Reliable long term series for analysing climate change at Météo-France

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8th Seminar for Homogenization and 3rd Conference on Spatial Interpolation
Budapest, 12-16 May 2014

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Plan

- Presentation of the context

- Methodology

- First results on temperature homogenized dataset

- Evolution of extremes : need of reliable daily series

- Conclusion

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Meteo France current program

- In 2010 Meteo France began a new homogenization program coordinated by the Climatology Department in order to create a dataset of homogenized series :
  - Around 200 monthly minimum and maximum temperature series
  - More than 500 monthly precipitation series
  - With data records longer than 50 years
  - Covering France, mainland and overseas
  - With a good density for local climate change analysis, impacts studies and adaptation strategies
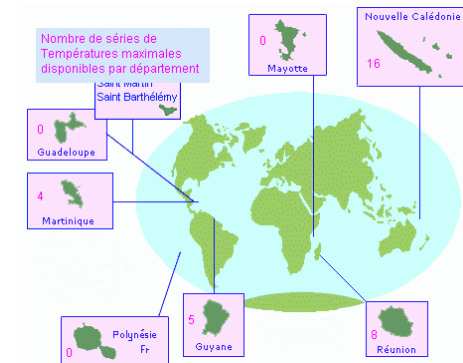
- This action is associated with the national DARE program, as most of temperature series stored in the French climatological database are available from 1959.

  Great efforts are dedicated to collect both data AND metadata concerning the long term series and to digitalize these information.

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Preparation of the data - 1

- Identification of the series
  - beginning in the 50's, and still opened,
  - with few monthly missing values,
  - Data rescue if needed and possible

    Ex : Monthly precipitation in Provence-Alpes-Côte d'Azur region :
    years 1954 and 1957 missing in ~ 75% of the series to homogenize. In such cases, local climatologists are contacted to try to find the original documents and to put those information in MF database

- Station history documentation, that is greatly helpful when identifying non climatic inhomogeneities :
  - Successive station relocations
  - Instrumentation
  - Observing practices
  - Station environment
 - Change from manual to automatic weather station

INSEE	NOM POSTE	Alti	Date ouvertur	Date fermetur	Statut	automatisatio	Date chgt modèle	Date déplacement poste	Date déplacement pluvio	Date chgt modèle pluvio	Type	Date débu
67005001	ALTECKENDORF	174	01/10/1955		ouvert				11/1964 - 01/1971	10/1989	10/1972 - 10/1989	4	
67021001	BARR	195	01/12/1935		ouvert					05/1968 - 09/1987	05/1968 - 08/1980	4	
67067001	BRUMATH	139	01/01/1935		ouvert				01/1971	12/1970 - 10/1989 - 06/2004	10/1972 - 10/1989	4	
67095001	DIEMERINGEN	##	01/06/1942	31/12/1992	fermé				04/1367 - 04/1984 - 09/1986 - 11/1991	07/1983	07/1983	4	01/06/1942
67435001	SARREWERDEN	##	01/08/1970		ouvert				1979 - 10/1987	08/1984	08/1984	4	
67115001	EBERSHEIM	163	01/04/1934		ouvert				12/1966 - 01/1991 - 01/2009	11/1966 - 06/2004	02/1982	4	
67124001	STRASBOURG-ENTZHEIM	150	01/01/1921		ouvert	06/1986	6/1993 - 04/2009				01/1971 - 01/1976 -	0	

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Preparation of the data - 2

- **Definition of climatic homogeneous areas**

  Pairwise detection relies on comparison between the candidate series and its neighbours located in the same climatic area

  - climatologist expertise to define the area,
  - for minimum and for maximum temperatures,
  - Climatol checks option in Homer : correlogram, dendrogram, and plotting of the suggested classification are useful tools
  - define overlapping areas, because it may be delicate for the series located at the edge of the area
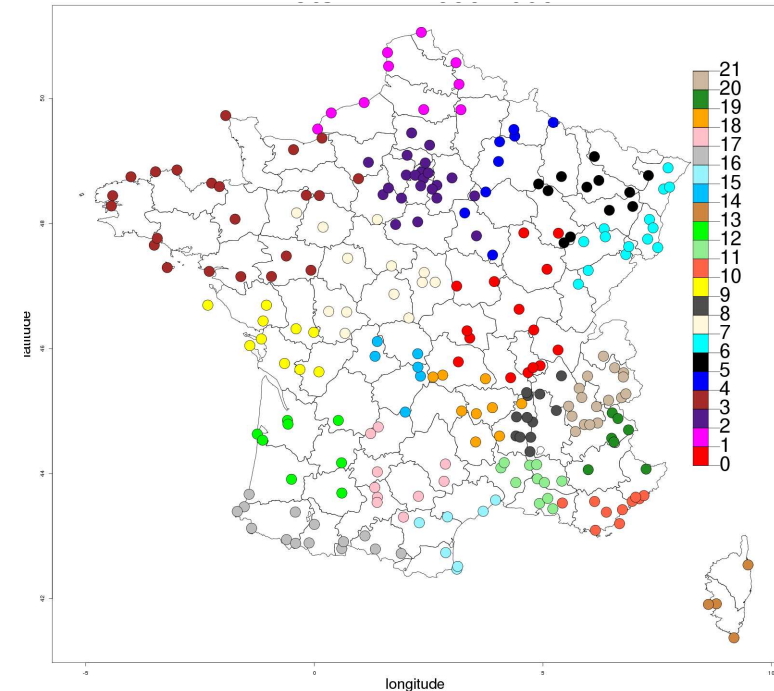
Areas defined to homogenize monthly maximum temperature series

