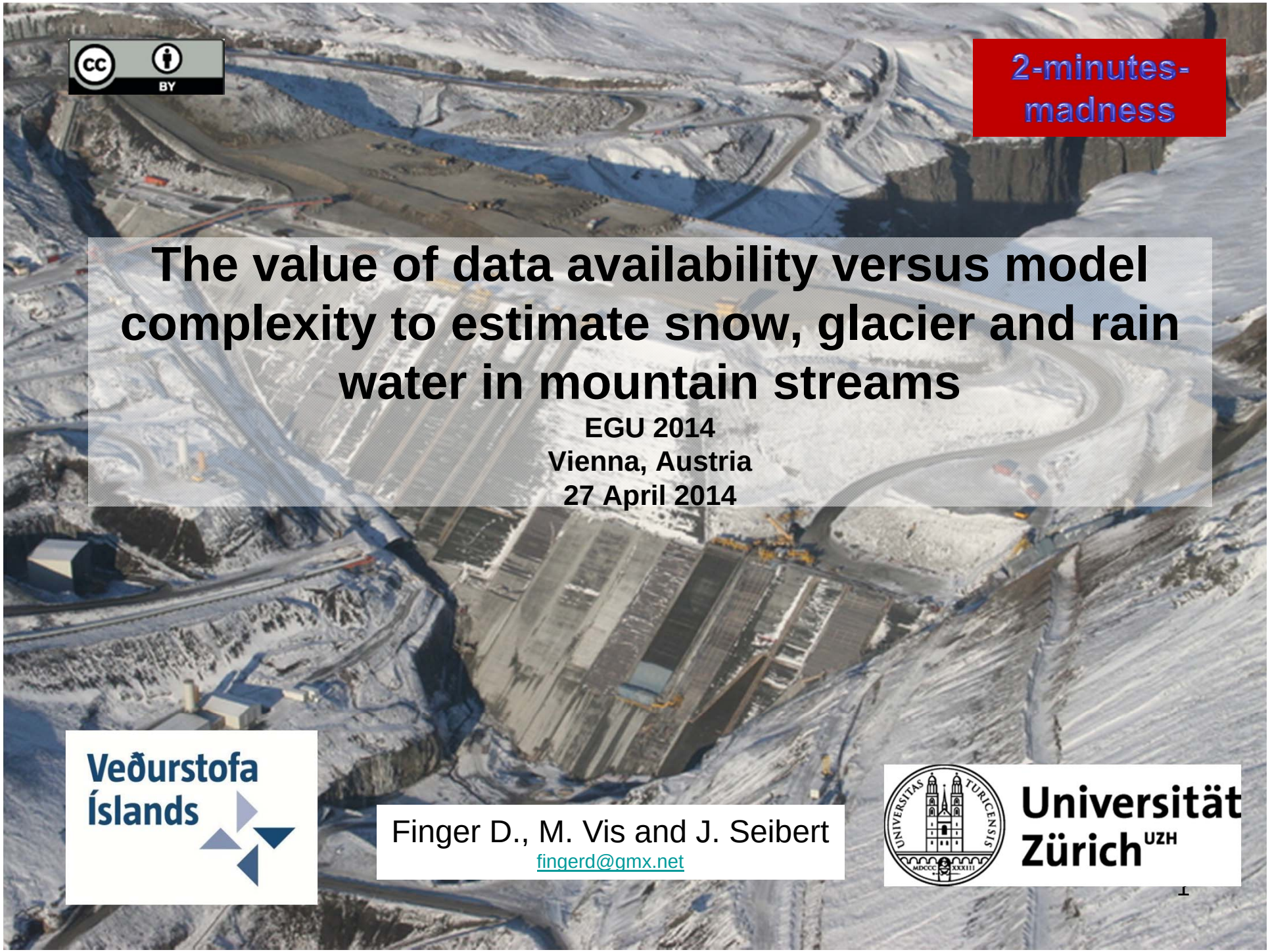

2-minutes-madness

The value of data availability versus model complexity to estimate snow, glacier and rain water in mountain streams

EGU 2014
Vienna, Austria
27 April 2014

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Veðurstofa Íslands

Universität Zürich[UZH]

2-minutes-madness

mbl.is

fimmtudagur, 24. apríl 2014

Forsíða | Viðskipti | Íþróttir | Fólkið | Smartland | Monitor | Bílar | Greinar

Innlent | Erlent | Tækni og vísindi | Kosningar | Nýjast | Vinsælast | Fréttaleit | News in English

Innlent | Morgunblaðið | 15.4.2014 | 5:30

Hækkar lítillega í miðlunarlónum

Staðan á miðlunarlónum Landsvirkjunar fer batnandi. Tímabundið aukið rennsli í ám hefur skilað sér í hækkun á vatnshæð í Þórisvatni og Blöndulóni.

Objective: Estimate seasonal contribution of snow, glacier and rainfall runoff in mountain streams

Blöndulón á Auðkúluheiði. mbl.is/Einar Falur Ingólfsson

Morgunblaðinu í dag.

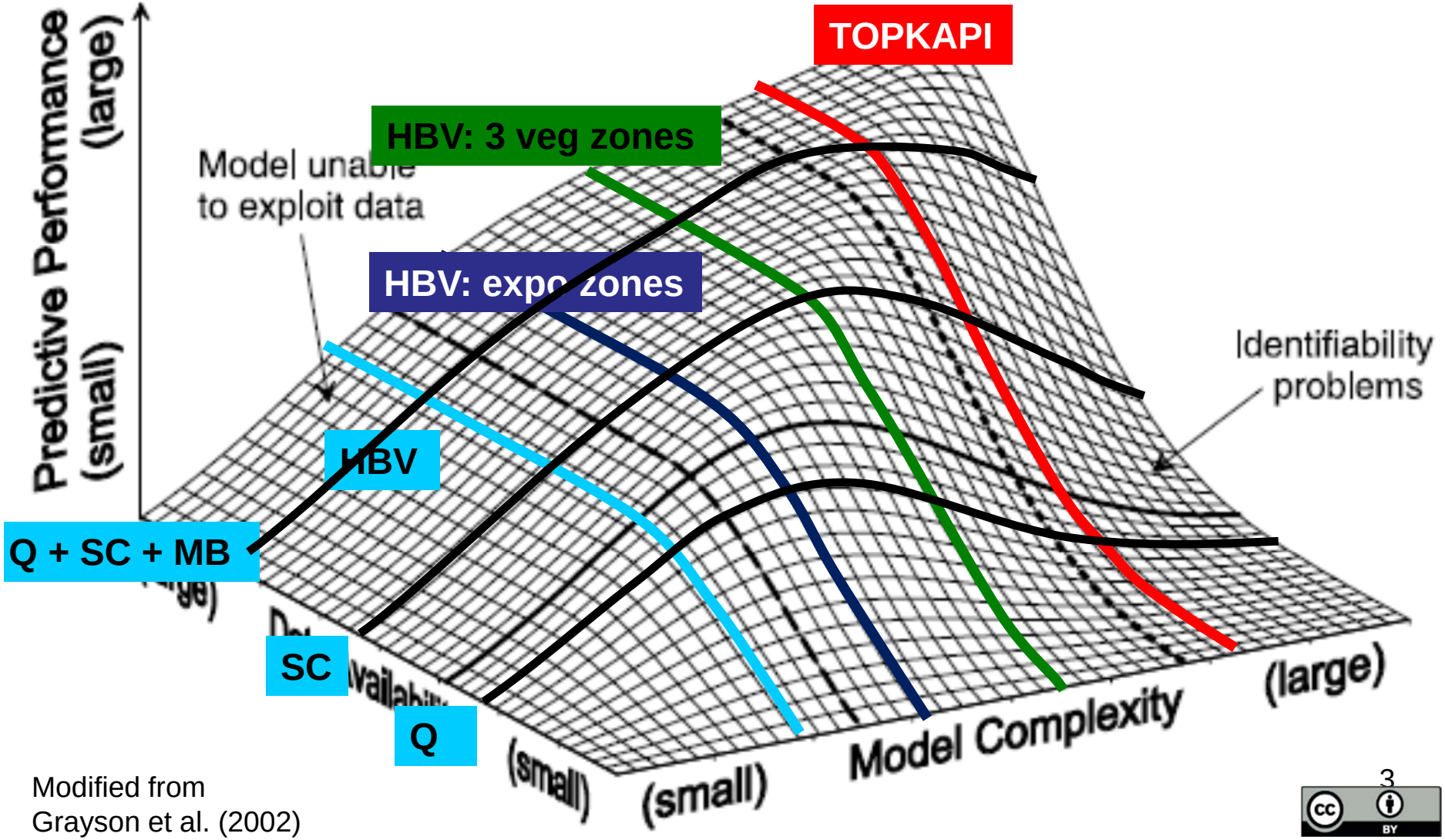
Tíðarfarið í vetur hefur verið Landsvirkjun mjög óhagstætt og innrennsli í lónin afbrigðilegt. En breyting varð til batnaðar í veðrinu í byrjun apríl og í síðustu viku hófst hægfara leysing á hálendinu og rennsli í Tungnaá, Þjórsá og Blöndu jókst.

