



Universität
Zürich ^{UZH}

Groundwater gradient dynamics in a boreal headwater catchment

jana.erdbuegger@geo.uzh.ch



Jana Erdbrügger, Kevin Bishop,
Ilja van Meerveld, Jan Seibert



Temporal & spatial variation in groundwater levels and gradients

- How do groundwater levels and gradients vary in time and space?
- How do groundwater levels and gradients change in response to precipitation and dry conditions?
- What is the best DEM resolution to replicate the groundwater surface?

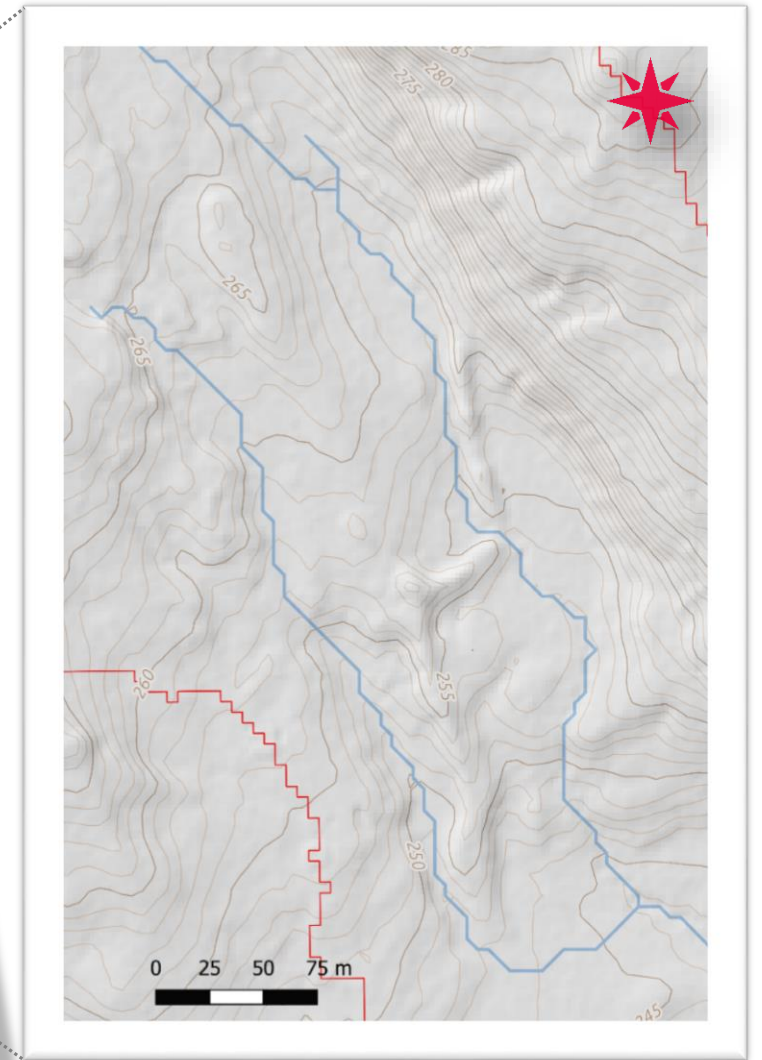
The study catchment



Sweden



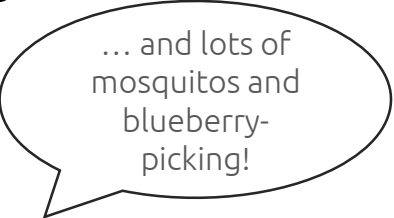
Krycklan



Subcatchment

Krycklan, Sweden

- Cold temperate humid climate with persistent snow cover during the winter *
- 30 year mean annual temperature (1981–2010) is 1.8°C, January -9.5°C, and July 14.7°C *
- Mean annual precipitation is 614 mm, annual runoff is 311 mm (evapotranspiration ~ 303 mm) *
- Study-subcatchments at 250-270m elevation (mostly forested and some small mire areas)
- Fieldwork campaigns during summer 2018 and 2019
 - Well installation
 - Manual water level measurements
 - Logger installation and maintenance

