SPATIAL MAPPING OF HYPORHEIC AND STREAM AQUIFER INTERACTIONS

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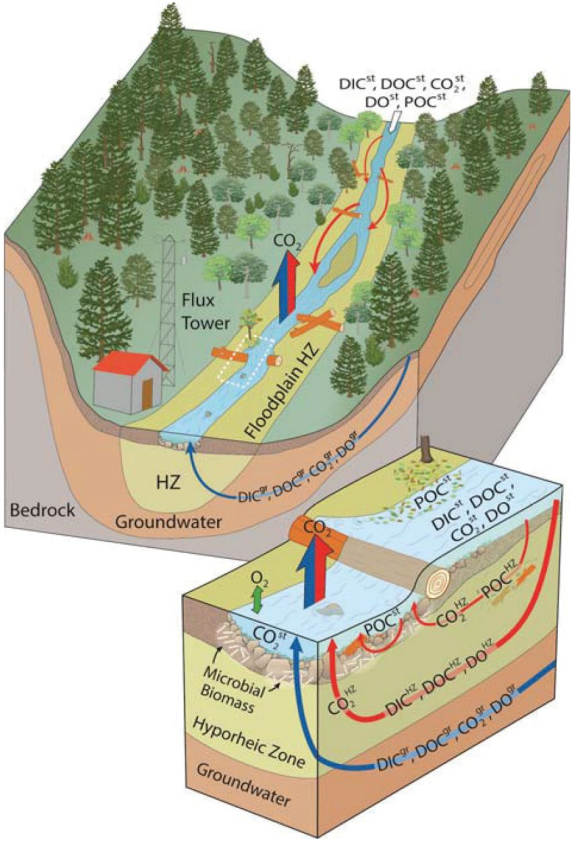
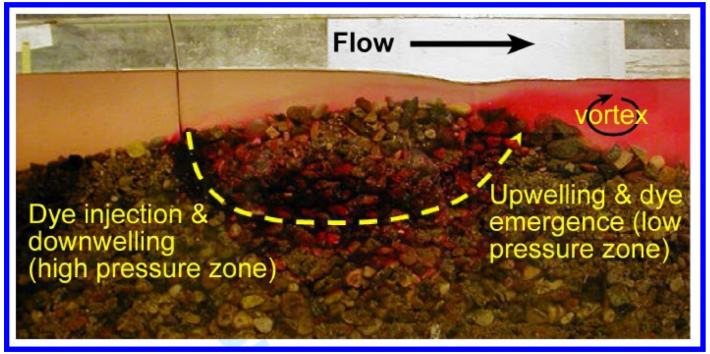
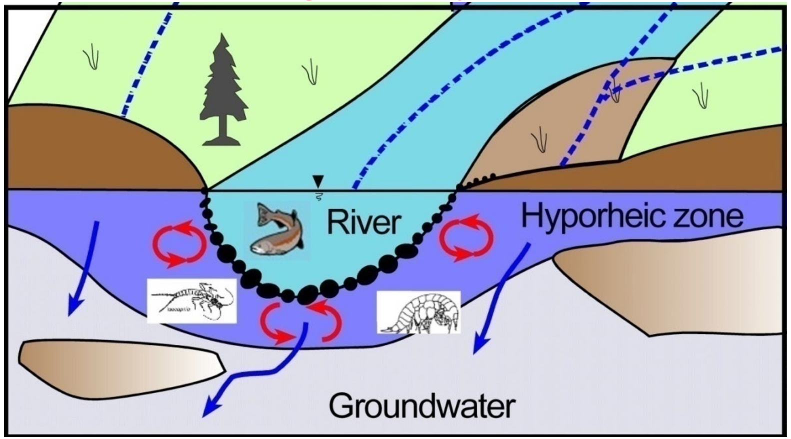
SURFACE-SUBSURFACE WATER EXCHANGE





longitudinal profile



landscape cross section

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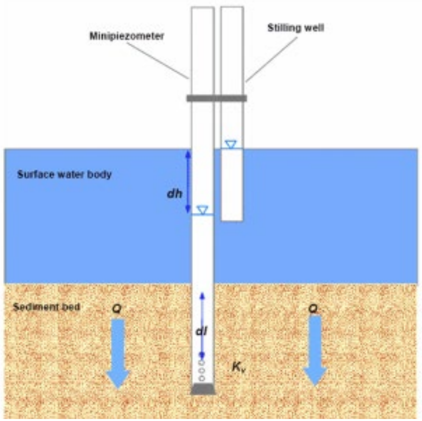
[*Tonina & Buffington*, Geography Compass, 2009]
[*Buffington & Tonina*, Geography Compass, 2009]

HOW TO MEASURE HYPORHEIC FLOW

Many ways to measure water exchange:

- Seepage meters
- Darcy's Law ($q = K \Delta h/l$) / Pressure gradients
- Incremental streamflow
- Solute tracer
- Temperature



