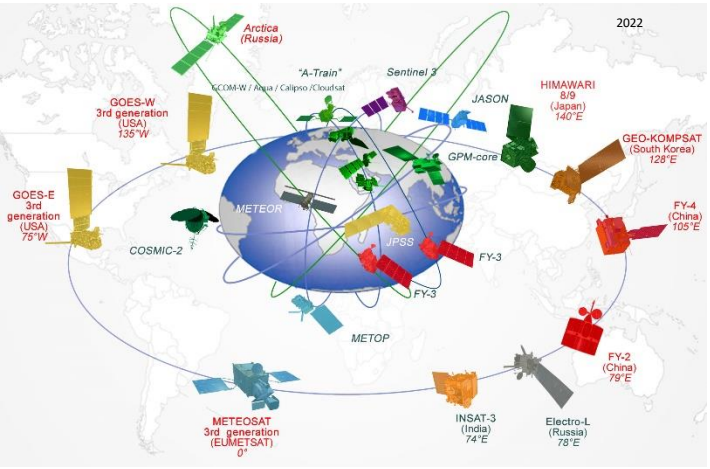


GSICS Executive Panel Report to Plenary on the Annual State of the Observing System

Presented to CGMS-47 Plenary] 5, agenda item 5.2

Coordination Group for Meteorological Satellites

GSICS Global Space-based Inter-Calibration System

CGMS

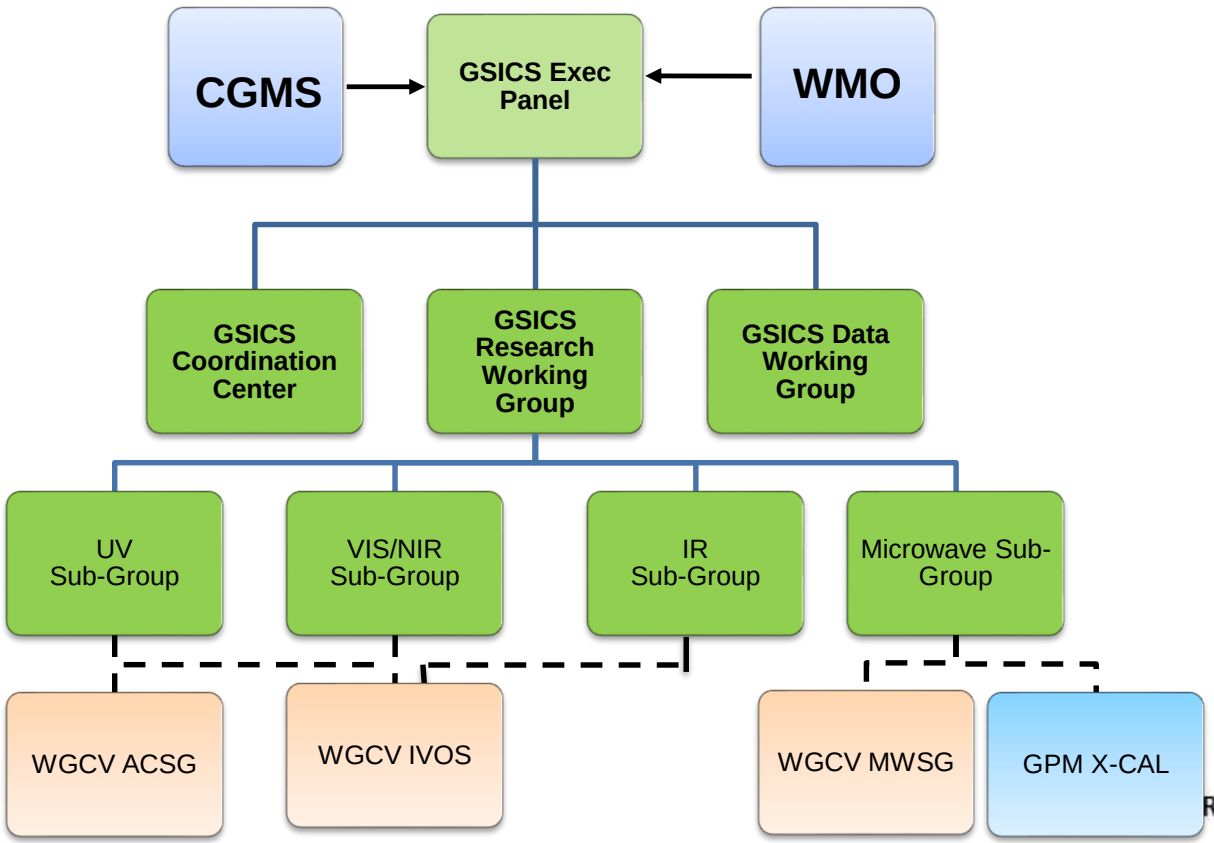
The twentieth session of the GSICS Executive Panel (EP) was held in Sochi, Russian Federation from 16-17 May 2019, in advance of the 47thCGMS meeting.
It was attended by representatives of CMA, EUMETSAT, IMD, ISRO,JAXA, JMA, KMA, NASA, NOAA, ROSHYDROMET, ROSCOSMOS, SITP/CAS, WMO (Secretariat), GCC (Director), GDWG (Chair), GRWG (Chair) and CGMS SWTCG(Co-Chair).
NASA, USGS, GRWG Chair, CGMS SWCG (Co-Chair) were participated remotely.

CGMS-47-GSICS, Sochi Russian Federation, 16-17 May 2019

Top Discussion Topics

- GSICS Annual Observing System Report
  - To Roshydromet and ISRO to contribute to AOSR
  - To Microwave and "UV" subgroups to contribute to AOSR.
- Cal/Val Landing Pages
  - Research agencies to provide links to GSICS relevant mission
- GSICS:WIGOS Integration
  - Support to the Manual on the WMO Integrated Global Observing System through key workshops
- Space Weather – GSICS Framework Discussion
  - Action to SW Task Group on InterCalibration to develop white paper on intercalibration needs and level of effort to allow agencies to assess support for a GSICS-like framework
- Additions to HLPP

GSICS Structure & Partnerships



EUMETSAT, CNES, JMA, NOAA, CMA, KMA, ISRO, NASA, WMO, USGS, NIST, JAXA, ROSHYDROMET, IMD, ESA, SITP

New members

GSICS Annual Meeting

Included a short special session on reprocessing

GSICS Global Space-based Inter-Calibration System

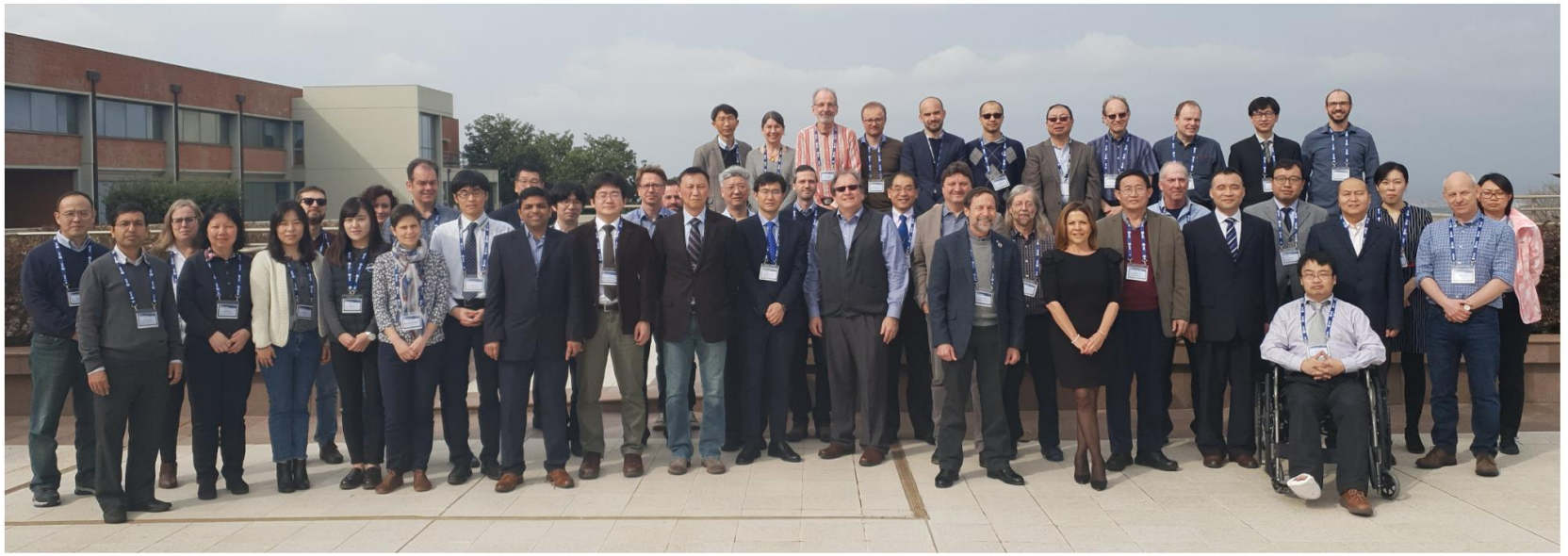
An international collaboration
to examine and harmonize data from operational weather satellites
to improve climate monitoring and weather forecasting

Jump

GSICS Wiki > Development web > AnnualMeeting2019 (09 May 2019, TimHewison)

Tags: create new tag , view all tags

GSICS Annual Meeting 2019, Frascati, Italy, 2019-03-04/08



Minutes http://gsics.atmos.umd.edu/bin/view/Development/AnnualMeeting2019?sortcol=1;table=1;up=0#sorted_table

- The final meeting minutes are available.

Agenda

GRWG Subgroups

- MW has grown and is still expanding. Continue to engage with other communities. Focus on methods to characterize MW sensors. Includes intercalibration of MW Imagers, collaboration with GPM X-Cal.

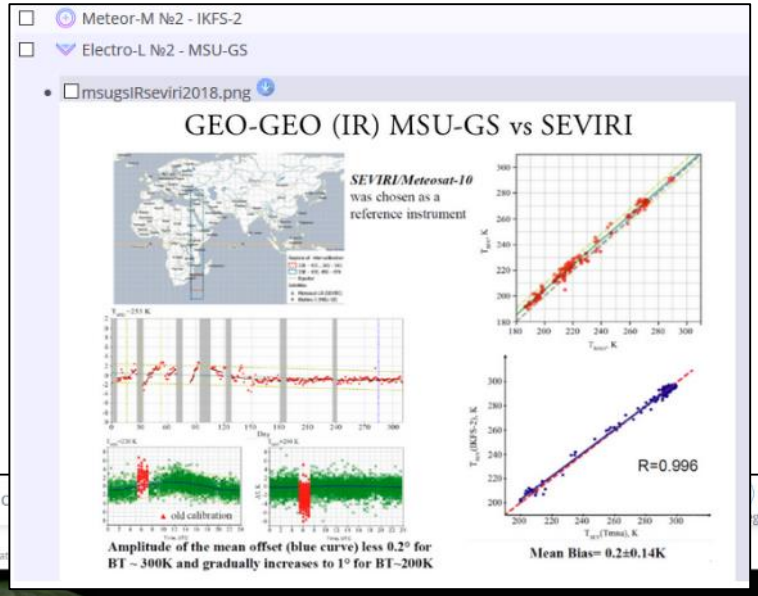
- IR focuses on hyperspectral instruments and multispectral band instruments, and pointed out several emerging issues, including gap filling , collocation , RTM convolution (GEO to LEO focus).

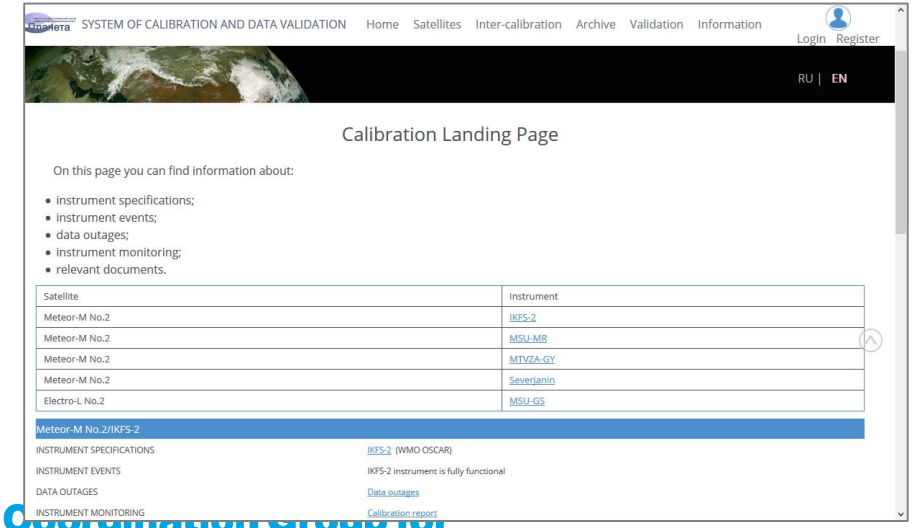
- VNIR has generated new Spectral Band Adjustment Factors enabling SNPP-VIIRS NOAA V2 product as the GSICS official VIS/NIR Reference, Investigating how best to use Lunar Calibration, DCC Calibration along with VIIRS.

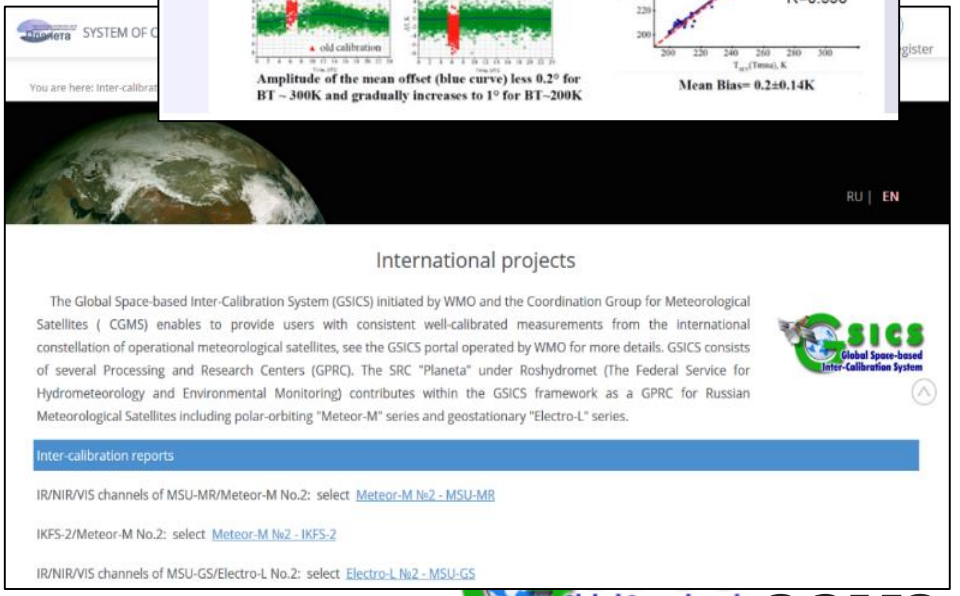
- UV is focused on trace gas products and leading project on ground-based characterization. Proposed to re-name the sub-group as Reflective Solar Spectrometer.

