



Introduction to the Planet Constellations of Satellites and Imagery



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PLANET'S MISSION

To image the whole world every day,
making change **visible, accessible,
and actionable.**



Planet Dove Satellite



- Always-on, broad-area monitoring
- 3 meter resolution
- RGB and NIR bands



97° Orbital
Inclination

Planet SkySat Satellite



- Custom, targeted monitoring
- 72 centimeter resolution
- RGB, NIR, and Pan bands



OUR CONSTELLATIONS

Constellation	Dove (Planetscope)	RapidEye	SkySat
Orbit Altitude	475 km	630 km	500 km
Spacecraft #	120 +	5	14
Image capture capacity	346 million km ² /day	6 million km ² /day	500,000 km ² /day
GSD (Nadir)	3.7 m	6.5 m	0.72 m PAN
Pixel Resampled	3.125 m	5 m	1 m
Telescope and Camera	Bayer mask CCD sensor (Dove Classic); butcher block CCD (Dove-R + SuperDove)	Push broom imager	CMOS Frame Camera with Cassegrain telescope
Spectral Bands	RGB and NIR	RGB, Red Edge and NIR	RGB, PAN and NIR
Archive start	2014	2009	2014





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Archive start	2014	2009	2014

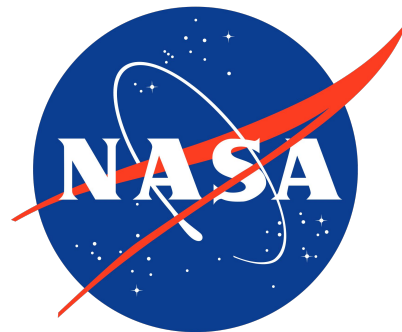
Access not
included





The new NASA agreement provides access to all NASA-funded researchers

Researchers can be based at NASA, universities, national labs, or other government institutions (i.e., USGS, NOAA, etc.)



What is included?

- PlanetScope with 30-day latency*
- RapidEye archive
- 5,000,000 km² initial quota per user*

What is not included?

- SkySat tasking + archive
- PlanetScope + SkySat Basemaps

Questions?
nasa_cs@federal.planet.com

*Exceptions may be approved by NASA on a case-by-case basis



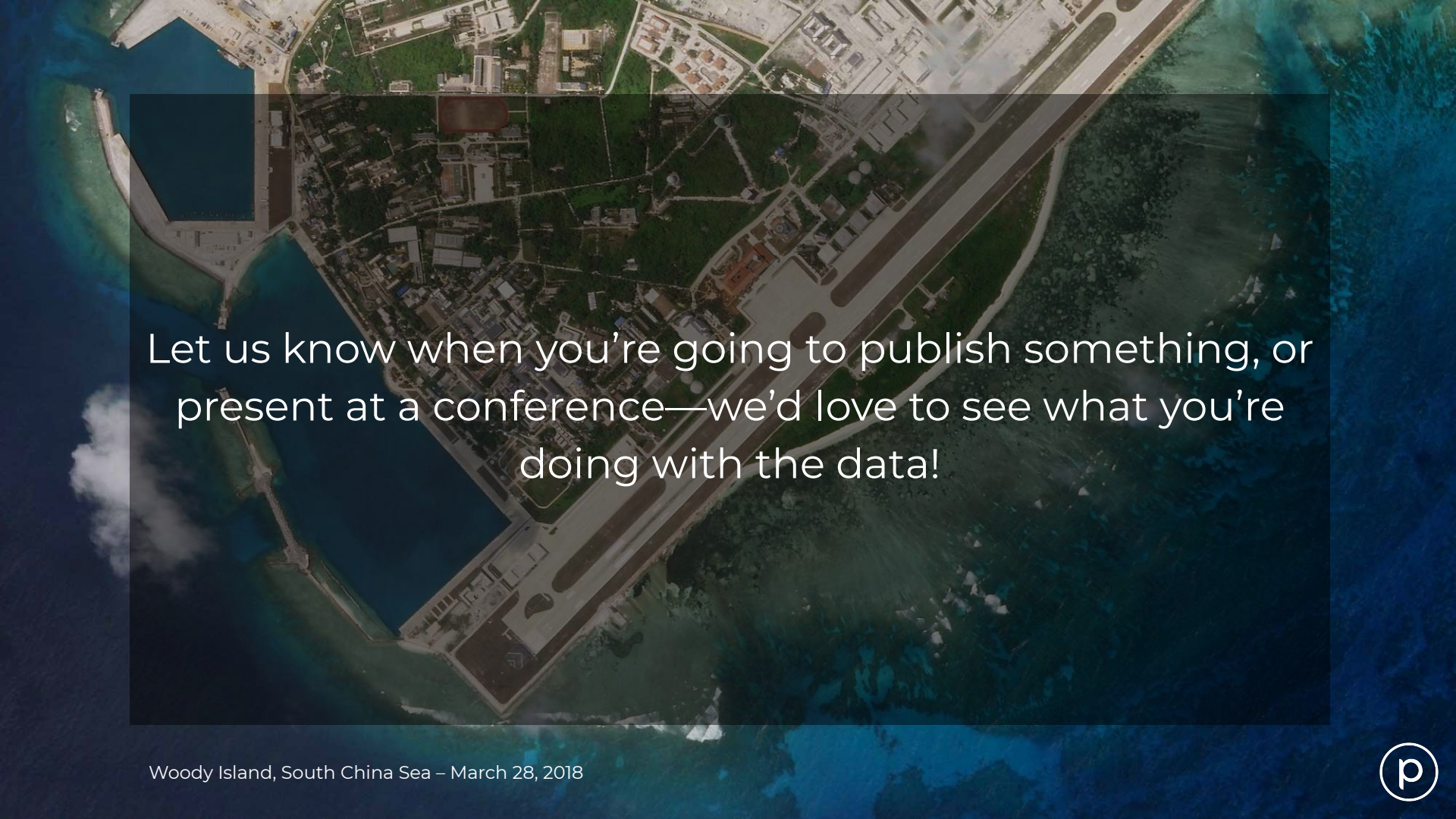


Planet Imagery Usage Terms

PlanetScope and RapidEye data are provided under a Scientific Use License.

- Imagery can be used for the purpose of conducting experiments, evaluation, research, and/or development, including applied research
 - **Cannot** be used for the development of commercial products or services
 - **Cannot** be used for non-NASA-funded work
- Derivative products (i.e., maps, figures, etc.) can be used in conference presentations, journal publications, and media releases about your research
 - Raw imagery **cannot** be shared with non-NASA-funded researchers
 - Products using Planet imagery should be noted as such in the caption information where possible
- Use this citation in publications when Planet imagery is used:
 - Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. <https://api.planet.com>.



