

Theoretical Basis for Meteosat SEVIRI-IASI Inter-Calibration Algorithm for GSICS

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1. Introduction

1.1. Background

The Global Space-based Inter-Calibration System (GSICS) enhances the calibration of satellite instruments and validation of satellite observations. This makes GSICS a critical system in the Global Earth Observation System of Systems (GEOSS). Upon completion, GSICS will have several components for inter-calibration among geostationary (GEO) and low earth orbiting (LEO) satellites, such as GEO-GEO, LEO-LEO, and GEO-LEO.

1.2. Scope

All these components and the individual inter-calibration therein employ common procedures such as collocating measurements in time and space. On the other hand, each inter-calibration may be unique because each involves different orbit, instrument, field-of view (FOV), spectrum, and so forth. This Algorithm Theoretical Basis Document (ATBD) follows the hierarchical principles proposed to the GSICS Research Working Group. This hierarchy first defines the general principles of each step of the inter-calibration procedure. Different options are then suggested for their implementation in general. These are then refined for each class of inter-calibration (e.g. inter-sensor/inter-satellite, GEO-LEO) and finally defined for each specific instrument pair.

This document forms the ATBD for the inter-calibration of the infrared channels of SEVIRI on the GEO Meteosat Second Generation satellites with the Infrared Atmospheric Sounding Interferometer (IASI) on board LEO Metop satellites.

Different versions of each component of the algorithm may exist, which must be clearly labelled and documented. However, at any point in time, GSICS will define the “baseline” algorithm by identifying one version of each component, against which the performance of other versions may be compared.

1.3. History

The initial version of this ATBD, designated *post factum* as Version 0.1, was presented at the GSICS Research Working Group (GRWG-II, February 2007) and articles in the GSICS Quarterly newsletter (König, 2007 and Hewison, 2008a). It was described in detail in a EUMETSAT internal report [Hewison, 2008b], which was later extended to include a physical model to explain the changing bias found in one of Meteosat’s channels [Hewison and König, 2008].

Since then, EUMETSAT’s SEVIRI-IASI inter-calibration algorithm has been re-coded as the IDL suite ICESI (Inter-Calibration EUMETSAT SEVIRI-IASI), which is documented in Annex A. This allows routine, automatic processing of data delivered by standing orders set up on EUMETSAT’s Unified Meteorological Archive and Retrieval Facility (U-MARF) after conversion to NetCDF formats. Many components of the inter-calibration have been revised when coding this algorithm. These are denoted as v0.3, but should still be considered as prototypes and are currently under review.

2. Design Principle and Justification

Inter-calibration is the comparison of collocated measurements by different sensors. Unlike conventional pre-launch and onboard calibration, for which the signals from calibration sources (space or blackbody) are precisely known, inter-calibration relies on the assumption that the collocated measurements by different sensors are statistically the same. In other words, the agreement among the measurements must be within the expected uncertainty when the difference in observations, in terms of time, location, sensor's spectral response, viewing geometry, and so forth, are minimized and/or otherwise accounted for.

The GSICS Research Working Group conducted a critical review of a number of inter-calibration algorithms (GRWG-I Report), including those used by Minnis et al (2002), Tian et al (2004), Gunshor et al (2004), Tobin et al (2006), Rossow et al (ref.), König (ref.), and Tahara (ref.). It was concluded that the first goal for GSICS is to quantify the difference between the measurements by two satellites *for the collocations being considered*. This is useful because the results can be generalized, albeit often implicitly, to measurements by the same two satellites *not* being directly compared to each other. An advanced goal for GSICS is that the results should help diagnosing instrument performance, i.e., not only to indicate whether the two measurements agree with each other but also to suggest which instrument has what type of error under which conditions and why.

A necessary condition to achieve both goals is that the sample measurements should include conditions under which the satellites operate. Specifically, the collocations are required to adequately cover the normal range of:

1. Spectral band
2. Scene temperature
3. Geographic location
4. Viewing geometry
5. Time of day
6. Day of year
7. Satellite age

The first requirement enables user to quantify possible spectral variation of differences between satellites. It can be easily achieved by collecting data for all bands.

The second requirement enables user to quantify possible scene dependence of differences between satellites. For this reason it is desirable to reduce the size of collocation, to single instantaneous field of view or pixel if possible.

The next three requirements enable user to quantify possible geographic, geometric (angular), and diurnal variation of differences between satellites. They all require that the collocations away from the GEO nadir be collected. Note that sun-synchronous satellites (most LEOs) always pass the nadir of a geostationary satellite (all GEOs) at the fixed time of day (local time).

