## Document Change Record

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<th>Date</th>
<th>DCN. No</th>
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<td>V1</td>
<td>06/06/2017</td>
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<td>Initial version</td>
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<tr>
<td>V1A</td>
<td>14/06/2017</td>
<td></td>
<td>Prepared for publication</td>
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1 INTRODUCTION

1.1 Purpose

The document presents assessment results for the IASI Level 2 (L2) products generated with the version 6.3, the latest revision of the IASI L2 Product Processing Facility (PPF, also referred to as processor or processing chain). The v6.3 is the third incremental upgrade to the IASI L2 processor since the operational release of the version 6 in September 2014.

This report is intended to all Users of the IASI L2 products. It provides detailed information about the IASI L2 sounding products performances in terms of yield/coverage and precision. It illustrates the continuity and improvements as compared to the former revision v6.2.

This validation report is also intended to the Product Validation Review Board, to complete the qualification process for this new revision and support its operational release.

1.2 Background and Scope

Extensive validation studies were carried out for the release of the IASI L2 processor version 6. The uncertainties assessments were performed by comparisons to in situ (e.g. atmospheric radio-sondes, maritime buoys...) and ground-based measurements (e.g. precipitable water-vapour with radio-occultation instruments, Lidars, Microwave atmospheric sounders, land surface radiometers...), as well as comparisons to numerical models or to other satellite data. The results can be found in the IASI L2 v6 validation reports [RD-1, RD-4] and in external validation papers [RD-2, RD-3].

The present assessment focuses on establishing evidences of:
- the continuity with the version 6.2, for the geophysical parameters whose associated retrieval algorithms have not changed in v6.3;
- the improvements where algorithms changes occurred, i.e. with the Sea Surface Temperature (SST);
- readiness of the new parameters, namely a dust indicator (unitless) and the EUMETSAT AC SAF IASI SO2 product.

1.3 Processor versions and data description

The analyses presented in this report relate to the versions 6.3.0 to 6.3.1 of the PPF, obtained from off-line processing on the Technical and Computing Environment (TCE) of EUMETSAT and from routine production on GS2 since the 08/03/2017. The patch 6.3.1 was released to fix an anomaly with the encoding of the dust index, when the latter is exactly set to zero.

Both Metop-A and Metop–B products are evaluated. They are presented separately in this document to demonstrate their consistency.
1.4 Summary of the changes to the processing chain

The version 6.3 adds two new products: the retrieval of SO$_2$ partial columns [RD-5, RD-6] and a unitless dust indicator, giving pseudo-quantitative information of the dust load [RD-7]. This new version will also bring improvements to the L2Pcore SST product: the yield of the SST retrievals has been increased, especially outside of the intertropical band, using a new quality control mechanism. Also, two new experimental fields have been added to the product: the above dust index and a cloud signal in the form of a predicted “obs-calc” in window channels. The additions brought to the IASI L2 product are summarized in the following table:

<table>
<thead>
<tr>
<th>Processing function</th>
<th>Evolution in v6.3</th>
<th>Products added/enhanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brescia SO$_2$</td>
<td>The SO$_2$ partial columns retrieval computed by the Brescia-SO2 library, forms the EUMETSAT AC SAF IASI SO2 product.</td>
<td>SO2 partial columns added</td>
</tr>
<tr>
<td>Clouds parameters</td>
<td>A unitless dust index added in the IASI L2 product (flg_dustcld) to qualitatively inform on the dust load.</td>
<td>Dust index added</td>
</tr>
<tr>
<td>L2Pcore SST</td>
<td>A new filtering scheme has been added for the selection and the classification of the SST retrievals in the IASI L2P SST product. This lead to a noticeable increase of the retrieval yield, especially outside of the intertropical band, where low yields were observed in the previous versions, while preserving consistent precisions.</td>
<td>L2P SST retrieval yield increased</td>
</tr>
<tr>
<td>L2Pcore SST</td>
<td>Two new experimental fields have been added to the L2P SST: the above dust index and the predicted “obs-calc”$^1$. These fields can be used by the users to perform their QC and data selection</td>
<td>dust_index and obs_minus_calc fields have been added the hdf5 L2P SST products</td>
</tr>
</tbody>
</table>

The version 6.3 also fixes an anomaly in the encoding of the detailed processing information flag “BDIV” in the CO product (anomaly number EUM/EPS/AR/17052).

