Passive-DTS measurements conducted in Kerrien

Name of experiment: Passive_DTS_Kerrien_2015_2016

Date: From December 2nd, 2015 to July 05th, 2016

Objectives: Long-term monitoring of streambed temperature through passive-DTS measurements

Principle: A Fiber Optic (FO) cable is buried in the streambed sediment of a stream in a small agriculture catchment. The streambed temperature is continuously monitored at high resolution all along the FO cable in order to highlight and quantify groundwater/stream exchanges

1. Installation and experimental setup

Passive-DTS measurements were conducted from December 2nd, 2015 to July 05th, 2016 by deploying a FO cable in the streambed in the Kerbernez catchment (see Figure 1 for localization)

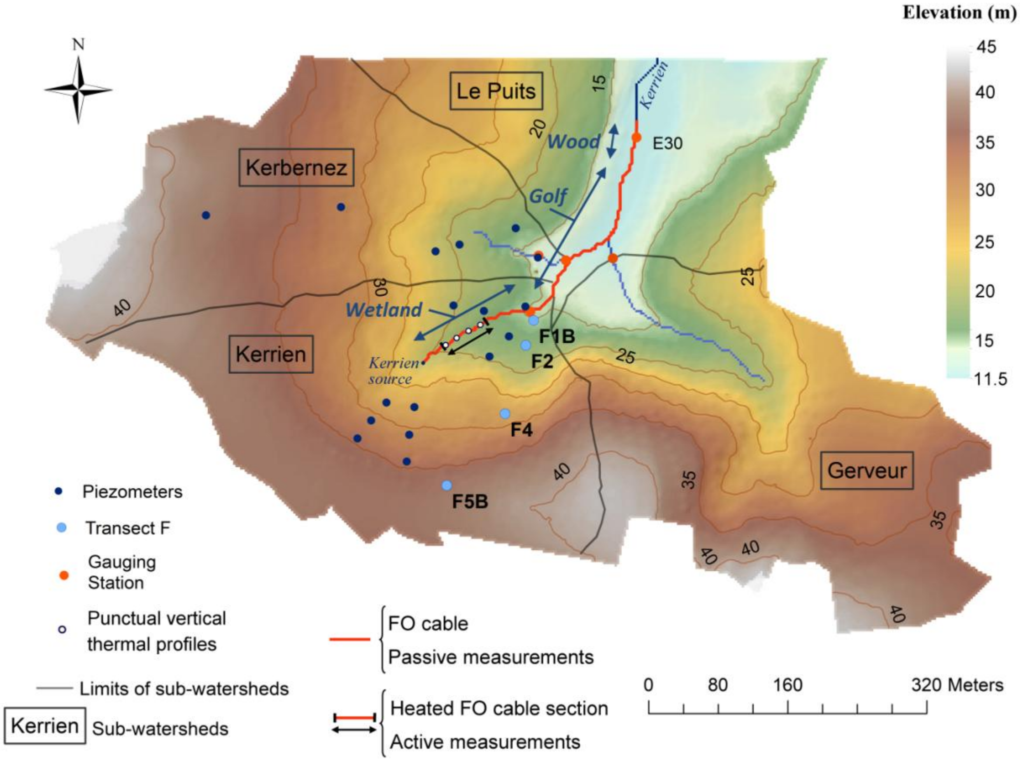

Figure 1: The active-DTS measurements were conducted in the stream located in the wetland area of the Kerrien catchment.

The FO cable has been deployed from Kerrien source and in total, more than 530 m length of BruSens FO cable has been buried directly into the streambed. As detailed in Figure 2 that also details the distance of measurement between the DTS unit and each measurement point, the first 165 meters of the FO cable have been deployed in the Kerrien sub-catchment, where the stream is surrounded by a wetland. Then, the FO cable was deployed in the golf area. In few local places, the deployment was not possible and FO cable was set on the streambed. The last 70 meters of the FO cable have been deployed in a wood plain, a natural environment, where a thick sandy riverbed facilitates cable burying.

