Forecasting drought severity based on spatial hydro-meteorological indicators

6th Symposium on the hydrological modelling of the Meuse basin

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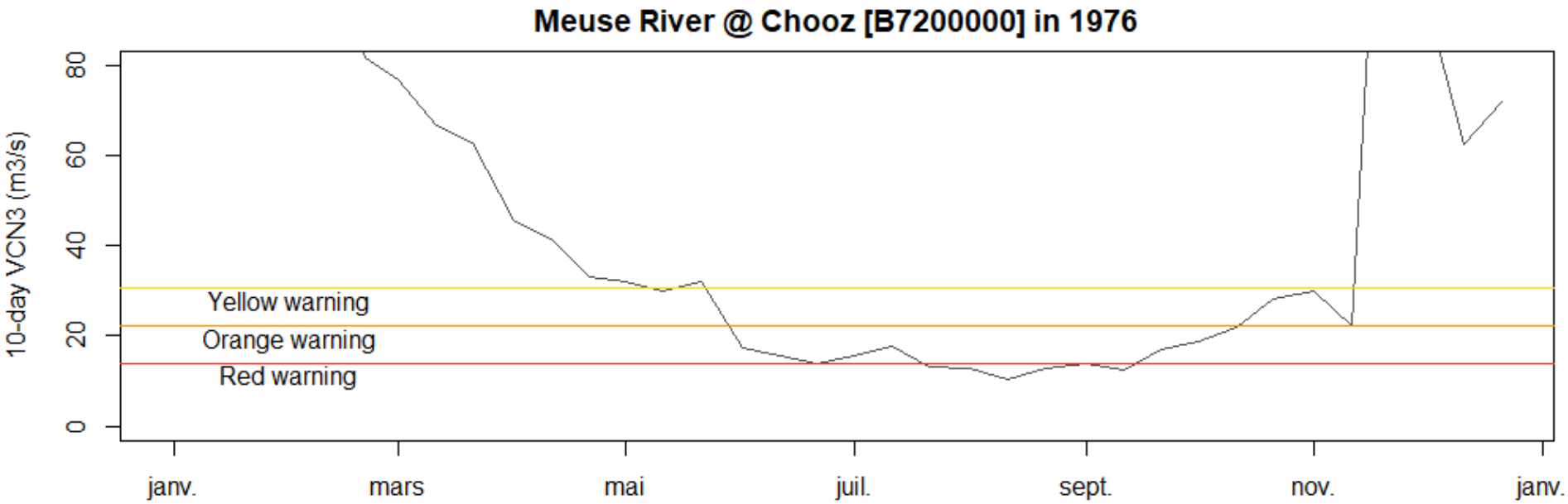
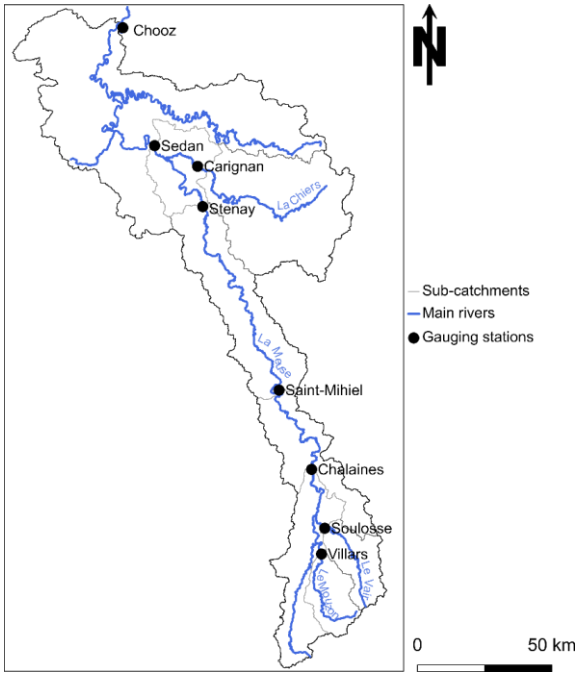
Introduction

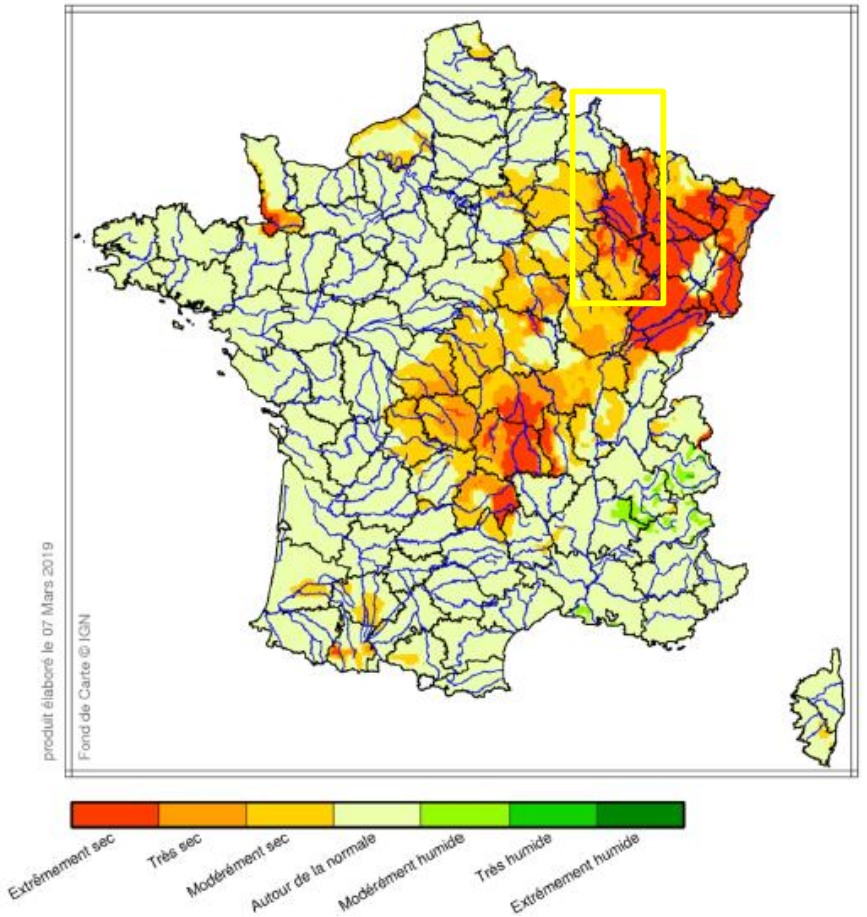
- Water managers are concerned about drought hazard on the French Meuse River catchment.
- Hydrologists of DREAL Grand-Est need new statistical tools to anticipate drought warning levels based on data provided by MeteoFrance.
- These needs are particularly exacerbated in a climate change context.



