

Climate indices based on MESCAN-SURFEX reanalysis: Comparison to operational indices over France

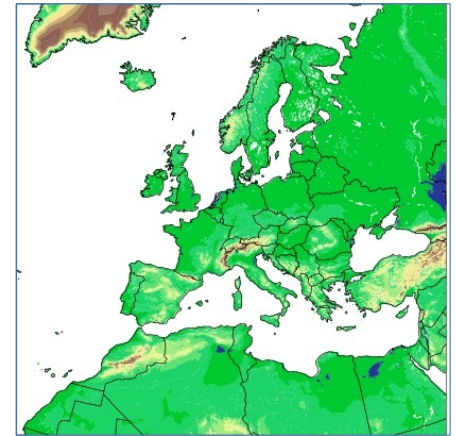
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Météo-France

Tarragona, 30/11/2017

Plan

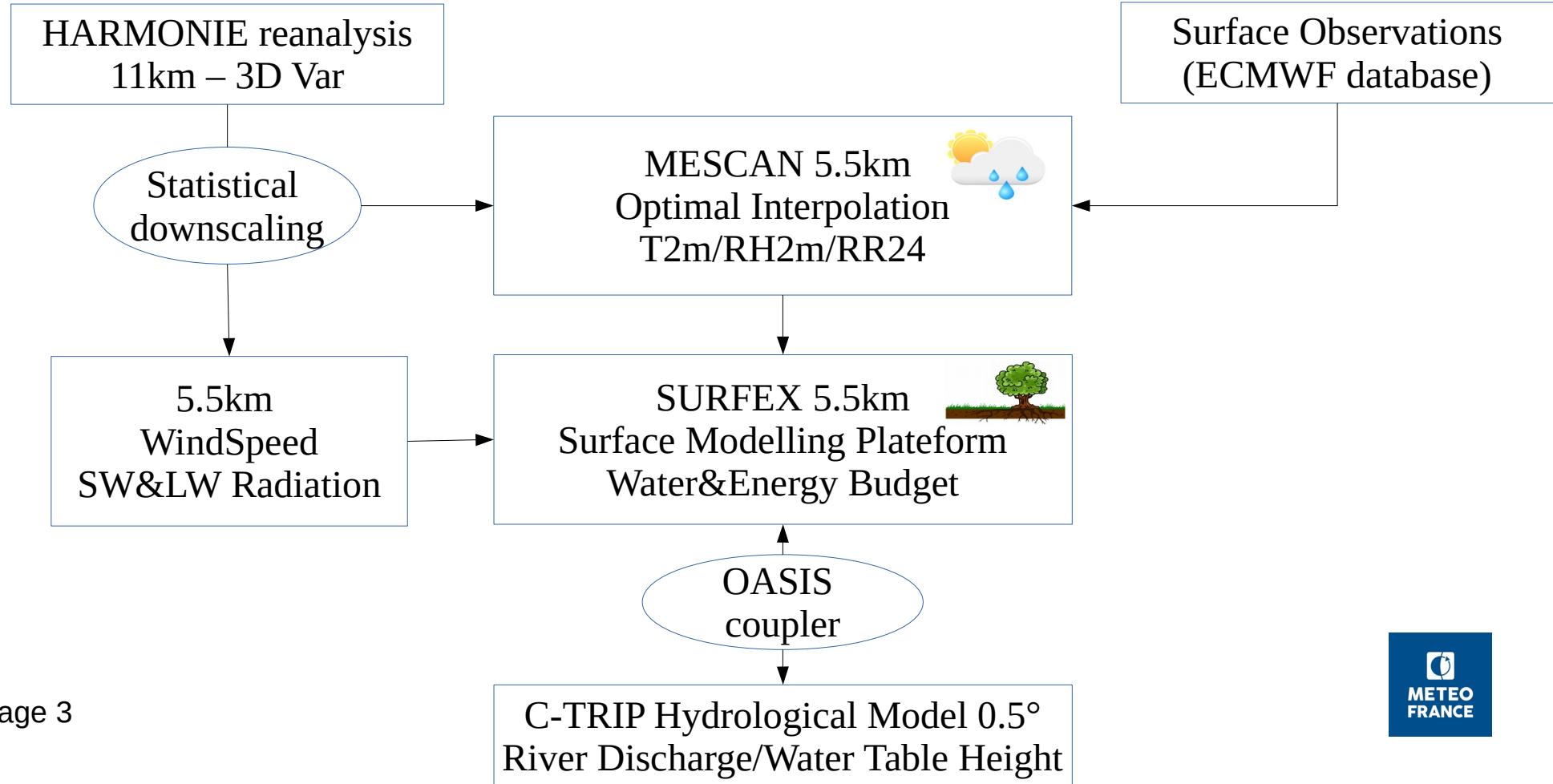
1. MESCOAN-SURFEX : quick overview
2. Climate indices coming from MESCOAN outputs
3. Climate indices coming from SURFEX outputs

MESCAN-SURFEX reanalysis system



■ Aim: provide a reanalysis dataset from 1961 to 2015 over UERRA domain for:

- atmospheric parameters at surface level
- surface/soil parameters



MESCAN-SURFEX reanalysis system

- List of available parameters on Mars Archive:
 - **2m temperature** & Relative Humidity ; 10m Wind Speed/Direction ; Shortwave & Longwave incident radiation (6h time step)
 - daily **precipitation** (liquid and solid)
 - Volumetric water content (14 levels), **Soil wetness index**, Runoff, Drainage (1h time step)
 - Snow Water Equivalent, Snow Depth/Density (1h time step)
 - Soil Temperature (14 layers), Skin Temperature, Albedo, Latent/Sensible Heat Fluxes (1h time step)

Plan

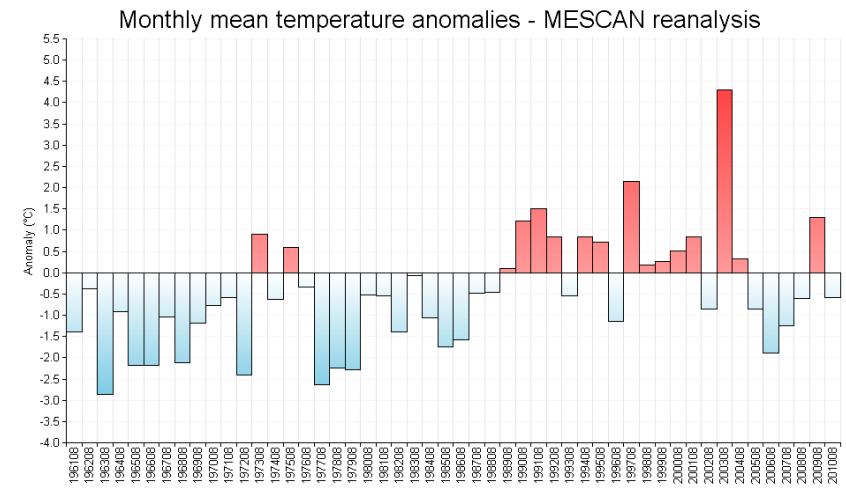
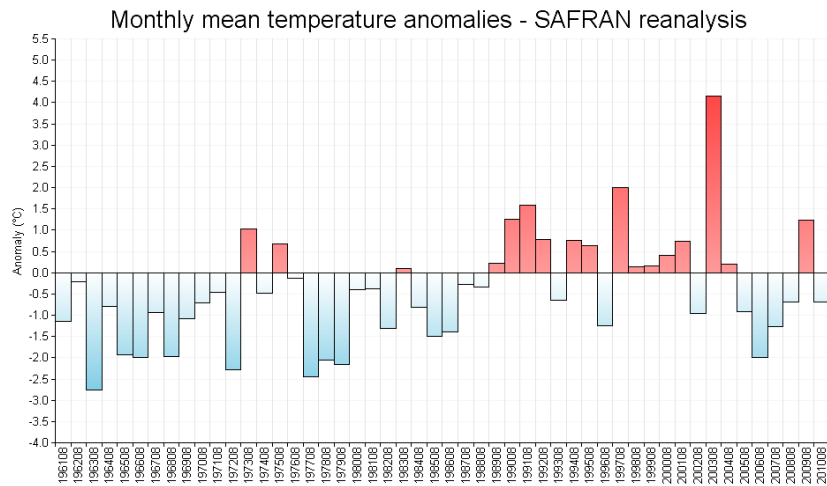
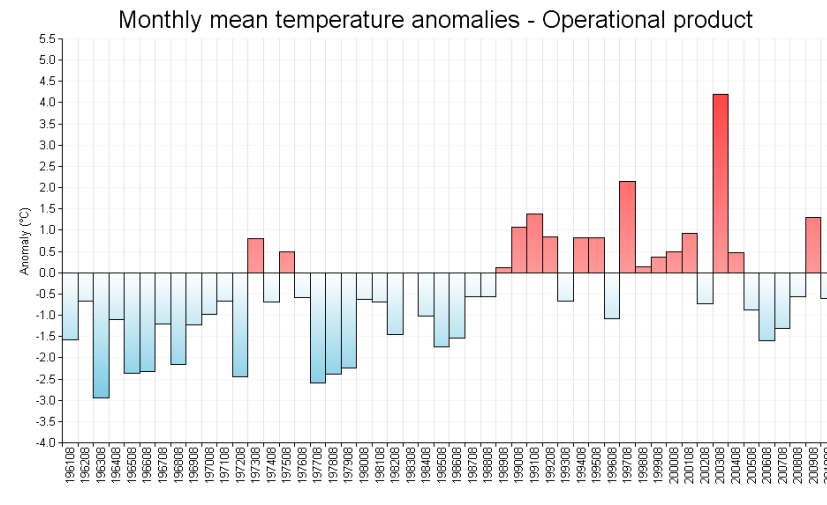
1. MESCAN-SURFEX : quick overview
2. Climate indices coming from MESCAN outputs
 1. 2m temperature
 2. Precipitation
3. Climate indices coming from SURFEX outputs

2.1 Climate indices coming from MESCAN : T2m

- Available: 2m temperature at 6hours time step on a 5.5km regular grid
- Temporal agregation
 - Daily mean temperature (average T2m at 00h, 06h, 12h, 18h UTC)
 - Monthly mean temperature
- Period: 1961-2010
- Comparison to:
 - A reference: thermic index operational at Météo-France
 - based on an ensemble of 30 stations (long term series)
 - available at monthly time-step from 1900, daily time step from 1947
 - Daily mean temperature as $(T_n + T_x)/2$
 - An other reanalysis dataset: SAFRAN reanalysis
 - Uses ERA40/ERA-Interim + observations
 - 8km resolution over France ; hourly time step
 - Daily mean temperature as mean of hourly values [00h; 23h]

