Global Space-based Inter-Calibration System Research Methods and Resources

Compiled by Lawrence Flynn from presentations by GSICS participants including the GRWG Chair, Dohyeong Kim, and Vice Chairs, Tim Hewison and Scott Hu, GDWG Chair, Masaya Takahashi, GRWG Visible SG Chair, Dave Doelling, GRWG MW SG Chair, Ralph Ferraro, and GCC Deputy Director, Manik Bali

AC-VC May 1-4, 2018 NCWCP, College Park MD

Introduction

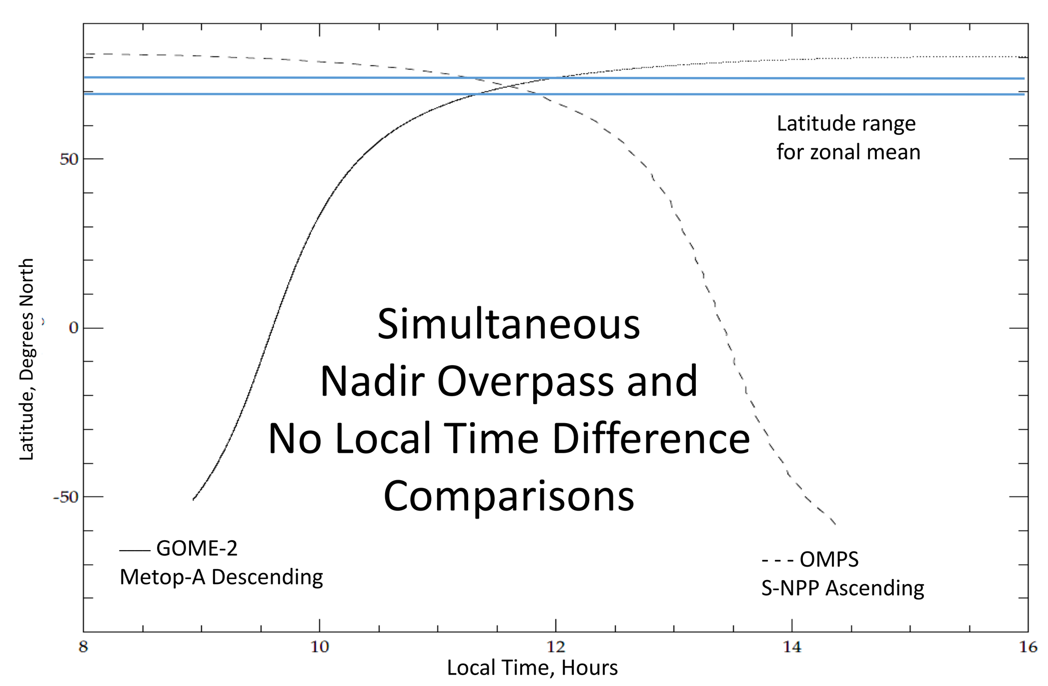
This poster presents an overview of GSICS research and development activities. It introduces some of the calibration comparisons methods, data sets and tools with examples of their use for creating GSICS products. The methods include Simultaneous Nadir Overpass (SNO) for LEO to LEO comparisons, ray matching underpass for LEO to GEO comparisons, Deep Convective Cloud statistical comparisons, Lunar models, Solar models, and Spectral Response Function tuning. Additional background information on GSICS can be found at

http://gsics.wmo.int/
https://www.star.nesdis.noaa.gov/smcd/GCC/index.php
http://gsics.atmos.umd.edu/bin/view/Development/MeetingsAndConferences

