Origin and dynamic of spring flows during flood events inferred from innovative tracers

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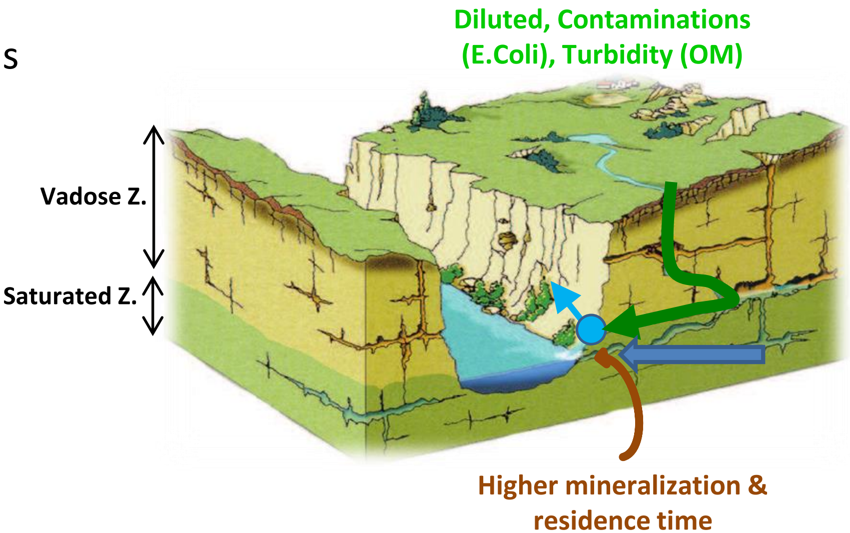
CORUM CONFERENCE CENTER
43rd IAH congress

Karst aquifers

- ✓ Heterogeneous structure : different flowpaths

  Surficial infiltration
  Saturated zone
  (Deep contribution)

- ✓ Mixing vary within the hydrologic cycle



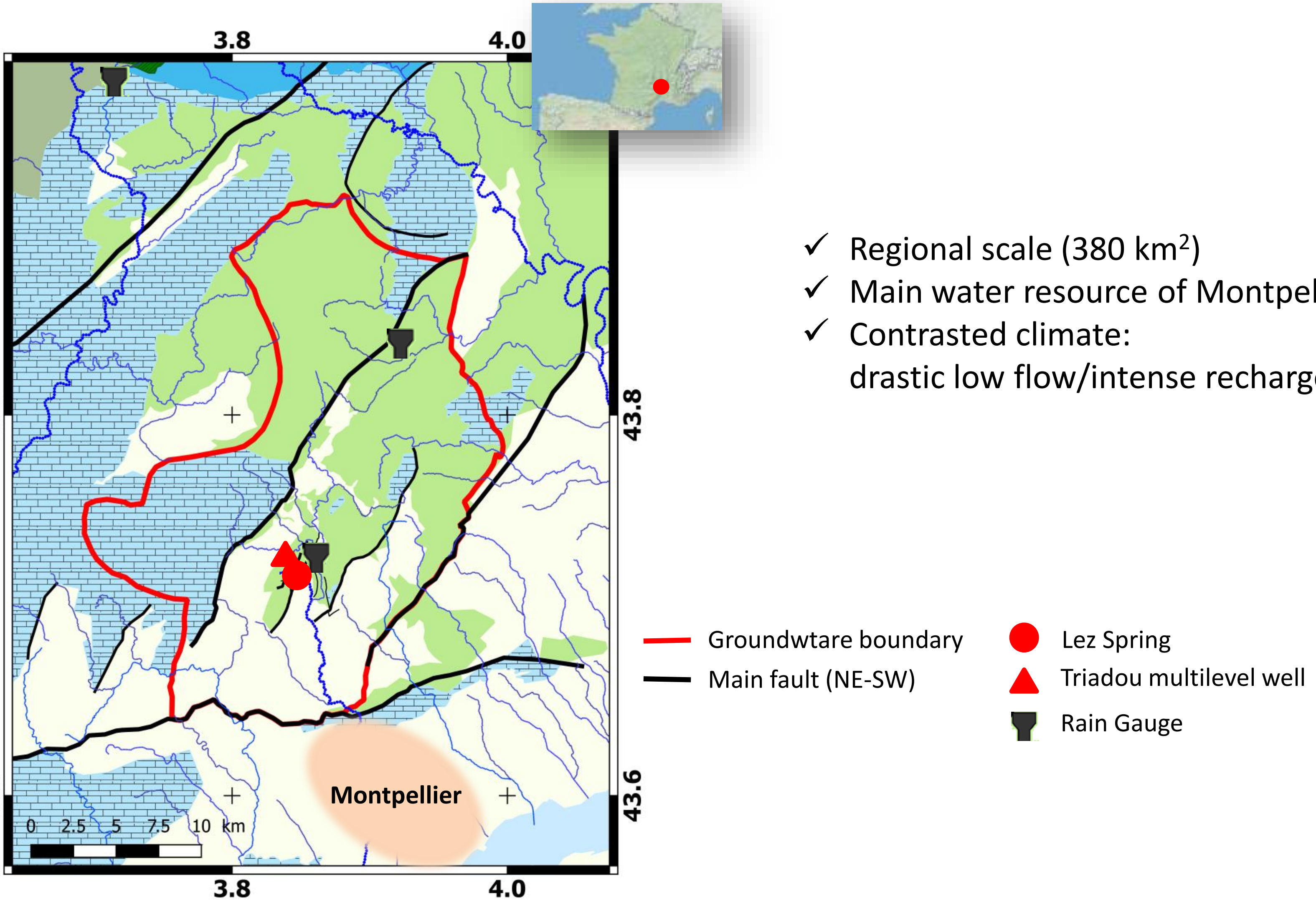
Bloc diagram of a karst, BRGM

Mediteranean context

- ✓ Intense recharge event
- ✓ Strong anthropogenic pressure and increasing water demand

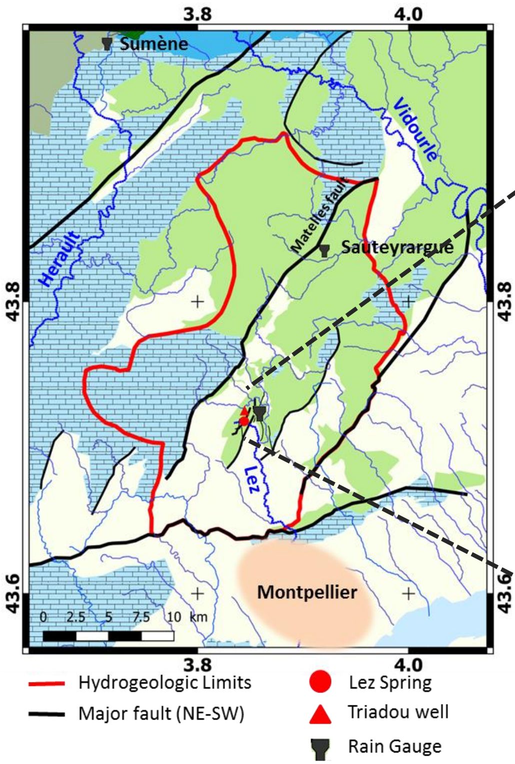
How to identify **the origin and mixing of water during flood event?**
⇨ assess vulnerability to contaminant transfers during intense storm events

