Comparison of atmospheric profiles between COSMIC radio occultation and radiosonde observations in the Qinghai-Tibet Plateau

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Motivation

Atmospheric temperature and humidity profiles are significant for meteorological research, and commonly obtained with traditional radiosondes, which are launched only twice each day in operation. However, their horizontal distribution is inhomogeneous, and their density is relatively low (particularly over the plateau, oceans, and polar regions).

The successful launch of the six-satellite FORMOSAT-3/Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) in April 2006 began a new era of GPS atmospheric remote sensing. COSMIC is providing more than 1,500 GPS radio occultation (RO) soundings every 24 hours, uniformly distributed around the globe. With these RO soundings, the atmospheric profiles of temperature, pressure, and vapor pressure can be retrieved.

This study is to compare the atmospheric profiles derived from COSMIC RO data in the Qinghai-Tibetan Plateau (QTP) with collocated radiosonde soundings. As precipitable water (PW) can be calculated from atmospheric profiles, comparison of PW is also performed.

Data and Methods

The radiosonde soundings of 8 sites in the QTP from February to July 2008 are used in this study, with temporal interval of 6 h and vertical spatial resolution of 10-100 m. COSMIC wet profiles are coupled to the radiosonde soundings with a sampling distance less than 300 km and a sampling time within 2 h.

The information of 8 sites are presented in Table 1 and their distribution are shown in Figure 1.

Table 1. Information of the 8 sites in the Qinghai-Tibetan Plateau

Site	TNCH	BEKM	BFDI	BFLJ	LASA	LITA	GAIZ	NAQU
Lon. / °E	98.5	102.7	100.2	100.2	91.8	100.3	84.4	92.1
Lat. / °N	25.0	25.0	25.7	26.9	29.7	30.0	32.2	31.5
Alt. / m	1656	1889	1991	2390	3649	3950	4416	4508

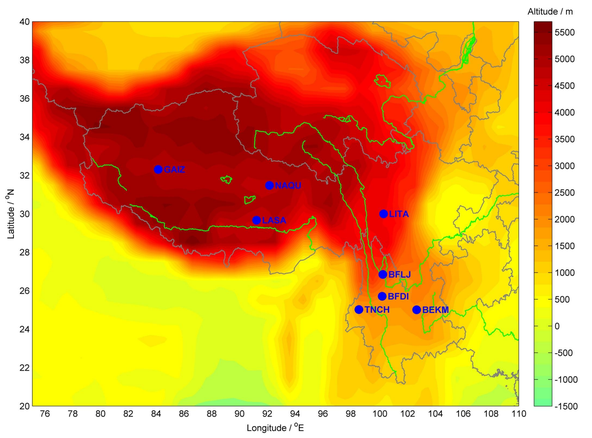

Figure 1. Distribution of the 8 sites in the Qinghai-Tibetan Plateau

Methods used in this study are simply and straightforward, and the correlation coefficients, biases, and RMSEs between the COSMIC and the radiosonde soundings for each parameter (e.g. temperature, pressure, vapor pressure, and PW) are calculated. The discrepancies between COSMIC and radiosondes at different heights are calculated to explore how the COSMIC retrievals vary with height.

Results

(1) Temperature comparison

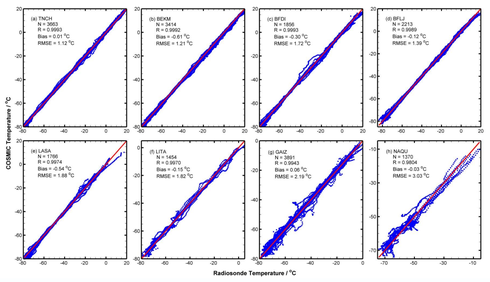

Figure 2. Scatter plots for COSMIC temperature against radiosondes at 8 stations in the Qinghai-Tibetan Plateau

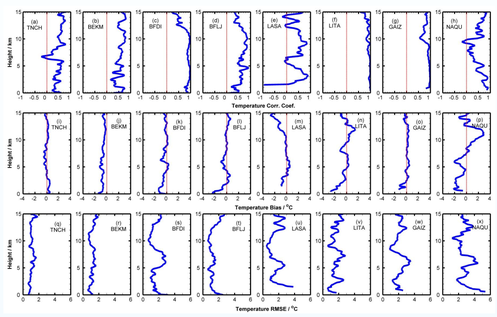

Figure 3. The correlation coefficients, biases, and RMSE of COSMIC temperature against radiosondes at 8 stations in the Qinghai-Tibetan Plateau

(2) Pressure comparison

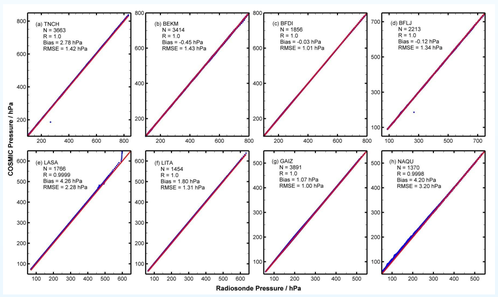

Figure 4. Scatter plots for COSMIC pressure against radiosondes at 8 stations in the Qinghai-Tibetan Plateau.

