



The thermal regime of abandoned channels

Towards a water temperature model for the
River Allier, France

Ana CASADO and Jean-Luc PEIRY

EGU General Assembly, 27 April to 02 May 2014, Vienna



GEOLAB UMR 6042
Université Blaise Pascal - CNRS



Agence de l'Eau Loire-Bretagne
Etablissement Public Loire

River water temperature = heat energy / water volume

Drivers of water temperature

Atmospheric processes

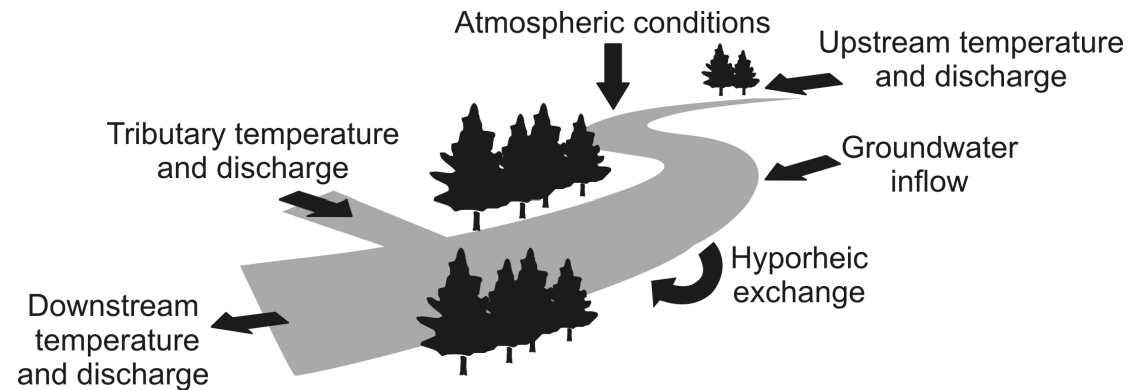
air/water surface heat exchange

Hydrological processes

volume of water – mixing of water

Streambed processes

water/stream bed heat exchange



How these processes drive water temperature in abandoned channels?

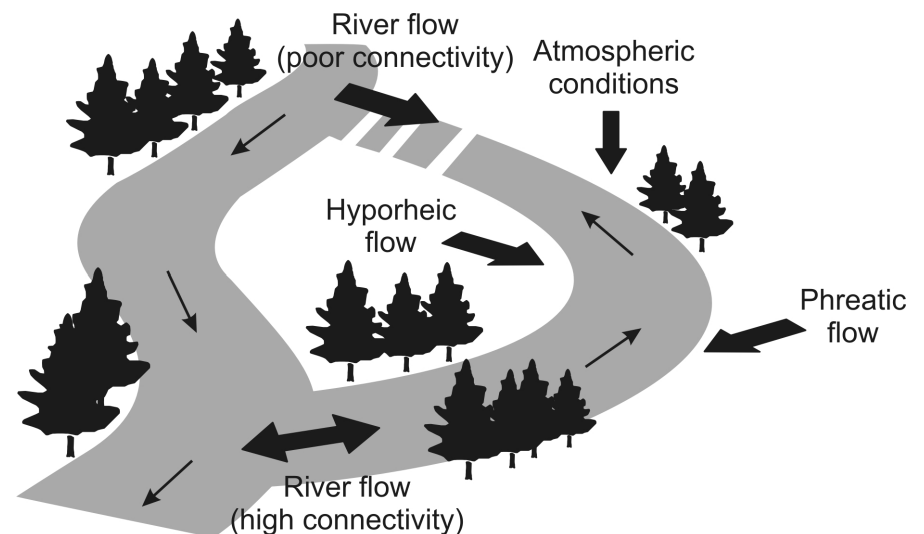
Triple hydrological influence

Hyporheic flow

Phreatic flow

River flow

Temporal and spatial variations of hydrological connectivity



WATER TEMPERATURE ABANDONED CHANNELS

upstream section \neq downstream section



What is the thermal behaviour of abandoned channels?

1. Thermal regime assessment

Regime type, frequency and seasonality
Upstream section vs downstream section



Which factors influence the thermal regimes?

2. Sensitivity assessment

Air
temperature

River water
temperature

Groundwater
temperature



To which degree?

