Thermodynamic Profiler Temperature Sounding Accuracy

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The US National Weather Service is establishing a Next Generation National Profiler Network (NGNPN) including up to 120 wind and thermodynamic profiler sites. As a part of this process, microwave radiometer profiler, 300-m tower and radiosonde measurements at the NOAA Boulder Atmospheric Observatory (BAO) facility were compared. Results are presented here.

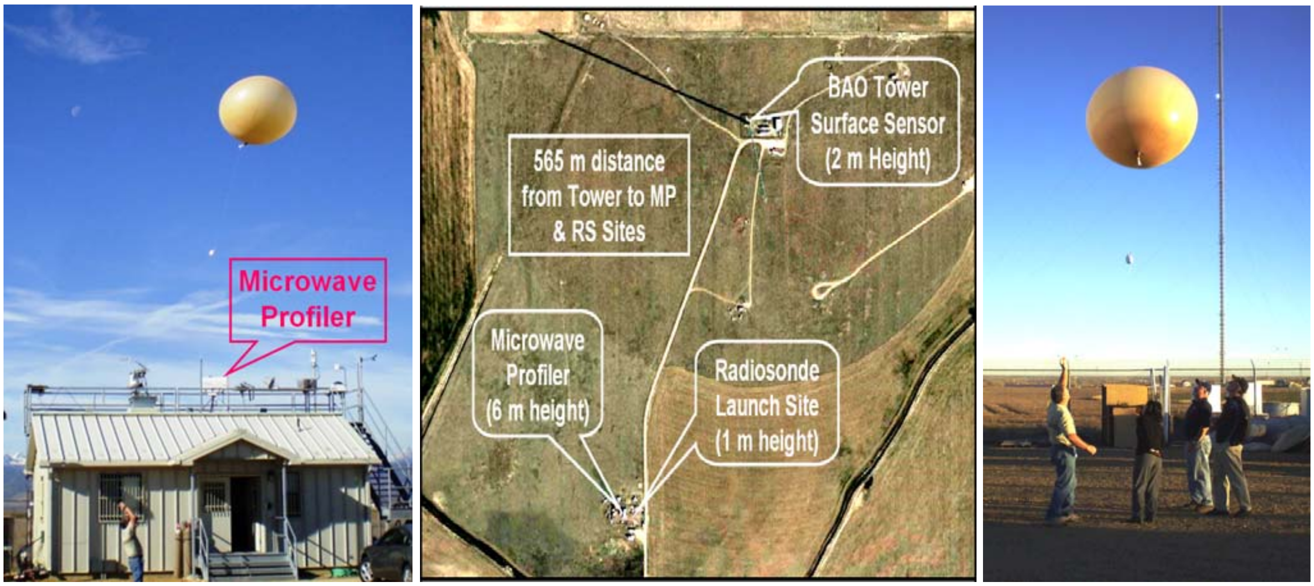

Figure 1. Radiosonde, radiometer and tower site map and launch photos.

A Radiometrics MP-3000A on a rooftop location is shown at left in Figure 1. Twenty radiosondes were launched ~10-m east of the building during the nine-day test period. The tower is located 0.5 km from the radiometer-radiosonde launch site. Surface temperatures were measured by an aspirated sensor at 6-m height in the radiometer blower intake, by the radiosonde sensor package at ~1-m height, by an ancillary radiosonde ground station at 1.5 m height, and by a tower sensor at 2-m height.

