Results of an Automated Comparison Between Winds and Virtual Temperatures from Radiosonde and Profilers

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Introduction

Data from the radar wind profiler Radio Acoustic Sounding System (RASS) and balloon borne sounding system (BBSS) provide a useful tandem for scientific studies, instrument comparison, and instrument maintenance at the Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) central facility. The RASS measures virtual temperature profiles remotely from, nominally, 100 m to 1500 m above the surface 10 min out of every hour and wind speed and direction for the remaining 50 min. In comparison, the BBSS measures profiles of wind, wind direction, temperature, and moisture from the surface to 30 km or more with samples of winds approximately every 50 min and temperature and moisture every 10 m. Because the BBSS data are sampled with a free-flying balloon, the vertical profile is a Lagrangian measure, at least in the horizontal; they are affected by horizontal and temporal differences in the meteorological fields. The profiler winds and temperatures are true vertical profiles anchored to the central facility and are Eulerian measures.

The RASS virtual temperatures and winds averaged over the hour during which the BBSS launches are scheduled are extracted daily. The only treatment of the data is to interpolate them to a 100-m vertical grid. Although it would be possible to perform the comparison on the basis of the true profiler range gate spacing (that is, average the BBSS data to the profiler spacing - see below), this method allows data intercomparison to continue through periods when the radar range gate changes (for intensive observation periods, e.g.). Missing or bad data are replaced with 9999 so that when compared to BBSS values, the very large difference can be easily identified and eliminated.

The BBSS temperature, pressure, and water vapor data, on the other hand, are combined to calculate the virtual temperature and averaged to the same vertical grid as that of the profiler grid. Only data between the end points of each 100 m are used for each calculation.

Each day, the data from the previous day from the two systems are gridded and passed to a simple statistical analysis routine that produces means and standard deviations of the differences, calculated over all available heights in the profiler profile, between BBSS and wind profiler wind speeds, wind directions, and virtual temperatures. The statistics produced are calculated over the data from a single hour/launch with no attempt to combine larger samples of data. The statistics are then reported automatically, usually five per day corresponding to the BBSS launches at 0830, 1130, 1430,1730 and 2330. They are also appended to a file containing the results of the statistical analysis which began in June 1995.

Uses

A time series of the mean and standard deviation of the differences is shown in Figure 1. Differences of about 1 m/s, 5 deg and 0.5 K for wind speed, wind direction, and virtual temperature, respectively, appear to be “normal” for these two instruments. These values can be used as comparison values in rapidly scanning the daily reports to decide if the instruments are working properly. Note the well-defined increase in the mean and standard deviation of wind speed and direction differences in November 1995. In this case, the antenna phase shifter for the wind profiler was deteriorating, but the instrument was reporting data. The noticeable increase in the values reported by this comparison enabled relatively early detection of the problem. The distribution (Figure 2) of differences is almost symmetrical for T_v; however, the wind speed differences have an apparent positive bias. This is true even if the data between day 275 and 324 are removed (during this period, the profiler performance was degraded due to phase shifter failure). Figure 1 indicates that since the phase shifter was replaced there is a noticeable positive bias in the wind speed differences with little or no parallel comparable bias in the wind direction. This possible problem is under investigation.

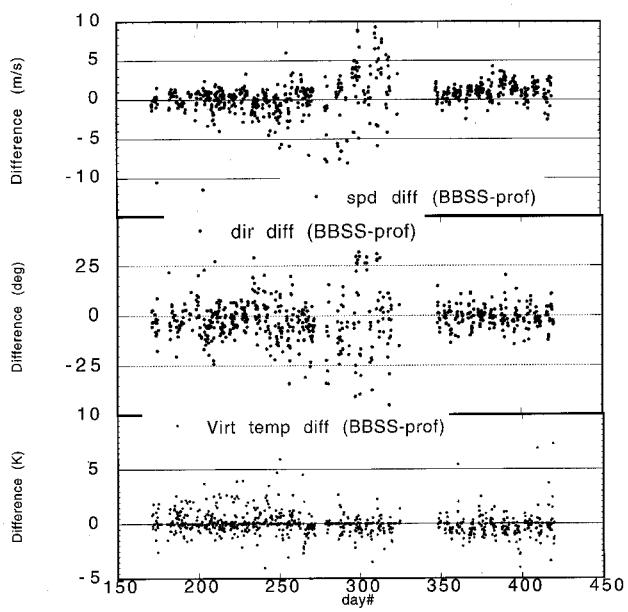

Figure 1. Time series of difference in wind speed, wind direction, and virtual temperature between BBSS and wind profiler RASS. Differences are averages over accessible height range of profiler. Day number is after 1 January 1995.

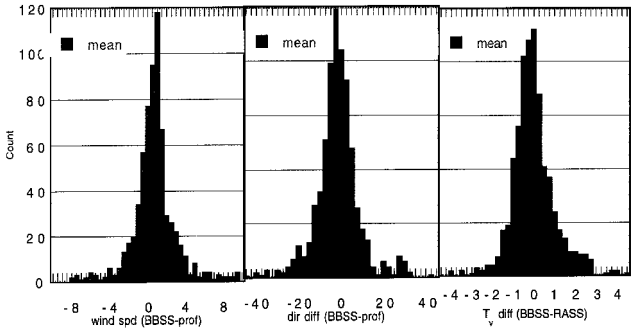

Figure 2. Distribution of wind speed, wind direction, and virtual temperature differences. Data include period between day #275 and 324 when profiler performance was degraded.

The data also present an opportunity to routinely compare estimates from Eulerian and Lagrangian samples. The mean difference between BBSS and profiler wind speeds, directions, and virtual temperatures are (0.69, 1.8 deg, 0.04 K) after periods with malfunctioning equipment are eliminated. It is a straightforward matter to include mean values of wind speed, direction, and virtual temperature in the data file; this information can be used to establish possible effects of surface and terrain on the vertical structure of the atmosphere by looking at the distribution of differences as a function of wind direction, for example.