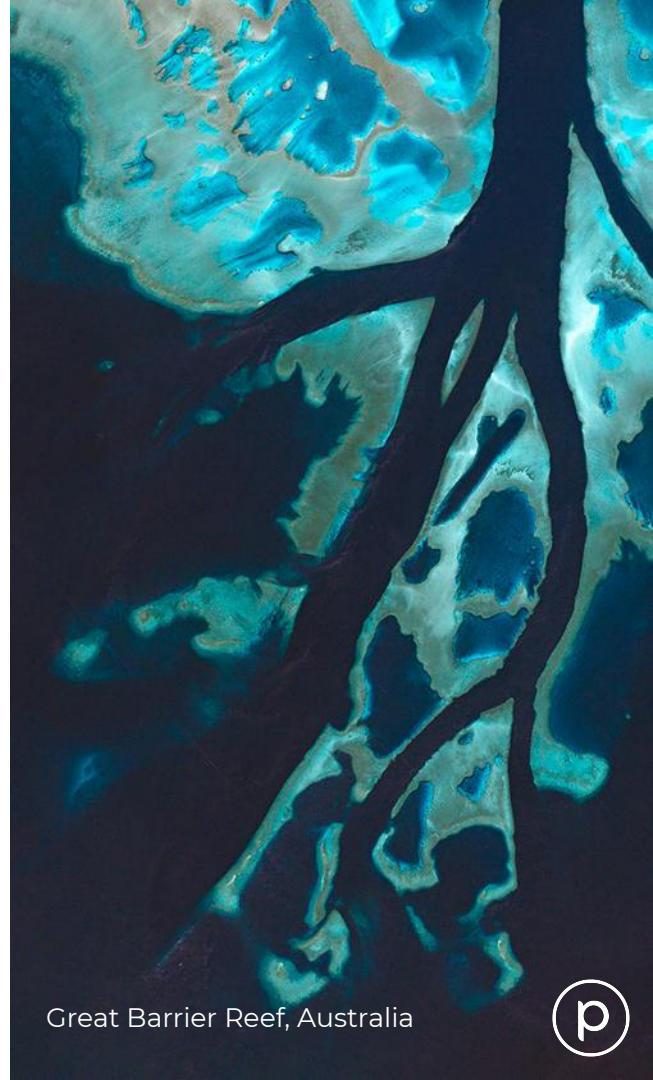


Let us know when you're going to publish something, or
present at a conference—we'd love to see what you're
doing with the data!



Scientific Advantages to Planet Data

- Unprecedented **temporal resolution**
- Unmatched **areal coverage** at relatively high spatial resolution (3–5 m)
 - Facilitates global-scale studies
 - Allows for research in areas that might otherwise be neglected coverage-wise by other providers (i.e., remote areas)
 - More chances for low/cloud-free coverage over features of interest
- **Data fusion** with other satellite, airborne, and ground-based datasets

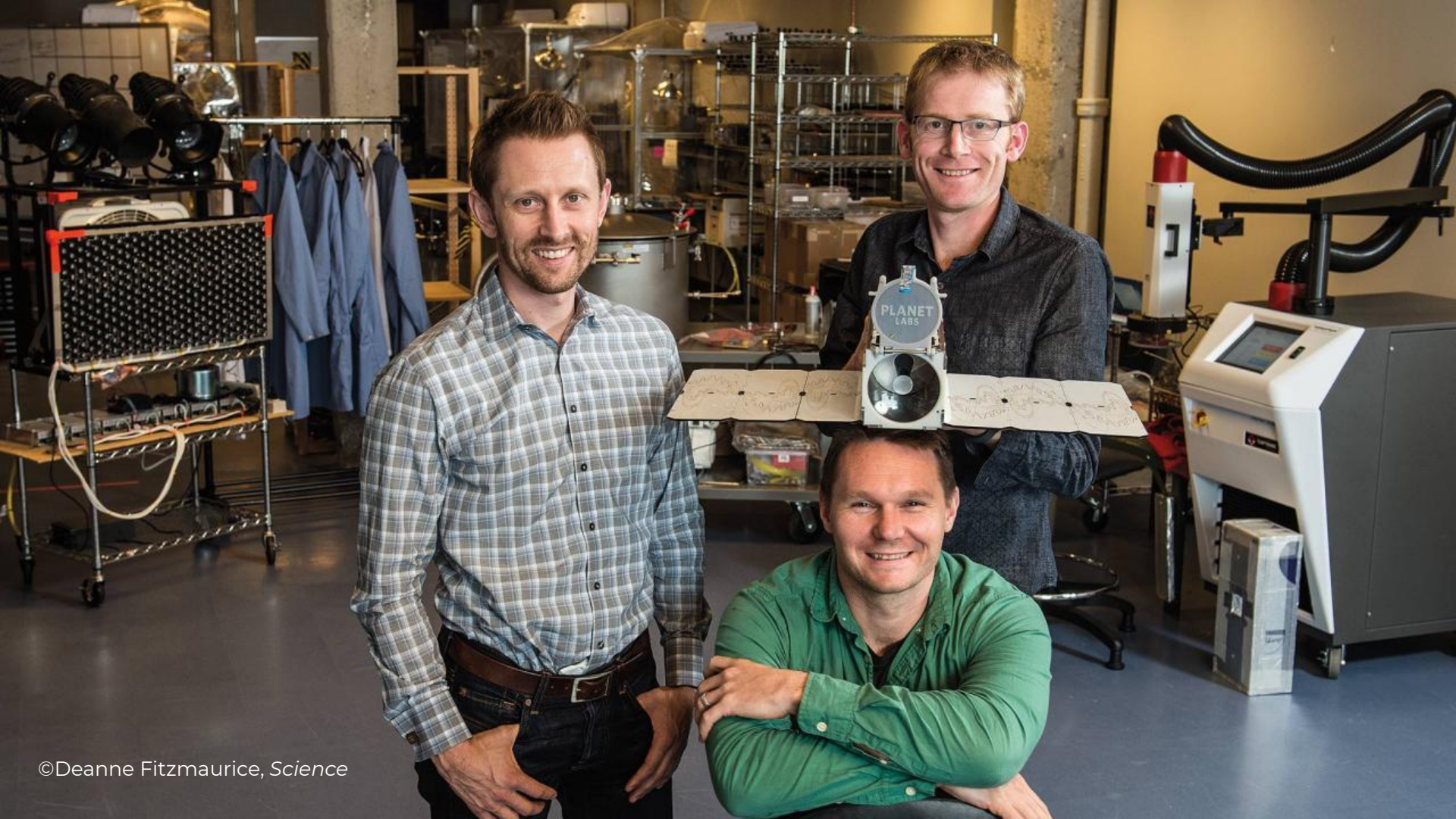


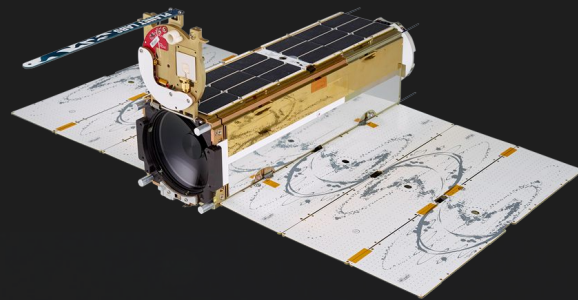
Great Barrier Reef, Australia



PLANETSCOPE CONSTELLATION (DOVES)







