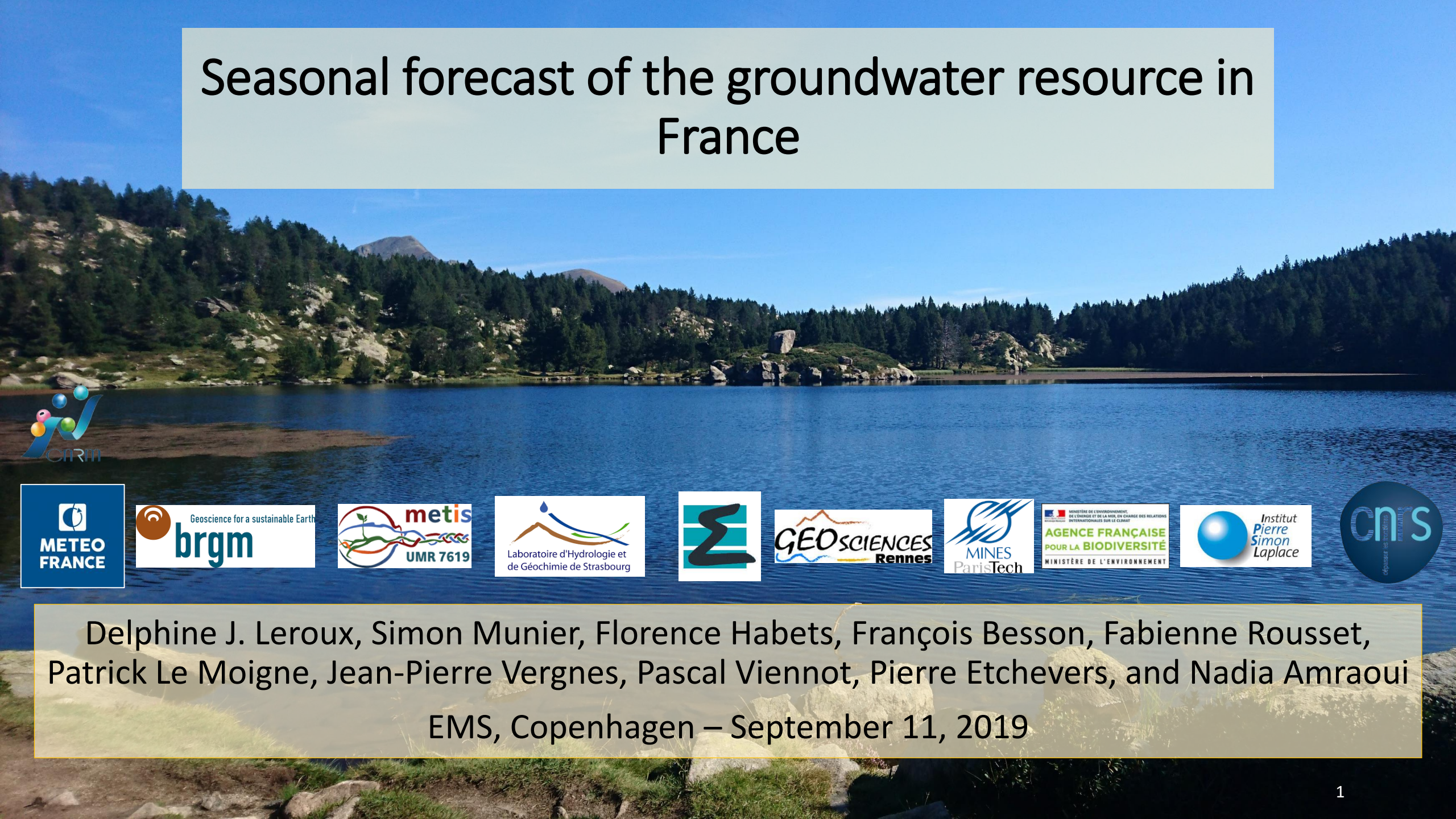
Seasonal forecast of the groundwater resource in France



Delphine J. Leroux, Simon Munier, Florence Habets, François Besson, Fabienne Rousset, Patrick Le Moigne, Jean-Pierre Vergnes, Pascal Viennot, Pierre Etchevers, and Nadia Amraoui

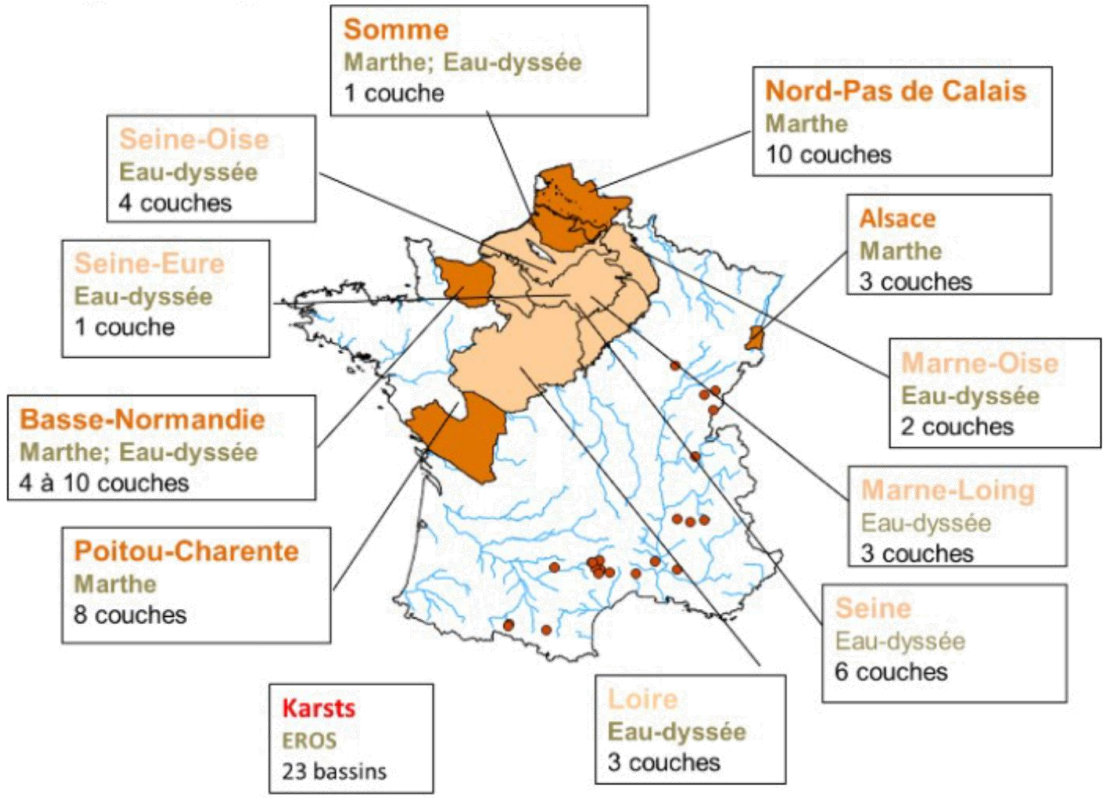
EMS, Copenhagen – September 11, 2019

The Aqui-FR project

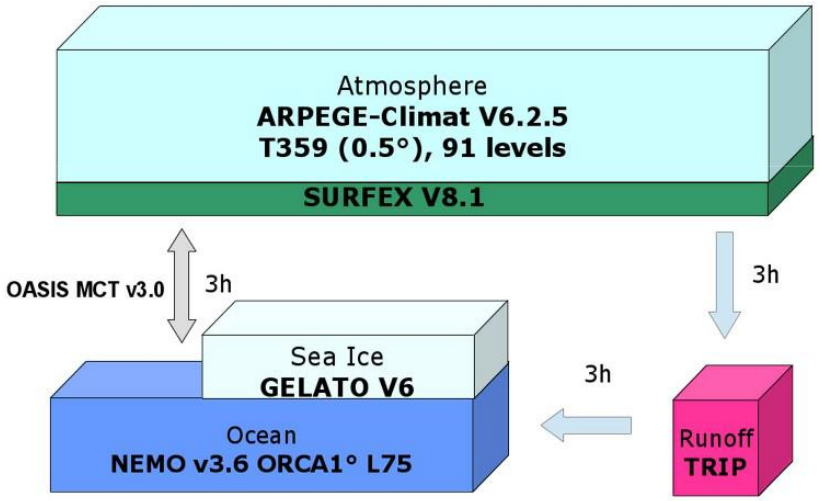
- **Objectives**
  - Better understand and manage properly our groundwater resources
  - Provide monitoring and forecasts over France (10-day, seasonal, long term)

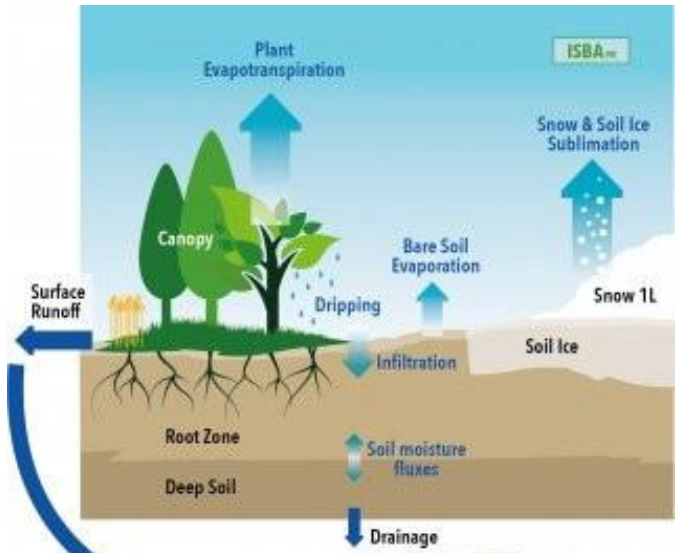
- **Hydrological modeling**
  - Rely on existing hydrogeological applications (1 to 10 layers, 100m-1km resolution)
  - Other applications are implemented

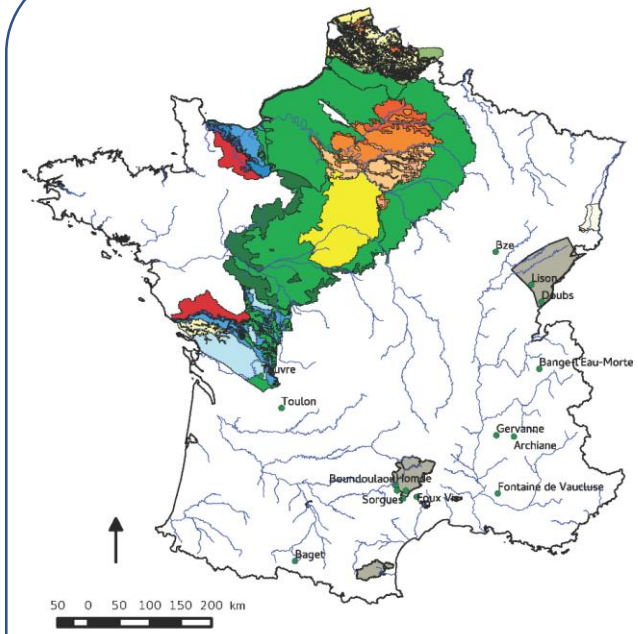
- **Seasonal forecasts**
  - Expertise at Météo-France in terms of seasonal forecasts with ARPEGE System 6 (and System 7 should be available in the upcoming months)



The Aqui-FR platform







<u>Atmospheric conditions:</u>

- Long run, SAFRAN [t°, precip., etc.] (**REA, 1958-now**)
- 6-month forecasts, ARPEGE S6 (**ESF, 51 members in "real-time",** 25 members for hindcast 1993-2016)

(8 km)

<u>SURFEX:</u>

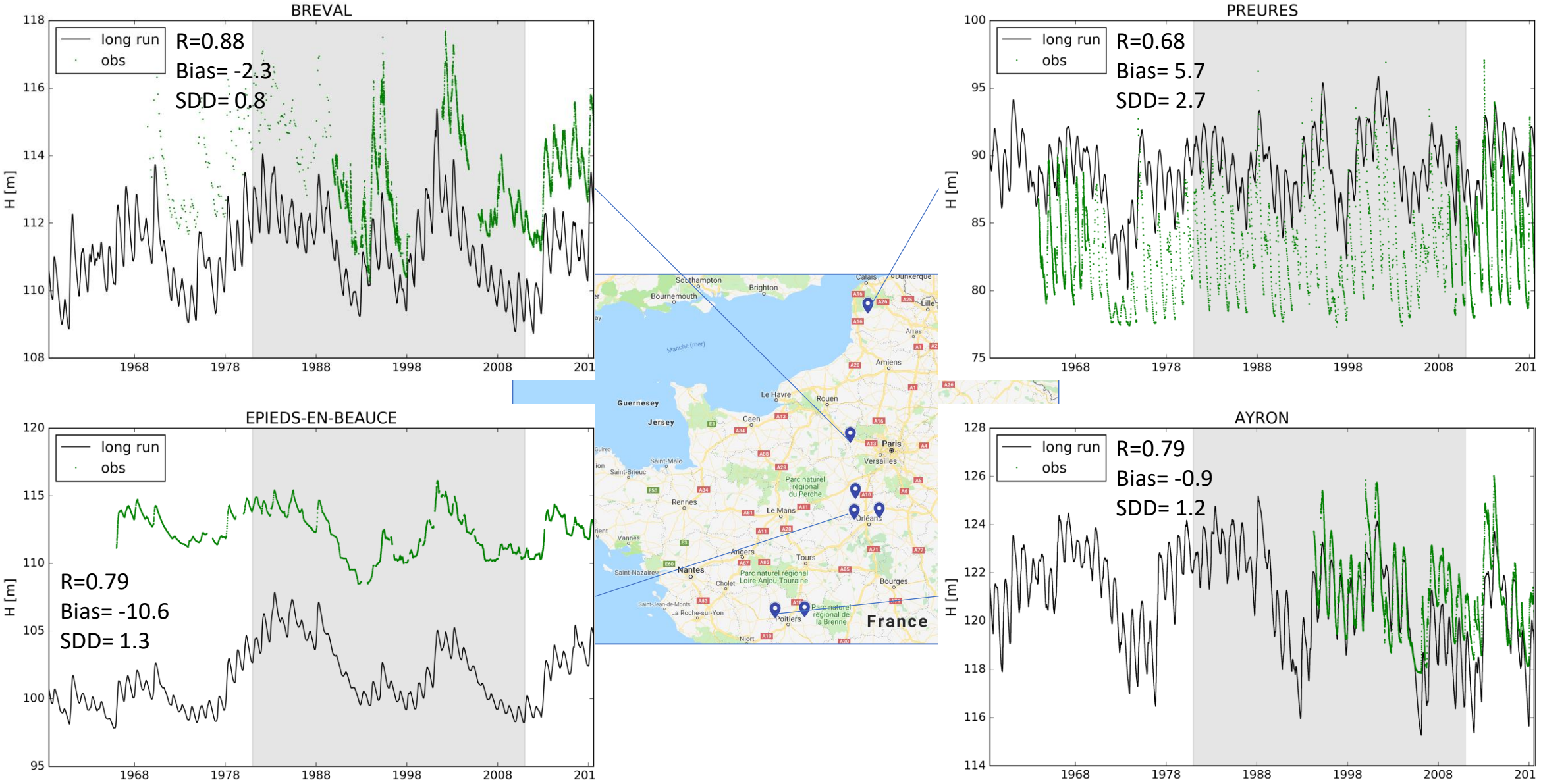
- V8, ISBA-DIF (SIM2 version before MODCOU)
- Daily cumulated **drainage** and **runoff** (25 or 51 scenarios)

(8km)

<u>AQUI-FR:</u>

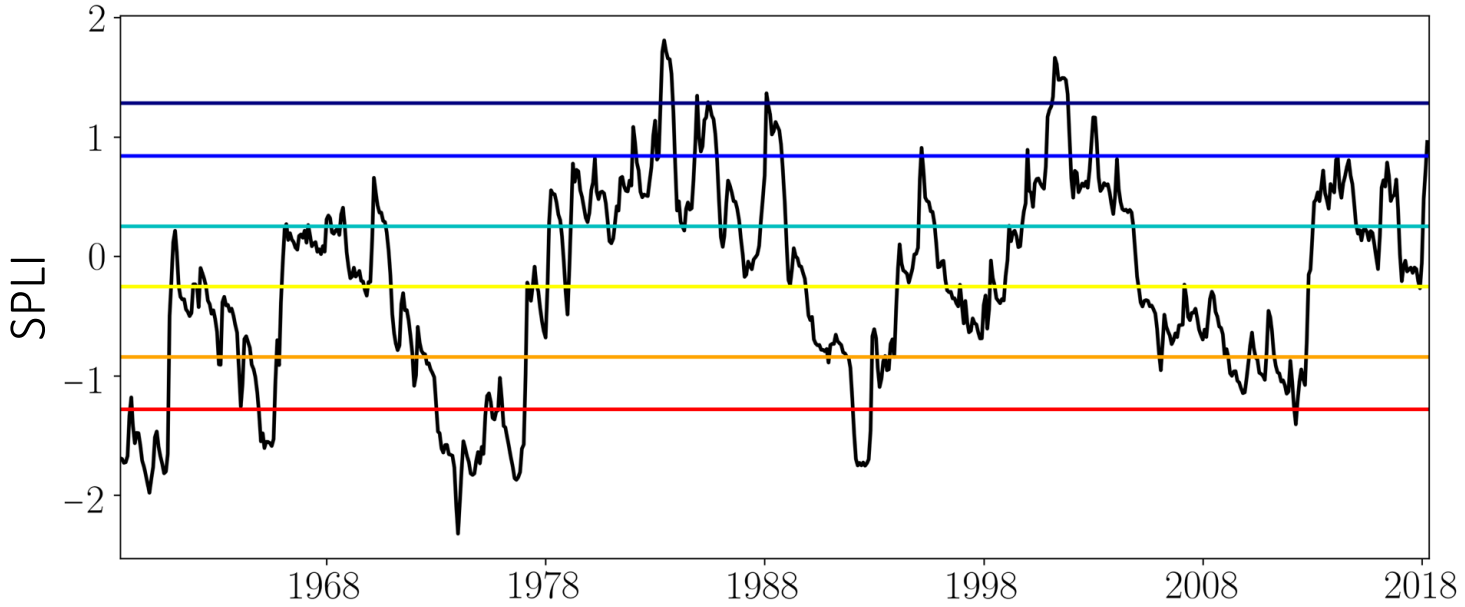
- **Groundwater level**, exchange with rivers, river discharge
- H: monthly over each point, daily for piezo stations (639 stations)

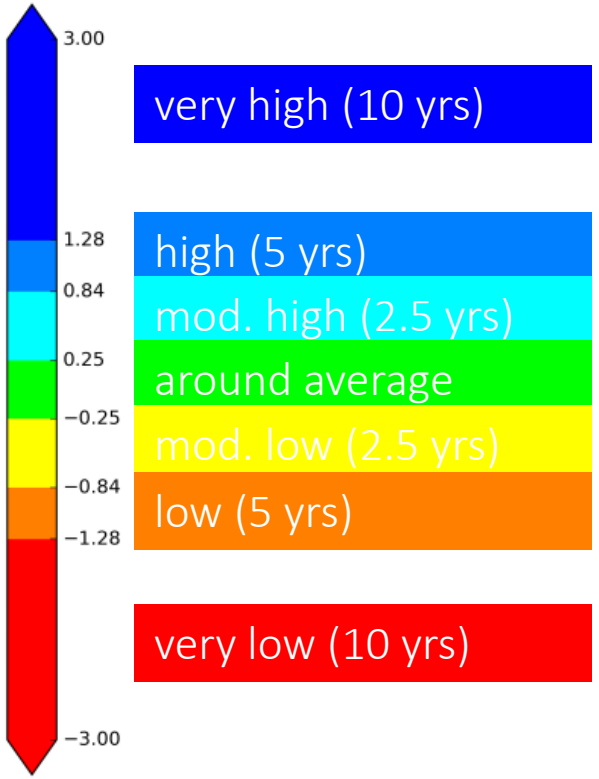
Groundwater past simulations (REA) – example of piezometric stations [1958-2018] vs observations



