Cal/Val Plan and Field Campaign Preparation

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Outline

- J1-VIIRS Cal/Val Plan
- J1-VIIRS Field Campaign Preparation

J1 VIIRS Cal/Val Plan Status

- **Cal/Val plan (Version 1.0) prepared by STAR**
- **Under review by external members**

Joint Polar Satellite System (JPSS)
VIIRS Calibration/Validation Plan

Version 1.0

Prepared by
The VIIRS SDR Science Team
(POC: Mitchell A. Schull)
NOAA/Center for Satellite Applications and Research

Date: June 19, 2015

Section 3 of VIIRS Cal/Val Plan

- ***3.1. J1 VIIRS Pre-launch Characterization***
  - Summarize major test results and their analysis from Performance Verification Reports (PVRs)
  - *Band-to-Band Registration (BBR)*
  - *Crosstalk*
  - *Emissive Band Calibration*
  - *Near Field Response (NFR)*
  - *Pointing*
  - *Polarization Sensitivity*
  - *Radiometric Sensitivity Dynamic Range*
  - *Reflective Band Radiometric Calibration*
  - *Day/Night Band (DNB) Radiometric Calibration*
  - *Relative Spectral Response*
  - *Spatial*
  - *Straylight*

3.2. Post-launch Tests (PLT) (Being filled)

Test	Test Description	Objective
VIIRS Activation	Includes initial power on, possible memory loads/patches/dumps including DNB Table Loads. When Operational Power is applied by the S/C, Section A of the VIIRS internal power supply becomes active, which results in power being applied to the SBC with associated telemetry and communications electronics becoming active. Upon receipt of power, the FSW automatically performs the BIT routines and reports their successful completion via the housekeeping telemetry packet and VIIRS is then placed in ACT mode	To activate/turn-on VIIRS for satellite operations and perform memory loads to adjust DNB Science Data output. DNB Tables loads may include test tables (for calibration or diagnostics), modifications to adjust Science Data output, command sequence updates (SCT) and contingency fixes (tables can be uploaded in Safe mode)
VIIRS Trending	Monitor Power, Instrument Temperatures, SC Temperatures for VIIRS, BB, Cryo-Performance, Motor Current, Motor temperatures, Scan Rate/Control, Time Sync	To trend telemetry mnemonics for the performance of the instrument and quality of science data.
VIIRS Dynamic Range and Linearity Verification	A "Fast Find," to restore the FPA offsets, must be performed each time the user changes the integration times. Collect up to one orbit of data with each of the integration times. Repeat for all integration times desired then change the integration times back to the nominal on-orbit values	To characterize the Imaging Frame Sync (ISF) or Radiometric Frame Sync (RSF).
DNB Offset Determination	DNB Offsets are comprised of Detector Dark Current and Electronic/Clock Offsets	"Provide data necessary to periodically update the DNB Offsets Correction tables applied to the Earthview data as part of the VIIRS on-board processing, and should be run frequently during LEO&A to better understand the frequency of the DNB Offset Variability. Eventually, the frequency will be reduced to once every few months when confidence and understanding in the Offset Stability is established. NOTE: "Composite" Dark Current and Clock Offset data will be available no more than once a month as it should be collected over the ocean and with no moon."
Solar Diffuser Calibration	Initial measurements of the Solar Diffuser (SD) reflectance to be made with the Solar Diffuser Stability Monitor (SDSM) as soon as possible on orbit	"Provide a relative SDSM measurement of reflectance and the first on-orbit measurements. The SDSM measures three items during each calibration sequence: the radiance of the Sun as attenuated by the SD Attenuation Screen and as reflected by the SD, a direct measurement of the Sun's radiance as measured through the SDSM Solar Attenuation Screen, and a no irradiance dark view. These measurements are made sequentially as the SDSM's optical input is directed to each of these three sources by a steering mirror, but simultaneously in eight separate spectral channels."

