

EGU GIFT WORKSHOP
Monday 19 and Wednesday 23 April 2021



HYDROGEOLOGY AT SCHOOL

PART 2 : INTENSE MEDITERRANEAN RAIN

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² : EduMed Observatory, IDEX UCA^{EDU}, Education & outreach cell – UMR Géoazur (UCA, OCA, CNRS, IRD)



Storm Alex 02/03 October 2020



Bridge of the Maille, St Martin Vésuble (L. Lecourtier, 02/10/2020)



Vintimiglia, Italia (Twitter UNMDOfficial)



Vesubie valley (Jaime Marrades)



Vesubie valley (Pompier 06)



Napoleon bridge, Nice (D. Dziadula)

EGU GIFT WORKSHOP



Wednesday 23th April 2021 11:00 AM

PART 2 : INTENSE MEDITERRANEAN RAIN

HYDROGEOLOGY AT SCHOOL

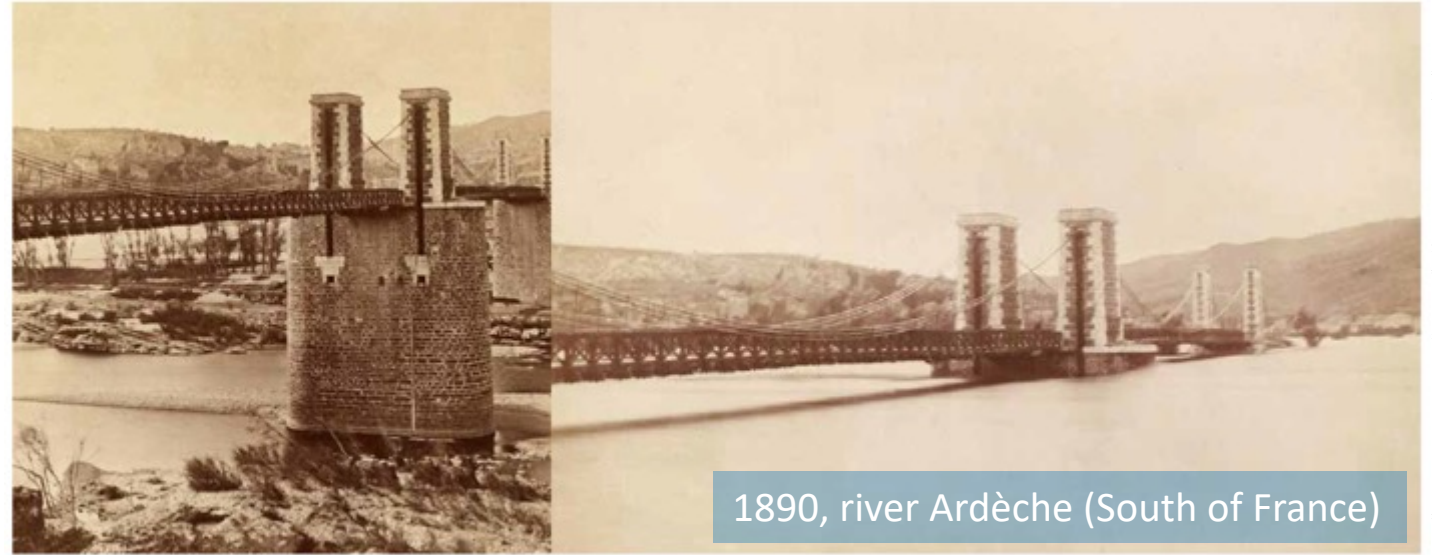
- A recurrent risk for the population
- Meteorological phenomenon
- Effects on rivers
- Role of the karst and the underground
- Effect on the sea and consequences
- Intense mediterranean rain, global warming and citizen issues at school

1875, river Adour (South-west of France)



Dessin du pont de Tarbes sur l'Adour lors de son effondrement...
Source Christophe Cathelain - ioucrup65.fr

...puis photographié.
Source Christophe Cathelain - ioucrup65.fr



1890, river Ardèche (South of France)

L'Ardèche au pont reliant Salavas (en arrière-plan) à Vallon Pont d'Arc. À gauche à l'étiage* à droite lors de la crue du 22 septembre 1890. Elle a atteint une hauteur de 17m60 !
Source : gallica.bnf.fr/ Bibliothèque Nationale de France.

Pictures of this slide :

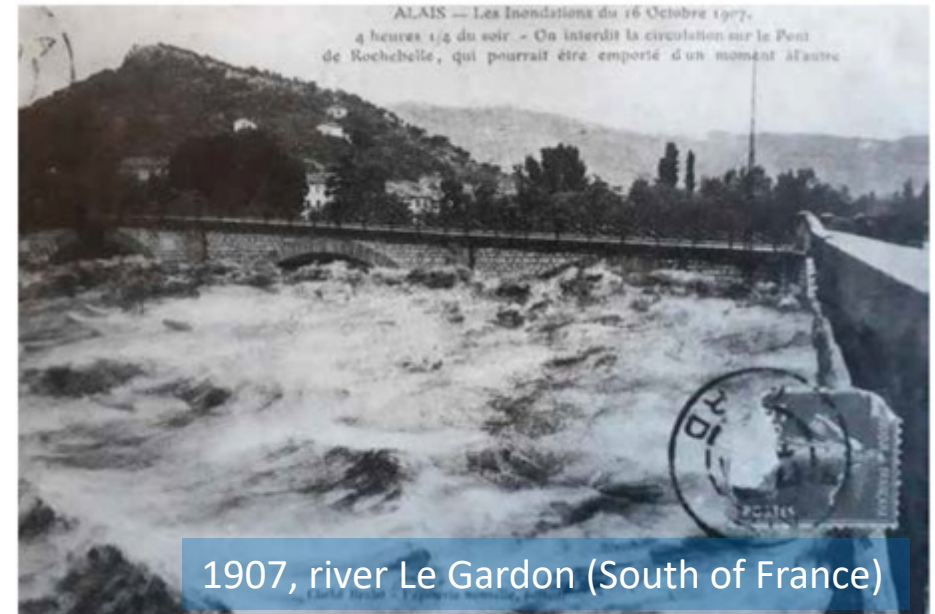
LA MÉMOIRE

150 ANS D'INONDATIONS EN PHOTOGRAPHIES SUR L'ARC MÉDITERRANÉEN
PAR L'IMAGE

JM Décombe et G. Verrhiest-Leblanc

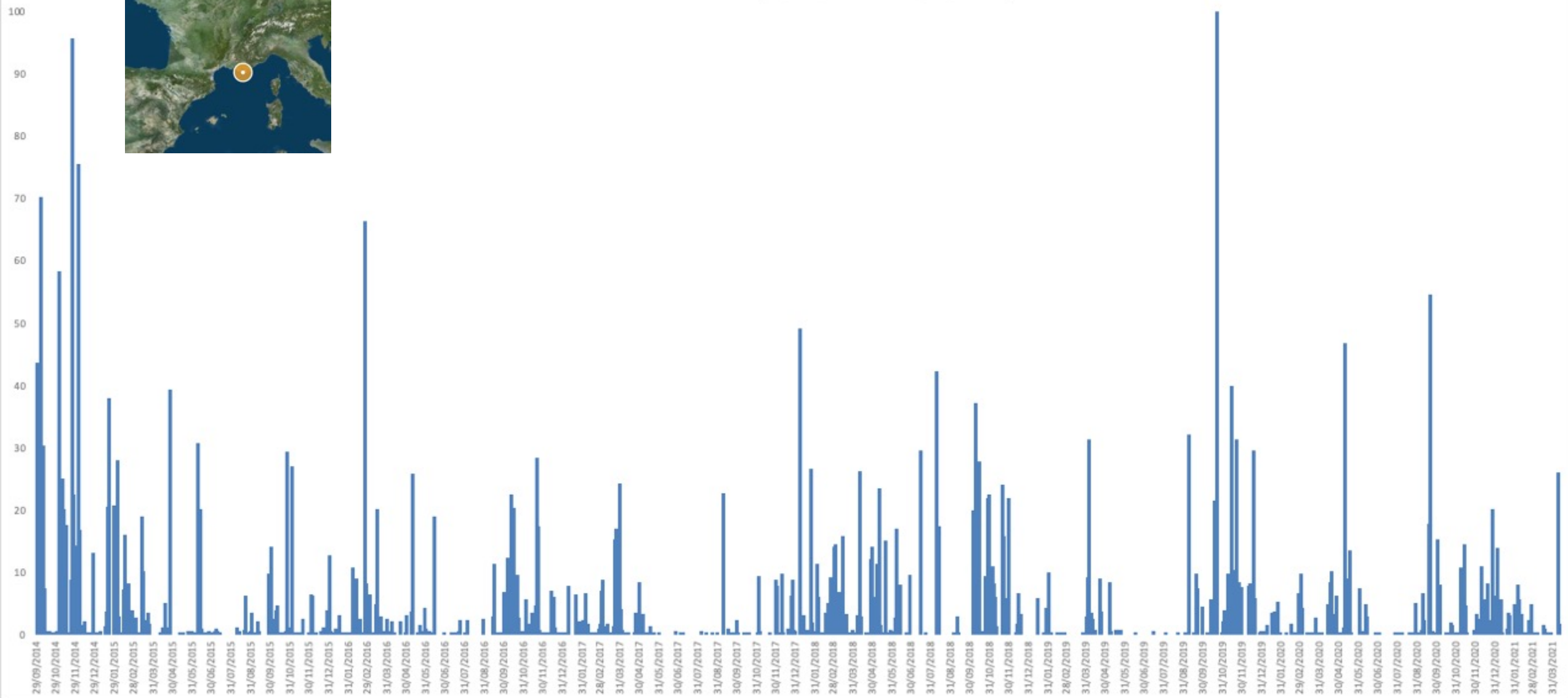
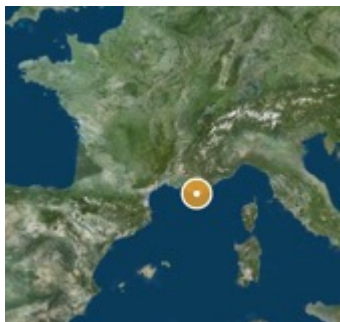


Le Gardon d'Alès en crue
au niveau du Pont vieux
et de Rochebelle à Alès le 16 octobre.
Source : archives départementales du Gard.



