Homogeneity tests on surface data using 20CR and ERA-20C as reference series

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Work Package 4 ERA-CLIM2

ERA-CLIM2 2nd General Assembly 9-11 December 2015

WP4: Quantifying uncertainty

Task 4.1 – Quality control, bias adjustment and homogenisation of input observations (22 persons / month)

D4.3. OQA report: QC, break detection and homogenisation for observations supplied by FFCUL (FFCUL)   month 36 (48)

D4.4. OQA report: A visualisation tool for QC (FFCUL)   month 12 (D)

Outline

 Update on D4.4

 Break detection in surface pressure, temp series using 20CR and ERA-20C

1 - Angra (Azores)

2 - Ponta Delgada (Azores)

3 - Funchal (Madeira)

WP4: Quantifying uncertainty

Update on D4.4. OQA report: A visualisation tool for QC (FFCUL)

- CQ_SURFACE is a tool (originally written in Fortran and using GNUPLOT) that allows the user to perform quality control tests to meteorological surface observations series

  - CQ_SURFACE
  1. Quality control
  2. Deliver products – Error files, Formatted data (ISPD and ERA-CLIM), QC flags, stats
  3. Visualization (graphics)

Developed for Windows, has now been implemented for LINUX.

The source code needs to be compiled and linked in LINUX, whereas in Windows an executable file is provided by FFCUL.

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WP4: Quantifying uncertainty
D4.3 QC, break detection and homogenisation for observations supplied by FFCUL (FFCUL)

Software:

RhTestsV4 (Wang and Feng, 2013) Penalised Maximal F, t-tests

Without reference series (Wang2008a)

With reference series (Wang 2008)

Observations:

Annual mean surface pressure and temperature at 9h and 21h (local time), Tmax,Tmin Azores (Angra and Ponta Delgada) and Madeira (Funchal) 1871-1936
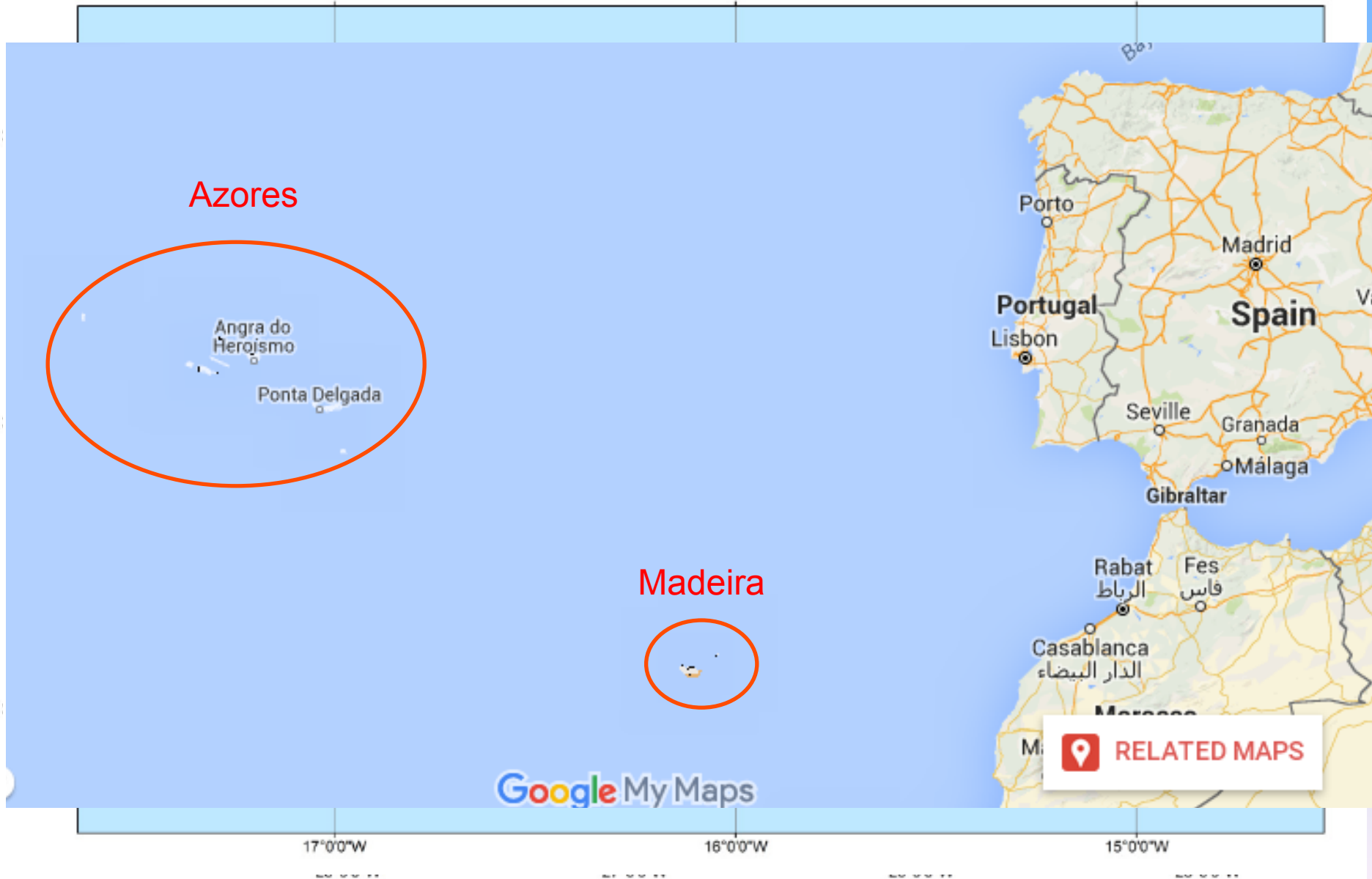
Reference series:

Annual mean slp and mslp and surface temperature

20CR (Compo et al, 2011)

ERA-20C (Hersbach et al, 2015; Poli et al, 2013)

Annual mean mslp ICOADS (Woodruff et al, 2011)

WP4: Quantifying uncertainty

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Metadata:

Location changes of Azores and Madeira stations are described in the IDL Annales (the data source) up to 1946. Portuguese Met Service has also basic metadata location information until present time.

No information was found about instrumentation changes or methodologies.

There are to be expected at least barometer changes, if the metadata for Lisbon/Geophysical Institute (the Central Observatory until 1946) is taken into account.

Azores and Madeira pressure data included in ISPDv3 (1871-1888), but not in ISPDv2:

Therefore the 20CR and ERA-20C data series used as reference series are not affected by the observations being tested for breaks.

