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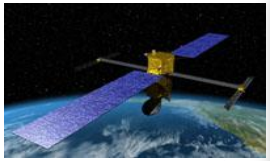

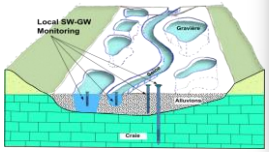

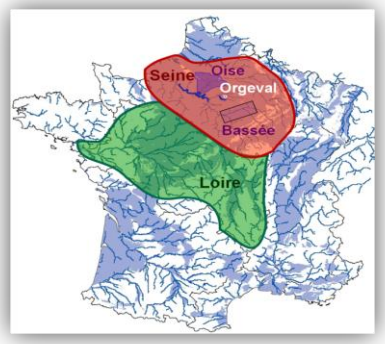

ICT for the study of continental hydro-eco-systems

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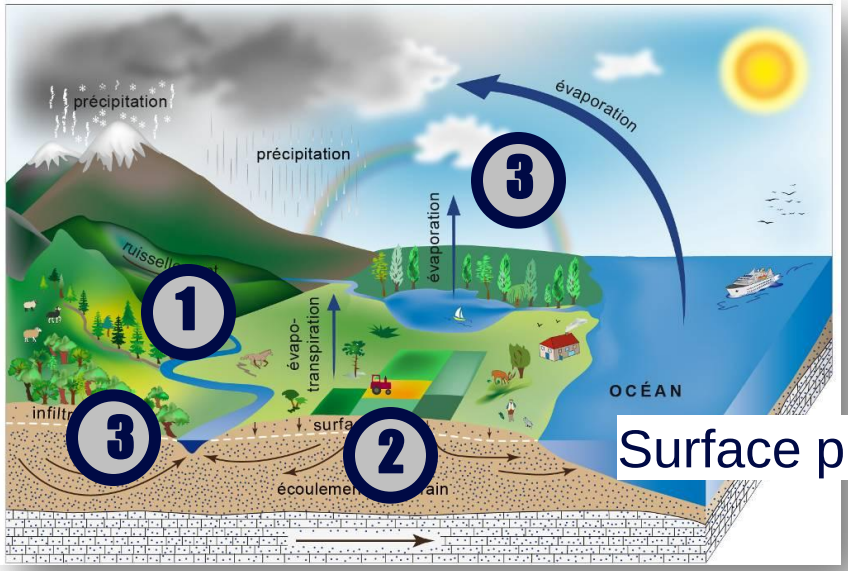
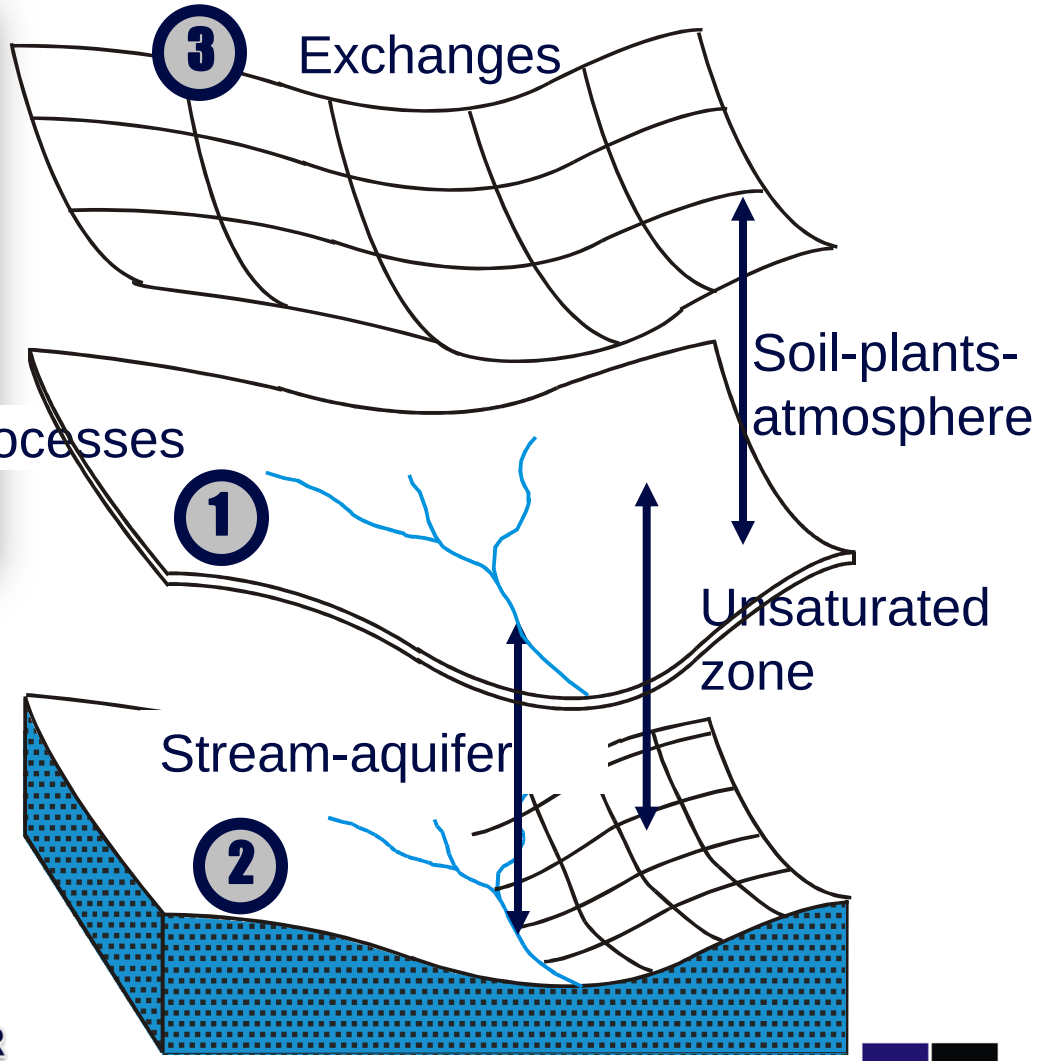
Hydrosystem Modelling

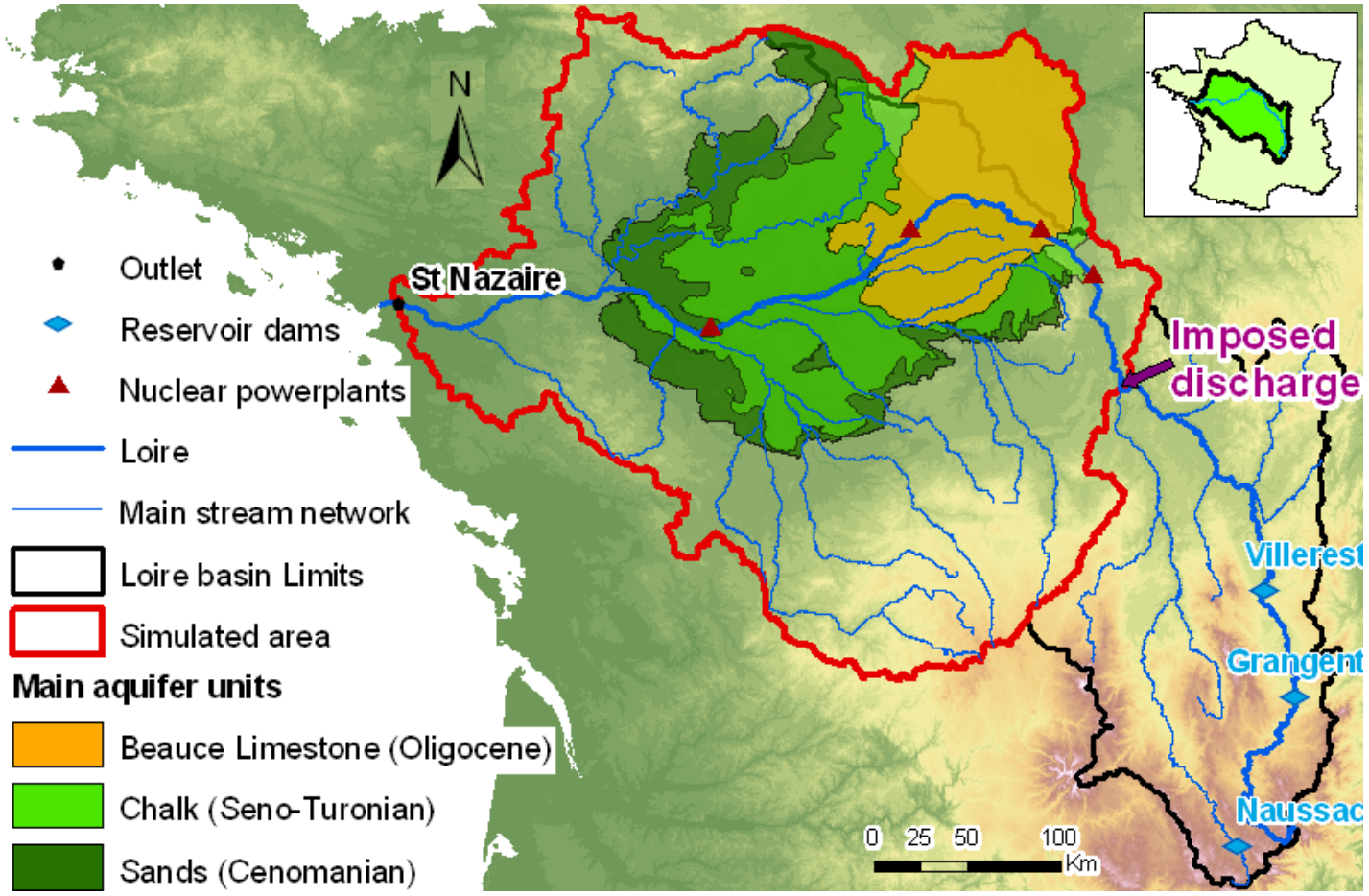




Groundwater Processes

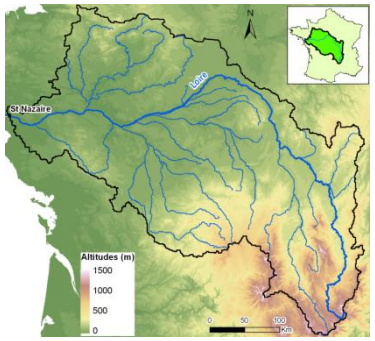
Ledoux et al. 1984, HB; Flipo et al. 2012, WRR

