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page 1 of 27

New Third Party Mission, Quality Assessment

DMC UK / Nigeria Sat Missions

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DMC UK / Nigeria Sat Missions

DOCUMENT STATUS SHEET

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1 INTRODUCTION

1.1 Purpose of this document

In the frame of ESRIN Contract No 19565/06/I-OL, purpose of this study is the achievement of an expertise on the DMC mission.

Some issues have been raised and report in the document [R-1] delivered to ESA / ESRIN in May of Year 2006. The main purpose of this document is to validate that the anomalies previously detected are now closed.

Moreover, this document reports additional studies lead in the fields of radiometric calibration of the two DMC missions, UK DMC, NigeriaSat.

The quality of the mission has been evaluated according pre defined quality items. These items are defined in the document [R-4]. They have been established in the frame of standardization. This approach makes more straightforward the comparison with other EO missions.

1.2 Document overview

- Chapter 1 Introduces the document and the references. This is the current chapter;
- Chapter 2 Provide a summary of the validation exercise; status and recommendation,
- Chapter 3 The validation results are proposed.

1.3 Applicable documents

A-1 *New Third Party Missions: quality assessment*

ESRIN Contract N°: 19565/I-OL
May 3rd, 2006
ESA-ESRIN

1.4 Reference documents

This section describes the related documents and applied conventions to be considered within the present document.

R-1	<i>GAEL-P232-DOC-001</i>	<i>A new third party quality assessment Template document: DMC Mission profile Version 2, May 03rd, 2006 GAEL Consultant</i>
R-2	<i>GAEL-P232-DOC-004</i>	<i>Processing level standardization Version 1, Issue 0, September, 1st, 2007 GAEL Consultant.</i>
R-3	WMCO-0115056-01	DMC Data Product Manual June, 27, 2008 DMC International Imaging Ltd.
R-4	<i>GAEL-P232-DOC-011</i>	TPM Mission Comparison form Version 1, January, 20, 2009 GAEL Consultant

1.5 Abbreviations and Acronyms

This chapter controls the definition of the common abbreviations and acronyms used within the project. Special attention has been paid to adopt abbreviations, acronyms and their definitions from international standards as ISO, ANSI or ECSS.

The list is written in alphabetic order.

ANSI	American National Standards Institute
ALOS	Advanced Land Observing Satellite
AVNIR-2	Advancer Visible and Near Infrared Radiometer 2
BNSC	British National Space Center
CCD	Charge Couple Device
DMC	Disaster Monitoring Constellation
DIMAP	Digital Image MAP
ESA	European Space Agency
UK	United Kingdom
FAQ	Frequently Asked Question (document)
GCP	Ground Control Point
GPS	Global Positioning System
NIR	Near Infra Red (channel)
S/C	Spacecraft
SLIM6	Surrey Linear Imager - 6 channels
SSTL	Surrey Satellite Technology Limited
RGB	Red Green Blue (band composition)
TBC	To Be Confirmed
TBD	To Be Defined
TOA	Top Of Atmosphere
WWW	World Wide Web
XML	Extensible Markup Language

1.6 Definitions

This chapter provides the definition of all common terms used within the project. Special attention has been paid to adopt definitions from international standards as ISO, ANSI or ECSS.

The list is written in alphabetic order.

CCD Camera	Charge coupled device (CCD) cameras contain light-sensitive silicon chips that detect electrons excited by incoming light. They also contain micro circuitry that transfers a detected signal along a row of discrete picture elements or pixels, scanning the image very rapidly. CCD cameras use two-dimensional CCD arrays with many thousand of pixels
-------------------	--

CMOS	Complementary metal oxide semiconductor (CMOS) image sensors operate at lower voltages than CCDs, reducing power consumption for portable applications. Analog and digital processing functions can be integrated readily onto the CMOS chip, reducing system package size and overall cost
Dynamic range	The dynamic range of a sensor system is determined by the ratio of the maximum observable energy (Q_{max}) and the minimum of the still useful energy (noise level Q_{min}) it is defined in decibels (dB) as $10\log(Q_{max}/Q_{min})$. All radiant energy $<Q_{min}$ vanishes into noise, while the energy above Q_{max} disappears into saturation of the detector.
Duty Cycle	Fraction of orbital period in which a sensor is actually operational, determined by the overall power limitations of the payload.
Focal plane Array	Focal plane arrays (FPA) are detectors which have more than one row of detectors and one line of detectors together.
IFOV	The IFOV is the angular cone of visibility of the sensor and determines the area on the Earth surface.
LEO (Low Earth Orbit)	The term LEO is used in Earth Observation as well as for communication satellite constellations. These are usually circular or near circular at altitudes less than 200 km above Earth's surface. The orbital period in the altitude range of 300-2000 km varies between 90 and 120 minutes. The visibility period of the satellite over the horizon may vary for an observer (ground station) may vary from about 5 up to 20 minutes.
Radiometric resolution	Radiometric resolution refers to the resolving power of a system in wavelength and energy. The limiting factor for radiometric resolution is the signal to noise ratio of the instrument receiver. Considering the effect of varying illumination, the radiometric dynamic range of a sensor is determined by the maximum radiance value that sensor can experience for a given band. Measurements are converted into a number of discrete digital levels in a process also referred to as 'quantization'.
Spatial or geometric resolution	Spatial resolution refers to the area on the ground that an imaging system can distinguish. It is measured as the size of a pixel on the ground, when the image is displayed at full resolution (<i>CCRS Tutorial, 2004</i>). Spatial resolution is a function of geometry (scale) between sensor and target for the instant of measurement.
Spectral resolution	The spectral resolution of the sensor represents the capability of the sensor to distinguish fine wavelength interval and is described by the number of band their wavelength ranges. High spectral resolution is achieved by narrow bandwidths, which collectively, are likely to provide a more accurate spectral signature for discrete observation than broad bandwidths.
Temporal resolution	Temporal resolution is closely related to revisit period, which refers to the interval of time needed by a satellite for one entire orbit. Absolute temporal resolution is the interval time between two successive acquisitions of exactly the same area.
Signal to Noise Ratio	The ratio of the level of information bearing signal power to the level of signal power. The maximum SNR of a device is called the 'dynamic range'. In general, the higher the signal value is and the better the signal quality for recognition and detection.
Magnetometers	Measuring the known magnetic fields components

2 STATUS AND RECOMMENDATIONS

The status and recommendations are proposed according pre defined categories, detailed in the next document part [3]; documentation, data format, geometric model, radiometry and overall image quality. This second verification exercise has been conducted taking as reference the results from the first assessment report [R-1].

2.1 Summary

This second validation exercise demonstrated that the overall quality of DMC mission improved specifically in the fields of the user documentation, data format and the visual aspects of the image.

Regarding the geometric model, the systematic errors are inherit to the on board orbit and attitude control system. The platform is not three axis stabilized. A specification within 1 km (RMS) as for Landsat TM may be achieved.

The planar or planimetric accuracy is within 30 and 45 m (RMS). The visual quality of the geo coded product is good and no distortions observed. It would be now very interesting to assess the LIT product (ortho corrected product) to confirm that DMC products can be used to build consistent base map.

Some questions are raised regarding the radiometry and more specifically the absolute calibration of SLIM 6 instrument on board the both platform. Even if the calibration of radiometry is stable with time, the absolute calibration looks to deviate surprisingly.

2.2 Documentation

The DMC documentation is now very operational and accurate. The customer is now able to fully use the product in reading the available documentation. The format description document is somehow misaligned compared to the actual output product format.

A FAQ and anomaly inventory sections have been added to the user manual. The interaction with the user service has not been evaluated because no major issue has been raised during the first assessment.

2.3 Data format

In the light of our inspection, there is **no major non conformance regarding the product format**. The DIMAP format (LIR products) investigated did not include the xml elements embedded within the tag *<quality assessment>*. This is not compliant with the documentation of the DMC product format (refer to R-3, Appendix C).

The level of information or metadata content may however be improved; it can be noted for instance that the orbital (position, velocity, attitude of the platform) elements are not provided with the LIR and LIT product level but only with the raw product level.