- **Data quality control**

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Homogenization at Météo-France

- PRODIGE method, used when beginning in 2010
  - Developed at Météo-France by Olivier Mestre (2000)
  - Relative method, several series in a homogeneous region
  - Detection of shifts and correction of series
    - → No hypothesis on the shape of climate signal

- Then, HOMER method
  - Action COST ES0601 HOME www.homogenisation.org
  - Intercomparison of methods for detection and for correction
  - Delivery of a software HOMER, with some of the best methods for detection and correction *[eg Mestre et al., 2013]*

- In addition, introduction of the same penalized likelihood criteria as in PRODIGE (C&L) to get coherent results with pairwise detection (O. Mestre)

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Homogenization : Feedback

- The use of three methods of detection : pairwise, joint detection and ACMANT (pairwise and joint for precipitation) was really appreciated using HOMER

- HOMER used in an interactive mode
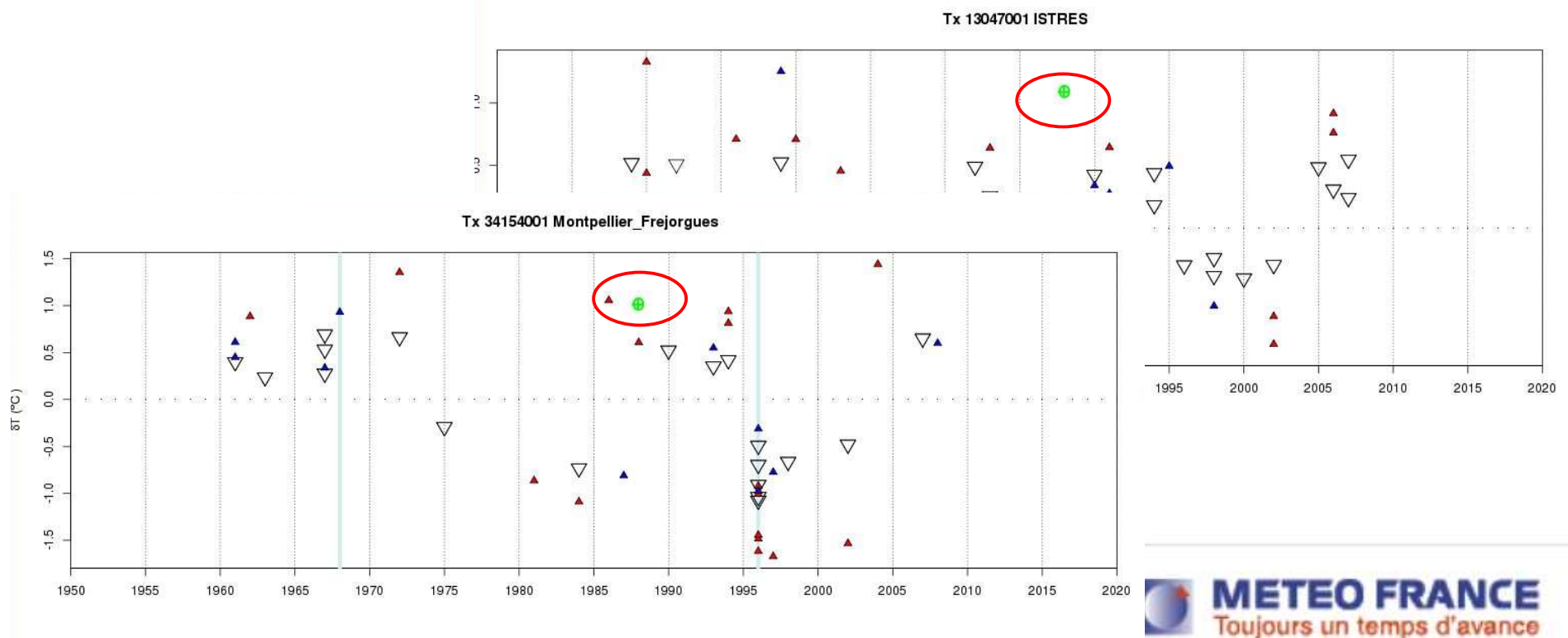
Homogenized datasets

- Some series were rejected during homogenization
  - poor quality of the raw data,
  - high amplitude of the detected breaks
    - 1°C (absolute value) for annual temperature
    - 20 % of the mean annual amount for precipitation
  - Two many breaks since the 50's (more than 5 for temperature, 3 for precipitation)
  - High noise in the comparison series (σ) in pairwise detection

- The validated series are stored in database with the corresponding metadata (stations used to build the series, date of breaks, correction coefficients, residual breaks amplitude..)

