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Nathan Rispal, Bruno Arfib, Philippe Audra, Pierre Henry, Ludovic Mocochain, et al.. Element of a pluri-disciplinary project on karstic reservoir characterization: groundwater modelling of the Dévoluy Massif, France.. Eurokarst, Jun 2024, Roma Sapienza Università, Italy. 2024. hal-04628392

HAL Id: hal-04628392

<https://hal.science/hal-04628392>

Submitted on 28 Jun 2024

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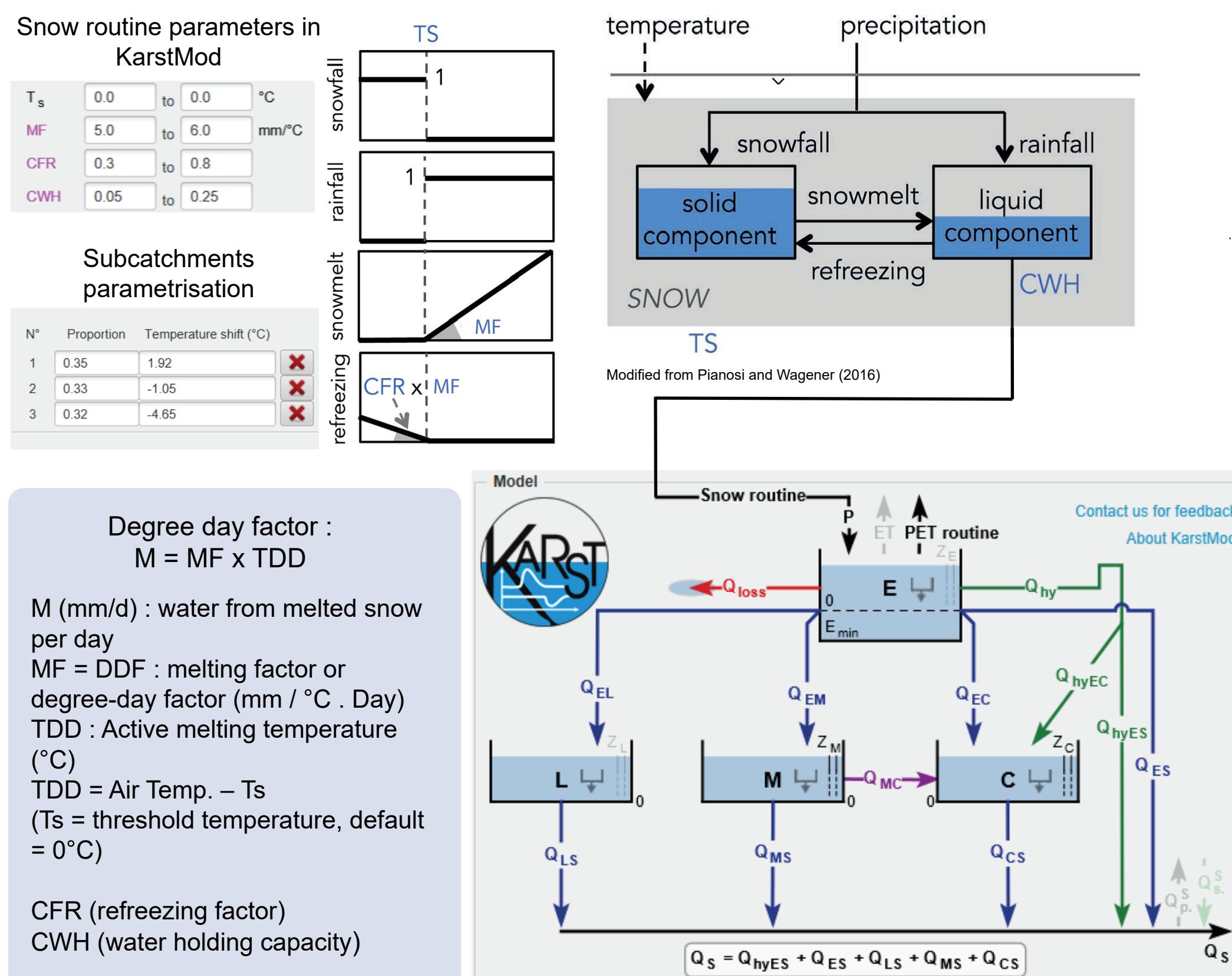
Element of a pluri-disciplinary project on karstic reservoir characterization : groundwater modelling of the Dévoluy Massif, France.

