Technical Note on Quality Assessment for FSSCat HyperScout-2

Author(s): **_Samantha Lavender_**
Task 2 Mission Expert

Approval: **_Fay Done_**
Task 2 Lead

Accepted: **_Clement Albinet_**
ESA EDAP Technical Officer

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1. INTRODUCTION

This technical note details the results of the (preliminary) mission data quality assessments (including geometric calibration, radiometric calibration and image quality) performed on a sample of HyperScout-2 (onboard the FSSCat satellite, also named PhiSat-1) Land Level 1C products provided by Cosine Measurement Systems, the instrument developer who is based in the Netherlands.

The aforementioned mission data quality assessments are performed in accordance with the assessment guidelines, detailed in [RD.1] and [RD.2], which 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 (e.g., data and documentation) provided by the data provider or operator, some of which may not be publically 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).*

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

The above assessments are performed by the EDAP 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 that the delivered commercial mission data is fit for purpose and that all decisions regarding the inclusion of the commercial mission as an ESA third party mission can be made fairly and with confidence.

1.1 Reference Documents

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

[RD.1] EDAP Mission Quality Assessment Guidelines, Issue 1.2, 19 July 2019.

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

[RD.3] FSSCat/PhiSat-1 overview: https://directory.eoportal.org/web/eoportal/satellite-missions/p/phisat-1

[RD.4] 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. 2019. RadCalNet: A Radiometric Calibration Network for Earth Observing Imagers Operating in the Visible to Shortwave Infrared Spectral Range. *Remote Sens.*, https://doi.org/10.3390/rs11202401

[RD.5] COSINE. 2020. HyperScout VNIR Level-1C data product specification, CR-HSTPM-SP01, Issue 2, 15 July 2021.

[RD.6] RadCalNet Working Group, The 2020 data collection – changes, improvements and quality, Version 1.0, 07 March 2020. https://www.radcalnet.org/documentation/RadCalNetProcessing/2020_Data_Collection_Changes_Improvements_Quality_v20200317.pdf

[RD.7] Roy, D.P.; Li, J.; Zhang, H.K.; Yan, L.; Huang, H. 2017. Examination of Sentinel-2A multispectral instrument (MSI) reflectance anisotropy and the suitability of a general method to normalise MSI reflectance to nadir BRDF adjusted reflectance. *Remote Sens. Environ.*, 199, 25–38.

[RD.8] CEOS, 2020. RadCalNet Quick Start Guide: https://www.radcalnet.org/resources/RadCalNetQuickstartGuide_20180702.pdf

[RD.9] https://sentinel.esa.int/web/sentinel/user-guides/sentinel-2-msi/definitions

[RD.10] Gascon, F., et al. (2017). Copernicus Sentinel-2A calibration and products validation status. Remote Sensing, 9, 584. https://doi.org/10.3390/rs9060584

[RD.11] Zanoni, "IKONOS Signal-to-Noise Ratio Estimation", March 25-27, 2002, JACIE Workshop, 2002 https://ntrs.nasa.gov/search.jsp?R=20040004380

1.2 Glossary

The following acronyms and abbreviations have been used in this report:

ATBD	Algorithm Theoretical Basis Document
BRDF	Bidirectional Reflectance Distribution Function
CEOS	Committee on Earth Observation Satellites
DEM	Digital Elevation Model
EDAP	Earthnet Data Assessment Pilot
ESA	European Space Agency
GCP	Ground Control Points
NBAR	Nadir BRDF-Adjusted Reflectance
NPL	National Physical Laboratory
PUG	Product User Guide
RadCalNet	Radiometric Calibration Network
RD	Reference Document
SNR	Signal-to-Noise Ratio
TOA	Top of Atmosphere

VNIR	Visible and Near-InfraRed

2. EXECUTIVE SUMMARY

The aim of this work is to perform the following data quality assessments on the HyperScout-2 data provided:

- Assessment (review) of documentation (EDAP Maturity Matrix);
- Assessment of geometric and radiometric calibration quality, using **Level 1C** (L1C) products (procured in July 2021).

A HyperScout-2 L1C product, acquired over Railroad Valley (U.S.A), has primarily been used to assess the absolute radiometric accuracy. The results of the latter included those from the previously assessed HyperScout-1 L1C mission for comparison. In addition, a product acquired over Libya-4 has been used for an SNR assessment and an acquisition over Mexico is used for the geometric assessments.

Overall, the results were positive as shown in Table 2-1, but as the data was limited in scope the results are considered as preliminary.

Table 2-1: Mission – HyperScout-2: Assessment Results

Assessment Area	Results
Visual Inspections	The visual inspections did not show any gross anomalies or artefacts. See Section 4.2.
Geometric Calibration Quality	**Absolute Geolocation Accuracy**: The results of the geometric calibration quality assessment indicate agreement with the geolocation accuracy performance requirement, detailed in provided technical note [RD.5], of approximately 0.5-pixel average (0 to 3 pixels range). For the Mexico acquisition, the analysis was performed on a small area with identifiable features that gave an easting and northing error of less than 1 pixel. See Section 4.4.1. **Band Co-registration Accuracy**: The results of the band co-registration accuracy assessment indicate that the accuracy is sub-pixel. However, this result is based on just the visual evaluation of the products, so it has limited applicability. See Section 4.4.3.
Radiometric Calibration Quality	**Absolute Radiometric Accuracy**: The result of the absolute radiometric accuracy assessment indicates the accuracy is good. The assessment results indicate a close matchup between the HyperScout-2 and Hyperscout-1 / RadCalNet data for the Railroad Valley site, alongside the Sentinel-2 data. This result is not unexpected as Railroad Valley is used as a vicarious calibration site, so it is not an independent dataset. See Section 4.3.

