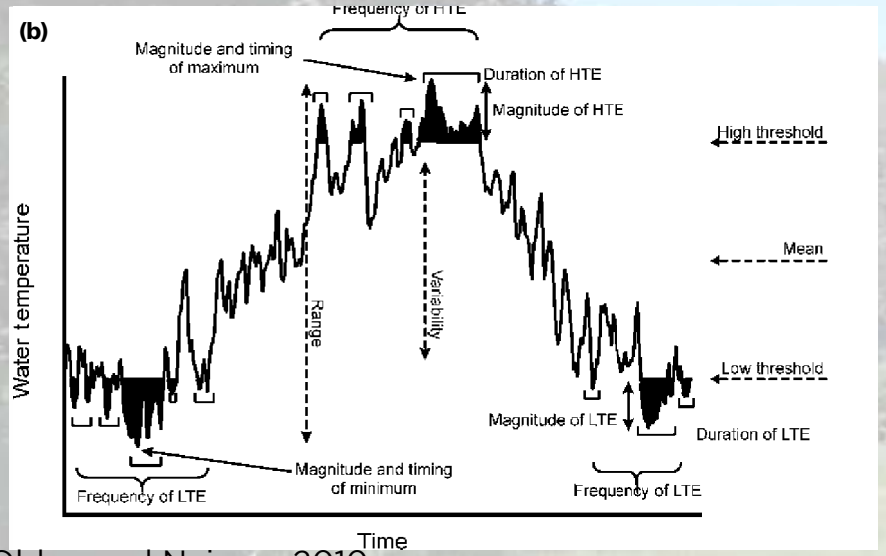
La thermie des rivières des Vosges du Nord : effets mesurés et anticipés de différentes contraintes anthropiques