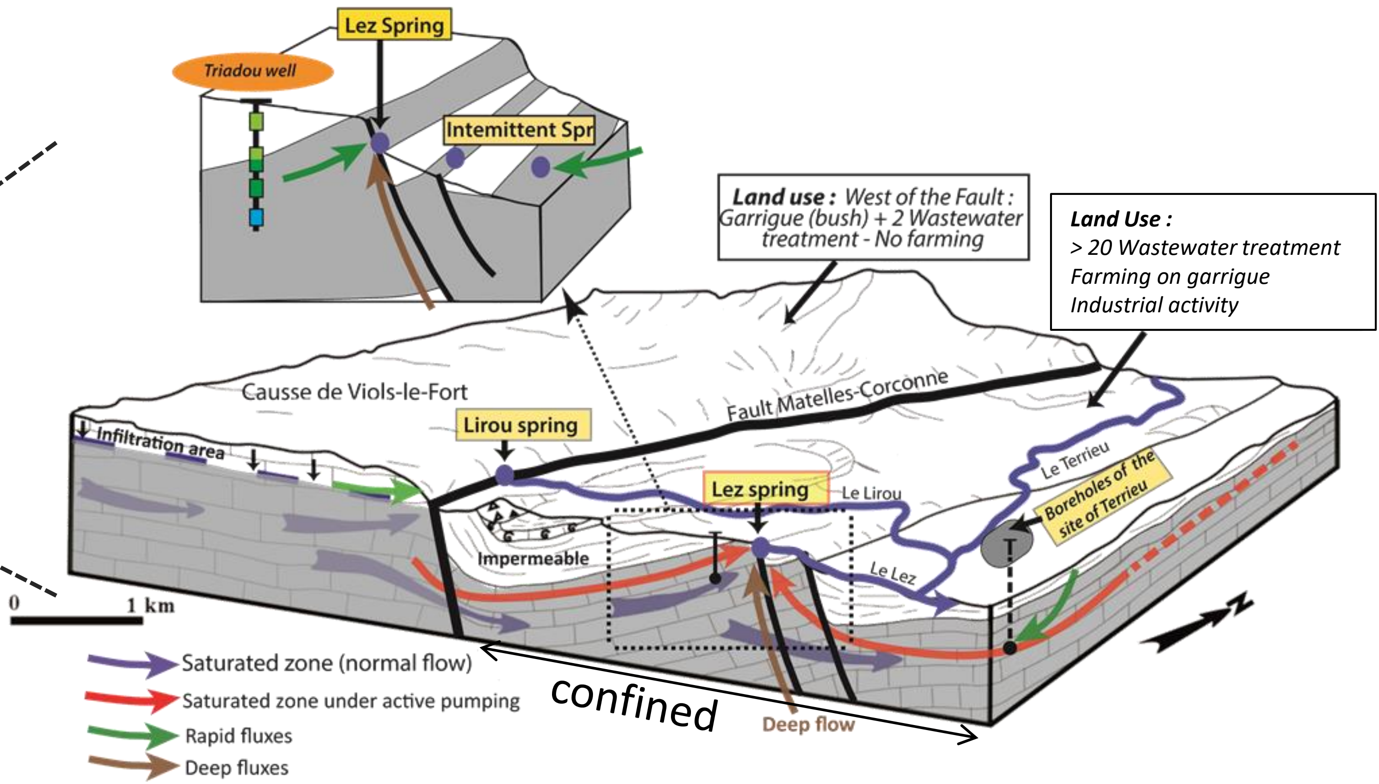
- Focus on a Mediterranean karst aquifer: Lez hydrosystem



✓ Regional scale (380 km^2)
✓ Main water resource of Montpellier
✓ Contrasted climate:
drastic low flow/intense recharge event

- Focus on a Mediterranean karst aquifer: Lez hydrosystem





✓ **3 types of flow identified at seasonal scale:**

Saturated zone

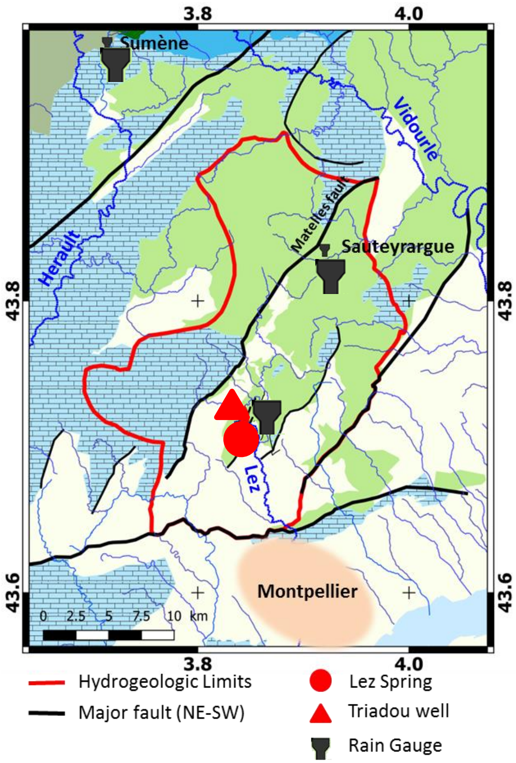
Surficial infiltration

Deep contribution : presence of episodic high mineralized water at the beginning of the hydrologic cycle (first flood event)

✓ **Strong anthropogenic pressure** :

Waste water/Urban Industrial activity

• Monitoring



Lez Spring

✓ Continuous and high frequency monitoring	
• ^{18}O, ^{2}H - Picarro -1min -± 0.04 ‰	pre-event/event
• EC, DO, pH, Cl, Temp. -10min	mineralised/diluted flow
• Natural Fluorescence (humic/proteic like compounds) - 10 min	Surficial flow/ contamination (waste water plant)
✓ Daily sampling of innovative tracers	
• Dissolved gazes (CFCs, SF_6,Ne, Ar)	Residence time(< 50 yrs) Contamination (Urban/Industrial)
• ^{222}Rn	Deep flow/surficial flow

