Benchmarking the Performance of Daily Temperature Homogenisation Algorithms

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Overview

- Introduction - Aims and definitions
- Modelling - Creating the data
- Release - Regions and requests
- Validation - Methods and measures
- Summary and conclusions - What is being achieved and how can it inform future work?

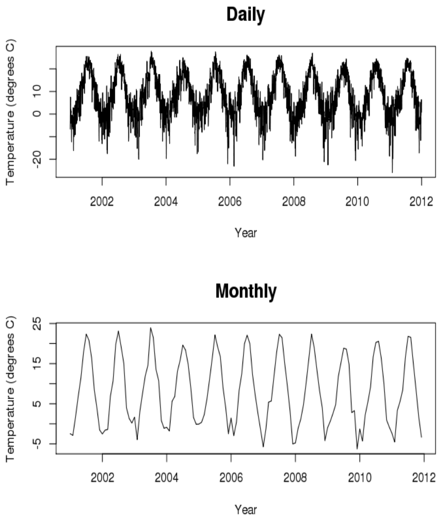
Introduction

Homogenisation to date has mainly been focussed on monthly or annual time scales.

Daily temperature data pose new problems compared to data at larger time scales:

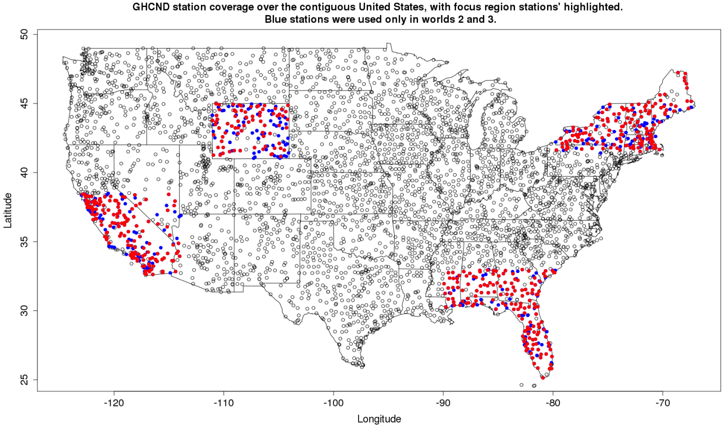
- Variability,
- Quantity,
- Correctly adjusting for inhomogeneities even after they've been found.

This is a benchmarking study; homogenised results are compared to a known truth - the benchmark.



The Modelling

- Stations for four regions in North America are modelled over the period 1970-2011.
- Generalised additive models (GAMs) with observed mean temperatures as the response and various explanatory variables are used to create the synthetic series.



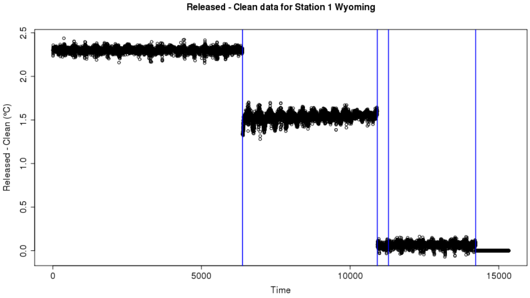
Inhomogeneities

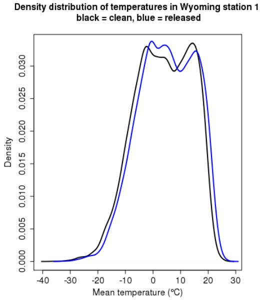
- Three inhomogeneities are focussed on: station relocations, shelter changes and urbanisation.
- These can be added using constant offsets (30%) or perturbation of explanatory variables (70%).
- Four worlds were created with different characteristics.

World No.	Region	Characteristics Explored
1	All	Initial best guess for the world
2	All	Impacts of increased station density
3	All	Impacts of trend inhomogeneities
4	Wyoming	Impacts of autocorrelated data

An Example

1. Pick a station.
2. Use an exponential distribution to decide the location of the inhomogeneities.
3. Decide on the types of inhomogeneities and how they will be added using random numbers.
4. Make necessary alterations to input variables and predict.

