TEMPERATURE OBSERVATIONS OF SHALLOW SUBSURFACE WATER INFLOWS IN A FIRST ORDER STREAM USING DISTRIBUTED TEMPERATURE SENSING

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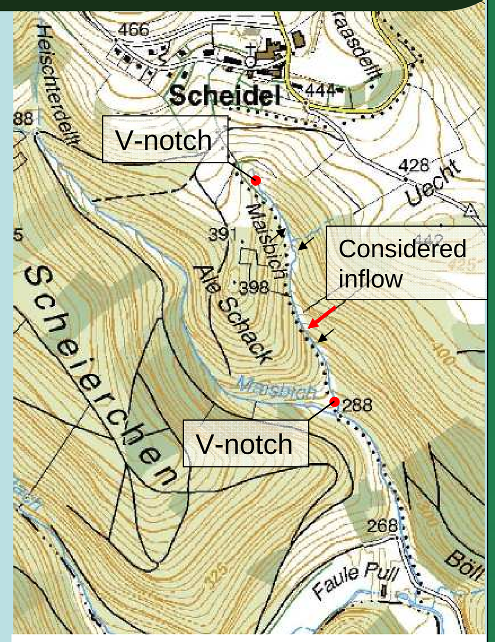
Introduction

High resolution temperature measurements (DTS) are used in order to locate and quantify lateral inflows into a first order stream. If the temperature of the inflows are known, the relative discharge can be determined. The temperature varies over space and time. This poster shows results of the temperature of one of the four lateral inflows observed in the Maisbich catchment in Luxembourg.



The measurements were done in the river Maisbich, located in the central Luxembourg.

Objective

Observation and interpretation of the temperature fluctuations of lateral inflows over time.

Methods

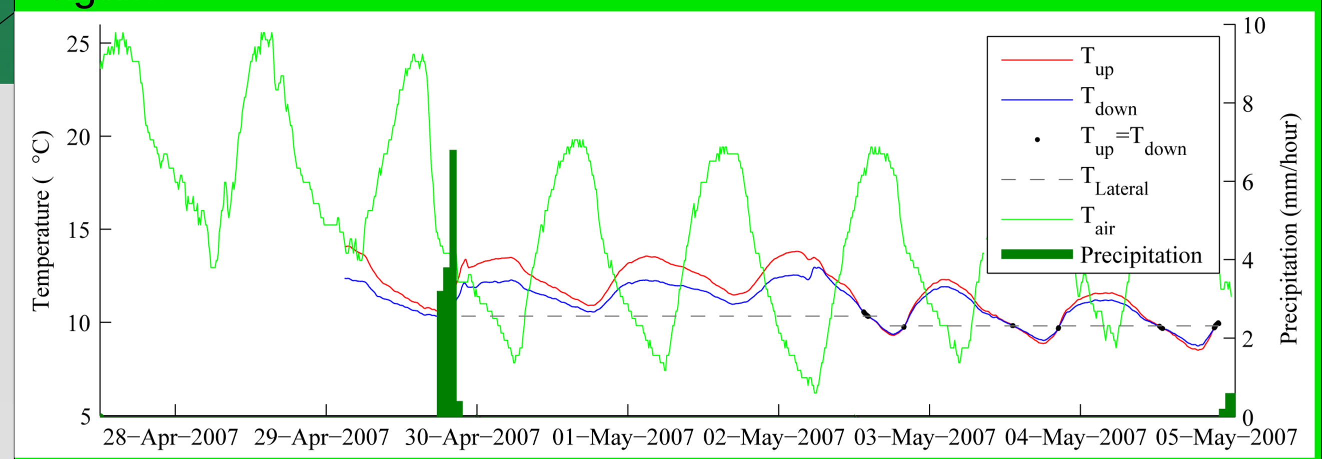
A DTS (Distributed Temperature Sensing) fibre optic cable is used to measure the temperature along the stream with a resolution of 2 meter and 9 minutes. The accuracy is ~0.1°C.

The temperature of lateral inflows ($T_{Lateral}$) is determined in 3 ways:

1. If the temperature upstream and downstream of an inflow are the same, the temperature of the lateral inflow should be the same too.
2. If the assumptions are made that the temperature and the relative contribution of the lateral inflow are constant over a certain period, both the temperature and the relative contribution can be determined using a mass balance for two moments in time.
3. A temperature sensor has been put in the lateral inflow.

April 2007

- Peak discharge 2.5l/s, from 1st of May ~0.5l/s.
- $T_{Lateral}$ is constant 1st three days after rain event, using method 1 (T_{up}=T_{down}) and method 2 (mass balance). After 3 days $T_{Lateral}$ drops.
- This drop is either a delayed reaction to colder atmospheric conditions (ca 3days), or $T_{Lateral}$ returned to pure base flow again.

