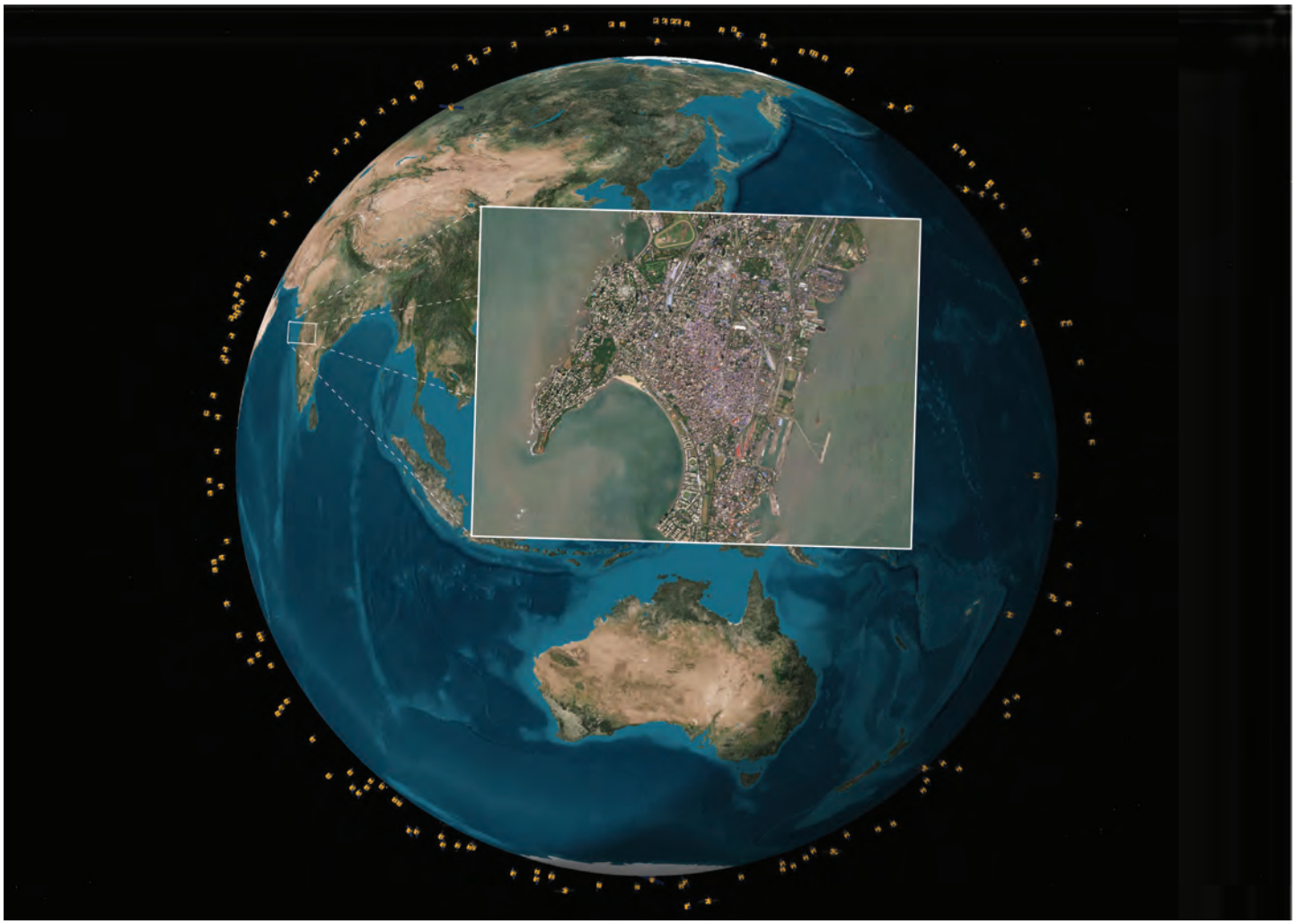
USGS
science for a changing world

System Characterization Report on Planet's Dove-R

Chapter D of
System Characterization of Earth Observation Sensors



Open-File Report 2021–1030–D

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

Cover. Satellite image of Mumbai, India, taken November 7, 2019, using the Planetscope sensor. Image courtesy of Planet, licensed under the Creative Commons Attribution-NonCommercial 2.0 Generic license. An image showing the current (2021) operational Planet flock satellites, generated from Analytical Graphics, Inc., Systems Tool Kit.

System Characterization Report on Planet's Dove-R

By Minsu Kim,[1] Seonkyung Park,[1] Cody Anderson,[2] and Gregory L. Stensaas[2]

Chapter D of
System Characterization of Earth Observation Sensors
Compiled by Shankar N. Ramaseri Chandra[1]

[1]KBR, Inc., under contract to the U.S. Geological Survey.

[2]U.S. Geological Survey.

Open-File Report 2021–1030–D

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

U.S. Geological Survey, Reston, Virginia: 2021

Suggested citation:
Kim, M., Park, S., Anderson, C., and Stensaas, G.L., 2021, System characterization report on Planet's Dove-R, chap. D *of* Ramaseri Chandra, S.N., comp., System characterization of Earth observation sensors: U.S. Geological Survey Open-File Report 2021–1030, 34 p., https://doi.org/10.3133/ofr20211030D.

ISSN 2331-1258 (online)

Contents

Figures

Tables

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
GSD	ground sample distance
JACIE	Joint Agency Commercial Imagery Evaluation
USGS	U.S. Geological Survey

System Characterization Report on Planet's Dove-R

By Minsu Kim,[1] Seonkyung Park,[1] Cody Anderson,[2] and Gregory L. Stensaas[2]

Executive Summary

This report addresses system characterization of Planet's Dove-R 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 2013, Planet has launched more than 360 Dove 3U CubeSats, where U stands for 10-centimeter (cm) x 10-cm x 10-cm stowed dimensions, each weighing about 5 kilograms. Since 2015, all Dove satellites have had four-band imagers with about a 4-meter (m) pixel ground sample distance. Since 2016, all Doves have been launched into Sun-synchronous orbits varying from 474 to 524 kilometers, with inclinations between 97 and 98 degrees. The Dove series satellites do not have orbit maintenance capabilities; thus, their orbits decay slowly over time, contributing to shorter lifetimes of about 3 years. More information on Planet satellites and sensors is available in the "2020 Joint Agency Commercial Imagery Evaluation—Remote Sensing Satellite Compendium" and from the manufacturer at https://www.planet.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 Dove-R has an interior geometric performance in the range of −0.306 (−0.102 pixel) to 0.286 m (0.095 pixel) in easting and 0.090 (0.030 pixel) to 1.084 m (0.361 pixel) in northing in band-to-band registration, an exterior geometric performance of −5.10 m (−0.51 pixel) in easting and 3.30 m (0.33 pixel) in northing offset in comparison to Sentinel-2, a radiometric performance in the range of −0.023 to −0.008 in offset and 0.948 to 1.077 in slope, and a spatial performance in the range of 2.96 to 3.15 pixels for full width at half maximum, with a modulation transfer function at a Nyquist frequency in the range of 0.001 to 0.003.

Introduction

Planet, Inc. is well known for launching reduced-mass Earth observation satellites, with its Dove satellites weigh-ing 5.8 kilograms (12.8 pounds). Each Dove is a 3U CubeSat, where U stands for 10-centimeter (cm) x 10-cm x 10-cm stowed dimensions. The first prototype Doves were launched in April 2013, followed by at least 20 more successful launches in the 7 years since, each carrying a flock of multiple Dove satellites, for a total of more than 360 Dove satellites launched into orbit. Planet has used this frequent launch cadence to produce at least 17 builds, or generations, of Doves with various technological and operating improvements in each build, which has resulted in continual advancement in capability in the 7 years since the launch of the first Dove. All data are provided with permission from Planet through their standard data access portal.

The data analysis results provided within 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. In this chapter, the Dove-R sensor is described. The performance testing of the system is limited to geometric, radiometric, and spatial. The scope of the geometric assessment is limited to testing the interior alignments of spectral bands against each other, and the exterior alignment is tested in reference to Sentinel-2.

The U.S. Geological Survey (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

[1]KBR, Inc., under contract to the U.S. Geological Survey

[2]U.S. Geological Survey.

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 Planet's Dove-R sensor.

Satellite and Operational Details

The satellite and operational details for Planet's Dove-R are listed in table 1.

Sensor(s) Information

The imaging sensor details for Planet's Dove-R are listed in table 2. The relative spectral responses for Planet's Dove-R are shown in figure 1.

Table 1. Satellite and operational details for Planet's Dove-R.

[cm, centimeter; NIR, near infrared; km, kilometer; °, degree; ±, plus or minus; lat., latitude; m, meter; <, less than]

Product information	Dove-R
Satellite and operational information	
Product name	Level 3B
Satellite name	Planet's Dove-R
Satellite size	CubeSat 3U form factor (10 cm x 10 cm x 30 cm)
Sensor name(s)	Planetscope
Sensor type	Multispectral (blue, green, red, NIR)
Mission type	Global land-monitoring mission
Launch date	Multiple dates, beginning November 2018
Number of satellites	130 Planetscope satellites within constellation
Expected lifetime	About 6 years
Operator	Planet
Operational details	
Operating orbit	Sun-synchronous orbit
Orbital altitude range	475 km
Sensor angle altitude	98.0° inclination
Imaging time	9:30–11:30 a.m. (local solar time)
Geographic coverage	Land imaging ±81.5° lat.
Temporal resolution	Daily
Temporal coverage	2018 to present
Imaging angles	±25°
Ground sample distance(s)	3 m
Data licensing	Restricted
Data pricing	Limited free data; commercial imagery pricing
Data latency	<24 hours
Product abstract	https://www.planet.com/products/planet-imagery/
Product locator	https://www.planet.com/products/

Table 2. Imaging sensor details for Planet's Dove-R.

[µm, micrometer; m, meter; NIR, near infrared]

Spectral band(s) details	Dove-R			
	Lower band (µm)	Upper band (µm)	Radiometric resolution (bits)	Ground sample distance (m)
Band 1—blue	0.464	0.517	12 (scaled to 16)	3
Band 2—green	0.547	0.585	12 (scaled to 16)	3
Band 3—red	0.650	0.682	12 (scaled to 16)	3
Band 4—NIR	0.846	0.888	12 (scaled to 16)	3

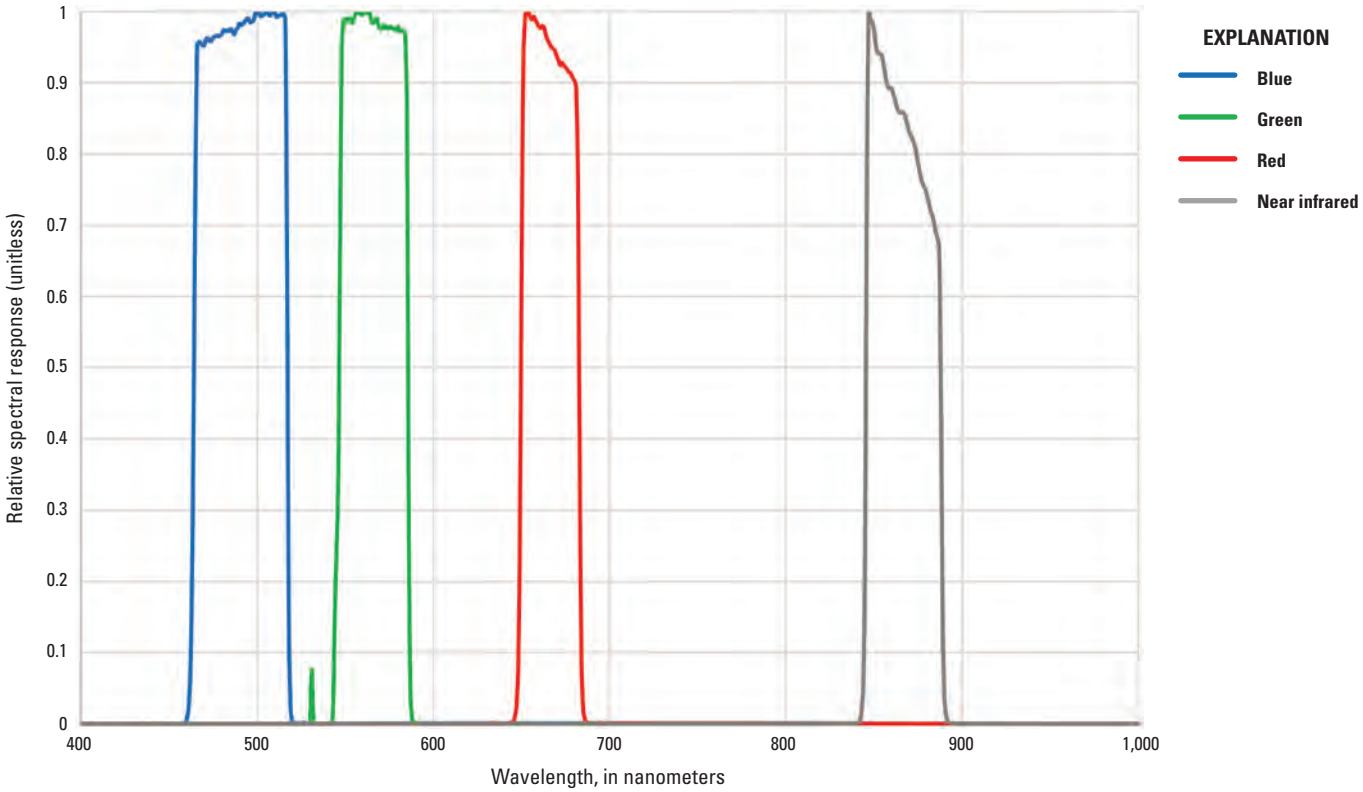


Figure 1. Planet's Dove-R relative spectral response.

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; RMSE, root mean square error; FWHM, full width at half maximum; MTF, modulation transfer function]

Description of product	Top of Atmosphere reflectance
USGS measurement results	
Geometric performance (easting, northing), in meters (pixels)	
Interior (band to band)	Band 1 (blue) Mean: −0.277 m (−0.092), 1.084 m (0.361) RMSE: 1.643 m (0.547), 2.003 m (0.667) Band 2 (green) Mean: 0.286 m (0.095), 0.242 m (0.081) RMSE: 1.440 m (0.480), 1.645 m (0.548) Band 3 (red) Mean: 0.100 m (0.033), 0.305 m (0.101) RMSE: 1.455 m (0.485), 1.478 m (0.493) Band 4 (near infrared) Mean: −0.306 m (−0.102), 0.090 m (0.030) RMSE: 1.892 m (0.631), 1.598 m (0.533)
Exterior (geometric location accuracy)	Mean: −5.10 m (−0.51), 3.30 m (0.33) RMSE: 2.6 m (0.26), 2.4 m (0.24)
Radiometric performance (offset, slope)	
Radiometric evaluation (Linear regression—Dove-R versus Sentinel-2 reflectance)	Band 1 (offset, slope): −0.008, 1.077 Band 2 (offset, slope): −0.004, 0.989 Band 3 (offset, slope): −0.010, 1.007 Band 4 (offset, slope): −0.023, 0.948
Spatial performance	
Spatial performance measurement	Band 1: FWHM = 3.00 pixels; MTF at Nyquist = 0.002 Band 2: FWHM = 3.15 pixels; MTF at Nyquist = 0.001 Band 3: FWHM = 2.96 pixels; MTF at Nyquist = 0.003 Band 4: FWHM = 3.10 pixels; MTF at Nyquist = 0.002
Known artifacts and quality issues	
USGS noted artifacts/quality issues	As predicted by the large line spread function (FWHM of 2.6 pixels or greater), the Dove-R imagery does not have precise transition across a target edge.

