From simple to realistic water supply to the subglacial hydrologic system at the Kongsfjord basin, Svalbard

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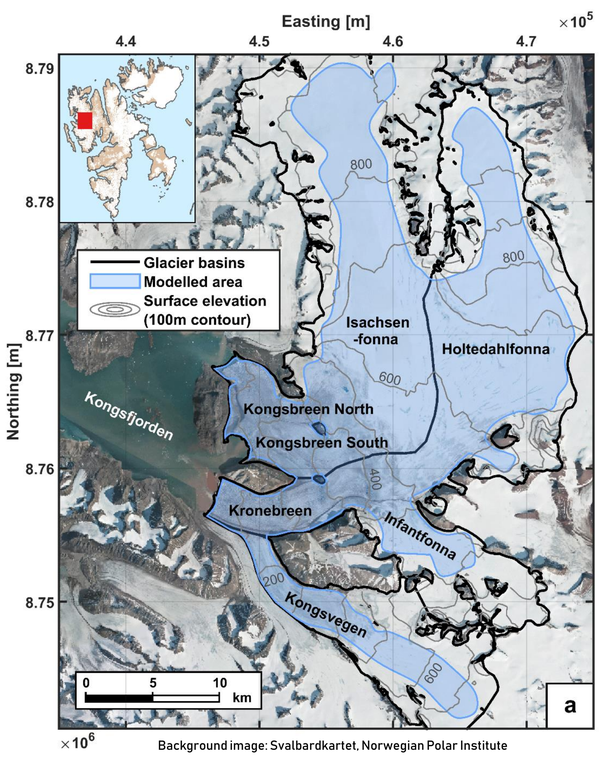
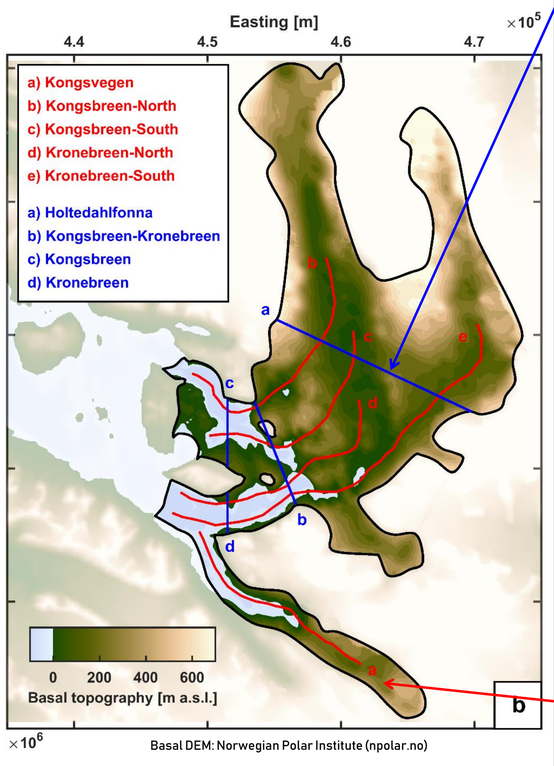
Motivation

- Increased surface runoff in response to atmospheric warming will likely affect glacier dynamics through basal sliding, which is modulated by the subglacial drainage system.
- Supraglacial hydrology, by regulating the amount, the timing and the spatial distribution of runoff delivery to the bed, potentially exerts a major control on the subglacial drainage system.
- Realistic representation of runoff access to the bed in subglacial hydrologic models is crucial to understand how ice dynamics respond to changes in runoff production in a warming climate.

