An example of model result correction to study the impact of climate change on electricity consumption

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Goal of the study

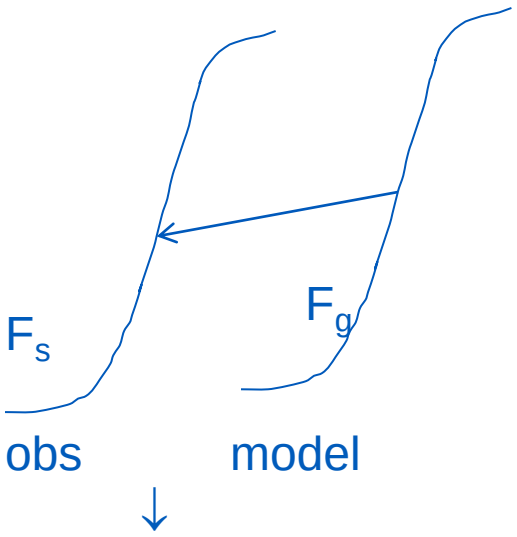
- Estimation of the change in the thermal part of electricity consumption
  - Consumption model
  - Conso = f(date, calendar, parameters) = Phc + Pc (+Peff)
  - Only temperature is changed

- Needed data
  - Hourly temperature: France average, suitably weighted / electricity consumption

- Available data
  - Suitable France average 1982-2007
  - ENSEMBLES models results: daily min, max and mean T

Reconstitution of the desired France average

- ENSEMBLES: ensemble mean
- Quantile matching correction: different approaches
  - Déqué 2007



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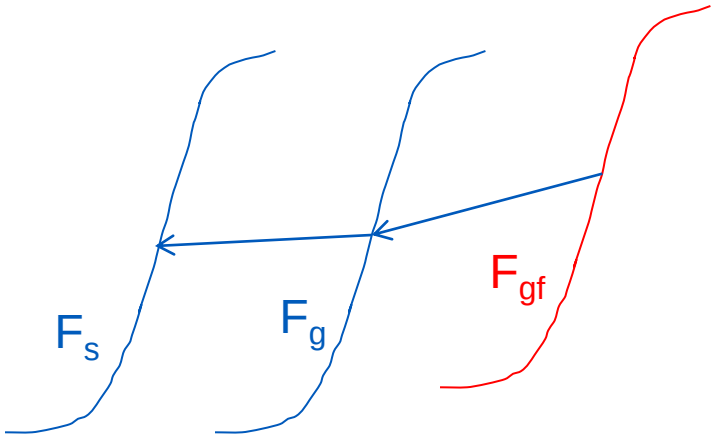
Correction table

Future climate value: sorted in current climate model distribution then corrected

