



workshop 2023



Centre de Recerca Aplicada
en Hidrometeorologia

UNIVERSITAT POLITÈCNICA DE CATALUNYA

Evaluation of a Real-time Regional Ensemble Flow Forecasting System in Catalonia of a 2-Year Term

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BACKGROUND



EUROPA PRESS NEWS VIA GETTY IMAGES

In Les Cases d'Alcanar, Tarragona, roads were flooded after Storm Dana



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Més locura a les Cases d'Alcanar...@TomasMolinaB
@miqalonso @StormChasersSP @severeweatherEU
@spainsevere @AlcanarAJ @eltempsTV3 @alexmegapc
@tiempobrasero



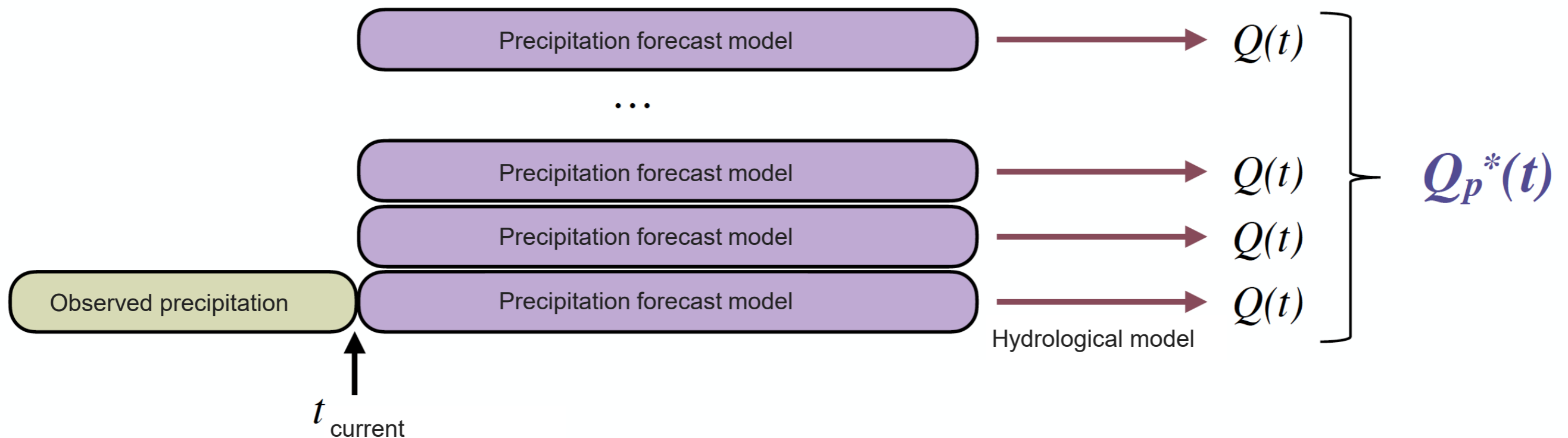
1:50 PM · Sep 1, 2021



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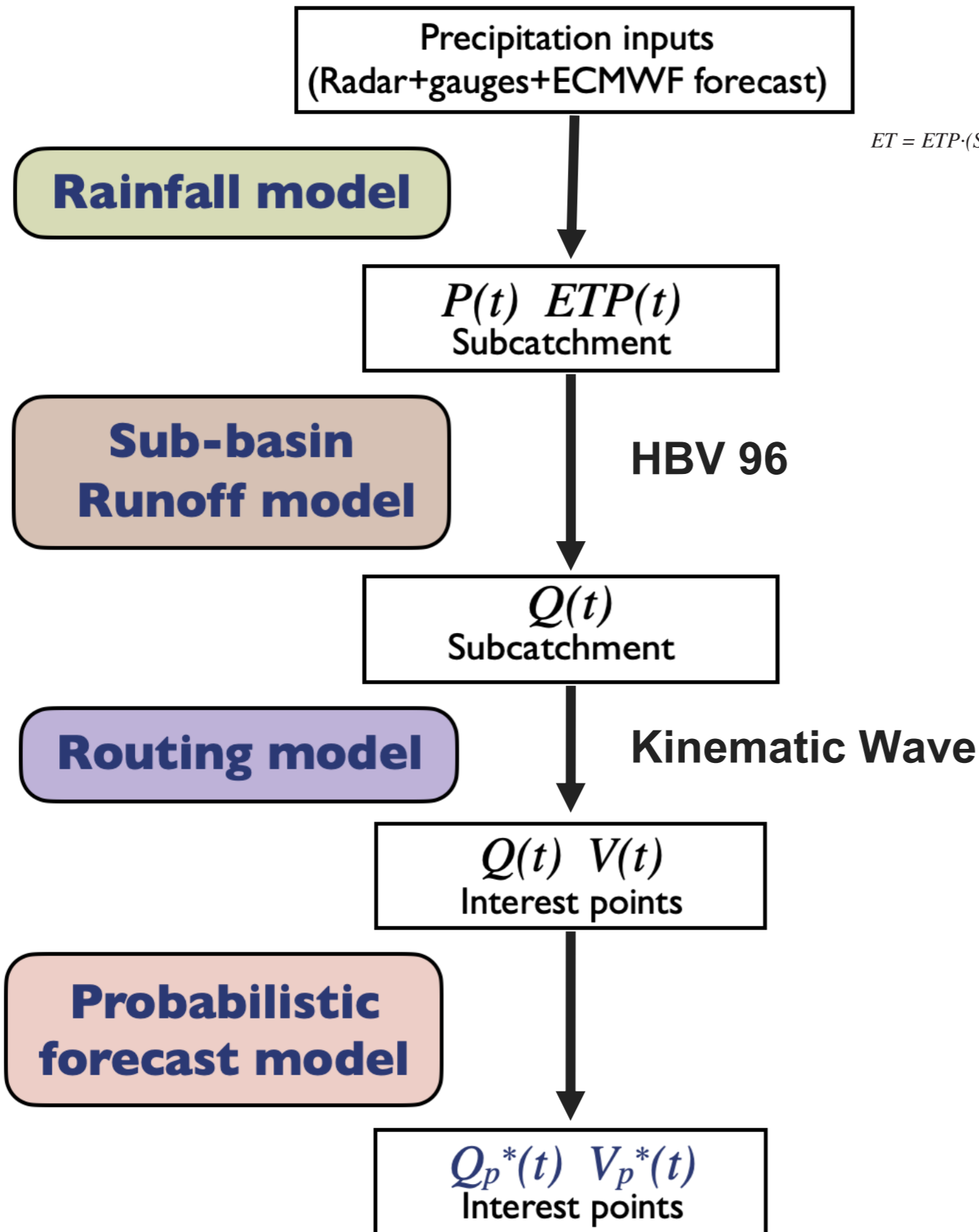
MOTIVATION

An ensemble flow forecasting system has been running in real-time since June 2020, in all the gauging stations of the Catalan Water Agency.

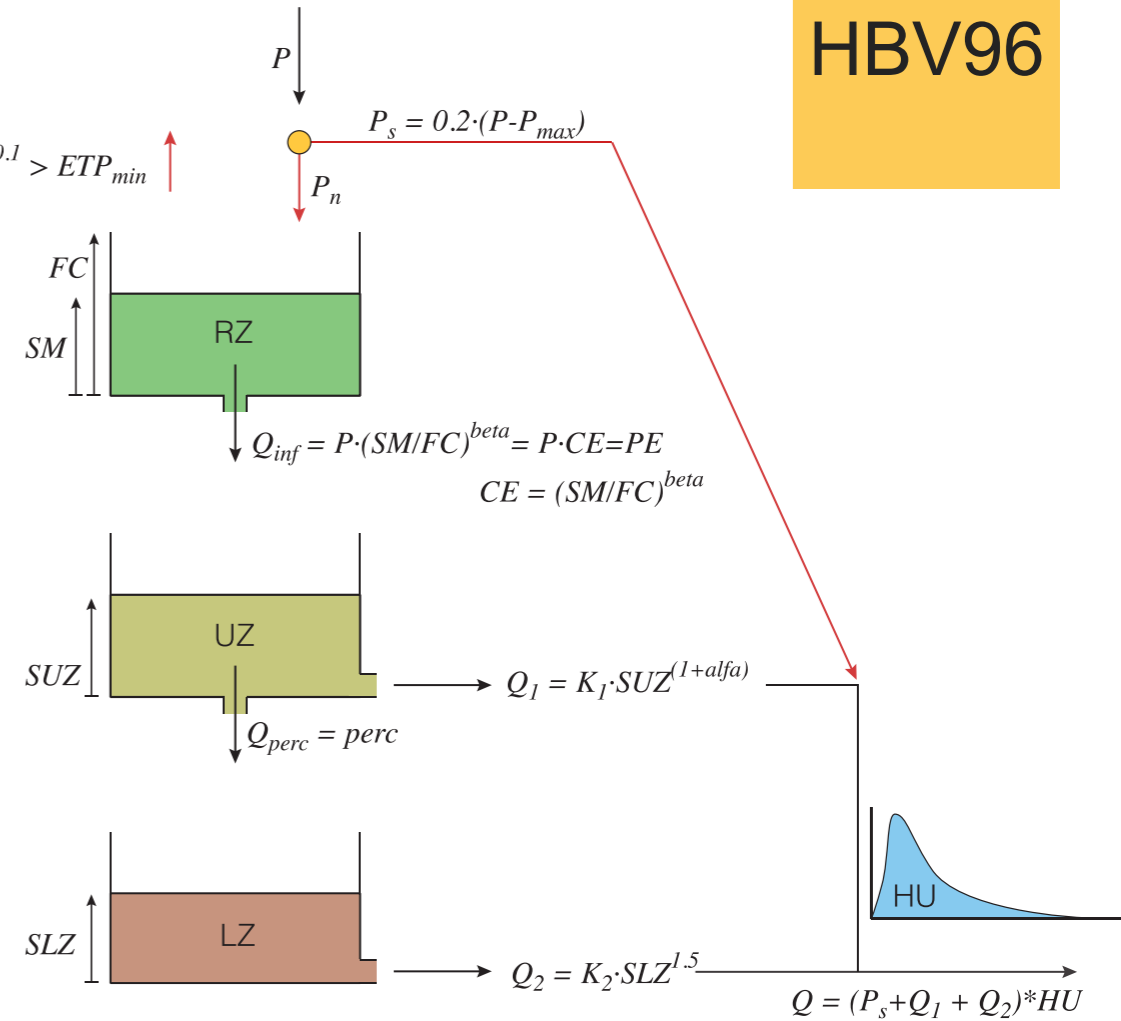


HYDROLOGICAL MODEL

HBV96



$$ET = ETP \cdot (SM/FC)^{0.1} > ETP_{min}$$



Continuous model with three storages

Model resolution: 1h

System execution: 1h

OBJECTIVES

- The long-term performance of this flow forecasting system should be evaluated since 2020.
- Both deterministic and probabilistic scores will be used for evaluation.

KGE

The discharge forecast without rainfall forecast **(no forecast)** has been used as **benchmark**.

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

$$= 1 - \sqrt{(r - 1)^2 + \left(\frac{\sigma_{sim}}{\sigma_{obs}} - 1\right)^2 + \left(\frac{\mu_{sim}}{\mu_{obs}} - 1\right)^2}$$

$$RPS_i = \frac{1}{Q_{max} - Q_{min}} \sum_{n=1}^{N_C} (P_{forecast_{n,i}} - P_{observation_{n,i}})^2 \Delta Q$$

$$RPS = \frac{1}{N_T} \sum_{i=1}^{N_T} RPS_i$$

RPS /
RPSS

STUDY AREA



8 main river catchments

7 reservoirs

39 gauging points

TER_P5A

Area : 1137.3 km²

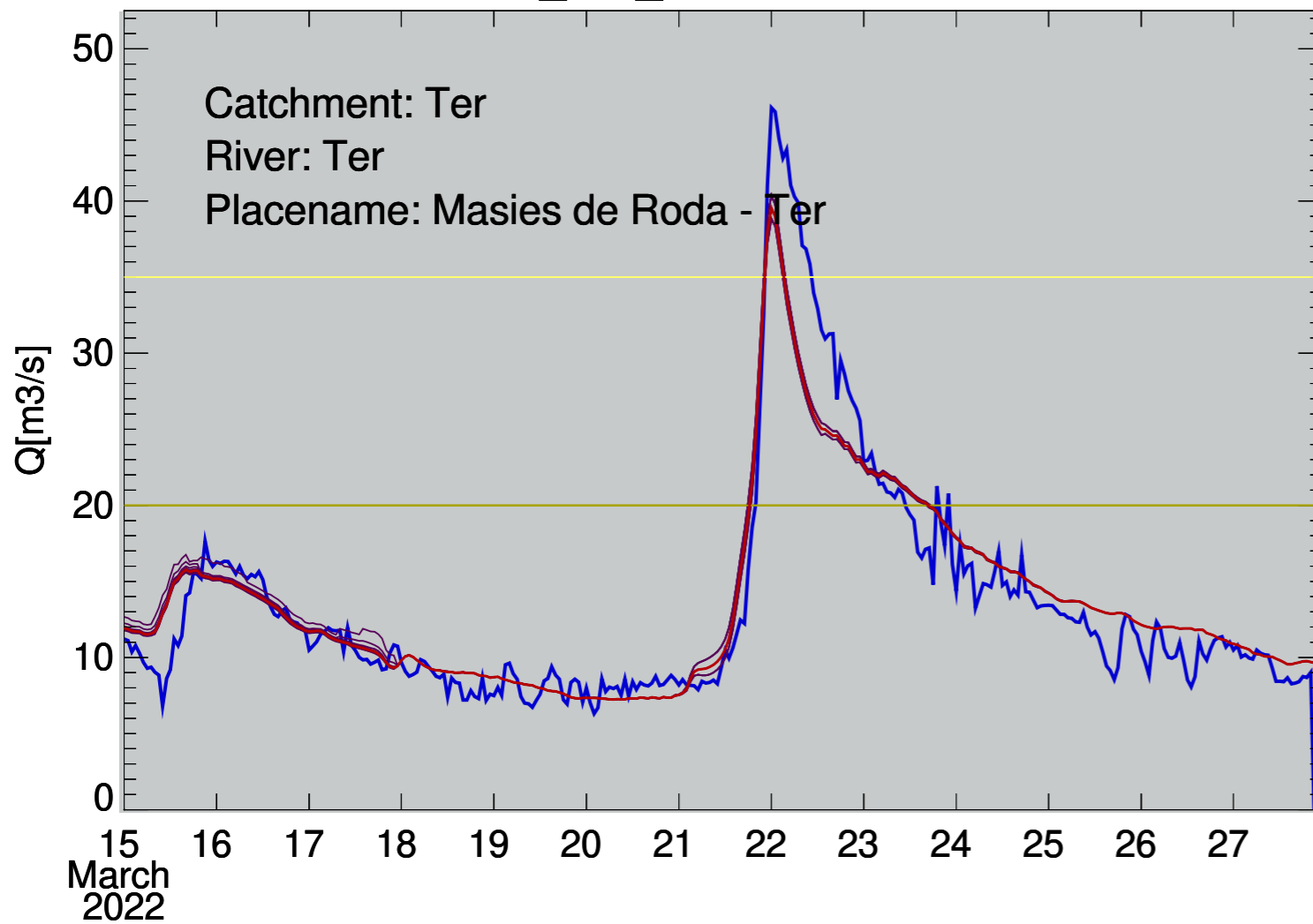
2-year return period: 20.0 m³/s

10-year return period: 35.0 m³/s

49 significant events have been identified between June 2020 and June 2023 in Catalonia

