RECENT PATTERNS OF DISCHARGE AND SEDIMENT OUTPUT OF THE GORNER GLACIER, SWITZERLAND

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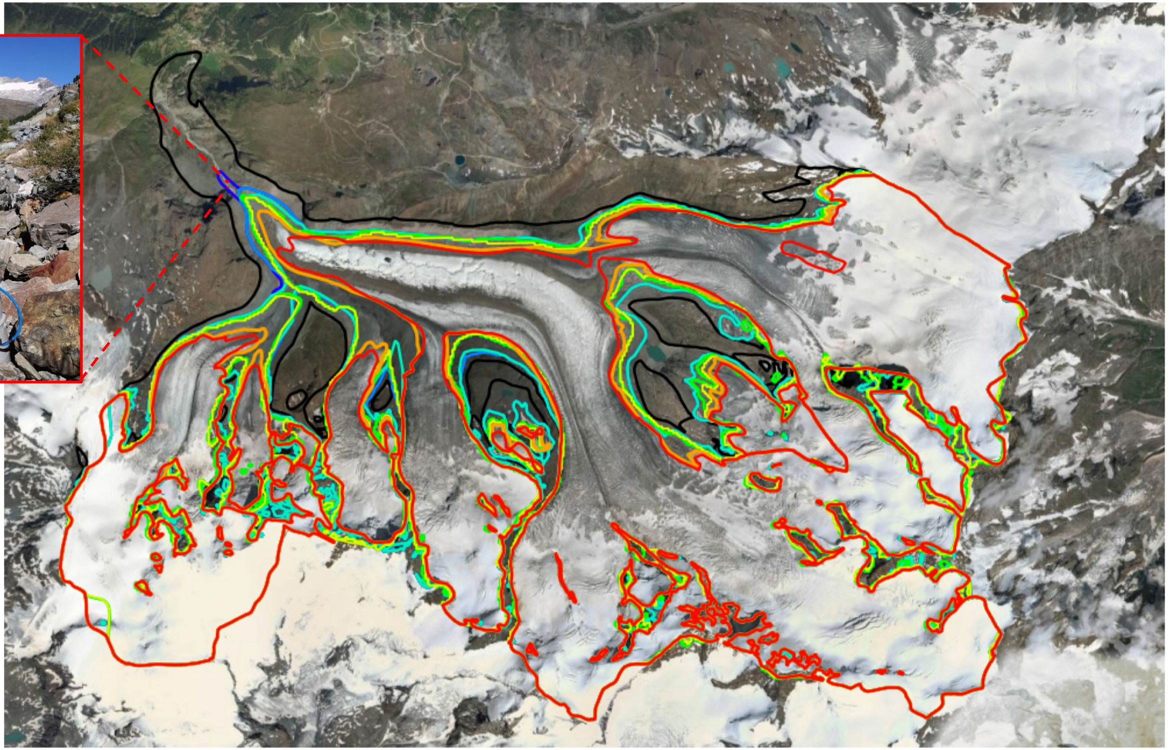
LOCATION

- Second-largest glacier system in the European Alps; glacier area ca. 50 km^2
- Pump sampler located approximately 750 m down-valley of current terminus



