Uncertainty in Radiosonde Temperatures Trend in China Relating to Homogenization Using Reanalysis as Reference and Comparison with Satellite Data

Yanjun Guo
National Climate Center/China Meteorological Administration

Using radiosonde temperatures of selected stations in China, the uncertainties in homogenization processes caused by different reference series, including nighttime temperature, the ERA-40 and NCEP reanalysis, are examined via a two-phase regression approach. Although the results showed limited consistency in the temporal and spatial distribution of identified break points (BPs) in the context of metadata events of instrument model change and correction method, significant uncertainties still existed in BP identification, adjustment, and impact on the estimated trend. Reanalysis reference series generally led to more BP identification in homogenization. However, those differences were parts of global climatic shifts, which may have confused the BP calculations. Discontinuities also existed in the reanalysis series due to changes in the satellite input. The adjustment values deduced from the reanalysis series ranged widely and were larger than those from the nighttime series and, therefore, impacted the estimated temperature trend.

The adjusted temperatures by NCEP reference results showed that, during 1958–2005, averaged temperatures in China tended to decrease in the lower stratosphere and upper troposphere, in contrast to warming trends in the mid- and lower troposphere. The trends varied with two different subperiods. For 1958–1978, cooling trends in the entire atmosphere were similar to trends at the global scale. For 1979–2005, warming occurred in the lower troposphere, with the amplitude of the warming tending to weaken with increases in altitude and shifting to a cooling trend above 400 hPa. Seasonal trend structures suggest that warming in the lower troposphere is attributable to temperature increases in December–February (DJF); cooling in the upper troposphere and stratosphere was found mainly in June–August (JJA). Unlike with results of a larger spatial scale, a robust cooling layer was found around 300 hPa in China. The disparity in temperature variation between China and the world, as a whole, were in early period (1960s and 1970s). Temperature in the lower stratosphere decreased by a smaller range in China than it did in the world. The cooling layer at 300hPa in China took place chiefly after 1993. In addition, the average temperature in the mid-upper troposphere in China during 1960s and 1970s was higher than global average temperature.

We also compared the upper air temperatures in middle, upper troposphere and lower stratosphere in China between adjusted radiosonde time series with NCEP reanalysis as reference and satellite (AMSU) time series during 1979-2005. Both trends for temperatures in middle troposphere are warming and the variations are similar. The inconsistency between radiosonde and AMSU temperatures is found in upper troposphere and lower stratosphere. AMSU TMT trend is warming (0.06K/10a) while radiosonde trend is cooling (-0.28K/10a). TLS trend are both cooling but the trend from radiosonde(-0.73K/10a) is much larger than that from AMSU(-0.3K/Decade). The obviously negative anomalies after 1993 in upper troposphere and after 1999 in lower stratosphere led to cooling trend in radiosonde time series, while temperature anomalies from AMSU is much smoother. There are two cause lead to the inconsistency. One is from homogenization process. By comparing vertical profile of trend among original, reference and adjusted temperatures, homogenization with NCEP time series as reference weakened warming trend in middle troposphere and enhance cooling trend in upper troposphere and lower

stratosphere during 1979-2005. The second reason is from difference between radiosonde and AMSU. Above results confirmed the previous conclusions included radiosonde datasets in general showed more cooling than satellite datasets in stratosphere and radiosonde data showed cooling whereas the satellite indicates warming in global or hemispheric region scale. Therefore, this research suggests that for better estimating regional upper-air temperature trend in China especially in the lower stratosphere and middle troposphere, it is necessary to analyze multiple independent dataset.

Corresponding Author:

Name: Yanjun Guo
Organization: National Climate Center
Address: China Meteorological Administration
Zhong-guan-cun-nan-da-jie, No.46, Haidian District
Beijing 100081
China