**Water Vapor Change from Radiosonde Observations and Reanalysis Products over China**

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**Abstract**

 Radiosonde humidity data provide the longest record for assessing changes in atmospheric water vapor, but they often contain large discontinuities because of changes in instrumentation and observational practices. In this study, the variations and trends in tropospheric humidity (up to 300 hPa) over China are analyzed using a newly homogenized radiosonde dataset. There are, however, many spurious changes and discontinuities in the raw radiosonde records resulting from changes in instruments, observational practice, processing procedures, station relocations, and other issues. Recently, the daily humidity records radiosonde derived from about 130 Chinese stations were homogenized using a new approach developed by Dai et al. (2011). It is shown that the homogenization removes the large shifts in the original records of humidity resulting from sonde changes in recent years in China, and it improves correlation of the precipitable water (PW) with precipitation and the spatial coherence of the PW trend during recent 40 years. The PW variations and changes are highly correlated with those in lower–midtropospheric mean temperature (r = 0.83), with a dPW/dT slope of ~7.6% K−1, which is slightly higher than the 7% K−1 implied by Clausius–Clapeyron equation with a constant relative humidity (RH). The radiosonde data show only small variations and weak trends in tropospheric RH over China.

 Using these homogenized observations, the PW from the NCEP/NCAR, NCEP/DOE, MERRA, JRA-55, JRA-25, ERA-Interim, ERA-40, CFSR and 20CR reanalyses is evaluated for the period from 1979-2012 (1970-2001 for ERA-40). Results suggest that the PW biases in the reanalyses are within ∼20% for most of northern and eastern China, but the reanalyses underestimate the observed PW by 20%–40% over western China, and by ∼60% over the southwestern Tibetan Plateau. The newer-generation reanalyses (e.g., JRA25, JRA55, CFSR and ERA-Interim) have smaller root-mean-square error (RMSE) than the older-generation ones (NCEP/NCAR NCEP/DOE and ERA-40). Most of the reanalyses reproduce well the observed PW climatology and interannual variations over China. However, few reanalyses capture the observed long-term PW changes, primarily because they show spurious wet biases before about 2002. This deficiency results mainly from the discontinuities contained in reanalysis RH fields in the mid-lower troposphere due to the wet bias in older radiosonde records that are assimilated into the reanalyses. Thus, more efforts are needed to remove spurious changes in input data for future long-term reanlayses.