- For temperature, few series without any break

Number of breaks	0	1	2	3	4	5
Amount of series	5%	10%	25%	25–30 %	20-25%	10%

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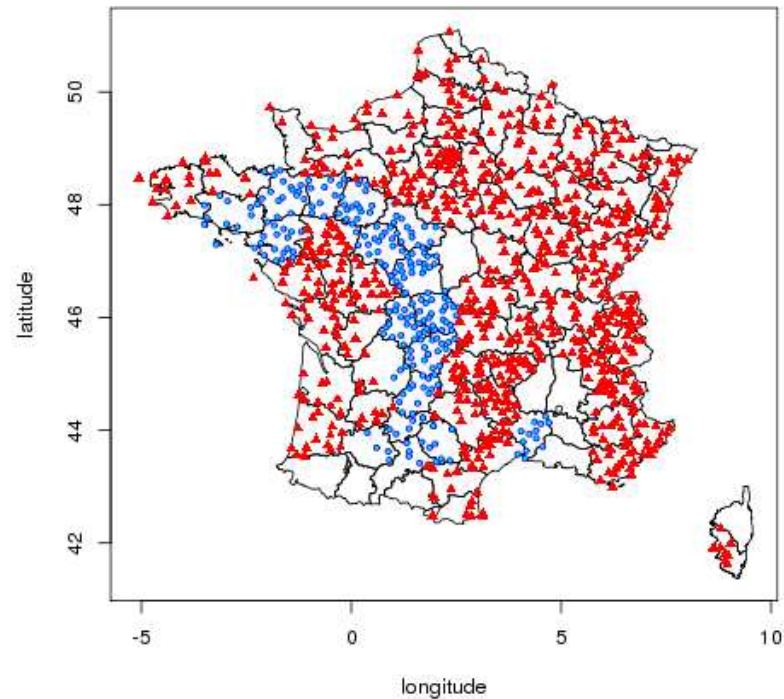Toujours un temps d'avance

Homogenized datasets
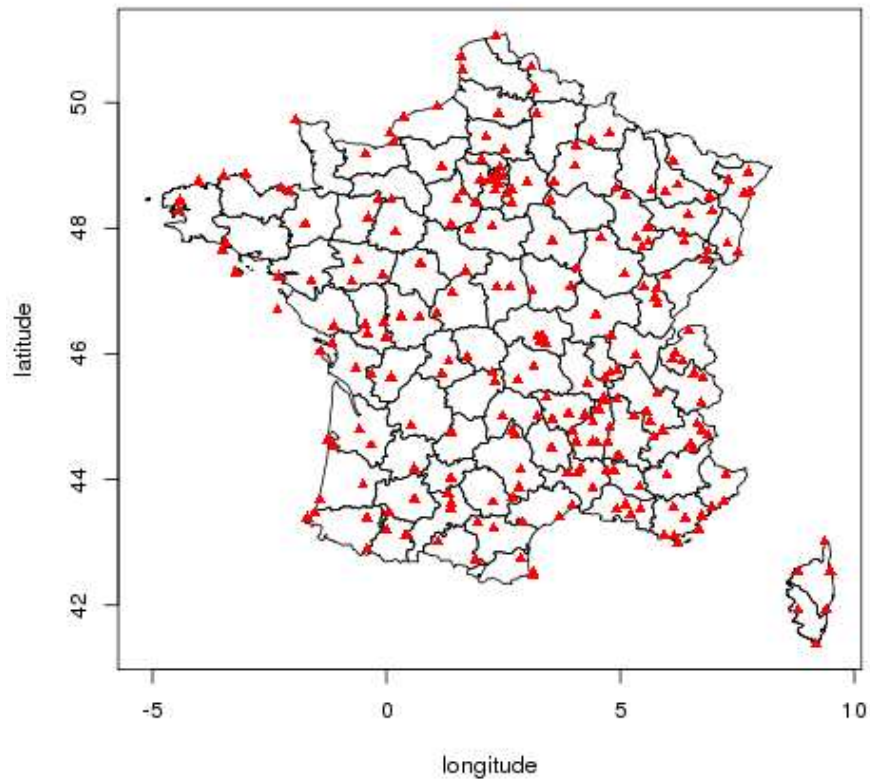
Minimum temperatures

233 monthly homogenized series available for minimum temperature

Precipitations

red : 759 monthly homogenized series for precipitations

blue : current homogenizations

All the country has to covered by the end of 2014

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Need to update the homogenized series

- Despite the improvement in measurement conditions, the last period is not free from inhomogeneities
  - A metrological problem is identified on a type of rain gauge installed in some stations in the 2000's, causing a heterogeneity in the precipitation series