Image Quality	**Signal-to-Noise Ratio:** The SNR analysis failed to produce an output for the standard (newer) approach and the image acquired over Libya-4 was highly variable. Therefore, an older (less robust) approach was tested and appear to show consistent results with that obtained by COSINE. See Section 4.2.2. **Other:** For users of ESA's SNAP tool, it would be useful for the HyperScout-2 format to be explicitly recognised so that the geometry is recognised, and the data can be analysed using, for example, spectral profiles.

3. EDAP QUALITY ASSESSMENT

3.1 EDAP Maturity Matrix

Note with each iteration of this report, the available documentation has been checked and updated where necessary.

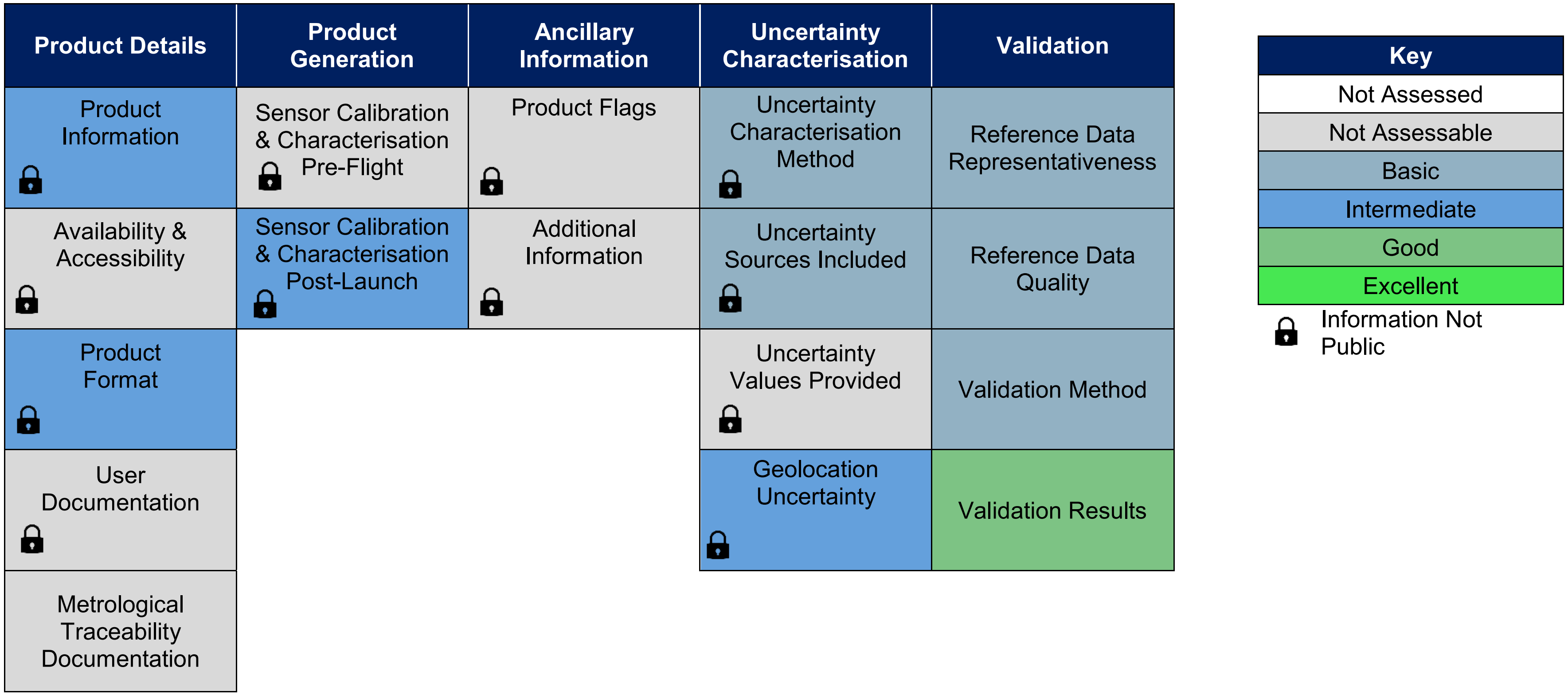

Figure 3-1 – HyperScout-2 Cal/Val Maturity Matrix

3.1.1 Product Details

Product Information	
Grade: Intermediate	
Product Name	VNIR Level -1C
Sensor Name	HyperScout-2
Sensor Type	Hyperspectral imager
Product Version Number	Only schema version quoted in HDF header
Product ID	N/A
Processing level of product	Level 1C (**L1C**)
Measured Quantity Name	Reflectance
Measured Quantity Units	Unitless
Stated Measurement Quality	Radiometric and geometric assessment provided in the supplied technical note
Spatial Resolution	Ground Sample Distance (GSD) @500 km altitude is 75 m
Spatial Coverage	200 km @540 km altitude
Temporal Resolution	Acquisition on-demand
Temporal Coverage	Acquisition on-demand
Mission coverage	Global
Point of Contact	COSINE Measurement Systems
Product locator (DOI/URL)	N/A
Conditions for access and use	Data provided privately under the restrictions of an NDA
Limitations on public access	No public access
Product Abstract	N/A

Product Availability & Accessibility	
Grade: Not Assessable	
Compliant with FAIR principles	Examples provided for review, dataset not free-to-access
Data Management Plan	Not provided
Availability Status	Size of overall archive unknown

Product Format
Grade: Intermediate

Product File Format	HDF
Metadata Conventions	Although a specific convention is not stated, the naming and metadata used for the HyperScout-2 compared to HyperScout-1 files has improved.
Analysis Ready Data?	Not as provided

Product User Documentation		
Grade: Not Assessable		
Document	*Reference*	*QA4ECV Compliant*
Product User Guide (**PUG**)	For the assessment, EDAP were provided with a technical note [RD.5]	No
Algorithm Theoretical Basis Document (**ATBD**)	N/A	No

Metrological Traceability Documentation	
Grade: Not Assessable	
Document Reference	Not provided
Traceability Chain / Uncertainty Tree Diagram Available	Not provided

3.1.2 Product Generation

Sensor Calibration & Characterisation – Pre-Flight	
Grade: Not Assessable	
Summary	Not provided / found from online search
References	N/A

Sensor Calibration & Characterisation – Post-Launch	
Grade: Intermediate	
Summary	Limited information available publicly, increased information has been provided in the product specification.
References	• Provided within the supplied product specification [RD.5]

3.1.3 Ancillary Information

Product Flags	
Grade: Not Assessable	
Product Flag Documentation	Product has no flags
Comprehensiveness of Flags	N/A

Additional Information	
Grade: Not Assessable	
Ancillary Data Documentation	None provided
Comprehensiveness of Data	N/A
Uncertainty Quantified	N/A

3.1.4 Uncertainty Characterisation

Uncertainty Characterisation Method	
Grade: Basic	
Summary	Uncertainty established by limited comparison to measurements by other sensor/s.
Reference	Provided within the supplied product specification [RD.5].

