Hydrological forecast systems using SURFEX

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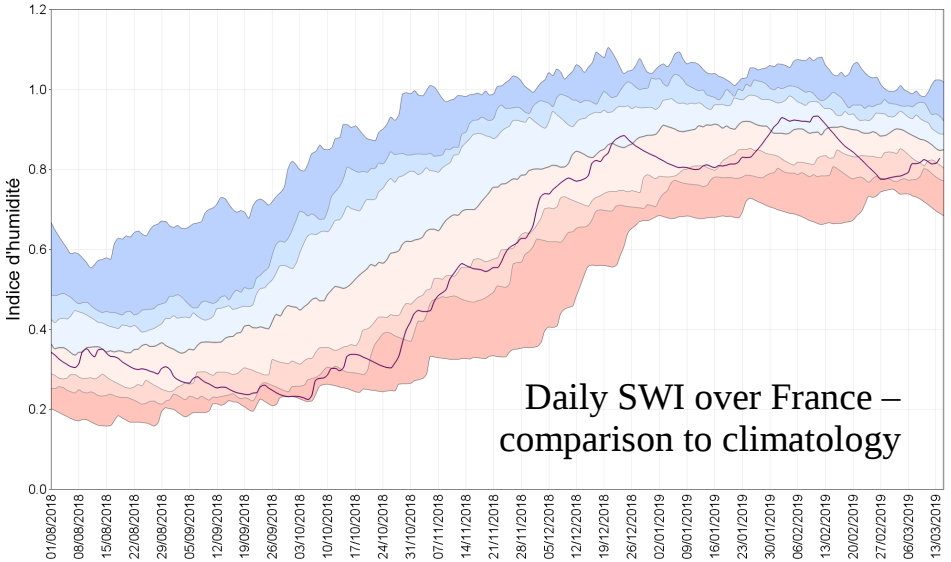
Toulouse, 19/03/2019

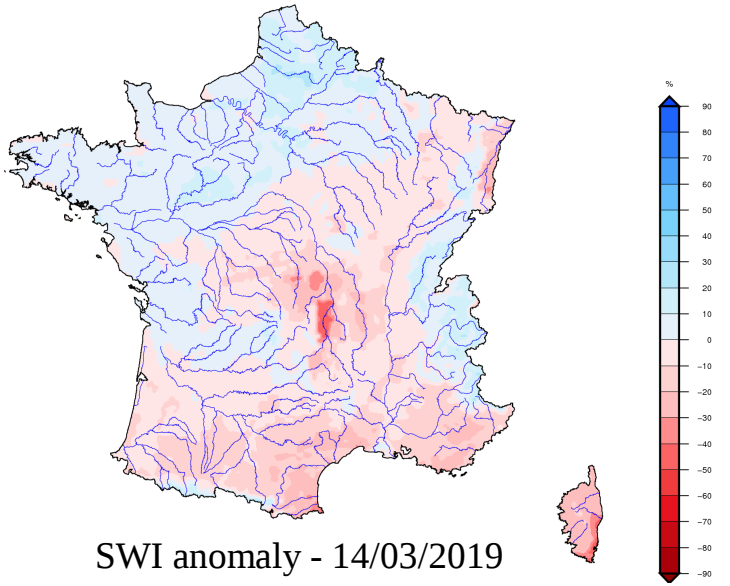
Context

- Since 2003 Météo-France operates daily the SAFRAN-SURFEX-MODCOU model chain for water ressources real-time monitoring
- SAFRAN-SURFEX-MODCOU reanalysis [August 1958 – Present]

SAFRAN	SURFEX (ISBA-DIF)	MODCOU
Input *:* *Guess + Observations*	***Input*** *:* *Atmospheric forcing*	***Input*** *:* *Drainage & Runoff*
Output *:* *Atmospheric forcing 8km grid – hourly time step*	***Output*** *:* *Water & Energy fluxes*	***Output*** *:* *Daily river discharges*



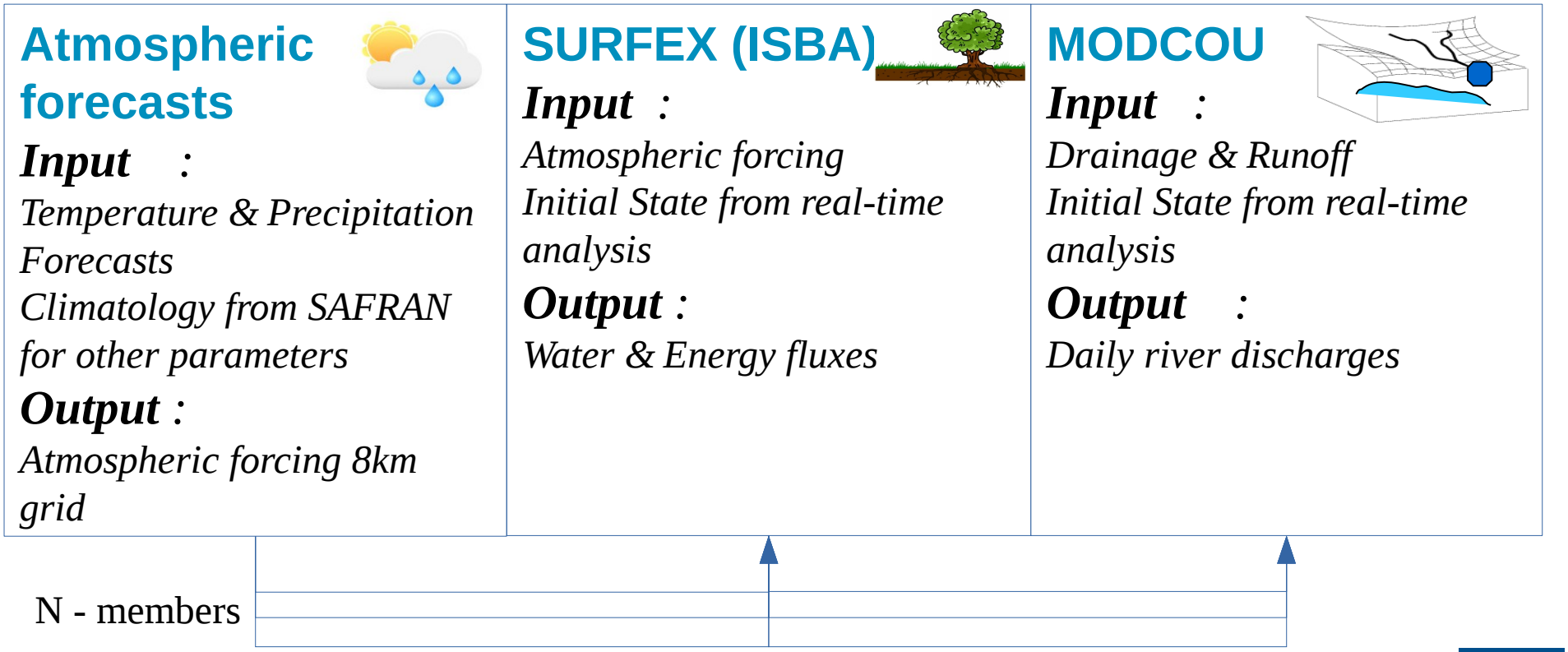
Daily SWI over France – comparison to climatology