CASE STUDY · DETERMINISTIC SCORE

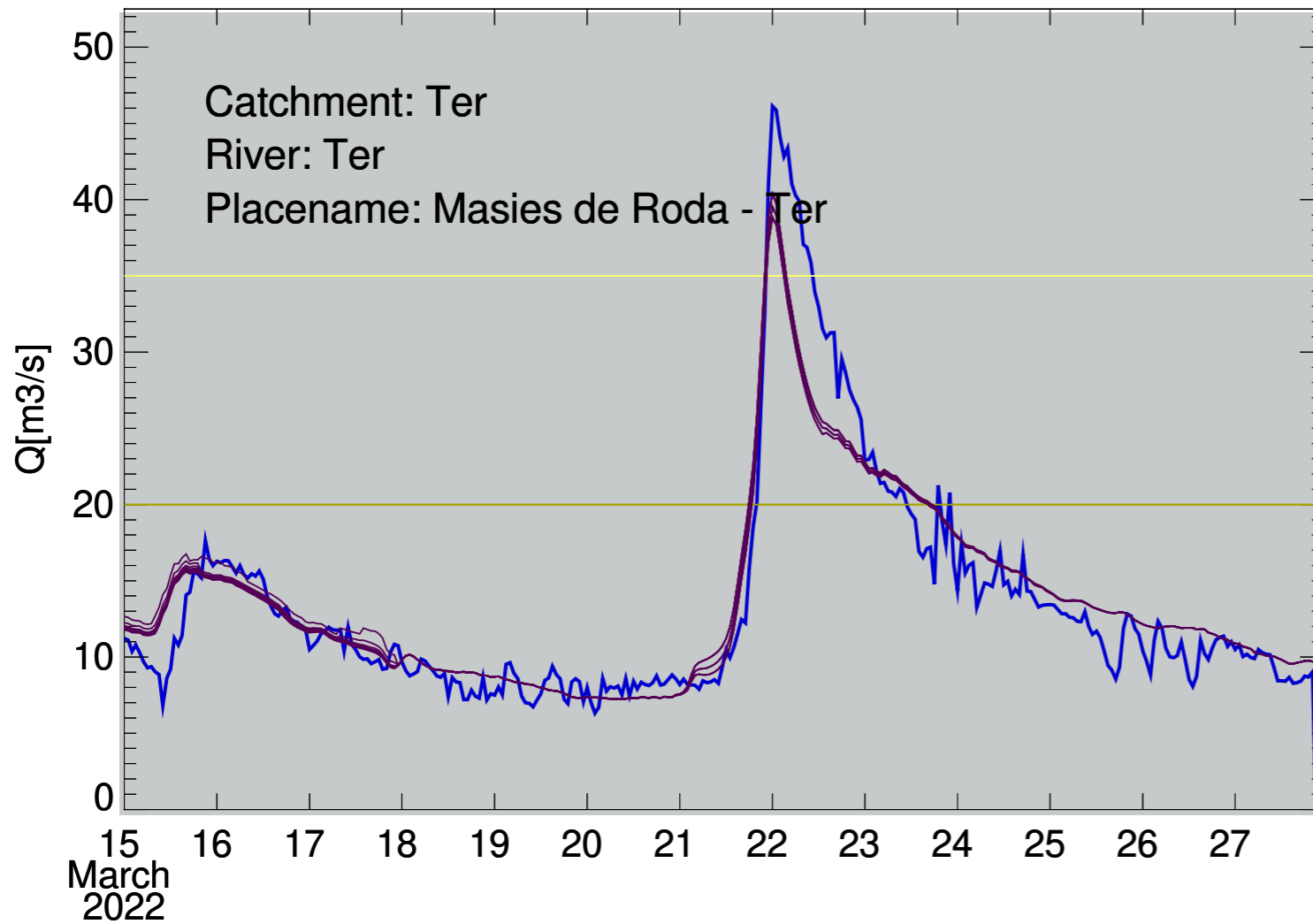
event5_Ter_P5A lead time=00



Observed flow ——— flow forecast ———
simulated flow ——— no forecast ———

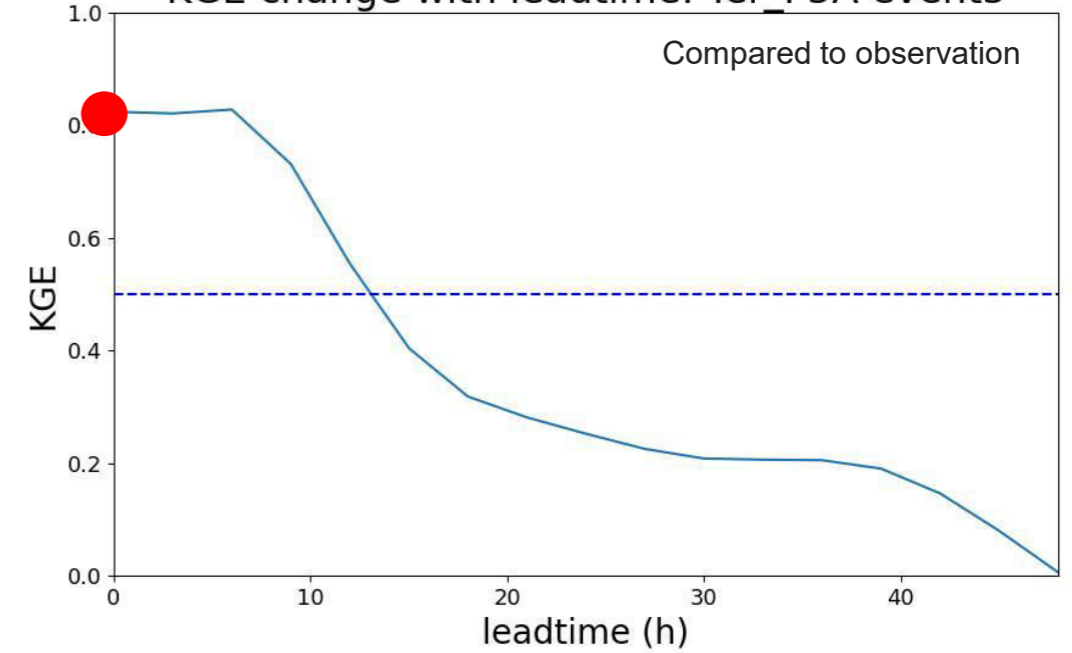
CASE STUDY · DETERMINISTIC SCORE

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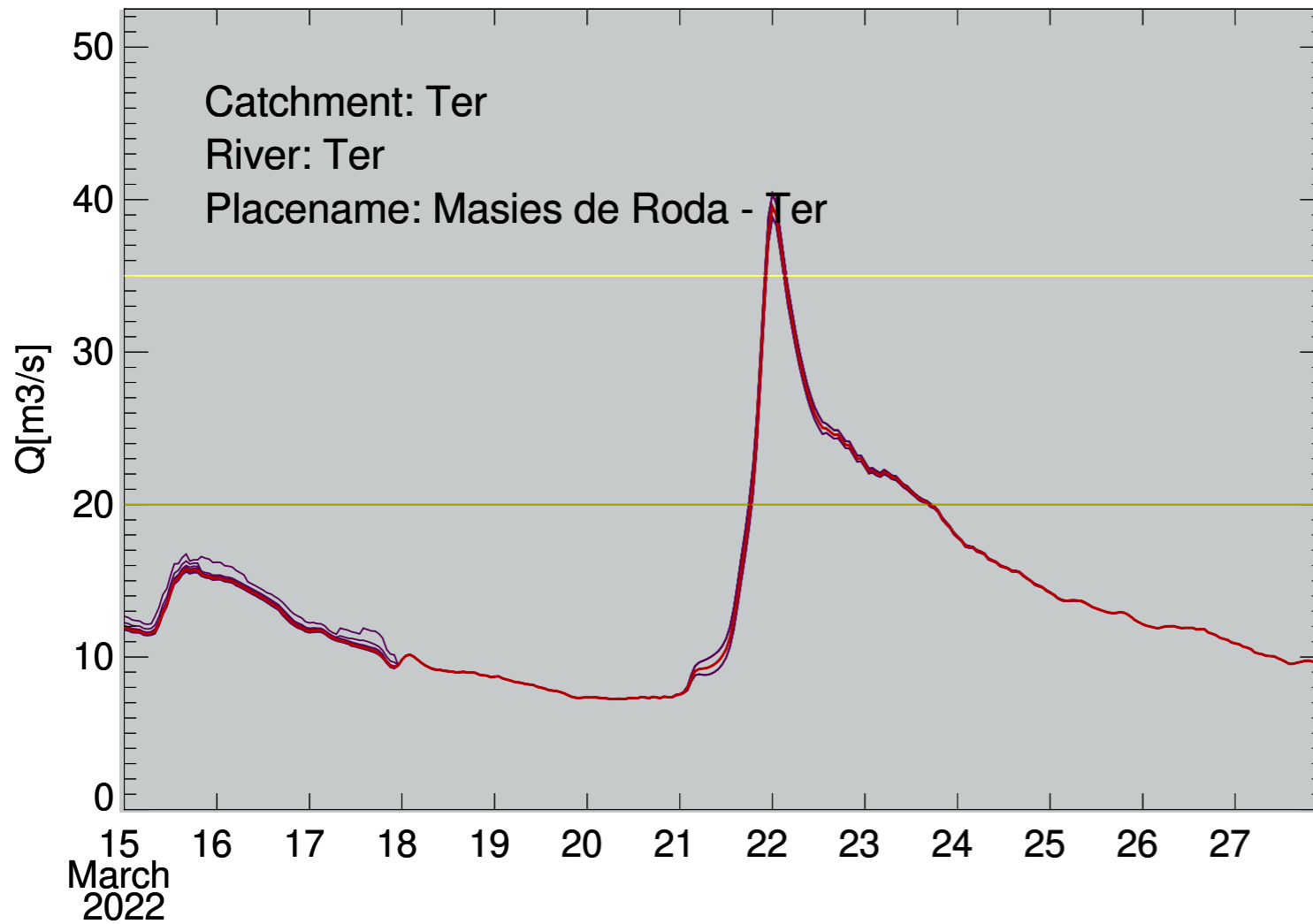
Observed flow ———— flow forecast ————
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KGE change with leadtime: Ter_P5A event5