Triadou multilevel well

✓ Shallow water level 68m

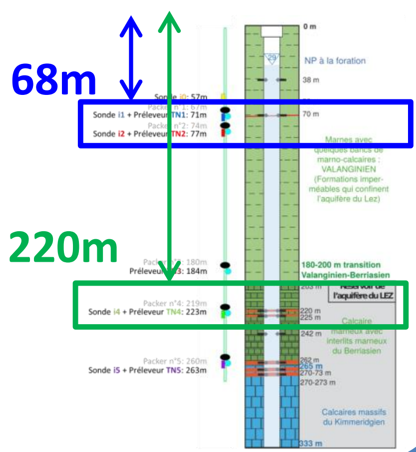
✓ Deep water level 220m

Rain Gauge

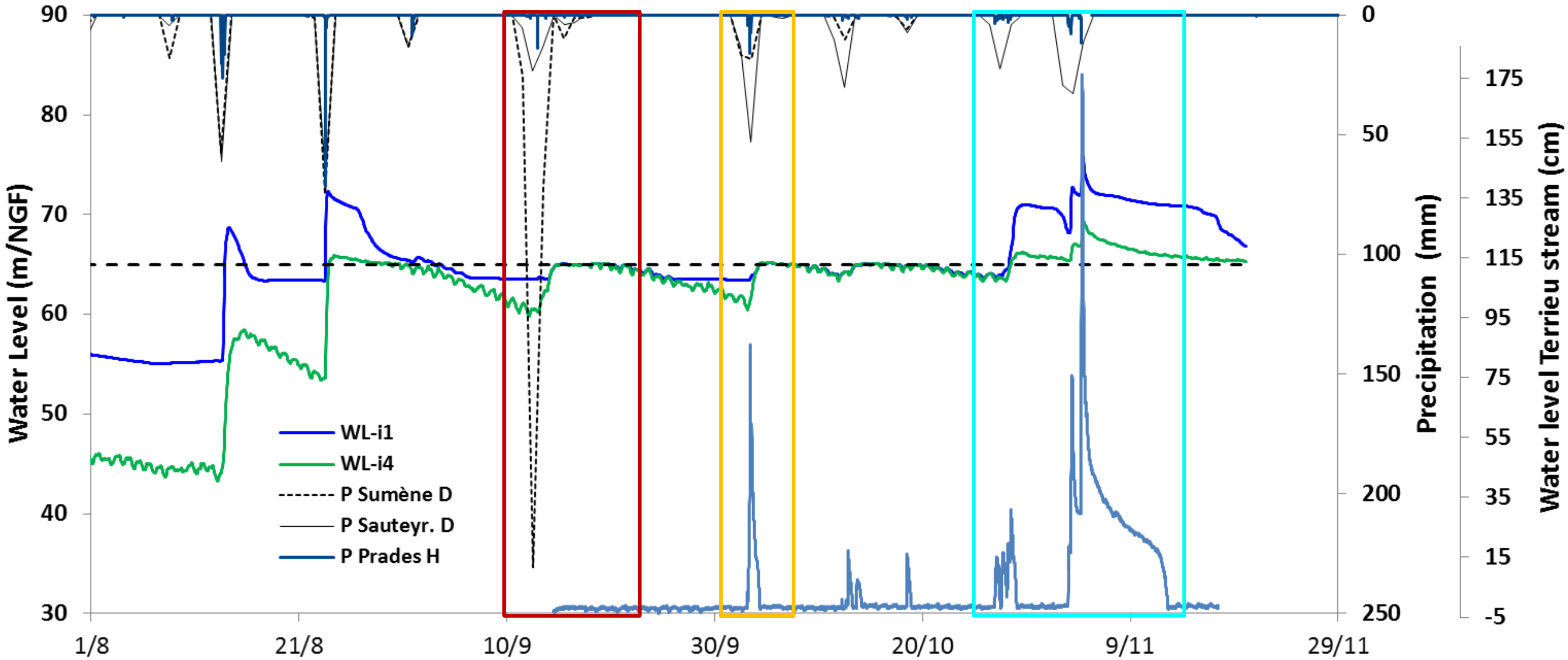
✓ Local/Regional

✓ 18O,2H sampling

Intermittent stream level



- Recharge dynamic



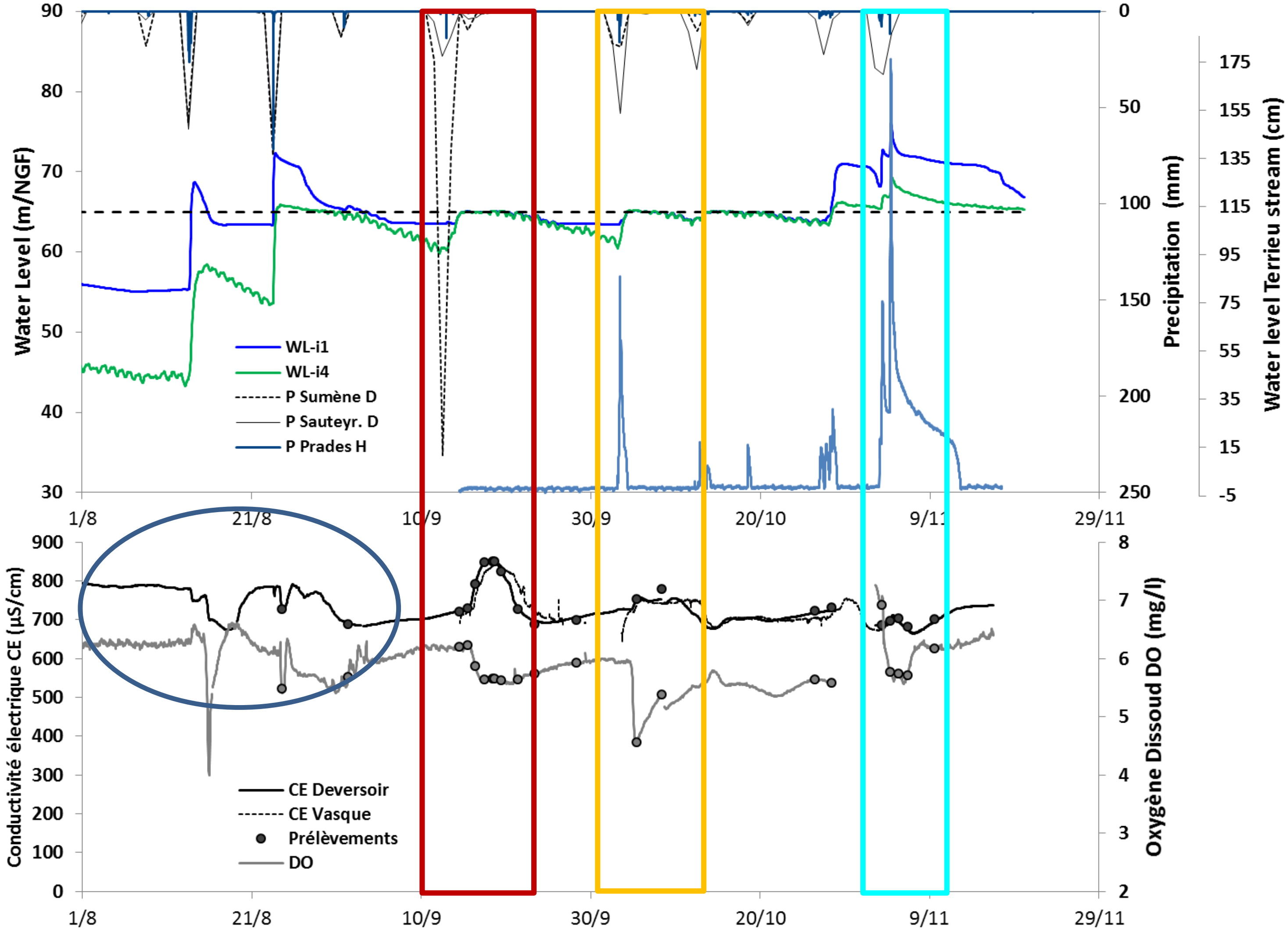
Event 1: 14 Septembre
- Local rainfall < 50 mm
- Regional rainfall > 350 mm (NW)
- No surficial flow
- Δ i1< i4

Event 2: 4 Octobre
- Local rainfall > 50 mm
- Surficial flow
- Δ i1> i4

Event 3: 4 Novembre
- Local rainfall > 120 mm
- Surficial flow
- Δ i1> i4

⇨ Consequences on the hydrochemical response?
⇨ Indicators of flow type at the spring?

