IASI L2 land surface temperature inter-comparison with LSA SAF SEVIRI measurements

Monthly report for February 2023,
Platform: M01,
GroundSegment: GS1

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1 INTRODUCTION

1.1 Purpose and scope

This report compiles inter-comparison statistics from the daily monitoring of the IASI L2 surface temperature [RD 1] with MSG SEVIRI measurements.
The IASI L2 products come from the operational ground segment GS1. The reference measurements are retrieved from LSA SAF [RD 3] MSG Land Surface Temperature MLST [RD 4] for clear sky cases. The collocation and statistics are computed with the MAP_GII visualization facility [RD 6].

This document is intended for internal monitoring purposes, to characterise and detect possible changes or trends in performances. It is also a public report to Users interested in IASI L2 product uncertainties. In this respect, it is important to note that differences with MLST products also include uncertainties of the product themself as well as collocation uncertainties. These come from the representativeness of a 3x3 km (sub satellite point) footprint of SEVIRI *vs* the 12-40 km footprint of IASI and from the spatial and temporal lags between SEVIRI and IASI-L2 acquisitions.

1.2 Collocation criteria and data selection

MLST products are available every 15 minutes mostly covering Africa and Europe. Due to the geostationary orbits and the high repetition rate, collocations with IASI measurements can be found daily for the entire MSG-DISK with not more than 10 mins differences. The statistics are computed for the whole MSG-DISK excluding regions with strong variations in surface emissivity (SAHARA desert, arabian peninsula) and for Europe separately with clear-sky pixel (FLG_CLDNES = 1 or 2 [RD 2]) successfully processed with the statistical (in blue) and optimal estimation (in red) retrieval methods. The quality control on the IASI L2 products retains profiles with quality indicators (uncertainty estimates) better than 1.5 K for surface skin temperature. This selection usually represent more than 70% of the pixel flagged free of clouds (20% of the overall measurements). A collocation between IASI IFOV's and SEVIRI measurements is found iterating the following steps. At First the footprint of each IASI individual field of view (IFOV) is calculated dependent on the viewing geometry. In a second step all SEVIRI Pixel inside the footprint of the IFOV are calculated using a normalized geostationary projection [RD 5]. For each IFOV then the maximum and actual (reduced by clear-sky measurements) number of MSG pixel together with the standard deviation of all inter-IFOV LSA SAF MLST values are calculated and used as quality control for the collocation. Collocations with a SEVIRI Pixel fraction of at least 75% and a MLST standard deviation of lower than 2K are averaged and stored as matchup in a matchup database. Collocations with high SEVIRI zenith angles are neglected because of an increasing collocation uncertainty. Figure 1.1 shows examples of collocations between SEVIRI Pixels and IASI IFOVs. Shown are good and bad cases together with their respective SEVIRI Zenith Angle. The calculated IASI IFOV ellipse is show in red and the collocated SEVIRI pixel are illustrated as black grid boxes with their respective center point higlighted as plus (+). SEVIRI grid center points with distances to the IASI-IFOV center greater than the semiminor axis are shown in yellow, greater than the major axis in red. All green SEVIRI pixel are considered as directly inside and therefore as best possible collocation. An increasing number of yellow or even red points represent also an increasing uncertainty that the pixel assignment was done correct.

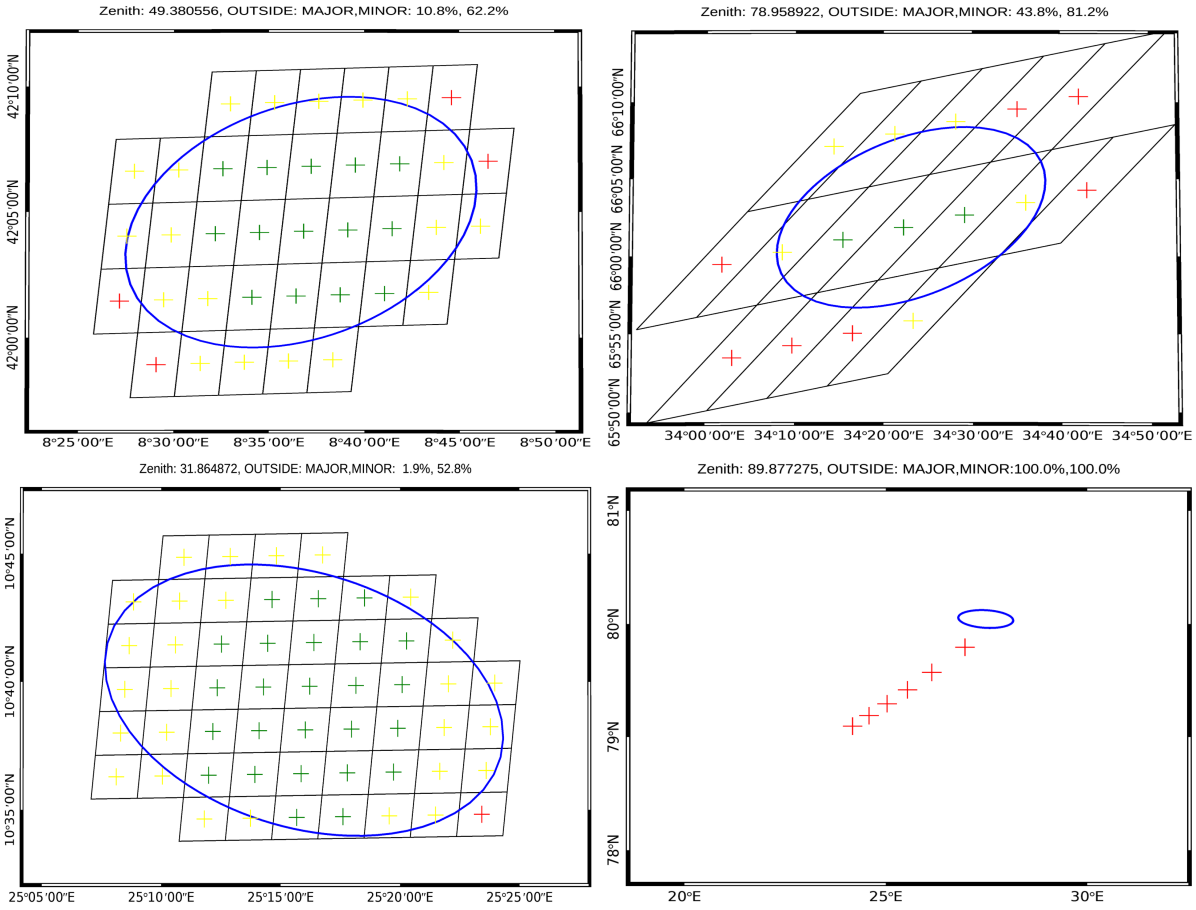

Figure 1.1: Finding Matchups between SEVIRI and IASI. Examples are ordered Good (left) and bad (right). The title indicates the SEVIRI Zenith ANGLE at IFOV Center and the Fraction of SEVIRI Pixel Center (+) that lie outside the SEMIMAJOR (red) and SEMIMINOR (yellow) AXIS Radius. The IASI IFOV is shown as ellipse in blue.

The fraction of pixel with distances greater the minor or major axes can be used to illustrate the uncertainty of the collocation and can be helpful to establish a certain Zenith angle Threshold that should be used to increase the accuracy of the inter-comparison. Figure 1.2 shows the fraction of pixel outside the circle defined by the minor/major axes as function of the SEVIRI zenith angle. As consequence a threshold of 75 degree SEVIRI Zenith angle was choosen for this study. Table 1.1 summarises the thresholds used to define a matchup between an IASI-IFOV and SEVIRI.

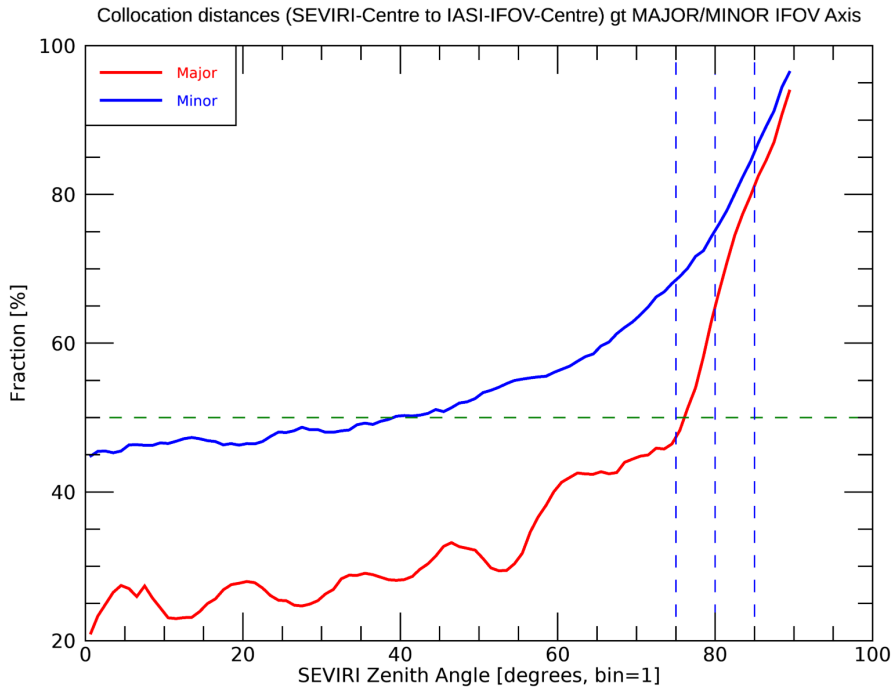

Figure 1.2: Fraction of SEVIRI Matchups with Center points outside of the respective IASI-IFOV for different SEVIRI Zenith Angles. Matchups with distances between SEVIRI pixel center and IASI-IFOV center greater than the IASI semiMajor axis are shown in red; greater the semiMinor axis in blue.