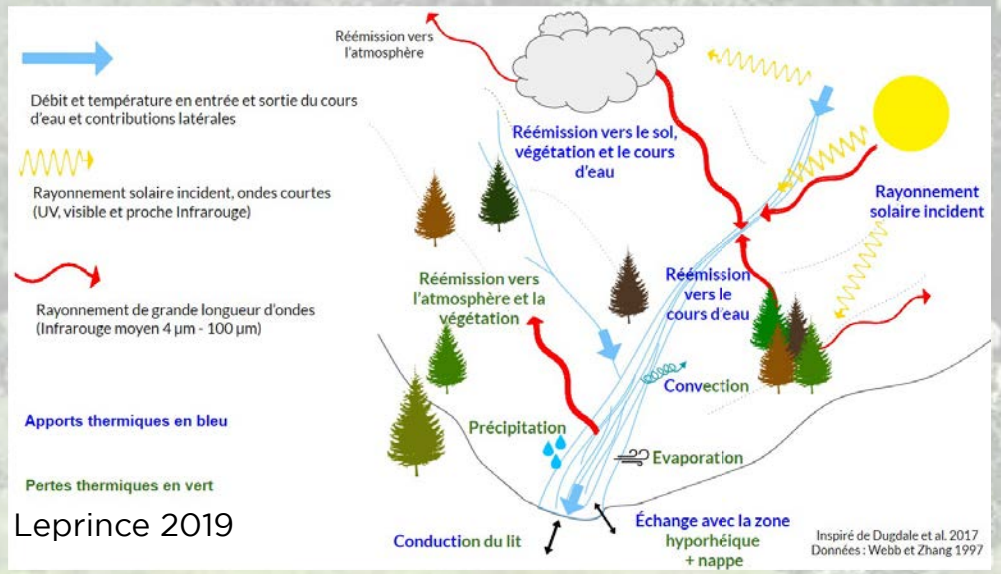
Paul Bois, ENGEES/Icube

Bad Bergzabern (D), 06/10/2023

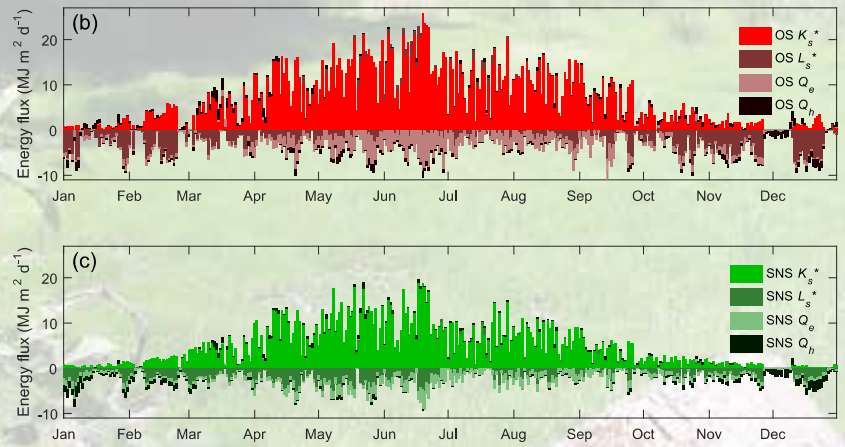
Contexte



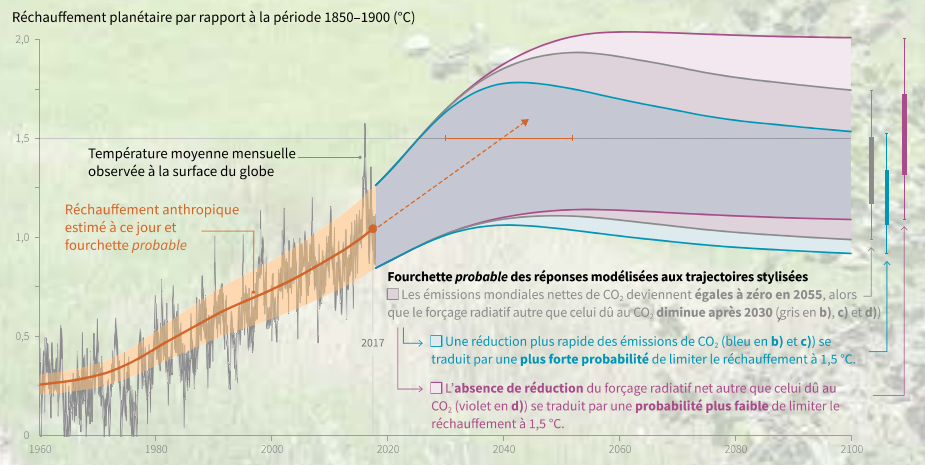
Olden and Naiman 2010



Leprince 2019



Dugdale et al. 2018



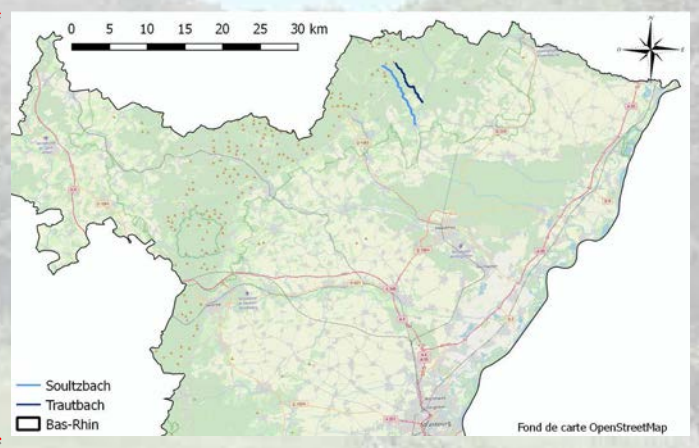
IPCC 2019

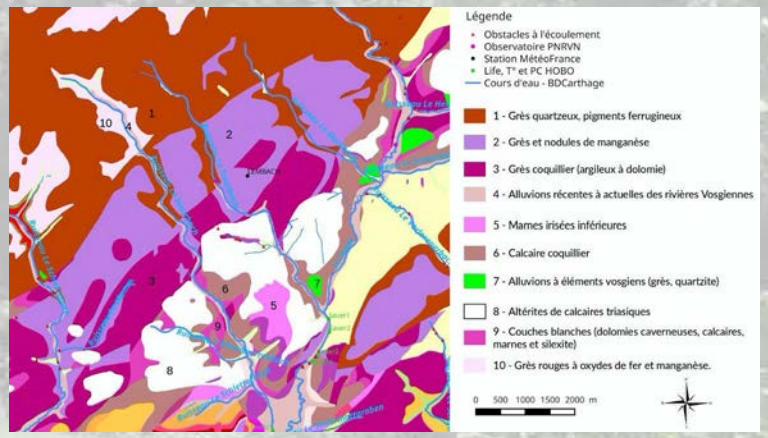
Objectifs

- Mesurer et suivre l'évolution de température sur 2 cours d'eau des Vosges du Nord
- Evaluer l'impact des retenues d'eau
- Evaluer la contribution thermique du sous-écoulement (hyporheos)