The last two requirements enable user to quantify possible seasonal variation and long term trend of differences between satellites. They require that the GSICS be operated continuously throughout the life time of satellites

In summary, *GSICS goals require that single pixel collocations anywhere within the GEO field of regard be collected continuously over long term for all bands.*

A pair of collocated measurements by two instruments should match in space, time, viewing geometry, and spectrum. In practice, the match is always imperfect in one or more of those attributes, so it is really a match within certain threshold. Another principle for GSICS algorithm is therefore to set the threshold values reasonably tight to keep the data volume manageable, meanwhile sufficiently tolerant to allow down selection later by different users for various applications. In short, *collect all it can to allow future selection and manipulation by users.*

3. Algorithm Description

This algorithm is defined as a series of generic steps agreed at the GSICS Data Working Group meeting (February 2008):

- 1) Find Collocation
- 2) Transform Data to allow comparisons
- 3) Filtering
- 4) Analysis and Reporting
- 5) Supplying Operational Correction (not included in this draft ATBD)

Each of these steps comprises a number of discrete processes. Each of these can be defined in a hierarchical way, starting from basic principles, which apply to all inter-calibrations, building up to implementation details for specific instrument pairs:

- i. Describe the basic principles of each process in this generic data flow.
- ii. Provide different options for how these may be implemented in general.
- iii. Recommend specific procedures for inter-calibration class (e.g. GEO-LEO).
- iv. Provide specific details for each instrument pair (e.g. SEVIRI-IASI).

Each component is defined independently and may exist in different versions. However, the implementation of the algorithm need not follow the steps sequentially, rather the overall logic.

The current version of this algorithm covers only steps 1-4. These need full review before the method of providing operational corrections can be agreed.

3.1. Find Collocations

The first step is to obtain the data from both instruments, select the relevant comparable portions and identify the collocated pixels.

3.1.a. Select Orbit

3.1.a.i. We first perform a rough cut to reduce the data volume and only include relevant portions of the dataset (channels, area, time, viewing geometry).

3.1.a.ii. General Options

3.1.a.ii.v0.1. Data is selected on a per-orbit or per-image basis. To do this, we need to know how often to do inter-calibration – which is based on the observed rate of change and must be defined iteratively with the results of the inter-calibration process.

3.1.a.iii. Infrared GEO-LEO inter-satellite/inter-sensor Class

3.1.a.iii.v0.1. We define the GEO Region of Interest (RoI) as within 60° (latitude or longitude) of the GEO Sub-Satellite Point (SSP). The GEO and LEO data is then subsetted to only include observations within this RoI within each inter-calibration period.

3.1.a.iv. SEVIRI-IASI specific

3.1.a.iv.v0.1. For SEVIRI, the GEO RoI is further reduced to include only data within $\pm 30^\circ$ lat/lon of the SSP. A single Metop overpass is selected with a night-time equator crossing closest to the GEO SSP. The IASI data within this overpass is then geographically subsetted to only include data within this smaller GEO RoI by applying time filtering.

3.1.a.iv.v0.2. As v0.1, except that a fixed GEO time frame is taken every day at the nominal LEO local equator crossing time (21:30) and the RoI is extended to $\pm 35^\circ$ in the North-South direction. This is implemented as a standing order from EUMETSAT's Unified Meteorological Archive and Retrieval Facility (U-MARF). The native format datasets are then converted to NetCDF format, as described in Annex A.

3.1.b. Collocate Pixels

3.1.b.i. This component of the first step defines which pixels can be used in the direct comparison. To do this, we need to define the Field of View (FoV) for all pixels, and the *environment* around them. Then we need to identify those pixels for both instruments within these areas that meet collocation criteria for time, space and geometry.

3.1.b.ii. General Options

3.1.b.ii.v0.1. Each pixel in the LEO dataset is tested sequential to identify those GEO pixels within its FoV and environment. This is slow.

3.1.b.ii.v0.2. Not implemented yet.

3.1.b.ii.v0.3. A more efficient method of searching for collocations is to calculate 2D-histograms of the distributions of GEO and LEO observations on a common grid in latitude/longitude space. Non-zero elements of both histograms identify the location of collocated pixels and their indices provide the coordinates in observation space (scan line, element, FoV, etc...).

3.1.b.ii.v0.4. v0.3 does not capture pixels that straddle bin boundaries of the histograms. This may be refined in future by repeating the histograms on 4

staggered grids, offset by half of the grid spacing, and rationalising the list of collocated pixels returned by the 4 independent searches to remove any duplication. (Not implemented yet.)

3.1.b.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.1.b.iii.v0.1. The geometric alignment of the pixels is implemented by selecting only the GEO/LEO pixels where secants of their zenith angles are within 0.01. The temporal alignment is checked by only selecting GEO/LEO pixels with time differences <300s.