In addition, the processing software version is not written into the product format, the product traceability is only based on the acquisition / processing date.

2.4 Geometric model

The location accuracy of the six DMC dataset assessed (3 DMC-UK and 3 DMC-NigeriaSat) remains consistent with the first validation exercise; **the accuracy varies between 12 and 24 km** for the both missions.

The error magnitude is temporally stable for the DMC UK product but not for NigeriaSat. The systematic error observed on DMC UK products is more likely due to an alignment error whereas for NigeriaSat, it tends to be due to a shift in time of the orbit data.

For NigeriaSat, the error looks to depend on the instrument bank used during the data acquisition procedure or is not stable with time;

- For the starboard bank, the accuracy remains about 22 km,
- For the port bank, the accuracy is about 12 km.

In addition, **the planimetric accuracy** is demonstrated to be conformed to the expectations. The error varies between **1 and 1.5 pixels**. No major image distortions have been observed. The planimetric accuracy of the DMC-UK products is better than the NigeriaSat one.

Moreover, **the band to band registration accuracy** is good and previous results are confirmed. The displacement between bands does not exceed **25% of the pixel**.

As the working dataset embedded images observed from only bank, the geometric artefact due to bank to bank registration could not be observed. A full swath product may be ordered in order to check this issue.

2.5 Image radiometry

No horizontal striping has been observed. **A residual vertical striping** is however magnified for the DMC-UK NIR band and has been quantified using suitable ground targets. Note that this is not a major non conformance. The magnitude of this artefact has more likely decreased compared to the first validation results.

The temporal calibration stability for the two missions is highlighted. The TOA measurements from two image banks are consistent together and for the whole of bands. This last assertion is however mitigated with the results of DMC-UK green band.

To check the absolute calibration, an inter comparison exercise with ALOS / AVNIR-2 has been performed. In the light of the method, the calibration of the both missions can be considered out of specification. For instance **in case of the green band**, the deviation with the AVNIR-2 instrument is maintained **within 20% for DMC-NigeriaSat and within 38% for DMC-UK**.

Major improvements of the calibration look up table lead by SSTL may occur shortly. So that, procedure should be played back for anomaly closure purposed.

2.6 Overall Image quality

Three categories of artefacts are visually observed in the image; **missing data, speckle and blur**. These artefacts are of minor importance except for the blur that decrease the spatial resolution of the images.

The missing data artefact is only observed on the UK DMC products for the two image banks and is not associated to a specific detector number. The speckle contaminates the red band; for the both missions and the both image banks. In addition, the blur is observed on the green band for the both missions and the both image banks as well.

In addition, **no image saturation is observed** on the image assessed.

3 SECOND VALIDATION

3.1 Introduction

DMC-Nigeria and DMC-UK are two satellites, launched together. The both platforms belong to the Disaster Monitoring Constellation, the constellation of small satellites.

- **2003 September 27 - NigeriaSat 1 (DMC-Nigeria) - Launch Site: [Plesetsk](#). Launch Vehicle: [Kosmos 11K65M](#). Mass: 80 kg (176 lb). Perigee: 677 km (420 mi). Apogee: 694 km (431 mi). Inclination: 98.20 deg. Period: 98.50 min.**

A technical description of the DMC missions based on S100 micro satellite bus (platform) and with the SLIM 6 imager on board is provided with the document [R-1].

The products assessed are listed in the table just here after. The products are from scenes observed over South of France (La Crau), mainly dedicated to geometric activities and over Libya desert site for radiometric comparison purposes.

Scene Name	UK DMC	Nigeria Sat	Sw_Ver	Processing Date	Observation Date	Target / Site
DN000679s		X		28/11/2008	18/08/2008	La Crau
DN00067bp		X		28/11/2008	20/08/2008	La Crau
DN000688s		X		28/11/2008	31/08/2008	La Crau
DU000d5cp	X			28/11/2008	16/08/2008	La Crau
DU000d6cp	X			28/11/2008	24/08/2008	La Crau
DU000d7ap	X			28/11/2008	01/09/2008	La Crau
DN000696p		X		28/11/2008	14/09/2008	Libya
DN000698s		X		28/11/2008	17/09/2008	Libya
DU000d92p	X			28/11/2008	15/09/2008	Libya
DU000d98s	X			28/11/2008	18/09/2008	Libya

table 1 - The list of the working dataset.

The raster data embedded within DMC products have been processed into GeoTIFF format. To the image is associated the metadata or auxiliary data stored into an ASCII file (the 'dim' file). The format of the 'dim' file is an implementation of the DIMAP XML.

The product level of the working dataset is the Level 1R; at this stage of the processing, products are band registered and radiometric corrections are applied ([R-2]).

3.2 Quality of the user documentation and Service

IQ Id	Description	IQ Status			Remark
		P	W	F	
DOC-FA-10	Frequently Asked Question		X		There no user FAQ. The User manual intends to resolve some user questions and includes a FAQ section. Some product anomalies are described as well.



IQ Id	Description	IQ Status			Remark
		P	W	F	
DOC-FS-10	User Manual	X			The document [R-3] is up to date. The DIMAP-XML implementation for DMC product is well documented.
FOR-FS-30	Format Specification	X			The DIMAP XML and GeoTIFF formats are documented. SpotImage is provided the user with the DIMAP XML documentation ¹ . The GeoTIFF format is a standard well documented at ²
DOC-US-10	User Service	X			No specific interaction with the DMC user service.

table 2 - Quality of the documentation.

3.3 Quality of the format: metadata and raster data

Metadata

IQ Id	Description	IQ Status			Remark
		P	W	F	
FOR-AU-10	Compliance of the metadata format with the related specification documents		X		For the set of product inspected, the format of the '.dim' file complies with the specification document. The DIMAP elements <quality assessment> documented into the product description is not implemented with the actual processing version. Moreover, there is no mean within the format to report the s/w version used for the product processing.
FOR-AU-20	Reliability of the metadata content.	X			The information provided within the 'dim' file is reliable.

table 3 - Quality of the format, auxiliary data.

Raster data

IQ Id	Description	IQ Status			Remark
		P	W	F	
FOR-IM-10	Compliance of the raster format with the related specification document.	X			The format of the image data complies with GeoTIFF format. The GeoTIFF format implementation for L1R product level is interesting; a rid of tie points is provided in the header of the raster image format. This information is redundant with the one provided within the Dim file.
FOR-IM-20	Quicklook and	X			The quality of product quick looks is conformed. Note, that

¹ The XML DIMAP version 1.1, <http://www.spotimage.fr/dimap/spec/documentation/refdoc.htm>

² The GeoTIFF format specification, version 1.8.2, December 2000;
<http://www.remotesensing.org/geotiff/spec/geotiffhome.html>.

