How confident are we when adjusting the data at the daily scale?

Statistical and physical approaches: the parallel measurements (POST) Initiative and the MEDARE involvement

**Task Team on Homogenization (TT-HOM) of WMO Commission for Climatology (CCI)**

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- Jose Antonio Guijarro, Spain

**Content**

1. Recent developments in homogenization
   - Daily data
   - Global mean temperature
2. Parallel Observations Science Team (POST)
   - Raison d'être
   - Studies
3. Task Team on Homogenization (TT-HOM)
   - Guidance on homogenization
   - Guidance on transition to AWS
   - Metadata exchange

**Motivation: daily data**

"[Inhomogeneous data] affects, in particular, the understanding of extremes, because changes in extremes are often more sensitive to inhomogeneous climate monitoring practices than changes in the mean."


**Extremes, mean and variability**
Importance changes in variability and mean

The relative sensitivity of an extreme to changes in the mean (dashed line) and in the standard deviation (solid line) for a certain temperature threshold (x-axis). The relative sensitivity of the mean (standard deviation) is the change in probability of an extreme event to a change in the mean (or standard deviation) divided by its probability. From Katz and Brown (1992).

Australia: Albany airport and town

Figure 1. Differences (°C) between percentile points of summer maximum temperature at Albany airport (009741) and Albany town (009508) during the overlap period (2002-2009). The 90th and 10th percentiles indicate the lowest and highest values recorded during the overlap period.

From Trewin (2012).

Spain: Montsouri screen, Stevenson observations, Stevenson automatic

Murcia: South East Spain, Mediterranean.
La Coruña, Coruna: North West Spain, Atlantic.

Montsouri vs. Stevenson: difference as function of Diurnal Temperature Range and Tmax

April

Juli

Montsouri vs. Stevenson: difference as function of Diurnal Temperature Range and Tmax

April

Juli

Parallel measurements – Kremsmünster

Böhm et al. (2010)
Kremsmünster – percentiles difference

Böhm et al. (2010)

Homogenization of distribution daily data

- Necessary because used to study change in distribution
- Methods in their infancy
  - Not well validated yet
  - No methods for gradual inhomogeneities
- Most datasets not homogenized
  - Many only homogenized for mean
    - Not enough for most studies
- Need parallel measurements
  - Study magnitude
  - Validation

Parallel measurements

- WMO recommendation: several years of parallel measurements in case of change in observation
- Experiments with parallel measurements
  - WMO studies for operational instruments
  - Climatological studies with historical instruments
  - Typically analysed for change in mean only
- Two studies on temperature distribution
  - Australia, relocation:
  - Austria, north wall and Stevenson screen:

Motivation global mean temperature

- Well-homogenized national datasets
  - Australia, Austria, France, Hungary, Netherlands, Israel, Italy, Slovenia, Spain and Switzerland
- Compared global collection
  - Annual mean averaged over same countries
    - Berkeley Earth Surface Temperature (BEST)
    - GHCNv3, GISS
    - CRUCY, CRUTEM4
- National datasets are expected to be better
  - More data: better correlated references
  - More metadata: station history
  - More care and better methods

Difference (national – global) BEST (1800)

Difference – BEST (1911)
Sources of global temperature trend bias

- Details: [http://tinyurl.com/reasons-temp-bias](http://tinyurl.com/reasons-temp-bias)
- Transition to Stevenson screens
- Transition to Automatic Weather Stations
- Urbanization
  - Urban Heat Island and relocations
  - Relocations to airports
- Station siting quality
  - Centre of villages to current location outside
- Irrigation & watering

Parallel Data Initiative

- Produce an open database
  - Initially data is restricted to contributors
    - Incentive to contribute
      - Until first joint paper(s) by contributors are written
- Tasks
  - Inventory & accessing parallel datasets
  - Data processing in R
    - Conversion, QC, indices, various averages
  - Analysis & publication
- To join and for more information
  - [http://tinyurl.com/ISTI-Parallel](http://tinyurl.com/ISTI-Parallel)
  - Victor.Venema@uni-bonn.de

