Bias Corrections for the Global In Situ Upper Air Temperature and Wind Dataset

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The global radiosonde temperature dataset reaches back to the 1940s, tracked balloon data even reach back to the early 1920s. Bias corrections have been applied to these important input data only in some reanalyses, and only in the satellite era. These adjustments are, however, even more necessary in the pre-satellite era since radiosondes were practically the only upper air observing system in those days and since the biases were a lot larger, sometimes more than 3K in 100 hPa. We will give a short general overview how to diagnose and estimate those errors and then focus on recently improved bias correction methods that work offline, i.e. outside a data assimilation system, but employ the background departure statistics available from past and present reanalyses such as ERA-40 and ERA-Interim. Shifts in the background departure time series at radiosonde stations are reliable indicators of changes in either the radiosonde observations or in data from other observing systems that have been assimilated. Shifts in these time series are detected using statistical tests and are then adjusted a) again with background departure information at the same station (we call this method is called RAOBCORE) or b) with information from neighboring radiosonde stations. This method, which is more similar to classical methods used for surface data homogenization, is called RICH. RAOBCORE is simpler to implement but suffers from inhomogeneities in the background forecast time series, often caused by the introduction of new satellite sensors. RICH is more independent of the background but has difficulties to find suitable neighboring stations at remote sites. We applied both methods to the radiosonde dataset back to 1958 and found quite encouraging results. Especially RICH works well on data from the pre-satellite period. The spatiotemporal consistency of the data increases markedly compared to raw data and also compared to earlier versions of RAOBCORE and RICH. The differences between RAOBCORE and RICH as well as between realizations of adjustments gained with RICH using different parameter settings give a good indication of the uncertainties involved in the bias corrections. The adjusted temperature records also show maximum warming trends in the tropical upper troposphere in all 20 year subperiods between 1964 and 2010, with amplification factors compared to surface trends between 1.3 and more than 3. This is roughly consistent with climate model expectations.

While the temperature homogenization method has matured, the wind homogenization is still under development but we know that there are many stations that have systematic errors in the reported wind direction. The wind adjustment system will use observation collected in ERA-40 and ERA-Interim but includes also the CHUAN dataset, reaching back to the 1920s. This is challenging since wind data are often on height levels without accompanying temperature information and at asynoptic times. We use the 20th century reanalysis for interpolation to pressure level and for interpolation in time. First results of this extended wind adjustment system indicate both the need for and the feasibility of a wind bias correction, at least for wind direction. The presentation will conclude with our views on how to further improve upper air bias corrections and thus future reanalyses together with work based upon them.

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