3.1.b.iv. *SEVIRI-IASI specific*

3.1.b.iv.v0.1. The IASI FoV is defined as a circle of 12km diameter at nadir. The SEVIRI FoV is defined as square pixels with dimensions of 3x3km at SSP. The default time difference was relaxed to <900s to match SEVIRI's observing period. An array of 5x5 SEVIRI pixels closest to centre of each IASI pixel are taken to represent both the IASI FoV and its *environment*.

3.1.b.iv.v0.2. Not implemented yet.

3.1.b.iv.v0.3. As v0.1, except that SEVIRI and IASI pixels are selected that fall within the same bin of a 2-D histograms with 0.125° lat/lon grid, covering ±35° lat/lon. This is implemented in the routine **icesi_collocate** (see Annex A).

3.1.c. *Pre-select Channels*

3.1.c.i. Select only broadly comparable channels from both instruments (to reduce data volume).

3.1.c.ii. *General Options*

3.1.c.ii.v0.1. This selection is based on pre-determined criteria for each instrument pair.

3.1.c.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.1.c.iii.v0.1. Only the channels of the GEO and LEO sensors are selected in the thermal infrared range of 3-15µm.

3.1.c.iv. *SEVIRI-IASI specific*

3.1.c.iv.v0.1. Select SEVIRI's IR channels: 3.9, 6.2, 7.3, 8.7, 9.7, 10.8, 12.0, 13.4 µm. Select all channels for IASI. These selections are implemented in the U-MARF standing orders, as shown in Annex A.

3.2. Transform Data to allow comparisons

At each stage in this process, the best estimate of the channel radiance should be produced, together with an estimate of its uncertainty.

3.2.a. Collect Radiances

3.2.a.i. Convert observations from both instruments to a common definition of radiance to allow direct comparison.

3.2.a.ii. General Options

3.2.a.ii.v0.1. The instruments' observations are converted from Level 1.5/1b/1c data to radiances, using pre-defined, published algorithms specific for each instrument.

3.2.a.iii. Infrared GEO-LEO inter-satellite/inter-sensor Class

3.2.a.iii.v0.1. Perform comparison in radiance units: $\text{mW/m}^2/\text{st/cm}^{-1}$.

3.2.a.iv. SEVIRI-IASI specific

3.2.a.iv.v0.1. The Meteosat radiance definition applicable to each level 1.5 dataset is used to account for the instrument's Spectral Response Functions. IASI data are converted to radiances using the published algorithm [EUMETSAT, 2006]. These conversions are implemented in the routines **read_msg_nc** and **read_iasi_nc**, which read the NetCDF format data.

3.2.b. Spectral Matching

3.2.b.i. Firstly, we must identify which channel sets provide sufficient common information to allow meaningful inter-calibration. These are then transformed into comparable pseudo channels, accounting for the deficiencies in channel matches.

3.2.b.ii. General Options

3.2.b.ii.v0.1. The Spectral Response Functions (SRFs) must be defined for all channels. Channels identified as comparable are then co-averaged. A Radiative Transfer Model can be used to account for any differences in the pseudo channels' characteristics. The uncertainty due to spectral mismatches is then estimated for each channel.

3.2.b.iii. Infrared GEO-LEO inter-satellite/inter-sensor Class

3.2.b.iii.v0.1. For hyper-spectral instruments, all SRFs are first transformed to a common spectral grid. The LEO hyperspectral channels are then convolved with the GEO channels' SRFs to create synthetic radiances in pseudo-channels, accounting for the spectral sampling and stability in an error budget.

3.2.b.iv. SEVIRI-IASI specific

3.2.b.iv.v0.1. IASI channels are assumed to be spectrally stable and contiguously sampled. MSG's SRFs for an operating temperature of 95K, published by EUMETSAT are interpolated onto IASI's spectral grid. Any negative responses in the interpolated SRFs are set to zero. This is implemented in the **icesi_convolve** routine (see Annex A).

$$\text{Equation 1: } R_{GEO} = \frac{\int_{\nu} R_{\nu} \Phi_{\nu} d\nu}{\int_{\nu} \Phi_{\nu} d\nu}$$

where R_{GEO} is the simulated GEO radiance, R_{ν} is IASI radiance at wave number ν , and Φ_{ν} is GEO spectral response at wave number ν .

3.2.b.iv.v0.2. As v0.1, but the radiance missing from IASI's coverage of SEVIRI IR3.9 channel is also estimated by assuming a uniform brightness temperature across the missing part of the passband at the mean brightness temperature observed over the rest of the passband. (Not yet implemented).

3.2.c. *Spatial Matching*

3.2.c.i. The observations from each instrument are transformed to comparable spatial scales. The uncertainty in this transformation due to spatial variability is estimated.

