# Radiometric Profiling of Atmospheric Temperature and Humidity

The Radiometrics TP/WVP-3000 Profiler provides continuous atmospheric temperature, humidity soundings to 10 km height with an accuracy equivalent to co-temporal radiosonde soundings when used in numerical weather analysis. The Profiler also provides cloud liquid soundings. The instrument (Figure 1) is highly reliable as demonstrated by more than one million hours of operations in the Arctic, mid-latitudes and the Tropics.


**Figure 1. Radiometrics TP/WVP-3000 temperature, humidity and cloud liquid profiling radiometer.**

Atmospheric temperature inversions (temperature increasing with height) commonly occur in the boundary layer. Urban smoke and pollution are typically trapped below the temperature inversion. Thus, continuous temperature profiling is useful for atmospheric dispersion and pollution applications.

Radiosondes are traditionally used for atmospheric temperature sounding. They provide temperature measurements with ~0.1 C accuracy along the radiosonde ascent path. However, additional error (~1.7 C) is associated with radiosonde measurements when they are used to characterize the atmosphere for numerical weather modeling[1].

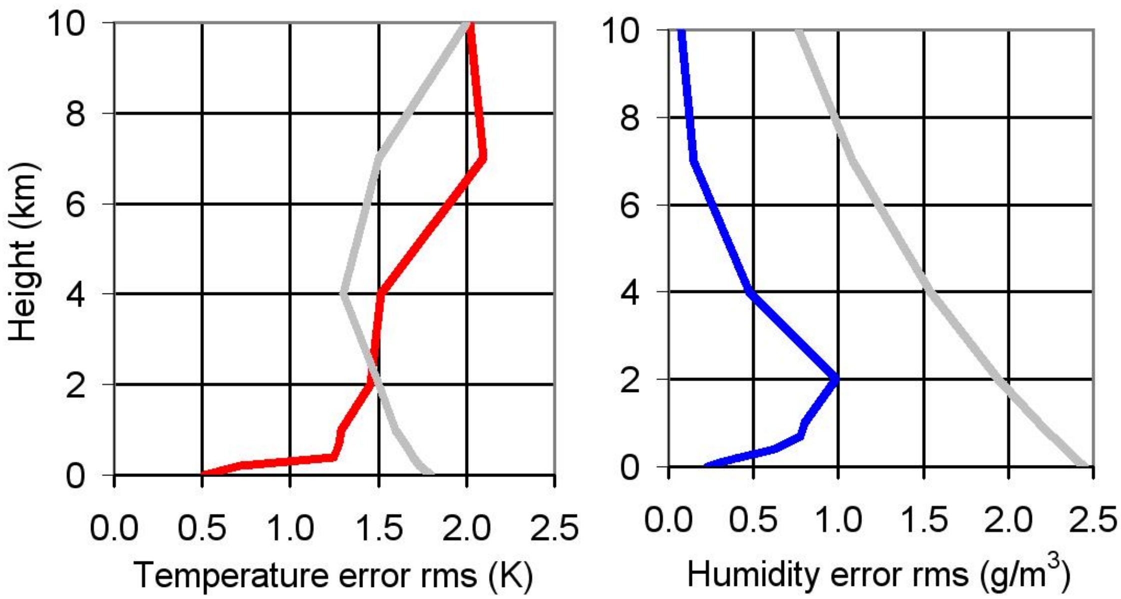


**Figure 2. Radiosonde errors for atmospheric representation on 20 km horizontal scales (gray) and statistical error for radiometer-radiosonde comparisons (red and blue).**

Statistical comparisons of co-temporal radiosonde and radiometric profiles show agreement within 1.5 C below 2 km height[2]. However, continuous radiometric profiles show significantly larger changes (>5 C) that commonly occur over time intervals of several hours[3,4]. Example radiometric boundary

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[1] Error assigned to radiosonde profiles for assimilation in 20 km mesoscale models are posted by NOAA: http://wwwt.emc.ncep.noaa.gov/gmb/bkistler/oberr/reanl-obs.html.