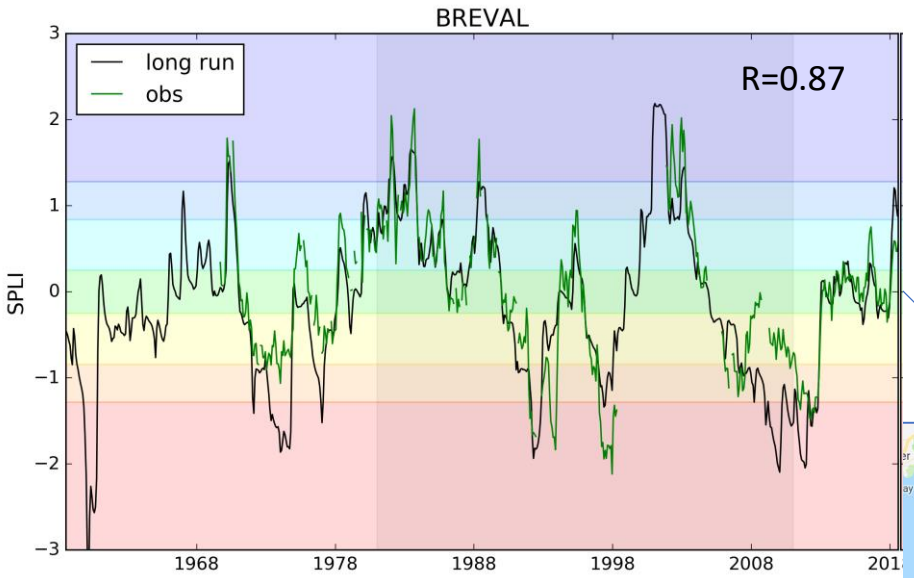
The Standardized Piezometric Level Index (SPLI)

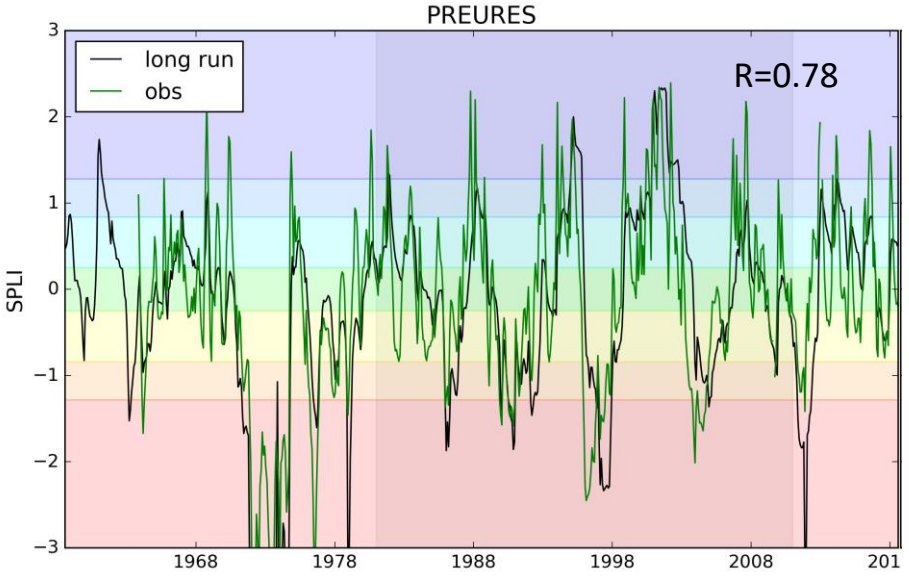
- In order to be able to compare the different levels on a same map (only topography otherwise), we use a frequential index called SPLI based on the return frequency
  - SPLI < -1.28: 10 year **dry** can mean a severe drought as it only happens every 10 years in average
  - SPLI > +1.28: 10 year **wet** can mean a risk of flooding if the groundwater reaches the surface
  - compared to average from a reference time period [1981-2010]

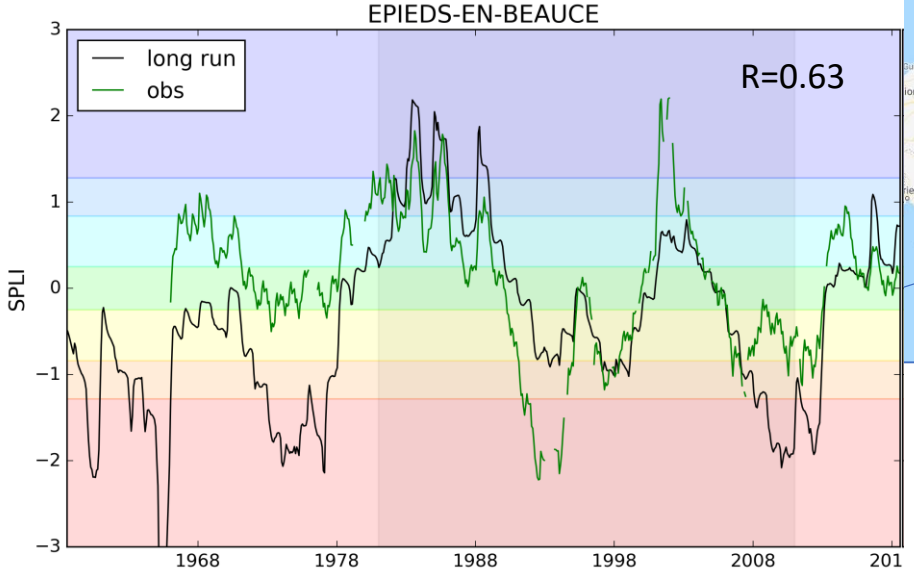


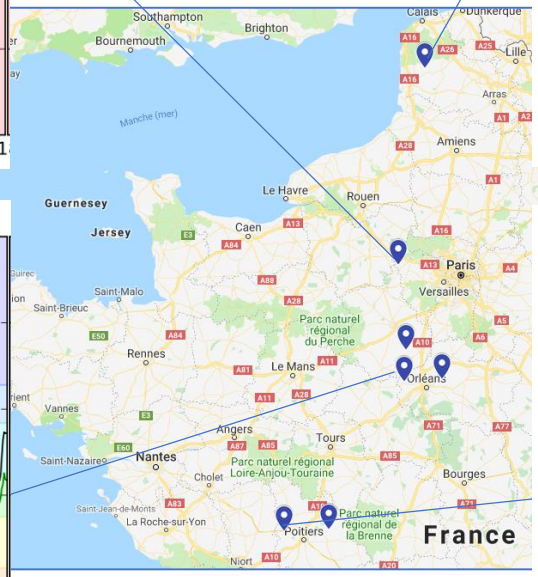


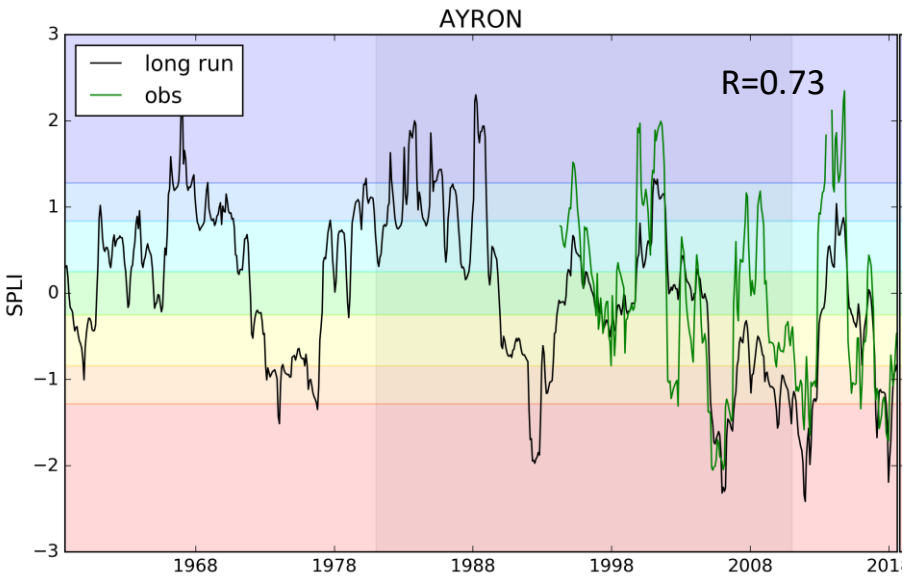
SPLI – same piezometric stations



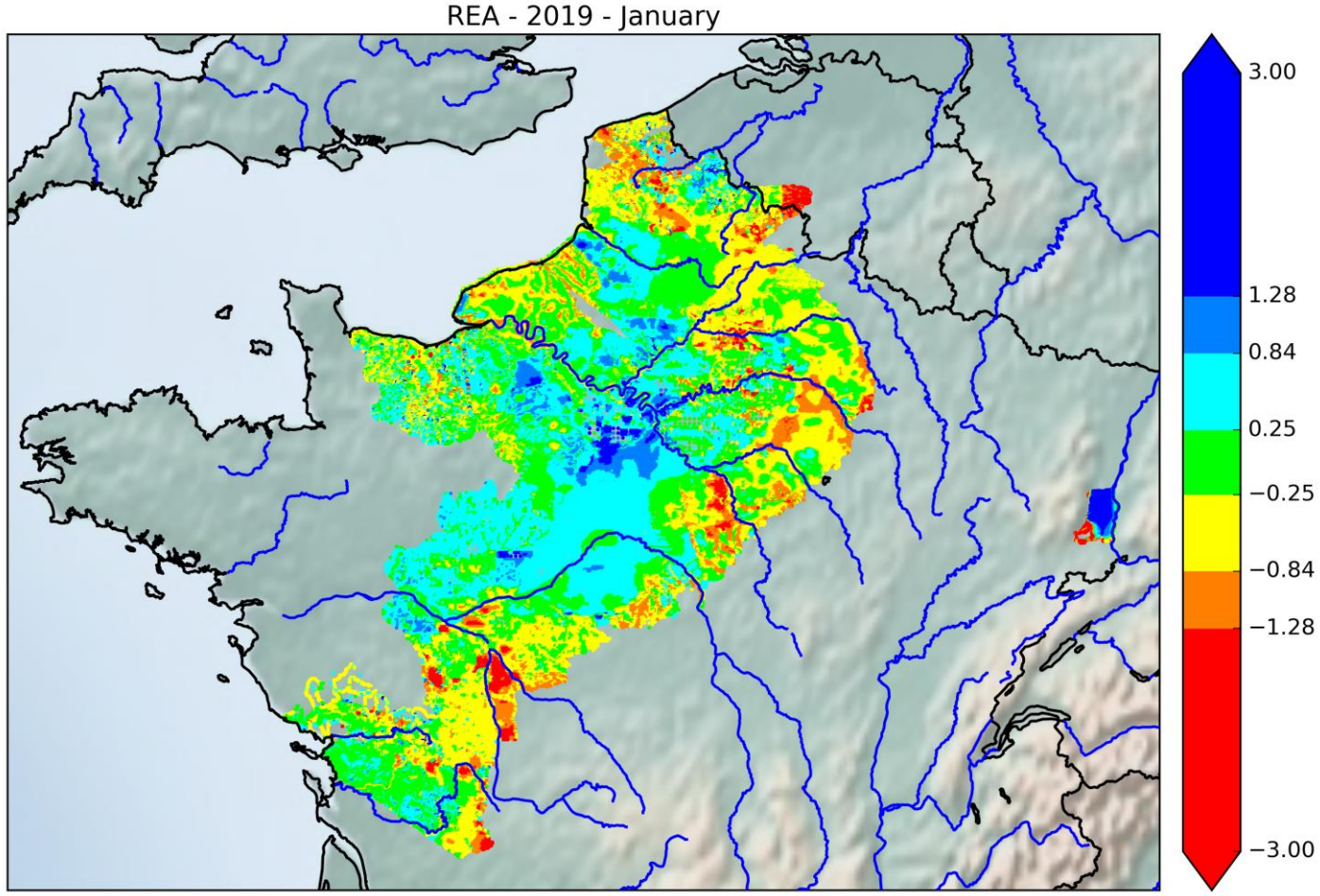








Maps of SPLI – **REA** until now and maps of drought



January 2019

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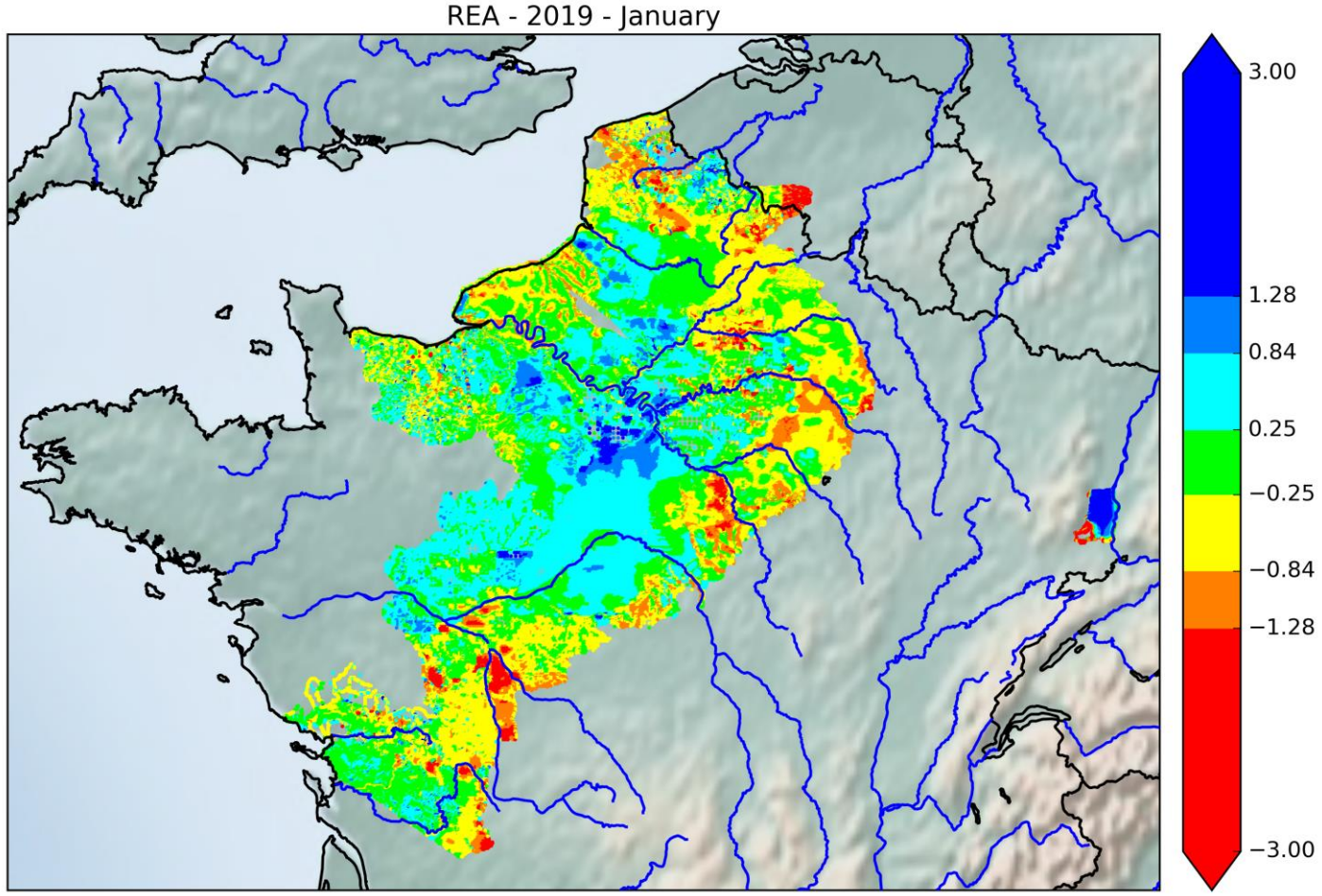
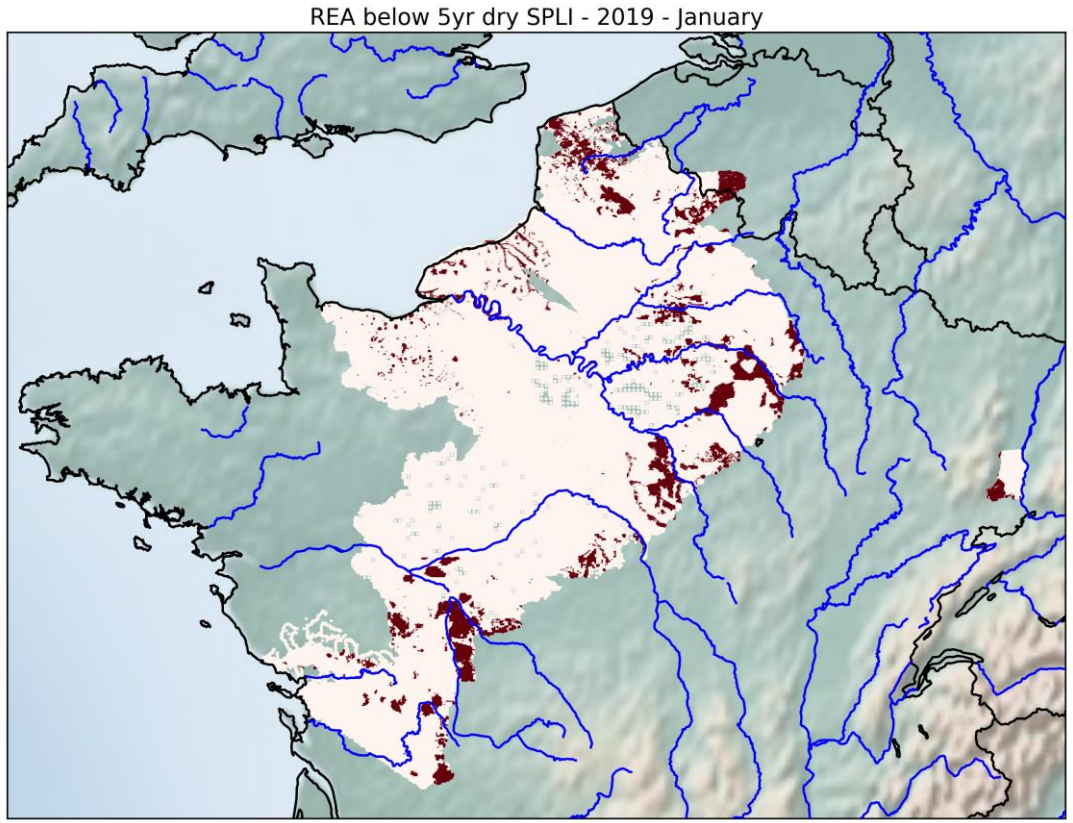