Value	**Threshold**
SEVIRI Zenith ANGLE	$\leq 75^{\circ}$
MLST inter-IFOV STD	$\leq$2K
Pixel Fraction (Valid/MAX)	$\geq$75%
IASI QTs Quality Indicator	$\leq$1.5K

Table 1.1: Thresholds used to define a matchup between SEVIRI and IASI.

1.3 Reference Documents

ID	Title	Reference
[RD 1]	"IASI Level 2 Product Generation Specifications"	EPS.SYS.SPE.990013
[RD 2]	"IASI Level 2 Product Guide"	EUM/OPS-EPS/MAN/04/0033
[RD 3]	"Land Surface Analysis Special Application Facility - LSA SAF"	https://landsaf.ipma.pt/en/
[RD 4]	"MSG Land Surface Temperature"	https://landsaf.ipma.pt/en/products/land-surface-temperature/lst/
[RD 5]	"LRIT/HRIT Global Specification"	CGMS03/issue2.6/1999
[RD 6]	"MAP_GII"	IDL based Visualization Software

1.4 Terminology

- M01 : Metop B
- M02 : Metop A
- M03 : Metop C
- Ground Segment 1 (GS1) : operational
- Ground Segment 2 (GS2) : validation
- Ground Segment 3 (GS3) : experiment
- Optimal estimation (OEM) : Optimal estimation retrieval for IASI
- Piecewise linear regression (PWLR) : statistical retrieval for IASI
- First Guess (FG) : First guess for OEM (= PWLR)

2 MATCHUPS

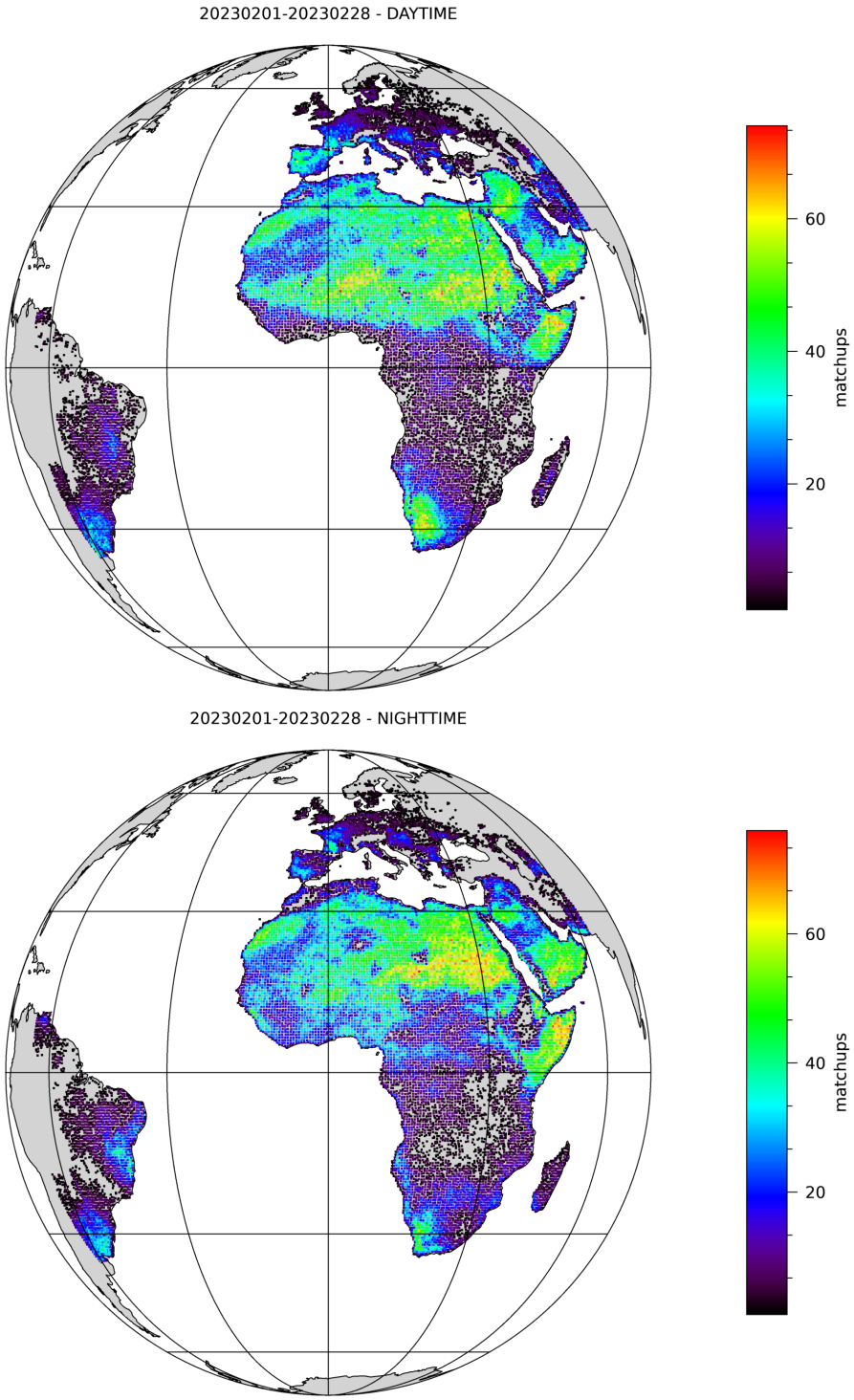

Figure 2.1: Number of match-ups per gridbox (0.5 degree equal angle) with M01 IASI L2 from GS1 for 01-28/02/2023

3 MSG-DISK W/O DESERTS MONTHLY CLEAR-SKY STATISTICS

3.1 Monthly time series

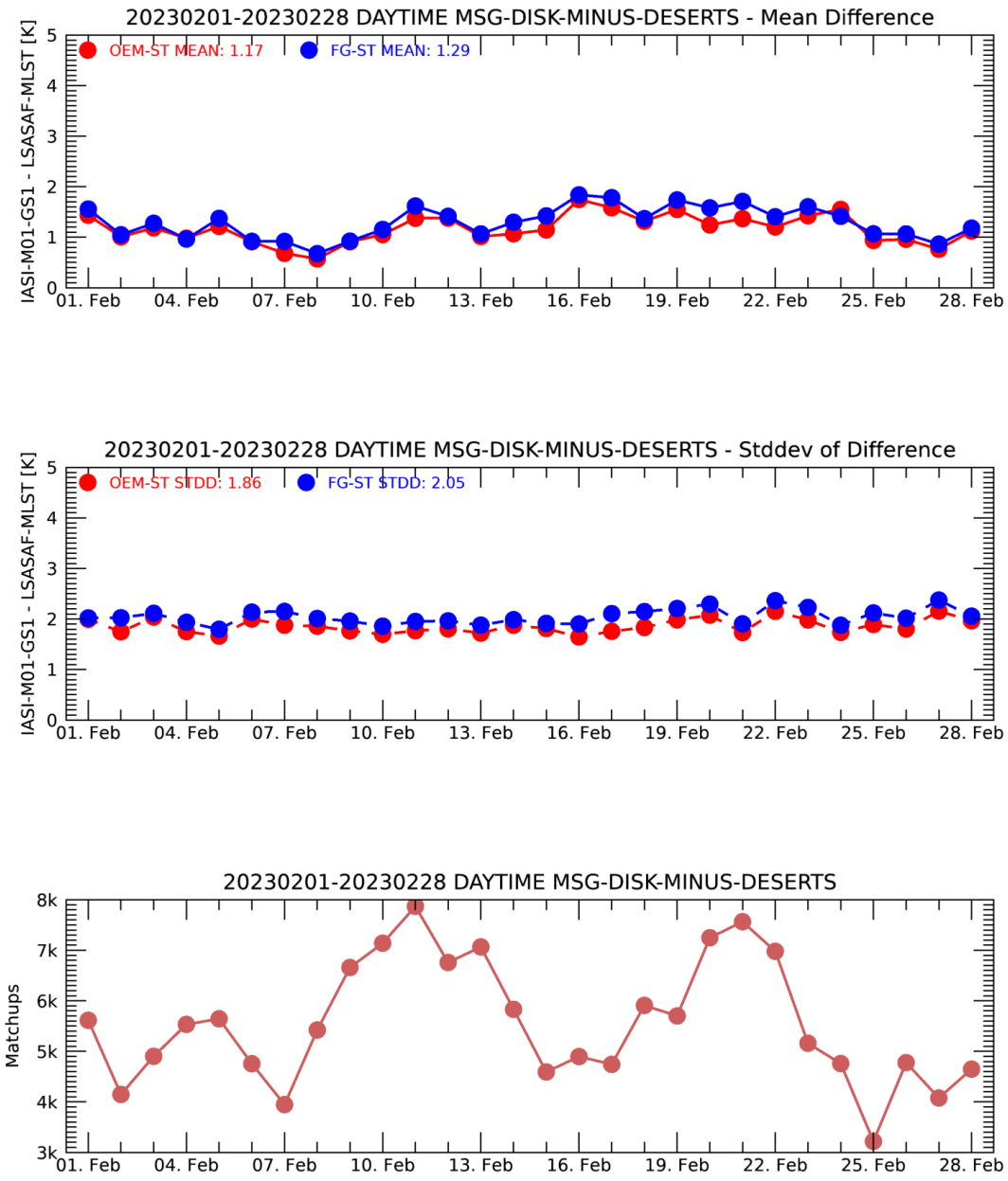

Figure 3.1: Monthly time series of mean difference and standard deviation between IASI L2 - LSA SAF. The bottom panel shows the number of daily match-ups. Daytime statistics with M01 IASI L2 from GS1 for 01-28/02/2023

