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DOE/SC-ARM/TR-087

Merged Sounding Value-Added Product

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ARM CLIMATE RESEARCH FACILITY

DISCLAIMER

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1.0 Introduction

The Merged Sounding (MERGESONDE) value-added product (VAP) uses a combination of observations from radiosonde soundings, the microwave radiometer (MWR), surface meteorological instruments, and European Centre for Medium-Range Weather Forecasts (ECMWF) model output with a sophisticated scaling/interpolation/smoothing scheme in order to define profiles of the atmospheric thermodynamic state at one-minute temporal intervals and a total of at least 266 altitude levels. There are two versions of this VAP (Mergesonde1mace and Mergesonde2mace) that are run concurrently. The three differences between the versions are

- Version 1 achieves a maximum height of 20 km above ground level (266 altitude levels) whereas Version achieves a maximum height of 60 km above ground level (316 altitude levels).
- Version 2 incorporates the Miloshevich dry bias correction as applied to all ARM radiosondes. The issues and correcting algorithms have been extensively documented. For example, see Miloshevich et al. 2009. These changes have been used to create a new datastream (SONDEADJUST). This new datastream is used as input in place of the sondewnpn datastream. The technical document for this VAP is DOE/SC-ARM/TR-102 and is found at http://www.arm.gov/publications/vaps.
- Version 2 also applies the Revercomb ECMWF RH correction. (See Wang et al. 2005.)

Figure 1 shows a sample of the Merged Sounding VAP version 1. An example of version 2 of the Merged Sounding VAP is shown in Figure 2.

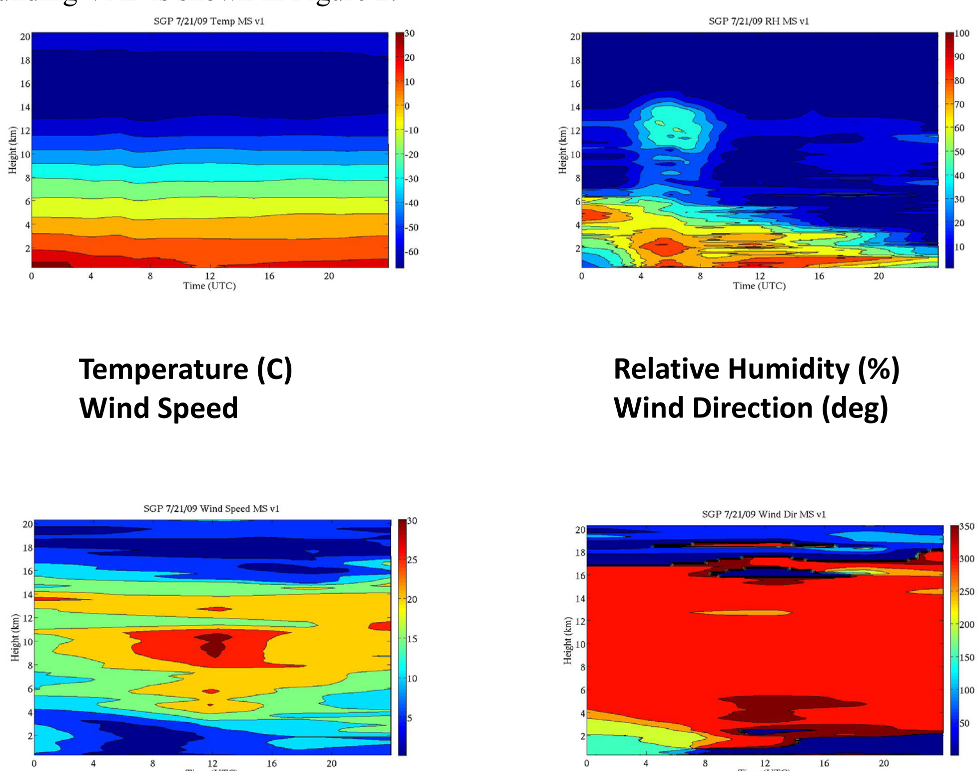

Figure 1. Merged Sounding v1 output profiles for temperature, relative humidity wind direction, and wind speed at the ARM Climate Research Facility Southern Great Plains Central Facility on 07/21/09. Maximum altitude is 20 km above ground level (y-axis); time is in minutes (x-axis).

