

## Early global warming in the period 1850 to 1920

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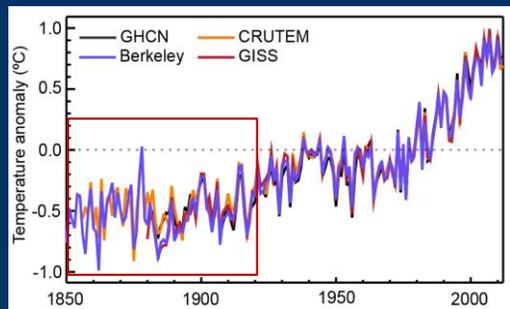
## Outline talk

- Main global warming estimates
- Non-climatic temperature changes
- Other early climatic changes
- Feedback/help
  - Further indicators whether it was warming
  - Difference in warming between ocean and land
  - Could land use explain warming?
  - Parallel measurements
- Red rectangle indicates period of interest
- Temperatures
  - Global
  - Land (countries)
  - Ocean (SST)

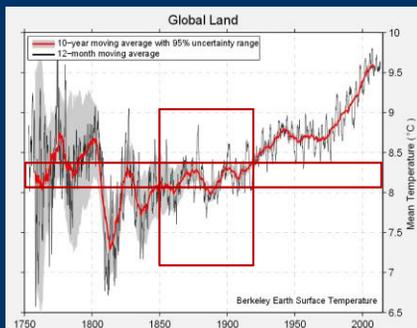
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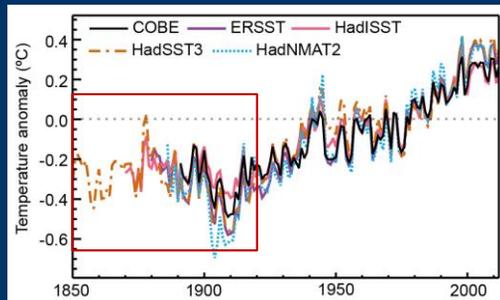
## Global temperature changes



## Berkeley Earth – global land temperature



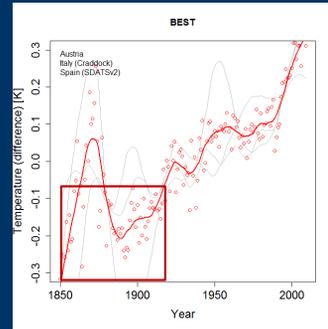
## Sea Surface Temperature (AR5)



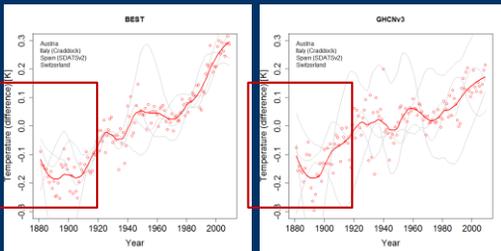
### Indications of more early warming

- Inhomogeneities in temperature observations
  - Well-homogenized national dataset see more warming up to 1920 than global datasets
  - Transition to Stevenson screen
    - old data too warm
  - Small adjustments for this transition in GHCNV3