…… In collaboration with NASA Flight Project

3.3 VIIRS Cal/Val Post-launch Tasks

- *Update from 56 tasks for SNPP-VIIRS to form 72 tasks for J1-VIIRS*
- *Functional Performance and Format (FPF) Evaluation*
- *Calibration System Evaluation (CSE)*
- *Image Quality Evaluation (IMG)*
- *Radiometric Evaluation (RAD)*
- *Geolocation/Geometric Evaluation (GEO)*
- *Performance and Telemetry Trending (PTT)*
- Waiver verification/validation (WAV) (added for J1)

65	WAV1	J1 DNB aggregation mode verification	To verify that aggregation option 21is implemented and processed correctly.
66	WAV2	J1 DNB geolocation vs. aggregation zone	To verify that the geolocation is processed correctly by aggregation zone to ensure the modified geo code software is functioning properly
67	WAV3	J1 DNB aggregation mode change test	Change the J1 DNB aggregation mode from Op21 to Op21/26 to collect data and perform analysis for optimizing the aggregation
68	WAV4	J1 DNB straylight assessment and correction LUT development	To assess the straylight and temporal variability to develop correction LUTs.
69	WAV5	J1 DNB radiometric/geolocation monitoring using point sources	To evaluate the radiometric and geolocation stability, as well as band to band coregistration of DNB using point sources such as bridge lights, oil platforms, flares.
70	WAV6	J1 VIIRS saturation monitoring	To characterize the saturation in several bands including M8, M7, and others. Develop a solution if possible.
71	WAV7	J1 VIIRS SWIR nonlinearity characterization	To characterize SWIR nonlinearity and develop a solution if possible.
72	WAV8	J1 VIIRS polarization characterization	To characterize polarization of the VIS bands by comparing observations with data from other sources (other satellites, ground/aircraft measurements, models)

3.4 Calibration Tools

- **NOAA-STAR (STAR), NASA, Raytheon (RTN), The Aerospace Corp. and others**
- **Currently have 38 tools and being added**
  - *J1-VIIRS Data Extraction Tools*
  - *Integrated Cal/Val System (ICVS)*
  - *J1-VIIRS Orbital Prediction Toolkit*
  - *Tool kits for Radiometric Calibration Analysis and Testing of J1-VIIRS*
  - *Offline F/H Factor Analysis, Prediction and Validation Tool*
  - *SNO Based Inter-satellite Calibration Tool*
  - *J1-VIIRS SWIR Band (1.61 μm) Inter-calibration Tool*
  - *Validation Site Time Series Monitoring Tool*
  - *Radiative Transfer Modeling tool for Post-launch Cal/Val of J1-VIIRS*
  - *Dual Gain Anomaly (DGA) Analysis Tool*
  - *Offline DNB Calibration/Validation Tools*
  - *DNB On-board Offset LUTs Verification Tool*
  - *DNB Stray Light Correction LUT Generation and Validation Tool*
  - *Tool for Inter-comparison of CrIS-VIIRS Geolocation*
  - *VIIRS DNB Geolocation Validation Tool*
  - *DNB Aggregation Mode Change Analysis Tool*
  - *…….*

4. METHODOLOGY OF CAL/VAL TASKS

- **Methodology for 72 tasks**

Example

4.9 Onboard Calibrator Black Body (OBCBB) Temperature Uniformity

Task Objectives: To verify that telemetered values of the six thermistors in the OBCBB are within specified bounds.

Prerequisites and Conditions: SC Mode: Nominal, VIIRS Mode: Operational

Methodology: This recurrent task requires that the thermistors be monitored over the life of the instrument. The thermistors values are obtained from either the engineering packet or the SDR Calibration Intermediate Product (IP). Time series of the values of each thermistors, the mean of the six thermistors, and the standard deviation of the six thermistors are generated to monitor changes in thermistor behavior. The SDR algorithm must be updated to compensate for changes if any of the thermistors should exhibit "out-of-family" behavior.

Necessary Tools: Telemetry Probes-Encoder, Temperatures, SDSM

Products: Time series of values, mean and standard deviation of 6 OBCBB thermistors.