- Hydrochemical response

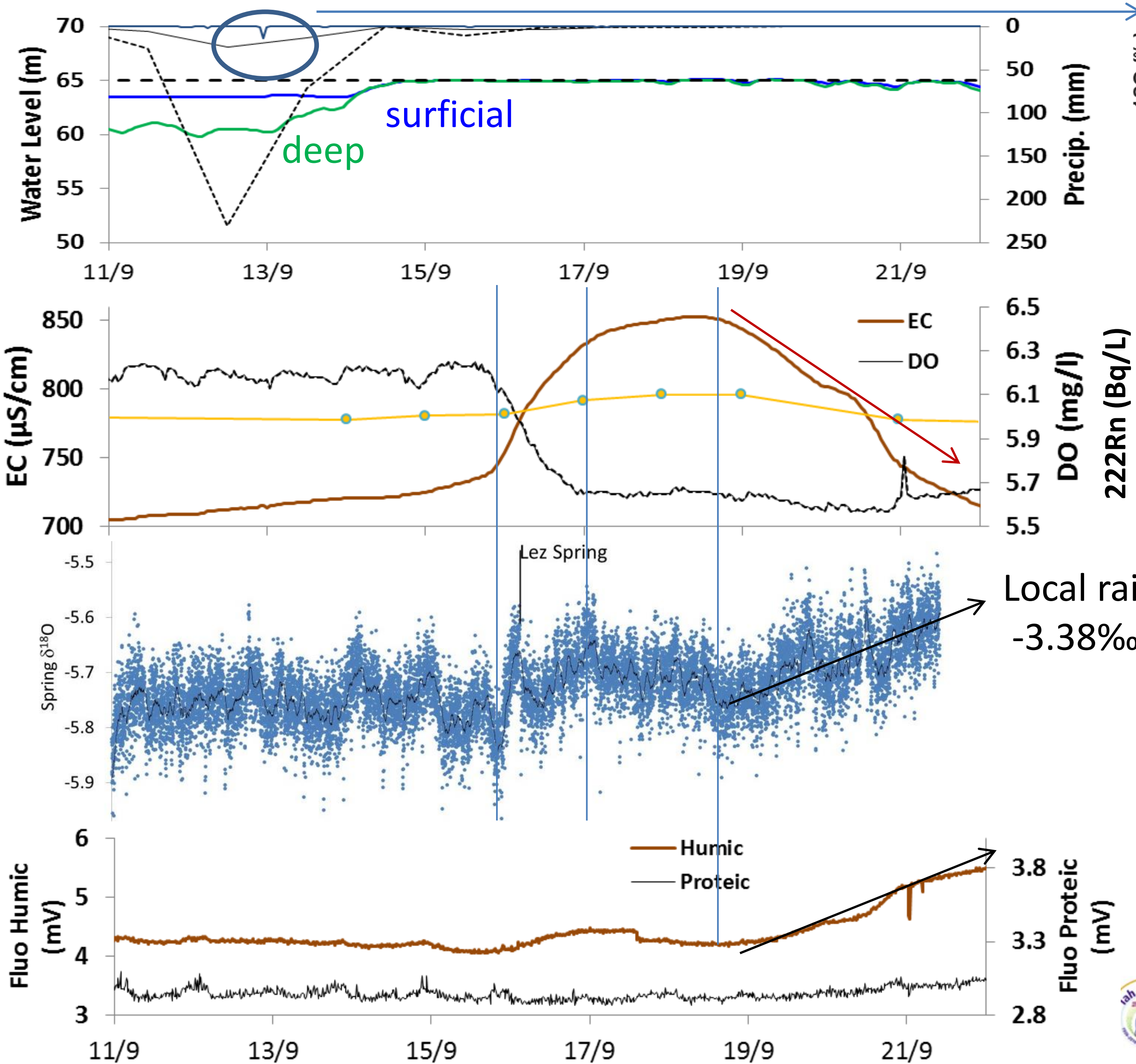


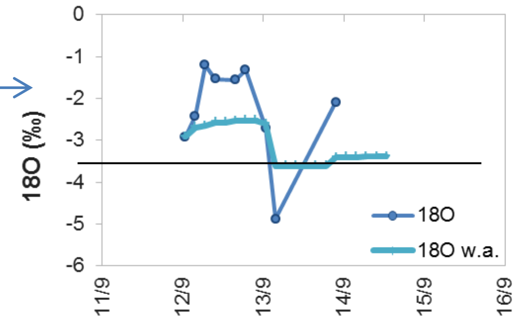
Event 1: 14 Sept.
↗ EC et ↘DO ⇨ Deep Flow

Event 2: 4 Oct.
↗ EC faible et ↘ ↘ DO
⇨ Deep flow contribution?

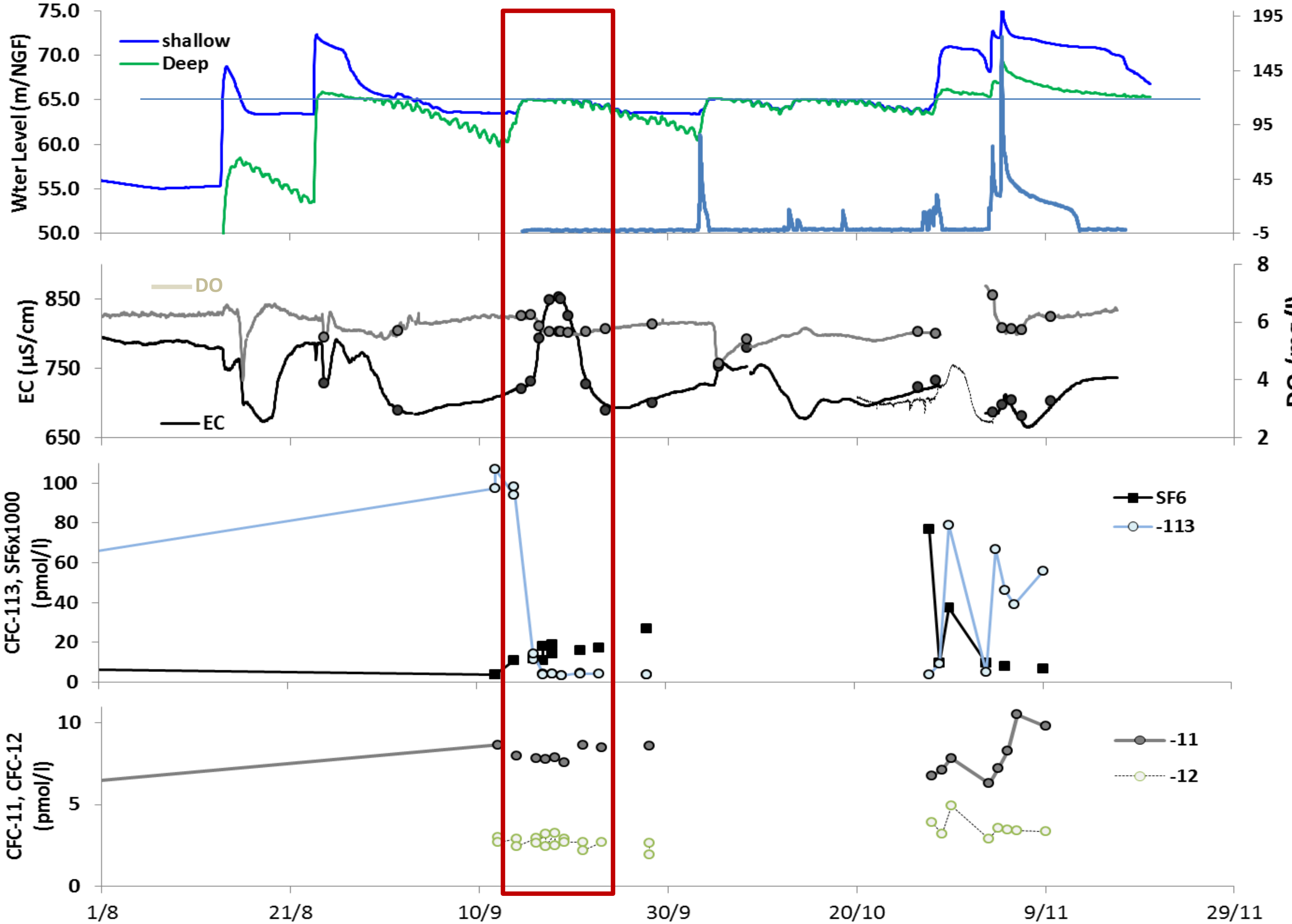
Event 3: 4 Nov.
↘ EC et ↗ DO ⇨ Surf. flow