[2] Güldner, J., and D. Spänkuch, 2001: Remote sensing of the thermodynamic state of the atmospheric boundary layer by ground-based microwave radiometry, **J. Atmos. Ocean. Tech., 18**, 925-933.

[3] Ware, R., R. Carpenter, J. Güldner, J. Liljegren, T. Nehrkorn, F. Solheim, and F. Vandenberghe, 2003: A multi-channel radiometric profiler of temperature, humidity and cloud liquid, **Rad. Sci., 38**, 8079-8032.

[4] Ware, R., D. Cimini, F. Vandenberghe, J. Vivekanandan, and E. Westwater, Ground-Based Radiometric Profiling during Dynamic Weather Conditions, 2004: **J. App. Meteor.** (in review).

layer profiles during stable and dynamic atmospheric conditions are shown in Figures 3 and 5. Comparisons with co-temporal radiosondes are shown in Figures 4 and 6.

The standard radiometric retrieval provides 100 m resolution (vertical step size) from the surface to 1 km height, and 250 m resolution from 1 to 10 km. Custom software is available that provides 50 m (or higher) resolution.

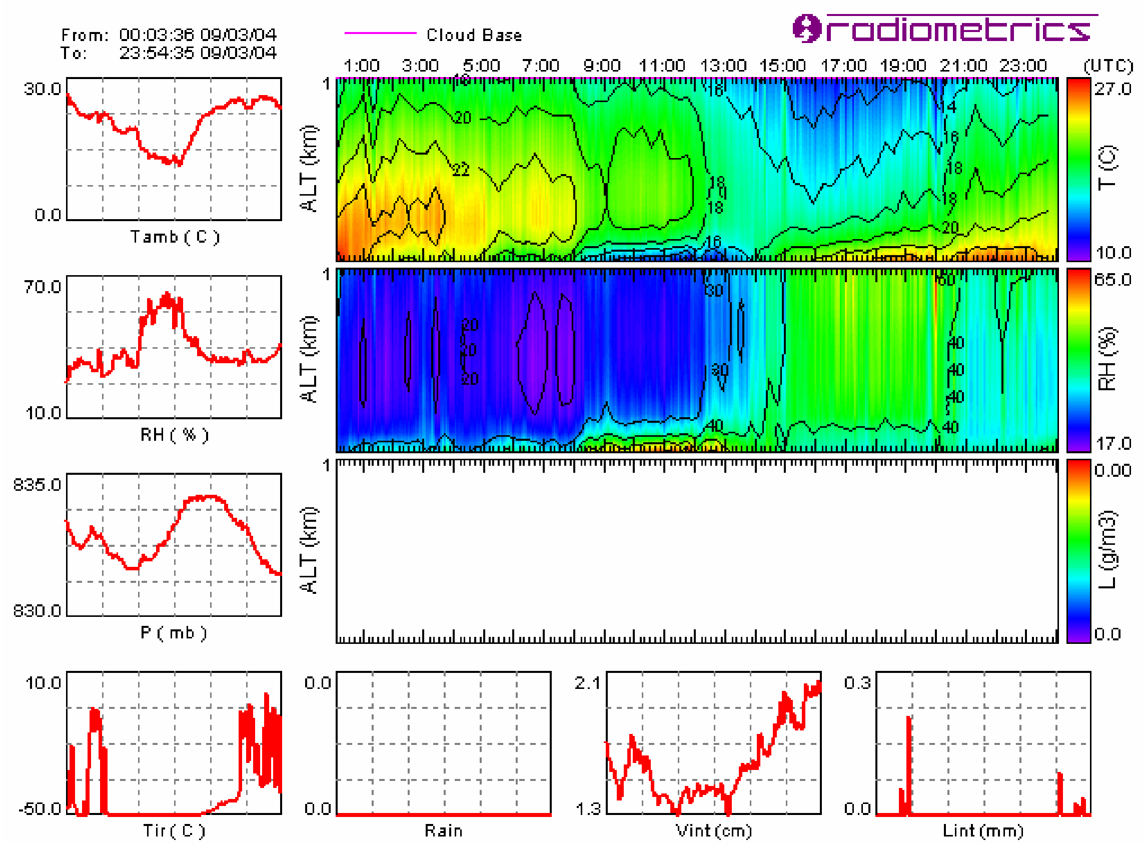


**Figure 3. Radiometric profiling of the boundary layer during stable atmospheric conditions for 3 Sep 2004 at Boulder, Colorado. Temperature changes greater than 5 C are seen during several hour intervals.**