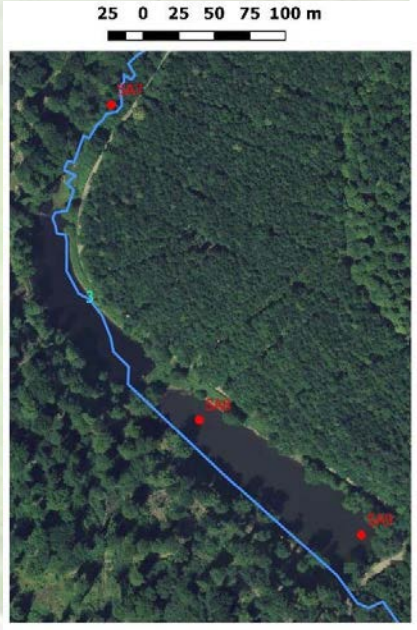
Site d'étude

OpenStreetMap 2021





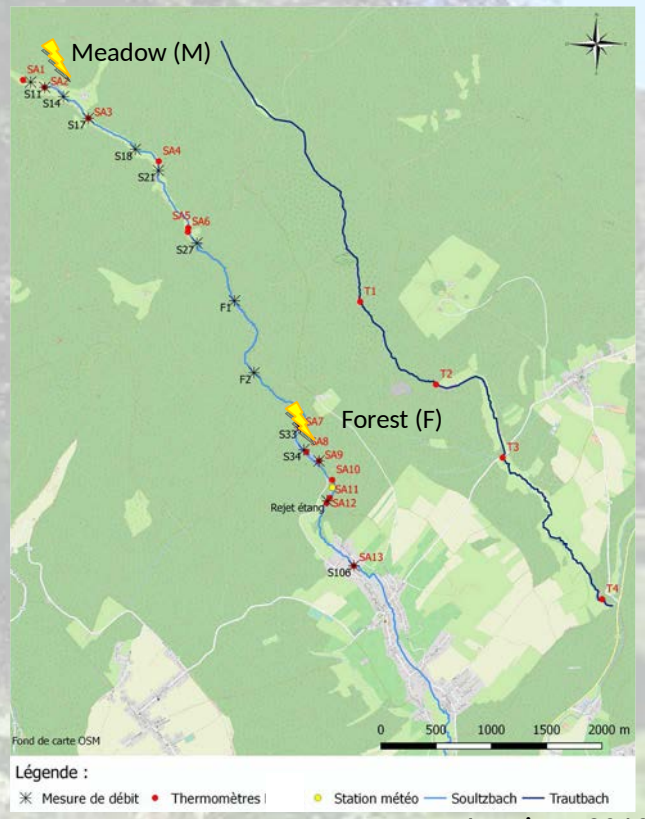
BDCharm BRGM



Orthophotography CIGAL Grand Est

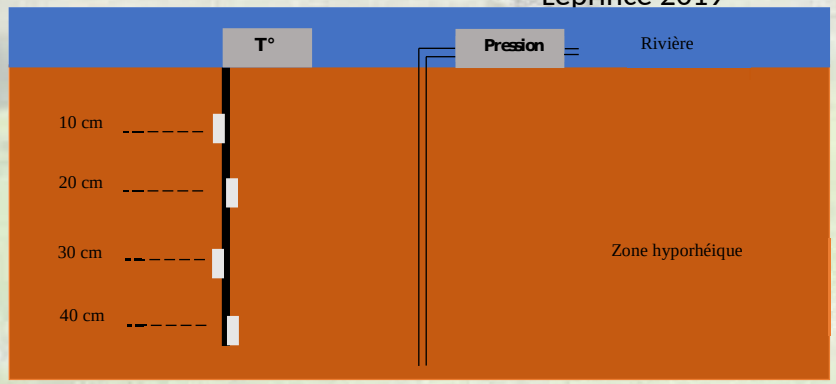
Wasgauer Gespräche

Matériel et Méthodes



Leprince 2019

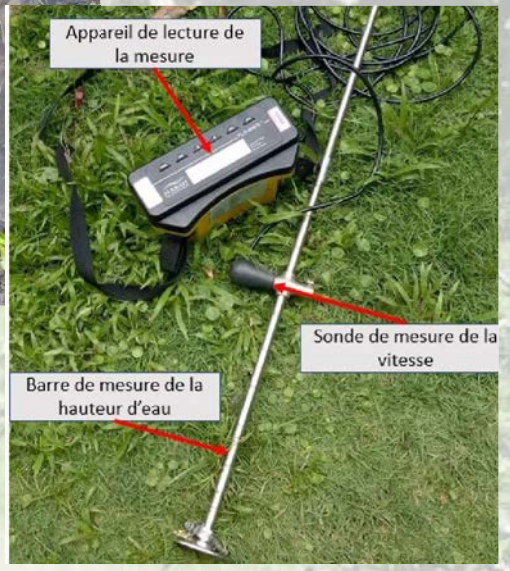
Leprince 2019



Leprince 2019

Leprince 2019

Soullié 2020



- Mars 2019 à Décembre 2021
- Température de l'eau paramètres climatiques
- Hauteur piézométrique et température du sous-écoulement
- Débit