Analysis

This section of the report describes the geometric, radiometric, and spatial performance of Planet's Dove-R.

Geometric Performance

The geometric performance for Planet's Dove-R are characterized in terms of the interior (band-to-band alignment) and exterior (geometric location accuracy) geometric analysis results.

Interior (Band to Band)

For this analysis, each band of the Dove-R imagery was registered against all other bands. Results from three separate images were gathered to determine the mean error and root mean square error as listed in table 4 with results represented in pixels. Geometric error maps for each band combination over the Imperial Valley, California, image, as well as the corresponding histogram graphs, are shown in figures 2 through 13, where red arrow represents an error vector with easting and northing component and the blue dot is the center of each grid. The geometric error maps indicate the directional shift and relative magnitude of the shift, whereas the histogram graphs indicate frequency of observed mean error measurements within the image. 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.

Exterior (Geometric Location Accuracy)

For this analysis, band 4 (near infrared) of the Dove-R images was compared against the corresponding band from three Sentinel-2 images over sites in Australia, South Africa, and the United States. 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 with results represented in pixels at a 10-m GSD. For each of the three images, geometric error maps displaying the directional shift and relative magnitude of the shift, when compared with Sentinel-2, are provided in figures 14 through 16. The Sentinel-2 imagery had a control uncertainty of about 3.6 m.

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)
20181224_180018_51_105e (Imperial Valley, California)	Band 1–band 2	−0.278	−0.376	0.381	0.530
	Band 1–band 3	0.340	0.352	0.470	0.461
	Band 1–band 4	0.203	0.230	0.456	0.417
	Band 2–band 3	0.051	−0.019	0.109	0.129
	Band 2–band 4	−0.123	−0.117	0.301	0.419
	Band 3–band 4	−0.187	−0.127	0.308	0.364
20181226_080136_03_105e (Johannesburg, South Africa)	Band 1–band 2	−0.314	0.619	0.633	0.818
	Band 1–band 3	0.054	0.506	0.591	0.732
	Band 1–band 4	−0.190	0.346	0.650	0.697
	Band 2–band 3	0.434	−0.105	0.656	0.497
	Band 2–band 4	0.297	−0.175	0.664	0.598
	Band 3–band 4	−0.005	0.036	0.613	0.514
20181230_234302_48_105e (Gunnedah, Australia)	Band 1–band 2	−0.001	0.573	0.444	0.849
	Band 1–band 3	0.073	0.558	0.414	0.826
	Band 1–band 4	−0.718	0.444	0.890	0.679
	Band 2–band 3	0.069	−0.190	0.271	0.450
	Band 2–band 4	−0.708	−0.273	0.860	0.644
	Band 3–band 4	−0.787	−0.095	0.934	0.461

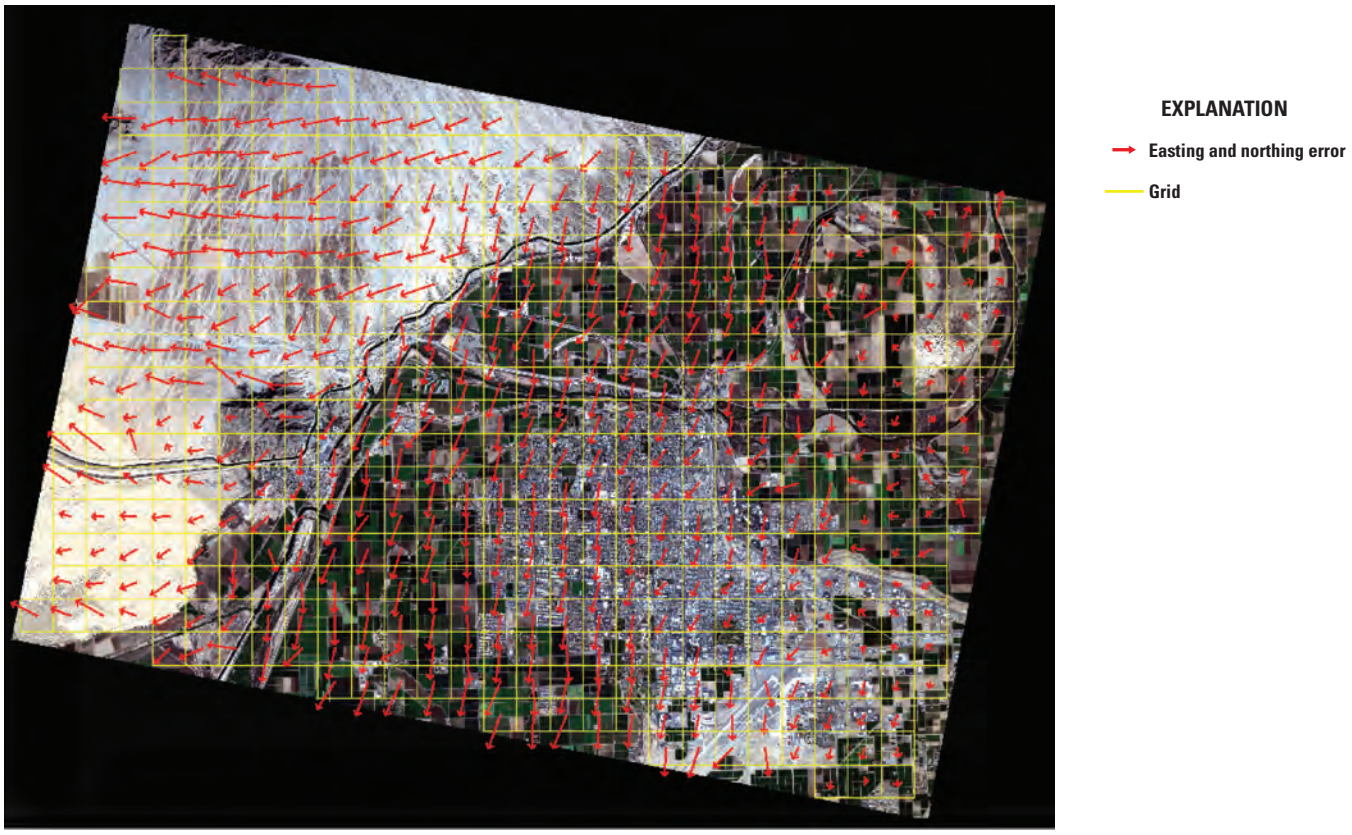


Figure 2. Band 1 (blue) to band 2 (green) geometric error map of Imperial Valley, California.

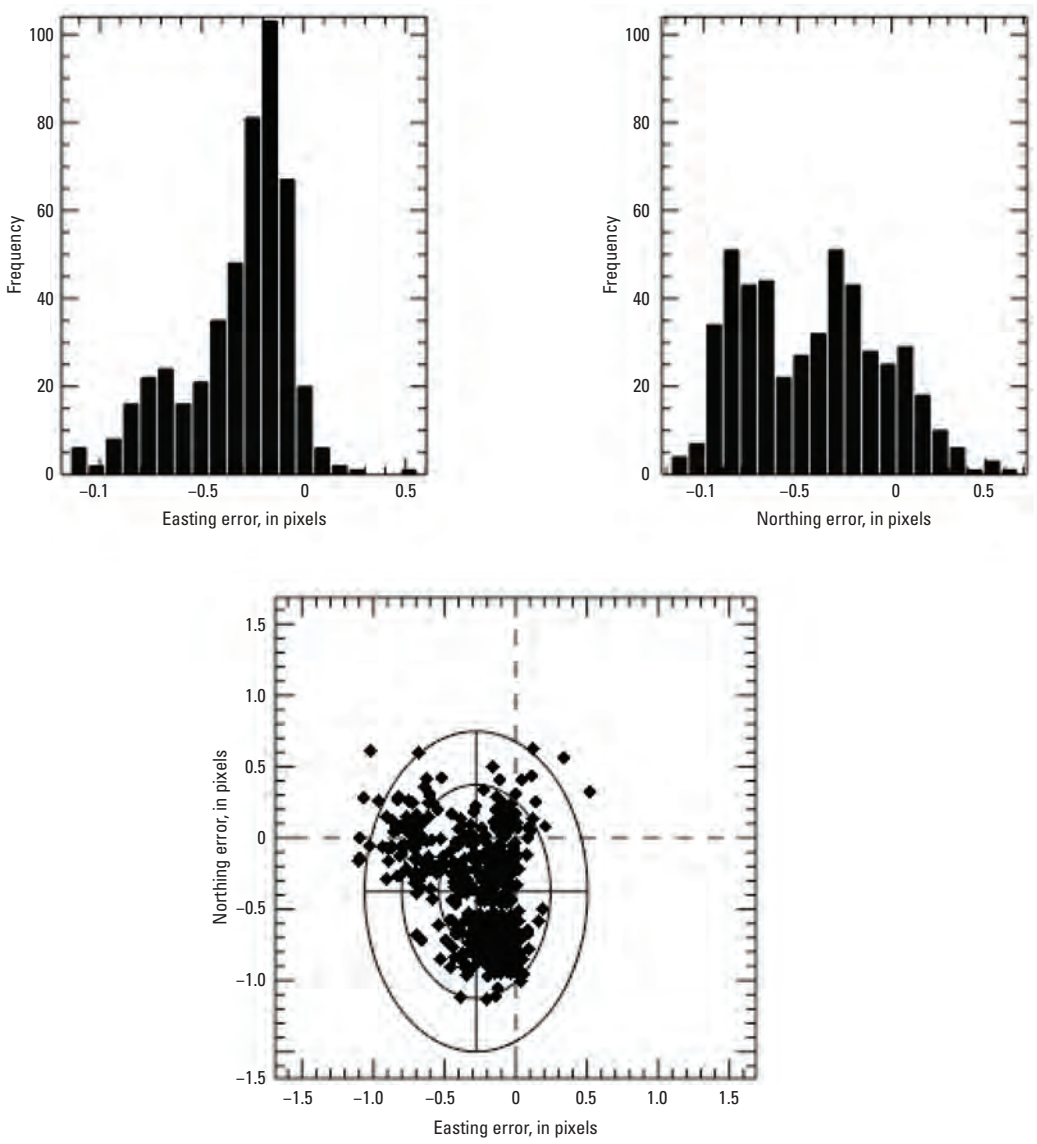


Figure 3. Band 1 (blue) to band 2 (green) geometric error histograms for easting and northing (upper) and error distribution (lower) for Imperial Valley, California.

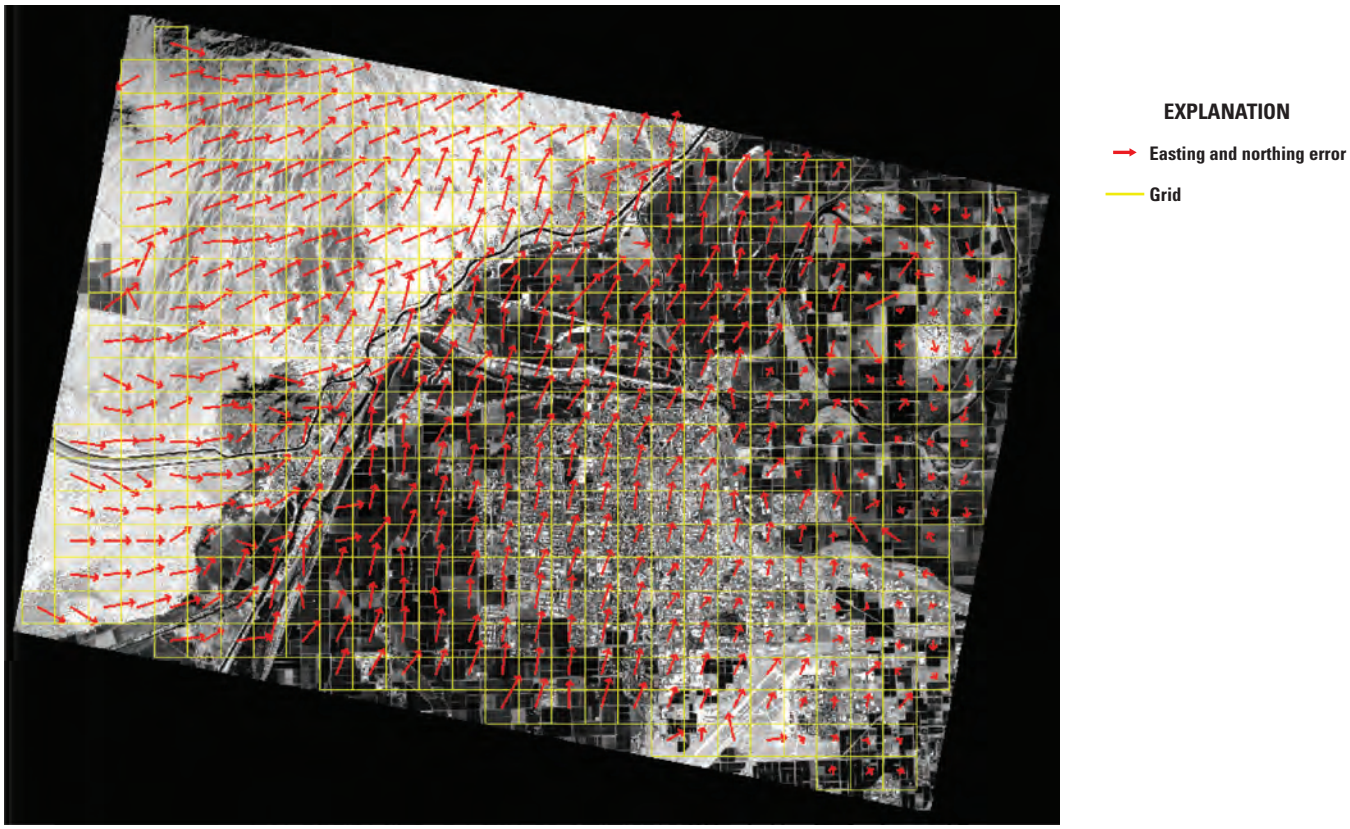


Figure 4. Band 1 (blue) to band 3 (red) geometric error map of Imperial Valley, California.

