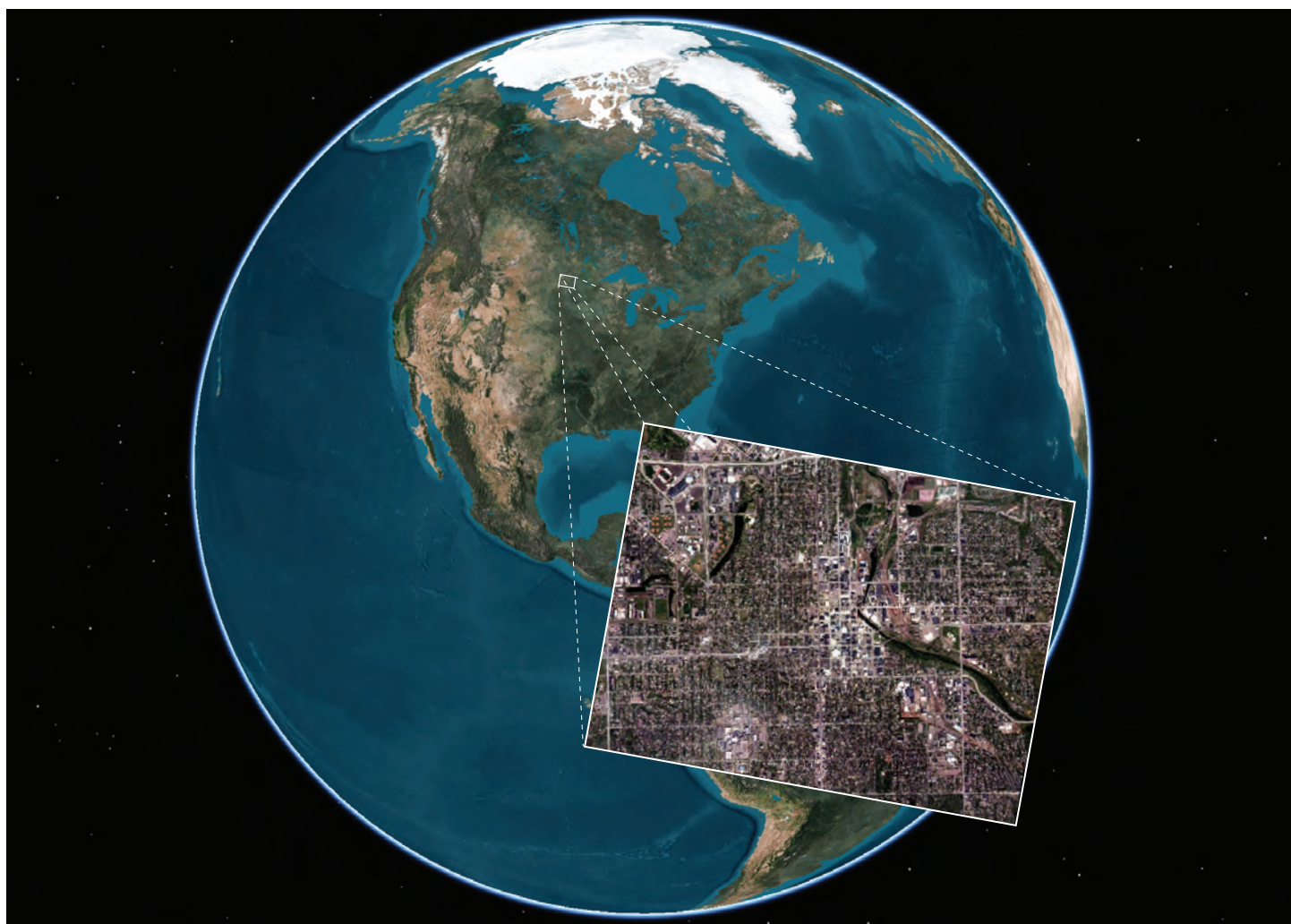


System Characterization Report on the Satellogic NewSat Multispectral Sensor

Chapter L of
System Characterization of Earth Observation Sensors



Open-File Report 2021–1030–L
Version 1.1, April 2022

U.S. Department of the Interior
U.S. Geological Survey

Satellite image of Sioux Falls, South Dakota, captured by the Satellogic NewSat satellite. Image courtesy of Satellogic, used with permission. Image of Earth from Analytical Graphics, Inc., Systems Tool Kit.

System Characterization Report on the Satellogic NewSat Multispectral Sensor

By James C. Vrabel,¹ Paul Bresnahan,² Gregory L. Stensaas,³ Cody Anderson,³
Jon Christopherson,² Minsu Kim,² and Seonkyung Park²

Chapter L of
System Characterization of Earth Observation Sensors

Compiled by Shankar N. Ramaseri Chandra²

¹Imaging Technology Consultants, Inc., under contract to the U.S. Geological Survey.

²KBR, Inc., under contract to the U.S. Geological Survey.

³U.S. Geological Survey.

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
Length		
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
kilometer (km)	0.6214	mile (mi)
Mass		
kilogram (kg)	2.205	pound avoirdupois (lb)

Abbreviations

ECCOE	Earth Resources Observation and Science Cal/Val Center of Excellence
GCP	ground control point
GSD	ground sample distance
JACIE	Joint Agency Commercial Imagery Evaluation
USGS	U.S. Geological Survey

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Executive Summary

This report addresses system characterization of Satellogic's NewSat satellite (also known as ÑuSat) and is part of a series of system characterization reports produced and delivered by the U.S. Geological Survey Earth Resources Observation and Science Cal/Val Center of Excellence. These reports present and detail the methodology and procedures for characterization; present technical and operational information about the specific sensing system being evaluated; and provide a summary of test measurements, data retention practices, data analysis results, and conclusions.

Since 2016, Satellogic has launched 17 NewSat satellites. All NewSat satellites have four-band imagers with a 1-meter (m) ground sample distance, and values in pixels are identical to values in meters. All NewSats have been launched into Sun-synchronous orbits of about 475 kilometers, with inclinations of about 97.5 degrees. The satellites have expected lifetimes of about 3 years. More information on the Satellogic satellites and sensors is available in the "2020 Joint Agency Commercial Imagery Evaluation—Remote Sensing Satellite Compendium" and from the manufacturer at <https://satellogic.com/>.

The Earth Resources Observation and Science Cal/Val Center of Excellence system characterization team completed data analyses to characterize the geometric (interior and exterior), radiometric, and spatial performances. Results of these analyses indicate that the NewSat satellites have an interior geometric performance in the range of -0.119 (-0.119 pixel) to 0.020 m (0.020 pixel) in easting and -0.148 (-0.148 pixel) to 0.014 m (0.014 pixel) in northing in band-to-band registration, an exterior geometric performance of -9.04 (-9.04 pixels) to -5.84 m (-5.84 pixels) in easting and 1.25 (1.25 pixels) to 3.11 m (3.11 pixels) in northing offset in comparison to Sentinel-2, an exterior geometric performance using ground control points of a 6.5-m circular error (95 percent),

a radiometric performance in the range of 0.034 to 0.081 in offset and 0.652 to 0.808 in slope, and a spatial performance in the range of 1.61 to 1.76 pixels for full width at half maximum, with a modulation transfer function at a Nyquist frequency in the range of 0.081 to 0.138.

Introduction

Satellogic is an Argentinian company, founded in 2010, that specializes in building and operating Earth observation satellites. Their small satellites, known as NewSats (or ÑuSats), have been launched since May 2016. These satellites carry video, multispectral, and hyperspectral sensors. The NewSats are 43 centimeters (cm) x 45 cm x 75 cm in size and have a mass of about 37 kilograms. As of August 2021, Satellogic has 17 NewSats in orbit. This assessment focuses on their four-band multispectral sensor, which collects data at a 1-meter (m) spatial resolution. All Satellogic data used in this assessment were provided with permission from Satellogic. More information on the Satellogic satellites and sensors is available in the "2020 Joint Agency Commercial Imagery Evaluation—Remote Sensing Satellite Compendium" (Ramaseri Chandra and others, 2020) and from the manufacturer at <https://satellogic.com/>.

The data analysis results provided in this report have been derived from approved Joint Agency Commercial Imagery Evaluation (JACIE) processes and procedures. JACIE was formed to leverage resources from several Federal agencies for the characterization of remote sensing data and to share those results across the remote sensing community. More information about JACIE is available at https://www.usgs.gov/core-science-systems/eros/calval/jacie?qt-science_support_page_related_con=3#qt-science_support_page_related_con.

Purpose and Scope

The purpose of this report is to describe the specific sensor or sensing system, test its performance in three categories, complete related data analyses to quantify these performances, and report the results in a standardized document.

¹Imaging Technology Consultants, Inc., under contract to the U.S. Geological Survey.

²KBR, Inc., under contract to the U.S. Geological Survey.

³U.S. Geological Survey.

In this chapter, Satellogic’s NewSat sensor is described. The performance testing of the system is limited to geometric, radiometric, and spatial qualities. The scope of the geometric assessment is limited to testing the interior alignments of spectral bands against each other. The exterior alignment is tested in reference to Sentinel-2 and in reference to ground control points (GCPs) collected in the Sioux Falls, South Dakota, area.

The USGS Earth Resources Observation and Science Cal/Val Center of Excellence (ECCOE) project, and the associated system characterization process used for this assessment, follows the USGS Fundamental Science Practices, which include maintaining data, information, and documentation needed to reproduce and validate the scientific analysis documented in this report. Additional information and guidance about Fundamental Science Practices and related resource information of interest to the public are available at <https://www.usgs.gov/about/organization/science-support/office-science-quality-and-integrity/fundamental-science-practices>. For additional information related to the report, please contact ECCOE at eccoe@usgs.gov.

System Description

This section describes the satellite and operational details and provides information about Satellogic’s NewSat sensor.

Satellite and Operational Details

The satellite and operational details for Satellogic’s NewSat are listed in [table 1](#).

Sensor Information

The imaging sensor details for Satellogic’s NewSat are listed in [table 2](#). The relative spectral response for Satellogic’s NewSat is shown in [figure 1](#).

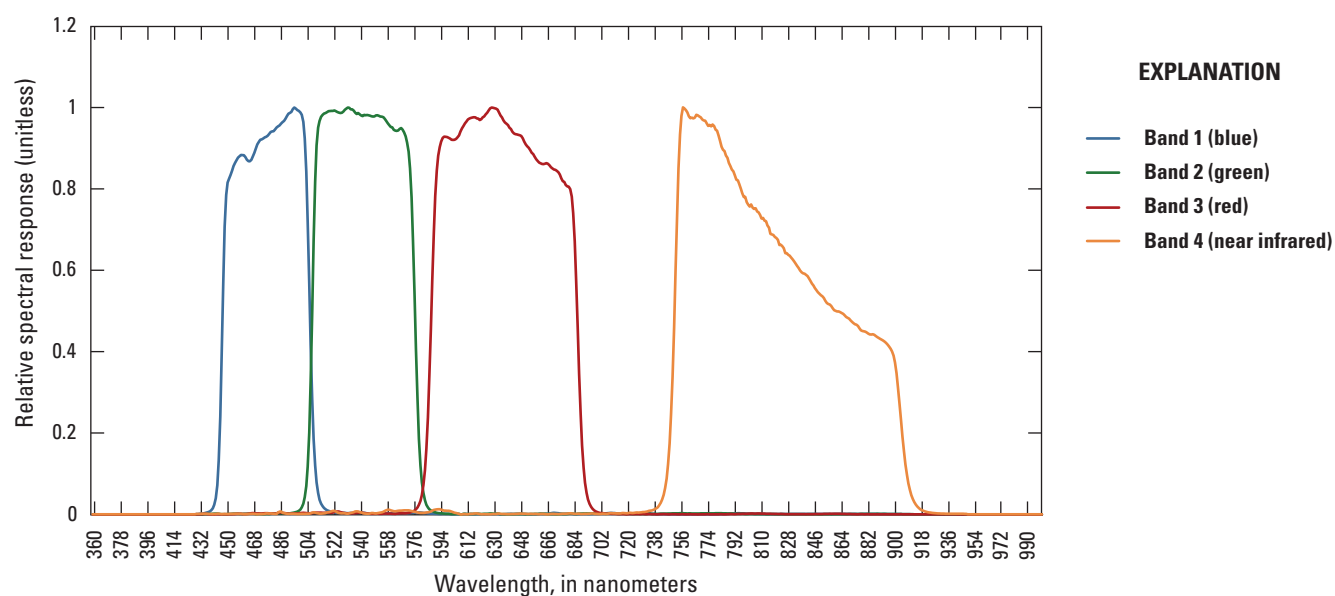
Table 1. Satellite and operational details for Satellogic’s NewSat multispectral sensor.

