GSICS User Requirements and Feedback

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2016 GSICS Users Workshop

Outline

- Introduction
  - Where are we?
- User Requirements
  - Targeted groups
- Requirements from Users of GSICS Products
- Survey result summary
  - Expectation from Reference Instrument
  - Requirements from climate community
- Way forward

Introduction

EP-16 observed 10 years of GSICS existence in Denver, Colorado USA.

- **GCC presented an overview of User Requirements (Doc. 9) that were gathered from reviews of GSICS Products in the GPPA.**
- **In a major thrust to connect GSICS with scientific community and potential users Ep-16 placed the following actions**

Action 16.10: All satellite operators to evaluate their requirements for GSICS resources, products and services to serve their internal users (NRT or climate applications such as SCOPE-CM projects): identify application areas, draft requirement indicating the characteristics of the product needed, quality criteria and delivery mode. Requirements shall be communicated to the GCC who will present a synthesis to the EP.

Action 16.11: GCC and GRWG Chair to organize a discussion on user requirements in the context of the 2015 GSICS User Workshop (Toulouse, 22 September 2015).

Action 16.12: GCC to analyze, in consultation with GCOS/AOPC, the implications of GCOS observation needs on GSICS products.

This presentation is in response to Action 16.11

Targeted Groups

- **Users of GSICS products**
  - Products were made available to experts and their opinions were taken as to what they view as the applications of the products and what they expect from GSICS.
- **GSICS member agencies**
  - Survey questions were posed to members agencies and their responses were tabulated and evaluated.
- **Climate Monitoring groups (FIDUCEO)**
  - The FIDUCEO Project has compiled a set of requirements as part of their work.

User Requirements- Using GSICS Products

Basic User Requirements

- A clear path towards benefits from using the product.
- Mature ATBD

Could be a part of GPPA submission

- Product Related Docs and Publications (Perhaps WMO, WIGOS accepted)
- User Manual (information on Uncertainties and basic i/o), easy to understand with examples.
- Uncorrected/Corrected Radiances.
- Support from product developers.
- Estimates of the GSICS references quality (Recent submission on IASI/AIRS) and Traceability documentation.
  - Products should be easy to use. (We Score 3 out of 10.)
  - Radiance values with uncertainties.

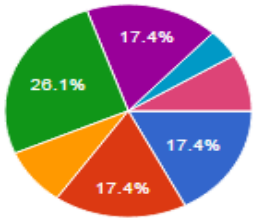
User requirement survey

Categories of Questions

- GSICS Intermediate Data and GEO Ring
- GSICS IR Products
- GSICS VIS Products
- GSICS MW Products
- GSICS UV Products
- Expectation from GSICS References
- Climate Users (added later)

Response statistics

Would you like to give Feedback on use of



GSICS Intermediate data and GEO Ring requirements	4	17.4%
GSICS IR Products	4	17.4%
GSICS VIS Products	2	8.7%
GSICS MW Products	6	26.1%
GSICS UV Products	4	17.4%
Other Calibration Products	1	4.3%
Expectation from a Reference Instrument	2	8.7%
Other	0	0%

GSICS Global Space-based Inter-Calibration System

Requirements of Climate Community

Need for bias monitoring at diurnal and temporal scales of decades

Strawman FCDR=AVHRR1+AVHRR2+AVHRR3+AVHRR4….

- **Long Term Monitoring across temporal scales**
- **Harmonization-> Techniques developed for Prime product can be used**
- **Uncertainty estimates**
- **FIDUCIO -> GSICS MVIRI-SEVIRI Product can be used. (Ref FIDUCIO User Requirement Report)**
- **MW FCDR -> Just the inter-comparison coefficients are of no help (Ref Feedback from GSICS User Survey).**

Should products be a blend of coefficients and intermediate data ?.

Requirements of Climate Community

Strawman FCDR=AVHRR1+AVHRR2+AVHRR3+AVHRR4+……

All known and established corrections for timing, geo-location, and viewing geometry of pixels should be applied in the FCDR record and described in associated documentation. Associated uncertainties should also be included or described

Long term monitoring using stable references

Harmonization

Uncertainties estimates of bias

Direct usage of GSICS products may not be possible

……However…….

GSICS expertise , Algorithms and Deliverables can contribute towards meeting these goals.

Survey Summary

	Do you need Products	Requirement
Do you need GSICS Intermediate Data	Yes (63%)	GEO-LEO, LEO-LEO, Moon data needed
GEO Ring	Yes	Needed for global measurements
IR Products	Yes	Need Diurnal variation of bias and uncertainties
VIS Products	Yes	Frequently update calibration coefficients of each sensor. Aqua MODIS and VIIRS as reference
MW Products	Yes	Need corrected L1B on a global scale, more precise but can be less frequent
UV Products	Yes	In-orbit references are calibrated using Ground based products and other satellite products
Reference Instrument	Yes	Monitored instrument with high accuracy and stability (scan angle spectral and temporal)
Climate Users	Yes	GSICS expertise , Algorithms and Deliverables can contribute towards meeting climate goals.

Way forward

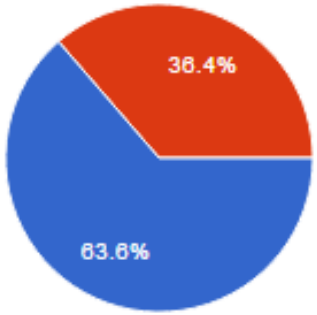
- GSICS has made progress in meeting the needs of users from the weather and climate satellite calibration communities and demands are growing.
- Propose to discuss survey results within each subgroup to help in planning future activities and goals of the sub group
- It is felt that more communication (within and outside GSICS) is needed to meet future needs and to document those needs…
- GCC will continue to collect user requirements.
- This year targeted groups would be GCOS SCOPE-CM , WMO and member agencies.
- An evaluation of requirements is critically needed to move ahead
- Tim Hewison's proposed questionnaire can be viewed here .

