Technical Note on Quality Assessment for Jilin-1 SP and GF03C Video Missions

26/04/2022

Author(s): ***Béatrice Berthelot***
Gilles Doyon
Thomas Ristorcelli
(Magellium)
Task 1 Mission Expert

Approval: ***Fay Done***
Task 1 Lead

Accepted: ***Clément Albinet***
EDAP Technical Officer

EDAP.REP.046 *Issue: 1.0* *27 04 2022*

TABLE OF CONTENTS

The Amendment Record Sheet below records the history and issue status of this document.

ISSUE	DATE	REASON
0.1	21/01/2022	First draft for ESA review
1.0	27/04/2022	First issue

1. EXECUTIVE SUMMARY

The Jilin-1 Earth Observation (**EO**) satellite constellation, developed and operated by **Chang Guang Satellite Technology Co., Ltd.** (China), includes the **Jilin-1 SP 03 - 08** (launched between January 2017 and January 2018) and **Jilin-1 GF03C 01 - 03** (launched September 2020) satellites that provide the user community with Very High Resolution (**VHR**) video products.

The results of the preliminary data quality assessments, performed on the video products of the aforementioned satellites (except for Jilin-1 SP 04 – 08), procured from the data provider, **Head Aerospace**, between June and August 2021, are summarised in Table 1-1.

Table 1-1: Jilin-1 SP and GF03C Video Missions: Assessment Area Results

Assessment Area	Results
Geometric Calibration	Jilin-1 SP 03 - 08 Ground Sampling Distance @ Nadir: 0.92 m Jilin-1 GF03C 01 - 03 Ground Sampling Distance @ Nadir: 1.2 m **1. Absolute Geolocation Accuracy** The results of this assessment indicate the absolute geolocation accuracy of SP 03 imagery (i.e. video frames) is degraded; shifts in rows and columns are significantly variable, where shifts in rows are < 2.2 km (< 2.2 km in desert areas and < 1.7 km in urban areas) and shifts in columns are between < 0.7 km. Therefore, the minimum performance requirement specified by the mission provider as 200 m (CE90), without ground control points, has not been met. The results of this assessment indicate the absolute geolocation accuracy of GF03C 01 - 03 imagery (i.e. video frames) is also degraded; shifts in rows are < 0.5 km, and shifts in columns are < 1.8 km. Therefore, the minimum performance requirement specified by the mission provider as 300 m (CE90), without ground control points, has not been met. **2. Temporal Geolocation Accuracy** The results of this assessment indicate the temporal geolocation accuracy is degraded, varying significantly (estimated shifts < 1.0 km), and most likely corresponds to a bias and a rotation. However, more accurate (reliable) results can only be achieved if more products, needed to construct a sufficient time series, were procured and assessed. Note no minimum performance requirement has been specified. **3. Band Co-registration Accuracy**

	The results of this assessment indicate that the band co-registration accuracy is good for all products assessed (better than 10 cm except for one product). Note no minimum performance requirement has been specified.
Radiometric Calibration	**1. Absolute and Temporal Radiometric Accuracy** These two assessments could not be performed as the radiometric calibration coefficients were not provided in the product metadata (it is not clear whether these coefficients, detailed in the product guide, are to be provided or not). Note no minimum performance requirement has been specified.
Image Quality	**1. Modulation Transfer Function** This assessment could not be performed because the data had been radiometrically compressed, either onboard or by the ground segment, and resampled. Note no minimum performance requirement has been specified. **2. Signal-to-Noise Ratio** This assessment could not be performed as the radiometric calibration coefficients, used to convert to top of atmosphere radiances from which the signal-to-noise ratio can be estimated, were not provided. Note no minimum performance requirement has been specified. **3. Object Detection and Tracking** The results of this assessment indicate the videos are of a quality (i.e. interpretability) that allows for objects to be successfully detected and tracked (not accurately tracked with the products procured as the video data contained missing frames). Note no minimum performance requirement has been specified.
Visual Inspections	The visual inspections were performed on the product quicklooks (one video major frame) and the results indicate there are no anomalies or artefacts present in the procured videos (except saturation observed on bright surfaces such as clouds).

2. INTRODUCTION

This technical note details the results of the preliminary data quality assessments (geometric calibration, radiometric calibration and image quality) performed on a sample of video products generated for the optical EO **Jilin-1 SP 03** and **GF03C 01 - 03 satellites** (missions).

The aforementioned data quality assessments are performed in accordance with the assessment guidelines, detailed in [RD-1, RD-2], that constitute the European Space Agency (**ESA**) Earthnet Data Assessment Pilot (**EDAP**) Project's EO Mission Data Quality Assessment Framework. An important representation of the latter framework, constructed by the National Physical Laboratory (**NPL**), is what is known as the maturity matrix. It is a diagrammatic summary of the following:

- ***Documentation Review****: the EDAP Optical team reviews materials provided by the data provider and / or operator (e.g., ancillary / auxiliary data and documentation), some of which may not be publicly available, or even the scientific community (e.g., published papers). The results are detailed in Section 3 (covering the first four columns of the maturity matrix, see Table 3-1).*

- ***Data Quality Assessments:*** *the EDAP Optical team performs data quality assessments (i.e. validation assessments), independently of those performed by the data provider and / or operator. The results are detailed in Section 4 (covering the last column of the maturity matrix, see Table 3-1).*

The above data quality assessments are performed by the project's optical team using the appropriate in-house and open-source ad-hoc scripts / tools.

It is important to note the purpose of the EDAP EO Mission Data Quality Assessment Framework is to ensure the delivered commercial mission(s) data (products) are fit for purpose and that all decisions regarding the inclusion of the commercial mission(s) as an ESA third party mission can be made fairly and with confidence.

2.1 Reference Documents

The following is a list of reference documents with a direct bearing on the content of this proposal. Where referenced in the text, these are identified as [RD-n], where 'n' is the number in the list below:

RD-1. EDAP Best Practice Guidelines, EDAP.REP.001, v1.2, September 2019.

RD-2. Earth Observation Mission Quality Assessment Framework – Optical Guidelines, EDAP.REP.002, v2.0, December 2020.

RD-3. Chang Guang Satellite Technology Co Ltd., Jilin-1 Imagery Product Guide, v1.1, April 2021.

RD-4. Wilkinson, M.D., Dumontier, M., Aalbersberg, I.J., Appleton, G., Axton, M., et al. 2016. The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data 3, 160018. (doi:10.1038/sdata.2016.18)

RD-5. Head Aerospace – Introduction to the Jilin-1 Satellites and Products, v1.1, April 2021.

RD-6. Bouvet, M.; Thome, K.; Berthelot, B.; Bialek, A.; Czapla-Myers, J.; Fox, N.P.; Goryl, P.; Henry, P.; Ma, L.; Marcq, S.; Meygret, A.; Wenny, B.N.; Woolliams, E.R. RadCalNet: A Radiometric Calibration Network for Earth Observing Imagers Operating in the Visible to Shortwave Infrared Spectral Range. Remote Sens. 2019, 11, 2401, https://doi.org/10.3390/rs11202401

RD-7. https://sentinel.esa.int/documents/247904/685211/Sentinel-2_User_Handbook

RD-8. M. Cournet, A. Giros, L. Dumas, J.M. Delvit., D. Greslou, F. Languille, G. Blanchet, S. May, and J. Michel (2016). 2D Sub-Pixel Disparity Measurement Using QPEC / Medicis, Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLI-B1, 291-298, doi: 10.5194/isprs-archives-XLI-B1-291-2016.

RD-9. Johnson, J., (1958), "Analysis of Image Forming Systems", Proceedings of the Image Intensifier Symposium, 6-7 October 1958: AD220-160, U.S. Army Engineer Research and Development Lab, Fort Belvoir, VA, 249-273.

RD-10. Chang Guang Satellite Technology Co., Jilin-1 Satellites Radiometric Calibration <document not dated or versioned, not available publicly>

2.2 Glossary

The following acronyms and abbreviations have been used in this Report.

CEOS	Committee for Earth Observing Satellites
EDAP	Earthnet Data Assessment Pilot
EO	Earth Observation
ESA	European Space Agency
FAIR	Findable, Accessible, Interoperable and Reusable
MTF	Modulation Transfer Function
NPL	National Physical Laboratory
ROI	Region of Interest
RPC	Rational Polynomial Coefficients
SNR	Signal-to-Noise Ratio
VHR	Very High Resolution
ZNCC	Zero-normalised Cross-correlation

3. EDAP QUALITY ASSESSMENT

3.1 EDAP Maturity Matrix

Table 3-1: Maturity Matrix for Jilin-1 SP 03 and Jilin-1 GF03C 01 - 03

Product Information	Product Generation	Ancillary Information	Uncertainty Characterisation	Validation
Product Details	Sensor Calibration & Characterisation Pre-Flight 🔒	Product Flags	Uncertainty Characterisation Method	Reference Data Representativeness
Product Availability & Accessibility	Sensor Calibration & Characterisation Post-Launch 🔒	Ancillary Data	Uncertainty Sources Included 🔒	Reference Data Quality
Product Format 🔒	Additional Processing 🔒		Uncertainty Values Provided 🔒	Validation Method
User Documentation			Geolocation Uncertainty 🔒	Validation Results
Metrological Traceability Documentation				

Key
Not Assessed
Not Assessable
Basic
Intermediate
Good
Excellent
🔒 Not Public

3.1.1 Product Information

Product Details	
Grade: Basic *Justification: As there is some required and recommended information (included in product metadata, documentation, etc.) missing, the status of this section of the maturity matrix has been graded as "Basic".*	
Product Name	*SP 03 – 08 videos* *GF03C 01 – 03 videos*
Sensor Name	*JL1SP03 – 08 (Satellite ID JL103B – JL1008B)* *JL1GF03C01 – 03 (Satellite ID JL1GF03C01 – 03)*
Sensor Type	*SP 03, 04 – 08 Video* *RGB (Bayer pattern)* *Red B1: 580-723 nm, 580-730 nm* *Green B2: 489-585 nm, 490-580 nm* *Blue B3: 437-512 nm, 430-520 nm* *GF03C 01 – 03* *RGB (Bayer pattern)* *Red B1: 580-730 nm* *Green B2: 490-580 nm* *Blue B3: 430-520 nm*
Mission Type	*Sub-constellation satellites*
Mission Orbit	*GF03C: Sun-synchronous (535 km altitude, descending node local 09:20)* *SP03-08: Sun-synchronous (535 km altitude, descending node local 10:30)*
Product Version Number	*/*
Product ID	*JL103B_MSS_20210526154839_200051060_101_001_L1B* *Satellite Name and number (JL103B), multispectral camera (MSS), Imaging Time (YYYYMMDDHHMMSS (Beijing Local)), Mission Planning Number, Segment Number, Scene Number, Production Times, Product Level.* *JL1GF03C01_MSS_20210614113746_200052709_101_001_L1B* *Satellite Name and number (JL1GF03C0x: 1 - 3), multispectral camera (MSS), Imaging Time (YYYYMMDDHHMMSS (Beijing Local)), Mission Planning Number, Segment Number, Scene Number, Production Times, Product Level.*
Product Processing Level	*The products used for these assessments are L1B.* *Description: Sensor corrected reflectance product. Atmospheric correction is applied to the data based on L1 products, provided with imagery RPC model files. Fusion processing is supported.* *Suggested Application: Used for professional ground object inversion applications.*

Measured Quantity Name	*Digital Numbers (8 bits)*
Measured Quantity Units	*Digital number*
Stated Measurement Quality	*Radiometric Quality: Not specified.* *Geometric Quality:* • *< 200 m (CE90) for Jilin-1 SP03 (without ground control points)* • *<100 m (CE90) for Jilin-1SP04–08 (without ground control points)* • *< 300m (CE90) for Jilin-1 GF03C (without ground control points)*
Spatial Resolution	*Very High Resolution* *Multispectral: 0.92 m at Nadir for Jilin-1 SP* *Multispectral: 1.2 m at Nadir for Jilin-1 GF03C*
Spatial Coverage	*Global (orbit inclination not provided)*
Temporal Resolution	*Revisit not provided*
Temporal Coverage	*Design life:* *Jilin-1 SP: 1 – 3 years* *Jilin-1 GF03C: /*
Point of Contact	*contact@head-aerospace.fr*
Product locator (DOI/URL)	*/*
Conditions for access and use	*/*
Limitations on public access	*The sensor products are made available upon request (orders / tasks are placed with the data provider's imagery support team: contact@head-aerospace.fr) or through their online catalogue (https://headfinder.head-aerospace.eu/pub).*
Product Abstract	*The standard license for imagery, adapted on a case-by-case basis (i.e. depending upon the needs of the user), is delivered to the customer by the Head Aerospace sales team (contact e-mail address provided above).*

Availability & Accessibility	
Grade: Basic *Justification: The products and their content meets some of the Findable, Accessible, Interoperable and Reusable (**FAIR**) Data Principles [RD-4] for scientific data management and stewardship. The data is available to users, at cost, through an easy-to-access commercial license.*	
Compliant with FAIR principles	*The product information (included in product metadata, etc.) provided meets partially some of the FAIR principles only.*
Data Management Plan	*This is not shared by the data provider.*
Availability Status	*As mentioned previously, the products are made available upon request (orders / tasks are placed with the data provider's imagery support team: contact@head-aerospace.fr) or through their online catalogue (https://headfinder.head-aerospace.eu/pub).*

Product Format, Metadata & Flags

Grade: Basic *Justification: The product format and content, in which standard file formats and naming conventions are generally used, is only partially described in [RD-3]; product metadata file format and content is not fully described and product quality metadata file format and content, with valuable / useful data, is not described at all (this includes units and how the values for quality parameters are calculated / determined).* *It is recommended that existing documentation be updated in order to ensure the format and contents of all products are confirmed (e.g. the document mentions the availability of radiometric calibration coefficient whereas they are not provided in the xml file).* *The data is not considered as analysis ready data (e.g. Committee for Earth Observing Satellites (**CEOS**) Analysis Ready Data, https://ceos.org/ard/).*	
Product File Format	*The product format ensures the following imagery and metadata files, adopting standard file formats includes video file, RPC model file, metadata file, and other auxiliary files:* • *RPC model file (_rpc.txt)* • *Stabilised video file (.avi)* • *Metadata file, including solar elevation and azimuth angle, satellite elevation and azimuth angle, imaging time, geography longitude and latitude and other basic information for advanced image exploitation (_meta.xml)* • *Coarse resolution (1:5) thumbnail for quick visual display (.jpg)* • *Coarse resolution (1:25) thumbnail for quick visual display (.jpg)* • *Layer vector map, representing the coverage of image (.shp)* • *Index file of geometric features for .shp file (.shx)* • *Projection information for .shp file (.prj)* • *Property sheet for .shp file (.dbf)*
Metadata Conventions	*Not implemented as optional (e.g. Geographic Information – Metadata ISO).*
Analysis Ready Data?	*No*