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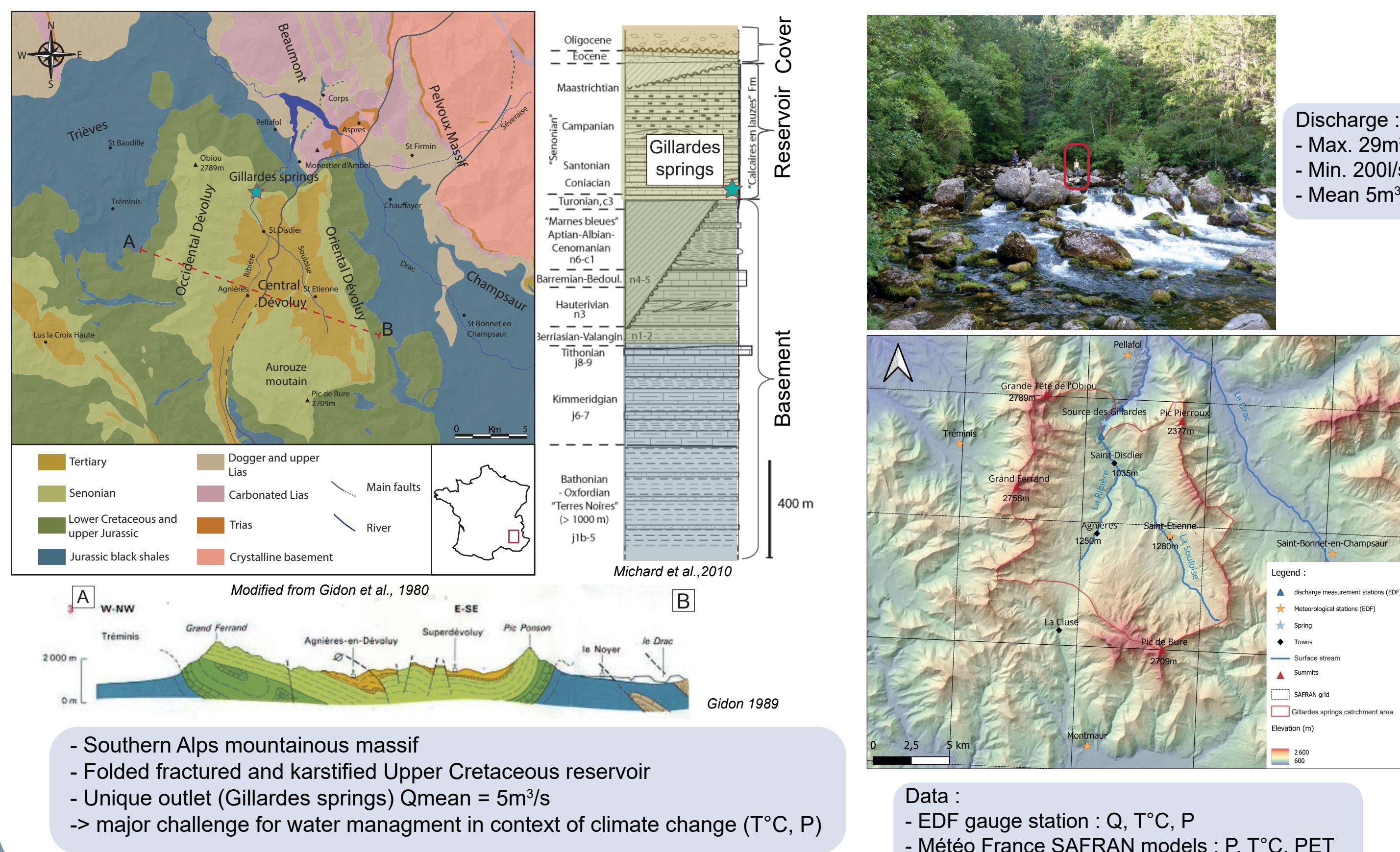
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Objectives : the aim of this study is to understand the behavior of a mountainous karstic reservoir. Exploration of hydrodynamic and meteorological data coupled to simulation on KarstMod platform with a snow routine module helps to decipher if discharge variations at the springs are related wether to recharge processes or properties of storage and flow in the reservoir.