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PROBE INSTALLATION

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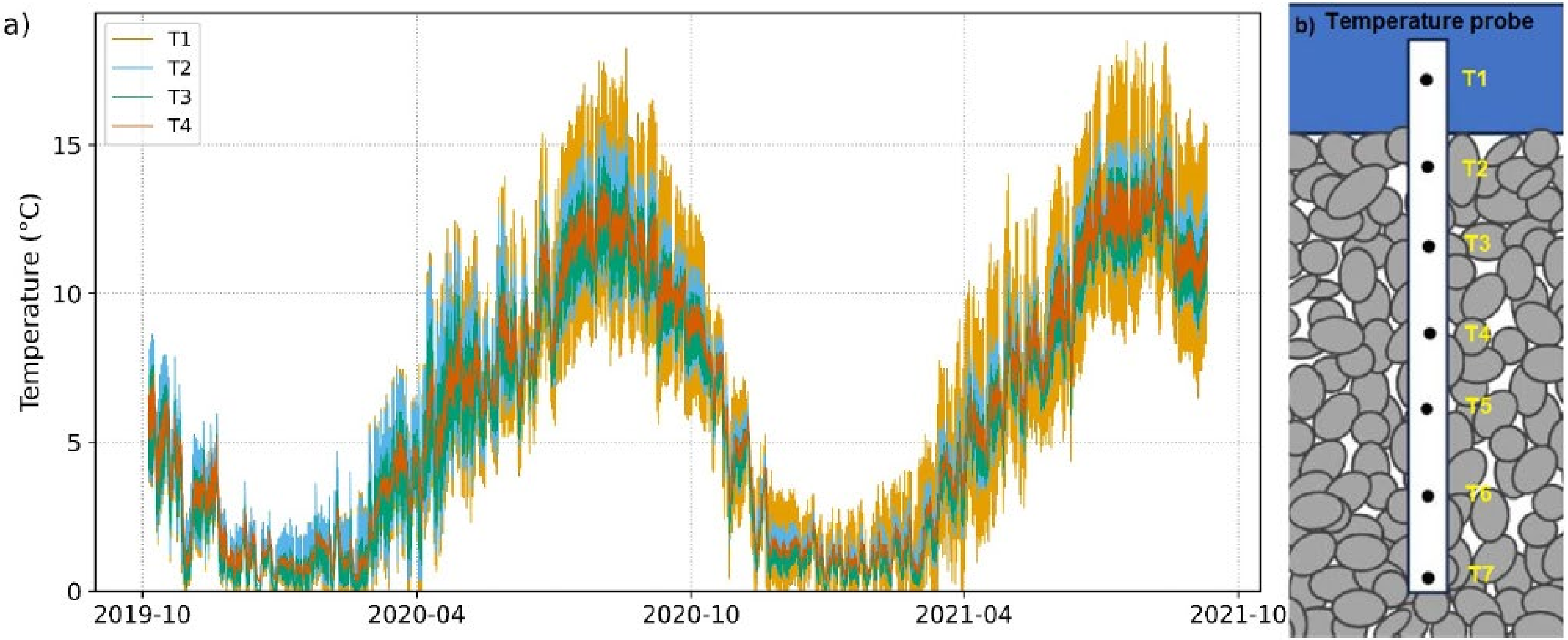
HOW TO MEASURE HYPORHEIC FLOW



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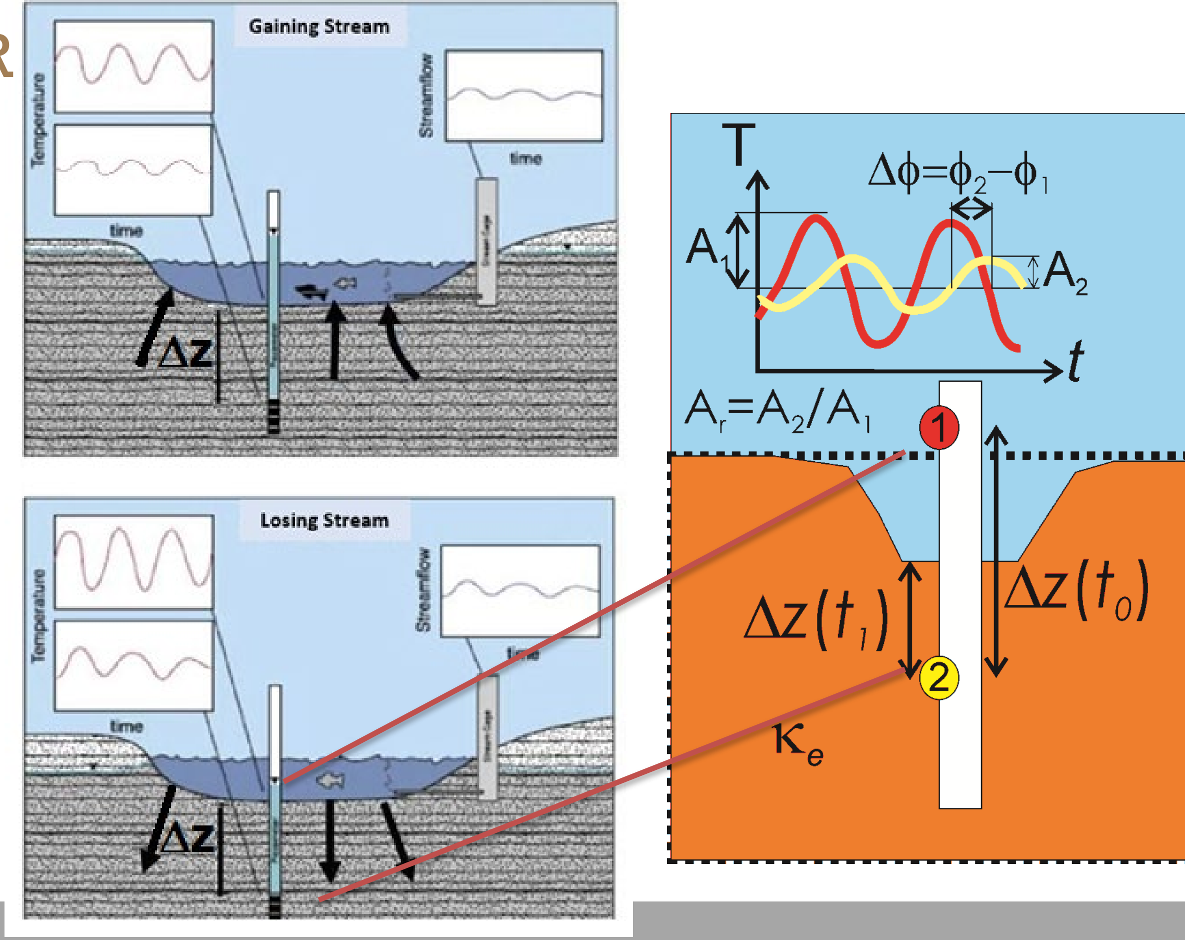
Bertagnoli *& al* (WRR, 2025)