Hydrological budget of the Loire Basin

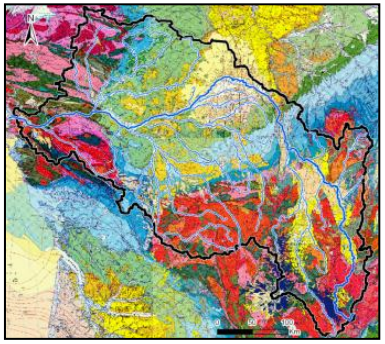


Data needed to model the system

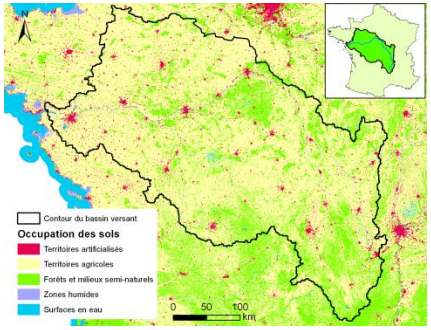
DEM & stream network



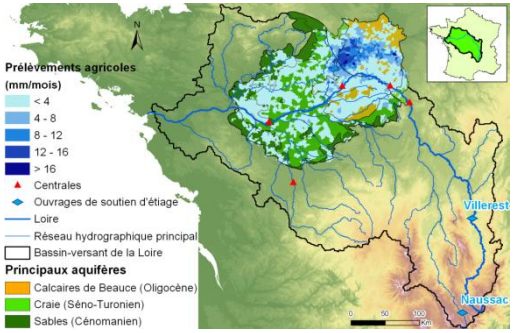
Geology



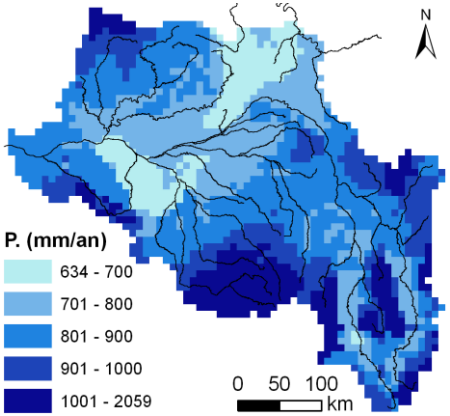
Land use



Withdrawals

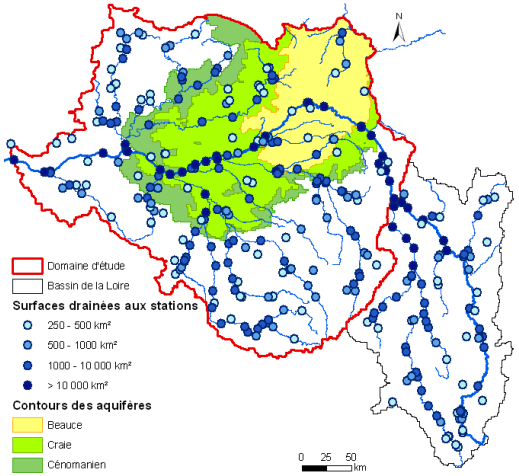


Météo :
Precipitation, PET

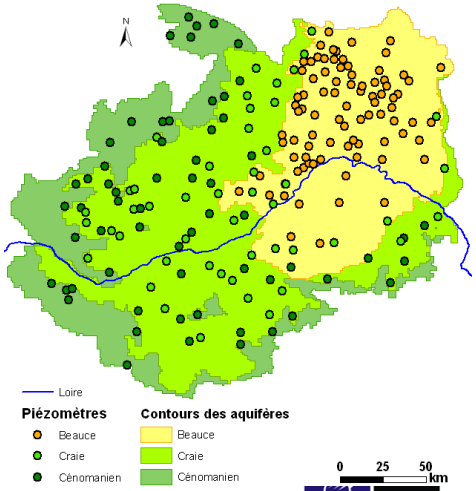


Simulations

Discharges



Piezometers

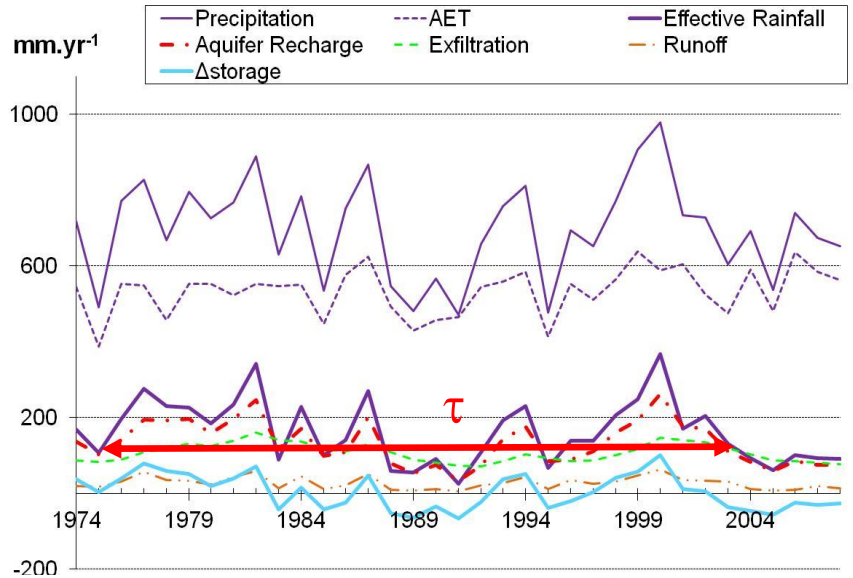


Monteil, 2011; Flipo et al. 2012, WRR

Stationnarity of water budget components

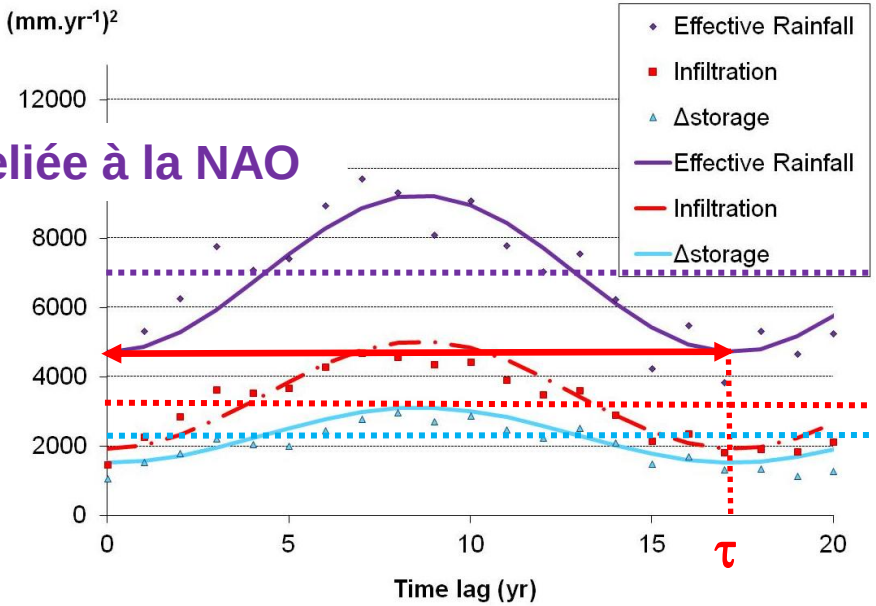
Z(t)

Ajustement variographique conjoint



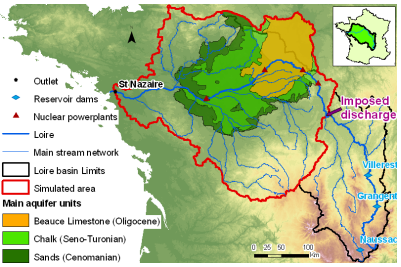
Périodicité de 17.2 ans reliée à la NAO

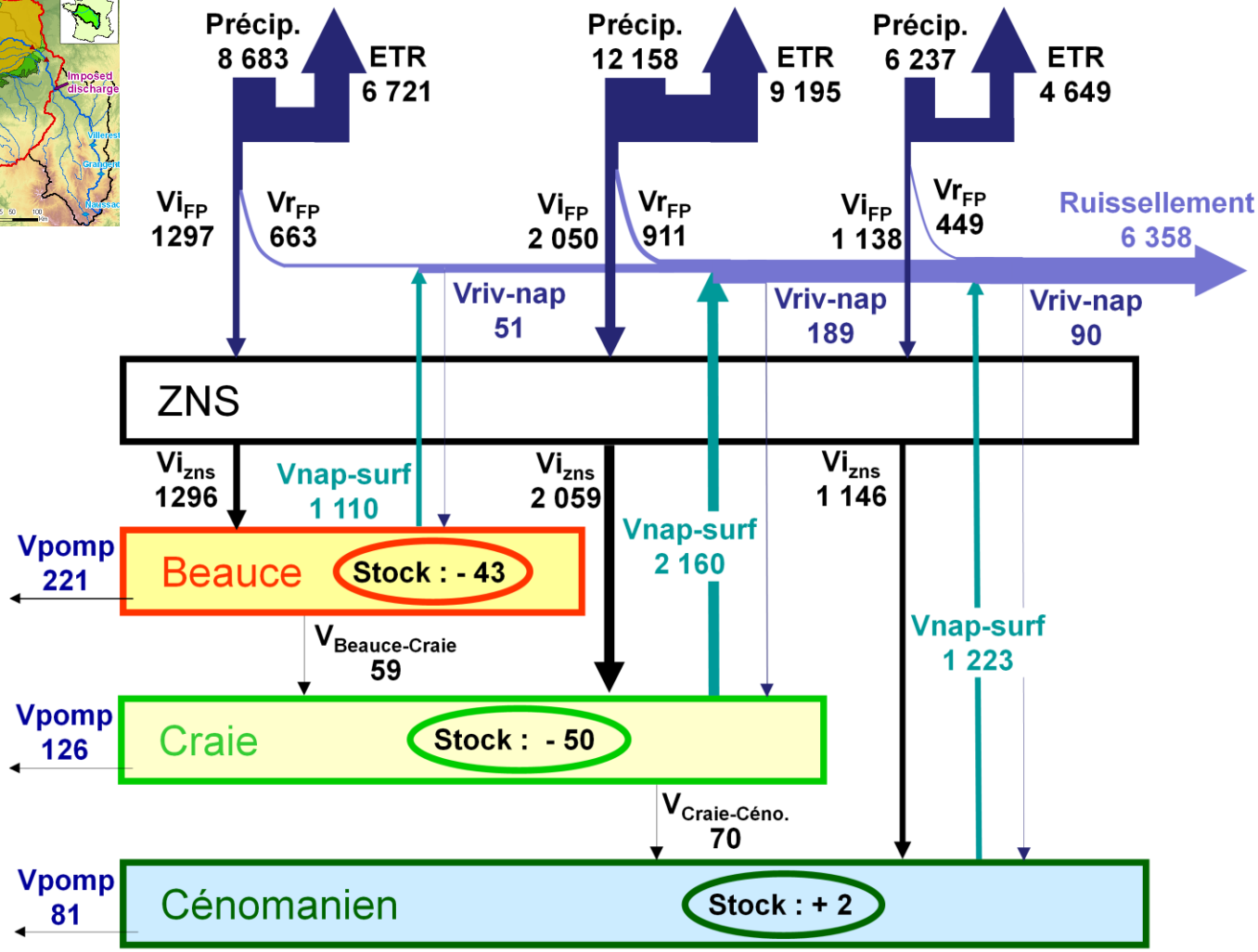
γ(τ)



Flipo et al. 2012, WRR

Mean water budget in Mm^3/an (1974-2009)