D4.3 Azores – Angra do Heroísmo 1872-1917

Station: Angra do Heroísmo
Variable: Pressure 9h, 15h, 21h
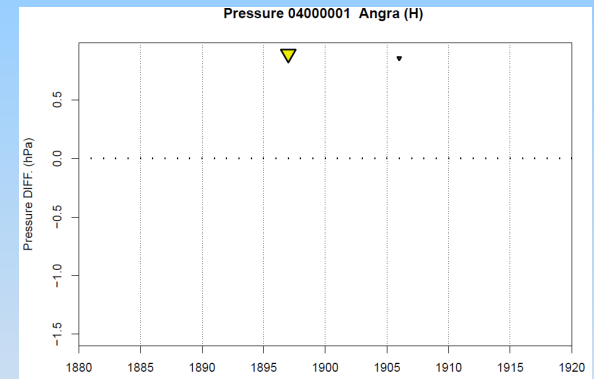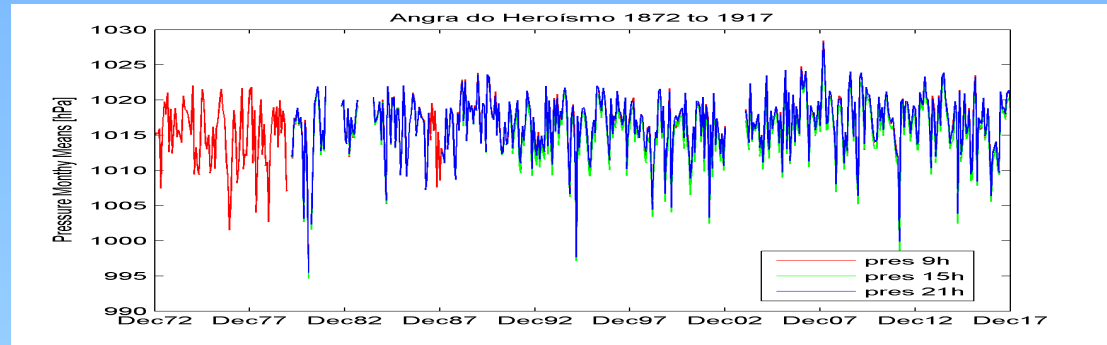Sample: Montly mean

RhtestV4

5 change points found
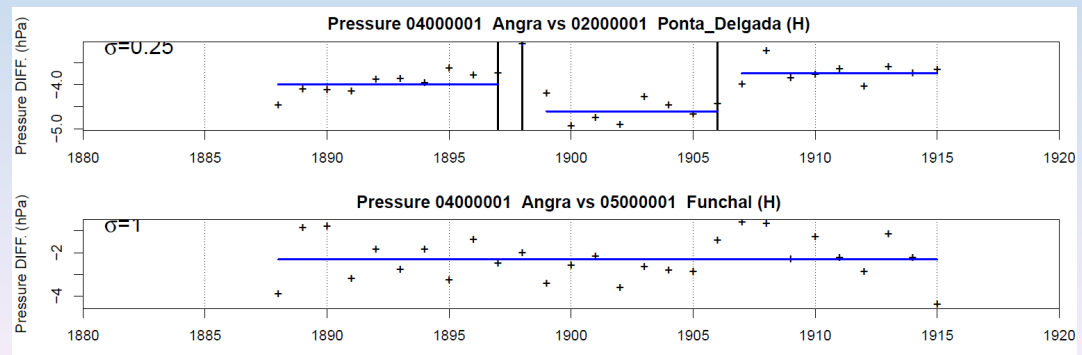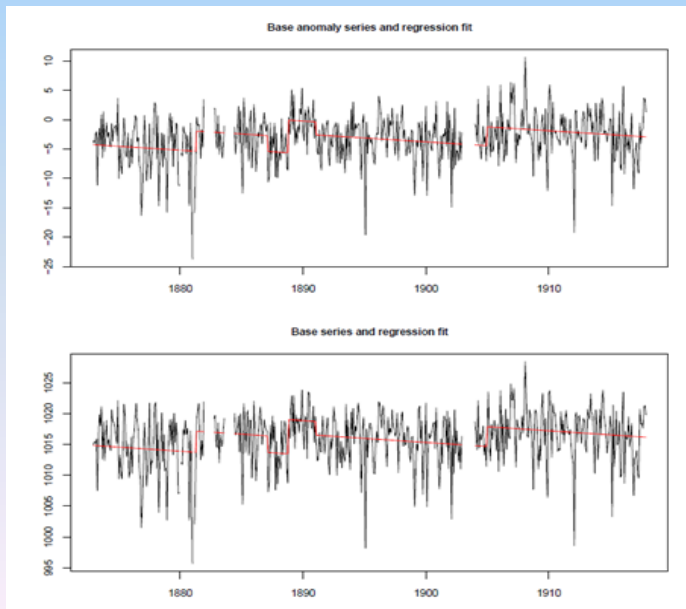0 Yes   188104 – Supported by metadata
0 YifD 188702
0 Yes   188810
0 YifD 189101
0 YifD 190412

Homer 2.6 Joint detection

0 Break points

Angra do Heroísmo 1872 to 1917

Pressure 04000001 Angra (H)

Base anomaly series and regression fit

Base series and regression fit

Pressure 04000001 Angra vs 02000001 Ponta_Delgada (H)

Pressure 04000001 Angra vs 05000001 Funchal (H)

Surface pressure and mslp for observations, ICOADS, 20CR and ERA-20C (alt changes=54m,48m,44m,41m)

