Hydrologic evaluation of CH-2018 climate scenarios using a stochastic high-resolution downscaling approach

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Rationale

- new CH2018 scenarios will provide more detail in climate change signals than CH2011
- broader scope of CC impact assessment requires methods to assess CC impacts that account for higher space-time resolutions

1. High **space** (sub-km) and **time** (sub-daily) **resolutions** are necessary for runoff predictions in Alpine catchments

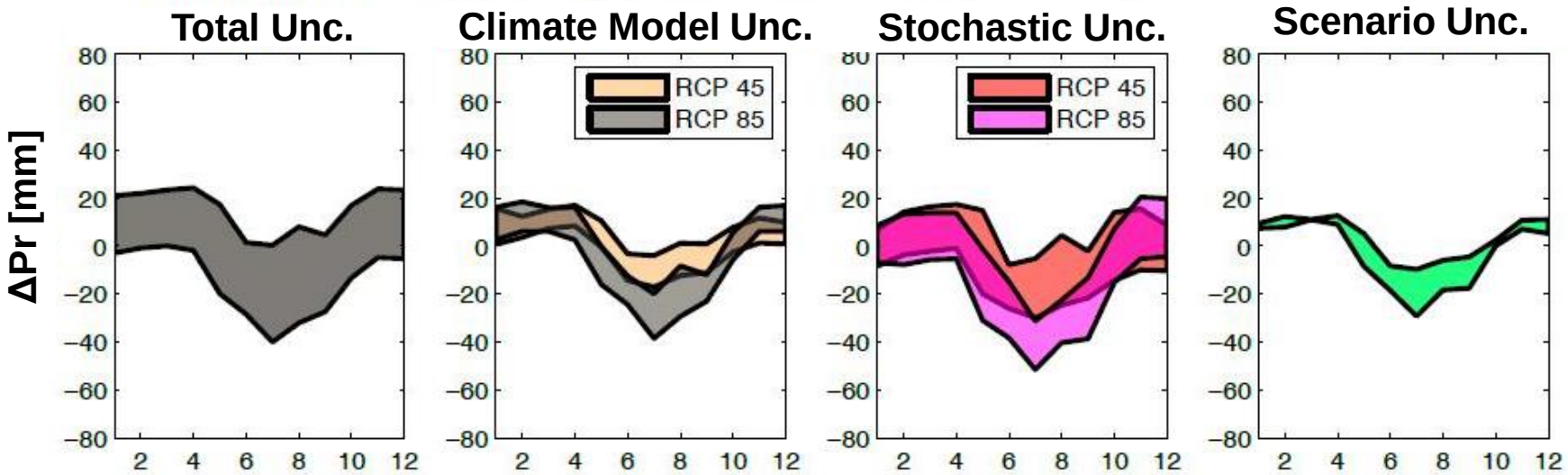
2. Distributed and **physically-based hydrological modelling** is necessary for hydrological consistency (soil water content, ET, snow, etc.)

3. It is important to **partition uncertainty** in climate change impact studies, in particular include internal climate variability

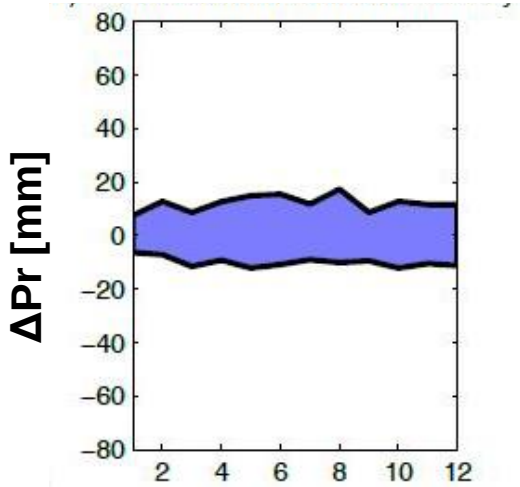
Partitioning uncertainty

Fatichi et al. (2016, EF)

Role of **internal climate variability** is important for climate change impact studies, especially for precipitation-driven processes



Historical Period – Stochastic Unc.



