Climate change impacts on extreme rainfalls, discharges and floods in Mediterranean catchments: Application to the Orbieu.

Colmet-Daage Antoine[1, 2, 3], Llovel Cécile[1], Borrell Estupina Valérie[2], Servat Eric[4], Sanchez-Gomez Emilia[3], Ricci Sophie[3]

[1]WSP France, Toulouse, France
[2]Hydrosciences Montpellier, Univ. Montpellier, Montpellier, France
[3]CECI, CERFACS – CNRS TOULOUSE, Toulouse, France
[4]Institut Montpelliérain de l'Eau et de l'Environnement – IRD, Montpellier, France

Workshop MISTRALS, Montpellier 16-18 October 2017

Mediterranean Floods

- Major source of damages in France (Ricard et al., 2012; Gaume et al., 2016)
- From 2001 to 2015(BD CATNAT)
  - 201 deaths
  - 800 M€/year

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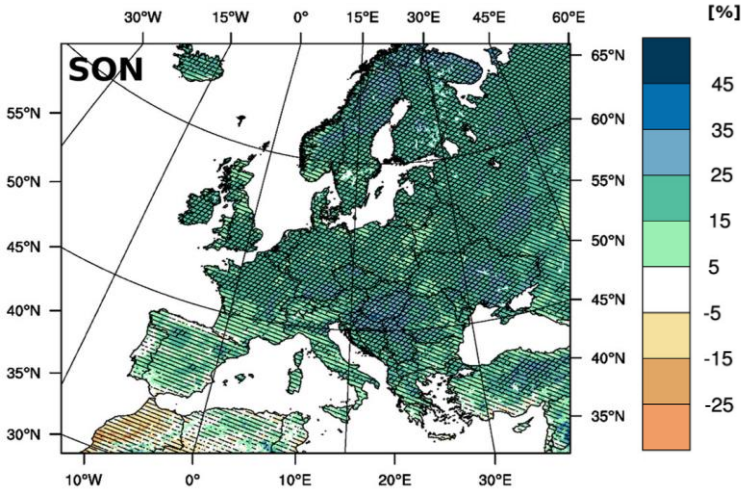
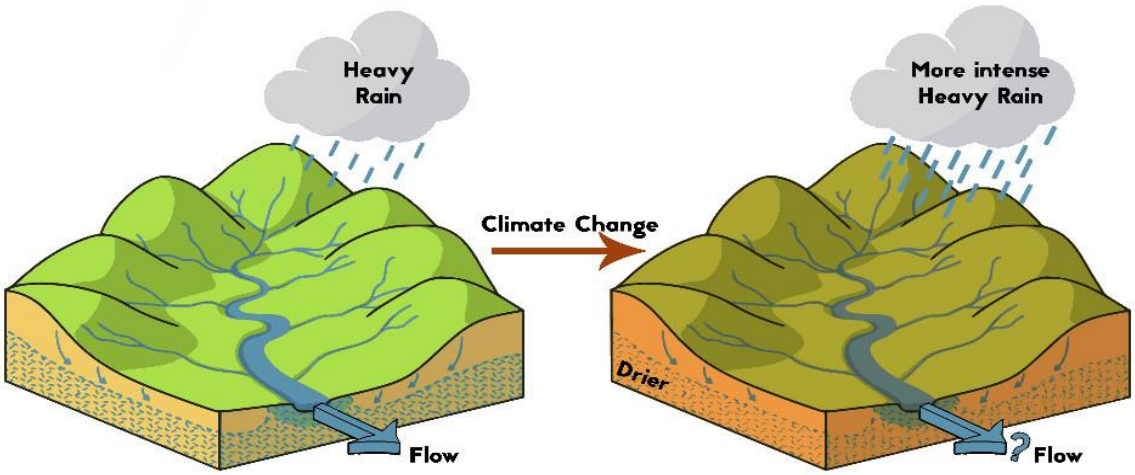
Climate change

'Mediterranean change are … hotspot … when you look at extreme seasonal precipitation' ***Diffenbaugh and Giorgi, 2012***

'The water-holding capacity of soil will affect possible changes in soil moisture deficits' ***IPCC, SREX 2012***



Projected changes seasonal changes of heavy precipitation for 2071-2100 compared to 1971-2000, for RCP8.5. Figure from Jacob et al., 2013

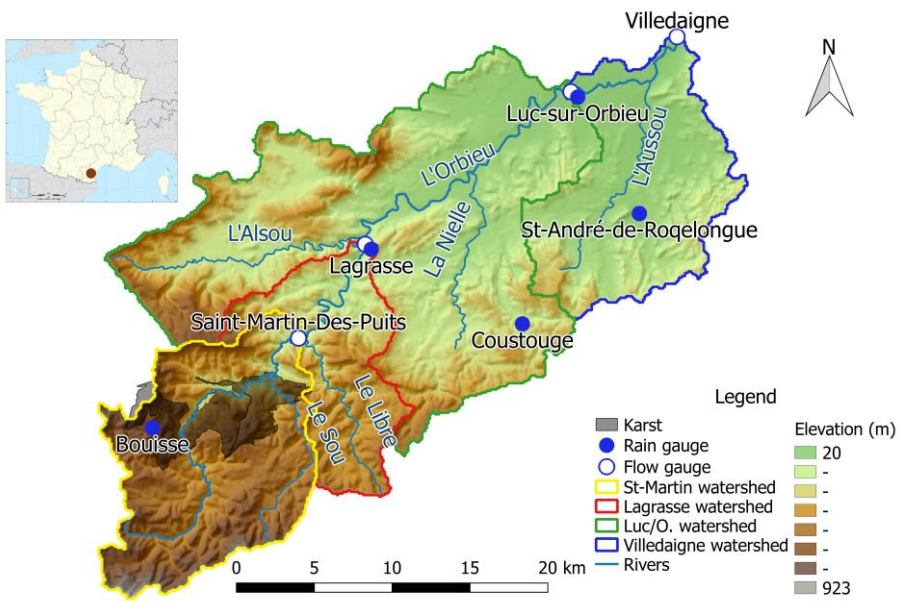


How does **climate change** will affect precipitation, discharges and **floods in Mediterranean mesoscale catchments**?

- Create an operational tool for the WSP France
- Develop a methodology of local estimation according to the EU directive on flood risks
- Assessment of the precipitation change uncertainties
- Assessment of the hydrological modelling uncertainties
- Assessment of the future soil humidity uncertainties

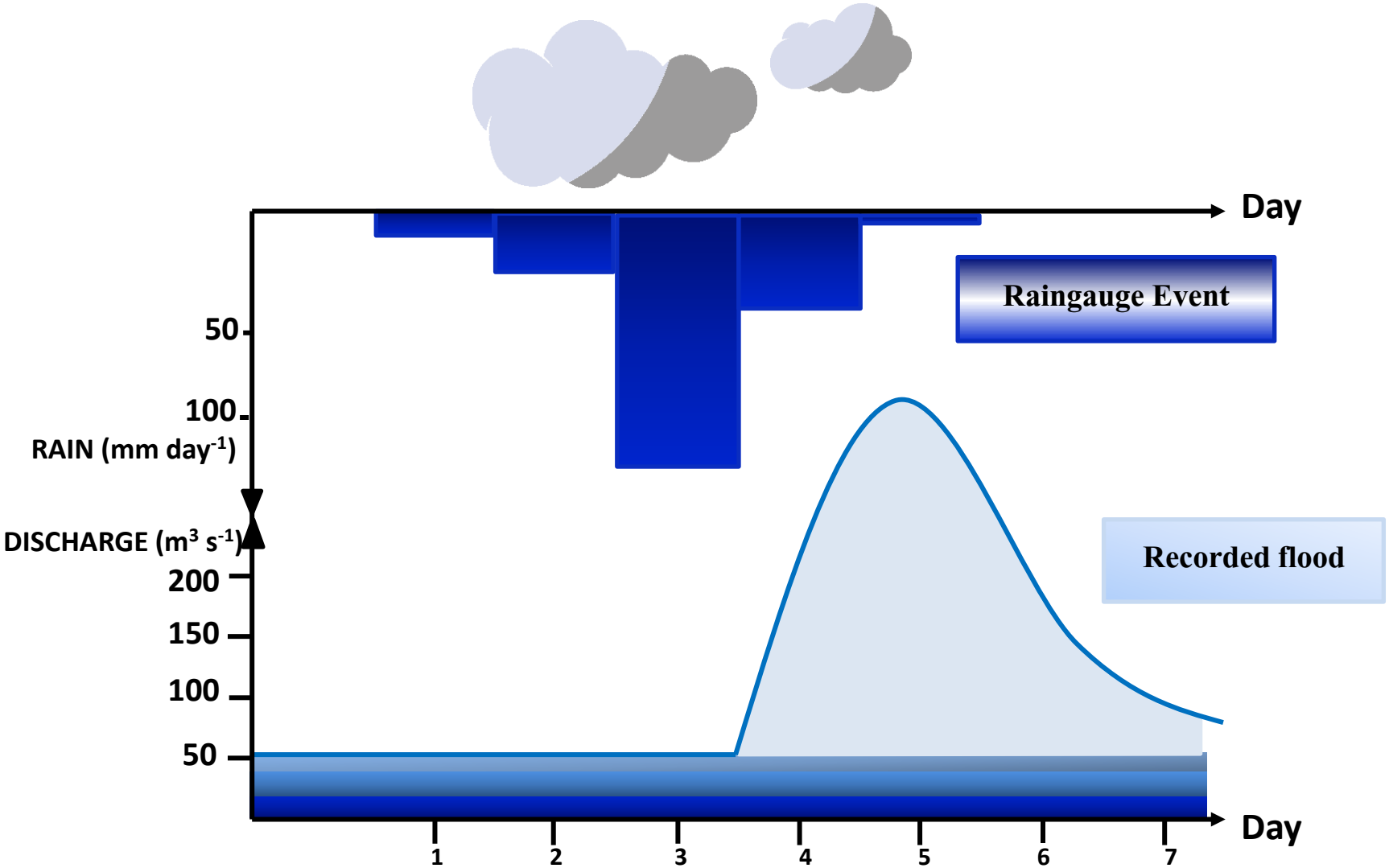
Case study : Orbieu catchment

- Important issues for SPC, SMMAR and SCHAPI
- Ø structures on the river
- Area: 780km² , Length: 72km
- Robust data from 2005-2017



Luc-sur-Orbieu bridge in Aude catchment, 14/02/2017

Observed data: February 2017 in Orbieu catchment (France)



