EUMETSAT

Towards a GSICS VNIR product based on the DCC method

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GSICS Research and Data Working Group Annual Meeting
VIS/NIR subgroup
17.03.2022

Some reminders…

- Strawman for GSICS VNIR product format was discussed in the past

- In particular:
  - Annual meeting 2014 - Proposal for a GSICS DCC product
  - VIS/NIR subgroup web meeting 2014-06-05
  - Annual meeting 2017 – Strategy for combining corrections for VIS/NIR+IR channels and plotting tool

- Strawman discussed and agreed with GDWG (2014)

Answering users' needs…

- What do the users want to see?
  - What pieces of information?
  - How to display it?
- What do we need to produce?
  - GSICS VNIR products per method?
  - Consolidated GSICS VNIR products (e.g. blends)?
  - GSICS VNIR products combined to GSICS IR products?
  - Which frequency?
- How do we answer those questions?
- In fact, first question is "who are the users?"

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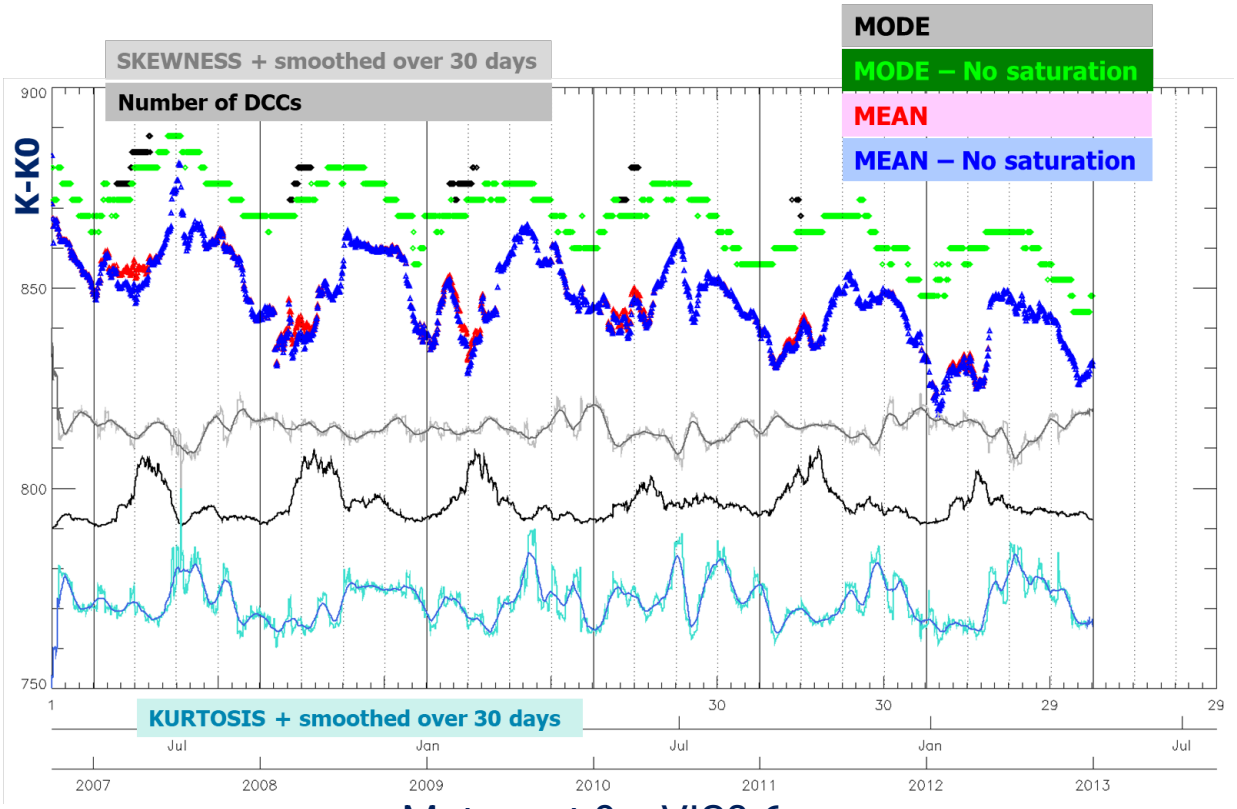
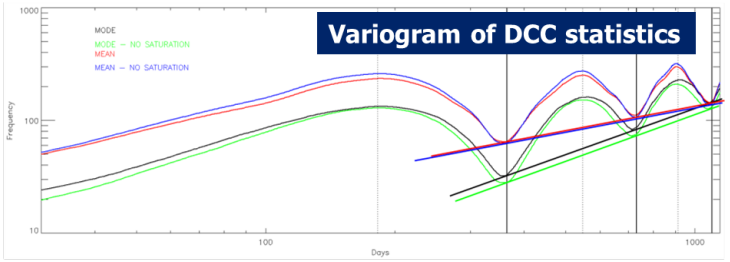
- How do we answer those questions?
- In fact, first question is "who are the users?" ➔ As for IR:
  - Experts users dedicated to mission radiometric performances
  - Level 1 users to produce Level 2 and Level 3 geophysical products