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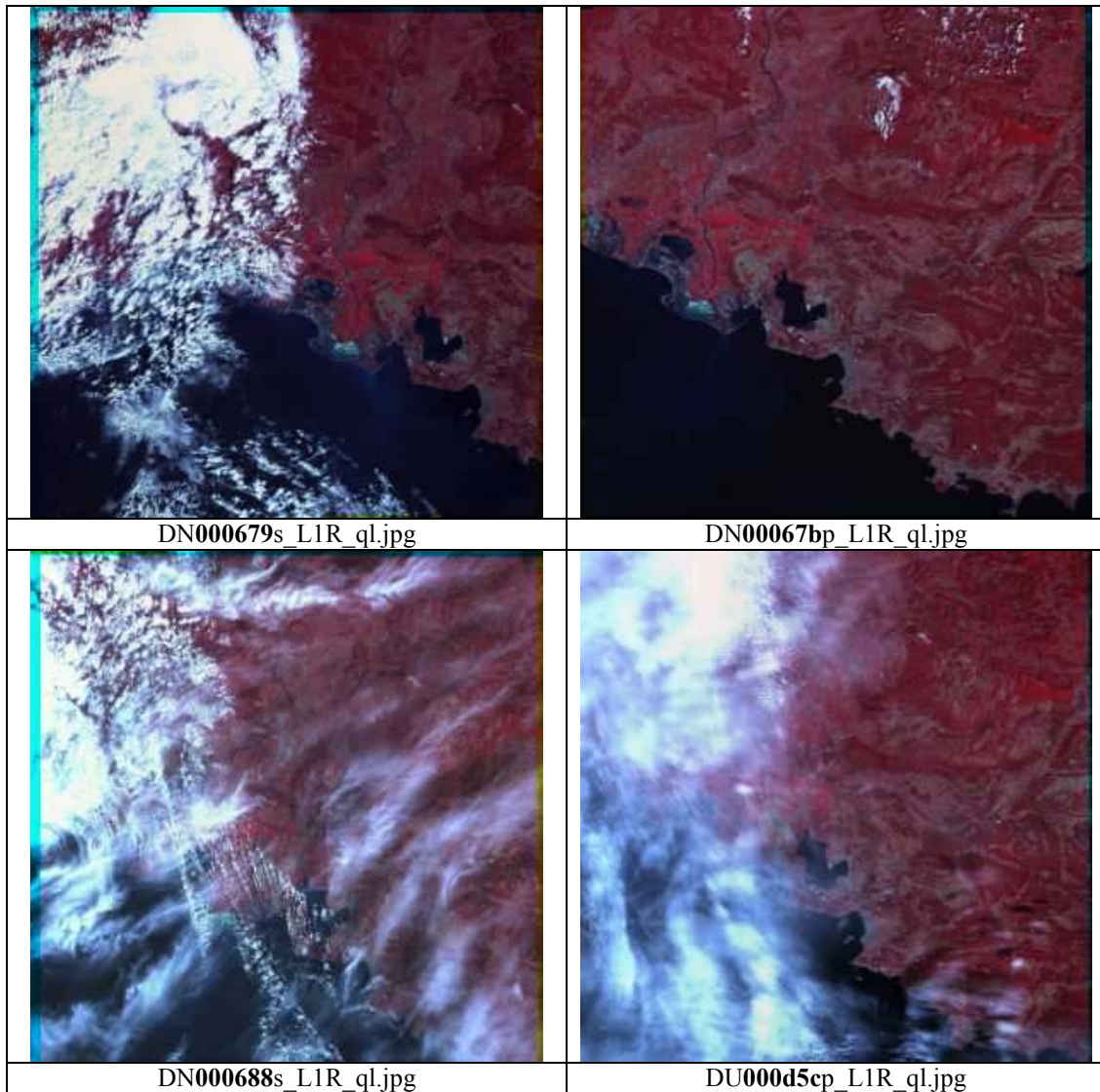
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IQ Id	Description	IQ Status			Remark
		P	W	F	
	Thumbnail				the band fringes (image margins) remain visible on the NigeriaSat product but not on the DMC UK product [table 5].

table 4 - Quality of the image format and quicklooks.











	
DU000d6cp_L1R_ql.jpg	DU000d7ap_L1R_ql.jpg
 <p>Visible band fringes</p>	
DN000696p_L1R_ql.jpg	DN000698s_L1R_ql.jpg
	
DU000d92p_L1R_ql.jpg	DU000d98s_L1R_ql.jpg

table 5 - Level 1R Products quicklooks.

3.4 Quality of the geometric model

The location accuracy assessment has been performed on the full dataset delivered by DMC for scenes observed over La Crau (France), refer to table 1.

The location model is based on the 25 tie points provided within the GeoTIFF format. The tie points are interpolated using a bi linear model in order to predict the location for any pixels of the scene.

There is a redundancy; a second set of 16 tie points is also available with the DIMAP-xml file. Even if the number of tie points (GeoTIFF format, DIMAP-xml file) and the associated coordinates (image and geographic) are different, the accuracy of the model based on this two set of tie points is similar.

Then, please note that the results report has been computed based on the first set of points.

The location predicted thanks to this DMC model is compared to the reference location of Ground Control Points (GCP). The GCPs are derived from the field measurement (GPS data, 35 cm accuracy).

Location accuracy

IQ Id	Description	IQ Status			Remark
		P	W	F	
GEO-LA-10 NigeriaSat	Accuracy of the scene footprint			X	For the three products, the accuracy varies between 12 and 23 km (RMS).
GEO-LA-20 (POL) NigeriaSat	Accuracy of the geometric model (polynomial)			X	For the three products, the accuracy varies between 12 and 24 km (RMS). The error is mostly pronounced according to the flight direction. This is mainly related to shift in time of the state vector. The location error looks to depend on the instrument bank; <ul style="list-style-type: none"> • For the starboard bank, the accuracy remains about 22 km, • For the port bank, the accuracy is about 12 km. This assertion should be confirmed using more dataset.
GEO-LA-10 UK DMC	Accuracy of the scene footprint			X	For the three products, the accuracy varies between 18 and 20 km (RMS).
GEO-LA-20 (POL) UK DMC	Accuracy of the geometric model (polynomial)			X	For the three products, the accuracy is about 20 km (RMS). The error is systematic and mostly pronounced along with the cross track flight direction (19 km). This is mainly related to alignment error between the focal plan and satellite coordinate system.

table 6 - Quality of the geometric model, location accuracy.

NigeriaSat

Id	Mean X	Mean Y	Mean	RMS error X	RMS error Y	RMS error
DN000679s_L1R	7494,030	-17766,578	19344,551	7638,503	17808,605	19808,610
DN00067bp_L1R	3348,387	-11407,080	11898,834	3367,475	11466,210	11951,280
DN000688s_L1R	7021,832	-21526,114	22653,114	7056,736	21548,879	22678,440

fig. 1 - Footprint geolocation accuracy assessment results, NigeriaSat.

Id	Mean X	Mean Y	Mean	RMS error X	RMS error Y	RMS error
DN000679s_L1R	7303,815	-23043,223	24176,978	7305,799	23053,53	24187,253
DN00067bp_L1R	5299,647	-10784,659	12021,252	5304,382	10827,69	12059,051
DN000688s_L1R	4352,196	-21484,545	21922,416	4356,234	21503,777	21941,967

fig. 2 - Geolocation accuracy assessment results, NigeriaSat.

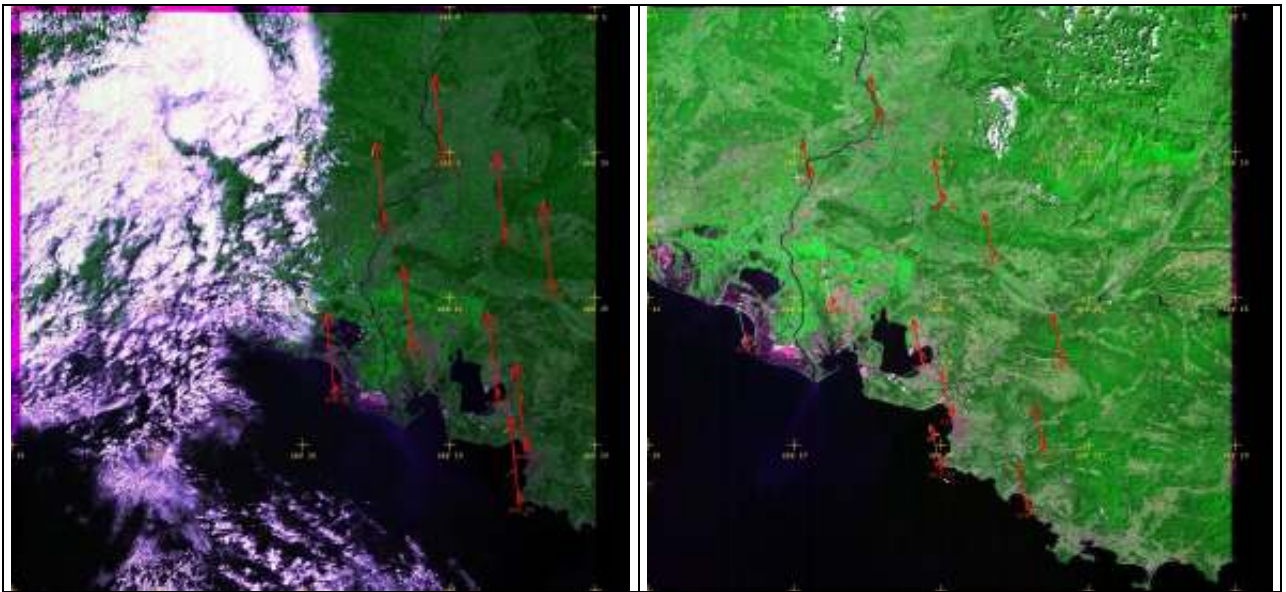


fig. 3 - Error vector fields (DN000679s_L1R (left), DN00067bp_L1R (right)).

