VIGICRUES

Towards Probabilistic Flood Forecasting in France

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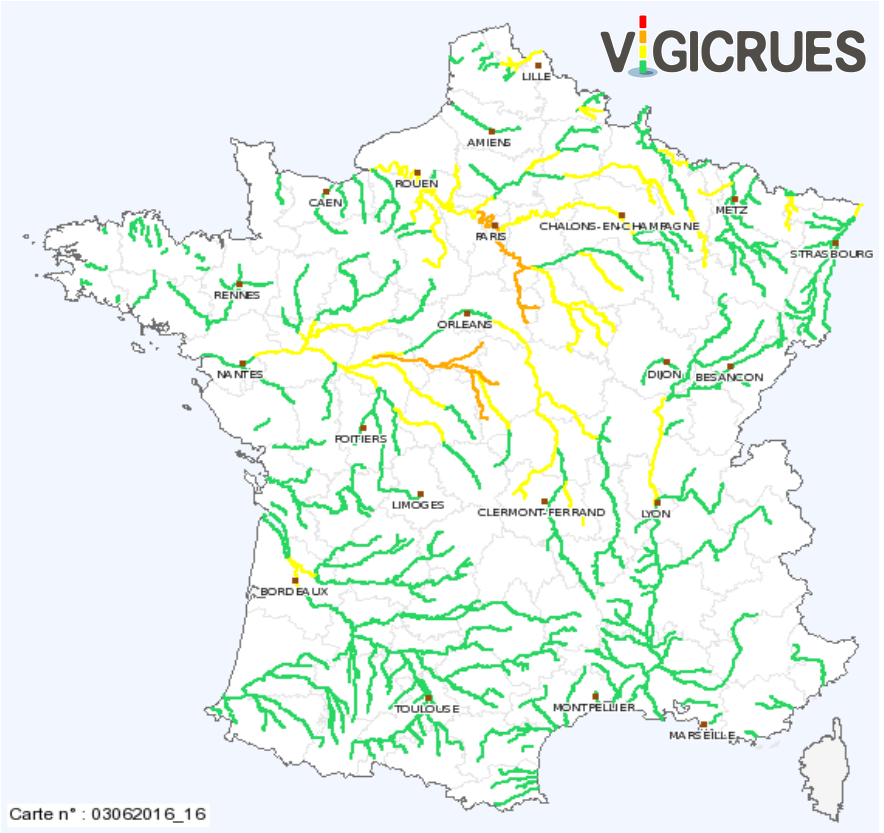
RÉPUBLIQUE FRANÇAISE

Ministère de l'Environnement, de l'Énergie et de la Mer

French flood forecasting network

- **1 national centre (SCHAPI,** Tanguy *et al.*, 2005**)**
  - Publication of flood warning Map on vigicrues.gouv.fr

