# EUMETSAT

# IASI Level 1 Day-2 Product Validation Test Report

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## *Document Change Record*

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| 1.0 | 12 March 2010 | 338684 | First Release |
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# 1 INTRODUCTION

## 1.1 Purpose and Scope

This report provides the results of the validation testing undertaken on the Day-2 version of the IASI Level 1 operational products. The so-called Day-2 IASI L1 PPF in version 5.0.2 (with format version 11.0) incorporates improvements required by the users of the IASI products and is intended to replace the Day-1 version (format version 10.0, processor version 4.0.3) in the operational near real time dissemination and data centre, without overlap. The development of IASI L1 PPF Day-2 has been initiated by ECP 328.

## 1.2 Applicable Documents

Table 1: Applicable Documents

| Number | Document Title | Document ID |
|--------|----------------|-------------|
| AD 1 | EPS Programme Generic Product Format Specification | EUM.GGS.SPE.96167 |
| AD 2 | AVHRR L1 Product Format Specification | EPS.MIS.SPE.97231 |
| AD 3 | IASI L1 Product Format Specification | EUM.EPS.SYS.SPE.990003 Version 9A |
| AD 4 | Dossier de definition des algorithms IASI | IA-DF-0000-2006-CNE |
| AD 5 | IASI L1 Day-2 product specifictaion | EUM/OPS-EPS/SPE/08/0184 HB #211132 V1 23/06/2008 |
| AD 6 | IASI L1 PPF evolution for Day-2 | CNES  RF_001 HB #300724 V1 25/07/2008 |
| AD 7 | IASI L1 PFS update for Day-2 | CNES EP_001 HB #300723 V1 23/12/2008 |

## 1.3 Reference Documents

Table 2: Reference Documents

| Number | Document Title | Document ID |
|--------|----------------|-------------|
| RD 1 | CRE Recette IASI OPS V5.0 | IA-CRE-2100-3379-CNE<br><br>HB #331310 |
| RD 2 | STB du logiciel operationnel IASI | IA-SB-2100-9462-CNE |
| RD 3 | Software_Release_Note_for_MON_BGO_V5.0 | EUM/OPS-EPS/TEN/09/0363<br>HB #318168 |
| RD-4 | IASI_L1_PPF_V50_Acceptance_Val_Day-2 | EUM/LEO/TEN/09/0701<br>HB #317358 |

## 2 OVERVIEW OF THE IASI DAY-2 LEVEL 1 PRODUCT CHANGES

The flowing changes have introduced in the IASI L1 PPF with the version 5.0.0 the so-called Day-2:

1. A Pixel dependent threshold for the calculation of the spectral shift is added to the IASI L1 processor. This is to improve the spectral calibration.

2. Computation of 4 AVHRR pseudo channels (AVHRR channel 4 and 5) (ENG).

3. IIS variance and average is added to IASI L1C and ENG product.

4. The "BArcImageMeanRMS" originating from the IASI L0 is added to the IASI L1 ENG product.

5. A new index and flag for the SSD algorithm is added to the ENG product.

6. More detailed product quality information are provided to L1ABC and ENG

    a. Add band dependency from GQisFlagQual

    b. Add new quality indicator GQisFlagQualDetailed

7. A NZPD inter pixel differences is added to the IASI L1 ENG product.

8. Cloud, Land and Sea-Ice information based on the AVHRR L1B is provided as a weighted average for each IASI field of view in L1C and ENG products. A quality indicator for the AVHHR L1B based information is also added to the L1 C and ENG products.

9. A user spectral database (IASI_SDB) for L1A in the same binary format as the IASI_SDB for the L1B has been created.

10. User specified default values for the optical axis position are used if a cold start IASI_CTX files is used.

# 3    VALIDATION TEST SET-UP AT EUMETSAT

The operational version 4.0.3 of IASI L1 PPF is running on GS1 since the 29/09/2008 at Orbit 10095 sensing start time 06:35:52 UTC. The operational IASI L1 PPF is currently using the so-called auxiliary files SET 8 (see the IASI L1 product guide for further details).

The new Day-2 version of the IASI l1 PPF (5.0.2) has been tested on GS2 and was firstly installed on the 9th of Nov 2009. Since then no new NCR have been raised on this version. No production losses due the IASI L1 PPF have been reported. Auxiliary files BRD and GRD with new format of version 1.7 are required to be used with the Day-2 PPF.