User Documentation		
Grade: Basic *Justification: The product user guides, provided upon request to the data provider, contains high-level information only (e.g. basic description of sensor, product type and processing level, spectral information and instructions that allow users to convert data from digital numbers to top-of-atmosphere reflectance). The product user guide, or any other documentation made available, does not contain algorithm theoretical basis document-type information. Therefore, the status of this section of the maturity matrix has been graded as "Basic".*		
Document	*Reference*	*QA4ECV Compliant*
Product User Guide (Chang Guang)	*[RD-3]*	*No*
Product User Guide (Head Aerospace)	*[RD-5]*	*No*
Algorithm Theoretical Basis Document	*Not provided.*	*N/A*

Metrological Traceability Documentation	
Grade: Not assessable.	
Traceability Chain / Uncertainty Tree Diagram Available	*Not provided.*
References	*N/A*

3.1.2 Product Generation

Sensor Calibration and Characterisation – Pre-Flight	
Grade: Basic *Justification: There is very basic information (i.e. stated values and not methodology used) provided on pre-launch radiometric calibration and characterisation, using the radiometric and spectral calibration test platform of Chang Guang Satellite Technology, only. As there is no information on pre-launch spectral or spatial calibration and characterisation activities, this section of the maturity matrix has been graded as 'Basic'.*	
Summary	*This document provides high-level information on the radiometric calibration of all sensors within the Jilin-1 constellation. However, the document is not made available to users.*
References	*[RD-10]*

Sensor Calibration and Characterisation – Post-Launch	
Grade: Not assessable.	
Summary	*Not provided.*
References	*N/A*

Additional / Mission Specific Processing	
Grade: Not assessable	
Summary	*Not provided.*
Reference	*N/A*

3.1.3 Ancillary Data

Ancillary Data	
Grade: Basic *Justification: The key ancillary data required to define measurement data has been provided but not the associated uncertainties and so this section of the maturity matrix has been graded as 'Basic'.*	
Description	*The product-specific ancillary data (e.g. viewing and solar geometry angles, longitude, latitude), used to define measurements, can be found in product metadata and general ancillary data (e.g. in-band solar irradiance) can be found in the product guide. However, uncertainties have not been quantified, where applicable, for ancillary data. Relative spectral response is not provided.*

Reference	*[RD-3]*

Product Flags	
Grade: Not Assessable *Justification: These products do not contain flags, in their conventional form, and so this section of the maturity matrix has been graded as 'Not Assessable'.*	
Description	*The products do not contain flags in the conventional form (e.g. bit settings) but they do contain quality information which can be used as flags (e.g. cloud content, product quality grade, etc.).*
Reference	*[RD-3]*

3.1.4 Uncertainty Characterisation

Uncertainty Characterisation Method	
Grade: Not Assessable *Justification: The methods used to characterise the uncertainties associated with geometric and radiometric calibration quality are not included in the documentation made available to users, and so this section of the maturity matrix has been graded as 'Not Assessable'.*	
Description	*Not provided.*
Reference	*N/A*

Uncertainty Sources Included	
Grade: Not Assessable *Justification: There is no information / documentation concerning the sources of uncertainty. Therefore, this section of the maturity matrix has been graded as 'Not Assessable'.*	
Description	*Not provided.*
Reference	*N/A*

Uncertainty Values Provided	
Grade: Not Assessable *Justification: The documentation does not provide any uncertainty values that could be used to characterise geometric performance per-product and for the mission as a whole only, and so this section of the maturity matrix has been graded as 'Not Assessable'.*	
Description	*Not provided.*
Reference	*N/A*

Geolocation Uncertainty	
Grade: Not Assessable *Justification: The geolocation uncertainty (i.e. geolocation accuracy) value is not provided.*	
Description	*Not provided.*

Reference	*N/A*

3.1.5 Validation

It is important to note this section, relating to the 'Validation' column of the maturity matrix, is based on the results of the data quality assessments performed by the EDAP Optical team **only** (i.e. **independently** of any data quality assessments performed by the data provider and / or operator).

Reference Data Representativeness	
Grade: Basic *Justification: The representativeness of used reference data (sensor data from similar or 'gold' standard missions, in-situ data, ground control data), against which this sensor data is compared against, is good but the variety of reference data is small compared with the reference data available. Therefore, this section of the maturity matrix has been graded as 'Basic'.*	
Summary	*(See above)*
References	-

Reference Data Quality and Suitability	
Grade: Basic *Justification: The reference data quality and suitability used by EDAP comes with comparison with an orthorectified multispectral imagery. As the radiometric calibration coefficients are not available, no comparison using PICS or RadCalNet data could be performed to validate the TOA reflectances. So, this section of the maturity matrix has been graded as 'Basic'.*	
Summary	*References such as RadCalNet data exists since videos have been acquired over three RadCalNet sites. But, as no calibration coefficient are available, the performance is not assessed.* *The data used as reference for the geometric calibration quality assessments include orthorectified multispectral imagery from Sentinel-2A.*
References	*[RD-6, RD-7]*

Validation Method	
Grade: Good *Justification: The validation methods used for geometry accuracy assessment relies on CNES tool used and so this section of the maturity matrix has been graded as 'Good'.*	
Summary	*The validation methods used to assess geometric calibration are all well-documented and used by the scientific community.*
References	*[RD-8]*

Validation Results
Grade: Intermediate *Justification: The validation results, from validation assessment performed independently of those performed by the operator, indicate there are a number of improvements that can be made to the data but the most important one relates to the geometric quality of the data (e.g. providing users with a refined RPC model) as this may have an impact on the applications of the data. The image quality of the data, from the perspective of using the data to detect and track objects, is*

sufficient (degradation in image quality expected for video data due to excessive, compared to still imagery, compression). Therefore, this section of the maturity matrix has been graded as 'Intermediate'.	
Summary	*The validation results of all assessments are summarised in Section 1.*
References	*See Section 4.*

4. DETAILED JILIN-1 SP & GF03C DATA QUALITY ASSESSMENTS

4.1 Objectives

The objective of this work is to assess all core aspects of sensor data quality (geometric calibration, radiometric calibration, image quality) against sensor and product performance requirements or specifications, using the sample of sensor products procured.

4.2 Geometric Calibration Quality

This section describes the assessment of geometric calibration quality, implemented by the processing chain, of sensor products in terms of **absolute geolocation accuracy**, **temporal geolocation accuracy** and **band co-registration accuracy**.

The products used for the assessments performed here, detailed in Table 4-1, correspond to the following regions of interest: Gobabeb (Namibia (NA)), Libya (desert near Egyptian border (LY)), Railroad Valley Playa (desert in Nevada (USA)), Baotou (China (CN)), Barcelona (Spain (ES)), Tarascon-sur-Ariège (France (FR)) and Toulouse (France (FR)).

Note for each product assessed, the Rational Polynomial Coefficients (**RPC**) model, found in the product .rpc file, and the main frame, extracted from the video sequence according to the major frame index found in the product metadata .xml file, are used.

Table 4-1: Geometric Calibration Quality Assessment Product Sample

Product acquisition date (Satellite ID)	Site	Country
2021-05-26 (JL103B)	Gobabeb	NA
2021-06-04 (JL103B)	Libya	LY
2021-06-15 (JL103B)	Libya	LY
2021-06-07 (JL103B)	RRVP Nevada	US
2021-06-17 (JL1GF03C02)	Baotou	CN
2020-11-21 (JL1GF03C01)	Barcelona	ES
2021-06-25 (JL1GF03C02)	RRVP Nevada	US
2021-07-11 (JL1GF03C03)	Tarascon-sur-Ariège	FR
2021-06-26 (JL1GF03C01)	Toulouse Airport-(<10°)	FR
2021-07-18 (JL1GF03C01)	Toulouse Airport-(<10°)	FR
2021-07-01 (JL1GF03C03)	Toulouse Airport-(<10°)	FR
2021-07-19 (JL103B)	Toulouse Airport-(>30°)	FR

4.2.1 Absolute Geolocation Accuracy

4.2.1.1 Description and Method

The following data preparation method, applied to the sensor data, is adopted for this assessment:

1. The RPC model provided in the product is used to compute the UTM cartographic coordinates of the major frame image corners (i.e. defining the bounding box). This is illustrated in Figure 4-1.

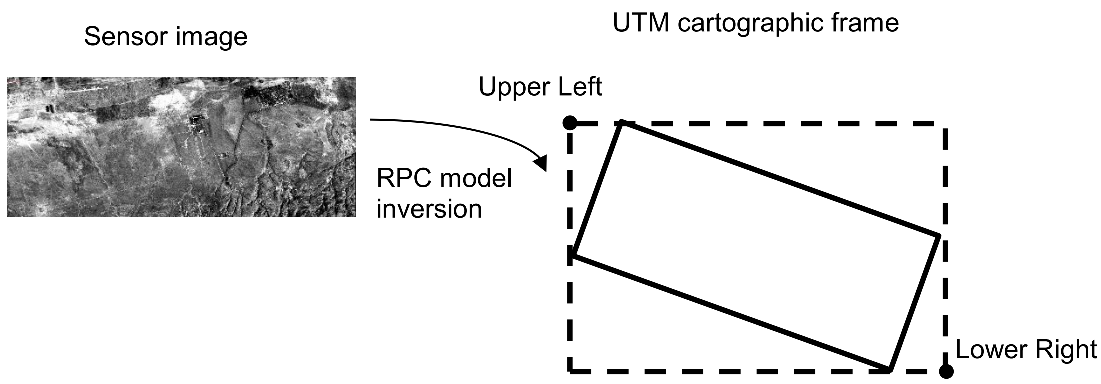


Figure 4-1: Illustration of the UTM cartographic coordinates computation.

2. The resampling grid (UTM geometry to sensor geometry) is then computed using the Magellium Euclidium tool, also taking into account a digital terrain model (SRTM90). This is illustrated in Figure 4-2.

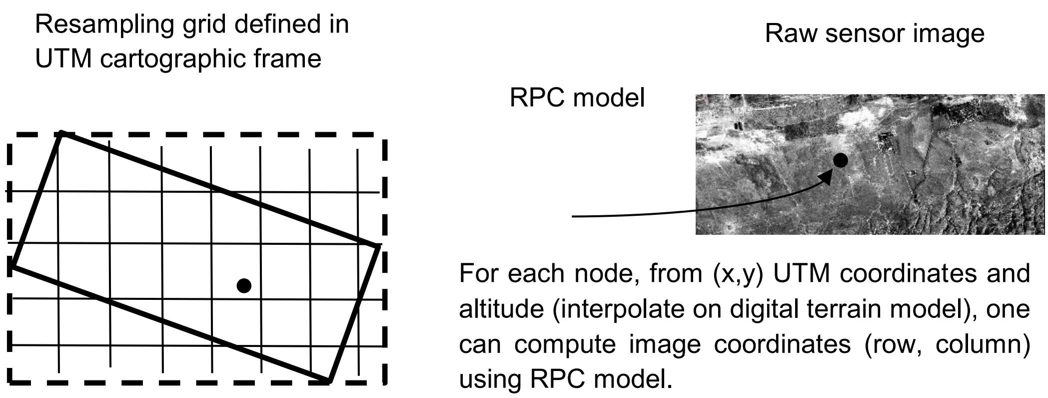


Figure 4-2: Illustration of resampling grid computation.

3. The raw sensor image in UTM geometry is then resampled, using the CNES Orion tool, to the approximate sensor spatial resolution (1.0 m). This is illustrated in Figure 4-3.

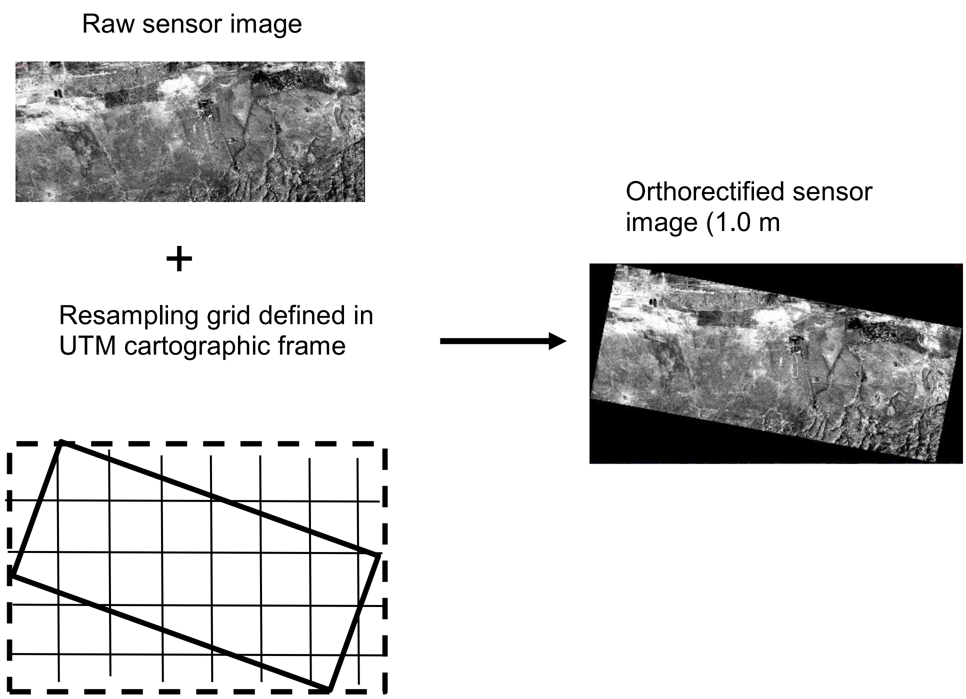


Figure 4-3: Illustration of the resampling.

4. The orthorectified image is then sub-sampled in order to obtain an image at the same spatial resolution of the reference sensor, Sentinel-2, (band 4) orthorectified image (10.0 m), and this is necessary for the dense image matching performed at a later stage. This is illustrated in Figure 4-4.

