Introduction to the Planet Constellation of Satellites and Imagery

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Shark Bay, Australia

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

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 km²/day	6 million km²/day	500,000 km²/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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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 km^2 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

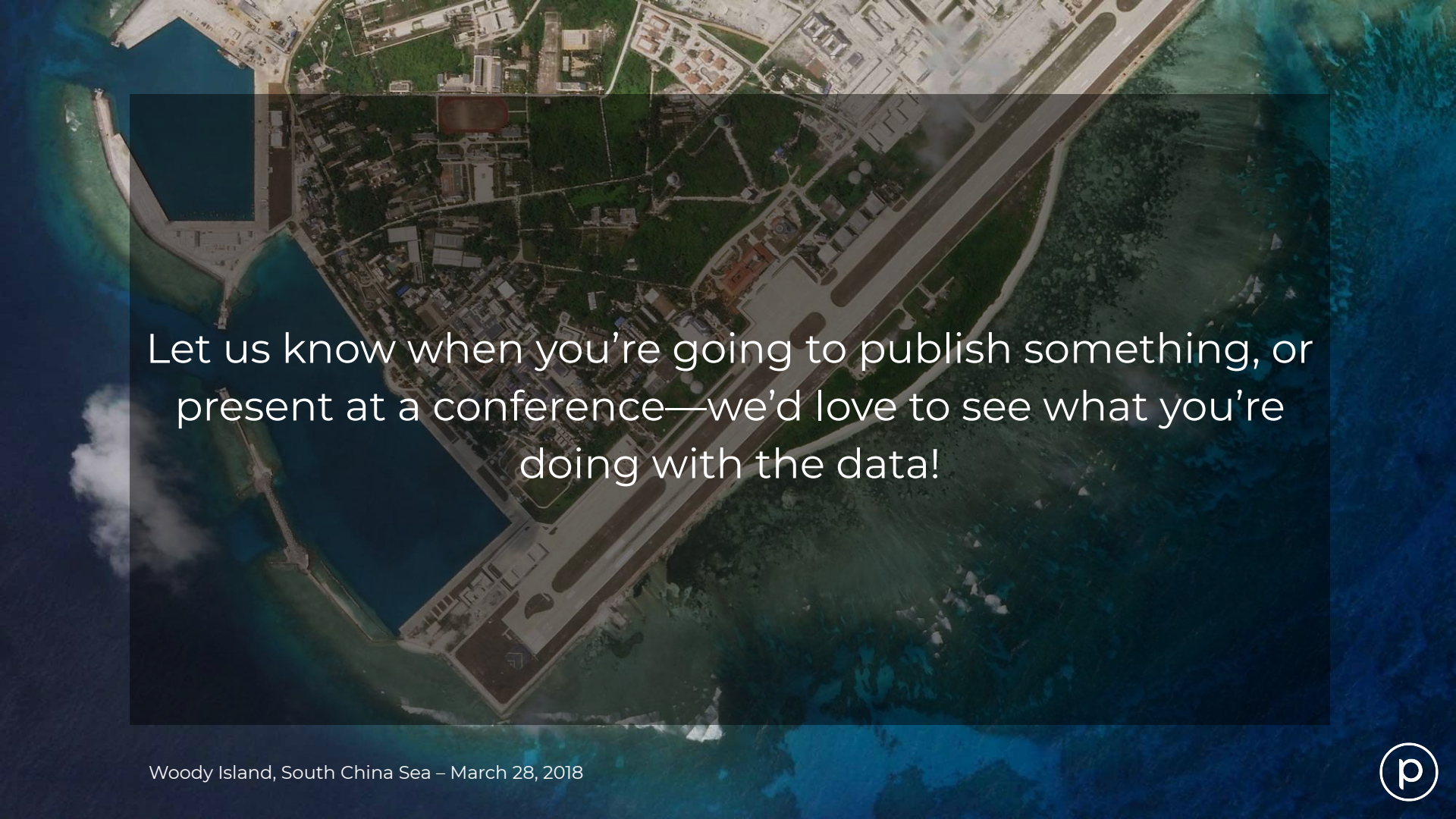
Planet Imagery Usage Terms

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.



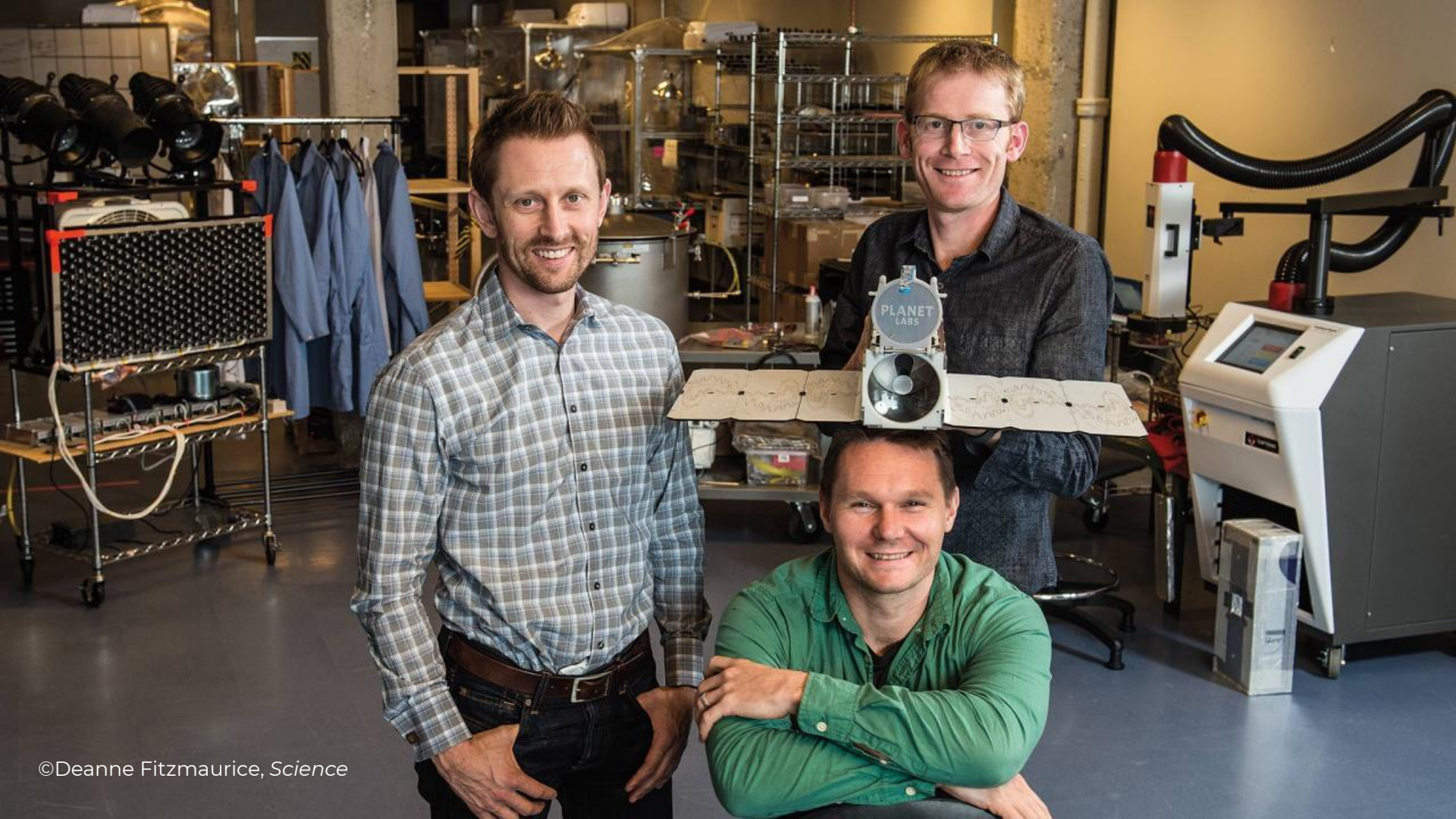
Let us know when you're going to publish something, or present at a conference—we'd love to see what you're doing with the data!