[TOA, Top of Atmosphere; cm, centimeter; ~, about; kg, kilogram; MSI, Multispectral Imager; NIR, near infrared; Q3, July–September; km, kilometer; °, degree; ±, plus or minus; m, meter]

Product information	NewSat
Satellite and operational information	
Product name	Level 1 TOA reflectance
Satellite name	Satellogic NewSat (also known as ÑuSat)
Satellite size	Small satellite (43 cm × 45 cm × 75 cm), mass ~37 kg
Sensor name	MSI
Sensor type	Multispectral (blue, green, red, NIR)
Mission type	Global land-monitoring mission
Launch date	Multiple dates, beginning in May 2016
Number of satellites	17 (in orbit as of Q3 2021)
Expected lifetime	3 years
Operator	Satellogic
Operational details	
Operating orbit	Sun-synchronous orbit
Orbital altitude range	475 km
Sensor angle altitude	97.5° inclination
Imaging time	10:30 a.m. (local time)
Temporal resolution	As much as 4 times per day, depending on latitude
Temporal coverage	2016 to present (2021)
Imaging angles	±25°
Ground sample distance(s)	1 m
Data licensing	Restricted
Data pricing	Limited free data; commercial imagery pricing
Website	https://satellogic.com/

Table 2. Imaging sensor details for Satellogic’s NewSat.[μm , micrometer; m, meter; NIR, near infrared]

Spectral band details	NewSat			
	Lower band (μm)	Upper band (μm)	Radiometric resolution (bits)	Ground sample distance (m)
Band 1—blue	0.40	0.51	16	1
Band 2—green	0.51	0.58	16	1
Band 3—red	0.58	0.69	16	1
Band 4—NIR	0.75	0.90	16	1

**Figure 1.** Satellogic’s NewSat relative spectral response.

Procedures

ECCOE has established standard processes to identify Earth observing systems of interest and to assess the geometric, radiometric, and spatial qualities of data products from these systems.

The assessment steps are as follows:

- system identification and investigation to learn the general specifications of the satellite and its sensor(s);
- data receipt and initial inspection to understand the characteristics and any overt flaws in the data product so that it may be further analyzed;
- geometry characterization, including interior geometric orientation measuring the relative alignment of spectral bands and exterior geometric orientation measuring how well the georeferenced pixels within the image are aligned to a known reference;
- radiometry characterization, including assessing how well the data product correlates with a known reference and, when possible, assessing the signal-to-noise ratio; and
- spatial characterization, assessing the two-dimensional fidelity of the image pixels to their projected ground sample distance (GSD).

Data analysis and test results are maintained at the USGS Earth Resources Observation and Science Center by the ECCOE project.

Measurements

The observed USGS measurements are listed in [table 3](#). Details about the methodologies used are outlined in the “Analysis” section.

Table 3. U.S. Geological Survey measurement results.

[USGS, U.S. Geological Survey; m, meter; GSD, ground sample distance; RMSE, root mean square error; %, percent; FWHM, full width at half maximum; RER, relative edge response; MTF, modulation transfer function]

Description of product	Top of Atmosphere reflectance
USGS measurement results	
Geometric performance ranges (easting, northing), in meters (pixels are 1-m GSD and are identical to values in meters)	
Interior (band to band)	Band 1 (blue) to reference band 2 (green) Mean: 0.003 to 0.020 m, -0.025 to 0.002 m RMSE: 0.036 to 0.05 m, 0.037 to 0.051 m Band 3 (red) to reference band 2 (green) Mean: 0.002 to 0.019 m, -0.016 to 0.014 m RMSE: 0.029 to 0.064 m, 0.039 to 0.062 m Band 4 (near infrared) to reference band 2 (green) Mean: -0.119 to -0.016 m, -0.148 to -0.079 m RMSE: 0.052 to 0.181 m, 0.105 to 0.195 m
Exterior (geometric location accuracy compared to Sentinel-2)	Mean: -9.04 to -5.84 m, 1.25 to 3.11 m RMSE: 6.05 to 9.30 m, 2.52 to 5.87 m
Exterior (geometric location accuracy compared to ground control points)	Circular error: 6.5 m (95%)
Radiometric performance ranges (offset, slope)	
Radiometric evaluation (linear regression—NewSat versus Sentinel-2 reflectance)	Band 1: (0.041 to 0.081, 0.652 to 0.754) Band 2: (0.034 to 0.071, 0.703 to 0.783) Band 3: (0.041 to 0.074, 0.679 to 0.727) Band 4: (0.054 to 0.075, 0.725 to 0.808)
Spatial performance (FWHM, RER, MTF at Nyquist)	
Spatial performance measurement	Band 1 1.61 pixels, 0.62, 0.138 Band 2 1.64 pixels, 0.56, 0.115 Band 3 1.63 pixels, 0.53, 0.110 Band 4 1.76 pixels, 0.41, 0.081
Known artifacts and quality issues	
USGS noted artifacts/quality issues	None

Analysis

This section of the report describes the geometric, radio-metric, and spatial performance of Satellogic’s NewSat.

Geometric Performance

The geometric performance for Satellogic’s NewSat is characterized in terms of the interior (band-to-band alignment) and exterior (geometric location accuracy) geometric analysis results. Interior accuracy measures how well the various bands of NewSat are aligned to each other. Exterior accuracy mea-sures the geometric location accuracy of NewSat compared to Sentinel-2 imagery and GCPs.

Interior (Band to Band)

The band-to-band alignment analysis was completed using the Earth Resources Observation and Science System Characterization software on two images over Fès, Morocco, and Railroad Valley, Nevada. Band combinations were registered against each other to determine the mean error and root mean square error, as listed in [table 4](#), with results represented in pixels at a 1-m GSD (values in meters are identical to values in pixels because the sensor has a 1-m GSD). Results of band comparisons to the green band are provided. Geometric error maps for each green band comparison over

the two scenes, as well as the corresponding error plots, are shown in [figures 2–15](#). Geometric error histogram graphs also are shown for the green-to-blue band comparisons for each of the scenes. The geometric error maps indicate the directional shift and relative magnitude of the shift, and the histogram graphs indicate the frequency of observed mean error measurements within the image. The geometric error plots indicate the easting and northing errors between the designated bands. Together, the interior and exterior geometric analysis results, as reported in the “Interior (Band to Band)” and “Exterior (Geometric Location Accuracy)” sections, provide a comprehensive assessment of geometric accuracy.

Table 4. Band-to-band registration error (in pixels).

[ID, identifier; RMSE, root mean square error]

Scene ID	Band combination	Mean error (easting)	Mean error (northing)	RMSE (easting)	RMSE (northing)
20210423_110441_SN10_L1_Full (Fès, Morocco)	Band 2–band 1	0.020	0.002	0.050	0.037
	Band 2–band 3	0.019	0.014	0.064	0.062
	Band 2–band 4	–0.119	–0.148	0.181	0.195
20210228_183201_SN10_L1_Full (Railroad Valley, Nevada)	Band 2–band 1	0.003	–0.025	0.036	0.051
	Band 2–band 3	0.002	–0.016	0.029	0.039
	Band 2–band 4	–0.016	–0.079	0.052	0.105

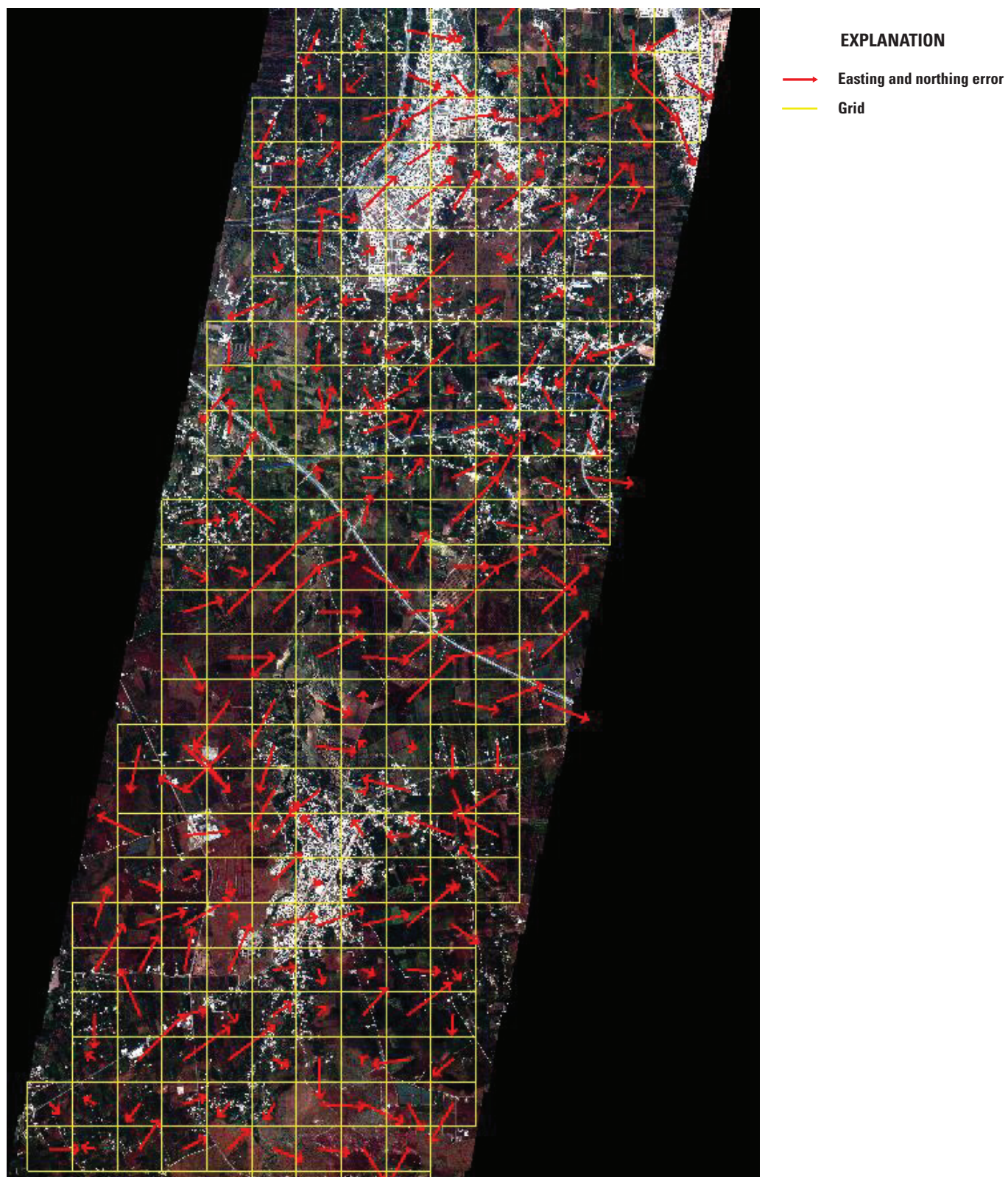


Figure 2. Band 1 (blue) to band 2 (green) geometric error map, Fès, Morocco.

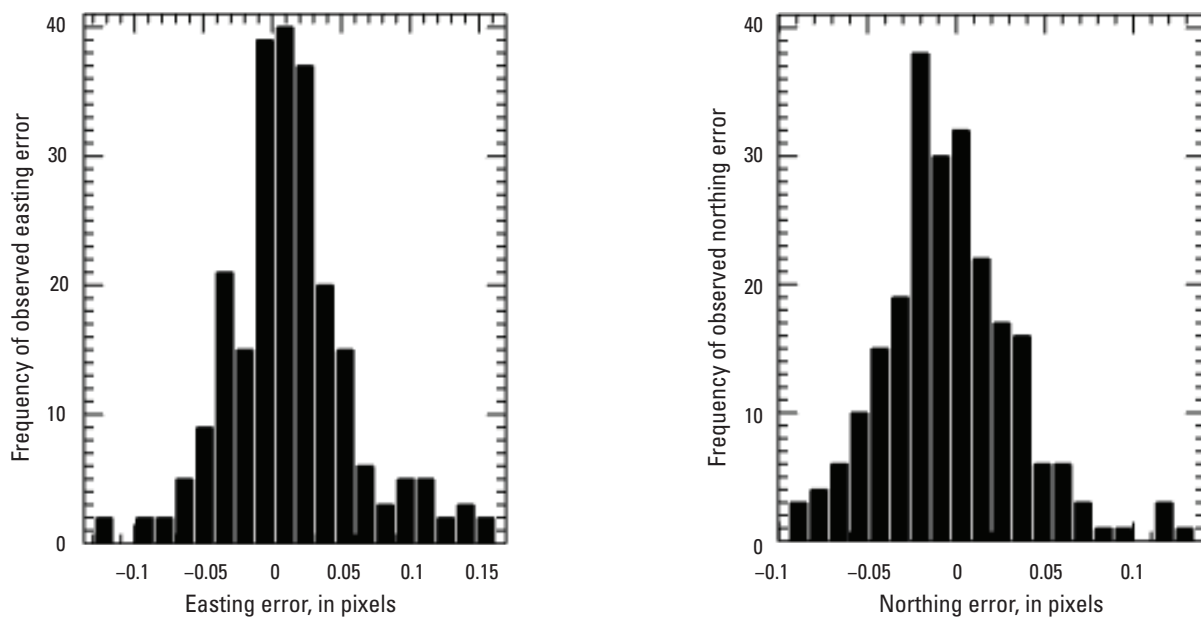


Figure 3. Band 1 (blue) to band 2 (green) geometric error histogram, Fès, Morocco.