GDWG supported implementation of calval landing pages for GSICS agencies

- In 2018, ROSHYDROMET launched:
  - GSICS website
  - *Landing Page* for satellite/instrument calibration event logging







GSICS Annual Observing System Report

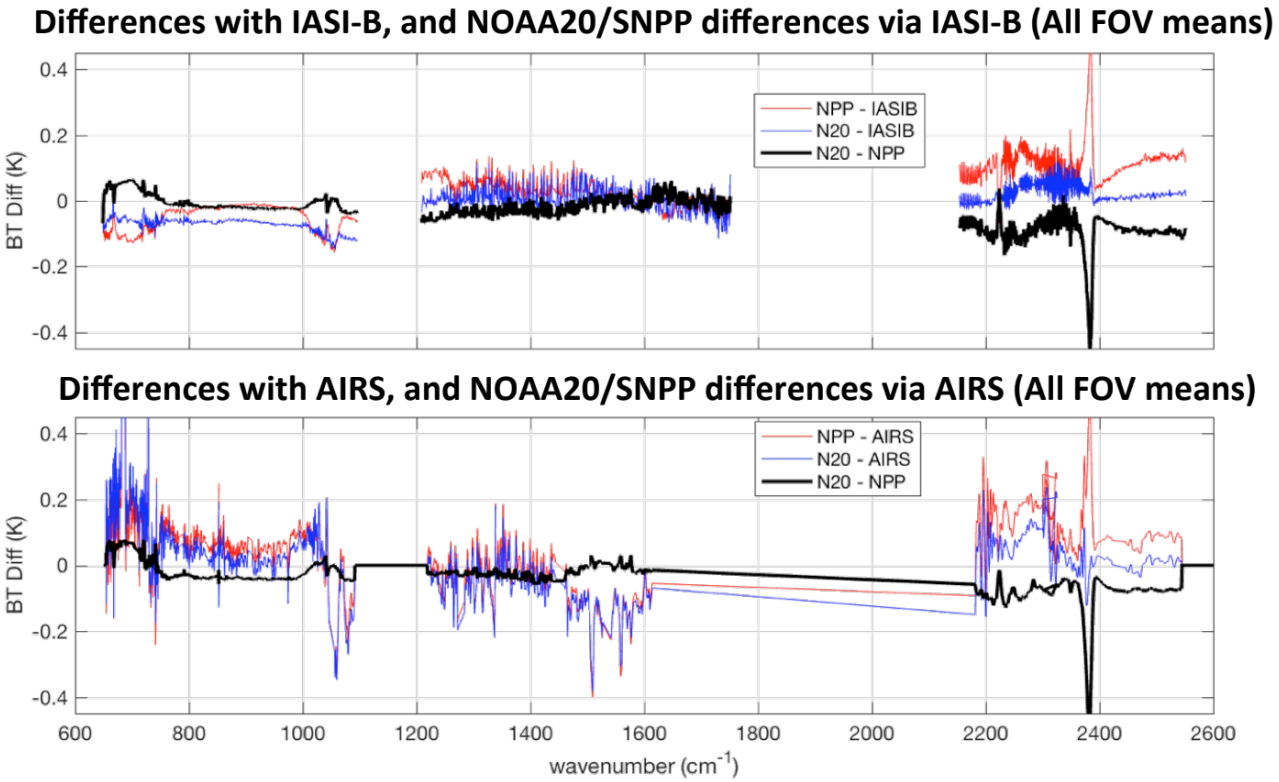
(Full written report is being prepared, ppt version is in backup)

Concepts of Annual Report

- Target audience: satellite data users + operators (incl. non calibration experts)
- Keeping report contents SIMPLE
  - Satellite/Instrument events on calibration: 1 page for agency
  - Radiometric calibration performance for GEO imagers (at this stage)
    - ✓ 1-2 page / instrument using GSICS inter-calibration approaches
    - ✓ Table summarizing bias/unc for one year (shorter period in special cases)
    - ✓ Time series chart of bias/unc for days since operation start (or one year)
  - Performance of reference instruments by Double Difference
    - ✓ Agencies responsible for the instruments are expected to do the validation
  - Detailed information: to be navigated to Calibration Landing Page
- Adopting existing formats as possible
  - Color chart on NOAA satellite status, visualization tools (e.g. GSICS Plotting Tool)

Monitoring the reference instruments

Example Cal/Val Result: SNOs with IASI and AIRS



- Differences between NOAA20 CrIS and SNPP CrIS are less than 0.1K
- Differences from IASI-B are less than 0.2K, Differences from AIRS are less than 0.4K
- Larger diffs observed for cold SW scenes, but with NOAA20 CrIS agreeing better with IASI and AIRS as compared to SNPP CrIS. Expect some improvements with polarization correction.

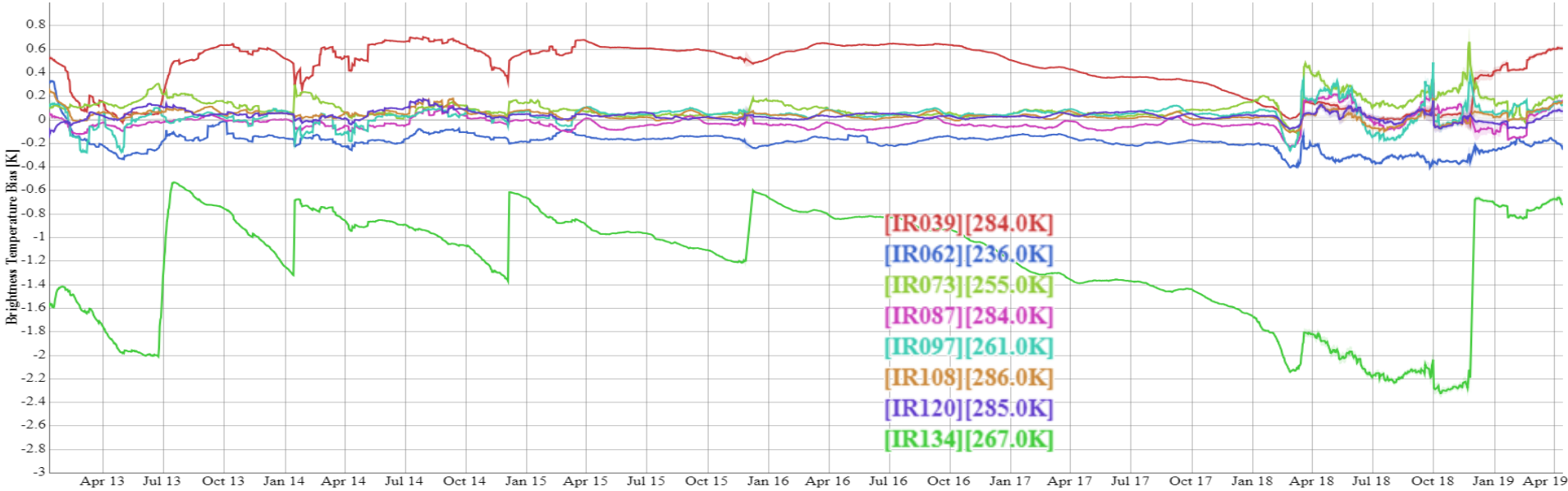
EUM:Calibration Performance: Meteosat-10/SEVIRI IR Bands

Summary Statistics of Meteosat-10/SEVIRI IR Calibration Performance in 2018 (All uncertainties are k=1)

Channel Name	IR3.9	IR6.2	IR7.3	IR8.7	IR9.7	IR10.8	IR12.0	IR13.4
Standard Radiance as Tb (K)	284	236	255	284	261	286	285	267
Mean Bias (K)	+0.10	-0.30	+0.21	+0.04	+0.05	+0.01	+0.02	-1.94
Standard Deviation of Bias (K)	0.10	0.05	0.13	0.12	0.15	0.06	0.05	0.41
Mean Drift Rate of Bias (K/yr)	+0.07	-0.07	+0.11	+0.05	-0.02	-0.00	-0.05	+0.22

- The statistics are derived from Meteosat-10/SEVIRI Operational GSICS Re-Analysis Correction vs. Metop-A/IASI
- Biases defined for Standard Radiance: typical scene for easy inter-comparison of sensors' inter-calibration biases
- Decontaminations introduce calibration jumps – most obvious in the IR13.4 channel due to ice contamination

Time series of Meteosat-10/SEVIRI Tb biases w.r.t. Metop-A/IASI at standard radiance



JMA: Calibration Performance: Himawari-8/AHI Infrared Bands

Summary Statistics of Himawari-8/AHI IR Calibration Performance in 2018 (All uncertainties are k=1)

	Channel Name (Central Wavelength in μm)	BAND07 (3.9)	BAND08 (6.2)	BAND09 (6.9)	BAND10 (7.3)	BAND11 (8.6)	BAND12 (9.6)	BAND13 (10.4)	BAND14 (11.2)	BAND15 (12.4)	BAND16 (13.3)
	Std. Radiance as Tb (K)	286.0	234.6	243.9	254.6	283.8	259.5	286.2	286.1	283.8	269.7
Metop-A/ IASI	Mean Bias (K)	-0.149	-0.184	-0.223	-0.127	-0.062	-0.239	0.036	0.047	-0.036	0.106
	Stdv. of Bias (K)	0.006	0.009	0.008	0.020	0.012	0.012	0.020	0.020	0.017	0.016
S-NPP/ CrIS	Mean Bias (K)	-0.114	-0.165	-0.248	-0.157	N/A	-0.249	-0.019	-0.012	-0.099	0.036
	Stdv/ of Bias (K)	0.177	0.011	0.014	0.028	N/A	0.010	0.017	0.017	0.016	0.013

- The statistics are derived from Himawari-8/AHI GSICS Re-Analysis Correction (ATBD)
- Standard Radiance: typical scene defined by GSICS for easy inter-comparison of sensors' inter-calibration biases

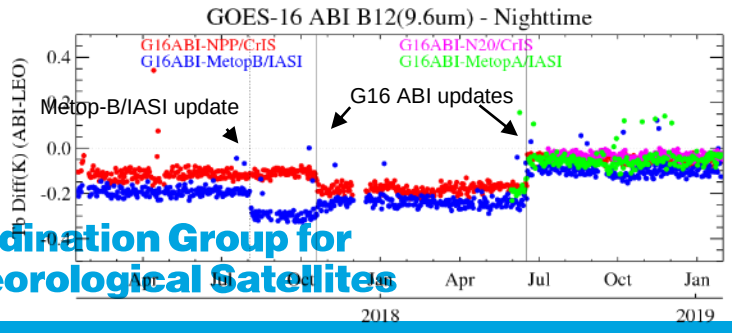
Time series of Himawari-8/AHI Tb biases w.r.t. Metop-A/IASI at std. radiance (2015-07-07 to 2018-12-31)

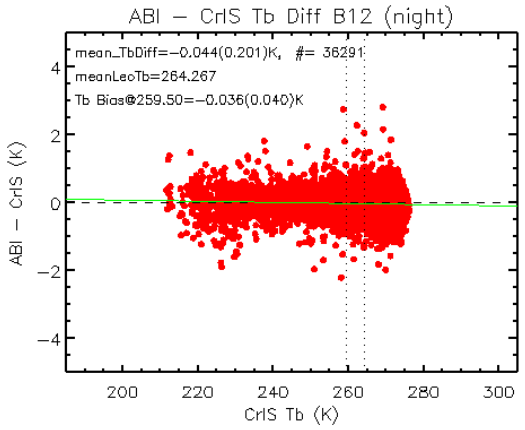
NOAA:Calibration Performance: GOES16/ABI Infrared Bands

Summary Statistics of GOES-16/ABI IR Calibration Performance in December 2018 (All uncertainties are k=1)

	Channel Name (Central Wavelength in μm)	BAND07 (3.9)	BAND08 (6.2)	BAND09 (6.9)	BAND10 (7.3)	BAND11 (8.6)	BAND12 (9.6)	BAND13 (10.4)	BAND14 (11.2)	BAND15 (12.4)	BAND16 (13.3)
	Std. Scene Tb (K)	286.0	234.5	244.0	254.5	284.0	259.5	286.0	286.0	283.5	269.5
Metop-A/ IASI	Bias at Std. Scene(K)	-0.03	-0.11	-0.12	-0.05	-0.05	-0.05	-0.03	0.04	0.03	-0.10
	Stdv. of Bias (K)	0.08	0.06	0.07	0.08	0.11	0.08	0.12	0.12	0.12	0.12
Metop-B/ IASI	Bias at Std. Scene(K)	-0.00	-0.12	-0.14	-0.07	-0.04	-0.10	-0.02	0.05	0.03	-0.12
	Stdv. of Bias (K)	0.18	0.13	0.08	0.09	0.19	0.13	0.21	0.21	0.22	0.20
S-NPP/ CrIS	Bias at Std. Scene(K)	-	-	-0.14	-0.09	-	-0.05	-0.07	-0.01	-0.03	-0.15
	Stdv of Bias (K)	-	-	0.03	0.04	-	0.04	0.06	0.06	0.07	0.06
NOAA-20/ CrIS	Bias at Std. Scene(K)	-	-	-0.11	-0.06	-	-0.04	-0.01	0.05	0.03	-0.11
	Stdv of Bias (K)	-	-	0.03	0.03	-	0.04	0.06	0.06	0.06	0.07

- **GOES-16 ABI IR calibration is very stable.**
- **The mean Tb bias to CrIS/IASI less than 0.15K after the operational update on 06/19/2018.**
- **No significant scene dependent Tb bias to the reference instruments for all the IR channels**



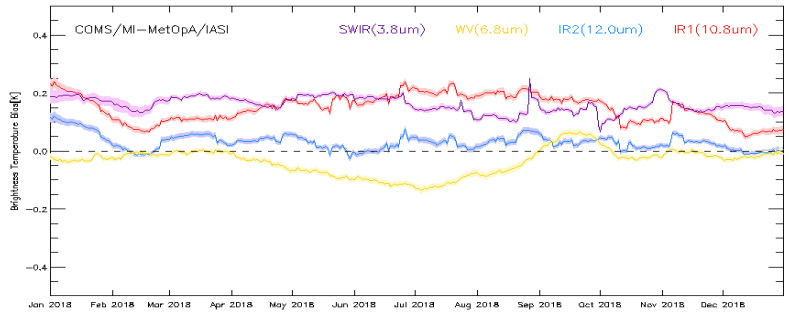


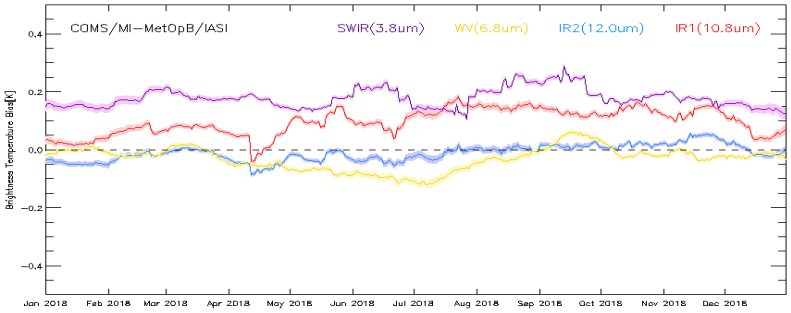
KMA:Calibration Performance: COMS/MI Infrared Bands

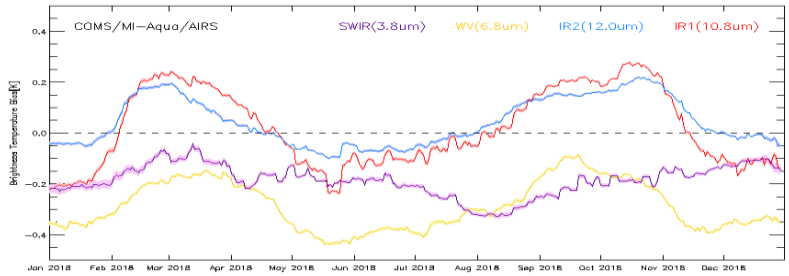
Summary Statistics of COMS/MI IR Calibration Performance in 2018 (All uncertainties are k=1)

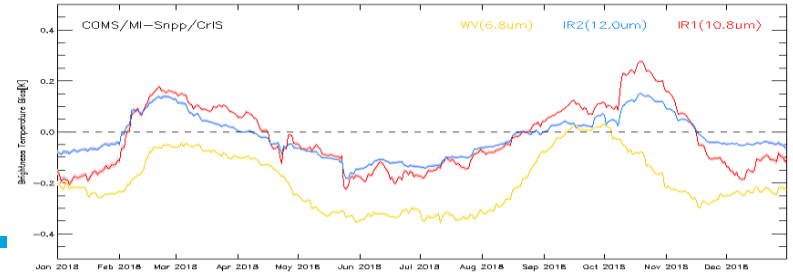
	MetOp-A/IASI				MetOp-B/IASI			
Channel Name	IR3.8	IR6.8	IR10.8	IR12.0	IR3.8	IR6.8	IR10.8	IR12.0
Std Rad as Tb (K)	286	238	286	285	286	238	286	285
Mean Bias (K)	0.16	-0.03	0.15	0.03	0.18	-0.03	0.10	-0.01
Stdv of Bias (K)	0.03	0.05	0.05	0.03	0.03	0.04	0.05	0.03
Mean Drift Rate of Bias (K/yr)	+0.18	-0.05	+0.16	+0.05	+0.17	-0.04	+0.05	-0.04

	Snpp/CrIS				Aqua/AIRS			
Channel Name	IR3.8	IR6.8	IR10.8	IR12.0	IR3.8	IR6.8	IR10.8	IR12.0
Std Rad as Tb (K)	286	238	286	285	286	238	286	285
Mean Bias (K)	-	-0.20	-0.02	-0.02	-0.19	-0.29	0.02	0.04
Stdv of Bias (K)	-	0.10	0.13	0.08	0.06	0.09	0.15	0.09
Mean Drift Rate of Bias (K/yr)	-	-0.19	-0.04	-0.03	-0.18	-0.29	-0.01	+0.02









- The statistics are derived from COMS/MI Operational GSICS Re-Analysis Correction vs. Metop-A/IASI, Metop-B/IASI, Aqua/AIRS, SNPP/CrIS
- Biases defined for Standard Radiance: typical scene for easy inter-comparison of sensors' inter-calibration biases

Mean biases(GEO-LEOs) – May 16, 2019

Preliminary results

	Band 7 3.8	Band 8 6.2	Band 9 6.9	Band10 7.3	Band11 8.6	Band12 9.6	Band13 10.4	Band14 11.2	Band15 12.4	Band16 13.3
AMI [K]	0.04	-0.002	-0.23	-0.06	0.10	-0.05	0.18	0.16	0.15	**-0.59**
AHI [K]	-0.15	-0.27	-0.28	-0.16	-0.11	-0.29	-0.03	-0.02	-0.09	+0.06
ABI [K]	-0.03	-0.11	-0.12	-0.05	-0.05	-0.05	-0.03	+0.04	+0.03	-0.10

Significance: The recent current generation of weather satellites are approaching "climate" quality -- larger impacts for weather forecasting, easier integration of geo and leo satellites for blended products, lower uncertainties in climate data records.

