What is the contribution of snow and glacier to discharge in Swiss alpine headwater catchments under climate change?

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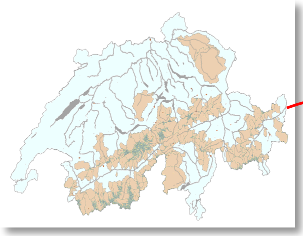
Context

This project is part of three sister projects with the aim to model daily contribution to discharge from rainfall, snow and glacier melt for the past & future 100 years for the entire Rhine River catchment (ASG1 & ASG2) and for all glacierized headwater catchments in Switzerland (HYDRO-CH2018).

ASG1:
- Hydrological model chain HBV+LARSIM
- Model development with focus snow & ice
- Tracking of discharge components

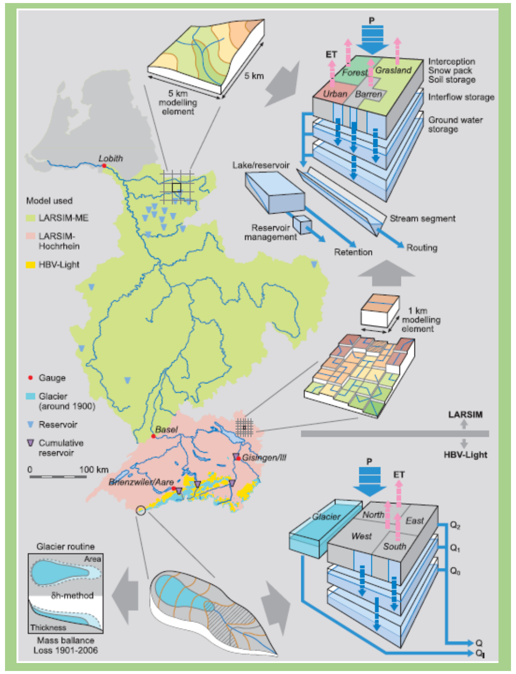
HYDRO-CH2018:
- HBV-light

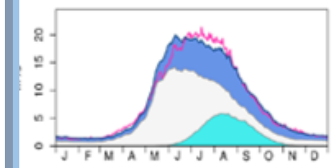


Model setup, Q components

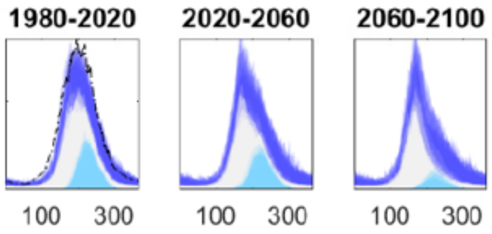
ASG2:
- Model chain

1900 — 1973 — Present — 2100





Model calibration on actual climate



Model simulations with future climate scenarios RCP2.5, RCP4.5, RCP8.5

Further informations:

Stahl et al (2017), CHR/KHR report.
http://www.chr-khr.org/sites/default/files/chrpublications/asg-rhein_synthesis_en.pdf

HYDROCH-2018 Synthesis report (in prep.)
https://www.nccs.admin.ch/nccs/de/home/das-nccs/themenschwerpunkte/hydro-ch2018/hydro-ch2018-forschungsprojekte.html

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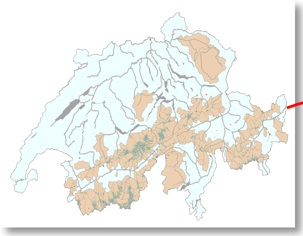
Research questions?

ASG1:
- Hydrological model chain HBV+LARSIM
- Model development with focus snow & ice
- Tracking of discharge components