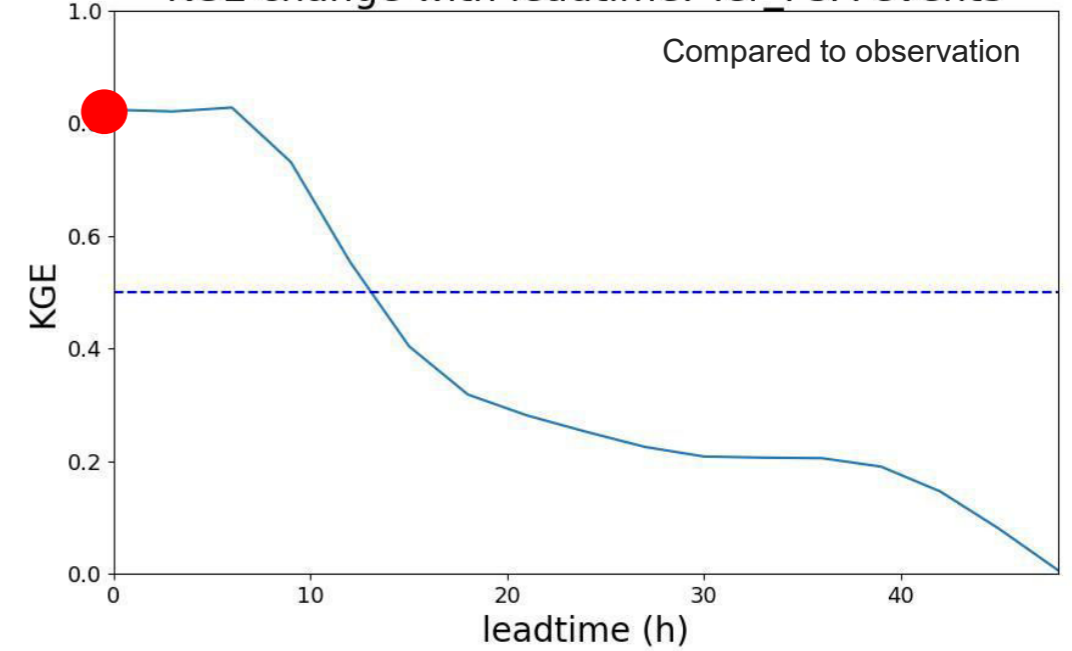
CASE STUDY · DETERMINISTIC SCORE

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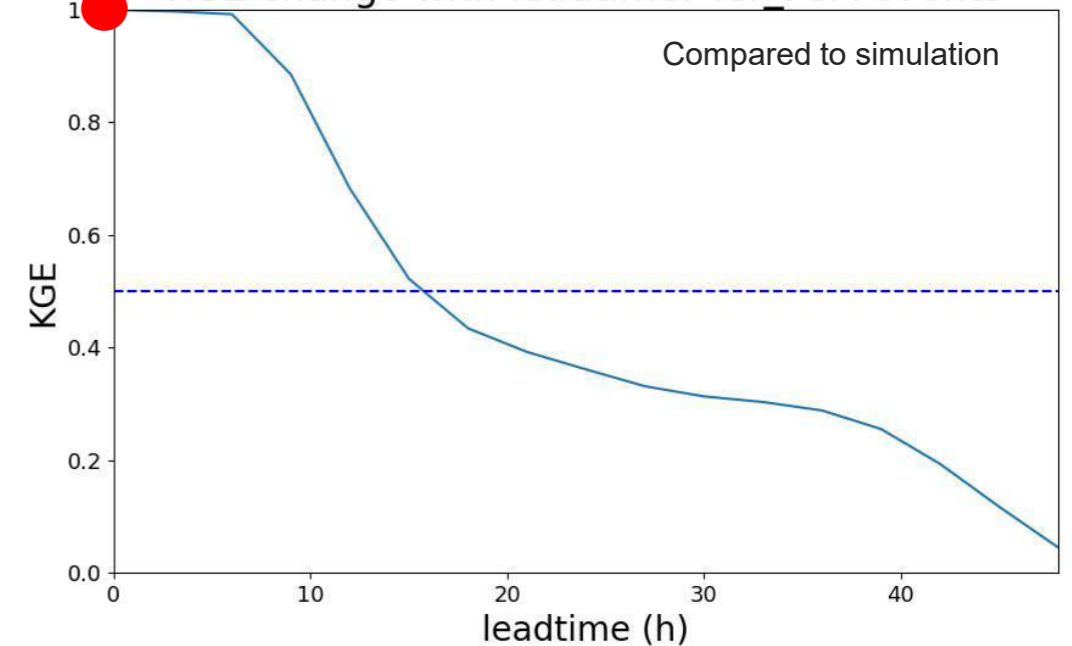


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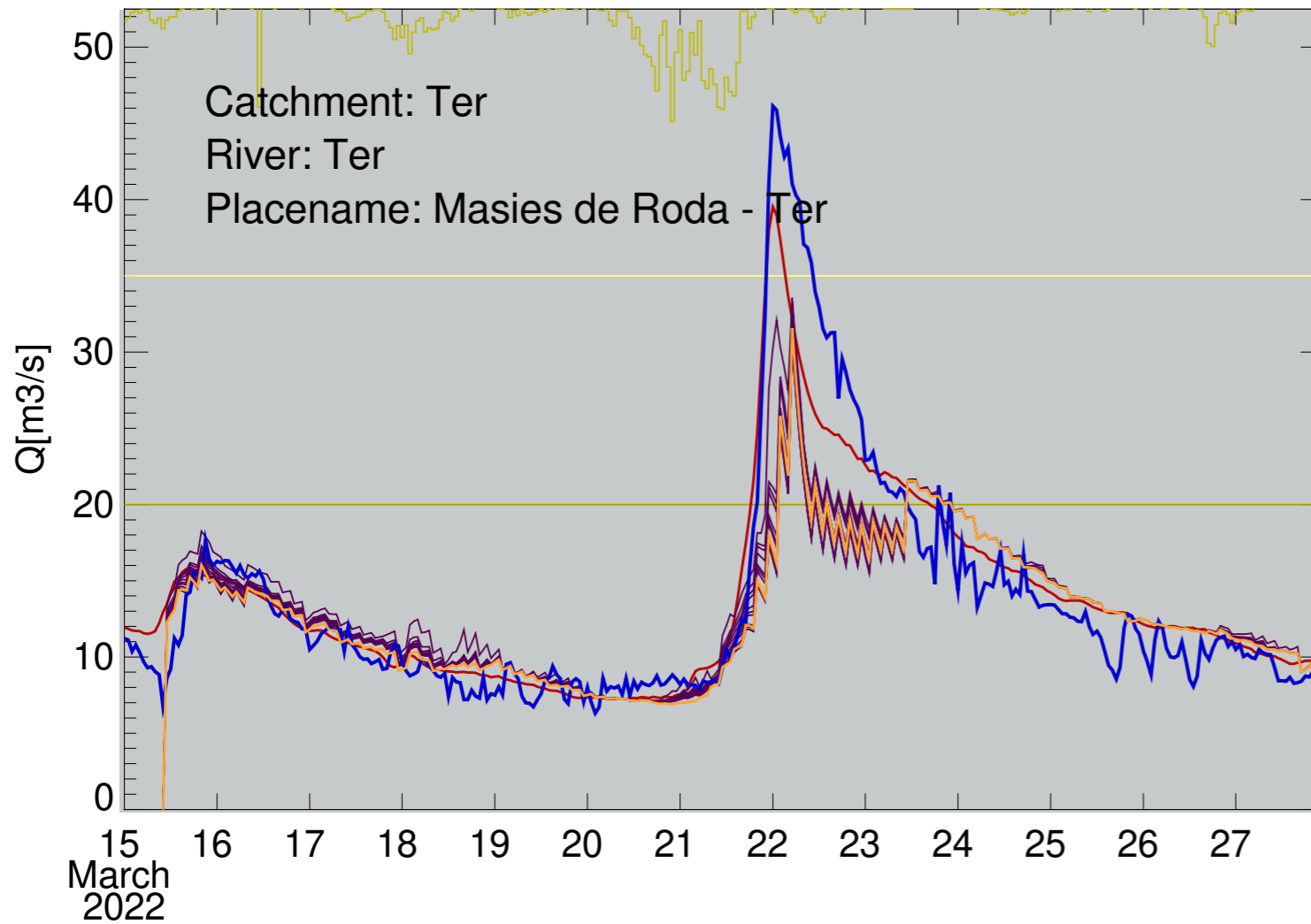


KGE change with leadtime: Ter_P5A event5



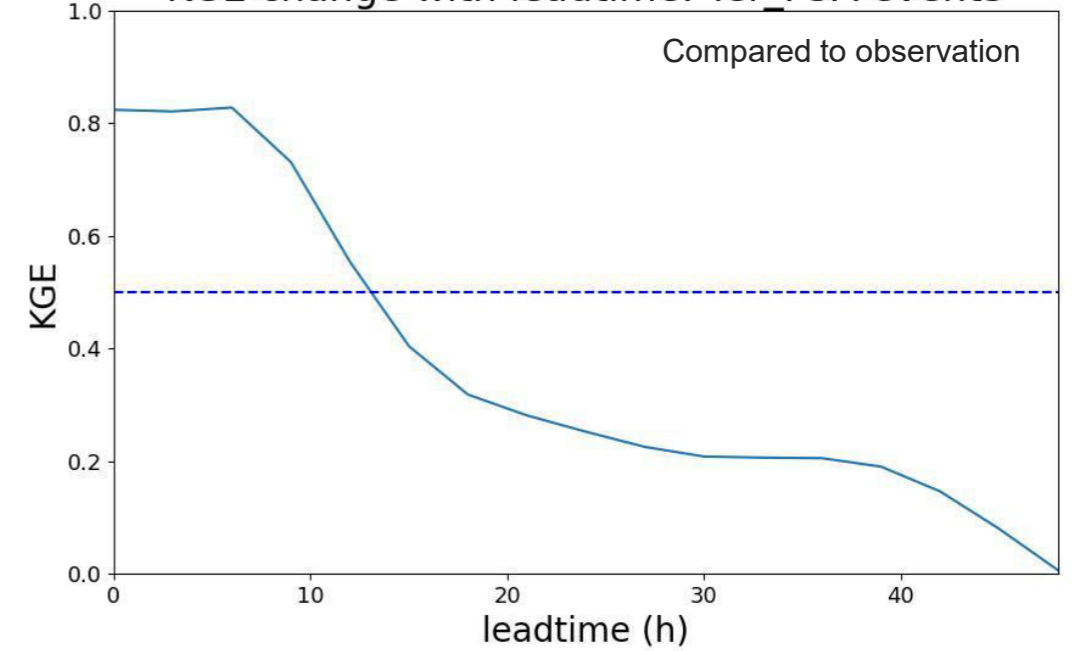
CASE STUDY · DETERMINISTIC SCORE

event5_Ter_P5A lead time=12

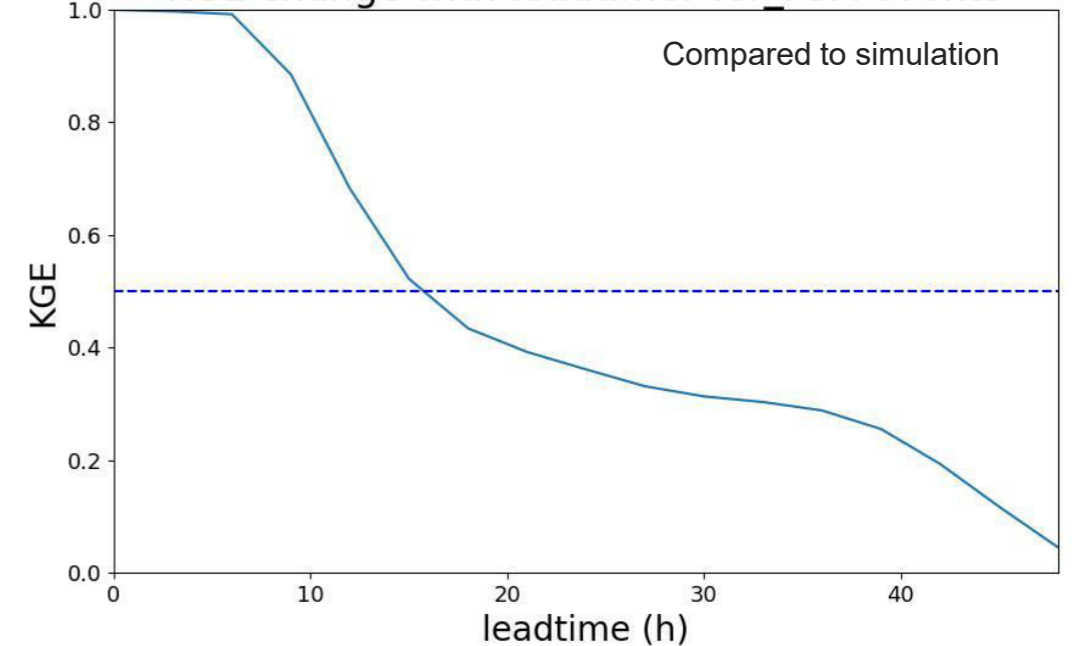


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KGE change with leadtime: Ter_P5A event5

