Ensemble 10 day forecast streamflows with the SAFRAN-ISBA-MODCOU chain

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Context and Motivations

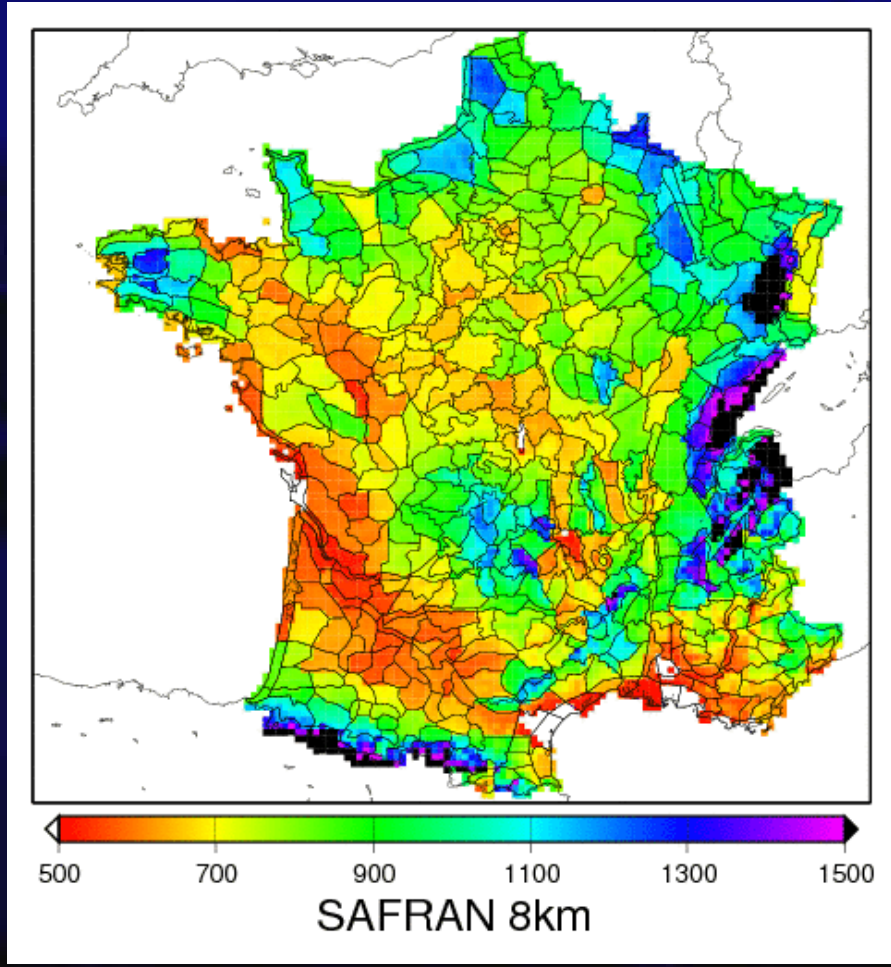
- Météo-France developed, in cooperation with the Cemagref and the Ecole des Mines de Paris a coupled meteorological – hydrological model (SIM).
  - Validation of the surface water and energy budget with discharge
  - Analysed meteorological data for various applications (e. g. agriculture)
  - Soil wetness (drought) monitoring

- Aim of the present work :
  - Evaluation of the ability of the system to forecast discharge using the EPS of the ECMWF.

- Plan :
  1. ***Description of SIM***
  2. ***Desagregation of the input data***
  3. ***Evaluation of the discharge forecasts***

SAFRAN-ISBA-MODCOU

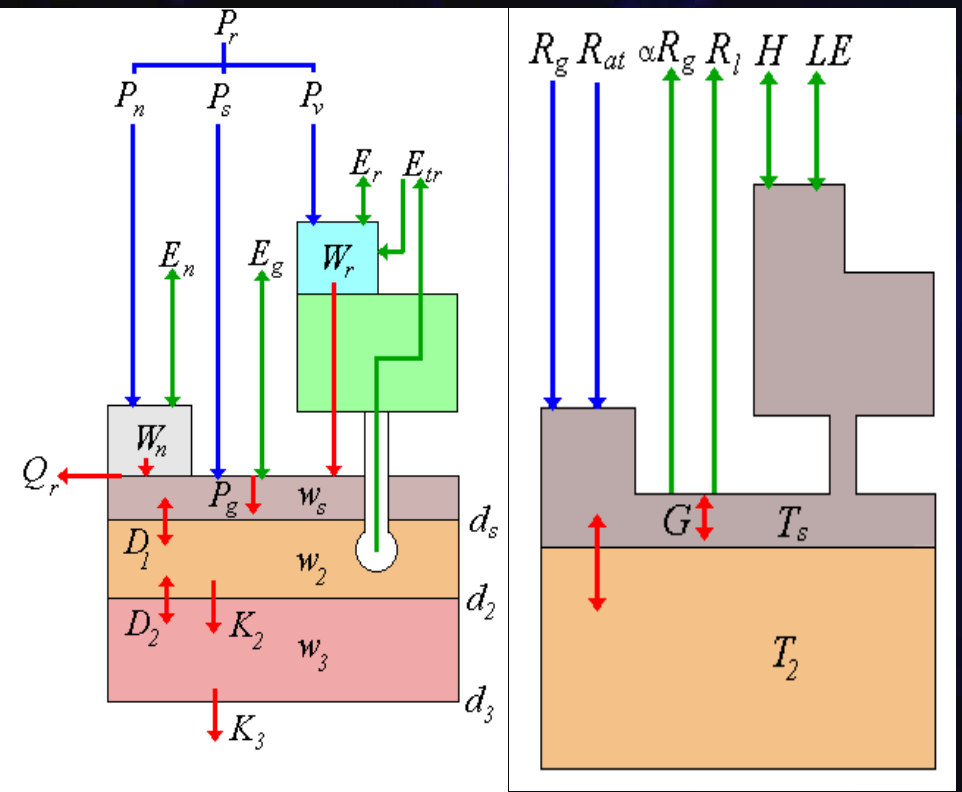
- **SAFRAN** : met analysis
- Analysis of all meteorological variables to force surface models : T2m,HU2m,V,Precip,snow, IR and solar radiation
- Based on optimal interpolation, by zones
- Input : observations (manual and automatic stations, meteorological models for first guess)