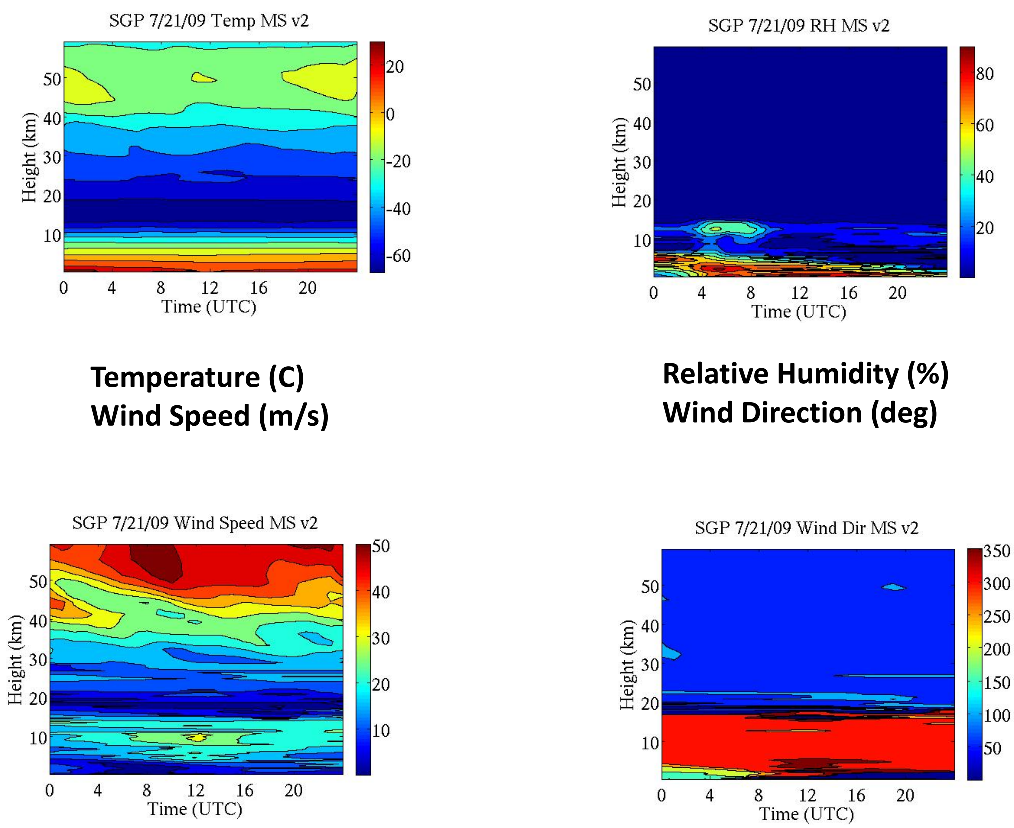

Figure 2. Merged Sounding v2 output profiles for temperature, relative humidity wind direction, and wind speed at ARM Climate Research Facility Southern Great Plains Central Facility on 07/21/09. Maximum altitude is 20 km above ground level (y-axis); time is in minutes (x-axis).

1.1 General Description

MERGESONDE VAP produces a thermodynamic profile of the atmosphere from the surface to approximately 20 km above-ground-level (AGL) for version 1. Version 2 achieves a maximum height of 60 km AGL. The temporal resolution is one-minute, whereas the vertical resolution varies with height. Table 1 lists the vertical resolutions for above-ground altitude resolutions.

Table 1. Altitude resolutions.