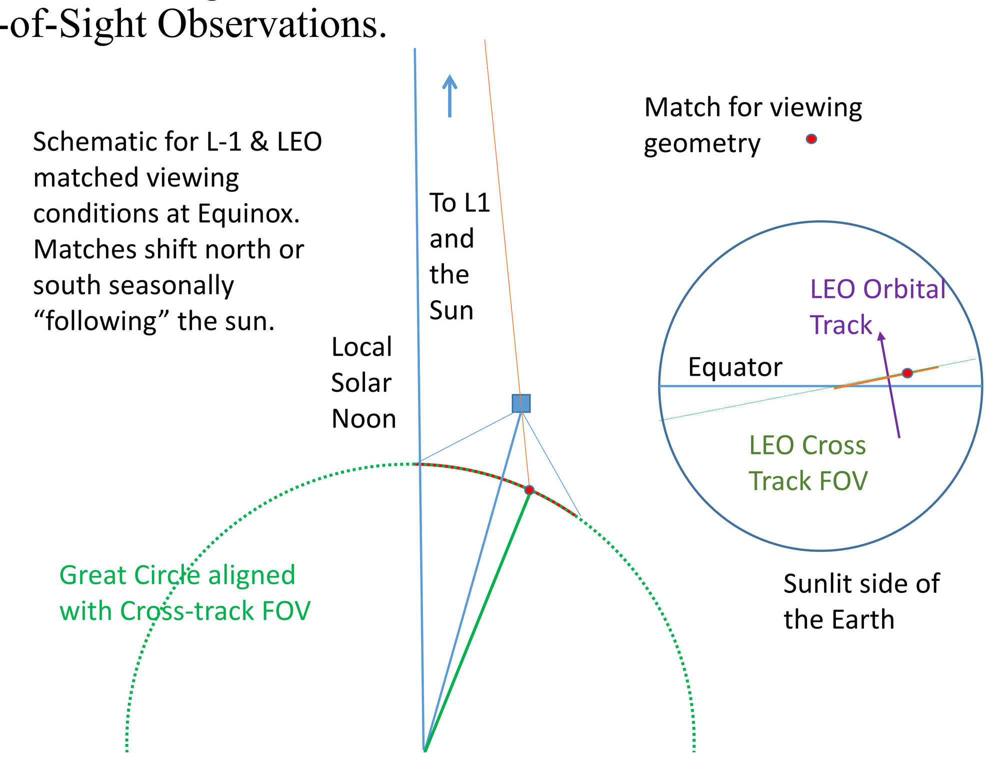
In particular, the last website has links to all of the talks presented at the recent annual research meeting held in Shanghai China from March 19th to March 23rd 2018.

Match-Up Comparisons

A variety of methods are used to obtain match-ups between measurements from instruments on different satellites. Approaches include: (1) LEO vs LEO Simultaneous Nadir Overpass (and its non-simultaneous No-Local-Time-Difference zonal means)



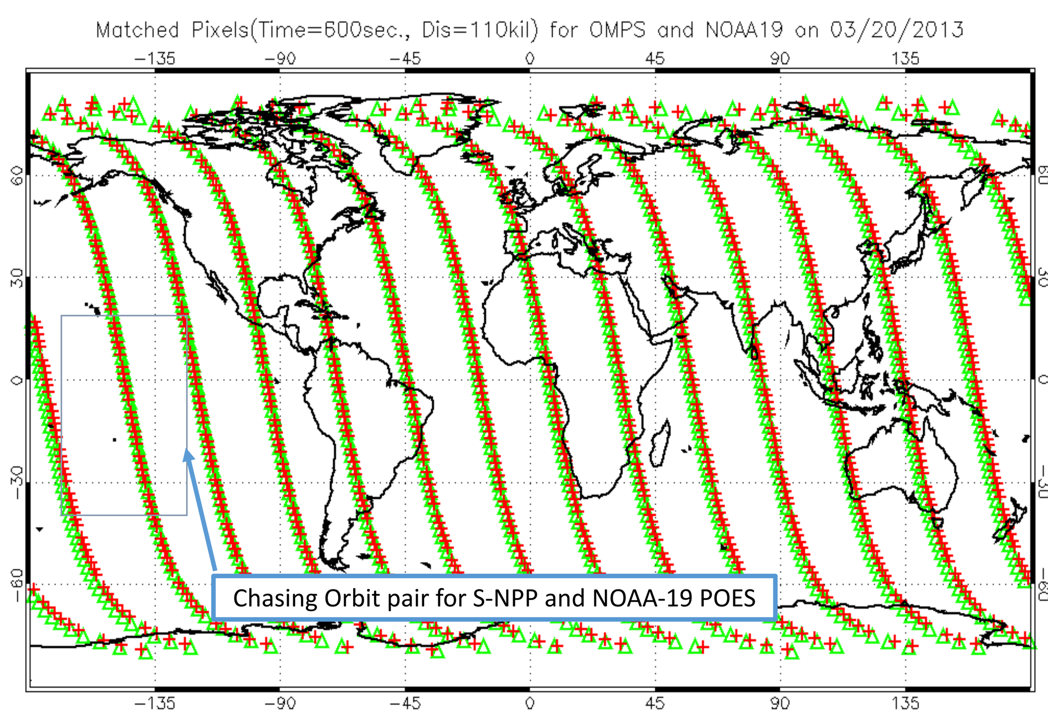
The figure above shows that the Metop-A and S-NPP pass over 72° N at the same time of day. Given the relative precession of their orbital tracks, they will also be over close, to the same location at close to the same time on occasion. These are called Simultaneous Nadir Overpass (SNO) events. One can also produce daily zonal means in a band about this latitude. Comparisons of these zonal means should not be affected by diurnal variations.
(2) LEO underflights of GEO and L-1 instruments – Coincident Line-of-Sight Observations.