Angra do Heroísmo 1871 to 1936

Cor=0.75 to 0.9

Legend:
- 9h
- 21h
- ERA 20C MSL
- ERA 20C SP
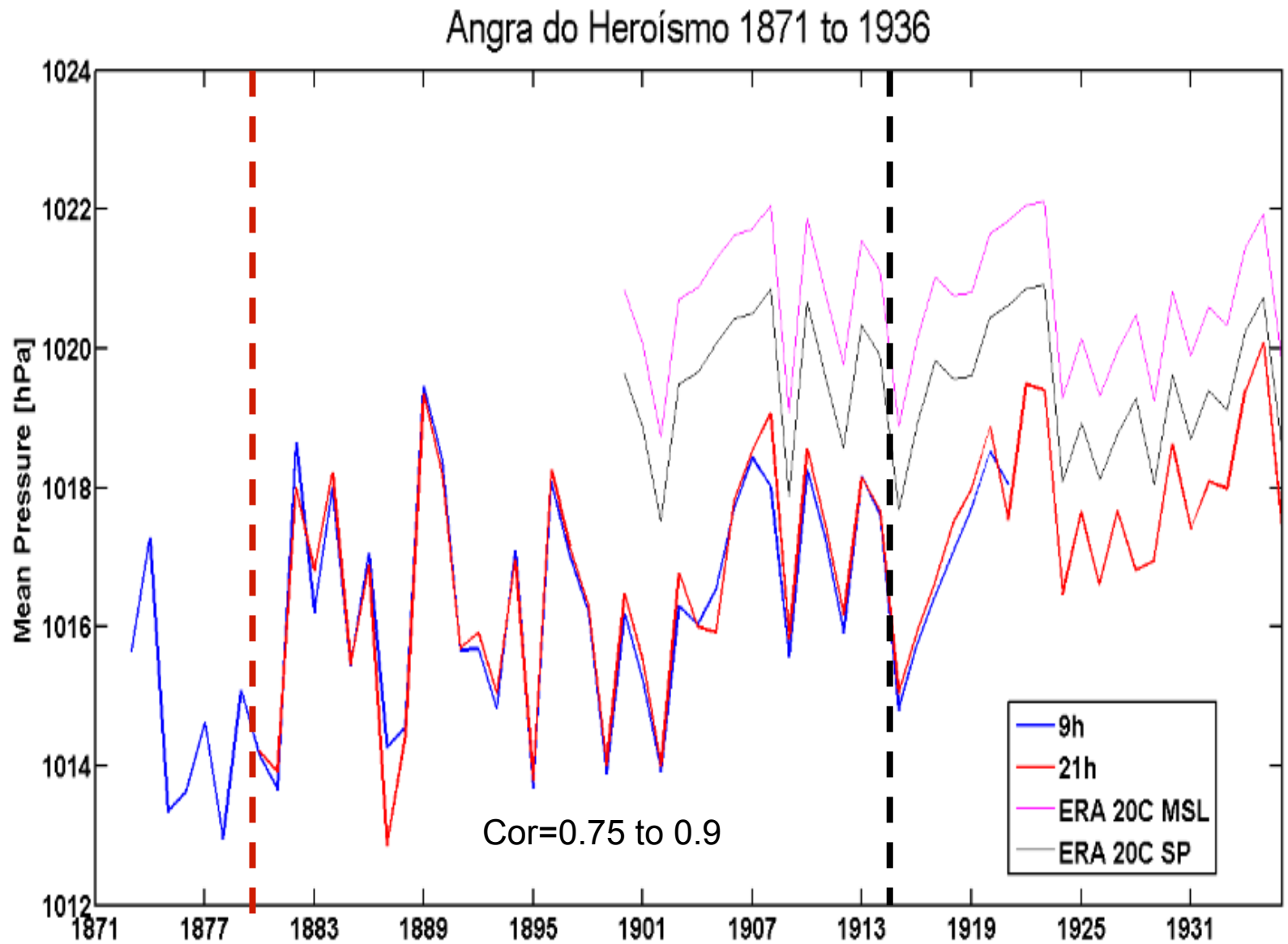
Mean difference MSLP-SP for NOAA 20CR
Negative for Azores and Positive for Madeira
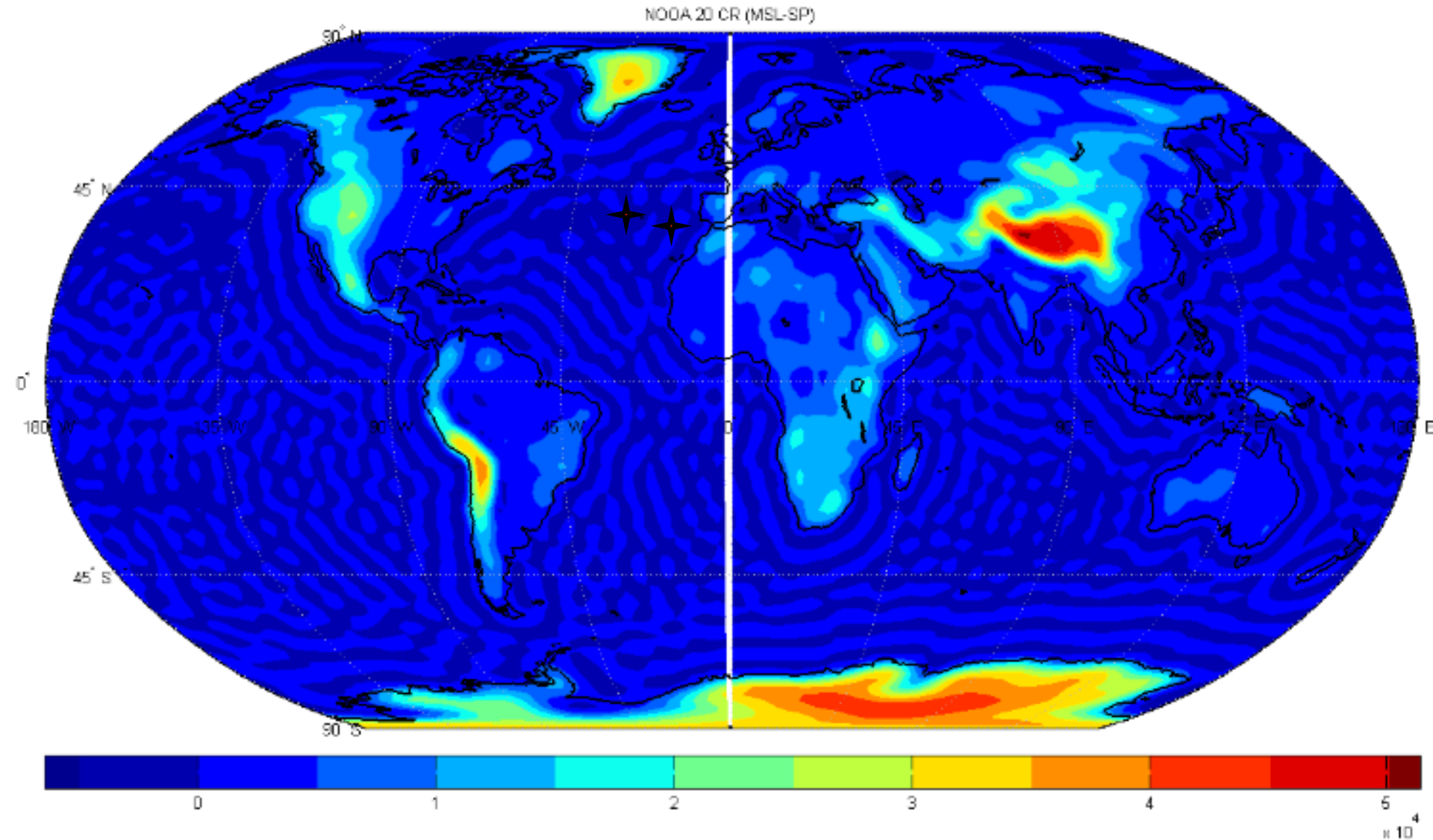
Testing the homogeneity of Angra do Heroísmo annual surface pressure
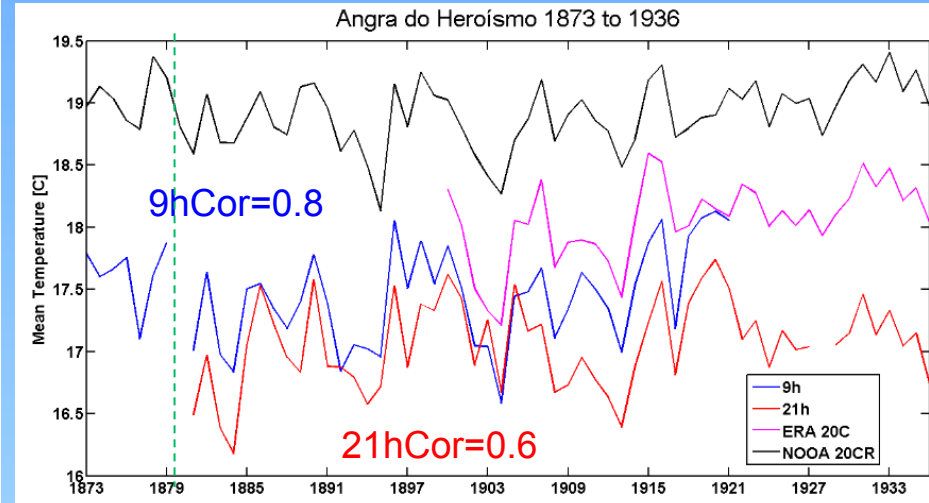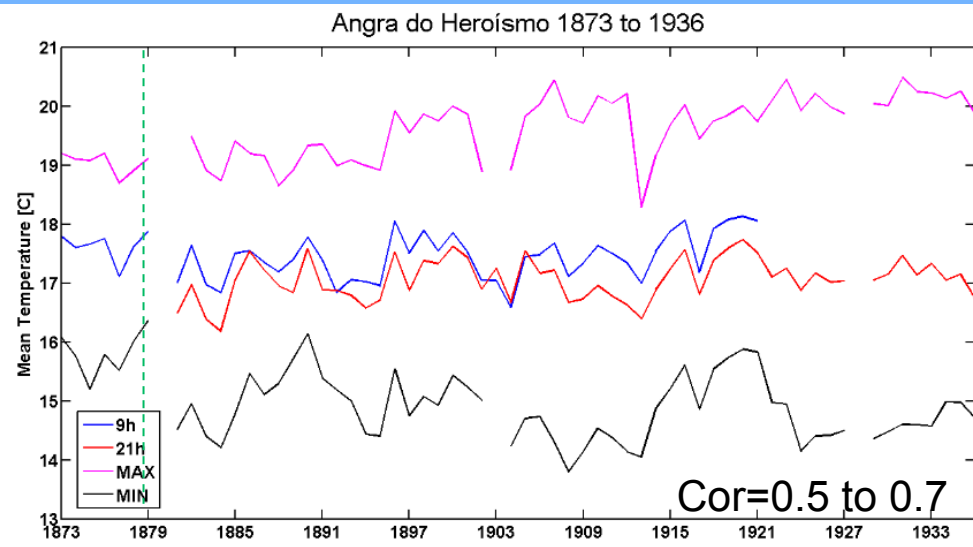
Absolute tests give no breakpoints

Relative tests are rather inconclusive

ICOADS has a low correlation with observations

Breakpoints are detected in 1897 (20CR) and 1905/1906 (20CR and ERA-20C)
None is supported by metadata.

