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Comparison of different daily adjustment methods for the maximum and minimum temperature in Israel

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The study goals

1) Exploring the characteristic of some daily adjustment methods when applying them to real records.

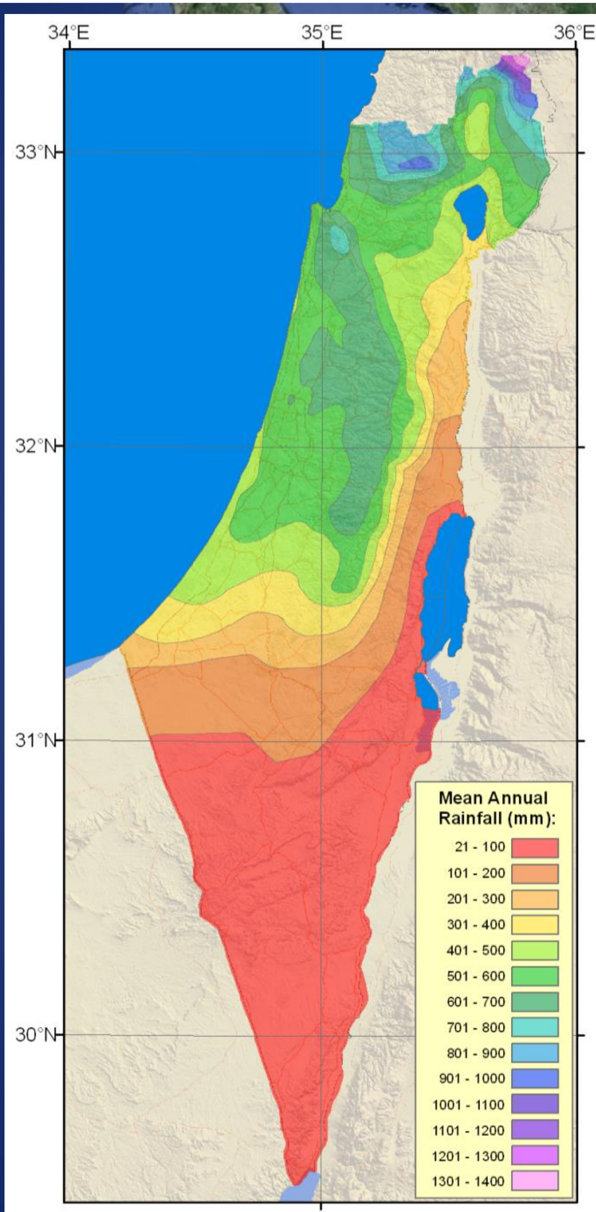
2) Learning on the way each method influencing the trend on some selected extreme indices (ETCCDI).

Outlines

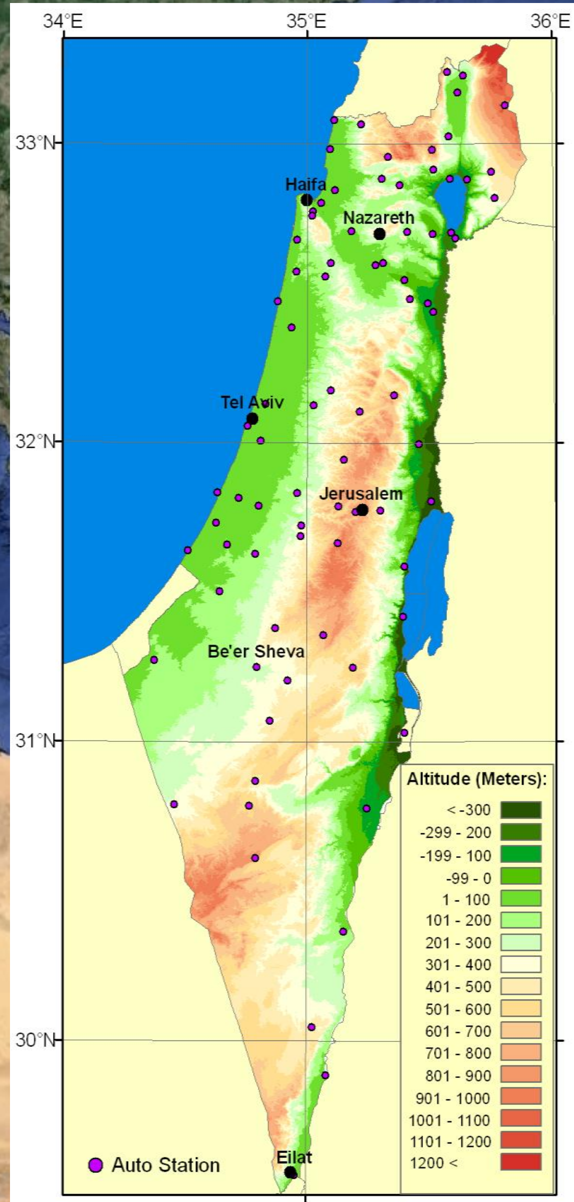
1) **Israel location, climatology and monitoring**
2) **Methodology**
   - Monthly optimal break-point detection – integrated model
   - Daily adjustments – major approaches
   - Extreme indices
3) **Results**
   - The characteristics of the different methods
   - Extreme indices – trend analysis
4) **Summary and conclusions**

Israel location, climatology and monitoring

Mean annual precipitation 1981-2010



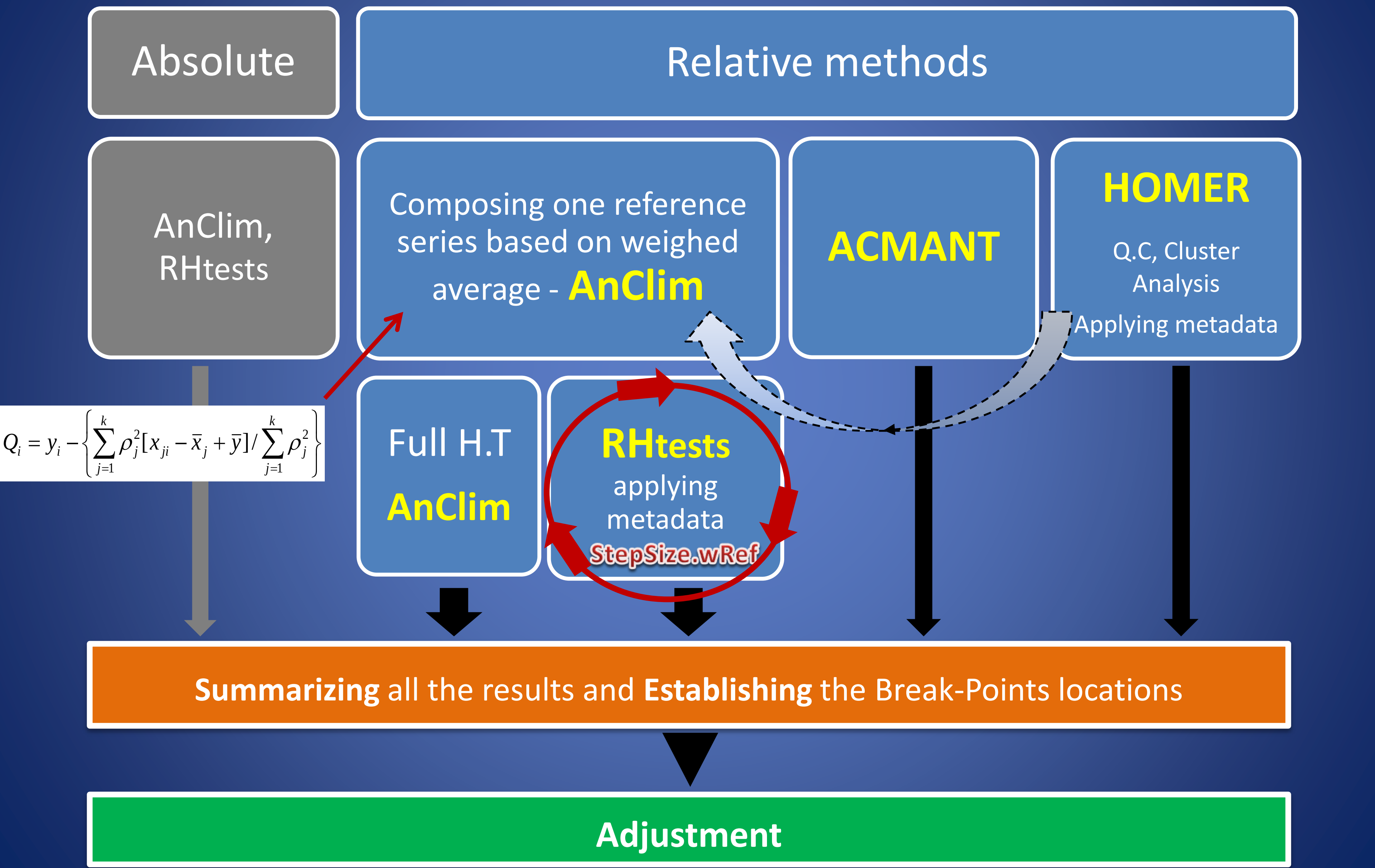
Distribution of AWS

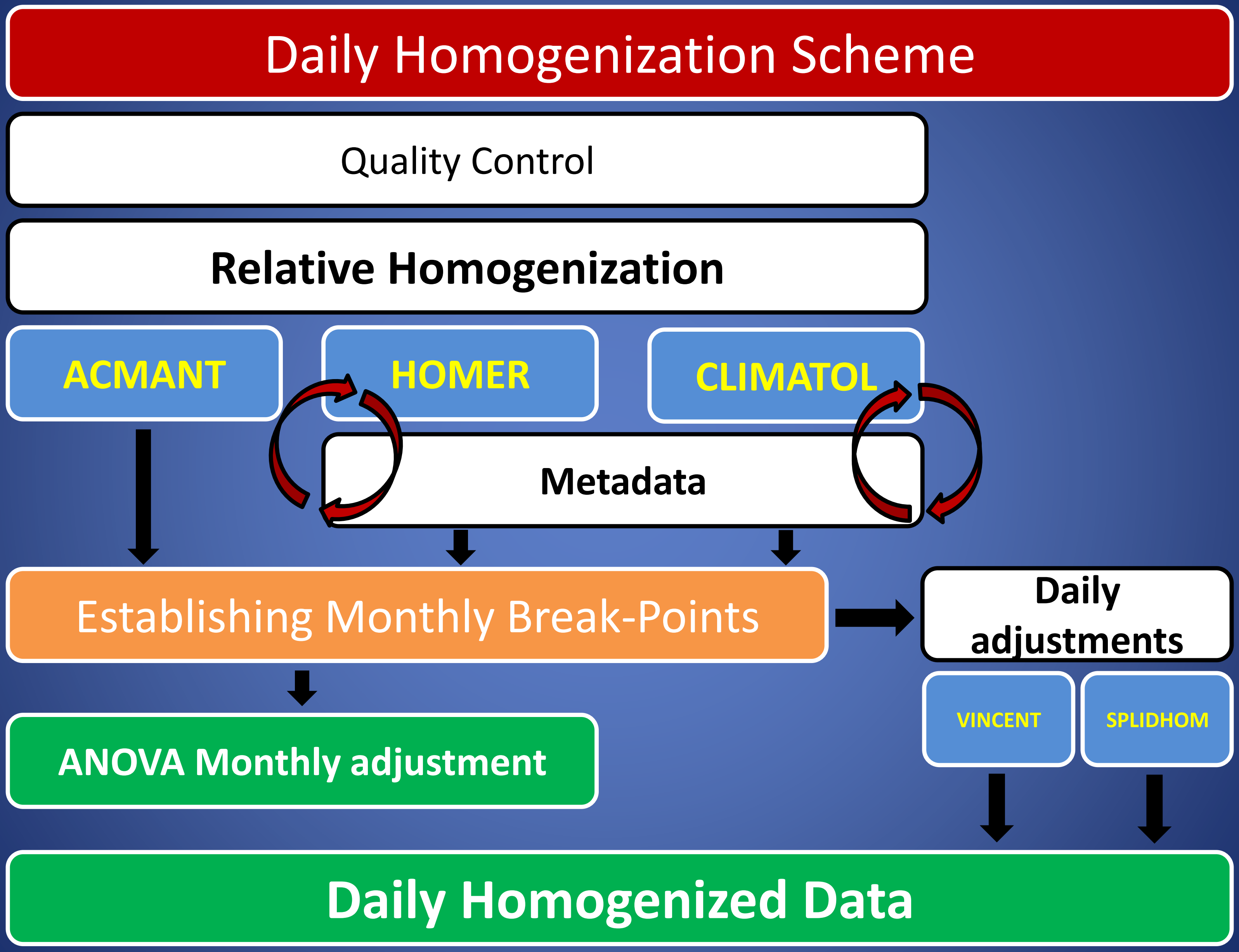


Methodology

1. **Break-point detections on monthly scale:** A number of different homogeneity tests were applied into an integrated model. This model involves several iterations where the use of metadata is essential. This thorough procedure allows obtaining optimal break-point detection and thus achieving a better-quality time series.
2. **Applying different daily adjustment methods** to the raw data based on the monthly detected breaks.
3. **Analyzing the difference** between the homogenized and the raw data for each method. $\Delta T = T_{adjusted} - T_{raw}$ *(for each day)*
4. **Extreme indices calculation and trends comparisons**, Raw vs. Homogeneous.