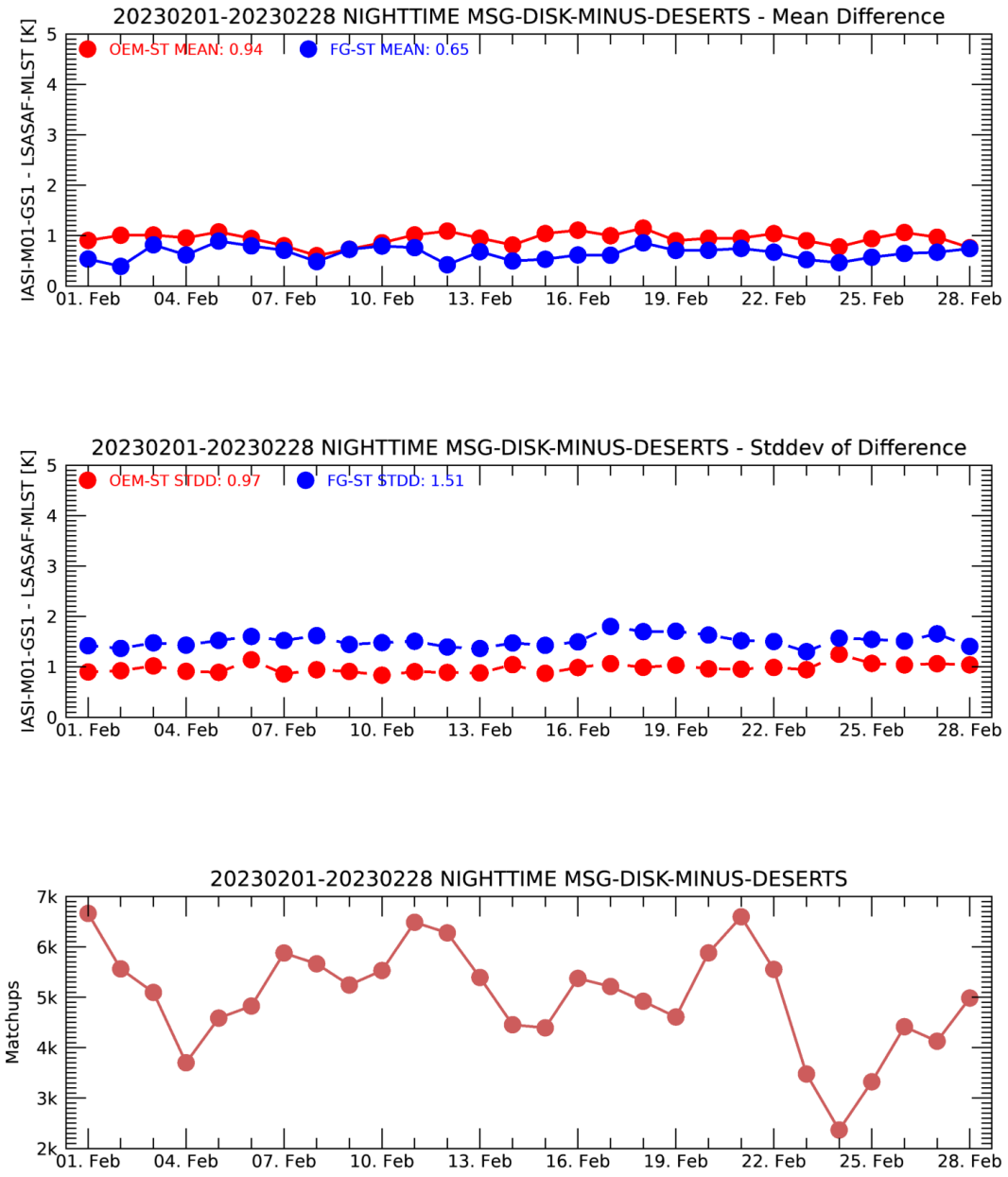

Figure 3.2: Monthly time series of mean difference and standard deviation between IASI L2 - LSA SAF. The bottom panel shows the number of daily match-ups. Nighttime statistics with M01 IASI L2 from GS1 for 01-28/02/2023

3.2 Long-term time series

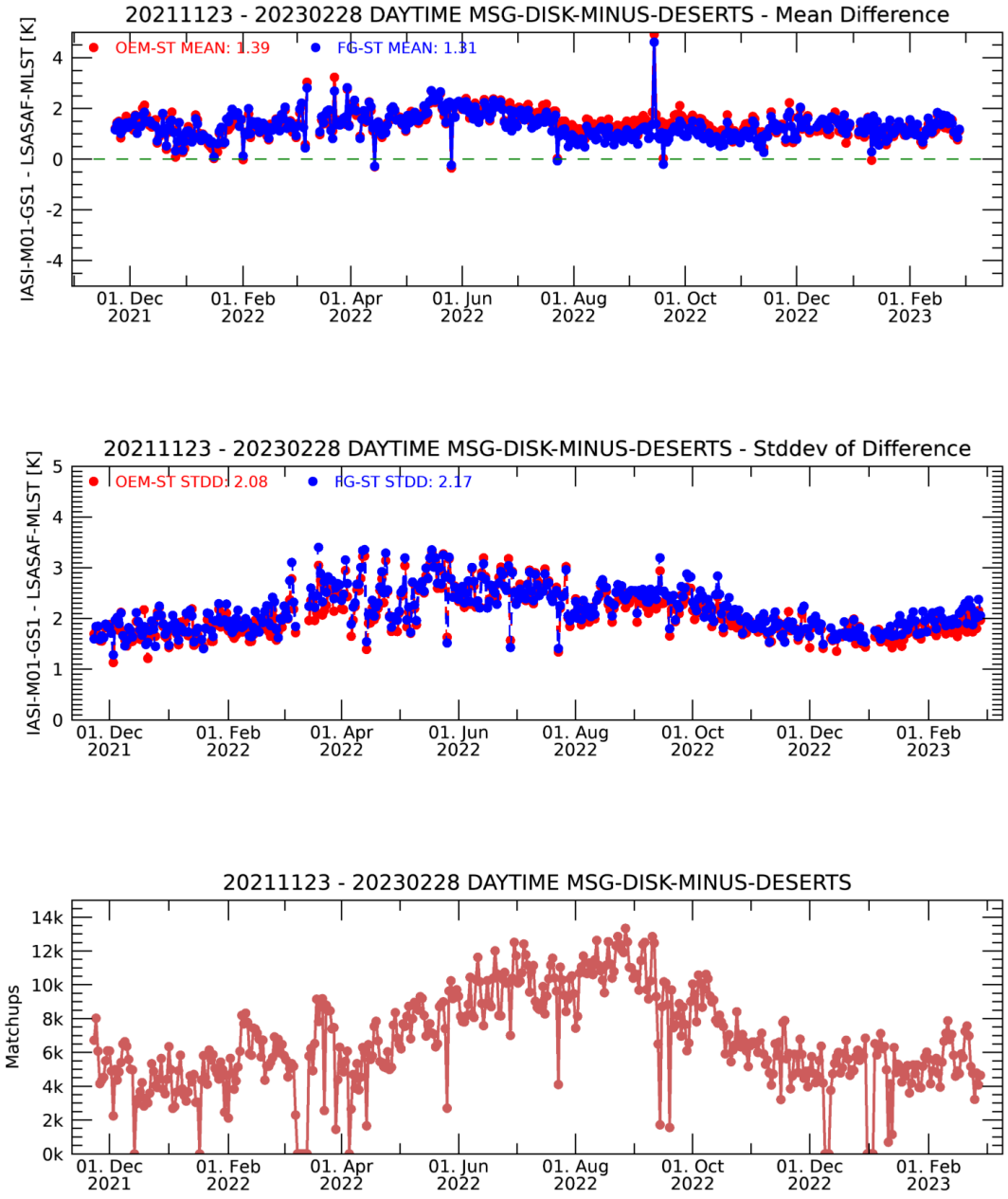

Figure 3.3: Monthly time series of mean difference and standard deviation between IASI L2 - LSA SAF. The bottom panel shows the number of daily match-ups. Daytime statistics with M01 IASI L2 from GS1 for 01-28/02/2023