3.2.c.ii. *General Options*

3.2.c.ii.v0.1. The Point Spread Functions (PSFs) of each instrument are identified. The *target area* is specified and the pixels within it identified. The *environment* around the target area is specified. The radiances of all pixels within the specified target areas are averaged and their variance calculated to estimate the uncertainty on the mean due to spatial variability.

3.2.c.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.2.c.iii.v0.1. The *target area* is defined as the nominal LEO FoV at nadir. The GEO pixels within target area are averaged and their variance calculated. The *environment* is defined by the GEO pixels within 3x radius of the target area from the centre of each LEO FoV.

3.2.c.iv. *SEVIRI-IASI specific*

3.2.c.iv.v0.1. The IASI FoV is defined as a circle of 12km diameter at nadir. The SEVIRI FoV is defined as square pixels with dimensions of 3x3km at SSP. The default time difference was relaxed to <900s to match SEVIRI's observing period. An array of 5x5 SEVIRI pixels closest to centre of each IASI pixel is taken to represent both the IASI FoV and its *environment*.

3.2.c.iv.v0.2. Not implemented yet.

3.2.c.iv.v0.3. As v0.1, except that SEVIRI and IASI pixels are selected that fall within the same bin of a 2-D histograms with 0.125° lat/lon grid, covering ±35° lat/lon. This is implemented in the routine **icesi_collocate** (see Annex A) simultaneously with the collocation process (1b).

3.2.d. *Temporal Matching*

3.2.d.i. The timing difference between instruments' observations is established and the uncertainty of the comparison is estimated based on (expected or observed) variability over this timescale.

3.2.d.ii. *General Options*

3.2.d.ii.v0.1. Each instrument's sample timings are identified.

3.2.d.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.2.d.iii.v0.1. Only the GEO image closest to the LEO Equator crossing time is selected. The time difference between the GEO and LEO observations is calculated for each collocated pixel.

3.2.d.iii.v0.2. Sequential GEO images are interpolated to the LEO observation time and weighted according to the time difference between each. The uncertainty of the weighted mean could also be estimated. (Not yet implemented.)

3.2.d.iv. *SEVIRI-IASI specific*

3.2.d.iv.v0.1. Only pixels with time differences <900s are selected. They are assumed to be observed simultaneous and no uncertainty is associated with

the time difference. This is implemented in the routine **icesi_collocate** (see Annex A).

3.3. *Filtering*

3.3.a. *Uniformity Test*

3.3.a.i. To reduce uncertainty in the comparison due to spatial/temporal mismatches, the collocation dataset may be filtered so only observations in homogenous scenes are compared.

3.3.a.ii. *General Options*

3.3.a.ii.v0.1. The spatial/temporal variability of the scene within the target area is compared with pre-defined thresholds to exclude scenes with greater variance from analysis. This may be performed on a per-channel basis.

3.3.a.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.3.a.iii.v0.1. The variance of the radiances of all the GEO pixels within each LEO FoV is calculated.

3.3.a.iii.v0.2. The interpolation between sequential GEO images may be included in future. (Not yet implemented.)

3.3.a.iv. *SEVIRI-IASI specific*

3.3.a.iv.v0.0. No homogeneity filtering is implemented, as found to not change the results significantly. (Results rely instead on inhomogeneous scenes having lower weighting in regression and include the full range of scene radiances.)

3.3.a.iv.v0.2. Any targets where the standard deviation of the scene radiance is >5% of the reference scene radiance (see 4b) are rejected. This is implemented in the routine **icesi_analyse** (see Annex A).

3.3.b. *Outlier Rejection*

3.3.b.i. To prevent anomalous observations having undue influence on the results, 'outliers' may be identified and rejected on a statistical basis. Small number of anomalous pixels in the environment, even concentrated, may not fail the uniformity test. However, if they appear only in one sensor's field of view but not the other, it can cause unwanted bias in a single comparison. Since the anomaly has equal chance to appear in either sensor's field of view, comparison of large number of samples remains unbiased but has increased noise.

3.3.b.ii. *General Options*

3.3.b.ii.v0.1. The radiances in the target area are compared with those in the surrounding *environment*, and those targets which are significantly different from the environment (3σ) may be rejected.

3.3.b.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.3.b.iii.v0.1. The mean GEO radiances within each LEO FoV are compared to the mean of their *environment*. Targets where this difference is >3 times the standard deviation of the environment's radiances are rejected.

3.3.b.iv. *SEVIRI-IASI Specific*

3.3.b.iv.v0.1. Not yet implemented.

3.3.c. Auxiliary Datasets

3.3.c.i. Incorporation of auxiliary datasets to allow analysis of statistics in terms of other geophysical variables – e.g. land/sea/ice, cloud cover, etc.

3.3.c.ii. *General Options*

3.3.c.ii.v0.1. Not yet implemented.

3.3.c.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.3.c.iii.v0.1. Not yet implemented.