Kárahnjúkavirkjun (690 MW)
Mühleberg (KKM) (1972) (BWR) – 355 MW

We tested

- **4 model complexities (HBV and Topkapi Versions)**
- **Used discharge (Q), snow cover images (SC) and mass balances (MB) for calibration**

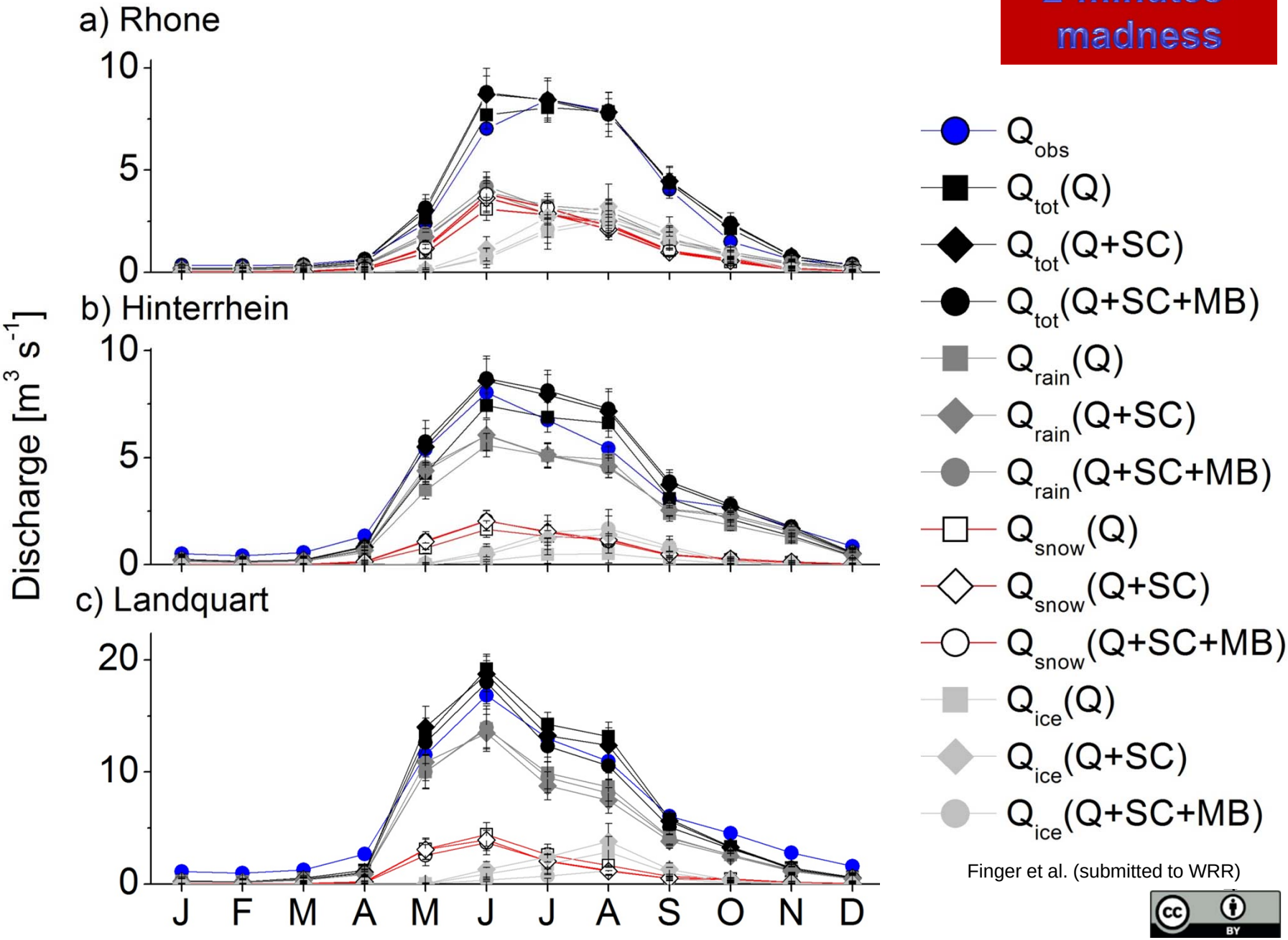
2-minutes-madness



Modified from Grayson et al. (2002)

Result: Snow, Glacier and Rainfall Runoff

2-minutes-madness

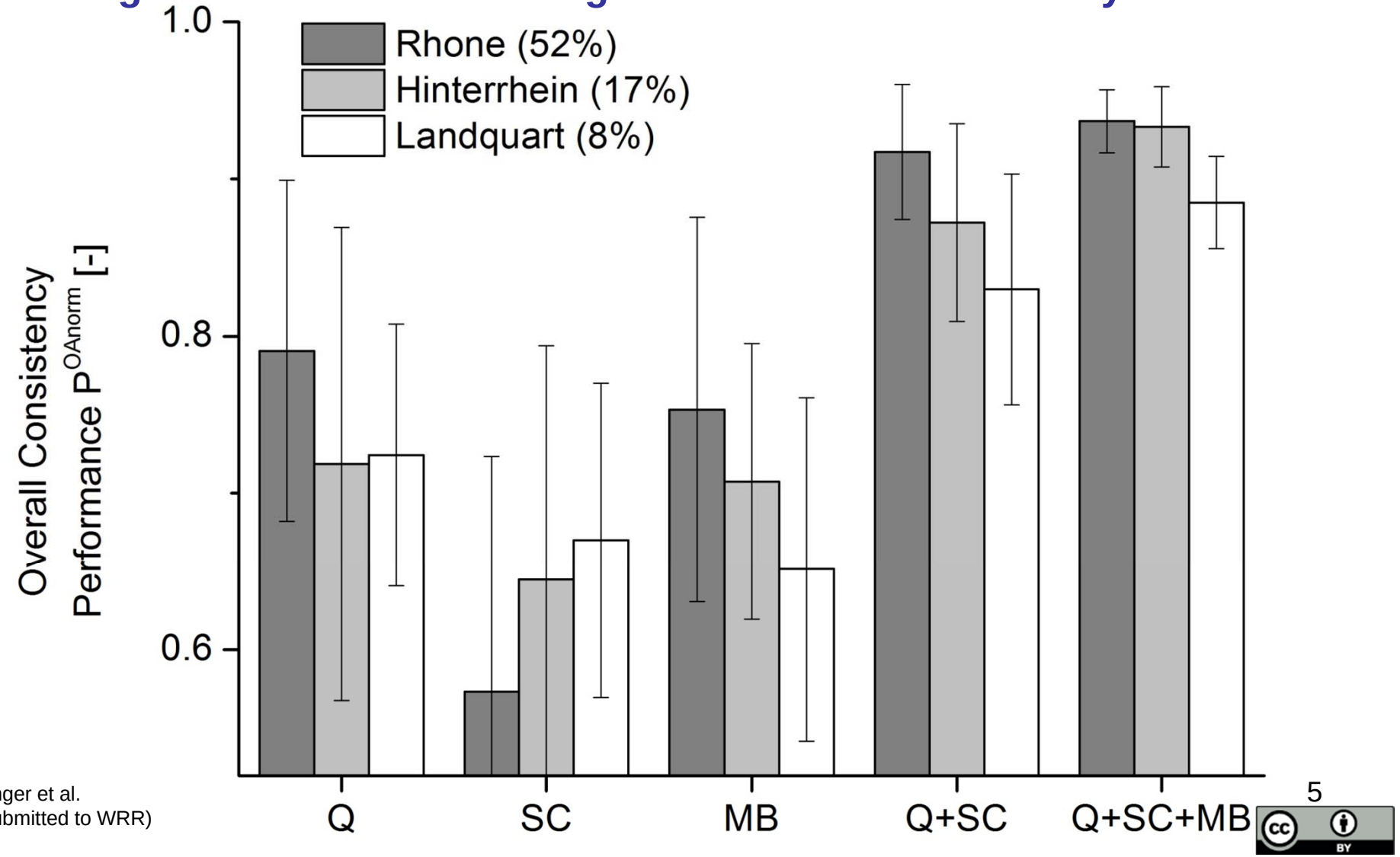


Finger et al. (submitted to WRR)