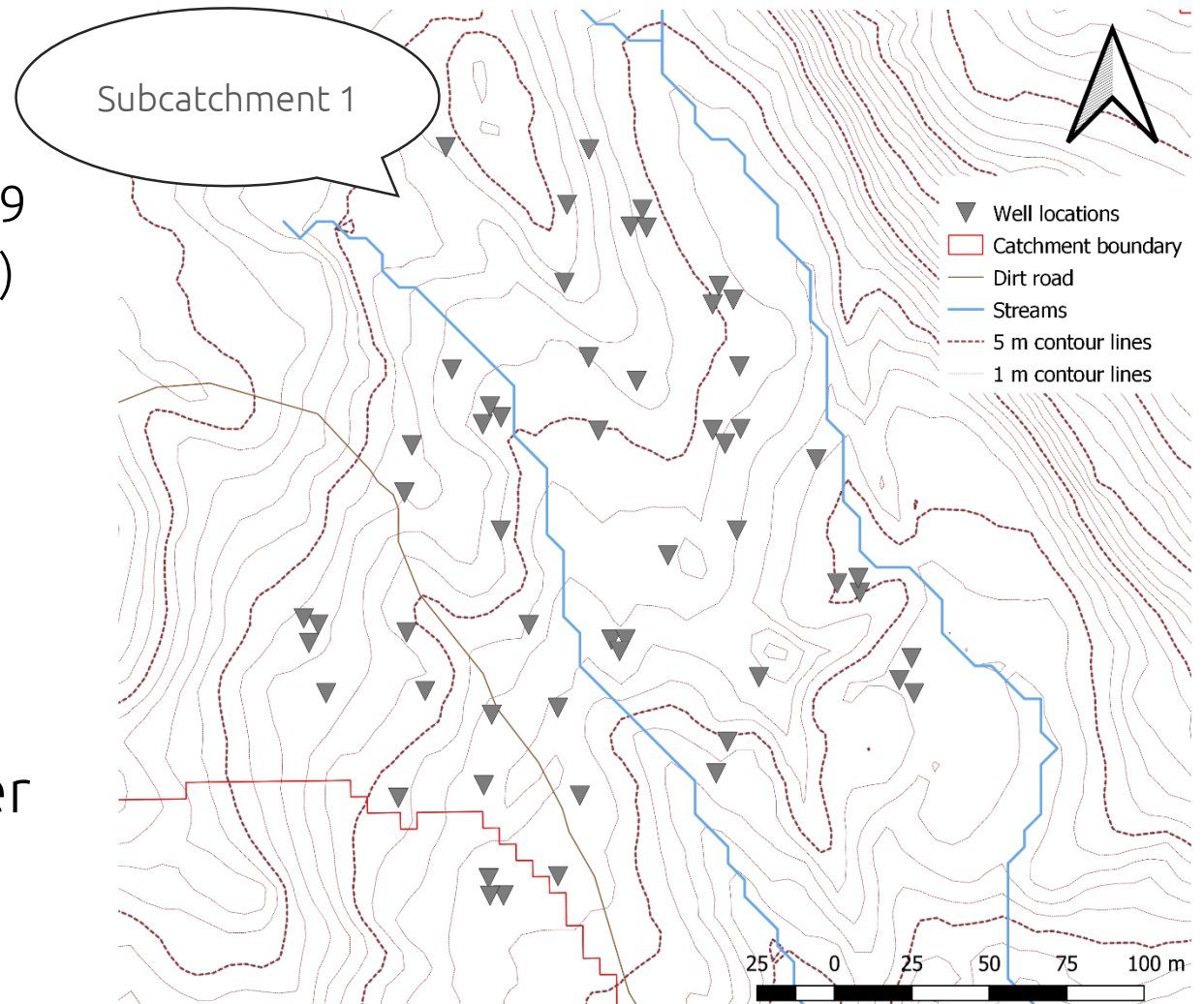


... and lots of
mosquitos and
blueberry-
picking!

