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Contrasting energy-balanced based snowmelt runoff estimates with isotopic hydrograph separation for a small arctic mountainous catchment in Svalbard

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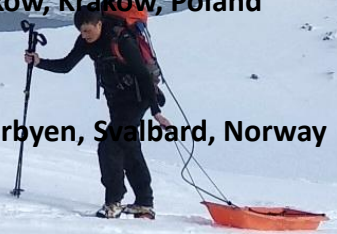


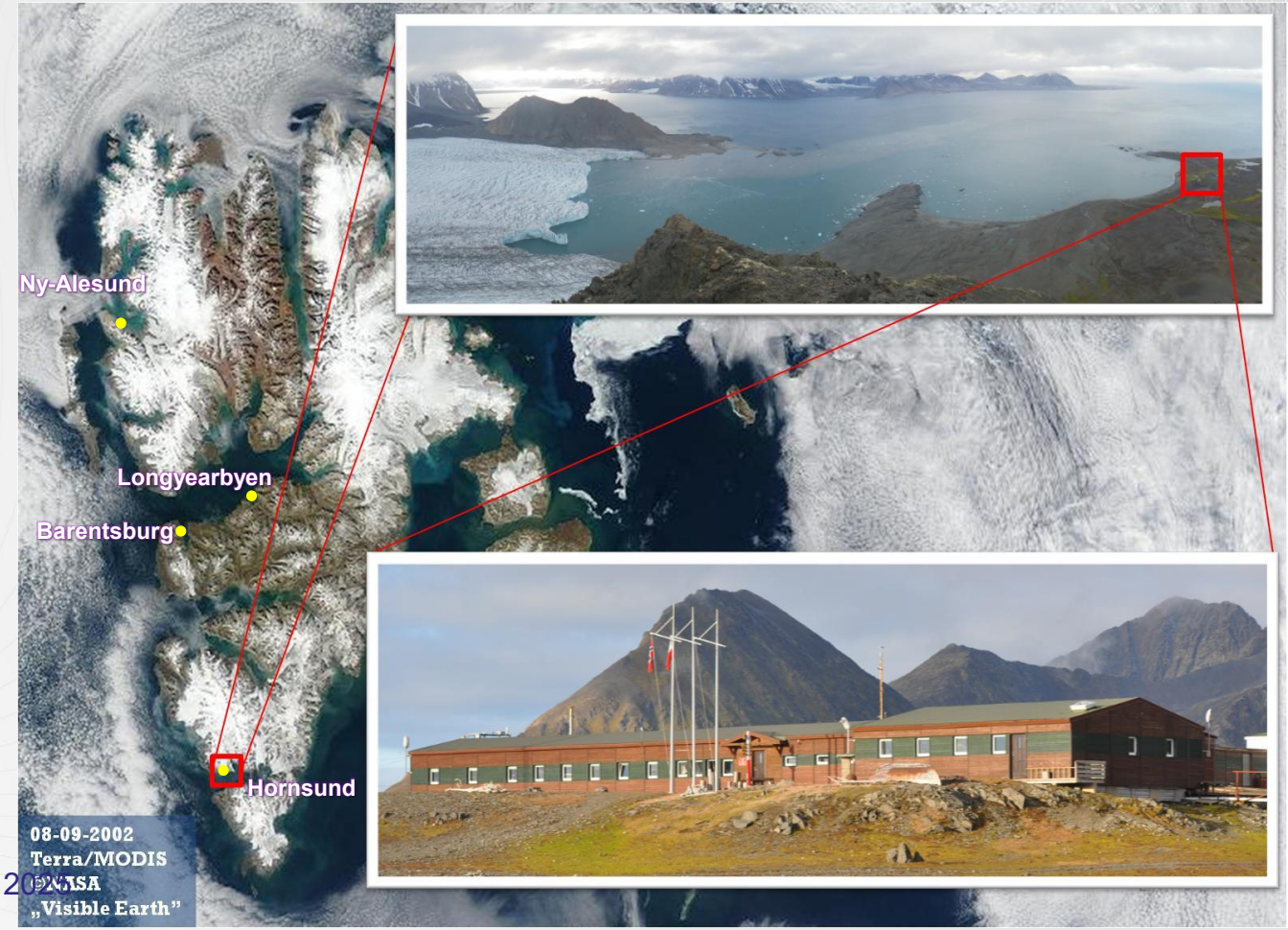
Polish Polar Station Hornsund

Founded in 1957 (International Geophysical Year)

