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Identifying Homogeneous sub-periods in HadISD

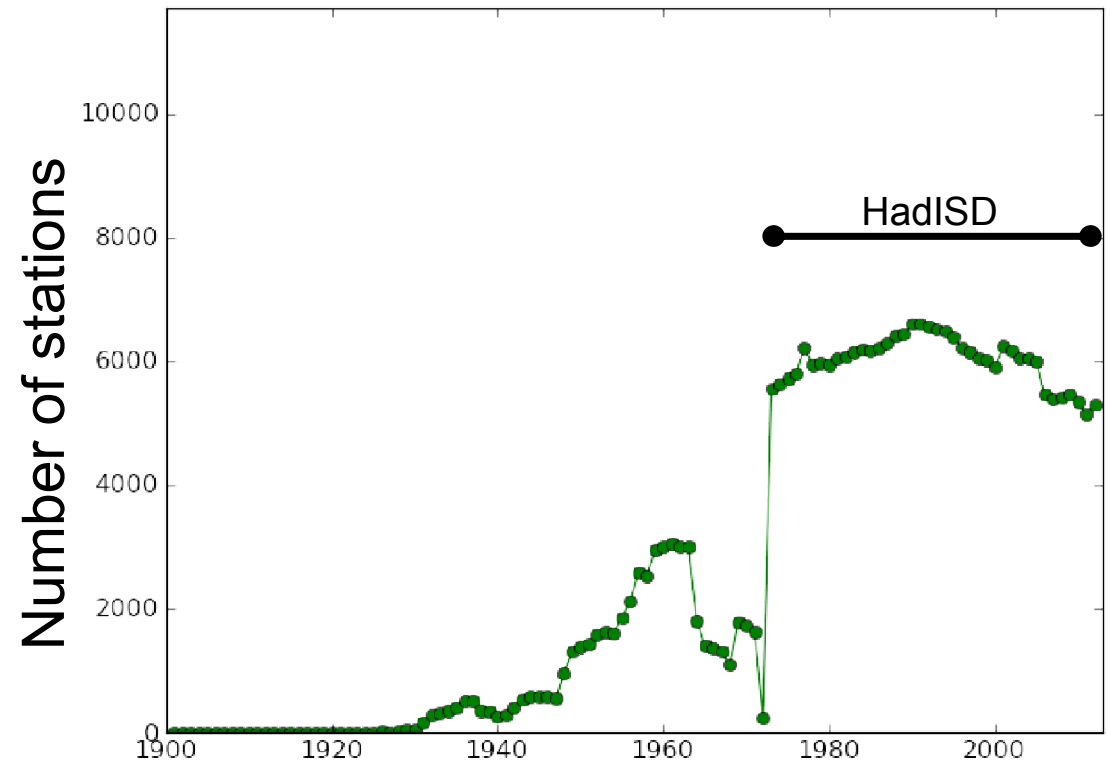
Robert Dunn, Kate Willett, Colin Morice, David Parker (Met Office)

Outline

- Introducing HadISD
- Homogenising >6000 stations of sub-daily data
 - Identifying homogeneous sub-periods
 - Change point validation
- An application to global temperature
 - Selecting progressively more homogeneous stations
- Summary

What is HadISD?

- HadISD is based on NCDC's Integrated Surface Dataset (ISD)
 - Hourly and 3-hourly station data
 - 6103 stations worldwide
 - Data from 1973-2013
 - Annual update cycle (current=v1.0.2.2013f)
 - Temperature, Dewpoint, Wind speed, SLP and Clouds
 - More variables & greater temporal coverage for future updates

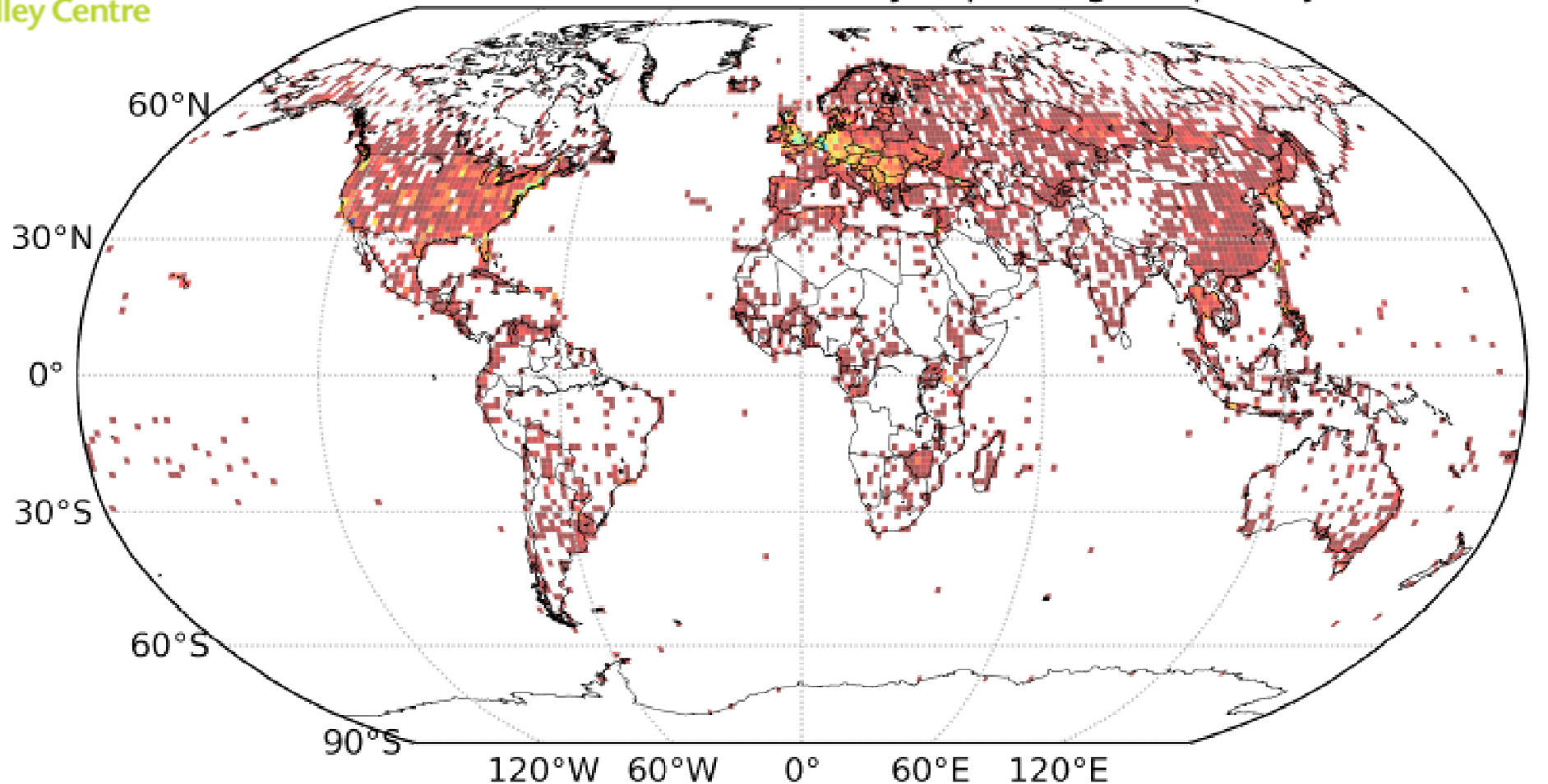




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Station Coverage

Station distribution for 3 hourly reporting frequency



1

5

10

15

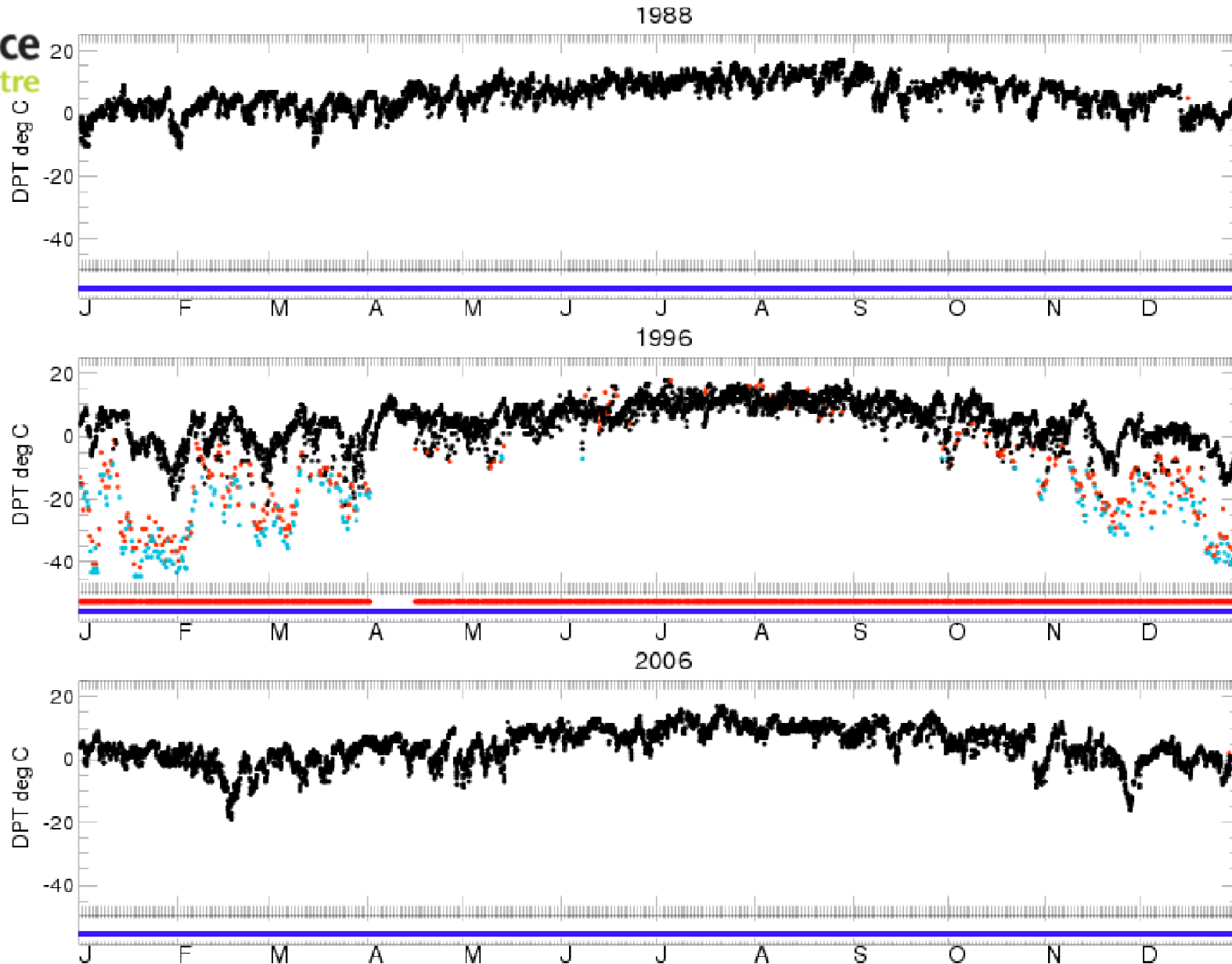
20

Number of Stations



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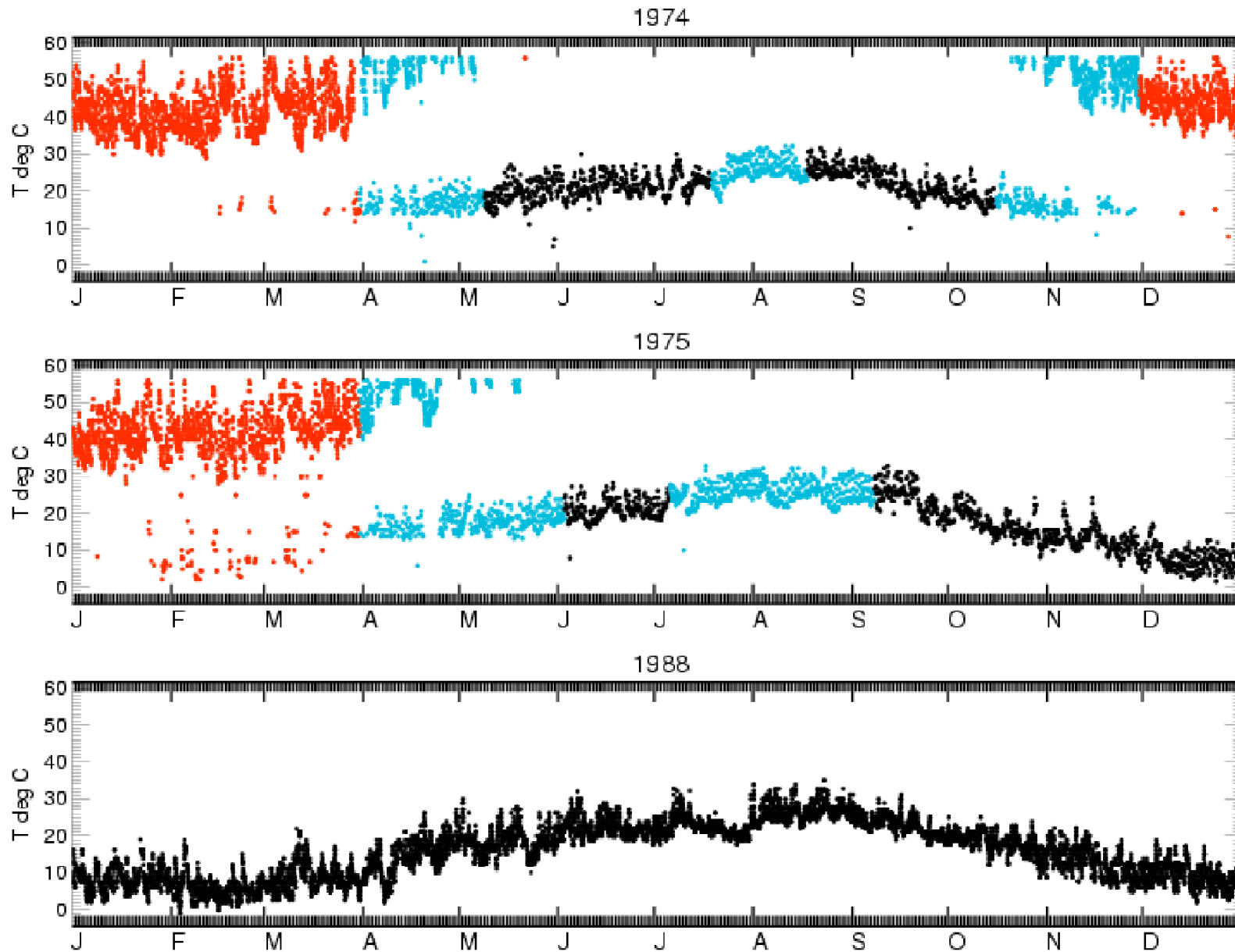
Why we need to QC