The following auxiliary data files are used on GS2 with IASI L1 PPF V5.0.2:

http://tctrac/iasi_l1_ppf/browser/aux/BRD/IASI_BRD_xx_M02_20091012082439Z_xxxxxx xxxxxxxxZ_20091012083220Z_IAST_0000000012

http://tctrac/iasi_l1_ppf/browser/aux/GRD/IASI_GRD_xx_M02_20091012082439Z_xxxxxx xxxxxxxxZ_20091012083230Z_IAST_0000000019

http://tctrac/iasi_l1_ppf/browser/aux/ODB/IASI_ODB_xx_M02_20070705200000Z_xxxxxx xxxxxxxxZ_20070705153529Z_IAST_0000000007

Two weeks of IASI L1C and IASI L1 ENG full orbit products retrieved from the UMARF from the period 2009-12-30 00:29:59 until 2010-01-13 20:53:56 from GS1 (V4.0.3) and GS2 (V5.0.2) have been compared systematically.

The comparison tool "mon" has been used in version 5.0.0 (rev 407). Further details on "mon" tool are provided under http://tctrac/iasi_l1_ver/ (see also RD-3).

# 4    VALIDATION RESULTS

The validation of the IASI L1 PPF has been performed during the acceptance test of the version 5.0 at the IASI TEC in Toulouse in 2009 (see RD-1 and RD-4). In addition an operational validation has been performed running the new Day-2 IASI L1 PPF V5.0.2 operationally on GS2 since November 2009.

## 4.1    Operational Validation

During the period since November 2009 no production losses were related to the new IASI L1 PPF V5.0.2. The processor has not violated the timeliness requirements. However the margin regarding timeliness on the old EPS ground segment hardware is not large.

## 4.2    Product format verification

The verification of the product format of the IASI L1 product A, B, C, ENG and VER has been performed during acceptance test and by using mon V5.0 (see RD-3). The product format is compliant with the IASI L1 PFS in Version 9A (Day-2).

## 4.3    Non-regression

Non-regression testing has been performed during the acceptance testing of the version 5.0.0.

Further test has been performed at EUMETSAT by comparing the IASI L1C and ENG product from IASI L1 PPF V4.0.3 and V5.0.2. The products forms 2 weeks of product processing were systematically performed using "mon" V5.0.

The variables of the IASI L1C product were differences between V4.0.3 and V5.0.2 are observed are summarized in the following table. Please note that radiance differences (GS1cSpect) are discussed separately in section 4.4

Table 3: Differences observed between V4.0.3 and V5.0.2 on every orbit in the comparison period from the 30th of December 2009 until 13th of January 2010.

| Variable name | V4.0.3 | V5.0.2 | Comment |
|---|---|---|---|
| PRODUCT_SIZE | 2086974338 | 2087846438 | In-line with IASI PFS |
| FORMAT    MAJOR VERSION | 10 | 11 | In-line with IASI PFS |
| GEPSIdConf | 37 (ID) | 39 (ID) | In line with different auxiliary files version numbers of IASI_BRD |
| GIsfColOrigin | Variable | Variable | In-line with change No. 1 on spectral calibration |
| $GIsfPds_{i\ i=1,4}$ | Variable | Variable | In-line with change No. 1 on spectral calibration |

| rec_size | 2727768 | 2728908 | In-line with IASI PFS |
|---|---|---|---|
| rec_subclass_version | 4 | 5 | In-line with IASI PFS |

All differences observed in the L1C products and given in Table 3 are in-line with implemented changes of the Day-2 version V5.0.2 and are not due a regression of the IASI L1 PPF. No other differences were observed (except on GS1cSpect which is discussed in the next section).

The following differences on geo-location are due to regression in V5.0.2 (FT-2751) Table 4 shows the values of all 12 differences observed in the comparison period. The differences are only observed in the MPHR but not with the geo-location of the individual IASI IFOV. The differences in geo-location are in the order of 50 km.

