Diurnal temperature cycle deduced from extreme daily temperatures and impact over surface reanalysis systems

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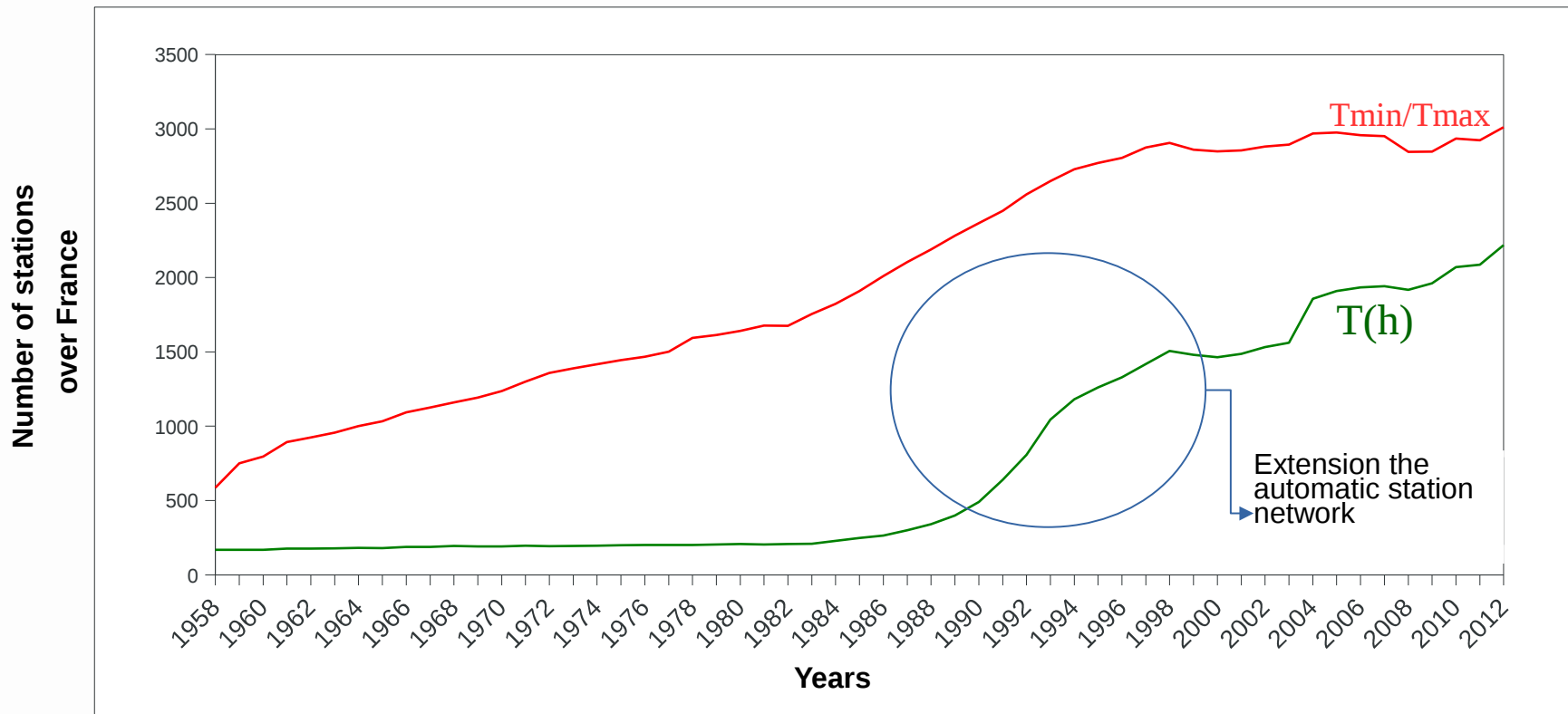(Météo-France, CNRM/GAME)

UERRA GA
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UERRA project => surface reanalysis for a 50 years period over Europe