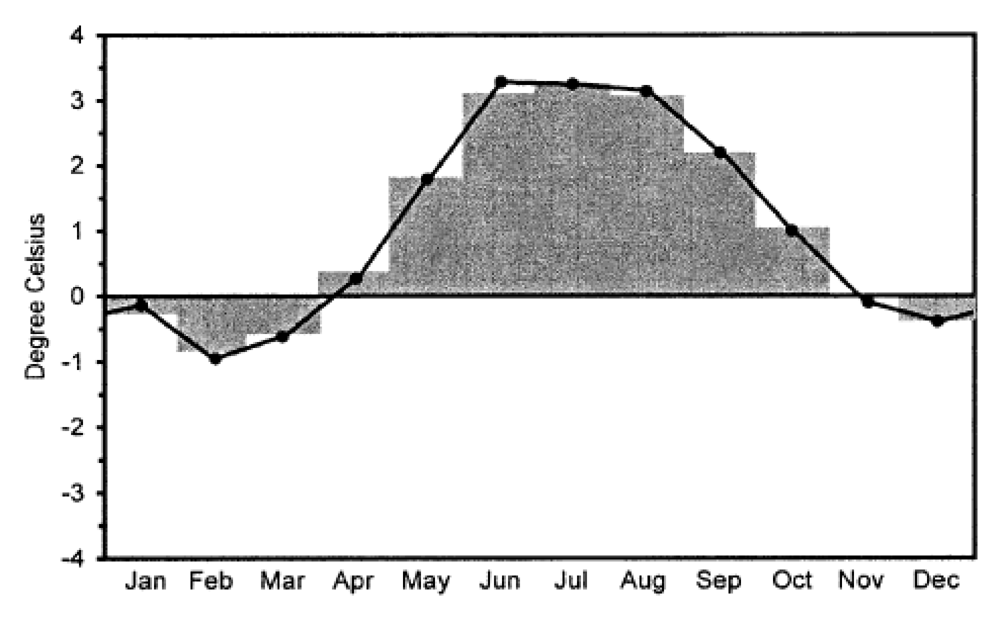
An Integrated Homogenization Model




Daily Homogenization Scheme
Quality Control
Relative Homogenization
ACMANT
HOMER
CLIMATOL
Metadata
Establishing Monthly Break-Points
Daily adjustments
VINCENT
SPLIDHOM
ANOVA Monthly adjustment
Daily Homogenized Data

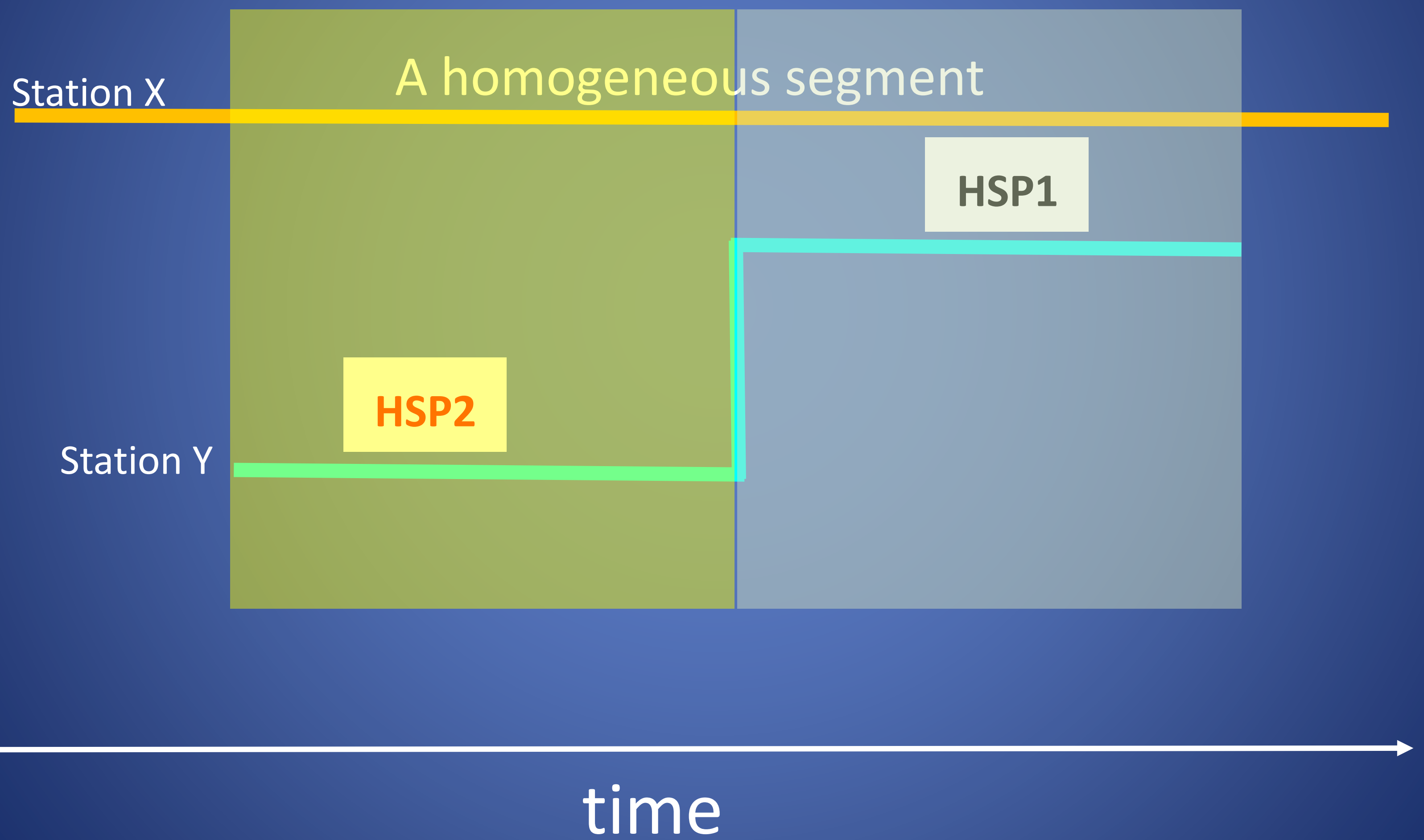
Daily adjustments major approaches

- Linear interpolation (from monthly correction factors to the daily): **Vincent, ACMANT**



Vincent, L. A., Zhang, X., Bonsal, B. R., and Hogg, W. D. (2002). Homogenization of daily temperatures over Canada. *Journal of Climate*, *15*(11), 1322-1334.

Homogeneous sub period (HSP)

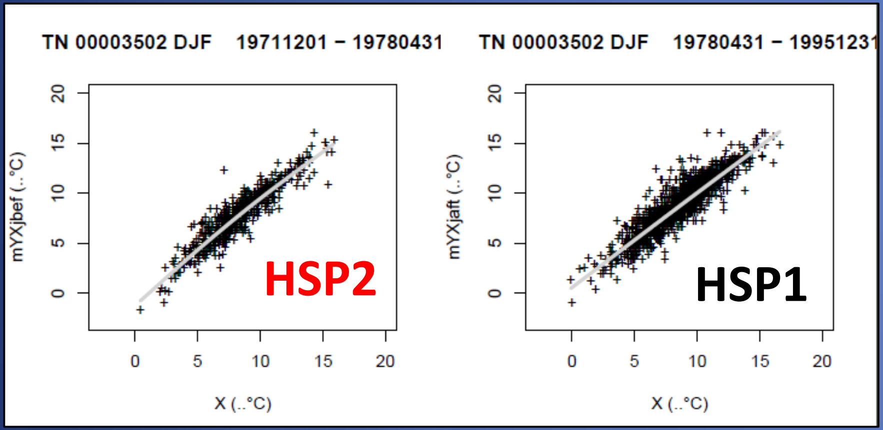


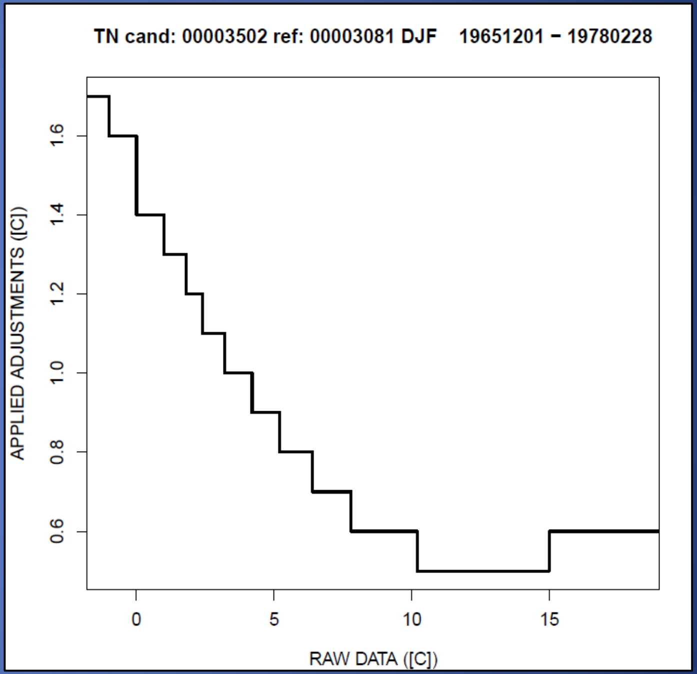
Daily adjustments major approaches

- Indirect nonlinear regression functions estimates by cubic smoothing splines:

SPLIDHOM

Before After



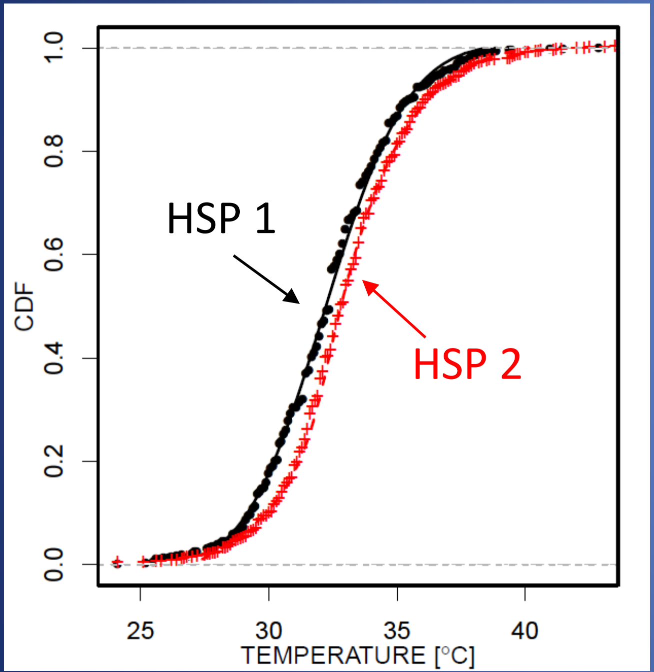


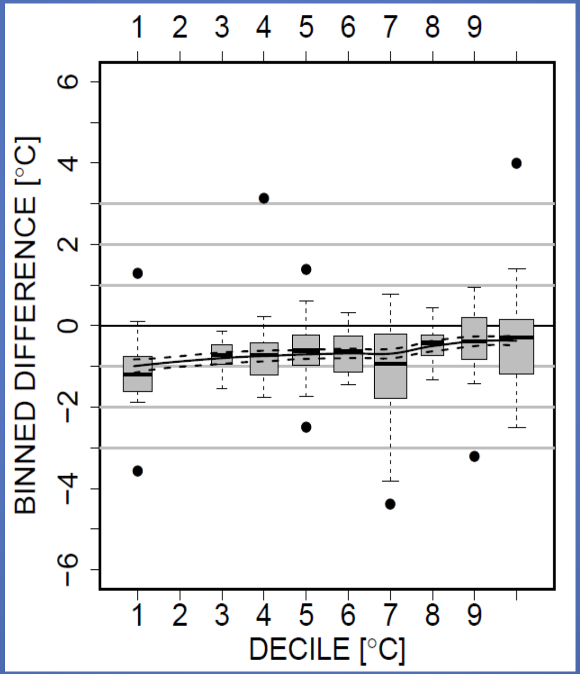
NEGBA station, TN, DJF, break-point 04/1978

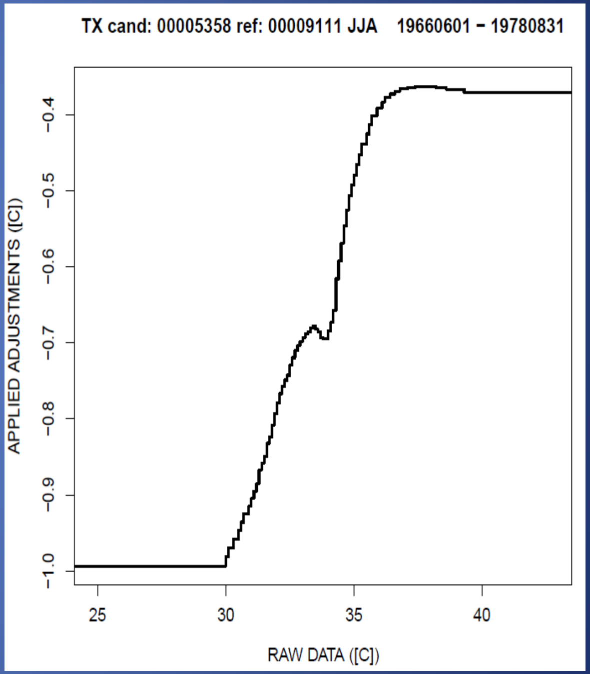
Mestre, O., Gruber, C., Prieur, C., Caussinus, H., and Jourdain, S. (2011). SPLIDHOM: A method for homogenization of daily temperature observations. *Journal of Applied Meteorology and Climatology*, *50*(11), 2343-2358.