* Laudon et al., 2013

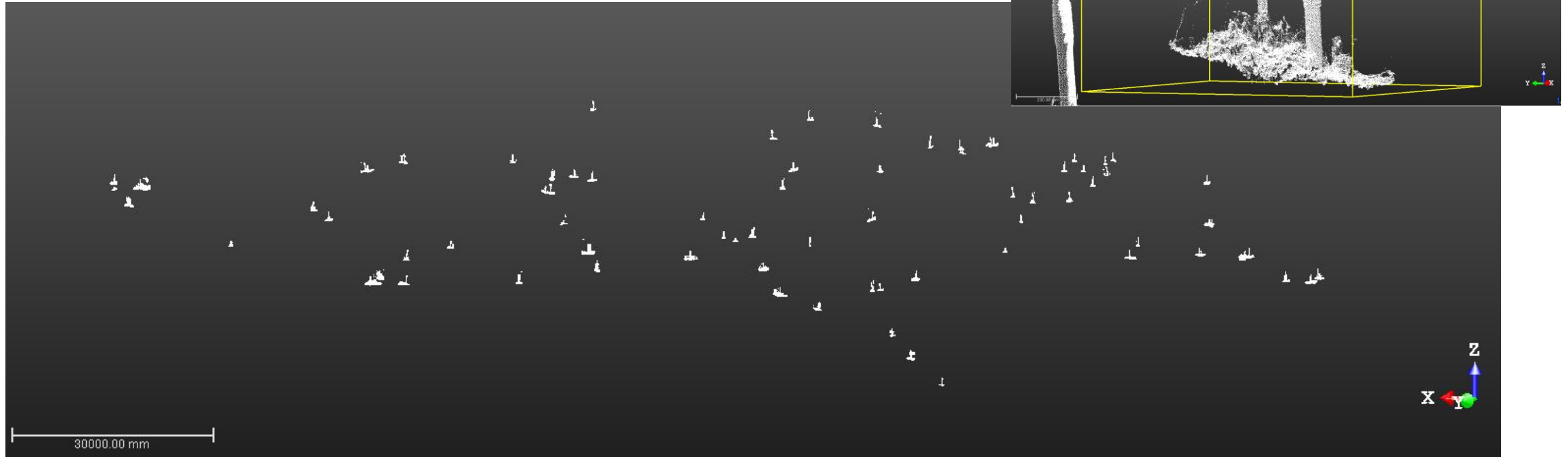
Installations and instrumentation

- 75 fully screened wells
 - Summer 2018 and early winter 2019
 - Subcatchment 1: 55 wells (see map)
 - Subcatchment 2: 20 wells
- All wells are equipped with Odyssey water level loggers (capacitance sensors)
 - 10 – 30 min interval
- For exact data on well top positions we did a terrestrial laser scan (TLS) in both areas
 - May/June 2019