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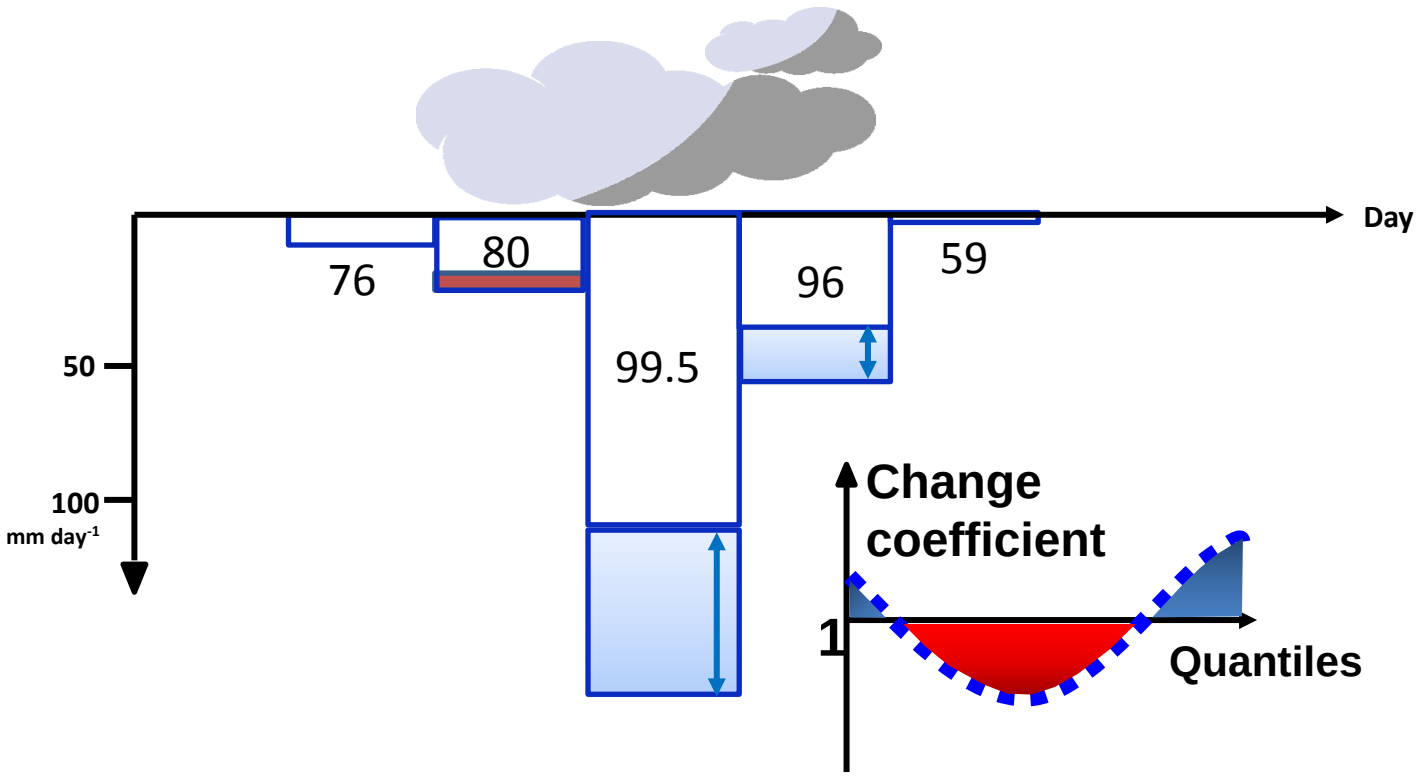
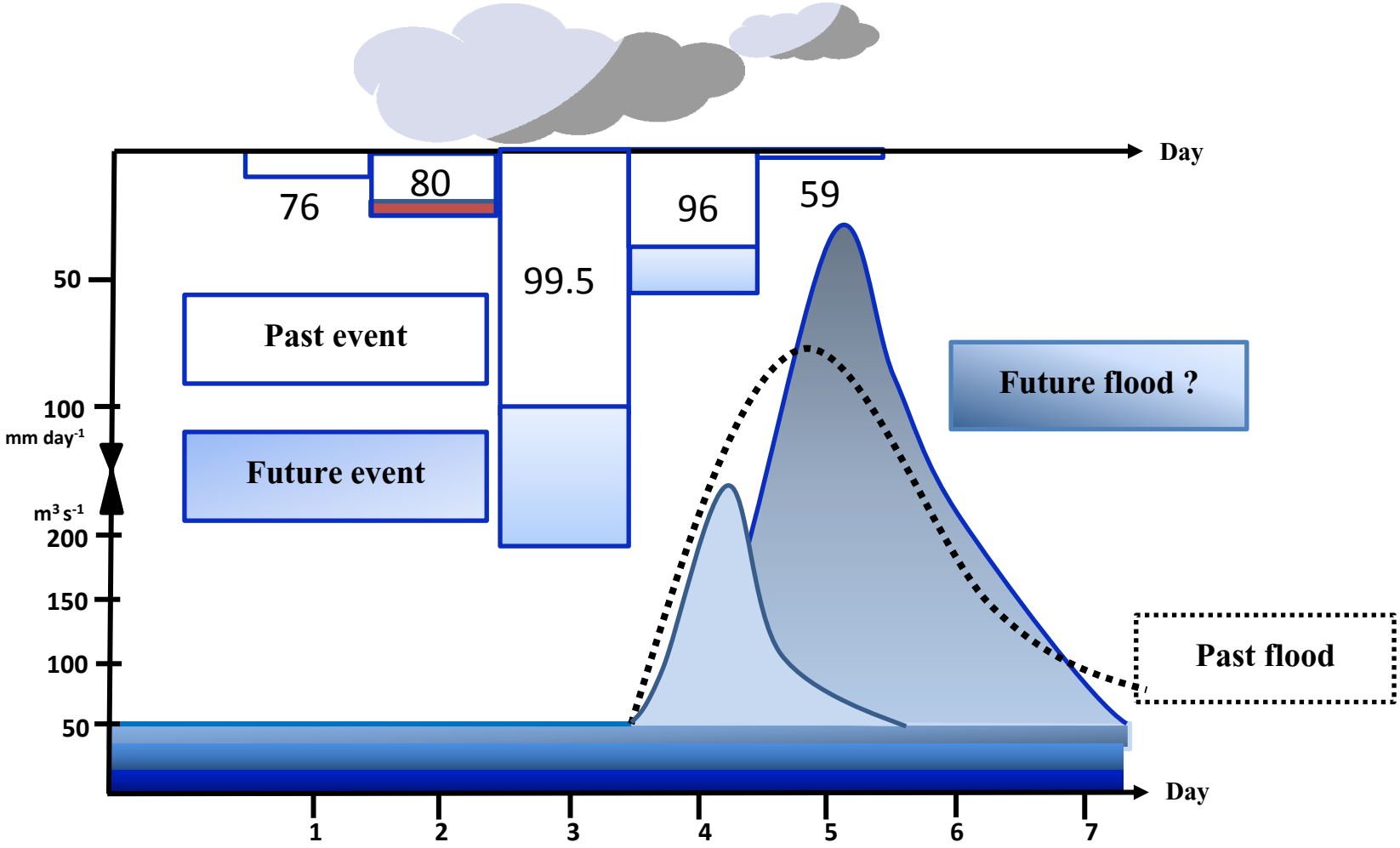


Applying quantile-specific change coefficient to the corresponding precipitation event observed in the past period (Colin et al., 2011; Harader, 2015)



Assessment of flow modification with the future precipitation applied to the hydrological model

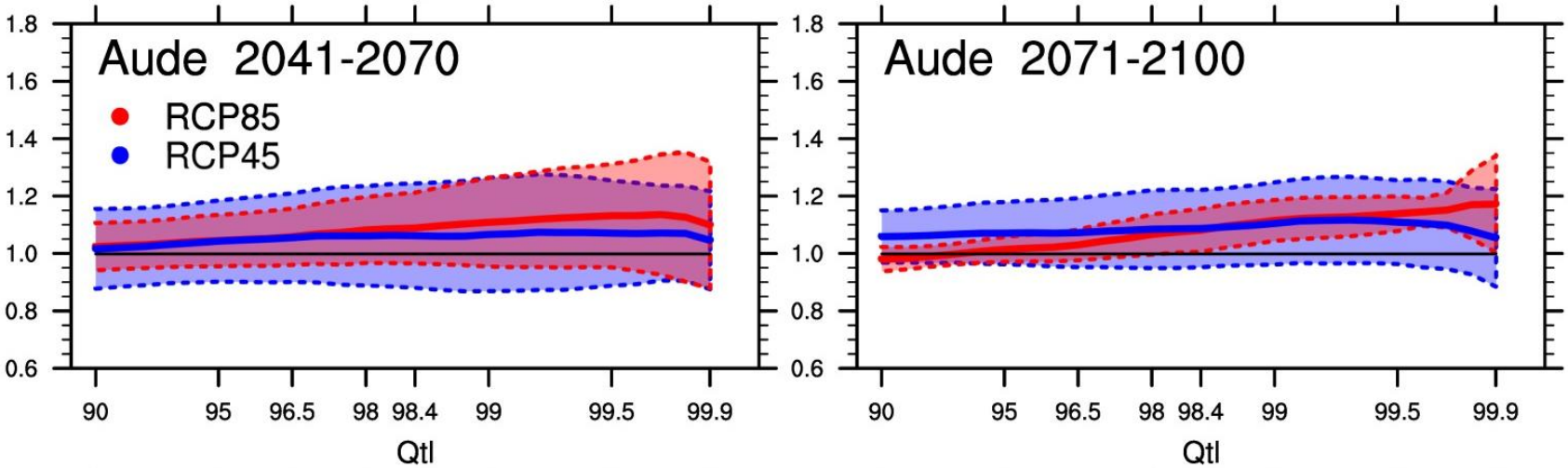
Precipitation from from CORDEX (Giorgi et al., 2009) simulations at 0.11° :

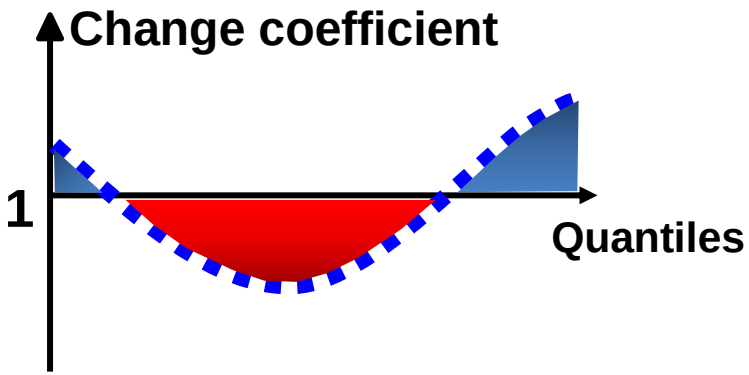
- **Complex orographic** region (Harader, 2015)
- Precipitation **spatial variability** (Gaume et al., 2004)
- **Added value of 0.11°** for mean (Kotlarski et al., 2014) and extreme precipitation (Prein et al., 2016)