Uncertainty Sources Included	
Grade: Basic	
Summary	Some important sources of uncertainty missing – just absolute radiance levels discussed.
Reference	Provided within the supplied product specification [RD.5].

Uncertainty Values Provided	
Grade: Not Assessable	
Summary	No uncertainty information provided.
Reference	N/A
Analysis Ready Data?	N/A

Geolocation Uncertainty	
Grade: Intermediate	
Summary	The geolocation uncertainty is provided both for HyperScout-2 overall and for some of the example products provided. Error-covariance information between pixels is not provided.
Reference	Provided within the supplied product specification [RD.5]

3.1.5 Validation

Validation Activity #1	
Independently Assessed?	Limited analysis by EDAP within this report, COSINE have provided their information in the product specification.

Reference Data Representativeness	
Grade: Basic	
Summary	Overall, the results were positive but as the data was limited in scope and had been adjusted using one of the sites supplied then the results are considered as preliminary.
Reference	Section 4
Reference Data Quality & Suitability	
Grade: Basic	
Summary	RadCalNet for the radiometric analysis. Although there was no RadCalNet data for the Railroad Valley scene provided, a cross-comparison with Hyperscout-1 and Sentinel-2 was undertaken.
Reference	[RD.4] RadCalNet: A Radiometric Calibration Network for Earth Observing Imagers Operating in the Visible to Shortwave Infrared Spectral Range
Validation Method	
Grade: Basic	
Summary	As described in Section 4.
Reference	N/A
Validation Results	
Grade: Good	
Summary	As described in Section 4.
Reference	N/A

4. DETAILED HYPERSCOUT-2 QUALITY ASSESSMENT

4.1 Goals

PhiSat-1 (Φ-Sat-1) is two 6U CubeSats that constitutes the FSSCat (Federated Satellite System) mission – a 2017 Copernicus Masters winning idea [RD.3]. PhiSat-1 was launched on 03 September 2020.

HyperScout-2 is carried onboard the B mission (named 3CAT-5B for the Two-Line Element data) and is a hyperspectral imager with 50 spectral bands within the 400-1000 nm wavelength range. The maximum size of an image is 400 x 1850 pixels.

This report includes inspections regarding image quality, radiometric calibration, and geometric calibration, as follows:

- The radiometric calibration quality and stability is essential for scientific assessments, including temporal assessments. The measured radiance depends on the sensor and changing viewing conditions (sun sensor view angle). The assessment is based on a comparison to in-situ measurements from the Radiometric Calibration Network (**RadCalNet**) [RD.4].
- The geometric calibration quality is assessed in order to understand the quality of ortho-processing, which is often based on both a sensor model and Ground Control Points (**GCP**). The procured products are compared to Sentinel-2. Temporal geometric registration accuracy is required for time-series analysis. As only a single HyperScout-2 image has been supplied over a location where this can be assessed, the aim is to understand whether users would have to perform additional processing for the data to be applicable (i.e., whether the geometric accuracy is sufficient to be immediately usable or if further processing using GCPs is needed first).
- The image quality is assessed in terms of format compatibility using ENVI and SNAP i.e., the ease of reading the data in and viewing it as a georeferenced dataset with flags, where applicable. In addition, it is assessed visually to see if any anomalies are visible within the data. Then, the Signal-to-Noise Ratio is calculated using a location with low spatial variability.

4.2 Image Quality

Two images were provided for assessment, see **Figure 4-1**. The L1C data Visible and Near-InfraRed (**VNIR**) product is composed of a Top of Atmosphere (**TOA**) reflectance hyperspectral cube. Images can be generated up to a size of 4000 x 4000 pixels, but downlink limitations result in smaller images being available to analyse on-ground. The supplied images are from (**Figure 4-1a**) Railroad Valley, USA, and (**Figure 4-1b**) Ceylanpinar, Turkey.

