CLARREO PATHFINDER SOLAR DIFFUSER CALIBRATION PROGRESS

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ABSTRACT

Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder (CPF) mission's Hyperspectral Imager for Climate Science (HySICS) instrument's transmissive flight diffuser calibration is presented. The absolute Bidirectional Transmittance Distribution Function (BTDF) measurement of the transmissive diffuser is needed to calculate the instrument's absolute efficiency. Along with a known solar irradiance source such as Total Solar Irradiance Sensor (TSIS), it can provide an absolute irradiance measurement path on orbit, with NIST traceability. This provides an additional path for CPF to cross compare with other on orbit sensors' measurement such as Visible-Infrared Imaging Radiometer Suite (VIIRS), Clouds and the Earth's Radiant Energy System (CERES). The flight diffuser was calibrated at NASA's Goddard Space Flight Center (GSFC) using the Facility's Optical Scatterometer.

Index Terms— Bidirectional Transmittance Distribution Function, BTDF, Diffuser Calibration Targets, Remote Sensing, HySICS, CLARREO Pathfinder

1. INTRODUCTION

CLARREO Pathfinder (CPF) uses a Polytetrafluoroethylene (PTFE) 100microns thick foil based transmissive diffuser [1] for instrument flat fielding characterization on orbit. The diffuser was calibrated using NASA's GSFC Scatterometer, which performs both in-plane and out-of-plane BTDF measurements. The spectral range could be from 250nm up to 2.4microns. Different sources such as fixed wavelength and tunable coherent sources, a monochromator, or a supercontinuum laser can be integrated into the measurement setup. The detectors are extended Si, InGaAs or extended InGaAs based photodiodes depending on the spectral range.

Figure 1: CAD model of calibration item in its mount

The diffuser's approximate diameter is 75mm, Figure 1. A more detailed description of the scatterometer capabilities is available in [2], [3]. The calibration item was mounted on the scatterometer sample stage shown on Figure 2.

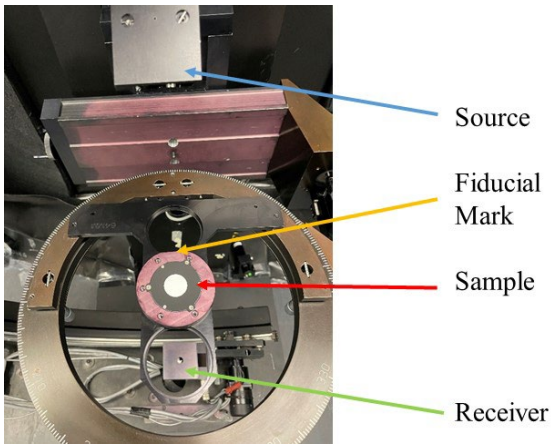

Figure 2: Calibration item on the sample stage

The fiducial mark was aligned with the Scatterometer Y axis. The angular convention is shown in Figure 3.