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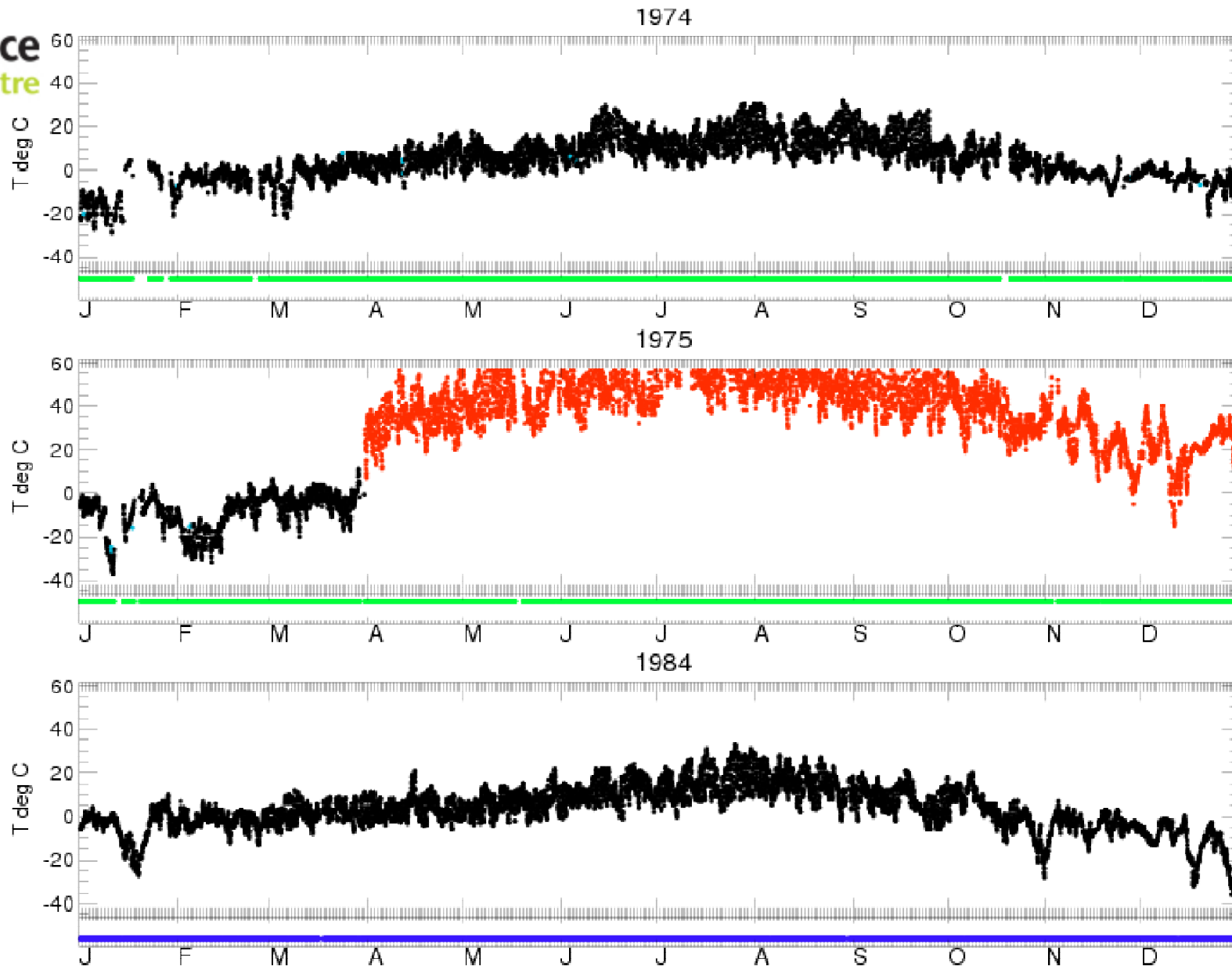
Celsius or Fahrenheit?





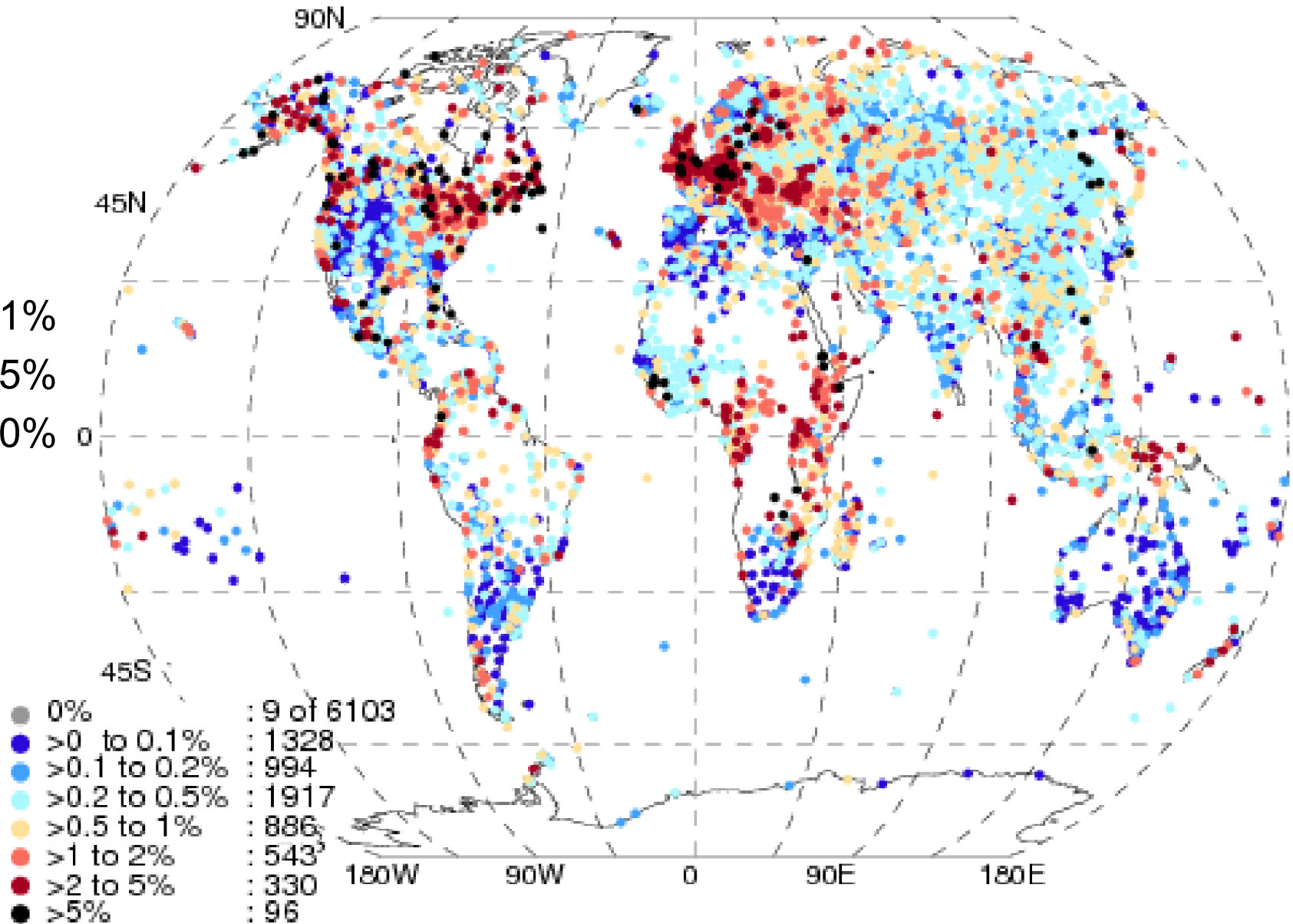
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Inhomogeneities

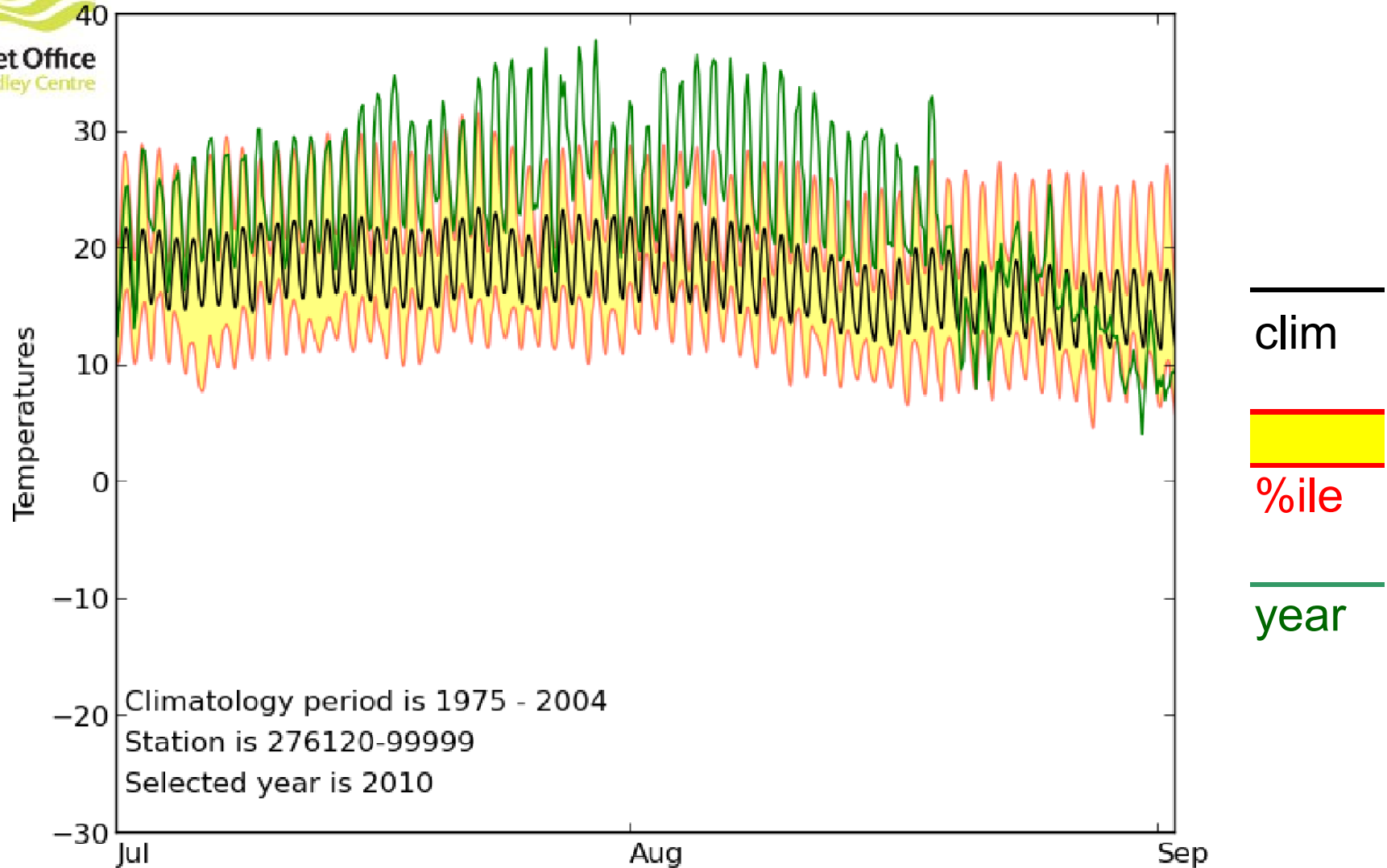


Global Temperature Flags

- 22% $\leq 0.1\%$
- 70% $\leq 0.5\%$
- 84% $\leq 1.0\%$



Moscow Heatwave



- Moscow Botanical Gardens, 2010
- HadISD $T_{\max}=37.8^{\circ}\text{C}$, Observed $T_{\max}=38.2^{\circ}\text{C}$