Glacier extent

- 1850
- 1973
- 1985
- 1992
- 1998
- 2003
- 2009
- 2018

Data source: GLIMS (analysts Mauro and Fischer) and own mapping

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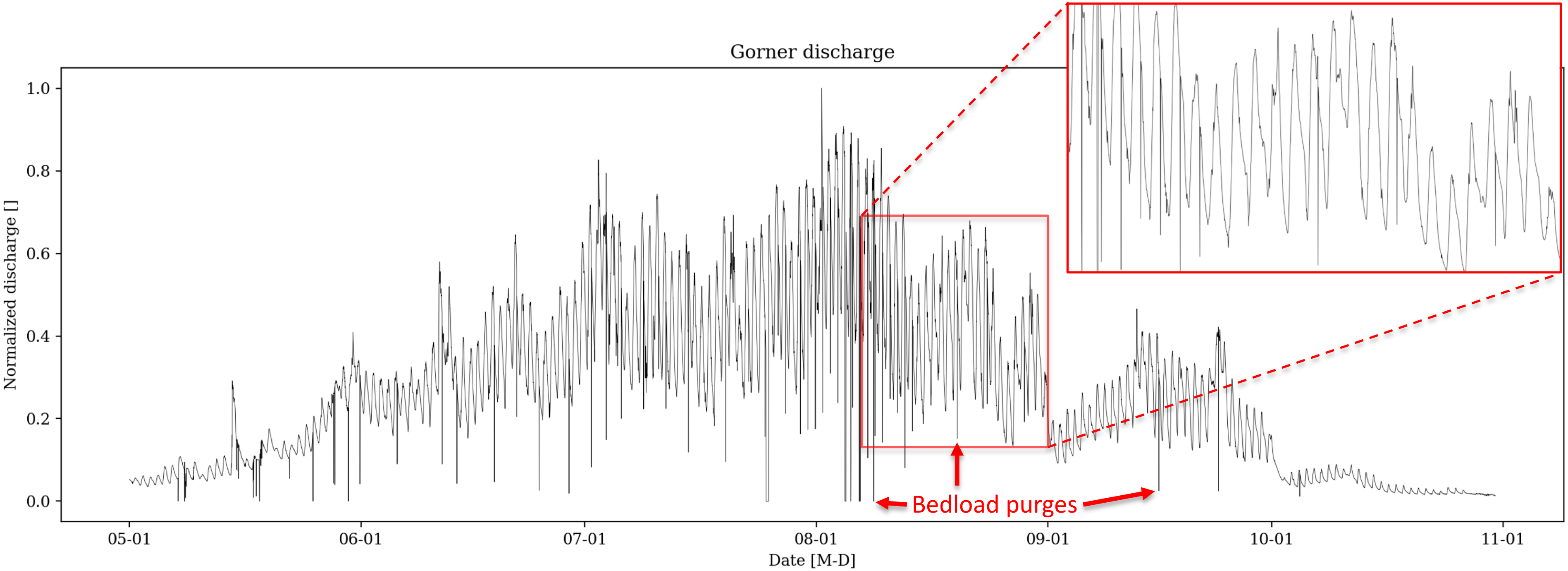
DISCHARGE

- Discharge measured at hydropower water intake ca. 1 km below terminus
- Emptying of bedload trap causes discharge drops in record
- Emptying signature removed by automated identification and interpolation of steep drops in discharge



Data source: Hydro Exploitation SA

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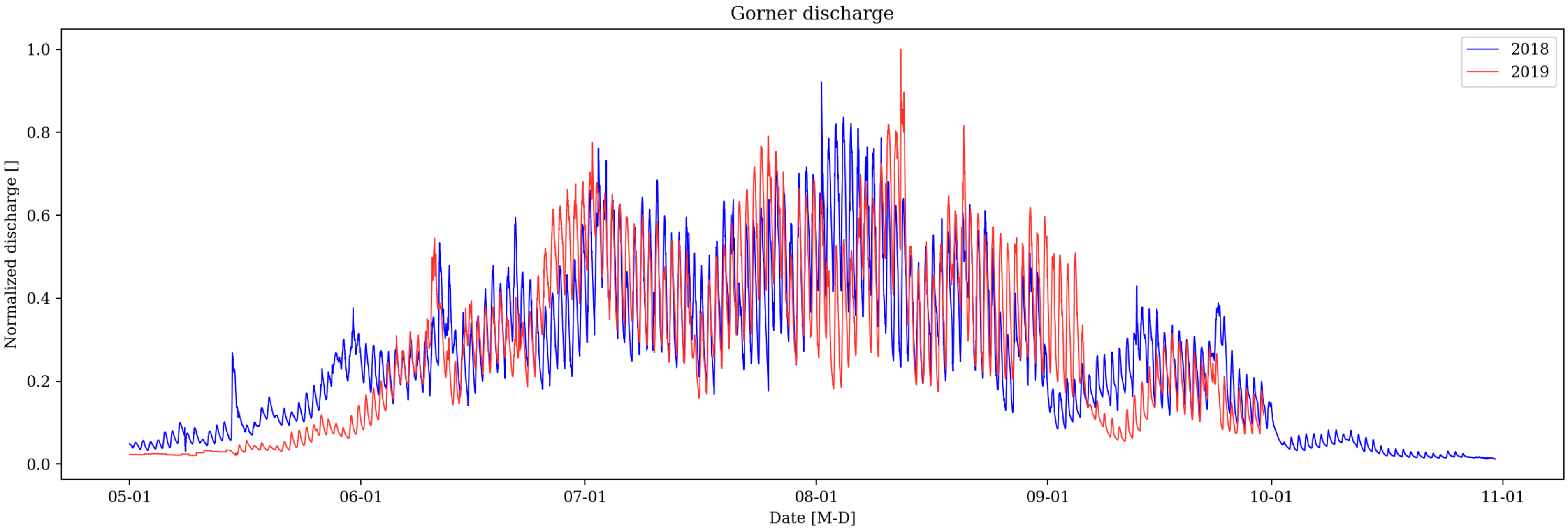
DISCHARGE