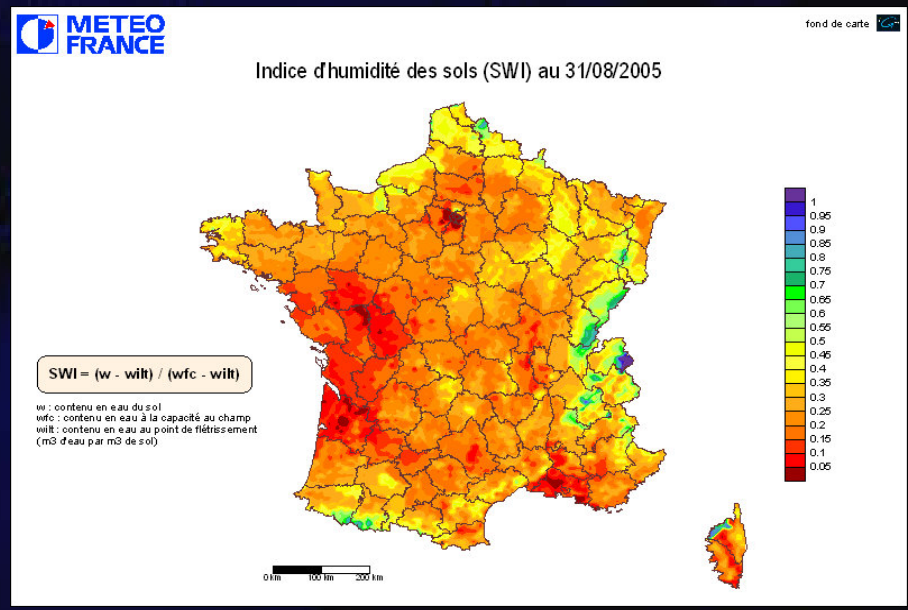


Precipitation 2001/2002

SAFRAN-ISBA-MODCOU

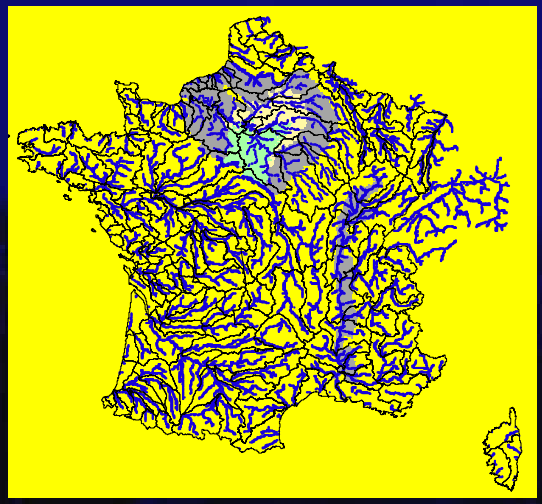
- ISBA : a « SVAT » model
- Simulates the water and energy transfers
- 8 km grid over France

