HadAT1: a new gridded radiosonde temperature product

Peter W. Thorne, David E. Parker, Simon F. B. Tett, Phil D. Jones‡, and Mark McCarthy

Hadley Centre for Climate Prediction and Research, Met Office, UK. ‡ Climatic Research Unit, University of East Anglia, UK.

Peter.Thorne@metoffice.com

Rationale

Recent studies (1-4) highlight the degree of uncertainty in upper-air temperature records and the effect that this can have upon e.g. detection studies (4). It is imperative that we create multiple independent long-term homogeneous timeseries to fully investigate and understand this uncertainty. The Hadley Centre's current radiosonde-based global gridded upper-air product, HadRT2.1s (5), has major limitations regarding the selection of potential break-points and their treatment with MSU satellite based co-located series, limiting our corrections solely to post-1979. These corrections reduce the dataset's spatio-temporal consistency (6) and independence from MSU. We aim to address these deficiencies in creating our new dataset: HadAT1.

Method

We augment our CLIMAT TEMP station records with data held by NCDC as part of the CARDS project (7). We also consider two additional datasets – LKS (8; 87 stations) and GUAN (9; 151 stations). This combined database contains over 2,000 stations, some with multiple dataset versions, a subset of which are complete enough to calculate a 1966-1995 climatology for at least one version. We use the skeletal network of LKS and GUAN records to identify remaining long-term station records in this subset in reasonable agreement with these products that we can use in a first iteration. In the current version 477 radiosonde stations are used (Figure 1).

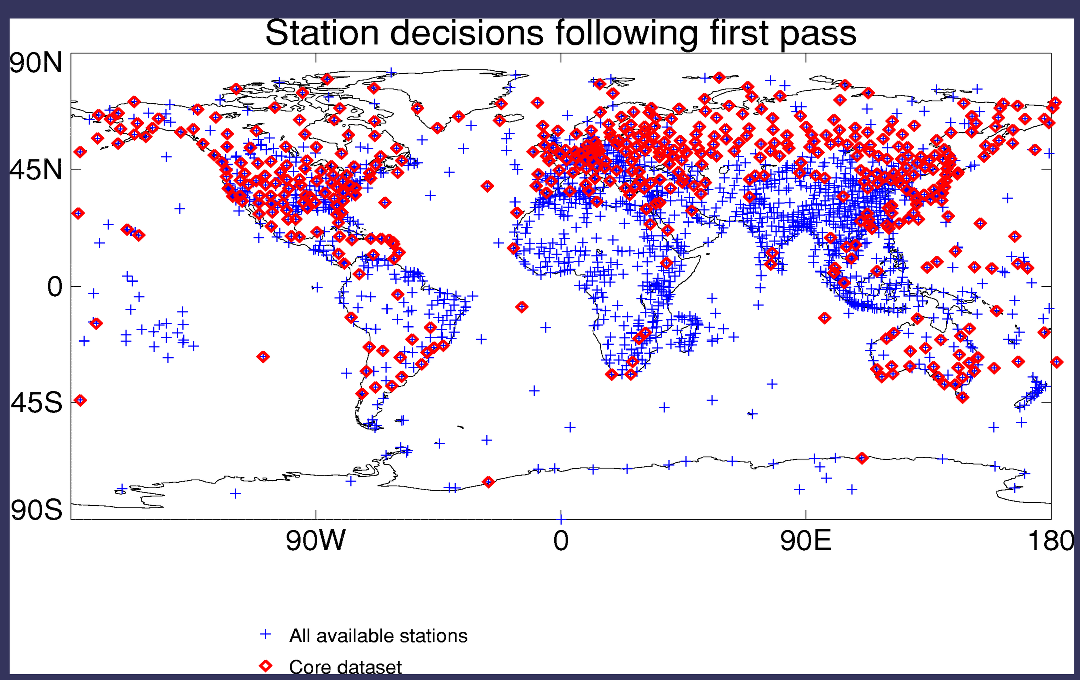

Figure 1. The 477 stations used in HadAT1 and all available stations.

We homogenise the individual station series by near-neighbour checks to maintain spatio-temporal consistency. Neighbours are drawn from the contiguous region with correlation r>1/e for each target station, as defined by NCEP reanalyses fields (10). Weightings used to develop neighbour averages for each station are the NCEP correlation. We apply a moving Kolomogorov-Smirnov test through the difference series (target station – neighbour average) on a level-by-level and seasonal basis to identify potential jump-points, using metadata, where available, to confirm these jump-points. Timeseries are corrected based upon the change in the mean of the difference series across the break-point. We only proceed if this is >0.1K to avoid artificially reddening the time-series. The process is then iterated to a subjectively-assessed degree of convergence on a station-by-station basis.

