



Homogenization of the global radiosonde temperature and wind data set

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Radiosonde data are the only upper air observing system reaching back to the 1940s. Due to numerous changes in instrumentation they need to be homogenized before they can be used in reanalyses or for climate research. Radiosonde data pose special problems (daily data, very short intervals between breaks, annual cycles in difference time series) which must be dealt with in the homogeneity testing method. We have developed several homogenization methods that make use of the background forecasts of climate data assimilation systems (reanalyses such as ERA-40, ERA-Interim or the 20th century reanalysis) as reference for break detection. The methods analyze the time series of differences between these forecasts and the radiosonde observations with a variant of the Standard Normal Homogeneity Test that incorporates a priori information from station metadata and of the Caussinus-Mestre Test.

It can be shown that the tropical and global mean trends in the upper troposphere from homogenized radiosonde data exhibit more than 0.2K/decade more warming than the raw data for the period 1979-2009 and thus fit better to independent evaluations using satellite data. The sensitivity of the homogenization results on the detection method and on the composition of the reference series is discussed and is used as proxy for the uncertainties involved in the adjustment process.

It can be also shown that the quality of radiosonde observations and fields from the 20th century reanalysis is good enough for homogenization purposes back to the 1940s. Difficulties with radiosonde data before 1957 such as nonstandard observation time, reporting only on altitude levels lead to more variance in the difference series but the homogeneity tests are still sensitive enough to find many inhomogeneities.

Construction of a reference series for adjustments in the early period is particularly challenging, since the radiosonde network was then rather sparse outside the US and Europe. Background forecast time series from ERA-40 and the 20th century reanalysis in the 1960s and 1970s show substantial differences and jumps relative to each other, especially in the upper troposphere and lower stratosphere. It needs to be carefully assessed in how far they can be used as reference for the adjustment of breaks in temperature and wind time series.