07/07/2008 :

change of rain gauge
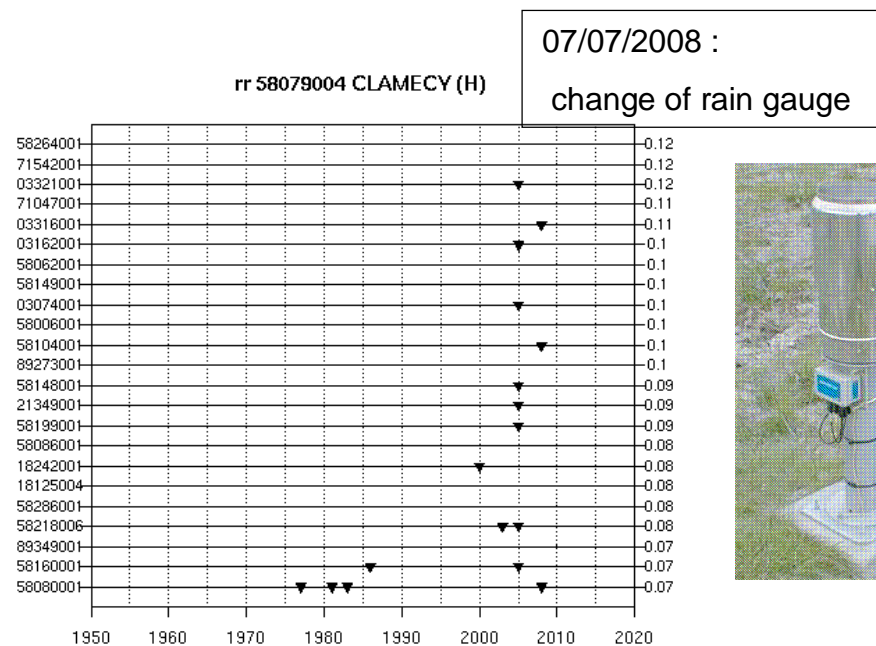
→Homogenized series must be updated regularly,

MF plans to update the series every 3-5 years.

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Homogenization : lessons learnt

- Training, experience in homogenization is useful :
  - Several colleagues were trained to HOMER
  - The latest homogenization areas were processed more quickly than the earliest ones

- Do not hesitate to reject low quality series DURING homogenization process (poor quality, to many breaks…)

- Metadata are really helpful, both to validate and identify the exact position of the breaks

- On the same area, the homogenization of minimum temperature is generally more difficult than that of maximum temperature, at least for French mainland series

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Additional lessons learnt

- The most frequent identified reasons for inhomogeneities in French temperature series are due to changes in shelter, network automation and station relocation.

- Simultaneous changes may have happened for a specific network (automation,…). It is useful to use series from different networks : professional stations and climate stations

- Stations with homogenized data have to be maintained, in order to update the results in the future

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First results using the homogenized temperature datasets