Data

- Indicator maps: SPI, SSWI
  - 10-day and/or monthly time-step
  - 8km grid
- Drought warning levels
  - 8 stations
- Observed daily streamflow
  - 1993-2016





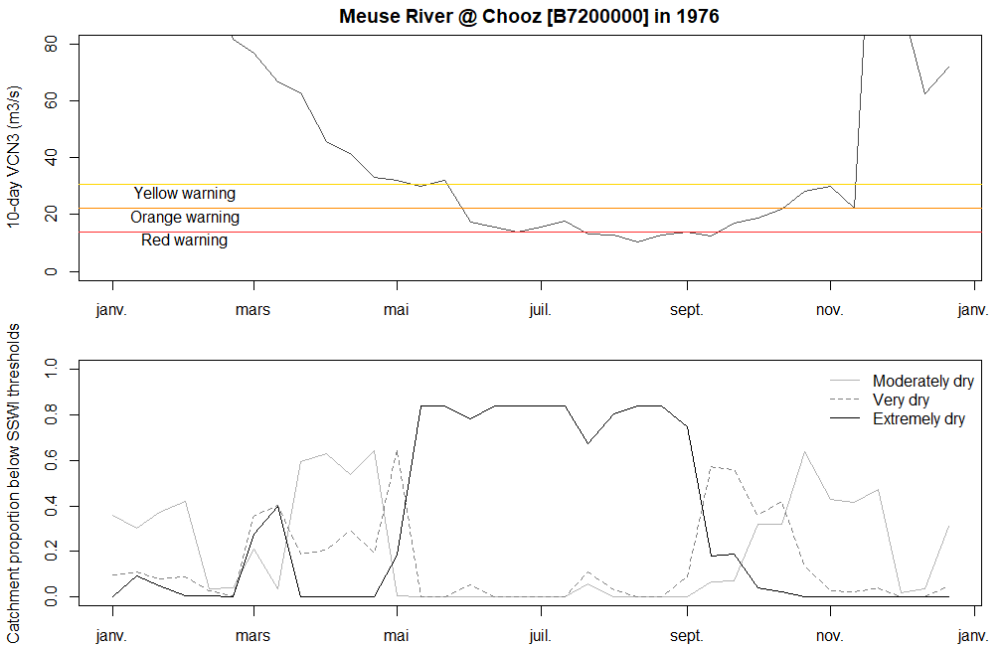
Station Code	Station Name	Basin area (km^2)	Yellow level (m^3/s)	Orange level (m^3/s)	Red level (m^3/s)
B1092010	Mouzon@Villars	405	0,15	0,09	0,02
B1282010	Vair@Soulosses	443	0,5	0,36	0,21
B1340010	Meuse@Chalaines	869	1,95	1,38	0,8

Binary model

- The glm model:

$$p(1|x) = \frac{e^{b0+b1.x1+\cdots+bn.xn}}{1+e^{b0+b1.x1+\cdots+bn.xn}}$$

  - Predicts binary data
  - Probability to **reach Yellow Warning level** at the **next time-step** across the catchment



- Moderately Dry: between -0.84 and -1.28 (quantiles 0.2 and 0.1)
- Very Dry: between -1.28 and -1.75 (quantile 0.04)
- Extremely Dry: < -1.75.

Tests, tests, and more tests

- Time steps: **10-day** and **monthly**
- Time periods: **1970-1993** and **1993-2016** (SST calibration/validation)
- Calibration/validation over the whole year (**12 months**) and summer (**6 months**: May - October and **3 months**: July - September)
- Tested i
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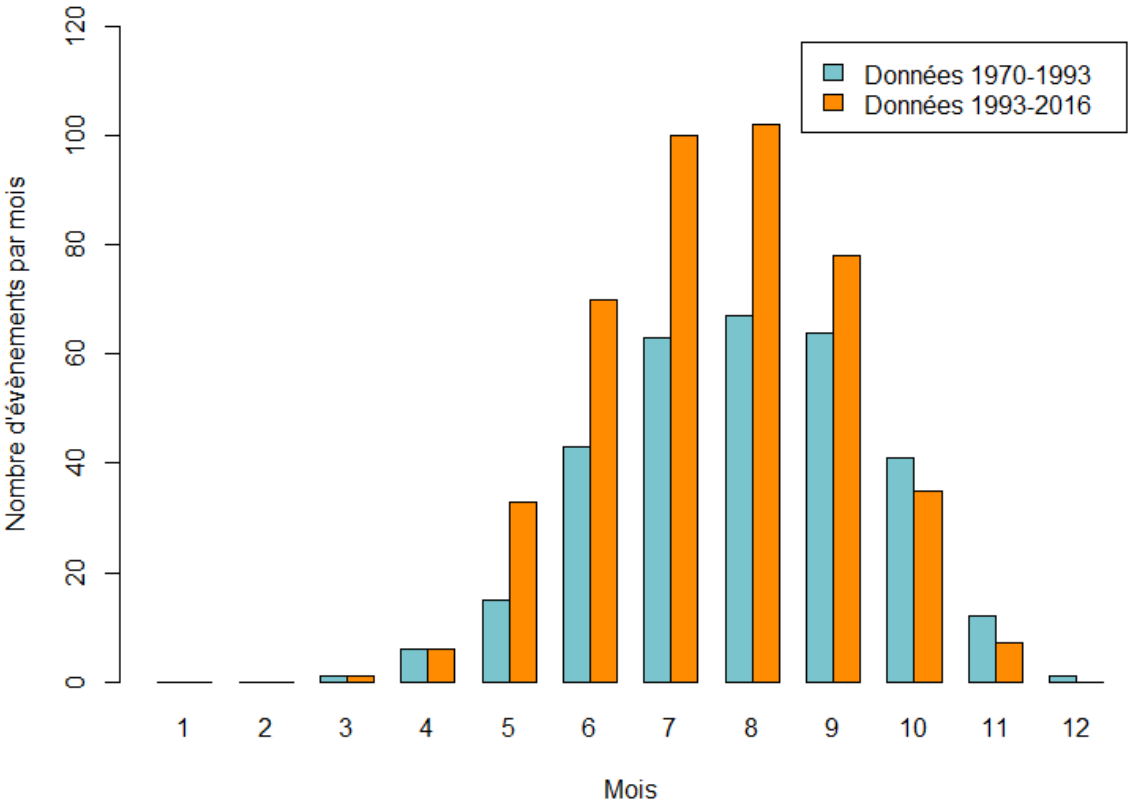
→ 2 x 3 x 8
→ 2 x 3 x 8



d yellow

s series
2 to 0,9

Model calibration

Performances:

Contingency table:

- A = Nothing to declare
- B = Misses
- C = False alarms
- D = Hits

		OBSERVATIONS	
		0	1
SIMULATIONS	0	A	B
	1	C	D

Performance criteria:

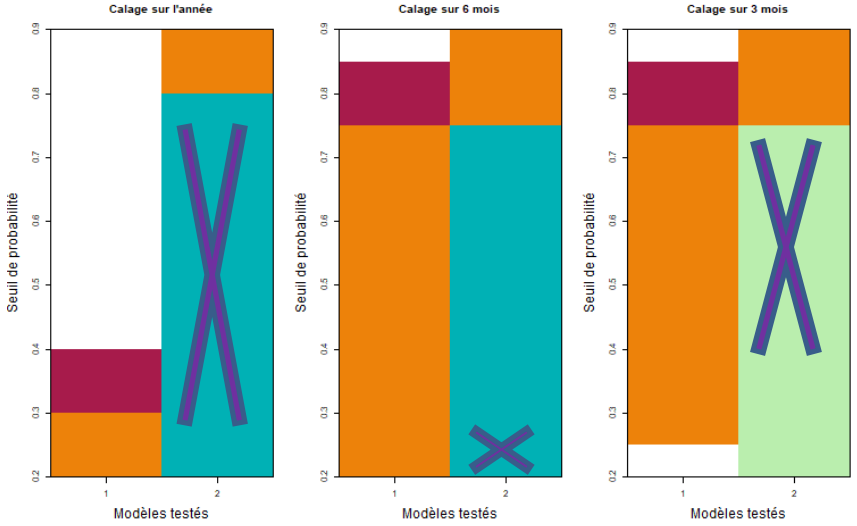
$$KSS = \frac{(AD)-(BC)}{(A+C).(B+D)}$$

→ Optimum value: KSS = 1 with B = C = 0

= best model

10-day results

Performance des modèles décadaires en calage sur 1970-1993



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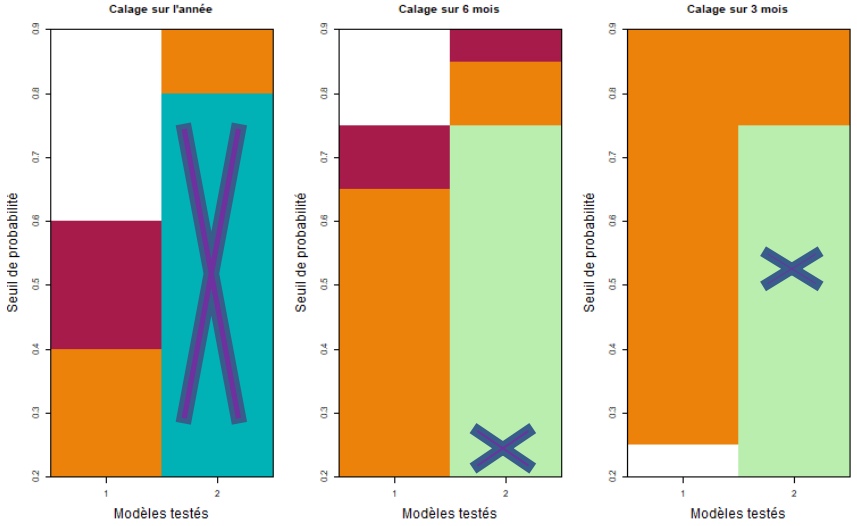
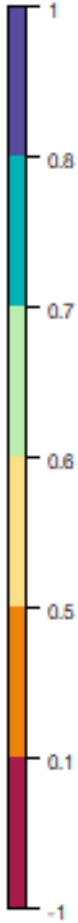


KSS



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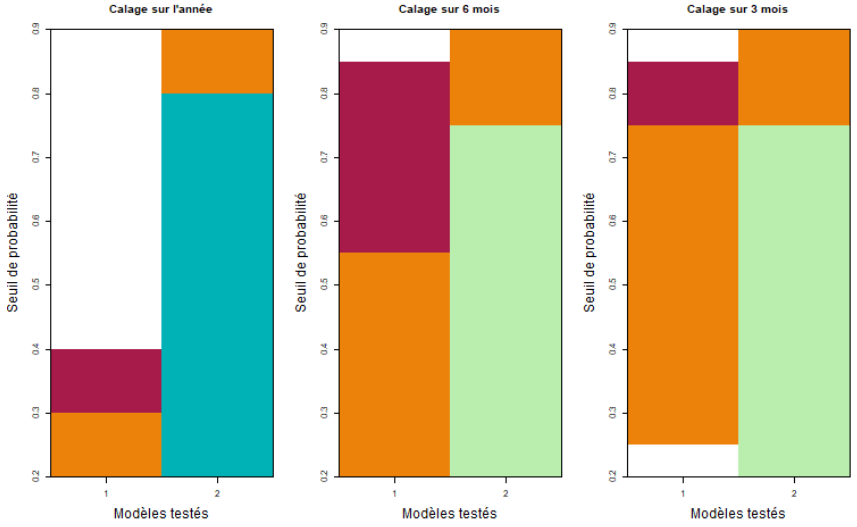

