

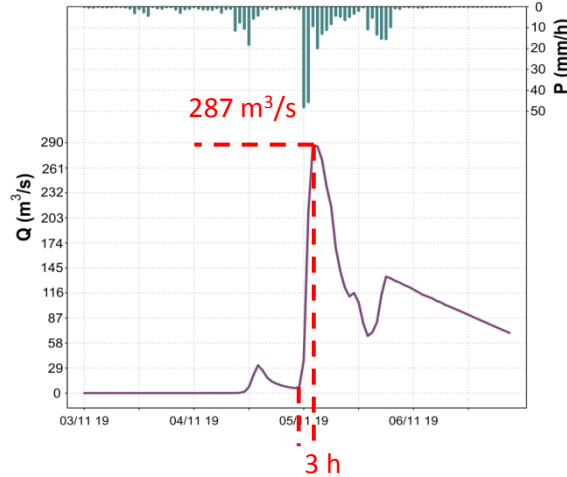
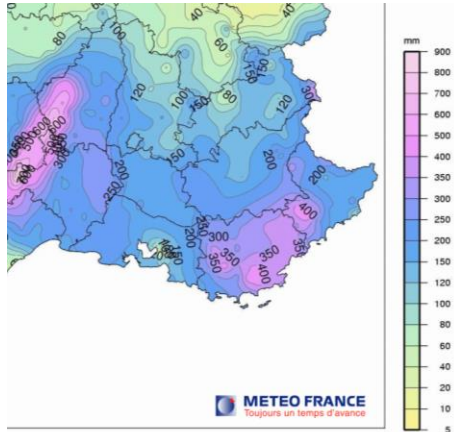
➤ Investigating hydrological model versatility to simulate flood events

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➤ High-impact floods in the Mediterranean region



Large potential impacts:

- Human losses
- Infrastructure damage

Our objective:

To investigate how improving hydrological model versatility can contribute to improve the simulation of different types of extreme flood events in a flash-flood prone catchment in the Mediterranean region of Southwest France.

Contribution to the French research project:

<https://pics.ifsttar.fr/>

PICS

Prévision Immédiate Intégrée
des Impacts des Crues Soudaines

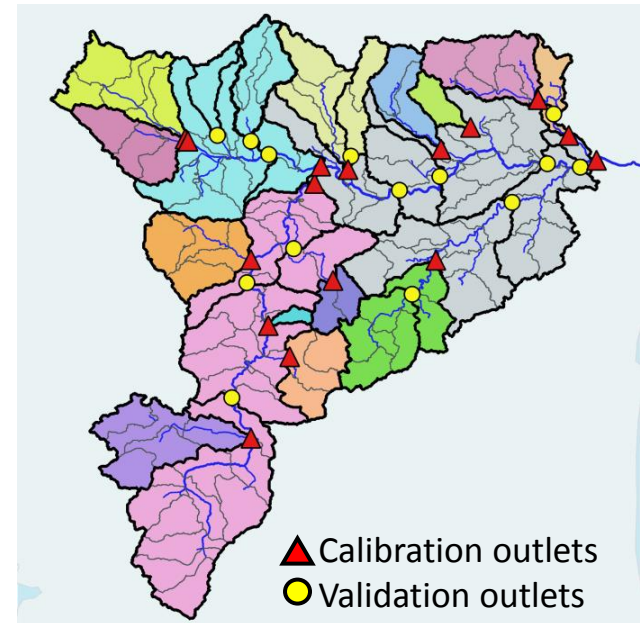
➤ Case study: The Aude River Basin

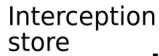


Aude River Basin (31 gauged outlets) – Hourly data		
	Rainfall data	Streamflow
Observations	ANTILOPE J+1	Banque Hydro
Events	- March 2011 - November-December 2014 - February 2017 - October 2018	

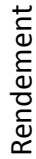
- **Surface:** 4,840 km²
- **Semi-distributed hydrological model:** GRSD
(Lobligeois *et al.*, 2014; de Lavenne *et al.*, 2019)
- **Size of the modelling units:** ≈ 50 km²
- **Calibration period:** Oct 2008 – Oct 2018
- **Number of calibration outlets:** 16
- **Number of validation outlets:** 15

- Lobligeois, F. *et al.*, 2014. When does higher spatial resolution rainfall information improve streamflow simulation? An evaluation using 3620 flood events. *HESS*, [doi: 10.5194/hess-18-575-2014](https://doi.org/10.5194/hess-18-575-2014)
- de Lavenne, A., Thirel, G., Andréassian, V., Perrin, C., and Ramos, M.-H., 2016. Spatial variability of the parameters of a semi-distributed hydrological model. *Proceedings of the International Association of Hydrological Sciences*, 373, 87–94, <https://doi.org/10.5194/piahs-373-87-2016>.