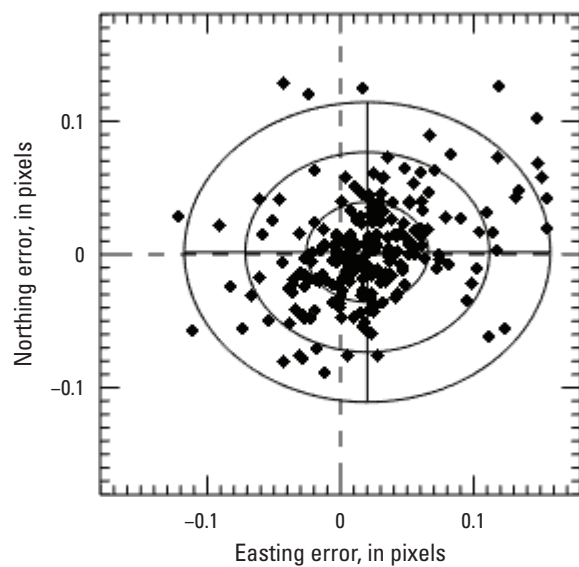


Figure 4. Band 1 (blue) to band 2 (green) geometric error plot, Fès, Morocco.

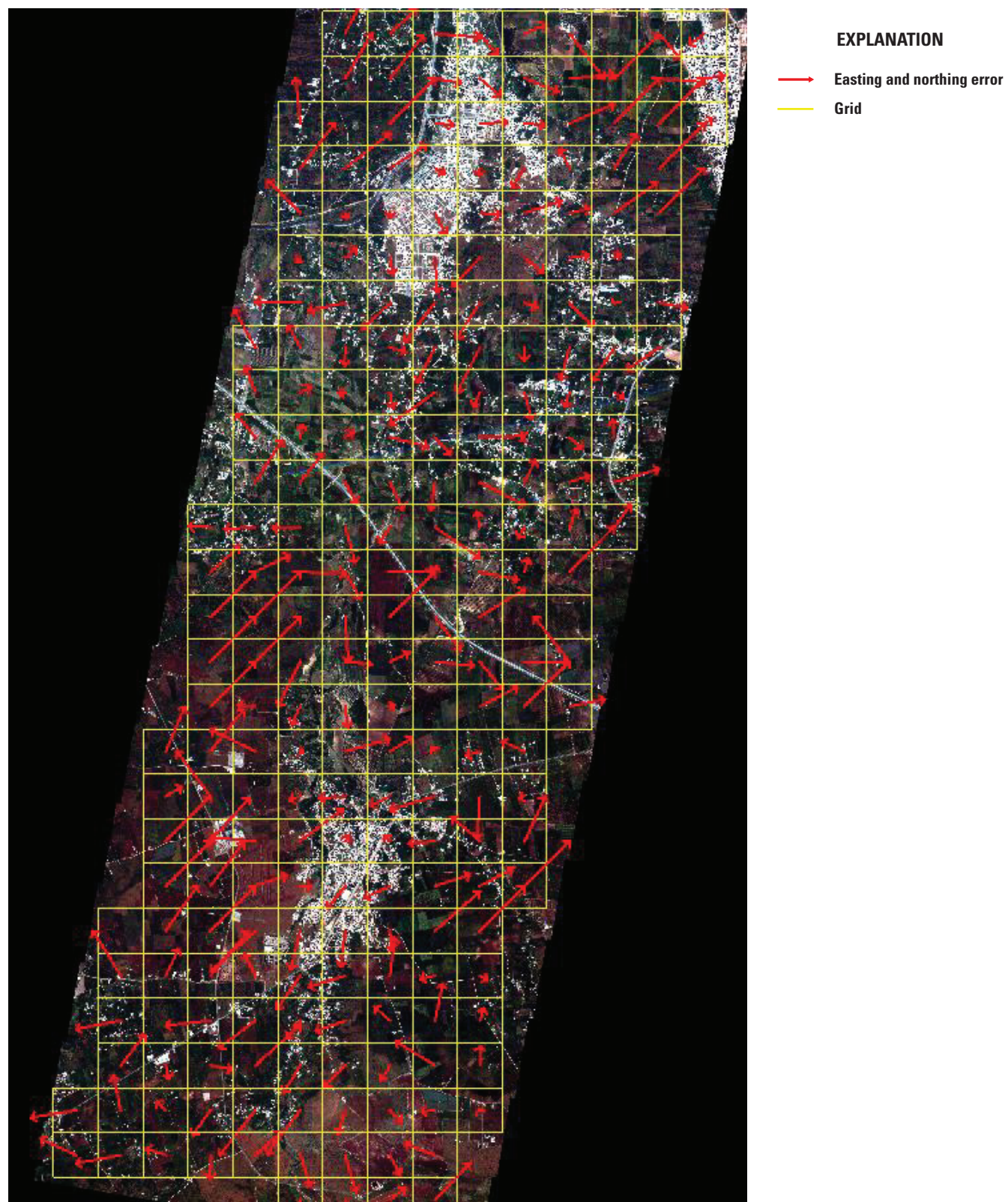


Figure 5. Band 2 (green) to band 3 (red) geometric error map, Fès, Morocco.

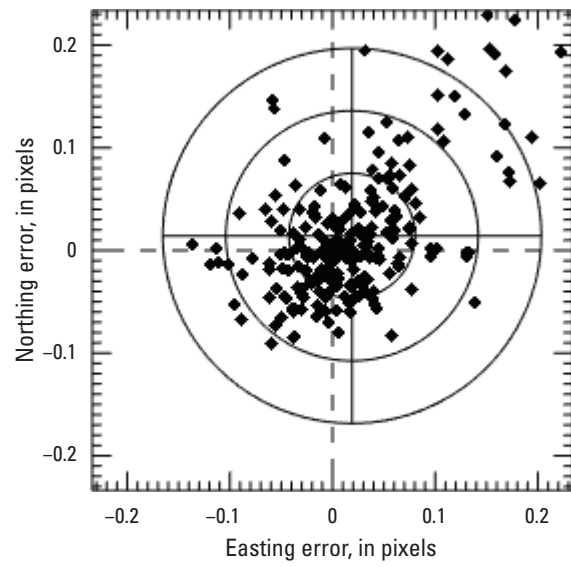


Figure 6. Band 2 (green) to band 3 (red) geometric error plot, Fès, Morocco.

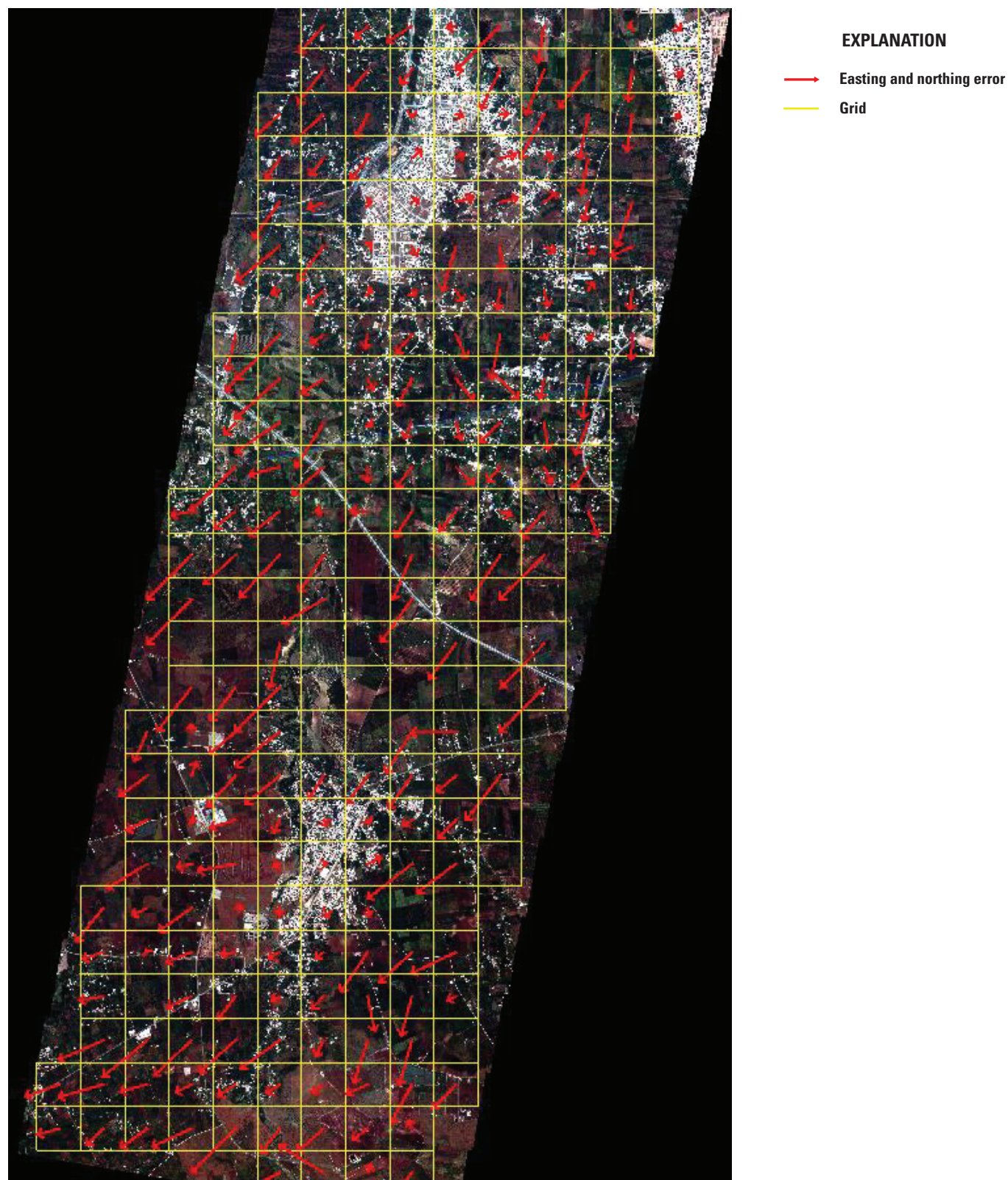


Figure 7. Band 2 (green) to band 4 (near infrared) geometric error map, Fès, Morocco.

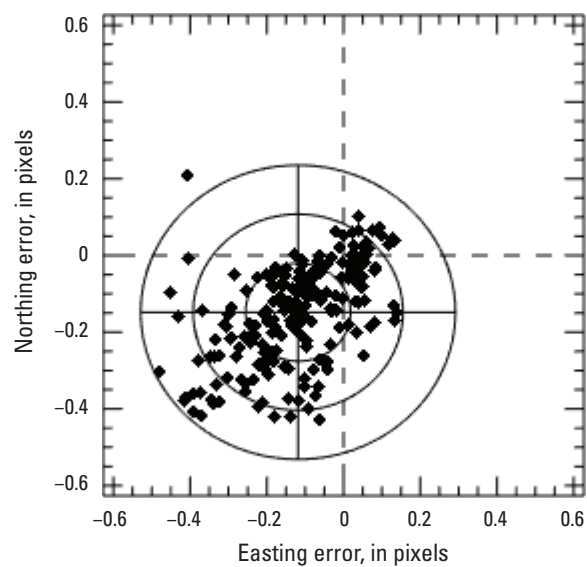


Figure 8. Band 2 (green) to band 4 (near infrared) geometric error plot, Fès, Morocco.

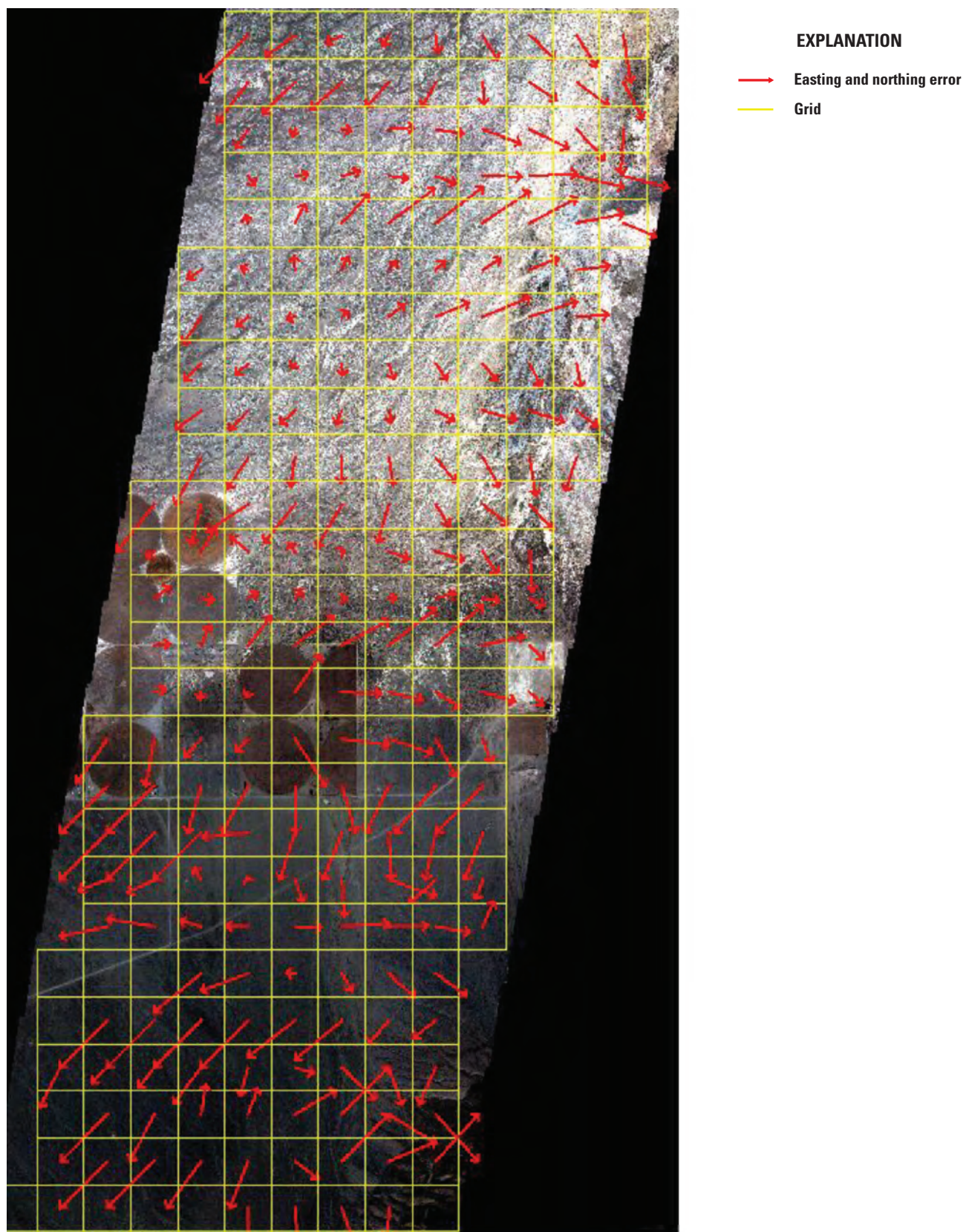


Figure 9. Band 1 (blue) to band 2 (green) geometric error map, Railroad Valley, Nevada.