Operates year-round since 1978

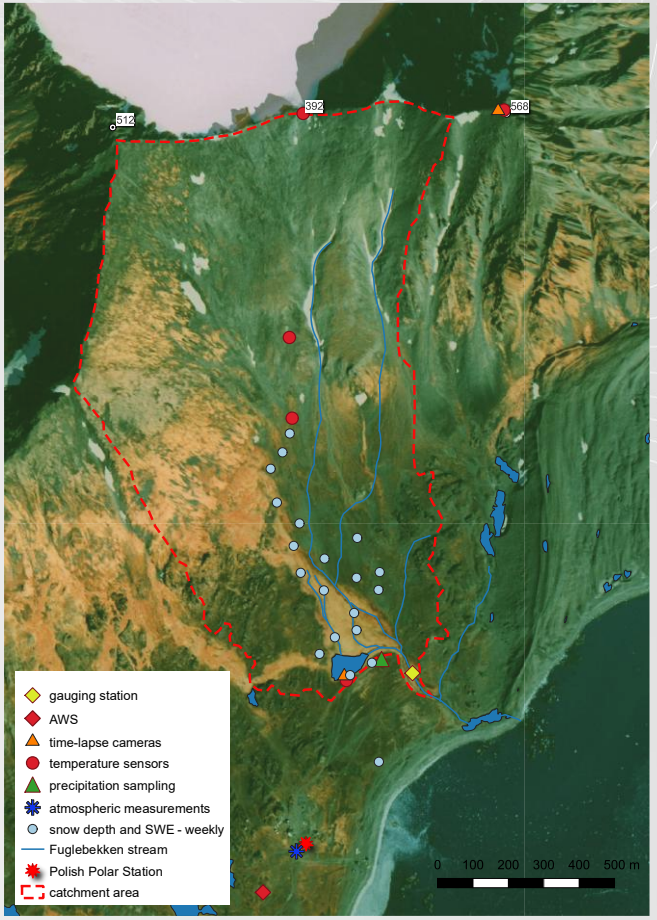
One of four permanent settlements in Spitsbergen

Only year-round operated Research Infrastructure in SW Spitsbergen



Fuglebekken catchment

F = 1.28 km^2
H = 3 – 500 m



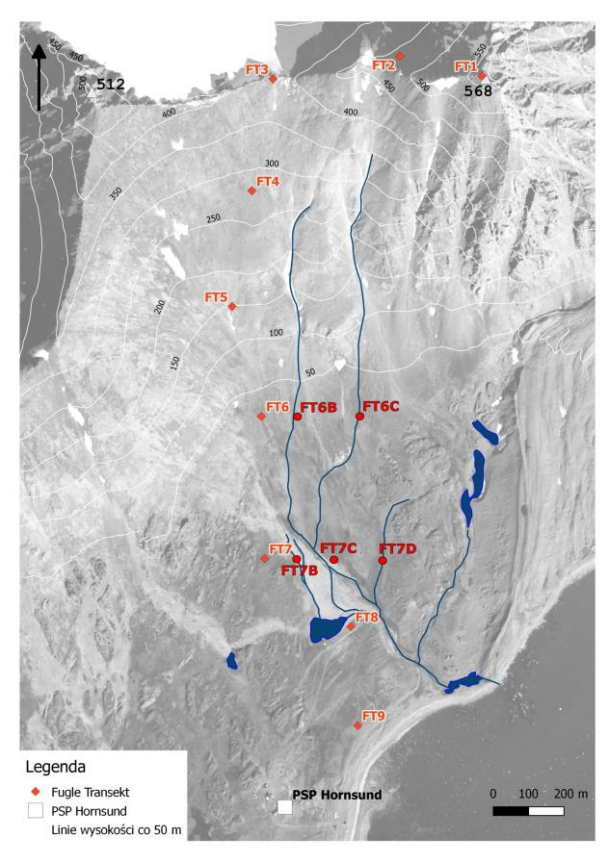
- SWE distribution monitoring
- fresh snowfall and precipitation sampling
- Hydrological monitoring
- Hydrochemical monitoring
- permafrost monitoring – 3 boreholes
- 6 piezometers
- Time-lapse camera
- nearby WMO meteorological station

Fuglebekken catchment isotopic sampling campaign 2024

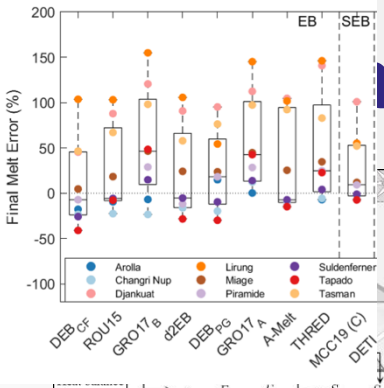
- Time period: 08.05.2024 – 24.09.2024
- Fuglebekken river runoff - daily
- Precipitation – event based
- Snow: 2 snowpits by layers 13.05 and 07.06
- Snow from the surface in 12 points