GCMs_ RCMs:	CNRM-CM5_ ALADIN52	CNRM-CM5_ ALADIN53	CNRM-CM5_ RCA4	MOHC_ RCA4	MPI_ RCA4	ICHEC_ RCA4	ICHEC_ HIRHAM5	ICHEC_ RACMO22E

"*Evaluation of uncertainties in mean and extreme precipitation under climate changes for northwestern Mediterranean watersheds with high-resolution Med and Euro-CORDEX ensembles*" **Colmet-Daage Antoine,** Sanchez-Gomez Emilia, Ricci Sophie, Llovel Cécile, Borrell Estupina Valérie, Quintana-Seguí Pere, Llasat Maria Carmen, Servat Eric, **in review in HESS**

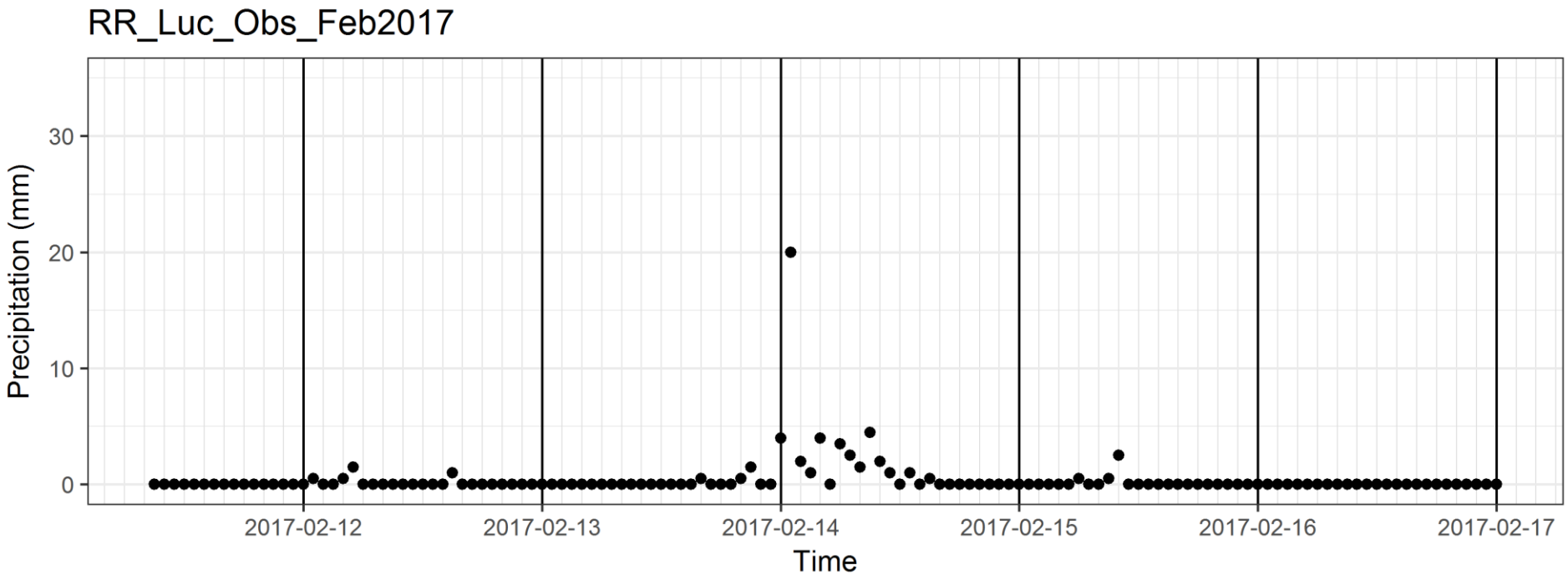
Estimated changes in extreme precipitation:





- **Increase** of extreme precipitation intensity
- 2071-2100: spread mostly positive
- RCP8.5 changes are similiar to RCP4.5 changes

Application of the futurisation method with CNRM-CM5_ALADIN5.3 to the Orbieu pluviometers of the February 2017 event :



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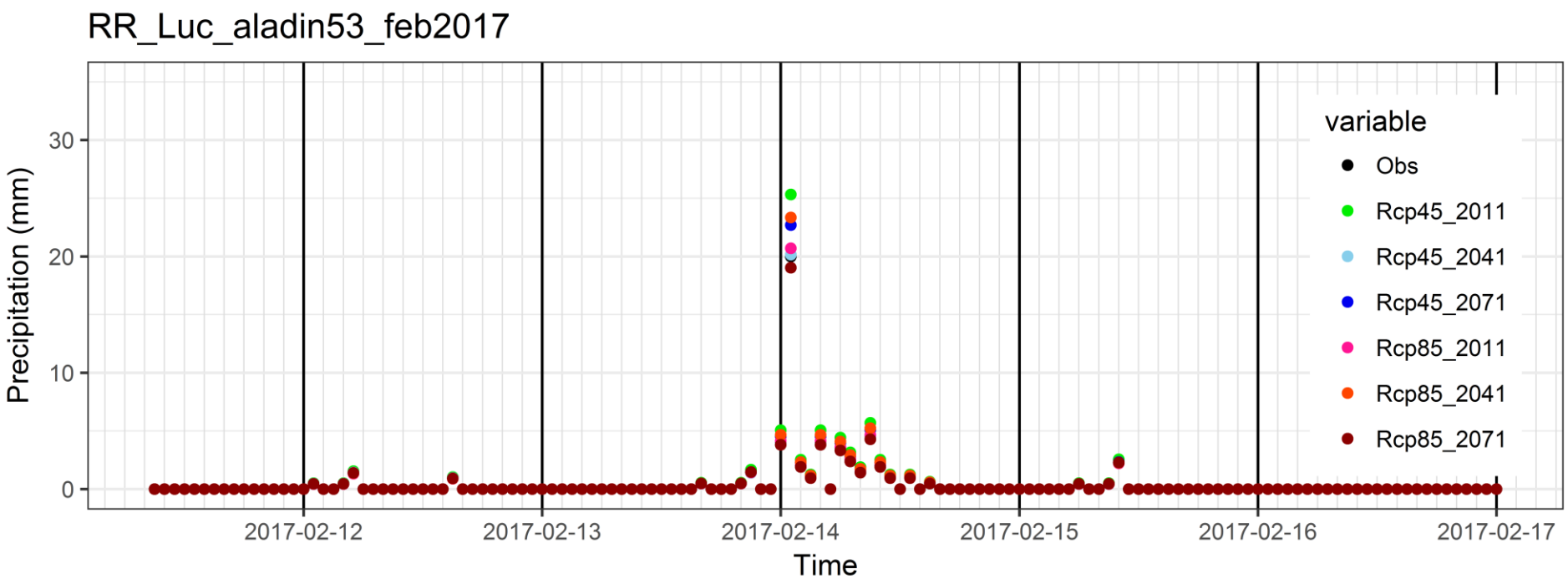

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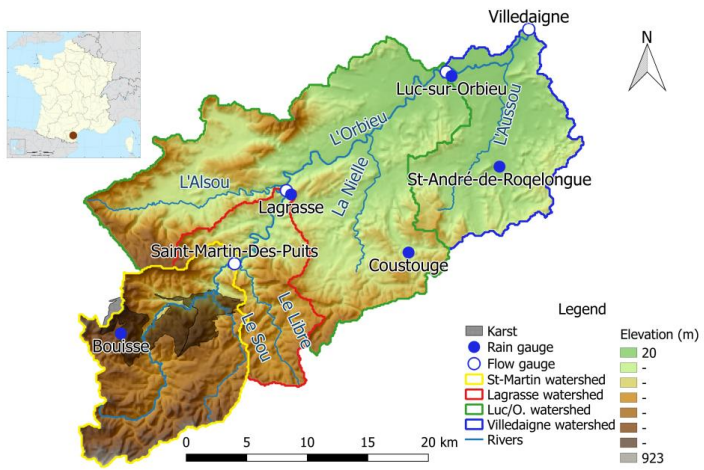
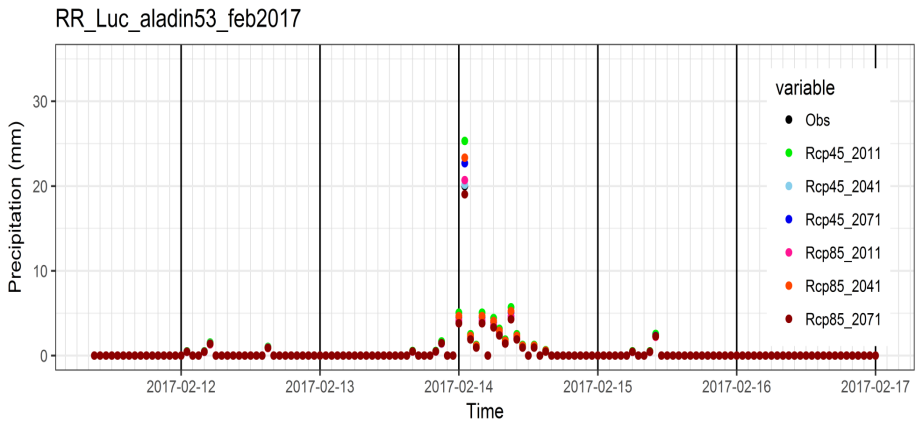
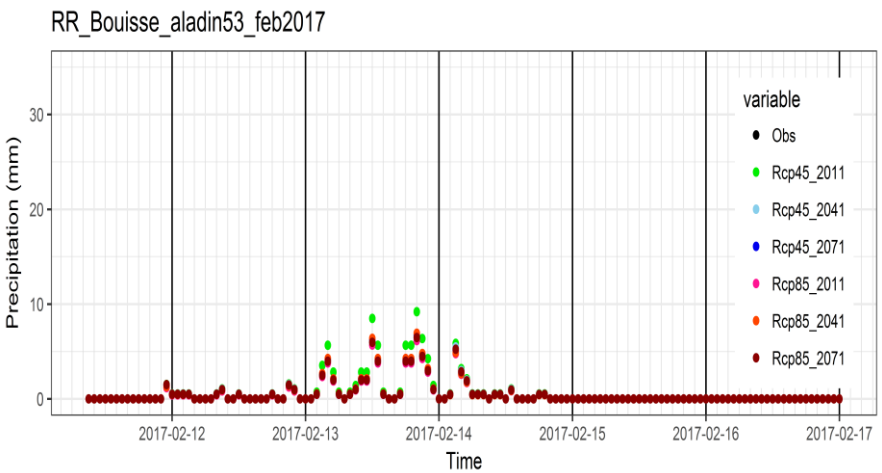
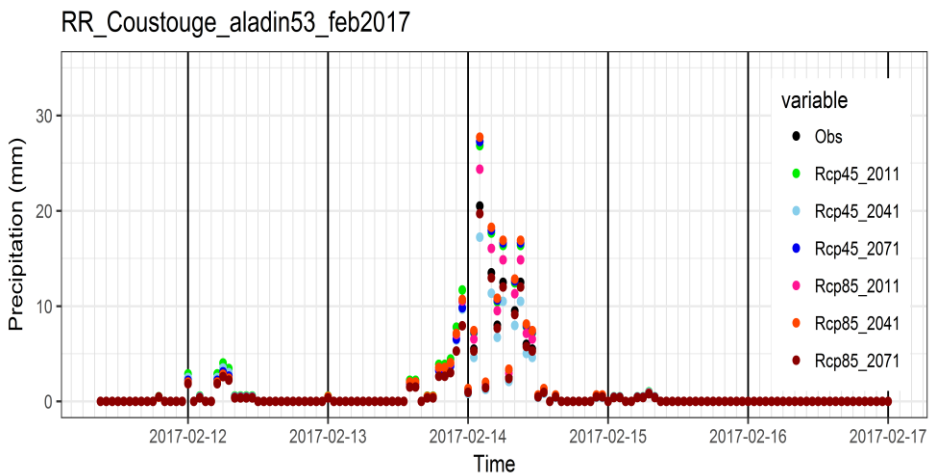
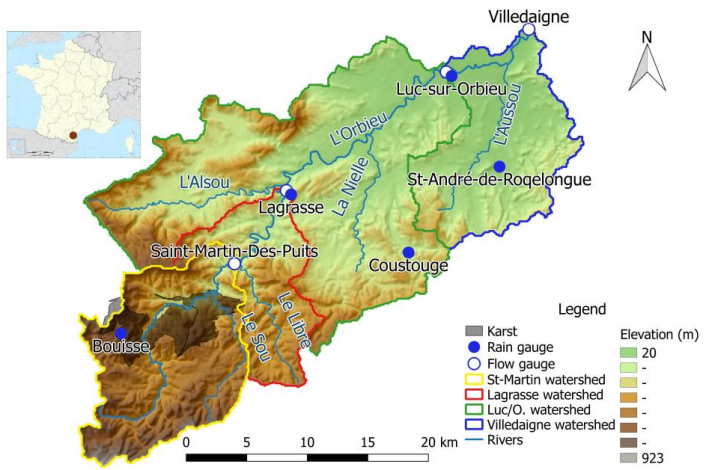


