A climate service prototype for water resource management at seasonal scales

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Outline

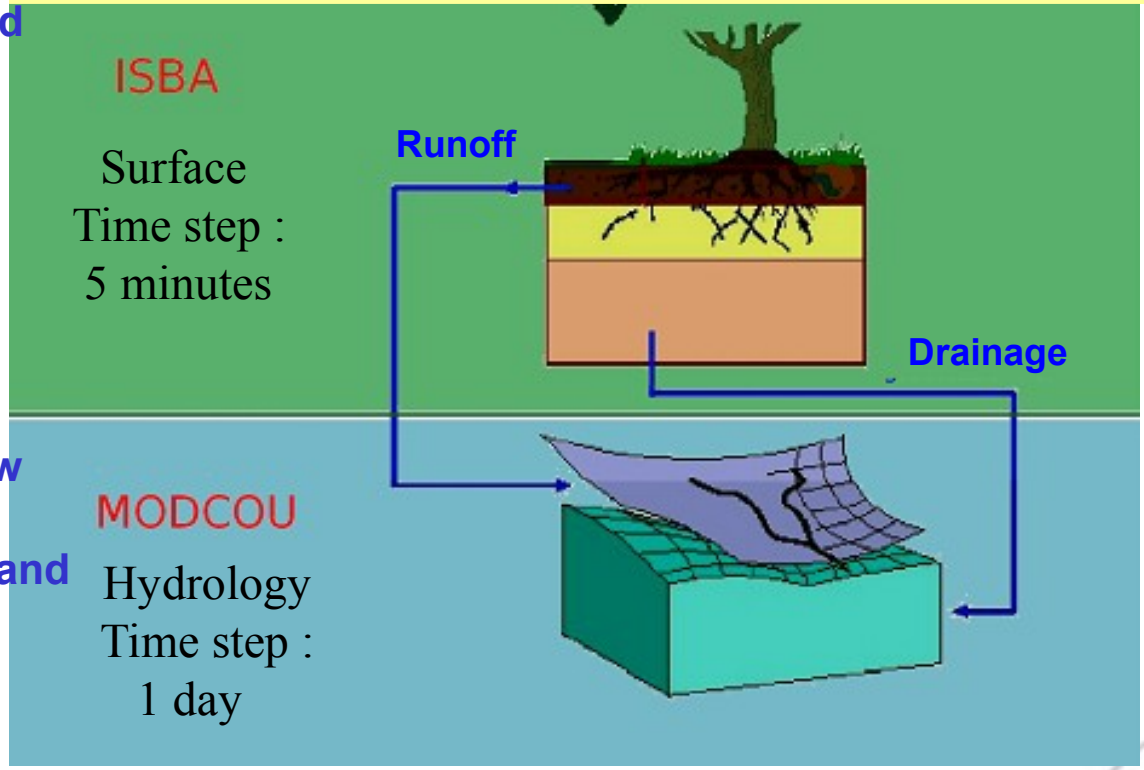
- **The Hydrometeorological suite**
  - Hydrometeorological forecasting suite
  - Some results
- **Meteo-France prototype**
  - Description
  - Example for the low flow period
  - Example for the reservoir refilling period
- **Tailored Climate Information to DMPs**
  - Lead-Time results (from February to May IC)
  - Comparison Hydro-SF and RAF for April IC
- **Some Challenges**
  - Evaluation of the impact of the information onto the DMPs
- **Conclusion & Perspectives**

The hydrometeorological suite

Seasonal Forecasts
(Ensemble forecast 9 members)
Temperature, Precipitation
Wind, Humidity, Pressure, Radiation (IR+Global)

Water and Energy budget

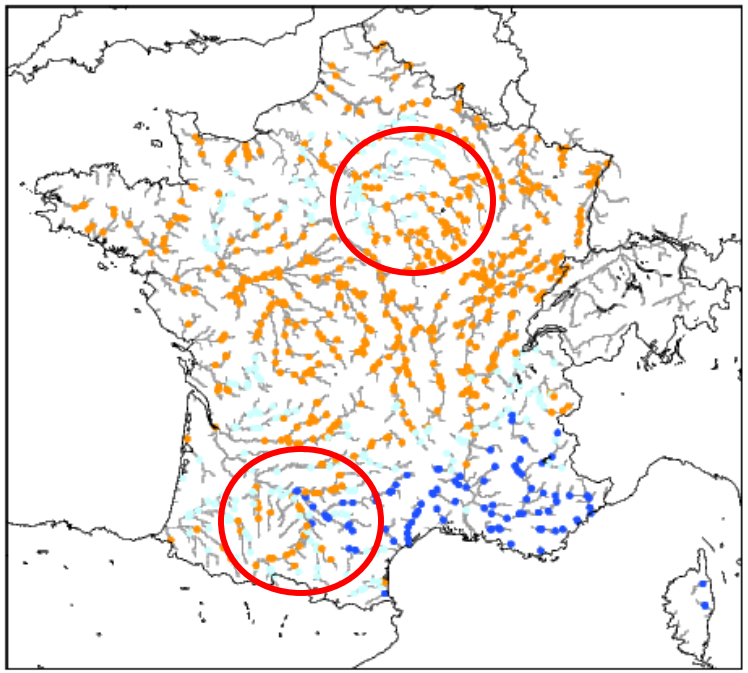
River flow for ~900 stations and Aquifers



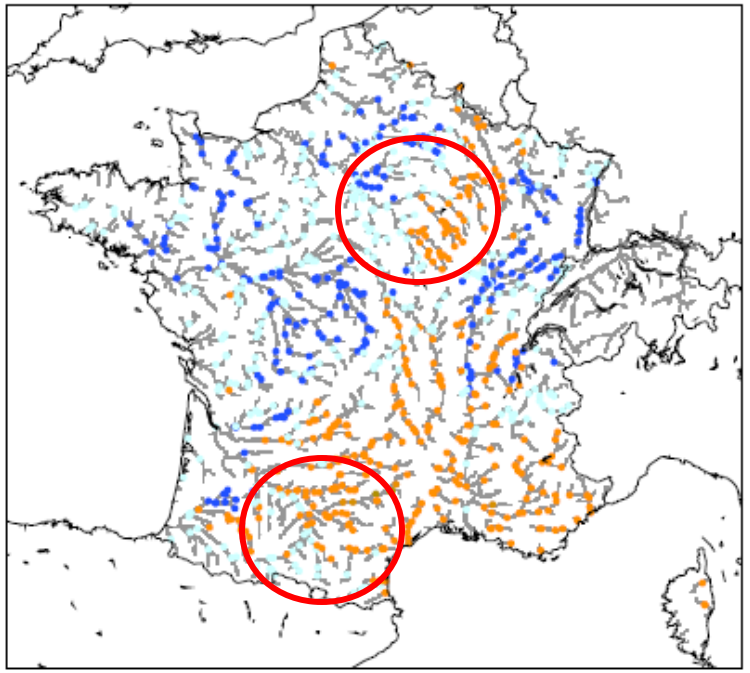
- **Météo-France Arpège** model used in the ENSEMBLES project and Operationnal Forecasting suite (System 3)
- **SAFRAN-ISBA-MODCOU (SIM)** validated over all France (Habets *et al*, 2008) and operational since 2004.

