Report on COST ES601 Expert Meeting Vienna

01-02 December 2009

Participants:

Stefan Brönnimann MC member
Leopold Haimberger MC member
Renate Kocen (guest)
Petr Stepanek MC member

Objective of meeting:

Develop and improve methods on homogenization/correction of daily/subdaily data

The meeting took place at the University of Vienna, Department of Meteorology and Geophysics, Althanstrasse 14 1090 Vienna. Beginning was 01 December 15.00, end of meeting was 17.00

The following topics have been discussed in more detail:

Quality Control (QC)

Petr Stepanek stressed that QC must be done on subdaily data; many outliers are not detected using daily means. Similarly, inhomogeneities in subdaily data are often masked/averaged out in daily data. Only combination of several methods makes it possible to automate QC with satisfying results (e.g. in ProClimDB).

Thresholds in quality control can critically influence bias estimation. It can happen, especially in the context of reanalyses, that a large fraction of strongly biased but otherwise useful data are flagged or rejected. It can make large differences whether shifts are estimated with/without rejected data. If a disproportional number of observations is rejected this may be an indication of strongly biased data that should not be considered as outliers.

Time of observation adjustment

Petr Stepanek suggested an adjustment (shift in observation hours) according to recent measurements (possibility to get daily cycle from today's automatic data, then apply it for correction of shifts in observation times). Stefan Brönnimann suggested that, in a first step (for subperiods without change in observation times) no adjustment is necessary, but at a later stage it would be desirable. Assimilation systems might use uncorrected data at the time of observations, but currently this only holds for pressure (for air temperature and other variables, or generally climatological analysis, diurnal cycle adjustments must be made at some point). It was agreed that first individual segments (with observation hours) should be homogenized, and for other versions of series (longer ones), observation hours should be adjusted and then time series as a

whole should be homogenized. What is not needed (or even is distractive), however, is the daily mean calculation.

Switzerland has four series with two to six times daily records of temperature, pressure, cloudiness, wind direction back to before 1800. These are valuable data; e.g. it could be shown that morning observation in the year without summer are almost normal whereas afternoon observations show pronounced cool anomaly. Difficulties for correction arise because of changing observation times. This was experienced by all experts as well. Capabilities of correction options are limited for early data. Correction is questionable when data are to be assimilated, since assimilation system will take care of changing observation times.

It is noted that shifts in time of observations or observation location should not be adjusted for data assimilation applications. However the effects of these shifts have to be taken into account for other applications such as trend estimation. Therefore different sets of adjustments are needed depending on the application. This issue also applies to urbanization, which is considered as signal in some applications but as artificial in trend analysis.

Break detection

Leo Haimberger presented his method, in which metadata are used to specify prior probabilities. These are used together with SNHT in a Bayesian framework to obtain posterior probabilities. This is possible if the Guidelines on Metadata and Homogenisation by Aguilar et al (2003) are obeyed, who recommend some form of standardized digitisation of metadata.

Petr Stepanek compared break detection on the level of daily data with that based on monthly data. Daily data have the disadvantage that they tend to be autocorrelated and have an annual cycle (detectable even in individual months). This puts additional challenges on the application of statistical methods, which often assume independent and identically distributed data. This seems to be a problem especially for surface station temperatures. Deseasonalisation is also handled very differently. Daily data are, however, quite useful for detecting breaks close to each other (or near the ends of the record).

Leo Haimberger presented how he accounted for serial correlation in SNHT (e.g., Wilks equation of full autocorrelation). In difference series, especially in the anomaly difference series, the autocorrelation is often quite low even for daily data. Formula of Wilks (2006) is recommended $Neff=N(1-a)/(1+a)$ where a is the lag 1 autocorrelation. This means that the breaks have to be larger than for random samples to be detected

Stefan Brönnimann reported how he accounts for uncertainties (in the case of statistically reconstructed reference series) in the reference series in the break detection and adjustment. This can be done by inflating the variance of the difference series with the uncertainty of the reconstructed reference series, which may be quantifiable from other sources (e.g. validation experiments). Like for autocorrelation this means that the breaks must be larger to be detected.