Daily adjustments major approaches

- Cumulative distribution function value (decile) : **HOM**





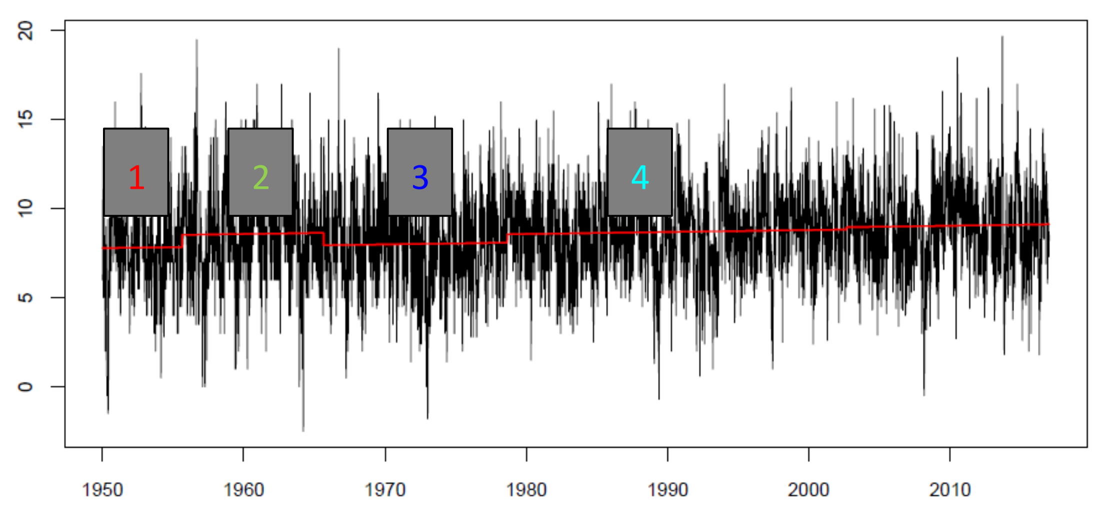


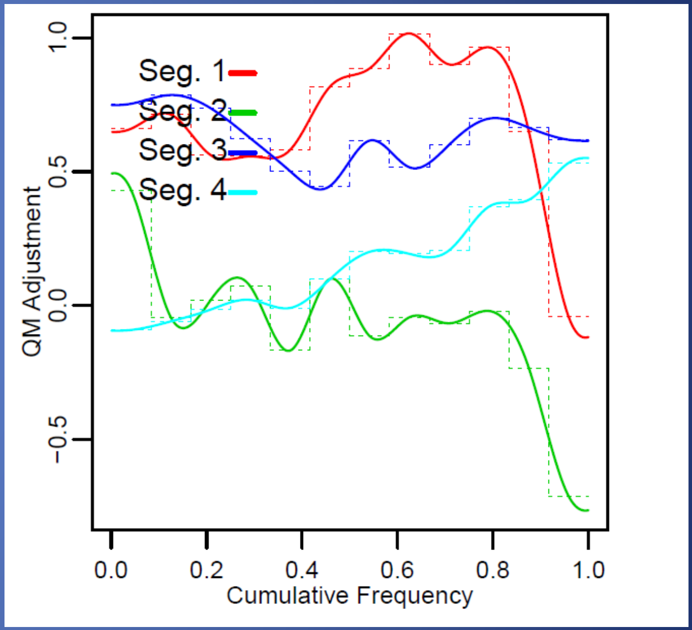
TAVOR station, TX, JJA, break-point 12/1978

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

Daily adjustments major approaches

- Probability distribution function value (quantile) : **Quantile Matching**



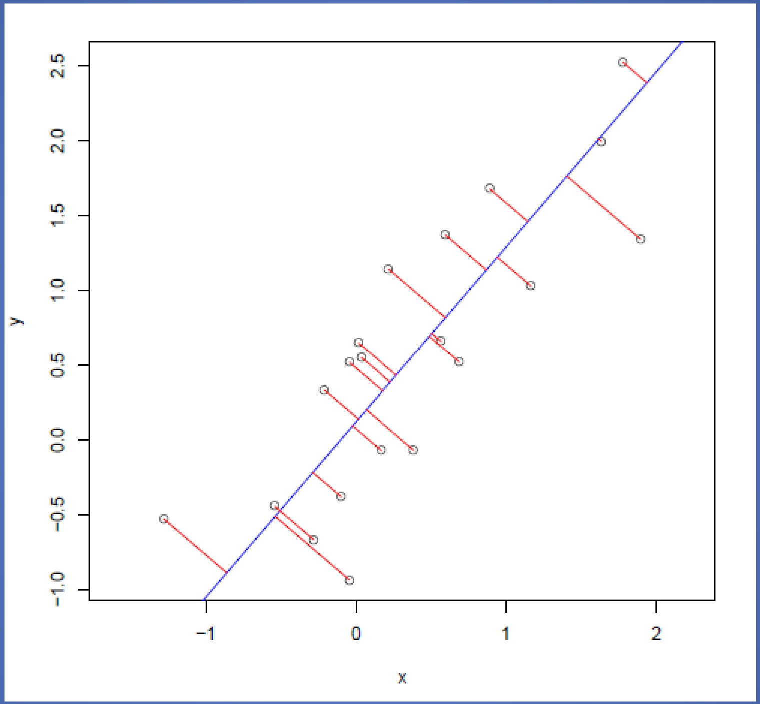


NEGBA station, TN, DJF, 1950-2016

Wang, X. L., H. Chen, Y. Wu, Y. Feng, and Q. Pu, 2010: New techniques for the detection and adjustment of shifts in daily precipitation data series. J. Appl. Meteor. Climatol., 49, 2416–2436.

Daily adjustment technique

- RMA – Reduced Major Axis (Leduc, 1987): **CLIMATOL**



Orthogonal Regression (type II regression)

Guijarro, J. A., 2014: User’s guide to climatol. An R contributed package for homogenization of climatological series. State Meteorological Agency (AEMET), Balearic Islands Office, Spain.

The daily adjustments methods

1. HOM (hom): Della-Marta and Wanner, 2006.
2. SPLIDHOM (spl): Mestre *et al.,* 2011.
3. ACMANT3(acm): Domonkos, 2016.
4. VINCENT (vin): Vincent *et al.,* 2002.
5. CLIMATOL (cli): Guijarro, 2017.
6. Quantile Matching (qm): Wang *et al.,* 2010.
7. Mean adjustments (RH_mean): RHtestV4, Wang & Feng 2013.
8. QM in absolute mode with seasonal trends and distributions (ABS_QM_s): Wang et al., 2010.

Results

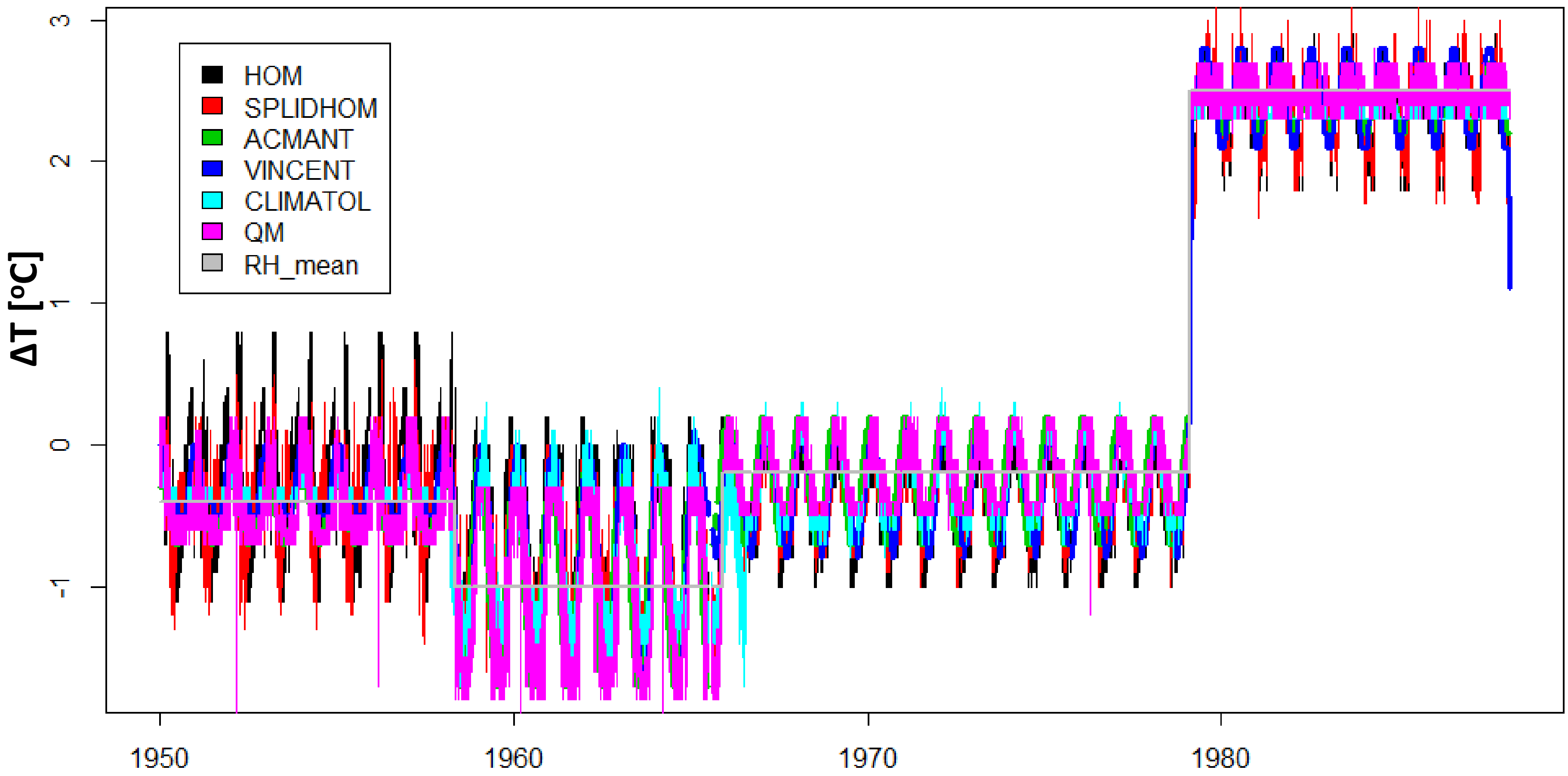
1) The characteristics of the daily adjustments methods, analyzing $\Delta T = T_{adjusted} - T_{raw}$ for:

– TAVOR station, daily TX, 1950-1987 and 1950-1957.

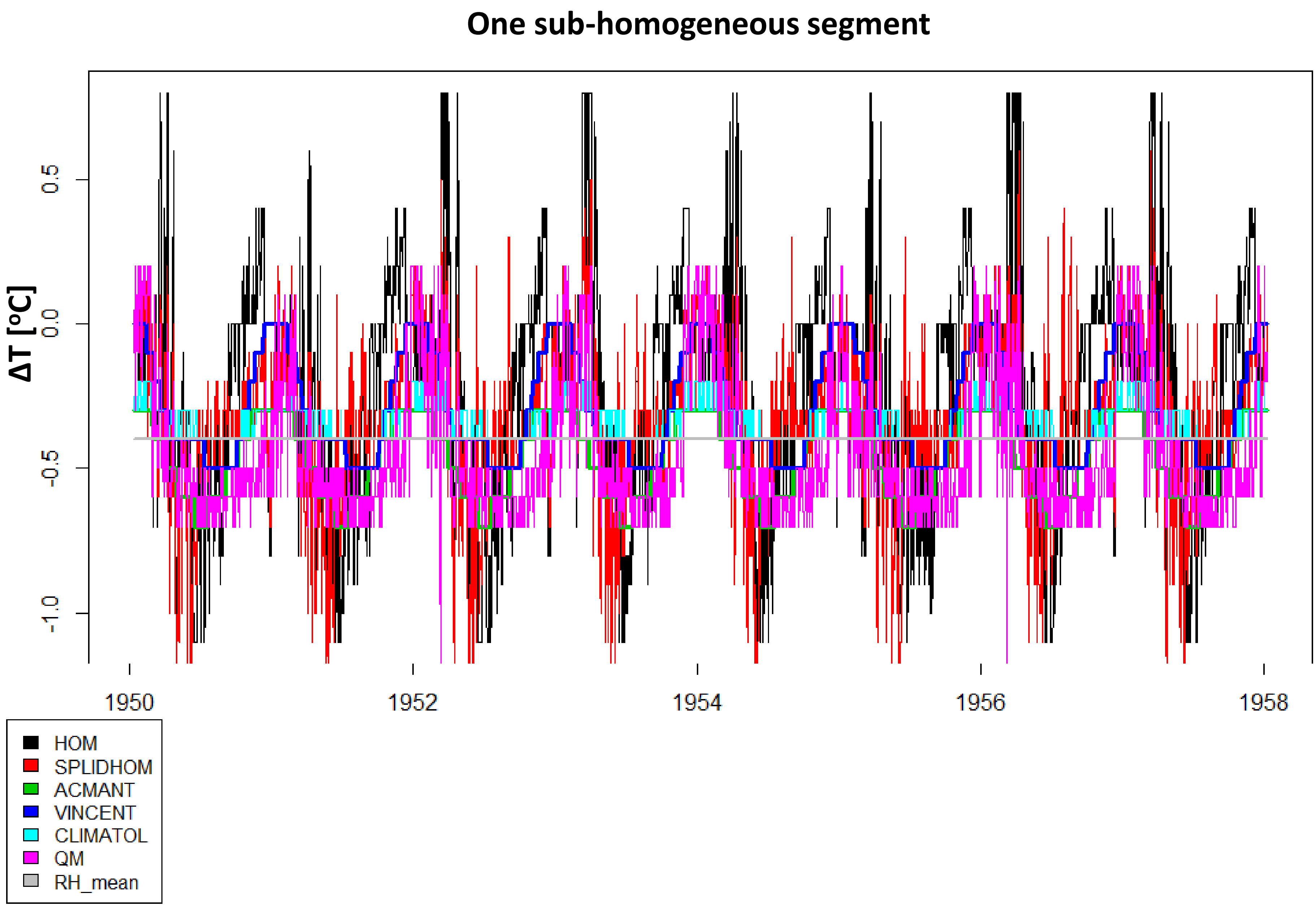
– NEGBA station, daily TN, 1950-2016, and 1956-1964.