Woody Island, South China Sea – March 28, 2018

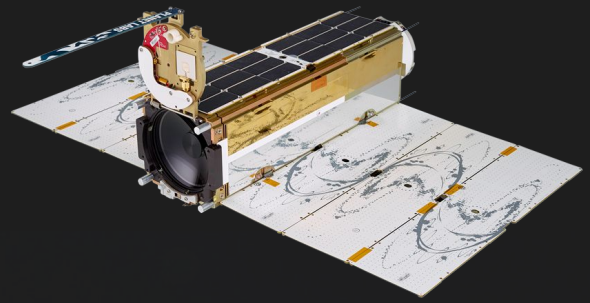
Scientific Advantages to Planet Data

- 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

PLANETSCOPE CONSTELLATION (DOVES)



©Deanne Fitzmaurice, *Science*

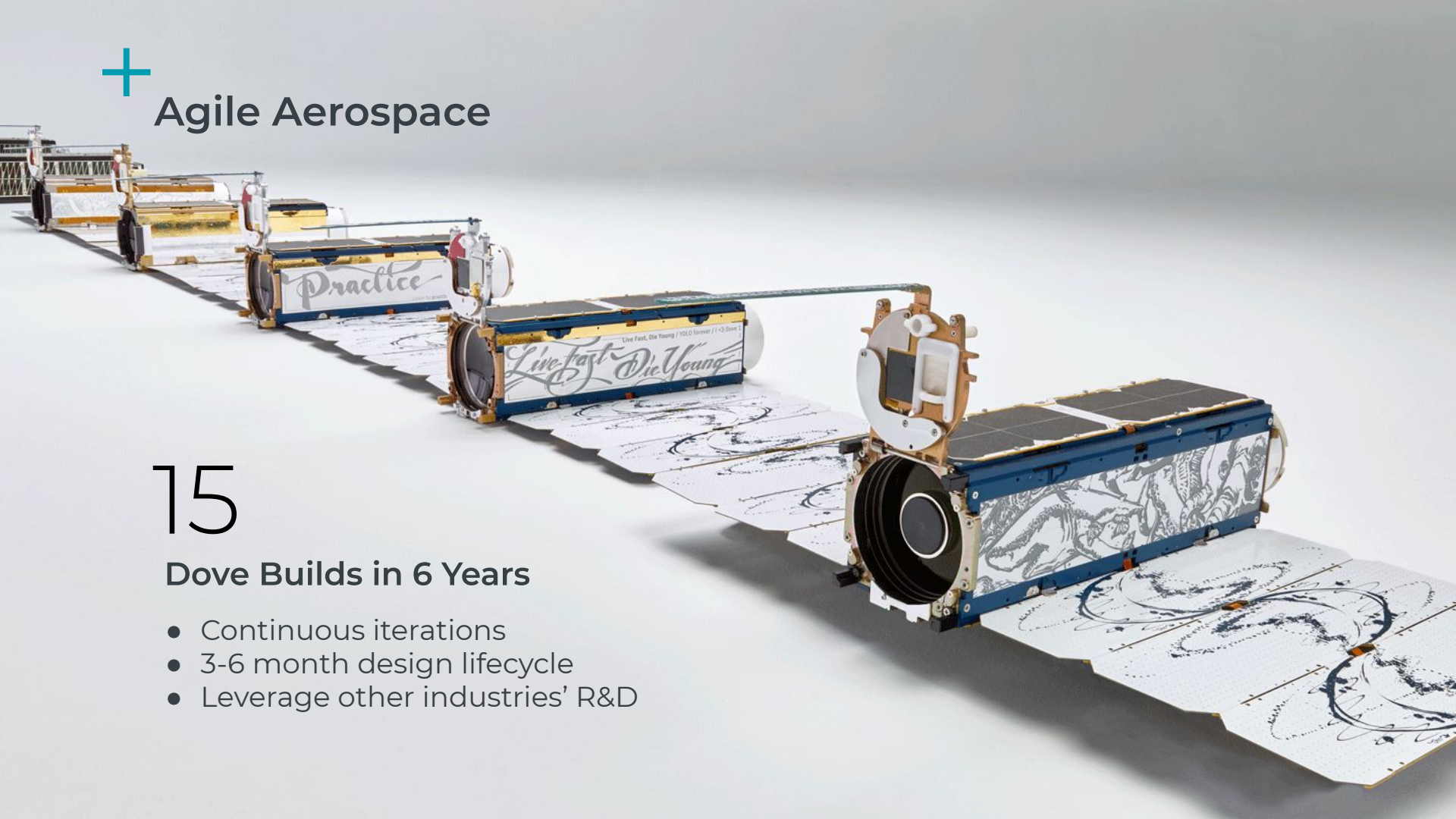


Doves

SATELLITES	GSD	CAPACITY
120+	**3.9 m**	**200 million km²**/day

ORBIT ALTITUDE	SPECTRAL BANDS
475 km	**RGB** and **NIR**

Agile Aerospace



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Dove Builds in 6 Years

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

Detect changes early with high frequency imagery

Constellation Overview: Planetscope

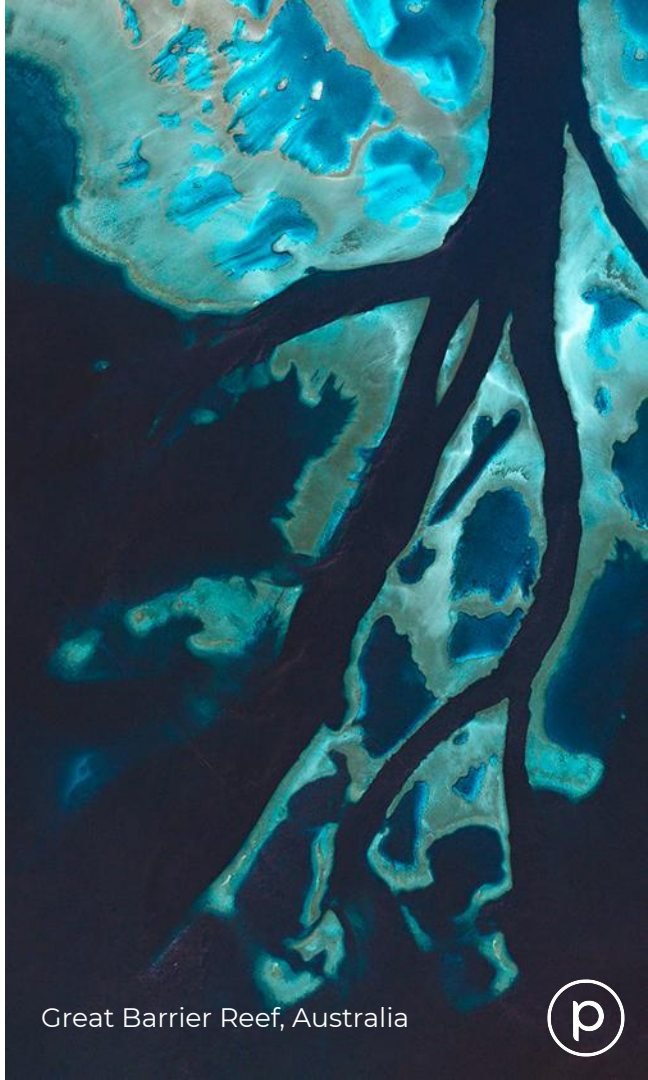
Mission Characteristics	Sun-synchronous Orbit		
Instrument	PS2 [Dove]	PS2.SD [Dove-R]	PSB.SD [SuperDove]
Orbit Altitude (reference)	475 km (~98° inclination)		
Max/Min Latitude Coverage	±81.5° (depending on season)		
Equator Crossing Time	9:30 - 11:30 am (local solar time)		
Sensor Type	Four-band frame 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 km²		
Revisit Time	Daily at nadir		
Image Capture Capacity	200 million km²/day		
Camera Dynamic Range	12-bit		