3. Identifying thresholds of thermal influence

Ambient
conditions



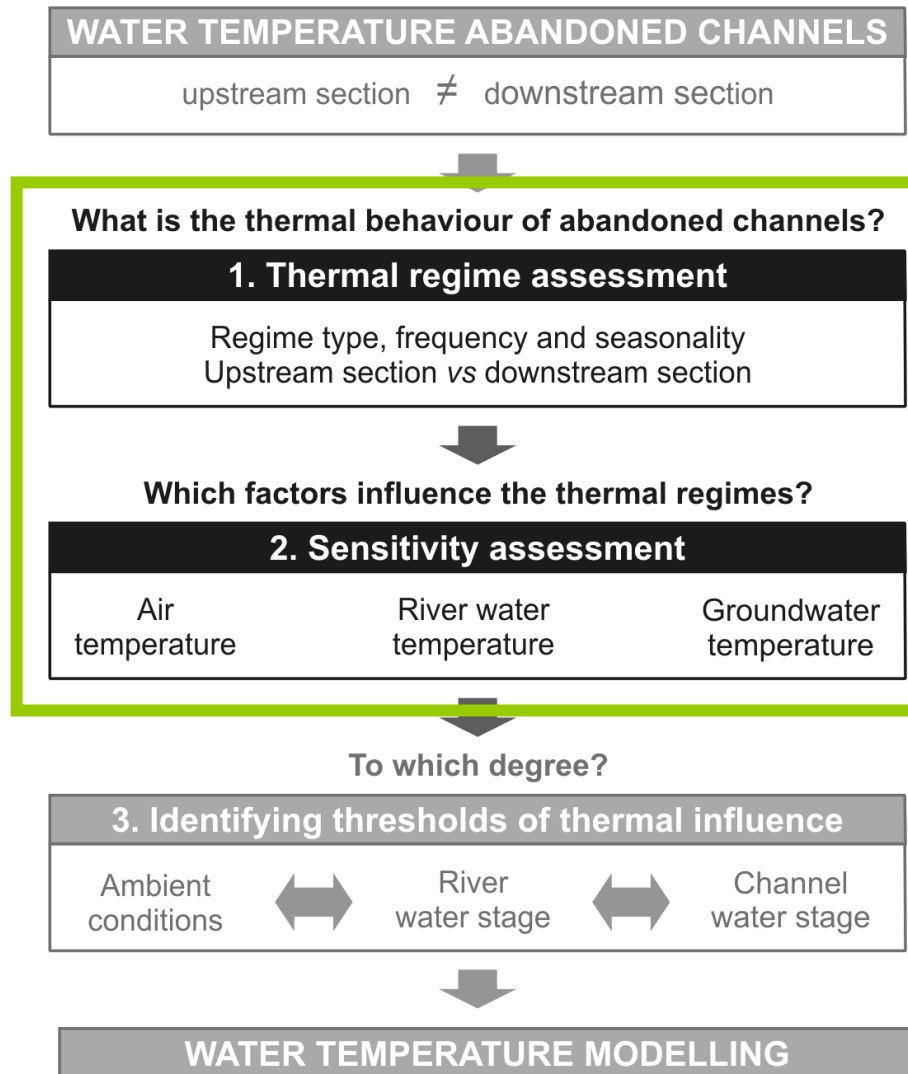
River
water stage



Channel
water stage

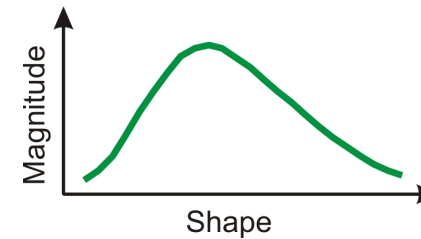


WATER TEMPERATURE MODELLING



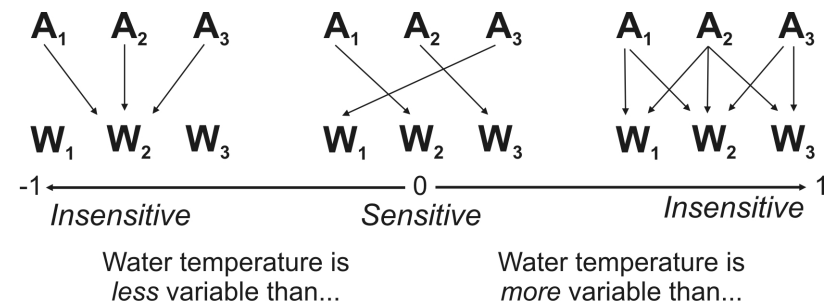
1. Thermal regime classification

Hierarchical clustering of thermal regimes
Shape (timing) & Magnitude (size)
(Hannah *et al.*, 2000)



2. Regime sensitivity assessment

Equitability Index → regime stability
Sensitivity Index → regime sensitivity
(Bower *et al.*, 2004)



WATER TEMPERATURE ABANDONED CHANNELS

upstream section \neq downstream section

What is the thermal behaviour of abandoned channels?

