ARM TR-061

Normal Incidence Multi-Filter Radiometer (NIMFR) Handbook

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Contents

1. General Overview

The Normal Incidence Multi-Filter Radiometer (NIMFR) is a ground-based instrument that provides a time series of the shortwave spectral direct normal irradiance. Additionally, there is a broadband silicon detector that can crudely measure the direct normal broadband irradiance. These irradiance measurements can be used to infer clear sky aerosol optical depth and columnar abundances of ozone and water vapor. The NIMFR is one of a class of instruments known as sun photometers.

2. Contacts

2.1 Mentor

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2.2 Instrument Developer

This section is not applicable to this instrument.

3. Deployment Locations and History

The SHEBA NIMFR has been removed from service. There has been and will be a NIMFR deployed at the Barrow NSA site during the time of the year that the sun is up.

4. Near-Real-Time Data Plots

See General Quick Looks.

5. Data Description and Examples

This section is not applicable to this instrument.

5.1 Data File Contents

5.1.1 Primary Variables and Expected Uncertainty

The primary quantities measured by the NIMFR are direct normal spectral irradiances at six discrete wavelengths (with units of W/m^2/nm) as well as a broadband measurement from the silicon detector.

5.1.1.1 Definition of Uncertainty

The uncertainties in the measurement depend on the state of calibration of the instrument. A well-calibrated instrument can measure the spectral irradiances to within 2% (or maybe even a little better). A calibration of this accuracy can only be obtained using sun photometry and it assumes that the extraterrestrial radiation upon which the calibration depends is known with negligible error. At the present time, sun photometry is not used to calibrate the NIMFR; instead the instrument is calibrated using a standard lamp that is uncertain to +/- 5%. With proper calibration, the broadband measurement is accurate to about 5%.

The calibration stability of the instrument depends on the several factors, including the stability of the interference filters used to make the spectral observations and the temperature stability of the MFRSR head. Although there have been problems in the past with interference filter stability (the transmission of these devices can change over time), these problems have been largely solved for the NIMFRs ... or so we hope. Time will tell if the problem has indeed been solved, but so far the filters are staying stable.

The head temperature affects the magnitude of the signal coming out of the MFRSR head, and this sensitivity has been estimated to be a 0% to 2% change in output per 1^{o} C change in head temperature. It is not unusual for the head temperature to fluctuate over a range of +/- 1^{o} over the course of a day, and +/- 3^{o} over the course of a year. Such fluctuations can cause the calibration to change significantly in step with the temperature variations. To date, this problem has not been solved. The extent to which this problem affects measurements from any given NIMFR has not been determined. All we can say is that the error could be as large as +/- 6% for some wavelengths. Not all instruments will exhibit errors of this magnitude and for a given instrument the error may be small for one wavelength channel and large for another. The 6% figure cited above should be considered a worse-case scenario.

5.1.2 Secondary/Underlying Variables

This section is not applicable to this instrument.

5.1.3 Diagnostic Variables

This section is not applicable to this instrument.

5.1.4 Data Quality Flags

See NIMFR Data Object Design Changes for ARM netCDF file header descriptions.

5.1.5 Dimension Variables

This section is not applicable to this instrument.

5.2 Annotated Examples

This section is not applicable to this instrument.

5.3 User Notes and Known Problems

This section is not applicable to this instrument.

5.4 Frequently Asked Questions

This section is not applicable to this instrument.

6. Data Quality

6.1 Data Quality Health and Status

The following links go to current data quality health and status results:

- DQ HandS (Data Quality Health and Status)
- NCVweb for interactive data plotting using.

The tables and graphs shown contain the techniques used by ARM's data quality analysts, instrument mentors, and site scientists to monitor and diagnose data quality.

6.2 Data Reviews by Instrument Mentor

This section is not applicable to this instrument.

6.3 Data Assessments by Site Scientist/Data Quality Office

All DQ Office and most Site Scientist techniques for checking have been incorporated within DQ HandS and can be viewed there.

6.4 Value-Added Procedures and Quality Measurement Experiments

Many of the scientific needs of the ARM Program are met through the analysis and processing of existing data products into "value-added" products or VAPs. Despite extensive instrumentation deployed at the ARM CART sites, there will always be quantities of interest that are either impractical or impossible to measure directly or routinely. Physical models using ARM instrument data as inputs are implemented as VAPs and can help fill some of the unmet measurement needs of the program. Conversely, ARM produces some VAPs not in order to fill unmet measurement needs, but instead to improve the quality of existing measurements. In addition, when more than one measurement is available, ARM also produces "best estimate" VAPs. A special class of VAP called a Quality Measurement Experiment (QME) does not output geophysical parameters of scientific interest. Rather, a QME adds value to the input datastreams by providing for continuous assessment of the quality of the input data based on internal consistency checks, comparisons between independent similar measurements, or comparisons between measurement with modeled results, and so forth. For more information, see the VAPs and QMEs web page.

7. Instrument Details

7.1 Detailed Description

7.1.1 List of Components

The instrument consists of a "head" from an MFRSR to which a collimating tube is attached. This assembly is mounted in a solar tracker so that the instrument points directly at the sun (i.e., the collimating tube points at the sun). The collimating tube has a narrow field of view designed to admit only the direct normal irradiance; this radiation hits the detectors housed in the MFRSR head. A very small amount of diffuse radiation is also admitted by the tube and sensed by the detectors. The amount of diffuse radiation that strikes the detector is so small in relation to the direct beam radiation that it is usually neglected. For the spectral measurements, the detector for each wavelength channel consists of a combination interference filter/silicon photodiode. The instrument's head is kept at a relatively constant temperature of about 35^{o} C.

7.1.2 System Configuration and Measurement Methods

The NIMFR is mounted on a solar tracker that is usually about 2 or 3 meters above the ground. At a specified time interval (20 sec at the NSA sites), the instrument takes a reading (six spectral irradiances and one broadband irradiance). The readings are stored on a nearby data logger.

7.1.3 Specifications

The spectral measurements are made at nominal wavelengths of 415, 500, 615, 673, 870, and 940 nm. The nominal width of the interference filters' passband is 10 nm. The broadband silicon detector responds only to radiation in an interval from about 300 and 1100 nm.

7.2 Theory of Operation

This section is not applicable to this instrument.

7.3 Calibration

7.3.1 Theory

This section is not applicable to this instrument.

7.3.2 Procedures

This section is not applicable to this instrument.

7.3.3 History

The SHEBA NIMFR was calibrated by a standard lamp on March 6, 1998.
The Barrow NIMFR was calibrated by a standard lamp on March 6, 1998.

7.4 Operation and Maintenance

7.4.1 User Manual

This section is not applicable to this instrument.

7.4.2 Routine and Corrective Maintenance Documentation

This section is not applicable to this instrument.

7.4.3 Software Documentation

ARM netCDF file header descriptions may be found at NIMFR Data Object Design Changes.

7.4.4 Additional Documentation

This section is not applicable to this instrument.

7.5 Glossary

See the ARM Glossary.

7.6 Acronyms

NSA: North Slope of Alaska
SHEBA: Surface Heat Budget of the Arctic Program

Also see the ARM Acronyms and Abbreviations.

7.7 Citable References

This section is not applicable to this instrument.