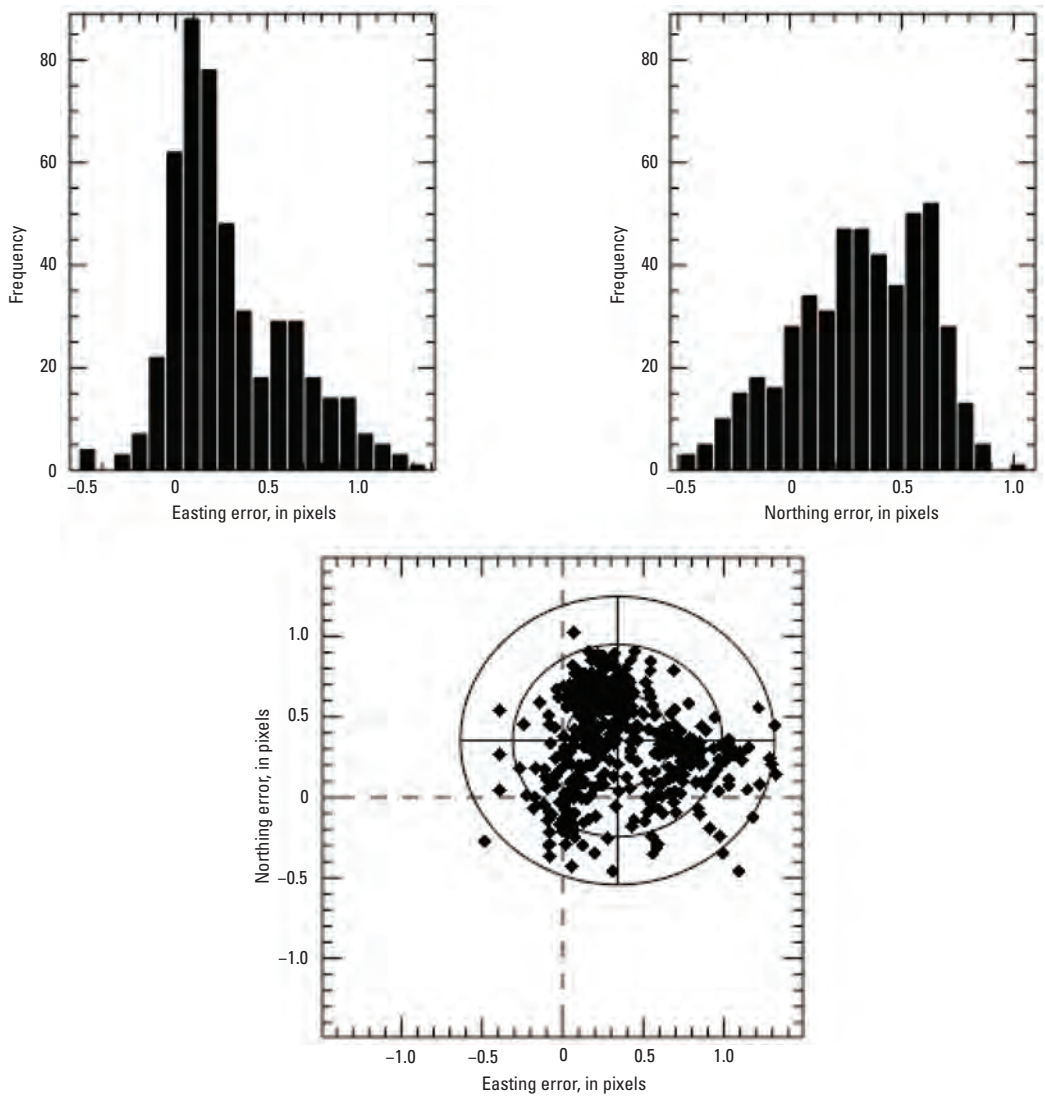


Figure 5. Band 1 (blue) to band 3 (red) geometric error histograms for easting and northing (upper) and error distribution (lower) for Imperial Valley, California.

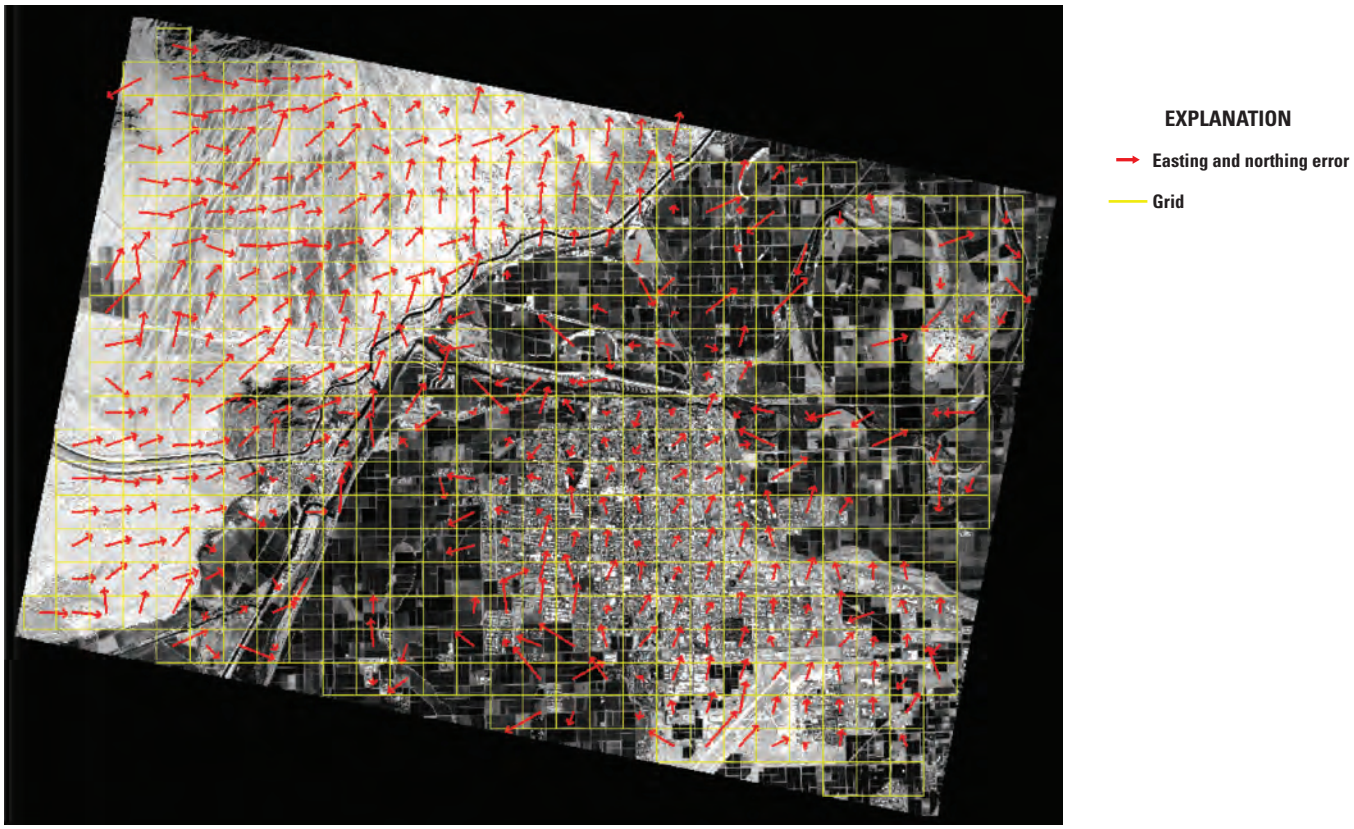


Figure 6. Band 1 (blue) to band 4 (near infrared) geometric error map of Imperial Valley, California.

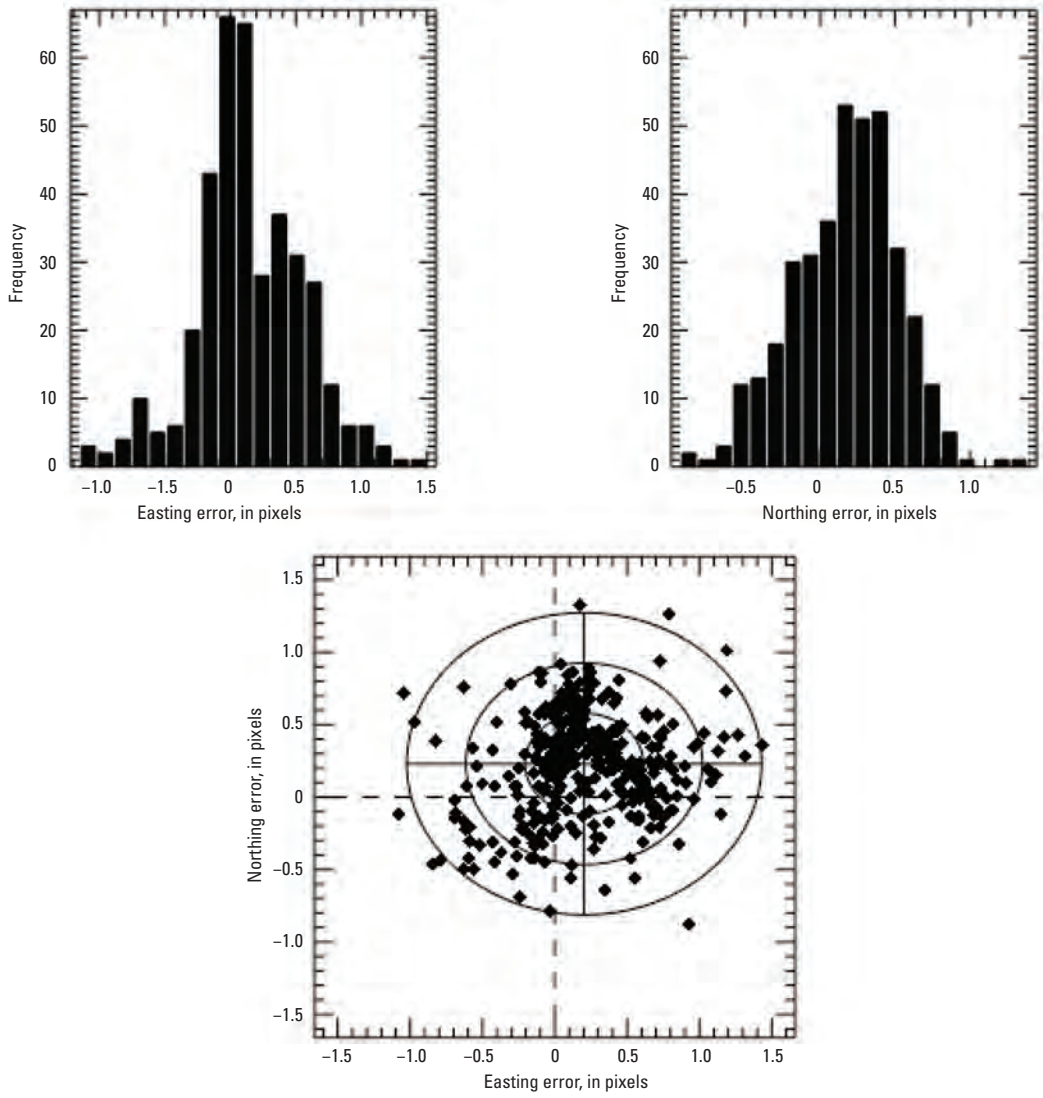


Figure 7. Band 1 (blue) to band 4 (near infrared) geometric error histograms for easting and northing (upper) and error distribution (lower) for Imperial Valley, California.

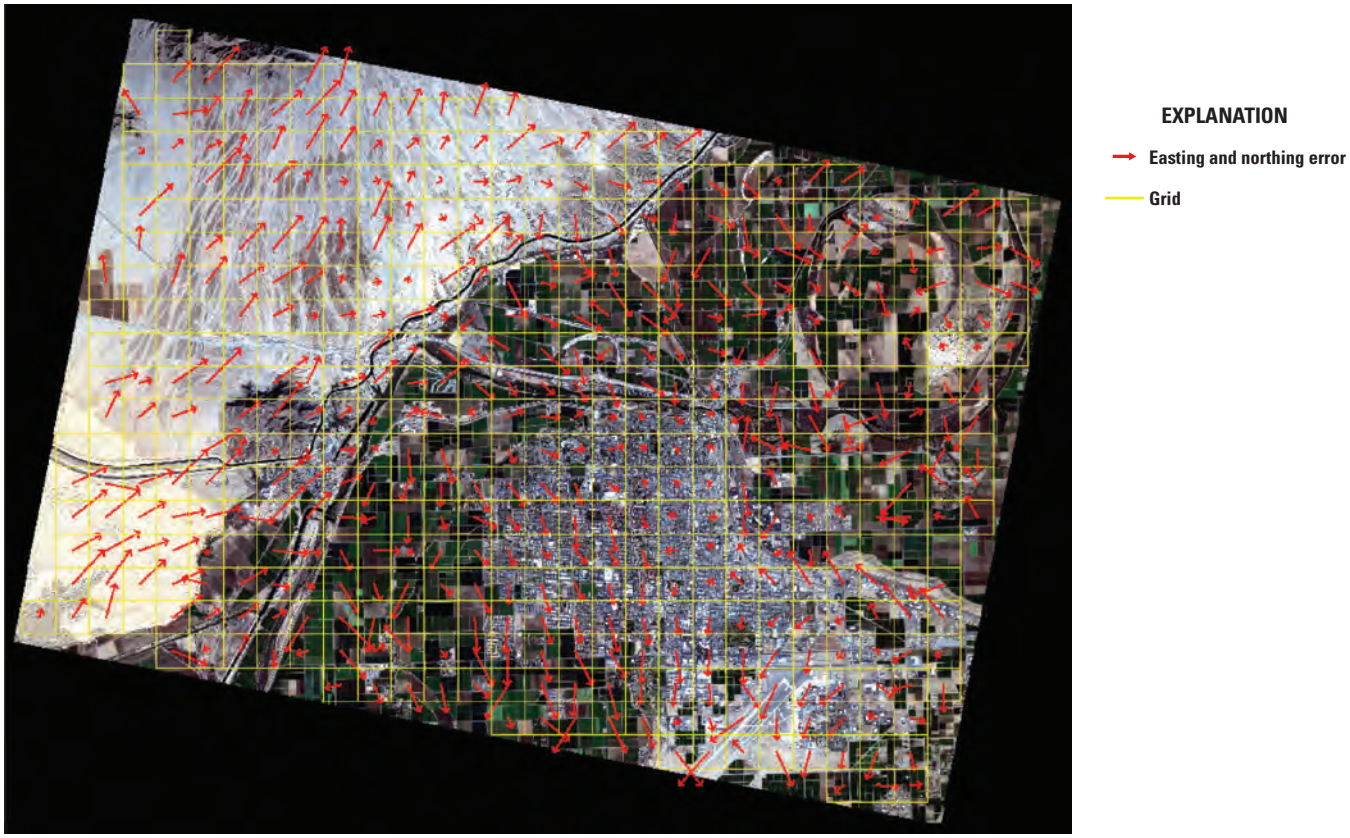


Figure 8. Band 2 (green) to band 3 (red) geometric error map of Imperial Valley, California.