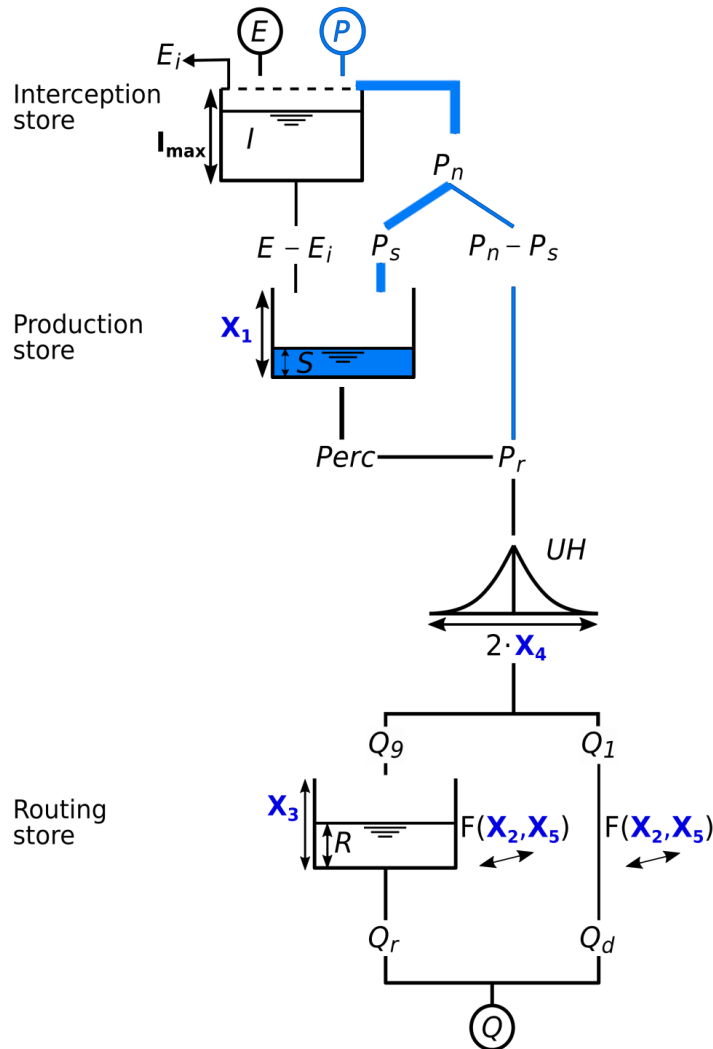




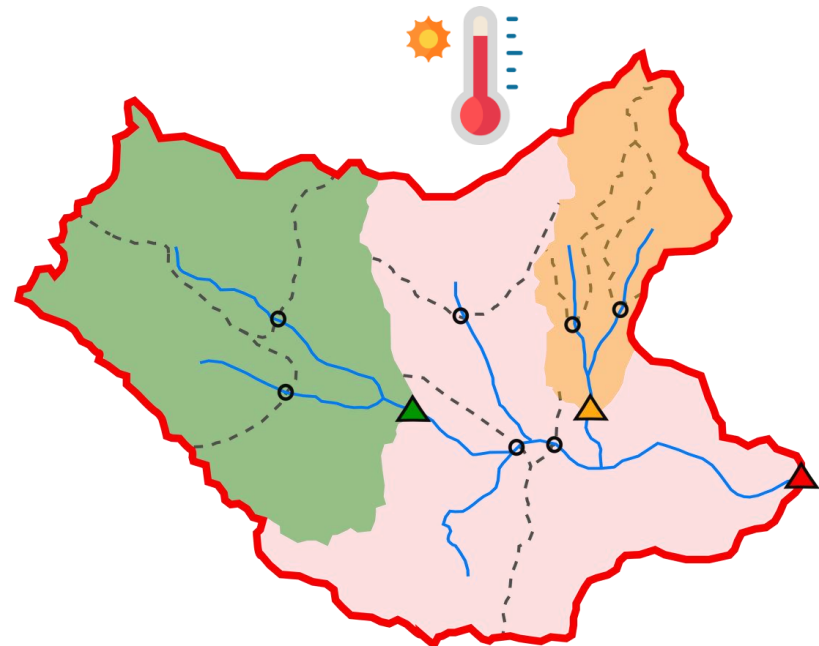
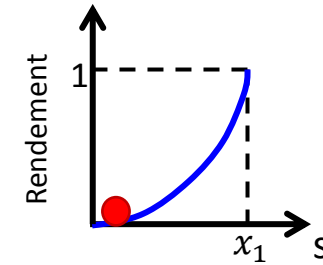
$$\eta = \left[\frac{S}{x_1} \right]^2$$