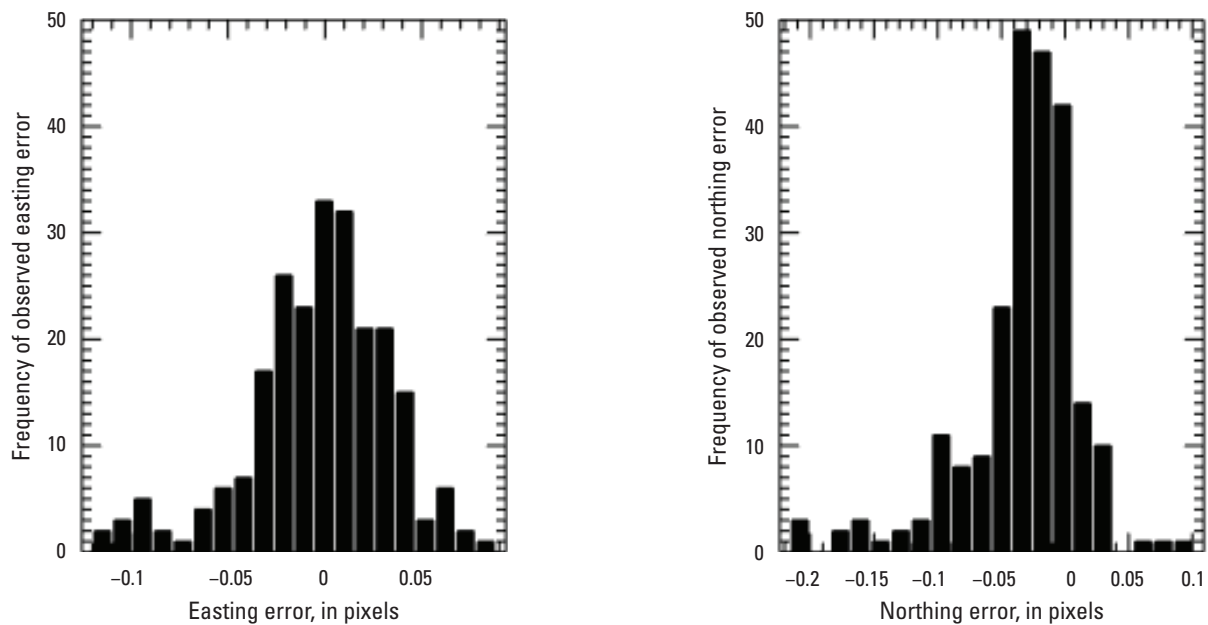


Figure 10. Band 1 (blue) to band 2 (green) geometric error histogram, Railroad Valley, Nevada.

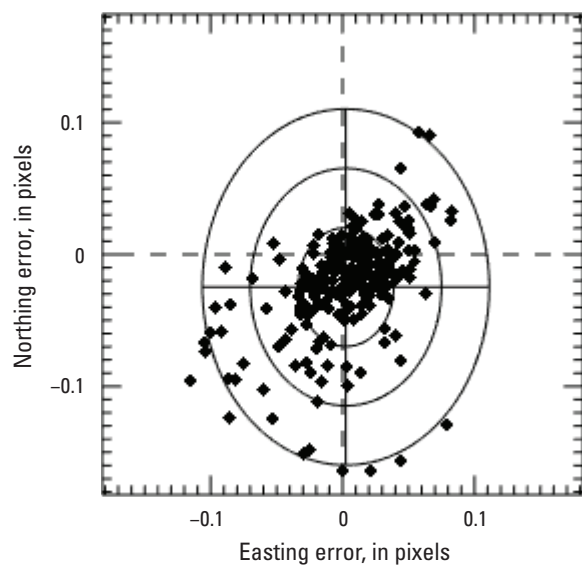


Figure 11. Band 1 (blue) to band 2 (green) geometric error plot, Railroad Valley, Nevada.

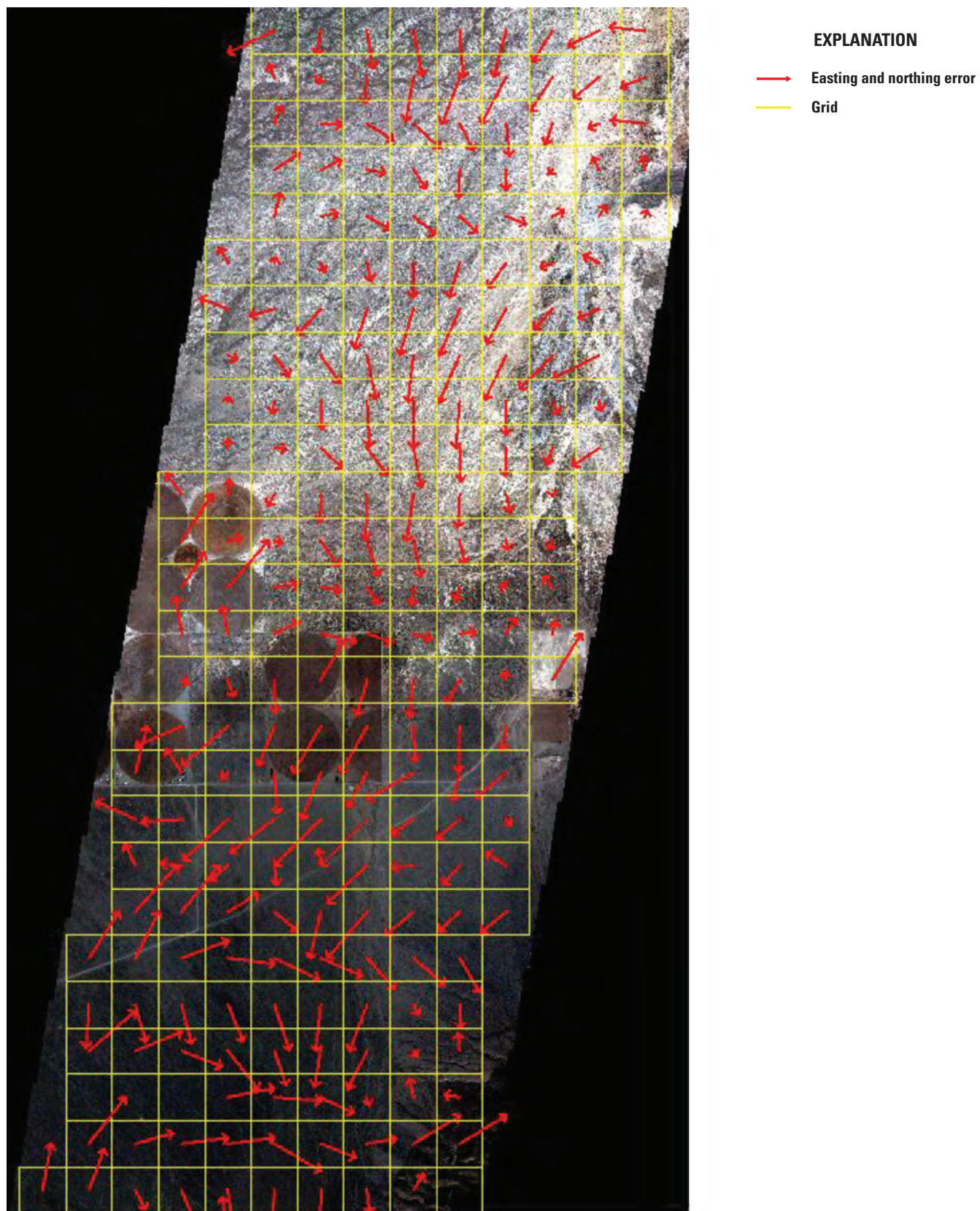


Figure 12. Band 2 (green) to band 3 (red) geometric error map, Railroad Valley, Nevada.

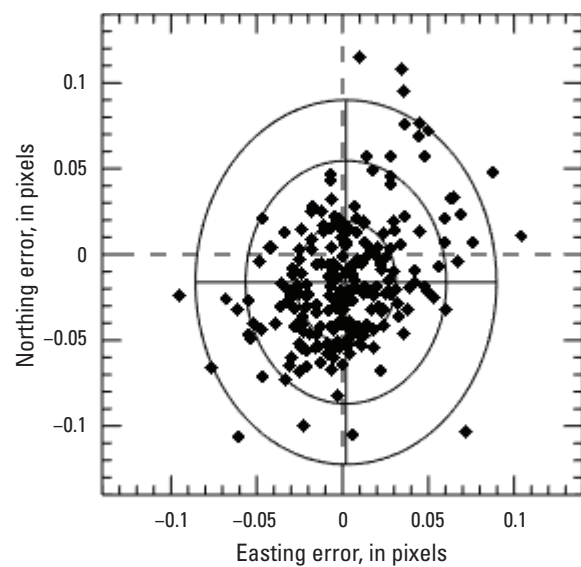


Figure 13. Band 2 (green) to band 3 (red) geometric error plot, Railroad Valley, Nevada.

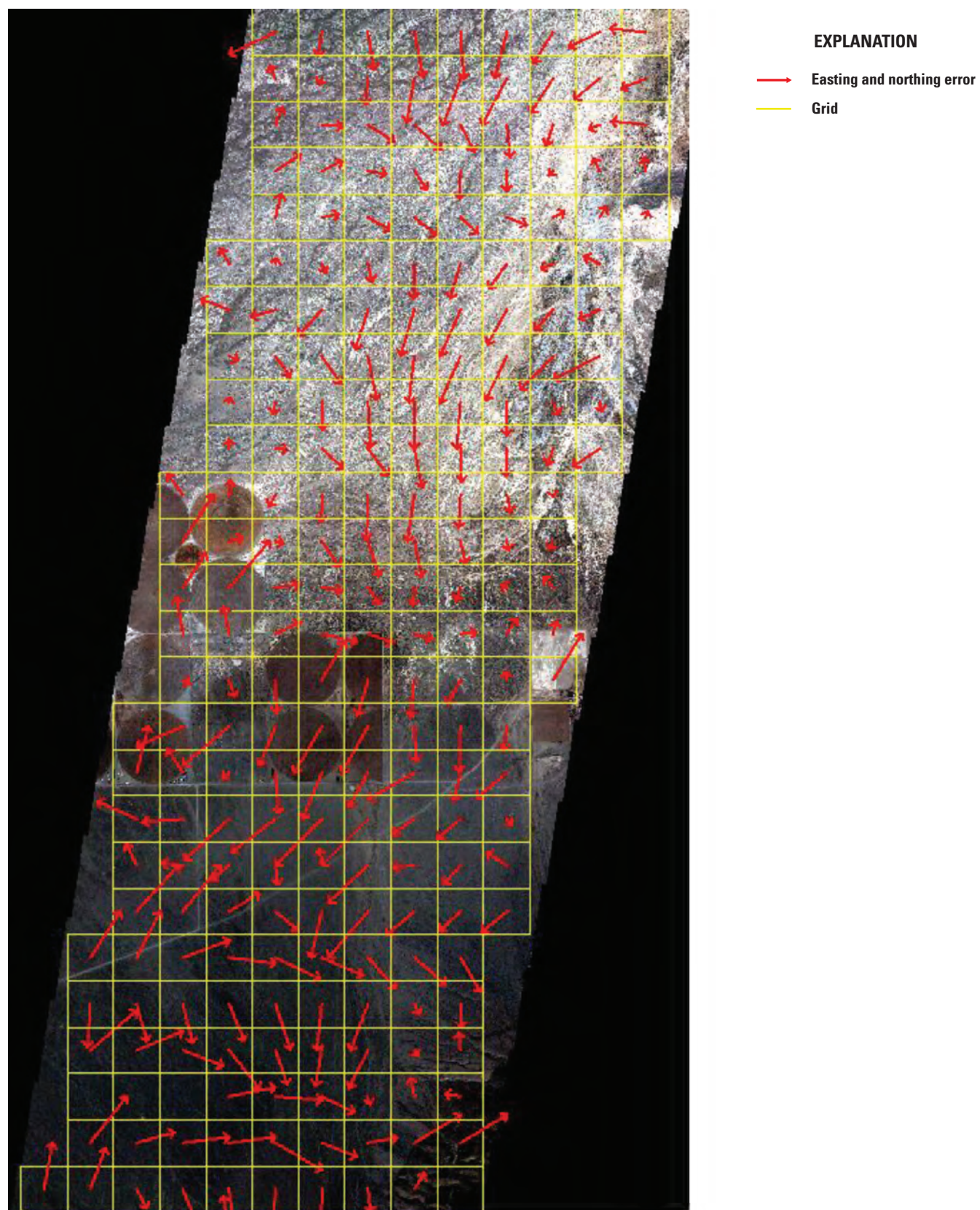


Figure 14. Band 2 (green) to band 4 (near infrared) geometric error map, Railroad Valley, Nevada.