The hydrometeorological suite

Comparison of skills between Hydro-SF and RAF fro River Flow forecasts



Spring (February IC)



Summer (April IC)

Regions where Hydro-SF is significantly better than RAF

Regions where Hydro-SF is equivalent to RAF

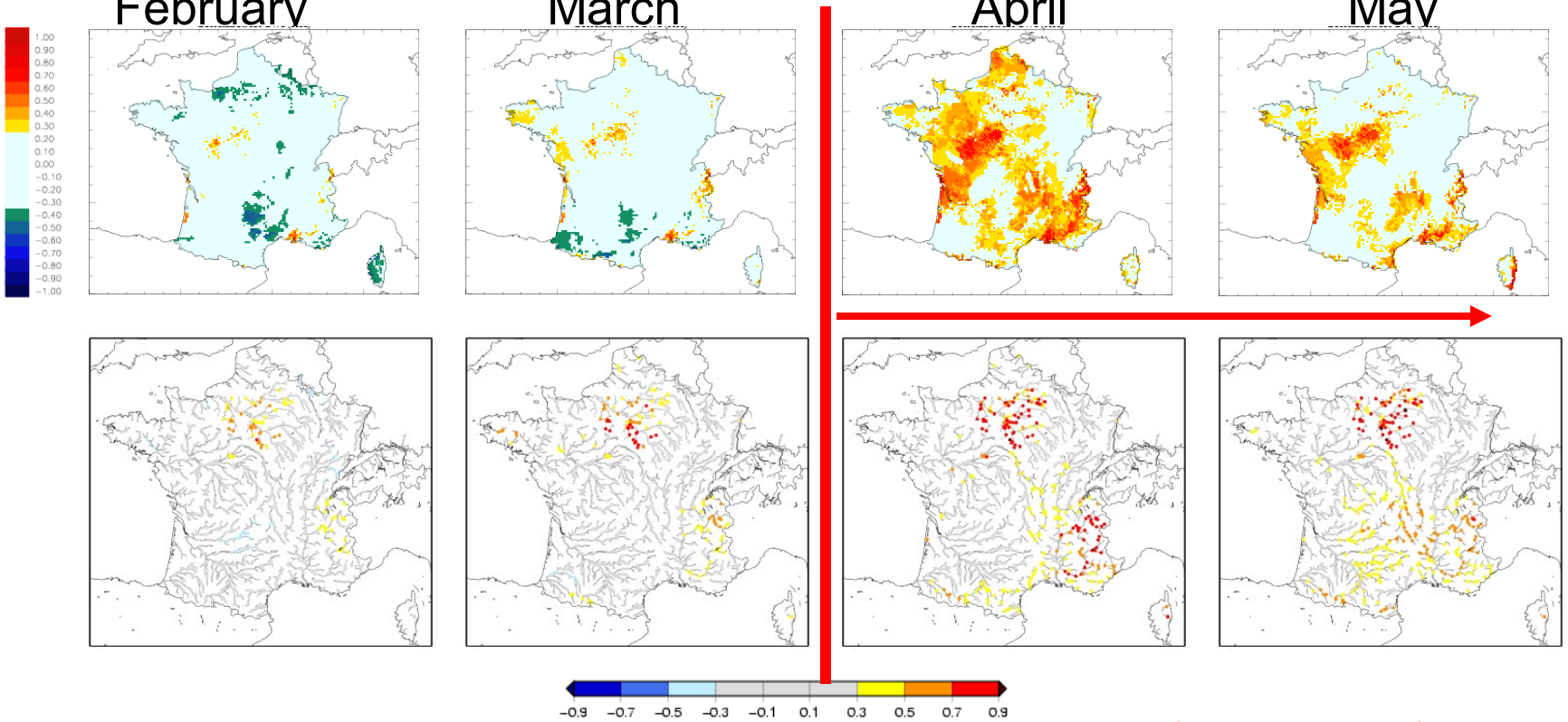
Regions where RAF is significantly better than Hydro-SF

Skills can significantly better for River Flow and SWI than for Temperature and Rainfall

(Ref : Singla 2012)

The hydrometeorological suite

- Correlation for SWI and River Flows over the 1979-2007 period (HYDRO-SF / ARPEGE-S3) for different IC for the summer forecast (JJA)



Correlations > 0.3 significant.
Clear improvement between March and April

No useable information before the beginning of April

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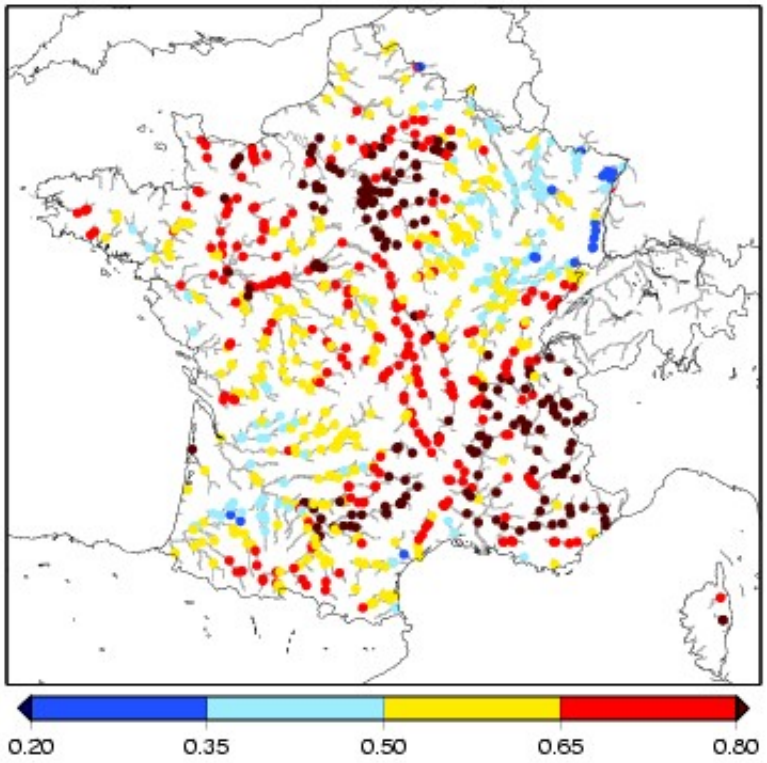
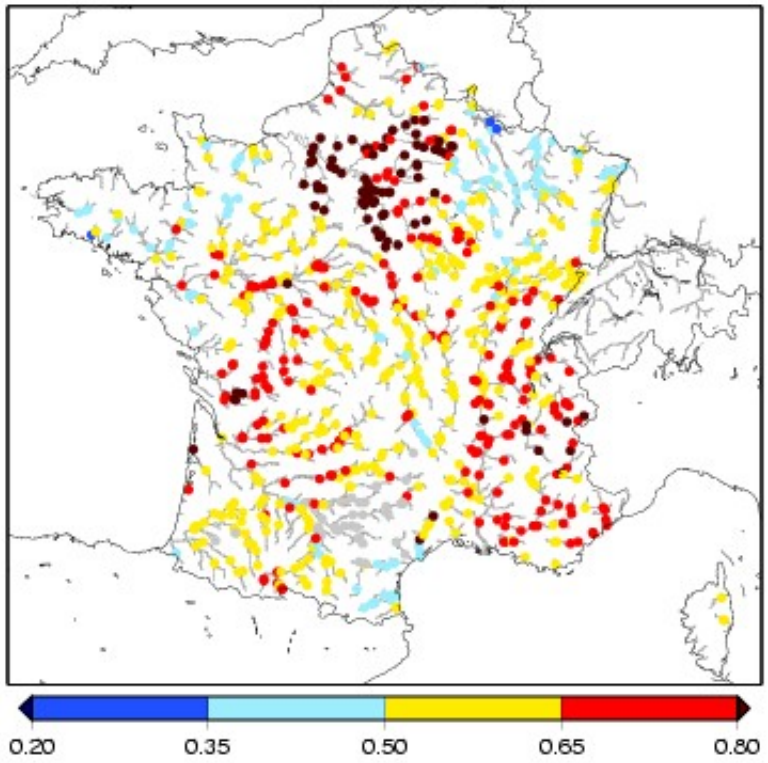
The hydrometeorological suite

ROC scores for Hydro-SF (1979-2007 – IC from 1st of April)