➤ Production rate inside the GRSD model

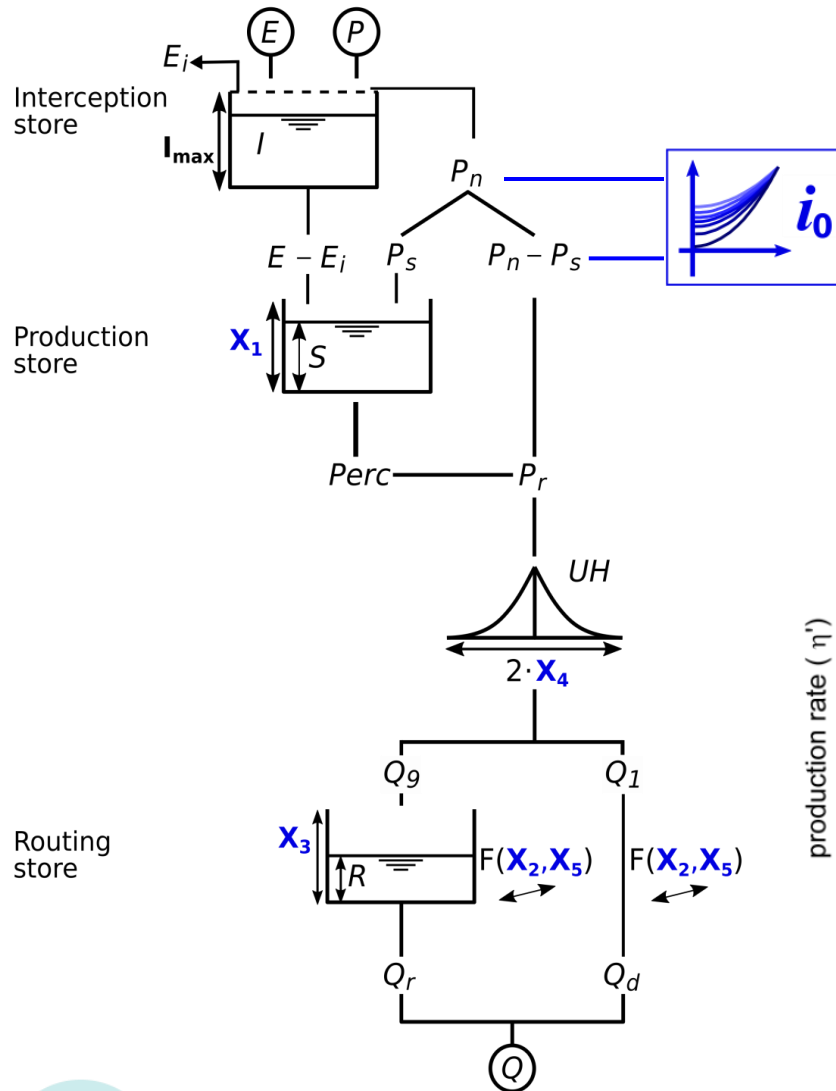


$$\eta = \left[\frac{S}{x_1} \right]^2$$

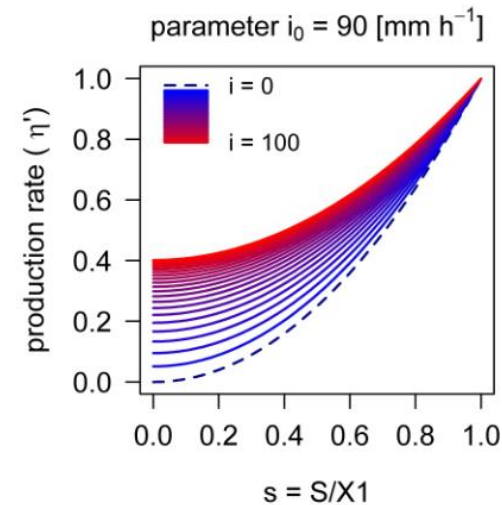
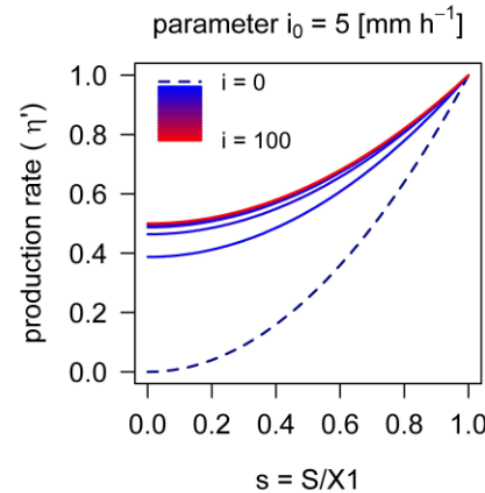


Production rate $\uparrow$ S $\uparrow$
 Production rate $\downarrow$ S $\downarrow$

➤ From the GRSD model to the GRSDi model (Peredo *et al.*)



