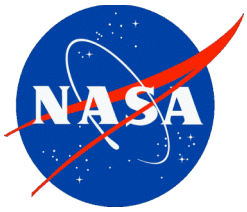
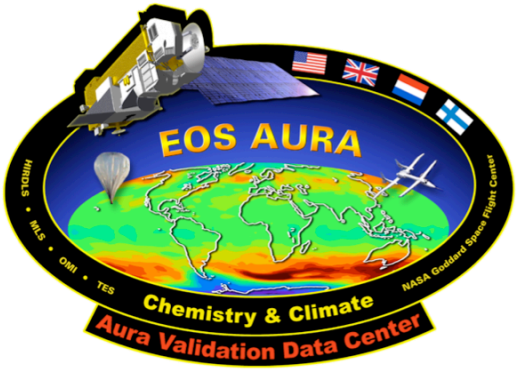


National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, MD



AVDC/NDACC MWR Data Reporting Guidelines

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See Also:	Bojkov *et al*., 2002, 2006

Table Of Contents

1 Overview

This document outlines data reporting requirements for the Microwave Radiometer (MWR) systems of the Network for the Detection of Atmospheric Composition Change (NDACC). These guidelines were developed by the Microwave Radiometer Working Group of the NDACC and the Aura Validation Data Center (AVDC) to facilitate the submission of MWR datasets in the AVDC/Envisat HDFv4 file formulation (Bojkov *et al.*, 2002) to the AURA Validation Data Center (AVDC) and the NDACC Data Handling Facility (DHF).

2 Guidelines

2.1 Instrument Naming

Although microwave radiometer systems have the capability to measure multiple entities simultaneously, the instrument names of the different MWR systems are based on the primary measured entity [GAS] to be reported in a file:

Table 2.1: MWR instrument names

Primary Measured Entity [GAS]	AVDC Instrument Name
Ozone	MWR.O3
Water vapor	MWR.H2O
ClO	MWR.ClO
CO	MWR.CO
N_2O	MWR.N2O
HNO_3	MWR.HNO3
HCN	MWR.HCN

2.2 Variable Reporting

Each measured primary entity [GAS] requires a mandatory set of 22 variables to be reported within a file MWR.[GAS] (24 variables for MWR.O3):

Notes:

DATETIME – is a single weighted mean time of the measurement – i.e. after accounting for periods where there are no measurements because of poor weather conditions, calibrations etc.

INTEGRATION.TIME – the effective integration time of the spectra used in the retrieval, which will generally be less than the difference between the start and stop times (after accounting for non-spectral, bad or missing measurements).

[GAS].MIXING.RATIO_EMISSION_AVK – if averaging kernels are routinely generated for each measurement as part of the retrieval, these should be reported in the HDF file, otherwise a generic set may be used.

Table 2.2: MWR mandatory variables

#	Variable	Units (VAR_UNIT)	Numeric type (VAR_DATA_TYPE)	Formatting (VIS_FORMAT)	Fill value (VAR_FILL_VALUE)	Comment
1	LATITUDE.INSTRUMENT	Deg	REAL	F9.2	-90000.00	*Inst. geolocation*
2	LONGITUDE.INSTRUMENT	deg	REAL	F9.2	-90000.00	*Inst. geolocation*
3	ALTITUDE.INSTRUMENT	m	LONG	I6	-90000	*Inst. geolocation*
4	DATETIME	MJD2000	DOUBLE	F16.9	-90000.000000000	*Weighted meas. time*
5	ANGLE.VIEW_AZIMUTH	deg	REAL	F9.2	-90000.00	*Inst. view. angle*
6	ANGLE.VIEW_ZENITH	deg	REAL	F9.2	-90000.00	*Inst. view. angle*
7	ANGLE.SOLAR_ZENITH_MEAN	deg	REAL	F9.2	-90000.00	*Weighted mean SZA*
8	OPACITY.ATMOSPHERIC.VERTICAL_EMISSION	Np	REAL	F10.3	-90000.000	*Opacity*
9	[GAS].MIXING.RATIO_EMISSION_START.TIME	MJD2000	DOUBLE	F16.9	-90000.000000000	*Meas. start*
10	[GAS].MIXING.RATIO_EMISSION_STOP.TIME	MJD2000	DOUBLE	F16.9	-90000.000000000	*Meas. End*
11	[GAS].MIXING.RATIO_EMISSION_INTEGRATION.TIME	h	DOUBLE	F9.2	-90000.00	*Effective meas. time*
12	ALTITUDE	m	LONG	I6	-90000	*Ref. GMH*
13	PRESSURE_INDEPENDENT	hPa	REAL	E12.4	-9.0000E+004	*P ref. profile*
14	TEMPERATURE_INDEPENDENT	K	REAL	F9.2	-90000.00	*T ref. profile*
15	[GAS].MIXING.RATIO_EMISSION	ppv	REAL	E12.4	-9.0000E+004	
16	[GAS].MIXING.RATIO_EMISSION_UNCERTAINTY.RANDOM	%	REAL	F9.2	-90000.00	
17	[GAS].MIXING.RATIO_EMISSION_UNCERTAINTY.SYSTEMATIC	%	REAL	F9.2	-90000.00	
18	[GAS].MIXING.RATIO_EMISSION_UNCERTAINTY.TOTAL	%	REAL	F9.2	-90000.00	
19	[GAS].MIXING.RATIO_EMISSION_RESOLUTION.ALTITUDE	m	LONG	I6	-90000	
20	[GAS].MIXING.RATIO_EMISSION_APRIORI	ppv	REAL	E12.4	-9.0000E+004	
21	[GAS].MIXING.RATIO_EMISSION_APRIORI.CONTRIBUTION	%	REAL	F9.2	-90000.00	
22	[GAS].MIXING.RATIO_EMISSION_AVK	DIMENSIONLESS	REAL	E10.2	-9.00E+004	
23	O3.COLUMN.VERTICAL_EMISSION	DU	REAL	F9.2	-90000.00	*For ozone only*
24	O3.NUMBER.DENSITY_EMISSION	molec m-3	REAL	E12.4	-9.0000E+019	*For ozone only*

