# CRITICAL PEAT project : The importance of hydrology for Carbon Reactivity along with atmosphere - peatland interactions. Preliminary results from the Frasne peatland monitoring (Jura Mountains, France).

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# The CRITICAL PEAT Project : The importance of hydrology for carbon reactivity along with atmosphere – peatland interactions. Preliminary results from the Frasne peatland observatory (Jura Mountains, France).

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## I Peatlands: a threatened 3 pillar equilibrium

**~3 % of emerged surfaces** (Joosten and Clarke, 2002)

**~30 % of soil carbon** (Parish et al, 2008), an underestimated stock? (Nichols et al., 2019)

**~10 % of global freshwater resources** (Joosten and Clarke, 2002)

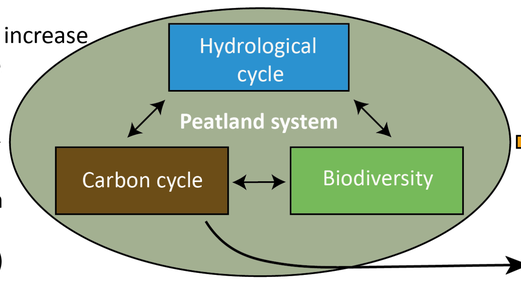
**Global threats**

Global air temperature increase (IPCC, 2014), rainfall regime changes (Trenberth, 2011)

**Local threats**

Peat extraction and drainage (XVIIIth to XXth century)

Restoration (2015/2016)




Peatland observatory in Frasne (Jura mountains, NE France) since 2008

Monitoring of possible hydro-ecological changes.

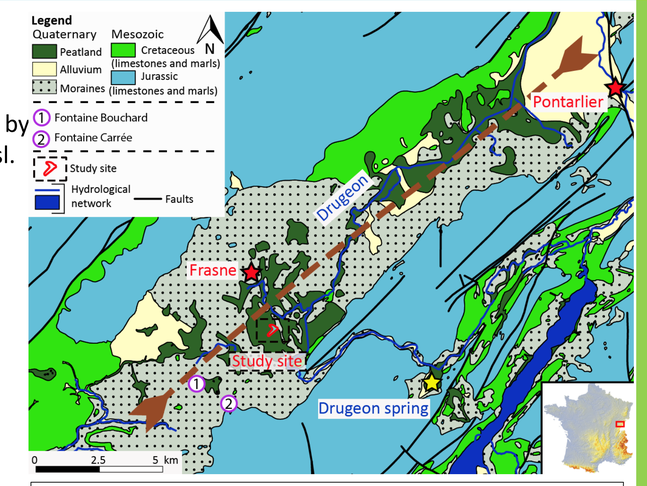
**Retroaction ?**

**The Frasne peatland is representative of a sensitive compartment of the Critical Zone combining water, carbon and biodiversity stakes.**

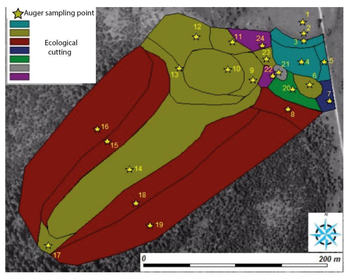
## II Context: a pedo-geological mosaic?

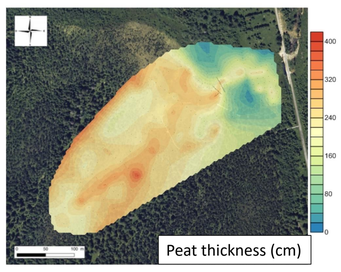
### ❑ Geological framework

A large Jurassic syncline of the Jura arc: karstified limestones overlain by moraines. Mountainous area at 800 to 1100 m asl. Frasne peatland at 834 m asl.




### ❑ Pedological framework




A diversified peatland patchwork: ecological mosaic (vegetation, peat fiber rate) (Briot, 2004; Grosvernier, 2005), variable peat thickness (Collin, 2016).