Issue for climatological use: Evolution of the observation network density along a reanalysis period.
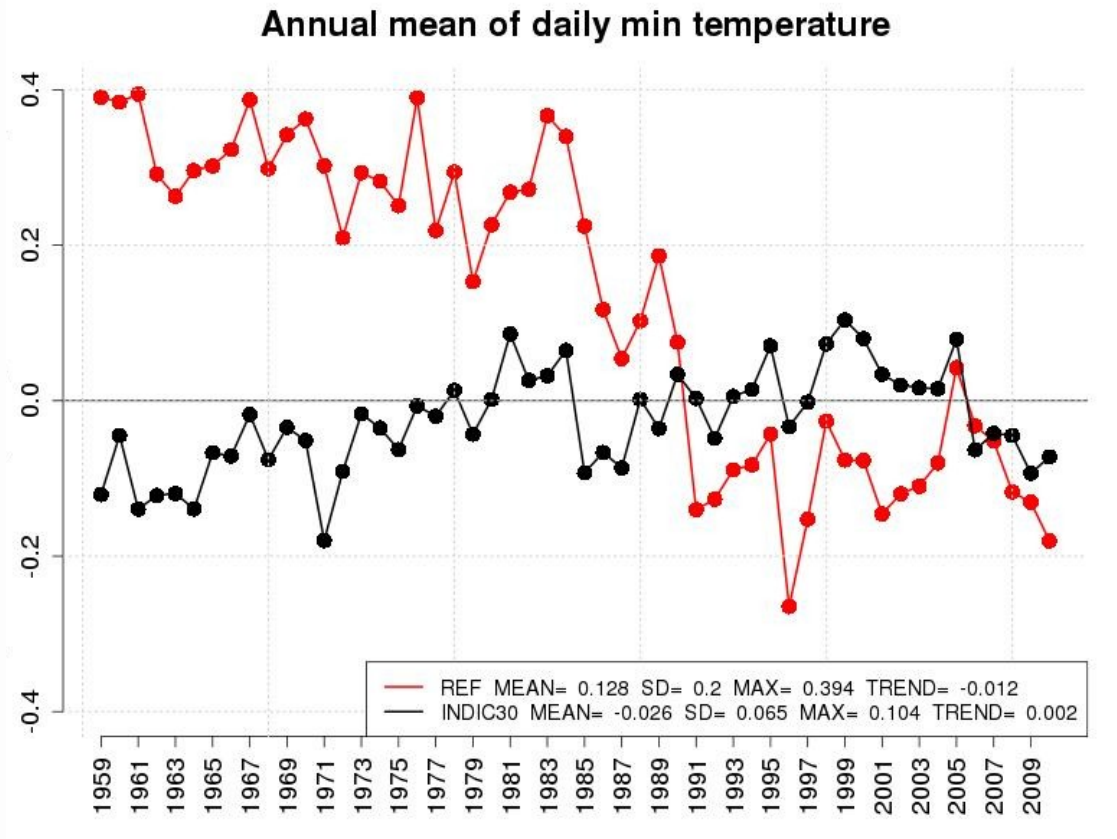
Exemple over France:

Impact on surface reanalysis:

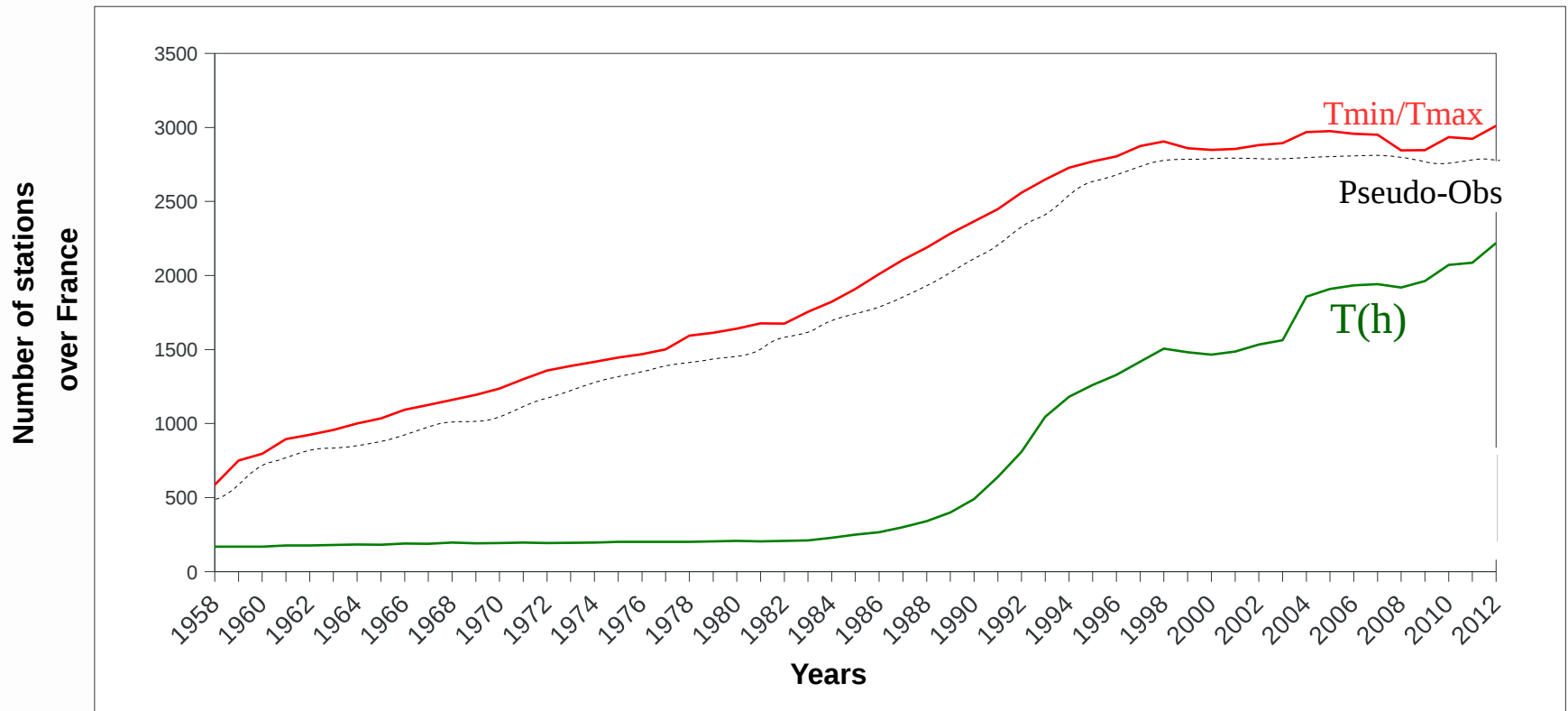Exemple of SAFRAN reanalysis (1958-present) over France – comparison to homogenized series

Annual mean of daily min temperature

- INDIC30: index build on 30 stations - REF: index build on SAFRAN results

=> temporal heterogeneities for REF experiment

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Purpose

- Add pseudo hourly t2m observations for stations with extrem temperatures data

- How it impacts temperature reanalysis?

