Analysis of Virtual Temperature Between RASS and BBSS at SGP CART Site

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Instrumentation

At the Atmospheric Radiation Measurement (ARM) Program's Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) site, there are several radar wind profilers (RWP) outfitted with radio acoustic sounding systems (RASS), which return vertical profiles of virtual temperature. These instruments transmit an acoustic signal vertically into the atmosphere and, in return, measure the speed of the propagation of the wavefront, which is proportional to the square root of the virtual temperature.

There are two RASS units at the SGP central facility located near Lamont, Oklahoma, operating at radar frequencies 915 MHz and 50 MHz. The profiles of virtual temperature from the two instruments are quality controlled and merged into a single profile by a value added procedure (VAP) called RWPTEMP. The quality control (QC) algorithm is an objective technique that flags data points that are significantly different than their neighbors in space or time.

In addition, the National Oceanic and Atmospheric Administration (NOAA) has outfitted their Wind Profiler Demonstration Network (WPDN) 449-MHz profilers at the Hillsboro (Kansas), Vici (Oklahoma), Morris (Oklahoma), and Purcell (Oklahoma) boundary facilities with RASS units. These instruments provide profiles of virtual temperature on the boundaries of the CART site.

The RASS profiles from the ARM central and boundary facilities are compared to profiles derived from the nearest Balloon-Borne Sounding System (BBSS) launch. The BBSS observations use relative humidity, pressure, and absolute temperature profiles to calculate virtual temperature. These profiles are interpolated to the nearest RASS altitudes for a direct comparison between the instruments (see Figure 1).

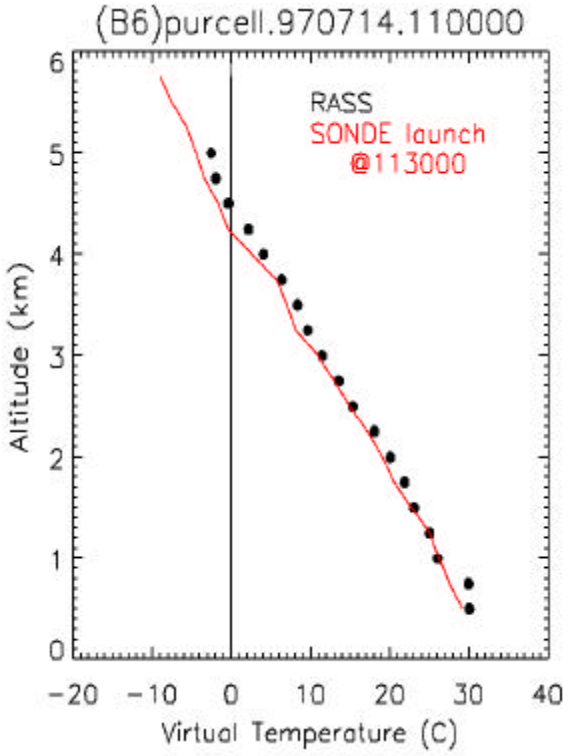

Figure 1. This is an example of a typical day for the Purcell boundary facility RASS 449 MHz with respect to the nearest BBSS launch with respect to time. Sample time, Greenwich Mean Time (GMT), is July 7, 1997, at the hour 11, minute 00, and seconds 00.

Methodology

The purpose of this research is to calculate the average of the residuals between the RASS and radiosonde virtual temperature profiles at each of the RASS altitudes. That requires reading the nearest BBSS within 3 hours of the RASS sample time. All RASS data points are placed under a QC method.

The purpose of the QC algorithm is to flag any points that appear to be outliers, and exclude such points from the ensemble average calculations. A point is omitted if: a central facility sample failed the RWPTEMP QC comparison with any of its neighboring points; there is a bias between the RASS and SONDE that is greater than 15 °K; or any temperature difference is outside 4 standard deviations of the mean residuals at the altitude.

There were two intensive operational periods (IOPs) selected for this research that maximize the number of BBSS launches throughout the day. The Summer 1997 IOP was from June 18 to July 18, whereas the Winter 1998 IOP was from January 18 to February 8.