3.3.c.iv. *SEVIRI-IASI Specific*

3.3.c.iv.v0.1. Not yet implemented.

3.4. Analysis and Reporting

This step includes the actual comparison of the collocated radiances produced in Steps 1-3, the analysis of the results and reporting any differences in ways meaningful to a range of users.

3.4.a. Regression

3.4.a.i. This component performs a systematic comparison of collocated radiances from 2 instruments. This allows us to investigate how biases depend on various geophysical variables and provides statistics of any significant dependences, which can be used to investigate their possible causes. (This comparison may also be done in counts or brightness temperature.)

3.4.a.ii. *General Options*

3.4.a.ii.v0.1. Simply average the differences between collocated radiances.

3.4.a.ii.v0.2. Perform weighted linear regressions of collocated radiances, using the estimated uncertainty on each point as a weighting.

3.4.a.ii.v0.3. Perform stepwise multiple linear regression to investigate dependence of various geophysical variables.

3.4.a.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.4.a.iii.v0.1. Never implemented.

3.4.a.iii.v0.2. Inter-calibrations are repeated daily using only night-time LEO overpasses. Only incidence angles $<30^\circ$ are included. Collocations are weighted by the inverse variance of target radiances in the regression.

3.4.a.iv. *SEVIRI-IASI Specific*

3.4.a.iv.v0.1. Repeat inter-calibration every 10 days (nights). Only pixels with incidence angle $\sim 15^\circ \pm 1^\circ$ are selected.

3.4.a.iv.v0.2. Range of incidence angles extended to $<40^\circ$ implicitly due to RoI constraints. Inter-calibrations are attempted every day (although only $\sim 1/2$ of cases contain collocations). The results may be averaged over periods of ~ 1 week. (Longer periods are subject to drift due to ice contamination.) However, the resulting statistics must be reset following Meteosat decontamination procedures. This is implemented in the routine **icesi_analyse** (see Annex A).

3.4.b. Define reference radiances

3.4.b.i. This component provides standard reference scene radiances at which instruments' inter-calibration bias can be directly compared. Because biases can be scene-dependent, it is necessary to define channel-specific reference scene radiances. More than one reference scene radiance may be needed for different applications – e.g. clear/cloudy, day/night.

3.4.b.ii. *General Options*

3.4.b.ii.v0.1. A representative Region of Interest (RoI) is selected and histograms of the observed radiances within ROI are calculated for each channel. Histogram peaks are identified corresponding to clear/cloudy scenes to define reference scene radiances. These are determined *a priori* from representative sets of observations.

3.4.b.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.4.b.iii.v0.1. The RoI is limited to within 30° latitude/longitude of the GEO sub-satellite point and times limited to night-time LEO overpasses.

3.4.b.iv. *SEVIRI-IASI Specific*

3.4.b.iv.v0.1. Find the mode of the histogram of each channels' brightness temperature for collocated pixels in 5 K wide bins from 200 to 300 K. (For bimodal distributions, the mean of the modes is used.)

Ch (μm)	3.9	6.2	7.3	8.7	9.7	10.8	12.0	13.4
T _{bref} (K)	290	240	260	290	270	290	290	270

3.4.b.iv.v0.2. Define cold reference scene for high cloud as 220K for all channels.

3.4.c. Calculate biases

3.4.c.i. Inter-calibration biases should be directly comparable for representative scenes in a way easily understood by users.

3.4.c.ii. *General Options*

3.4.c.ii.v0.1. Regression coefficients are applied to estimate expected bias and uncertainty for reference scenes in radiances, accounting for correlation between regression coefficients. The results may be expressed in absolute or percentage bias in radiance, or brightness temperature differences.

3.4.c.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.4.c.iii.v0.1. Biases and their uncertainties are converted from radiances to brightness temperatures for visualisation purposes.

3.4.c.iv. *SEVIRI-IASI Specific*

3.4.c.iv.v0.1. The definition of effective radiance is used in the conversion to brightness temperatures.

3.4.d. Test non-linearity

3.4.d.i. Any non-linearity in the relative differences between instruments should be characterised, or, at least, limits should be placed on its maximum magnitude. These non-linearity errors may be used to account for detector non-linearity, calibration errors or inaccurate spectral response functions.

3.4.d.ii. *General Options*

3.4.d.ii.v0.1. The results of linear and quadratic regressions of collocated radiances are compared to estimate the maximum departure from linearity, the scene radiance at which it occurs and the uncertainty associated with it.

3.4.d.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.4.d.iii.v0.1. It is necessary to combine multiple LEO overpasses to produce enough data to identify the instruments' relative linearity to the level of the instruments' noise. (Any non-linearity is likely to be relatively constant in time.)