What do we want to see?

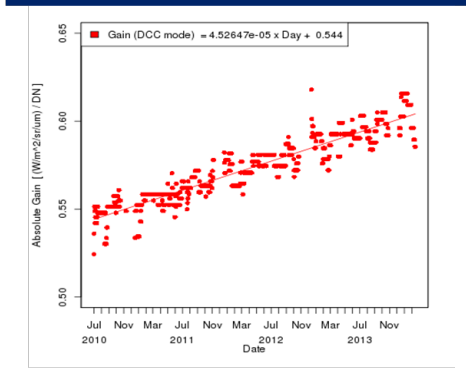
- What can we monitor?
  - ✓ DCC statistics time series (mean, mode, ...)
  - ✓ Trend analysis (instrument degradation in radiance, reflectance, digital counts,...)
  - ✓ Variogram of DCC statistics (this may be useful for R&D) ➔ seasonality



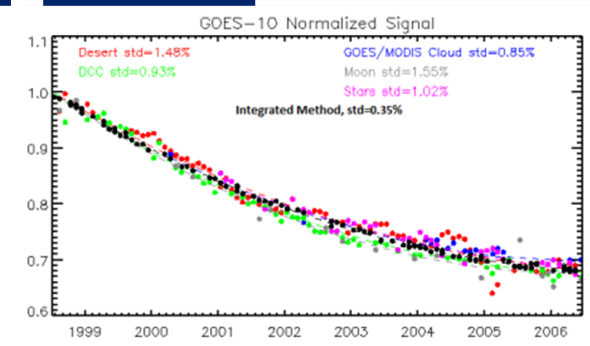
Meteosat-9 - VIS0.6



Time series of gain against Aqua/MODIS



Trend analysis



From Fangfang's presentation at web meeting in Jan. 2014

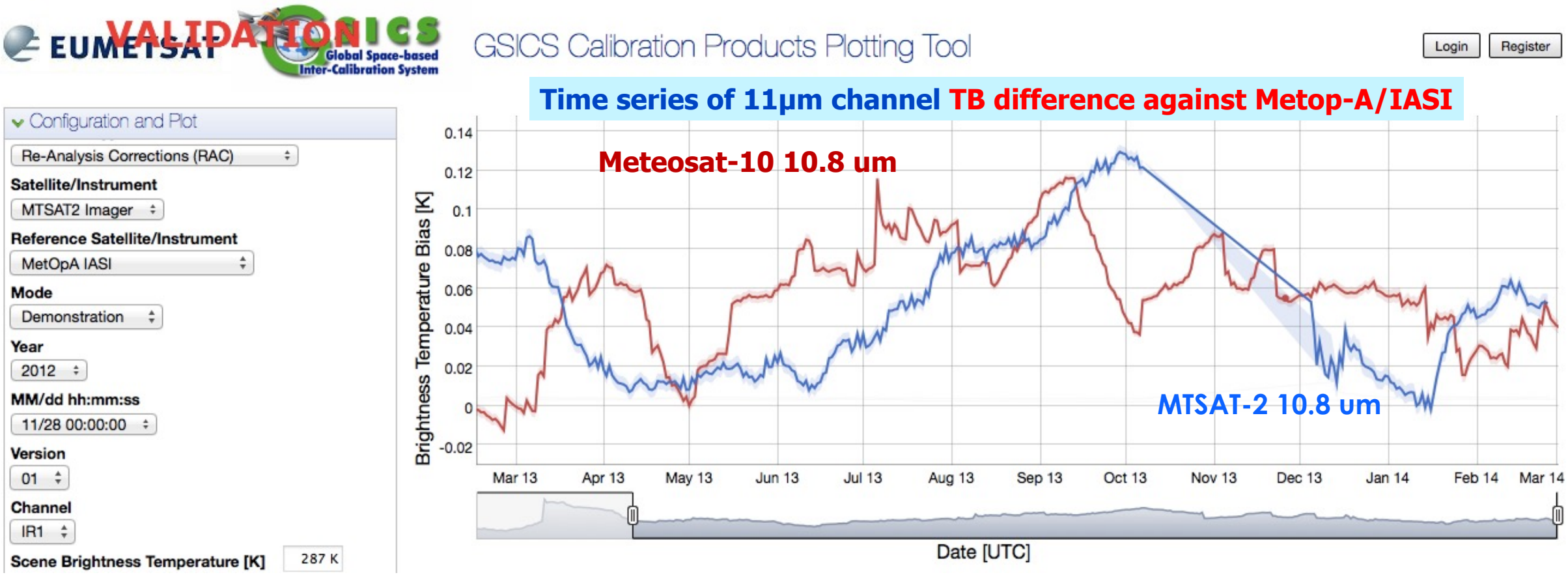
What do we need to produce?