Historical Period: 1981-2010

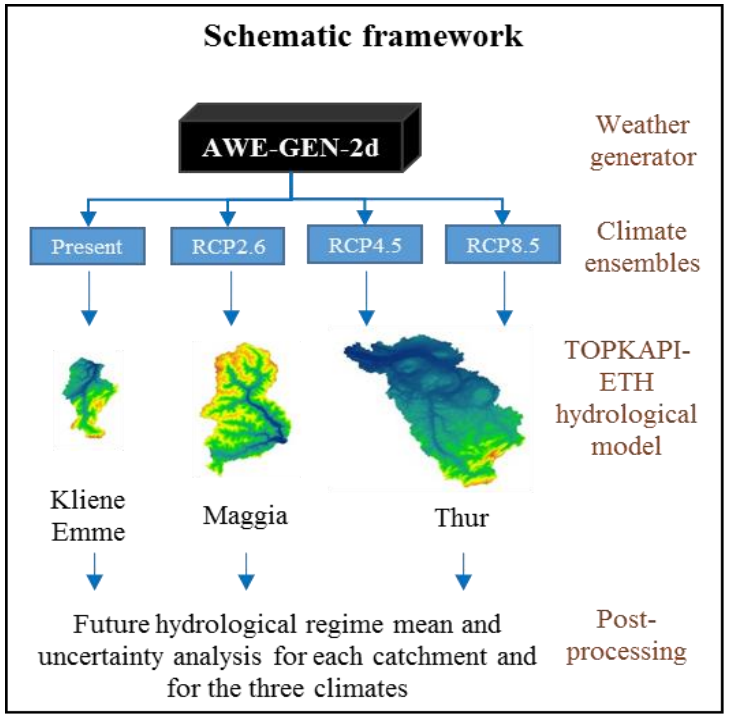
High resolution downscaling approach

WHY

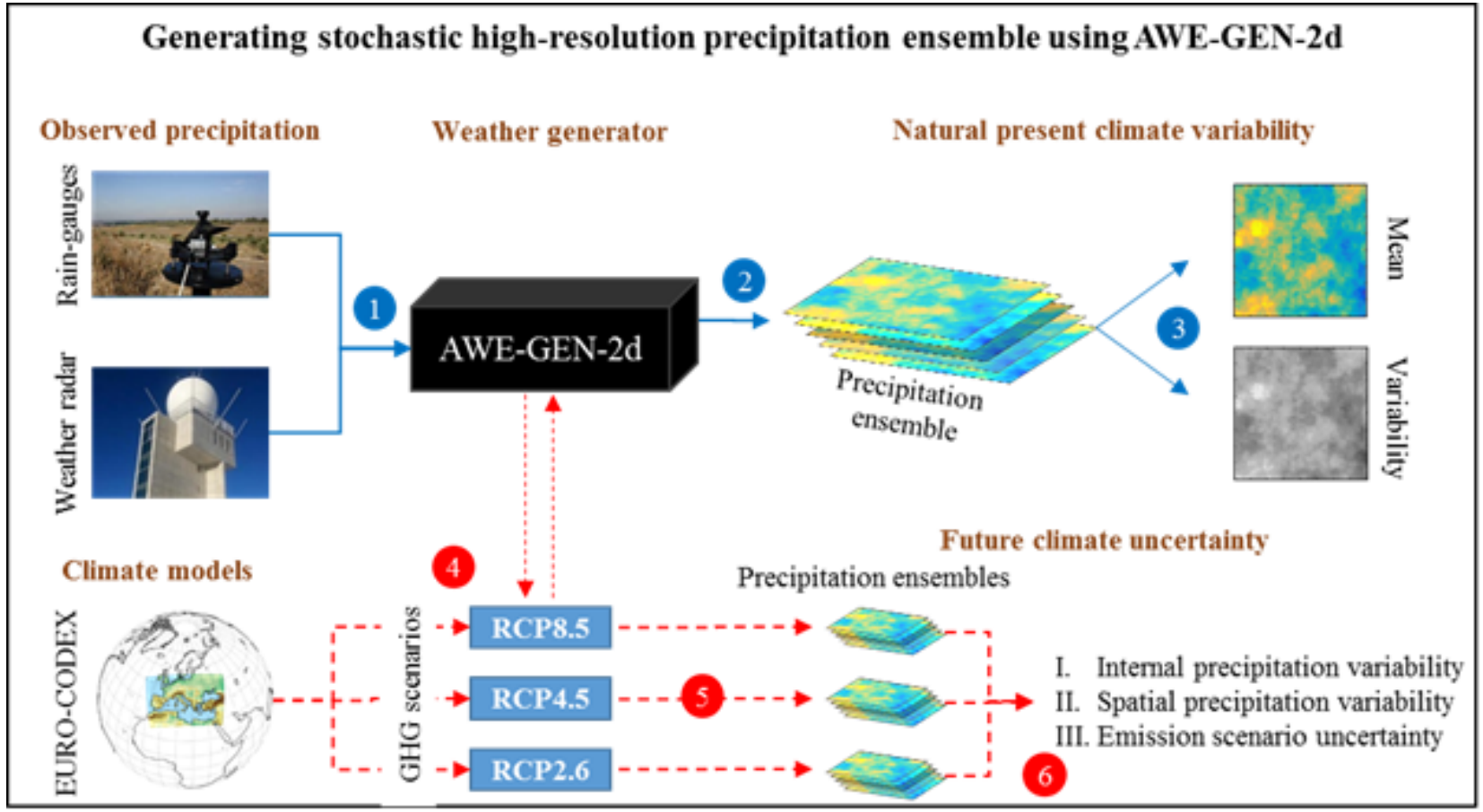
- Quantile mapping: one CC trajectory is not enough
- Internal (stochastic) climate variability is important for CC impacts

HOW

- Apply CH2018 to space-time statistics for future climate
- Consider 3 emission scenarios
- Generate spatial fields of precipitation, temperature,…
- Apply to 3 basins: Maggia, Kl. Emme, Thur
- Apply distributed physically-based model Topkapi-ETH
- Analyse changes in hydrological variables