Simultaneous View Path (SVP) match up between DSCOVR EPIC at 0° offset with the Earth/Sun line and S-NPP OMPS. Matches will be present for any BUV instrument on a GEO platform with one in a LEO orbit as the LEO orbital tracks pass near the GEO sub-satellite point.

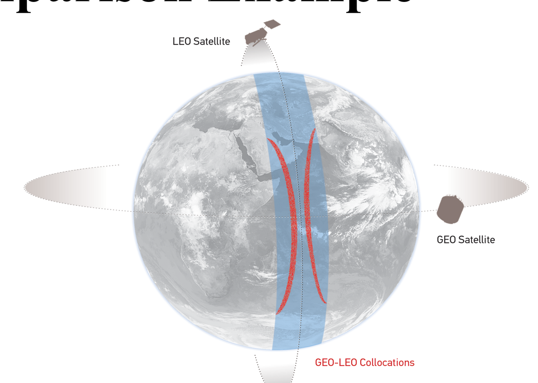
(3) Measurements over target areas. Examples include desert sites, ice fields, cloud free open oceans and Deep Convective Clouds. (DCCs).

And (4) Chasing Orbits (Opportunistic Formation Flying) For example S-NPP and EOS-Aura have 16-day repeat cycles but one makes 227 orbits and the other 233 so once every 16 days they are flying with orbital tracks within (360/14)*110/(14*16*2) ~ 6 km of each other, 15 minutes apart.



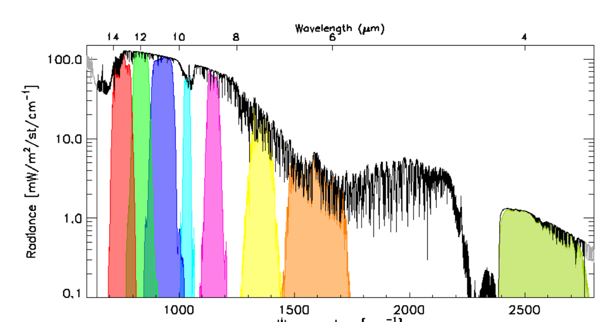
GEO-LEO IR Comparison Example

Simultaneous near-Nadir Overpasses of GEO imager and LEO sounder.
Select Collocations:
Spatial, temporal and geometric thresholds.



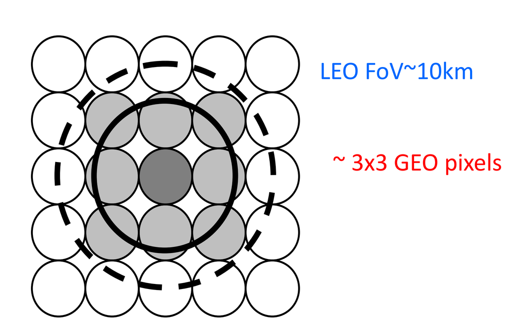
Schematic illustration of the geostationary orbit (GEO) and polar low Earth orbit (LEO) satellites and distribution of their collocated observations.

Spectral Convolution:
Convolve LEO Radiance Spectra with GEO Spectral Response Functions to synthesise radiance in GEO channels.