Research on parallel data

- Large database with parallel measurements needed to study daily inhomogeneities
  - Study statistical & physical properties of daily IH
    - Dependence on local weather and regional climate
    - Global biases due to common transitions
    - Most studies are currently about mid-latitudes
  - Develop daily correction methods
    - Weather dependent
    - Stochastic
- Large database with parallel measurements needed to study daily inhomogeneities
  - Generate benchmark data with realistic inhomogeneities
    - For example, second cycle of ISTI
  - Validate detected inhomogeneities
Post-early
- Lead authors: Theo Brandsma & Renate Auchmann
- Study the transition to Stevenson screen
- Focus on mean
- If possible also for probability distribution

Exposure
- Insolation
  - Sun, hot ground, scattered radiation
- Humidity and clouds
  - Infrared radiative cooling
- Wind
  - Heat exchange
- Design
  - Size sensor
  - Shielding
  - Mechanical ventilation

Radiation error
- Insolation: Sun, hot ground, scattered radiation
- Humidity and clouds: Infrared radiative cooling
- Wind: Heat exchange
- Design: Size sensor, shielding, mechanical ventilation

Parallel measurements
- Transition to Stevenson screens
  - North-West Europe: < 0.2°C (Various, Parker)
  - Basel, Switzerland: 0°C (0.25°C?) (Wild screen)
  - Kremsmünster, Austria: 0.2°C (North-wall)
  - Adelaide, South Australia: 0.2°C (Glaisher stand)
  - Spain: 0.35°C (French screen)
  - Sri Lanka: 0.37°C (Tropical screen)
  - India: 0.42°C (Tropical screen)

Global temperature changes
- GHCN, CRUTEM, Berkeley, GISS
- Temperature anomaly (°C)
- Figure: IPCC (2013)
POST-AWS-temp

- Lead author: Enric Aguilar
- Transition from conventional observations to automatic weather stations
- Conventional observations
  - Stevenson screens
- Automatic weather stations
  - Often screen change
  - Often location change

10 countries up to now

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POST-AWS-temp – conclusions

- Change of screen is large part of the inhomogeneity
- Relocations need to be considered
  - AWS in USA are less well sited
  - Modern AWS may be better sited
- Need more dataset for global bias estimate

Argentina, Australia, Brazil, Israel, Kyrgyzstan, Peru, Slovenia, Spain, Sweden, USA

POST-AWS-precip, Petr Stepanek: Available datasets

Differences in CON-AWS Monthly Sums for individual regions

Note: boxplot width differs with number of available stations
**POST-AWS-precip – conclusions**

- AWS observes less precipitation
  - Especially solid precipitation challenge for AWS
- Need more data for a global estimate
- Modern equipment may be better again

**POST-move**

- Lead author: Alba Gilabert
- Influence of relocations
  - Often related to urbanization
  - Villages and urban station
  - Move to airports
  - Expect: improvement in siting

**Relocations in villages (Jenny Linden)**

- Sweden
  - Center (5/5)
  - Resid 1 (3/3)
  - Resid 2 (6/6)
  - SMHI current met station (3/4)

- Germany
  - Center (5/5)
  - Resid (6/6)
  - DWD current met station (3/4)
  - River (DDV)

**Task Team on homogenization (TT-HOM)**

- Guidance on homogenization
  - Report
  - Frequently Asked Questions (internet)
  - List with homogenization software (internet)
- Guidance on transition to AWS
  - Screen and location change important
- International sharing of metadata on breaks
  - Small subset of WMO specification on metadata
  - Main information for known past breaks

**Conclusions**

- Trend difference between well-homogenized datasets and global collections
- Inhomogeneities in tails of distribution expected to be larger
- Expect the largest biases in (sub-)tropical and continental climates
- Climatology urgently need a major investment in homogenization research

**Future research – Physical reasons**

- Understanding of cooling biases is poor
  - Reduction radiation errors
  - Relocations, better siting
  - Irrigation and watering near weather stations
- Large global parallel dataset can help (ISTI-POST)
  - Transition to AWS
  - Transition to Stevenson screen
  - Relocations
    - Changes in weather variability and extreme weather
    - Precipitation, humidity, wind(?)