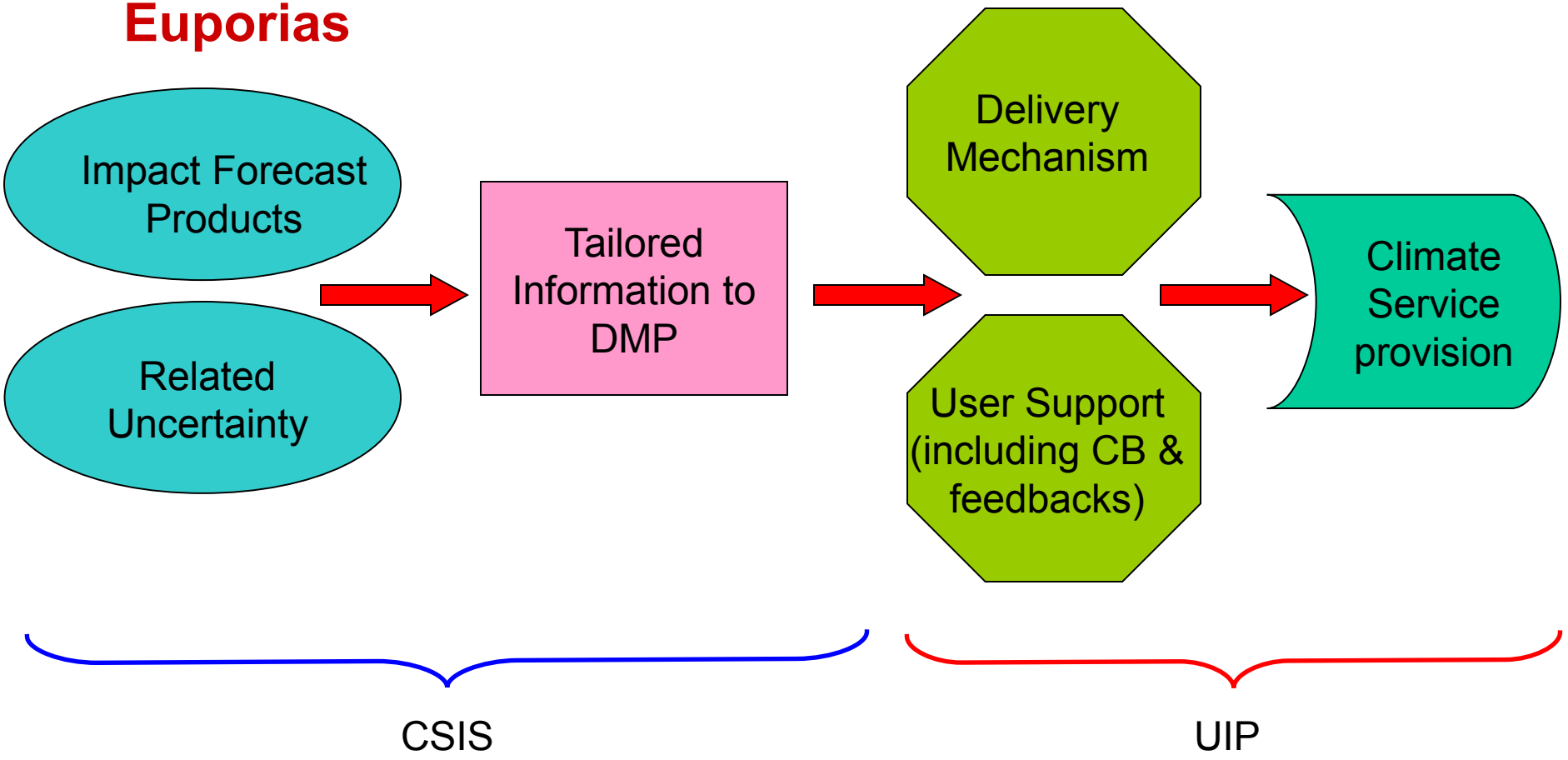
Upper Tercile



Lower Tercile

Which Climate Service ?

- **Schematic vision for a Climate Service within Euporias**



Impact Forecasting suites

General Remarks

- **Impact variables**
  - Directly related to Stakeholder activity
  - Relevant to describe Climate impact onto the user activity
  - Possibly mixing climate and non climate information
- **Impacts models**
  - Similar (in term of processes) to any climate model,
  - Needs of hindcast experience (skill, bias correction, …)
  - Input related to climate and possibly non climate data,
  - Needs of initial conditions and forcing terms along the simulation,
  - Relative weight of climate variables onto the output,
- **Impact forecasting suites**
  - Downstream of the Climate forecasts,
  - Needs for downscaled climate information,
  - Process similar to Climate Forecasts (ensemble forecasts, multi-model issues, uncertainty assessment, probabilistic forecast, …),
  - Output relevant for Decision Making (possibly after some post-processing),

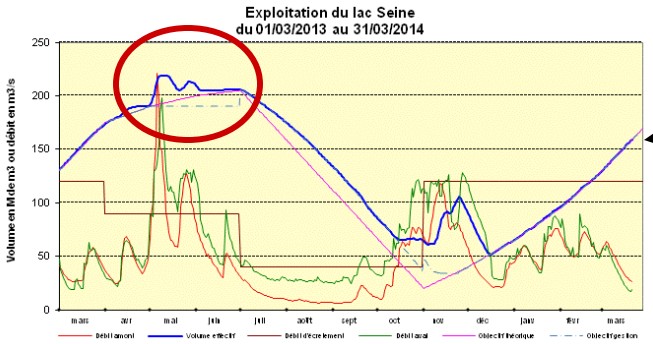
Météo-France prototype

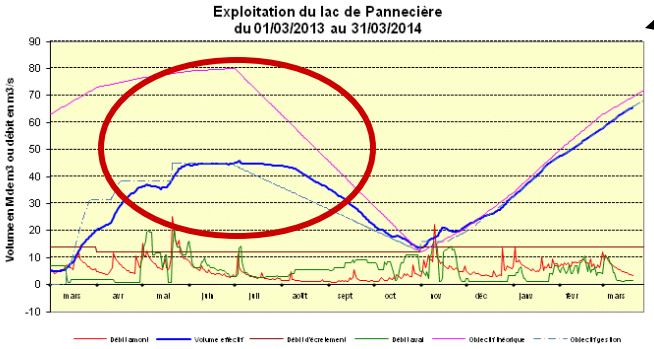
Overview of the main components

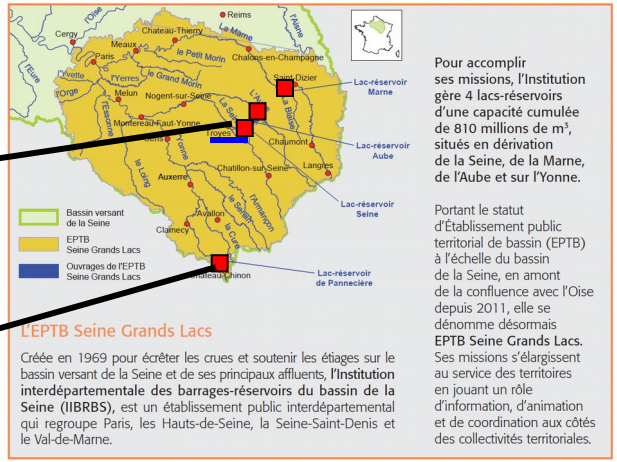
- **River Flow forecasts information based**
  - Predictability related to both atmosphere and surface conditions
  - Better skill for river flow than for atmosphere
  - Better skill than Random Atmospheric Forcing based forecasts (climatology) depending of regions and seasons
- **Stakeholders**
  - Seine River Catchment : EPTB Seine Grands Lacs,
  - Adour-Garonne Catchment : DREAL Midi-Pyrénnées (and SMEAG),
- **Stakes**
  - In summer : major stakes related to fresh water supply and power station cooling (Paris & Seine river) and irrigation (Adour-Garonne)
  - At Spring : major stakes related to the reservoir refilling (all) and flood control (Paris urban area),
- **Decisions**
  - Related to the reservoir refilling and low flow periods
  - Mostly related to the water stock into the reservoirs
  - Technical and Coordination Committees (e.g. COTECO) taking the decision
  - Strong economical impacts

Météo-France Prototype

Management of the Reservoirs







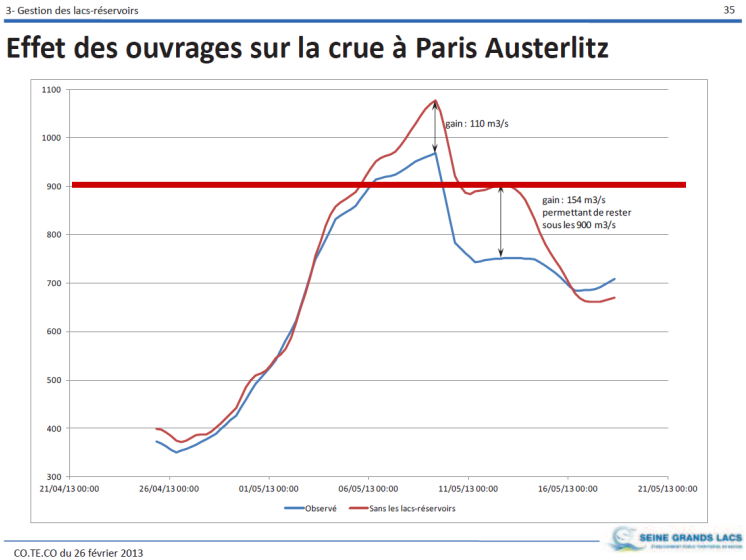
Pour accomplir ses missions, l'Institution gère 4 lacs-réservoirs d'une capacité cumulée de 810 millions de m³, situés en dérivation de la Seine, de la Marne, de l'Aube et sur l'Yonne.