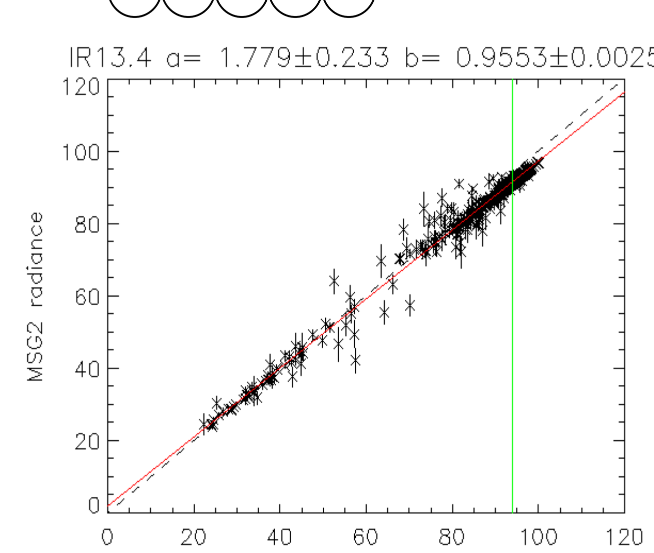


Example radiance spectra measured by IASI (black), convolved with the Spectral Response Functions of SEVIRI channels 3-11 from right to left (colored shaded areas).

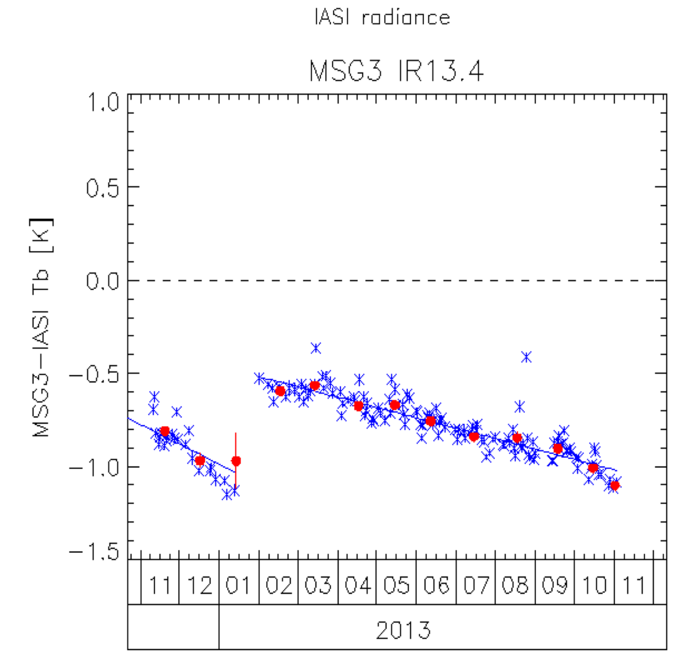
Spatial Averaging:
Average GEO pixels in each LEO FoV with Standard Deviation of GEO pixels as weight.



Weighted Regression of LEO versus GEO radiances:
Evaluate Bias for Standard Radiance Scene.
Weighted linear regression of $L_{GEO|REF}$ and $<L_{GEO}>$ for Meteosat-9 13.4μm channel based on single overpass orbit of IASI.



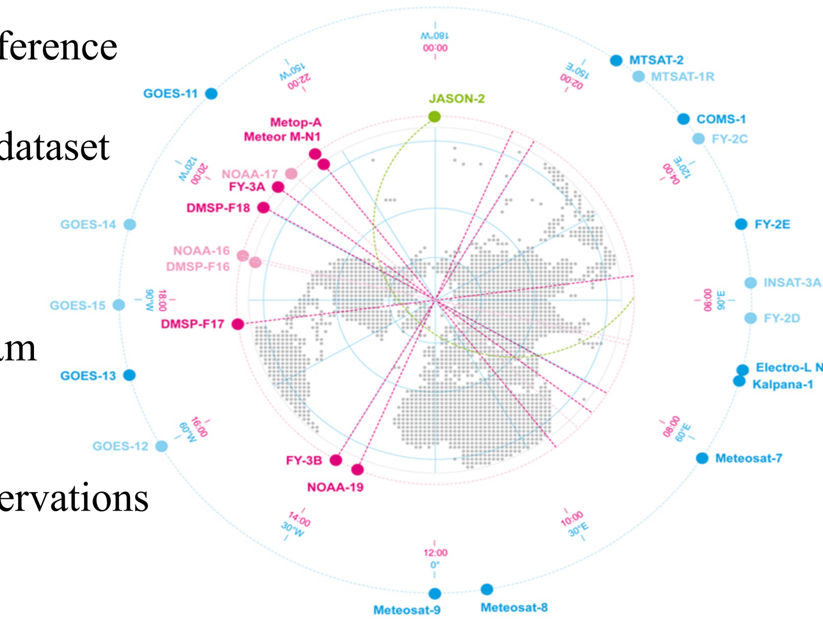
Plot time series of Biases:
Time Series of Bias from inter-calibration of 13.4μm channel of Meteosat-10/SEVIRI with Metop-A/IASI expressed in Brightness Temperature Bias for Standard Scene Radiance, Blue x = Daily Result, Blue Line=trend, Red dot = Monthly Average