   Note the absolute geolocation accuracy of orthorectified imagery from Sentinel-2 is < 6 m [RD-7].

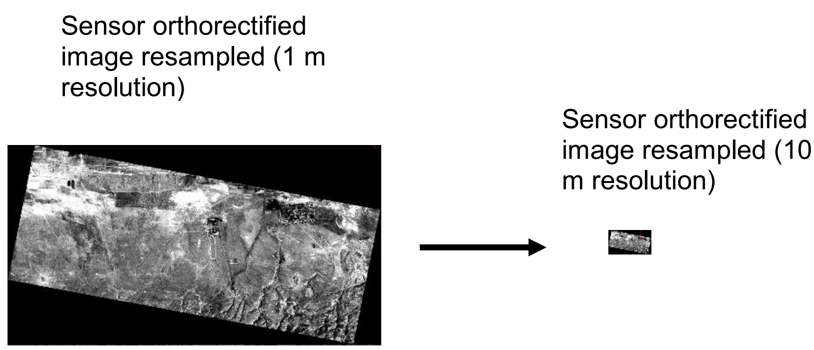


Figure 4-4: Illustration of sub-sampling spatial resolution.

5. The previously defined bounding box (i.e. region of interest (**ROI**)) is extracted from the Sentinel-2 orthorectified tile (L1C, 100 km x 100 km). This is illustrated in Figure 4-5.

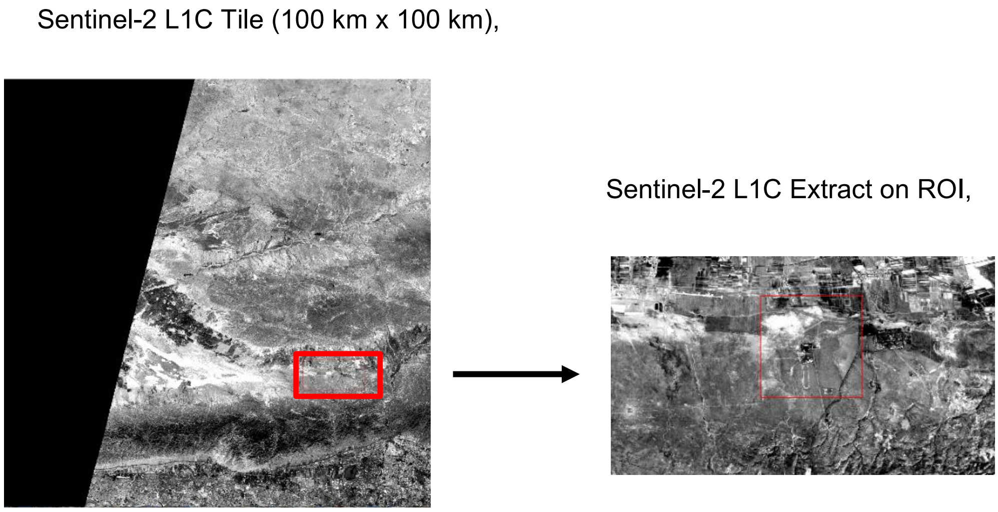


Figure 4-5: Illustration of the Sentinel-2 L1C ROI extraction.

Once the data has been suitably prepared, the following method is adopted by this assessment:

1. The two images are now in the same geometry (UTM cartographic projection). As the shifts between the two images are most likely not simply due to bias, we take a sample of tie points, illustrated in Figure 4-6, in order to compute an approximate model (translation, rotation and homothety). This approximate model is used as input for dense image matching (correlation).

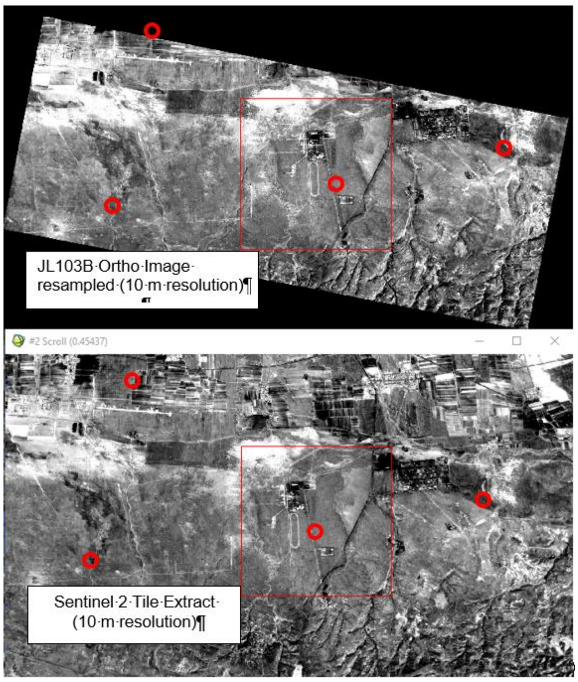


Figure 4-6: Illustration of tie point and ROI selection.

2. By using the approximate model as a prediction, dense image matching can then be performed using the zero-normalised cross-correlation algorithm provided by the CNES QPEC / Medicis tool RD-8].

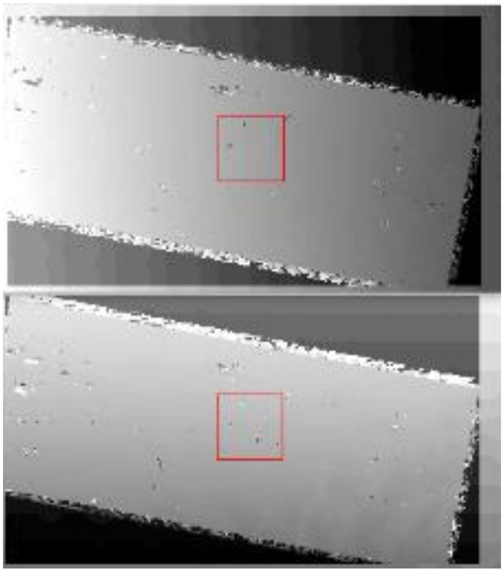


Figure 4-7: Illustration of the resulting shifts in row and column from dense image matching.

3. The global statistics are computed, including the mean shifts line by line or column by column, as illustrated in Figure 4-7, just in case deformation is not simply due to bias.

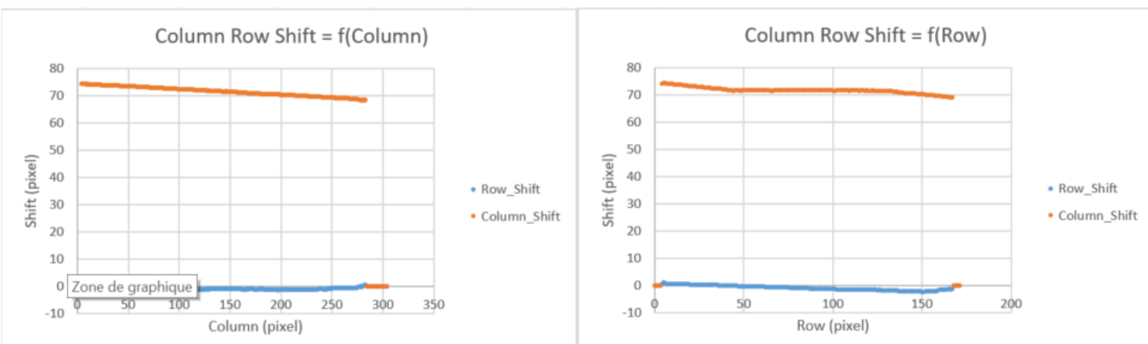
4.2.1.2 Results

The results of this assessment are detailed in Table 4-2 and Figure 4-8. Note the results are given in **pixels** (**1 pixel = 10 m** because the lowest spatial resolution was chosen (i.e. spatial resolution of Sentinel-2)).

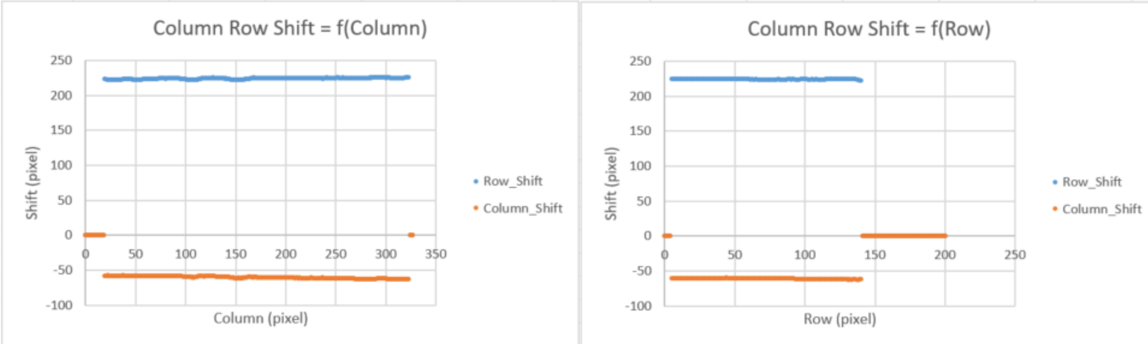
Table 4-2: Absolute Geolocation Accuracy Assessment Results

Product / Site	Mean Row Shift	Std Dev Row Shift	Mean Column Shift	Std Dev Column Shift	Valid points %
2021-05-26 (JL103B) Gobabeb NA	-1.02	0.94	71.72	1.67	68%
2021-06-04 (JL103B) Libya LY	224.66	1.51	-60.37	1.85	49%
2021-06-15 (JL103B) Libya LY	1.46	1.52	46.78	2.03	46%
2021-06-07 (JL103B) RRVP Nevada US	66.06	0.77	28.56	2.00	59%
2021-06-17 (JL1GF03C02) Baotou CN	-11.65	2.44	54.67	5.16	65%
2020-11-21 (JL1GF03C01) Barcelona ES	46.41	2.44	11.80	1.75	14%
2021-06-25 (JL1GF03C02) RRVP Nevada US	33.54	2.78	-2.90	5.67	42%
2021-07-11 (JL1GF03C03) Tarascon-sur-Ariege FR	-30.48	2.86	-271.13	1.46	55%
2021-06-26 (JL1GF03C01) Toulouse Airport (<10°) FR	53.61	1.35	13.05	2.72	58%
2021-07-18 (JL1GF03C01) Toulouse Airport (<10°) FR	58.29	1.49	8.88	2.65	64%
2021-07-01 (JL1GF03C03) Toulouse Airport (<10°) FR	53.01	1.22	-182.48	1.56	60%
2021-07-19 (JL103B) Toulouse Airport (>30°) FR	- 175.95	0.31	-266.93	1.23	75%