Table 4: Geo-location differences in MPHR due to regression in V5.0.2

| LATITIDE/LONGITUDE | V4.0.3 | V5.0.2 | Differences in deg |
|---|---|---|---|
| SUBSAT_LATITUDE_END | 64.435 | 63.992 | 0.443 |
| SUBSAT_LONGITUDE_END | 0.797 | 0.387 | 0.410 |
| SUBSAT_LATITUDE_END | 69.712 | 70.137 | -0.425 |
| SUBSAT_LONGITUDE_END | -38.482 | -37.845 | -0.637 |
| SUBSAT_LATITUDE_END | 56.680 | 57.135 | -0.455 |
| SUBSAT_LONGITUDE_END | 41.360 | 41.633 | -0.273 |
| SUBSAT_LATITUDE_END | 64.857 | 64.415 | 0.442 |
| SUBSAT_LONGITUDE_END | 22.163 | 21.742 | 0.421 |
| SUBSAT_LATITUDE_END | 65.269 | 64.828 | 0.441 |
| SUBSAT_LONGITUDE_END | 43.536 | 43.103 | 0.433 |
| SUBSAT_LATITUDE_END | 67.457 | 67.891 | -0.434 |
| SUBSAT_LONGITUDE_END | 86.980 | 87.506 | -0.526 |

## 4.4    Radiance comparison

Differences of the IASI spectra GS1cSpect are to be expected due improvements of the spectral calibration. The changes applied to the calculation the spectral shift in the Day-2 IASI L1 PPF are causing systematic radiance differences between Version 4.0.3 and V5.0.2. The small radiances differences are demonstrating the improvements of the so-called Day-2 version of the IASI L1 PPF.

During the radiances comparison at EUMETSAT only the changes larger than 2 LSB are considered. The results of the comparison are show in Figure 1. The data have been also provided to CNES for further analysis.
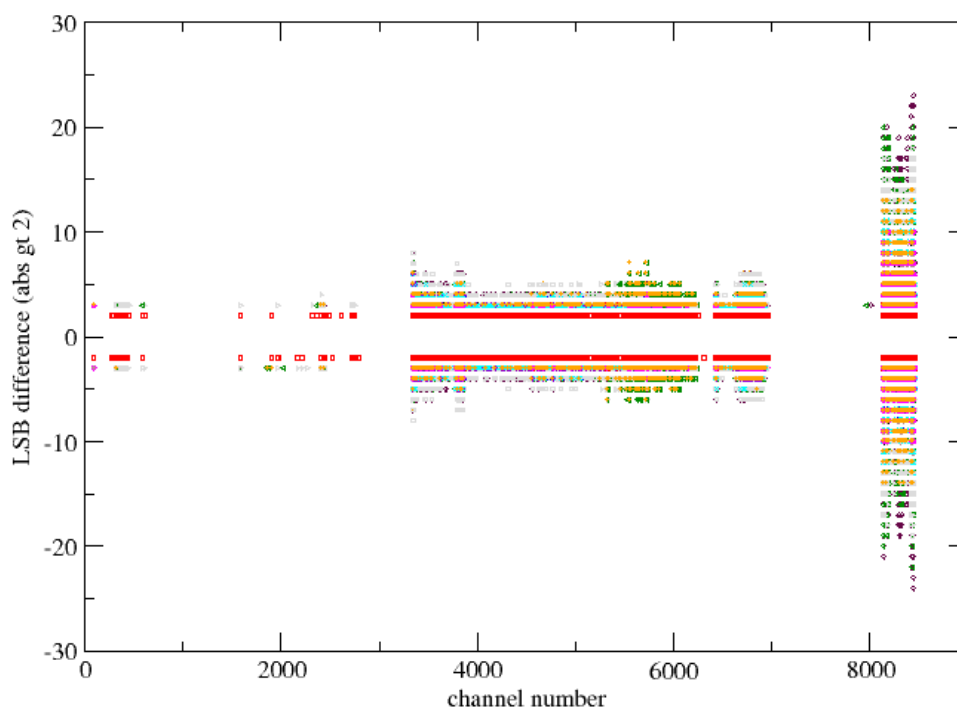


Figure 1: Radiance differences larger 2 LSB per channels.