GEO-Ring Demonstration Dataset GSICS Corrections for all GEO imagers

Inter-calibrate to common reference
Metop-A/IASI
Generating GEO-ring demo dataset
2014-03-01 – Every 3hrs
2014-03-20 – Every 3hrs
Baseline Channels
IR: 4μm, 7μm, 11μm, 13μm
VIS: 0.6μm
GEO-GEO Comparisons

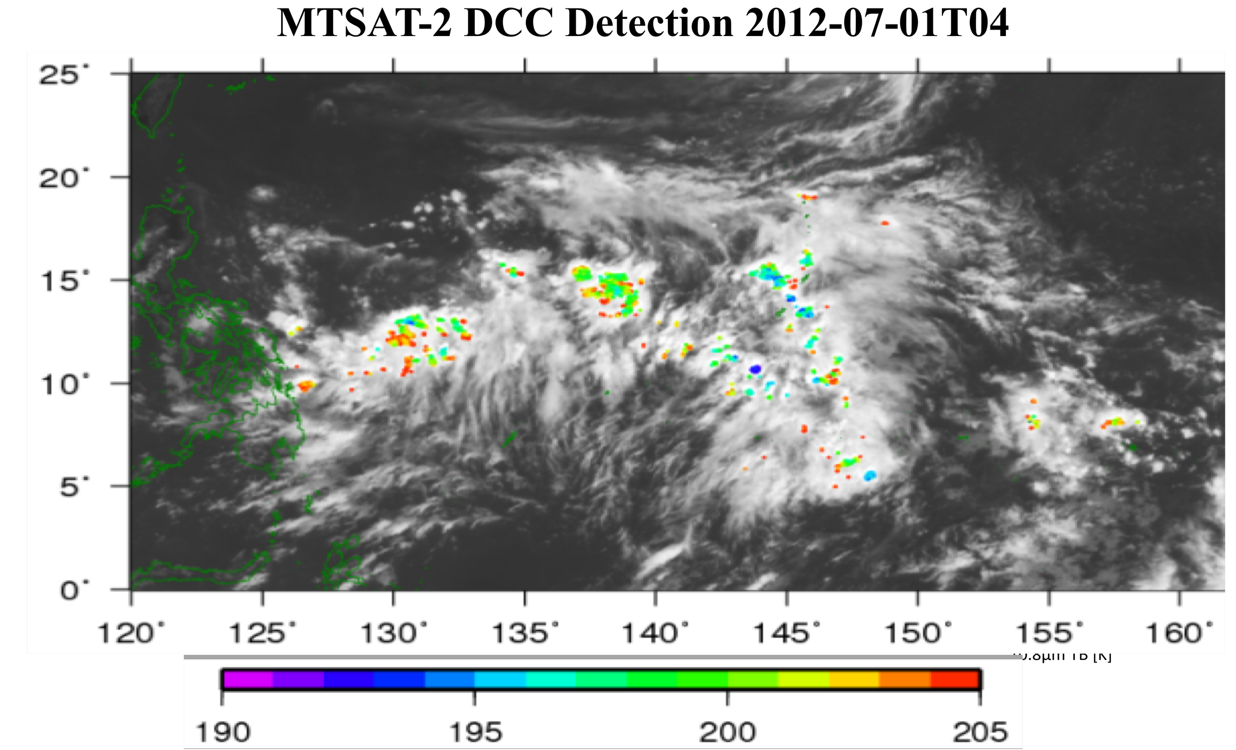
- Based on collocated observations
- GEO imager pairs
- Need SBAFs
- Check internal consistency & Uncertainties



GEO-LEO VIS – Deep Convective Clouds (DCCs)