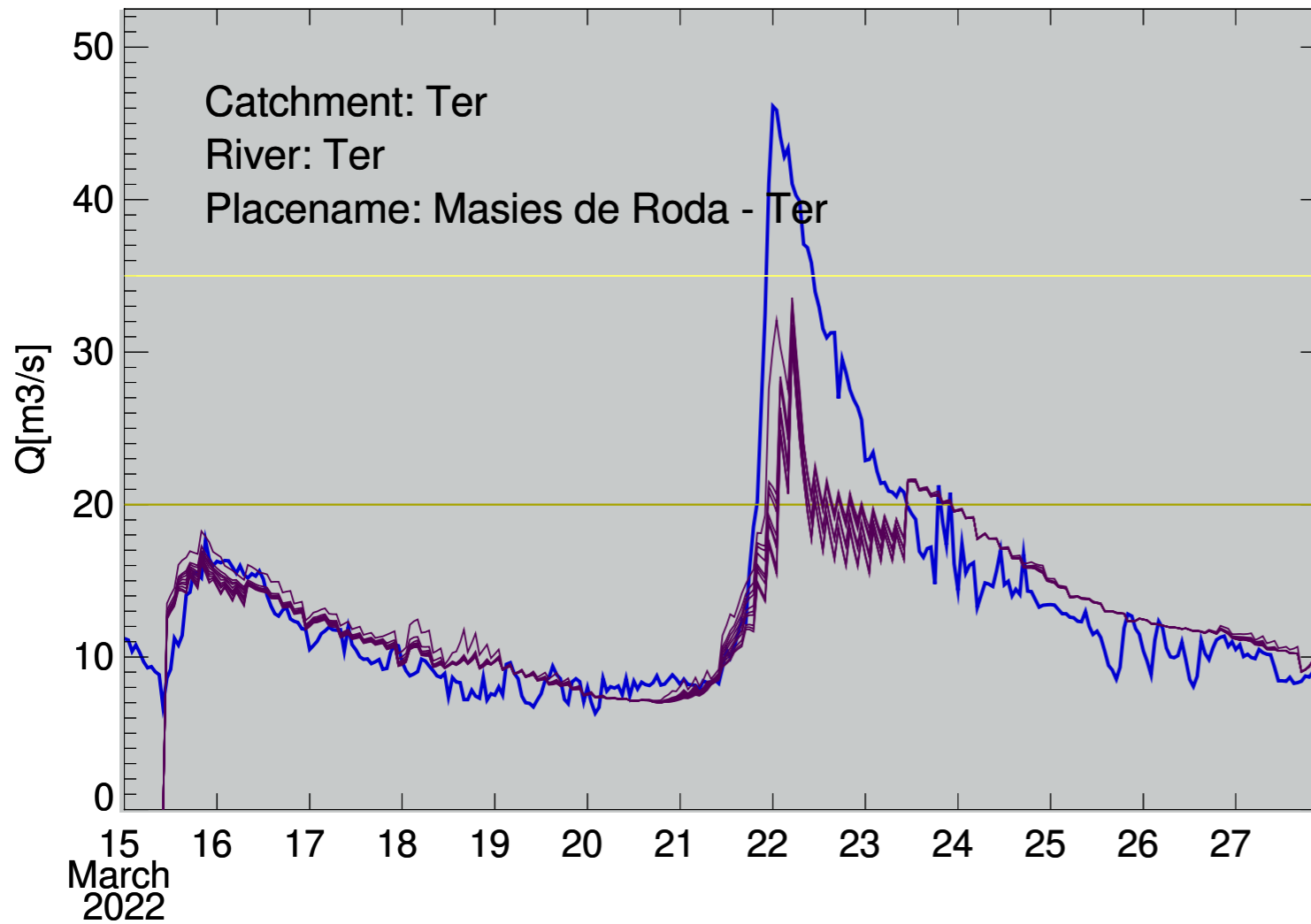


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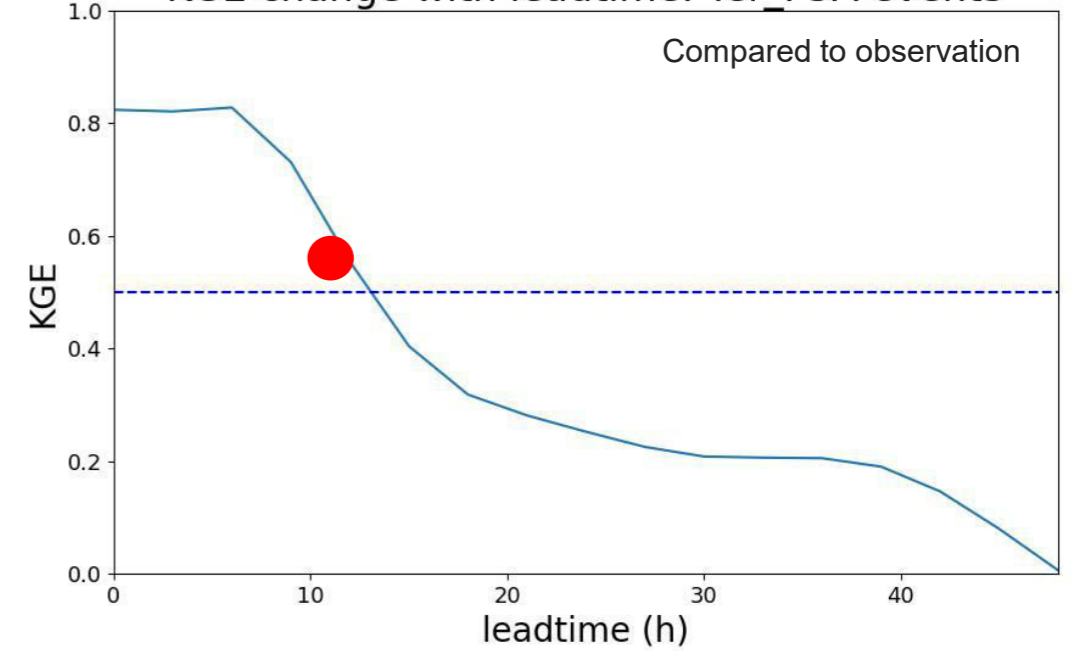
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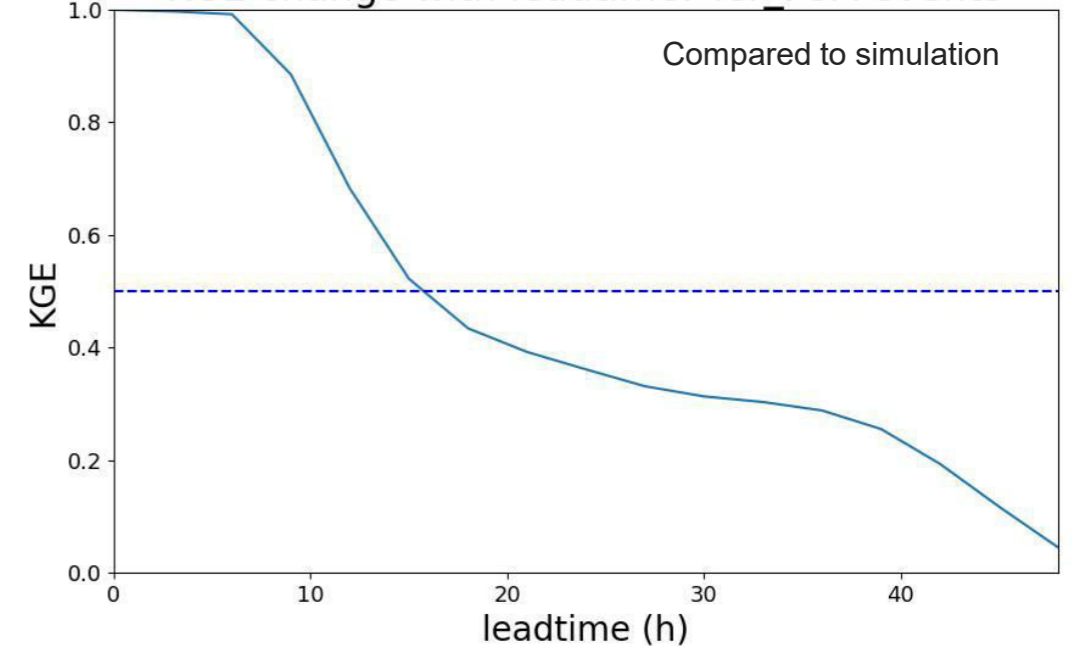


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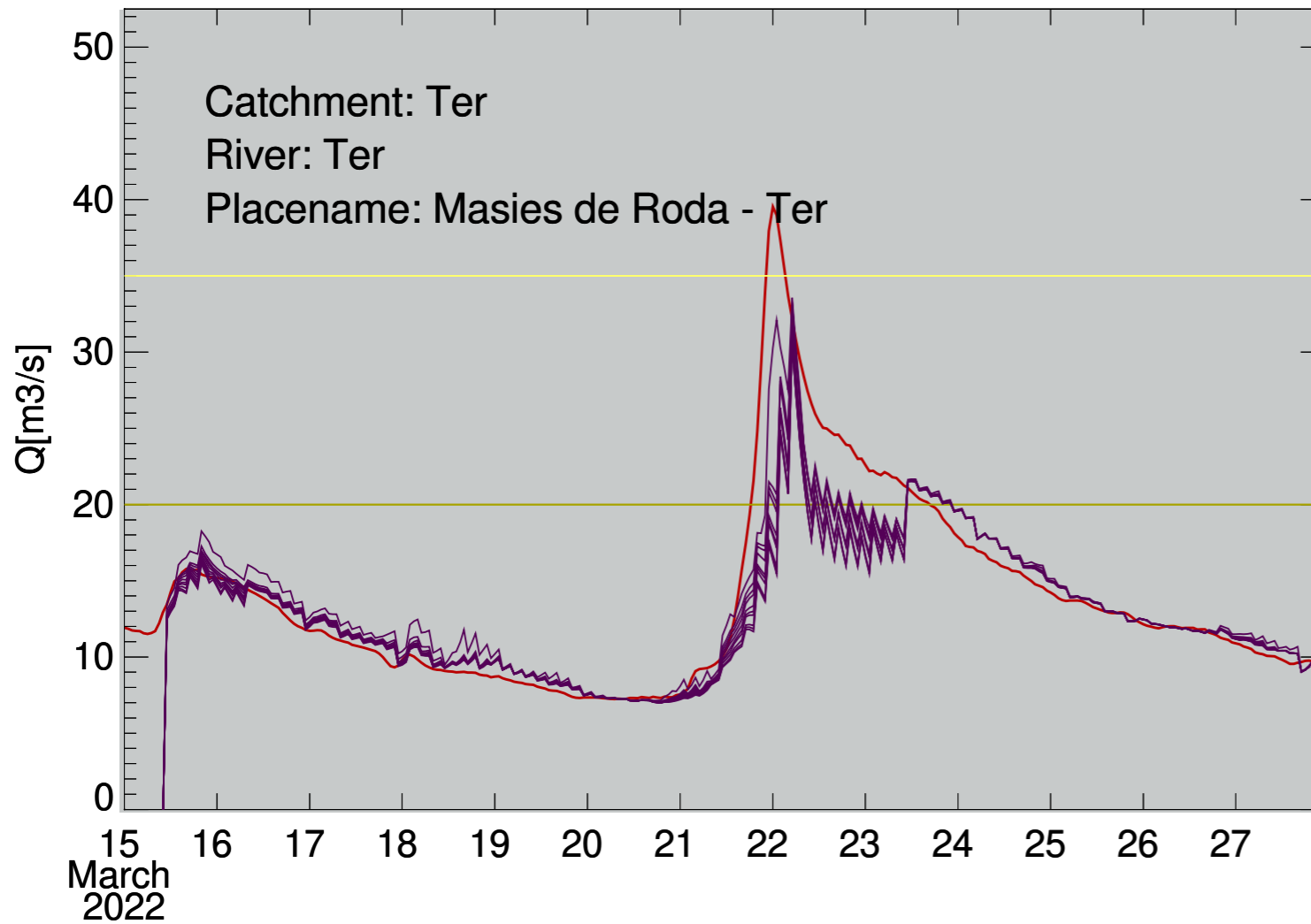


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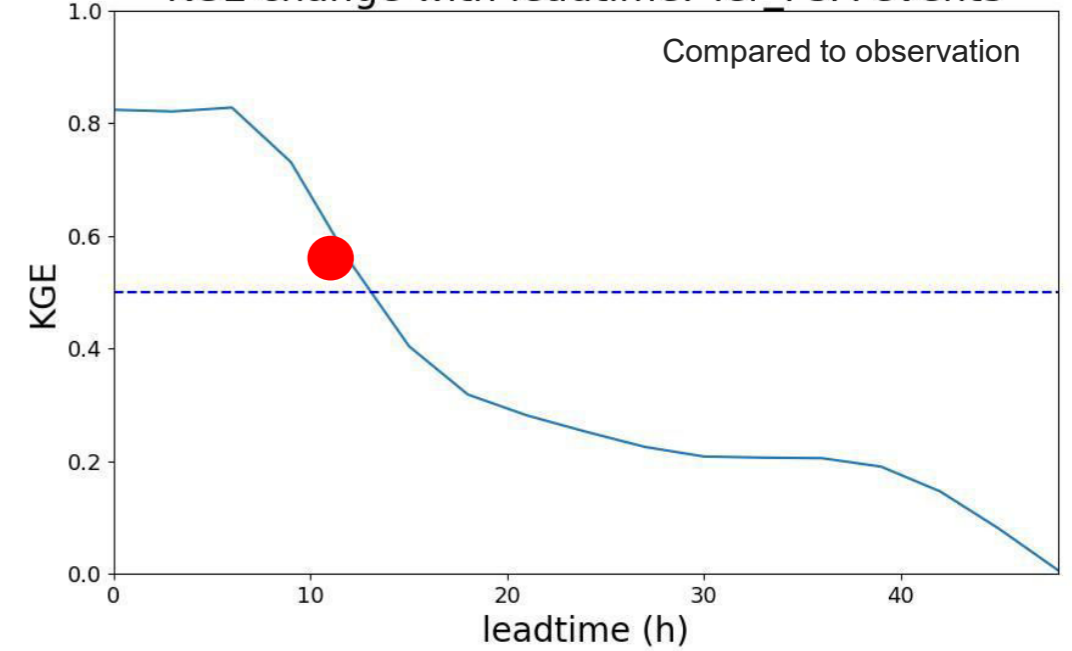
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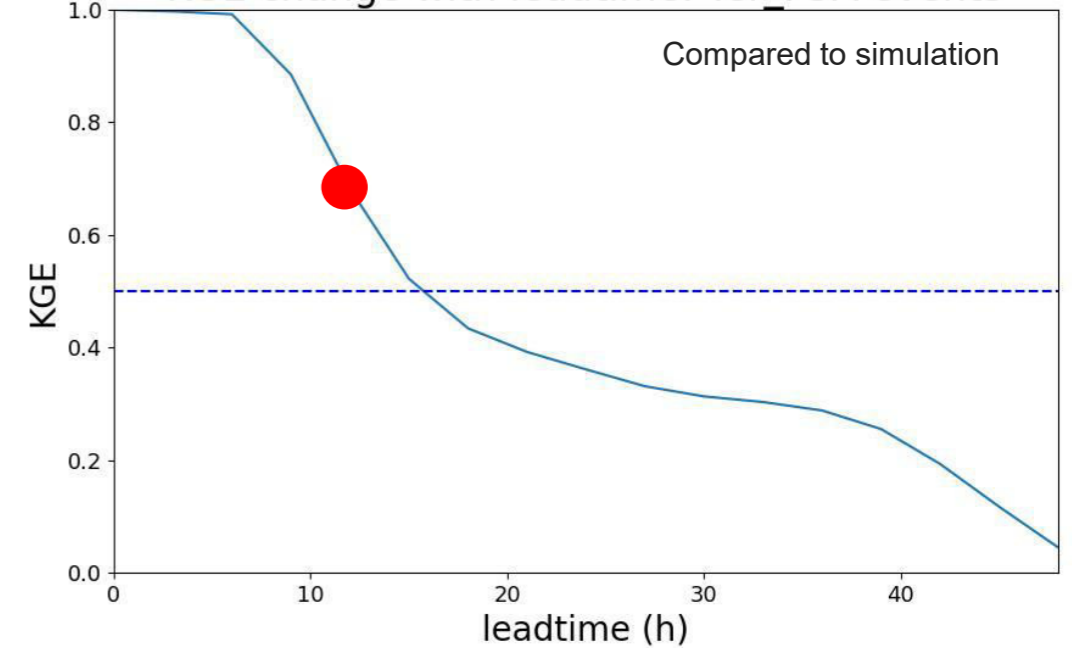


