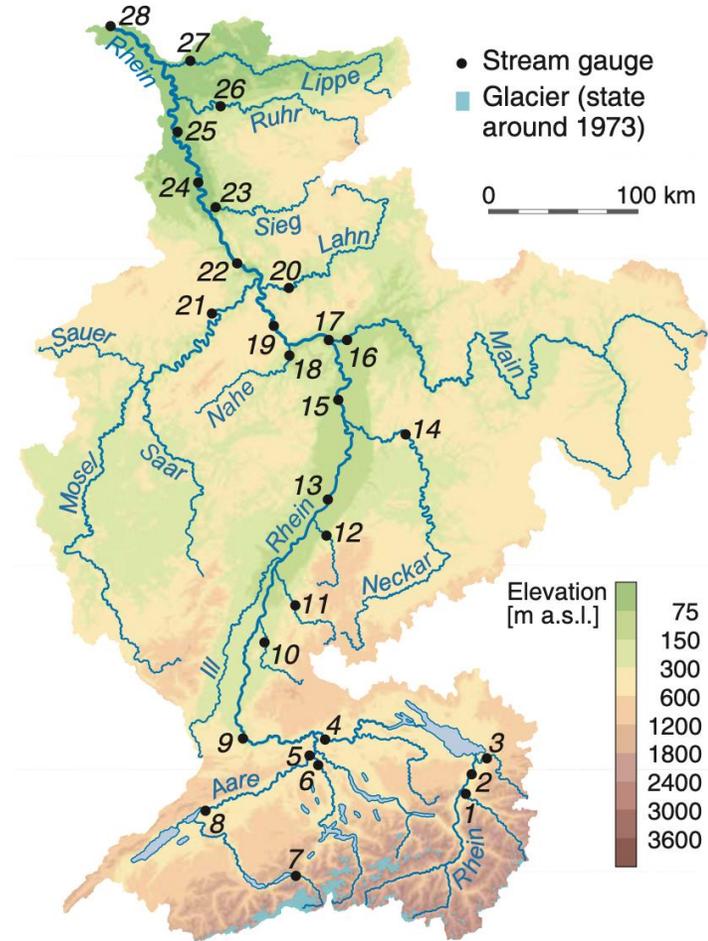
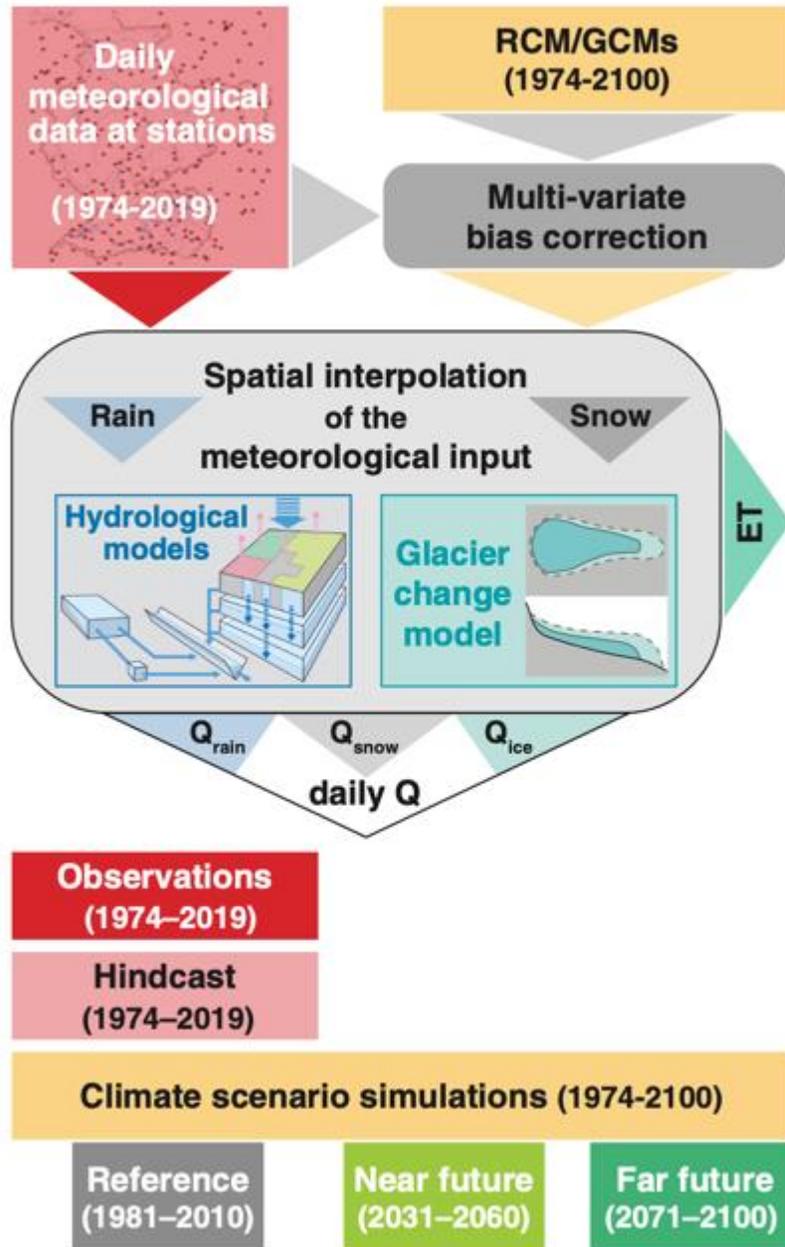


