Assessment of Radiosonde Temperature Measurements in the Upper Troposphere and Lower Stratosphere using COSMIC Radio Occultation Data

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COSMIC unique:
~2500 profiles per day
~90% of COSMIC data penetrate to 2 km height or lower after using open loop tracking.

The six-satellite Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) mission
Green Dots: COSMIC RO locations
Red dots: operational radiosonde stations

Radiosonde

Pro: long term; high vertical resolution
Con: Instrument changes => Spatial and temporal inhomogeneity
The degraded accuracy in the upper air (1°C-10km, 4°C-30km)

COSMIC

Pro: Free of instrumental bias
Independent of geographical location
High accuracy at 5-25 km

Motivation: assess the quality of different types of radiosonde in UTLS using the COSMIC data
Data: atmPrf / sonPrf / ecmPrf (CDAAC)

- atmPrf ---observed N, Height, Tdry, Press
- sonPrf ---Press, Height, Tson, WV and calculated N
- ecmPrf---Press, Height, Tecm, WV and calculated N

\[ N = 77.6 \frac{P}{T} + 3.73 \times 10^5 \frac{P_W}{T^2} \]

Matching method:

Vertical: interpolated Tdry profile into the height of pressure levels of radiosonde and ECMWF
Horizontal: 2hr300km
Height: 12-25km
Time:
Jun.,2006-Feb.,2007

<table>
<thead>
<tr>
<th>Sonde Type</th>
<th>Matched sample (Percentage)</th>
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<tbody>
<tr>
<td>MRZ</td>
<td>4728 (17.8%)</td>
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<tr>
<td>Shanghai</td>
<td>1751 (6.6%)</td>
</tr>
<tr>
<td>VIZ-B2</td>
<td>1474 (5.6%)</td>
</tr>
<tr>
<td>Vaisala-RS92</td>
<td>3786 (14.3%)</td>
</tr>
</tbody>
</table>

AVK-MRZ (17.8%)
Shanghai (6.6%)
VIZ-B2 (5.6%)
Vaisala-RS92 (14.3%)
Larger bias are shown for MRZ and VIZ-B2 above 20km.
Slight difference for Shang and Vaisala.
For MRZ, it has large difference above 12km in daytime while slight difference in the night.

For MRZ, the larger solar angle $\theta$ shows the warmer bias.

The warm bias is mainly caused by the solar radiation heating in the daytime.
For VIZ-B2, the large positive difference occurs above 20km in night while more negative difference occurs for large solar angle in the day.
TDry-Tecm
(Time: Jun-Oct, 2006)
For MRZ and VIZ-B2, the large T differences of Tdry-Tson pairs are not shown in those of Tdry-Tecm pairs, and the latter agrees quite well, which imply the stability of RO results.
<table>
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<th>Solar absorptivity ($\alpha$)</th>
<th>Emissivity ($\varepsilon$)</th>
</tr>
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<tbody>
<tr>
<td>MARS-Russia</td>
<td>0.2</td>
<td>0.04</td>
</tr>
<tr>
<td>VIZ-USA</td>
<td>0.15</td>
<td>0.86</td>
</tr>
</tbody>
</table>

(Cited from Luers et al., 1998)

![Graph](image1)

**FIG. 6.** Russian MARS radiosonde day and night temperature errors.

![Graph](image2)

**FIG. 1.** VIZ radiosonde day and night temperature errors.
GZZ was introduced in 1960s– The old version radiosonde in China

(Cited from Luers et al., 1998)

Fig. 9. Chinese GZZ radiosonde day and night temperature errors.
Two types of Shanghai
Shang/E(70%)--new
Shang/M(30%)--old

Shang/E (day)

Shang/E (night)

Shang/M (day)

Shang/M (night)
COSMIC data is highly stable and can identify the performance of different type radiosonde.

Temperature measurements from the Vaisala-RS92 and Shanghai radiosonde agree well with those of COSMIC.

Large temperature biases are shown for MRZ and VIZ-B2 radiosonde relative to COSMIC, which are probably caused by diurnal radiative effects.

Temperature measurements from Chinese radiosonde are obviously improved, especially the new one, by comparing with COSMIC measurements.

Thanks !