1. Thermal regime assessment

Regime type, frequency and seasonality
Upstream section vs downstream section

Which factors influence the thermal regimes?

2. Sensitivity assessment

Air
temperature

River water
temperature

Groundwater
temperature

To which degree?

3. Identifying thresholds of thermal influence

Ambient
conditions

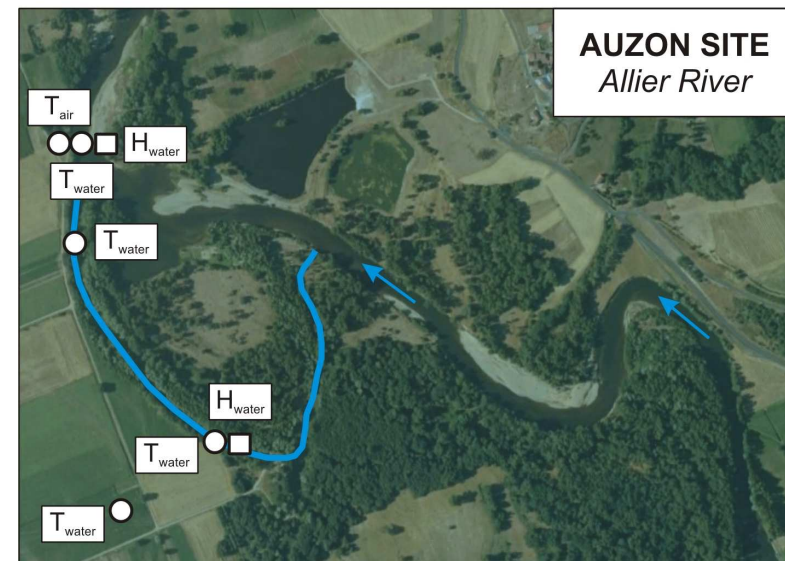
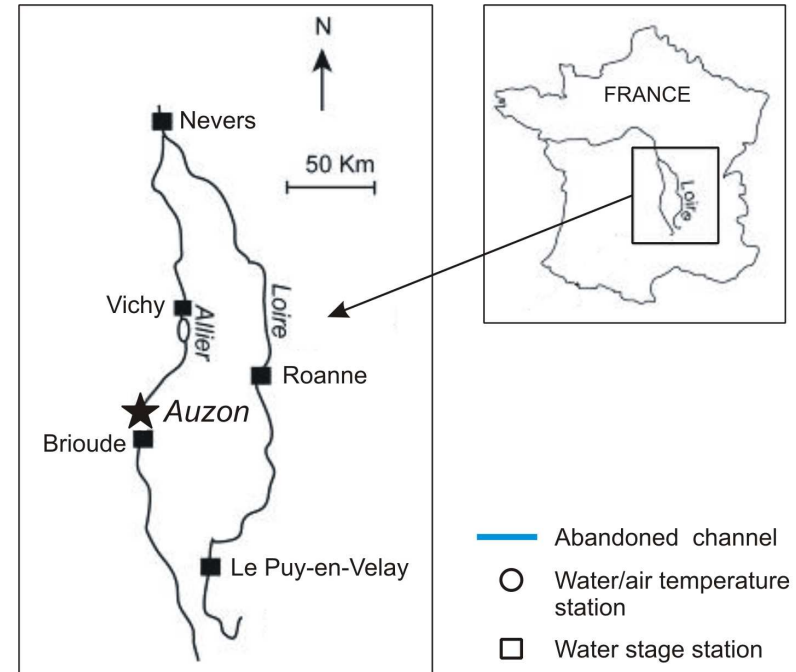