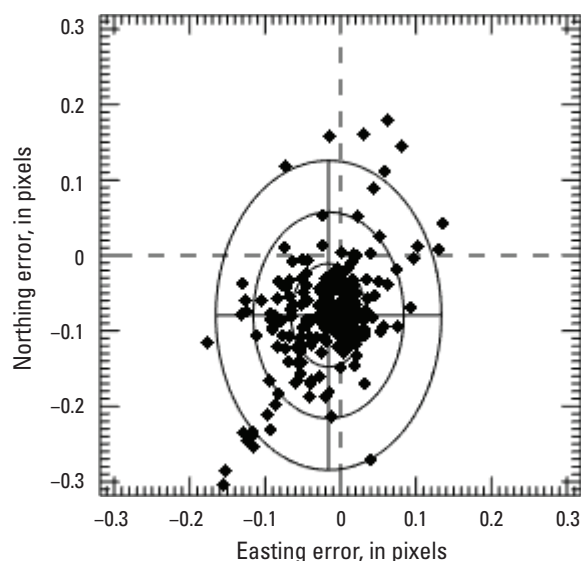


Figure 15. Band 2 (green) to band 4 (near infrared) geometric error plot, Railroad Valley, Nevada.

Exterior (Geometric Location Accuracy)

For this analysis, two procedures were used. In the first procedure, band 4 (near infrared) of two NewSat images was compared with the corresponding band from two Sentinel-2 images over Fès, Morocco, and Railroad Valley, Nev., using the Earth Resources Observation and Science System Characterization software. Conjugate points in the reference and search images were identified automatically and refined using similarity measures such as normalized cross-correlation metrics, and the mean error and root mean square error results are listed in [table 5](#), in pixels at a 1-m GSD. For each of the two images, geometric error maps showing the directional shift and relative magnitude of the shift, when compared with Sentinel-2, are provided in [figures 16 and 17](#). The Sentinel-2 imagery had a control uncertainty of about 3.6 m (95 percent).

In the second external geometric location accuracy procedure, a NewSat image over Sioux Falls, S. Dak., was compared to previously collected GCPs. For this analysis, 23 GCPs over Sioux Falls, S. Dak., were manually measured on the Satellogic four-band orthorectified image using the QGIS software (formerly known as Quantum Geographic Information System software). The horizontal coordinates derived from the image were compared to the known horizontal coordinates of the GCPs. Error statistics are listed in [table 6](#), and an error plot is shown in [figure 18](#). The National Standard for Spatial Data Accuracy metric, which is a 95-percent circular error value, is 6.5 m.

Table 5. Geometric error of Satellogic’s NewSat relative to Sentinel-2 imagery.

[ID, identifier; RMSE, root mean square error; m, meter]

Scene ID	Mean error (easting)	Mean error (northing)	RMSE (easting)	RMSE (northing)
20210423_110441_SN10_L1_Full S2B_MSIL1C_20210423T105619_N0300_ R094_T30STC_20210423T115904 (Fès, Morocco)	−5.84 pixels (−5.84 m)	1.25 pixels (1.25 m)	6.05 pixels (6.05 m)	2.52 pixels (2.52 m)
20210228_183201_SN10_L1_Full L1C_T11SPC_A029725_20210301T183130 (Railroad Valley, Nevada)	−9.04 pixels (−9.04 m)	3.11 pixels (3.11 m)	9.30 pixels (9.30 m)	5.87 pixels (5.87 m)

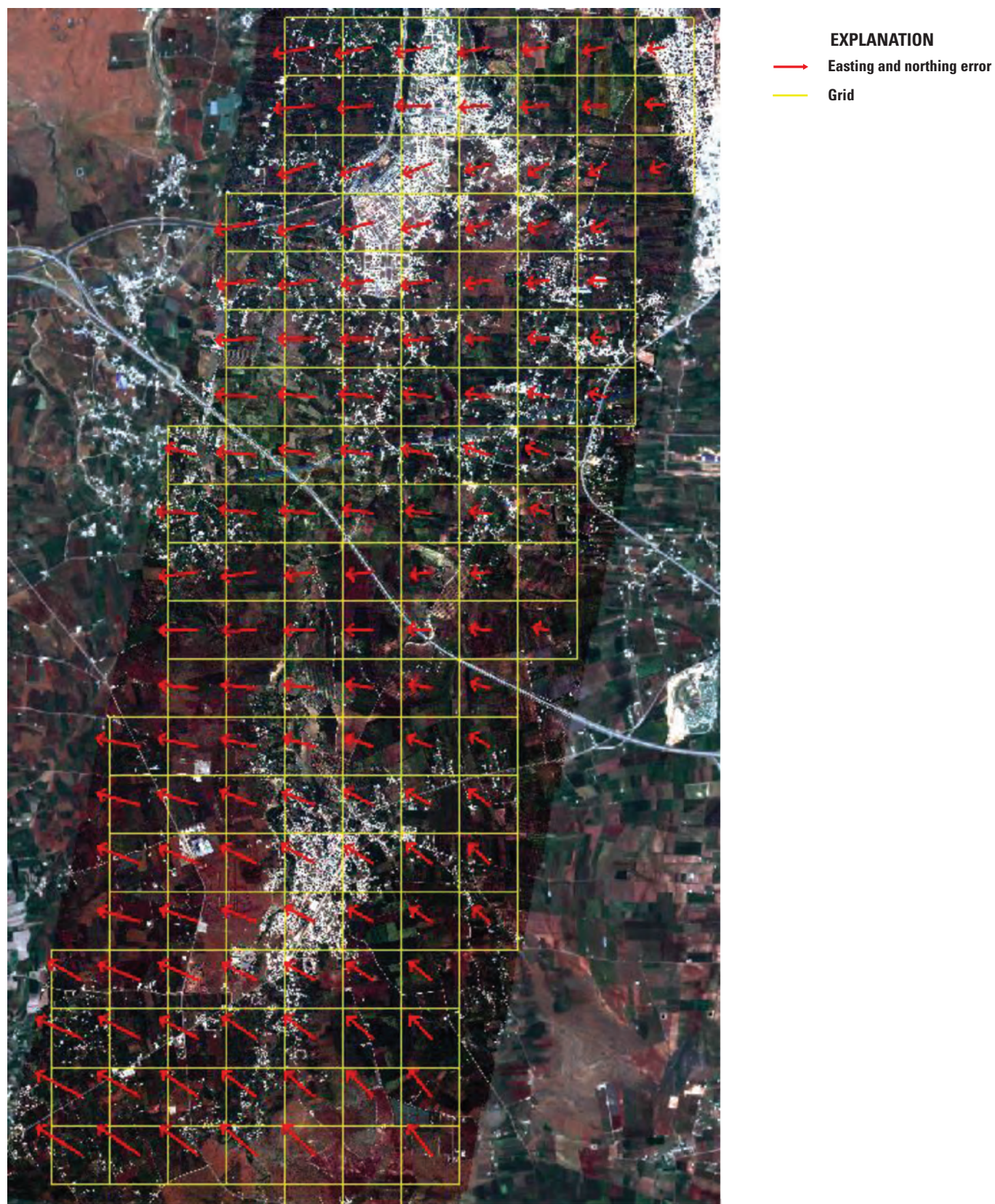


Figure 16. Relative geometric error comparison for Satellogic's NewSat and Sentinel-2, Fès, Morocco.

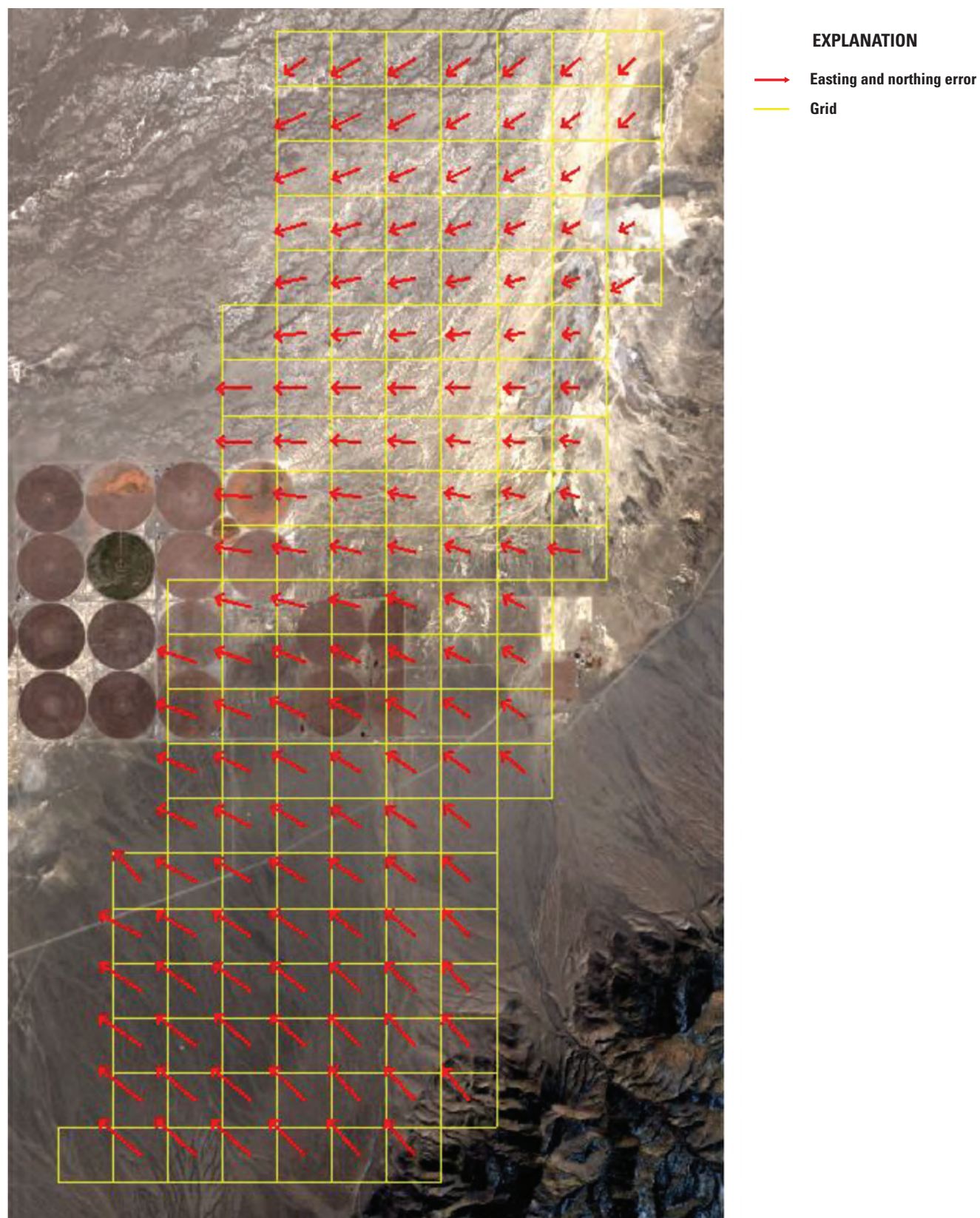


Figure 17. Relative geometric error comparison for Satellogic's NewSat and Sentinel-2, Railroad Valley, Nevada.

Table 6. Geometric error of Satellogic’s NewSat orthorectified image relative to ground control points.

