

# Seasonality and climate change in temperature series of Europe and the United States

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# Outline

- ▶ Used datasets
- ▶ Methodology
- ▶ Results
  - Station level
  - Continental level
- ▶ Discussion and perspectives

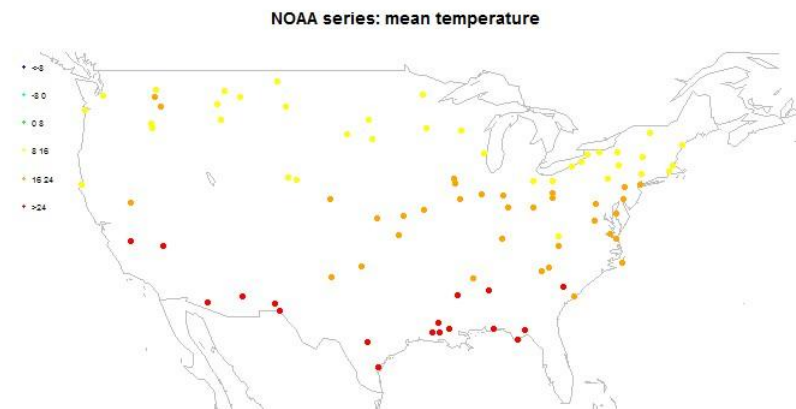
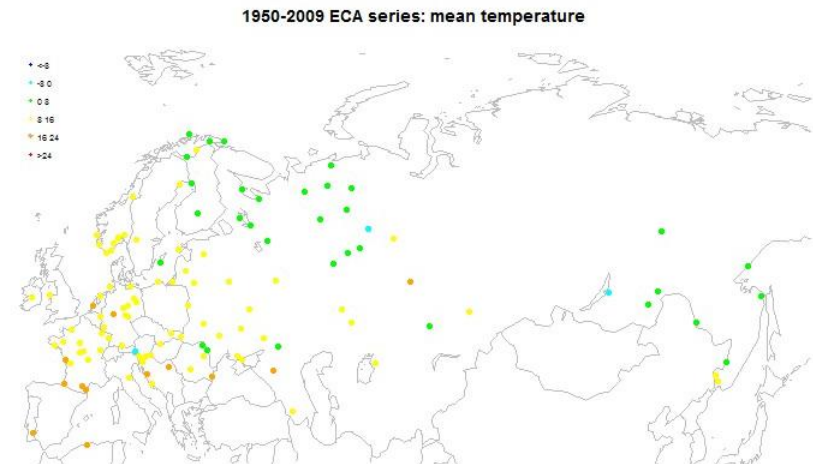
# Datasets

## ▶ Europe: ECA&D 1901-2009 and 1950-2009

- Homogenous
- 129 series
- Tx, Tn

## ▶ United States: NCDC, Global Historical Climatology Network

- Series with <4 years of missing data
- Beginning before 1966 and ending after 2008
- 89 series
- Tx, Tn