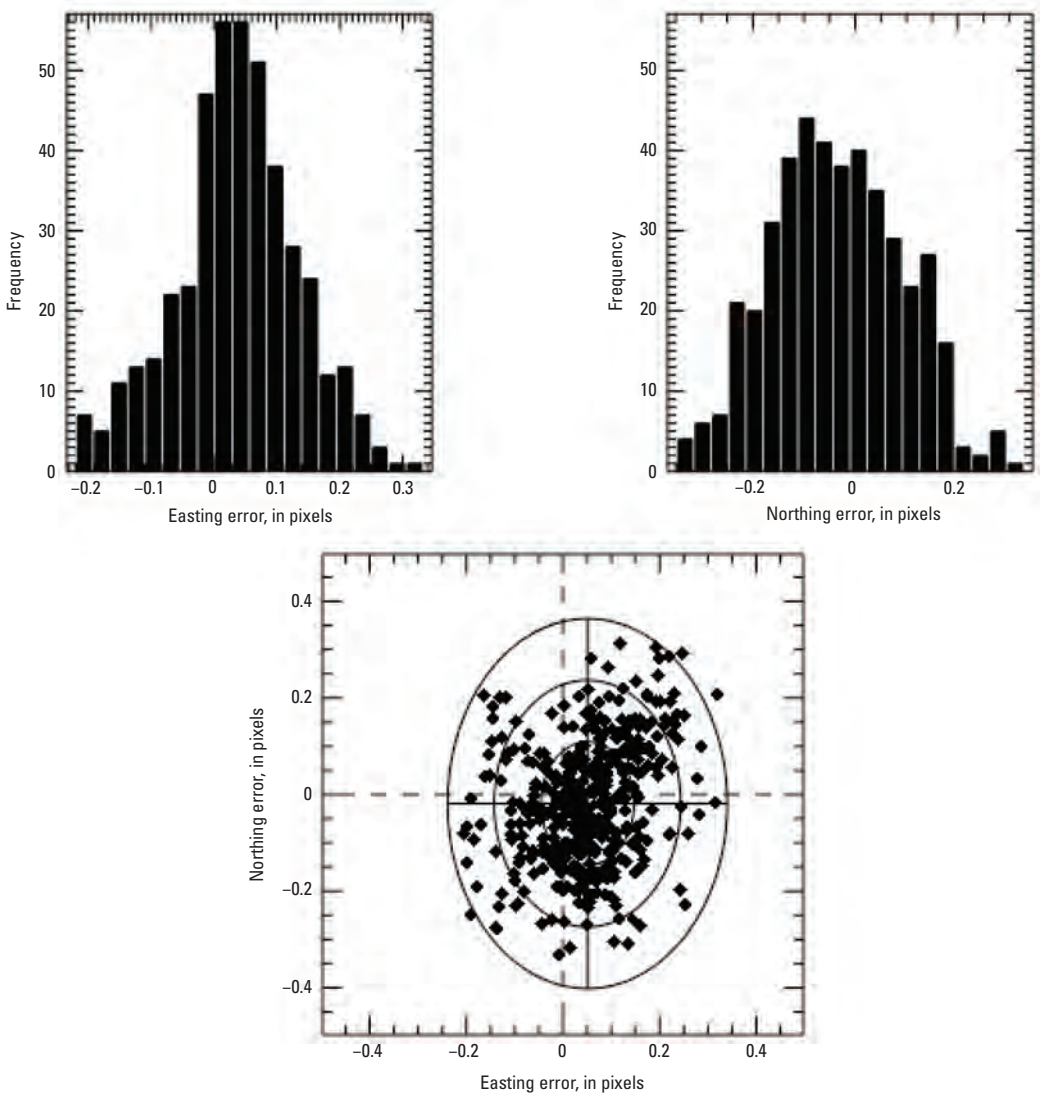


Figure 9. Band 2 (green) to band 3 (red) geometric error histograms for easting and northing (upper) and error distribution (lower) for Imperial Valley, California.

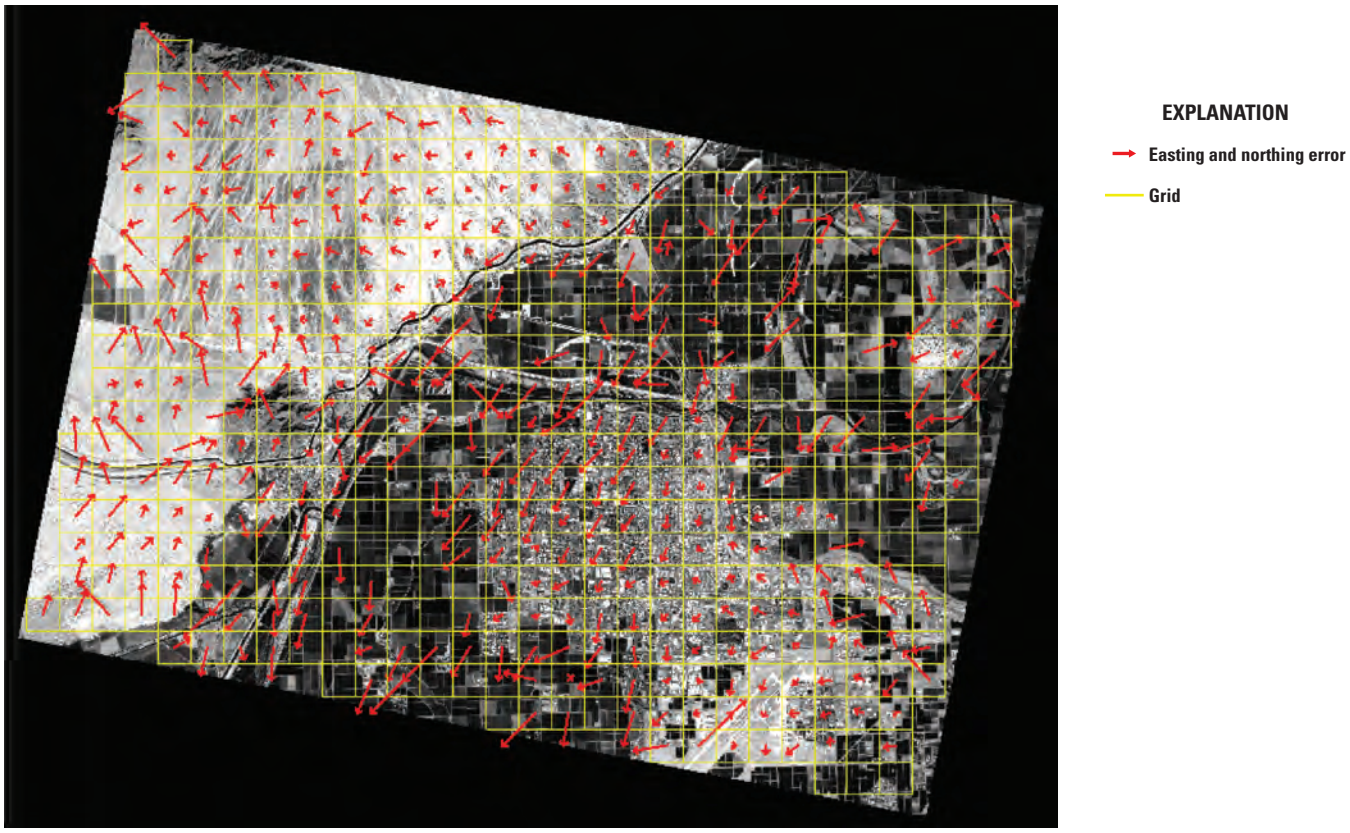


Figure 10. Band 2 (green) to band 4 (near infrared) geometric error map of Imperial Valley, California.

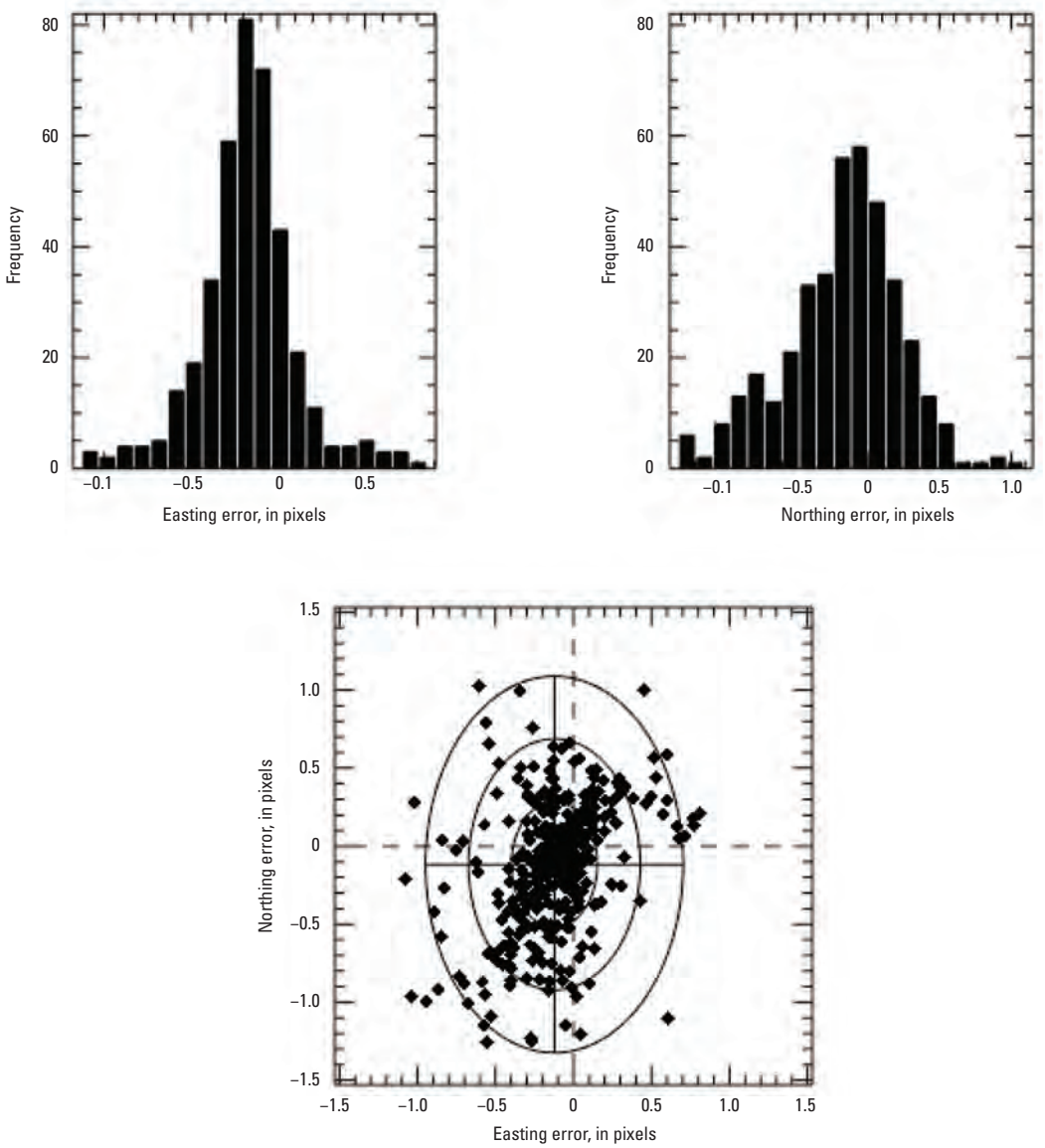


Figure 11. Band 2 (green) to band 4 (near infrared) geometric error histograms for easting and northing (upper) and error distribution (lower) for Imperial Valley, California.

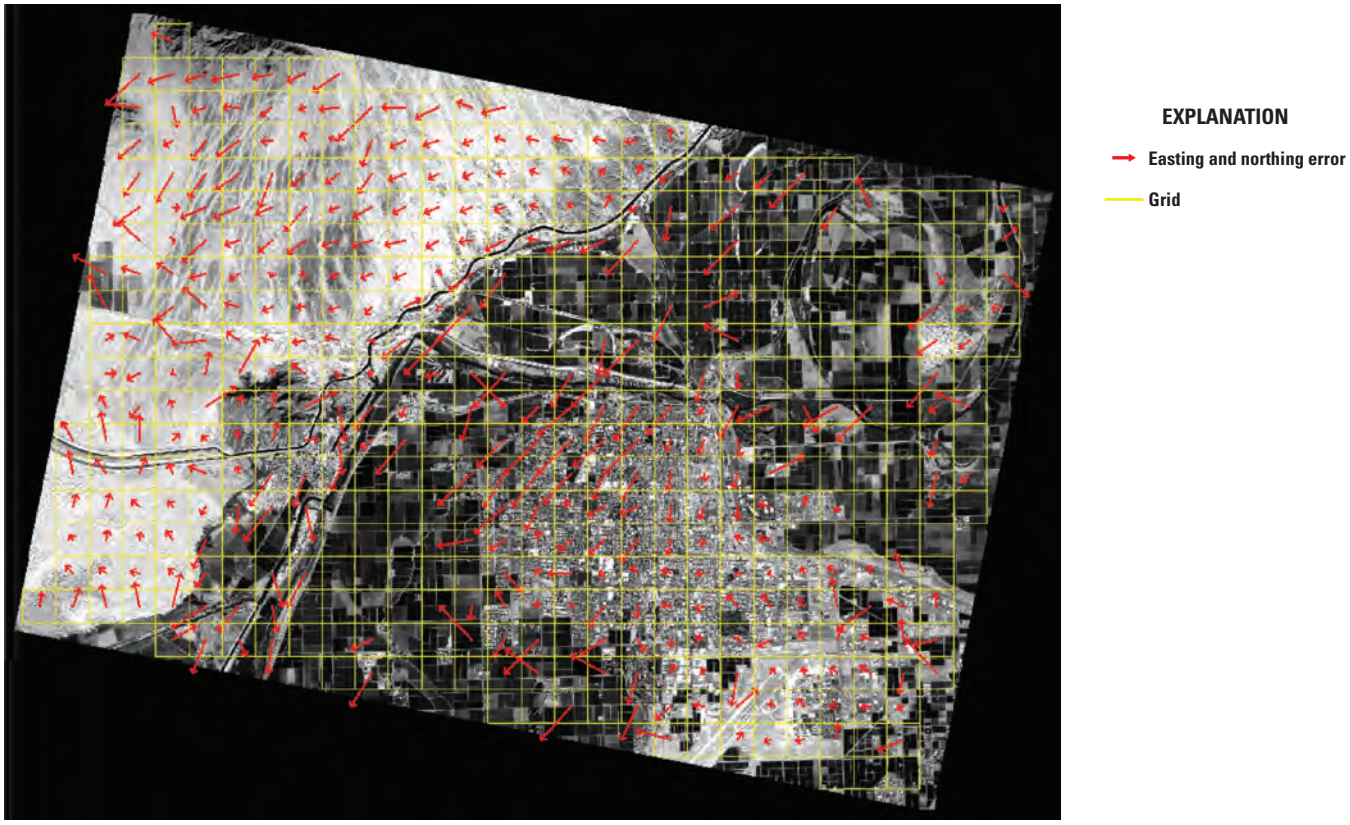


Figure 12. Band 3 (red) to band 4 (near infrared) geometric error map of Imperial Valley, California.

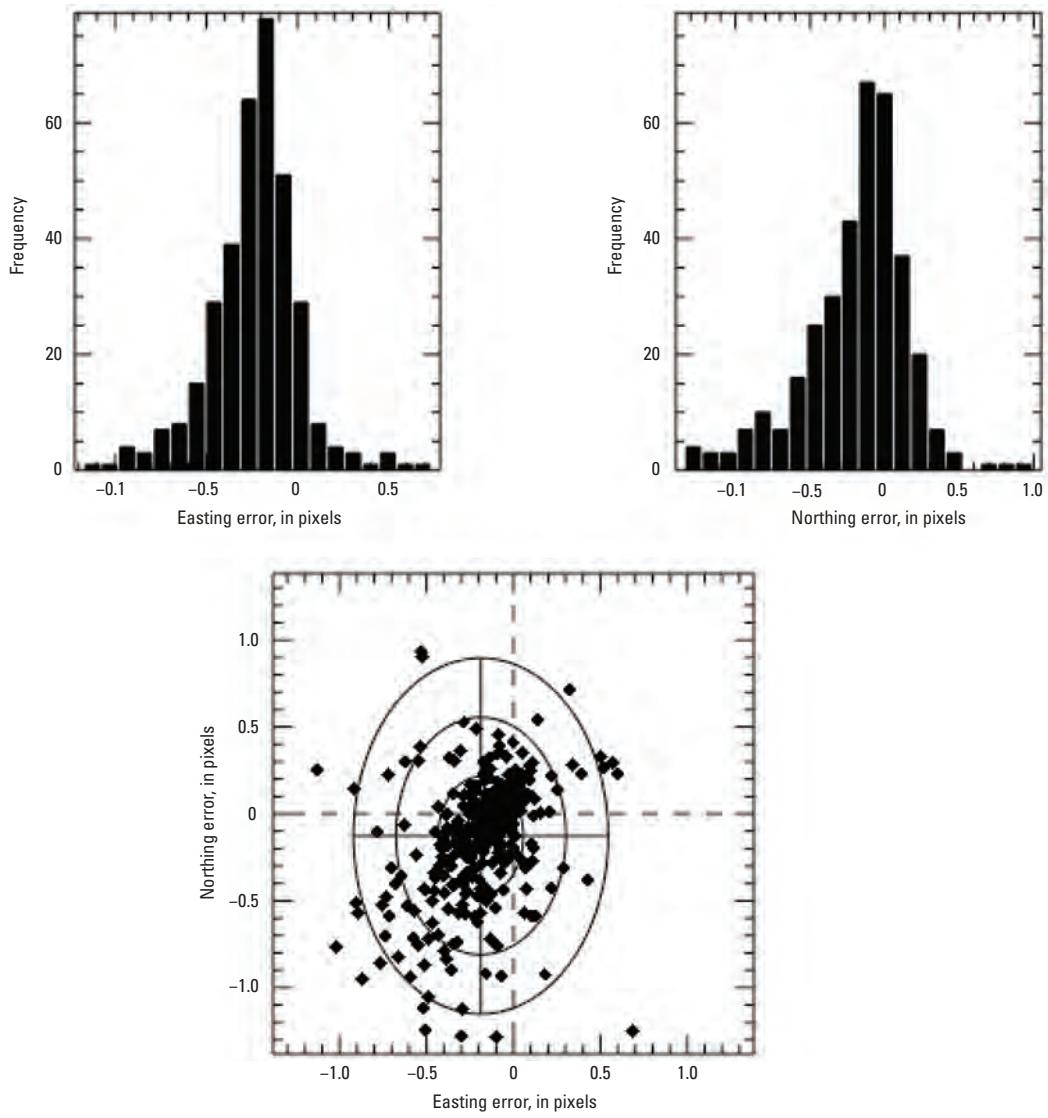


Figure 13. Band 3 (red) to band 4 (near infrared) geometric error histograms for easting and northing (upper) and error distribution (lower) for Imperial Valley, California.