[ID, identifier; SDDEV, standard deviation; RMSE, root mean square error; NSSDA, National Standard for Spatial Data Accuracy; %, percent; m, meter]

Scene ID	Mean error (easting)	Mean error (northing)	SDDEV error (easting)	SDDEV error (northing)	RMSE error (easting)	RMSE error (northing)	NSSDA (95%)
20210509_171929_ SN10_L1_Full (Sioux Falls, South Dakota)	0.46 pixel (0.46 m)	−0.49 pixel (−0.49 m)	3.1 pixels (3.1 m)	2.1 pixels (2.1 m)	3.1 pixels (3.1 m)	2.1 pixels (2.1 m)	6.5 pixels (6.5 m)

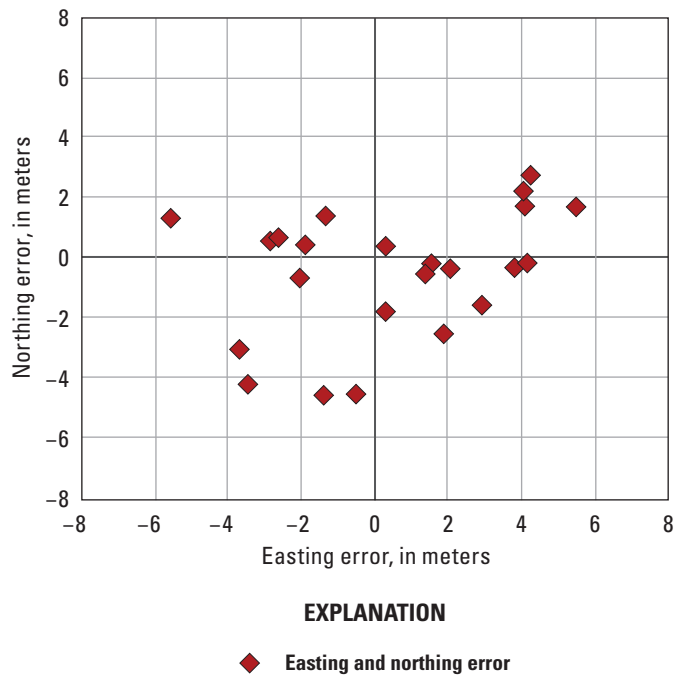


Figure 18. Satellogic’s NewSat geometric error plot showing horizontal geolocation accuracy, Sioux Falls, South Dakota.

Radiometric Performance

For this analysis, cloud-free regions of interest were selected within two near-coincident Satellogic NewSat and Sentinel-2 scene pairs. Once the relative georeferencing error between Sentinel-2 and Satellogic’s NewSat has been corrected, Top of Atmosphere reflectance values from the two sensors are extracted. The scatterplots (figs. 19 and 20) are drawn in a way that the x-axis is the reference sensor and the y-axis is the comparison sensor. The linear regression, thus, represents Top of Atmosphere reflectance relative to that of

the reference sensor. Ideally, the slope should be near unity, and the offset should be near zero. For instance, if the slope is greater than unity, that means the comparison sensor has a tendency to overestimate Top of Atmosphere reflectance compared to the reference sensor.

Top of Atmosphere reflectance comparison results are listed in table 7. A band-by-band graphical comparison between the NewSat image over Fès, Morocco, when compared with the corresponding Sentinel-2 band is shown in figure 19. A band-by-band comparison for the image over Railroad Valley, Nev., is shown in figure 20.

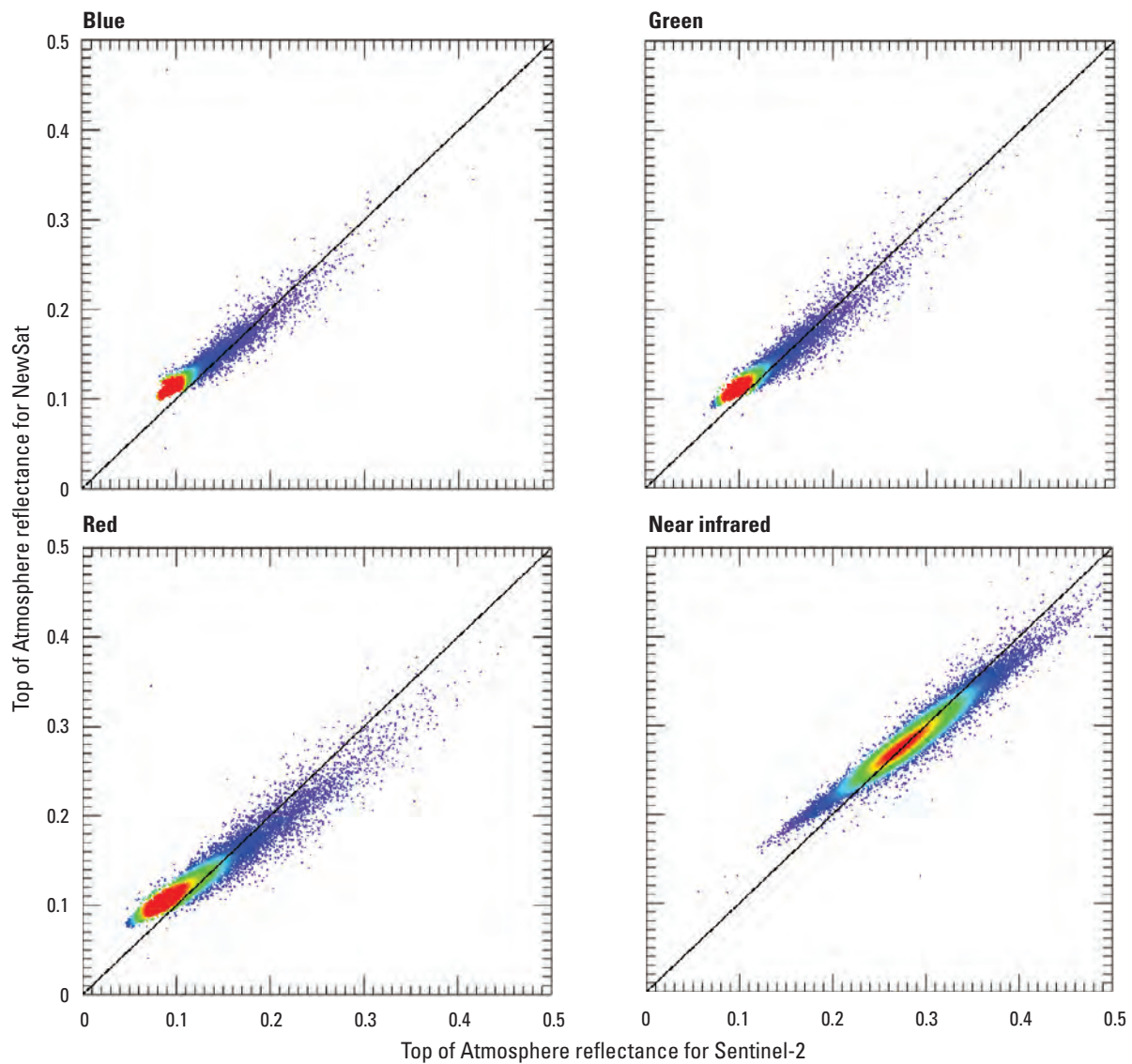


Figure 19. Top of Atmosphere reflectance comparison for Sentinel-2 and Satellogic's NewSat images, Fès, Morocco.

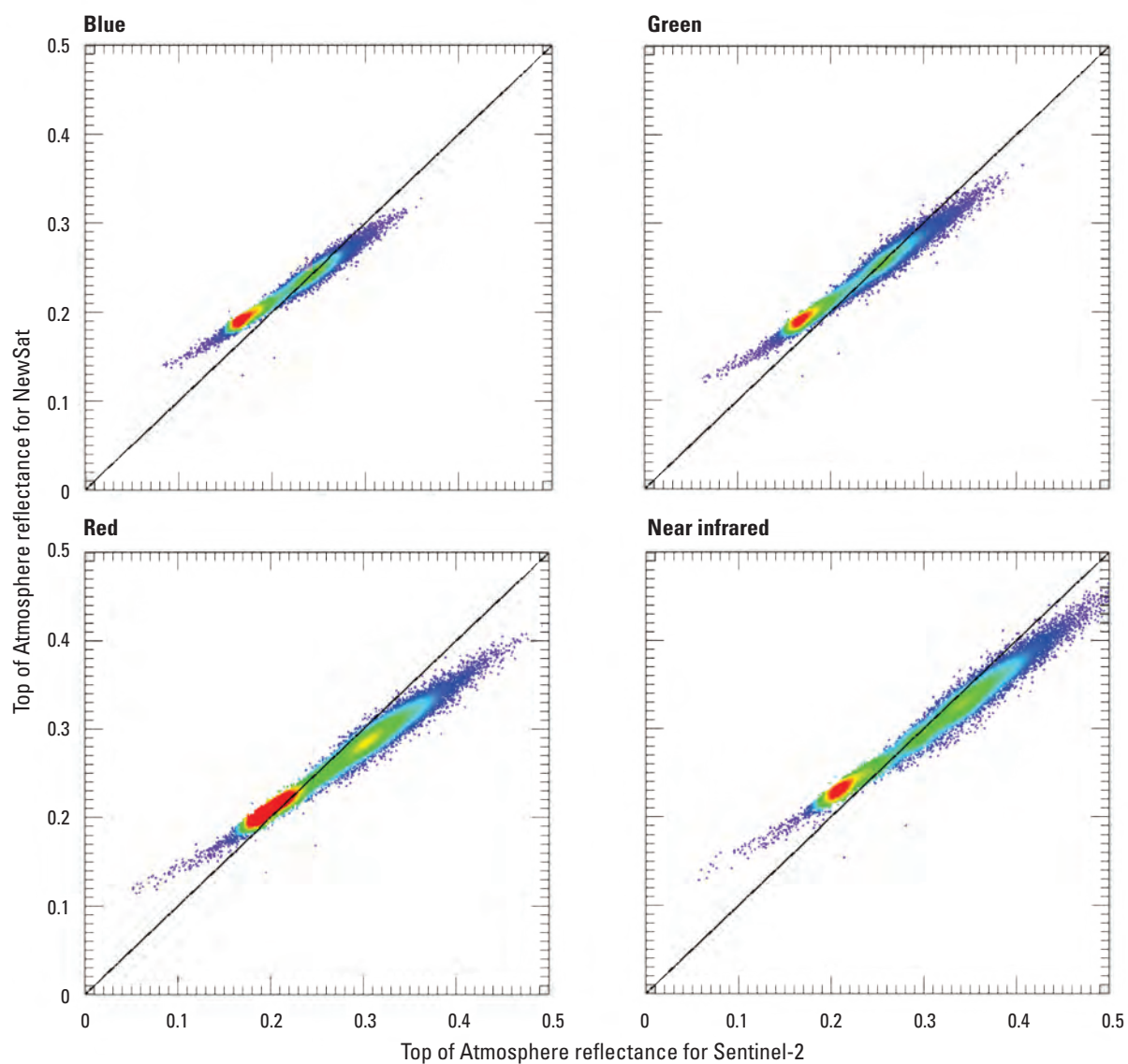


Figure 20. Top of Atmosphere reflectance comparison for Sentinel-2 and Satellogic's NewSat images, Railroad Valley, Nevada.

Table 7. Top of Atmosphere reflectance comparison for Sentinel-2 against Satellogic's NewSat.[ID, identifier; NIR, near infrared; %, percent; R^2 , coefficient of determination]

Scene ID	Statistics	Band 1 (blue)	Band 2 (green)	Band 3 (red)	Band 4 (NIR)
20210423_110441_SN10_L1_Full	Uncertainty (%)	5.48	6.04	10.72	4.05
S2B_MSIL1C_20210423T105619_N0300_	R^2	0.932	0.935	0.936	0.943
R094_T30STC_20210423T115904	Regression offset	0.041	0.034	0.041	0.054
(Fès, Morocco)	Regression slope	0.754	0.783	0.727	0.808
20210228_183201_SN10_L1_Full	Uncertainty (%)	2.65	2.89	3.12	2.81
S2A_MSIL1C_20210301T182301_N0209_	R^2	0.874	0.885	0.886	0.895
R127_T11SPC_20210301T203801	Regression offset	0.081	0.071	0.074	0.075
(Railroad Valley, Nevada)	Regression slope	0.652	0.703	0.679	0.725

Spatial Performance

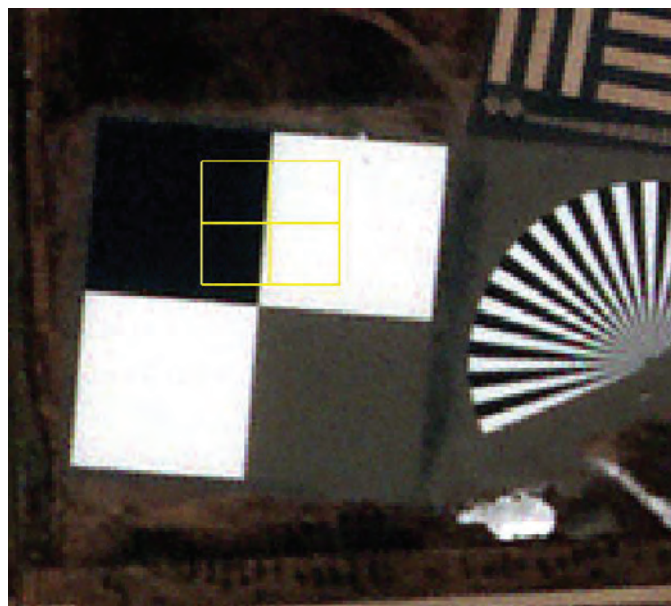
For this analysis, edge spread and line spread functions were calculated with resulting full width at half maximum and modulation transfer function at Nyquist frequency analysis outputs, as listed in [table 8](#). The Satellogic NewSat image used for the analysis is “20210502_033103_SN10_L1_Full.tif” for Baotou, China ([fig. 21](#)), and includes the edge transect bounding box. The results for band 1 (blue) are shown in [figures 22 and 23](#). In [figure 22](#), the raw transects, the middle transect, and the region of the curve that is used for alignment

are shown in the upper plot. The lower plot in [figure 22](#) shows the aligned transect and the edge spread function. The upper plot in [figure 23](#) shows an edge spread function with the relative edge response and a line spread function with a line segment representing full width at half maximum. The lower plot in [figure 23](#) shows a modulation transfer function up to Nyquist frequency (0.5) and the frequency corresponding to the 50-percent modulation transfer function value. The results for band 2 (green) are shown in [figures 24 and 25](#), the results for band 3 (red) are shown in [figures 26 and 27](#), and the results for band 4 (near infrared) are shown in [figures 28 and 29](#).