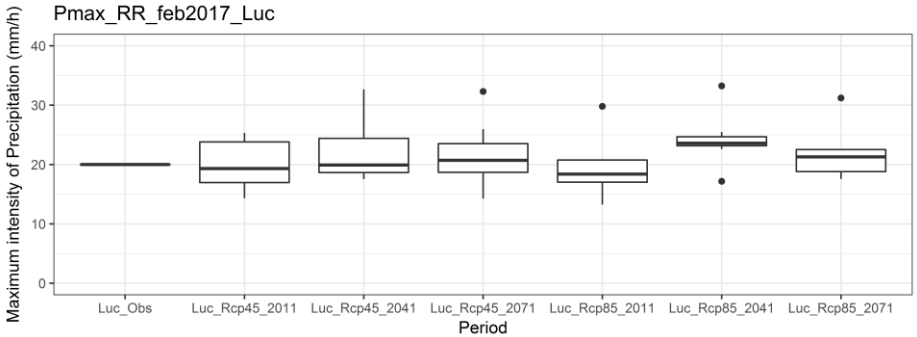


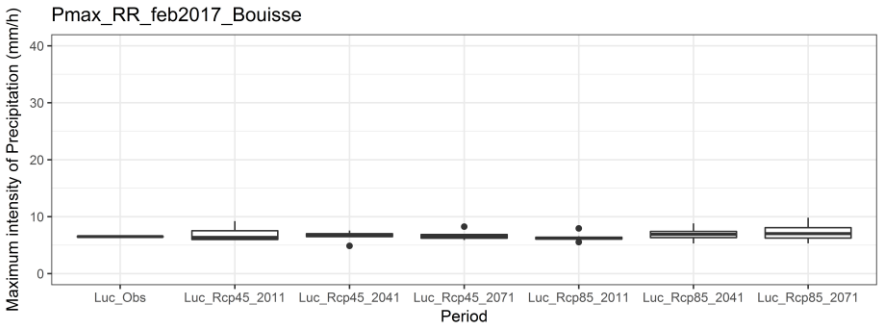


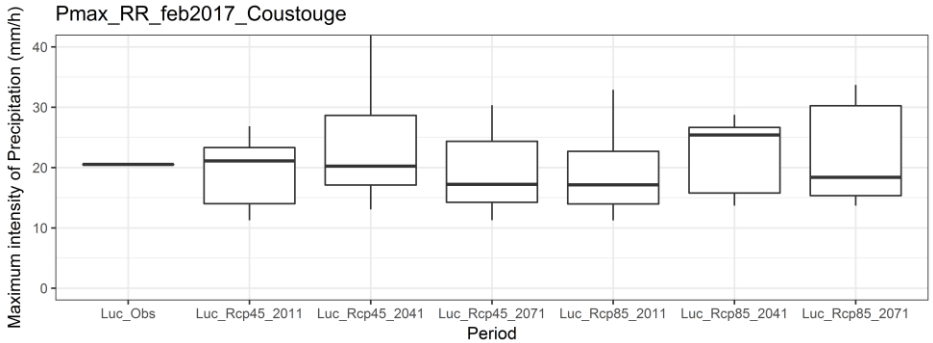


Application of the futurisation method with the CORDEX ensemble to the Orbieu pluviometers of the February 2017 event :





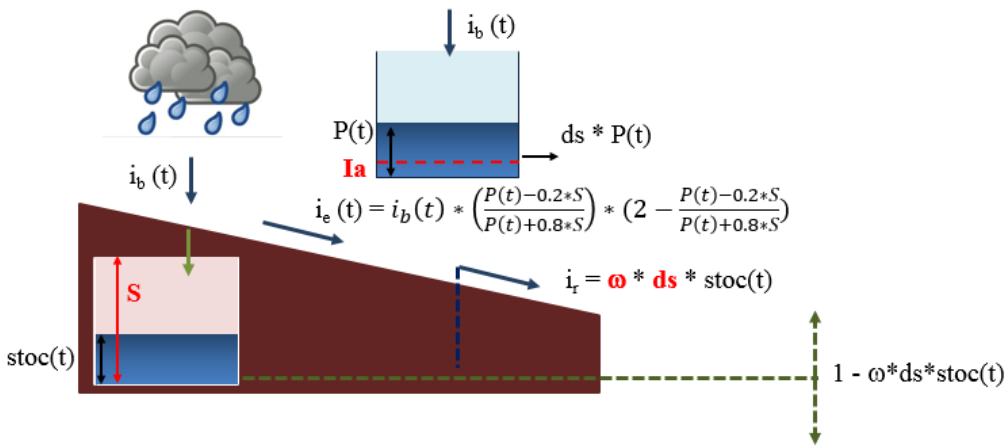




Conceptual event-based hydrological model to simulate the Orbieu discharges: SCS-LR

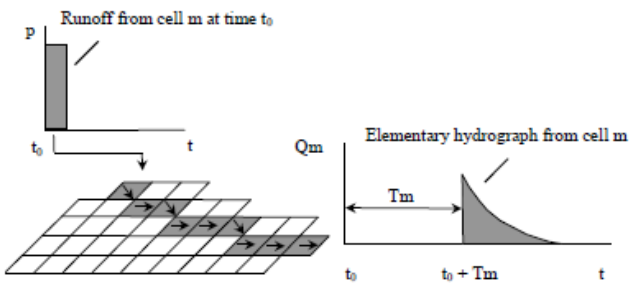
- Calibration/Validation based on Coustau et al., 2012
- Simple implementation in accordance with WSP France demand

Production



4 parameters : S (mm), Ia/S (ad.), ω (ad.), ds (j^{-1})

Rooting

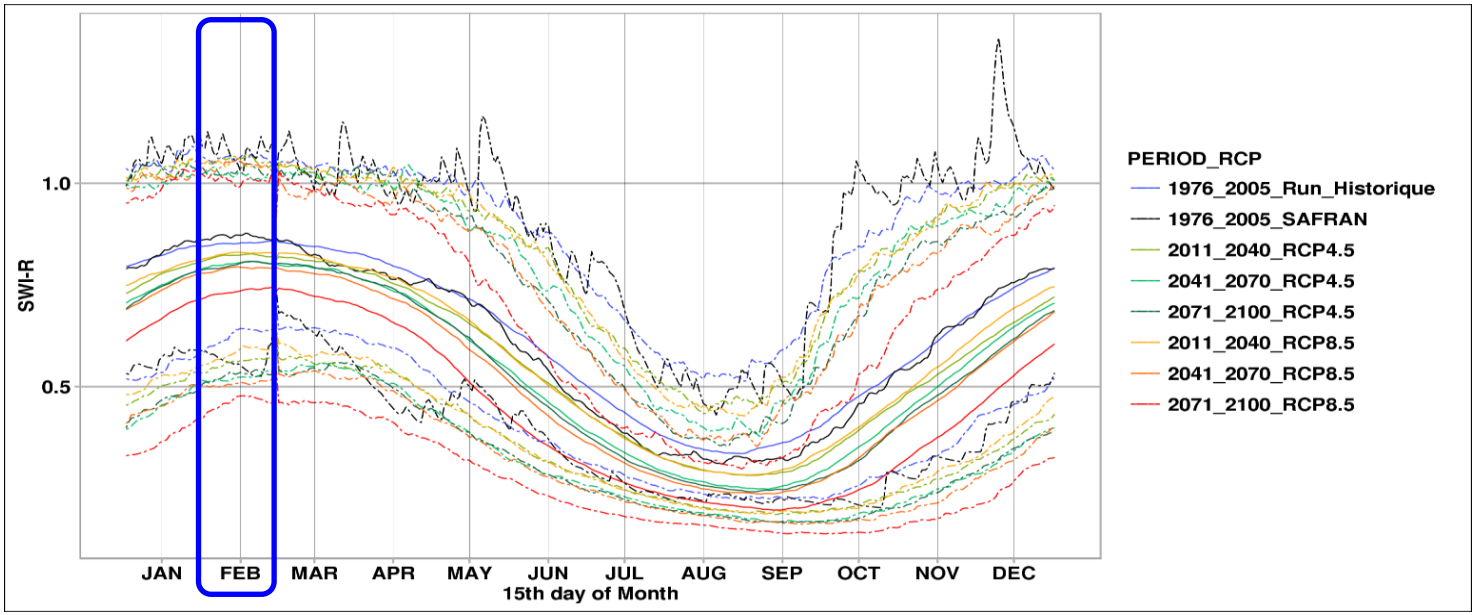


2 parameters : V_0 (m/s), K_0 (ad.)

