Radiometer Calibration Facility (RCF) Handbook

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Contents

1. General Overview

Background

The ARM Program requires accurate measurements of solar radiation from radiometers used in ground-based networks and airborne instrument platforms. These measurements are needed to improve the mathematical description of radiative transfer processes simulated in global circulation models used to predict climate change. For example, evaluations of the so-called "excess absorption" by clouds and radiative transfer models for clear skies are highly dependent on accurate surface measurements of downwelling solar radiation. The ARM program has acquired more than 100 pyranometers and pyrheliometers for measuring shortwave solar irradiance. The data quality of the measurements from these radiometers requires accurate and regular recalibration traceable to the World Radiometric Reference, the international standard of solar radiation measurement. Understanding the total atmospheric energy balance requires the measurement of longwave (thermal) radiation in addition to monitoring the shortwave (solar) portion of the energy spectrum.

Purpose

The RCF provides shortwave radiometer calibrations traceable to the World Radiometric Reference. Electrically self-calibrating, absolute cavity radiometers are used to calibrate pyrheliometers and pyranometers for measuring the direct normal (or "Beam") and total hemispheric (or "Global") shortwave irradiances respectively. The calibration of longwave radiometers are based on exposures to temperature-controlled blackbodies and outdoor comparisons with standard pyrgeometers.

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 Radiometer Calibration Facility is located at the ARM Program's Central Facility at the Southern Great Plains site in Oklahoma.

The ARM Pyrgeometer Blackbody Calibration System was installed at the RCF in April 2002. The new system provides pyrgeometer calibrations consistent with the WMO's Baseline Surface Radiation Network (BSRN) calibration protocol. This will complement the BORCAL procedure for calibrating the broadband shortwave radiometers.

4. Near-Real-Time Data Plots

This section is not applicable to this instrument.

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

During shortwave radiometer calibration periods under clear-sky conditions, the following solar irradiance components are measured on a 30-second interval:

Direct normal ("beam") solar irradiance	(Watts/square meter)
Diffuse horizontal ("sky") solar irradiance	(Watts/square meter)
Radiometer body temperature	(Degrees Celcius)
Pyrgeometer dome temperature	(Degrees Celcius)
Air temperature near calibration tables	(Degrees Celcius)
Relative Humidity near calibration tables	(Percent)

5.1.1.1 Definition of Uncertainty

This section is not applicable to this instrument.

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

This section is not applicable to this instrument.

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

None.

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 section is not applicable to this instrument.

7.1.2 System Configuration and Measurement Methods

This section is not applicable to this instrument.

7.1.3 Specifications

This section is not applicable to this instrument.

7.2 Theory of Operation

Shortwave radiometer calibrations are accomplished using the Summation Technique.

7.3 Calibration

7.3.1 Theory

Certain standards are used frequently to calibrate radiometers deployed in continuous monitoring stations. The World Radiometric Reference (WRR) is the internationally recognized standard for solar (shortwave) irradiance measurement. A group of seven self-calibrating absolute cavity radiometers form its basis. Reference standard radiometers from around the world are compared every five years to the WRR at the World Radiation Center in Switzerland. By participating in these comparisons, the ARM Program Reference Standard Radiometer has direct traceability to the WRR. Annually, this reference standard is compared with other cavity radiometers used at the Department laboratories, the National Oceanic and Atmospheric Administration (NOAA), and private industry to transfer the calibration to so-called working standards.

Instrument calibration is the first step in proper data quality control. The RCF is designed to simultaneously calibrate up to 100 radiometers in outdoor conditions similar to those the field instruments

would experience in routine monitoring. Instruments calibrated at the site include 1) pyrheliometers, which are used to measure direct (beam) solar irradiance; 2) pyranometers, which have a hemispheric (fish-eye) field of view and are designed to measure the total direct and diffuse (sky) irradiance on a flat surface; and 3) pyrgeometers, which are similar to pyranometers, but have an outer blocking filter to eliminate the high energy solar irradiance and measure only the longwave, thermal (or infrared) radiation from the atmosphere.

Pyrgeometers are calibrated in special, temperature-controlled blackbody chambers. In the fall of 1999, the ARM Program hosted the First International Pyrgeometer and Absolute Scanning Radiometer Comparison (IPASRC-1). This initiative of the World Meteorological Organization Global Climate Research Program's Baseline Surface Radiation Network community used side-by-side nighttime comparisons at the RCF to calibrate 15 pyrgeometers. Complex energy exchanges between the sun and the earth's ocean, land, and atmosphere provide a balance that makes up our climate. Accurate radiation measurements are essential for improving our understanding of this balance.

7.3.2 Procedures

This section is not applicable to this instrument.

7.3.3 History

This section is not applicable to this instrument.

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

This section is not applicable to this instrument.

7.4.4 Additional Documentation

This section is not applicable to this instrument.

7.5 Glossary

See the ARM Glossary.

7.6 Acronyms

AHF: ?
BORCAL: broadband outdoor radiometer calibration
RCC: radiometer calibration and characterization
NIP: normal incidence pyrheliometer
PIR: precision infrared radiometer
PSP: precision spectral pyranometer

Also see the ARM Acronyms and Abbreviations.

7.7 Citable References

None.