Doves



SATELLITES
150+

GSD
3.9 m

CAPACITY
200 million km²/day

ORBIT ALTITUDE
475 km

SPECTRAL BANDS
RGB and NIR



Agile Aerospace



15

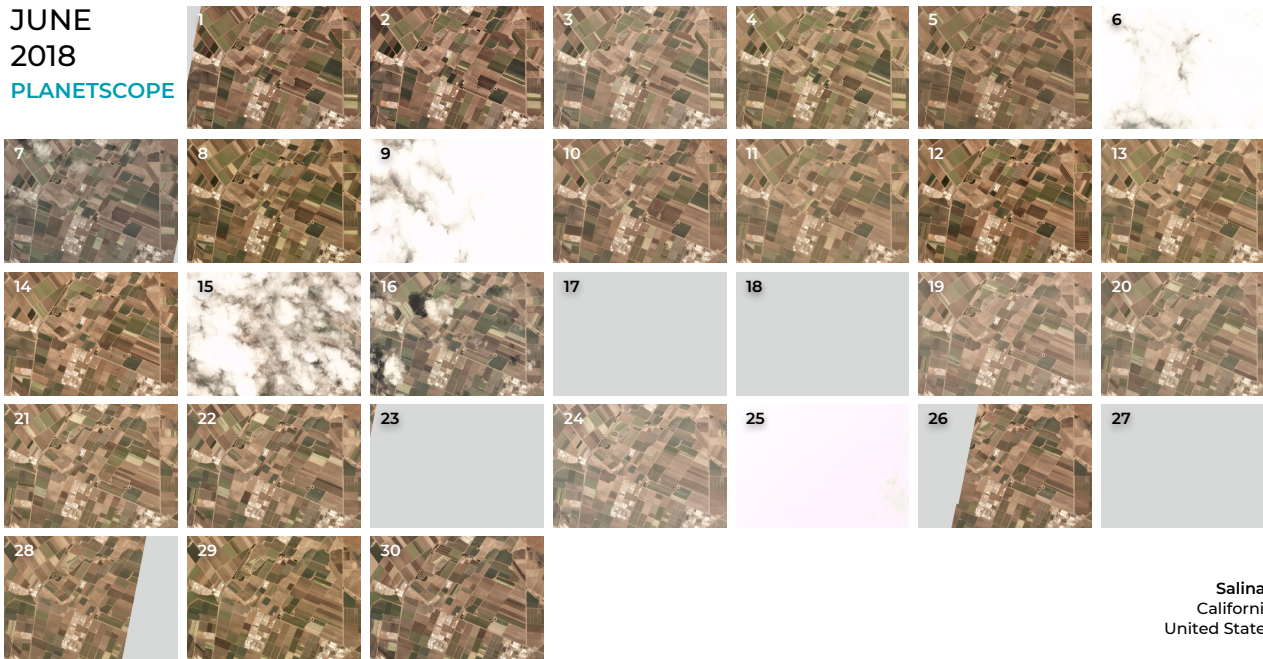
Dove Builds in 6 Years

- Continuous iterations
- 3-6 month design lifecycle
- Leverage other industries' R&D



Detect changes early with high frequency imagery

JUNE
2018
PLANETSCOPE



Salinas
California
United States



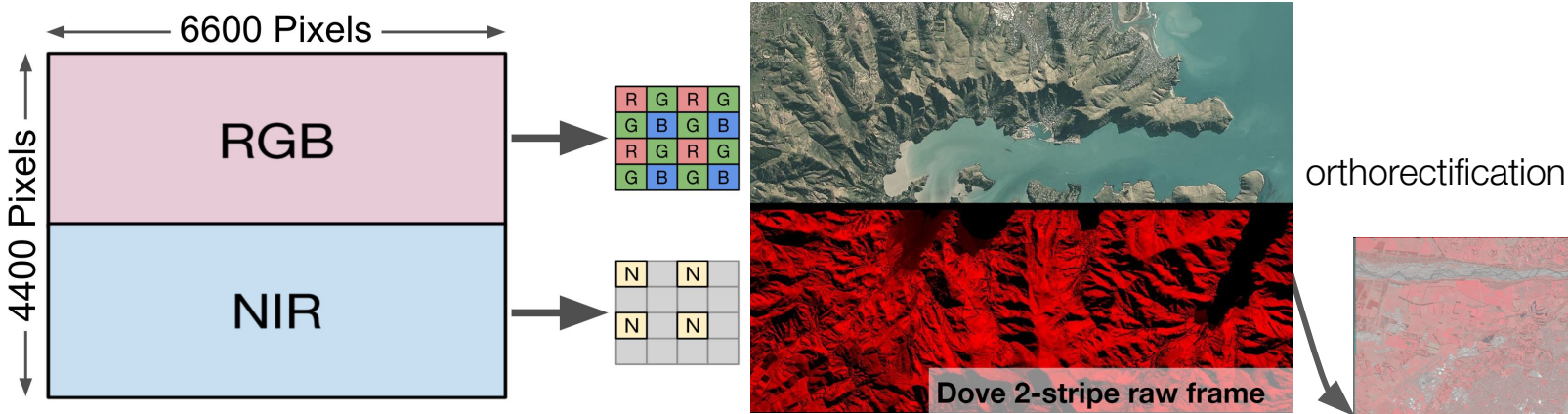


Constellation Overview: Planetscope

Mission Characteristics	Sun-synchronous Orbit		
Instrument	PS2 [Dove]	PS2.SD [Dove-R]	PSB.SD [SuperDove]
Orbit Altitude (reference)	475 km (~98° inclination)		
Max/Min Latitude Coverage	±81.5° (depending on season)		
Equator Crossing Time	9:30 - 11:30 am (local solar time)		
Sensor Type	Four-band frame Imager with a split-frame VIS+NIR filter	Four-band frame imager with butcher-block filter providing blue, green, red, and NIR stripes	Eight-band frame imager with butcher-block filter providing blue, green, red, red-edge, and NIR stripes
Spectral Bands	Blue: 455 - 515 nm Green: 500 - 590 nm Red: 590 - 670 nm NIR: 780 - 860 nm	Blue: 464 - 517 nm Green: 547 - 585 nm Red: 650 - 682 nm NIR: 846 - 888 nm	Blue: 457.5 - 522.5 nm Green: 542. - 577.5 Red: 650 - 680 Red-Edge: 697.5 - 712.5 NIR: 855 - 875
Ground Sample Distance (nadir)	3.7 m (approximate)		
Frame Size	24 km x 8 km (approximate)	24 km x 16 km (approximate)	32.5 km x 19.6 km (approximate)
Maximum Image Strip per orbit	20,000 km ²		
Revisit Time	Daily at nadir		
Image Capture Capacity	200 million km ² /day		
Camera Dynamic Range	12-bit		




Dove Classic sensor layout



Type	Band	Pixel Pitch (um)	Sampling Frequency	Base GSD (meters)	Effective GSD (meters)	Ortho Scale (meters)
MS	Blue	5.5	0.50X	3.9 ¹	7.8	3.125
	Green		0.71X		5.5	
	Red		0.50X		7.8	
	NIR		0.50X		7.8	
PAN ²	Luminance		1.00X		3.9	

2-stripe half-frame composite

A high-resolution satellite image of a mountainous region, likely the Alps, showing detailed terrain features, snow cover, and some forested areas. The image is used as a background for a text overlay.