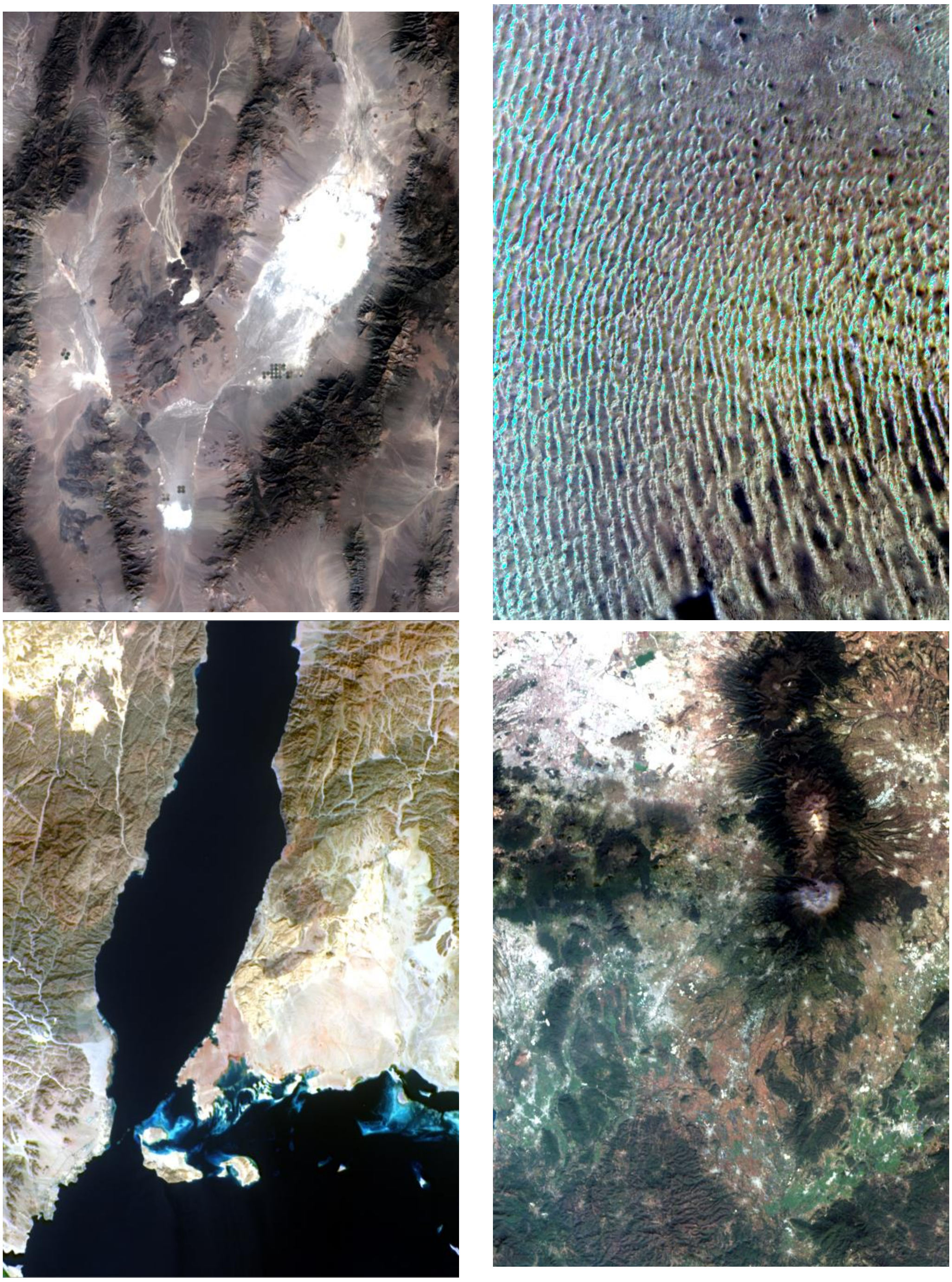

Figure 4-1: HyperScout-2 images from (top left to bottom right) Railroad Valley (USA), Libya-4, Saudi Arabia and Popocatepetl volcano (Mexico) shown as pseudo colour composites (650, 550 and 490 nm as RGB).

The product specification for the three primarily used images [RD.5] are shown in Table 4-1.

Table 4-1. Hyperscout-2 Image Specifications

Specification	Railroad Valley	Libya-4	Saudi Arabia	Popocatepetl volcano
Filename	HS-L1C-FB-03D3-20201105T183552-	HS-L1C-FB-0558-20210118T090934-	HS-L1C-FB-0379-20201030T082412-	HS-L1C-FB-03A7-20201104T171434-

	20210714T164049-00	20210714T154733-00	20210714T171438-00	20210714T162312-00
Date of Acquisition (Time UTC)	2020-11-05 18:36:09	2021-01-18 09:09:52	2020-10-30 08:24:29	2020-11-04 17:14:51
Dimensions (columns x rows)	1220 * 1760	1209 * 1622	1221 * 1760	1239 * 1726
No. of Bands	50	50	50	50

4.2.1 Top of Atmosphere Reflectance

The data is supplied as TOA reflectance data resampled to a cartesian map projection:

- Railroad Valley (U.S.A): UTM zone 11N (EPSG:32611)
- Libya-4 (Libya): UTM zone 34N (EPSG:32634)
- Saudi Arabia: UTM zone 36N (EPSG:32636)
- Popocatepetl Volcano (Mexico): UTM zone 14N (EPSG:32614)

The HDF file contains no data flags or mask bands to indicate data quality.

4.2.2 Signal-to-Noise Ratio

The Signal-to-Noise Ratio (**SNR**) is a vital image quality indicator to assess the potential of data. Visual interpretation of an image does not require high SNR data; even in the presence of noise, an operator can identify an object. However, multispectral image processing requires high SNR values to control, as much as possible, uncertainties in the measurement.

4.2.2.1 Method

The SNR is used to quantify the performance of a sensor in response to a particular exposure; it quantifies the ratio of the sensor's output signal to the noise present in the output signal and can be expressed by the following:

$$\boldsymbol{SNR = \frac{\mu}{\sigma}}$$

Where μ is the mean signal and σ is the standard deviation of the signal.

This assessment was performed on the following product: **Libya-4 (Libya, Africa)**

The approach developed for EDAP applies filtering to remove non-homogenous areas and so produces a more consistent result. The steps include:

1. Compute the local statistics of a small (3 x 3 pixels) sliding window applied to the imagery being assessed. Then, select only the "best" (in practice, this uses a Sobel filter and threshold of 1.0) small windows for the following steps.

2. Compute the statistical distribution (histogram), between the **minimum** and **maximum radiance**, of the selected "best" small windows (statistics of 3 x 3 pixel windows) – the signal is defined as the peak (i.e. mean radiance) of this statistical distribution, and the noise is defined as the standard deviation of this statistical distribution about the mean.

4.2.2.2 Results

Figure 4-2 shows a clip of the Libya-4 image selected for the assessment of spectral SNR; band 20 @ 650 nm shown. The newer approach, presented at a JACIE workshop [RD.11], did not work as the scene is too spatially variable, which can also be seen from the band 20 (650 nm) view of the full scene in Figure 4-1, and so the pixels are removed by the Sobel filtering. Therefore, an older approach was used for this mission that still uses a Sobel filter but is less robust to in-scene variability.