Conclusions

2-minutes-madness

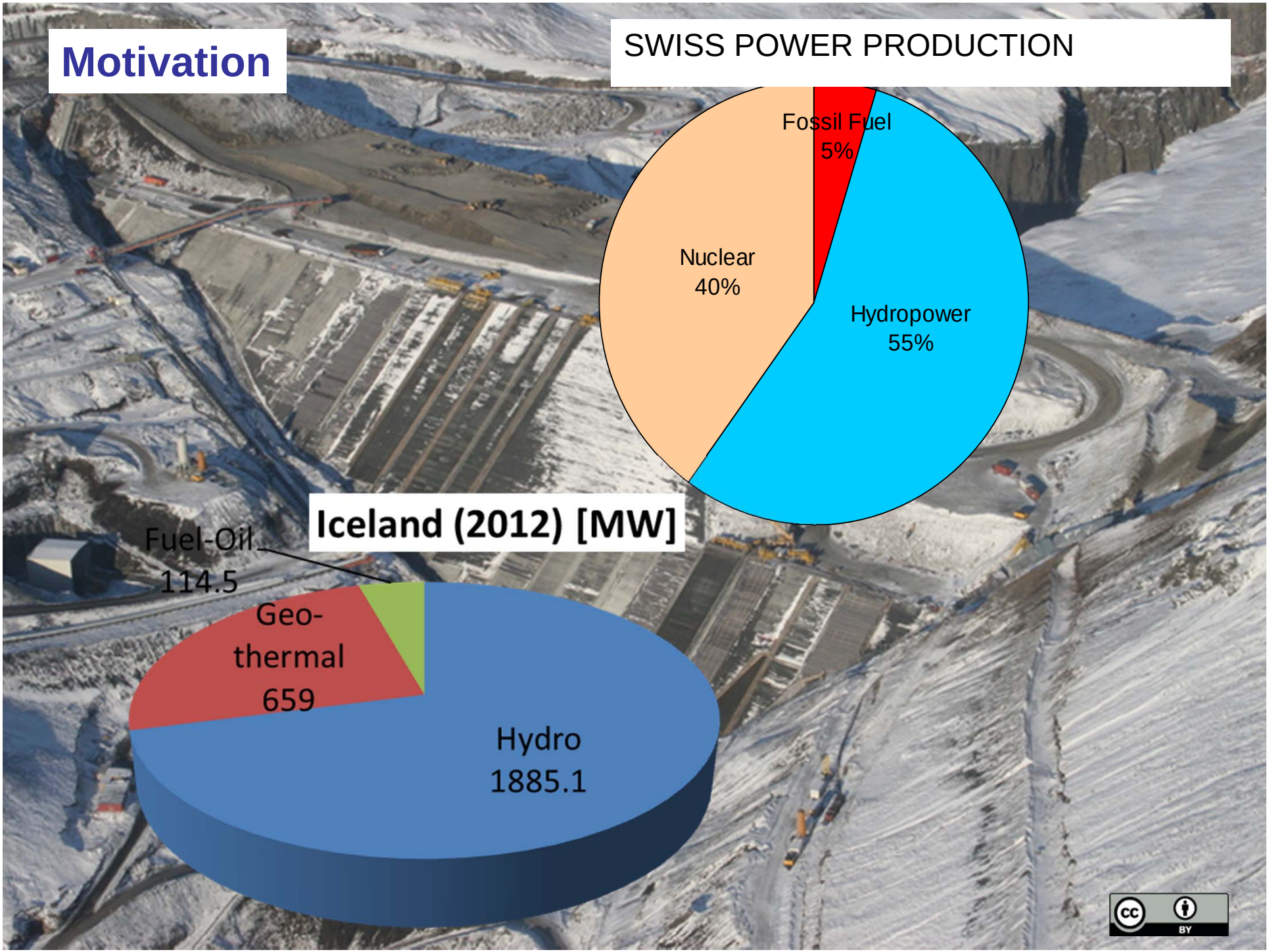
- **Model complexity does not enhance performance**
- **In smaller catchments with high glaciation MB are necessary**
- **In large catchments with low glaciation SC are necessary**



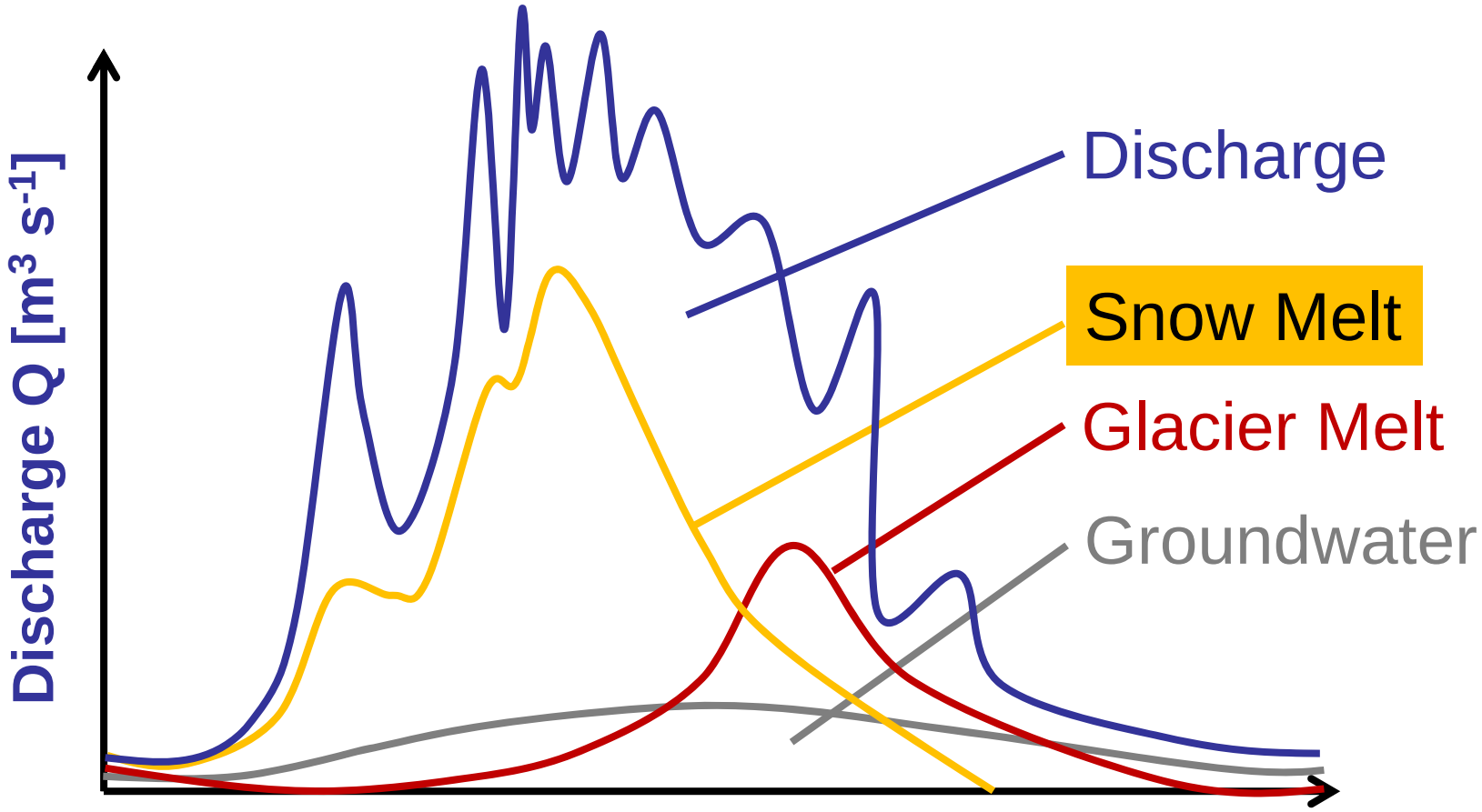
Finger et al.
(submitted to WRR)