The detected break-points for those stations were in agreement for (almost) all of the methods.

TAVOR, TX, 1950-1987, 4 BP

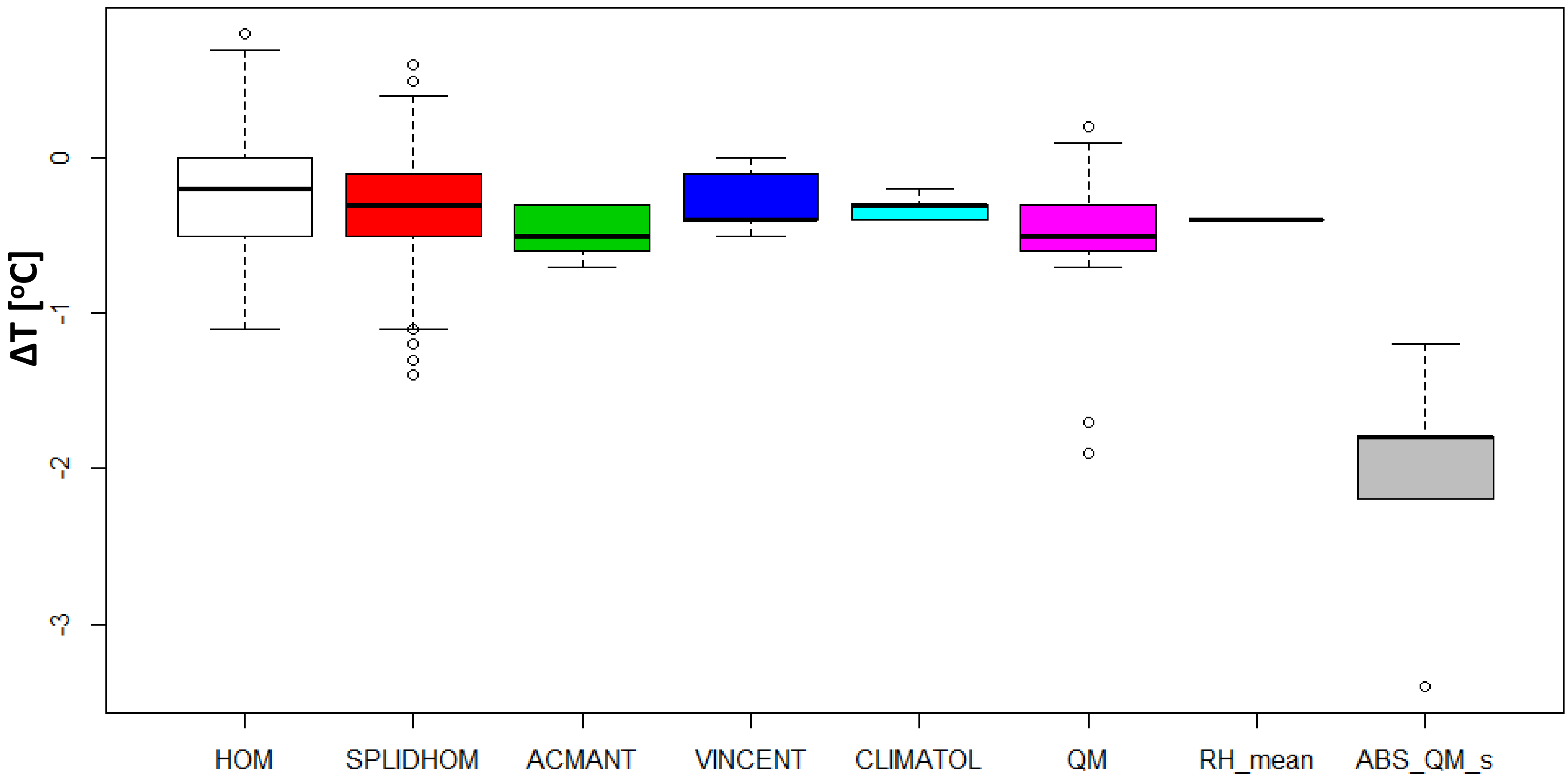


TAVOR, TX, 01/01/**1950**-31/12/**1957**

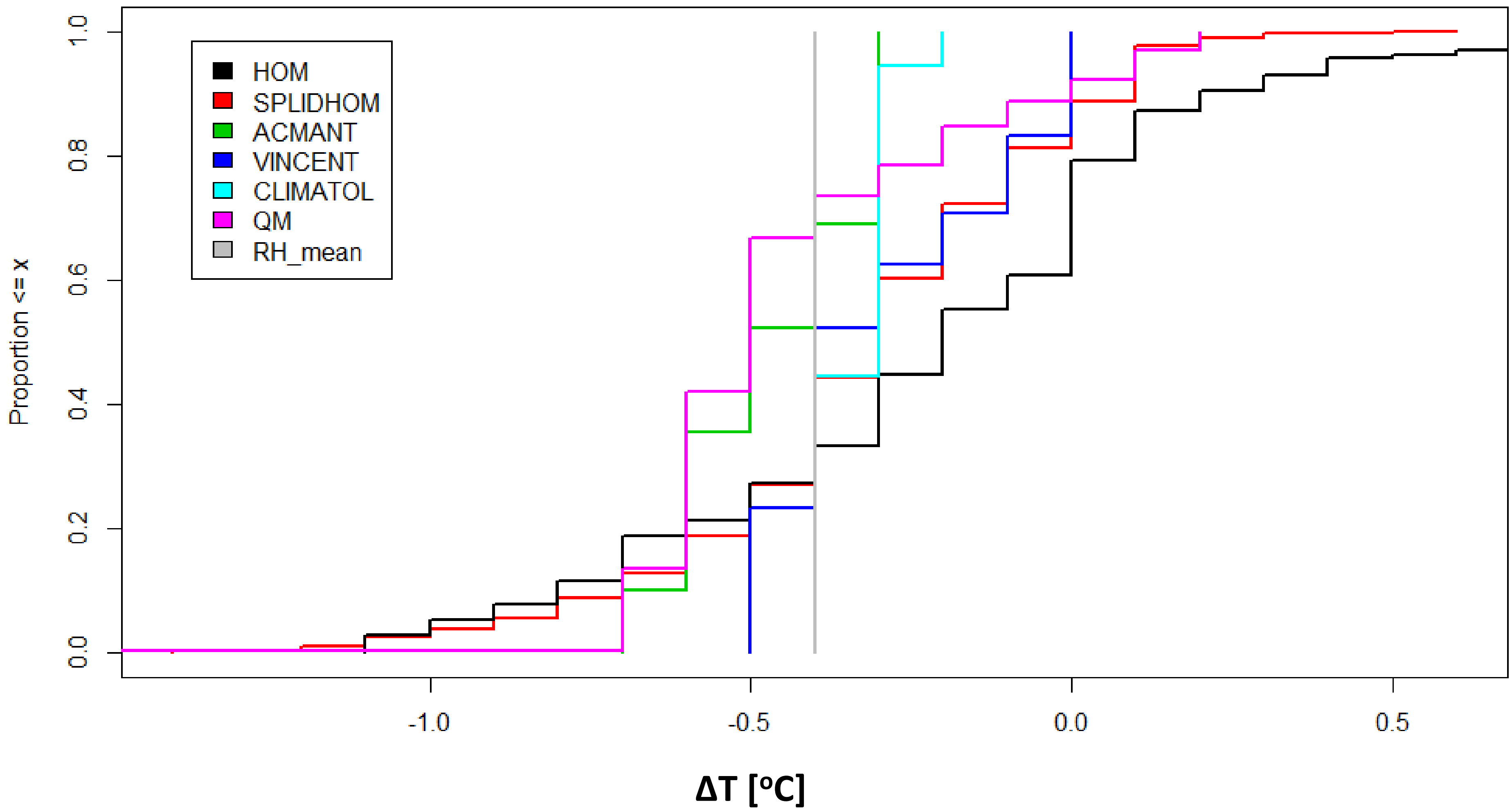


TAVOR, TX, 1950-1957

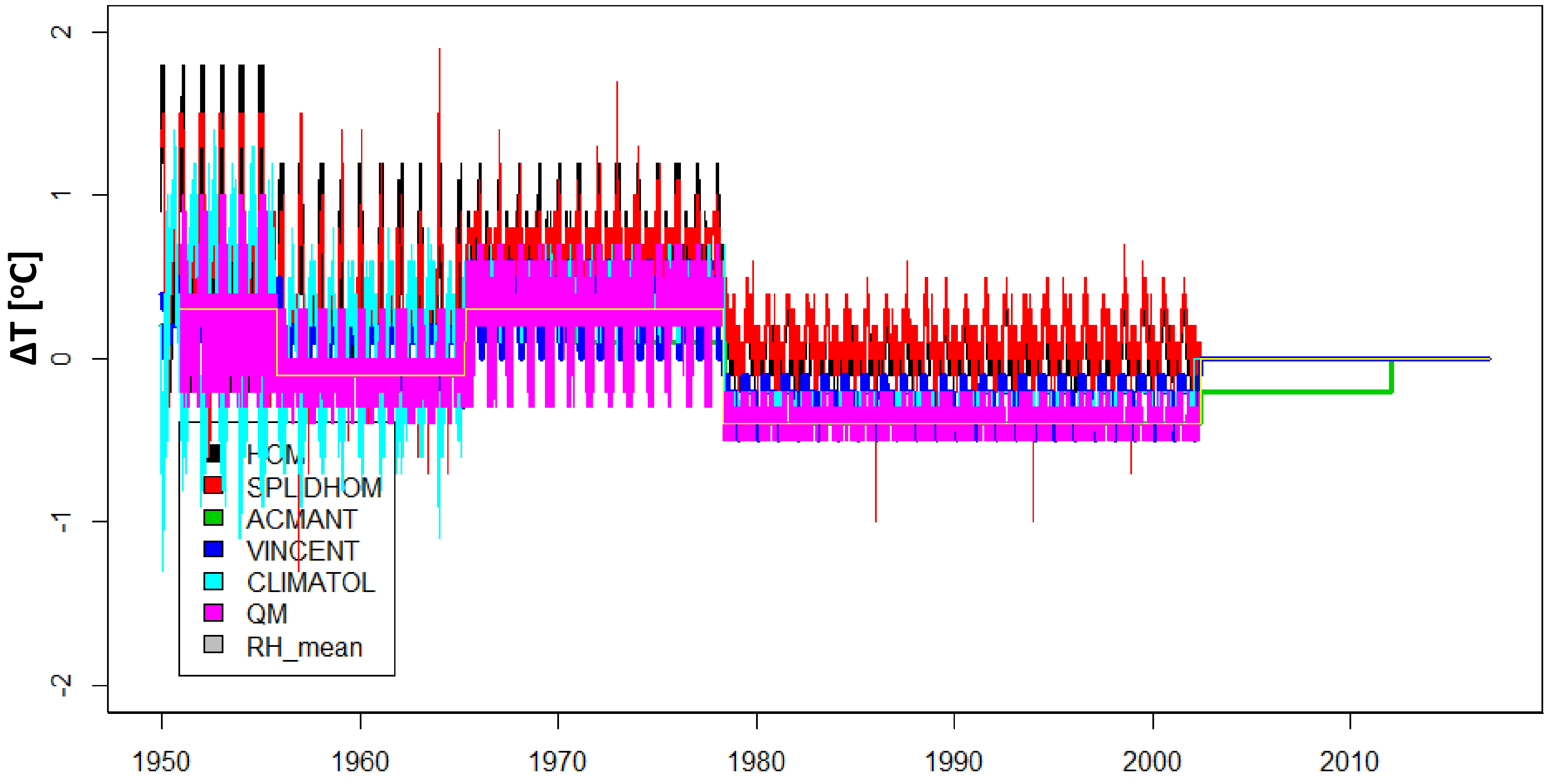
One sub-homogeneous segment



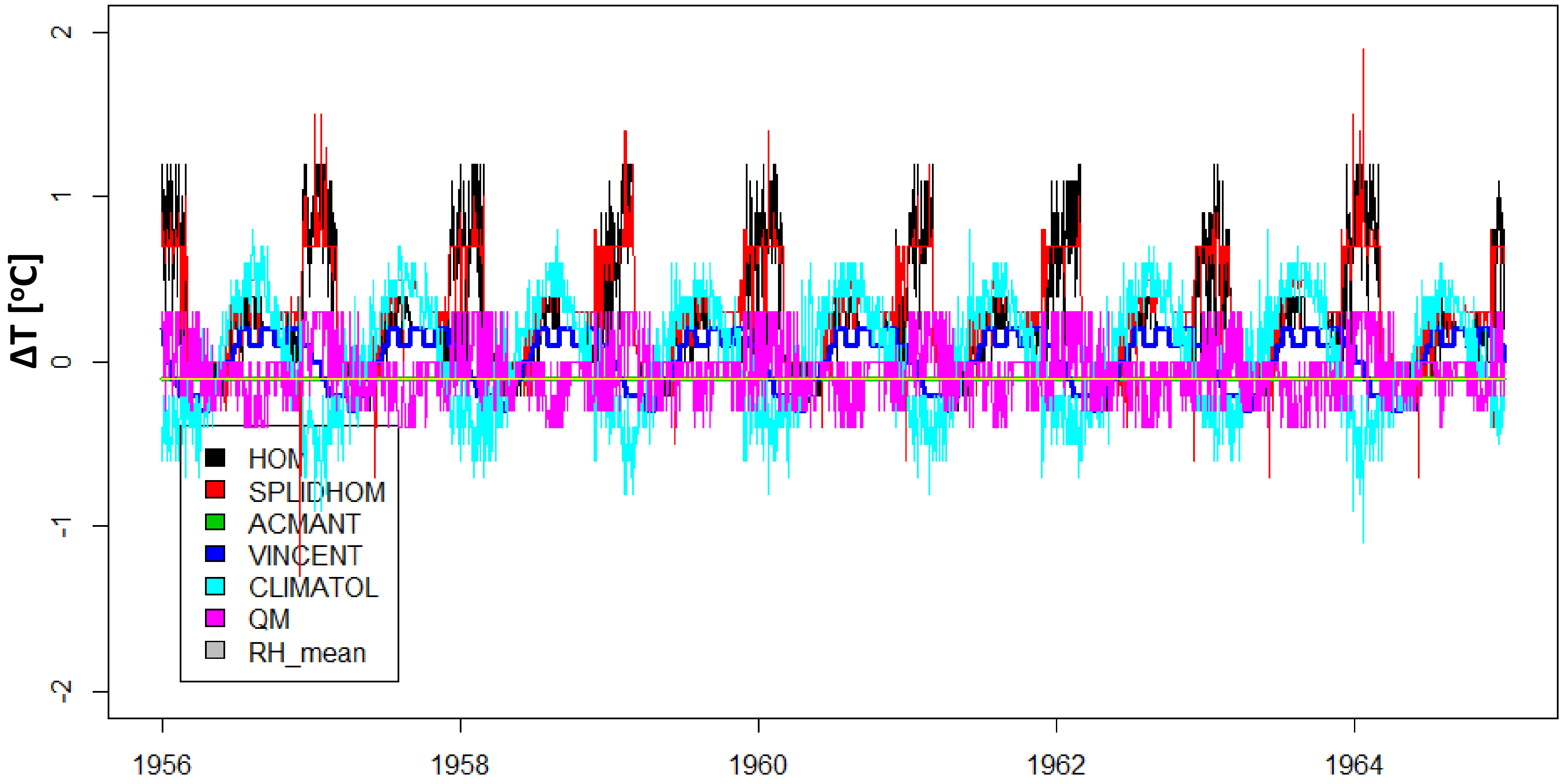
TAVOR, TX, 1950-1957, CDF



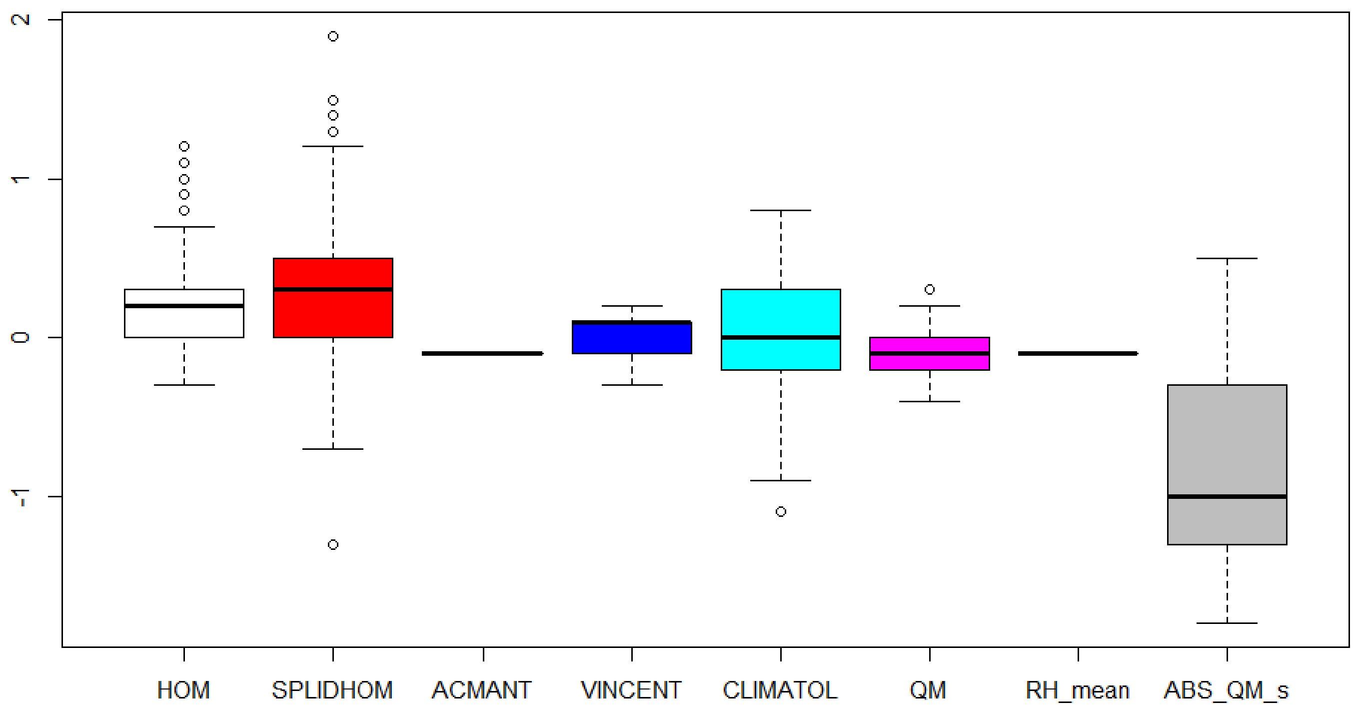