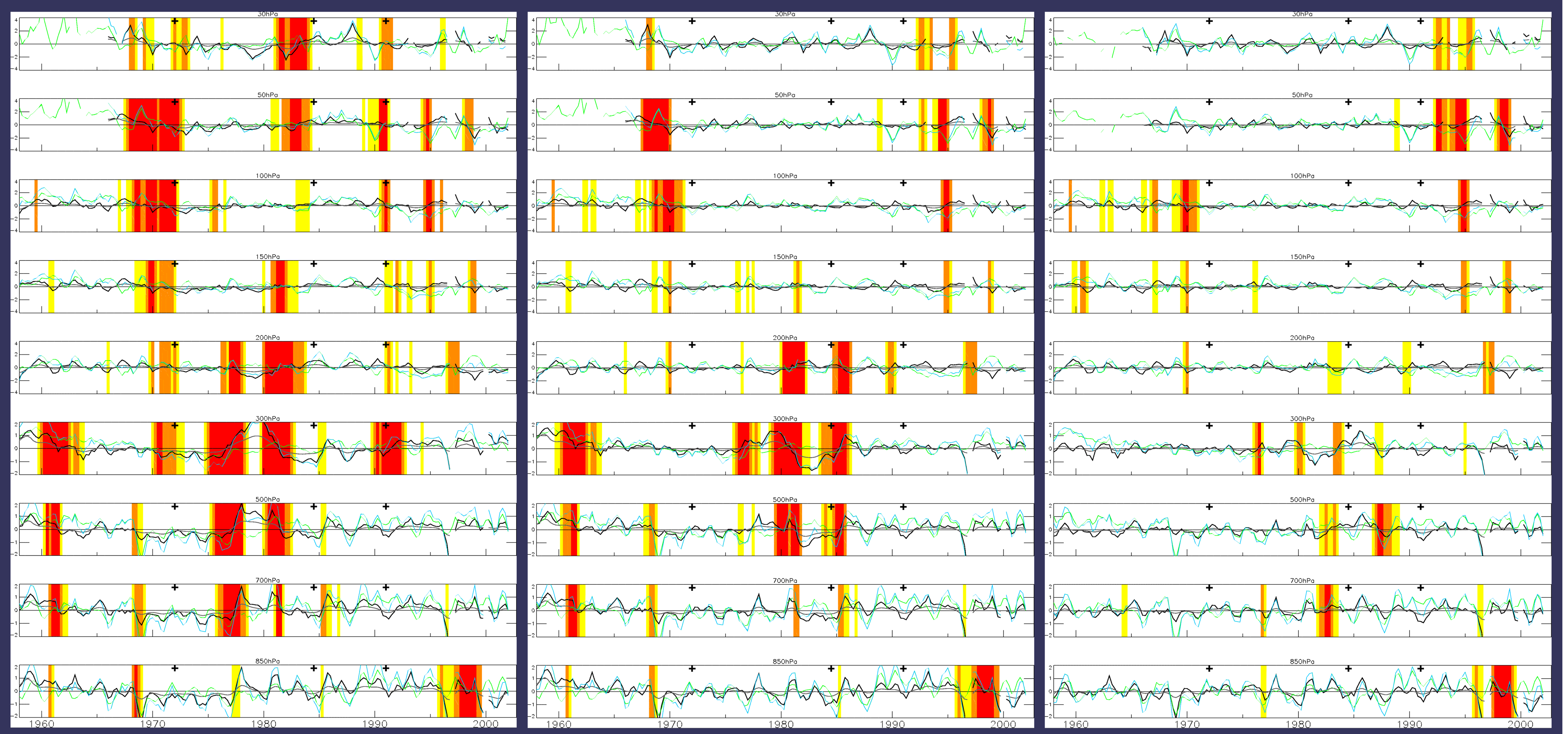

Figure 2. Station 29698 (Nizhneudinsk, Russia) for the first three iterations. Green is neighbour composite, blue station series, and black the difference series. K-S tests significant at 90% (yellow), 95%(orange) and 99%(red). Known metadata events are shown with crosses.