TEMPERATURE TRACER

Why temperature?

- Robust
- Relatively inexpensive



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Luce & al (WRR, 2013)
Bertagnoli & *al* (WRR, 2025)

BENEFITS

Solution of the flux

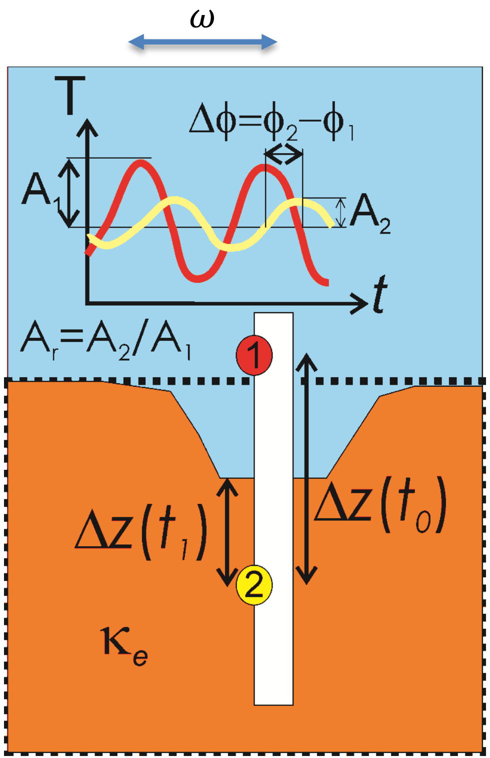
$$q(t) = f(\frac{A_2}{A_1}, \phi_2 - \phi_1, \omega, \Delta z, \gamma)$$

Solution of the sediment effective thermal properties

$$\kappa_e(t) = f(\frac{A_2}{A_1}, \phi_2 - \phi_1, \omega, \Delta z)$$

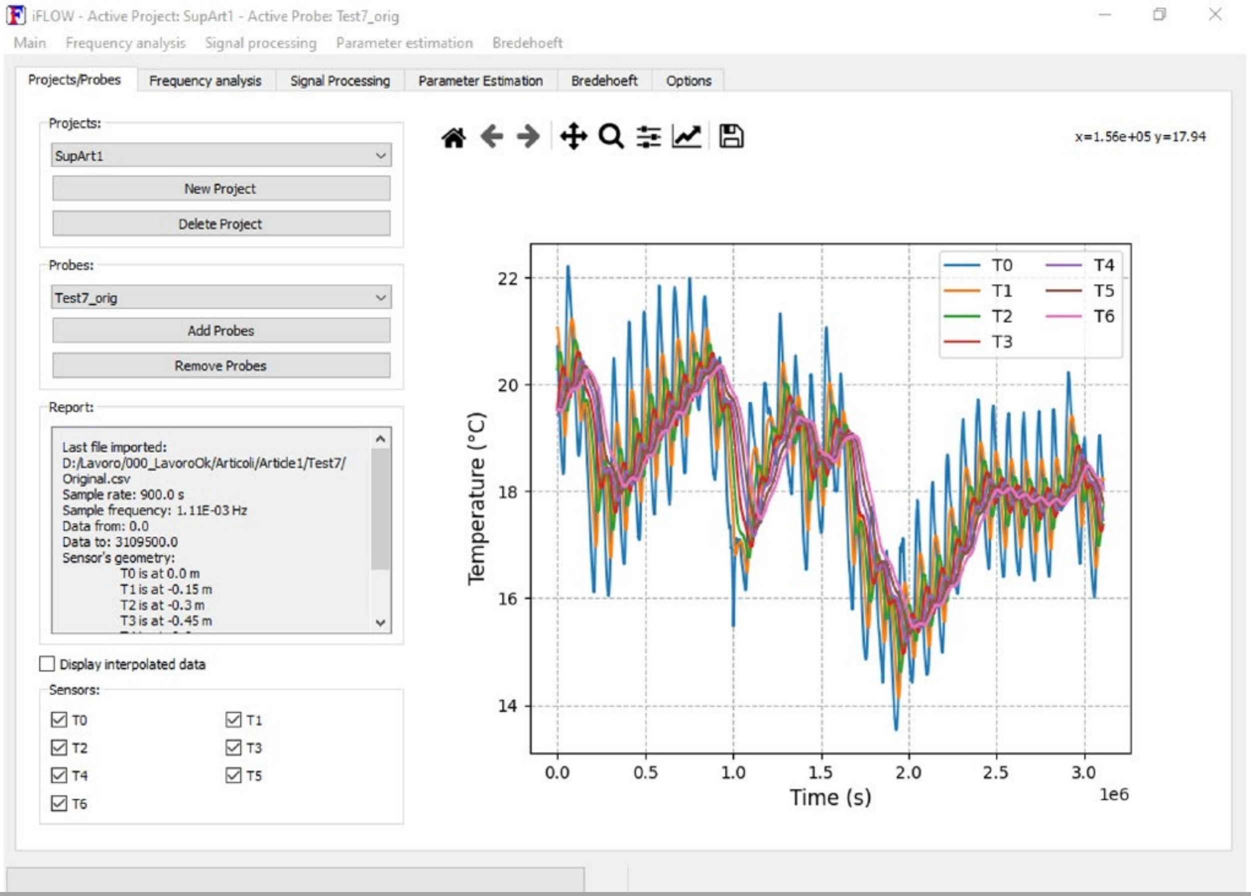
Explicit solution of streambed temporal changes