Degree Days over Climatology for Jul-Aug 2010



30°W

50°N

20°W

40°N

10°W

0°

10°E

20°E

30°E

40°E





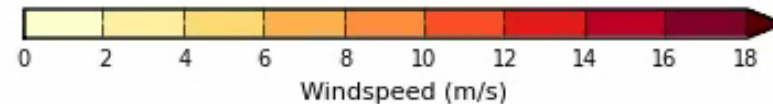
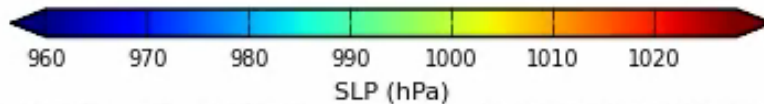
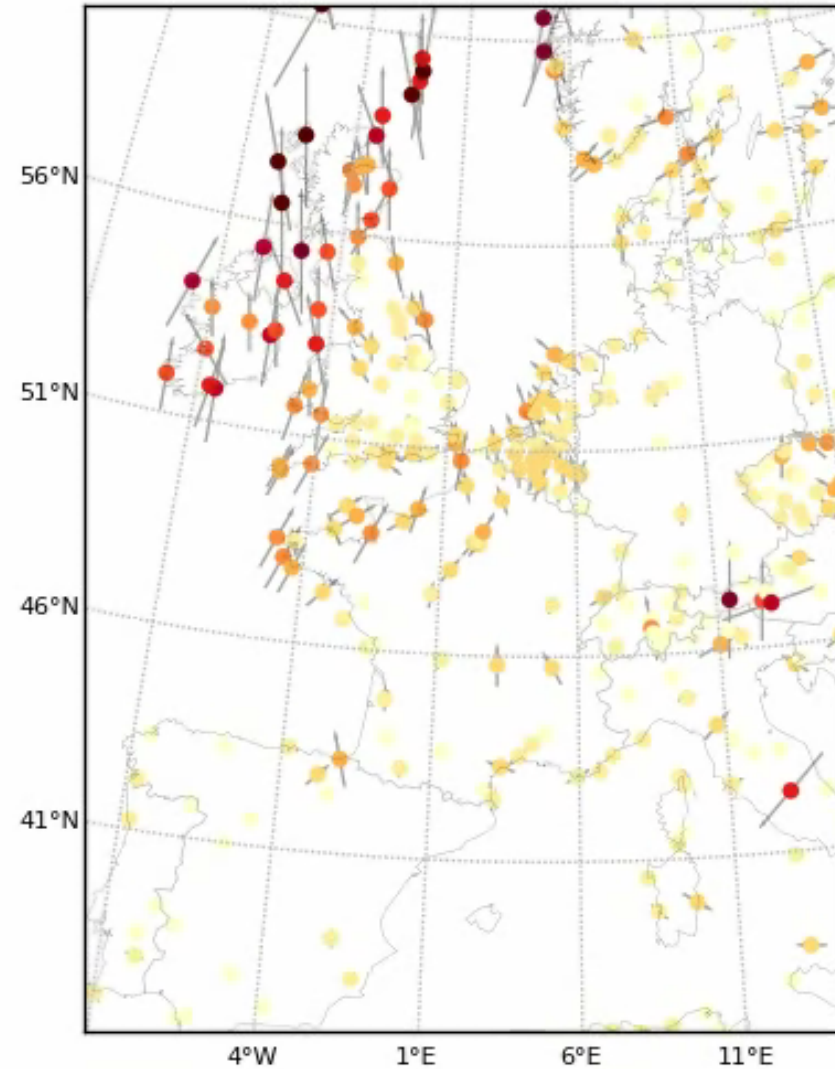
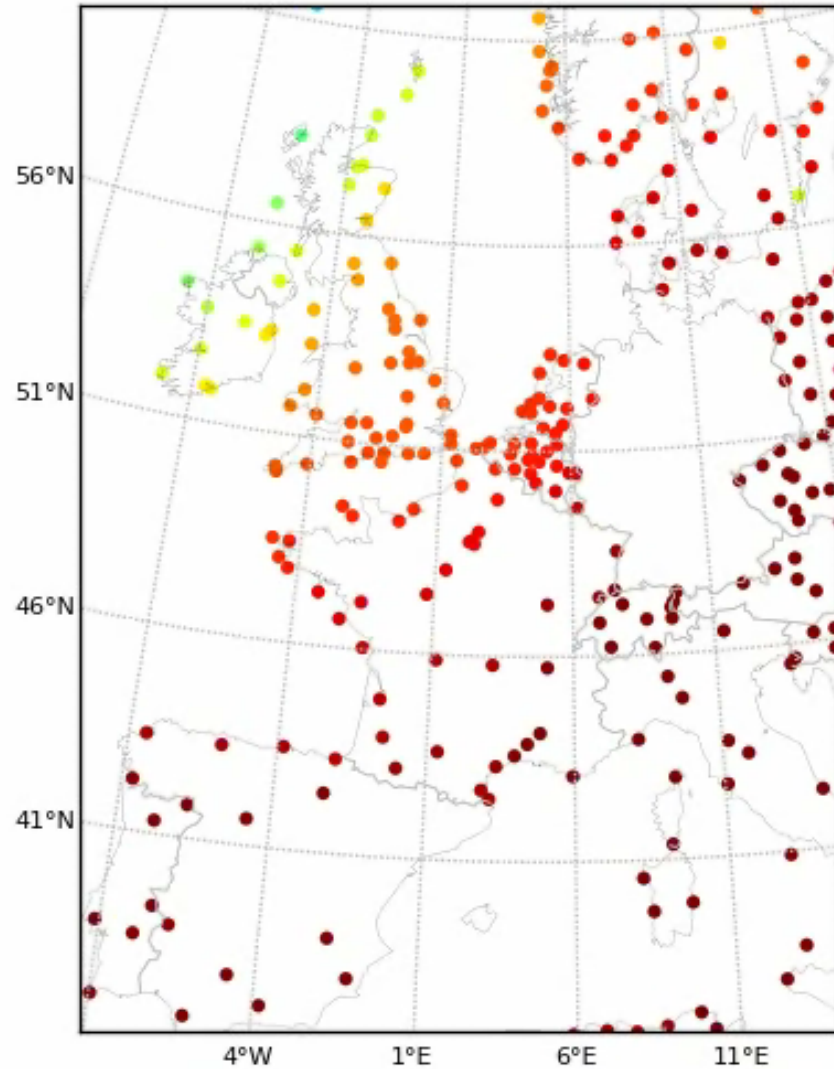
Windstorms

M
Ha

2013 December 18, 00:00 UT

SLP

Windspeed



HadISD/analyses/general/trunk/make_video_frames_hours_slp_wind.py 31-Jan-2014 12:05



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Homogeneous Sub-periods in HadISD

Homogenisation Strategy

- If anyone has any good ideas about how to homogenise 41 years of sub-daily multi-variate data for 6000 stations...
 -find me afterwards!
- Not letting the perfect be the enemy of the good
 - The ideal is to find change points on a daily-level and adjust each hour separately.
 - To our knowledge, no system currently exists to do this automatically,
- Not making the final data product worse
 - Take a step back, and do something which is
 - Achievable
 - Useful to dataset users

Homogenising HadISD

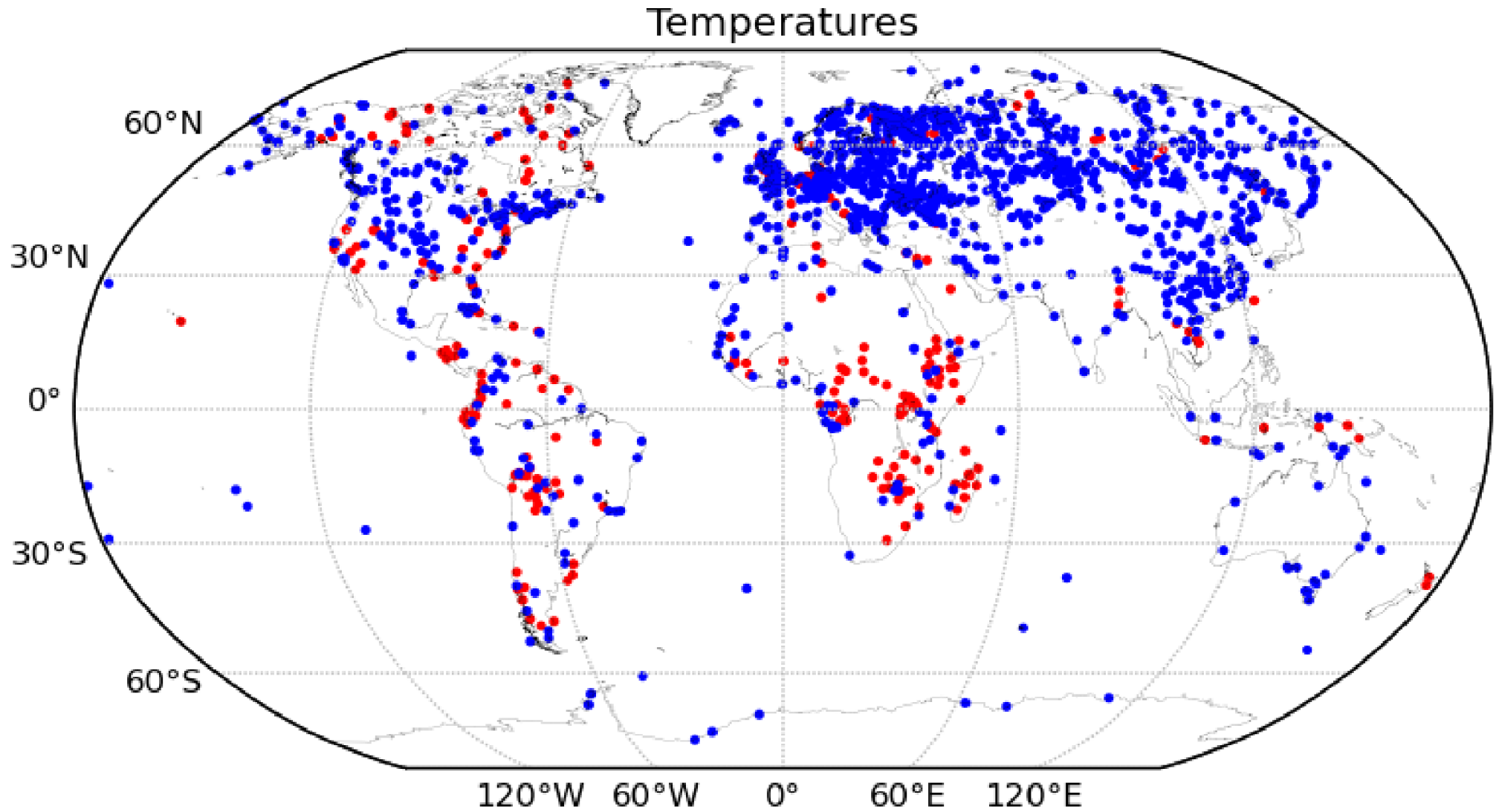
- Identify change-points on monthly averages
- Use Pairwise Homogenisation Algorithm (Menne & Williams, 2009)
 - Proven success for USHCN, GHCN-monthly and HadISDH
 - Fully automated and quick
 - Benchmarked under COST-HOME
- Applied to T, Td, SLP and wind speed
- Allow users to determine how to include this information
- Submitted to Climate of the Past
 - Currently under open review at CP Discussions
[Dunn, Willett, Morice & Parker, 2014, CPD, 10, 1567-1607]

Homogenisation Method

- Rather than just use monthly means in PHA
 - Mean & diurnal range for T & Td (Wijngaard+ 2013)
 - Mean & maximum for wind speed (Trewin 2013)
 - Will be sensitive to different types of inhomogeneities.
- Convert hourly data to monthly means
 - Need 4 observations over 12 hours to calculate daily mean
 - Need 20 qualifying days to calculate monthly mean
- If change points found in both mean and DTR/max
 - Merged if within 1 year of each other
- Used HadISD v1.0.2.2013p
 - Will be re-run on v1.0.2.2013f when manuscript is finalised