NEGBA, TN, **1950-2016**, 4 BP



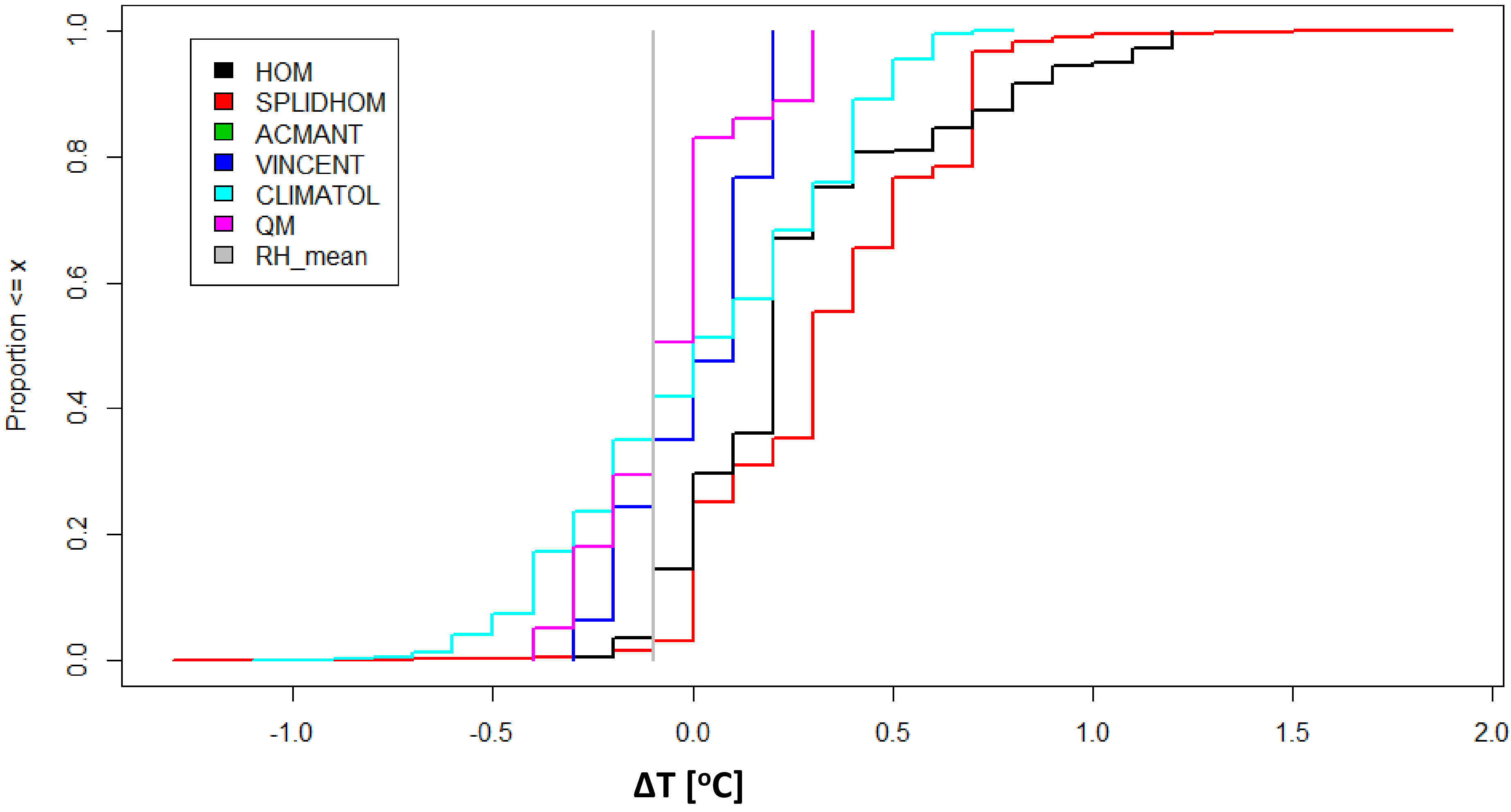
NEGBA, TN, 01/01/**1956**-31/12/**1964**



NEGBA, TN, **1956-1964**



NEGBA, TN, **1956-1964**, CDF



Results

2) Extreme indices:

- TXx (°C)
- TXn (°C)
- TX≥35 (Days)
- TX≥30 (Days)
- TX>25 (Days)
- TX90p (%)
- TX10p (%)
- wsdi (Days)

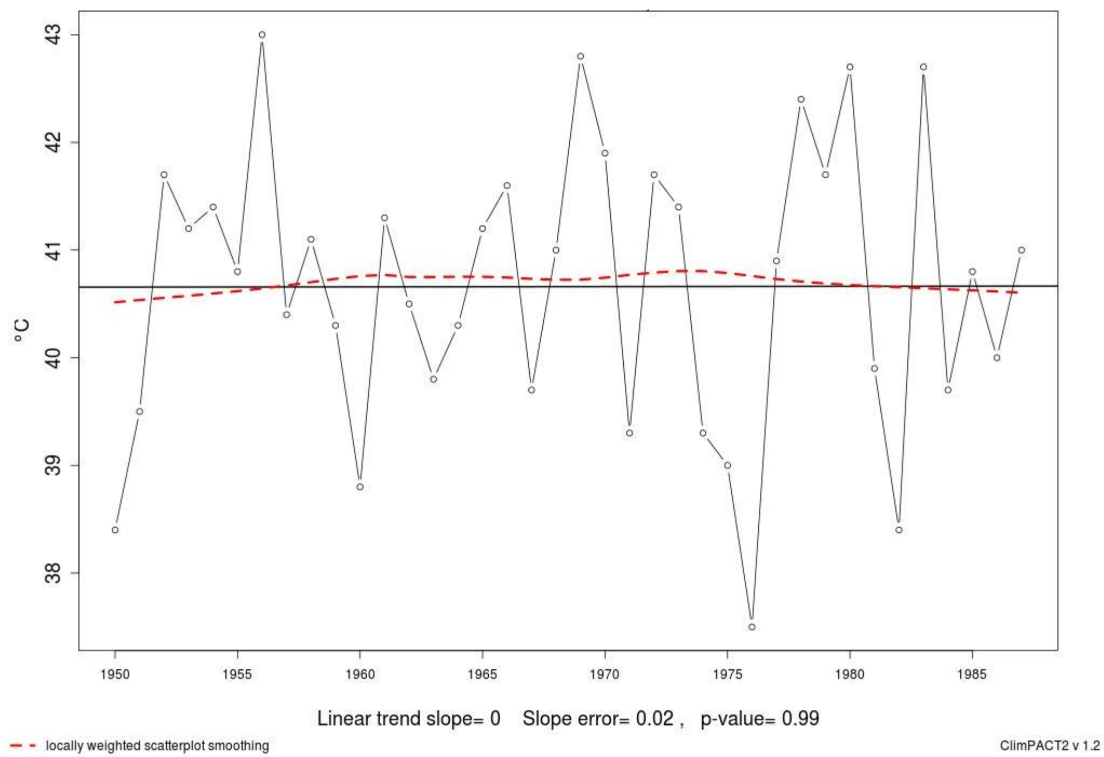
- TNn (°C)
- TNx (°C)
- TN>20 (Days)
- TN<2 (Days)
- TN90p (%)
- TN10p (%)
- csdi (Days)

Calculating simple linear regression.