Altitude Range	Resolution
0–3 km AGL	20 m
3–13 km AGL	50 m
13–16 km AGL	100 m
16–20 km AGL	200 m
Version 2 only: 20–60 km AGL	200 m

The outputted thermodynamic profile is created by building two temporary profiles on the same grid. First, one 24-hour profile using only the radiosonde data and interpolation/extrapolation techniques is created. Then a second profile using the ECMWF data and the same interpolation/extrapolation techniques is made. These two profiles are combined, or "merged," into one thermodynamic profile using the temporal distance from the nearest radiosonde observation to determine the weight that each profile contributes to the merged product. At any given altitude, there are a given number of radiosonde observations that depend upon the day of the week, the site, the launch data, and the ascent of the balloon flight. These observations have a weight of 100%. That is, the final profile has no contribution from ECMWF data where there are actual observations. As the time from an actual observation increases, the radiosonde contribution decreases while the contribution from the ECMWF increases. The weighting function used is:

$$Sonde\_Weight = \frac{1}{1+\left[e^{\left(\frac{diff}{(hwhm*60)}-1\right)hwhm}\right]^{slope}} \tag{1}$$

where *hwhm* (half-width half-mean) and *slope* are the site specific variables used in this double-sigmoid function.

This function produces values between 0 and 1, inclusive. The weight of the model data is then

model_weight = 1-sonde_weight.

This value is also between 0 and 1.

Surface meteorology and meteorological tower instruments are used as boundary conditions for the lowest levels of the atmosphere. These data are vital to creating the ECMWF profile, since the modeled data does not reach ground level. Pressure levels from the ECMWF are converted to meters above ground level using the hypsometric equation. Without surface meteorological data, this would be impossible to determine.

Additional datastreams used are (1) MWR retrievals (MWRRET), in order to access accurate microwave radiometer precipitable water vapor data needed to constrain the total column water vapor and scale the relative humidity within the one-minute profiles, and (2) extra radiosondes at the North Slope of Alaska site, including National Weather Service (NWS) radiosondes for their temperature and pressure readings and radiosondes used during the 2004 Arctic Winter Water Vapor Intensive Operational Period (IOP).

2.0 Algorithm and Methodology

1. Load all applicable datastreams.
2. Place all data onto a common grid of 1-minute time resolution and 266 altitude bins.
3. Complete radiosonde profile.
    a. Fill data gaps between adjacent radiosonde times using linear interpolation.

4. Complete ECMWF profile.
   a. Fill data gaps between adjacent ECMWF times using linear interpolation.
5. Combine radiosonde and ECMWF profiles.
   a. Calculate the weights—based on the double sigmoid function presented above—of both the radiosonde and ECMWF profiles, and use these weights to derive values for the "merged" profile.
   b. The parameters for the double sigmoid function were chosen to provide greater weight to the radiosonde data based on the proximity to radiosonde observations.
   c. See Table 2 for a summary of double sigmoid parameters.
6. Smooth data.
   a. Use a box-car approach to find the average of the four nearest neighbors.
   b. If the relative average is more than 20% different from the center point, replace the center with the five-point average.
   c. This is performed for all variables at each time and height.
   d. Calculate relative humidity using MWR data as the scale factor, using precipitable water vapor (PWV) for the procedure.
7. Ensure no physically impossible situations exist.

Table 2. Double sigmoid parameters.

Location	Slope	Half Width–Half Mean
SGP	1.50	4.00
NSA	0.75	8.00
TWP Manus	1.10	6.00
TWP Nauru	1.10	6.00
TWP Darwin	1.50	4.00
Mobile Facility (All Sites)	1.10	6.00

These parameters are largely based upon two factors: the number of radiosondes launched per day at a given site and the typical variation between the daily sonde readings. These values were tested by matching the merged sounding profiles calculated using a sub-sample of radiosonde profiles to the merged sounding profiles created using all radiosondes.