Monteil 2011

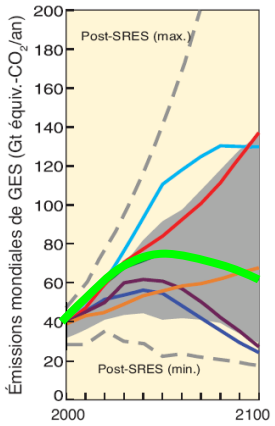
Climate change effect

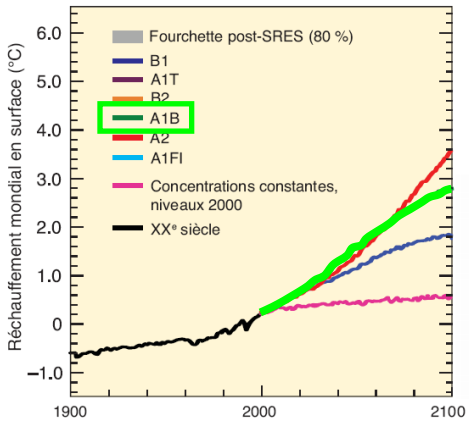
A1B Gas Emission Scenario

GCM

Regionalization

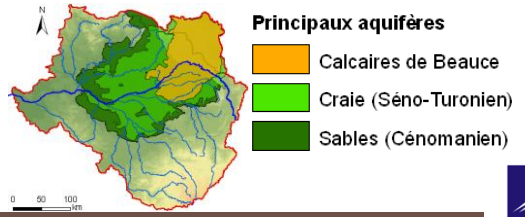
Loire basin Model



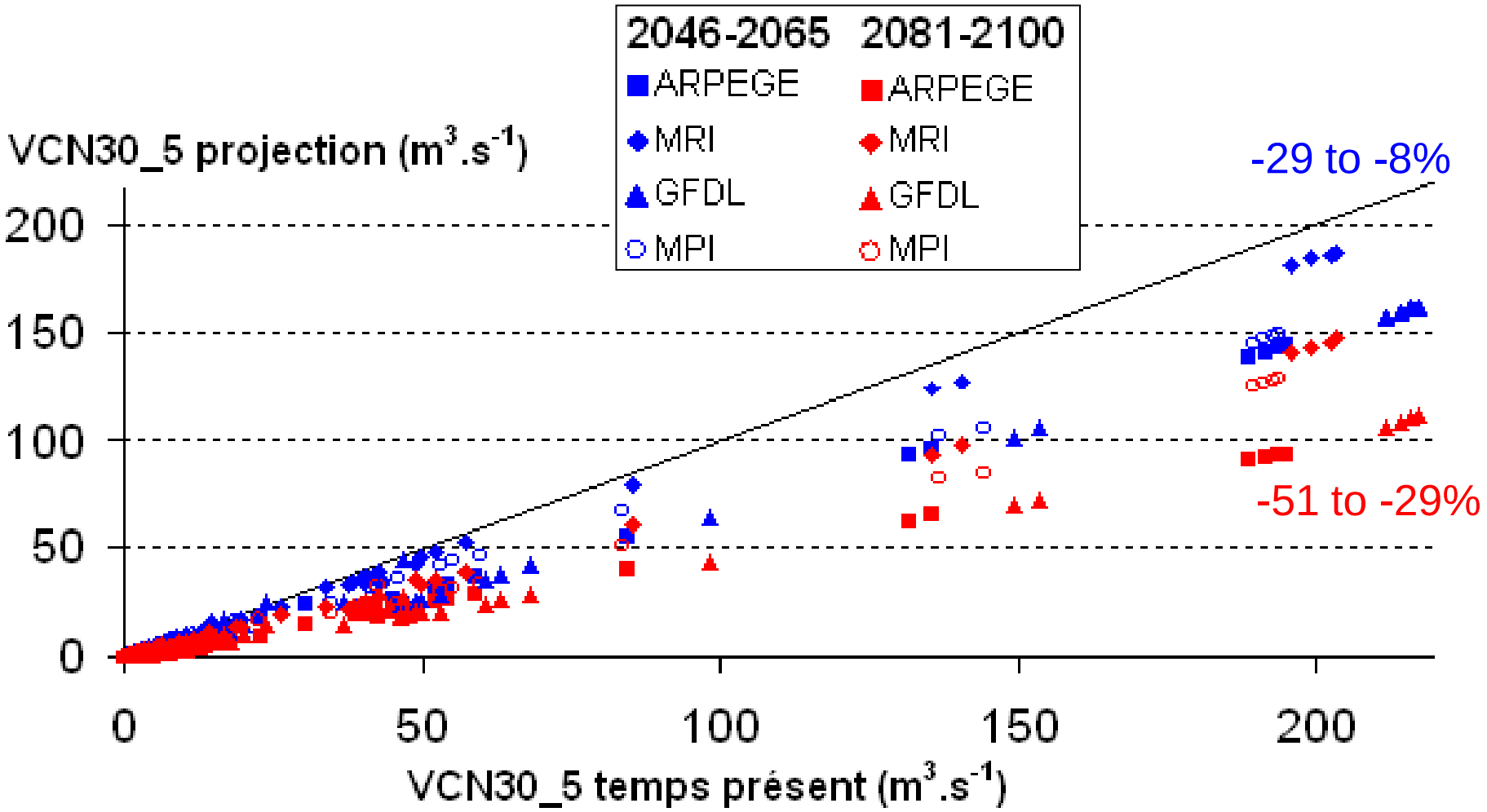


D'après Giec (2007)

ARPEGE (Météo France)
MRI (Japan)
GFDL (US)
MPI (Germany)

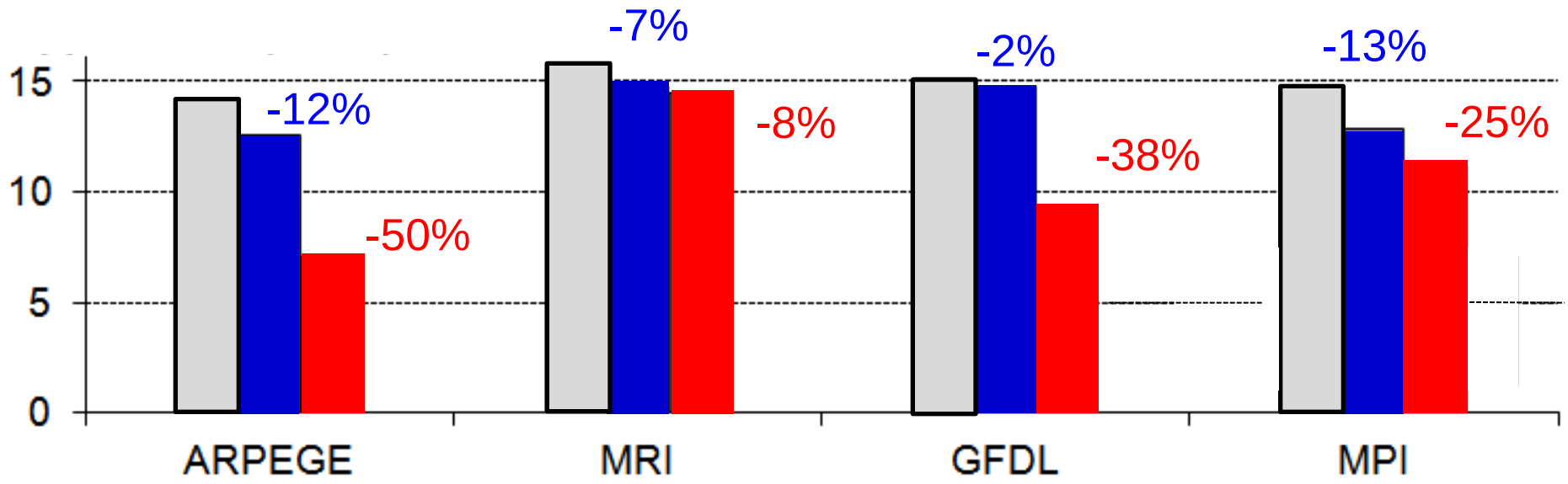


Estimates of the future exchanges



Estimates of the future exchanges

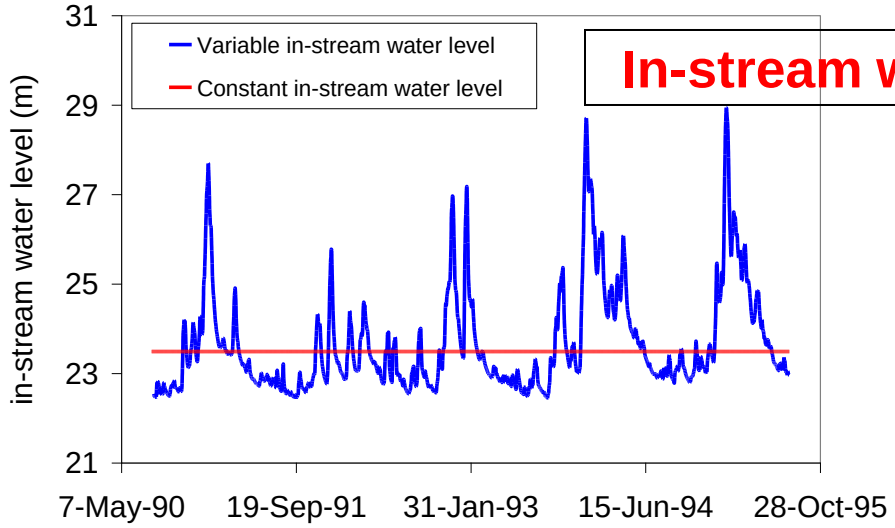
- **Aquifer → River Inflows ($m^3.s^{-1}$)**