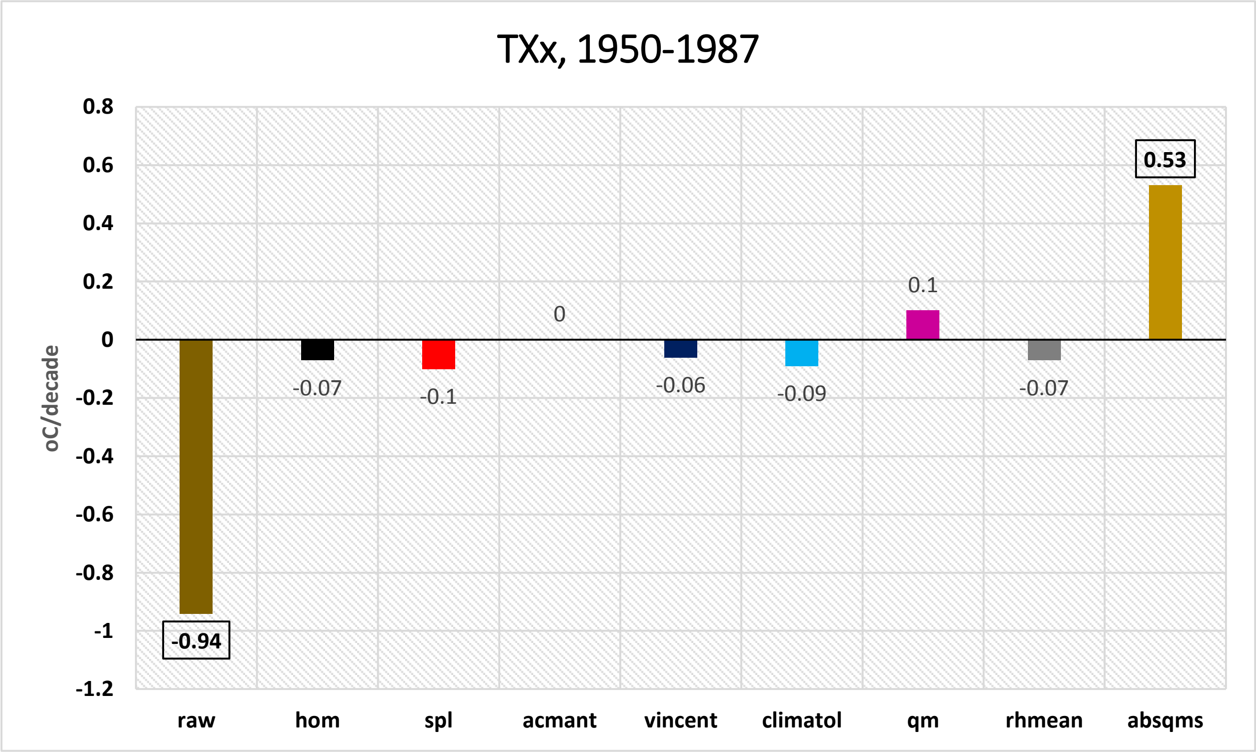
$\alpha=0.05$

The indices calculation was preformed by ClimPACT2 software package (Alexander and Herold, 2015)

TXx [°C]– Annual warmest daily TX

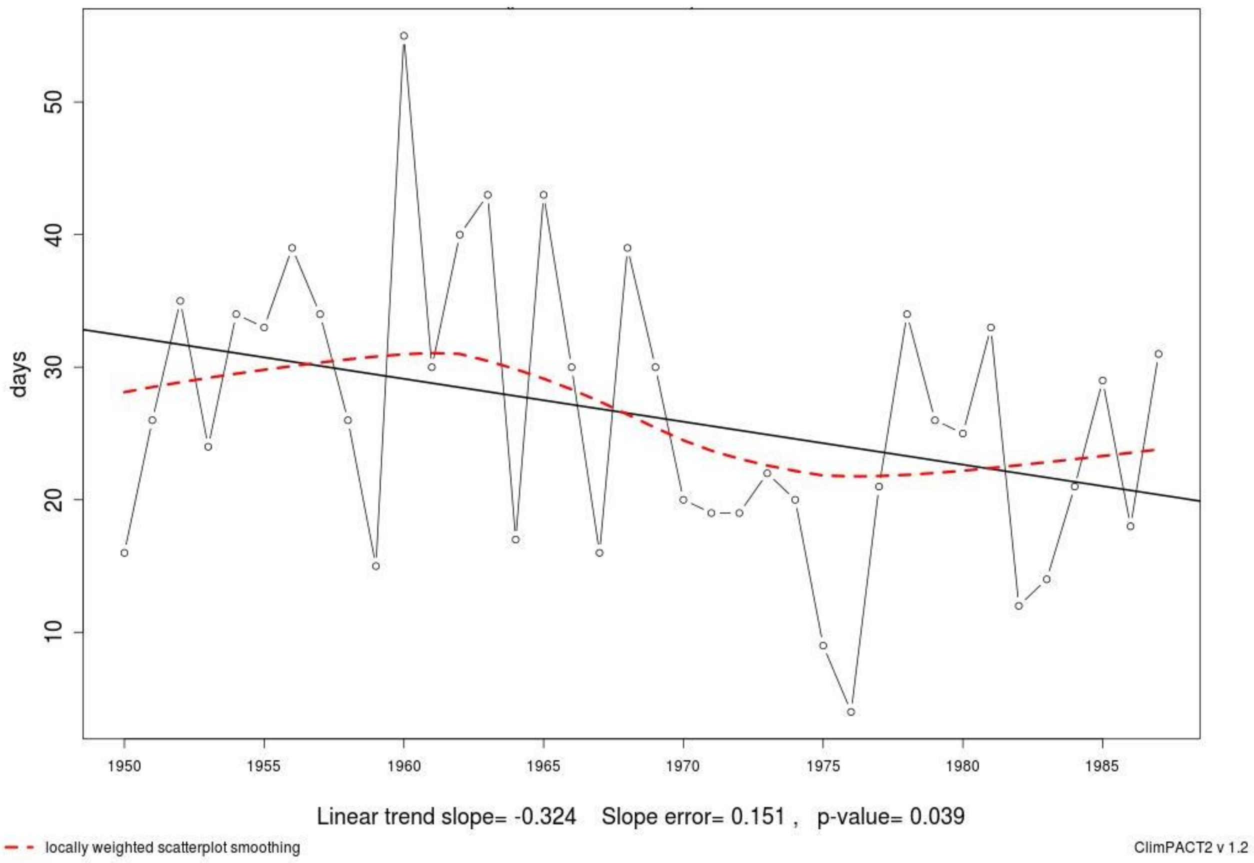


TXx [^{o}C]– Annual warmest daily TX



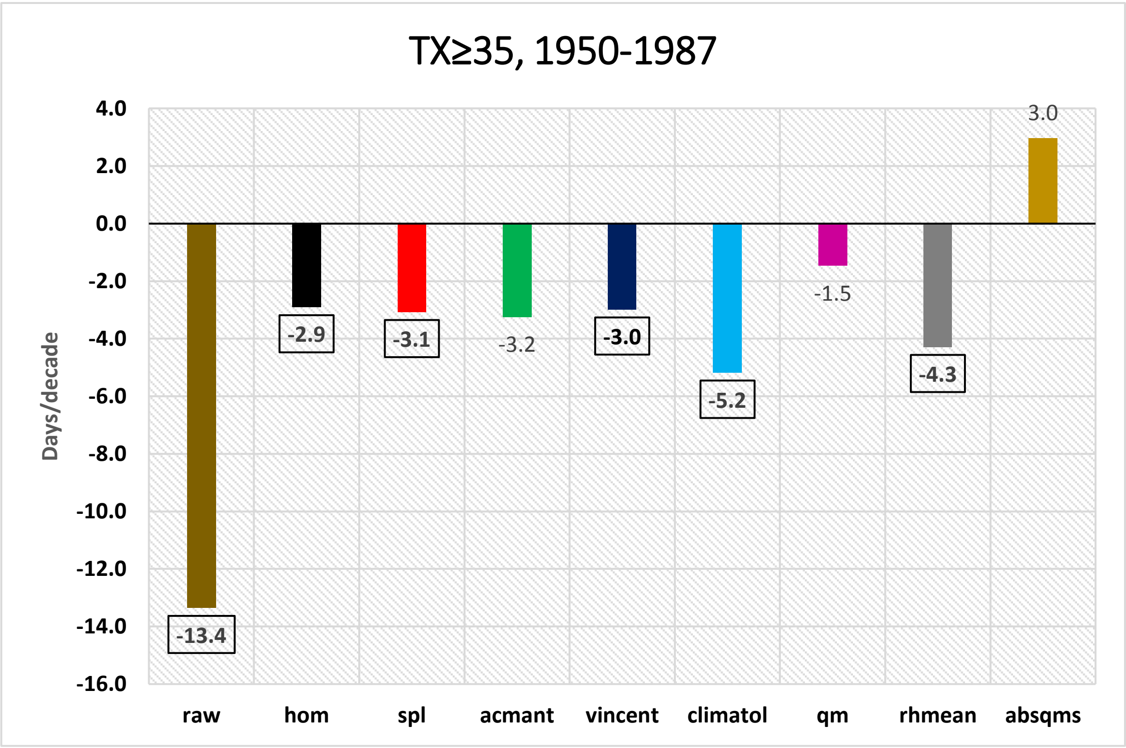
p-value≤0.05

TX≥35 [Days]– Annual number of days when TX≥35 [^oC]



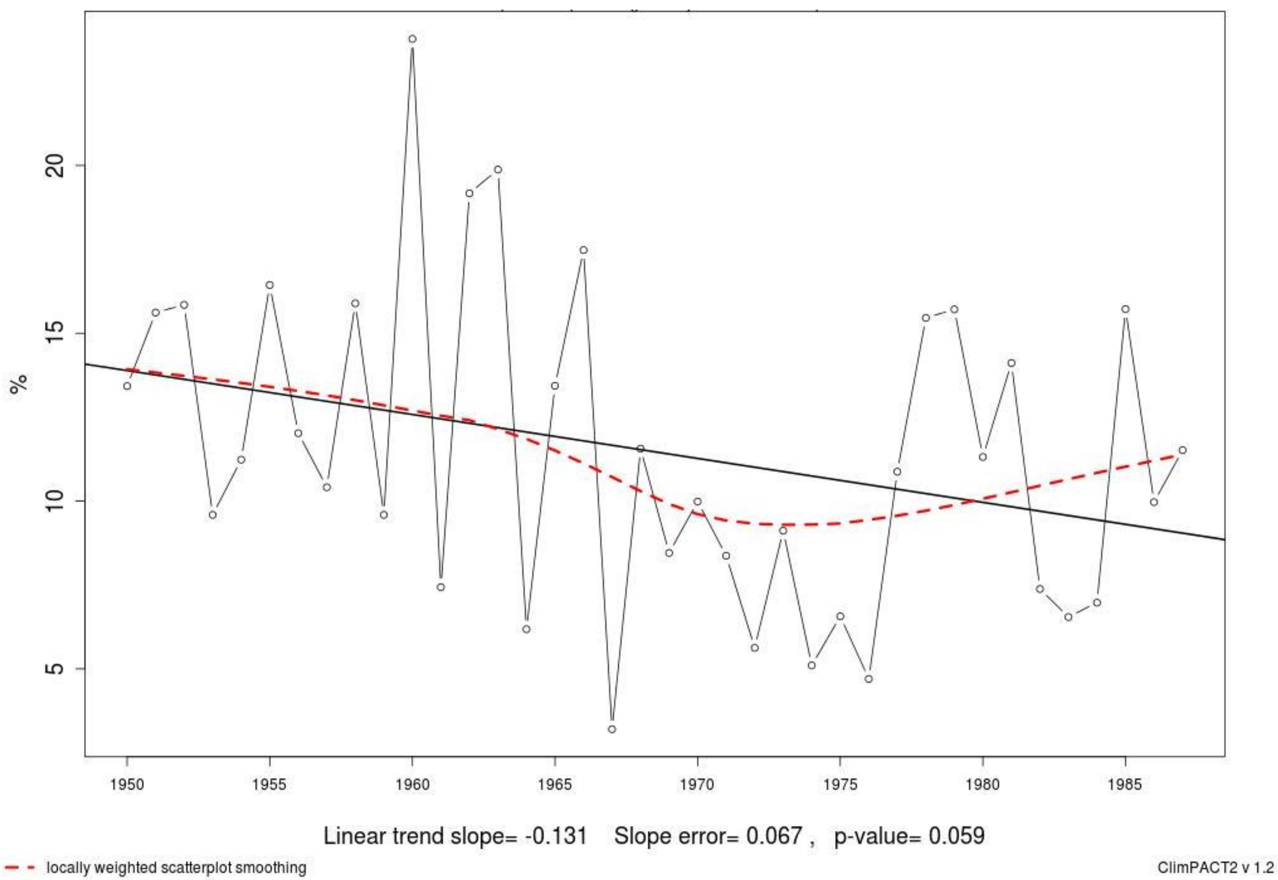
TX≥35 [Days/Decade]– Annual number of days when TX≥35 [ºC]

(SU 35 – Very hot days)