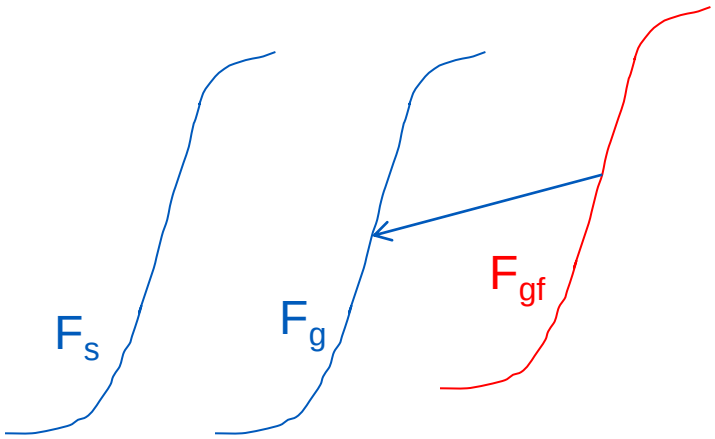
Michelangeli et al. 2009: CDFt



$$F_{sf}(x)=F_s[F_g^{-1}(F_{gf}(x))]$$

Reconstitution of the desired France average

- Slightly different quantile matching correction



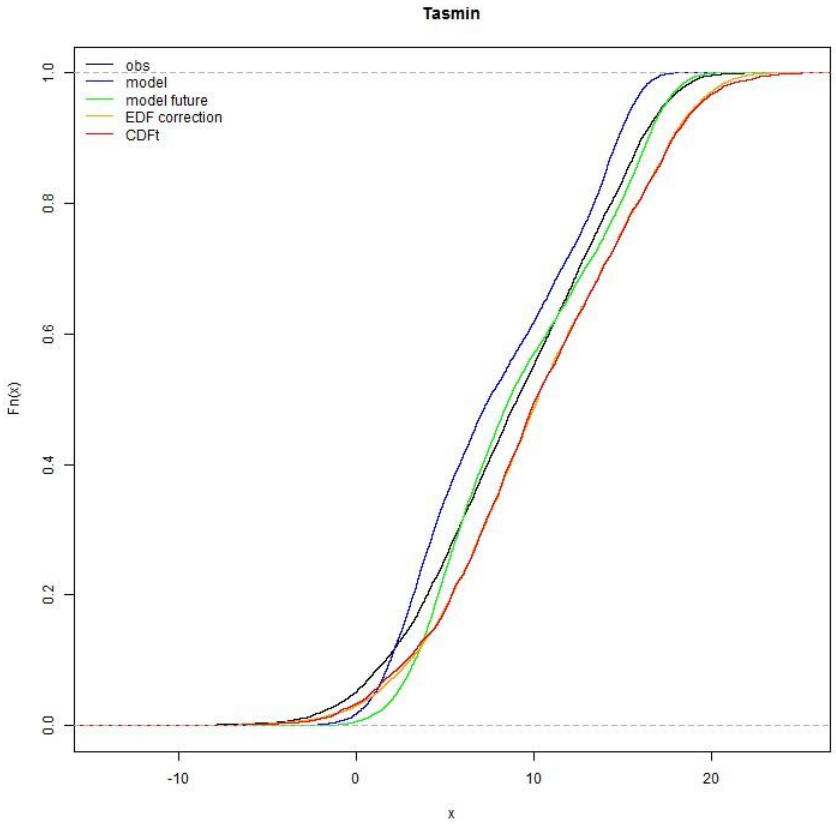
obs Model current Model future

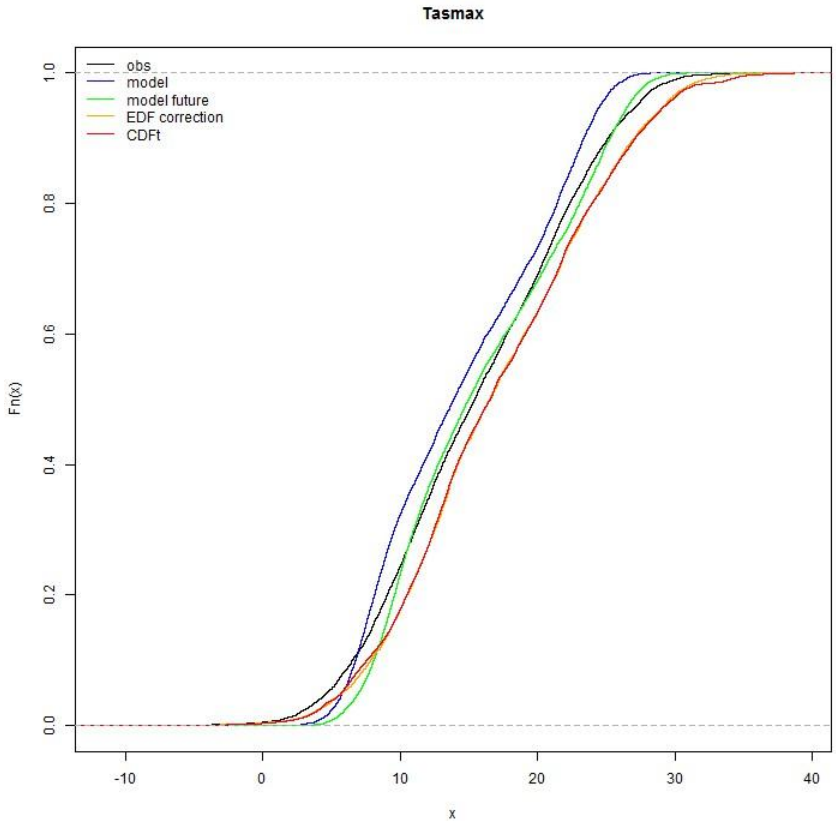
$x_g \mid F_g(x_g)=F_{gf}(x)$
$x_s \mid F_s(x_s)=F_g(x_g)$