- Expert users are probably expecting as much detailed information as possible to support in-depth analysis…
- For the generation of Level 2 and Level 3 products, probably corrections or calibration coefficients (on the reference instrument scale)
- In both cases, what about displaying the information content?
  - For IR ➔ GSICS plotting tool available
  - For VNIR ➔ No shared tool so far
    - Need for a separate tool? ➔ More flexibility
    - Fused with IR tool?

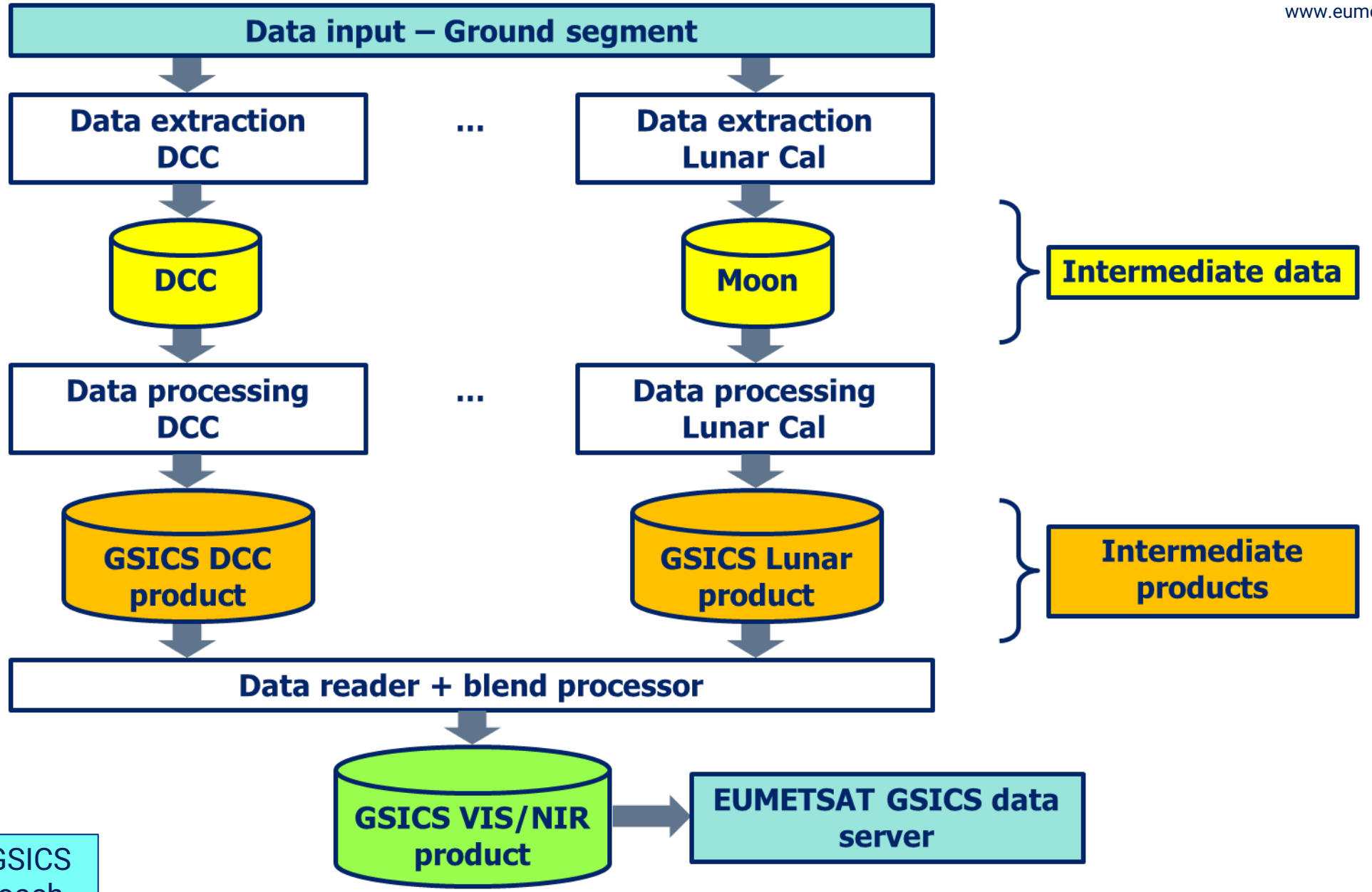
      ➔ Probably requires commonalities in the content definition