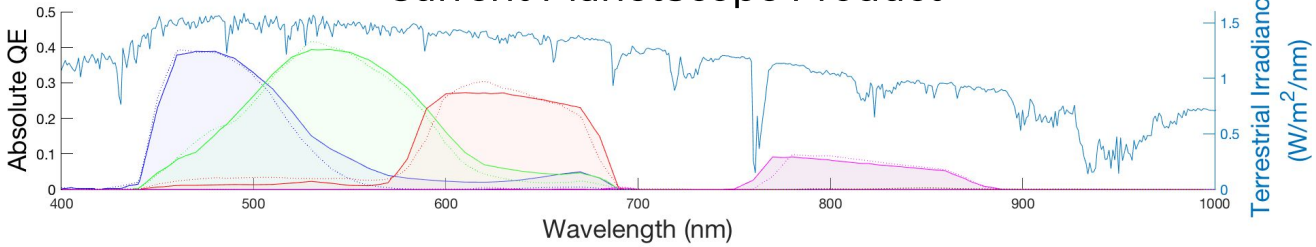
Dove-R provides significant improvements to spectral resolution, image sharpness, and dynamic range over the older Dove satellites.

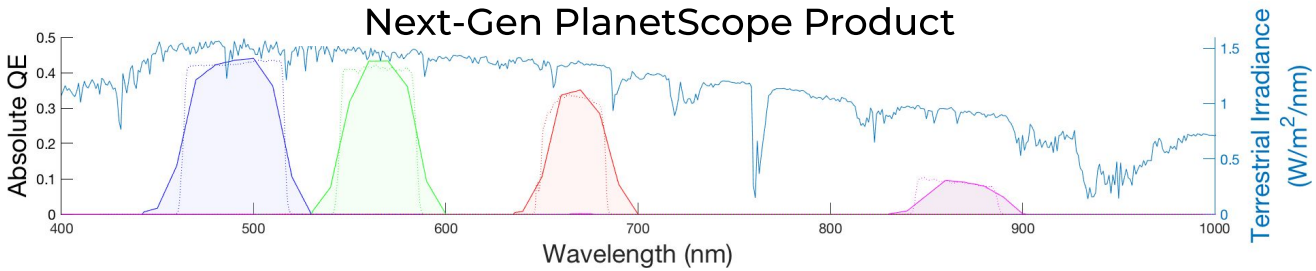
What is “next generation PlanetScope” imagery?

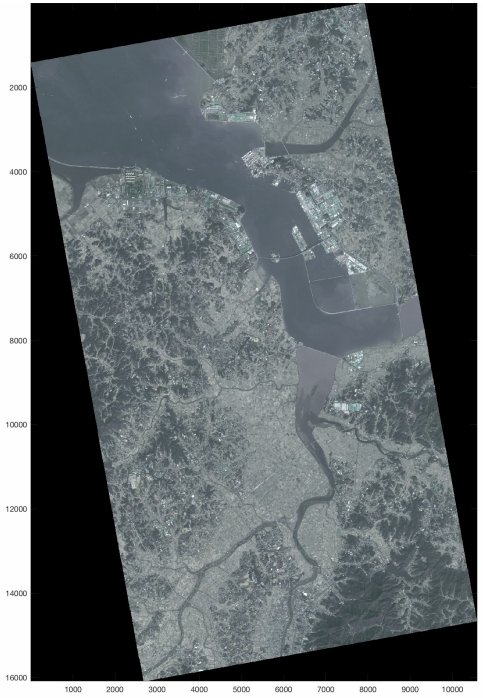
This refers to improvements made to our flagship PlanetScope imagery on the sensor and hardware:

- **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

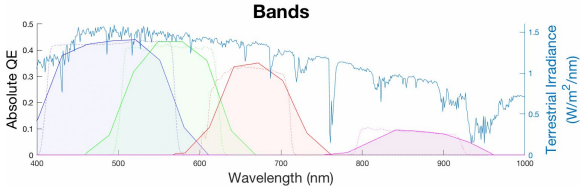








- Richer color
- Aligned with Sentinel-2 bands
- Improved land cover classification
- Improved vegetation stress detection
- More accurate surface reflectance



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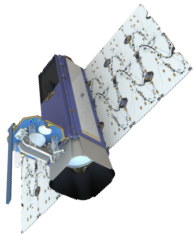
DOVE-R - MARCH 29, 2019 CANADA

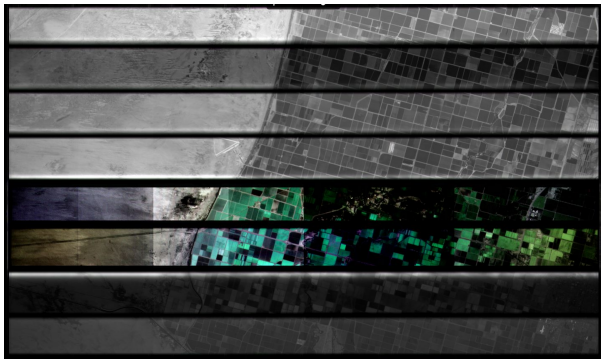
DOVE-R - SEPTEMBER 4, 2019 GREENLAND

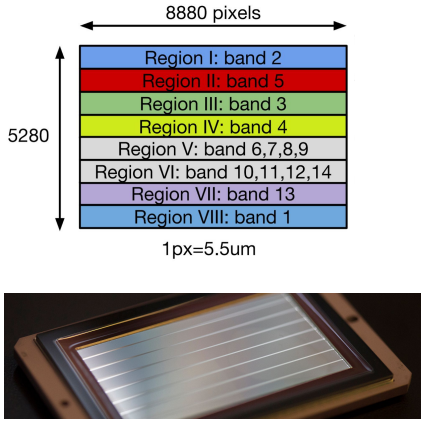
SuperDove: More bands, more science!