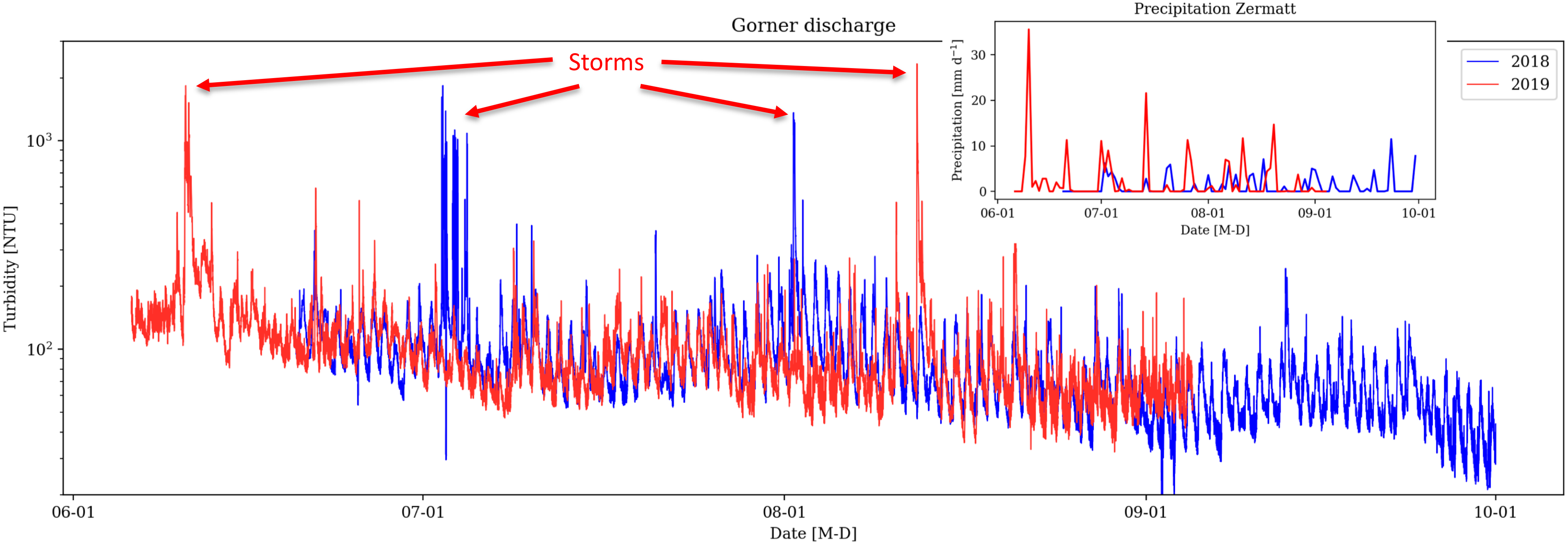
- Discharge of 2018 and 2019 with signature of bedload purges removed
- Strong seasonal and diurnal discharge pattern
- Diurnal discharge amplitude increases from May to August: faster hydrologic response



Data source: Hydro Exploitation SA

TURBIDITY

- At the sampling station, turbidity was measured in a 5 minute interval over the summers of 2018 and 2019
- Storms occurring on the background melt cycles generally produce the highest discharges, leading to the highest turbidity