January 2019



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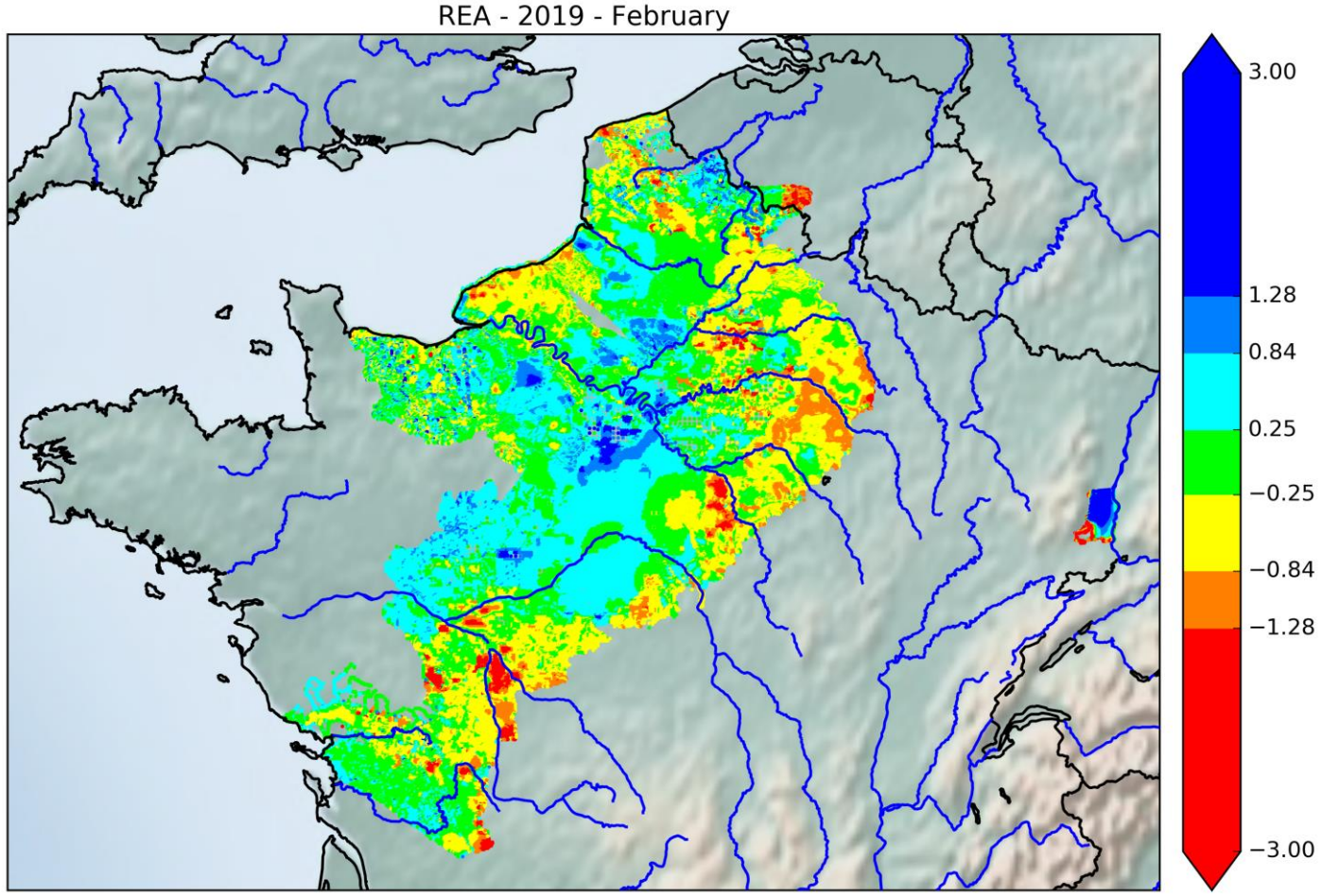
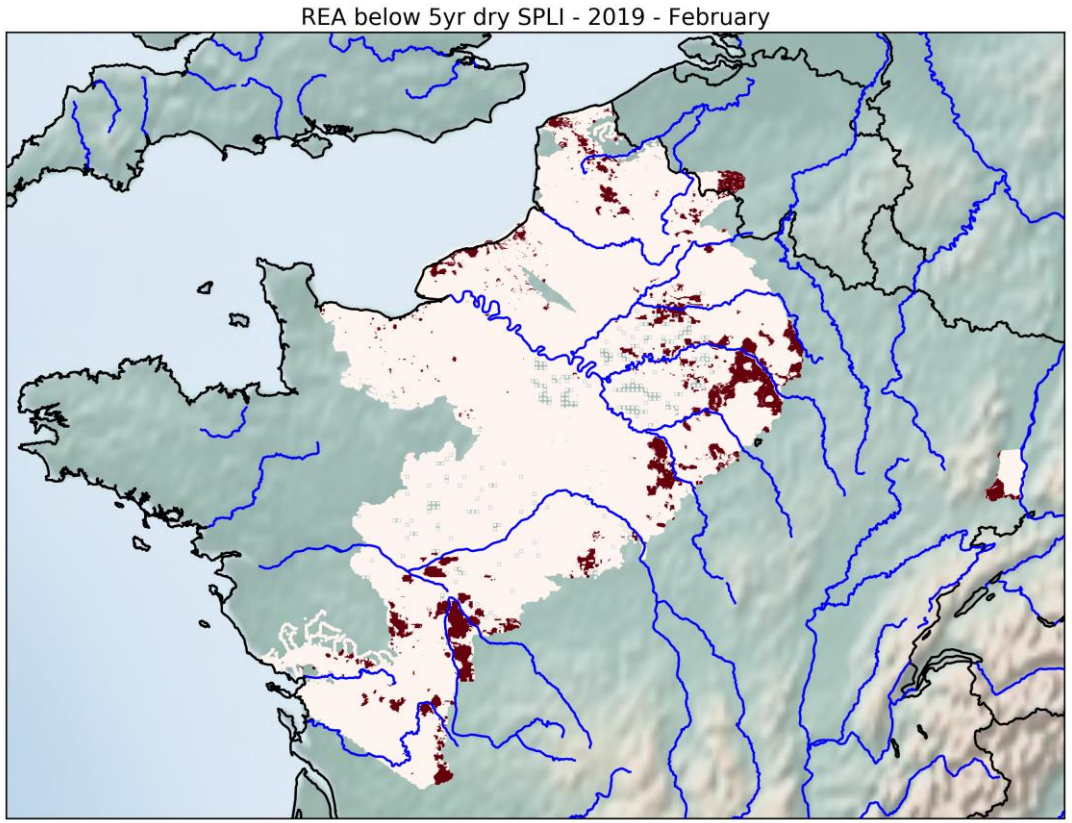
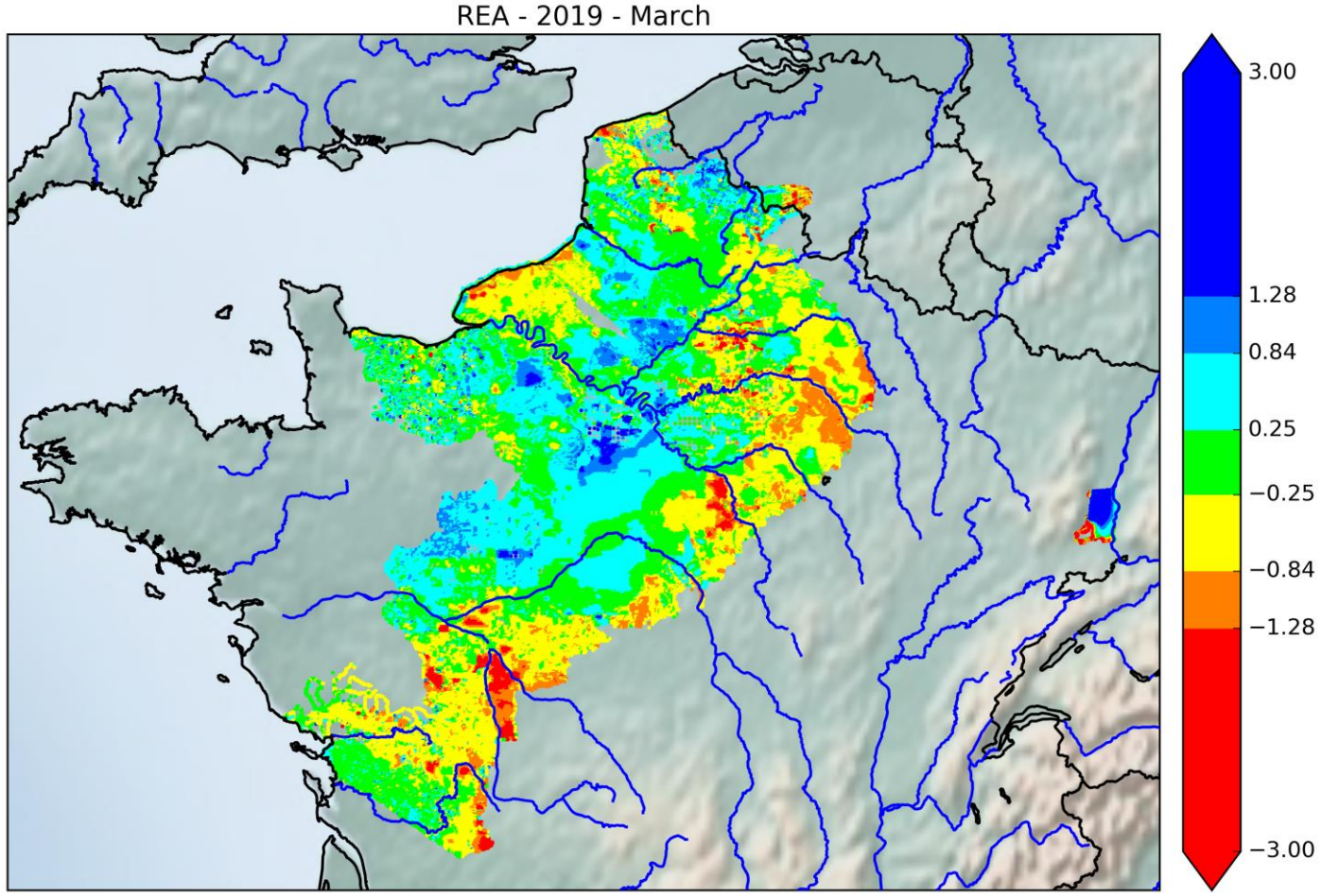


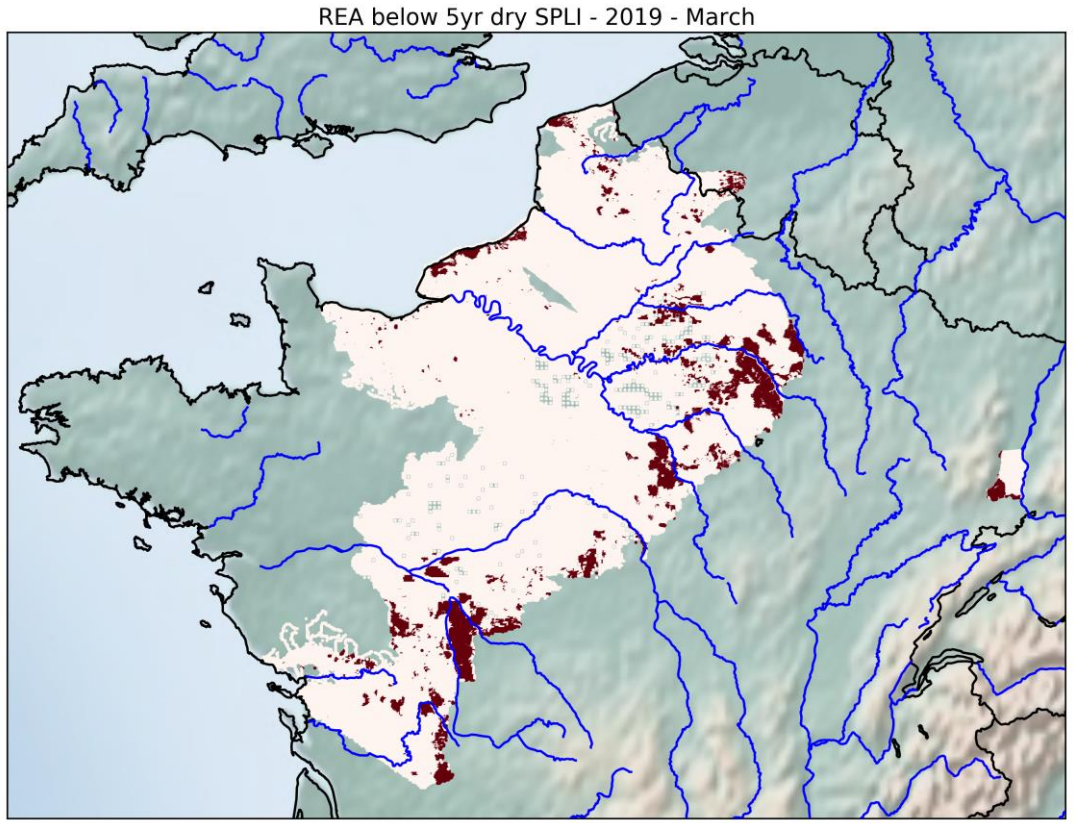
February 2019



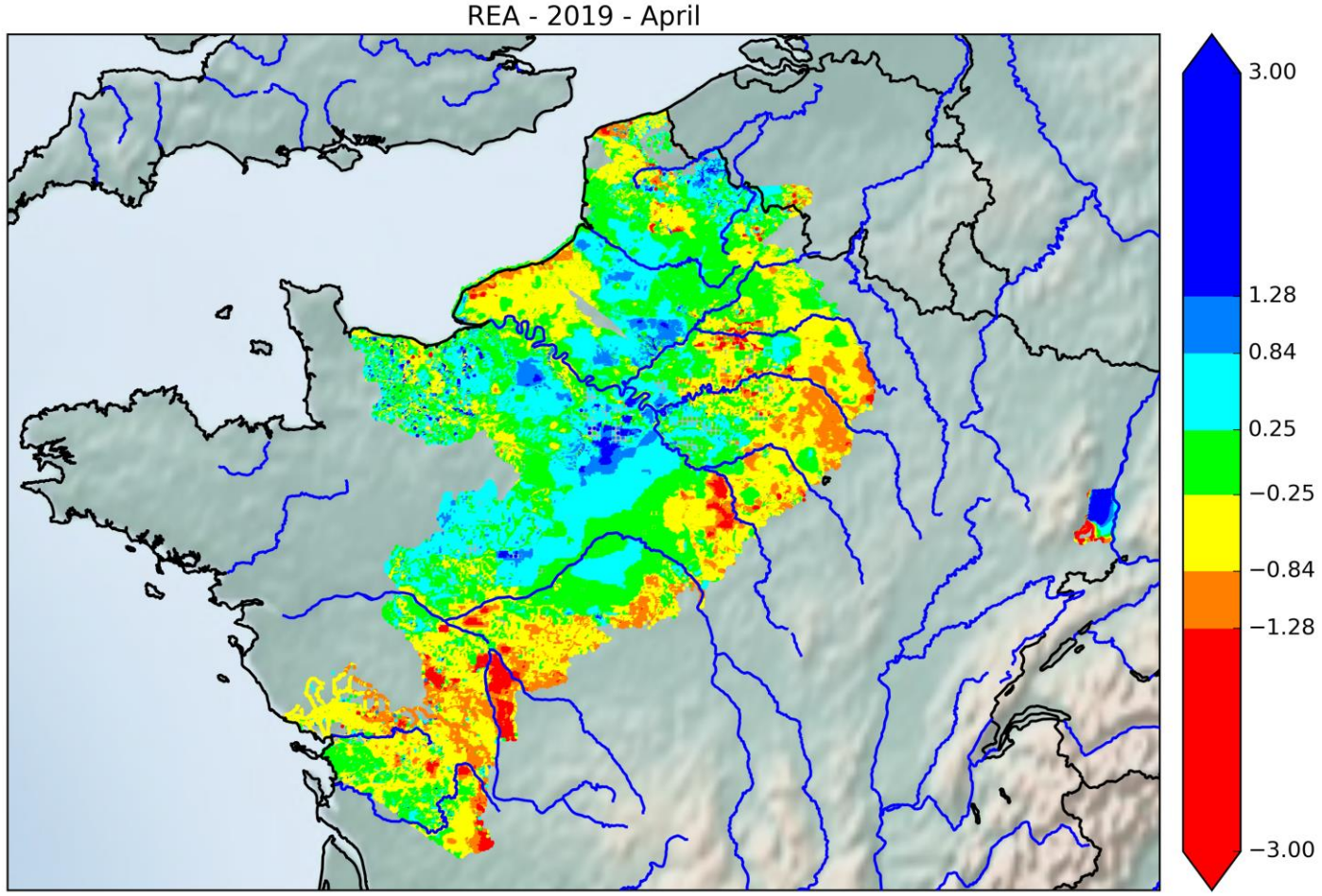
Maps of SPLI – **REA** until now and maps of drought