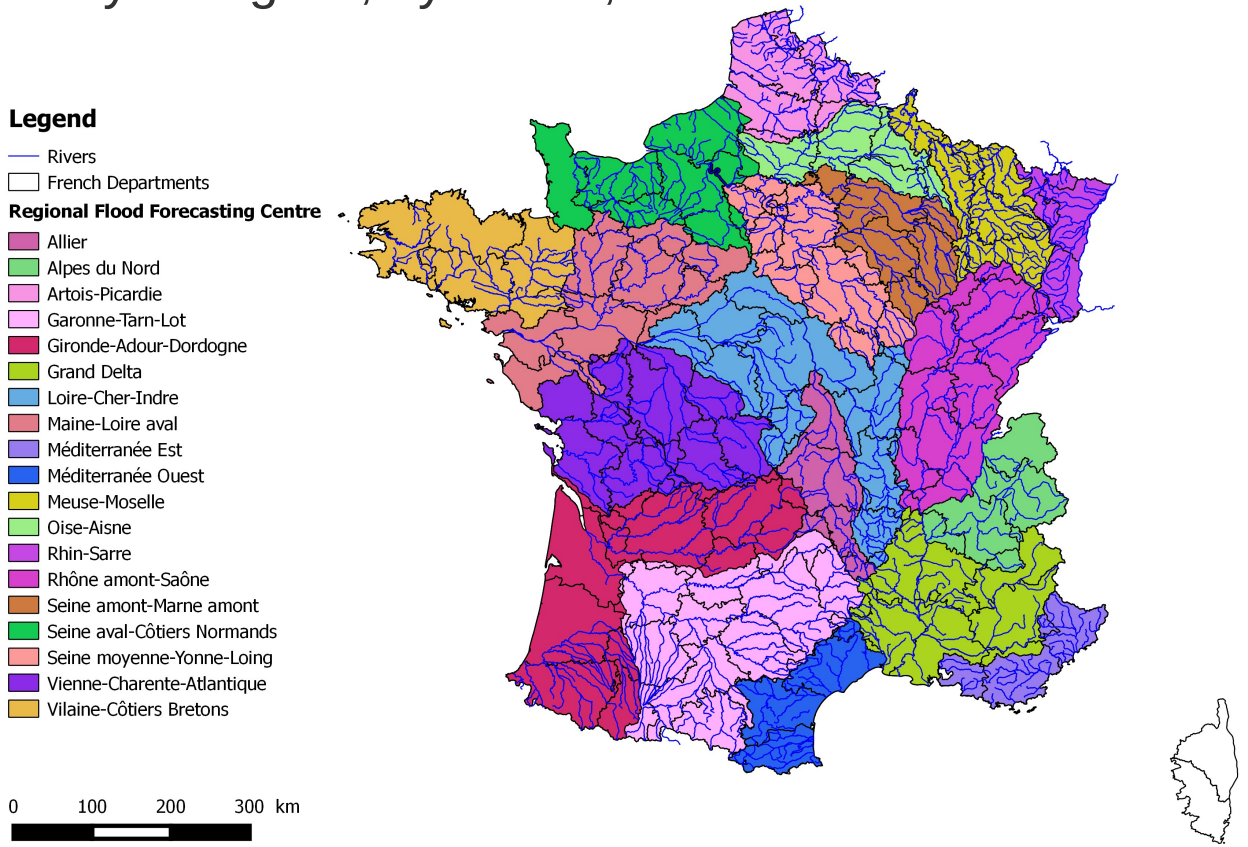
Flood Warning Map
2016-06-03 am



  - 1-week ahead survey based on
    - EFAS (Thielen *et al.*, 2009)
    - SIM-PE (Cousteau *et al.*, 2013)

French flood forecasting network

- **19 regional Flood Forecasting Centres**
  - Monitored rivers: 22000 km, 3000 active gauges
  - Short-term deterministic flood forecasting
    - Limited number of meteorological scenarios
    - Hydrological, hydraulic, statistical models



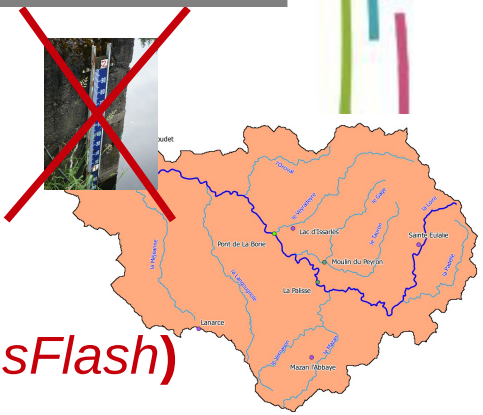
French flood forecasting network

- **1-week ahead survey**
  - Based on **probabilistic** forecasting system
  - EFAS, SIM-PE
- **24-hr flood warning**
  - Regulatory framework focusing on gauged basins
  - Often with **deterministic** hydrological forecasts
  - Sometimes based on several hydrological scenarios

⇨ **Upgrading hydrological prediction system to explicit uncertainty (**project *Prévision2015*)