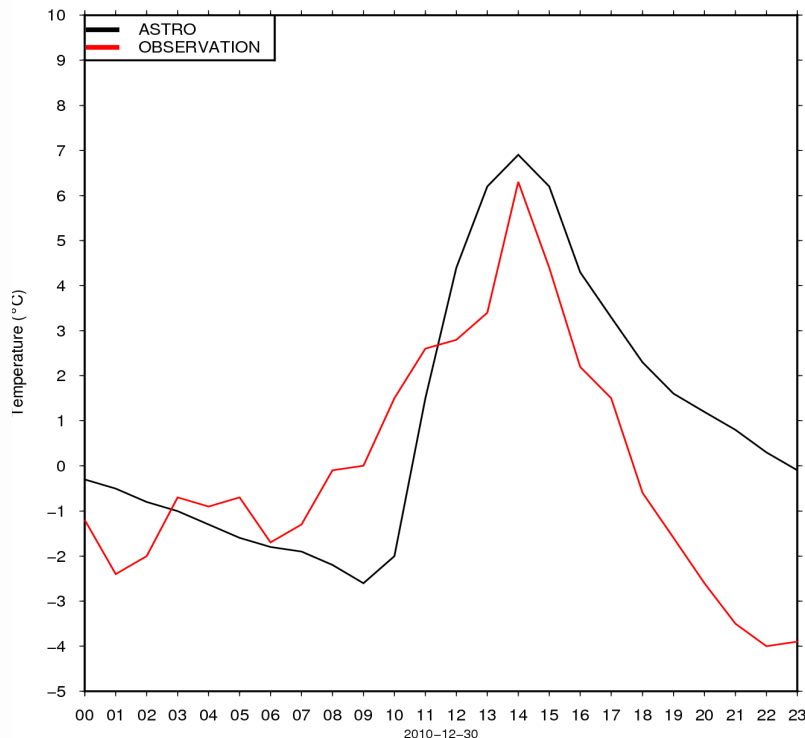1- Methods to deduce hourly temperatures

2- Impact on reanalysis systems

3- Impact on a 50-year reanalysis

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Astro method (D.C Reicosky, L.J Winkelman, J.M Baker and D.G Baker (1988))

- Extreme temperature + metadata (sunrise, sunset times)
- Split the diurnal temperature evolution in three parts
- Advantage: Only need extreme temperature + metadata at the observation point
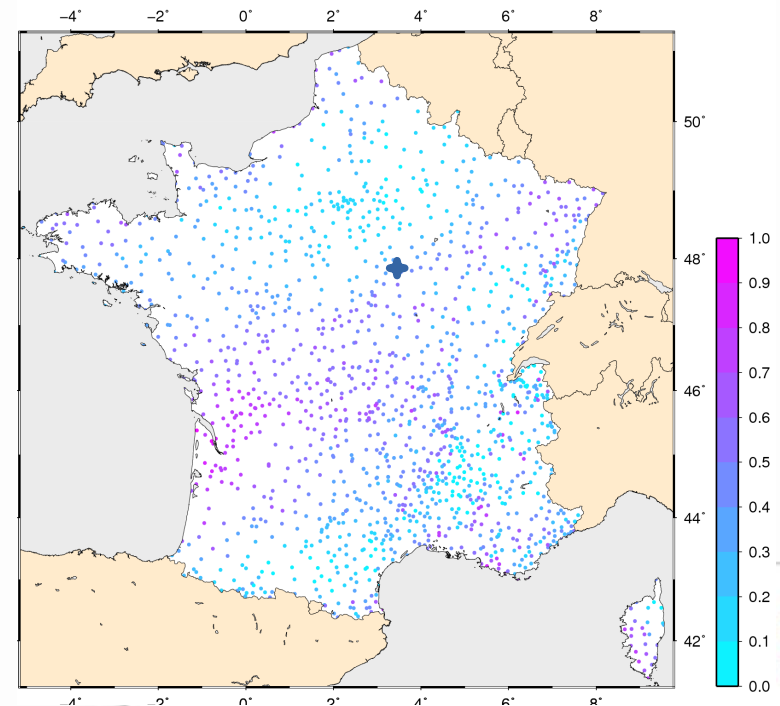- Inconvenient: Poor quality for « non classic » day

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Alpha method

$$\rightarrow T(h) = Tmin + \alpha(h)(Tmax - Tmin)$$

- **compute alpha** coefficient for station with hourly observation
- **deduce alpha** coefficient for station whitout hourly observation:
  - Mean of alpha coefficient from N neighbors with
    - Maximum distance = 100km
    - Difference of altitude < 200m