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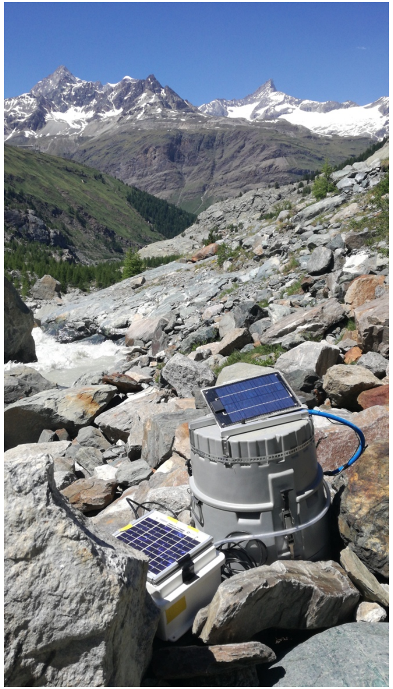
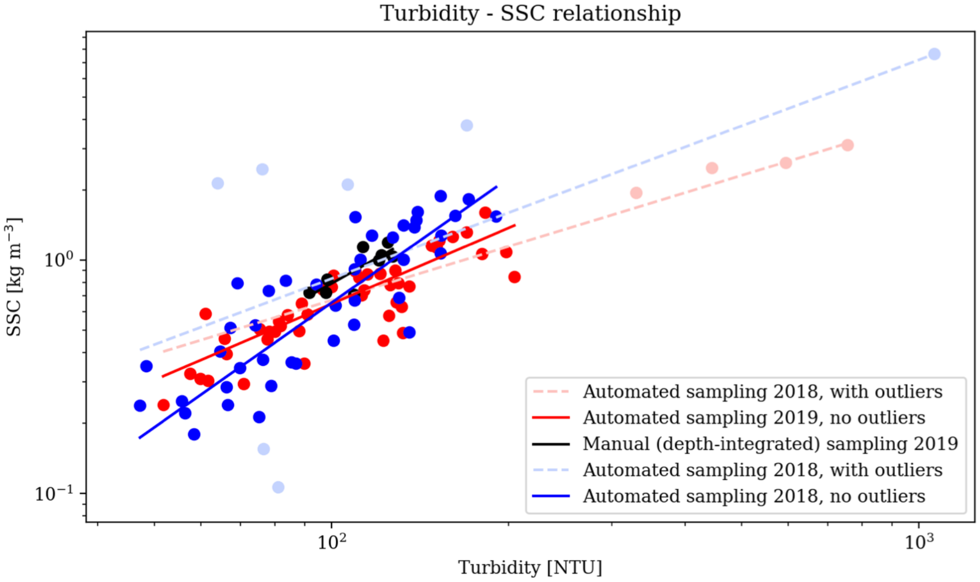
SUSPENDED SEDIMENT

