

# **Radiosonde Replacement System WMO Levels Generation for Coded Messages**

## **Radiosonde Replacement System WMO Coded Message Length Changes**

The implementation of the Radiosonde Replacement System at field sites commencing with Sterling, Virginia, on or about 1 August, 2005 will introduce longer coded messages. The format of the messages will be the same WMO format for coded upper air messages used with the MicroART legacy system. The number of levels in the coded messages will be two to three times greater for the TTBB and TTDD parts. The number of levels in the TTAA, TTCC, PPBB, and PPDD parts will be relatively unchanged. These changes reflect updated coding practices and higher resolution level selection criteria. The maximum size limits of the parts of the coded messages follow:

TTAA	TTCC	TTBB	TTDD	PPBB	PPDD
15 levels	10 levels	135 levels	40 levels	40 levels	40 levels

In addition, the 31313 message indicator associated with the message parts TTAA, TTBB, TTDD, and TTCC parts of the message will be included. This 31313 group includes information on the solar radiation correction used for the radiosonde, the radiosonde type, and the ground system as well as the group for radiosonde time of release. With the legacy system this correction was applied by the National Centers for Environmental Prediction. With the Radiosonde Replacement System and Software, it will be applied at the field site. For additional information on the message requirements please reference the WMO 306, Manual on Codes, International Codes, Volume 1.1 Part A—Alphanumeric Codes and WMO 306, Manual on Codes, Regional Codes and National Coding Practices, Volume II.

## **WMO Guidance for Coded Message Parts for Section 5, Coded message parts TTBB and TTDD Significant Thermodynamic Levels and Coded Message Part for Section 4 Significant Winds Levels Parts PPBB and PPDD**

### **Significant Thermodynamic Levels Parts TTBB and TTDD**

The reported significant levels alone shall make it possible to reconstruct the air temperature and relative humidity profiles within the limits of the criteria specified. (WMO Manual on codes number 306, Paragraph 35.3.1.1.)

Levels which are necessary to ensure that the temperature obtained by linear interpolation (on a T-log P or essentially similar diagram) between adjacent significant levels shall not depart from the observed temperature by more than 1 degree C below the first significant level reported above the 300-hPa level or the first tropopause, whichever, level is the lower, or by more than 2 degrees C thereafter. (WMO Manual on codes 306, Paragraph 35.3.1.3 (a))

Levels which are necessary to ensure that the relative humidity obtained by linear interpolation between adjacent significant levels shall not depart by more than 15 percent from the observed values. (The criterion of 15 percent refers to an amount of relative humidity and not to the percentage of the observed value, e.g. if an observed value is 50 percent, the interpolated value shall lie between 35 percent and 65 percent.) (WMO Manual on codes 306, Paragraph 35.3.1.3 (b)).

### **Significant Winds Levels parts PPBB and PPDD**

The reported significant data alone shall make it possible to reconstruct the wind profile with sufficient accuracy for practical use. Care shall be taken that:

- (a) The direction and speed curves (as a function of the log of pressure or altitude) can be reproduced with their prominent characteristics.
- (b) These curves can be produced with an accuracy of at least 10 degrees for direction and 5 meters per second for speed.
- (c) The number of significant levels is kept strictly to a necessary minimum.

To satisfy these criteria, the following method of successive approximation is recommended, but other methods of obtaining equivalent results may suit some national practices better and may be used:

(1) The surface level and the highest level attained by the sounding constitute the first and the last significant levels. The deviation from the linearly interpolated values between these two levels is then considered. If no direction deviates by more than 10 degrees and no speed by more than 5 meters per second, no other significant levels need be reported. When one parameter deviates by more than the limit specified in paragraph (b) above, the level of greatest deviation becomes a supplementary significant level for both parameters.

(2) The additional significant levels so introduced divide the sounding into two layers. In each separate layer, the deviations from the linearly interpolated values between the base and the top are then considered. The process used in paragraph (1) above is repeated and yields other significant levels. These additional levels in turn modify the layer distribution, and the method is applied again until any level is approximated to the above mentioned specified values.