Full presentation start here

Motivation

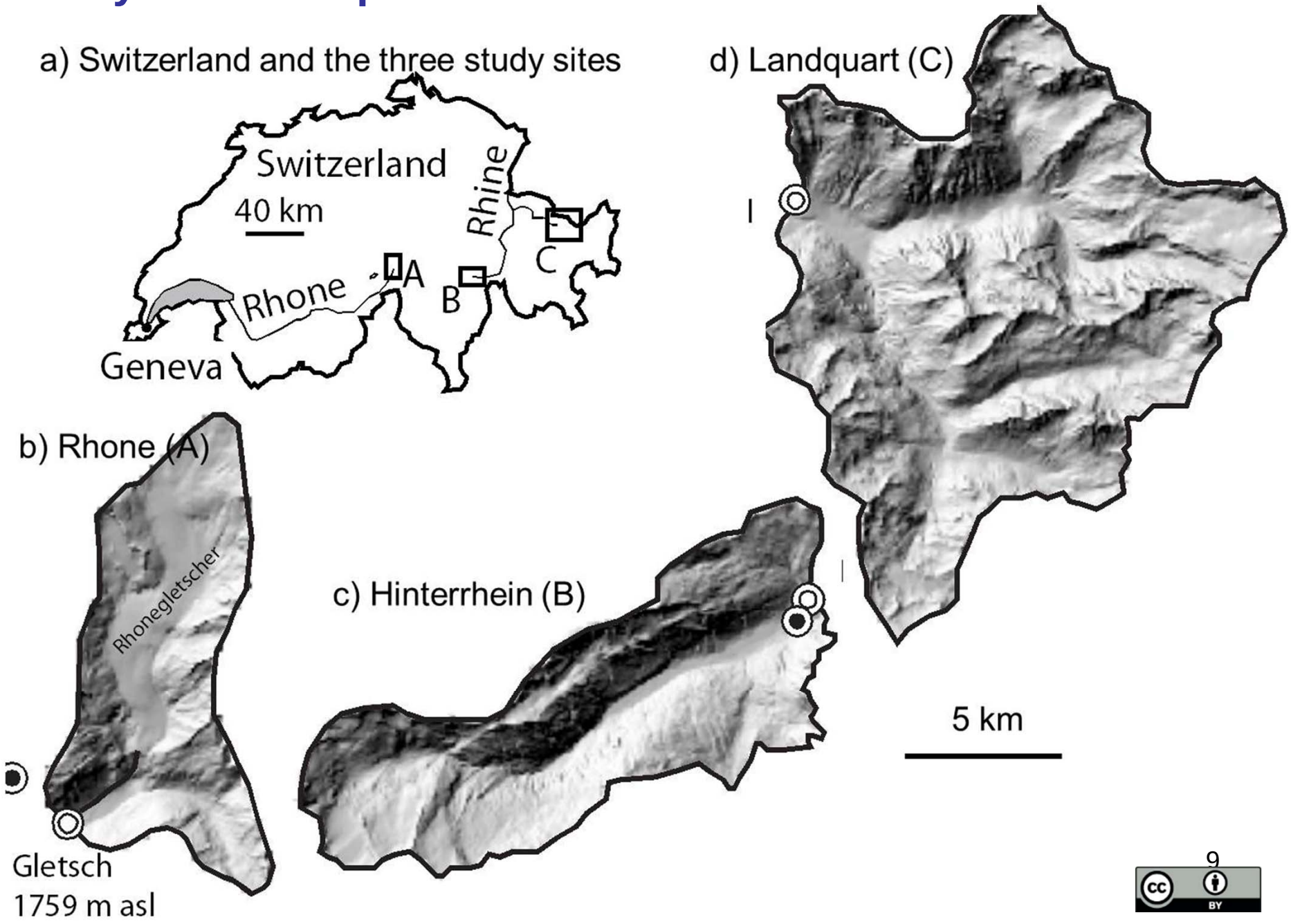

SWISS POWER PRODUCTION
Fossil Fuel
5%
Nuclear
40%
Hydropower
55%
Iceland (2012) [MW]
Fuel-Oil
114.5
Geo-
thermal
659
Hydro
1885.1

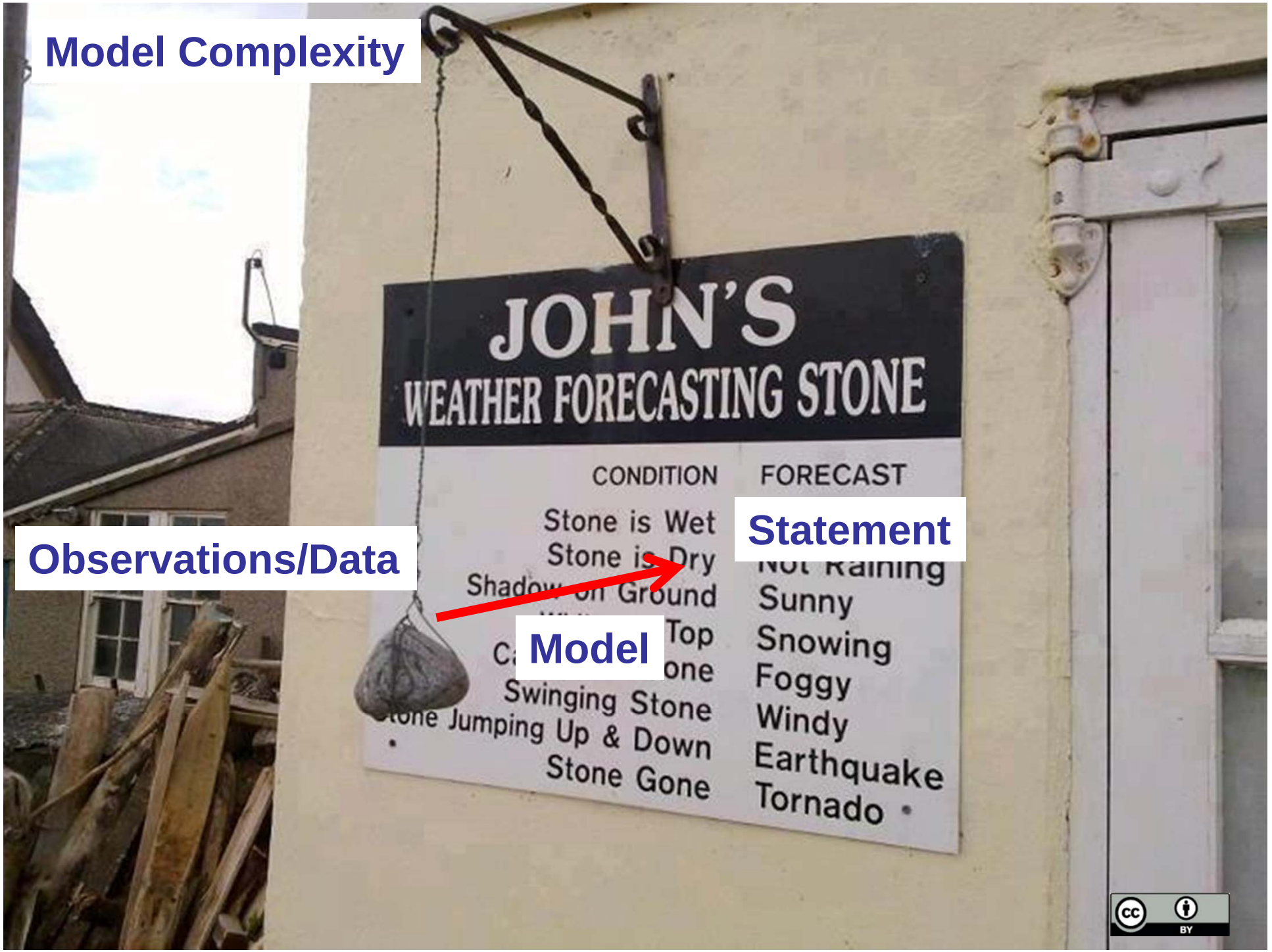
Objective: How much Snow- Glacier and Rain Runoff is available for Hydropower Production



Finger et al. (2012)

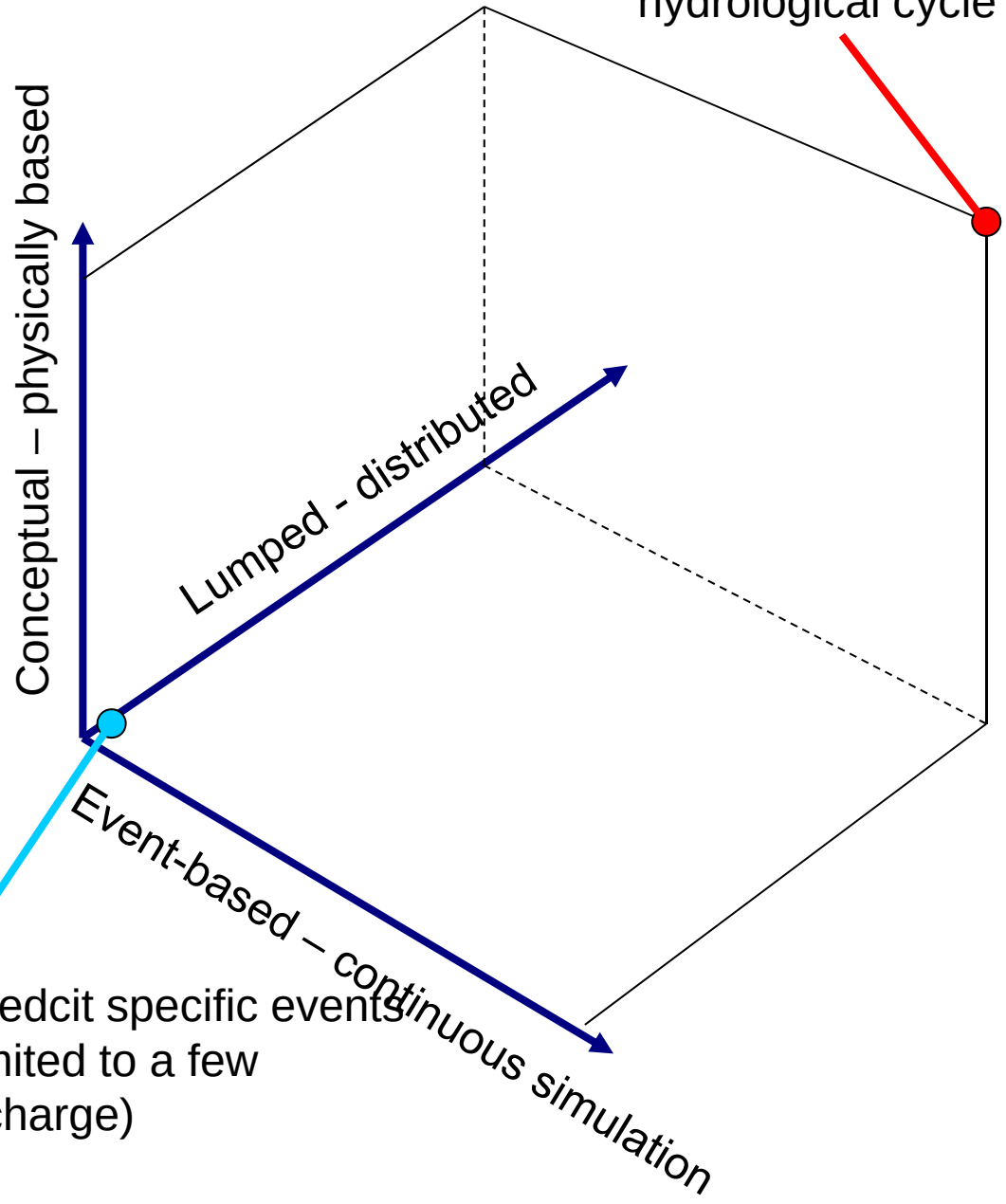
Study sites: 3 representative Swiss catchments