GSICS monitors the health and stability of the observing system

Coordination Group for Meteorological Satellites

GSICS Global Space-based Inter-Calibration System

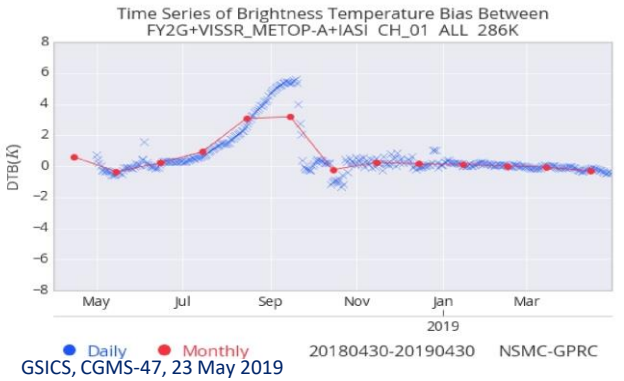
CGMS

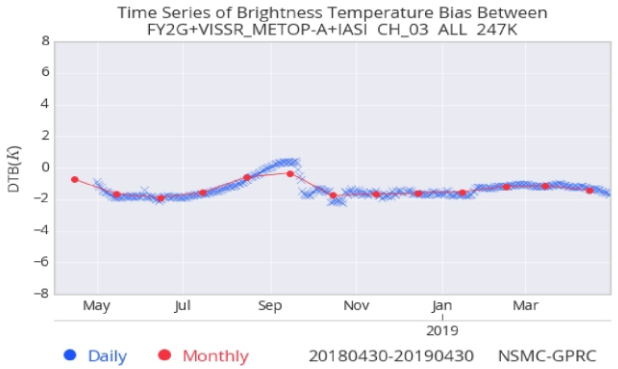
CMA: Calibration Performance: FY-2 /VISSR IR Bands

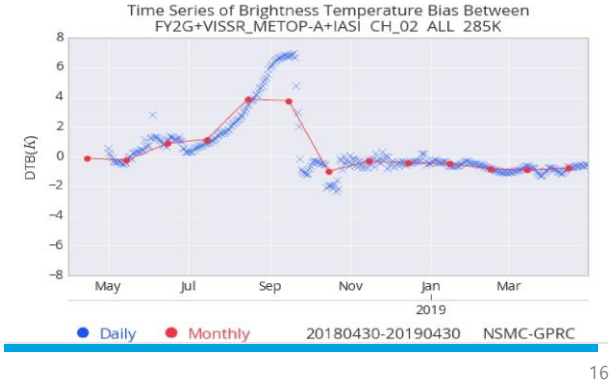
		FY-2F			FY-2G			FY-2H		
	Channel Name (Central Wavelength in μm)	BAND1 (10.8)	BAND2 (12)	BAND3 (6.7)	BAND1 (10.8)	BAND2 (12)	BAND3 (6.7)	BAND1 (10.8)	BAND2 (12)	BAND3 (6.7)
	Std. Radiance as Tb (K)	286	285	247	286	285	247	286	285	247
Metop-A/ IASI	Mean Bias (K)	2.373	3.827	1.739	0.171	-0.467	-1.749	-1.423	-2.676	-2.178
	Stdv. of Bias (K)	1.457	1.604	1.942	1.140	1.168	0.480	1.209	1.287	0.585
S-NPP/ CrIS	Mean Bias (K)	2.038	3.240	1.844	0.058	-0.516	-1.312	-1.369	-2.609	-2.127
	Stdv/ of Bias (K)	1.670	1.895	1.244	1.096	1.131	0.691	0.967	1.015	0.487

- The statistics are derived from FY-2 GSICS Re-Analysis Correction (ATBD)
- Standard Radiance: typical scene defined by GSICS for easy inter-comparison of sensors' inter-calibration biases
- Mean Bias: monthly average and standard deviation of the daily results in January 2019

Time series of FY-2G /VISSR Tb biases w.r.t. Metop-B/IASI at std. radiance



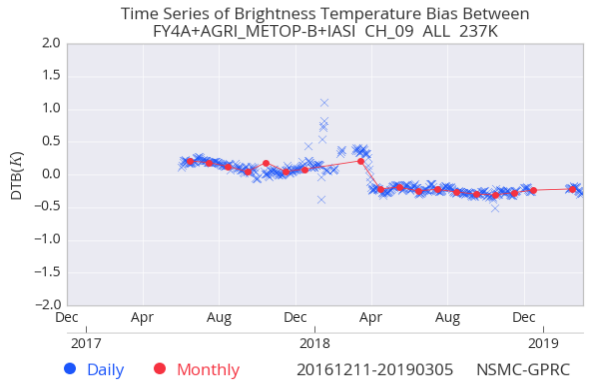


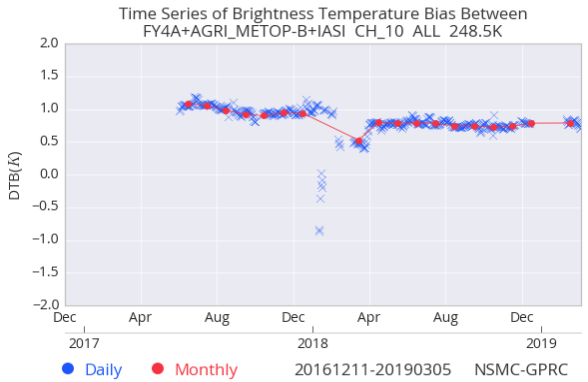


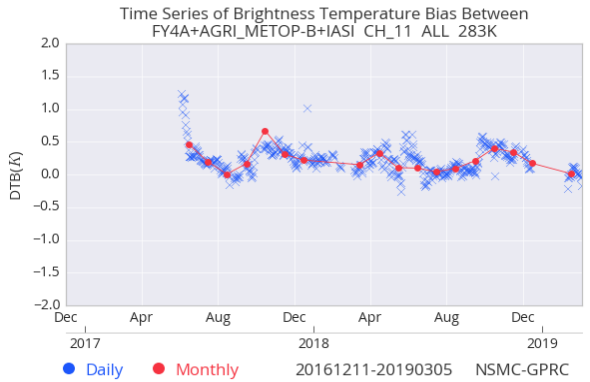
CMA: Calibration Performance: FY-4 /AGRI IR Bands

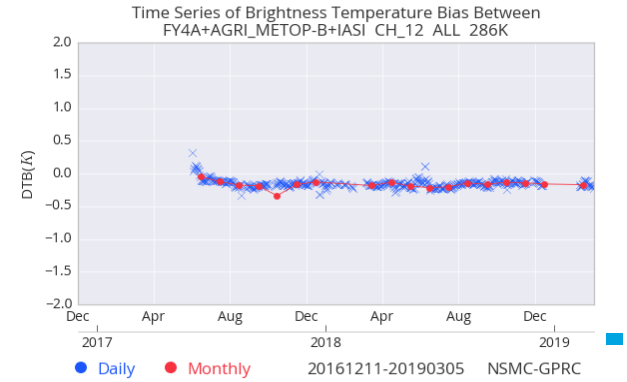
	Channel Name (Central Wavelength in μm)	BAND09 (6.3)	BAND10 (7.1)	BAND11 (8.5)	BAND12 (10.8)	BAND13 (12)	BAND14 (13.3)
	Std. Radiance as Tb (K)	237	248	283	286	285	258
Metop-A/ IASI	Mean Bias (K)	-0.190	0.753	0.290	-0.115	-0.156	0.127
	Stdv. of Bias (K)	0.211	0.194	0.559	0.187	0.213	1.172
S-NPP/ CrIS	Mean Bias (K)	-0.211	0.728	0.300	-0.135	-0.196	0.248
	Stdv/ of Bias (K)	0.229	0.209	0.607	0.216	0.209	1.347

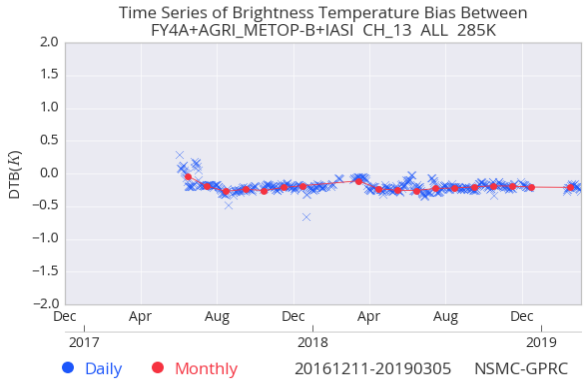
- Mean Bias: monthly average and standard deviation of the daily results in Jan. 2019

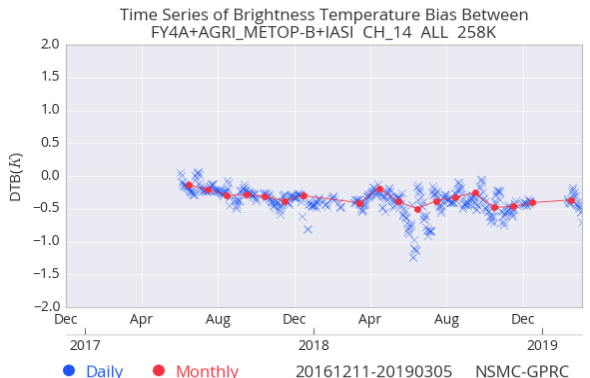




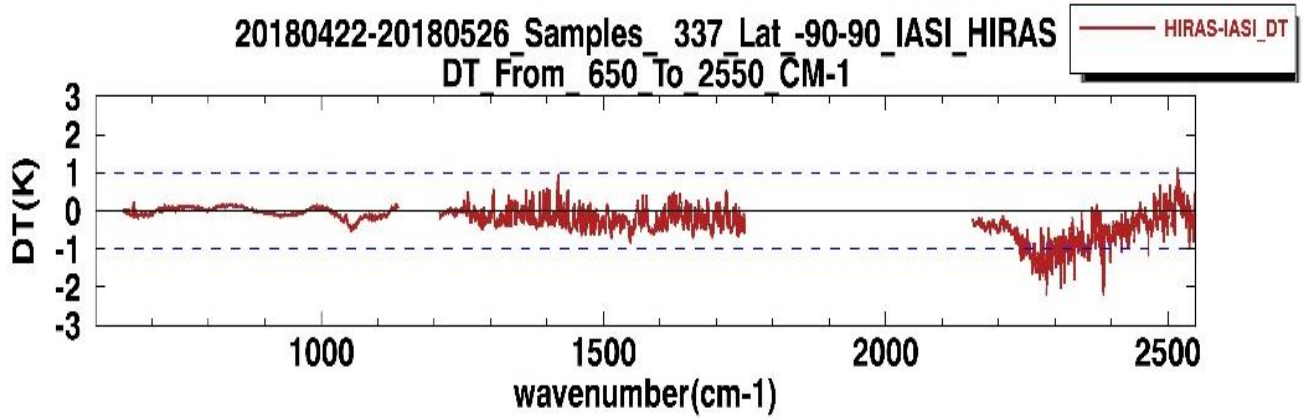


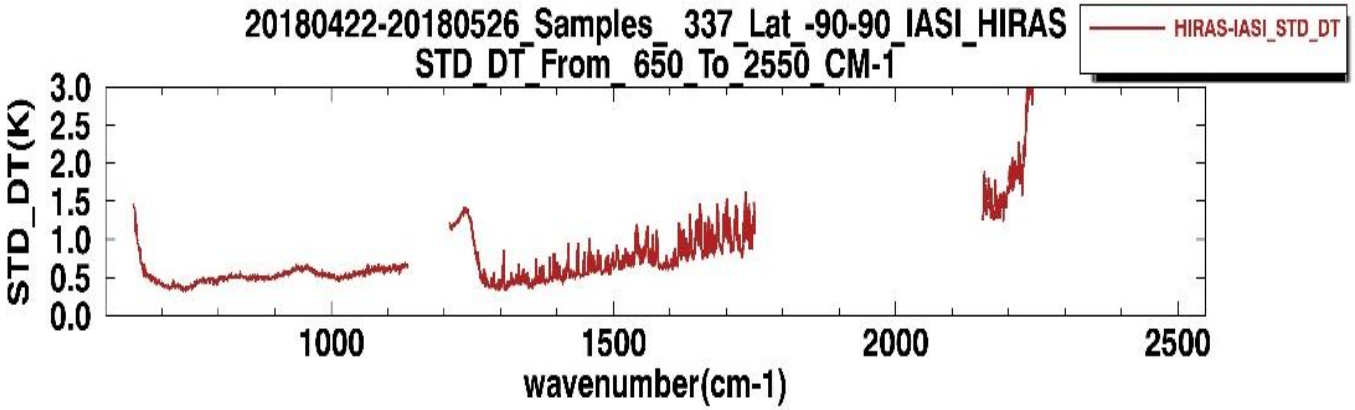






CMA: HIRAS Calibration bias with respect to IASI

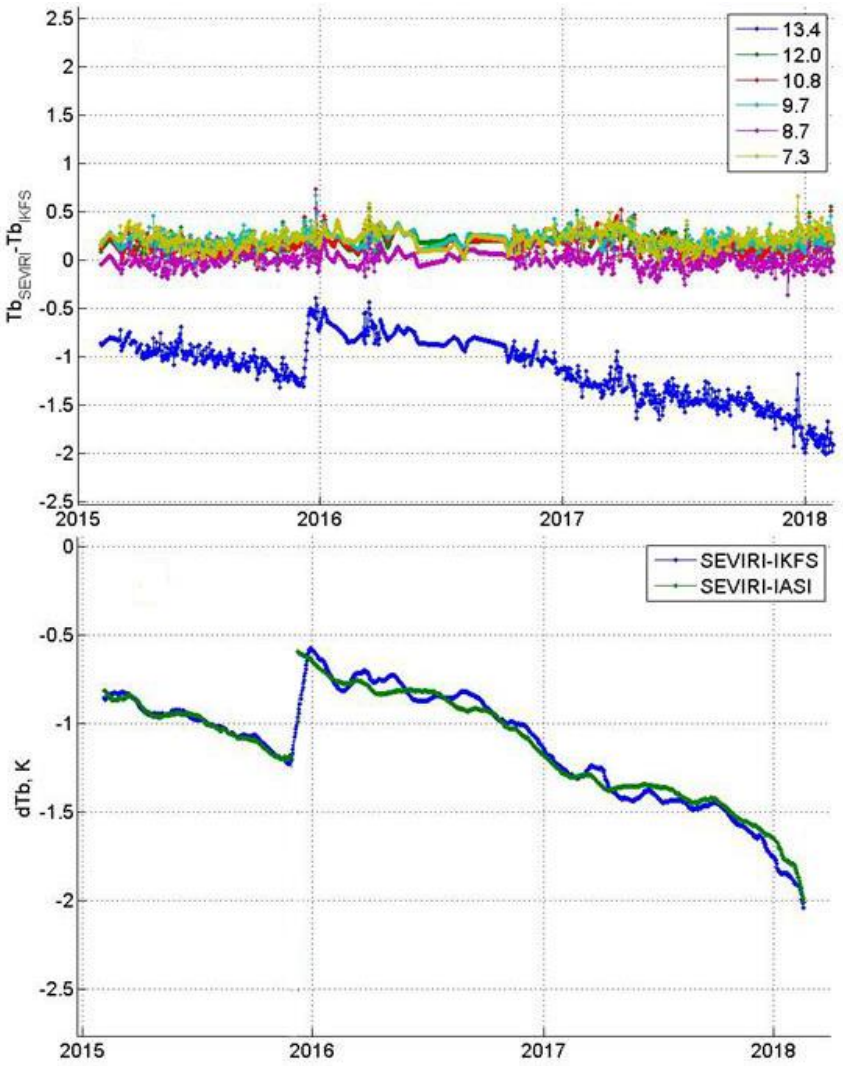




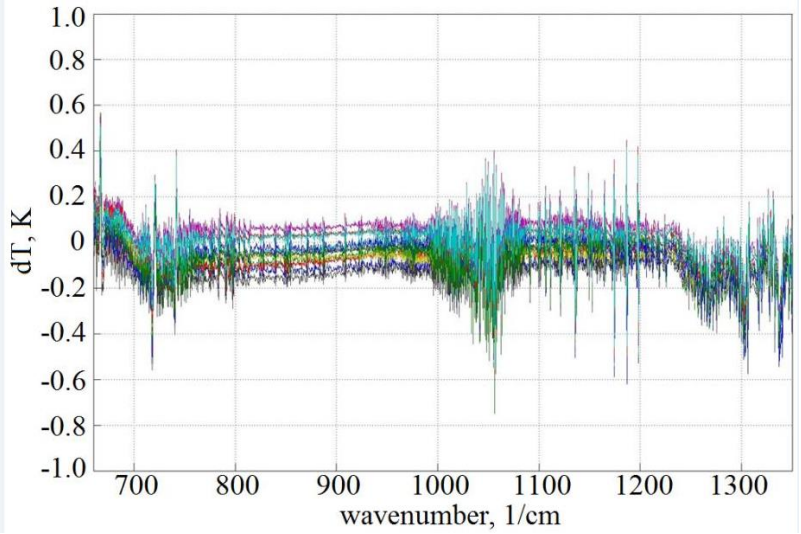
- Data:2018.04.22-2018.05.26 17 days
- LW bt bias better than 0.5K， MW bt bias less than 0.7K；
- LW bias std less than 0.5K， MW bias std in 0.5~1K， SW window and weak absorption region meet 0.5K；

Calibration Performance: IKFS-2

Comparison with SEVIRI/Meteosat-10 channels



Daily averaged (IKFS-IASI) BT differences from Jul 2015 to Jun 2017 (once per 2 months)



These results, firstly, confirm the proper quality and stability of the radiometric calibration of the IKFS-2 measurements, and secondly, demonstrate good quality of the spectral calibration of the IKFS-2 instrument.