Suspect or Missing Data

There are several problems from the RASS that have affected the ensemble average calculations. One of these noted circumstances occurred when the Morris Boundary Facility (B5) did not contribute data from January 25 to February 1, 1998. This had an affect on the number of samples used since there were originally 22 days during the Winter 1998 IOP, and this facility used only 14 days worth of data. Another noted problem occurred at the central facility 50-MHz RASS. All of this instrument's data was contaminated from November 1996 to August 1997 as a result of a bad parameter height file (see summer 1997 plots). One can refer to PIF P970729.1 or CAR C970729.1 for more about the poor virtual temperature retrievals during this time period. Another noted problem was the occasional outlier outbreaks that occurred at the Vici boundary facility (B4) during the Summer 1997 IOP (see Figure 2).

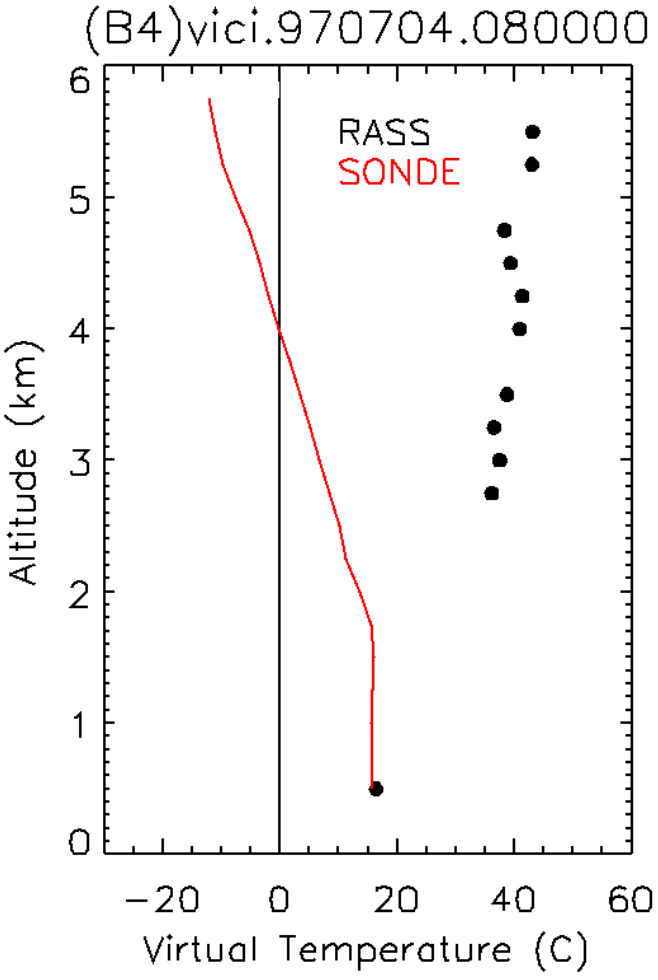

Figure 2. Unexplained occasional outbreak that occurred at Vici (B4) during the Summer 1997 IOP. The QC invoked on all data cleans up any discrepancies similar to this.

Approximately 4% of Vici samples for this period had multiple outliers similar to this; the other facilities were much cleaner. The QC algorithm already implemented removes all such outliers before averaging.

Conclusions

The RASS virtual temperatures are slightly warmer than the BBSS at all facilities by approximately +0.5 °K to +1.0 °K (see Table 1). There was a seasonal bias from the summer 1997 to winter 1998 with a small increase in virtual temperature by approximately +0.3 °K (see Table 1). The central facility temperature bias is slightly warmer than the boundary facility bias by approximately +0.2 °K (see Table 1). There does not appear to be any significant altitude dependence in the temperature bias for any of the facilities (see Figures 3 and 4). All these conclusions do not include the Summer 1997 IOP for the central facility as a result of the corrupt data files during this time frame.

Table 1. Average virtual temperature bias, °K (RASS minus BBSS).

Facility	IOP 1997	IOP 1997
Central	(a)	1.13
Morris	0.76	0.94
Purcell	0.66	0.91
Vici	0.54	0.82
Hillsboro	0.65	0.97

(a) Bad 50-MHz RASS data.

These results were derived by taking the average of all the RASS altitude ensemble averages.