SWI anomaly - 14/03/2019

Context

- Forecast applications, use of:
  - atmospheric forecast instead of SAFRAN analysis forcing,
  - real-time analysis outputs for SURFEX & MODCOU initial states from



Plan

1) 10-day range Hydrological Ensemble Prediction System
2) Hydrological LongTerm Prediction Systems

1) 10-day range Hydrological Ensemble Prediction System

- Atmospheric forecasts: EPS from ECMWF
- 3hourly temperature & precipitation - resolution 0.25° ; interpolated on the 8km grid
- Validity: up to 10 days
- Frequency: 1 per day – Base time 00hUTC
- Validation over 2 years ; Reference : SAFRAN-SURFEX-MODCOU Reanalysis

- Application for flood episods :
  - End user : authority in charge of flood forecasts (SCHAPI)
  - Information at some specific locations with 2 thresholds <=> yellow/orange awareness levels

Site expérimental réservé au réseau de la prévision des crues SCHAPI-SPC et à Météo-France

Pour télecharger la documentation sur la prévision hydro-météorologique SIM, cliquer ici

Documentation sur l'utilisation des prévisions d ensemble météorologiques à la résolution de 0.25° (effectif depuis le 02/04/2013 00H UTC) cliquer ici

Page Générale

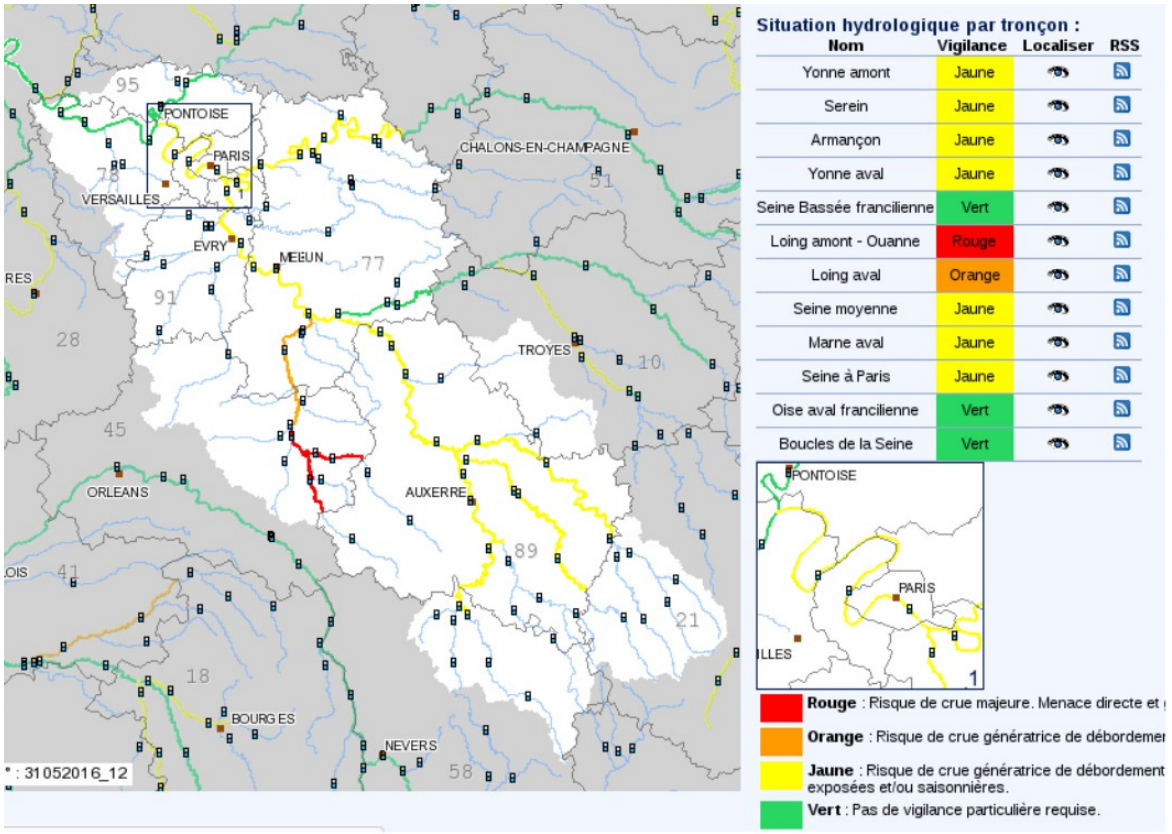
Tableau général d alerte crue

Date de dernière mise à jour : lundi 28 janvier 2019 15:30:02 GMT

Nom du SPC	Risque Max seuil Moy %	Risque Max seuil Haut %	Nom du SPC	Risque Max Seuil Moy %	Risque Max Seuil Haut %
SPC Meuse-Moselle	0	0	SPC Rhin-Sarre	0	0
SPC Seine aval-Cotiers Normands	31	0	SPC Oise-Aisne	0	0
SPC Seine amont-Marne amont	0	0	SPC Seine Moyenne Yonne Loing	0	0

1) 10-day range Hydrological Ensemble Prediction System

- Study Case May-June 2016 flood event over Seine Basin (31/05/2016)



Situation hydrologique par tronçon :