1905 had already appeared when tested against other reference series in Azores

Barometer location changes occur in 1878/1879 (site) and 1913/1914 (height change).

Angra do Heroísmo 1873 to 1936

Cor=0.5 to 0.7

9hCor=0.8
21hCor=0.6

Testing the homogeneity of Angra do Heroísmo surface temperature

Absolute tests give no breakpoints

Breakpoints appear in 1913 (20CR) and 1904/1905 (20CR and ERA-20C)
Again none is supported by metadata.

Thermometer location changes occur in 1878/1879 (site)

Results are again inconclusive although a case could be made for a correction
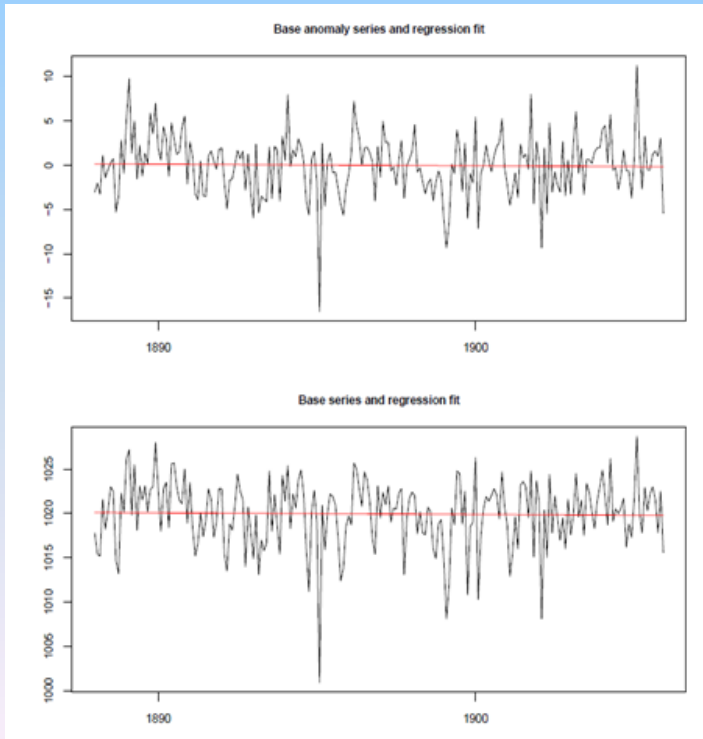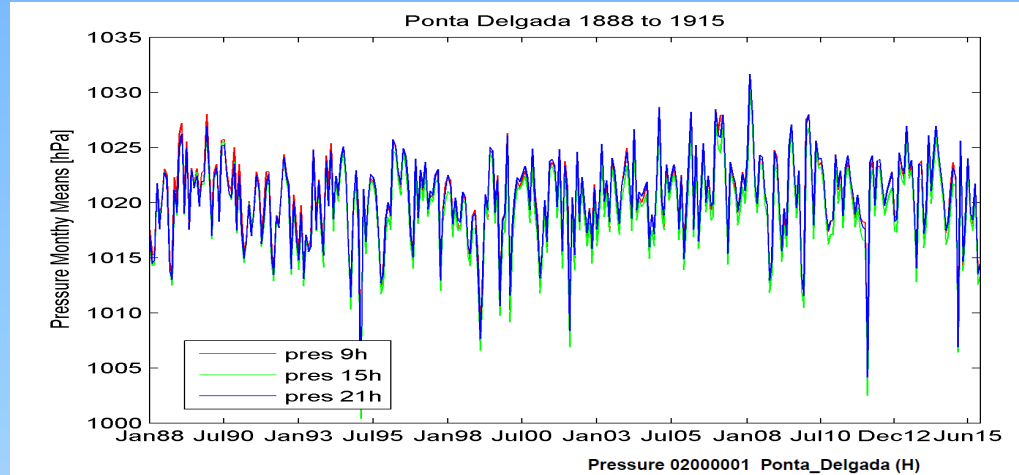before 1879 for the minimum temperature.

D4.3 Azores – Ponta Delgada 1888-1915

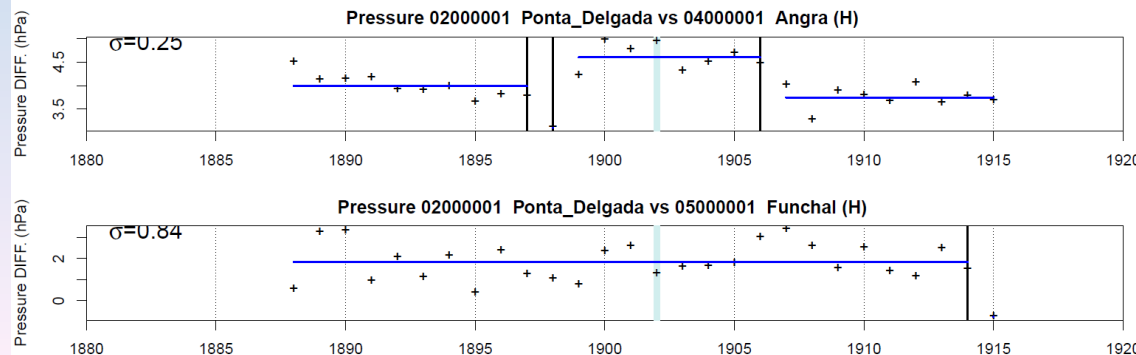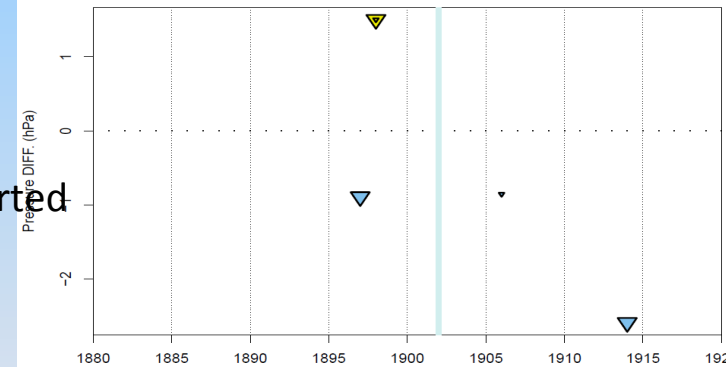Station: Ponta delgada