Table 8. Spatial performance of Satellogic's NewSat.

[RER, relative edge response; FWHM, full width at half maximum; MTF, modulation transfer function; NIR, near infrared]

Spatial analysis	RER	FWHM	MTF at Nyquist
Band 1—blue	0.62	1.61 pixels	0.138
Band 2—green	0.56	1.64 pixels	0.115
Band 3—red	0.53	1.63 pixels	0.110
Band 4—NIR	0.41	1.76 pixels	0.081



EXPLANATION

— Edge transect bounding box

Figure 21. Satellogic NewSat image of calibration site at Baotou, China.

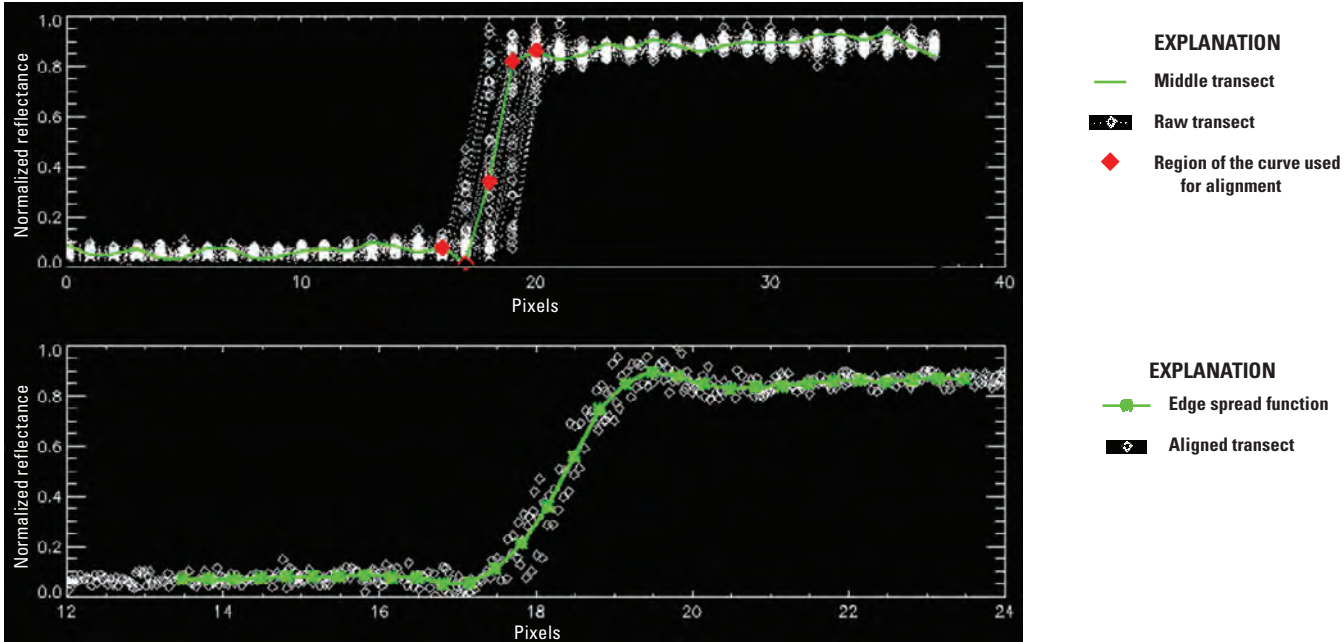


Figure 22. Band 1 (blue) raw edge transects (upper) and shifted transects (lower) at Baotou, China.

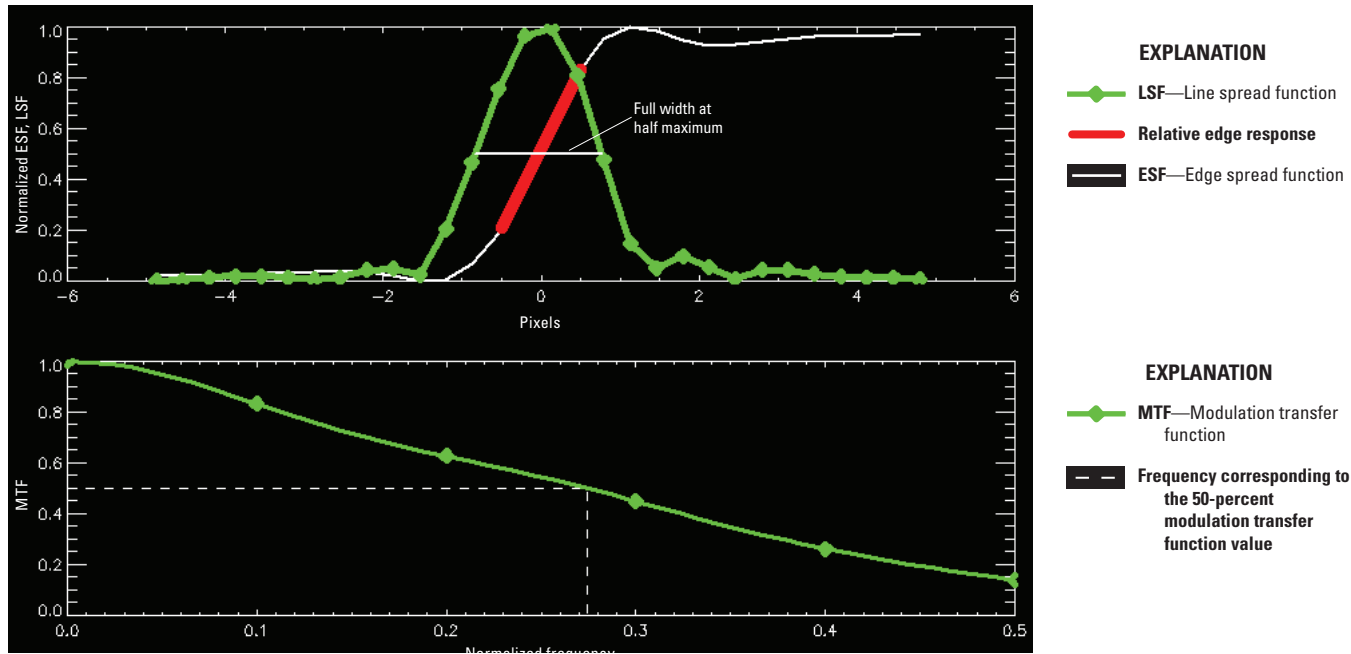


Figure 23. Band 1 (blue) edge spread function and line spread function (upper) and modulation transfer function (lower) at Baotou, China.

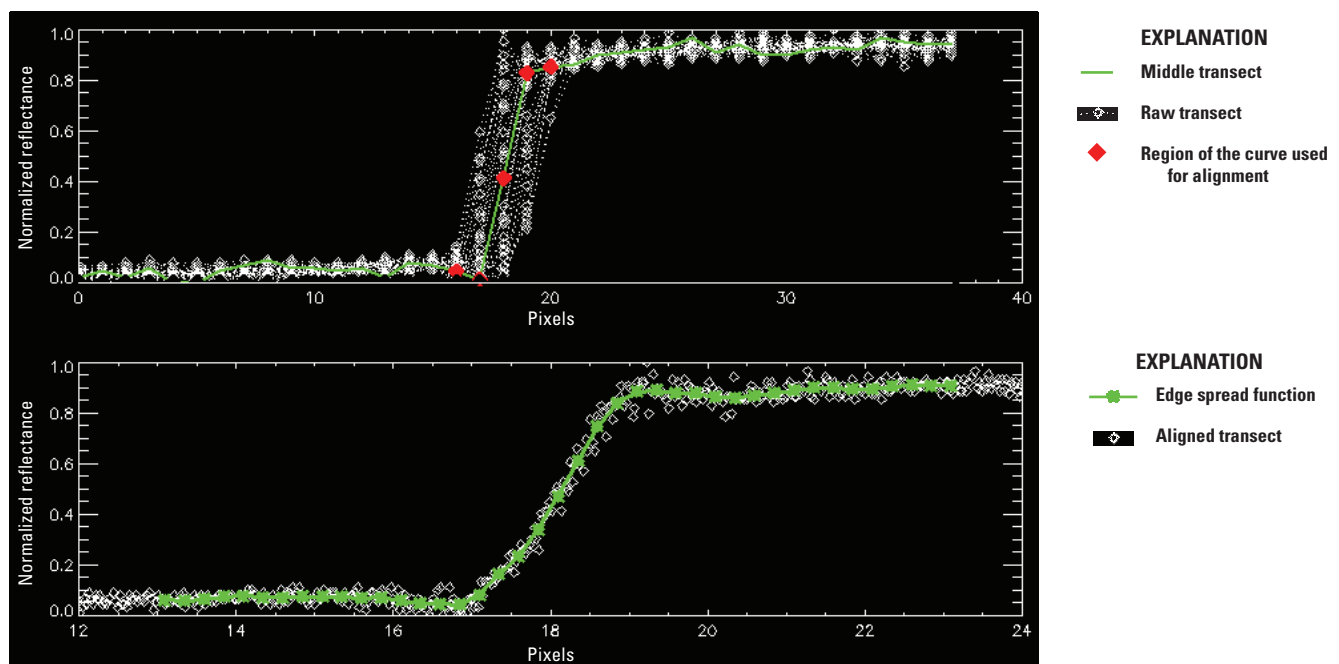


Figure 24. Band 2 (green) raw edge transects (upper) and shifted transects (lower) at Baotou, China.

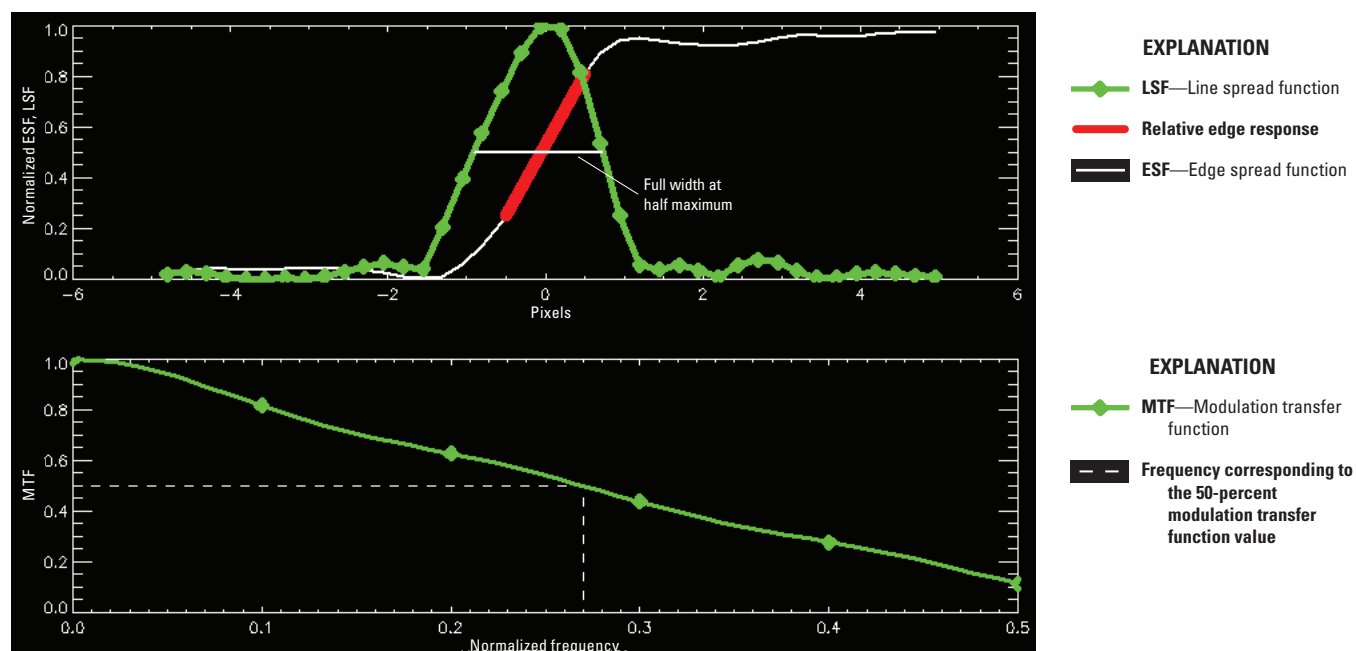


Figure 25. Band 2 (green) edge spread function and line spread function (upper) and modulation transfer function (lower) at Baotou, China.