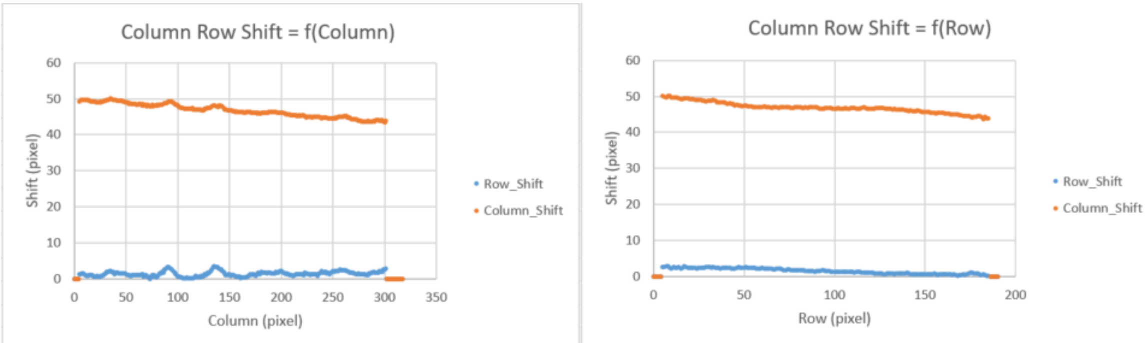
2021-05-26 (JL103B) Gobabeb NA



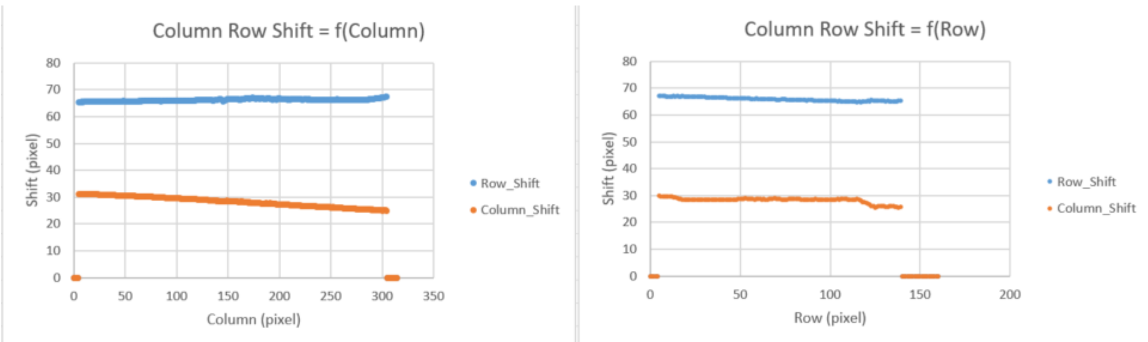
2021-06-04 (JL103B) Libya LY



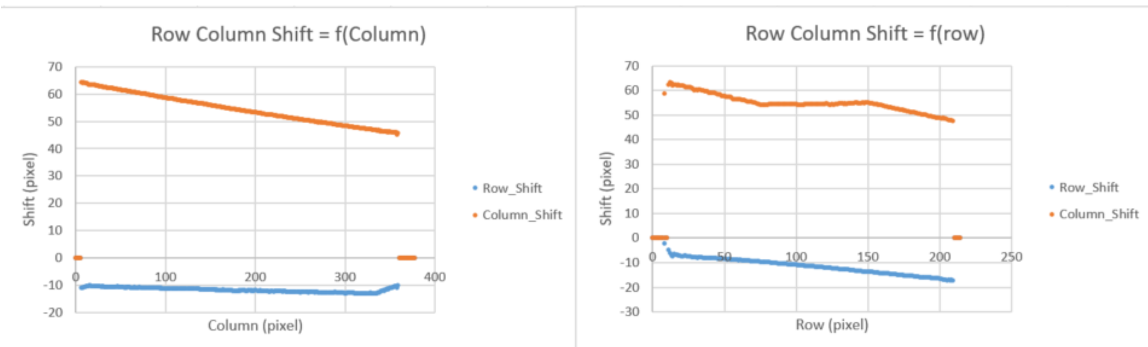
2021-06-15 (JL103B) Libya LY



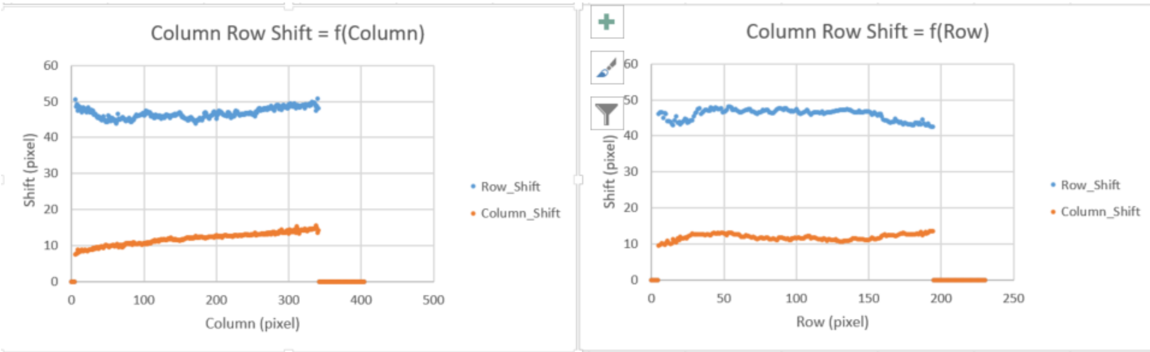
2021-06-07 (JL103B) RRVP Nevada US



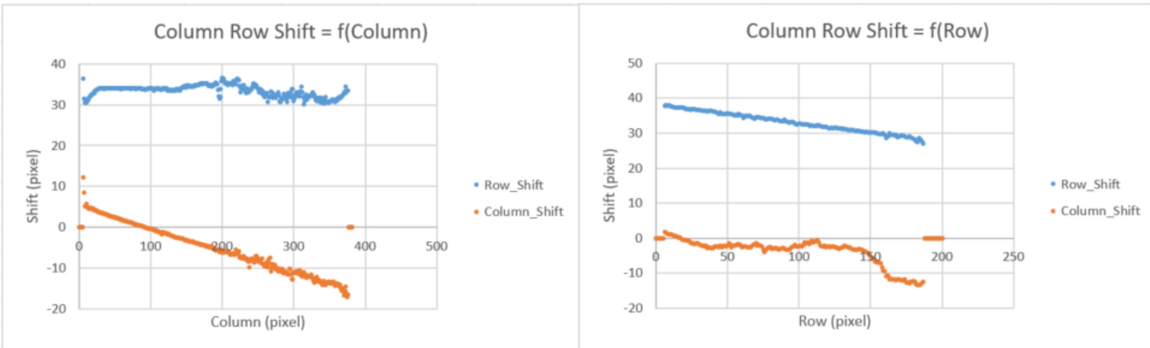
2021-06-17 (JL1GF03C02) Baotou CN



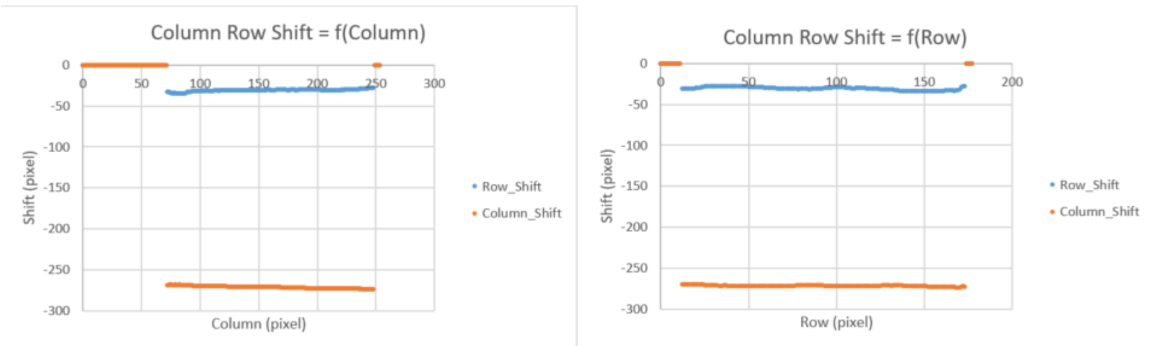
2020-11-21 (JL1GF03C01) Barcelona ES



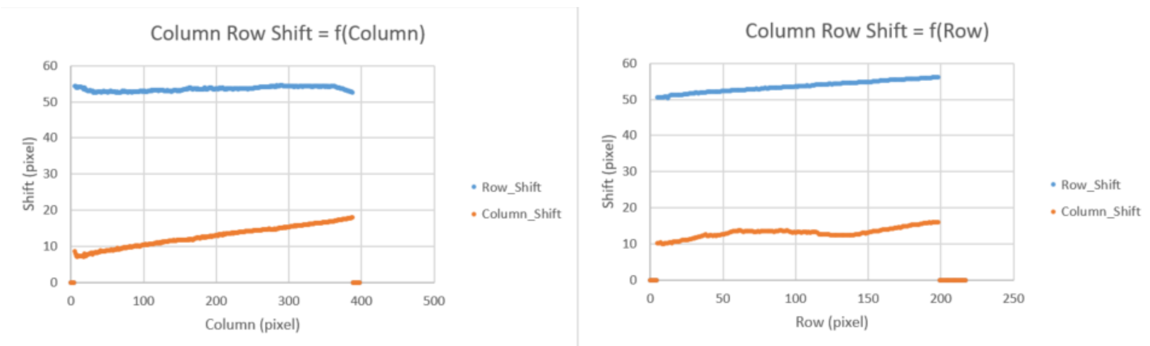
2021-06-25 (JL1GF03C02) RRVP Nevada US



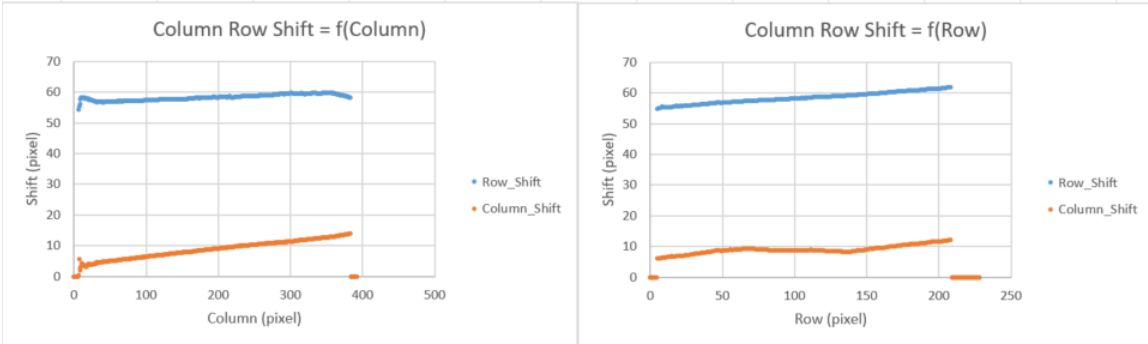
2021-07-11 (JL1GF03C03) Tarascon-sur-Ariège FR



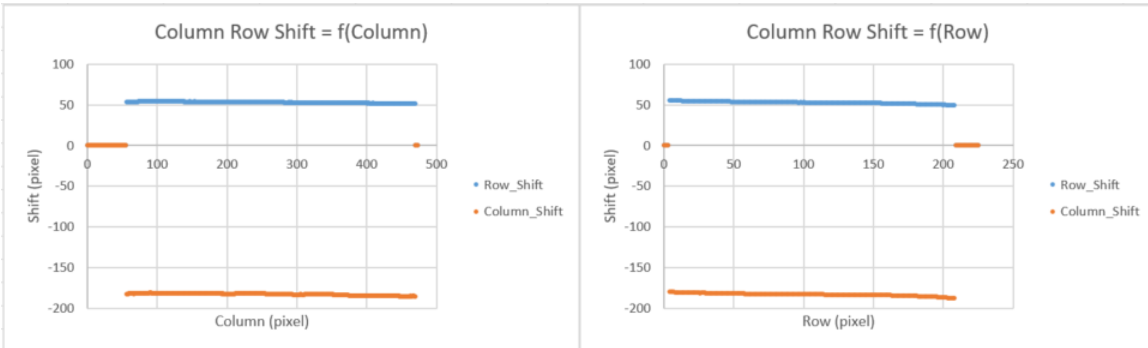
2021-06-26 (JL1GF03C01) Toulouse-airport-(Less-than-10-degrees) FR



2021-07-18 (JL1GF03C01) Toulouse-airport-(Less-than-10-degrees) FR



2021-07-01 (JL1GF03C03) Toulouse-airport-(Less-than-10-degrees) FR



2021-07-19 (JL103B) Toulouse-airport-(More-than-30-degrees) FR

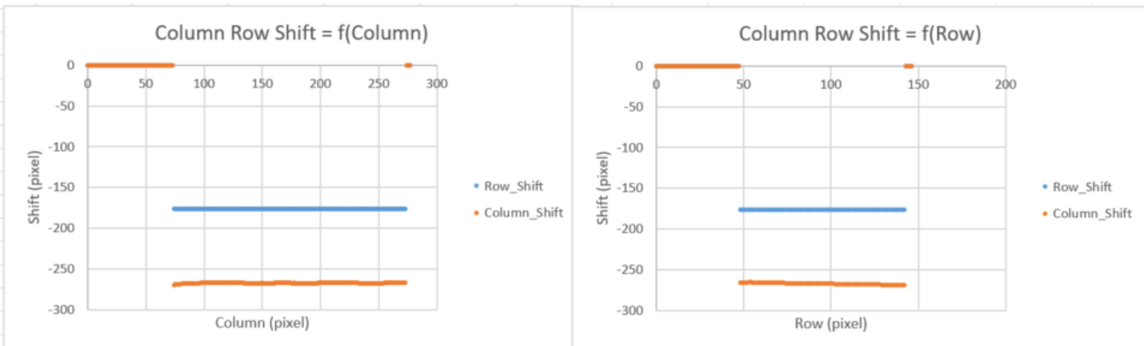


Figure 4-8 Dense image matching results for all products assessed.

The results generally indicate the absolute geolocation accuracy appears to be degraded (shifts are of the order of a few hundred metres most of the time), and highly variable, for each product assessed. This may be due to having only the RPC model from the L1B products used to evaluate this metric, which was probably built with raw geometric ancillary data (ephemeris, attitudes, etc.) which are not accurate.

The minimum performance requirement specified by the operator as 200 m and 300 m for Jilin-1 SP03 and GF03C, respectively, is not met.

Note this can be confirmed visually by looking at the geographical location of the bounding boxes, as it is illustrated in Figure 4-9.

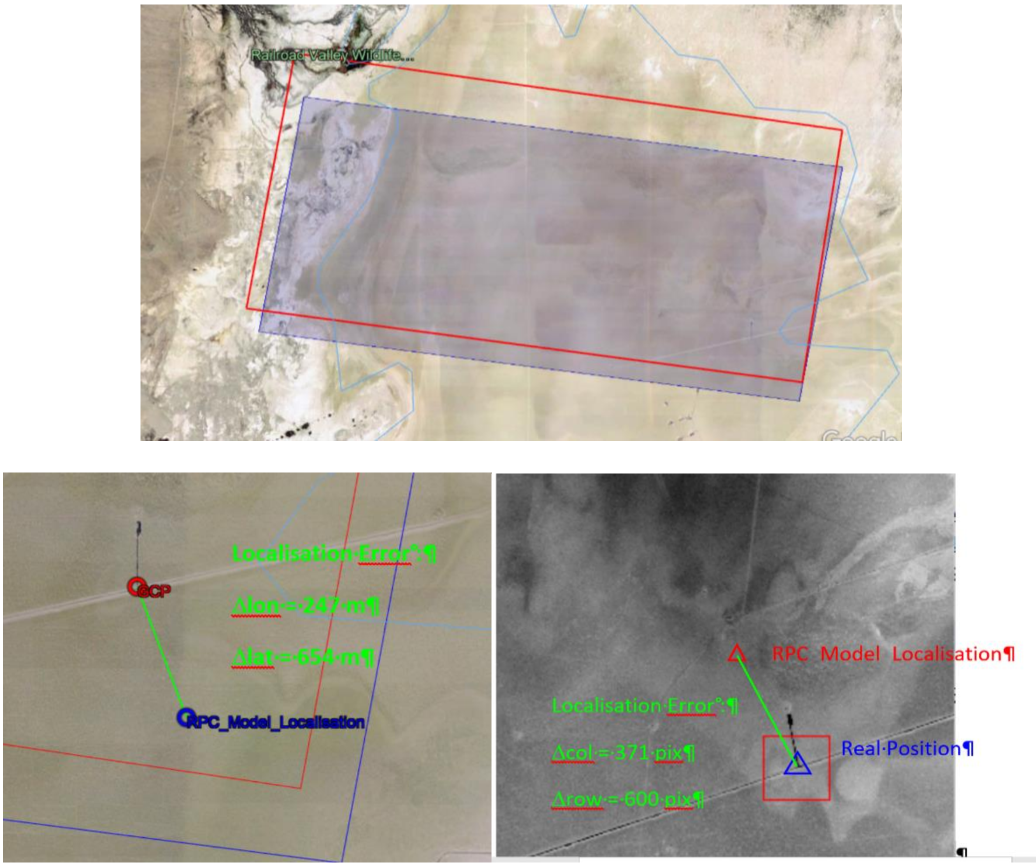


Figure 4-9: Overview in Google Earth of geometry products accuracy.

To improve absolute geolocation accuracy, it is recommended the RPC model be refined with ground control points.

4.2.2 Temporal Geolocation Accuracy

4.2.2.1 Description and Method

The method adopted for this assessment is performed as follows:

1. The bounding box of a series of images (i.e. major frames) over a common area are computed (using the aforementioned RPC models). This is illustrated in Figure 4-10.