Variables: Pressure 9h, 15h, 21h

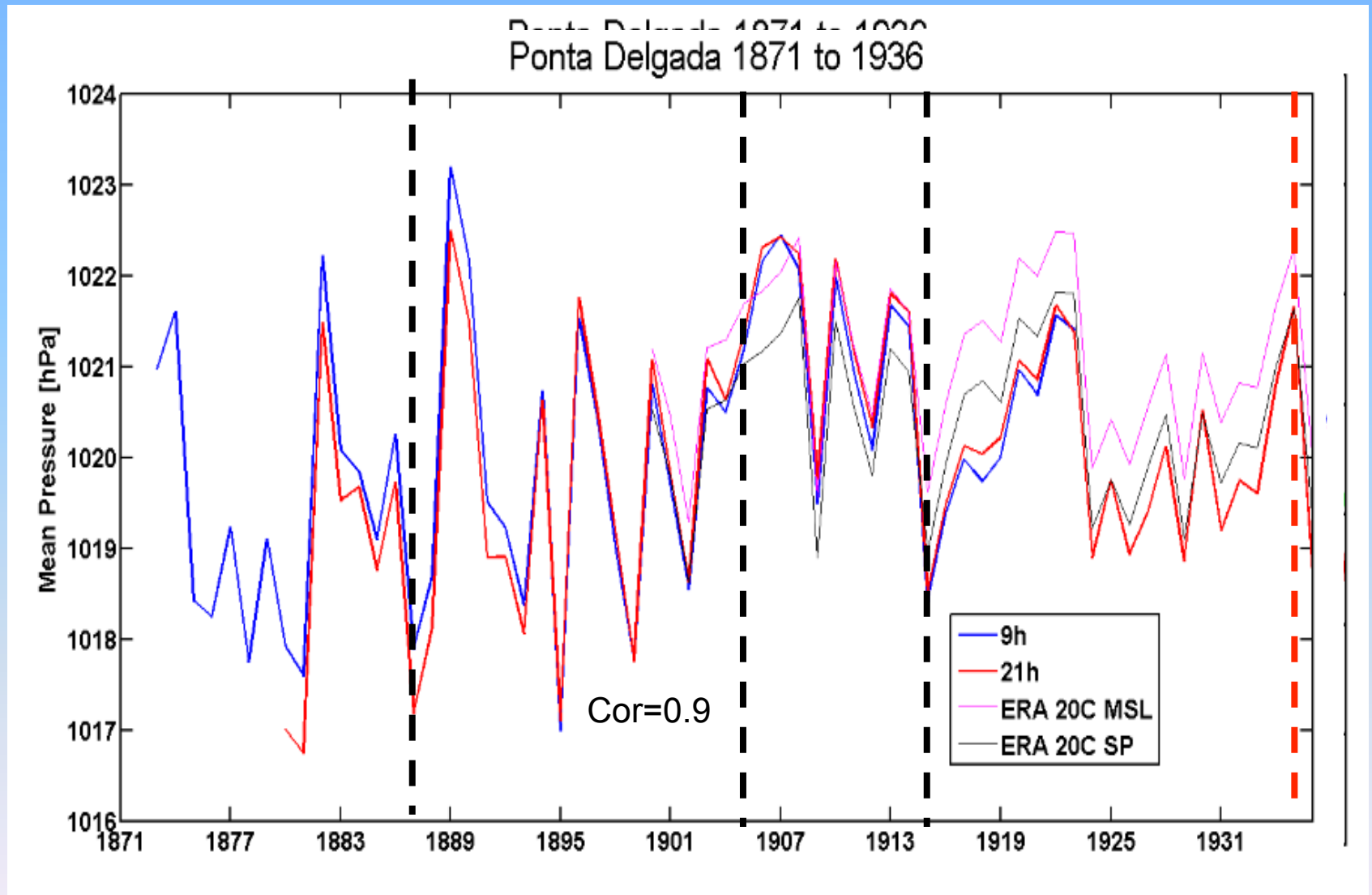Sample: Montly mean

RhtestsV4
0 change points in Series

Homer 2.6 Joint detection
BREAK 1902- not supported by the metadata

Surface pressure and mslp for observations, ICOADS, 20CR and ERA-20C (alt changes=20m,17m,22m,136m)

Ponta Delgada 1871 to 1936

Cor=0.9

Legend:
- 9h
- 21h
- ERA 20C MSL
- ERA 20C SP

Ponta Delgada is one of the original NAO nodes

Testing the homogeneity of Ponta Delgada annual surface pressure

Absolute tests give a 1923 breakpoint in the 21h series.

Relative tests identify Breakpoints in 1913/1014 (20CR and ERA-20C) and 1905 (ERA-20C)
1913/1914 is supported by metadata.

Barometer location changes occur in 1935/1936 (site) and 1887/1888, 1905/1906 and 1914/1915 (height change).

The surface pressure series in Ponta Delgada are inhomogeneous and have to be corrected.

We should verify the Ponta Delgada series that has been used internationally to calculate the NAO.

Ponta Delgada 1873 to 1936
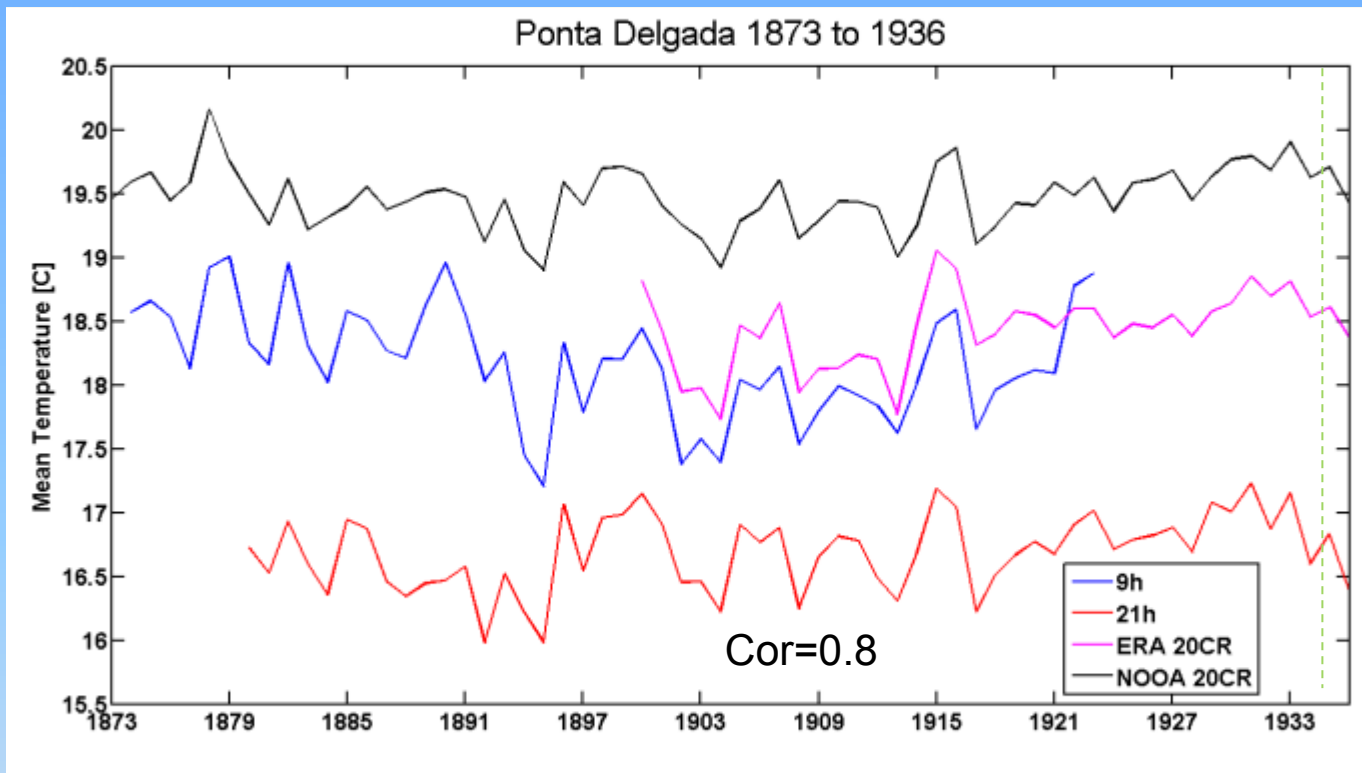
Testing the homogeneity of Ponta Delgada surface temperature

Absolute tests give breakpoints for the 9h series in 1891 and 1901 but thermometer location changes only occur in 1935/1936 (site)

Results are inconclusive for relative tests but the possibility of the series being inhomogeneous around the 1890 years should be further investigated.

