8th Seminar for Homogenization and Quality Control in Climatological Databases
3rd Conference on Spatial Interpolation Techniques in Climatology and Meteorology
BUDAPEST, HUNGARY
12 – 16 May 2014

Homogenization of Monthly Temperature Series in ISRAEL 1950-2012

an integrated approach for optimal break-points detection

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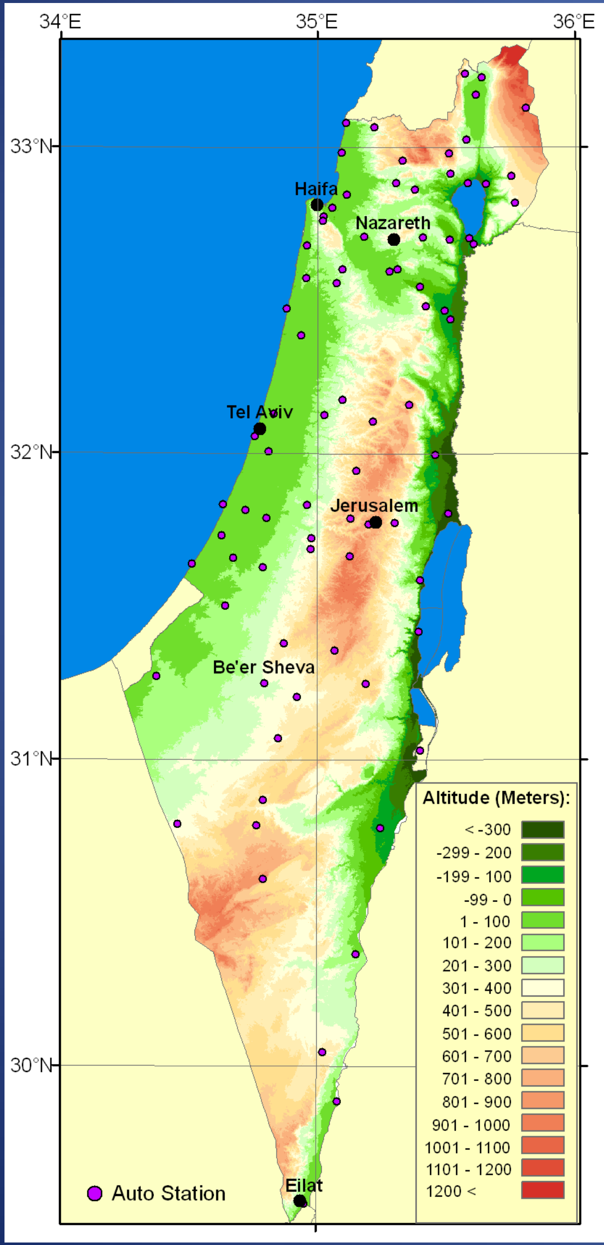
Outline

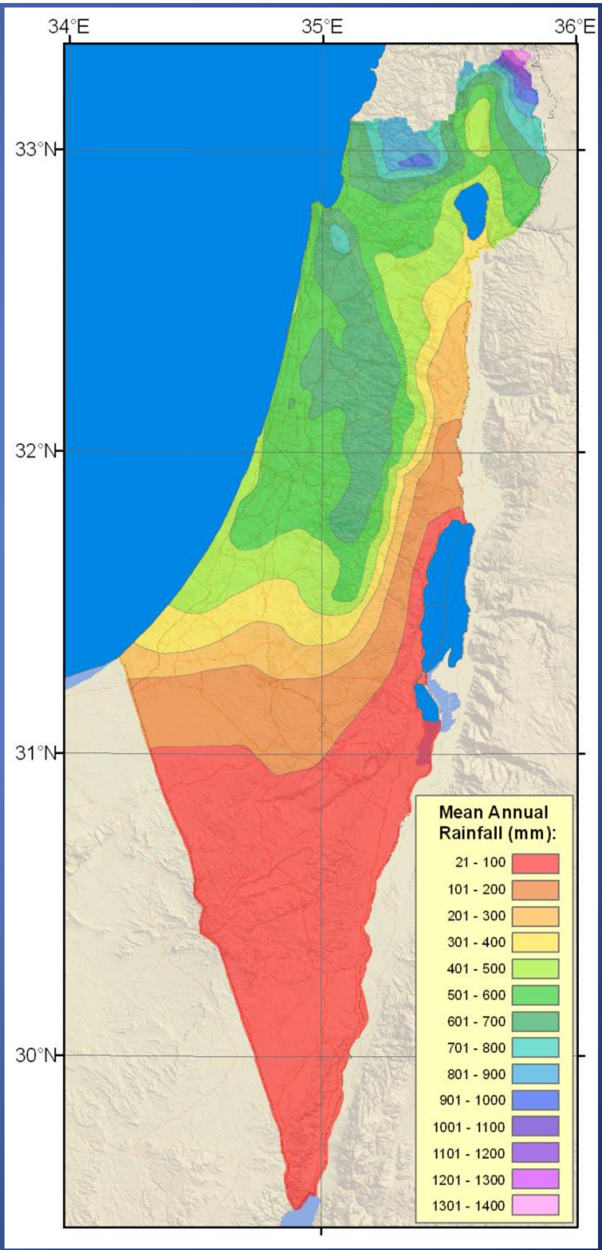
- Introduction
  - Climate of Israel and Israeli climatological stations (ICS)
  - Key factors causing inhomogeneity in the ICS temperature data
  - Major problems in carrying out homogenization of the ICS in temperature data.
- Methodology
  - The procedure of break-point detection and data adjustment at the IMS
- Results
  - Maximum and Minimum temperatures - adjusted series 1950-2012
- Conclusions and summary

Climate of Israel and Israeli climatological stations (ICS)

Distribution of AWS

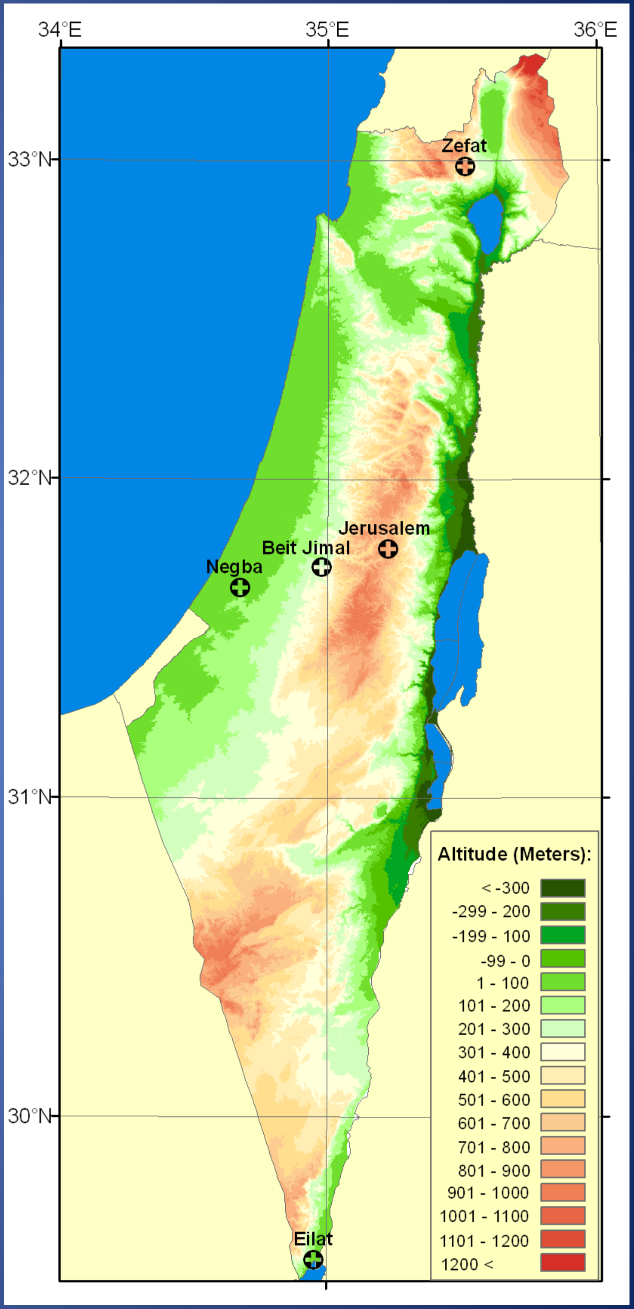


Mean annual precipitation 1981-2010



Focusing on 5 stations

- ✓ Long climate records.
- ✓ Data use after a systematic Quality Control procedure.
- ✓ Availability of reliable metadata.
- ✓ Good representation of various climate regions in Israel.
- ✓ The average of the mean temperature of these 5 stations represents quite well the average temperature of all Israel.



