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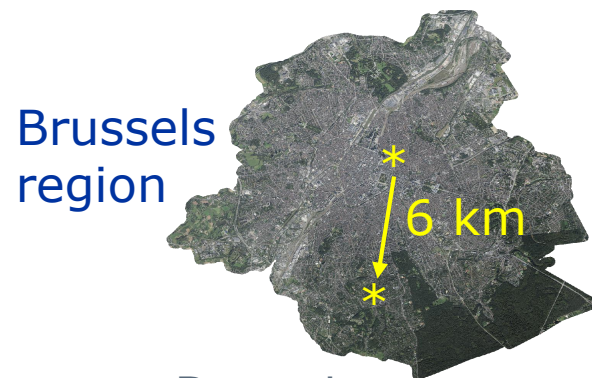
Royal Meteorological Institute

The daily and monthly temperature time series in Brussels–Uccle

Laurent Delobbe, Cedric Bertrand, Mel Brehon,
Romain Ingels and Michel Journée

Royal Meteorological Institute of Belgium

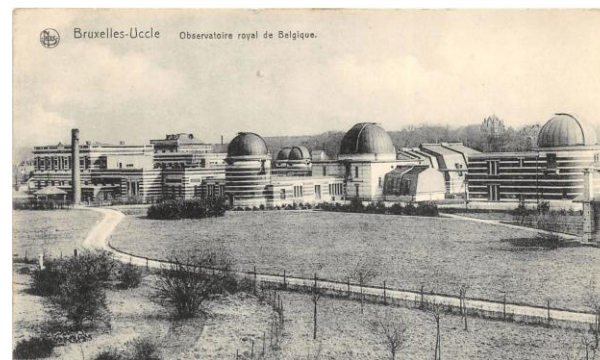Eumetnet DMW 2025 workshop – Oslo – 4-6 Nov. 2025

Temperature observations in Brussels-Uccle

Brussels region

6 km

Brussels Saint-Josse

Uccle

Open shelter

Closed shelter

1833

1890

1983

Outline

1. Construction reference daily temperature series (1890 onwards)

2. Construction reference monthly temperature series (1833 onwards)

3. Comparisons with HOMER homogenized series

4. Comparisons with additional series : ERA5, ERA5-LAND and series from neighbouring countries

5. Climate change indicators
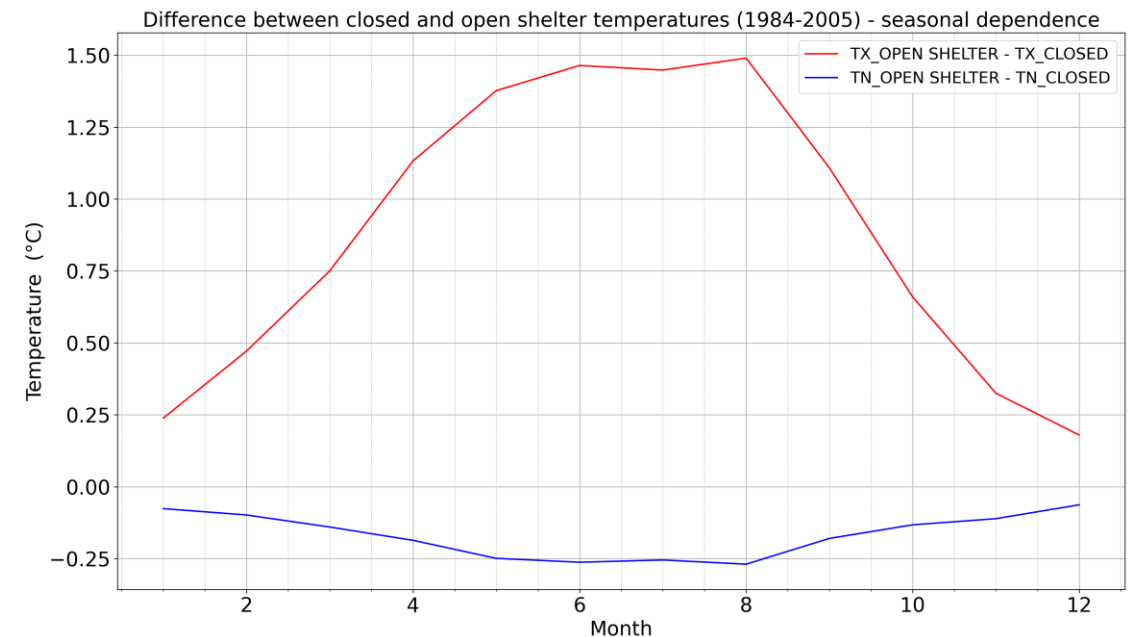
6. Summary and future work

Construction daily 0-24 TN, TM and TX series

- All observations in Uccle

- 0-24 TN and TX available since 1892 (min and max thermometers)

- 0-24 TM available since 1901 (thermohygrograph)

- Open shelter since the beginning

- Closed shelter available since 1983-06

- Parallel observations open/closed shelter :
1984 to 2005


TX : - 0.89

TN : + 0.17

Difference between closed and open shelter temperatures (1984-2005) - seasonal dependence

— TX_OPEN SHELTER - TX_CLOSED
— TN_OPEN SHELTER - TN_CLOSED

Construction daily 0-24 TN, TM and TX series

- Homogenization correction : from open (T^o) to closed shelter (T^c) temperatures using linear regressions

- 80 % training and 20 % verification for selection of regression method and verification

- Seasonal linear regressions (DJF, MMA, JJA, SON)