Evolution Tn - 1959-2009

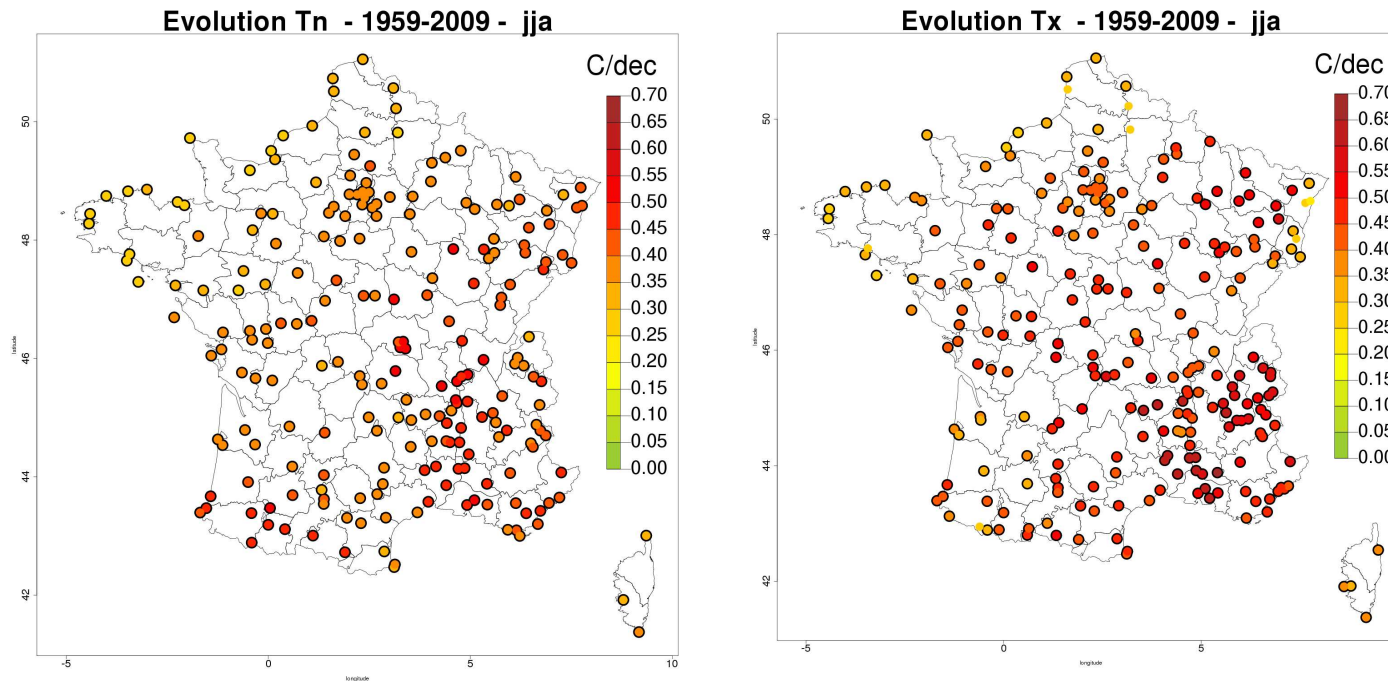**Evolution Tx - 1959-2009**

Tn

+0.29°C/dec

On average

Tx

+0.32°C/dec

On average
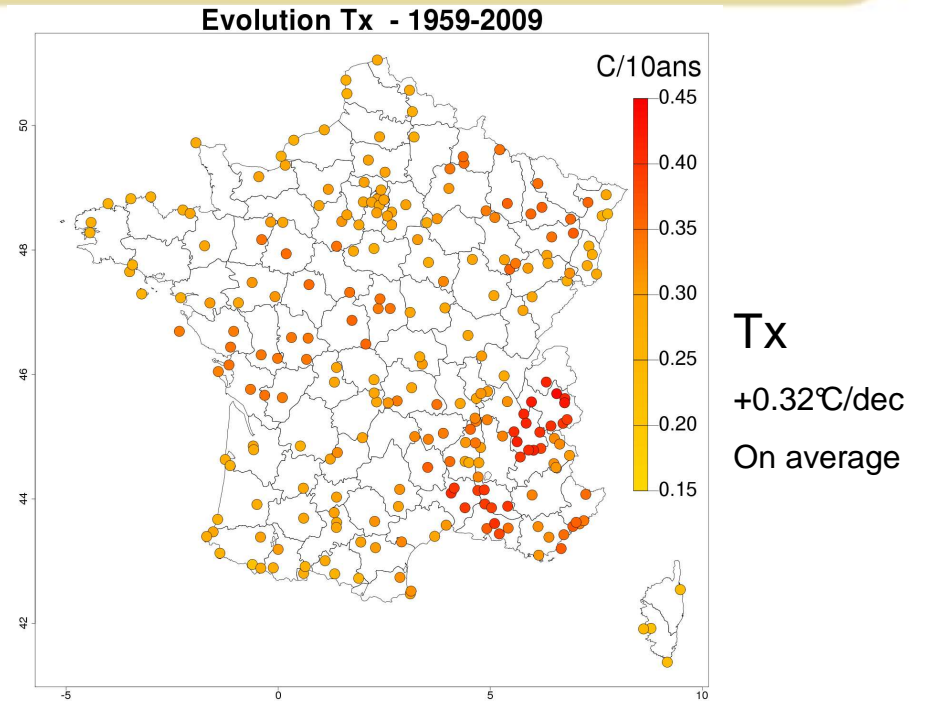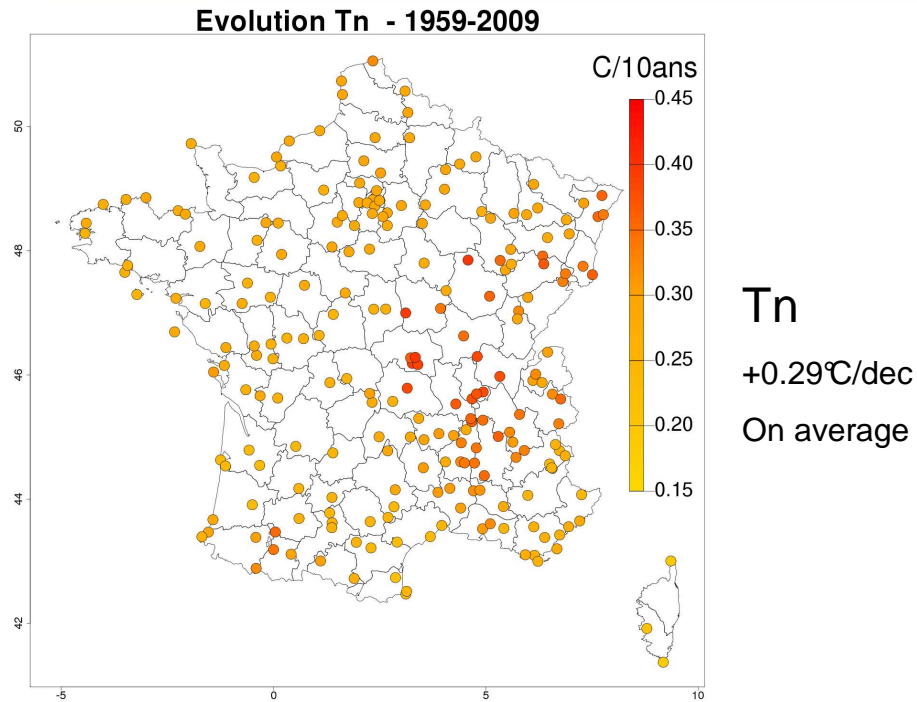
A quite homogenous warming all around the country, both for minimum and maximum temperature, significant at the 95% level