$$\Delta z(t) = f(\frac{A_2}{A_1}, \phi_2 - \phi_1, \omega, \kappa_e(t))$$



Luce & al (WRR, 2013)
Tonina & *al* (WRR, 2014)

IFLOW



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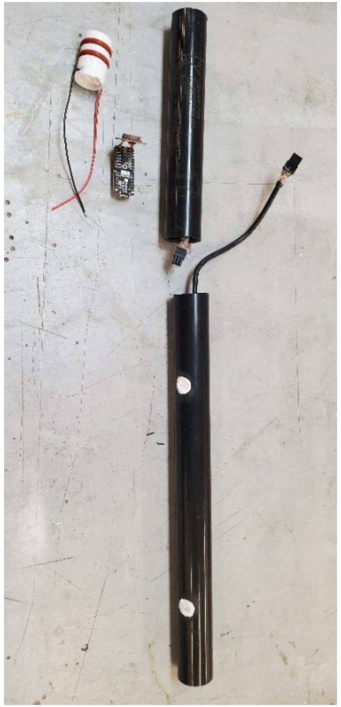
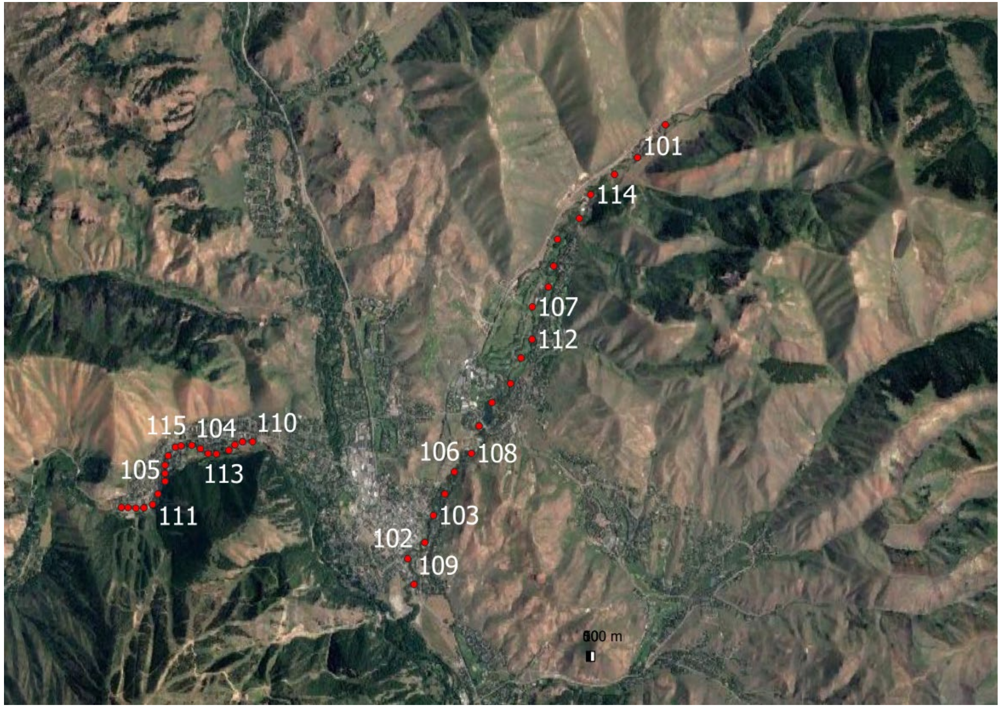
Bertagnoli *& al* (WRR, 2025)

APPLICATION OF THE METHOD

Have a USGS gaging station at each ends of the reach in Warm Springs Creek (~2 miles long) and Trail Creek (~4 miles long)