Portant le statut d'Établissement public territorial de bassin (EPTB) à l'échelle du bassin de la Seine, en amont de la confluence avec l'Oise depuis 2011, elle se dénomme désormais **EPTB Seine Grands Lacs.** Ses missions s'élargissent au service des territoires en jouant un rôle d'information, d'animation et de coordination aux côtés des collectivités territoriales.

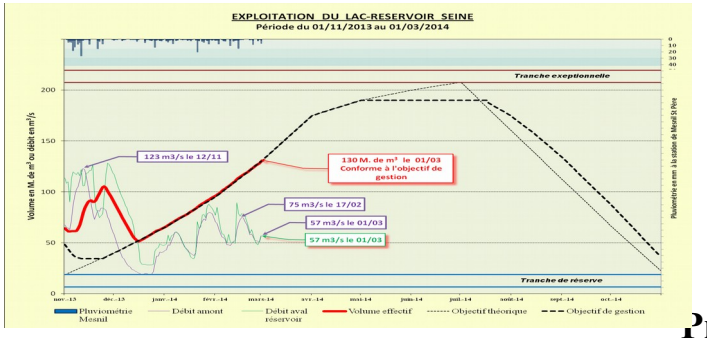
L'EPTB Seine Grands Lacs

Créée en 1969 pour écrêter les crues et soutenir les étiages sur le bassin versant de la Seine et de ses principaux affluents, **l'Institution interdépartementale des barrages-réservoirs du bassin de la Seine (IIBRBS)**, est un établissement public interdépartemental qui regroupe Paris, les Hauts-de-Seine, la Seine-Saint-Denis et le Val-de-Marne.

Flood control



Nevertheless strong damages for Toyes Urban area



Météo-France Prototype

Management of the Low Flow period

Bilan hydrologique sur la période 2001-2012 (efficacité du soutien d'étiage)
(Illustration n°3)

Année au DOE non satisfait — Année au DOE satisfait

À Portet-sur-Garonne

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
AVEC soutien d'étiage	2001						2007		2009		2011		3 années sur 12
SANS soutien d'étiage													7 années sur 12
Années :	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	

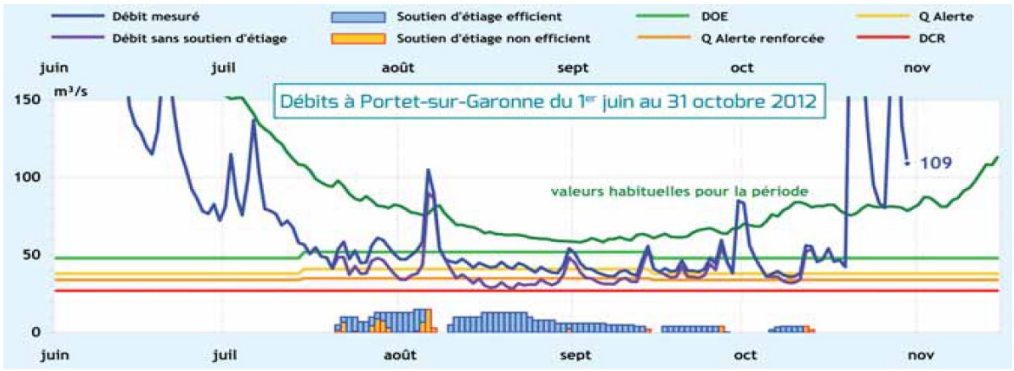
À Lamagistère

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
AVEC soutien d'étiage	2001							2008		2010	2011		6 années sur 12
SANS soutien d'étiage													10 années sur 12
Années :	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	

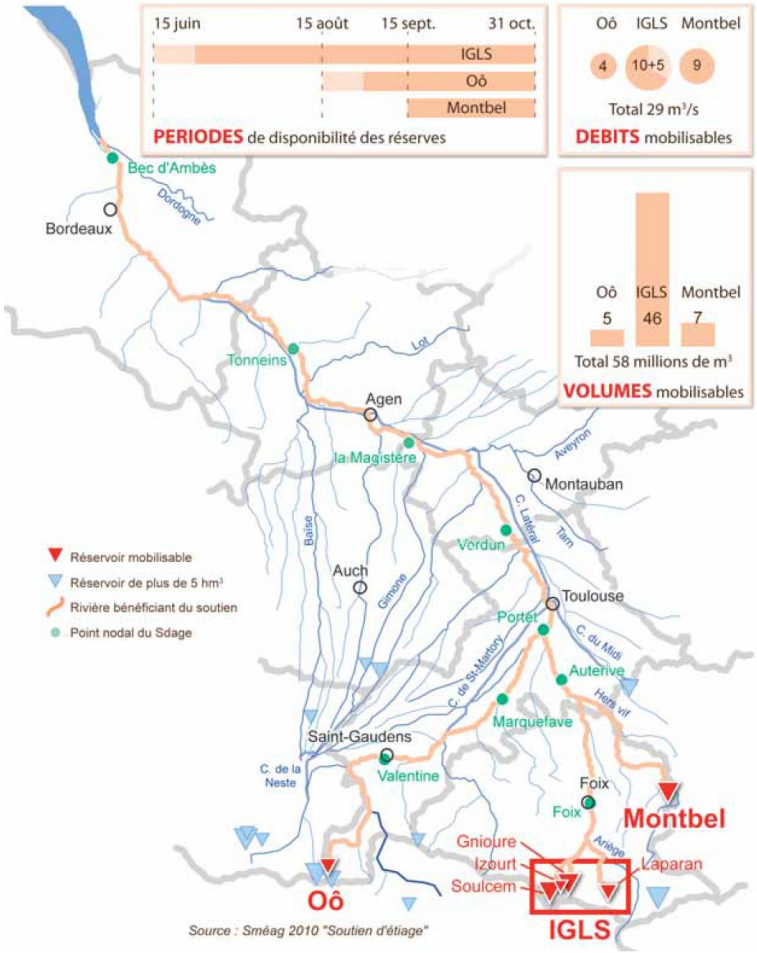
À Tonneins

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
AVEC soutien d'étiage									2009	2010		2012	3 années sur 12
SANS soutien d'étiage													7 années sur 12
Années :	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	

Bilan hydrologique 2012, avec et sans soutien d'étiage, à Portet-sur-Garonne
(Illustration n°4)



Le dispositif de soutien d'étiage de 2013 reconduit sur la période 2014-2018
(Illustration n°7)