      ➔ Towards an instrument product (e.g. VNIR + IR combined product) ? ➔ discussed in 2017…

GSICS plotting tool – The IR example



What do we need to produce? A general perspective…



Example of EUMETSAT GSICS product generation approach

Technical requirements to follow

GSICS file naming convention:
http://gsics.atmos.umd.edu/wiki/Development/FilenameConvention

➔ Follows the rules given in the General File Naming Conventions section of the *W.M.O. Manual on The Global Telecommunication System*

GSICS file naming convention:
http://gsics.atmos.umd.edu/wiki/Development/NetcdfConvention

➔ Relies on the following NetCDF conventions:

- NetCDF Climate and Forecast Metadata Convention
  http://cfconventions.org/cf-conventions/cf-conventions.html

- NetCDF Attribute Convention for Dataset Discovery
  https://wiki.esipfed.org/Category:Attribute_Conventions_Dataset_Discovery

File naming (based on: http://gsics.atmos.umd.edu/wiki/Development/FilenameConvention)

Proposal (e.g., Meteosat-10/SEVIRI Re-Analysis Correction):

W_XX-EUMETSAT-Darmstadt,SATCAL+RAC+GEOLEOVISNIR,MSG3+SEVIRI-Aqua+MODIS_C_EUMG_20130601000000_demo_01.nc

GSICS Product Taxonomy:

- http://gsics.atmos.umd.edu/wiki/Development/ProductTaxonomy
- discussion among Tim, Fangfang and Aleksandar in Apr. 2013
- Spectral Range, Instrument Class, Principal Methodology, Product Type, ...

Spectral Range	Acronym	Wavelength Range (μm)
Ultraviolet	UV	below 0.4
Visible	VIS	0.4 to 0.75
Near-infrared	NIR	0.75 to 3.0
Infrared	IR	3.0 to 15.0
Far-infrared	FIR	15 to 1,000
Microwave	MW	greater than 1,000

- Do we agree with this classification?
- In the future, do we want to put all VIS/NIR inter-calibration results (e.g., DCC, Moon, Rayleigh Scattering...) into one file?
- If GSICS products should be different at each calibration method, we have to think about to add it to the file naming (e.g., ...GEOLEOVISNIR+DCC,MSG2...)