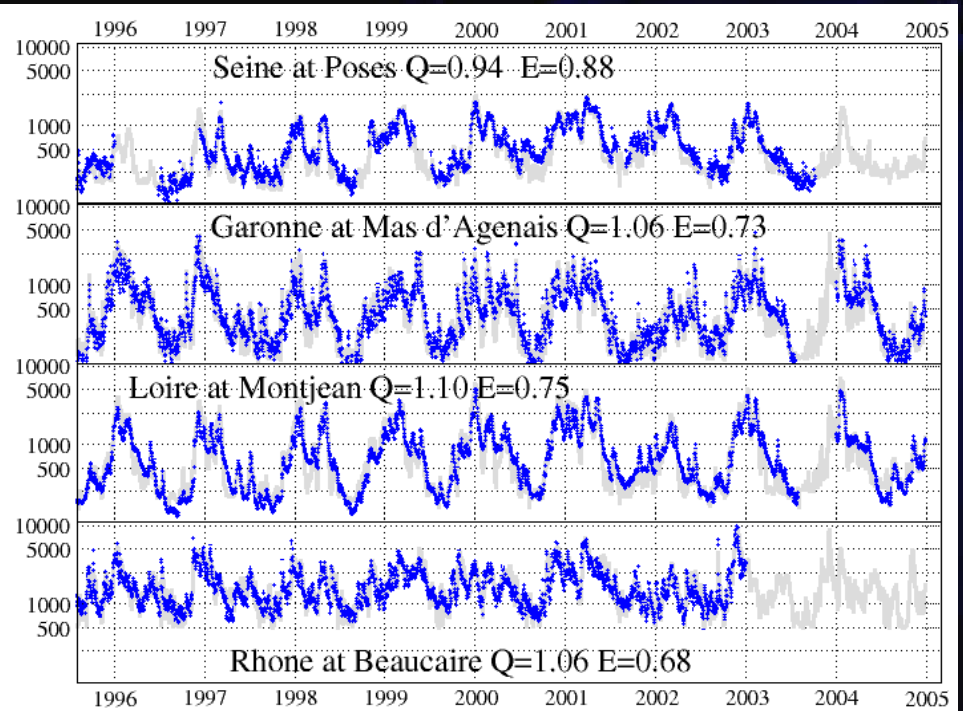




Soil wetness index
31 Aug. 2005

SAFRAN-ISBA-MODCOU

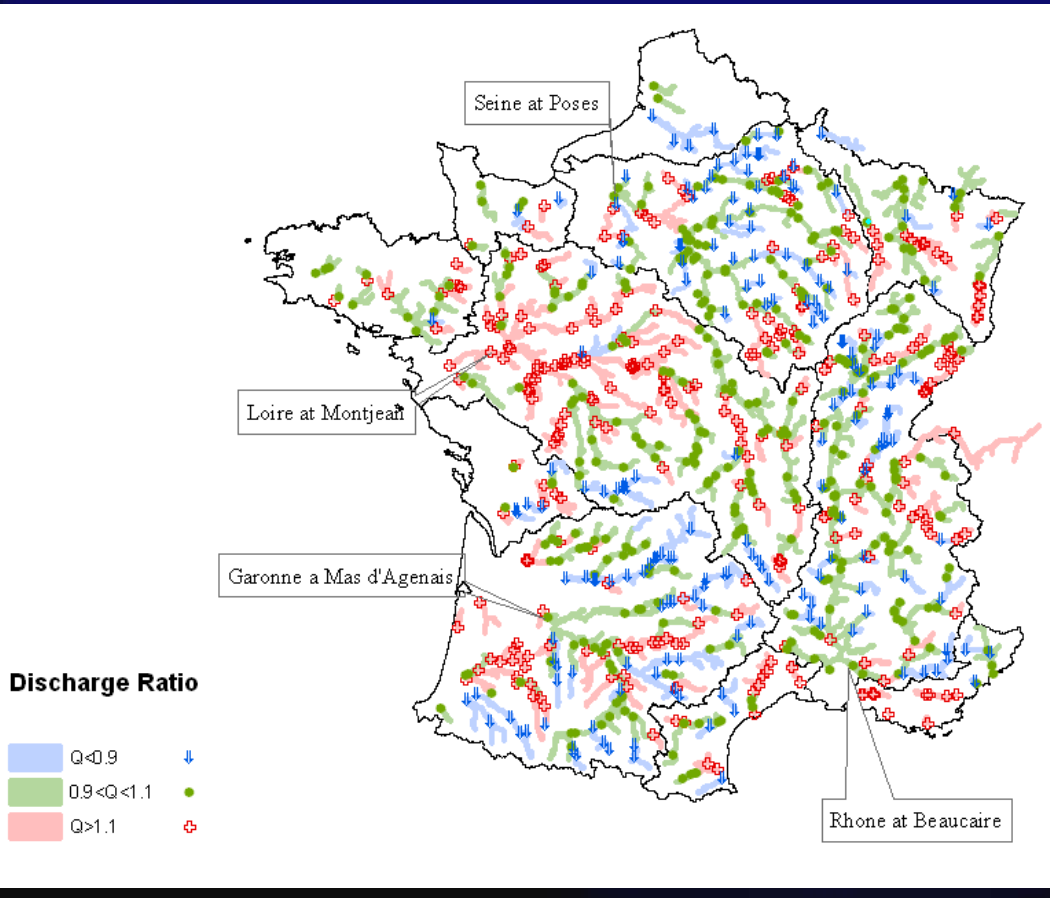




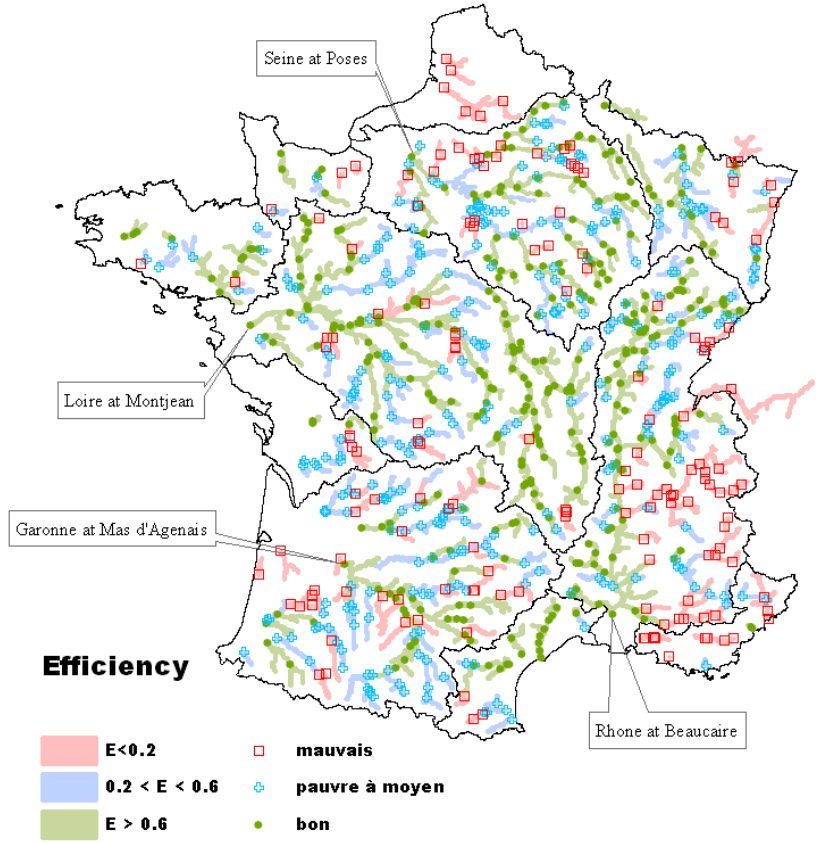
- **MODCOU** : distributed hydrological model
- Developed by the Ecole des Mines de Paris

- Variable grid (1x1 km to 64x64)
- Discharge simulations at 900 points
- Water table for the Seine and Rhône basins
- Validated on a 10 year database.