Thank you

- **BACKUP SLIDES**

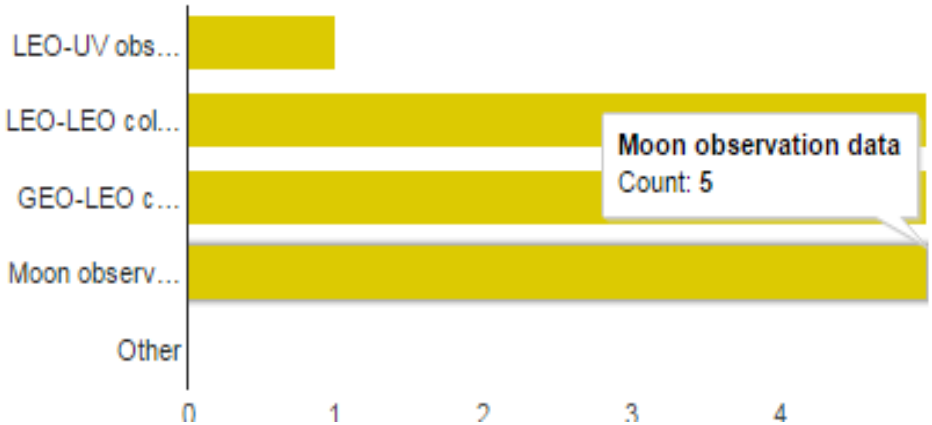
GSICS Intermediate and GEO Ring data

Would you be interested to obtain intermediate data, used by GSICS to generate inter-calibration products. For example, MTSAT-LEO collocation netCDF files are available on the EUMETSAT GSICS server: http://gsics.eumetsat.int/thredds/catalog/mtsat2-imager-metopa-iasi-colloc/catalog.html.



Yes	7	63.6%
No	4	36.4%

Which of the following intermediate data are required? (please select all that apply)



LEO-UV observation and its RT simulation data	1	12.5%
LEO-LEO collocation data	5	62.5%
GEO-LEO collocation data	5	62.5%
Moon observation data	5	62.5%
Other	0	0%

GSICS Intermediate and GEO Ring data

What is your application (and spectral range) by means of intermediate data?

Inter-calibration of monitored instrument(s) by yourself	9	100%
Other (please specify. e.g. evaluation of your own L2 product and required spectral bands)	1	11.1%

Requirements for GEO-GEO intercomparisions

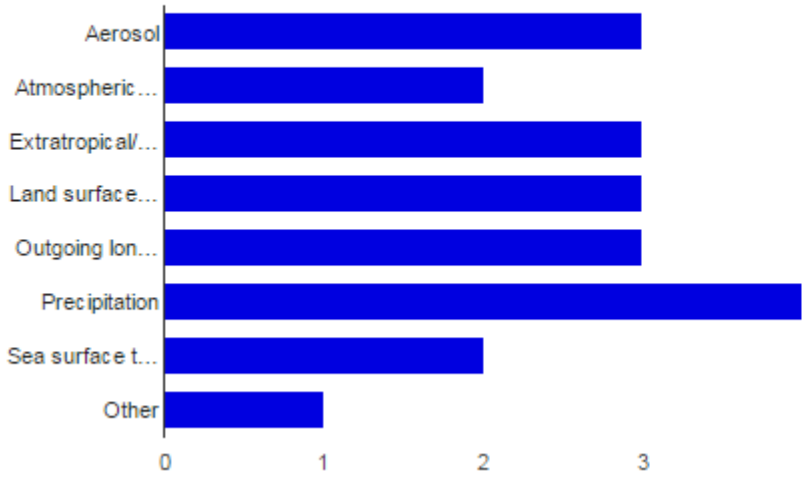
L1 data (e.g. radiance) quality monitoring	4	66.7%
Validation of GEO-LEO-IR inter-calibration uncertainty estimation to ensure the consistency	3	50%
Global L2/L3 "GEO-Ring" product (e.g. radiance, reflectance, brightness temperature)	4	66.7%
Other	0	0%

GSICS Intermediate and GEO Ring data

What is your requirement for GEO-Ring data? (e.g. uncertainty, horizontal/temporal resolution, spectral range)

full temporal and spatial resolution and coverage, # IR window and WV channel(s), ideally all IR channels, # spectral intercallibration coefficients, e.g. as information layer # Quality flags (e.g., incomplete disc coverage, stripes, suspicous geolocation,...) # GSICS recommendation (based on quality) on usage of GEO in overlapping regions # GCOS requirements on accuracy
If GSICS adopts a common (virtual) sensor response function, it may be convenient that users can select to convert GEO data to the common SRF or not.
Not applicable to me.
Uncertainty, horizontal/temporal resolution, spectral range

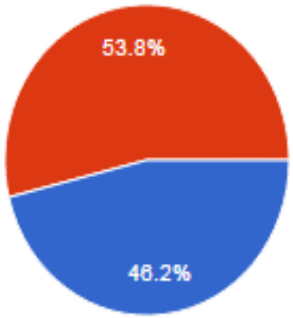
Which of the following application of GEO-Ring are you interested in? (please select all that apply)



Aerosol	3	50%
Atmospheric motion vector	2	33.3%
Extratropical/Tropical cyclone (genesis, intensity, etc.)	3	50%
Land surface albedo	3	50%
Outgoing longwave radiation	3	50%
Precipitation	4	66.7%
Sea surface temperature	2	33.3%
Other	1	16.7%

GSICS IR Products

If the products of diurnal variation of the IR calibration are provided, would you utilize the information in your work, for example NWP?



Yes	6	46.2%
No	7	53.8%

If yes then, which study area do you want to use?