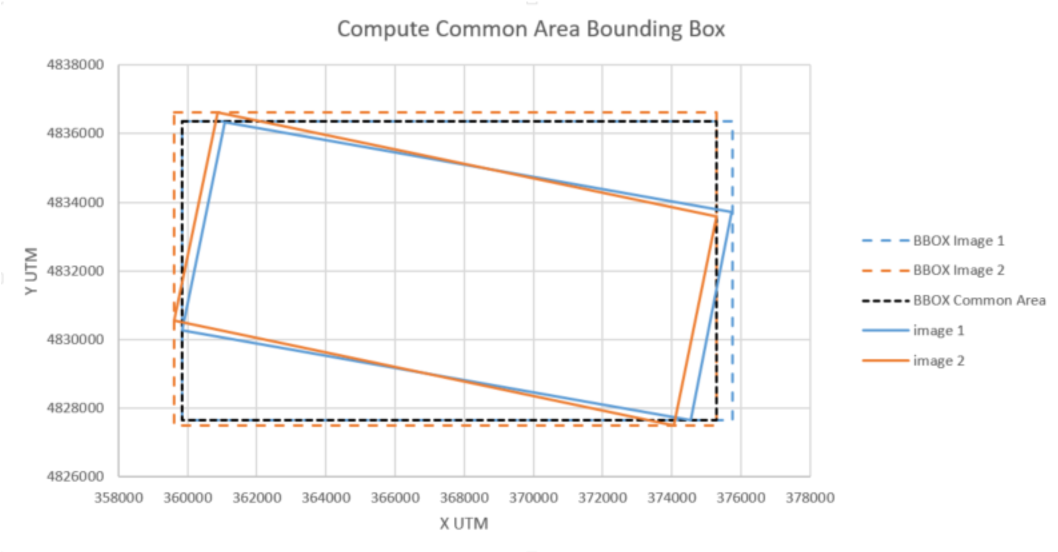


Figure 4-10: Illustration of computing the bounding box location.

2. The resampling grids are computed, for the bounding box of each image in the image series assessed. This is illustrated in Figure 4-11.

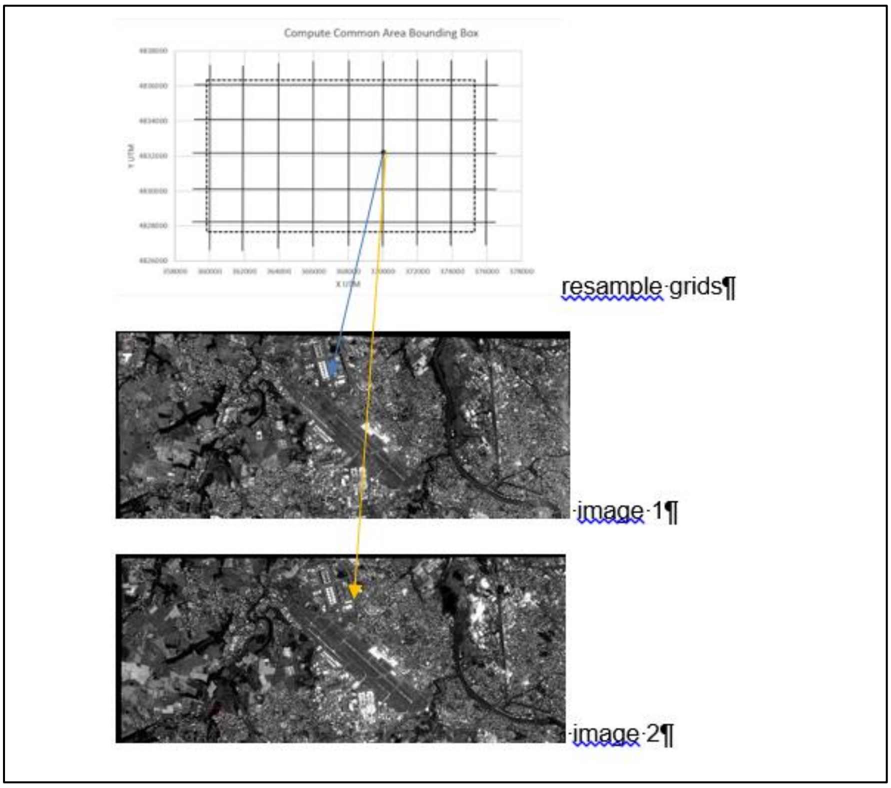


Figure 4-11: Illustration of resampling grid computation.

3. The images are resampled in the same geometry (UTM projection) in order to get a temporal image series to compare using dense image matching. This is illustrated in Figure 4-12.

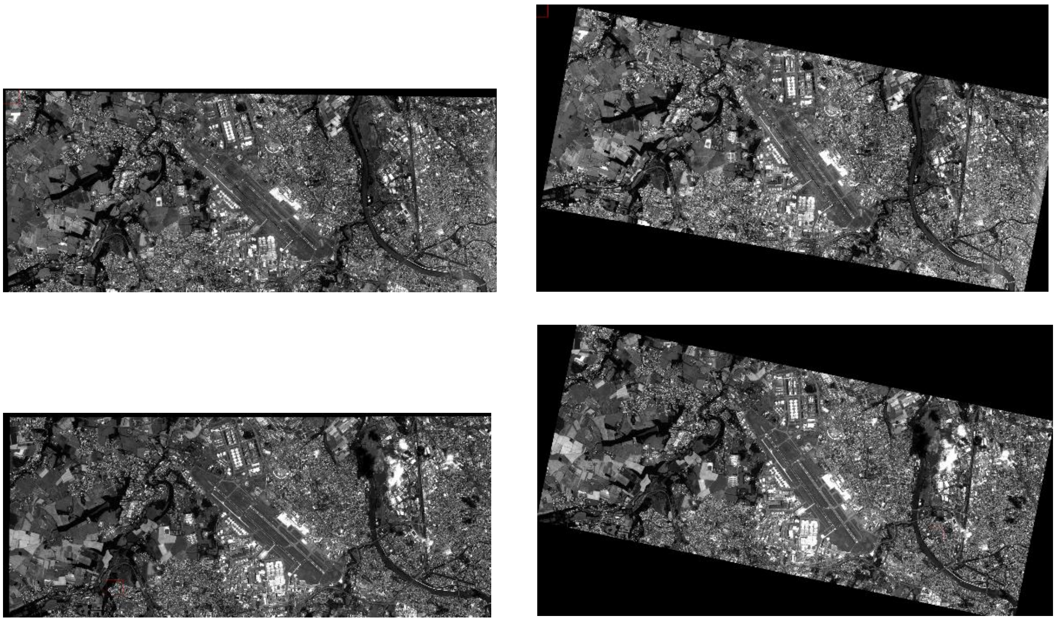


Figure 4-12: Illustration of image resampling.

4. The approximate models, as a prediction, are computed between images using tie points, illustrated in Figure 4-13, and then used as input for dense image matching.

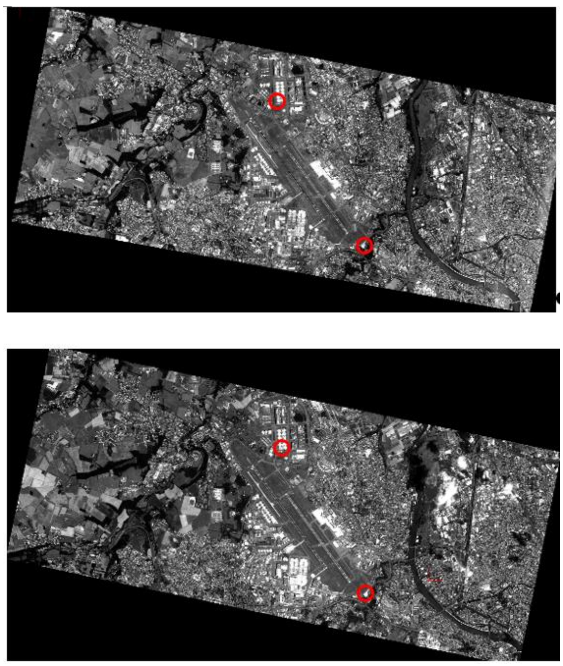
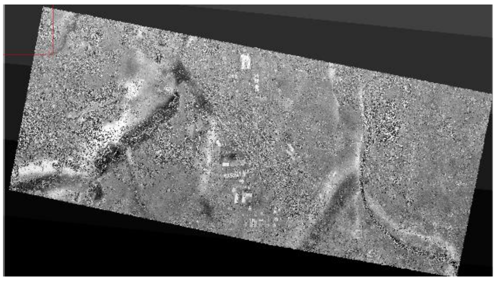
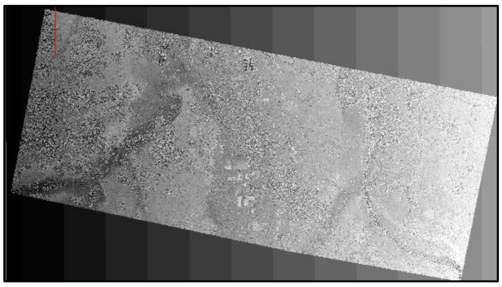


Figure 4-13: Illustration of the tie point locations used to compute approximate models.

5. The global statistics are computed, including the mean shifts line by line or column by column, as illustrated in
6. Figure 4-14, just in case deformation is not simply due to bias.



Column shifts



Row shifts

Figure 4-14: Illustration of the resulting row and column shifts, computed using dense Image matching.

4.2.2.2 Results

The results of this assessment are detailed in Table 4-3 and Figure 4-15 - Figure 4-16. Note the results are given in pixels (**1 pixel = 1 m** because comparisons are made with orthorectified images JL103B / JL1GF03C at this spatial resolution).

Table 4-3: Temporal Geolocation Accuracy Assessment Results

Images Pairs/ Site	Mean Row Shift	StdDev Row Shift	Mean Column Shift	StdDev Column Shift	Valid points %
2021-06-04 (JL103B) LY 2021-06-15 (JL103B) LY	-2223.44	6.39	1065.47	6.05	6%
2021-06-26 (JL1GF03C01) FR 2021-07-18 (JL1GF03C01) FR	48.94	3.37	-37.97	1.72	23%

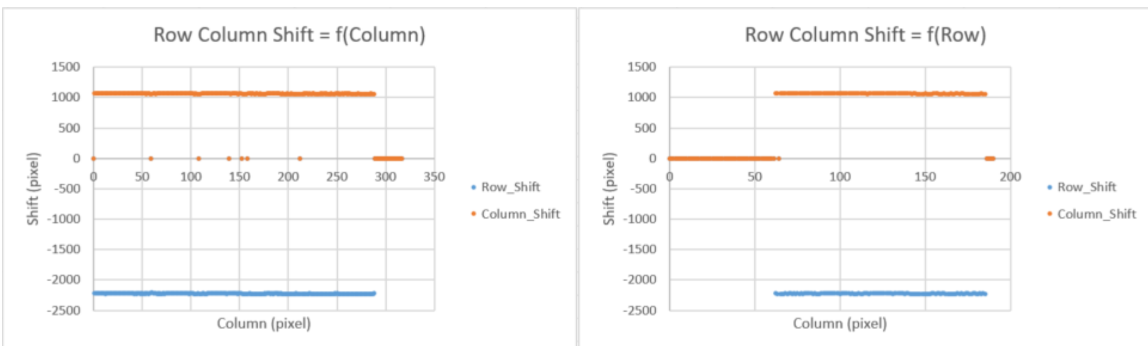


Figure 4-15: Temporal geolocation shift between pair of 2021-06-04 (JL103B) and 2021-06-15 (JL103B) Libya images.

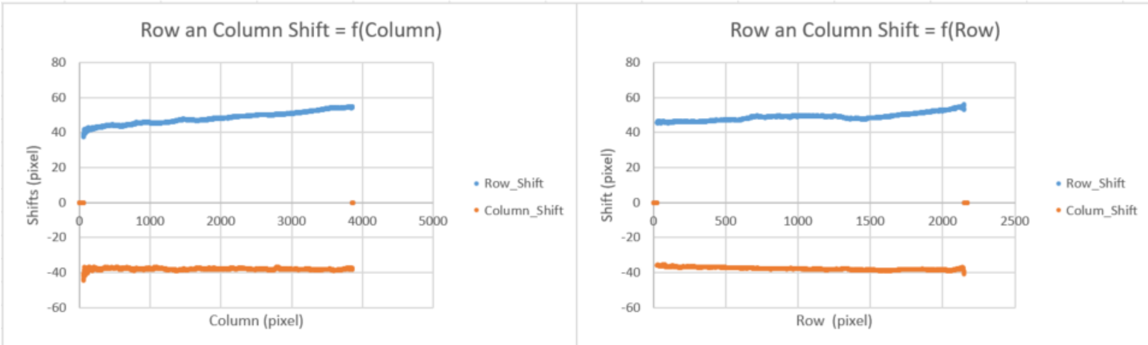


Figure 4-16: Temporal geolocation shifts between pairs of images 2021-06-26 (JL1GF03C01) and 2021-07-18 (JL1GF03C01) Toulouse Airport images.

The general results of this assessment indicate the temporal geolocation accuracy is degraded (as expected based on the general results of the absolute geolocation accuracy assessment) and this is most likely due to the same reason that the RPC models should have been generated using a refined physical model). The estimated shifts, in both directions, are of the order of a few kilometres over desert sites and sub-kilometre over urban sites (e.g. Toulouse) and appear to correspond to a bias and a rotation.

Note it may be difficult to rely on the video products for geophysical applications due to the degraded temporal geolocation accuracy.

4.2.3 Band Co-registration Accuracy

4.2.3.1 Description and Method

The band co-registration accuracy assessment method is based on the following:

- Compare the geometry between two image bands by using dense image matching;
- Evaluate the geometric registration between each band pair, using band 1 as the reference band (i.e. b1b2, b1b3);
- Compute error budget, per site analysis and output global statistics.

For each band pair, the CNES QPEC / Medicis tool is used to estimate the geometric registration (or band pair displacement) in both row and column directions.

4.2.3.2 Results

The results of this assessment are detailed in Table 4-4. Note the results are given in pixels (**1 pixel ~ 1 m** because the spatial resolution of the JL103B and JL1GF03C raw images).