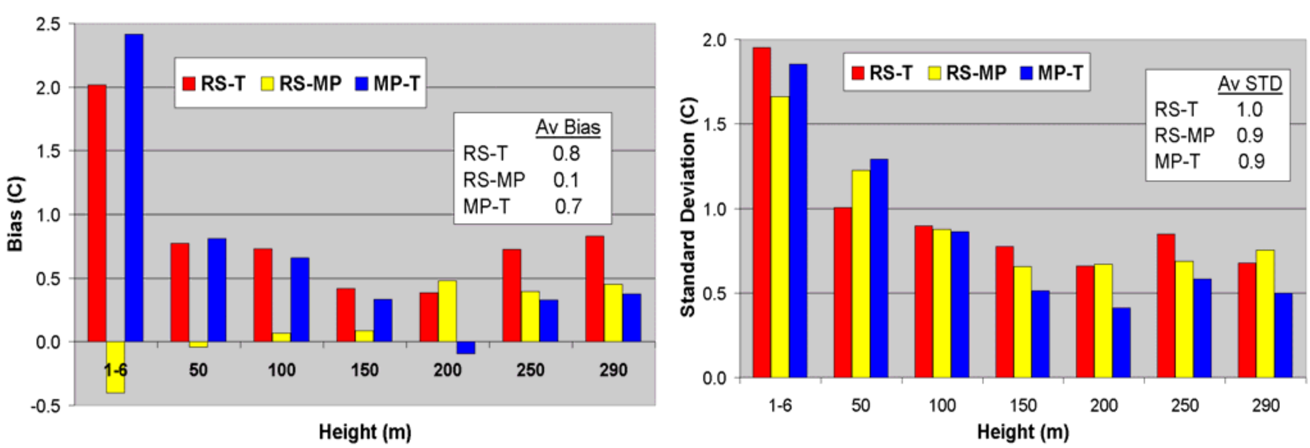

Figure 2. Simultaneous radiosonde (RS), microwave profiler (MP) and tower (T) comparison bias (left) and standard deviation (right) to 290 m height.

Statistics of microwave profiler, radiosonde and tower temperature measurement comparisons from near-surface to 290 m height are shown in Figure 3. The largest bias (>2 C) and standard deviation (>1.5 C) are seen in near-surface measurements. At 50-m height and above the bias is less than 1 C and the standard deviation is less than 1.5 C.

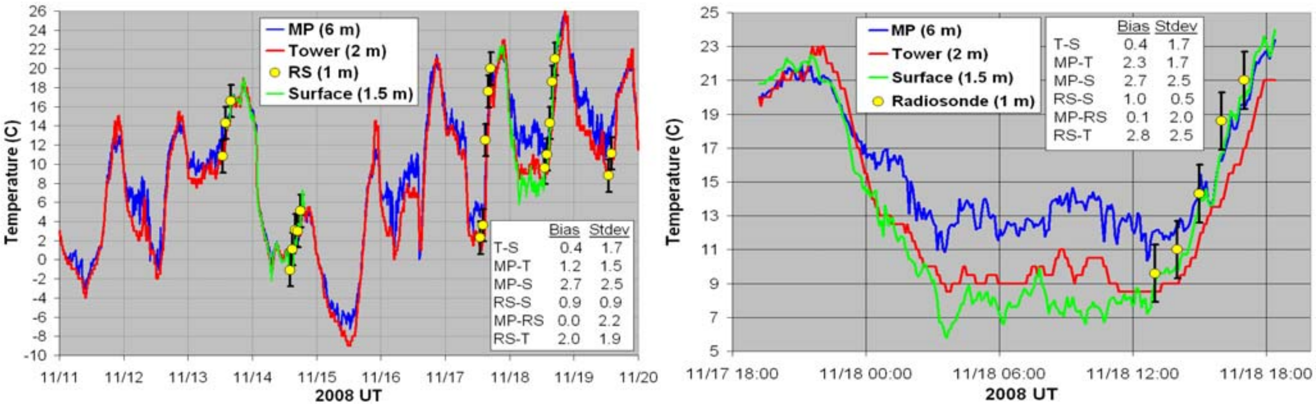

Figure 3. Near-surface tower (T), microwave profiler (MP), radiosonde (RS) and ancillary surface temperature (S) observations during 9 days (left) and 12 hrs (right).

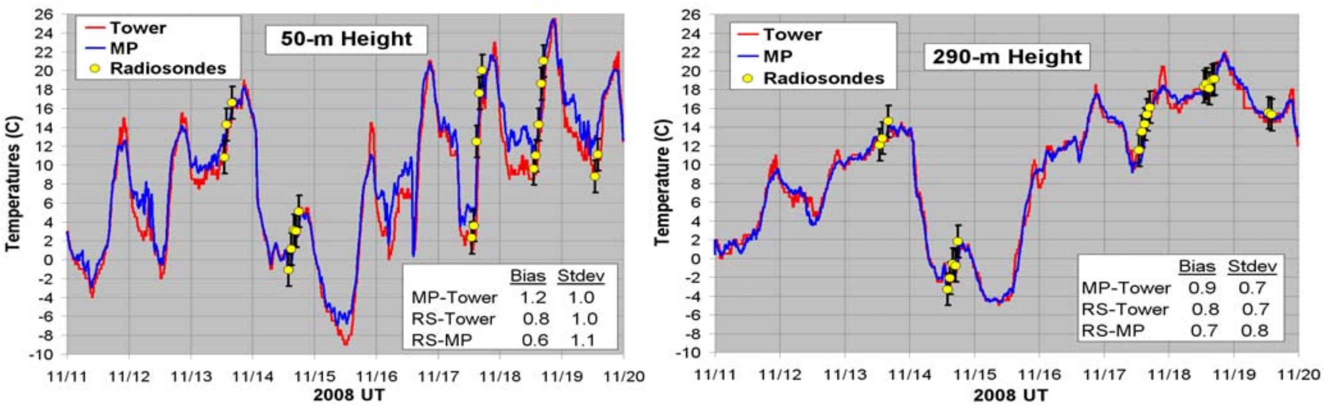

Figure 4. Tower, microwave profiler and radiosonde measurements to 290 m height. Point measurement representativeness error is shown with radiosonde data.

