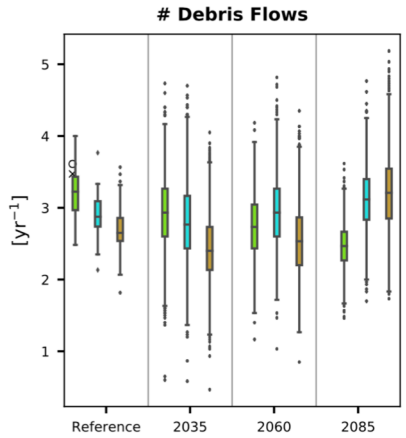
Climate change impacts on sediment yield and debris-flow activity at the Illgraben (CH)



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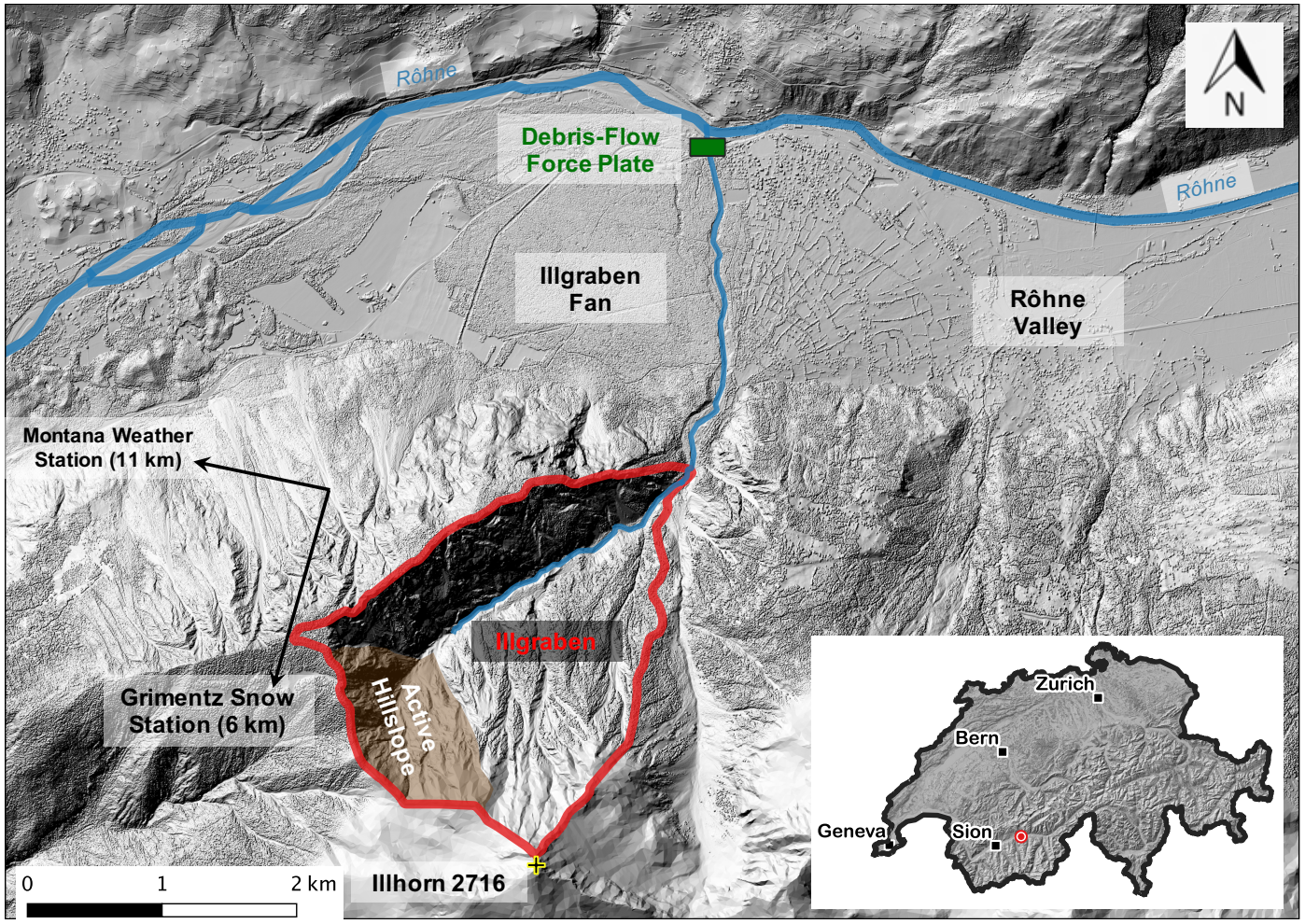
Study site: Illgraben (CH)