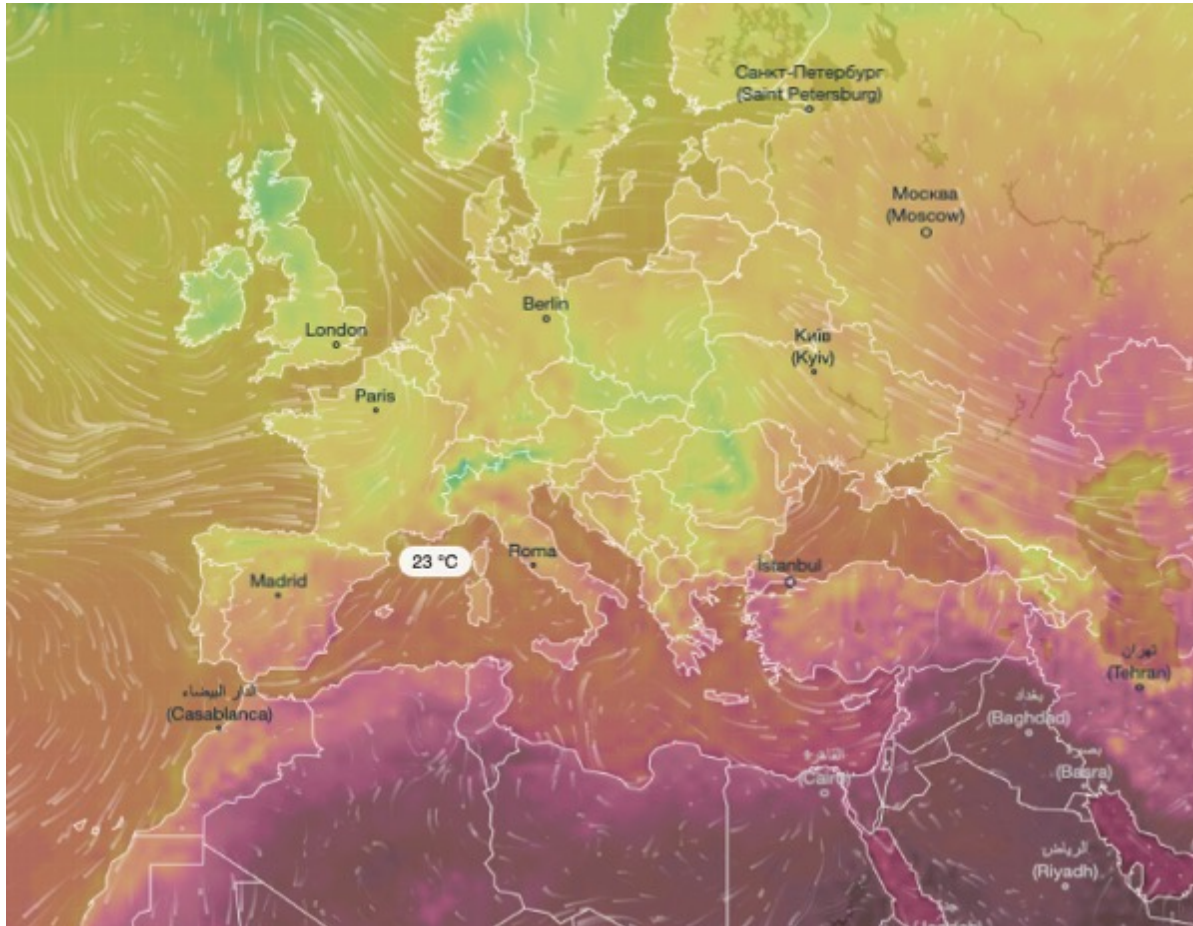
1907, river Le Gardon (South of France)

Daily Rainfall, city of Toulon (Var-France)
 Data : MétéoFrance (29/09/2014 - 14/04/2021)

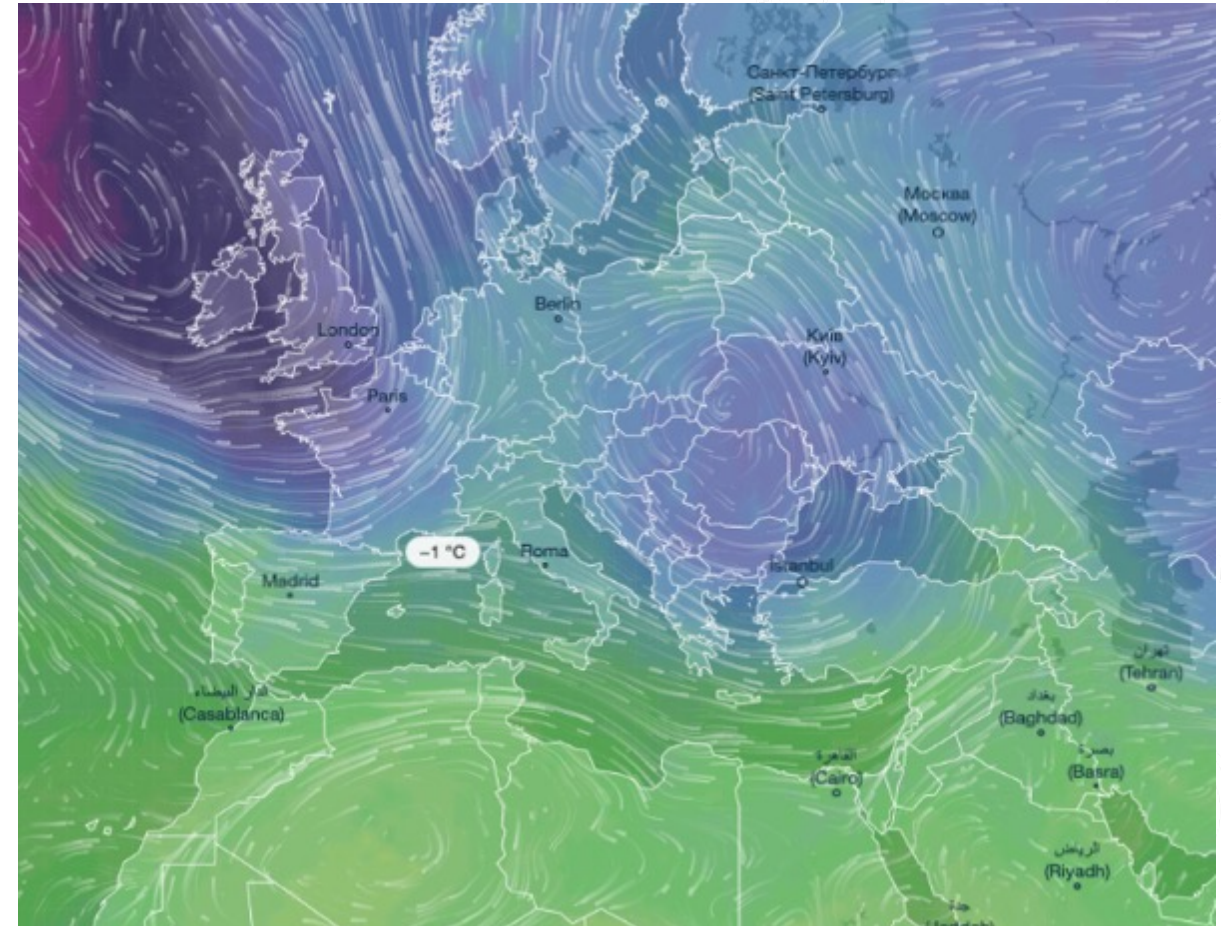


Fall 2014 Fall 2015 Fall 2016 Fall 2017 Fall 2018 Fall 2019 Fall 2020

Edumed.unice.fr → Data Center Meteo (Ventusky interface)