5. CAL/VAL CHALLENGES AND AREAS OF CONCERN

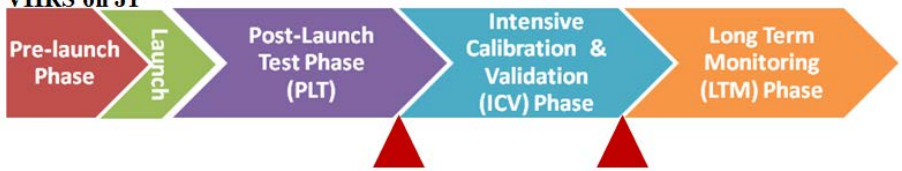
- DNB non-linearity
- SWIR and MWIR non-linearity
- DNB image artifacts
- DNB Straylight
- Stronger polarization sensitivity effects in bands M1-M4
- Multiple uncertainties in the solar diffuser stability monitoring
- Saturation and roll-over in radiometric response in several bands
- Non-operational or noisy detectors
- Band-to-band thermal dependence

6. SCHEDULES AND MILESTONES

6.1 Cal/Val Maturity Timeline

J1

VIIRS on J1



JPSS SDR Product Maturity Levels
Beta • Early release product. • Initial calibration applied. • Minimally validated and may still contain significant errors (rapid changes can be expected. Version changes will not be identified as errors are corrected as on-orbit baseline is not established) • Available to allow users to gain familiarity with data formats and parameters • Product is not appropriate as the basis for quantitative scientific publications studies and applications
Provisional • Product quality are nominal but may not be optimal • Incremental product improvements are still occurring as calibration parameters are adjusted with sensor on-orbit characterization (versions will be tracked) • General research community is encouraged to participate in the QA and validation of the product, but need to be aware that product validation and QA are ongoing • Users are urged to contact JPSS Cal/Val Team representatives prior to use of the data
Validated/Calibrated • On-orbit sensor performance characterized and calibration parameters adjusted accordingly • Ready for use by the Centrals and in scientific publications • There may be later improved versions • There will be strong versioning with documentation

Pre & Post-Launch Activities/Milestones

Pre-Launch Activities/Milestones

Table 4: Pre-launch Cal/Val schedule: tasks/activities, deliverables, and timeline

Year	Tasks/Activities	Deliverables
2015	• Address the Waiver Tasks described in Sections 3.1, 3.2 and 4. • Ground test data analysis and software development.	• Initial Pre-launch LUTs • Software code changes • Cal/Val documentation
2016	• Further analysis on pre-launch test data and refinement of LUTs	• Improved version of Pre-launch LUTs • Revised Cal/Val documentation • Ground and field campaign preparation

Post-Launch Activities/Milestones

Table 5: Post-lauch Cal/Val schedule: tasks/activities, deliverables, and timeline

Year, Phase	Tasks/Activities	Deliverables
2017, PLT to ICV	• Execute the Cal/Val tasks (> 60) described in Sections 3.2 and 4. • Checkout of the VIIRS instrument during normal operation mode • Adjust instrument settings • Update appropriate SDR LUTs and coefficients that optimize the sensor's performance. • Make the instrument and software properly staged for Intensive Cal/Val (ICV) activities.	Provisional SDR products
2018, ICV to LTM	• Continue with cal/val, perform intercomparisons with other instruments and in situ measurements; • Improve the calibration; establish longterm monitoring. • Validate the VIIRS products through verification and cross-comparison with external independent measurements and models. • Make refinement of the VIIRS algorithms • Provide radiances that are stable and accurate to support EDR retrievals.	Validated VIIRS SDR products