- Thermal amplitude (TX-TN) used as additional predictor
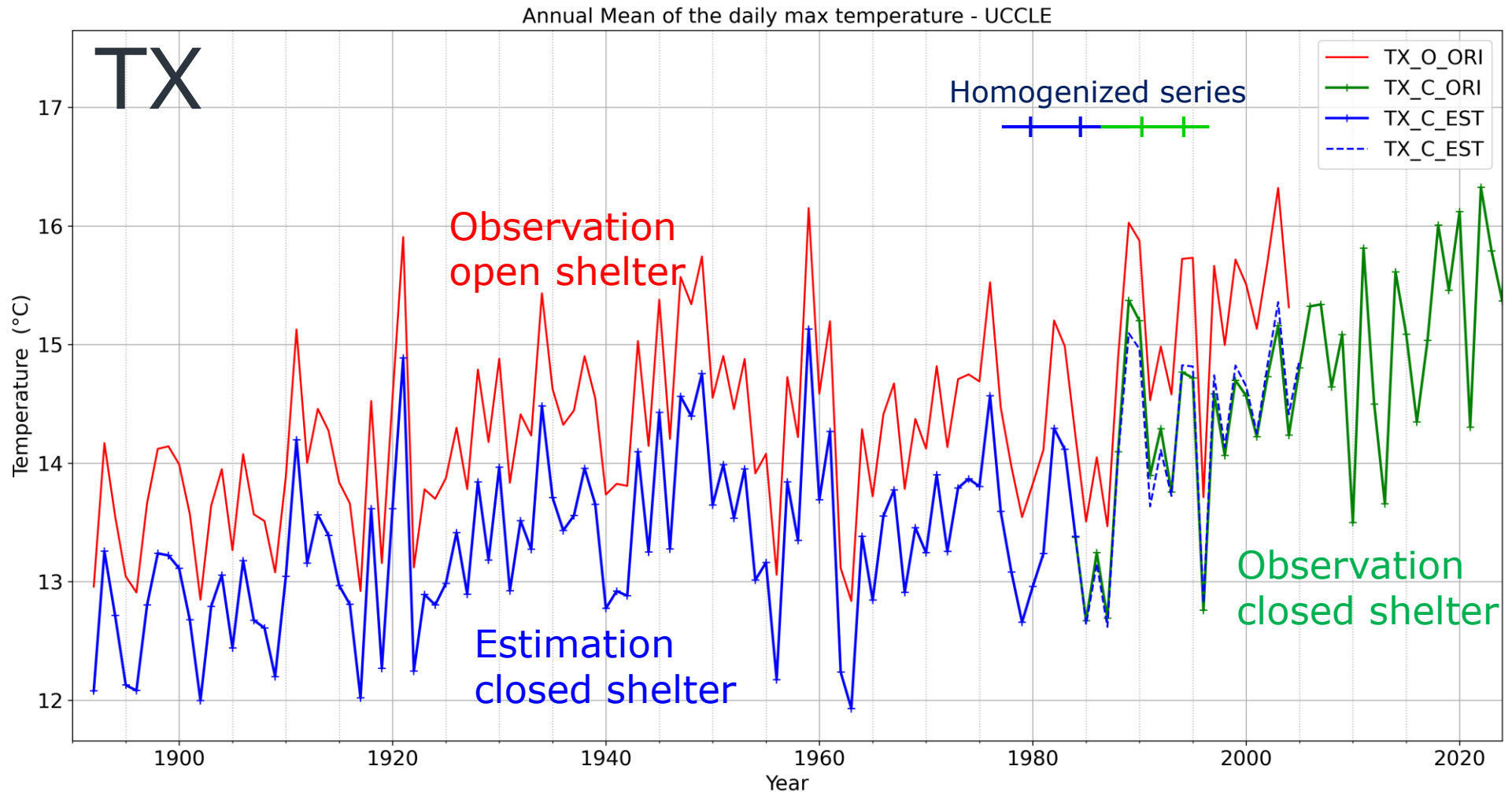
$$TN^c = a_N + b_N \, TN^o + c_N \, (TX^o - TN^o)$$
$$TM^c = a_M + b_M \, TM^o + c_M \, (TX^o - TN^o)$$
$$TX^c = a_X + b_X \, TX^o + c_X \, (TX^o - TN^o)$$

Linear regression: TX_CH_ORI from TX_OH_ORI

TX JJA
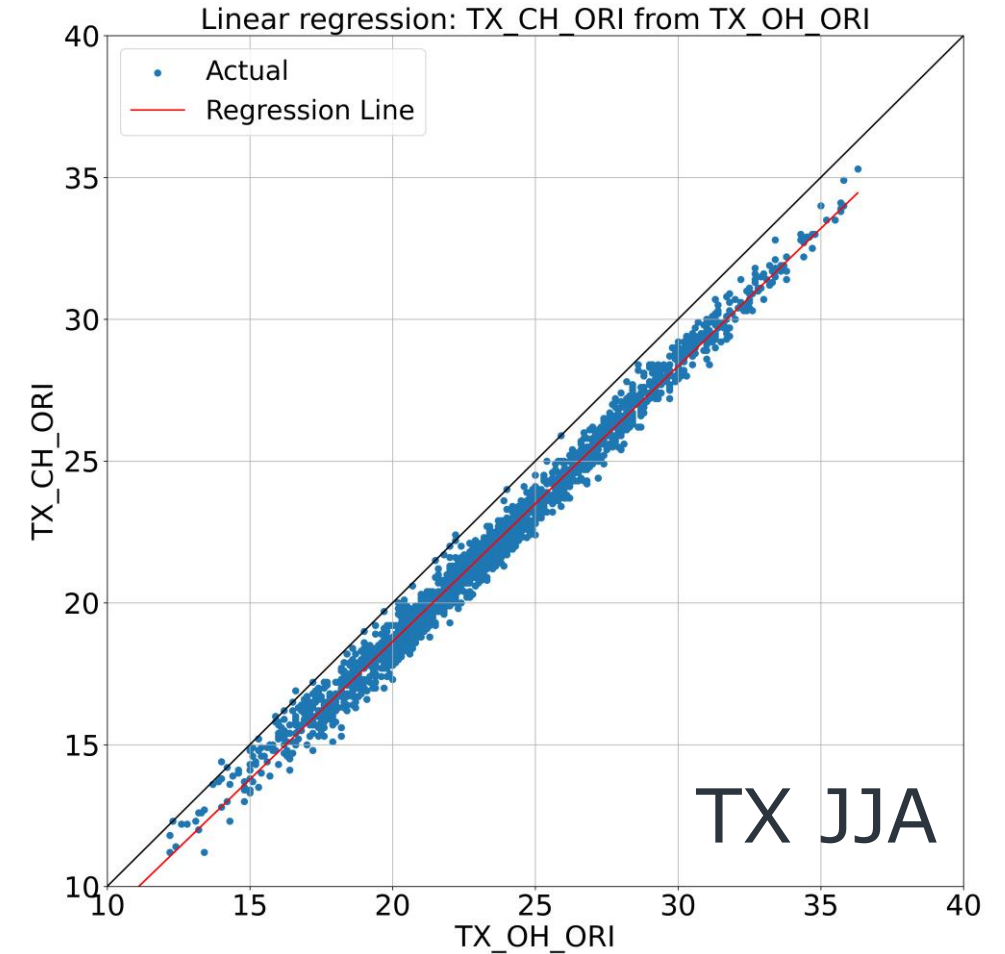
$$TX^c = -0.82 + 1.0057 \; TX^o - 0.074 \, (TX^o - TN^o)$$

Annual Mean of the daily max temperature - UCCLE

Verification of daily series

- Verification of closed shelter estimates using verification dataset (20 % of full dataset : beginning of the overlap period)

- Error on daily values (°C)

	TN	TM	TX
BIAS	0.12	0.05	-0.05
RMSE	0.31	0.24	0.41

Error on monthly means (°C)