Coordination Group for Meteorological Satellites

GSICS Global Space-based Inter-Calibration System

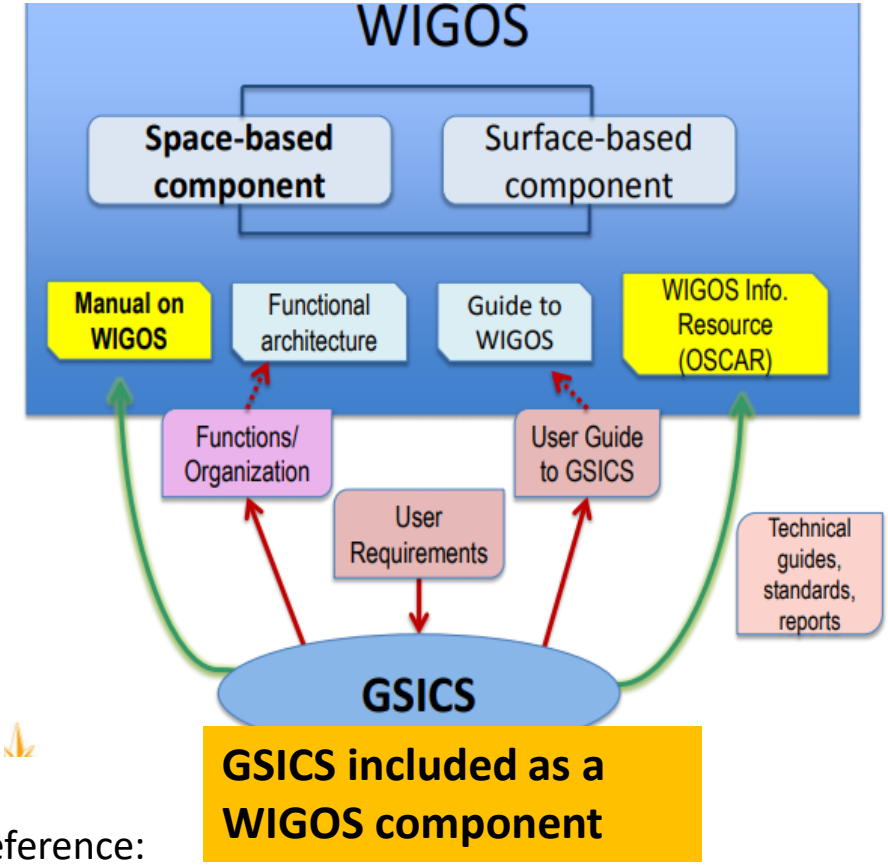
CGMS

GSICS: A WIGOS Component

GSICS is now integrated into WIGOS

Recognizing GSICS as an element of WIGOS

- ✓ The new Manual on WIGOS requires calibration along GSICS standards
- ✓ WIGOS/OSCAR will contain links to GSICS calibration information



GSICS included as a WIGOS component

Reference: http://www.wmo.int/pages/prog/sat/meetings/documents/GSICS-EP-16_Doc_06-01_reference-documents.pdf

GSICS is a pivotal element of the WMO Integrated Global Observing System (WIGOS), as it enables interoperability of different missions contributing to the space-based component of WIGOS.

GSICS 2020 Document: https://gsics.wmo.int/documents/GSICS_Vision-for-GSICS-in-2020s.pdf

V. INTER-CALIBRATION
Instruments should be inter-calibrated on a routine basis against reference instruments or calibration sites. The routine and operational inter-calibration and corrections shall be performed in accordance with standards as agreed by the Global Space-based Inter-calibration System (GSICS). (*Reference: WMO-No 1160 Manual on the WMO Integrated Global Observing System(WIGSO)*)

Manual on the WMO Integrated Global Observing System

Annex VIII to the WMO Technical Regulations

2015 edition

Manual on the WMO Integrated Global Observing System

4.3.1 **Calibration and traceability**

4.3.1.1 **Satellite operators shall perform a detailed instrument characterization before launch.**

4.3.1.2 **After launch, satellite operators shall calibrate all instruments on a routine basis against reference instruments or calibration targets.**

Notes:

1. Advantage should be taken of satellite collocation to perform on-orbit instrument intercomparison and calibration.
2. Calibration must be done in accordance with methodologies established and documented by the Global Space-based Inter-calibration System and the Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation.

4.3.1.3 **Satellite operators shall ensure traceability to the International System of Units (SI) standards.**

Note: The *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* (2010 Update), GCOS-138 (WMO/TD-No. 1523) calls for sustained measurement of key variables from space traceable to reference standards and recommends implementing and evaluating a satellite climate calibration mission.

4.3.1.4 **To ensure traceability to the International System of Units (SI) standards, satellite operators shall define a range of ground-based reference targets for calibration purposes.**

Forthcoming meetings and workshops

1. An SI-Traceable Space-based Climate Observing System Workshop(CEOS, CGMS/WMO-GSICS), NPL, UK, Sep 9-11, 2019

2. CEOS WGCV & CGMS/WMO GSICS pre-launch calibration and characterization workshop in early 2020.

3. Workshop on Recalibration/Re-processing for long term data records is being planned.

4. Expert meeting on Microwave Imager intercalibration at the GSICS research and data working group annual meeting – March 2020 - Seoul

Relevance to CGMS:

- Space Weather white paper on intercalibration needs and level of effort to allow agencies to assess support for a GSICS-like framework (New Action)
- GSICS integration in WIGOS and need for community workshops to develop or enhance the best practices and commitments to support the “Manual on the WMO Integrated Global Observing System”
- CGMS-46 Action on GSICS to have an expert workshop on microwave imager calibration/intercalibration will be held at the March 2020 GSICS Annual Meeting
- HLPP has been updated. MW and Reflective Solar Spectrometer subgroups have actions to determine how they can contribute to the Annual Observing System Report.
- ITWG radiative transfer (RT) model subgroup will establish a community reference RT line by line model to tie GSICS with GRUAN

To be considered by CGMS:

- For actioning: Space Weather white paper on intercalibration and level of effort to allow agencies to assess support for a GSICS-like framework

Backup - HLPP additions, GSICS internal actions and GSICS Observing System Report

Review of HLPP

4 ENHANCE THE QUALITY OF SATELLITE-DERIVED DATA AND PRODUCTS

4.1 Establish a fully consistent calibration of relevant satellite instruments across CGMS agencies, recognising the importance of collaboration between operational and research CGMS agencies

- 4.1.1 Establish within GSICS a consistent inter-calibration for thermal IR channels using hyper-spectral sounders as reference. The implementation will be done successively by the individual satellite operators;

- 4.1.2 Establish within GSICS a consistent inter-calibration for solar channels using instruments with adequate in-orbit calibration and vicarious methods as reference. The implementation will be done successively by the individual satellite operators;

New proposed HLPP Targets

- 4.1.3 Establish within GSICS a consistent calibration for reflective solar spectrometers by using instruments with stable orbits, good ground-based pre-launch calibration, adequate on-board degradation and wavelength scale characterization, and monitored records over PICS and ground-based atmospheric composition measurement sites with state of the art RT generation of radiance / irradiance ratios either absolute or relative constituent pattern differences.

- 4.1.4 Establish within GSICS a consistent inter-calibration for microwave channels. The implementation will be done successively by the individual satellite operators;

New Actions from EP-20

NEW ACTIONS FROM EP-20 (1/3)

Reference	Action Description	Actionee	Due date
A.GEP.20190517.1	EP Chair to coordinate with WIGOS for utilizing GSICS Product Catalog with Quicklooks in WDQM system	EP Chair	EP-21
A.GEP.20190517.2	EP Chair to coordinate with WIGOS to enhance collaboration to integrate GSICS into WIGOS	EP Chair	EP-21
A.GEP.20190517.3	NASA, ESA, ISRO to provide a landing page with instrument link(s) for inclusion in the satellite instrument pages in WMO-OSCAR. Initially, the landing page will provide a link or link(s) to those satellite instruments of high interest to GSICS.	NASA, ESA, ISRO	EP-21
A.GEP.20190517.4	EP members to review the CGMS SWCG white paper for a possible contribution to SWCG activity	EP members	EP-21
A.GEP.20190517.5	ROSCOSMOS requested to remove requirement of login on their GPRC page	ROSCOSMOS	EP-21
A.GRWG.20190516.1	GRWG to prepare the State of Observing System report	GRWG Chair	EP-21

NEW ACTIONS FROM EP-20 (2/3)

Reference	Action Description	Actionee	Due date
A.GRWG.20190516.2	GRWG to organize the mini-conference on MW inter-calibration in 2020 GSICS annual meeting	GRWG+GDWG chair	March 2020
A.GRWG.20190516.3	GRWG to develop Terms of References for sub-groups.	GRWG Chair	EP-21
A.GDWG.20190516.1	GDWG Chair to request CGMS Task Force on Satellite Data and Codes to review a proposal of adding SRF to International Data Subcategory of Common Table C-13 of WMO Manual on Codes for a coordination with WMO IPET-CM.	GDWG Chair	EP-21
A.GDWG.20190516.2	GDWG Chair and Rob Roebeling (EUMETSAT) to review existing event logging database at each agency to ensure best practices are met.	GDWG Chair	EP-21
A.GDWG.20190516.3	GDWG Chair to develop a procedure on updating Annual GSICS Observing System Report.	GDWG Chair	EP-21

NEW ACTIONS FROM EP-20 (3/3)

Reference	Action Description	Actionee	Due date
A.GCC.20190516.1	GCC to relax User Guide requirement and Uncertainty for GSICS Products, if measurements come from operational maturity	GCC	EP-21
A.GCC.20190516.2	GCC with GRWG to demonstrate the QA4EO nature of selection criterion of reference Instrument to EP members	GCC	EP-21
A.GCC.20190516.3	GCC to draft the QA4EO based selection criterion of GSICS Deliverables for the endorsement by EP	GCC	EP-21
A.GCC.20190516.4	GCC to share the recommendations of EXP-5 on applying QA4EO processes in GSICS (e.g. GPPA) with GSICS EP	GCC	EP-21
A.GEP.20190516.6	WMO to address the letter to ISRO GDWG Chair	WMO	June 2019

Annual GSICS Calibration Report on the State of the Observing System

Masaya Takahashi (JMA), Xiuqing Hu (CMA) and Dohyeong Kim (KMA) with great supports of GRWG members of GEO operating agencies

Background/Progress

- Action at GSICS-EP-18 (2017)

Reference	Action Description	Actionee	Due date
EP-18.A03	GDWG and GRWG to develop an approach for an Annual GSICS report on the State of the Observing System with respect to Instrument Performance and Inter-comparisons with GSICS Reference Instruments	GDWG and GRWG	EP-19 (Jun 2018)

- Reports for operational GEO imagers
  - Draft was developed by GRWG/GDWG and endorsed at 2019 GRWG/GDWG Annual Meeting (Mar 2019, Frascati)
  - To be submitted by GSICS-EP to CGMS-47 as “First Annual State of Global Observing System” (CGMS-47-GSICS-WP-02)

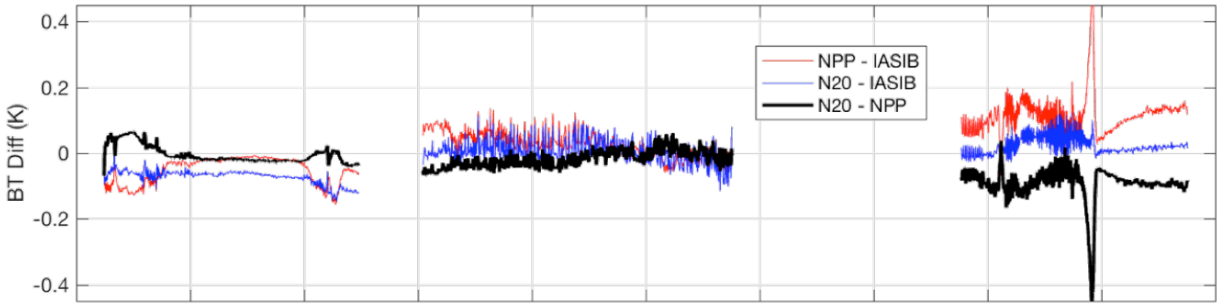
Concepts of Annual Report

- Target audience: satellite data users + operators (incl. non calibration experts)
- Keeping report contents SIMPLE
  - Satellite/Instrument events on calibration: 1 page for agency
  - Radiometric calibration performance for GEO imagers (at this stage)
    - ✓ 1-2 page / instrument using GSICS inter-calibration approaches
    - ✓ Table summarizing bias/unc for one year (shorter period in special cases)
    - ✓ Time series chart of bias/unc for days since operation start (or one year)
  - Performance of reference instruments by Double Difference
    - ✓ Agencies responsible for the instruments are expected to do the validation
  - Detailed information: to be navigated to Calibration Landing Page
- Adopting existing formats as possible
  - Color chart on NOAA satellite status, visualization tools (e.g. GSICS Plotting Tool)

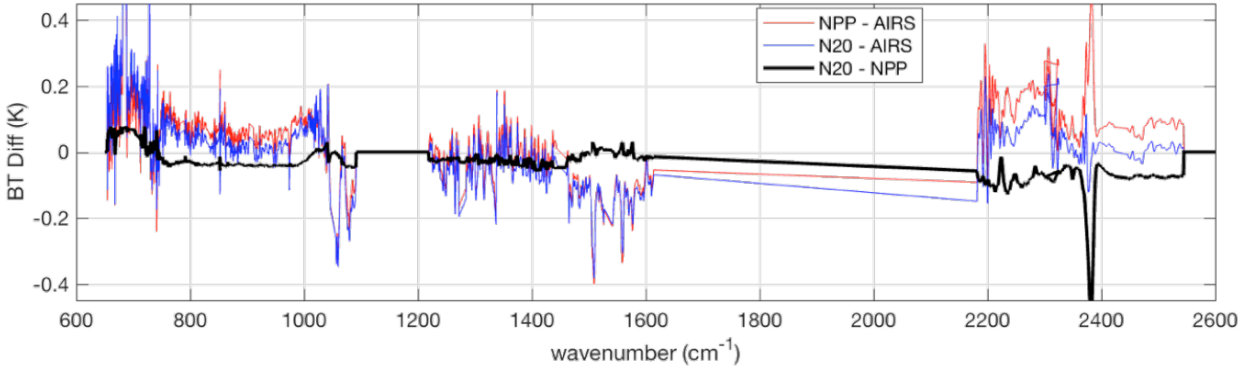
Establishing reference instruments

Example Cal/Val Result: SNOs with IASI and AIRS

Differences with IASI-B, and NOAA20/SNPP differences via IASI-B (All FOV means)



Differences with AIRS, and NOAA20/SNPP differences via AIRS (All FOV means)



- Differences between NOAA20 CrIS and SNPP CrIS are less than 0.1K
- Differences from IASI-B are less than 0.2K, Differences from AIRS are less than 0.4K
- Larger diffs observed for cold SW scenes, but with NOAA20 CrIS agreeing better with IASI and AIRS as compared to SNPP CrIS. Expect some improvements with polarization correction.