- 4.8 km^2
- 3-4 debris flows per year on average
- 75 debris flows (and floods) recorded between 2000 and 2017 (ongoing)



Objectives

We use the latest **climate change scenarios**, a state-of-the-art **weather generator** and a **sediment cascade model** to…

… predict changes and uncertainties in sediment yield and debris flows as a results of changes in precipitation and temperature.

… assess how the climate change signal is reflected in sediment production.

… test the sensitivity of key geomorphic processes for sediment production and transfer to elevation.

Methods

- CH2018[1] - climate change scenarios based on EURO-CORDEX but bias-corrected for Switzerland (daily and 2 km resolution)
- AWE-GEN[2] - a stochastic weather generator generating hourly time series of correlated weather variables
- SedCas[3] - a stochastic sediment cascade model, improved and re-calibrated, reproducing debris-flow first-order characteristics such as magnitudes and frequencies
- Debris flow observations[4] - since the year 2000 and ongoing

With these tools we simulate sediment yield and debris flows representative for the current and 3 future climates under emission scenario RCP8.5:

- 1981 – 2010 (Reference)
- 2020 – 2049 (2035)
- 2045 – 2074 (2060)
- 2070 – 2099 (2085)

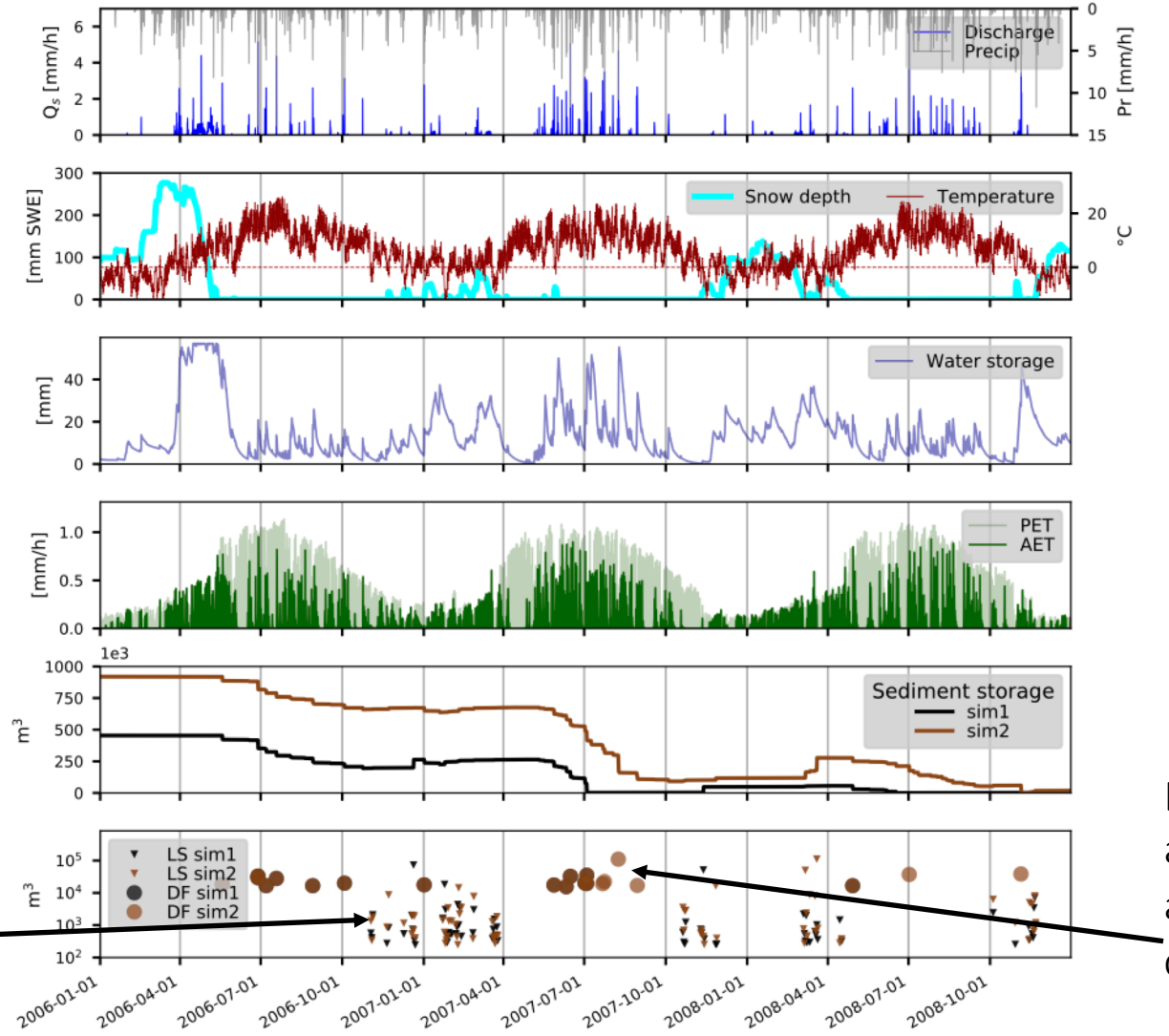
[1] CH2018 – Climate Scenarios for Switzerland, Technical Report, National Centre for Climate Services, Zurich, ISBN: 978-3-9525031-4-0