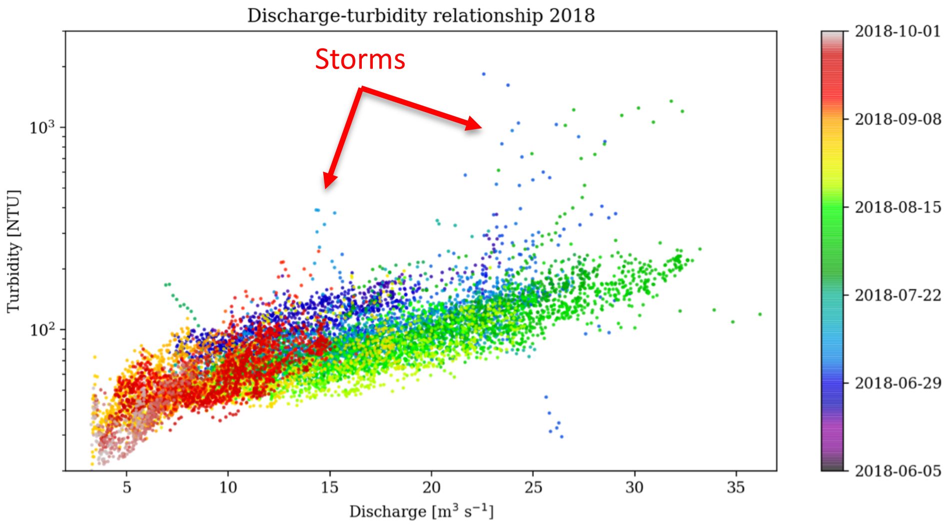


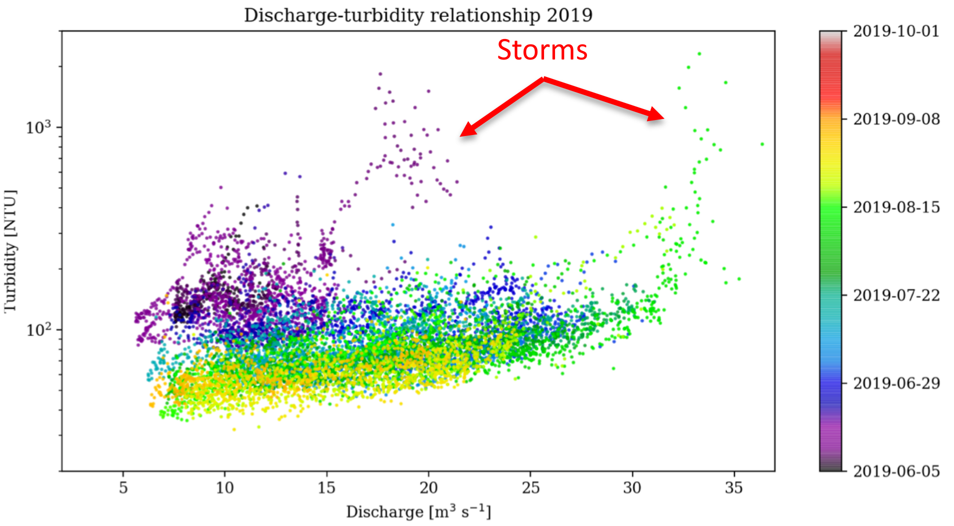
- In addition to measuring turbidity, water samples were taken automatically every day at 19 h at the sampling station to obtain a turbidity-suspended sediment concentration (SSC) rating curve. A power-law was fitted to the turbidity-SSC data.
- Further, automated samples taken at uniform depth were complimented by manually-taken depth-integrated samples in 2019 for comparison



SEASONAL TURBIDITY-DISCHARGE PATTERN

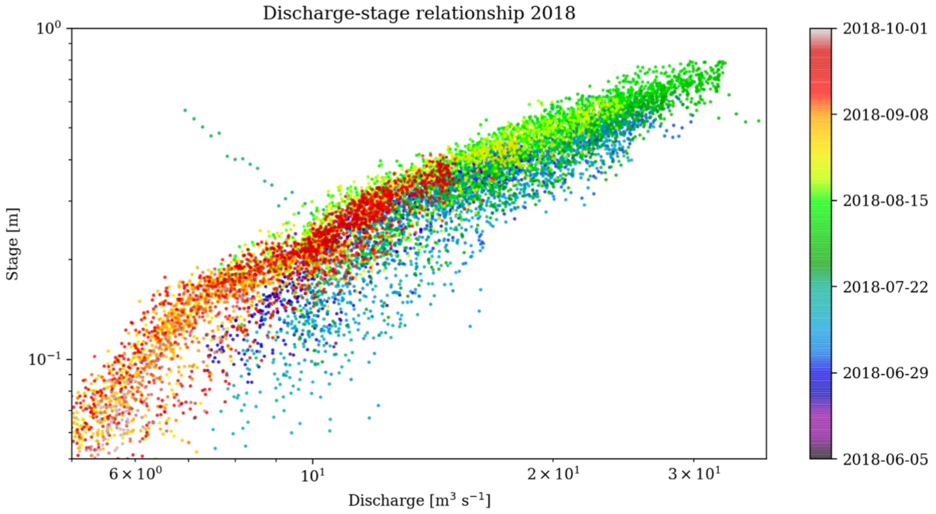
- Combining discharge with turbidity data shows a seasonal pattern with turbidity at similar discharge decreasing during the summers of 2018 and 2019.
- The relationships between discharge and turbidity seem to differ between years
- Exhaustion of sediment supply through the melt season (except September 2018)
- Deviating storm patterns suggest activation of different sediment sources