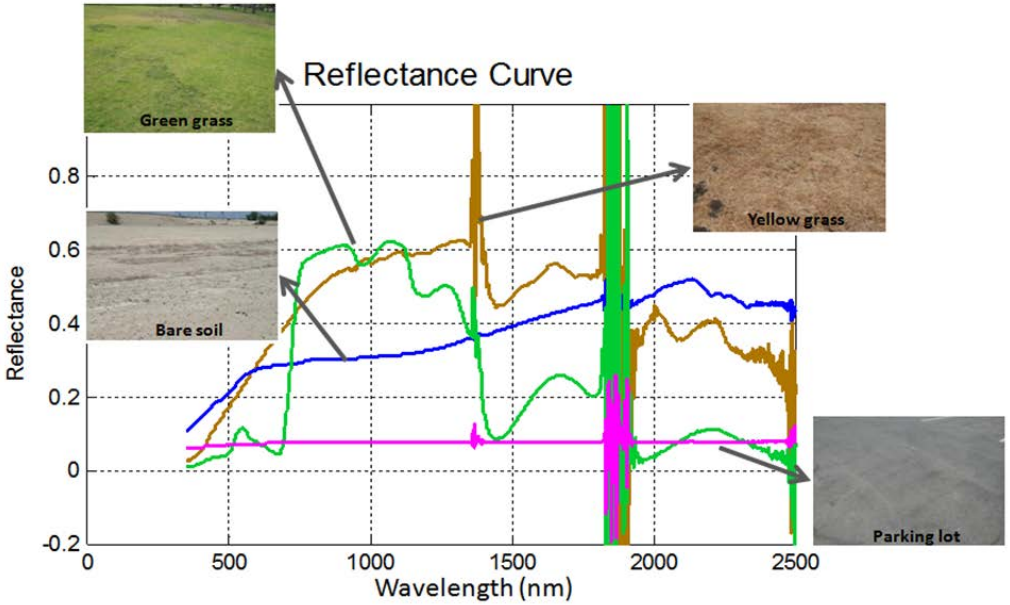
Being Developed

Field Campaign Preparation

- Ongoing preparation
- Ground and near surface measurement to support J1-VIIRS overflight field campaign
- Collaborative efforts to enhance J1 VIIRS field campaign capabilities with Unmanned Aircraft System (UAS)
  - Collaborate with GOES-R CWG, NOAA UAS program and University of Maryland
  - Enable large area goniometric surface measurements
- Address J1 VIIRS polarization sensitivity impacts with ground-based polarimeter
- Collaborate with NIST to characterize solar diffuser degradation through NIST-NOAA NCC collaboration

Ground and Near-surface measurements in support of J1-VIIRS Cal/Val

- Leverage past experience of ground and near surface field measurements to support J1-VIIRS Cal/Val
  - Portable ASD spectrometer
  - Sun photometer
  - Kinetic Temperature Measurement
  - Surface Atmospheric State
  - Handheld Context Devices
- Sonoran desert, Salton Sea



Collaborative Efforts to Enhance J1 VIIRS Field Campaign Capabilities with Unmanned Aircraft System (UAS)

- Collaborate with the **NOAA UAS Program**
- Leverage support from **GOES-R CWG** through "Near Surface UAS Feasibility Demonstration Study" project - NOAA Cooperative Institute Partnership with the University of Maryland (UMD)
- Small UASs combined with compact sensors provide an unmatched surface observation capability:
  - Collect high quality goniometric observations of surface targets
  - Large geospatial coverage comparable to satellite observations

Rotary Systems

Objective:

Collect high quality goniometric observations of the Earth's surface (launched & recovered from an ocean vessel):
» L1b, Radiation Budget, Aerosol, LST, SST