Soil Humidity strategy:

- CMIP5 models statistically downscalled on SAFRAN grid (Dayon, 2017)
- SIM (SAFRAN-ISBA-MODCOU)
- SWI-Root from MODCOU

$$\textbf{SWI-Root} = \frac{W_{Total} - W_{Wilt}}{W_{FieldCapacity} - W_{Wilt}}$$



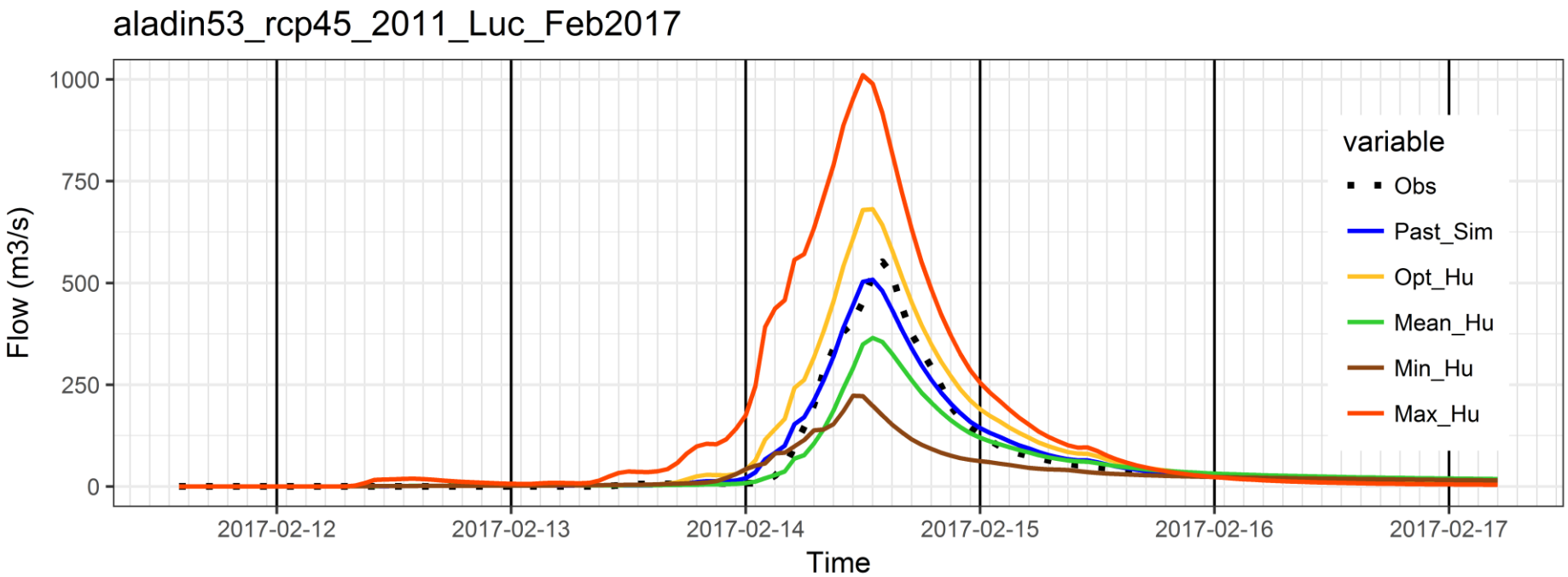
February SWI for Rcp4.5 in 2011-2041

SWI mean= 0.82 SWI max= 1.06 SWI min= 0.55

Initial soil deficit S (mm):

S opt = 77 mm S mean = 50 mm S max = 0 mm S min = 77 mm

Hydrological impact of the futurizated precipitation in the Orbieu discharges for the February 2017 event :



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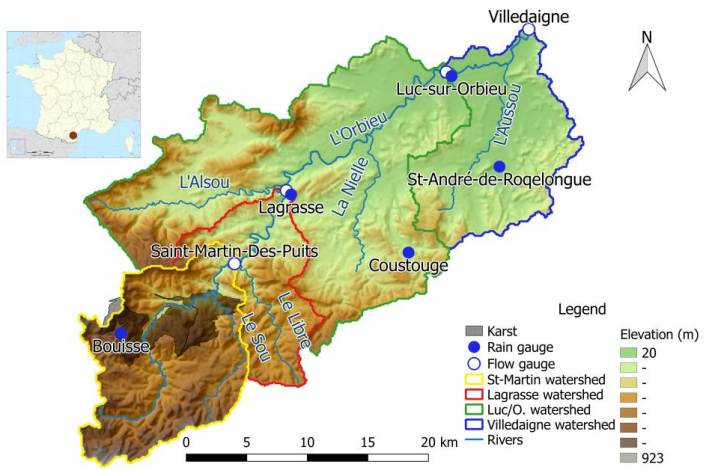
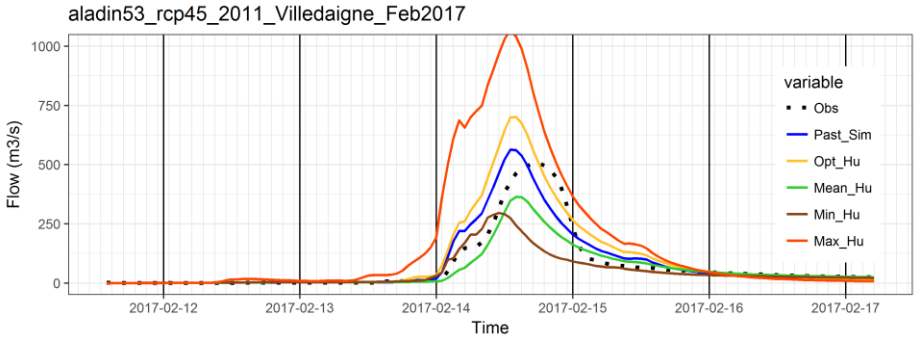
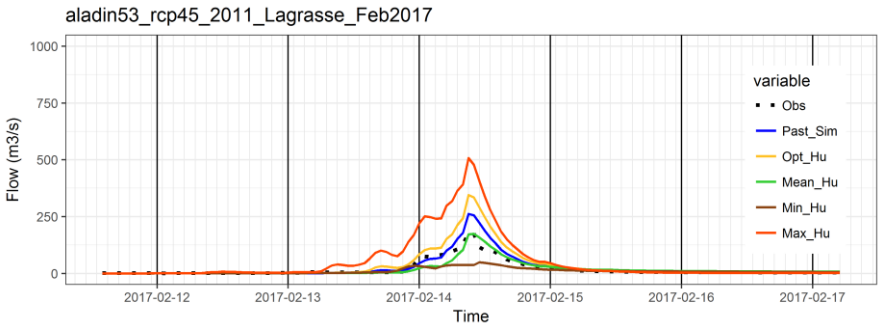
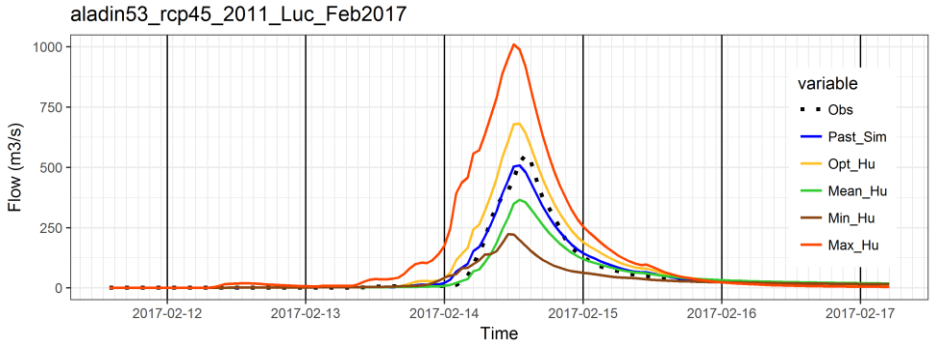








Method:

- Estimation of the statistical counterpart of pasts events of precipitation considered by the stakeholders

CC impacts on extreme precipitation:

- Extreme precipitation intensity is projected to **increase** for both RCP scenarios
- Precipitation changes have an important spatial variability
- Climate model variability considered