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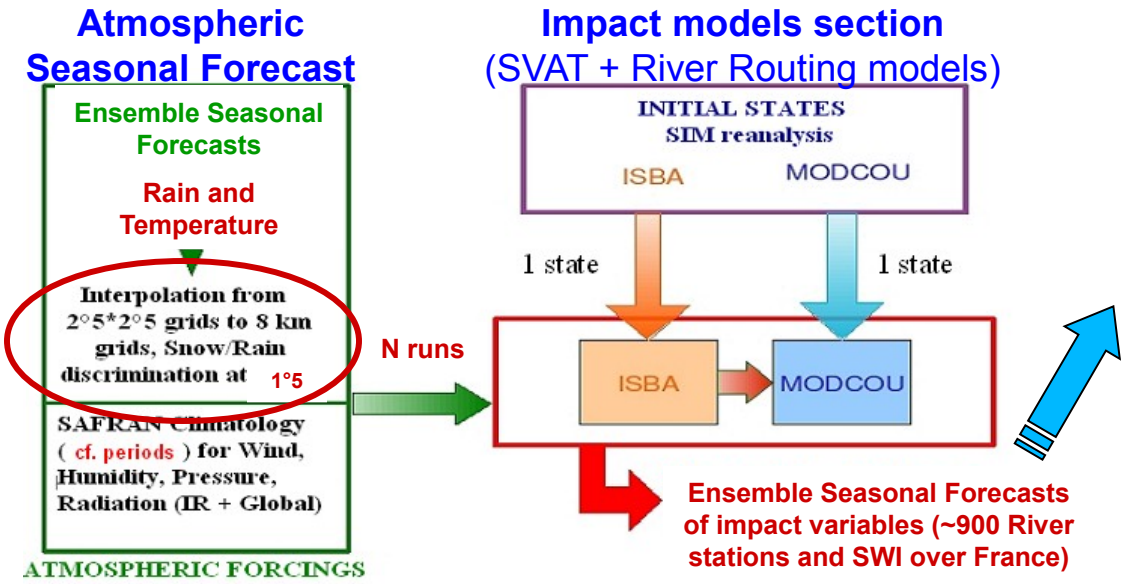
Météo-France Prototype

Schematic representation of the Water resource prototype (within Euporias)



- **Tailoring the climate information** to the needs of the DMPs of our stakeholders - critical thresholds and related risk assessment for decisions
- **Conveying the probabilistic information** up to the Decision Making Processes

Feedback tp the previous section

- **Running the DMPs** in a retrospective mode (over the hindcast period) with 2 set of forecasts as proposed in the Placebo protocol
- **Assessing the added value of the seasonal forecast**, the impact of the use of the information onto the DMPs and the relative weight of the Climate Information within the DMPs (thanks to the Placebo protocol)

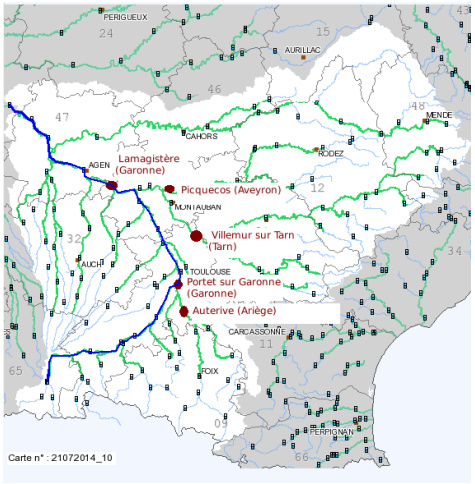
- **Building the Climate Service prototype** first tailored to our specific stakholders and their DMPs
- **Providing the Climate Service in operational mode** using web based services and existing web plateforms (to be likely adpated) at Météo-France
- **Extending the Climate Services** across France, application domains (e.g. Energy, Agriculture) and potentially across Europe

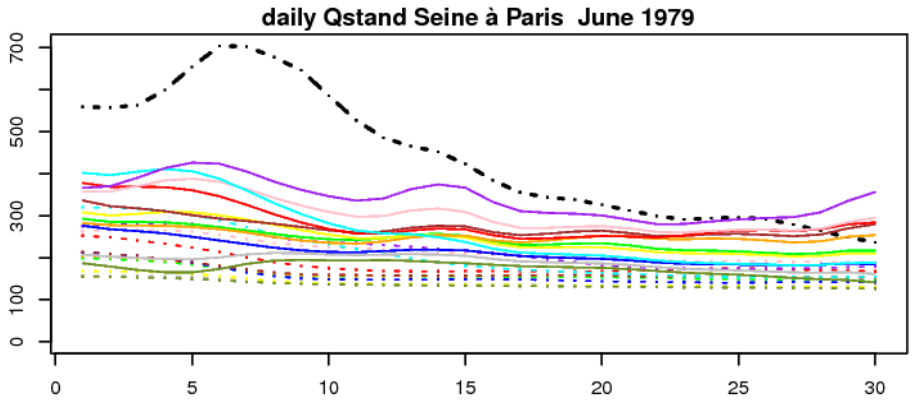
Tailored information to DPMs

- Tailored Information for the Low Flow period
  - **Provision to EPTB (Seine) and SMEAG (Adour-Garonne)**
    - At key stations used into the DMPs
    - End of Spring (May – beginning of June) with possible insight up to end of November (forecast updated each month useful)
    - River Flow Monthly means : Climagrams
    - River Flow Daily time series :
      - ✓ Ensemble Median, outer Deciles (and Quintile possibly),
      - ✓ For additional simulation (EROS model over the Marne river)
    - River Flow “0” rain scenario (daily values) : for assessing the maximum volume of water to be released (worst scenario).
    - Additional products : Water Volume integrated along the period, Number of days below the relevant thresholds
  - **Communication**
    - Products : Graphics and Digital
    - Risk assessment : Odds or relative Odds instead probabilities

Tailored information to DPMs

- Some examples

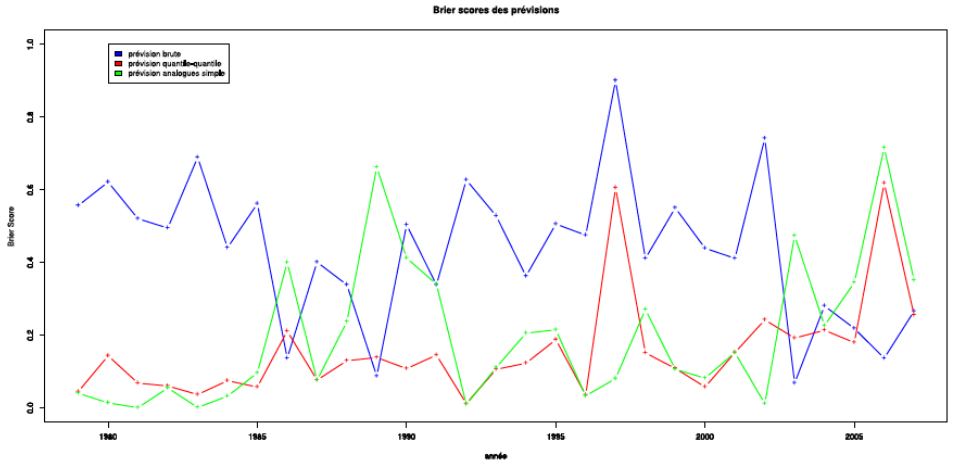




Key Stations used by the SMEAG

Tailored information to DPMs

- Calibration of the River Flows (with respect of stakeholders data)
  - **Several methods tested against raw forecasts**
    - Quantile/Quantile correction,
    - Analogues
      - ✓ Ensemble Median or Ensemble mean, number of analogues, Time window considered,
    - PDF adjustement,



Comparison of Brier Scores for different calibration methods over the Hindcast period (1979-2007) at Lamagistère (S1 – Garonne)

Stat.	S1 Gar.	S2 Gar.	S3 Tarn	S4 Ave.	S5 Ariè.
Met.	**QQ**	**QQ**	**QQ**	**ANA 1**	**QQ**

Best calibration method for different rivers and stations (period 1979-2007)