Fixed-Wing Systems

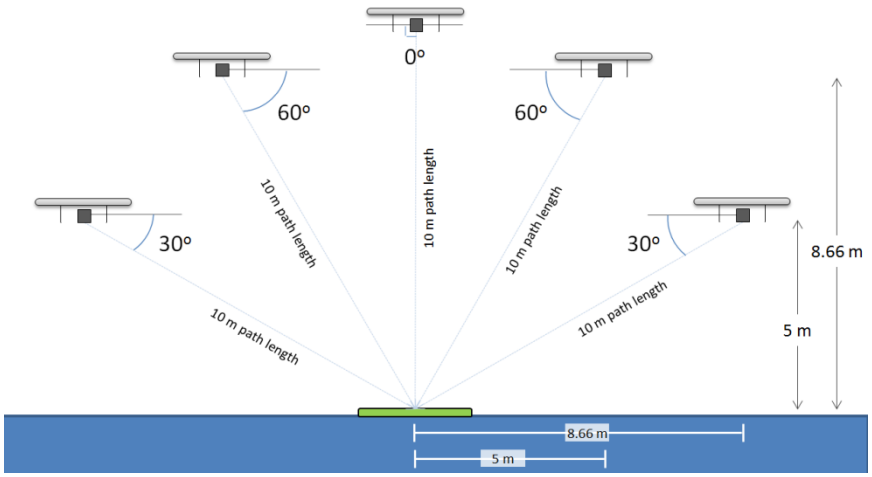
Objective:

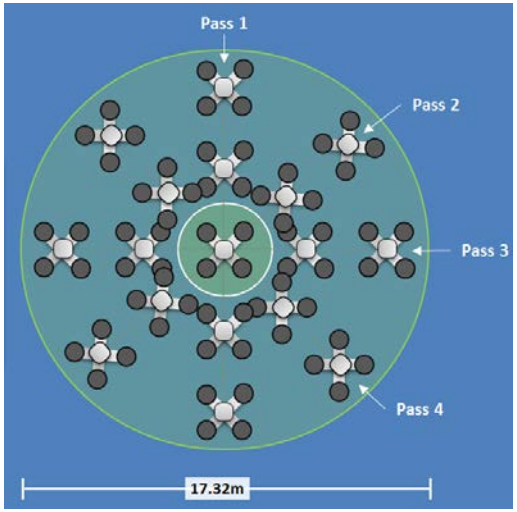
Collect high quality large area observations of the Earth's surface:
» L1b, LST, SST

hyperspectral observations (0.4 – 2.5 µm) and **(broadband IR – 8-14 µm/potentially filtered to match the VIIRS channels)**

