ARM TR-039

Absolute Solar Transmittance Interferometer (ASTI) Handbook

January 2005

C. Flynn

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

Contents

1. General Overview

The absolute solar transmittance interferometer (ASTI) provides calibrated spectra of the solar irradiance at the surface of the earth over a wavelength region from 1 to 5 microns at a resolution of 2 wavenumbers. The system consists of a BOMEM MB-120 interferometer equipped with a CaF2 beamsplitter and an InSb detector. The interferometer is coupled with a scanning mirror and automated solar-tracking system permitting collection of relative solar irradiance spectra throughout the day. Periodic calibration against a National Institute of Standards and Technology (NIST) standard lamp source yields absolute solar irradiance at the surface of the earth.

2. Contacts

2.1 Mentor

Connor Flynn
Pacific Northwest National Laboratory
P.O. Box 999
Richland, WA 99352
Phone: 509-375-2041
Fax: 509-375-4545
connor.flynn@pnl.gov

2.2 Instrument Developer

University of Denver
Department of Physics and Astronomy
Dr. Frank Murcray, Chairman
2112 Wesley Avenue
Denver, CO 80208
Phone: (303) 871-2238
murcray@ram.phys.du.edu

Primary Contacts:
Art Dybdahl
Phone: (303) 871-3389
adybdahl@du.edu

Joe Landry
Phone: (303) 871-4351
jland@fox.phys.du.edu

3. Deployment Locations and History

Updated 5/15/00:

The ASTI is used during intensive operational periods (IOPs) and is not run routinely. However, there is a permanent location at the Southern Great Plains (SGP) to host this instrument while it is on location. This is a concrete pad with power and network connections located within 50 yards of the central cluster, permitting an unobstructed view within 10° of both east and west horizons.

Data available from the Archive:

1997 - June 24, 25, 27
1998 - August 6, 7, 9, 15-24, 27, September 15, 17, 30
1999 - March 3, 20, 21

4. Near-Real-Time Data Plots

This section is not applicable to this instrument.

5. Data Description and Examples

Data available from the ARM Archive:

1997 - June 24, 25, 27
1998 - August 6, 7, 9, 15-24, 27, September 15, 17, 30
1999 - March 3, 20, 21

5.1 Data File Contents

5.1.1 Primary Variables and Expected Uncertainty

Solar irradiance spectra are measured in milliwatts/square meter*wavenumber*steradian (mW/m^2*n*sr) from wavelengths of 1 to 5 microns.

Integrated column amounts of O_3, N_2O, and other trace molecules are derived from data streams.

5.1.1.1 Definition of Uncertainty

Determination of wavenumbers: What uncertainty inherent?
Absolute calibration of irradiance: Uncertainty from NIST lamps of 3-4 percent over range.
Detector non-linearity?
Uncertainty in column retrievals?

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

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 the Atmospheric Radiation Measurement (ARM) Program's data quality analysts, instrument mentors, and site scientists to monitor and diagnose data quality.

6.2 Data Reviews by Instrument Mentor

- **QC frequency:** Not specified; automatic after each data integration interval is planned
- **QC delay:** Not specified
- **QC type:** Comparison to similar measurements
- **Inputs:** Raw data files, and SORTI data
- **Outputs:** Not specified
- **Reference:** N/A

Automated data quality products have not yet been implemented. for the ASTI and the solar radiance transmission interferometer (SORTI). Initial work has been carried out that is similar to that done for the SORTI; see the entry for the SORTI. The ASTI is used primarily during IOPs and is not run routinely. Instrument mentor Connor Flynn is working with Tim Shippert to ensure that the ingested files be configured for efficient use in a shortwave line-by-line Quality Measurement Experiment (LBL QME). A case study with the ingested data should be carried out to test procedures and further evaluate ASTI performance.

6.3 Data Assessments by Site Scientist/Data Quality (DQ) Office

All Data Quality 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 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 to fill unmet measurement needs, but 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 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

BOMEM Model MB 120 interferometer NIST calibration lamp(s):

Optical Interference Filters:

Computer type:

Operating system:

Quadrant Sensor:

Solar Tracker:

Overall dimensions:

7.1.2 System Configuration and Measurement Methods

This section is not applicable to this instrument.

7.1.3 Specifications

Wavelength range: 1 to 5 microns (10000 to 2000 wavenumber).

Resolution:

Accuracy:

Precision:

Decimal resolution:

Height: Views from bottom to top of atmosphere on clear-sky days.

7.2 Theory of Operation

Theory of operation of interferometer, introduction to Fourier Transform, and discrete Fourier Transform.

7.3 Calibration

7.3.1 Theory

Direct calibration against standard lamps.

Caveats:

1. Lamps have a finite lifetime, and must be used carefully and precisely to get stated performance.
2. Both lamps and solar spectra have fine structure at this resolution.

7.3.2 Procedures

This section is not applicable to this instrument.

7.3.3 History

Repeated on a daily basis during use. Calibration files are found with relative spectra from the same day.

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

Irradiance - Radiative flux per square meter (W/m^2)

Radiance - Radiative flux per steradian (W/sr)

Also see the ARM Glossary.

7.6 Acronyms

ASTI: Absolute Solar Transmittance Interferometer
IOP intensive operational period
LBL line-by-line
NIST National Institute of Standards and Technology
QC quality control
QME Quality Measurement Experiment
SGP Southern Great Plains
SORTI solar radiance transmission interferometer
VAP value-added product

Also see the ARM Acronyms and Abbreviations.

7.7 Citable References

This section is not applicable to this instrument.