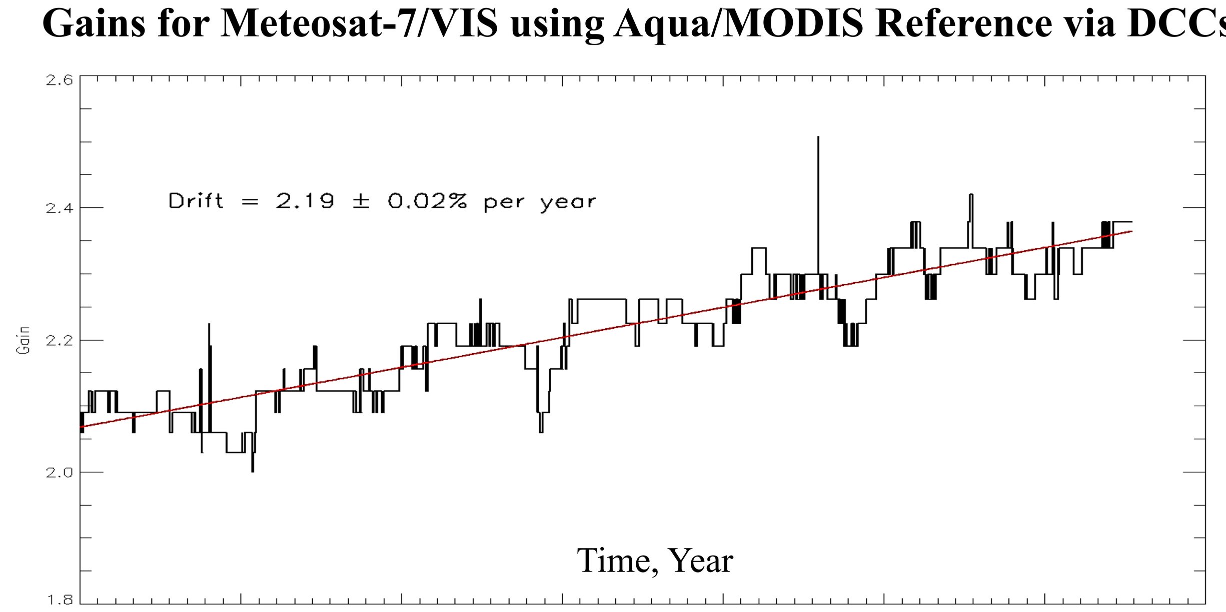
Deep Convective Clouds (DCCs) are bright, natural solar diffusers. They are located near the top of the troposphere so there are small water vapour and aerosol signals. They are present globally in the Equatorial band.

MTSAT-2 DCC Detection 2012-07-01T04



They can be used as Pseudo Invariant Targets to transfer calibration from MODIS to GEO imagers. Here is a brief description of the process to use them as calibration transfer targets:
Select the coldest, brightest pixels,
Identify them by using a T_{IR} threshold,
Apply scene homogeneity tests,
Limit viewing and solar angles,
Build up monthly PDF statistics, and
compare time series of modes and means
with those from reference observations.

Gains for Meteosat-7/VIS using Aqua/MODIS Reference via DCCs

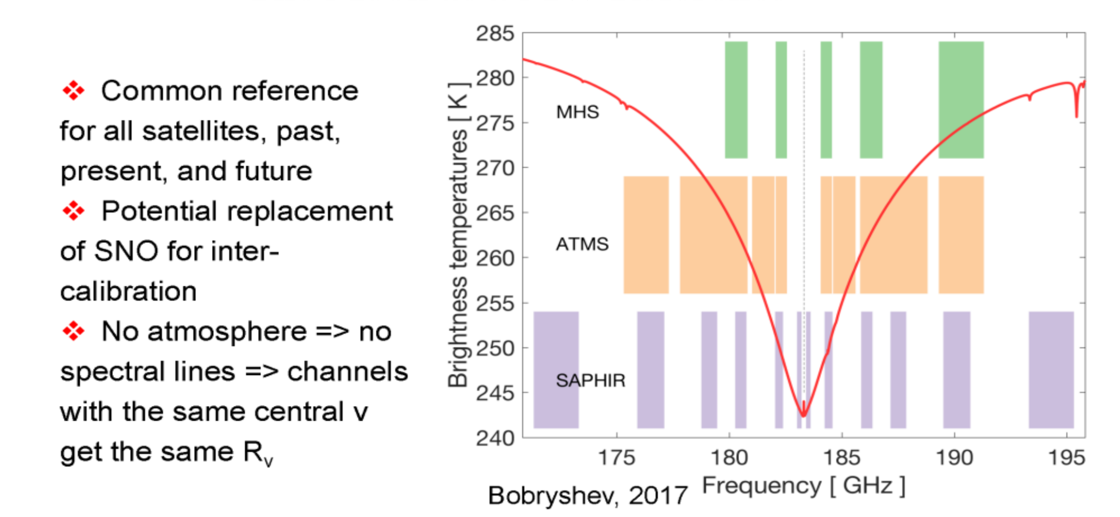


Acknowledgment and Disclaimer
This work was supported by the NOAA JPSS program. The contents of this poster are those of the authors and do not necessarily reflect any position of the US Government or NOAA.