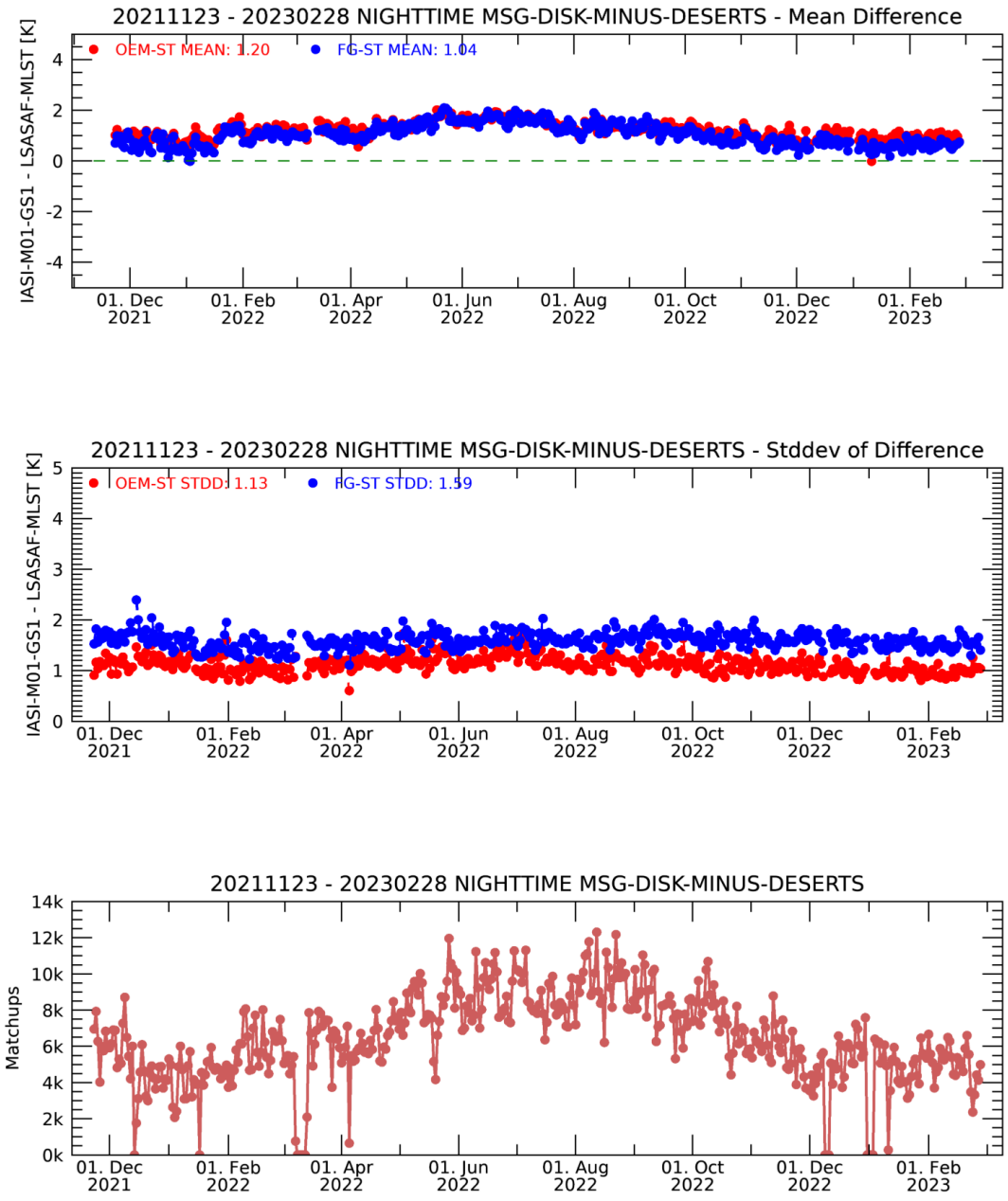

Figure 3.4: Monthly time series of mean difference and standard deviation between IASI L2 - LSA SAF. The bottom panel shows the number of daily match-ups. Nighttime statistics with M01 IASI L2 from GS1 for 01-28/02/2023

3.3 Histograms

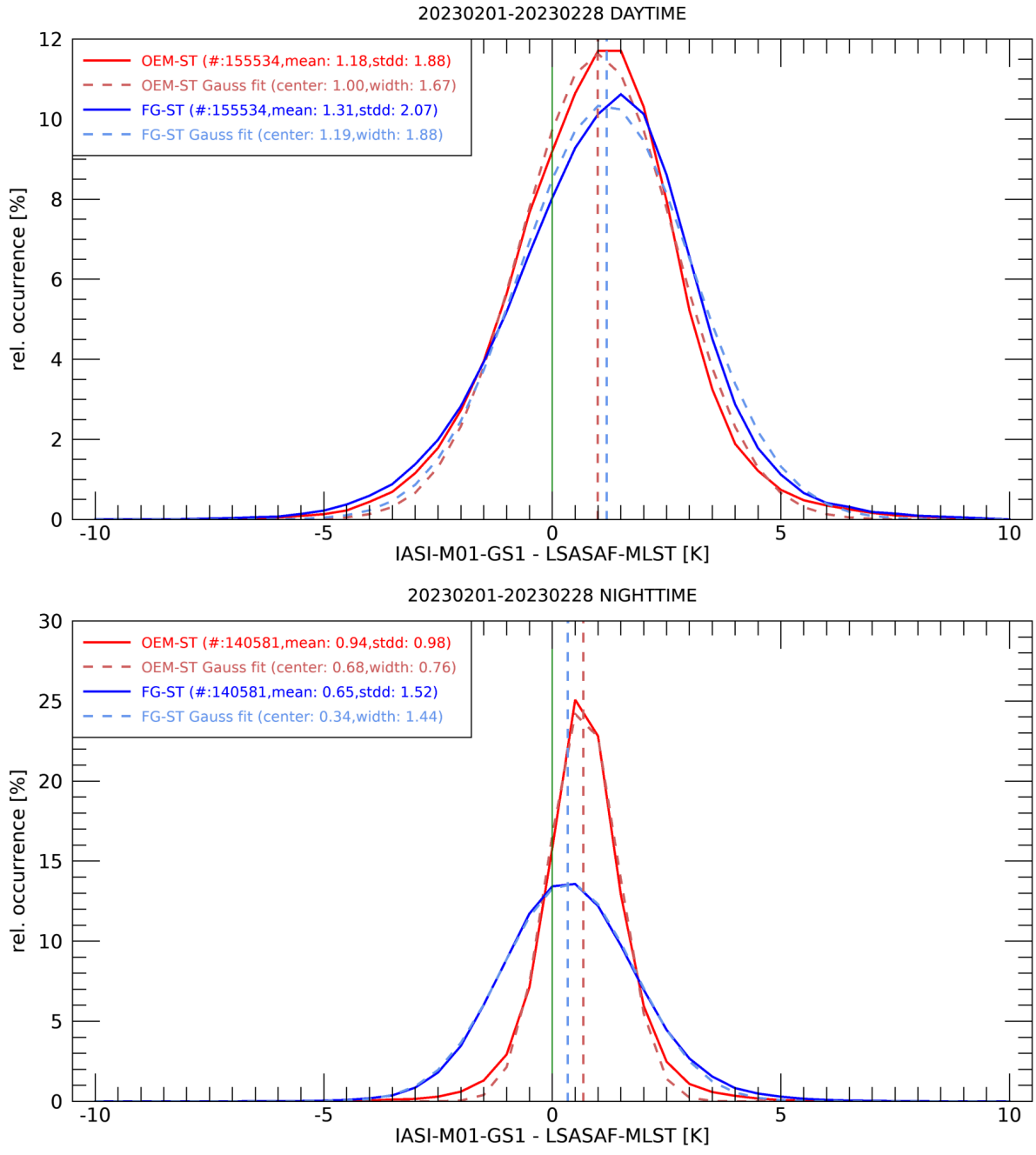

Figure 3.5: Daytime (top) and Nighttime (bottom) histogram of the difference between IASI L2 - LSA SAF, with M01 IASI L2 from GS1 for 01-28/02/2023