Table 4-4: Band Co-registration Accuracy Assessment Results

Product / Site	Bands	Mean Row Shift (pixel)	StdDev Row Shift (pixel)	Mean Column Shift (pixel)	StdDev Column Shift (pixel)	Valid points %
2021-05-26 (JL103B) Gobabeb NA	B1-B2	**0.002**	0.218	**-0.008**	0.22	63%
	B1-B3	**0.003**	0.348	**-0.002**	0.355	53%
2021-06-04 (JL103B) Lybia LY	B1-B2	**-0.000**	0.121	**-0.002**	0.122	57%
	B1-B3	**-0.000**	0.201	**-0.002**	0.193	54%
2021-06-07(JL103B)RRVP Nevada US	B1–B2	**0.000**	0.056	**-0.001**	0.057	63%
	B1-B3	**0.000**	0.070	**-0.002**	0.072	65%
2021-06-17 (JL1GF03C02) BAOTOU CN	B1–B2	**-0.000**	0.115	**-0.001**	0.121	87%
	B1-B3	**0.000**	0.134	**-0.000**	0.137	82%
2020-11-21 (JL1GF03C01) Barcelona ES	B1–B2	**-0.012**	0.279	**-0.016**	0.224	69%
	B1-B3	**-0.020**	0.408	**-0.017**	0.317	60%
2021-06-25 (JL1GF03C02) RRVP Nevada US	B1–B2	**0.000**	0.103	**0.002**	0.002	60%
	B1-B3	**0.001**	0.116	**0.002**	0.113	68%
2021-07-11 (JL1GF03C03) Tarascon-sur-Ariege FR	B1–B2	**0.001**	0.149	**0.001**	0.168	85%
	B1-B3	**-0.001**	0.176	**0.003**	0.196	77%
2021-06-26 (JL1GF03C01) Toulouse-airport -(Less-than-10-degrees) FR	B1–B2	**0.009**	0.217	**0.015**	0.215	77%
	B1-B3	**0.010**	0.247	**0.017**	0.242	73%
2021-07-18 (JL1GF03C01) Toulouse-airport -(Less-than-10-degrees) FR	B1–B2	**0.009**	0.189	**0.014**	0.189	82%
	B1-B3	**0.011**	0.230	**0.018**	0.228	79
2021-07-01 (JL1GF03C03) Toulouse-airport -(Less-than-10-degrees) FR	B1–B2	**0.009**	0.185	**0.021**	0.187	81%
	B1-B3	**0.011**	0.216	**0.024**	0.214	78%
2021-07-19 (JL103B) Toulouse-airport -(More-than-30-degrees) FR	B1–B2	**-0.000**	0.168	**0.009**	0.185	87%
	B1-B3	**0.000**	0.229	**0.011**	0.248	81%

4.3 Radiometric Calibration Quality

This section describes the assessment of radiometric calibration quality of sensor products, in terms of **absolute** and **temporal radiometric calibration accuracy**; the absolute accuracy can be determined using data from RadCalNet sites, whereas temporal accuracy can be determined using ocean and desert sites.

The products that can be used for these assessments are detailed in Table 4-5; the first four video products can be used for the assessment of the absolute radiometric accuracy (cross-validation with data from RadCalNet) and the last seven products can be used for the assessment of the relative radiometric accuracy (i.e. cross-validation with a reference sensor).

Table 4-5: Sites and data used for radiometric calibration assessment

	Site	Satellite ID	Product ID
1	Baotou	Jilin-1 GF03C02	JL1GF03C02_MSS_20210617102314_200052997_101_001_L1B
2	Gobabeb	Jilin-1 SP03	JL103B_MSS_20210526154839_200051060_101_001_L1B
3	RRVP[1]	Jilin-1 SP03	JL103B_MSS_20210607010204_200052177_101_001_L1B
4	Nevada	Jilin-1 GF03C02	JL1GF03C02_MSS_20210625011920_200053727_101_001_L1B
5	Libya	Jilin-1 SP03	JL103B_MSS_20210604155000_200051959_101_001_L1B
6			JL103B_MSS_20210615154721_200052883_101_001_L1B
7	SIO	Jilin-1 SP03	JL103B_MSS_20210614112540_200052774_101_001_L1B
8		Jilin-1 GF03C01	JL1GF03C01_MSS_20210614113746_200052709_101_001_L1B
9			JL1GF03C01_MSS_20210625114029_200053715_102_001_L1B
10		Jilin-1 GF03C02	JL1GF03C02_MSS_20210620115215_200053288_102_001_L1B
11			JL1GF03C02_MSS_20210622113533_200053420_102_001_L1B

In addition to the sensor data detailed above, the required ancillary information, extracted from the product guide or the product metadata, includes the following: the spectral band location, solar irradiance and relative spectral response for each spectral band (see Figure 4-17 - Figure 4-18) and the radiometric calibration coefficients. However, the latter required ancillary information (i.e. the radiometric calibration coefficients) are missing from the product data (unexpected as it is mentioned in the product guide, clips shown in Figure 4-17 - Figure 4-18) and so the assessment of the absolute and temporal radiometric accuracy could not be performed.

Warning The metadata `<ProcessInfo>` and thus, the calibration coefficients, which are presented in the screenshots above (Figure 4-17 and Figure 4-18), are not provided within the .xml metadata of the products.

Note the assessment of the temporal radiometric accuracy was not performed, mainly due to the absence of the radiometric calibration coefficients as mentioned previously, but also due to the small sample of products being from different satellites so a suitable, temporal series could not be constructed.

[1] *RRVP – Railroad Valley Playa*

Table 3.1 The Parameters of Jilin-1SP03

Attribute	Value
Imaging mode	Staring imaging, Low light level imaging
GSD (at nadir)	0.92 m
Spectral bands	RGB (Bayer pattern) Red B1: 580-723 nm Green B2: 489-585 nm Blue B3: 437-512 nm
Dynamic range	8 bits
Standard scene size (at nadir)	11.0 km × 4.6 km
Orbit	Type: Sun-synchronous Altitude: 535 km Local time at descending node: 10:30 am

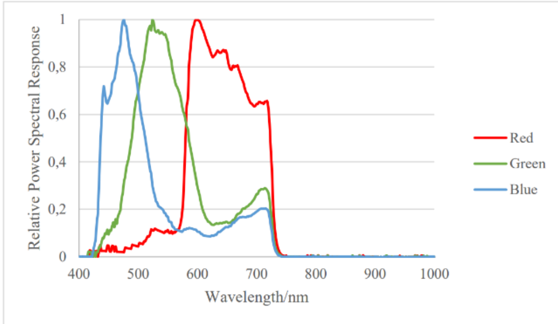


Figure 3.1 Jilin-1SP03 MSS Relative Spectral Response

Table 3.2 Spectral Calibration Results of Jilin-1SP03 MSS

Spectral Band	50% Response Wavelength		Center	Spectral Width
	Rising Edge (nm)	Falling Edge (nm)	Wavelength (nm)	(nm)
Red	580	723	651.5	143
Green	489	585	537	96
Blue	437	512	474.5	75

Table 3.3 Solar Spectral Irradiance of Jilin-1SP03 MSS

[Unit: W/(m^2. μm)]

Spectral Band	R	G	B
Spectral Irradiance	1629.7	1811.5	1867.2


```
<ProcessInfo>
    <ProductTime>2018-08-18 10:37:11</ProductTime>
    <ProductCity>ChangChun</ProductCity>
    <DataSource>RAW</DataSource>
    <RadiometricCalibrationInfo>NULL</RadiometricCalibrationInfo>
    <RadiometricMethod>REL</RadiometricMethod>
    <!--<ARCCoeff>gain offset</ARCCoeff>,L=DN*gain+offset,W*m^(-2)*sr^(-1)*um^(-1)-->
    <RedAbsRadioCalibrationCoeff>0.000722 0.015718</RedAbsRadioCalibrationCoeff>
    <GreenAbsRadioCalibrationCoeff>0.001910 0.038906</GreenAbsRadioCalibrationCoeff>
    <BlueAbsRadioCalibrationCoeff>0.004449 0.092277</BlueAbsRadioCalibrationCoeff>
    <MtfCompensation>NO</MtfCompensation>
    <GeometricCalibrationInfo>NULL</GeometricCalibrationInfo>
    <GeometryMethod>SEC</GeometryMethod>
    <HeightMode>DEM</HeightMode>
    <BayerMethod>SCALE</BayerMethod>
</ProcessInfo>
```


Figure 4-17: Spectral information for Jilin-1 SP03.

Table 3.38 The Parameters of Jilin-1GF03C

Attribute	Value
Imaging mode	Staring imaging
GSD (at nadir)	1.2 m
Spectral bands	RGB (Bayer pattern) Red B1: 580-730 nm Green B2: 490-580 nm Blue B3: 430-520 nm
Dynamic Range	8 bits / 12 bits
Standard scene size (at nadir)	14.4 km × 6 km
Orbit	Type: Sun-synchronous Altitude: 535 km Local time at descending node: 9:20 am

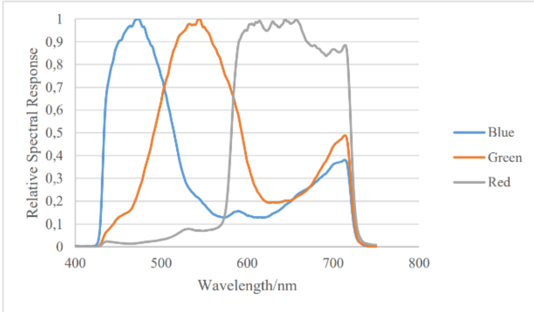


Figure 3.44 Jilin-1GF03C02 PMS Relative Spectral Response

Table 3.47 Spectral Calibration Results of Jilin-1GF03C02 PMS

Spectral Band	50% Response Wavelength		Center Wavelength (nm)	Spectral Width (nm)
	Rising Edge (nm)	Falling Edge (nm)		
Red	581.72	720.91	651.32	139.18
Green	491.51	593.76	542.63	102.26
Blue	433.57	515.01	474.29	81.44

Table 3.50 Solar Spectral Irradiance of Jilin-1GF03C

[Unit: W/(m^2.μm)]

Band		R	G	B
Spectral Irradiance	JL1GF03C01_PMS	1608.38	1785.91	1839.16
	JL1GF03C02_PMS	1611.03	1787.61	1837.56
	JL1GF03C03_PMS	1610.14	1785.92	1833.21


```xml
<ProcessInfo>
    <ProductTime>2021-03-01 02:31:51</ProductTime>
    <ProductCity>Changchun</ProductCity>
    <DataSource>RAW</DataSource>
    <RadiometricCalibrationInfo>Model</RadiometricCalibrationInfo>
    <RadiometricMethod>null</RadiometricMethod>
    <!--<ARCCoeff>gain,offset</ARCCoeff>,L=DN*gain+offset,W*m^(-2)*sr^(-1)*um^(-1)-->
    <RedAbsCalibrationCoeff>0.000296,0.014166</RedAbsCalibrationCoeff>
    <GreenAbsCalibrationCoeff>0.000319,0.013368</GreenAbsCalibrationCoeff>
    <BlueAbsCalibrationCoeff>0.000473,0.009222</BlueAbsCalibrationCoeff>
    <MtfCompensation>no</MtfCompensation>
    <GeometricCalibrationInfo />
    <GeometryMethod>SEC</GeometryMethod>
    <HeightMode>DEM</HeightMode>
    <BayerMethod>SCALE</BayerMethod>
</ProcessInfo>
```


Figure 4-18 : Spectral information for Jilin-1GF03C02.

4.4 Image Quality

This section describes the assessment of product image quality on the supplied sensor products in terms of **Signal-to-Noise Ratio** (**SNR**), **Modulation Transfer Function** (**MTF**) and **Object Detection and Tracking** (**Image Interpretability)**.

4.4.1 Signal-to-Noise Ratio

The assessment of SNR could not be performed as the radiometric calibration coefficients required to convert to TOA radiance were not provided. Note no minimum performance requirement has been specified.

4.4.2 Modulation Transfer Function

The assessment of the MTF could not be performed as data has been compressed (either onboard or by ground segment) and resampled. In addition to the latter, the radiometric interpolation of aliased data makes it impossible to measure the MTF of the sensor. Note no minimum performance requirement has been specified.

4.4.3 Object Detection and Tracking

4.4.3.1 Description and Method

This assessment has been performed using video products acquired over urban sites (i.e. where there are plenty of objects to detect and track).

The video products were first examined visually by our experts; the typical sizes of objects, in pixels, were measured and references to the Johnson criteria [RD-9] which allows for calculating the maximum range at which object detection, recognition and identification could take place, with a 50% probability of success.

- Detection: The ability to detect if there is some ‘thing' vs. nothing.
- Recognition: The ability to recognise what type of thing it is (person, animal, vehicle, etc.).
- Identification: The ability to identify the specific type of thing it is (i.e. type of vehicle (e.g. truck, lorry)).

The Johnson Criteria is calculated based on how many pixels are necessary in order to make an accurate evaluation of your object. The values are as follows:

- Detection: 2 vertical pixels of the target are visible.
- Recognition: 8 vertical pixels of the target are visible.
- Identification: 14 vertical pixels of the target are visible.

4.4.3.2 Results

4.4.3.2.1 Detection

The assessment of the Barcelona video (see Figure 4-19) shows that vehicles on the streets should be detectable but the poor image quality, caused by JPEG compression, makes this a tough challenge (with single frames, this same task would be an even tougher challenge). Therefore, the best way to perform this assessment would be to use movement detection algorithms using consecutive frames, but only moving vehicles can be detected in this way.

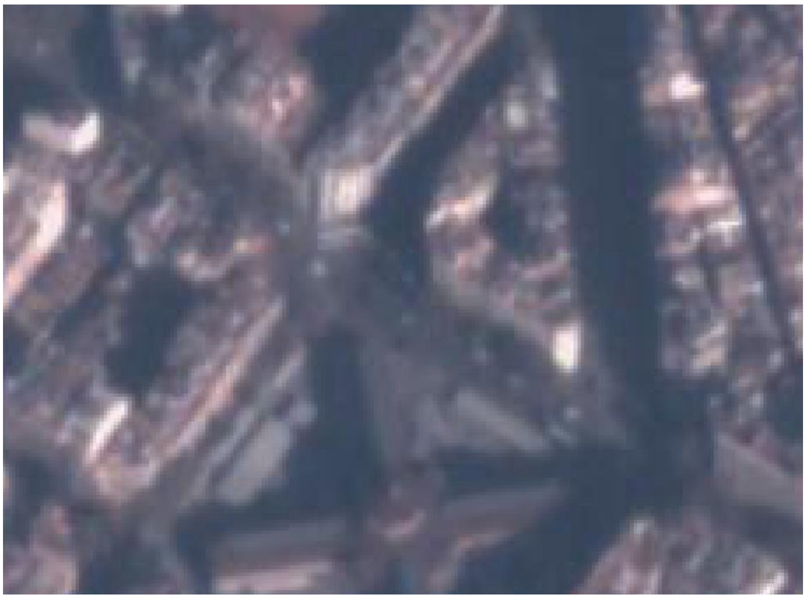


Figure 4-19: Vehicles on the streets of Barcelona.