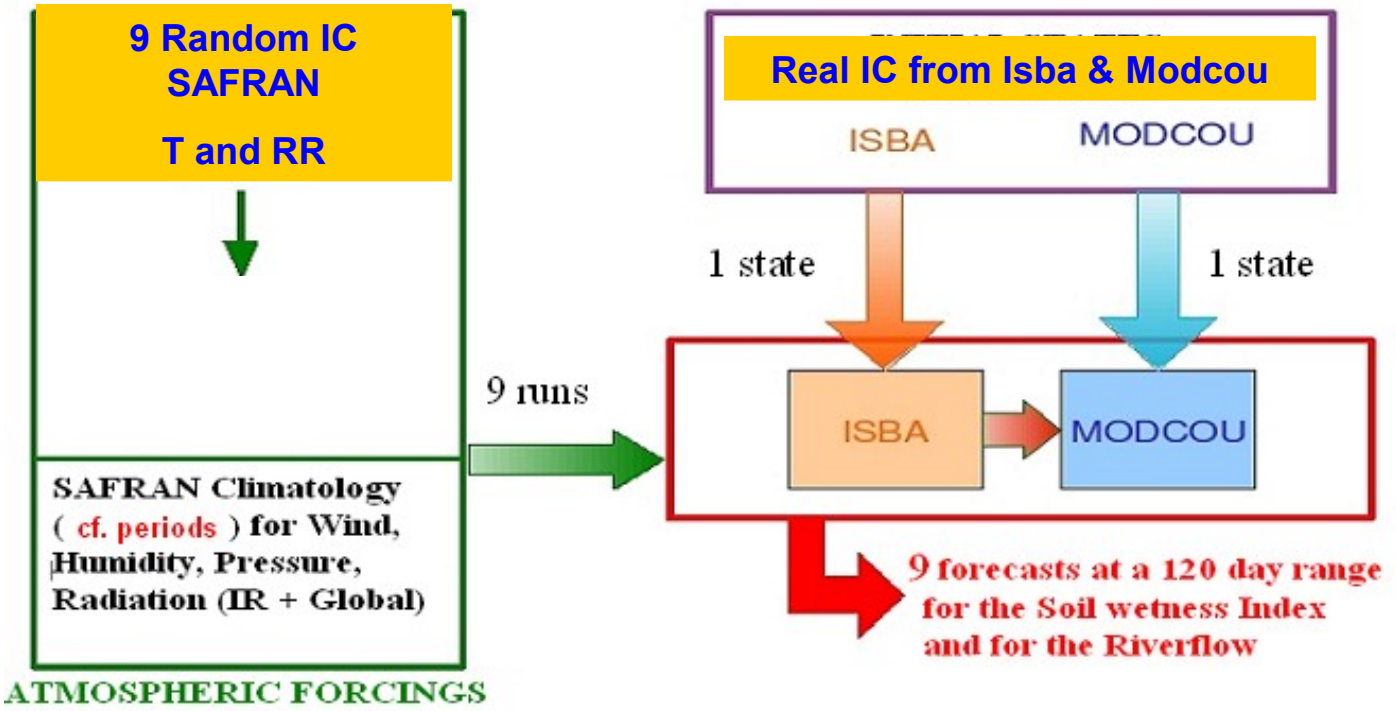
The QQ correction is the best calibration method most of the time

Some Challenges

- Placebo Protocol
  - **Method proposed to stakeholders**
    - Provision of 2 set of hindcasts (set 1 and set 2),
    - Set 1 and set 2 indistinguishable, used in blinded-like mode
    - Years not in chronological order,
    - Stakeholders “replaying” (if possible) 30 years of decisions,
    - Issuing a comprehensive analysis of the Decision made,
      - ✓ Set 1 , Set 2 and Past decisions
      - ✓ Note the need to define what is a “good” decision, a ”bad” decision and likely an “acceptable” decision
  - **Expected results**
    - To assess the added value of the impact forecasts (vs random atmospheric forcing),
    - To assess the impact of using impact forecasts on decision made,
    - To assess to some extent the relative weight of CI into DMPs,
    - To provide (if relevant) recipes usable to demonstrate the interest and the value of the provided Climate impact forecasts and beyond of the provided Climate Services.

Some Challenges

- Reference Strategy
  - Random Atmospheric Forcing - **Additional forecast**



- Period from 1958 to 2005 (ENSEMBLES) – 9 members
- Period from 1979 to 20012 (System3) – 9 or 11 members

Conclusions & Perspectives

- Predictability sources for Spring (Singla *et al.*, 2012)
  - Snow in mountainous regions (Alps and Pyrenees)
  - Aquifer for the Seine river catchment
  - Atmosphere over plain regions (to the exception of specific regions) ; mostly T2m and total precipitation.

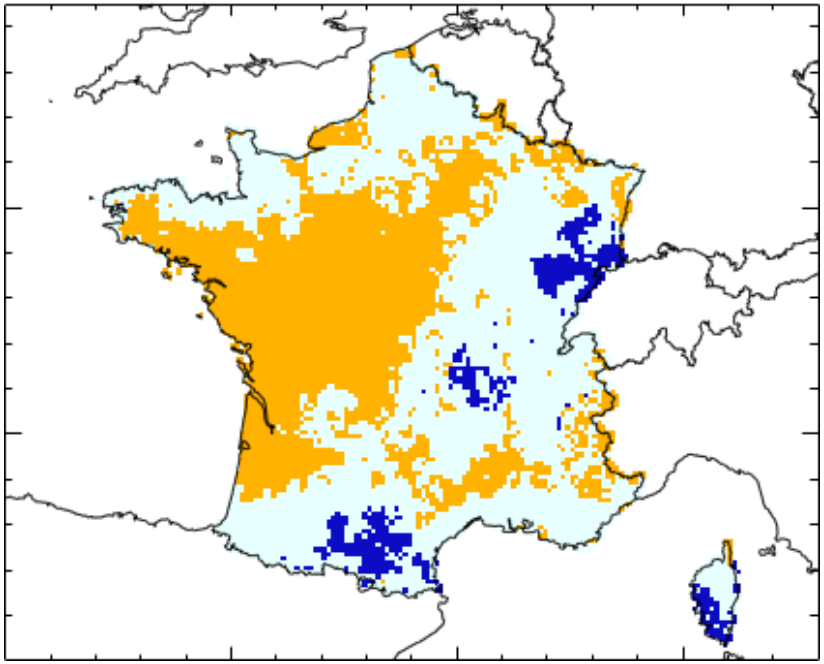
- Evaluation of Hydro-SF for Spring (Singla *et al.*, 2012)
  - For SWI : better performance (vs RAF) over the half North of France
  - For River Flow : better performance over a large portion of France
  - For both : Degradation over regions close to the Mediterranean basin

A faire !!!

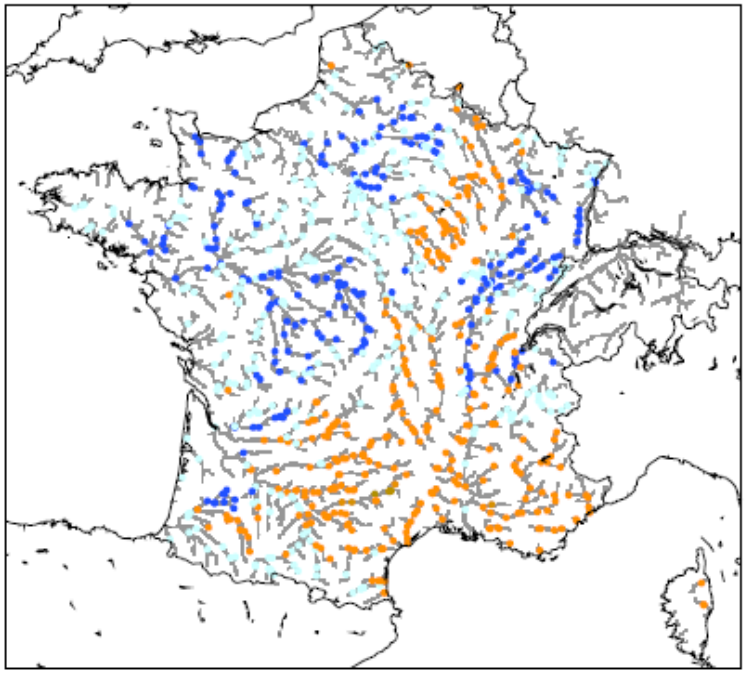
Thank you for attention

Results for Summer (JJA)

