EUMETSAT Inter-Calibration of Meteosat/SEVIRI with Metop/IASI:
GSICS Near Real Time Correction (NRTC) – ReadMe Quick Guide

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Method

This document summarises the process of applying the GSICS Correction to inter-calibrate the infrared channels of SEVIRI on the Geostationary (GEO) Meteosat Second Generation satellites with the Infrared Atmospheric Sounding Interferometer (IASI) on Low Earth Orbit (LEO) Metop satellites.

The inter-calibration process [EUMETSAT, 2010a] is based on the comparison of thousands of observations of the two instruments, collocated in space, time and viewing geometry, taken within 14 days from the observation date. These observations are transformed spatially and spectrally to allow direct comparison by linear regression to estimate the coefficients, a_r and b_r, required to convert GEO radiances, L_{GEO}, to the reference LEO radiances, L_{LEO}:

Equation 1: $$L_{GEO} = a_r + b_r L_{LEO}$$

This relationship can be inverted to apply the regression coefficients, a_r and b_r, to convert GEO radiances, L_{GEO}, into radiances consistent with the LEO reference instrument, $\hat{L}_{LEO}$,

Equation 2: $$\hat{L}_{LEO} = -\frac{a_r}{b_r} + \frac{1}{b_r} L_{GEO}$$, together with the estimated uncertainty:

Equation 3: $$\sigma^2_{\hat{L}_{LEO}} = \left(\frac{\sigma_{a_r}}{b_r}\right)^2 + \left[(L_{GEO} - a_r)\sigma_{b_r}\right]^2 - 2\frac{(L_{GEO} - a_r)}{b_r}\sigma_{a_r b_r},$$

The regression coefficients, a_r and b_r, and their uncertainties, σ_{a_r}, σ_{b_r} and $\sigma_{a_r b_r}$ are given as variables *offset*, *slope*, *offset_se*, *slope_se* and *covar_of_offset_and_slope*, respectively, in netCDF files for each available date, *yyyymmdd*, e.g. **W_XX-EUMETSAT-Darmstadt,SATCAL+NRTC, Met09+SEVIRI-MetopA+IASI_C_EUMG_*yyyymmdd*0000000_demo_03.nc**, which are downloadable from EUMETSAT's GSICS Data and Products Server: http://gsics.eumetsat.int.
L, and a_r have units of mW/m^2/sr/cm^{-1}, following the Meteosat/SEVIRI radiance convention.

Applicability

These inter-calibration results have been derived over the geographical domain of ±35°N/S, ±35°E/W, using only night-time observations. Although strictly only applicable to these conditions, a sensitivity analysis [Hewison and König, 2008] suggest they are generally applicable, although diurnal variation in the bias of the IR3.9 channel is possible. Use the NRTC file with the date closest to the time of interest. Take great caution where results are older than 14 days, as determined by the netCDF *validity_period* variable.

Typical Results

The mean bias of Meteosat-9 relative to IASI during May 2010 is calculated for a standard scene radiance and given below, expressed as brightness temperature difference, together with its median uncertainty, $\sigma_{\hat{L}_{LEO}}$ (also in K):

Channel	IR3.9	IR6.2	IR7.3	IR8.7	IR9.7	IR10.8	IR12.0	IR13.4	
Standard Scene T_b	284	236	255	284	261	286	285	267	K
Mean Bias, SEVIRI-IASI	+0.025	-0.052	+0.096	-0.015	+0.018	+0.032	+0.042	-1.101	K
Uncertainty (1-σ)	0.006	0.006	0.006	0.005	0.008	0.005	0.006	0.008	K

An error analysis [Hewison, 2010] suggests the uncertainties quoted above and in the netCDF file underestimate the total uncertainty by a factor of ~4 and that there is a systematic bias of -0.232 K in the IR3.9 channel in this version of the algorithm due to incomplete coverage of this channel by IASI.

Example Application

Real-time applications should use the 'Near Real-Time Correction'. The Re-Analysis Correction is intended for reprocessing type analysis, as it has a longer latency time (15d) to allow more smoothing of the results by combining more collocations over a longer period.

The GSICS Correction can be used to correct the operationally produced radiance in the GEO Meteosat L1.5 data, L_{GEO}, so it's calibration is consistent with that of the LEO reference instrument, Metop/IASI, L_{LEO}.

The operational radiance, L_{GEO}, is calculated from the L1.5 counts as:

Equation 4: $L_{GEO} = a_c + b_c C$,

where C is the pixel count, a_c and b_c are the operational offset and slope calibration coefficients, respectively.

The GSICS Corrected radiance is then given by Equation 2, which may be re-writen as

Equation 5: $\hat{L}_{LEO} = \left(\frac{a_c - a_r}{b_r}\right) + \left(\frac{b_c}{b_r}\right) C$,

where a_r and b_r are the coefficients of the GSICS Correction given in the netCDF file as *offset* and *slope*, respectively.

This is equivalent to changing the space count and calibration coefficient in Equation 4 to $a_g=(a_c- a_r)/b_r$ and $b_g= (b_c/b_r)$, respectively.

For example, a typical scene radiance for Meteosat-9 IR13.4 channel might be C=620 counts.

Using the operational calibration, a_c= -8.0376 mW/m^2/sr/cm^{-1}and b_c=0.1576 mW/m^2/sr/cm^{-1}/count gives a radiance of L_{GEO} =89.7 mW/m^2/sr/cm^{-1}, corresponding to a brightness temperature of 267.0 K (close to the GSICS *standard scene radiance* for this channel).

Applying the formula in Equation 5 with example GSICS Correction coefficients, a_r=+2.04 mW/m^2/sr/cm^{-1} and b_r=0.95, gives the GSICS Corrected radiance, $\hat{L}_{LEO}$ =92.2 mW/m^2/sr/cm^{-1}, corresponding to a brightness temperature of 268.8 K. i.e. an increase of +1.8 K compared to the operational calibration, to correct the standard bias of this channel of -1.8 K shown in the GSICS Bias Monitoring:
http://www.eumetsat.int/Home/Main/DataProducts/Calibration/Inter-calibration/GSICSBiasMeteosatIRInter-calibration/index.htm?l=en&satellite=msg2

References

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EUMETSAT, 2010a: ATBD for Prototype GSICS SEVIRI-IASI Inter-Calibration, EUMETSAT Technical Note: EUM/MET/TEN/09/0774.

EUMETSAT, 2010b: GSICS SEVIRI-IASI Inter-calibration Uncertainty Evaluation, EUMETSAT Technical Report EUM/MET/TEN/09/0750.

Hewison, T.J. and M. König, 2008: Inter-Calibration of Meteosat Imagers and IASI, Proceedings of EUMETSAT Satellite Conference, Darmstadt, Germany, September 2008. (Available online).