Temperatures 5cm above ground



Temperatures at 3600 metres above sea level

01/10/2020 11:00 AM

Summer

Autumn

Winter



Summer

Autumn

Winter

Summer

Autumn

Winter

Atmospheric forcing



A meteorological instability at each autumn



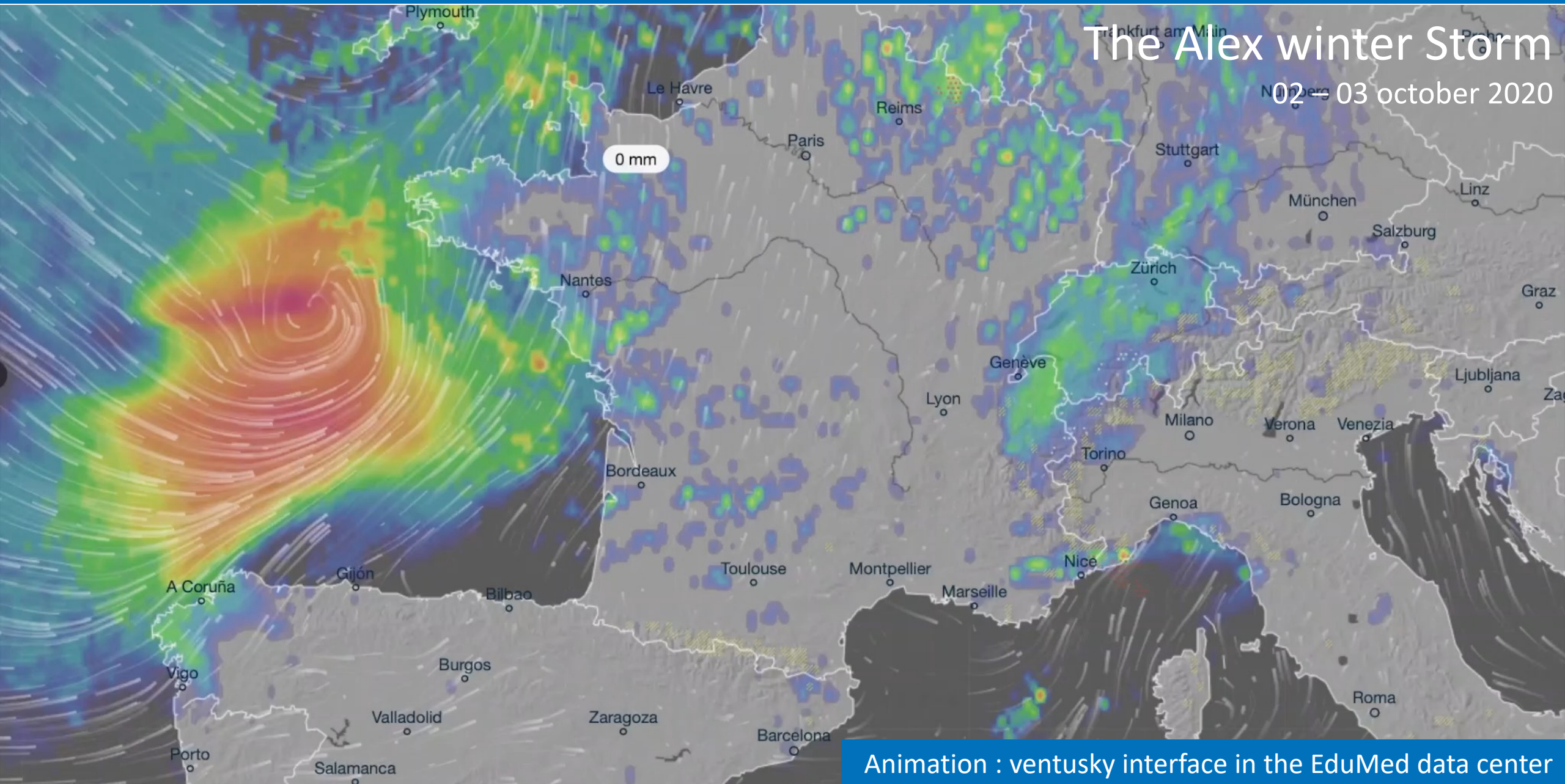
Summer

Autumn

Winter

The Alex winter Storm

02 – 03 october 2020



Animation : ventusky interface in the EduMed data center

Summer

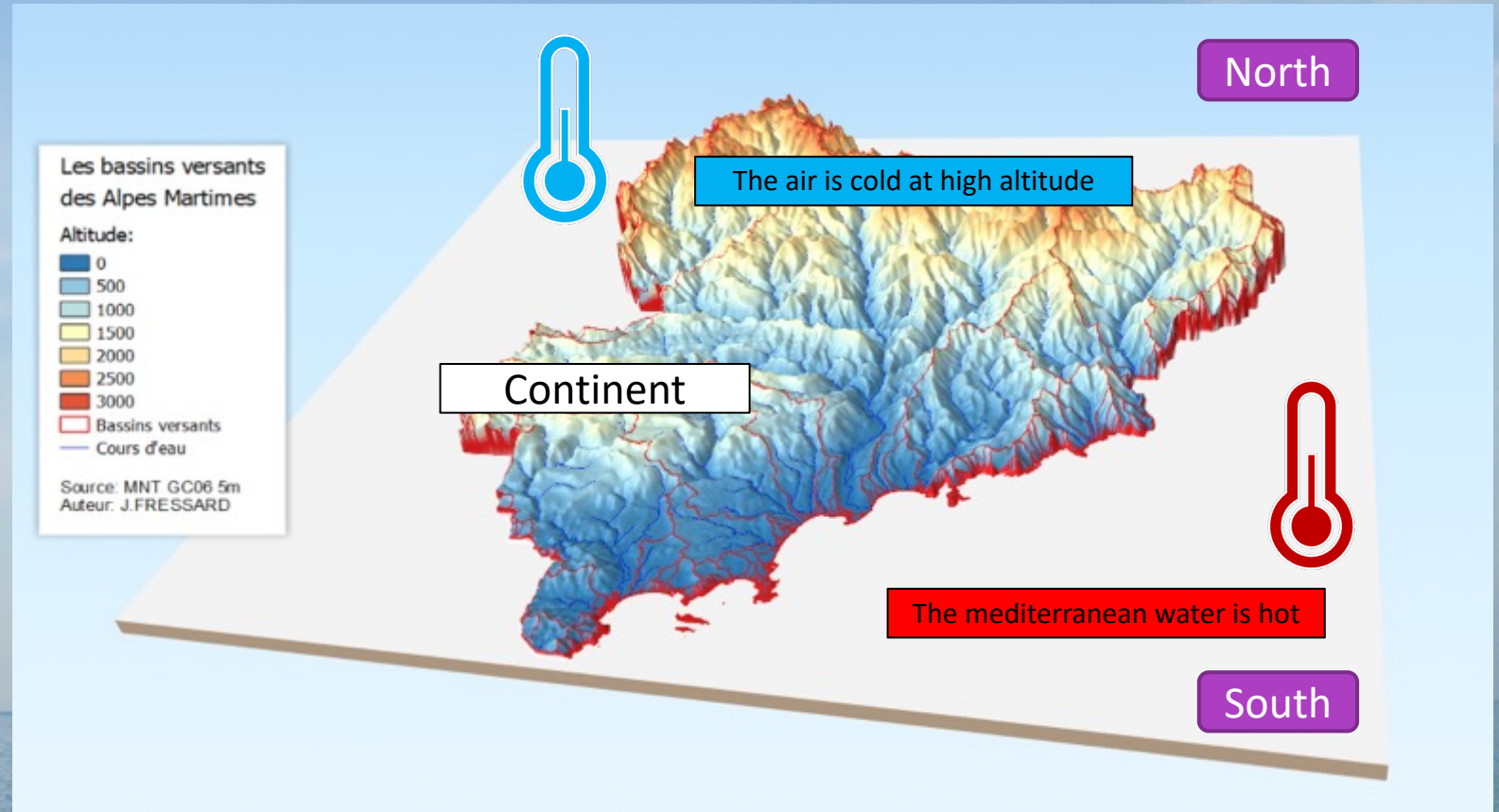
Autumn

Winter

Atmospheric forcing



A meteorological instability at each autumn



Summer

Autumn

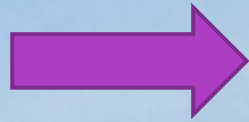
Winter

Summer

Autumn

Winter

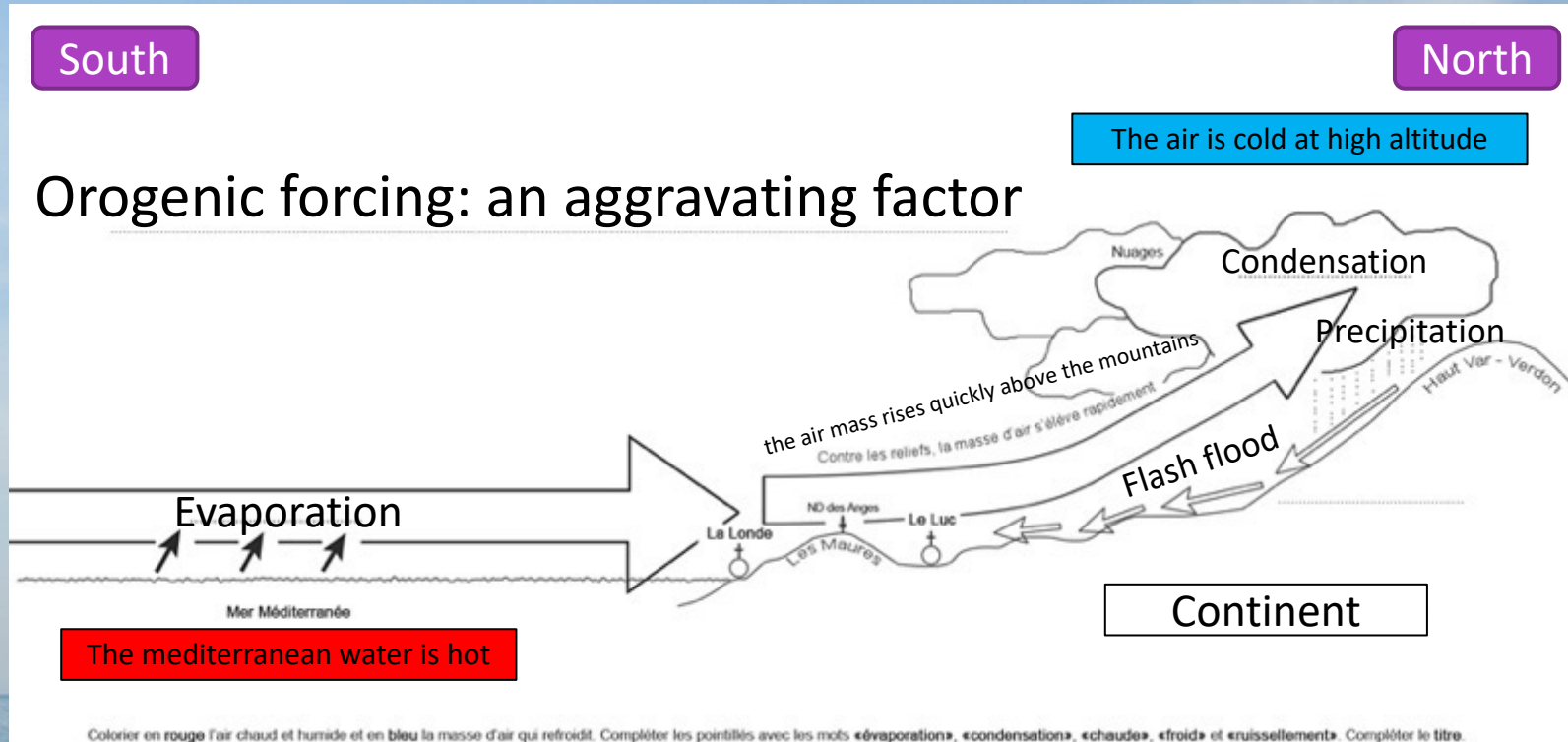
A scheme used with my pupils



Atmospheric forcing



A meteorological instability at each autumn



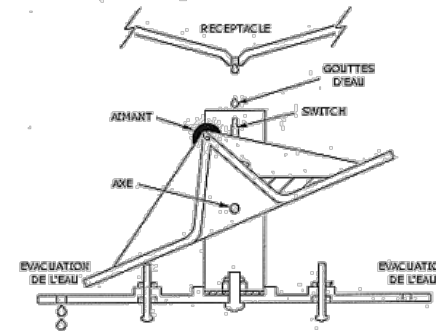
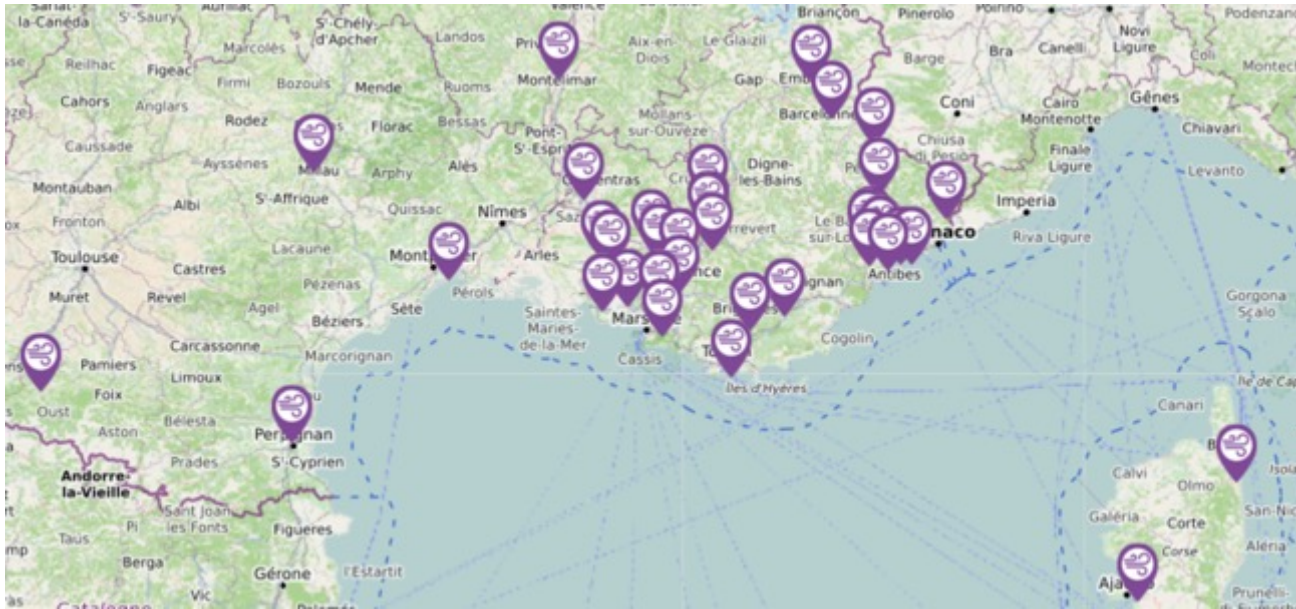
Summer

Autumn

Winter

Rain gauges

How to measure rainfall ?