- Use the formula => T(h)
- Experiments:
1 to 10 neighbors + All Neighbors

- Inconvenient: Need hourly observations
in the neighborhood
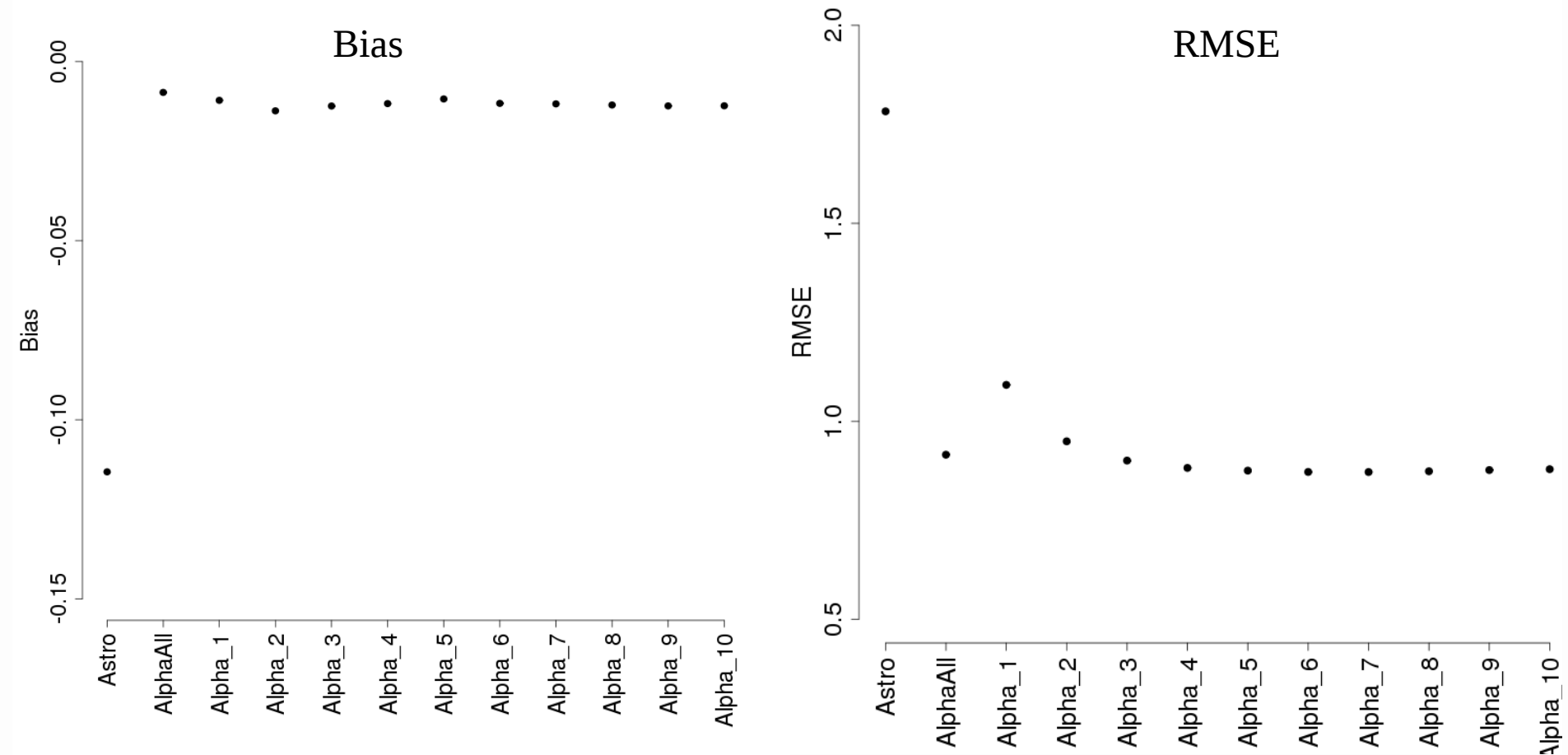- Advantage: OK for « non classic » day

Alpha coefficient
20100101 00hUTC

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Methods to deduce hourly temperatures

Comparison of the methods: Pseudo observations .vs. Real observations

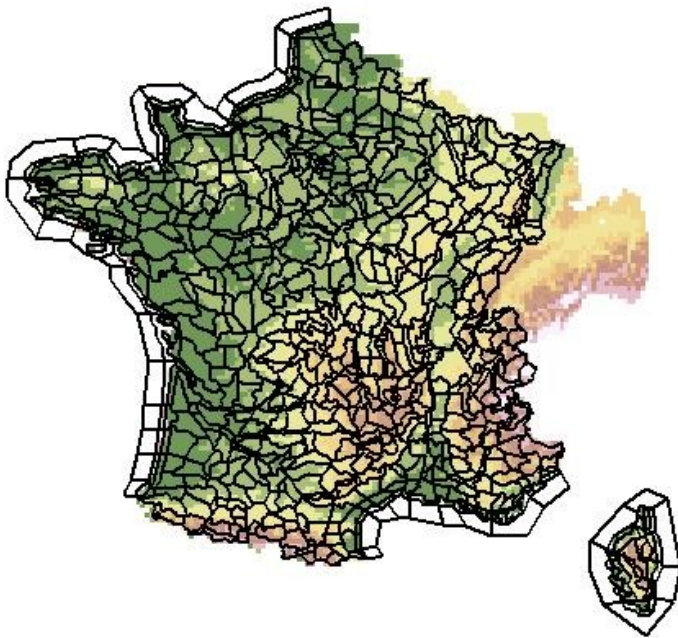Period Aug.2009 – Jul.2010 every 6 hours (Aug.1978 – Jul.1979 not shown here)