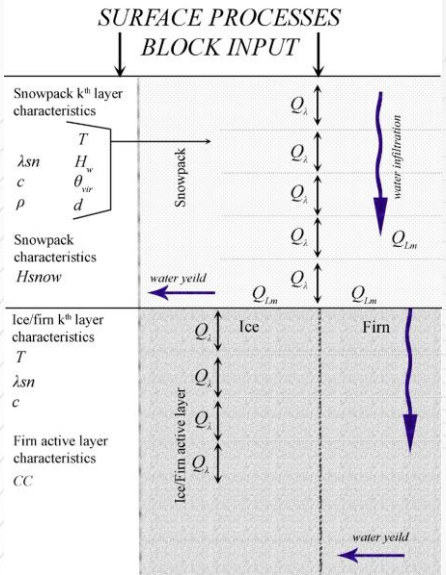
across the watershed 08.05, 14.05

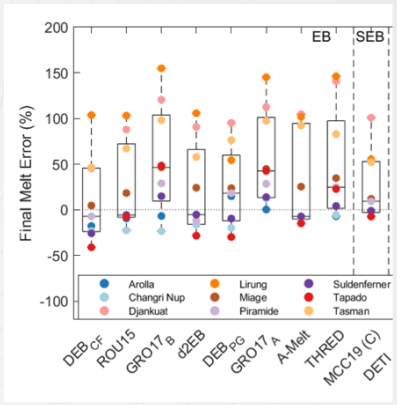
- Sampling from 6 piezometers 2-6 times during season

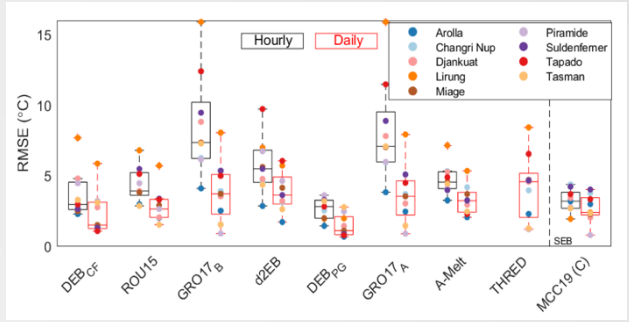


nowmelt modelling: A-Melt model (1/2)









- A-Melt model performance compared to other energy-balance models withing the DCG-MIP Experiment of the Debris-Covered Glacier Working Group of the IACS (Pellicciotti et al., 2025)

Snowmelt modelling: A-Melt model (2/2)

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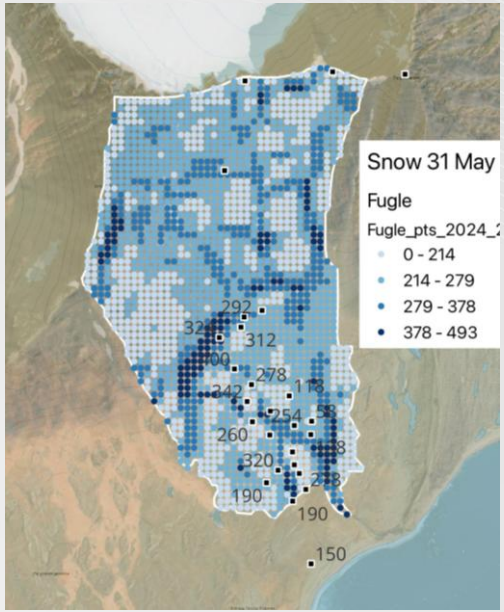
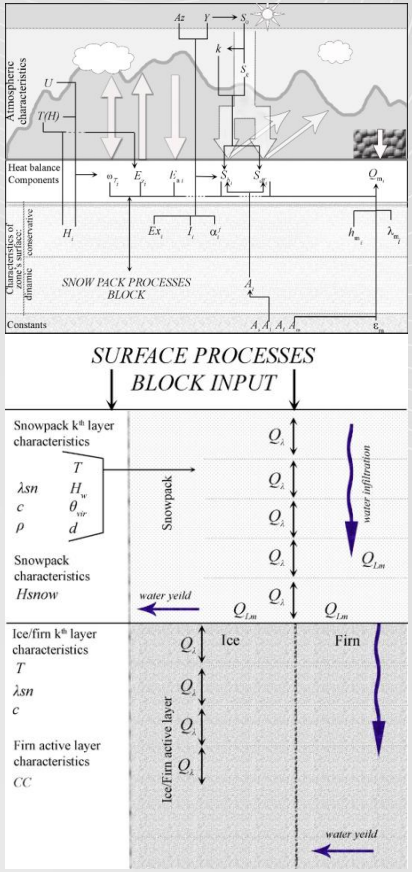
Input: - Radiation, Temperature, Precipitation, Air humidity, Wind speed from the Hornsund WMO station

- Snow depth in 26 points around the basin
- Density measurements
- Verified against time-lapse photos