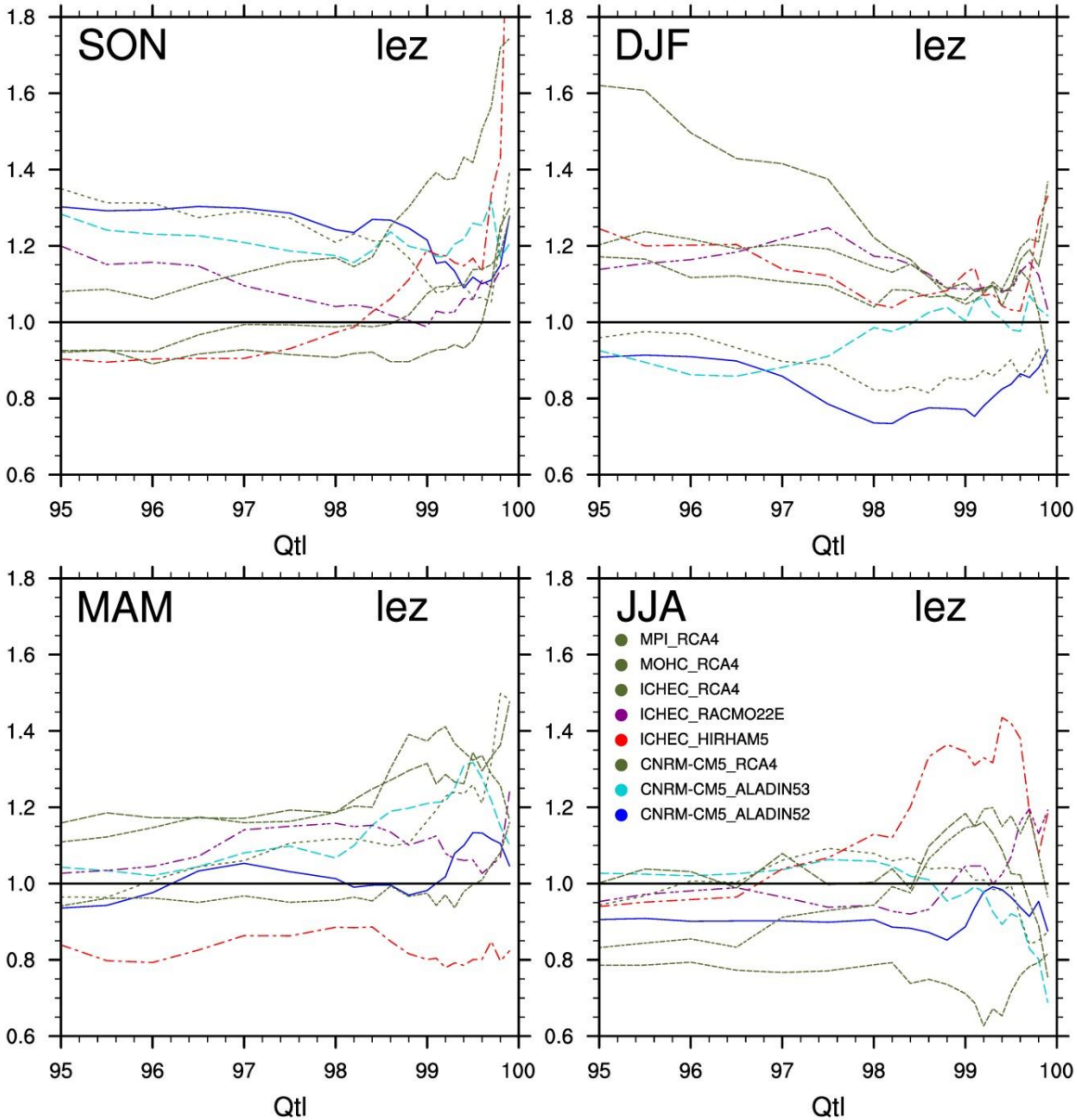
Future precipitation impact on discharges :

- Different soil humidity scenarios are considered and impact strongly the response
- With a saturated soil, the pick of discharges can increase twice

Coming soon :

- Assess the global uncertainties on the hydrological impacts
- The methodology have been applied to the Lez catchment. A comparison between the two catchment can validate the methodology for other catchments.
- Compare and validate the use of the SCS-LR model with a physical based model

Thanks for your attention.


SON
lez
DJF
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MAM
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JJA
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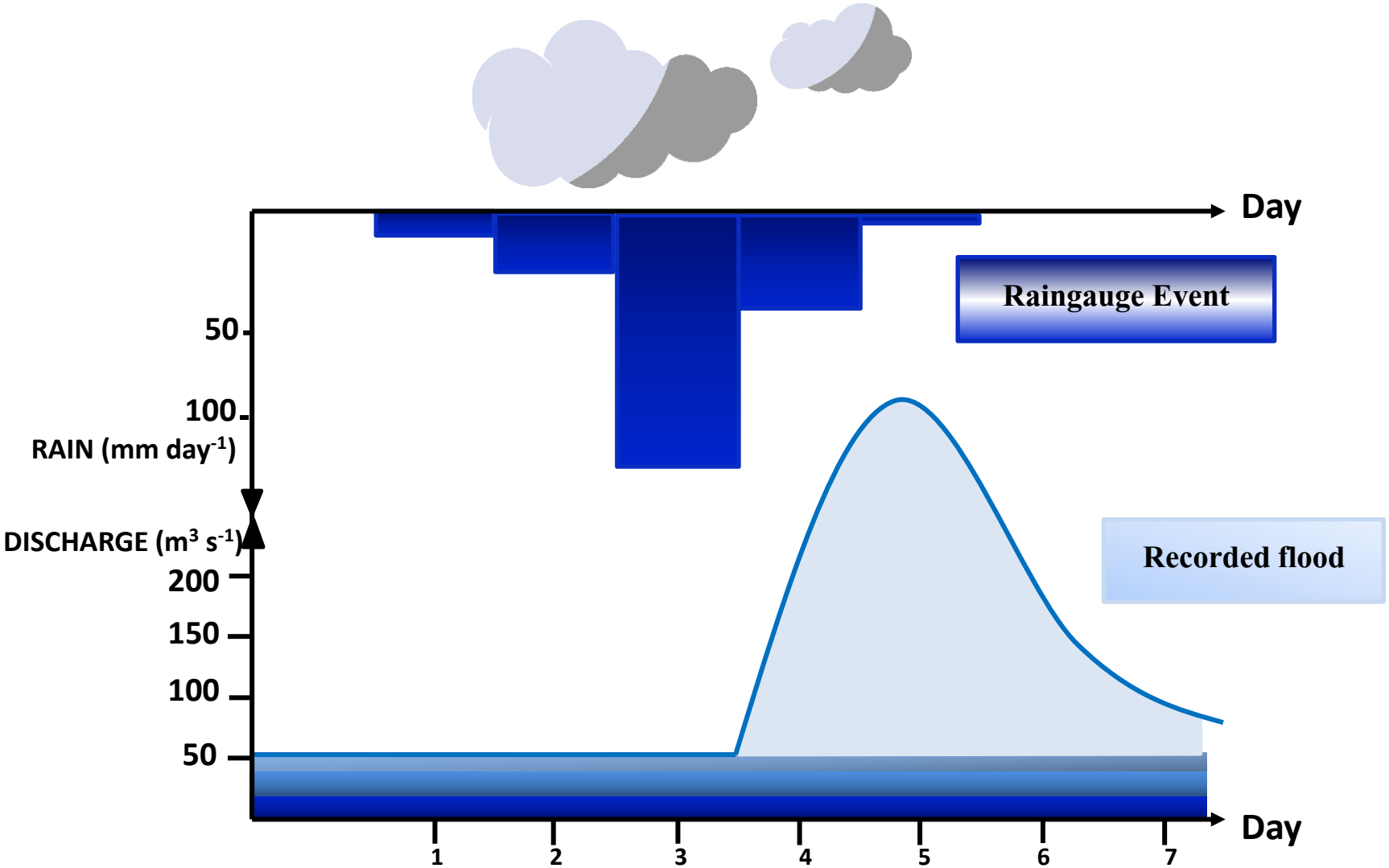
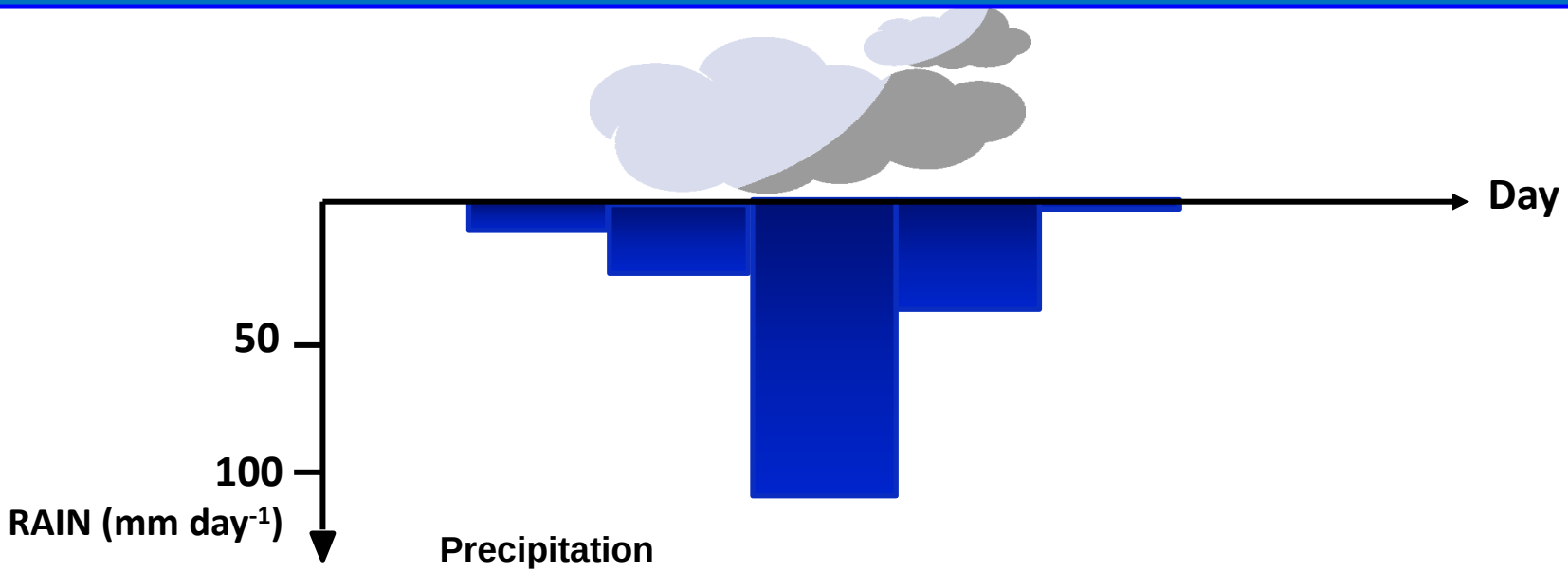
MPI_RCA4
MOHC_RCA4
ICHEC_RCA4
ICHEC_RACMO22E
ICHEC_HIRHAM5
CNRM-CM5_RCA4
CNRM-CM5_ALADIN53
CNRM-CM5_ALADIN52
1.8
1.6
1.4
1.2
1.0
0.8
0.6
95
96
97
98
99
100
Qtl