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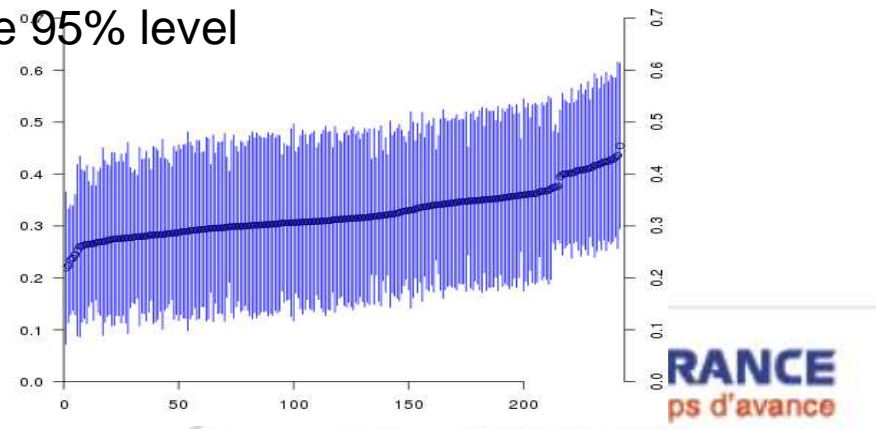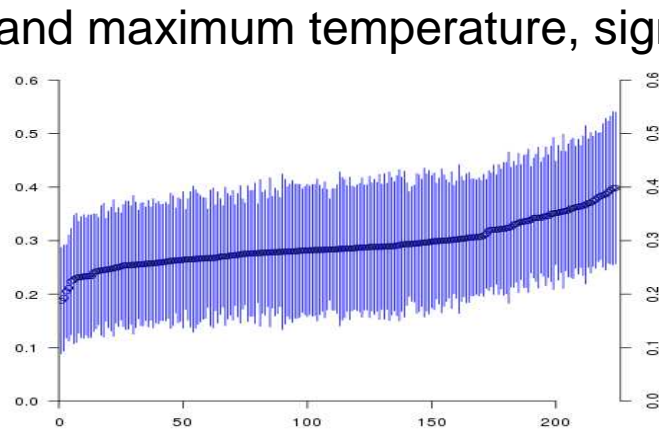
First results at seasonal timescale

- In spring (mam) and summer (jja), significant warning (at 95% level) all over the country both for minimum and maximum


- In autumn (son) and winter (djf), minimum and maximum temperature are also increasing, but not necessarily significantly (95%)

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Consistency with other available datasets - 1

▪**First set of French temperature homogenized series**

–70 min. and max. temperature series [Mestre]

–Covering the 1901-2000 period

–comparison on the common series and over the common period 1959-2000 :
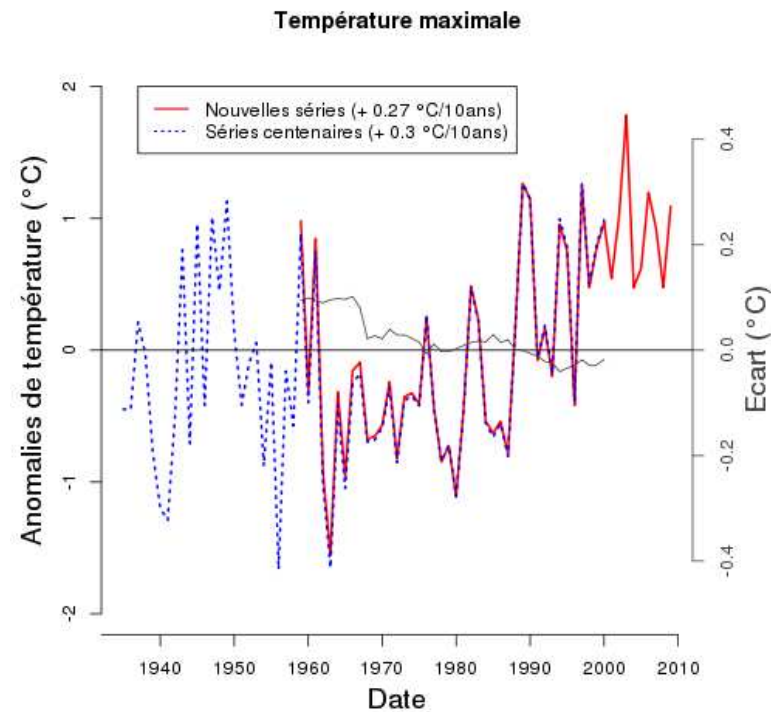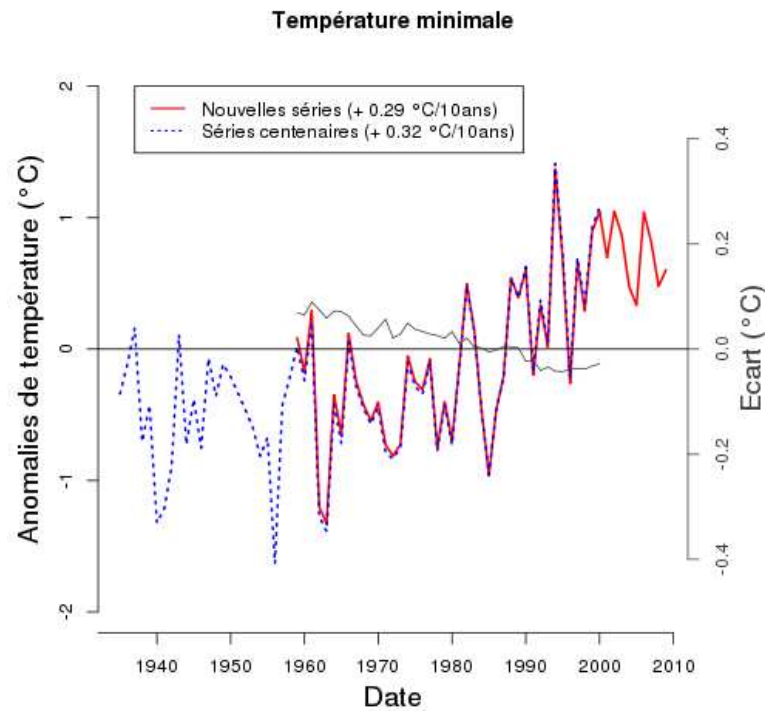
Consistency with other available datasets - 2