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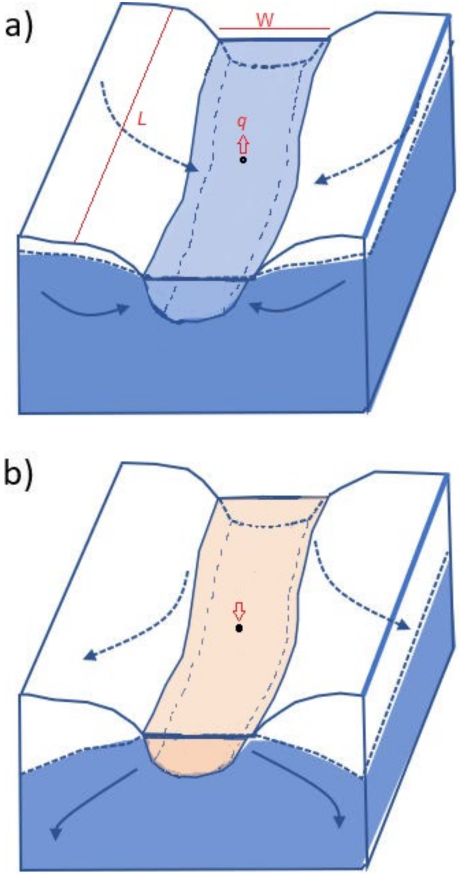
SEEPAGE DISCHARGE

$$Q_{reach} = q_i A_i = \boldsymbol{q}_i W_i L_i$$



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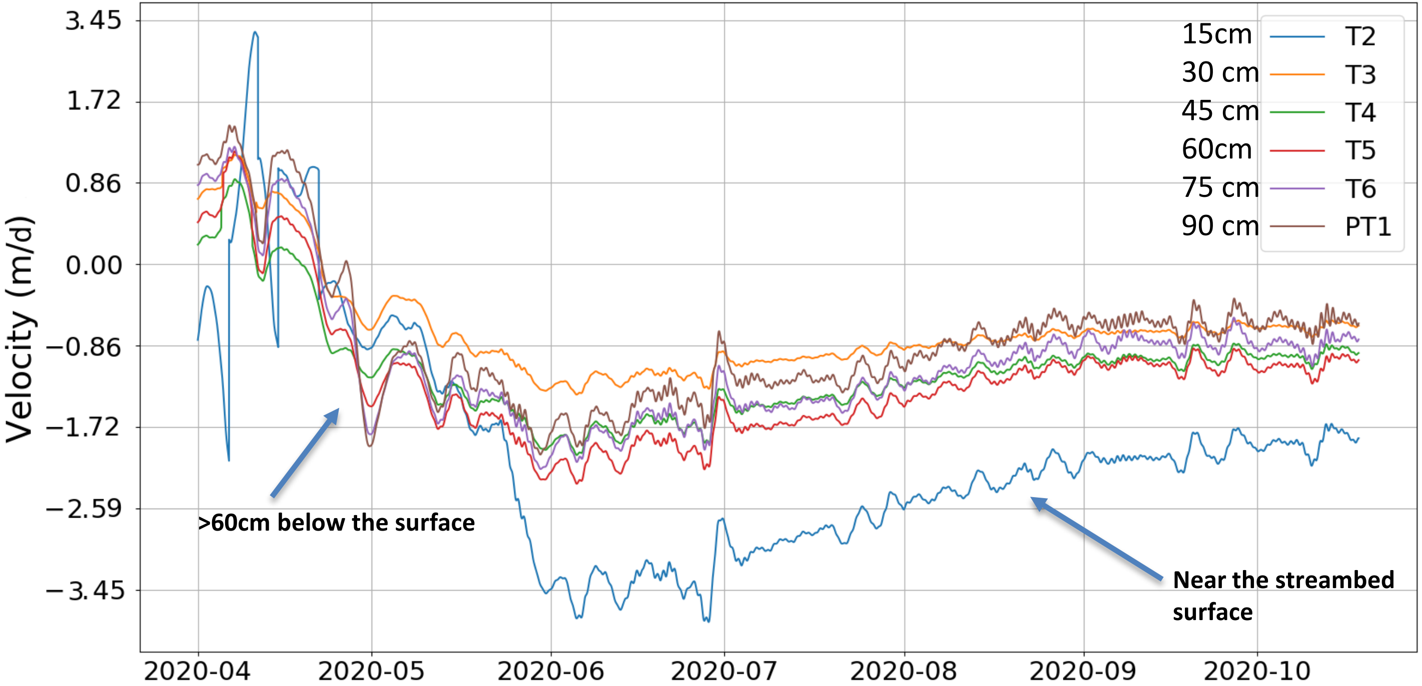
DEPTH EFFECT