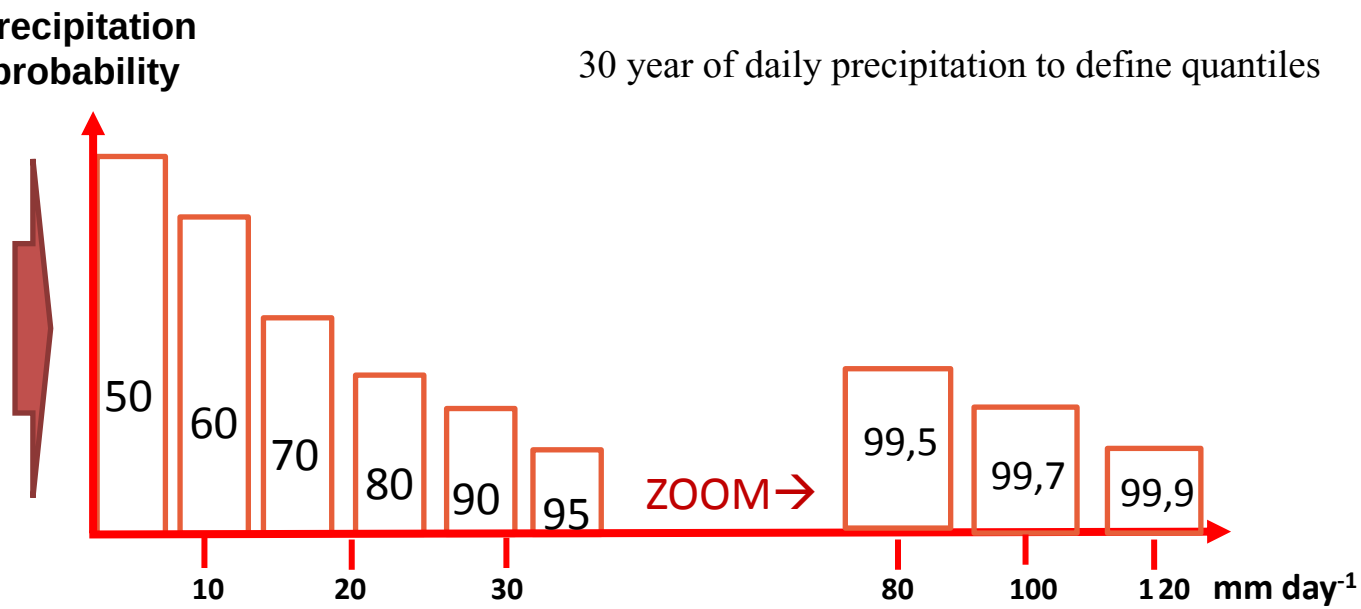
Observed data: February 2017 in Orbieu catchment (France)

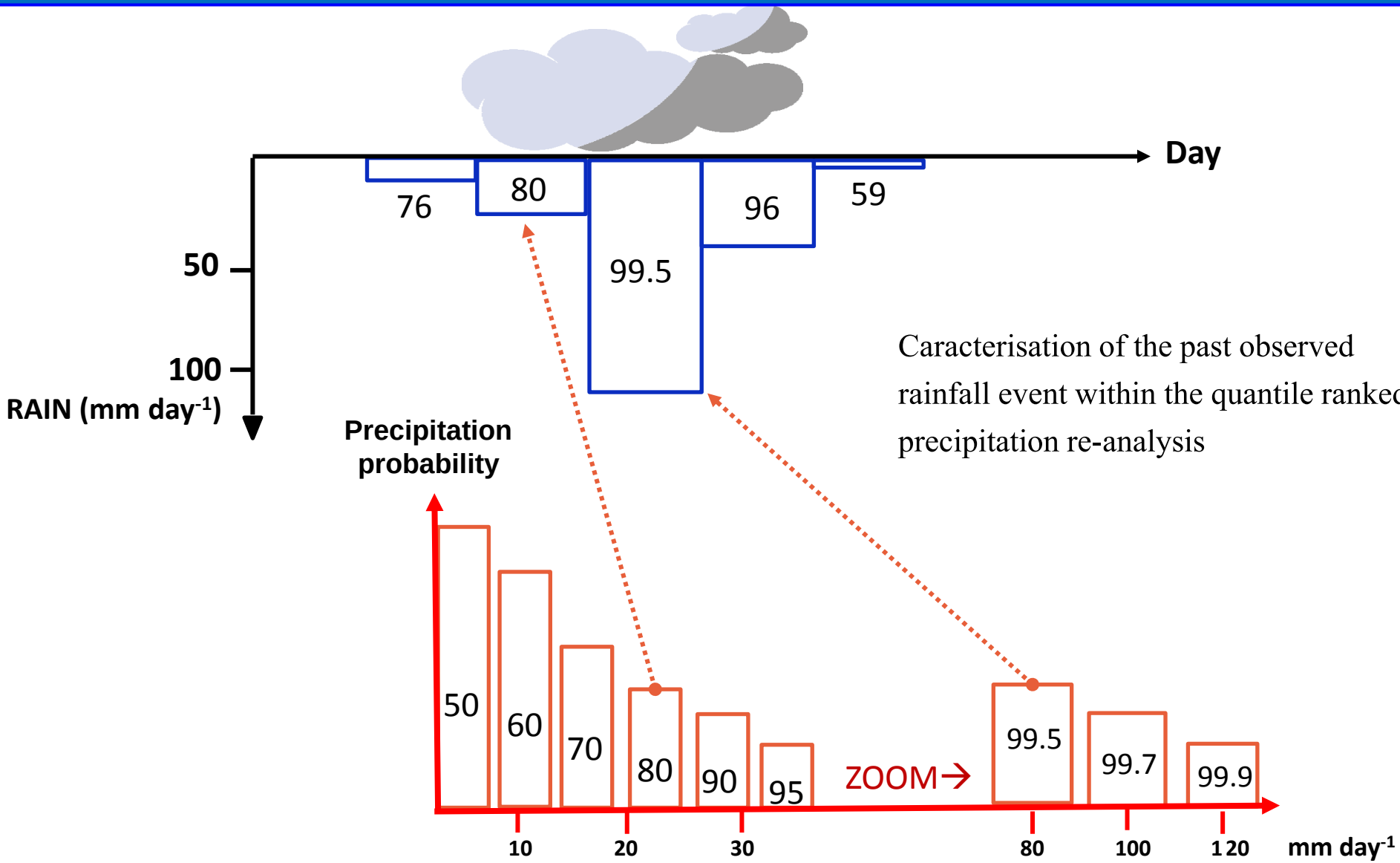




30 year of daily precipitation to define quantiles

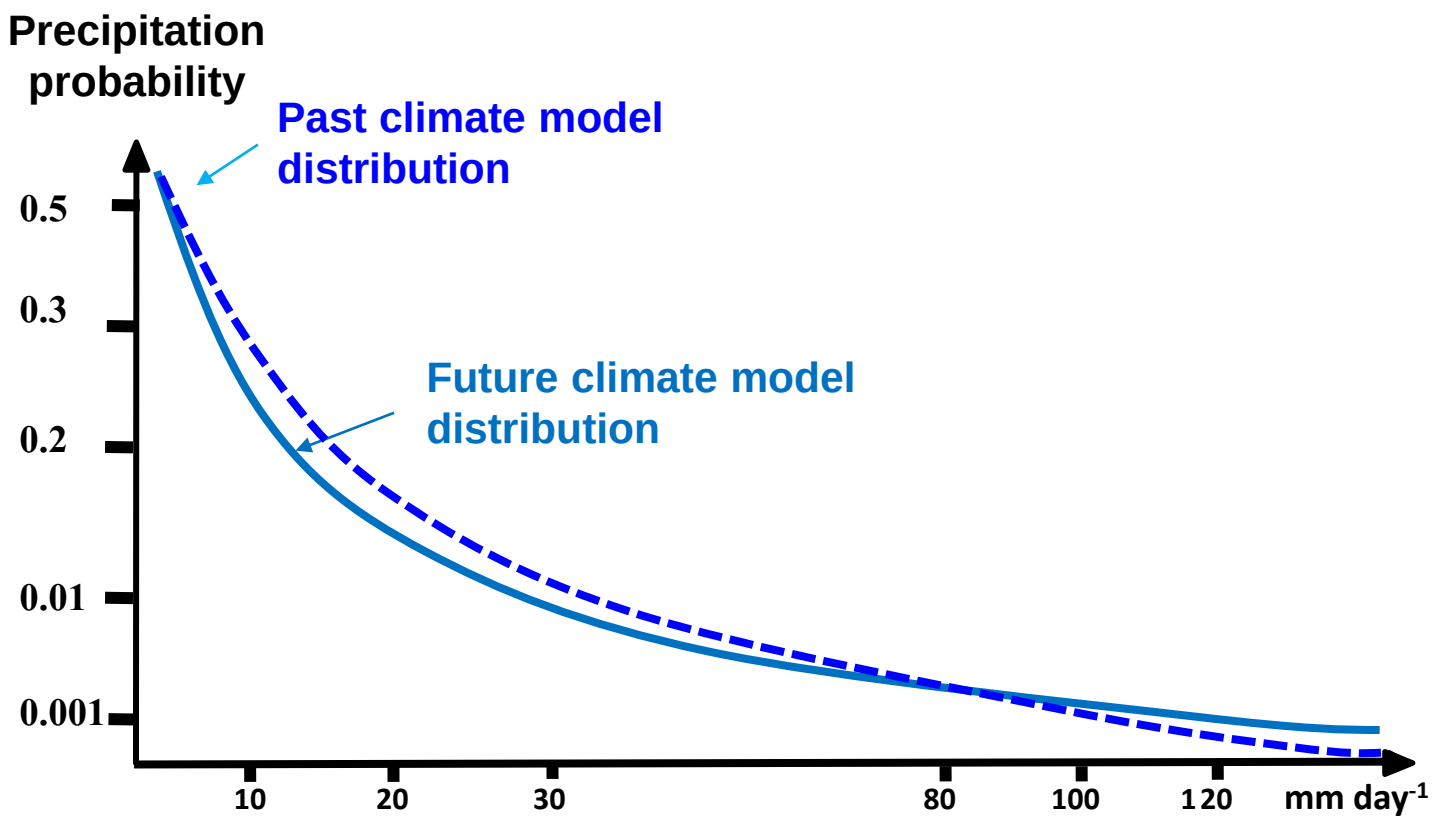
SAFRAN
Durand *et al.* (1993)
Quintana-Segui *et al.* (2008)