Task 1: Generating climate ensembles

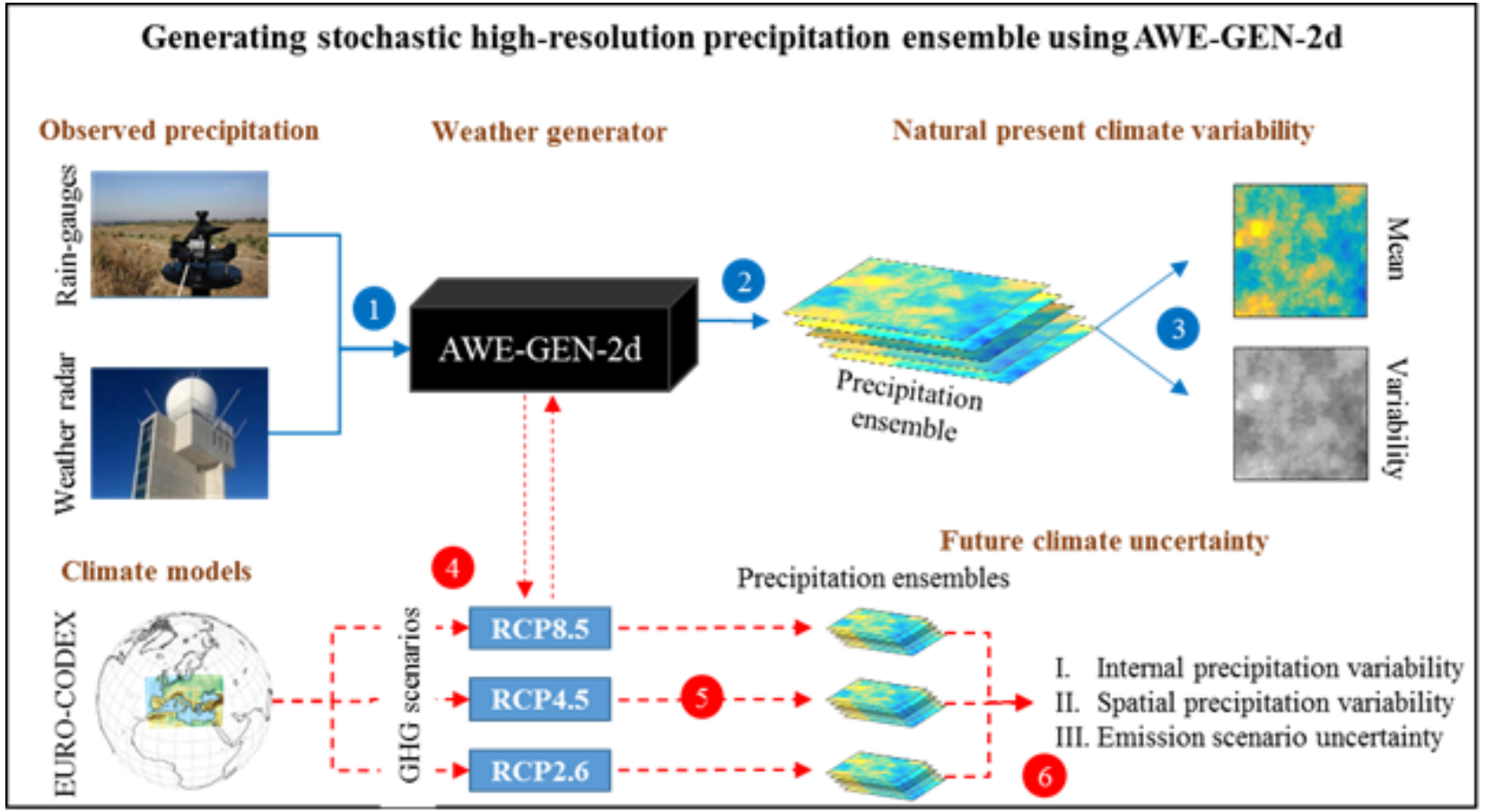


1: Gauge and radar data for calibration

2: Stochastic realizations (n=50)

3: Validation of rain statistics on three study catchments (areas)