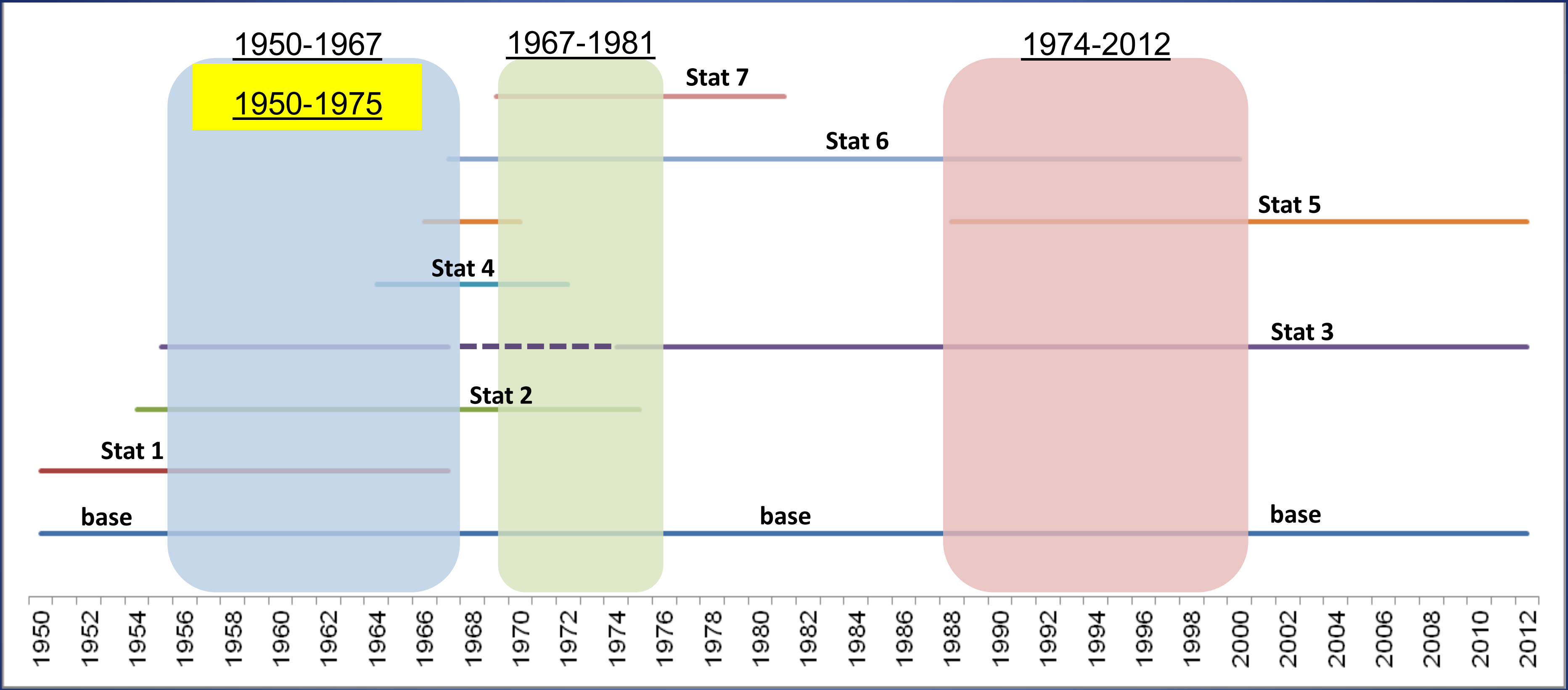
Key factors causing inhomogeneity in the ICS temperature data

- Relocations
- Instrumentation (calibration, upgrading to electronic sensors, types of sensors).
- Changing screen design.

Major problems in carrying out homogenization of the ICS in temperature data

- Lack of stations during the 1950’s and backward.
- Lack of stations from the same climatological region.
- Missing values and discontinuity records at a given station.

Discontinuous records and short periods



Data availability for the base and reference stations

Common Homogenization Procedure

Q.C. Stations (base, reference)

↓

Collecting the relevant Metadata

↓

Building the reference series

↓

Homogeneity tests (absolute & relative)

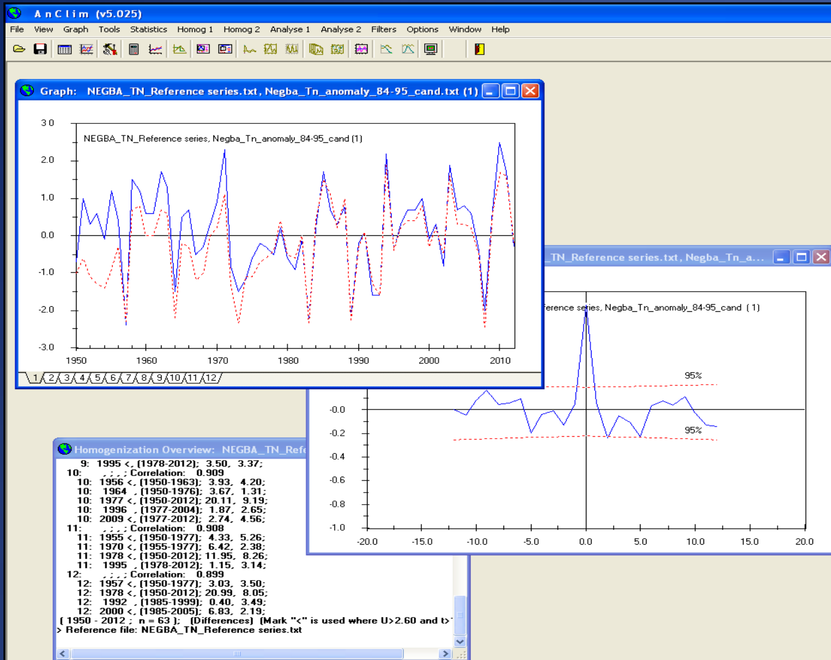
↓

Break-points location

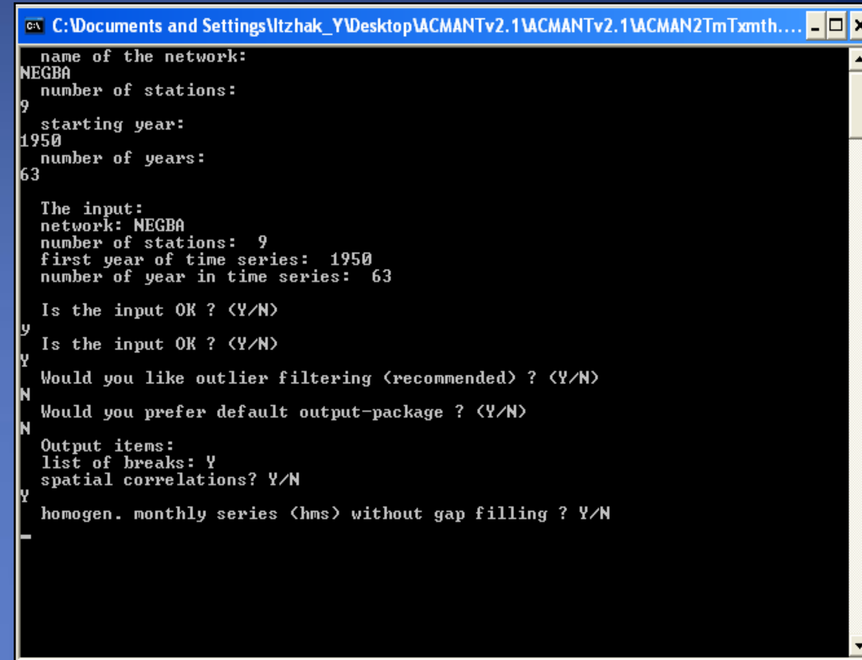
↓

Adjustment

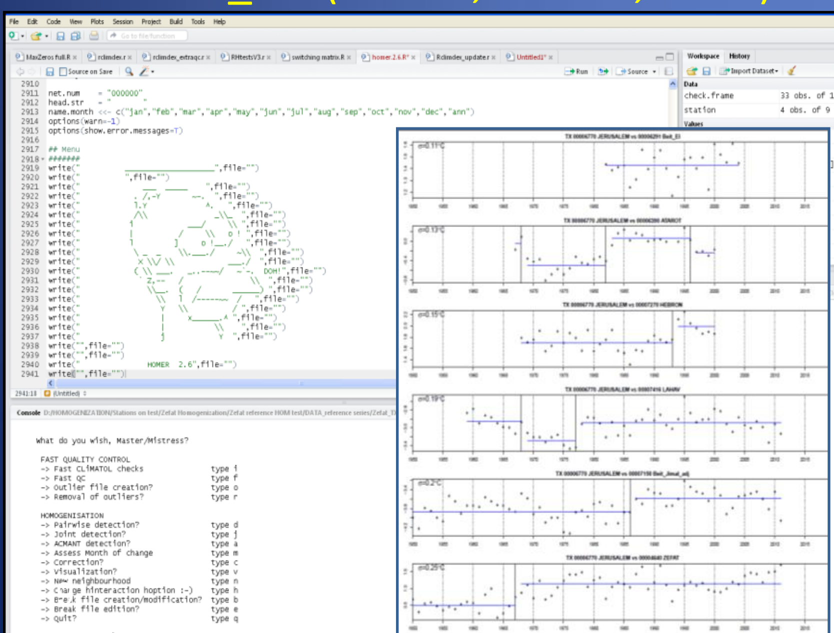
AnClimv5 (*Štěpánek, P. 2008*)



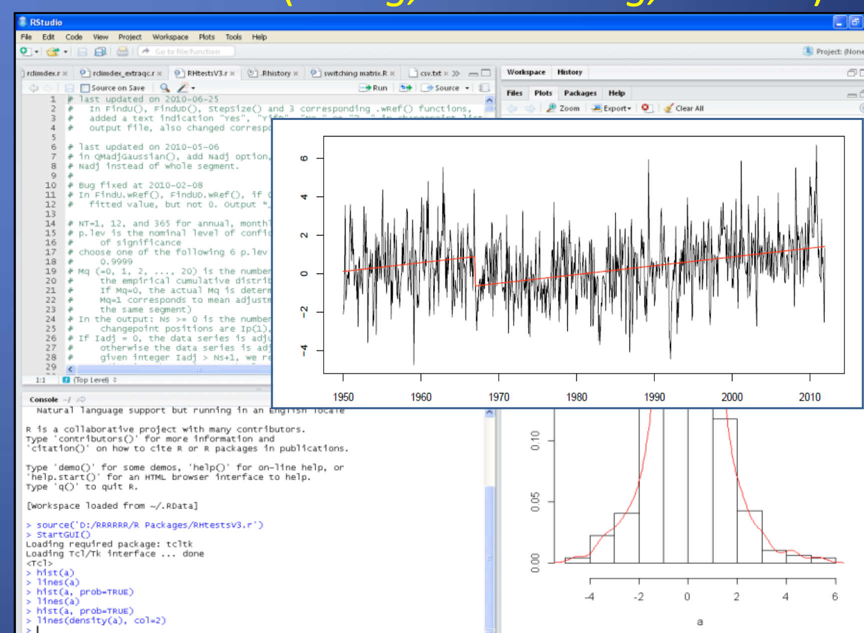
ACMANTv2 (*Domonkos, P. 2012*)