Below the streambed



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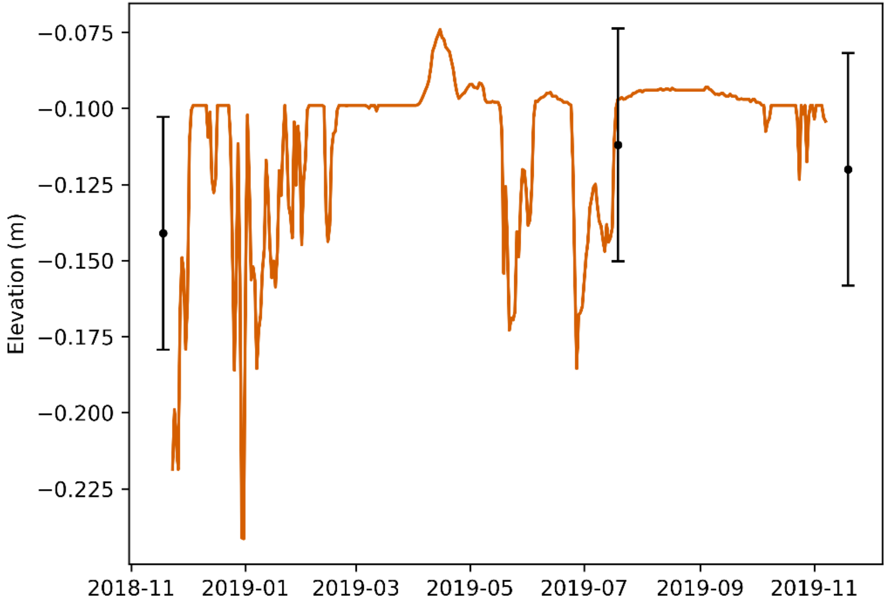
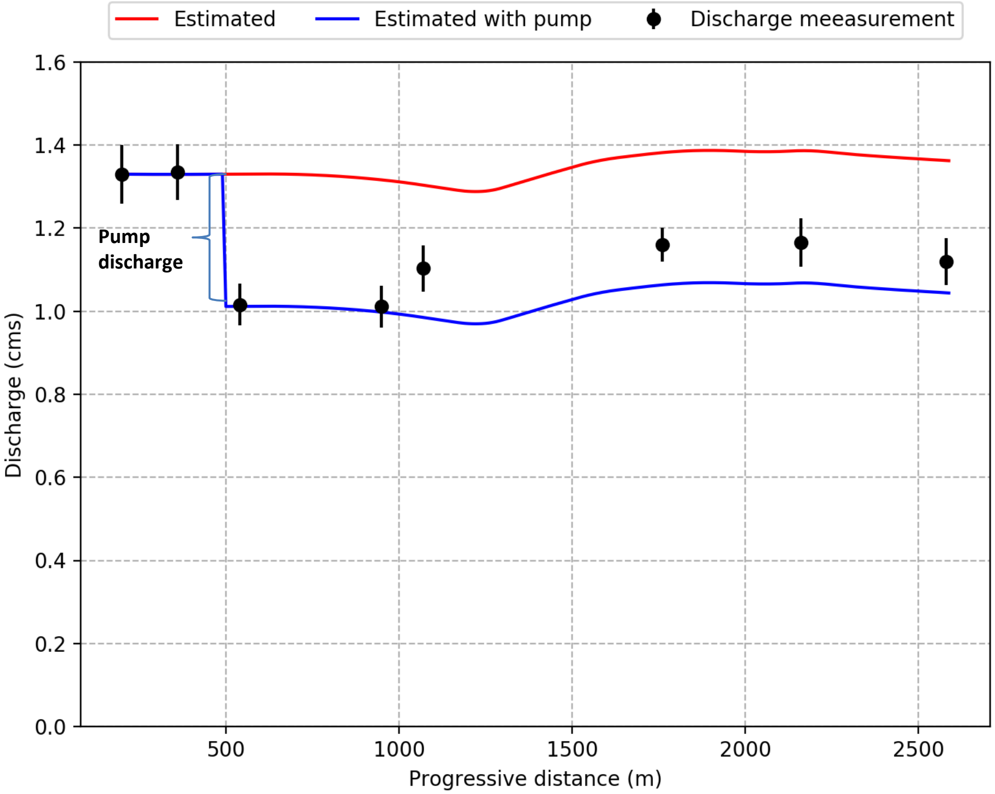
SCOUR AND DEPOSITION



WARM SPRINGS CREEK SEEPAGE OCTOBER 31, 2019

Snow Pump
0.32 cms



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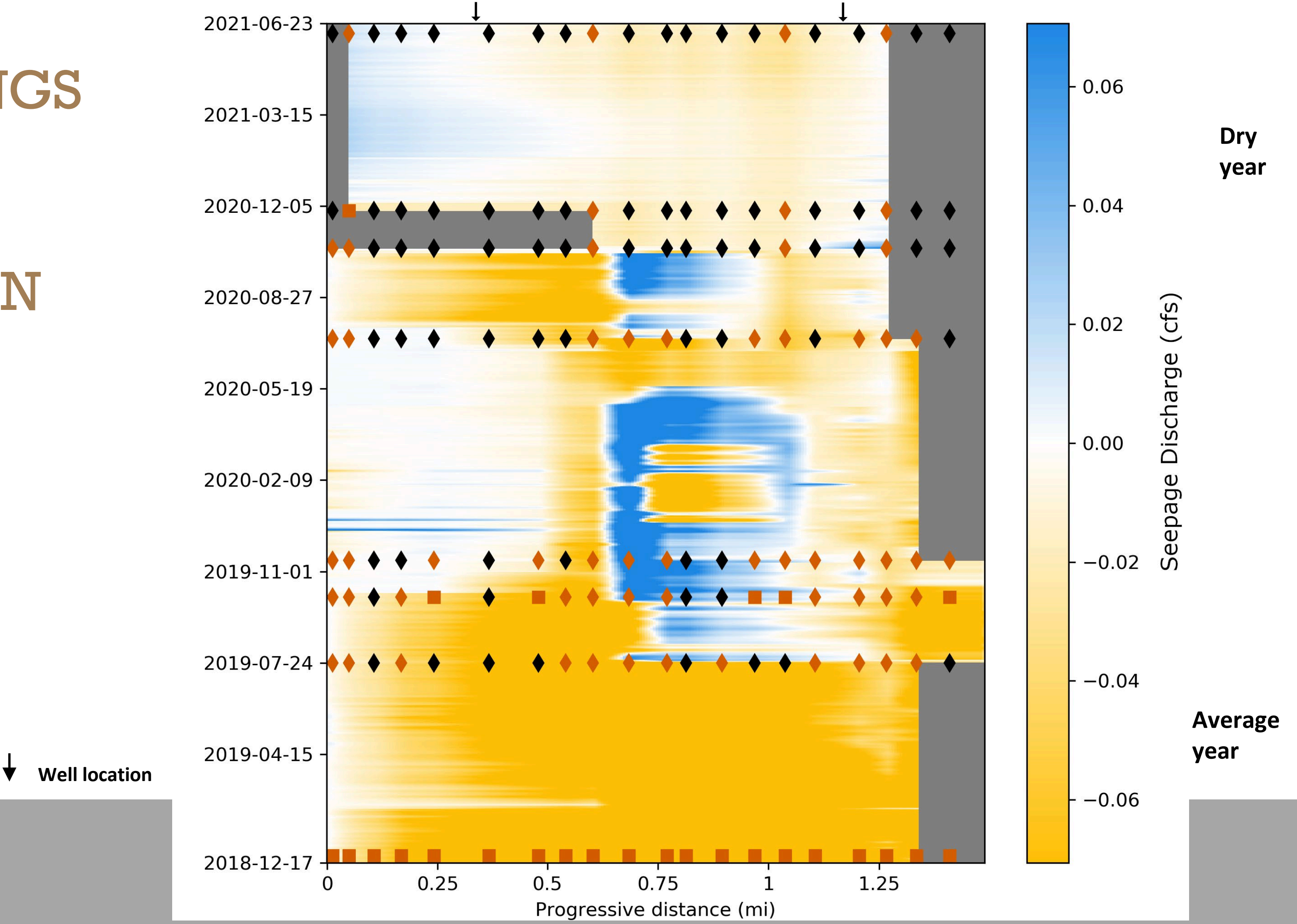
WARM SPRINGS CREEK SEEPAGE DISTRIBUTION