Model Complexity
JOHN'S
WEATHER FORECASTING STONE
CONDITION
FORECAST
Stone is Wet
Stone is Dry
Shadow on Ground
Top
Swinging Stone
Stone Jumping Up & Down
Stone Gone
Not Raining
Sunny
Snowing
Foggy
Windy
Earthquake
Tornado
Observations/Data
Model
Statement

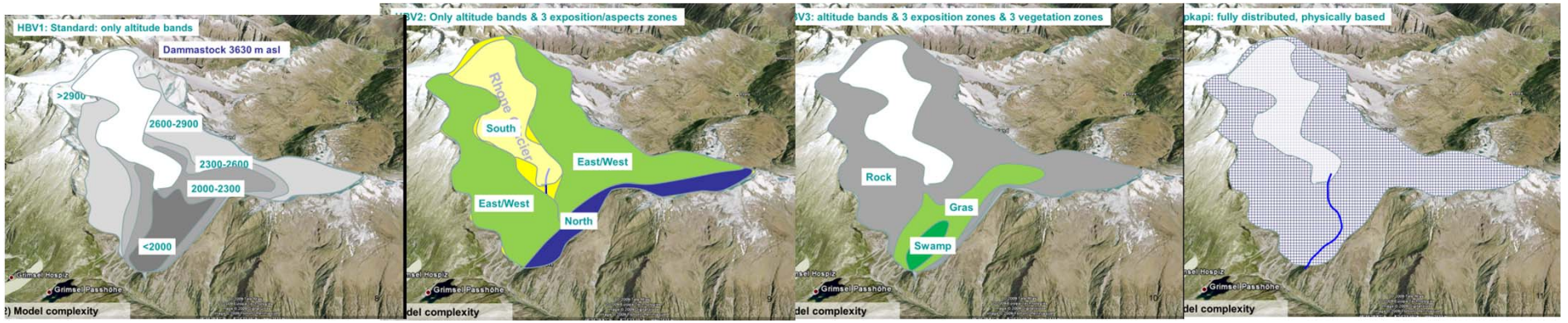
Model Complexity

Complex models: which can compute noumerous variables related to the hydrological cycle



Simple Models: predcit specific events and are usually limited to a few variabes (e.g. discharge)

Summary of Model Complexity used in our study

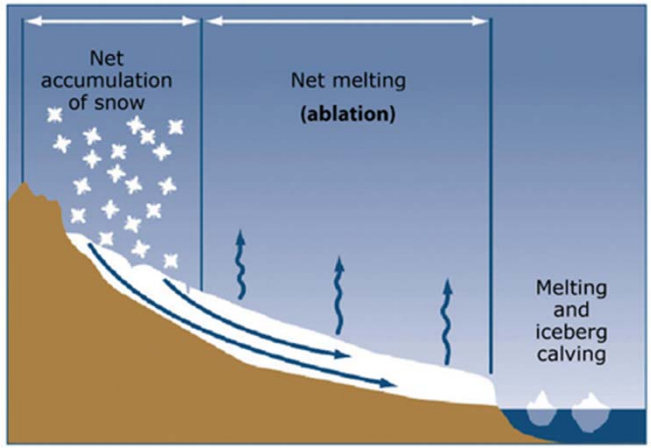


	HBV1:	HBV2: with 3 asp. Zones	HBV3: 3 asp. &3 veg. zones	TOPKAPI
Spatial	Alt. bands	S/N/E-W	S/N/E-W & gras, swamp, rocks	Distrib.
time	Daily	Daily	Daily	hourly
Soil	One GW Box Model	One GW Box Model	3 * One GW Box Model	Distrib.
Snowmelt	DD	DD (zone)	DD (zone)	ETI
Glacier	DD gla	DD gla (zone)	DD gla (zone)	ETI gla

Multi-Variable calibration according to Finger et al. 2011

Discharge **(Q)**
- 10 min resolution
- Rhone valley

$$R^2 = 1 - \frac{\sum_{i=1}^{n}\left(Q_{i,\mathrm{obs}} - Q_{i,\mathrm{sim}}\right)^2}{\sum_{i=1}^{n}\left(Q_{i,\mathrm{obs}} - \overline{Q_{i,\mathrm{obs}}}\right)^2}$$



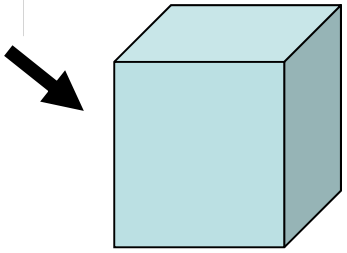
Mass Balances **(MB)**
- Every 100 m altitude
- 1900 to present
- → For Gletsch: 2 values per year
- (winter and summer)

$$RMSE_{MB} = \sqrt{\sum_{j=1}^{m}\left(MB_{j,\mathrm{obs}} - MB_{j,\mathrm{sim}}\right)^2}$$

MODIS snow cover data **(SC)**
- Twice a day (TERRA and AQUA)
- 500 m resolution
- Entire world

$$CPSC = \frac{c_{\mathrm{corr}}}{c_{\mathrm{tot}} - c_{\mathrm{missing}}}$$

Stochastic Calibration: Monte Carlo Simulations (Finger et al., 2011)



1. Run 10'000 plausible parameter sets

2. Assessment of performance

$$R^2 = 1 - \frac{\sum_{i=1}^{n}\left(Q_{i,\mathrm{obs}} - Q_{i,\mathrm{sim}}\right)^2}{\sum_{i=1}^{n}\left(Q_{i,\mathrm{obs}} - \overline{Q_{i,\mathrm{obs}}}\right)^2}$$

$$RMSE_{MB} = \sqrt{\sum_{j=1}^{m}\left(MB_{j,\mathrm{obs}} - MB_{j,\mathrm{sim}}\right)^2}$$

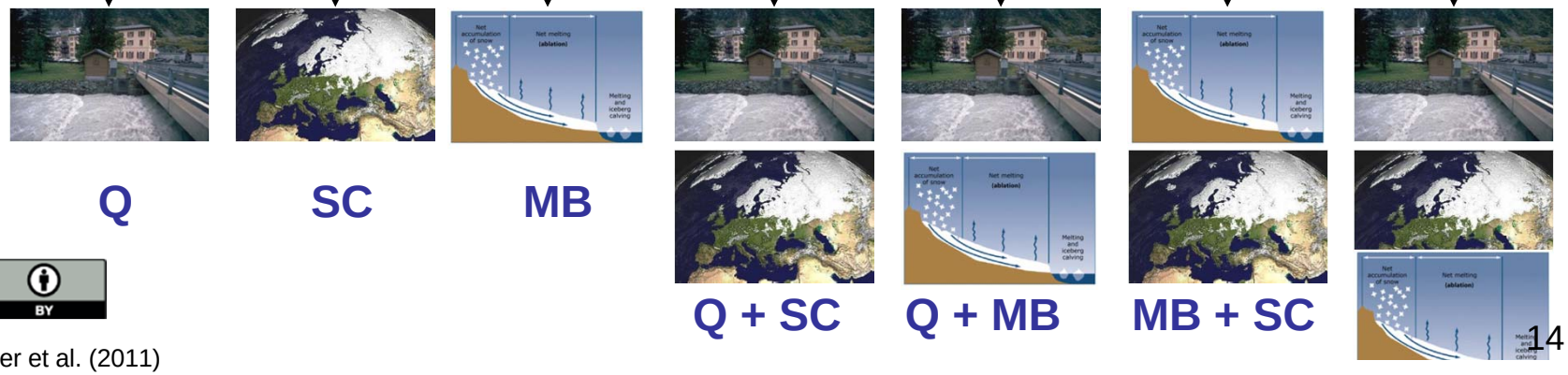
$$CPSC = \frac{c_{\mathrm{corr}}}{c_{\mathrm{tot}} - c_{\mathrm{missing}}}$$