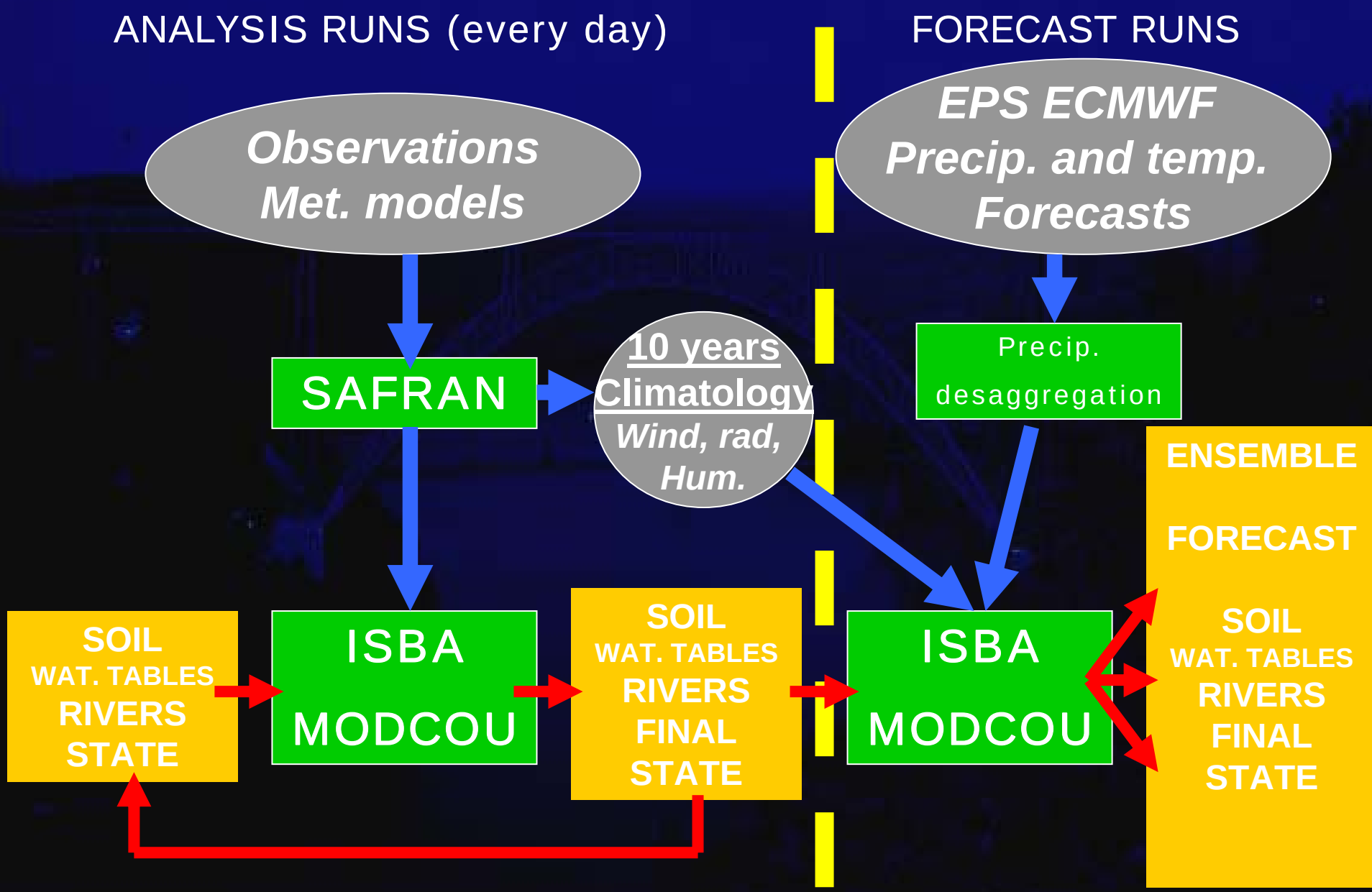
Discharge ratio



Efficiency



Current implementation

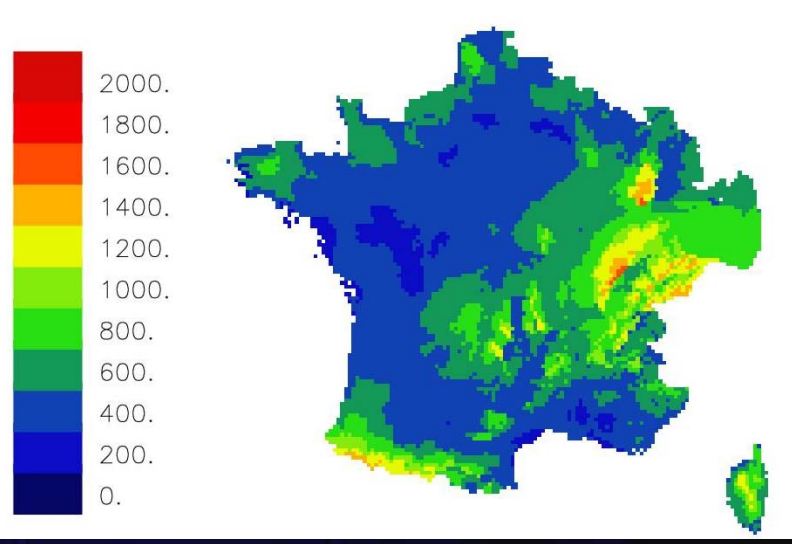


Desagregation of the precipitations

- ECMWF precipitations are interpolated at each analysis zone
- An altitudinal gradient is applied

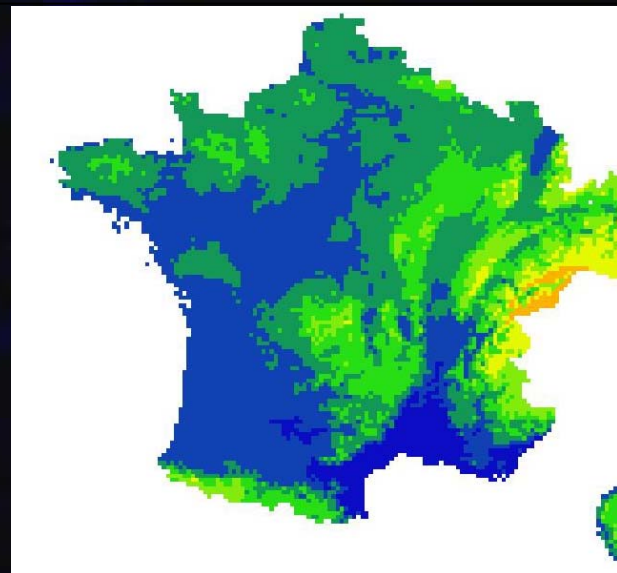
Analyses of forcing data

- Precipitations
  - Desaggregation definitely needed
  - Ensemble mean > SAFRAN (1.95 mm
  - Increase with forecast range (2.1 to 2.35 mm/day)
  - Ensemble mean better than the control run
  - The ensemble spread increases a lot during the first days 44% from day 1 to day 2
  - Underestimation of the probability of « extreme events » (RR=0, RR > 20 mm)
- Other parameters
  - Temperature used for critical snow/rain temperature
  - Wind, HU, radiation : climatological values



