EUMETSAT Inter-Calibration of Meteosat/MVIRI with Metop/IASI:
GSICS Re-Analysis Correction (RAC) – 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 MVIRI on the Geostationary (GEO) Meteosat First Generation satellites with the Infrared Atmospheric Sounding Interferometer (IASI) on Low Earth Orbit (LEO) Metop satellites.

The inter-calibration process [EUMETSAT, 2010] 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: $$\sigma^2_{\hat{I}_{LEO}} = \left(\frac{\sigma_{a_r}}{b_r}\right)^2 + \left[(L_{GEO} - a_r)\sigma_{b_r}\right]^2 - 2\frac{(L_{GEO} - a_r)}{b_r}\sigma_{a_r b_r},$$

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+RAC, MET07+MVIRI-MetOpA+IASI_C_EUMG_*yyyymmdd*0000000_demo_03.nc**, which are downloadable from EUMETSAT's GSICS Data and Products Server: http://gsics.eumetsat.int. The contents of these files follow the GSICS convention [EUMETSAT, 2009], with coefficients recalculated each day, stored in 2-D arrays of *number_of_channels* (2) x *date*(~1000).

n.b. The GSICS Corrections for Meteosat/MVIRI are defined using the same radiance convention as for Meteosat/SEVIRI, where L, and a_r are defined in units of mW/m^2/sr/cm^{-1}. The user will need to first convert the L1.5 MVIRI radiances from the native units of W/m^2/sr by dividing by a scaling factor corresponding to the integral of each channel's Spectral Response Function (*filter_integral*) and multiplying by 1000, following Tjemkes [2005]. This factor corresponds to 256.218 cm^{-1} for the WV channel and 132.279 cm^{-1} for the IR channel of Meteosat-7/MVIRI.

Applicability

These inter-calibration results have been derived over the geographical domain of ±35°N/S, 22-92°E, using only night-time observations. Although strictly only applicable to these conditions, a sensitivity analysis [Hewison and König, 2008] suggest they are generally applicable. Use the most recent RAC file and read the coefficients for the date of interest. Take great caution where no results are available within 14 days, as determined by the netCDF *validity_period* variable.

Typical Results

The mean bias of Meteosat-7 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, $\sigma_{\hat{I}_{LEO}}$ (also in K):

Channel	WV	IR	
Standard Scene T_b	245	295	K
Mean Bias, SEVIRI-IASI	+2.593	-2.326	K
Uncertainty (1-σ)	0.005	0.007	K

An error analysis [Hewison, 2011] suggests the uncertainties quoted above and in the netCDF file underestimate the total uncertainty by a factor of ~3 in this version of the algorithm.

Example Application

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 radiance, L_{GEO}, is calculated in units of mW/m^2/sr/cm^{-1} from the L1.5 counts as:

Equation 4: $L_{GEO} = [P - S_o][C_o]F$,

where P is the pixel count, S_o and C_o are the operational space count and calibration coefficients, respectively, and the scaling factor (based on the integral of the spectral response function), F = *1000/filter_integral* = 3.90293 cm and 7.55978 cm for the WV and IR channels of Meteosat-7, which is used to convert from the native radiance units of Meteosat-7 (W/m^2/sr) to those of the GSICS Correction (mW/m^2/sr/cm^{-1}).

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

Equation 5: $\hat{L}_{LEO} = \left[P - \left(\frac{a_r}{C_o F} + S_o\right)\right]\left[\frac{C_o F}{b_r}\right]$,

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 $S_g = (a_r/(C_o F) + S_o)$ and $C_g = (C_o F / b_r)$, respectively.

For example, a typical scene radiance for Meteosat-7 WV channel might be P=109 counts.

Using the operational calibration, S_o=6 counts and C_o=0.01102 W/m^2/sr/count gives a radiance of L_{GEO}=4.43 mW/m^2/sr/cm^{-1}, corresponding to a brightness temperature of 244.9 K (close to the GSICS *standard scene radiance* for this channel).

Applying the formula in Equation 5 with example GSICS Correction coefficients, a_r=+0.049 mW/m^2/sr/cm^{-1} and b_r=1.095, gives the GSICS Corrected radiance, $\hat{L}_{LEO}$ =4.00 mW/m^2/sr/cm^{-1}, corresponding to a brightness temperature of 242.2 K. i.e. an decrease of 2.7 K compared to the operational calibration, to correct the standard bias of this channel of +2.7 K shown in the GSICS Bias Monitoring: http://www.eumetsat.int/Home/Main/DataProducts/Calibration/Inter-calibration/GSICSBiasMeteosatIRInter-calibration/index.htm?l=en&satellite=met7.

References

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