Then $x_{sf}=x_{gf}+(x_g-x_s)$

- Daily maximum and minimum temperature
- Hourly data: « normal » daily cycle between min and max

Corrections comparison

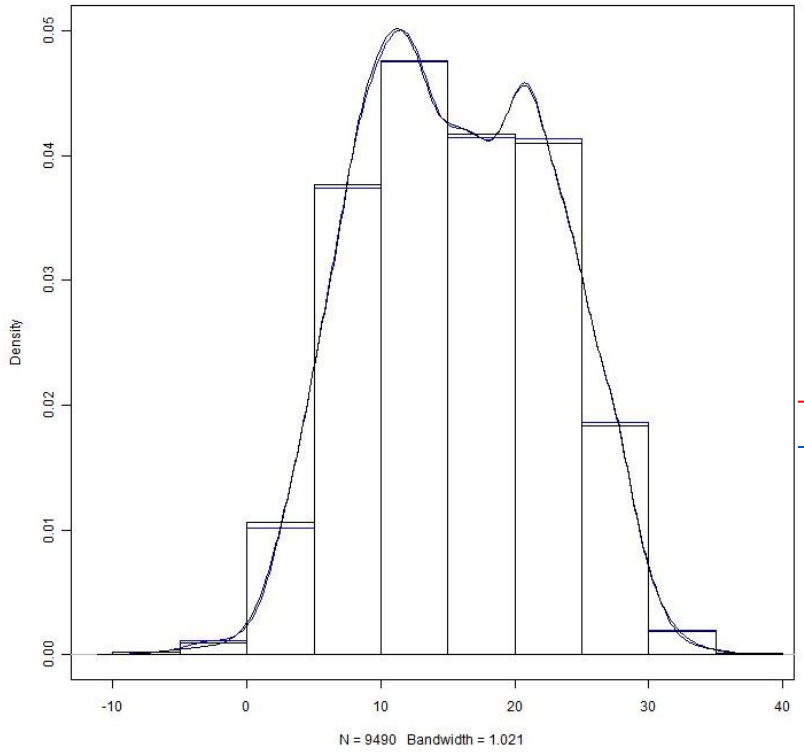




First calculation: annual distribution correction

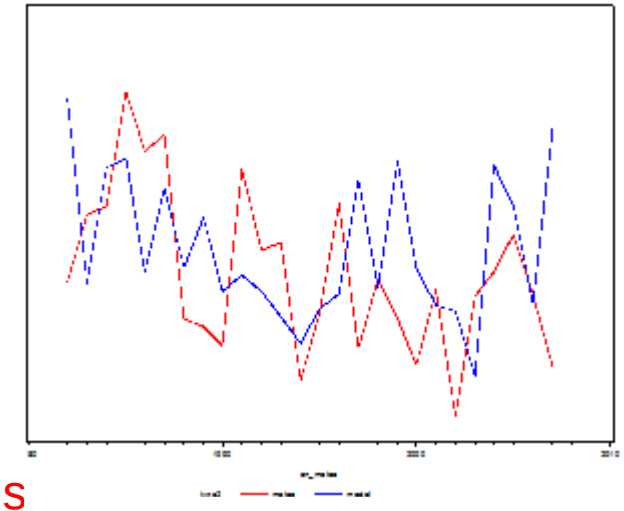
Observations
Corrected model

1987-2002