Task 2: Generating future climate

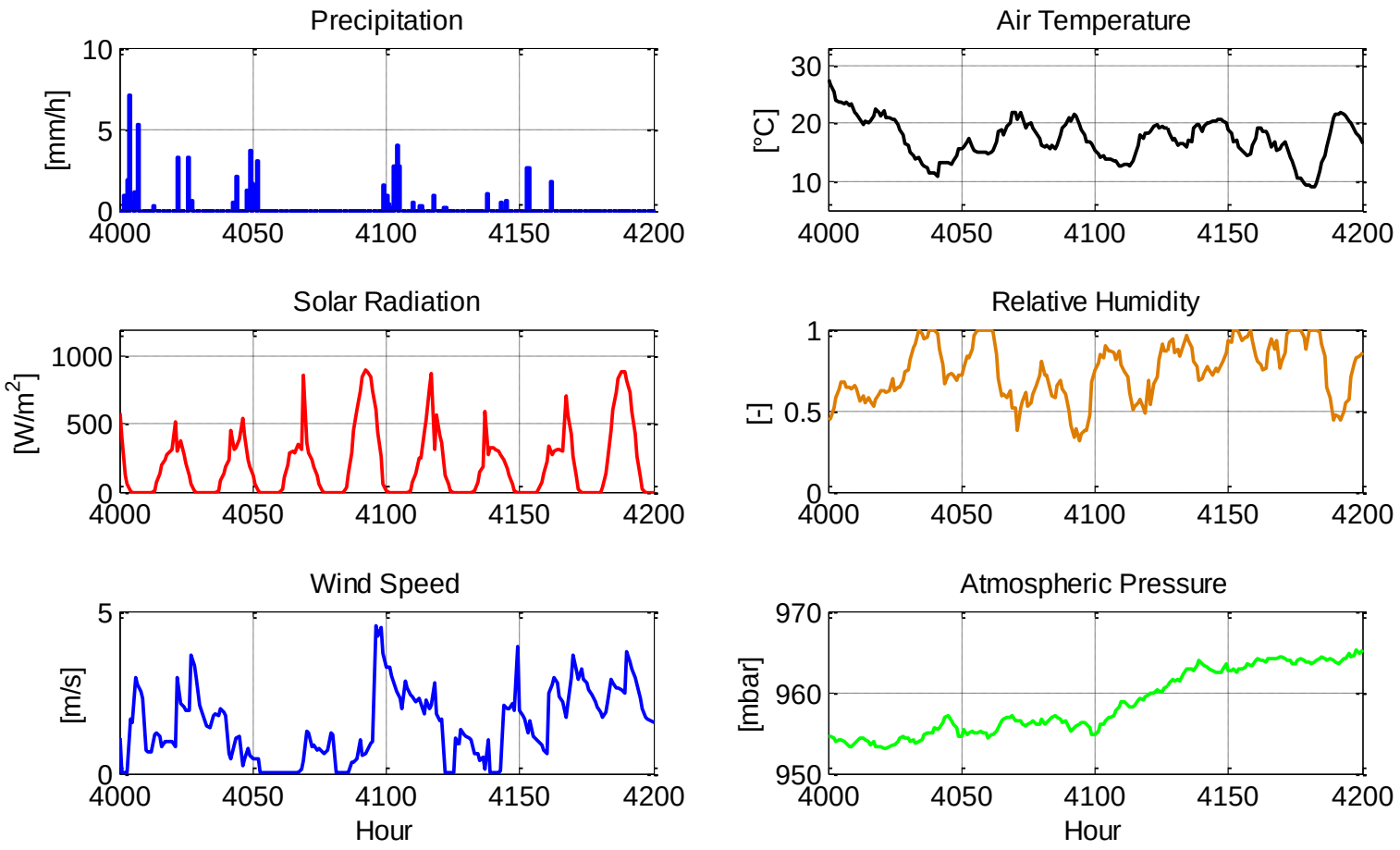


4: Multi-model ensemble
5: Realizations (n=50)
6: Partitioning uncertainty

Runs: 3 x 3 x 50 x 10 x 5 (#catchment-ensemble, #climate-ensembles, #realizations, #members, #decades)

What is AWE-GEN-2d ?

- Advanced WEather GENerator for a 2-dimensional grid AWE-GEN-2d (Peleg et al., 2017)
- High spatial resolution (2x2 km for precipitation & could cover, 100x100 m for air temperature, solar radiation, vapor pressure, atm. Pressure, and near-surface wind)
- High temporal resolution (1 hr)



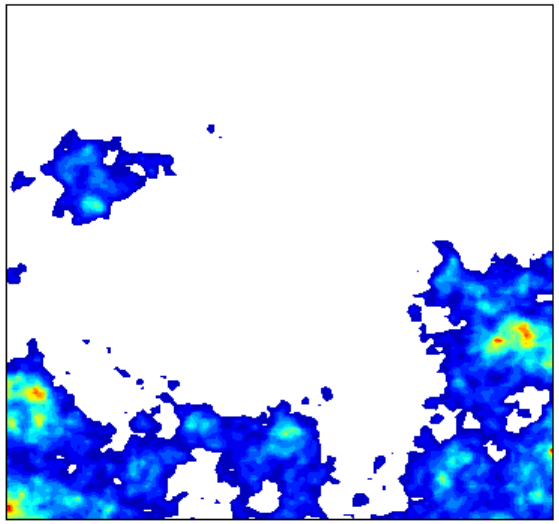
Peleg et al. (2017)