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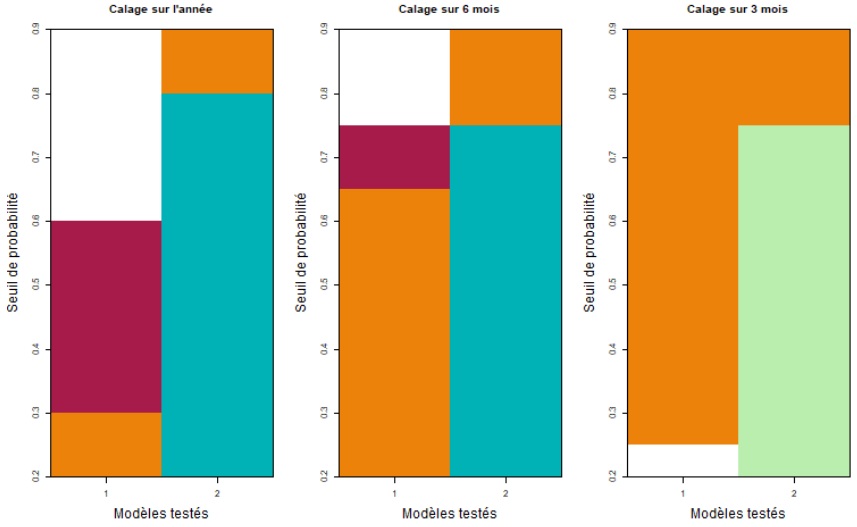
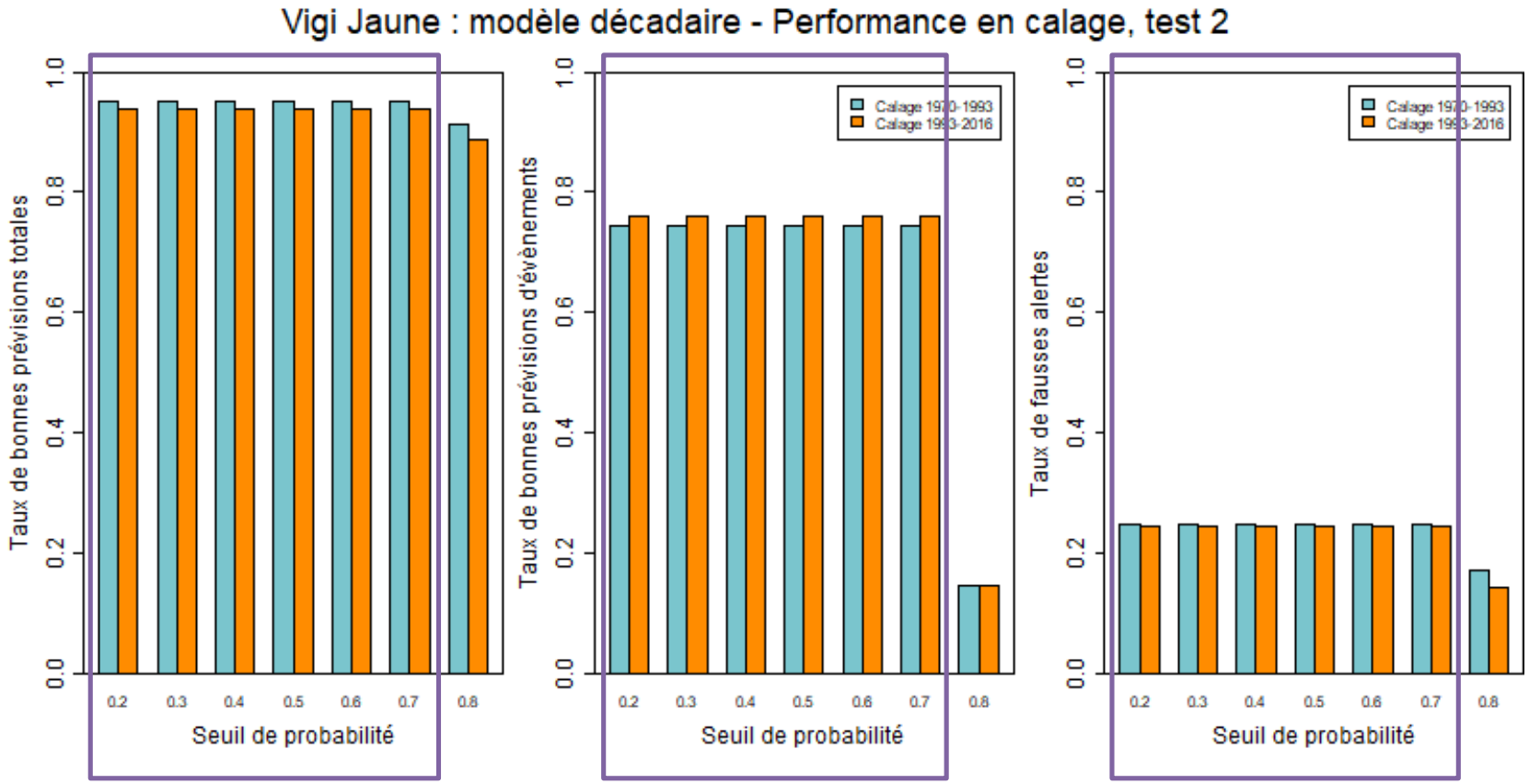


10-day results

Calibration on the **total** period:

- Good prediction of total series (0 + 1)
- Good prediction of warning series (1)
- False Alarms



10-day results

Calibration on the **6-month** summer period:

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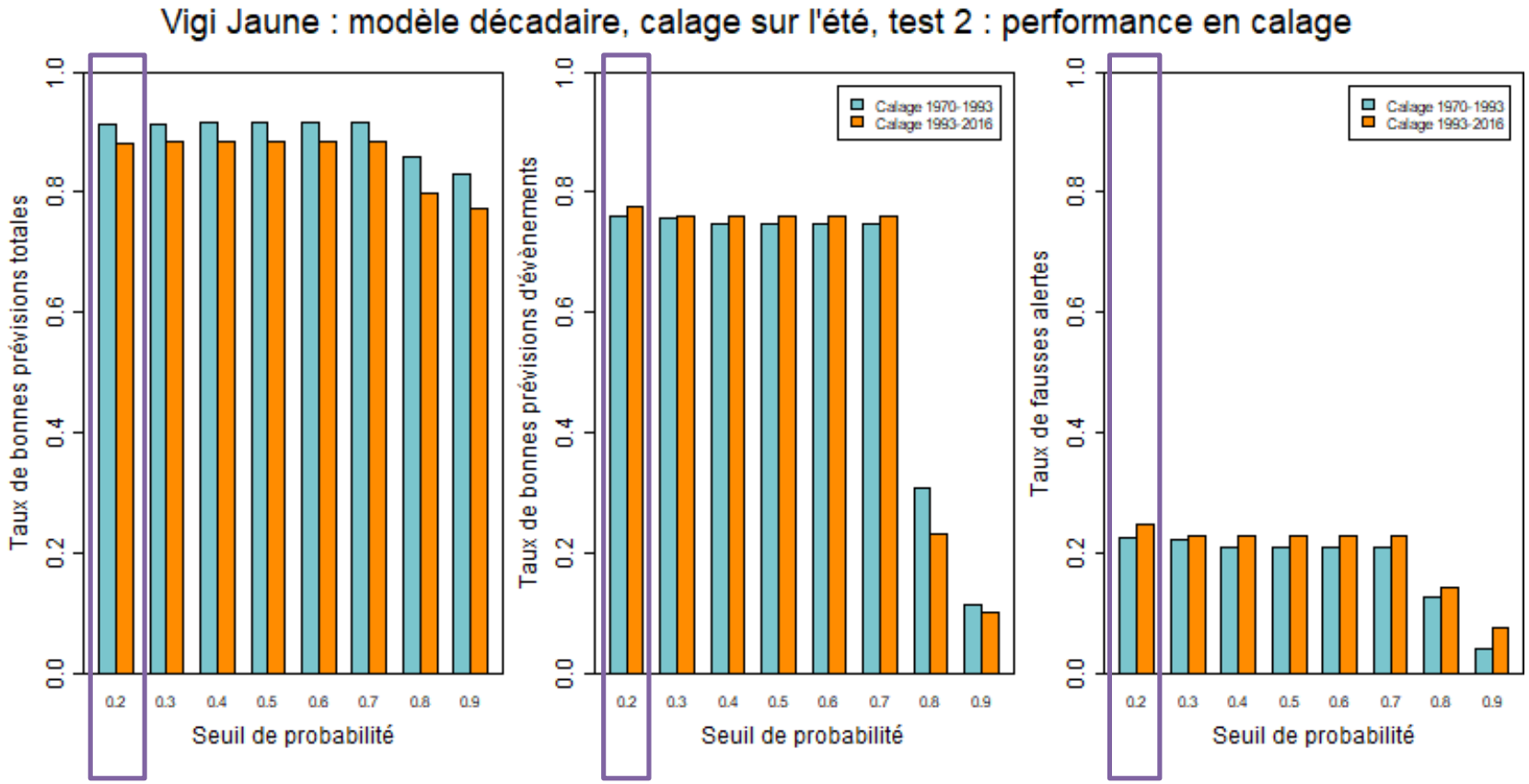
- Good prediction of warning series (1)
- False Alarms



10-day results

Calibration on the **3-month** summer period:

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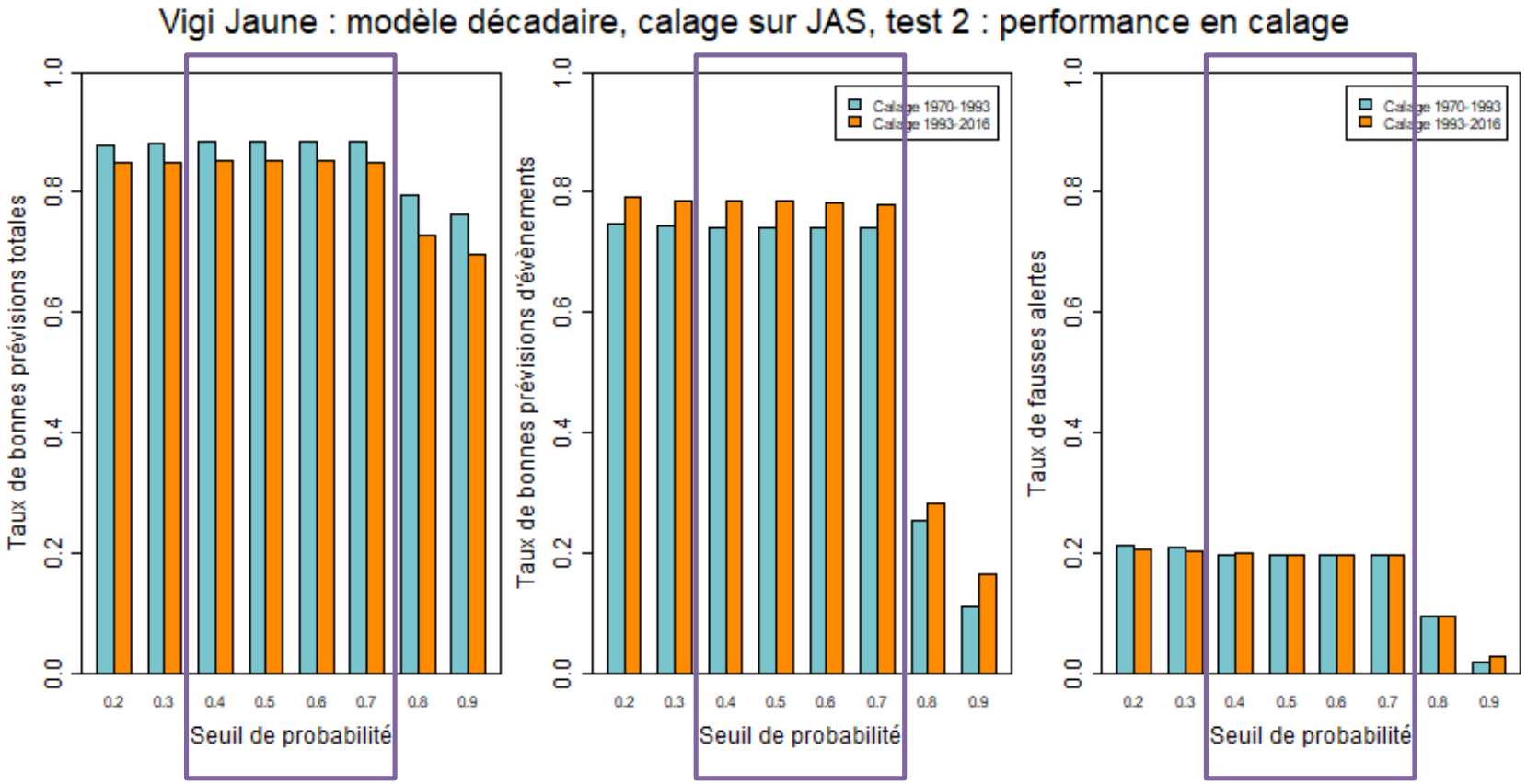
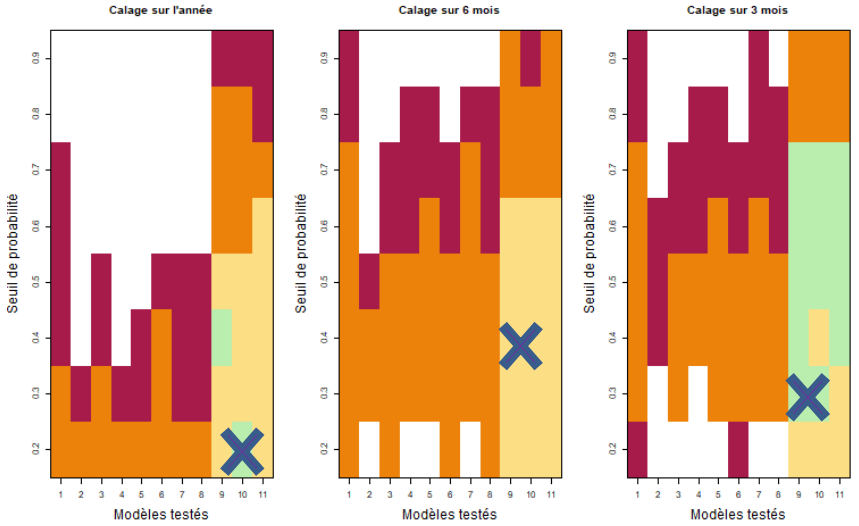
- False Alarms