Table 5. Geometric error of Sentinel-2 relative to Planet's Dove-R imagery.

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

Scene ID	Mean error (easting)	Mean error (northing)	RMSE (easting)	RMSE (northing)
S2B_MSIL1C_20181224T181749_N0207_ R084_T11SQS_20181224T195553 20181224_180018_51_105e (Imperial Valley, California)	−0.16 pixel (−1.56 m)	−0.70 pixel (−7.03 m)	0.24 pixel (2.42 m)	0.20 pixel (1.99 m)
S2A_MSIL1C_20181226T080331_N0207_ R035_T35JMH_20181226T101636 20181226_080136_03_105e (Johannesburg, South Africa)	−0.63 pixel (−6.34 m)	0.61 pixel (6.07 m)	0.32 pixel (3.18 m)	0.28 pixel (2.76 m)
S2B_MSIL1C_20181231T000239_N0207_ R030_T56JKL_20181231T011037 20181230_234302_48_105e (Gunnedah, Australia)	−0.74 pixel (−7.40 m)	1.09 pixels (10.90 m)	0.21 pixel (2.15 m)	0.26 pixel (2.59 m)

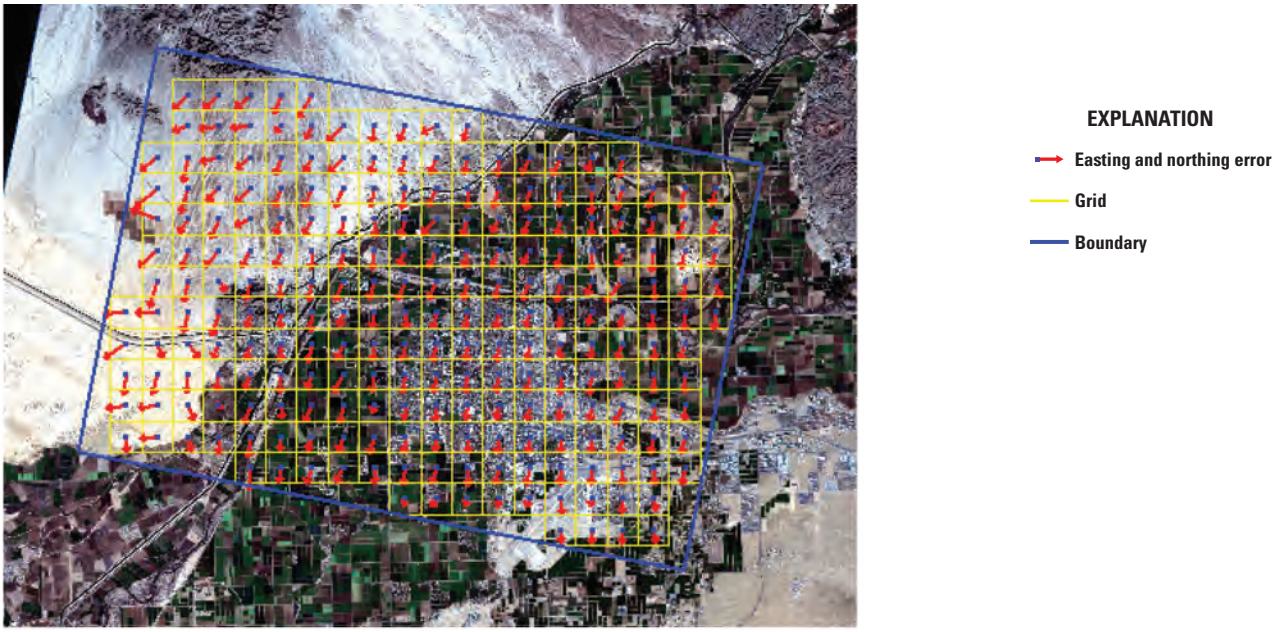


Figure 14. Relative geometric error comparison for Sentinel-2 and Planet's Dove-R, Imperial Valley, California.

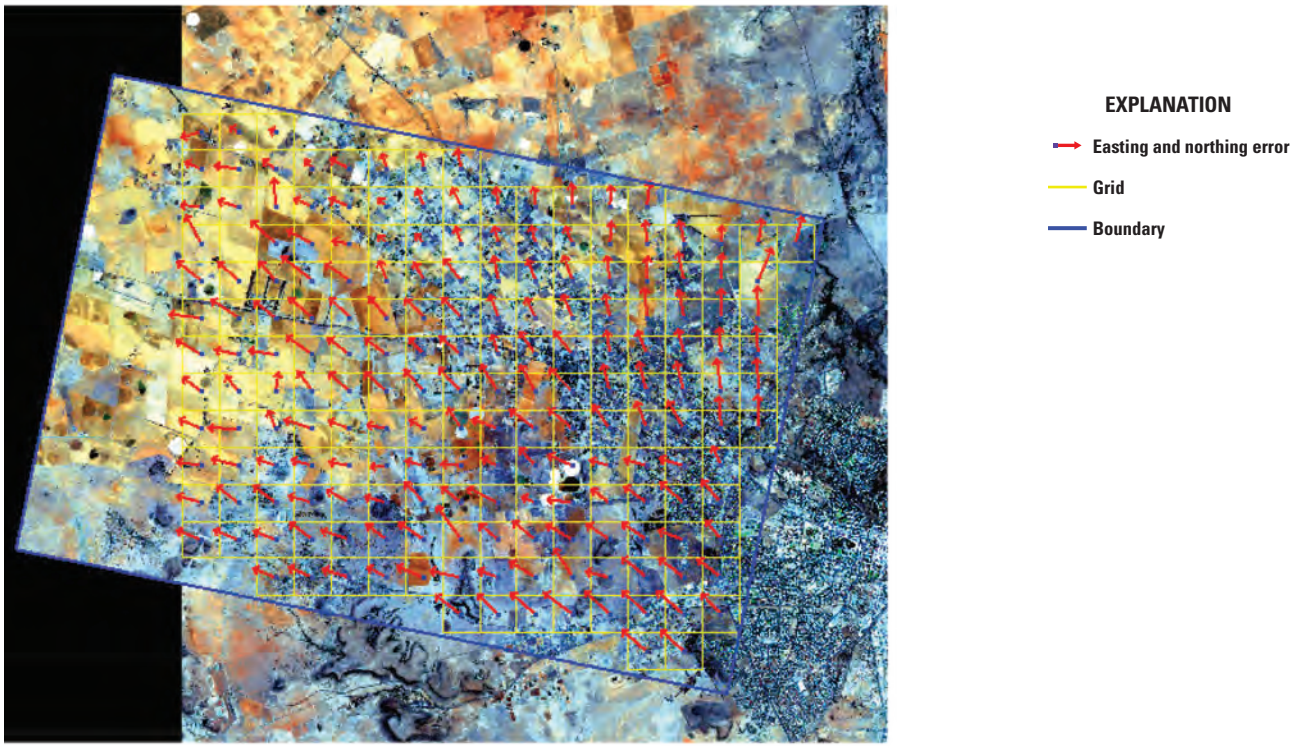


Figure 15. Relative geometric error comparison for Sentinel-2 and Planet's Dove-R, Johannesburg, South Africa.

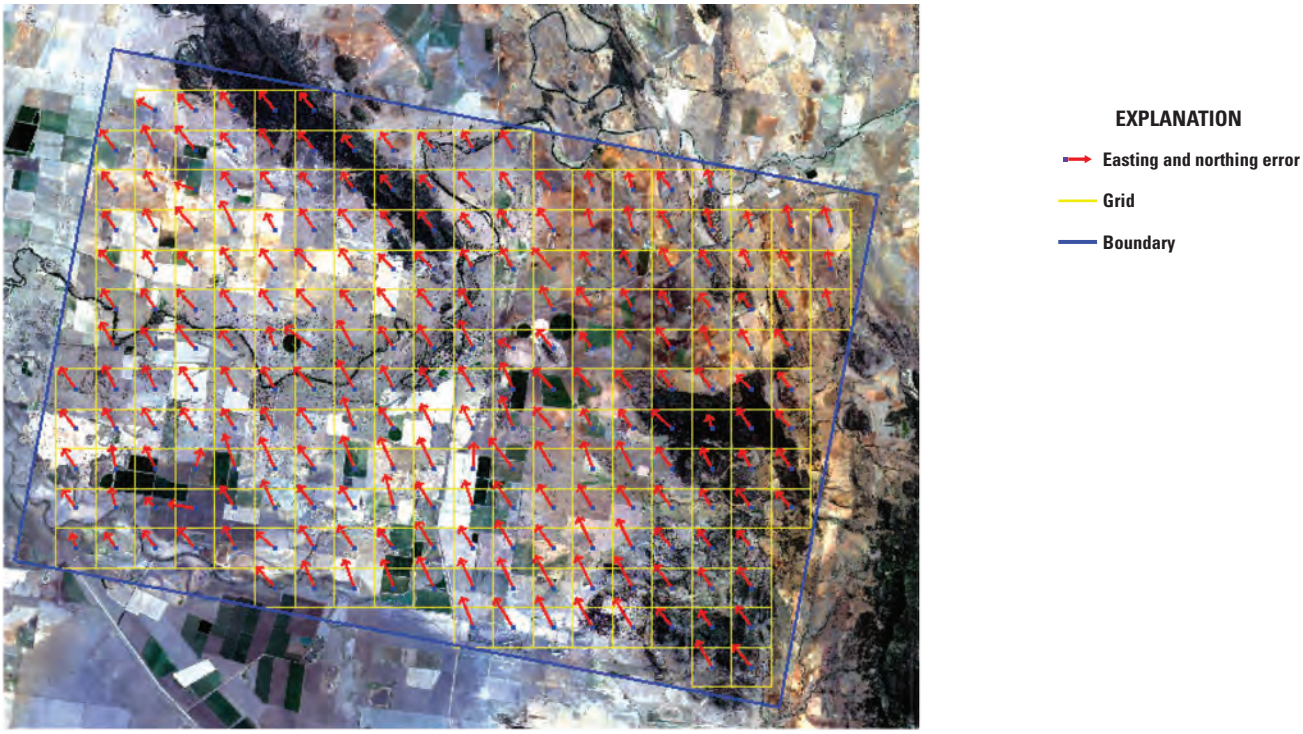


Figure 16. Relative geometric error comparison for Sentinel-2 and Planet's Dove-R, Gunnedah, Australia.

Radiometric Performance

For this analysis, cloud-free regions of interest were selected within three near-coincident Dove-R and Sentinel-2 scene pairs. Once the relative georeferencing error between Landsat 8 Operational Land Imager and Dove Classic has been corrected, Top of Atmosphere reflectance values from the two sensors are extracted. The scatterplots, figures 17 through 19, 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 6. A band-by-band graphical comparison between the Dove-R image over Imperial Valley, Calif., when compared with the corresponding Sentinel-2 band is shown in figure 17. A band-by-band comparison for the image over Johannesburg, South Africa, is shown in figure 18, and a comparison over Gunnedah, Australia is shown in figure 19.

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 7. The Dove-R image used for the analysis is "20200527_031133_59_1065_3B_AnalyticMS.tif" for Baotou, China, shown in figure 20. The yellow box shows the edge transect bounding box. The results for band 1 (blue) are shown in figures 21 and 22. In figure 21, the dotted lines with diamond symbols are the raw transects. The green line is the middle transect, where the red dots are the region of the curve that is used for alignment. The lower plot in figure 21 is the aligned curve and the green line represents edge spread function. In the upper plot in figure 22, a white curve is an edge spread function with red line segment showing relative edge response; the green curve is a line spread function with a white line segment representing full width at half maximum. The lower plot in figure 22 is a modulation transfer function up to Nyquist frequency (0.5) and the dashed line shows the frequency corresponding to the 50-percent modulation transfer function value. The results for band 2 (green) are shown in figures 23 and 24, the results for band 3 (red) are shown in figures 25 and 26, and the results for band 4 (near infrared) are shown in figures 27 and 28.

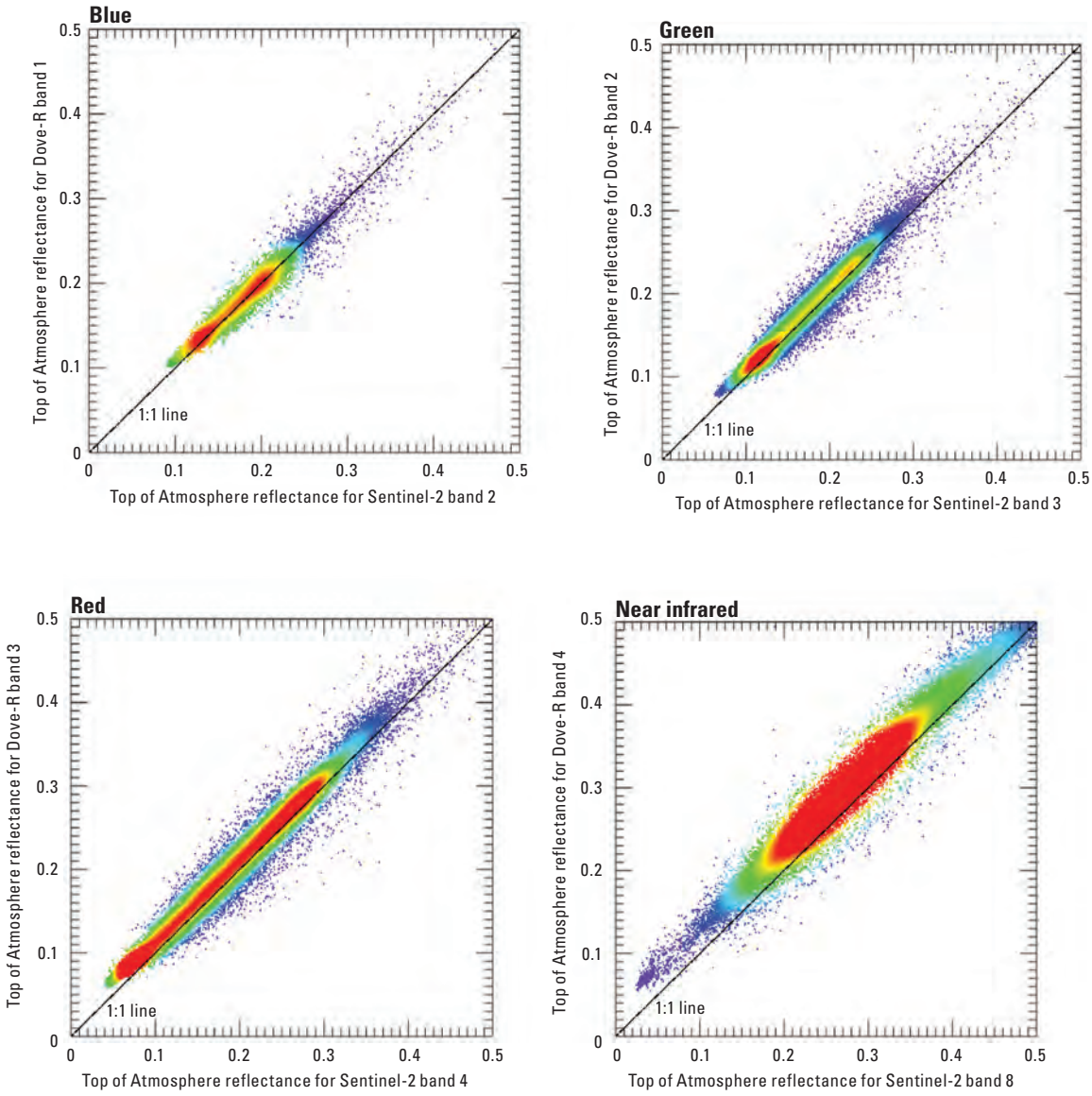


Figure 17. Top of Atmosphere reflectance comparison for Sentinel-2 and Planet's Dove-R, Imperial Valley, California.