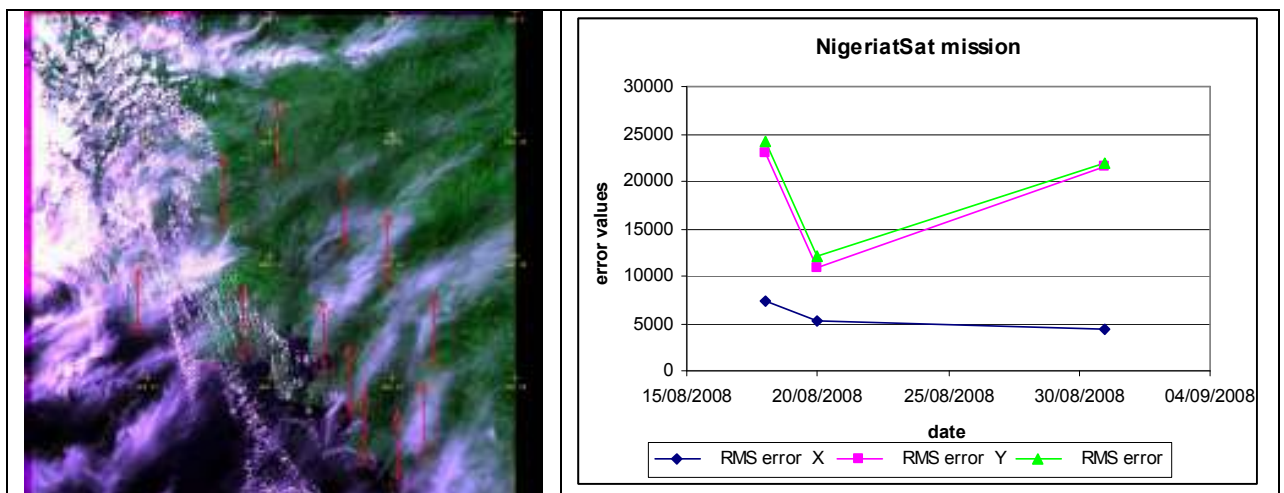


fig. 4 - Error vector fields (DN000688s_L1R (left), temporal analysis of the location accuracy (right)).

UK DMC

Id	Mean X	Mean Y	Mean	RMS error X	RMS error Y	RMS error
DU000d5cp_L1R	17773,689	-4595,386	18398,585	17779,377	4727,881	18403,083

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DU000d6cp_L1R	17549,091	-8392,054	19485,441	17553,439	8553,216	19492,381
DU000d7ap_L1R	16837,014	-10753,094	19993,399	16845,722	10767,570	20004,321

fig. 5 - Footprint Geolocation accuracy assessment results, UK DMC.

Id	Mean X	Mean Y	Mean	RMS error X	RMS error Y	RMS error
DU000d5cp_L1R	19667,123	-3922,831	20082,529	19668,448	4034,663	20083,603
DU000d6cp_L1R	19207,832	-7840,637	20775,744	19208,439	7895,228	20778,068
DU000d7ap_L1R	18263,602	-10239,521	20957,415	18263,916	10259,739	20960,449

fig. 6 - Geolocation accuracy assessment results, UK DMC.

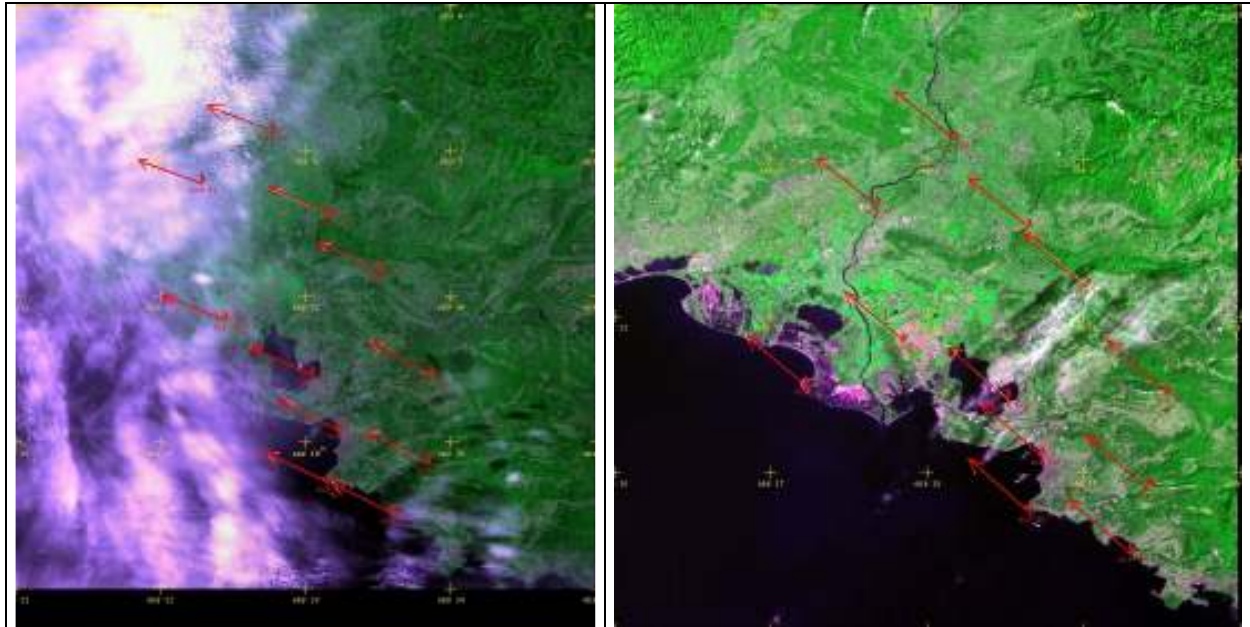


fig. 7 - Error vector fields (DU000d5cp_L1R (left), DU000d7ap_L1R (right)).

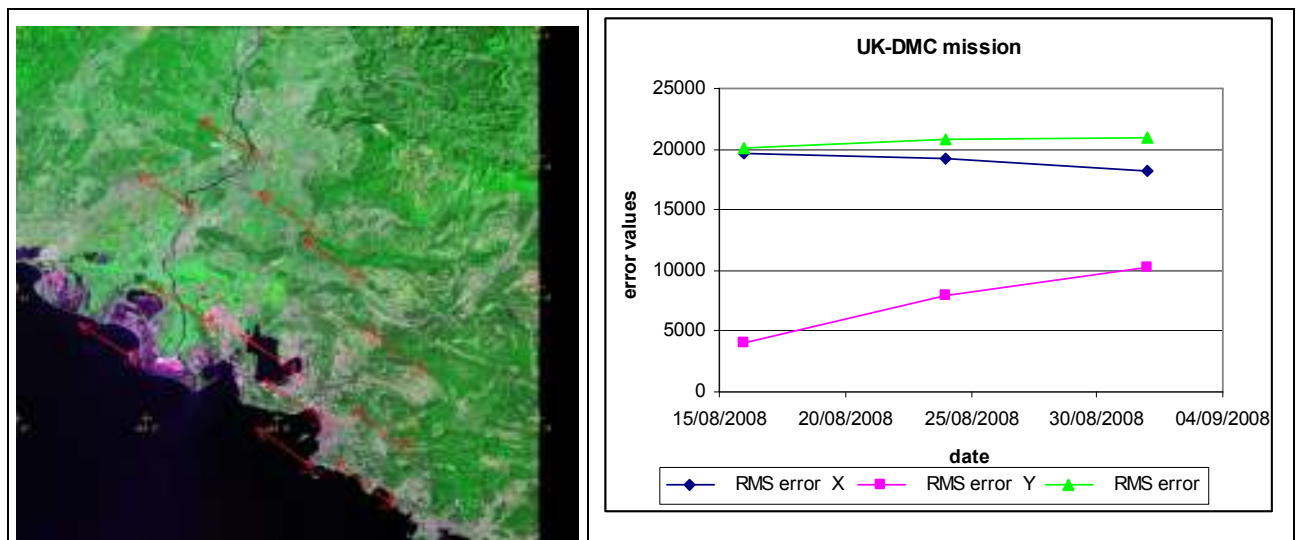




fig. 8 - Error vector fields (DU000d5cp_L1R (left), temporal analysis of the location accuracy (right).

