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METEOROLOGICAL SENSOR CALIBRATION FACILITY

by

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Radiosonde Temperature Corrections

The meteorological sensor calibration facility is designed to test and assess radiosonde measurement quality through actual flights in the atmosphere. United States radiosonde temperature measurements are deficient in that they require correction for errors introduced by long- and short-wave radiation. This situation has existed since the later 1950's when the present radiosonde design was introduced. The effect of not applying corrections results in a large bias between daytime and nighttime measurements. This day/night bias has serious implications for users of radiosonde data, of which NASA is one. Examples are: 1) ground truth (satellites such as SAGE, NIMBUS, SME, TIROS N/NOAA-series, etc., lidars, and ST-type radars); 2) temperature retrieval from satellite remote measurements (operational NOAA-series satellite retrievals depend on a regression scheme that uses the world-wide radiosonde temperature; a physical retrieval scheme is planned); 3) climatological studies and other upper-air research, especially model development; and 4) initialization data to tie-on to other measurements systems (e.g.,rocketsondes). Adjustments to the temperatures and geopotentials were derived for use by analyses centers to compensate for the bias. However, these adjustments only are made to daytime measurements making them equivalent to nighttime and are not "true" corrections. The day/night difference at 100 hPa is estimated to be ~47 meters representing a temperature bias of ~0.7°C.

The derivation of corrections for the US radiosonde is quite important. Determination of corrections depends on solving the heat-transfer equation of the thermistor using laboratory measurements of the emissivity and absorptivity of the thermistor coating. Because of the presence of other unknowns in the equation (e.g., the long-wave and incident radiant short-wave powers), simultaneous solutions of three equations is desirable using a like number of thermistors. Ninety successful flights have been made at solar elevation angles up to 80 degrees. From these measurements, a family of temperature correction curves versus solar angle as a function of pressure were derived. While the daytime correction reaches about 0.8°C, a decrease in the magnitude of the daytime correction is observed at levels above 20 hPa. Other investigators have indicated larger daylight errors at these altitudes (mostly theoretical). Although, the solar heating of the thermistor increases with decreasing density (increasing altitude), it turns out that the emissivity from the sensor is large; the long-wave emission cools the thermistor at a rapid rate, thus decreasing the daytime correction above 20 hPa.

The United States radiosonde observations from the World Meteorological Organization International Radiosonde Intercomparison were used as the data base to test whether the day/night height bias can be removed. Twenty-five noontime and

26 nighttime observations were used. Corrected temperatures were used to calculate new geopotentials. Day/night bias in the geopotentials decreased significantly when corrections were introduced.

The National Weather Service's National Meteorological Center and the European Centre for Medium-Range Weather Forecasts have offered to test the corrections in their analyses and models, respectively. We are in the process of rechecking our data prior to releasing the corrections for testing. A few papers have already been presented, and formal papers are in preparation for submission to the American Meteorological Society Bulletin. Because of the small sample, another 100 modified instruments have been procured and are to be flown this year.

Relative Humidity Sensor Lag

Some testing of thermal lag attendant with the standard carbon hygristor has taken place. Two radiosondes with small bead thermistors imbedded in the hygristor have been flown. Detailed analysis has not been accomplished; however, cursory examination of the data showed that the hygristor is at a higher temperature than the external thermistor indicates. Normal reduction procedure is to use the external temperature to reduce relative humidity for the measurements and also to calculate mixing ratio and dew point. Temperature differences of 8 to 10 degrees Celsius at 500 hPa were indicated. A further look into the seriousness of this problem is planned.