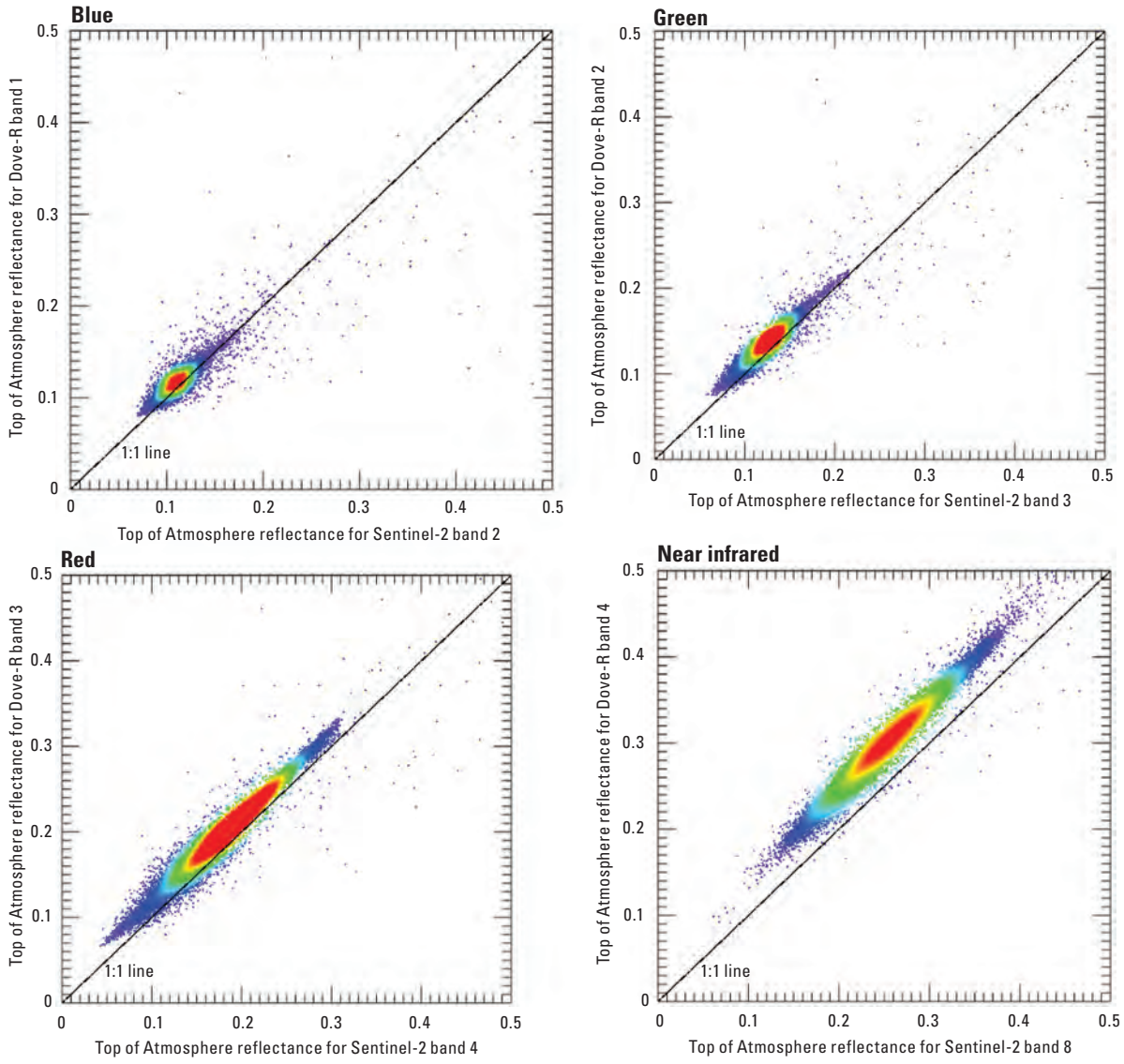


Figure 18. Top of Atmosphere reflectance comparison for Sentinel-2 and Planet's Dove-R, Johannesburg, South Africa.

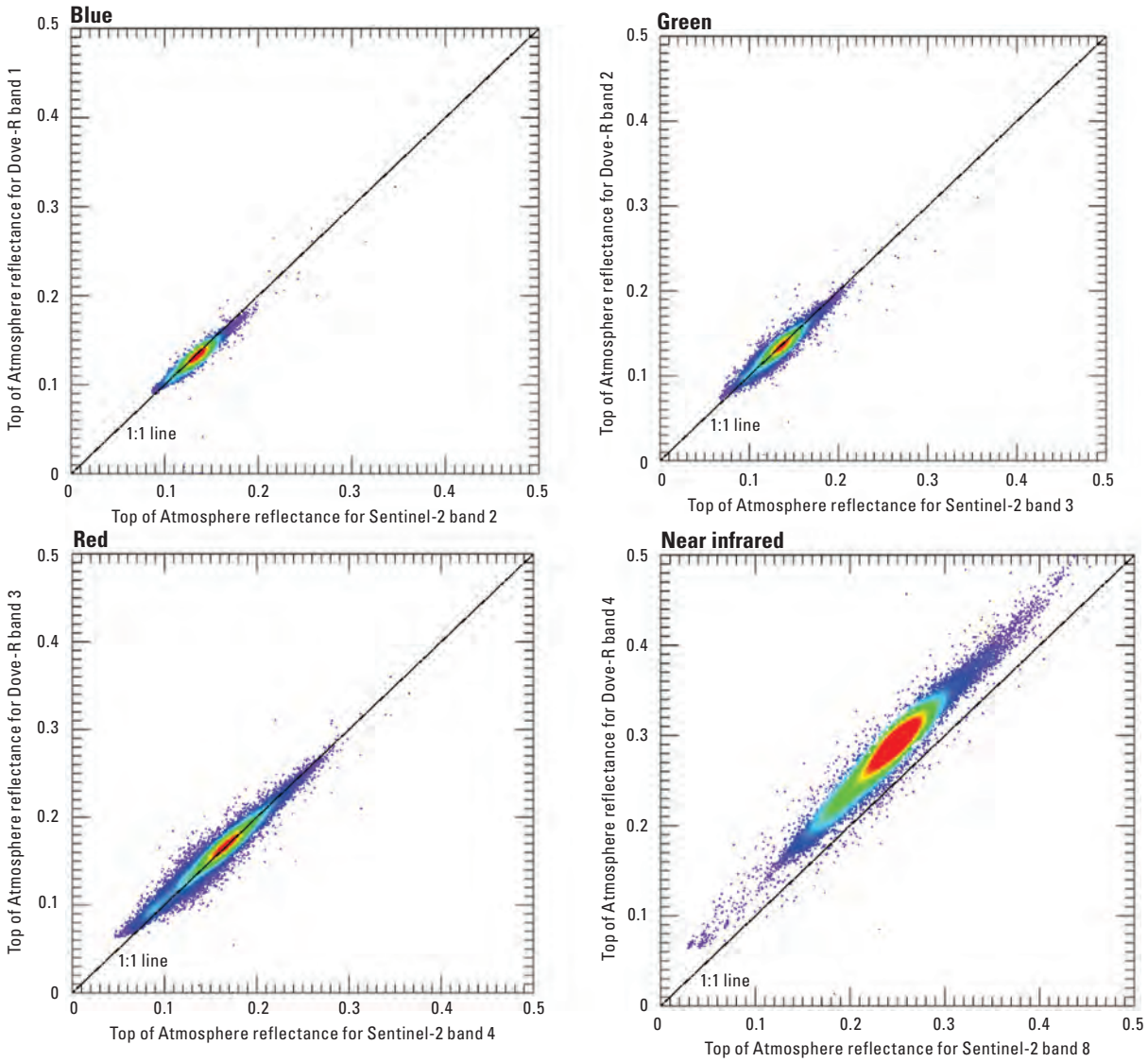


Figure 19. Top of Atmosphere reflectance comparison for Sentinel-2 and Planet's Dove-R, Gunnedah, Australia.

Table 6. Top of Atmosphere reflectance comparison for Sentinel-2 against Planet's Dove-R.

[ID, identifier; B, band; %, percent; R^2, coefficient of determination; NIR, near infrared]

Scene IDs	Statistics	B1 (blue)	B2 (green)	B3 (red)	B4 (NIR)
S2B_MSIL1C_20181224T181749_N0207_R084_T11SQS_20181224T195553201812 24_180018_51_105e (Imperial Valley, California)	Uncertainty (%)	3.87	4.41	5.51	4.71
	R^2	0.941	0.950	0.960	0.953
	Regression offset	−0.004	−0.002	−0.008	−0.023
	Regression slope	1.102	0.974	0.994	0.998
S2A_MSIL1C_20181226T080331_N0207_R035_T35JMH_20181226T101636201812 26_080136_03_105e (Johannesburg, South Africa)	Uncertainty (%)	3.54	3.98	3.66	2.77
	R^2	0.897	0.899	0.953	0.961
	Regression offset	−0.012	−0.007	−0.015	−0.035
	Regression slope	1.045	0.966	0.986	0.957
S2B_MSIL1C_20181231T000239_N0207_R030_T56JKL_20181231T011037 20181230_234302_48_105e (Gunnedah, Australia)	Uncertainty (%)	1.91	2.46	3.20	3.00
	R^2	0.948	0.947	0.964	0.950
	Regression offset	−0.009	−0.002	−0.008	−0.011
	Regression slope	1.083	1.026	1.041	0.890

Table 7. Spatial performance of Planet's Dove-R.

[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	0.31	3.00 pixels	0.002
Band 2—green	0.30	3.15 pixels	0.001
Band 3—red	0.31	2.96 pixels	0.003
Band 4—NIR	0.29	3.10 pixels	0.002

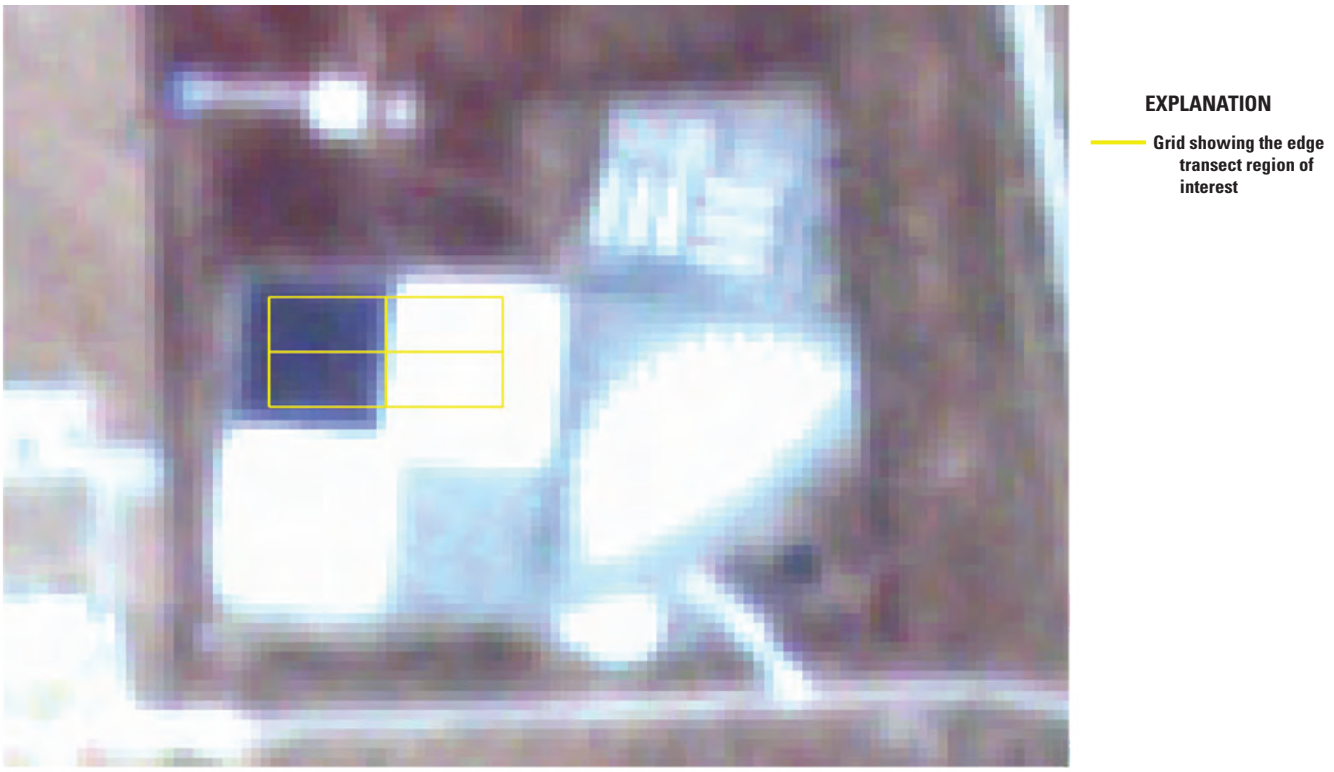


Figure 20. Dove-R image of calibration site at Baotou, China.