= best model

Monthly results

Performance des modèles mensuels en calage sur 1970-1993



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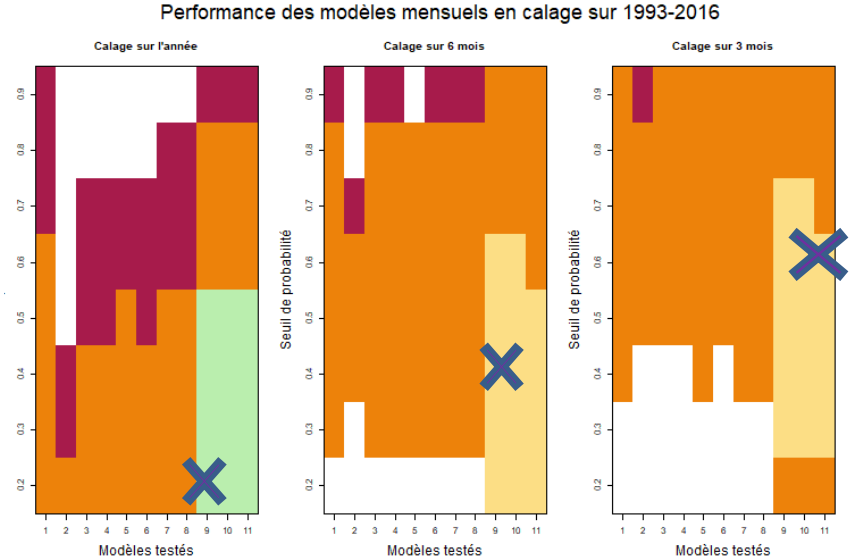

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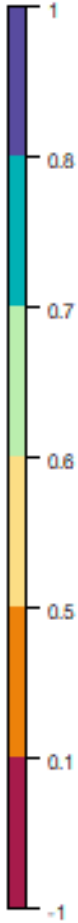

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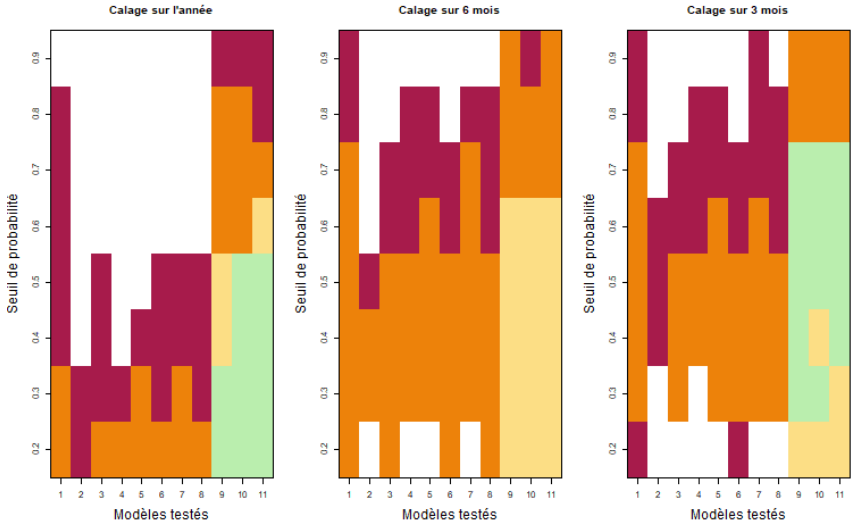

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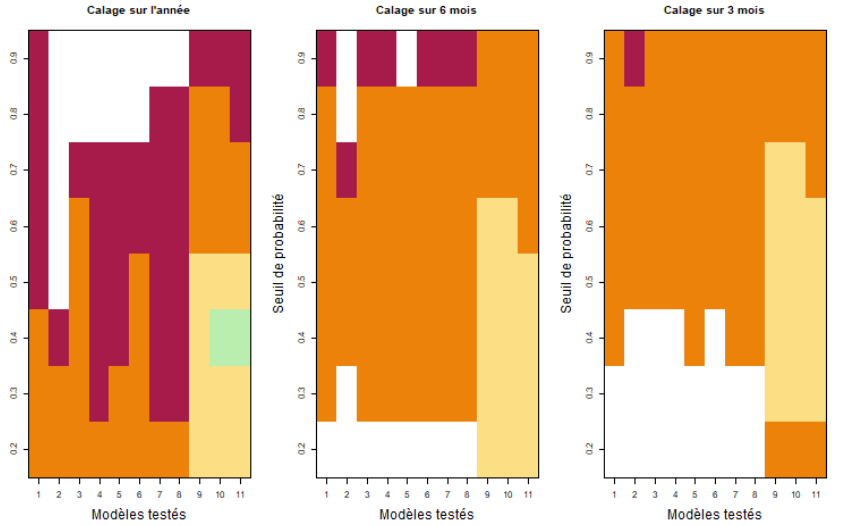