- Event hydrochemical characteristic





Local rainfall
-3.38‰


75.0
70.0
65.0
60.0
55.0
50.0
Wter Level (m/NGF)
shallow
Deep
195
145
95
45
-5
Water level Stream (m)
850
750
650
EC (µS/cm)
DO
EC
8
6
4
2
DO (mg/l)
100
80
60
40
20
0
CFC-113, SF6x1000 (pmol/l)
SF6
-113
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5
0
CFC-11, CFC-12 (pmol/l)
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-12
1/8
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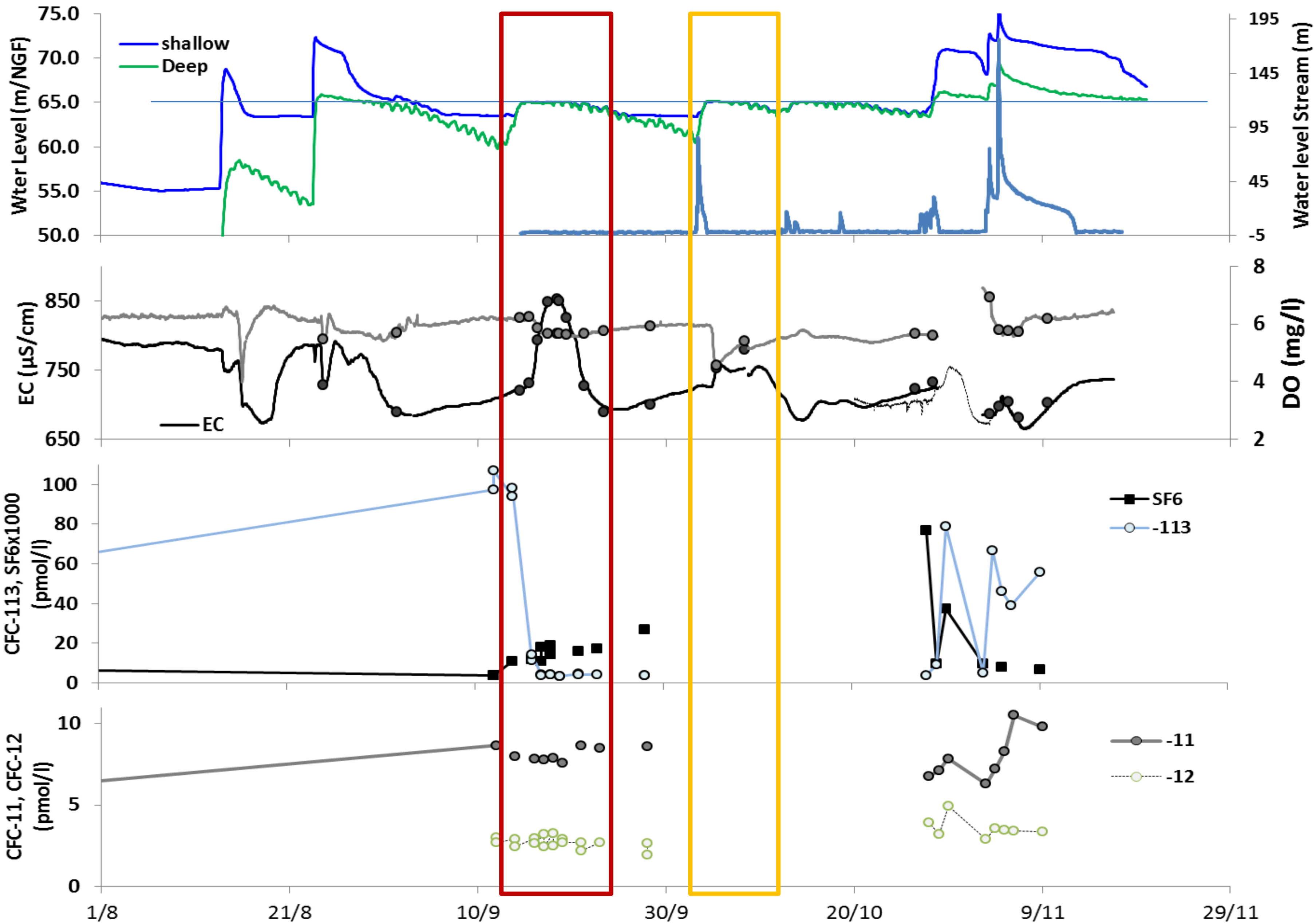
10/9
30/9
20/10
9/11
29/11