-Climate Change Observatory in the Pyrenees (OPCC)

  - Collaboration between Agencia Estatal de Meteorología, Météo France and Meteorological Service of Catalonia, Centre d'Estudis de la Neu i la Muntanya d'Andorra, and Zaragoza University

  - Climate database of 66 monthly temperature series and 139 monthly precipitation series covering the 1950-2012 period

  - Homogenized using HOMER

  -Consistency of the results over the Pyrénées

- Analysis available from Meteosuisse

Tendances de la température trimestrielle [°C/décennie]
1961–2013/14   sign.: p<0.05

Evolution of extremes : daily reliable series

- The homogenized monthly series allow characterizing the mean climate change

- One major concern of climate change : **Evolution of extremes ?**

  – indices recommended by the CCL/CLIVAR/ETCCDI (Expert Team for Climate Change Detection Monitoring and Indices)

  – Reliable daily series are required, as inhomogeneities may severely affect the extremes.

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Evolution of extremes : Daily Reference Series

Selection of relevant series : (station * parameter * period)

Daily Reference Series (DRS)

Parameters : Tn, Tx and rainfall

- **From the set of homogenized monthly series**
  - Hypothesis : monthly break detected $\Rightarrow$ there is a break on daily data

$\Rightarrow$ **Use of quality criteria** from monthly homogenization to **select** reliable period for daily values

- Breaks number, Amplitude of breaks, Cumulative amplitude of breaks
- Daily data missing rate
- Number and amplitude of relocations

Tn DRS from 1961
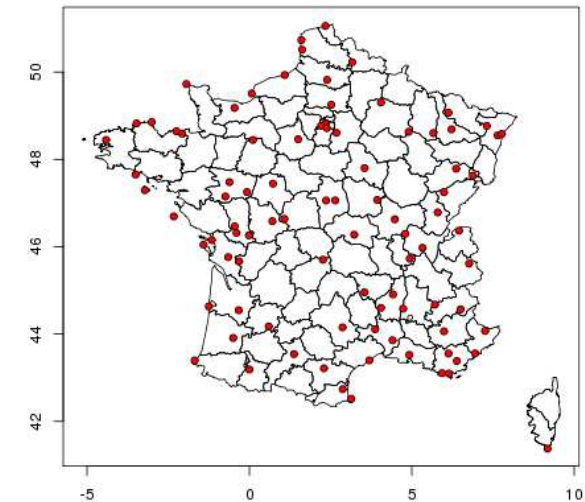
Tx DRS from 1961
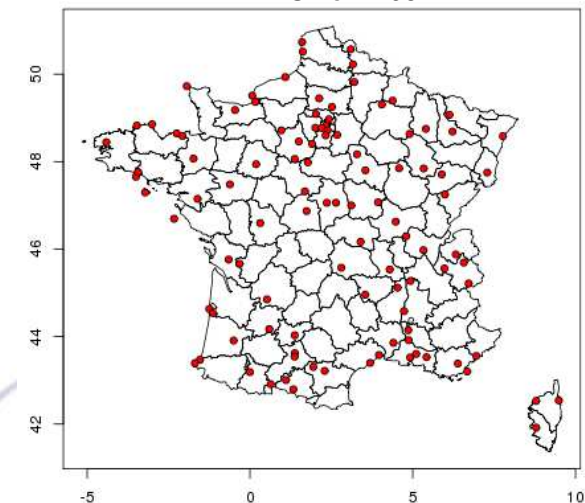
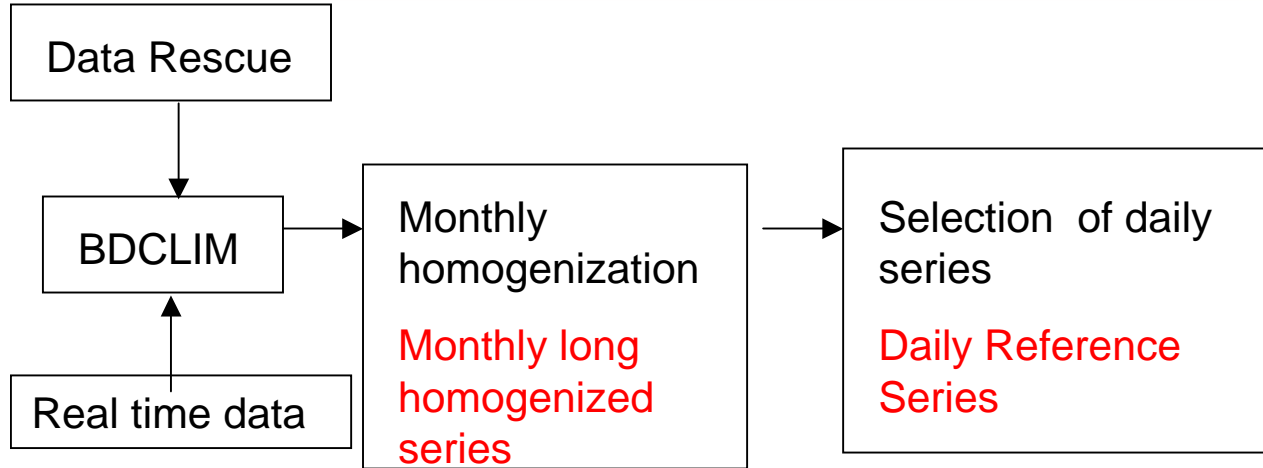# Evolution of extremes : Daily Homogenized Series