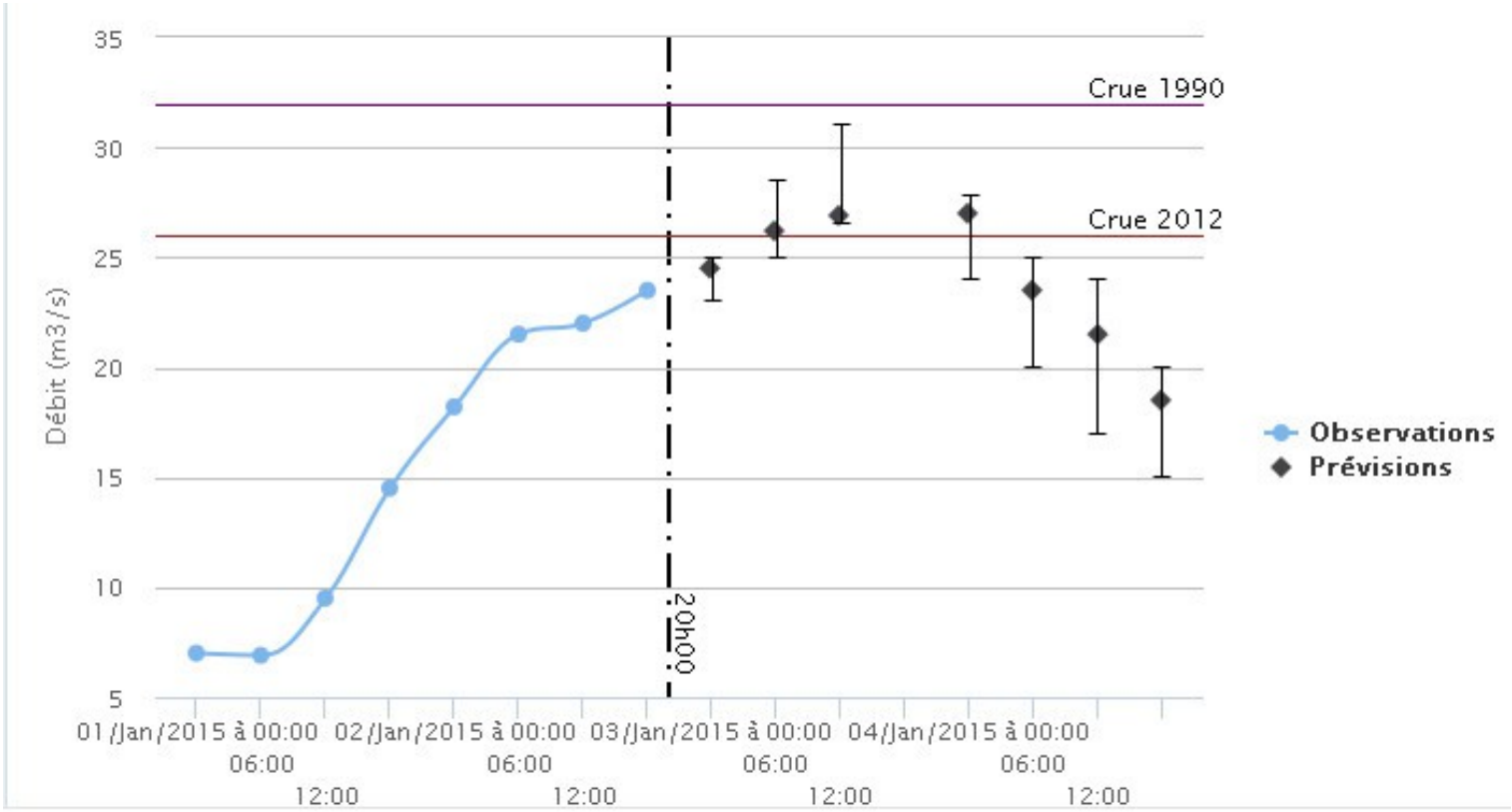
- **Ungauged basins**
  - Currently: only warning on intense precipitation

⇨ **Design of an integrated hydro-meteorological without human real-time expertise (**project *VigicruesFlash*)



Prévision2015

- **Literally “Forecast2015”**
- **Explicit forecast uncertainty**
- **Display probabilistic forecasts on the VIGICRUES website**



Prévision publiée le 03/01/2015 à 20h00

Prévision2015

- **Assessing total predictive uncertainty**
  - Considering meteorological uncertainty
    - ensemble prediction systems (Météo France, ECWMF)

      still experimental in French flood forecasting network
    - analog sorting approach (Marty *et al.*, 2012)

      only cover Alps and Loire catchments
  - Objective assessment of hydrological model uncertainty