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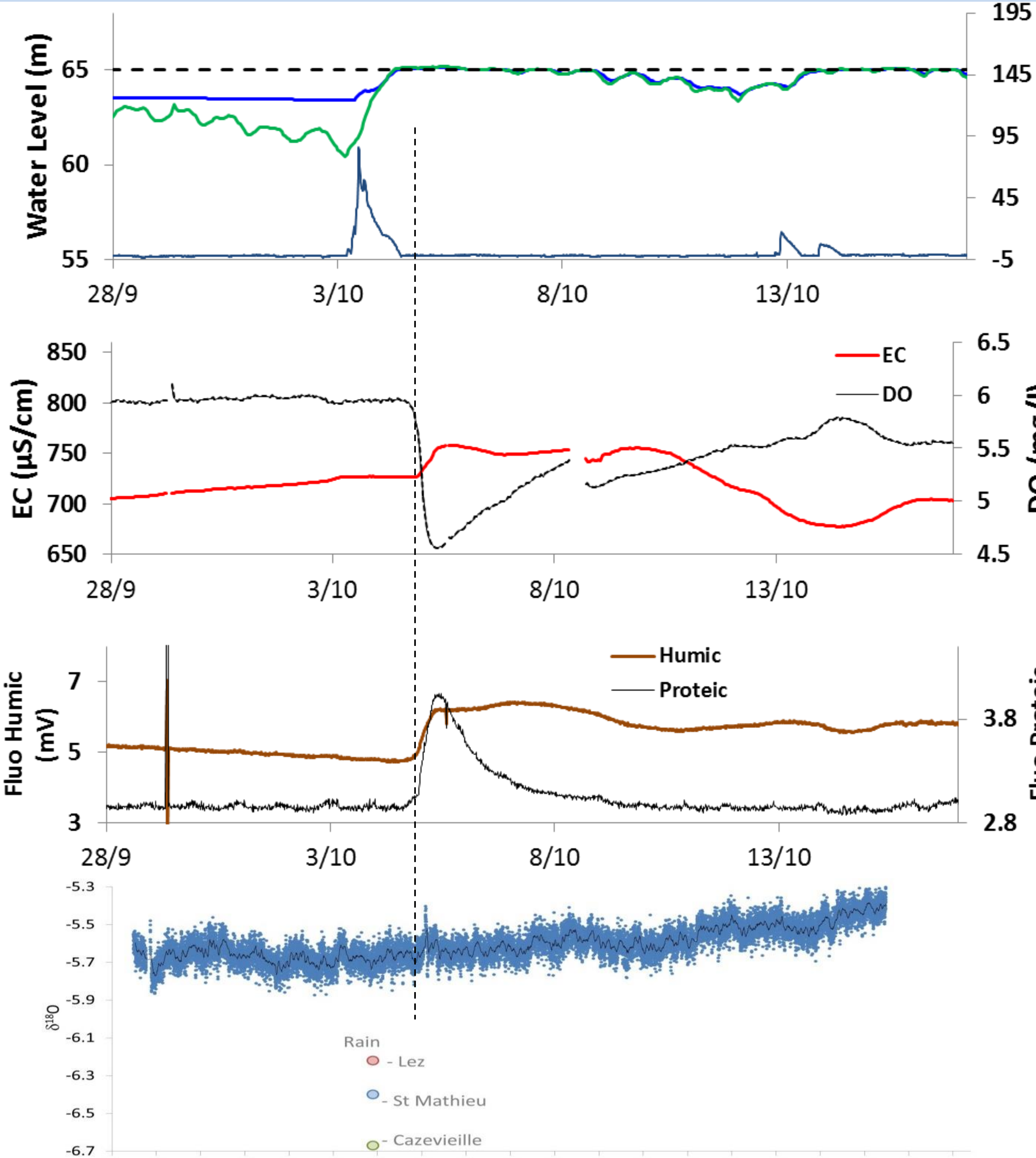
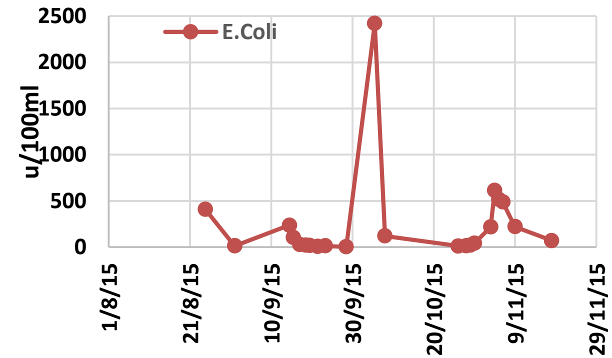
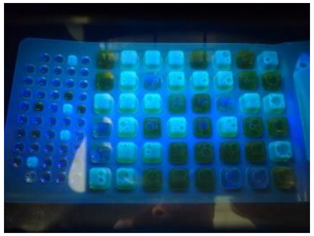


Event 2: 4 Octobre

6/10





- Conclusions
  - Monitoring at the event scale (with low gap!)
    - Relevance of continuous field monitoring using laser spectrometer
    - Dissolved gases time series
  - Better constrain the origin and the occurrence of flows:

Contaminated surficial infiltration	Low rain inducing surface flows	Peak of proteic like compound
Deep mineralized water	Rain inducing deep water level (i4) increase up to 65m BUT low surface flows	Decrease of CFC contamination Variation of ^{18}O

⇨ Crucial information for managing Montpellier water resource

- Next steps?
  - Combined hydrodynamical information to create a proxi
  - Mixing proportions
  - Origin of contaminations

Thank you for your attention

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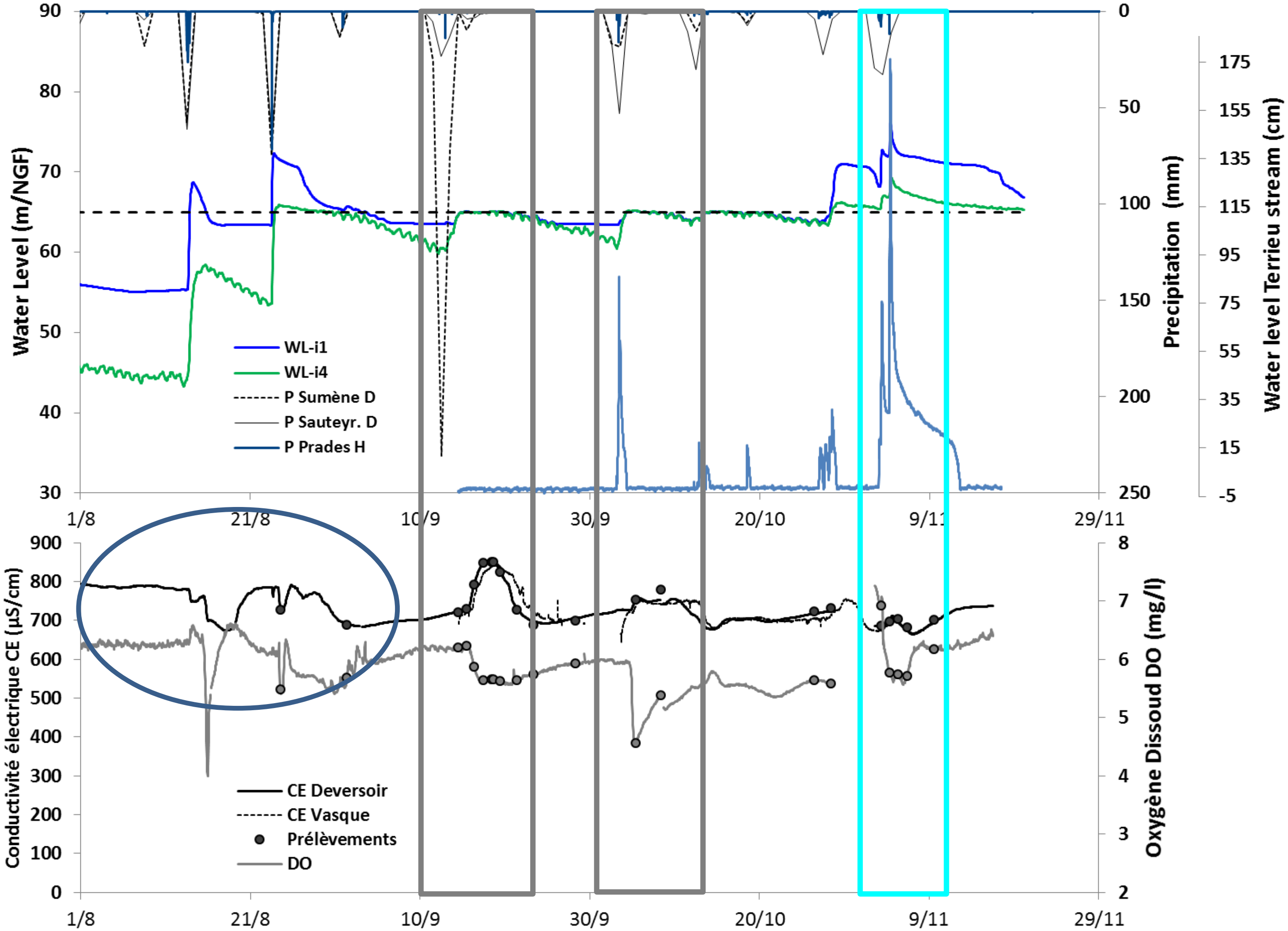
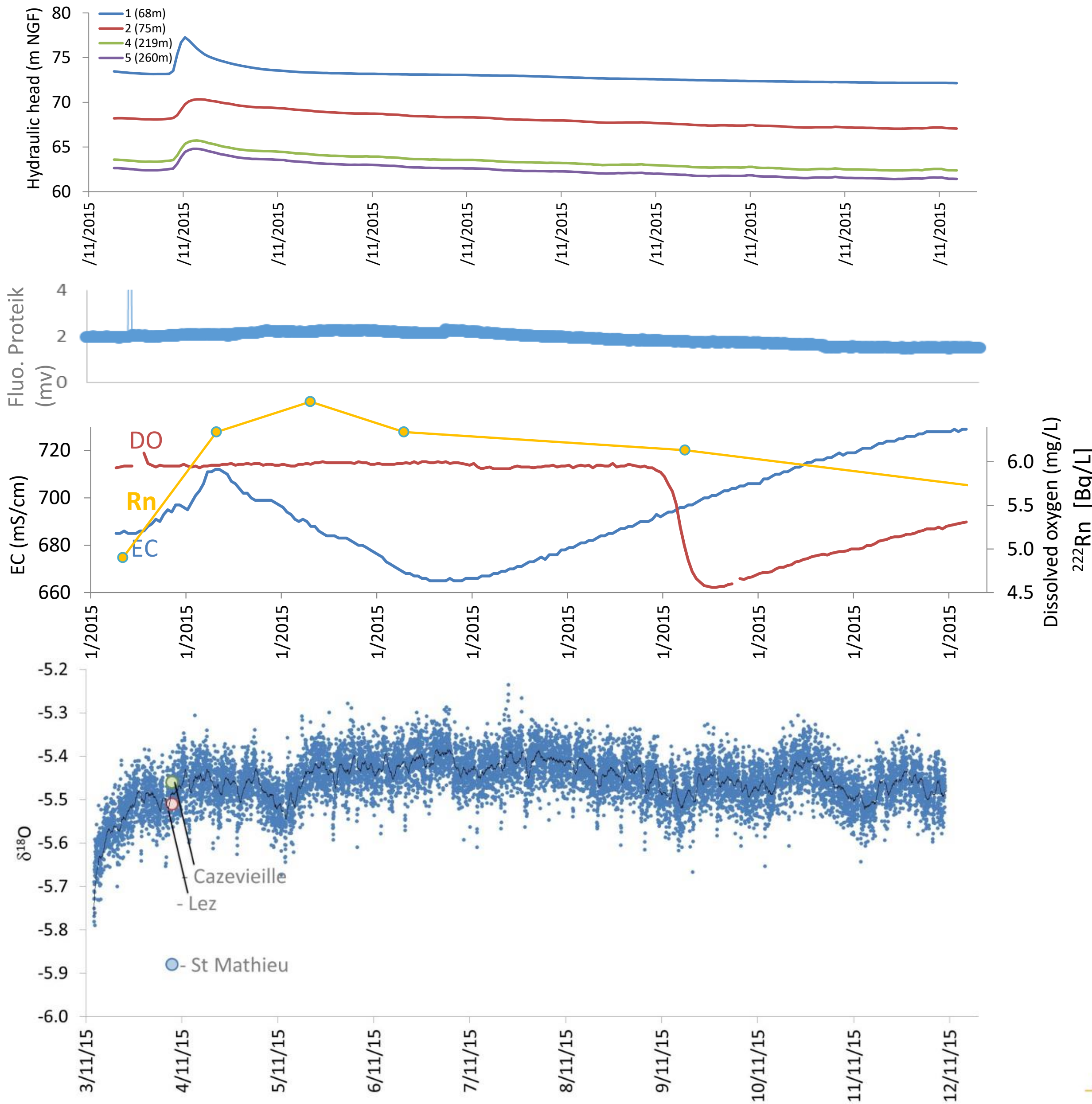
- Hydrochemical response

