

Towards homogenizing land surface data: QC and breakpoint detection

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Work Package 4 ERA-CLIM2

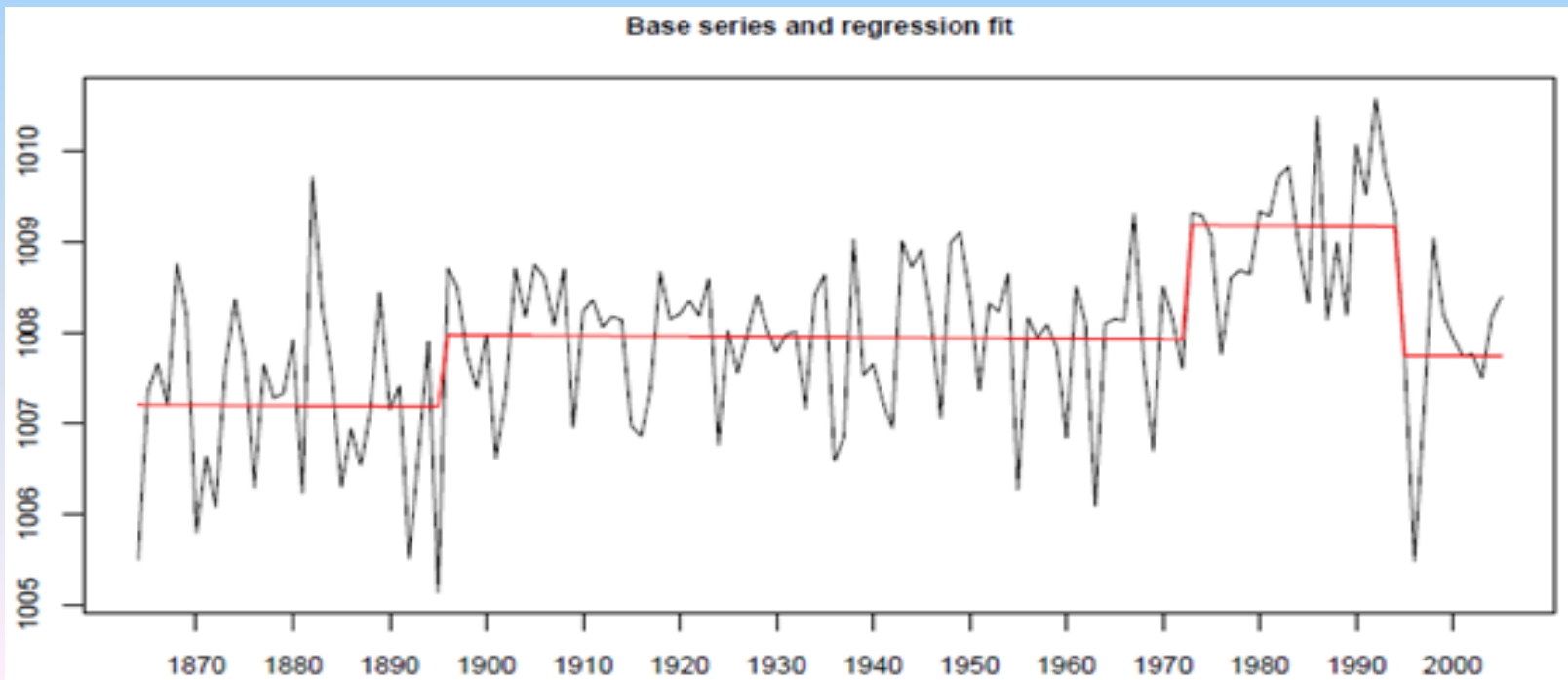
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Land surface Variables Assimilated – mslp or surface pressure

In ISPD V3 we have contributed for the 20th century essentially with sub-daily data for

- 1863-2006 Lisbon pressure series
- 1893-2007 Porto pressure series
- 1946-1996 Coimbra pressure series

Lisbon annual pressure series tested by RHtestsV3 without reference series (PMFred model). Displayed is the base series with the estimated mean shifts and linear trend.

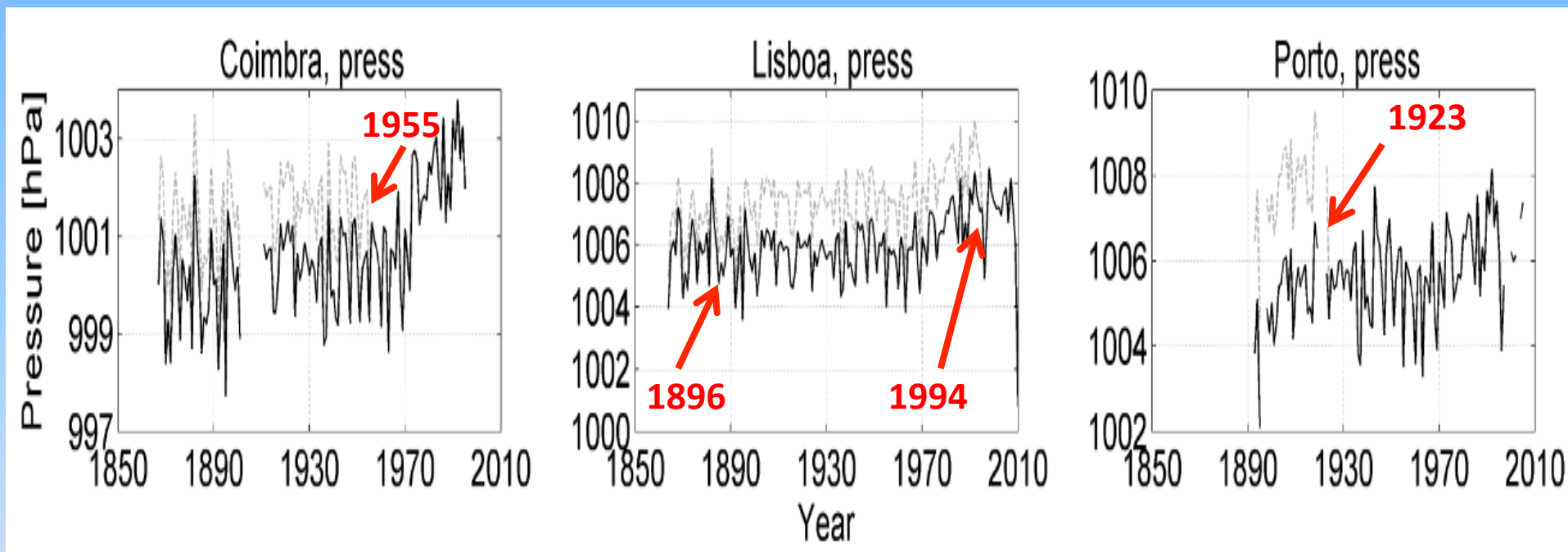


- ISPD V3 has also several Portuguese and former colonies stations from 1872 to 1888 including a 1861-1898 Porto Series

