Validity of Interpolating and Extrapolating Temperature Anomalies across the Arctic. An Investigation using Era-Interim.

Emma May Ann Dodd[1]
Supervised by: Chris Merchant[1], Simon Tett[1] and Nick Rayner[2]
1. University of Edinburgh
2. Met Office Hadley Centre

1. Introduction

Global and regional mean surface temperature anomaly datasets are produced from temperature records using various methods. Some datasets interpolate and extrapolate temperatures using assumptions about the spatial correlation of temperature anomalies.[1,2] What assumptions are valid for the Arctic?

Why is this important?

- Global average surface temperatures have risen by ~0.74°C over the past hundred years.[3]
- This warming is occurring more rapidly in the Arctic with global and regional consequences.[3]
- It is therefore important that we use the most appropriate methods to monitor Arctic warming.

2. Method:

- Monthly and annual Surface Air Temperature anomalies were produced from Era-Interim data for 1979-2011.
- The locations of all stations above 65°N used in the GISTEMP dataset were identified and anomalies from the Era grid cell nearest each station were used as pseudo-station records.
- The spatial cross correlation for each pseudo-station record was calculated (Figures 1 and 2) and a polynomial fit of the correlation with distance for each station (Figure 3) was produced.
- This gives spatial correlation functions for Arctic stations that can be compared with assumptions used in major analyses, such as GISTEMP and Berkeley Earth.

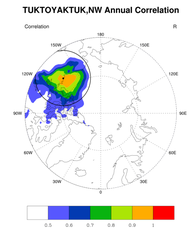

Figure 1: Annual average correlation of the Tuktoyaktuk pseudo-station with all other Era-Interim grid cells.

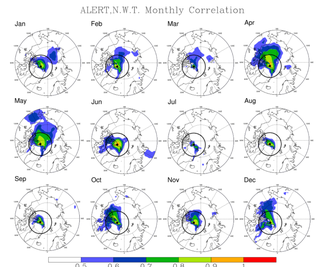

Figure 2: Monthly average correlation of the Alert, N.W.T pseudo-station with all other Era-Interim grid cells.

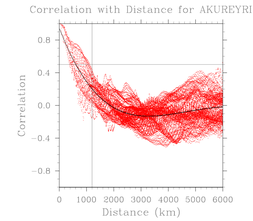

Figure 3: Scatter plot of annual average correlation with distance and the associated polynomial fit for the Akureyri, Iceland pseudo-station.

3. Interpolation and Extrapolation at Annual Time Scales

GISTEMP interpolates and extrapolates station temperature anomalies up to 1200 km away on the basis that correlation is typically 0.5 at this distance. Berkeley Earth uses a model fit which assumes a correlation of 0.29 at 1200 km.

In the Arctic we find that:

- 56.3% of the pseudo-stations analysed have annual correlation values of less than 0.5 at 1200 km distance and therefore do not fit the GISTEMP analysis assumptions.
- 93.3% of the pseudo-stations analysed have annual correlation values of less than 0.29 at 1200 km distance and therefore do not fit the Berkeley Earth analysis assumptions.
- There seems to be a spatial pattern to the stations' correlation value at 1200 km.

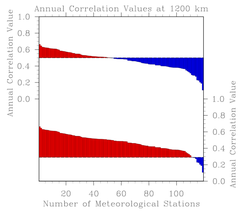

Figure 4: Graph of annual cross correlation at 1200 km for all stations above 65°N with reference to GISS and Berkeley assumed correlation values (0.5 and 0.29) at 1200 km.

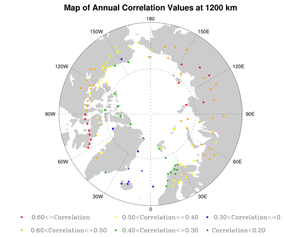

Figure 5: Map of annual cross correlation at 1200 km for all stations above 65°N with station locations shown as coloured points coloured according to their correlation values at 1200 km.

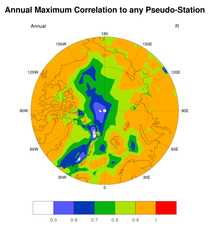

Figure 6: Maximum correlation to any pseudo-station for each grid cell at annual time scales.

4. Interpolation and Extrapolation at Monthly Time Scales

- All pseudo-stations have a monthly correlation value in July and August that is lower than assumed in the GISTEMP analysis.
- The average of all pseudo-stations' monthly correlation at 1200 km is below the value assumed by GISTEMP in all months and below the value implicit in the Berkeley analysis in July and August.

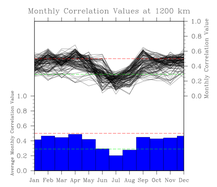

Figure 7: Monthly cross correlation at 1200 km for all stations above 65°N (black lines) and average monthly cross correlation at 1200 km for stations above 65°N (bar chart)with reference lines showing GISS (red) and Berkeley (green) assumed correlation values at 1200 km.

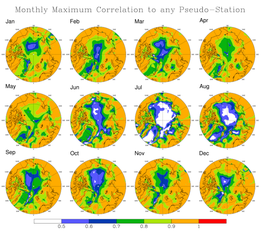

Figure 8: Maximum correlation to any pseudo-station for each grid cell at monthly time scales.

5. Conclusions:

- One single correlation function for all stations and months of the year is an approximation.
- The results shown here are likely to be optimistic:
  - Actual station data is not representative of a whole grid cell
  - Era-Interim data does not contain station measurement uncertainties.

6. Future Work:

- Are the assumptions in temperature anomaly datasets valid for actual station data?
- Or are the issues shown here limited to Era-Interim?

Contact

If you have any questions, comments or suggestions then please send an email to:

E.M.A.Dodd@sms.ed.ac.uk

Emma May Ann Dodd

References

1. J. Hansen, R. Ruedy, M. Sato, and K. Lo. Global surface temperature change. *Reviews of Geophysics*, 48, 2010.
2. R. Rohde, J. Curry, D. Groom, R. Jacobsen, R.A. Muller, S Perlmutter, A. Rosenfeld, C. Wickham, and J. Wurtele. Berkeley earth temperature averaging process. In review
3. IPCC., Climate Change 2007: Chapter 3: Observations: Surface and Atmospheric Climate Change.