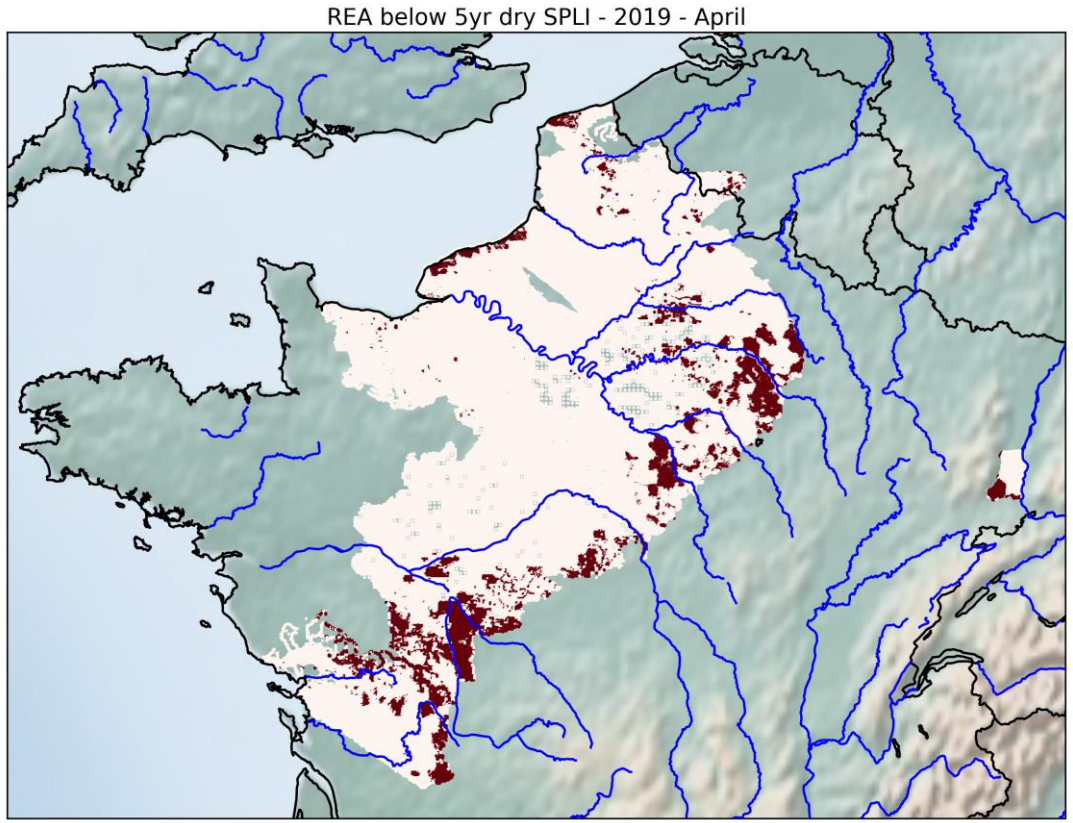
March 2019



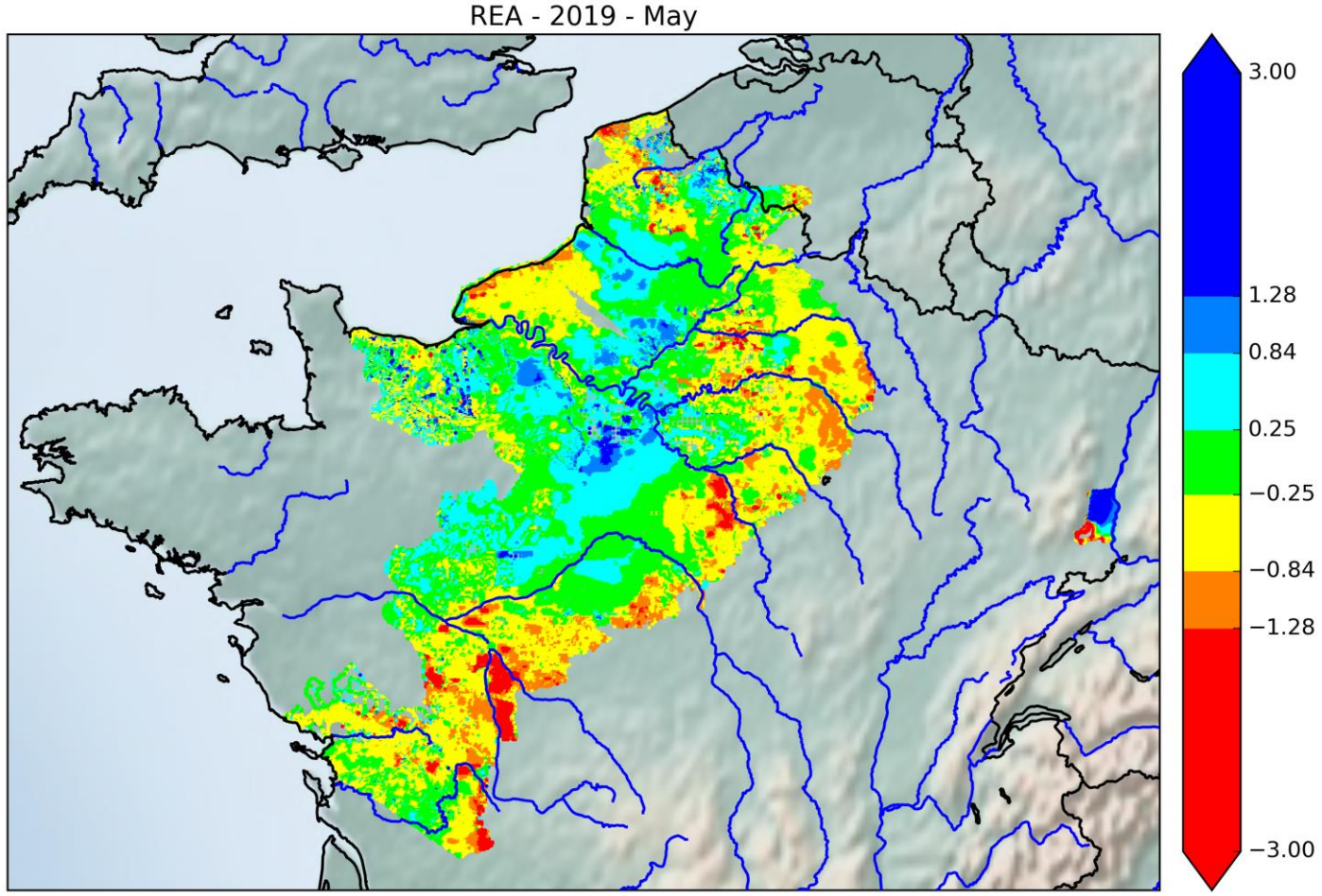
Maps of SPLI – **REA** until now and maps of drought



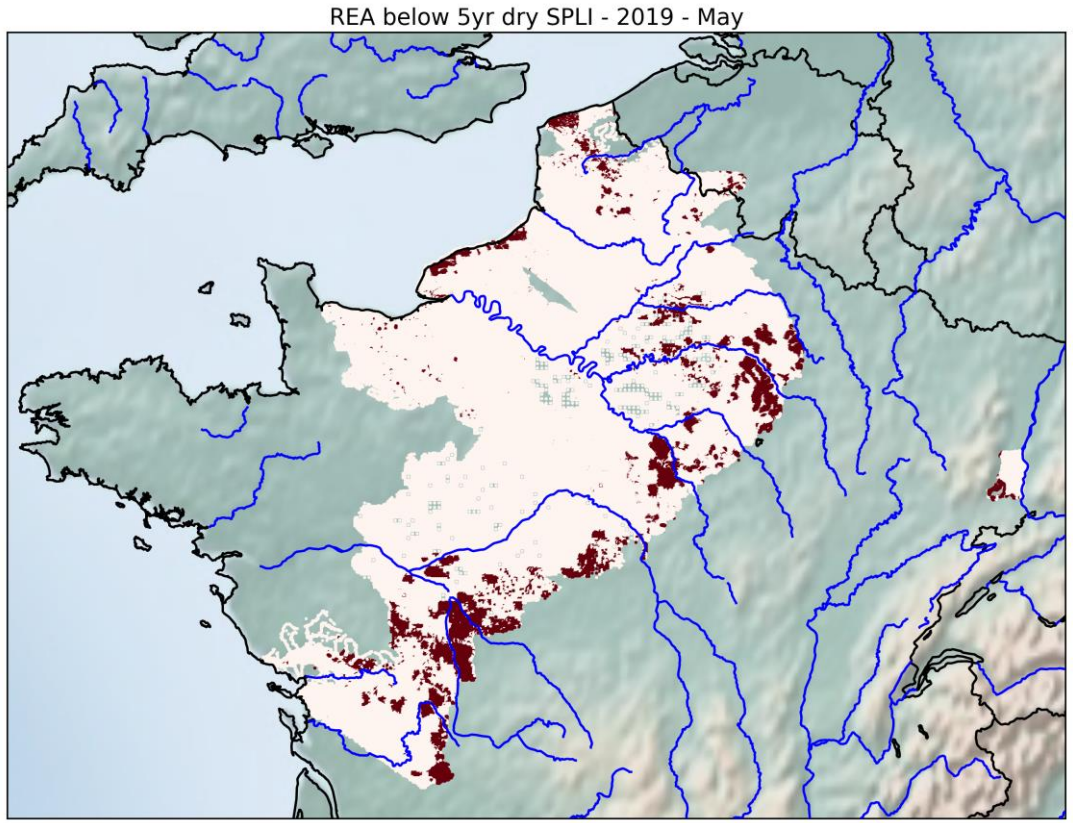
April 2019



Maps of SPLI – **REA** until now and maps of drought



May 2019



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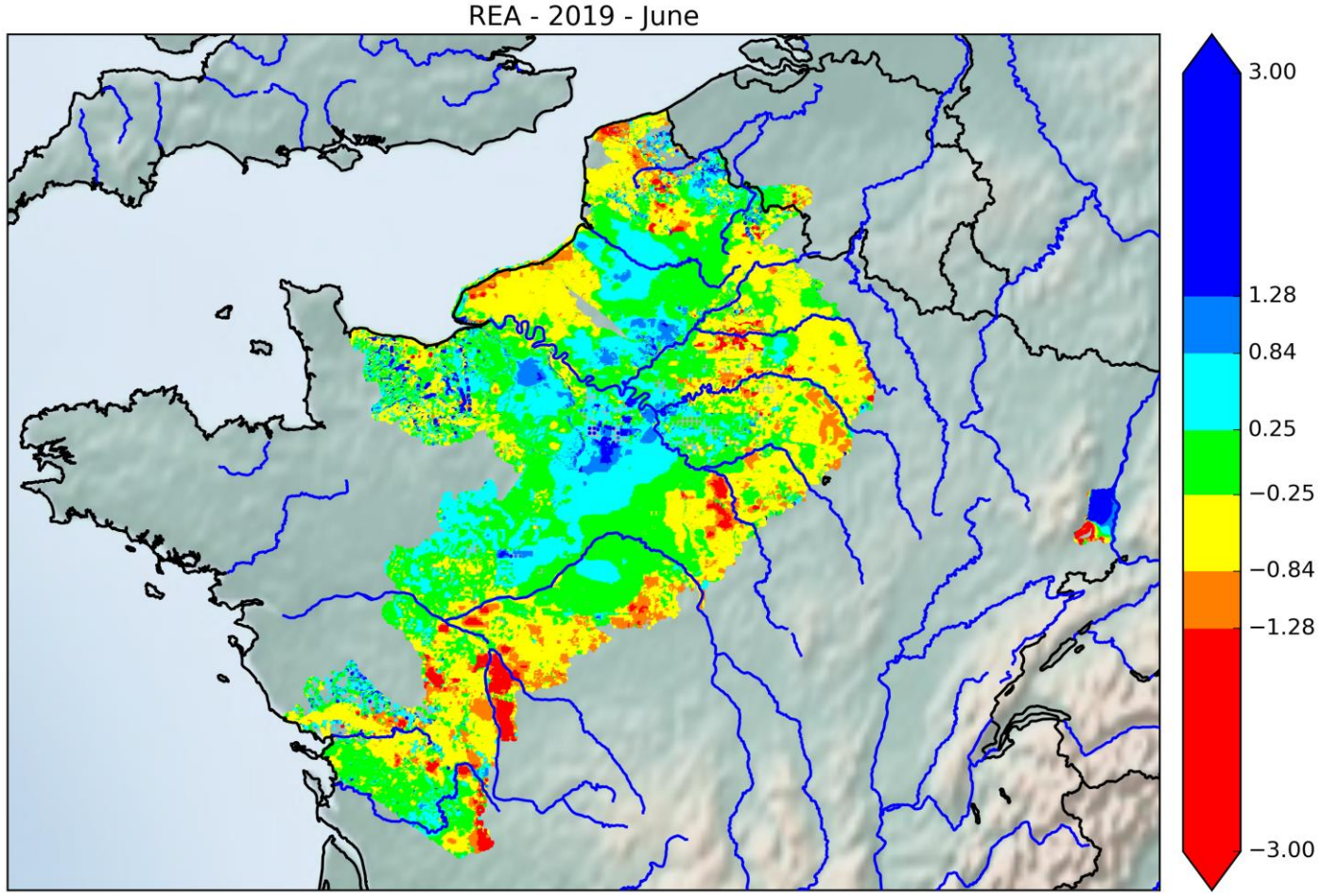
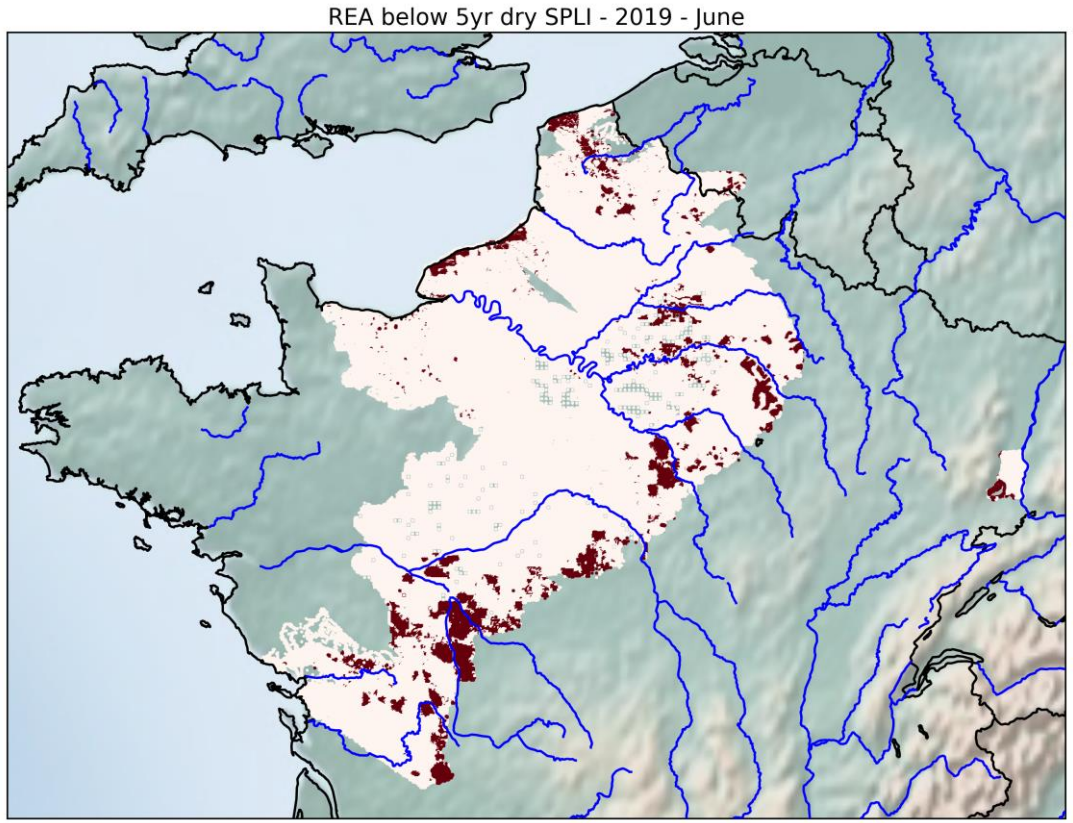
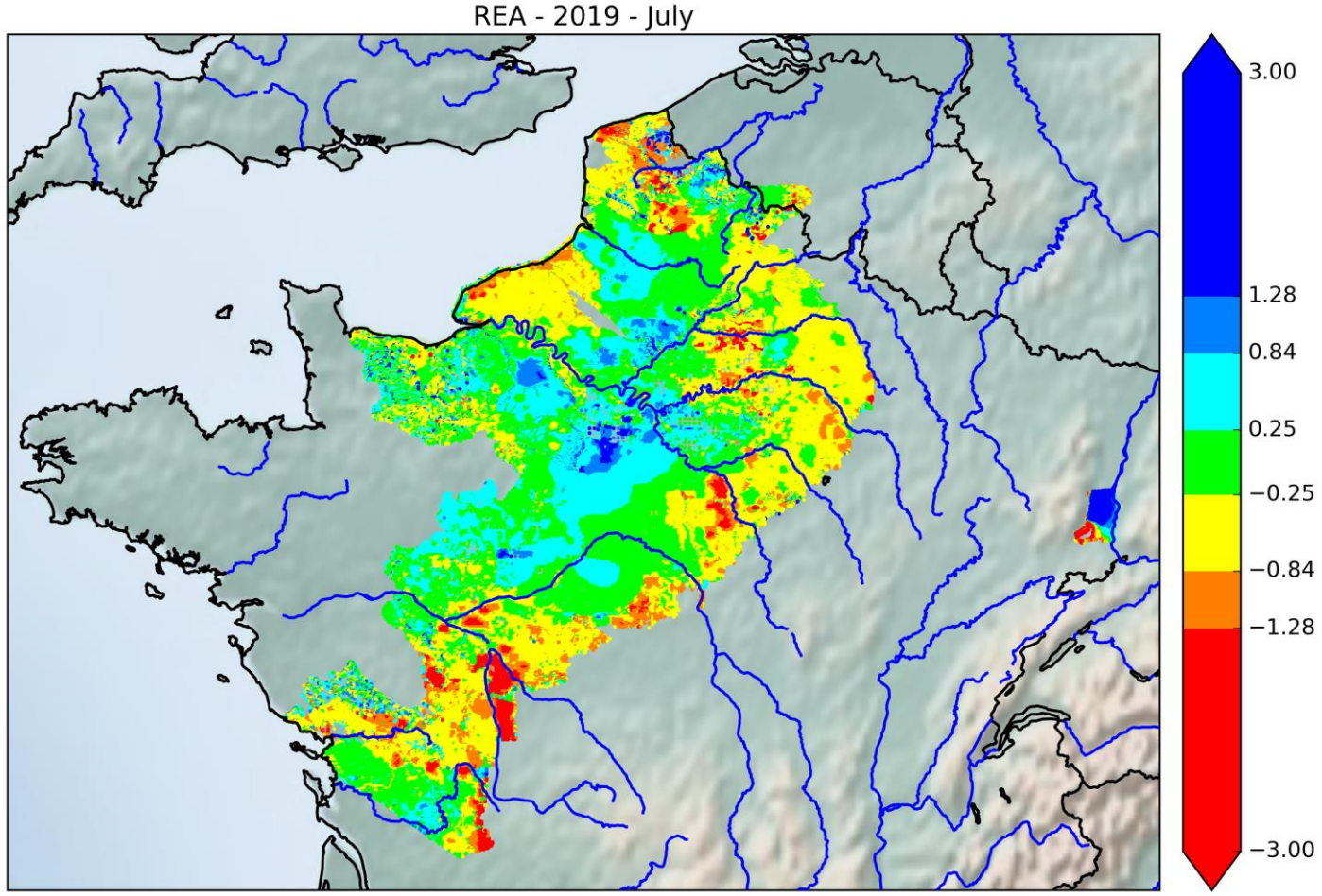