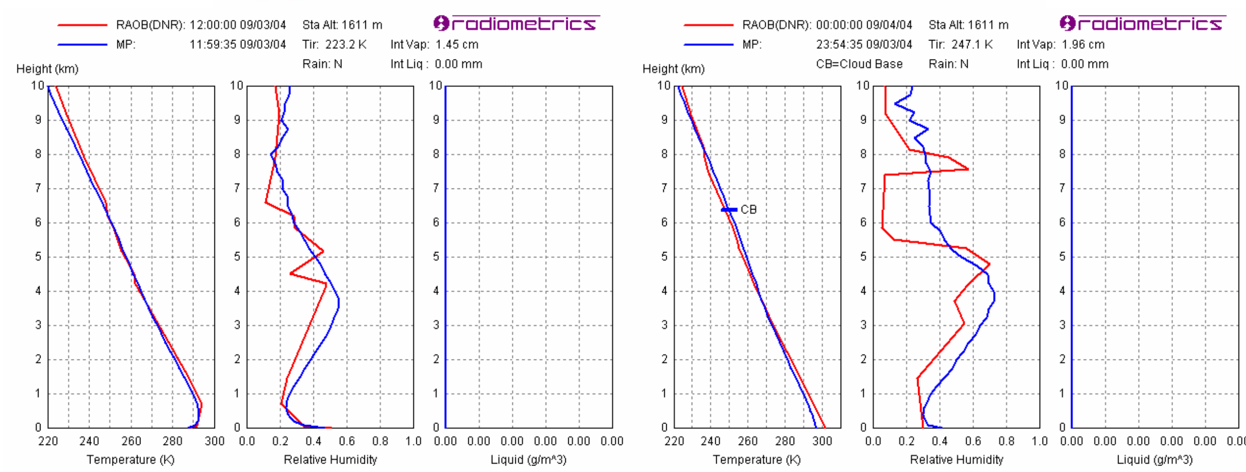


**Figure 4. Co-temporal Denver radiosonde (red) and Boulder radiometer (blue) soundings at 1159 and 2354 UTC on 3 Sep 2004. Denver is 50 km SE of Boulder. The soundings agree within the representation error shown in Figure 2.**