The following slides: reports for operational GEO imagers for 2018

1. CMA
2. EUMETSAT (Tim Hewison and Sebatien Wagner)
3. JMA (Masaya Takahashi and Yusuke Yogo)
4. KMA (Dohyeong Kim, Minju Gu, and Eunkyu Kim)
5. NOAA (Fred Wu, Fangfang Yu, and Hyelim Yoo)
6. ROSHYDROMET (Alexey Rublev and Alexander Uspensky)

CMA Annual GSICS Calibration Report for 2018

Satellite/Instrument Summary - GEO

Hyperlinks on instrument names navigate to the Calibration Landing Page

Satellite (status)		Location	Launch date	EO instruments			
FY-2F	(L)	112 E	2012-1-13	S-VISSR			
FY-2G	(Op)	105 E	2014-12-31	S-VISSR			
FY-2H	(L)	97 E	2018-06-05	S-VISSR			
FY-4A	(P)	104.7 E	2016-12-11	AGRI	GIIRS	LMI	SEP

- Major calibration relevant events in 2018

Satellite Status

Op = Operational

P = Pre-operational

B = Back-up, secondary

L = Limited availability

Instrument Status

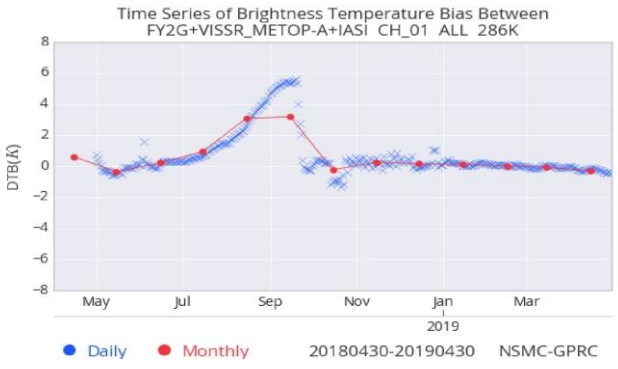
- Operational (or capable of)
- Operational with limitations (or Standby)
- Operational with Degraded Performance
- Not Operational
- Functional, Turned Off

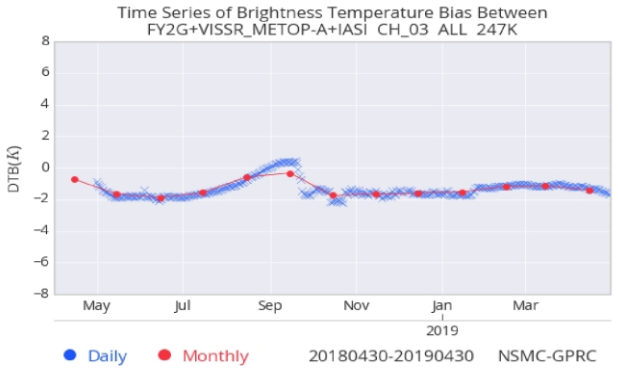
Calibration Performance: FY-2 /VISSR IR Bands

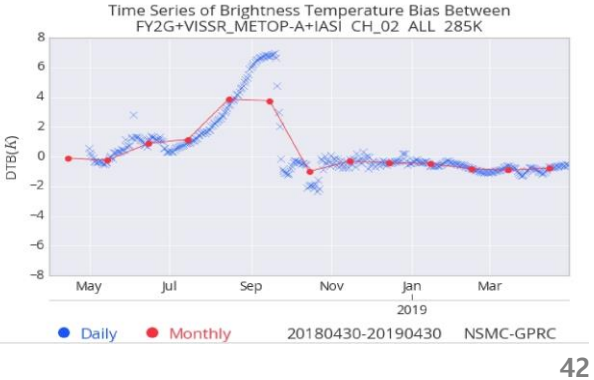
		FY-2F			FY-2G			FY-2H		
	Channel Name (Central Wavelength in μm)	BAND1 (10.8)	BAND2 (12)	BAND3 (6.7)	BAND1 (10.8)	BAND2 (12)	BAND3 (6.7)	BAND1 (10.8)	BAND2 (12)	BAND3 (6.7)
	Std. Radiance as Tb (K)	286	285	247	286	285	247	286	285	247
Metop-A/ IASI	Mean Bias (K)	2.373	3.827	1.739	0.171	-0.467	-1.749	-1.423	-2.676	-2.178
	Stdv. of Bias (K)	1.457	1.604	1.942	1.140	1.168	0.480	1.209	1.287	0.585
S-NPP/ CrIS	Mean Bias (K)	2.038	3.240	1.844	0.058	-0.516	-1.312	-1.369	-2.609	-2.127
	Stdv/ of Bias (K)	1.670	1.895	1.244	1.096	1.131	0.691	0.967	1.015	0.487

- The statistics are derived from FY-2 GSICS Re-Analysis Correction (ATBD)
- Standard Radiance: typical scene defined by GSICS for easy inter-comparison of sensors' inter-calibration biases
- Mean Bias: monthly average and standard deviation of the daily results in January 2019

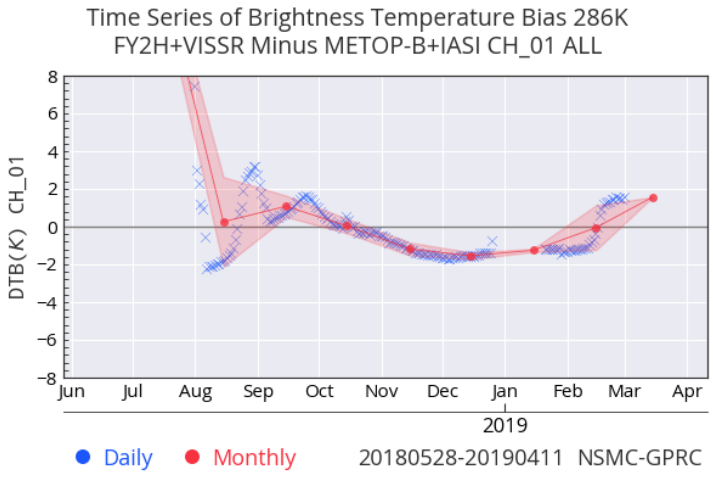
Time series of FY-2G /VISSR Tb biases w.r.t. Metop-B/IASI at std. radiance

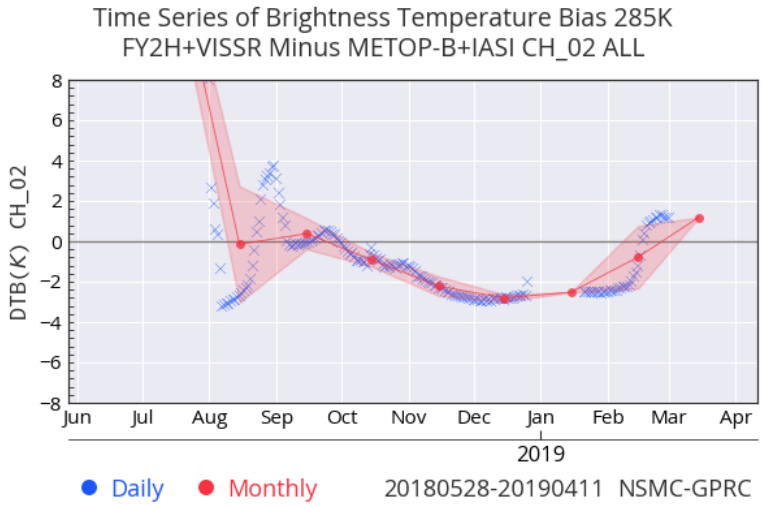


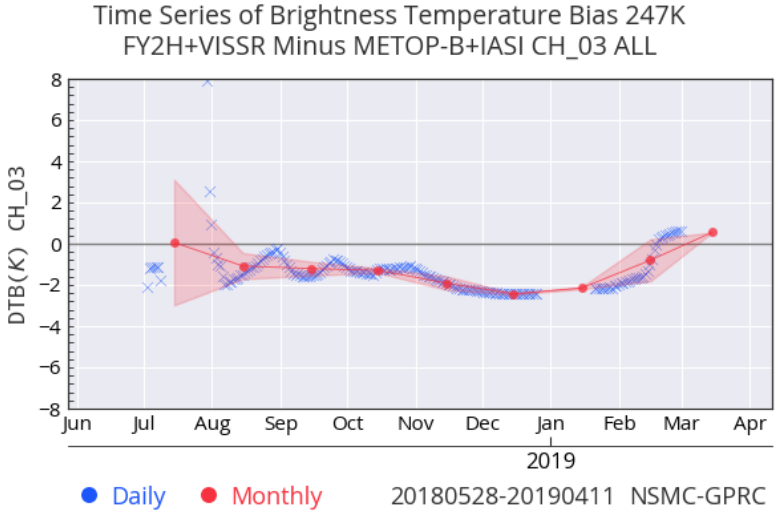




FY-2H IR calibration monitoring





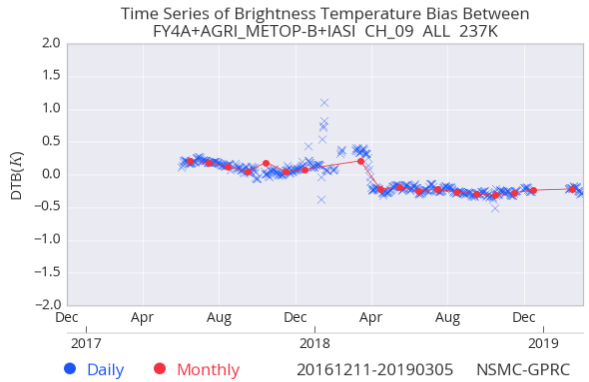


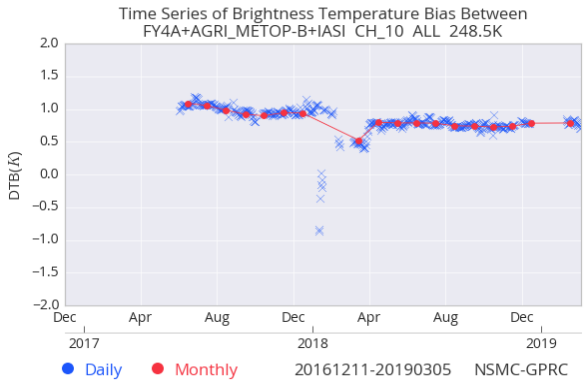
FY-2H stands as “Belt and Road” satellite. Its IR calibration monitoring based on IASI and CrIS is not operationally running currently

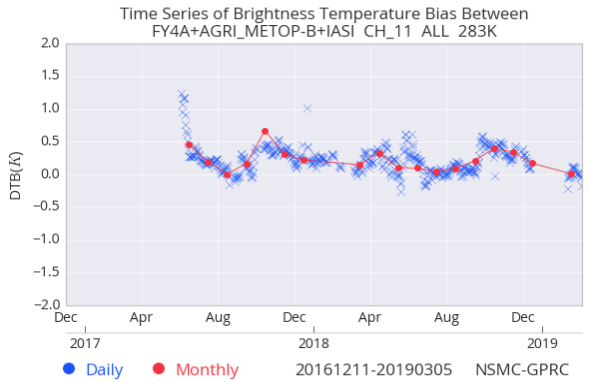
Calibration Performance: FY-4 /AGRI IR Bands

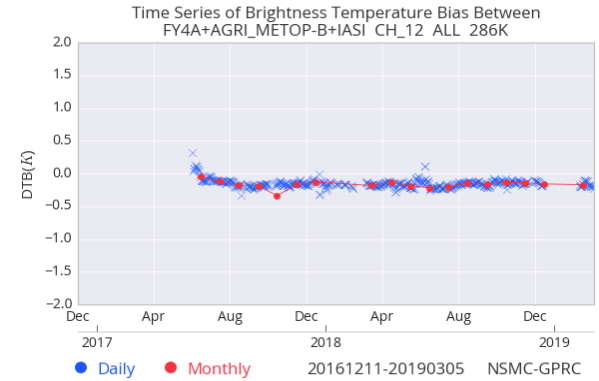
	Channel Name (Central Wavelength in μm)	BAND09 (6.3)	BAND10 (7.1)	BAND11 (8.5)	BAND12 (10.8)	BAND13 (12)	BAND14 (13.3)
	Std. Radiance as Tb (K)	237	248	283	286	285	258
Metop-A/ IASI	Mean Bias (K)	-0.190	0.753	0.290	-0.115	-0.156	0.127
	Stdv. of Bias (K)	0.211	0.194	0.559	0.187	0.213	1.172
S-NPP/ CrIS	Mean Bias (K)	-0.211	0.728	0.300	-0.135	-0.196	0.248
	Stdv/ of Bias (K)	0.229	0.209	0.607	0.216	0.209	1.347

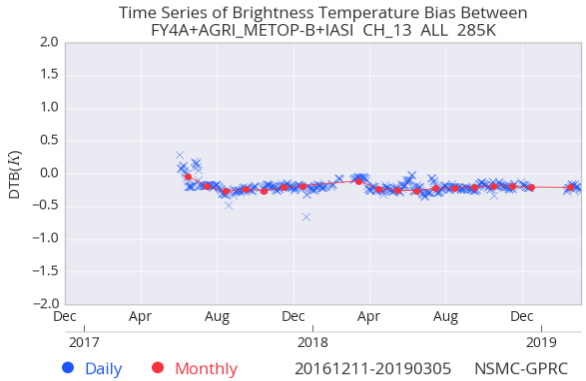
- Mean Bias: monthly average and standard deviation of the daily results in Jan. 2019

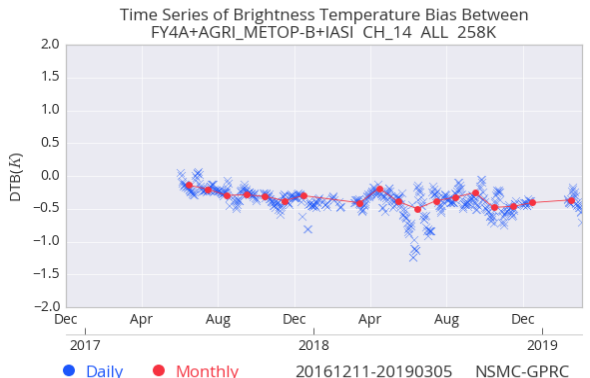








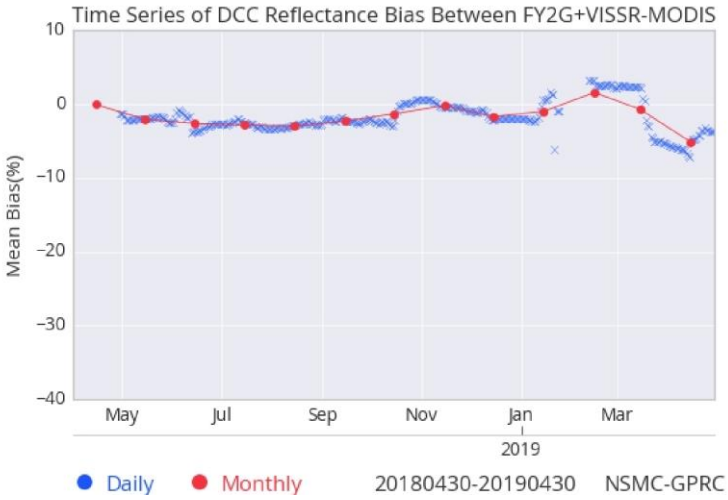


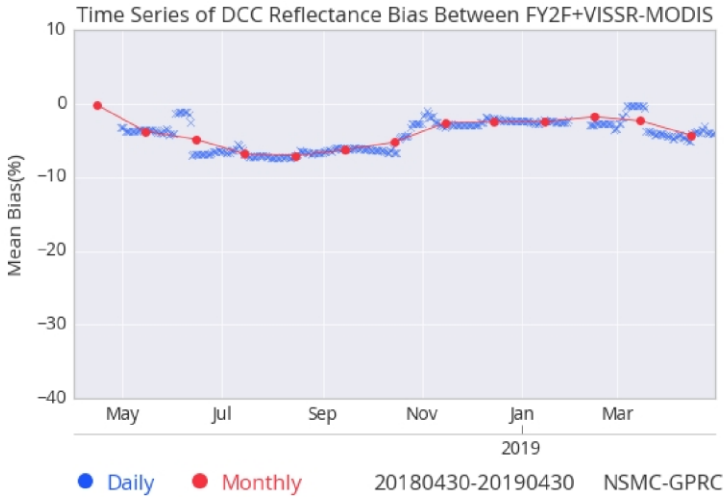


Calibration Performance: FY-2/VISSR VIS Bands

Channel Name (Central Wavelength in μm)		FY-2F	FY-2G	Units
DCC	Mean Bias	-4.27 ± 2.01	-1.86 ± 2.04	%
	Annual Drift	3.39	0.80	%/yr

- Mean Bias: monthly average and standard deviation of the daily results in January 2018
- Annual Drift: calculated using Mean Bias from July 2015 to January 2019





EUMETSAT Annual GSICS Calibration Report for 2018

Tim Hewison, Sebastien Wagner

EUMETSAT

Satellite/Instrument Summary - GEO

Hyperlinks on instrument names navigate to the Calibration Landing Page

Satellite (status)		Location	Launch date	EO instruments			
Meteosat-8	Op	41.5 E	2002-08-28	SEVIRI	GERB		
Meteosat-9	B	3.5 E	2005-12-21	SEVIRI	GERB		
Meteosat-10	RSS	9.5 E	2012-07-05	SEVIRI	GERB		
Meteosat-11	Op	0.0 E	2015-07-15	SEVIRI	GERB		