$$\eta' = \frac{\left[\frac{S}{x_1}\right]^2 + 1 - \exp\left(-\frac{i}{i_0}\right)}{2 - \exp\left(-\frac{i}{i_0}\right)}$$



- Peredo, D. et al., submitted to HSJ, 2021

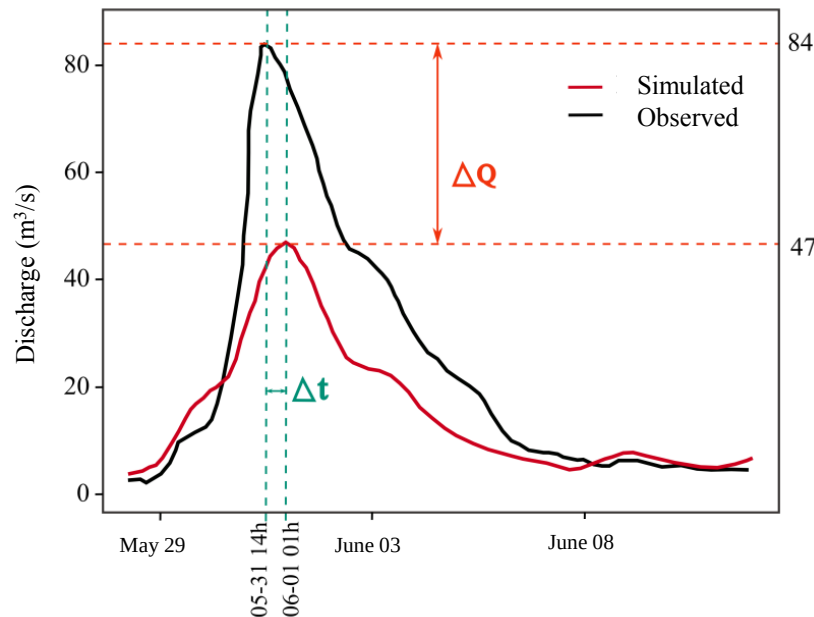
➤ Evaluation of simulated streamflows

Calibration and validation criteria over the study period (Oct 2008 - Oct 2018):

$$KGE = \sqrt{(r - 1)^2 + (\alpha - 1)^2 + (\beta - 1)^2}$$

Kling-Gupta Efficiency (Gupta *et al.*, 2009)