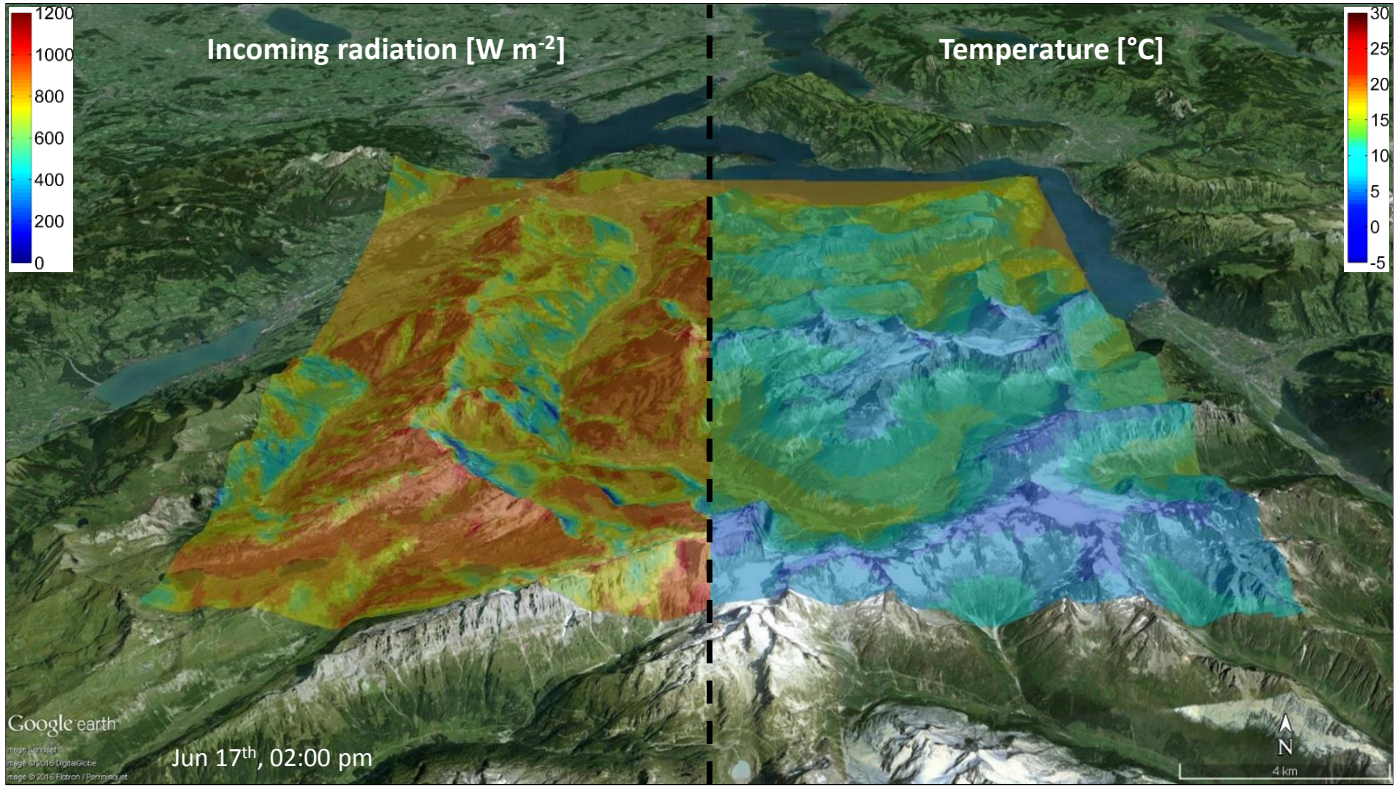
What is AWE-GEN-2d ?