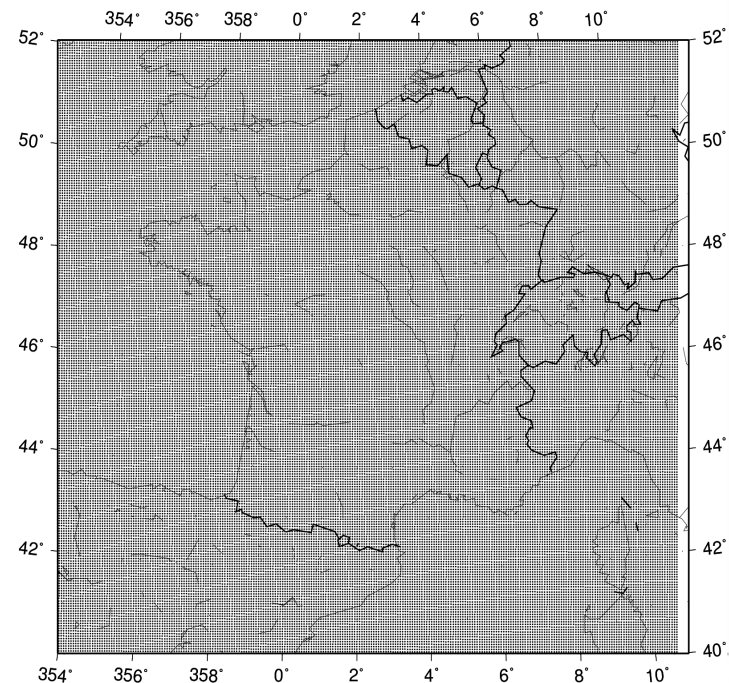- Best results for Alpha methods - No elevation dependancy (not shown here)

=> **Methods kept: Astro/AlphaAll/Alpha5**

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Impact on reanalysis systems

- 2 systems used: SAFRAN; MESCAN

- Domain: France

- Experiments with only pseudo observations from Astro, AlphaAll and Alpha5 methods replacing real observations

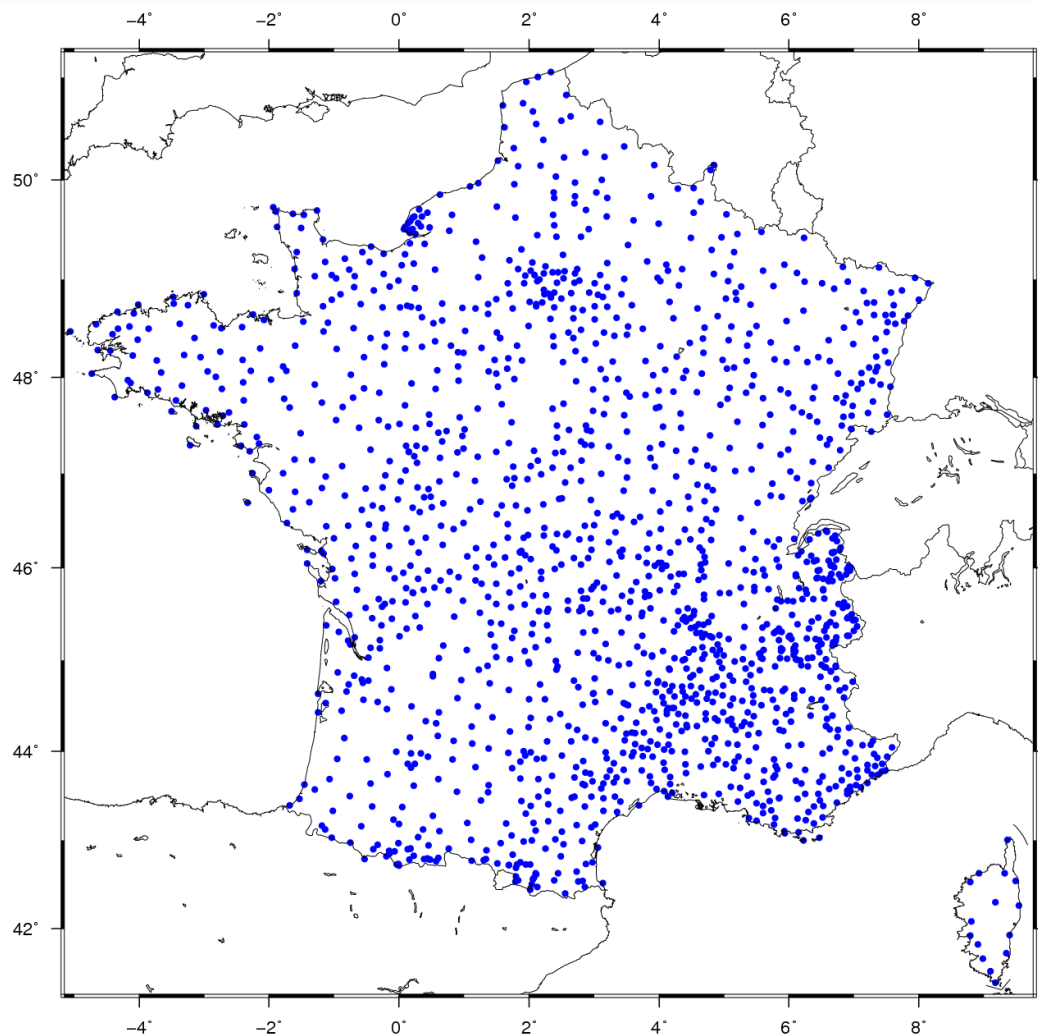- Common Period: Oct.2009-Jun.2010

SAFRAN areas

MESCAN grid 5.5km

- Reprojection on the observation's location (1555 stations)

