GSICS VIS/NIR perspective to recommend calibration reference sensor

David Doelling

March 1, 2021

GSICS goals

- Global Space-based Inter-Calibration Sytem (GSICS) is an international collaborative effort initiated in 2005
- The goals are to monitor, improve and harmonize the quality of observations from operational weather and environmental satellites of the Global Observing System by determining best practices amongst agencies to
  - monitoring instrument performances
  - operational inter-calibration of satellite instruments
  - tying the measurements to absolute references and standards
  - recalibration of archived data.

Steps needed to obtain consistent retrievals across sensors

Instrument Calibration
- Count to radiance response
- Sensor Gain degradation
- Detector response equalization
- Scan angle dependence
- Polarization
- Straylight
- Properly characterized spectral response functions
- Out of band response
- Geolocation

Calibration team goals:
to monitor and mitigate these issues

Inter-calibration
- Radiometric scaling to a reference SITSAT
- as if the SITSAT onboard calibration system was installed on the target sensor.
- is scene independent

GSICS goals:
Intercalibrate the target sensor with a reference sensor use of invariant targets, SNOs, SBAFs

Spectral Band Adjustment
- Spectral band scaling between target and reference sensor
- is scene dependent
- as if the global mosaic is composed of exact sensor copies
- usually considered in the sensor retrievals

Retrieval team goals:
Remove spectral response function differences between two sensors so that the same retrieval algorithm can be applied to both sensors

Sensor Retrievals
- Cloud/aerosol/land use/ocean color retrievals are consistent in both space and time
- Must account for BRDF, view angle, parallax, number of channels, pixel size, etc.

Retrieval team goals:
The retrieval algorithm is robust enough to account for viewing and solar geometry, pixel resolution, etc, so that the retrieval is identical between sensors

GSICS requirements to recommend a VIS/NIR reference sensor

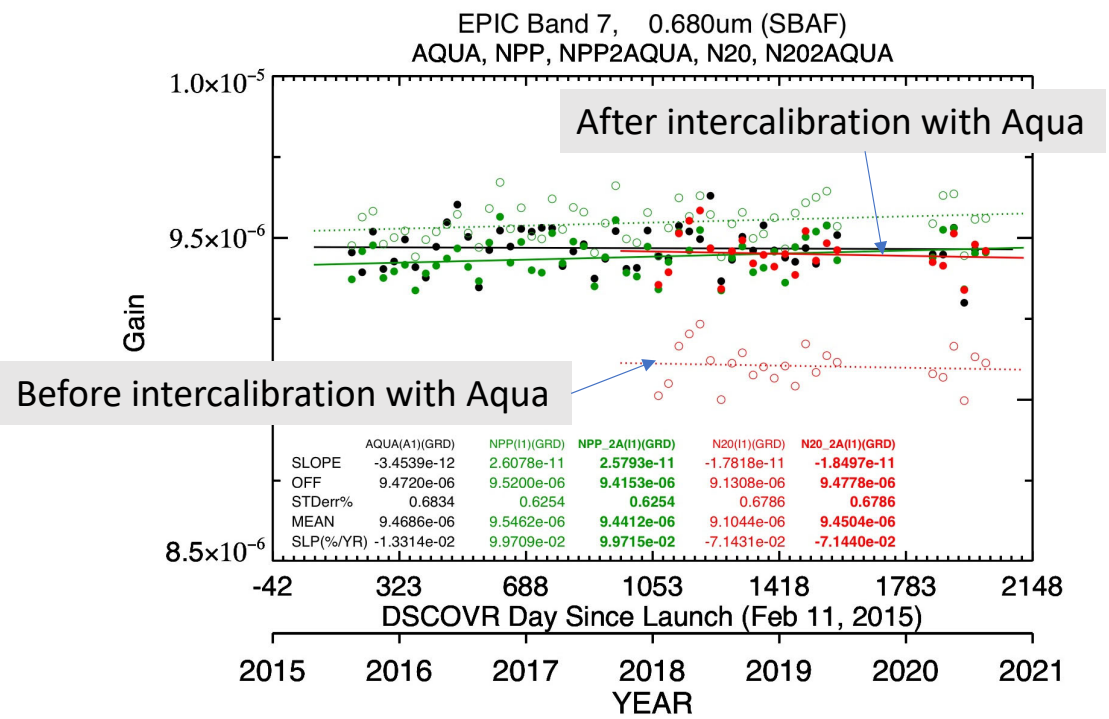
- Highest priority given to SI traceable sensor
  - CLARREO, TRUTHS
  - The sensor is onboard a precessionary satellite in order to inter-calibrate many polar orbiting sensor in various orbits
- A hyper-spectral VIS/NIR sensor in order to account for spectral response functions amongst the target sensors that are being inter-calibrated needed for consistent retrievals
  - The hyper-spectral needs to cover most of the VIS/NIR wavelengths
  - Hyper-spectral VIS/NIR sensor needs to stable over time
  - SCIAMACHY had some drawbacks (shown on next slide)
- Else a narrowband channel imager is recommended
  - Such a MODIS and VIIRS