Stations with no Change Points

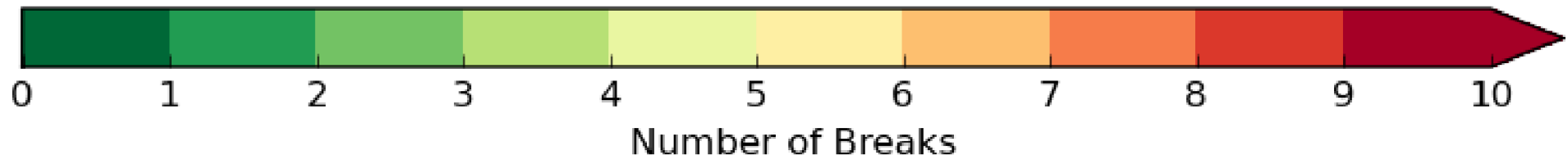
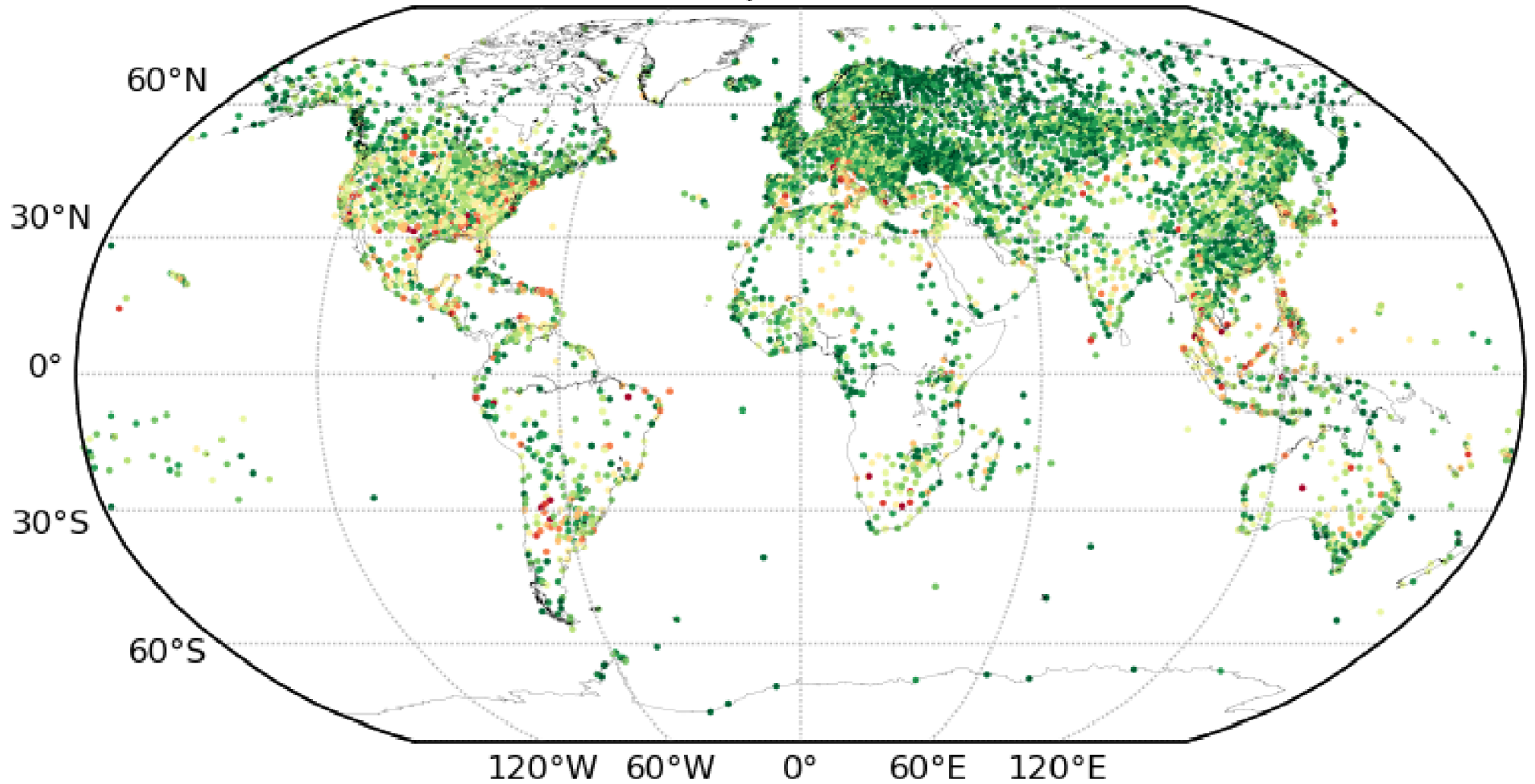


••• Not processed by PHA (252)

••• No Change Points (1206)

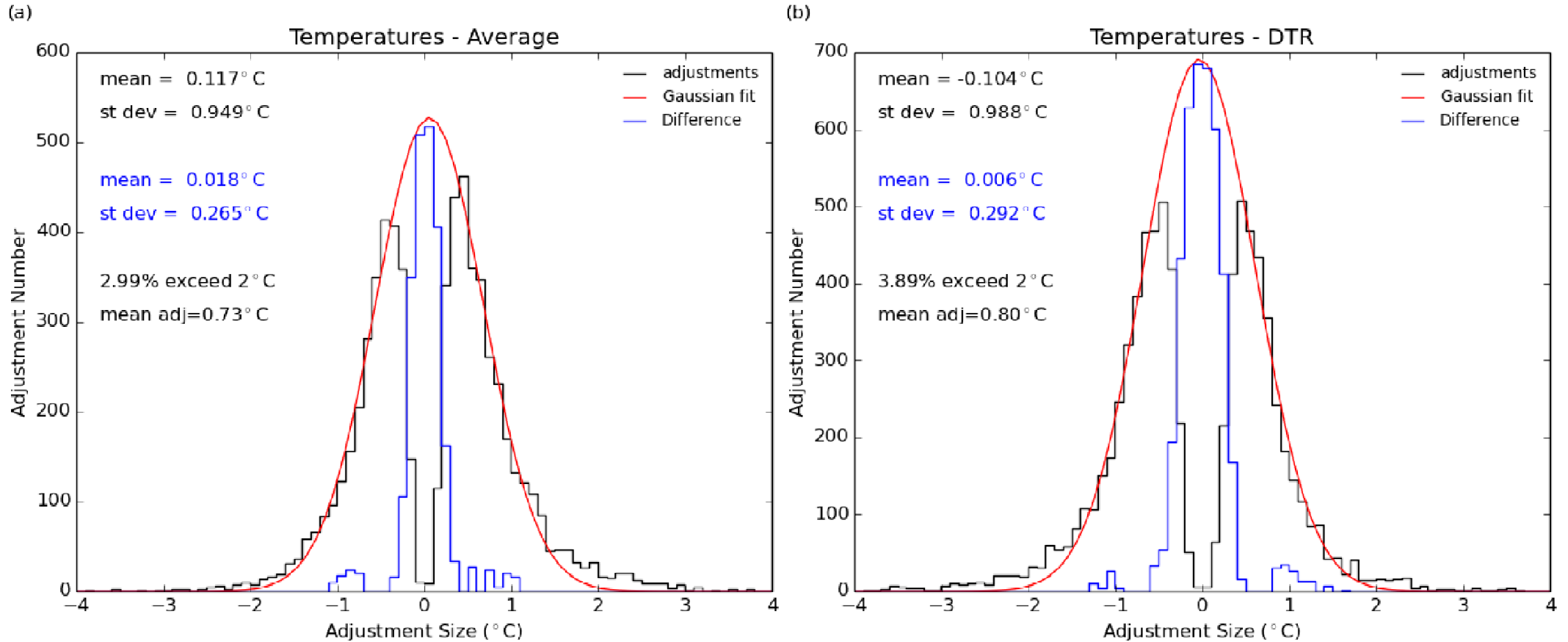
Number of Stations = 5851

Temperatures





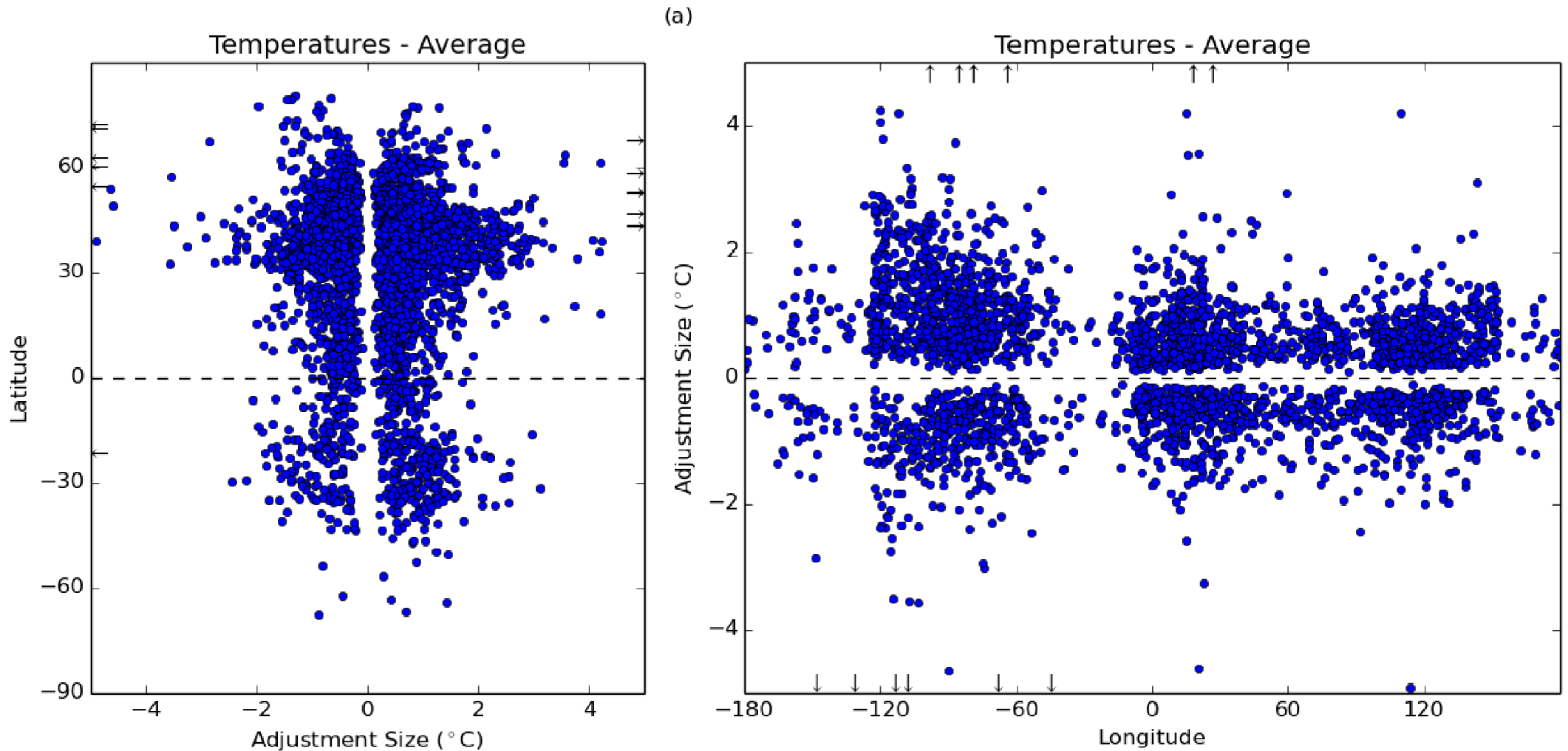
Change Point Distributions



- Change points with adjustment magnitudes $>\sim 0.5^{\circ}\text{C}$ have been detected
- No large bias in adjustment sizes
- No large bias in the “missing middle”



Spatial Distributions

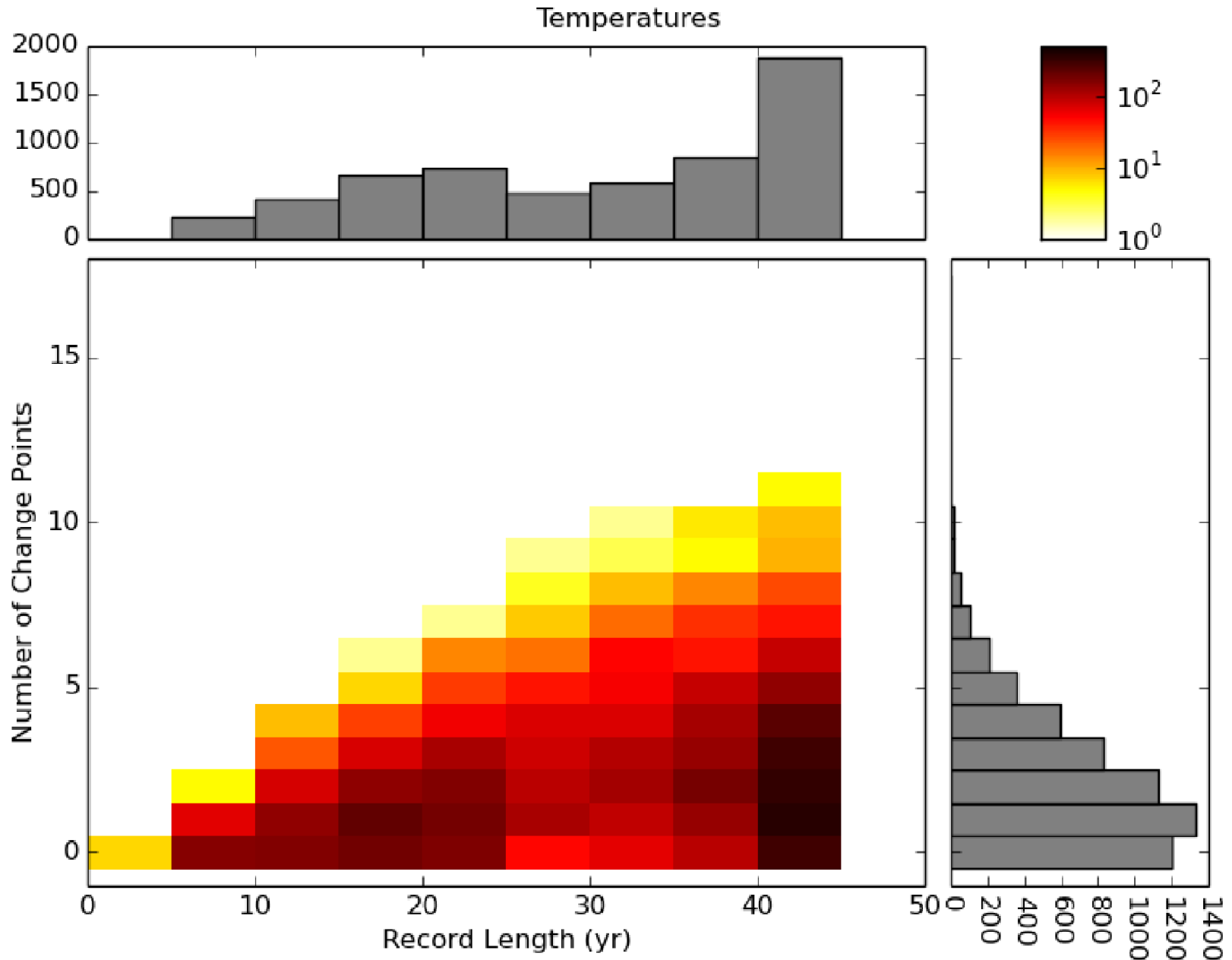


- No obvious zonal or meridional effects
- But smaller adjustments are found in areas with denser station networks (North America)