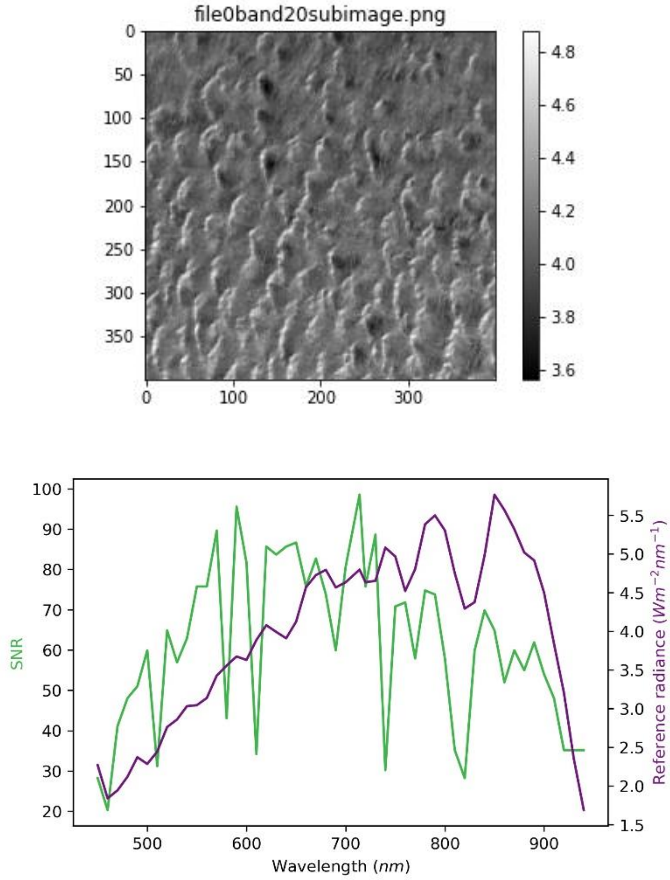

Figure 4-2: Subset of the HyperScout-2 scene used (top) and SNR spectral plot (bottom) showing the estimated SNR and reference radiance for all the VNIR bands 02 May 2021 image.

The information provided by COSINE [RD.5], lists a single SNR of 50 for the mission with the range for this product being:

- Minimum: 23; Maximum: 82; Medium: 64

These results appear consistent with the results from COSINE.

4.3 Validation of the Radiometric Calibration

RadCalNet is an initiative of the Working Group on Calibration and Validation of the Committee on Earth Observation Satellites (**CEOS**). The RadCalNet service provides SItraceable TOA spectrally-resolved reflectances to aid in the post-launch radiometric calibration and validation of optical imaging sensor data [RD.4].

The free and open access service provides a continuously updated archive of TOA reflectances derived over a network of sites, with associated uncertainties, at a 10 nm spectral sampling interval, in the spectral range from 380 nm to 2500 nm and at 30-minute intervals.

4.3.1 Methods and Data

The method used for this exercise consists of different processing stages, as shown in Figure 4-3. The approach was implemented in a series of Jupyter notebooks so that the assessment can easily be rerun.

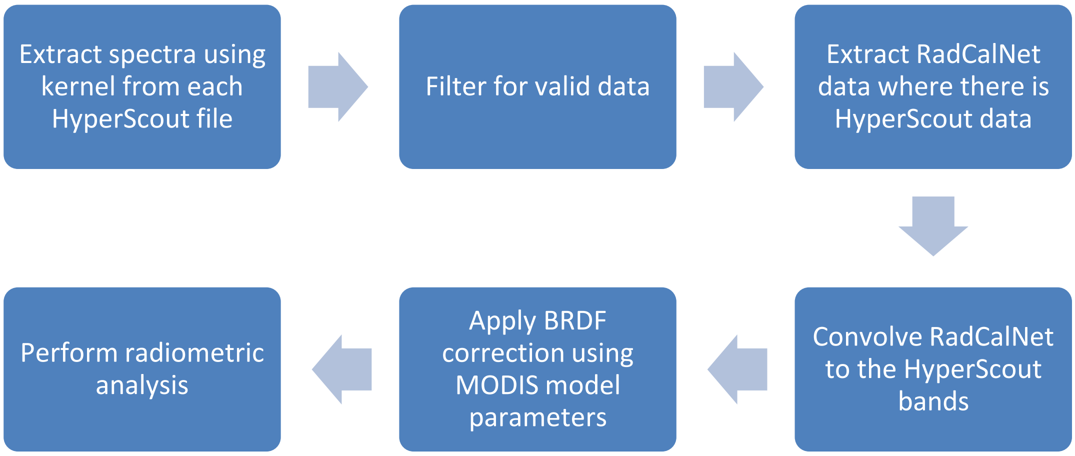

Figure 4-3: The workflow of the radiometric calibration assessment using RadCalNet data.

These different processing stages can be summarised as follows:

1. Extract multispectral TOA measurements from the HyperScout-2 product collected over the Railroad Valley (Nevada, U.S.A) RadCalNet station.
2. The measurement is spatially integrated over a 3 x 3 pixel kernel, which is a window of size of 210 by 210 m, where there is valid data.
3. Extract the RadCalNet 2020 data collection [RD.6] TOA measurements where there is valid HyperScout-2 data. It is not possible to get exact observation time of the HyperScout-2 product, so temporal interpolation is performed to overcome this.
4. Convolve the RadCalNet 10 nm TOA spectrum with the HyperScout-2 spectral band pass to get the reference measurements for each sensor spectral band.
5. Application of the Bidirectional Reflectance Distribution Function (BRDF) correction to the HyperScout-2 data using the model parameters in the MODIS albedo/BRDF product (MCD43A1) using the c-factor method as defined in [RD.7]:

$$NBAR = c_\lambda * \rho_\lambda\left(\theta_v = \theta_v^{HyperScout}, \theta_s = \theta_s^{HyperScout}\right)$$

$$c_\lambda = \frac{\rho_\lambda^{MODIS}(\theta_v = 0, \theta_s = k)}{\rho_\lambda^{MODIS}\left(\theta_v = \theta_v^{HyperScout}, \theta_s = \theta_s^{HyperScout}\right)}$$

where θ_v is the view zenith angle, θ_s is the solar zenith angle and k is the average solar zenith angle of the pair of forward and backward scattering observations. The MODIS reflectances are calculated from the model parameters in the MODIS product using the view and solar zenith and azimuth angles.