Figure 1: Rhine river basin with important tributaries and gauging stations. Names of stations see Fig. 3.

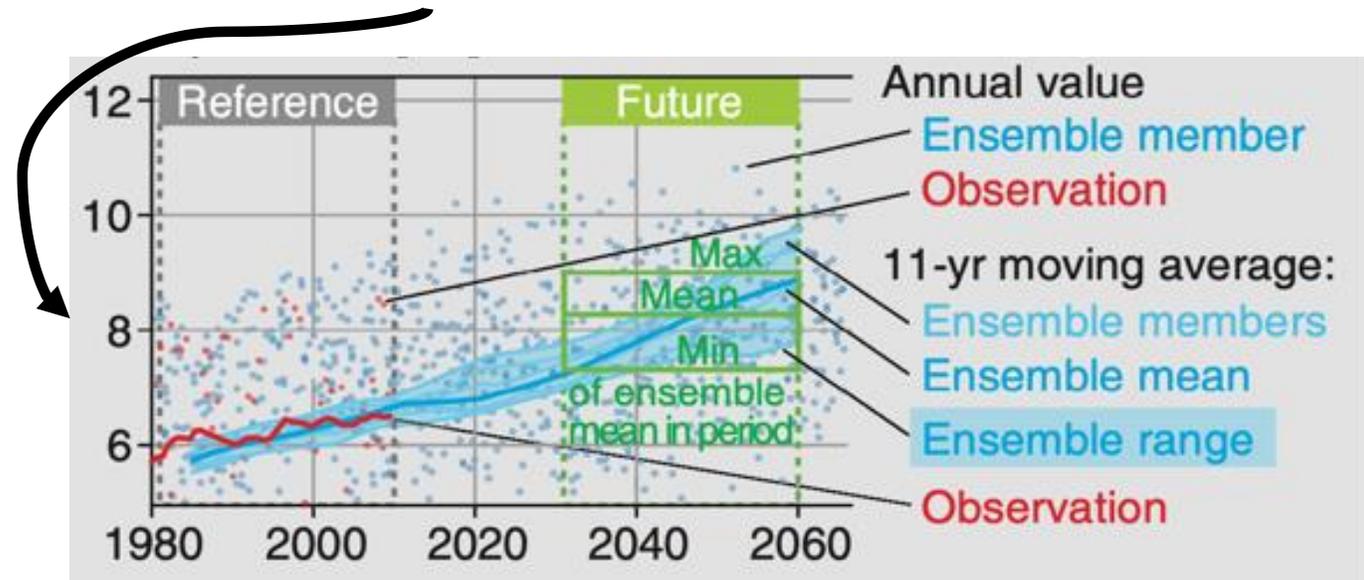
➤ Daily streamflow components for climate change scenarios at many gauging stations