3. Ranking of parameter sets according to the 3 criteria

4. Determination of the ranking value

5. Overall performance = average of P^i_r

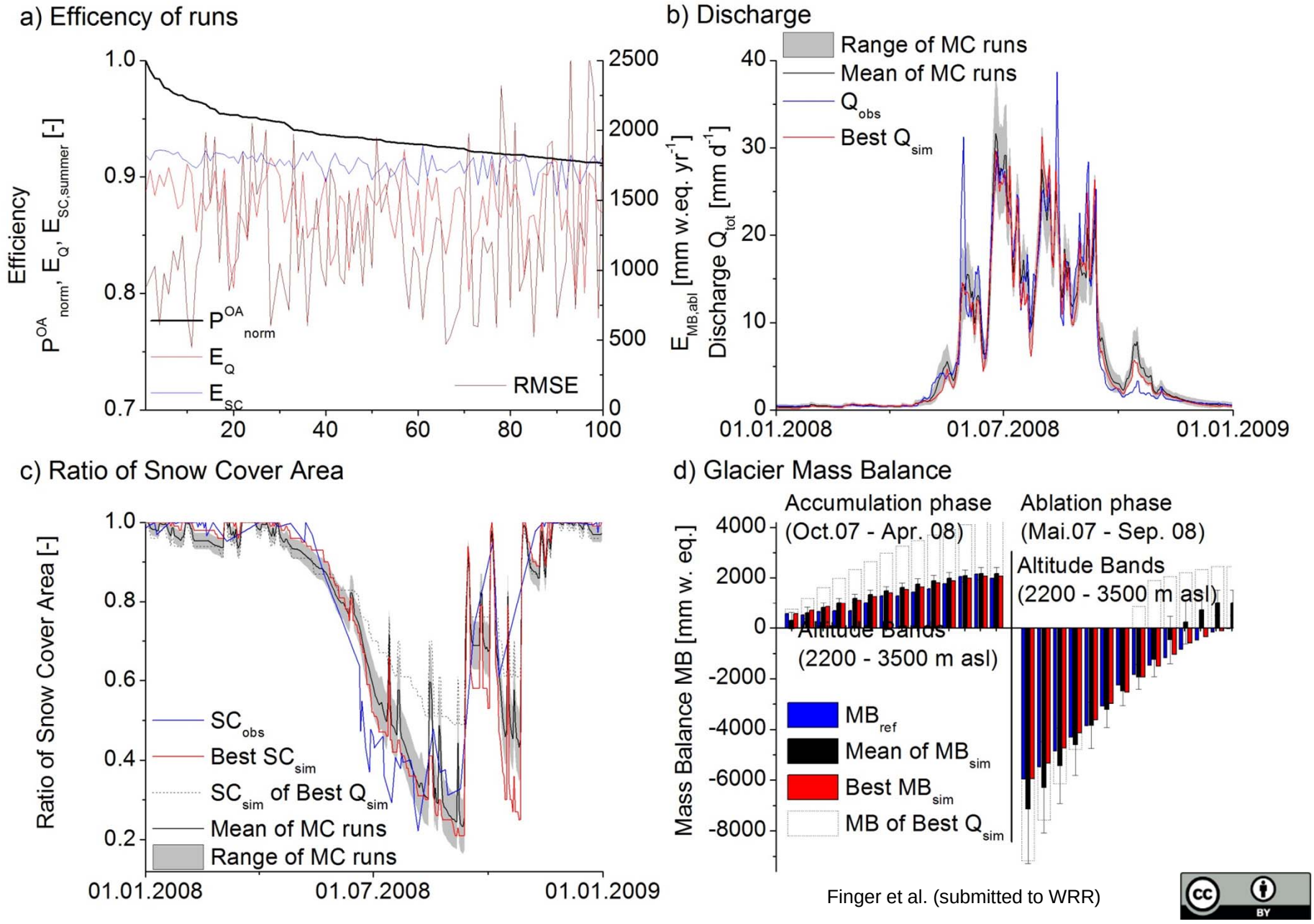
$$P_r^i = \frac{(N+1) - Rank_r^i}{N}$$



Q SC MB Q + SC Q + MB MB + SC Q + MB + SC

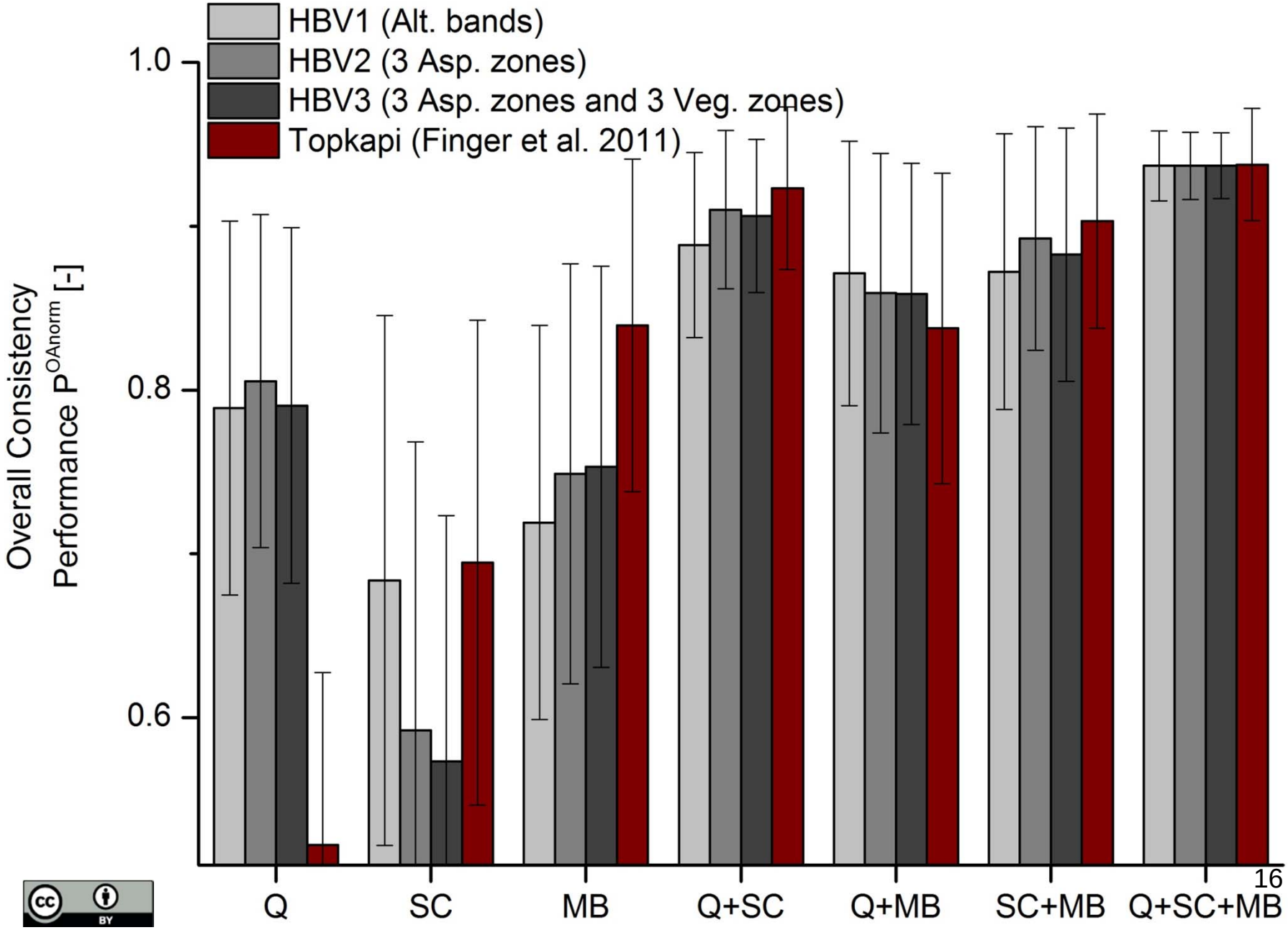
Finger et al. (2011)