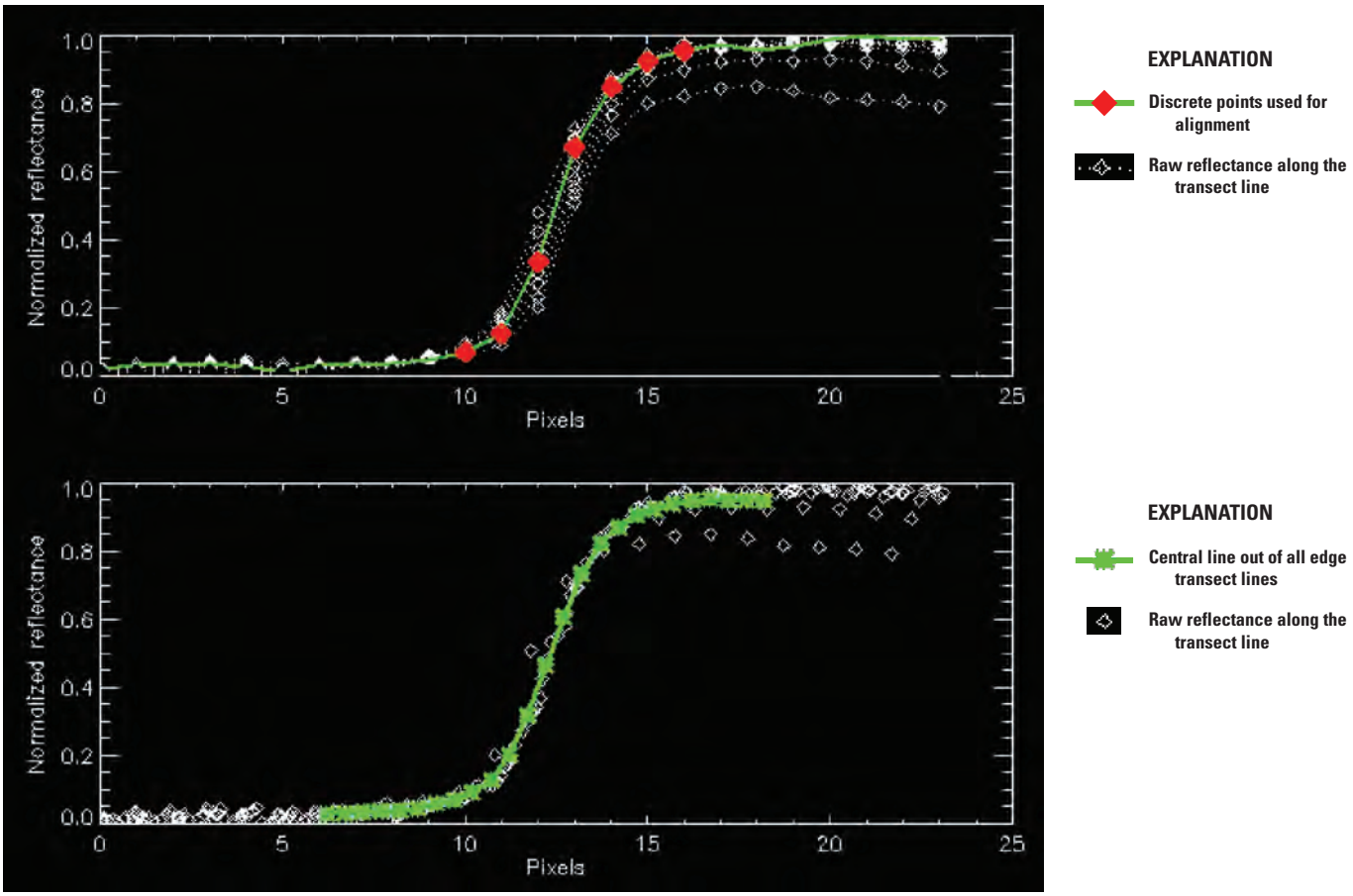


Figure 21. Band 1 (blue) raw edge transects (upper) and shifted transects (lower).

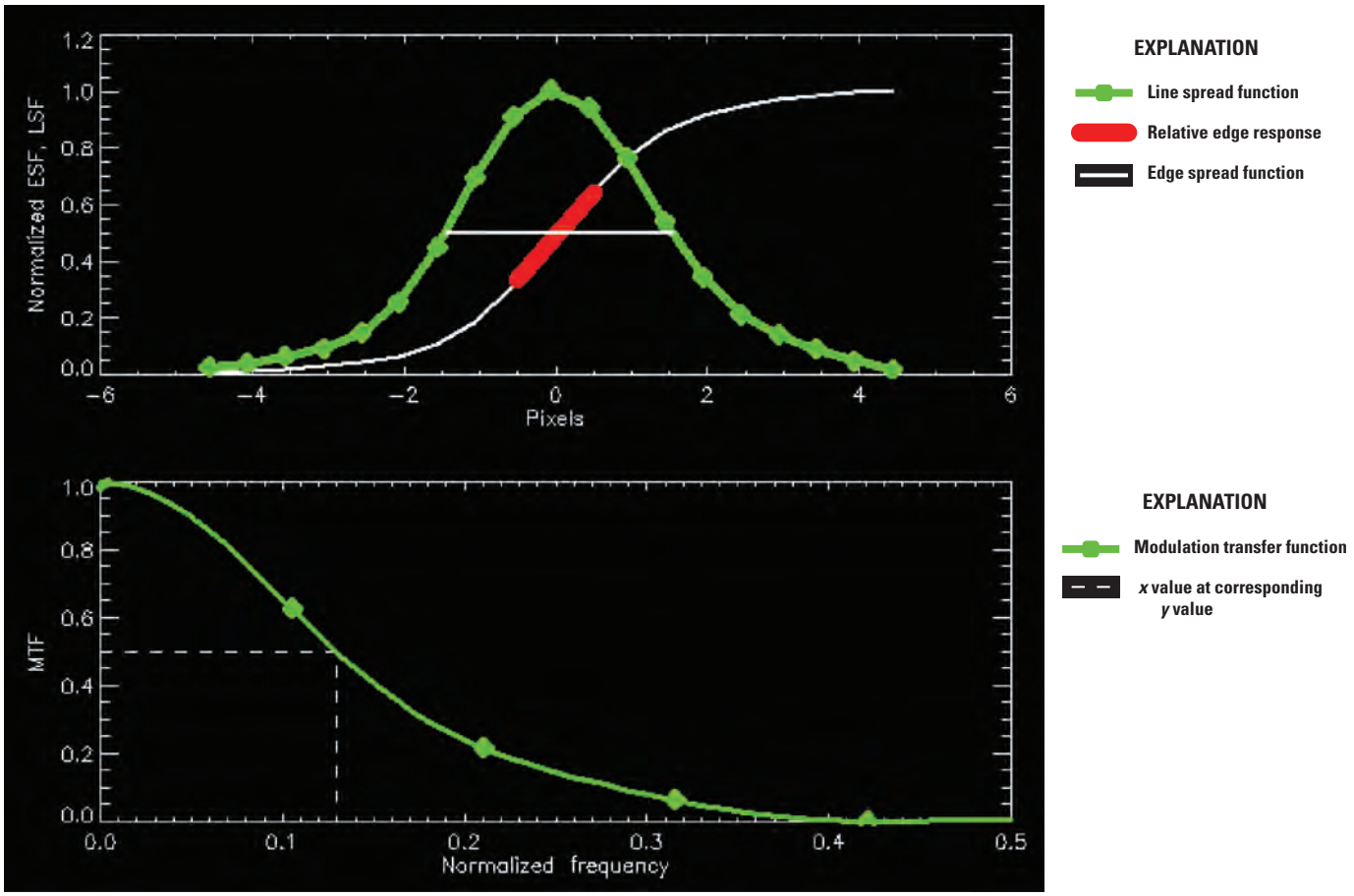


Figure 22. Band 1 (blue) edge spread function (ESF) and line spread function (LSF; upper) and modulation transfer function (MTF; lower).

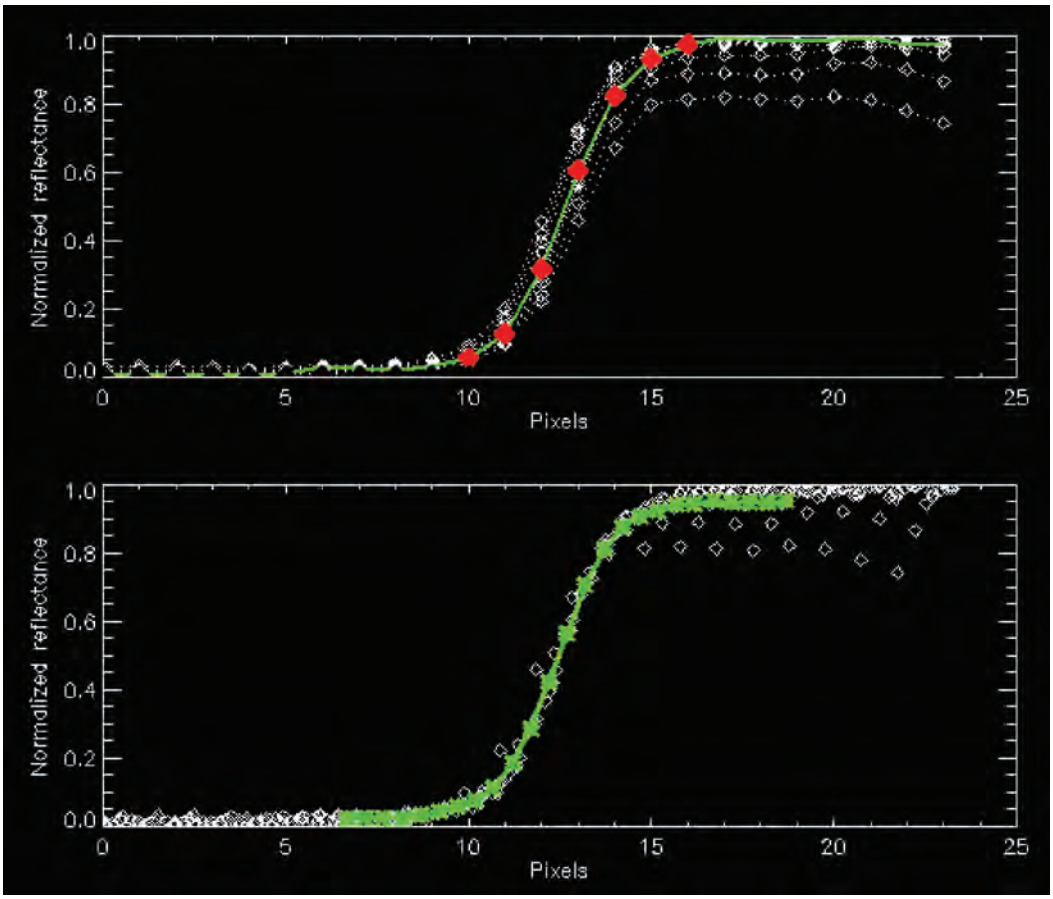


Figure 23. Band 2 (green) raw edge transects (upper) and shifted transects (lower).

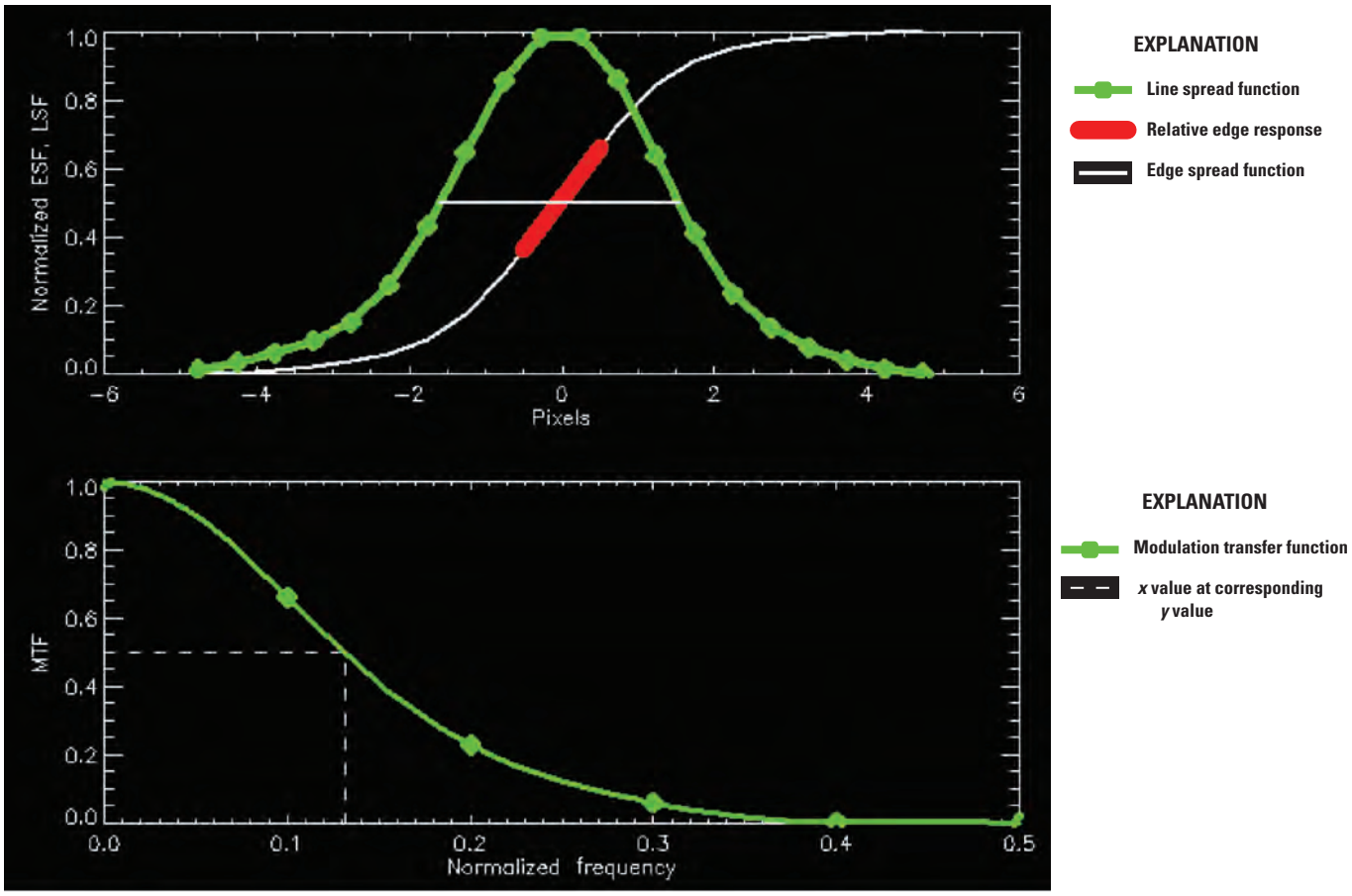
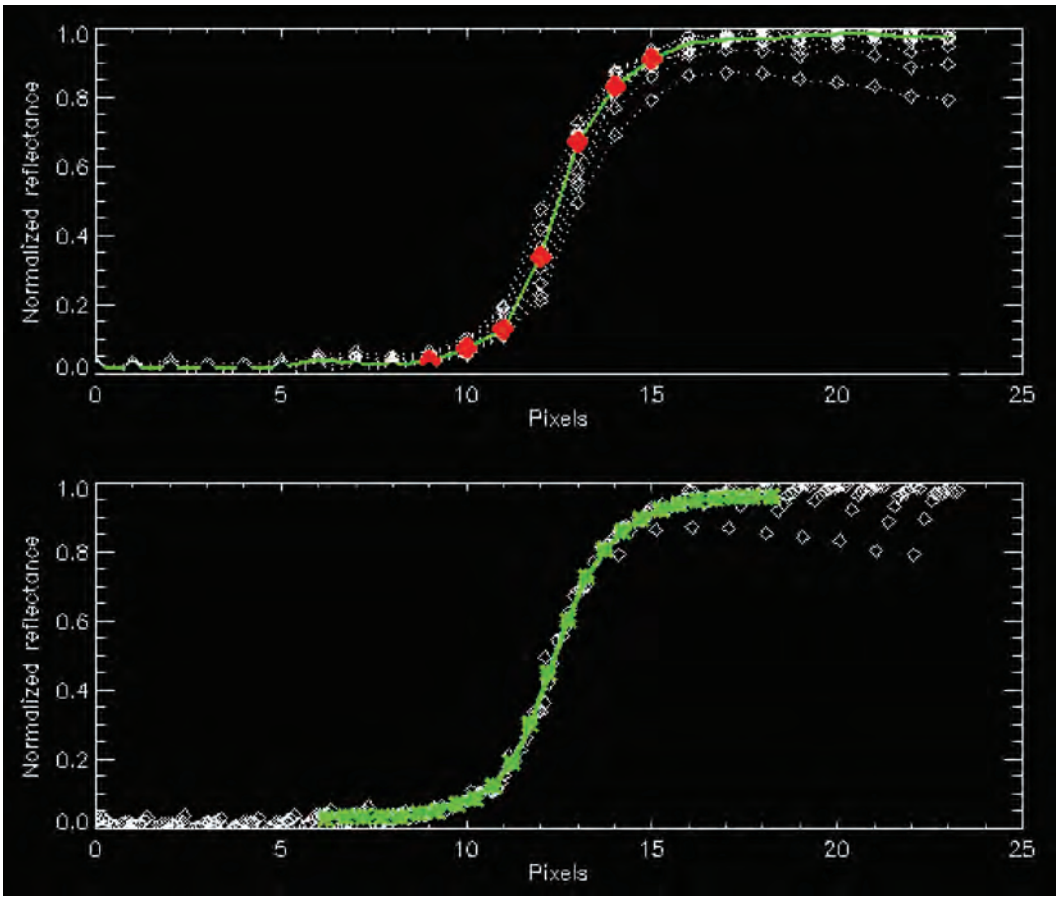
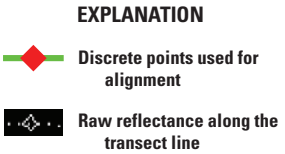


Figure 24. Band 2 (green) edge spread function (ESF) and line spread function (LSF; upper) and modulation transfer function (MTF; lower).