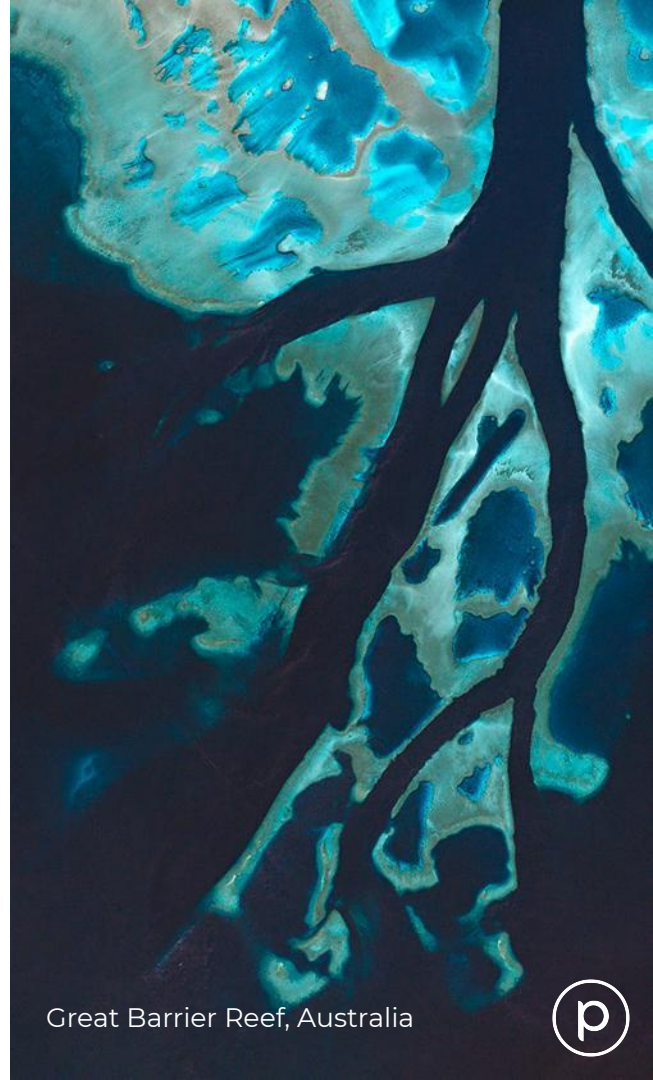
Dove-R provides significant improvements to spectral resolution, image sharpness, and dynamic range over the older Dove satellites.



What is “next generation PlanetScope” imagery?

This refers to improvements made to our flagship PlanetScope imagery on the sensor and hardware:

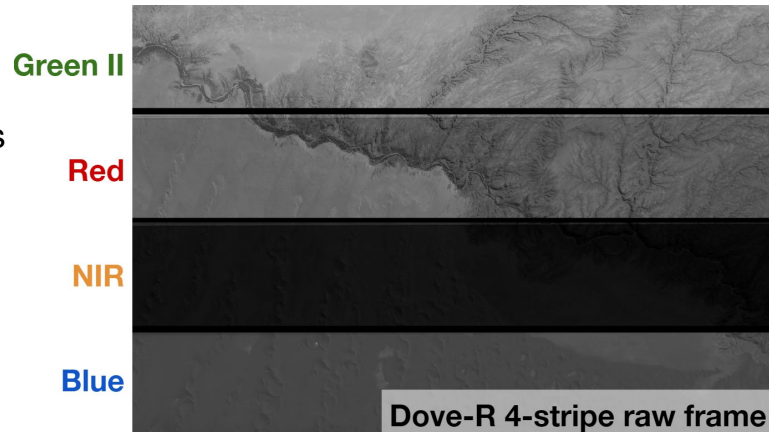
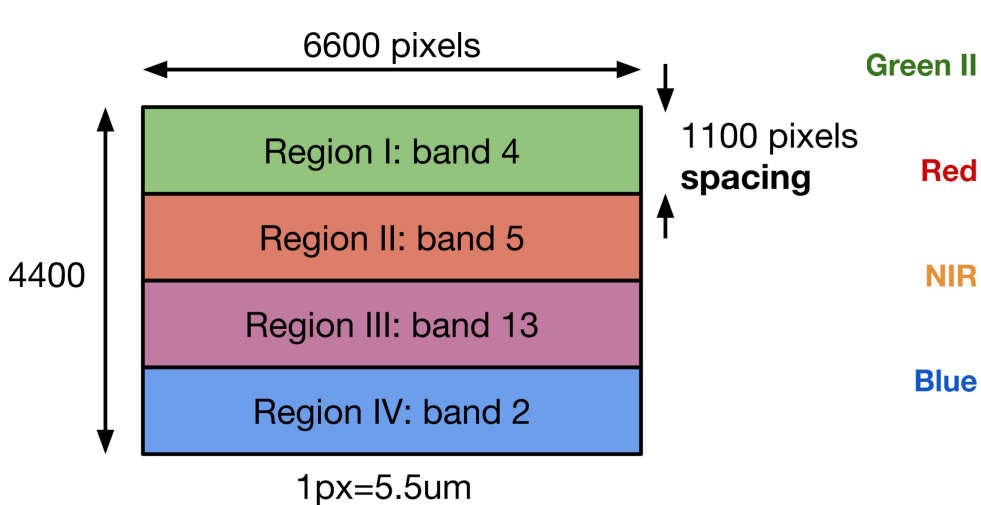
- **Richer color and vibrancy** due to narrower spectral bands
- **Sharper images** through the elimination of the color filter array
- **Larger images** with ~2x longer image footprint