Study area: the Kongsfjord glacier basin



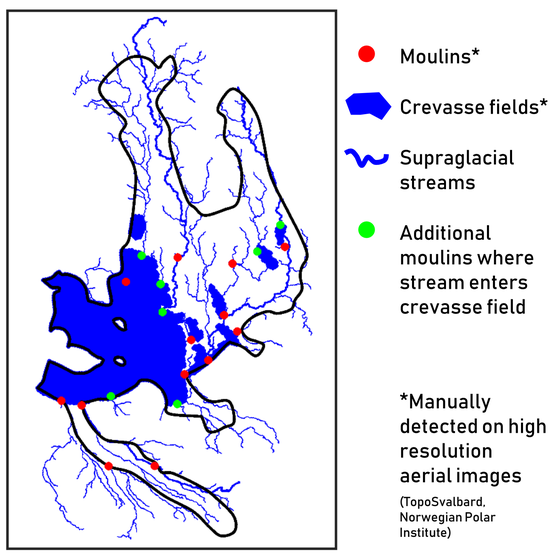


Mapping the supraglacial hydrology

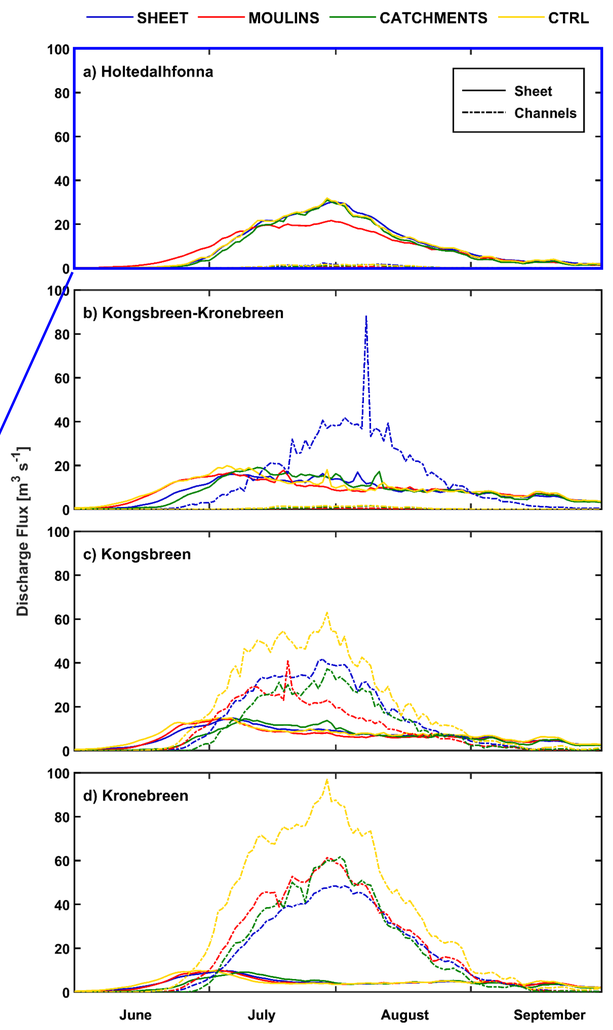
TopoToolbox (Schwanghart & Kuhn, 2012): program for flow pattern analysis in DEMs.

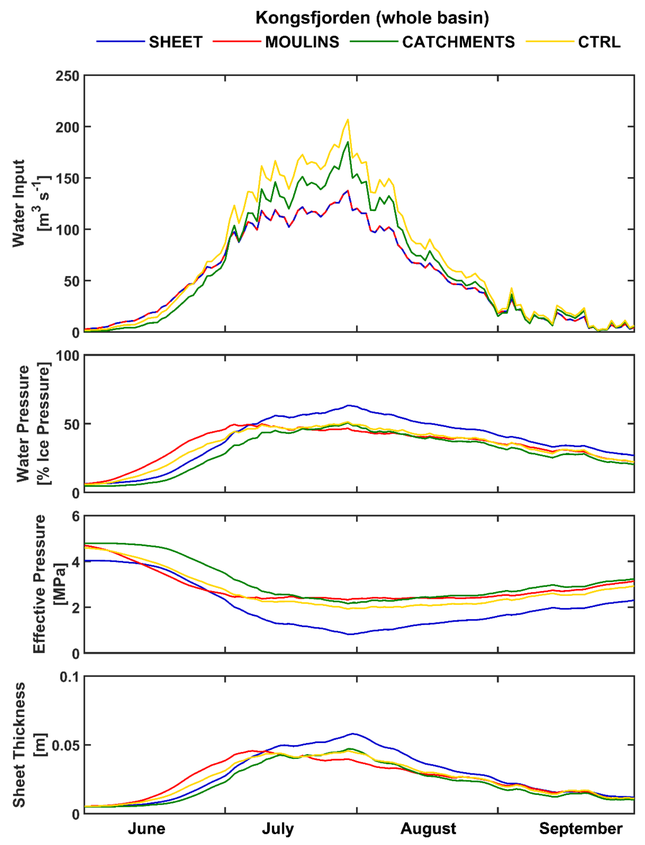
Input: 40x40m surface DEM

Outputs:
- Stream network (flow paths)
- Drainage basins (catchments)