Validation criteria over flood events:

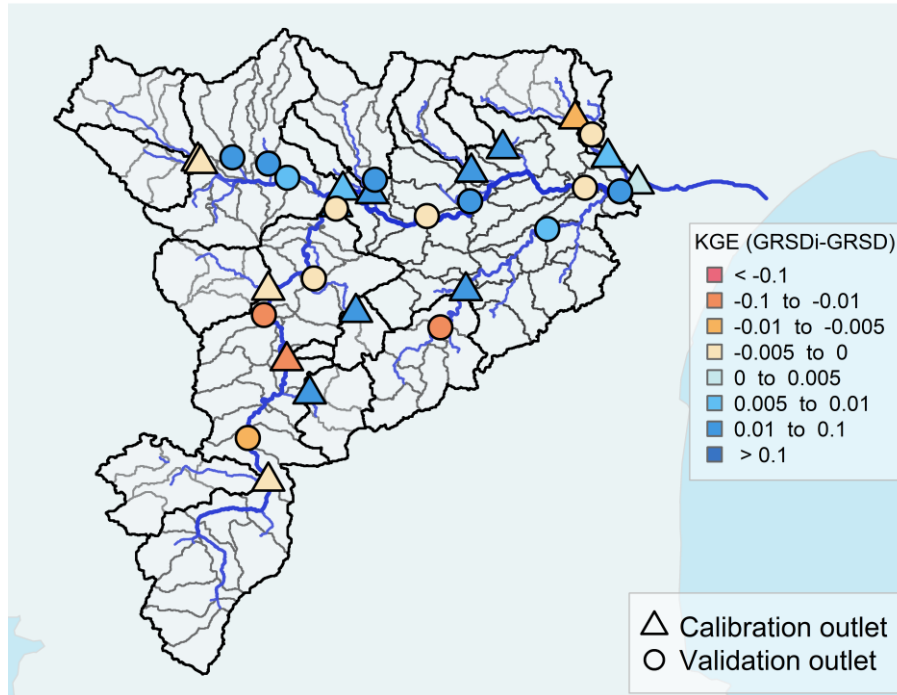


$$\Delta Q = \frac{Q_{sim} - Q_{obs}}{Q_{obs}}$$

$$\Delta t = t_{sim} - t_{obs}$$

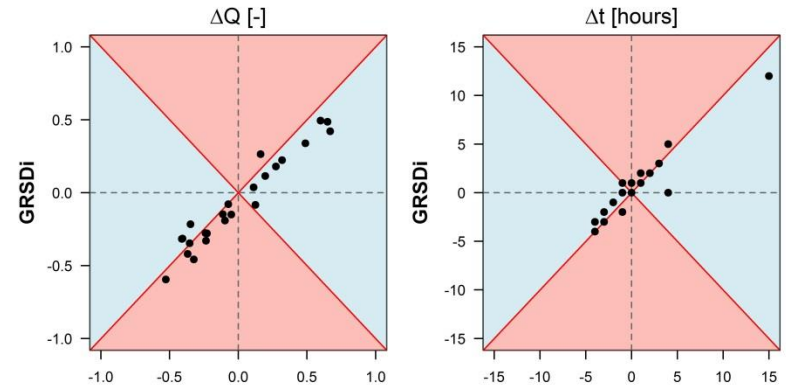
- Peredo, D. et al., submitted to HSJ, 2021