The larger differences in band 3 (above channels number 8000) are due to very precise coding tables in this spectral range. In addition the observed differences are only a fraction of the IASI instrument noise (see Figure 2).
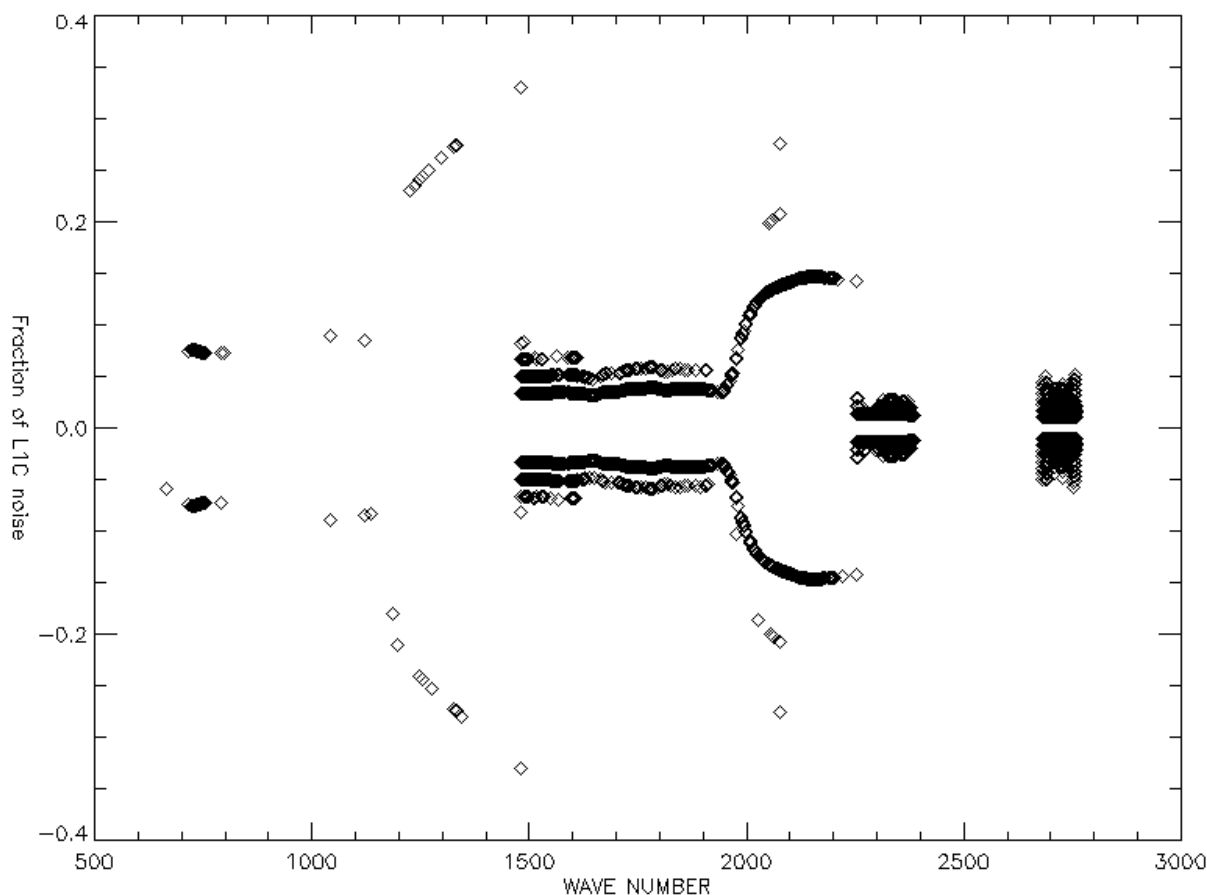
Figure 2: Observed differences in fraction of instrument noise (from CNES).

The following table summarizes the magnitude of the differences. In total $1.4564*10^{11}$ measurements (values per channel and spectrum) have been compared from the given period. It can be seen that the number of observed differences is very small.

Table 5: Number of comparisons and differences

|  | Counts | Percent |
|---|---|---|
| All measurements | **$1.4564*10^{11}$** | **100 %** |
| All differences larger 2 LSB | **22107547** | **0.0151 %** |
| -3 to 3 LSB | **17725009** | **0.0121 %** |
| -5 to 5 LSB | **21673989** | **0.0148 %** |
| -10 to 10 LSB | **22090841** | **0.0151 %** |

| Larger 10 LSB | **16706** | **$1.1*10^{-5}$ %** |
|---------------|-----------|---------------------|

The probability on the occurrences of differences has been also been investigated by CNES and the observation provided in table 5 were confirmed.