How the snow routine works in KarstMod

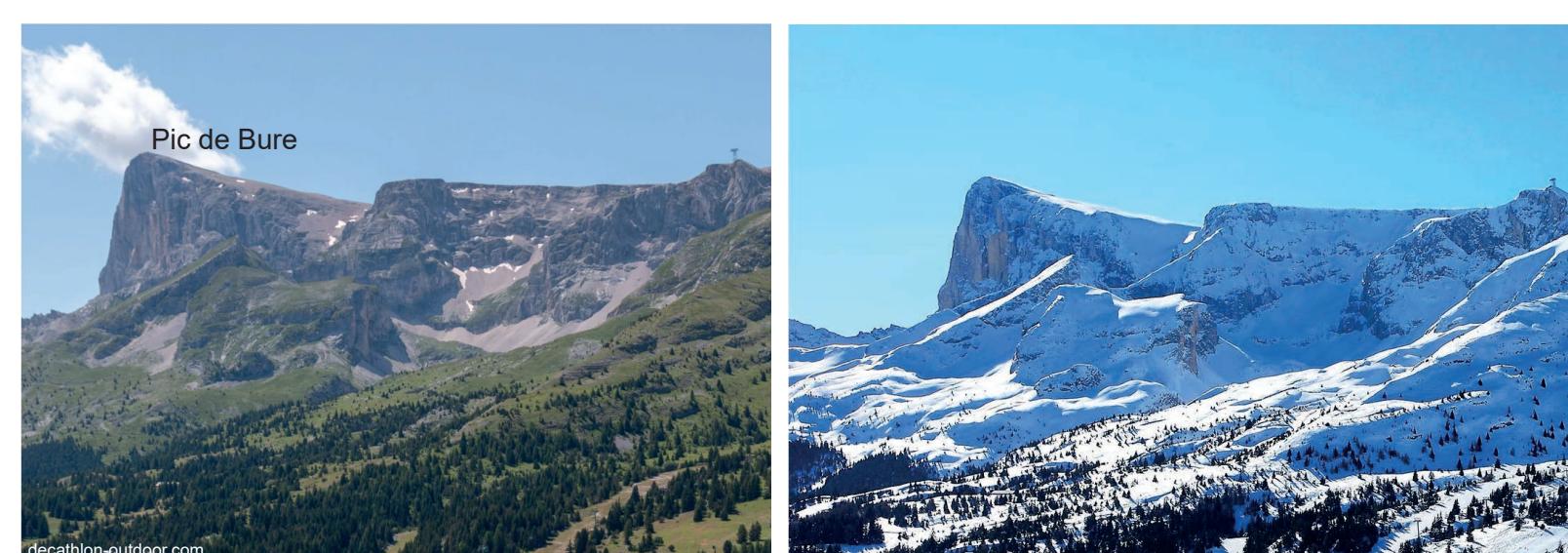


Case study : the Dévoluy karstic reservoir

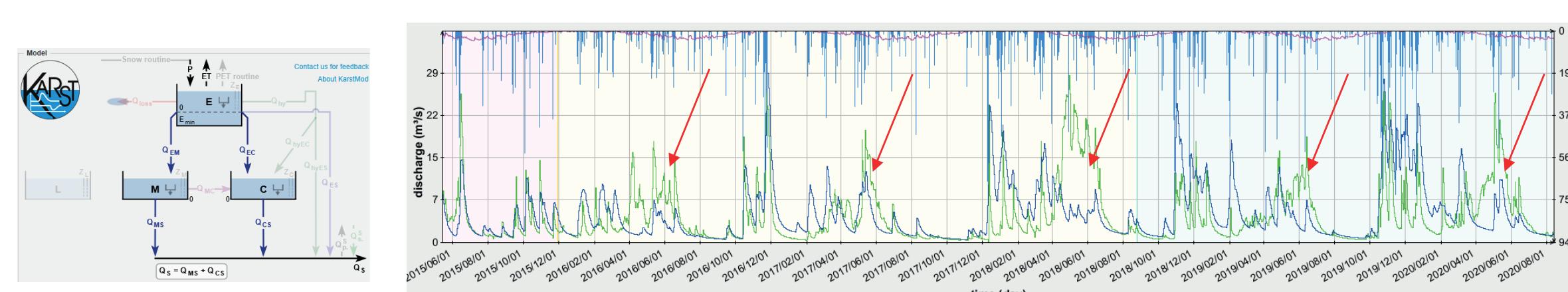


Workflow : modelling a snow-influenced karstic aquifer