The assessment of the videos of Toulouse Airport show the same target dimensions and thus leads to the same conclusions.

The latter conclusions were checked / tested using one of our on-the-shelf motion detector software that performs a classical background subtraction and is known to perform well when the background is fixed. Here, the good results obtained show that this approximation is good – in Figure 4-20, moving vehicles on the highways can easily be detected despite the poor image quality.

Figure 4-20 - Vehicles on the streets of Toulouse.

In our experience, it is also possible to obtain good detection accuracy by applying single-frame neural networks (e.g. convolutional neural network) that have been trained to detect small vehicles. However, our convolutional neural network instances have been trained to detect cars in Pléiades images and are therefore not operational on images that have been JPEG compressed (i.e. we could not reproduce our results on the Jilin-1 images).

Other, bigger, objects should be easily detected by state-of-the-art neural networks such as the ones we have prototyped for CNES (study on airplane detection) or Airbus Geo-intelligence (study on boat detection using One-Atlas images).

Figure 4-21 - Boats in Barcelona harbour.

The boats measured more than 50 pixels and could be automatically detected and classified as such (see Figure 4-21). Airplanes, however, should be easily detected and recognised.

Figure 4-22 - Airplanes in Toulouse Airport.

We mentioned here two different object detection methods:

- Classical motion detection is not very CPU consuming but only performs well when the background is fixed. It may be difficult to run it on-board as the apparent geometrical stability of the video sequence is likely obtained via post-processing.
- Deep neural networks are much more CPU/GPU consuming but there is on-going work that focuses on optimising the neural network architecture for FPGA inference, which would ease greatly on-board detection.

4.4.3.2.2 Object Tracking

We distinguish two types of object tracking methods:

- Appearance based tracking: an initial region of interest is tracked in consecutive images based on the image features inside the ROI. Magellium has developed such a neural network-based tracker that performs very well, including in typically hard situations (contrast inversion, geometry variation, and occultation).
- Detection or plot-based tracking: an algorithm solves the association problem between sets of objects detected by another algorithm. Several methods exist, in order of growing complexity: Kalman based tracker, Multiple Hypothesis Tracker, Neural Network based methods.

In our experience, the first family of trackers will be unsuccessful on small vehicles in the Jilin-1 videos due to the lack of distinctive geometrical features. The second family however will perform well once the task of detection is successful. We were able to test our on-the-shelf tracker based on Kalman filters for plot-based tracking, as shown in Figure 4-23, but were unfortunately unable to find the right parameterisation to do this accurately. This is mostly due to sudden apparent accelerations of the moving objects due to missing frames.

Figure 4-23: Tracking illustration.

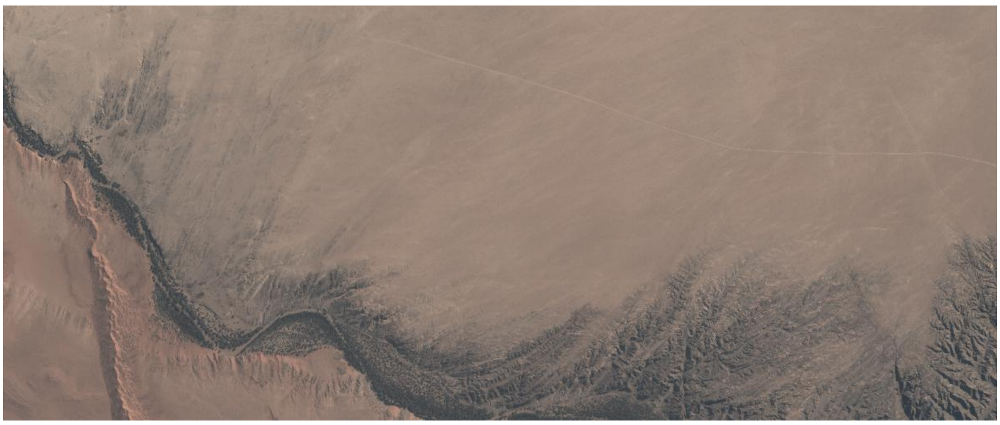
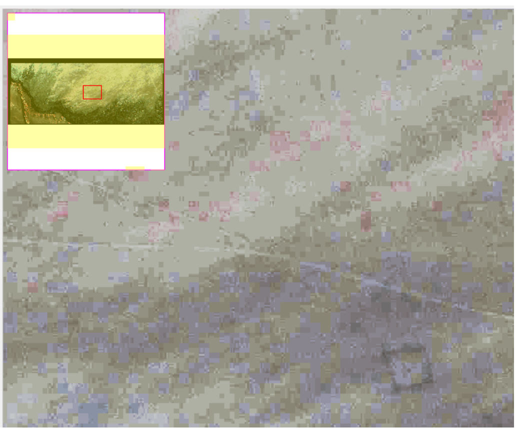
4.5 Visual Inspections

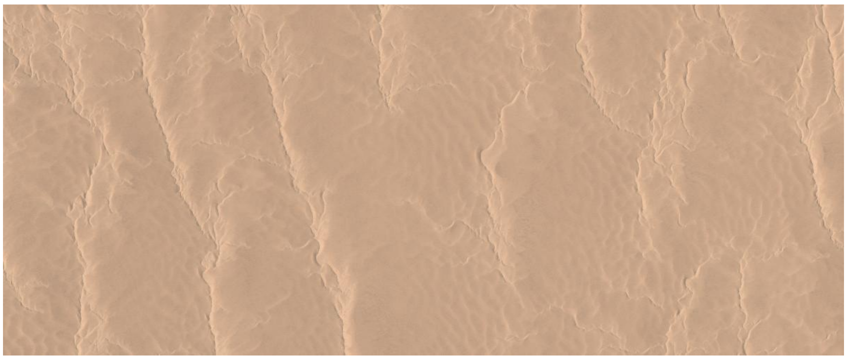
4.5.1 Description and Method

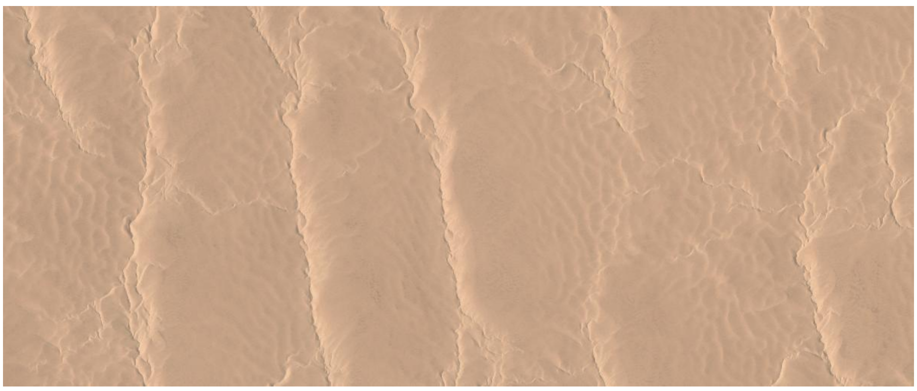
General visual inspections were performed on the procured videos, whose browse images are shown below in order to ensure that there were no anomalies or artefacts present. The results are detailed in Section 4.5.2 for each sensor.

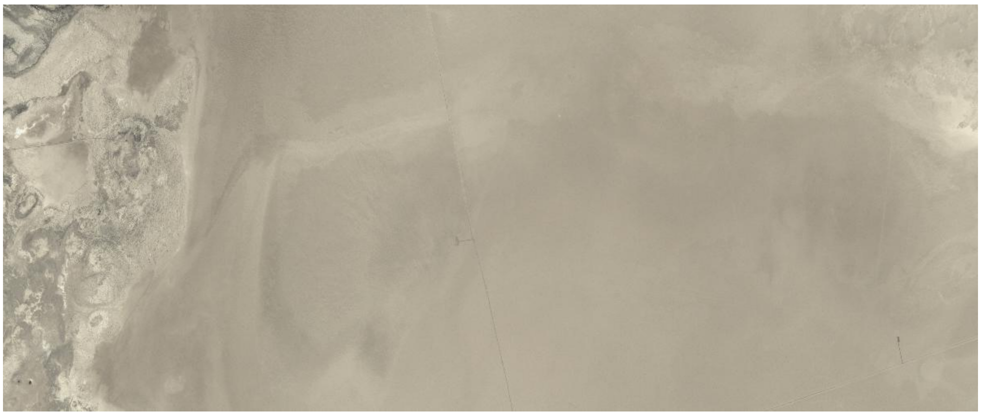
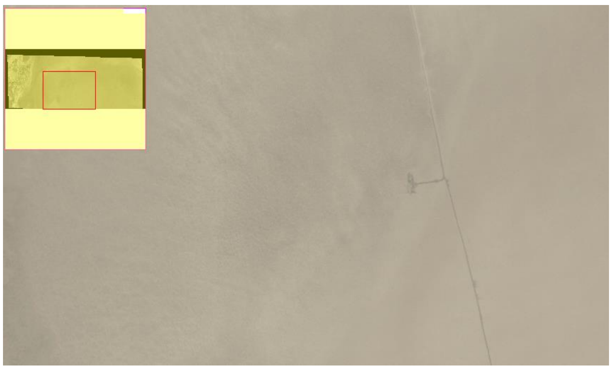
4.5.2 Results

4.5.2.1 JL103B

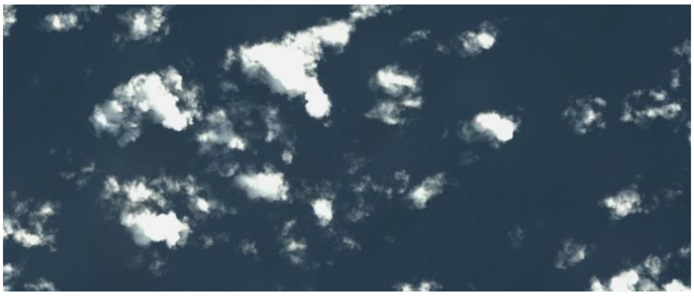
Product	Visual Inspection Results
1	Gobabeb 26/05/2021 **Product Name**: JL103B_MSS_20210526154839_200051060_101_001_L1B **Product Quality Grade**: A **Cloud Score**: 7 % **Purpose**: Radiometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. The cloud score is overestimated. No cloud is visible on the video. This product could have been used for the absolute radiometric calibration accuracy assessment as there is Gobabeb RadCalNet data available for the date of this acquisition.
	  RadCalNet GONA site

Product	Visual Inspection Results
2	Libya 04/06/2021 **Product Name**: JL103B_MSS_20210604155000_200051959_101_001_L1B **Product Quality Grade**: A **Cloud Score**: 97 % **Purpose**: Radiometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. The cloud score also is completely overestimated. This product could be used for the relative radiometric calibration accuracy assessment.
	

Product	Visual Inspection Results
3	Libya 15/06/2021 **Product Name**: JL103B_MSS_20210615154721_200052883_101_001_L1B **Product Quality Grade**: A **Cloud Score**: 97 % **Purpose**: Radiometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. The cloud score also is completely overestimated. This product could be used for the relative radiometric calibration accuracy assessment.
	

<table>
<tr><th>Product</th><th>Visual Inspection Results</th></tr>
<tr><td>4</td><td>RRVP 07/06/2021
Product Name:
JL103B_MSS_20210607010204_200052177_101_001_L1B
Product Quality Grade: A
Cloud Score: 25 %
Purpose: Radiometry assessment
Comment: The imagery does not appear to contain any anomalies or artefacts. The cloud score also appears to be overestimated. Clouds are not visible on the video.
This product could not have been used for the absolute radiometric calibration accuracy assessment as there is no RadCalNet data available for the date of this acquisition.</td></tr>
<tr><td></td><td>

RRVP site location</td></tr>
</table>

<table>
<tr><th>Product</th><th>Visual Inspection Results</th></tr>
<tr><td>5</td><td>SIO 14/06/2021
Product Name:
JL103B_MSS_20210614112540_200052774_101_001_L1B
Product Quality Grade: A
Cloud Score: 42 %
Purpose: Radiometry assessment</td></tr>
</table>

	Comment: The imagery does not appear to contain any anomalies or artefacts, except that the clouds digital counts are saturated. The cloud score also appears to be estimated accurately. This product could have been used for the absolute radiometric calibration accuracy assessment.
	

Product	Visual Inspection Results
6	Toulouse Airport 19/07/2021 **Product Name**: JL103B_MSS_20210719170132_200056000_102_001_L1B **Product Quality Grade**: A **Cloud Score**: 0 % **Purpose**: Object detection and tracking, and geometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. The cloud score also appears to be estimated accurately.
	 

4.5.2.2 JL1GF03C01

Product	Visual Inspection Results
7	SIO 14/06/2021 **Product Name**: JL1GF03C01_MSS_20210614113746_200052709_101_001_L1B **Product Quality Grade**: A **Cloud Score**: 33 % **Purpose**: Radiometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts, except that the digital counts over clouds are saturated. The cloud score also appears to be estimated accurately. This product could have been used for the absolute radiometric calibration accuracy assessment.
	

Product	Visual Inspection Results
8	SIO 25/06/2021 **Product Name**: JL1GF03C01_MSS_20210625114029_200053715_102_001_L1B **Product Quality Grade**: A **Cloud Score**: 16 % **Purpose**: Radiometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts, except that the clouds digital counts are saturated. The cloud score also appears to be estimated accurately. This product could have been used for the absolute radiometric calibration accuracy assessment if the radiometric calibration coefficients were available.