NWP
calibration monitoring
Climate trends
Calibration
Not until we have a 3-axis stabilised geostationary platform
Clear/All Sky Radinace, Sea Surface Temperature

GSICS IR Products

If the answer is yes to 1, which channel is your first priority?

11um
Microwave channels
Window channel!
VIS and UV
3.9 um
No special channel.

VIS- GSICS Products

If your application retrieves properties from multiple imagers, how does your algorithm account for the differences in sensor calibration and spectral band differences?

We use LUTs to retrieve L2 products. The LUT is created for each sensor spectral band. The observation data (digital count) is tied to radiance based on each sensor's calibration coefficients. So, the differences in sensor calibration and spectral band differences are considered by LUT and calibration coefficients.

I take it as that there are no differences in sensor calibration. About the differences of spectral band, I will use the linearity interpolation to get the spectral resolution I needed.

What products can GSICS provide to help out in providing consistent cross-sensor retrievals?

Frequently update calibration coefficients of each sensor.
Similar to GSICS IR's case, I need relationship between a target sensor and a common reference sensor such as AIRS or IASI in IR bands.

Would visible or IR spectral band adjustment factors (depending on purpose) over specific Earth targets from hyperspectral TOA radiances be useful?

Yes. I think it's useful for calibration (e.g. inter-comparison) and product retrieval. Usually, we have a preferable radiance range for product retrieval or calibration. For instance, a calibration engeneer who adopt DCC as a reference doesn't care dark ocean surface. Such users will prefer SBAF optimised over specific Earth targets.
yes

VIS- GSICS Products

Would a web site that can provide TOA (Top Of Atmosphere) adjustment factors be helpful, where the user can adjust the solar, viewing, and humidity conditions to their application?

yes
I'm interested in it, because I don't know if the SBAF is effected by geometry angles or humidity. If the effect is negligible, I don't think it is necessary function for the Web site.

GSICS provides visible channel calibrated radiances referenced to Aqua-MODIS in the visible and IASI for the IR, would this be helpful in retrieving properties from multiple datasets?

yes of course
It will be helpful because Aqua-MODIS and IASI is well calibrated sensor. What sensor will be the next reference after MODIS? VIIRS?

Does your community have a reference sensor, in which all retrieval algorithms are tied or compared to?

Not yet, that is the orient of our en devour

Is radiometrically scaling the MODIS and VIIRS radiances a high priority?

The scaled radiance is convenient to use multiple sensors, because we don't need to care difference of solar spectra profile between sensors. Thuillier, MODTRAN, new Kurucz, ...
yes

VIS- GSICS Products

Is radiometrically scaling the current contiguous geostationary radiances a high priority?

yes
Same as above, but not mandatory.

What incoming solar spectra does your community regard as the reference? Would calibration coefficients that take into the solar spectra be helpful, or just to provide the GSICS reference solar spectra?

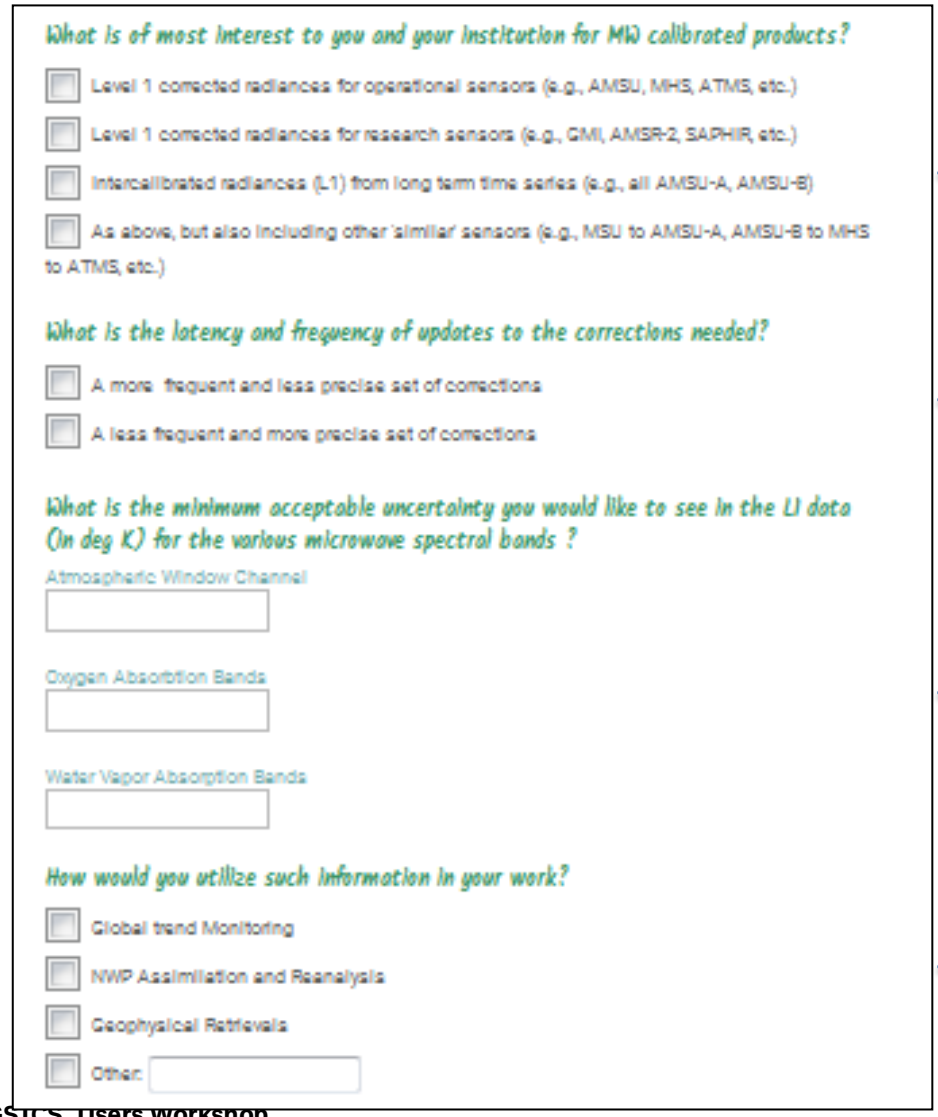
The MODTRAN solar spectra were used as the reference. Providing the GSICS reference solar spectra are more convenient to my opinion
If GSICS decide a solar spectra as reference, the spectra should be the one accessible freely.