1.5 Applicable Documents

<table>
<thead>
<tr>
<th>Id</th>
<th>Title</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD-1</td>
<td>EPS Programme End User Requirements Document</td>
<td>EUM/EPS/MIS/REQ/93/001</td>
</tr>
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</table>

1.6 Reference Documents

<table>
<thead>
<tr>
<th>Id</th>
<th>Title</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>RD-1</td>
<td>IASI L2 PPF v6: Validation Report</td>
<td>EUM/TSS/REP/14/776443</td>
</tr>
<tr>
<td>RD-3</td>
<td>“Identification and intercomparison of surface-based inversions over Antarctica”</td>
<td>Boylan et al., JGR 2016, submitted</td>
</tr>
</tbody>
</table>

$^1$ The “obs-calc” refers to the sum of the differences between the observed radiances (obs) and the synthetic radiances (calc) calculated with a radiative transfer model assuming clear-sky and an atmospheric state vector coming from the L2.. This computation is made on a selection of channels in the window region.
| RD-4 | OSI-SAF Metop-A IASI Sea Surface Temperature L2P (OSI-208) Validation report, April 2015 | SAF/OSI/CDOP2/M-F/TEC/RP/210, v1.4 |
| RD-6 | “Tracking and quantifying volcanic SO2 with IASI, the September 2007 eruption at Jebel at Tair” | Clarisse et al., ACP 2008, doi:10.5194/acp-8-7723-2008 |
| RD-7 | “A unified approach to infrared aerosol remote sensing and type specification” | Clarisse et al., 2013, doi:10.5194/acp-13-2195-2013, 2013 |
| RD-8 | “Assessing The Impact of Aerosol on the Accuracy of IASI SST” | Trent et al., 4th IASI Conference, 2016 |
| RD-9 | Group for High-Resolution Sea Surface Temperature (GHRSSST) | https://www.ghrsst.org/ |
| RD-11 | Polar Multi-Sensor Aerosol Product: ATBD | EUM/TSS/SPE/14/739904 |
| RD-12 | Polar Multi-Sensor Aerosol Product: Validation Report | EUM/TSS/REP/14/745438 |
| RD-13 | EUMETSAT AC SAF IASI SO2 product User manual | SAF/AC/ULB/PUM/002 |
| RD-15 | Monitoring & Evaluation of Thematic Information from Space (METIS) | http://metis.eumetsat.int |
### 1.7 Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Meaning</th>
</tr>
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<tbody>
<tr>
<td>ANN</td>
<td>Artificial Neural Network</td>
</tr>
<tr>
<td>ARM</td>
<td>Atmospheric Radiation Measurement (US program)</td>
</tr>
<tr>
<td>AOD</td>
<td>Aerosol Optical Depth</td>
</tr>
<tr>
<td>AVHRR</td>
<td>Advanced Very High Resolution Radiometer, the imager on-board Metop</td>
</tr>
<tr>
<td>CALC</td>
<td>Usually refers to synthetic radiances calculated with a radiative and an atmospheric state vector which may come from the NWP or the L2.</td>
</tr>
<tr>
<td>Cal/Val</td>
<td>Calibration / Validation</td>
</tr>
<tr>
<td>DU</td>
<td>Dobson Units</td>
</tr>
<tr>
<td>ECMWF</td>
<td>European Centre for Medium-Range Weather Forecasts</td>
</tr>
<tr>
<td>EPS</td>