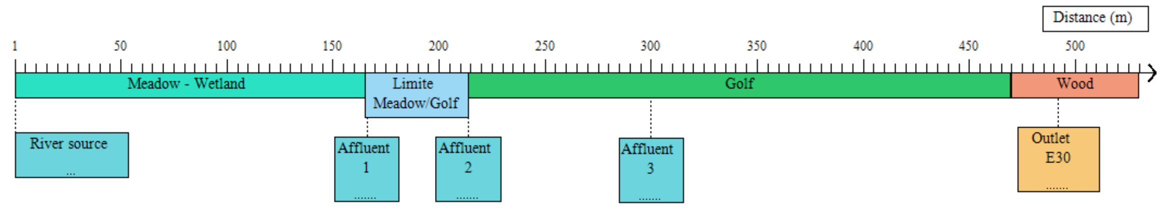

Figure 2: installation of the FO in the streambed sediments in the catchment. Reference points for DTS measurement.

The FO cable has been connected to a FO-DTS control unit, a **Silixa XT-DTS instrument** (5 km range). The DTS unit was configured in **double-ended configuration** to collect data at **25 cm and 10 minutes sampling interval**. Two calibration baths (one at the ambient temperature and a fridge), as well as PT100 probes (0.1°C) and RBR SoloT probes (0.002°C accuracy) were used to calibrate the data. To assess the accuracy of temperature measurements, a RBR SoloT probe was set up **at the gauging station E30 located at the entrance of the wood** (shed). Comparison between DTS measurements and RBR SoloT probes validated the temperature measurements, with a relative uncertainty of measurements estimated at 0.05°C and absolute uncertainty of measurement estimated at 0.2°C. Another RBR Solo T was installed **in a well near the Kerrien source** in order to measure groundwater temperature.

In complement, **4 vertical temperature profiles (VTP)** were installed in the streambed in the wetland area by deploying temperature sensors at 12.5 and 22 cm-depth in the streambed sediments (**as described in Simon et al.,2021**). The position of these punctual sensors in the stream is shown in Figure **Erreur ! Source du renvoi introuvable.**. From upstream to downstream, the VTP are numbered from 1 to 4. For each location, the evolution of temperature was recorded from **April 07th, 2016 to May 03rd, 2017 using HOBO U12-015-02 sensors (±0.25°C precision)**.

__Summary of equipments:__

- Fiber optic cable : 3.8-mm-diameter fiber optic cable (BruSens cable; reference LLK-BSTE 85°C) containing 4 multimode 50/125-µm fibers
- Calibration : double-ended calibration ; 2 paired-fibers (red – blue and yellow and green) spliced and connected at the end of the cable
- Measurements:
    - Silixa Ultima S DTS unit reporting temperature every 25 cm at a-10 minutes sampling interval
- Calibration:
    - 20 m of cable placed in a ambient calibration bath and 20 m in a cold calibration bath (fridge)
    - RBR SoloT probes (0.002°C accuracy) recorded the temperature in each bath
    - RBR SoloT probes (0.002°C accuracy) recorded the temperature at the gauging station E30 located at the entrance of the wood (shed)

- Spatial resolution: experimentally estimated during heating periods between 51 and 67 cm [further details : Simon, N., Bour, O., Lavenant, N., Porel, G., Nauleau, B., Pouladi, B., & Longuevergne, L. (2020). A Comparison of Different Methods to Estimate the Effective Spatial Resolution of FO-DTS Measurements Achieved during Sandbox Experiments. *Sensors*, 20(2). https://doi.org/10.3390/s20020570]

- Complementary equipments:
    - RBR Solo installed in a well near the Kerrien Source
    - 4 VTP profiles (2 temperature probes for each profile)

2. Data available in the database

- **FO data**

Name of the file : **FO_Passive_DTS_measurements**

Contents : 3 data files (format .txt)

- **'Distance'** - Localization of measurement points along the FO cable (Distance from the DTS unit, located in 0) – 2084 points, each separated of around 25 cm
- **'Time'** – Time of the temperature record – 31068 points
- **'Temperature'** – Temperature measured for each measurement point located along the FO cable and at each moment of the experiment – 2084 x 31068 points

- **Temperature recorded with RBR Solo T**

Name of the file : **RBR_data**

Contents: 8 data files (format .txt)

Cold Calibration Bath (fridge)

- **'Temperature_RBR312_CB'** - Temperature recorded with the RBR SoloT n°312, installed in the cold calibration bath
- **'Time_RBR312_CB'** - Time of the temperature record (corresponding to the RBR SoloT n°312 installed in the cold calibration bath)