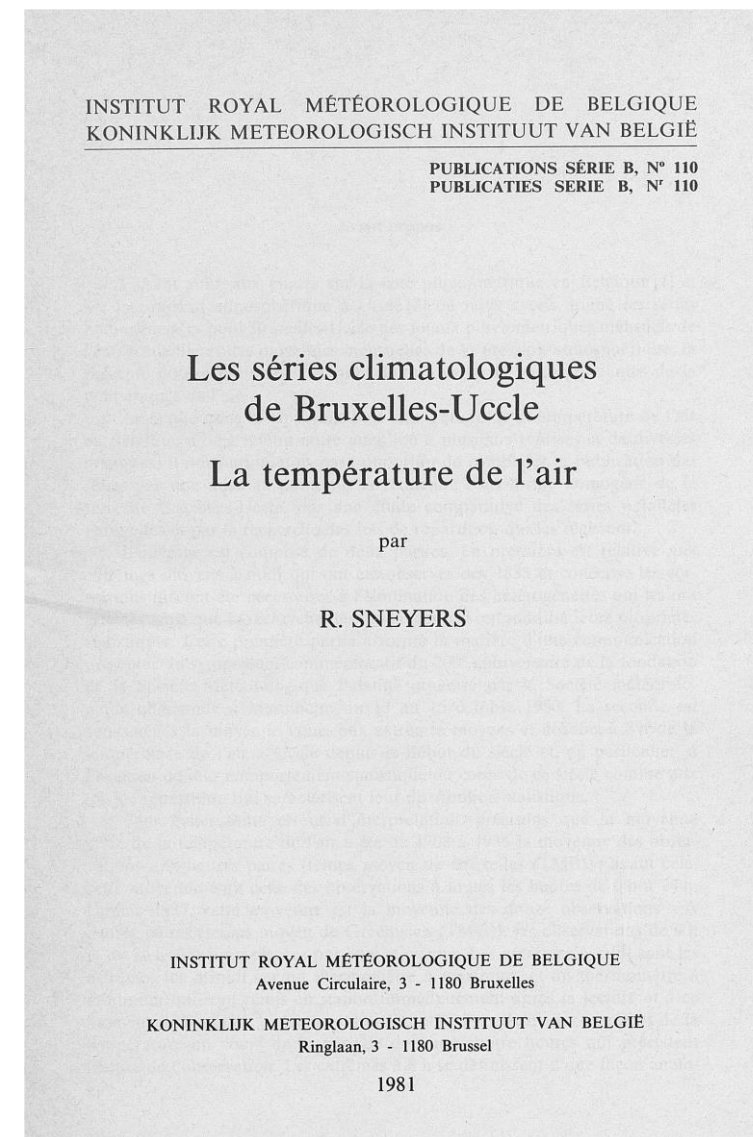|	TN	TM	TX
BIAS	0.12	0.05	-0.05
RMSE	0.16	0.13	0.18

RMSE monthly ≈ RMSE daily / 2

→ Daily errors within a month are not independent
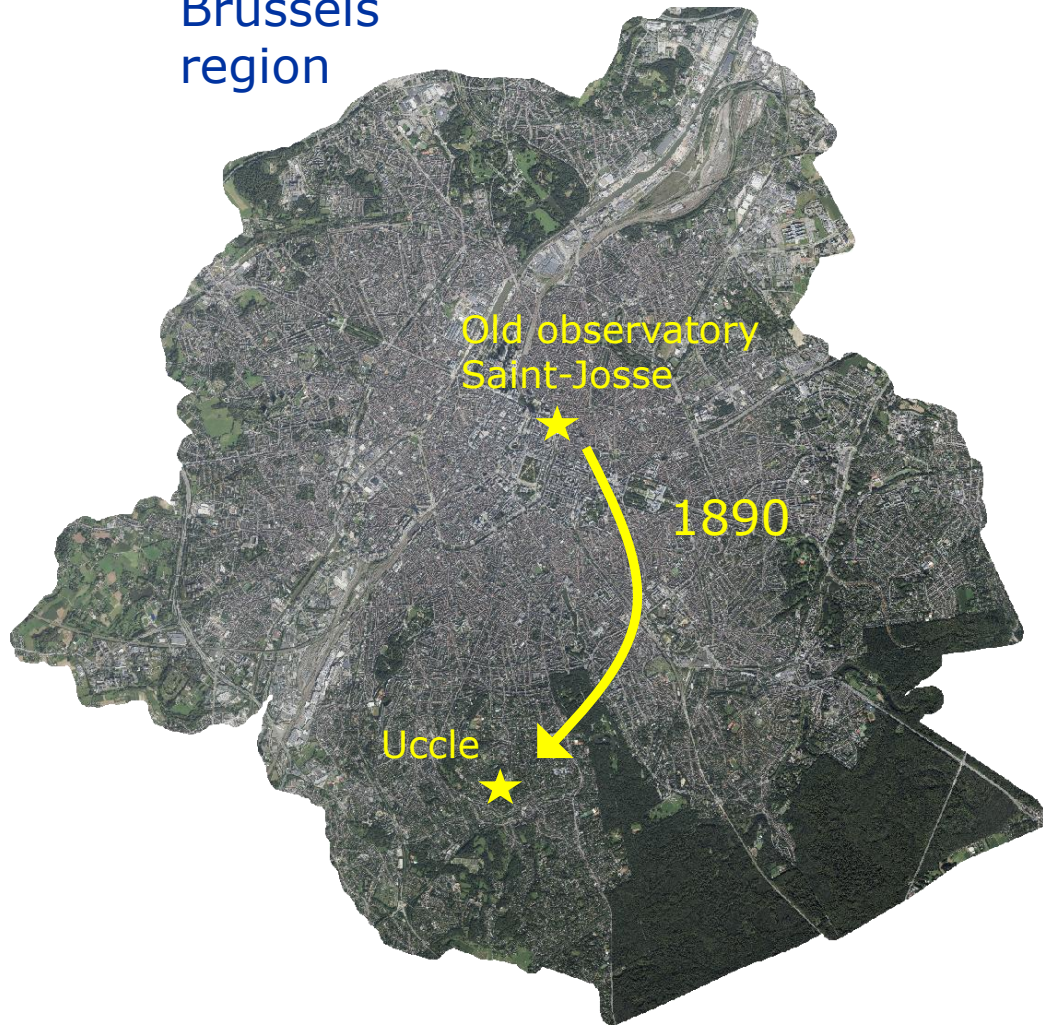(RMSE monthly would be equal to RMSE daily / 5.5   (5.5=sqrt(30))

Construction monthly series 0-24

- Directly derived from 0-24 daily series when available

- Before 1892 for TX and TN and before 1901 for TM:
  use of the monthly homogenized series published by Sneyers in 1981

- Sneyers series :

  - Homogenized monthly series 1833-1979
    of TN and TX 12-12 reduced to Uccle under open shelter
  - TM as (TX+TN)/2
  - Corrections (1) for changing observation times (0-24 → 12-12 during 1878-1886) and
    (2) for the move from Saint-Josse to Uccle

- Overlap between Sneyers series and homogenized daily series :
  - 1890-1979 for TN and TX
  - 1901-1979 for TM

- Merging using same regression methods (seasonal, 2 predictors).