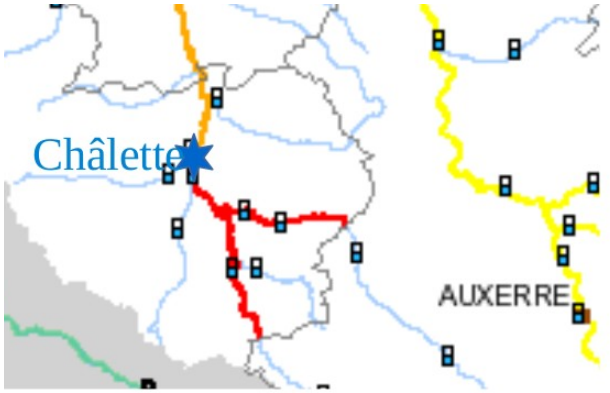
Nom	Vigilance	Localiser	RSS
Yonne amont	Jaune		
Serein	Jaune		
Armançon	Jaune		
Yonne aval	Jaune		
Seine Bassée francilienne	Vert		
Loing amont - Ouanne	Rouge		
Loing aval	Orange		
Seine moyenne	Jaune		
Marne aval	Jaune		
Seine à Paris	Jaune		
Oise aval francilienne	Vert		
Boucles de la Seine	Vert		

Rouge : Risque de crue majeure. Menace directe et

Orange : Risque de crue génératrice de débordemer

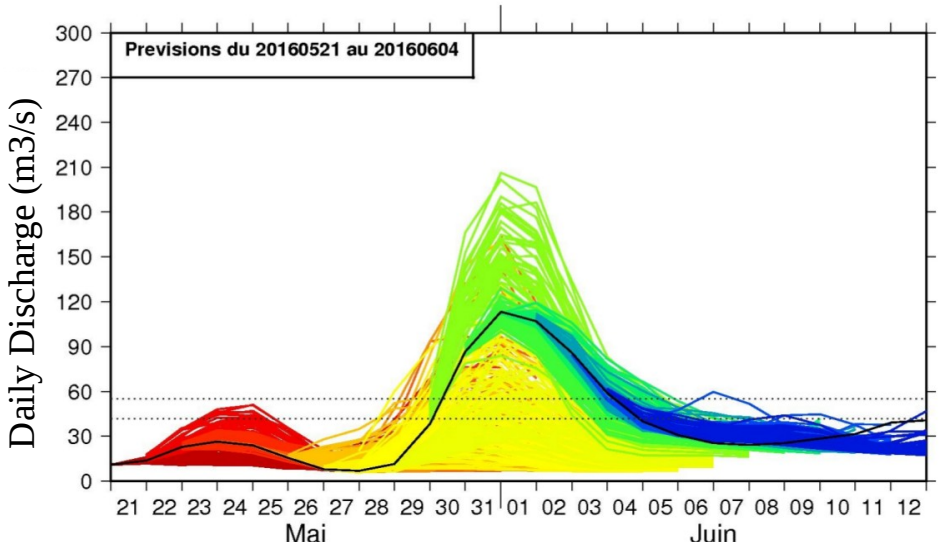
Jaune : Risque de crue génératrice de débordement exposées et/ou saisonnières.

Vert : Pas de vigilance particulière requise.

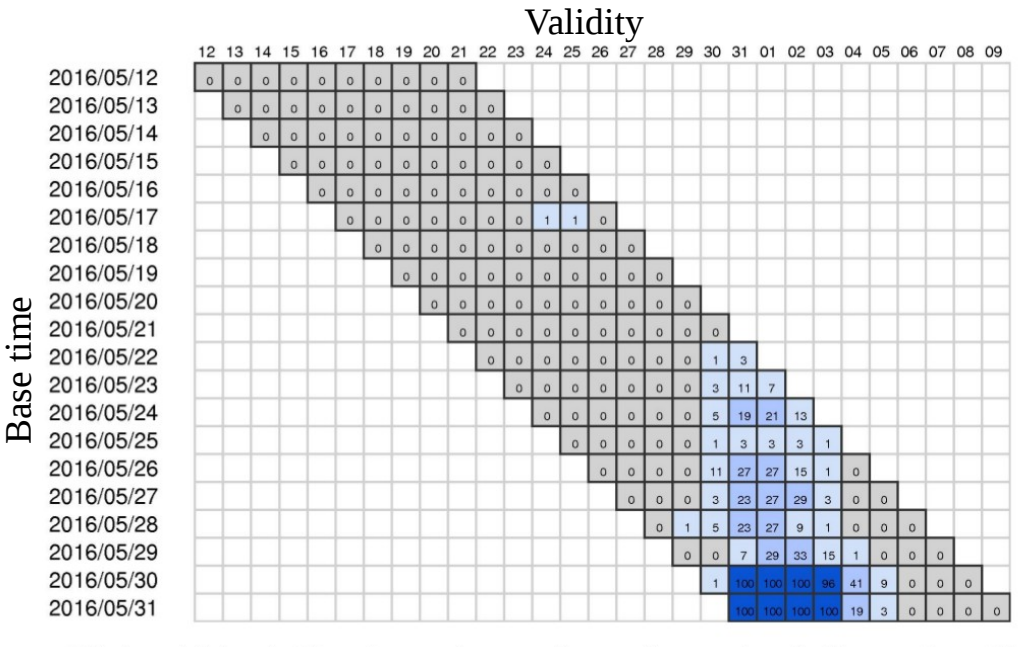


1) 10-day range Hydrological Ensemble Prediction System

- Study Case May-June 2016 flood event over Seine Basin. Station Chalette – Loing River