Objective: Detect breakpoints in the series and send a list to ECMWF

- We have applied several homogeneity tests to these pressure series
 - Tests have been performed in absolute and relative mode (RhtestsV3 & 4, HOMER)
 - With neighbouring stations, gridded observations or reanalyses data, including 20CR, ERA-20C.
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- We also have compiled metadata related to these stations
 - Listed the dates with metadata changes
 - Confronted them with the homogeneity tests results i.e. the dates with breakpoints

Surface Pressure Breakpoints



Coimbra: 1955 – Change of barometer

Lisbon: 1896, 1994 – Change of barometer

Porto: 1923 – Station closed during 1920-1922 – probable change of barometer

The list contains the breakpoints that coincide with metadata changes and one for which we can make a case for a non-documented metadata change (1923 in Porto is not documented).

We have continued to send new pressure series to ISPD which appear in more recent versions.

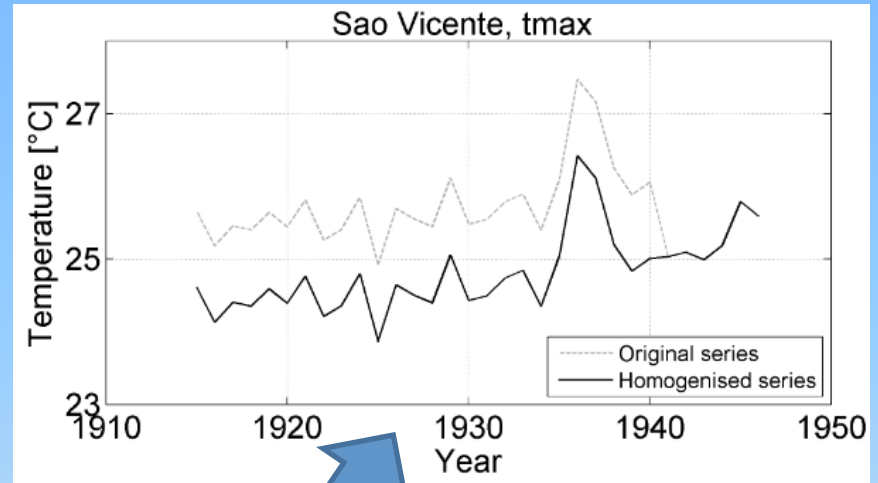
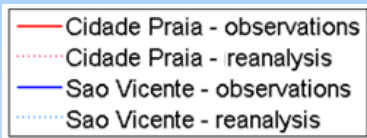
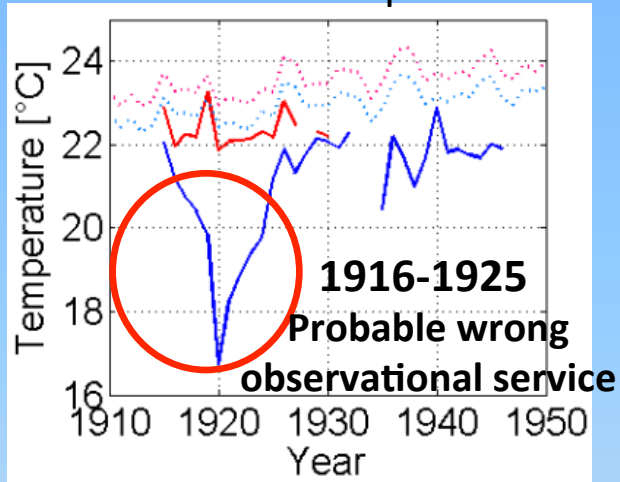
When (?) ECMWF updates the ISPD version that is used as input in the forthcoming Reanalyses, it will contain the

1915-1946 former Portuguese colonies pressure dataset

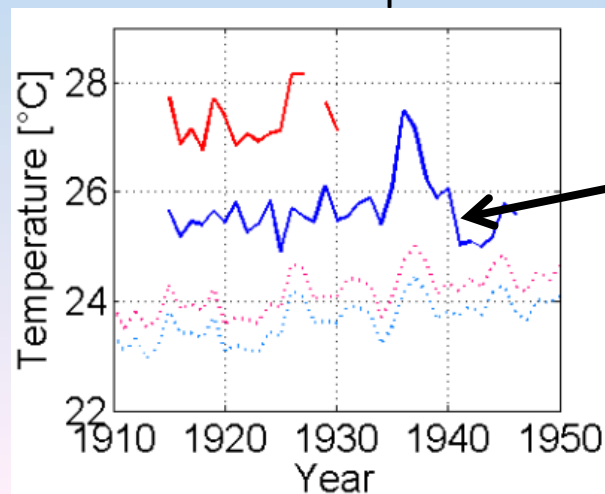
- ❖ Cape Verde – Cidade da Praia, São Vicente
- ❖ Angola – Luanda
- ❖ Mozambique – Maputo (Lourenço Marques), Inhambane, Beira, Quelimane
- ❖ Guiné-Bissau
- ❖ São Tomé
- ❖ India – Goa
- ❖ China Macau

Cape Verde – Cidade Praia (1915-1930), Sao Vicente (1915-1946)