Strawman as produced by EUMETSAT in demonstration

- Currently one unique file for more methods

- Global attributes ➔ describe the dataset + its limitations + its origins (traceability, in particular to the version of the datasets used for the processing [reference + monitored instrument])
- Dimensions:
  - 1 record per file for Near-Real-Time products
  - Full time series to date for Re-Analysis products
  - Individual method results are all available ➔ "Blend" = one additional method
- Variables:

```
central_wavelength = 0.000635 ;
channel_name = "VIS06" ;
date = time_0…N;
method_name = "DCC", "BLEND" ;
mon_official_offset = Level 1.5 offset_time_0…N;
mon_official_slope = Level 1.5 slope_time_0…N;
mon_offset = method_1_offset_time_0…N, … , method_M_offset_time_0…N;
mon_slope = method_1_slope_time_0…N, … , method_M_slope_time_0…N ;
validity_period = start_time_0…N, end_time_0…N;
weight_method = weight_method_1_time_0…N, … , weight_method_M_time_0…N;
```

Dimensions and variables

DIMENSIONS		
NAME	VALUE	DESCRIPTION
Chan	1 (for SEVIRI VIS0.6)	Number of channels
chan_strlen	5	Maximum length of variable: channel_name (see Table 3)
method_strlen	5	Maximum length of variable: channel_name (see Table 3)
Validity	2	Value of the dimension on the validity
Method	2	Number of methods.
Date	UNLIMITED	Number of dates (1 for NRT products and more for RA products)

VARIABLES				
NAME [dimension]	LONG NAME	UNITS	VALUE	TYPE
central_wavelength[chan]	Nominal channel central wavelength	m	e.g. 0.000635	Float
channel_name[chan,chan_strlen]	Channel identifier	1	As expressed in the GSICS SRF file	Char
date[date]	Date of evaluation	seconds since 1970-01-01T00:00:00Z	e.g. 1463184000.0	double precision
method_name[method, method_strlen]	method identifier	1	e.g. "DCC", "BLEND"	Char
mon_official_offset[date, chan]	official calibration offset	W m^{-2} sr^{-1} μm^{-1}	e.g. 26.41869	Float
mon_official_slope[date, chan]	official calibration slope	W m-2 sr-1 µm-1 DC^{-1}	e.g. 0.5180135	Float
mon_offset[date, chan, method]	calibration offset with respect to reference instrument	W m-2 sr-1 µm-1		Float
mon_slope[date, chan, method]	calibration slope with respect to reference instrument	W m-2 sr-1 µm-1 DC-1	e.g. 0.5868232, 0.5868232	Float
validity_period[date, validity]	correction validity period	seconds since 1970-01-01T00:00:00Z	e.g. 1460592000.00004, 1463184000.00004	Double precision
weight_method[date, chan, method]	weight of the methods used for the blend in each channel	1	E.g. 1,1	Float

Some potential evolutions

- Presentation by Fred Wu on Monday
  - Proposal to revise the naming conventions in the IR products to allow more flexibility…

GSICS Harmonization and Its Implementation for ABI

Xiangqian Wu and Fangfang Yu

14 March 2022, GSICS Mini-Conference at the Annual Meeting

Disclaimer: The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the author(s) and do not necessarily reflect those of NOAA or the Department of Commerce.

Change of Terminology

- Was specific for pairs of GEO-LEO:
  - $R_{GEO} = a_r + b_r R_{LEO}$, a_r & b_r are regression coefficients
  - $R_{cor} = a_c + b_c R_{GEO}$, a_c & b_c are correction coefficients
  - $a_c = -\frac{a_r}{b_r}, \quad b_c = \frac{1}{b_r}$
- Is generic for any pair:
  - $R_{raw} = a_r + b_r R_{ref}$, a_r & b_r are regression coefficients
  - $R_{har} = a_h + b_h R_{raw}$, a_h & b_h are harmonization coefficients
  - $a_h = -\frac{a_r}{b_r}, \quad b_h = \frac{1}{b_r}$
- The mathematics is the same, only the names are more generic and neutral to be used more broadly.
  - This rose should smell as sweet.