Impact on reanalysis systems

MESCAN	BIAS	RMSE
using ASTRO	0.01	1.96
Using ALPHAALL	0.09	1.30
Using ALPHA5	0.09	1.26
Using Real Obs	0.09	1.12
Guess	-0.72	2.09

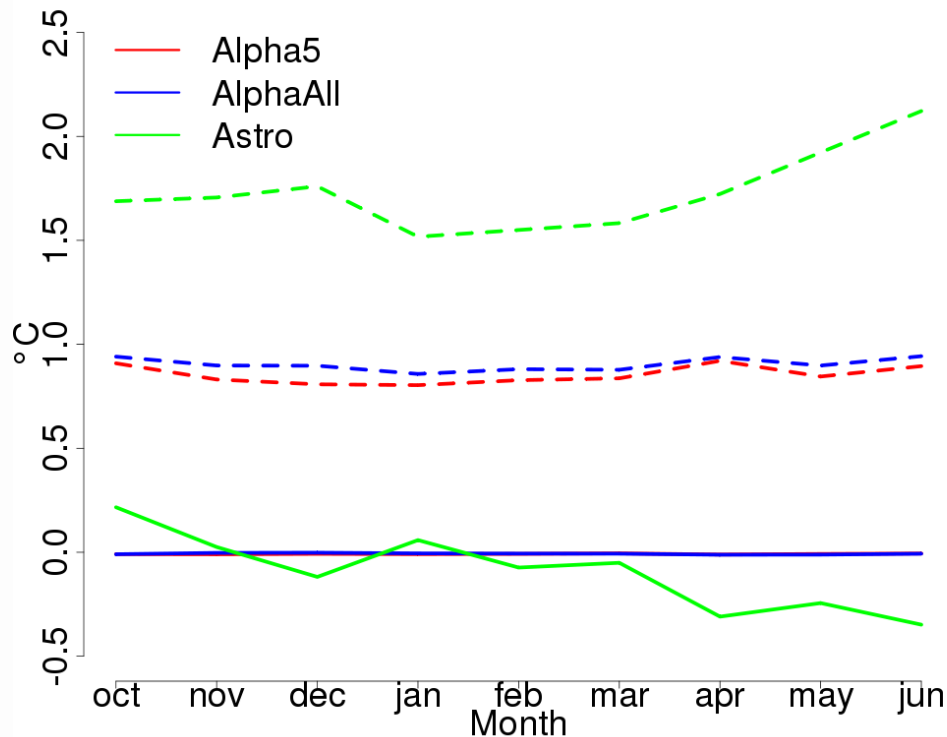| PSEUDO-OBS .vs. OBS	BIAS	RMSE
ASTRO	-0.09	1.73
ALPHAALL	0	0.90
ALPHA5	0	0.85

- Low bias values for MESCAN and SAFRAN
- AlphaAll and Alpha5 better than Astro
- SAFRAN errors ~ MESCAN errors
- Erros using AlphaAll/Alpha5 ~ Errors using Real Obs

SAFRAN	BIAS	RMSE
using ASTRO	-0.1	1.85
using ALPHAALL	-0.06	1.15
Using ALPHA5	-0.05	1.06
Using Real Obs	0	0.93

RMSE and BIAS for PSEUDO-OBS

RMSE and BIAS for MESCAN or GUESS

- Consistant results with pseudo-observation error using SAFRAN (not shown here) or MESCAN
- Error's statistics for Astro seems to be monthly dependant

- To use in reanalysis system, set up σ_o for pseudo-observations :