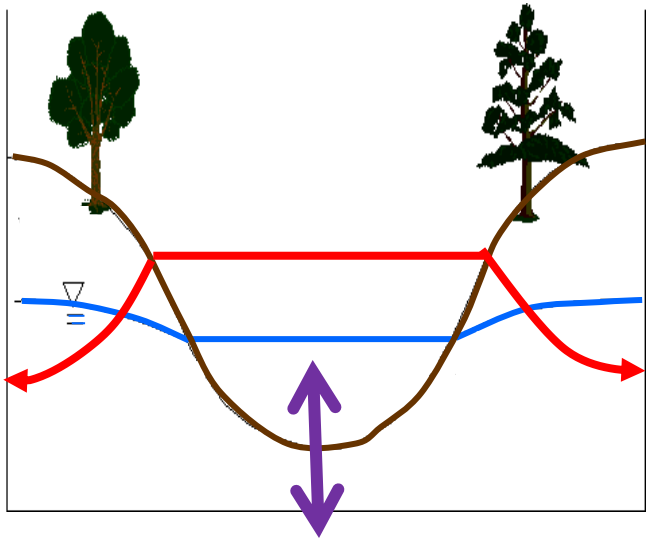
Middle of the century 2046 -2065

End of the century 2081-2100

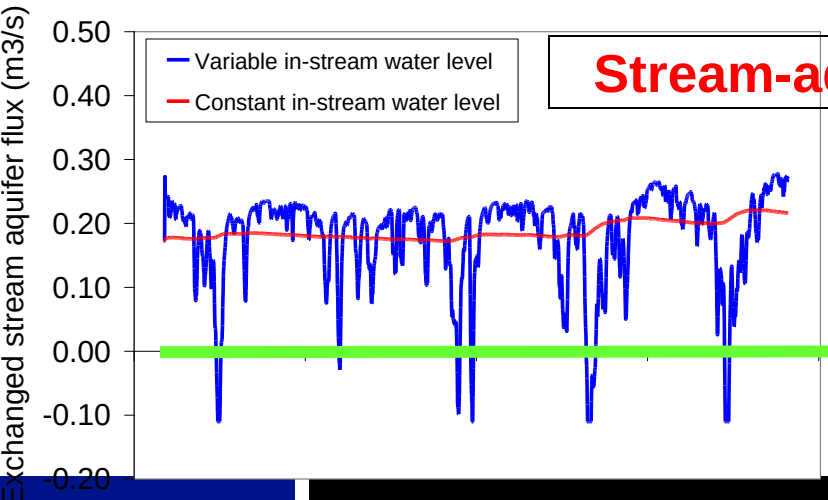
Stream-aquifer water exchanges



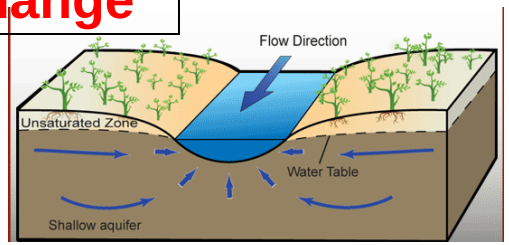
In-stream water level



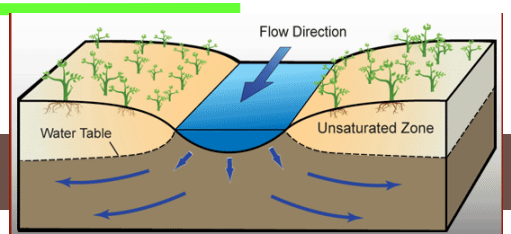
Saleh et al. 2011, JH



Stream-aquifer exchange



Gaining

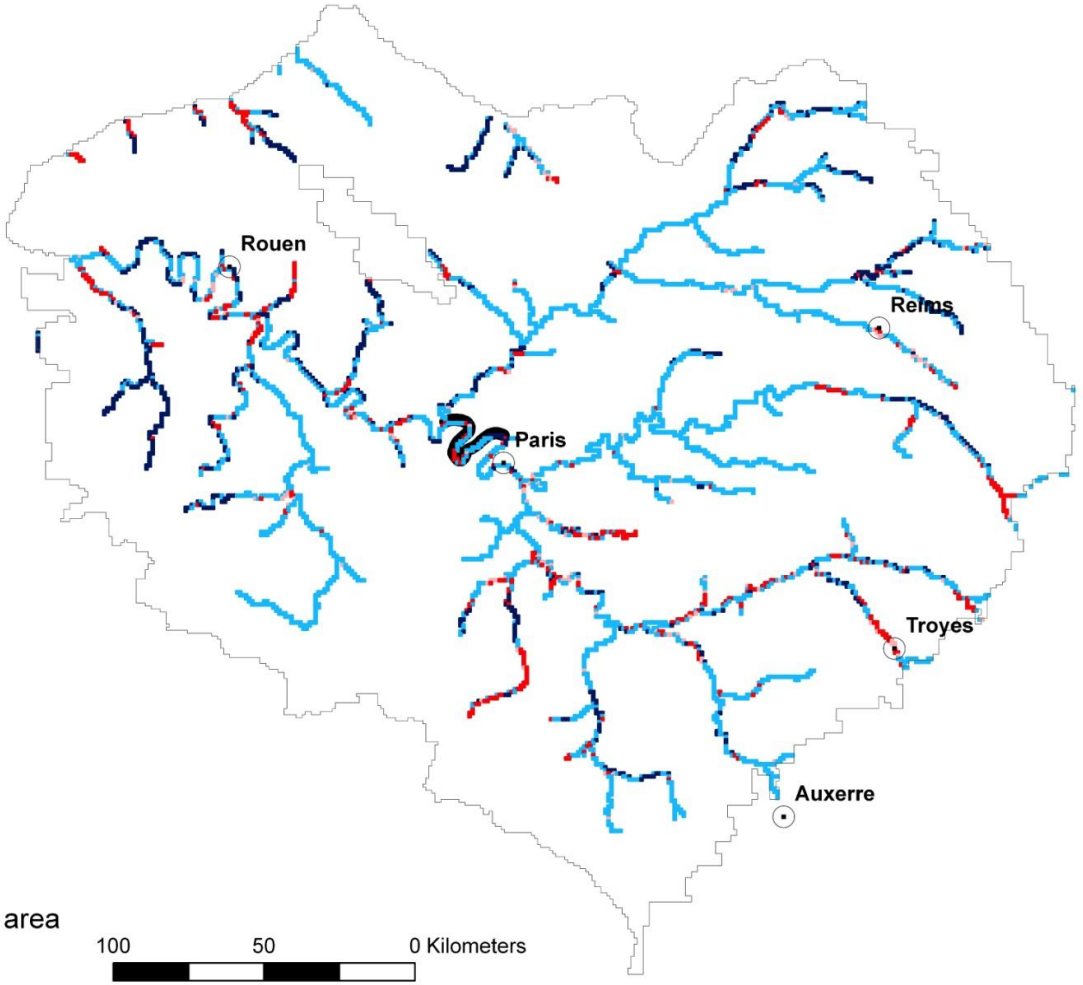


Losing

Stream-aquifer exchanges (1993-2010)