SUPERDOVE



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





SUPERDOVE MARCH 11, BEYARJMAND, بخش بیارجمند, IRAN

Planet Dove Satellite

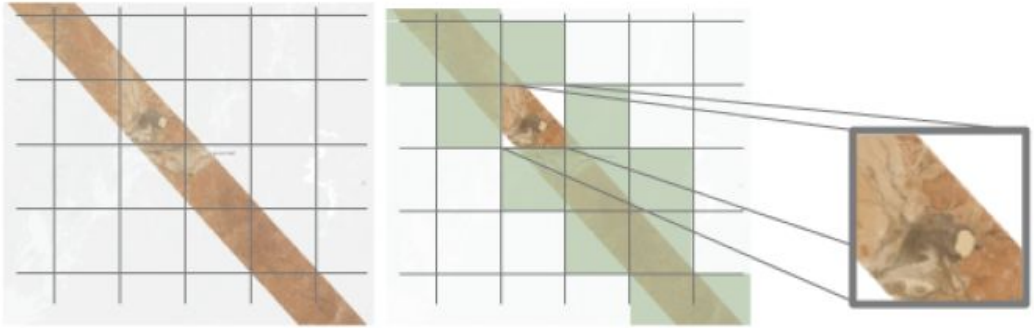
- Always-on, broad-area monitoring
- 3 meter resolution
- RGB and NIR bands

PlanetScope Data Products

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

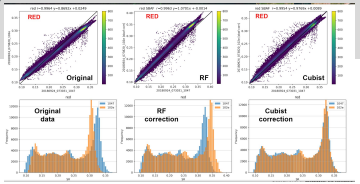
PlanetScope Ortho Tiles

Striped Scenes Collection | Single RGB + IR Striped Scene | Scenes Strip



UTM Grid Overlay | PlanetScope Tiled Product | Single PlanetScope Tile

Forward- and Backwards-Compatibility



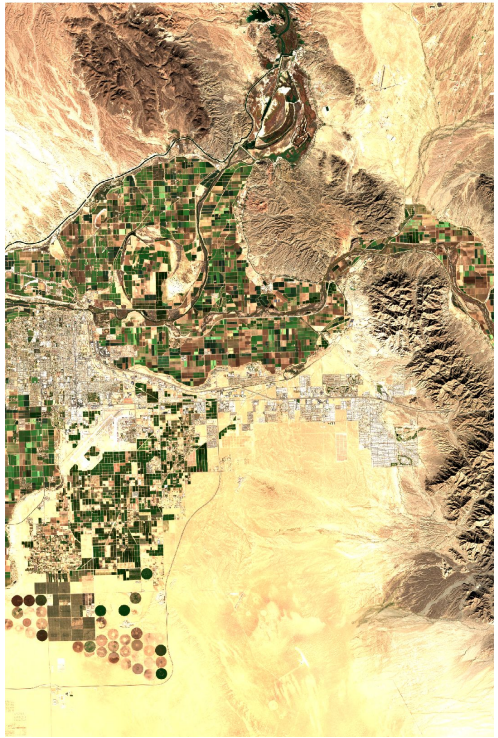
Sentinel-2

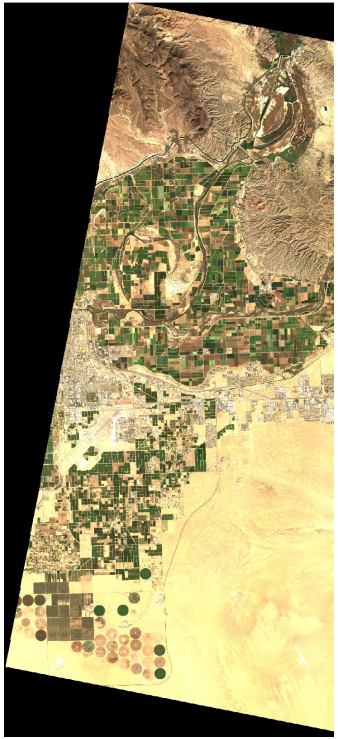
Already Interoperable!

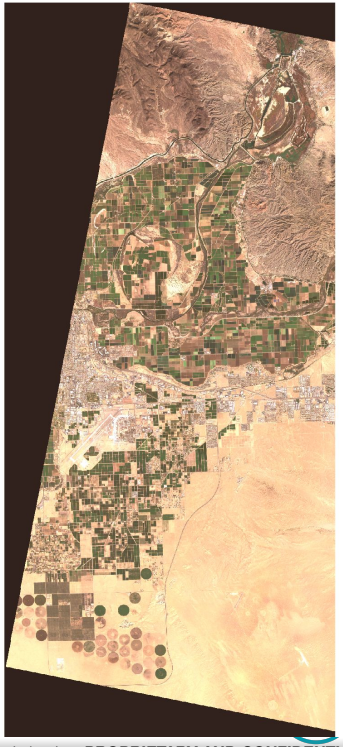
Dove-R (105A)

Dove (1002)