Multispectral registration

IQ Id	Description	IQ Status			Remark
		P	W	F	
GEO-MR-10 NigeriaSat	Multispectral registration	X			In agreement with the first validation results,
GEO-MR-10 UK DMC	Multispectral registration	X			

table 7 - Quality of the geometric model, multispectral registration.

Planimetric accuracy

For this assessment, the L1R products have been geo referenced using 3 degree polynomial functions. The coefficients are estimated using least square method based on a set of 10 accurate ground control points used as reference. No digital elevation model is applied to account for the terrain relief. There is no ortho-rectification procedure.

IQ Id	Description	IQ Status			Remark
		P	W	F	
GEO-PA-10 NigeriaSat	Planimetric accuracy	X			Better results are observed for DMC UK. The results are in agreement with the ones report during the first validation exercise. The planimetric accuracy varies between 1 and 1.5 pixels .
GEO-PA-10 UK DMC	Planimetric accuracy	X			

table 8 - Quality of the geometric model, planimetric accuracy.

Id	Mean X	Mean Y	Mean	RMS error X	RMS error Y	RMS error
DN00067bp_L1R	-14.606	-8.158	44.401	44.939	20.703	49.478
DU000d6cp_L1R	-11.131	-4.937	25.945	21.8	22.56	31.372

fig. 9 - Planimetric accuracy results (m), NigeriaSat, UK DMC.



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fig. 10 - Planimetric accuracy results (m), DN00067bp, NigeriaSat (Vector magnification X300).



fig. 11 - Planimetric accuracy results (m), DN00067bp, UK DMC (Vector magnification X300).

3.5 Quality of the image radiometry

Equalization between detectors

IQ Id	Description	IQ Status			Remark
		P	W	F	
RAD-EQ-10 NigeriaSat	Equalization between detector	X			No vertical striping observed.
RAD-EQ-10 UK DMC	Equalization between detector		X		Vertical striping is observed on product DU000d98s. The striping is visible on the NIR band but not on the two other bands. The standard deviation computed over uniform area is 0.4 DN above for the NIR band compare to the Red and Green bands. The vertical striping may degrade the image resolution in the flight direction.
RAD-EQ-20 NigeriaSat	Equalization between line	X			No horizontal striping observed.
RAD-EQ-20 UK DMC	Equalization between line	X			Anomaly closed. No horizontal striping observed.

table 9 - Quality of the image radiometry, equalization between detectors / lines.

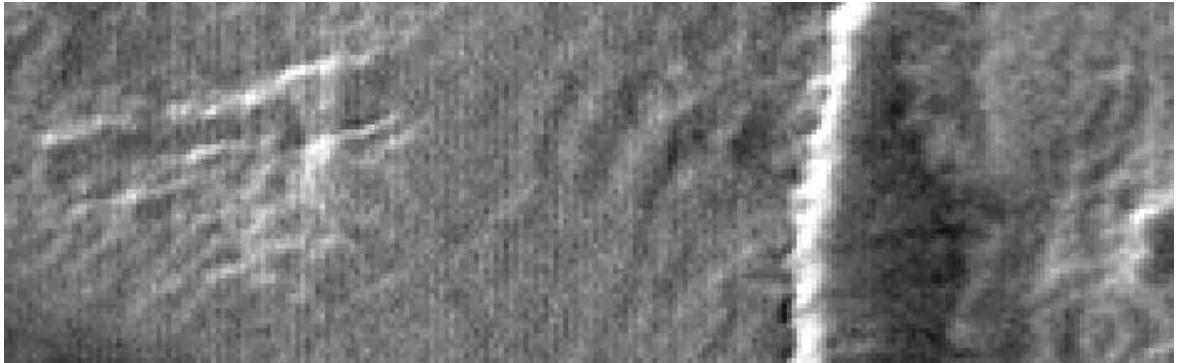


fig. 12 - NIR Band,, vertical striping over Libya scene, DMC UK (DU000d98s)

Note that the radiometric equalization between image banks has not been assessed because product delivered was derived from observations done using one bank, the port or star bank, the ‘full swath’ product was not available.

Temporal calibration

The stability of the Top Of Atmosphere (TOA) calibration has been checked for the both DMC missions. The couple of UK and NigeriaSat scenes have been observed in September of Year 2008 with a three days interval (table 1).

The SLIM-6 imager is a dual bank linear push broom imager. The observations are performed using conjointly the starboard and port image banks (R-2).

For the two missions, a different image banks have been used to observe the working scene. Then, when checking the stability in time, the consistency of the measurement between banks is checked as well.

The statistical results report in the frame of this validation item has been confirmed using five test windows. The whole of results was agreeing together.

IQ Id	Description	IQ Status			Remark
		P	W	F	
RAD-TC-20 NigeriaSat	Multi Temporal band calibration Stability (TOA)	X			The stability of the calibration within 3 days is confirmed, the measurement between image banks is consistent. Band 1 NIR: -0.59% Band 2 Red: 1 % Band 3 Green: -4%
RAD-TC-20 UK DMC	Multi Temporal band calibration Stability (TOA)		X		The stability of the calibration within 3 days is confirmed, the measurement between image banks is consistent. The percent differences for the green band exceed 10% in all the cases (for the whole of test windows). Band 1 NIR: -0.75% Band 2 Red: -2.34 % Band 3 Green: 10.05% The green band calibration and stability should be re checked.

table 10 - Multi temporal band calibration stability.