➤ Results on model performance

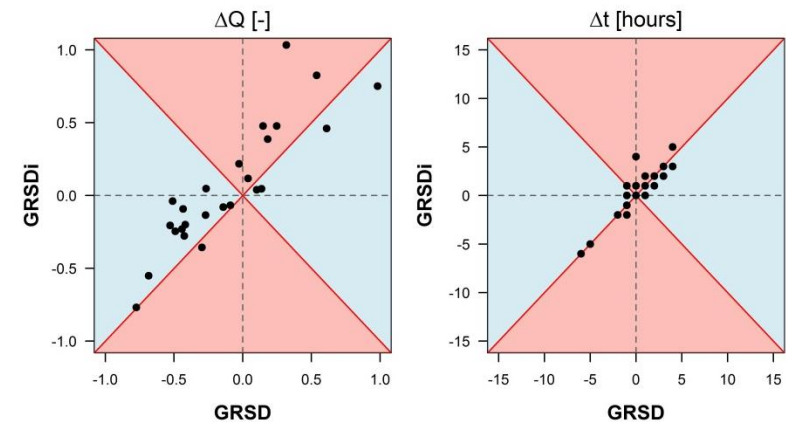


KGE performance for the period 2008-2018

15-17 Mars 2011



14-15 October 2018



Performance over flood events

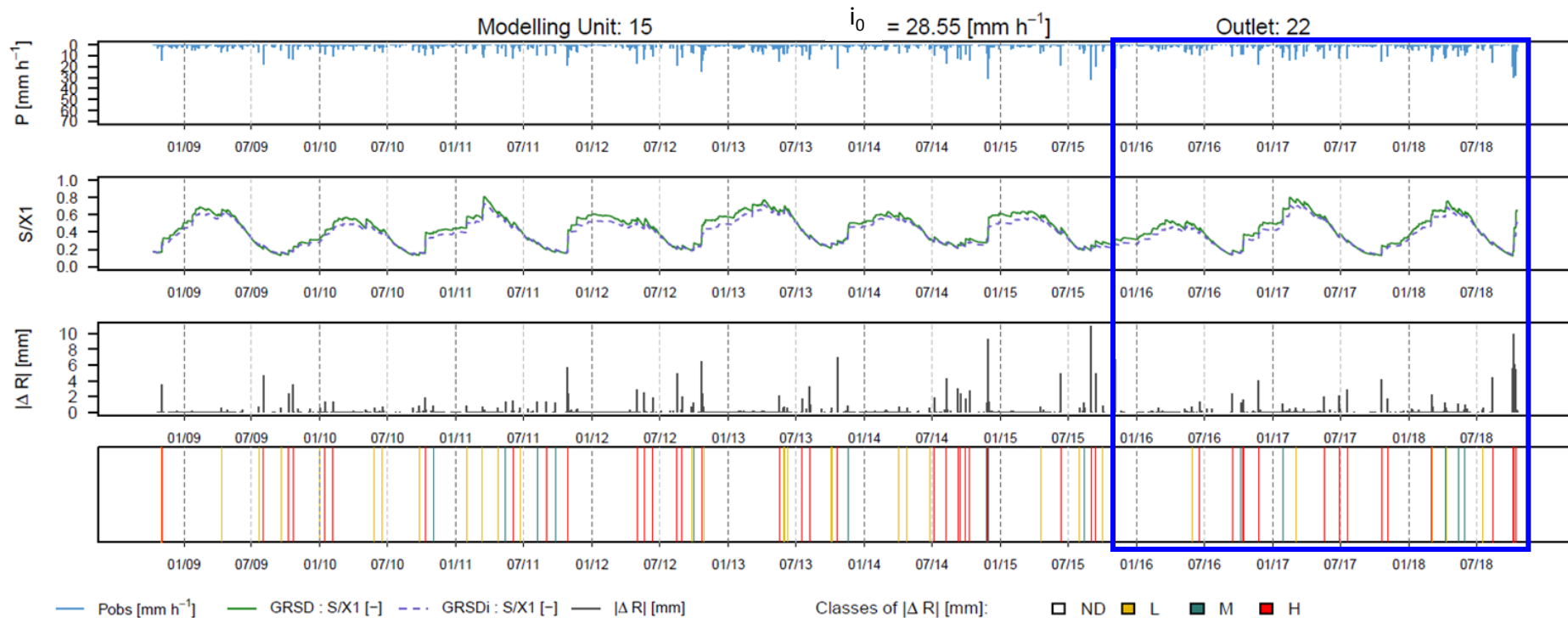
- Peredo, D. et al., submitted to HSJ, 2021