HYDRO-CH2018:
- HBV-light



Model setup, Q components

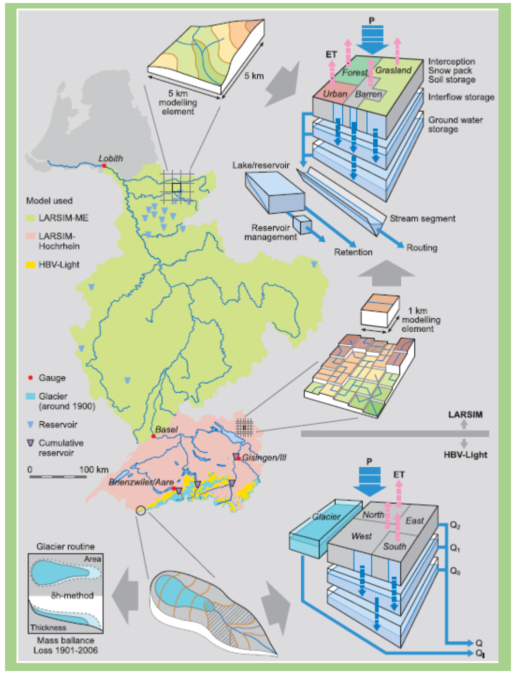
ASG2:
- Model chain

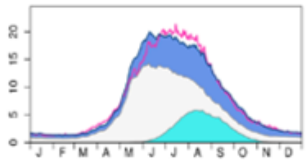
1900

1973

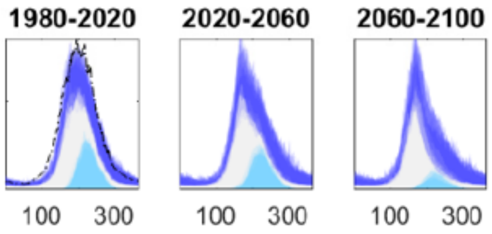
Present

2100





Model calibration on actual climate



Model simulations with future climate scenarios RCP2.5, RCP4.5, RCP8.5

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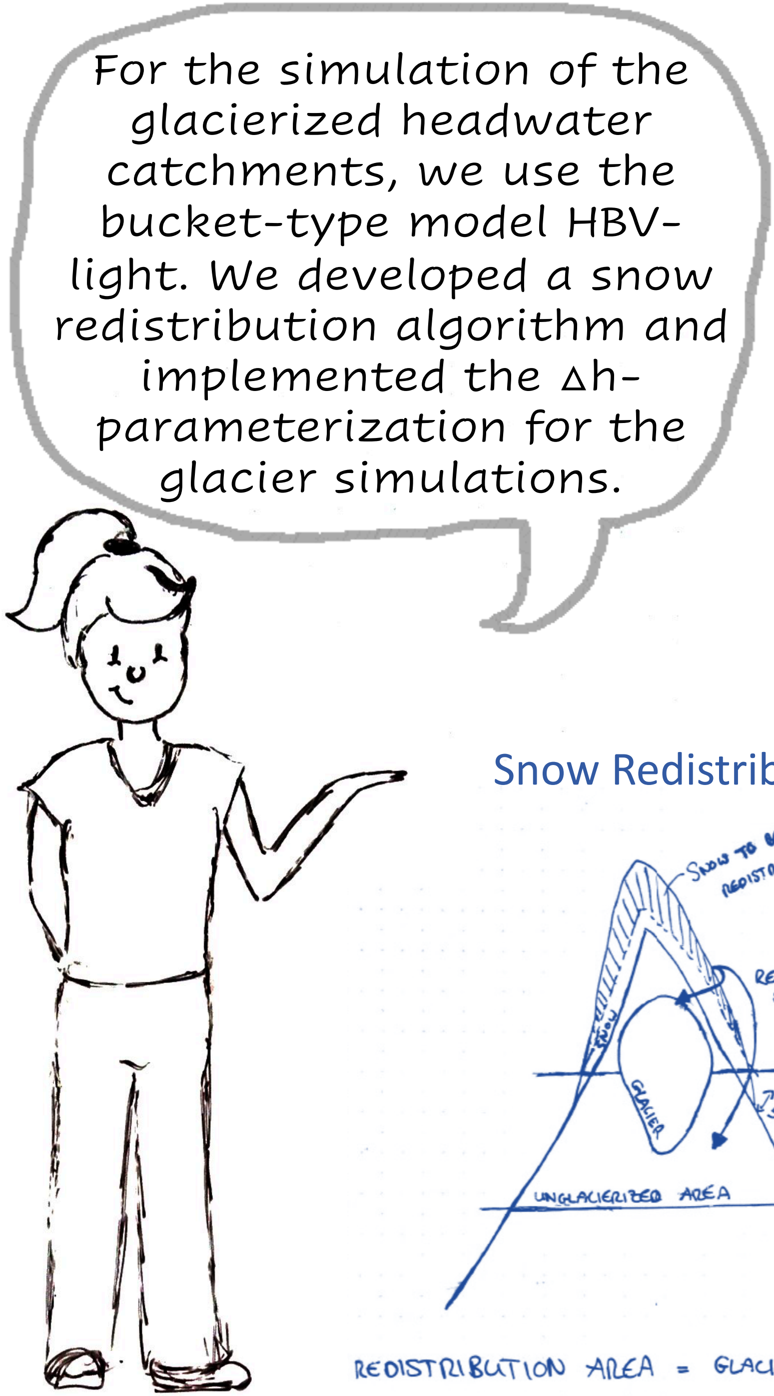
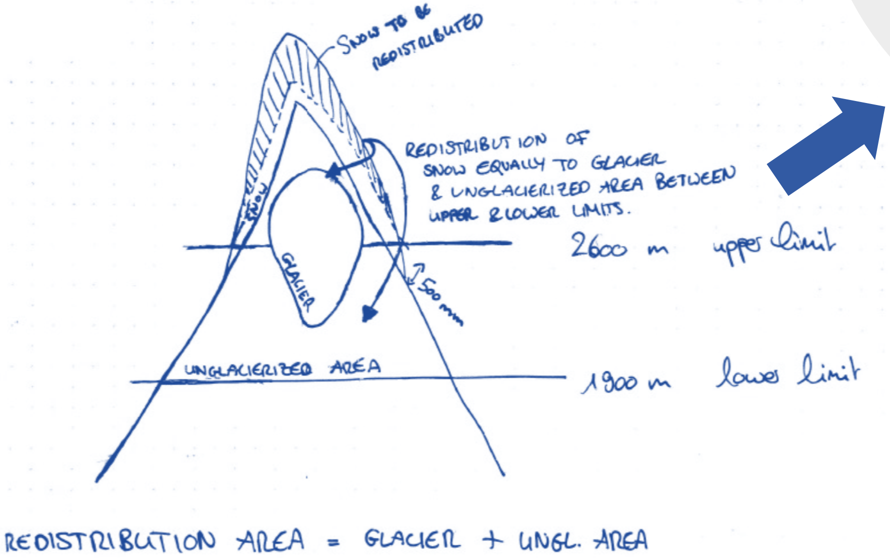
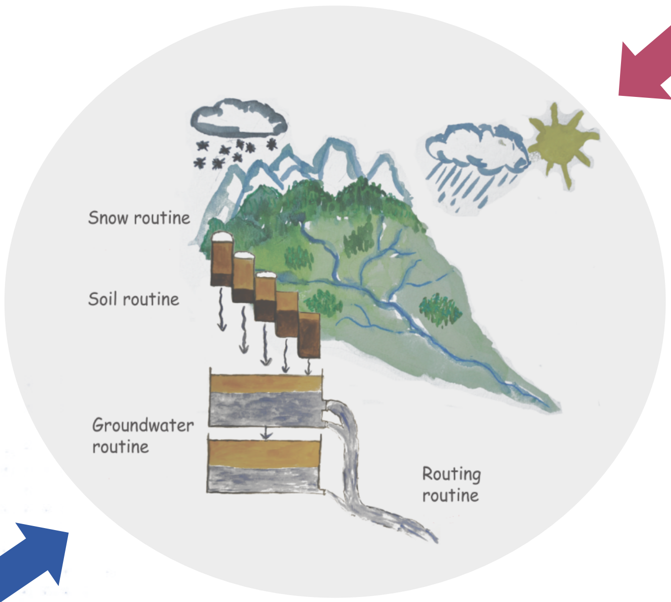
Model for headwater catchments