Results

Our QC procedure has been through a total of six iterations, with only 23 of the 477 stations requiring correction on the last iteration. Figure 2 shows a randomly chosen station series for the first three iterations. Although we have not necessarily removed all discontinuities from all station records we have removed the major discontinuities, at least away from the sparsely-sampled high southern latitudes. The resulting zonal trends are spatio-temporally smoother than either the uncorrected analysis or HadRT2.1s (Figure 3). Importantly, the observed tropical tropospheric cooling over the satellite period remains. Grid-box trends on specific levels for 1958-2001 are spatially consistent (Figure 4).

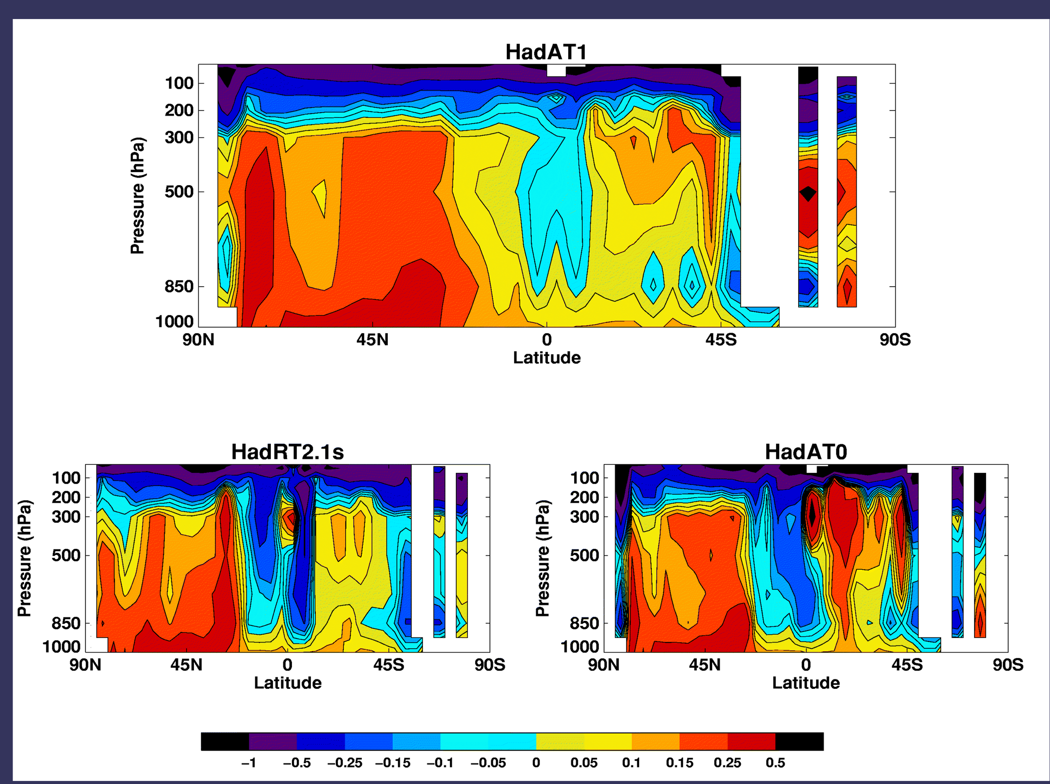

Figure 3. Zonal-mean trends (K/decade) 1979-2001 for HadAT1, HadRT2.1s, and the raw data (HadAT0).