Ambient Calibration Bath ("warm")

- **'Temperature_RBR310_WB'** - Temperature recorded with the RBR SoloT n°310, installed in the warm calibration bath
- **'Time_ RBR310_WB'** - Time of the temperature record (corresponding to the RBR SoloT n°310 installed in the warm calibration bath)

At the gauging station E30 located at the entrance of the wood (shed)

- **'Temperature_ RBR316_Shed'** - Temperature recorded with the RBR SoloT n°316, installed At the gauging station E30 located at the entrance of the wood (shed)
- **'Time_ RBR316_Shed'** - Time of the temperature record (corresponding to the RBR SoloT n°316 installed At the gauging station E30 located at the entrance of the wood (shed))

in a well near the Kerrien Source

- **'Temperature_RBR314_Well'** - Temperature recorded with the RBR SoloT n°314, installed in a well near the Kerrien Source
- **'Time_ RBR314_Well'** - Time of the temperature record (corresponding to the RBR SoloT n°314 installed in a well near the Kerrien Source)

- **VTP**

Name of the file : **Data_VTP**

Contents: 4 files, each containing 2 data files (format .txt)

File: VTP 1

- **'Temperature_HOBO4162_12_5cm'** - Temperature recorded with the HOBO Sensor n°4162 at 12.5-cm depth at the location 1 (See Figure 1)
- **'Time_ HOBO4162_12_5cm'** - Time of the temperature record (corresponding to the HOBO Sensor n°4162 at 12.5-cm depth at the location 1 (See Figure 1))
- **'Temperature_HOBO4160_22cm'** - Temperature recorded with the HOBO Sensor n°4160 at 22-cm depth at the location 1 (See Figure 1)
- **'Time_ HOBO4160_22cm'** - Time of the temperature record (corresponding to the HOBO Sensor n°4160 at 22-cm depth at the location 1 (See Figure 1))

File: VTP 2

- **'Temperature_HOBO4167_12_5cm'** - Temperature recorded with the HOBO Sensor n°4167 at 12.5-cm depth at the location 2 (See Figure 1)
- **'Time_ HOBO4167_12_5cm'** - Time of the temperature record (corresponding to the HOBO Sensor n°4167 at 12.5-cm depth at the location 2 (See Figure 1))
- **'Temperature_HOBO4171_22cm'** - Temperature recorded with the HOBO Sensor n°4171 at 22-cm depth at the location 2 (See Figure 1)
- **'Time_ HOBO4171_22cm'** - Time of the temperature record (corresponding to the HOBO Sensor n°4171 at 22-cm depth at the location 2 (See Figure 1))

File: VTP 3

- **'Temperature_HOBO4168_12_5cm'** - Temperature recorded with the HOBO Sensor n°4168 at 12.5-cm depth at the location 3 (See Figure 1)
- **'Time_ HOBO4168_12_5cm'** - Time of the temperature record (corresponding to the HOBO Sensor n°4168 at 12.5-cm depth at the location 3 (See Figure 1))
- **'Temperature_HOBO4170_22cm'** - Temperature recorded with the HOBO Sensor n°4170 at 22-cm depth at the location 3 (See Figure 1)
- **'Time_ HOBO4170_22cm'** - Time of the temperature record (corresponding to the HOBO Sensor n°4170 at 22-cm depth at the location 3 (See Figure 1))

File: VTP 4

- **'Temperature_HOBO4169_12_5cm'** - Temperature recorded with the HOBO Sensor n°4169 at 12.5-cm depth at the location 4 (See Figure 1)
- **'Time_ HOBO4169_12_5cm'** - Time of the temperature record (corresponding to the HOBO Sensor n°4169 at 12.5-cm depth at the location 4 (See Figure 1))

- **'Temperature_HOBO4159_22cm'** - Temperature recorded with the HOBO Sensor n°4159 at 22-cm depth at the location 4 (See Figure 1)
- **'Time_ HOBO4159_22cm'** - Time of the temperature record (corresponding to the HOBO Sensor n°4159 at 22-cm depth at the location 4 (See Figure 1))

3. About the FO data

<u>Concerning the 'Distance':</u>

- Details about the localization of the FO in the catchment are provided in Figure 2.