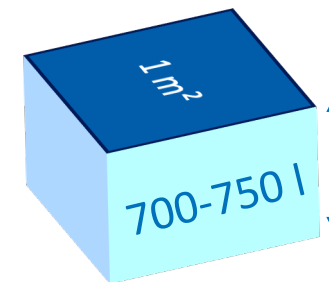
The EduMed website gathers data from weather stations installed in schools and research stations

Tipping bucket rain gauge

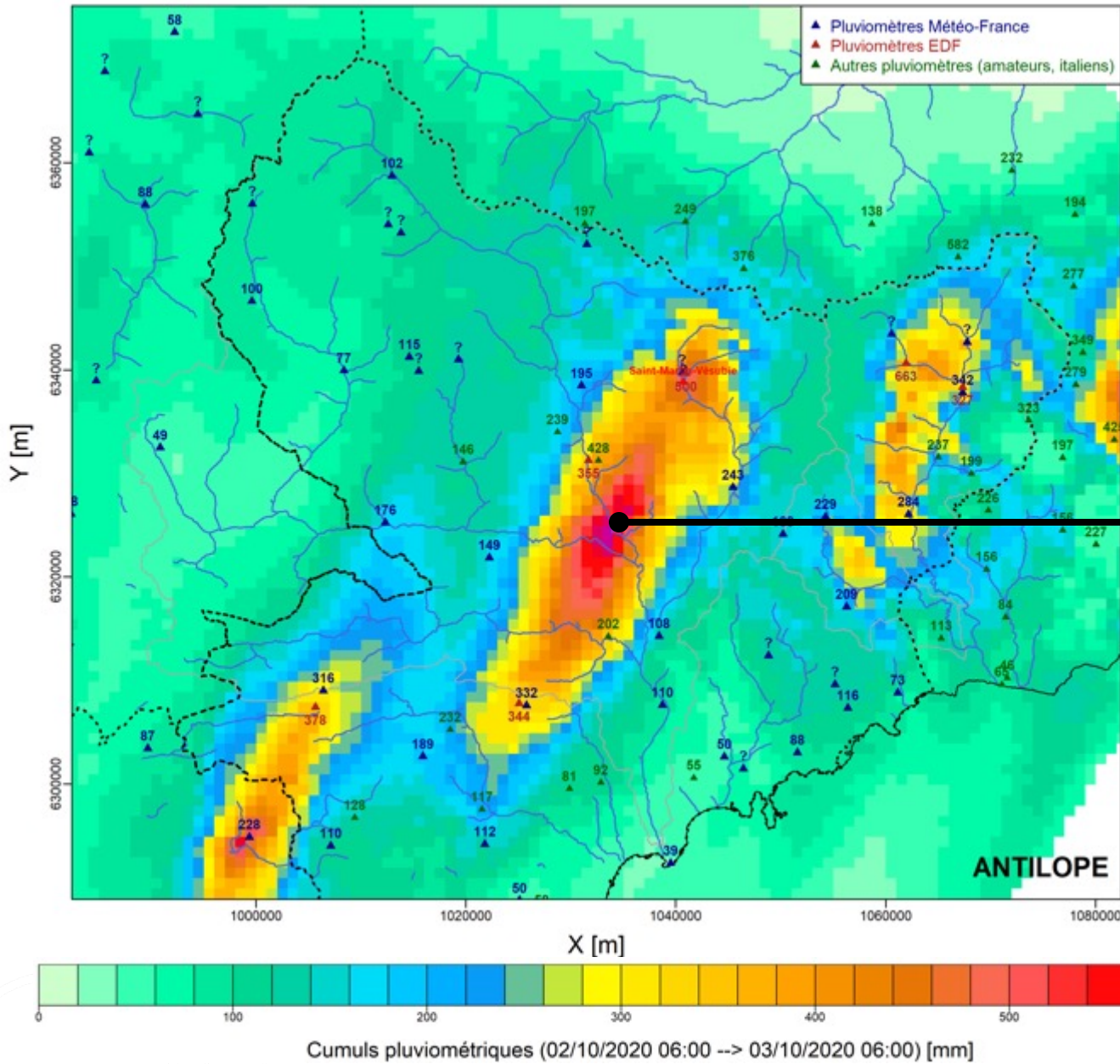
How to measure **intense** rainfall ?

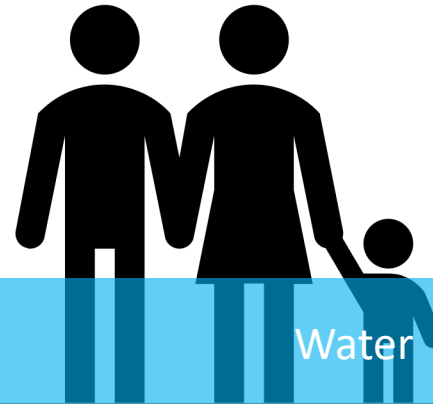


Values are probably underestimated



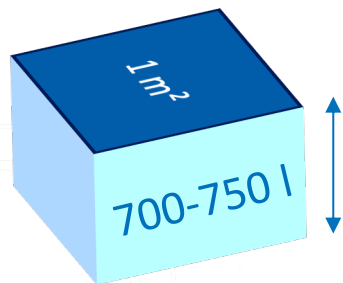
700 -750 mm
Per square meter



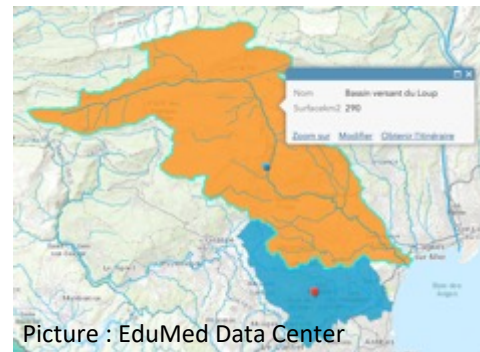


700 -750 mm

Soil and underground



700 -750 mm



Picture : EduMed Data Center

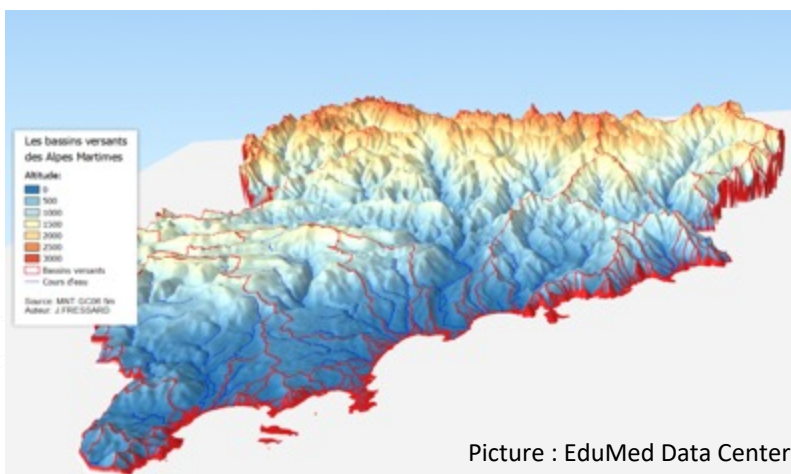
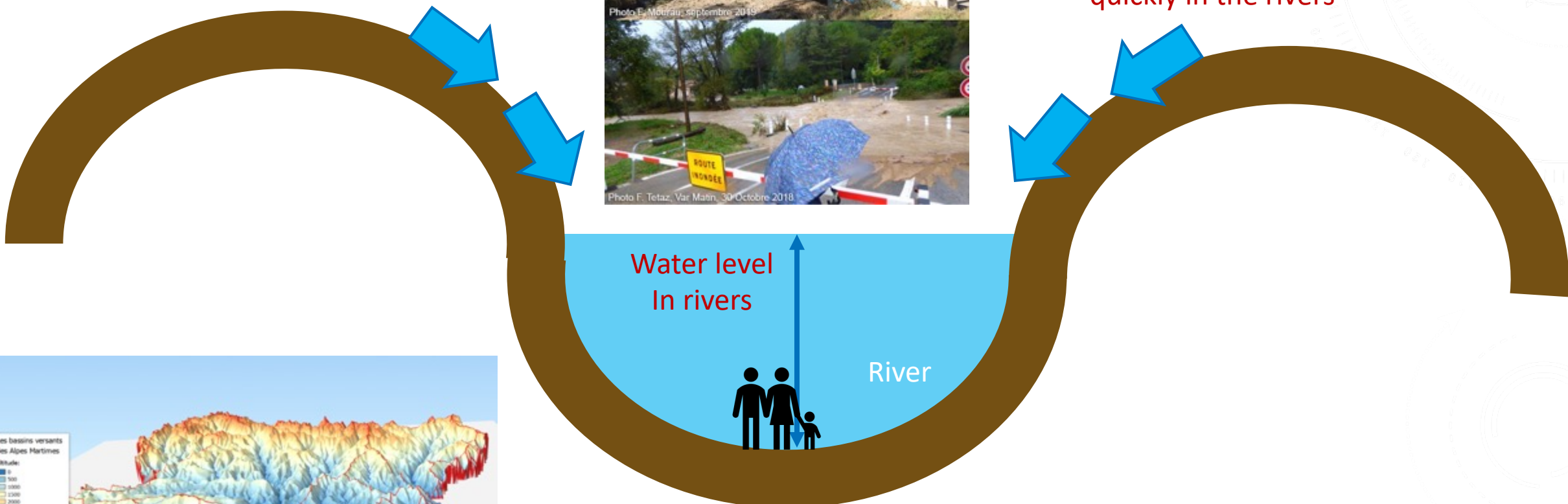
At the scale of the drainage basin

$$290 \text{ km}^2 = 290\,000\,000 \text{ m}^2 \times 700 \text{ liters} = 203 \text{ billions of liters}$$