Results of the 100 best runs from 10’000 MC runs

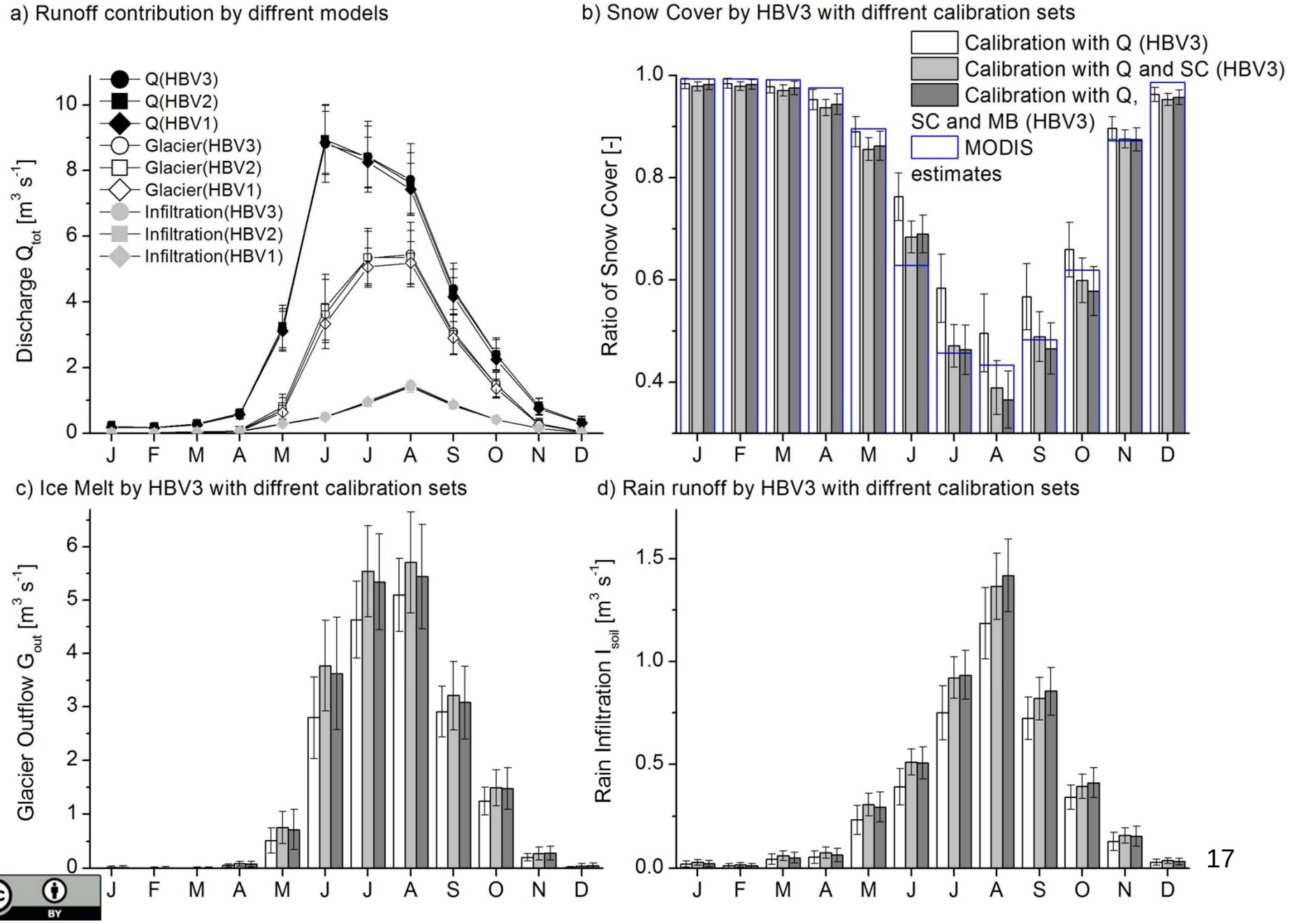


Finger et al. (submitted to WRR)

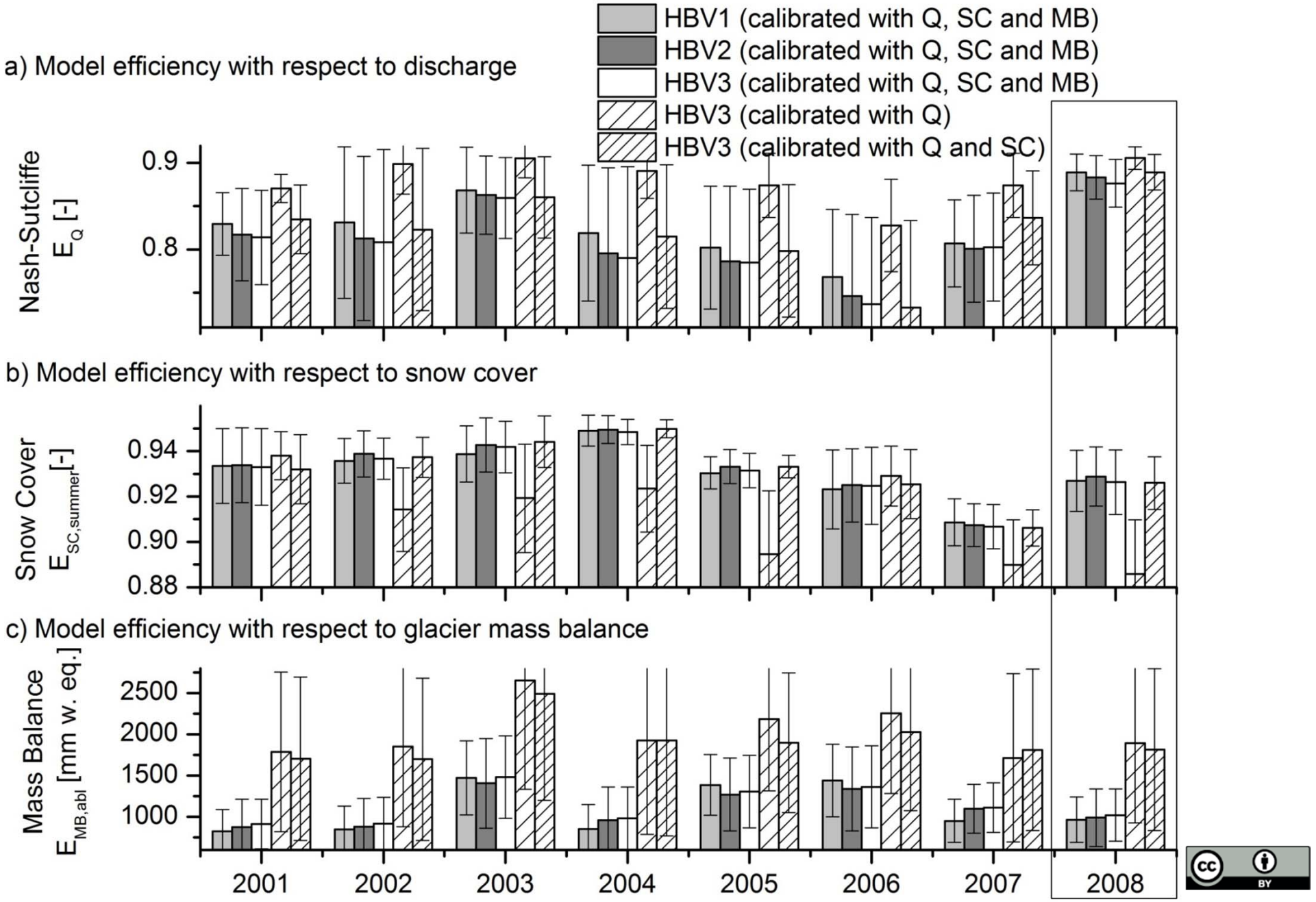
Overall consistency performance of the 4 models



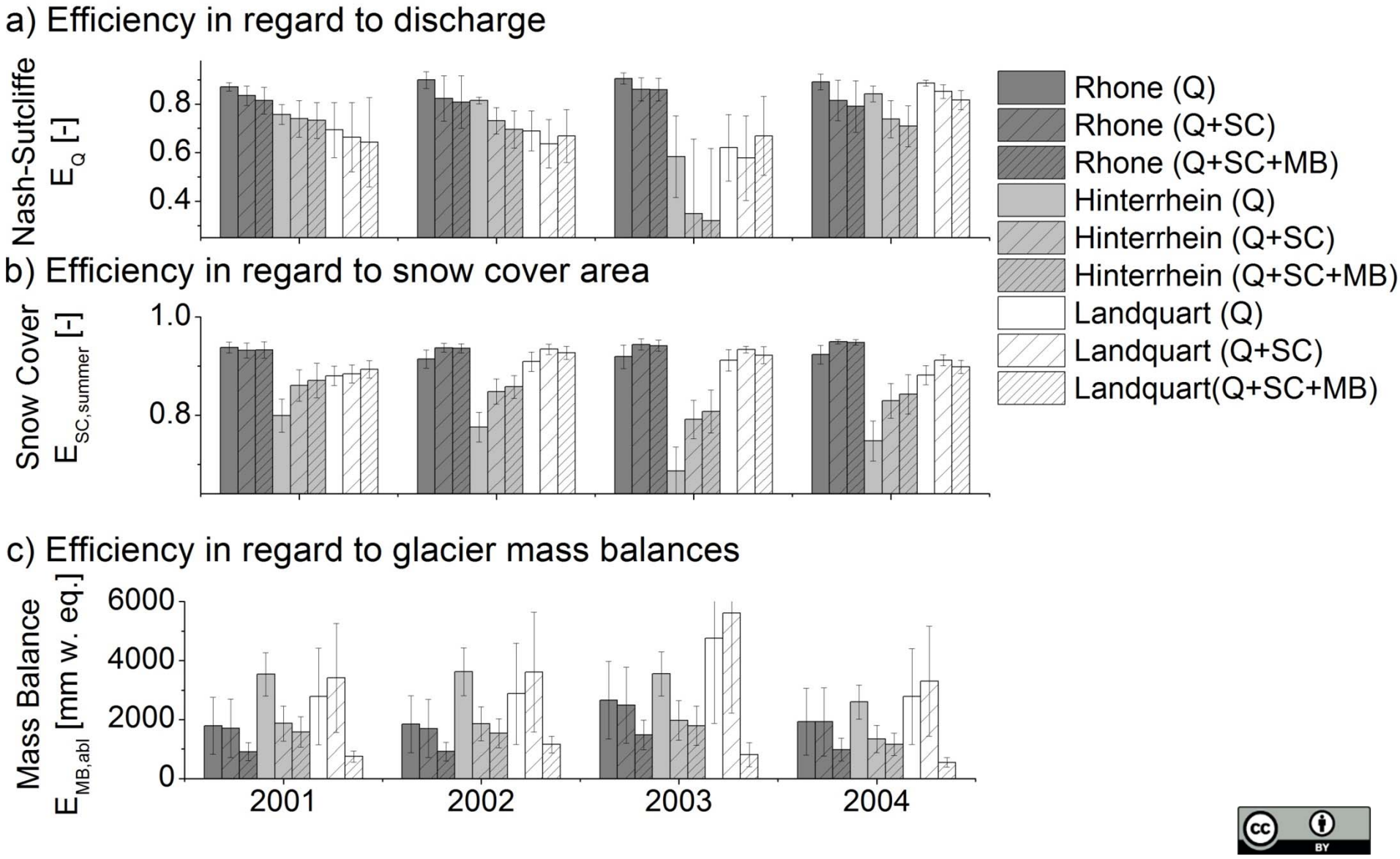
Effects of Model complexity and data availability on results