Dove-R (105A) - Monitoring







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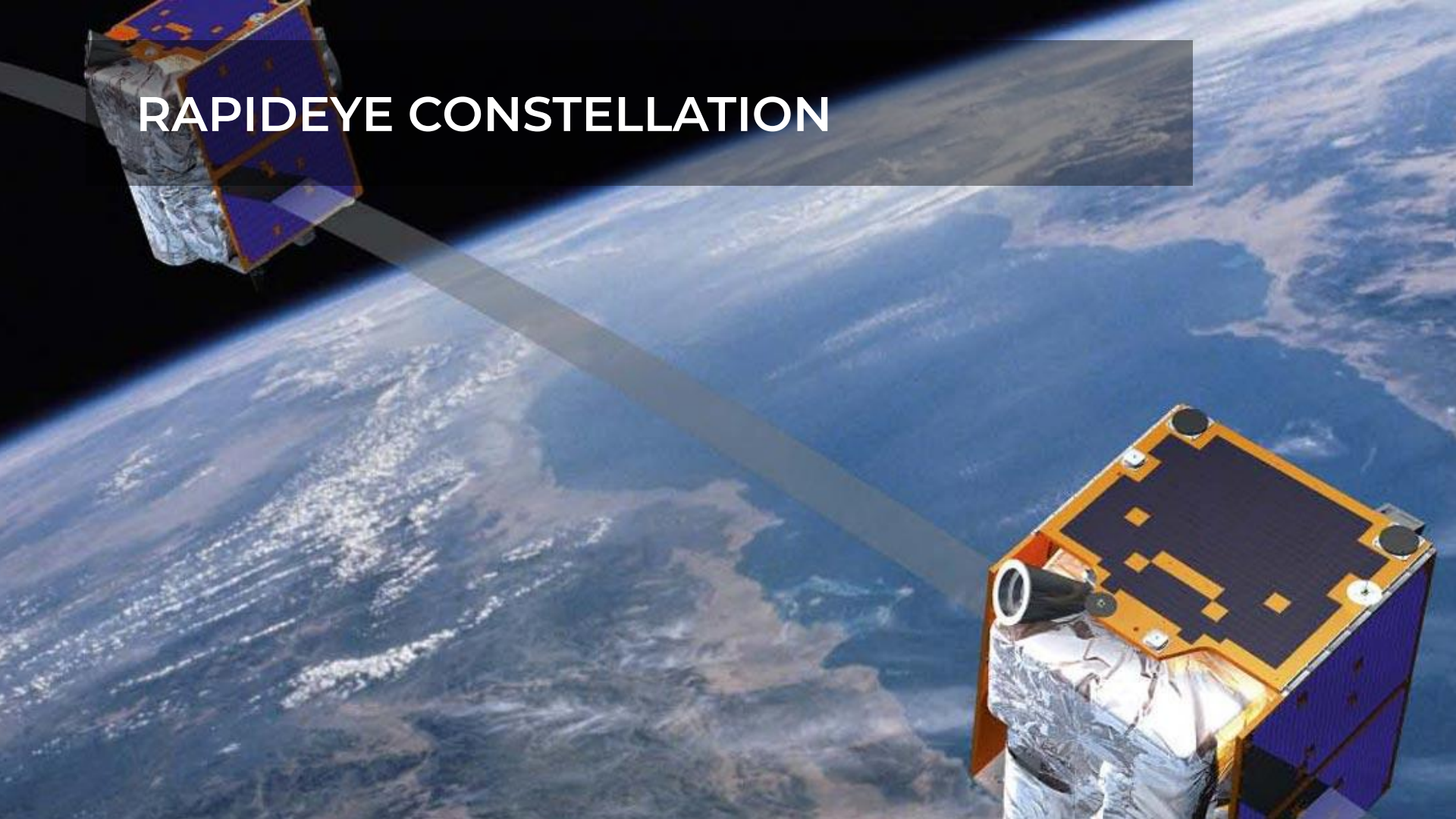
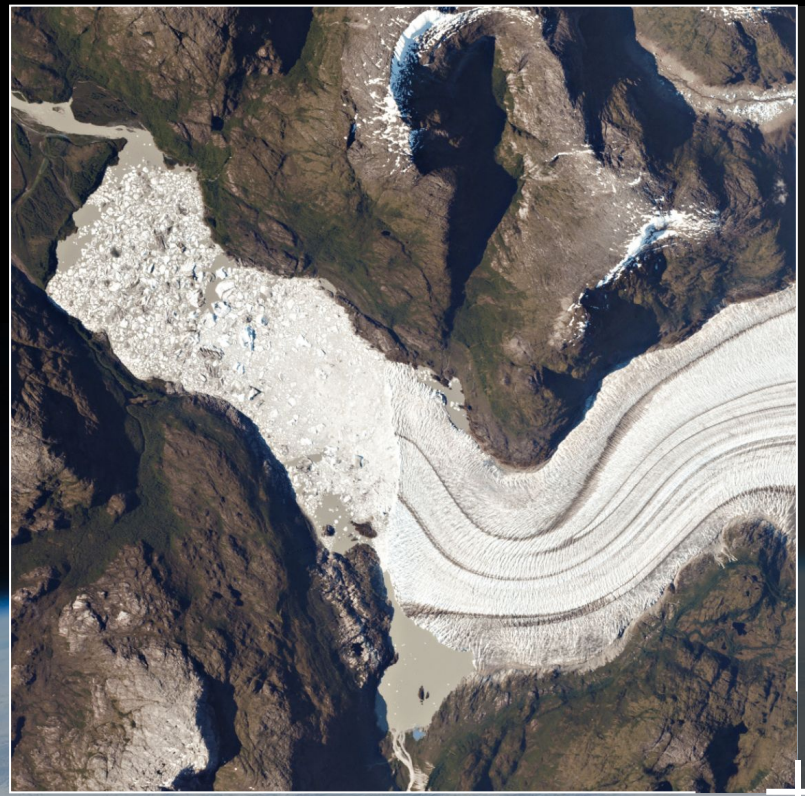
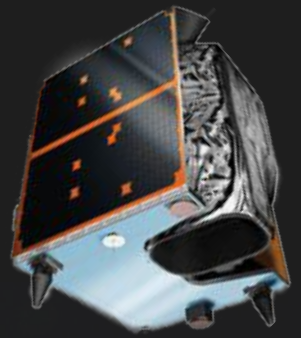
RAPIDEYE CONSTELLATION







RapidEye

SATELLITES	GSD	CAPACITY
5	**6.5 m**	**6 million km²**/day

ORBIT ALTITUDE	SPECTRAL BANDS
630 km	**RGB, Red Edge** and **NIR**

RETIRED

Ra idE

SATELLITES	GSD	CAPACITY
5	**6.5 m**	**6 million km²**/day

ORBIT ALTITUDE	SPECTRAL BANDS
630 km	**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 km²/day
Camera Dynamic Range	12-bit

RapidEye Data Products

Basic Scene	Ortho Tile
Scaled Top of Atmosphere Radiance (at sensor) Radiometrically + sensor corrected No atmospheric or terrain correction Not map projected Designed for users with advanced image processing capabilities	25 x 25 km tiles comprised of consecutively acquired scenes Orthorectified Radiometrically, sensor, and geometrically corrected Scaled Top of Atmosphere Radiance (at sensor) product -**Visual (8-bit)** 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.kaulfus@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
May 6 11-12pm EST	Introduction to the Planet Constellation of Satellites and Imagery	This presentation will give an overview of Planet's constellations and image data products, along with highlights of scientific applications from across the research community.
May 13 11-12pm EST	Introduction to Planet Explorer	Planet Explorer is an online tool that can be used to search Planet's catalog of imagery, view metadata, and download full-resolution imagery. This presentation will include an in-depth explanation on how Planet Explorer can be used to search for and download imagery. https://www.planet.com/explorer
May 20 11-12pm EST	Office Hours	General Q&A
May 27 11-1pm EST	Introduction to the Data API	Planet's Data API allows users to search for and download images. It supports batch activation and download and can be a powerful tool for working with a lot of imagery. This presentation will cover set-up and go through a list of common commands to search for and download imagery.

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

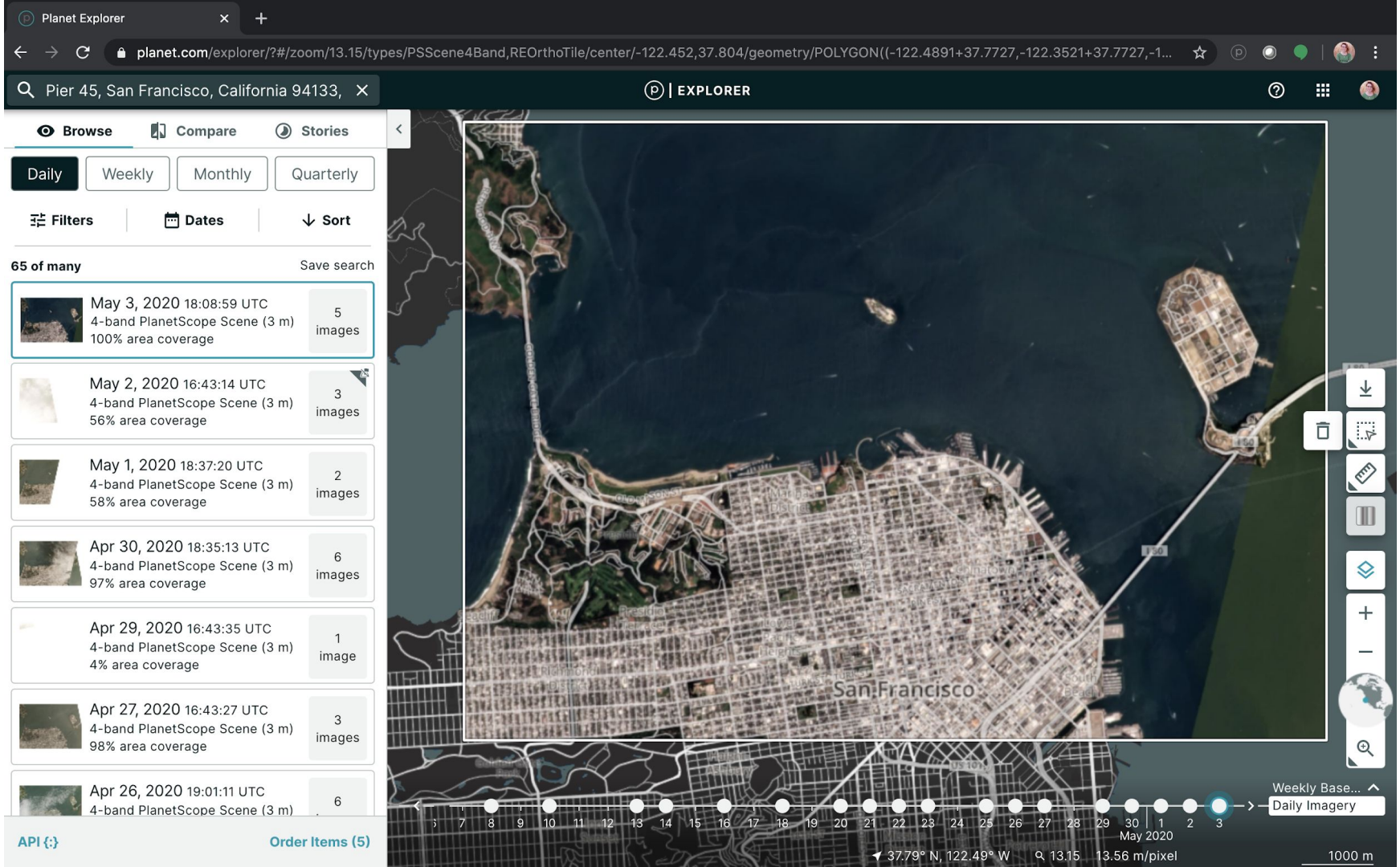
Best for: QGIS users; more advanced browsing; small & large downloads
https://developers.planet.com/docs/integrations/qgis/