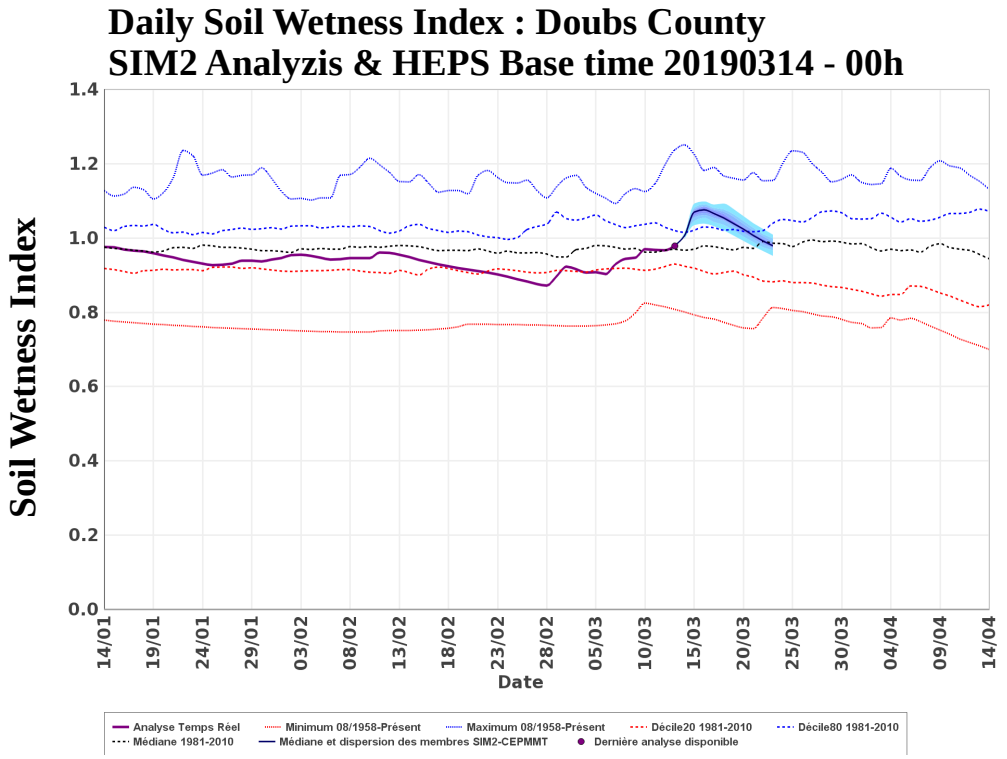
Forecasts from 21/05/2016 Base time to 04/06/2016 Base time

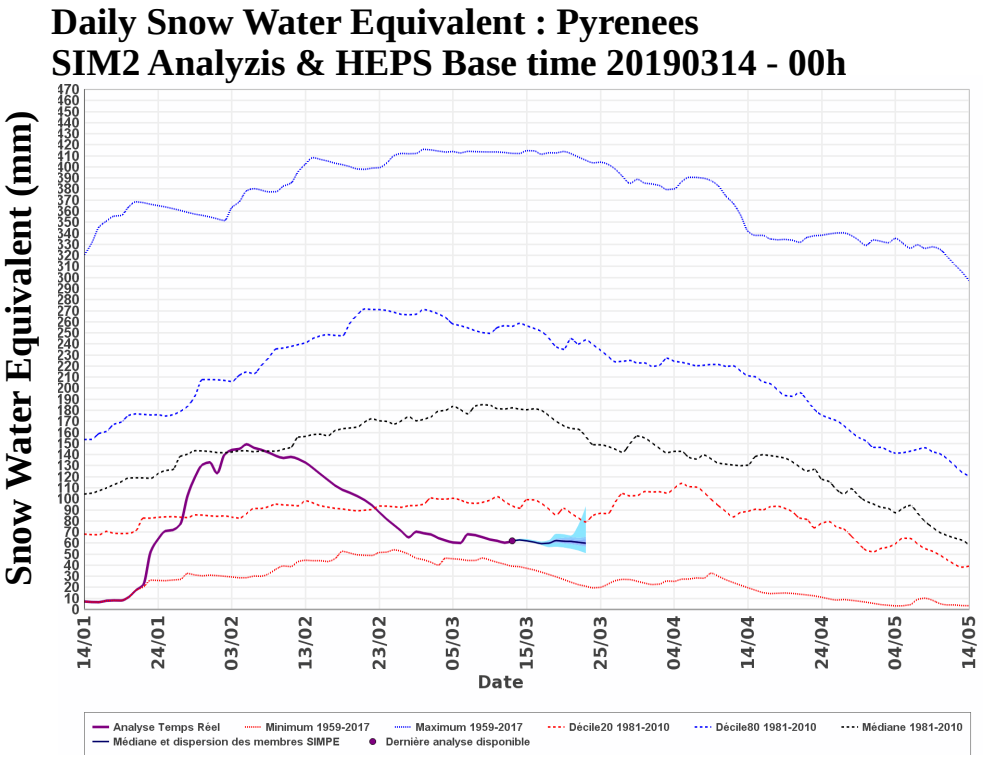


Awareness table for the highest threshold 12/05/2016 Base time to 31/05/2016 Base time

1) 10-day range Hydrological Ensemble Prediction System

- Application for water ressources management
  - Main variables: SWI & SWE





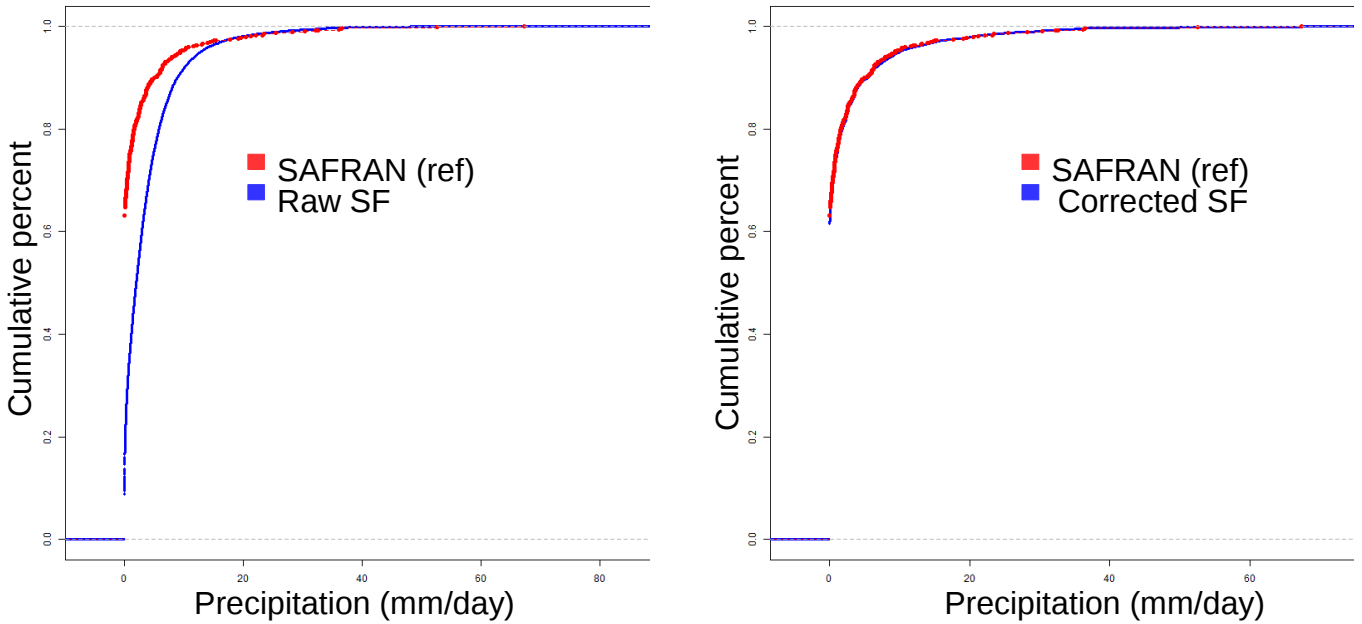
Plan

1) Hydrological Ensemble Prediction System
2) Hydrological LongTerm Prediction Systems