# The model approach



## Transient Runs!

Any variable: climate or hydrology

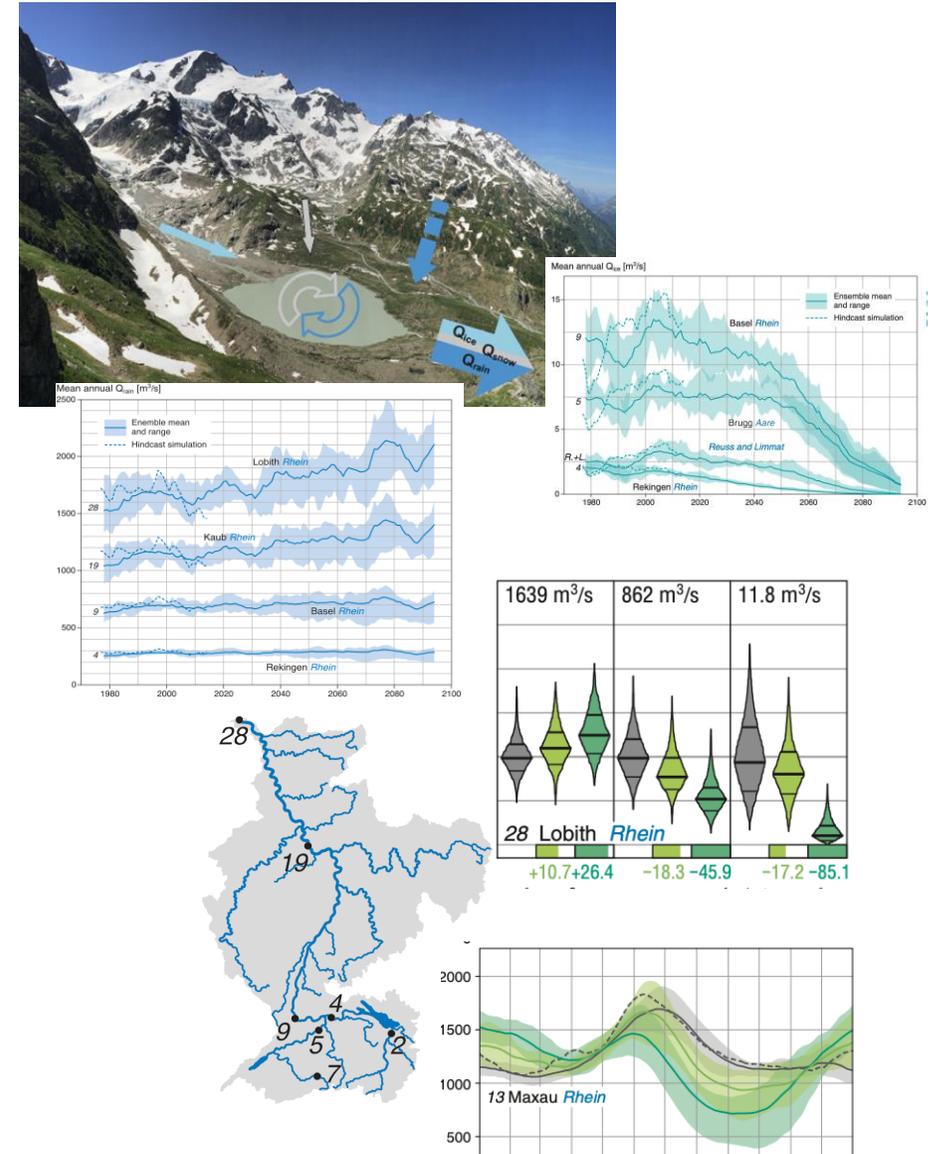


X ← → +20%

Comparing period-means and extremes

# A glimpse into today's highlights

- Tackling many modelling challenges
- Alpine headwaters: snow and icemelt will decrease, but how much?
- Rhine downstream: can rain compensate for less meltwater?
- From headwaters to lowlands: how will these component changes influence streamflow seasonality?



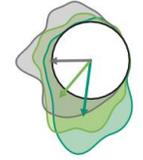
# A glimpse into tomorrow's highlights

- Changed seasonality: will extremes be more extreme?
- Summer-Fall as critical seasons: how will low flows change?
- Water uses: how strongly will thresholds change?
- The extreme events that motivated the ASG project: how might they change?
- The 2018 event in a deglaciated catchment of, e.g., 2070: how much more severe would the event be?