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/


Planet Explorer
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EXPLORER
Browse
Compare
Stories
Daily
Weekly
Monthly
Quarterly
Filters
Dates
Sort
65 of many
Save search
May 3, 2020 18:08:59 UTC
4-band PlanetScope Scene (3 m)
100% area coverage
5 images
May 2, 2020 16:43:14 UTC
4-band PlanetScope Scene (3 m)
56% area coverage
3 images
May 1, 2020 18:37:20 UTC
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Apr 30, 2020 18:35:13 UTC
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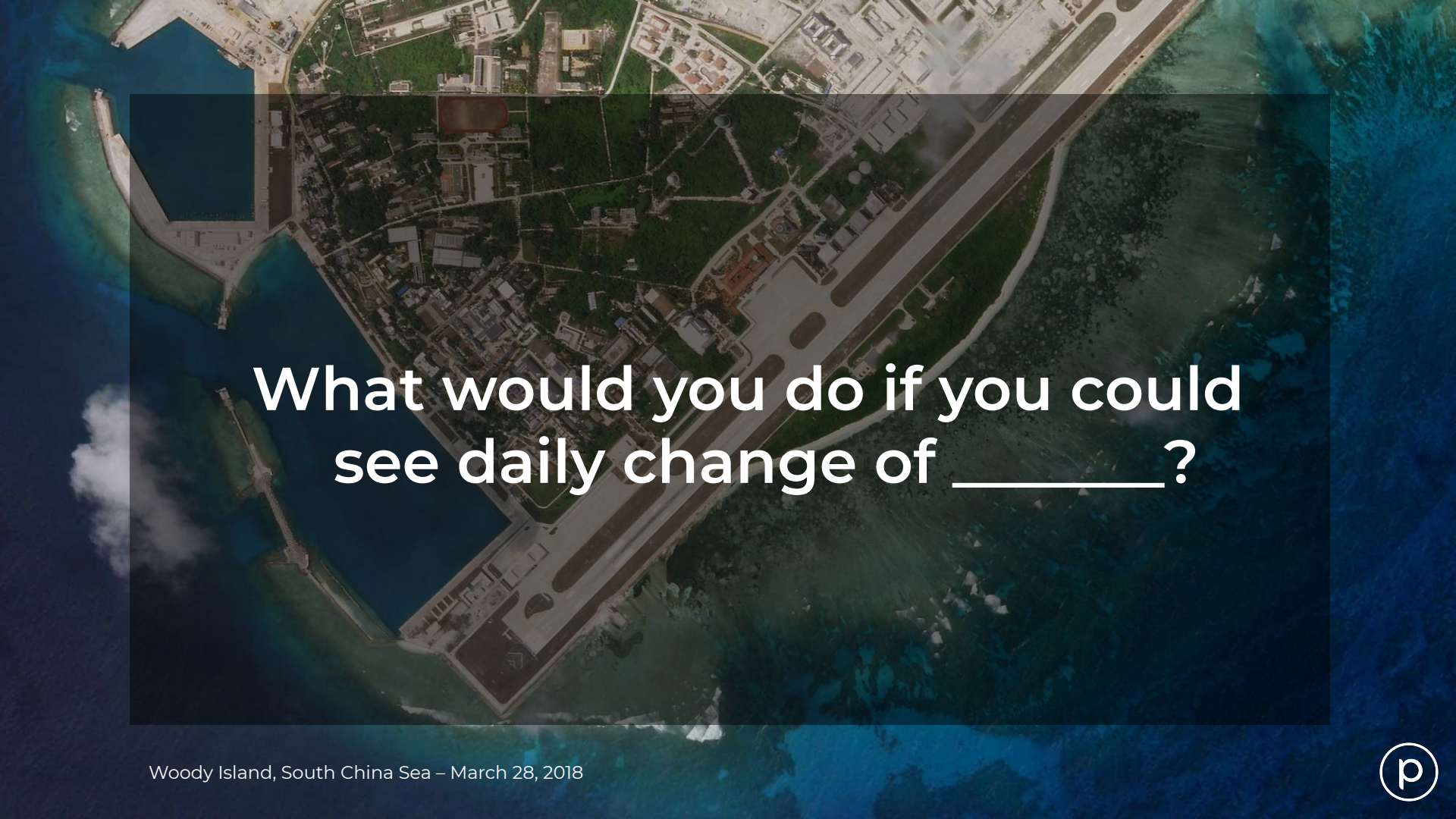
97% area coverage
6 images
Apr 29, 2020 16:43:35 UTC
4-band PlanetScope Scene (3 m)
4% area coverage
1 image
Apr 27, 2020 16:43:27 UTC
4-band PlanetScope Scene (3 m)
98% area coverage
3 images
Apr 26, 2020 19:01:11 UTC
4-band PlanetScope Scene (3 m)
6
API {:}
Order Items (5)
San Francisco
Weekly Base...
Daily Imagery
May 2020
37.79° N, 122.49° W
13.15
13.56 m/pixel
1000 m

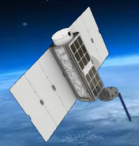


What would you do if you could see daily change of _____?