High precision position of wells

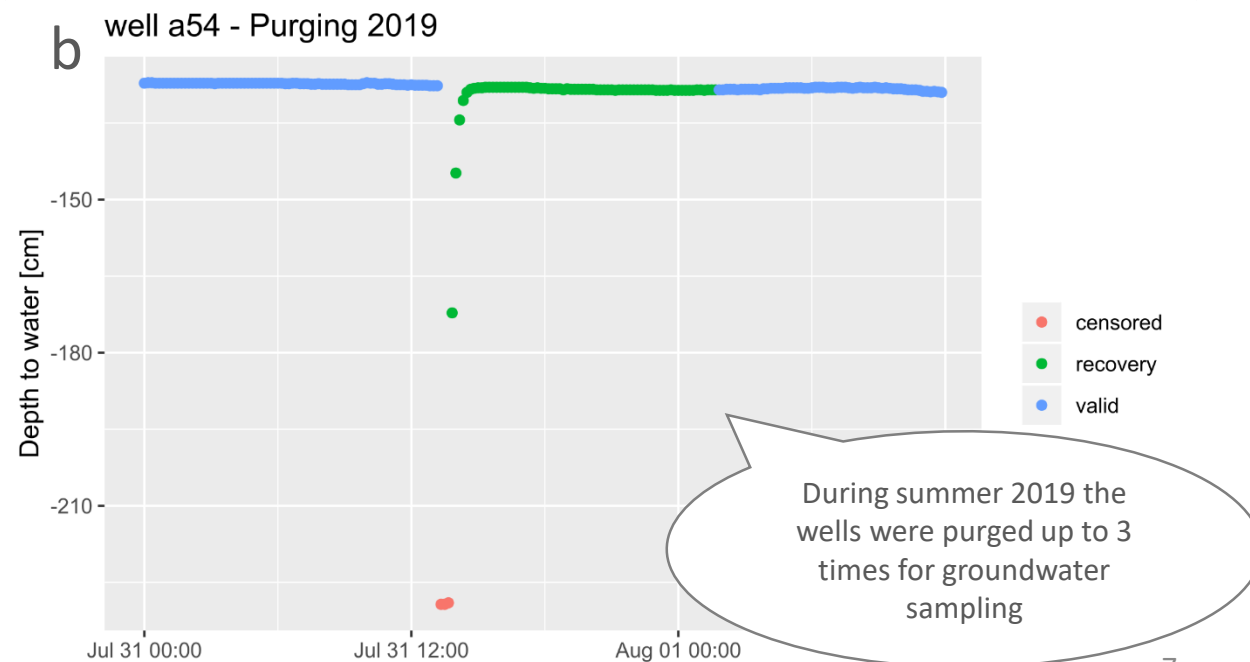
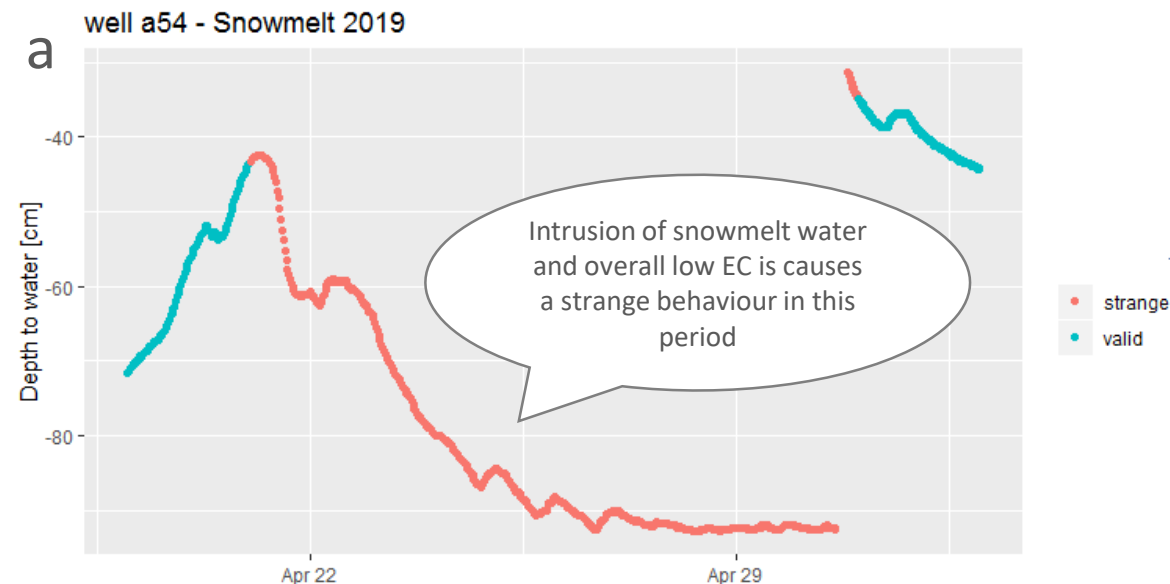
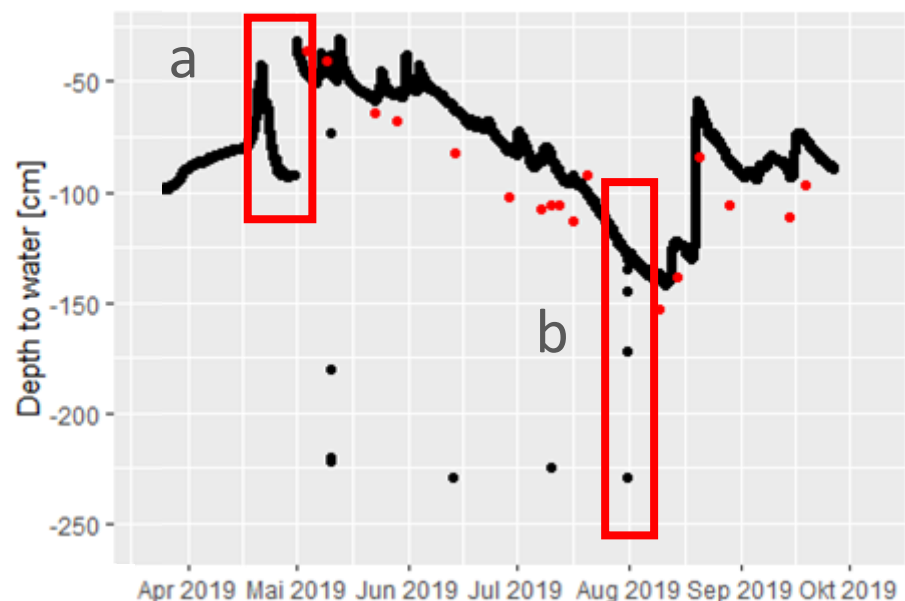
- TLS scan and manual extraction of wells and well top positions