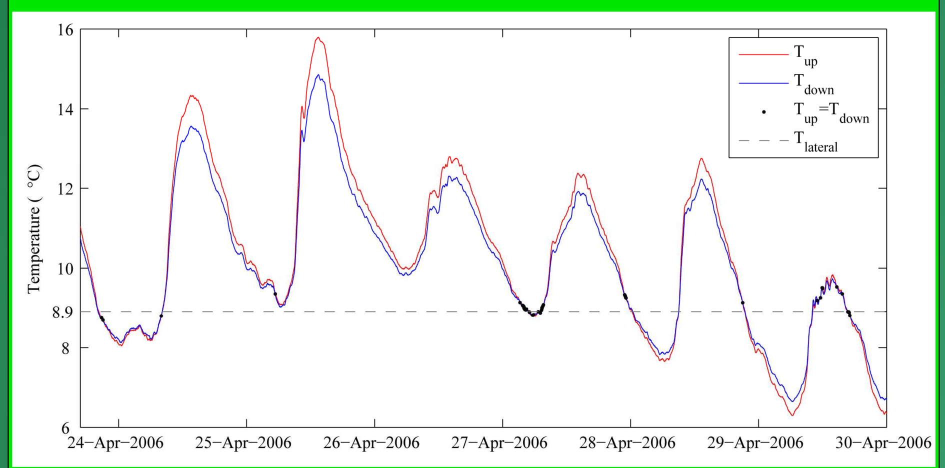


January 2008

- Peak discharge 10l/s, recession curve until 4l/s
- Temperature drop (observed) during rain event, may be caused by cold rain (delay ca 8h) or by the cold atmosphere (delay ca 3 days).
- After 1st event $T_{Lateral}$ is 1.5ºC warmer, due to warmer atmosphere

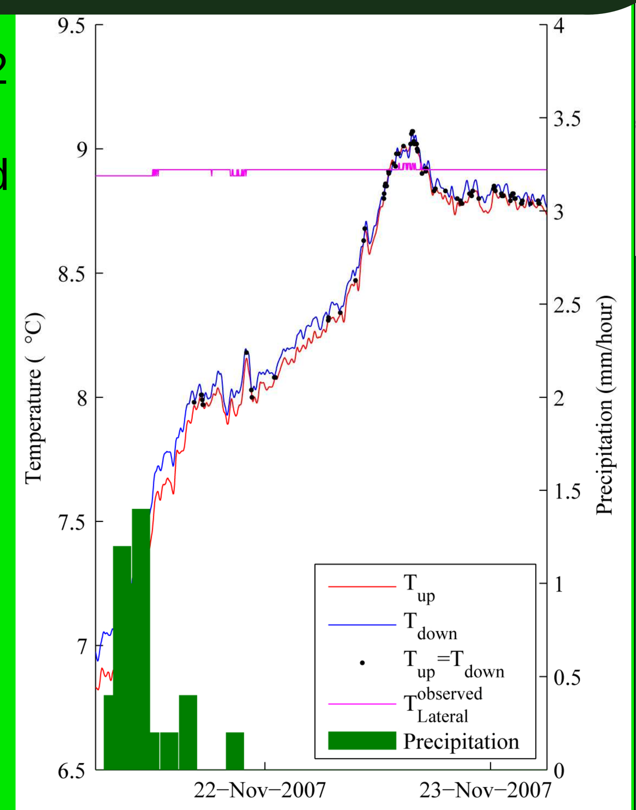
April 2006

- Constant discharge (1.2l/s)
- Large diurnal temperature variation
- Temperature determined with method 1 (T_{up}=T_{down}), is equal to temperature determined using method 2 (mass balance).
- $T_{Lateral}$ can be considered constant over time



November 2007

- Discharge rises from 0.7 to 1.2 l/s
- $T_{Lateral}$ determined with method 1 (T_{up}=T_{down}), rises after rainfall until 24h after the rain, while $T_{Lateral}$ determined with method 3 (sensor), remains constant over time.
- This may be due to another runoff mechanism, reacting 12-24hours after the rainfall.



Conclusions

- $T_{Lateral}$ can be considered constant over time when the discharge is constant for a long period.
- Rain can have a delayed (8-24h) impact on $T_{Lateral}$. This is an indication of rapid subsurface flow.
- Atmospheric changes can have a similar impact on $T_{Lateral}$. In this case the time scale is longer (~3days).
- Other tracer tests are necessary.

Future work

- Monitoring temperature of rain.
- Isotope tracer tests
- Determine lateral discharge
- Inverse modelling to quantify different runoff processes.

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