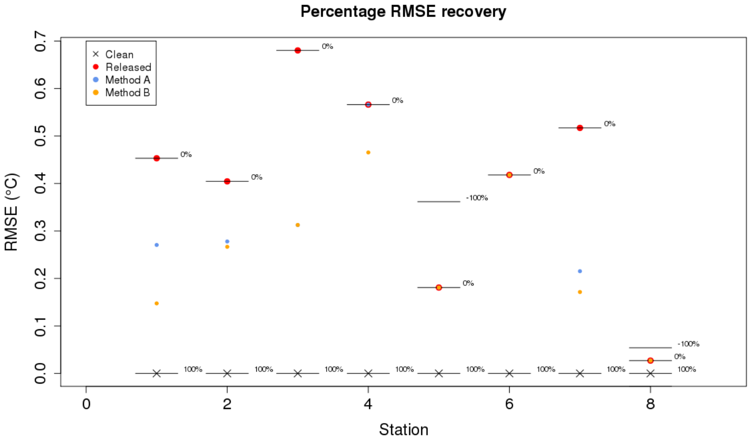




Participation and Validation

- 5 different groups took part in this study running a total of 15 different algorithms.
- Here 2 methods are focused on for Wyoming world 1.
- The results are being evaluated according to measures that assess:
  - Similarity to the clean series - RMSE, correlation, trend recovery, scale similarity, bias, extremes.
  - Ability to detect inhomogeneities - hit rate, false alarm rate, percentage correct.

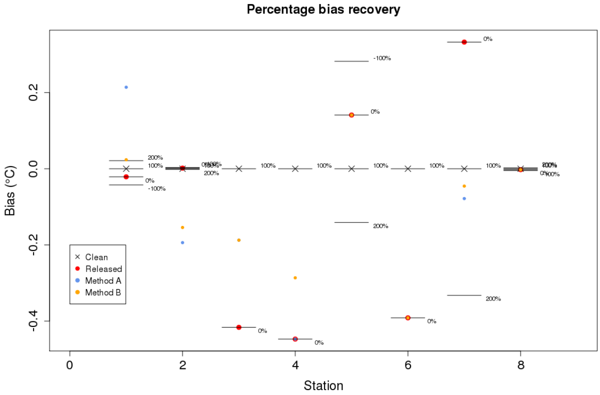
Similarity to clean series: RMSE



Method A: 4 stations improved, 4 unchanged.

Method B: 5 stations improved, 3 unchanged.

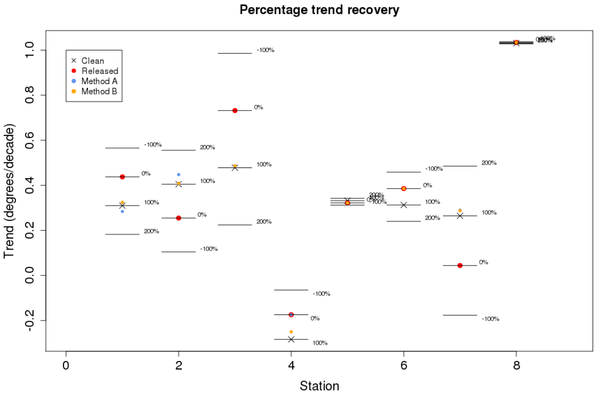
Similarity to clean series: Bias



Method A: 2 stations improved, 2 moved too far in the right direction, 4 unchanged.

Method B: 3 stations improved, 2 moved too far in the right direction, 3 unchanged.

Similarity to clean series: Trend Recovery



Method A: 1 station improved, 3 moved a little too far in the right direction, 4 unchanged.

Method B: 3 stations improved, 3 moved a little too far in the right direction, 2 unchanged.

Detection ability

Here the numbers in black are for method A and the numbers bracketed and in blue are for method B.