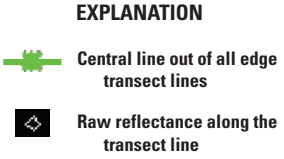


Figure 25. Band 3 (red) raw edge transects (upper) and shifted transects (lower).

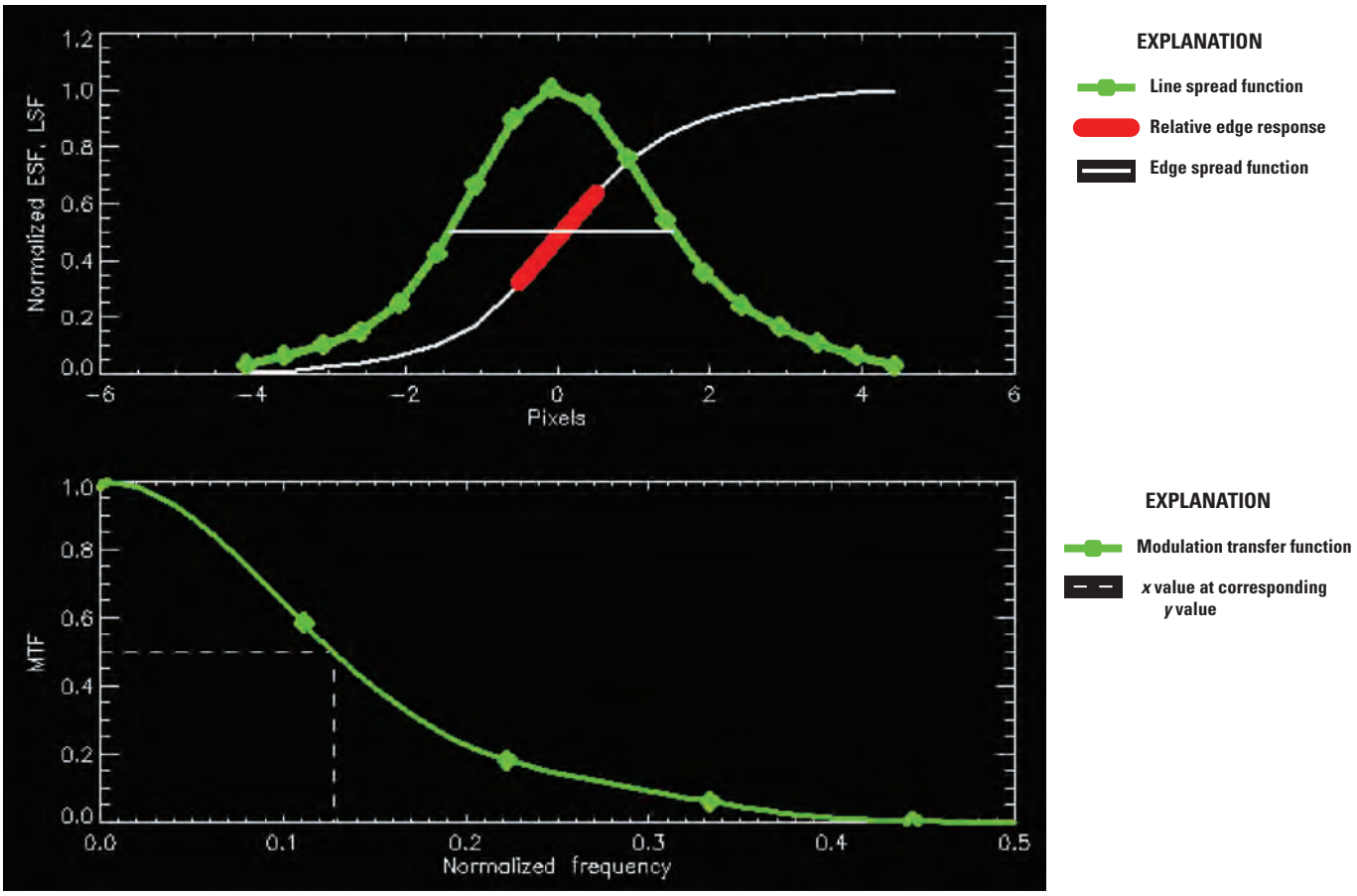
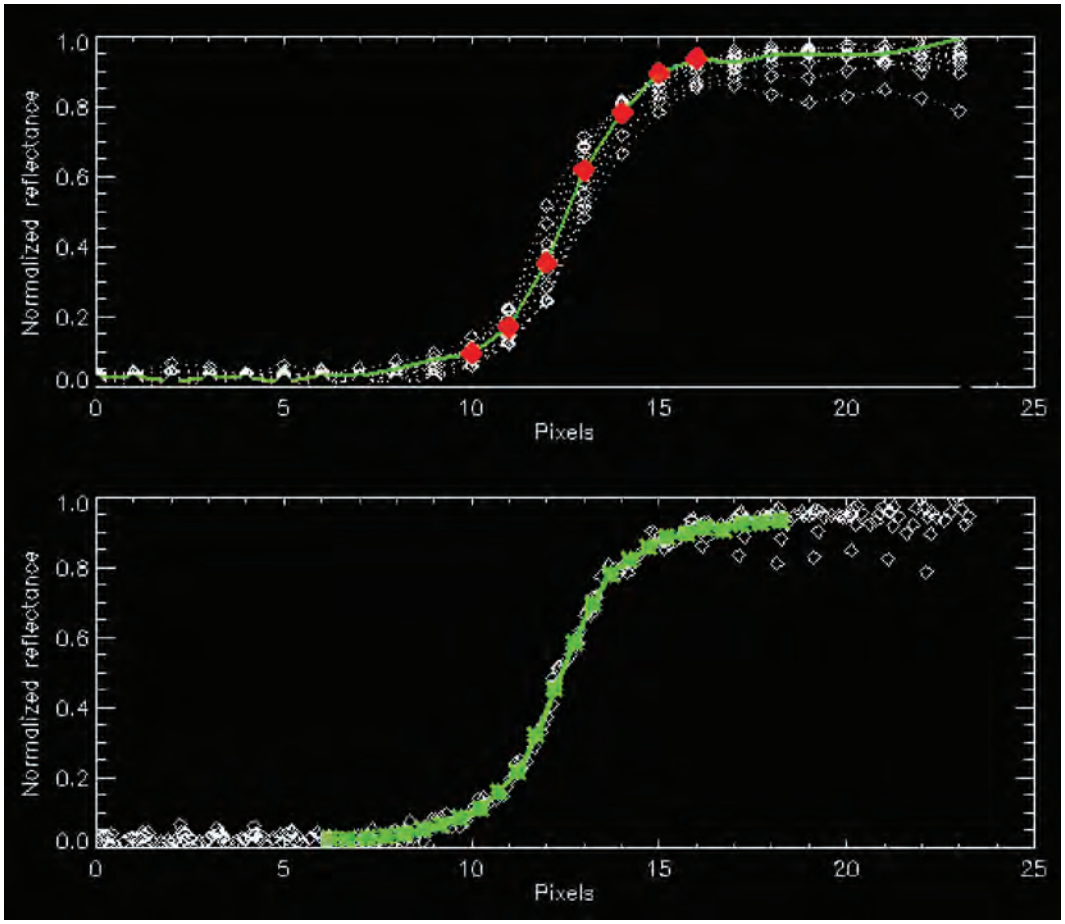


Figure 26. Band 3 (red) edge spread function (ESF) and line spread function (LSF; upper) and modulation transfer function (MTF; lower).



EXPLANATION

Discrete points used for alignment

Raw reflectance along the transect line

EXPLANATION

Central line out of all edge transect lines

Raw reflectance along the transect line

Figure 27. Band 4 (near infrared) raw edge transects (upper) and shifted transects (lower).

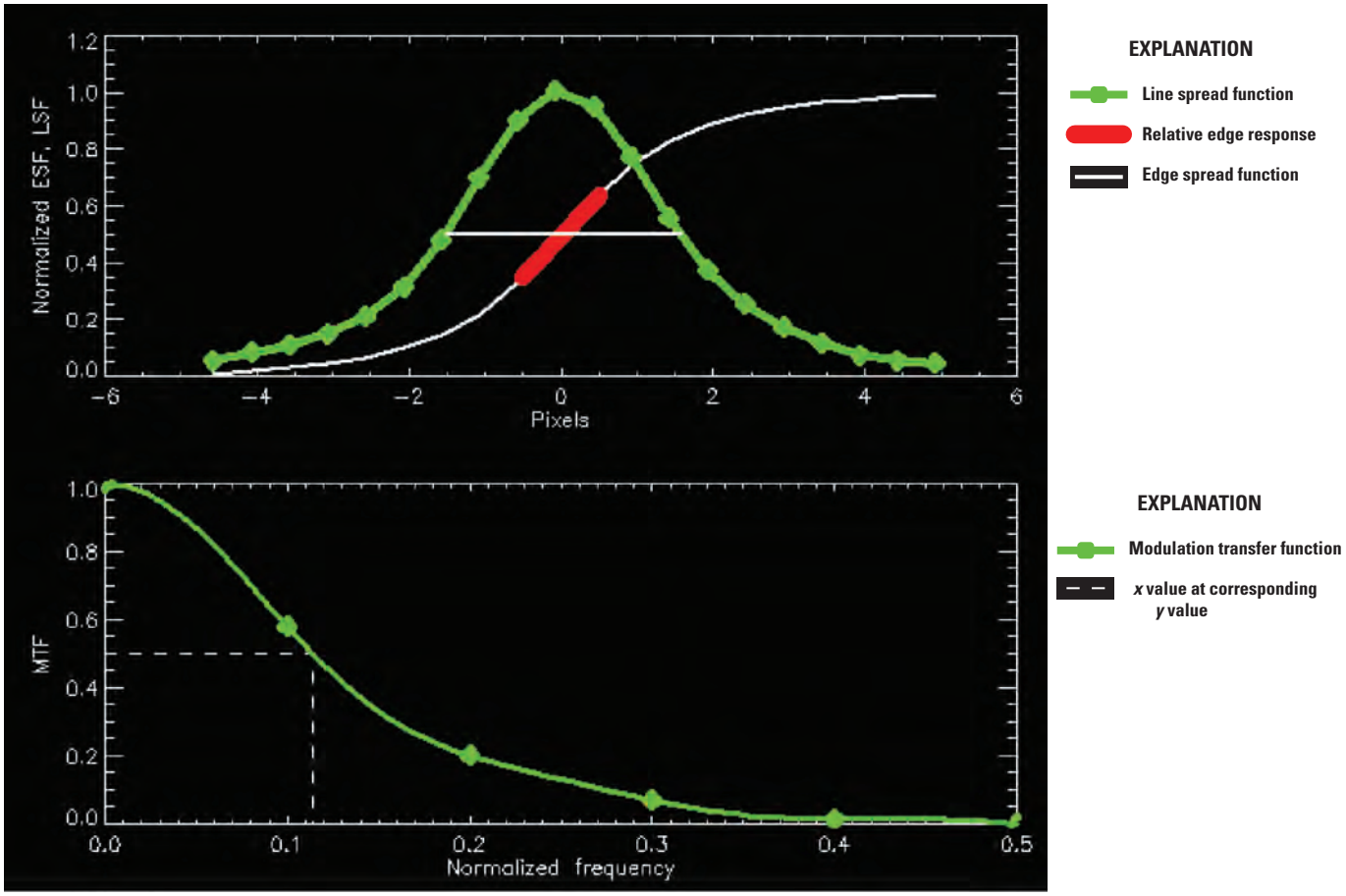


Figure 28. Band 4 (near infrared) edge spread function (ESF) and line spread function (LSF; upper) and modulation transfer function (MTF; lower).

Summary and Conclusions

This report summarizes the sensor performance of Planet's Dove-R 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 of −0.306 (−0.102 pixel) to 0.286 meter (m; 0.095 pixel) in easting and 0.090 (0.030 pixel) to 1.084 m (0.361 pixel) in northing in band-to-band registration, an exterior geometric performance of −5.10 m (−0.51 pixel) in easting and 3.30 m (0.33 pixel) in northing offset in comparison to Sentinel-2, a radiometric performance in the range of −0.023 to −0.008 in offset and 0.948 to 1.077 in slope, and a spatial performance in the range of 2.96 to 3.15 pixels for full width at half maximum, with a modulation transfer function at a Nyquist frequency in the range of 0.001 to 0.003.

In conclusion, the team has completed an ECCOE standardized system characterization of the Dove-R 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 Dove-R. 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.

Selected References

Planet Labs, Inc., 2021, Planet: Planet Labs, Inc., web page, accessed August 2020 at https://www.planet.com/.

Ramaseri Chandra, S.N., Christopherson, J.B., and Casey, K.A., 2020, 2020 Joint Agency Commercial Imagery Evaluation—Remote sensing satellite compendium (ver. 1.1, October 2020): U.S. Geological Survey Circular 1468, 253 p. [Also available at https://doi.org/10.3133/cir1468.] [Supersedes USGS Circular 1455.]

U.S. Geological Survey, 2020a, EROS CalVal Center of Excellence (ECCOE): U.S. Geological Survey web page, accessed March 2021 at https://www.usgs.gov/core-science-systems/eros/calval.

U.S. Geological Survey, 2020b, Landsat missions—Glossary and acronyms: U.S. Geological Survey web page, accessed March 2021 at https://www.usgs.gov/core-science-systems/nli/landsat/glossary-and-acronyms.

For more information about this publication, contact:
Director, USGS Earth Resources Observation and Science Center
47914 252nd Street
Sioux Falls, SD 57198
605–594–6151

For additional information, visit: https://www.usgs.gov/centers/eros

Publishing support provided by the
Rolla Publishing Service Center

ISSN 2331-1258 (online)
https://doi.org/10.3133/ofr20211030D