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Aerosol Observing System Surface Meteorology (AOSMET) Instrument Handbook

J Kyrouac

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ARM

CLIMATE RESEARCH FACILITY

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Acronyms and Abbreviations

AOS	Aerosol Observing System
AMF	ARM Mobile Facility
ARM	Atmospheric Radiation Measurement Climate Research Facility
C	Celsius
cm	centimeter
cm^2	square centimeters
DOE	U.S. Department of Energy
DQAR	Data Quality Assessment Report
DQR	Data Quality Report
hPa	hectopascal
hr	hour
mm	millimeter
m/s	meters per second
s	second
VAP	Value-Added Product

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1.0 General Overview

The U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility 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 WXT520 Weather Transmitter mounted on top of the AOS aerosol inlet, at a height of approximately 10 meters.

2.0 Contacts

2.1 Mentor

Jenni Kyrouac
Atmospheric Instrument Specialist
Environmental Science Division
Argonne National Laboratory
9700 S. Cass Ave.
Argonne, IL 60439
USA
Phone: (815) 347-6969
Email: jkyrouac@anl.gov

2.2 Vendor/Instrument Developer

Vaisala, Inc. (North America Support Office)
10-D Gill St.
Woburn, MA 01801
USA
Phone: (781) 933-4500
Email: helpdesk@vaisala.com
Website: www.vaisala.com

An instrument manual is available from the manufacturer at www.vaisala.com

Descriptions, specifications, and other information presented in this instrument handbook have been borrowed from the user manuals of Vaisala Inc. Such information is used with the permission of Vaisala and remains the property of Vaisala.

3.0 Deployment Location and History

Table 1. Deployment location and history.

Parent Facility	Site	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
AMF2	TMP	01/22/2014	09/13/2014
AMF2	ACX	01/9/2015	02/14/2015
Fixed	ENA	01/10/2015	present
AMF2	AWR	11/15/2015	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 Description 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%)

Variable	NetCDF Name	Unit	Uncertainty
			± 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	WindDirection	degree	± 3%
Rain amount	rain_amount	mm/s	± 5% (not including errors induced by wind)
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 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

5.1.3 Dimension Variables

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

5.3 User Notes and Known Problems

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

There is evidence that the sensor under-reports very light rain when compared with nearby precipitation instruments. The manufacturer confirms that this is due to sensor mechanics. The sensor plate requires precipitation to be falling at terminal velocity to register, and light rain often does not reach terminal velocity.

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 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 Weather Transmitter

12V External Power Supply

7.1.2 System Configuration and Measurement Methods

The WXT520 sensor is mounted on the aerosol inlet at a height of approximately 10 meters.

Pressure, temperature, and relative humidity measurements use a 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 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 WXT520s that have heating enabled, the heating elements below the precipitation sensor and inside the ultrasonic transducers activate when the ambient temperature reaches 4° Celsius (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 hectopascals (hPa)
- Resolution: 0.1 hPa

Wind speed:
- Range: 0 m/s to 60 meters per second (m/s)
- Resolution: 0.1 m/s
- Response time: 0.25 second (s)

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

Precipitation cumulation:
- Collection area: 60 square centimeters ($cm^{2)}$
- Resolution: 0.01 millimeter (mm)

Precipitation duration:
- Response time: 10 s

Precipitation intensity:
- Range: 0 to 200 mm/ hour (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 removed 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 ARM Climate Research 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 the user's order.

7.4.3 Additional Documentation

Vaisala WXT520 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.

www.arm.gov

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