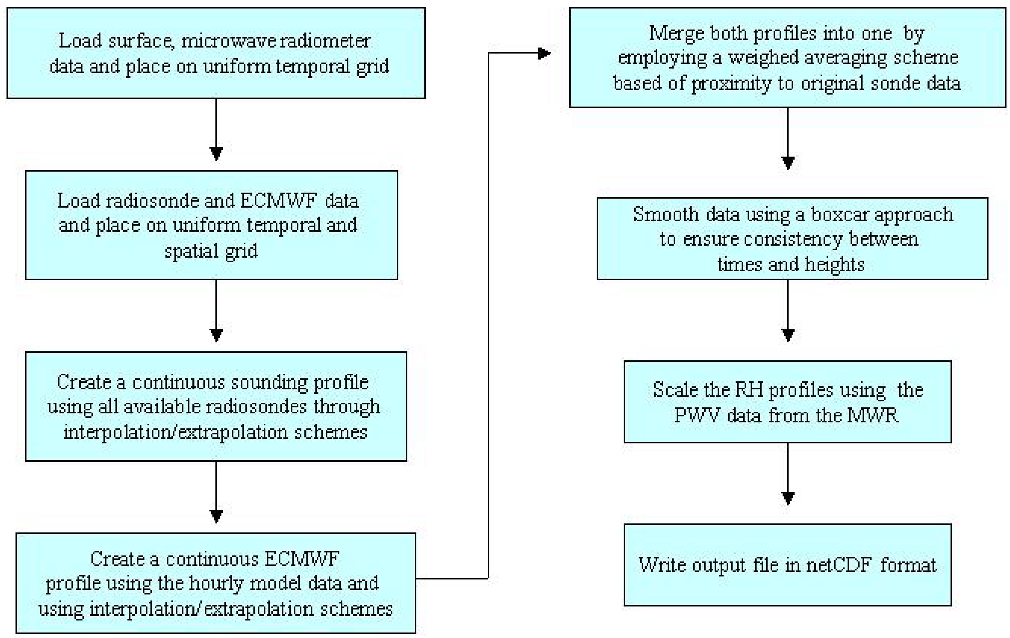

Figure 3. Merged Sounding Flow Chart.

3.0 Data

The files that are used as input are listed in Table 3 below. Only the three major regions are listed; the locations of the mobile facility will each have similar files. Note that at each TWP site there are different names for each ECMWF file (twpecmwfman… for Manus, twpecmwfnau… for Nauru, twpecmwfdar… for Darwin). The '#' indicates the unique number associated with each site: '1' for Manus, '2' for Nauru, and '3' for Darwin.

Table 3. Mergesondemace input files.

Instrument	SGP	NSA	TWP
Radiosondes – ARM *Version 2 radiosonde files:*	sgpsondewrpnC1 *sgpsondeadjustC1*	nsasondewnpnC1 *nsasondeadjustC1*	twpsondewnpnC# *twpsondeadjustC#*
– NWS		nsa06snwsupabrwX1*	
– IOP		nsasondewnpnS01	
ECMWF Model Output	sgpecmwfvarX1	nsaecmwfvarX1	twpecmwf…varX1
Surface or Tower Meteorology	sgp1smosE13 or sgpmetC1	nsamettwr4hC1 or nsametC1	twpsmet60sC# or twpmet#
Microwave Radiometer (physical/statistical)	sgpmwrret1liljclouC1	nsamwrret1liljclouC1	twpmwrret1liljclouC#
Microwave Radiometer (MWR-LOS)**	sgpmwrlosC1	nsamwrlosC1	twpmwrlosC#
* The Relative Humidity field from this radiosonde is not used. ** Microwave Radiometer line-of-sight (MWR-LOS) is used only when the mwrret1liljclouC1 datastream is not available.			

3.1 Value-Added Output

The value of this VAP is that variables found at relatively sparse times and heights throughout a 24-hour period now encompass the entire day at one-minute time intervals and all heights. Sparse, discrete data have become dense and continuous. This high-resolution data is important for higher order VAPs for determining cloud microphysical properties.

Additionally, fields such as potential temperature and relative humidity (RH) scaled by the PWV from the MWR are calculated and outputted. Since these fields are not included as inputs from any platform, they are considered value-added fields.