[2] Fatichi, S., et al. "Simulation of future climate scenarios with a weather generator." *Advances in Water Resources* 34.4 (2011)

[3] Bennett, G. L., et al. "A probabilistic sediment cascade model of sediment transfer in the Illgraben." *Water Resources Research* 50.2 (2014)

[4] McArdell, B.W.., et al. »Field observations of basal forces and fluid pressure in a debris flow." *Geophysical Redsearch Letter* (2007)

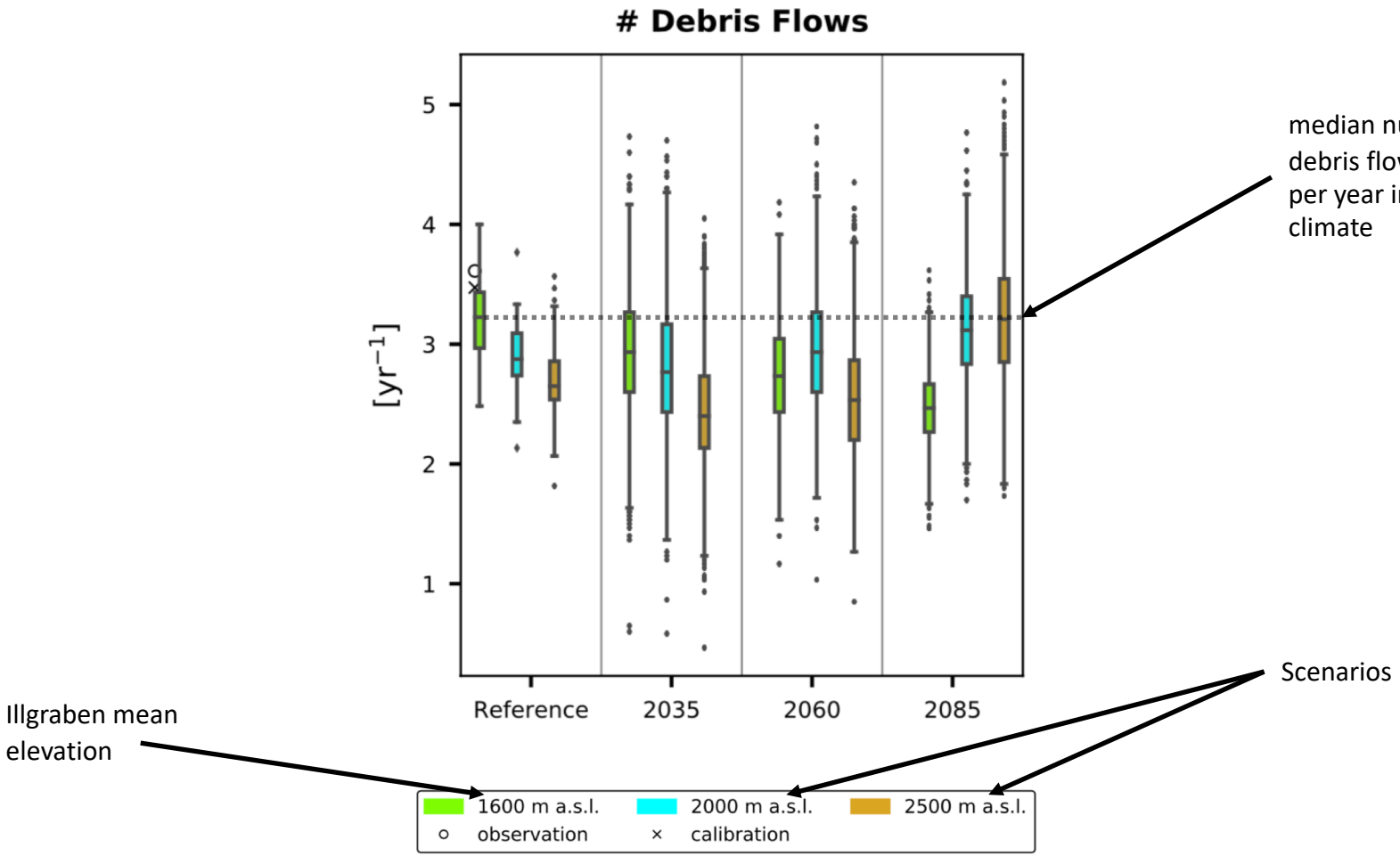
Example of SedCas inputs and outputs



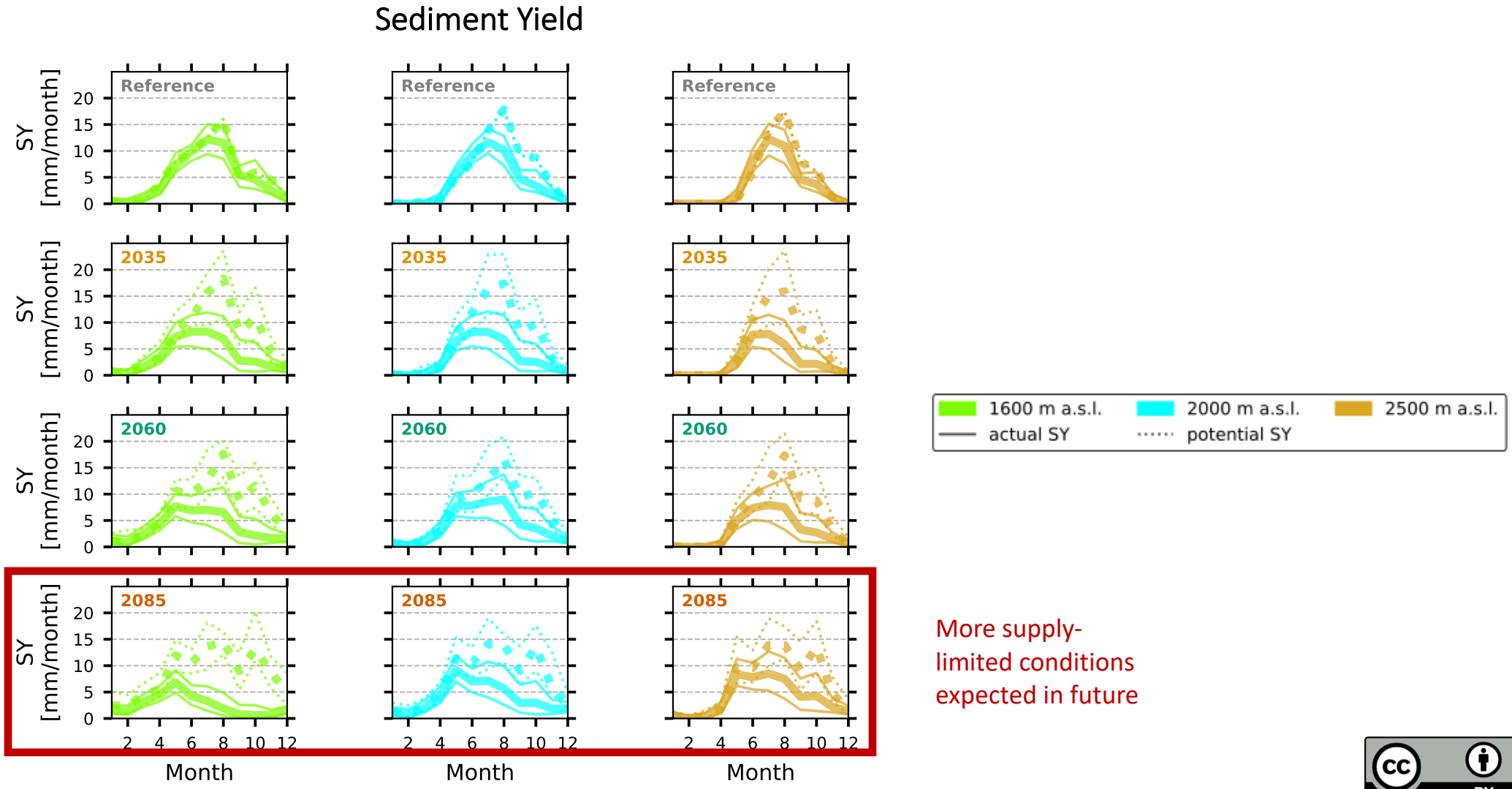
Landslides (LS) fill the channel sediment storage as a result of frost weathering