- Major calibration relevant events in 2018
  - **2018-02-05/13** Meteosat-11 moved 3.4°W to 0°E
  - **2018-02-08/27** Meteosat-10 moved 0°E to 9.5°E
  - **2018-02-21/03-05** Meteosat-9 moved 9.5°E to 3.5°E
  - **2018-02-20** Meteosat-11 Operational 0° prime
  - **2018-03-13** Meteosat-10 Operational 9.5°E RSS
  - **2018-03-13** Meteosat-9 to Backup
  - **2018-12-03/08** Meteosat-10 Decontamination

  - UNS Technical Bulletin

Satellite Status

Op = Operational

P = Pre-operational

B = Back-up, secondary

L = Limited availability

Instrument Status

Operational (or capable of)

Operational with limitations (or Standby)

Operational with Degraded Performance

Not Operational

Functional, Turned Off

Calibration Performance: Meteosat/SEVIRI Visible Bands

Summary Statistics of Meteosat/SEVIRI VIS/NIR Calibration Performance (All Uncertainties are k=1)

Channel Name		VIS0.6	VIS0.8	NIR1.6	HRV	Units
Meteosat-8	Mean Bias (DCC-SSCC)	**+13.6 ± 2.5**				%
	Annual Drift (DCC)	-0.54 ± 0.08				%/yr
	Annual Drift (SSCC)	-0.56 ± 0.03	-0.55 ± 0.03	-0.04 ± 0.03	-0.52 ± 0.03	%/yr
	Annual Drift (LCS)	-0.57 ± 0.01	-0.53 ± 0.01	-0.02 ± 0.02	-0.55 ± 0.02	%/yr
Meteosat-9	Annual Drift (SSCC)	-0.54 ± 0.08	-0.57 ± 0.07	-0.04 ± 0.07	-0.55 ± 0.08	%/yr
	Annual Drift (LCS)	-0.57 ± 0.01	-0.52 ± 0.01	-0.06 ± 0.03	-0.52 ± 0.03	%/yr
Meteosat-10	Annual Drift (SSCC)	-0.66 ± 0.14	-0.63 ± 0.11	-0.02 ± 0.11	-0.71 ± 0.12	%/yr
	Annual Drift (LCS)	-0.84 ± 0.03	-0.71 ± 0.02	-0.01 ± 0.08	-0.98 ± 0.08	%/yr
Meteosat-11	Mean Bias (DCC-SSCC)	**+10.0 ± 0.8**				%
	Annual Drift (DCC)	-0.13 ± 0.11				%/yr
	Annual Drift (SSCC)	-0.30 ± 0.38	-0.25 ± 0.36	-0.08 ± 0.34	-0.32 ± 0.36	%/yr
	Annual Drift (LCS)	-0.60 ± 0.07	-0.42 ± 0.05	+1.18 ± 0.20	-0.75 ± 0.08	%/yr

- Mean Bias: Mean and SD of difference of DCC from operational (SSCC) calibration for all 2018 pentad results
- Annual Drift: Mean gain drift and uncertainty calculated from DCC and operational (SSCC) over each satellite life
- DCC: Demonstration GSICS Deep Convective Cloud inter-calibration, with respect to Aqua/MODIS
- SSCC: SEVIRI Solar Channel Calibration System = vicarious calibration used operationally for SEVIRI

Calibration Performance: Meteosat/SEVIRI Visible Bands

- Mean Bias: Mean and SD of difference of DCC from operational (SSCC) calibration for all 2018 pentad results
- Annual Drift: Mean gain drift and uncertainty calculated from DCC and operational (SSCC) over each satellite life
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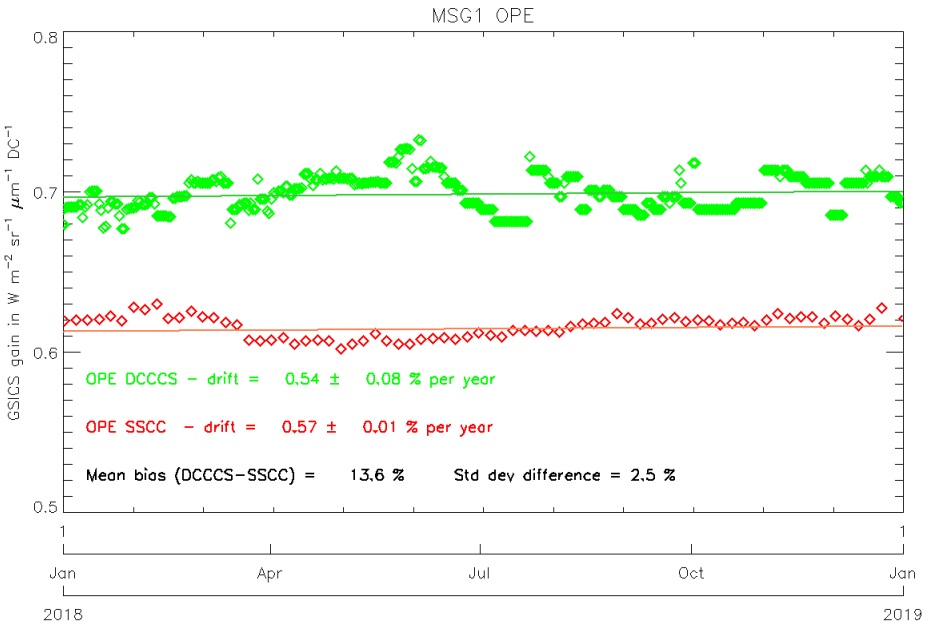
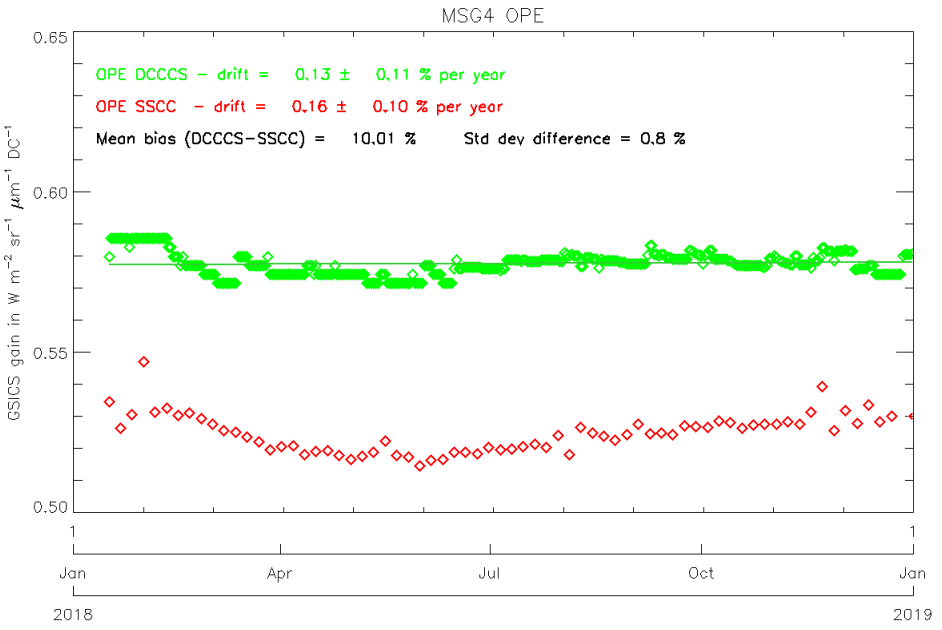




Time Series of gains derived for Meteosat-8 (MSG1) and -11 (MSG4) VIS0.6 channel
SSCC (red), DCC (green).

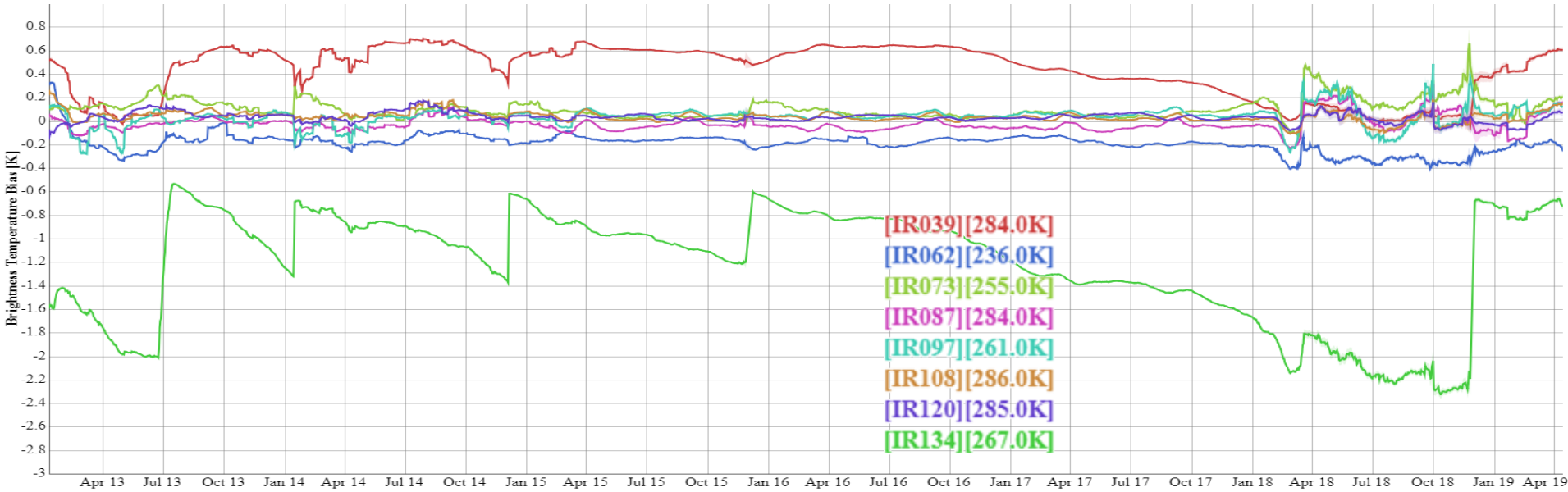
Calibration Performance: Meteosat-10/SEVIRI IR Bands

Summary Statistics of Meteosat-10/SEVIRI IR Calibration Performance in 2018 (All uncertainties are k=1)

Channel Name	IR3.9	IR6.2	IR7.3	IR8.7	IR9.7	IR10.8	IR12.0	IR13.4
Standard Radiance as Tb (K)	284	236	255	284	261	286	285	267
Mean Bias (K)	+0.10	-0.30	+0.21	+0.04	+0.05	+0.01	+0.02	-1.94
Standard Deviation of Bias (K)	0.10	0.05	0.13	0.12	0.15	0.06	0.05	0.41
Mean Drift Rate of Bias (K/yr)	+0.07	-0.07	+0.11	+0.05	-0.02	-0.00	-0.05	+0.22

- The statistics are derived from Meteosat-10/SEVIRI Operational GSICS Re-Analysis Correction vs. Metop-A/IASI
- Biases defined for Standard Radiance: typical scene for easy inter-comparison of sensors' inter-calibration biases
- Decontaminations introduce calibration jumps – most obvious in the IR13.4 channel due to ice contamination

Time series of Meteosat-10/SEVIRI Tb biases w.r.t. Metop-A/IASI at standard radiance



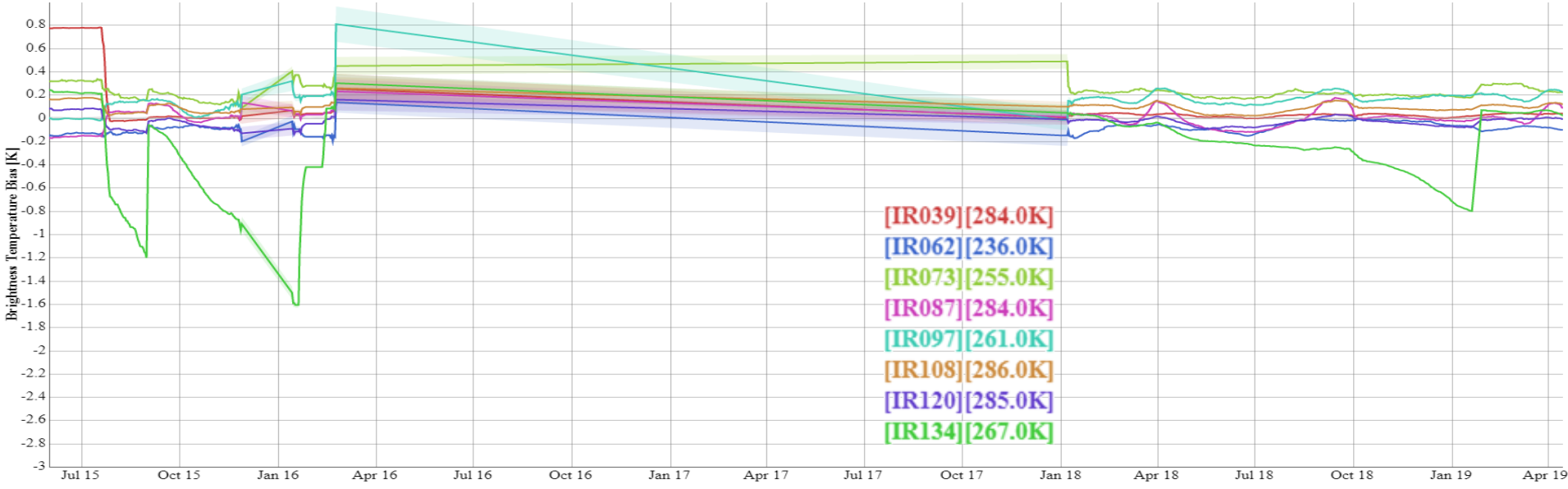
Calibration Performance: Meteosat-11/SEVIRI IR Bands

Summary Statistics of Meteosat-10/SEVIRI IR Calibration Performance in 2018 (All uncertainties are k=1)

Channel Name	IR3.9	IR6.2	IR7.3	IR8.7	IR9.7	IR10.8	IR12.0	IR13.4
Standard Radiance as Tb (K)	284	236	255	284	261	286	285	267
Mean Bias (K)	+0.03	-0.06	+0.22	+0.00	+0.17	+0.09	-0.03	-0.22
Standard Deviation of Bias (K)	0.01	0.05	0.04	0.07	0.04	0.04	0.03	0.17
Mean Drift Rate of Bias (K/yr)	-0.01	+0.11	-0.05	+0.01	+0.04	-0.01	-0.01	-0.58

- The statistics are derived from Meteosat-11/SEVIRI Operational GSICS Re-Analysis Correction vs. Metop-A/IASI
- Biases defined for Standard Radiance: typical scene for easy inter-comparison of sensors' inter-calibration biases
- Decontaminations introduce calibration jumps – most obvious in the IR13.4 channel due to ice contamination

Time series of Meteosat-11/SEVIRI Tb biases w.r.t. Metop-A/IASI at standard radiance



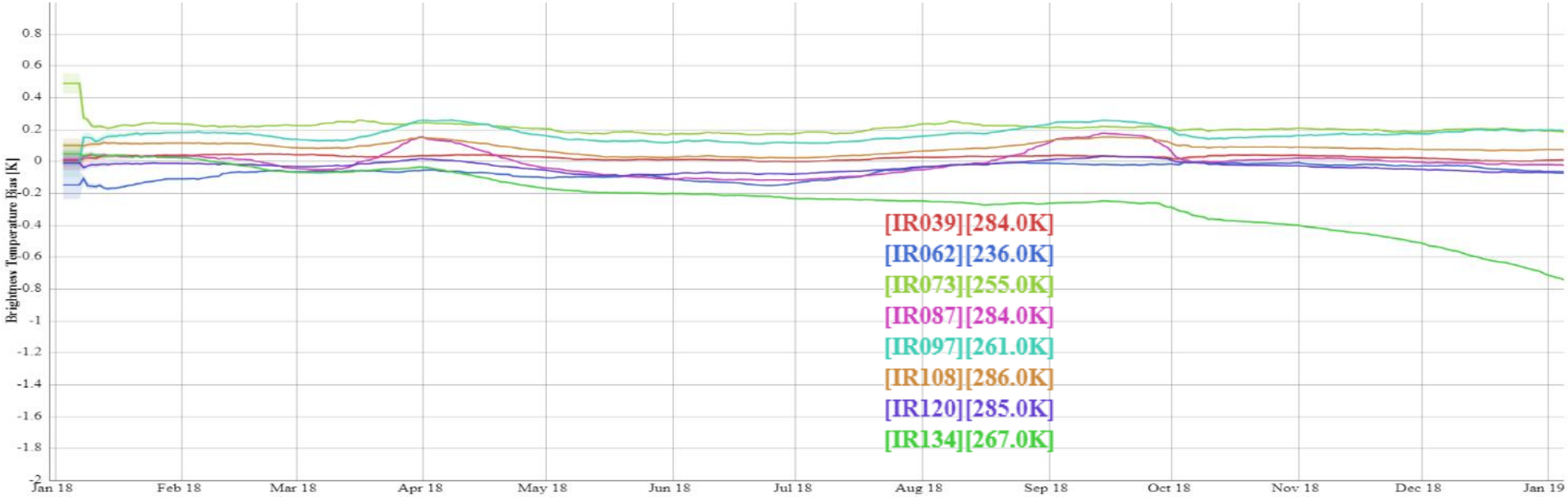
Calibration Performance: Meteosat-11/SEVIRI IR Bands