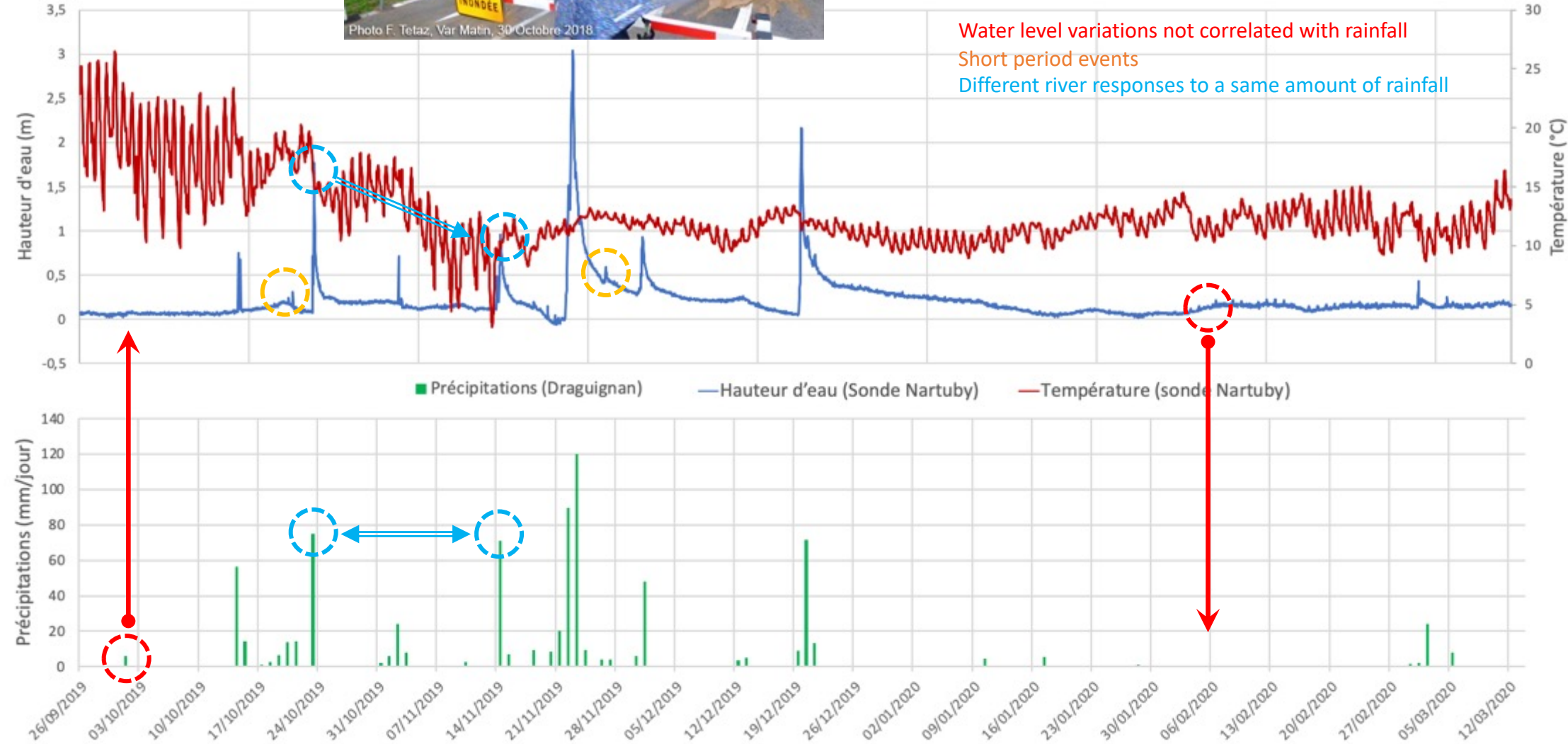
DO YOU REMEMBER DATA RECORDED BY JEAN ROSTAND SCHOOL IN DRAGUIGNAN ?



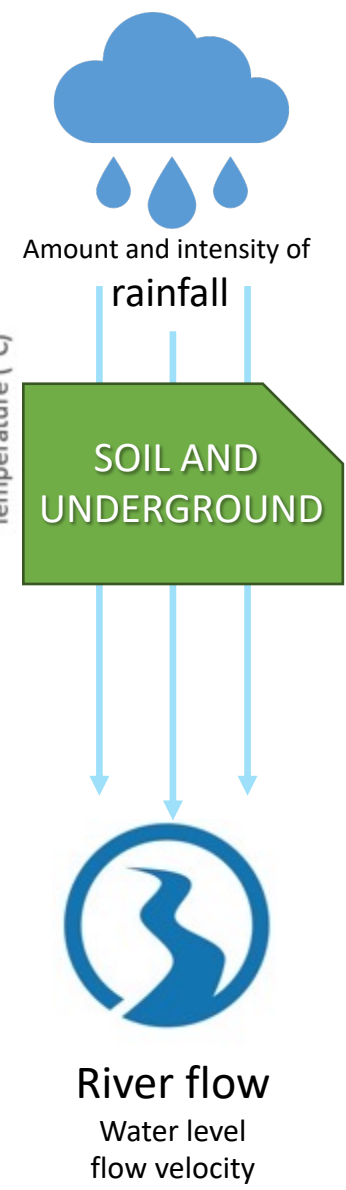
Flash flood event : with the relief of Provence, water flows down the hillsides and concentrates quickly in the rivers

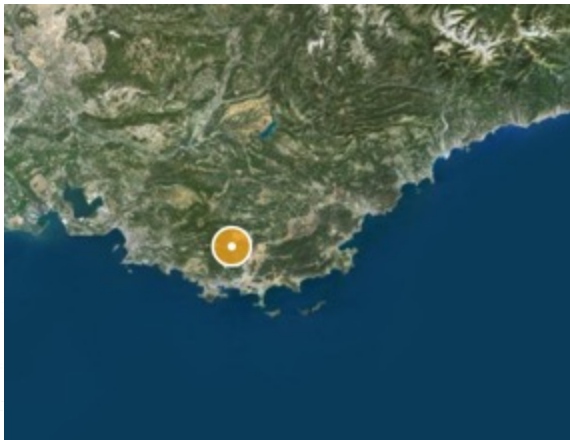
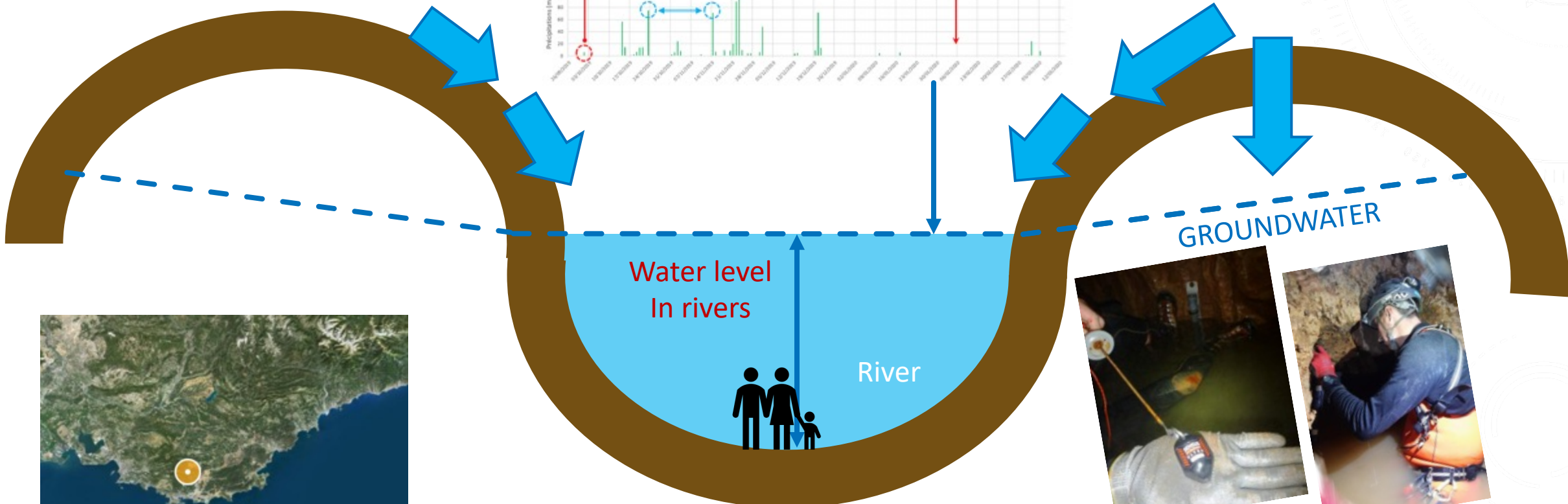
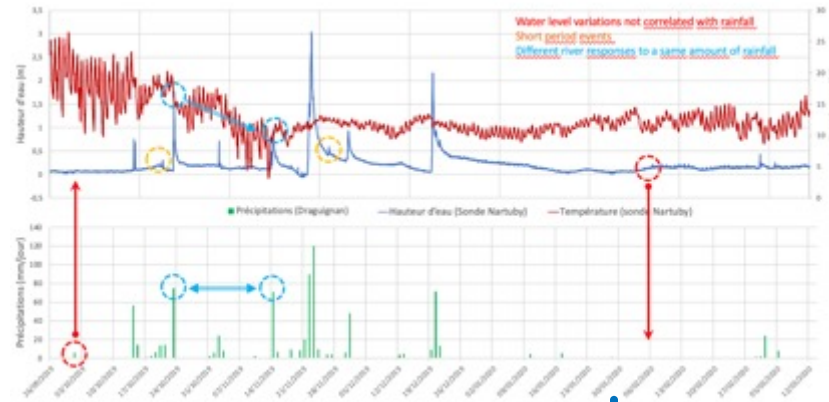


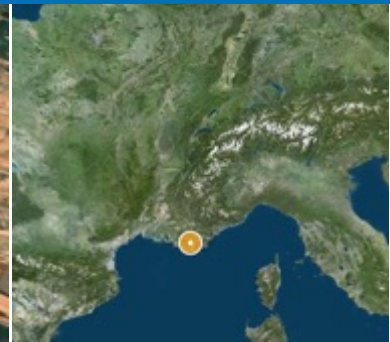
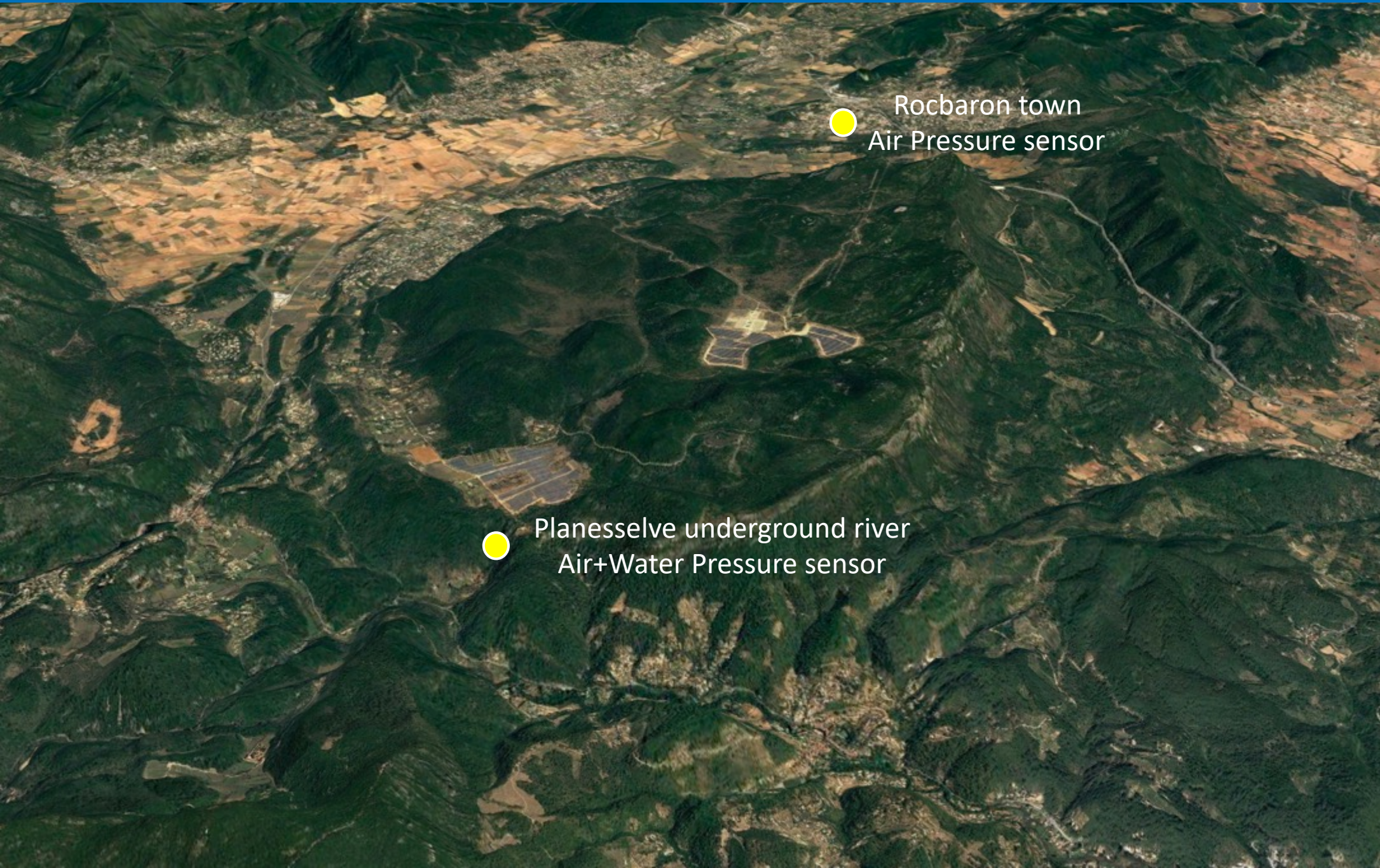
Picture : EduMed Data Center