    ⇨ **OTAMIN**
  - Need to include human (subjective) expertise

    ⇨ **EAO / EXPRESSO**
  - In order to provide proper uncertainty estimation

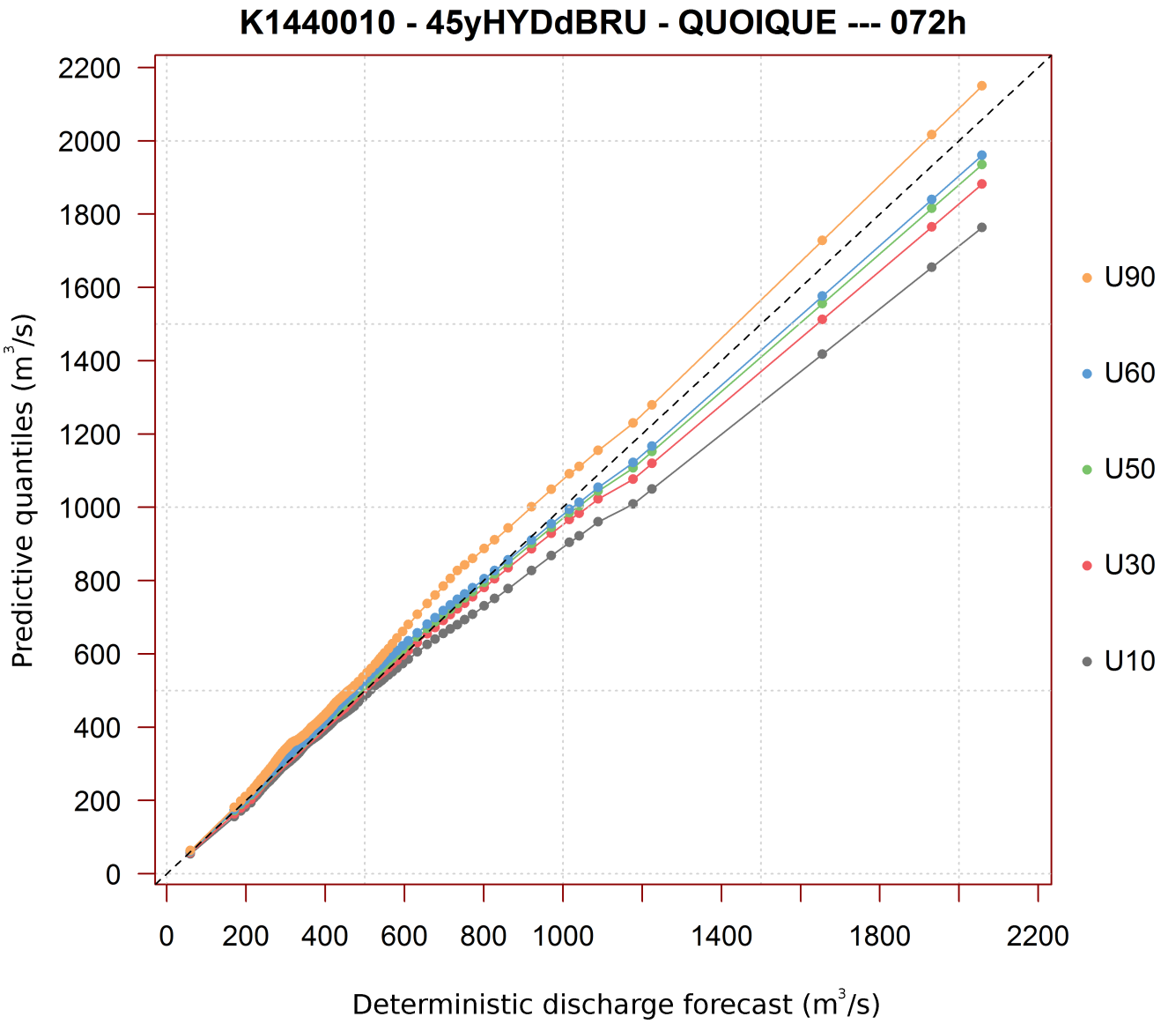
Prévision2015 : OTAMIN

- **OTAMIN**
  - Developed by C. Furusho, J. Viatge and C. Perrin (IRSTEA)
    http://webgr.irstea.fr/modeles/otamin
  - Tests and first applications by Loire-Cher-Indre Centre
  - Objective assessment of model predictive uncertainty
  - Based on the analysis of past forecasting errors

