IASI QUARTERLY PERFORMANCE REPORT

FROM 2014/03/01 TO 2014/05/31

BY IASI TEC (TECHNICAL EXPERTISE CENTER)

FOR IASI FM2 ON METOP A

ANALYSE DOCUMENTAIRE

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Figures and tables

List of acronyms

[TBC]	To be confirmed
[TBD]	To be defined
APO	Other Parameters OPS
AR	Anomaly Report
BRD	BoaRD configuration
CGS	Core Ground Segment at EUMETSAT
CNES	Centre National d'Etudes Spatiales
DA	Applicable document
DPS	Data Processing Subsystem
EPS	EUMETSAT Polar System
EUMETSAT	European organisation for exploitation of METeorological SATellites
FM2 / FM3	Flight Model n°2 or 3
IASI	Infrared Atmospheric Sounding Interferometer
IIS	Integrated Imaging Subsystem
METOP	METeorological OPerational satellite
OPS	Operational Software
PDU	Power Distribution Unit
PL SOL	Payload switch off-line (It's a spacecraft anomaly external to IASI but still resulting in a switch off of the instrument.
PTSI	Parameter Table Status Identifier
RD	Reference document
SEU	Single Event Upset
TEC	IASI Technical Centre of Expertise (located in CNES, Toulouse)
VDS	Verification Data Selection

1 INTRODUCTION

The IASI TEC is based at CNES Toulouse and is responsible for the monitoring of the IASI system performances, covering both instrument and level 1 processing sub-systems.

This document describes the activities and results obtained at the IASI TEC for instrument FM2 on METOP-A during the following period:

- Start Time: 2014/03/01 Orbit: 38207
- End Time: 2014/05/31 Orbit: 39513
- Duration:3 months

Note that IASI ended the Calibration / Validation (commissioning) phase on July 2007.

2 RELATED DOCUMENTS

2.1 APPLICABLE DOCUMENTS

N°	Reference	Titre
DA.1	IA-SP-0000-3242-CNE	Spécification de suivi de la performance en vol de IASI sur METOP-A

2.2 REFERENCE DOCUMENTS

N°	Reference	Titre
RD.1	EUM/OPS-EPS/REP/08/0565	IASI annual in-flight review 1st February 2007 - 31st August 2008
RD.2	EUM/OPS-EPS/REP/09/0223	IASI annual in-flight performance report 2009
RD.3	EUM/OPS-EPS/REP/10/0020	IASI annual in-flight performance report 2010
RD.4	EUM/OPS-EPS/REP/11/0059	IASI annual in-flight performance report 2011
RD.5	EUM/OPS-EPS/REP/12/0620	IASI annual in-flight performance report 2012

3 SIGNIFICANT EVENTS

The following tables present a timeline of the various requests sent by TEC and the external IASI activities.

Those events are typically the configuration changes, programming requests, software update, but also any external operation or activity such as mission interruption, manoeuvre, dissemination problem, ...

3.1 *EXTERNAL CALIBRATION*

Table 1 shows the External Calibration within the time period reported here. Note that the VDS files that come with each request are not described here.

Execution	TEC ref.(1)	Description	Activities
05/03/2014 from 5h13 to 9h09 orb. 38266 to 38268	RM-80	Monthly_MPF(2) Targets: Earth 15, Blackbody, 2nd Deep Space, Mirror Backside	For routine monitoring (IIS and IASI NeDT, scan mirror reflectivity, ghost,…)
03/04/2014 from 5h13 to 9h09 orb. 38678 to 38680	RM-81		
02/05/2014 from 5h13 to 9h09 orb. 39090 to 39092	RM-82		
31/05/2014 from 5h13 to 9h09 orb. 39502 to 39504	RM-83		

Table 1: External Calibration TEC Requests

(1) TEC convention: R for Routine, M for Monthly and L for moon avoidance, followed by a chronological number

(2) An external calibration could be the result of:

- a TEC request or
- a "MPF" uploaded directly by EUMETSAT in full accordance with TEC. The reference "Monthly_MPF" is based on the March 2008 TEC External Calibration request. The MPF for moon avoidance is based on the December 2008 TEC External Calibration request: "ICAL_OCF_xx_M02_20081216060000Z_20090616060000Z_20081209100934Z_IAST_EXTCALIBRA.dts"

3.2 *ON BOARD CONFIGURATION*

Table 2 presents the on-board processing configuration updates that had been made within the time period reported here:

PTSI	IASI on board parameter files	Delivery by TEC	activated on	TEC ref.	affected parameters of a DPS TOP configuration update

Table 2: DPS and MAS configuration TEC Requests

For information, Table 3 shows the delivery applicable at the beginning of the period:

PTSI	IASI on board parameter files	Delivery by TEC	activated on	TEC ref.	affected parameters of a DPS TOP configuration update
14 2.0	IDPS_OBP_xx_M02_ 20130822131701Z_20140222131701Z_ 20130822125747Z_ IAST_DPSPARAMOD.tar	22/08/2013 13h00	28/08/2013 10h08 orbit 35584	R_56	Update of reduced spectra, Modification of on-board thresholds (ArcImagMeanRMSCutOff and ZpdQualIndexCutOff) to be in line with the IASI-B filtering strategy

Table 3: DPS and MAS previous configuration

The associated ground configuration table (BRD file), necessary to handle coherent configuration at system level, is presented in the next section. These associated configuration table are necessary for L1 processing.

3.3 GROUND CONFIGURATIONS UPDATES FOR LEVEL 1 PROCESSING

Table 4 presents the on-ground processing configuration updates that had been made within the time period reported here:

IDef	IASI L1 auxiliary files	Delivery by TEC	Upload on GS1	Content

Table 4: IASI L1 Auxiliary File Configuration on the Operational EPS Ground Segment

For information, Table 5 shows the delivery applicable at the beginning of the period:

IDef	IASI L1 auxiliary files	Delivery by TEC	Upload on GS1	Content
57 **29** **14**	IASI_BRD_xx_M02_20130822141643Z_xxxxxxxxxxxxxxZ_20130822135729Z_IAST_0000000014 IASI_GRD_xx_M02_20130822141643Z_xxxxxxxxxxxxxxZ_20130822135732Z_IAST_0000000029 IASI_ODB_xx_M02_20130417080000Z_xxxxxxxxxxxxxxZ_20130417074829Z_IAST_0000000014	22/08/2013 13h57 17/04/2013	BRD & GRD activated on 16/09/2013 11:31 orbit 35853	

Table 5: IASI L1 auxiliary file previous configuration

3.4 DATA BASES UPDATE FOR THE USERS

The Noise Covariance Matrix (NCM) and Spectral data base (SDB) are specific data bases for the users. They are updated according to the main ground level 1 evolutions.

Table 6 presents the updates of the NCM and SDB that had been made within the time period reported here:

IDef	Users Data-Base	Delivery by TEC	TEC ref.	Comments

Table 6: IASI Data Bases for the users

For information, Table 7 shows the delivery applicable at the beginning of the period:

IDef	Users Data-Base	Delivery by TEC	TEC ref.	Comments
4	IASI_NCM_xx_M02_20110318060000Z_20110318060000Z_20110317130441Z_IAST_SPECTRESPO	17/03/2011	R_COV_4	Noise Covariance Matrix after decontamination; Covariance matrix from L0 noise on BB (External Calibration of 2010/12/02)
14	IASI_SDB_xx_M02_20130923140000Z_20130923140000Z_20130923124758Z_IAST_IASISPECDB	23/09/2013	R_57	User database associated to ODB IDefSDB 14

Table 7: previous IASI Data Bases

3.5 ON GROUND HW/SW EVOLUTION

Table 8 presents the updates of PPF L1 software within the time period reported here:

IASI L1 PPF software version	Delivery by TEC	**Date introduced on GS1**	**Comments**

Table 8: IASI L1 PPF Configuration on the Operational EPS Ground Segment

For information, Table 9 shows the software version applicable at the beginning of the period:

IASI L1 PPF software version	Delivery by TEC	**Date introduced on GS1**	**Comments**
7.0	07/2013	08/08/2013 for sensing time 08:11 UTC Orbit 35299	

Table 9: Previous IASI L1 PPF

3.6 DECONTAMINATION

Table 10 presents decontaminations that have been made or requested within the time period reported here:

Last due date	**Date of decontamination**	**Description**
In 2015	Scheduled in September 2014	

Table 10: Decontamination TEC Requests

For information, Table 11 shows the previous decontamination:

Last due date	**Date of decontamination**	**Description**
Before end 2010	31/08/2010	

Table 11: Previous decontamination

3.7 INSTRUMENT

3.7.1 External events

This category is for those activities/events that are external to IASI but still have an impact. It is broken down into classes of *PL-SOL* and *OOP* manoeuvre.

3.7.1.1 Manoeuvres

Date	**Type(*)**	**Description**	**IP flag**	**OoP mission Outage**
2014/03/26	OoP	OoP Burn 1 manoeuvre #30 (orbits 38567-38569)		
2014/04/09	OoP	OoP Burn 2 manoeuvre #31 (orbits 38765-38767)		

Table 12: Overview of METOP manoeuvres in the reporting period

(*): IP for In-Plane manoeuvres (IASI stays in NOp) and OoP for Out of plane manoeuvres (IASI is put in Heater 2)

3.7.1.2 PL-SOL

Table 13 presents the PL-SOL events that have occurred within the time period reported here:

Dates	Orbits	Description

Table 13: PL-SOL

3.7.2 Operation leading to mission outage

This chapter presents the intervention on IASI needing routine interruption that have occurred within the time period reported here.

Dates	Orbits	type	IASI mode	Description

Table 14: Scheduled interruptions

3.7.3 Anomaly leading to mission outage

Table 15 and Table 16 present the major and minor anomalies internal to IASI that have occurred within the time period reported here.

Note that, in this section minor anomalies are all identified and without any impact on the mission, and major anomalies only affect IASI instrument, and no other sub-systems of the spacecraft.

Dates	Orbits	Anomaly type (*)	IASI mode	Description

Table 15: Major anomalies

(*): SEU (LAS, CCM or DPS) anomalies or SET anomalies

Day	Orbits	error n°	Severity	Anomaly type	LN	SN	Description
2014/03/22 13:56:58	38513	13	2B	MASVLN flag	54686	11	DPS_LNR-Rx_VLN

Table 16: Minor anomalies

4 PERFORMANCE MONITORING

4.1 PERFORMANCE MONITORING

In order to ensure that the IASI system is permanently running in good conditions, the CNES (IASI TEC) and EUMETSAT (CGS) are monitoring each orbit, both at line, PDU and DUMP levels.

The on-board and ground processing performance algorithms issue more than one hundred quality indicators, called flags and simple parameters. Those are alarms for any bad functioning or local performance degradation.

According to the results, the TEC is also in charge of delivering new on-board or ground parameters to EUMETSAT when it is necessary. EUMETSAT is then in charge of uploading them on-board or as an input of the level 1 processing chain. During the whole instrument life, these parameter adjustments are necessary in order to take into account instrument evolution in the processing and finally to maintain a good data quality.

The Table 17 is the colour code used for the status report.

Status Colour	Meaning
GREEN	≥ 95
YELLOW	< 95
RED	Production interrupted
BLANK	No Status Reported

Table 17: Functional status legend

4.2 PERFORMANCE SYNOPSIS

Table 18 provides a synthetic view of all the indicators evaluated for L0/L1 data and their current status.

Section	Component	Description	Status	Comments
4.3	L0	**Level-0 Data Quality** • Overall quality • Main flag and quality indicator parameters - Spikes monitoring - ZPD monitoring - Overflows/Underflows monitoring - Reduced Spectra monitoring • Second level flag and quality indicators	GREEN	On-board processing
4.4	L1	**Level-1 Data Quality** • Overall • Main flag and quality indicator parameters • Second level flag and quality indicators	GREEN	On ground processing
4.5	L1	**Sounder radiometric performances** • Radiometric noise • Radiometric calibration • Optical transmission • Interferometric contrast • Detection chain	GREEN	
4.6	L1	**Sounder spectral performances** • Dimensional stability • Acquisition chain delay • Ghost evolution • Instrument parameters	GREEN	
4.7	L1	**Geometric performances** • Sounder/IIS co-registration • IIS/AVHRR co registration	GREEN	
4.8	L1	**IIS radiometric performances** • IIS radiometric noise monitoring • IIS radiometric calibration monitoring	GREEN	

Table 18: IASI product components functional status

4.3 LEVEL 0 DATA QUALITY (L0)

4.3.1 <u>Overall quality</u>

The IASI L0 data quality (orbit average) through IASI engineering products is shown in Figure 1.

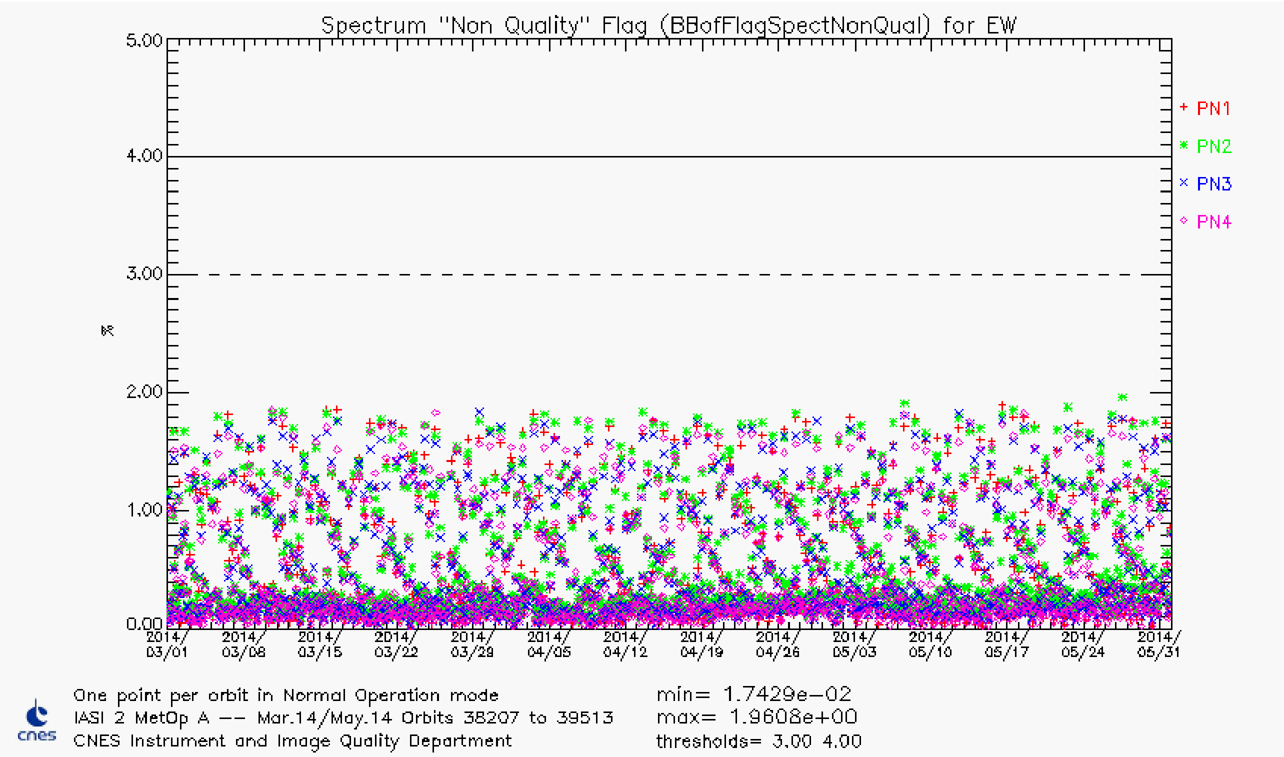


Figure 1 : IASI L0 data quality orbit average (per pixel and CCD)

The geographical distribution of the overall L0 (board) quality flag for the 4 pixels is shown in Figure 2.

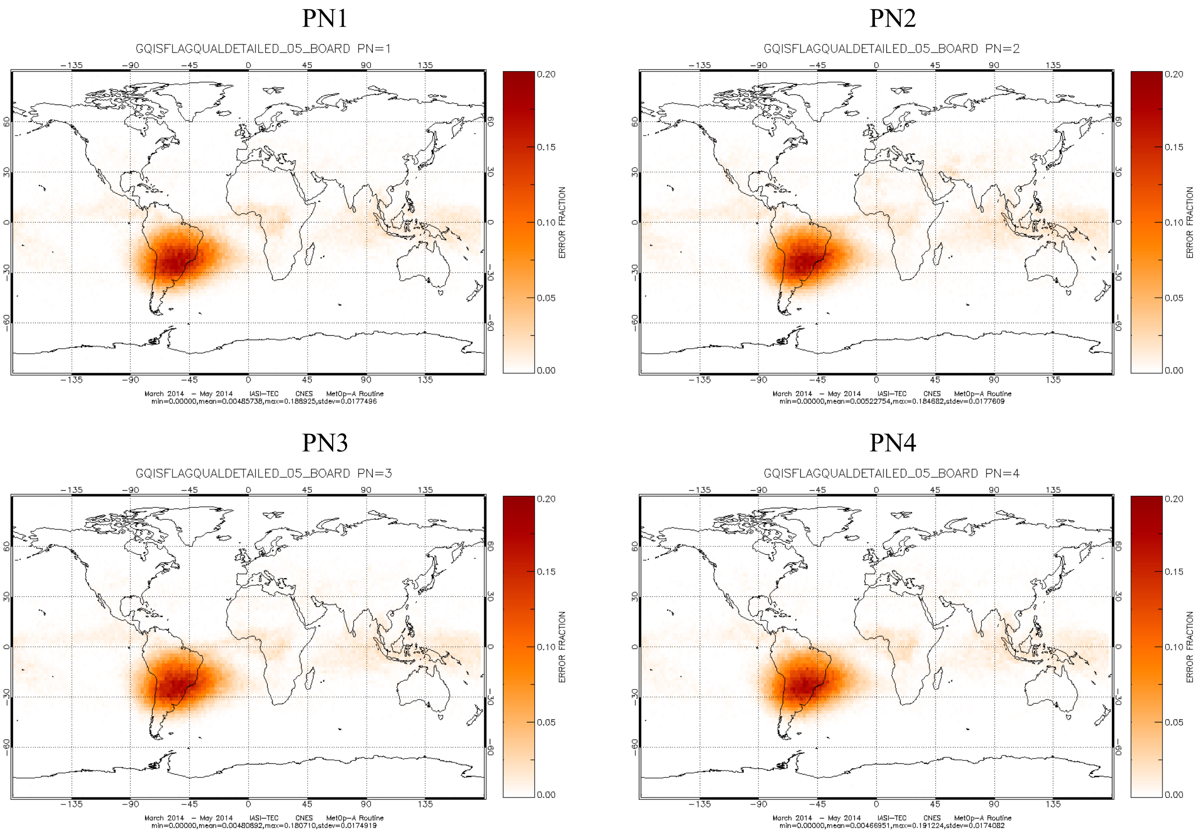


Figure 2 : IASI L0 data quality spatial distribution (per pixel)

The IASI L0 quality and on-board processing are nominal.

4.3.2 Main flag and quality indicator parameters

The main contributors to the rejected spectra by on-board processing are: spikes (proton interaction on detectors), failure of NZPD algorithm determination and over/underflows (measured data exceeding on-board coding tables capacity). They are analysed in details hereafter.

4.3.2.1 Spikes monitoring

Spikes occur when a proton hits a detector. This very high energetic particle disrupts the measure of the interferogram and then corrupts the spectrum.

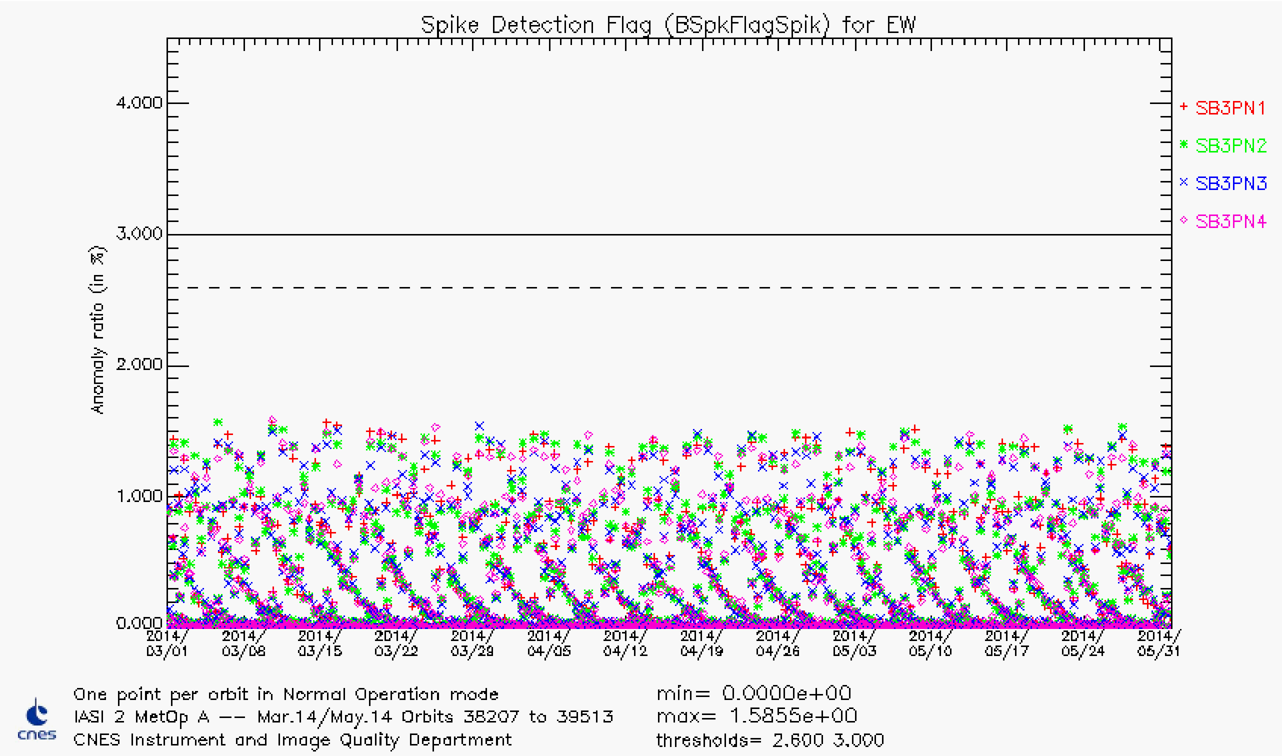


Figure 3 : Temporal evolution of spikes anomaly ratio in % for all pixels (orbit average)

An example of the geographical distribution of spikes occurrences on band 3 for the 4 pixels is shown in Figure 4.