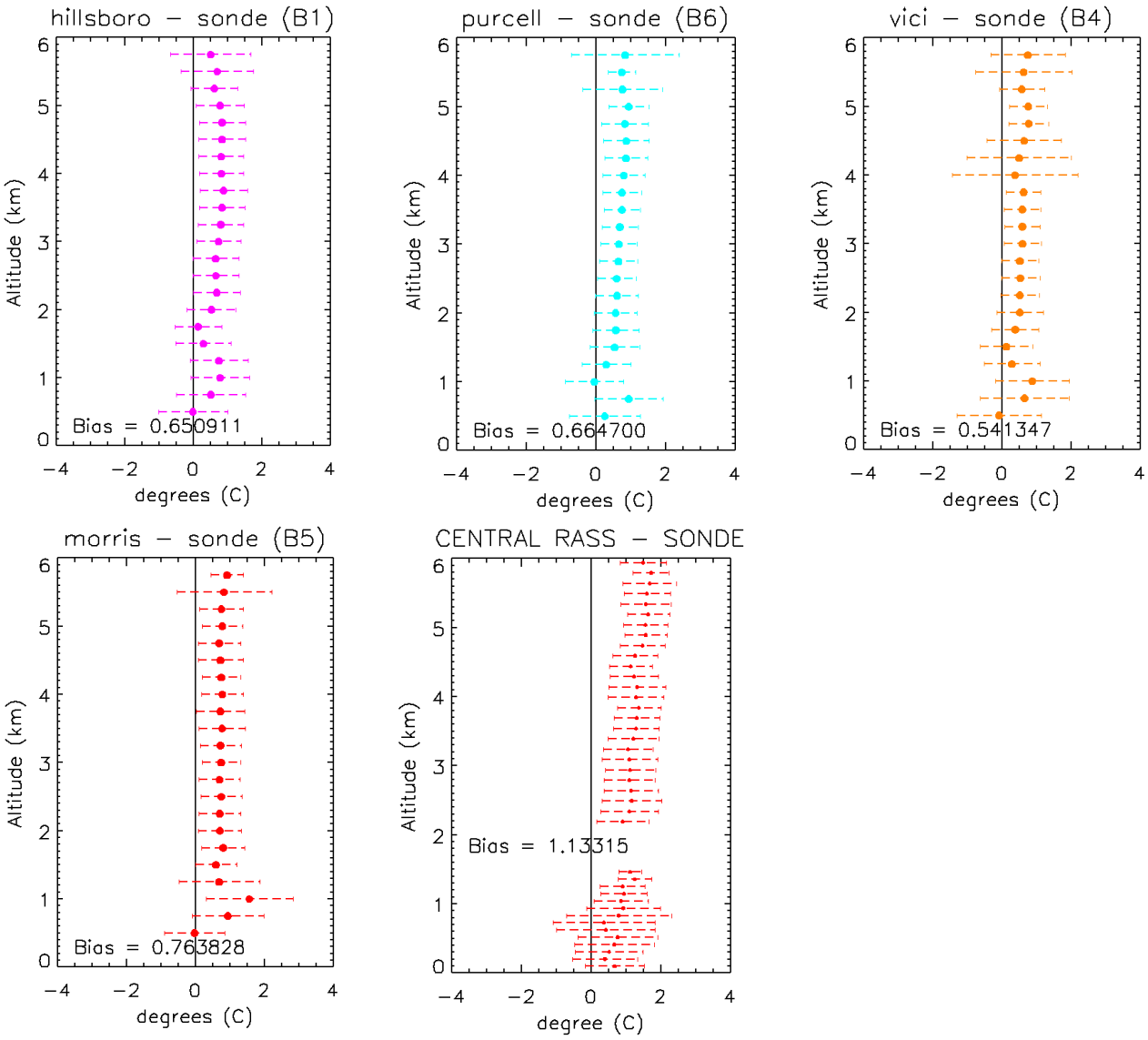

Figure 3. These plots contain the average of the residuals of the RASS minus BBSS at each of the RASS altitudes for the Summer 1997 IOP. The plot above displays the unreliable data profiles for the 50 MHz during this time period. However, the other facilities, even the 915 MHz at the central facility (these are the averages at the lower altitudes) portray a bias that is less than 1.0 °K.