# Methodology

## ▶ Annual cycle

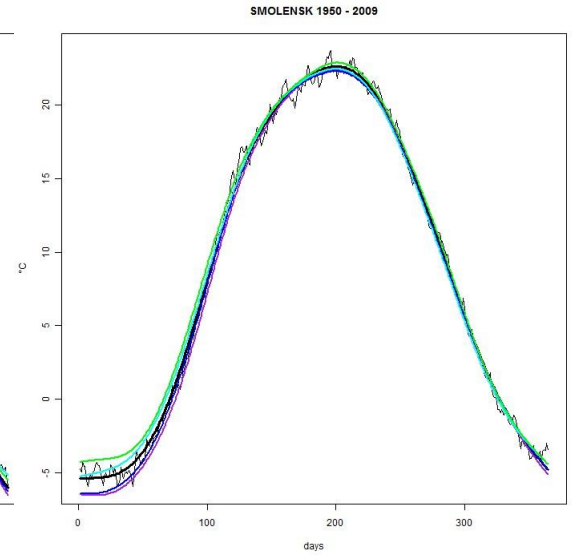
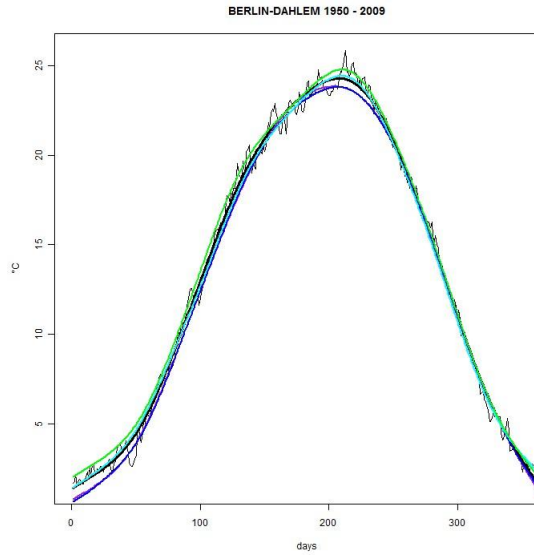
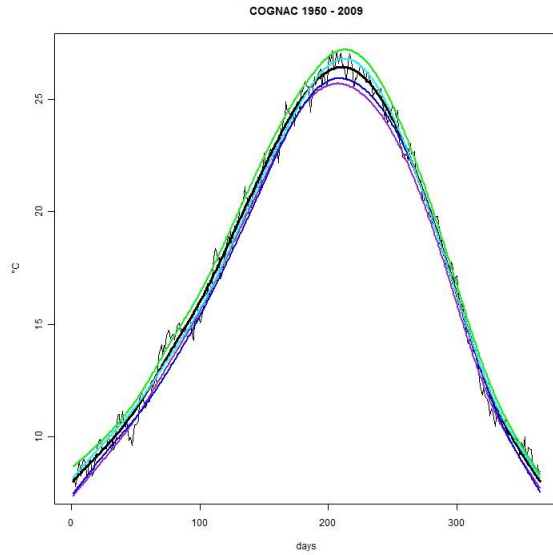
- Mean annual cycle over the whole period
- 30-year periods, every 10 years
- Cubic splines smoothing (0.8)
- Shift: differences between last and first periods (or max diff / last period) for annual minimum (winter) and annual maximum (summer)

## ▶ Trend

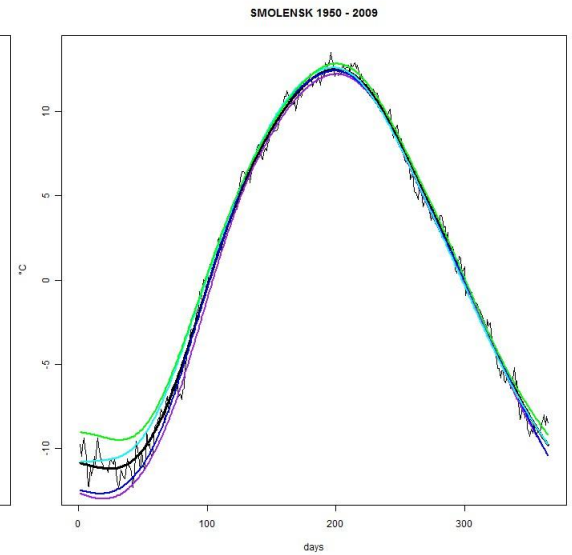
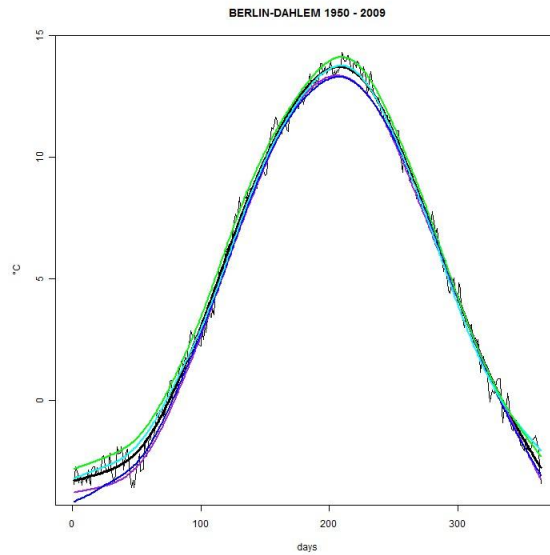
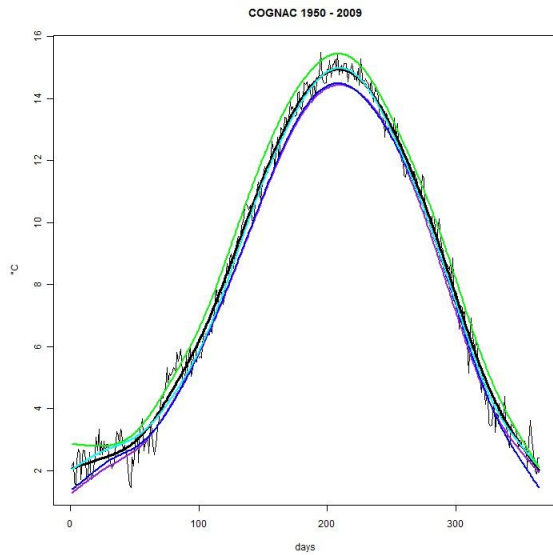
- Non parametric trends: LOESS
- Modified partitioned cross-validation  $\Rightarrow$  smoothing parameter 0.17
- Mean then variance
- $X$  : raw data,  $m$ : non parametric trend in mean,  $v$ : non parametric trend in std
  - $X$
  - $X-m$
  - $(X-m)^2 \Rightarrow v \Rightarrow s$
  - $Y = (X-m)/s$