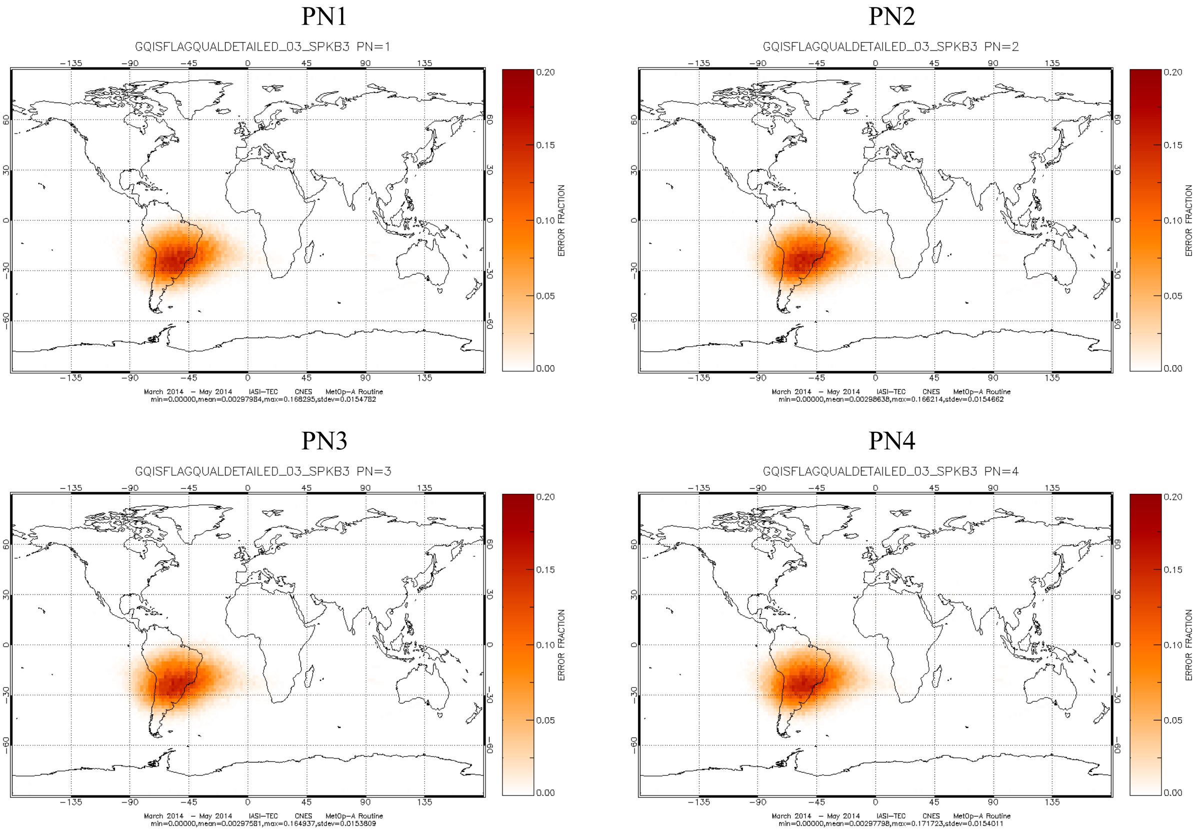


Figure 4 : Geographical distribution of spikes occurrences in % for band 3 and all pixels

Spikes are mainly located in the regions of Earth where the magnetic field doesn't protect the satellite from the energetic particles: the poles and the SAA (South Atlantic anomaly).

Spike anomaly ratio is nominal for the reported period.

4.3.2.2 ZPD monitoring

The ZPD ("Zero Path Difference") is the position of the central fringe of the interferogram. The NZPD is the number of the sample detected as the ZPD. On IASI, it is determined by a software. This is a special feature of IASI in comparison to other instruments for which NZPD determination is done by hardware.

NZPD variations are governed by two phenomenons:

1. ASE fluctuations which have the same effect on each pixel and can produce NZPD variation of 30-40 samples over month. This is the first order phenomena.
2. Mechanical deformation of the interferometer or evolution of detection chain delays. These phenomenons affect the 4 pixels in different way. However this phenomenon has a second order effect in comparison to the first one.

We monitor both NZPD determination quality flag and interpixel homogeneity. We expect stability.

BZPDFlagNZPDNonQualEW: Temporal evolution of NZPD determination quality flag for earth view

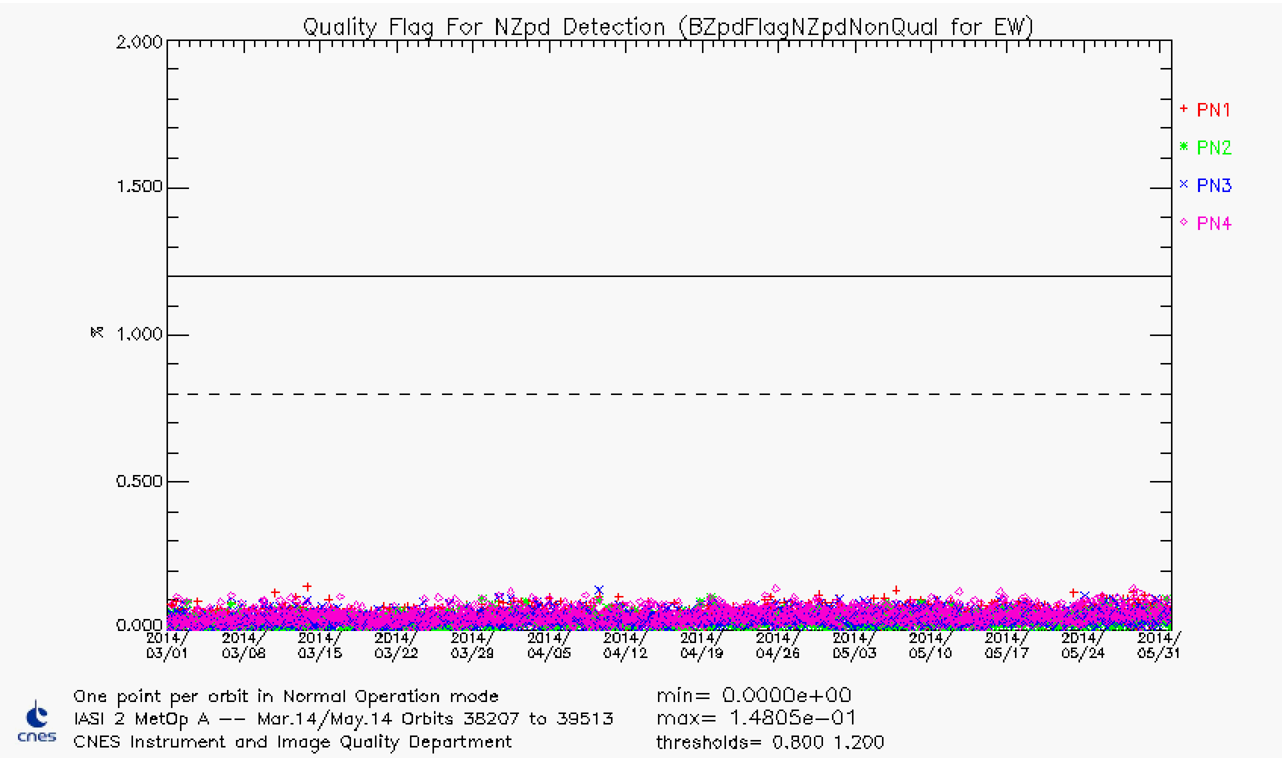


Figure 5 : Temporal evolution of NZPD determination anomaly ratio in % for all pixels (orbit average)

NZPD determination anomaly ratio is nominal for the reported period.

The geographical distribution of the NZPD determination quality flag for the 4 pixels is shown in Figure 6.

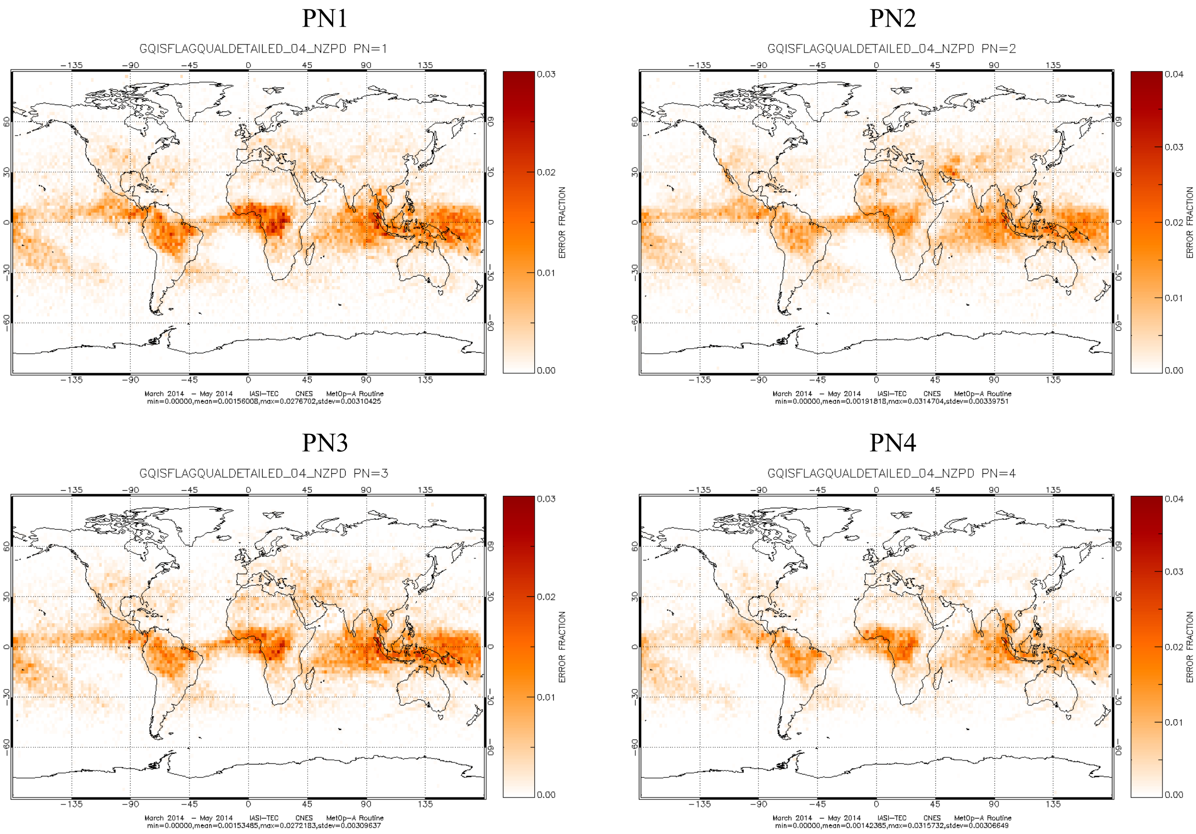


Figure 6 : IASI NZPD determination quality flag spatial distribution (per pixel)

The NZPD determination fails over some clouds that have a temperature that induces no energy in the central fringe of the interferogram.

NZPD inter-pixel homogeneity monitoring

This monitoring is necessary in order to follow potential deformation of the interferometer or evolution of detection chain delay.

The NZPD inter-pixel homogeneity is nominal over the reported period. Consequently, these parameters are perfectively stable and in-line with the specification.

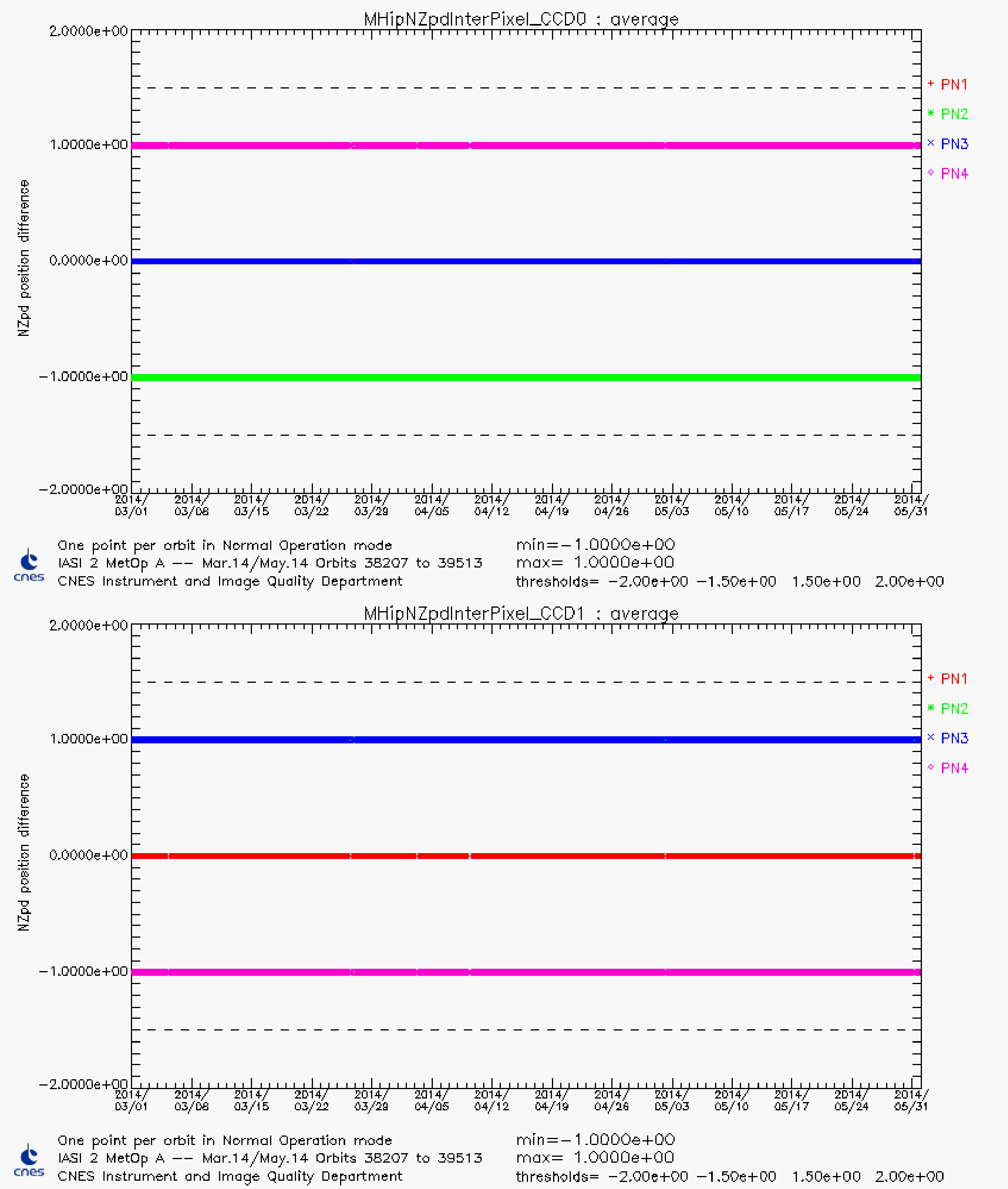


Figure 7 : NZPD inter-pixel for all pixels and CCD calculated with respect to pixel 1 (orbit average)

4.3.2.3 Overflows / Underflows monitoring

The total number of bits available for a spectrum to be transmitted to the ground is limited. For that reason, we have defined coding tables to encode each measured spectrum. These tables have been design by using "extreme spectrum" corresponding to known drastic atmospheric conditions. The coding step is also set to not introduce additional noise into the spectrum. However for very extreme atmospheric conditions (sunglint in B3, very high stratospheric temperature…) a measure can exceed on-board coding tables' capacity and causes an over/underflow.

Over/underflows occurrences are monitored and stability is expected. As long as they remain to low levels, the coding table is not changed. Note that changing the coding tables requires compromises. Indeed, increasing the encoding capacity can be achieved by two different ways. A first solution consists in an increase of the coding step without changing the number of bits. However, that leads to an increase of the digitalization noise. Then, a second solution consists in keeping the coding step constant while increasing the number of bits available for a particular band. But, the total amount of bits available for the entire spectrum is limited and constant. So, that requires to decrease the encoding capacity in another spectral band.

Time series of Overflows and Underflows (orbit average) are shown in following figure for all pixels.

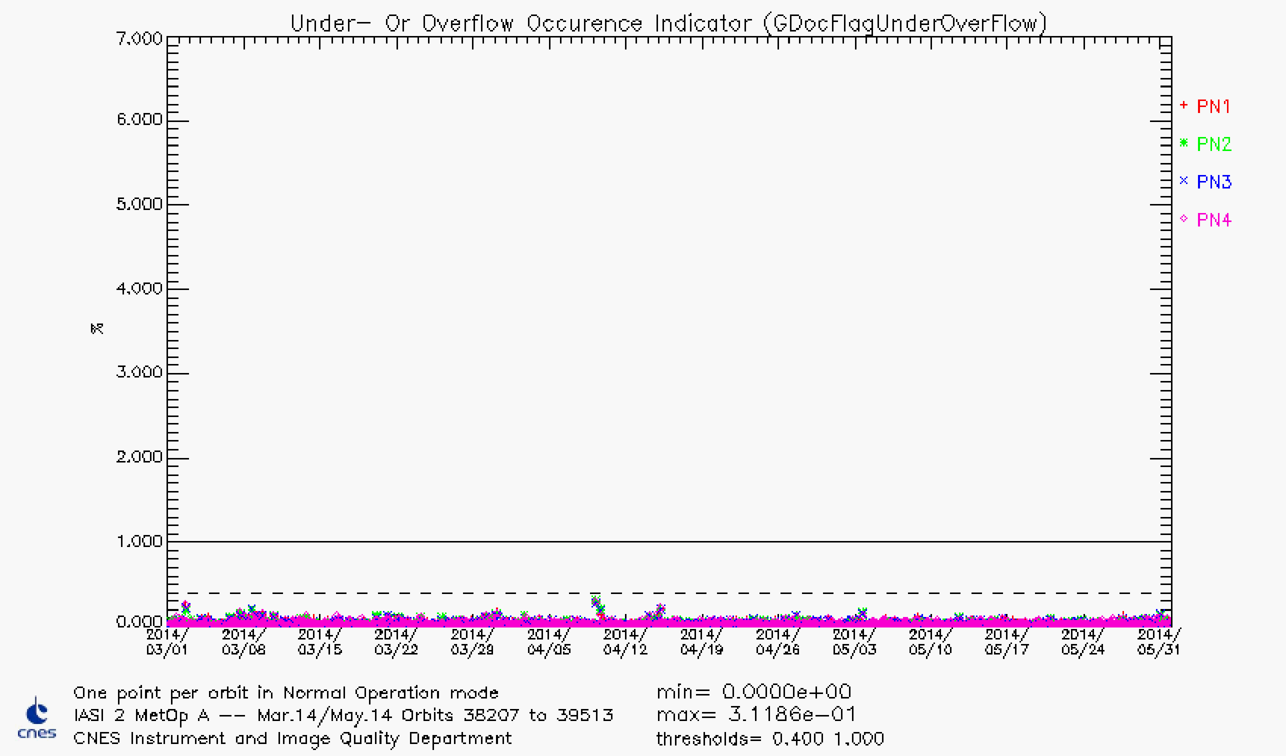


Figure 8 : IASI L0 over/under-flows orbit average of all pixels

Over/underflows ratio is nominal for the reported period.

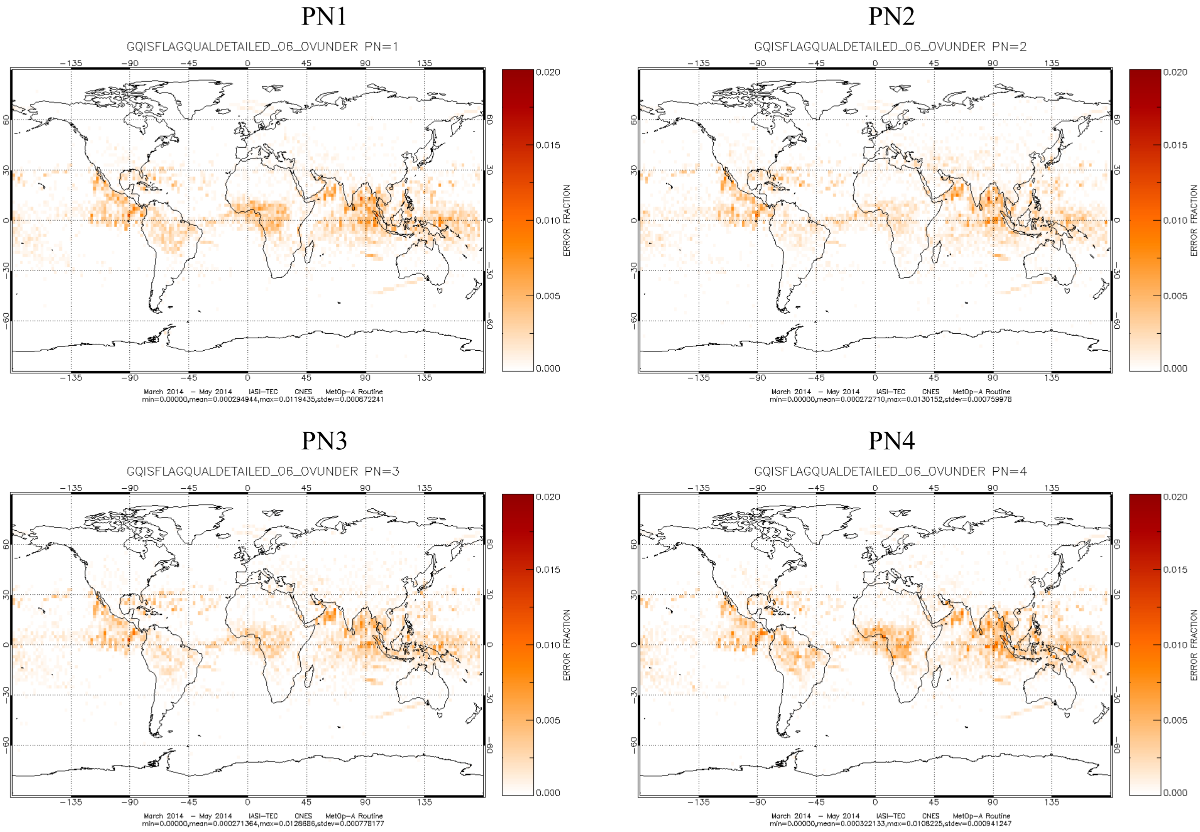


Figure 9 : IASI Overflows and Underflows spatial distribution (per pixel)

4.3.2.4 Reduced Spectra monitoring

On-board Reduced Spectra is one of the most important monitoring. It ensures that on-board spectra still have a good radiometric calibration when on-board configuration reduced spectra are reloaded. This is the case, for instance, after an instrument mode change.

Reduced spectra are slightly evolving with respect to potential deformation of the interferometer (optical bench).