GSICS Harmonization for ABI | Mini Conference at GSICS Annual Meeting, Virtual, 2022-03-14 | 4

Discussion

GSICS VNIR DCC product

(from meeting in June 2014, with updated URLs)

File naming (based on: http://gsics.atmos.umd.edu/wiki/Development/FilenameConvention)

Proposal (e.g., Meteosat-10/SEVIRI Re-Analysis Correction):

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netCDF: Global attributes – Part 1

In blue = as in existing IR products.
In red = specific to DCC
In green = comment/question

- Conventions = "CF-1.6" **➔ to be updated to 1.9?**
- Metadata_Conventions = "Unidata Dataset Discovery v1.0"
- standard_name_vocabulary = "CF Standard Name Table (Version 19, 22 March 2012)"
- project = "Global Space-based Inter-Calibration System"
- title = "MSG3+SEVIRI vs Aqua+MODIS GSICS Re-Analysis Correction"
- summary = "Coefficients of the GSICS Correction for the reflective solar bands of a GEOstationary imager using a LEO reference instrument"
- institution = "EUMETSAT"
- date_created = "2013-08-02T14:02:16Z"
- date_modified = "2014-03-12T14:52:30Z"
- license = "Calibration information delivered as a GSICS operational product is generated in accordance with GSICS principles and practices.; GSICS operational and demonstration products may be used and redistributed freely. Scientific publications using GSICS operational or demonstration products should however acknowledge both GSICS and the relevant producer organization.; There is no warranty on the data express or implied, including warranties of merchantability and fitness for a particular purpose, or any assumed legal liability for the accuracy, completeness, or usefulness, of this information. The user of the data do so at their own risk."
- comment = "Use the RAC with the time closest to the time of interest. Take great caution when applying it at a date where this difference is greater than the window period."

netCDF: Global attributes – Part 2

In blue = as in existing IR products.
In red = specific to DCC
In green = comment/question

- naming_authority = "int.eumetsat.gsics"
- creator_name = "EUMETSAT - European Organisation for the Exploitation of Meteorological Satellites"
- creator_email = "ops@eumetsat.int"
- creator_url = "http://www.eumetsat.int"
- references = "Aqua MODIS Collection 6 Level 1B"
- atbd_doc_url = ATBD URL
- atbd_doc_doi = ATBD DOI (or OID)
- product_doi = Product DOI (or OID), used in Operational-Phase
- history = Info about algorithm version / set-up etc (free content)
- processing_level = "demonstration/v03.05.00"
- time_coverage_start = "2013-08-01T00:00:00Z"
- time_coverage_end = "2014-02-26T24:00:00Z"
- geospatial_lat_min = Min_LatGEO
- geospatial_lat_max = Max_LatGEO
- geospatial_lon_min = Min_LonGEO
- geospatial_lon_max = Max_LonGEO
- geospatial_lat_units = "degrees_north"
- geospatial_lon_units = "degrees_east"

Open Question: what kinds of information is suitable for? Version of dataset, documents? This issue is also related to the other GSICS products.

New proposal from Peter and I. Details will be introduced/discussed in the GDWG web meeting about doi/iod.

Open Question: Actual GEO coverage? Or area where the DCC algorithm is applied (where the method is validated)?

netCDF: Global attributes – Part 3

In blue = as in existing IR products.
In red = specific to DCC
In green = comment/question

- id = "W_XX-EUMETSAT-Darmstadt,SATCAL+RAC+GEOLEOVISNIR,MSG3+SEVIRI-AQUA+MODIS_C_EUMG_20130801000000_demo_03.nc"
- wmo_data_category = 30
- wmo_international_data_subcategory = 4 or 5 "4" for NRTC, "5" for RAC
- local_data_subcategory = 3 "1" for GEO-LEO-IR, "2" for LEO-LEO-IR, "3" will be for GEO-LEO-VISNIR
- keywords = "GSICS, satellites, inter-calibration, VIS, NIR" (free content)
- monitored_instrument = "MSG3 SEVIRI"
- reference_instrument = "Aqua MODIS"
- monitored_instrument_wmo_code = "(56, 207)"
- reference_instrument_wmo_code = "(784, 389)"
- window_period = "P30D"
- dcc_brdf_model = "Hu et al. (2004)"
- averaging_method = "mode"
- trend_calculation_formula = "a*date^2+b*date^2+c"

→ **Do we need new global attributes about dataset version (e.g., Aqua/MODIS Collection 6)?**

From the WMO's Common Code Tables C-5 and C-8. This was proposed in 2010:
https://groups.google.com/forum/#!topic/gsics-dev/FVV68cGqVWU

Period of 30 days for statistics

"mode" , "mean", "median"

fitting function to plot a time series of instrument degradation. Needed if an official plotting tool supports this plotting.

netCDF: Global attributes – Part 4

In blue = as in existing IR products.
In red = specific to DCC
In green = comment/question

Users can find these information in the ATBD, so it may be redundant for the GSICS products. But we can contain them to the netCDF if we want!