Depending on the sediment available in the channel storage, a debris flow (DF) is triggered if a critical discharge is exceeded

Results (1): Debris-flow occurrence is expected both to increase and decrease, dependent on mean catchment elevation



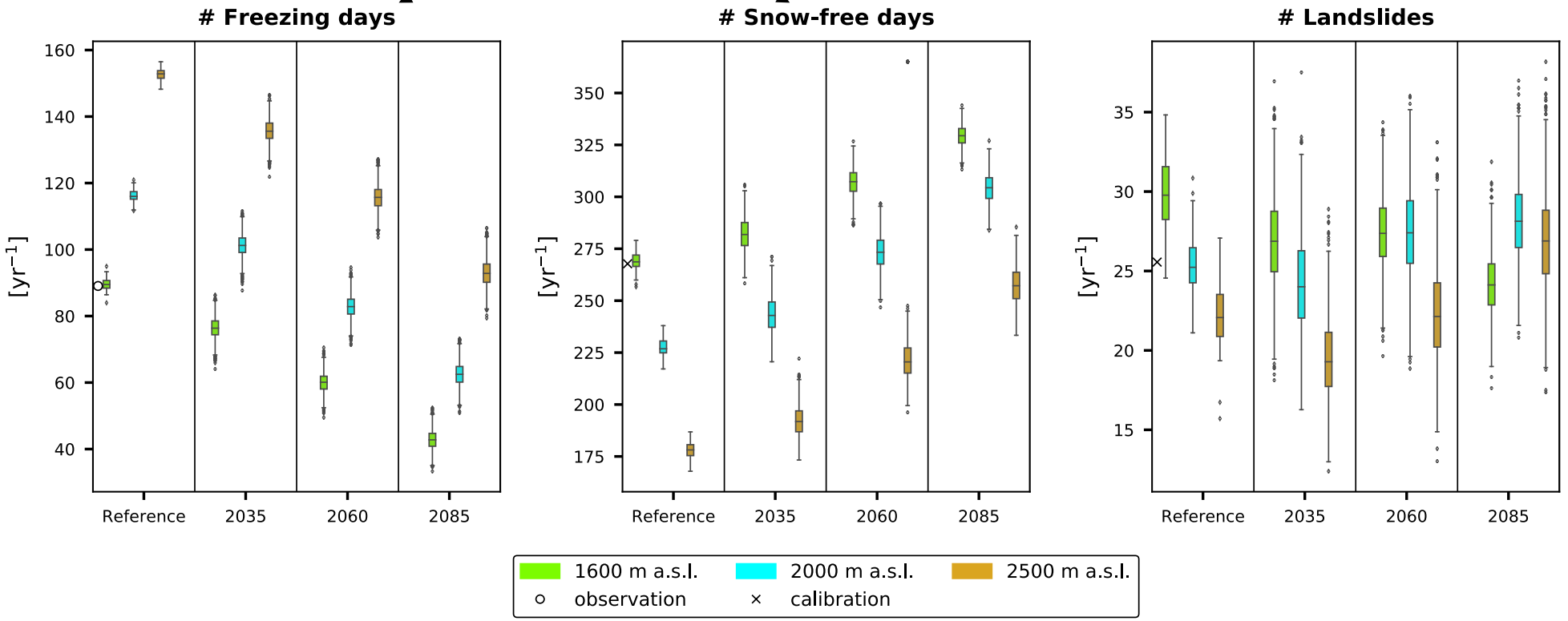
Results (2): Potential sediment yield is expected to increase at all elevations, but is constrained by sediment availability