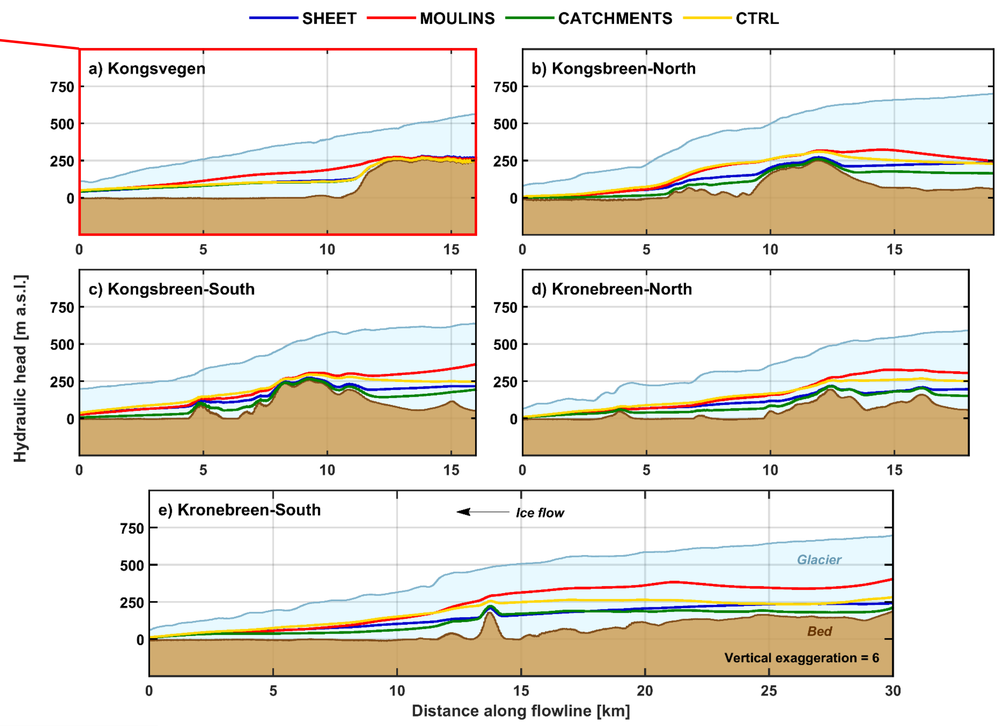
Results





Key findings

- In the accumulation area, drainage is dominated by the distributed (inefficient) system, regardless of water input scenario.
- In the ablation area, drainage is distributed at the start of the melt season, then channelized (efficient) drainage takes over. Timing of switch in hydrological regime depends on water input scenario ➔ implications for sliding.