### Temperature difference series – 3 countries



### Temperature difference series – 4 countries



### Physical reasons: Radiation errors

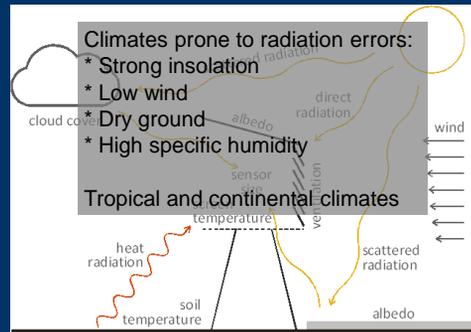


### Montsouris/French screen (in Spain)



Photo: URV, Tarragona, SCREEN experiment

### Radiation error

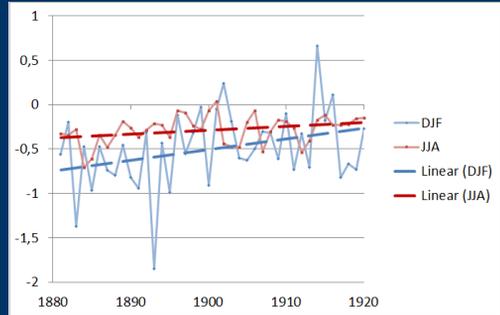


### Parallel measurements Transition to Stevenson screens

- North-West Europe: <math>< 0.2^{\circ}\text{C}</math> (Various, Parker)
- Basel, Switzerland:  $\sim 0 (0.25)^{\circ}\text{C}$  (Wild screen)
- Kremsmünster, Austria:  $0.2^{\circ}\text{C}$  (North-wall)
- Adelaide, South Australia:  $0.2^{\circ}\text{C}$  (Glaisher stand)
- Spain:  $0.35 (0.5)^{\circ}\text{C}$  (French screen)
- Sri Lanka:  $0.37^{\circ}\text{C}$  (Tropical screen)
- India:  $0.42^{\circ}$  (Tropical screen)



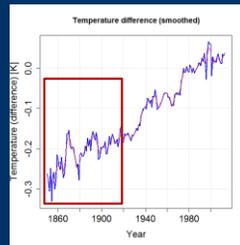
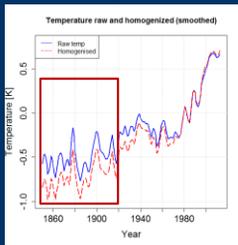
### Winter and summer trend



### Inhomogeneities in GHCNv3

Global Land Surface Temperature

Adjustments

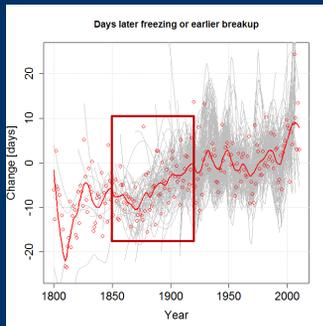


Averaging: Zeke Hausfather  
Data: GHCNv3

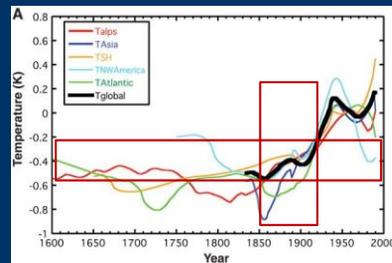
### Climatic changes in 19th century

- Trend in lake temperatures, ice season shorter – <http://tinyurl.com/lake-temp>
- Glacier retreat
- Sea level rise

### Lake and river freezing

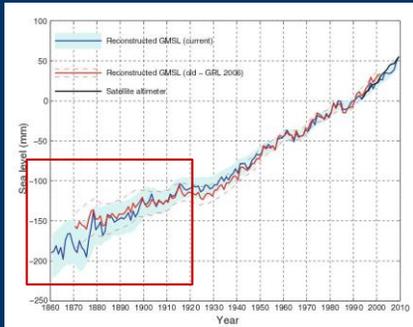


### Temperature reconstruction from glaciers



Oerlemans, J., 2005: Extracting a Climate Signal from 169 Glacier Records. *Science*, 308, no. 5722, pp. 675-677.

## Sea level rise



Church & White, 2011

## Conclusions

- A warm bias in the early instrumental data
  - Parallel data suggest clear bias
    - Transition to Stevenson screens
  - Corrections GHCNv3 small and early
  - Winter trend stronger than summer trend
- Large differences between global and national datasets
- Station data is just one line of evidence

## Conclusions

- Warming
  - River and lake freezing
  - Glaciers
  - Proxy data
  - Sea level rise
- More than expected?
  - Needs quantitative study
    - Berkeley Earth shows some warming over land (Arctic)
  - Would need collocation of datasets
    - Much of the evidence is from cold climates
  - Another indication of a remaining warm bias

## Outlook

- More evidence?
  - National well-homogenized datasets
    - Climate Data Homogenization:
      - Room 0.31; Friday 09:00–09:15; EGU2016-8841
  - Long well-homogenized station series
  - Parallel measurements
- Parallel Observations Science Team
  - International Surface Temperature Initiative
  - Contribute data: co-author
  - <http://tinyurl.com/paralleldata>
  - [Victor.Venema@uni-bonn.de](mailto:Victor.Venema@uni-bonn.de)
- <http://variable-variability.blogspot.com/2016/02/early-global-warming-transition-Stevenson-screens.html>