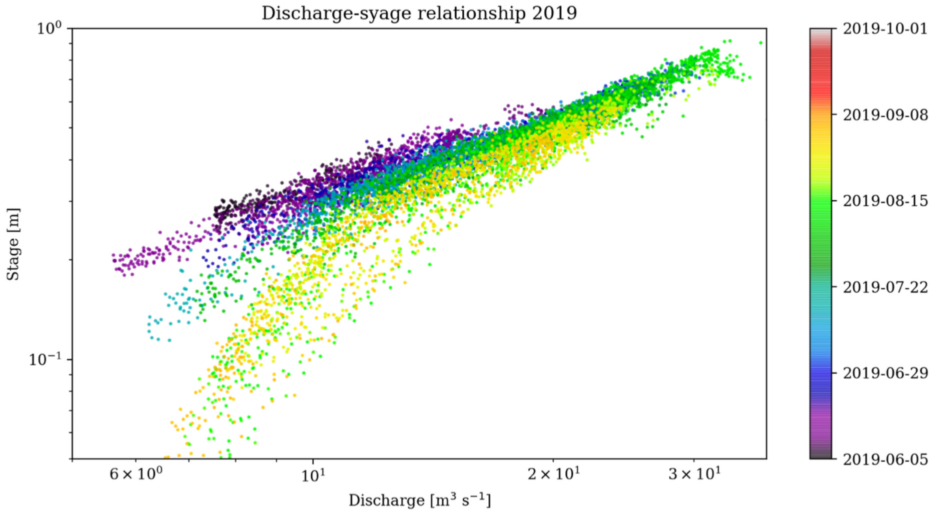




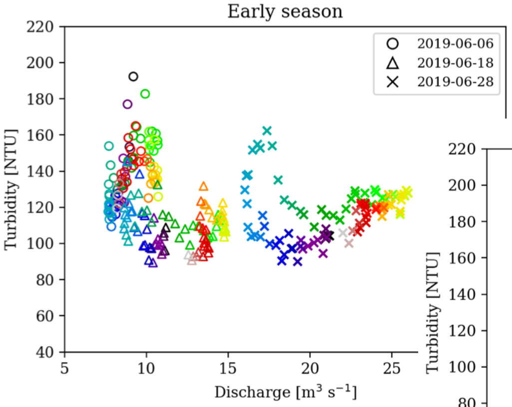
SEASONAL TURBIDITY-STAGE PATTERN

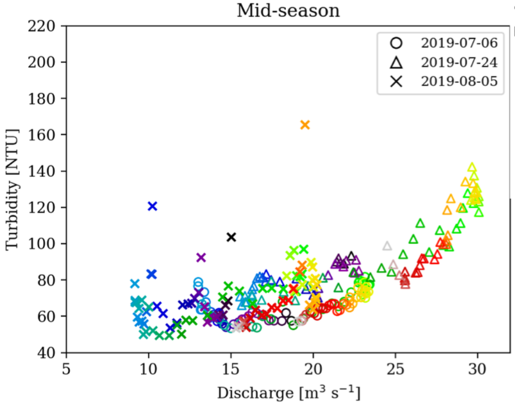
- In addition to turbidity, stage (i.e. water level above the sensor) was also measured at the sampling station
- Stage changed for similar discharge during the season, particularly in 2019, which indicates an unstable channel section.
- Part of the observed seasonal changes in turbidity are likely linked to changes in the measurement depth.