In order to prevent a large difference between current and on-board configuration reduced spectra, we monitor the evolution of ZPD determination quality index for calibration views (BZpdNzpdQualIndexBB and CS) obtained by DPS processing by simulating a perpetual mode change. Results of this monitoring are given hereafter.

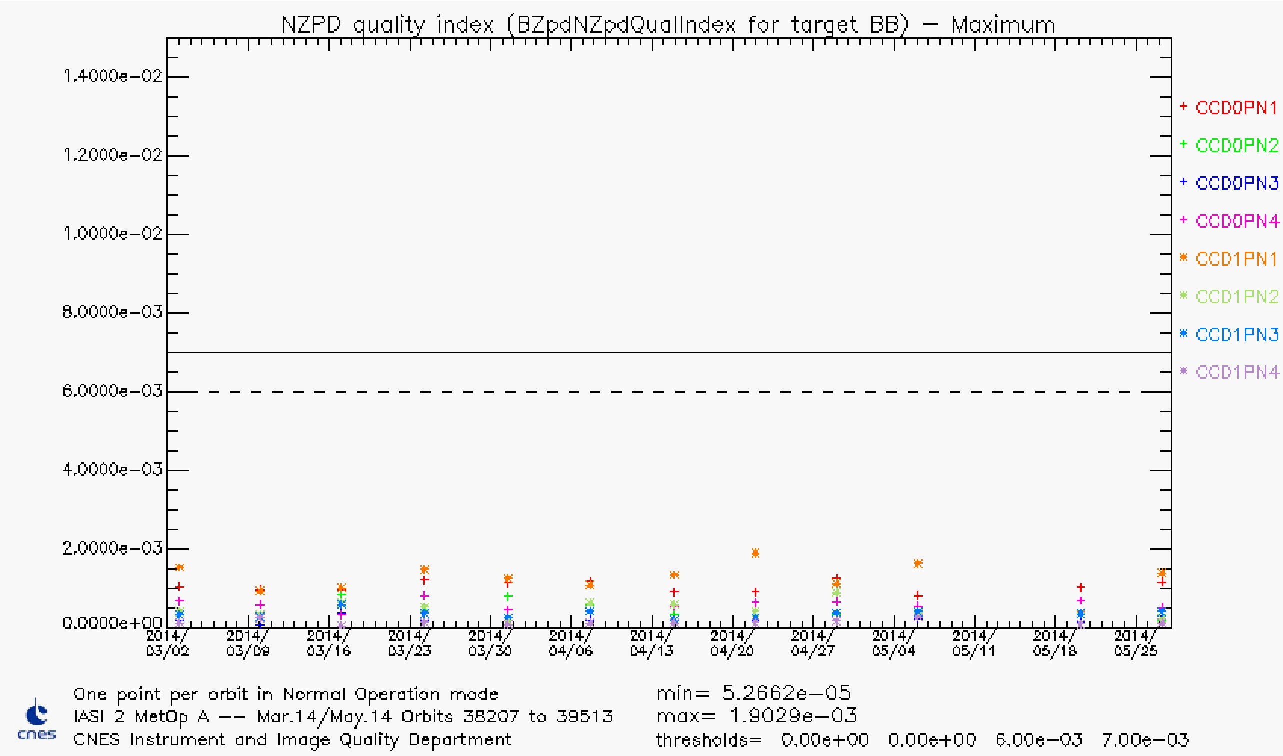


Figure 10 : Max of NZPD quality index for all pixels and CCD - BB

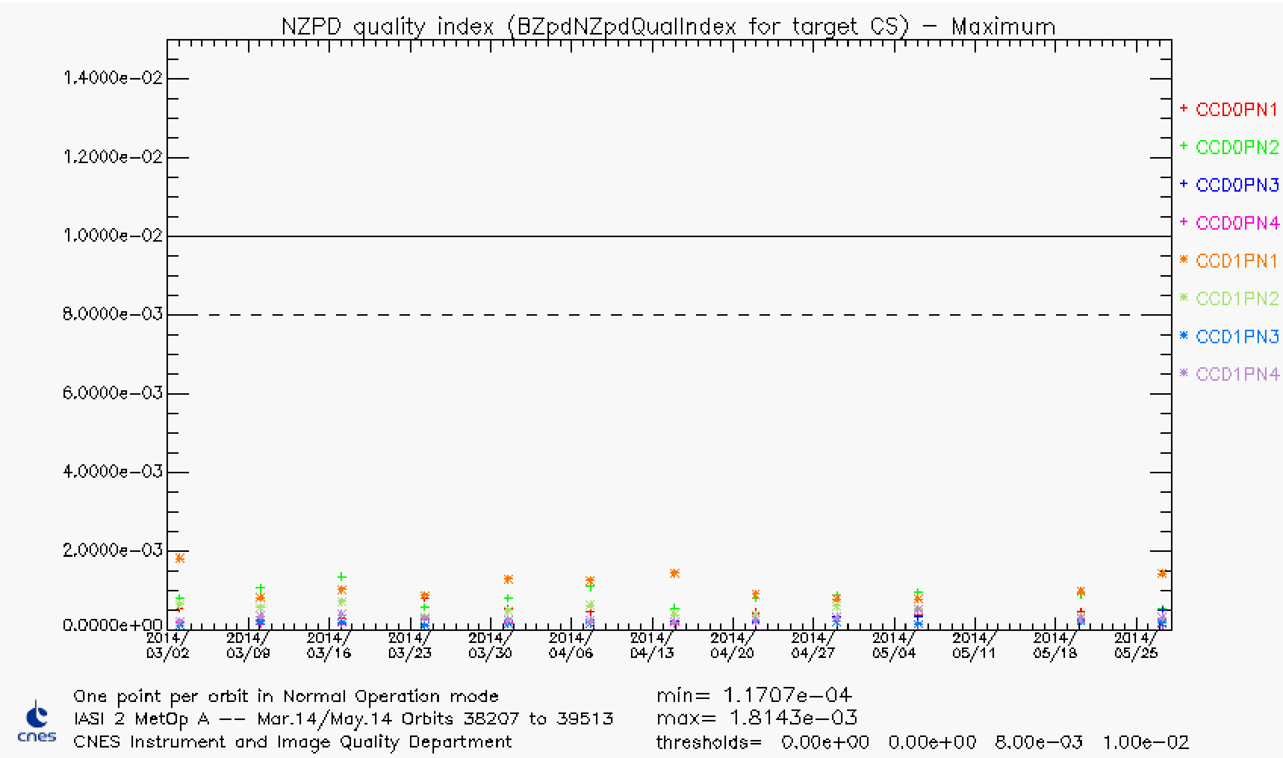


Figure 11 : Max of NZPD quality index for all pixels and CCD - CS

As soon as average BZPDNZPDQualIndexBB and CS remain below 0.01 on-board reduced spectra are robust to an instrument mode change.

The reduced spectra quality is well within specification since the last update of the on-board reduced spectra performed in August 2013.

4.3.3 Second level flags and quality indicators

All second level flags and indicators are stable and nominal.

4.3.4 Conclusion

L0 Flag and quality indicators are stable.

4.4 LEVEL 1 DATA QUALITY (L1)

4.4.1 Overall quality

The IASI overall quality is shown as the orbit averages of the quality indicator for the individual pixels in the next figure.

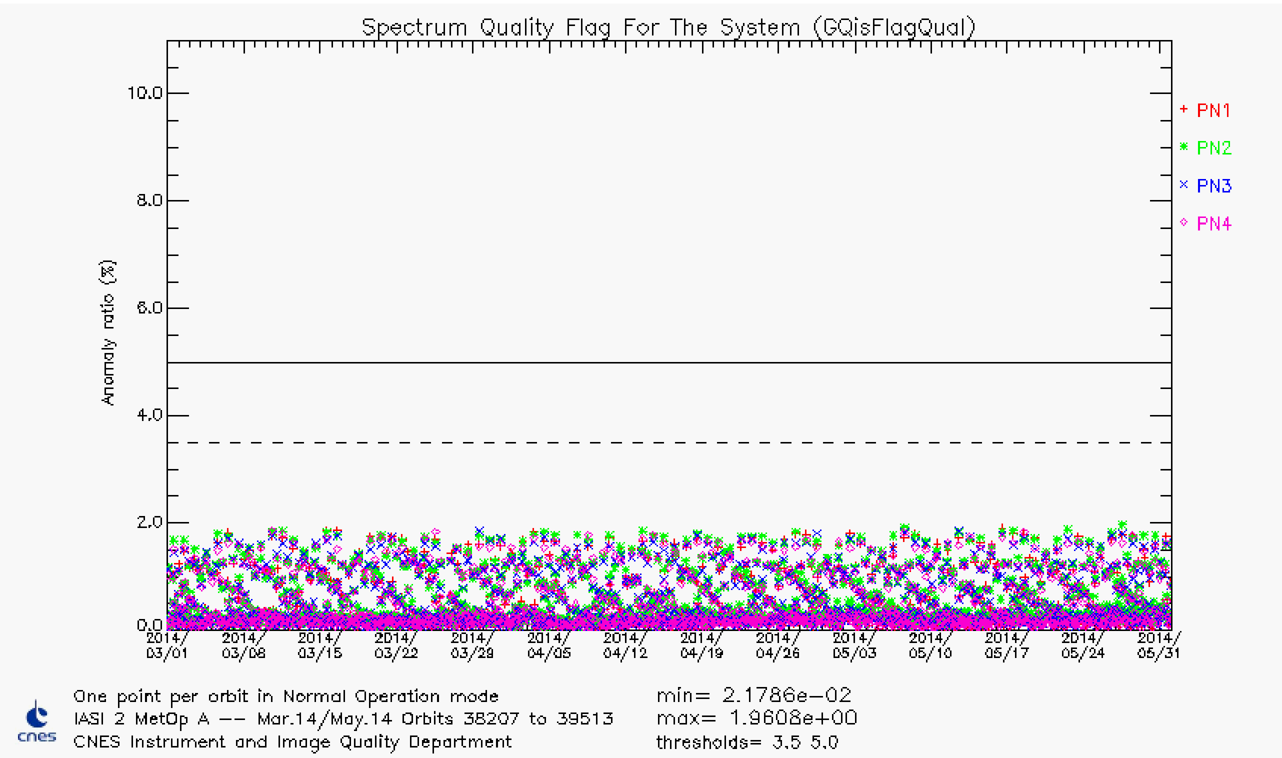
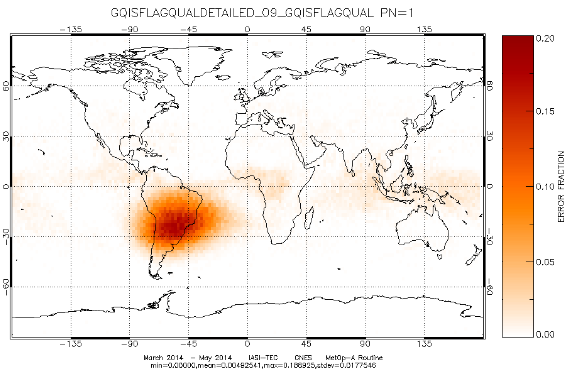


Figure 12 : IASI L1 data quality orbit average (% of bad by PN)

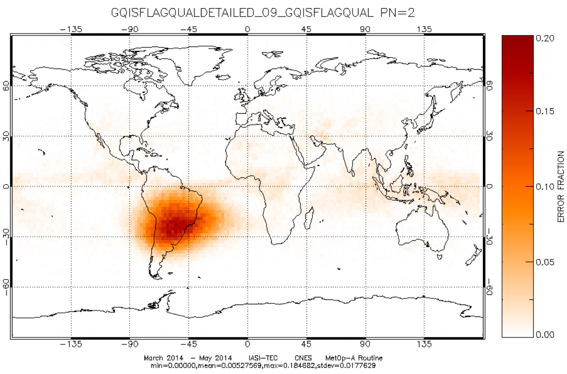
One should note that, over the period covered by the present document, the averaged data rejection ratio is less than 1%.We clearly see that data quality is better on the bands B1 and B2 in comparison to band B3 (which is the most affected by spikes).

The geographical distribution of the IASI product overall quality for the 4 pixels is shown in Figure 13.

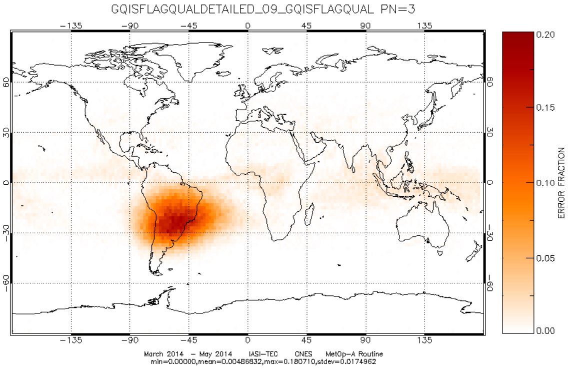
PN1



PN2



PN3



PN4

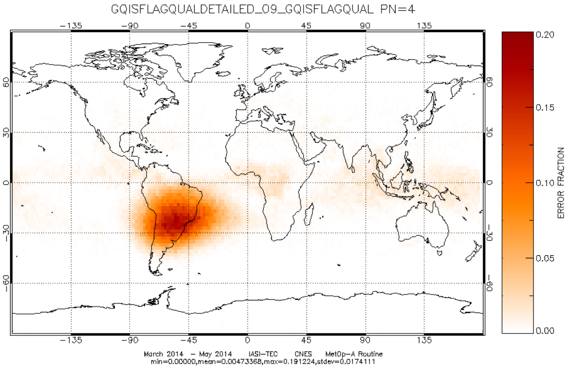


Figure 13 : IASI product overall quality spatial distribution (per pixel)

The main contributors are the spikes in band 3.

4.4.2 Main flag and quality indicator parameters

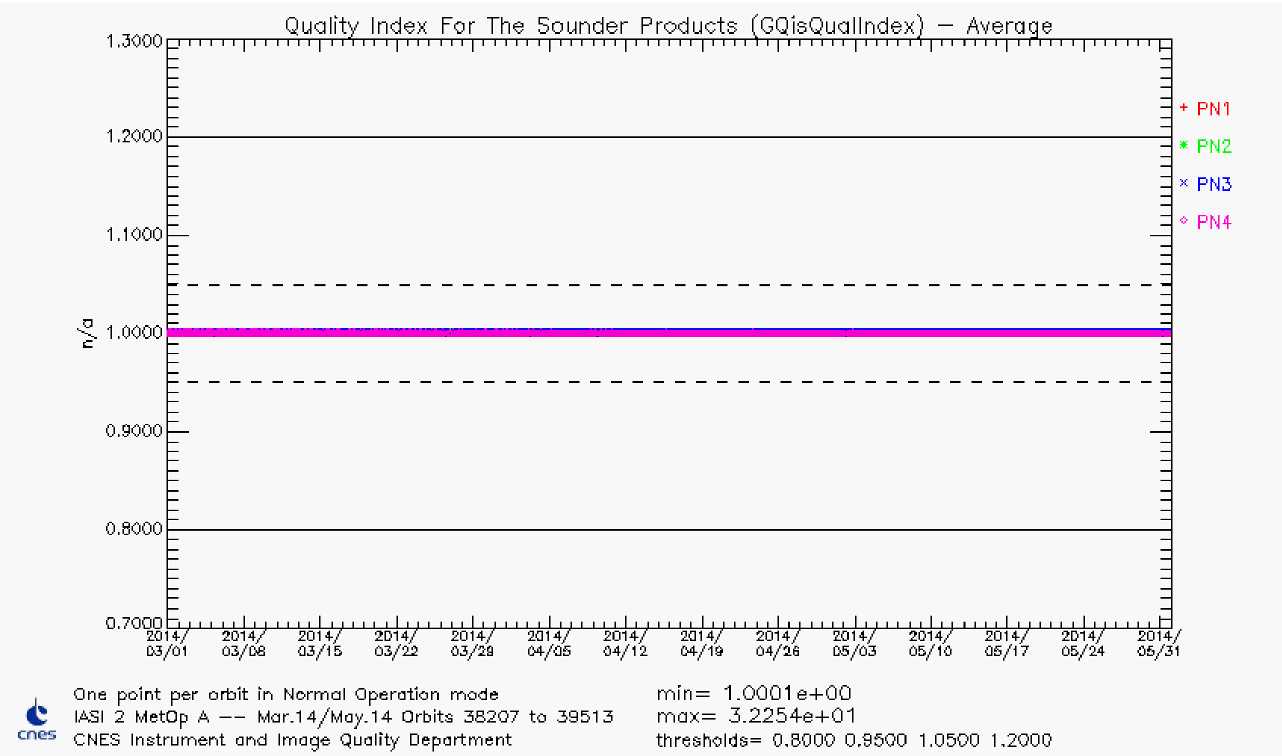


Figure 14 : GQisQualIndex average (L1 data quality index for IASI sounder)

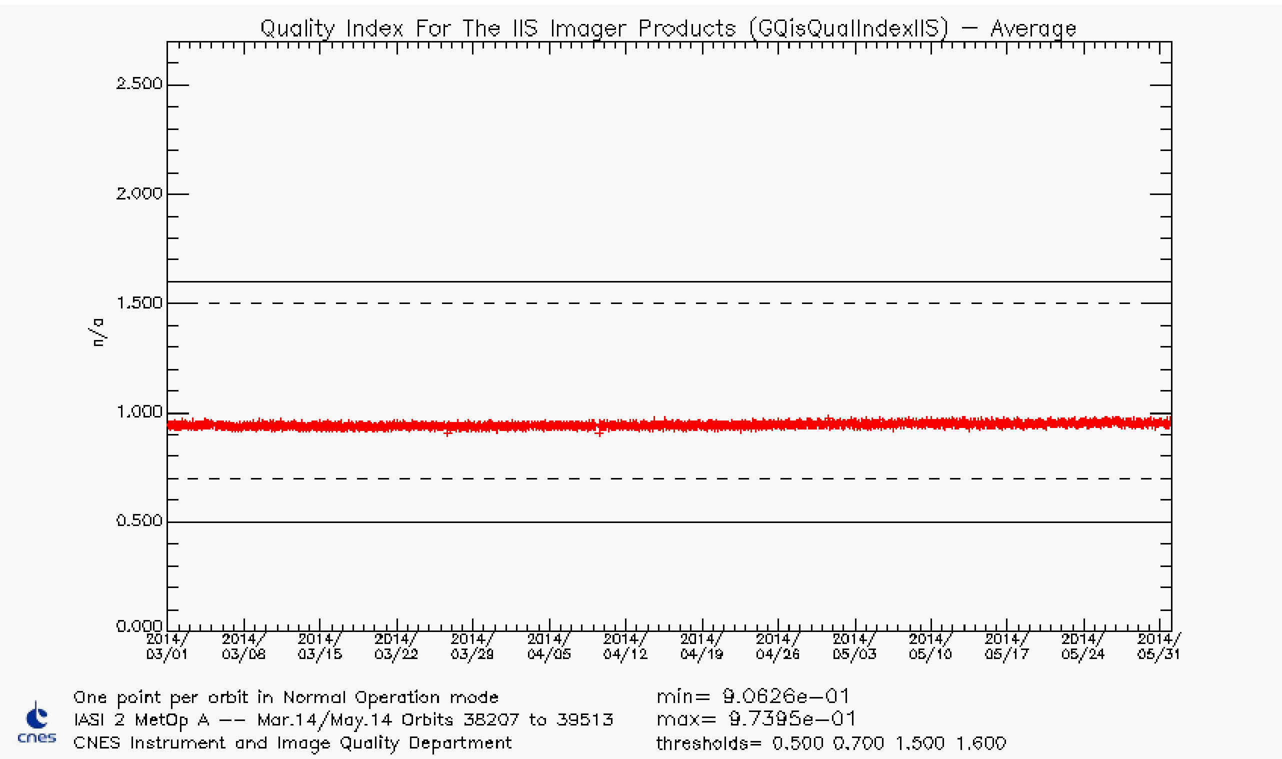


Figure 15 : GQisQualIndexIIS average (L1 data quality index for IASI Integrated Imager)

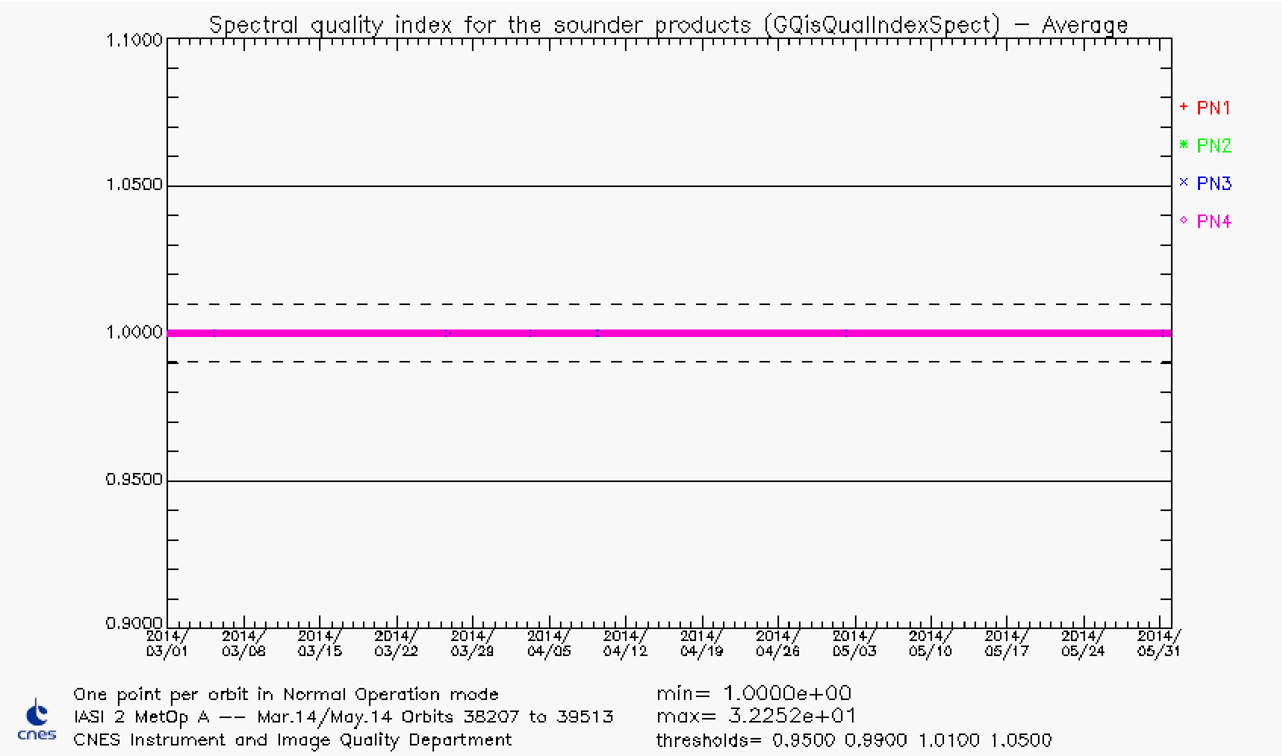


Figure 16 : GQisQualIndexSpect average (L1 data index for spectral calibration quality)