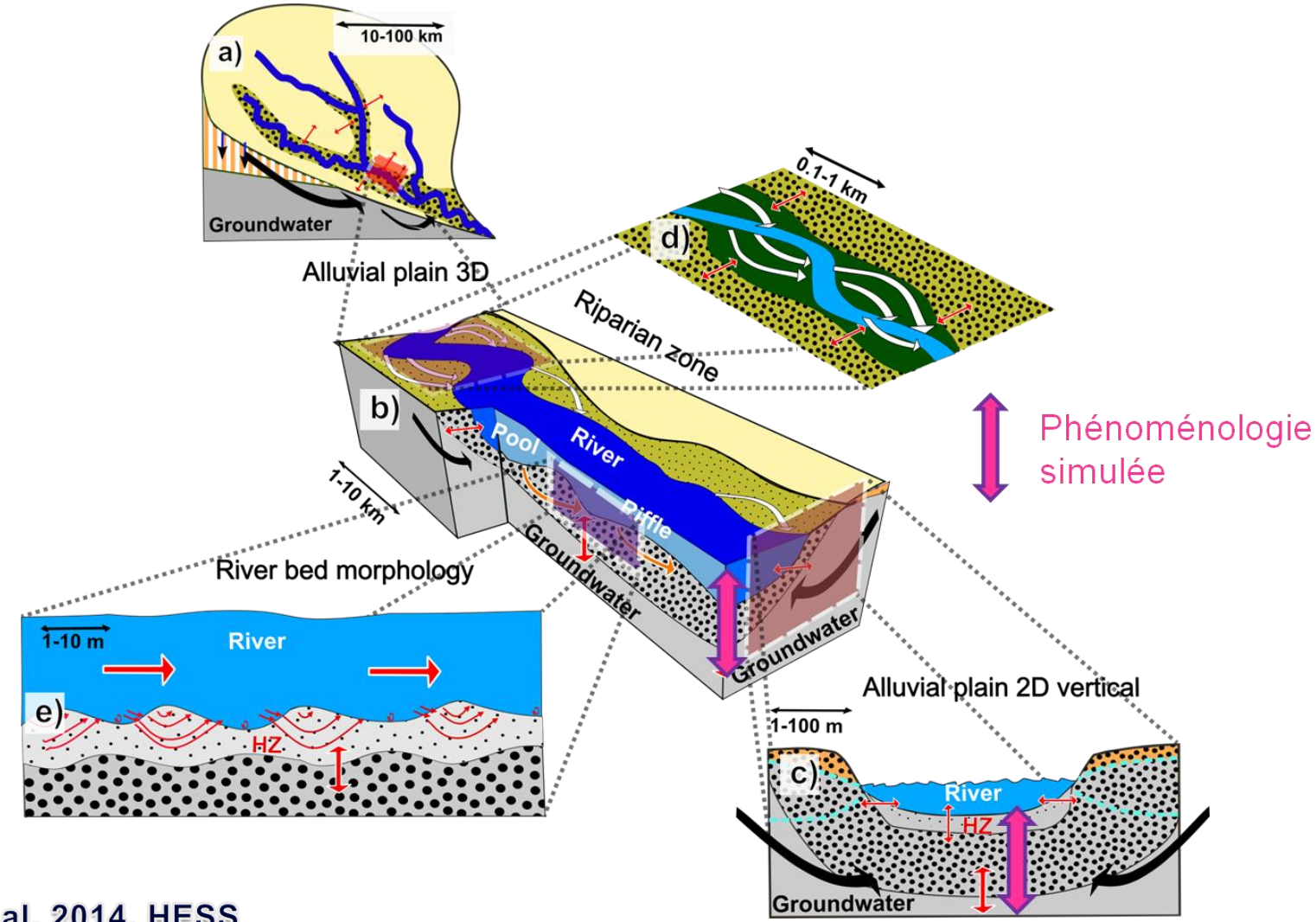
$$q_{aq->riv} = fK_h L(H_n - H_r)$$

3250 km
82% draining (76%-86%)
~60 $m^3.s^{-1}$



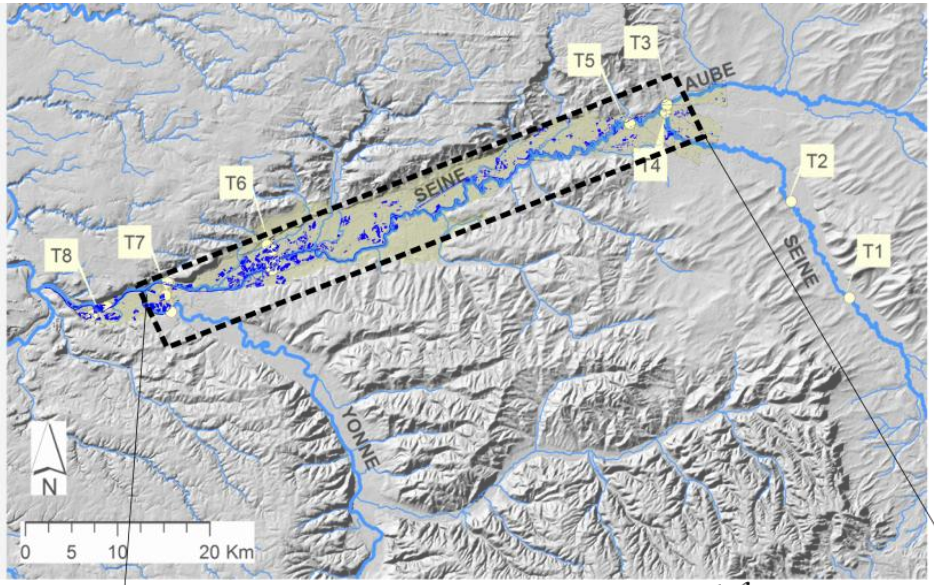
Pryet et al. 2015, WRM

Nested interfaces



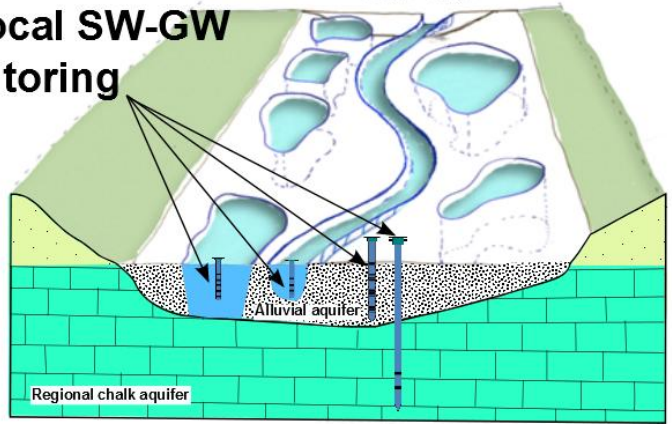
Flipo et al. 2014, HESS

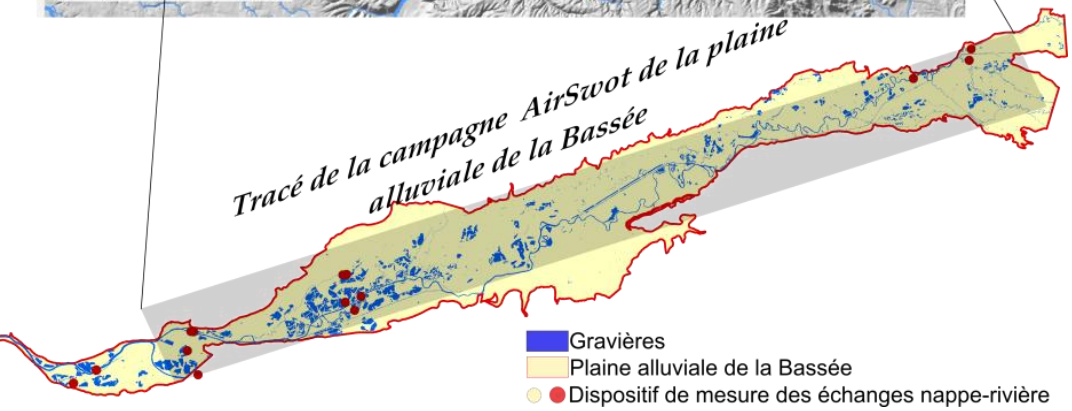
Hydrodynamics of alluvial plains



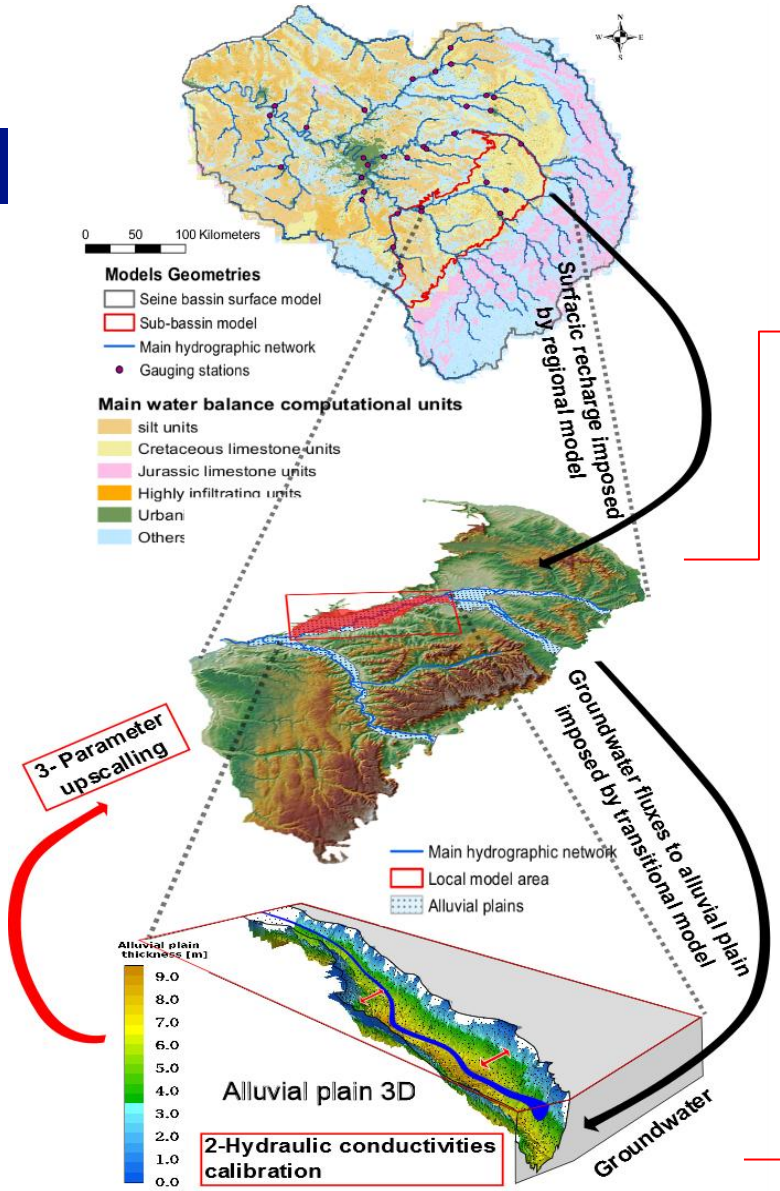
a) AirSwot airborne and satellite campaign

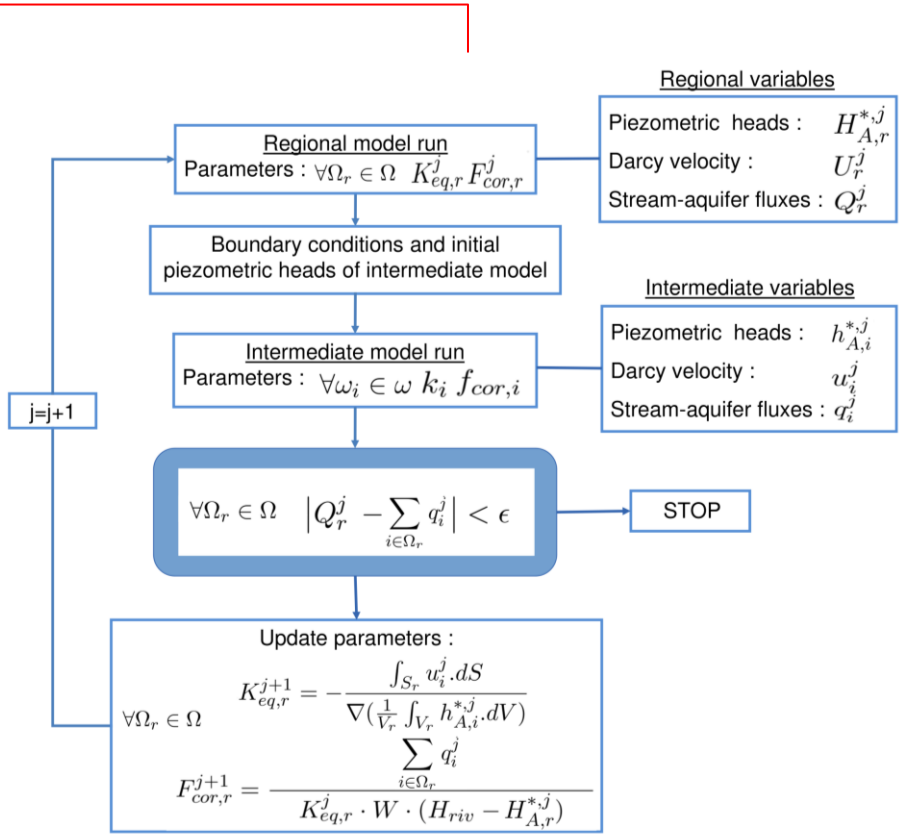
b) Local SW-GW Monitoring





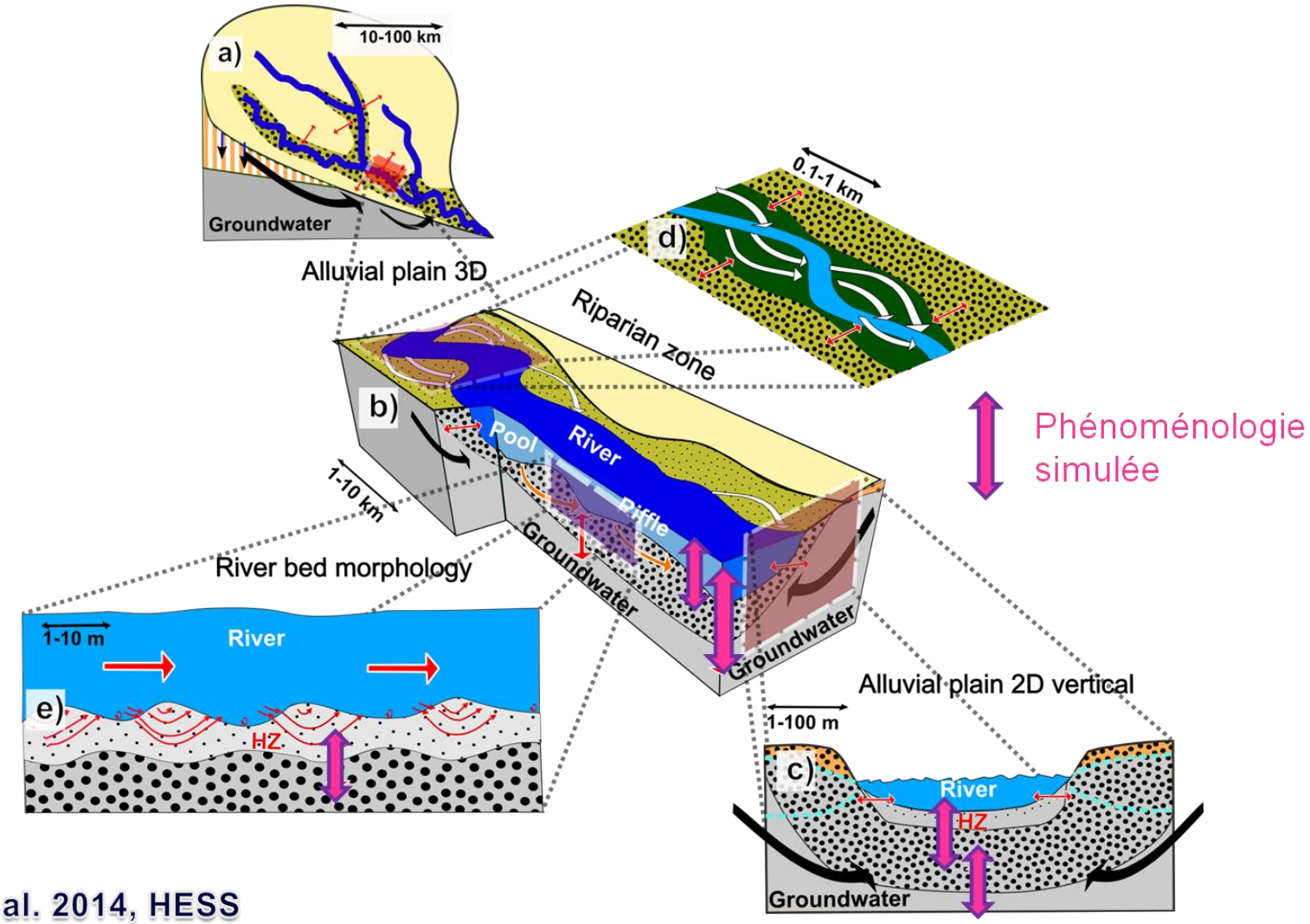
Nested modelling





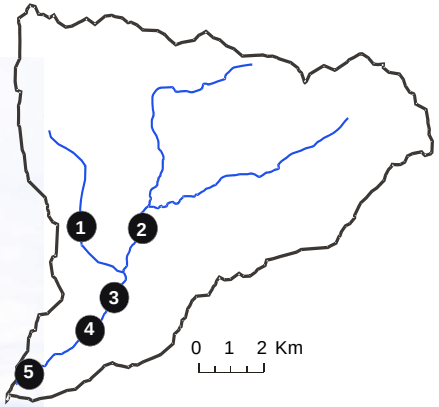
Flipo et al. 2014, HESS

Nested interfaces

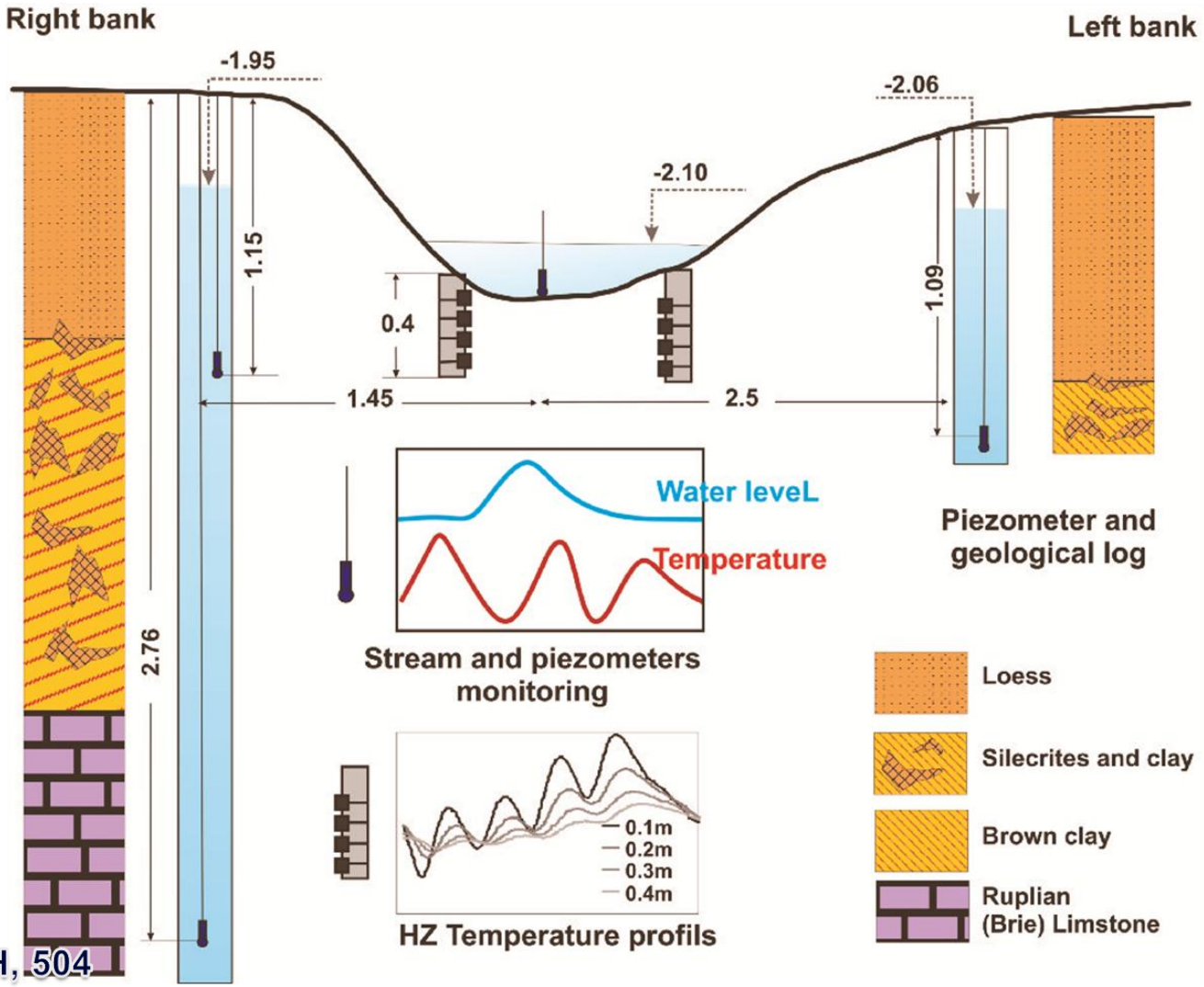


Flipo et al. 2014, HESS

LOcal MOnitoring Station (LOMOS)