3.2 Data Quality Assessment Included

Standard data quality variables are attached to the product. Included in these variables are:

- qc_time
- qc_precip
- qc_temp
- qc_rh
- qc_vap_pres
- qc_bar_pres
- qc_wspd
- qc_wdir

In fact, all physical variables have a quality control field associated with them. As per the QC Standards, each variable has a bit-packed quality control variable named qc_xxxx immediately following field xxxx.

In addition to the quality control variables required by the Data Quality (DQ) Office, there are several output fields which are used to show status of a given data point. These are **vapor_source** (which describes the type of mwr data used, see below) and **sonde_fraction** and **sonde_fraction_rh** (which are values between 0 and 1 that represent the weighting of the sonde measurement that contributes to the merged value).

3.3 Output Products

MERGESONDE generates only one datastream per version per site. Using the standard VAP naming conventions, we have the following filenames:

Southern Great Plains [SGP]:	sgpmergesonde1maceC1.c1	sgpmergesonde2maceC1,c1
North Slope of Alaska [NSA]:	nsamergesonde1maceC1.c1	nsamergesonde2maceC1.c1
Tropical Western Pacific [TWP]		
Manus:	twpmergesonde1maceC1.c1	twpmergesonde2maceC1.c1
Nauru:	twpmergesonde1maceC2.c1	twpmergesonde2maceC2.c1
Darwin:	twpmergesonde1maceC3.c1	twpmergesonde2maceC3.c1

ARM Mobile Facility (AMF) sites will be named according to their official prefix. To date, the Merged Sounding files produced for the AMF deployments are

Point Reyes, California [PYE]	pyemergesonde1maceM1.c1	pyemergesonde2maceM1.c1
Niamey, Niger [NIM]	nimmergesonde1maceM1.c1	nimmergesonde2maceM1.c1
Heselbach, Germany [FKB]	fkbmergesonde1maceM1.c1	fkbmergesonde2maceM1.c1
Shouxian, China [HFE]	hfemergesonde1maceM1.c1	hfemergesonde2maceM1.c1
Graciosa Isle, Azores [GRW]	grwmergesonde1maceM1.c1	grwmergesonde2maceM1.c1

3.4 Descriptions of Products

Table 4 summarizes the variables from the input datastreams that are used to create the output file. The only other important field that is not included on this table is the PWV, which is from the MWR datastream.

Table 4. Location of variables used in and produced by Mergesondemace.

	Radiosonde	Surface Meteorological Instruments	ECMWF	Output
Barometric Pressure	X	X	X	X
Temperature	X	X	X	X
Relative Humidity	X (except NWS)	X	X	X
Wind Speed/Direction	X	X		X
U- and V-Wind	X		X	X
Dew Point	X			X
Vapor Pressure		X		X
Specific Humidity			X	X
Precipitation		X		X
Potential Temp				X
Scaled RH				X