<td>EUMETSAT Polar System</td>
</tr>
<tr>
<td>EUMETSAT</td>
<td>European Organisation for the Exploitation of Meteorological Satellites</td>
</tr>
<tr>
<td>EURD</td>
<td>End User Requirements Document</td>
</tr>
<tr>
<td>EOF</td>
<td>Empirical Orthogonal Function</td>
</tr>
<tr>
<td>FG</td>
<td>First Guess</td>
</tr>
<tr>
<td>GCOS</td>
<td>Global Climate Observing System</td>
</tr>
<tr>
<td>GHRsst</td>
<td>Group for High Resolution Sea Surface Temperature</td>
</tr>
<tr>
<td>GRUAN</td>
<td>GCOS Reference Upper-Air Network</td>
</tr>
<tr>
<td>IASI</td>
<td>Infrared Atmospheric Sounding Interferometer</td>
</tr>
<tr>
<td>IASI-A</td>
<td>IASI onboard Metop-A</td>
</tr>
<tr>
<td>IASI-B</td>
<td>IASI onboard Metop-B</td>
</tr>
<tr>
<td>IFOV</td>
<td>Instantaneous Field Of View</td>
</tr>
<tr>
<td>LATMOS</td>
<td>Laboratoire Atmosphères, Milieux, Observations Spatiales (Paris, France)</td>
</tr>
<tr>
<td>LSA</td>
<td>Land Surface Analysis</td>
</tr>
<tr>
<td>LST</td>
<td>Land Surface Temperature</td>
</tr>
<tr>
<td>L2</td>
<td>Level 2</td>
</tr>
<tr>
<td>MACC</td>
<td>Monitoring Atmospheric Composition and Climate</td>
</tr>
<tr>
<td>MODIS</td>
<td>Moderate Resolution Imaging Spectroradiometer</td>
</tr>
<tr>
<td>MWR</td>
<td>Microwave radiometer</td>
</tr>
<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration (US)</td>
</tr>
<tr>
<td>NPROVS</td>
<td>NOAA Products Validation System</td>
</tr>
<tr>
<td>NRT</td>
<td>Near-Real Time</td>
</tr>
<tr>
<td>NWP</td>
<td>Numerical Weather Prediction</td>
</tr>
<tr>
<td>OBS</td>
<td>Observations (usually refers to L1c radiances)</td>
</tr>
<tr>
<td>OEM</td>
<td>Optimal Estimation Method</td>
</tr>
<tr>
<td>O3M-SAF</td>
<td>Ozone and atmospheric chemistry Monitoring Satellite Application Facility</td>
</tr>
<tr>
<td>OSI-SAF</td>
<td>Ocean and Sea Ice Satellite Application Facility</td>
</tr>
<tr>
<td>OSTIA</td>
<td>Operational Sea Surface Temperature and Sea Ice Analysis</td>
</tr>
<tr>
<td>PC</td>
<td>Principal Components</td>
</tr>
<tr>
<td>PPF</td>
<td>Product Processing Facility</td>
</tr>
<tr>
<td>PWV</td>
<td>Precipitable Water Vapour</td>
</tr>
<tr>
<td>PWLR</td>
<td>Piecewise Linear Regression</td>
</tr>
<tr>
<td>PWLR³</td>
<td>Piecewise Linear Regression-cube</td>
</tr>
<tr>
<td>RMS</td>
<td>Root Mean Square</td>
</tr>
<tr>
<td>SAF</td>
<td>Satellite Application Facility</td>
</tr>
<tr>
<td>SEVIRI</td>
<td>Spinning Enhanced Visible and Infrared Imager</td>
</tr>
<tr>
<td>SIVVR</td>
<td>System Integration, Verification and Validation Readiness Review</td>
</tr>
<tr>
<td>SST</td>
<td>Sea Surface Temperature</td>
</tr>
<tr>
<td>ULB</td>
<td>University Libre de Bruxelles (Belgium)</td>
</tr>
<tr>
<td>UTC</td>
<td>Coordinated Universal Time</td>
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### 1.8 Document Structure