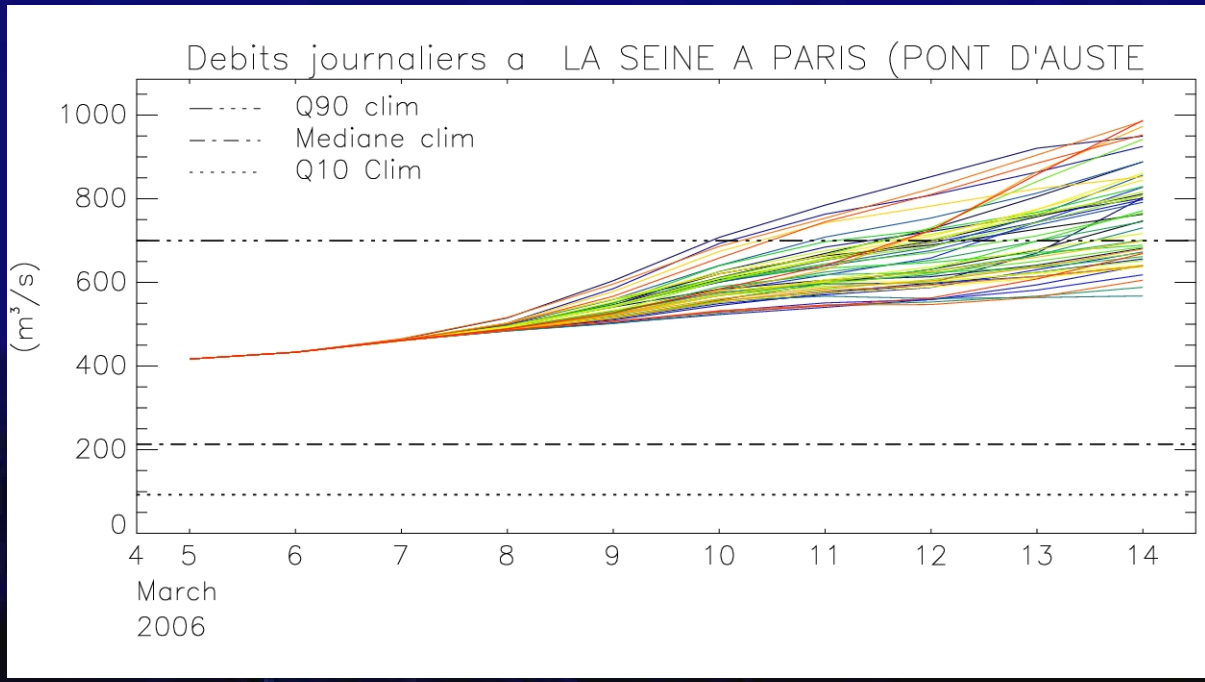
SAFRAN analysis : 649 mm

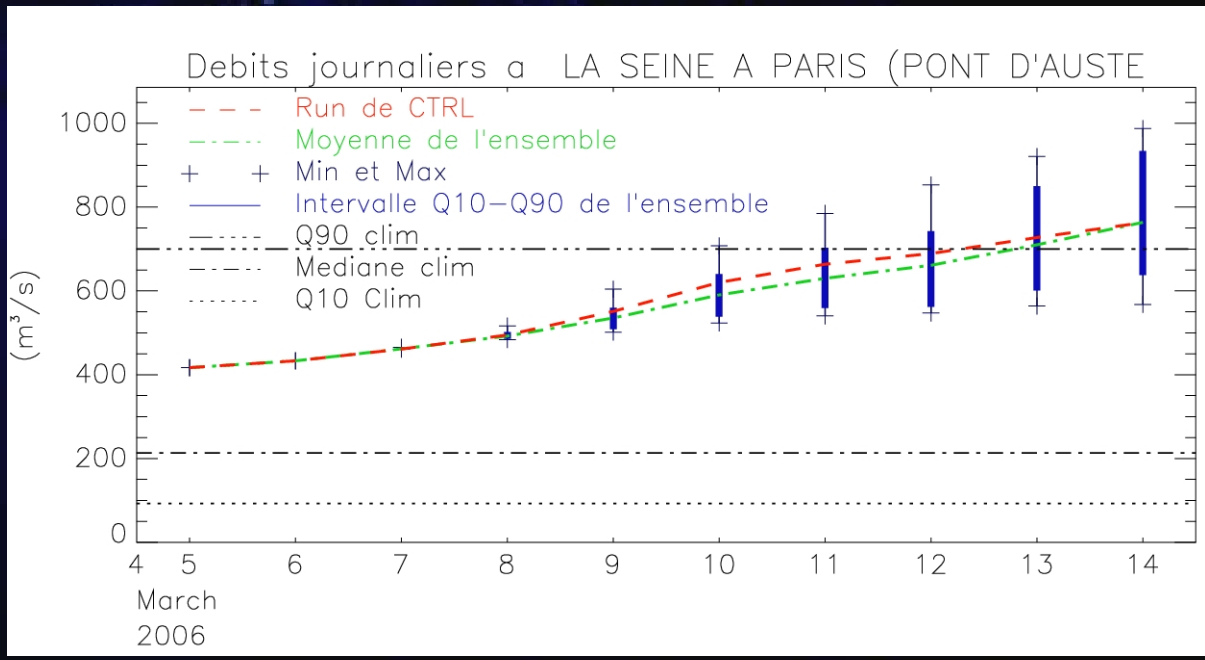
24 For. Ens Mean. : 698 mm



Outputs

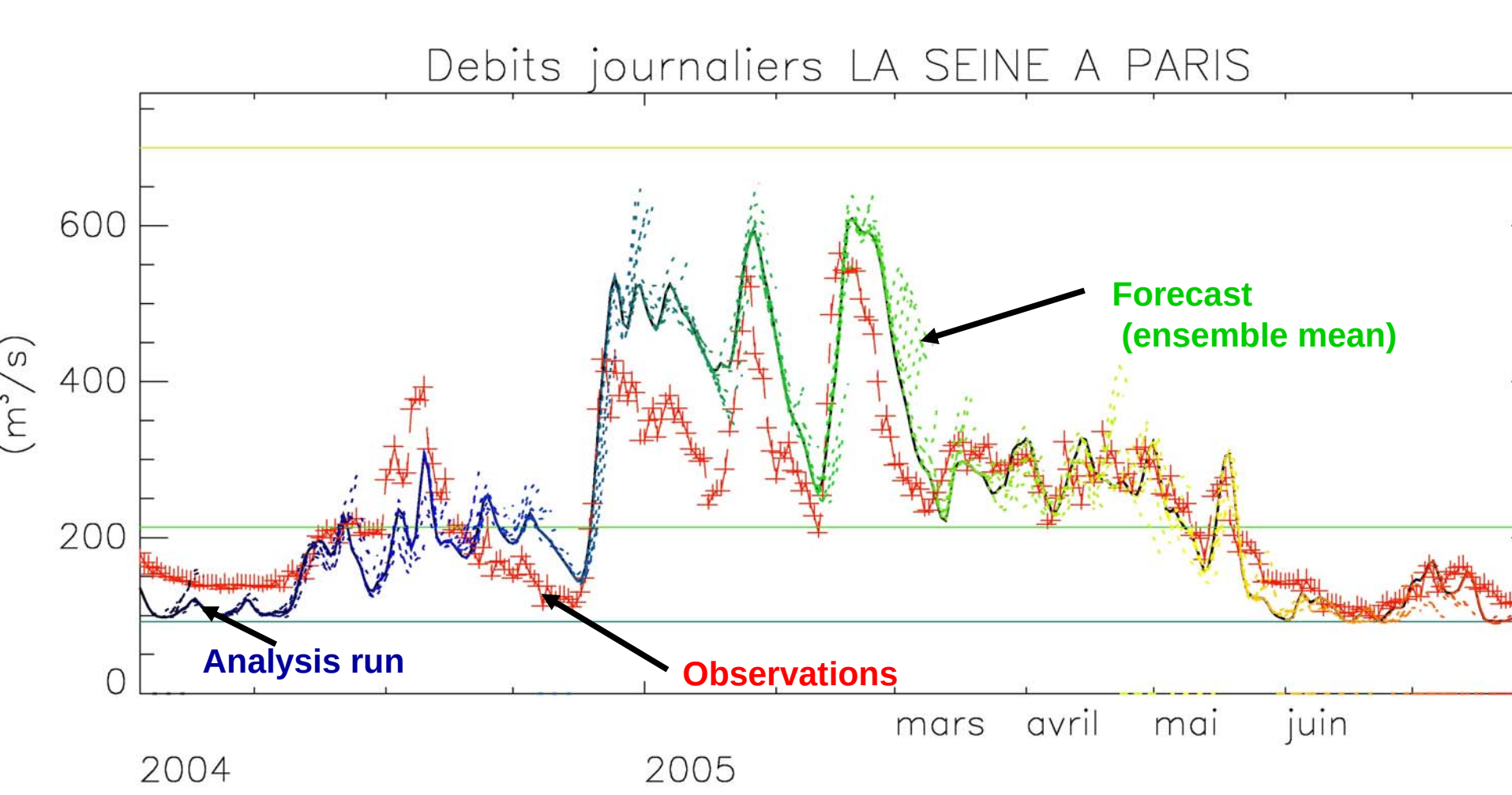
- Raw outputs « Spaghettis »
- Statistics of the ensemble
  - Ensemble mean
  - Quantiles
  - Control run
- Comparison to the actual statistics of observed discharge