# Europe: 3 behaviours

$T_x$

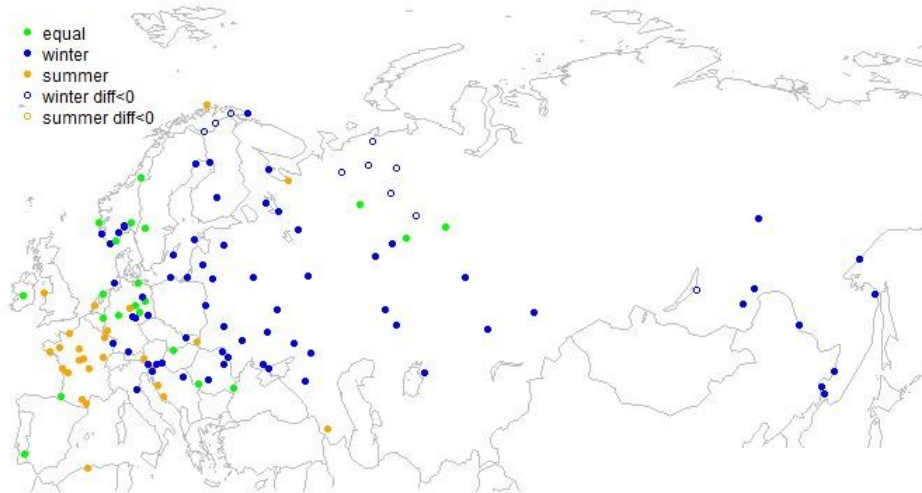


$T_n$



# Europe

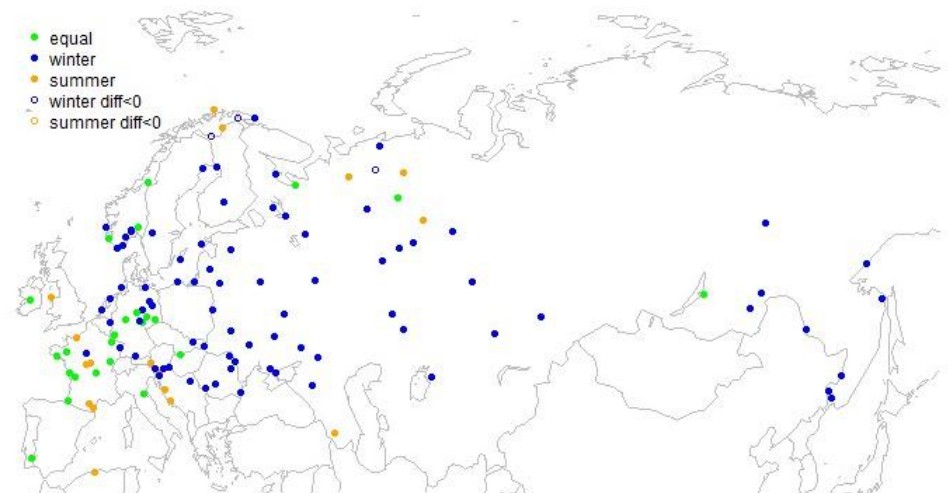
1950-2009 ECA series: season shift X



Tn