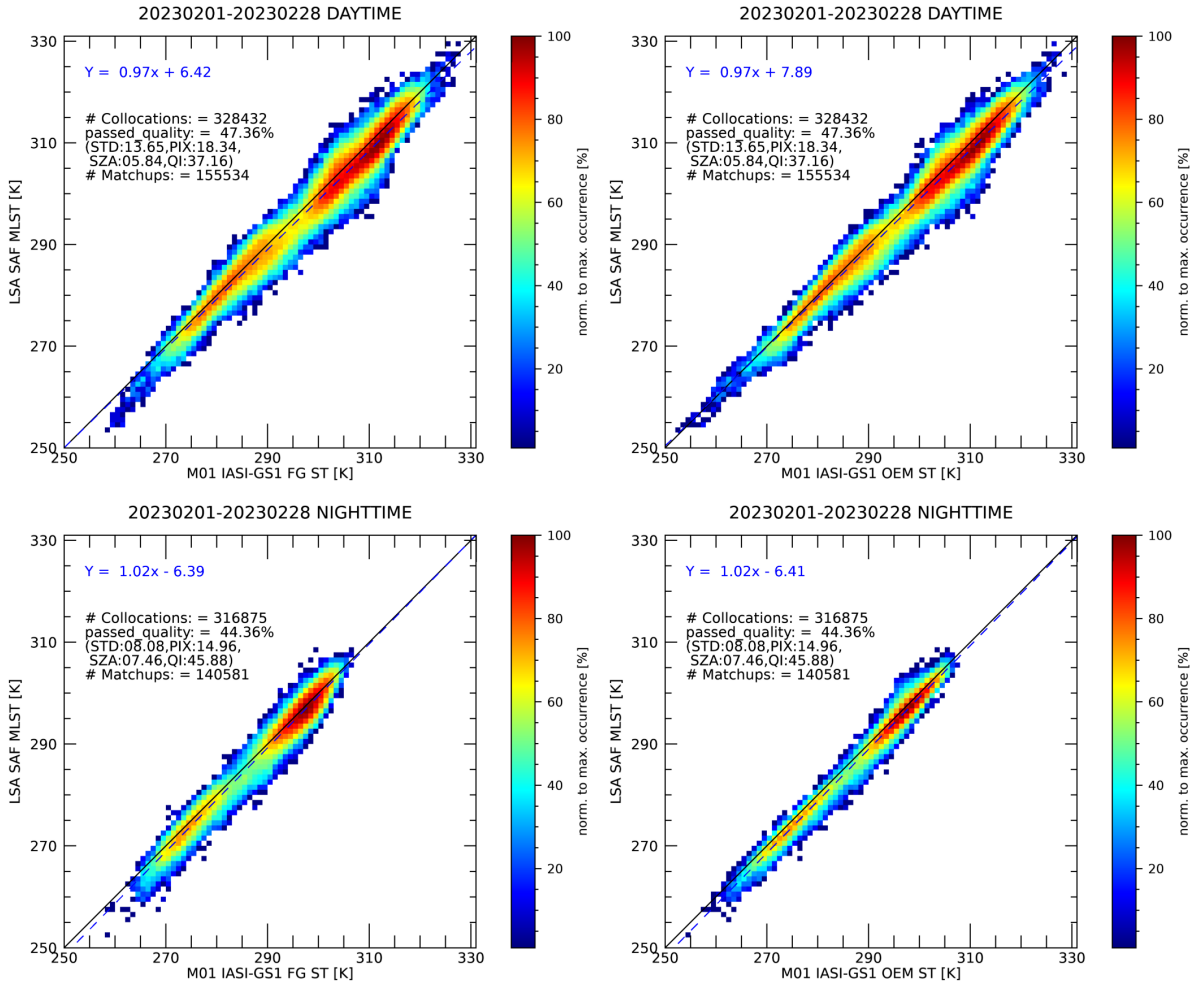

Figure 3.6: 2D Histograms for Day (top), Night (Bottom), Regression (FG) (left) and OEM (right) retrieval, with M01 IASI L2 from GS1 for 01-28/02/2023

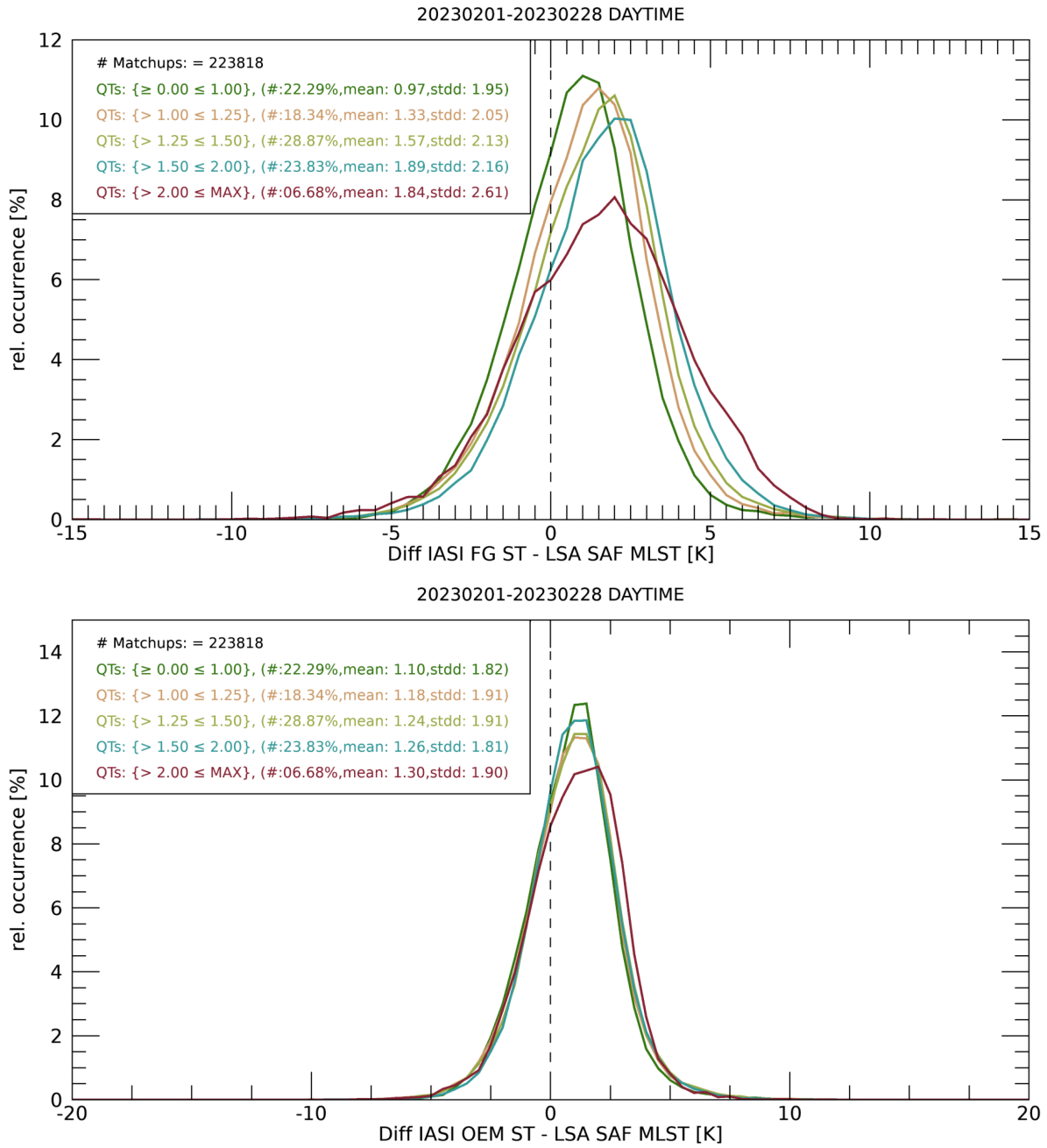

Figure 3.7: Difference histograms grouped for different quality indicators for Regression (FG) (top) and OEM retrieval (bottom) retrieval between IASI L2 - LSA SAF, Daytime statistics with M01 IASI L2 from GS1 for 01-28/02/2023