Section 1   General information (this section)

Section 2   Summary of the assessment results for the EUMETSAT AC SAF IASI SO2

Section 3   Summary of the assessment results for the Dust index

Section 4   Summary of the non-regression tests for temperature and humidity sounding

Section 5   Summary of the non-regression tests for sea surface temperature product and evaluation of the extended L2Pcore SST products.

Section 6   Summary of the non-regression tests for land surface temperature product

Section 7   Summary and recommendations
2 ASSESSMENT OF THE SO\textsubscript{2} PRODUCT

The validation of the SO\textsubscript{2} product (including partial columns and processing quality information) is performed by the atmospheric composition monitoring Satellite Application Facility (AC SAF) of EUMETSAT.

Thorough verification activities have been performed to ensure the exact correspondence between the off-line BRESCIA-SO\textsubscript{2} v20150205_sp1 productions in the research line at the University Libre de Bruxelles (ULB) and with its integration into the operational IASI L2 processor at EUMETSAT. The BRESCIA-SO\textsubscript{2} integrated and the IASI L2 PPF matches the stand-alone reference version within the numerical precision of the machines.

The Figure 1 illustrates the systematic comparisons performed with several days worth of data between the SO\textsubscript{2} produced at ULB and the SO\textsubscript{2} produced at EUMETSAT from within the IASI L2 PPF. The SO\textsubscript{2} quantities are provided as if the SO\textsubscript{2} cloud was at each of 5 static default altitudes. The Level 10 and Level 3 in the below correspond to two of those.

![Figure 1: SO\textsubscript{2} content at the altitude 0 (left) and 3 (right) for EUMETSAT IASI L2 SO\textsubscript{2} vs ULB SO\textsubscript{2} for data accumulated during the 2011 Puyuhue eruption (06/06/2011)](image)

The exhaustive verifications performed off-line were completed by the analyses of products generated from the GS2 vs their stand-alone counterpart at ULB, in the research production line. The case studied is the Bogoslof eruption from 8 March 2017, illustrated in Figure 2. The verification results of the retrieved SO\textsubscript{2} integrated quantities, expressed in Dobson Units (DU), are presented in Figure 3 and Figure 4. The overall quality flag QFLAG indicates to the User whether a retrieval was performed (>0) and where the input temperature (T) and humidity (q) profiles come from (9: IASI L2 products, 11: from ECMWF forecasts in case IASI L2 T/q are not available) RD-13.
Figure 2: SO2 retrieved quantities with altitude assumption of 10km, after the eruption of Bogoslof volcano (Alaska) on 8 March 2017.

QFLAG=9

<table>
<thead>
<tr>
<th>Altitude</th>
<th>SO2 retrieval</th>
<th>ULB</th>
<th>EUMETSAT</th>
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<tr>
<td>7km</td>
<td>SO2_TT(:,2)</td>
<td>4000</td>
<td></td>
</tr>
<tr>
<td>10km</td>
<td>SO2_TT(:,3)</td>
<td>5000</td>
<td></td>
</tr>
<tr>
<td>13km</td>
<td>SO2_TT(:,4)</td>
<td>6000</td>
<td></td>
</tr>
<tr>
<td>16km</td>
<td>SO2_TT(:,5)</td>
<td>7000</td>
<td></td>
</tr>
<tr>
<td>25km</td>
<td>SO2_TT(:,7)</td>
<td>8000</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: Scatter plots with SO2 quantities retrieved at ULB and from GS2 with the IASI L2 PPF for different assumed altitudes and for pixels where the IASI L2 T/q profiles were available as inputs to BRESCIA SO2.
Anomaly:
An anomaly (EUM/EPS/AR/17514) was reported by the AC SAF experts for the SO2 products in the static description of the altitudes where the concentrations are provided. They currently read 4, 5, 6, 7 and 8 km with the IASI L2 v6.3.1, while the AC SAF draft product manual specifies 7, 10, 13, 16 and 25 km. A patch is required before activation on GS1 to provide the correct altitude assumptions to the users.
ASSESSMENT OF THE DUST INDEX PRODUCT

The dust index newly introduced in the version 6.3 implements the method developed by L. Clarisse (ULB) [RD-7]. It is a unitless indicator providing a pseudo-quantitative information of the dust load in the IASI pixels. As such, it is not a physical quantitative characterisation of the dust content and nature. The values typically range between 0 and 10, can reach higher values in exceptional dust outbreaks. The presence of dust is suspected when the index is greater than about 2.

The evaluation of its significance was performed by comparisons to model and other satellite data, particularly to MODIS AOD at 550nm [RD-7]. As a result of the EUMETAT study “IASI and AATSR Collocated SST and Aerosol Datasets” performed by University of Leicester, the IASI dust index generated after (Clarisse, 2013) has been compared to the aerosol optical depth at 550nm retrieved from the Advance Along-Track Scanning Radiometer (AATSR) [RD-8]. The Figure 5 illustrates the correlation between the two different aerosol parameters with AATSR-IASI collocated data between October 2007 and December 2008.