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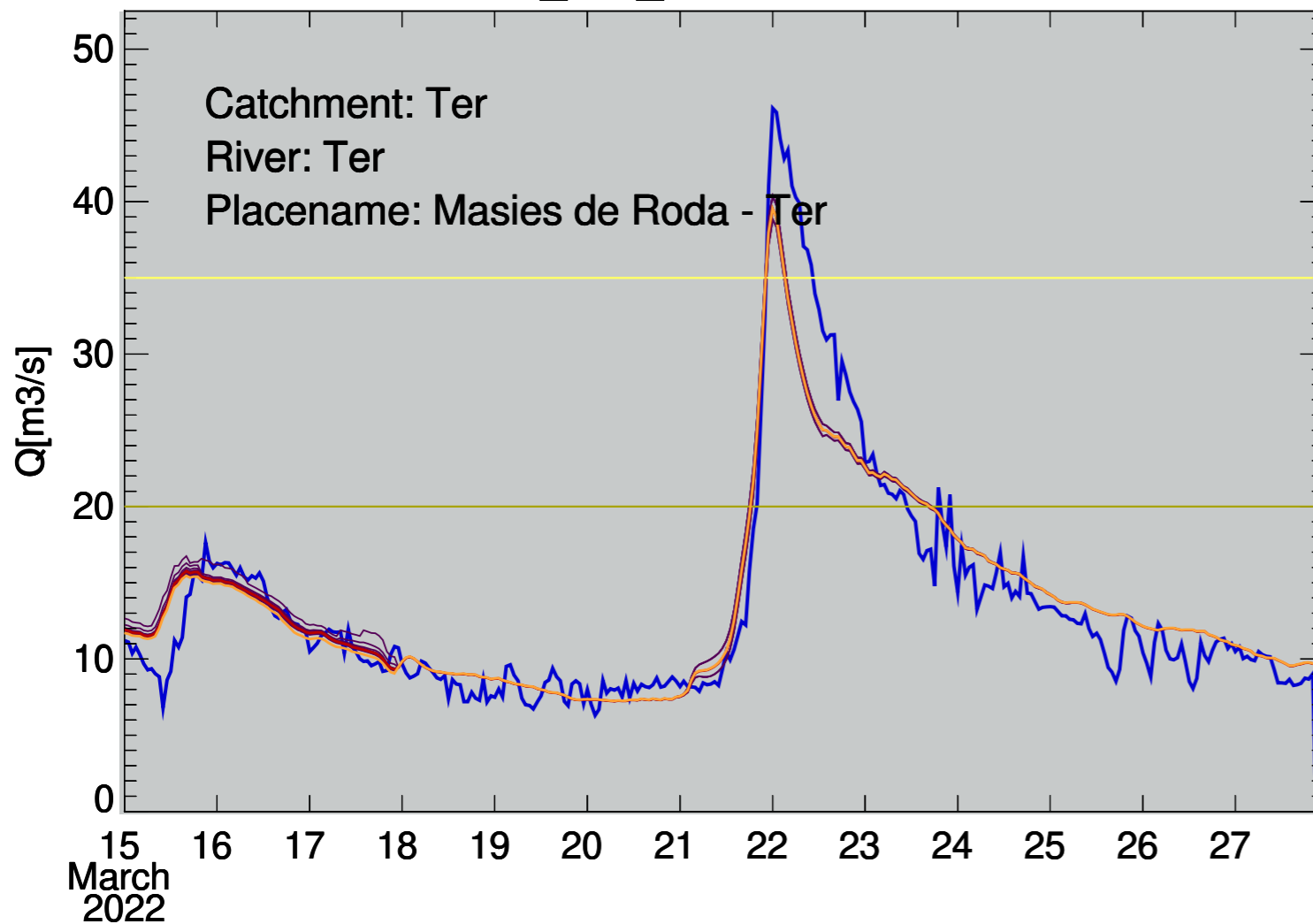


KGE change with leadtime: Ter_P5A event5



CASE STUDY · PROBABILISTIC SCORE

event5_Ter_P5A lead time=00



Observed flow — blue — flow forecast — purple —
simulated flow — red — no forecast — orange —

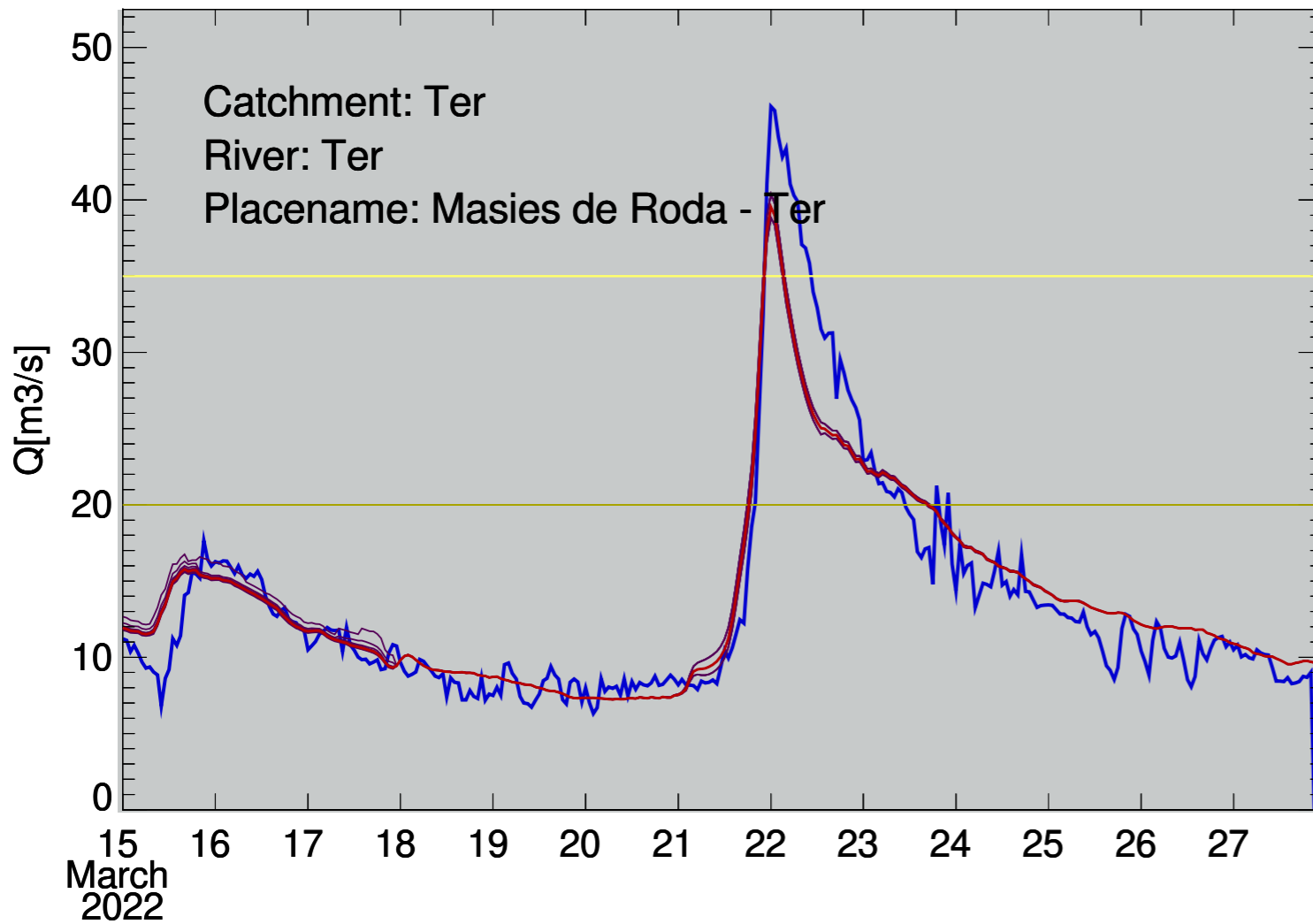
$$RPS_i = \frac{1}{Q_{max} - Q_{min}} \sum_{n=1}^{N_C} (P_{forecast_{n,i}} - P_{observation_{n,i}})^2 \Delta Q$$

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CASE STUDY · PROBABILISTIC SCORE

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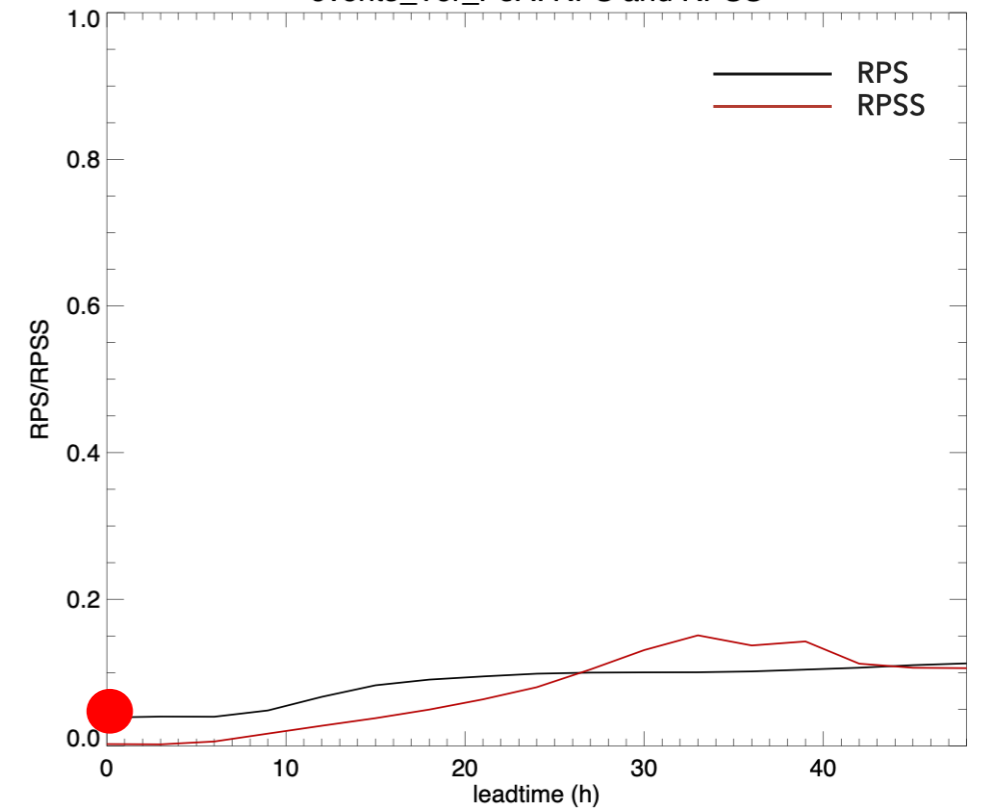


