What is Historical Climatology?

Phil Jones
CRU, UEA, Norwich, UK
Summary

• Historical Climatology is the study of past weather and climate, using observational ‘measurements/data’ (i.e. probably not climate models?)
• Importance of Instrumental Data
• Changes to the way measurements have been made through time, the importance of metadata
• Comparing different types of data (key word here is consistency)
• Pressure Triangles – for wind speed estimation
• Copernicus Climate Change Service (C3S)
Importance of Instrumental Data

• Direct measurements of Essential Climate Variables (ECVs, including air temperature, precipitation and pressure)
• Tells us how things have varied in the past
• Not just summers, which is what most proxy climate information tells us
• With instrumental measurements we can look at the atmospheric circulation, seasonal differences, extremes, etc. (most proxy data generally assumes summer responding proxies can be inferred as annual)

• Users/researchers know that a single observational series is representative of a region. Why then with a proxy series (which explains only some of the variance of an instrumental series) do researchers think it is representative of a larger region?
What could we do if we have winter season data/proxies?

- Most proxy series are summer, but a few are winter responding
- River freeze-ups
- Sea-ice freezing
- Days of snow lying
- In Europe there are long instrumental series to calibrate with

- The important aspect of winter is the circulation
- In Europe (and eastern North America), the North Atlantic Oscillation (NAO) causes out-of-phase relationships between NW Europe and West Greenland and between the North and South of Europe
SW Greenland winter T and PC1 of winter isotopes – one of the few long winter proxy series outside Europe

Note the length of the Greenland instrumental record. Only for winter, though.
Winter Reconstructions

Ice Cores (Greenland)
Long Instrumental and Dutch Canal Freezing (NW Europe)

If proxies correct an out-of-phase relationship should exist between West Greenland and NW Europe

This relationship (due to the NAO) has not been recently discovered. It was widely known to the Norse in Greenland in Medieval times and also to Danish missionaries in Greenland in the eighteenth century.
Importance of Metadata

• How were the measurements taken?
• Instruments used and observing times?
• Ways to adjust data for early observing schedules?
• Pictures of early screens, exposures

• Rebuilding old screens to take parallel measurements today
• Occasionally the old way of measuring still occurs today
• Observing times/schedules. *Ever wondered why some 19th century European locations measured data hourly for 10 years?*
• Now we can use AWS measurements, but Reanalyses can potentially help users deal with these issues when hourly AWS data not available
Experiment beginning in the Netherlands
The Pagoda screen is how measurements were made by KNMI (Dutch Met Service) at De Bilt (nr Utrecht).
This will take several years of measurements before anything can be reported.
Another earlier screen to the right of the Pagoda is also being tested.
Kremsmünster - Austria

When built in the 1770s, this monastery was the tallest in Europe for the time.
Comparing different types of data

• In the European Alps there are paintings, pictures and photographs of glacier termini
• Need to understand why glaciers advance and retreat, but in the Alps it is mostly due to temperatures in summer
• In western Norway it is winter precipitation
• Clearly also used in New Zealand, where it is more like Norway than the Alps

• Islands have air temperatures, but they also have sea-surface temperature (SST) measurements
• SSTs have issues with how they have been taken over the last 200 years, but these are quite well understood
• SST adjustment is independent of air temperature issues

UK (50-60°N, 0-10°W) - annual
NZ will also respond to changes in the atmospheric circulation. The approach applied for the Falkland Islands should work.

Removal of Australia

Globe

Southern Hemisphere
Pressure Triangles – estimating wind speeds

- 3 sites needed
- Here we use London, Paris and Amsterdam
- Here data back to 1854
- When all data sorted out this will be back to ~1770s
- Observation time at the three sites is their ‘noonish’ measurement

- Possible to do these calculations anywhere with three sites using this sort of size region, or slightly larger
- An additional of rescued data
Storminess Indices

Pressure Triangle, based on London, Paris and De Bilt

Back to 1850s, but could go back to 1770s

Ultimate test of MSLP data quality

Here using the ‘near noon’ MSLP values. Observing schedule changes rule out doing things at synoptic times (00, 06, 12, 18)