Attribution

Stefan Brönnimann would like to attribute inhomogeneities to physical causes, which then can be corrected using a physics-based model. He showed this for the case of the radiosonde data, for which the vertical structure of the difference between reference and candidate series in both GPH and temperature is used to attribute inhomoheneities to pre-specified error types such as radiation error or constant temperature offsets. For surface data, it is not yet clear how attribution can be done, but it might use information on the change in the seasonal cycle before and after break, or it might use a multi-element attribution (e.g., check changes in correlations between variables at one location). Changes in the variance or in extremes are another possibility for attribution. In any case, these techniques can also be used to assess corrections.

Subdaily information is crucial for the attribution step.

Correction

Petr Stepanek recommended that when applying „delta" method, monthly „daily" adjustments should be smoothed to get a natural annual cycle. The variable correction methods (based on changing PDF) are able to solve not only change in mean, but also in variance and other statistical moments (but not trends).

As in case of outliers detection, it is better to apply detection and correction on subdaily scale (individual observation hours) because in aggregates like daily mean possible problems are masked to some extend

Petr Stepanek reported results from a preliminary analysis based on 70 stations from Czech Republic. It seems that separation of data by weather types/clouds, etc. does not help too much (does not improve the statistics between neighbouring stations). Problem with weather types can be that they characterize large-scale circulation, which may not be manifested fully to stations data (local scale). Next task will be to try EOF approach (based on various meteorological elements measured at the place) to defined group of days with similar pattern (such approach is currently used e.g. for correction of RCM outputs, e.g. in Meteo France by Michel Déqué).

Correction depends strongly on selection of neighbour composite selection and weighting. It may be useful to create different reference series depending on weather types, although no significant impact could be found yet.

Generate estimates of adjustment uncertainty by selecting different sets of reference stations, which yield different break size estimates. Non-isotropic weighting of zonal/meridional/altitude distance could also be used for generating reference series.

Physics-based corrections

Stefan Brönnimann would like to use semi-empirical, „physics-based" corrections (on a subdaily scale). This can be done in various ways, either based only on metadata (statistics is only used to detect and attribute a break), or by scaling the physics-based correction such as to match a known break-size of, e.g., monthly means. This approach worked well for radisonde data for a number of predefined error types (and available error models). For surface parameters, error models first need to be constructed, but could include (for temperature) radiation and ventilation errors and temperature offsets. It is doubtful whether station relocations can be corrected in such a way (or whether they should be corrected at all).

Radiosonde bias correction

Much of the discussion focused on homogenisation of radiosonde data. Stefan Brönnimann uses bias models for certain types of error. Bias patterns can be diagnosed from comparison with reconstructions or reanalyses. The attribution of pattern to certain bias type is difficult. If successful, results are good, but only a fraction of the biases could be corrected.

Leo Haimberger uses statistical method for radiosonde temperature/wind bias correction, employing time series of background departures from reanalyses. Only shifts in the mean have been adjusted, but no annual cycle of bias.

In the RICH procedure, the background is used to detect supposed breaks, then a first homogenization is performed in chunks that are considered "safe" based on the above procedure. Then a full homogenization is performed backwards in time using homogenized reference series (rather than homogeneous subperiods).

This procedure may be useful also for surface data. For instance, available monthly reconstructions (Luterbacher et al., 2004) could be used as a first step in order to select possibly homogeneous subperiods in individual records. This could guide the process of building reference series (or it could help in specifying prior probabilities). Petr Stepanek made a remark that relationship of reanalysis (or RCM driven with re-analysis data) may not be related well in all the months, it can work well for winter months but has purer correlations for summer.

Other related projects (networking)

Common expert meeting COST ESO601 (HOME) and COST 733 (Weather types)

Rudolf Brazdil and Petr Stepanek has project on historical data homogenisation in the Czech Republic

Common project plans /ideas

Petr Stepanek/Stefan Brönnimann: Collaborate on (1) exchange historical records (to address network-wide changes and to assess the regional

performance of the methods), (2) observation time, (3) incorporating weather types or multi-element approaches in homogenization

Leo Haimberger's adjustment method could be used to fit parameters of correction models from Stefan Brönnimann for different types of radiosondes. It should be tried to give RICH estimates for different solar angles to get better estimate of radiation error model parameters. Different error model fits could be compared with statistically based estimate. Best matching physical correction pattern could be applied.