- land_sea_mask = "(SEA, SEA, LAND, BOTH)" Flag for filter on land and sea to select dcc pixels
- mon_max_ir_tb = 205 Threshold of BT11um for the DCC selection
- mon_ir_tb_homogeneity = 2 Standard deviation of 3x3 pixels BT11µm < 1°K
- mon_vis_radiance_homogeneity = 0.5 Standard deviation of 3x3 pixels visible radiance < 3%
- mon_time_range = "T03:00:00Z/PT3H" Observation time range for DCC selection as UTC
  Need to be checked if it follows ISO8601 convection
- mon_pdf_increment = "(5, 5, 5, 10)" Increment for the PDF
- mon_average_pixel_size = "(2, 2, 2, 6)" Compensating the pixel size
- mon_vza_max = "(40, 40, 40, 40)" Threshold of viewing zenith angle [deg]
- mon_sza_max = "(40, 40, 40, 40)" Threshold of solar zenith angle [deg]

Should be duplicated for the reference instrument (use global attributes: ref_*)

netCDF: Variable – Part 1

In blue = as in existing IR products.
In red = specific to DCC
In green = attribute: long_name

Variable dimensions:

- chan = Number of reflective solar bands (e.g. 4 for SEVIRI)
- chan_strlen = 5 (e.g., “VIS06”)
- date = 1 for NRT and N for RAC (complete timeseries)
- validity = 2 (i.e. for the min and the max)

Variables [dimenison]:

- char **channel_name** [chan]: channel identifier
- float **central_wavelength** [chan]: nominal channel central wavelength
- float **validity_period** [date, validity]: correction validity period start and end time
- float **sbaf** [chan]: spectral band adjustment factor for monitored instrument
- Int **mon_k0_av** [date, chan]: average of deep space count for monitored instrument
- float **mon_gain** [date, chan]: calibration gain with respect to reference instrument
- float **mon_gain_se** [date, chan]: standard error on the gain with respect to reference instrument

monitored instrument (=GEO)

netCDF: Variable – Part 2

In blue = as in existing IR products.
In red = specific to DCC
In green = attribute: long_name

- int **mon_number_of_targets** [date, chan]: number of dcc pixels to calculate correction of monitored instrument
- float **mon_mode_dc** [date, chan]: mode of digital counts for monitored instrument
- float **mon_mean_dc** [date, chan]: mean of ...
- float **mon_kurtosis_dc** [date, chan]: kurtosis of ...
- float **mon_skewness_dc** [date, chan]: skewness of ...
- int **ref_number_of_targets** [date, chan]: number of dcc pixels to calculate correction of reference instrument
- float **ref_mode_radiance** [date, chan]: mode of radiance for reference instrument
- float **ref_mean_dc** [date, chan]: mean of ...
- float **ref_kurtosis_dc** [date, chan]: kurtosis of ...
- float **ref_skewness_dc** [date, chan]: skewness of ...
- float **mon_sol_irr** [chan]: band solar irradiance of monitored instrument
- float **ref_sol_irr** [chan]: band solar irradiance of reference instrument

Necessary if an official plotting tool supports bias plotting regarding reflectance

Open question: what kinds of uncertainties we should include?
Fangfang's suggestion at the annual meeting (2014):
Uncertainty of reference reflectance, fitting coefficients, Correction coefficients, BRDF model, …

GSICS VNIR product

Current EUMETSAT GSICS VNIR products

- Updated once per day (Near Real Time + Re-Analysis)
- A product user's manual in preparation
- EUMETSAT ATBD available
- For NRT + RA ➔ see http://gsics.eumetsat.int