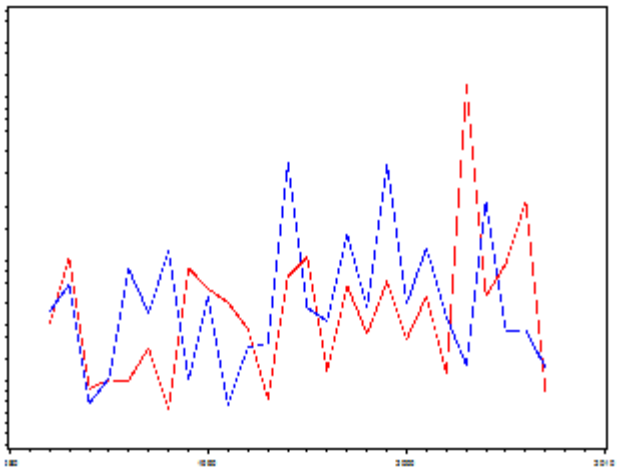


Annual temperature distribution

Annual heating energy



Observations
Model



Annual Cooling energy

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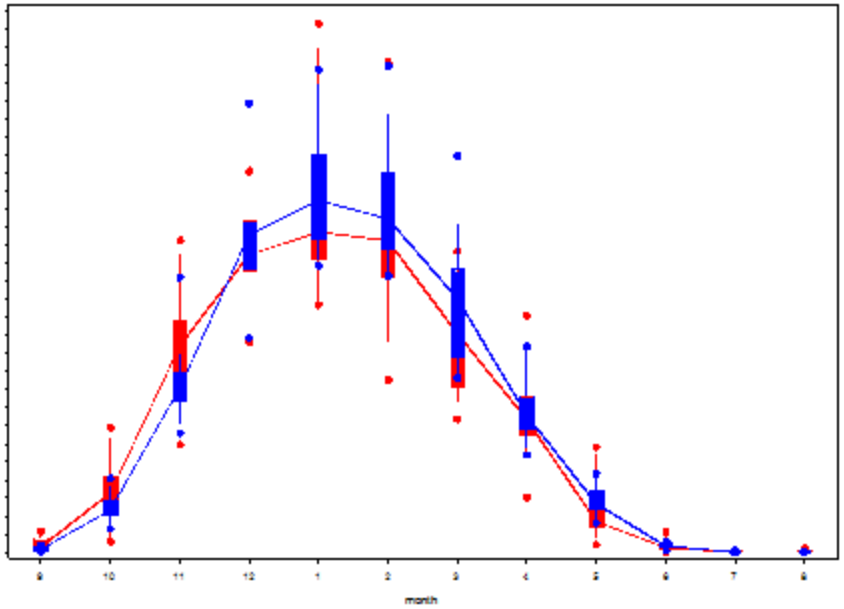
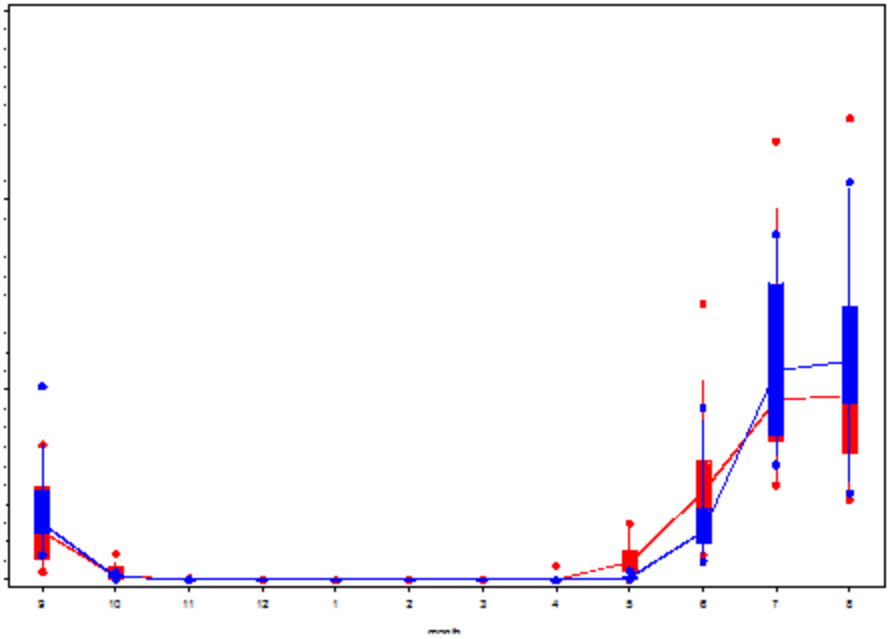
Annual cycle (from September to August)