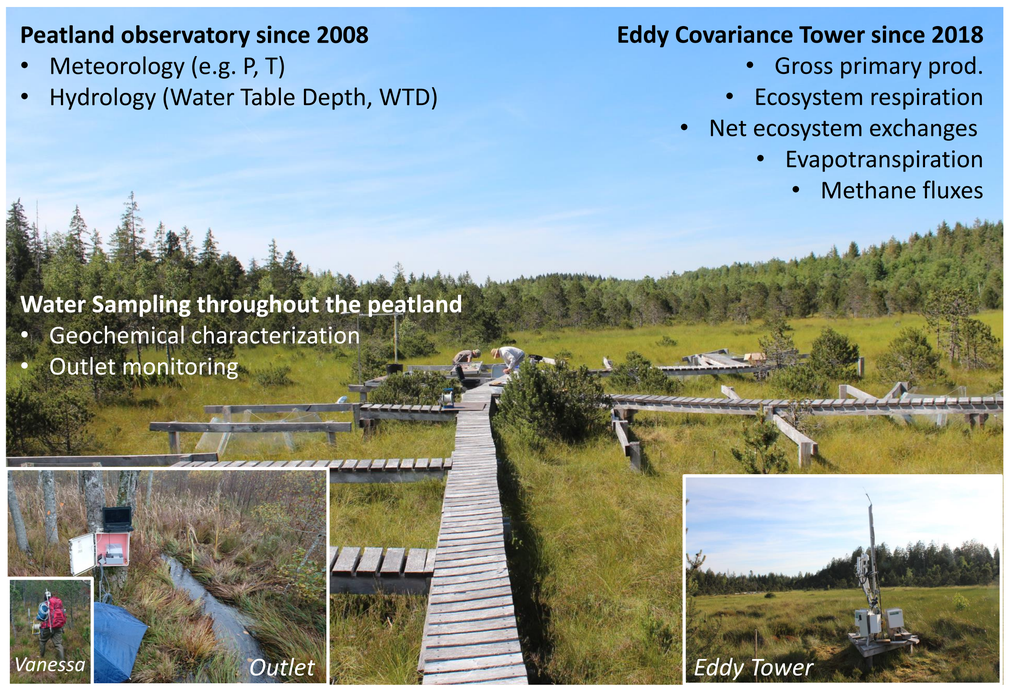
**These heterogeneities could favor a patchwork-like hydro-ecological functioning.**

## III Materials and methods

**Peatland observatory since 2008**
- Meteorology (e.g. P, T)
- Hydrology (Water Table Depth, WTD)

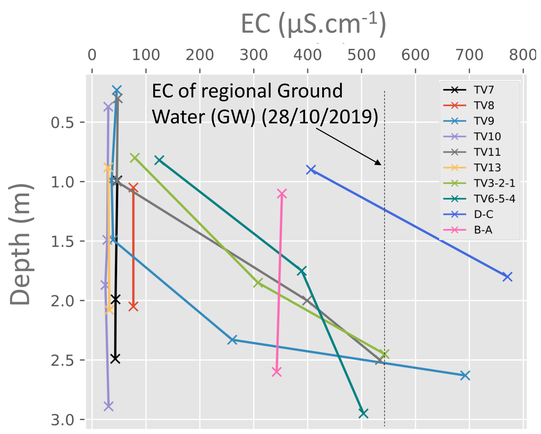
**Eddy Covariance Tower since 2018**
- Gross primary prod.
- Ecosystem respiration
- Net ecosystem exchanges
- Evapotranspiration
- Methane fluxes