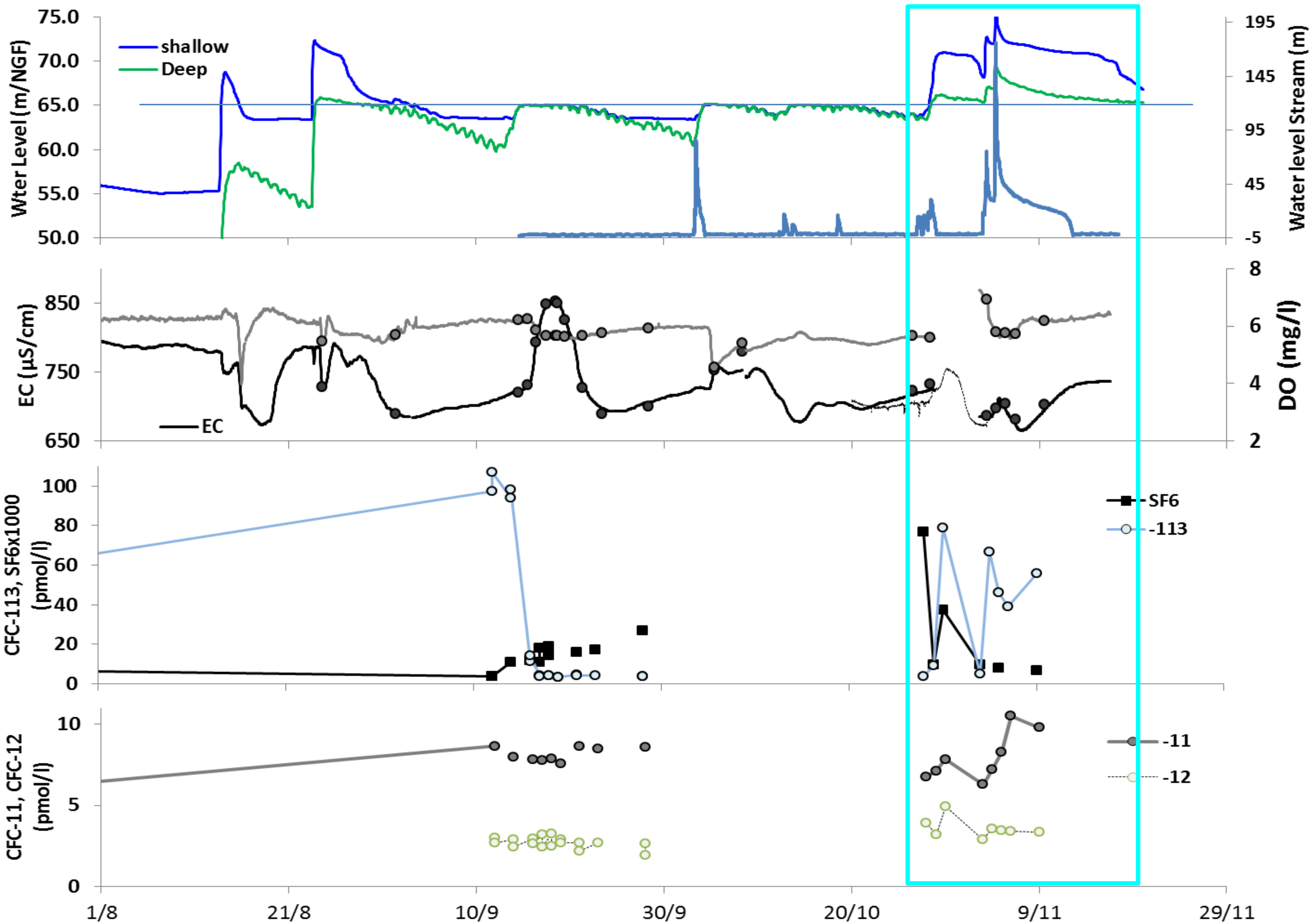


Event 3: 4 Nov.