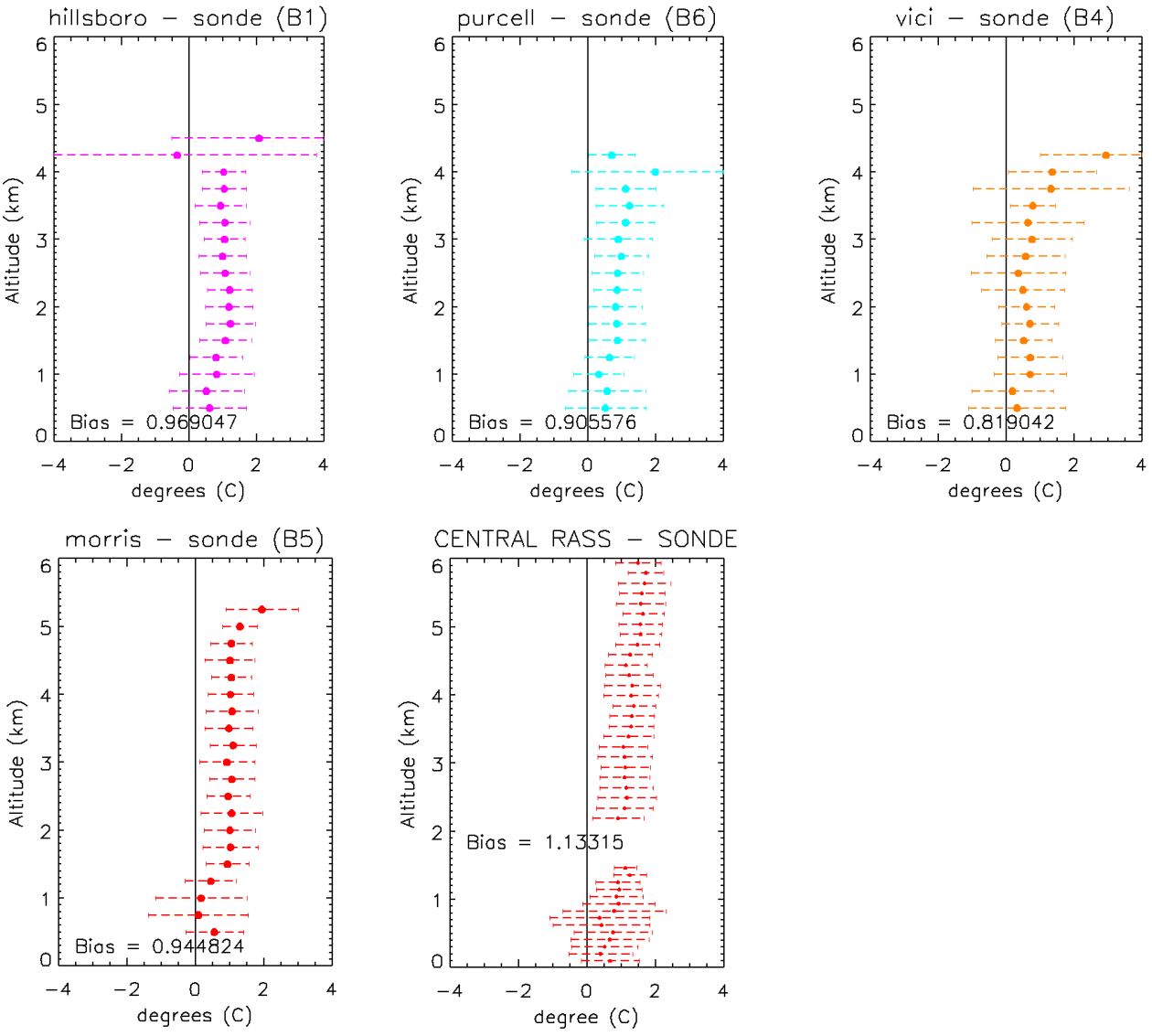

Figure 4. These plots contain the average of the residuals of the RASS minus BBSS at each of the RASS altitudes for the Winter 1998 IOP. These plots have a bias that is warmer than the Summer 1997 IOP bias by approximately +0.3 °K.