GSICS requirements to recommend a reference sensor

- A well-funded ground processing team that is actively monitoring the onboard sensor calibration systems in space
  - Well documented prelaunch characterization and continued documentation of instrument performance
- The L1B radiance data and retrieval products are made publicly available in near real time, in an easily readable format, and archived.
- The instrument L1B processing and archive center has adequate resources to readily reprocess the data after major sensor calibration anomalies are detected and mitigated along with proper data and software version control
- In the absence of SI traceability, it is advantageous to choose a sensor that is used for climate quality cloud, aerosol, land use and ocean color retrievals because these groups are also monitoring the sensor stability
- Preference to multiple sensor missions having overlapping records within in the same polar orbit

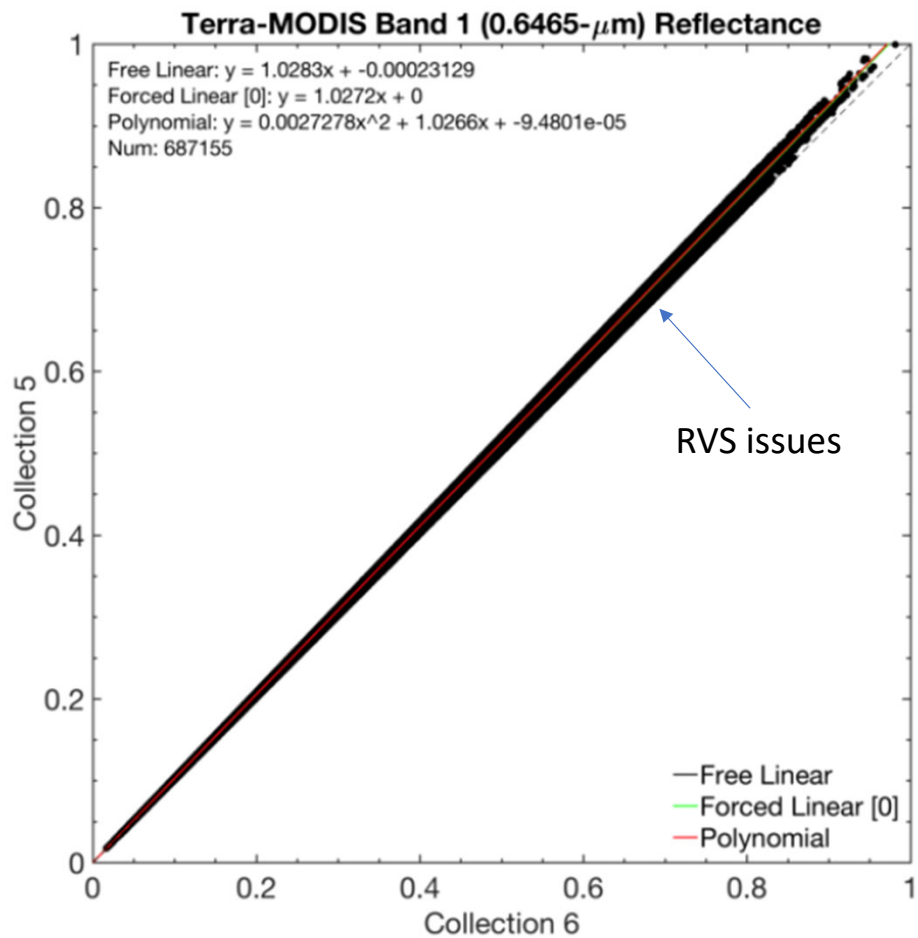
Inter-calibration of MODIS and VIIRS imagers

Use of DSCOVR EPIC imager as a comparison radiometer



- The recommended sensor have overlapping records and are in the same polar orbit
- Inter-calibrate the imagers using SNO, ray-matching, invariant targets
- Eventually tie the record to CLARREO or TRUTHs record to transfer the calibration back in time

Granule comparison between MODIS versions

- We compare the difference between collections or version by simply regressing granule pixel level reflectances
- What is the best to quantify the NOAA and NASA VIIRS reflectance differences?
  - Hopefully maintain a web site with the current NOAA and NASA N20 VIIRS calibration differences

An Example of Terra-MODIS C5 vs C6 single granule pixel reflectance comparison