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DOE/SC-ARM-TR-184

Aerosol Observing System Surface Meteorology (AOSMET) Instrument Handbook

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November 2019

ARM

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Work supported by the U.S. Department of Energy,
Office of Science, Office of Biological and Environmental Research

Acronyms and Abbreviations

ACX	ARM Cloud Aerosol Precipitation Experiment (ACAPEX) field campaign, Sacramento, California
AMF	ARM Mobile Facility
ANX	Cold-Air Outbreaks in the Marine Boundary Layer (COMBLE) field campaign, Andenes, Norway
AOS	aerosol observing system
AOSMET	aerosol observing system surface meteorology
ARM	Atmospheric Radiation Measurement
ASI	Layered Atlantic Smoke Interactions with Clouds (LASIC) field campaign, Ascension Island
AWR	ARM West Antarctic Radiation Experiment (AWARE)
COR	Cloud, Aerosol, and Complex Terrain Interactions (CACTI) field campaign, Córdoba, Argentina
DQAR	Data Quality Assessment Reports
DQR	Data Quality Report
ENA	Eastern North Atlantic ARM observatory, Graciosa Island, Azores
MAG	Marine ARM GPCI Investigation of Clouds (MAGIC) field campaign, eastern Pacific Ocean
MAO	Observations and Modeling of the Green Ocean Amazon 2014/15 field campaign, Manacapuru, Brazil
MAR	Measurements of Aerosols, Radiation, and Clouds over the Southern Ocean (MARCUS) field campaign
MET	surface meteorological instrumentation
MOS	Arctic Ocean
OLI	Oliktok Point, Alaska
PTU	pan-and-tilt unit
PVC	Two-Column Aerosol Project (TCAP), Cape Cod, Massachusetts
RC	resistor-capacitor
SBS	Storm Peak Lab Cloud Property Validation Experiment, Steamboat Springs, Colorado
SGP	Southern Great Plains
TMP	Biogenic Aerosols –Effects on Clouds and Climate (BAECC) field campaign, Hyytiälä, Finland
VAP	value-added product

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1.0 General Overview

The aerosol observing system (AOS) surface meteorology instrument is an ancillary sensor that provides temperature, relative humidity, pressure, wind speed and direction, and precipitation data relevant to the AOS. It consists of a Vaisala weather transmitter (WXT520 or WXT530) mounted on top of the AOS aerosol inlet, at a height of approximately 10 meters.

2.0 Contacts

2.1 Mentor

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2.2 Vendor/Instrument Developer

Vaisala, Inc. (North America Support Office)
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USA
Phone: (781) 933-4500
Email: helpdesk@vaisala.com
Website: www.vaisala.com

3.0 Deployment Location and History

Table 1. Deployment location and history.

Parent Facility	Site/*Ship	Start Date	End Date
AMF2	SBS	10/03/2010	05/02/2011
AMF1	PVC	06/24/2012	04/02/2013
AMF2	MAG*	09/28/2012	10/02/2013
AMF1	MAO	12/12/2013	12/01/2015
Fixed	ENA	01/01/2014	present
AMF2	TMP	01/22/2014	09/13/2014

Parent Facility	Site/*Ship	Start Date	End Date
AMF2	ACX*	01/9/2015	02/14/2015
AMF2	AWR	11/15/2015	01/05/2017
AMF1	ASI	04/23/2016	11/01/2017
AMF3	OLI	08/05/2016	present
Fixed	SGP	11/15/2016	present
AMF2	MAR*	06/07/2017	03/24/2018
AMF1	COR	09/23/2018	04/29/2019
AMF2	MOS*	09/19/2019	present
AMF1	ANX	10/09/2019	present

4.0 Near-Real-Time Data Plots

Near-real-time data plots can be found at http://www.arm.gov/data/plots.

5.0 Data Descriptions and Examples

5.1 Data File Contents

5.1.1 Primary Variables and Expected Uncertainty

All variables in the AOSMET data files are .a1 level. This means that no quality flags are applied to the data. All data are functions of time, at 1-second intervals.