**Water Sampling throughout the peatland**
- Geochemical characterization
- Outlet monitoring



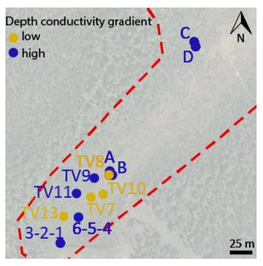

## IV A Hydro-geochemical mosaic?

### ❑ Electrical Conductivity (EC; Nov. 2018): A vertical mosaic?

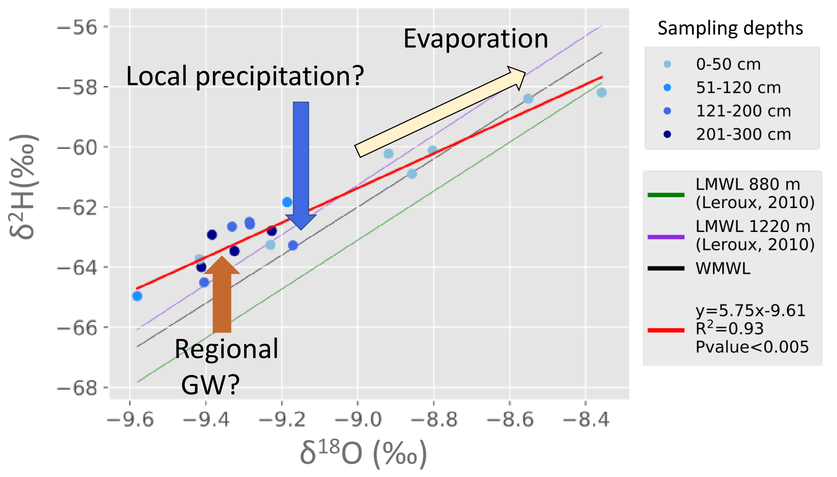



- Heterogeneous vertical EC gradient throughout the peatland.

→ Irregular peat/moraine contact? Small-scaled permeability and pressure changes as suggested by Hare et al. (2017)?



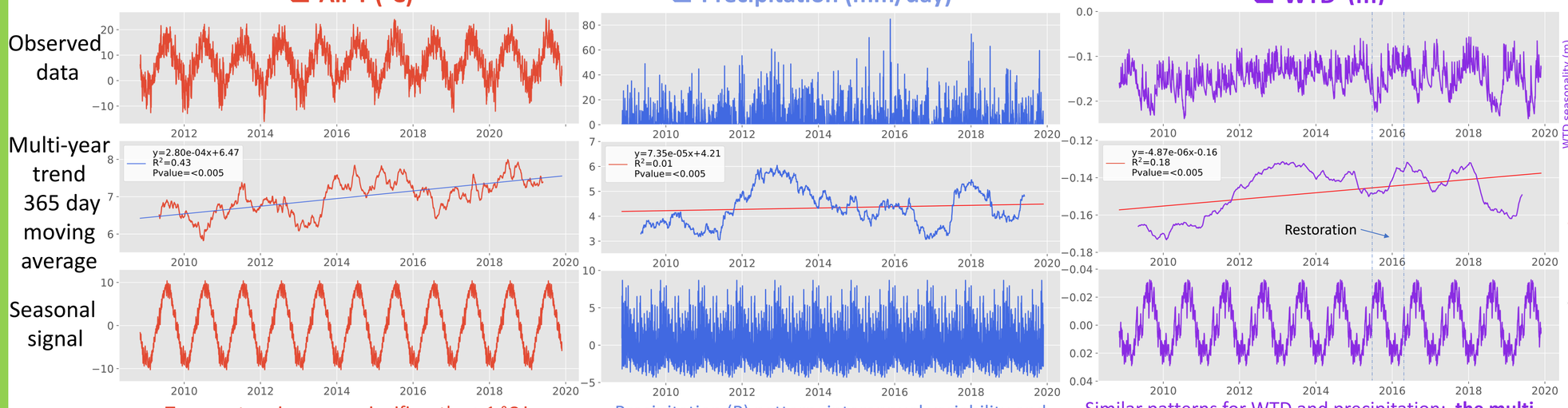

### ❑ Water isotopic signature (Aug. 2016): A mosaic of water origins and fates?




- Deepest water (< -50 cm) close to the LMWL (1200 m).
- Enriched superficial water (> -50 cm) suggesting evaporation.