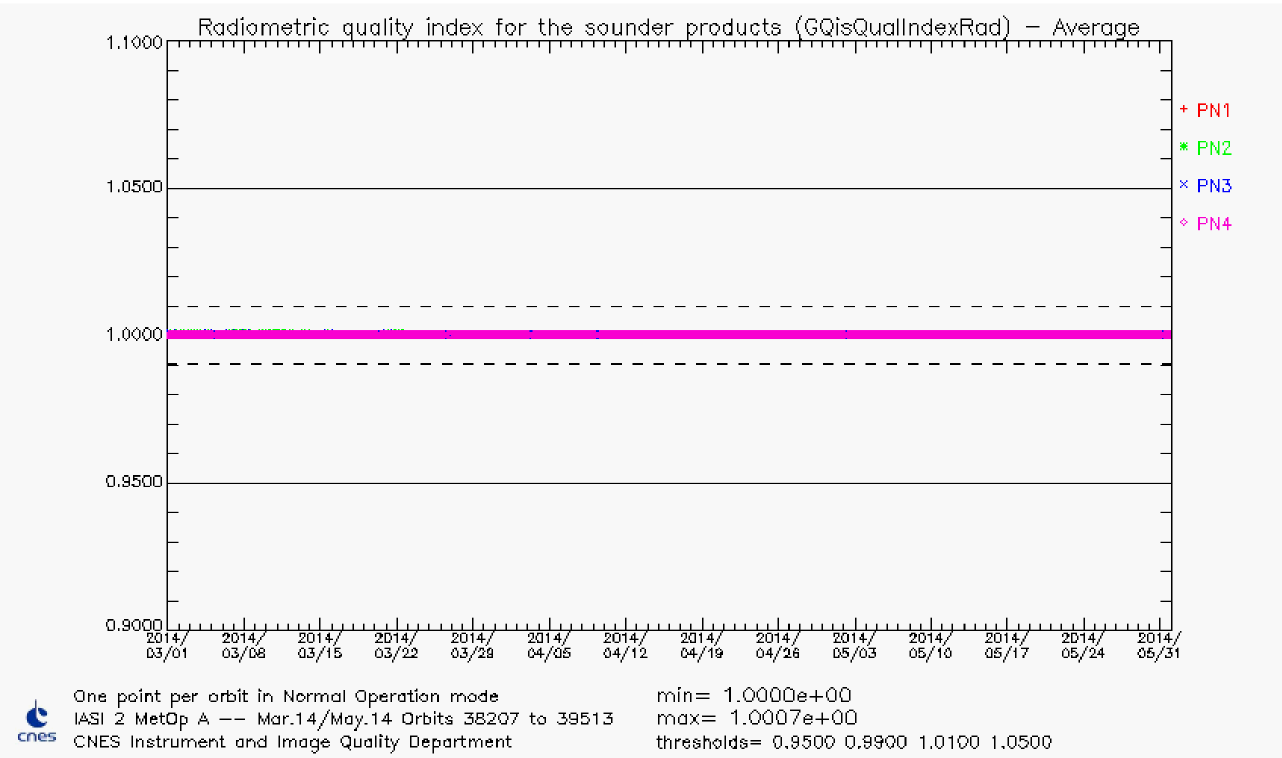


Figure 17 : GQisQualIndexRad average (L1 data index for radiometric calibration quality)

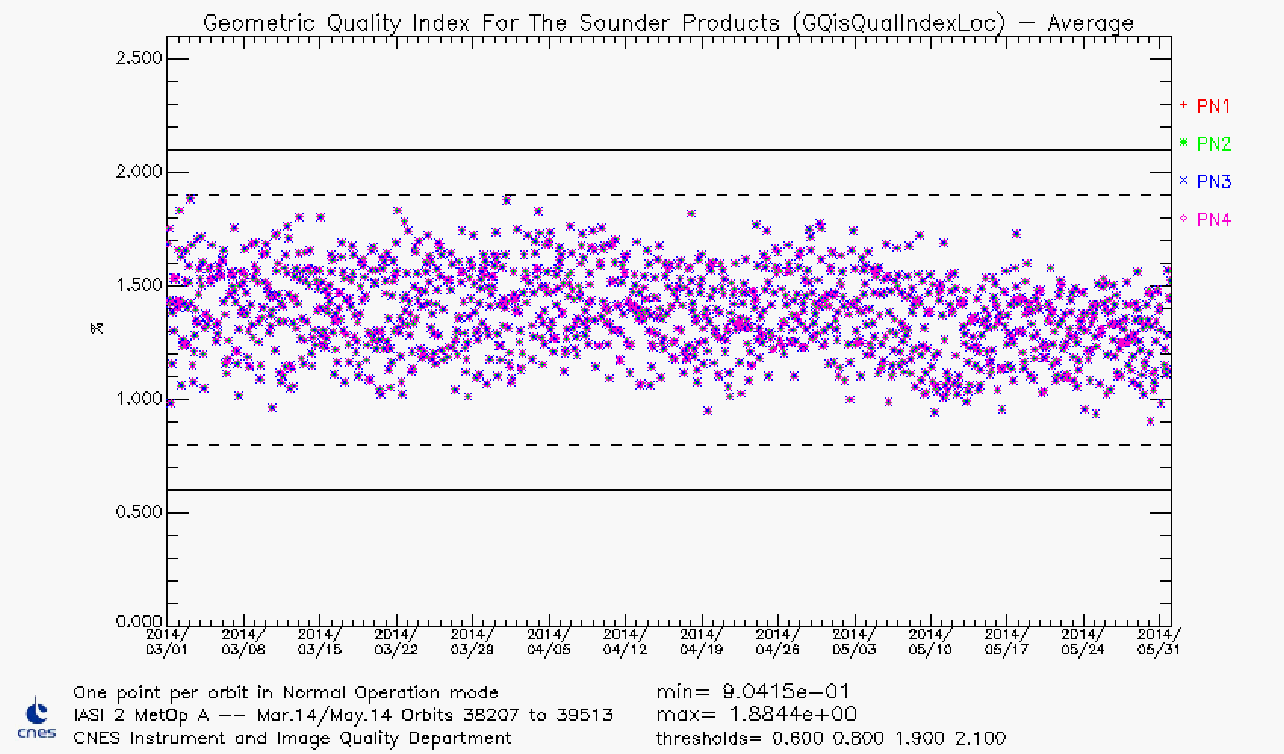


Figure 18 : GQisQualIndexLoc average (L1 data index for ground localisation quality)

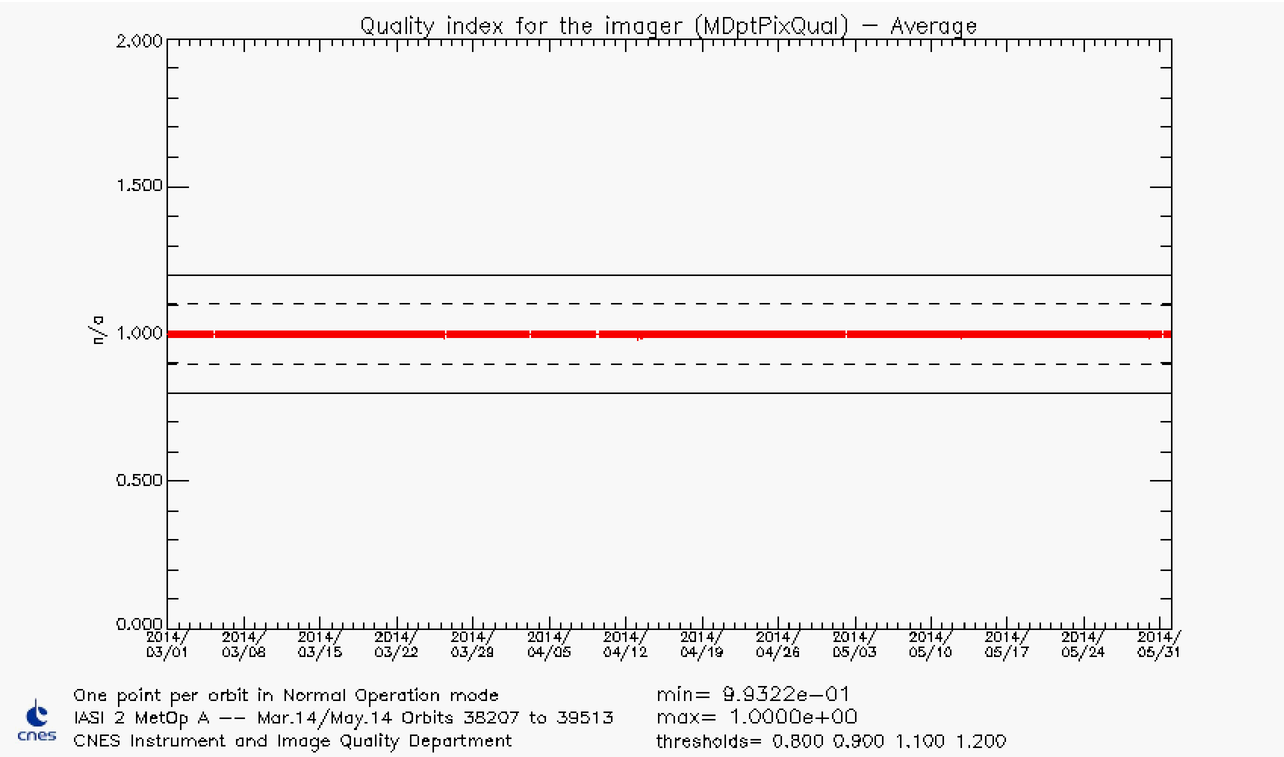


Figure 19 : MDptPixQual average (L1 quality index for IASI integrated imager, fraction of not dead pixels)

4.4.3 Conclusion

L1 Flag and quality indicators are stable and meet the specifications.

4.5 SOUNDER RADIOMETRIC PERFORMANCES

4.5.1 Radiometric Noise

Monitoring the radiometric noise allows to monitor the long term degradation of the instrument as well as to look for punctual anomaly of IASI or other component of METOP.

Monthly noise estimation (CE)

This monthly estimation is performed during routine External Calibration on BB views.

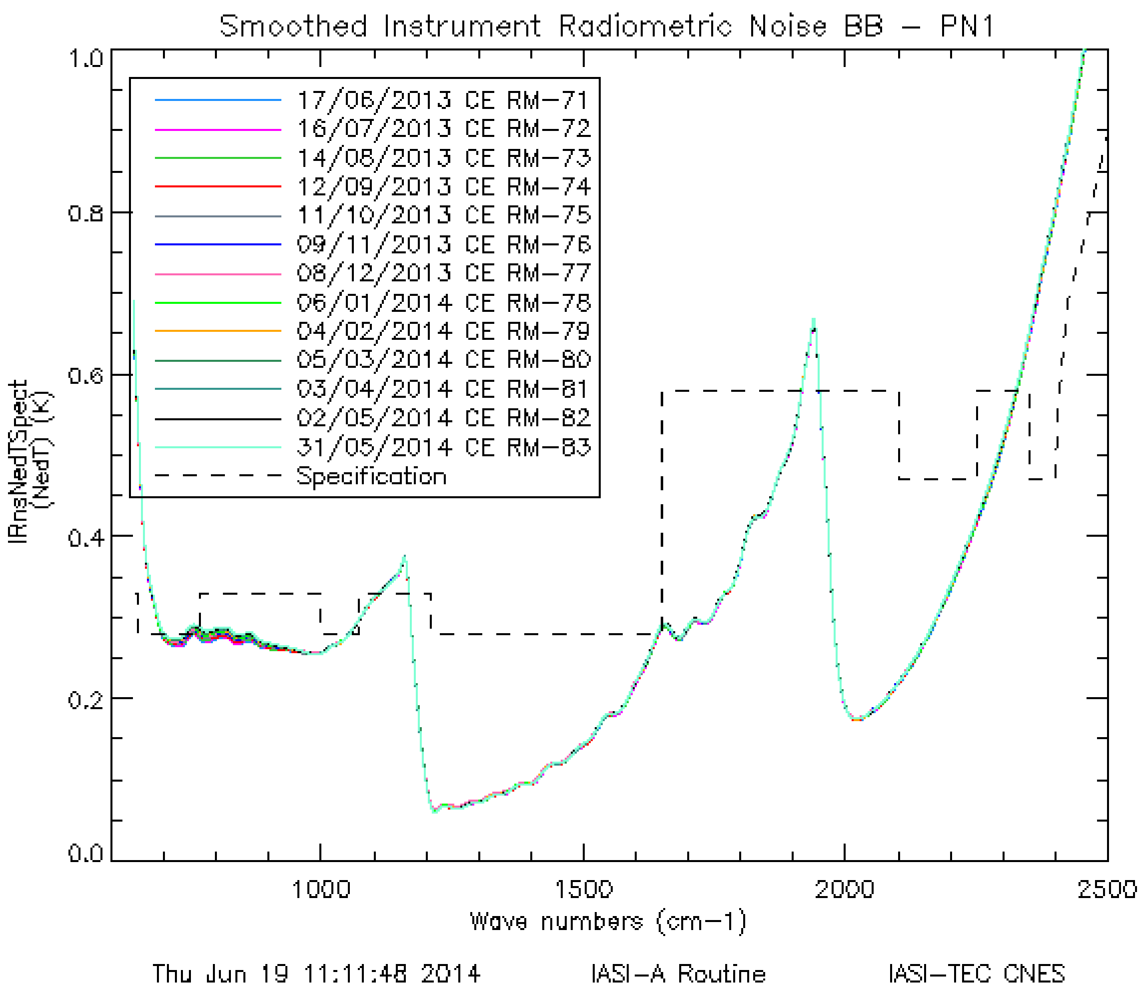


Figure 20 : Instrument noise evolution between start and end of the period

The instrument noise is very stable apart from ice effect between 700 and 1000 cm^{-1}. This point will be developed in section 4.5.4.1.

4.5.2 Radiometric Calibration

The radiometric calibration allows one to convert an instrumental measurement into a physical value. As far as IASI is concerned, the radiometric calibration is used to convert an interferogram into an absolute energy flux by taking into account instrument discrepancies. Even if the calibration has been studied on ground, it has to be continuously monitored in-flight in order to follow any potential degradation of the instrument (optics, detectors …).

Approach: Radiometric fine characterization has been done during ground testing and Cal/Val. All parameters likely to cause a failure in radiometric calibration process have been identified and are continuously monitored. As long as they remain stable, there is no problem with radiometric calibration.

Evolution of scanning mirror reflectivity

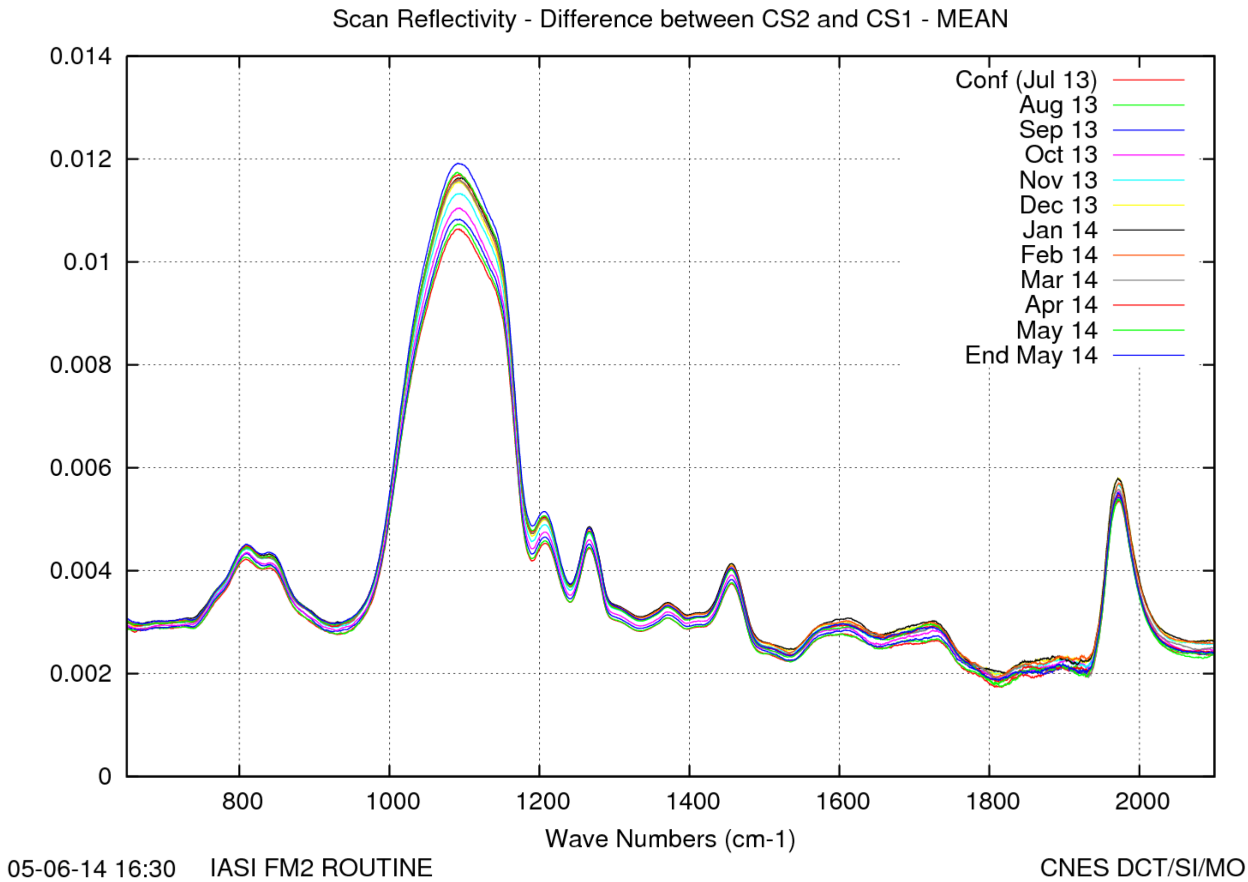


Figure 21 : Scan mirror reflectivity evolution

The reference reflexivity (in red) is the one computed on data from July 16th 2013. We see a slight evolution within [1000-1100 cm^{-1}] band. Values for wavenumbers greater than 2400 cm^{-1} are not significant because of instrument noise.

The next figure shows the translation of scan mirror reflectivity in terms of maximum radiometric calibration error for different scene temperatures.

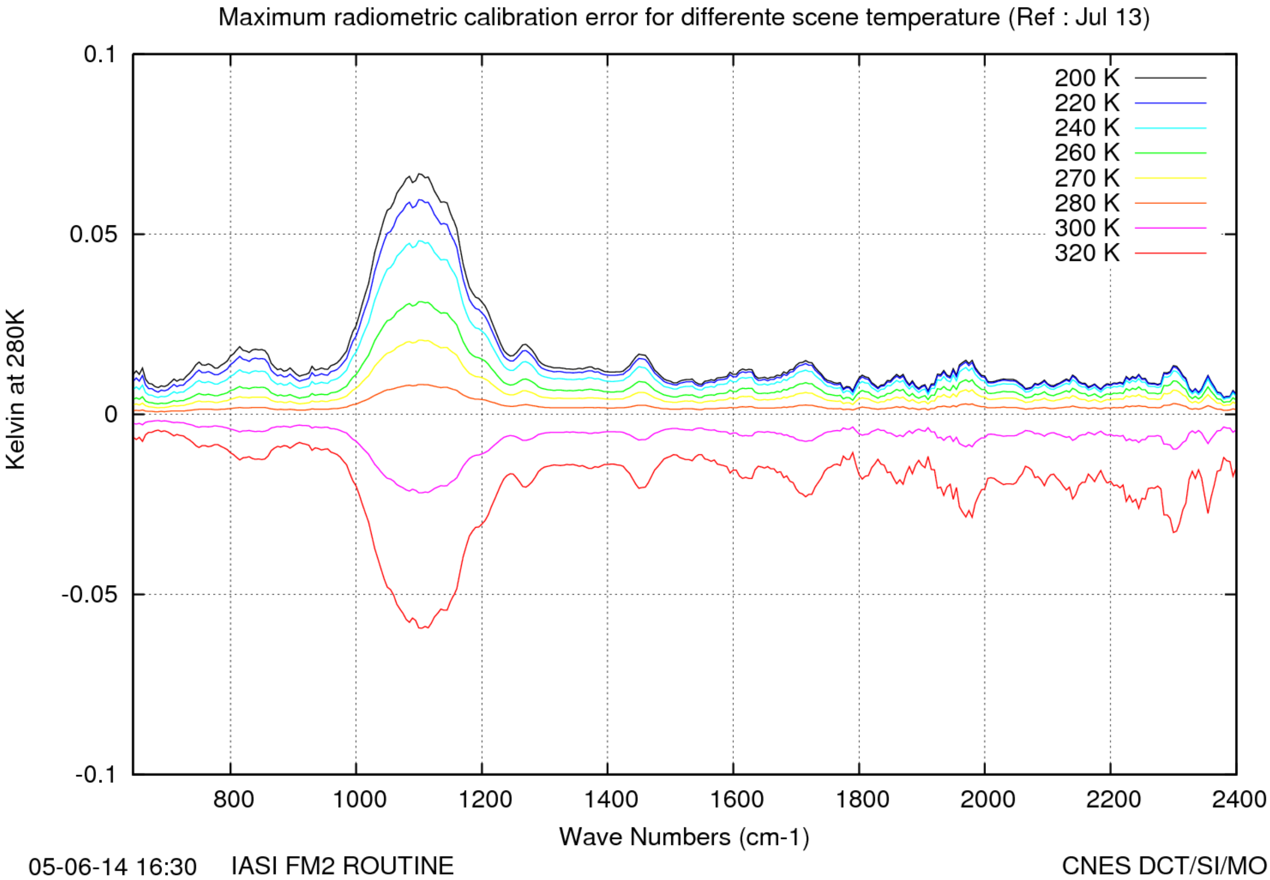
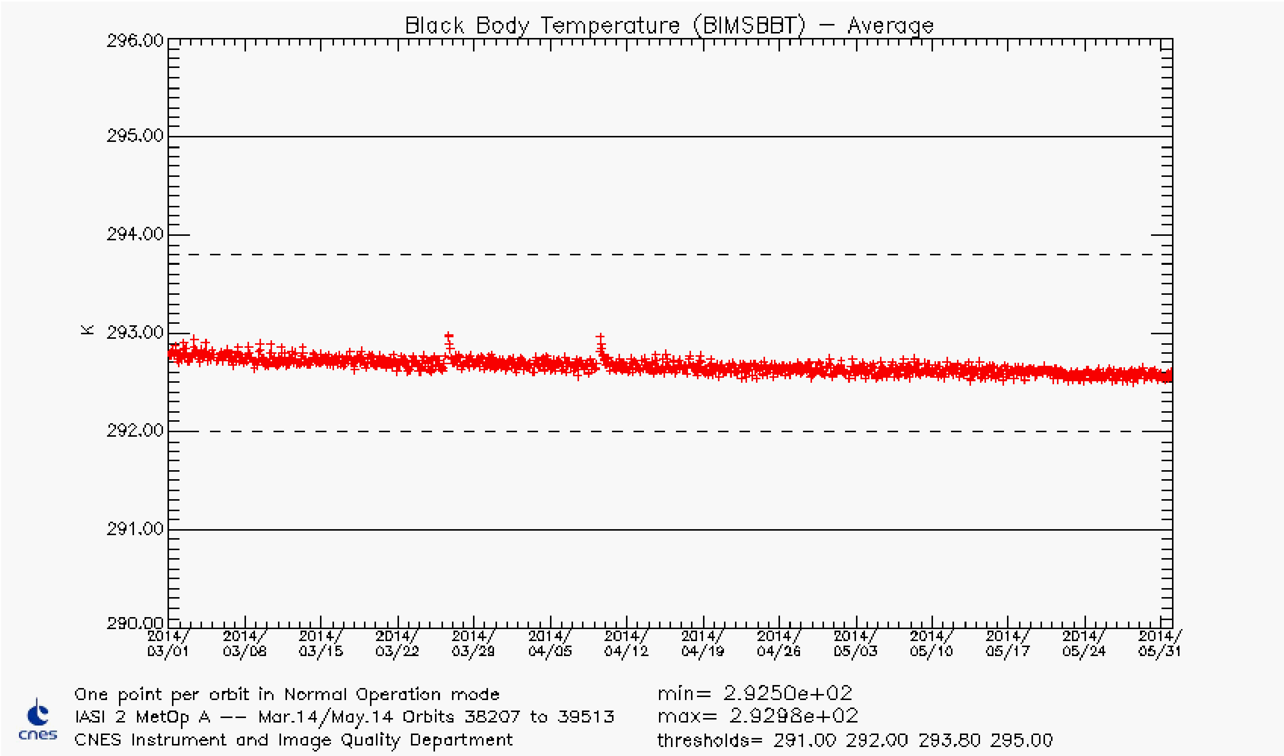