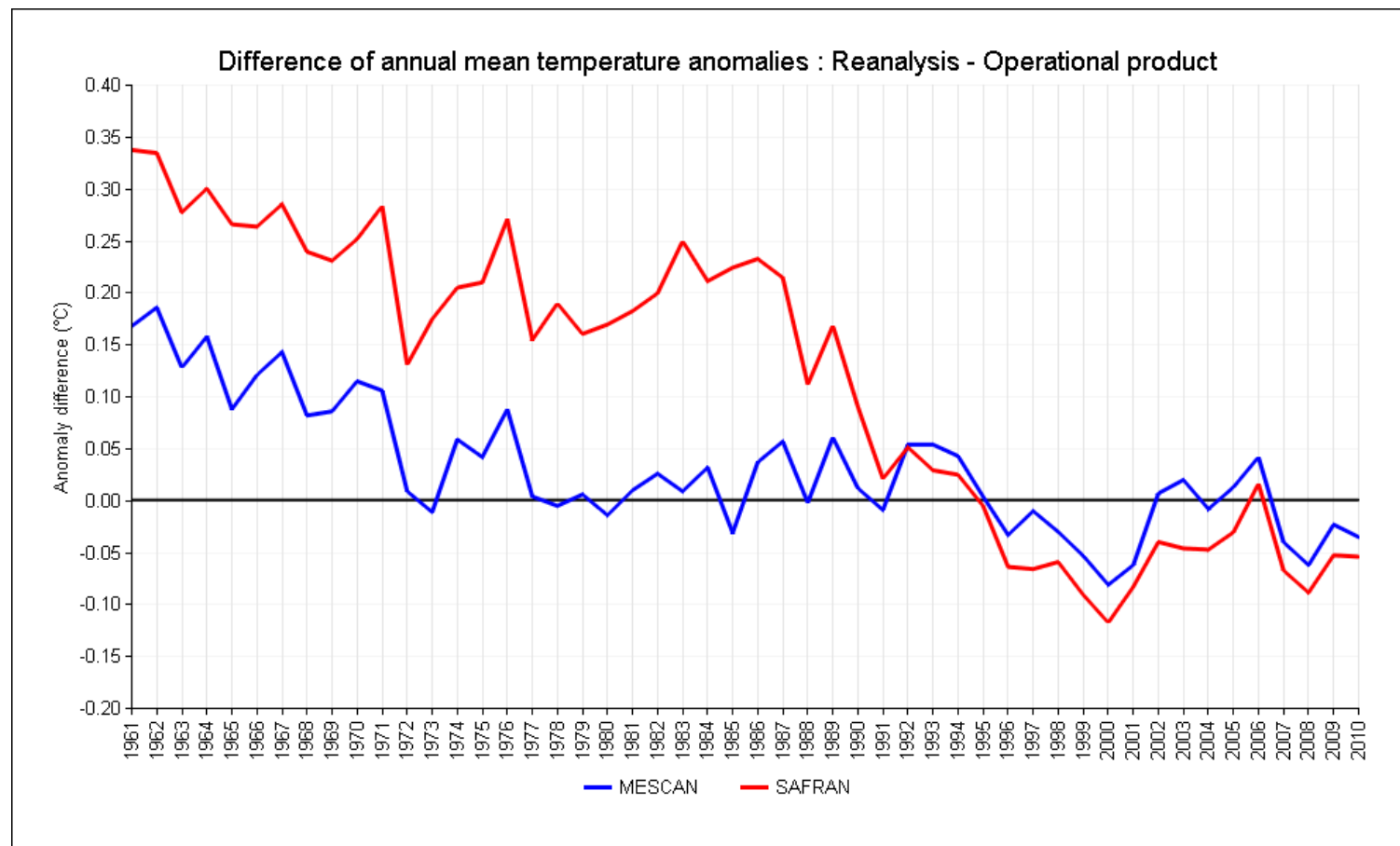
2.1 Climate indices coming from MESCAN : T2m

- Monthly/Annual time step : anomaly .wrt. 1981-2010 normal
- Good quality for reanalysis products compared to the reference



2.1 Climate indices coming from MESCAN : T2m

- Evolution of the difference between the anomalies from reanalysis products and operational product known as homogenous
- Temporal homogeneity of t2m anomalies better for MESCAN than for SAFRAN

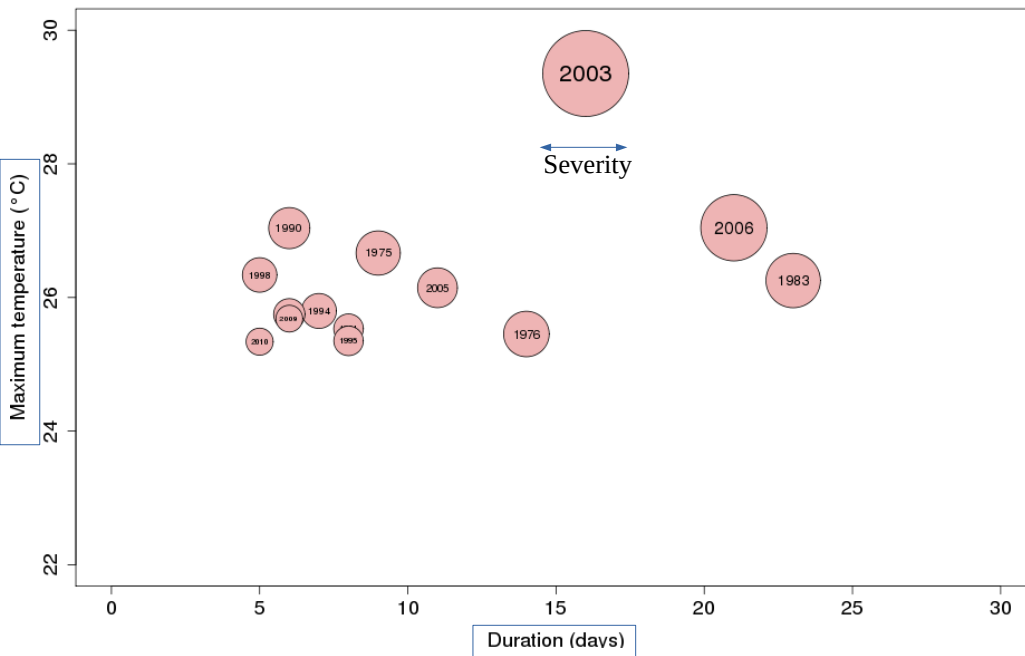


2.1 Climate indices coming from MESCAN : T2m

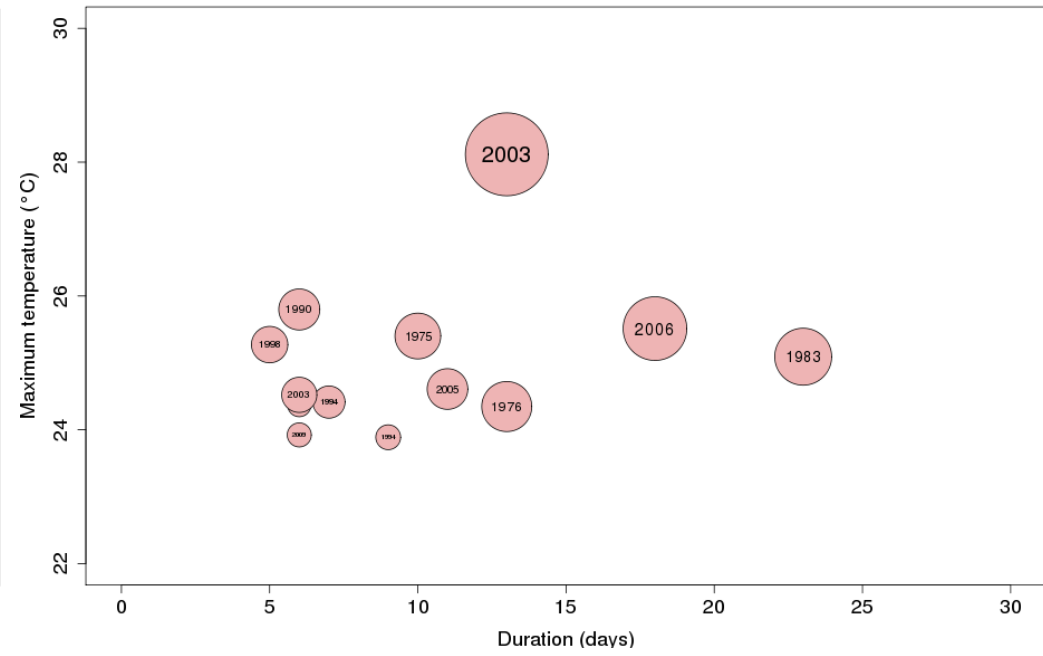
- Capability of daily t2m series to detect heat/cold waves
- Heat waves detection method:
 - Start time : daily $T^{\circ} > \text{percentile } 99.5 \text{ (C995)}$
 - Wave continues if daily T° is not lower than C975 for more than two consecutive days. Nota : Interruption if $T^{\circ} < C950$
 - While finished, main characteristics :
 - Duration (see point below)
 - Severity: $(\text{Sum of degrees over C975}) / (C995 - C975)$
 - Maximal intensity : max daily T° over the heat wave period
- Cold waves idem with C005/C025/C050
- Reference Period for percentile: 1981-2010
- Method applied on 1961-2010

2.1 Climate indices coming from MESCAN : T2m

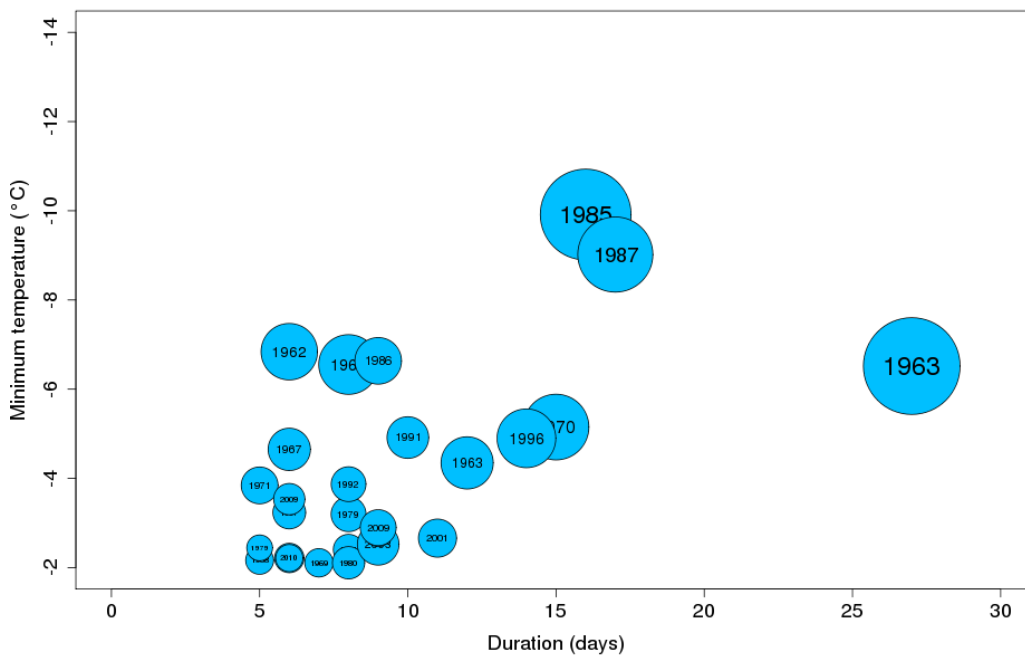
Heat waves over France
INDTH 1961-2010 (14)



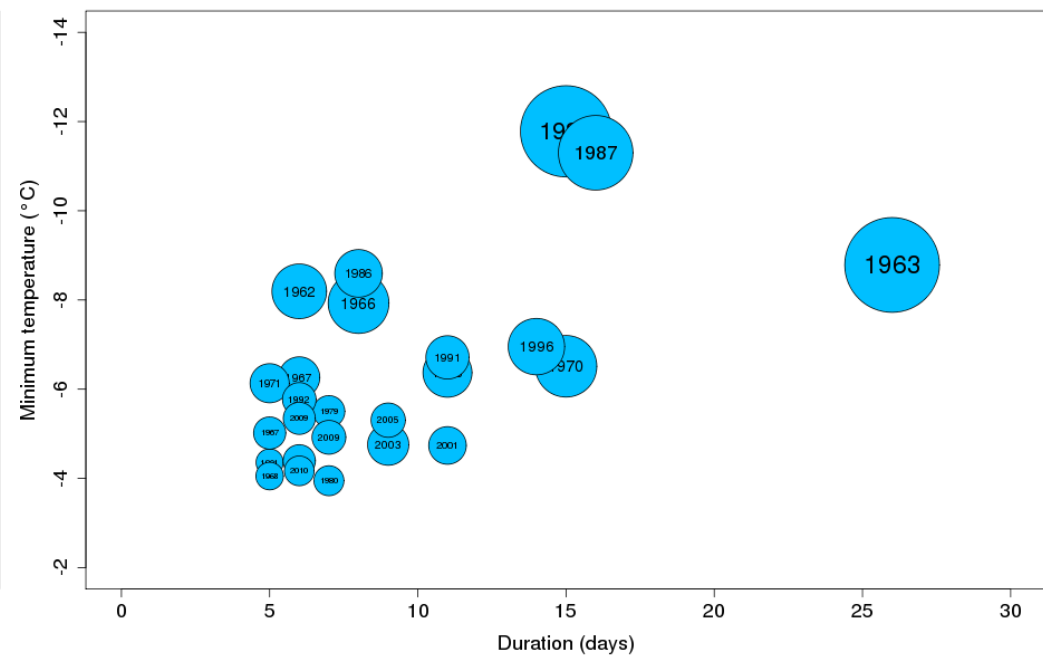
Heat waves over France
MESCAN 1961-2010 (13)