Data cleaning

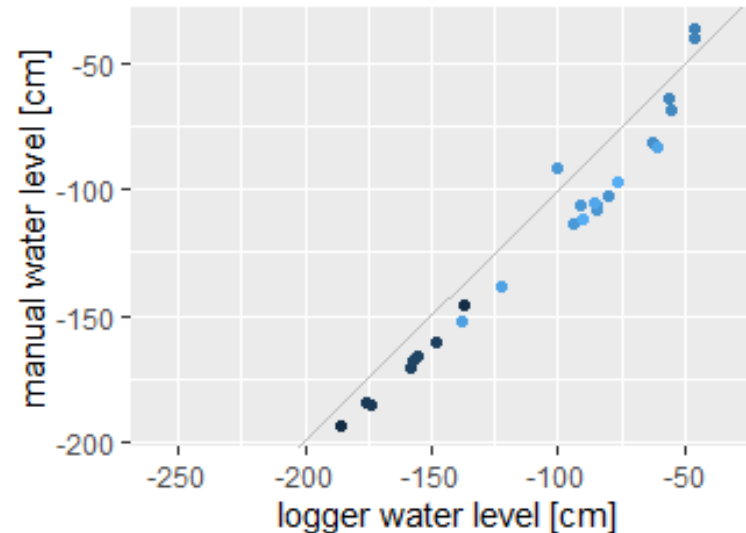
Post-processing of logger data included the classification of problematic data points that were not included in the analyses:

- Loggers out of well or dry well (censored)
- Well purging and recovery of water levels
- Strange behaviour during snowmelt

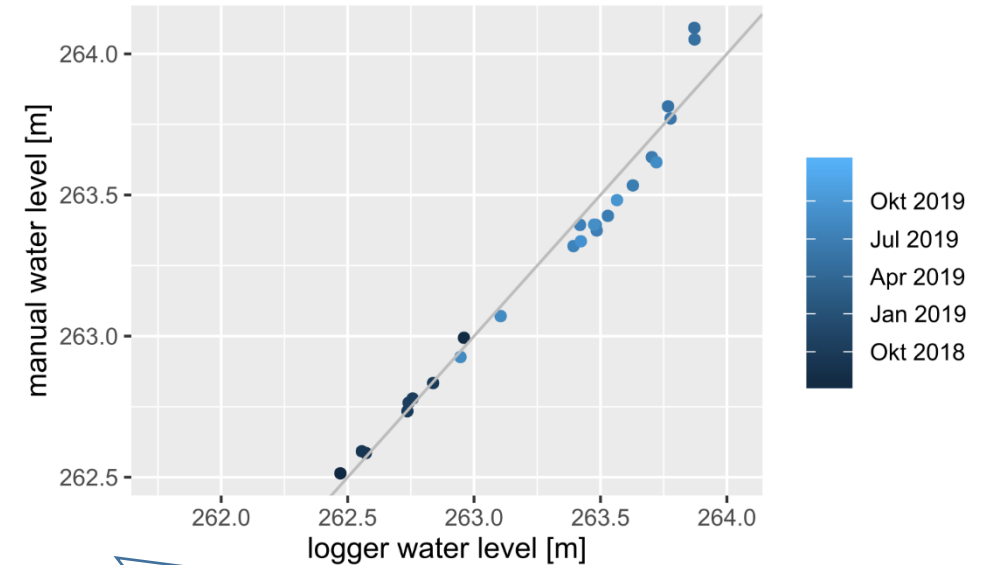


Logger re-calibration

- Manual water level measurements in summer 2018 and 2019
- A correction (adjusting the shift) of logger data was done based on manual measurements
 - Only if enough data points were available