Research Article

Simulation of mass balance and glacial runoff of Mount Elbrus from 1984 to 2022

Nelly Elagina, Ekaterina Rets, Irina Korneva, Pavel Toropov & Ivan Lavrentiev

Pages 1929-1949 | Received 06 Jun 2024, Accepted 12 May 2025, Accepted author version posted online: 05 Jun 2025, Published online: 07 Jul 2025

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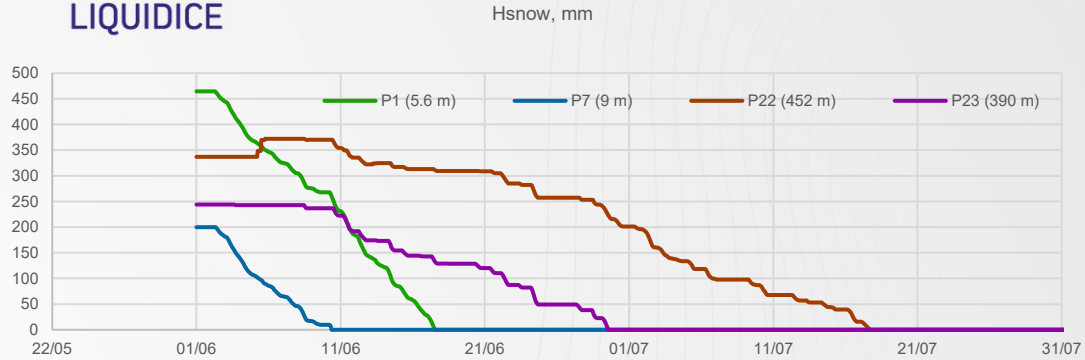
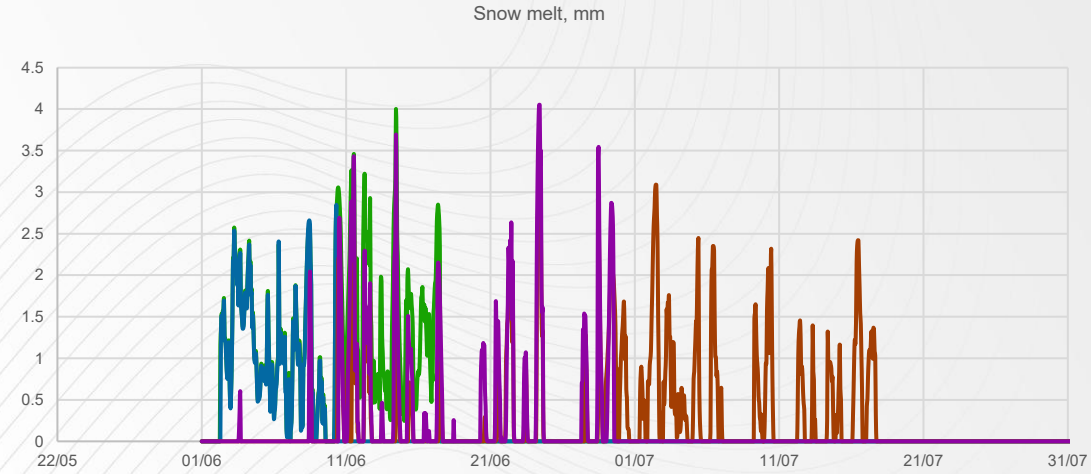
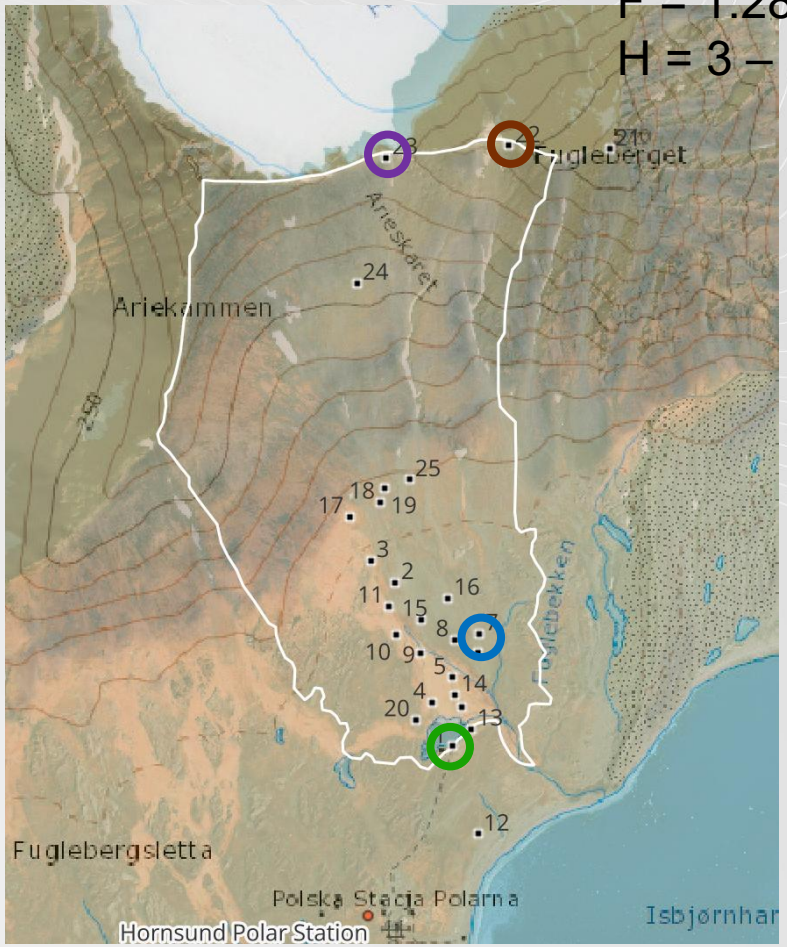
Snowmelt variability across the cathment