Cold waves over France
INDTH 1961-2010 (27)

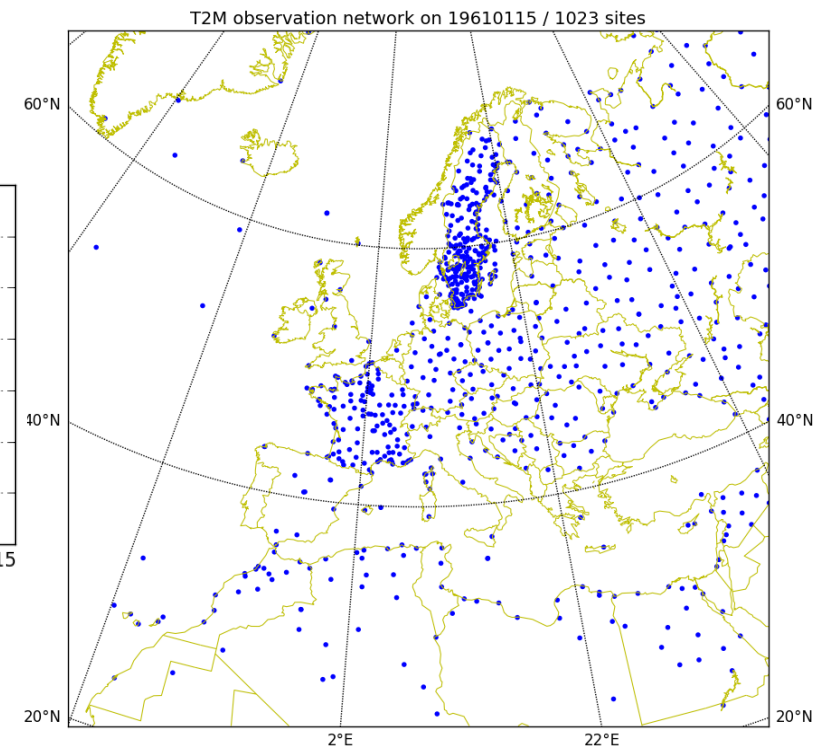
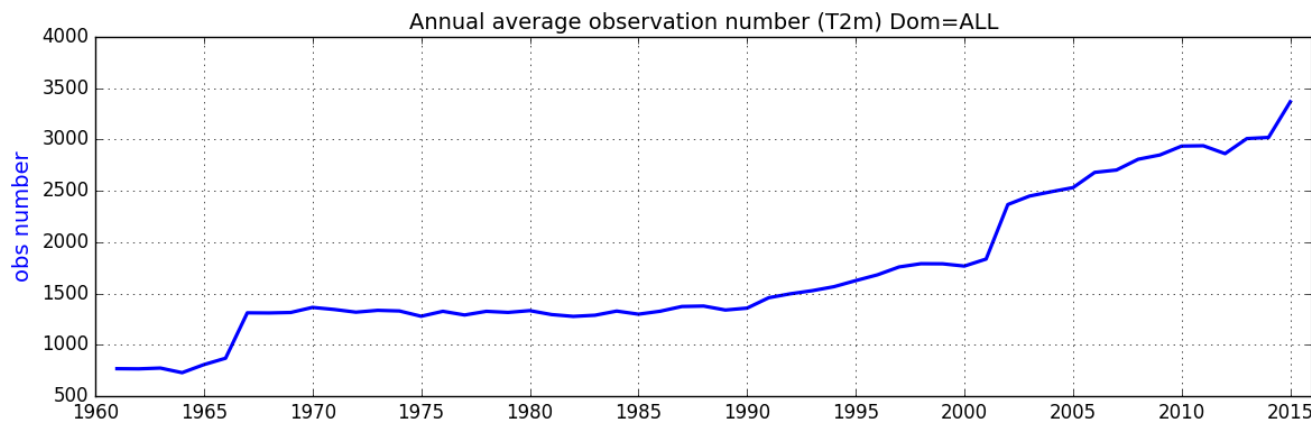


Cold waves over France
MESCAN 1961-2010 (25)



2.1 Climate indices coming from MESCAN : T2m

- For 2m-temperature MESCAN production performs well over France:
 - to get monthly to annual anomaly of temperature
 - to detect heat/cold waves using daily time series
- Remaining question: is it applicable:
 - at lower spatial scale ?
 - for area with major heterogeneities in the number of t2m observation available over the reanalysis period ?

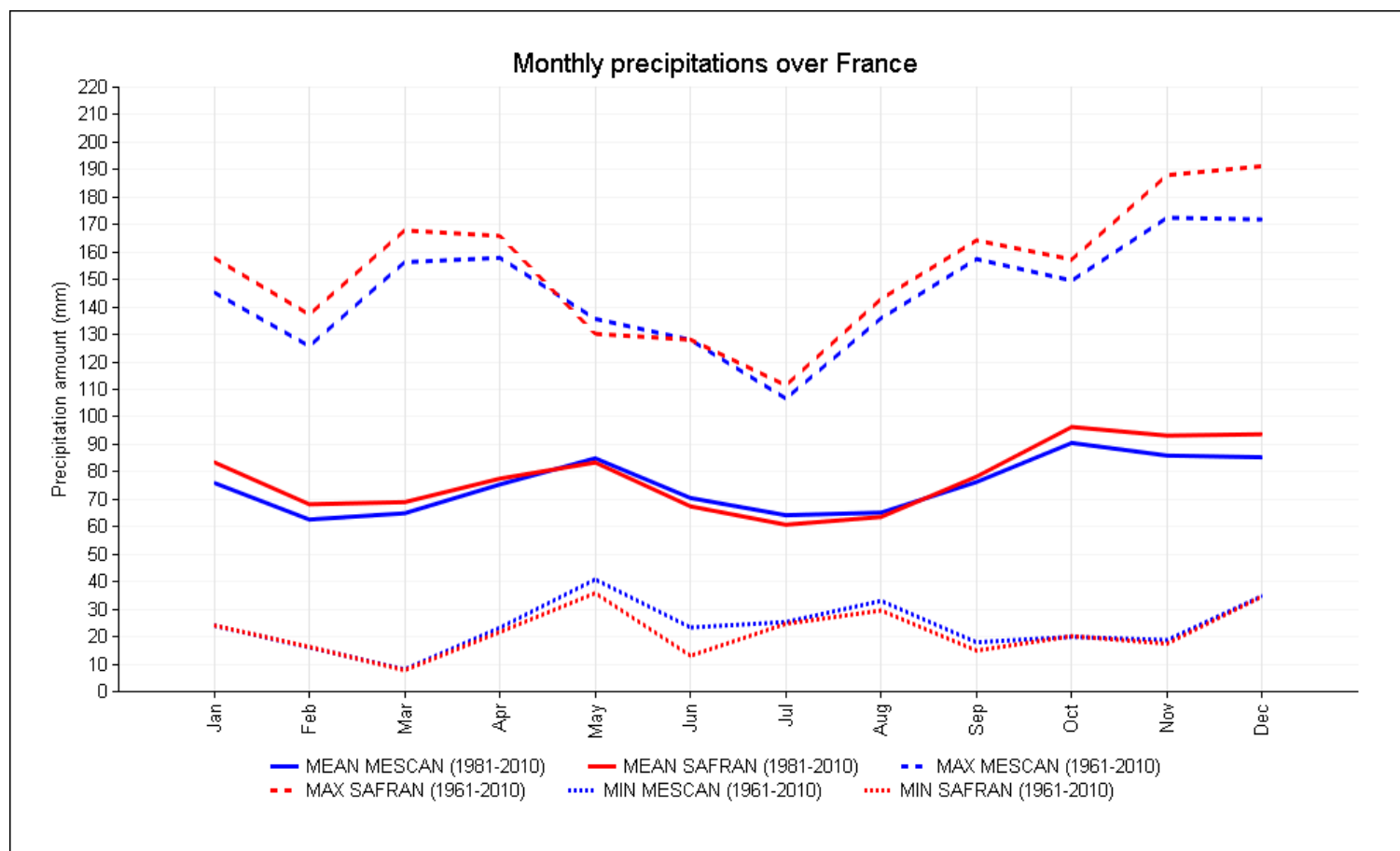


2.2 Climate indices coming from MESCAN : Precipitation

- Available : daily precipitation on a 5.5km regular grid
- Temporal agregation : Monthly accumulated precipitation
- Period: 1961-2010
- Comparison to:
 - SAFRAN reanalysis (used operationnaly for climate monitoring in real time)
 - Homogenized long term series used to detect trends over long period
- Indexes :
 - Normal / Anomaly / Min-Max
 - Standard Precipitation Index: accumulation over n months fitting to a normal distribution

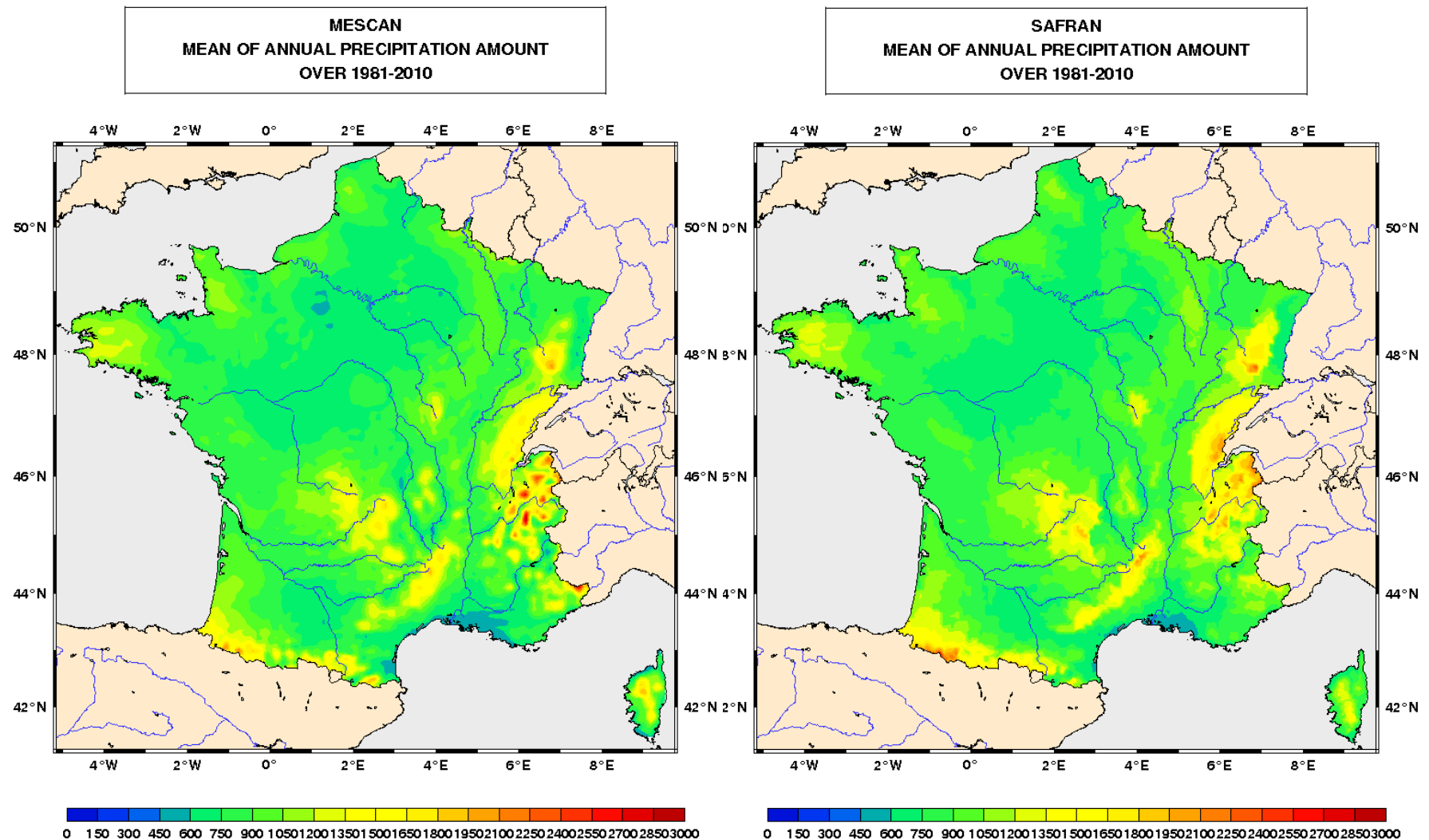
2.2 Climate indices coming from MESCAN : Precipitation