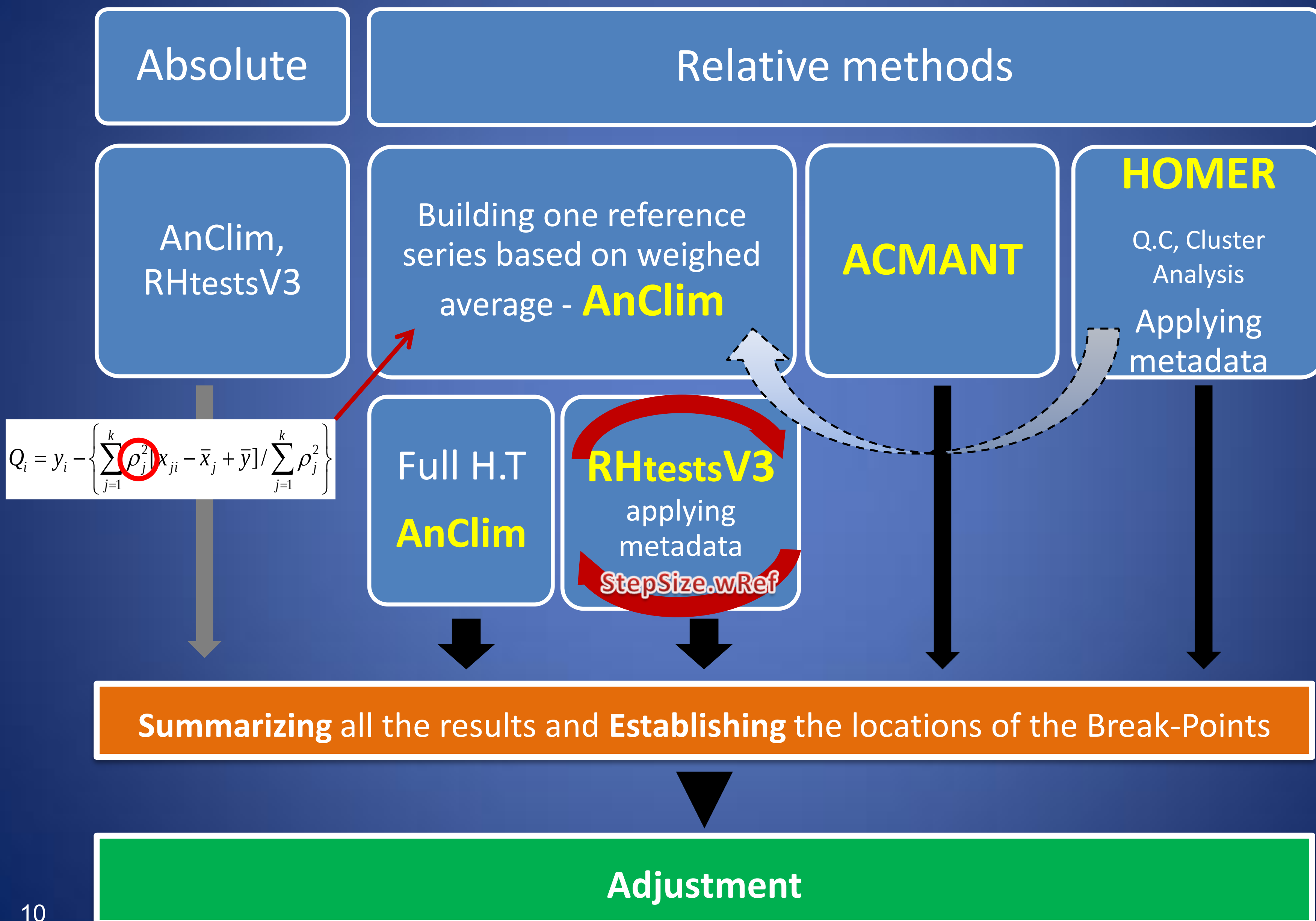
HOMER_2.6 (*Mestre, O. et al, 2012*)



RHtestsV3 (*Wang, X. L & Feng, Y. 2010*)



Homogenization at IMS



Summarizing all the results and **Establishing** the Break-Points

Station: <u>NEGBA 1950-2012</u>

TEMPERATURE: MAX / MIN / DTR Common Period: ______________

No. ref. Stations: 3-8

DATA: Year / Month / Day

Reference Tests

SNHT		
SNHT II		
SNHT two stand.dev		
SNHT Double Shift		
SNHT Trend		
Bivariate test		
Easterling & Peterson		
Vincent (4 steps)		
RHtestsV3		
ACMANT		
HOMER		

Adjustment

- Manually
- ACMANT
- HOMER

Absolute Homogenization Tests

The ECA&D suggests to do absolute tests when there is no reliable metadata.

<u>The 4 basic absolute tests:</u>

1. The standard normal homogeneity test (Alexandersson, 1986)

2. The Buishand range test (Buishand, 1982)

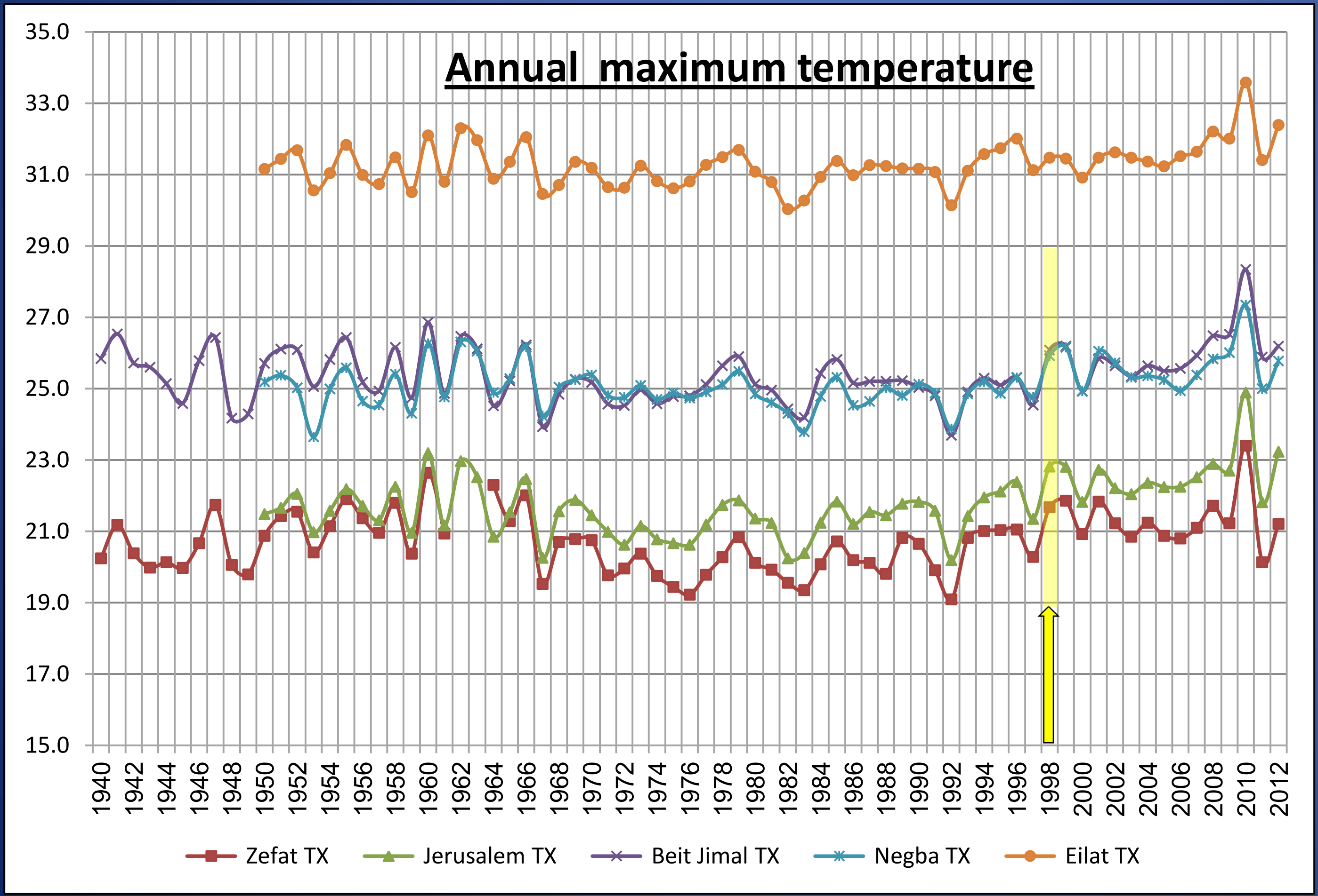
3. The Pettitt test (Pettitt, 1979)

4. The Von Neumann ratio test (Von Neumann, 1941)

Absolute Homogeneity Test

For the maximum and minimum temperature the year 1998 repeats at all the stations (except at Eilat).

The tests identify the real climate signals as break-points.