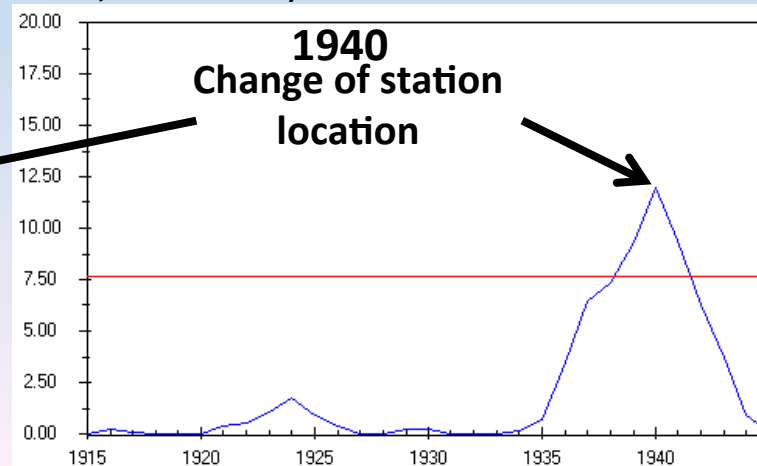
Minimum temperature



Maximum temperature

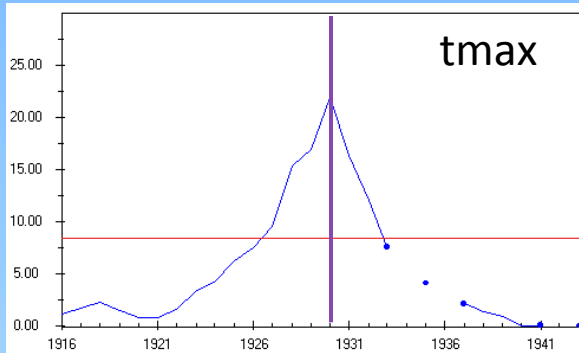


SNHT test with a critical value (95 % significance level) marked by red line, tmax, Sao Vicente

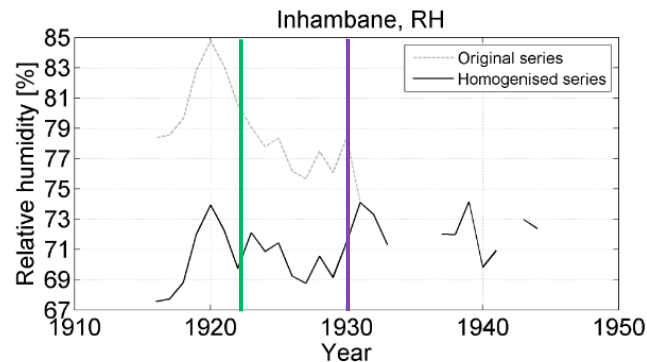
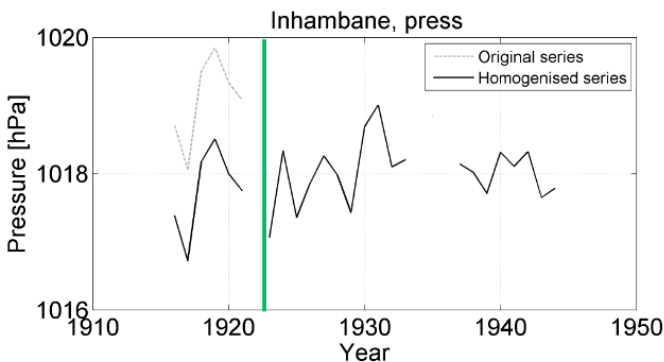
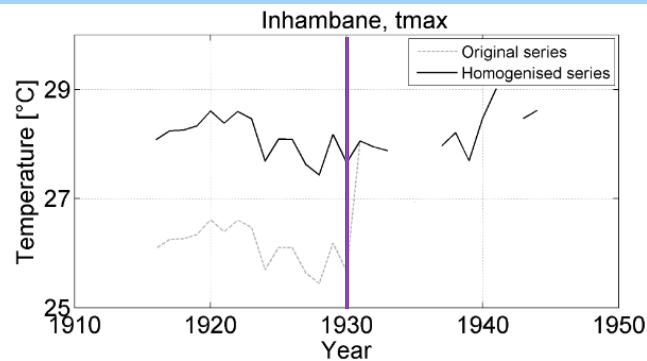
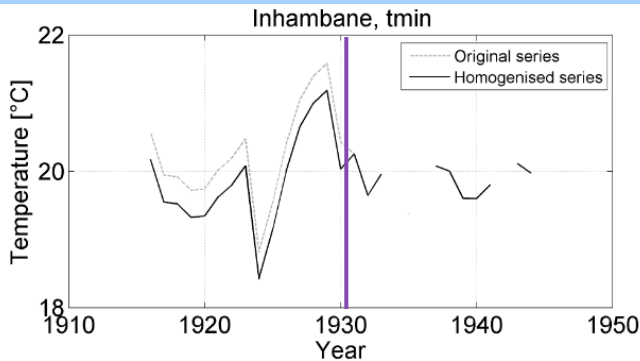
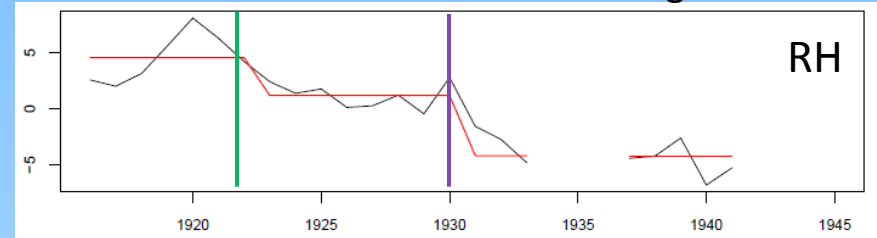


Mozambique – Inhambane (1916-1944)

Test statistic (bivariate test) with a critical value (95 % significance level) marked by red line