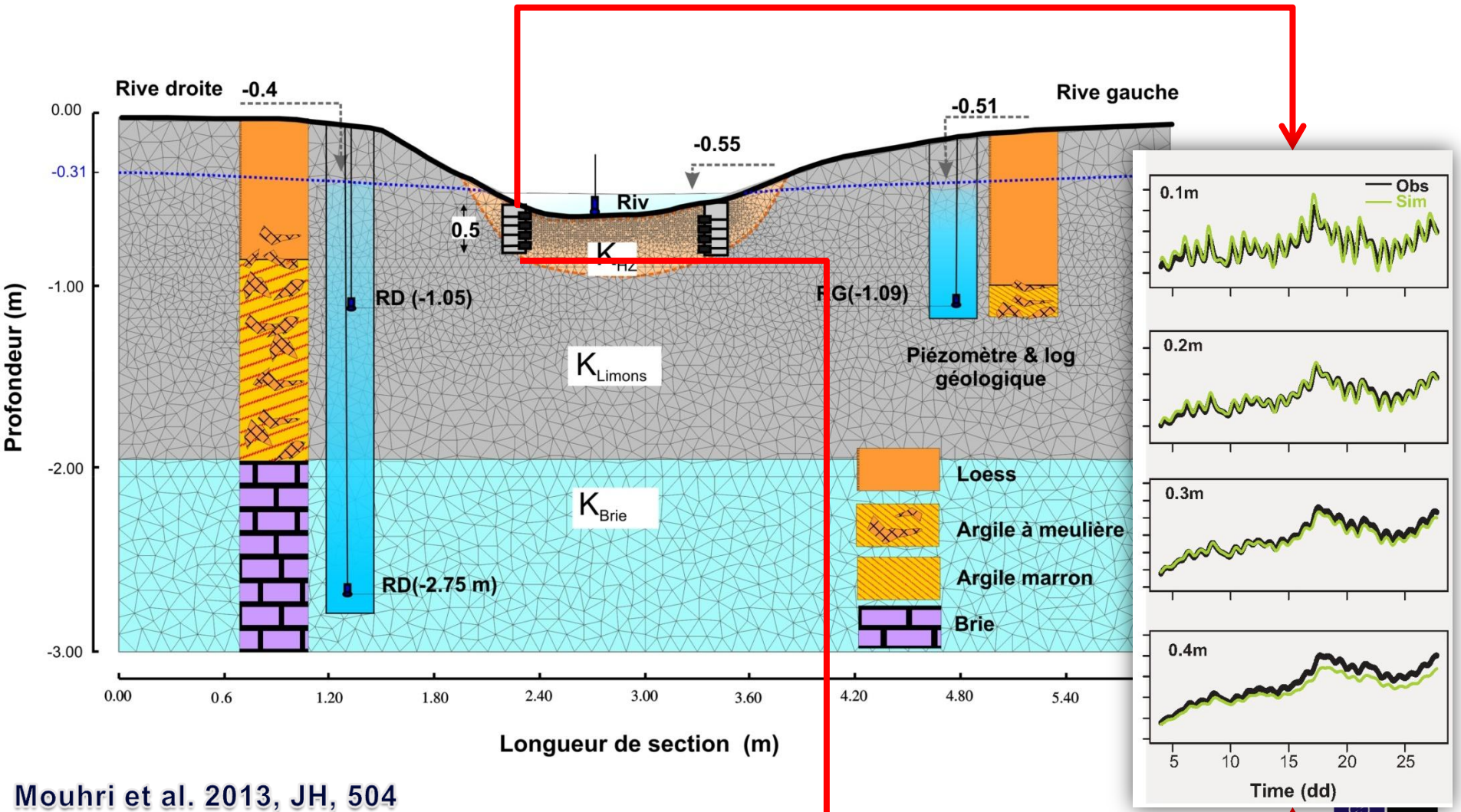


LOcal MOnitoring Station (LOMOS)