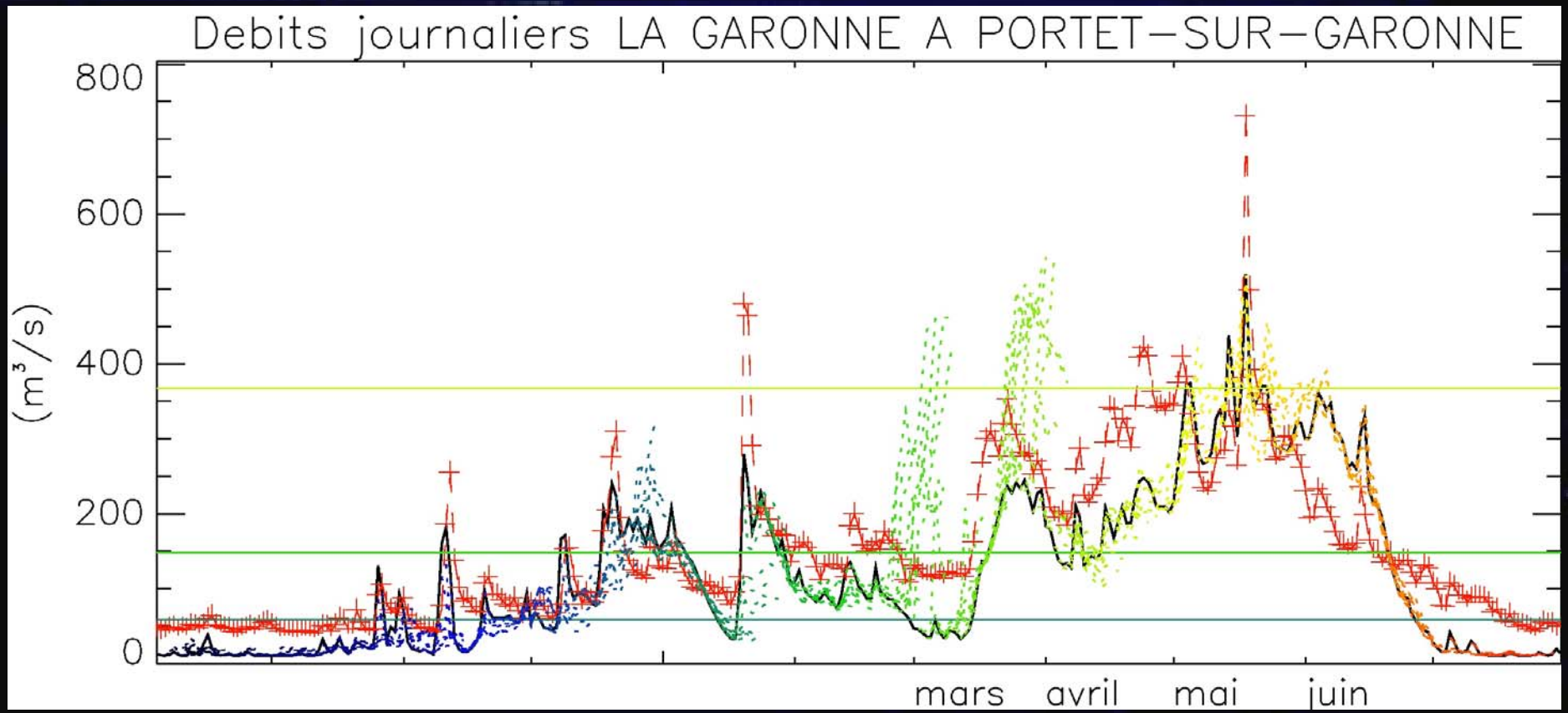


Ensemble mean : la Seine at Paris

4 sept 2004 to 31 july 2005



La Garonne (near Toulouse)