**→ 2 hypotheses : (1) Water/moraine interaction may vary laterally due to variable residence times, leading to contrasted EC. (2) Alternatively, punctual injection of karstic water at the bottom of the peatland.**

## V 10 years of hydro-meteorological monitoring, decomposition, and relationships

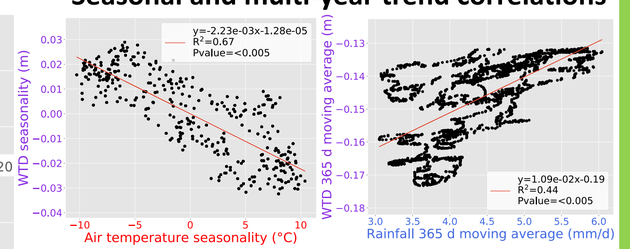



Temperature increases significantly: + 1 °C in 10 years.

Precipitation (P) pattern: interannual variability and slight increase since 2008.

Similar patterns for WTD and precipitation: **the multi-year WTD follows precipitation.** Buffered impact of the restoration at the center of the peat.

### Seasonal and multi-year trend correlations




- Seasonal T variability **explains 67 %** of the WTD variability, highlighting **the importance of evapotranspiration for seasonal WTD changes**.
- In contrast, P seasonality is not relevant for seasonal WTD changes, **but P multi-year trend may explain 44 % of the WTD multi-year trend.**

**→ Ongoing climate evolution implies contrasted effects with variable temporal scales over the peatland WTD.**

## VI Preliminary results from 1,5 year of Eddy Covariance monitoring Potential links with hydrology

Net Ecosystem Exchange [NEE] ($\mu molCO_2.m^{-2}.s^{-1}$)

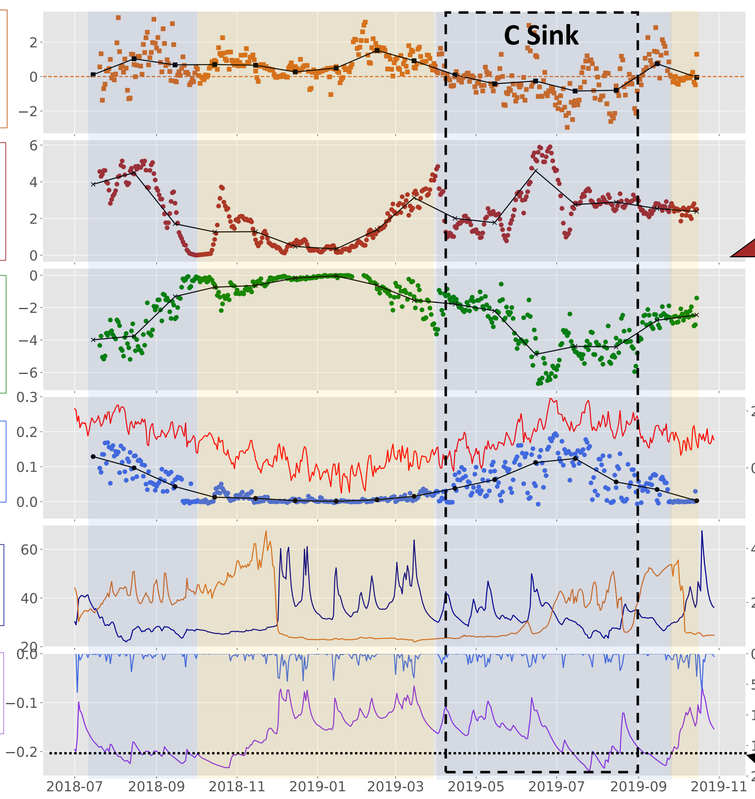
Ecosystem respiration [$R_{ECO}$] ($\mu molCO_2.m^{-2}.s^{-1}$)

Gross Primary Production [GPP] ($\mu molCO_2.m^{-2}.s^{-1}$)

Evapotranspiration ($mm\ H_2O.h^{-1}$)

Outlet water level (cm)