D4.3 Madeira – Funchal 1873 - 1915

Station: Funchal

Variable: Pressure 9h, 15h, 21h

Sample: Montly mean

RhtestsV4

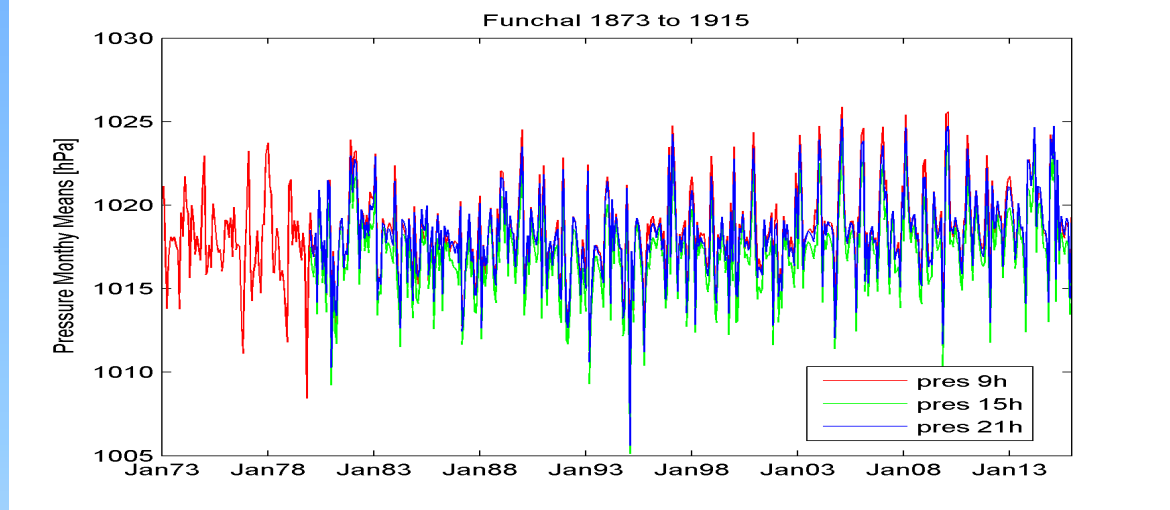6 change points in Series
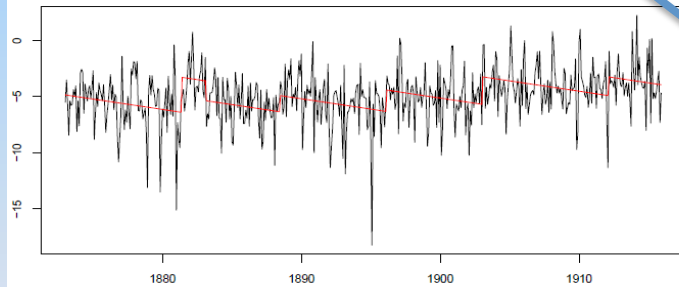0 Yes   18810500
0 YifD 18830200
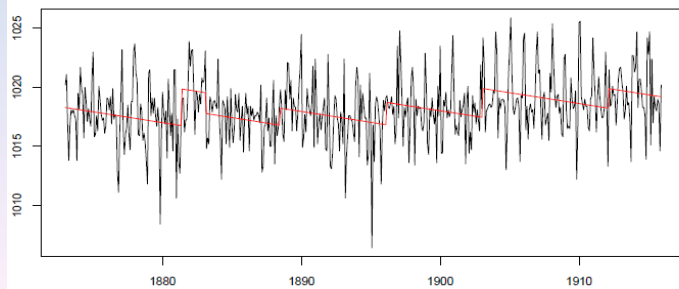0 YifD 18880600
0 YifD 18960200
1 ?   19030100
0 YifD 19120200

Funchal 1873 to 1915

Homer 2.6
Joint detection

Break point not
supported by
metadata

Pressure 05000001 Funchal (H)

BREAK 1898 3

Base anomaly series and regression fit

Base series and regression fit
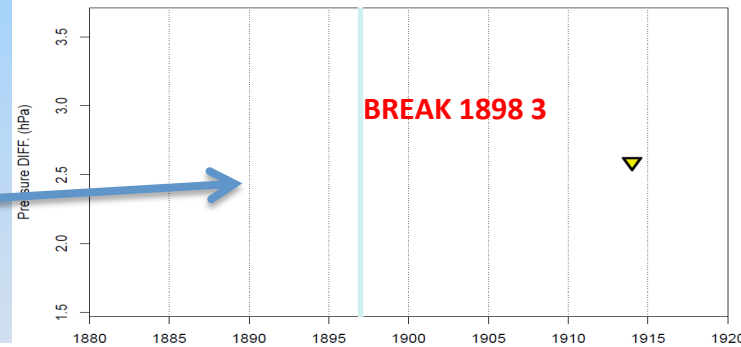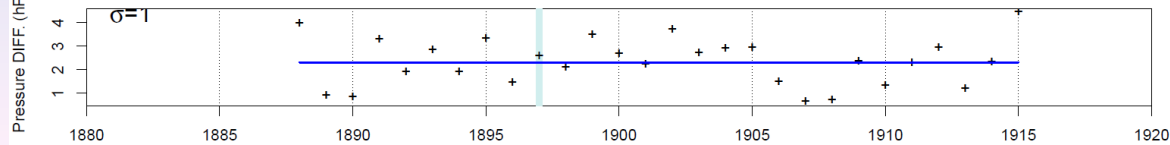