2) Hydrological LongTerm Prediction Systems

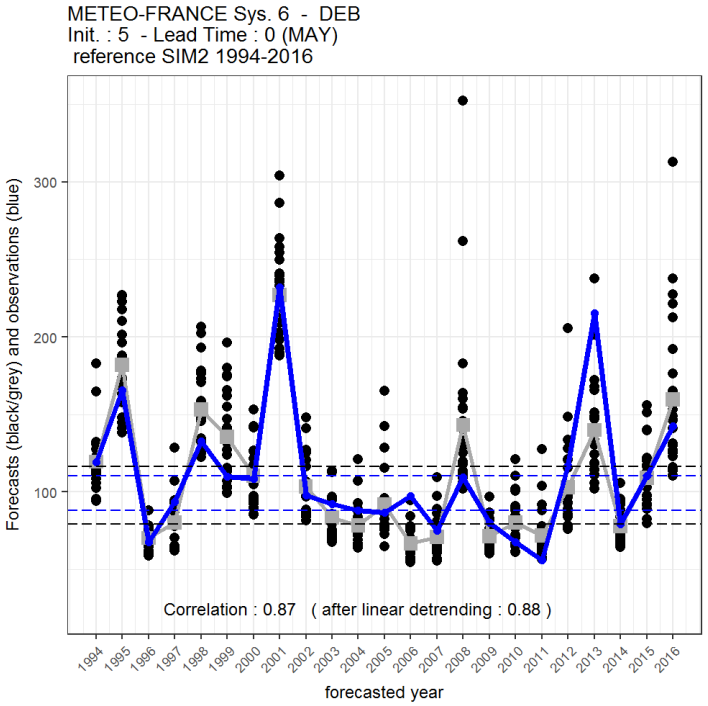
- Two kind of long-term prediction systems (up to 6-months):
  - **Climatological forecasts**: Atmospheric forecasts = Forcing from SAFRAN reanalysis (1958-present)
  - **Seasonal forecasts** : Atmospheric forecasts from Météo-France System 6
    - Available each month – Lead-time: 7months / 51 members / Resolution @ 0.5°
    - Need to be corrected to force impact models, Correction of daily precipitation & 6h-temperature with quantile mapping. Quantiles from:
      - Hindcast of the SF system: 1993-2016 period – 25 members
      - SAFRAN reanalysis (reference)

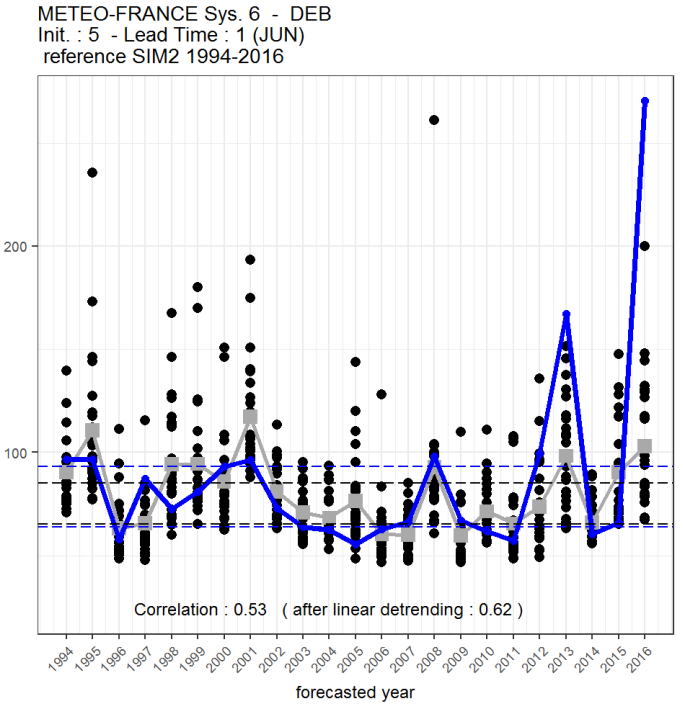
Cumulative distribution function of daily precipitation (month of June)



2) Hydrological LongTerm Prediction Systems

— Seasonal Prediction system : Quality depends on the month of initialization and the lead-time





Correlation	Init 09	Init 10	Init 11
September	0,6		
October	0,69	0,68	
November	0,18	0,47	0,8
December	0,26	0,55	0,4
January	0,31	0,48	0,5
February	0,3	0,39	0,6
March		0,43	0,3
April			0,3

=> Before using a real time forecast it's worth analysing the quality of the re-forecast experiment for this specific initialization month...