The order of magnitude of the observed radiances differences are in-line with the change of spectral calibration of about $2.34*10^{-7}$ for a references spectrum (see Figure 3).
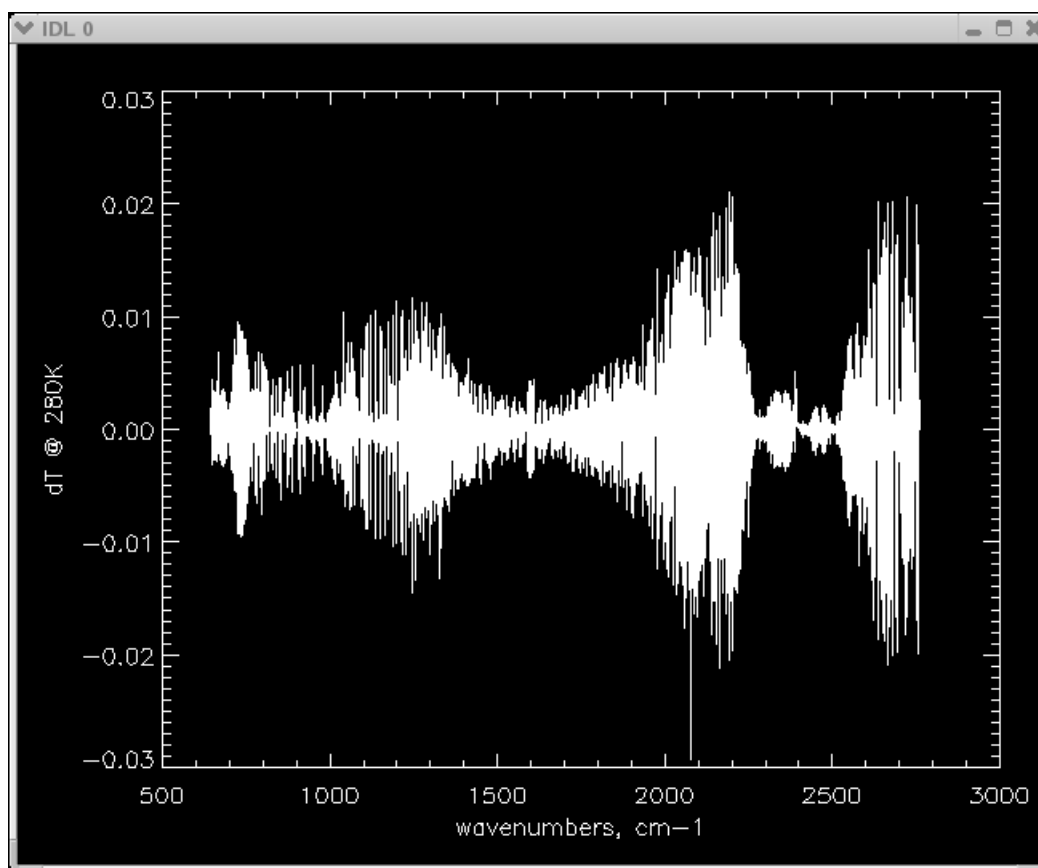