Table 2. AOSMET primary variables and uncertainty.

Variable	NetCDF Name	Unit	Uncertainty
Ambient air relative humidity	RH_Ambient	%	± 3% (from 0% to 90%) ± 5% (from 90% to 100%)
Ambient air temperature	T_Ambient	°C	± 0.3°C at 20°C (see manual for extended temperature uncertainty graph)
Ambient pressure	P_Ambient	hPa	± 0.5 hPa from 0°C to 30°C
Wind speed	WindSpeed	m/s	± 3% at 10 m/s
Wind direction, relative to true north (land deployments); relative to ship bowline (ship deployments)	WindDirection	degree	± 3%
Rain amount	rain_amount	mm/s	± 5% (not including errors induced by wind)

Variable	NetCDF Name	Unit	Uncertainty
Rain duration	rain_duration	s	± 5% (not including errors induced by wind)
Rain intensity	rain_intensity	mm/hr	± 5% (not including errors induced by wind)

5.1.2 Secondary/Site-Specific Variables

Not applicable.

5.1.3 Diagnostic Variables

Diagnostic variables regarding the sensor heating and power consumption are recorded in the data files to help identify potential sensor problems.

Table 3. AOSMET diagnostic variables.

Variable	NetCDF Name	Unit
Heater temperature	heater_temp	°C
Heater voltage	heater_volts	V
Supply voltage	supply_volts	V
Reference voltage	ref_volts	V

5.1.4 Data Quality Flags

Not applicable.

5.1.5 Dimension Variables

All AOSMET variables are dimensioned by time at 1-second intervals.

5.2 Annotated Examples

Not applicable.

5.3 User Notes and Known Problems

Wind measurements occasionally drop out in times of snow due to transducer blockage.

5.4 Frequently Asked Questions

Q: Should the AOSMET be used for surface meteorological studies?

A: No. Primary support for surface meteorological data resides in the surface meteorological instrumentation (MET) datastream. The AOSMET data are intended to be used specifically for hyper-local meteorological data relevant to the aerosol stack. On occasion, data from the AOSMET may be suggested as a secondary data source when the quality of MET data are compromised.

6.0 Data Quality

6.1 Data Quality Health and Status

Information regarding data quality and instrument status can be found at http://dq.arm.gov.

6.2 Data Reviews by Instrument Mentor

The instrument mentor performs routine data checks to diagnose potential problems. If a problem is found, appropriate actions are taken to mitigate the issue, such as initiating instrument maintenance and filing of a Data Quality Report (DQR).

6.3 Data Assessments by Site Scientist/Data Quality Office

In addition to data reviews by the instrument mentor, the ARM Data Quality Office submits weekly Data Quality Assessment Reports (DQAR). DQARs are used as a tool to identify potential instrument and data flow problems, and to inform applicable personnel about the general quality of the data. These assessments include visual inspection of the data, and comparison with co-located instrument systems that measure similar variables.

6.4 Value-Added Products and Quality Measurement Experiments

ARM produces a number of value-added products (VAP) by performing additional analyses and processing on existing data products. More information about historical and existing VAPs can be found at http://www.arm.gov/data/vaps.

7.0 Instrument Details

7.1 Detailed Description

7.1.1 List of Components

Vaisala WXT520/530 weather transmitter

12V external power supply

7.1.2 System Configuration and Measurement Methods

The WXT sensor is mounted on the aerosol inlet at a height of approximately 10 meters.

Pressure, temperature, and relative humidity measurements utilize a pan and tilt unit (PTU) module that contains Vaisala proprietary sensors. The PTU includes a capacitive silicon sensor, a capacitive ceramic sensor, and a capacitive thin-film polymer sensor for measurement of pressure, temperature, and humidity, respectively. According to the manufacturer’s manual, the measurement is based on an advanced resistor-capacitor (RC) oscillator, and capacitance of two reference capacitors is continuously measured. Temperature dependency of the pressure and humidity measurements is accounted for in the microprocessor.