Water level variations not correlated with rainfall
Short period events
Different river responses to a same amount of rainfall





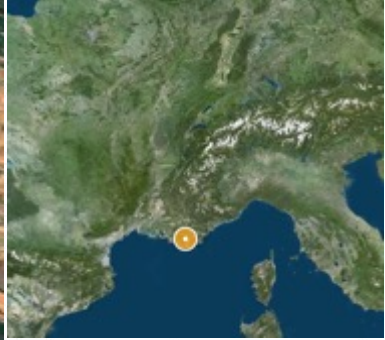


Pictures :
Google Earth
Geoportail
GAS-CDS83
(cavers)



Rocbaron town
Air Pressure sensor

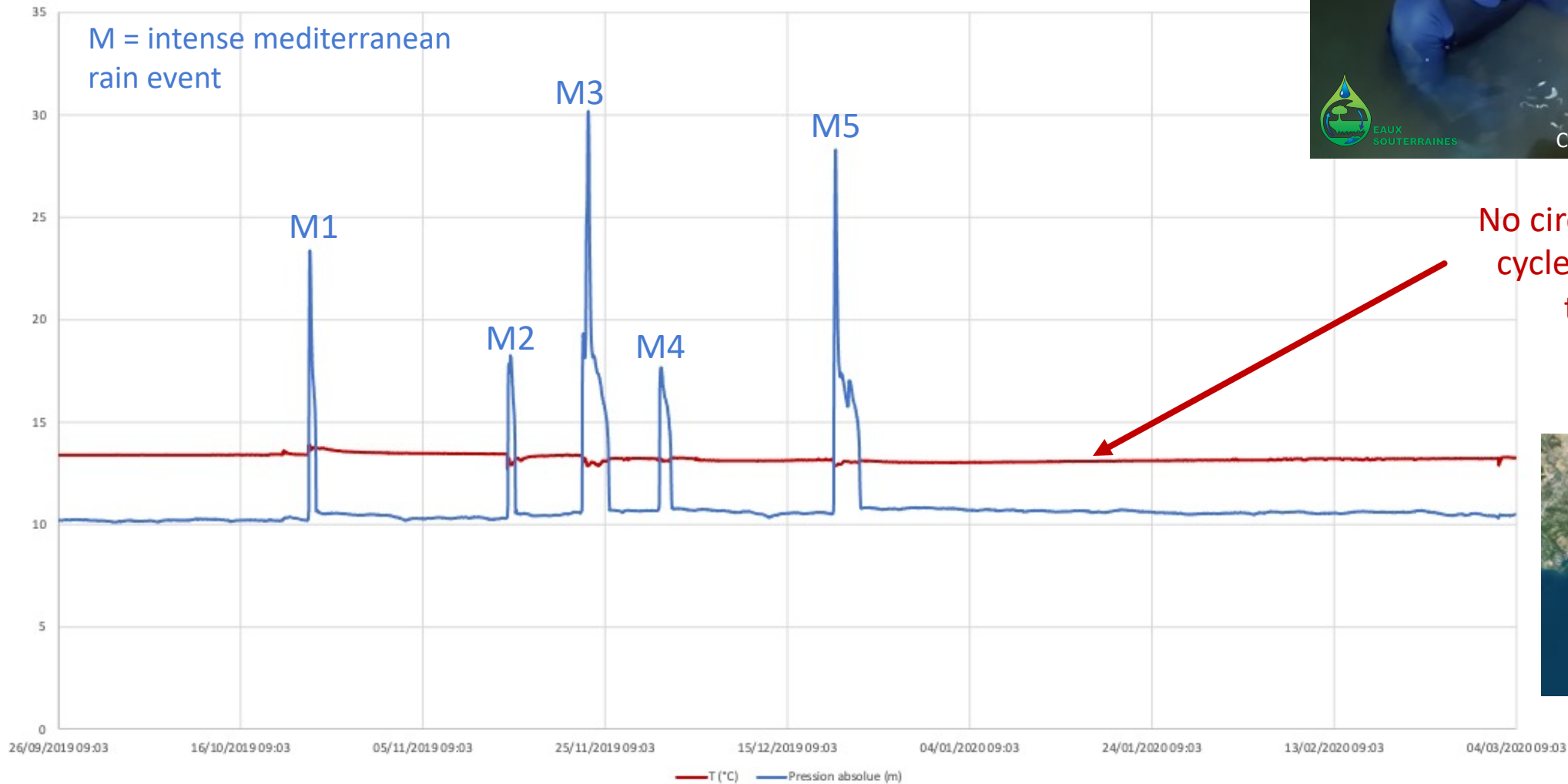
Planneselves underground river
Air+Water Pressure sensor



Pictures :
Google Earth
Geoportail
GAS-CDS83
(cavers)

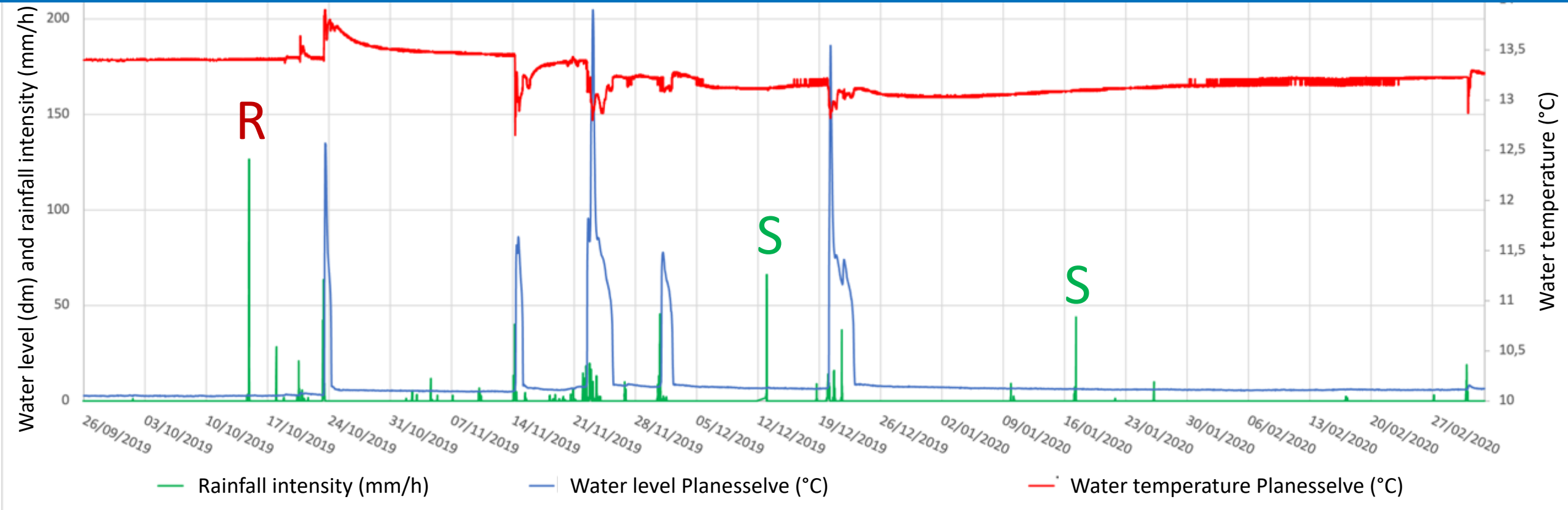
Data analysis : water level and temperature

Evolution de la température et de la hauteur d'eau dans la rivière souterraine de Planesselve
 Du 26/09/2019 au 04/03/2020
 (Données Eaux souterraines, CDS83/CEREGE/SpéléH2O)



No circadian (day/night) cycle on groundwater temperature





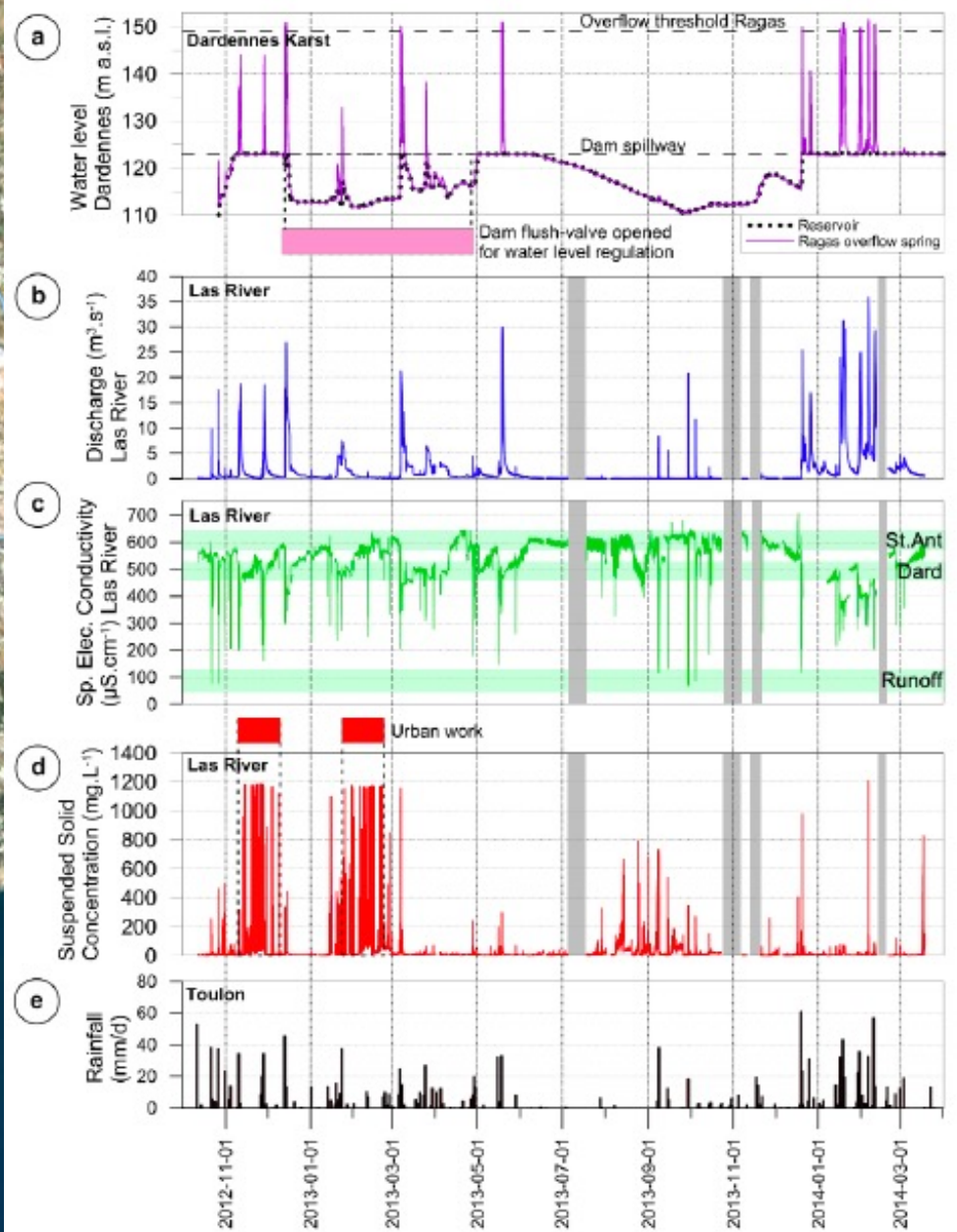
When they are very dry or totally saturated, the soil and epikarst cannot absorb water and it runs off the surface very quickly