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PUBLICATIONS SÉRIE B, N° 110
PUBLICATIES SERIE B, N' 110

Les séries climatologiques
de Bruxelles-Uccle

La température de l'air

par

R. SNEYERS

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1981

Move observatory to new location in Uccle

Brussels region

Old observatory Saint-Josse
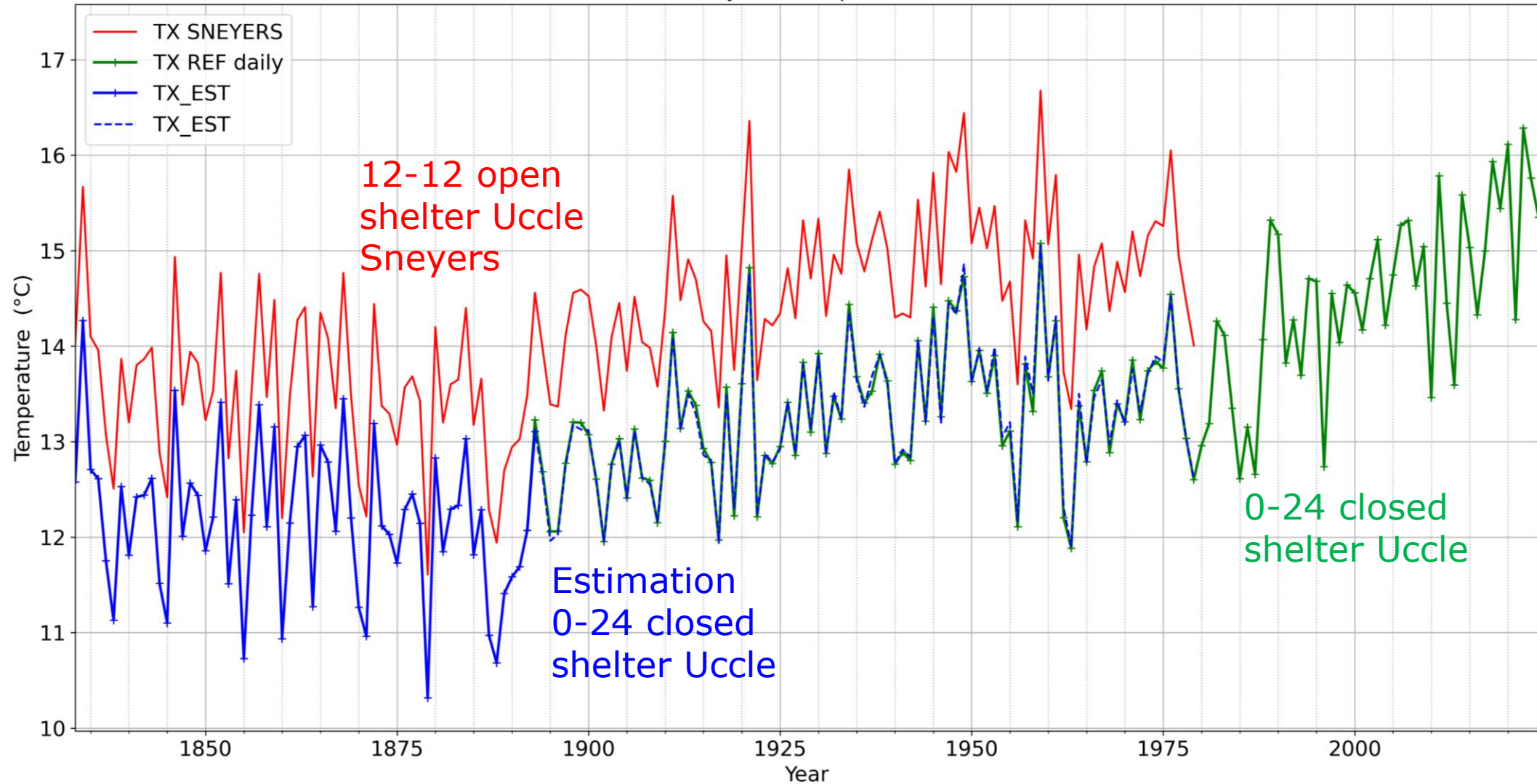
1890

Uccle

- From Saint-Josse to Uccle, distance : 6 km

- Altitude : 56 m → 100 m

- Parallel observations 1886-1891

- Impact on temperature:
  TM : - 0.7, TN: -1.03, TX: -0.35

- Monthly corrections applied for estimating Uccle TN/TX from Saint-Josse observations. TN and TX corrections approximated by 1st harmonics and first 2 harmonics, respectively

Monthly mean of the daily min and max temperatures - DIFF ST-JOSSE-UCCLE

RMSE : 0.25

RMSE : 0.23

TN ST-JOSSE - TN UCCLE
TN Correction Sneyers
TX ST-JOSSE - TX UCCLE
TX Correction Sneyers
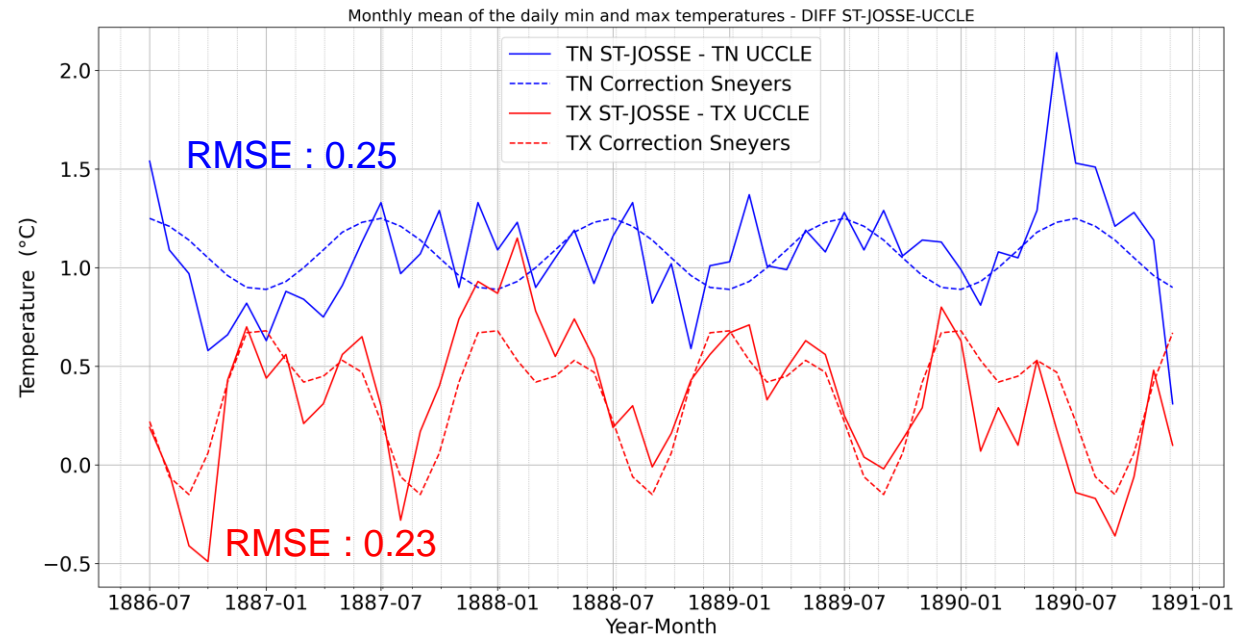
Final monthly series

Annual Mean of the daily max temperature - BRUSSELS-UCCLE

12-12 open shelter Uccle Sneyers

Estimation 0-24 closed shelter Uccle

0-24 closed shelter Uccle

Error merging : RMSE = 0.29 for TX, 0.19 for TM and 0.15 for TN

- Homogenization of 61 monthly TN and TX 8-8 series (Delvaux et al. 2019). Recently updated.