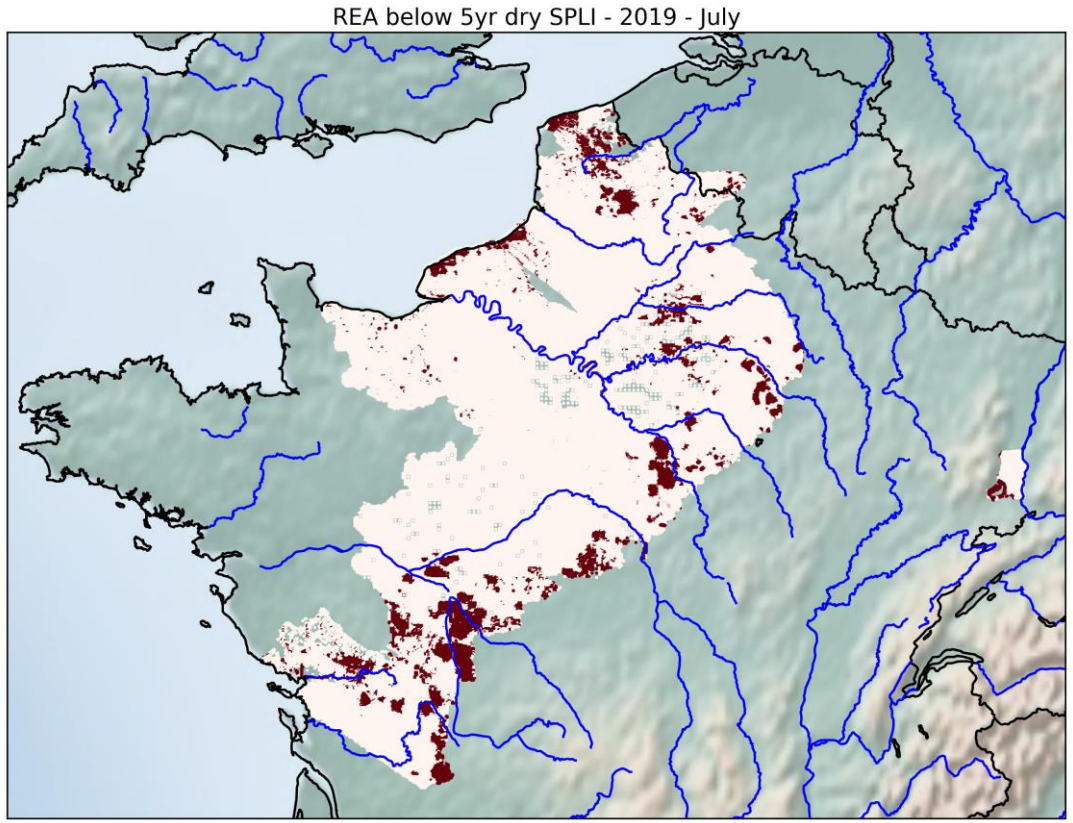
June 2019



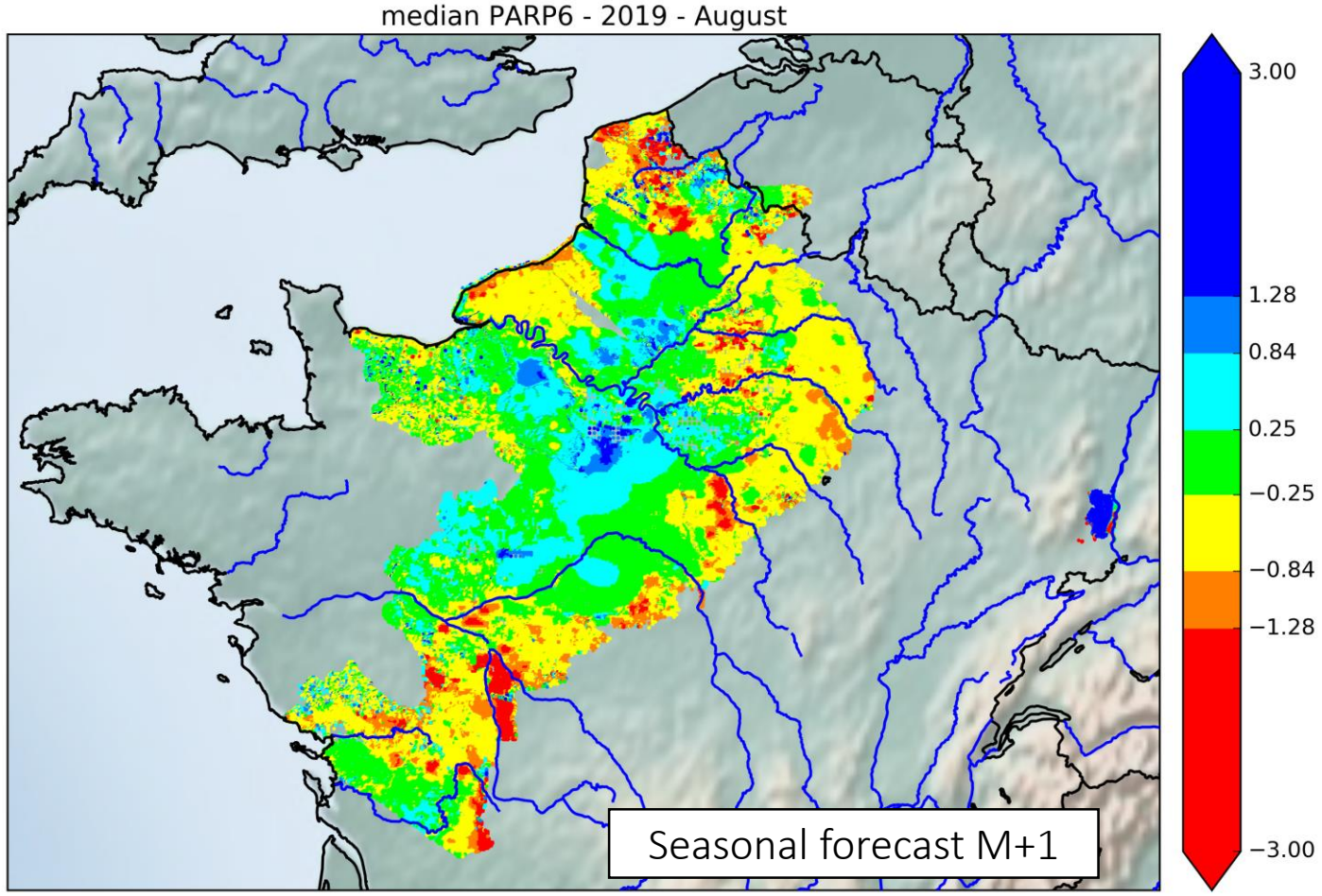
Maps of SPLI – **REA** until now and maps of drought



July 2019

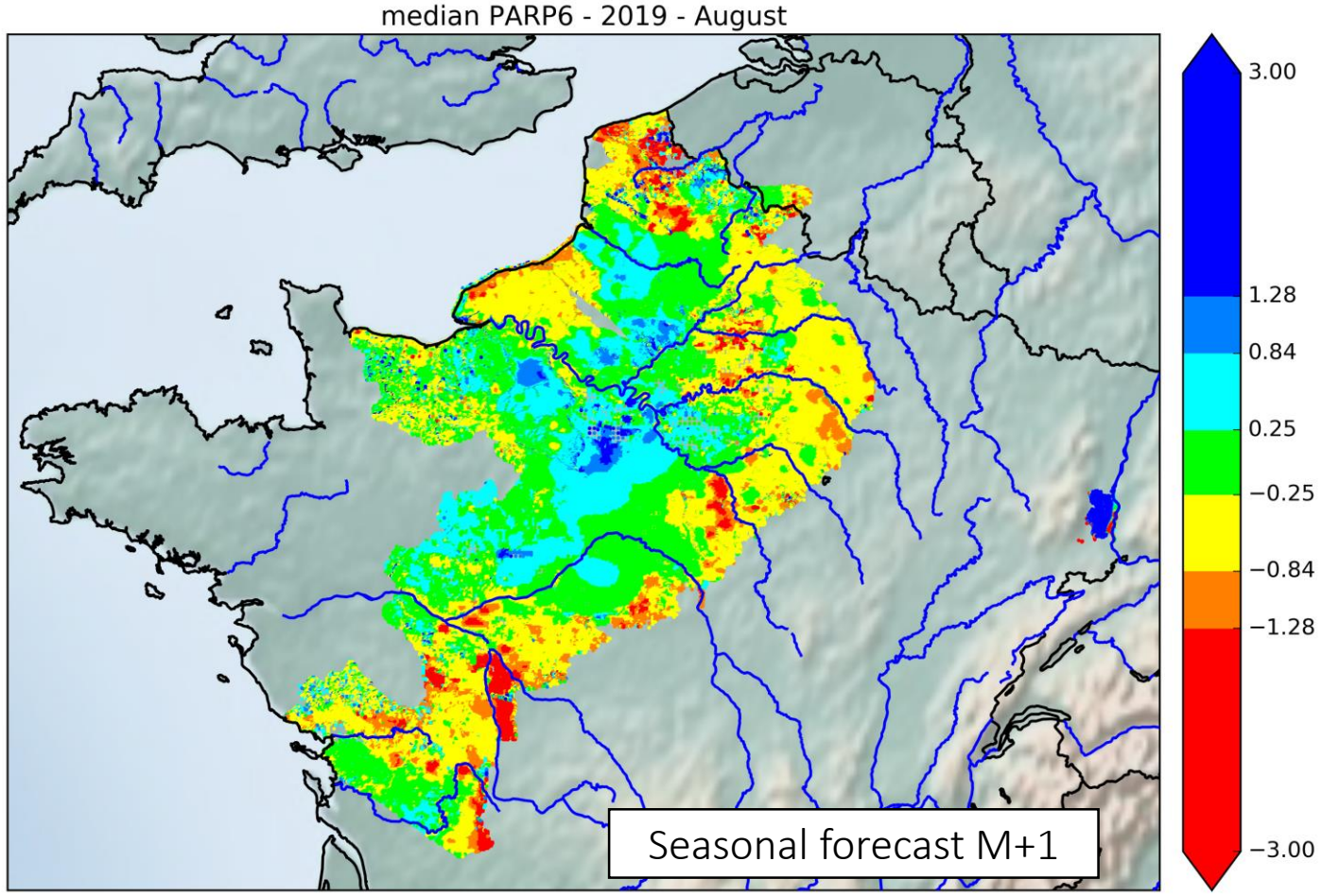


Maps of SPLI – **ESF** median and sum members for drought

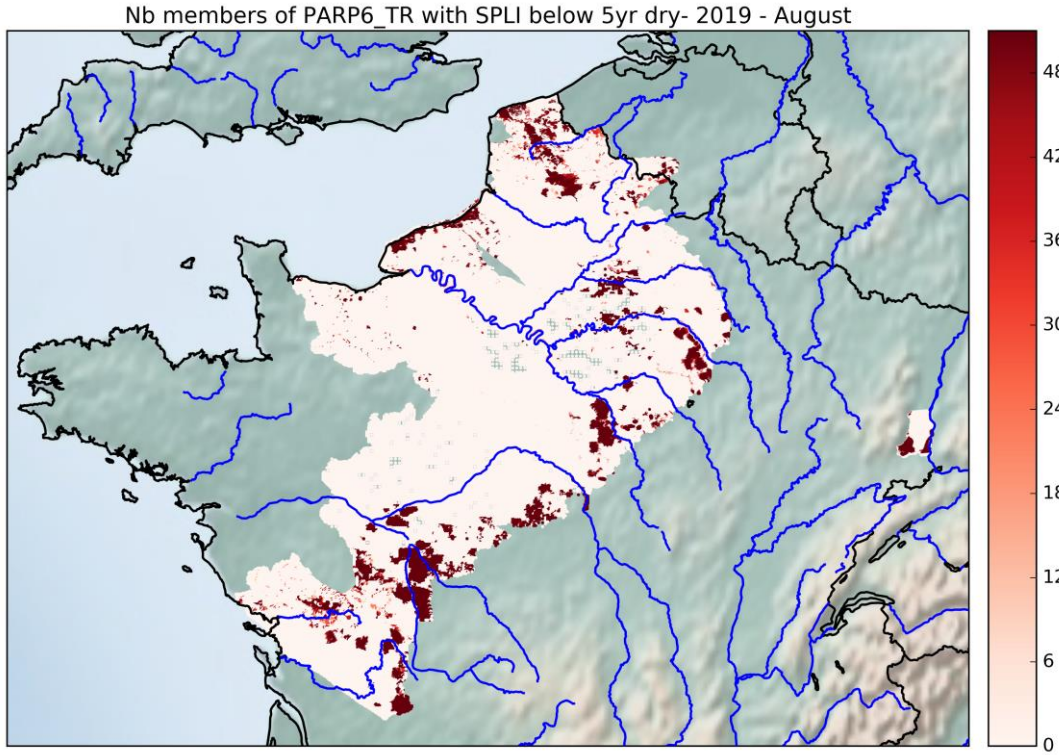


August 2019

Maps of SPLI – **ESF** median and sum members for drought



August 2019



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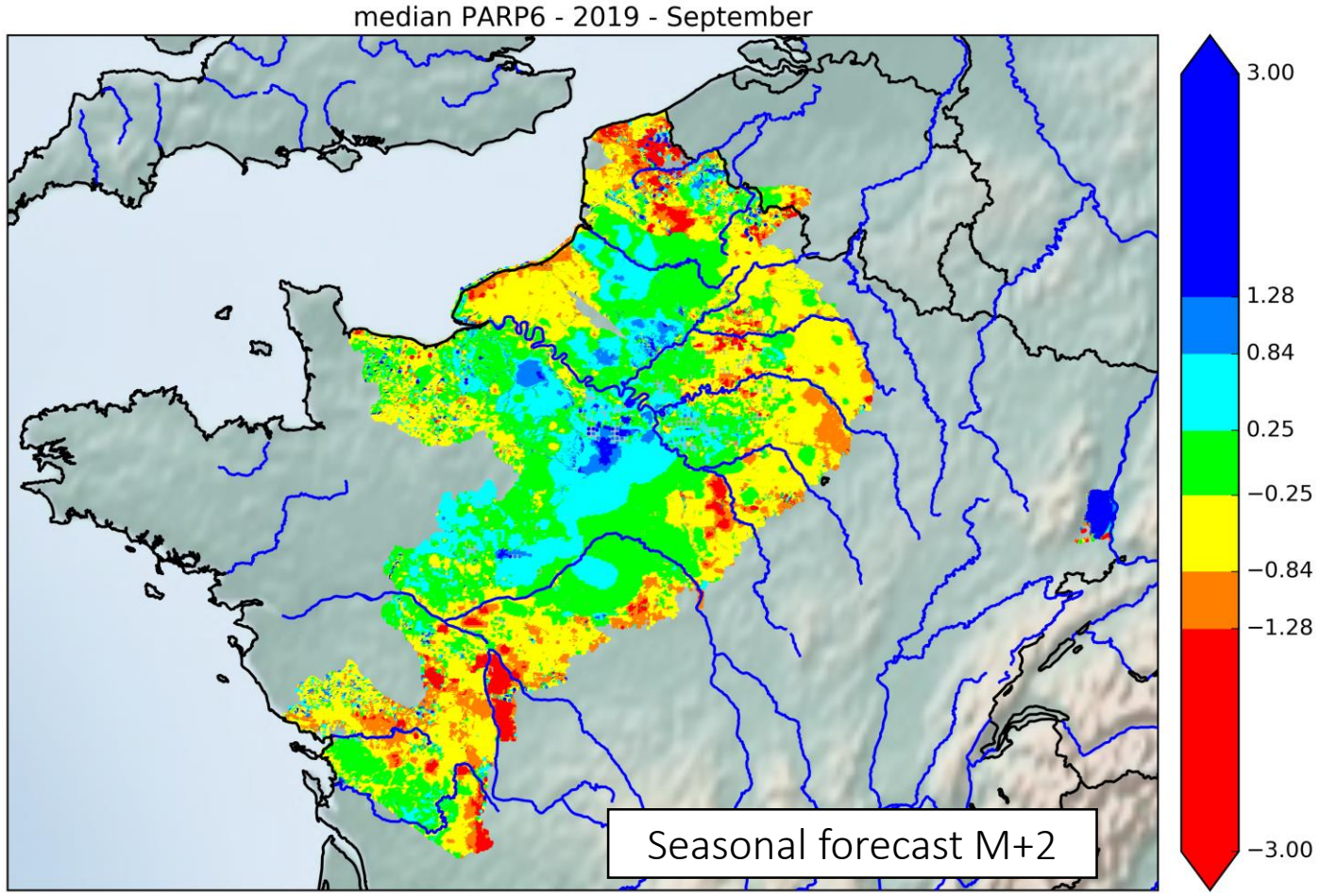
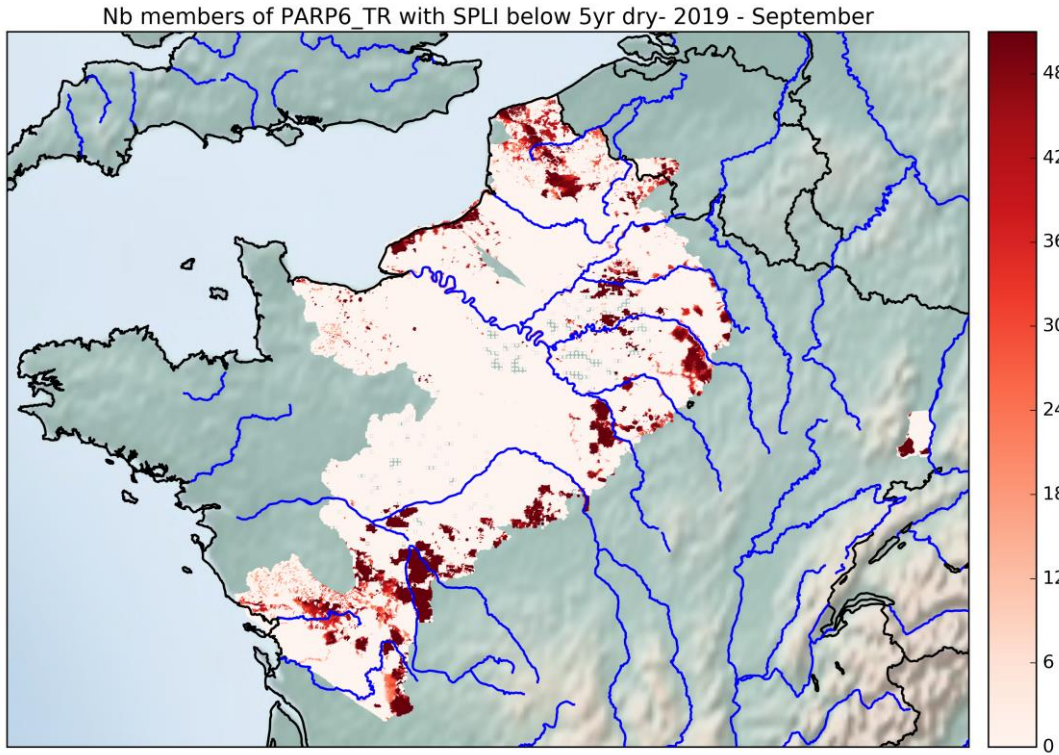