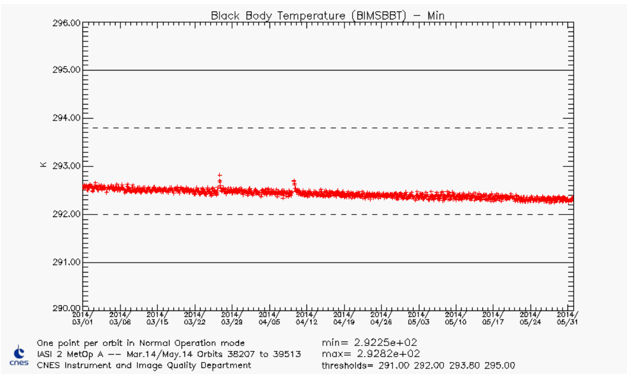
Figure 22 : Radiometric calibration error due to scan mirror reflectivity dependency with viewing angle Maximum effect on SN1 for different scene temperature. Done with the period July 2013 / May 2014

In any cases radiometric calibration maximum error is lower than the specification (0.1K). The scan mirror reflectivity law (on ground configuration), prepared with July 2013 routine External Calibration data, has been updated in the operational ground segment in September 2013.

Internal black body



Min



Max

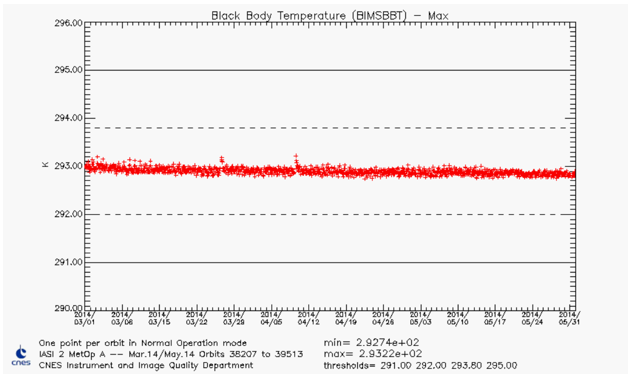


Figure 23 : Black Body Temperature

Non linearity of the detection chains

Non-linearity tables of the detection chains are still nominal as long as sounder focal plane temperature variation amplitude is lower than 1K.

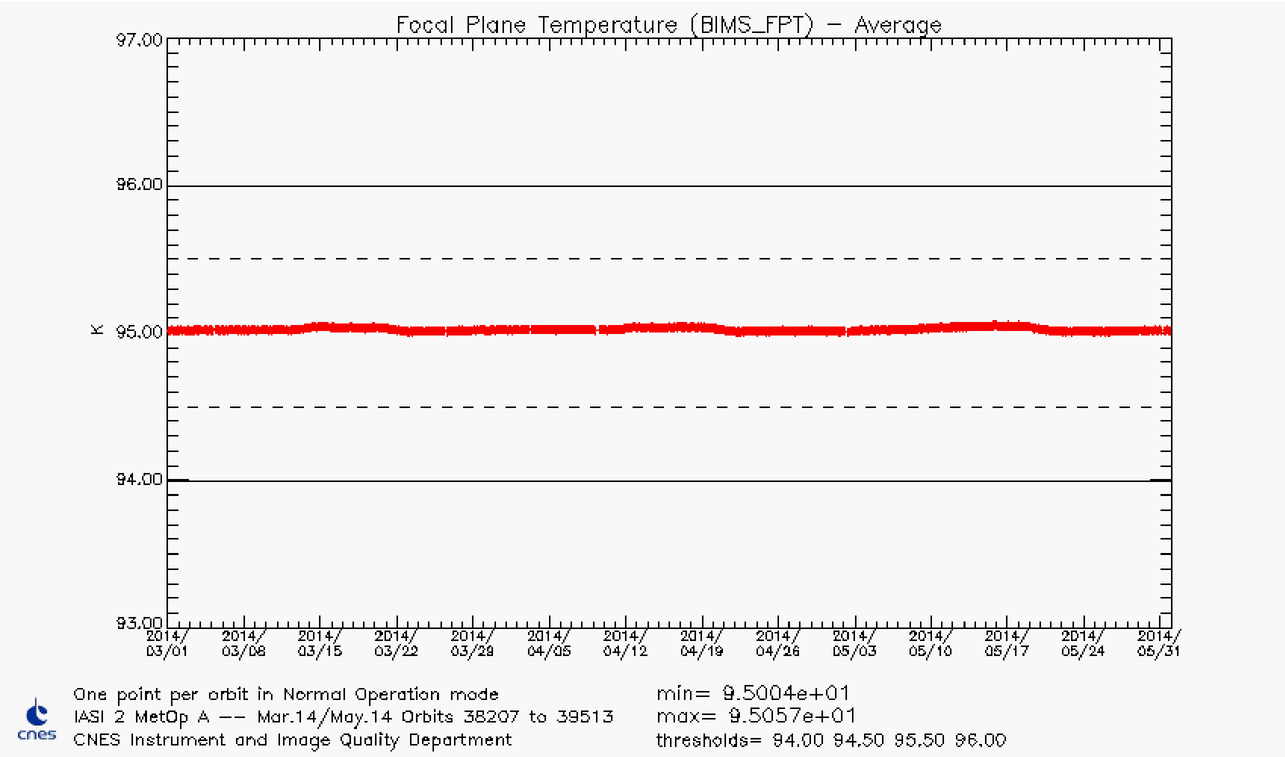


Figure 24 : Focal Plane Temperature

4.5.3 Delay of detection chains

Long term stability and values lower than 400 ns are required in order to properly take into account cube corner velocity fluctuations.

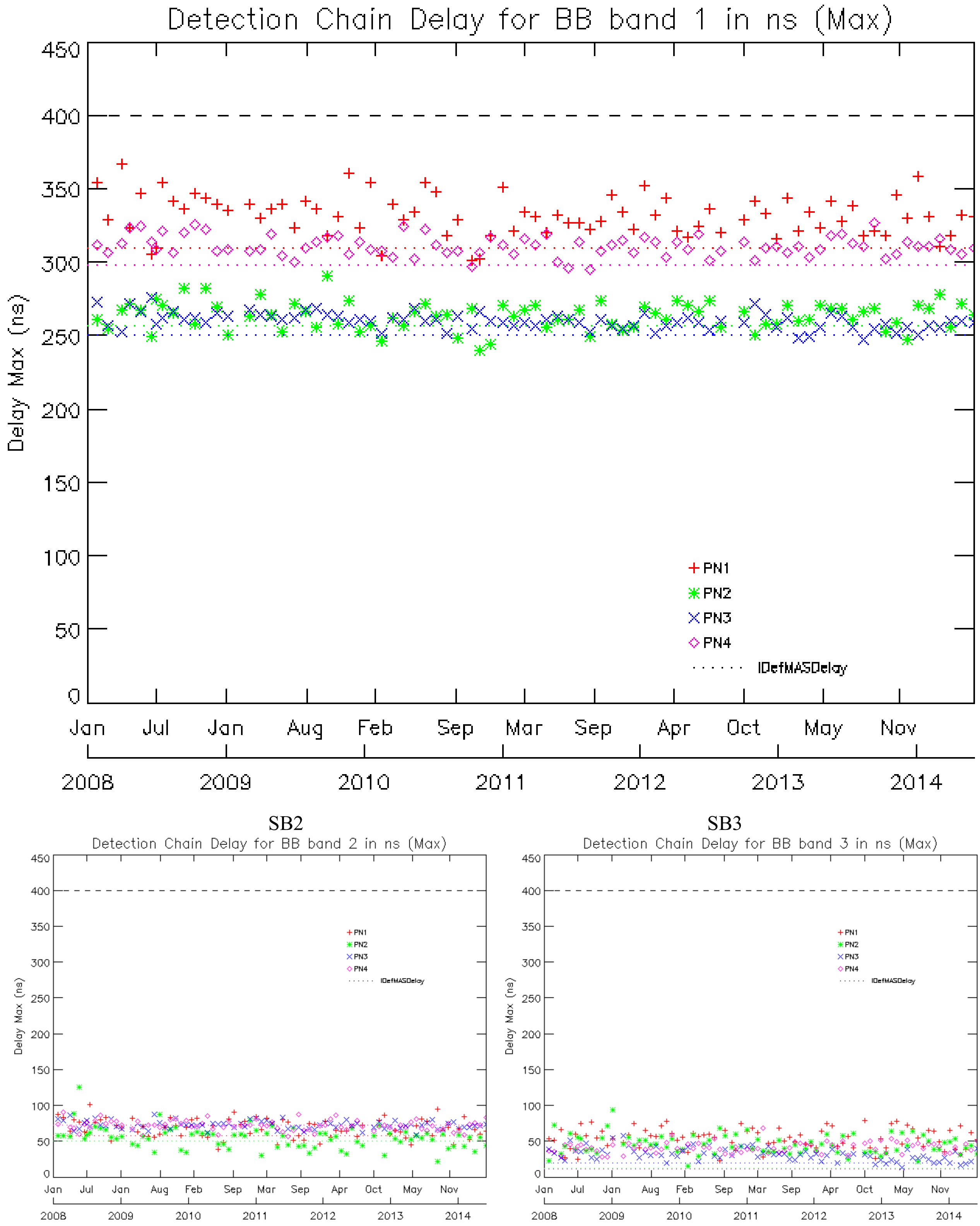


Figure 25 : Monitoring of detection chain maximum delays for all bands

4.5.4 <u>Optical Transmission</u>

4.5.4.1 Ice

The IASI interferometer and optical bench are regulated at 20°C temperature, while the cold box containing cold optics and detection subsystem is at about -180°C. Water desorption from the instrument causes ice formation on the field lens at the entrance of IASI cold box. This desorption phenomenon is particularly important at the beginning of the instrument in-orbit life. That's why one of the very first activities of IASI in-orbit commissioning was an outgassing phase consisting in heating the cold box up to 300 K during 20 days. This operation allows removing most of the initial contaminants coming from IASI and other MetOp instruments. A routine outgassing is then needed from time to time to remove ice contamination, but less and less frequently as the desorption process becomes slower. A first run of this routine outgassing procedure (shorter duration and at 200 K), was done for validation purpose during commissioning phase in December 2006. The second one, which was actually the first in routine phase, was done in March 2008. The third one was done in August 2010.

The maximum acceptable degradation of transmission is about 20% loss at 850 cm^{-1} (which corresponds to an ice deposit thickness of about 0.5 µm).

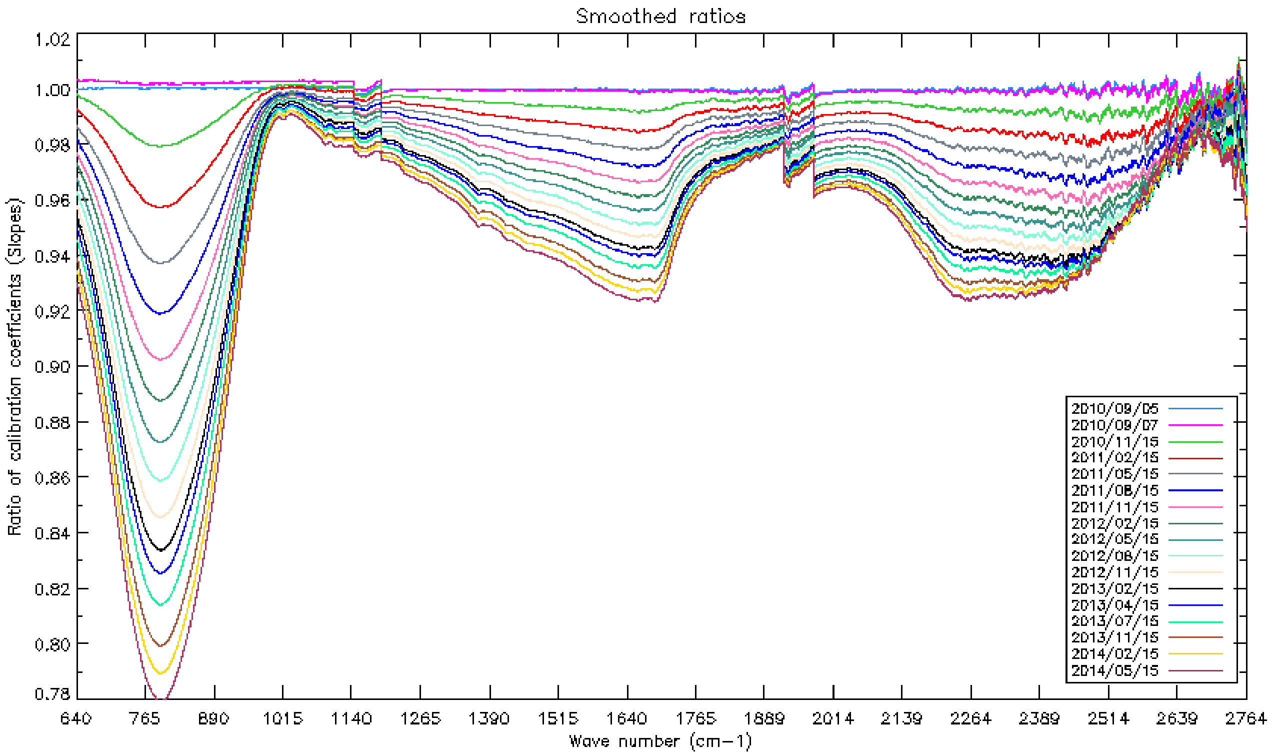


Figure 26 : Ratio of calibration coefficient slopes as a function of wave number and time after the last decontamination

4.5.4.2 Prediction of decontamination date

The transmission degradation rate is regularly monitored by CNES TEC through gain measurements given by calibration coefficients ratios.

The loss of instrument gain due to ice contamination is, as expected, decreasing over time. The next decontamination is scheduled in September 2014, the maximum degradation of transmission being not exactly at 850 cm^{-1}.

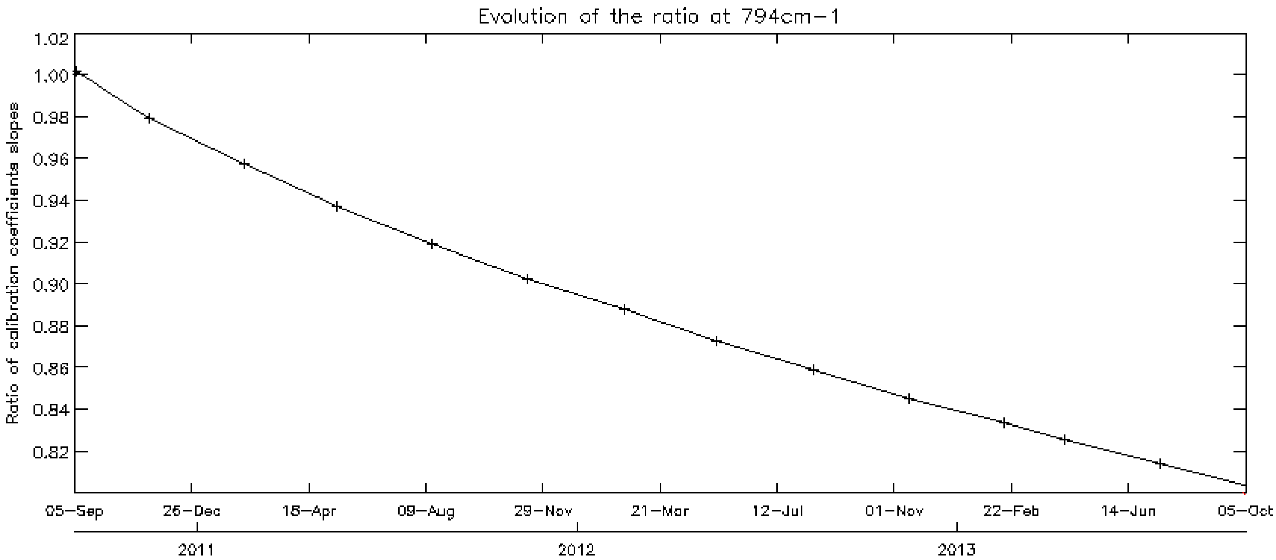
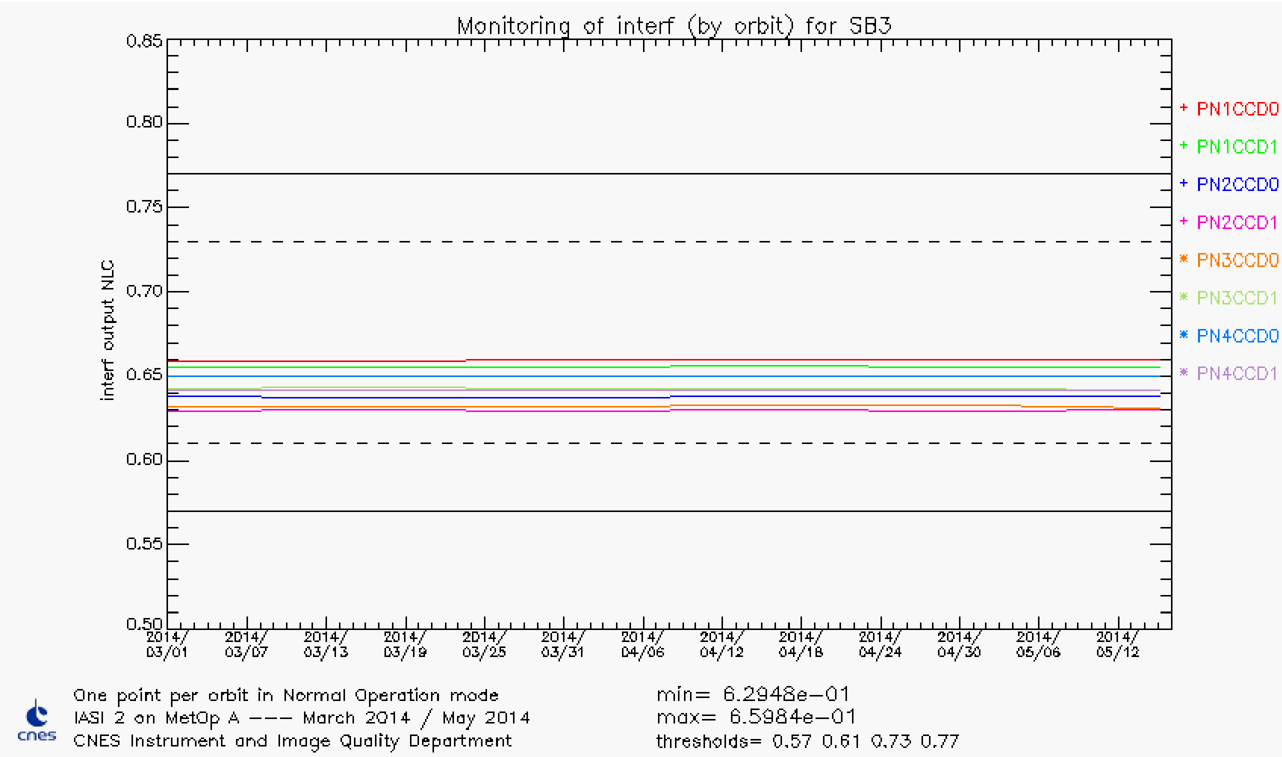


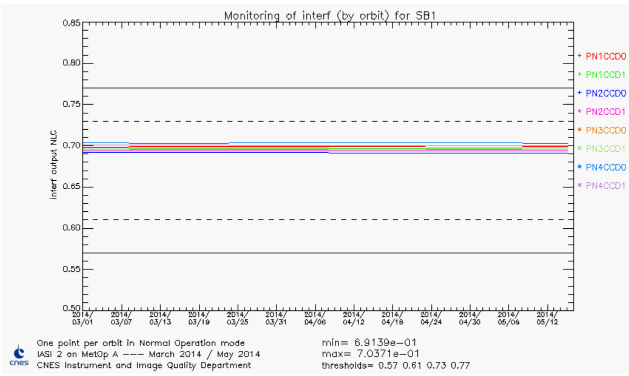
Figure 27 : Temporal evolution of calibration ratio coefficient slopes since the last decontamination. The curve was fitted with a decreasing exponential function to determine a rough date for the next decontamination (relative gain evolution of 0.8)

4.5.5 Interferometric Contrast

The interferometric contrast is defined as the interferogram fringe discrimination power. Figure 28 shows temporal evolution of instrument contrast on the quarter for all pixels and all CCD.