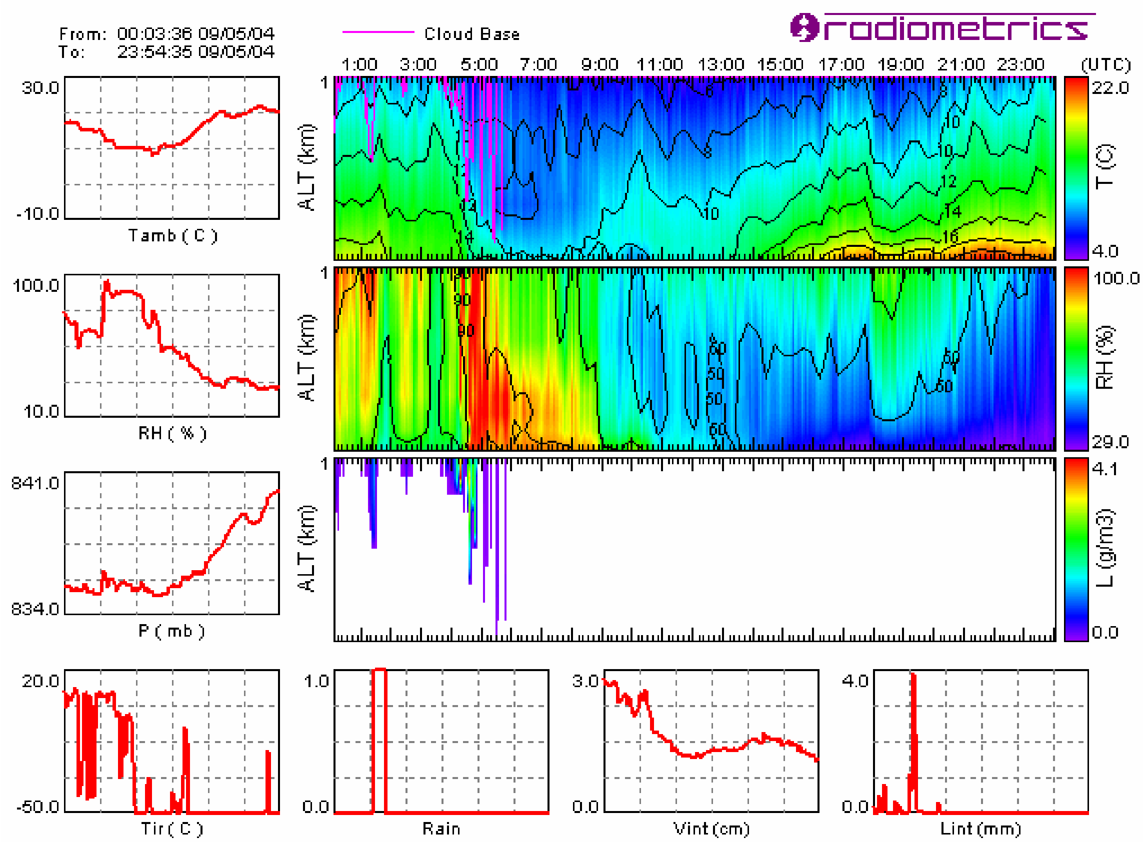


**Figure 5. Same as Figure 3 during dynamic atmospheric conditions on 5 Sep 2004.**

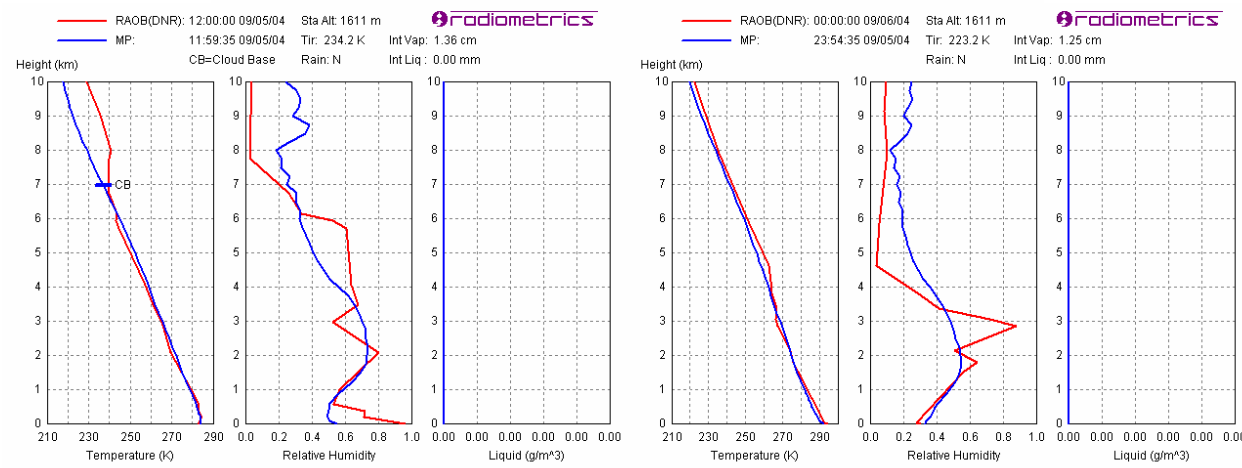


**Figure 6. Same as Figure 4 on 3 Sep 2004. Denver is 50 km SE of Boulder.**

These examples show that temporal changes in boundary layer temperature and humidity profiles can be significantly larger than errors associated with radiosonde assimilation in numerical weather analysis.