6. Plot the convolved RadCalNet data against the HyperScout-2 data.
7. Compute the calibration ratio between HyperScout-2 mean TOA reflectance and RadCalNet TOA reflectance, then compute the percent difference as follows:

$$\%Difference = \frac{100 * (TOA\_Measure - TOA\_Reference)}{TOA\_Reference}$$

Where $TOA\_Measure$ is the measurement processed from the HyperScout-2 product and $TOA\_Reference$ is the measurement processed from RadCalNet data.

As detailed in [RD.8], the TOA reflectance spectra over the Railroad Valley Playa RadCalNet site are representative of a square of 1 km x 1 km centred on 38.497° Latitude and -115.690° Longitude. This assessment is using the TOA nadir-observed reflectance data, and the HyperScout-2 pixels are 70 m in resolution, so we are assuming there is homogeneity between the original point TOA measurement and 3 x 3 HyperScout-2 kernel being investigated.

From Figure 4-4, it can be seen that the site is in the middle of the Playa where there is limited variation, although a road does run through the marked yellow square.

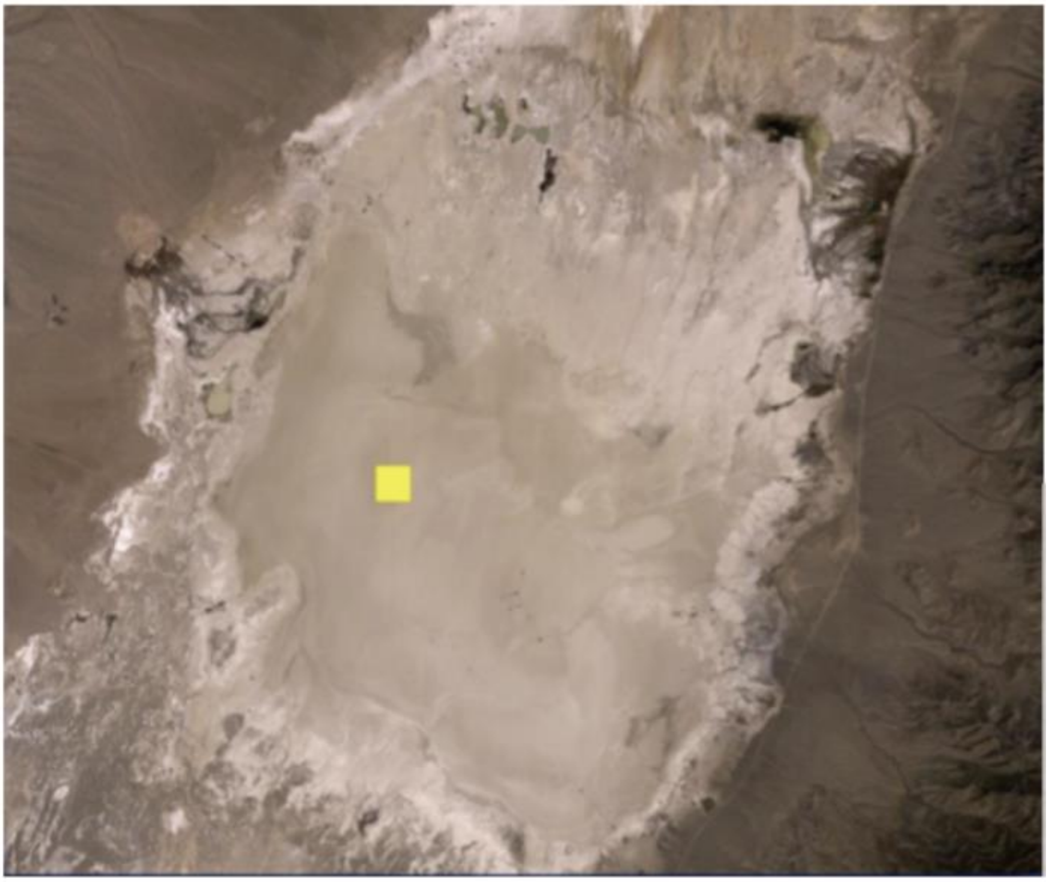

Figure 4-4: Railroad Valley location, with the RadCalNet site validity in yellow [RD.8].

4.3.2 Results

Unfortunately, for the date of the HyperScout-2 acquisition over Railroad Valley there was no RadCalNet data. Therefore, the HyperScout-2 data has been plotted alongside the HyperScout-1 data with its coincident RadCalNet data, and the Sentinel-2 extracted data for the same days. For both the Hyperscout-1 and HyperScout-2 images, the plot shows two versions of that data – before the Bidirectional Reflectance Distribution Function (**BRDF**) correction was applied and afterwards as the Nadir BRDF-Adjusted Reflectance (**NBAR**). As there were issues with georeferencing (see Section 4.4) the pixels to extract have been chosen by eye.