River
water stage



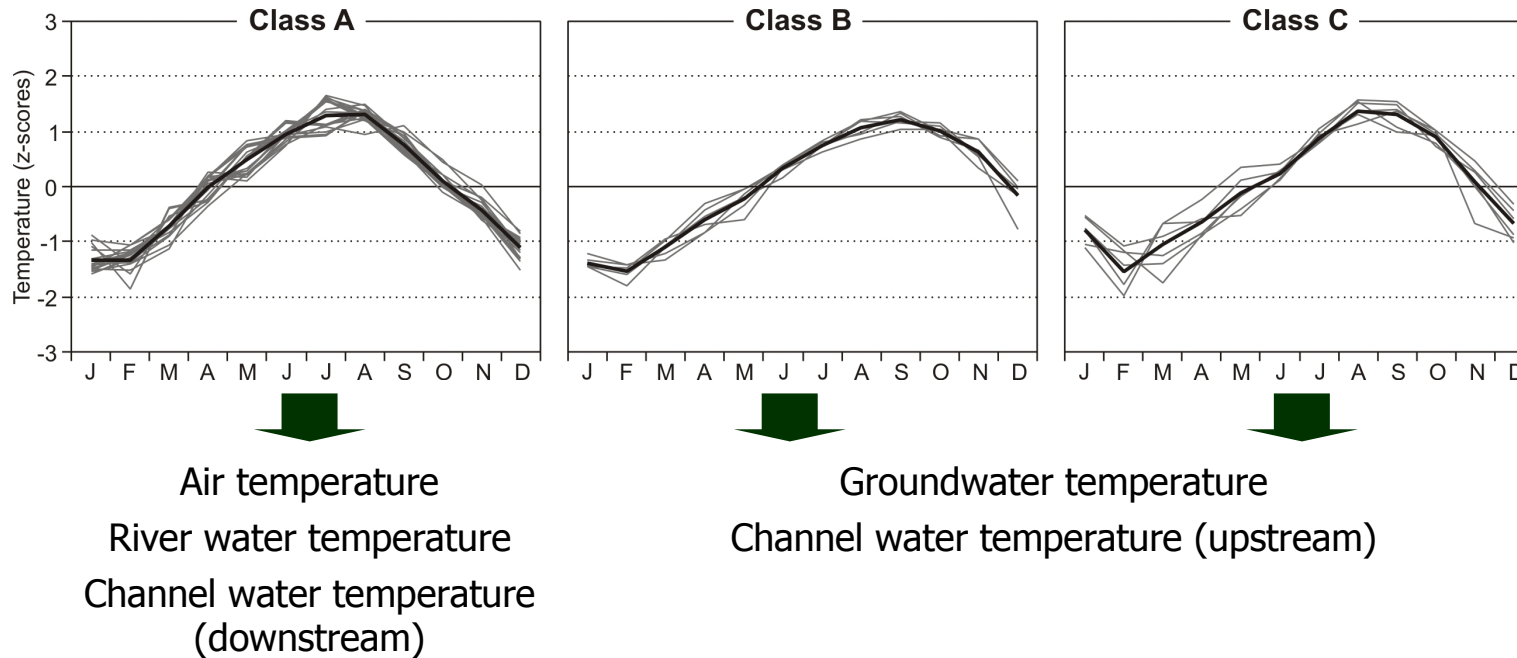
Channel
water stage

WATER TEMPERATURE MODELLING



Annual thermal regimes

3 classes of *regime shape* for all stations



Annual thermal regimes

3 classes of *regime magnitude* for all stations > **Class 1** = high magnitude and **Class 3** = low magnitude