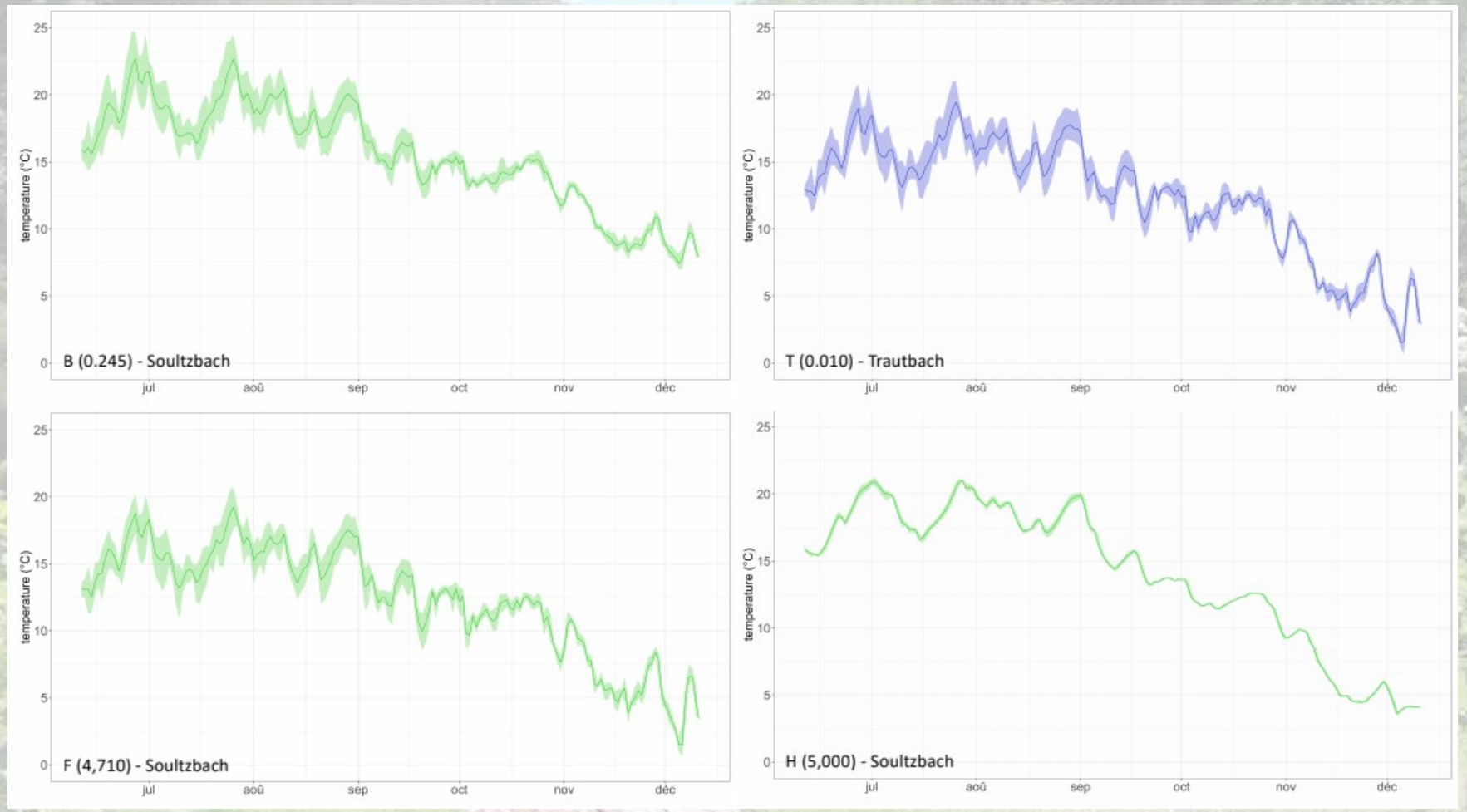
Influence des retenues d'eau - Températures à l'aval

Table 3. Daily mean, minimum, maximum, and standard deviation of stream temperature.

			Whole period				*Summer*				*Fall*			
		KP (m)	mean	Min	Max	SD	mean	Min	Max	SD	mean	Min	Max	SD
Soultzbach	Source impoundment													
	A	0	11.8	4.2	24.4	3.2	14.1	9.9	24.4	1.6	8.8	4.2	12.6	2.2
	Run-of-the-river impoundment													
	B	245	15.5	7.0	24.8	3.8	18.2	12.3	24.8	2.0	12.0	7.0	15.9	2.5
	C	1,870	11.9	3.4	22.7	3.0	14.0	9.0	22.7	1.3	9.3	3.4	13.1	2.3
	D	2,240	11.8	3.4	19.6	2.8	13.7	8.9	19.6	1.1	9.4	3.4	13.3	2.3
	E	4,710	12.4	0.6	20.7	4.1	15.2	8.5	20.7	1.8	8.8	0.6	13.7	3.2
	Run-of-the-river impoundment													
	F	5,000	14.1	3.4	21.2	5.1	18.0	13.5	21.2	1.8	9.3	3.4	13.8	3.5
	G	5,140	13.9	2.9	21.8	5.2	17.8	13.1	21.8	1.8	9.0	2.9	14.0	3.6
	H	5,560	12.2	4.2	18.3	3.1	14.4	10.3	18.3	1.3	9.5	4.2	13.3	2.5
	Outflow from by-pass impoundment													
	I	5,620	14.0	4.2	21.5	4.3	17.3	12.6	21.5	1.6	9.9	4.2	14.0	2.9
Trautbach	T	10	12.5	0.7	21.0	4.2	15.4	9.3	21.0	1.9	8.8	0.7	13.8	3.4
	U	2,350	12.4	2.3	20.1	3.2	14.6	9.0	20.1	1.3	9.7	2.3	14.6	2.8
	V	4,250	13.1	3.1	20.7	3.8	15.7	9.9	20.7	1.7	9.7	3.1	14.0	2.9