➤ Visualizing GRSDi model's versatility

Runoff comparison between models (4 classes)

$$\Delta R = |p_{r_{GRSDi}} - p_{r_{GRSD}}|$$

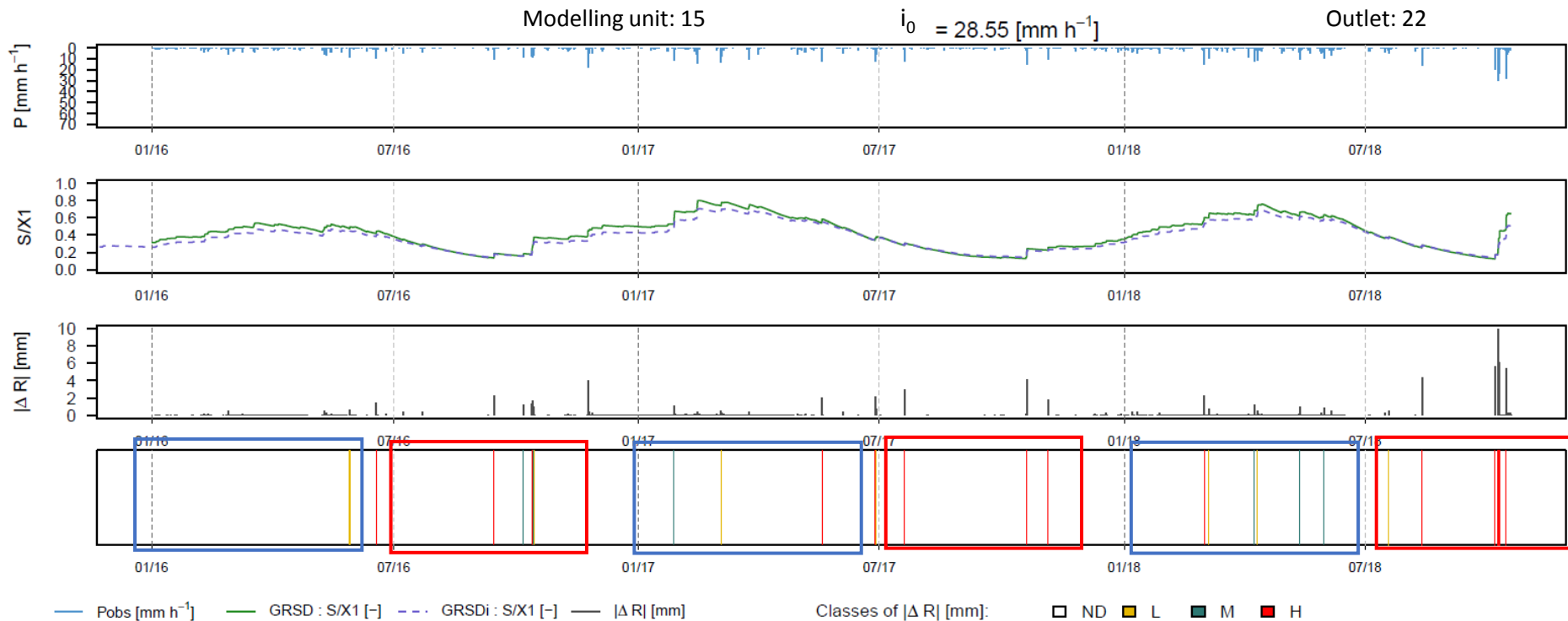
- No difference (ND)
- Low differences (L)
- Medium differences (M)
- High differences (H)



- Peredo, D. et al., submitted to HSJ, 2021

➤ Visualizing GRSDi model's versatility

Runoff comparison: January 2016 to October 2018



- Peredo, D. et al., submitted to HSJ, 2021

➤ Conclusions

- Long-term assessment of model performance (based on the KGE criteria): the model adaptation (new GRSDi model) does not deteriorate flow simulations when compared to the original GRSD model.
- Event-based assessment: the GRSDi model performs better than or equal to the GRSD model in terms of differences in time to the flood peak, regardless of the season of the year in which the flood occurs.
- GRSDi model improved the simulations of the magnitude of the flood peaks: the underestimations of the original GRSD model during the flood events occurring in autumn were corrected.
- Model versatility was shown for the simulation time steps where low, medium and high differences were observed: the modification introduced in the original model structure is activated when the model needs to adapt to specific flood conditions (intense rainfalls after long dry periods).

Find more at HS4.1 session on Wednesday 28 April 2021 at 15:51 CEST

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