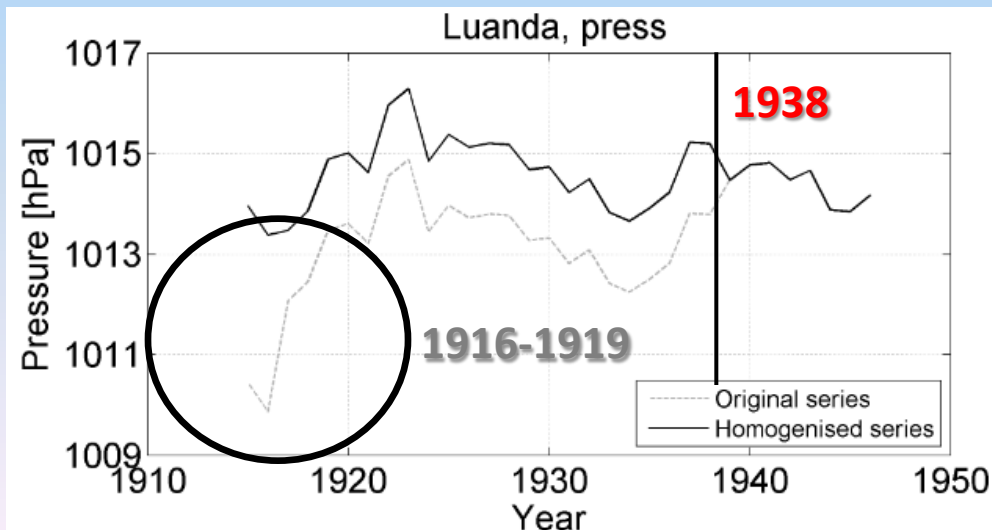
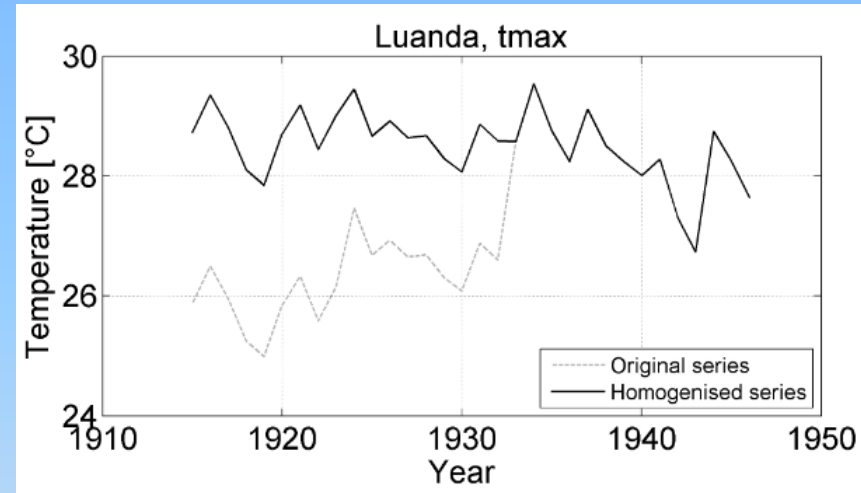
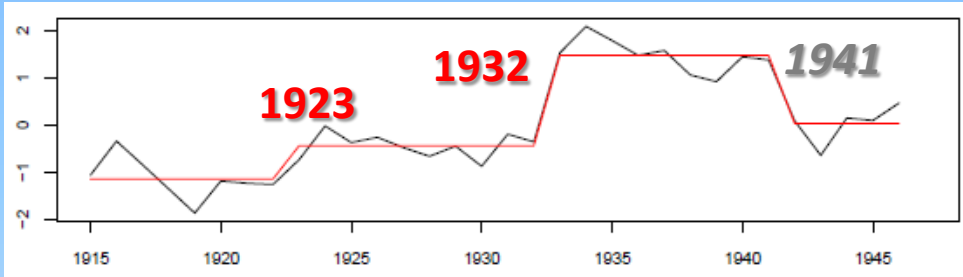
Base minus reference series with regression fit