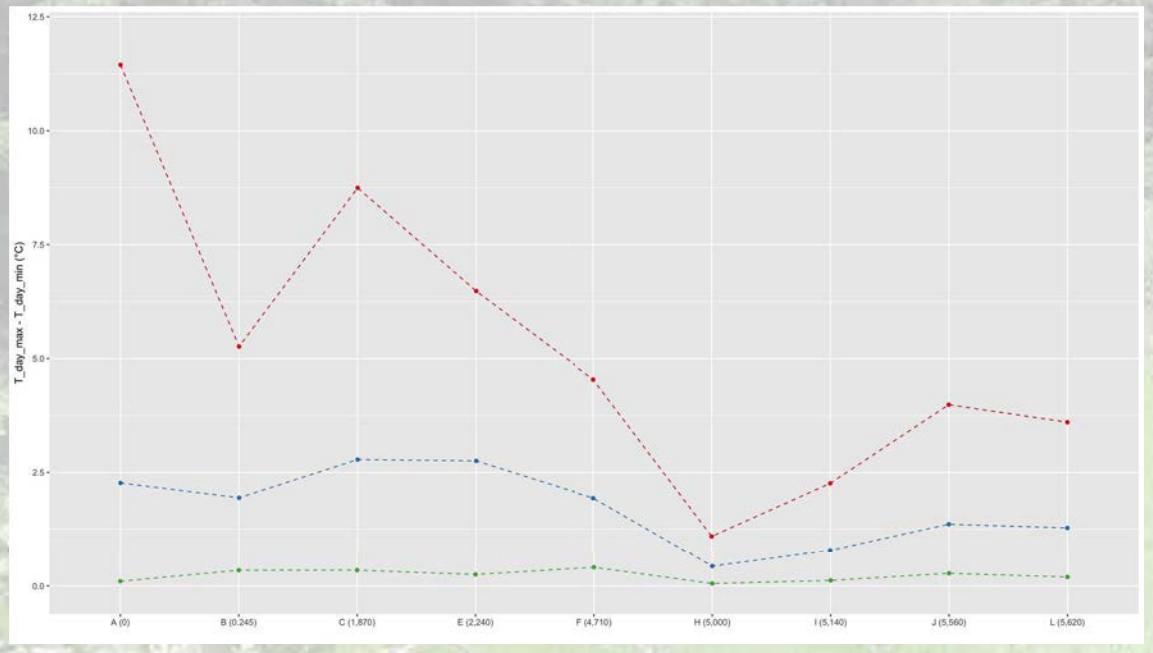
Summer: from June 11th to September 20th. Fall: from September 21st to December 11th. Green background indicates forest landscape, while orange background indicates open grassland landscape. The kilometric point (KP) indicates distance from the stream source. Dates when minimal and maximal temperatures were reached are indicated in S1A Table.