Observations
Model

Mean monthly heating power

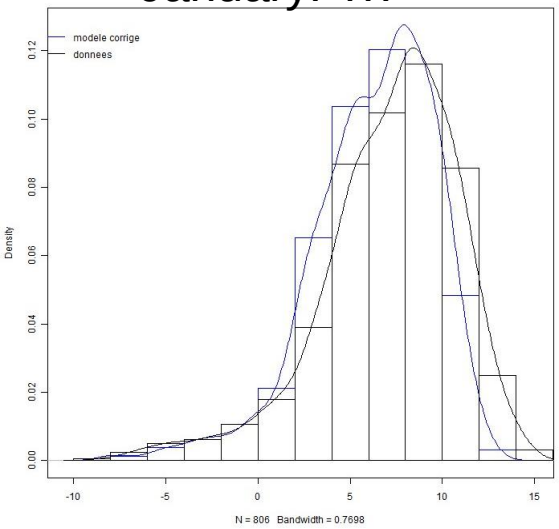
Mean monthly cooling power



Errors > consumption model precision

Comparison of monthly T distributions

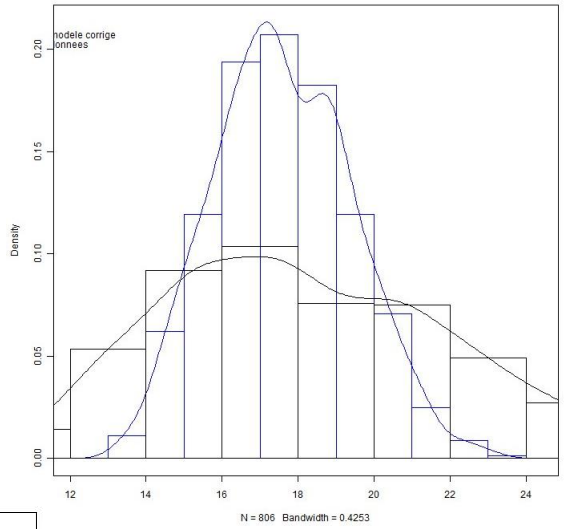
January: Tx



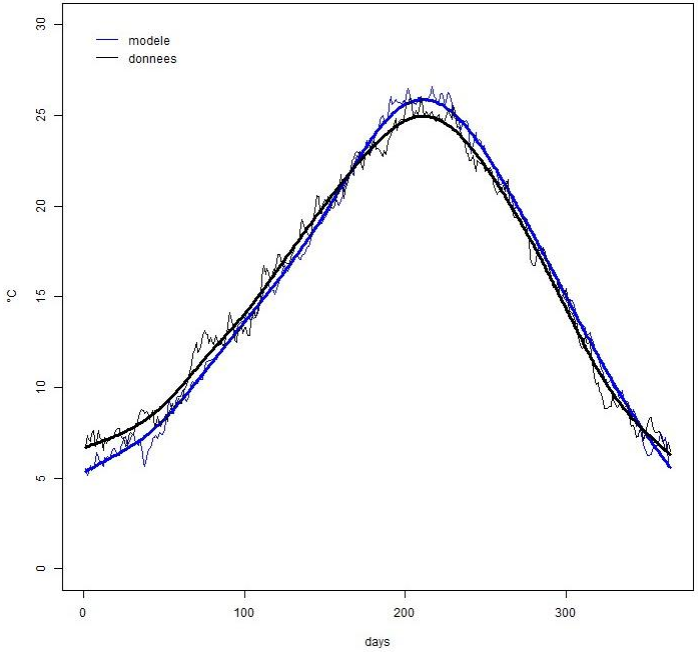
corrected model

Observations

May: Tx

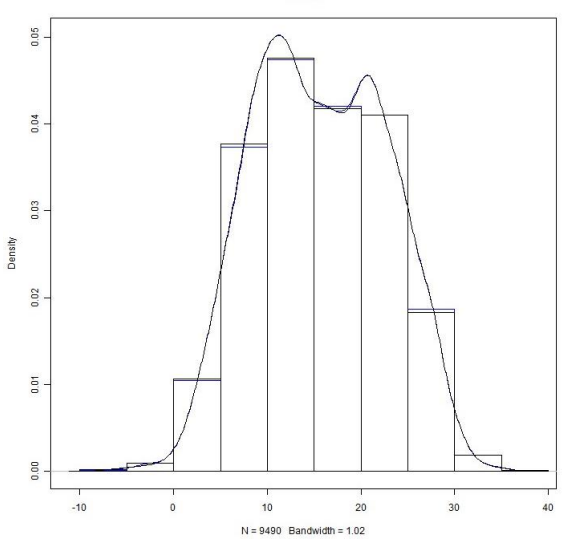


Tx: mean annual cycle