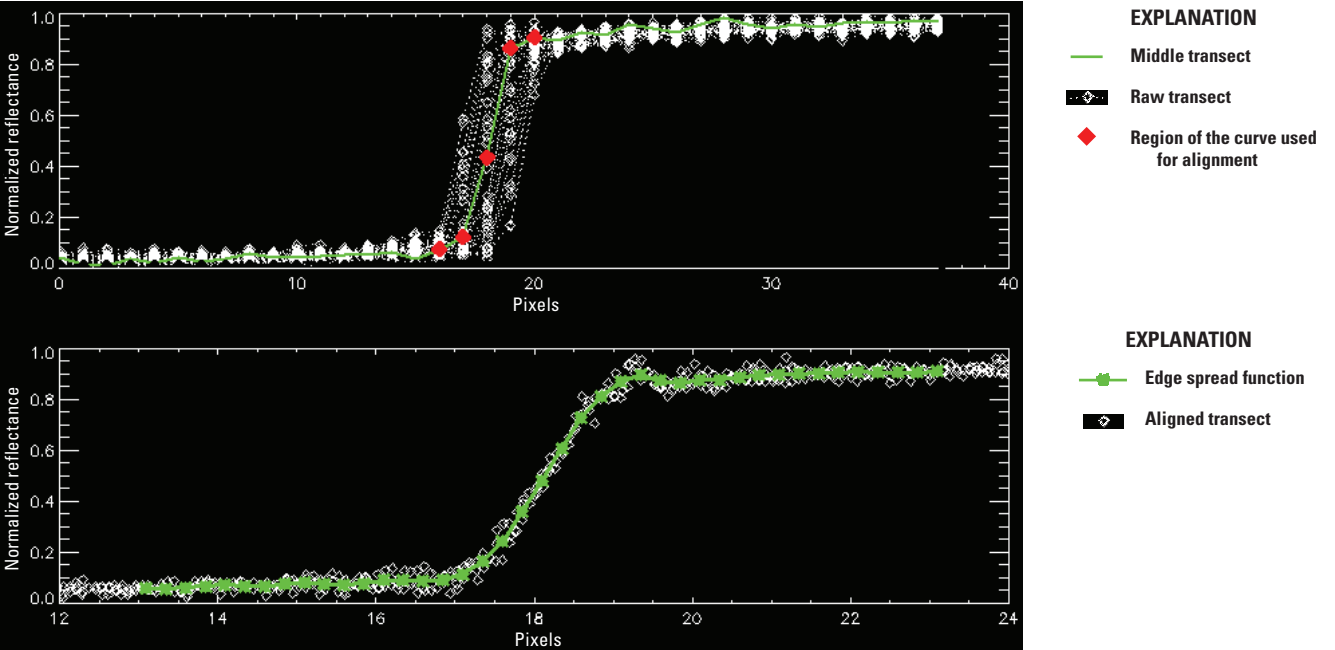


Figure 26. Band 3 (red) raw edge transects (upper) and shifted transects (lower) at Baotou, China.

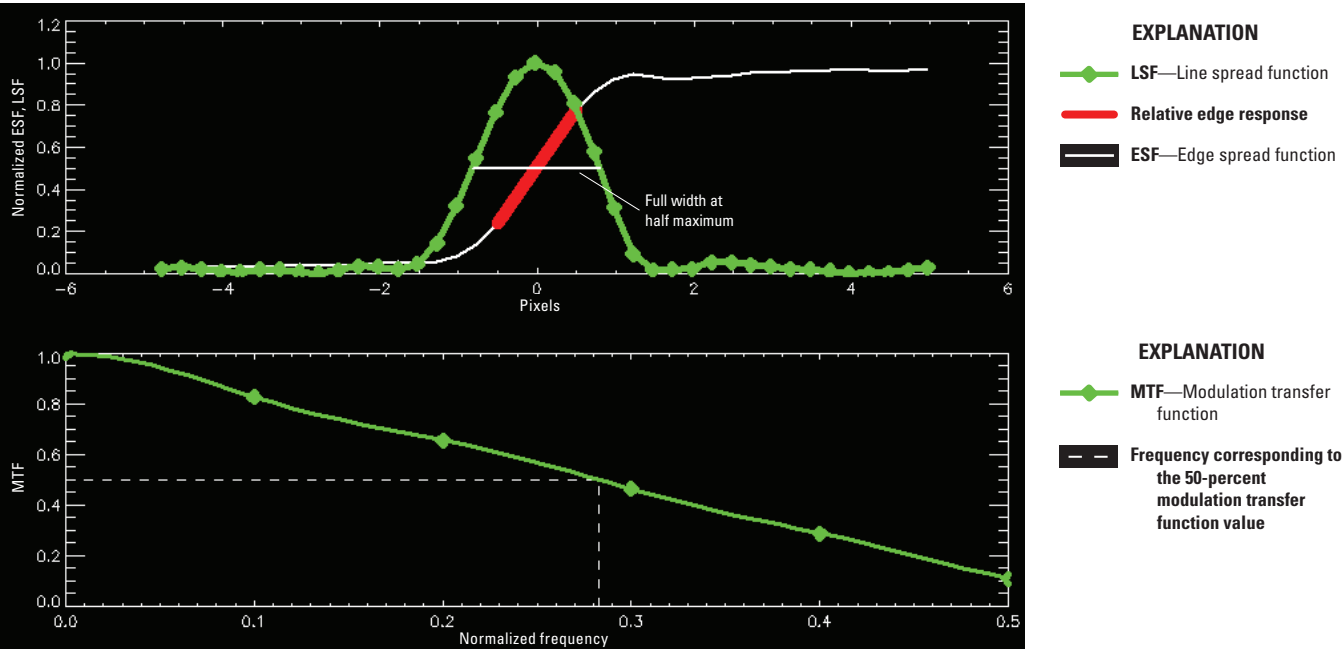


Figure 27. Band 3 (red) edge spread function and line spread function (upper) and modulation transfer function (lower) at Baotou, China.

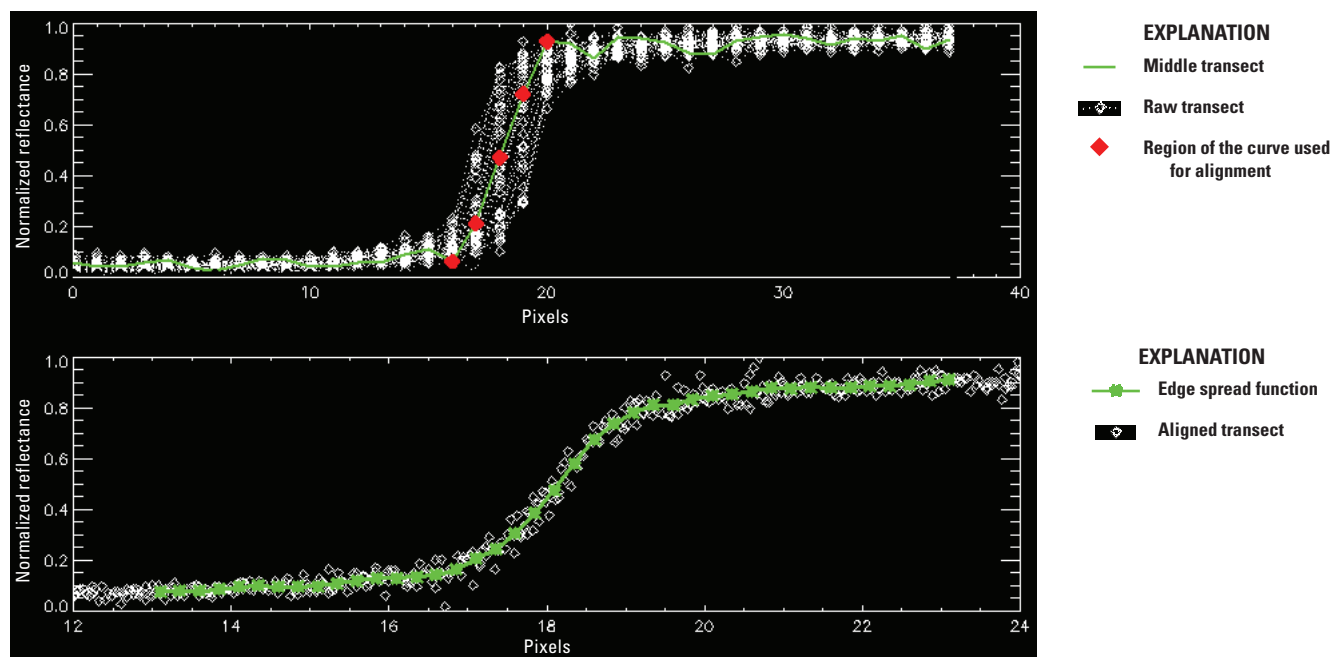


Figure 28. Band 4 (near infrared) raw edge transects (upper) and shifted transects (lower) at Baotou, China.

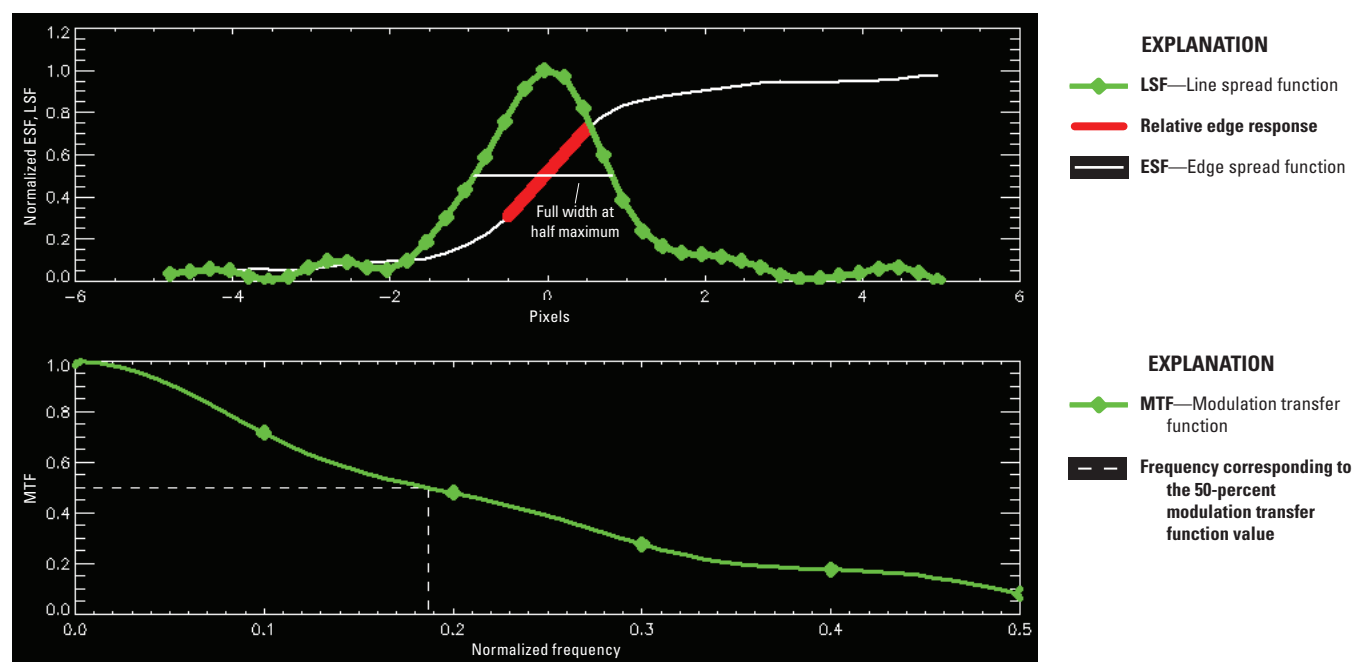


Figure 29. Band 4 (near infrared) edge spread function and line spread function (upper) and modulation transfer function (lower) at Baotou, China.

Summary and Conclusions

This report summarizes the sensor performance of Satellogic's NewSat satellite sensing system based on the U.S. Geological Survey Earth Resources Observation and Science Cal/Val Center of Excellence (ECCOE) system characterization process. In summary, we have determined that this sensor provides an interior geometric performance in the range -0.119 (-0.119 pixel) to 0.020 meter (m; 0.020 pixel) in easting and -0.148 (-0.148 pixel) to 0.014 m (0.014 pixel) in northing in band-to-band registration, an exterior geometric performance of -9.04 (-9.04 pixels) to -5.84 m (-5.84 pixels) in easting and 1.25 (1.25 pixels) to 3.11 m (3.11 pixels) in northing offset in comparison to Sentinel-2 (values in pixels are identical to values in meters because the sensor has a 1-m ground sample distance), an exterior geometric performance using ground control points of a 6.5-m circular error (95 percent), a radiometric performance in the range of 0.034 to 0.081 in offset and 0.652 to 0.808 in slope, and a spatial performance in the range of 1.61 to 1.76 pixels for full width at half maximum, with a modulation transfer function at a Nyquist frequency in the range of 0.081 to 0.138 .

In conclusion, the team has completed an ECCOE standardized system characterization of the Satellogic's NewSat satellite sensing system. Although the team followed characterization procedures that are standardized across the many sensors and sensing systems under evaluation, these procedures are customized to fit the individual sensor, as was done with the NewSat satellites. The team has acquired the data, defined proper testing methodologies, carried out comparative tests against specific references, recorded measurements, completed data analyses, and quantified sensor performance accordingly. The team also endeavored to retain all data, measurements, and methods. This is key to ensure that all data and measurements are archived and accessible and that the performance results are reproducible.

The ECCOE project and associated Joint Agency Commercial Imagery Evaluation partners are always interested in reviewing sensor and remote sensing application assessments and would like to see and discuss information on similar data and product assessments and reviews. If you would like to discuss system characterization with the U.S. Geological Survey ECCOE and (or) the Joint Agency Commercial Imagery Evaluation team, please email us at eccoe@usgs.gov.

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