3.4.d.iv. *SEVIRI-IASI Specific*

3.4.d.iv.v0.1. Not implemented yet.

3.4.e. Recalculate calibration coefficients

3.4.e.i. This component aims to produce revised sets of calibration coefficients for one instrument following its inter-calibration against a reference instrument. These would allow users to recalibrate data from the target instrument to be consistent with the reference instrument. It is also necessary to generate uncertainties with the calibration coefficients to allow users to specify the error bars on recalibrated data.

3.4.e.ii. *General Options*

3.4.e.ii.v0.1. The original calibration coefficients are read and the changes required to reproduce observed relative biases are calculated.

3.4.e.ii.v0.2. The original counts observed by the target instrument are read and fitted to the collocated radiances observed by the reference instrument.

3.4.e.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.4.e.iii.v0.1. Not implemented yet.

3.4.e.iv. *SEVIRI-IASI Specific*

3.4.e.iv.v0.1. Not implemented yet.

3.4.f. Report Results

3.4.f.i. The results should be reported quantifying the magnitude of relative biases by inter-calibration. This should allow users to :

- Monitor changes in instrument calibration in time,
- Recalibrate observations,
- Specify the uncertainty on observations,
- Derive relative biases and uncertainties between different instruments.

3.4.f.ii. *General Options*

3.4.f.ii.v0.1. Plots and tables of relative biases and uncertainties for reference scene radiances should be produced. These may show the evolution of the biases and their dependence on geophysical variables. Tables of recalibration coefficients for near-real-time and archive data should also be produced.

3.4.f.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.4.f.iii.v0.1. The relative brightness temperature biases for clear sky reference scenes in each channel should be plotted as time series with uncertainties. The trend line and monthly mean biases (and their uncertainties) should be calculated from these time series.

3.4.f.iv. *SEVIRI-IASI Specific*

3.4.f.iv.v0.1. This is implemented in the routine **icesi_plot_bias_ts** (see Annex A). The trends and statistics should be reset when decontamination procedures performed on MSG.

3.5. Operational Corrections

These are not yet defined. The following items provide a template to document future developments.

3.5.a. Component Process

3.5.a.i. Basic Principles.

3.5.a.ii. *General Options*

3.5.a.ii.v0.1. .

3.5.a.iii. *Infrared GEO-LEO inter-satellite/inter-sensor Class*

3.5.a.iii.v0.1. .

3.5.a.iv. *SEVIRI-IASI Specific*

3.5.a.iv.v0.1. .

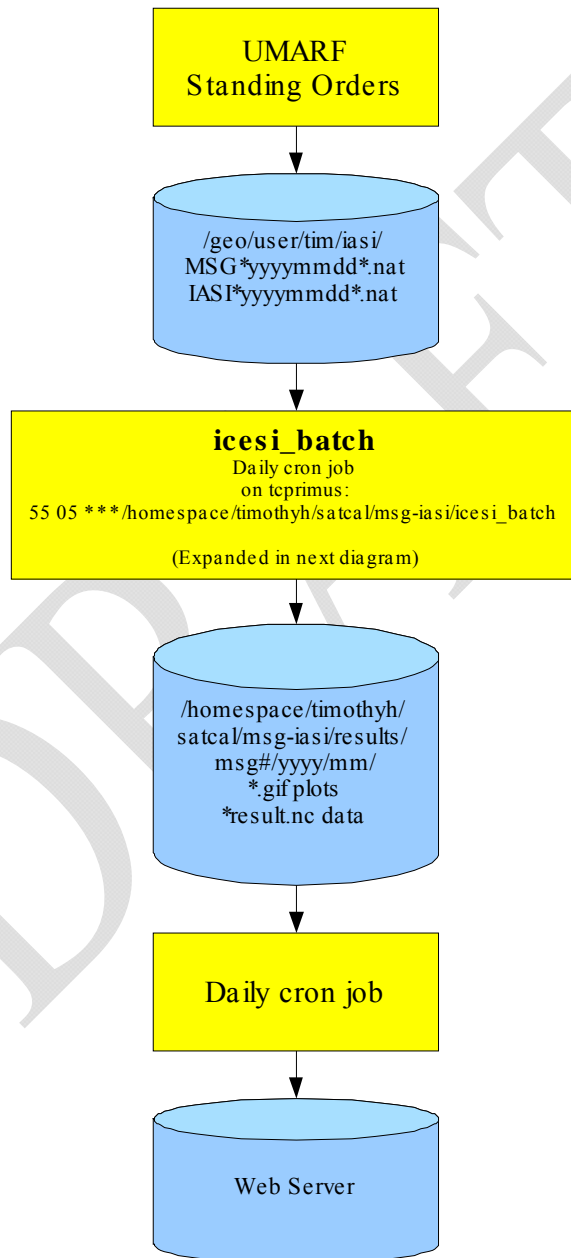
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- König, M., 2007: Inter-Calibration of IASI with MSG-1/2 onboard METEOSAT-8/9, GSICS Quarterly, Vol.1, No.2, August 2007 (Available [online](#)).

