

*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*

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## The International Surface Temperature Initiative (ISTI) Parallel Observations Science Team (POST)

### Members:

Victor Venema, Renate Auchmann, Enric Aguilar, Theo Brandsma, Peter Domanok, Jay Lawrimore, Jenny Lindén, Ewa Milewska, Øyvind Nordli, Jared Rennie, Petr Stepanek, Peter Thorne, Blair Trewin, Lucie Vincent, Kate Willett, Mareile Wolf

### Associate members:

Ingeborg Auer, Andreas Becker, Stefan Brönnimann, Manola Brunet, Michelle Brunetti, Sorin Cheval, Aryan van Engelen, Constantinos Kolokythas, Frank Kaspar, Albert Klein Tank, Franz Gunther Kuglitsch, Monika Lakatos, Anna Mamara, Hermann Mächel, Colin Morice, José Guijarro, Clara Oria, David Parker, Mário Gonzalez Pereira, Elke Rustemeier, Javier Sigo, Tamas Szentimrey, Gregor Vertacnik, Xiaolan L. Wang, Rachel Warren, Markus Ziese

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

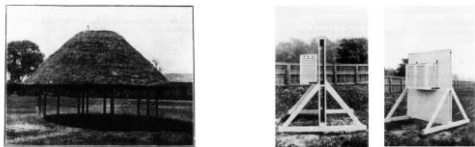
- Wilfrid Serge Raoul Likeba Louamba, Congo
- Ghulam Rasul, Pakistan
- Clara Oria, Peru
- Xiaolan Wang, Canada
- Matthew Menne, USA (co-leader)
- Blair Trewin, Australia
- Tamás Szentimrey, Hungary
- Victor Venema, Germany (leader)
- Jose Antonio Guijarro, Spain

## Content

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  - Guidance on transition to AWS
  - Metadata exchange

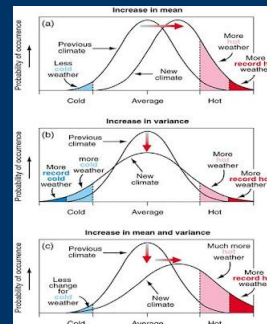
## Motivation: daily data

*"[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."*

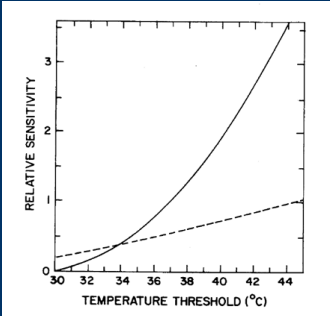


Trenberth, K.E., et al. 2007: Observations: Surface and Atmospheric Climate Change. In: Climate Change 2007: The Physical Science Basis. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

## 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 (or 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

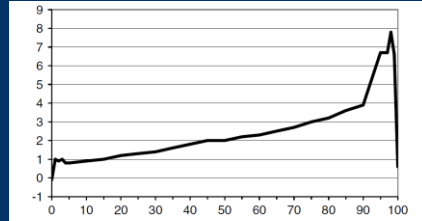


Figure 1. Differences (°C) between percentile points of summer maximum temperature at Albany airport (009741) and Albany town (009500) during the overlap period (2002-2009). The 0th and 100th percentiles indicate the lowest and highest values recorded during the overlap period.

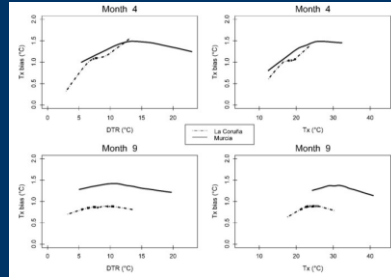
Trewin (2012)