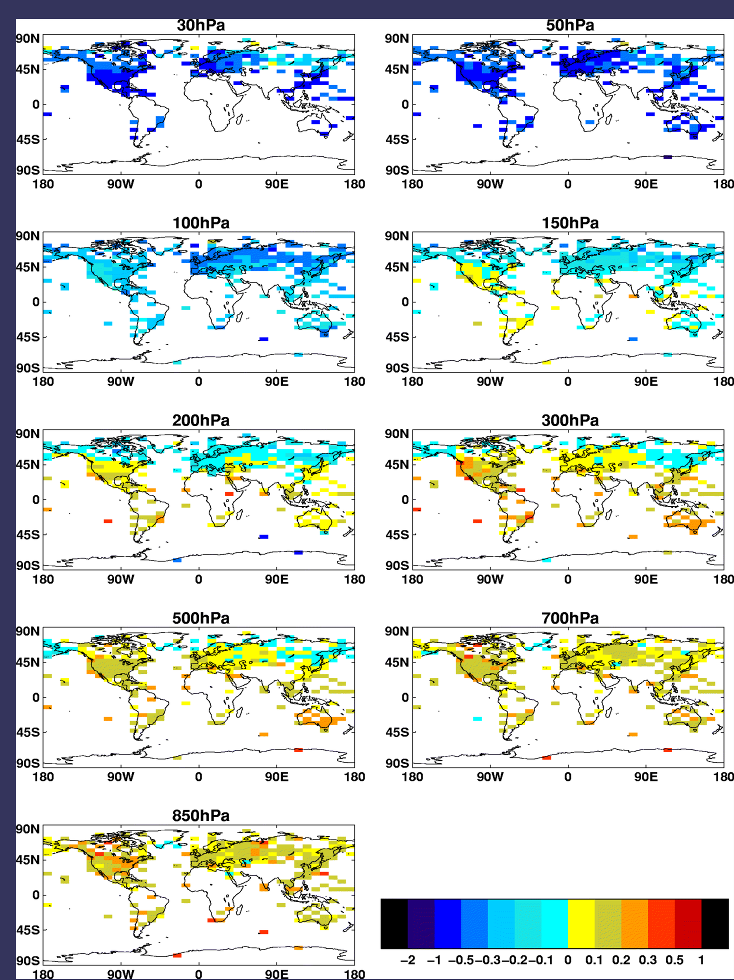

Figure 4. Grid-box trends (K/decade) in HadAT1 for 1958-2001 at all levels considered.

Future work

We plan to calculate error estimates, initially based solely upon our station corrections, to quantify uncertainty in grid-box and larger-scale trends. We have also rejected a further 277 stations in our initial selection which were not in sufficient agreement with GUAN / LKS – many in poorly sampled regions – for which we could calculate a climatology. We will incorporate these in our next generation of this product. In addition to these long-term stations there are over 1,000 extra shorter-record stations from which we could potentially incorporate information.

Acknowledgements and references

The Met Office authors are supported by the U.K. Department of the Environment, Food and the Rural Affairs under contract PECD7/12/37 and the Government Met Research program under Contract MSG-2/03.

1. Christy, J. R., Spencer, R. W., Norris, W. B., Braswell, W. D., Parker, D. E. (2003) Error estimates of Version 5.0 of MSU/AMSU Bulk Atmospheric Temperatures. J. of atmospheric and oceanic technology 20:613-629
2. .Mears, C. A., Schabel, M. C., Wentz, F. J. (2003) A reanalysis of the MSU channel 2 tropospheric temperature record. Accepted by J. Clim
3. Seidel, D. J., Angell, J. K., Christy, J., Free, M., Klein, S. A., Lanzante, J. R., Mears, C., Parker, D., Schabel, M., Spencer, R., Sterin, A., Thorne, P., Wentz, F. (2003) Uncertainty in signals of large-scale climate variations in radiosonde and satellite upper-air temperature datasets. Submitted to J. Clim.
4. Santer, B. D., Wigley, T. M. L., Meehl, G. A., Wehner, M. F., Mears, C., Schabel, M., Wentz, F. J., Ammann, C., Arblaster, J., Bettge, T., Washington, W. M., Taylor, K. E., Boyle, J. S., Bruggemann, W., Doutriaux, C. (2003) Influence of satellite data uncertainties on the detection of externally forced climate change. Science doi:10.1126/science.1082393
5. Parker, D. E., Gordon, M., Cullum, D. P. N., Sexton, D. M. H., Folland, C. K., Rayner, N. (1997) A new global gridded radiosonde temperature data base and recent temperature trends. GRL 24:1499-1502
6. Thorne, P. W., Jones, P. D., Tett, S. F. B., Allen, M. R., Parker, D. E., Stott, P. A., Jones, G. S., Osborn, T. J., Davies, T. D. (2003) Probable causes of late 20th Century tropospheric temperature trends. Submitted to Clim. Dyn.
7. http://lwf.ncdc.noaa.gov/oa/climate/cards/cards_homepage.html
8. Lanzante, J. R., Klein, S. A., Seidel, D. J. (2003) Temporal homogenization of monthly radiosonde temperature data: Part 1: Methodology. J. Clim. 16:224-240
9 .http://www.met-office.gov.uk/research/hadleycentre/guan/index.html
10. Kalnay, E. et al. (1996) The NCEP/NCAR 40-year reanalysis project. BAMS 77:437-471

CRU

Met Office

Hadley Centre