4. Annex A – IDL routines: Inter-Calibration (EUMETSAT) of SEVIRI- IASI (ICESI)

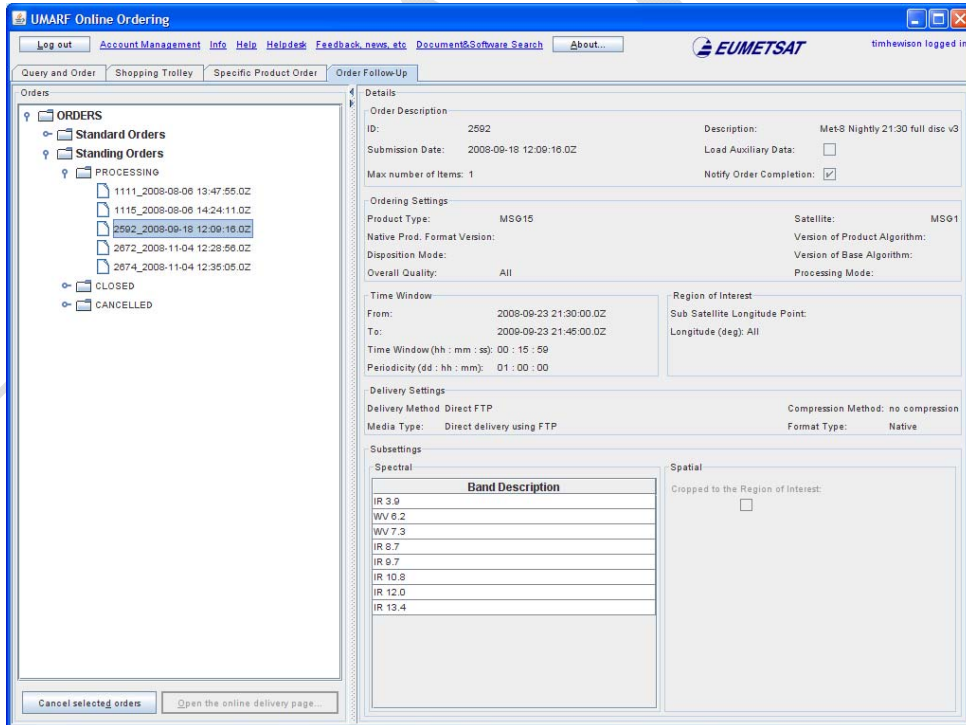
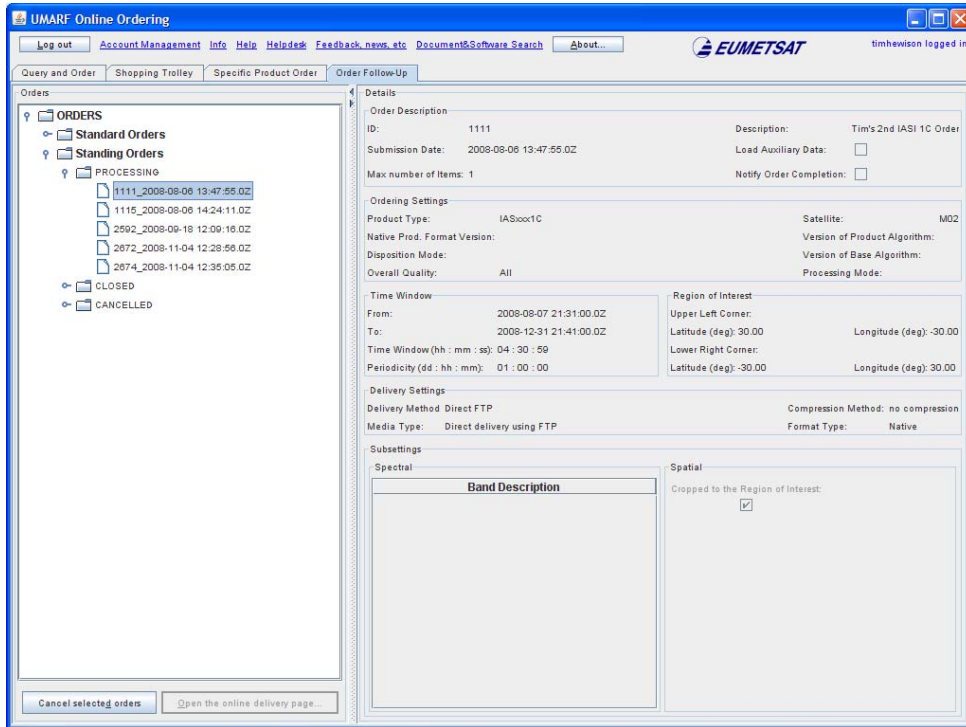
These routines and NetCDF data formats will be documented in detail in a separate document. This is an extract for information.