3.5 Description of Data Quality Fields

The data quality fields with their attributes are listed below. The fields to which they are associated have been excluded. The QC fields follow the field of the actual item. In addition to these QC fields, there are several status fields, which are listed below. These fields describe the way in which the product was created.

```
netcdf pyemergesonde2maceM1.c1.20050913.000000 {
dimensions:
        time = UNLIMITED ; // (1440 currently)
        height = 316 ;
variables:

        int qc_time(time) ;
                qc_time:long_name = "Quality check results on field: Time offset from midnight" ;
                qc_time:units = "unitless" ;
                qc_time:description = "This field contains bit packed values which should be interpreted
as listed. No bits set (zero) represents good data." ;
                qc_time:bit_1_description = "Delta time between current and previous samples is zero." ;
                qc_time:bit_1_assessment = "Bad" ;
                qc_time:bit_2_description = "Delta time between current and previous samples is less
than the delta_t_lower_limit field attribute." ;
                qc_time:bit_2_assessment = "Bad" ;
                qc_time:bit_3_description = "Delta time between current and previous samples is greater
than the delta_t_upper_limit field attribute." ;
                qc_time:bit_3_assessment = "Bad" ;
                qc_time:delta_t_lower_limit = 20. ;
                qc_time:delta_t_upper_limit = 20. ;
                qc_time:prior_sample_flag = 1 ;
                qc_time:comment = "If the \'prior_sample_flag\' is set the first sample time from a new
raw file will be compared against the time just previous to it in the stored data. If it is not set the qc_time
value for the first sample will be set to 0." ;

        int qc_precip(time) ;
                qc_precip:long_name = "Quality check results on field: Precipitation" ;
                qc_precip:units = "unitless" ;
                qc_precip:description = "This field contains bit packed values which should be
interpreted as listed. No bits set (zero) represents good data." ;
                qc_precip:bit_1_description = "Data value not available in input file, data value set to -
9999 in output file." ;
                qc_precip:bit_1_assessment = "Bad" ;

        int qc_temp(time, height) ;
                qc_temp:long_name = "Quality check results on field: Temperature" ;
                qc_temp:units = "unitless" ;
                qc_temp:description = "This field contains bit packed values which should be interpreted
as listed. No bits set (zero) represents good data." ;
                qc_temp:bit_1_description = "Value is less than the valid_min." ;
                qc_temp:bit_1_assessment = "Indeterminate" ;
                qc_temp:bit_2_description = "Value is greater than the valid_max." ;
                qc_temp:bit_2_assessment = "Indeterminate" ;
                qc_temp:bit_3_description = "Data value not available in input file, data value set to -
9999 in output file." ;
                qc_temp:bit_3_assessment = "Bad" ;
```

int qc_rh(time, height) ;
qc_rh:long_name = "Quality check results on field: Relative humidity" ;
qc_rh:units = "unitless" ;
qc_rh:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_rh:bit_1_description = "Value is less than the valid_min." ;
qc_rh:bit_1_assessment = "Indeterminate" ;
qc_rh:bit_2_description = "Value is greater than the valid_max." ;
qc_rh:bit_2_assessment = "Indeterminate" ;
qc_rh:bit_3_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_rh:bit_3_assessment = "Bad" ;

int qc_vap_pres(time, height) ;
qc_vap_pres:long_name = "Quality check results on field: Vapor pressure" ;
qc_vap_pres:units = "unitless" ;
qc_vap_pres:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_vap_pres:bit_1_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_vap_pres:bit_1_assessment = "Bad" ;

int qc_bar_pres(time, height) ;
qc_bar_pres:long_name = "Quality check results on field: Barometric pressure" ;
qc_bar_pres:units = "unitless" ;
qc_bar_pres:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_bar_pres:bit_1_description = "Value is less than the valid_min." ;
qc_bar_pres:bit_1_assessment = "Indeterminate" ;
qc_bar_pres:bit_2_description = "Value is greater than the valid_max." ;
qc_bar_pres:bit_2_assessment = "Indeterminate" ;
qc_bar_pres:bit_3_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_bar_pres:bit_3_assessment = "Bad" ;

int qc_wspd(time, height) ;
qc_wspd:long_name = "Quality check results on field: Wind speed" ;
qc_wspd:units = "unitless" ;
qc_wspd:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_wspd:bit_1_description = "Value is less than the valid_min." ;
qc_wspd:bit_1_assessment = "Indeterminate" ;
qc_wspd:bit_2_description = "Value is greater than the valid_max." ;
qc_wspd:bit_2_assessment = "Indeterminate" ;
qc_wspd:bit_3_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_wspd:bit_3_assessment = "Bad" ;

int qc_wdir(time, height) ;
qc_wdir:long_name = "Quality check results on field: Wind direction" ;
qc_wdir:units = "unitless" ;