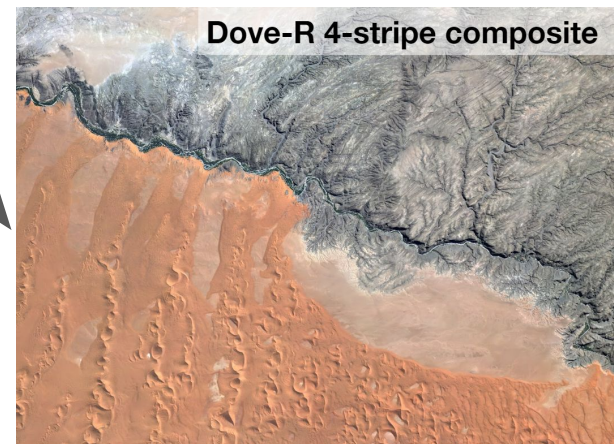
Great Barrier Reef, Australia



Dove-R sensor layout



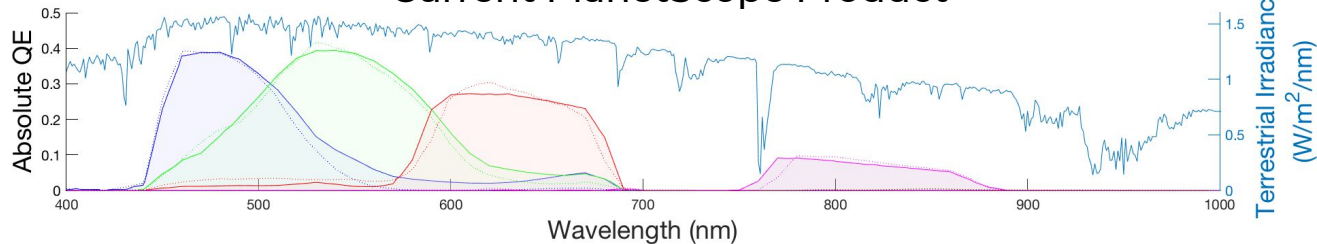
SfM pipeline



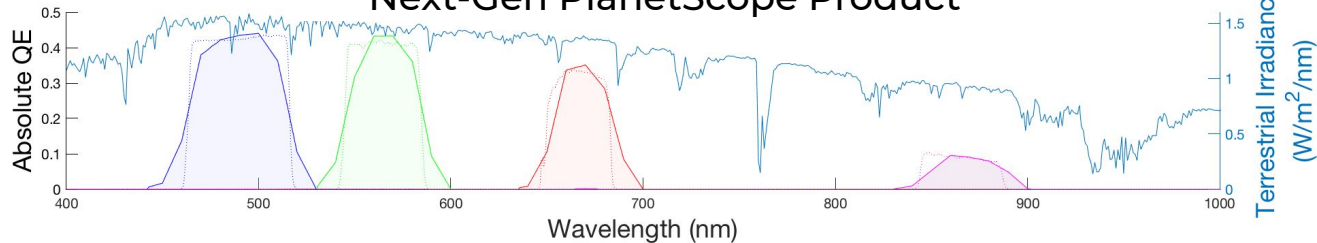
Band	Name	delta	Notes	Wavelength (nm)	spatial sampling	L_{ref} (W sr ⁻¹ um ⁻¹ m ⁻²)	SNR @ L_{ref} (t=10ms)*
2	Blue	narrow	core visible bands	490 (50)	0.5x	130	170
4	Green II	new		565(36)	1x		154
5	Red	keep		665 (31)			138
13	NIR	widen	narrow NIR	865 (40)	0.5x		98



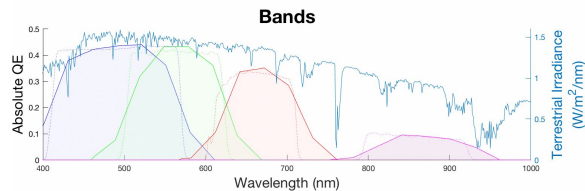
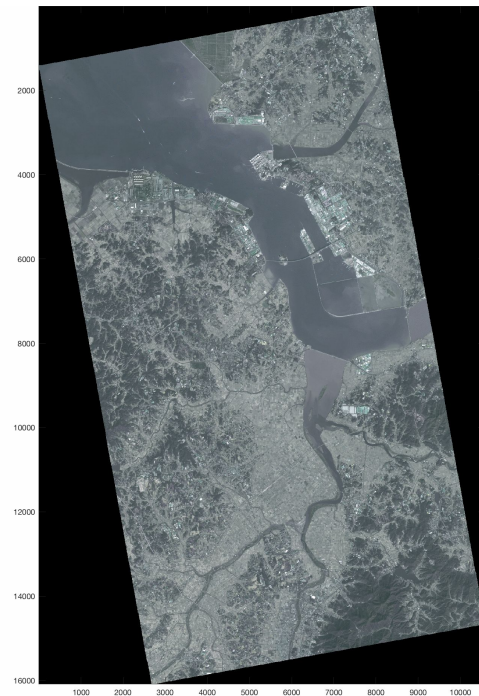
Current PlanetScope Product



Next-Gen PlanetScope Product



- Richer color
- Aligned with Sentinel-2 bands
- Improved land cover classification
- Improved vegetation stress detection
- More accurate surface reflectance





DOVE-R - MARCH 29, 2019 CANADA





DOVE-R - SEPTEMBER 4, 2019 GREENLAND



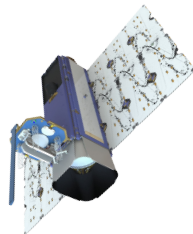
An aerial photograph of a rugged mountain range covered in snow. The peaks and ridges are white, while the valleys and some slopes show dark, forested areas. A dark grey rectangular box is centered over the image, containing white text.

SuperDove: More bands, more science!





SUPERDOVE



- Interoperable with RapidEye and Dove
- 5 VNIR spectral bands for land/ocean cover
- Next-gen avionics

Band	Name	Wavelength (fwhm)	Interoperable with Sentinel-2
1	Blue	490 (50)	Yes - with Sentinel-2 band 2
2	Green II	565 (36)	Yes - with Sentinel-2 band 3
3	Red	665 (31)	Yes - with Sentinel-2 band 4
4	Red edge I	705 (15)	Yes - with Sentinel-2 band 5
5	NIR	865 (40)	Yes - with Sentinel-2 band 8a



Desert Patterns, Saudi Arabia





SUPERDOVE MARCH 11, BEYARJMAND, بخش بیارجمند, IRAN





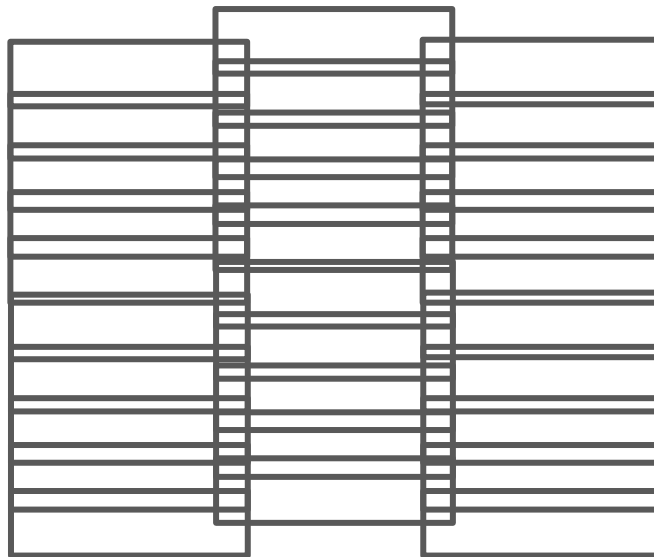
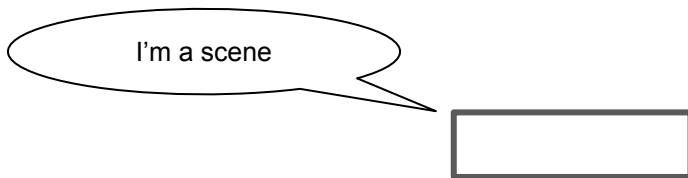
Imagery Basics

How our satellites collect images

Our satellites take many overlapping, images as they circle the Earth.