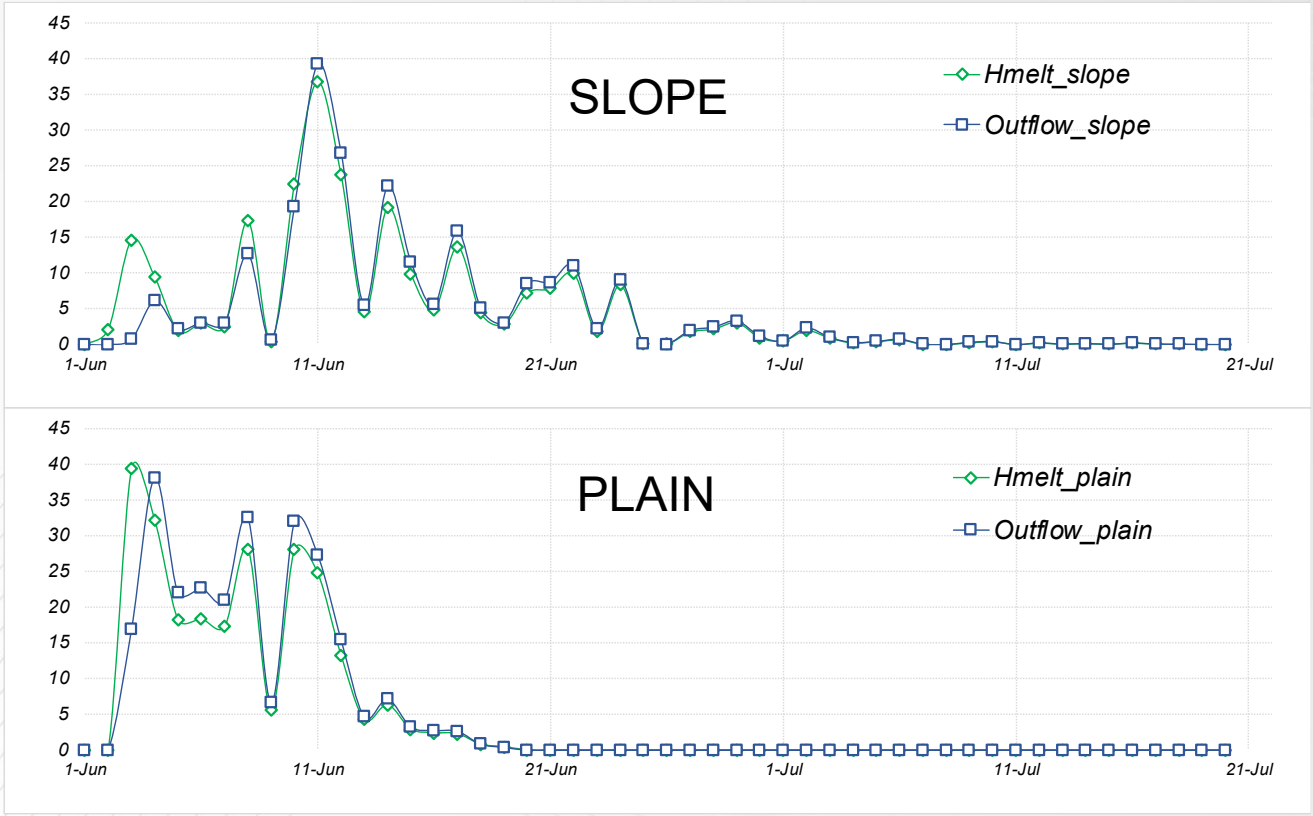


F = 1.28 km^2
H = 3 – 500 m

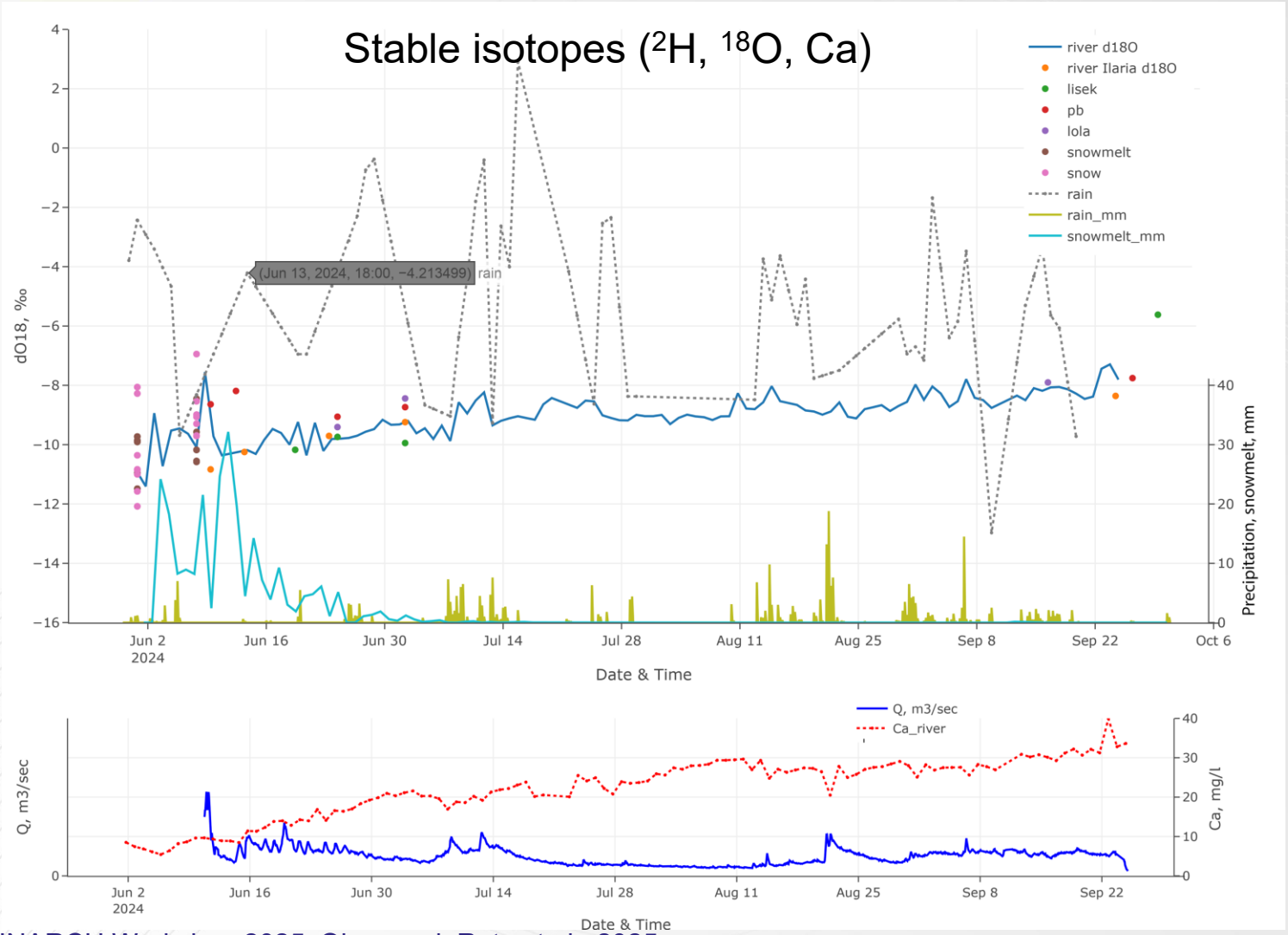


INARCH Workshop 2025, Obergurgl, Rets et al., 2025

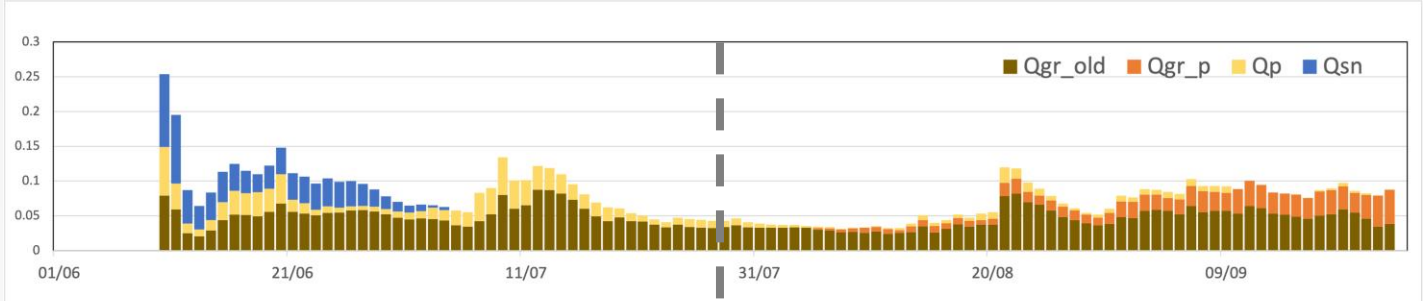
Snow melt rate vs. Snowpack outflow