qc_wdir:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_wdir:bit_1_description = "Value is less than the valid_min." ;
qc_wdir:bit_1_assessment = "Indeterminate" ;
qc_wdir:bit_2_description = "Value is greater than the valid_max." ;
qc_wdir:bit_2_assessment = "Indeterminate" ;
qc_wdir:bit_3_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_wdir:bit_3_assessment = "Bad" ;

int qc_u_wind(time, height) ;
qc_u_wind:long_name = "Quality check results on field: Eastward wind component" ;
qc_u_wind:units = "unitless" ;
qc_u_wind:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_u_wind:bit_1_description = "Value is less than the valid_min." ;
qc_u_wind:bit_1_assessment = "Indeterminate" ;
qc_u_wind:bit_2_description = "Value is greater than the valid_max." ;
qc_u_wind:bit_2_assessment = "Indeterminate" ;
qc_u_wind:bit_3_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_u_wind:bit_3_assessment = "Bad" ;

int qc_v_wind(time, height) ;
qc_v_wind:long_name = "Quality check results on field: Northward wind component" ;
qc_v_wind:units = "unitless" ;
qc_v_wind:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_v_wind:bit_1_description = "Value is less than the valid_min." ;
qc_v_wind:bit_1_assessment = "Indeterminate" ;
qc_v_wind:bit_2_description = "Value is greater than the valid_max." ;
qc_v_wind:bit_2_assessment = "Indeterminate" ;
qc_v_wind:bit_3_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_v_wind:bit_3_assessment = "Bad" ;

qc_dp:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_dp:bit_1_description = "Value is less than the valid_min." ;
qc_dp:bit_1_assessment = "Indeterminate" ;
qc_dp:bit_2_description = "Value is greater than the valid_max." ;
qc_dp:bit_2_assessment = "Indeterminate" ;
qc_dp:bit_3_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_dp:bit_3_assessment = "Bad" ;

int qc_potential_temp(time, height) ;
qc_potential_temp:long_name = "Quality check results on field: Potential temperature" ;
qc_potential_temp:units = "unitless" ;
qc_potential_temp:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;

qc_potential_temp:bit_1_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_potential_temp:bit_1_assessment = "Bad" ;

int qc_sh(time, height) ;
qc_sh:long_name = "Quality check results on field: Specific humidity" ;
qc_sh:units = "unitless" ;
qc_sh:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_sh:bit_1_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_sh:bit_1_assessment = "Bad" ;

int qc_rh_scaled(time, height) ;
qc_rh_scaled:long_name = "Quality check results on field: Relative humidity scaled using MWR" ;
qc_rh_scaled:units = "unitless" ;
qc_rh_scaled:description = "This field contains bit packed values which should be interpreted as listed. No bits set (zero) represents good data." ;
qc_rh_scaled:bit_1_description = "Value is less than the valid_min." ;
qc_rh_scaled:bit_1_assessment = "Indeterminate" ;
qc_rh_scaled:bit_2_description = "Value is greater than the valid_max." ;
qc_rh_scaled:bit_2_assessment = "Indeterminate" ;
qc_rh_scaled:bit_3_description = "Data value not available in input file, data value set to -9999 in output file." ;
qc_rh_scaled:bit_3_assessment = "Bad" ;
float sonde_fraction(time, height) ;
sonde_fraction:long_name = "Sonde contribution to the new data point" ;
sonde_fraction:units = "fraction" ;
sonde_fraction:comment_1 = "Remaining fraction is the contribution of model data" ;
sonde_fraction:comment_2 = "Value is between 0 and 1" ;
sonde_fraction:comment_3 = "Used for all fields other than rh (e.g. temp and bar_pres)" ;
sonde_fraction:comment_4 = "How Used: new_value = sonde_fraction * sonde_value + (1-sonde_fraction) * model_value" ;
sonde_fraction:missing_value = -9999.f ;
float sonde_fraction_rh(time, height) ;
sonde_fraction_rh:long_name = "Sonde contribution to the new rh" ;
sonde_fraction_rh:units = "fraction" ;
sonde_fraction_rh:comment_1 = "Remaining fraction is the contribution of model data" ;
sonde_fraction_rh:comment_2 = "Value is between 0 and 1" ;
sonde_fraction_rh:comment_3 = "Used for rh" ;
sonde_fraction_rh:comment_4 = "How Used: new_value = sonde_fraction_rh * sonde_value + (1-sonde_fraction_rh) * model_value" ;
sonde_fraction_rh:comment_5 = "Differs from sonde_fraction when rh field is not used from radiosonde" ;
sonde_fraction_rh:missing_value = -9999.f ;
float vapor_source(time, height) ;
vapor_source:long_name = "Source of the MWR Data used to Produce Scaled RH Field" ;
vapor_source:units = "unitless" ;
vapor_source:comment_1 = "0 -- Vapor from Turner Datastream without Problems" ;