- Mean annual values (1981-2010) : 901mm (MESCAN) / 934mm (SAFRAN) => relative bias : 3,5 %
- Monthly averages quite similar – Slight deficit during from October to March
- Monthly maximum values lower with MESCAN
- Monthly minimum values equals or higher with MESCAN



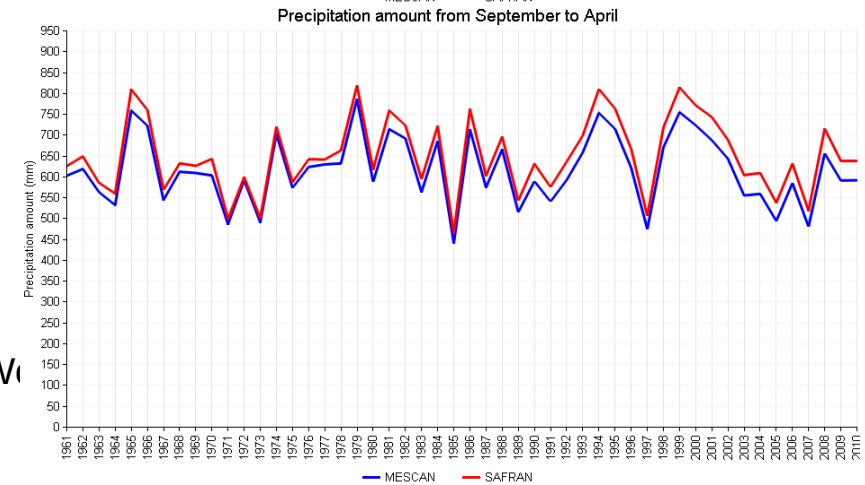
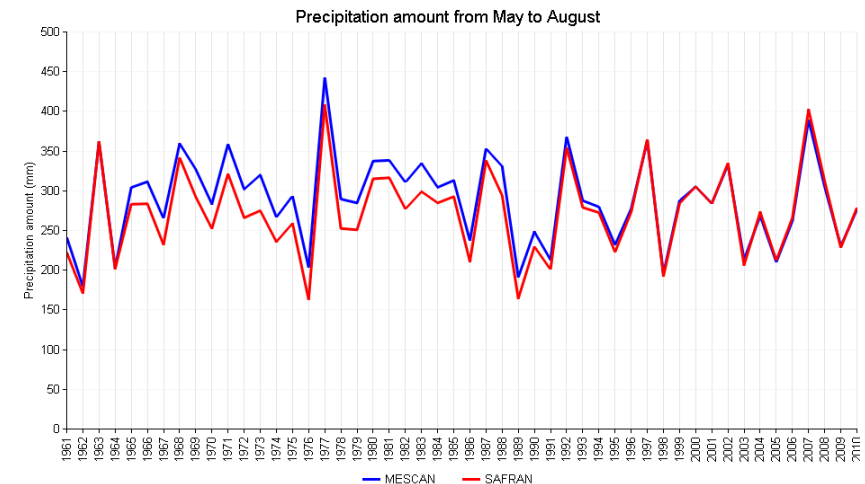
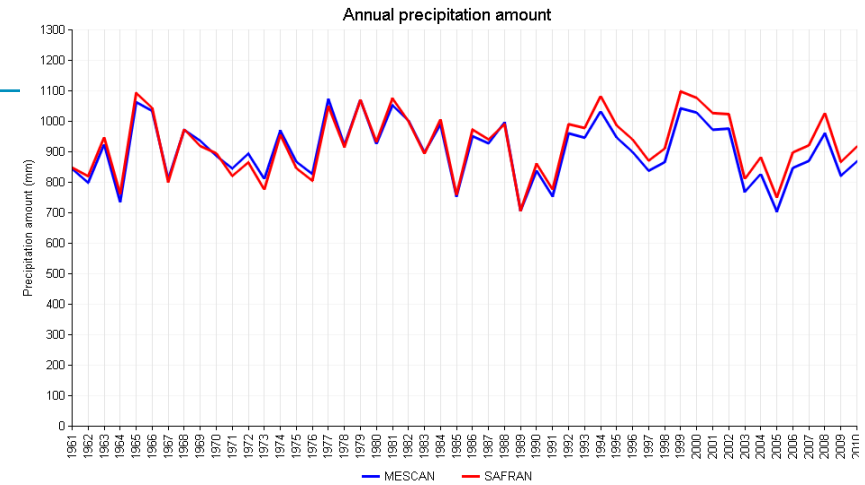
2.2 Climate indices coming from MESCAN : Precipitation

- Spatial repartition quite similar on flat area
- Different patterns in mountainous area: higher local maximum with MESCAN in the Alps; underestimation over Cevennes area & Pyrenees



2.2 Climate indices coming from MESCAN : Precipitation

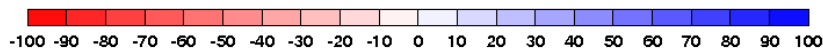
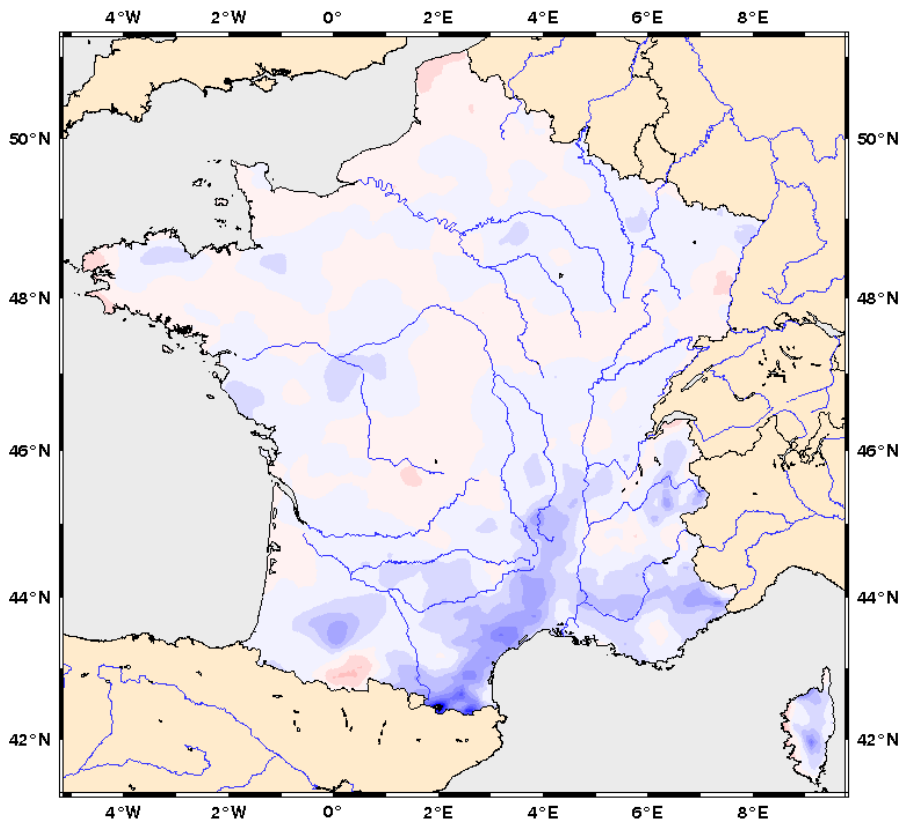
- Temporal evolution during the reanalysis period :
 - Underestimation of the annual precipitation from the 90's; quite similar before
 - May to August period: Overestimation from 60's to 80's ; then quite similar
 - September to April period: quite constant underestimation



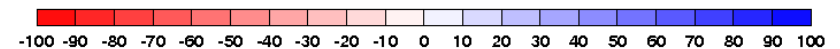
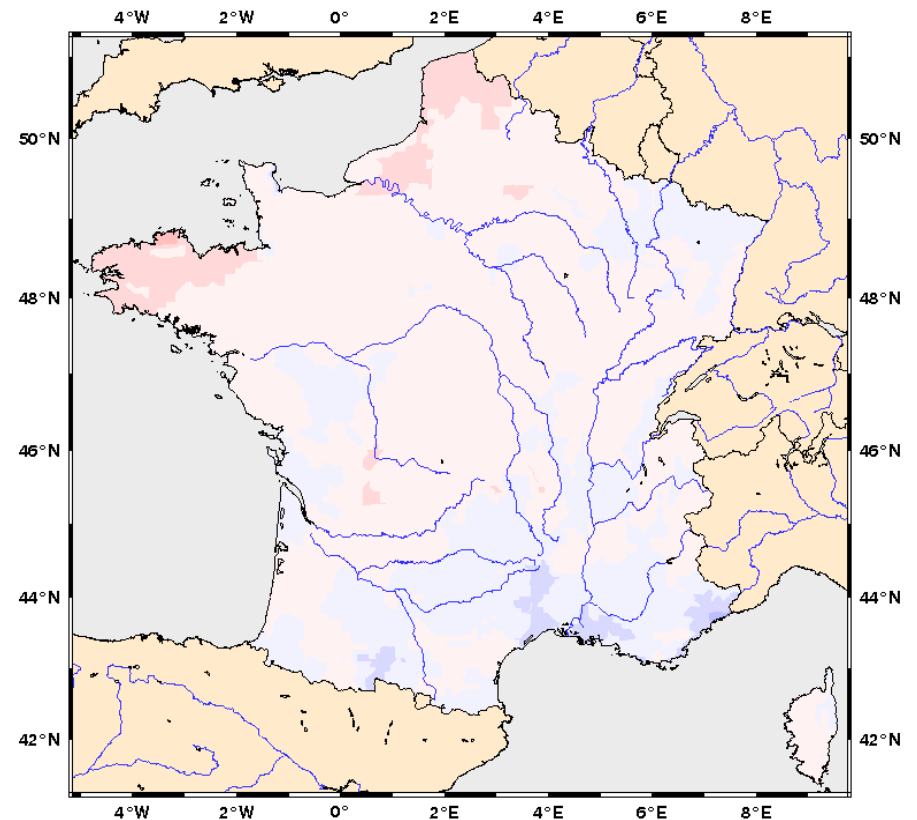
2.2 Climate indices coming from MESCAN : Precipitation

- Period May to August, comparison normal 1961-1990 and 1981-2010: large differences over the eastern part of Pyrenees and mediterranean coastline for MESCAN. Weaker signal for SAFRAN (except North and Britany)