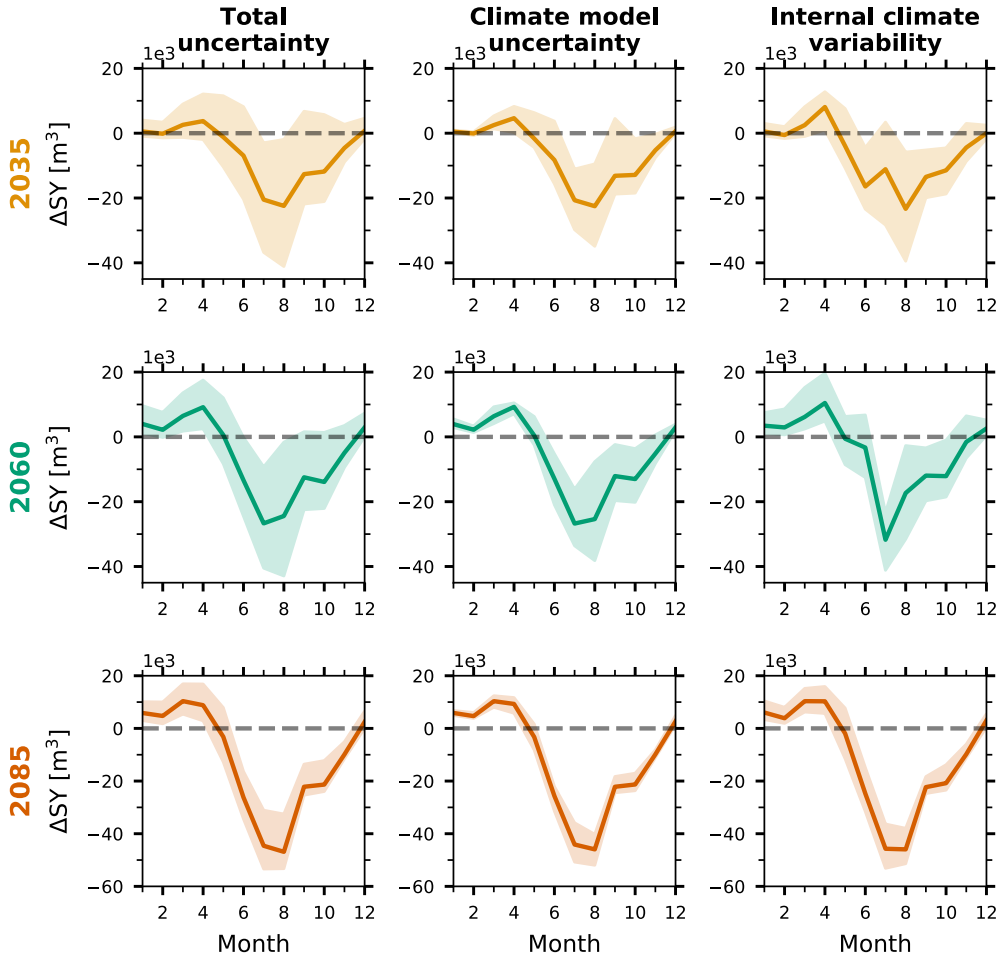
More supply-limited conditions expected in future

Results (3): Different developments at different elevations is explained with the conditions for sediment production

Conditions for landslide triggering
(i.e. sediment production)



Results (4): Total uncertainties are dominated by internal climate variability (stochastic uncertainty), but changes are significant at the end of the century



ΔSY: absolute change in sediment yield with respect to the reference period

Conclusions

- For the Illgraben basin, under RCP8.5, **potential sediment yield and debris flows are expected to increase (+48%)** due to a longer season and more intense rainfalls
- The increase is prohibited by **sediment production** by frost-weathering, which **may decrease at lower** and **increase at higher** elevations
- Uncertainties are dominated by internal climate variability (stochastic uncertainty), making it **difficult to recognize significant changes** before the end of the century
- A further important uncertainty is the assumption of sediment production mechanism by frost weathering and it's parameterization
- Paper in prep for JGR: Earth Surface
- Don't hesitate to contact me: jacob.hirschberg@wsl.ch