Summary Statistics of Meteosat-10/SEVIRI IR Calibration Performance in 2018 (All uncertainties are k=1)

Channel Name	IR3.9	IR6.2	IR7.3	IR8.7	IR9.7	IR10.8	IR12.0	IR13.4
Standard Radiance as Tb (K)	284	236	255	284	261	286	285	267
Mean Bias (K)	+0.03	-0.06	+0.22	+0.00	+0.17	+0.09	-0.03	-0.22
Standard Deviation of Bias (K)	0.01	0.05	0.04	0.07	0.04	0.04	0.03	0.17
Mean Drift Rate of Bias (K/yr)	-0.01	+0.11	-0.05	+0.01	+0.04	-0.01	-0.01	-0.58

- The statistics are derived from Meteosat-11/SEVIRI Operational GSICS Re-Analysis Correction vs. Metop-A/IASI
- Biases defined for Standard Radiance: typical scene for easy inter-comparison of sensors' inter-calibration biases
- Decontaminations introduce calibration jumps – most obvious in the IR13.4 channel due to ice contamination

Time series of Meteosat-11/SEVIRI Tb biases w.r.t. Metop-A/IASI at standard radiance



JMA Annual GSICS Calibration Report for 2018

Masaya Takahashi, Yusuke Yogo

Japan Meteorological Agency

Satellite/Instrument Summary - GEO

Satellite (status)		Location	Launch date	EO instruments			
Himawari-8	(Op)	140.7 E	2014-10-07	AHI			
Himawari-9	(B)	140.7 E	2016-11-02	AHI			

Hyperlinks on instrument names navigate to the Calibration Landing Page

- Major calibration relevant events in 2018
  - **2018-02-14**: Himawari-8 maintenance (backup operation by Himawari-9 for about 2 days)

Satellite Status

Op = Operational

P = Pre-operational

B = Back-up, secondary

L = Limited availability

Instrument Status

- Operational (or capable of)
- Operational with limitations (or Standby)
- Operational with Degraded Performance
- Not Operational
- Functional, Turned Off

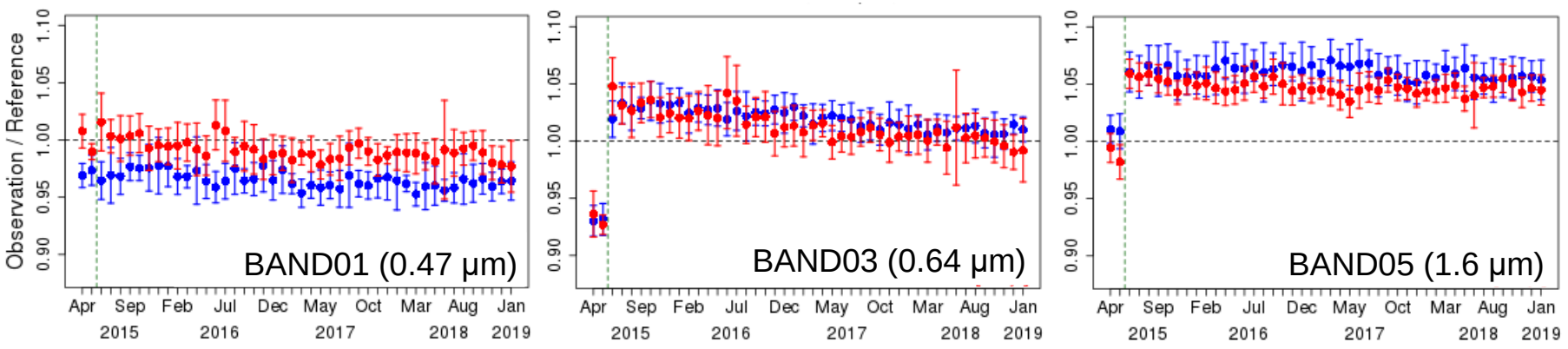
Calibration Performance: Himawari-8/AHI VIS/NIR Bands

Summary Statistics of Himawari-8/AHI VNIR Calibration Performance (All Uncertainties are k=1)

Channel Name (Central Wavelength in μm)		BAND01 (0.47)	BAND02 (0.51)	BAND03 (0.64)	BAND04 (0.86)	BAND05 (1.6)	BAND06 (2.3)	Units
Ray-matching w/ S-NPP/VIIRS	Mean Bias	-3.6 ± 2.6	-2.0 ± 1.6	+1.1 ± 2.1	-0.4 ± 1.8	+5.8 ± 1.2	-5.5 ± 1.5	%
	Annual Drift	-0.38 ± 0.08	-0.50 ± 0.07	-0.77 ± 0.05	-0.57 ± 0.04	-0.22 ± 0.07	-0.23 ± 0.05	%/yr
Vicarious Cal. using Aqua/MODIS + RTM	Mean Bias	-1.1 ± 1.6	-2.3 ± 1.6	+0.51 ± 1.7	+1.6 ± 1.6	+4.4 ± 0.9	-4.1 ± 1.0	%
	Annual Drift	-0.48 ± 0.10	-0.68 ± 0.10	-1.04 ± 0.10	-0.86 ± 0.10	-0.20 ± 0.07	-0.17 ± 0.10	%/yr

- Mean Bias: monthly average and standard deviation of the daily results in January 2018
- Annual Drift: calculated using Mean Bias from July 2015 to January 2019
- Ray-matching: Spectral Band Adjustment Factors on NASA Langley website compensates Spectral diff. (ATBD)
- Vicarious calibration uses optical parameters retrieved from Aqua/MODIS C6 L1B (Reference)

Trend of the ratio of observation to reference computed using Ray-matching / Vicarious calibration approaches



Calibration Performance: Himawari-8/AHI Infrared Bands

Summary Statistics of Himawari-8/AHI IR Calibration Performance in 2018 (All uncertainties are k=1)

	Channel Name (Central Wavelength in μm)	BAND07 (3.9)	BAND08 (6.2)	BAND09 (6.9)	BAND10 (7.3)	BAND11 (8.6)	BAND12 (9.6)	BAND13 (10.4)	BAND14 (11.2)	BAND15 (12.4)	BAND16 (13.3)
	Std. Radiance as Tb (K)	286.0	234.6	243.9	254.6	283.8	259.5	286.2	286.1	283.8	269.7
Metop-A/ IASI	Mean Bias (K)	-0.149	-0.184	-0.223	-0.127	-0.062	-0.239	0.036	0.047	-0.036	0.106
	Stdv. of Bias (K)	0.006	0.009	0.008	0.020	0.012	0.012	0.020	0.020	0.017	0.016
S-NPP/ CrIS	Mean Bias (K)	-0.114	-0.165	-0.248	-0.157	N/A	-0.249	-0.019	-0.012	-0.099	0.036
	Stdv/ of Bias (K)	0.177	0.011	0.014	0.028	N/A	0.010	0.017	0.017	0.016	0.013

- The statistics are derived from Himawari-8/AHI GSICS Re-Analysis Correction (ATBD)
- Standard Radiance: typical scene defined by GSICS for easy inter-comparison of sensors' inter-calibration biases

Time series of Himawari-8/AHI Tb biases w.r.t. Metop-A/IASI at std. radiance (2015-07-07 to 2018-12-31)

KMA Annual GSICS Calibration Report for 2018

Dohyeong Kim, Minju Gu, and Eunkyu Kim
Korea Meteorological Administration

Satellite/Instrument Summary - GEO

Satellite (status)		Location	Launch date	EO instruments			
COMS	(Op)	128.2E	2010-06-26	MI			
GK-2A	(P)	128.2 E	2018-12-04	AMI			

Hyperlinks on instrument names navigate to the Calibration Landing Page

- Major calibration relevant events in 2018
  - **2018-08-31** : relocation of COMS for preparation of GK-2A/2B collocation
  - **2018-12-04** : launch and start of commissioning GK-2A

Satellite Status

Op = Operational

P = Pre-operational

B = Back-up, secondary

L = Limited availability

Instrument Status

- Operational (or capable of)
- Operational with limitations (or Standby)
- Operational with Degraded Performance
- Not Operational
- Functional, Turned Off

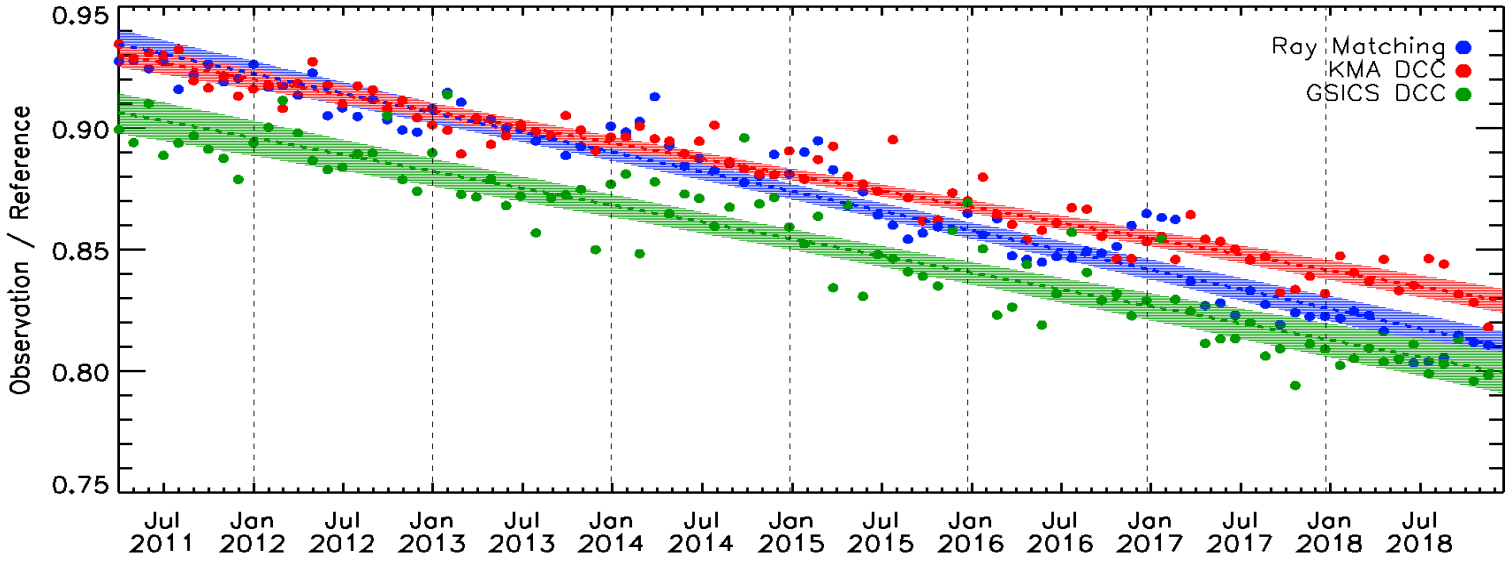
Calibration Performance: COMS/MI Visible Band

Summary Statistics of COMS/MI VIS Calibration Performance from 2011 to 2018 (All uncertainties are k=1)

- Mean Bias: monthly average and standard deviation of the daily results from April 2011 to December 2018.
- Annual Drift: calculated using Mean Bias from April 2011 to December 2018.
- Ray-matching: GEO-LEO Inter-calibration method using MI(COMS) and MODIS(Terra) based on DCC condition
- KMA DCC: Comparison MI and RTM(SBDART).
- GSICS DCC: Using Hu BRDF Model.

Channel Name		Visible (0.675μm)
Ray-matching (DCC) / MODIS(Terra)	Mean Bias[%]	-12.7 ± 5.5
	Annual Drift[%/yr]	-1.60 ± 0.12
KMA DCC / RTM(SBDART)	Mean Bias[%]	-12.0 ± 6.5
	Annual Drift[%/yr]	-1.30 ± 0.10
GSICS DCC / MODIS(Aqua)	Mean Bias[%]	-14.7 ± 9.2
	Annual Drift[%/yr]	-1.38 ± 0.16

Trend of the ratio of observation to reference computed using Ray-matching / KMA DCC / GSICS DCC approaches

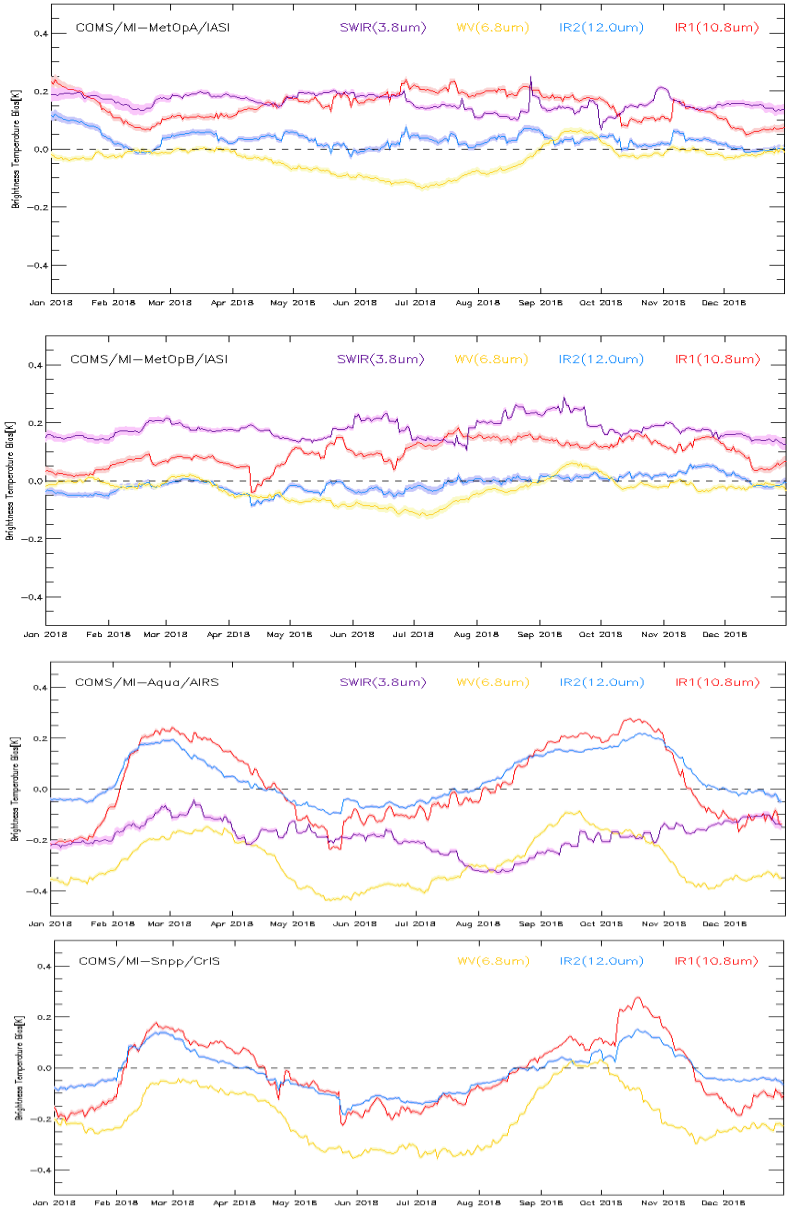


Calibration Performance: COMS/MI Infrared Bands

Summary Statistics of COMS/MI IR Calibration Performance in 2018 (All uncertainties are k=1)

	MetOp-A/IASI				MetOp-B/IASI			
Channel Name	IR3.8	IR6.8	IR10.8	IR12.0	IR3.8	IR6.8	IR10.8	IR12.0
Std Rad as Tb (K)	286	238	286	285	286	238	286	285
Mean Bias (K)	0.16	-0.03	0.15	0.03	0.18	-0.03	0.10	-0.01
Stdv of Bias (K)	0.03	0.05	0.05	0.03	0.03	0.04	0.05	0.03
Mean Drift Rate of Bias (K/yr)	+0.18	-0.05	+0.16	+0.05	+0.17	-0.04	+0.05	-0.04

	Snpp/CrIS				Aqua/AIRS			
Channel Name	IR3.8	IR6.8	IR10.8	IR12.0	IR3.8	IR6.8	IR10.8	IR12.0
Std Rad as Tb (K)	286	238	286	285	286	238	286	285
Mean Bias (K)	-	-0.20	-0.02	-0.02	-0.19	-0.29	0.02	0.04
Stdv of Bias (K)	-	0.10	0.13	0.08	0.06	0.09	0.15	0.09
Mean Drift Rate of Bias (K/yr)	-	-0.19	-0.04	-0.03	-0.18	-0.29	-0.01	+0.02