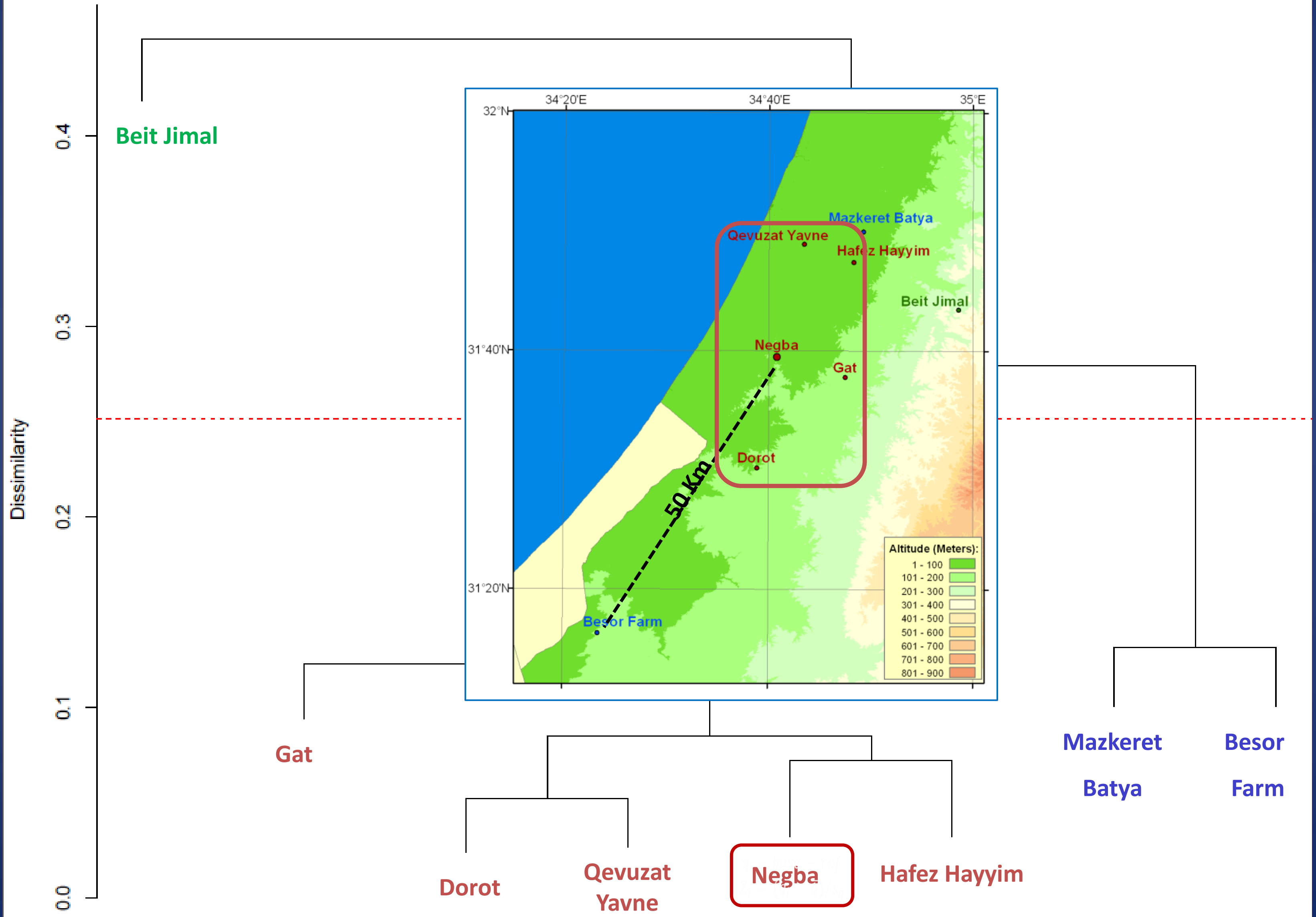


Station	TX	TN
Zefat (h=936m)	1967 1993 1998	1994 1998 2008
Jerusalem (h=810m)	1967 1978 1998	1993 1998
Beit Jimal (h=355m)	1964 1967 1998 2008	1964 1998 2008
Negba (h=95m)	1967 1998	1978 1985 1998
Eilat (h=22m)	1967 1994 2008	1955 1970 1994

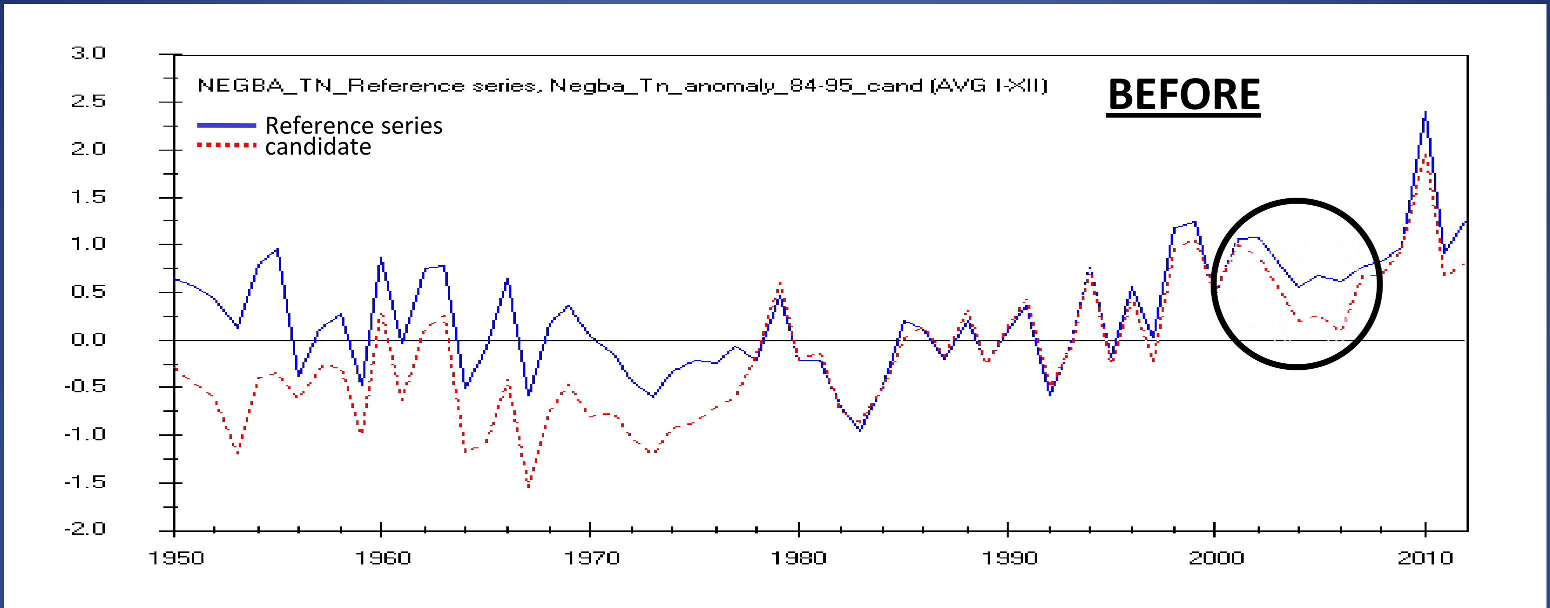
Significant annual break points (AnClim & RHtestsV3)

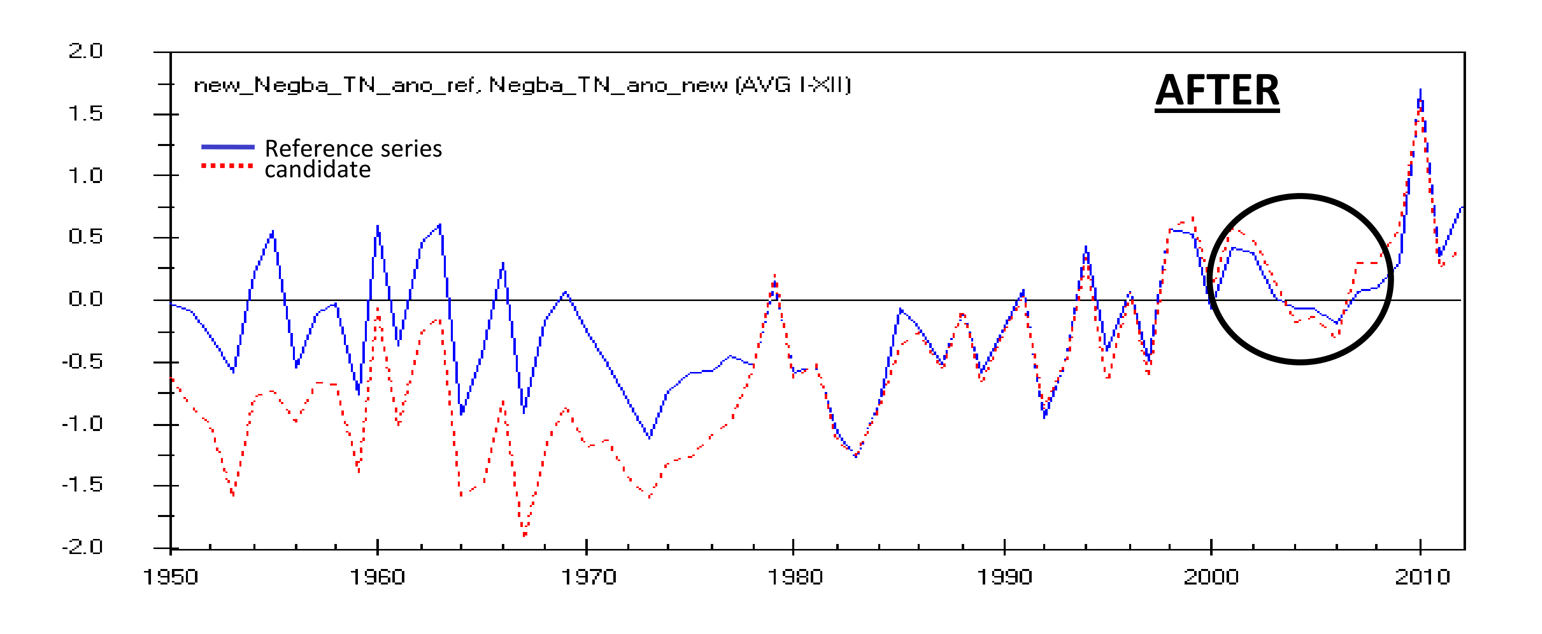
Using Cluster Analysis for choose reference stations

(Fast CLiMATOL checks_HOMER)