- **Calibration methods**
  - **QUOIQUE** (Bourgin *et al.*, 2014)
    - Non-parametric
    - Preferably for streamflow and multiplicative errors
  - **Quantile Regression** (Weerts *et al.*, 2011)
    - Parametric approach
    - Preferably for water level and additive errors

⇨ **Past error quantiles for each (predictand value, lead-time)**

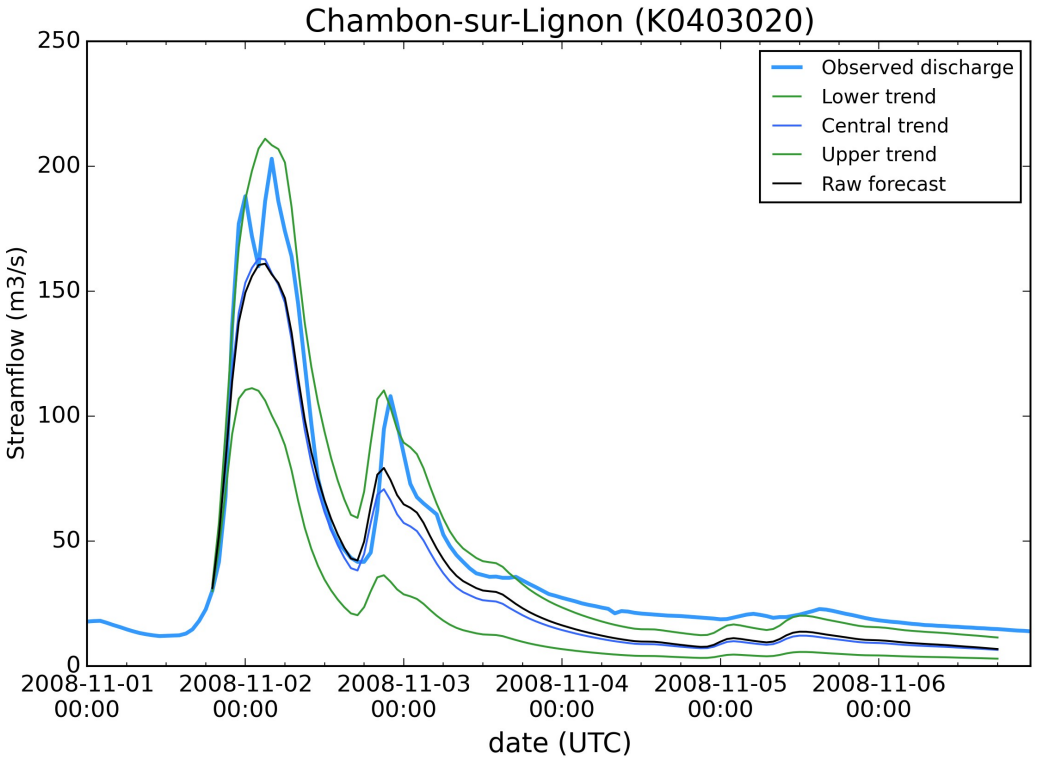
Prévision2015 : OTAMIN



⇨ **Past error quantiles for each (predictand value, lead-time)**

Prévision2015 : OTAMIN

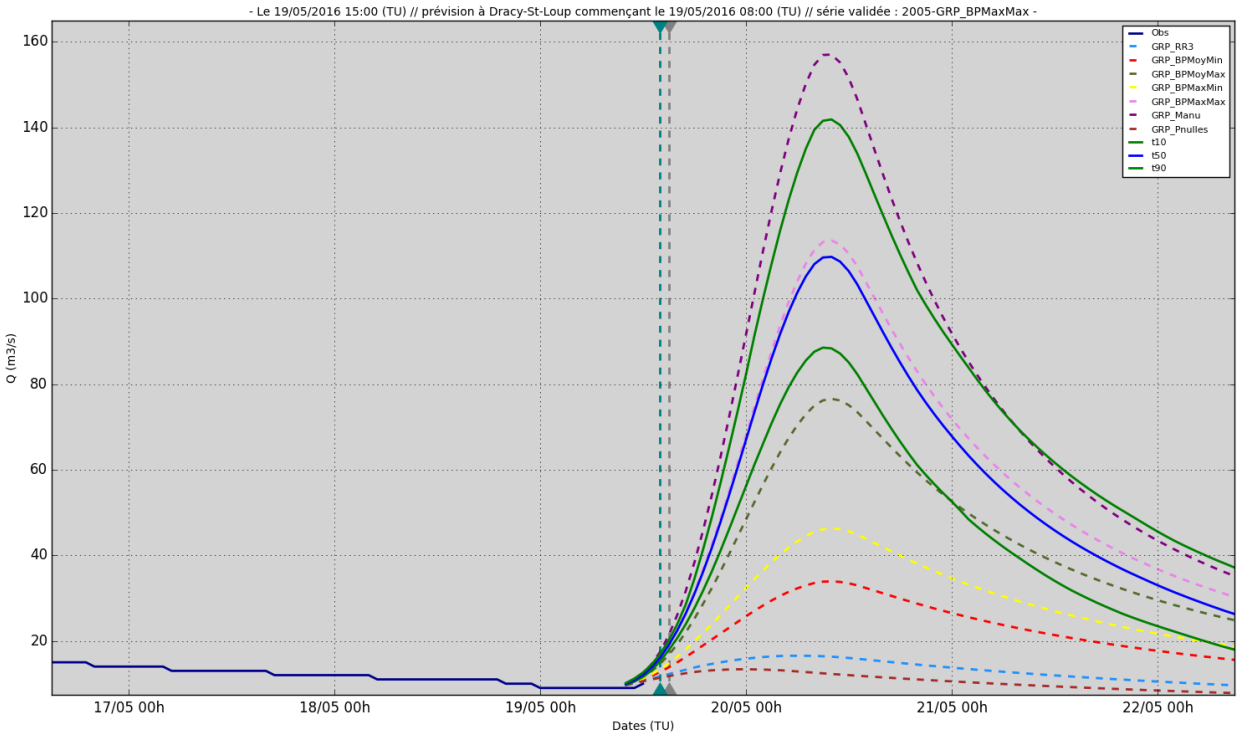