Influence des retenues d'eau – Dynamique temporelle

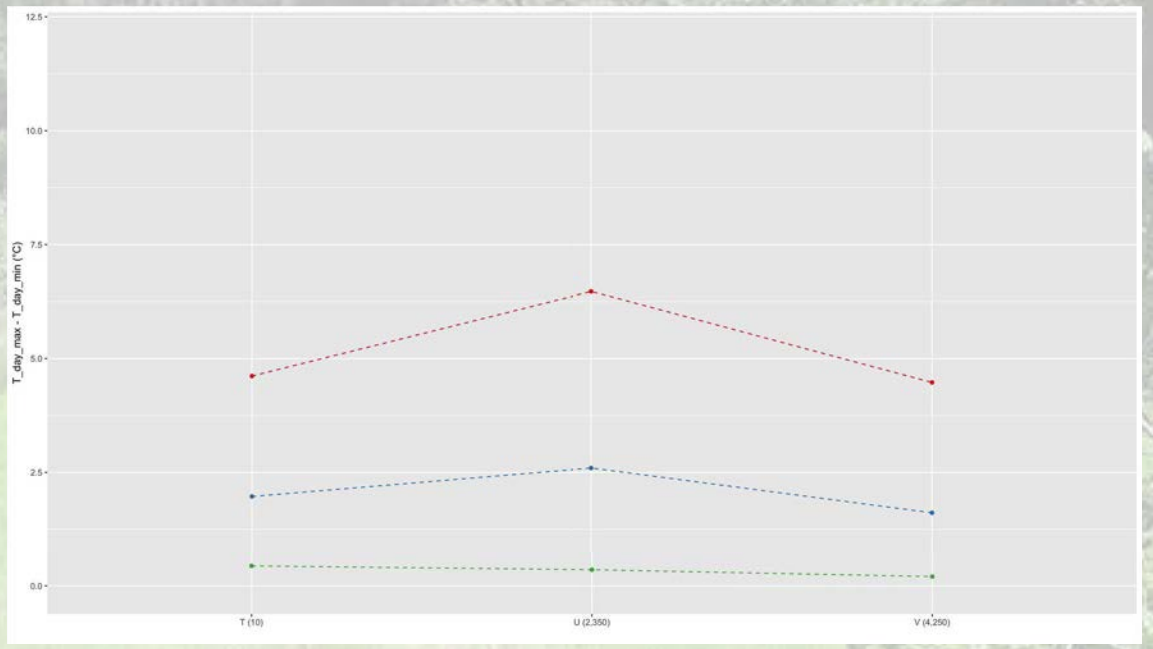


Influence des retenues d'eau – Amplitude thermique

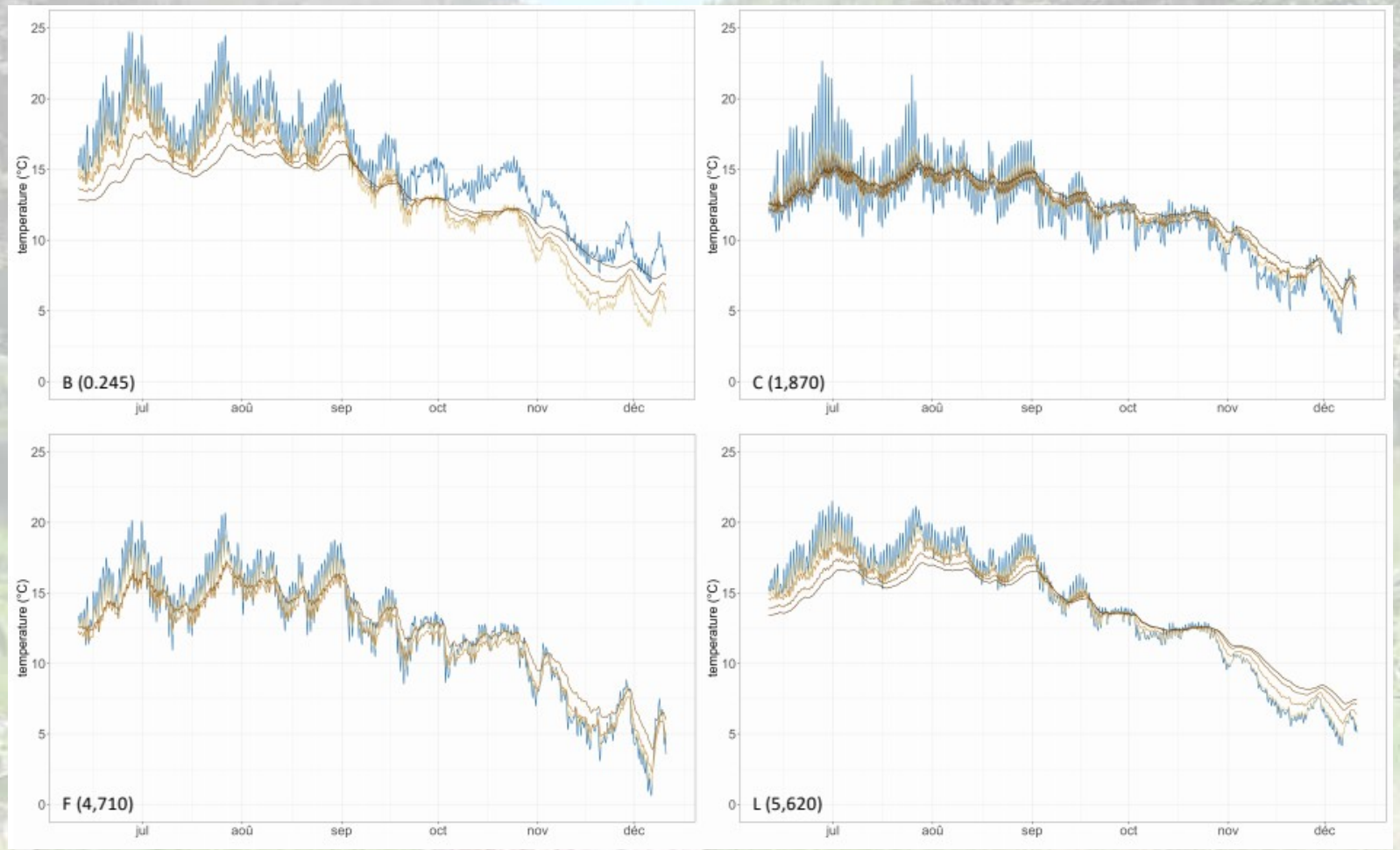
Soultzbach



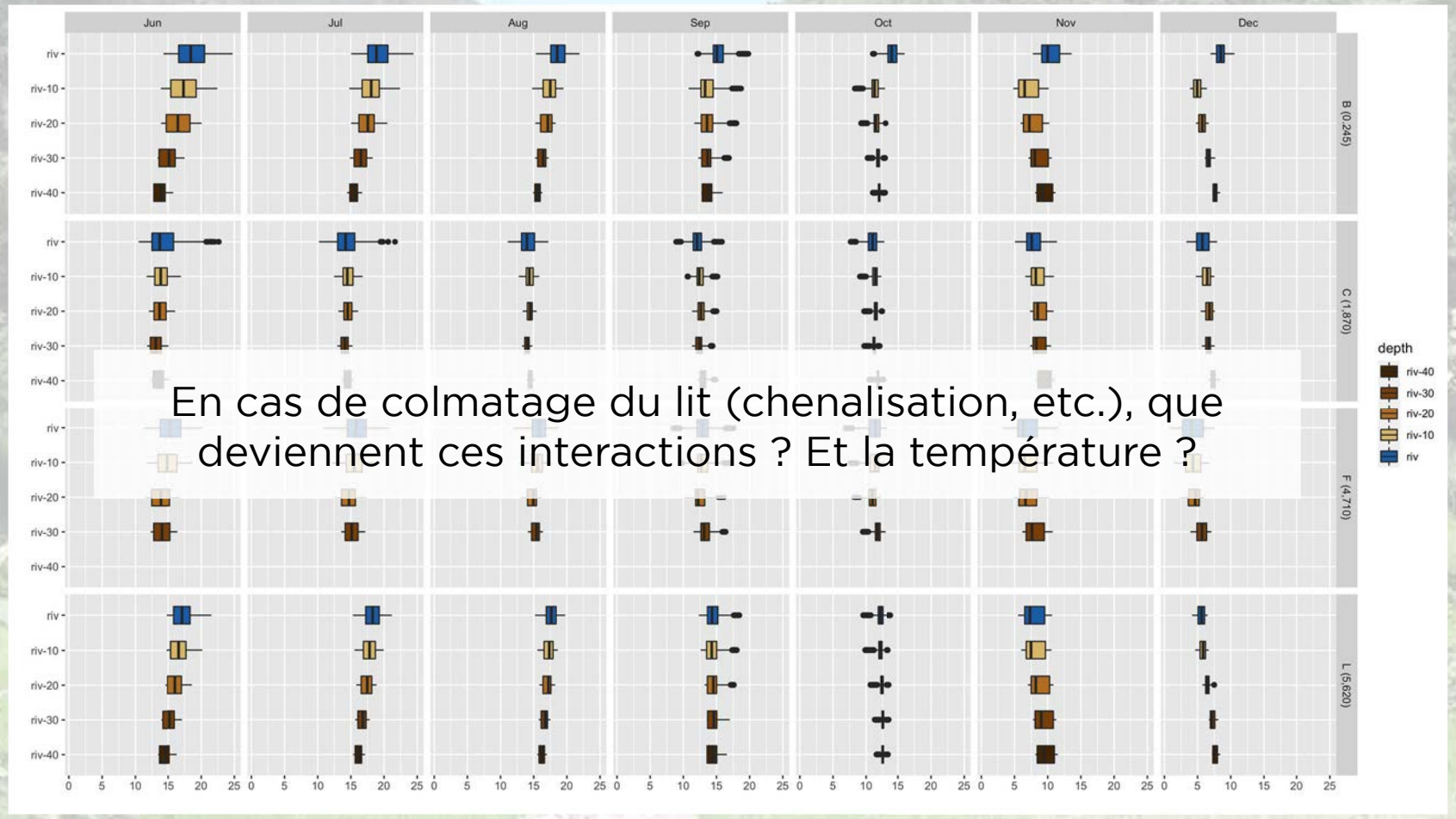
Trautbach (témoin)



Hyporheos


B (0.245)
C (1,870)
F (4,710)
L (5,620)
temperature (°C)
0
5
10
15
20
25