Mainly downwelling



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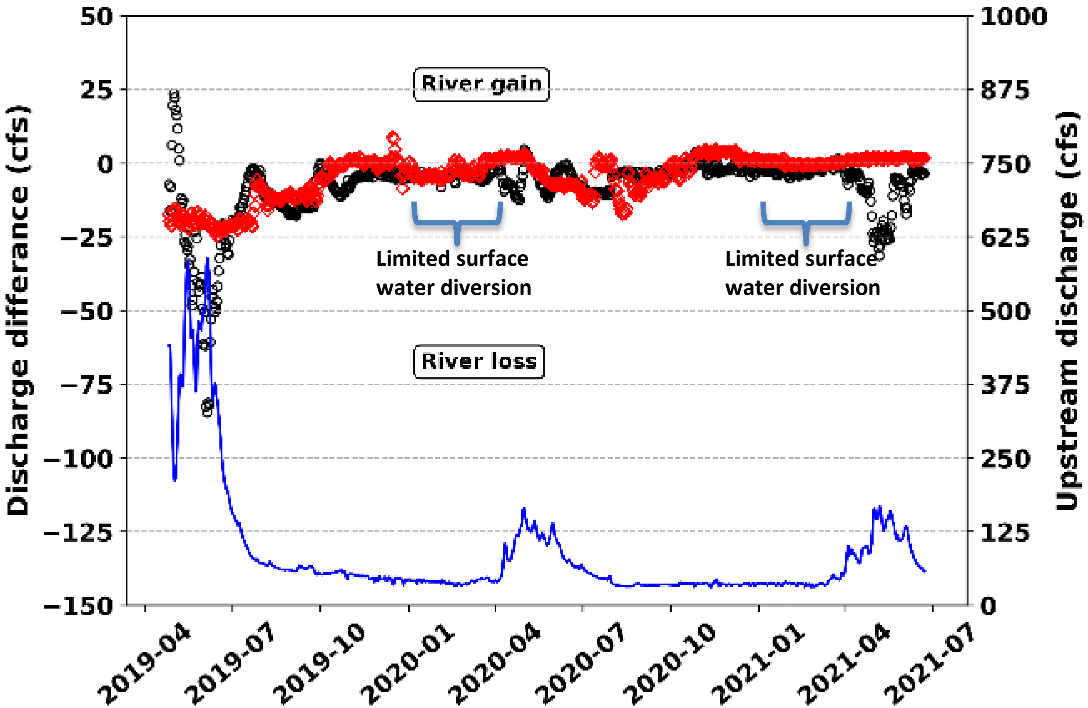
WARM SPRINGS CREEK SEEPAGE-USGS GAGING STATION COMPARISON

Total yearly seepage volume (over ~2 miles)