What sensors require improved vicarious calibration in order to provide useful retrievals that could benefit from GSICS calibration methods?

The sensor which has high accuracy onboard calibration, wide dynamic ranges, high spectral resolution is required besides MODIS.

GSICS MW Products

GSICS Microwave Survey



What is of most interest to you and your institution for MW calibrated products?

- [ ] Level 1 corrected radiances for operational sensors (e.g., AMSU, MHS, ATMS, etc.)
- [ ] Level 1 corrected radiances for research sensors (e.g., GMI, AMSR-2, SAPHIR, etc.)
- [ ] Intercalibrated radiances (L1) from long term time series (e.g., all AMSU-A, AMSU-B)
- [ ] As above, but also including other 'similar' sensors (e.g., MSU to AMSU-A, AMSU-B to MHS to ATMS, etc.)

What is the latency and frequency of updates to the corrections needed?

- [ ] A more frequent and less precise set of corrections
- [ ] A less frequent and more precise set of corrections

What is the minimum acceptable uncertainty you would like to see in the L1 data (in deg K) for the various microwave spectral bands ?

Atmospheric Window Channel

Oxygen Absorbtion Bands

Water Vapor Absorption Bands

How would you utilize such information in your work?

- [ ] Global trend Monitoring
- [ ] NWP Assimilation and Reanalysis
- [ ] Geophysical Retrievals
- [ ] Other:

Real time use and/or climate use?

Latency vs. precision?

Different spectrum has different use and requirements

Potential application areas

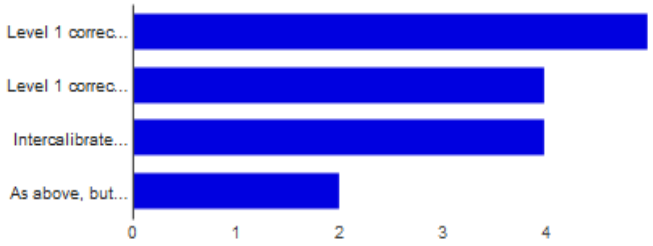
GSICS Global Space-based Inter-Calibration System

GSICS MW Products

6 responses as of 20 Sept 2015

Microwave Products

What is of most interest to you and your institution for MW calibrated products?

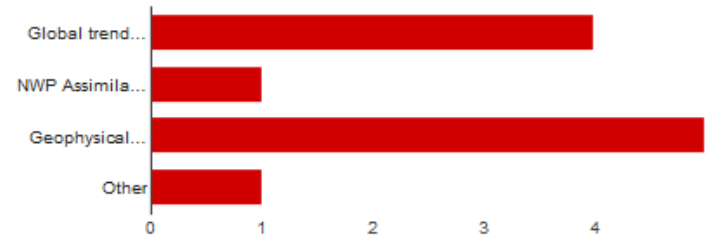


Level 1 corrected radiances for operational sensors (e.g., AMSU, MHS, ATMS, etc.)	5	83.3%
Level 1 corrected radiances for research sensors (e.g., GMI, AMSR-2, SAPHIR, etc.)	4	66.7%
Intercalibrated radiances (L1) from long term time series (e.g., all AMSU-A, AMSU-B)	4	66.7%
As above, but also including other 'similar' sensors (e.g., MSU to AMSU-A, AMSU-B to MHS to ATMS, etc.)	2	33.3%

What is the latency and frequency of updates to the corrections needed?

A more frequent and less precise set of corrections	1	16.7%
A less frequent and more precise set of corrections	5	83.3%

How would you utilize such information in your work?



Global trend Monitoring	4	66.7%
NWP Assimilation and Reanalysis	1	16.7%
Geophysical Retrievals	5	83.3%
Other	1	16.7%

GSICS Global Space-based Inter-Calibration System

GSICS MW Products

6 responses as of 20 Sept 2015

What is the minimum acceptable uncertainty you would like to see in the L1 data (in deg K) for the various microwave spectral bands ?

0.5		
0.4		
0.1	**Window Channels**	**Average ~ 0.4 K**
1		
<0.5 (ideally 0.1)		
0.20		

0.5		
0.2	**O_2 Channels**	**Average ~ 0.3 K**
0.1		
0.40		

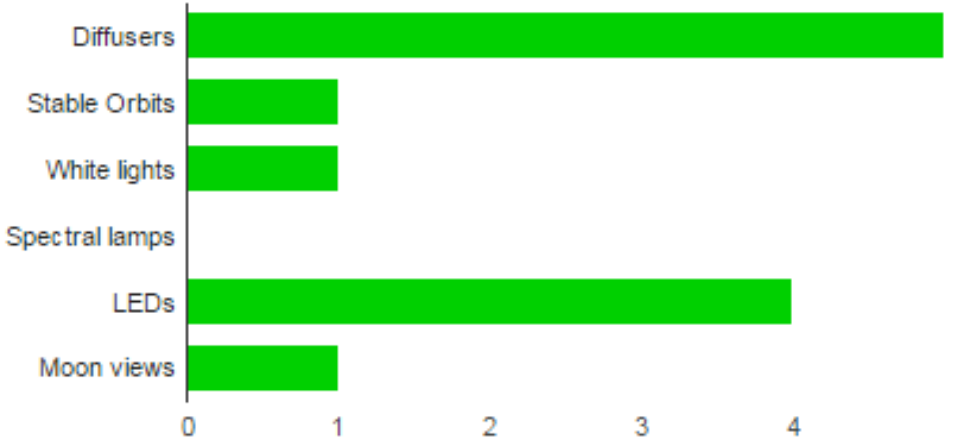
0.5		
0.3	**H_2O Channels**	**Average ~ 0.4 K**
0.1		
0.60		