Overlaps are necessary to ensure we provide gap-free images.

Each image is called a scene.





PlanetScope Data Products

Basic Scene	Ortho Scene	Ortho Tile
<p>Scaled Top of Atmosphere Radiance (at sensor)</p> <p>No atmospheric or terrain correction</p> <p>Not map projected</p> <p>Designed for users with advanced image processing capabilities</p>	<p>Orthorectified</p> <p>Terrain corrected</p> <p>Scaled Top of Atmosphere Radiance (at sensor) product -Visual (8-bit)</p> <p>Surface Reflectance product -Analytic (16-bit)</p> <p>Atmospheric correction on Surface Reflectance products</p> <p>Map projected (UTM, WGS84 datum)</p>	<p>25 x 25 km tiles comprised of consecutively acquired scenes</p> <p>Orthorectified</p> <p>Radiometrically, sensor, and geometrically corrected</p> <p>Scaled Top of Atmosphere Radiance (at sensor) product -Visual (8-bit)</p> <p>Surface Reflectance product -Analytic (16-bit)</p> <p>Map projected (UTM, WGS84 datum)</p>





PlanetScope Ortho Tiles



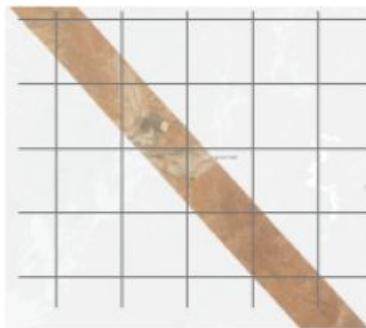
Striped Scenes Collection



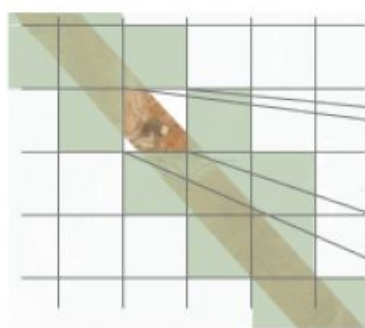
Single RGB + IR Striped Scene



Scenes Strip



UTM Grid Overlay



PlanetScope Tiled Product



Single PlanetScope Tile

Forward- and Backwards-Compatibility

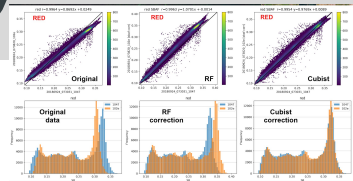
Sentinel-2

Already
Interoperable!

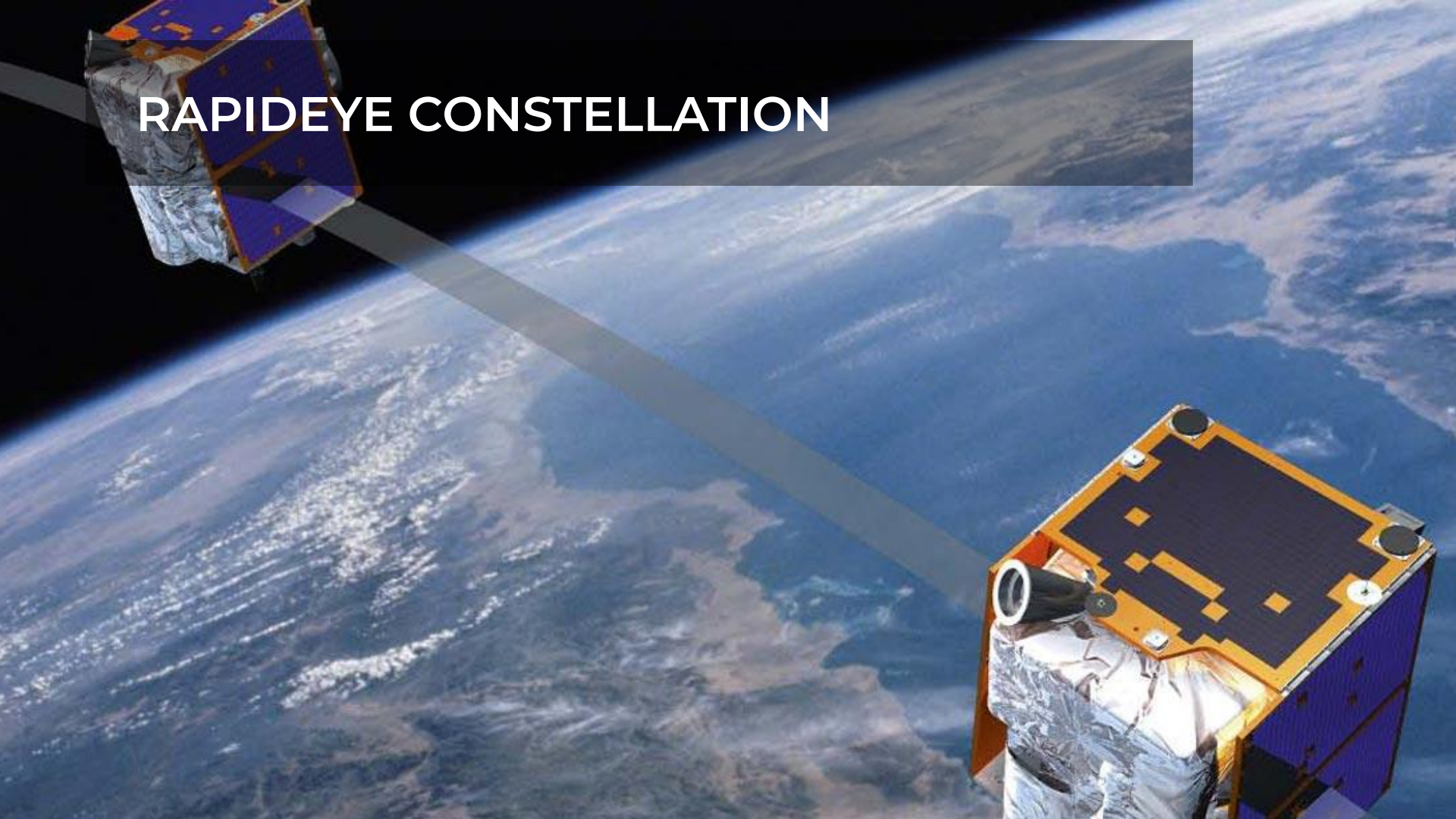
Dove-R (105A)