Candidate vs. Reference before and after cluster analysis

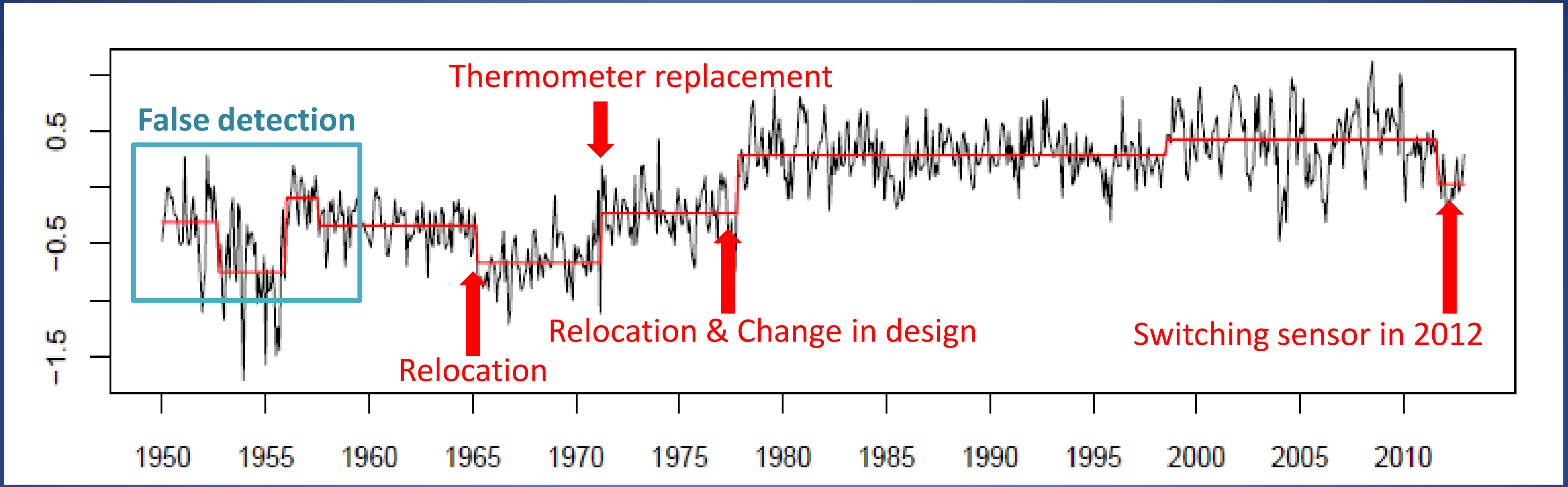




AnClim

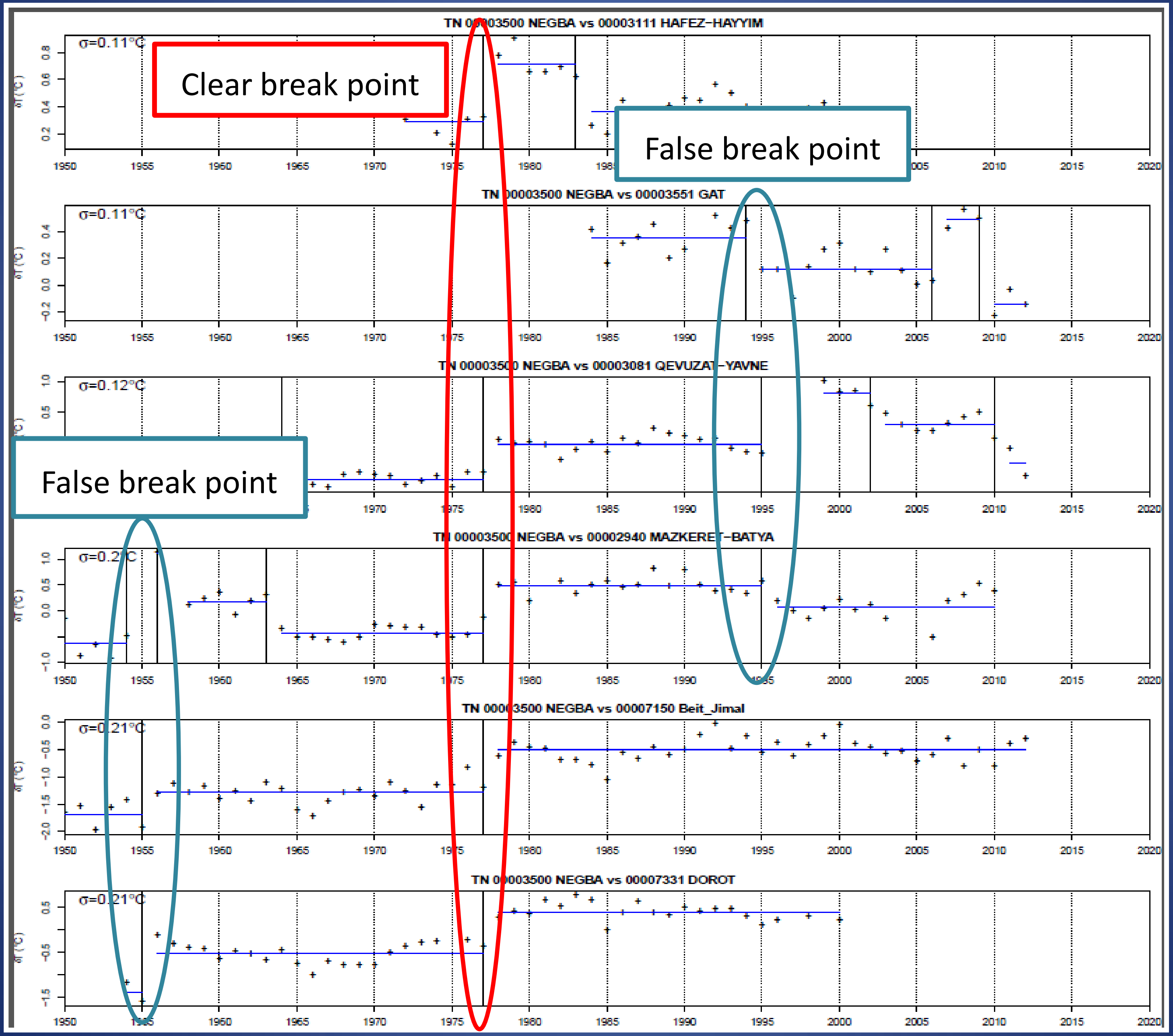
Break-point detection using RHtestV3

Negba: Base minus Reference (minimum temperature)



RHtestsV3

Using Pairwise detection for analyzing possible influence on the reference series



HOMER

Establishing the Break-Points

Metadata were used only after the detection phase, to validate the results

Negba - Minimum Temperature

Break points	AnClim	RHtestsV3	ACMANT	Metadata
1955	V	V		
1957		V		
1964	E.P	V	V	Relocation
1971	E.P	V	V	Thermometer replacement
1977	V	V	V	Relocation & Change in screen design

False

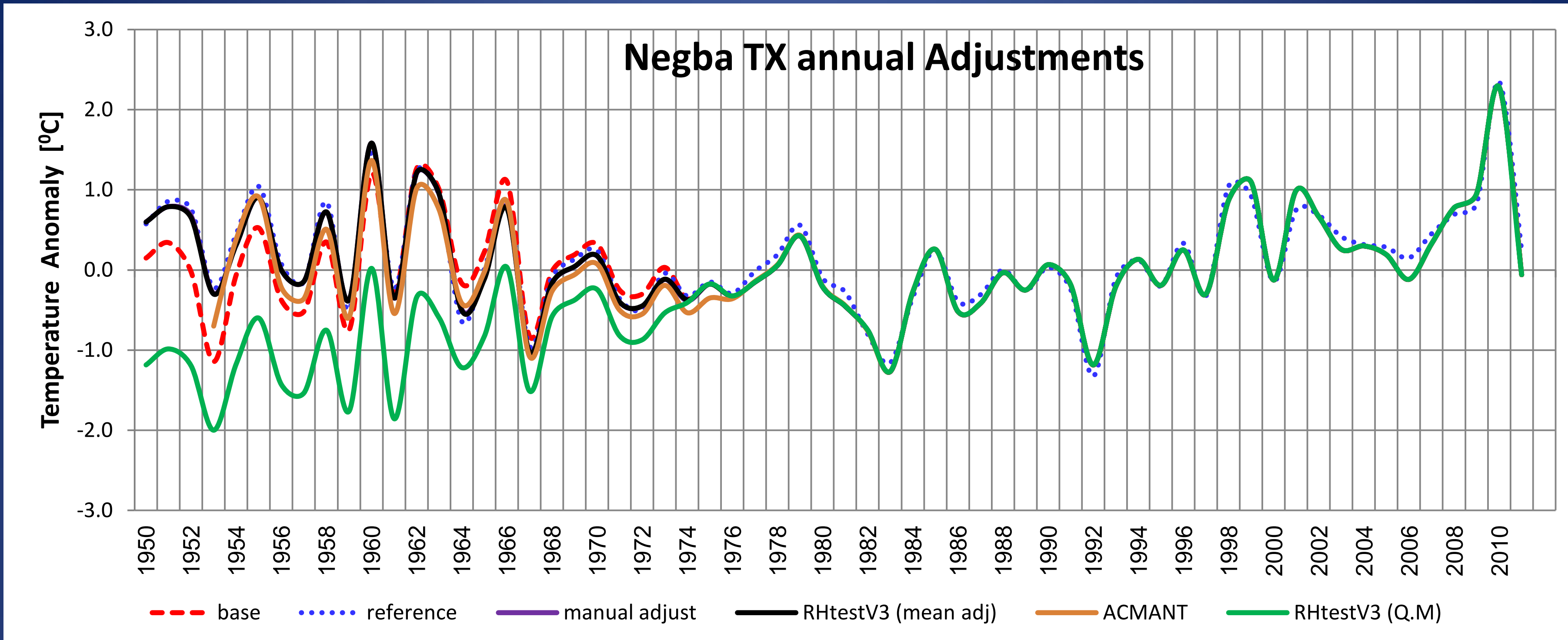
(**E.P** – Easterling, D. R and Peterson, T. C (1995))

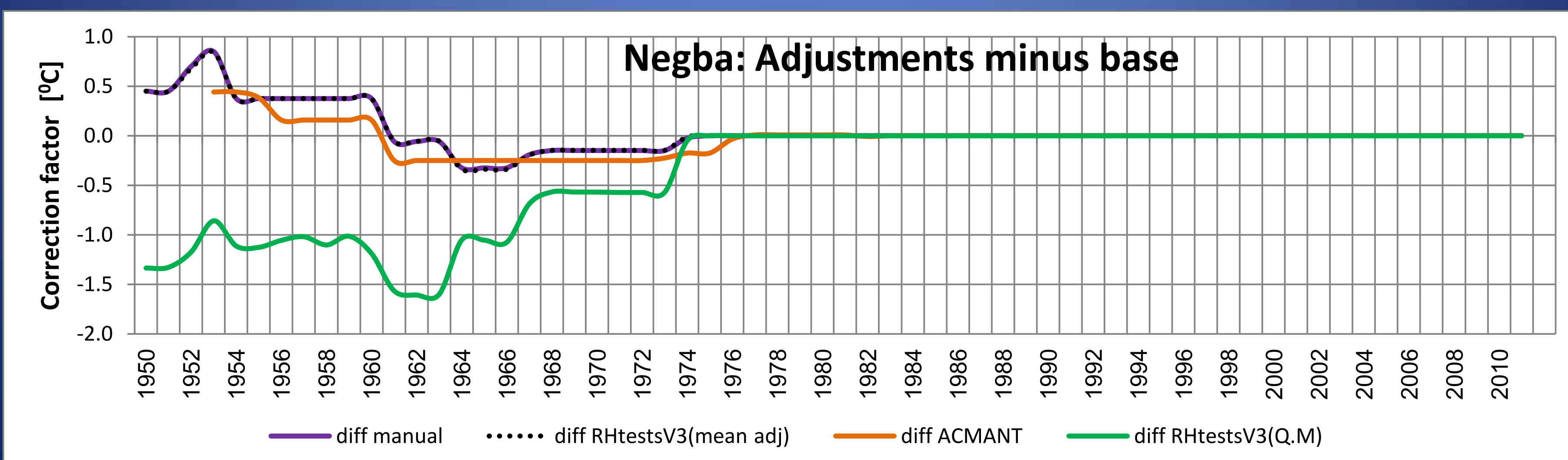
Zefat - Minimum Temperature

Break points	AnClim	RHtestsV3	ACMANT	Metadata
1990	V	V	V	No metadata
1992		V	V	Thermometer replacement
1995		V		Thermometer replacement
2000	V	V	V	Calibration
2004	V	V		Data from AWS
2008		V		Switching sensor