MESCAN
NORMAL 1961-1990 MINUS 1981-2010 (%)
PERIOD MAY TO AUG



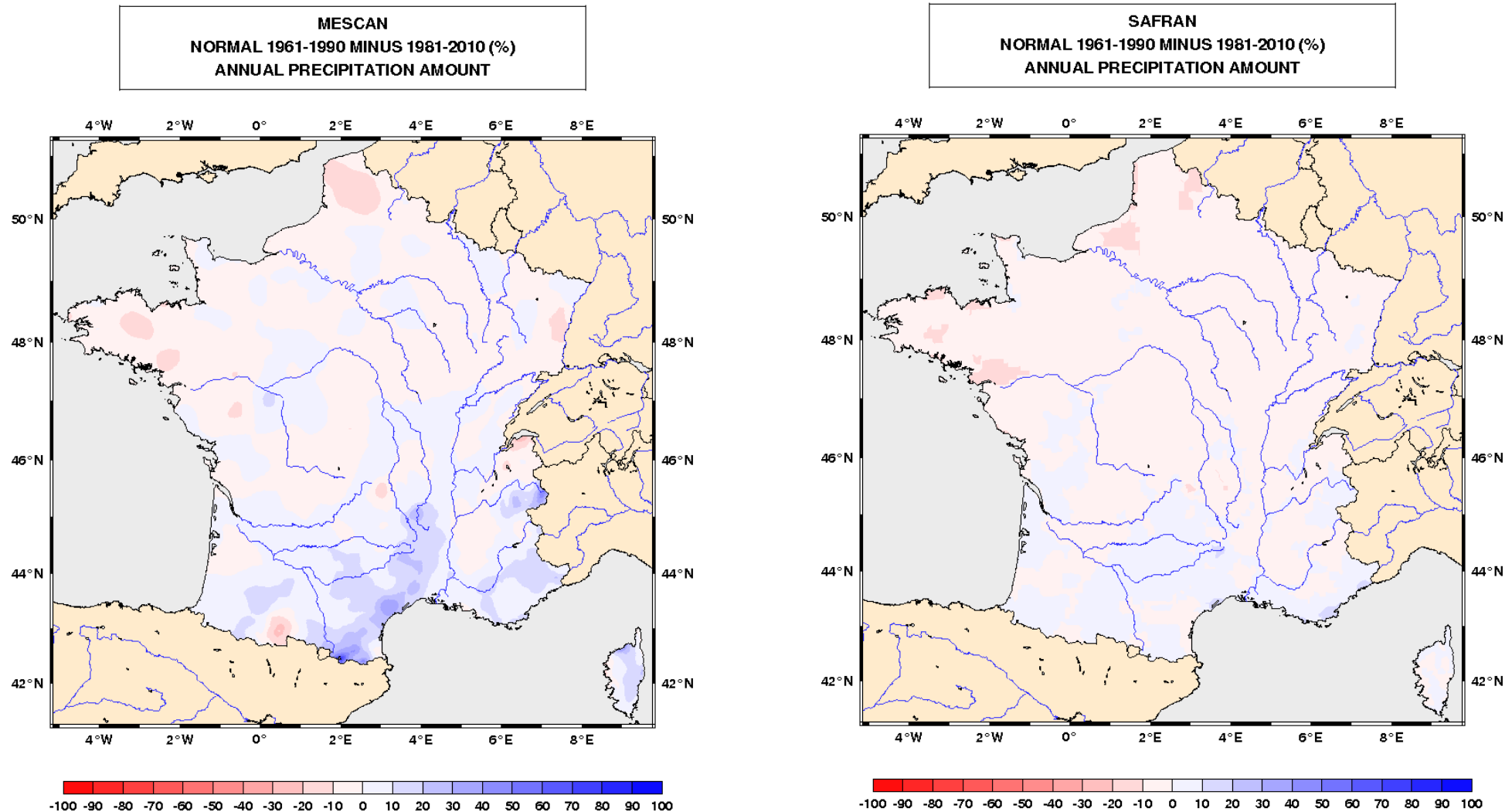
SAFRAN
NORMAL 1961-1990 MINUS 1981-2010 (%)
PERIOD MAY TO AUG



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2.2 Climate indices coming from MESCAN : Precipitation

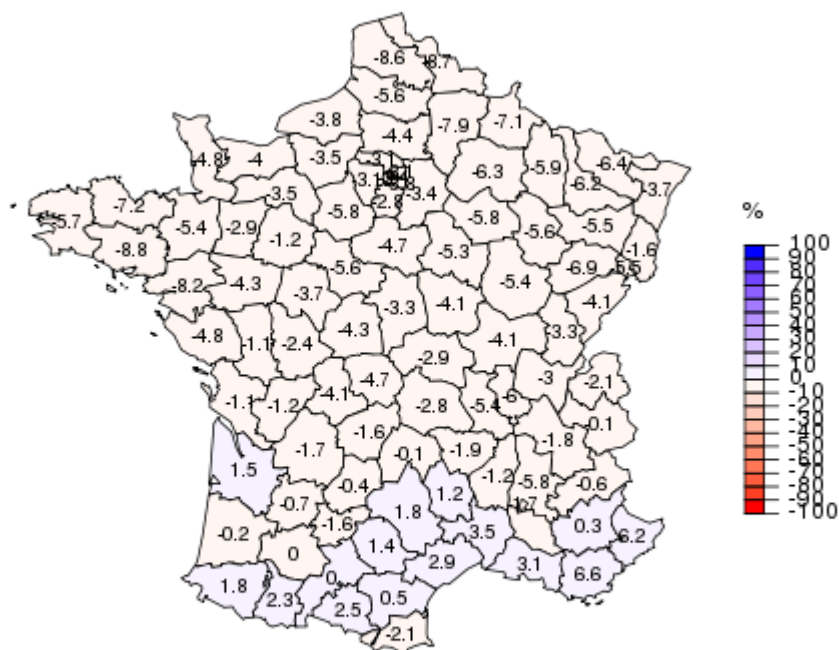
- Annual precipitation, comparison normal 1961-1990 and 1981-2010: same temporal heterogeneities. Is it valid?



2.2 Climate indices coming from MESCAN : Precipitation

- Validation wrt homogenized series (SH) gathered at county scale
 - Difference between SAFRAN normal 1961-1990 wrt 1981-2010 ~ Difference between SH normal 1961-1990 wrt 1981-2010
- => MESCAN trends (cf. previous slides) are not reliable

Normal 1961-1990 minus 1981-2010 (%) - SH dep. - ANN

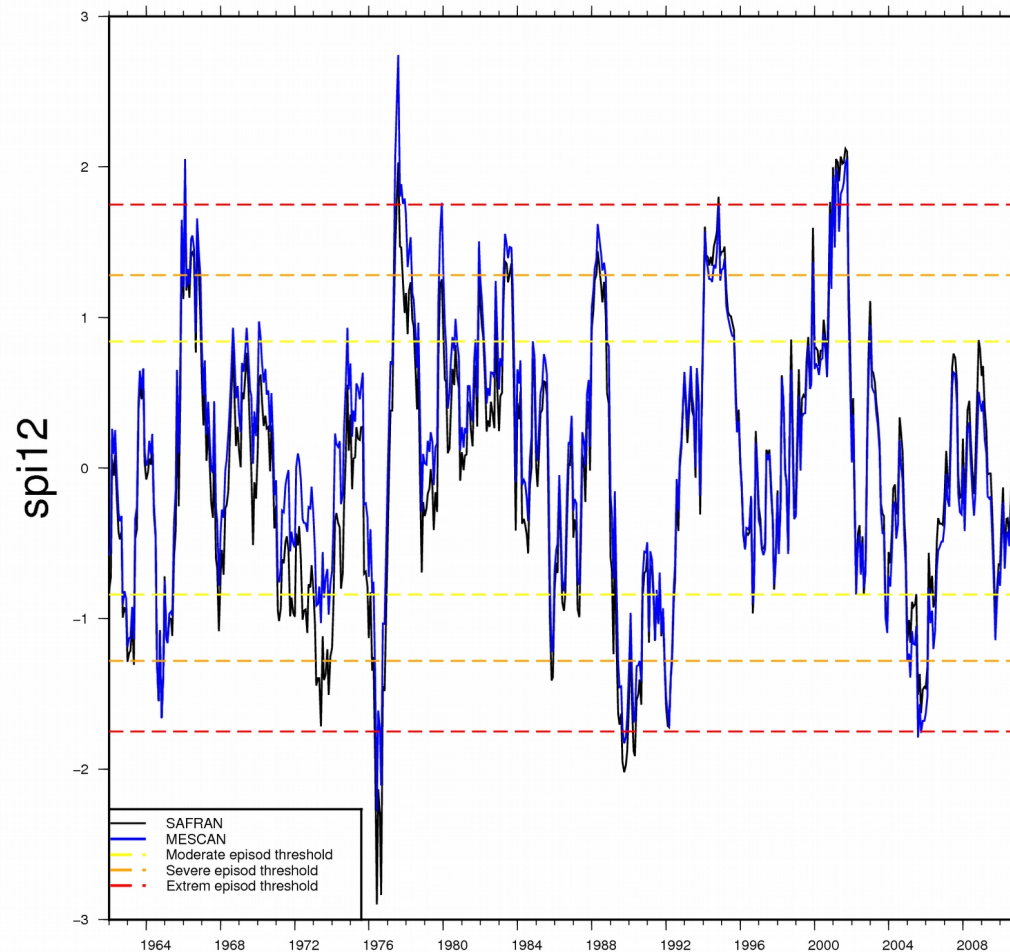


Normal 1961-1990 minus 1981-2010 (%) - SAFRAN - ANN



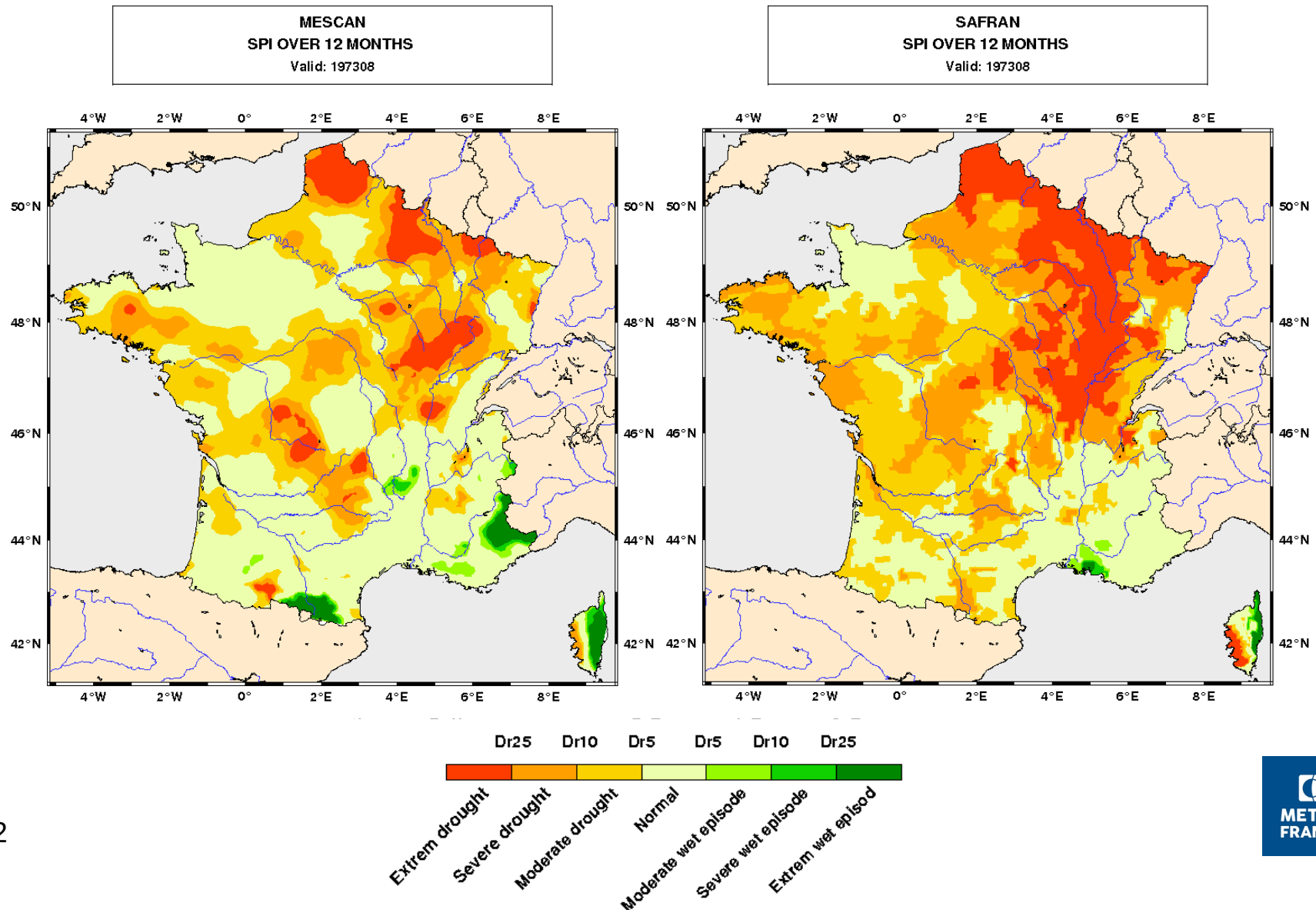
2.2 Climate indices coming from MESCAN : Precipitation