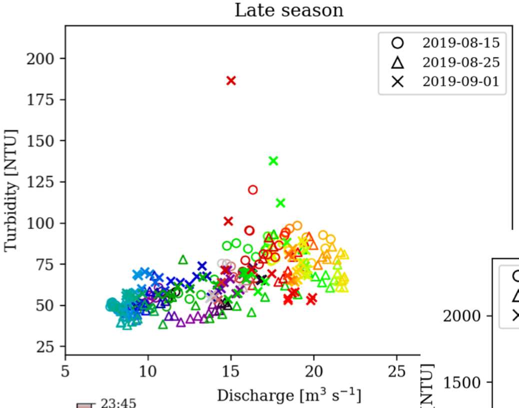


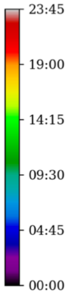


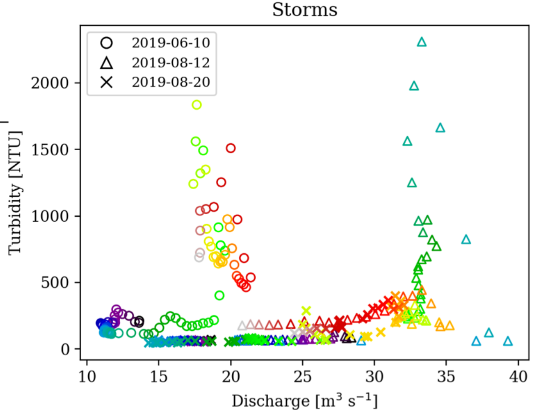
DAILY TURBIDITY-DISCHARGE PATTERN 2019







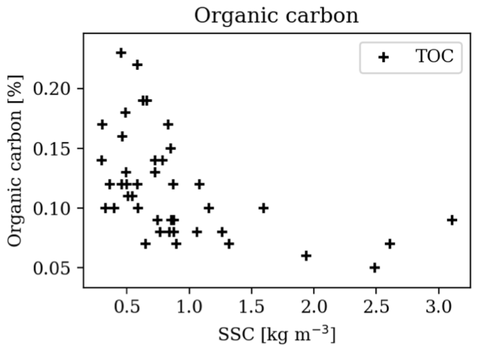


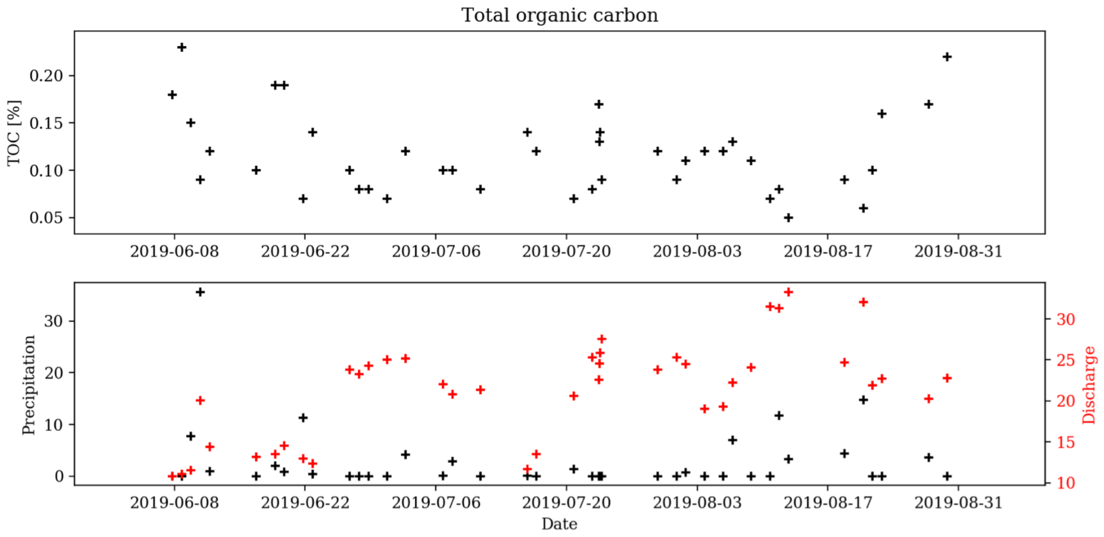


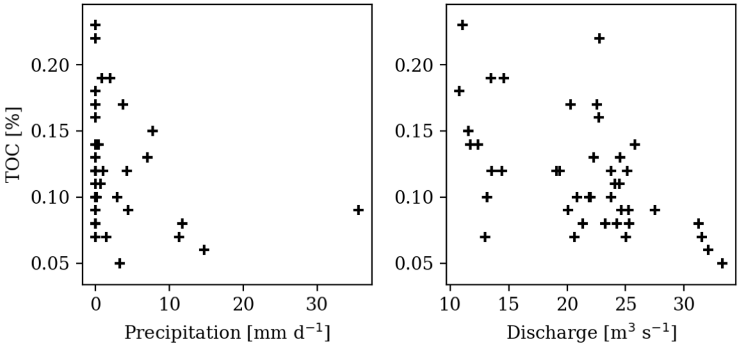
- The daily discharge-turbidity pattern changes over the season.
- In early summer, highest turbidity occurs during the night or in early morning and not at highest discharge
- Mid-summer, highest turbidity occurs at or shortly after highest discharge
- In late summer, highest turbidity occurs after highest discharge at the station
- Storms produce marked turbidity peaks which seem to be “independent” of discharge