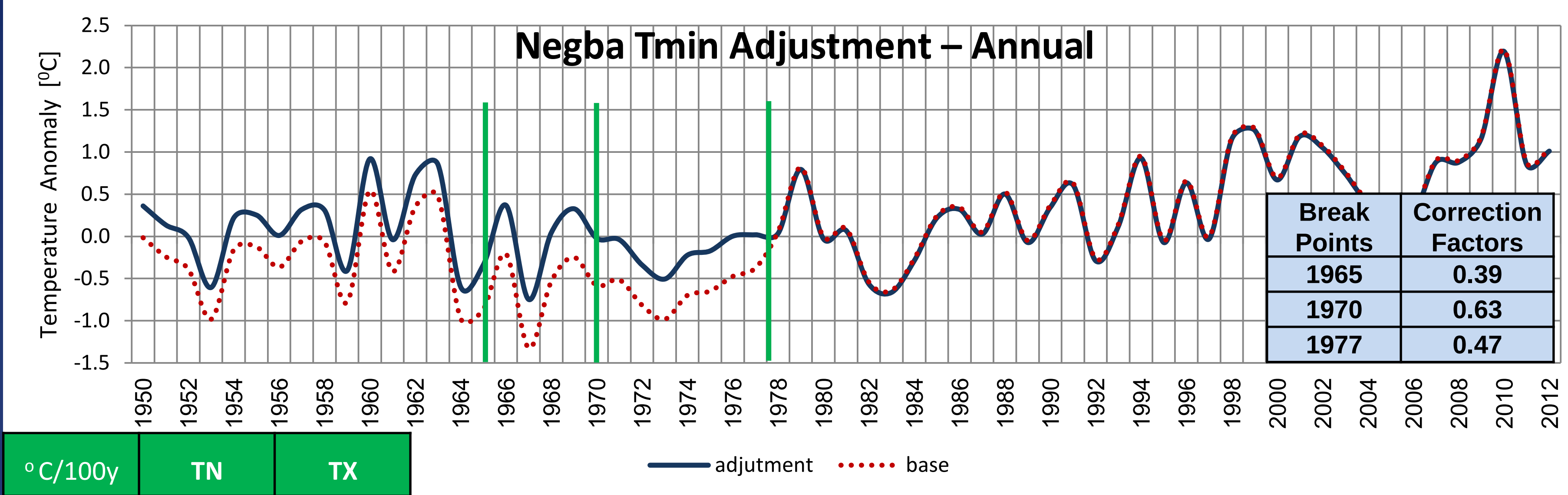
Adjusted Methods

1. Manual – Mean adjustment (monthly)
2. RHtestsV3 – Mean adjustment (annually)
3. RHtestsV3 – Quantile-Matching
4. ACMANT – ANOVA (monthly)


Negba TX annual Adjustments
Temperature Anomaly [ºC]
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
1950 1952 1954 1956 1958 1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010
base
reference
manual adjust
RHtestV3 (mean adj)
ACMANT
RHtestV3 (Q.M)

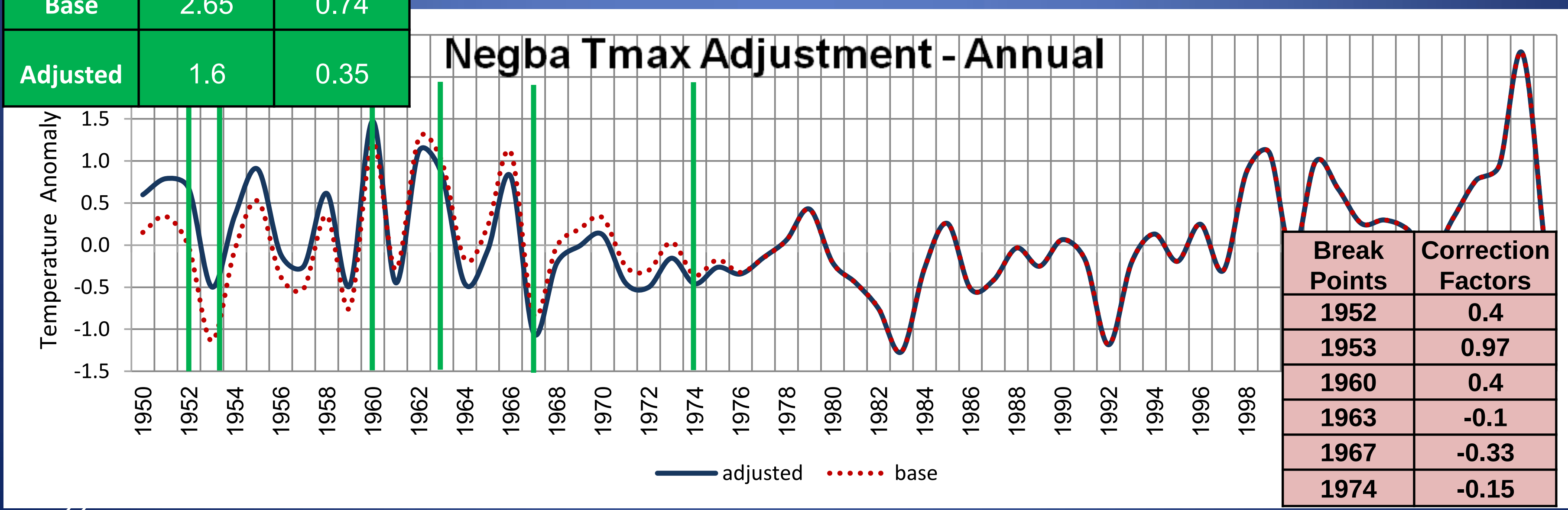

Negba: Adjustments minus base
Correction factor [ºC]
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1950 1952 1954 1956 1958 1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010
diff manual
diff RHtestsV3(mean adj)
diff ACMANT
diff RHtestsV3(Q.M)

Adjusted series and correction factors



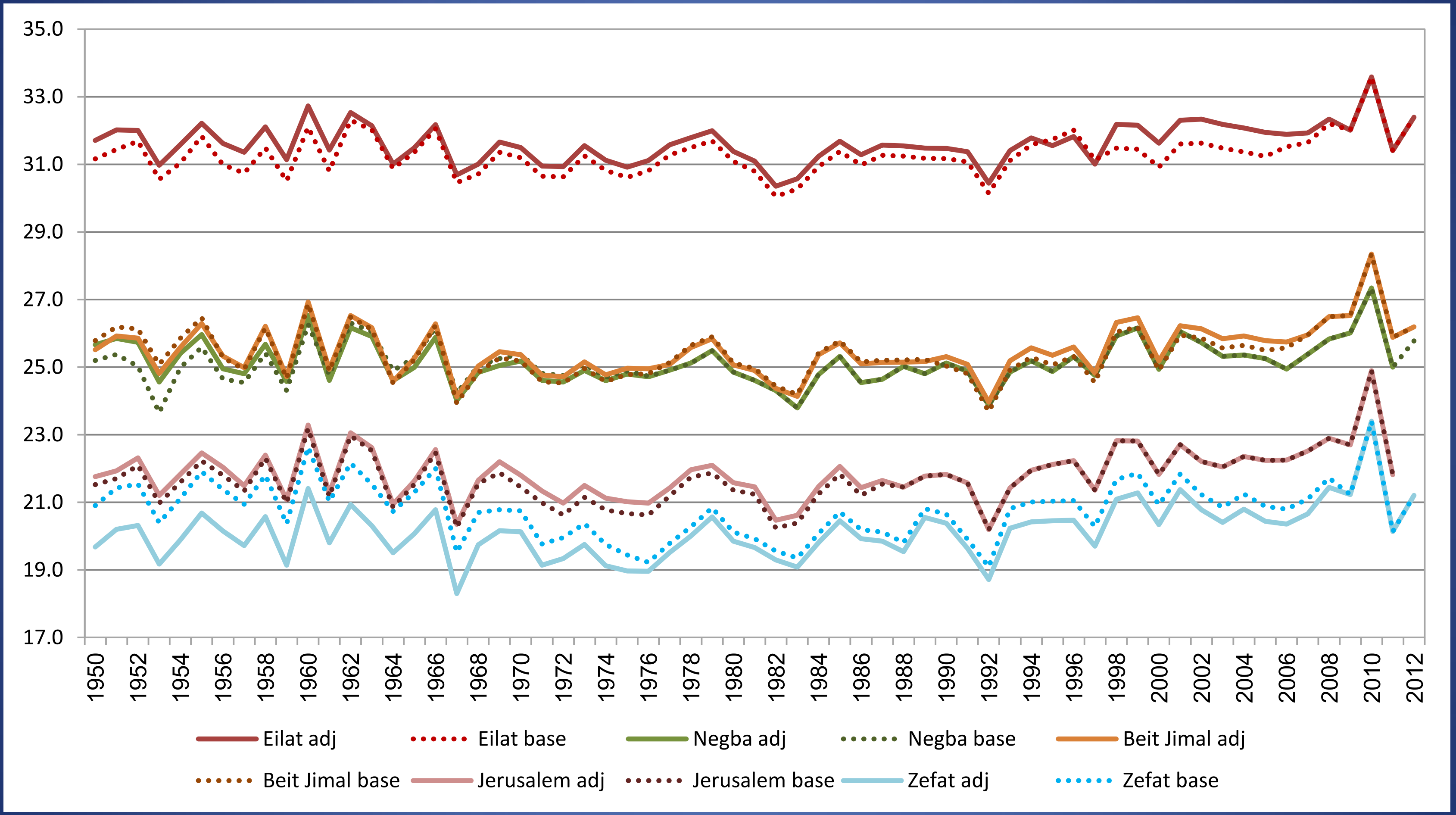
Break Points	Correction Factors
1965	0.39
1970	0.63
1977	0.47