  - 16 beginning before 1930

  - 8 beginning in 1880 including Brussels-Uccle

  - For Uccle, only manual observations

  Presented yesterday by Mel Brehon

- HOMER Software (Mestre et al. 2013) + semi-automization features taken from BART (Joelsson et al., 2021)

- Identification and correction of homogeneity breaks based on comparison with neighbouring stations

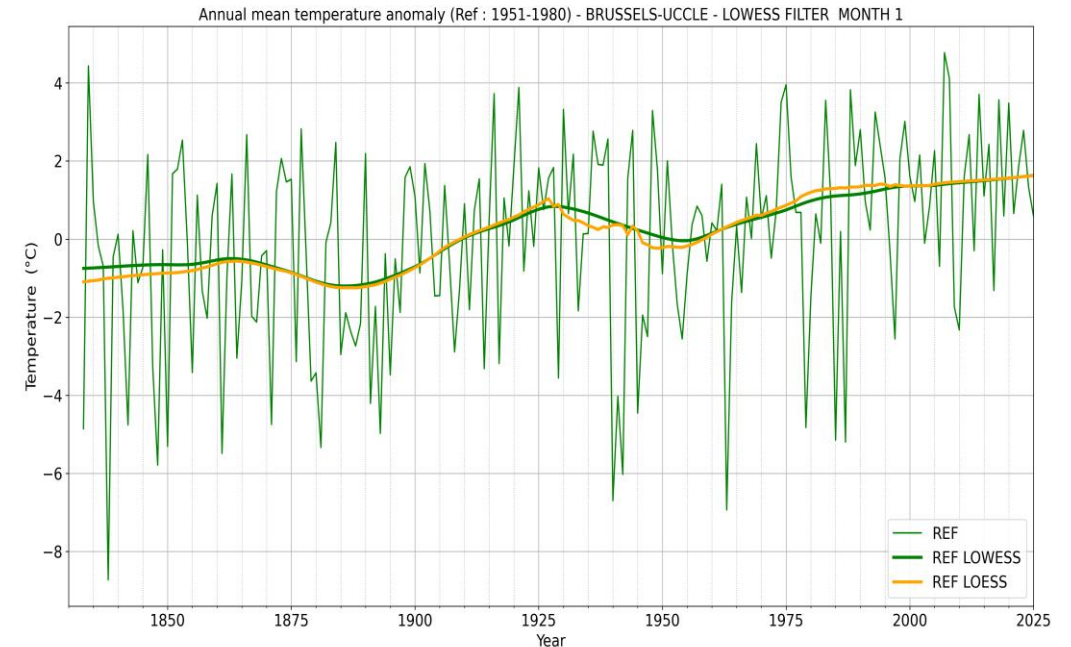- Parallel observations (Saint-Josse // Uccle, open // closed shelters) not exploited
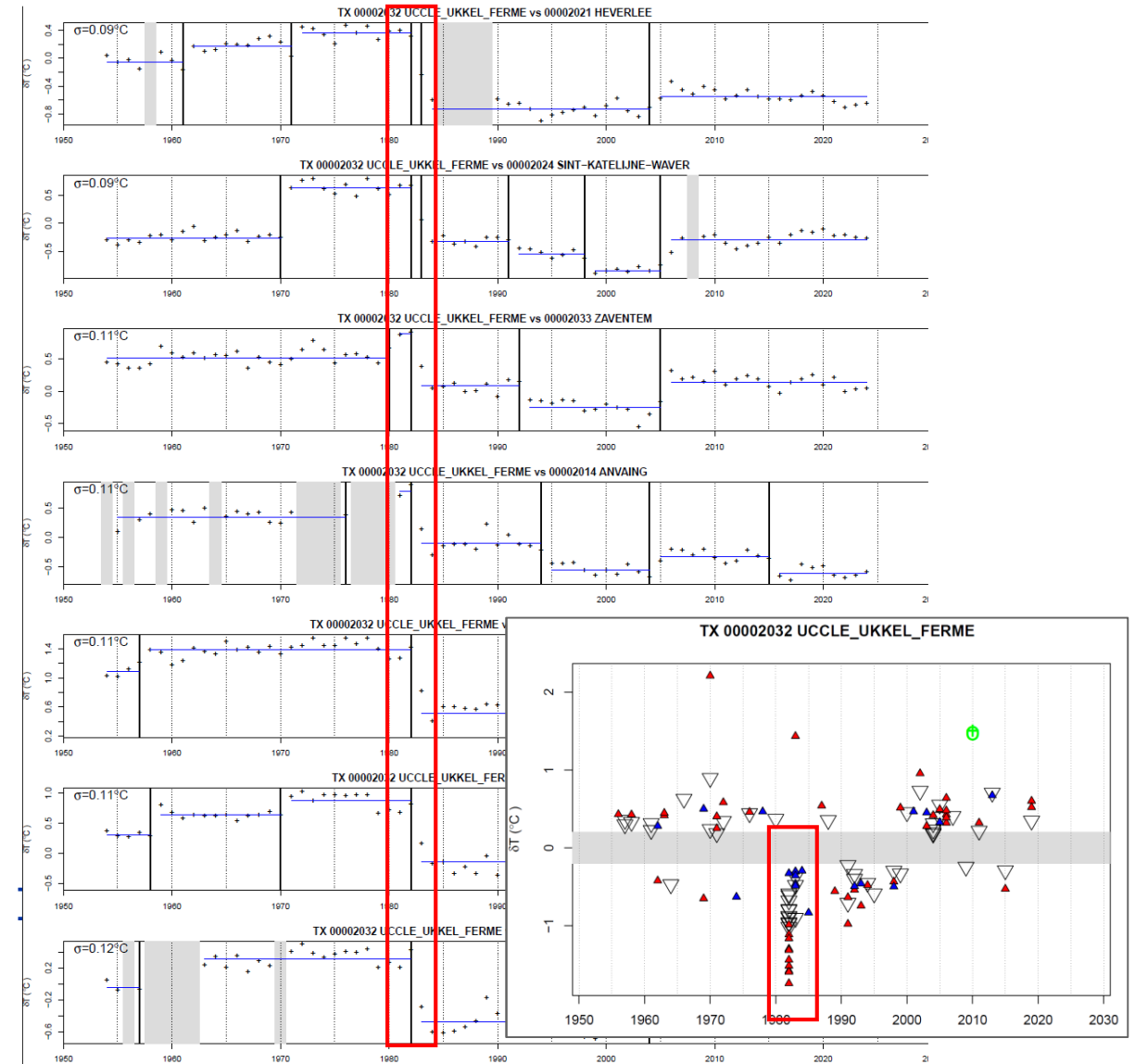
Open to closed shelter