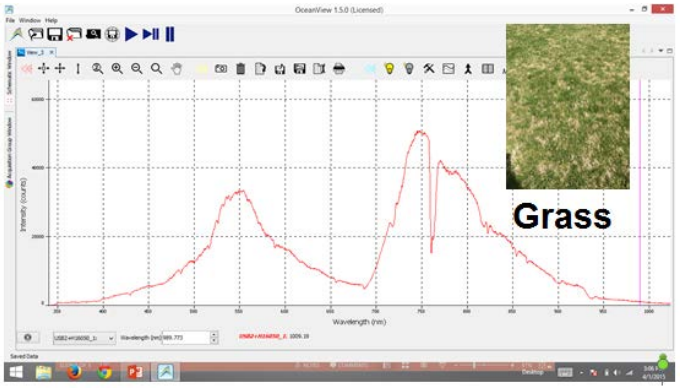
Acknowledgement： Frank Padula of GOES-R

Initial Efforts of UAS Field Campaign Design and Development



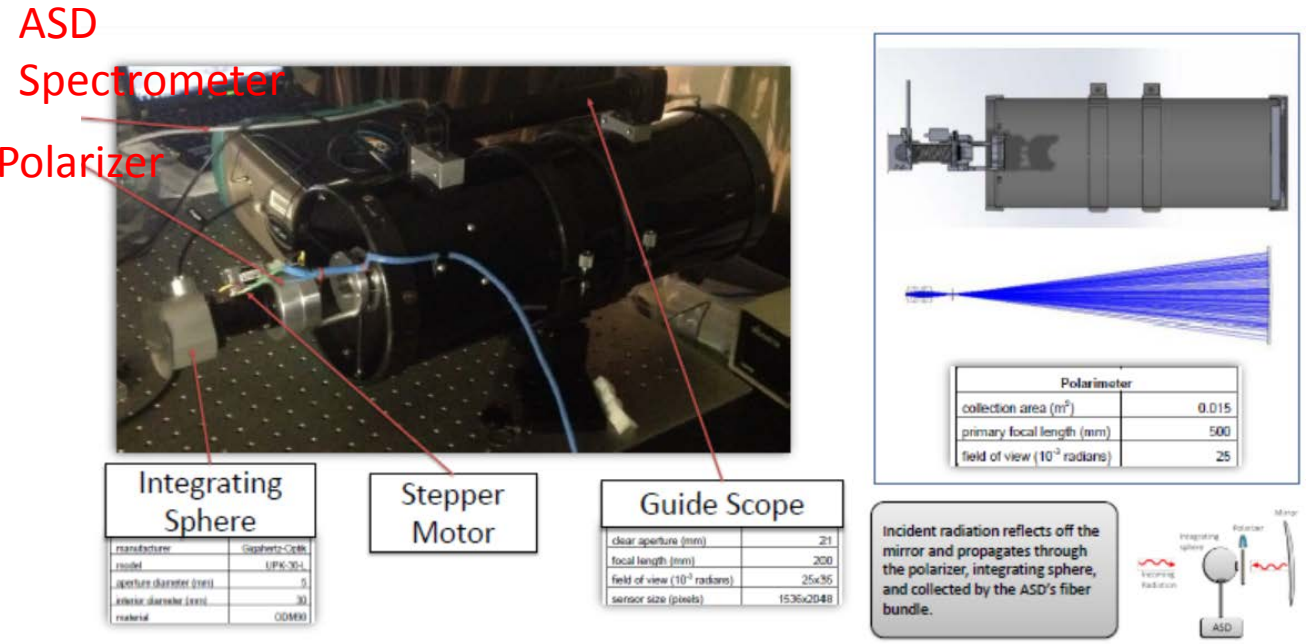


On going integration of modular spectrometer at University of Maryland

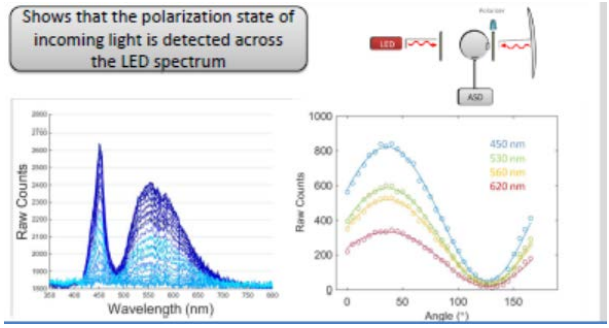


Address J1 VIIRS Polarization Sensitivity Impacts

- Prelaunch polarization characterization indicates that the polarization sensitivity in bands M1-M4 of the J1 VIIRS is higher than the performance specifications.
- This sensitivity influences retrievals of aerosol and ocean color products.
- Develop a ground-based spectroradiometer for polarization measurements by combining an off-the-shelf spectroradiometer with an enhanced front-end design to measure varying linear polarization states



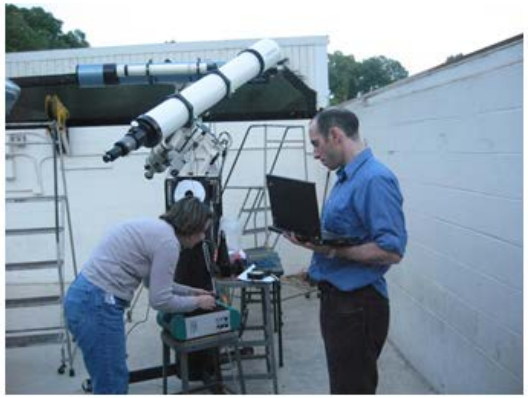
Lab Characterization

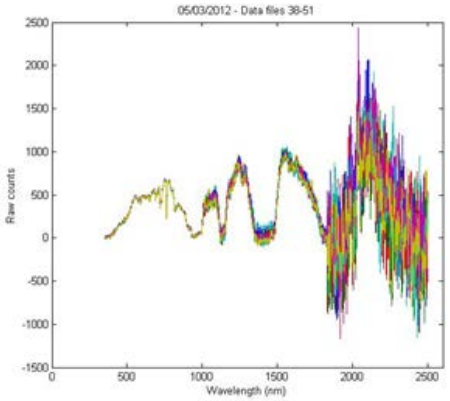


Courtesy: Aaron Pearlman, Steven Lorentz

Spectral and Polarization Measurement with Moon

- Collaborate with UMD Astronomical Observatory
- Performed initial spectral and polarization measurement with Moon