Snow Redistribution

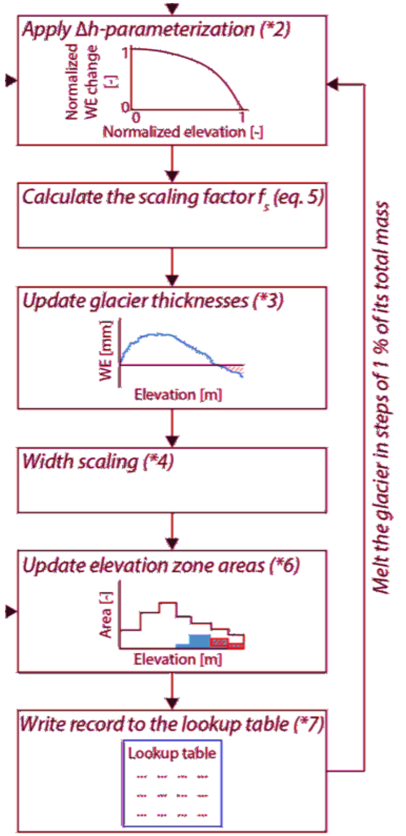




HBV-light

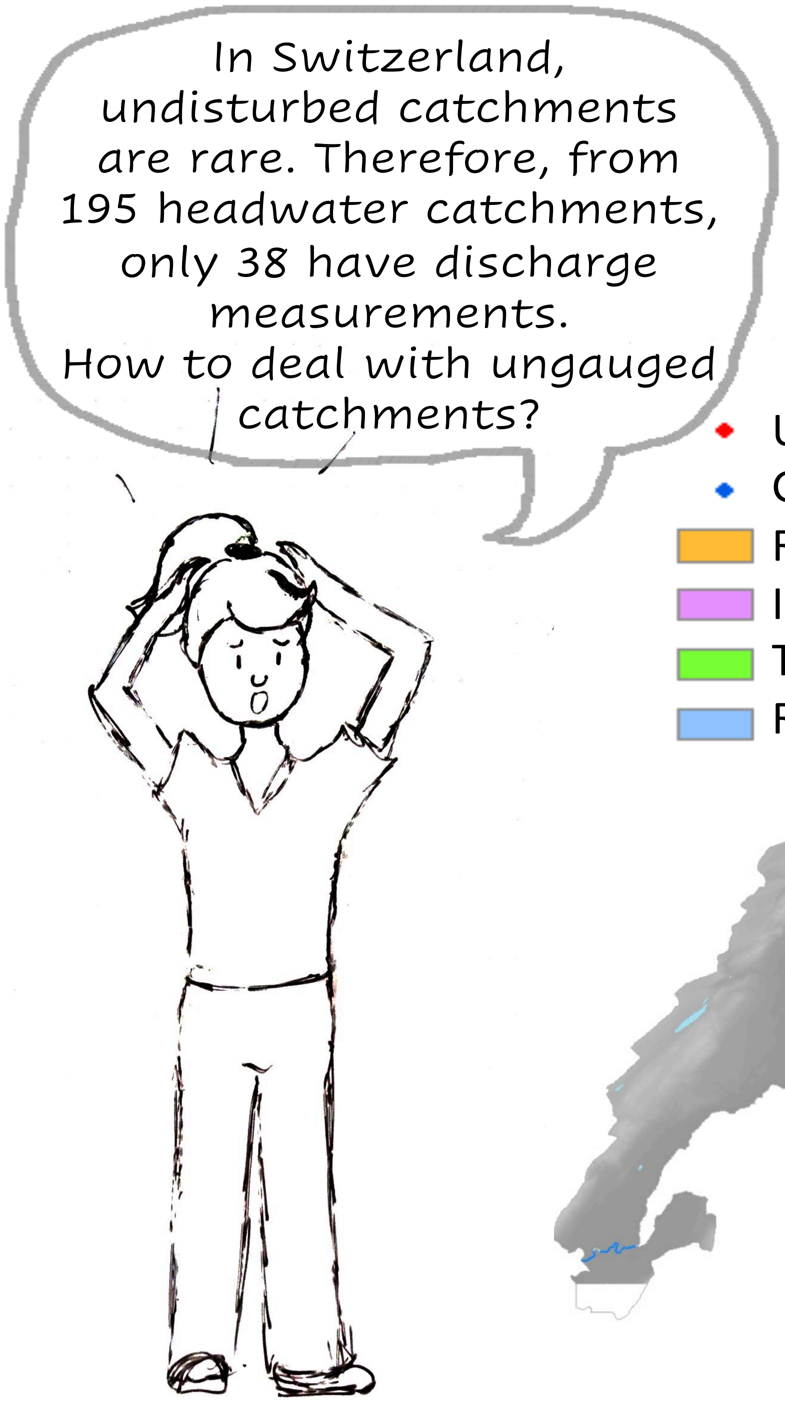
Seibert and Vis, HESS, 2012

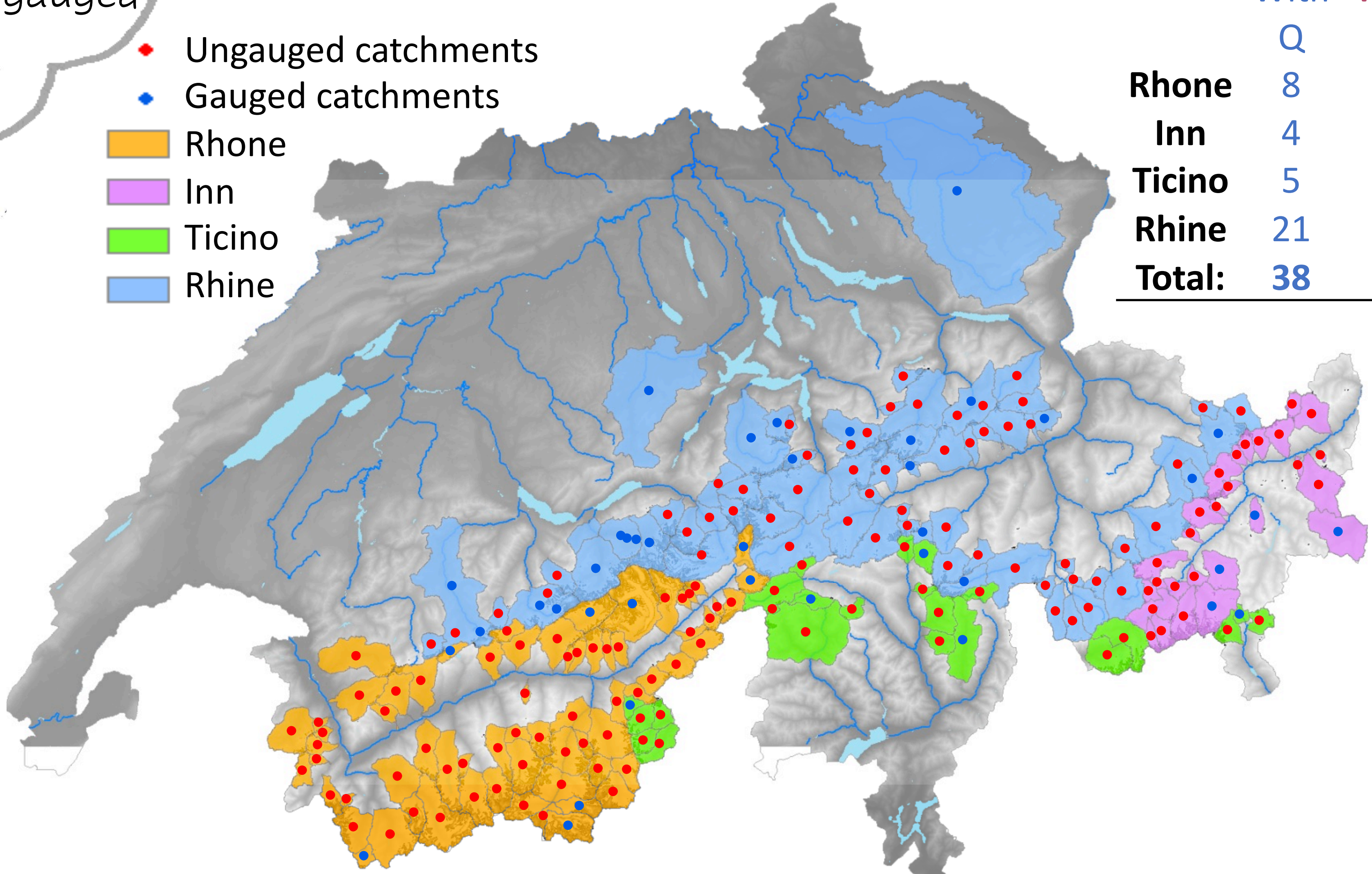
Glacier Geometry Changes



Seibert et al., HESS, 2018

Glacierized headwater catchments

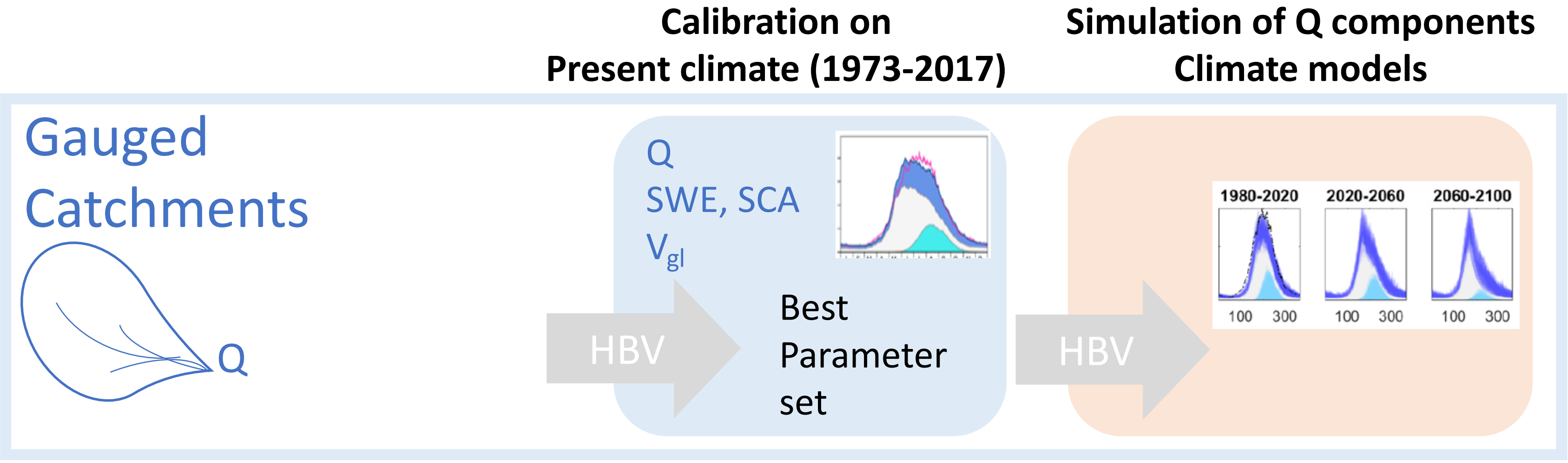




	Number of catchments		
	With Q	Without Q	Total
Rhone	8	59	67
Inn	4	23	27
Ticino	5	19	24
Rhine	21	56	79
Total:	**38**	**157**	**195**

Q: Discharge

Calibration of gauged catchments



Objective functions if precipitation (P) and Q are OK:

Q (50%):
Lindstrom Measure (20%)
Nash Sutcliff efficiency (log, 15%)
Seasonal Nash Sutcliff efficiency (jun-sept, 15%)

Snow & glacier (50%):
SCA: Root Mean Square Error (15%)
SWE: Mean Absolute Normalized Error (15%)
Glacier: Absolute Mean Relative Error (20%)

if P << Q:

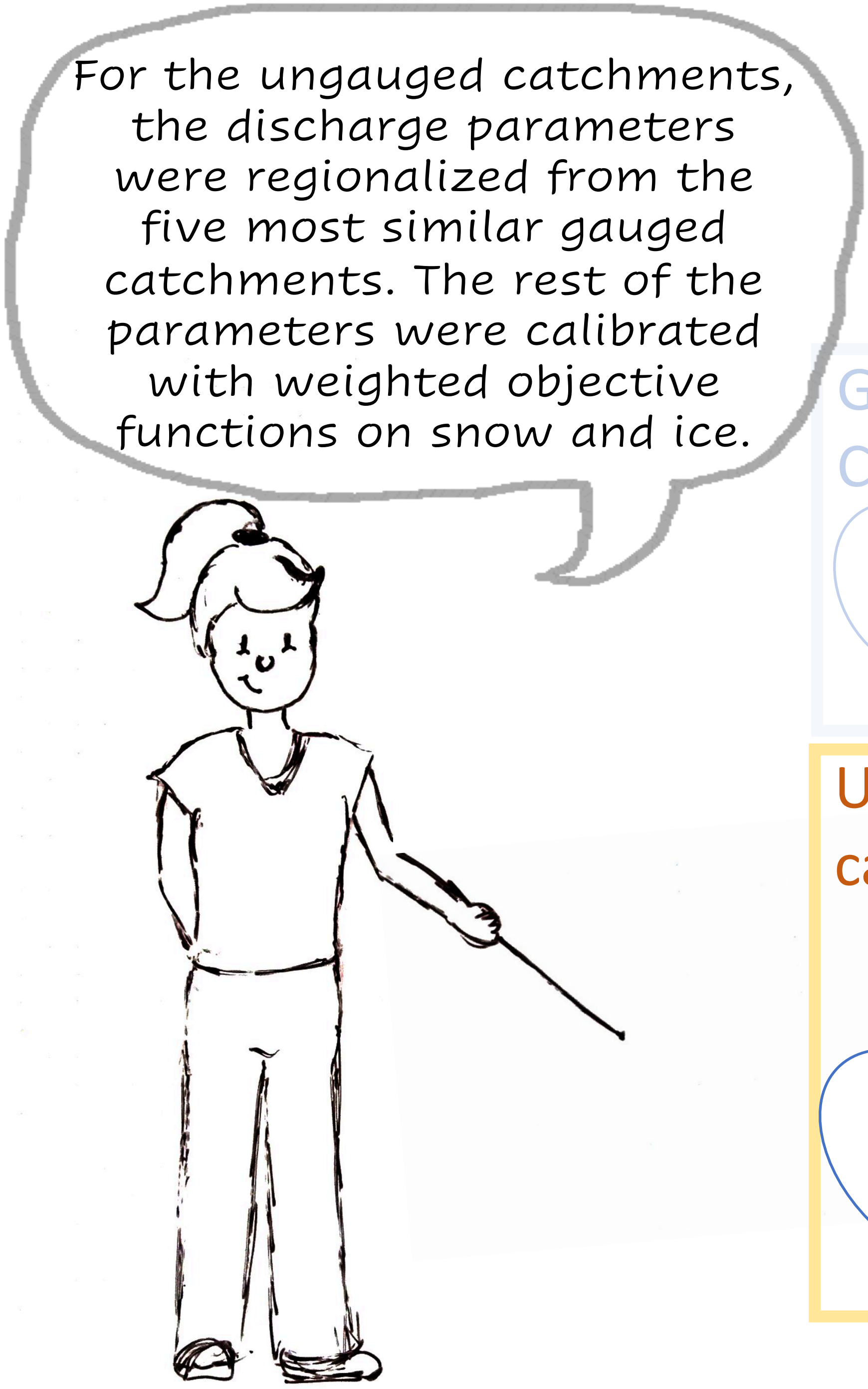
Q (30%):
Spearman Rank (30%)

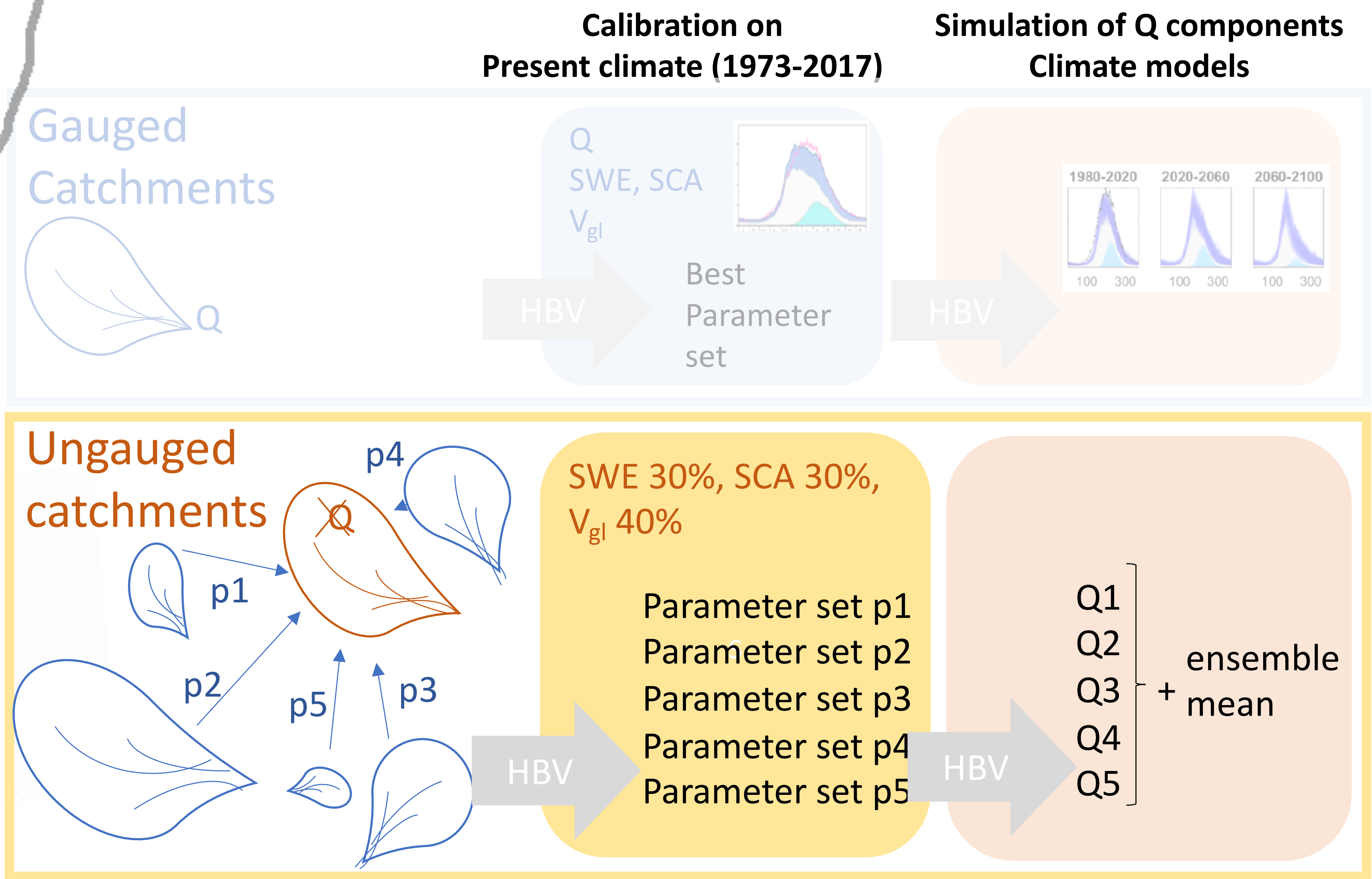
Snow & glacier (70%):
SCA: Root Mean Square Error (21%)
SWE: Mean Absolute Normalized Error (21%)
Glacier: Absolute Mean Relative Error (28%)

10 GAP-calibration, 50 parameter sets, >3500 runs

Q: discharge
P: precipitation
SWE: Snow water Equivalent
SCA: Snow covered area
Vgl: Glacier volume

Regionalization of ungauged catch.