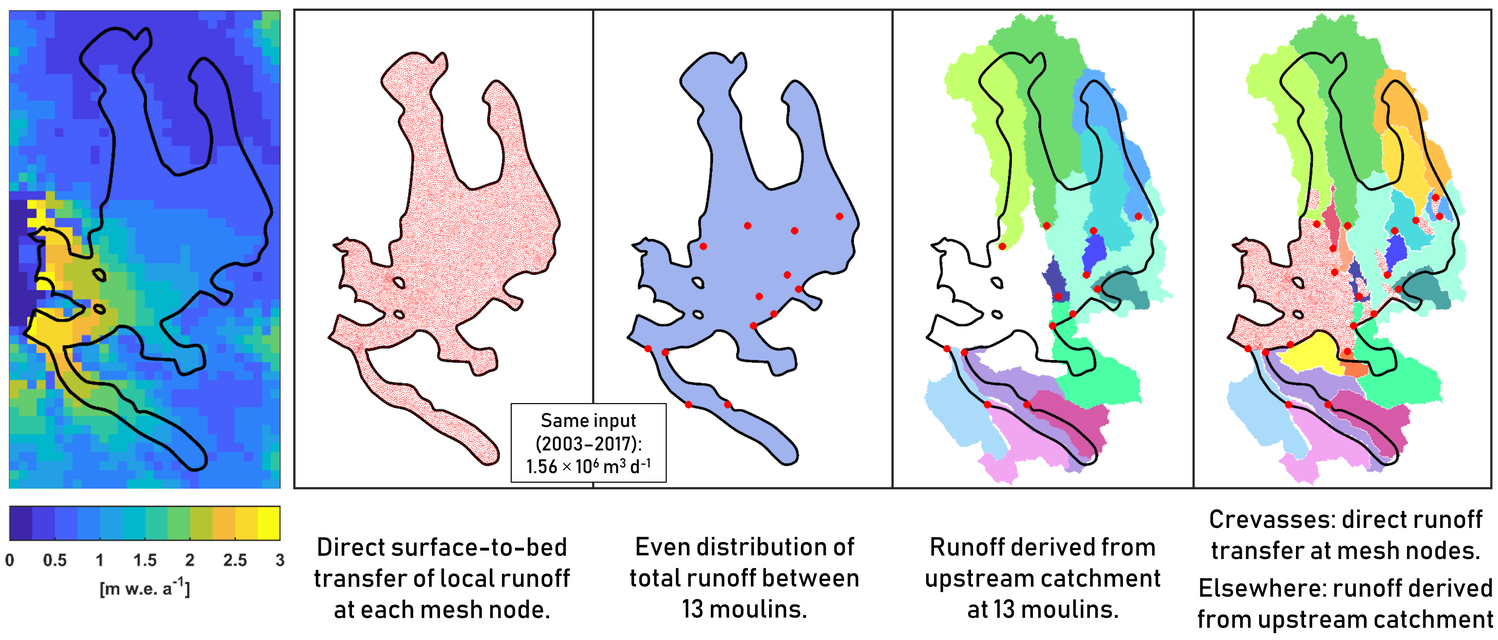


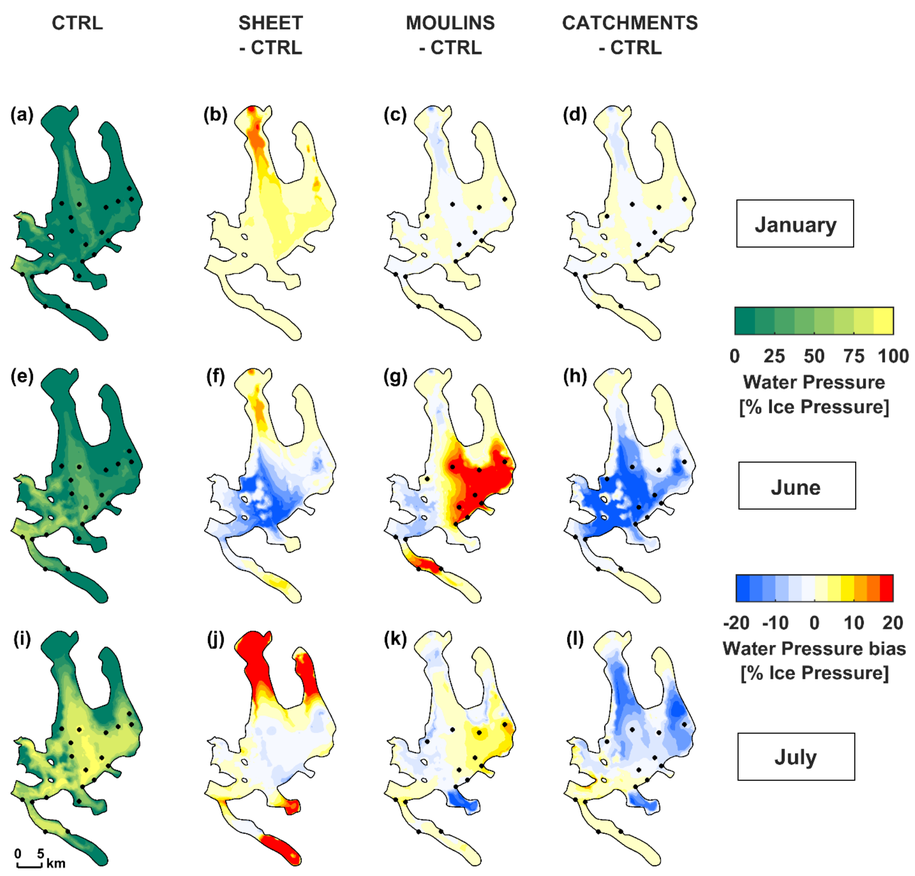
June (start of melt season)

Water supply to the subglacial hydrology model

- Subglacial drainage model: GlaDS (Werder et al., 2013)
- Water input: 1x1km runoff timeseries (2003–2017) generated by a coupled surface-energy-balance-snow model forced by the regional climate model HIRLAM (Van Pelt & Kohler, 2015).
- Runoff = surface meltwater + rain water – englacial storage (refreezing in firn).

Simplest to most realistic scenario





References

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