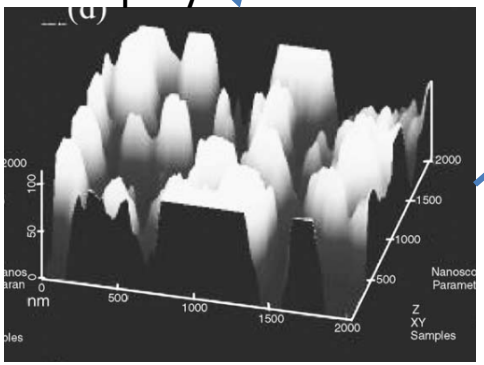
Spectral Polarimeter:
Initial Lunar Measurements

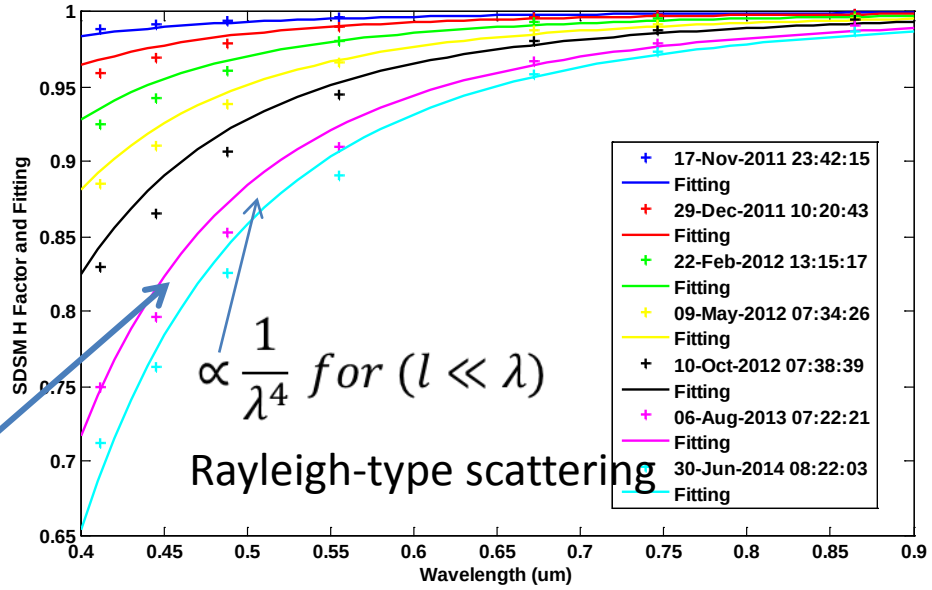
Characterization of Solar Diffuser Spectral Degradation

Solar Diffuser

UV
Protons
O^+

Surface roughness on Fluoropolymers due to UV





$$\propto \frac{1}{\lambda^4} \; for \; (l \ll \lambda)$$

Rayleigh-type scattering

NPP VIIRS SDSM Measurement of Solar Diffuser Spectral Degradation

- Radiometric calibration for RSB of J1 VIIRS relies on onboard solar diffuser
- Laboratory experiment to investigate spectral degradation of SD
  - Characterize UV exposure impacts on surface roughness change and spectral performance
- NIST-NOAA NCC Workshop held in July, 2015 to facilitate collaboration

Summary

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  - Cal/Val plan (Version 1.0) prepared by STAR
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- **Field Campaign Preparation**
  - Ground and near surface measurement
  - Collaborative efforts to enhance J1 VIIRS Field Campaign Capabilities with Unmanned Aircraft System (UAS)
  - Address J1 VIIRS polarization sensitivity impacts
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