Class 1 = air temperature regimes

Class 2 = river water temperature regimes

Class 3 = groundwater and channel water temperature regimes

Diurnal thermal regimes

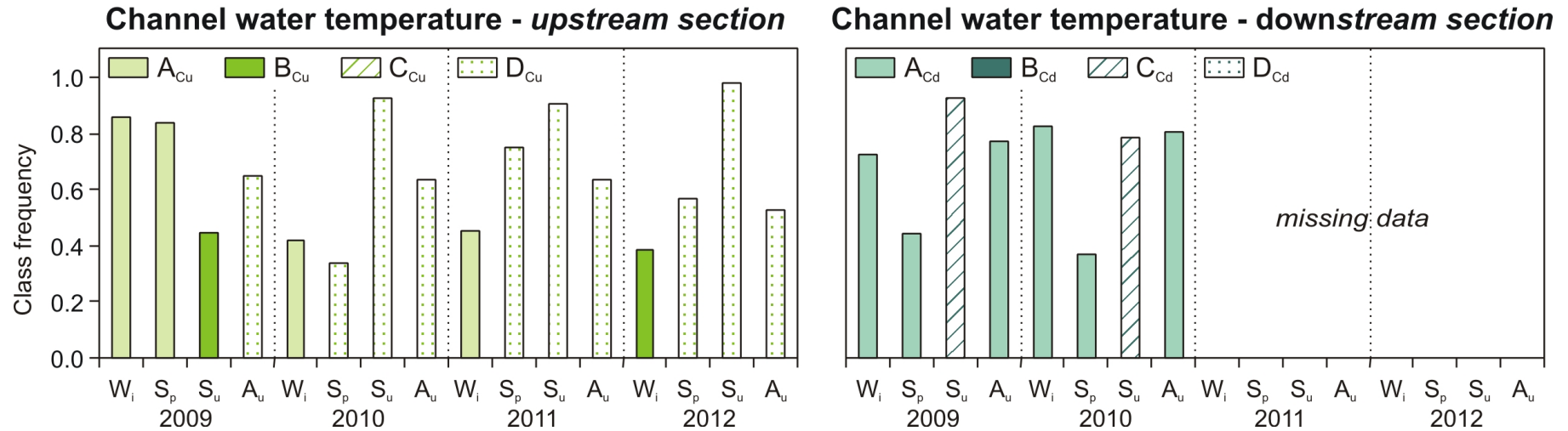
Complexity of *regime shape* classes among stations

4 classes of relative *regime magnitude* by station > **Class 1** = high magnitude and **Class 4** = low magnitude

Class frequency

Seasonality of regime shape classes

DOMINANT REGIME SHAPE CLASS PER SEASON



Diurnal thermal regimes

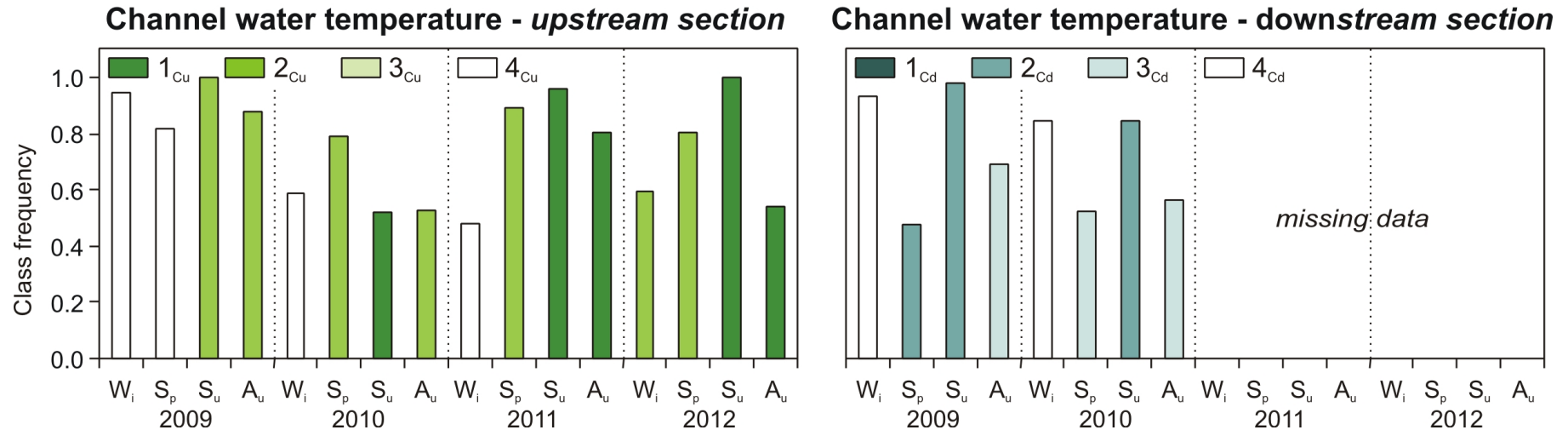
Complexity of *regime shape* classes among stations

4 classes of relative *regime magnitude* by station > **Class 1** = high magnitude and **Class 4** = low magnitude