Averaging kernel and a priori measurements are included in the file, so users have the option to convolve higher resolution datasets to the microwave resolution. This means that the reported altitude range will typically be wider than the normal measurement range. However, this does not mean that all data variables should be reported over the full range.

The following variables would generally be reported over the full range:

12 ALTITUDE,
13 PRESSURE.INDEPENDENT,
14 TEMPERATURE.INDEPENDENT,
20 [GAS].MIXING.RATIO_EMISSION_APRIORI,
22 [GAS].MIXING.RATIO_EMISSION_AVK

The remaining variables (rows 15-19, 21, 23-24 from Table 2.2) should contain measurements over the normal measurement range of the instrument only (i.e. not including measurements where the Averaging Kernels are not well resolved, or the errors are high, or the a priori dependence is high etc). Fill values (see Table 2.2 and Section 2.3) should then be used over the remaining altitude range.

2.3 Variable Fill Values

The variable fill value is a number inserted as a substitute data element if a data element of a variable is missing or erroneous. Special care must be given to the number of positions reported for the data format (VIS_FORMAT) to also accommodate the fill value. In most cases the reported variable fill value will be -90000, with precision and format as defined by VIS_FORMAT, as shown in the examples in Table 2.3 (and Table 2.2). The exception is O3.NUMBER.DENSITY_EMISSION, which has a fill value of -9.0000E+019.

Table 2.3: Fill value examples

Variable numeric type (VAR_DATA_TYPE)	Formatting (VIS_FORMAT)	Fill value (VAR_FILL_VALUE)
REAL	F9.2	-90000.00
REAL	E10.2	-9.00E+004
DOUBLE	E11.3	-9.000E+004
LONG	I6	-90000

2.4 File Granularity

The reporting granularity for MWR measurements is one file per measurement.

3 Metadata

3.1 Global Attributes

Each MWR.[GAS] file requires one set of **Global Attributes**. These have been grouped in to three categories describing the file contents, namely **Originator Attributes**, **Dataset Attributes** and **File Attributes**. An example of a microwave ozone global attributes measurement at Mauna Loa, Hawaii is given in Table 3.1.