Criteria for regionalization

Categories (all same weight):

1-4) Geographic & topographic catchment properties

- Distance, Area, Slope, Exposition

5) Elevation:

- Mean, min, max, Range

6) Glacier:

- Area 1973, Area change (2010/1973), Elevation, Exposition, Slope, Thickness 1973

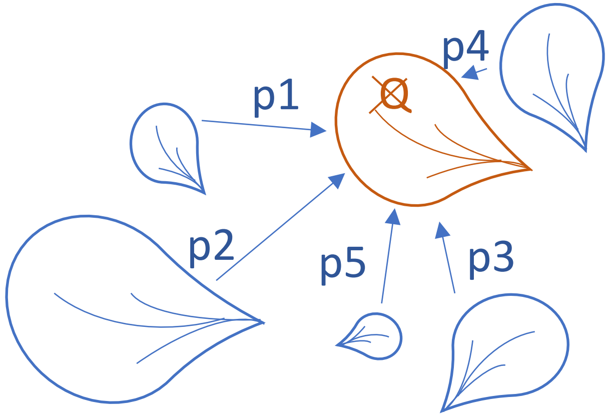
7) Meteorologie:

- Precipitation, Temperature, Rain/Snow, SWE, P/T Gradients, PET, 1°C-Elevation, Water balance

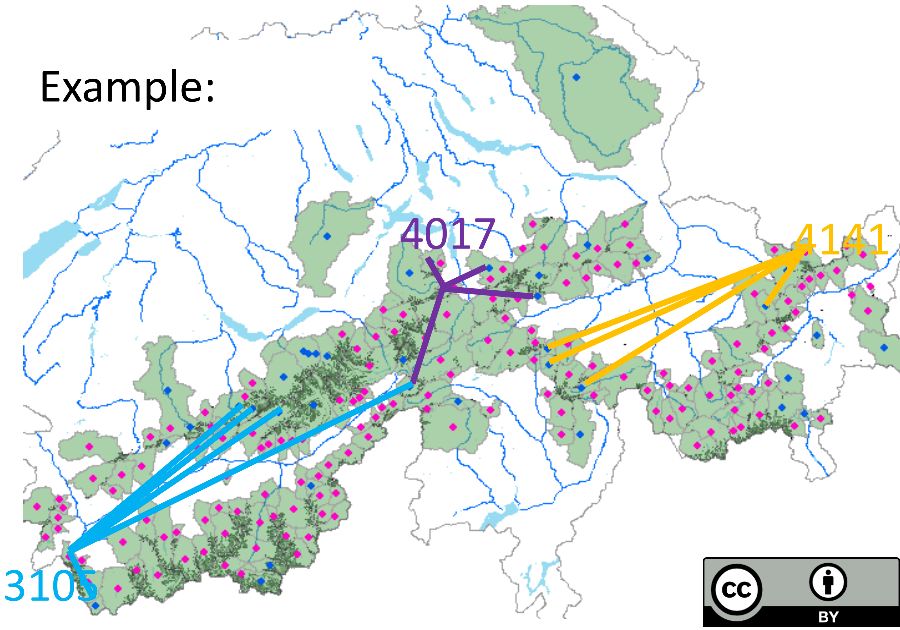
8) Regions:

- SLF, Alpine Regions (HADES)

9) Groundwater type



Example:



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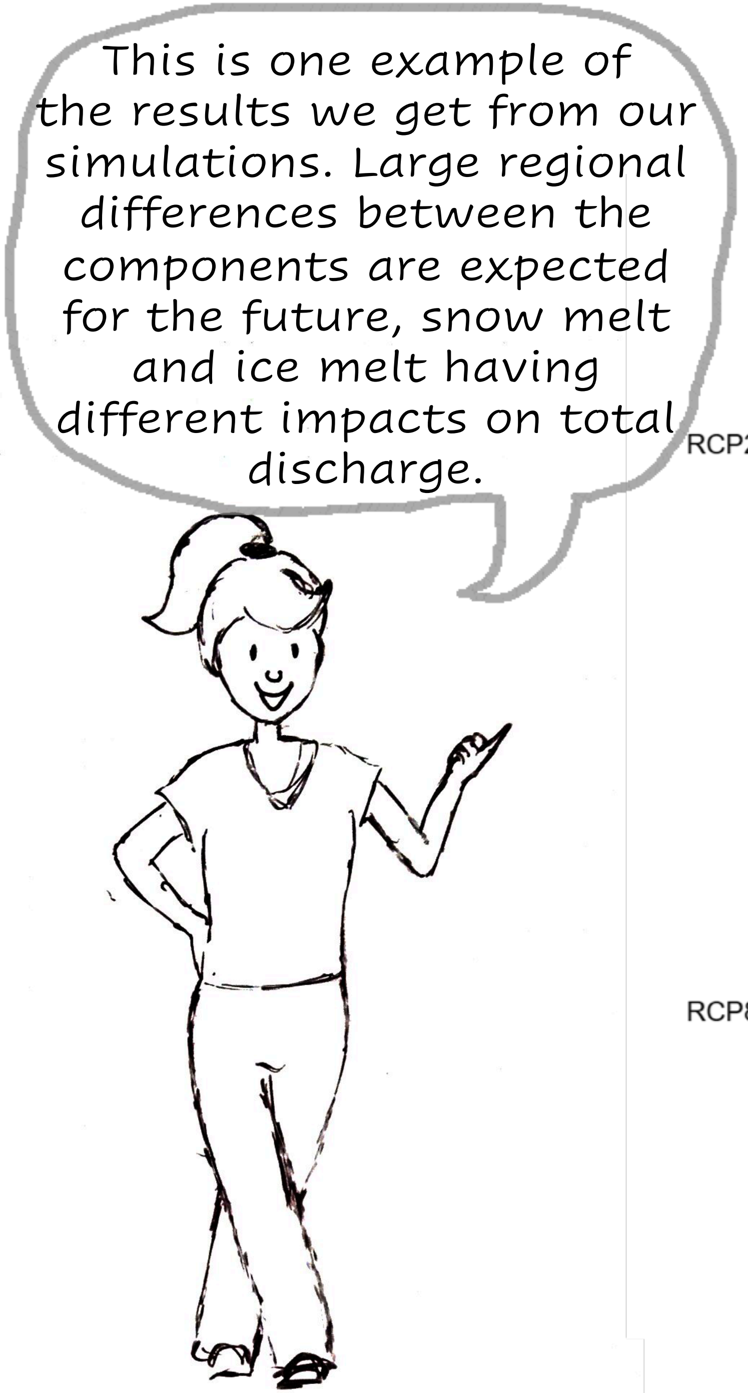
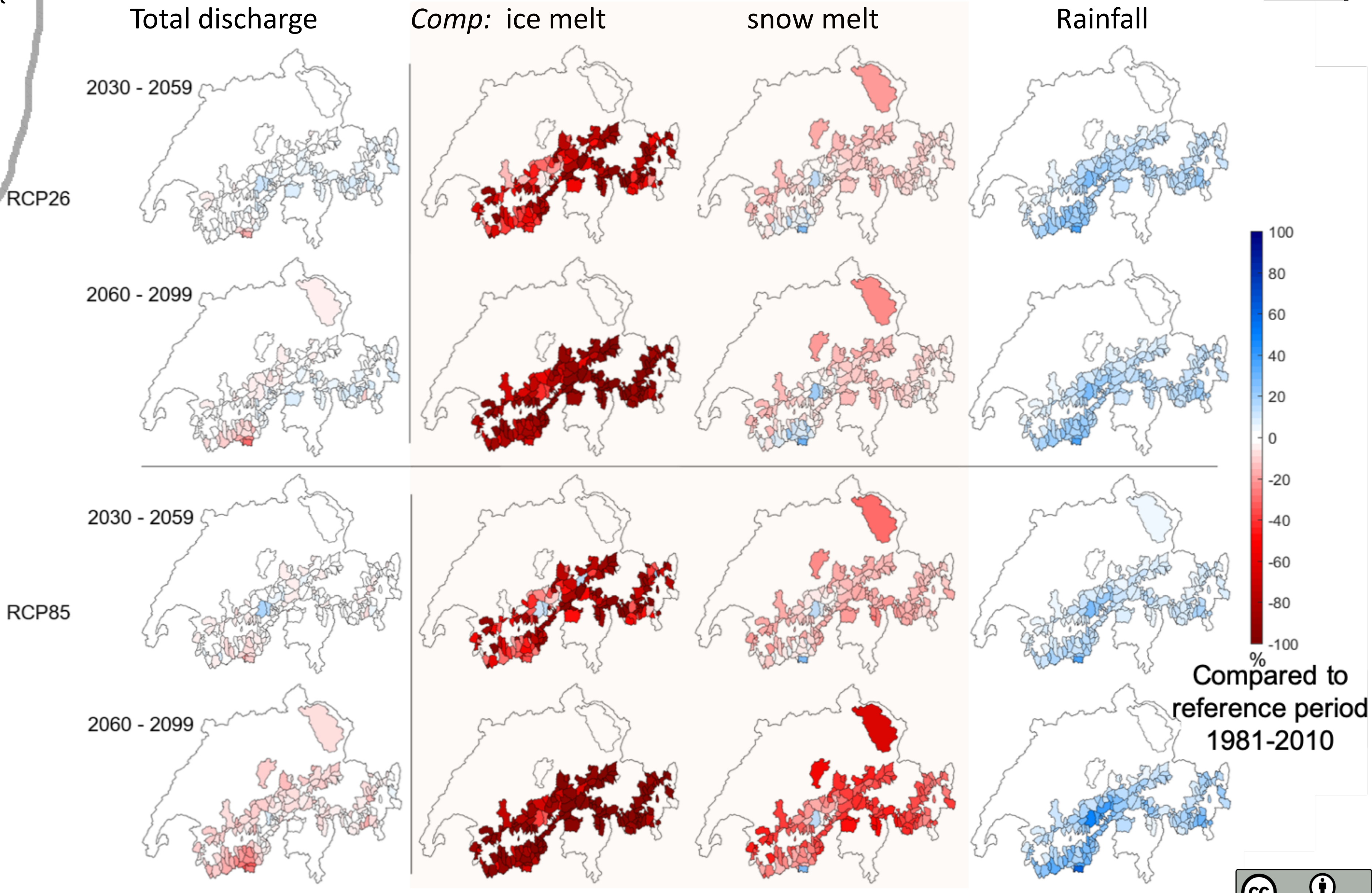
Changes in discharge components





Modified from HYDROCH-2018 Synthesis report (in prep.)