Monthly results

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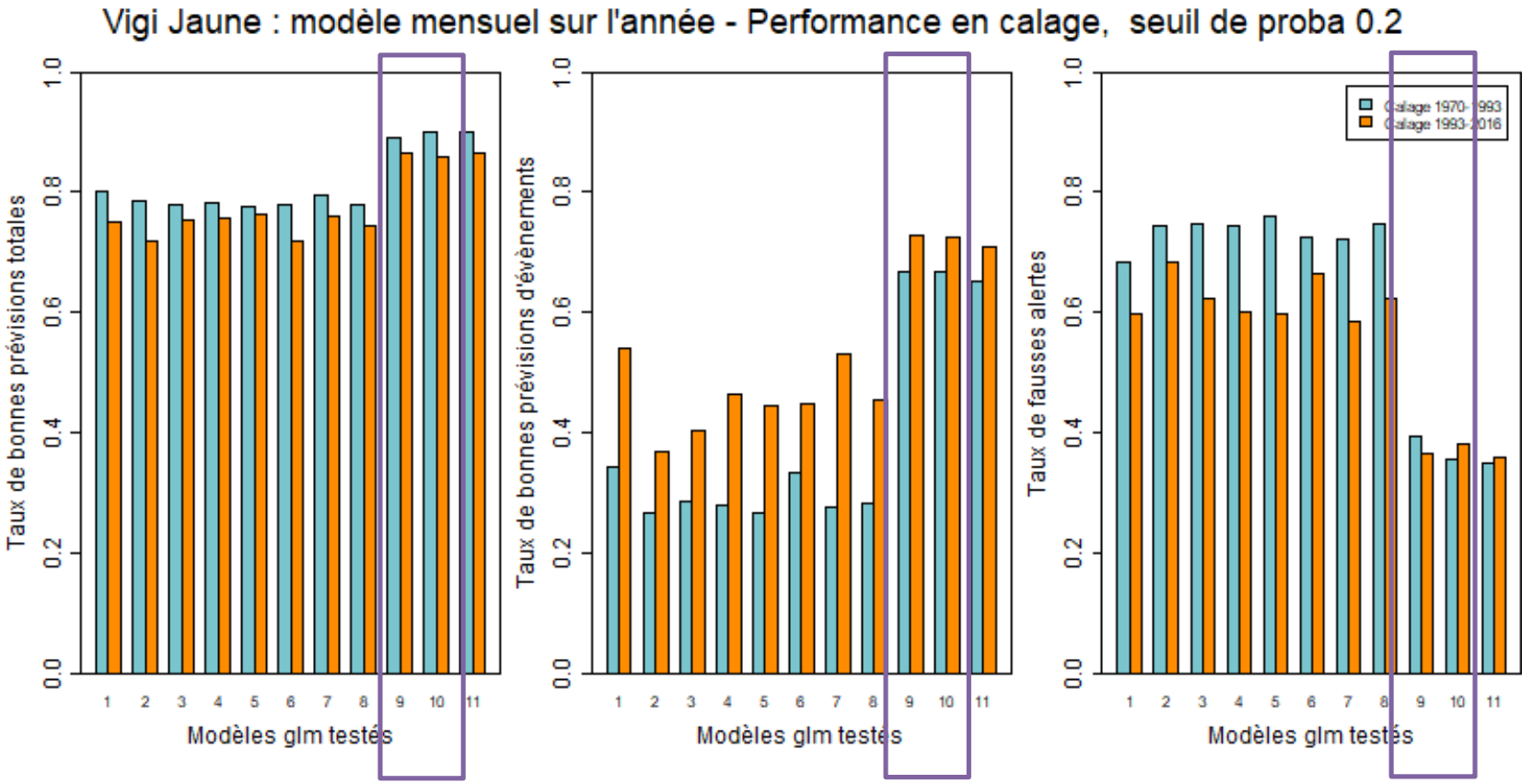

Monthly results

Calibration on the **6-month** summer period:

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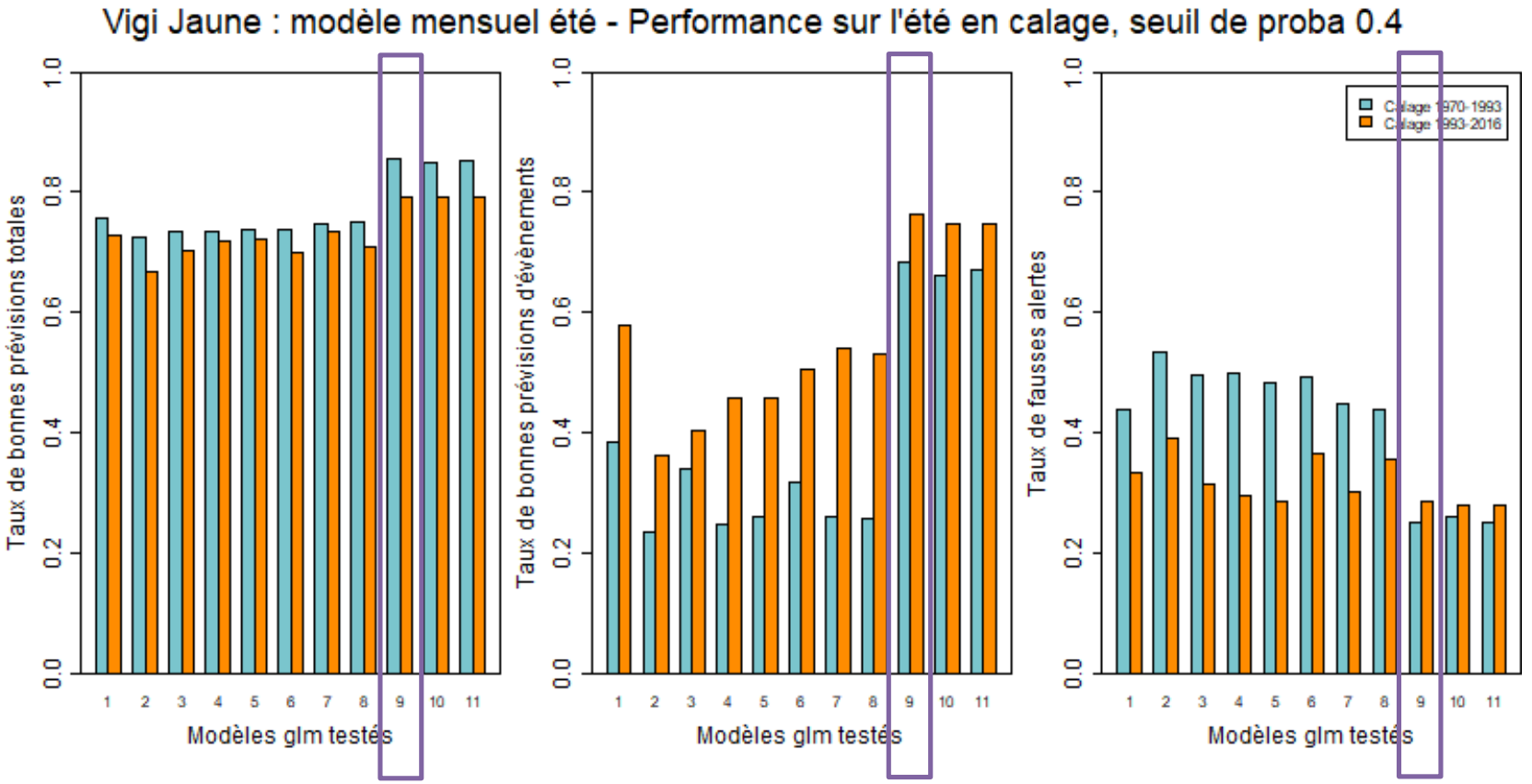