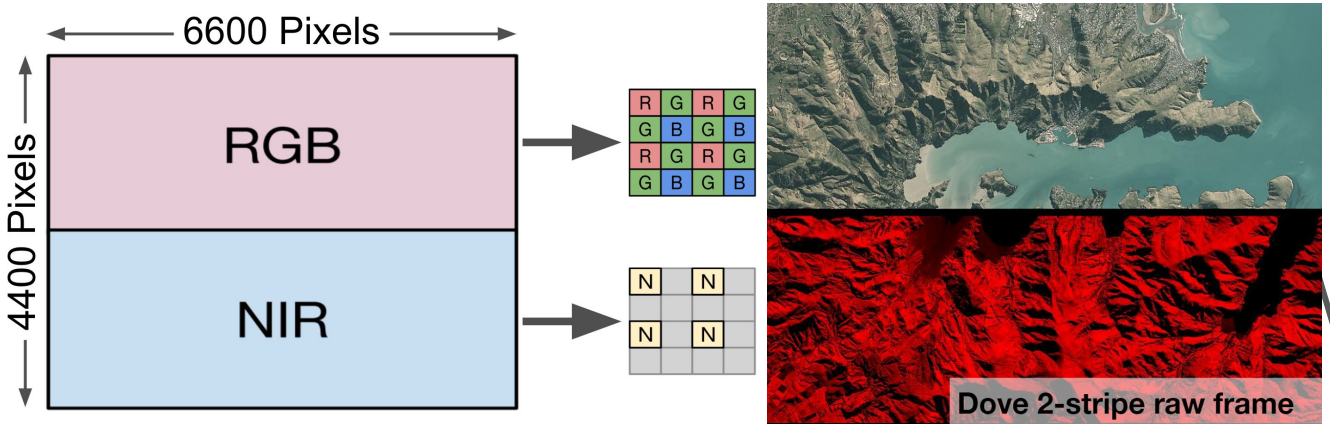
Woody Island, South China Sea – March 28, 2018

Questions?
nasa_cs@federal.planet.com

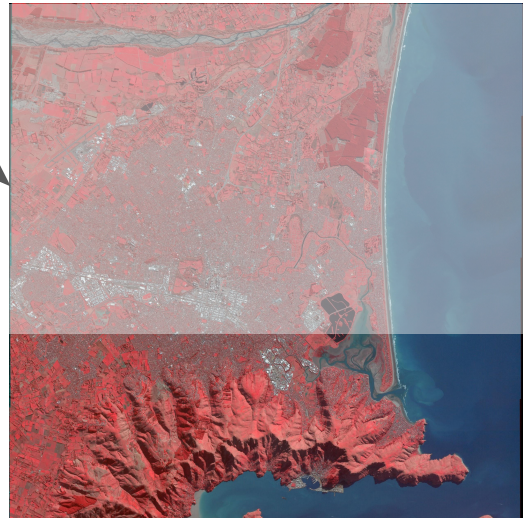
Backup Slides



Dove Classic sensor layout



orthorectification



2-stripe half-frame composite

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	

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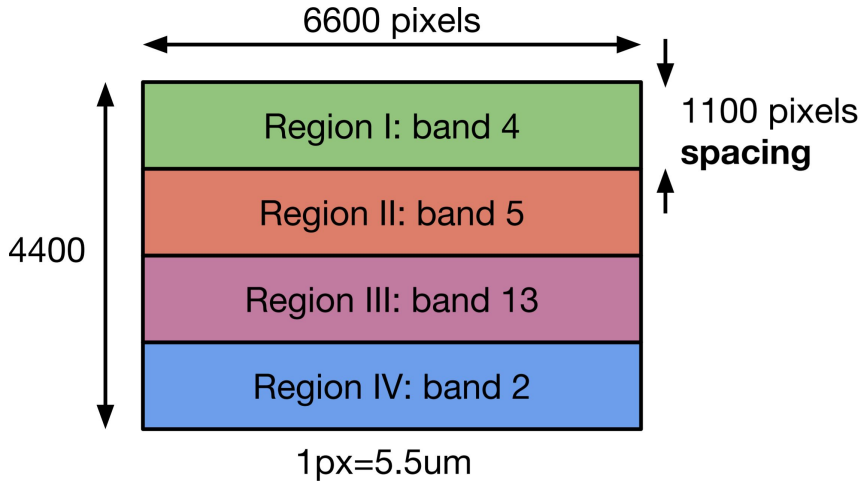
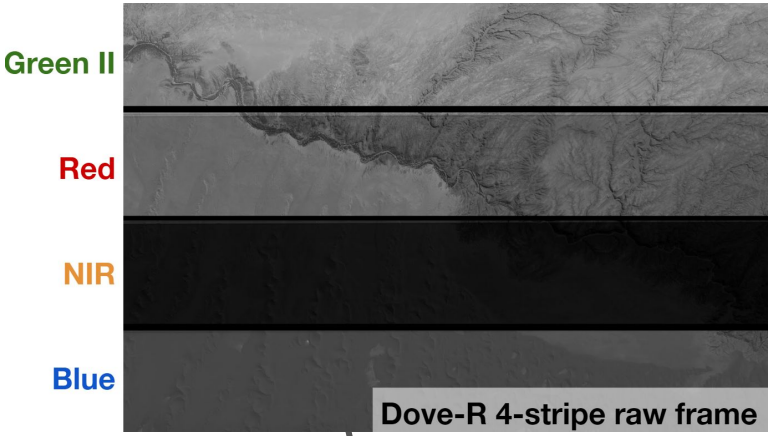
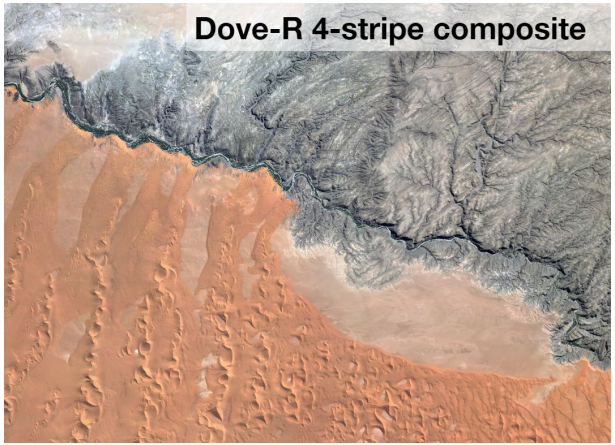
Dove-R continuity sensor layout





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

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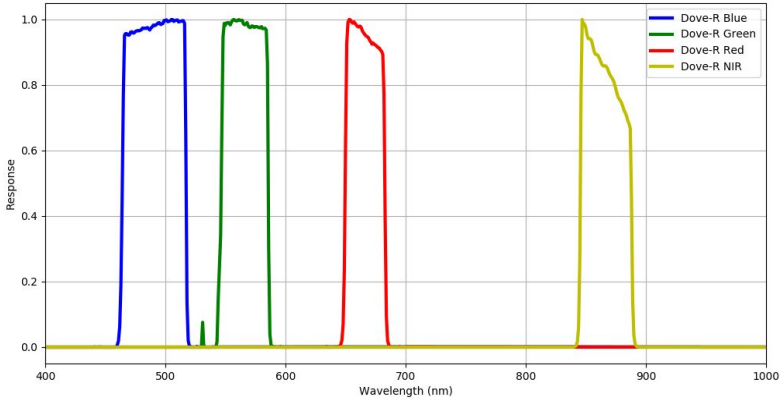
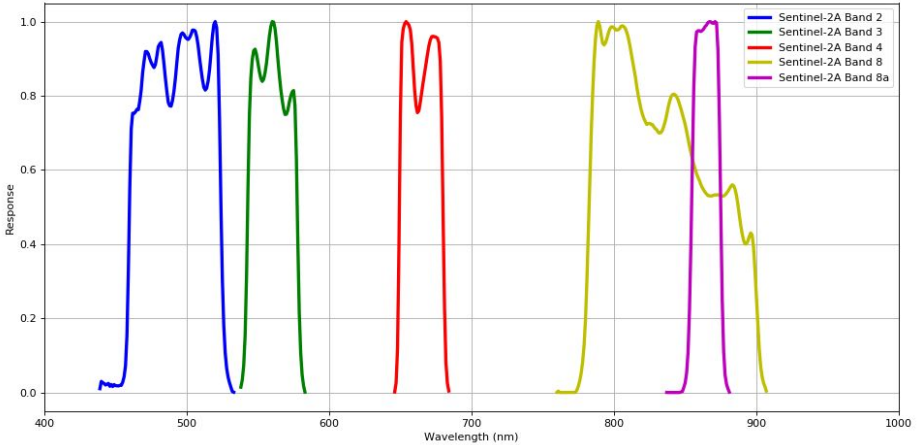
Dove-R relative spectral responses