Qs = -6,420,00 m^3 in 2019

-1,197,00 m^3 in 2020

Overall, a losing stream recharging the groundwater



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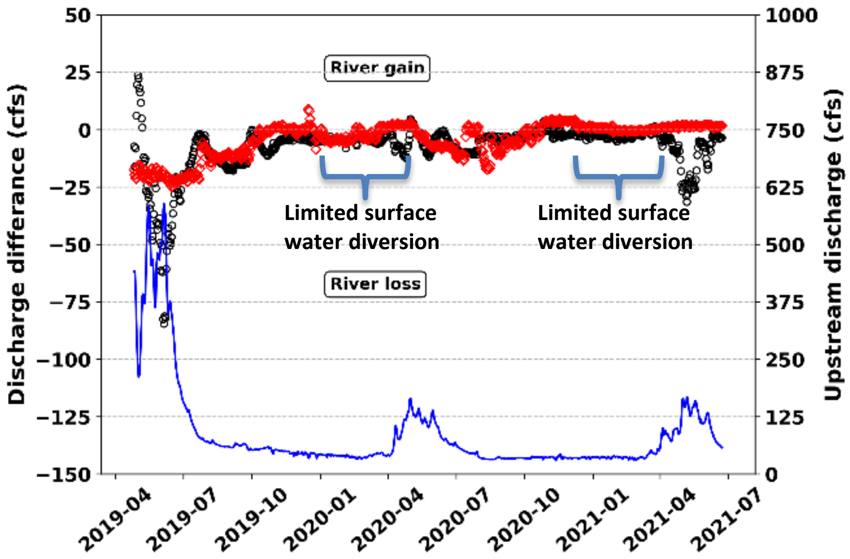
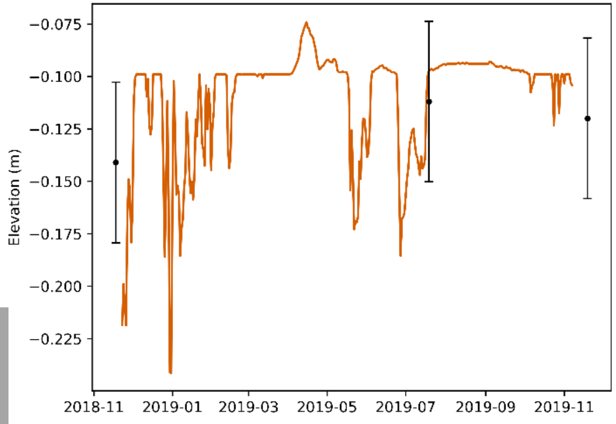
CONCLUSIONS

The thermal method provides

1. Good agreement with seepage run measurements when surface diversions are not present.



2. Local erosion and scour processes



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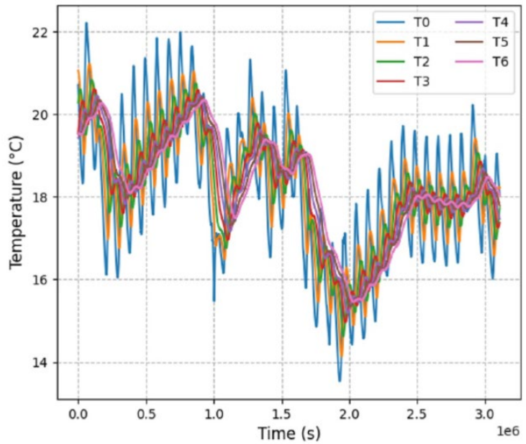
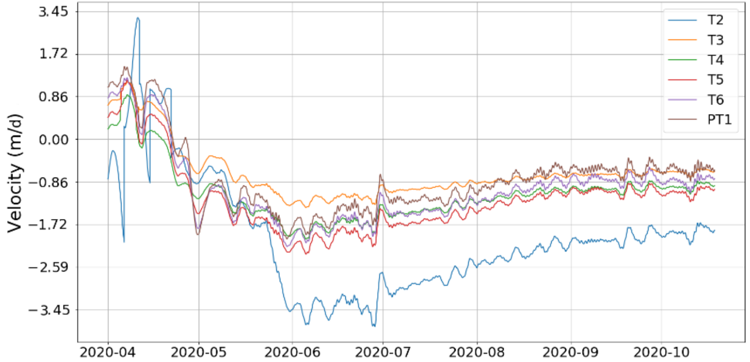
CONCLUSIONS

3. Thermal regime of the stream and streambed waters



4. Hyporheic and groundwater fluxes



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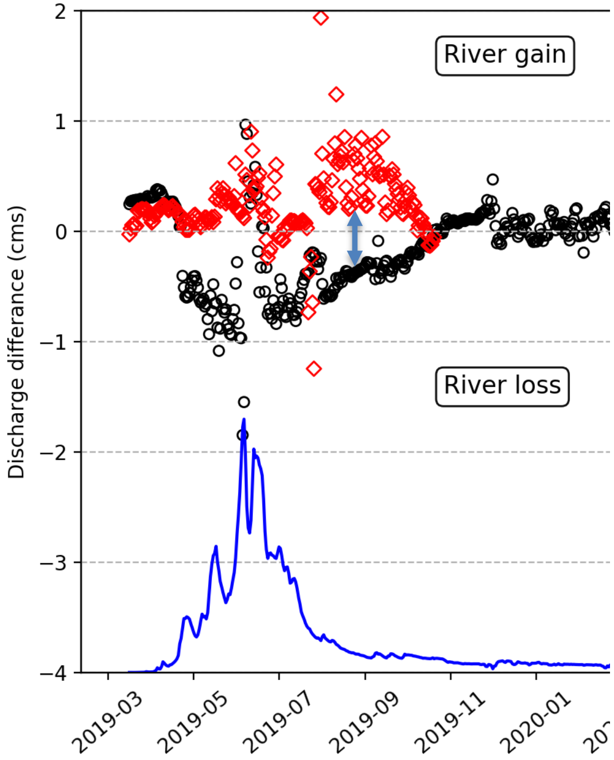
CONCLUSIONS

The method can measure local fluxes that may otherwise be lost in the differential gaging method.



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CONCLUSIONS

- Warm Springs Creek is a losing stream
- During a dry year Warm Springs Creek loses less water than a wet year
- The stream-groundwater interaction maintains more water in the stream.

QUESTIONS

Acknowledgements

- Idaho Department of water Resources
- Hatch Program IDA01722