Re-calibration

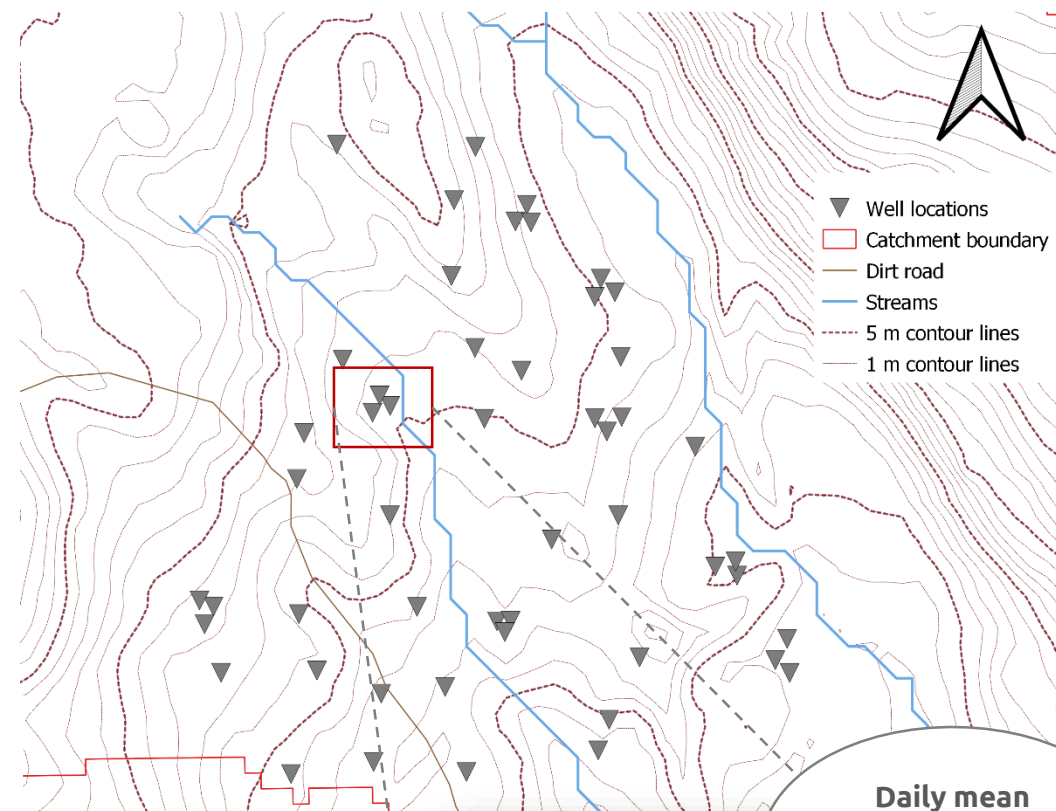
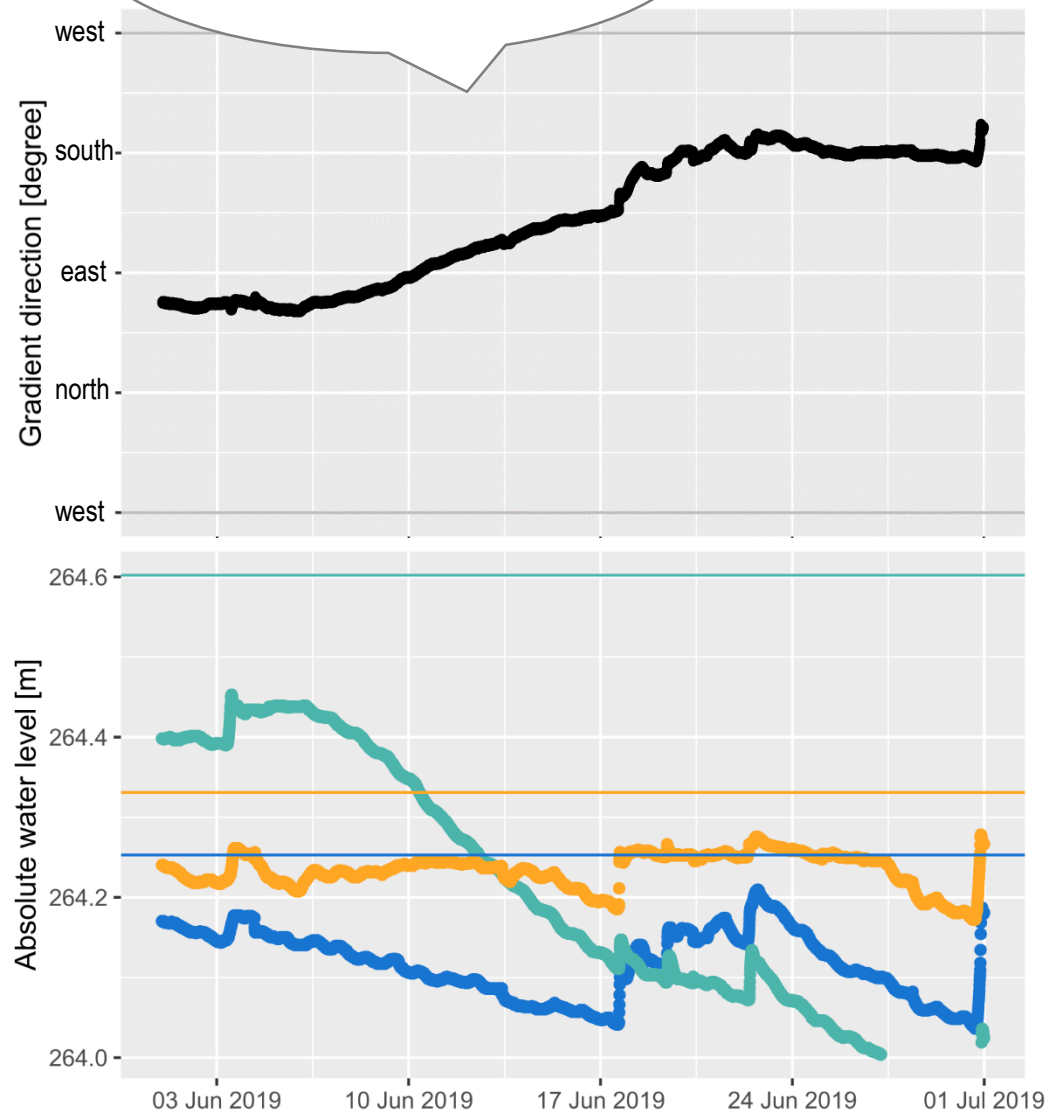