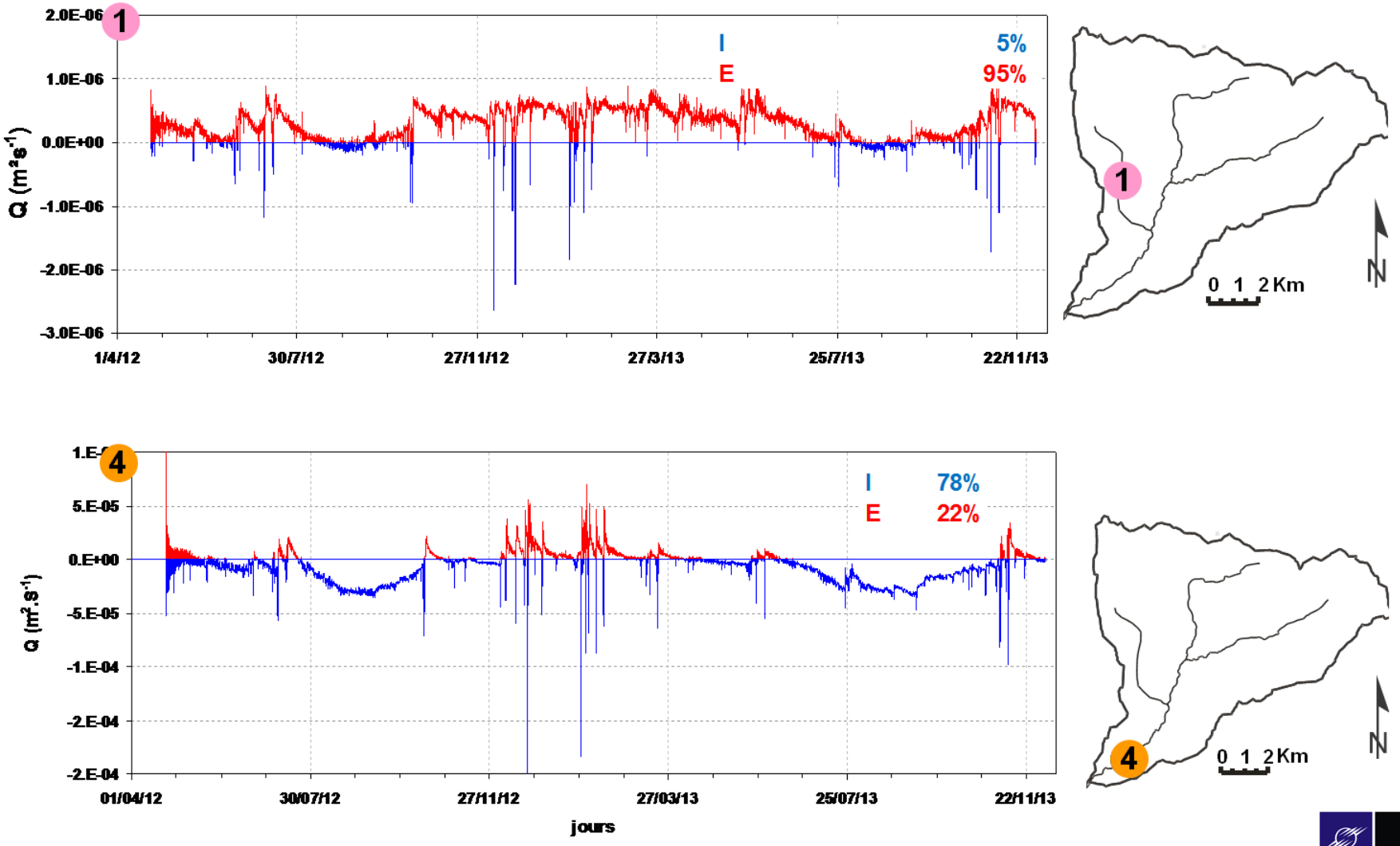
Mouhri et al., 2013, JH, 504

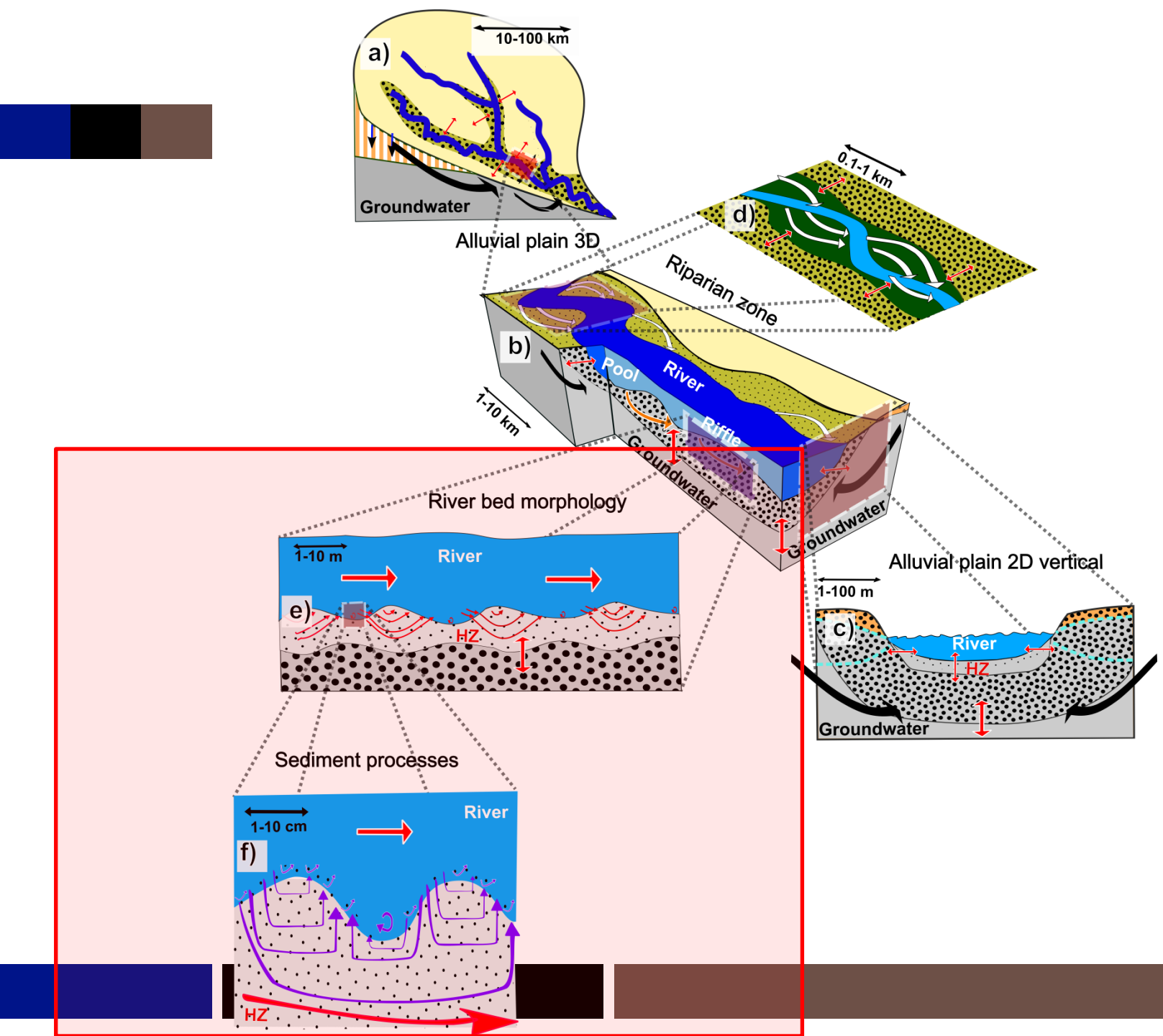
Heat as tracer of flow



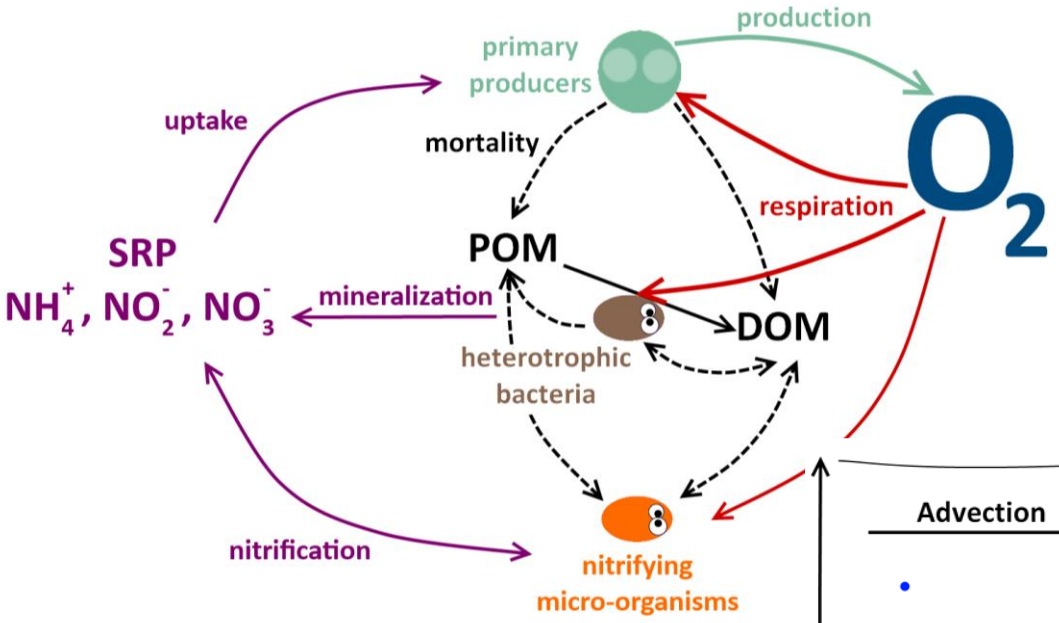
Mouhri et al. 2013, JH, 504

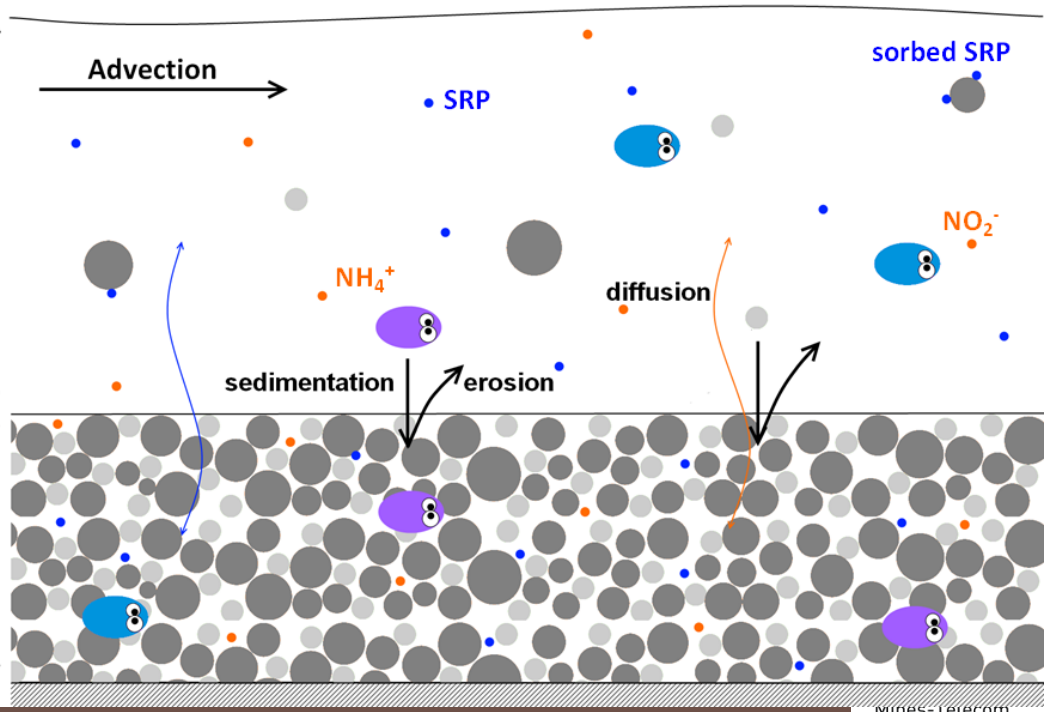
Spatio-temporal quantification of exchanges





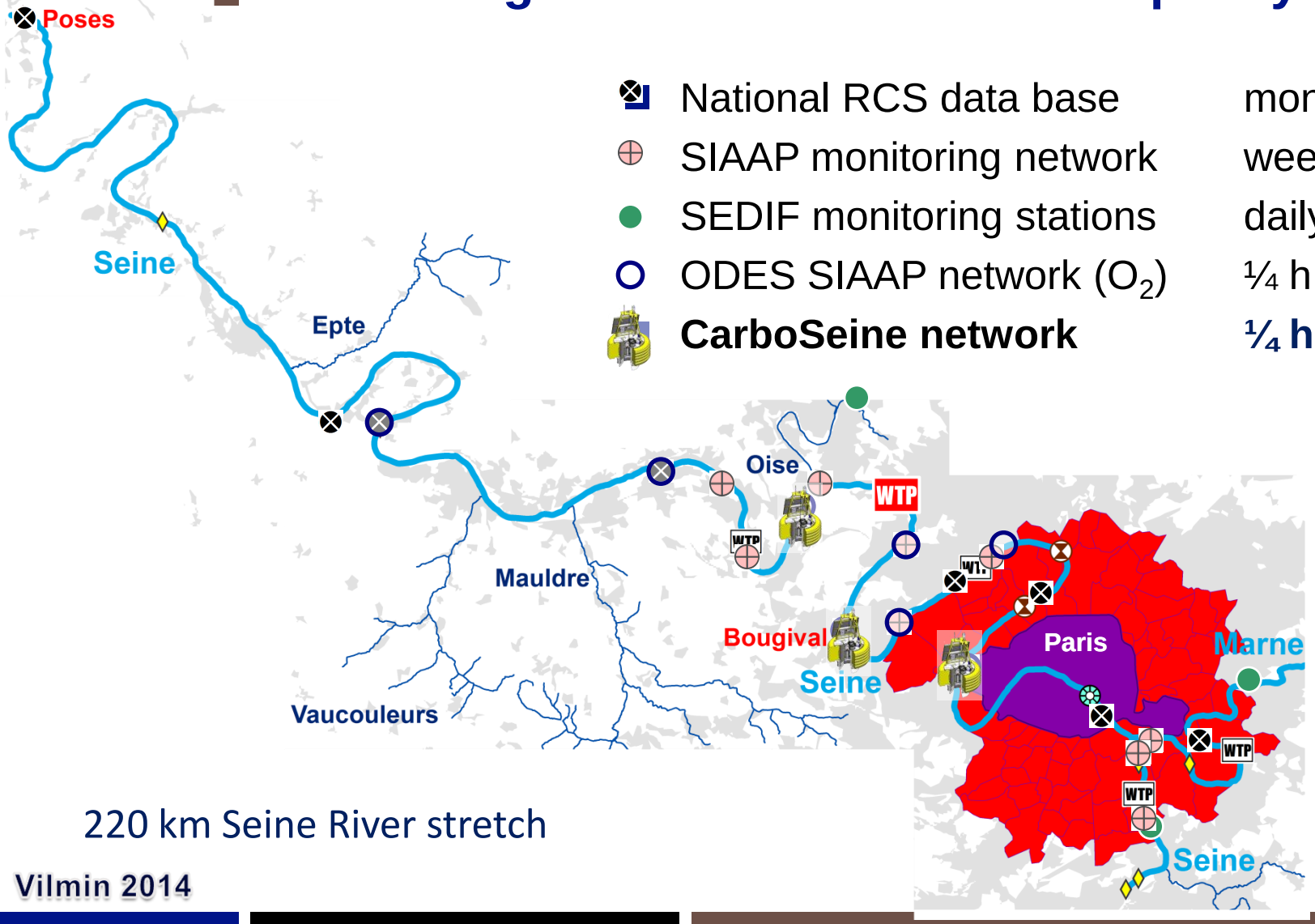
Hydro-ecological modelling of the River Seine– the ProSe model





Even et al., 1998, 2007; Flipo et al., 2007; Vilmin et al., 2015a&b

Monitoring of the Seine river water quality

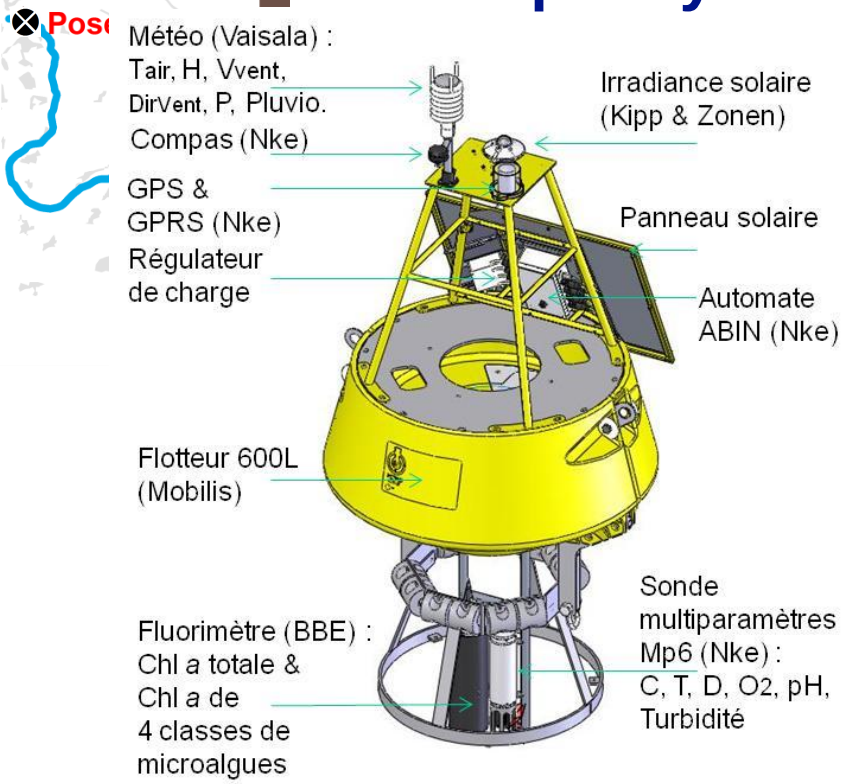


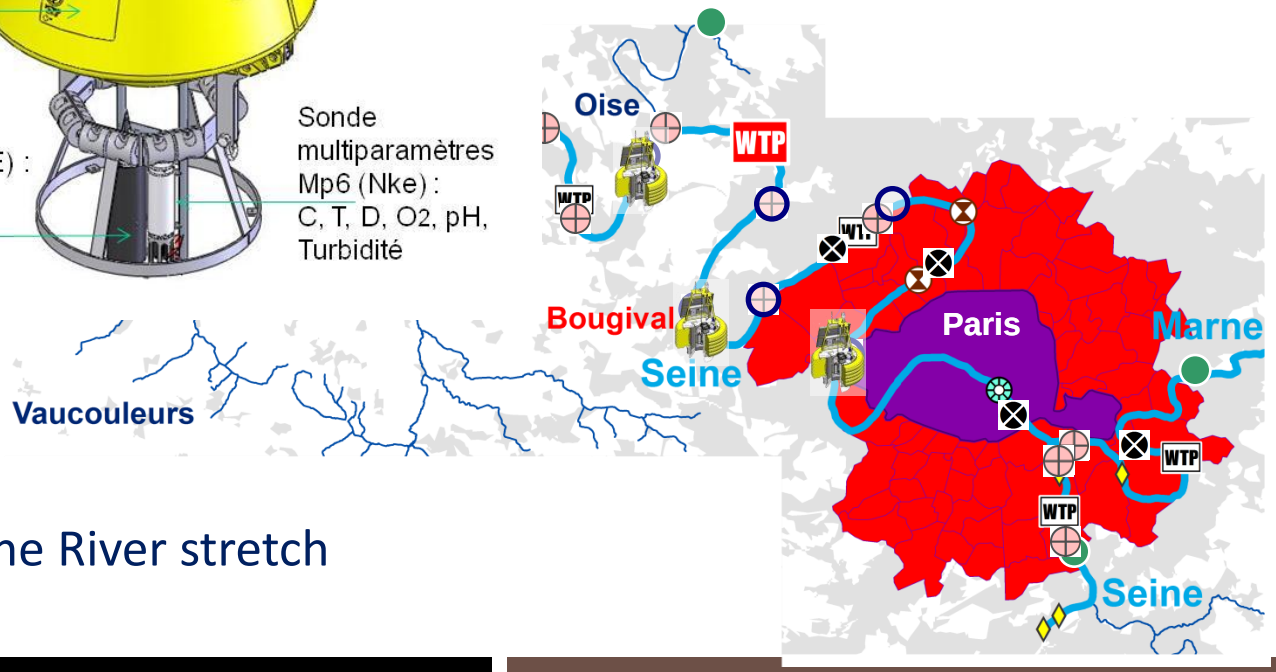
	National RCS data base	monthly
	SIAAP monitoring network	weekly
	SEDIF monitoring stations	daily
	ODES SIAAP network (O_2)	¼ h
	CarboSeine network	**¼ h (chl *a*, O_2)**