Figure 3: Expected radiometric differences in delta T at 280K between Day-1 and Day-2 (from CNES).
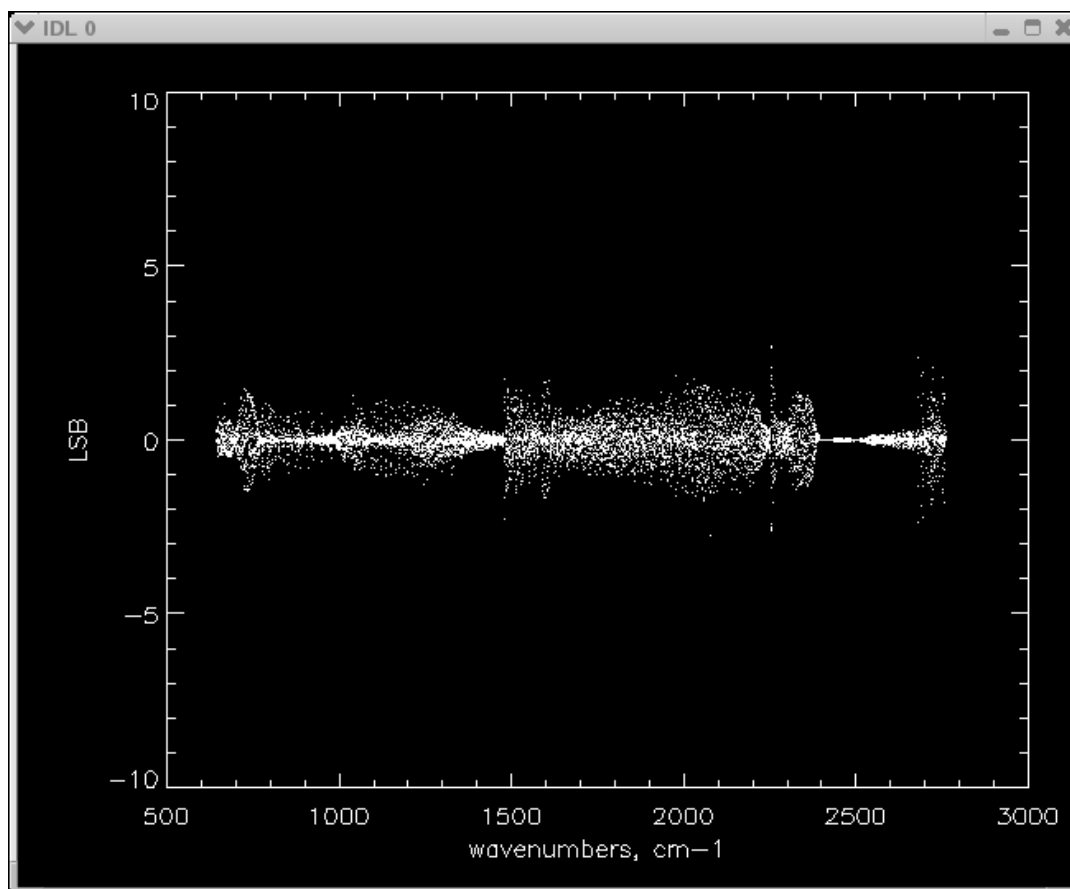
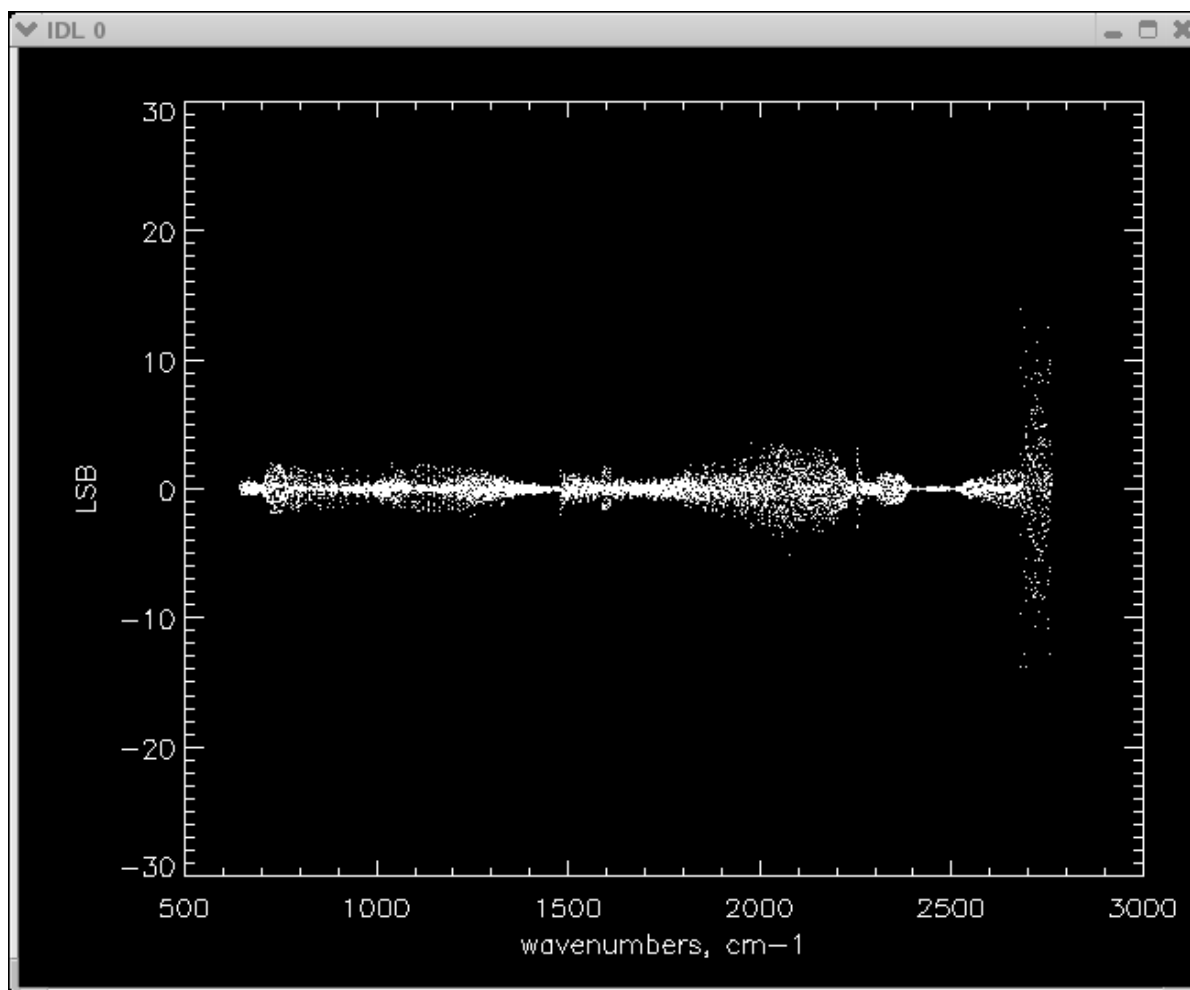Figure 4: Expected radiometric differences in LSB (from CNES).