![Figure 5: Correlation between collocated AATSR AOD at 550 nm with the ORAC algorithm and the IASI dust index included in the IASI L2 version 6.3.](image)

We present hereafter a comparison of the IASI L2 dust index to the PMap aerosol optical depth and dust classes [RD-11, RD-12] and to Aqua/MODIS AOD products with IASI L2 GS2 products from 29/05/2017 (Figure 6). The dust patterns put in evidence for instance in the central Atlantic, in the Red Sea and the Arabian Sea are also well visible in MODIS as well as in the PMAp AOD @550nm products. Interestingly, PMAp dust classification (Figure 11) also consistently identifies dust coarse modes (class 1) structures in the central Atlantic, over the Red Sea and the Arabian Sea. The presence of dust aerosols in the latter
two is also confirmed by visual inspection with the MODIS RGB high resolution images (Figure 8 and Figure 9).

Figure 6: Average IASI L2 dust index on 29/05/2017 from Metop-A (top) and Metop-B (bottom).
Figure 7: Aqua/MODIS OD at 550nm on 29/05/2017.
Figure 8: Terra/MODIS RGB showing dust outbreak over Arabian Sea on 29/05/2017.
Figure 9: Aqua/MODIS RGB showing dust outbreak over the Red Sea on 29/05/2017.
Figure 10: PMAp AOD at 550nm on 29/05/2017 from Metop-A (top) and Metop-B (bottom)
Figure 11: PMAp Dust class on 29/05/2017 from Metop-B

Aerosol type classification [RD-11]

0. fine mode
1. coarse mode
2. biomass burning
3. volcanic ash/dust
4. volcanic ash-SO2
15. No classification
4 ASSESSMENT OF THE TEMPERATURE AND HUMIDITY PROFILES

The revision 6.3 of the IASI L2 operational processing chain does not introduce any algorithm changes as concerns the temperature and humidity profiles. It is hence expected that the profiles generated with the v6.3 are consistent with the profiles produced with the v6.2 and that the validation results obtained from the former revision in terms of systematic and random error characteristics are still applicable.

We present hereafter non-regression assessments for Temperature and Humidity profiles showing that IASI L2 v6.2 and v6.3 agree within negligible range compared to required products precision. In the following figures 12 to 19 the respective temperature and humidity profiles are compared for cloudy (red) and clear-sky (blue) situations separately from 24 to 29/05/2017. The sample size are indicated in the figures next to the ‘#’ symbol. The non-regression is evaluated for the statistical retrieval referred to as PWLR3 (‘all-sky’) and the subsequent optimal estimation retrieval (OEM, clear-sky only).

4.1 First-guess PWLR$^3$ temperature retrievals

4.1.1 Metop-B v6.2 vs v6.3 first-guess Temperature

Figure 12: Clear (blue) and Cloudy (red) IASI-B L2 PWLR temperature, v6.3 vs v6.2. The solid lines are vertical profiles of the mean differences. Dashed lines are standard deviation, for the period 24/05/2017 to 29/05/2017.
4.1.2 Metop-A v6.2 vs v6.3 first-guess Temperature

Figure 13: Clear (blue) and Cloudy (red) IASI-A L2 PWLR temperature, v6.3 vs v6.2. The solid lines are vertical profiles of the mean differences. Dashed lines are standard deviation, for the period 24/05/2017 to 29/05/2017.
4.2 First-guess PWLR$^3$ humidity retrievals

4.2.1 Metop-B v6.2 vs v6.3 first-guess Humidity

Figure 14: Clear (blue) and Cloudy (red) IASI-B L2 PWLR humidity, v6.3 vs v6.2. The solid lines are vertical profiles of the mean differences. Dashed lines are standard deviation, for the period 24/05/2017 to 29/05/2017.
4.2.2 Metop-A v6.2 vs v6.3 first-guess Humidity

Figure 15: Clear (blue) and Cloudy (red) IASI-A L2 PWLR humidity, v6.3 vs v6.2. The solid lines are vertical profiles of the mean differences. Dashed lines are standard deviation, for the period 24/05/2017 to 29/05/2017.