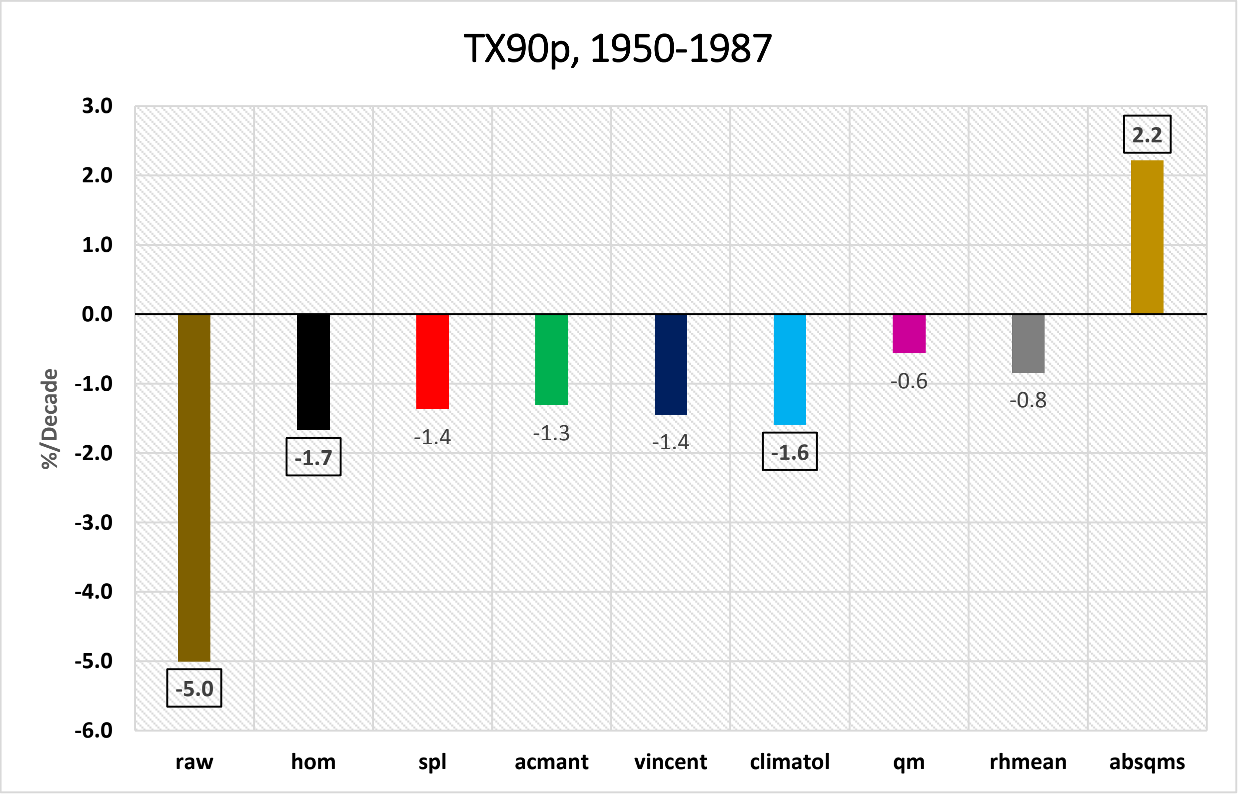


p-value≤0.05

TX90p [%]– Annual percentage of days when TX>90th percentile

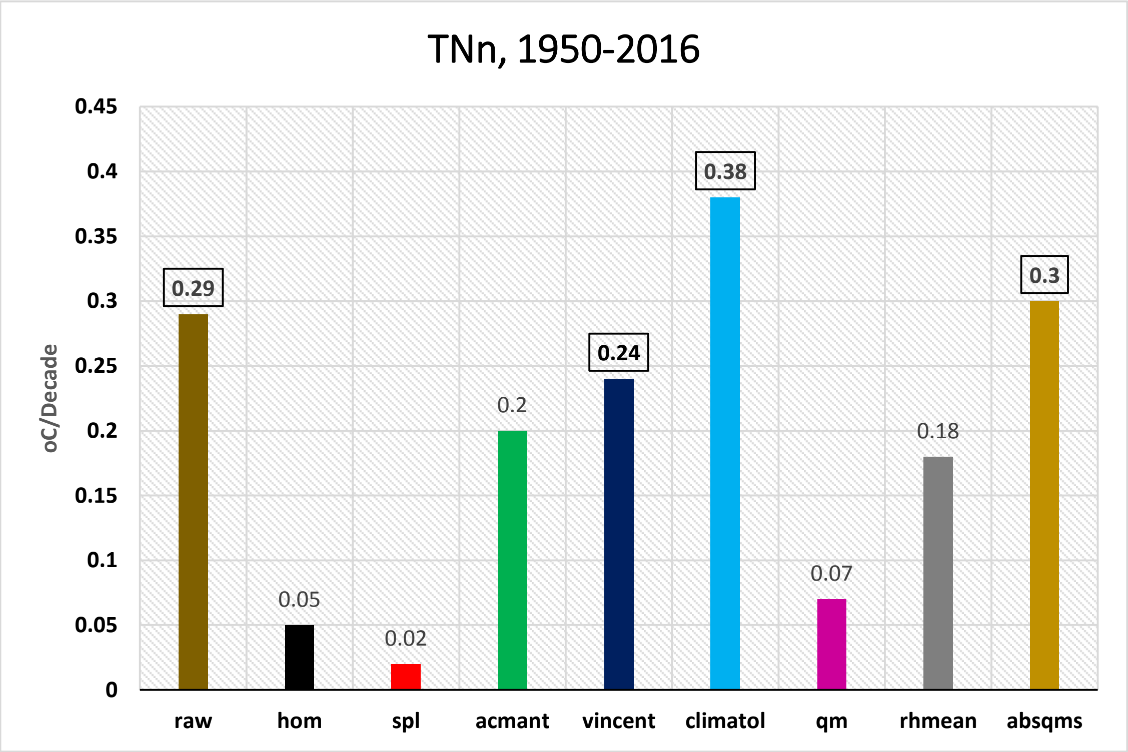


TX90p [%/Decade]– Annual percentage of days when TX>90th percentile (warm day-times)



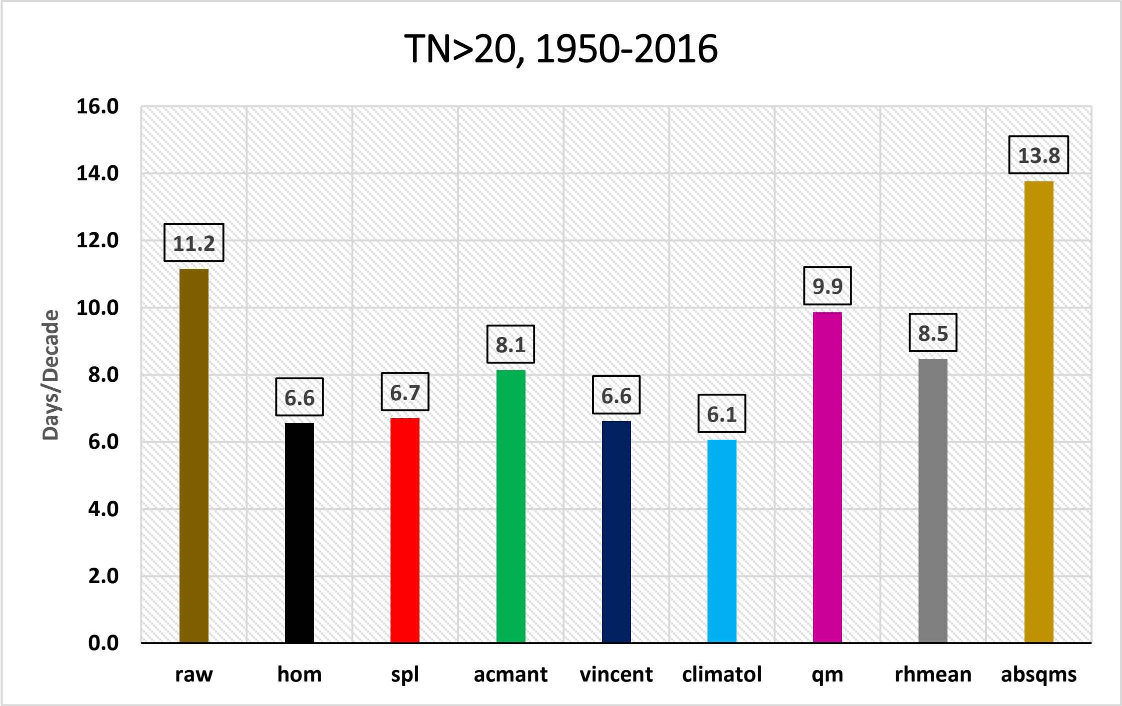
p-value≤0.05

TNn [^{o}C]– Annual coldest daily TN



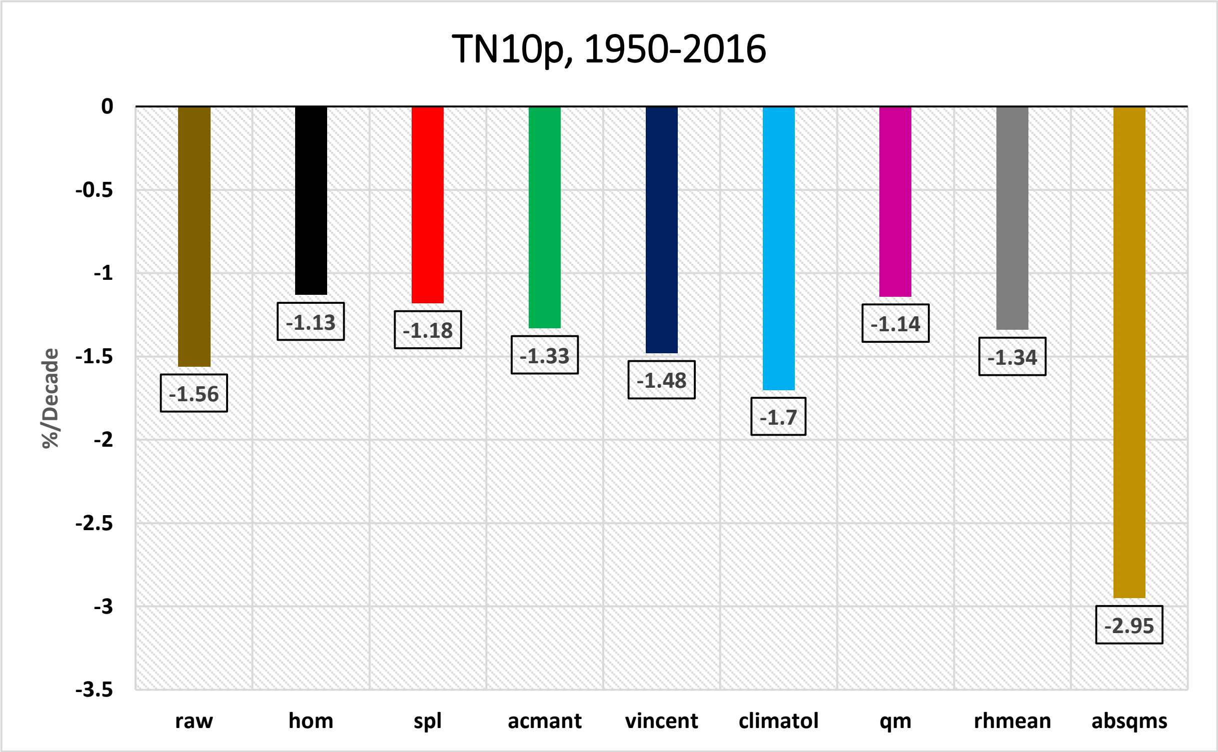
p-value≤0.05

TN>20 [Days/Decade]– Annual number of days when TN>20 [^{o}C] (TR20 – Tropical nights)



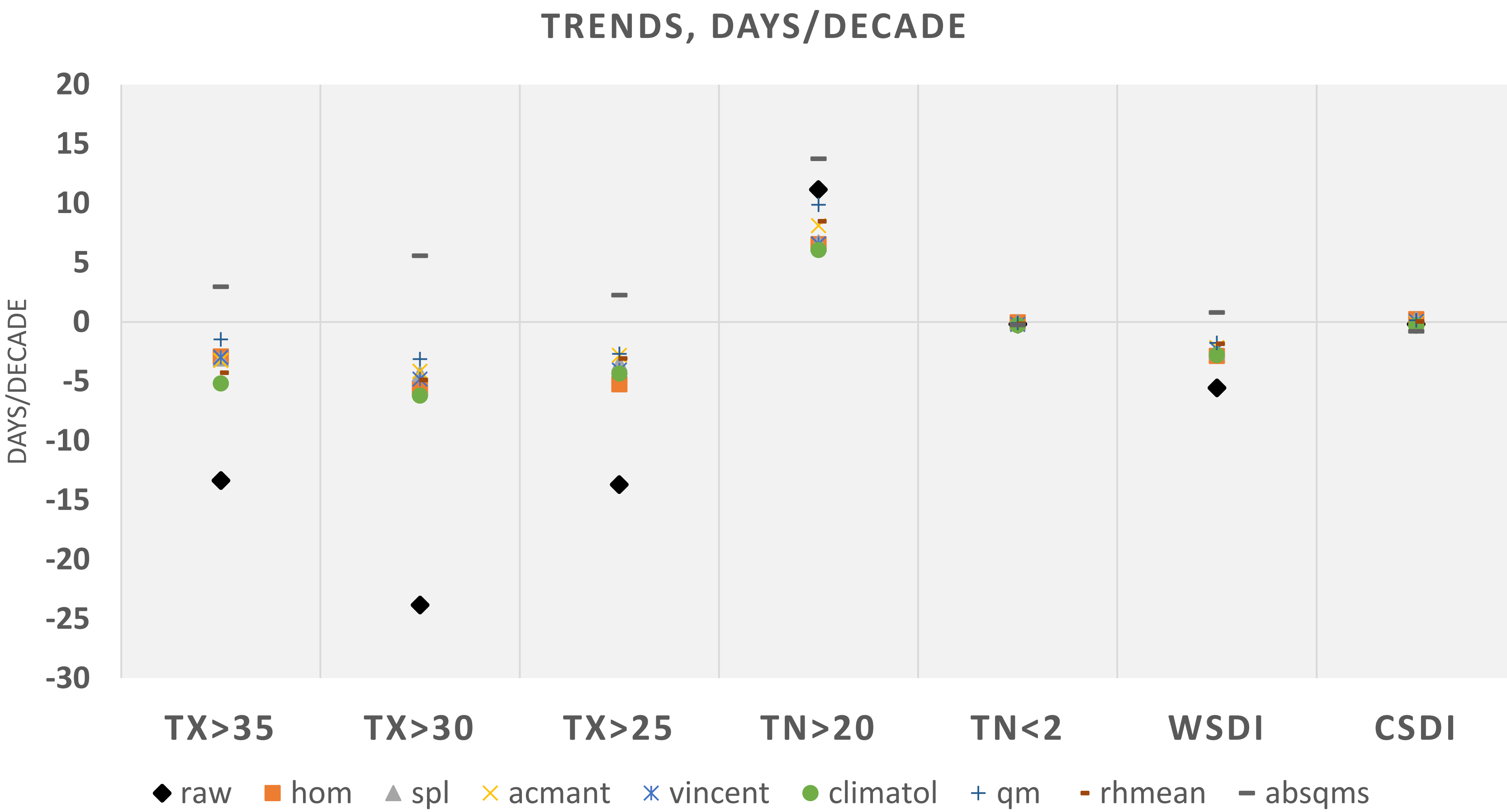
p-value≤0.05

TN10p [%/Decade]– Annual percentage of days when TN<10th percentile (cold nights)