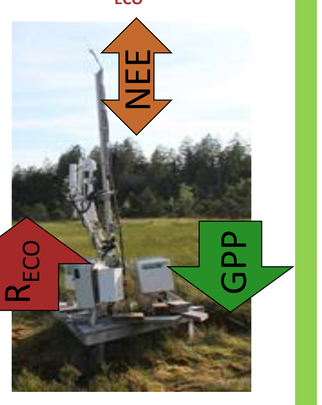
Piezometer WTD (m)




**High activity**

**Low activity**

NEE = $R_{ECO}$+GPP




### Atmospheric $CO_2$ fluxes

- The peatland was a $CO_2$ sink in summer 2019, but a source of $CO_2$ during the rest of the time.
- C balance of the peatland since July 2008: +167,8 gC/m².

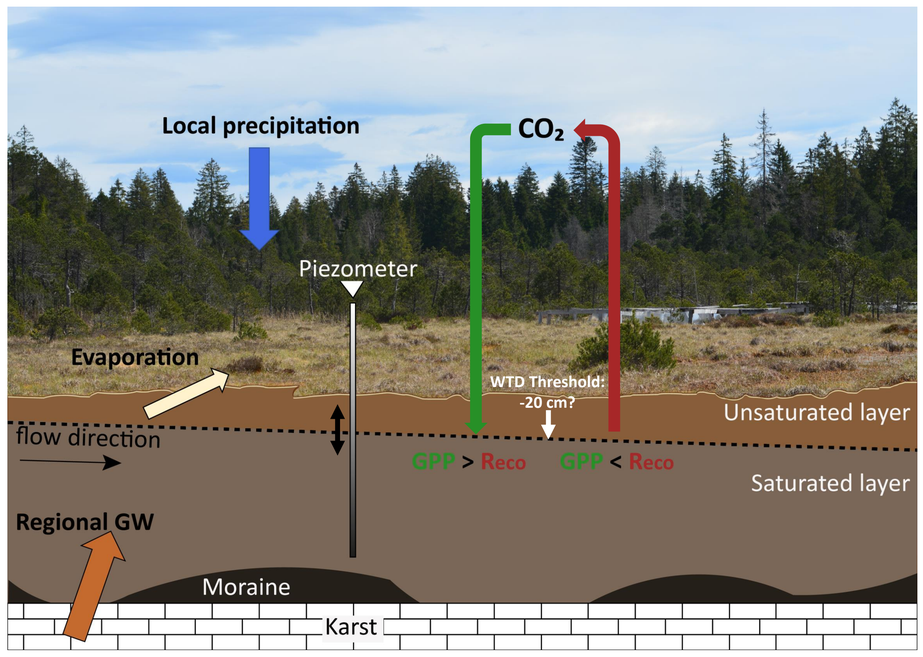
### Outlet flow monitoring

- Low EC during high flow (winter), high EC in summer.

→ Mobilization of strongly mineralized deep peat water or input of GW (moraines, karst) during dry periods.

**→ C sink function (NEE <0) partially dependent on the hydrological conditions. In particular, during the maximum metabolism period (ET>>0), great WTD (below -0,20 m) seems to be associated with a source function ($R_{ECO}$>|GPP|). In contrast, when WTD is closer to the surface, |GPP|> $R_{ECO}$).**

## VII Take Home Messages: Synthesis → Perspective




- **Water supply** from local P + regional GW? → To be evaluated through to LMWL under construction.
- **WTD evolution** strongly controlled by long-term P trend and seasonal T trend: multiscale temporal sensitivity → Hydro-climatic modelling for IPCC's scenarios (RCP's 4.5 and 8.5) until 2100 in progress.
- **Atmosphere-peatland C** exchange potentially changing when WTD = -0,20 m during active metabolism period. Lack of hindsight of restoration impact. → Need to integrate the interaction between the C, water, biodiversity pillars: $CH_4$ and $CO_2$ flux measurements combined with hydro-ecological conditions across the mosaic (WTD, peat T°, water quality, snow cover, vegetation type) starting in 2020 (See you next year? ;-)).

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