jul
août
sep
oct
nov
déc

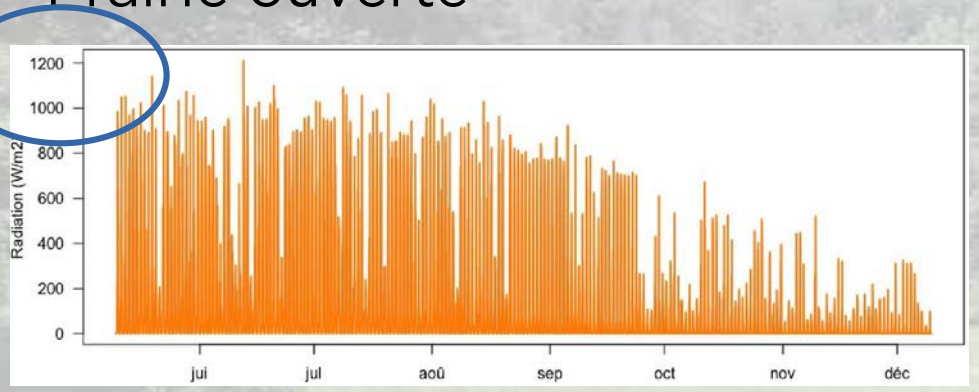
Hyporheos



En cas de colmatage du lit (chenalisation, etc.), que deviennent ces interactions ? Et la température ?

Ripisylve

Prairie ouverte



Forêt

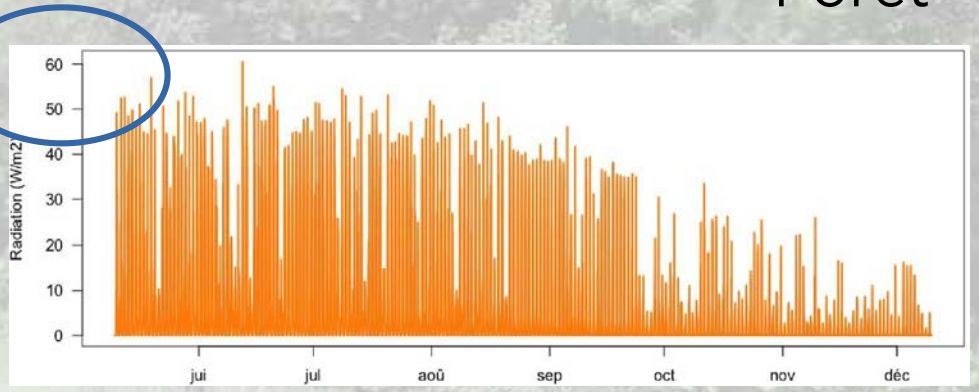


Table 3. Daily mean, minimum, maximum, and standard deviation of stream temperature.