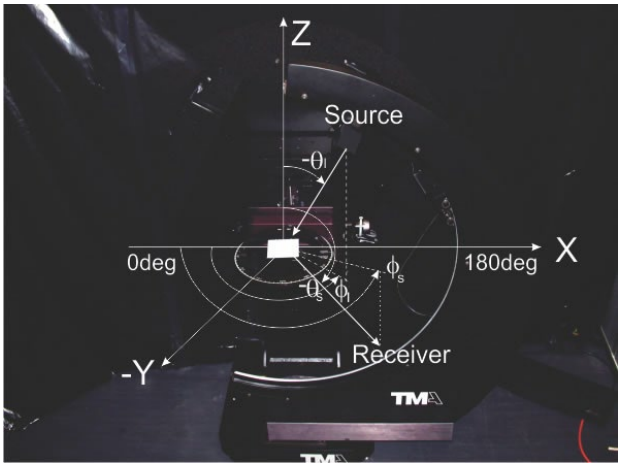

Figure 3. The scatterometer angular configuration

The sampling aperture location on the calibration item surface is at the center of the calibration item. The incident beam diameter on the calibration item surface was 14 mm at normal incidence. The spectral bandwidth was 12 nm. Different sources were used depending on the spectral range. Laser driven light source EQ-99 coupled to a monochromator was used at 400nm, 500nm and 900nm. The detector was an ultraviolet enhanced silicon photodiode. Coherent sources were used at 1500nm and 1600nm. The detector was an enhanced InGaAs photodiode. Measurements were made for polarizations of the illumination beam both parallel and perpendicular to the plane of incidence. The BTDF, for each polarization, was calculated by dividing the net signal from the transmitted radiant flux by the incident flux and the projected solid angle from the calibration item to the limiting aperture. The values for both polarizations were then averaged to yield the BTDF for unpolarized incident radiant flux, and the values from the repeat measurements were averaged. The BTDF was measured following the measurement matrix.

2. CALIBRATION GEOMETRY

We need single diagonal slice in the BTDF curve where the incidence and output angles are the same as presented in Figure 4. The angles are measured from the normal to the calibration item fixed horizontally on the sample stage, as shown in Figure 3. The 0deg is at the top on the Figure 3, whereas the 180deg is at the bottom. The diffuser calibration was performed at

- Wavelengths of 400, 500, 900, 1500, 1600nm
- Full measurement range is 6 degrees from diffuser normal, with 0.5 degree step: 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6deg
- Viewing (detector) angles: 174, 174.5, 175, 175.5, 176, 176.5, 177, 177.5, 178, 178.5, 179, 179.5, 180deg

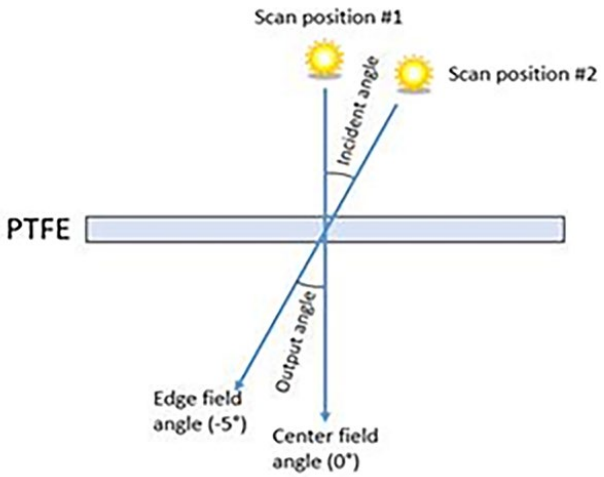

Figure 4. Calibration Geometry

3. NIST TRACEABILITY VALIDATION

Traceability of GSFC optical scatter measurements (i.e. BRDF and BTDF) to NIST is established and maintained using sets of diffuse reflective Spectralon lab standards for BRDF and sets of diffuse transmissive standards (Spectralon foil) for BTDF measured by NIST before all measurements by GSFC. Identical scatterometer hardware (i.e. optics, goniometer stages, electronics, source, detector, pre-amp, lock-in, and computer) and data acquisition and analysis software are used in all BRDF and BTDF measurements. The only difference in BTDF and BRDF measurements is the position of the scatterometer detector in a sample's transmissive scattering hemisphere below the sample stage versus a sample's reflective scattering hemisphere above the sample stage.

The GSFC Diffuser Calibration Facility has participated in numerous BRDF measurement comparisons with NIST and other industry and university-based metrology laboratories. The GSFC Diffuser Calibration Facility has completed BTDF measurements comparison with NIST before CPF diffuser calibration validating this way the facility scatterometer performed BTDF calibration measurements. The detailed validation procedure is described in [3].

4. RESULTS

The results of the diffuser calibration are presented in Figure 5.a, b, c, d for incident angles of 0, 2, 4, 6deg respectively. The scatter angles are from 174 to 180deg with increments of 0.5deg.