Monthly results

Calibration on the **3-month** summer period (1993-2016):

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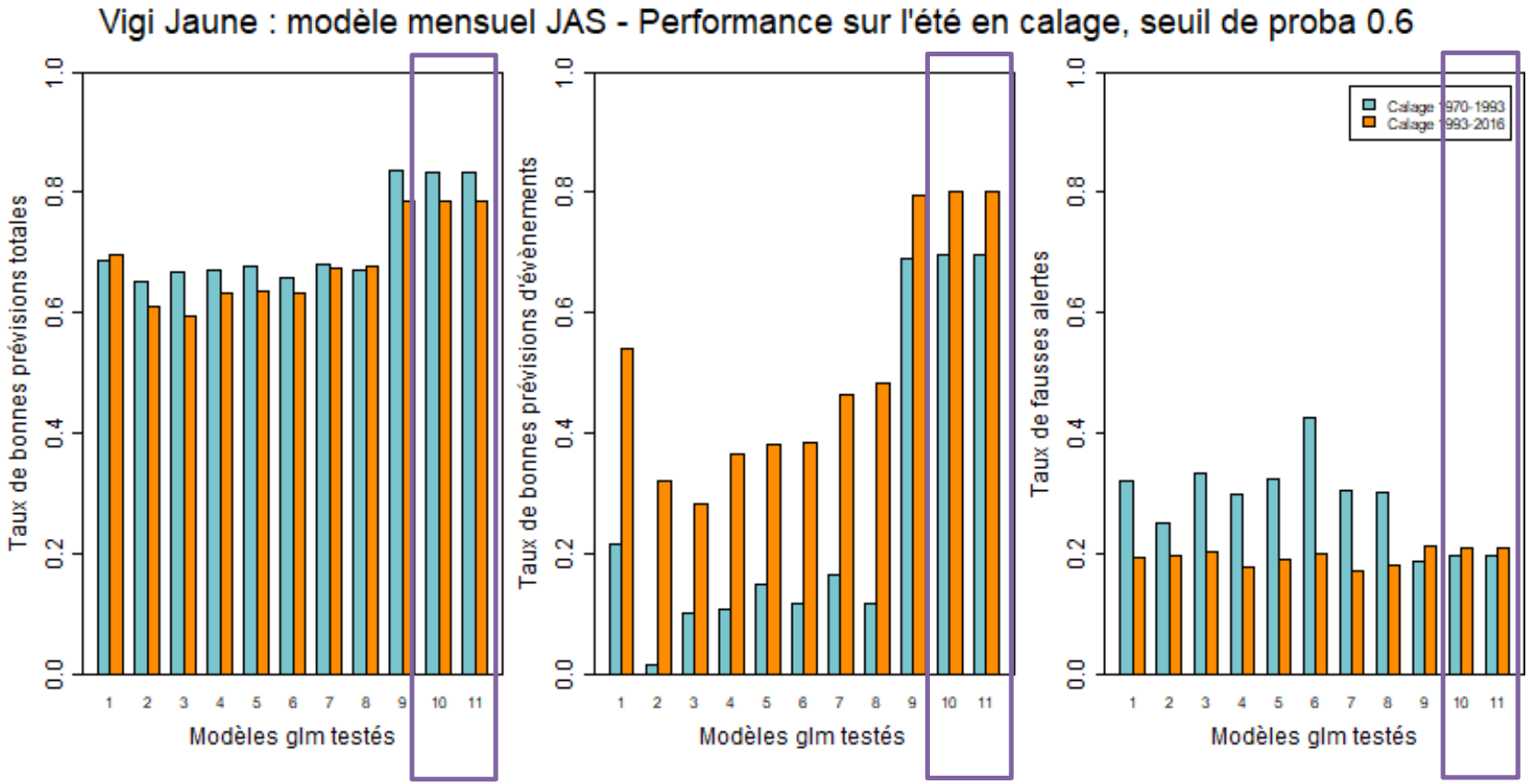

Any best model?

- Monthly vs 10-day time-step
- With or without observed yellow warning
- Annual, 6-month or 3-month calibration period
- Which probability threshold? **0,4-0,6**

→ Our champion is:

10-day time step/test 2/3-month/0,5

Next steps

- Performances for further lead times with best model(s)
- Orange and Red warning levels
- Proxy-based method for ungauged catchments application
- Providing a satisfactory model to local managers… if possible?

Thanks!
Questions?

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