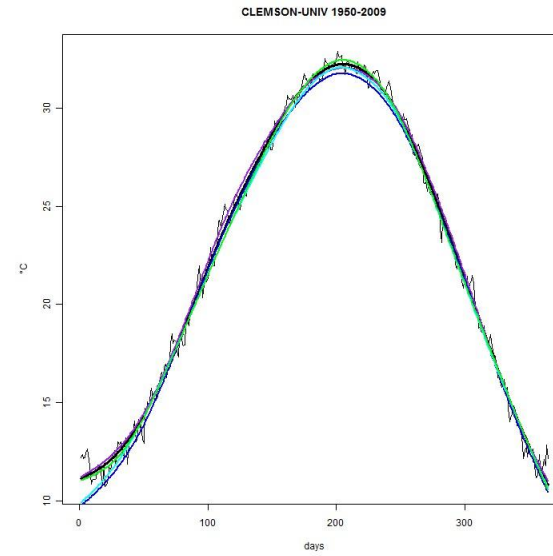
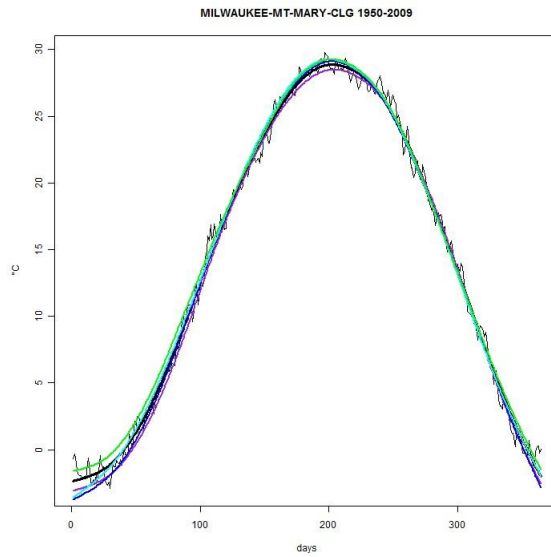
1950-2009 ECA series Tn: season shift X

Tx

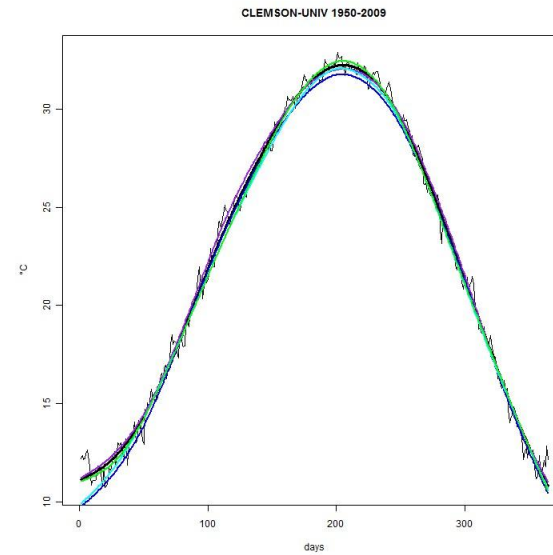
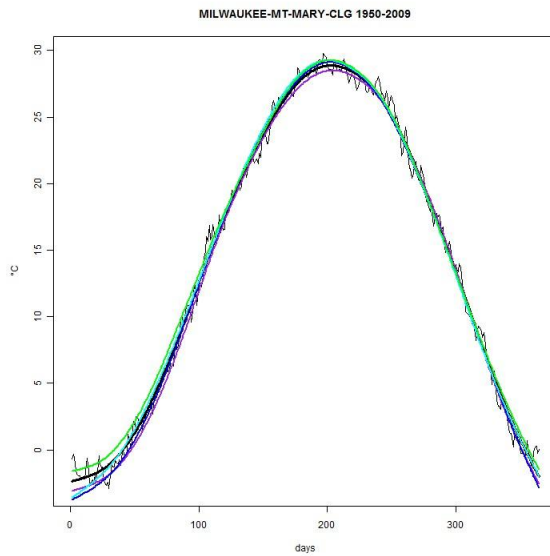