change of station
location : **1922**, **1930**

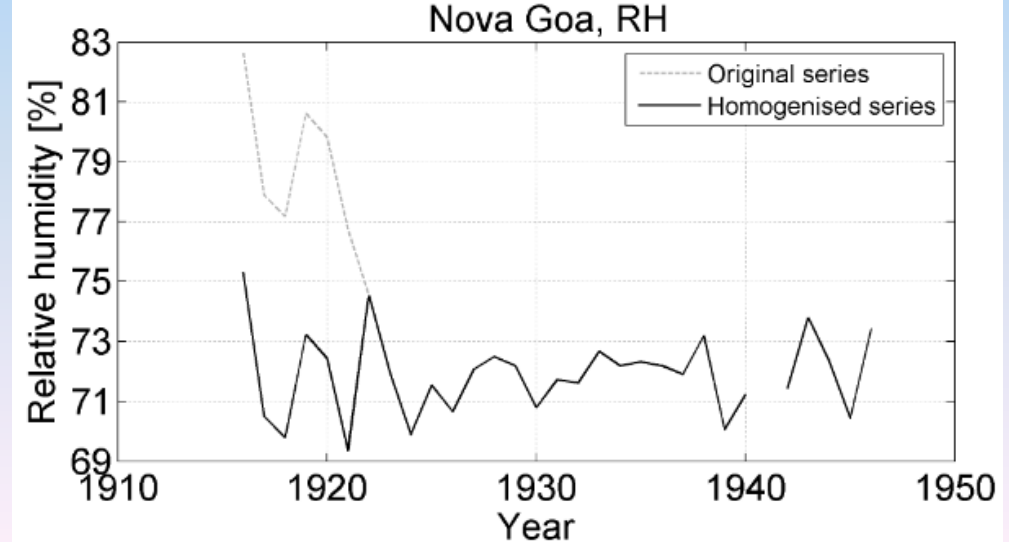
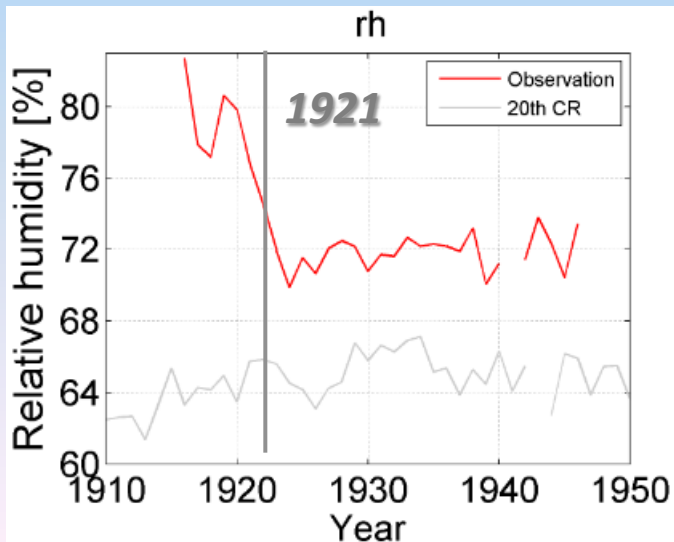
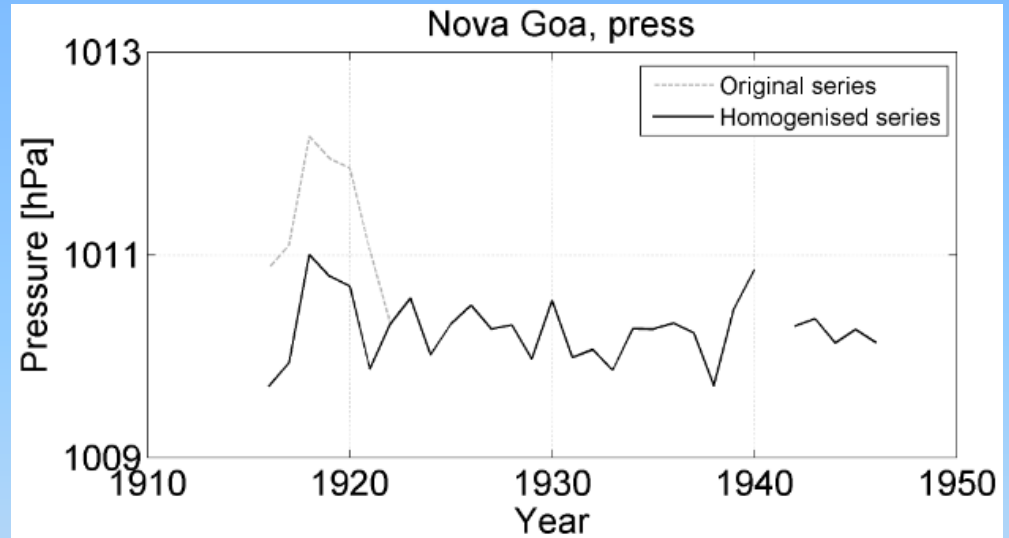
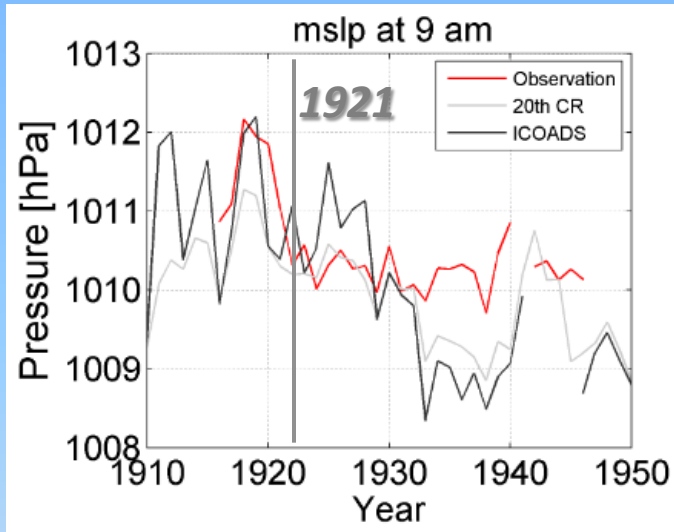
Angola – Luanda (1915-1946)

Base minus reference series with regression fit

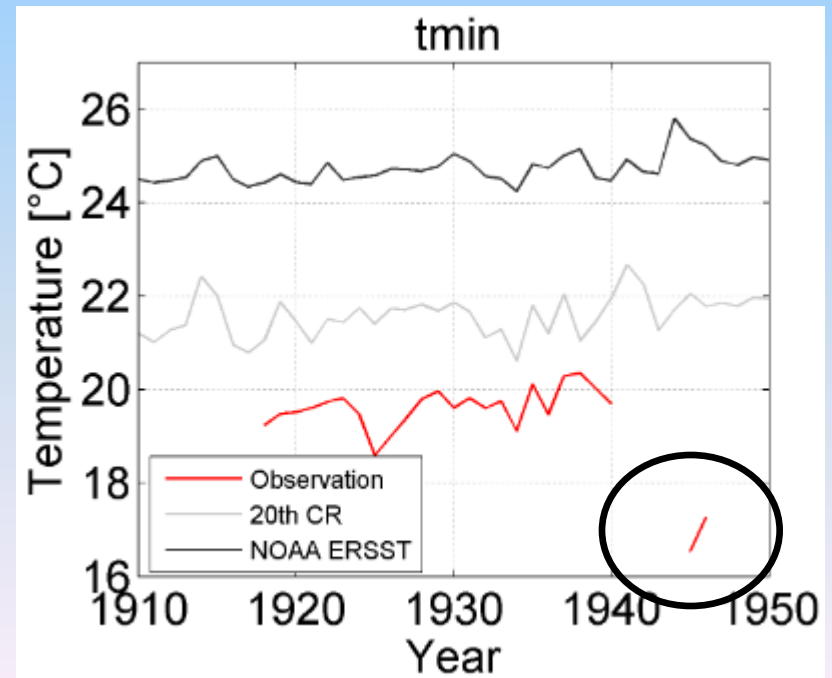
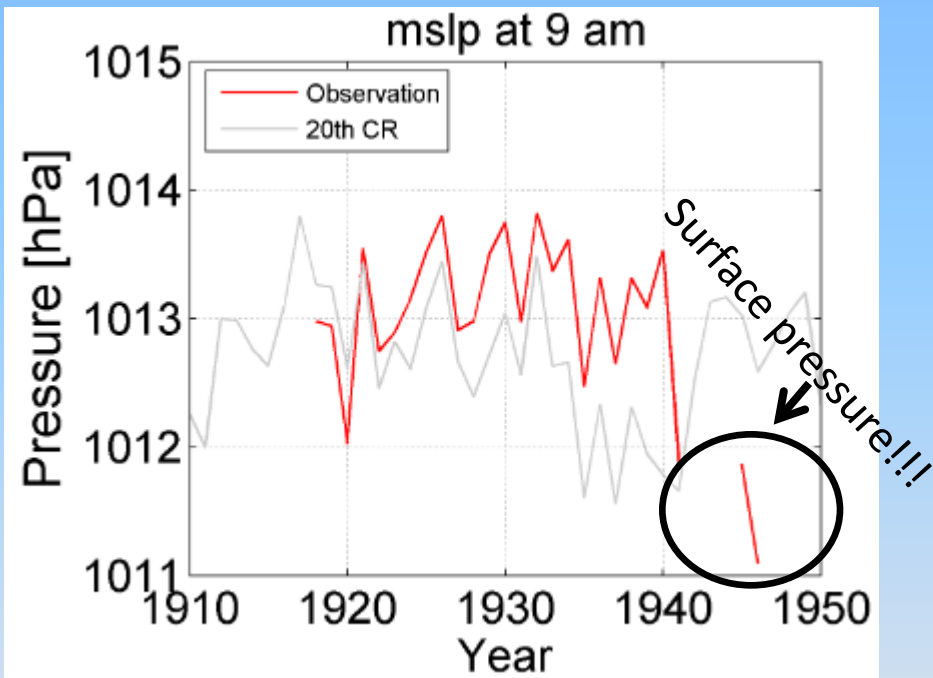