- 5-min (1 h) precipitation and cloud cover on a 2x2 km grid

- 1 hr air temperature, solar radiation, vapor pressure, atmospheric pressure and near-surface wind on a 100x100 m grid

Paschalis et al. (2013)





CH2018

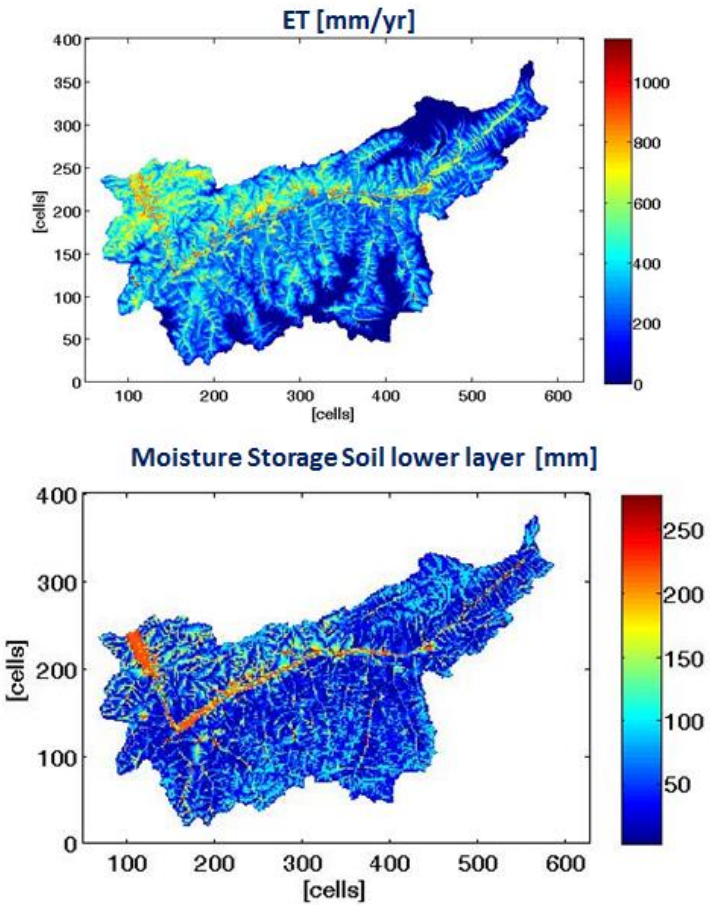
Task 3: Hydrological impact analysis

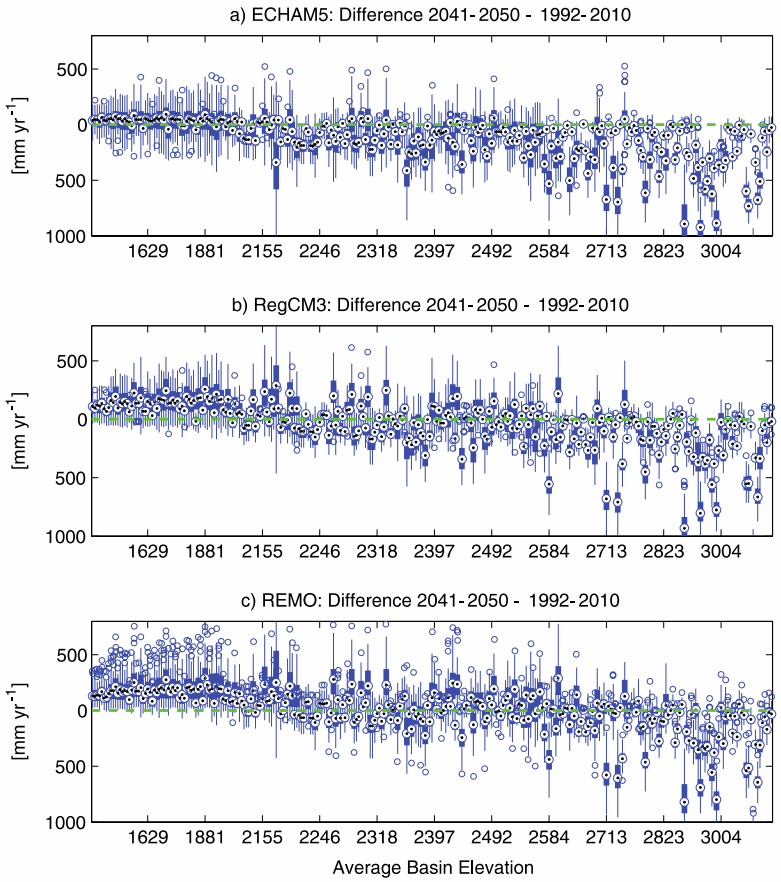
- Distributed physically-based hydrological model Topkapi-ETH