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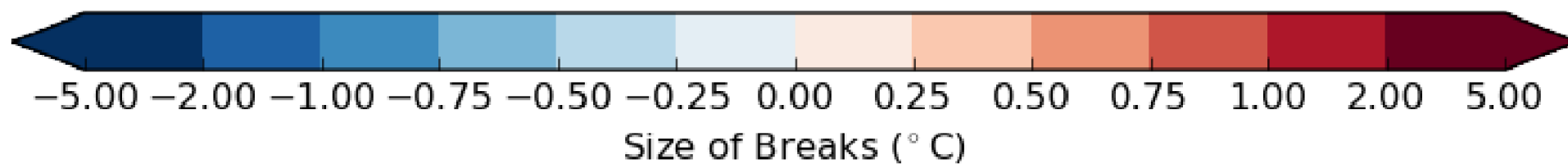
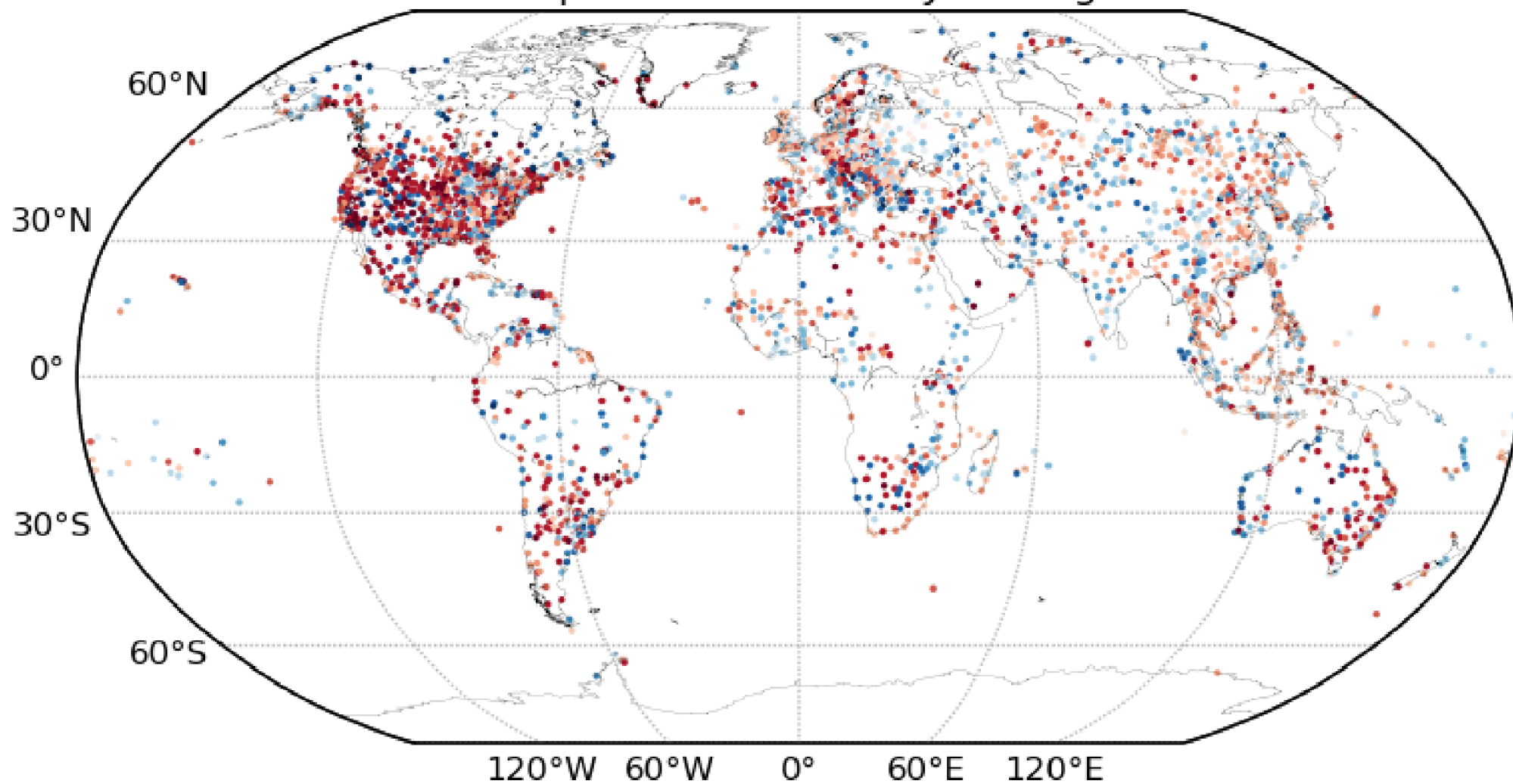
Record Length and CP number



(a)

Number of Stations = 3246

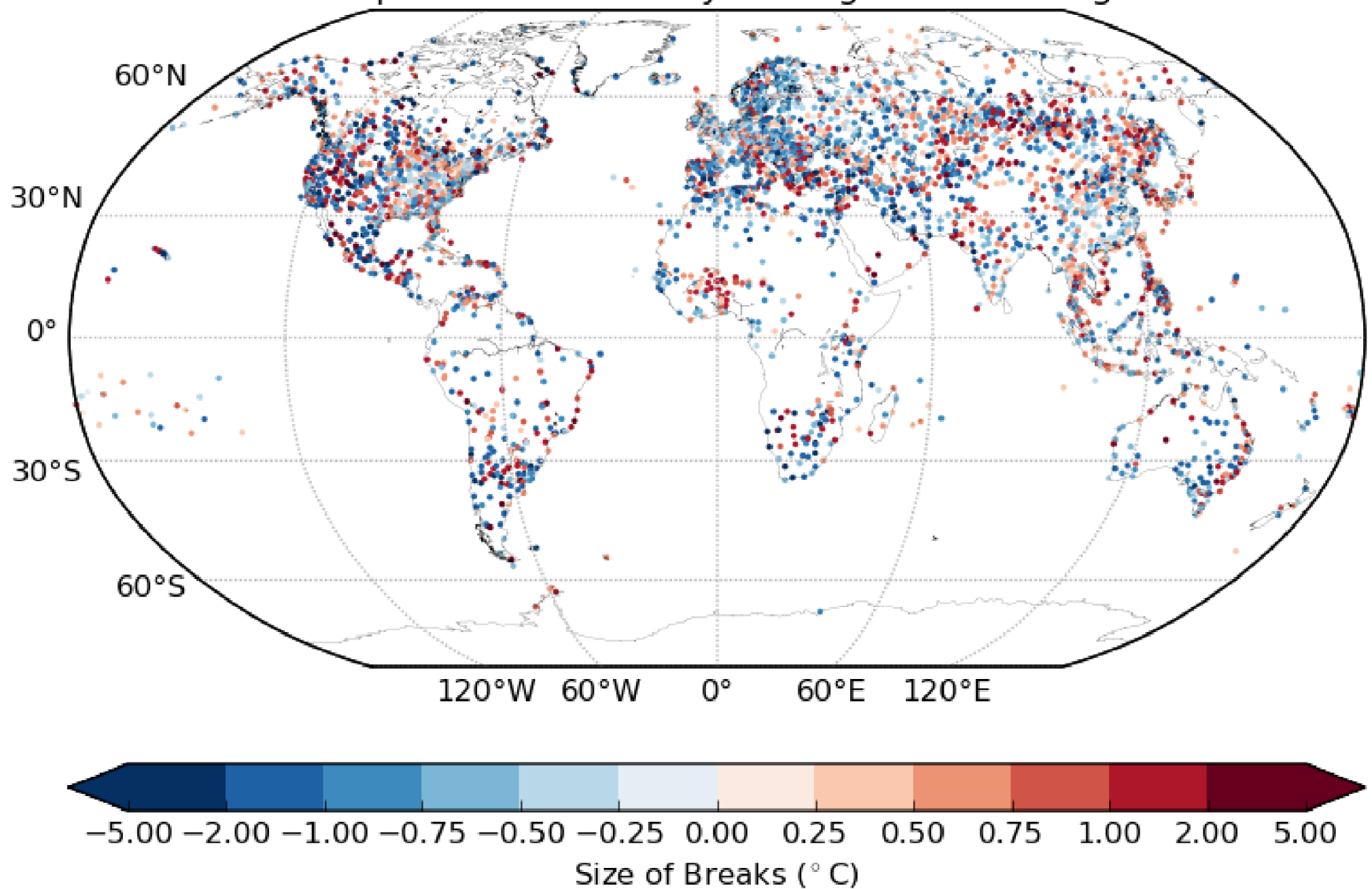
Temperatures: monthly average



(b)

Number of Stations = 3949

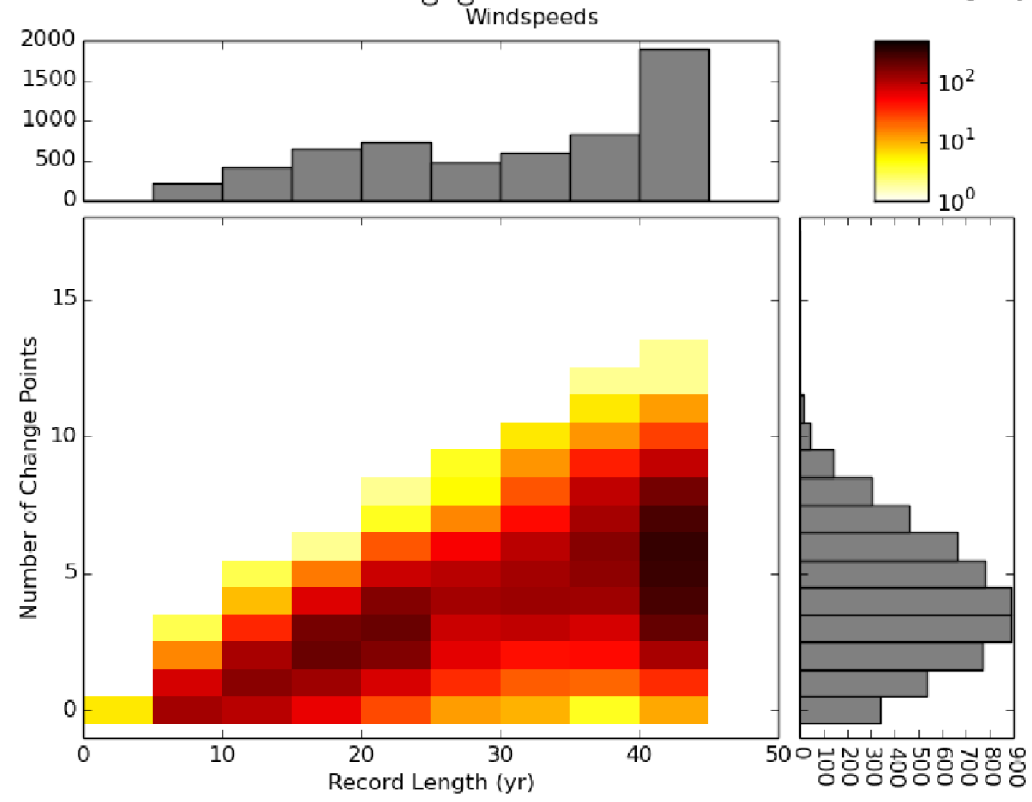
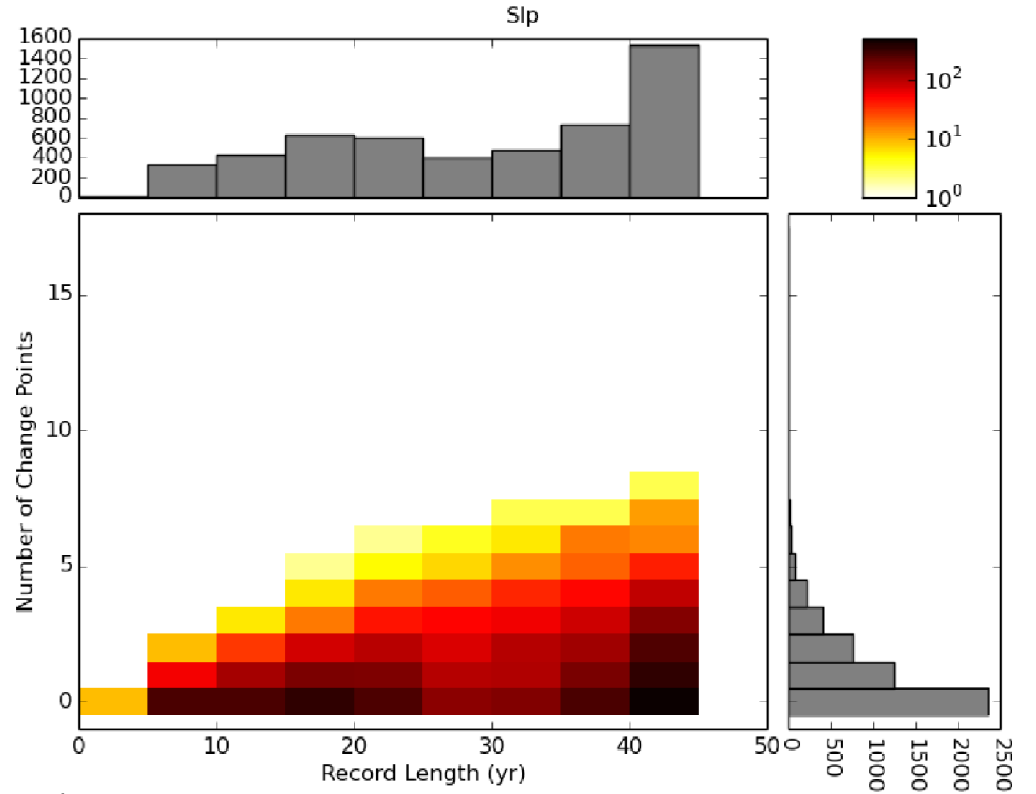
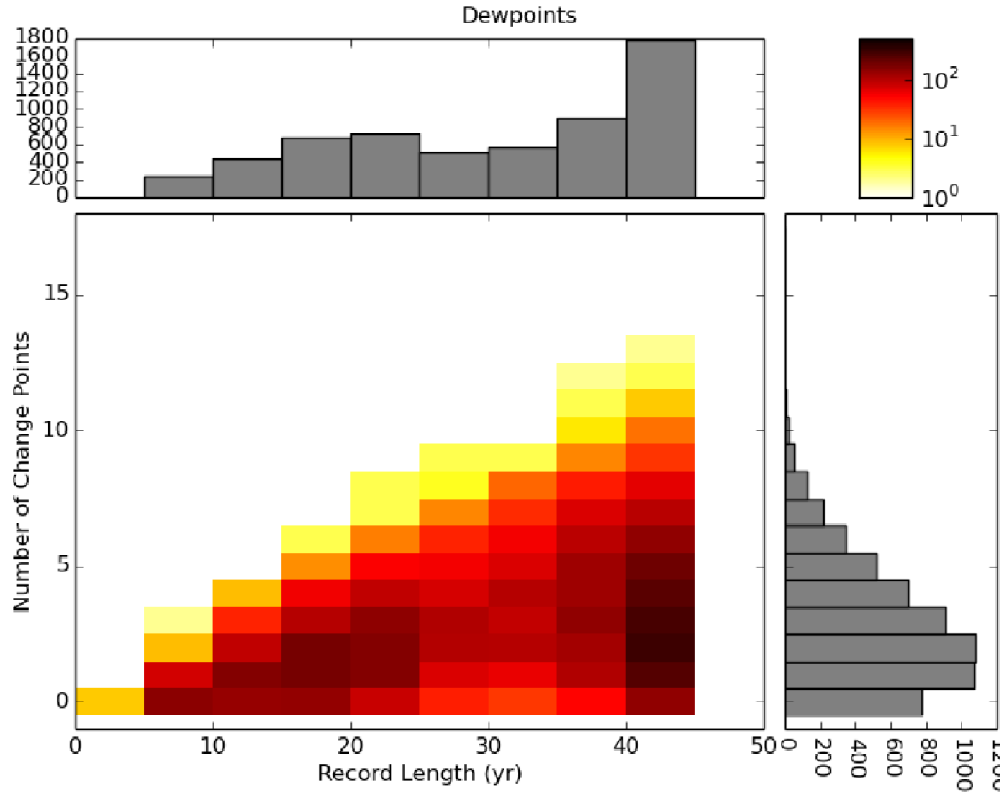
Temperatures: monthly average diurnal range