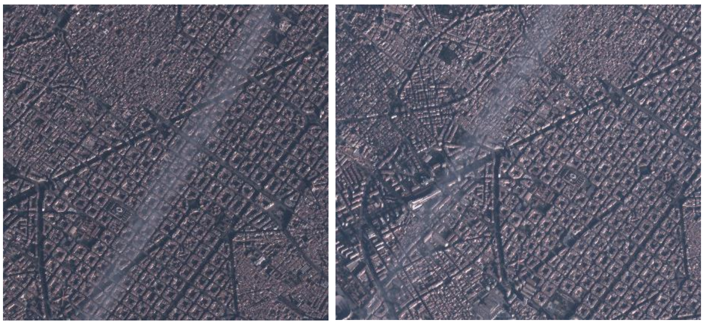
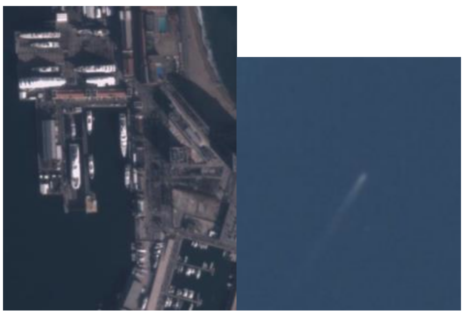
	

Product	Visual Inspection Results
9	Toulouse Airport 26/06/2021 **Product Name**: JL1GF03C01_MSS_20210626173409_200053792_102_001_L1B **Product Quality Grade**: A **Cloud Score**: 0 % **Purpose**: Object detection and geometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. The cloud score also appears to be estimated accurately. This product has been used for geometry assessment and object tracking.
	 

Product	Visual Inspection Results
10	Toulouse Airport 18/07/2021 **Product Name**: JL1GF03C01_MSS_20210718173900_200055958_102_001_L1B **Product Quality Grade**: A **Cloud Score**: 1 %

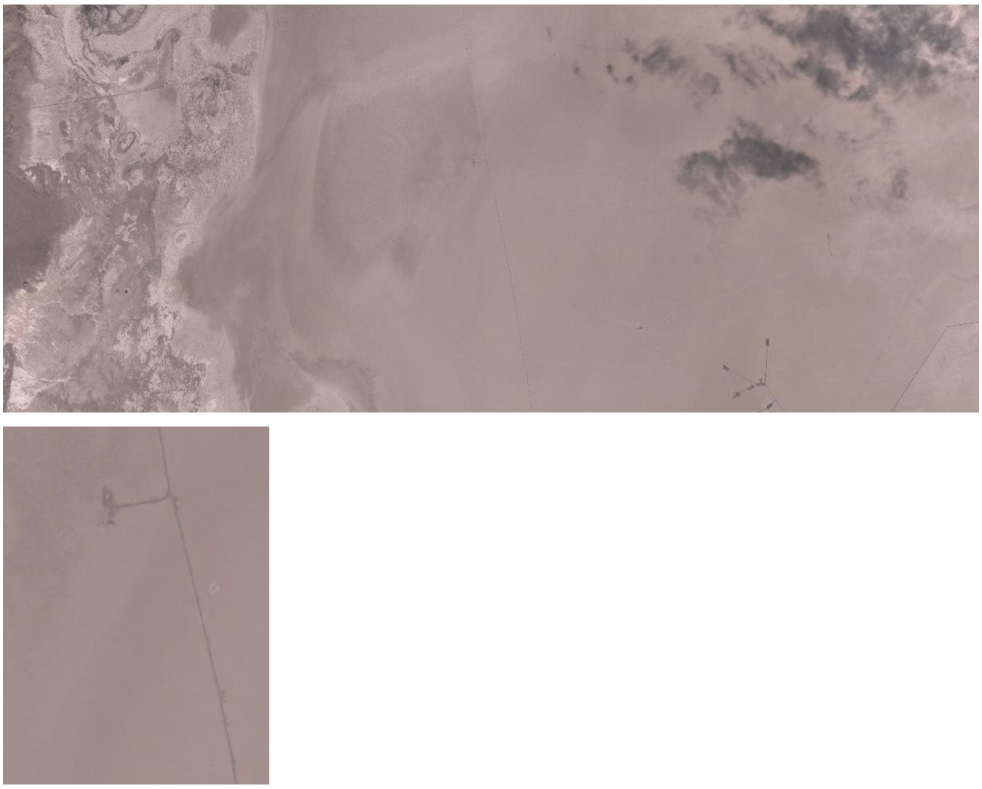
	Purpose: Object detection and geometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. The cloud score also appears to be estimated accurately. This product has been used for geometry assessment and object tracking.
	  Plane in movement

Product	Visual Inspection Results
11	Barcelona 21/11/2020 **Product Name**: JL1GF03C01_MSS_20201121173820_200034303_101_001_L1B **Product Quality Grade**: A **Cloud Score**: 3 % **Purpose**: Object detection and geometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. There are two contrails, moving from the west to the east of the images but no opaque cloud. This product has been used for geometry assessment and object tracking.

	  Wave moving  Contrails  boats

4.5.2.3 JL1GF03C02

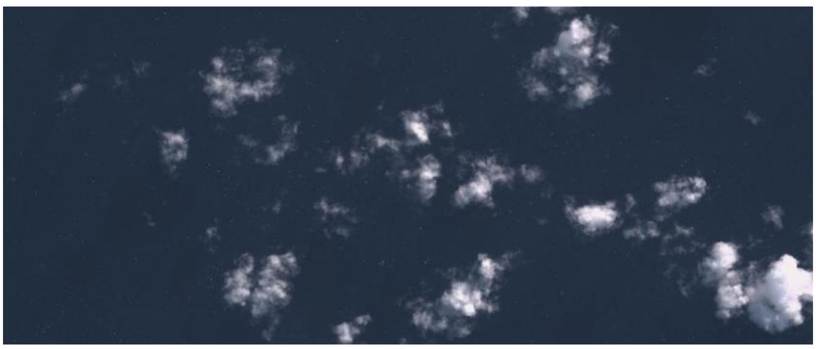
Product	Visual Inspection Results
12	RRVP 25/06/2021 **Product Name**: JL1GF03C02_MSS_20210625011920_200053727_101_001_L1B **Product Quality Grade**: A **Cloud Score**: 48 % **Purpose**: Radiometry assessment

	Comment: The imagery does not appear to contain any anomalies or artefacts. The cloud score also appears to be overestimated - only a small cirrus is visible on the video. This product could have been used for the absolute radiometric calibration accuracy assessment as there is RadCalNet data available for the date of this acquisition.
	 RRVP site

Product	Visual Inspection Results
13	Baotou 17/06/2021 **Product Name**: JL1GF03C02_MSS_20210617102314_200052997_101_001_L1B **Product Quality Grade**: A **Cloud Score**: 0 % **Purpose**: Radiometry and geometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. The cloud score also appears to be estimated accurately. This product could not be used for the absolute radiometric calibration accuracy assessment as there was no RadCalNet data available for the date of this acquisition.

	 BTCN and BSCN RadCalNet sites

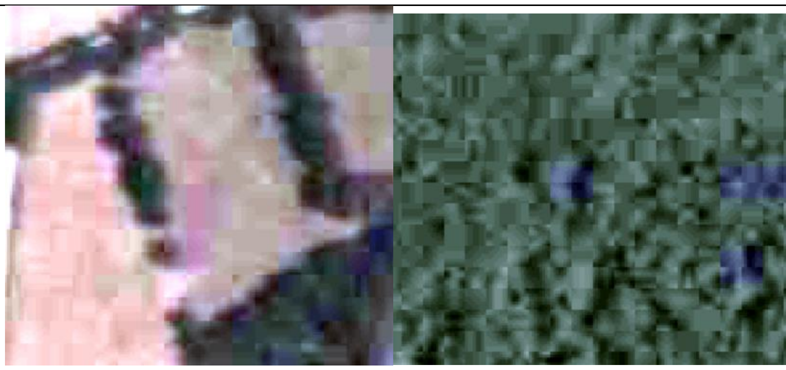
Product	Visual Inspection Results
14	SIO 20/06/2021 **Product Name**: JL1GF03C02_MSS_20210620115215_200053288_102_001_L1B **Product Quality Grade**: A **Cloud Score**: 12 % **Purpose**: Radiometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts White clouds are saturated. This product could have been for the absolute radiometric calibration accuracy assessment.
	

Product	Visual Inspection Results
15	SIO 22/06/2021 **Product Name**: JL1GF03C02_MSS_20210622113533_200053420_102_001_L1B **Product Quality Grade**: A **Cloud Score**: 11 % **Purpose**: Radiometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. White clouds are saturated. This product could have been for the absolute radiometric calibration accuracy assessment.
	

4.5.2.4 JL1GF03C03

Product	Visual Inspection Results
16	Toulouse Airport 01/07/2021 **Product Name**: JL1GF03C03_MSS_20210701172449_200054226_102_001_L1B **Product Quality Grade**: A **Cloud Score**: 0 % **Purpose**: Object detection and geometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. The cloud score also appears to be estimated accurately.
	  truck detection  Concorde plane

Product	Visual Inspection Results
17	Tarascon-sur-Ariege 11/07/2021 **Product Name**: JL1GF03C03_MSS_20210711173553_200055287_102_001_L1B **Product Quality Grade**: A **Cloud Score**: 0 % **Purpose**: Object detection and geometry assessment **Comment**: The imagery does not appear to contain any anomalies or artefacts. The cloud score also appears to be estimated accurately. White areas such as roof building are saturated. Compression issues are illustrated.
	  Saturation

	 Visible compression

5. CONCLUSIONS

This technical note details the results of the assessments performed on the video data from the following Jilin-1 sensors:

- JL103B (SP03) (6 videos)
- JL1GF03C01 (5 videos)
- JL1GF03C02 (4 videos)
- JL1GF03C03 (2 videos)

For the assessment of **geometric calibration quality**, the results indicate that 1) absolute geolocation accuracy is significantly degraded due to the RPC models included in the products, 2) temporal geolocation accuracy could not be assessed due to the significant variability of the latter as well as a small sample of products to construct a sufficient time series, and c) band co-registration accuracy is good (sub-pixel).

The assessment of the **radiometric calibration quality** was not possible due the lack of radiometric calibration coefficients.

For the assessment of **image quality**, more specifically object detection and tracking, the results indicate that the detection of objects such as vehicles, planes or boats is possible, and also the recognition and identification of larger objects such as planes or boats. The tracking of vehicles by motion detection approaches has been discussed and it is believed plot-based tracking of vehicles is achievable (accurate tracking was not possible for the assessment performed here as there were missing frames in the videos assessed).

APPENDIX A JILIN-1 SP03 and GF03C 01/02/03 Test dataset

Table 5-1: Dataset description

ROI	Center Latitude	Center Longitude	Date	Viewing Geometry (Off-Nadir Angle)	Satellite_ID	Product_ID
Gobabeb	-23.598322	15.12264	26/05/2021		JL103B	JL103B_MSS_20210526154839_200051060_101_001_L1B
Libya	28.551935	23.391945	04/06/2021		JL103B	JL103B_MSS_20210604155000_200051959_101_001_L1B
Libya	28.551454	28.586721	15/06/2021		JL103B	JL103B_MSS_20210615154721_200052883_101_001_L1B
RRVP	38.501625	-115.684855	07/06/2021		JL103B	JL103B_MSS_20210607010204_200052177_101_001_L1B
SIO	-30.249116	80.252785	14/06/2021		JL103B	JL103B_MSS_20210614112540_200052774_101_001_L1B
Toulouse airport	43.634749	1.366163	19/07/2021	More than 30 degrees	JL103B	JL103B_MSS_20210719170132_200056000_102_001_L1B
SIO	-30.252142	80.248476	14/06/2021		JL1GF03C01	JL1GF03C01_MSS_20210614113746_200052709_101_001_L1B
SIO	-30.252386	80.248114	25/06/2021		JL1GF03C01	JL1GF03C01_MSS_20210625114029_200053715_102_001_L1B
Toulouse airport	43.629224	1.361506	26/06/2021		JL1GF03C01	JL1GF03C01_MSS_20210626173409_200053792_102_001_L1B
Toulouse airport	43.629829	1.356938	18/07/2021		JL1GF03C01	JL1GF03C01_MSS_20210718173900_200055958_102_001_L1B
Barcelona	41.385596	2.165776	21/11/2020		JL1GF03C01	JL1GF03C01_MSS_20201121173820_200034303_101_001_L1B
RRVP	38.494838	-115.692454	25/06/2021	Within/less than 10 degrees	JL1GF03C02	JL1GF03C02_MSS_20210625011920_200053727_101_001_L1B
Baotou	56.1111	110.261	17/06/2021		JL1GF03C02	JL1GF03C02_MSS_20210617102314_200052997_101_001_L1B
SIO	-30.254809	80.247704	20/06/2021		JL1GF03C02	JL1GF03C02_MSS_20210620115215_200053288_102_001_L1B
SIO	-30.253868	80.248104	22/06/2021		JL1GF03C02	JL1GF03C02_MSS_20210622113533_200053420_102_001_L1B
Toulouse airport	43.630003	1.356438	01/07/2021	Within/less than 10 degrees	JL1GF03C03	JL1GF03C03_MSS_20210701172449_200054226_102_001_L1B
Tarascon-sur-Ariège	42.847578	1.597895	11/07/2021	Within/less than 10 degrees	JL1GF03C03	JL1GF03C03_MSS_20210711173553_200055287_102_001_L1B

APPENDIX B JILIN-1 SP03 and GF03C 01/02/03 MISSIONS

Table 3.1 The Parameters of Jilin-1SP03

Attribute	Value
Imaging mode	Staring imaging, Low light level imaging
GSD (at nadir)	0.92 m
Spectral bands	RGB (Bayer pattern) Red B1: 580-723 nm Green B2: 489-585 nm Blue B3: 437-512 nm
Dynamic range	8 bits
Standard scene size (at nadir)	11.0 km × 4.6 km
Orbit	Type: Sun-synchronous Altitude: 535 km Local time at descending node: 10:30 am

Figure 5-1: Jilin-1 SP03 specifications, taken from [RD-3]

Table 3.38 The Parameters of Jilin-1GF03C

Attribute	Value
Imaging mode	Staring imaging
GSD (at nadir)	1.2 m
Spectral bands	RGB (Bayer pattern)
	Red B1: 580-730 nm Green B2: 490-580 nm Blue B3: 430-520 nm
Dynamic Range	8 bits / 12 bits
Standard scene size (at nadir)	14.4 km × 6 km
Orbit	Type: Sun-synchronous Altitude: 535 km Local time at descending node: 9:20 am

Figure 5-2: Jilin1 SP03 specifications, taken from [RD-3]

[END OF DOCUMENT]