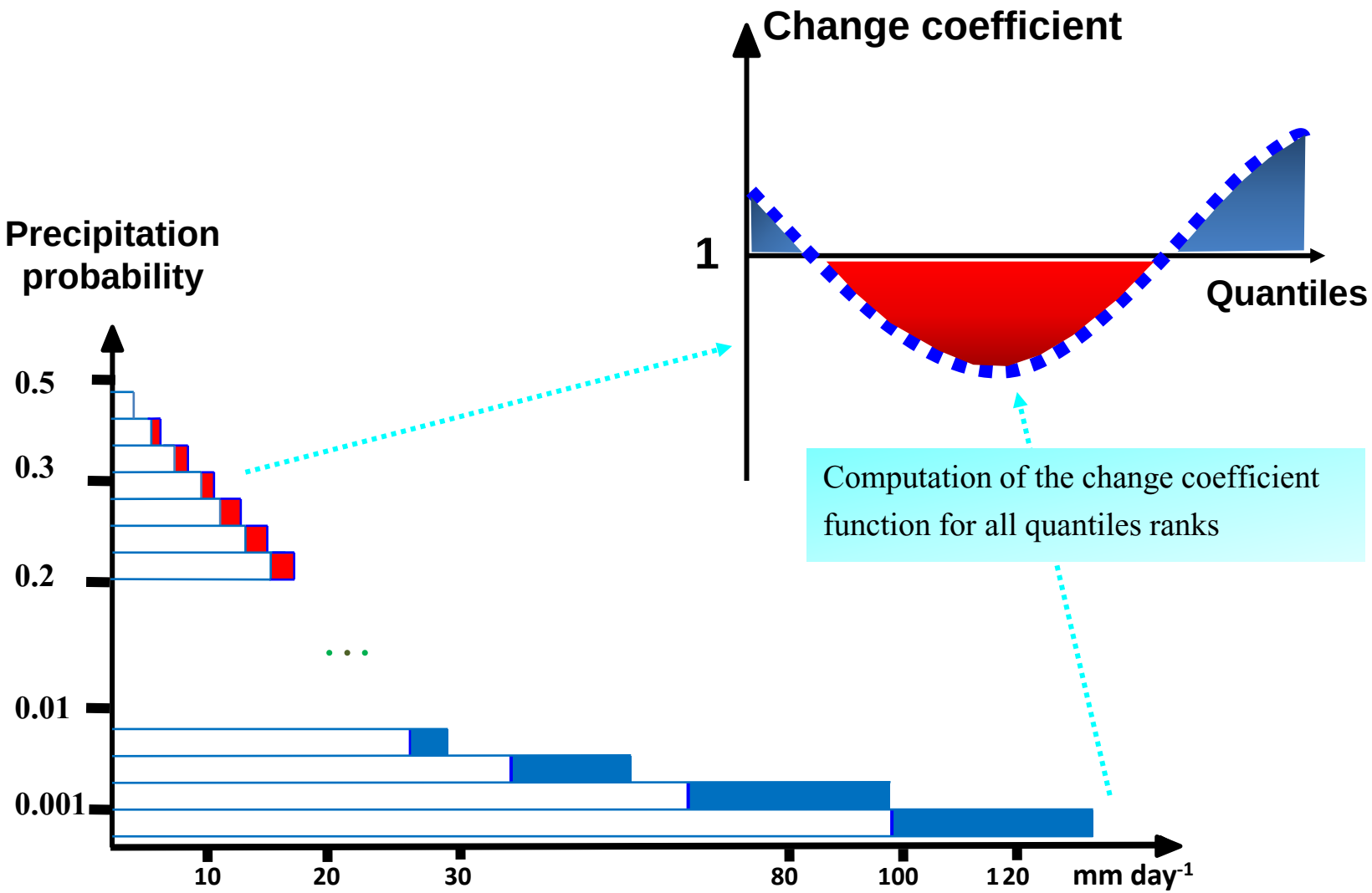




Caracterisation of the past observed rainfall event within the quantile ranked precipitation re-analysis

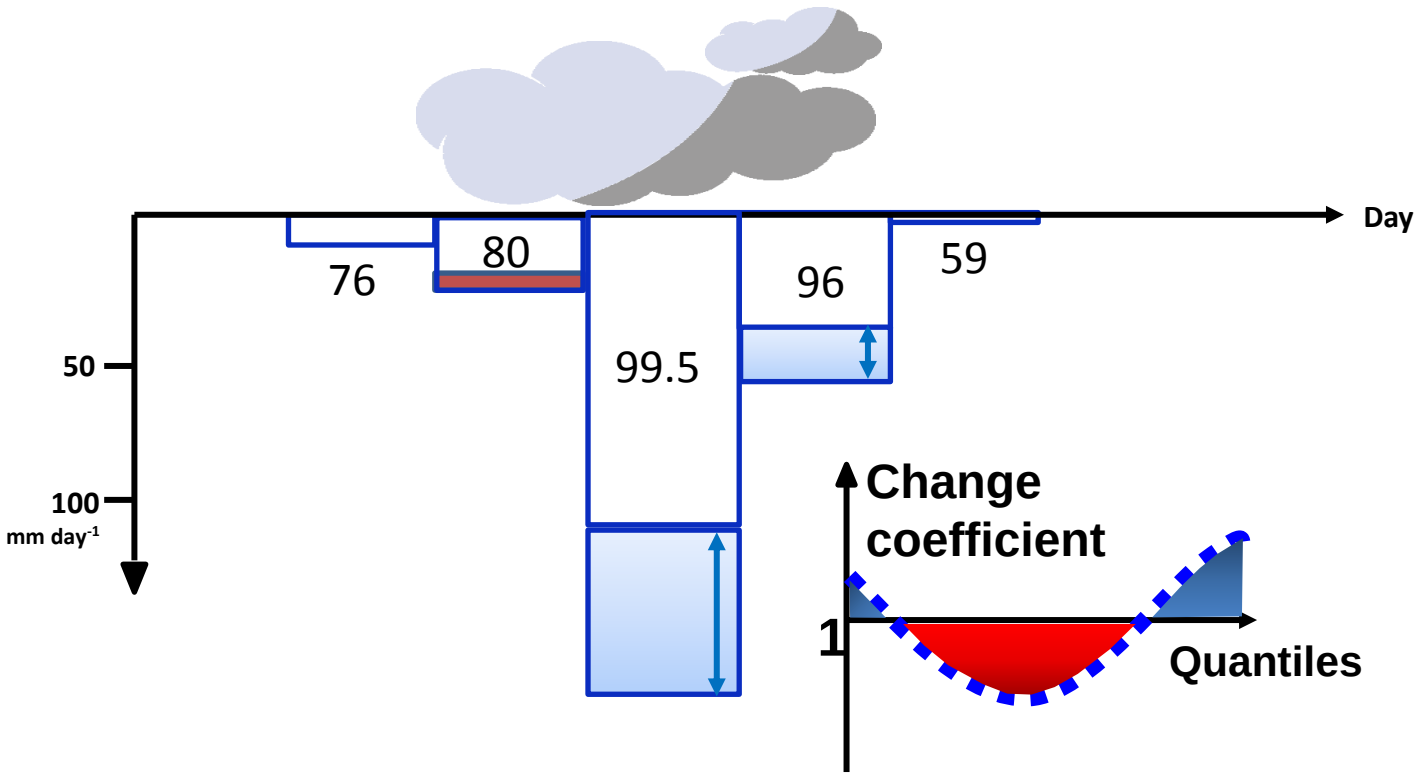
Simulated data from CORDEX regional climate models:





Computation of the change coefficient function for all quantiles ranks

Observed data: February 2017 in Orbieu catchment (France)



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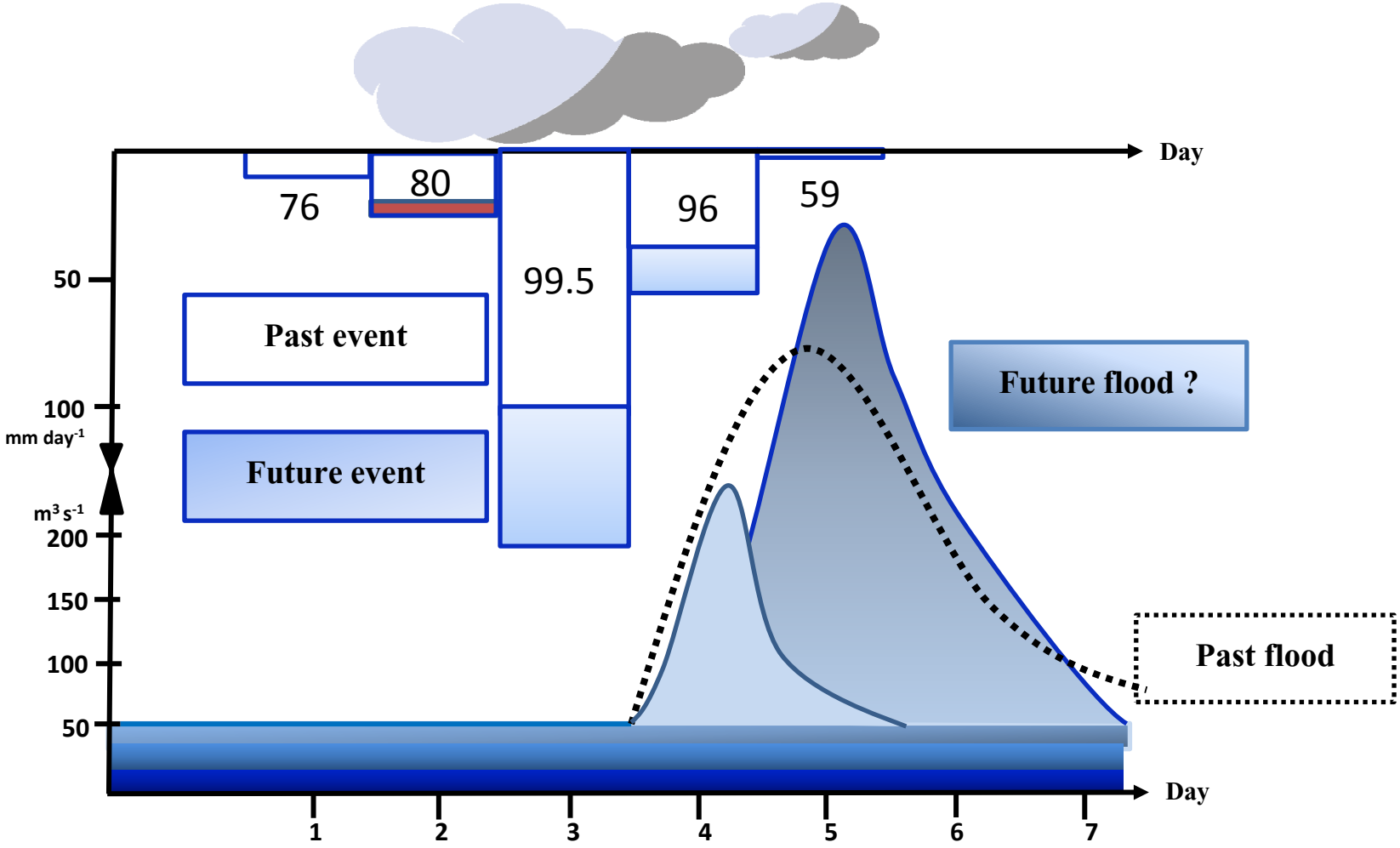

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