Pléiades 1A&1B – SPOT 6&7

A new era for constellation services

Alfonso Casado –Director Comercial
Astrium GEO-Information Services

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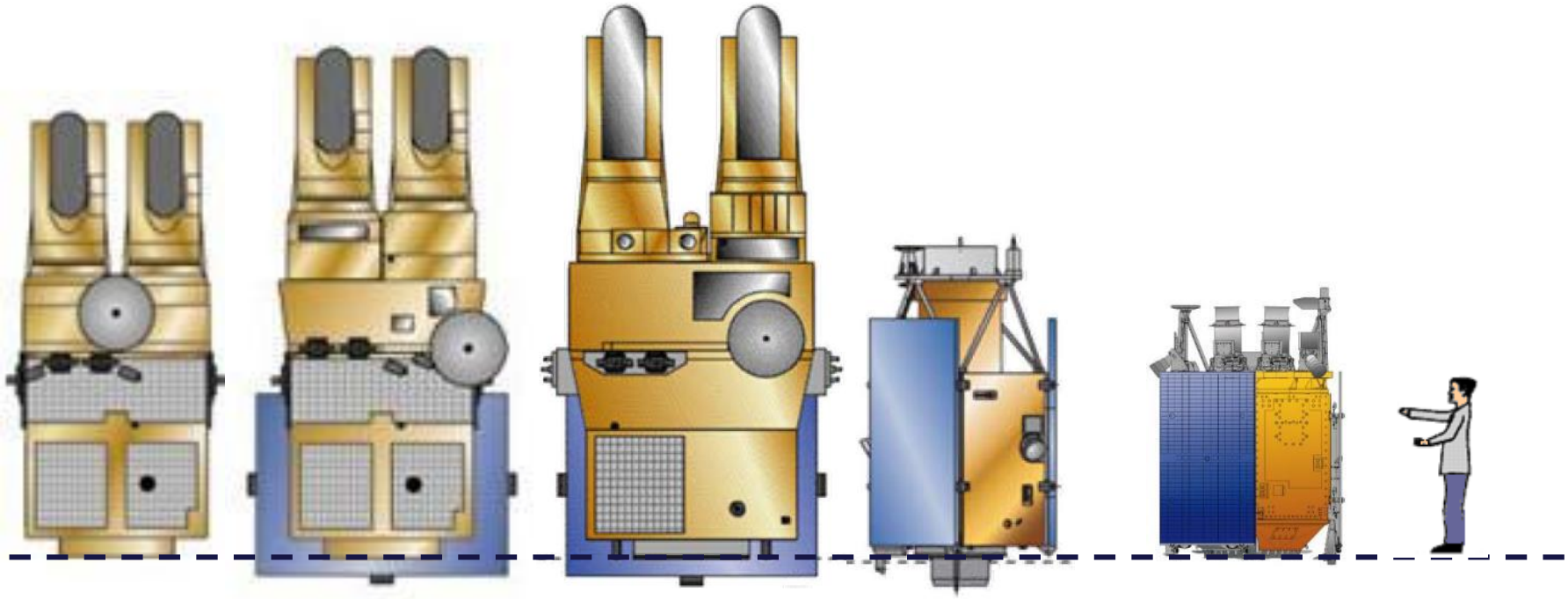
A technical evolution



SPOT 1,2,3	SPOT 4	SPOT 5	Pléiades	SPOT 6, SPOT 7
1800 kg	2760 kg	3000 kg	1000 kg	712 kg
1986,1990,1993	1998	2002	2011,2013	2012, 2014