Wind measurements use equally spaced ultrasonic transducers (in the same horizontal plane), and measure the transit time between each to determine speed and direction. According to the manufacturer’s manual, the formula for calculating transit time is:

$$V_w = 0.5 \times L \times (1/t_f - 1/t_r)$$

Where:

V_w = wind speed

L = distance between two transducers

t_f = forward transit time

t_r = reverse transit time

Precipitation measurements use a steel cover and piezoelectric sensor to detect precipitation impact proportional to drop volume, which is then translated to rain amount. Filtering techniques attempt to eliminate noise from non-precipitation sources. Precipitation is operated in time mode; messages are sent at the designated output time (1 second).

For the WXTs that have heating enabled, the heating elements below the precipitation sensor and inside the ultrasonic transducers activate when the ambient temperature reaches 4°C.

7.1.3 Specifications

All instrument specifications are as-stated by the respective manufacturer in the operation manuals.

Temperature:

- Range (operation): -52°C to 60°C
- Range (storage): -60°C to 70°C
- Resolution: 0.1°C

Relative humidity:

- Range: 0% to 100%
- Resolution: 0.1 %

Pressure:
Range: 600 hPa to 1100 hPa
Resolution: 0.1 hPa

Wind speed:
Range: 0 m/s to 60 m/s
Resolution: 0.1 m/s
Response time: 0.25 s

Wind direction:
Range: 0° to 360°
Resolution: 1°
Response time: 0.25 s

Precipitation cumulation:
Collection area: 60 cm^2
Resolution: 0.01 mm

Precipitation duration:
Response time: 10 s

Precipitation intensity:
Range: 0 to 200 mm/hr
Response time: running one min average in 10s steps

7.2 Theory of Operation

The AOSMET data are intended to be used as hyper-local ancillary data to the AOS. The datastream provides useful basic meteorological information at the aerosol inlet site for analyzing the aerosol data.

7.3 Calibration

7.3.1 Theory

The manufacturer provides no suggestion for a routine calibration interval. Since this instrument is used as supplemental data to the AOS, is not research-grade by standard (larger uncertainties), and requires lowering of the entire aerosol inlet, maintaining calibration has not been a priority. Beginning in 2016, wind data are verified to read zero, and an annual (or pre-deployment in the case of mobile facilities) replacement of the PTU module is performed.

7.3.2 Procedures

Wind speed verification: A bag is placed over the ultrasonic transducers and the speed is verified to be 0 m/s. If this is not the case, the instrument will be replaced and sent to the manufacturer for evaluation.

PTU module replacement: The sensor is uninstalled from the aerosol inlet. The old PTU module is removed using the fixing screws to open the sensor and access the module. The new module is inserted, and the fixing screws reset. The sensor is reinstalled to the aerosol inlet for operation.

7.3.3 History

To date, no routine calibrations have been performed on the sensors.

7.4 Operation and Maintenance

7.4.1 User Manual

In addition to the manufacturer's manual, the Atmospheric Radiation Measurement (ARM) user facility maintains instrument user manuals for internal operational use. These manuals contain information specific to instrument installation and configuration and are generally of no value to data users.

7.4.2 Routine and Corrective Maintenance Documentation

Preventative visual checks of the instrument and live data are performed daily. If a problem is noted, steps are taken to correct the issue. Any performed maintenance is documented using internal reporting forms. If data quality has been compromised, a DQR will be filed and supplied to the user with their order.

7.4.3 Software Documentation

Not applicable.

7.4.4 Additional Documentation

Vaisala WXT520 Weather Transmitter Manual

Vaisala WXT530 Weather Transmitter Manual

7.5 Glossary

ARM Glossary

7.6 Citable References

Vaisala. 2012. *User's Guide: Vaisala Weather Transmitter WXT520*. Helsinki, Finland: Vaisala Oyj.

Vaisala. 2017. *User Guide Vaisala Weather Transmitter WXT530 Series*. Helsinki, Finland: Vaisala Oyj.

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