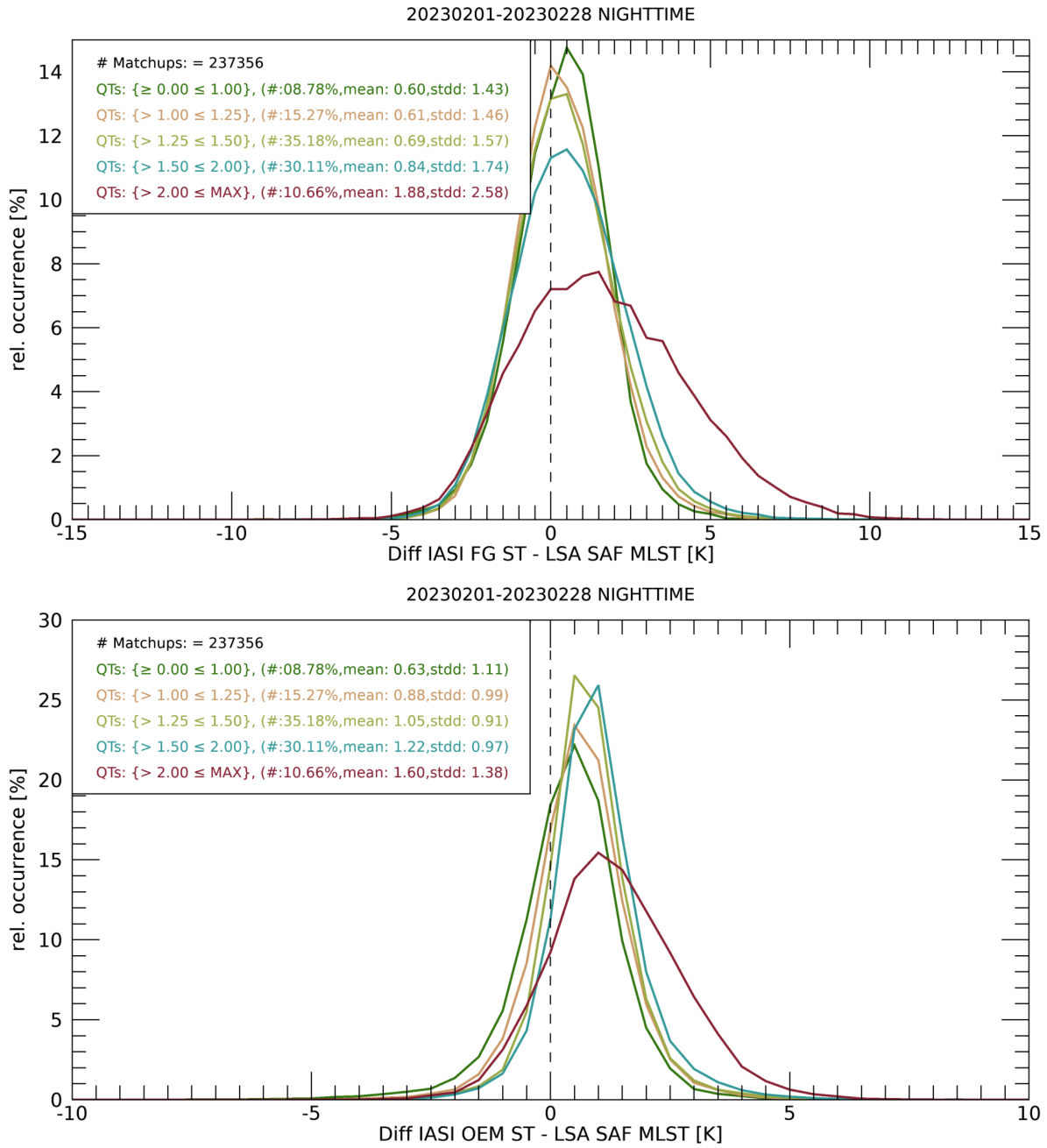

Figure 3.8: Difference histograms for different quality indicators for Regression (FG) (top) and OEM retrieval (bottom) retrieval between IASI L2 - LSA SAF, Nighttime statistics with M01 IASI L2 from GS1 for 01-28/02/2023

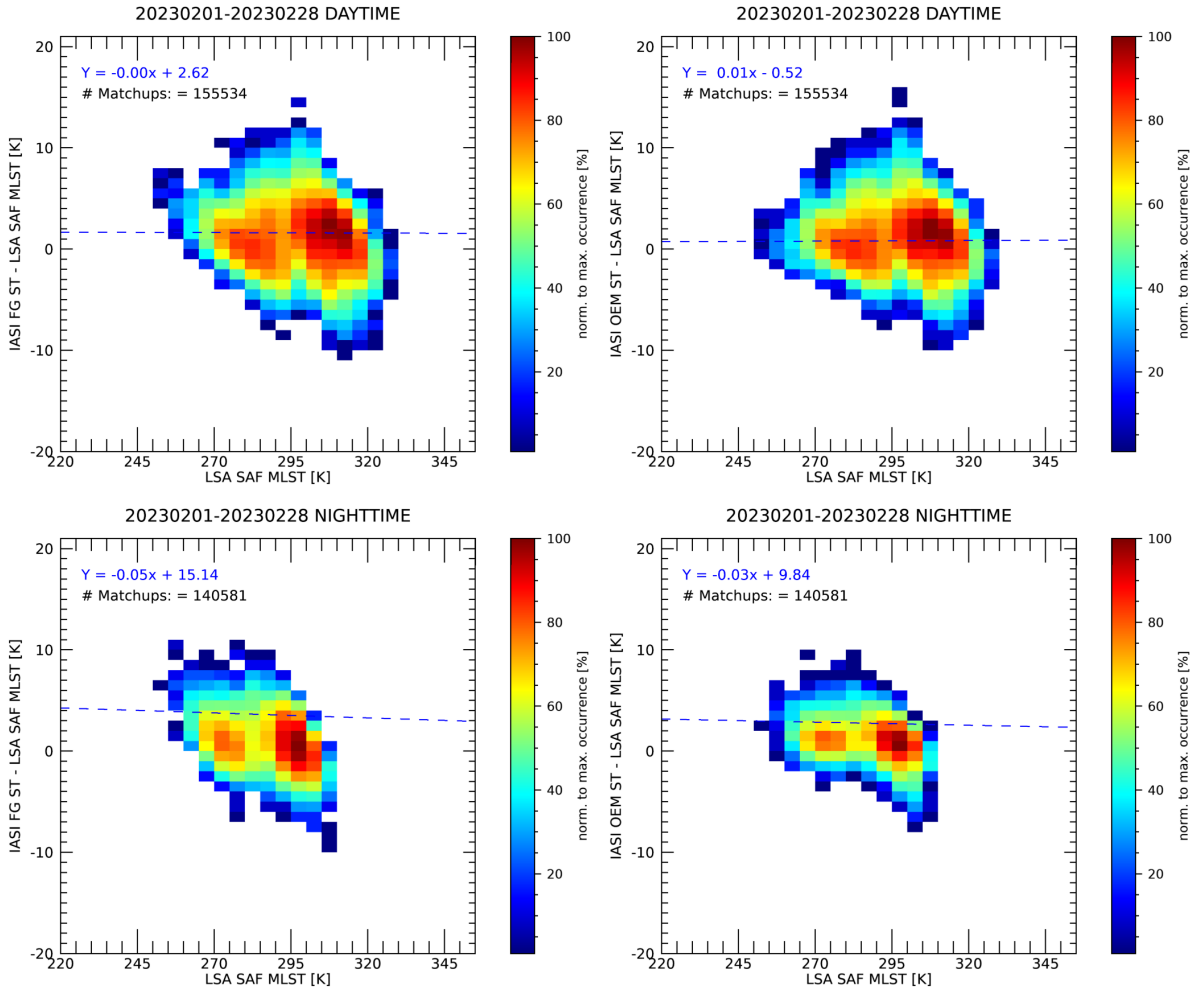

Figure 3.9: 2D Histograms difference of IASI - LSA SAF dependent on LSA SAF MLST for Day (top), Night (Bottom), Regression (FG) (left) and OEM (right) retrieval, with M01 IASI L2 from GS1 for 01-28/02/2023

3.3.1 Collocational dependencies

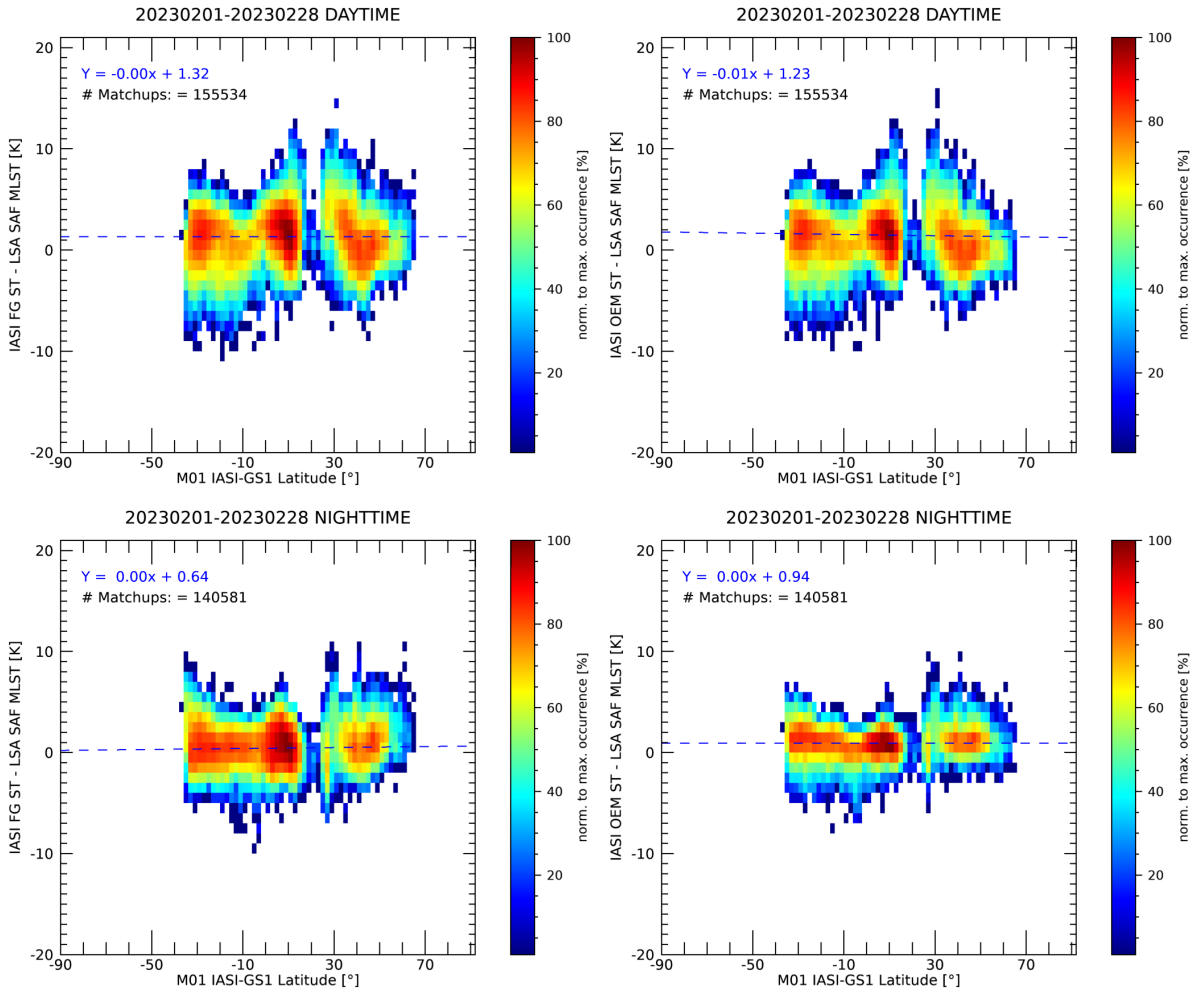

Figure 3.10: 2D Histograms difference of IASI - LSA SAF dependent on Latitude for Day (top), Night (Bottom), Regression (FG) (left) and OEM (right) retrieval, with M01 IASI L2 from GS1 for 01-28/02/2023