Comparison of correlations between Hydro-SF (April IC) and RAF



SWI



River Flow

Regions where Hydro-SF is significantly better than RAF

Regions where Hydro-SF is equivalent to RAF

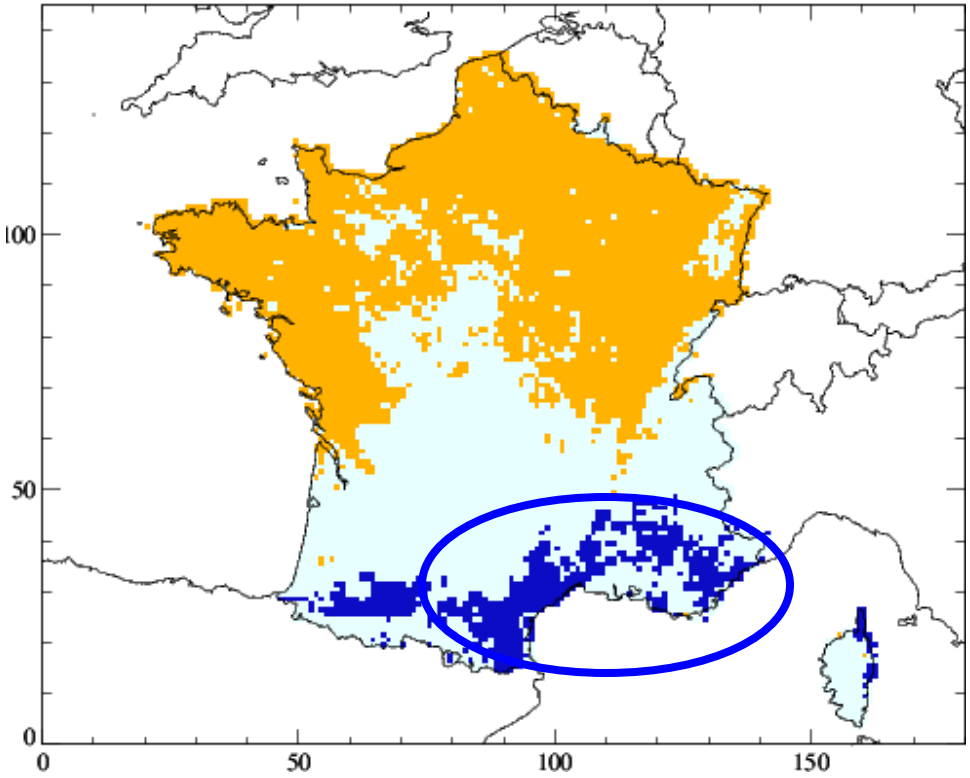
Regions where RAF is significantly better than Hydro-SF

Results for Spring (MAM)

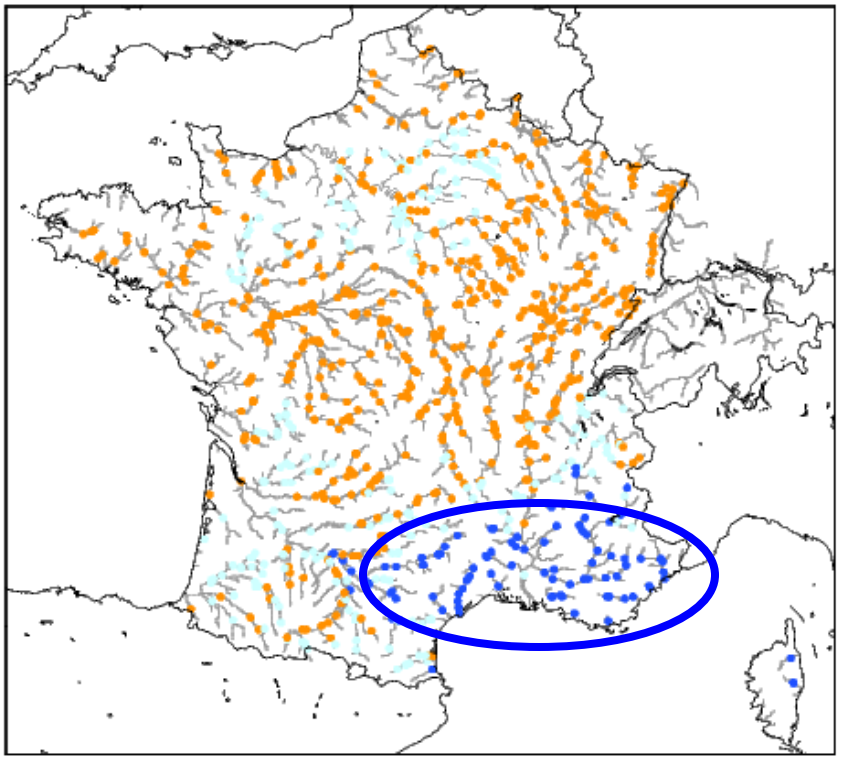
Comparison of correlations between Hydro-SF and RAF – IC 1st of February

(Singla *et al.*, 2012)

SWI



River Flow



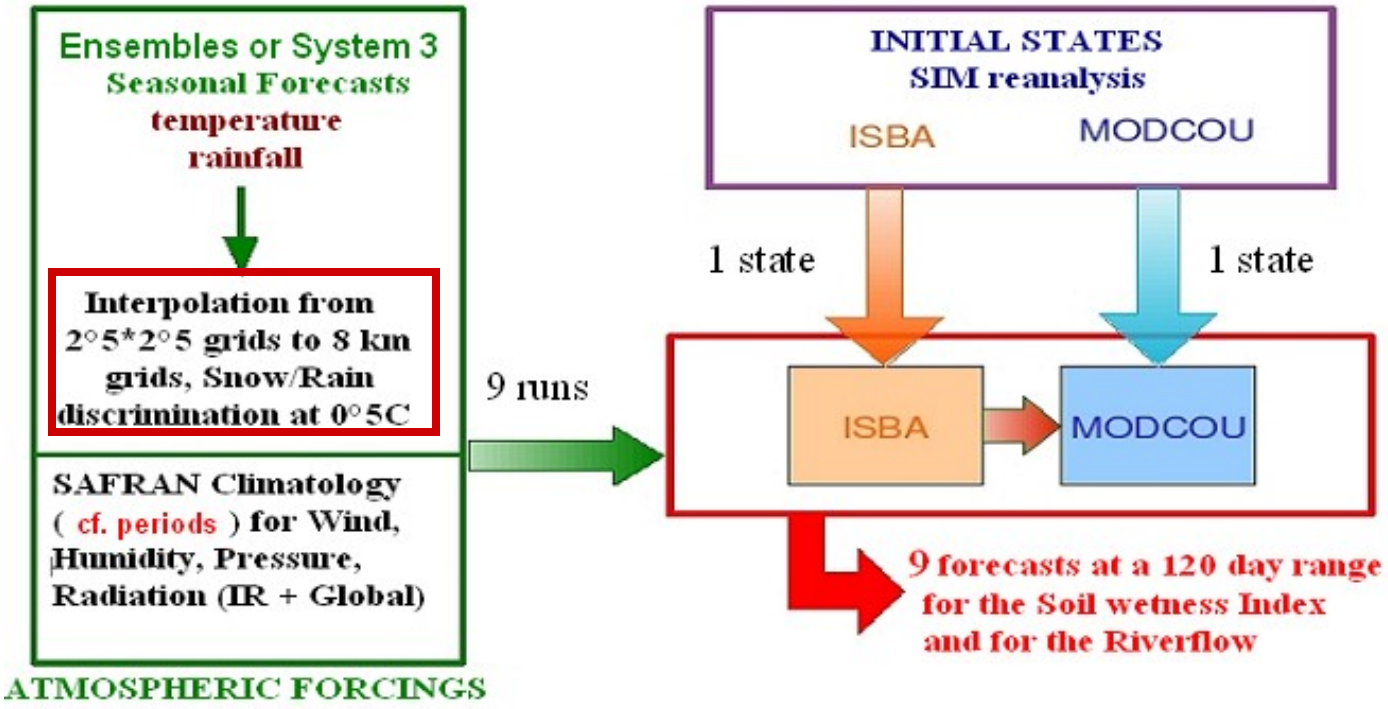
Regions where Hydro-SF is significantly better than RAF

Regions where Hydro-SF is equivalent to RAF

Regions where RAF is significantly better than Hydro-SF

The hydrometeorological suite

- Method adapted from the medium range ensemble riverflow forecast (Tanguy - 2009, Céron *et al.* - 2010)



- Period from 1958 to 2005 (ENSEMBLES) – 9 members
- Period from 1979 to 2007 (System3) – 9 or 11 members

Conclusions & Perspectives

- Predictability for Summer
  - Predictability barrier between March and April
  - Aquifer for the Seine river catchment (stronger than for Spring)
  - Snow for Northern Alps river catchments