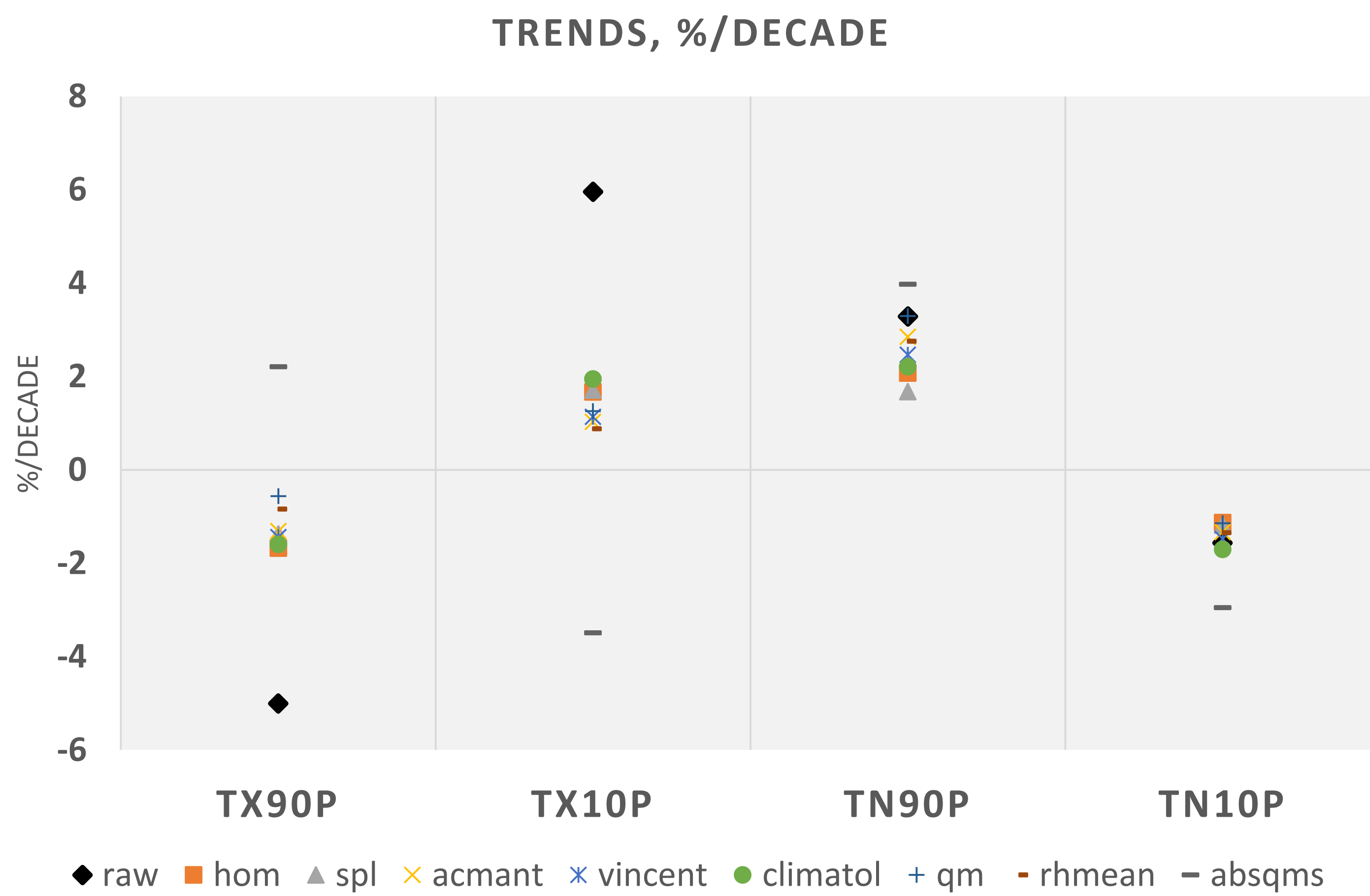


p-value≤0.05

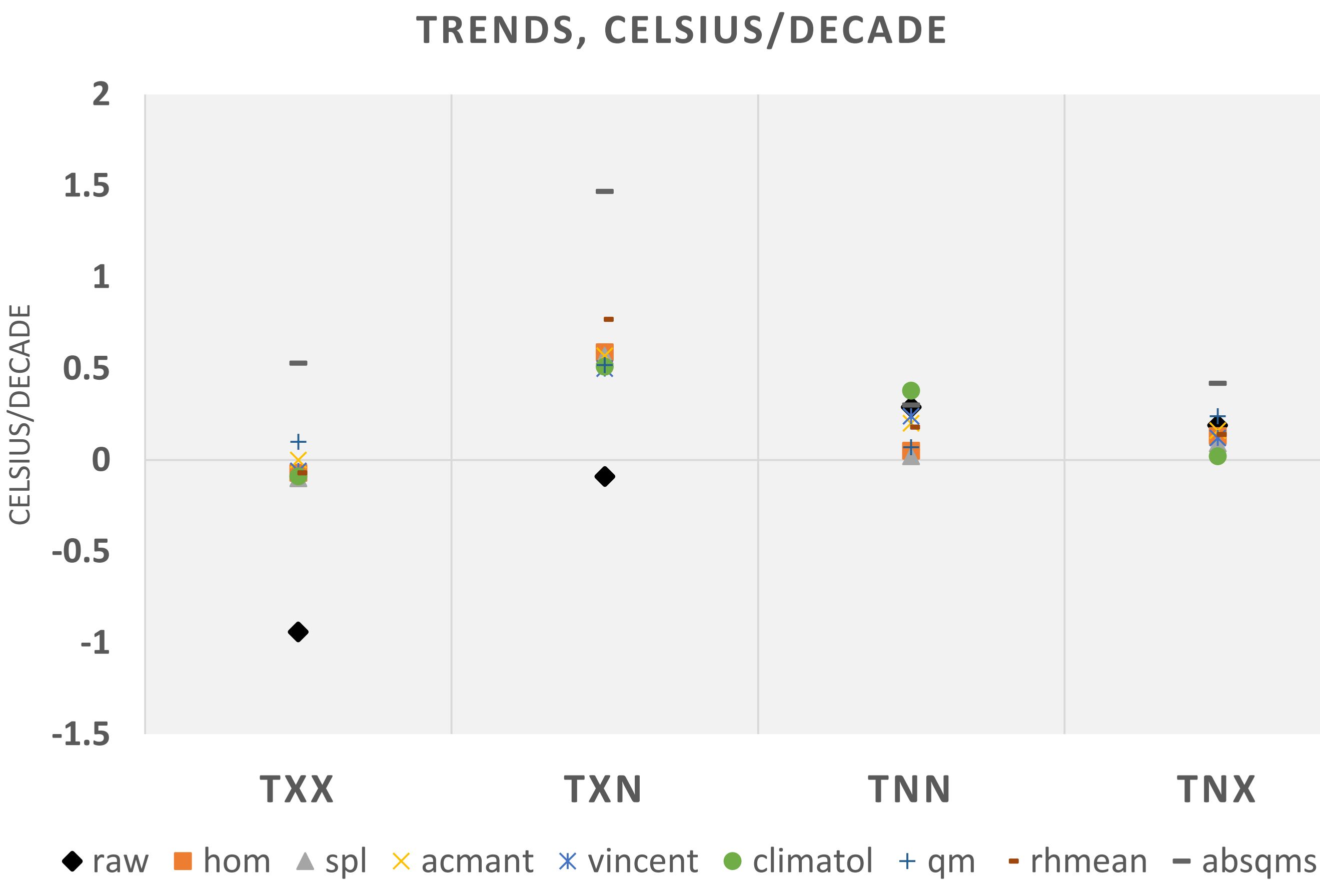
Summary of all the indices trends that are above/below a specific threshold



Summary of all the indices trends that are above/below a specific (percentage) threshold

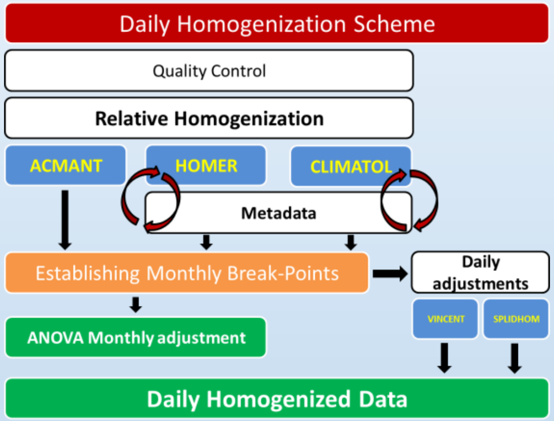


Summary of all the indices maximum and minimum temperature trends

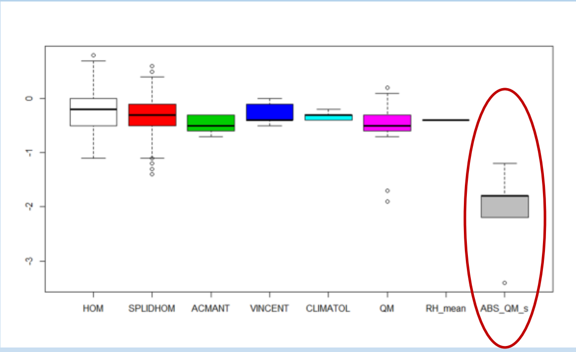


Summary and conclusions

1. The break-point detection is based on the monthly scale involving different methods.



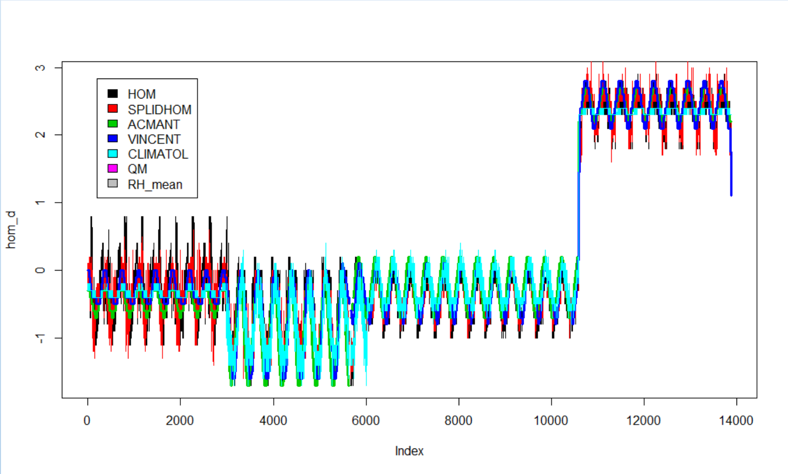
2. There are different approaches for daily adjustments: Linear interpolation, non-linear regression, quantile matching and orthogonal regression. Each method derives the daily correction factors differently:
   a. Avoid using absolute adjustments (and monthly break detections as well)



Summary and conclusions

2. b. The methods: **HOM, SPLIHOM, QM** allow larger daily correction range than the other analyzed methods together with **CLIMATOL** but not for all the breaks.

   c. **VINCENT** and **ACMANT** are more conservative in their daily correction factors when the latter gives constant factors for the TN daily adjustments.



Summary and conclusions

3. Generally it seems that there is no big differences in the trend analysis for these specific extreme indices among the methods:

- For the absolute temperature the range of the difference is [0.2-0.37] ^oC/decade – most of the trends are NOT SIGNIFICAT.
- The range of the difference for threshold above percentage is [0.57-1.62] %/decade.
- The range of the difference for number of days above/below a specific threshold [0.27, 3.72].

Without the Raw and the Absolute QM trends

Index	MAX	MIN	difference	No of sig' trends	Units
TXx	0.1	-0.1	**0.2**	None	^oC
TXn	0.77	0.5	**0.27**	2/7	^oC
TNn	0.38	0.02	**0.36**	2/7	^oC
TNx	0.24	0.02	**0.22**	2/7	^oC
TX90p	-0.56	-1.67	**1.11**	2/7	%
TX10p	1.95	0.88	**1.07**	All	%
TN90p	3.3	1.68	**1.62**	All	%
TN10p	-1.13	-1.7	**0.57**	All	%
TX>35	-1.46	-5.18	**3.72**	5/7	Day
TX>30	-3.13	-6.19	**3.06**	All	Day
TX>25	-2.68	-5.24	**2.56**	6/7	Day
TN>20	9.86	6.06	**3.8**	All	Day
TN<2	0	-0.27	**0.27**	3/7	Day
WSDI	-1.77	-2.85	**1.08**	3/7	Day
CSDI	0.23	-0.3	**0.53**	None	Day

Thank You for your attention!

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