4.1. Overview of Data Flow



4.2. Input Satellite Data

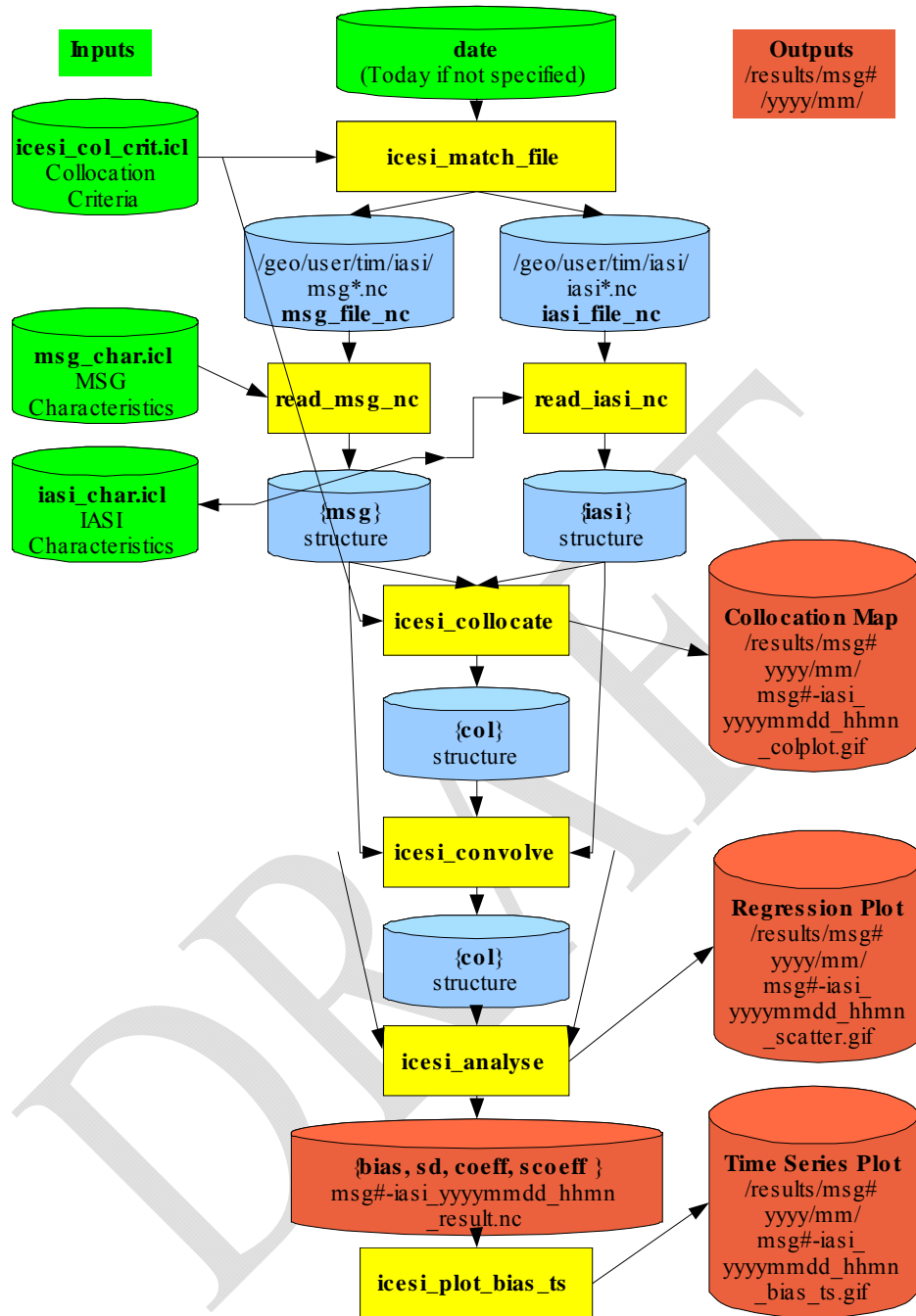
4.2.a. U-MARF Standing Order



4.2.b. NetCDF Format for Input Satellite Data

Reference external document

4.3. Detail of Inter-Calibration Processing ICESI BATCH



4.4. Configuration Options

4.5. Output Data

The data saved for each collocation should be comprehensive to facilitate future down selection, analysis, and certain reprocessing (e.g., spectral convolution). It should contain all the GEO and LEO data, as well as the metadata regarding the collocation.

DRAFT