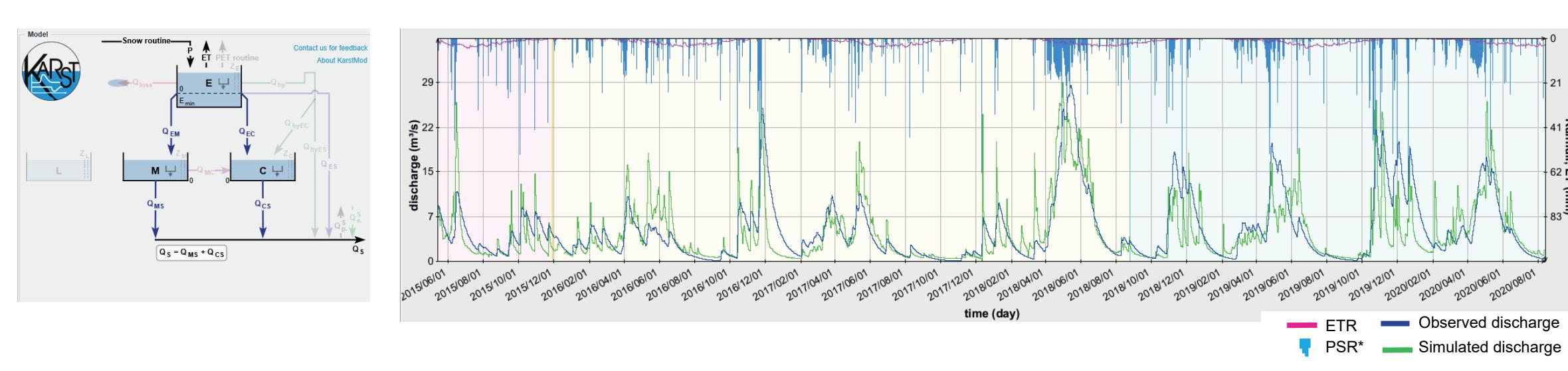
Field observations and data visualisation



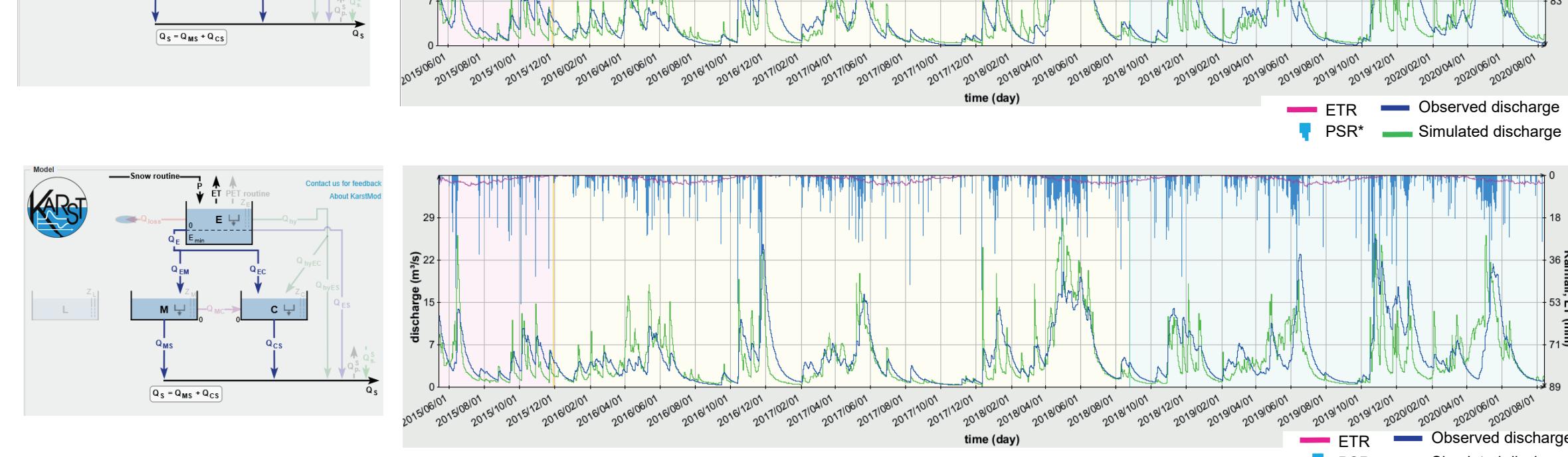
Model 1 :
Classical configuration with two reservoir and no snow routine