- **3 catchments**: Kl Emme, Maggia, Thur (landuse, regulation, natural)
- **calibration-validation** with current climate (30 yr period)
- **future climate** runs (moving 10 yr periods)

- **Analysis:** mean changes (Q, ET, SWC, SM/IM, SC, etc.), peak flows, low flows; partitioning uncertainty

Fatichi et al. (2015)
Paschalis et al. (2014)

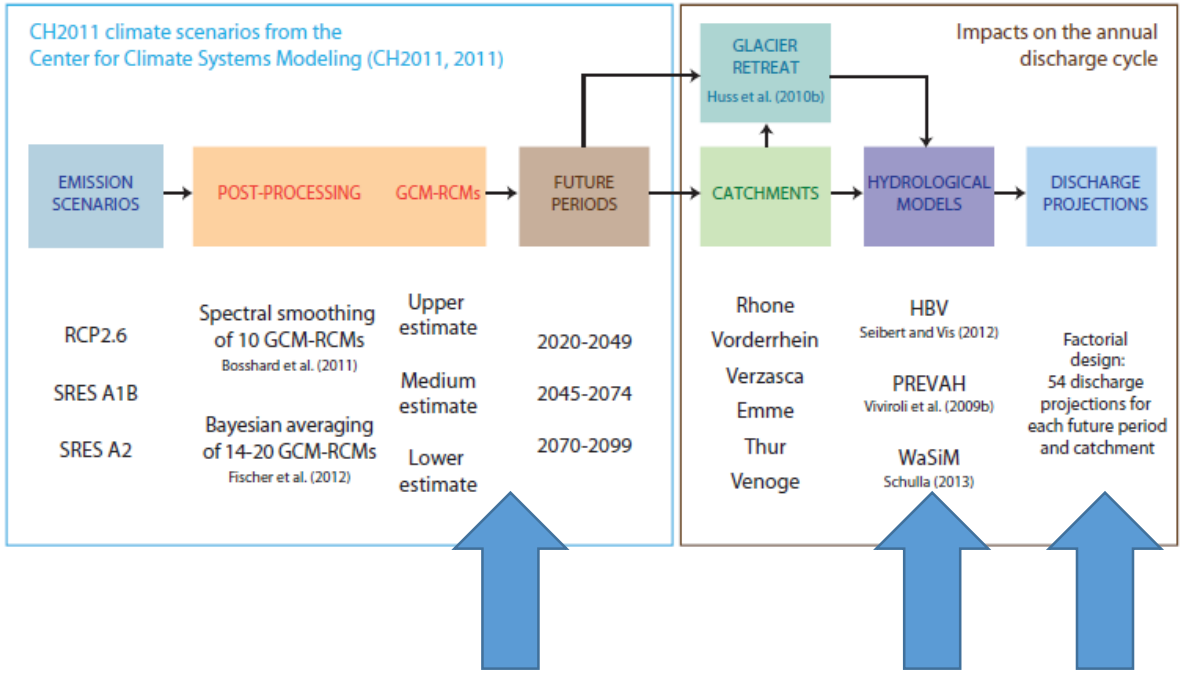




What is new compared to CH2011 ?

1. internal climate variability
2. fully-distributed approach
3. additional hydrological variables (e.g. snow cover, ET, …)

Addor et al. (2014, WRR)



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Main references

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