### Spain: Montsouri screen, Stevenson observations, Stevenson automatic



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

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

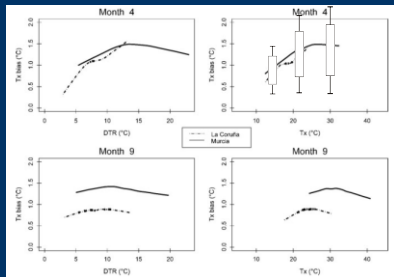


April

Juli

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

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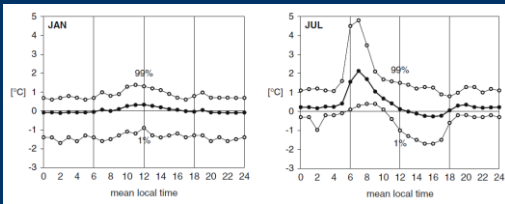
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### Parallel measurements – Kremsmünster



Böhm et al. (2010)

## Kreismuster – 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

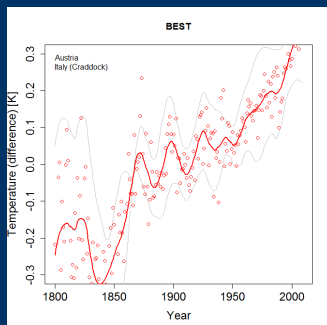
## Parallel measurements

- 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:
    - Trewin, B. A daily homogenized temperature data set for Australia. *Int. J. Climatol.*, doi: 10.1002/joc.3530, 2012.
  - Austria, north wall and Stevenson screen:
    - Böhm, R., P. D. Jones, J. Hiebl, D. Frank, M. Brunetti and M. Maugerl. The early instrumental warm-bias: a solution for long central European temperature series 1760–2007. *Climatic Change*, 101, pp. 41–67, doi 10.1007/s10584-009-9649-4, 2010.

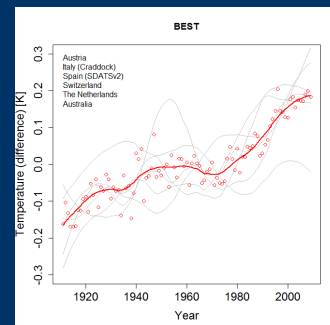
## Motivation global mean temperature

- 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

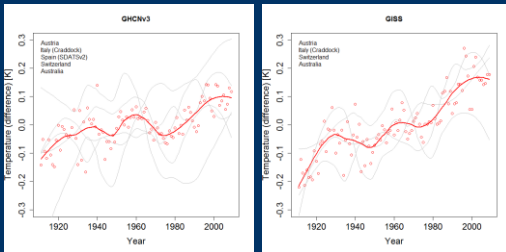
## Difference (national – global) BEST (1800)



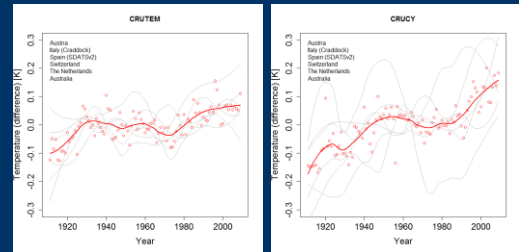
## Difference – BEST (1911)



## Difference – GHCNv3 & GISS (1911)



## Difference CRUTEM & CRUCL (1911)



## Sources of global temperature trend bias

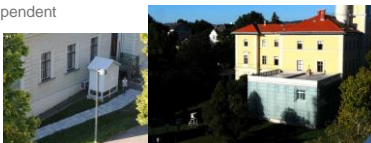
- Details: <http://tinyurl.com/reasons-temp-bias>
- Transition to Stevenson screens
- Transition to Automatic Weather Stations
- Urbanization
  - Urban Heat Island and relocations
  - Relocations to airports
- Station siting quality
  - Centre of villages to current location outside
- Irrigation & watering

## 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>
  - [Victor.Venema@uni-bonn.de](mailto: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