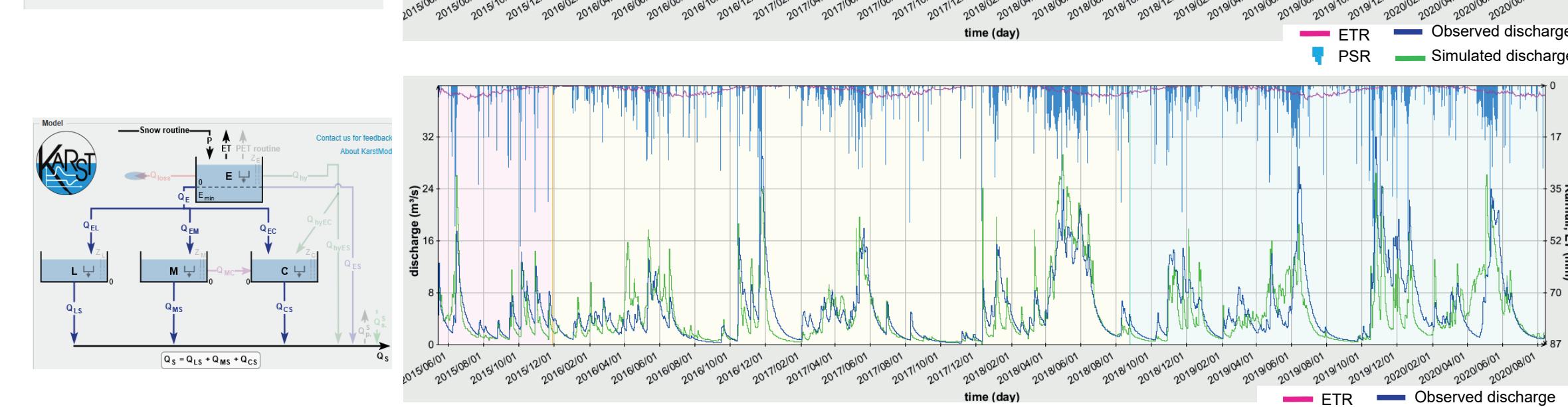
Model 2 :
Adding snow routine



Model 3 :
Adding subcatchments



Model 4 :
Refining model with third reservoir



Discussion

How to use the model once it is well calibrated ?

1/ Highlights the variations in flow rate in relation with the conditions of reservoir recharge.
Possible causes of variation in recharge in Dévoluy:
artificial snow at the ski resort, P and/or T°C variations due to climate change.

2/ Provides a better understanding of the hydrodynamic of the system in relation with groundwater management :
Architecture of the system, contribution of each reservoir to the discharge at spring, water resources.

key elements

Step 1 : identifying the role of snow in the recharge

During spring and summer, discharge increases at the Gillardes spring while there is no significant Q rise in la Souloise river.

Modelling without snowroutine shows that part of the discharge is lost during spring and summer.

Step 2 : Implementing snow routine in the model

Snow routine helps to better match observed discharge during spring and summer.

Subcatchments in snow routine enhance the recharge simulation (rainfall, snow and snowmelt) over the catchment area.

Adding third reservoir allows to better reproduce fast variations in discharge.

Conclusion and way-forward

Importance of recharge mechanisms : work is needed on recharge modeling to improve rainfall-discharge modeling with conceptual models («reservoir or compartments models» like KarstMod). Good model structure is not enough.

Snow routine module is efficient : the degree-day method used by KarstMod is effective when applied to a karstic spring.

Way-forward : threshold temperature or temperature shift in the subcatchments could be used to simulate futur climate change with KarstMod.

References and acknowledgments :

- Thanks to EDF DTG for P, T°C and Q data and Meteo France for meteorological data from SAFRAN models.
- Gidon, M. et al. (1980) «Carte Géologique de la France, BRGM, feuille de Saint Bonnet XXXIII 37, 1:50000»BRGM.
- Michaud, A. et al. (2010) Cretaceous folding in the Dévoluy mountains (Subalpine Chains, France) gravity-driven detachment at the European paleomargin versus compressional event, *Bulletin de la Société Géologique de France*, 181(6), pp. 565-581.
- Pianosi, F., and Wagener, T. (2016) Understanding the time-varying importance of different uncertainty sources in hydrological modeling using global sensitivity analysis, *Hydrolog. Process.*, 30, 3991–4003, doi: 10.1002/hyp.10988.
- Sivelle, V., Cinkus, G., Mazzolini, N., Labat, D., Berlin, D., and Jourde, H. Improvement of the KarstMod modeling platform for a better assessment of karst groundwater, *Hydrolog. Earth Syst. Sci. Discuss. [preprint]*, https://doi.org/10.5194/hess-2023-17, in review, 2023.
- Zappelli, A., Beleville, A., and Jagercikova, M. (2018) Hydrogeology of Dévoluy karstic system: New insights with dye tracing and rainfall-discharge model!, *Eurokarst*, Besançon.