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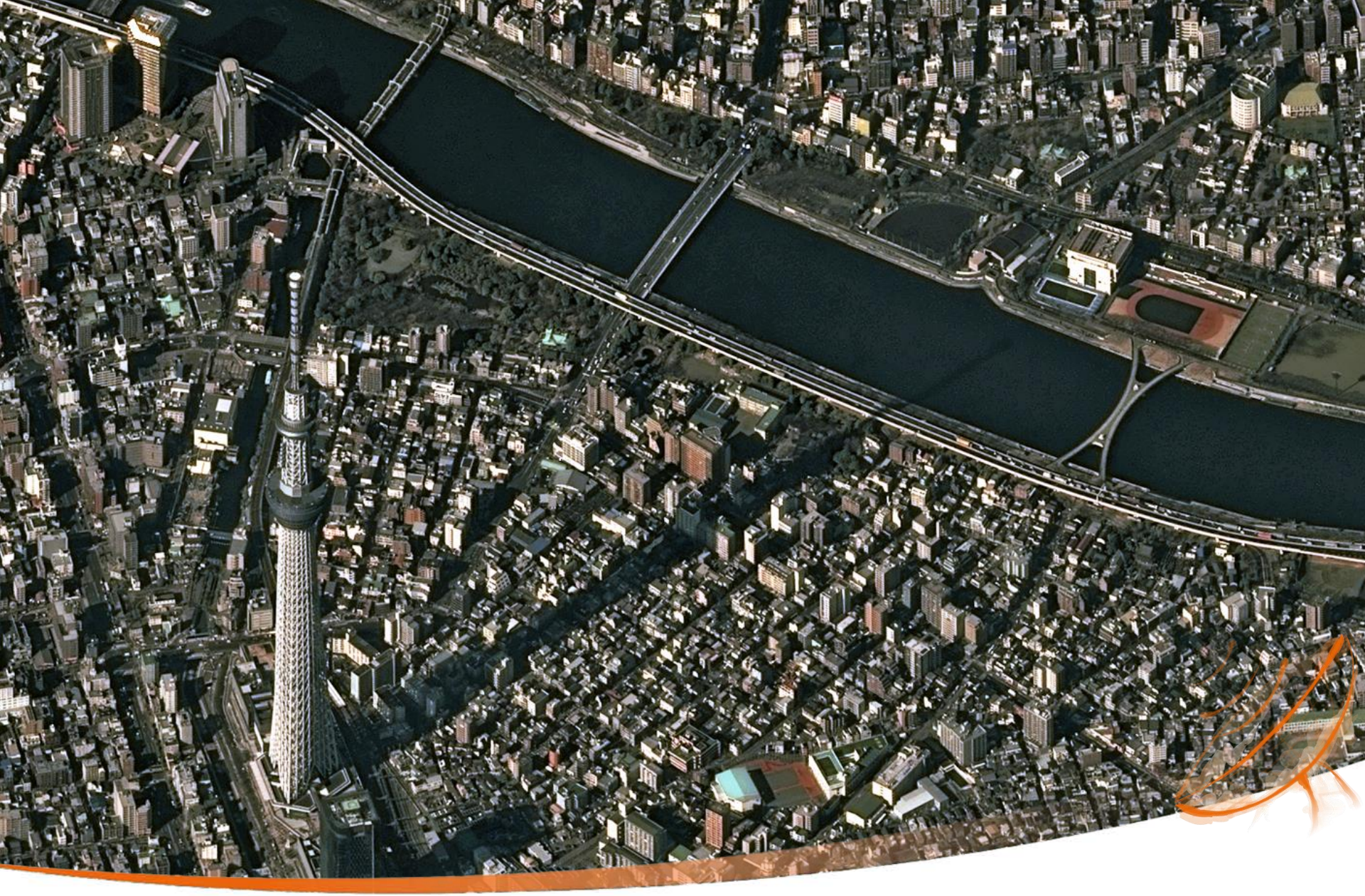

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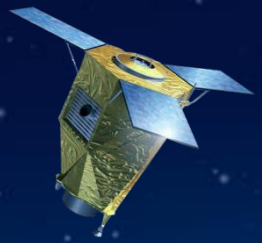
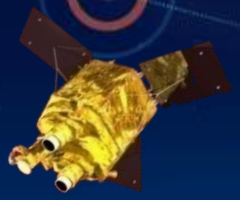