## Research on parallel data

- 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

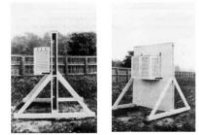


### Post-early

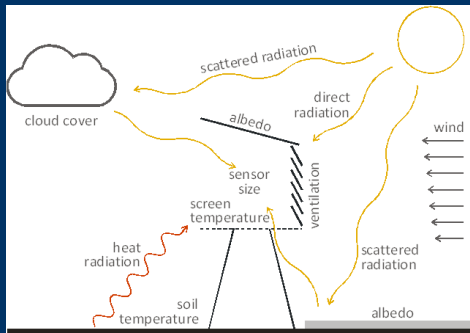
- Lead authors: Theo Brandsma & Renate Auchmann
- Study the transition to Stevenson screen
- Focus on mean
- If possible also for probability distribution

### Exposure

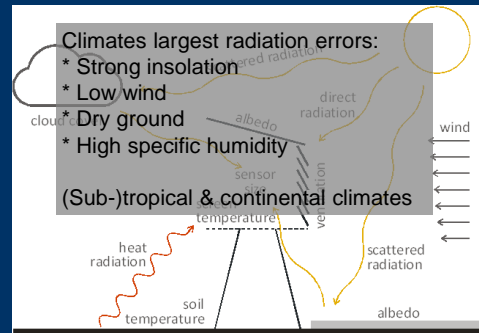
- Insolation
  - Sun, hot ground, scattered radiation
- Humidity and clouds
  - Infrared radiative cooling
- Wind
  - Heat exchange
- Design
  - Size sensor
  - Shielding
  - Mechanical ventilation



### Radiation error



### Radiation error



### 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° (Tropical screen)



### Global temperature changes

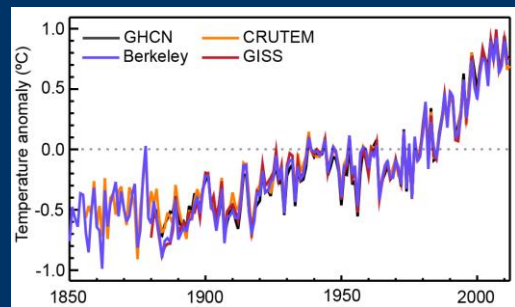
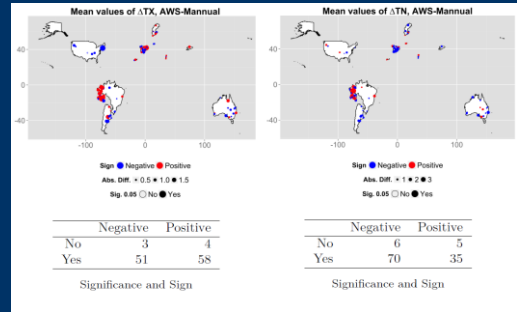


Figure: IPCC (2013)

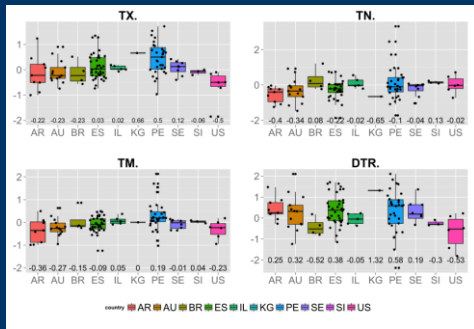
### POST-AWS-temp

- 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



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



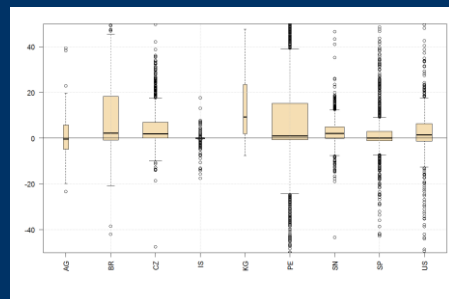
### POST-AWS-temp – conclusions

- 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

### 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)



### 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(?)