1923, 1932, 1938 – change of station location

India - Nova Goa (1916-1946)



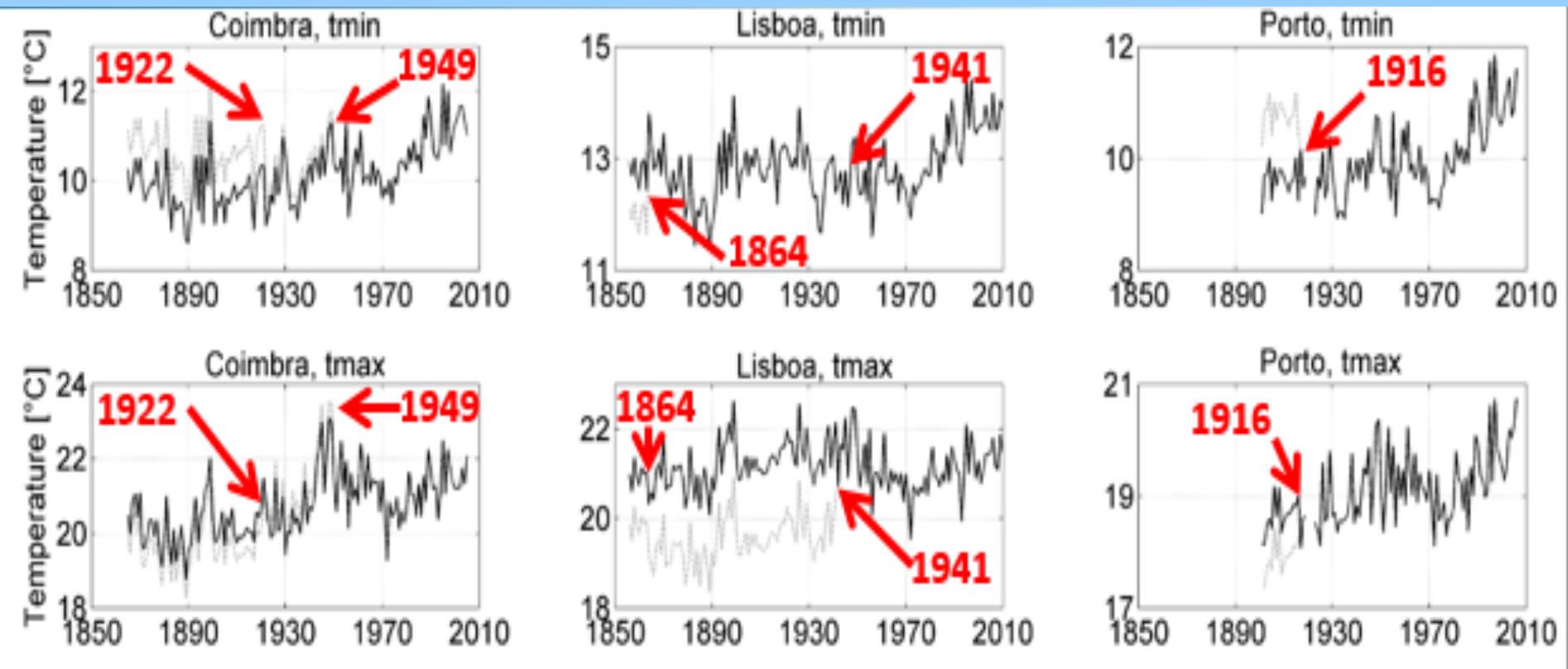
China – Macau (1918-1946)



- We have also tested the homogeneity of temperature, precipitation and relative humidity series for the former colonies 1915-1946 (as could be seen in the former plots)
- As we also did for mainland Portugal (Lisbon, Porto, Coimbra) and the Archipelagos of Azores and Madeira.