4.3 Optimal estimation of the temperature profile

The first-guess retrieval (with PWLR\(^3\)) evaluated in the sections 4.1 and 4.2 provides nearly all-sky sounding. It also initialises the subsequent optimal estimation attempted in cloud-free conditions (i.e. FLG_CLDNES equal 1 or 2) and using IASI measurements only.
4.3.1 Metop-B v6.2 vs v6.3 OEM Temperature

Figure 16: IASI-B L2 OEM temperature, v6.3 vs v6.2. The solid lines are vertical profiles of the mean differences. Dashed lines are standard deviation, for the period 24/05/2017 to 29/05/2017.
4.3.2 Metop-A v6.2 vs v6.3 OEM Temperature

![Graph showing OEM temperature comparison between v6.2 and v6.3]

Figure 17: IASI-A L2 OEM temperature, v6.3 vs v6.2. The solid lines are vertical profiles of the mean differences. Dashed lines are standard deviation, for the period 24/05/2017 to 29/05/2017.
4.4 Optimal estimation of the humidity profiles

4.4.1 Metop-B v6.2 vs v6.3 OEM Humidity

Figure 18: IASI-B L2 OEM humidity, v6.3 vs v6.2. The solid lines are vertical profiles of the mean differences. Dashed lines are standard deviation, for the period 24/05/2017 to 29/05/2017.
4.4.2 Metop-A v6.2 vs v6.3 OEM Humidity

Figure 19: IASI-A L2 OEM humidity, v6.3 vs v6.2. The solid lines are vertical profiles of the mean differences. Dashed lines are standard deviation, for the period 24/05/2017 to 29/05/2017.

4.5 Conclusions

The agreement between the GS2 v6.3 and the GS1 v6.2 temperature and humidity products is respectively below 0.01 to 0.02 K and below 0.02g/kg, of the order of the encoding precision in the EPS native format and well within the required precision for these products. This confirms the continuity of the T/q sounding products with v6.3.
5 ASSESSMENT OF THE SEA SURFACE TEMPERATURE

5.1 Status and changes in the Sea-surface temperature products

The IASI L2 sea surface temperature (SST) product is routinely monitored with the Ocean and Sea-Ice Satellite Application Facility (OSI-SAF). Owed to the quality of this product demonstrated since the version 6 [RD-4], the EUMETSAT IASI L2 SST has been included in the SST products collection maintained by the Group for High Resolution SST (GHRSST) [RD-9].

The revision 6.3 of the IASI L2 operational processing chain does not introduce any algorithm changes as concerns the native SST parameter. It is hence expected that the SST generated with the v6.3 are consistent with the SST produced with the v6.2 and that the validation results obtained from the former revision in terms of systematic and random error characteristics are still applicable.

However, in the IASI SST products reformatted in the GHRSST L2P standard, a new classification scheme has been implemented in order to improve the retrieval yield outside of the intertropical band. In addition, two new experimental fields have been added to the product:

- The “obs-calc” radiances difference, which is the information used to assign a quality class to each SST retrieval in the new classification scheme,
- The new dust index product (see also Section 3)

5.2 Native SST non-regression assessment

In the following, the continuity of the SST products in the EPS native files is demonstrated by direct comparison of v6.3 and v6.2 data, as done for temperature and humidity in Section 4.

We present hereafter non-regression assessments from IASI L2 v6.2 to v6.3 first-guess SST.
Figure 20: Maps of the mean (left) PWLR SST differences and standard deviation (right) between IASI L2 v6.3 and v6.2 in the period 24/05/2017 to 29/05/2017, for Metop-B (top) and Metop-A (bottom).

We present hereafter non-regression assessments from IASI L2 v6.2 to v6.3 OEM SST.
5.3 GHRSSST L2P IASI SST

The update of the IASI SST retrieval in v6.3 is intended to increase the number of observations available of good quality, particularly at higher latitudes where Users reported too sparse data. The quality of the SST is routinely evaluated against in situ buoy measurements and through comparisons to the model OSTIA, which produces a high resolution analysis of the current sea surface temperature for the global ocean [RD-14]. The former a longer integration time, typically of 6 months, to obtain significant statistics while the latter allows a shorter time larger and global statistics.

We present hereafter a summary of the assessment performed with OSTIA, based on the routine product validation and monitoring tool METIS-SST, which is the SST component of the Monitoring & Evaluation of Thematic Information from Space (METIS, RD-15) which provides near-real time diagnostics of EUMETSAT operational level-2 (L2) satellite SSTs.