3.3.2 Angular dependencies

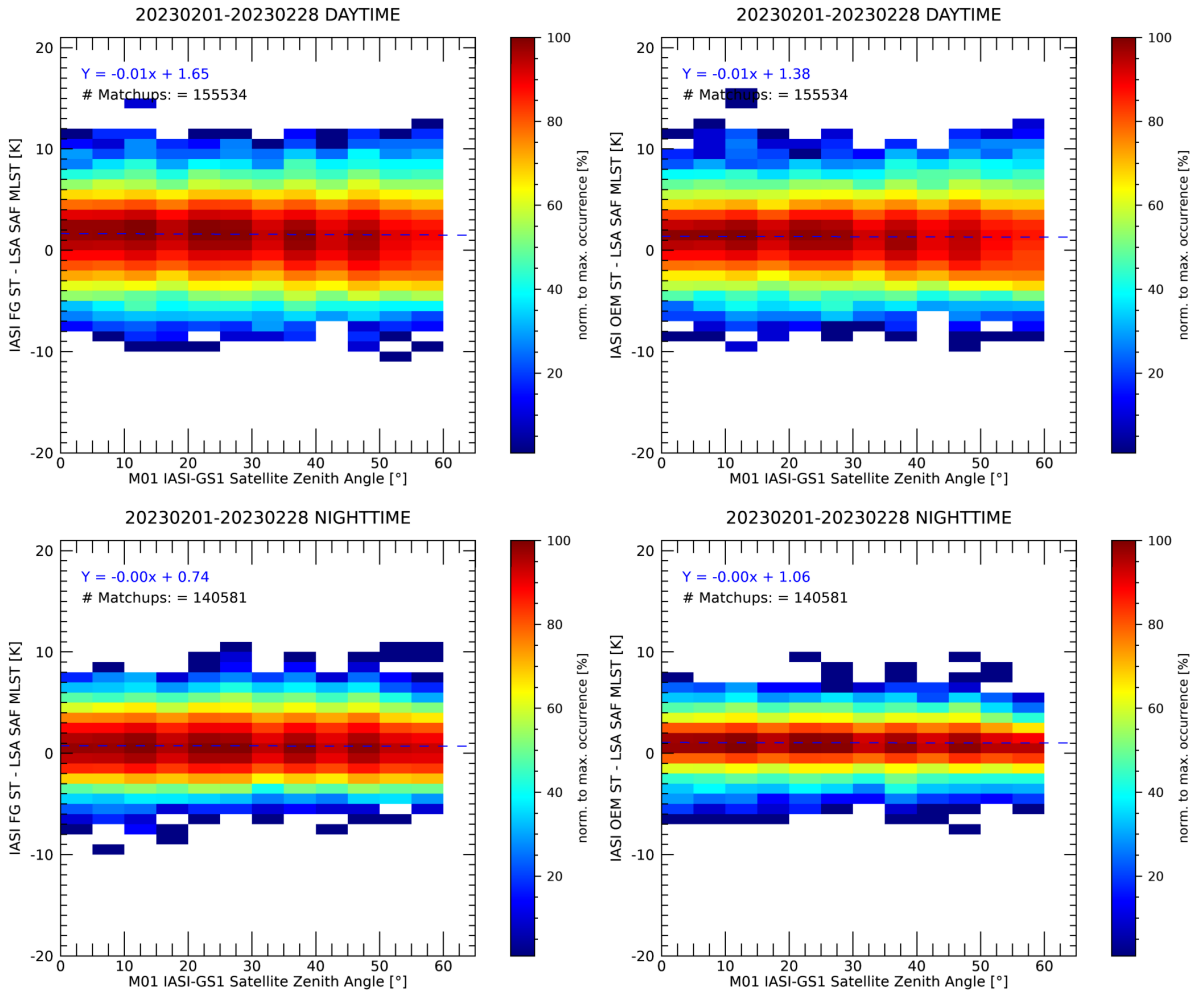

Figure 3.11: 2D Histograms difference of IASI - LSA SAF dependent on IASI Satellite Zenith Angles for Day (top), Night (Bottom), Regression (FG) (left) and OEM (right) retrieval, with M01 IASI L2 from GS1 for 01-28/02/2023

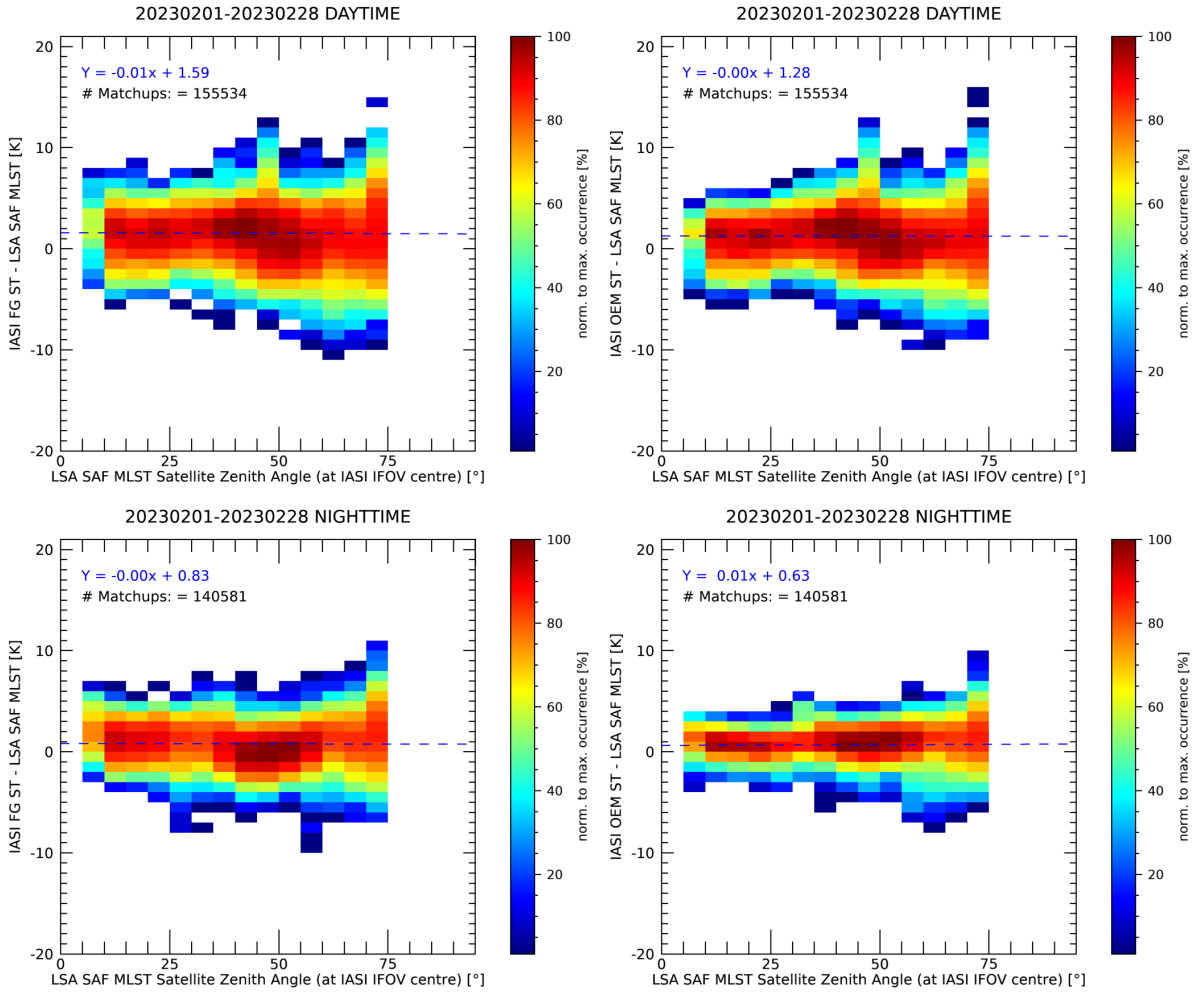

Figure 3.12: 2D Histograms difference of IASI - LSA SAF dependent on SEVIRI Satellite Zenith Angles for Day (top), Night (Bottom), Regression (FG) (left) and OEM (right) retrieval, with M01 IASI L2 from GS1 for 01-28/02/2023