Microwave – Challenges, Methods, Progress

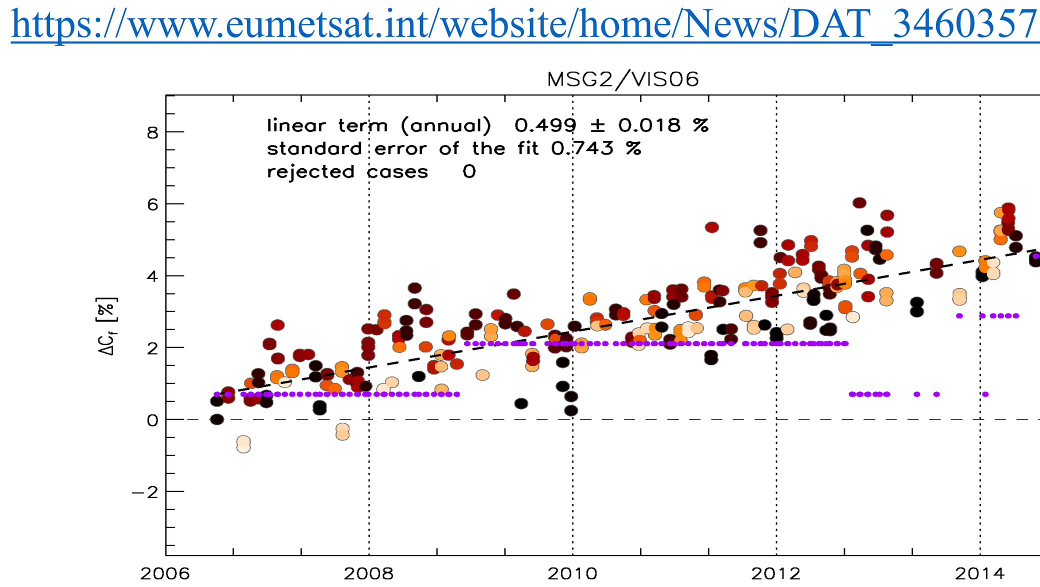
GSICS comparisons for Microwave instruments are complicated by a lack of a "true" reference for MW. NIST is developing on-ground reference for use with JPSS/ATMS instruments. The diversity of sensor channel (e.g., Window, O_2 and H_2O channels) and sensor types (e.g., conical, imagers, cross-track and sounders) also make comparisons more difficult. Progress is being made with the following approaches: (1) SNO – used by many groups, (2) Lunar calibration (M. Burgdorf, Univ. Hamburg), (3)GPM Microwave Imager (W. Berg, Colo. State Univ/NASA X-Cal team), (4) GRUAN observations with RTM (T. Reale, NOAA; H. Lawrence, UKMO), and MW FCDR's (K. Fennig, EUMETSAT; C-Z. Zou, NOAA).

The Moon as a MW Reference



GEO-LEO VIS/NIR – Lunar Target

The moon is an excellent target for in-flight comparisons. It is a dark, natural, extremely stable solar diffuser with no atmosphere, and it is globally available for viewing at all reflected solar channels. Eumetsat has implemented a model (GIRO/GLOD) to estimate the expect lunar spectra for different phases by using USGS ROLO measurements.
https://www.eumetsat.int/website/home/News/DAT_3460357.html



Meteosat-9/VIS06 Bias Change wrt ROLO Model Lunar Irradiance(after phase angle correction)

GSICS Products and Resources

The GSICS Intercalibration products along with ATBDs and other documents on their creation and performance are available from links at:
https://www.star.nesdis.noaa.gov/smcd/GCC/ProductCatalog.php
You can sign up for meeting notifications and to receive the quarterly newsletters with a link at the GSICS Coordination Center home page:
https://www.star.nesdis.noaa.gov/smcd/GCC/index.php
Member agencies also maintain their own GSICS pages, for example,
http://ds.data.jma.go.jp/mscweb/data/monitoring/calibration.html

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