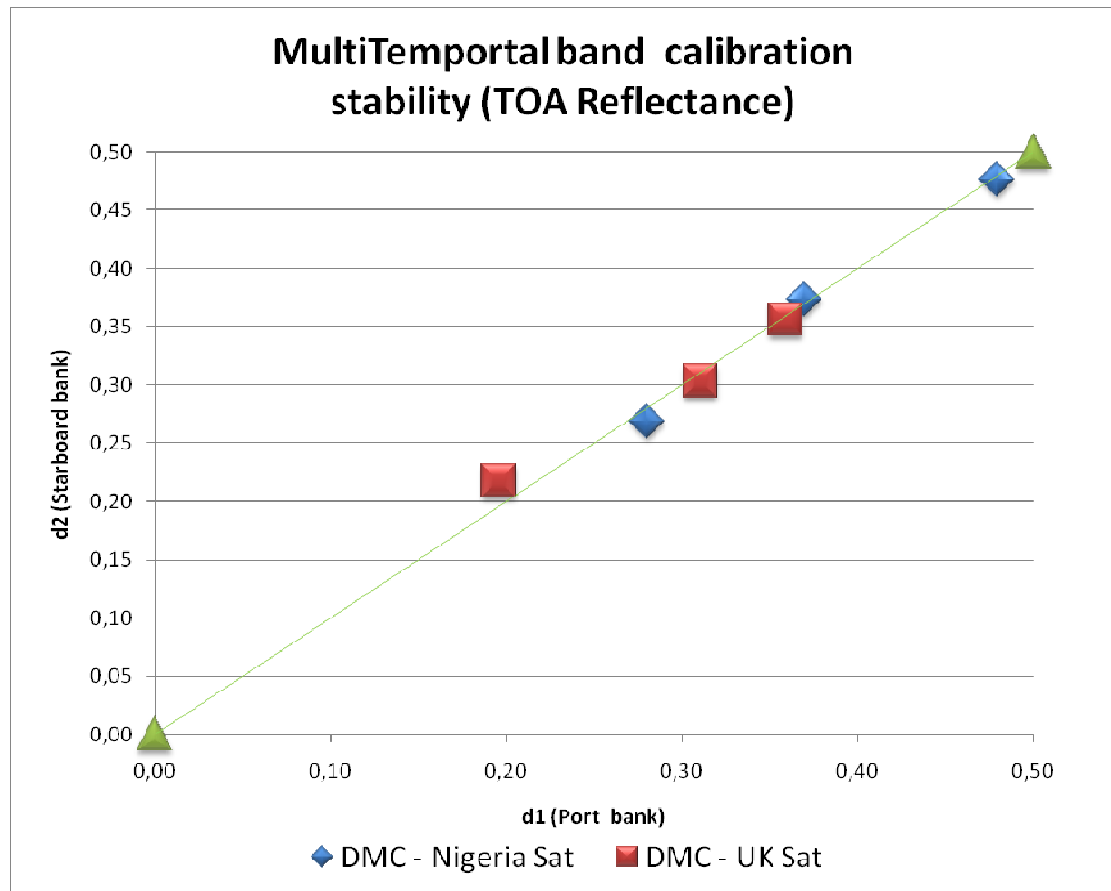


fig. 13 - Multi temporal band calibration stability ($d1/d2$ for the first/second acquisition date).

For same regions located over the Earth, the TOA reflectance measurements computed from the couple of images are not consistent between missions.

Relative Inter calibration

The relative inter calibration has been checked using as reference instrument ALOS /AVNIR-2. The comparison is performed according to hypothesis that the Libya site is stable over time and spatially homogeneous.

The database of the top of atmosphere AVNIR-2 measurements collected during one year has been used for the comparison purposes. The couple of DMC / AVNIR-2 observations have been selected when the geometry of observations was identical.

The geometry of observation is defined in the light of the diffusion angle value that is a composite measurement between the zenith, azimuth angles of the sun and instrument viewing direction..

The DMC product format does not inform on the azimuth of the platform and does not report the state vector files.

So that, an accurate azimuth angle of the viewing direction is difficult to evaluate. The DMC satellites are flying in ascending orbit with no pointing capability. With our working dataset; an azimuth angle of 170 degree has been supposed for DMC scenes. The diffusion angle for coincident scenes is estimated to be 0.7 at satellite Nadir. The statistics windows have been selected accordingly.

The spectral response of the both AVNIR-2 and DMC/SLIM 6 are not of the same shape, even if the width of the spectral range is similar.

The comparison of the **central wavelength** value between AVNIR-2 and DMC highlights that;



- There is a same value for the green band,
- There is a shift of about 6 nm for the red band,
- There is a shift of about 20 nm for the NIR band.

Moreover, the correlation computed between the both AVNIR/DMC spectral band response distributions for every channel confirms the previous assertion; this coefficient is equal to 0.93 for the green band, 0.83 for the red band and 0.80 for the NIR band.

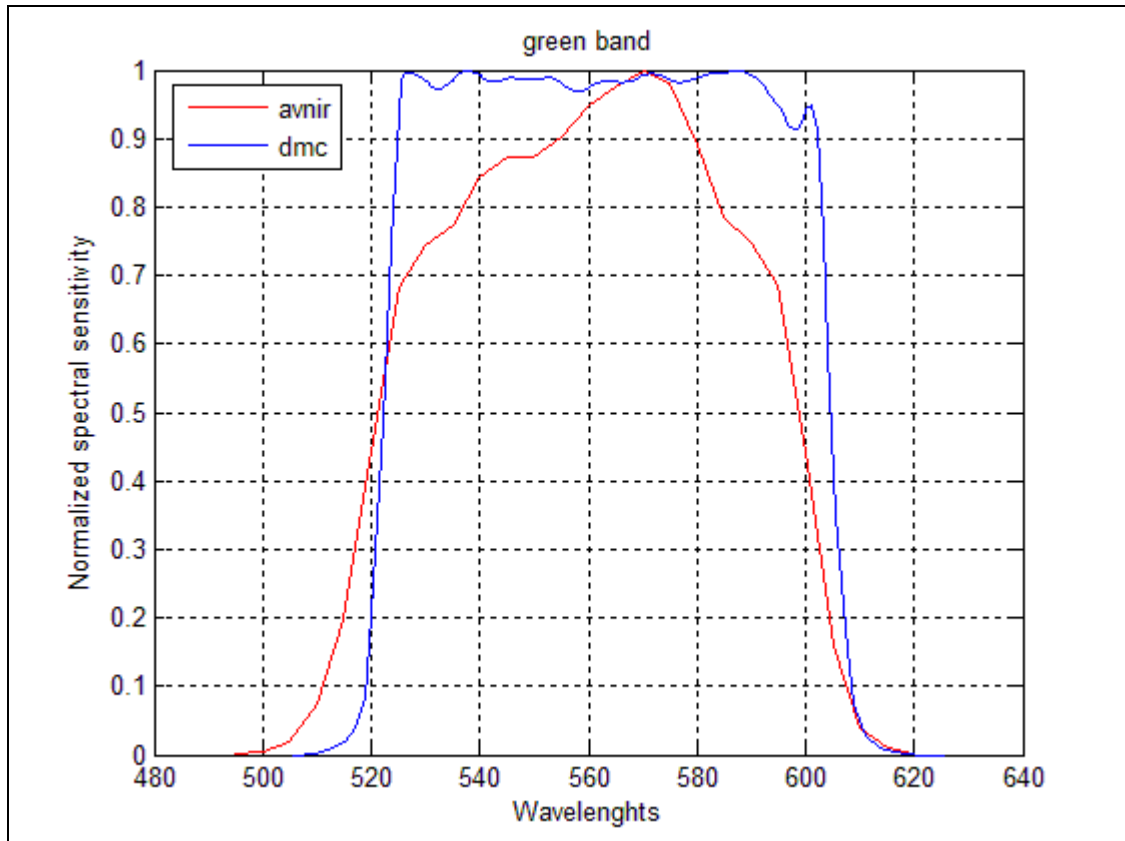


fig. 14 - DMC / AVNIR-2 spectral response comparison; green band.

A priori, the fit between TOA measurements should be improved when the spectral response shape (fig. 14, fig. 15, fig. 16) and central wavelengths are closed each other. When checking the inter comparison results, this is not the case.

When considering simulated DMC measurements still based on the AVNIR-2 ones but taking into account the DMC spectral response, the results are similar to the previous ones. A same deviation between AVNIR-2 and DMC calibration is observed.

This is obvious that the degradation that may occur on any optical system affects much more the blue, green band than the red or NIR band, and maybe explanation considered as an explanation, in accounting that the both DMC UK and NigeriaSat missions has been launched together.