- Use of Standardized Precipitation Index to detect extrem event over n months:
 - SPI12 over France:
 - Two products are consistent
 - Index values from SAFRAN lower than MESCAN index before 90's (consistent with MESCAN temporal heterogeneties at annual time scale)



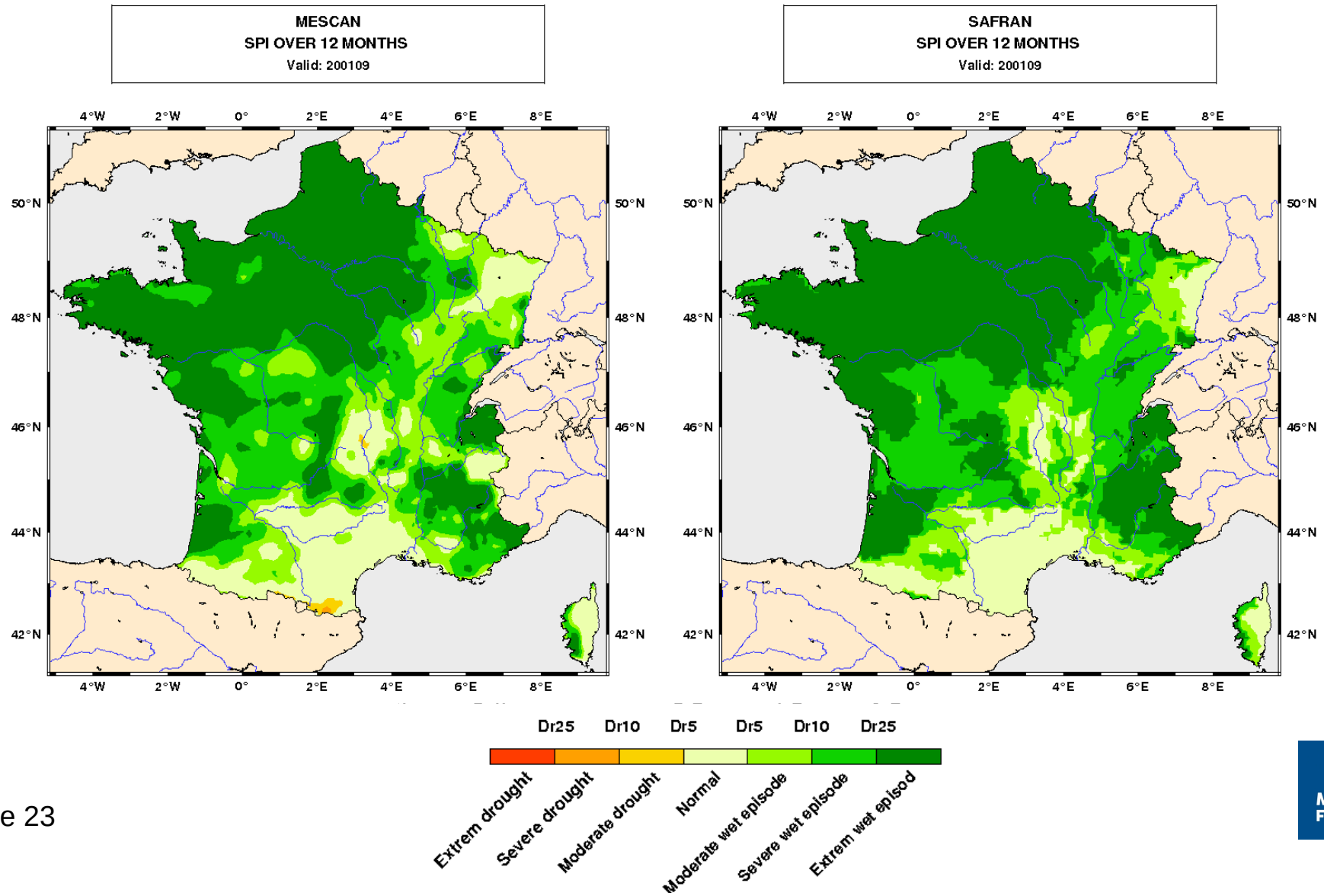
2.2 Climate indices coming from MESCAN : Precipitation

Drought episod : consistent spatial repartitions except for the eastern Pyrenees & southern Alps



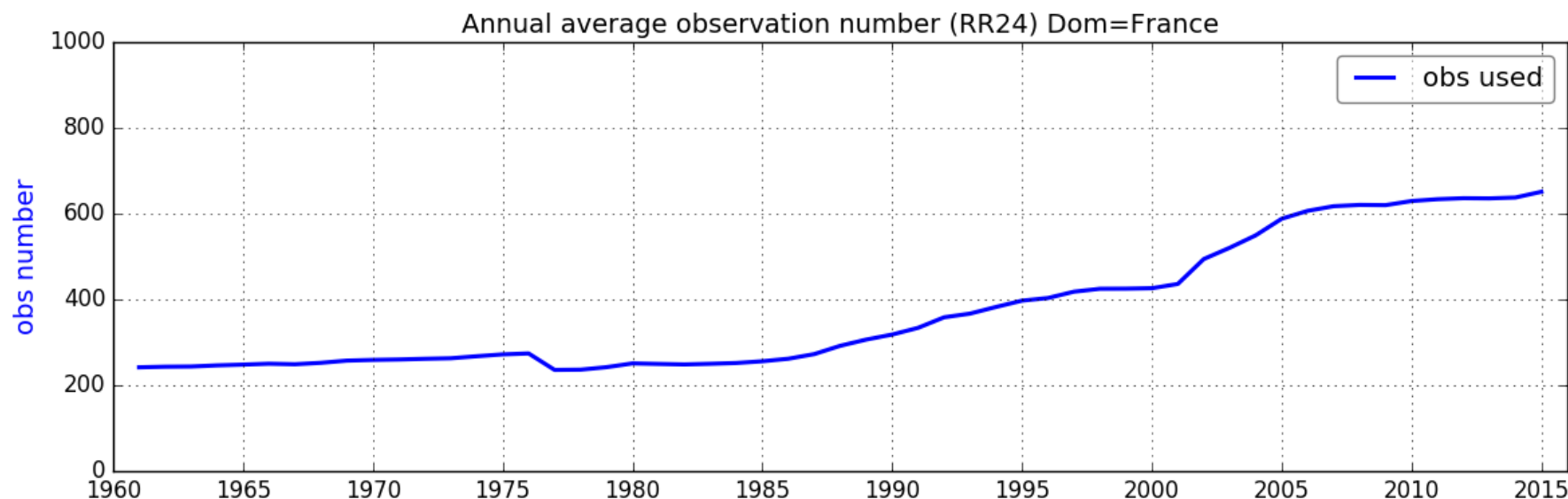
2.2 Climate indices coming from MESCAN : Precipitation

- Extrem wet episod over a large part of the country, similar repartition



2.2 Climate indices coming from MESCAN : Precipitation

- With much less rain gauges than in SAFRAN reanalysis (from ~3000 to ~4000 rain gauges from the 60's to nowadays), MESCAN reanalysis performs well at national scale:
 - Monthly & annual mean/max/min are closed
 - Wet/Dry episodes are detected
- Poorest quality in some mountainous area and temporal heterogeneities preventing us to use it to detect trends



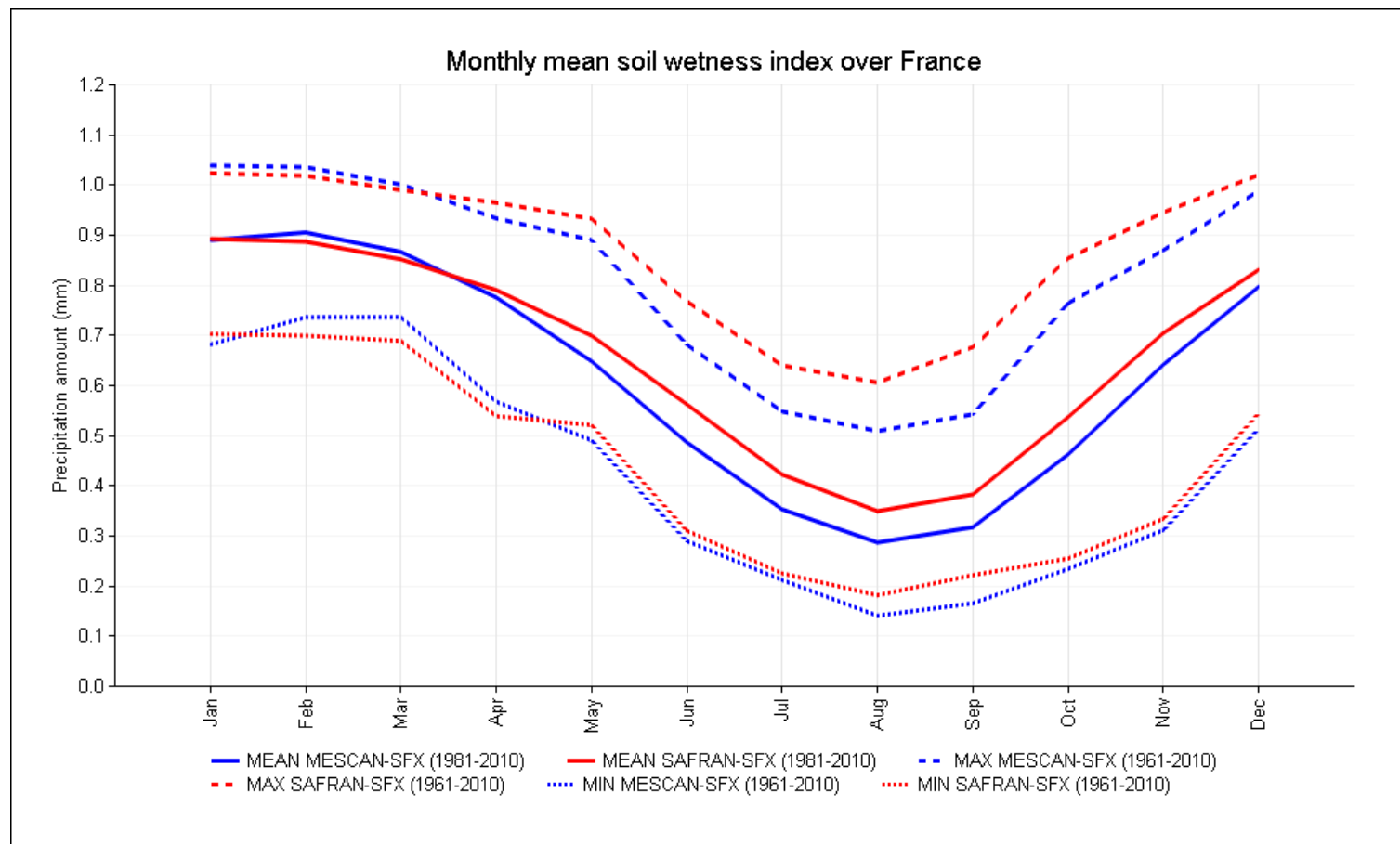
3. Climate indices coming from SURFEX: SWI

$$SWI = \frac{W - W_{wilt}}{W_{fc} - W_{wilt}}; W : \text{water content} ; W_{wilt} : \text{wilting point} ; W_{fc} : \text{field capacity}$$

- Available : Soil Wetness Index at hourly time step - 5.5km regular grid
- Temporal agregation : Monthly mean values
- Period: 1961-2010
- Comparison to SAFRAN-SURFEX reanalysis
- Indexes :
 - Normal / Anomaly / Min-Max
 - Standard SWI Index: averaging over n months fitting to a normal distribution