^{o}C/100y	TN	TX
Base	2.65	0.74
Adjusted	1.6	0.35

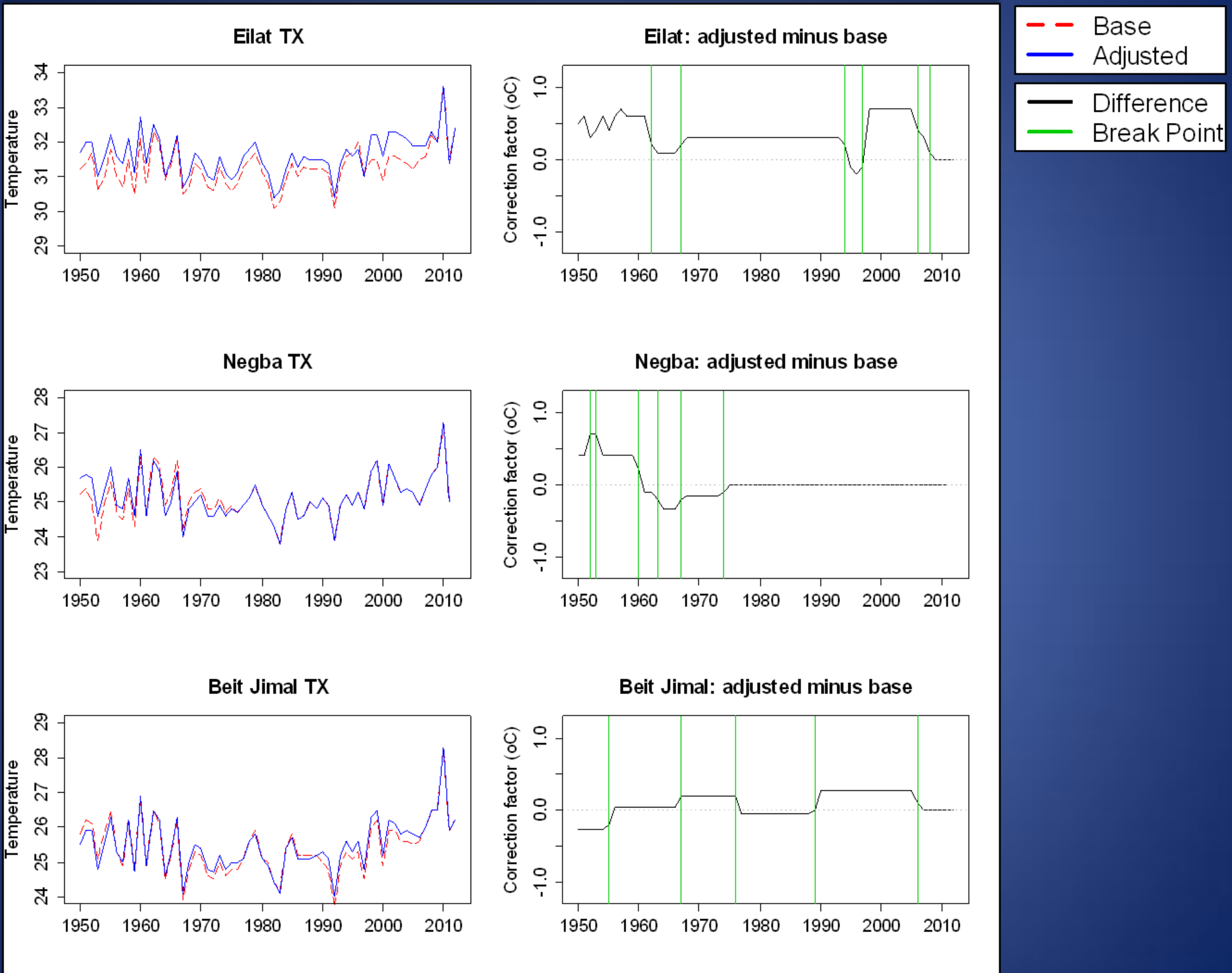


Break Points	Correction Factors
1952	0.4
1953	0.97
1960	0.4
1963	-0.1
1967	-0.33
1974	-0.15