Observed flow — flow forecast —
 simulated flow — no forecast —

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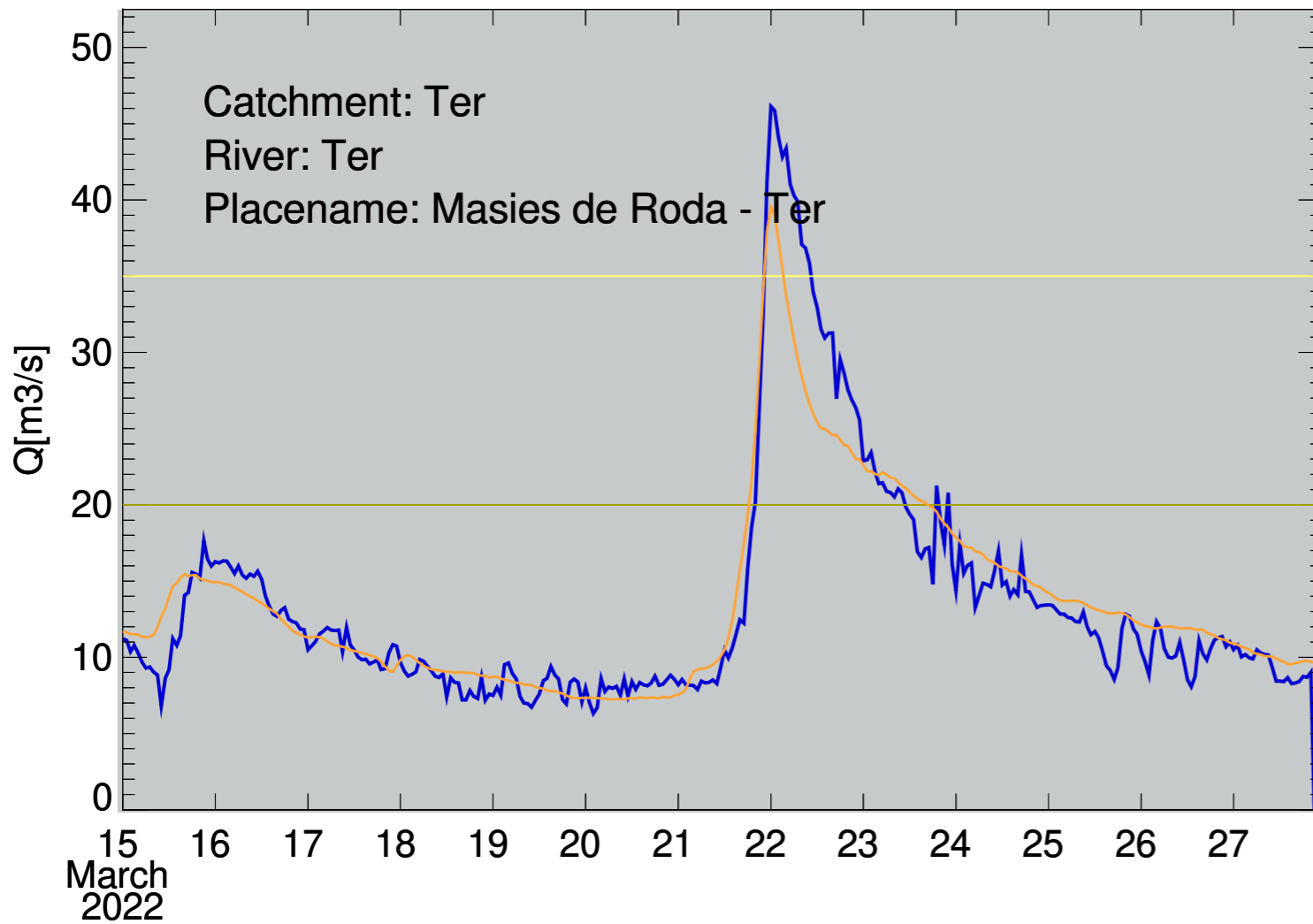
$$RPS = \frac{1}{N_T} \sum_{i=1}^{N_T} RPS_i$$

event5_Ter_P5A: RPS and RPSS



CASE STUDY · PROBABILISTIC SCORE

event5_Ter_P5A lead time=00

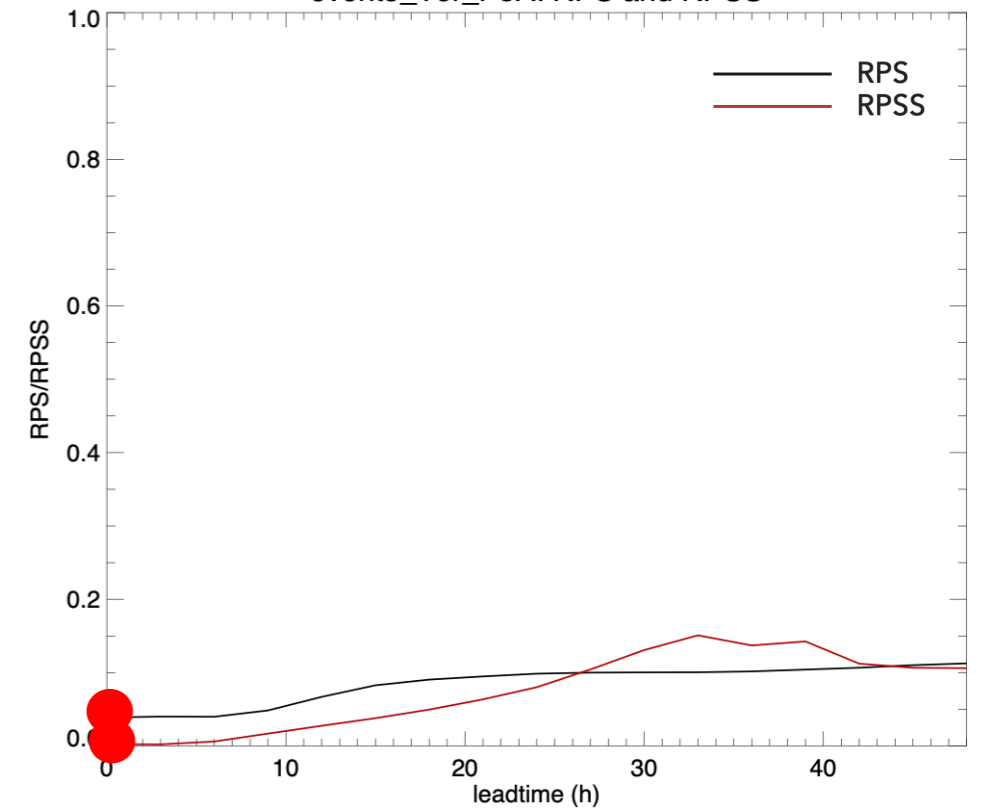


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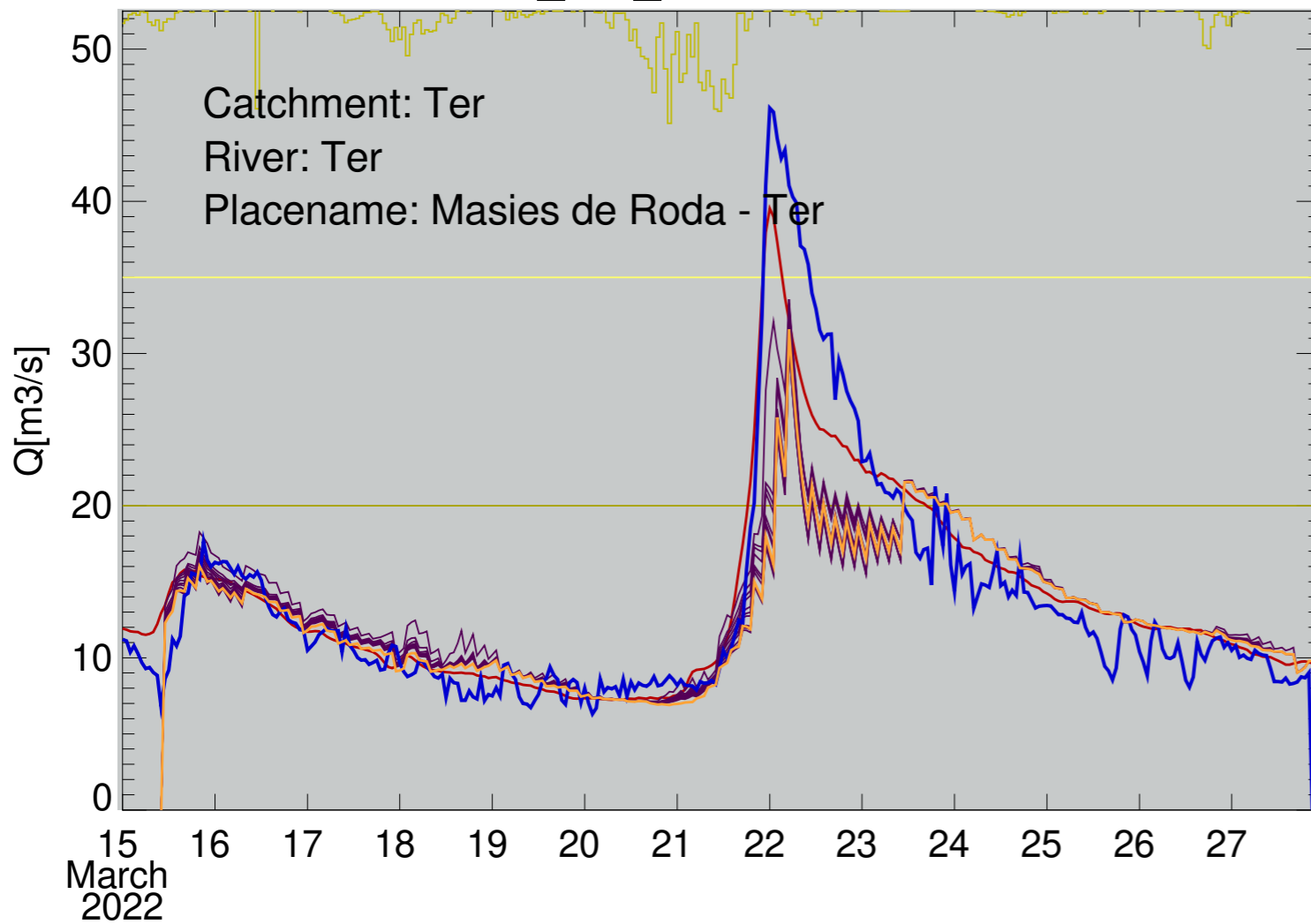
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CASE STUDY · PROBABILISTIC SCORE

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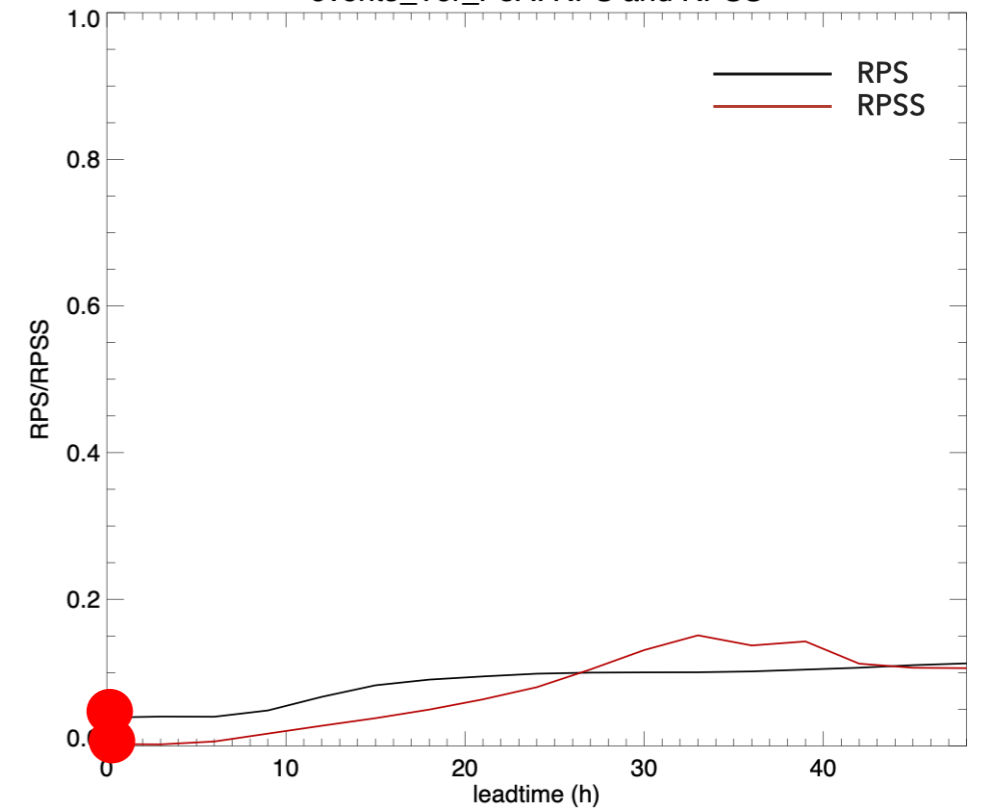