			Whole period				*Summer*				*Fall*			
		KP (m)	mean	Min	Max	SD	mean	Min	Max	SD	mean	Min	Max	SD
Soultzbach	Source impoundment													
	A	0	11.8	4.2	24.4	3.2	14.1	9.9	24.4	1.6	8.8	4.2	12.6	2.2
	Run-of-the-river impoundment													
	B	245	15.5	7.0	24.8	3.8	18.2	12.3	24.8	2.0	12.0	7.0	15.9	2.5
	C	1,870	11.9	3.4	22.7	3.0	14.0	9.0	22.7	1.3	9.3	3.4	13.1	2.3
	D	2,240	11.8	3.4	19.6	2.8	13.7	8.9	19.6	1.1	9.4	3.4	13.3	2.3
	E	4,710	12.4	0.6	20.7	4.1	15.2	8.5	20.7	1.8	8.8	0.6	13.7	3.2
	Run-of-the-river impoundment													
	F	5,000	14.1	3.4	21.2	5.1	18.0	13.5	21.2	1.8	9.3	3.4	13.8	3.5
	G	5,140	13.9	2.9	21.8	5.2	17.8	13.1	21.8	1.8	9.0	2.9	14.0	3.6
	H	5,560	12.2	4.2	18.3	3.1	14.4	10.3	18.3	1.3	9.5	4.2	13.3	2.5
	Outflow from by-pass impoundment													
	I	5,620	14.0	4.2	21.5	4.3	17.3	12.6	21.5	1.6	9.9	4.2	14.0	2.9
Trautbach	T	10	12.5	0.7	21.0	4.2	15.4	9.3	21.0	1.9	8.8	0.7	13.8	3.4
	U	2,350	12.4	2.3	20.1	3.2	14.6	9.0	20.1	1.3	9.7	2.3	14.6	2.8
	V	4,250	13.1	3.1	20.7	3.8	15.7	9.9	20.7	1.7	9.7	3.1	14.0	2.9

Summer: from June 11th to September 20th. Fall: from September 21st to December 11th. Green background indicates forest landscape, while orange background indicates open grassland landscape. The kilometric point (KP) indicates distance from the stream source. Dates when minimal and maximal temperatures were reached are indicated in S1A Table.

Les cours d'eau de tête de bassin versant ont une faible inertie thermique, et peuvent revenir à température (si l'occasion leur en est laissée)

En bref

- Evolution saisonnière et spatiale de la température du cours d'eau
- Impact marqué des retenues d'eau (hausse de température, diminution de variabilité et d'amplitude thermique)
- Variabilité forte au niveau du sous-écoulement, peut être amoindrie en cas d'aménagement morphologique
- Forte contribution du rayonnement, évoluant avec les caractéristiques de la ripisylve

- Les contraintes anthropiques variées pouvant s'exercer sur les cours d'eau ont un large panel d'impacts, dont l'impact thermique direct (avec des répercussions indirectes)

Merci de votre attention

Avez-vous des questions ?

- Remerciements : stagiaires (Corentin Leprince, Paul Soullié, Alexis Gobet, Jean-Baptiste Josselin), post-docs, techniciens de laboratoire, chercheurs et enseignant-chercheurs (J.-N. Beisel), gestionnaires du PNRVN (A. Cairault)
- Financement : OFB (projet ICRA), ENGEES (Conseil Scientifique)

Références :

- Bois P, Beisel J-N, Rivière A (2021) Groundwater contribution to thermal regime of the rivers: investigation on a small, forested stream on sandstone soil. First OZCAR-TERENO International Conference. 4-8/10/2021, Strasbourg (F)
- Bois P, Beisel J-N, Cairault A, Flipo N, Leprince C, Rivière A (2023) Water temperature dynamics in a headwater forest stream: Contrasting climatic, anthropic and geological conditions create thermal mosaic of aquatic habitats. PLoS ONE 18(2): e0281096. https://doi.org/10.1371/journal.pone.0281096
- Leprince C (2019) Modélisation thermique des cours d'eau de tête de bassin versant : chaîne analytique et premières observations. M2 Thesis, ENGEES
- Olden JD, Naiman RJ (2010) Incorporating thermal regimes into environmental flows assessments: modifying dam operations to restore freshwater ecosystem integrity. Freshwater Biology. 55(1):86–107
- Dugdale SJ, Malcolm IA, Kantola K, Hannah DM (2018) Stream temperature under contrasting riparian forest cover: Understanding thermal dynamics and heat exchange processes. Science of the Total Environment. 2018; 610:1375–89. https://doi.org/10.1016/j.scitotenv.2017.08.198 PMID: 28851157
- IPCC (2019) Report on climate change