Gradient calculations

- We used the nested groundwater well network to calculate groundwater gradients *
 - Very high time resolution (10 min) observations of groundwater gradient changes
 - Comparing the system responses to different antecedent conditions (wet vs dry)
- Different distances between well triplets (5 – 20 m) to compare gradient at different scales
 - Comparison of the measurements can give insight on the required spatial and temporal resolution of shallow groundwater data for modelling

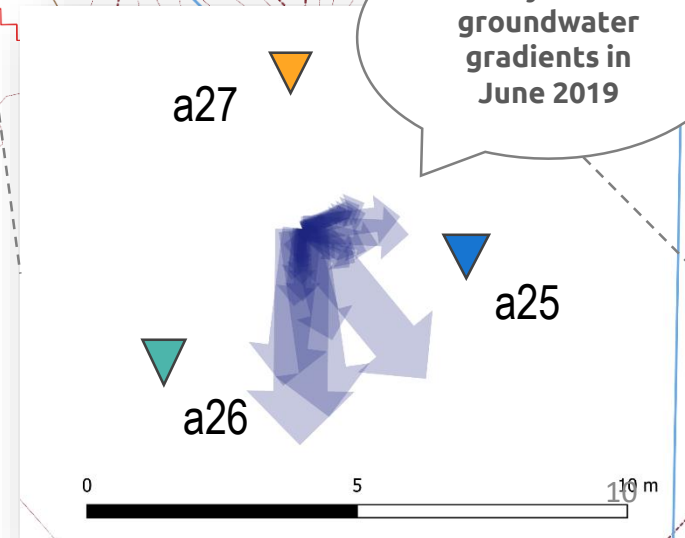
* Followin method of van Meerveld et. al, 2015