- **Real-Time post-processor**
  - Apply past error quantiles on current forecast
  - **Lower** (10%), **central** (50%) and **upper** (90%) trend



- **Limits**
  - No time correlation
  - Is calibration sample representative?
  - Performance in extrapolation?

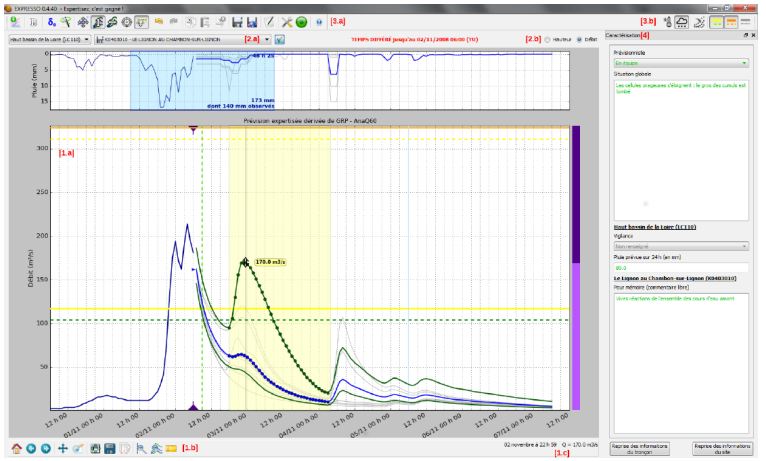
Prévision2015 : EAO / EXPRESSO

- **OTAMIN provides only a "first" guess**
  - All sources of uncertainty are **not** included:
    - Observation and forecast of precipitation, temperature
    - Observed water level and rating curve
  - Differences between models