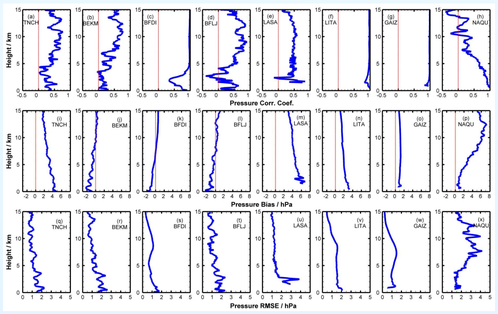

Figure 5. The correlation coefficients, biases, and RMSE of COSMIC pressure against radiosondes at 8 stations in the Qinghai-Tibetan Plateau

(3) Vapor pressure comparison

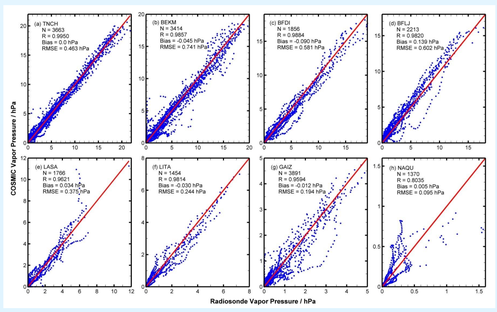

Figure 6. Scatter plots for COSMIC vapor pressure against radiosondes at 8 stations in the Qinghai-Tibetan Plateau

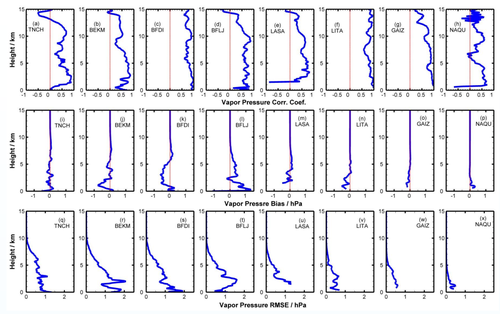

Figure 7. The correlation coefficients, biases, and RMSE of COSMIC vapor pressure against radiosondes at 8 stations in the Qinghai-Tibetan Plateau

(4) Precipitable water (PW) comparison

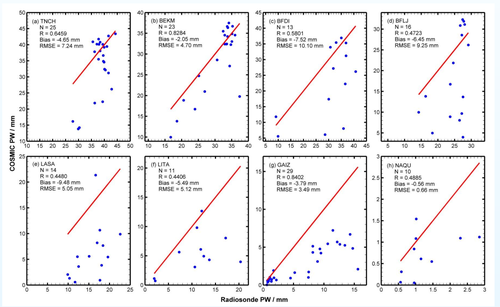

Figure 8. Scatter plots for COSMIC PW against radiosondes at 8 stations in the Qinghai-Tibetan Plateau

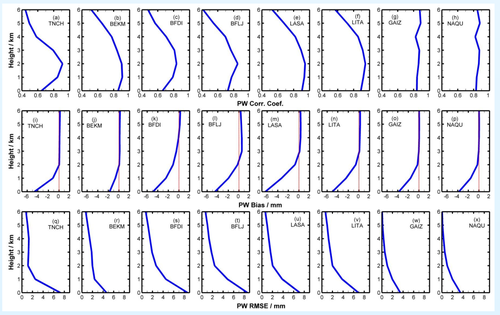

Figure 9. The correlation coefficients, biases, and RMSE of COSMIC PW against radiosondes at 8 stations in the Qinghai-Tibetan Plateau

Conclusion

- The atmospheric profiles of COSMIC have a satisfactory correlation with radiosondes. Compared to radiosondes, the COSMIC temperature, pressure and vapor pressure have a bias of -0.2 ℃, 1.7 hPa and 0 hPa, respectively, with a corresponding root-mean-square error (RMSE) of 1.8 ℃, 1.6 hPa and 0.4 hPa. The discrepancies are larger in lower troposphere and decrease with altitude.
- The precipitable water (PW) calculated from the wet atmospheric profiles of COSMIC also has a reasonable correlation with radiosondes. However, the COSMIC PW is smaller than that of radiosondes, with a bias of -5.0 mm and a RMSE of 5.7 mm. The discrepancy between them is obvious in lower troposphere.
- The instability of radiosonde sounding in near surface layer and the limited ability of model used in the COSMIC retrieving method in the QTP are mainly responsible for the discrepancy of atmospheric profile in lower troposphere, and the underestimated COSMIC PW is due to the underestimated COSMIC refractivity.

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