- Mestre et al 2011 :
  - 3 daily homogenization methods are compared : Vincent, HOM and SPLIDHOM
  - All 3 methods improve the data
  - « The adjustment of extreme quantiles is only possible if a highly correlated reference station exists »
  - Trustworthy results of SPLIDHOM with a correlation of 0.95

- Select the highly correlated series amongst the monthly homogenized one (cor>0.95) and use SPLIDHOM to get daily homogenized series

- Della-Marta, and Wanner, 2006: A method for homogenizing the extremes and mean of daily temperature measurements. J. Climate, 19, 4179–4197.

*- Mestre, et al 2011: SPLIDHOM: A Method for Homogenization of Daily Temperature Observations. J. Appl. Meteor. Climatol., 50, 2343–2358.doi:*http://dx.doi.org/10.1175/2011JAMC2641.1

- Vincent et al, 2002 : Homogenization of daily temperatures over Canada,. J. Climate, 15, 1322-1334

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Meteo-France long reference series

Data Rescue

BDCLIM

Real time data

Monthly homogenization
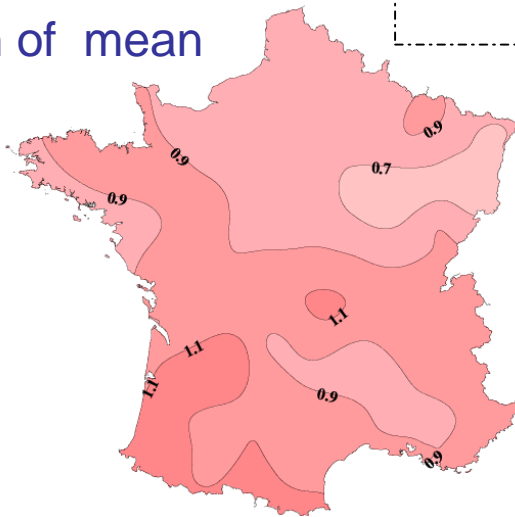
Monthly long homogenized series

Selection of daily series

Daily Reference Series

Evolution of climatic extremes

Number of summer days Su (Tx>25℃) in Toulouse and Paris
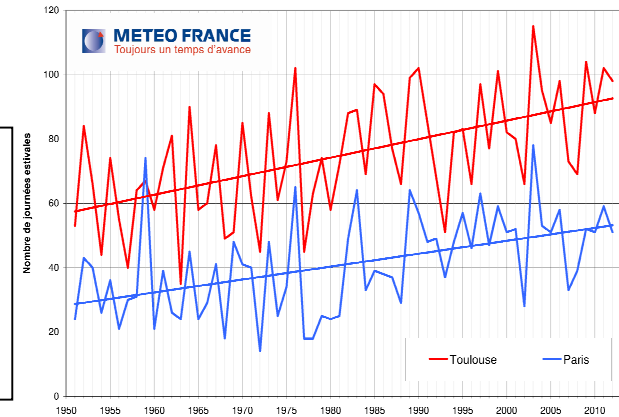
Evolution of mean climate

Daily Homogenization

Limited number of series

Trend of annual mean temperatures (℃/century) over the 1901-2000 period

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Conclusions

- Homogenization of French monthly temperature is done and precipitation is still in progress, in association with the national DARE program

- This program has created a good density network of monthly homogenized series for French mainland and overseas territory.

- Homogenization began using Prodige, and then benefited from Homer

- An update of the series is planed every 3-5 years

- By the end of 2014, homogenization of sunshine duration series beginning in 1931

- Taking benefit of the DARE action (access to French National Archives that was previously precluded due to asbestos) the homogenization of temperature series from 1901 is planned in 2015

- The Climatology department has just begun to work on the temperature daily homogenization.

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Thank you

for your attention

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