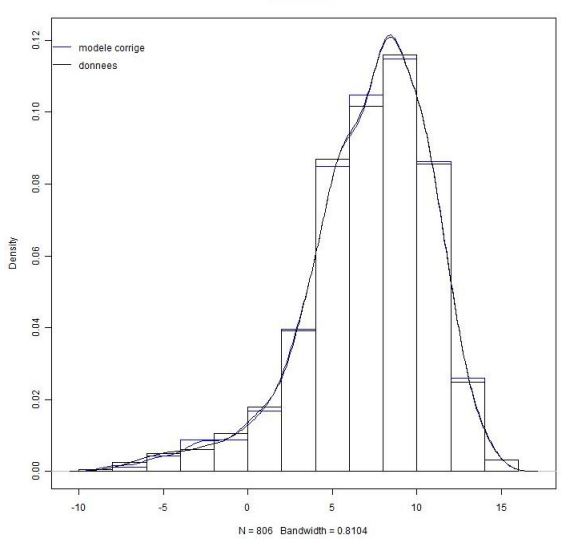


Necessity of a monthly correction

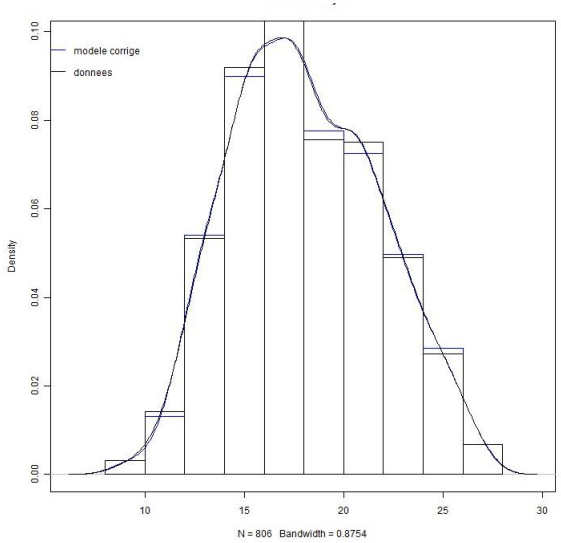
Annual: Tx

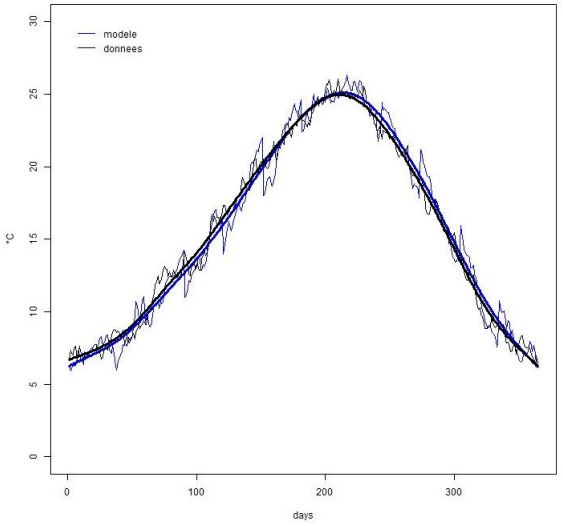


January: Tx



May: Tx



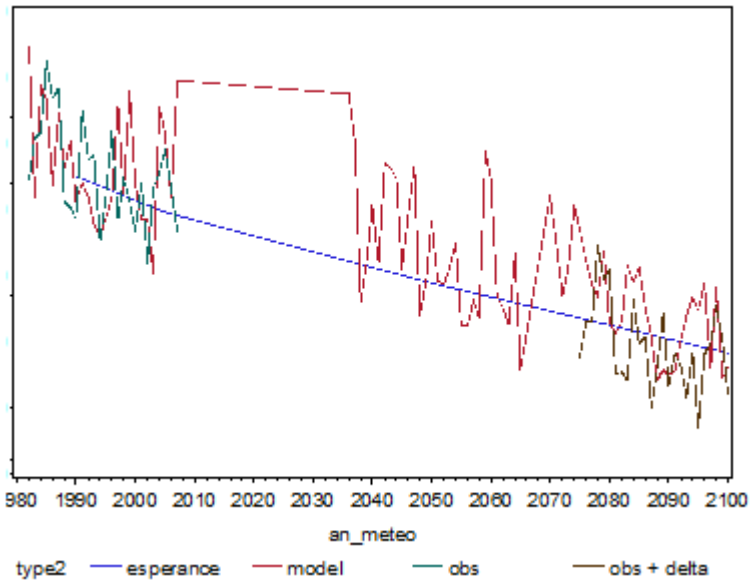


corrected model

Observations

Results: annual heating and cooling

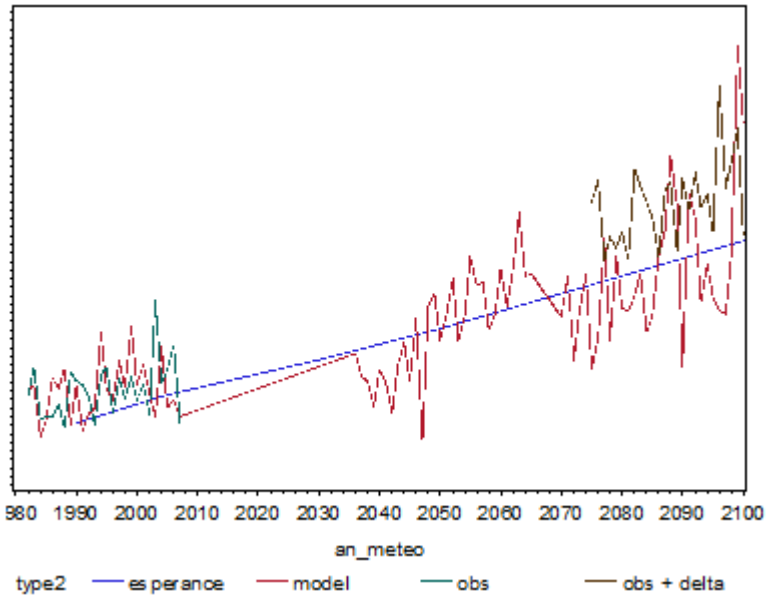
heating



Model