SB1



SB2

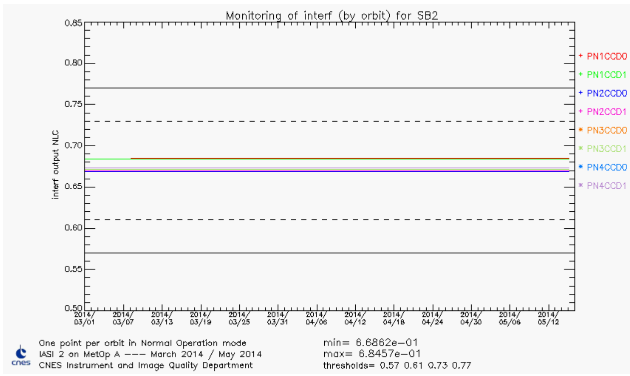


Figure 28 : Contrast Monitoring

4.5.6 Interferogram baseline

The interferogram baseline is the mean value of the interferogram. Figure 29 shows temporal evolution of the baseline of the raw interferograms on calibration targets (BB and CS). The values are raw values, they are not physical, but the evolution is interesting: as the values are proportional to the energy received from a target and calibration targets are stable, the evolution can show the decrease of intrument transmission or events due to energetic particles.

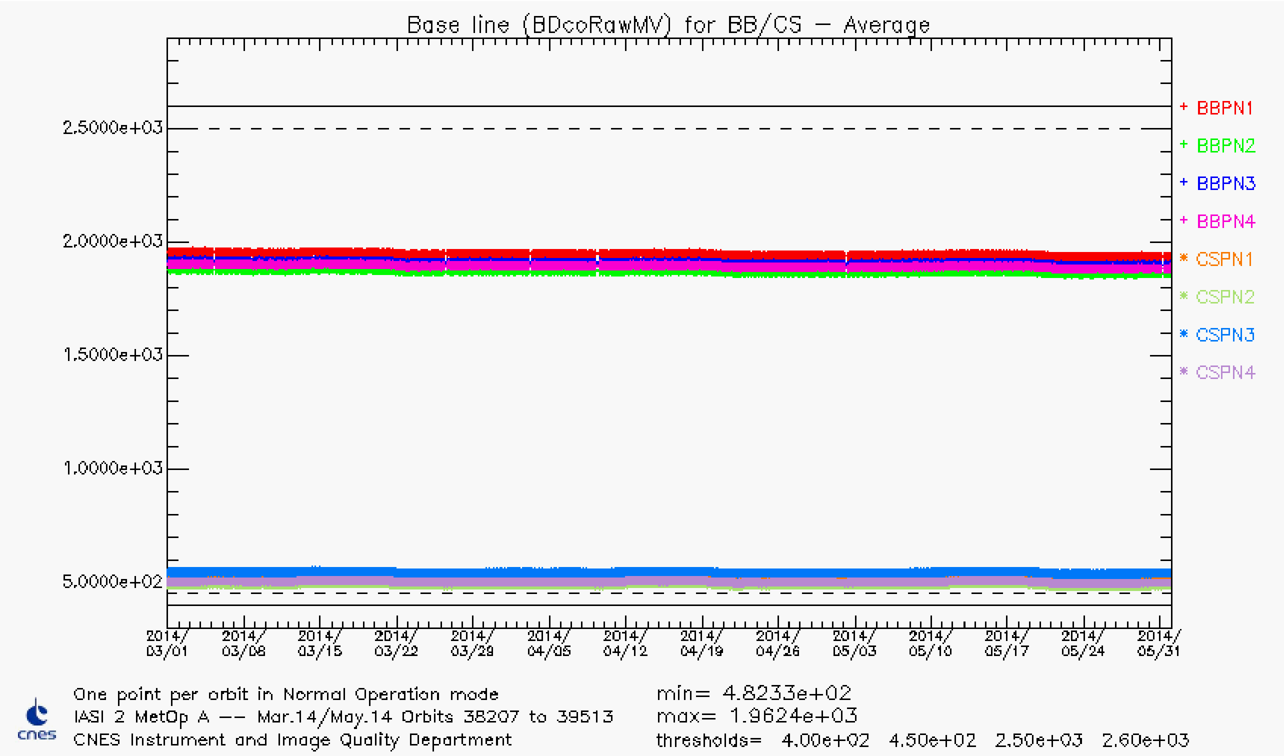
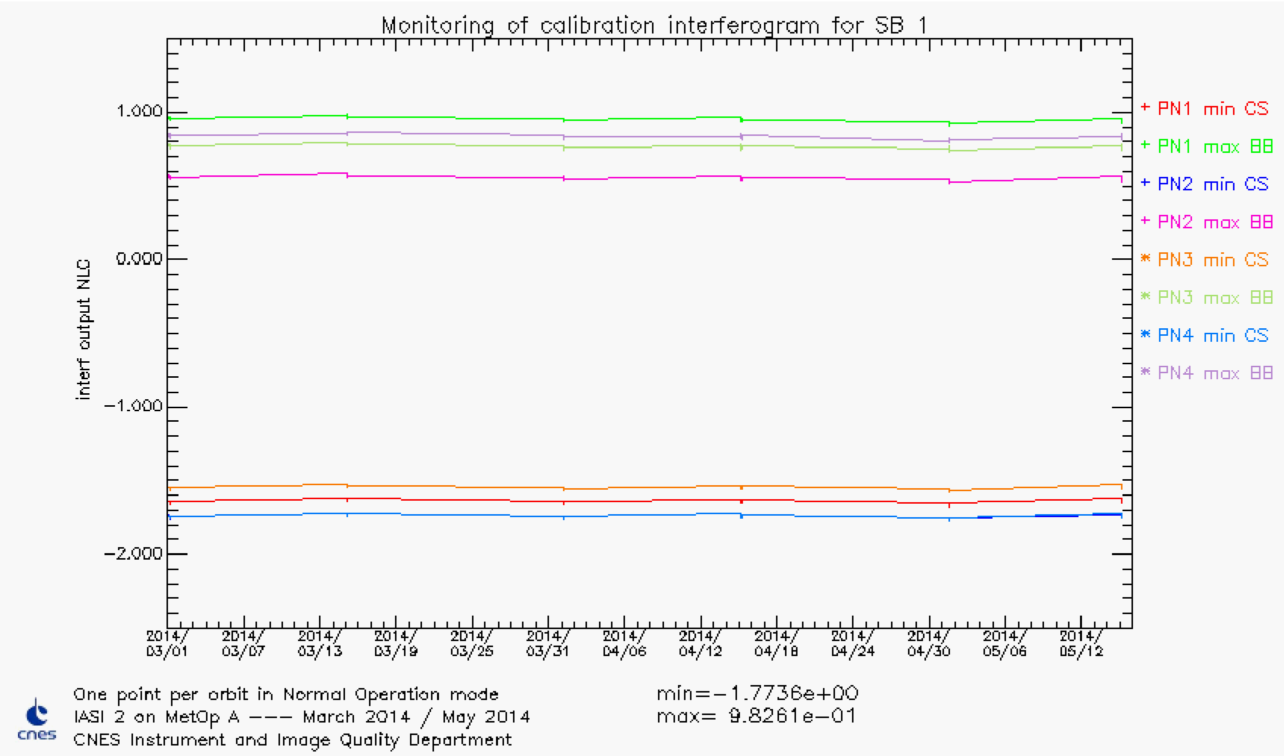


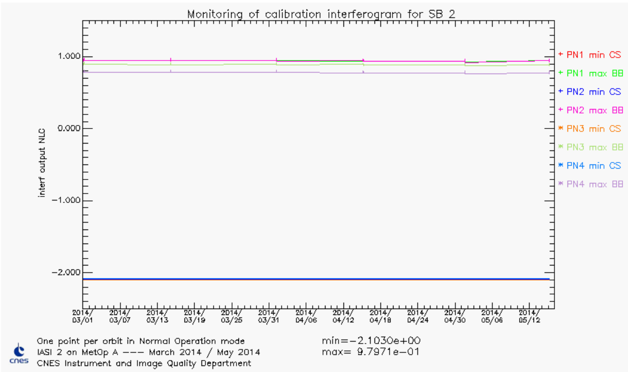
Figure 29 : Monitoring of interferogram baseline

4.5.7 Detection Chain

Detection chains are tuned in gain and offset via telecommand. The goal is to avoid saturation while conserving the maximum dynamic to limit digitalization noise.



SB2



SB3

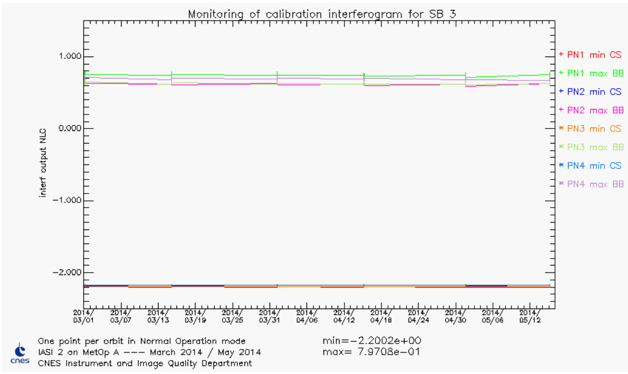


Figure 30 : Monitoring of detection chain margins

Margins are sufficient for the moment. The slight decreasing slope in SB1 (BB) for all pixels is linked to the instrument transmission evolution already mentioned in §4.5.4.1.

4.5.8 Conclusion

The radiometric performances of IASI are nominal and stable. The next decontamination is scheduled in September 2014. Scan mirror reflectivity was updated in September 2013 with July 2013 data. The next update is scheduled in June 2014.

4.6 SOUNDER SPECTRAL PERFORMANCES

This part is specific to hyperspectral sounders. The goal of the spectral calibration is to provide the best estimates of spectral position of the 8461 IASI channels.

The large sensitivity of infrared spectrum to spectral calibration errors has lead to stringent specifications:

• A prior knowledge of spectral position better than of 2.10^{-4} (design)

• A posterior maximum spectral calibration relative error of 2.10^{-6} (after calibration by OPS)

In order to reach the specification of 2.10^{-6}, we need an accurate Instrument Spectral Response Function (ISRF) model. This model have been done and validated in the early time of IASI development.

For sake of operational time constrain, complete ISRF calculation is not done in real-time by OPS software but pre-calculated and stored in a database called "spectral database". OPS processing determine on-line the most relevant instrument function to be used by OPS with respect to current values of a set of parameters (interferometric axis, cube corner offset…).

The approach to monitor IASI spectral performances is very similar to the one used for radiometric calibration. Spectral calibration fine characterization has been done during ground testing and Cal/Val. All parameters likely to cause a failure in spectral calibration process have been identified and are continuously monitored. As long as they remain stable, there is no problem with IASI spectral calibration.

In addition, a spectral calibration assessment is done over homogeneous scenes when IASI is in external calibration, nadir view.

4.6.1 <u>Monitoring of the ISRF inputs</u>

4.6.1.1 Position of the interferometric axis

The interferometric axis is the cube corner displacement direction. Its value was around (Y = -160µrad; Z = -450µrad) since the beginning of the life of IASI-A. Since the change of IPSF positions in 2013/05/16, its value has changed and is now stable around (Y = 445µrad; Z = 195µrad). The central position used in the "spectral database" generation, are 400 µrad and 200µrad, respectively for Y and Z axis.

Since the drift of the interferometer axis is lower than 300 µrad, there is no need to update the "spectral database".

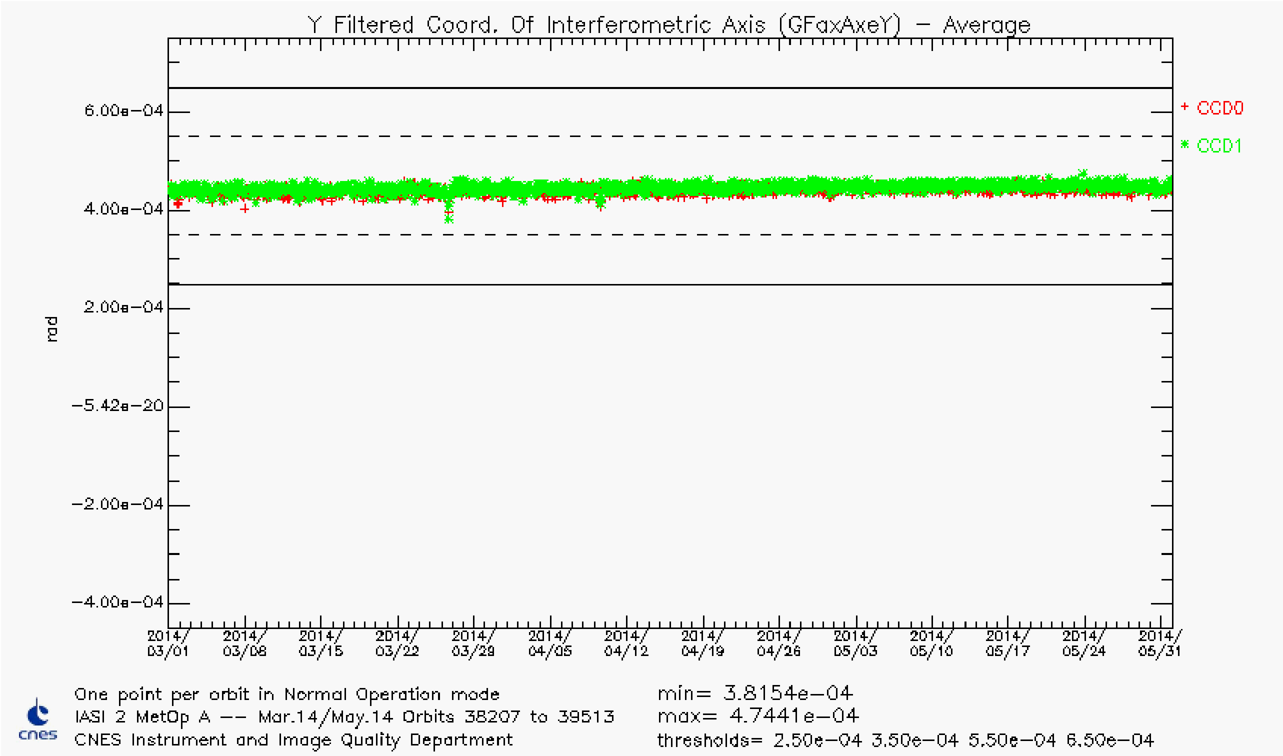


Figure 31 : GFaxAxeY average (Y filtered coordinates of sounder interferometric axis)

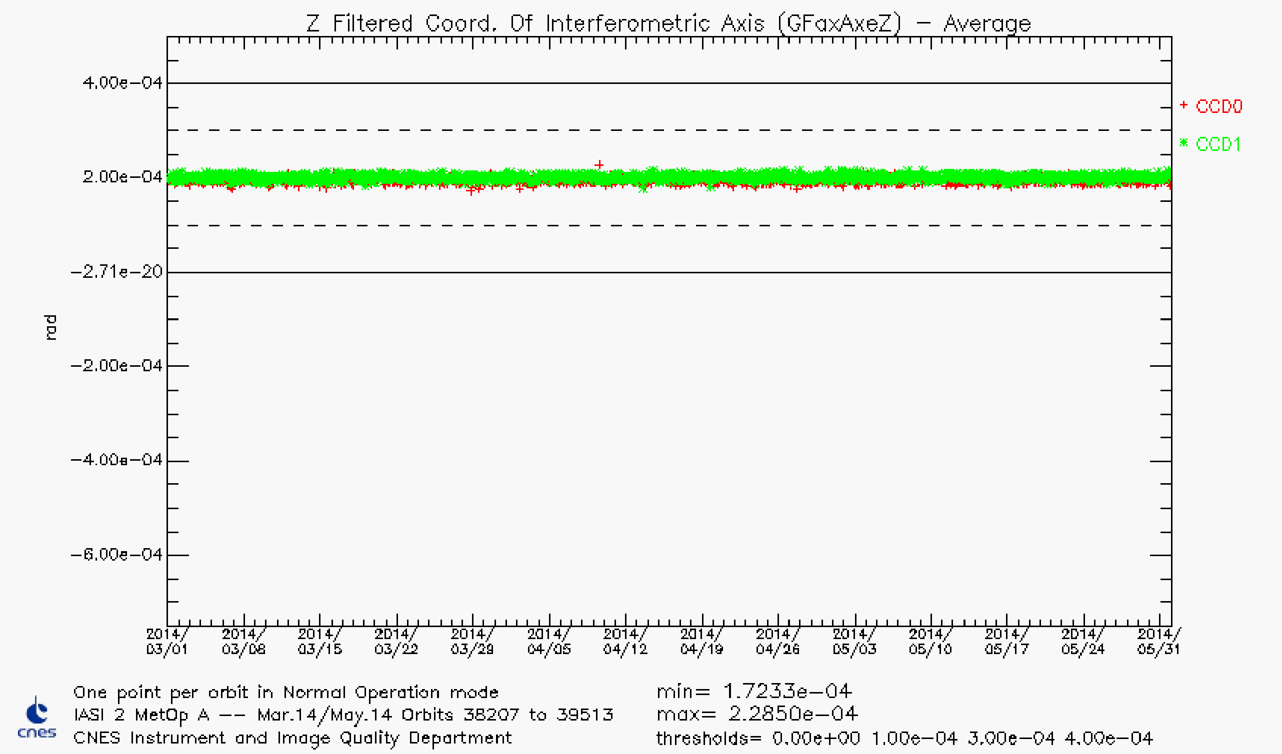


Figure 32 : GFaxAxeZ average (Z filtered coordinates of sounder interferometric axis)

4.6.1.2 Cube Corner constant offset

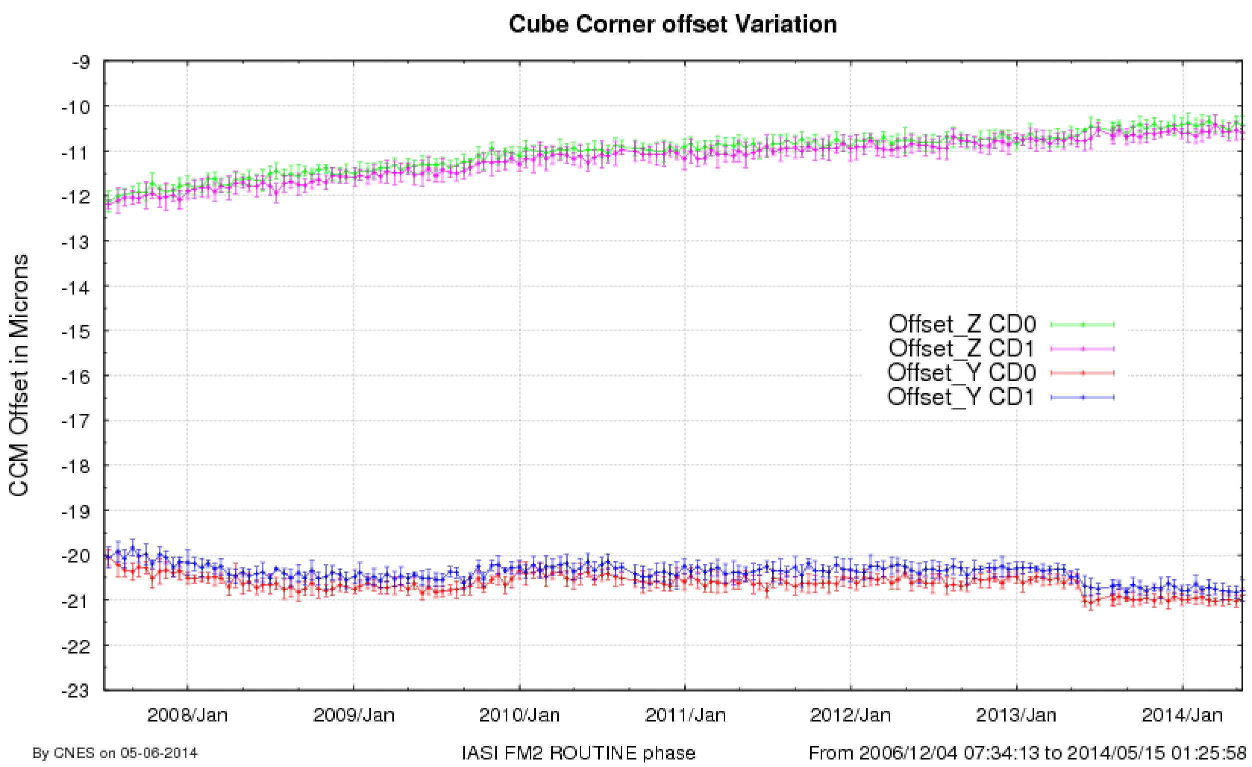


Figure 33 : Cube Corner offset variation

Reference cube corner offsets, used in the spectral database of the period (ODB14), are -21.08 µm, -20.69 µm, -10.49 µm and -10.77 µm, respectively for Y CD0, Y CD1, Z CD0 and Z CD1.

The slight change of the cube corner constant offset that happened in May 2013 is due to the update of the IPSF positions in the ground configuration.

Since the drift of cube corner offset is lower than 4 µm, there is no need to update the "spectral database".

4.6.1.3 Cube corner velocity

Refer to REVEX, paragraph 5.5.

4.6.1.4 Interferometer optical bench temperature

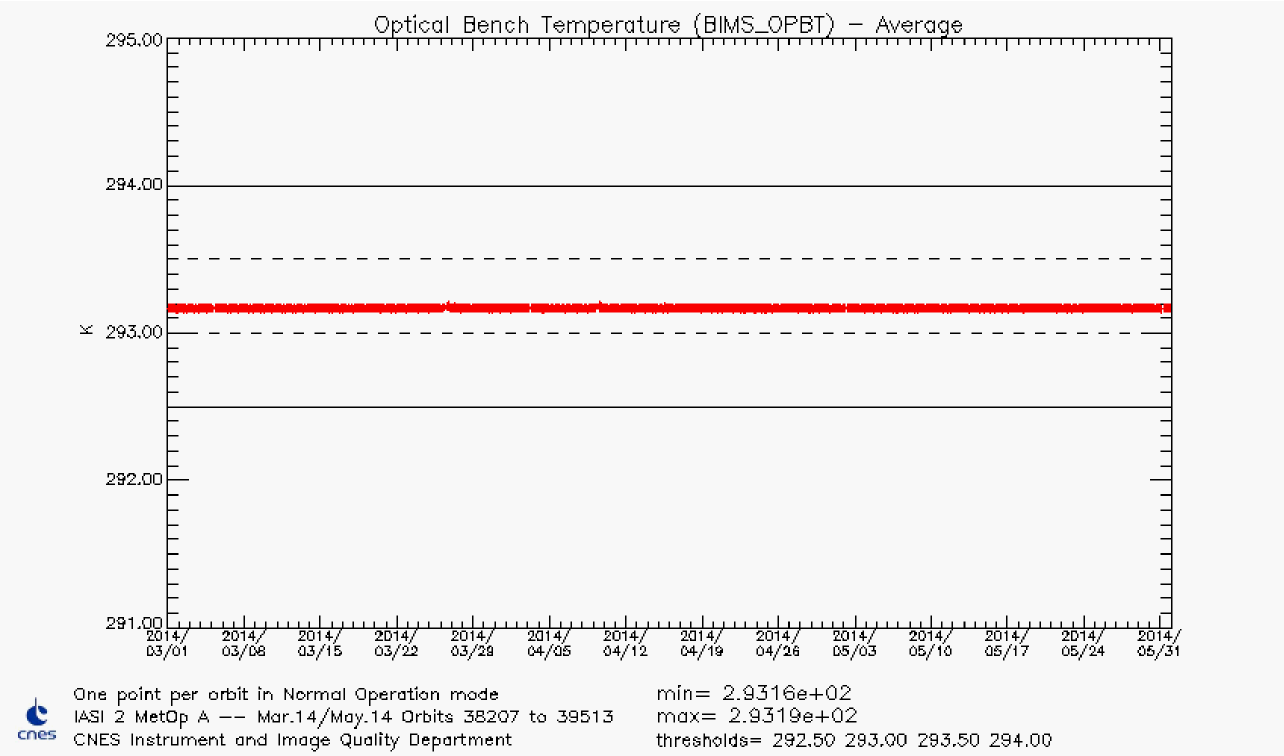


Figure 34 : Optical bench Temperature

4.6.2 Spectral calibration assessment

This assessment is performed during routine External Calibration on Earth views at nadir (SP 15).