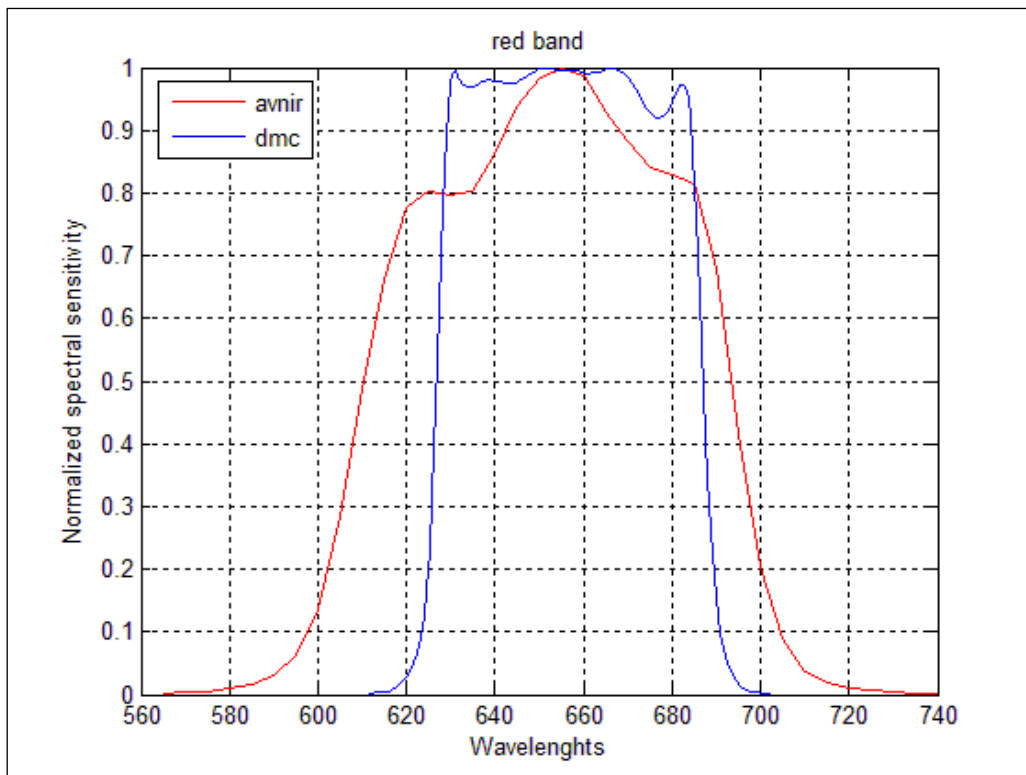


fig. 15 - DMC / AVNIR-2 spectral response comparison; red band.

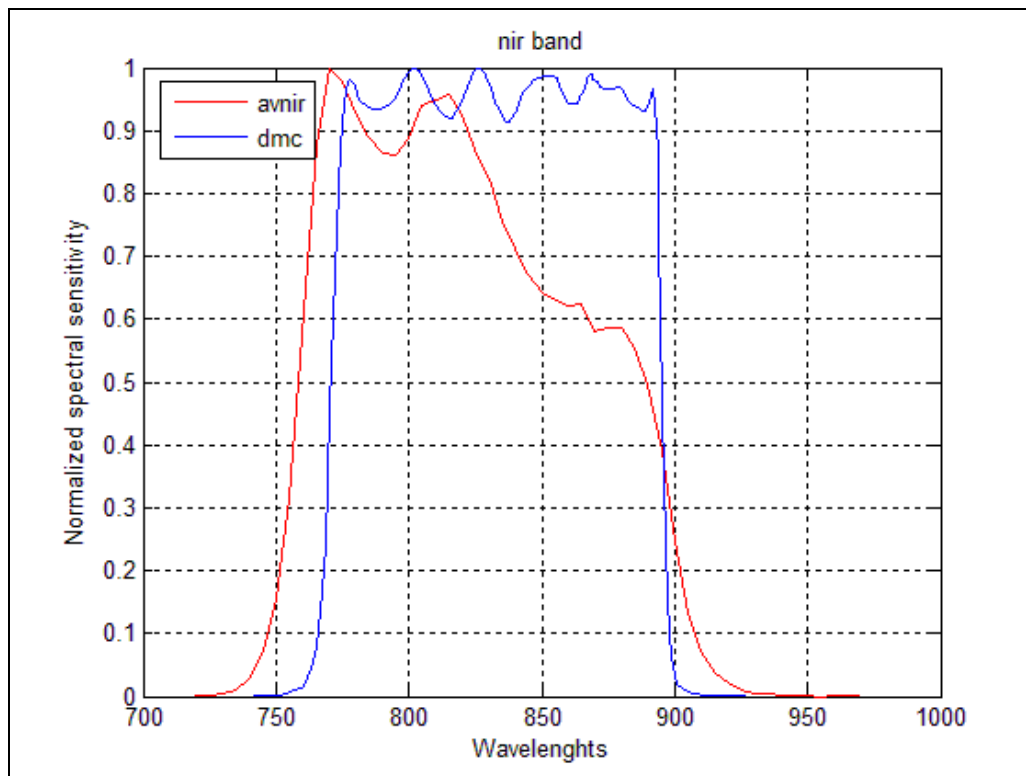


fig. 16 - DMC / AVNIR-2 spectral response comparison nir band.



IQ Id	Description	IQ Status			Remark
		P	W	F	
RAD-IC-10 NigeriaSat	Relative inter comparison (TOA) with AVNIR-2			X	In the light of the method, the calibration of NigeriaSat is below the expectation. Band 1 NIR: 1.06% Band 2 Red: -14.04% Band 3 Green: -17.17% This item should be rechecked when the up date of radiometric calibration will be triggered on the processing s/w side.
RAD-IC-10 UK DMC	Relative inter comparison (TOA) with AVNIR-2			X	In the light of the method, the calibration of NigeriaSat is below the expectation. Band 1 NIR: -24.38 Band 2 Red: -29.05% Band 3 Green: -37.54% This item should be rechecked when the up date of radiometric calibration will be triggered on the processing s/w side.

table 11 - Relative Inter comparison, DMC / ALOS AVNIR-2.

3.6 Overall image quality

IQ Id	Description	IQ Status			Remark
		P	W	F	
RAD-CN-10	Compression Noise	X			No compression noise applied.
RAD-SA-10	SATuration	X			No saturation observed for the two missions.
RAD-MD-10 UK DMC	Missing Data			X	Missing data column in DMC UK product, DU000d92p for the three bands. This is not the same image column contaminated, see [fig. 17]
RAD-MD-10 NigeriaSat	Missing Data	X			No missing data on NigeriaSat images.
RAD-OA-10	Other Artefact Blurred		X		A blurred is observed on the green band images (DMC UK & NigeriaSat). This issue already raised with the first validation report, should now be more characterized. The spatial resolution looks to be degraded with the green band. An image ratio in the Fourier domain may magnify the observation and confirm hypothesis..

table 12 – Overall image quality.



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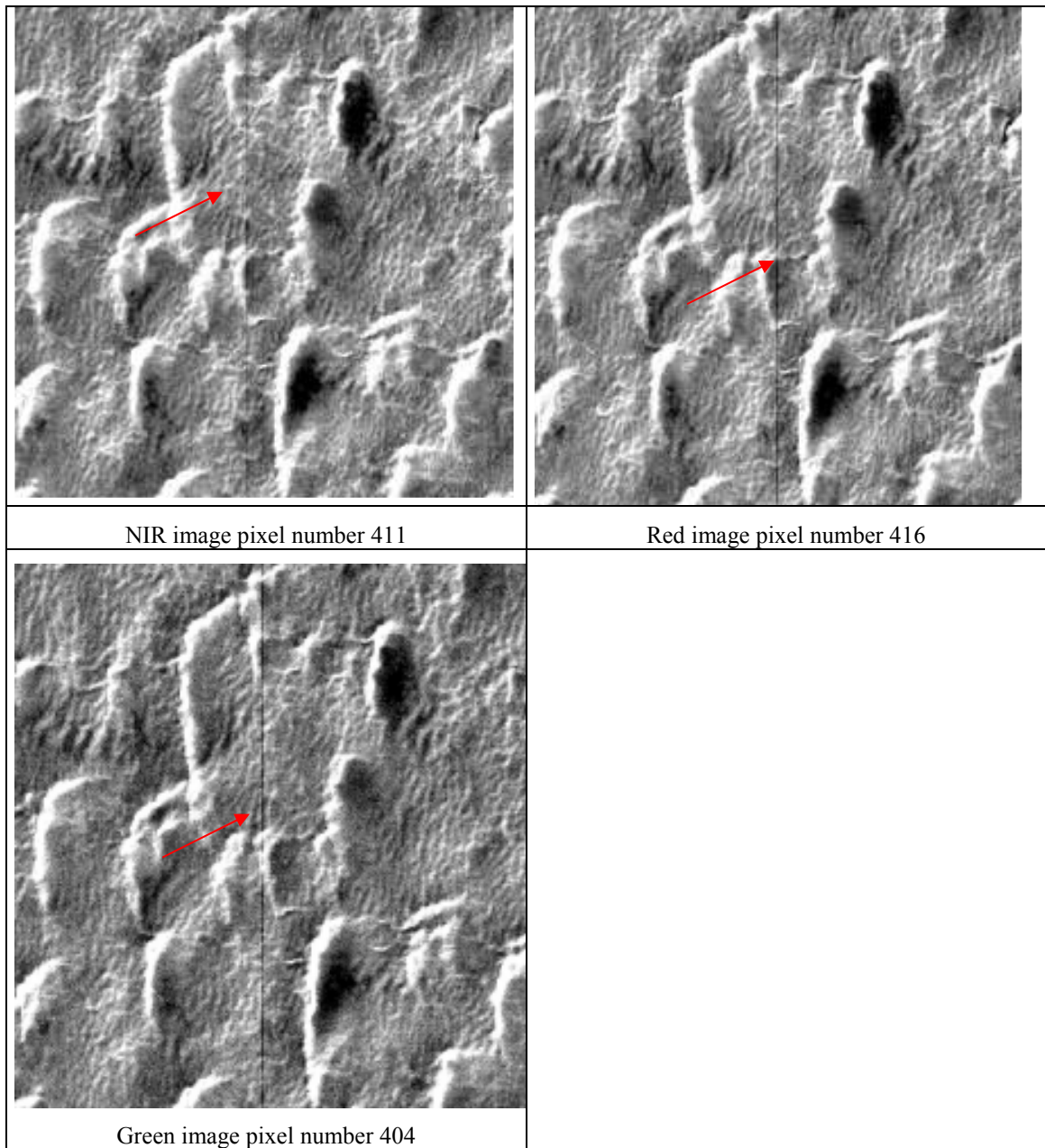