Comparison REF-HOMER TN

Annual Mean of the daily min temperature - BRUSSELS-UCCLE
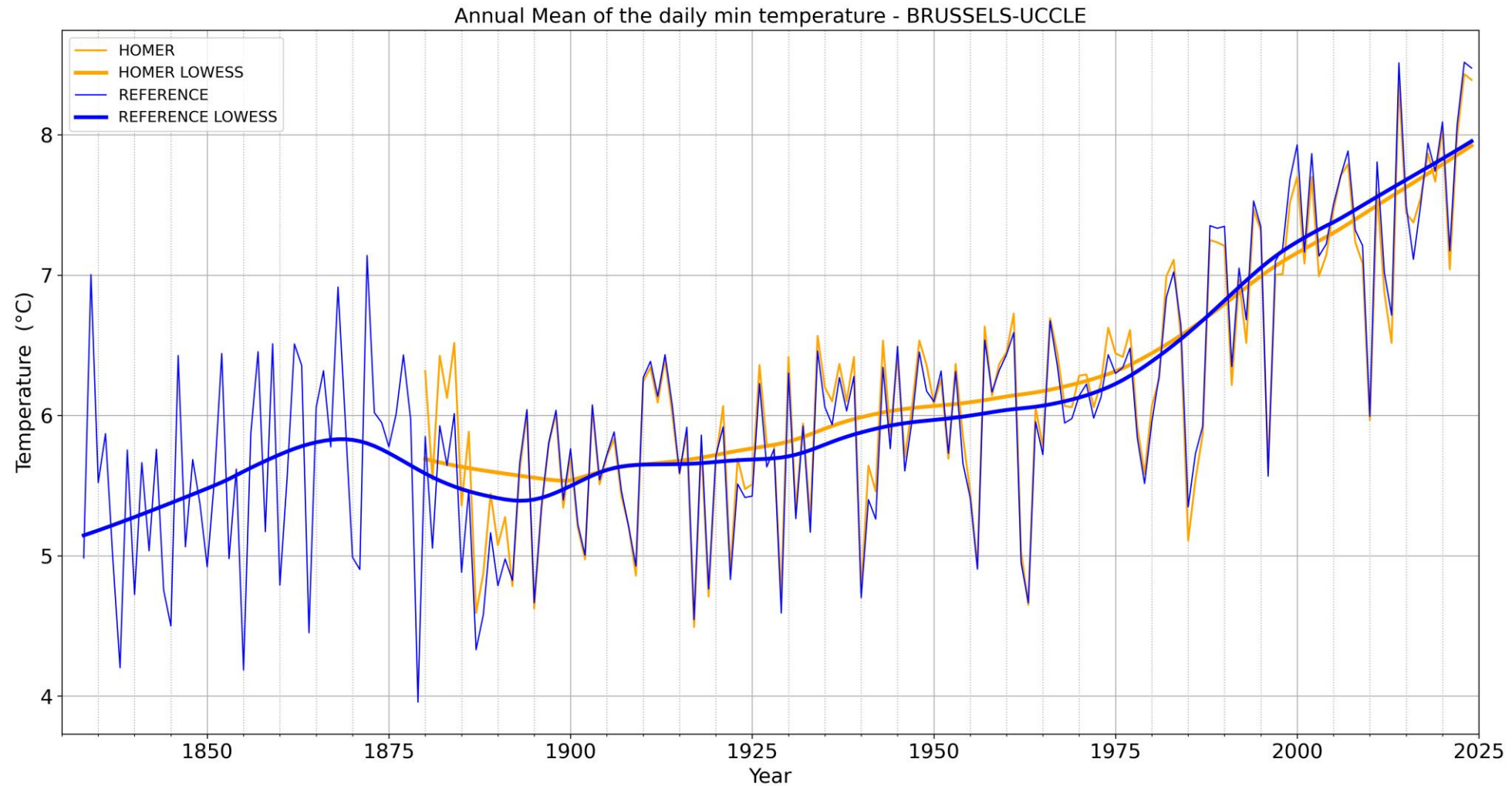
On the LOWESS/LOESS filter

- Non-parametric locally weighted linear regression used by several NMS for evaluating trends and current climate mean (CCM)

- Harmonization of trends and CCM estimation methods

- Assessment of various approaches by Scherrer et al. (2024) shows that 1st order LOESS with 42-year smoothing window performs best as CCM estimator (LO42; de Valk, 2020)

- Here LOWESS (locally weighted scatterplot smoothing): similar to 1st order LOESS (locally estimated scatterplot smoothing)

- Python implementation of LOWESS/LOESS :

  - LOWESS : statsmodels nonparametric.lowess
  - LOESS : loess.loess_1d
  - does not give exactly the same results as LOESS 1D with same 42 years window.
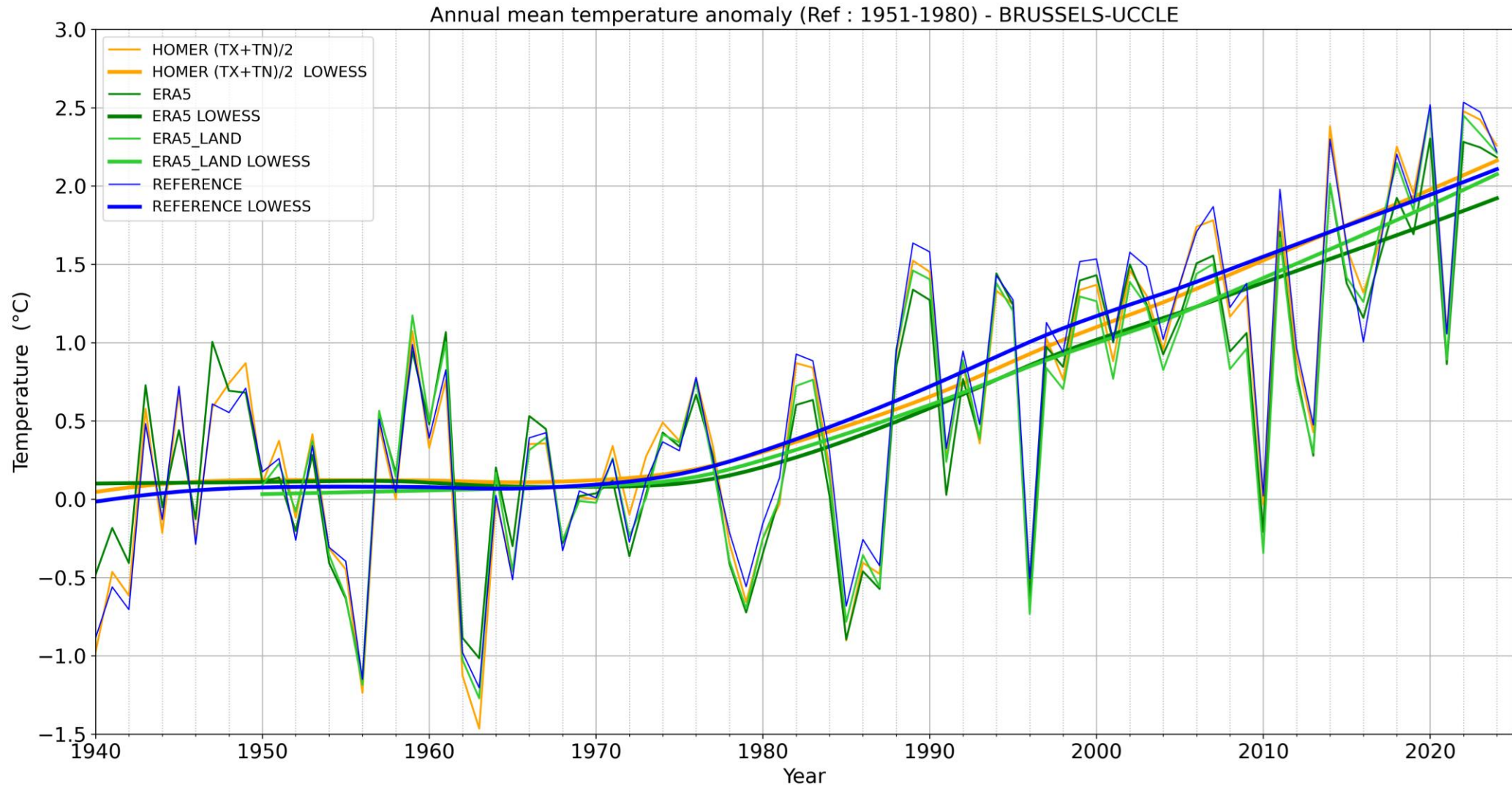