2) Hydrological LongTerm Prediction Systems

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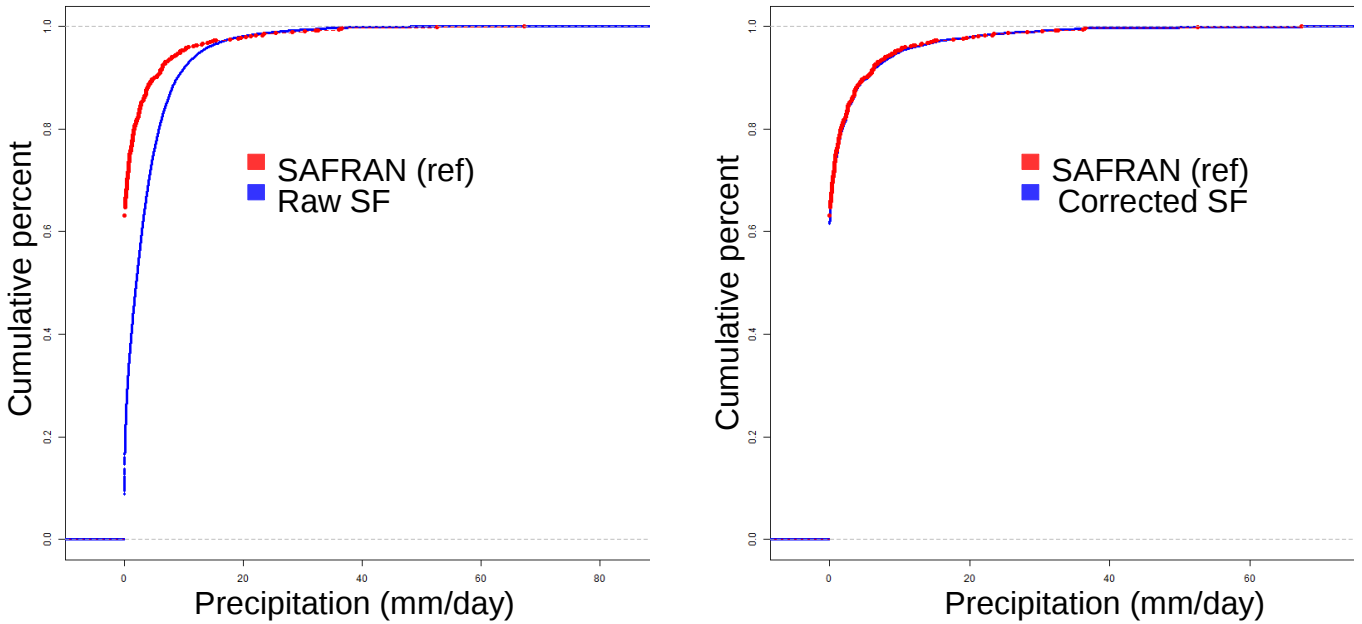
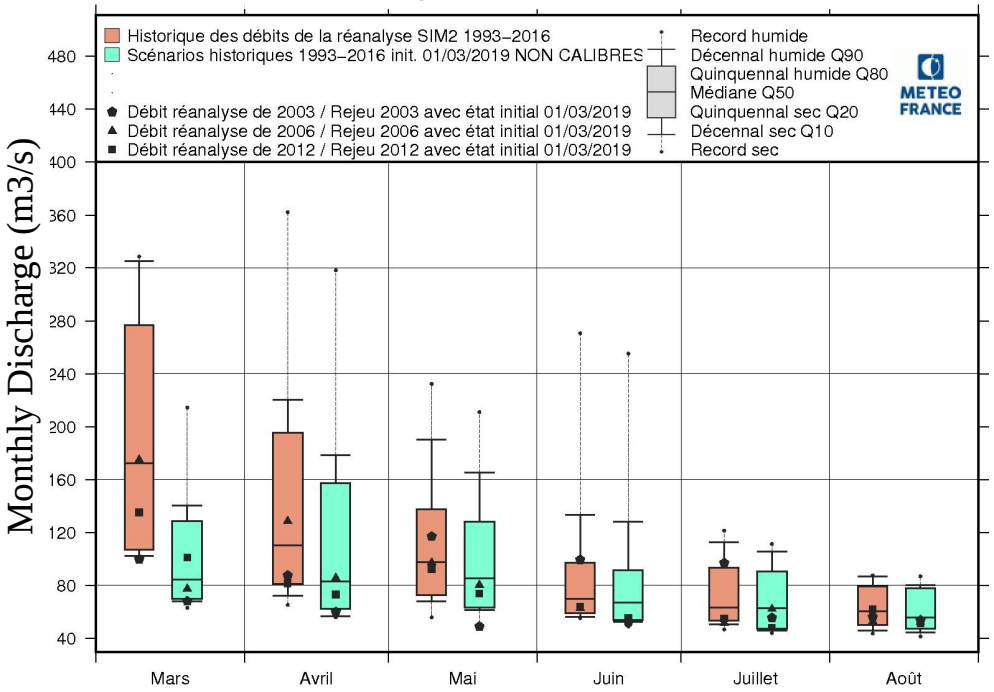


2) Hydrological LongTerm Prediction Systems

- Real-time production:
  - Monthly briefing with end-user: authority which manages lakes over the Seine basin. Aim: Fill lakes during winter in order to reduce winter-floods + ensure river flow during low flow period
  - Comparison between seasonal and climatological forecasts

Marne River @ Noisiel Station
Climatological Forecast - Init. 20190301



Marne River @ Noisiel Station
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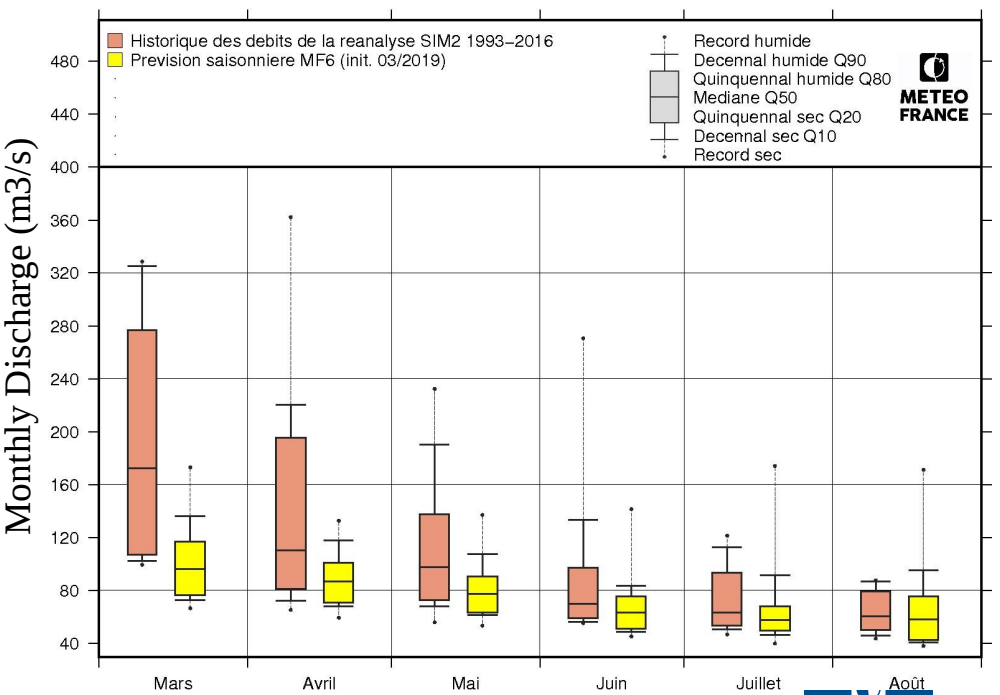
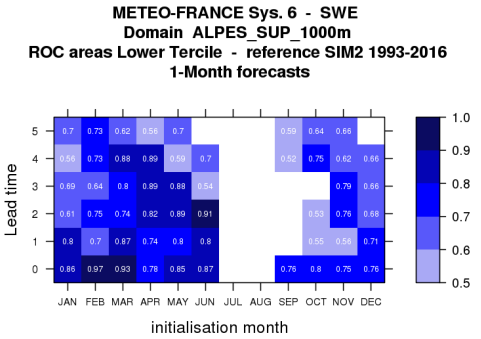
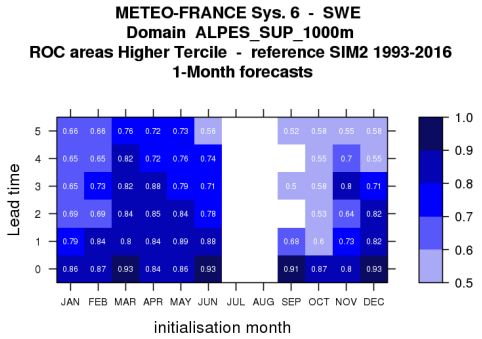
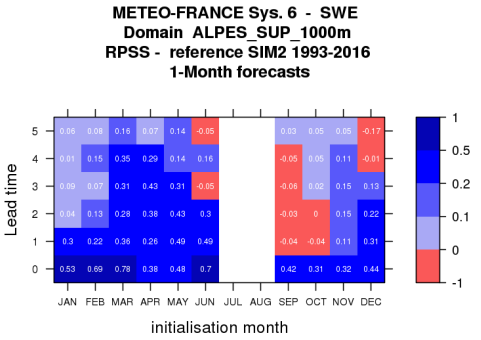