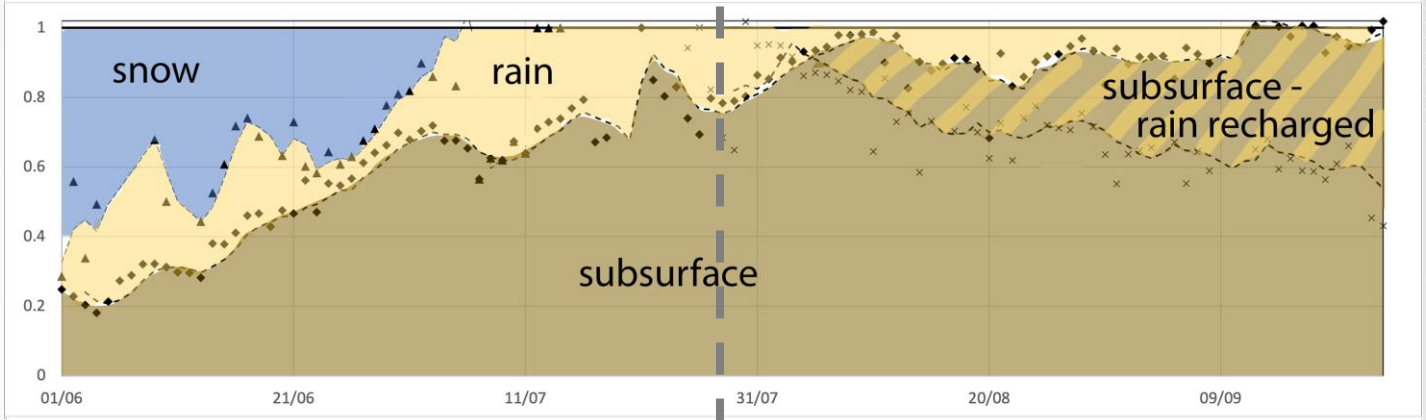


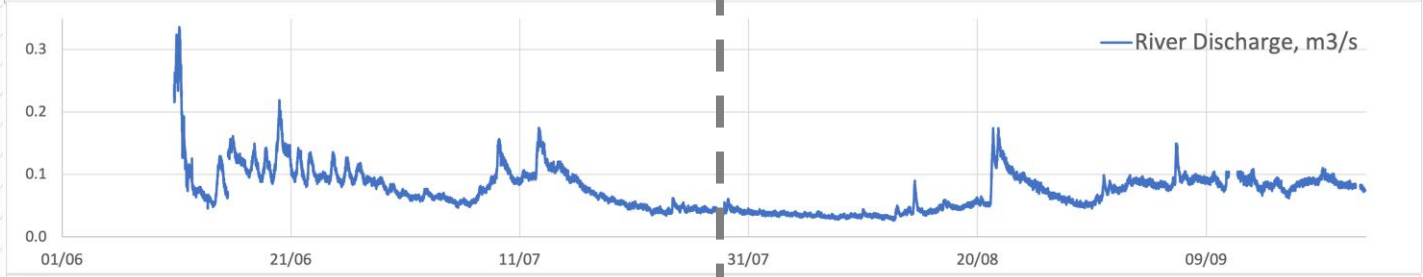
Results (1/3)

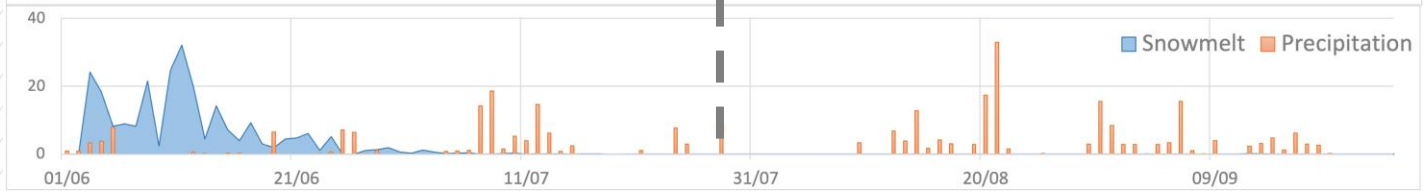

Stable isotopes (²H, ¹⁸O, Ca)
river d18O
river Ilaria d18O
lisek
pb
lola
snowmelt
snow
rain
rain_mm
snowmelt_mm
(Jun 13, 2024, 18:00, −4.213499) rain
dO18, ‰
Precipitation, snowmelt, mm
Date & Time
Q, m3/sec
Ca_river
Ca, mg/l
Jun 2
2024
Jun 16
Jun 30
Jul 14
Jul 28
Aug 11
Aug 25
Sep 8
Sep 22
Oct 6