↘ EC et ↗ DO ⇨ Surf. flow

Event 3: 4 Novembre

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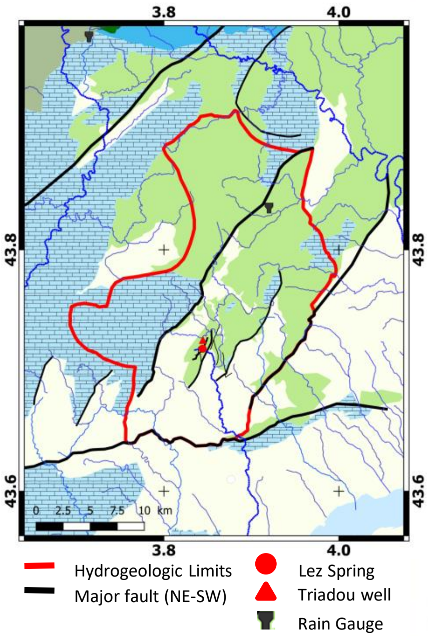
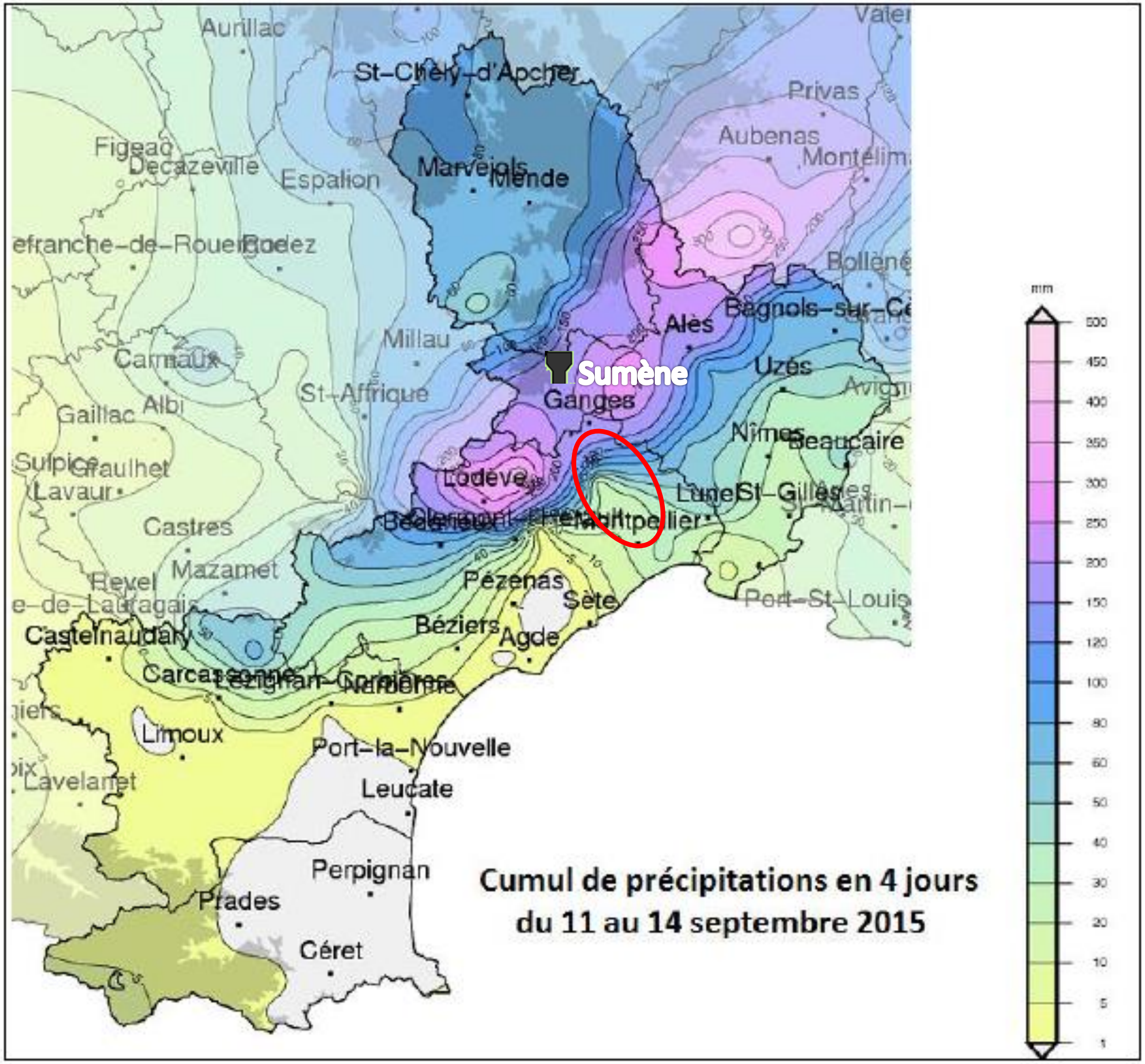
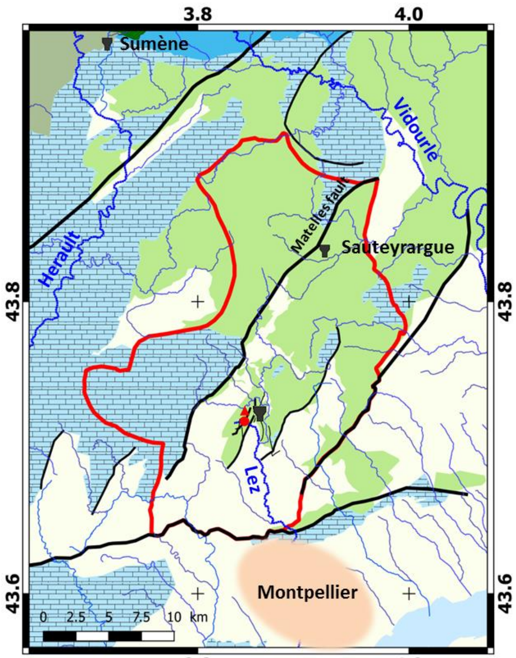




Carte 2: Pluviométrie régionale du 11 au 14/09 - sources MétéoFrance

- **Monitoring**



Hydrogeologic Limits
Major fault (NE-SW)
Lez Spring
Triadou well
Rain Gauge

Lez Spring

✓ **Continuous and high frequency monitoring:**

- 18O, 2H - Picarro - 1min precision ± 0.04 ‰
- natural fluorescence of humic and proteic-like compounds - 10min

✓ **Daily sampling of innovative tracers** :

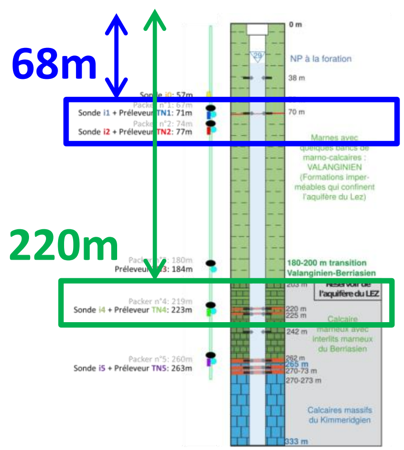
- Dissolved gases
- radon and radium isotopes
- 3D-fluorescence

Triadou multilevel well

✓ Surficial water level 68m

✓ Deep water level 220m

Intermittent stream level



Rain Gauge

✓ Local/Regional

✓ 18O,2H sampling