fig. 17 - Missing data over the DMC UK product, DU000d92p.

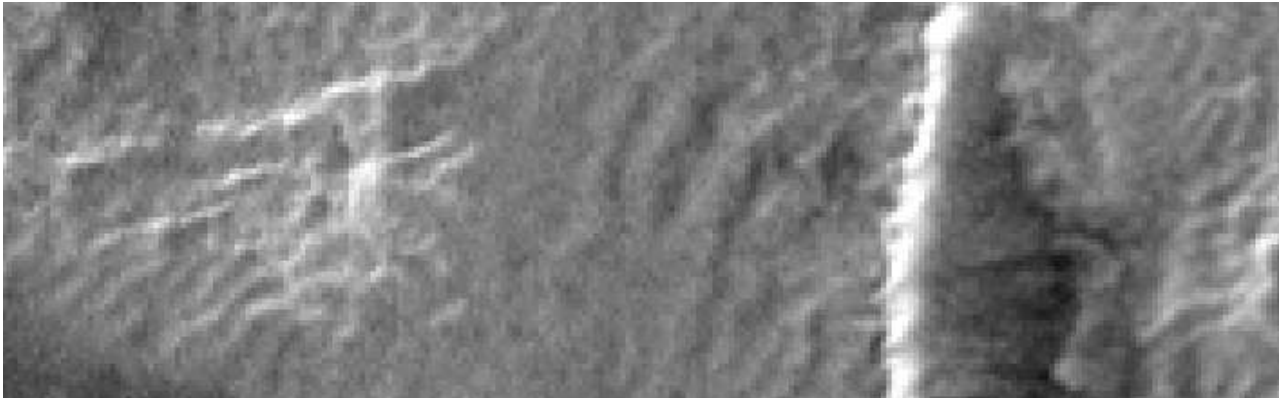


fig. 18 - Image blur magnified on the DMC green band (DU000d98s).

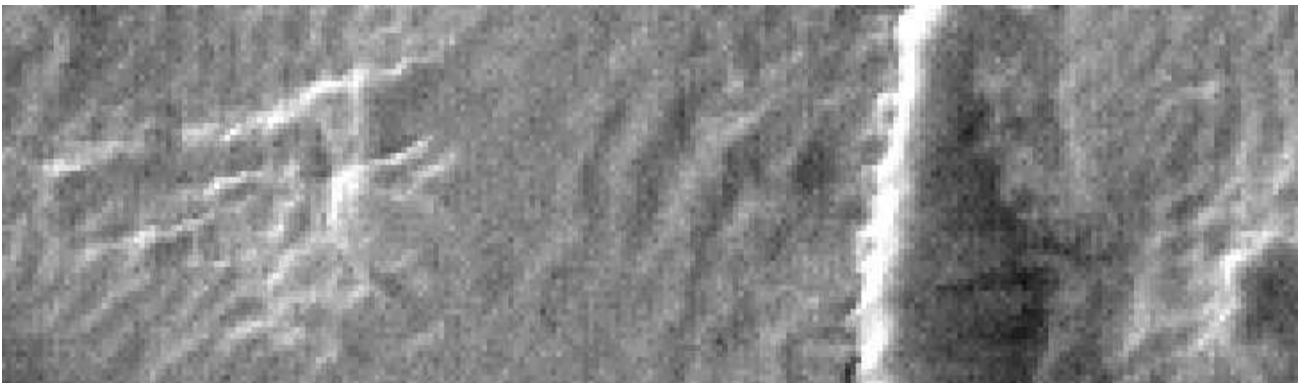
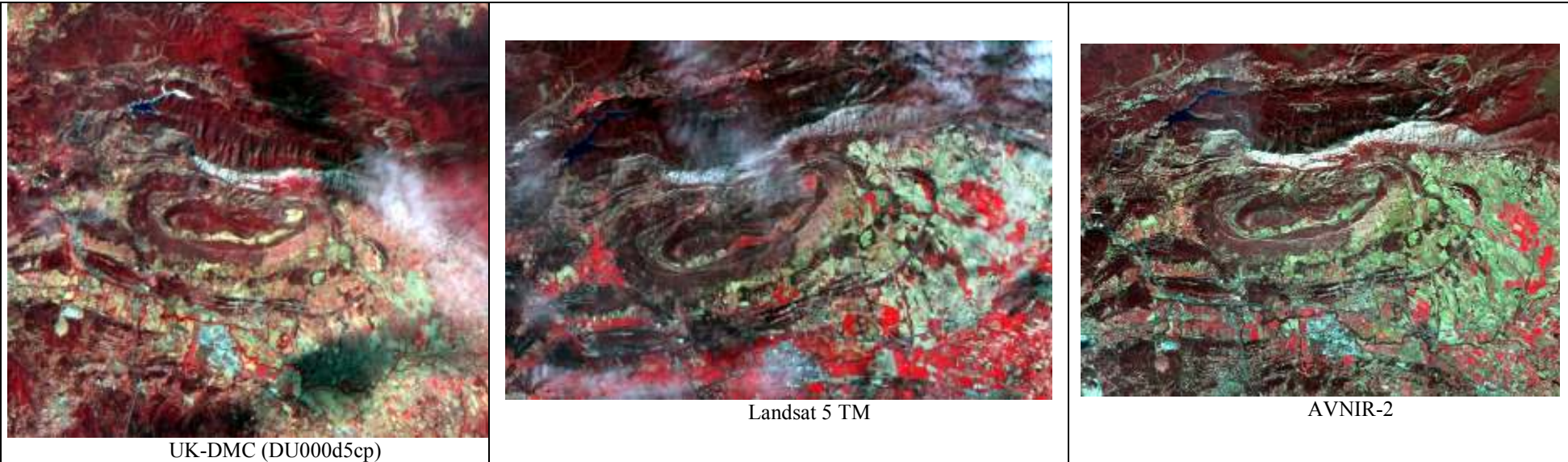


fig. 19 - No striping or blur on the Red band; only an additive noise or 'speckle' is visible (DU000d98s).

To illustrate the blur, the DMC band composition (RGB) has been visually compared with a band composition based on TM5 and ALOS/AVNIR-2 images. **The images just here after are displayed at the scale of the DMC full resolution images**



No blurred images



Blurred artefact on DMC image. The contrast of TM image composition is better than the DMC one.

fig. 20 - DMC images and blur artefact.