In GHRSSST L2P SST products, the retrievals in individual pixels are classified in quality classes from level 5 (best) to 2 (bad quality, not for use). A typical uncertainty bias and standard deviation, as assessed typically against buoys, is statically assigned to each of the classes. The IASI L2 v6.3 introduces a change in the classification method, which is now based on the retrieved cloud signal ‘OmC’, which is added as an experimental field to the L2Pcore products themselves. This new classification allows a more accurate assignment and retains more products of good quality in the mid and high latitudes. It is done as follows:

- Quality Level 5: $\text{abs}(\text{OmC}) \leq 0.5$
- Quality Level 4: $0.5 < \text{abs}(\text{OmC}) \leq 1$
Quality Level 3: $1 < \text{abs}(O\text{mC}) \leq 2$
Quality Level 2: $\text{abs}(O\text{mC}) > 2$

5.3.1 L2Pcore IASI SST yield

Figures 22 and 23 below show the night-time IASI SSTs plotted for quality level 3 and above, for the current operational version, and the new v6.3. It is observed that there is an increase of observations at higher latitudes in Figure 23.

![Figure 22: Metop-B L2Pcore IASI SST, 22nd January 2017, v6.2](image-url)
5.3.2 Monthly comparison against analysis SST using METIS (off-line reprocessing)

Daily inter-comparisons were performed using the METIS (http://metis.eumetsat.int) [username: metisuser, password: #cryo2] framework over the period 24th December 2016 to 22nd January 2017. Three curves are plotted for the operational IASI-B SST (blue) and the new test retrieval scheme for Metop-B (green) and Metop-A (red), showing the mean differences (Figure 24), standard deviations (Figure 25) and number of observations (Figure 26). The new retrieval scheme has the effect of a slight increase in standard deviations by around 0.1K for quality levels 3 and above. However, the number of available observations at quality level 3 and above has almost doubled. The global mean difference is slightly different to that of the current operational IASI SST, with the new retrieval being around 0.2K warmer globally and for quality levels 3 and above. This can be adjusted per quality level using the GHRSSST Sensor Specific Error Statistics definition.
Figure 24: Metop-B IASI SST minus OSTIA SST mean differences, night-time (top), day-time (bottom), 24th December 2016 to 22nd January 2017. IASI-B v6.2 is blue, IASI-A and IASI-B v6.3 are red and green resp.
Figure 25: Metop-B IASI SST minus OSTIA SST standard deviation, night-time (top), day-time (bottom), 24th December 2016 to 22nd January 2017. IASI-B v6.2 is blue, IASI-A and IASI-B v6.3 are red and green resp.
5.3.3 Daily comparison against analysis SST using METIS (GS2 data)

Further inter-comparisons of L2Pcore IASI SST data from the PPF v6.3 on GS2 were compared to OSTIA SST analysis, shown in Figure 27 (Metop-B) and Figure 28 (Metop-A) below. These are compiled with all available IASI SSTs of Quality levels 3 and above. The standard deviations are around 0.5K, with the IASI skin SSTs slightly cooler than the sub-skin OSTIA SST as should be expected.
Figure 27: Histograms and global maps of Metop-B IASI SST v6.3 minus OSTIA differences for night (top), day (bottom) on 28th May 2017.
Figure 28: Histograms and global maps of Metop-A IASI SST v6.3 minus OSTIA differences for night (top), day (bottom) on 28th May 2017.

5.3.4 Comparisons against buoy SST with the OSI SAF matchup dataset

When the new version has been implemented operationally, the OSI SAF will produce routinely the OSI SAF IASI matchup dataset of satellite observations collocated with drifting buoys for the new version, and this will be further analysed at EUMETSAT.

5.3.5 METIS analysis of SSES per quality level

Figures 29 and 30 show the global differences of IASI SST minus OSTIA SST separated by quality level for the 1st January 2017. The largest proportion of observations is included in Quality Level 5, the highest quality class. The useable observations are recommended to be within quality levels 3 to 5. A cool tail of IASI SSTs, e.g. from residual cloud contamination, are observed within quality level 2, although these are not recommended for use.
Figure 29: global map of Metop-B IASI SST v6.3 minus OSTIA SST 1st January 2017, separated per Quality Level 5 (top left), 4 (top right), 3 (bottom left), 2 (bottom right)

Figure 30: Histograms of Metop-B IASI SST v6.3 minus OSTIA SST 1st January 2017, separated per Quality Level 5 (top left), 4 (top right), 3 (bottom left), 2 (bottom right)
5.3.6 Summary

The new version of IASI SST for v6.3 gives a higher yield of observations (quasi doubled), particularly at high latitudes where users reported that the data were too sparse for use. There is a slight impact on the overall standard deviation, compared to the previous version. However, it is still within the target accuracy of 0.5K bias, 0.8K standard deviation (RD-10). The precision of the class 5 is still around 0.4 K.