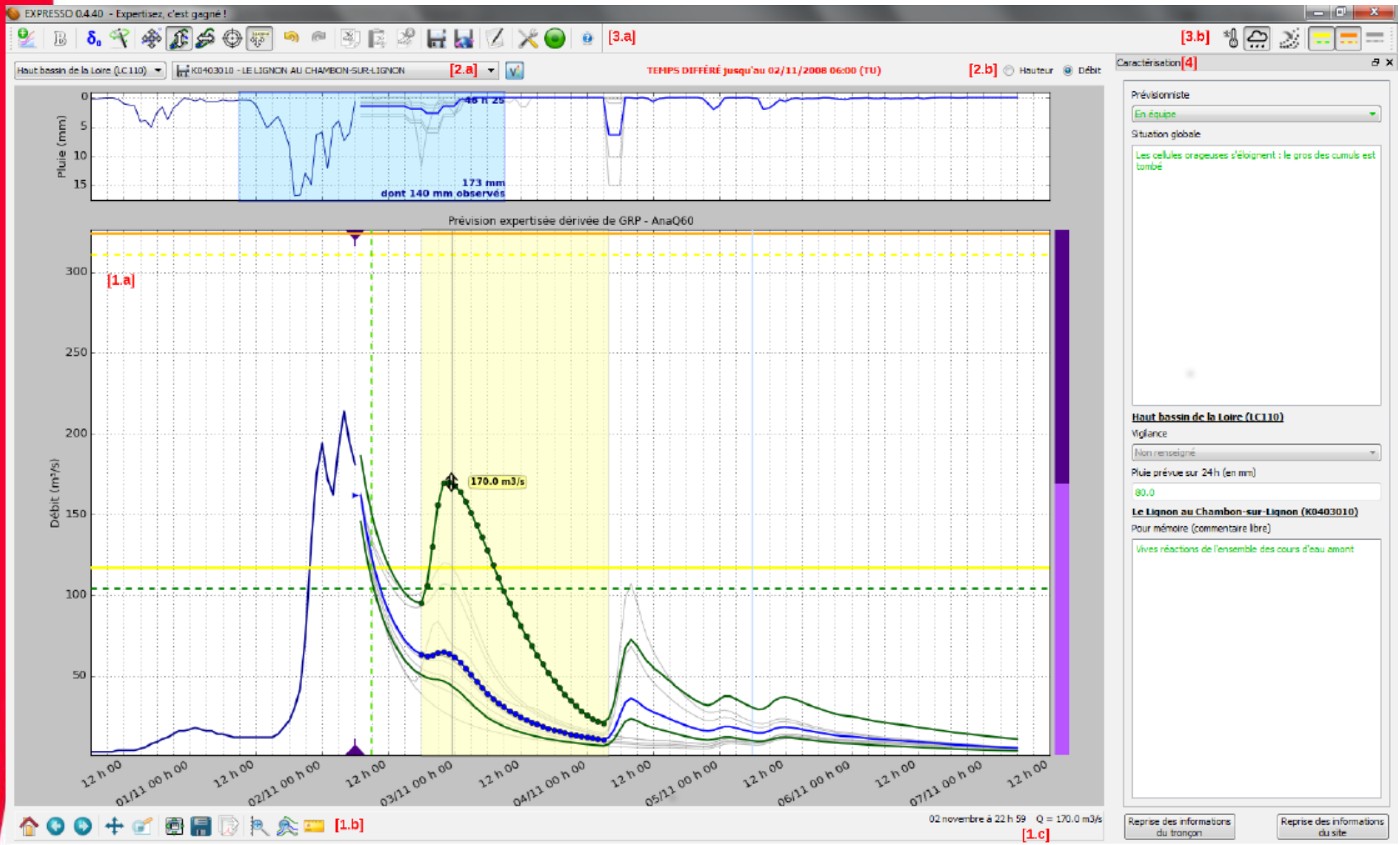


Prévision2015 : EAO / EXPRESSO

- **Computer-aided expert assessment**
  - Developed by L. Berthet, J. Barat and R. Marty
  - Interactive tool to help human forecasters to express
    - Their own expertise
    - The "final" assessment of total uncertainty
- **Graphical workspace**
  - Display forecasts, warning levels, state of rating curve
  - Handle quantiles curves (10%, 50% and 90%)
  - Release forecasts with its uncertainty to national server



Prévision2015 : EAO / EXPRESSO



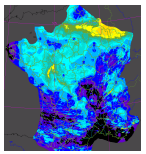
Prévision2015 : Verification

- **Imperfect total uncertainty assessment**
  - Limits of models and tools
  - Under- or over-confidence of human forecasters