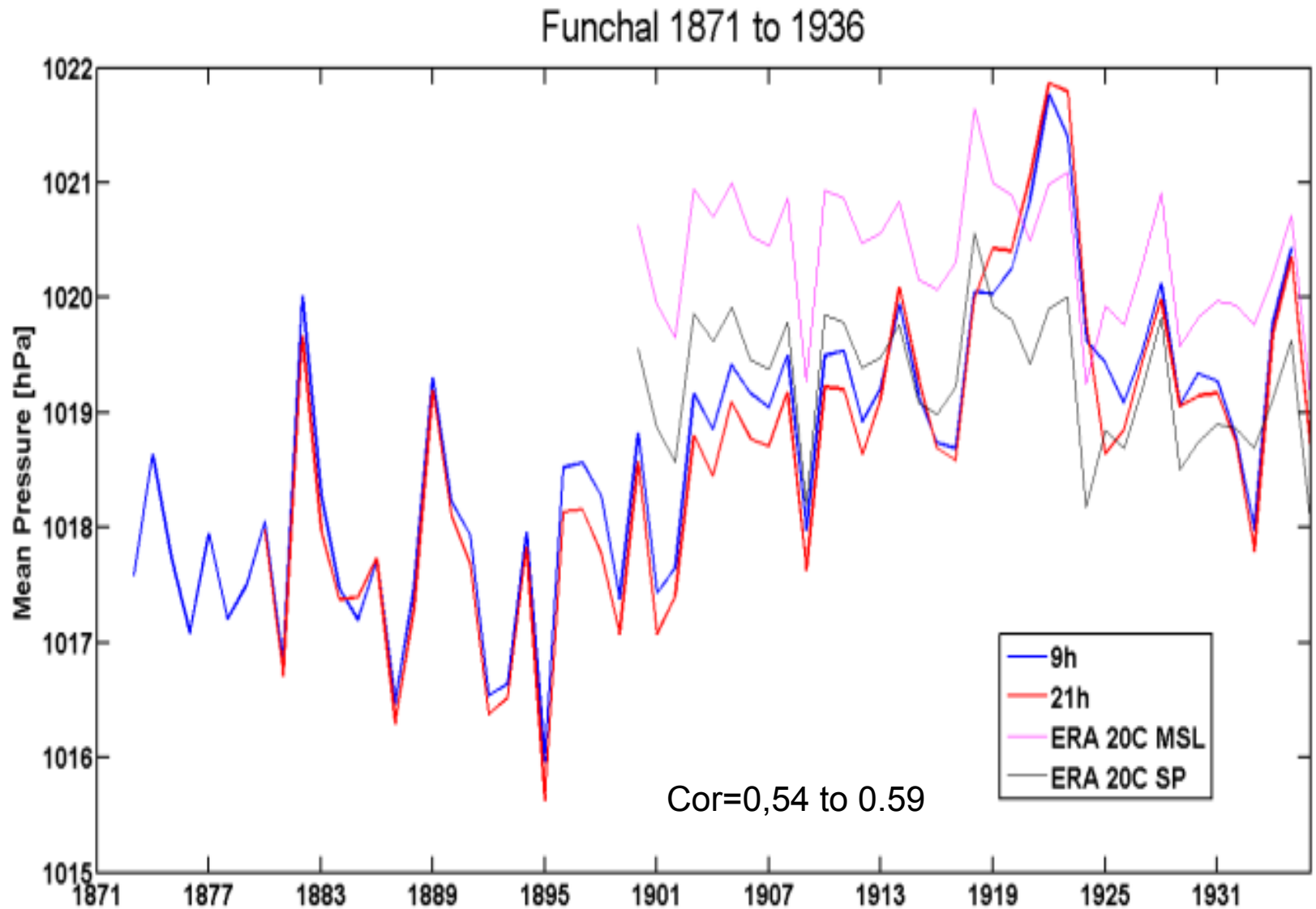Pressure 05000001 Funchal vs 02000001 Ponta_Delgada (H)

σ=0.84
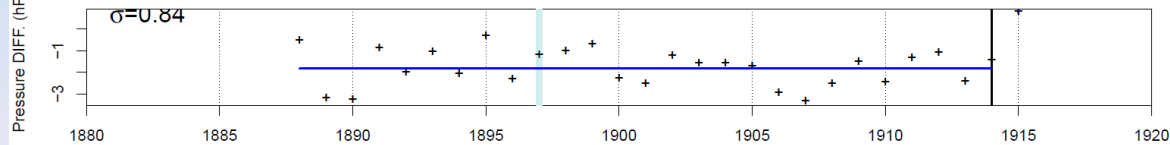
Pressure 05000001 Funchal vs 04000001 Angra (H)

σ=1

Surface pressure and mslp for observations, ICOADS, 20CR and ERA-20C (altitude=25m)

Funchal 1871 to 1936

Testing the homogeneity of Funchal annual surface pressure

Absolute tests give a 1923/1924 breakpoint in the 9h and 21h series.

Relative tests identify Breakpoints in several years with the most significant ones being in 1917 and 1924 (ICOADS, 20CR and ERA-20C)

None of the breakpoints is supported by metadata.

There are no barometer changes in location during the 1871-1936 period.

The observed series presents a steep positive trend in pressure that is only mirrored in part by 20CR. The peak values around 1922-23 are not reproduced by any of the reference series.

These observed pressure values should be investigated more thoroughly in relation to observation methodologies, possibility of instrument changes, etc.

For comparison purposes the Lisbon pressure series is shown below and doesn't show a clear positive trend between the 1900's and the 1920's
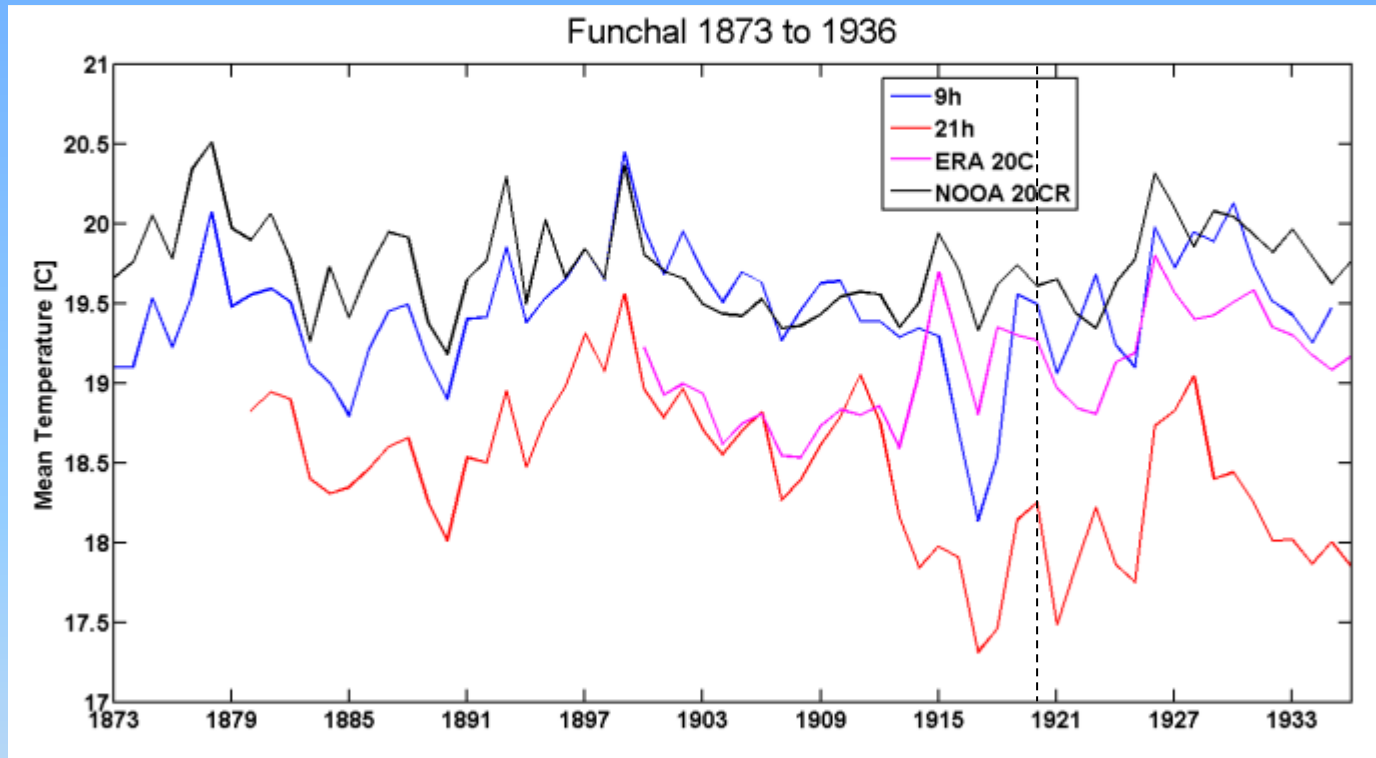