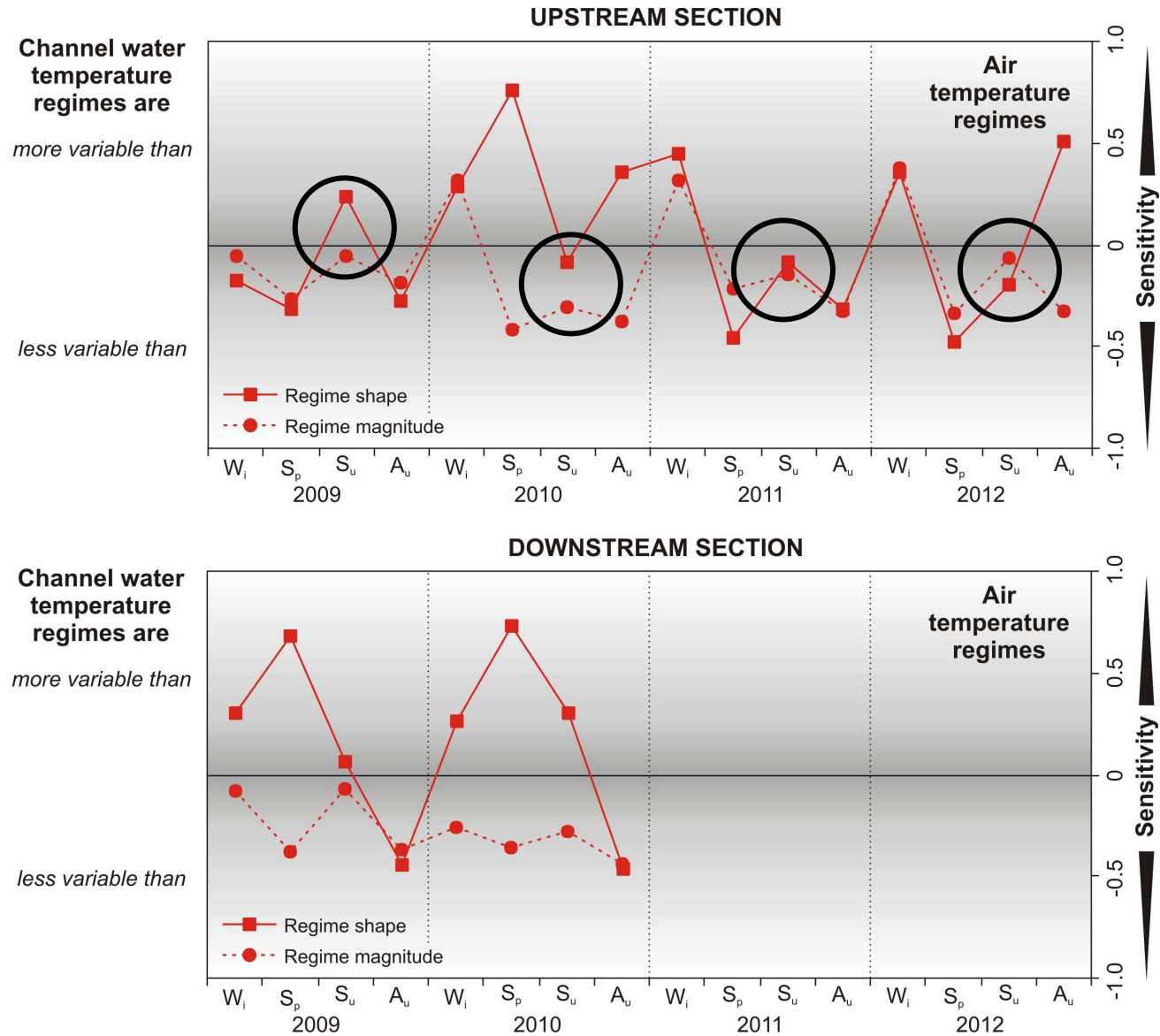
Class frequency

Seasonality of regime magnitude classes

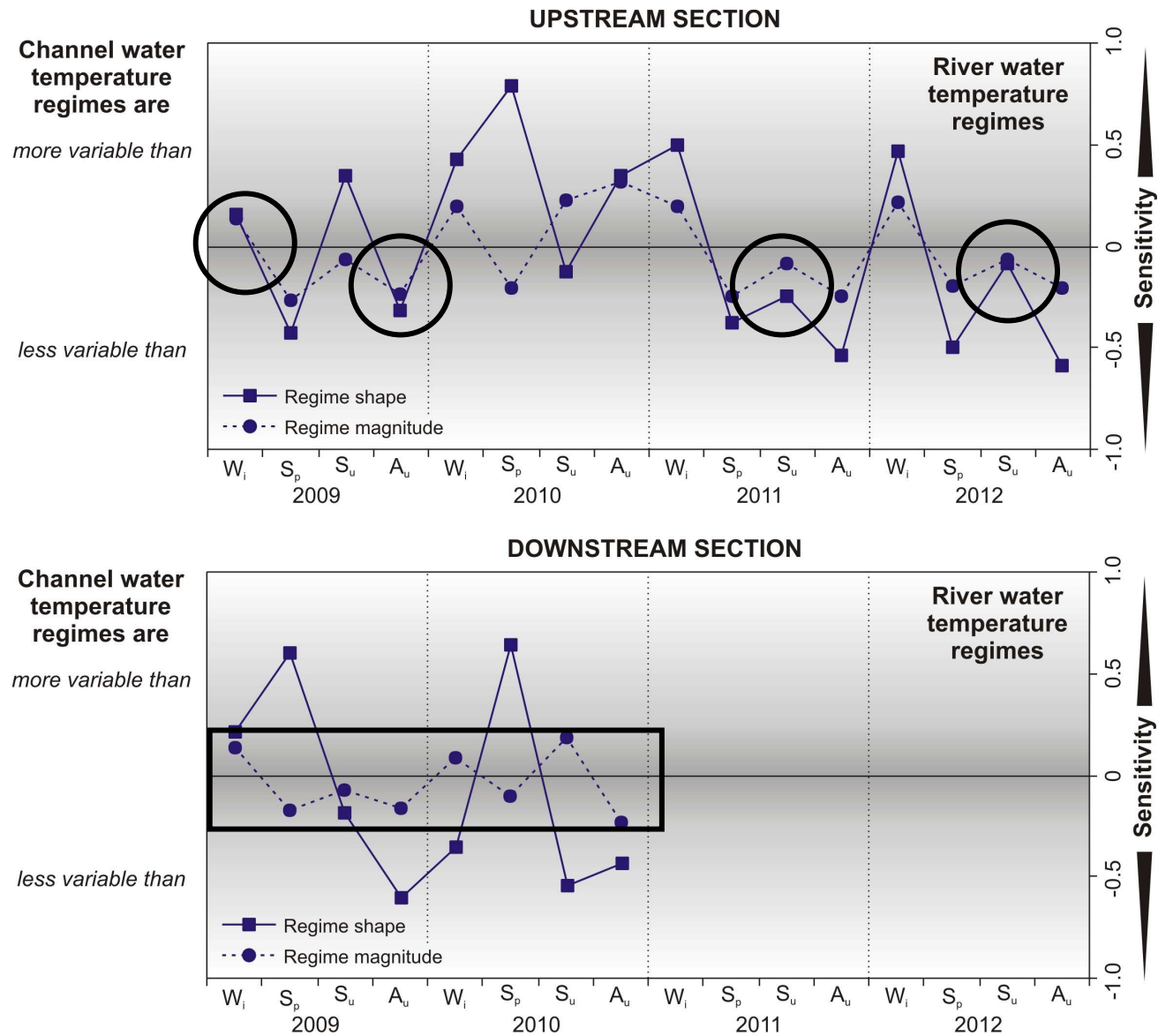
DOMINANT REGIME MAGNITUDE CLASS PER SEASON



Climatic sensitivity of diurnal thermal regimes per season



Hydrologic sensitivity of diurnal thermal regimes per season



Context

Methods

Results

Conclusions

Annual thermal regimes

Clear spatial differentiation
(upstream section \neq downstream section)

Inter-annual similarity

Strong groundwater influence



Multiple regression analysis

Identify correlations that best explain variance in water temperature data



Regression models of water temperature

(monthly scale)

Diurnal thermal regimes

Less clear spatial differentiation
(upstream section \approx downstream section)

Annual and inter-annual variability

Complex climatic and hydrologic influence



How to evaluate complexity?

1. Identify thresholds of climatic and hydrologic influence
2. Identify temporal and spatial variations in the strength of climatic and hydrologic influence



How to model complexity?

Logistic regression?
Fourier-based models?
(daily and hourly scales)



Influence of channel structure

Riparian vegetation, channel morphology,
aquifer structure



Thank you for your attention!

Questions?



GEOLAB UMR 6042
Université Blaise Pascal - CNRS



Agence de l'Eau Loire-Bretagne
Etablissement Public Loire