Figure 5: Expected radiometric differences in LSB for a hot scene with $T_s$=319K (from CNES).

The larger differences in LSB observed during the validation at EUMSTAT are in-line with the observation from CNES as a cold references spectrum has been used. Larger errors for other scenes are to be expected as show in the figure above for a different surface condition. For hot surface condition differences up to 14 LSB in band 3 are observed.

## 4.5    Quality flag assessment

The new band dependent quality flag has been validated during the acceptance testing of V5.0.0 at the IASI TEC at CNES and during the systematic comparison of Day-1 and Day-2 products at EUMETSAT. Both validations confirm the compliance of the new quality flag with the specifications.

A small inconsistency has been found by CNES and a "Fait Technique" (FT-2479) has been raised. This non conformance only occurs when the L0 input contain incomplete IASI scan lines and instrument source packets are missing. This may happen during the monthly calibration (EXT CAL) and the moon avoidance (twice per year).

## 4.6 Cloud and surface fraction assessment

The cloud and land cover is validated against an independent implementation in the IASI L1 Day-2 monitoring suite (JMonX). The bias between cloud and land cover of the two implementations is practically zero. However, small differences with a maximum of 5% are observed in the comparison. As the implementation in the monitoring suite is required to use a different "metop_lib" for LINUX but not AIX small difference are to be expected.

## 4.7 Integrated Imager Subsystem (IIS) validation

The new IIS average and standard deviation have been validated by CNES. Non conformances have not been found.

## 4.8 IASI L1 ENG product validation

The content of IASI L1 ENG product which does not overlap with the L1C product content has been validated by CNES. All other product content has been validated during the acceptance testing of the PPF version 5.0.0. It was also validated during the comparison performed by EUMTESAT. Non conformances on the IASI L1 ENG product format and content have not been observed.

## 4.9 BUFR encoding

The testing of BUFR encoding has been performed with 10 IASI L1C PDUs. Non conformances have not been reported.

## 4.10 NCR status

Table 4: The status of the NCRs.

| NCR | Title | Status | Comments |
|---|---|---|---|
| NCR-3962 | IASI L1C products have PX dependency | OPEN | Currently not related to software but auxiliary data |
| NCR-3924 | BFTBFilteredBBT incorrect in IASI_ENG product | OPEN | To be fixed in V5.0.3. This is handled at CNES also under FT-2750 |
| NCR-3805 | DDA (dossier de definition) is not in line with implementation | OPEN | Related to documentation only |
| NCR-3742 | Default value in IASI L1 products for geo-location is not compliant with GPFS. | CLOSED in version V5.0.2 | Improvement |