Dewpoints, SLP and Wind

	Stations with Change points	Change points per station	Max number of Change points
T	4645	2.79	11
Td	5051	3.32	13
SLP	2781	2.03	8
Wind	5496	4.33	13

- SLP has fewer change points than temperature
- Wind speed has more CPs than temperature
 - No scaling of distribution was used to “gaussianise” it

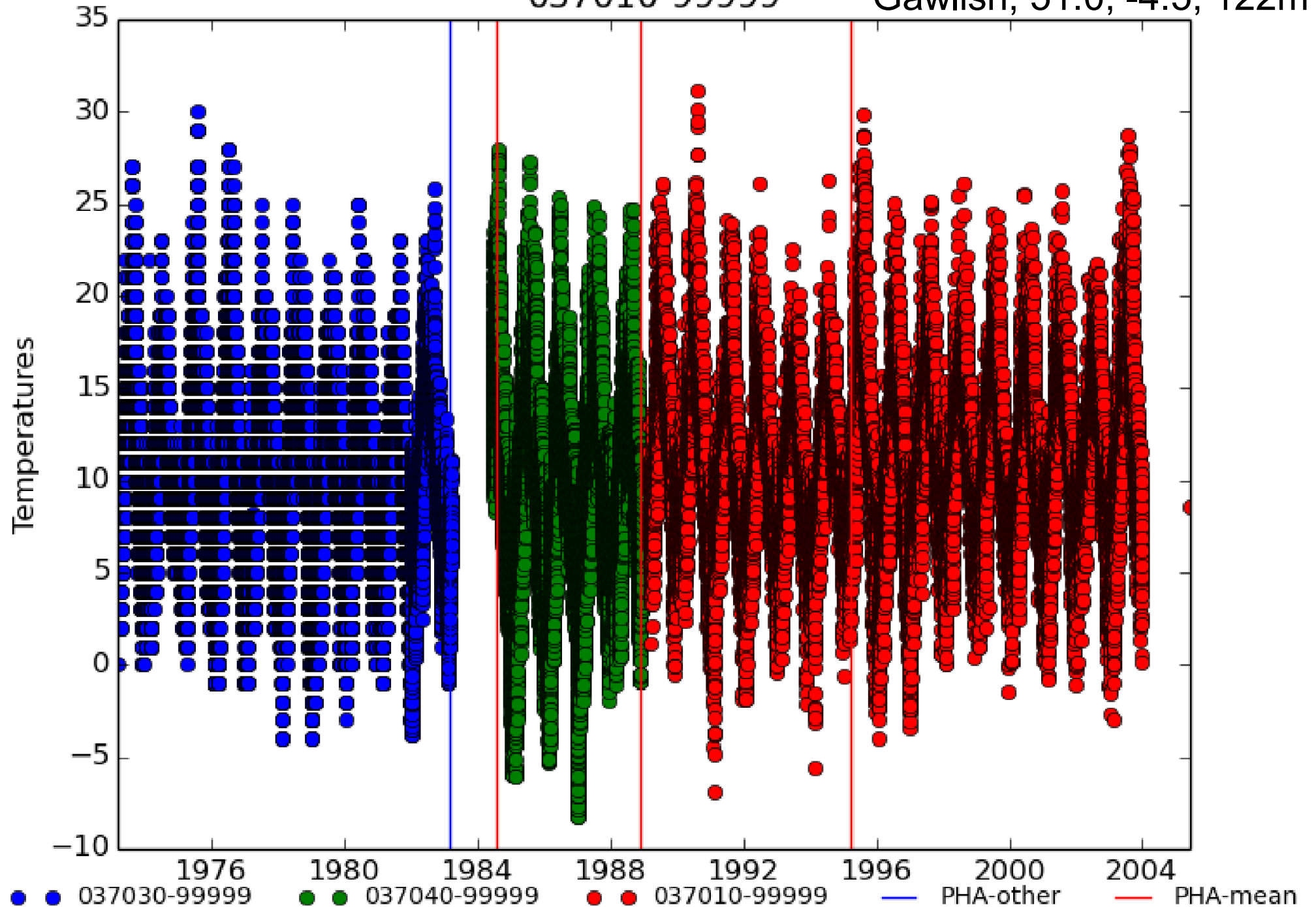


Validation

- Used the 153 UK stations in HadISD
 - Of which 102 contain the 196 change points
 - no CPs could be detected in 51 stations
 - 18 stations are mergers, containing 8 CPs
 - Reporting accuracy changes: 13 CPs
 - Stations with >2 CPs: 12 CPs identified from metadata
 - Post 2000 CPs: 7 CPs identified from metadata
- Find 40 (20%) of CPs can be traced back to a change in station location/instrumentation (using metadata)
- Hence 80% are not noted in incomplete metadata.

037010-99999

Gawlish, 51.0, -4.5, 122m



HartlandPoint

Hartland

Gawlish



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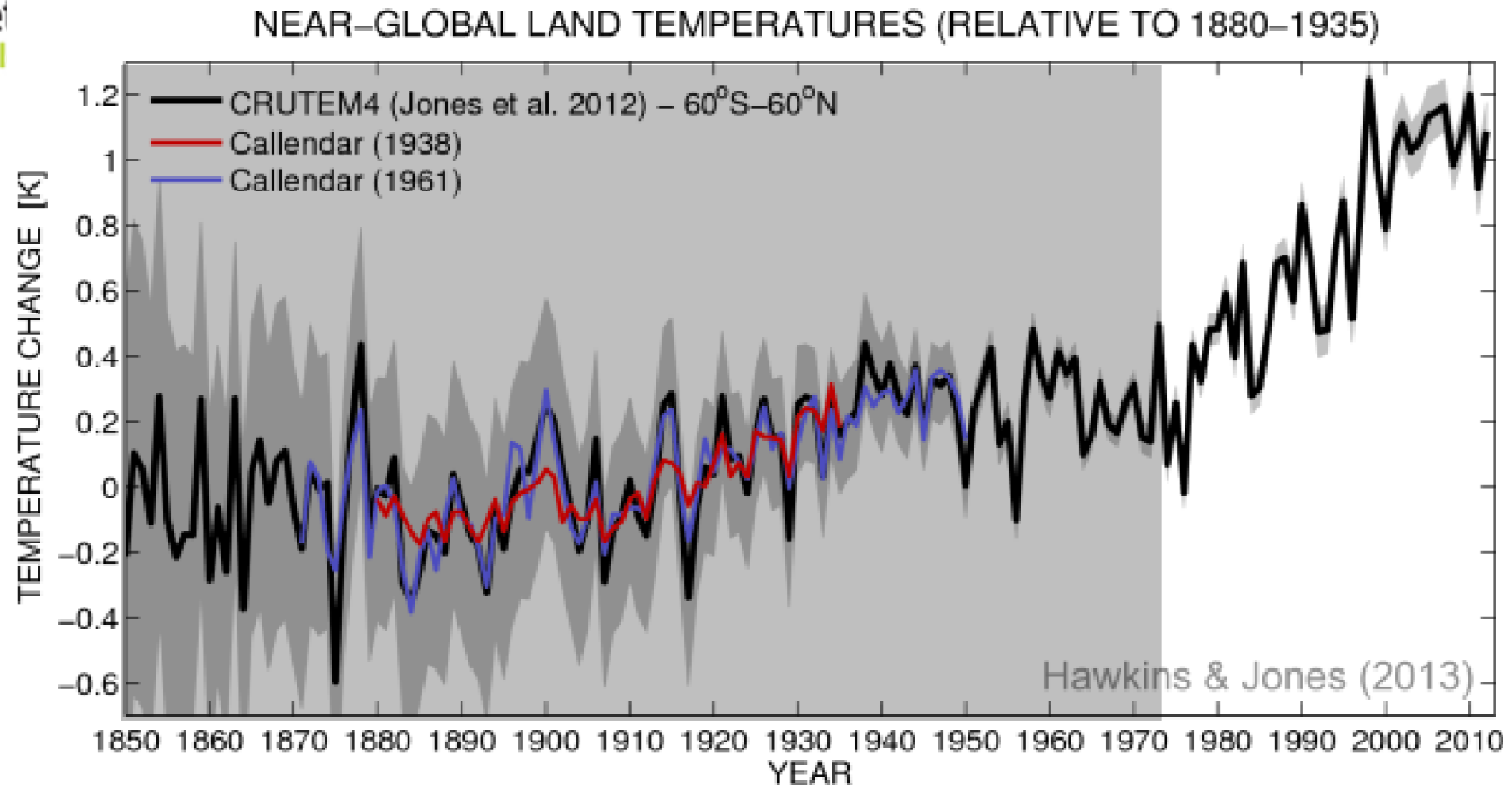
Using change-point information

A study with global land surface temperature



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Global Temperatures inspired by Callendar