# United States: 2 behaviours

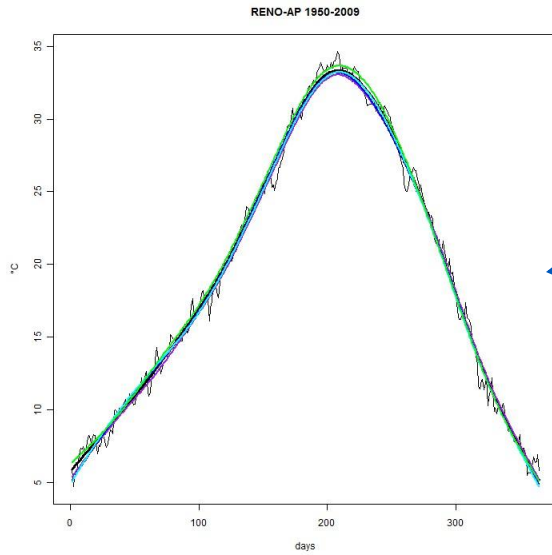
$T_x$



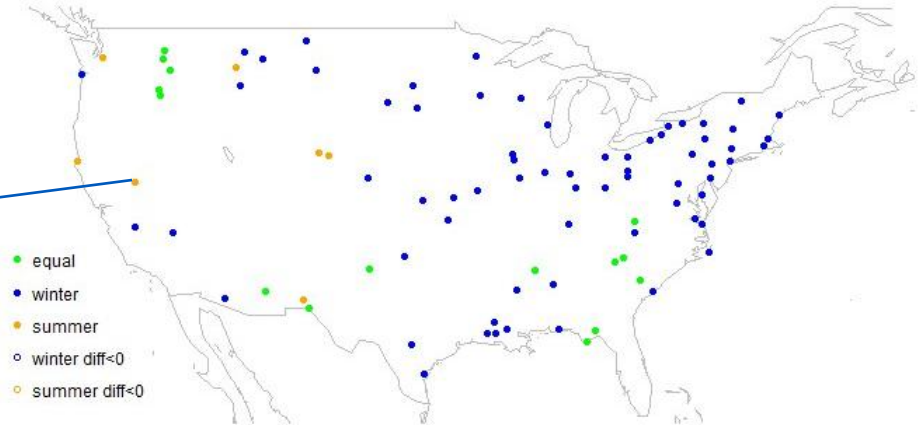
$T_n$



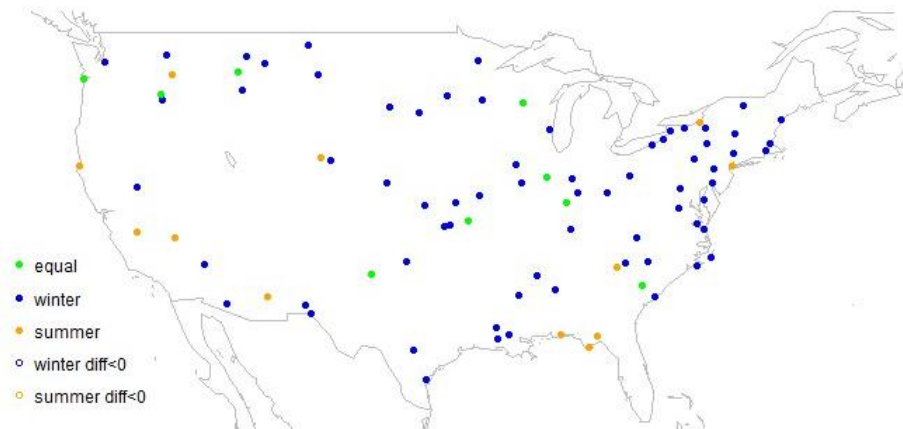
Tx