Summary

- Mapping time series of similar sensors but from vastly different heritage (e.g., SSMT2 to AMSU-B) together is of low priority (Q1)
- More precise, longer latency correction are preferred (Q2)
- It does appear most users would look at time series for global trends (most likely the O_2 & H_2O bands) and use to derive geophysical parameters (most likely window & H_2O bands) (Q3)
- The average desired accuracy of the corrections was on the order of 0.4 K (slightly less for the O_2 bands) (Q4)

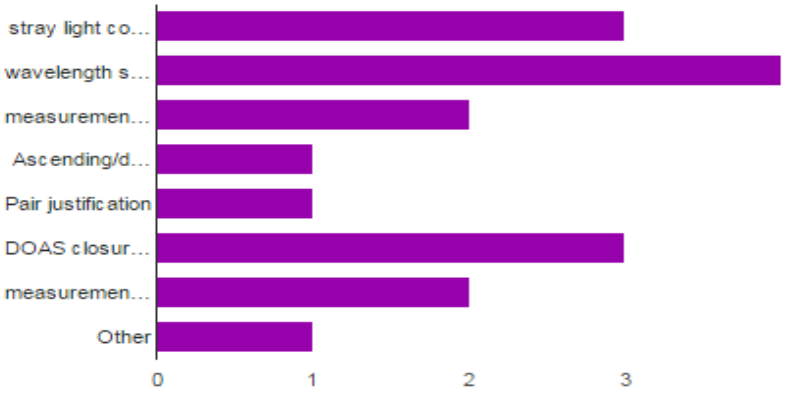
UV Products

What internal measurements do you make to maintain your instrument's calibration in orbit?



Diffusers	5	100%
Stable Orbits	1	20%
White lights	1	20%
Spectral lamps	0	0%
LEDs	4	80%
Moon views	1	20%

What internal consistency methods do you use to check the calibration?

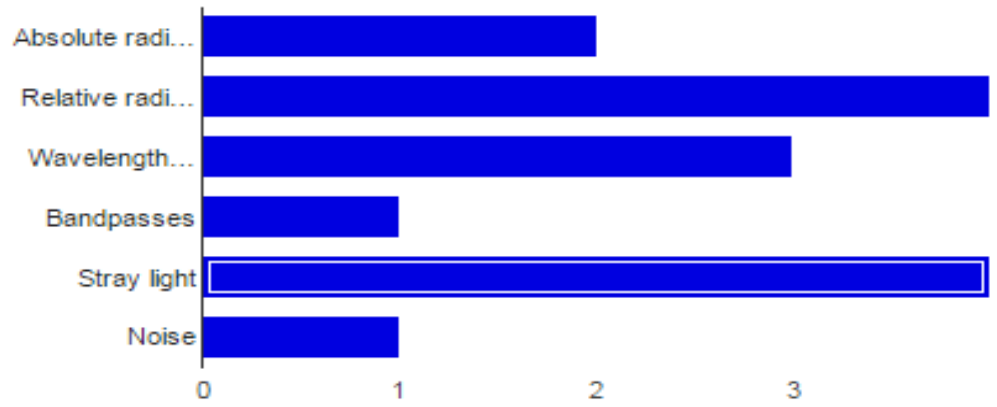


stray light correlations	3	60%
wavelength scale from solar and absorption features - shift and squeeze	4	80%
measurement residuals - aerosol index, reflectivity range/distribution	2	40%
Ascending/descending -- Langley methods	1	20%
Pair justification	1	20%
DOAS closure polynomials	3	60%
measurement residuals with respect to climatology	2	40%
Other	1	20%

Global Space-based Inter-Calibration System

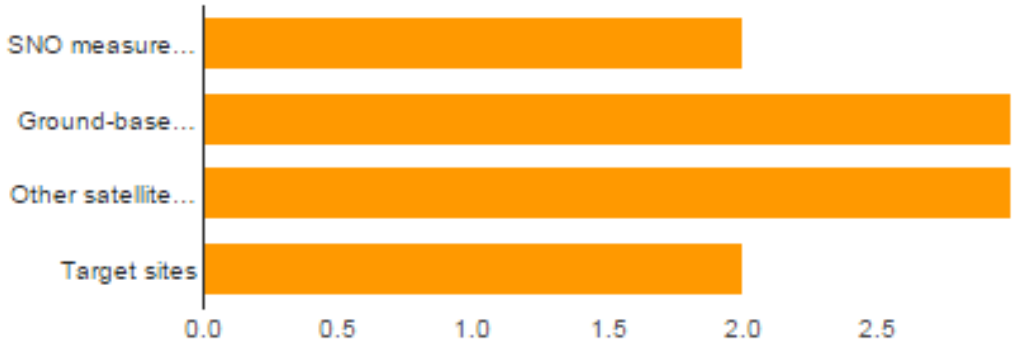
UV Products

What measurement characterizations are most important?



Absolute radiometric polarization	2	40%
Relative radiance/irradiance	4	80%
Wavelength scale	3	60%
Bandpasses	1	20%
Stray light	4	80%
Noise	1	20%

What external methods and measurements do you use to maintain your instrument's calibration in orbit?



SNO measurements	2	50%
Ground-based products	3	75%
Other satellite products	3	75%
Target sites	2	50%

UV Products

What external resources, if any, are regarded as reference measurements

Sun measurements
37. Total ozone measured in meteorological observation station all over the world

Does your community have any common standards to which all retrieval algorithms are tied or compared?