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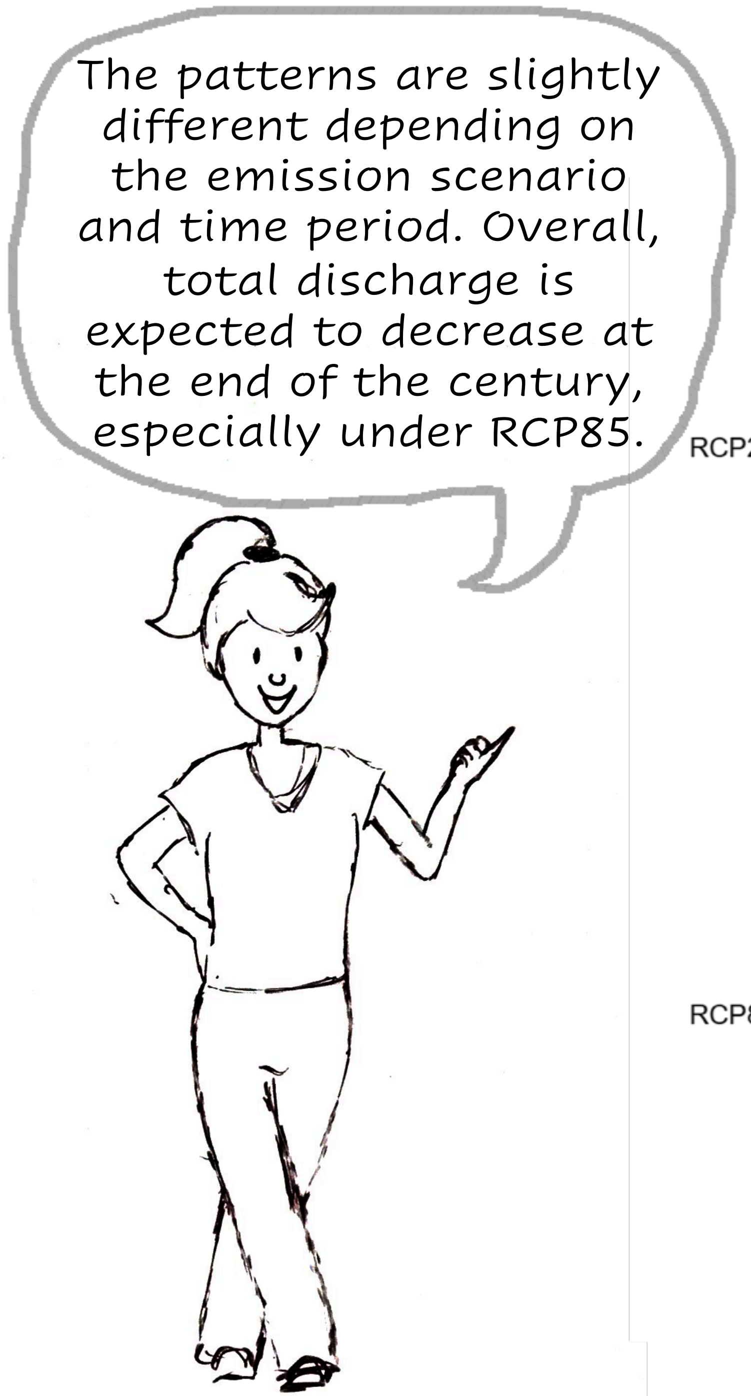
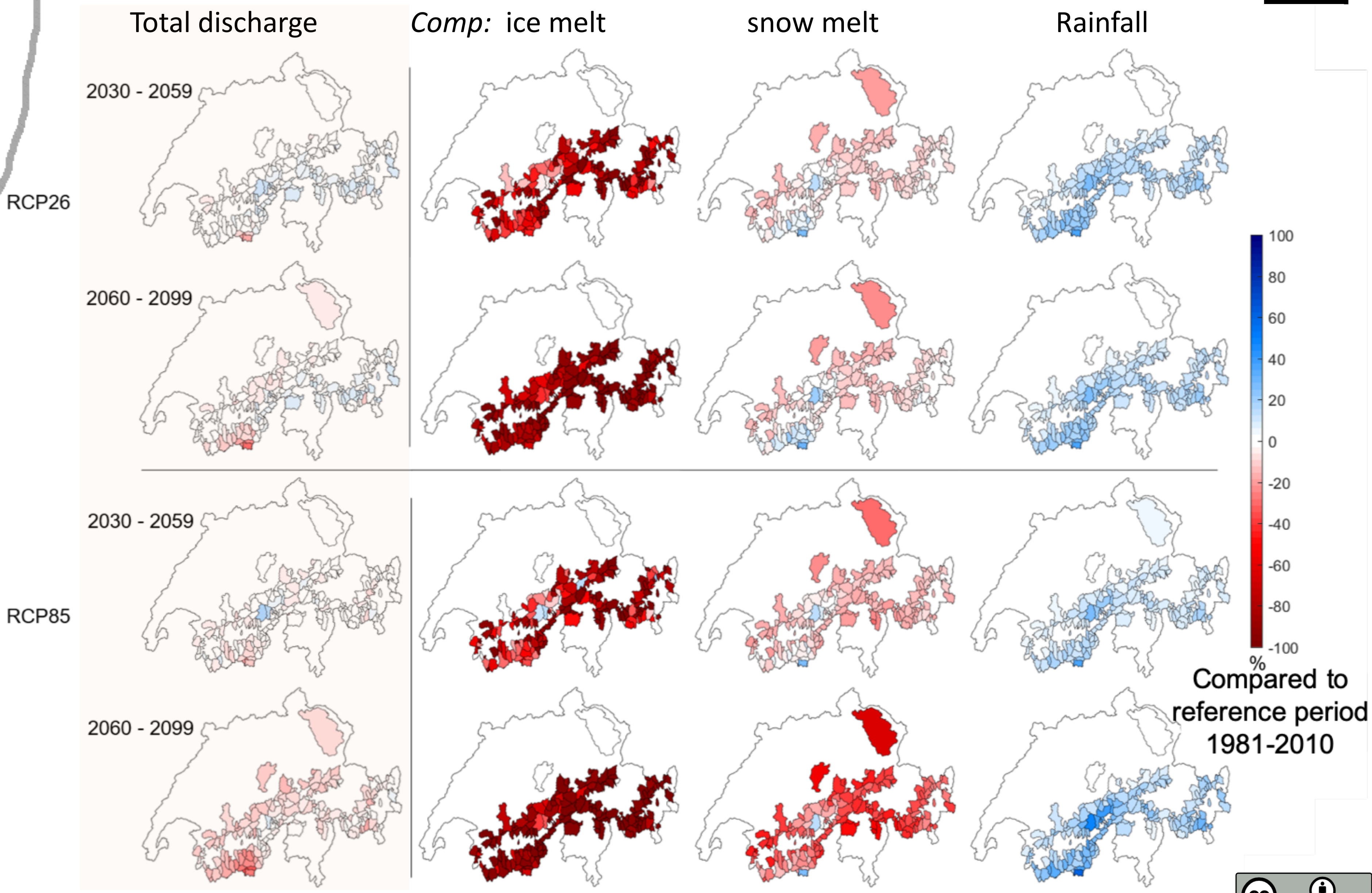


Changes in discharge components



Modified from HYDROCH-2018 Synthesis report (in prep.)

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