4.6.2.1 Absolute spectral calibration assessment

IASI L1C spectra are compared with simulated spectra over homogeneous scenes, warm and clear.

The spectra are simulated with 4AOP radiative transfer model with collocated input profiles: temperature and water vapor profiles are extracted from meteorological analysis from ECMWF, the others gazes like CO_2, O_3, CO, N_2O and CH_4 profiles are extracted from a climatological data base.

The IASI spectra are selected using the pseudo channel Variance of the IIS radiance. The variance must be lower than 0.65 Kelvin, that is very close to the IIS noise level. This criterion insures a quasi-perfect homogeneity of the scenes (but not necessarily clear). The minimum of the pseudo channel IIS brightness temperature is 286K, which insures to have a hot scene, rejecting the areas where there is a lack of dynamic in the atmospheric spectral lines and rejecting the majority of cloudy scenes (which are not simulated). Then only contiguous selected scenes are kept (20 lines maximum, 1000 km).

The 4AOP spectra are simulated using the coordinates of the center of each sequence.

The comparison is done by using the correlation method in spectral windows (using the derivative of the spectrum). The position of the maximum of the correlation coefficient gives us the spectral shift. The result is expressed in terms of relative spectral shift error between L1C simulated and measured spectra for each pixel.

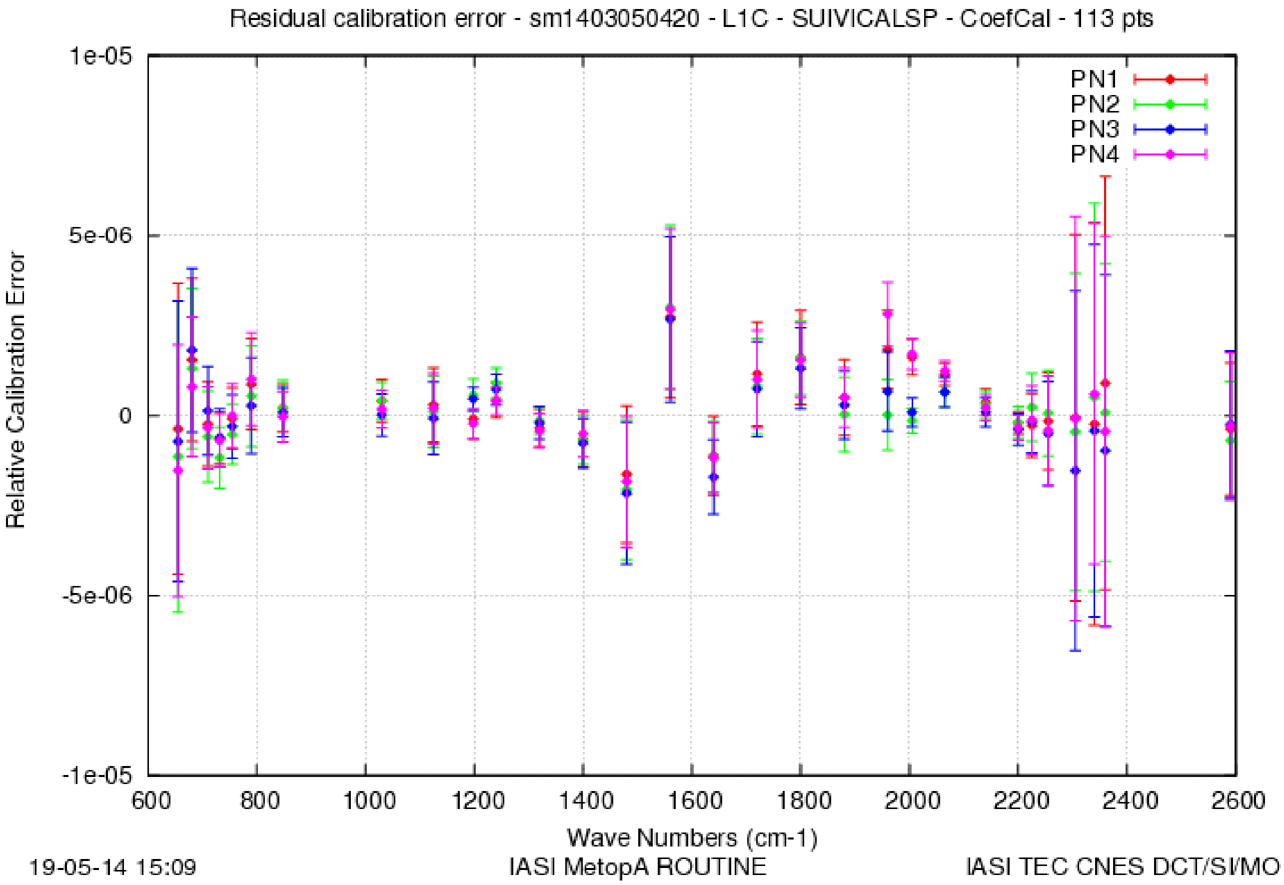


Figure 35 : Spectral shift error between L1C IASI and simulated L1C with A4/OP + ECMWF

The absolute spectral calibration assessment by comparison with a model is fully satisfactory on spectral bands that permits this exercise, the specification of 2.10^{-6} is reached.

We can note that the spectral shift in the inter-band is not good because of a sharp gradient of the spectral filters (transmission function) at the edge of spectral bands. So, the energy in a line is not the same in every channel included in the line, the barycenter of the line changes, that induces a spectral shift. For B1/B2, the inter-band limit is around 1169 cm^{-1}, and for B2/B3 it is around 1953 cm^{-1}.

The model has its limits : it is not true everywhere in the spectrum, because the geophysical conditions are not well known. For example, in B2 a bad knowledge of the water vapor content leads to a bad simulation and thus to a spectral shift in B2 only due to the variability of the water wapor. There are still improvements to make on spectroscopy and the radiative transfer models.

4.6.2.2 Interpixel spectral calibration assessment

Over the same homogeneous scenes used for absolute spectral calibration assessment, IASI L1C spectra of each pixel are compared with the average spectra of all pixels. The result is expressed in terms of interpixel relative spectral shift error.

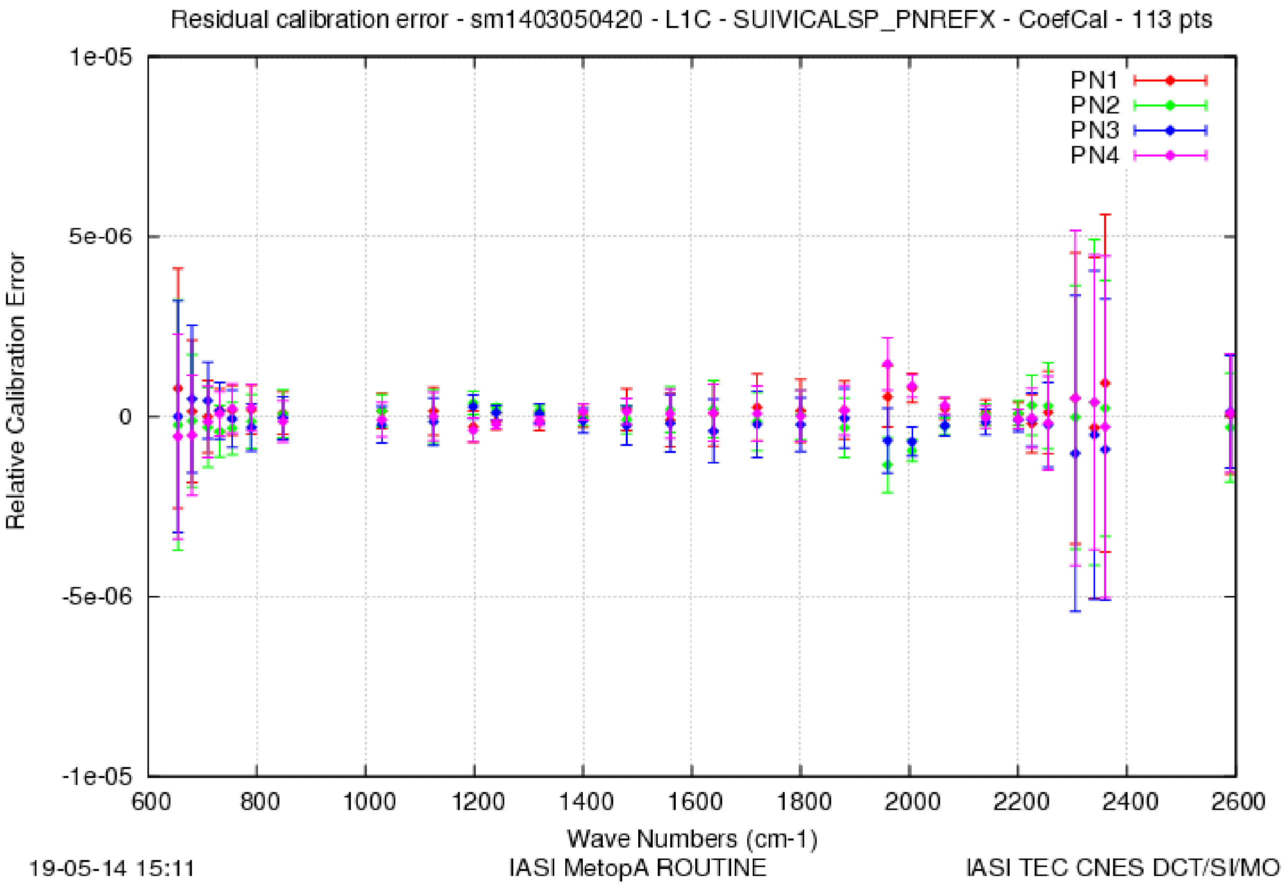


Figure 36 : Inter pixel spectral shift error for L1C IASI

The interpixel spectral calibration is better than 0.2ppm.

The results in the interband region are higher for the same reasons exposed in paragraph 4.6.2.1 . The error bars are high in B3 because of the noise that is higher at the end of B3.

In conclusion, the IASI pixels are spectrally independent.

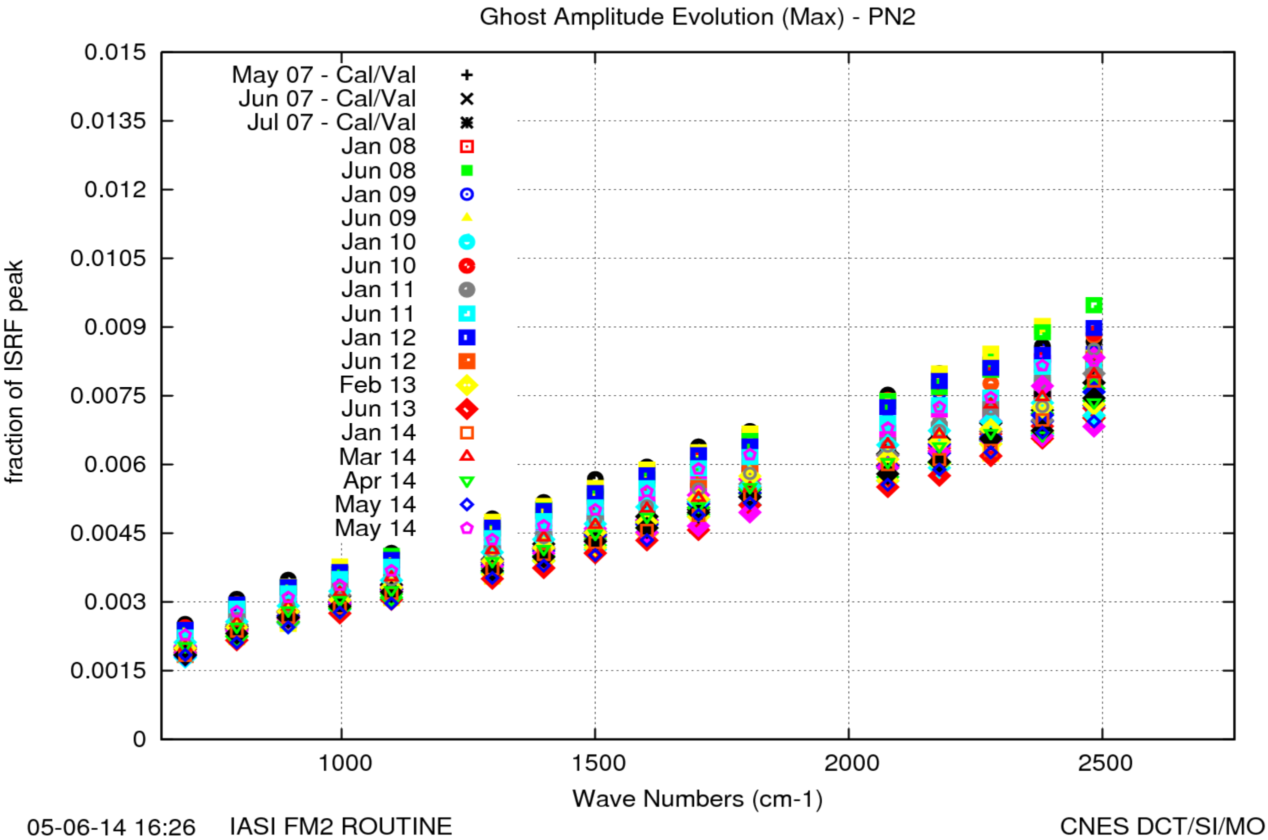
4.6.3 Ghost evolution monitoring

On-ground test of the instrument has shown a perturbation in the ISRF mainly caused by micro-vibrations of the interferometer separator blade. The amplitude of these micro-vibrations was characterized on ground and is measured on board.

Ghost origin is understood to be due to micro-vibrations of the beam-splitter. It is therefore stronger for the FOVs which project onto the top part of the beam-splitter (which vibrates more), and weaker for the FOVs which project onto the bottom part of the beam-splitter as it is attached to the optical bench.

The ghost affects the ISRF basically by replicating it at about $\pm 14 cm^{-1}$. Of course, the amplitude of these replications is very low with respect to ISRF maximum value. The amplitude and the central wave number of ISRF replications are function of: cube corner velocity, frequency and mechanical amplitude of the beam-splitter vibration and wave number.

We are continuously monitoring the impact of the ghost on ISRF by monitoring, for each wave numbers, the maximum amplitude of the replicated ISRF with respect to $ISRF_{max}$ value using monthly external calibration (BB views). The evolution over time of ghost amplitude with respect to $ISRF_{max}$ amplitude is shown below for pixel 2 and 4.



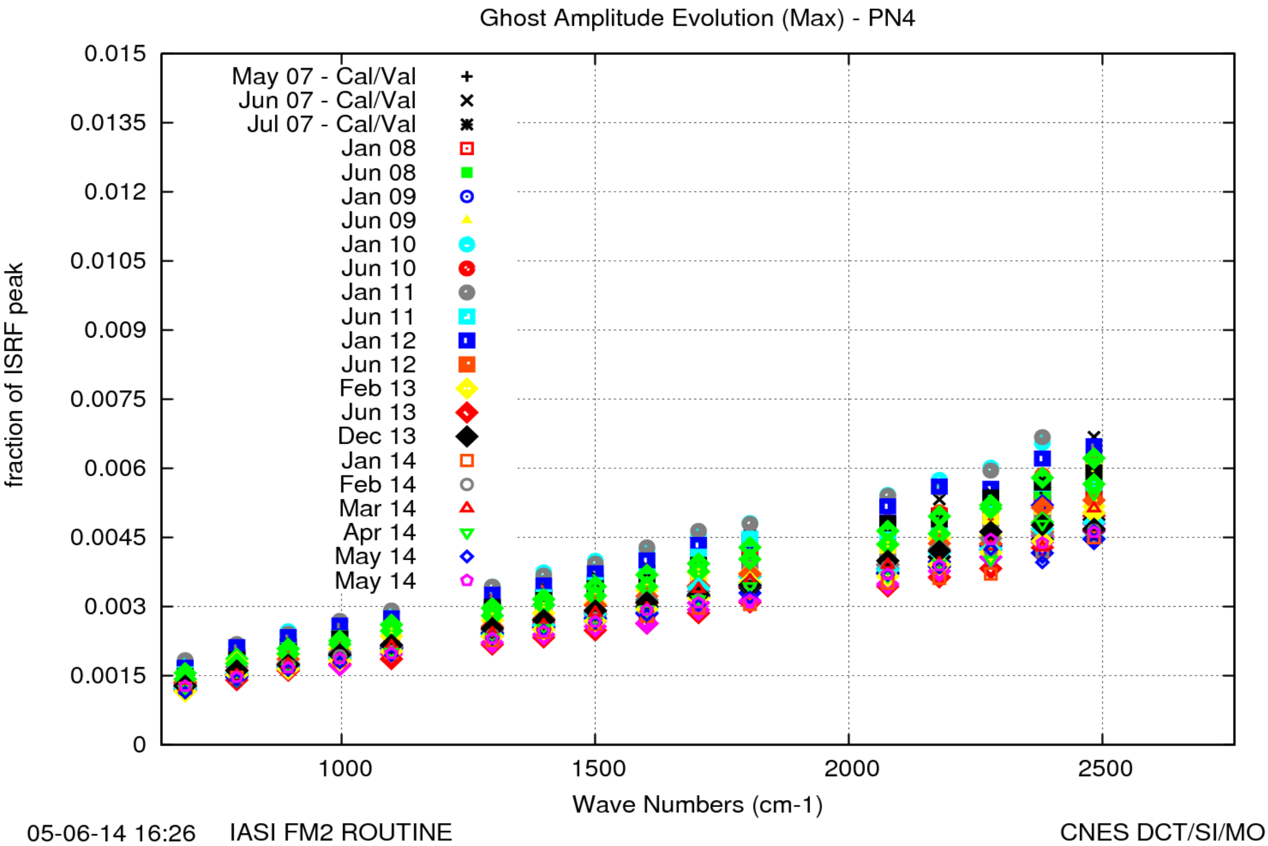


Figure 37 : Ghost amplitude as a function of wave number for different time (Top: pixel 2, bottom: pixel 4)

Maximum values of $ISRF_{max}$ (@2760 cm^{-1}) are respectively 1% for pixel 1-2 and 0.7% for pixel 3-4. We don't see any significant evolution over time.

Pseudo-noise induced by the ghost is lower than the 0.066K allocated specification and under control as soon as all cube corner velocity, frequency and mechanical amplitude of the beam-splitter vibration remain stable.

4.6.4 Conclusion

All parameters impacting IASI spectral calibration are stable and within specifications.

IASI has a fully satisfactory spectral calibration. The L1B processing, consisting in the spectral shift correction, and the L1C processing, consisting in the ISRF removal, are working very well.

4.7 GEOMETRIC PERFORMANCES

The geometric calibration is performed on ground (level 1 processing). Most of the analyses of geometric performances require being in external calibration mode.

Specifications are the following: the IIS/AVHRR co-registration has to be better than 0.3AVHRR pixel while the IIS/sounder co-registration has to be better than 0.8mrad.

4.7.1 Sounder / IIS co-registration monitoring

This monitoring is performed one time a year, generally around September for REVEX and march for mid-REVEX.

The sonder/IIS coregistration error is lower than 100µrad (eq. 100m on ground).

4.7.2 IIS / AVHRR co-registration

The IIS/AVHRR co-registration is permanently estimated by the L1 processing chain.

Note that AVHRR channels 4 and 5 are within the IIS spectral filter. The spatial resolution of the IIS (0,7km) is close to AVHRR (1km).

The IIS/AVHRR offset guess in the ground segment configuration is used when the algorithm of correlation between IIS and AVHRR does not converge (typically over homogeneous scenes).

The following figures show a comparison of IIS-AVHRR offsets (GIacOffsetIISAvhrr) mean profiles.