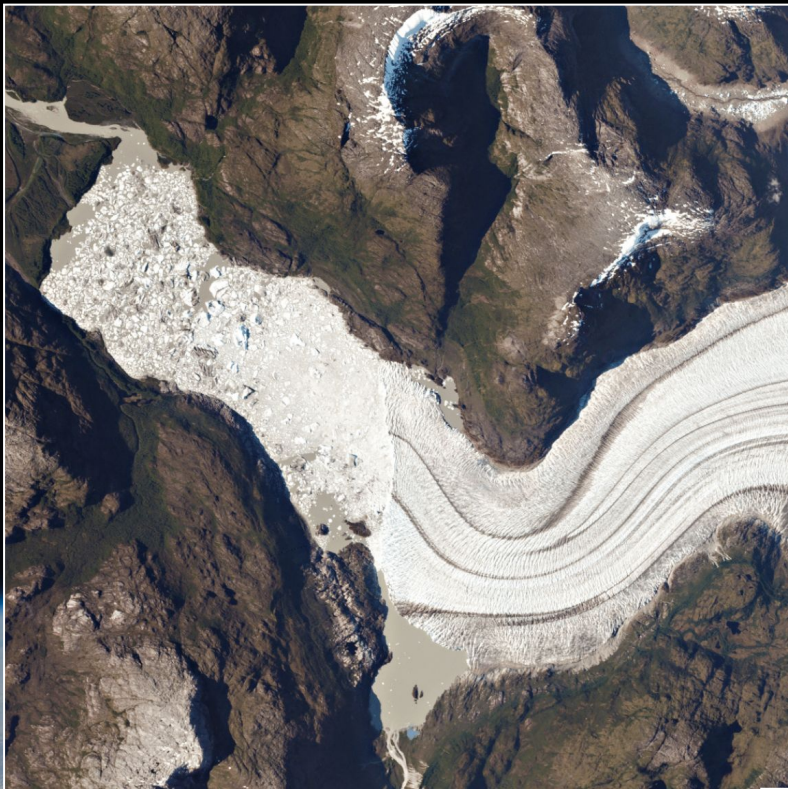
Dove (1002)

Dove-R (105A) - Monitoring



RAPIDEYE CONSTELLATION





RapidEye



SATELLITES
5

GSD
6.5 m

CAPACITY
6 million km²/day

ORBIT ALTITUDE
630 km

SPECTRAL BANDS
RGB, Red Edge
and **NIR**

RETIRED



RapidEye



SATELLITES
5

GSD
6.5 m

CAPACITY
6 million km²/day

ORBIT ALTITUDE
630 km

SPECTRAL BANDS
RGB, Red Edge
and **NIR**



Constellation Overview: RapidEye

Mission Characteristics	Information
Number of Satellites	5
Orbit Altitude	630 km in Sun-Synchronous Orbit
Equator Crossing Time	11:00 am local time (approximately)
Sensor Type	Multispectral push broom
Spectral Bands	Blue: 440 - 510 nm Green: 520 - 590 nm Red: 630 - 685 nm Red Edge: 690 - 730 nm NIR: 760 - 850 nm
Ground Sampling Distance (nadir)	6.5 m
Swath Width	77 km
Maximum Image Strip per orbit	Up to 1500 km of image data per orbit
Revisit Time	Daily (off-nadir) / 5.5 days (at nadir)
Image Capture Capacity	> 6 million km ² /day
Camera Dynamic Range	12-bit





RapidEye Data Products

Basic Scene	Ortho Tile
Scaled Top of Atmosphere Radiance (at sensor)	25 x 25 km tiles comprised of consecutively acquired scenes
Radiometrically + sensor corrected	Orthorectified
No atmospheric or terrain correction	Radiometrically, sensor, and geometrically corrected
Not map projected	Scaled Top of Atmosphere Radiance (at sensor) product - Visual (8-bit)
Designed for users with advanced image processing capabilities	Surface Reflectance product - Analytic (16-bit)
	Map projected (UTM, WGS84 datum)



PLANET DATA ACCESS

Cancún, Mexico – August 18, 2016





Getting Access Through the NASA Contract

Send an email to aaron.s.kaulhus@nasa.gov and manil.maskey@nasa.gov to request access and include:

- Name
- Email address
- Pertinent information: grant/contract number

Once the authorization process is complete, you and [Planet's Customer Success team](#) will be notified to kickoff account provisioning. We'll then send you onboarding documentation and invitations to upcoming training sessions and science seminars.





Upcoming Training Sessions

Date/Time	Topic	Description
June 24 11-12pm EST	Cloud Filtering: An Introduction to Usable Data Masks	This presentation will give an overview of Planet's cloud masking products, included in your image downloads.
July 1 11-12pm EST	Using Planet Data in Existing Workflows: Google Earth Engine	Intended for existing Google Earth Engine users, this workshop will cover the basics of ingesting Planet imagery into your GEE workflow for processing and using with other satellite datasets.
July 15 11-12pm EST	Office Hours	General Q&A
July 22 11-12pm EST	Multi-Mission Operations	Learn about how Planet operates two separate constellations of satellites in tandem—composed of over 150 separate CubeSats and SmallSats!





Downloading Planet Data

Four options depending on your needs

Planet Explorer

Best for: Browsing; small downloads

<https://developers.planet.com/docs/apps/explorer/>

Planet QGIS Plug-in

Best for: QGIS users; more advanced browsing; small & large downloads

<https://developers.planet.com/docs/integrations/qgis/>

Planet ArcGIS Plug-in

Best for: Easily searching for & downloading Planet data directly into your Arc projects

<https://developers.planet.com/docs/integrations/arcgis/>

Planet Data API

Best for: Heavy users proficient in Python

<https://developers.planet.com/docs/apis/>



Seminole Reservoir, Wyoming, USA



Planet Explorer

planet.com/explorer/?#/zoom/13.38/center/-122.440,37.797/geometry/POLYGON((-122.4778+37.7672,-122.3554+37.7672,-122.3554+37.8306,-122.4778...

135 Macondray Lane, San Francisco, Cali








EXPLORER

Browse Compare Stories

Daily Weekly Monthly Quarterly

Filters Dates Sort

72 of many Save search

	Jun 17, 2020 18:49:09 UTC 4-band PlanetScope Scene (3 m) 100% area coverage	7 images
	Jun 16, 2020 18:33:43 UTC 4-band PlanetScope Scene (3 m) 100% area coverage	4 images
	Jun 15, 2020 18:23:49 UTC 4-band PlanetScope Scene (3 m) 100% area coverage	5 images
	Jun 14, 2020 18:39:29 UTC 4-band PlanetScope Scene (3 m) 100% area coverage	5 images
	Jun 13, 2020 18:34:20 UTC 4-band PlanetScope Scene (3 m) 100% area coverage	5 images
	Jun 12, 2020 18:11:49 UTC 4-band PlanetScope Scene (3 m) 100% area coverage	4 images
	Jun 11, 2020 18:40:22 UTC	

API Order Items (7)

San Francisco

Alcatraz Island Treasure Island

MARINA DISTRICT NORTH BEACH

PACIFIC HEIGHTS CHINATOWN

RICHMOND DISTRICT

HAIGHT-ASHBURY

COLE VALLEY

MISSION DISTRICT

Gate Park

University of California

37.79° N, 122.46° W

Q 13.38 11.58 m/pixel

1000 m

Weekly Base... Daily Imagery

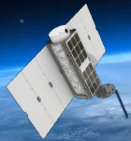
1 22 23 24 25 26 27 28 29 30 31 Jun 2020 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17





What would you do if you could
see daily change of _____?