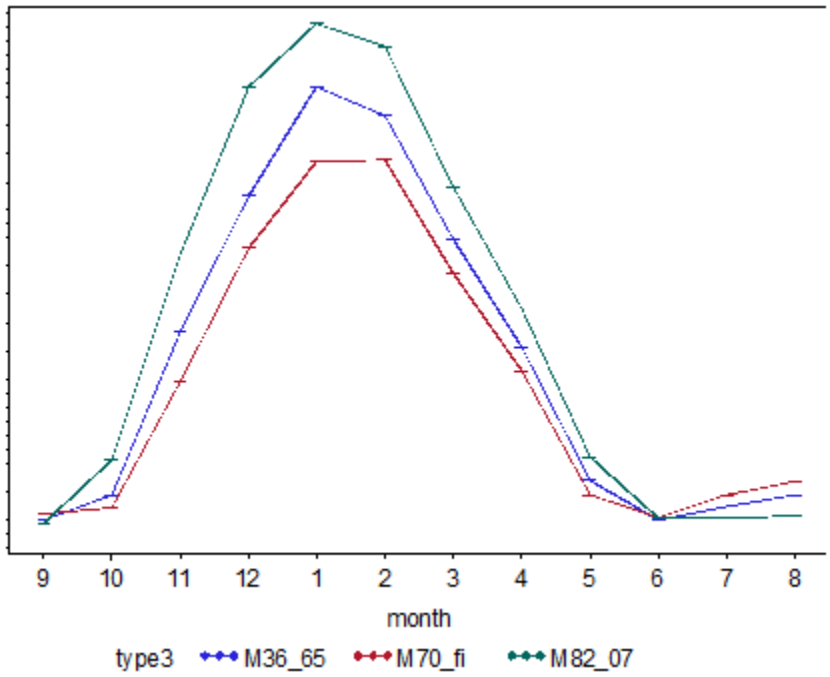
Observations

cooling



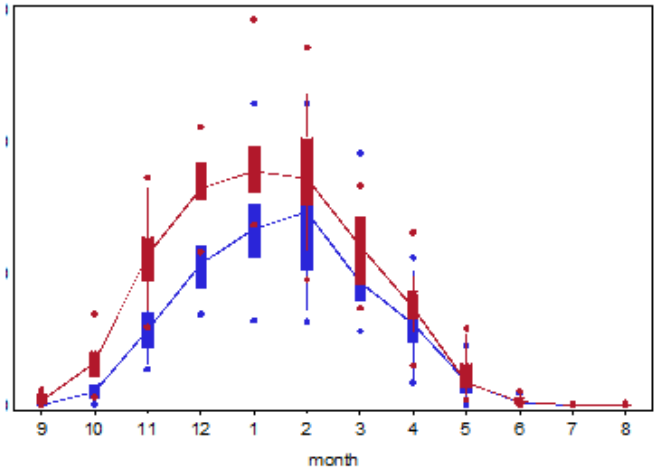
Results: month by month

Mean thermal part



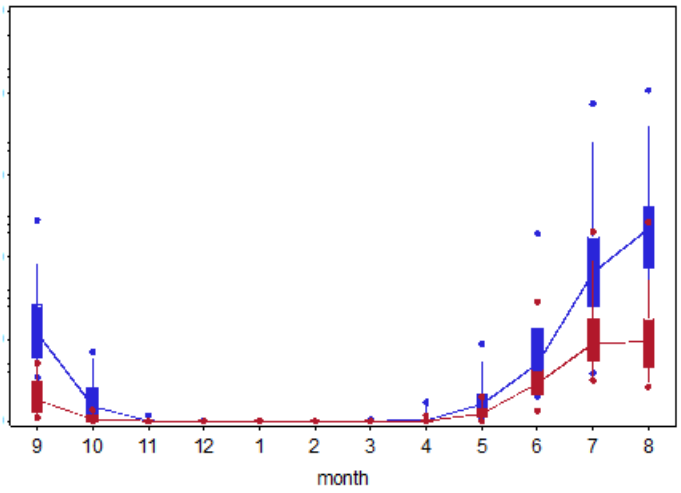
1982-2007
2036-2065
2070-2100

heating



Observations
2070-2100

cooling



Conclusion

- Hourly evolutions of France average temperatures
- Climate model bias correction
  - Quantile matching
  - 1987-2002; 2036-2065; 2070-2100
- Hourly evolution from daily min and max
- Electricity consumption (thermal part)
  - Annual distribution correction: mean annual energy ≅ OK
  - Monthly cycle
    - Needs a monthly based correction
    - Expected evolutions but inter-annual variability must not be neglected

Thanks for your attention

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