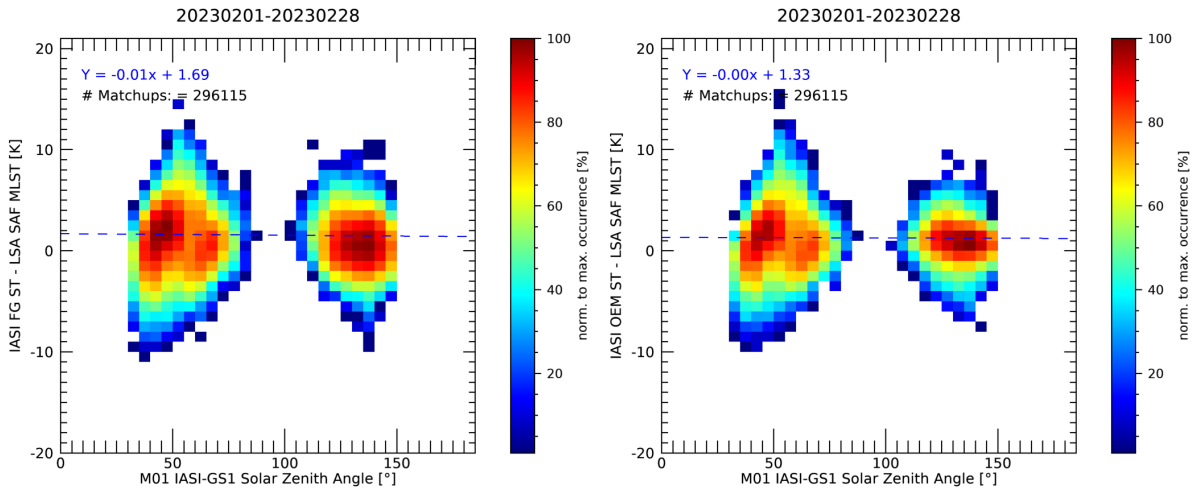

Figure 3.13: 2D Histograms difference of IASI - LSA SAF dependent on Solar Zenith Angle for Day (top), Night (Bottom), Regression (FG) (left) and OEM (right) retrieval, with M01 IASI L2 from GS1 for 01-28/02/2023

4 MSG-DISK MONTHLY CLEAR-SKY STATISTICS

4.1 Maps

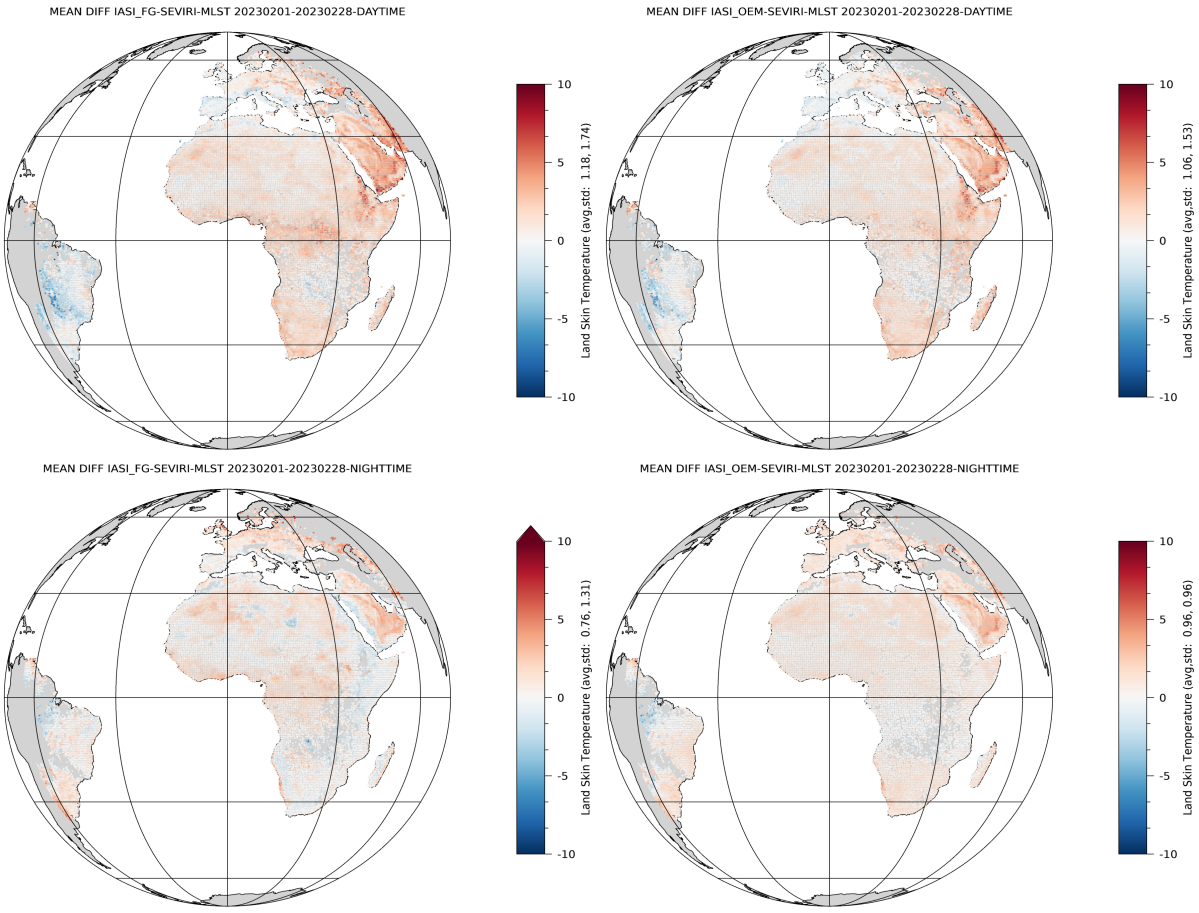

Figure 4.1: Day (top) and Night (bottom) Maps with mean Differences of the differences IASI - LSA SAF for Regression (FG) (left) and OEM (right) retrieval, with M01 IASI L2 from GS1 for 01-28/02/2023

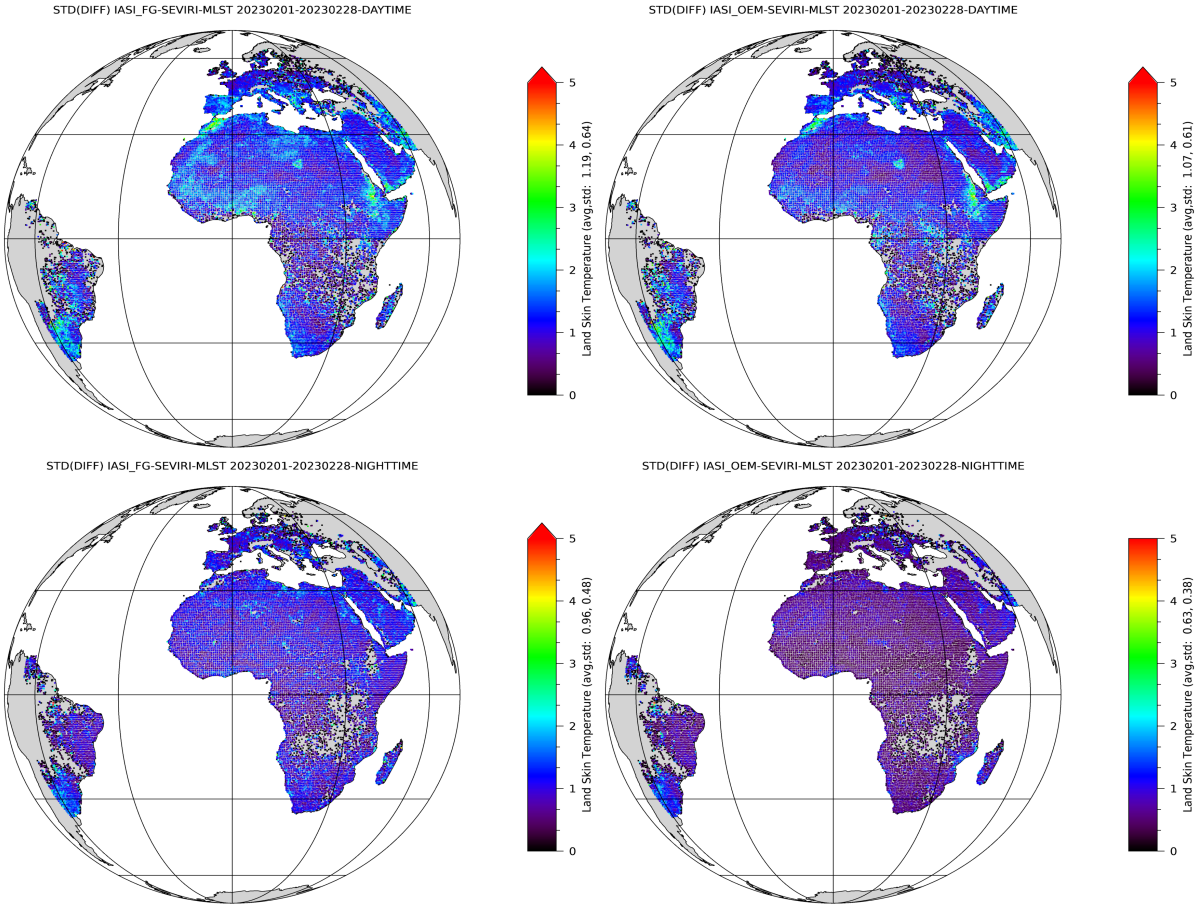

Figure 4.2: Day (top) and Night (bottom) Maps with the standard deviation of the differences IASI - LSA SAF for Regression (FG) (left) and OEM (right) retrieval, with M01 IASI L2 from GS1 for 01-28/02/2023