- $\sigma_{o\ pseudo-obs} > \sigma_{o\ real\ observation}$

- $\sigma_{o\ Astro}$ monthly dependent

Impact on a 50-year reanalysis

- Using SAFRAN over France (1958 to 2010)
- Real observations + ALPHA5 pseudo observations (without specific settings for errros' statistics)
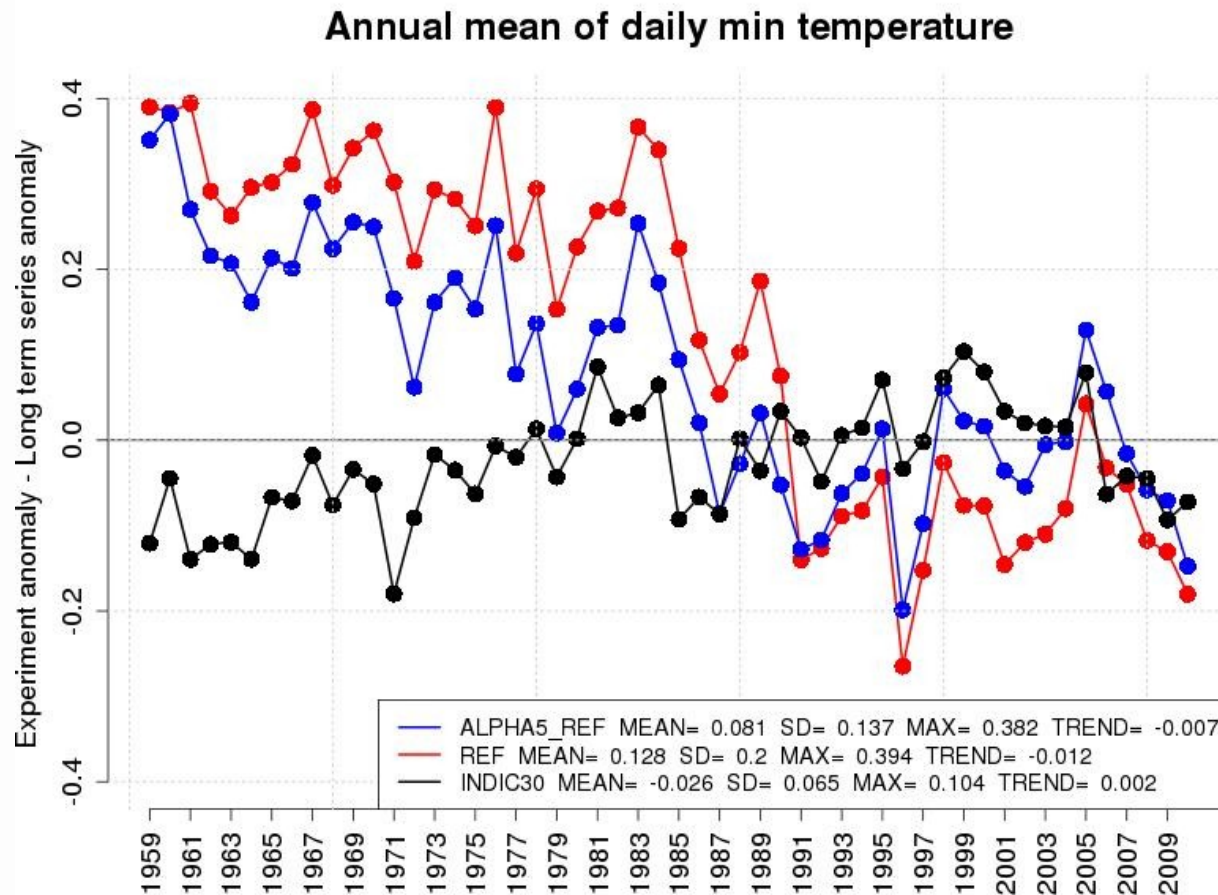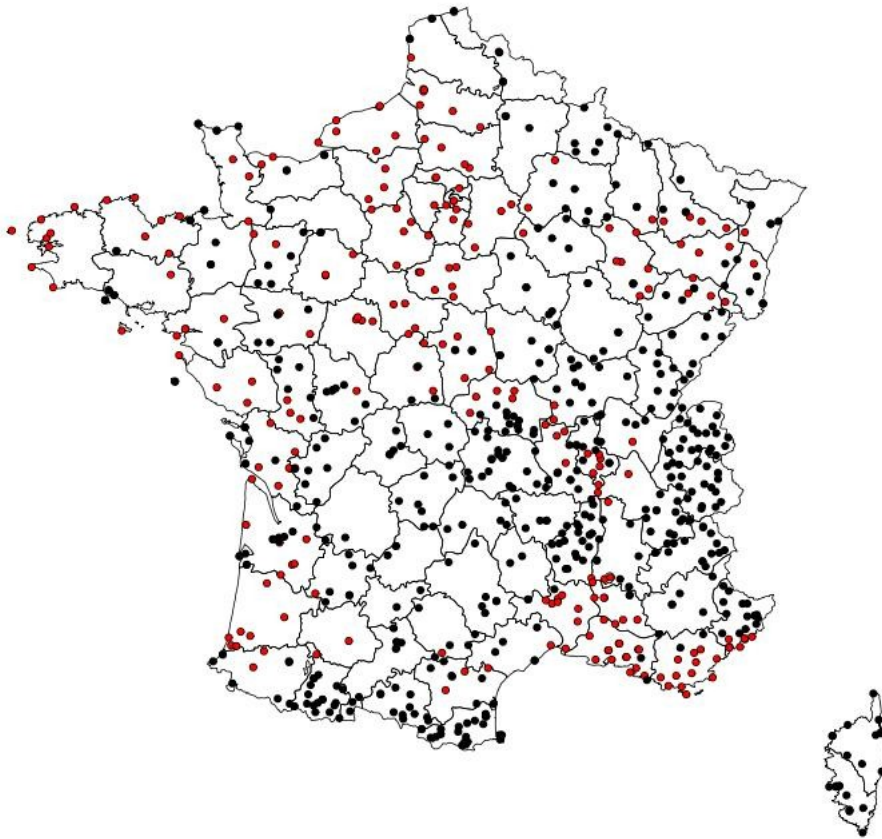

Real observations available 01/01/1960

Real observations +Pseudo observations 01/01/1960

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Impact on a 50-year reanalysis

Annual mean of daily min temperature

- Small reduction temporal heterogeneities adding ALPHA5 pseudo-observations
- Indic30's values still better