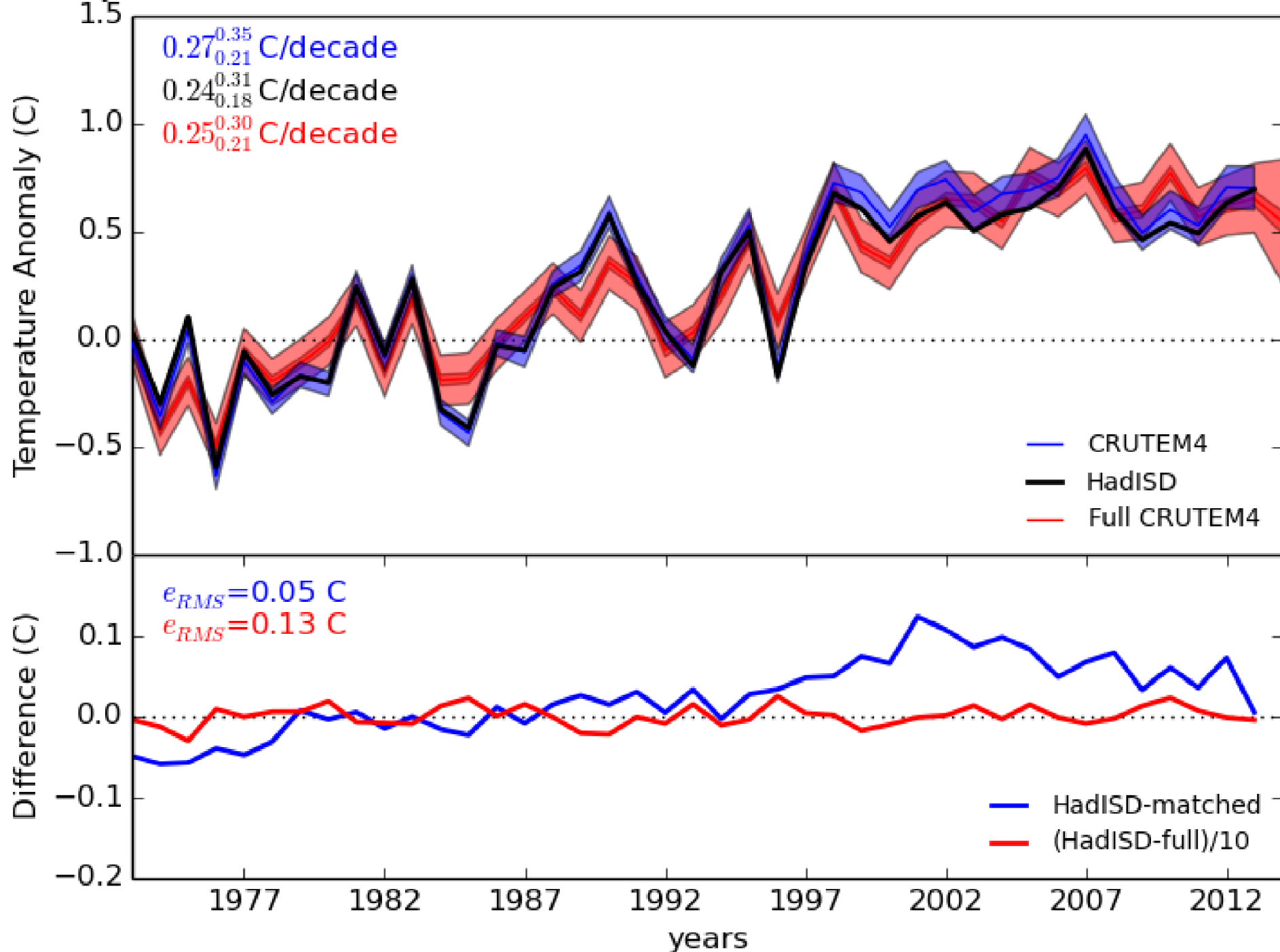
- Guy Callendar (1938) used 147 land stations to estimate the global T
- Hawkins & Jones (2013) show how close this is to current estimates of global T

Global T using HadISD

- How to use the Change point information?
- Use only stations with “perfect” records
 - No change points detected (1458 stations)
- Restrict the number of change points in the record.
 - ≤ 5 , ≤ 3 , ≤ 2 , ≤ 1 change points
- Restrict the maximum adjustment magnitudes
 - ≤ 2 °C, ≤ 1 °C, ≤ 0.5 °C (either mean-T or DTR)
 - Adjustment magnitudes are provided
 - But no adjustments have been made in the data

Adjustment ≤ 20.0 C Number of CPs ≤ 20

Number of Stations=6103

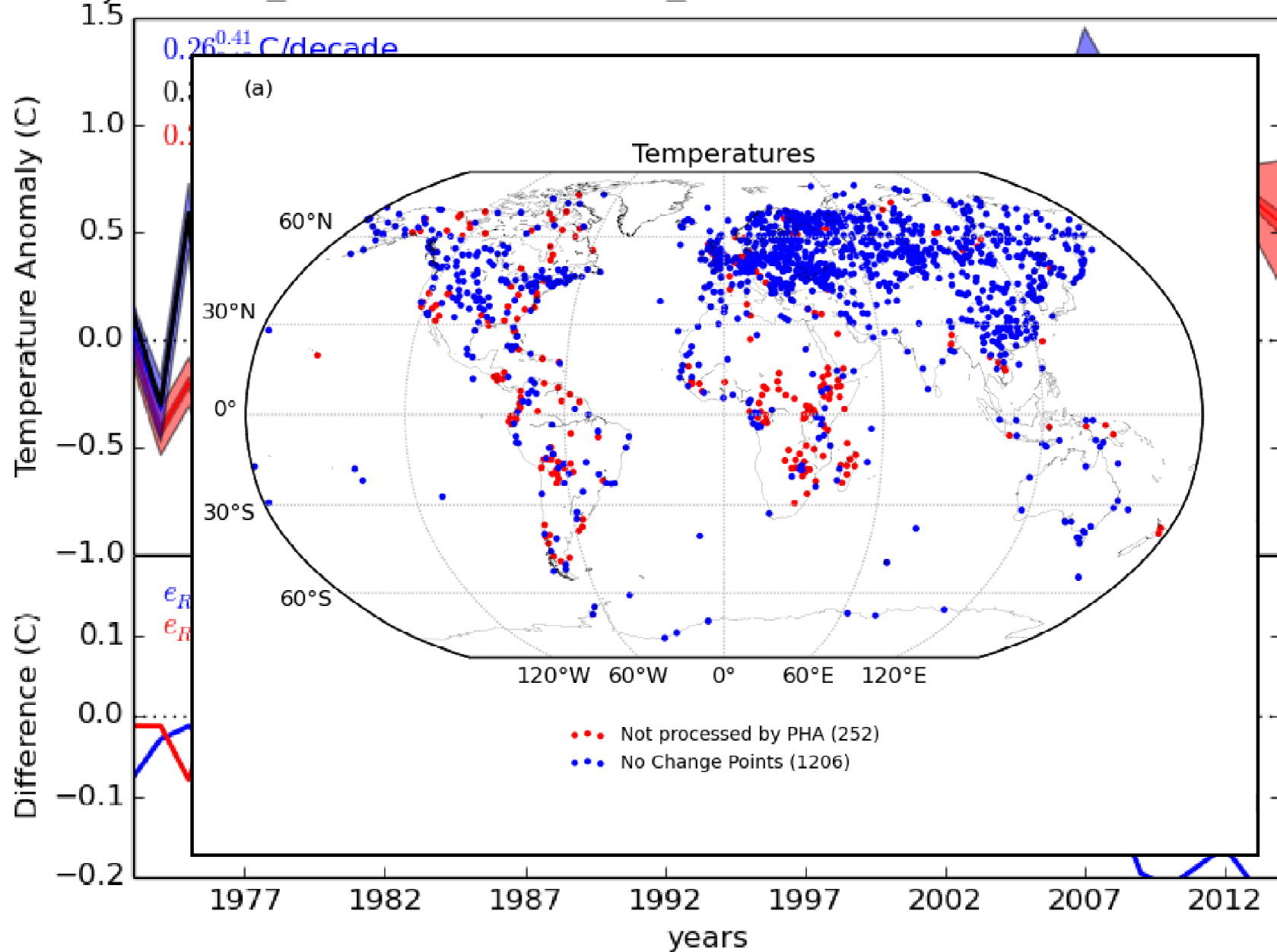




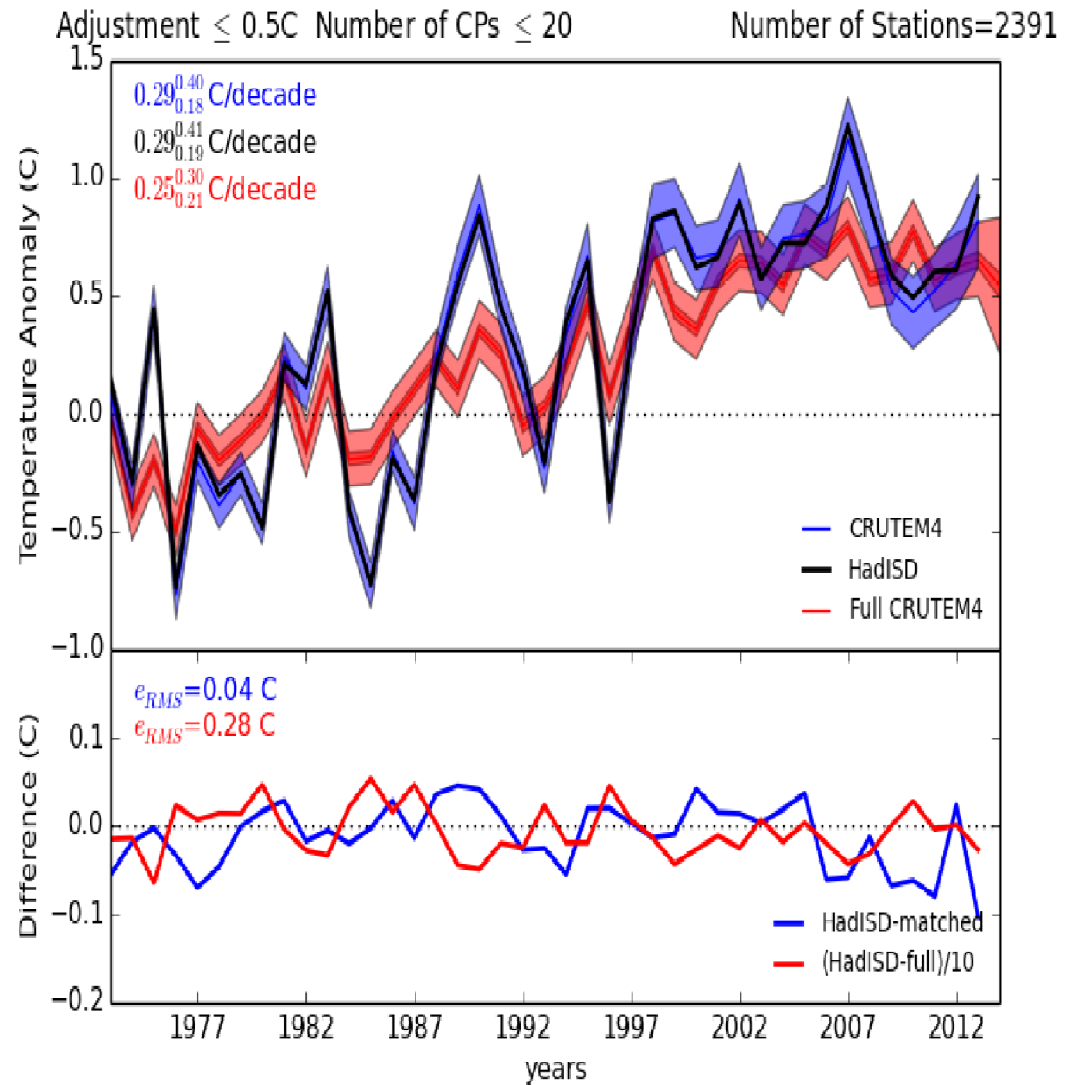
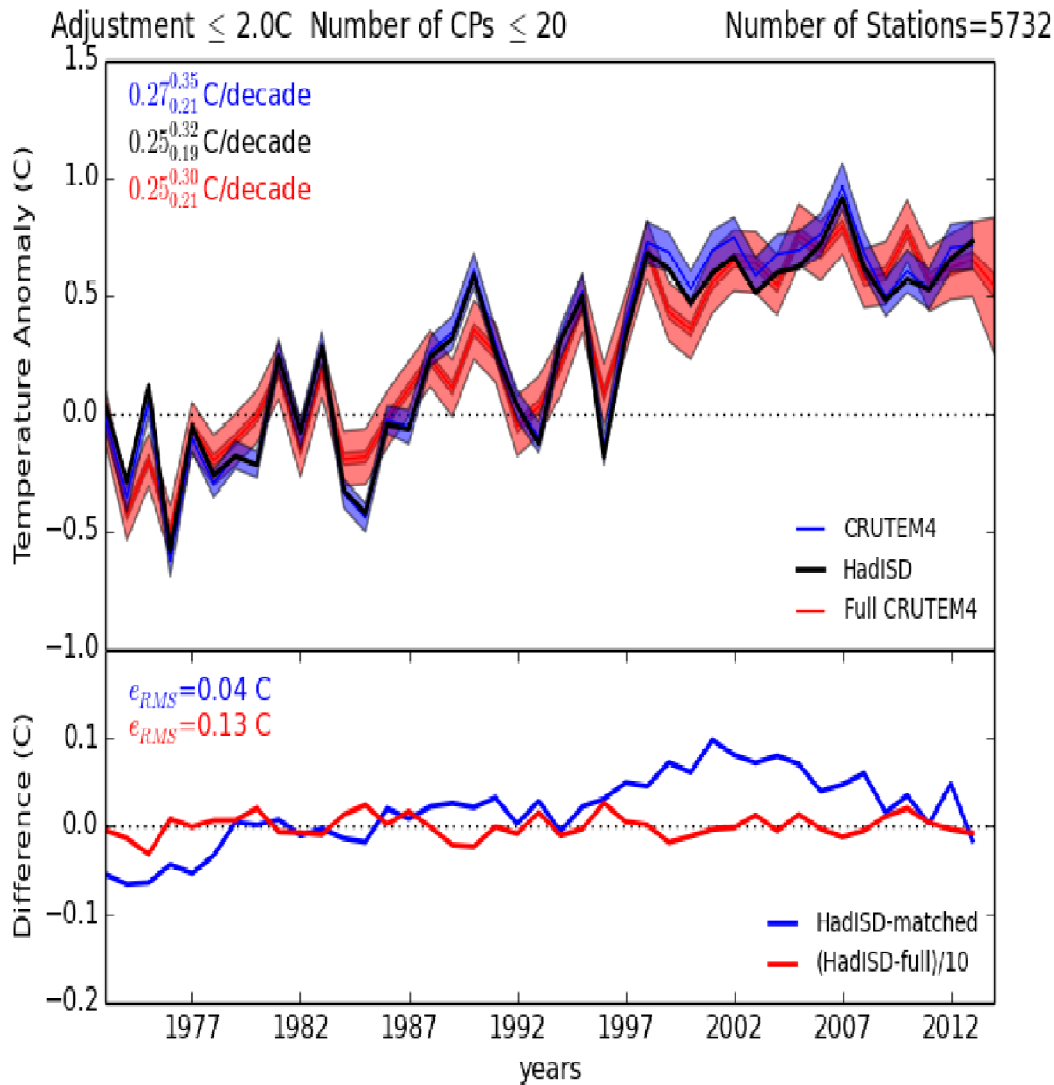
No Detected Change Points