Annual mean temperature anomaly (Ref : 1951-1980) - BRUSSELS-UCCLE - LOWESS FILTER MONTH 1

Additional series

ECWMF ERA5 and ERA5-LAND reanalysis

- Monthly mean temperatures at Uccle nearest grid point

- **ERA5** : fifth generation ECMWF global reanalysis at 0.25 deg. resolution , available **from 1940**

- **ERA-5 LAND** : land component of ERA5 replayed at enhanced resolution (0.1 deg.), available **from 1950**

- Spatial resolution around Brussels:

    - ERA5 (0.25 deg.) :   17.5 km x 27.5 km
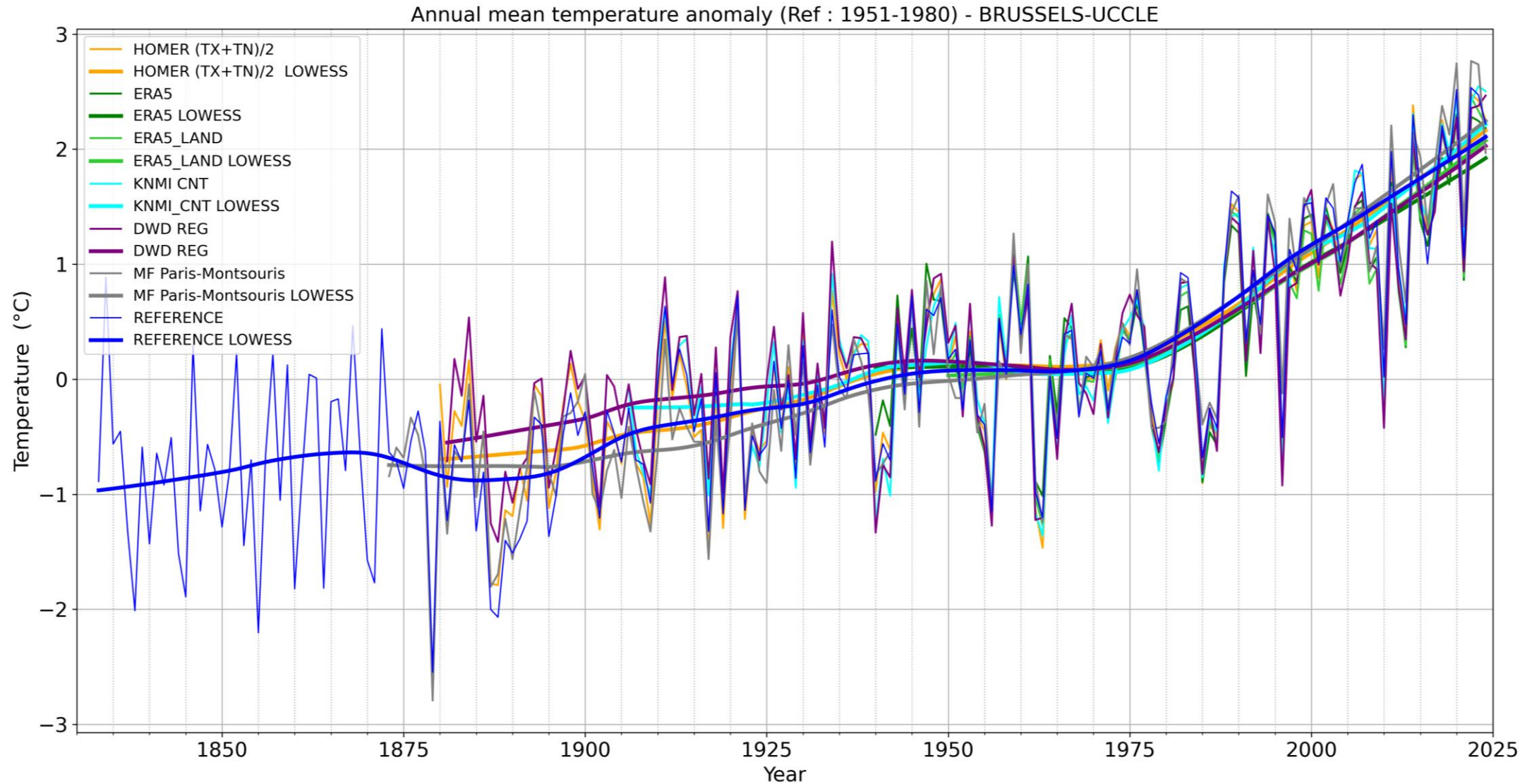   - ERA5-LAND (0.1 deg.) :   7 km x 11 km

Observational series from neighbouring countries

- **METEO-FRANCE** Paris-Montsouris : yearly mean temperature available **from 1873** onwards. New reconstruction is in progress at Météo-France (O. Mestre).