ORGANIC CARBON

- Organic carbon content in the suspended sediment samples was measured to inform about the sediment source (high TOC -> soil, low TOC -> rock)
- Total organic carbon content is generally very low (mostly below 0.2 %)
- TOC seems to decrease with increasing precipitation, discharge and suspended sediment concentration
- Sediment sources activated by storms may still be sediment from glacial erosion







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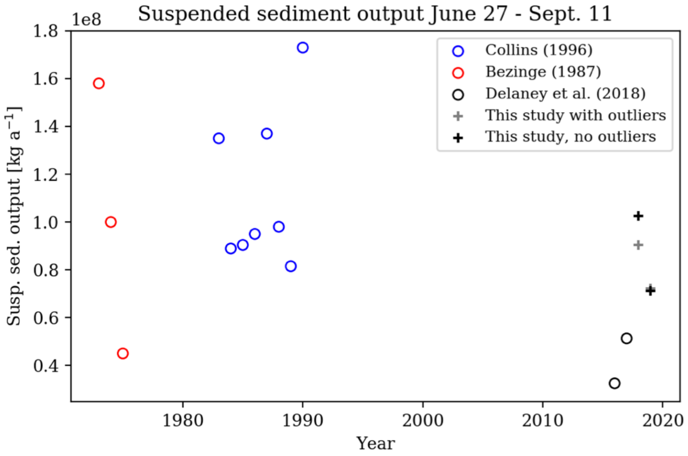
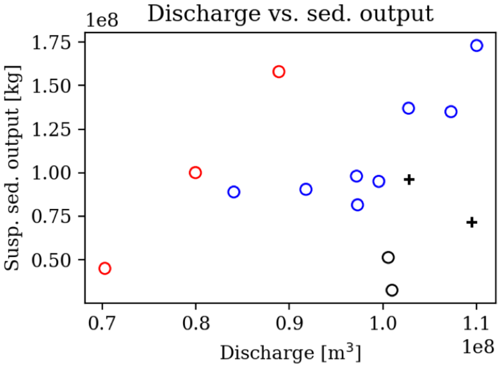
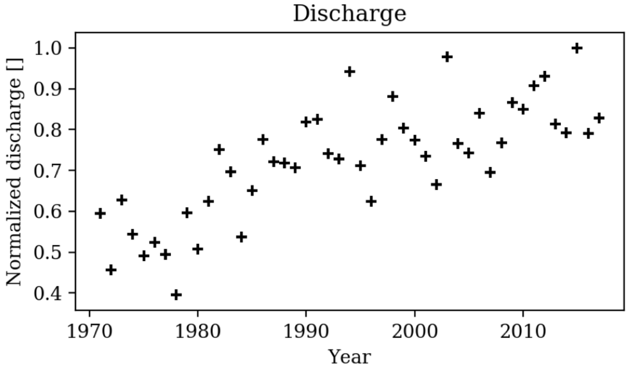
SUSPENDED SEDIMENT OUTPUT

- Suspended sediment output during the observation periods in 2018 and 2019 was derived by inferring the SSC timeline from the turbidity-SSC rating curve and multiplying with discharge.
- During the observation periods in 2018 and 2019, between 1.06×10^8 kg and 1.15×10^8 kg, and 0.88×10^8 kg and 0.92×10^8 kg of suspended sediment left the Gorner catchment, respectively.
- Comparison with other suspended sediment output data from the Gorner for the period June 27 to September 11 shows no long-term trend since 1970s
- While discharge increased since the 1970s, suspended sediment output did not.
- Suspended sediment output over the longer term seems to be widely independent of discharge







LET'S CHAT!

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