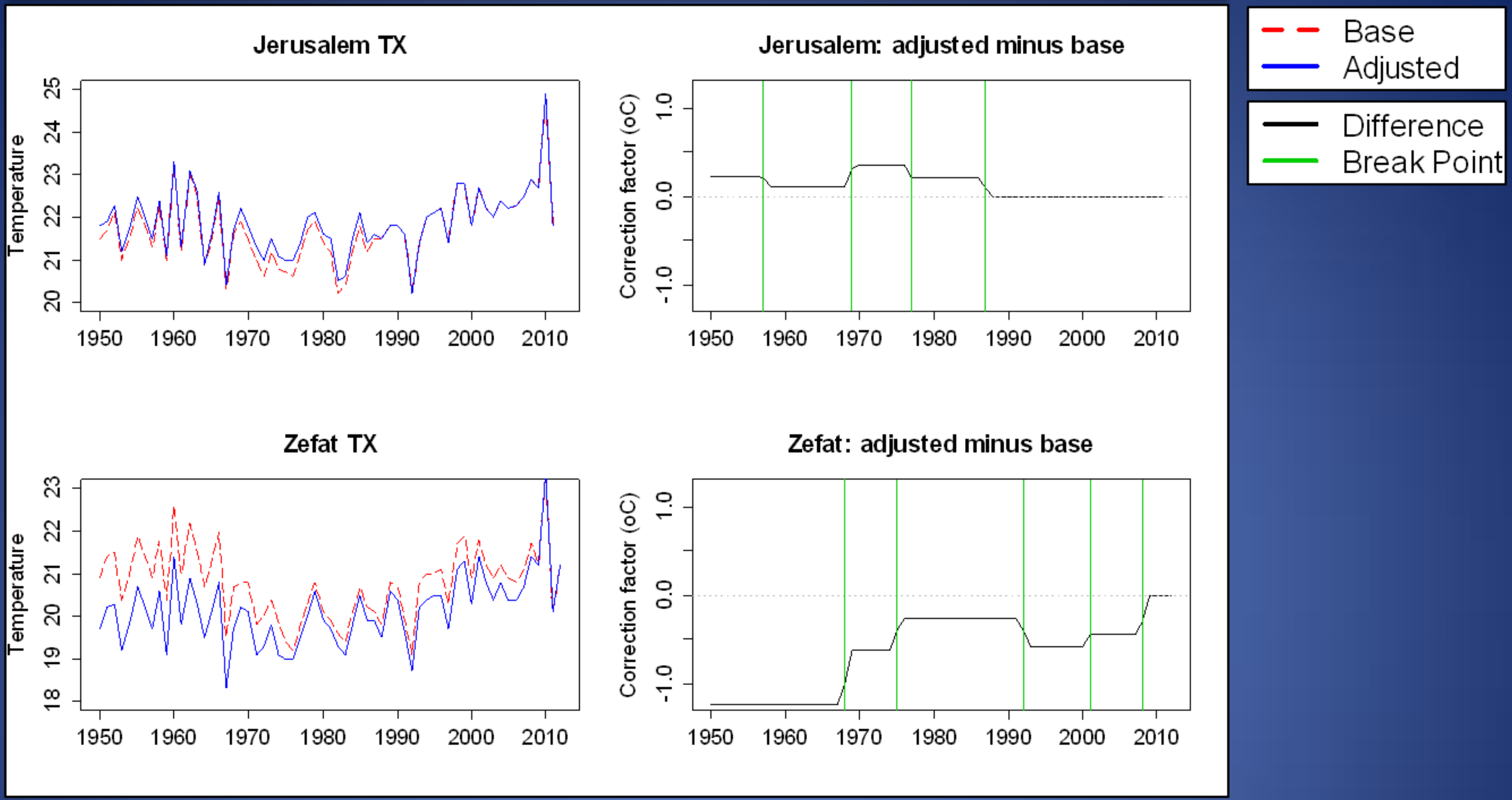
TX series results: adjusted vs. base



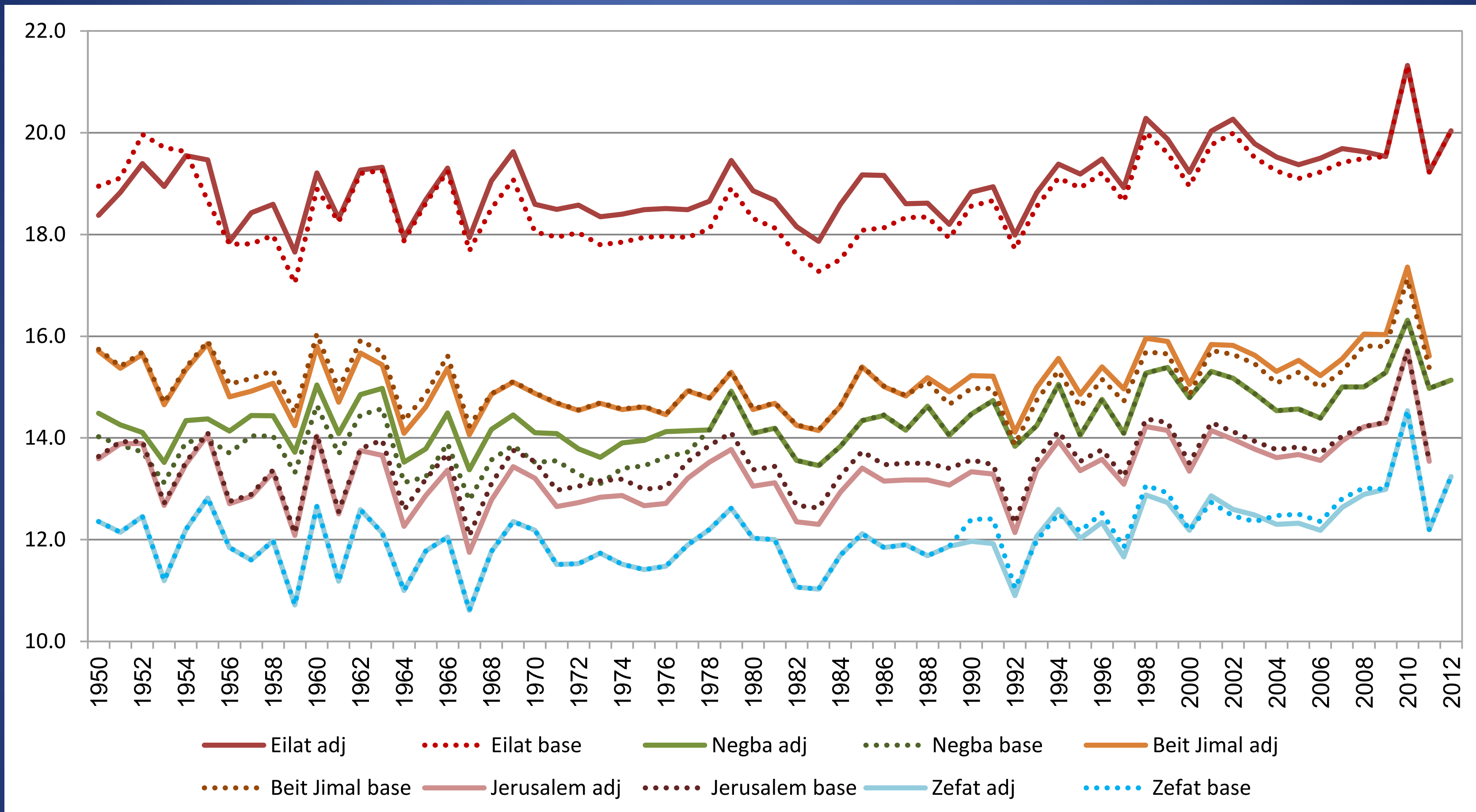
TX series results: adjusted vs. base



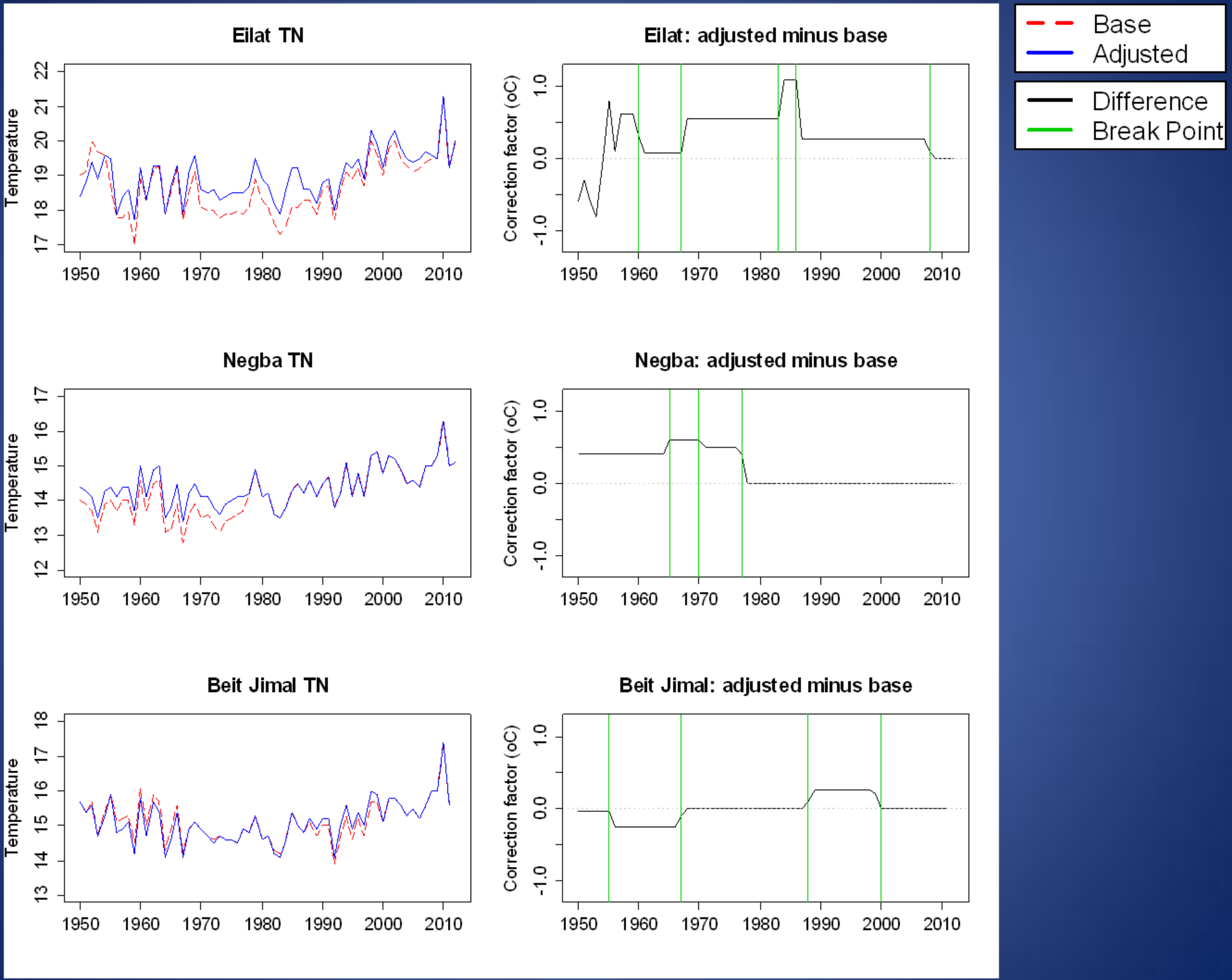
TX series results: adjusted vs. base



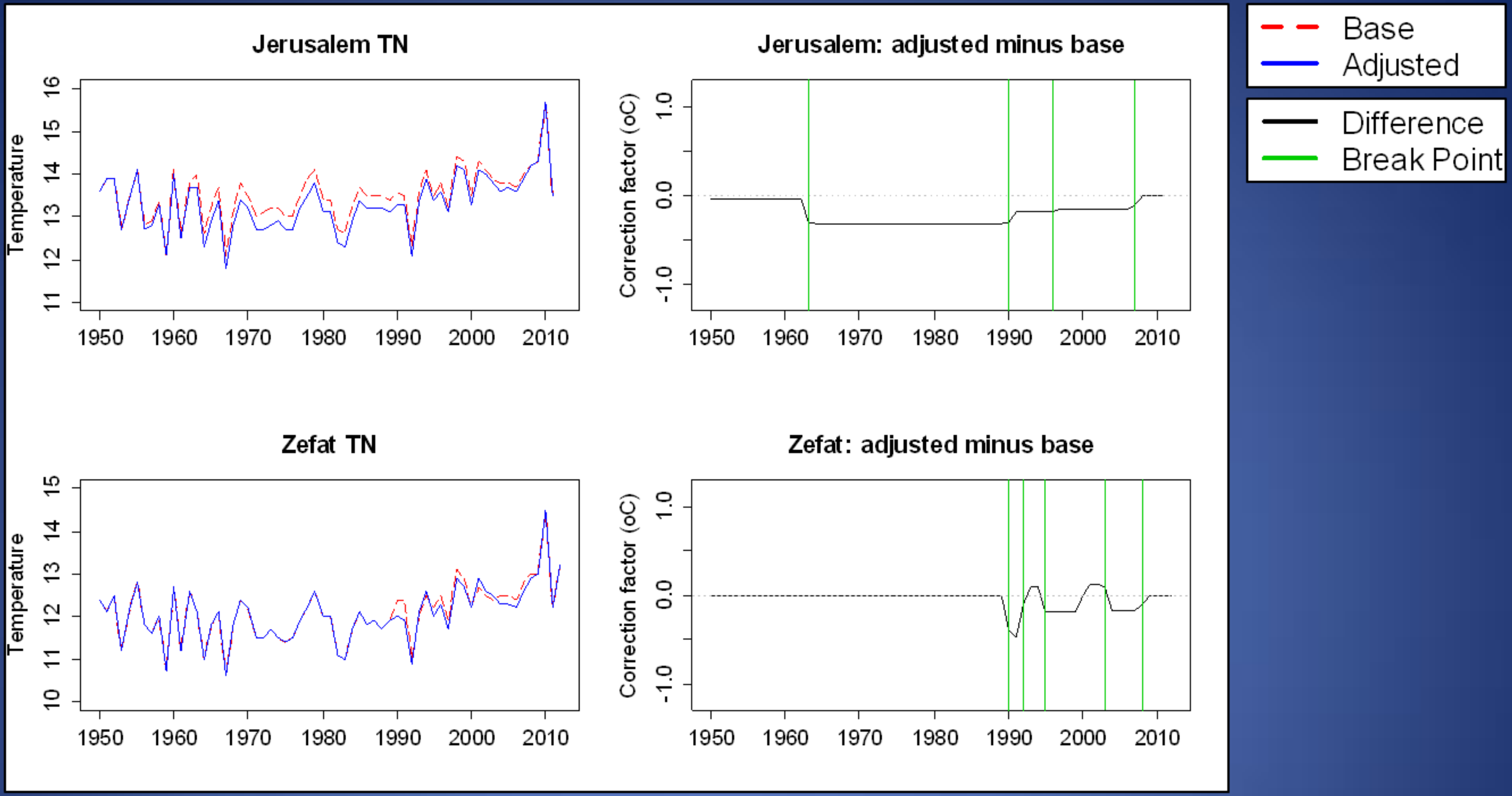
TN series results: adjusted vs. base



TN series results: adjusted vs. base



TN series results: adjusted vs. base



Conclusions and Summary

- The absolute tests are insufficient for Israel because they detect the real climate signals as break-points.
- Using cluster analysis as a preliminary step for building the reference series improves the final results in two ways:

  (a) prevent some false break-points detections.

  (b) help finding a more appropriated adjustment factor.
- When building one reference series it is important to know the strengths and weaknesses of the series.
- An integrated approach allows you to get an optimal break-point location and data adjustment factor.

Thank You for your attention!

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