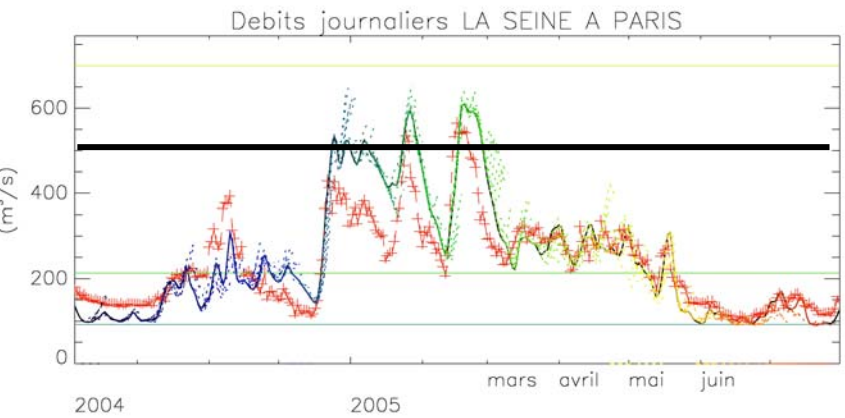


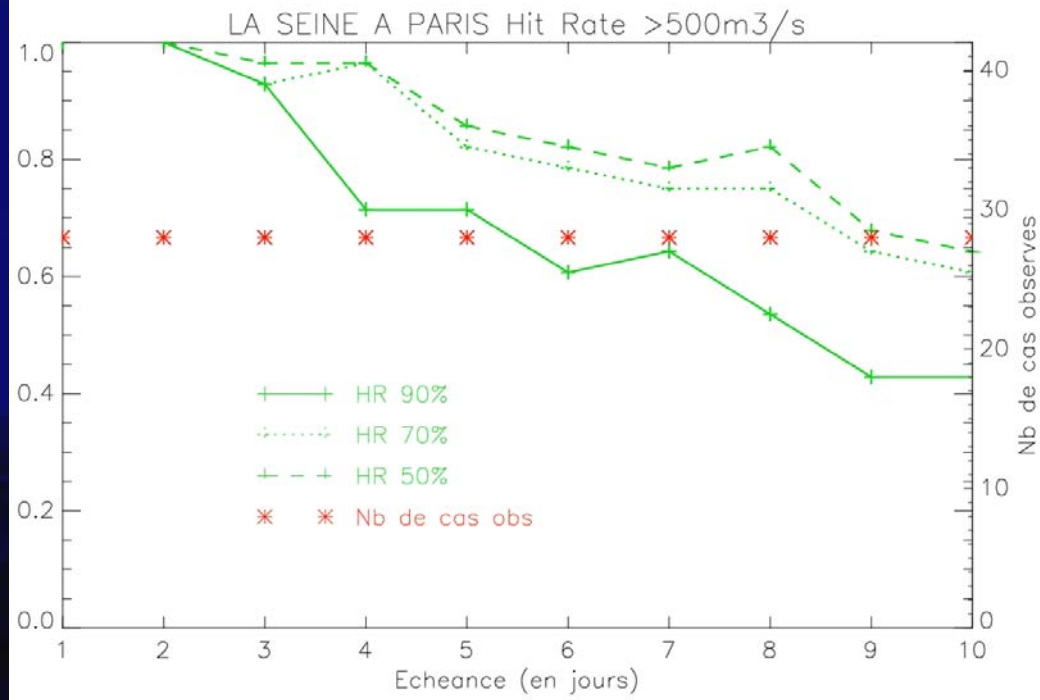
Validation

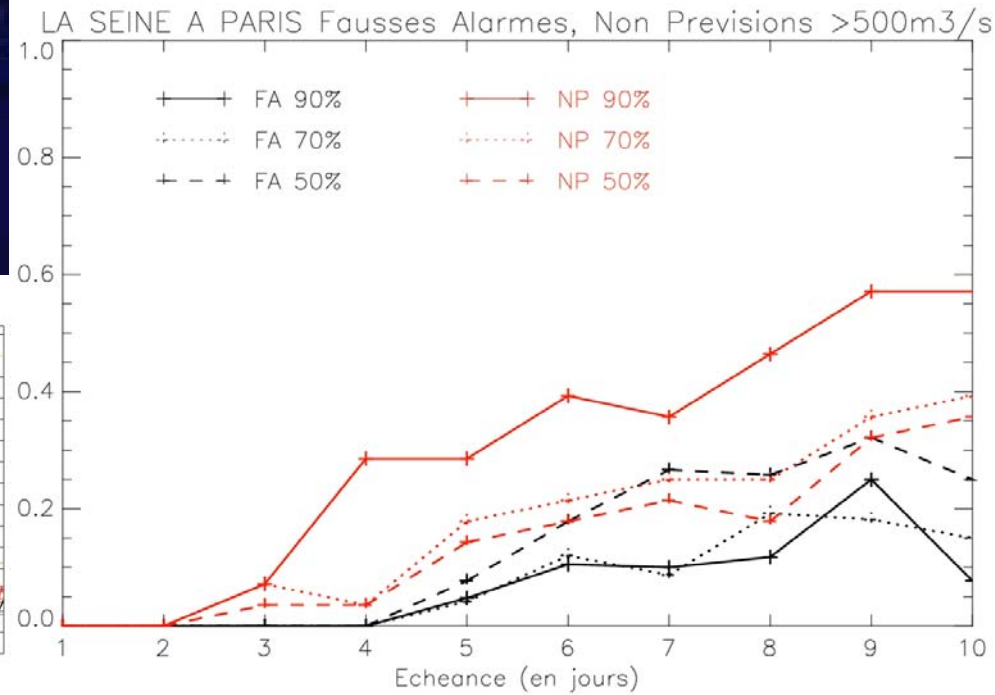
- Period 4 sept 2004 to 31 july 2005
- At this stage : Perfect model approach used (comparison with the reference run)
- No prediction, false alarm, Hit rate (% of observed events well predicted) above or below a given threshold
- The variability of the ensemble forecast

« High » discharge

- Threshold: 500 m³/s
- 30 cases
- Tests with 50, 70 or 90% of the members
- 90% rate has the lowest score (No prediction)







The spreading of the ensemble

- The members should have the same probability
- The members should cover all the possible cases