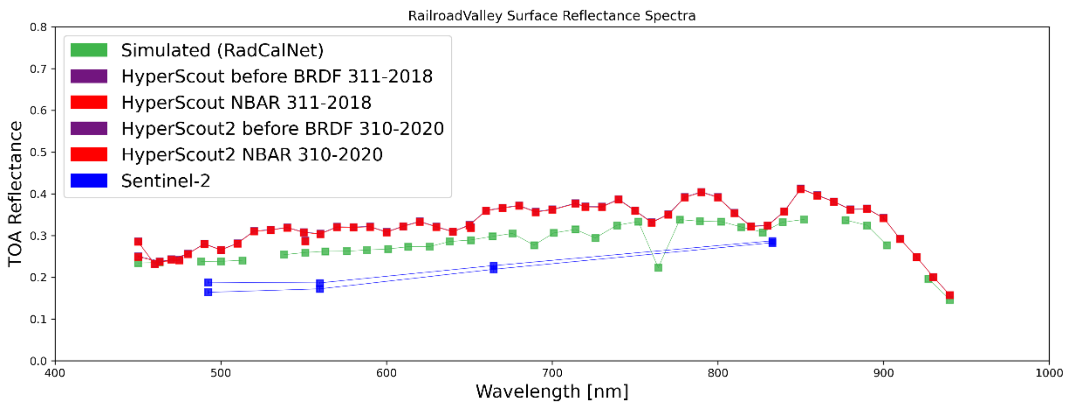

Figure 4-5: Comparison of HyperScout-2 data (with and without BRDF correction) and RadCalNet convolved to the HyperScout-2 bands. The marker size for the RadCalNet data has been made larger so it can be seen underneath the purple HyperScout-2 marker.

4.4 Validation of the Geometric Calibration

For HyperScout-2, we continued to have only a limited set of images, with the most promising for geometric analysis being Mexico.

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**.

4.4.1 Absolute Geolocation Accuracy

The absolute geolocation (planimetric / horizontal) accuracy of the imagery is assessed through visual comparison with Sentinel-2 for the following product:

- **Mexico:** S2B_MSIL1C_20201102T170449_N0209_R069_T14QNG_20201102T195211

Ideally sites with *relatively low and homogenous topographies* would be used, but as that was not possible two different sites have been chosen. The HyperScout-2 geometric accuracy is described as approximately 0.5-pixel average (0 to 3 pixel range) based on automatic keypoint comparison to Sentinel-2 imagery [RD.5]. In addition, the two products have the following individual specifications [RD.5]:

- **Mexico:** 805 tie points, 0.3 pixels mean, 0.7 pixels standard deviation and 4 pixels as the maximum.

There is no description of correction using a Digital Elevation Model (**DEM**), and hence a specification of the DEM used. Since March 2021, the DEM used for the orthorectification of the Sentinel-2 L1C data is the Copernicus DEM GLO-90m [RD.9], prior to that it was the Planet-DEM-90 [RD.10] based on ASTER and SRTM.

4.4.1.1 Method

The visual comparison used Sentinel-2 Level 1 imagery acquired on the same, or nearby, dates as the HyperScout-2 imagery, and so close in time. The Sentinel-2 data was read into SNAP and then exported as a GeoTIFF. Then, the combined Sentinel-2 / HyperScout-2 products were visualised in QGIS.

4.4.1.2 Results

Figure 4-7 compares the same areas (at two zoom settings from the whole image down to a small region) for Sentinel-2 on 02 November 2020 and HyperScout-2 on 04 November 2020. The effects of the different spatial resolutions, 10 m versus 75 m, can be seen.

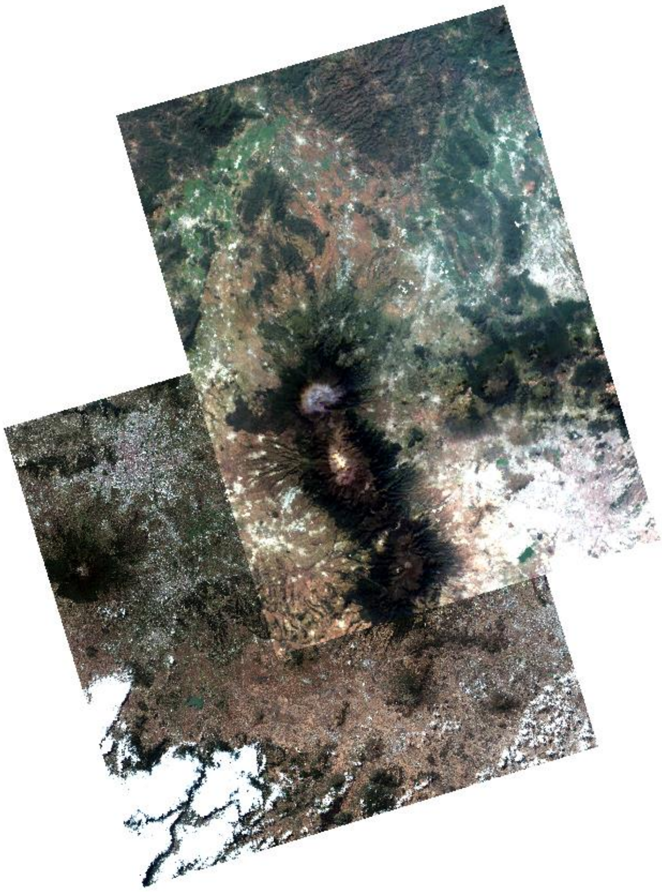

Figure 4-6: Comparison of the Sentinel-2 and HyperScout-2 pseudo-true colour imagery showing HyperScout-2 at the top and Sentinel-2 at the bottom.

Figure 4-7 (bottom) shows the HyperScout-2 (top) and Sentinel-2 (bottom) for a zoomed-in location, with Sentinel-2 overlaid with GCP locations for the Sentinel-2 image (red) and HyperScout-2 (blue). The average differences, for the x and y directions, compared to Sentinel-2 for the four locations was: -14.219 m and 12.198 m. Therefore, the difference was less than a HyperScout-2 pixel (75 m) in both directions.