### **Missing Wind Data**

If altitude is given in geopotential units in Parts B of D, a layer for which data are missing shall be indicated by reporting the boundary levels of the layer and a level in between with a height value somewhere in between the boundary heights and a group ddfi or solidi (////) to indicate the layer of missing data, provided that the layer is at least 1500 geopotential meters thick. The boundary levels are the levels closest to the bottom and the top of the layer for which the observed data are available. The boundary levels

are not required to meet “significant level” criteria. (WMO Manual on codes number 306, Paragraph 32.3.1.5.1.).

## **MicroART Legacy System Software**

### **Thermodynamic Significant Levels**

Selection of thermodynamic levels is a variant of the WMO procedure. Departures from linearity are determined between the consecutive standard levels or exceptional levels from flight initiation to termination. The WMO procedure selects the significant levels irrespective of the standard levels and the exceptional levels. This is accomplished from MicroART the six-second data. The level selection criteria for MicroART are also less stringent than for the Radiosonde Replacement System. Consequently, fewer levels are selected by MicroART than in the Radiosonde Replacement System.

### **Wind Significant Levels**

Levels selection techniques for winds are a variant of the WMO procedures for selecting significant wind levels. Wind speed and direction are selected at one-minute intervals from the flight initiation to flight termination. The data from one-minute winds files are then used to provide winds for standard pressure levels in the TTAA and TTCC message parts including maximum winds and coded in the PPBB and PPDD message parts of the coded message for the fixed regional levels (WMO Region 4). Winds are provided for the standard pressure levels in message Parts TTAA and TTCC to include the tropopause level(s) and the maximum wind levels.

## **Radiosonde Replacement System Radiosonde Workstation Software**

### **Significant Levels Selection**

Coded levels selection techniques by the RWS software follow the WMO departures from linearity procedure to select significant wind levels and thermodynamic levels. The significant levels are selected irrespective of the standard levels and the mandatory significant levels. This procedure is applied to one-second data-rate data and uses more stringent level selection criteria than suggested by the WMO and as used by MicroART. The significant levels portions of the Radiosonde Replacement System coded messages can be longer than those with the MicroART legacy system.

### **Thermistor Radiation Error Correction**

The radiation correction algorithm in the Radiosonde workstation is a departure from the model used by the National Centers for Prediction and from active correction models in software at sites that make corrections on site. Current thermistor radiation correction models use solar elevation angle, balloon ascent rate, and thermistor coating absorptivity and reflectivity characteristics to apply corrections to the radiosonde temperature readings. The model used for the Radiosonde Replacement System Mark IIA GPS radiosondes includes current approaches from older methods but also includes flight-time cloud and sky cover information. The inclusion of cloud information for overcast

conditions can increase temperature correction in the stratosphere by 0.3 degrees Celsius greater than that under clear conditions. Corrections over an entire flight from launch for a midday flight can range from near zero at the surface to approximately 1.3 degrees Celsius at 30 km altitude.

### Criteria for Significant Levels Selection for Coded Messages

Significant levels selection criteria for the Radiosonde Replacement System, MicroART, and WMO for the coded message transmitted over the Global Telecommunications System and for the data archived at the National Climatic Data Center are contained in the following table:

**Table 1. Significant Level Selection Criteria**

Linearity Criteria	Coded Message			NCDC Archive		
	Temperature	Relative Humidity	Wind	Temperature	Relative Humidity	Wind
WMO	1.0 °C surface to 300 hPa (or Trop)  2.0° C 300 hPa (or Trop) to flight termination	15 percent for entire flight	5 mps departure for wind speed and 10 degrees departure for direction	N/A	N/A	N/A
MicroART	1.0° C surface to 300 hPa (or Trop)  2.0° C 300 hPa (or Trop) to flight termination	10 percent for entire flight	Standard and fixed regional levels determined from one-minute winds	0.5° C surface to 100 hPa (or Trop)  1.0° C less than 100 hPa to flight termination	5 Percent for entire flight	One minute winds from surface to termination
RWS	0.5° C surface to 100 hPa  1.0° C less than 100 hPa to flight termination	5 Percent for entire flight	5 mps departure for wind speed and 10 degrees departure for direction	0.5° C surface to 100 hPa  1.0° C less than 100 hPa to flight termination	5 Percent for entire flight	