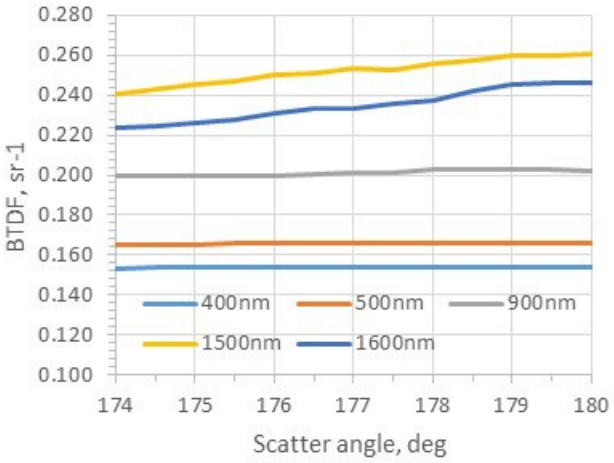

Figure 5.a. BTDF at AOI=0deg

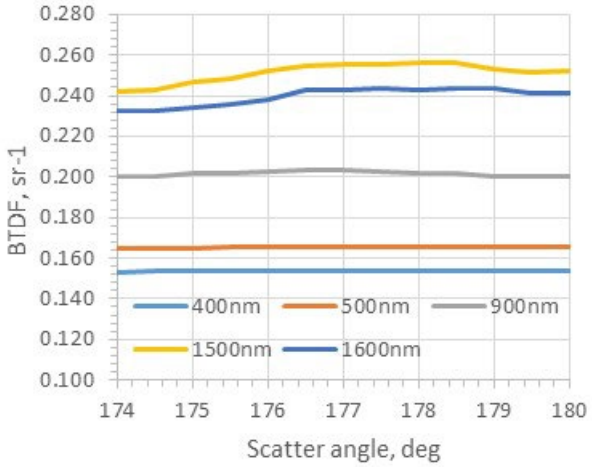

Figure 5.b. BTDF at AOI=2deg.

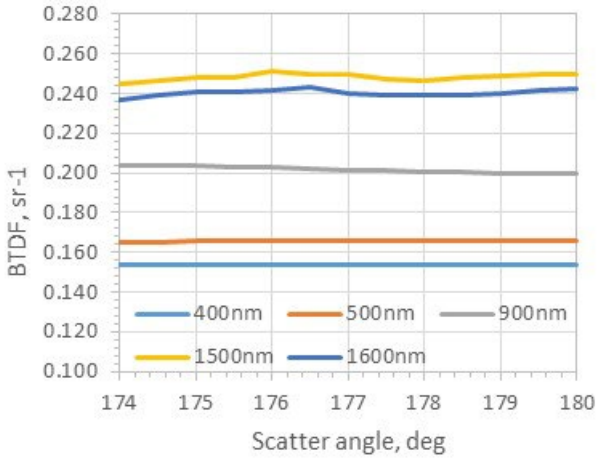

Figure 5.c. BTDF at AOI=4deg

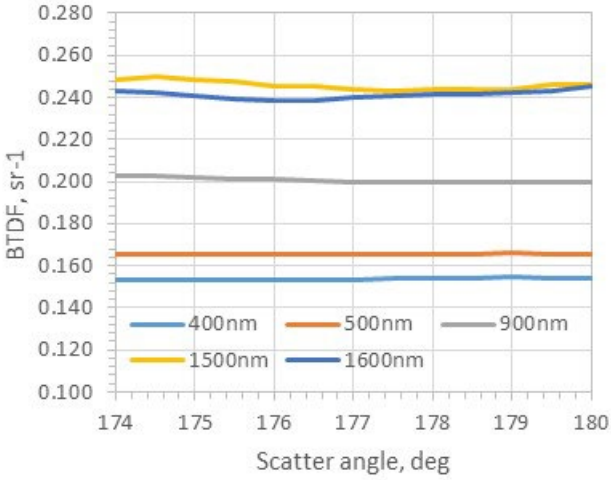

Figure 5.d. BTDF at AOI=6deg

4. REFERENCES

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