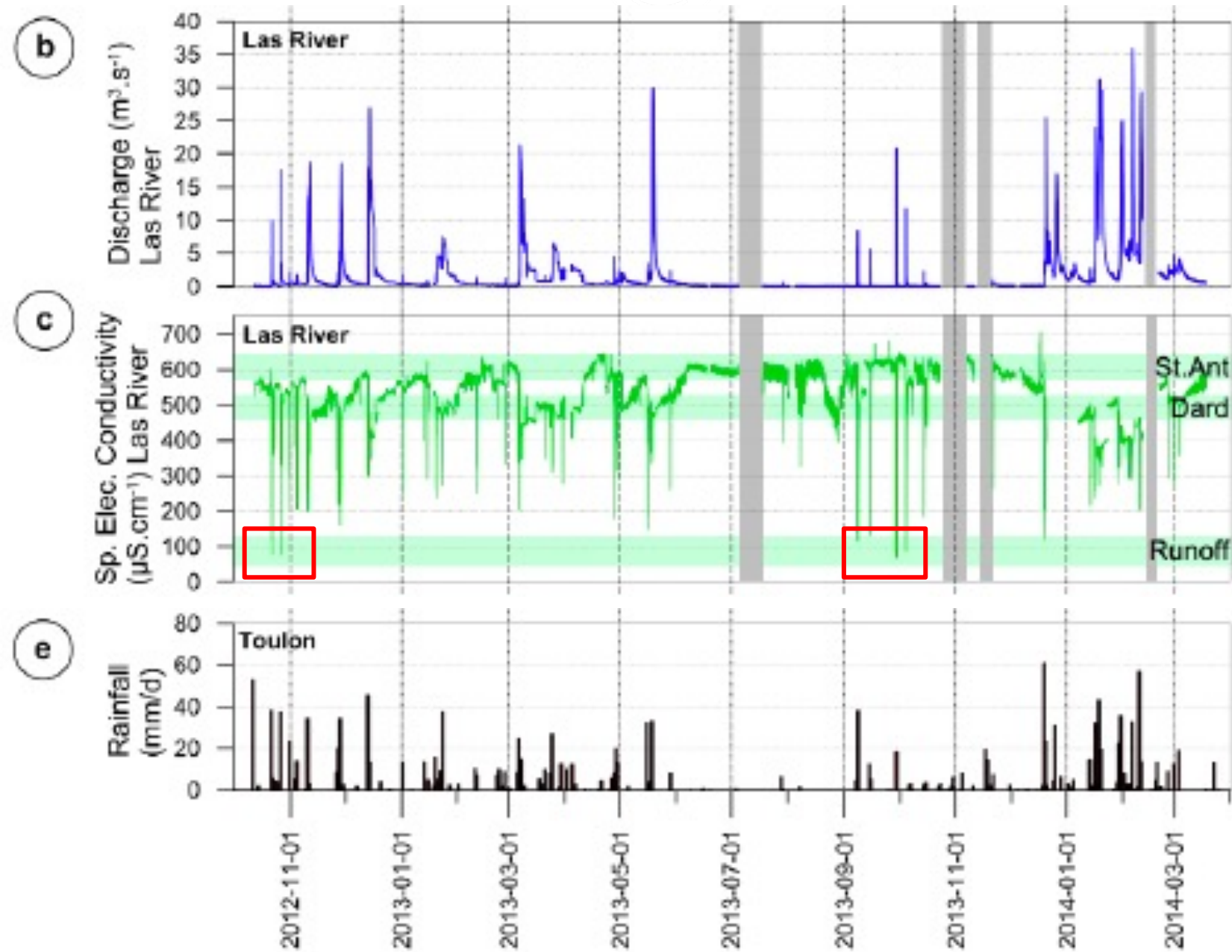
R
Run-off

S
Soil or
Sponge



When they are dry, the soil and the epikarst retain and then slowly transmit rainwater.



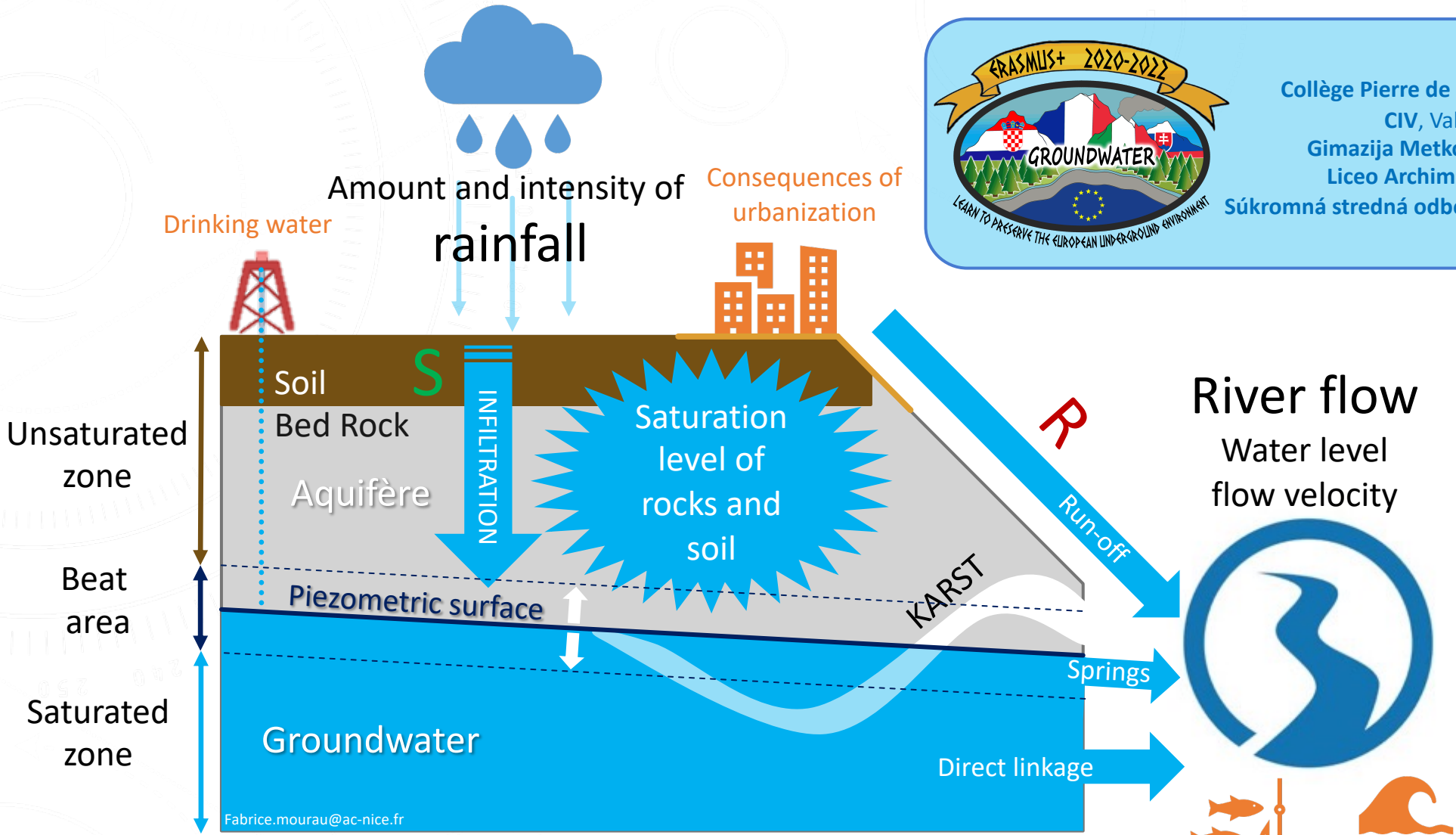


In urban areas
 Soil waterproofing increases the effect of runoff
 And increases the risk of flooding