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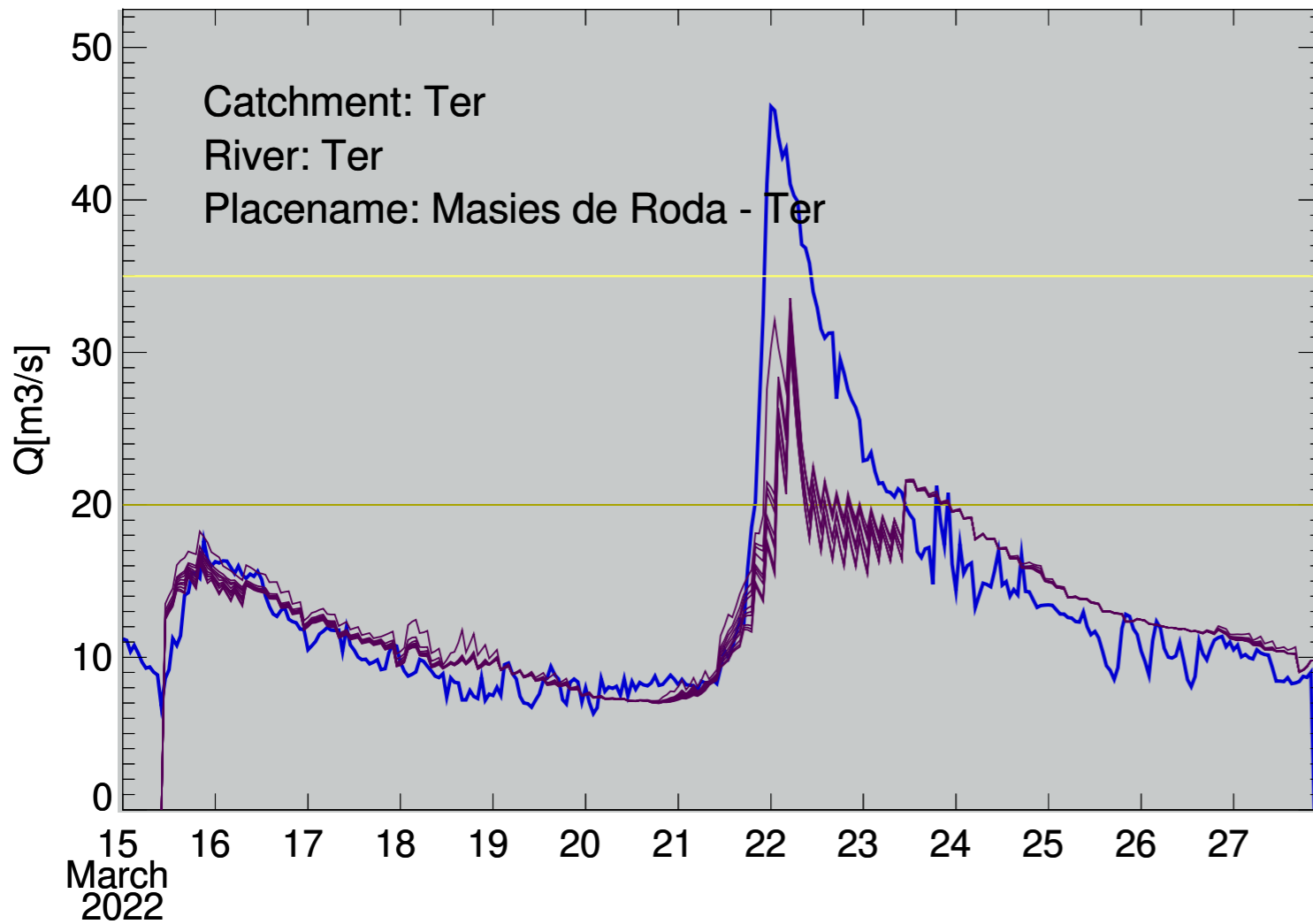
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event5_Ter_P5A: RPS and RPSS



CASE STUDY · PROBABILISTIC SCORE

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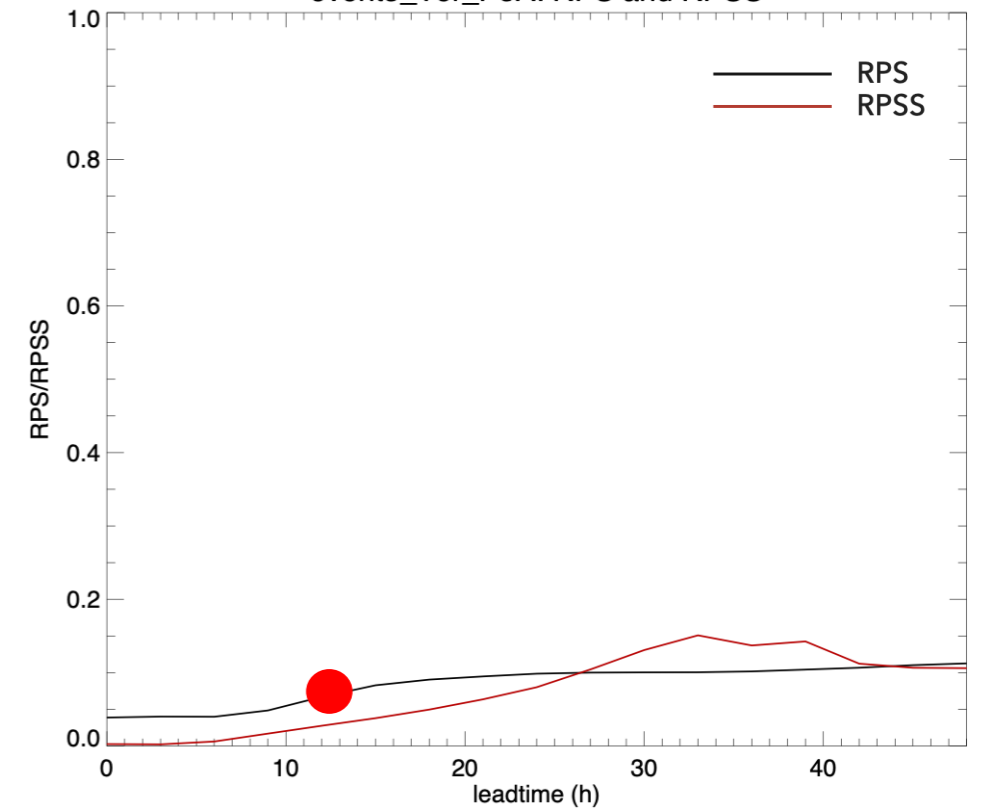


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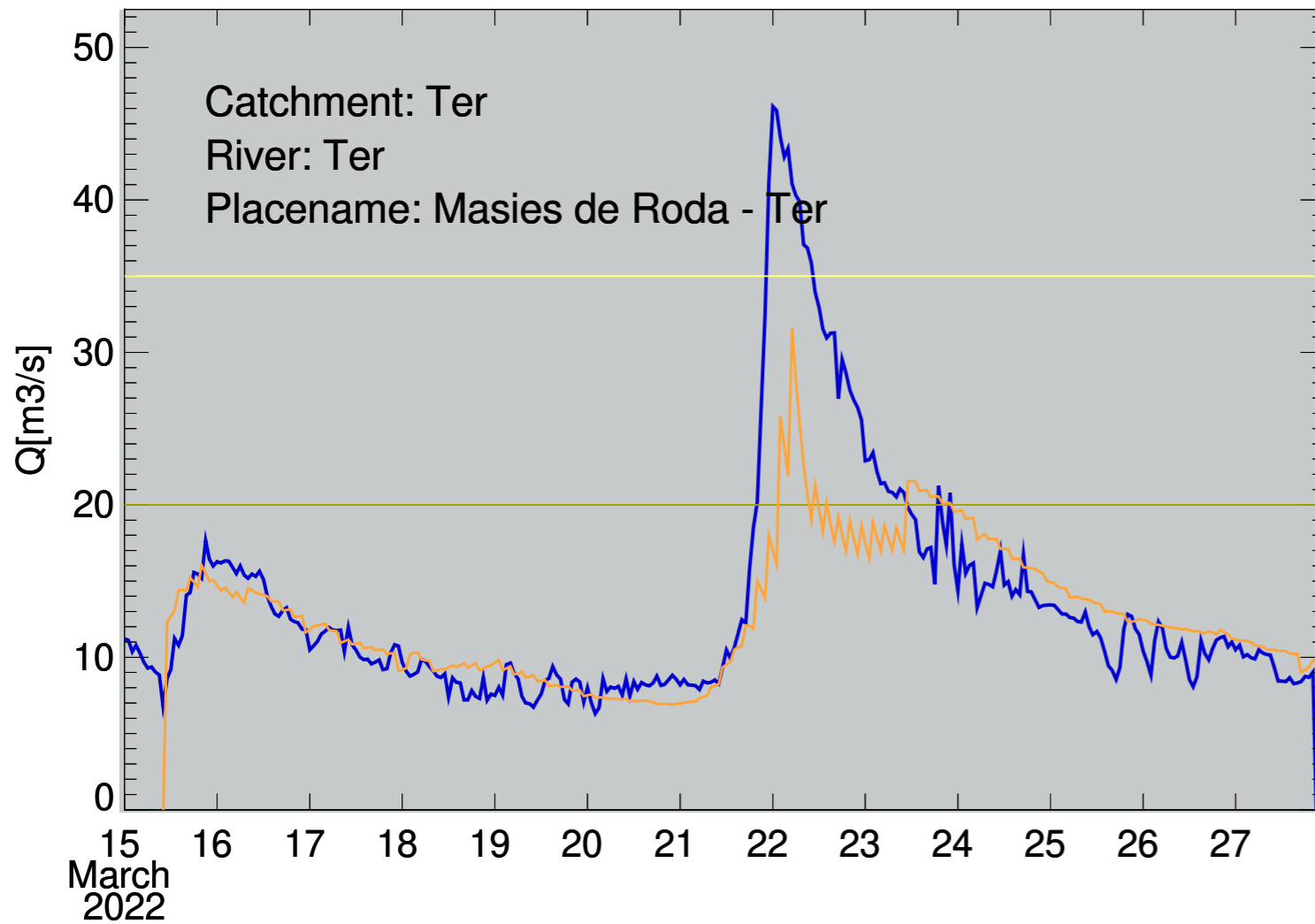
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event5_Ter_P5A: RPS and RPSS



CASE STUDY · PROBABILISTIC SCORE

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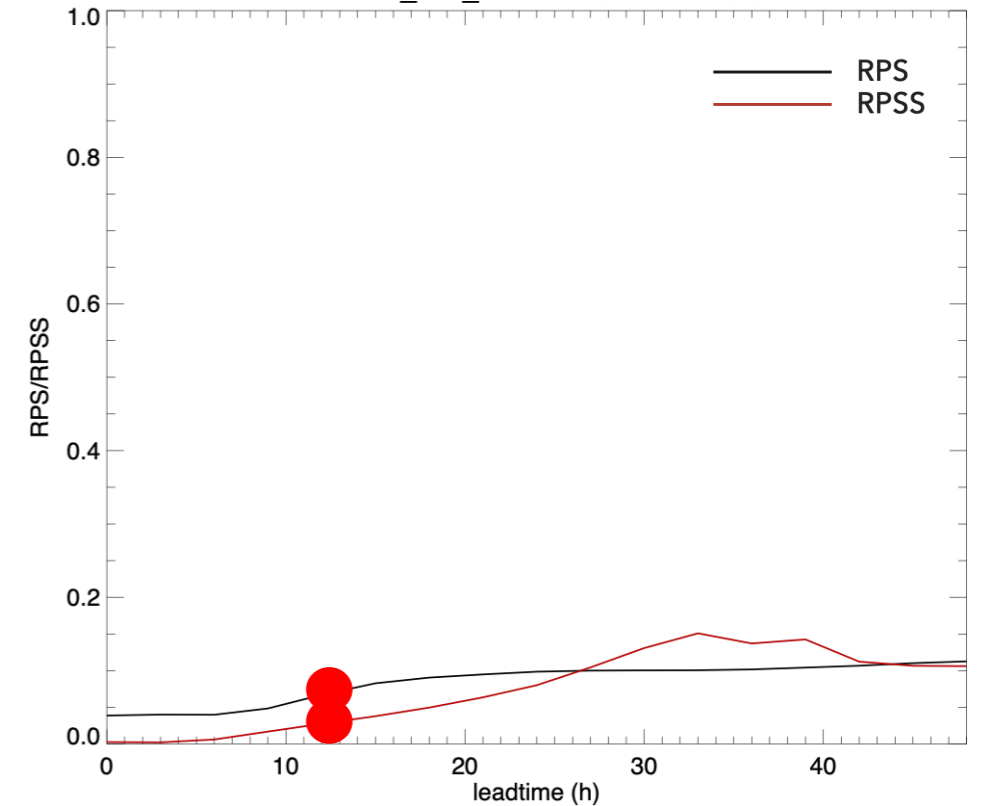


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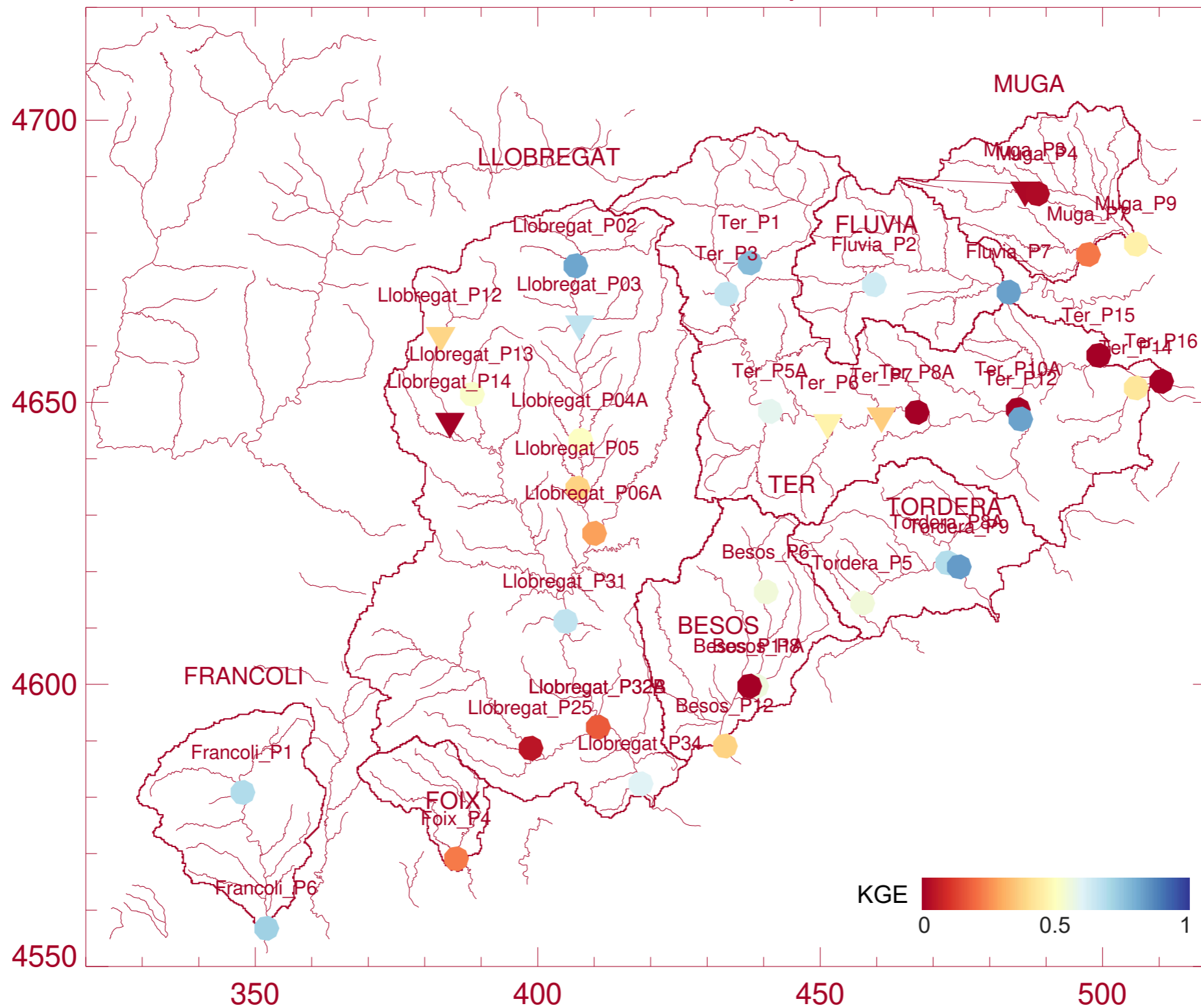
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event5_Ter_P5A: RPS and RPSS