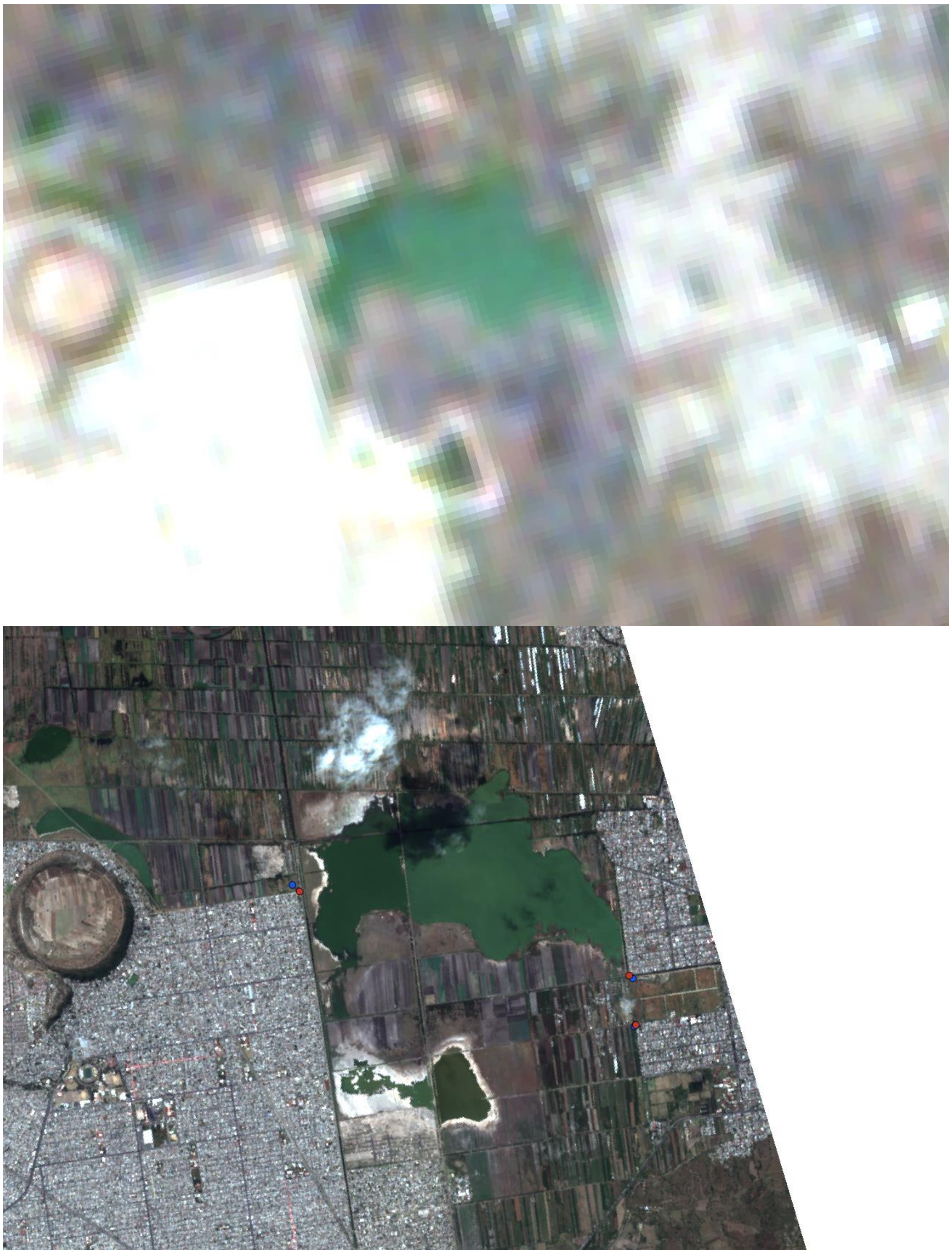

Figure 4-7: Comparison of (top) HyperScout-2 and (bottom) Sentinel-2 for an overlapping zoomed-in area with lots of features.

4.4.2 Temporal Geolocation Accuracy

The temporal planimetric geolocation accuracy (i.e. stability) of the imagery is determined by comparing imagery sensed at different points in time. Note: no minimum requirement has been specified for temporal planimetric geolocation accuracy.

This assessment was not performed as there was only a single image acquired for each site.

4.4.3 Band Co-registration Accuracy

A visual analysis was performed for the band co-registration assessment.

4.4.3.1 Method

All the bands are stored together in a single HDF file, and the geometric information held within those files applies to all bands.

4.4.3.2 Results

The previously reported visual inspection of the images, see Figure 4-1, indicated there were no visible anomalies or artefacts. In addition, zooming did not show any apparent band-to-band pixel shift when colour composites were created.

4.5 Conclusions

The conclusions from this Quality Assessment technical note for the HyperScout-2 land products are:

- Image Quality:
  - The HDF files have no quality flags or masks and, overall, the HDF file contains limited metadata. It is recommended to improve this information in order to improve the overall usability of the products.
  - For users of ESA's SNAP tool, it would be useful for the HyperScout-2 format to be explicitly recognised so that the geometry is recognised, and the data can be analysed using, for example, spectral profiles.
  - The SNR quoted in product specification [RD.5] has changed from a single number to a range of values for each supplied scene. The current approach used for EDAP did not run for the Libya-4 scene as it was analysed as being too spatially variable, but an older approach appeared to show consistent results.

- Radiometric assessment:
  - The assessment results showed a close matchup between the HyperScout-2 and Hyperscout-1/RadCalNet data for the Railroad Valley site, alongside the Sentinel-2 data. This result is not unexpected as Railroad Valley is used as a vicarious calibration site, so is not an independent dataset.
  - Previous discussions with Cosine for Hyperscout-1 revealed that the TOA reflectance is not BRDF corrected, but that these instruments are considered as nadir viewing. To improve the data's usefulness, e.g., in support of an atmospheric correction, the L1C HDF files should contain the satellite geometry information as part of the metadata if not as ancillary bands.

- Geometric assessment:
  - The assessment results showed that there were no obvious issues with the geometric information stored in the HDF files. The tested absolute accuracy was within the specification given with the product.

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