-
Ozone Absorption Cross Sections
No
yes
we are discussing with ESA for Sentinel 4 and NASA for Tempo.

Are there solar spectra that your community regard as the reference?

No, there are choices.
Kurutz
yes
Harvard Smithonians, JPL Jeff Toon's

UV Products

Does your sensors use vicarious calibration methods? If so, what adjustments are derived?

-
No
Yes The result of vicarious calibration is the same to the on board one.
We plan to use vicarious cal. but have not decided specifics yet.
Refelctivity for soft Rad/Irrad, clean atmospheres with 0 aerosol

On what timescales do you do (or wish to do) your online and offline continuous calibration.

Dark tables are updated weekly. Information on throughput degradation is updated every six months.
1 Year
It's decided by the decaying speed , 1 month ~ 12 month.
Daily solar and dark cal. Regular LED cal. And semi annually diffuser check against ref. diffuser.

THANK YOU

Requirements posted by friends WMO+CEOS+…

- EP stressed that GSICS should bring a key contribution to the Architecture for Climate Monitoring from Space in defining a calibration infrastructure and key processes to ensure seamless continuity and consistency of climate records.
- Pre-Launch Characterization
- Procedures, best practices and calibration resources required to ensure the consistency of data records through accurate and homogeneous calibration should be defined by GSICS and CEOS WGCV as an input to the Architecture for Climate Monitoring from Space.
- Increased attention should be given to ground calibration sites;

Summary

- User Requirements are central to creating GSICS Products / Deliverables and assigning maturity to GSICS Products.
- However these are closely linked to the kind of product being delivered.
- Need a plan to find applications of our products
- We need a clear plan to communicate with users, collect and document all of the user requirements.
  - Individual agencies collect requirements to identify product creation priorities, however these are not necessarily shared on GSICS platform.
  - Is GNU (GMES Network of Users) model of collecting user requirements a way forward ?
-)

FIDUCIO

Aim is to create four FCDR

1. MVIRI visible channel time-series from 1982-today (Infrared is done in SCOPE-CM);
2. HIRS time-series from 1982-2016 (NOAA and METOP);
3. Microwave Humidity Sounders time-series from 1992-2016 (SSM/T2, AMSU-B, and MHS);
4. AVHRR infrared and visible channels time-series from 1982-2016 (NOAA and METOP).

Eg. Strawman's FCDR=AVHRR1+AVHRR2+AVHRR3+AVHRR4+……

FIDUCIO Document

- An assessment of user requirements for Fundamental Climate Data Records (FCDRs) was undertaken using two sources: a set of 16 interviews with current FCDR users, and a review of prior literature. From this assessment, requirements for Fidelity and Uncertainty for Climate and Earth Observation (FIDUCEO) were defined as follows.

- But we are looking for what do FCDR producers need .

Eg. Strawman's FCDR=AVHRR1+AVHRR2+AVHRR3+AVHRR4+……

All known and established corrections for timing, geo-location, and viewing geometry of pixels should be applied in the FCDR record and described in associated documentation. Associated uncertainties should also be included or described

Long term monitoring using stable references

Harmonization

Uncertainties estimates of bias

Direct usage of GSICS products may not be possible

……however…….

However GSICS expertise , Algorithms and Deliverables can contribute towards meeting these goals. Expertise in blending IASI-A IASI-B (similar to GSICS Prime Ref) can help harmonization.

MVIRI“

Could use operational Global Space-based Inter-Calibration System (GSICS) inter-calibration factors for SEVIRI. use. Would be impossible to do a per-pixel This exists but I’m not using it. Further information, I probably wouldn’t uncertainty. If it was provided I probably wouldn’t trust it.”

Infrared

AVHRR

- *"Would be very useful to have clear information about stability, accuracy, and variability of the accuracy (precision). Flag information about how useful/trustworthy the intercalibration information is, on a pixel-basis. (Many problems with early 3.9 µm AVHRR.)"*

- *"Would be very useful to have clear information about stability, accuracy, and variability of the accuracy (precision). Flag information about how useful/trustworthy the intercalibration information is, on a pixel-basis. (Many problems with early 3.9 µm AVHRR.)"*

Microwave

- **AMSU**

- ***Uncertainties on the channel radiances. Characterisation of across-scan bias. The more detail the better. Historical disconnect between the engineering side and data users***

- ***Uncertainties on the channel radiances. Characterisation of across-scan bias. The more detail the better. Historical disconnect between the engineering side and data users***

Specific Sensors

- • AVHRR GAC PRT measurement sequence needs to be checked.
- • HIRS needs to be more stable than 0.2 K/decade for the production of CTH.
- • HIRS needs to be more stable than 0.05 K/decade for the production of SST.
- • AMSU needs to be more stable than 0.1 K/decade for the production of UTH.
- • AVHRR harmonisation should be better than 50 mK/decade.
- • AVHRR harmonisation should be better than 1 %, according to an “educated guess” by an AVHRR user.