- The statistics are derived from COMS/MI Operational GSICS Re-Analysis Correction vs. Metop-A/IASI, Metop-B/IASI, Aqua/AIRS, SNPP/CrIS
- Biases defined for Standard Radiance: typical scene for easy inter-comparison of sensors' inter-calibration biases

NOAA Annual GSICS Calibration Report for 2018

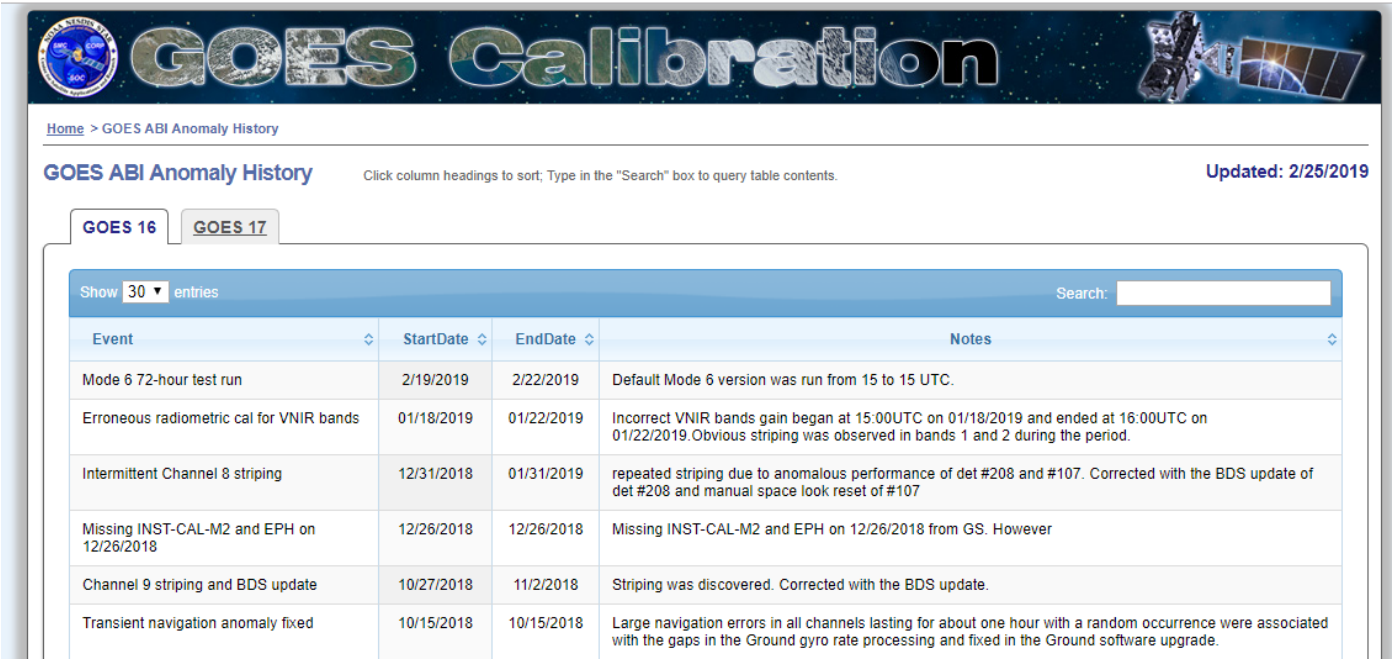
Fred Wu, Fangfang Yu, and Hyelim Yoo
NOAA

Satellite/Instrument Summary - GEO

Satellite (status)		Current Location	Launch Date	Operation Date
GOES-15*	(Op)	128W	2010-03-04	2011-12-06
GOES-16	(Op)	75.2W (GOES-East)	2016-11-19	2017-12-18
GOES-17	(Op)	137.2W (GOES-West)	2018-03-01	2019-02-12

* GOES-15 drifted from 135W on 2018-10-23 and arrived the new operating location of 128W on 2018-11-07. GOES-17 and GOES-15 will operate in tandem for 6 months from their respective locations of 137.2W and 128W.

GOES-16/17 ABI Calibration Event Log:
https://www.star.nesdis.noaa.gov/GOESCal/goes_SatelliteAnomalies.php

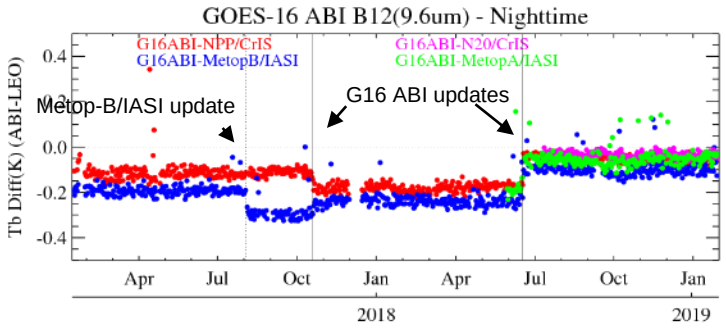


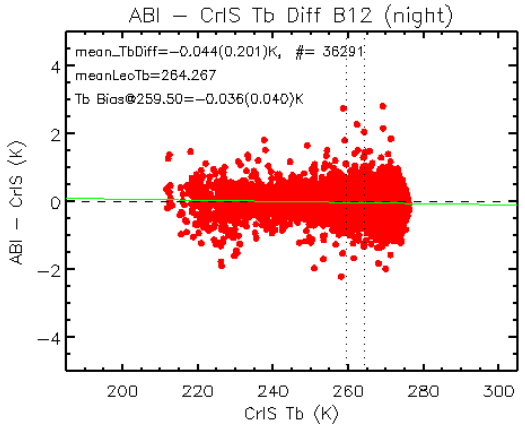
Calibration Performance: GOES16/ABI Infrared Bands

Summary Statistics of GOES-16/ABI IR Calibration Performance in December 2018 (All uncertainties are k=1)

	Channel Name (Central Wavelength in μm)	BAND07 (3.9)	BAND08 (6.2)	BAND09 (6.9)	BAND10 (7.3)	BAND11 (8.6)	BAND12 (9.6)	BAND13 (10.4)	BAND14 (11.2)	BAND15 (12.4)	BAND16 (13.3)
	Std. Scene Tb (K)	286.0	234.5	244.0	254.5	284.0	259.5	286.0	286.0	283.5	269.5
Metop-A/ IASI	Bias at Std. Scene(K)	-0.03	-0.11	-0.12	-0.05	-0.05	-0.05	-0.03	0.04	0.03	-0.10
	Stdv. of Bias (K)	0.08	0.06	0.07	0.08	0.11	0.08	0.12	0.12	0.12	0.12
Metop-B/ IASI	Bias at Std. Scene(K)	-0.00	-0.12	-0.14	-0.07	-0.04	-0.10	-0.02	0.05	0.03	-0.12
	Stdv. of Bias (K)	0.18	0.13	0.08	0.09	0.19	0.13	0.21	0.21	0.22	0.20
S-NPP/ CrIS	Bias at Std. Scene(K)	-	-	-0.14	-0.09	-	-0.05	-0.07	-0.01	-0.03	-0.15
	Stdv of Bias (K)	-	-	0.03	0.04	-	0.04	0.06	0.06	0.07	0.06
NOAA-20/ CrIS	Bias at Std. Scene(K)	-	-	-0.11	-0.06	-	-0.04	-0.01	0.05	0.03	-0.11
	Stdv of Bias (K)	-	-	0.03	0.03	-	0.04	0.06	0.06	0.06	0.07

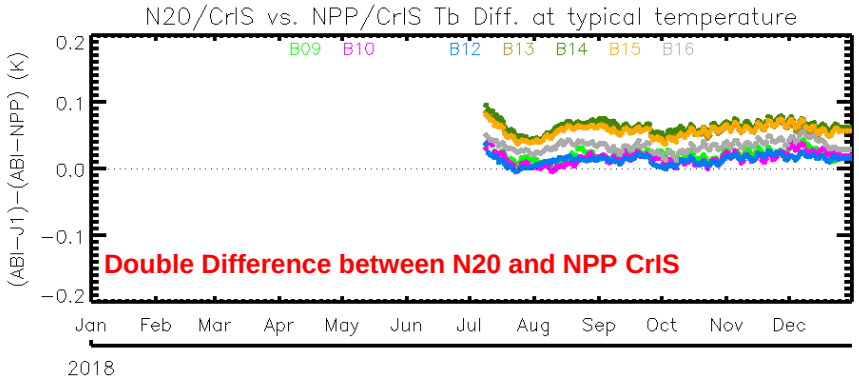
- **GOES-16 ABI IR calibration is very stable.**
- **The mean Tb bias to CrIS/IASI less than 0.15K after the operational update on 06/19/2018.**
- **No significant scene dependent Tb bias to the reference instruments for all the IR channels**



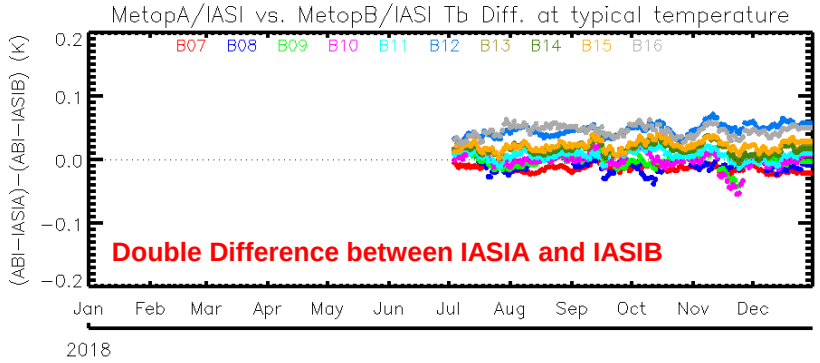


Reference Instrument Performance: Double Difference Using G16 ABI as the Transfer

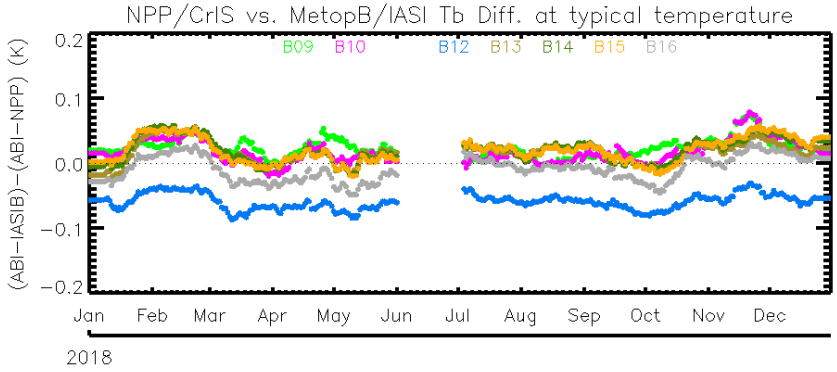
- **N20/CrIS, NPP/CrIS, Metop-A/IASI and Metop-B/IASI are all stable within the study period.**
- **The calibration difference is less than 0.1K among the four reference instruments**
- **N20/CrIS is slightly warmer than NPP/CrIS.**



N20/CrIS is slightly warmer than NPP/CrIS



Metop-A/IASI and Metop-B/IASI is in general within ~±0.05K



Double Difference between NPP/CrIS and IASI-B

Metop-B/IASI and SNPP/CrIS is in general within ~±0.1K

ROSHYDROMET Annual GSICS Calibration Report for 2018

Alexey Rublev, Alexander Uspensky

ROSHYDROMET

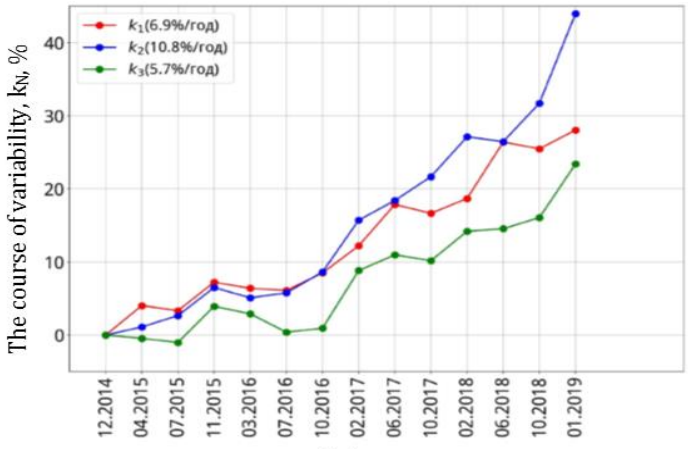
Satellite/Instrument Summary - LEO

Satellite (status)		ECT (Asc.)	Launch date
Meteor- M No.2	(Op)	09:10	2014-07-08

Year	2018												2019	
EO Instruments	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
MSU-MR														
IKFS-2														
MTVZA-GY														

Calibration Performance: MSU-MR

Shortwave channels vs AVHRR/Metop-A

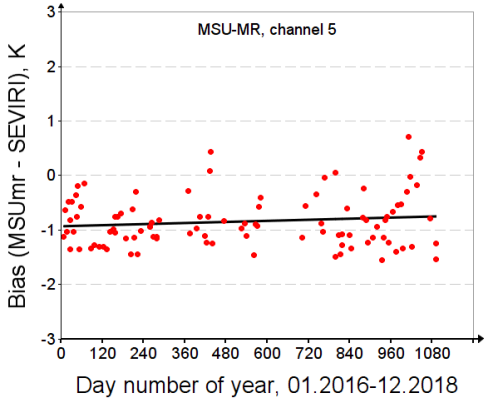


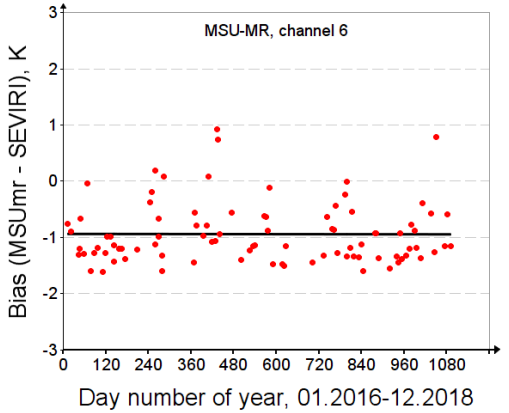
$$k_N = \frac{A_{AVHRR}}{SBAF_N \times A_{MSU-MR}}$$

N= 1,2,3, A—the spectral brightness coefficient
Calculated SBAF for reflectance between MSU-MR and AVHRR ~1.0 for each pair of channels

Date	κ1	κ2	κ3
03.2018	1.21	1.31	1.19
05.2018	1.28	1.36	1.22
08.2018	1.22	1.36	1.18
10.2018	1.25	1.42	1.24
12.2018	1.18	1.35	1.21
01.2019	1.27	1.55	1.32

IR channels vs SEVIRI/Meteosat-10 (-11)





2018 Y	ch5	ch6
Bias	-1.14 K	-1.28 K
RMS	0.80 K	0.82 K

Satellite/Instrument Summary - GEO

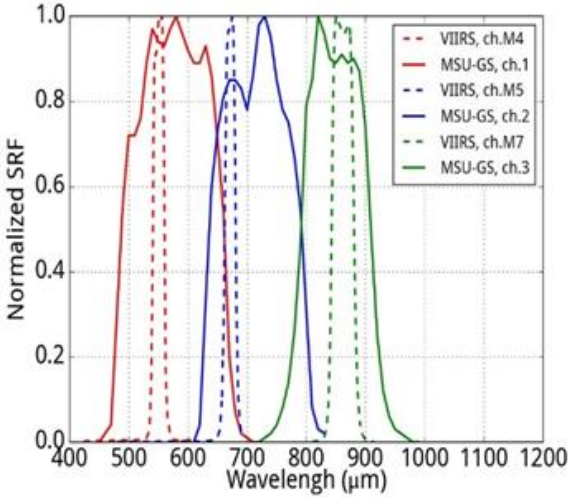
Satellite (status)		Location	Launch date	EO instruments
Elektro-L No.2	(Op)	76E	2015-12-11	MSU-GS imager (an analog of SEVIRI)

The MSU-GS instrument is functional with limitations (12 μm channel is absent).

Absolute calibration is completing.

Calibration Performance of MSU-GS: Visible/Near-Infrared Channels

Inter-calibration of MSU-GS shortwaves channels versus the VIIRS/Suomi NPP



Comparison above *deep convective clouds* over the Indian Ocean ± 20° North/South and East/West of Elektro-L #2 sub-satellite point (76 °E)

Calculated SBAF between MSU-GS and VIIRS ~1.0 for each pair of channels

Date	κ1	κ2	κ3
06.2018	1.04	1.09	1.09
07.2018	1.06	1.13	1.12
08.2018	1.06	1.16	1.17
09.2018	1.00	1.09	1.09
10.2018	1.05	1.15	1.14
11.2018	0.99	1.11	1.12
12.2018	1.04	1.14	1.12
01.2019	1.02	1.12	1.10