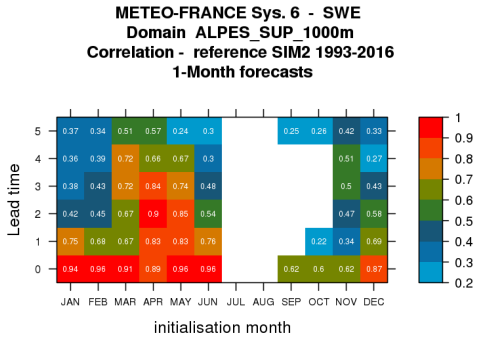
2) Hydrological LongTerm Prediction Systems

- Snow Water Equivalent forecasts
- Scores : good performance but... skill versus climatological forecasts needs to be evaluated

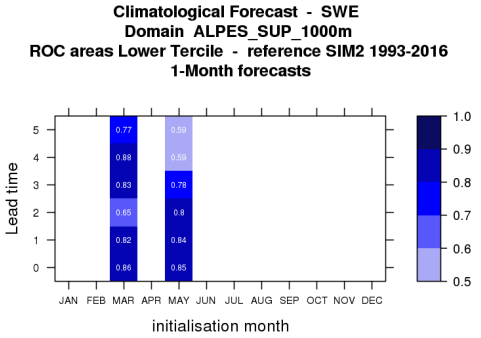


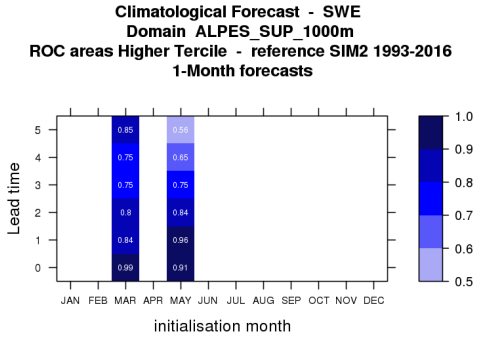


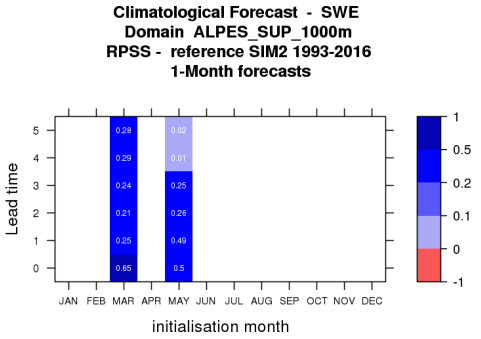


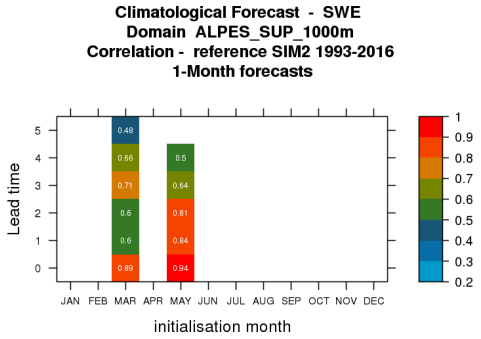


Seasonal Forecast Scores





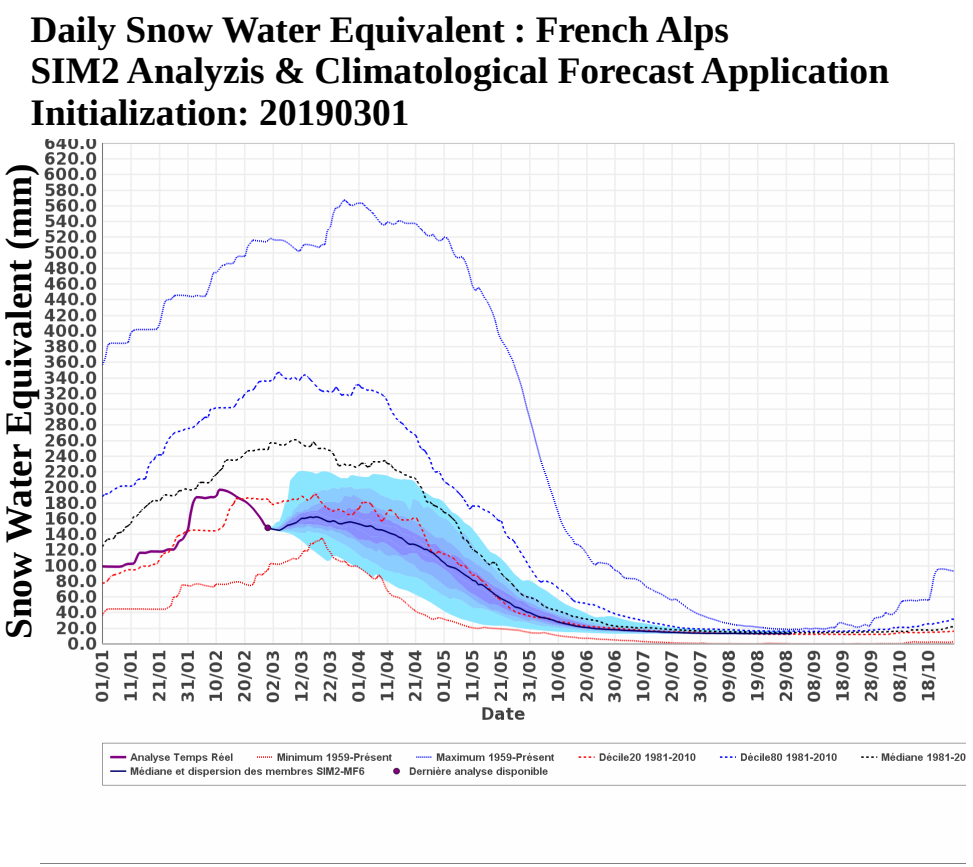


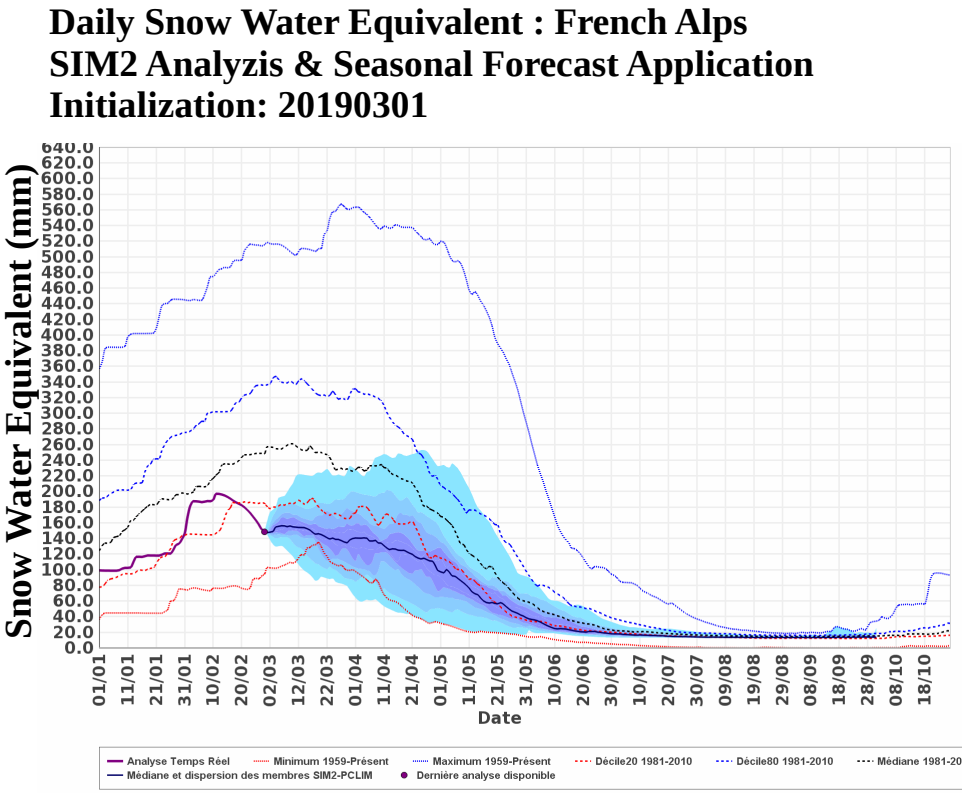


Climatological Forecast Scores

2) Hydrological LongTerm Prediction Systems

- Snow Water Equivalent forecasts – Example Initialization 20190301

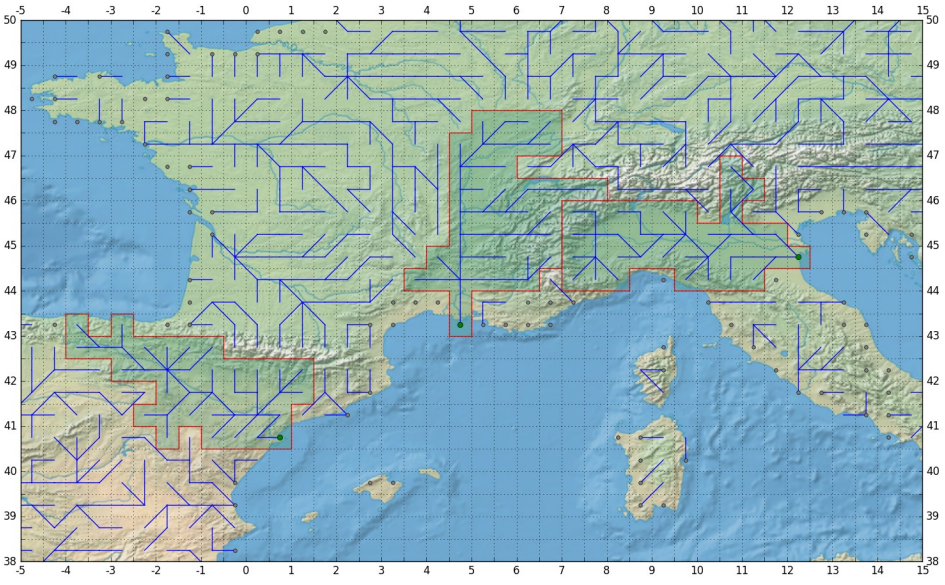




Conclusion & Perspectives

- Use of SURFEX in real-time to monitor the current situation but also to make forecasts
- Useful for flood event anticipation (medium-range) but also for water ressources management (medium to long term forecasts) – Collaboration with end-users

- Perspectives :
  - Extension of EPS from 10 to 14 (30) days & build a seamless forecast system
  - New methodology to correct seasonal forecasts coming from the atmospheric model
  - Extension to groundwater ressources using Aqui-FR (cf. D.Leroux talk)
  - Adapt the climatological/seasonal forecast application to other domain within MEDSCOPE project using SURFEX-CTRIP and UERRA reanalysis as reference for bias correction



MEDSCOPE Domain

Thank you for your attention