Can help in achieving these targets

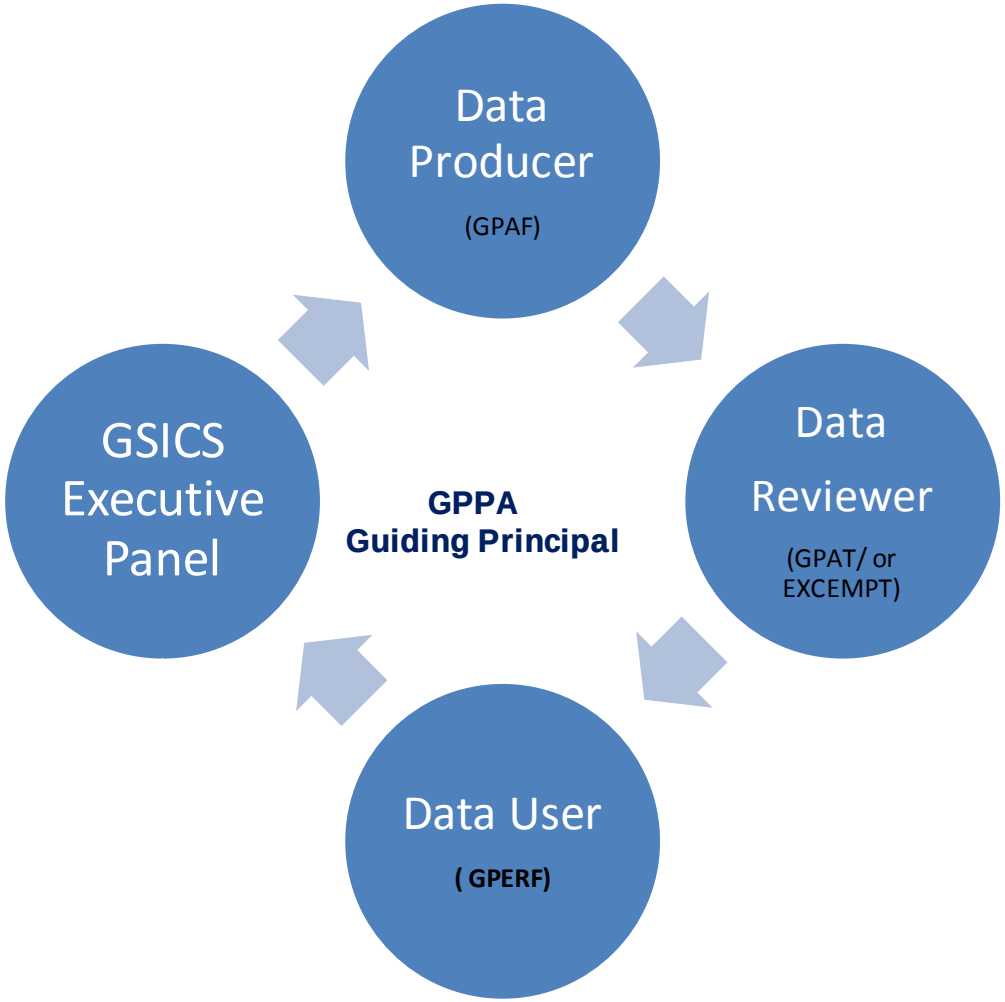
Pre-launch

- *Instrument calibration for nonlinearity. Antenna pattern measurements. We use what is available. Those are the main things. What was done was adequate for instrument specifications for operational use, but not adequate for climate applications. Disconnect*

- *Harmonization-> Satellites equatorial crossing times differ.*

GPPA Description

GPPA Maturity-Operational Phase



Users and Reviewers Feedback plays a pivotal role in assigning maturity

THANK YOU

Introduction

EP-16

GSICS user requirements should be more precise and traceable to identified requirements sources, i.e. statements or documents from representative users.

•Examples of such sources include: outcome of GSICS workshops, reports from GSICS beta-testers, requirements for GSICS by the GCOS-SC Chair (GSICS-EP-14), satellite instrument calibration for measuring global climate change (Ohring G. et al., BAMS, Sept 2005),

• GCOS Systematic observation requirements for satellite-based data products for climate (GCOS-154). For instance, GCOS-154 action C8 calls for "*Use of GSICS bias-corrected coefficients* and bias adjustment information from reanalysis".

GUW -15

GCC is to draft a strawman User Requirements' document and send it out for review.

Introduction

GSICS has 37 Inter-calibration products spanning IR and VIS wavelengths.

Products have bias, offset and uncertainty estimates.

Users of GSICS products play a central GSICS in defining GSICS current and future course of actions and we need their feedback from time to time to meet their requirements.

A survey was sent out to gather user expectations from GSICS

It can be accessed at here and we present here feedback we received so far

Proposed form users to indicate their requirements for GSICS Corrections (Tim Hewison

User Requirements

Application specific Requirements

SST retrieval – User need constant flow of (uncorr) TOA Radiances along with GSICS correction Coefficients and Uncertainty. Also wants to experiment with the smoothing period to optimize performance (GSICS products currently provide this flexibility).

Cloud Height Retrieval. User needs TOA Radiances and RTM runs (initialized by GCM forecasts).

SRF Retrieval. User needs GSICS correction Coefficients and TOA Radiances Uncertainty as well as intermediate collocated data (Hyper spectral radiances over the broad band)

Climate Applications. User needs intermediate cross calibrations as well as re-calibrated coefficients (multi step corrections) and a reference for long term validation of the TOA measurements.

"Just the calibration coefficients are of no use", need ancillary information to use them.

New Developments

Climate and Weather communities have placed a need to calibrate in-orbit instruments to a higher level of precision and stability of the instrument.

New techniques of In-Orbit Calibration have given opportunity to better calibrate instrument

Cross calibration of range of instruments in IR, VIS, UV and MW wave lengths with concurrently flying instruments, In-situ targets (DCC, Deserts) , Solar and Lunar targets, ray matching has given more opportunity to quantify and correct in-orbit biases.

Need of better accuracy and stability

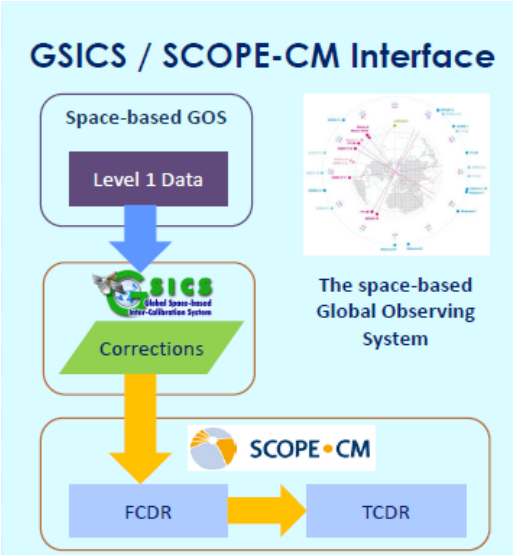
Thresholds of climate accurate L1 measurements have increased to accuracy better than .1 K and stability better than 0.05K/decade .