NOAA series 1950-2009: maximum season shift



NOAA series 1950-2009 TN: maximum season shift



Tn

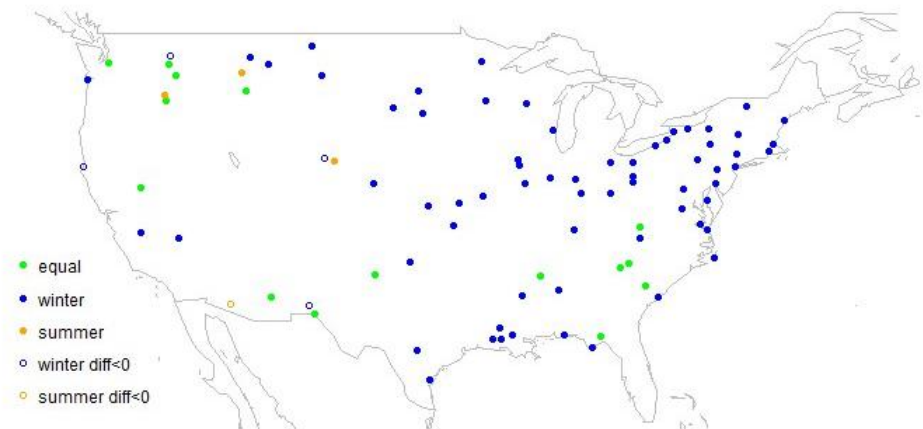


# Mean trend removal: X-m