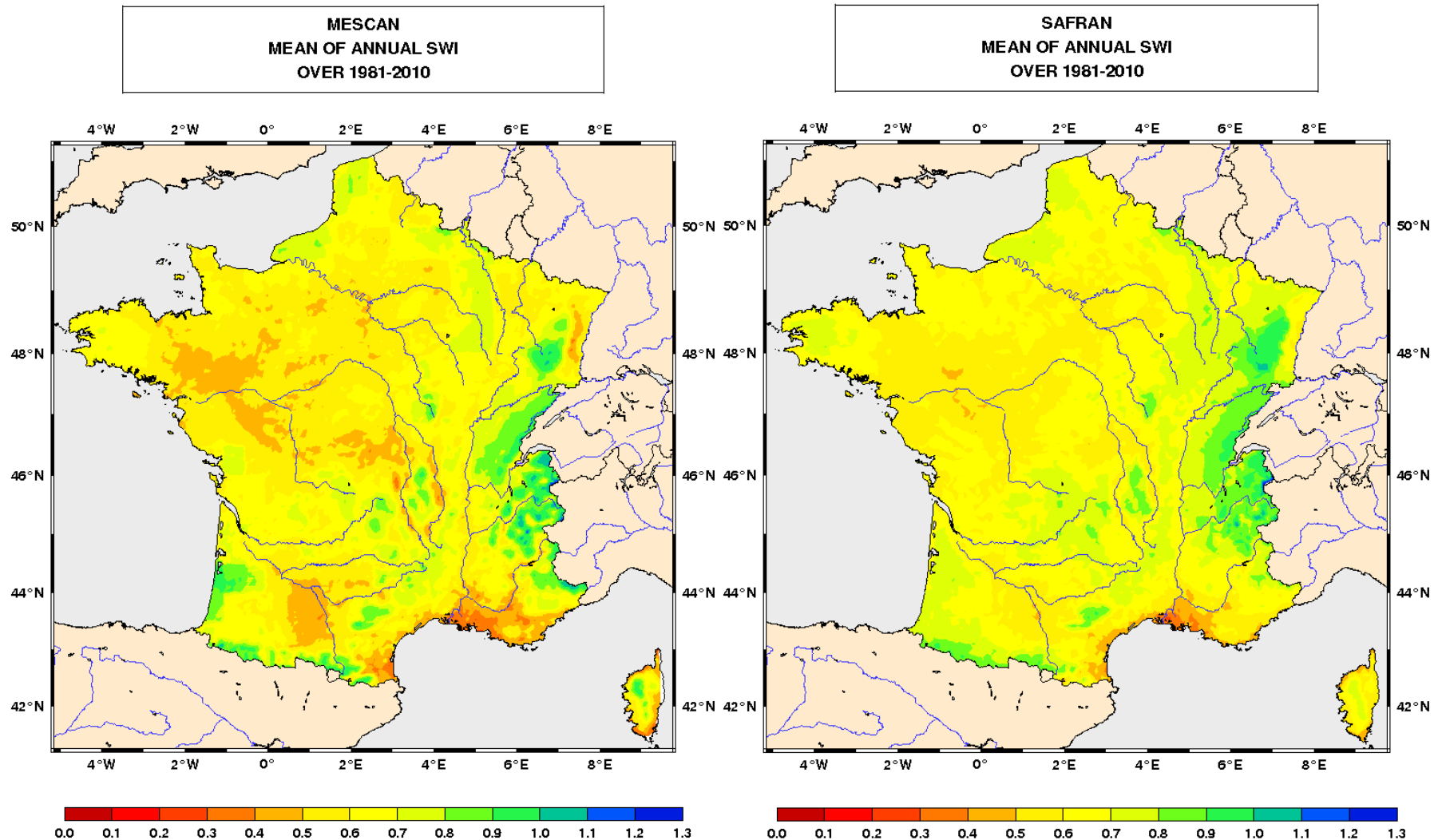
3. Climate indices coming from SURFEX: SWI

- Consistent annual cycle
- Lowest mean & max values for MESCAN (except January, February and March) – consequence of the precipitation underestimation



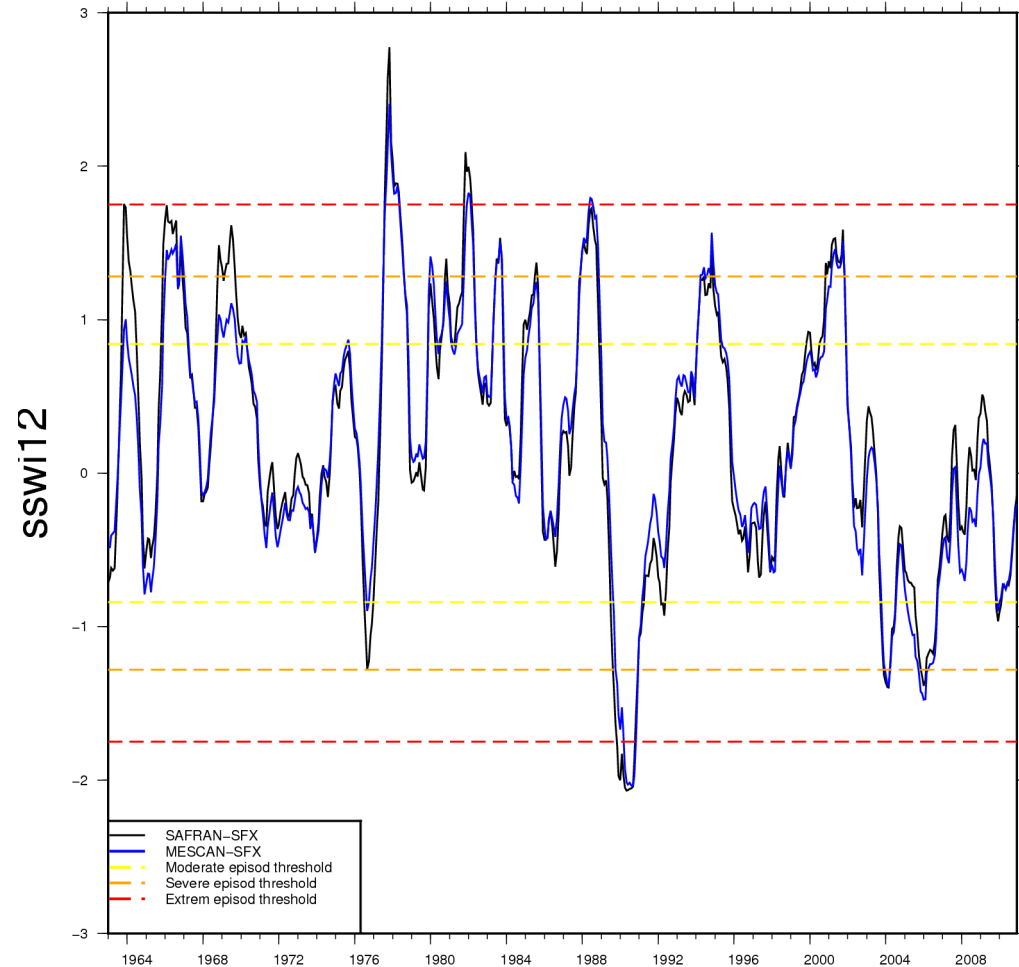
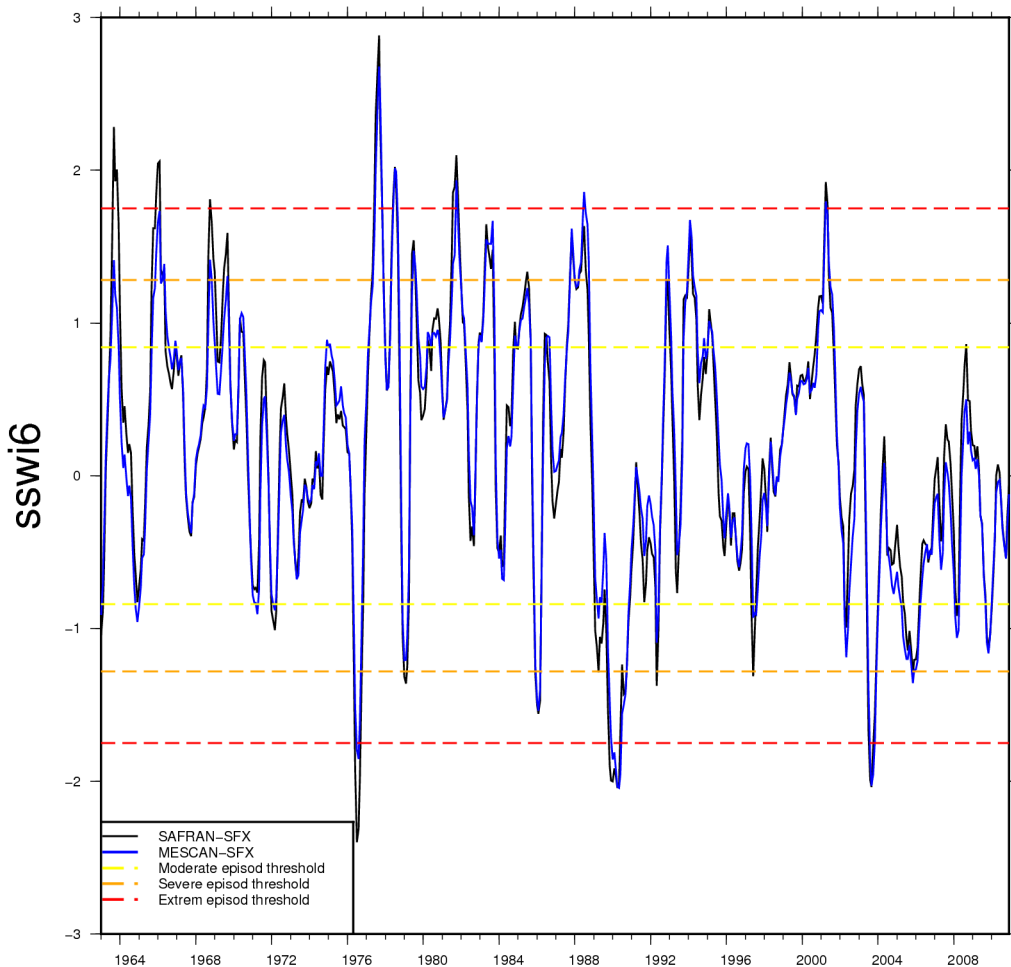
3. Climate indices coming from SURFEX: SWI

- Consistent spatial repartition
- Lowest values of SWI with MESCAN except in southern Alps & southern part of the Atlantic coastline