DETERMINISTIC SCORES

KGE distribution with leadtime 12 compared with simulation

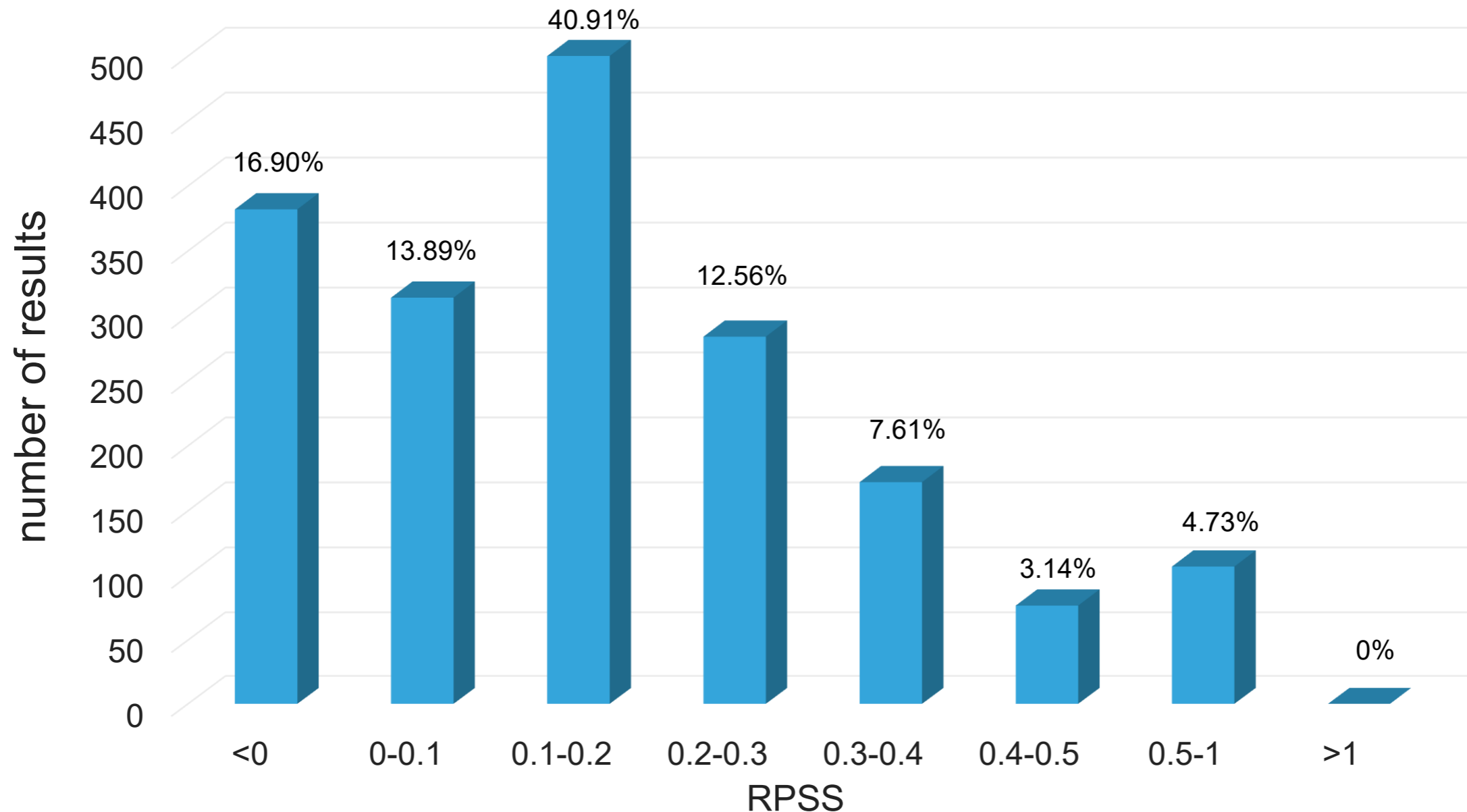


PROBABILISTIC SCORES

RPS /
RPSS
ALL
EVENTS
TOGETH

$$RPS_i = \frac{1}{Q_{max} - Q_{min}} \sum_{n=1}^{N_C} (P_{forecast_{n,i}} - P_{observation_{n,i}})^2 \Delta Q$$
$$RPS = \frac{1}{N_T} \sum_{i=1}^{N_T} RPS_i$$

Distribution of RPSS for all events together

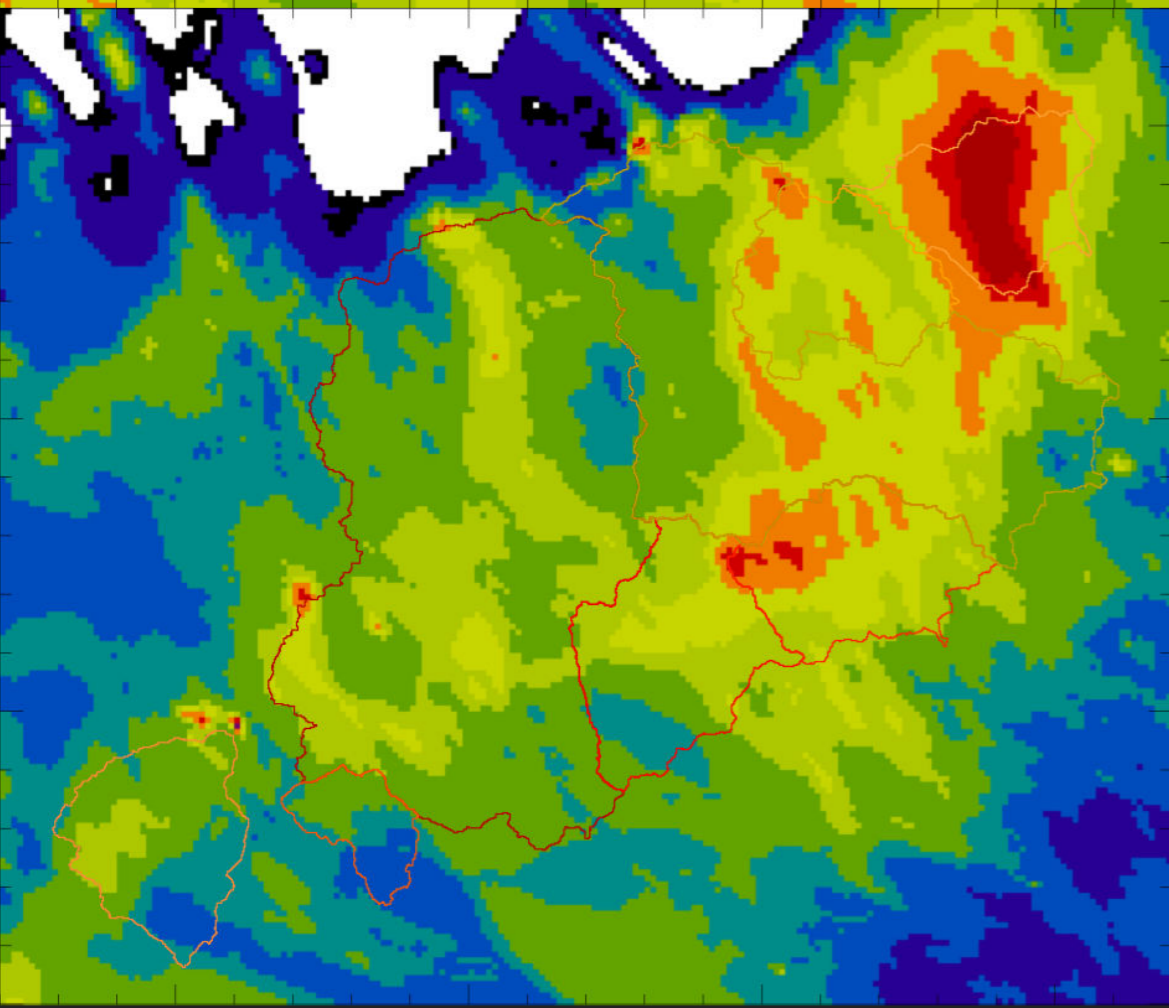
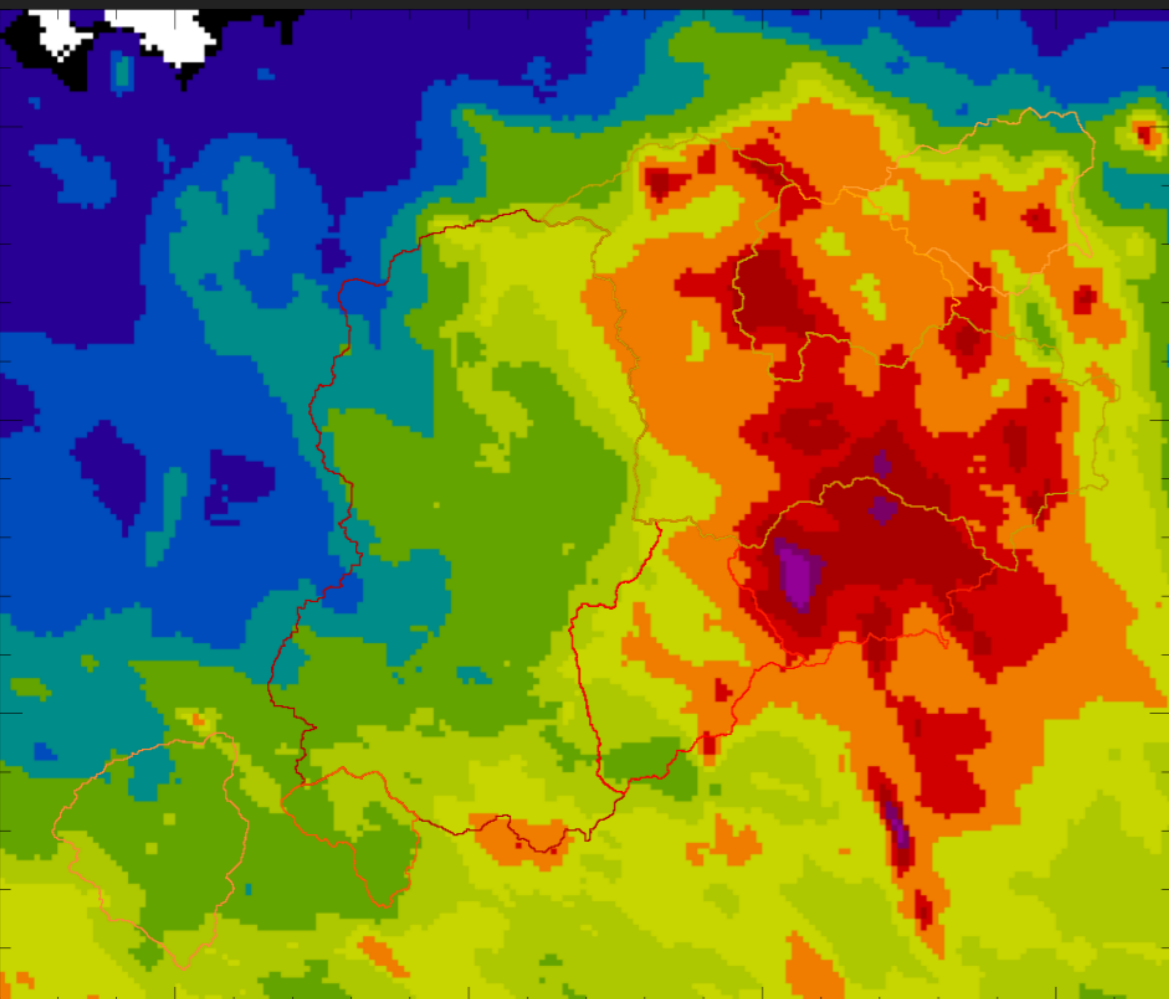


CONCLUSION

1. An evaluation framework for an ensemble forecasting system has been tested and applied to the real-time forecasting system.
2. Compared with simulated discharge, the forecast accuracy is quite satisfactory and the accuracy for most of the catchment is acceptable until 12 hour lead time.
3. The forecast skill highly depends on the quality of the rainfall forecast.

FUTURE WORK

1. Extend the analysis to all the events since 2020 to evaluate the overall performance of the system.
2. Find the relationship between the catchment size and the forecast accuracy.
3. Analyze the source of the uncertainty and the effect on the flood forecast.



THANKS
FOR
LISTENIN
G