September 2019



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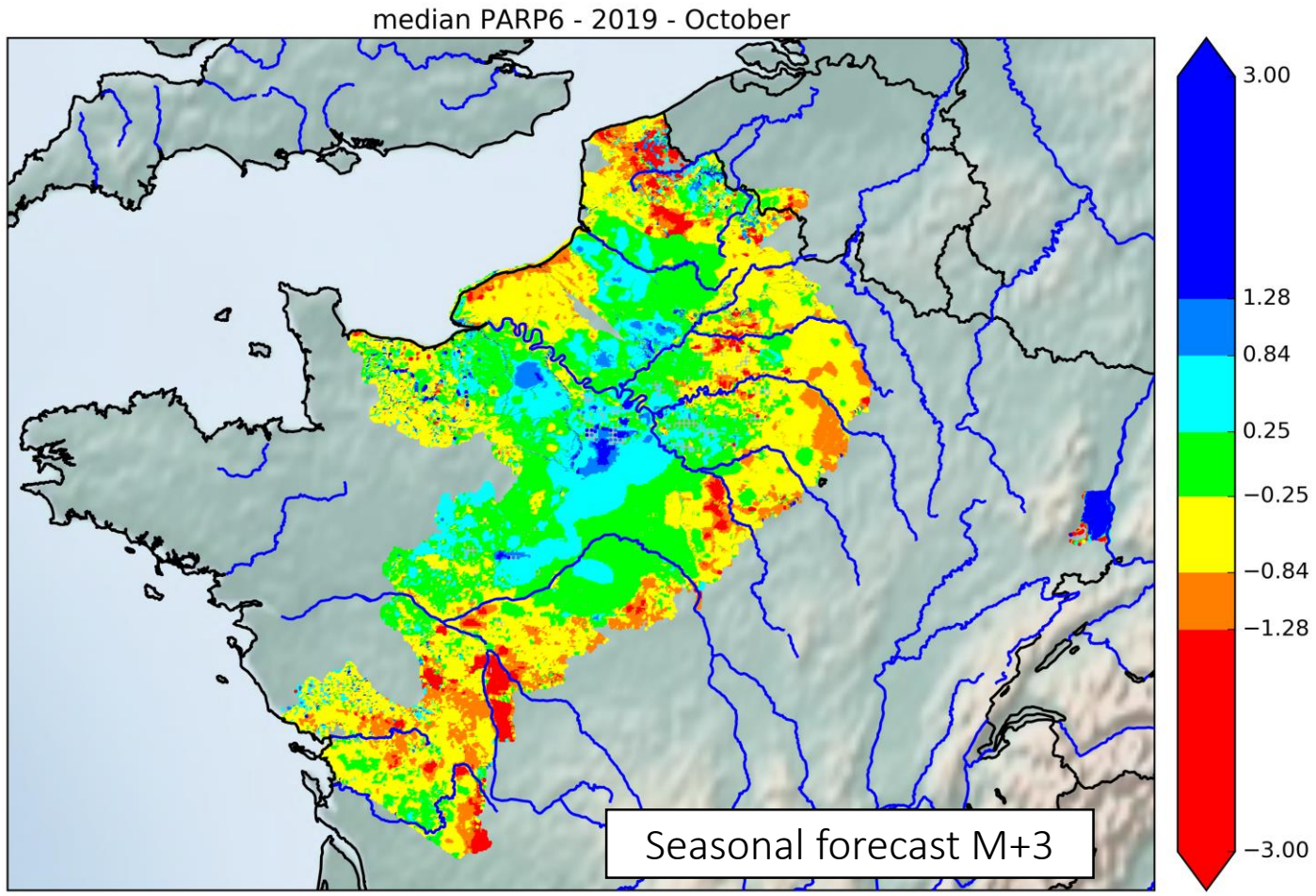
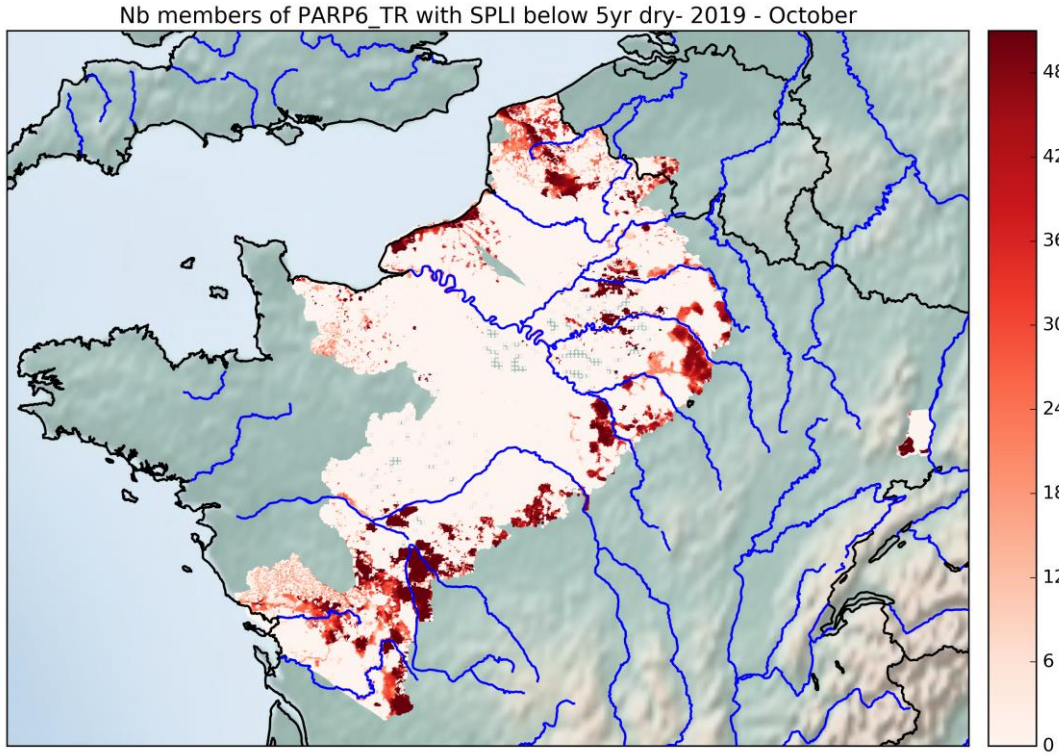
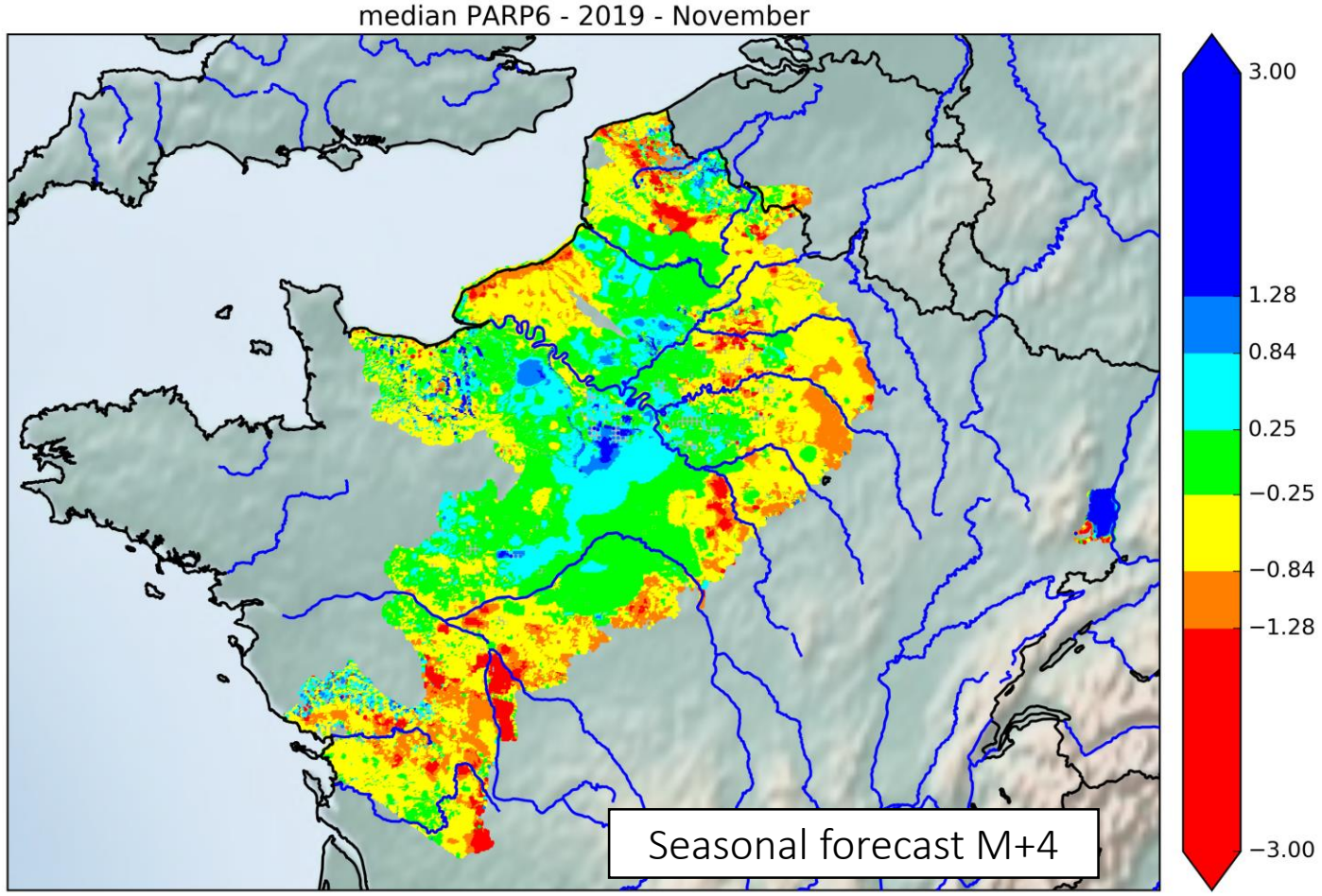


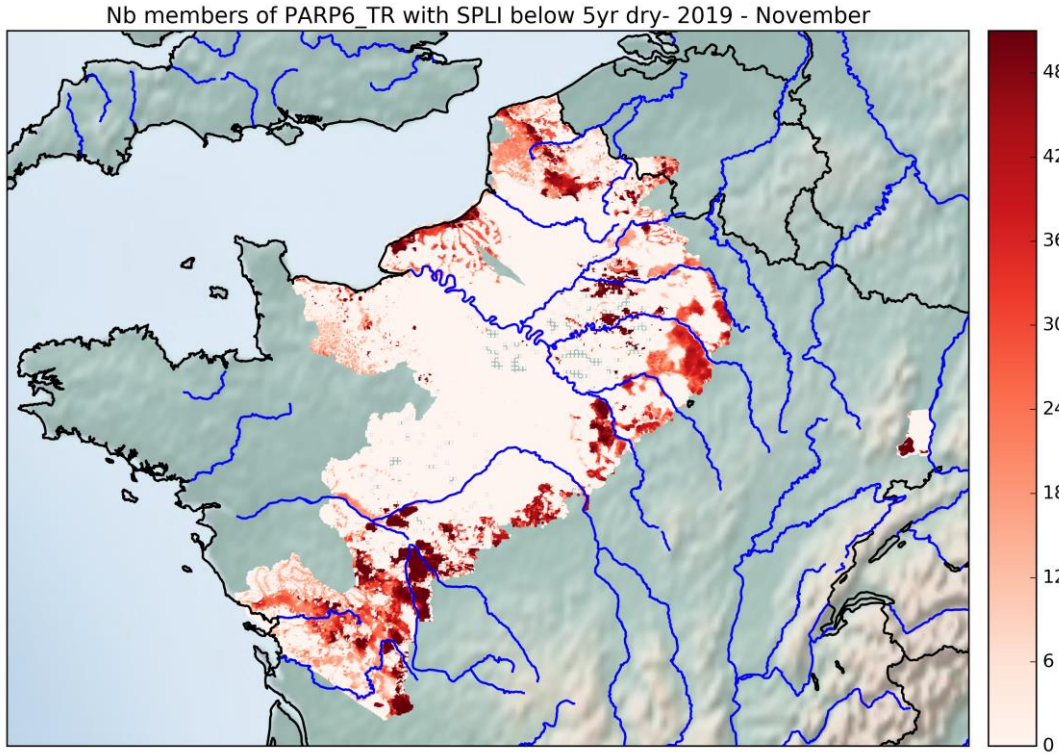
October 2019



Maps of SPLI – **ESF** median and sum members for drought



November 2019



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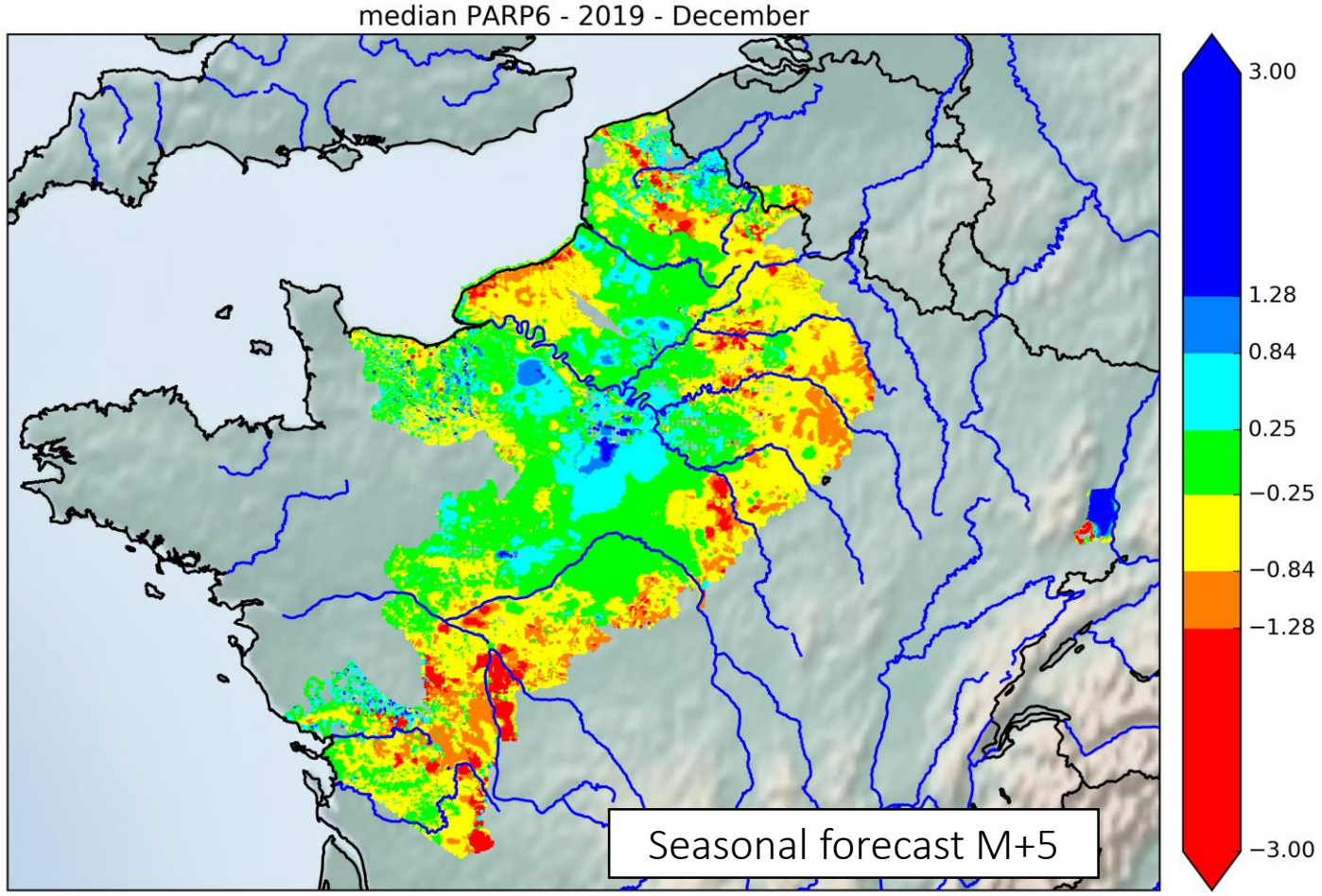
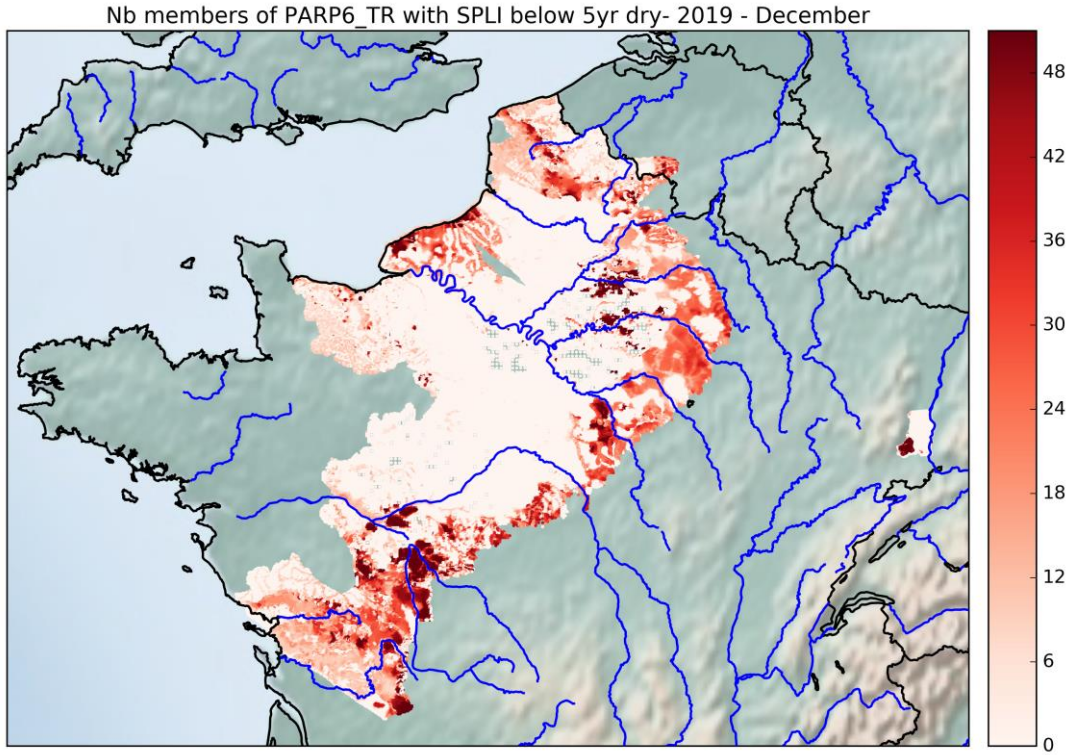