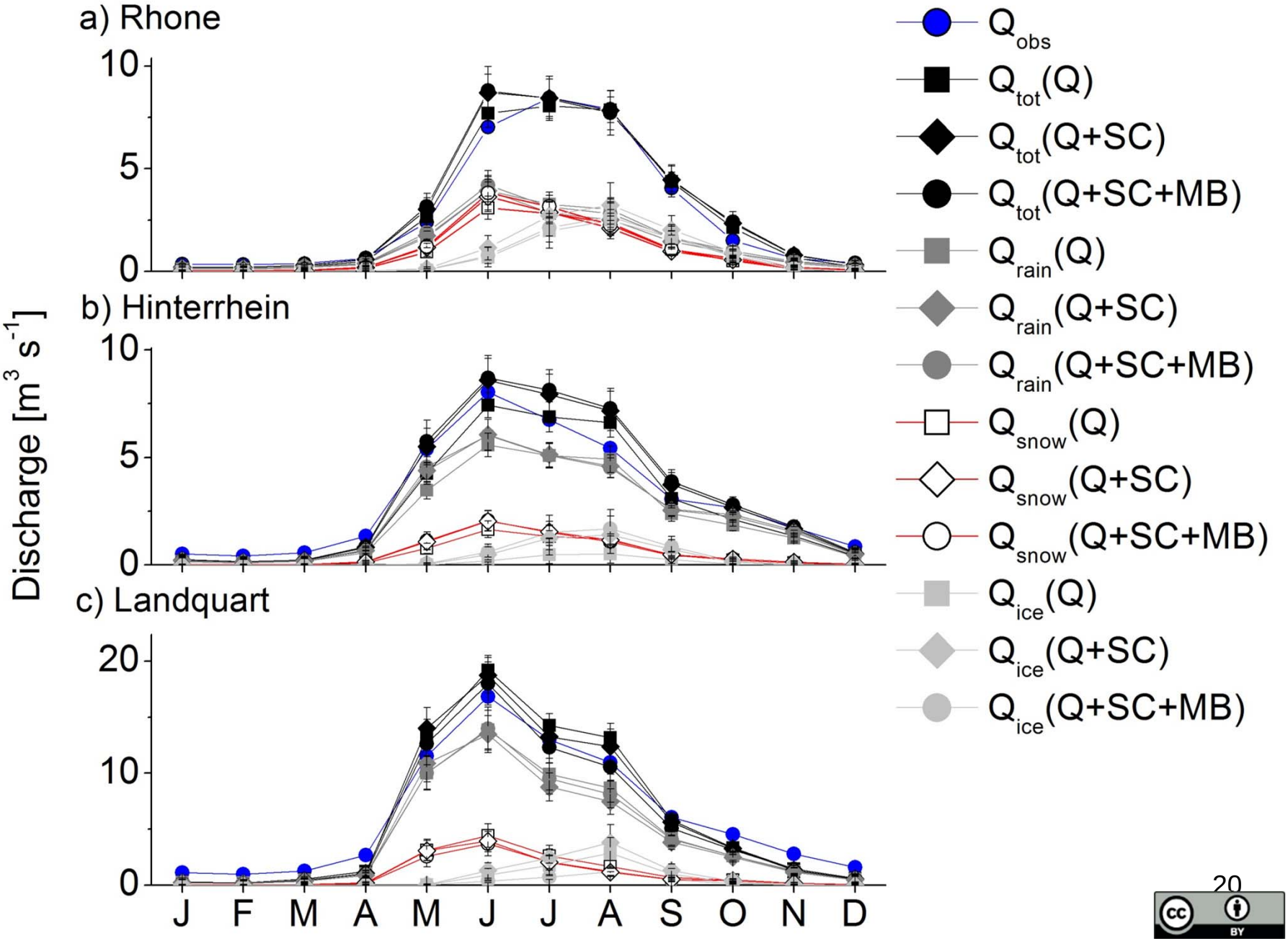
Validation of model performance for a 8-year period



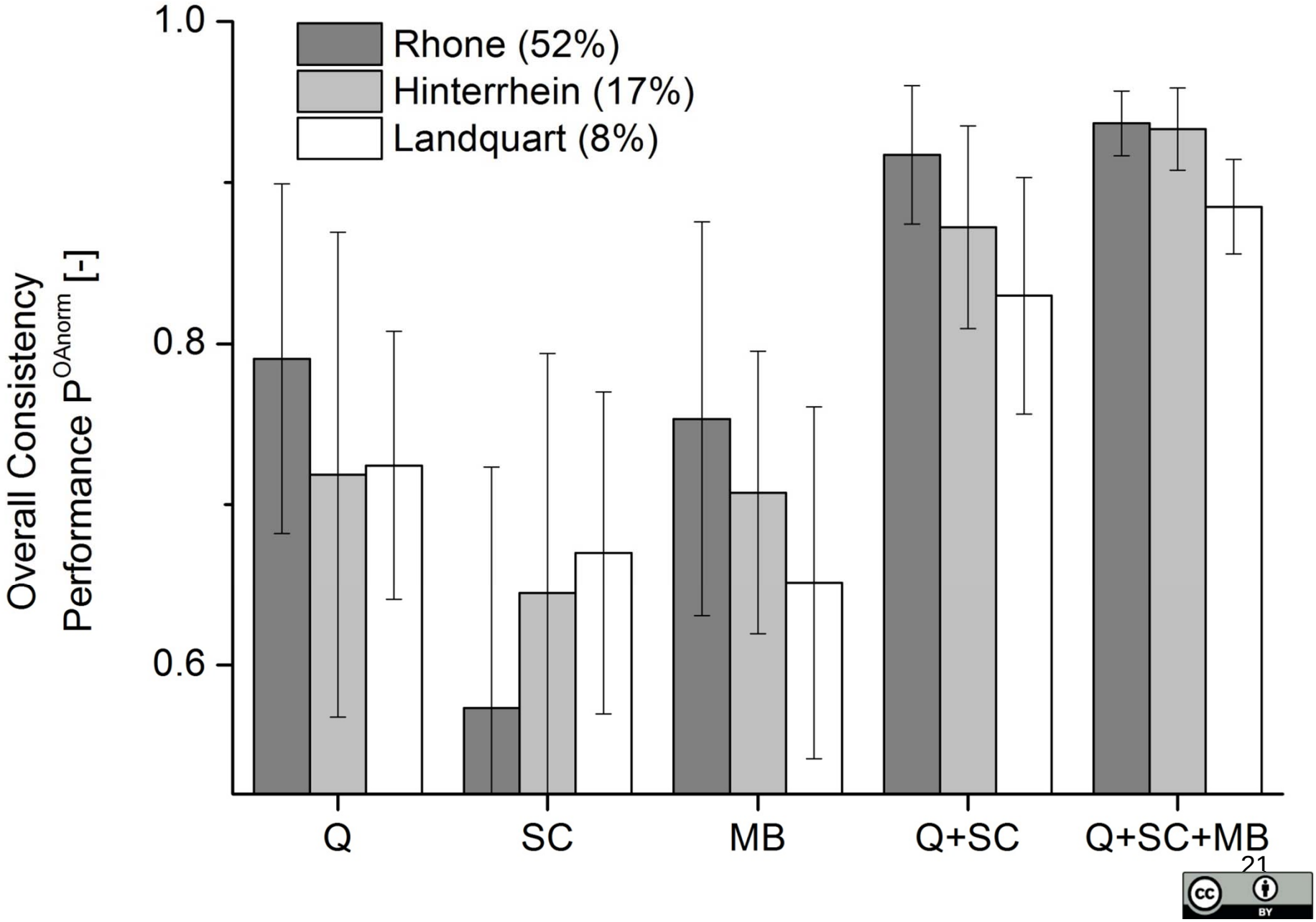
Model efficiency for the three study sites



Final Result: Snow-, Rain- and Glacier-Water in the Rhone



Overall consistency performance for all three study sites



Conclusions

- Multi variable calibration increases overall performance
  - Q and SC are a good combination
- Model complexity does not increase performance
  - The three HBV version reveald similar performance
- The value of SC increases with decreasing glaciation
  - Results for Hinterrhein and Silvretta are more significant
- The method can easily be applied to any headwater
  - Method is implemented in HBV

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