Red: observations + pseudo-observations
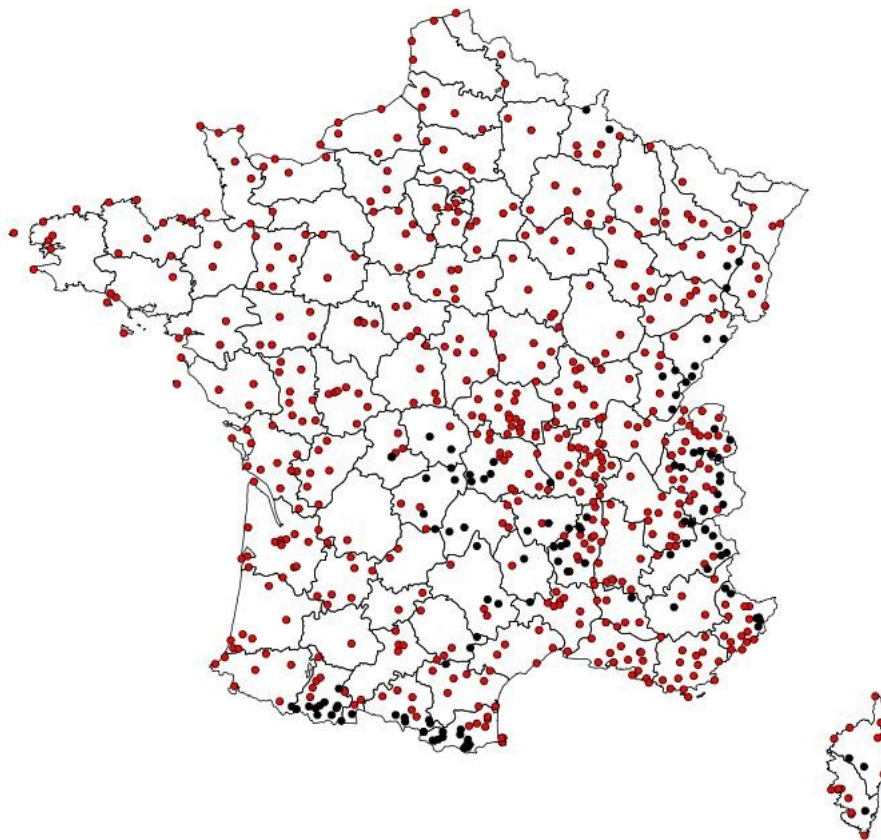ALPHA5 used
Black: extrem temperatures without
pseudo-observation deduced (less than 5
neighbors <100km or elevation criterion)

=> Increase data's spatial heterogeneities

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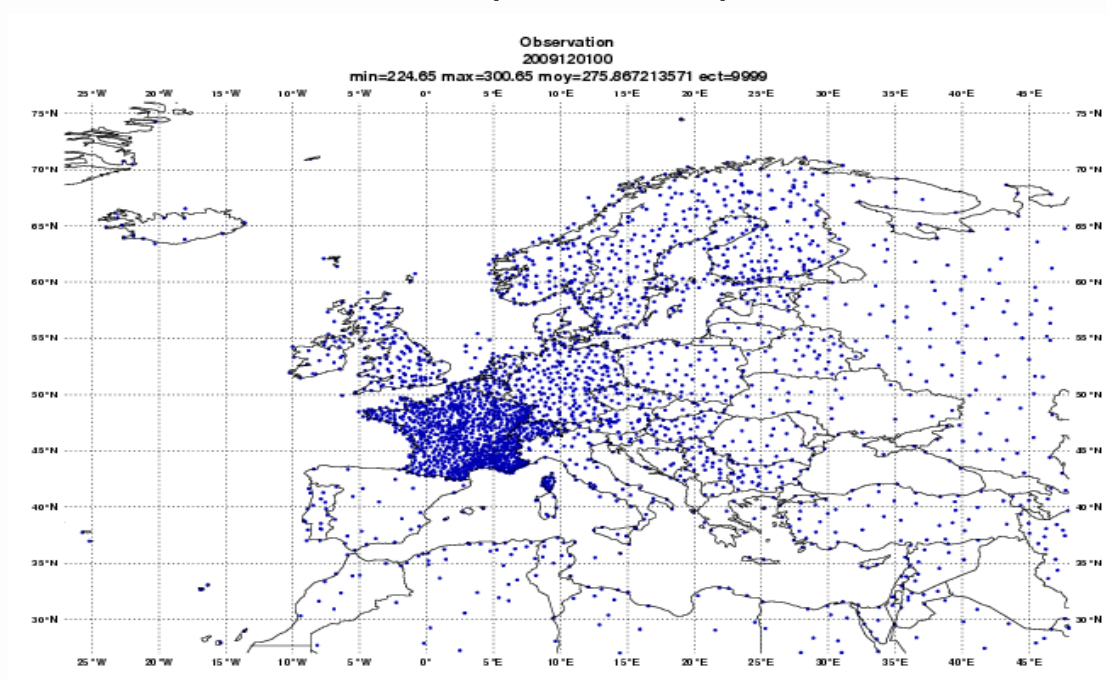
Red: observations + pseudo-observations ALPHA1 used
Black: extrem temperatures without pseudo-observation deduced (less than 1 neighbors <100km or elevation criterion)

=> Spatial repartition is better

Conclusions

- Two methods to deduce hourly temperatures :
    - Alpha method better than Astro method
    - Astro method needs a few data
    - Alpha method probably not suitable for very sparse network (or use criteria more permissive)

- Impacts on SAFRAN or MESCAN are similar

- Homogeneities with ALPHA1 simulation ?

- Try to apply this method over Europe :
    – which data are available ?
    – is the Alpha method suitable ?

- Set up σ_o in MESCAN for pseudo-observation for a potential use

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Thank you !!!

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