	IH added	IH not added
IH detected	64 (73)	6 (24)
IH not detected	213 (204)	328 (310)

$$\text{Hit Rate} = \frac{64}{64+213} = 0.231\ (0.263)$$

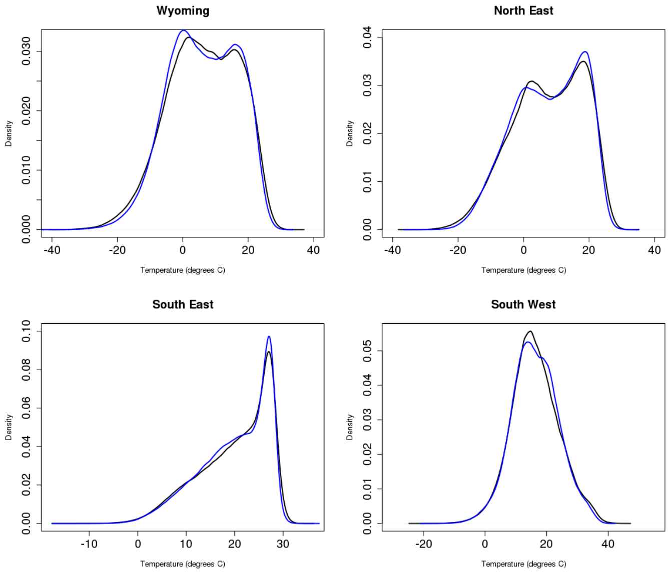
$$\text{False Alarm Rate} = \frac{6}{6+328} = 0.018\ (0.072)$$

$$\text{Percentage Correct} = \frac{64+328}{64+328+6+213} = 0.642\ (0.627)$$

Summary and Conclusions

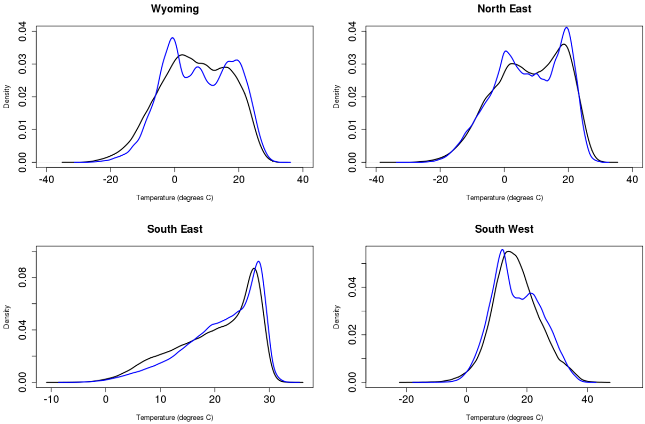
- The problem: We need homogeneous daily data with a well understood uncertainty estimate to robustly assess the impacts of climate change.
- The method: Using statistical models to create synthetic temperature series where the truth is known a priori to allow the benchmark testing of daily homogenisation algorithms.
- The intended outcomes: The assessment and improvement of daily homogenisation algorithms leading to more robust daily data sets.

The Model Performance



Re-analysis Temperatures

- Why not just use reanalysis temperatures if more can be assumed about their homogeneity?
- Scale - we can't get the same station level variability



The Actual Model Formulation

$$TMEAN60_{it} \sim Gamma(\mu_{it}, \phi)$$

where

$$\mu_{it} = \beta_0 + \beta_1 Altitude_{it} + \beta_2 Tempforecast_{it} + f_1(Dyear_{it}, UW_{it}) + f_2(Time_{it}) + f_3(Lat_{it}) + f_4(Long_{it}) + f_5(Sun_{it}) + f_6(SOI_{it}) + f_7(VW_{it}) + f_8(Precip_{it}) + f_9(PWC_{it}) + f_{10}(Coast_{it}) + f_{11}(SLP_{it})$$

- You can also include smooth surfaces
- Have investigated smooth surfaces of Day of the Year and Eastward wind, Northward wind and Precipitation - Allowing a seasonally varying relationship between the variable in question and temperature

Released and real world similarities

- Is it valid to use inhomogeneous data to create homogeneous data? Yes
- Are the inhomogeneity characteristics similar in the clean and released worlds? Yes