1922 – Relocation of the instrument park
 1949 – Change of observation time

1864 – Change of station location
 1941 – Change of thermometer height
 1916 – Change of station location

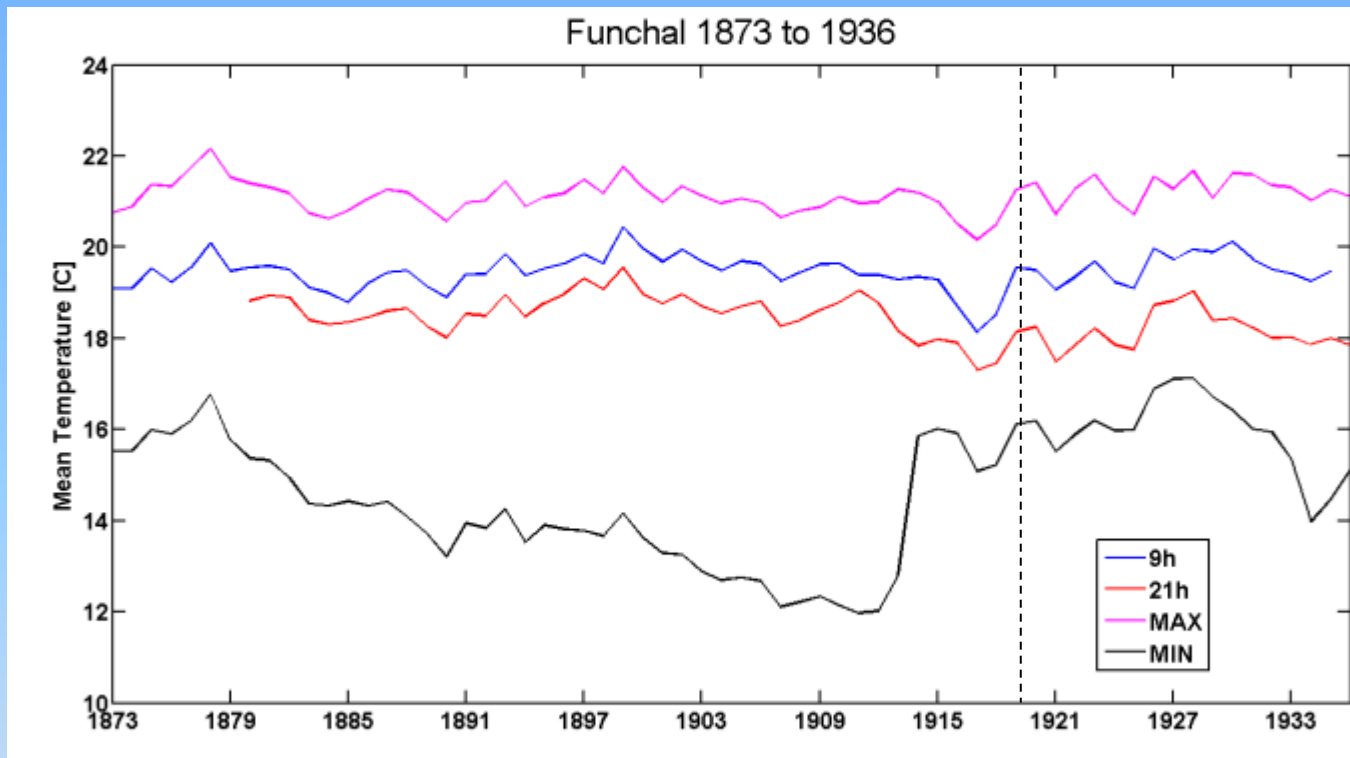


We have found

- Breakpoints coincidental with metadata changes
- Metadata changes that don't generate breakpoints
- Breakpoints that do not coincide with metadata changes

Sometimes we have inferred metadata changes from the breakpoints found

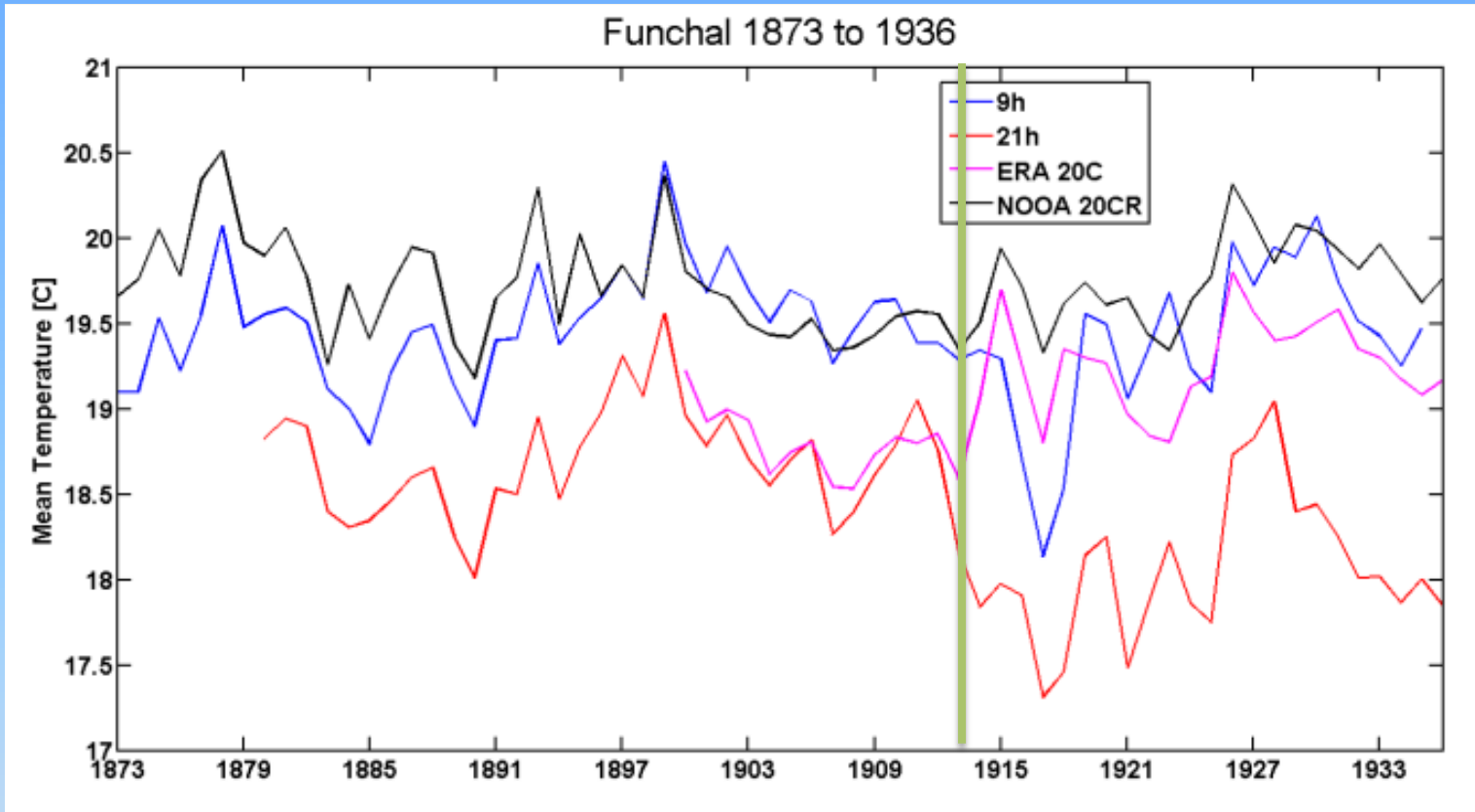
As was the case of the thermometers change in 1913 in Funchal (Madeira), and in the Azores.



