ARM TR-060

Narrow Field of View Zenith Radiometer (NFOV) Handbook

January 2005

D. Flynn
G. Hodges

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

Contents

1. General Overview 1
2. Contacts 1
3. Deployment Locations and History 1
4. Near-Real-Time Data Plots 1
5. Data Description and Examples 2
6. Data Quality 3
7. Instrument Details 4

1. General Overview

The Narrow Field of View Zenith Radiometer (NFOV) is a ground-based radiometer that looks straight up. As implied by the name, the field of view of the instrument is narrow, thus permitting the measurement of the downwelling zenith radiance. The output of the instrument consists of a time series of 1-sec observations of the zenith spectral radiance. The radiance is measured at a wavelength of 869 nm. Data from the instrument has many uses; for example, the internal structure of clouds may be characterized by examining a time series of the radiance data.

2. Contacts

2.1 Mentor

Gary Hodges
Phone: 303-497-6460
E-mail: Gary.Hodges@noaa.gov

Donna Flynn (data analysis)
Pacific Northwest National Laboratory
K9-24, P.O. Box 999
Richland, WA 99352
Phone: 509-375-6978
E-mail: Donna.Flynn@pnl.gov

John Schmelzer
Pacific Northwest National Laboratory
K5-08, P.O. Box 999
Richland, WA 99352
Phone: 509-375-3729
Fax: 509-375-3614
E-mail: john.schmelzer@pnl.gov

2.2 Instrument Developer

This section is not applicable to this instrument.

3. Deployment Locations and History

There is one NFOV instrument located at the Central Facility of the SGP site.

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 quantity measured by the instrument is the downwelling zenith spectral radiance with units ($W/m^2/nm/sr$).

5.1.1.1 Definition of Uncertainty

As mentioned in the "detailed description" above, the instrument's calibration depends upon the calibration of the sensor head (at plus or minus 4% - the actual uncertainty is probably larger than this) and the calculation of the solid angle of the collimating tube. This calculation is probably good to (plus or minus) 5%. There's also a glass window that sits atop the collimating tube, and if this gets soiled the calibration will be further in error. A crude estimate of the calibration error is (plus or minus) 15%.

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

-999.0 in the data stream means that the data is missing or not calculated.

For example, the ingested data will contain a field labeled something like "radiance _ temperature corrected." This field will have values of -999.0 indicating that the field has not been calculated. At this time, we cannot correct the radiance for head temperature variations because the head temperature has not been sufficiently stable, and the correction is reported as missing (-9999.0).

Additional information may be found at NFOV 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

This instrument is very simple. It consists two parts: a "head" from an MFRSR, and a collimating tube that sits atop the head. The head has been modified so that it consists of only one filter detector. The collimating tube restricts the field of view of the instrument so that a radiance is measured.

The accuracy of the radiance measurement depends on the following: (1) the calibration of the filter detector and (2) the characterization of the optical geometry of the instrument. The detector is calibrated by a standard lamp. The accuracy of this lamp is given as (plus or minus) 4%. The critical optical geometry of the instrument is the solid angle subtended by the collimating tube/detector assembly. This solid angle is calculated given measurements of the collimating tube.

7.1.2 System Configuration and Measurement Methods

The height of the instrument is about 2 meters.

7.1.3 Specifications

Sampling Interval: The measurements are made at one second time intervals, day and night. The night time measurements are used to assess the offset of the signal from zero.

Wavelength of Measurement: The measurements are made at a single wavelength, 869 nm, using an interference filter. The full width at half maximum of this filter is nominally 10 nm.

Field of View of Instrument: The full field of view of the instrument is 5.7 degrees.

Time constant of measurements: Very small, estimated to be 0.01 sec.

7.2 Theory of Operation

The instruments points straight up and the field of view of the instrument is restricted by the collimating tube. Photons that are traveling in the right direction so as to enter the collimating tube are sensed by the detector that resides in the instrument's head. The detector is an interference filter/Silicon diode detector. The head is kept at a constant temperature (insofar as possible) to prevent temperature effects from influencing the measurements. Even small variations in the head temperature -- on the order of one degree -- can alter the calibration of the instrument. The sensitivity to head temperature appears to be about a 1% change in radiance for every 1 degree (Kelvin) change in head temperature, but the actual temperature sensitivity appears to be more complicated than this simple linear relationship would imply.

(Note posted on 1999/01/06: As of this time, the temperature control mechanism is not working well - thus the measurements are being contaminated by temperature effects of an unknown magnitude).

(Note posted on 2000/03/01: As of this time, the temperature control mechanism is working well. The repaired instrument was installed on 2000/02/29.)

(Note posted on 2000/05/23: Occasionally, the radiance has become so high that the A/D convertor has saturated. This means that radiances that would register above 4095 counts are truncated to 4095 counts. Look at the data on 2000/05/10 and you'll see an example of this truncation. Looks like an old "flat top" haircut! After 2000/05/23 [20 GMT] the instrument was adjusted so that saturation no longer occurs. Saturation can be detected in the data from 2000/02/29 to 2000/05/23 by examining the variable "counts". If this variable is 4095, then you know that the instrument was saturating.

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 NFOV instrument at the SGP was calibrated with a standard lamp on 1997/11/12.

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 NFOV 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

See the ARM Acronyms and Abbreviations.

7.7 Citable References

This section is not applicable to this instrument.