Better way of looking at Storminess than using wind speed measurements prior to the 1960s
The C3S311a contract family – in situ observations
• 4 contracts 8 million euros 2017-2021
• Lot 1 – data rescue – Met Office lead
  • Data discovery
  • Data rescue tools
  • Data rescue -> repositories
• Lot 2 – access to global land and marine observations – Maynooth lead
  • Fulfill action A2 in IP (see also https://doi.org/10.1175/BAMS-D-16-0165.1)
    - integrated access to land holdings (across ECVs and hourly to monthly)
  • Collect and integrate wealth of global, regional and national data holdings
  • Improvements to ICOADS
• Lot 3 - access to baseline and reference observation networks – lead CNR (Italy)
  • Baseline and reference networks access
  • Particular attention to uncertainty quantification
  • Several atmospheric ECVs and including most GCOS Baseline networks and GRUAN

• Lot 4 – European data products – lead KNMI
  • Support for ECA&D
  • Sustained access and development to E-OBS
  • Ensemble gridded datasets of ECVs across Europe
  • Beyond C3S, KNMI will feed the software to their overseas partners (Indonesia/SE Asia/ northern Australia and western South America)
A reassessment of temperature variations and trends from global reanalyses and monthly surface climatological datasets

C3S provides the first global surface temperature estimate each month – so quicker than GISS and NOAA

Based on ERA-Interim and this paper

Lost SST datasets (in Kent et al., 2017)

James and Fox (1972): Approximately 16,000 log entries, each containing at least two measurements of SST and ancillary data, and metadata collected under the auspices of the World Meteorological Organization (WMO) and analyzed at the U.S. Naval Oceanographic Office in Washington, D.C.

Roll (1951a,b): Wind-tunnel measurements of the temperature change of a German SST bucket made at the Meteorological Office for northwestern Germany, Central Office, Hamburg. Also pairs of SST measurements made on the Fishery Patrol Vessel Meerkatze during 1950.

Ashford (1948): Wind tunnel measurements of temperature change of a range of SST buckets carried out in the Instruments Branch of the Meteorological Office, Air Ministry, United Kingdom.

Brooks (1926, 1928): Paired measurements of SST made on the Royal Mail Ship Empress of Britain and other ships in the 1920s. Analysis was at Clark University, Worcester, Massachusetts, and at least a subset of the data was filed with the Library of the U.S. Weather Bureau in Washington, D.C.

Are Data Rescue people aware of datasets they cannot find? (e.g. Moravian missions in Labrador)
A reassessment of temperature variations and trends from global reanalyses and monthly surface climatological datasets
Comparison of CRUTEM4 with papers by Callendar (1938, 1961)

Includes the error estimate ranges for CRUTEM4 developed by Morice et al (2012)
Further comparisons with earlier work in Ch 1 of WG1 from AR4

Robustness of the global temperature record (1) removal of all stations in the contiguous United States
Greenland ice cores - Vinther et al. (2010)
Winter oxygen isotope series

Similar plots for the other half year (summer). Then the first PC of each set of cores is taken. This explains about 40% of the variance.

Also note each ice core cross dated – like trees, so volcanic horizons line up.

Many high/low isotope years agree.
Stykkisholmur summer T and Greenland PC1 summer isotopes
Differences in the Seasons – Few proxies can do this

• Documentary records from much of Europe and also in China, Japan and Korea
• Ice cores have the potential to provide this in Greenland (and presumably in the Antarctic Peninsula given time)
• In Greenland (and the rest of the Arctic) winter temperatures vary 2-3 times more than summer temperatures, so they dominate the annual temperature series.
• Seasonally-stratified isotopes in Greenland ice cores (Vinther et al., 2010) do the same, so long timescale variations deeper in ice cores tell us more about the winter and less about the summer
• ‘Cross-dating’ the ice cores gets dating correct and enhances the ‘climate’ signal
• Corollary is that it shows how potentially poor a single ice core is!
• Reconstructions only possible to the early 1970s

If Greenland winters were warm, then the NAO tells us N. Europe and Eastern US winters were cool? See how smoothing changes the perception.
Using Trees to help data ice cores

- Trees because of cross-dating provide exact dates
- Ice core layer counting doesn’t involve cross dating, but as in the previous Greenland work, different ice cores can be aligned so as to improve cross dating
- This involves a need to determine why some ice cores have missing or extra layers counted
- Volcanic years can be used to help date ice cores. These years will have high acid contents in the layers, due to the sulphuric acid produced in the atmosphere from the combination of sulphur dioxide and water
- Volcanic years likely to deposit acid layers on the ice in the same year, so layers ought to line up across several Greenland Ice Cores. Also if a tropical eruption was to blame the acid layer ought to be in the same year in both ice sheets
  [http://dx.doi.org/10.1038/nature14565](http://dx.doi.org/10.1038/nature14565)