Lisbon annual pressure series, 9h
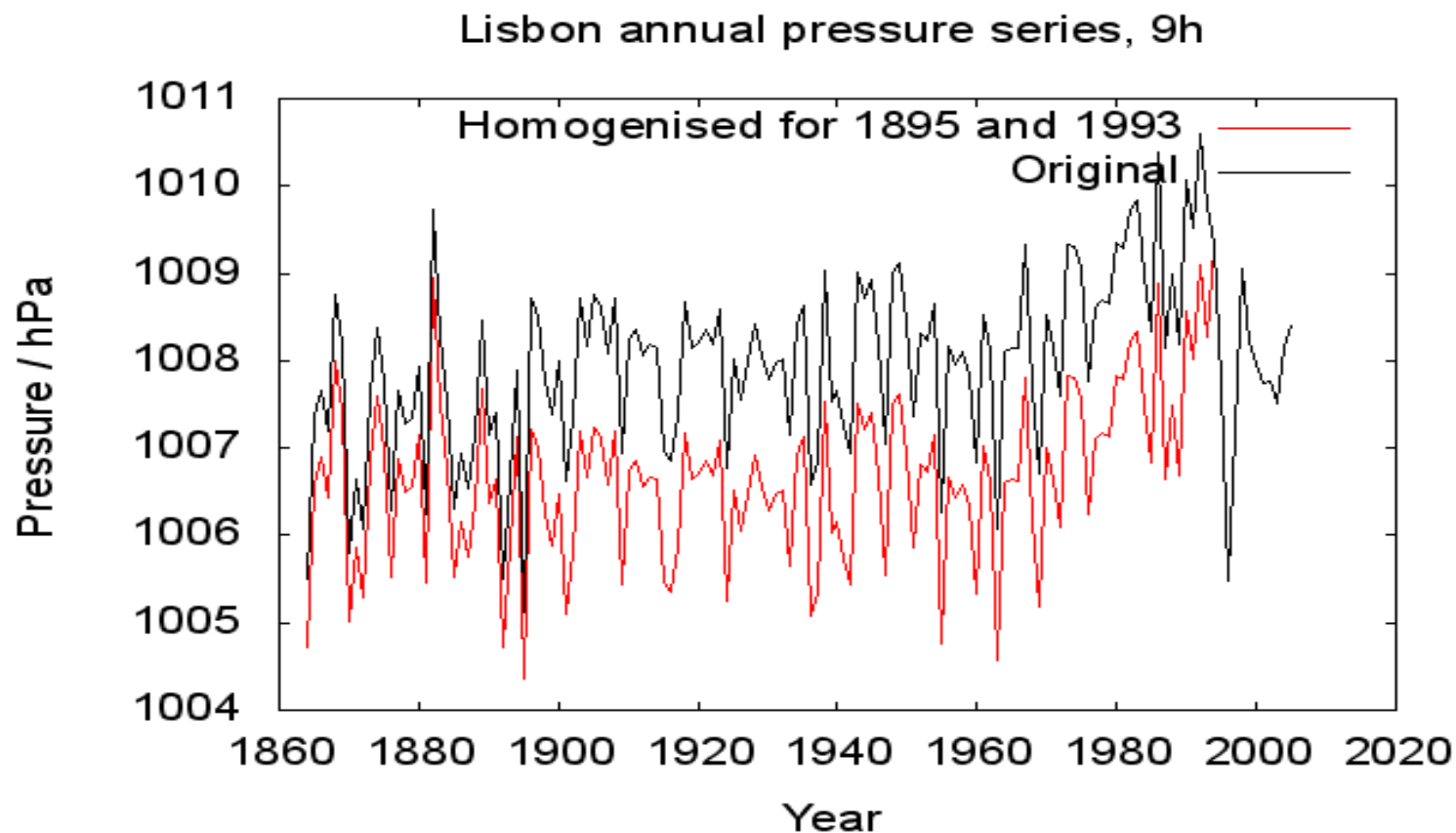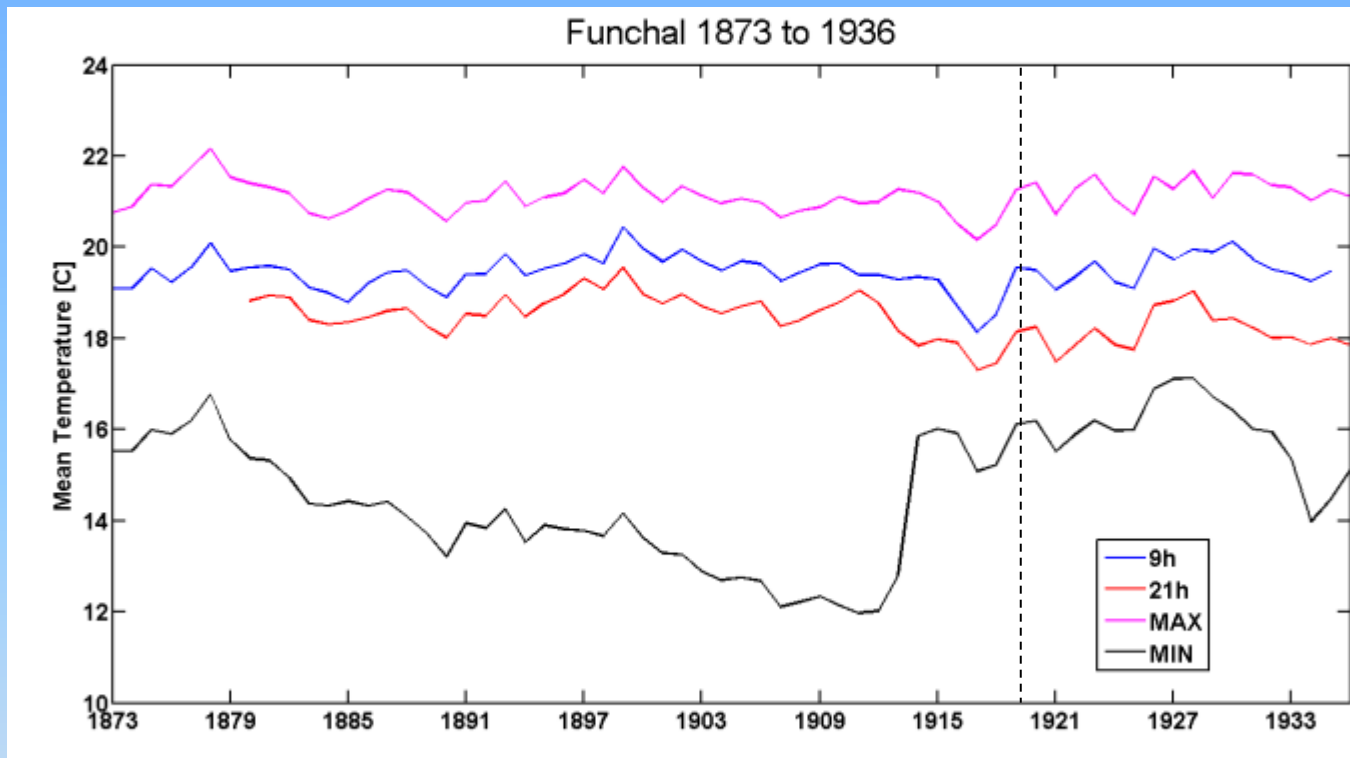
Surface Temperature series for Funchal, Tmax and Tmin

Just by visual inspection, a very clear breakpoint appears in the Tmin series in 1913 that needs to be corrected.

The thermometers changed their height by 7m in 1920.

Funchal 1873 to 1936

Testing the homogeneity of Funchal surface temperature

All tests with reference series detect a breakpoint in 1913 in the 9h and 21h series.

The series correlations are however rather low:
Between 0,36 and 0.54 for the 20CR case and between -0.08 and 0,22 for ERA20C.