December 2019



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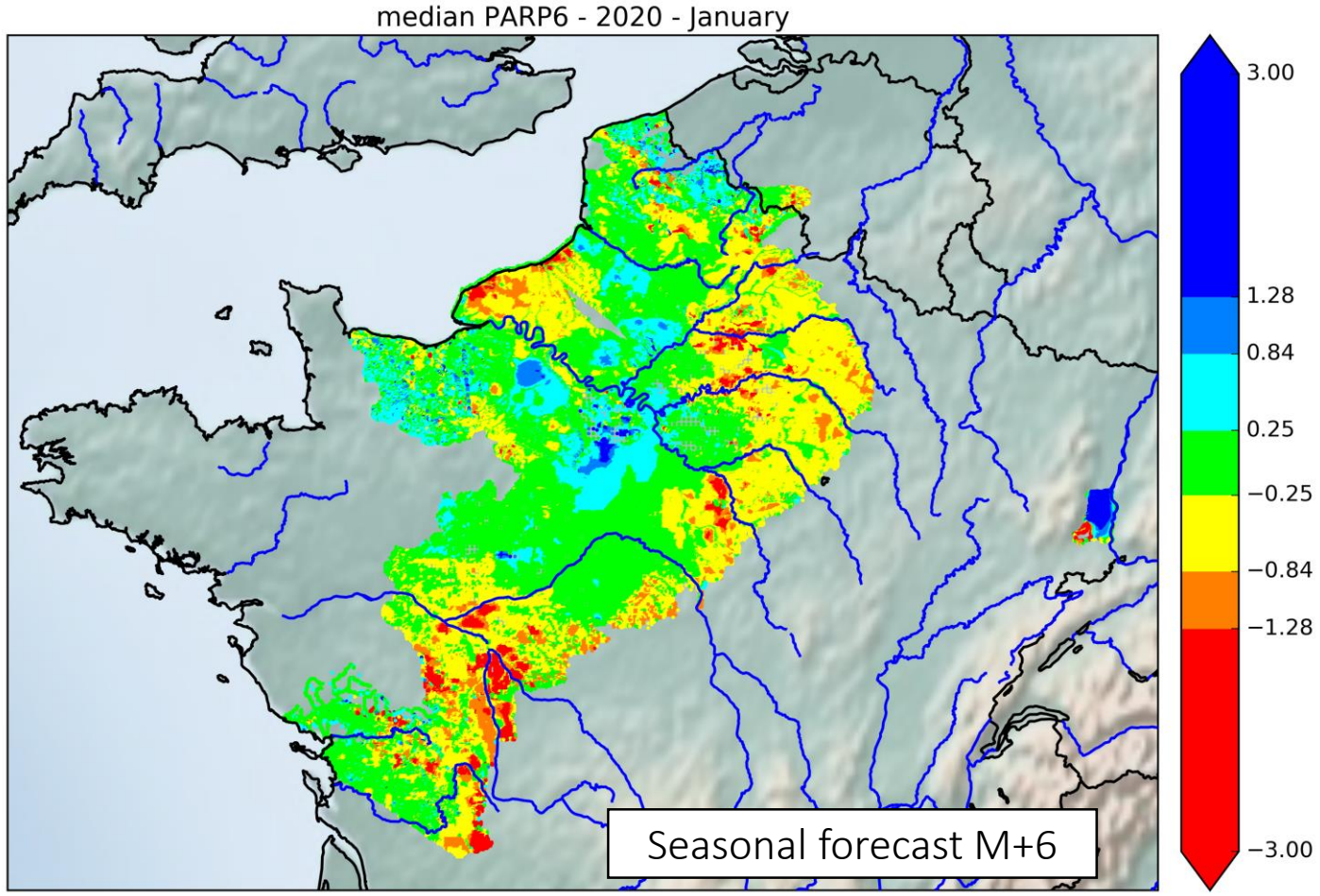
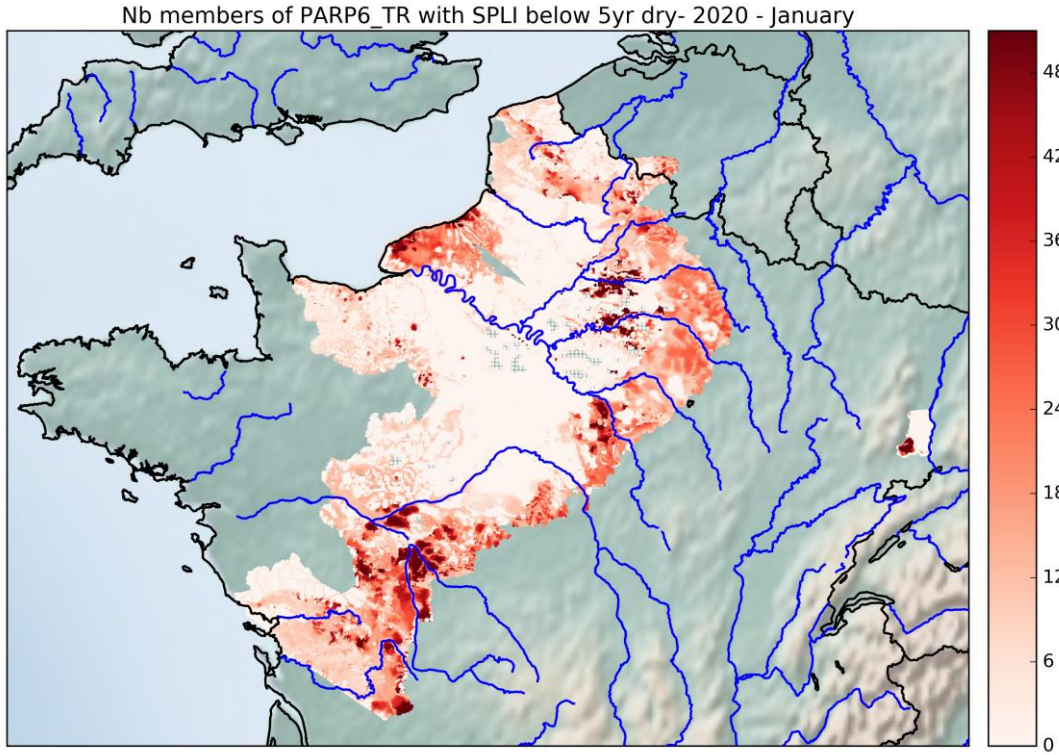


January 2020

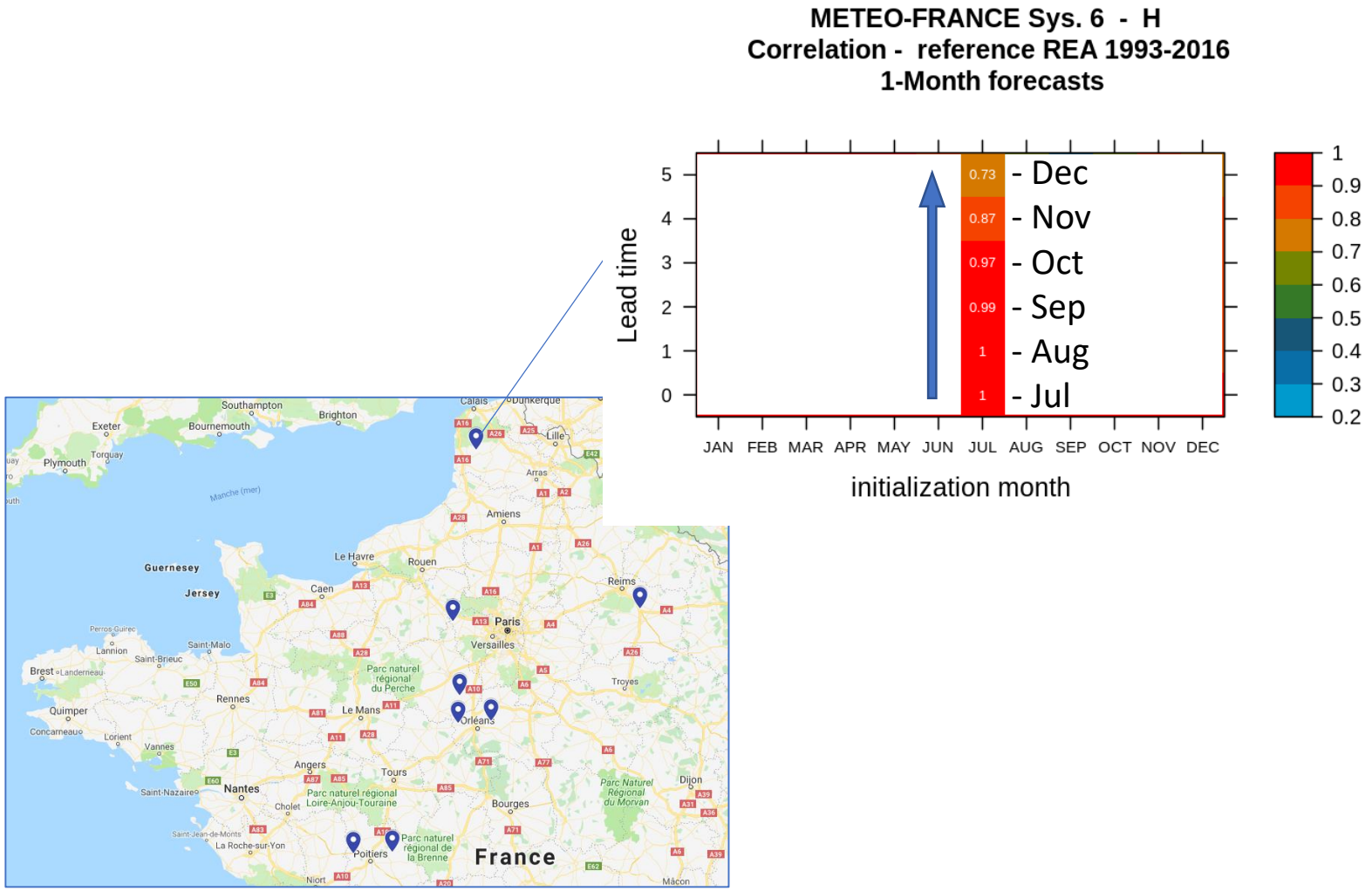


Evaluation methods

- Hindcast period:
  - 1993-2016: 24 years with 25 members
  - Seasonal forecast each month for 6 months
  - Comparison with REA long time run

- Statistical scores:
  - CORR: temporal correlation between the same months of each year
    - Correlation between the SF mean and the reference REA
    - Perfect score: 1
  - RPSS: ranked probability skill score
    - Evaluation of the ranking
    - Are the SF mean and the REA ranked in the same order without taking into account the absolute values ?
    - Perfect score: 1

Local evaluation – correlation per init month [1993-2016]



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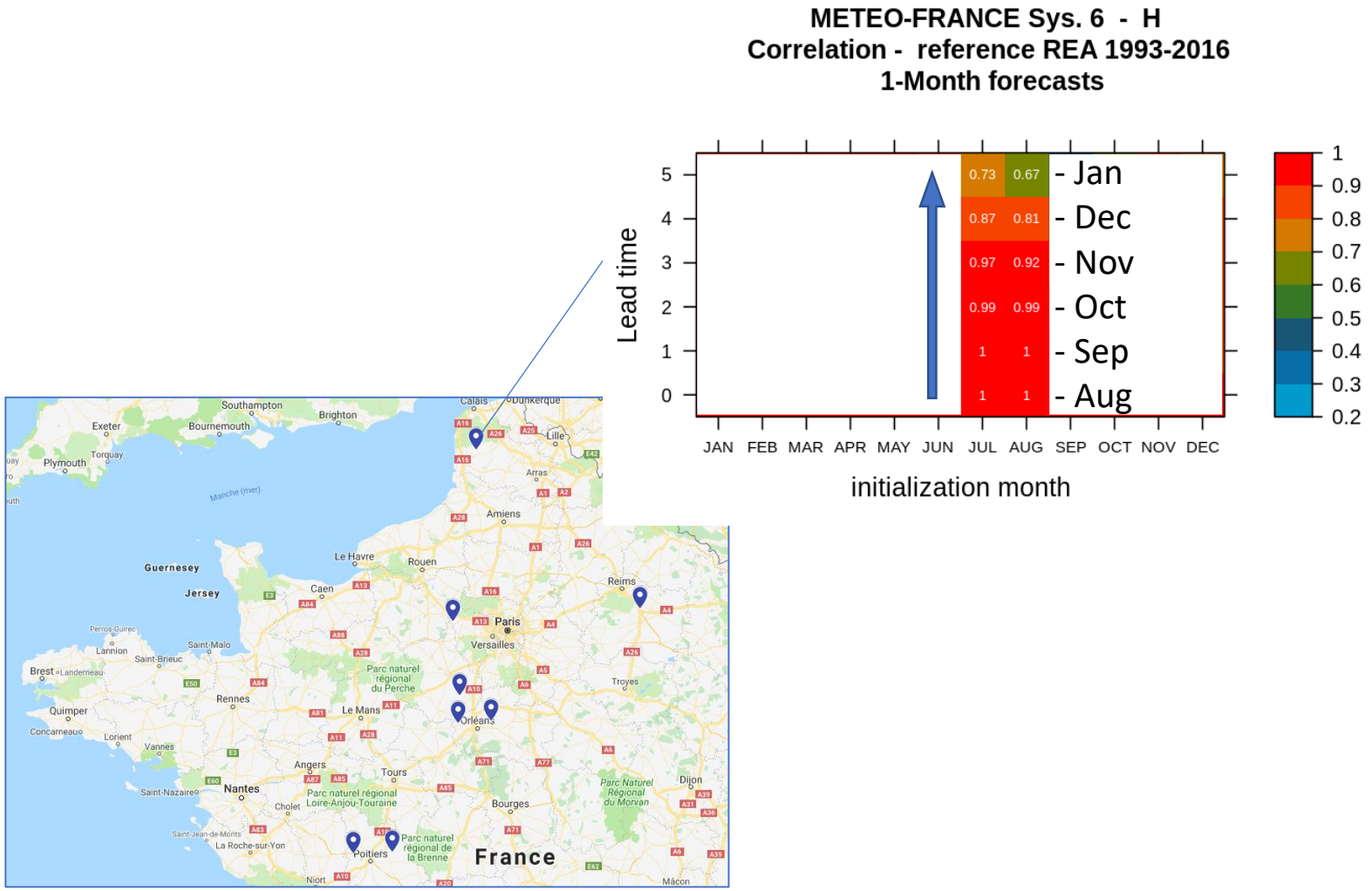

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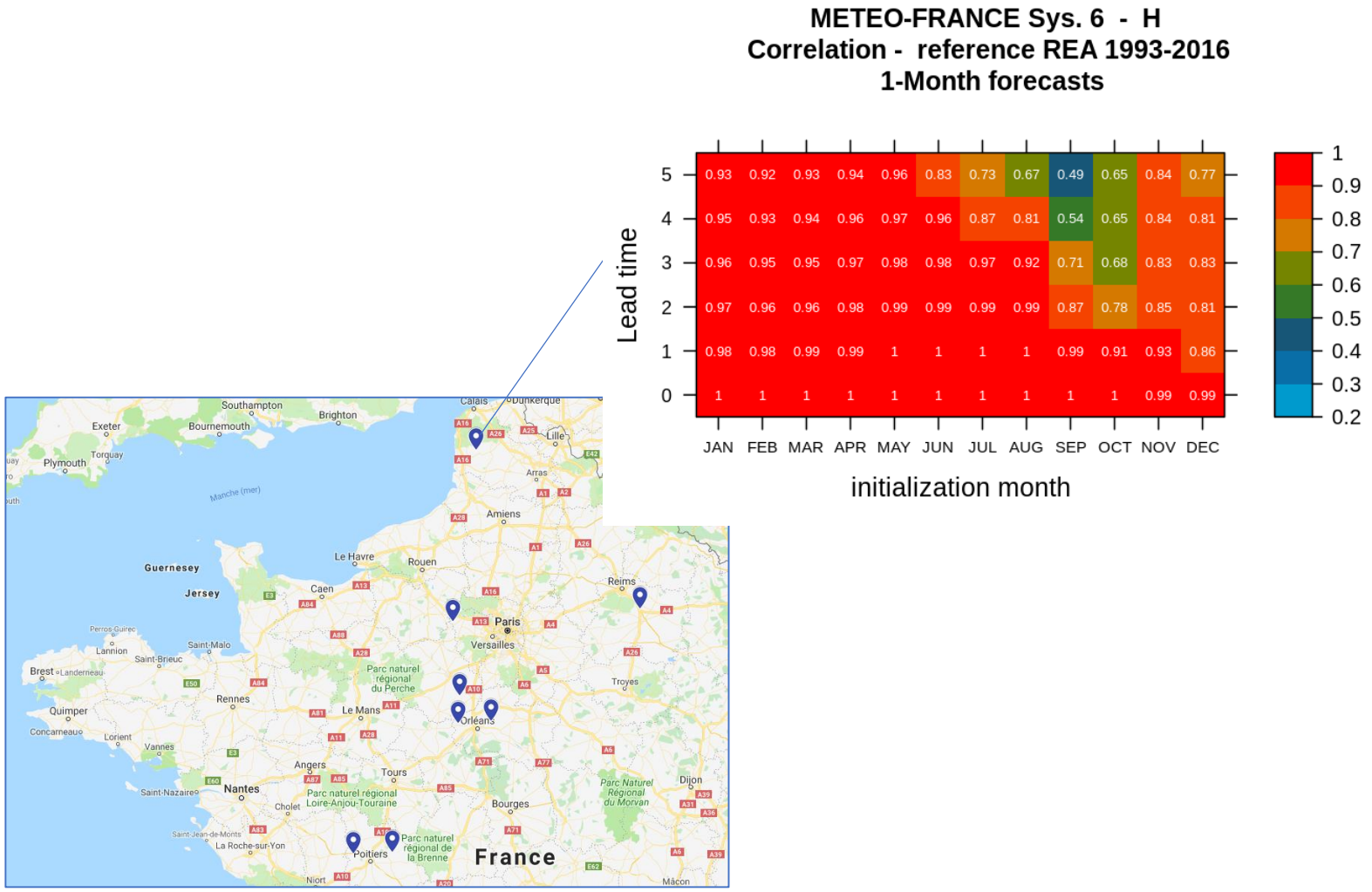

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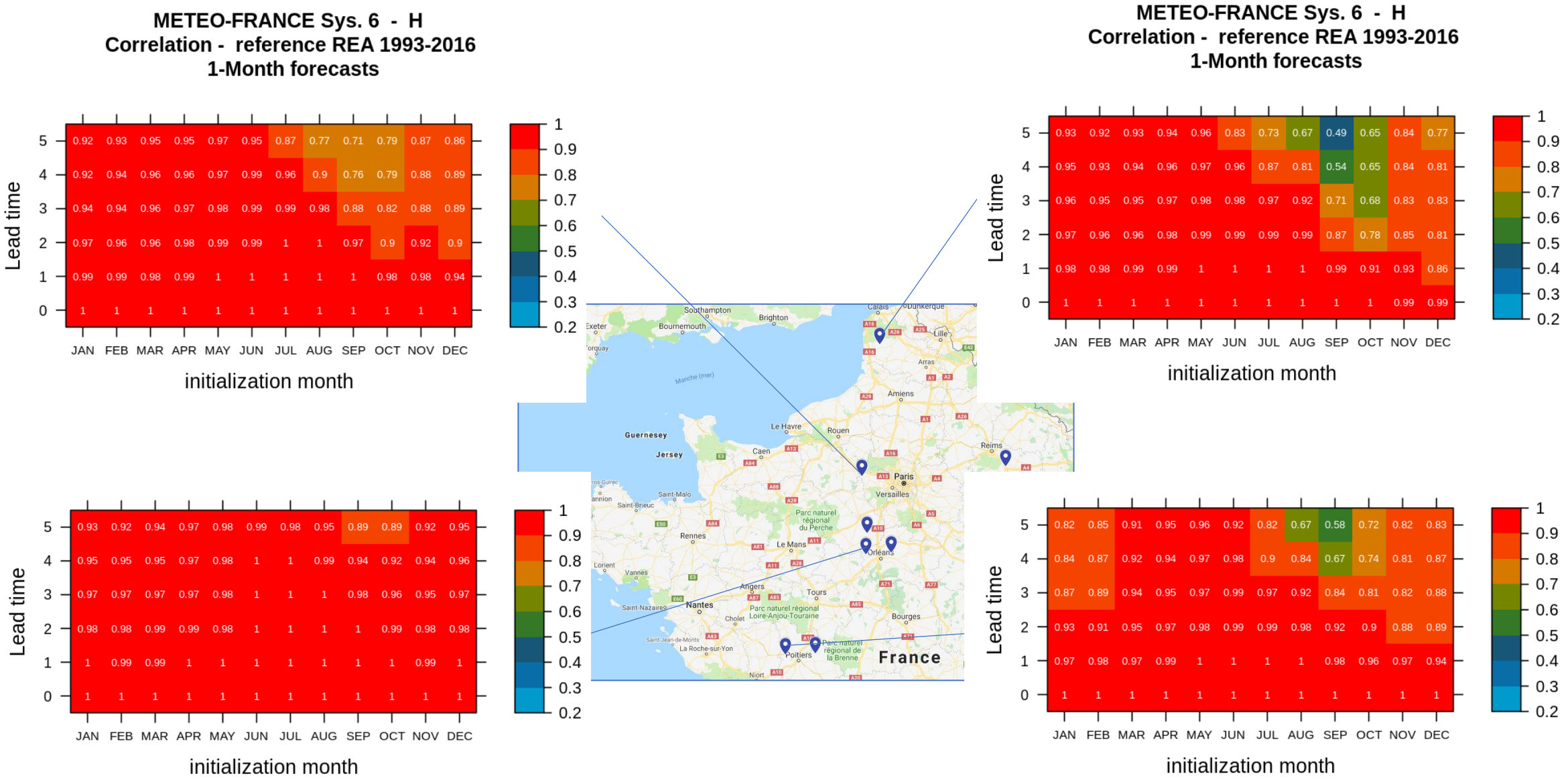