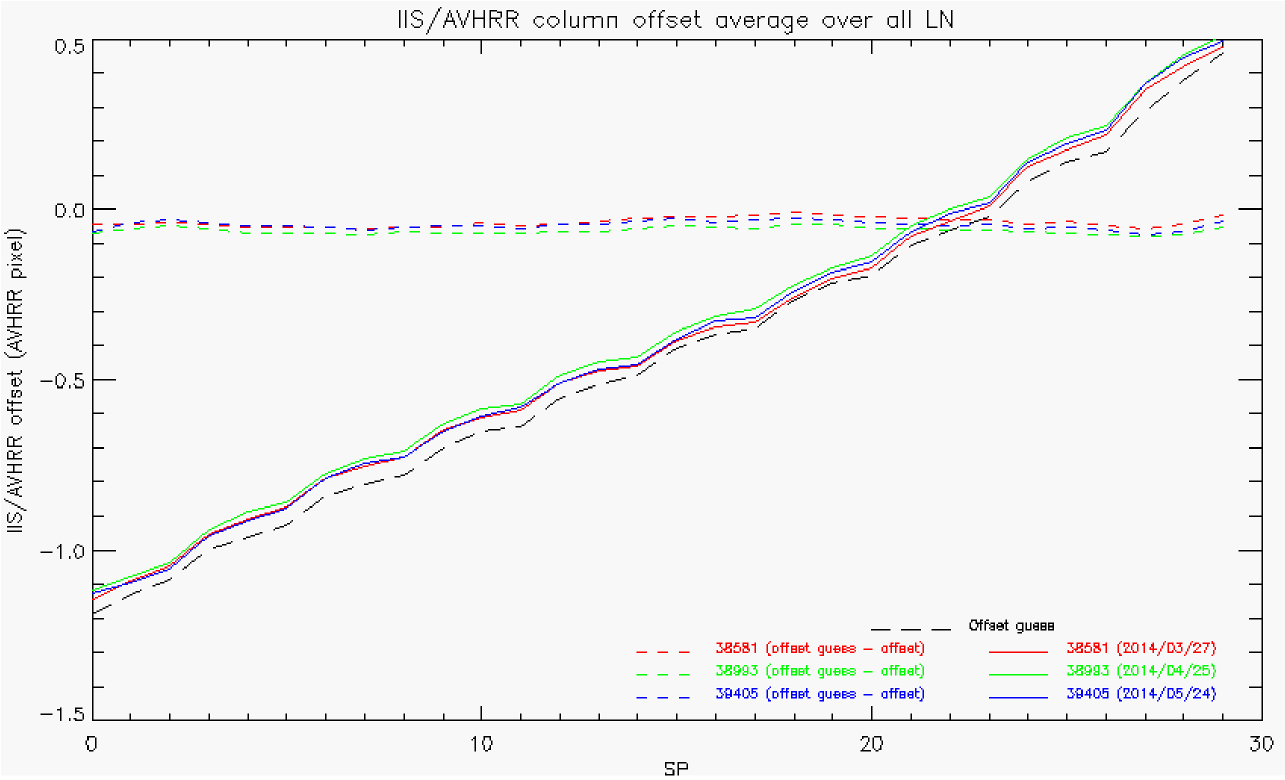


Figure 38 : Column offset (black) guess vs. column offset averaged over all lines (LN) as a function of the scan position (SP=SN), and orbit number

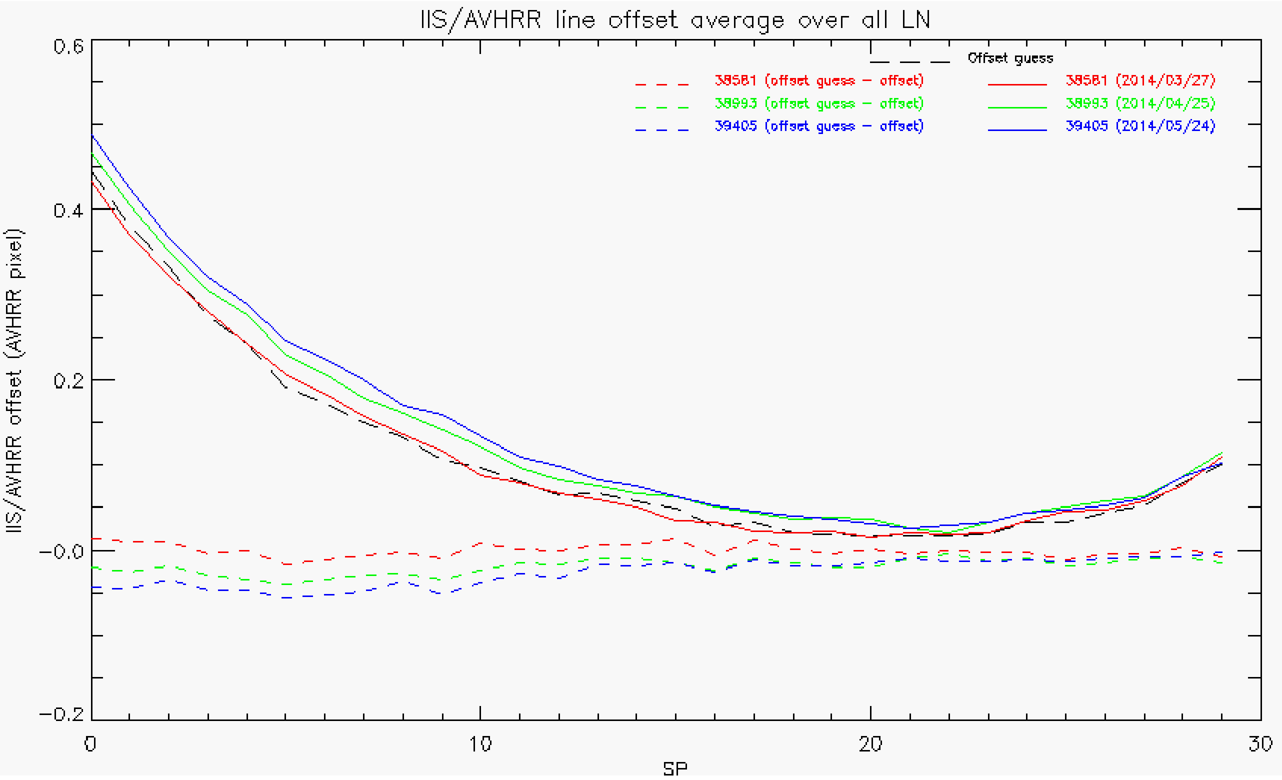


Figure 39 : Line offset guess (black) vs. line offset averaged over all lines (LN) as a function of the scan position (SP=SN), and the orbit number

For both across track and along track, the residuals between measured and IIS/AVHRR offset guess in the ground segment configuration are lower than 0.1 AVHRR pixel for all viewing angles, that is equivalent to 100m on ground.

The values are stable.

4.7.3 Conclusion

The positions of IASI pixel are considered stable and well within specification.

IIS-sounder co-registration is stable at about 100µrad which is equivalent to 100m on ground (specification : < 0.8 mrad).

IIS-AVHRR offset is lower than two pixels and stable over time: less than 0.1 AVHRR pixels over three months (specification: < 0.3 AVHRR pixel).

IASI pixel centre location accuracy in AVHRR raster is around 200m. The geolocation of IASI pixels are thus considered stable and well within specification (5 km).

4.8 IIS RADIOMETRIC PERFORMANCES

The main task of IIS is to insure a good relative positioning of IASI sounder pixels with respect to AVHRR. Its performances are studied each month using routine External Calibration data.

4.8.1 IIS Radiometric Noise Monitoring

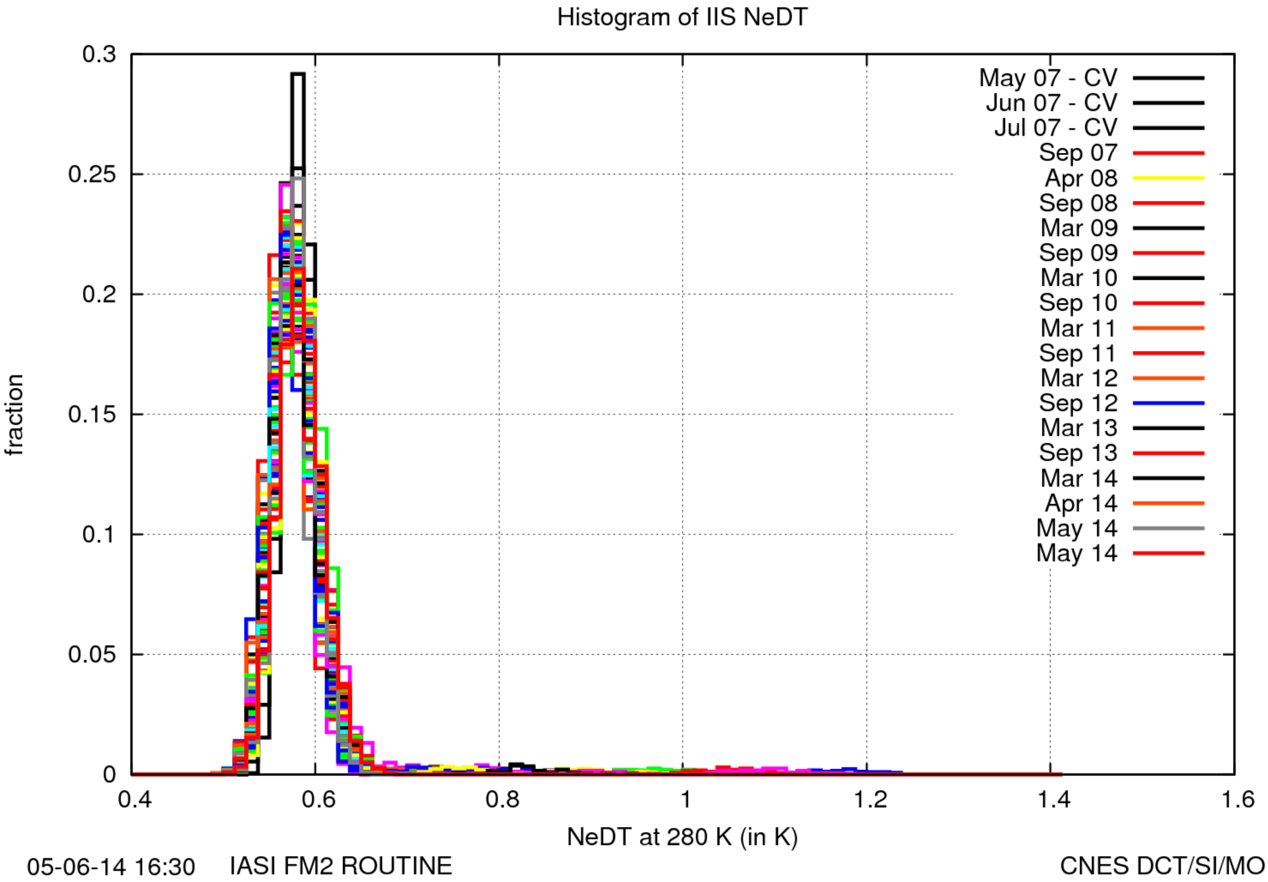


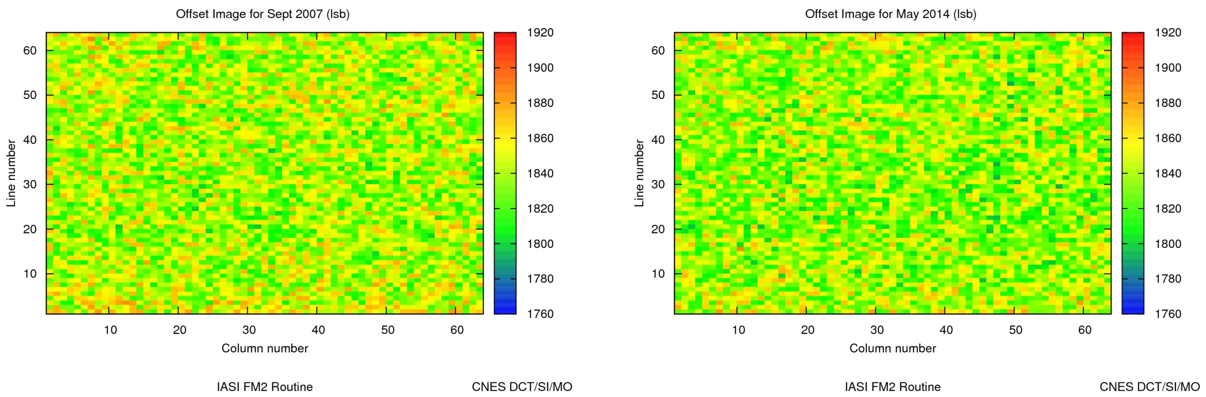
Figure 40 : Temporal evolution of the noise between start and end of the period

Radiometric noise of the IIS is very stable and lower than the specification of 0.8K.

4.8.2 IIS Radiometric Calibration Monitoring

In order to assess the stability of IIS radiometric calibration, we follow the time evolution of slope and offset coefficients. Figure 41 shows a comparison of slope and offset coefficients matrix between start and end of the period.

Offset Start period End period



Slope Start period End period

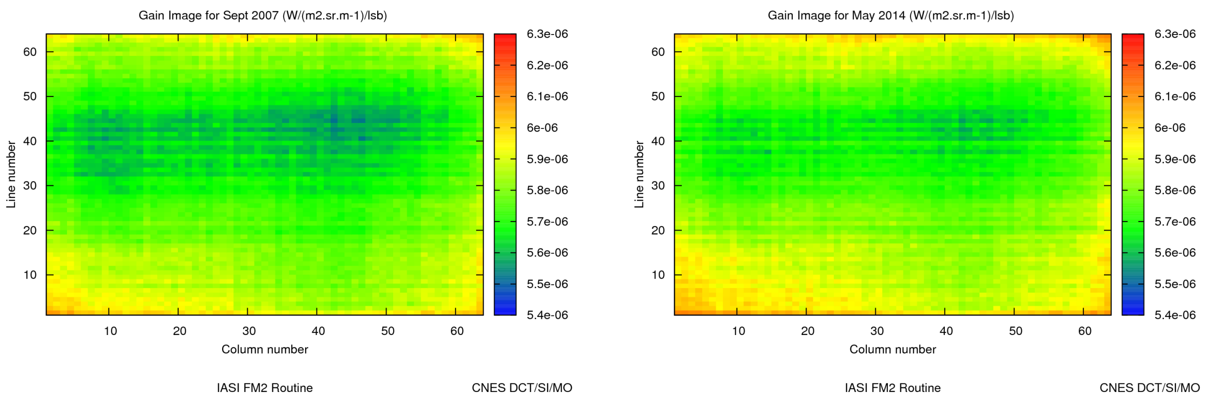


Figure 41 : Slope and offset coefficients matrix

The complete time series of average slope and offset coefficients is given in Figure 42.

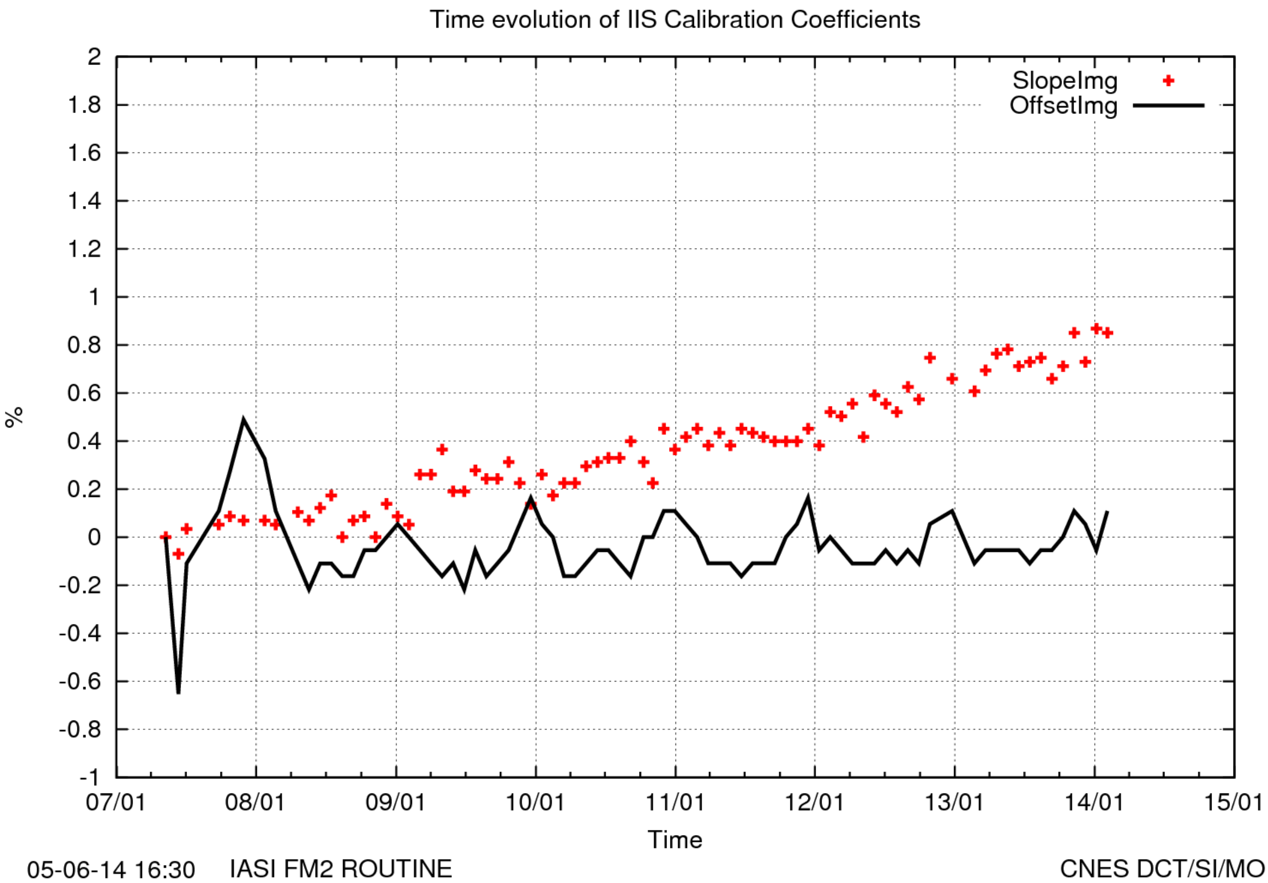


Figure 42 : Relative evolution in % of average of slope (red curve) and offset (black curve) coefficients

The offset coefficient is stable. The slope is slightly evolving (0.8%). This evolution is likely to be linked with the slight evolution of IIS focal plan temperature.

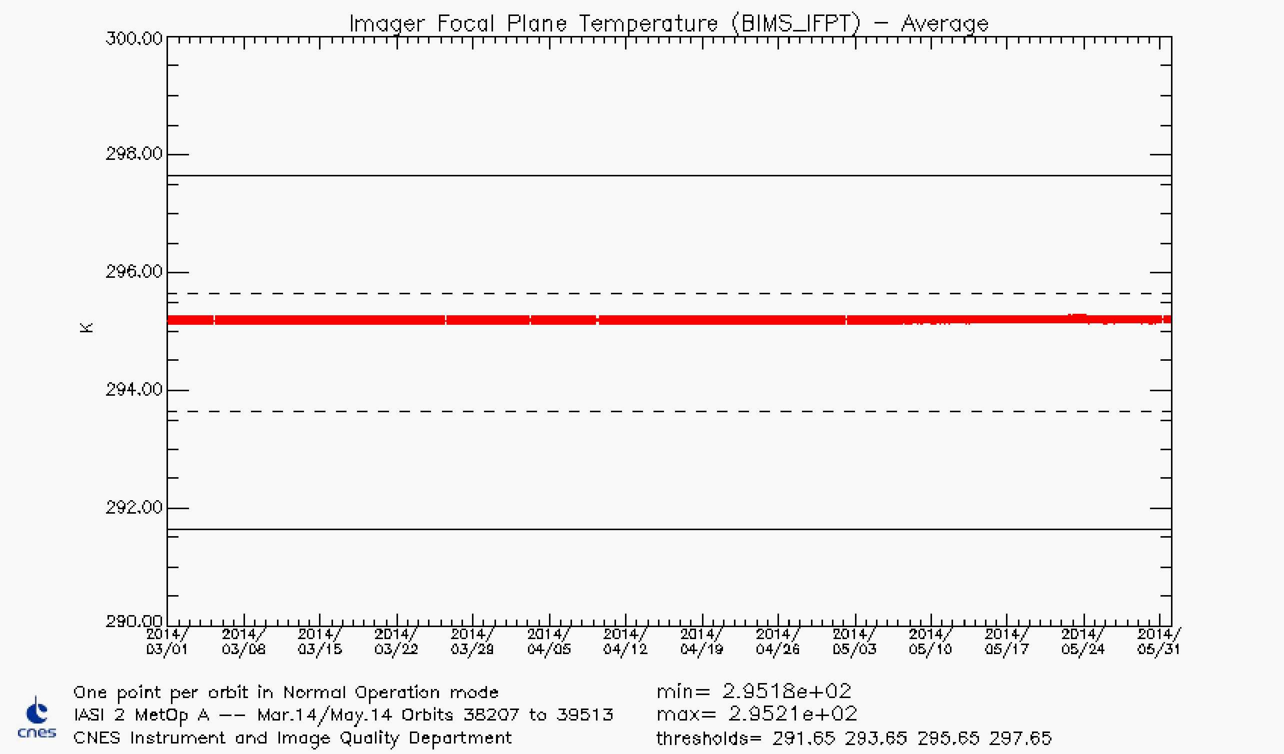


Figure 43 : IIS Focal Plane Temperature

4.8.3 <u>Conclusion</u>

The radiometric performance of IIS is very stable and within specification.

5 IASI TEC SOFTWARE AND INTERFACES

5.1 IASI TEC EVOLUTION

No evolution within the period.

Table 19 lists previous software evolutions.

IASI TEC software version	implementation	Comments
8.1	06 October 2011	Automatic downloads of L0 products from EUMETSAT FTP
8.2	12 April 2012	New version of product browser (handling IASI L0, L1C products and board configuration).
8.3	22 August 2012	Regularization version before IASI-B CAL/VAL CCAT replaced by CBST in TEC's logs
8.4	19 December 2013	New parameter SP_NV in SLT files Integration of board configuration generation tool (UTOPIE) Integration of LBR products management tool

Table 19: IASI TEC at CNES Toulouse

5.2 EUMETCAST INTERFACE

EUMETCast dissemination is used for Near Real Time data reception by IASI TEC at CNES, Toulouse. Each orbit, L1 ENG, L1 VER, and AVHRR 1B products are received under continuous series of 3 minutes PDU. Full dumps are reconstructed by the EUMETCAST terminal and pushed to a IASI TEC server. Since August 2012, NPP/CrIS PDU are also received to perform inter-comparison with IASI.

In case of failure of the prime EUMETCAST station, products remain available several days on a redundant station.

The behaviour of the EUMETCAST reception is nominal.

The following table lists the recent modifications in the EUMETCAST configuration:

Date	EUMETCAST configuration
29/03/2011	End of IASI L0 dissemination via EUMETCAST
03/08/2011	Hardware and software upgrade of the prime station
04/12/2011	Hardware and software upgrade of the back-up station
13/07/2012	Software patch to correct an anomaly concerning AVHHR files (reception of 0 byte files from EUMETCAST)
24/08/2012	Modification of EUMETCAST configuration to receive NPP/CrIS data
03/2013	"PARALLEL_RECONSTRUCTIONS" set to 3 to avoid missing PDU problems
09/2013	"RECONSTRUCTION TIME-OUT" set to 90 to avoid missing PDU problems

Table 7-44 : EUMETCAST configuration at CNES Toulouse

5.3 FTP INTERFACE

Since March 29th of 2011, IASI L0 full dumps are available in Near Real Time on a EUMETSAT FTP server. The IASI TEC software automatically downloads products from the EUMETSAT FTP server.

The reception of L0 products at IASI TEC is nominal.

6 CONCLUSION AND OPERATIONS FORESEEN

Please visit http://smsc.cnes.fr/IASI/ to get IASI news.

6.1 SUMMARY

The IASI FM2 instrument is fully operational.

The instrument configuration is the nominal one.

The main event is the Out of Plane METOP manoeuvre (2 Burns on 26 March and 9 April 2014).

6.2 SHORT-TERM EVENTS

- New ground configuration in June 2014 with update of scan mirror reflectivity
- Moon on 14-15 August 2014 and on 12-13 September 2014

6.3 OPERATIONS FORESEEN

- Next decontamination will happen in September 2014

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