- Evaluation of Hydro-SF for Summer
  - For SWI : better performance (vs RAF) over the Western regions
  - For River Flow : better performance over Southern regions (and part of North-Eastern regions)

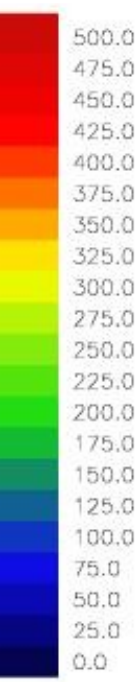
Conclusions & Perspectives

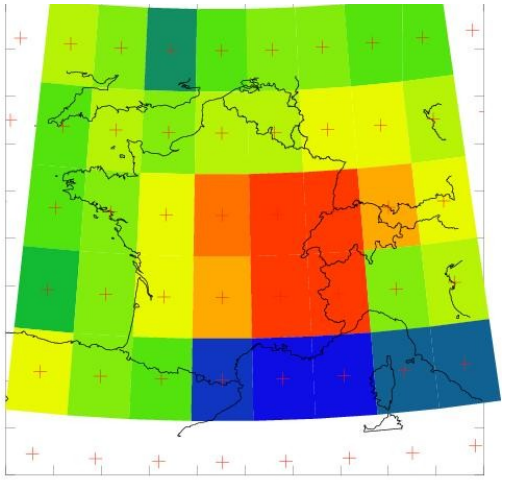
- Perspectives on the Hydro-SF suite
  - Improvement of the initial conditions (snow, river flow, aquifers …)
  - Improvement of the atmospheric forcing (seasonal forecast, downscaling …)
  - Models improvements
    - Arpège system 5
    - Isba (better snow representation, vegetation, …)
    - Modcou (implementation of other aquifers in progress, …)
  - Multi model approaches
- Evaluation of the usefulness of the information
  - Comparison with observed river flows
  - Euporias project (FP7 EU funded project – coordination UK Met Office)
  - Stakeholders at the river catchment and national levels
    - Seine river basin agency and DRIIE (institutional)
    - Adour-Garonne river basin agency and DREAL (institutional)
    - National Drought committee

The spatial downscaling

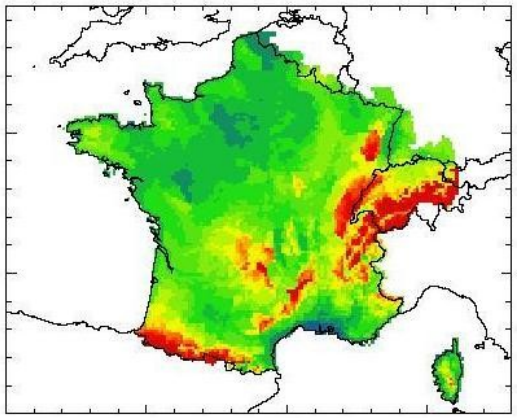
- Adaptation of the downscaling used for the medium range ensemble riverflow forecast (ROUSSET-REGIMBEAU,2007)

Accumulation (mm) on March-April-May 1998

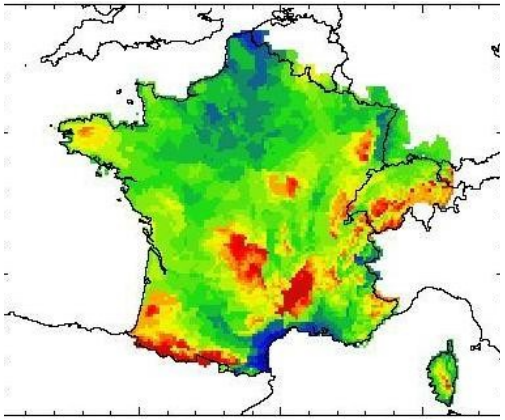




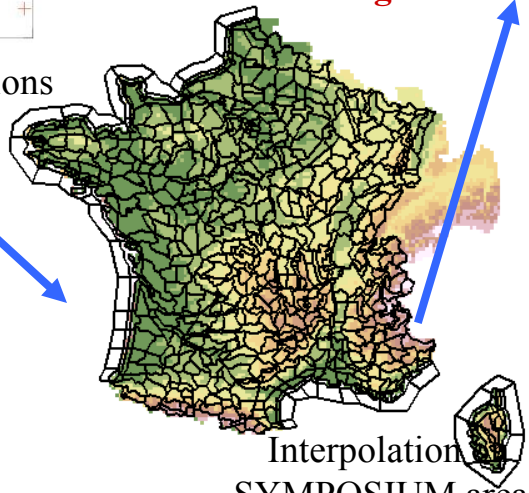
Seasonal forecast : precipitations



downscaling on ISBA mesh 8km



SAFRAN reference



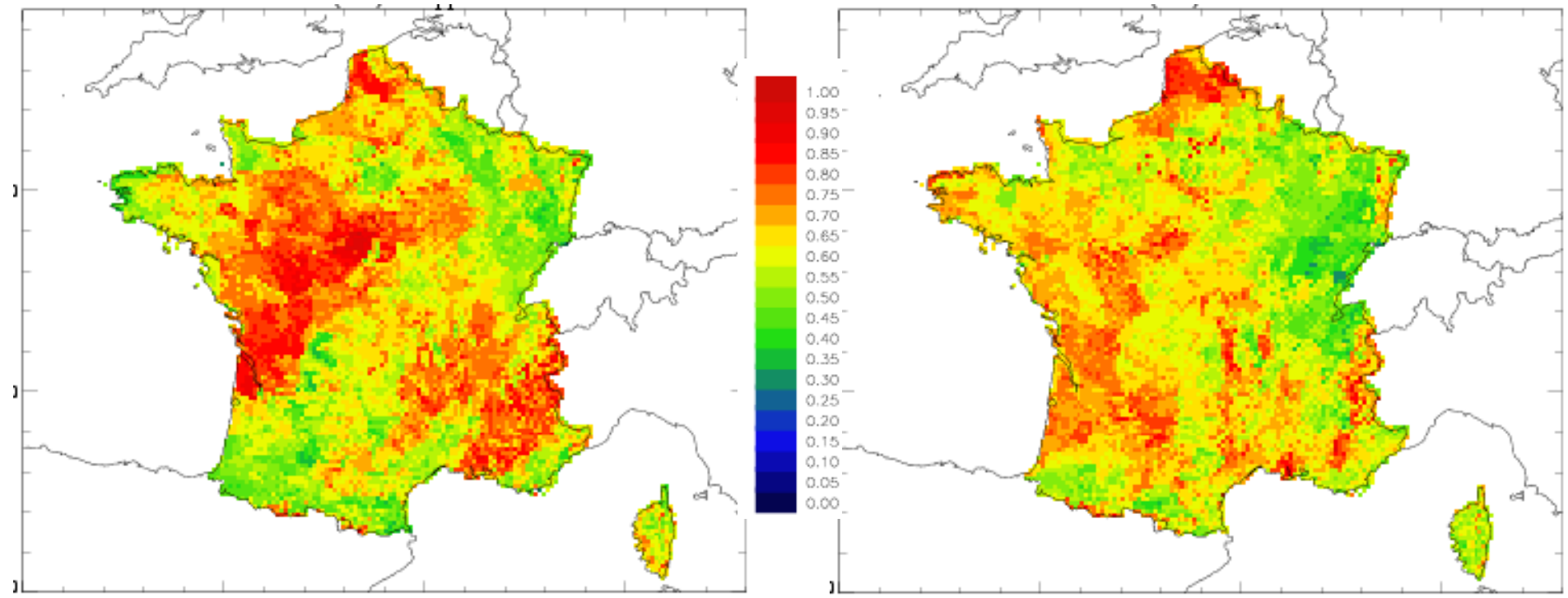
Interpolation
Distance
$1/r^2$

Considering local properties by using the Safran Climatology for computing the local anomaly (and then the value)

Interpolation on SYMPOSIUM areas

Results for Summer (JJA)

ROC scores for Hydro-SF (1979-2007 – IC from 1st of April)



Upper Tercile **Lower Tercile**

METEO FRANCE
Toujours un temps d'avance