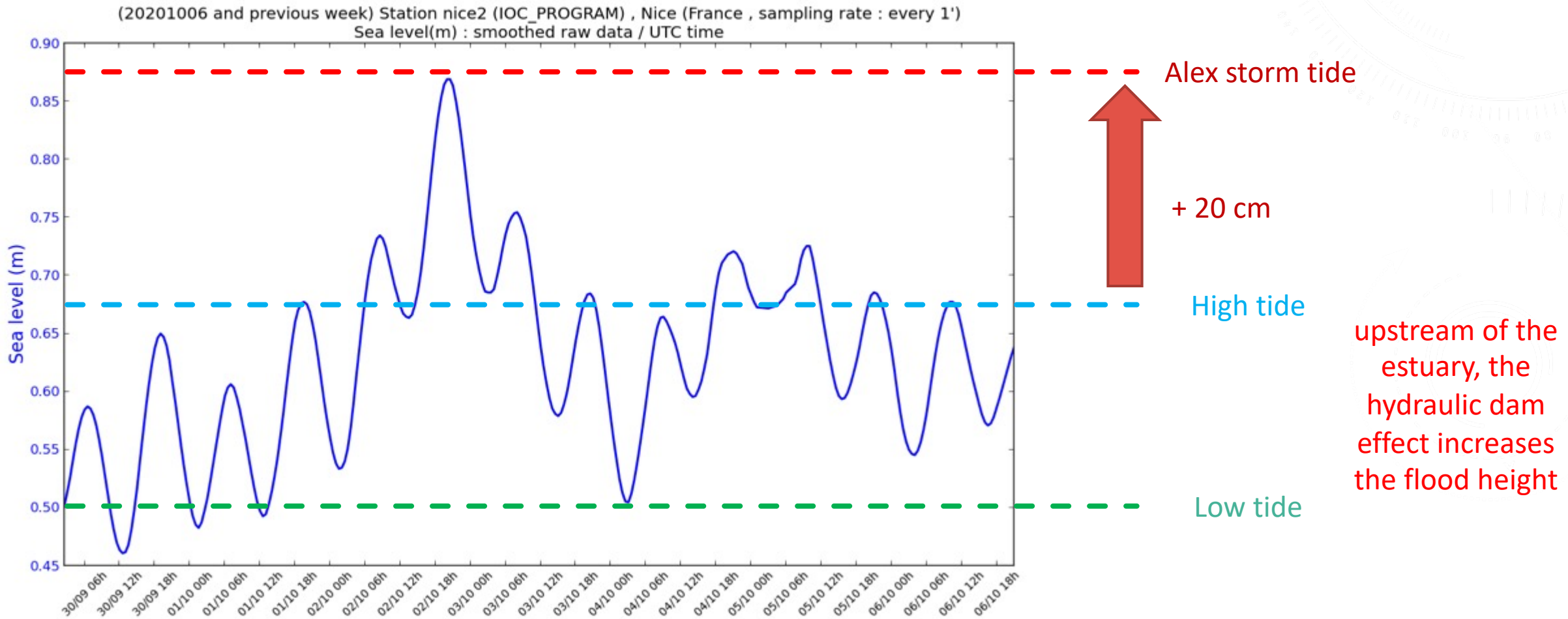
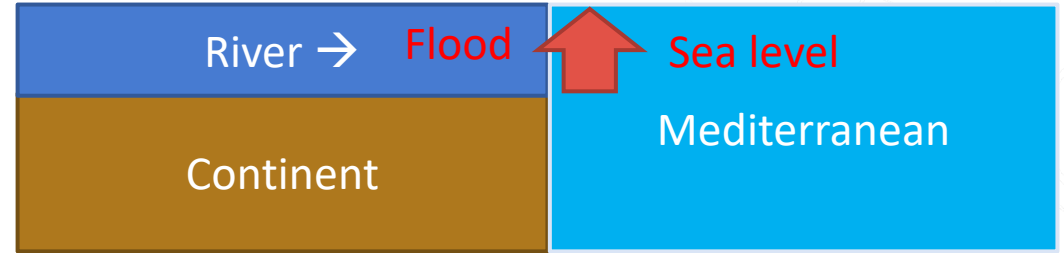
From : Christiane Dufresne, Bruno Arfib, Loic Ducros, Céline Duffa, Frank Giner, Vincent Rey (July 2020)



Collège Pierre de coubertin, Le Luc - France
CIV, Valbonne - France
Gimazija Metkovic, Metkovic - Croatia
Liceo Archimedeo, Acireale - Italia
Súkromná stredná odborná škola, Giraltove - Slovakia



The underground controls transfers between the atmosphere and the hydrosphere



<https://edugeo.ign.fr/carte/5538e68bfd44dcff1d797f41c0570031/Inondations+Puget+sur+Argens+>

SIG EduGeo, Pouzin j. (2019)



2 dead,
4 missing

November 2019

(AFP/V. Hache)



November 2014

(Var Matin JMJ)

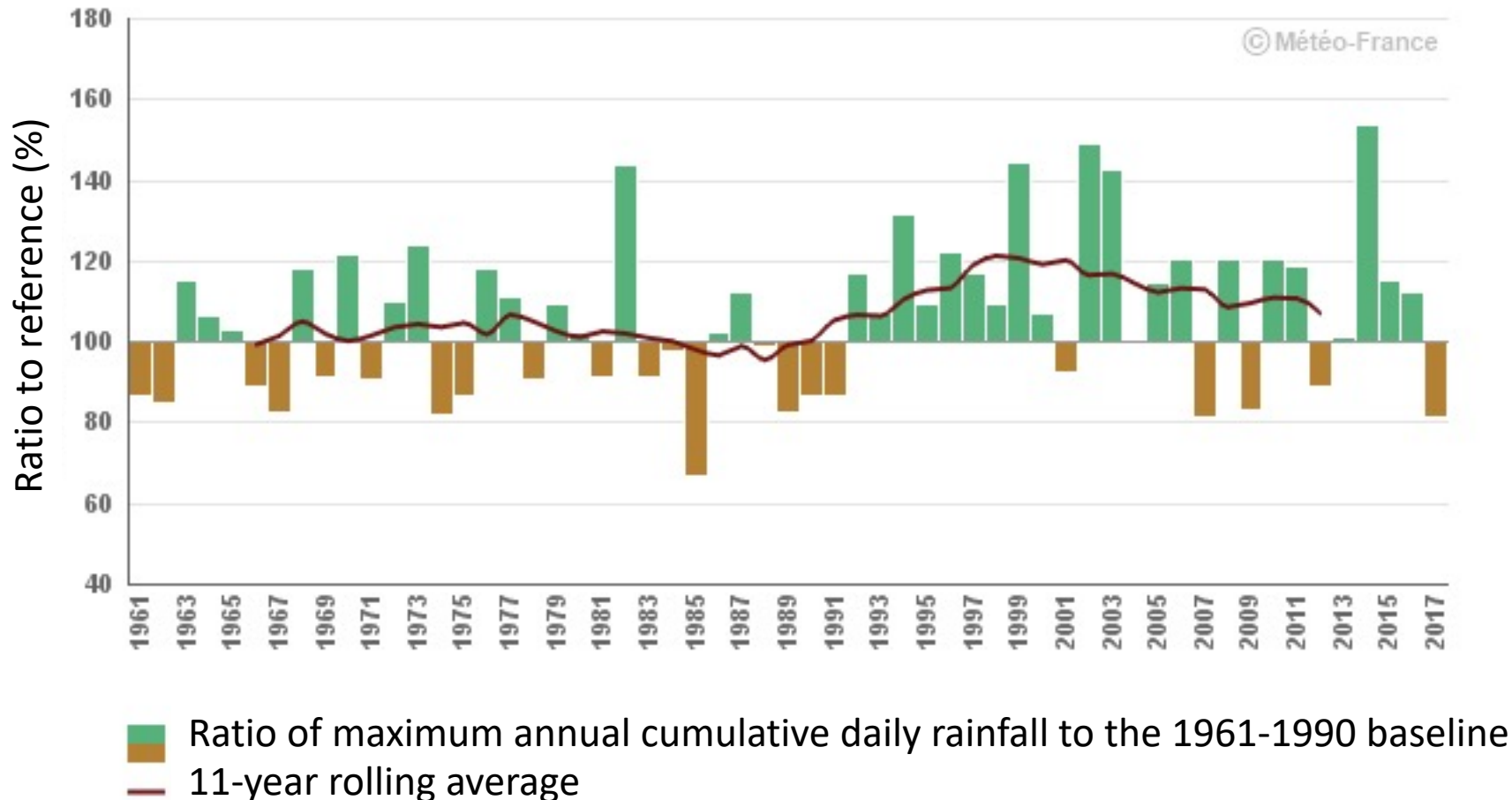


23 dead,
2 missing,
€1 billion
in damage

June 2010



Intensity of extreme rainfall in the Mediterranean region
On a reference network for monitoring extreme rainfall



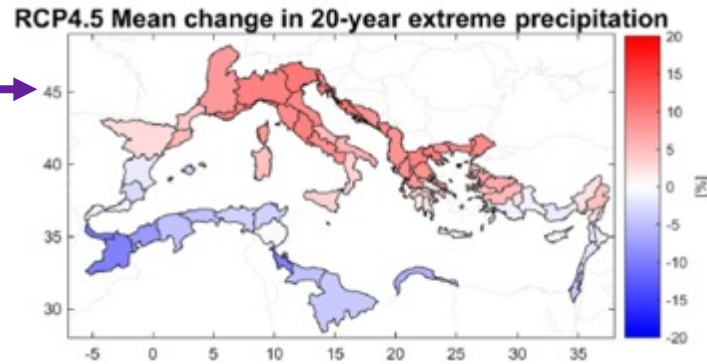
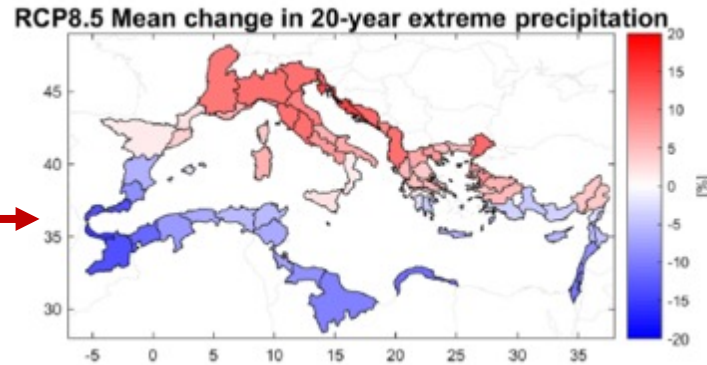
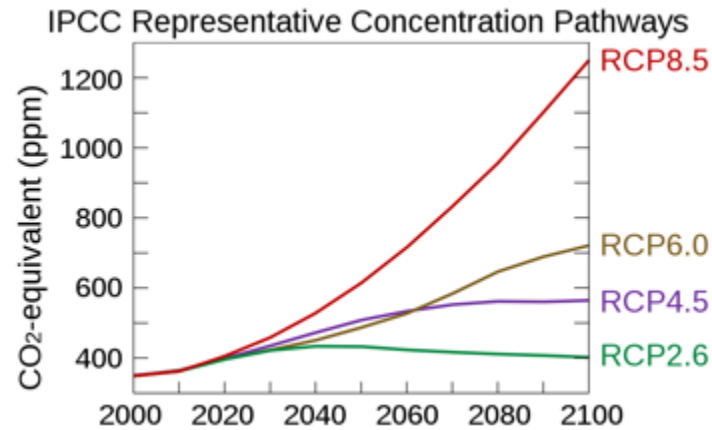
Intensification of heavy precipitation in the Mediterranean regions between 1961 and 2015:

+22%

on annual maximum daily totals, with a very high interannual variability, which explains the high uncertainty (from +7 to +39%) on the extent of this intensification

Increase in the frequency of the strongest Mediterranean episodes, in particular those exceeding the threshold of 200 mm in 24 hours.

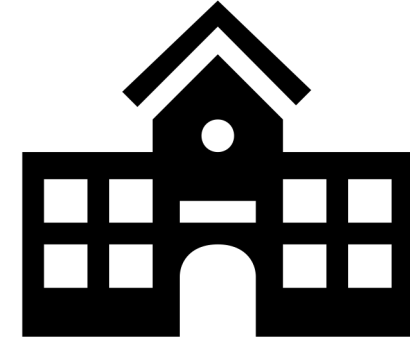
Scs : MétéoFrance.com



A Representative Concentration Pathway (RCP) is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC.

Average relative change in 2100 in daily precipitation values with a 20-year return period for 102 Mediterranean catchment areas for the RCP4.5 and RCP8.5 scenarios - © Météo-France

Teachers and school



1. Prevention to keep our students safe
2. Raising awareness of future citizens to fight against urban planning errors and the implementation of sustainable policies

Flood hazard

RISK

Human issues

Teachers and
school



1. Prevention to keep our students safe
2. Raising awareness of future citizens to fight against land planning errors and the implementation of sustainable policies