vapor_source:comment_2 = "1 -- Vapor from Turner Datastream with Problems" ;
vapor_source:comment_3 = "2 -- Vapor from MWRLOS Datastream without Problems" ;
vapor_source:comment_4 = "3 -- Vapor from MWRLOS Datastream with Problems" ;
vapor_source:comment_5 = "4 -- No Vapor from MWR" ;
vapor_source:missing_value = -9999.f ;

3.6 VAP Status and Version History

This is the initial production release of Mersondemace v2. This is the second release of Mergesondemace v1.

3.7 Time Periods Processed

As of March 8, 2012, data have been processed as follows:

	Mergesonde1mace	Mergesonde2mace
SGP:	1996–2011	2002–2009
NSA:	2002–2011	
MAN:	2000–2011	2008
NAU:	2002–2011	
DAR:	2002–2011	2008
PYE:	2005	2005
NIM:	2006	2006
FKB:	2007	2007
HFE:	2008	2008
GRW	2009–2010	2009–2010

3.8 Version Information

This is the initial production release of Mersondemace v2. This is a second release of Mergesondemace v1.

3.9 Plans for Future Modifications

All modifications enumerated in previous documents have been incorporated in Mergesondemace v2. These changes were:

1. Raise the maximum height to 60 km.
2. Incorporate the Miloshevich dry bias correction
3. Apply the Revercomb ECMWF RH correction.

3.10 Data Access

The ARM Data Archive requires a commitment to “the establishment, maintenance, validation, description, accessibility, and distribution of high-quality, long-term data sets”. Further, it calls *for “full* *and open sharing" of* data sets for all **global change** researchers. ARM fully supports the spirit and intent of this policy by providing "free and open" access via the ARM Archive. The Data Quality Office buttresses this effort in documenting and communicating data quality issues.

3.11 Registering at the ARM Archive

The ARM Archive supports the ARM Climate Research Facility by storing and distributing the large quantities of data produced. There is no charge for access to the ARM Archive. However, in the interests of communicating data quality concerns to users of ARM data and in order to fulfill obligations as a National User Facility, ARM requires users to register prior to having access via the ARM Archive. If you are not a registered ARM Archive User, please first proceed to the automatic online registration form before continuing with the instructions below on ordering data.

3.12 Routine Data Request

ARM data can be ordered from the ARM Archive via Web browser through the ARM Archive User Interface. Simply follow the directions on the page to enter your user name, or create a new user account. This page also features links to information about the ARM Archive.

4.0 Contacts

Translator

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Email:	troyan@bnl.gov

5.0 References

Miloshevich, LM, et al. 2009. "Accuracy assessment and correction of Vaisala RS92 radiosonde water vapor measurements." *Journal of Geophysical Research* 114: D11305, doi:10.1029/2008JD011565.2009.

Troyan, D. 2011. Sonde Adjust Value-Added Product Technical Report. U.S. Department of Energy. DOE/SC-ARM-TR-102. http://www.arm.gov/publications/tech_reports/doe-sc-arm-tr-102.pdf.

Wang, DY, et al. 2005. "Validation of stratospheric temperatures measured by Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on Envisat." *Journal of Geophysical Research* 110(D8): D08301.

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