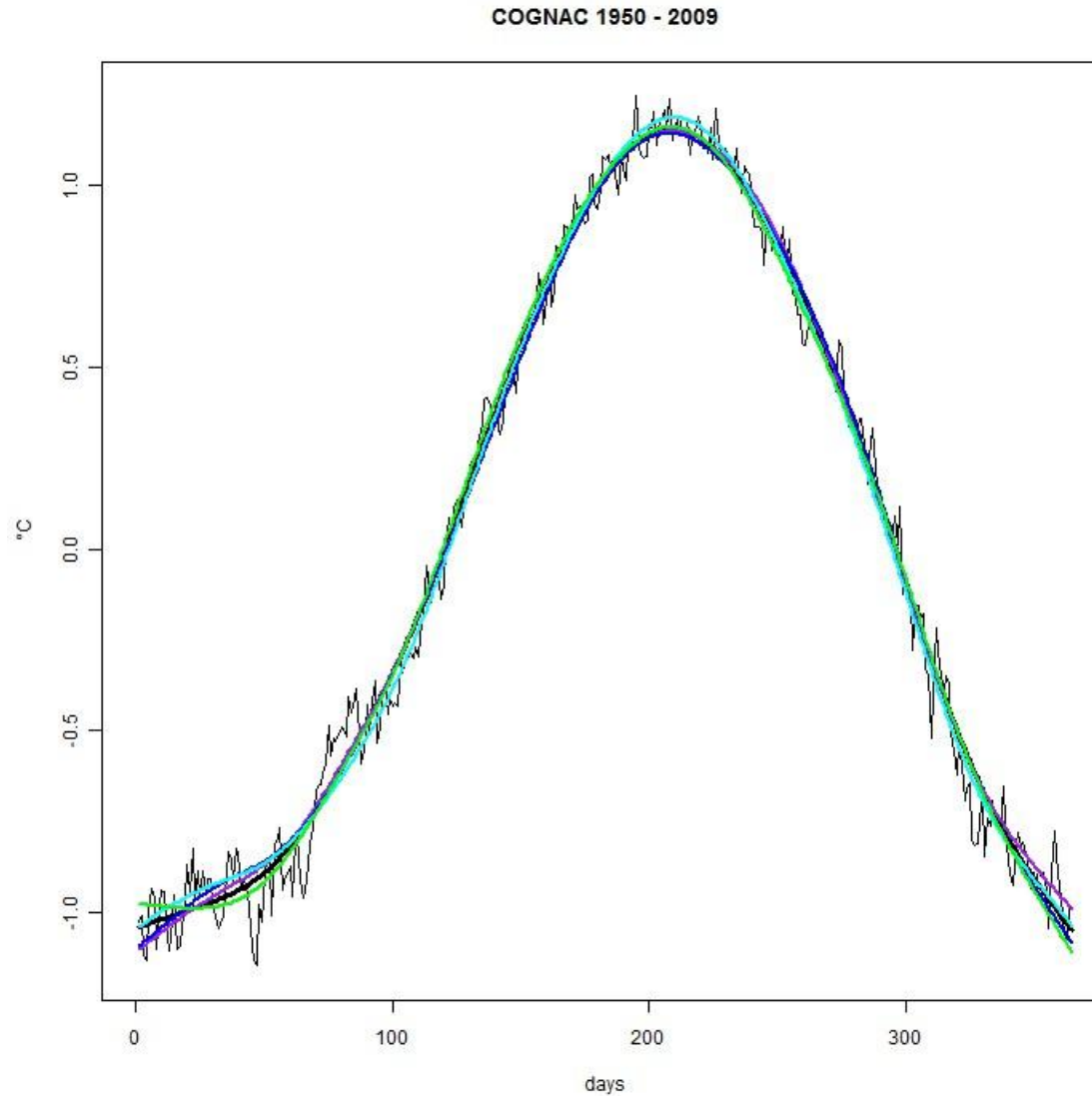
1950-2009 ECA series: season shift X-m



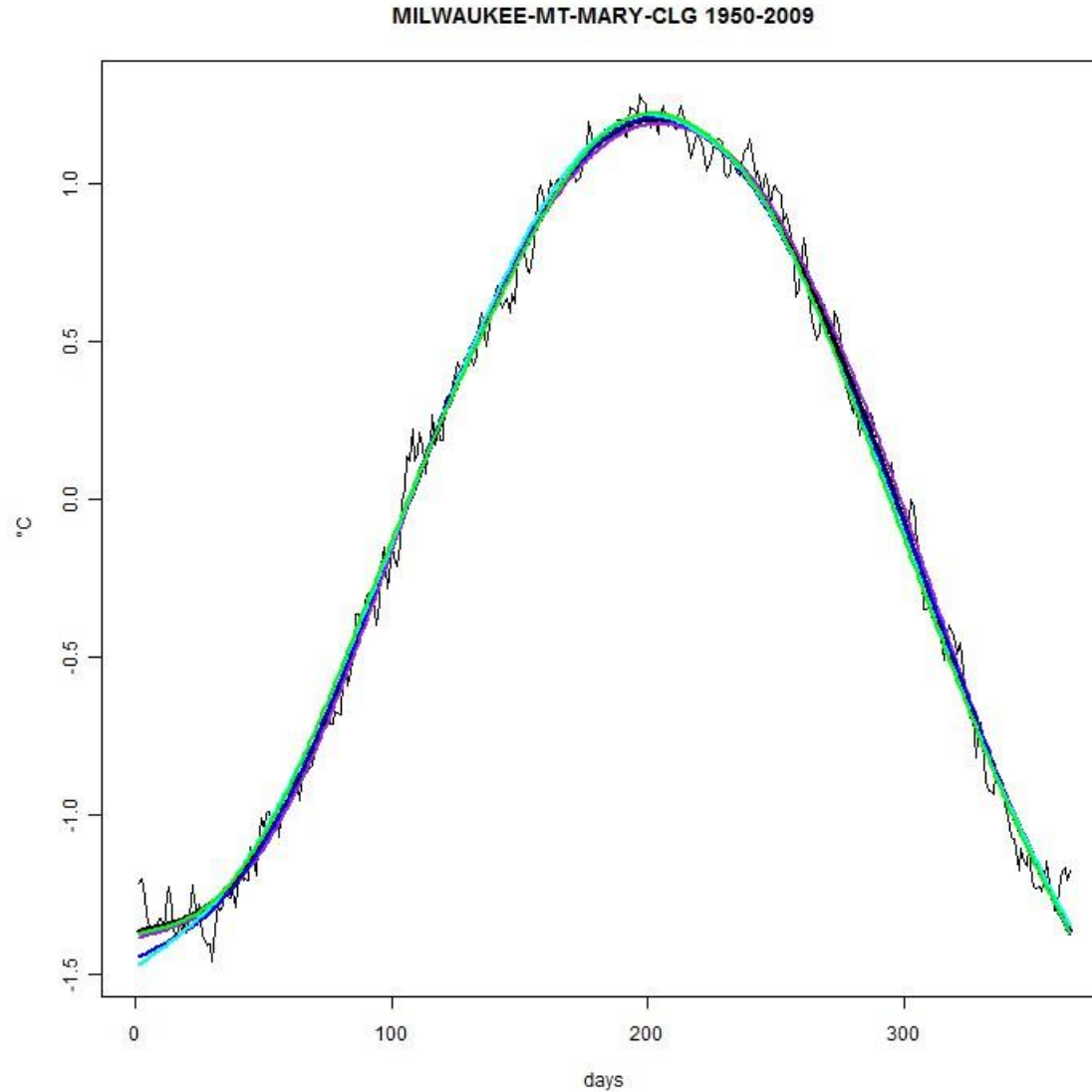
series 1950-2009: maximum season shift (detrended)