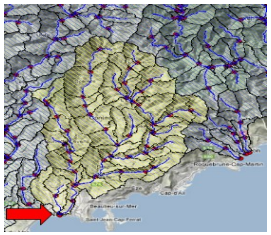
- **Unavoidable verification**
  - Systematic training for every forecaster
  - Regularly-scheduled forecast verification
  - Focus on reliability, accuracy and sharpness
  - Release our verification

Vigicrues Flash

- **Integrated hydro-meteorological without human real-time expertise**

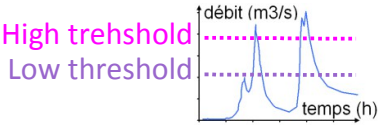


Radar gauge QPE



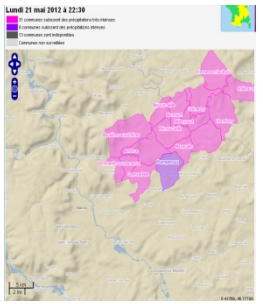
Distributed hydro modelling

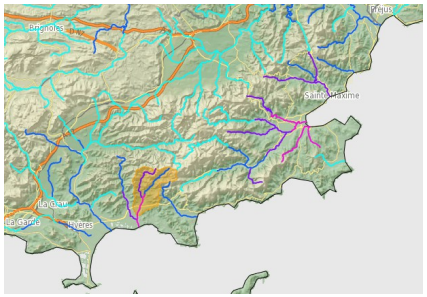
Determination of the basins concerned with threshold exceedance



Flash flood warning display

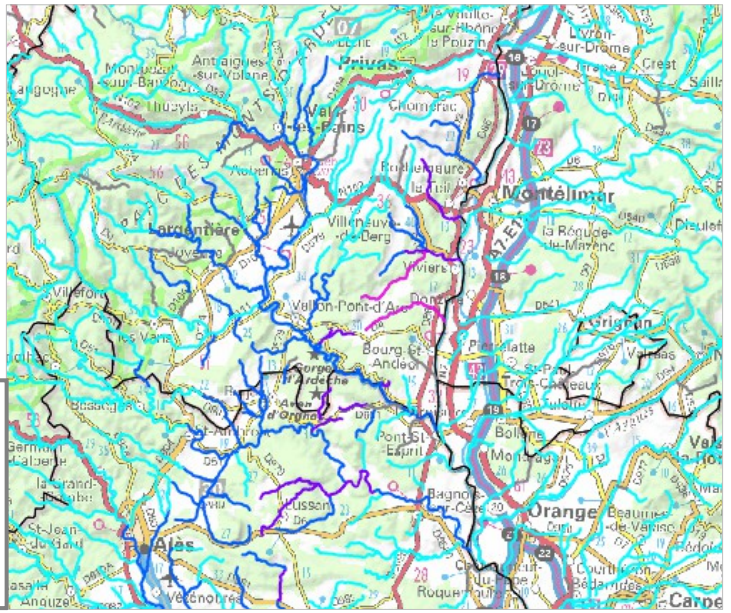
Flood warning maps available on the dedicated website





Vigicrues Flash

- **First version**
  - Implementation in **2016**
  - Only based on QPE by radar



Estimated Return Period

	< 2 years
2 ≤	< 10 years
10 ≤	< 50 years
	> 50 years

- **Work in progress**
  - Extend lead time by using QPF
  - High-resolution nowcasts from AROME
  - Mean gain in effective lead time
    - 2-yr threshold: 2-5 hours
    - 5-yr threshold: 1-3 hours

Technical and human challenge

- **Uncertainty assessment**
  - Meteorological uncertainty by meteorological ensembles?
  - Hydrological model uncertainty by multi-model approach?
- **Hydrological Prediction System for monitored basins**
  - Adapted to semi-distributed prediction chains?
  - Consistency at (sub-) basin scale ?
- **Future flash flood warning system**
  - Need to include human expertise?
  - Link with warning emitted within the regulatory framework?
- **Human challenge**
  - Role of human forecasters ?
  - How to deal with probability within the flood warning process and non-scientist end-user?

Thanks for your attention !