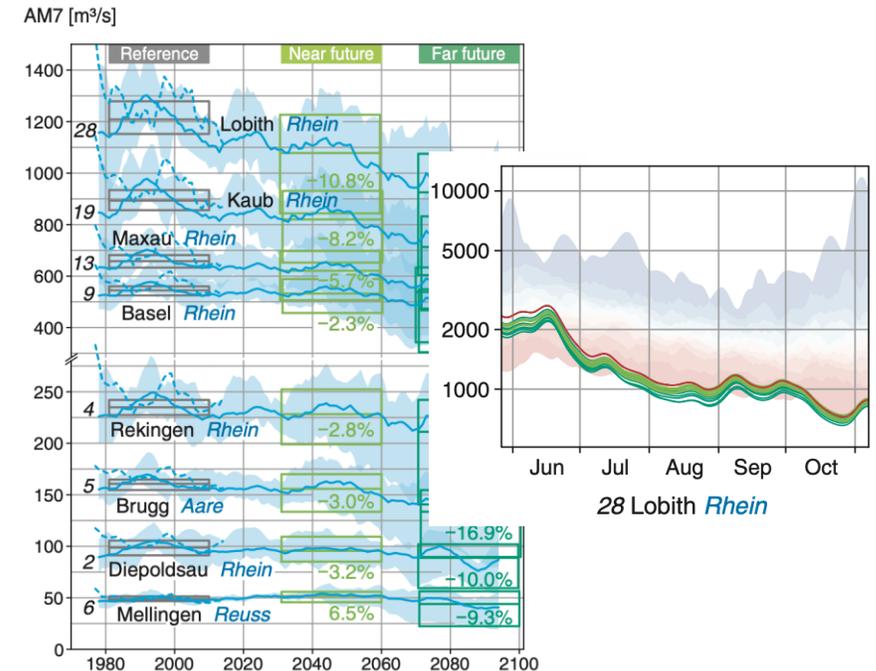
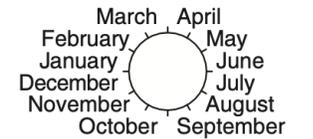


Navigation on the river Rhine near Oberwesel during the low flow situation in November 2015 (photo: Jörg Belz).

13 Maxau Rhein



Seasonality



Launching the report



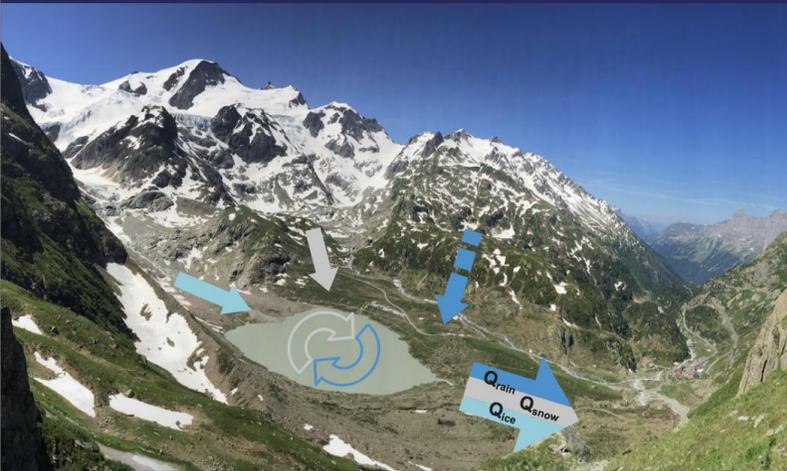
Internationale Kommission für die Hydrologie des Rheingebietes

International Commission for the Hydrology of the Rhine Basin

Impact of climate change on the rain, snow and glacier melt components of streamflow of the river Rhine and its tributaries

Synthesis report

Kerstin Stahl, Markus Weiler, Marit van Tiel, Irene Kohn, Andreas Hänsler, Daphné Freudiger, Jan Seibert, Kai Gerlinger, Greta Moretti



Report No. I-28 of the CHR

# Impact of climate change on the rain, snow and glacier melt components of streamflow of the river Rhine and its tributaries

Kerstin Stahl, Markus Weiler, Marit van Tiel, Irene Kohn,  
Andreas Hänsler,

Daphné Freudiger, Jan Seibert,

Kai Gerlinger, Greta Moretti

CHR Symposium  
1.+ 2. June 2022  
Olten - Switzerland



Universität  
Zürich <sup>UZH</sup>