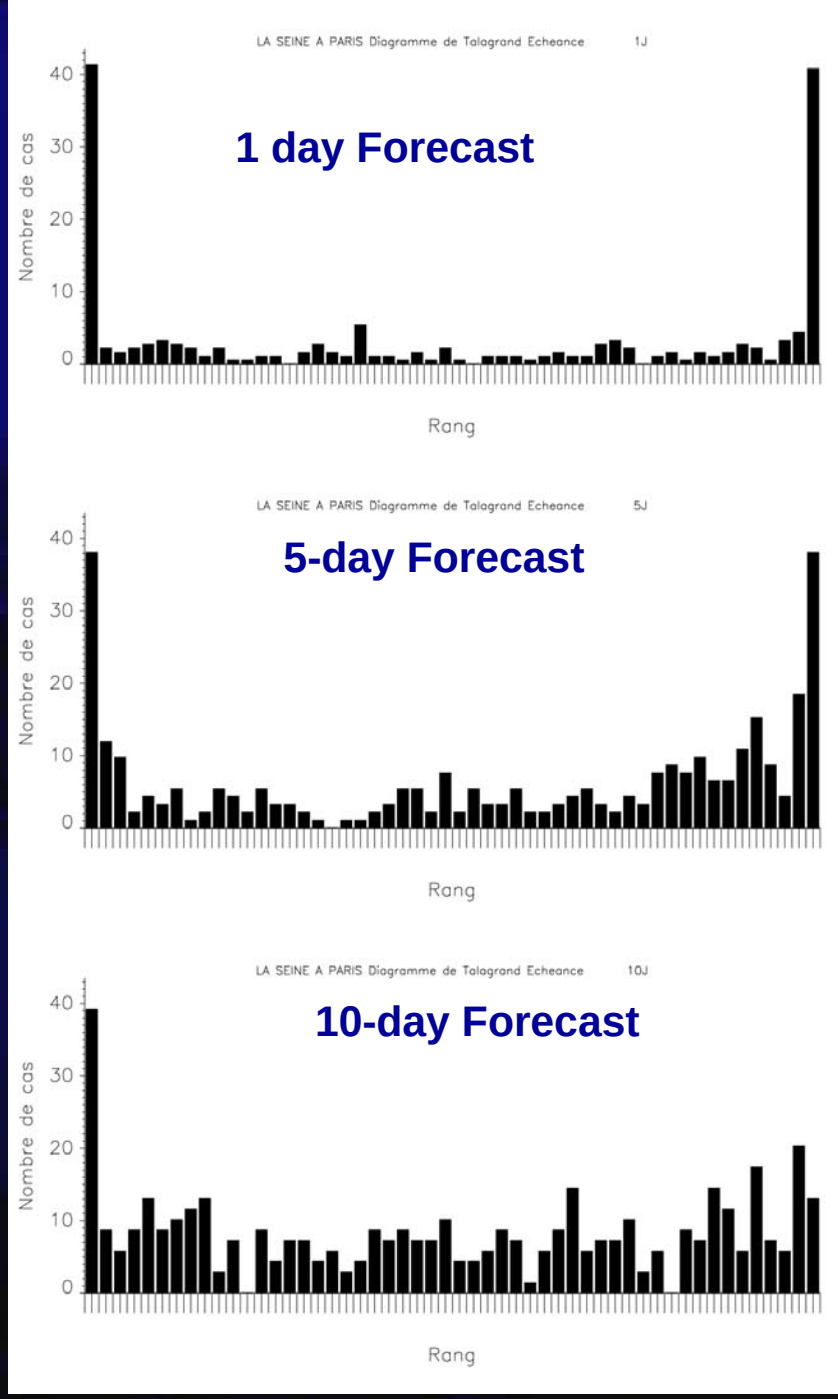
- The rank diagram (one point per day):
  - Order the members,
  - Place the observation in the ordered members and note the rank

- The ideal diagram is flat
  (Observed frequency = Predicted probability)

Rank diagrams

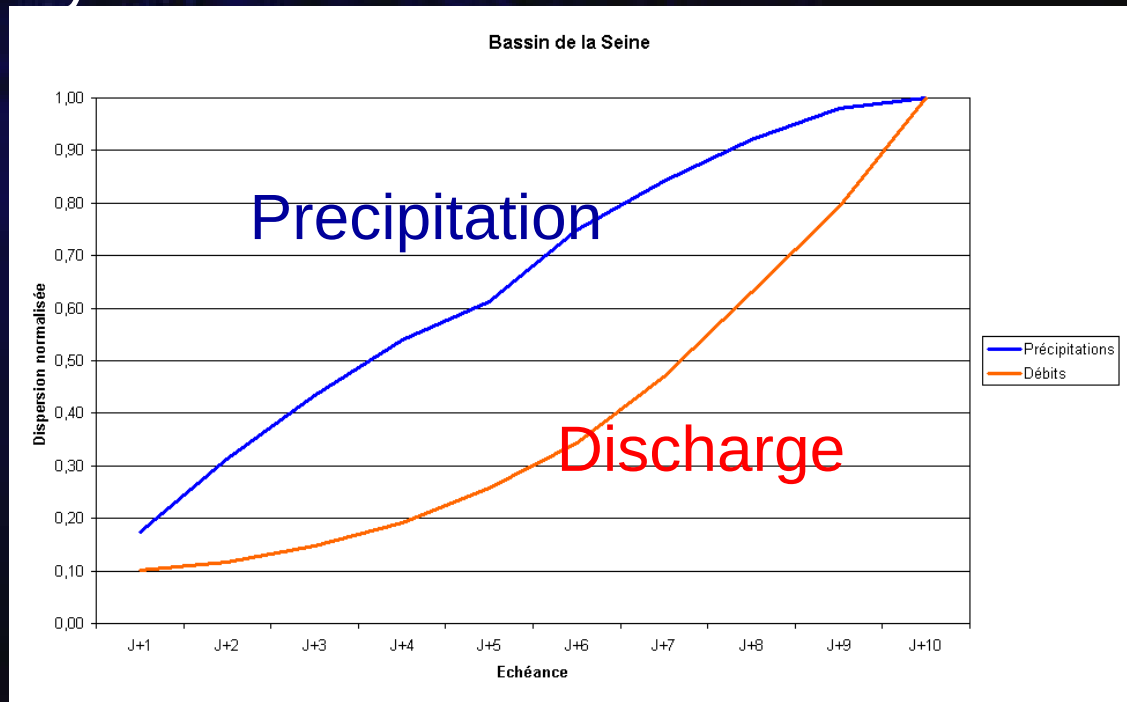
- Seine at Paris :

- Not enough variability at the beginning of the forecast (U-shape)
- Good results for the 10 day forecast, but to few members in the lower part of the forecast.



Comparison of the evolution of precipitation and discharge variability

- For the whole Seine basin :
- Variability of discharge increase later than precipitation and the increasing rate is maximum at 10 days



Conclusion

- The construction of the system is a big effort
- Main Conclusions :
  - Desaggregation of precipitation is needed
  - Ensemble spread is too low,
    - EPS ? Include all parameters in desaggregation ? Initial state ?
- Future directions :
  - Calculate the usual scores, scores with real observations, detailed studies of past flooding needed
  - Close cooperation with end users needed at this stage adapt the scores to their needs (FA vs ME)
  - Improve the physics of the ISBA/MODCOU system
  - Work on the initial state (introduce uncertainty in model physics or initial state? assimilation techniques?)


Thank you for your attention !