- **DWD** regional series for North Rhine-Westphalia: annual series of mean temperature available **from 1881** onward

- **KNMI** Central Netherlands Temperature series : monthly series of mean temperature available **from 1906** onwards
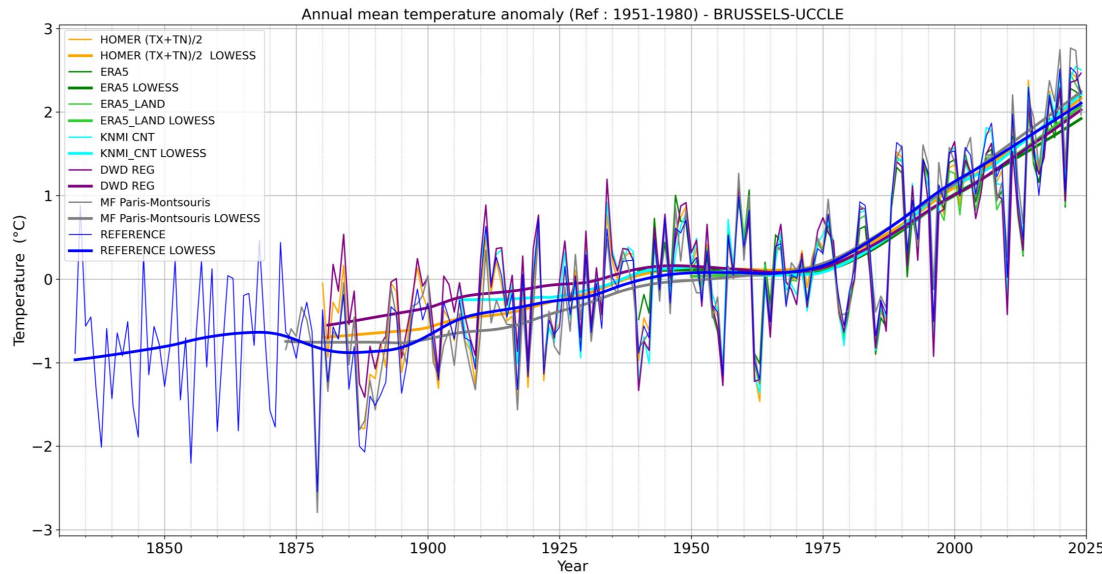
Annual mean temperature anomaly (Ref : 1951-1980) - BRUSSELS-UCCLE

Annual mean temperature anomaly (Ref : 1951-1980) - BRUSSELS-UCCLE

Annual mean temperature anomaly (Ref : 1951-1980) - BRUSSELS-UCCLE

Mean climate for a given year as centered 30-yrs average

- TM(1900) = Mean TM (1886-1915) from unfiltered series

- TM(1965) = Mean TM (1951-1980) from unfiltered series

- TM(2024) = TM in 2024 from LOWESS filtered series

- TREND 1980-2024 (A)/(B) = slope (°C/10yrs) based on unfiltered/filtered series

	TM(2024)-TM(1900)	TM(2024)-TM(1965)	TREND 1980-2024 (A)	TREND 1980-2024 (B)
REF UCCLE	2.80	2.11	0.42	0.41
HOMER UCCLE	2.76	2.16	0.46	0.43
ERA5 UCCLE	NaN	1.92	0.43	0.39
ERA5-LAND UCCLE	NaN	2.08	0.43	0.41
DWD North Rhine-Westphalia	2.38	2.03	0.43	0.40
KNMI Central Netherlands	2.38	2.22	0.46	0.45
FR Paris-Montsouris	2.98	2.25	0.46	0.44

- Production of daily and monthly reference series for use in climate studies

- Comparison with other series

- Uncertainties identified and quantified, when possible

- Further work

  - Verification will be improved :
    - 20% verification followed by 80 % training → leave-one-out cross-validation (one year out)
    - Combine error estimates from successive homogeneity corrections
  - Further analysis of 1875-1900 period
  - Extension of daily series back to 1833
  - Comparisons with daily ERA5/ERA5-LAND and daily series from neighbouring countries
  - Climate indicators based on daily values

Annual TN/TM/TX temperatures - BRUSSELS-UCCLE
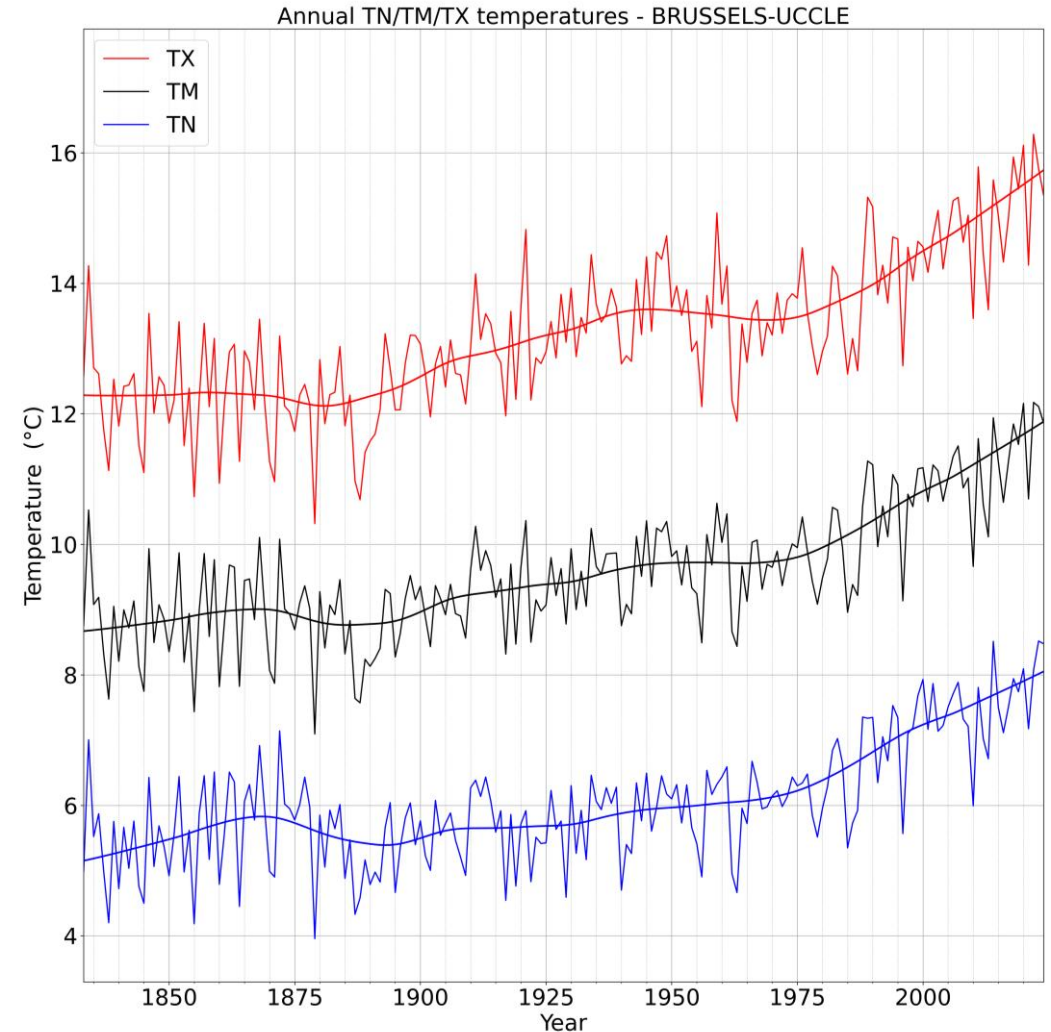
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