Changes in groundwater
gradients and water levels in a
well triplet in June 2019

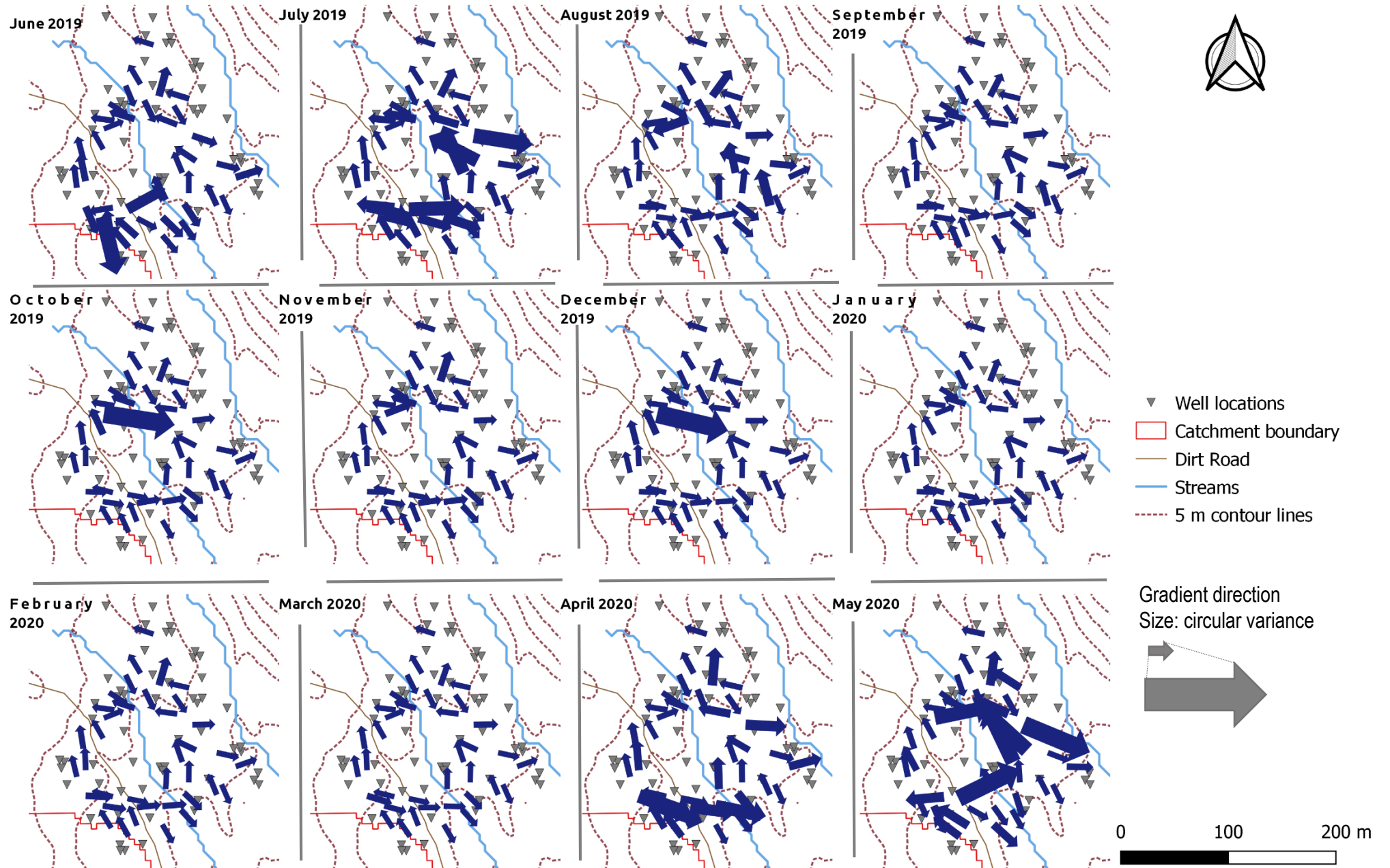


Daily mean
groundwater
gradients in
June 2019

- a25
- a26
- a27
- Ground surface
- Water level



Monthly variation in the mean gradient June 2019- May 2020



Preliminary results

... and open questions

- Large variations in groundwater gradients over the course of the year
 - Monthly mean gradient directions can change by more than 45°
 - How do precipitation or drought events influence the groundwater dynamics?
- Gradients are more stable for some locations than others
 - Are there defining topographic features that cause stable groundwater gradients?
- How do the groundwater dynamics this catchment compare to those in other catchments?



Thank you!

References

- Laudon, H., Taberman, I., Ågren, A., Futter, M., Ottosson-Löfvenius, M., Bishop, K., 2013. The Krycklan Catchment Study - A flagship infrastructure for hydrology, biogeochemistry, and climate research in the boreal landscape. *Water Resour. Res.* 49, 7154–7158. <https://doi.org/10.1002/wrcr.20520>
- van Meerveld, H.J., Seibert, J., Peters, N.E., 2015. Hillslope-riparian-stream connectivity and flow directions at the Panola Mountain Research Watershed. *Hydrol. Process.* 29, 3556–3574. <https://doi.org/10.1002/hyp.10508>

Bonus: Confetti-plot (not for the colorblind)

- Subcatchment 2
- Similar observations as for subcatchment 1
 - Strong changes in gradients over the course of a year
- Why upslope gradients?