## 4.11 FT status at CNES

Table 3: The status of FTs on Version V5.0.2 of the IASI L1 PPF

| AR/FT | Title | Status | Comments |
|---|---|---|---|
| FT-2751 | La gestion des variables SUBSAT_LATITUDE_START, SUBSAT_LONGITUDE_START, SUBSAT_LATITUDE_END et SUBSAT_LONGITUDE_END n'est pas "thread-safe". | OPEN | To be fixed in V5.0.3 |
| FT-2750 and NCR-3924 | Des problèmes ont été reportés par EUMETSAT (NCR 3924) dans la détermination de la température de corps noir filtrée GFtbFilteredBBT lors des transitions de mode. Les lignes incomplètes lors des transitions de mode sont mal gérées. Une valeur incohérente de -0.001K qui est utilisée pour le filtrage de la température du corps noir est à l'origine du problème. | OPEN | To be fixed in V5.0.3. |
| FT-2749 | Dans l'implémentation courante de 45_QIS, GQisFlagQual est levé par GOPSFtbBBTMiss alors que GQisFlagQualDetailled est levé par GFtbBBTNonQual. Nous demandons à ce que seul GFtbBBTNonQual soit utilisé pour la levé de GQisFlagQual et GQisFlagQualDetailled. | OPEN | To be fixed in V5.0.3. |

## 4.12 Operational monitoring

The operational monitoring has been updated for the new Day2- IASI L1 PPF format and content. In addition the radiances monitoring was improved by updating to RTTOV 9.3. This would in principle enable comparison also during day light conditions with a better global coverage.
The IASI Day-2 monitoring suite (JMonX) running on GS2. It is under version control (SVN revision: 72 JMonX version: 1.7.34).

A systematic analysis of the radiances from the V5.0.2 and the comparison with calculations based on RTTOV were not possible due to limited disk space on the development (GS2) machine.

The new radiance monitoring for Day-2 can only be enabled partly due to the incompleteness of ECP-410 from the 24th of April 2009 (upgrade of monitoring database IASIDB).

Missing partitioning in the currently used operational data base (IASIDB/GS1) is one of the risks which have been identified with the IASI L0/L1 NRT monitoring. These risks have been added to the EUMETSAT OPS risk register at the 21st of January 2010, 8th of February 2010, and 4th of March 2010.

## 5        ANOMALY STATUS

During the testing of IASI L1 PPF V5.0.2 no anomalies related to the PPF were raised by EUMETSAT.

CNES has raised one anomaly on and inconsistency between the new GQisFlagQual for the 3 bands and the GQisFlagQualDetailed (FT-2749). This new anomaly is likely to be related to the improper handling of incomplete IASI scan lines with respect to the L0 data (see NCR-3924).

In addition FT-2751 on the not thread safe geo-location has been raised at CNES. This problem may be related to old AR- 8968 which has been solved in V4.0.3. This observation is confirmed by the long duration comparison at EUMETSAT. However, the problem has occurred 6 orbits or 12 on Latitude and Longitude values of the geo-location in the MPHR of the L1C product. No differences have been observed on the geo-location of the sounder pixel itself.

The differences are less than 0.5 degrees latitude and longitude and only affect the MPHR.

## 6        CONCLUSION AND RECOMMENDATION

During the acceptance test and the long term validation of the new Day-2 IASI L1 PPF V5.0.2 is has been shown that:

- The new L1 products (A, B, C and ENG) are in-line with the format specification V9A (AD-3). The IASI L1 VER product remains unchanged.

- The observed product changes are conforming to the Day-2 specifications (AD-6).

- During the long term validation at EUMETSAT (since November 2009) no product losses or other anomalies were attributed to the IASI L1 PPF V5.0.2.

- CNES has shown that the radiances differences are in-line with the improvements of the spectral calibration.

- The anomaly on geo-location in the MPHR has been observed by CNES (FT-2751). This anomaly does not affect the usability of the IASI L1C product.

- The anomaly (FT-2949) is related to NCR-3924 and only occurs during instrument mode changes when incomplete scan lines of L0 data are provided to the PPF. This shall be fixed in with the next patch in V5.0.3

It is recommended to install the IASI L1 PPF V5.0.2 on GS1 and using it operationally. The two observed anomalies are not considered to have any significant impact on the users of the IASI L1C products.