Results (2/3)


Qgr_old
Qgr_p
Qp
Qsn
0.3
0.25
0.2
0.15
0.1
0.05
0
01/06
21/06
11/07
31/07
20/08
09/09


snow
rain
subsurface -
rain recharged
subsurface
1
0.8
0.6
0.4
0.2
0
01/06
21/06
11/07
31/07
20/08
09/09


River Discharge, m3/s
0.3
0.2
0.1
0.0
01/06
21/06
11/07
31/07
20/08
09/09


Snowmelt
Precipitation
40
20
0
01/06
21/06
11/07
31/07
20/08
09/09

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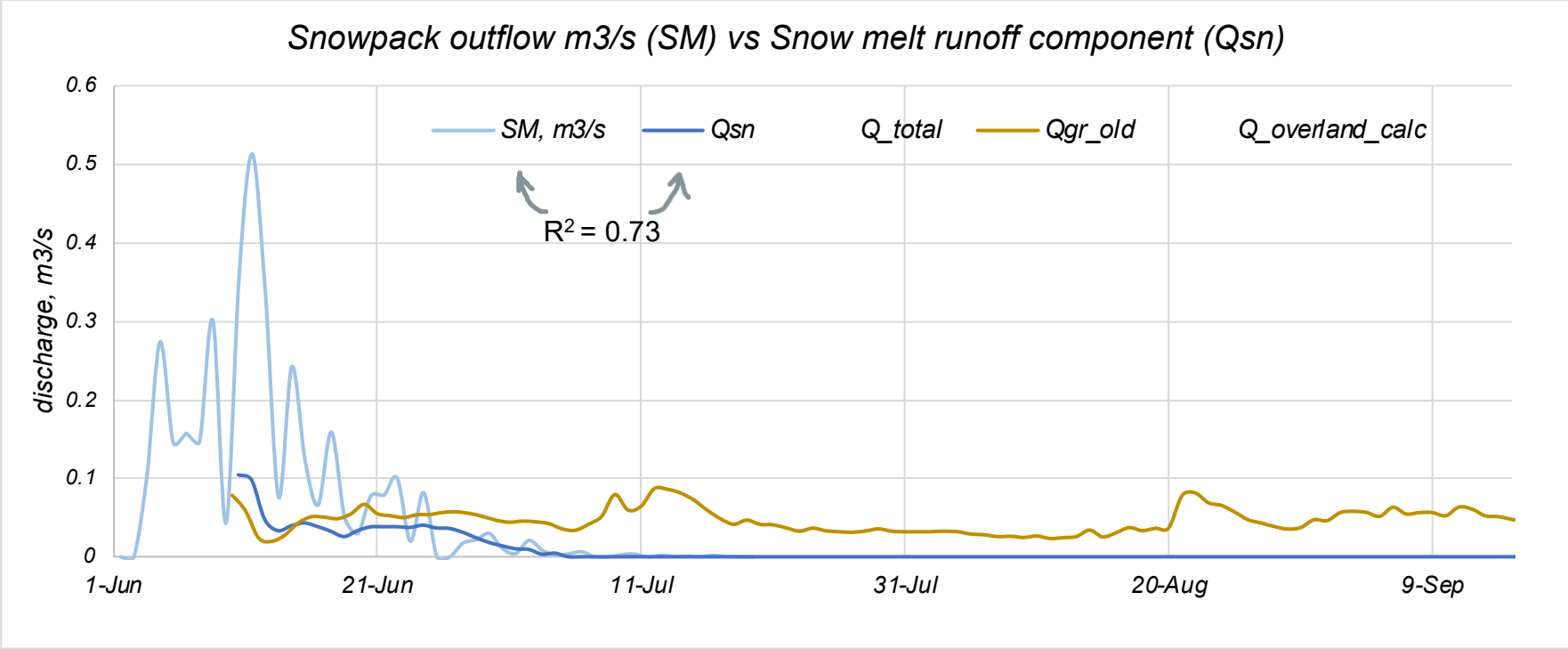
Snow melt yield in m^3/s (SM) vs. Snow melt runoff component (Q_{sn})



Conclusions

- Half of the snowmelt water, at the lowest estimates, is drained through the subsurface part of the basin
- After significant winter thaws, subsurface water bears snowmelt isotopic signal in the beginning of the summer season
- Rain groundwater recharge component becomes considerable from the end of July – beginning of August and gradually rises up to 40% by the end of September

If you have any comments or questions, please reach out at erets@igf.edu.pl

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