Questions?
nasa_cs@federal.planet.com

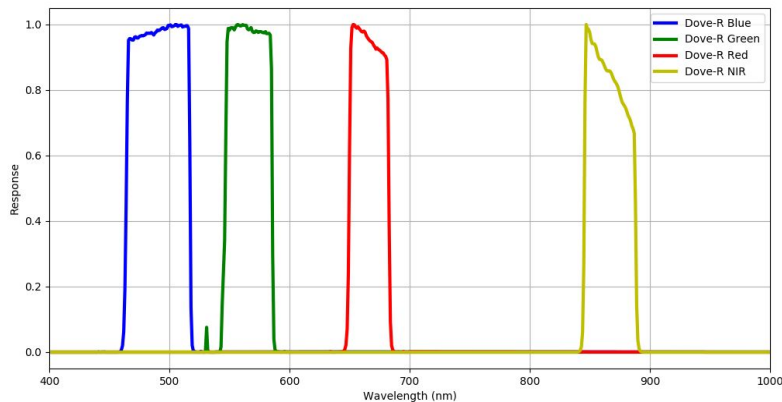


Backup Slides

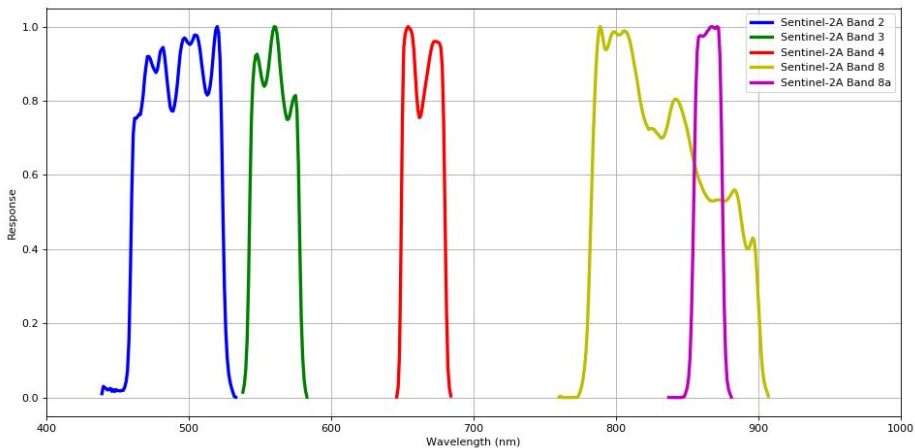


Dove-R relative spectral responses

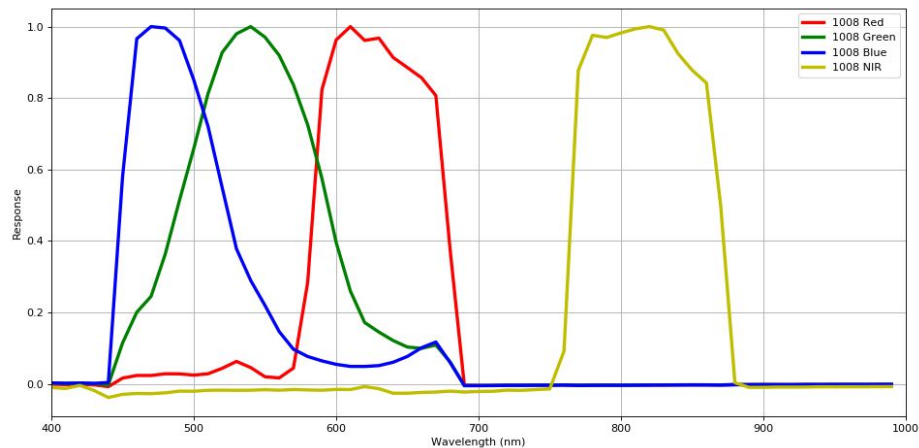
A Dove-R relative spectral response



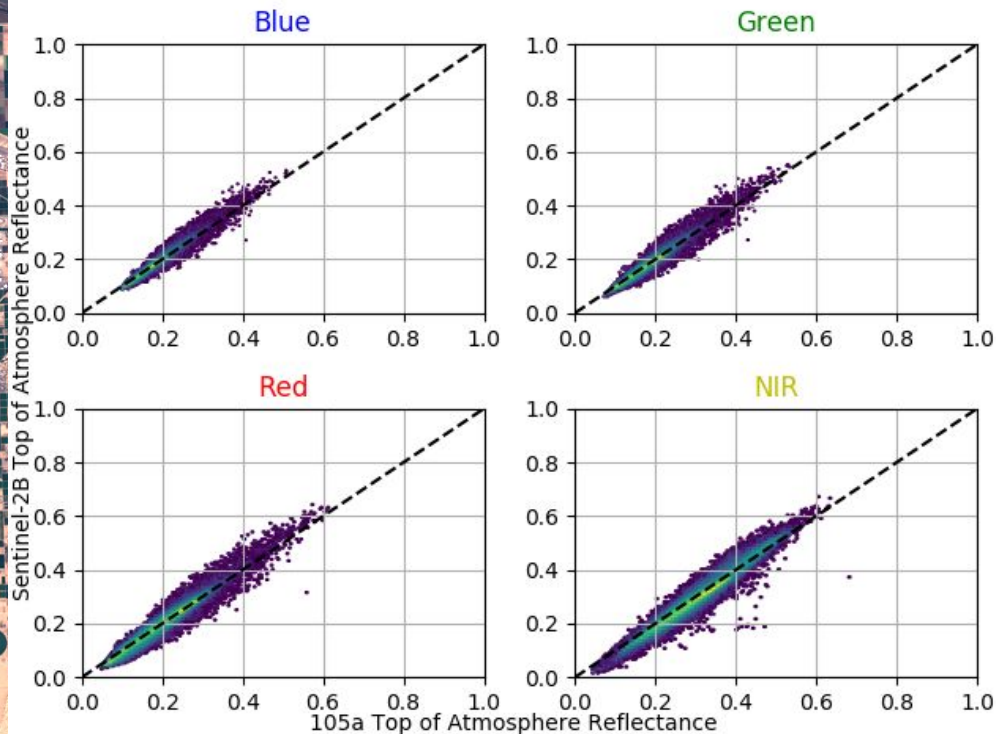
Sentinel 2A relative spectral response



A Dove Classic relative spectral response



Dove-R is natively interoperable with Sentinel-2



Sentinel-2

Dove-R





FROM DOVES TO SENTINEL THROUGH THE YEARS