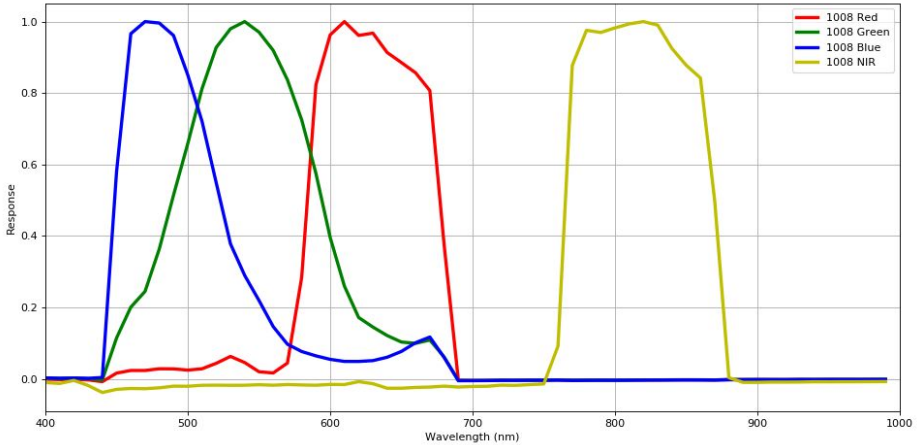
A Dove-R relative spectral response



Sentinel 2A relative spectral response



A Dove Classic relative spectral response



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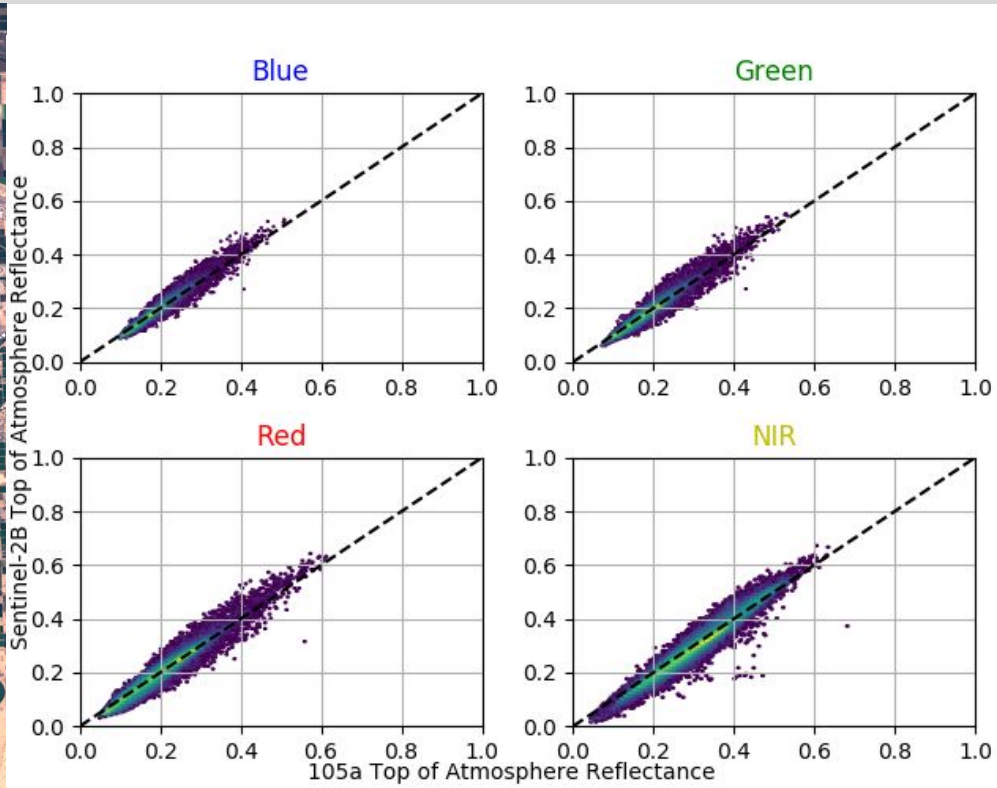
Dove-R is natively interoperable with Sentinel-2



Sentinel-2

Dove-R

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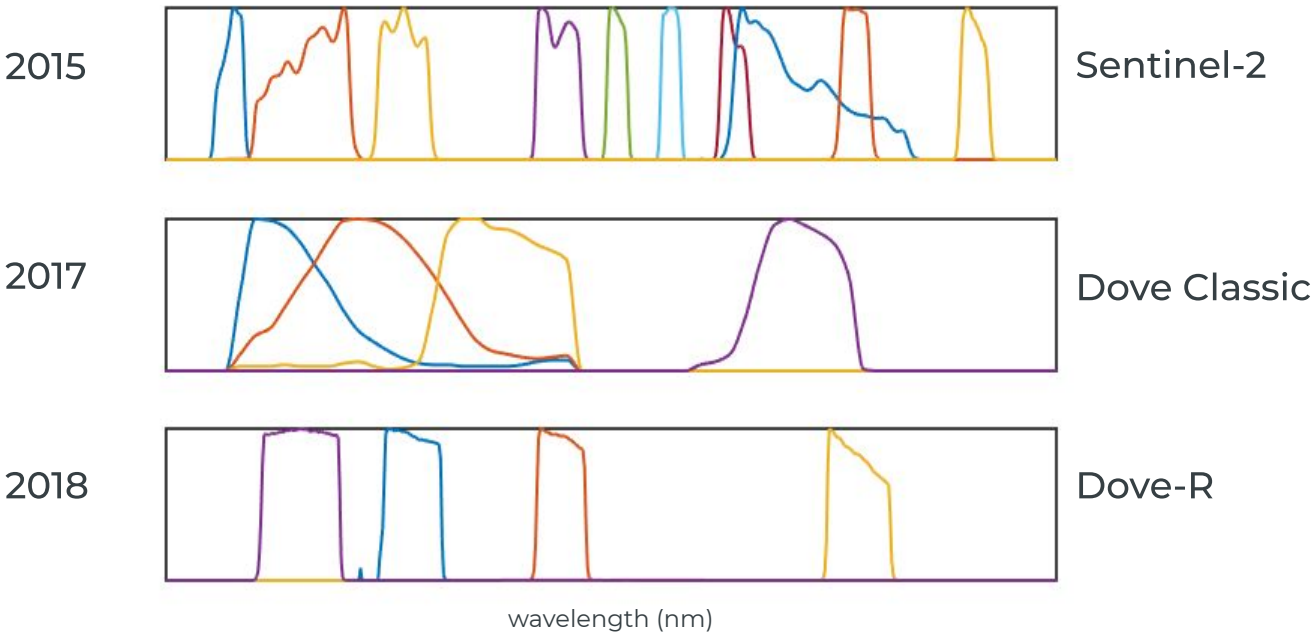
FROM DOVES TO SENTINEL THROUGH THE YEARS



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