Need to monitor instrument measurements at different times of the day

Requirements of the calibration community are growing

Strawman's list – Who are the users of In-Orbit Cross Calibration monitoring

- **The producers of cross calibration data are the first users of the cross calibration monitoring.**
- **The rest of the users are scattered in the community and mainly are the ones who need L1 radiances for applications that are sensitive to L1 radiance anomalies. Some examples are**
  - NRT, RAC Monitoring such as at GSICS
  - Climate Users (FCDR, TCDR)
  - Recalibration
  - Downstream services
    - » SST Retrieval
    - » Cloud Height Retrieval
    - » SRF Retrieval
    - » Monsoon Studies (ITCZ Movement)



List is growing and
User Requirements depends on the purpose for which the L1 corrections are applied

CDR Organizational Elements

- High-level leadership council
- Advisory council to represent climate research community and other stakeholders
- Fundamental Climate Data Record (FCDR) Teams
- Thematic Climate Data Record (TCDR) Teams

CDR Generation Elements

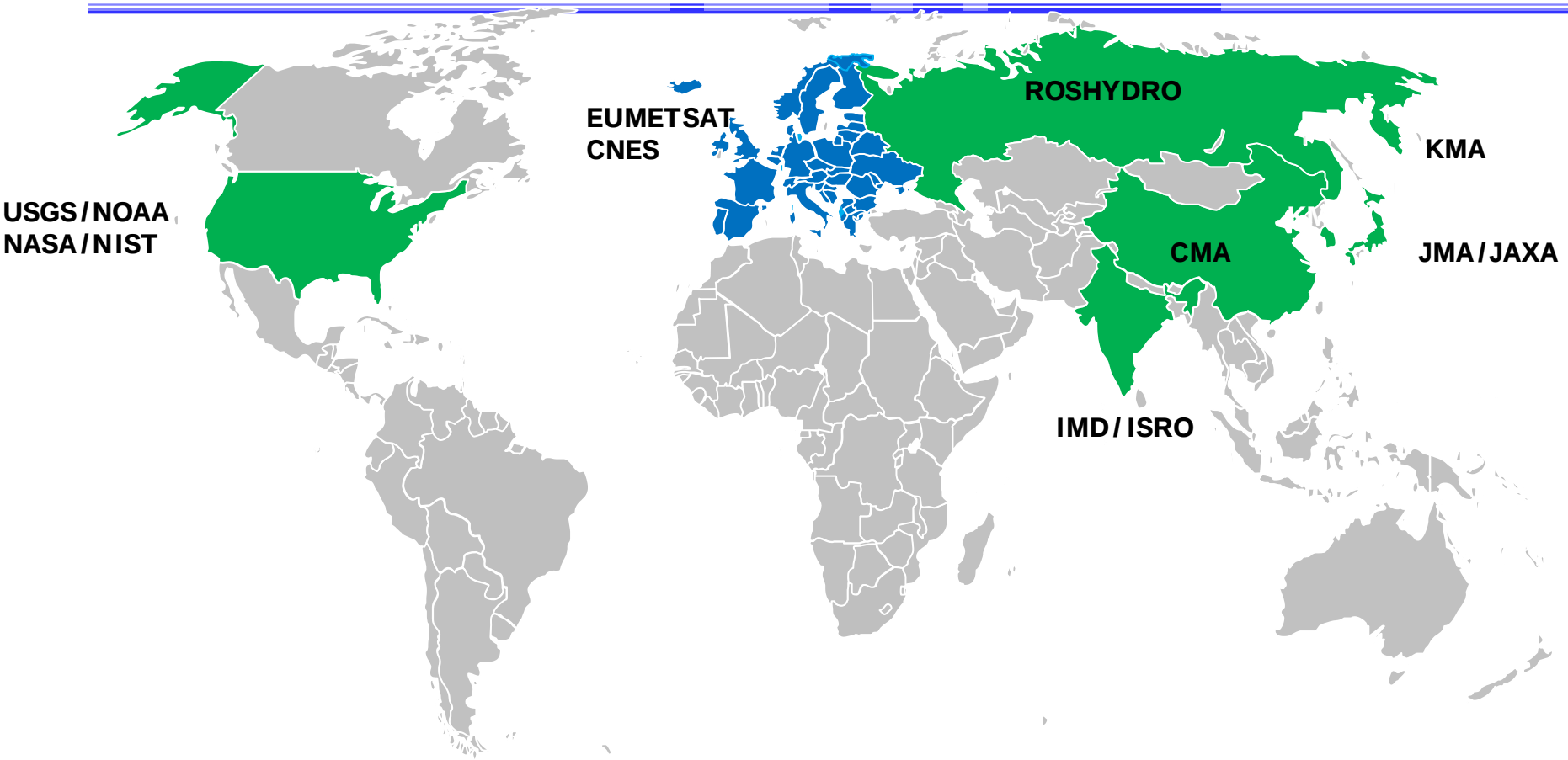
- High accuracy and stability of FCDRs
- Pre-launch characterization of sensors and lifetime monitoring
- Thorough calibration of sensors
- Well-defined criteria for TCDR selection
- Stakeholder involvement and feedback for TCDRs
- Well-defined criteria for TCDR validation
- Use of *in-situ* data for validation

Sustaining CDR Elements

- Available resources for reprocessing CDRs as new information becomes available
- Provisions for feedback from scientific community
- Long-term commitment of resources for generation and archiving of CDRs and associated data

GSICS Introduction

GSICS Members



Obs. ESA + CEOS
ASSO. GPX

14 Members Worldwide