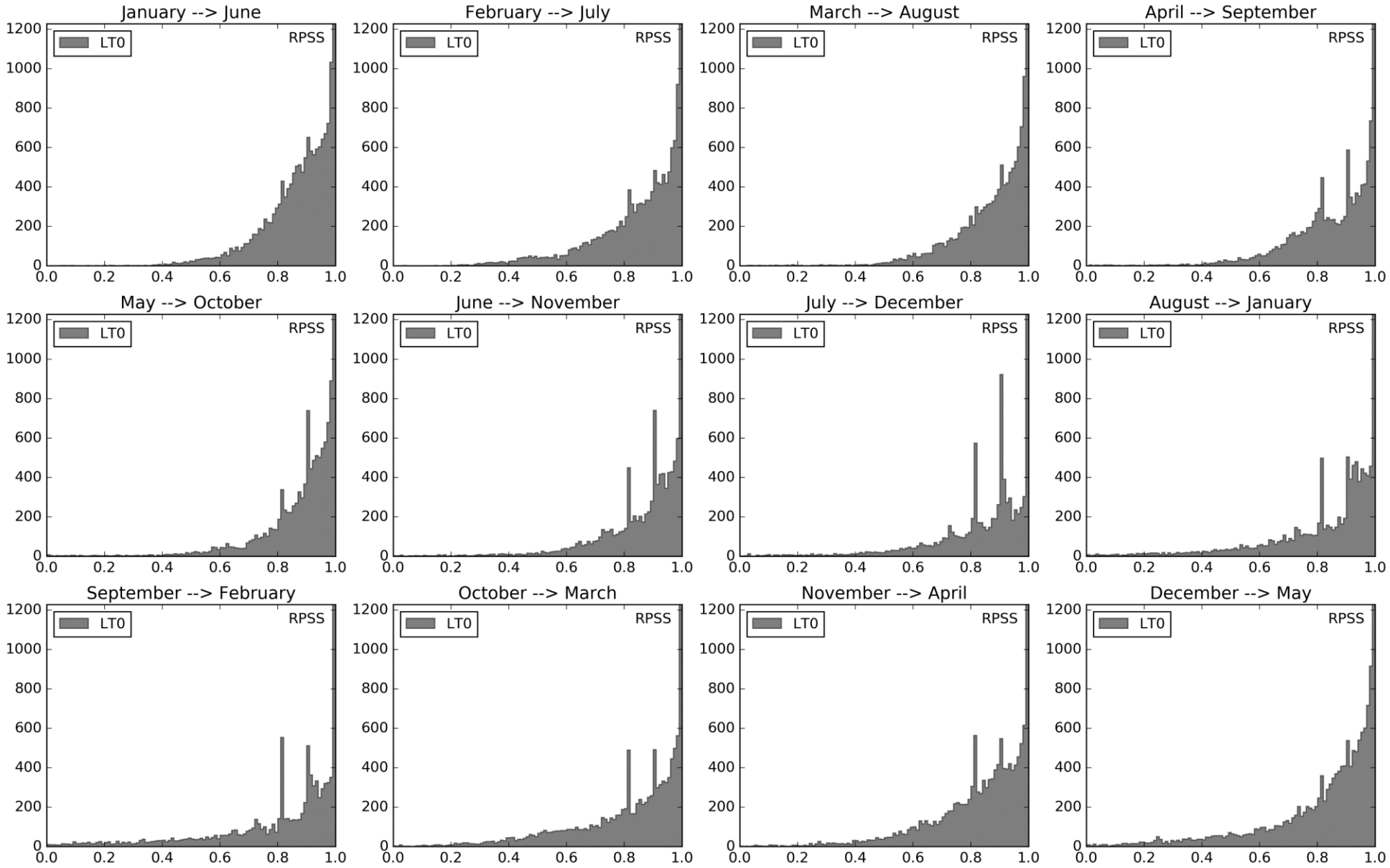
Summary and perspectives

- National platform to monitor and forecast the groundwater levels
  - More applications are coming: Britain, South Western region
- We propose a more spatial point of view
  - Good way to assess drought extents

- Not shown here:
  - Good rates of drought detection (95% the 1st month of forecast to 50% the 6th month)
  - PCLIM using past real atmospheric forcing instead of forecasts

- Perspectives:
  - Finish the evaluation of PCLIM to assess the benefit of ARPEGE system 6, identify when and where it is more relevant to use one or the other
  - Continue our discussions with the stakeholders in order to build the best indicator for their need
  - Investigate the benefit of the spread from the ensemble to compute a confidence index

Regional evaluation – RPSS – Seine basin (24,541 points)



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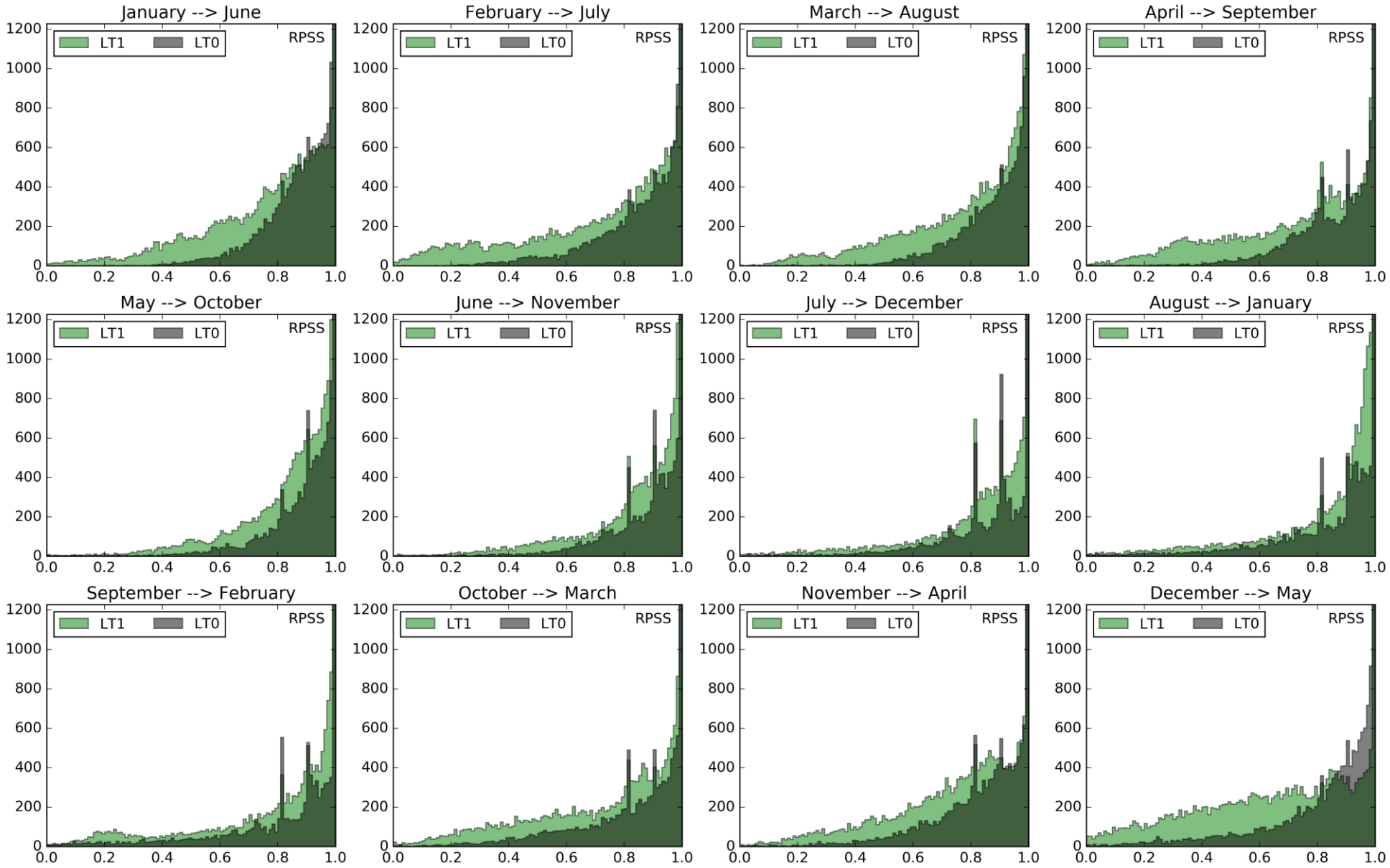

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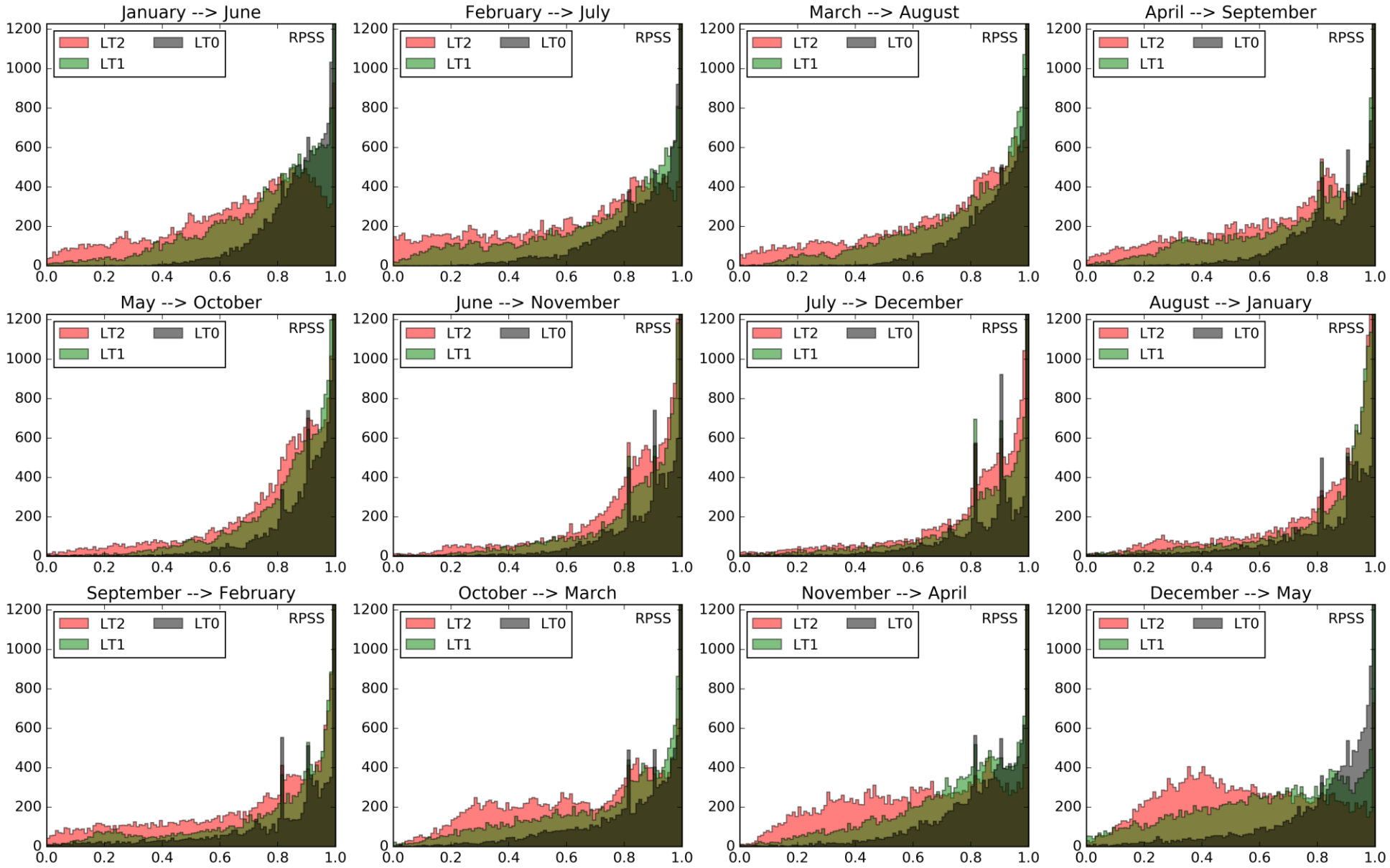

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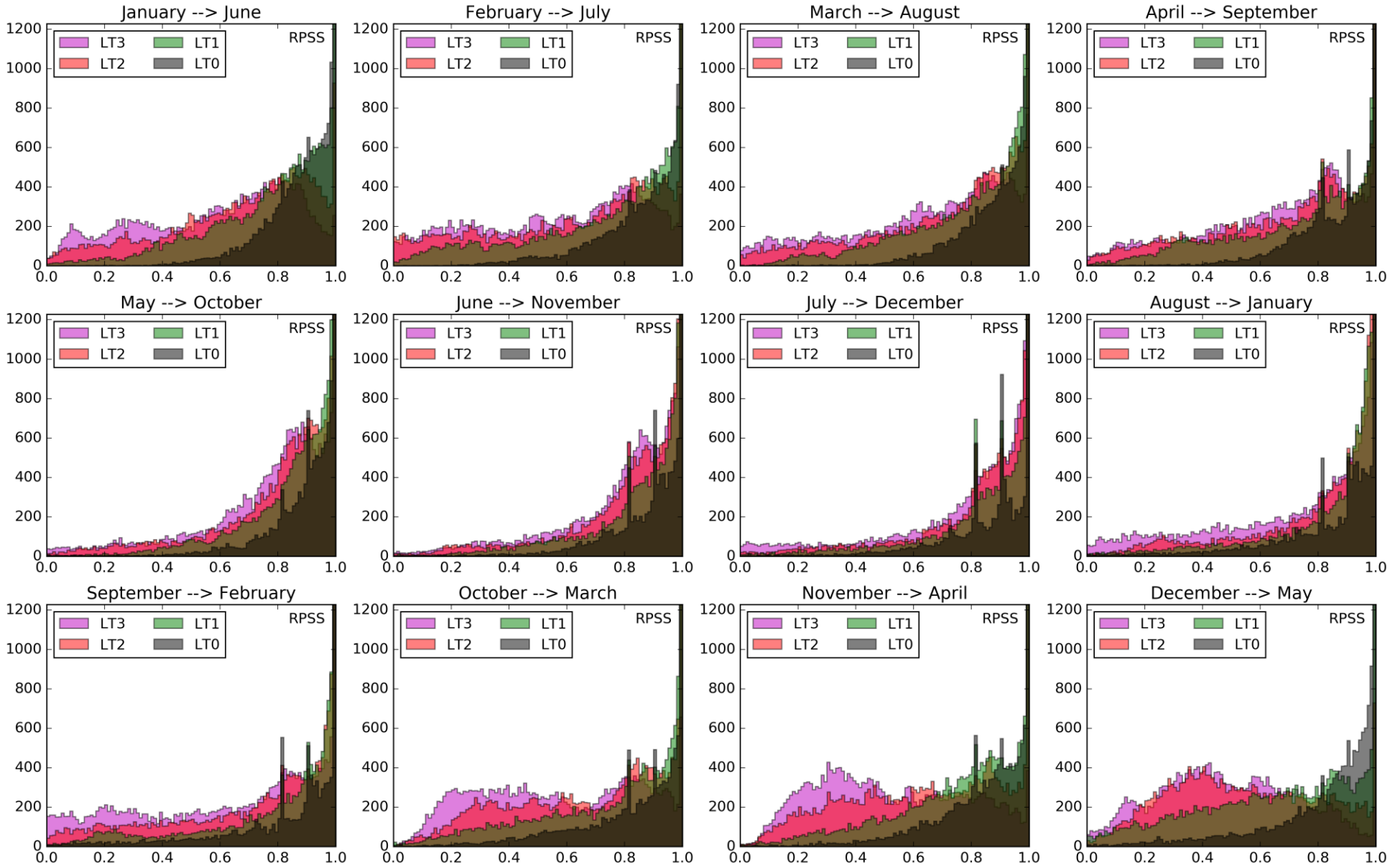

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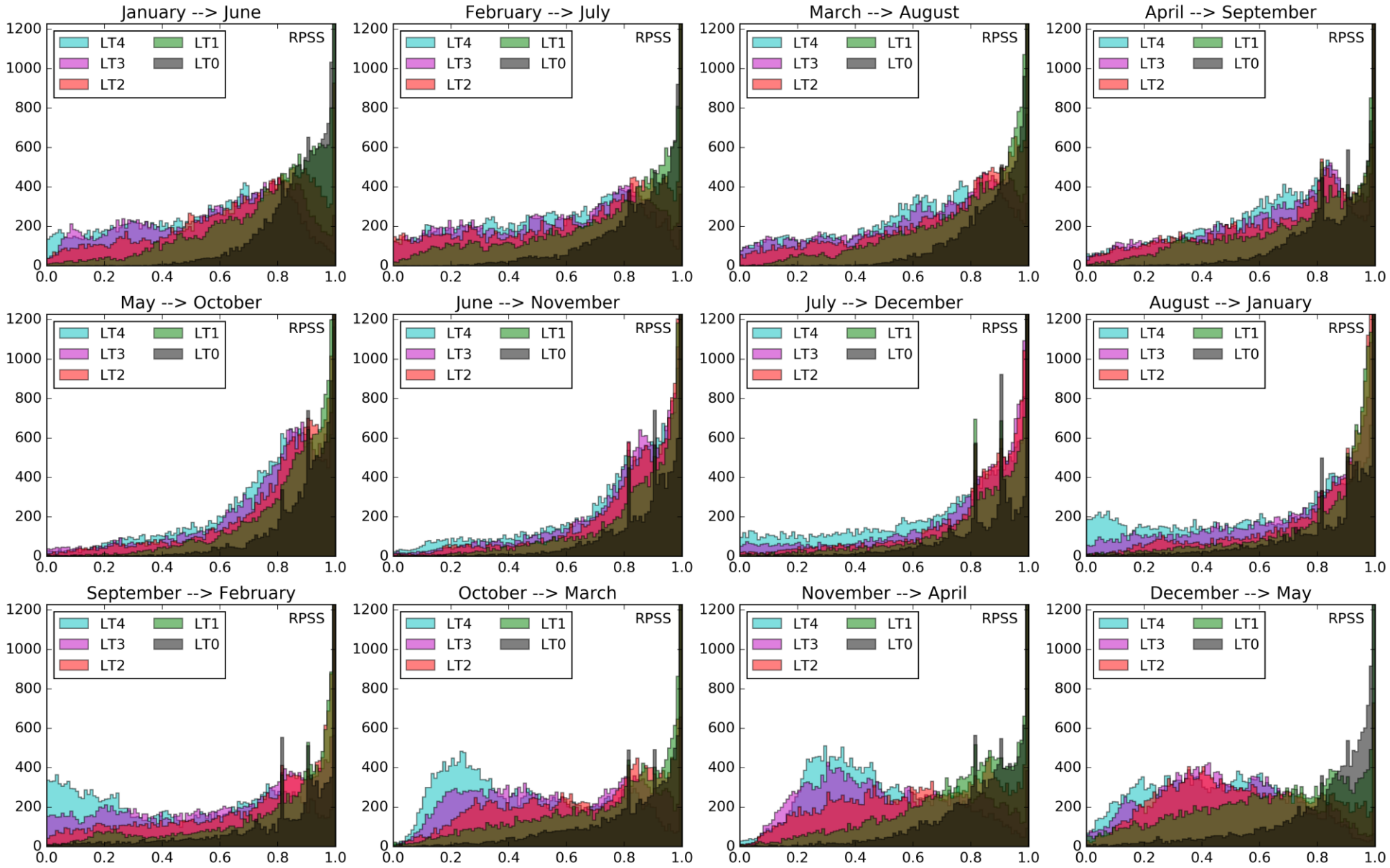

Regional evaluation – RPSS – Seine basin (24,541 points)