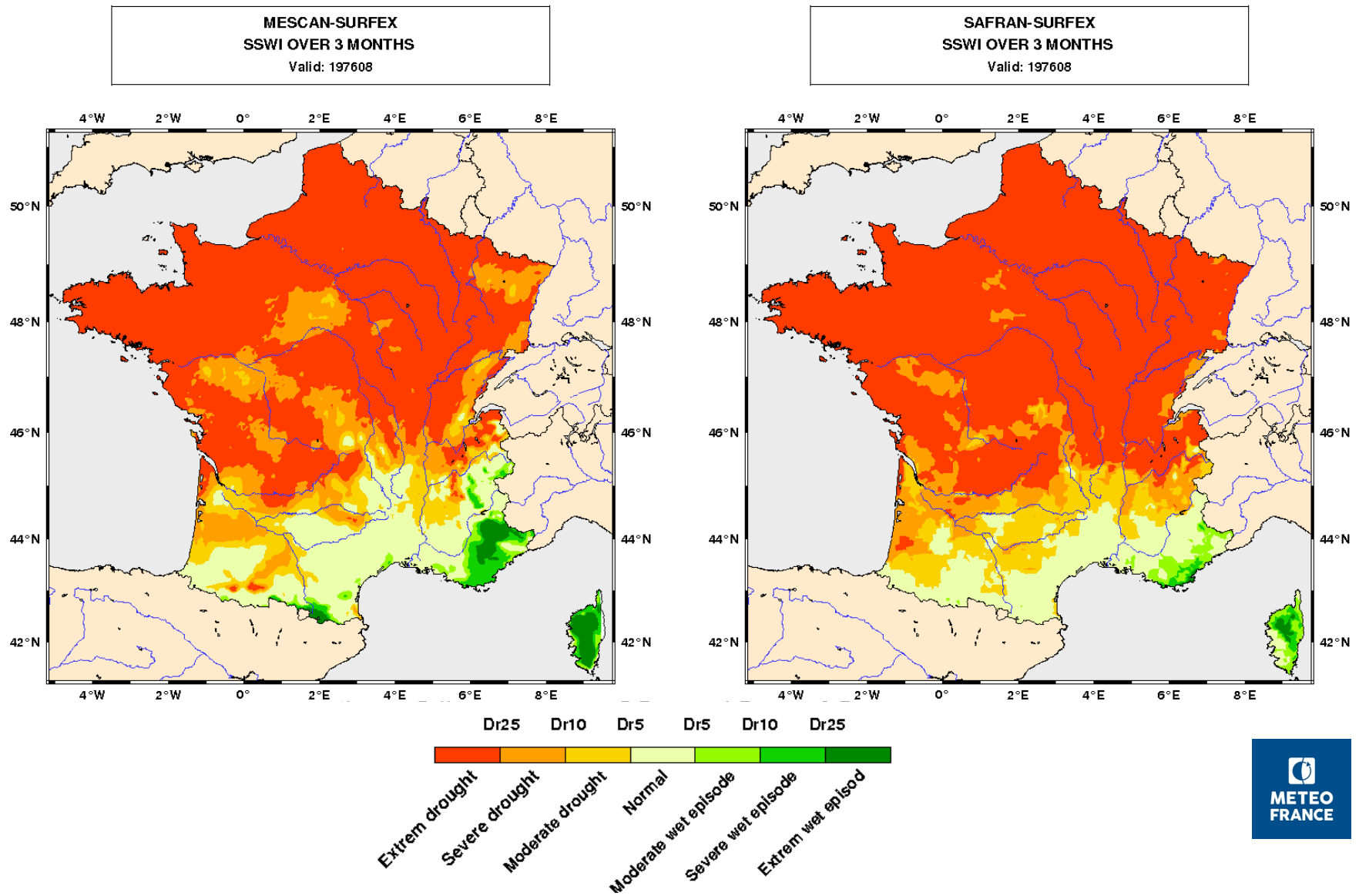
3. Climate indices coming from SURFEX: SWI

- Ability of MESCAN-SURFEX to reproduce major wet/dry events over France at different time scale



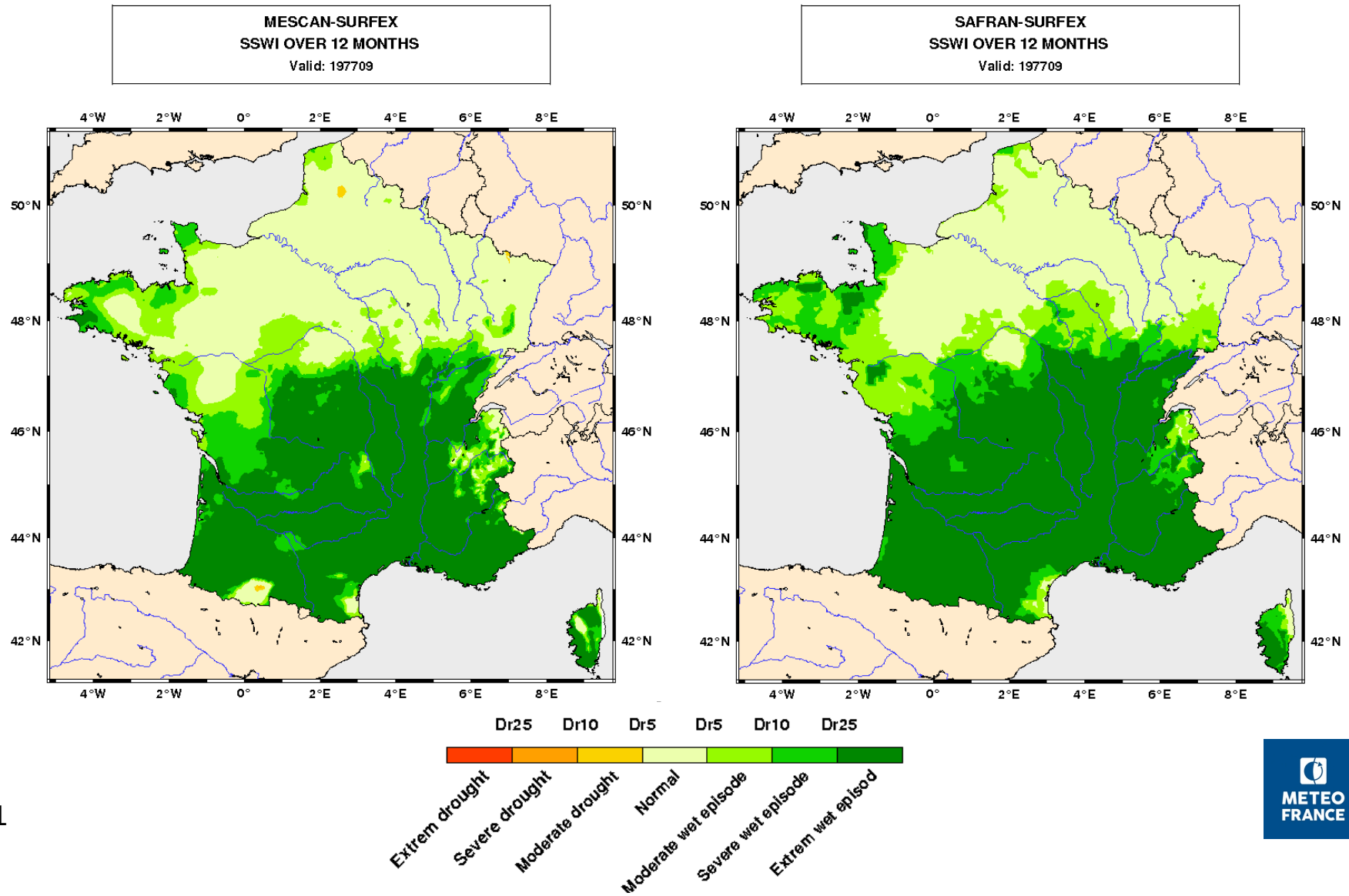
3. Climate indices coming from SURFEX: SWI

- Spatial repartition well reproduced except in eastern pyrennes & southern Alp as for precipitation



3. Climate indices coming from SURFEX: SWI

- Spatial repartition well reproduced except in Central Pyrennes



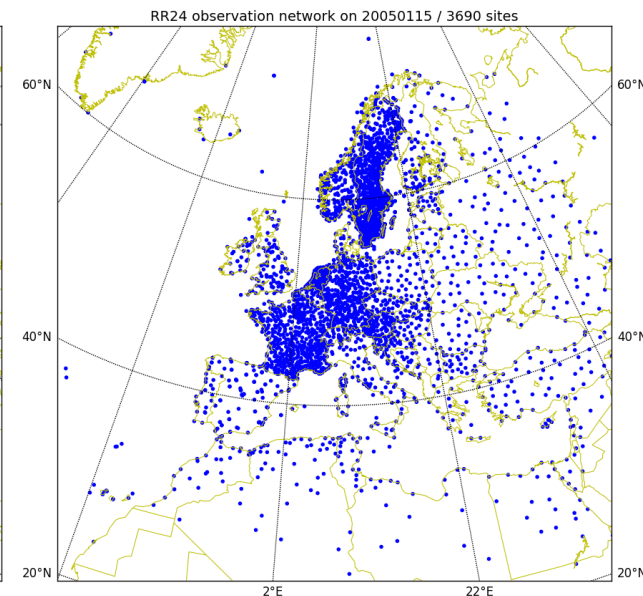
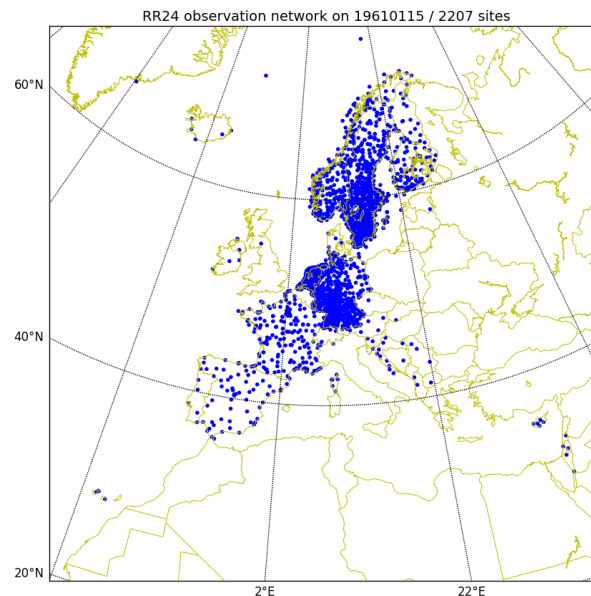
3. Climate indices coming from SURFEX

- Climatological characteristics of SURFEX's production depend on the quality of the forcing from MESCAN
- MESCAN-SURFEX useful to detect main drought/wet episodes : severity & spatial repartition

Conclusion

- Over France in comparison to operational climate indices, MESCAN-SURFEX reanalysis has capability
 - to detect major events : heat/cold waves; drought/wet episodes
 - To reproduce main climatological characteristics
- Temperature reanalysis has good temporal homogeneity since the 1970's
- Precipitation analysis is more heterogeneous (in particular at local scale in mountainous area) and is dependent on the observation network
- SURFEX output depend on the quality of the input from MESCAN

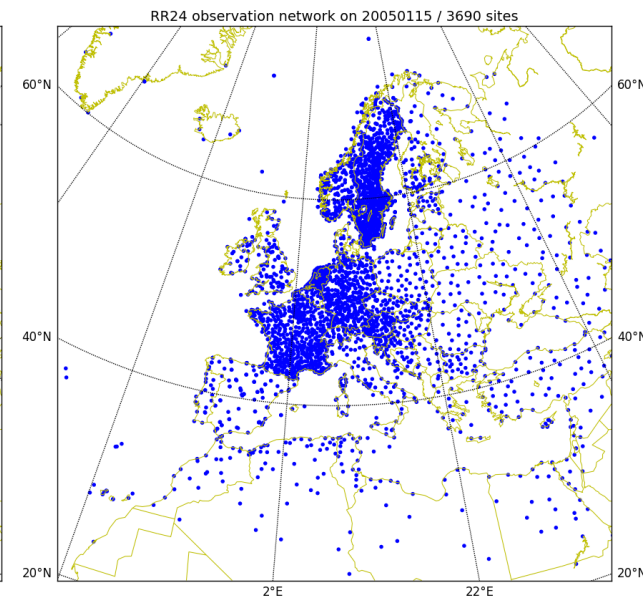
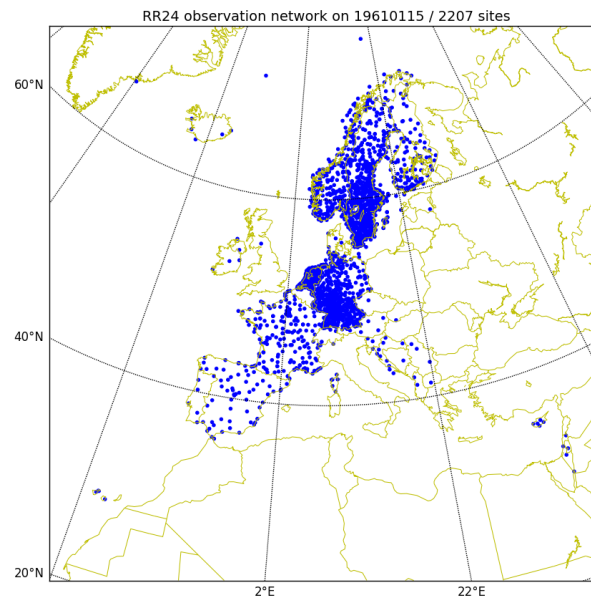
- The use of climate indices coming from MESCAN-SURFEX reanalysis over other area of the UERRA domain should be done carefully. Attention must be paid to the observation used over the study area, in particular for precipitation and/or for studies at small scale



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Thank you for your attention