<table>
<thead>
<tr>
<th>Quality Level</th>
<th>Metop-B</th>
<th>Metop-A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSES bias (K)</td>
<td>SSES standard deviation (K)</td>
</tr>
<tr>
<td>5</td>
<td>+0.07</td>
<td>0.39</td>
</tr>
<tr>
<td>4</td>
<td>-0.05</td>
<td>0.48</td>
</tr>
<tr>
<td>3</td>
<td>-0.32</td>
<td>0.67</td>
</tr>
<tr>
<td>2</td>
<td>-0.71</td>
<td>1.21</td>
</tr>
</tbody>
</table>

*Table 1: Single-sensor error statistics for IASI L2Pcore in the different quality classes*
6 LAND SURFACE TEMPERATURE

The revision 6.3 of the IASI L2 operational processing chain does not introduce any algorithm changes as concerns the LST parameter. It is hence expected that the LST generated with the v6.3 are consistent with the LST produced with the v6.2 and that the validation results obtained from the former revision in terms of systematic and random error characteristics are still applicable.

6.1 First-guess LST non-regression assessment

We present hereafter non-regression assessments from IASI L2 v6.2 to v6.3 first-guess LST.

Figure 31: Maps of the mean (left) PWLR LST differences and standard deviation (right) between IASI L2 v6.3 and v6.2 in the period 24/05/2017 to 29/05/2017, for Metop-B (top) and Metop-A (bottom).

6.2 OEM LST non-regression assessment

We present hereafter non-regression assessments from IASI L2 v6.2 to v6.3 OEM LST.
Figure 32: Maps of the mean (left) OEM LST differences and standard deviation (right) between IASI L2 v6.3 and v6.2 in the period 24/05/2017 to 29/05/2017, for Metop-B (top) and Metop-A (bottom).
7 SUMMARY AND RECOMMENDATIONS

The v6.3 of the IASI L2 PPF brings two new atmospheric products (SO$_2$ partial columns and dust index) and enhances the content of the L2Pcore SST product. The SO$_2$ partial columns constitute the EUMETSAT AC SAF IASI SO$_2$ products. They are retrieved with the Brescia-SO2 library (from ULB/LATMOS via AC SAF). Verifications between the stand-alone research processor and the centrally generated products confirmed the correct integration into the IASI L2 PPF, with the exception of the auxiliary static information (anomaly EUM/EPS/AR/17514 described in section 2). The anomaly is considered not blocking as it is not affecting the actual retrievals (products content), but only a static auxiliary information within the products describing the altitude levels at which the SO$_2$ contents are retrieved. The SO$_2$ product guide drafted by the AC SAF and made available to the Users clearly states the correct altitude values already. The EUMETSAT AC SAF SO$_2$ product is intended for dissemination with demonstrational status until completion of the ORR by AC SAF. A note clarifying the actual static altitude levels shall be organised in the User announcement if the PPF patch (v6.3.2) cannot be deployed and verified in due time for the activation on GS1 planned this month.

The Dust Index implements the L. Clarisse (ULB) algorithm, which was evaluated with numerical models, with other satellite dust products and high resolution RGB images.

Regarding the L2Pcore SST enhancements, the v6.3 restores a larger yield outside of the inter-tropical band, as requested by the users. The global yield is nearly doubled while the overall precision only marginally decrease in the least quality classes and remains as good in the highest quality classes. In addition to this enhancement, two experimental fields have been added to the L2Pcore SST product, providing additional information to the users to perform their own data selection.

The non-regression of the other temperature and humidity information has been demonstrated. It clearly shows the excellent level of agreement between parameters from v6.2 that have not changed in v6.3 and hence the continuity with these products.

Considering the above observations and conclusions, it is recommended to proceed with the release of the IASI L2 PPF v6.3, for NRT operational production and dissemination, with the v6.3.2 including the patch to the SO$_2$ altitudes if possible. Otherwise, it is recommended to activate v6.3.1 on GS1 with a clarification on the SO$_2$ altitudes in the User announcement and to proceed with the patch (v6.3.2) at a later stage.
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