Table 3.1: Global attributes

Global Attribute Label	Global Attribute Value (example)	Comment
PI_NAME	Parrish; Alan	
PI_AFFILIATION	University of Massachusetts; UMASS	
PI_ADDRESS	619 Lederle GRC, University of Massachusetts; Amherst MA 01003; UNITED STATES	
PI_EMAIL	parrish@astro.umass.edu	
DO_NAME	Parrish; Alan	
DO_AFFILIATION	University of Massachusetts; UMASS	
DO_ADDRESS	619 Lederle GRC, University of Massachusetts; Amherst MA 01003; UNITED STATES	
DO_EMAIL	parrish@astro.umass.edu	
DS_NAME	Boyd; Ian	
DS_AFFILIATION	NIWA Environmental Research Institute; NIWA.ERI	
DS_ADDRESS	501 Avis Drive, Suite 120; Ann-Arbor MI 48108; UNITED STATES	
DS_EMAIL	i.boyd@niwa.com	
DATA_DESCRIPTION	Atmospheric ozone profiles from continuous ground-based microwave measurements at Mauna Loa, Hawaii	*Free format*
DATA_DISCIPLINE	ATMOSPHERIC.PHYSICS; REMOTE.SENSING; GROUNDBASED	*Refer to standard*
DATA_GROUP	EXPERIMENTAL; PROFILE.STATIONARY	*Refer to standard*
DATA_LOCATION	MAUNA.LOA.HI	*Refer to standard*
DATA_SOURCE	MWR.O3_UMASS002	*Refer to standard*
DATA_LEVEL	H2	*Refer to standard*
DATA_VARIABLES	LATITUDE.INSTRUMENT; LONGITUDE.INSTRUMENT; ALTITUDE.INSTRUMENT; DATETIME; ANGLE.VIEW_AZIMUTH; ANGLE.VIEW_ZENITH_MEAN; ANGLE.SOLAR_ZENITH_MEAN; OPACITY.ATMOSPHERIC.VERTICAL_EMISSION; O3.MIXING.RATIO_EMISSION_START.TIME; O3.MIXING.RATIO_EMISSION_STOP.TIME; O3.MIXING.RATIO_EMISSION_INTEGRATION.TIME; ALTITUDE; PRESSURE_INDEPENDENT; TEMPERATURE_INDEPENDENT; O3.MIXING.RATIO_EMISSION; O3.MIXING.RATIO_EMISSION_UNCERTAINTY.RANDOM; O3.MIXING.RATIO_EMISSION_UNCERTAINTY.SYSTEMATIC; O3.MIXING.RATIO_EMISSION_UNCERTAINTY.TOTAL; O3.MIXING.RATIO_EMISSION_RESOLUTION.ALTITUDE; O3.MIXING.RATIO_EMISSION_APRIORI; O3.MIXING.RATIO_EMISSION_APRIORI.CONTRIBUTION; O3.MIXING.RATIO_EMISSION_AVK; O3.COLUMN.VERTICAL_EMISSION; O3.NUMBER.DENSITY_EMISSION	
DATA_START_DATE	20040801T030538Z	*ISO8601*
DATA_FILE_VERSION	v5.0	
DATA_MODIFICATIONS	Final v5.0 dataset	*Free format*
DATA_CAVEATS	NONE	*Free format*
DATA_RULES_OF_USE	Please contact Alan Parrish at parrish@astro.umass.edu	*Free format*
DATA_ACKNOWLEDGEMENT	We thank the JPL Lidar team and the Mauna Loa support staff for their efforts.	*Free format*
FILE_NAME	groundbased_mwr.o3_umass002_mauna.loa.hi_h2_20040801t030538z_v5.0.hdf	*Naming convention*
FILE_GENERATION_DATE	20051103T201804Z	*ISO8601*
FILE_ACCESS	AVDC; NDACC	*Project dependent*
FILE_PROJECT_ID		*Project dependent*
FILE_ASSOCIATION	NDACC	*Project dependent*
FILE_META_VERSION	02R0019; IDLCR8HDF	*Refer to standard*

3.2 Variable Attributes

Each variable reported in a MWR.[GAS] file requires one set of **Variable Attributes**. These have been grouped into two categories describing the variable, namely the **Variable Description Attributes** and the **Variable Visualization Attributes**. An example of an attribute set is given in Table 3.2.

Table 3.2: Variable attributes

Attribute Label	Attribute Value	Comment
VAR_NAME	O3.MIXING.RATIO_EMISSION_AVK	*Refer to standard*
VAR_DESCRIPTION	O3 Retrieval Averaging Kernels	*Free format*
VAR_NOTES	Generic Daytime Averaging Kernels for this site. First three AVK values for the lowest altitude level are: 0.071 0.128 0.140	*Free format*
VAR_DIMENSION	2	*2D matrix*
VAR_SIZE	49;49	*The number of elements in each dimension*
VAR_DEPEND	ALTITUDE; ALTITUDE	*INDEPENDENT, CONSTANT or a previously given one dimensional variable (in this case ALTITUDE)*
VAR_DATA_TYPE	REAL	*Allowable formats are INTEGER, LONG, REAL, DOUBLE*
VAR_UNITS	DIMENSIONLESS	*Refer to standard for permissible units*
VAR_SI_CONVERSION	0.0; 1.0; DIMENSIONLESS	*Refer to standard*
VAR_VALID_MIN	-1.00E+000	
VAR_VALID_MAX	1.00E+000	
VAR_AVG_TYPE	NONE	*Refer to standard*
VAR_FILL_VALUE	-9.00E+04	*Needs to be outside VAR_VALID_MIN and VAR_VALID_MAX values*
VIS_LABEL	Averaging Kernels (-)	*Free format*
VIS_FORMAT	E10.2	*Needs to accommodate valid minimum, valid maximum and the fill values*
VIS_PLOT_TYPE	XYZ.CONTOUR	*Refer to standard*
VIS_SCALE_TYPE	LINEAR;INCREASE	*Refer to standard*
VIS_SCALE_MIN	-2.00E-001	*Refer to standard*
VIS_SCALE_MAX	5.00E-001	*Refer to standard*