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 Tmin thermometer was changed in 1913.

Metadata information: The thermometers changed their height by 7m in 1920.



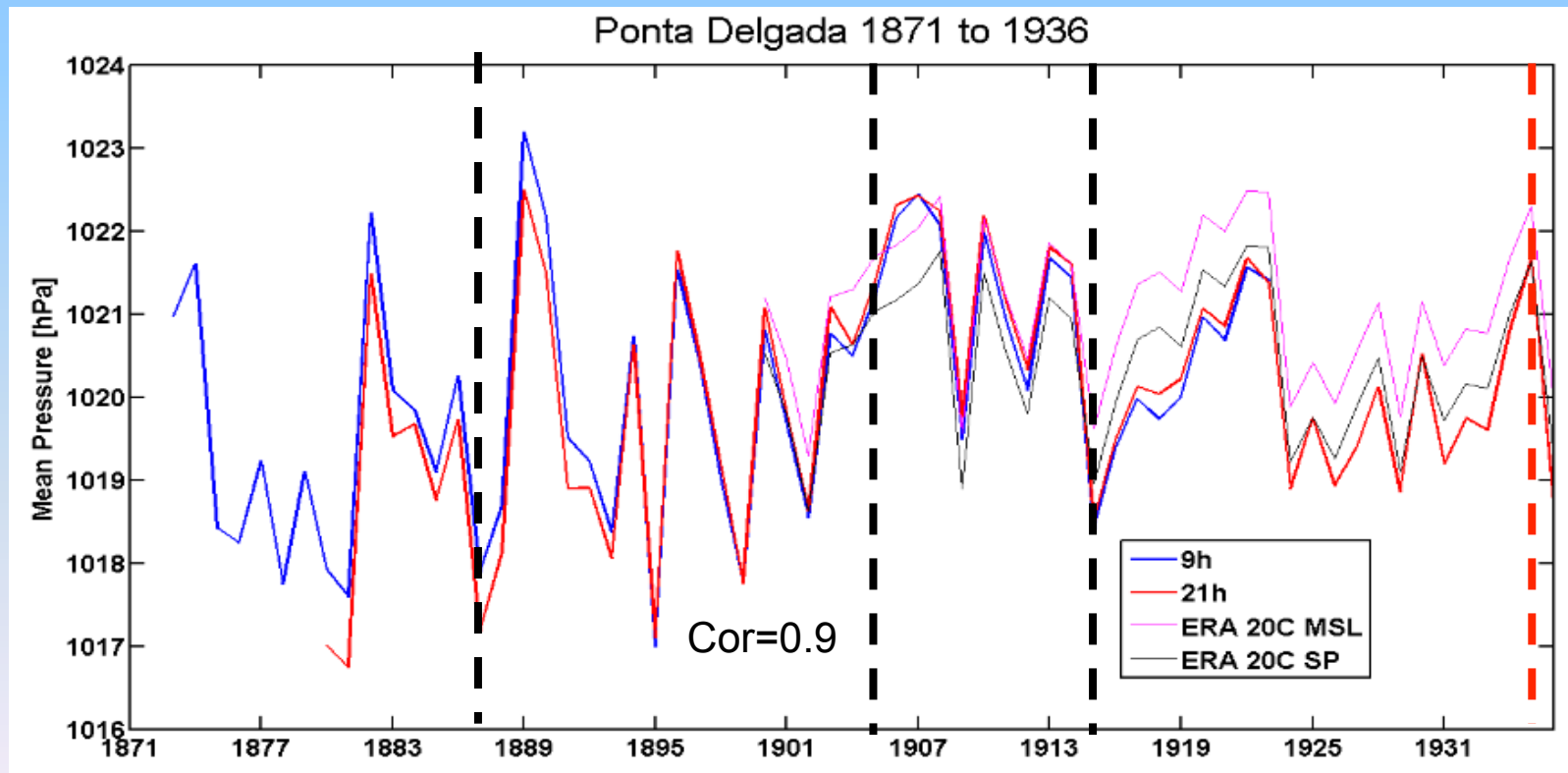
Testing the homogeneity of Funchal surface temperature

All tests with reference series (20CR and ERA-20C) detect a breakpoint in 1913 in the 9h and 21h series. Subsequent tests showed that the 1913 break is detected in Tmax also.

Conclusion: All thermometers were changed in 1913.

- The 1913 breakpoint appears in the Azores temperature series, when tested with reanalyses reference series.
- **It is therefore possible that the thermometers were changed in the Azores at the same time as in Funchal.**

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



Ponta Delgada is one of the original NAO nodes

- All the data presented was subjected to Quality Control Procedures, with the former colonies data being checked and formatted for ISPD and ERA-CLIM2 with our CQ_Surface QC tool, which we are making available for Copernicus.
- We homogenised the annual Lisbon, Porto and Coimbra series, using the chosen breakpoints presented here.
- Hopefully ECMWF will update its ISPD version, so that it can contain the several pressure datasets we have been digitising.
- ❖ By that time our list of breakpoints to send to ECMWF will be much longer than the presente one.