Surface temperature measurements (Figure 3 - left) show 35 C variability with <3 C bias and standard deviation during the entire intercomparison test period. A subset including a surface temperature inversion (Figure 3 - right) shows differences as large as 7 C between the four surface temperature measurements.

Height (meters)	MP-T		RS-T		RS-MP		Rep. Error
	Bias	STD	Bias	STD	Bias	STD	
1-6	2.41	1.85	2.02	1.95	-0.40	1.66	1.8
50	0.81	1.29	0.77	1.01	-0.04	1.23	1.8
100	0.66	0.86	0.73	0.90	0.07	0.87	1.8
150	0.33	0.51	0.42	0.78	0.08	0.66	1.7
200	-0.09	0.41	0.39	0.66	0.48	0.67	1.7
250	0.33	0.58	0.73	0.85	0.40	0.69	1.7
290	0.38	0.50	0.83	0.68	0.45	0.75	1.7

Table 1. Temperature intercomparison statistics and representativeness error (^oC).

Intercomparison statistics for radiometer, tower and radiosonde temperature measurements from the surface to 290 m height are listed in Table 1. Also shown is the representativeness error assigned to radiosonde point measurements when they are used in numerical weather modeling. Intercomparison standard deviations are in good agreement (<10%) with representativeness error at the surface and are 30-70% smaller to 290 m height.

Radiosonde-radiometer temperature statistics from the surface to 2 km height are shown in Figure 5. However, radiosonde-radiometer temperature bias and standard deviation reported over seasonal time periods are less than 2.5 C from the surface to 10 km height (Güldner and Spänkuch, 2001; Liljegren et al., 2004; Hewison et al., 2008), roughly equivalent to standard radiosonde point measurement representativeness error.

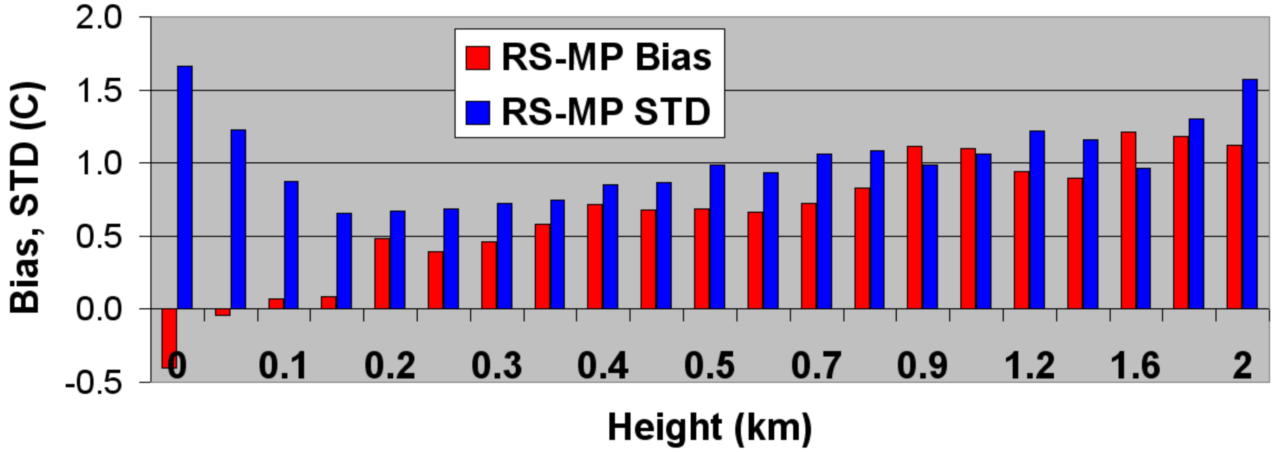

Figure 5. Radiosonde-radiometer statistics to 2 km height.

Statistics of radiosonde and radiometer temperature soundings to 2 km height are shown in Figure 5. Since representativeness error decreases from 1.8 C at the surface to 1.5 C at 2 km height (Kistler et al., 2001), the two sounding methods are equivalent in accuracy when they are used for numerical weather modeling.

Conclusions

For the nine-day test reported here, radiometer-radiosonde temperature comparisons were less than or equal to standard radiosonde point measurement representativeness error up to 2 km height. At higher levels, published seasonal radiosonde-radiometer comparison statistics also agree within standard representativeness error. High temporal resolution radiometer measurements can be used to improve local short-term weather prediction, including air quality, airport weather, hazardous material dispersion, fire weather, outdoor event and wind energy applications.

References

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