# From X to Y: Europe



# From X to Y: United States



# Y: no trend

1950-2009 ECA series: maximum season shift Y

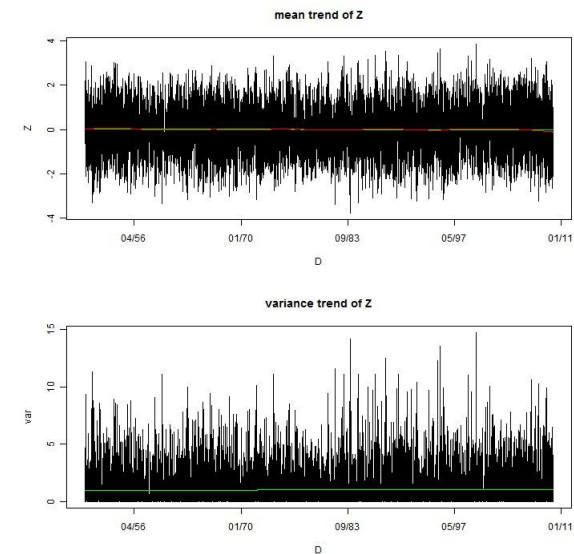
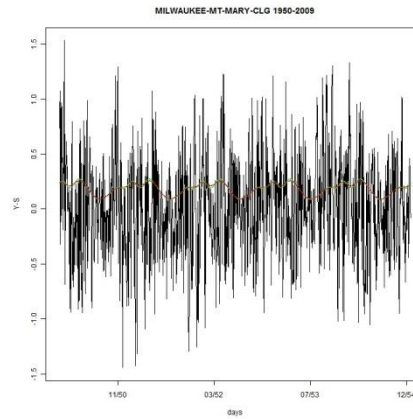
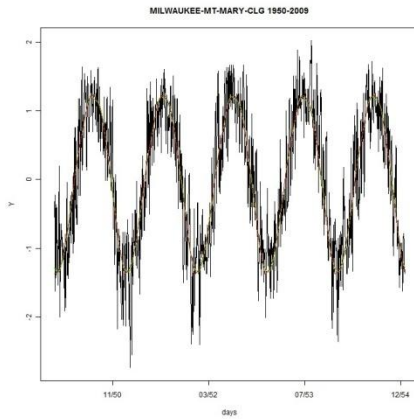


NOAA series 1950-2009: season shift (final-initial) Y



# Discussion

- ▶ Y: Trends seem to be removed
- ▶ Seasonality
  - trigonometric polynomial : mean S and variance  $V^2$
  - $Z = (Y-S)/V$



- ▶ Stochastic simulation: diffusion
- ▶ Study should be made with wavelets

# Thanks for your attention