220 km Seine River stretch

Vilmin 2014

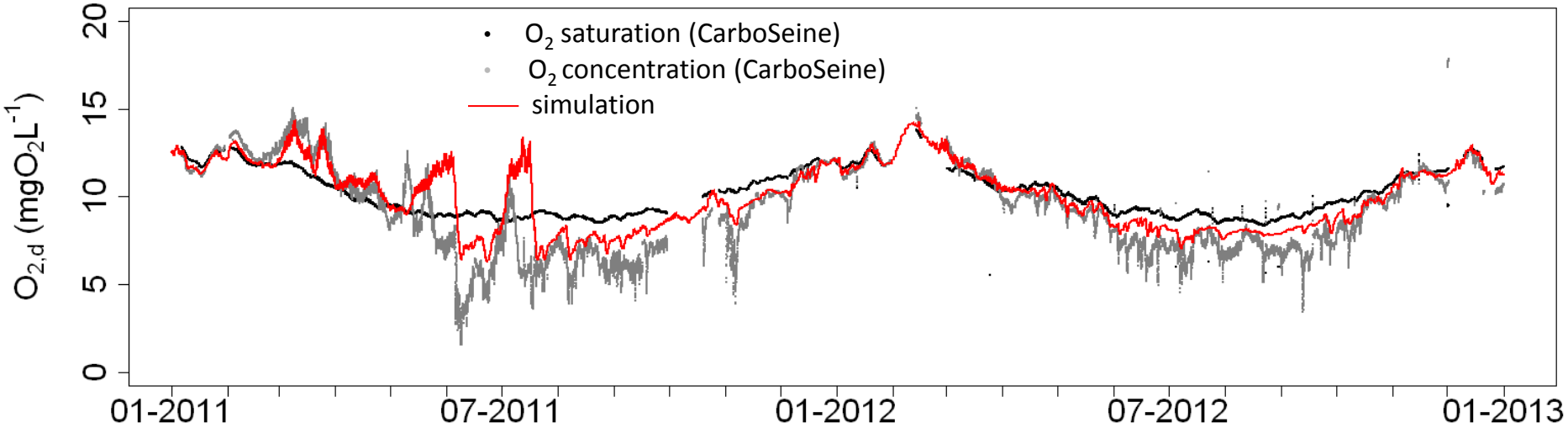
High frequency monitoring of the Seine river water quality: the CarboSeine network





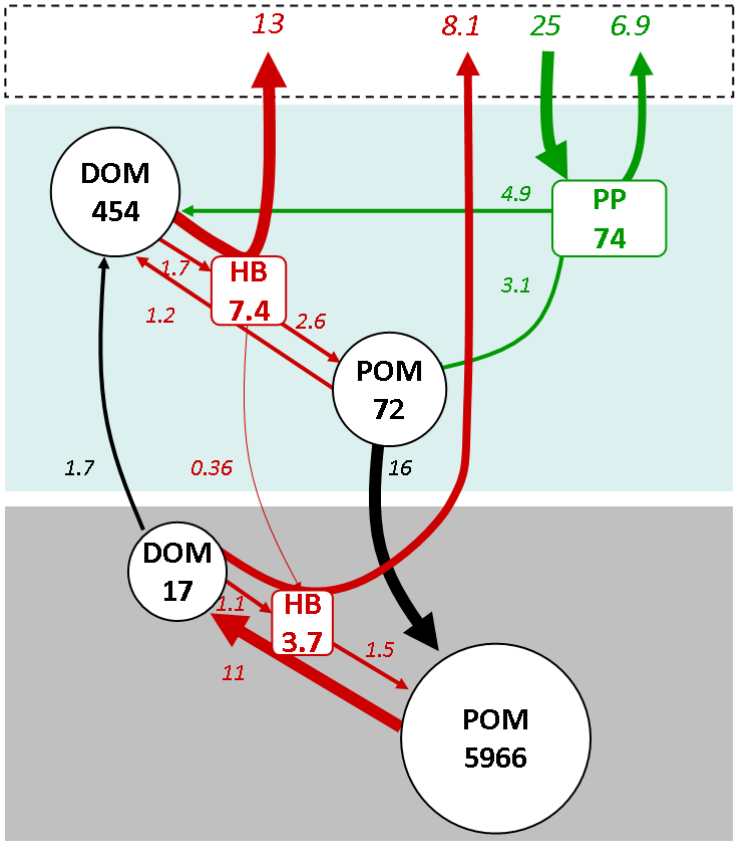
220 km Seine River stretch

Simulation of O_2 dynamics



Seine metabolism in low flow conditions

Production & respiration



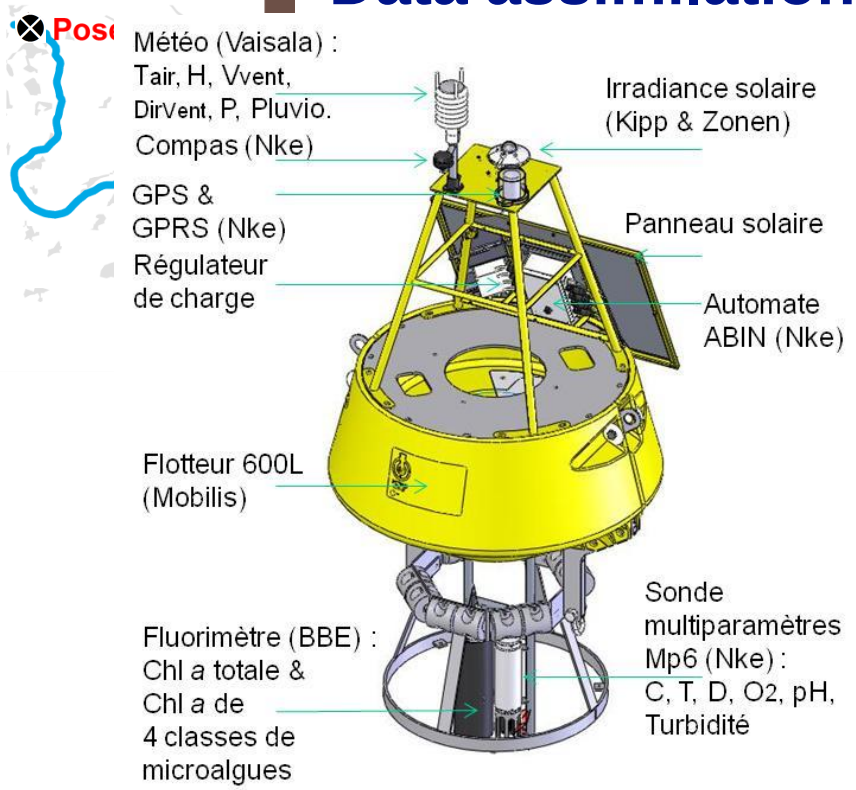
P + R = -3 TC/day

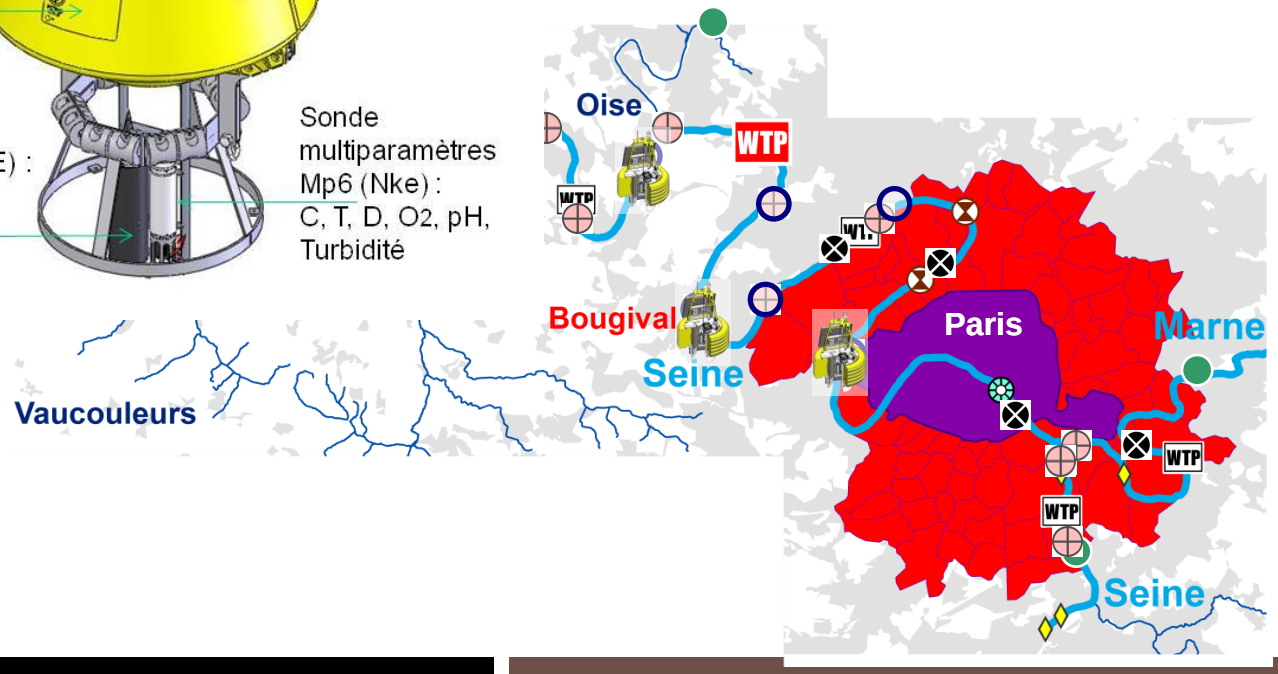
Fluxes in TC/day
stocks in TC

$$\Delta F = F_{out} - \sum F_{in}$$

DOM: -6.0
POM: -11

Data assimilation





Assimilation des données
pour pilotage en temps réel
des effluents urbains

Conclusions et perspectives

- In situ differential pressure sensors
- Develop methodologies for analysis and integration of space borne data → big data
- Nested models and scaling issues → coupling regional models with GCM
- Water temperature (drones+IR cameras, satelitte data, optic fiber)
- Heat transport in continental hydro-systems

- Greenhouse effect gaz emissions by surface waters → monitor and conceptualize models
- High frequency data assimilation in hydro-ecological models → Real time management of waste water treatment plants

Hydro-ecology

Merci