Adjustment $\leq 0.0\text{C}$ Number of CPs ≤ 0

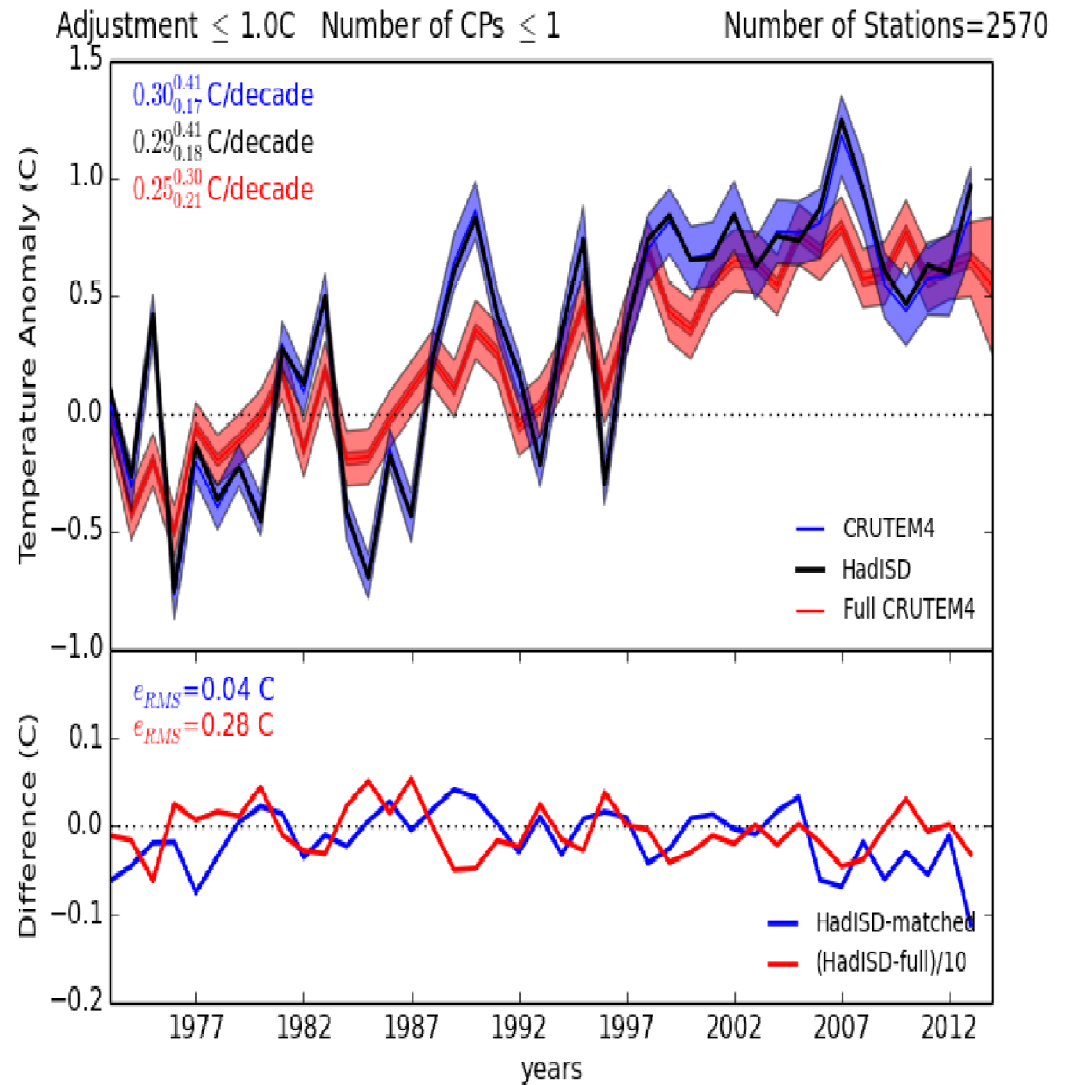
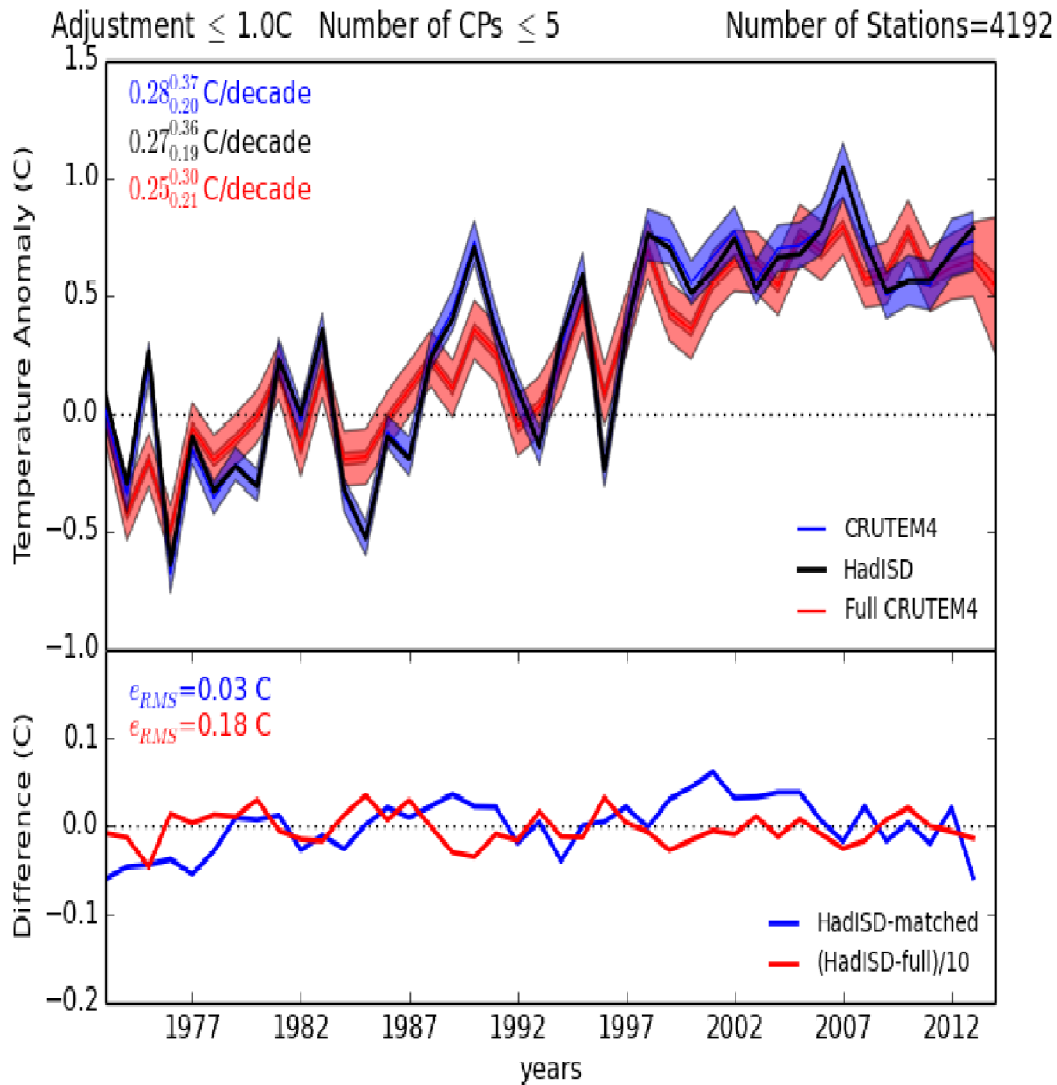
Number of Stations=1458



Adjustment magnitudes



Change point number



Station Quality vs. Coverage

- Linear trends over 40 years match within uncertainties
 - Regardless of which stations are selected
- Coverage has a larger effect than station homogeneity
 - Removing the most inhomogeneous stations does improve match
 - Restricting to the most homogeneous stations worsens it
 - Coverage may not have an effect in other analyses
- Users should be aware of the homogeneity information and use it appropriately.

Summary

- Monthly homogeneous sub-periods obtained for T, Td, SLP and wind speed in HadISD
 - Use diurnal range or maximum values as well as mean
 - No strong biases in detected adjustment magnitudes
- Data to be included in each annual update
 - Information released as text files of dates and magnitudes on www.metoffice.gov.uk/hadobs/hadisd
- Selecting stations on basis of homogeneity can improve fidelity of analyses
 - Other issues (coverage) can be more important
- For the future?
 - Identify change points on a daily basis
 - Apply adjustments on a hourly basis

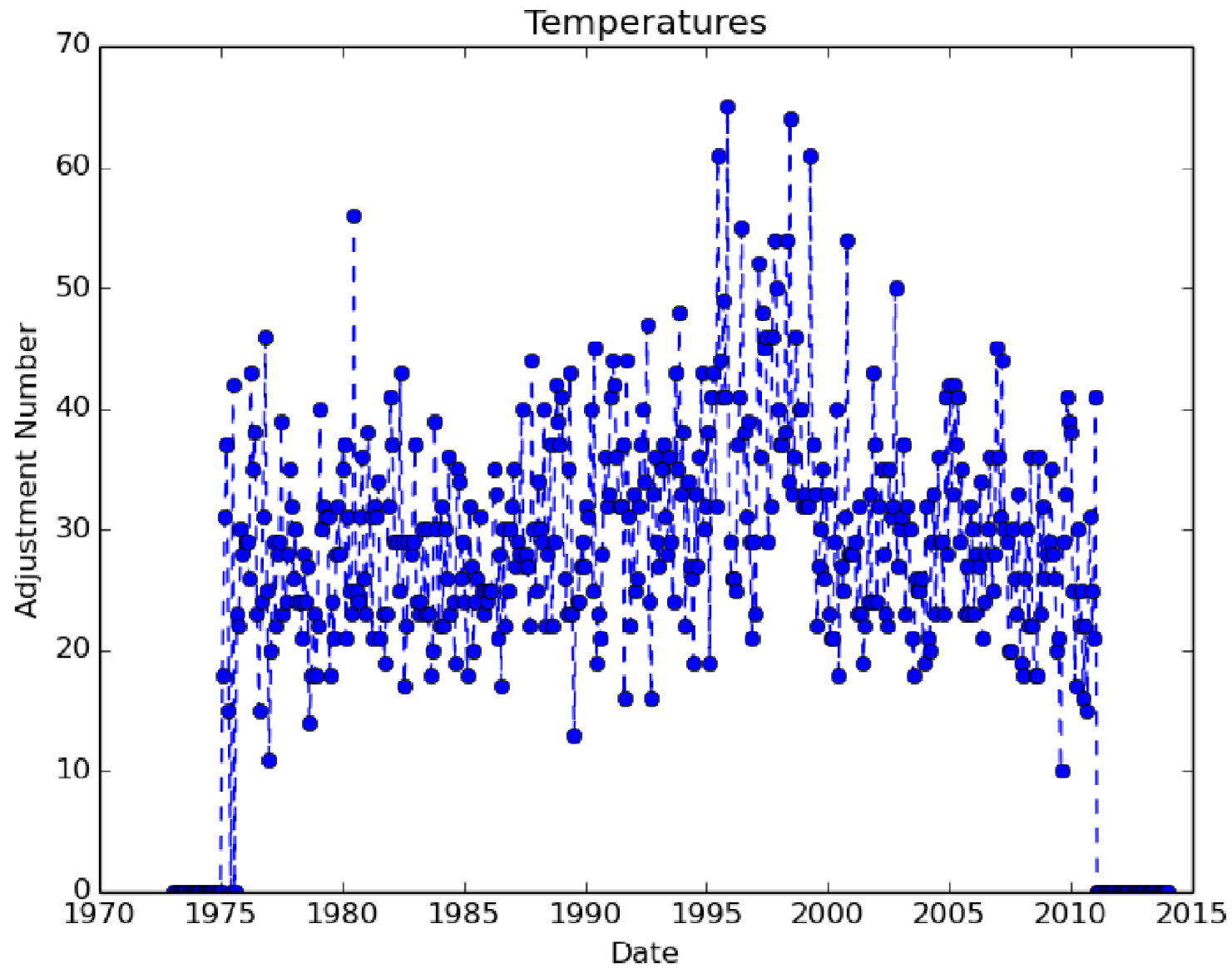


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Questions and answers



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