3.3 Metadata updates

Minor metadata updates and clarifications have been incorporated into the original Envisat Cal/Val metadata guidelines (Bojkov *et al.*, 2002). A detailed description of these changes[a] can be found in the AVDC addendum (Bojkov *et al.*, 2006).

[a] ESA has committed to synchronizing the Envisat Cal/Val metadata requirements to NASA's AVDC.

Table 3.3: Summary of metadata changes.

Attribute Name	Attribute Type	Change	Comment
DATA_TYPE	Global Attribute	DATA_LEVEL	*New name for clarity*
DATA_FILE_VERSION	Global Attribute	Additional entry formats allowed	*Now can also describe processing version. For example v8, 5.01, etc.*
FILE_META_VERSION	Global Attribute	Requires 2 mandatory entries	*Attribute entries are the metadata version and the conversion tool name.*
VAR_MONOTONE	Variable Attribute	Removed	
VIS_SCALE_TYPE	Variable Attribute	Entry change	*If VIS_PLOT_TYPE set to NONE, then VIS_SCALE_TYPE must be set to NONE;NONE*
VIS_SCALE_MIN/MAX	Variable Attribute	Entry change	*If VIS_PLOT_TYPE set to NONE, then VIS_SCALE_MIN and VIS_SCALE_MAX must be set to NONE*

4 HDF Implementations

The HDF version 4 (NCSA, 2001) file formulation is limited to: 1) the global attributes containing the file metadata, and 2) the scientific data sets (SDS) model to represent each variable with appropriate variable metadata. A similar file structure has been developed by the AVDC for the HDF 5 type files. A detailed description of the AVDC HDF 4 and the HDF 5 type files is provided by Bojkov *et al*., 2006.

5 Acronyms

AVDC	Aura Validation Data Center
DHF	NDACC Data handling Facility
HDF	Hierarchical Data Format
MJD2000	Modified Julian Date 2000
MWR	Microwave Radiometer
NCSA	National Center for Supercomputing Applications
NDACC	Network for the Detection of Atmospheric Composition Change
NDSC	Network for the Detection of Stratospheric Change

6 Version History

20060130:

- Add guidelines for reporting averaging kernels (section 2.2).
- Incorporate changes in the reporting of mandatory fill values (section 2.3).
- Added columns for the numeric type, the formatting and the fill values to Table 2.2.

20060922:

- Corrected variable naming errors:
  OPACITY.ATMOSPHERIC_EMISSION.VERTICAL is replaced by
  OPACITY.ATMOSPHERIC.VERTICAL_EMISSION and
  O3.COLUMN_EMISSION.VERTICAL is replaced by
  O3.COLUMN.VERTICAL_EMISSION
- Updated the Metadata updates table (Table 3.3).
- Global update of NDSC acronym to NDACC.
- Updates contact and affiliation information.

7 References

B.R. Bojkov, De Mazière, M. and R. Koopman, Generic metadata guidelines on atmospheric and oceanographic datasets for the Envisat Calibration and Validation Project, Version 01R001, April 23, 2002. Available for download at http://avdc.gsfc.nasa.gov/Documentation/Metadata/

B.R. Bojkov, Boyd, I., De Mazière, M. and R. Koopman, Addendum to the "Generic metadata guidelines on atmospheric and oceanographic datasets for the Envisat Calibration and Validation Project" as implemented by the Aura Validation Data Center (AVDC), August 31, 2006. Available for download at http://avdc.gsfc.nasa.gov/Documentation/Metadata/

NCSA, National Center for Supercomputing Applications – HDF 4 home page: http://hdf.ncsa.uiuc.edu/hdf4.html