2011

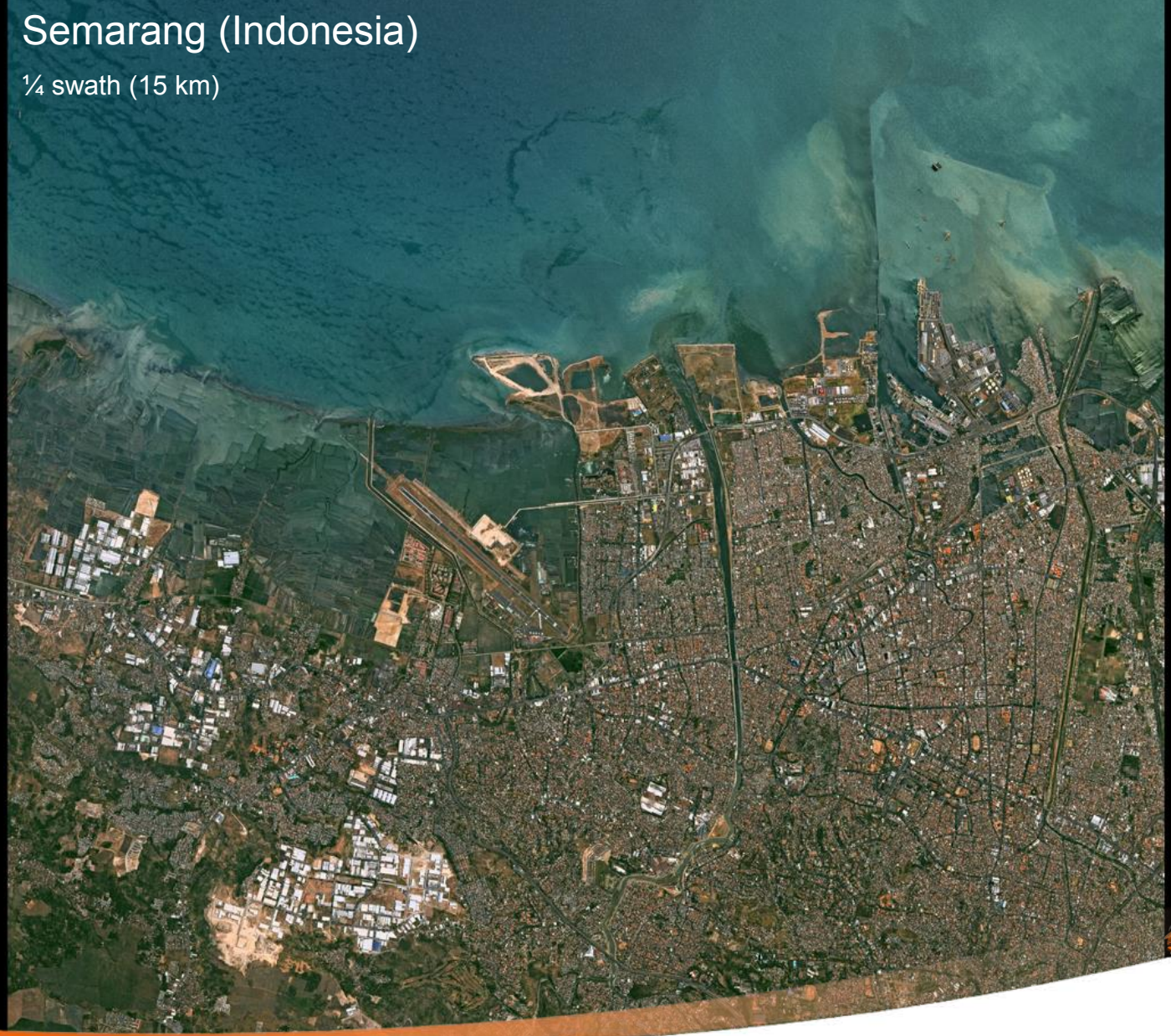
Pléiades 1A
50cm

2012

SPOT 6
1.5m

Semarang (Indonesia)

¼ swath (15 km)



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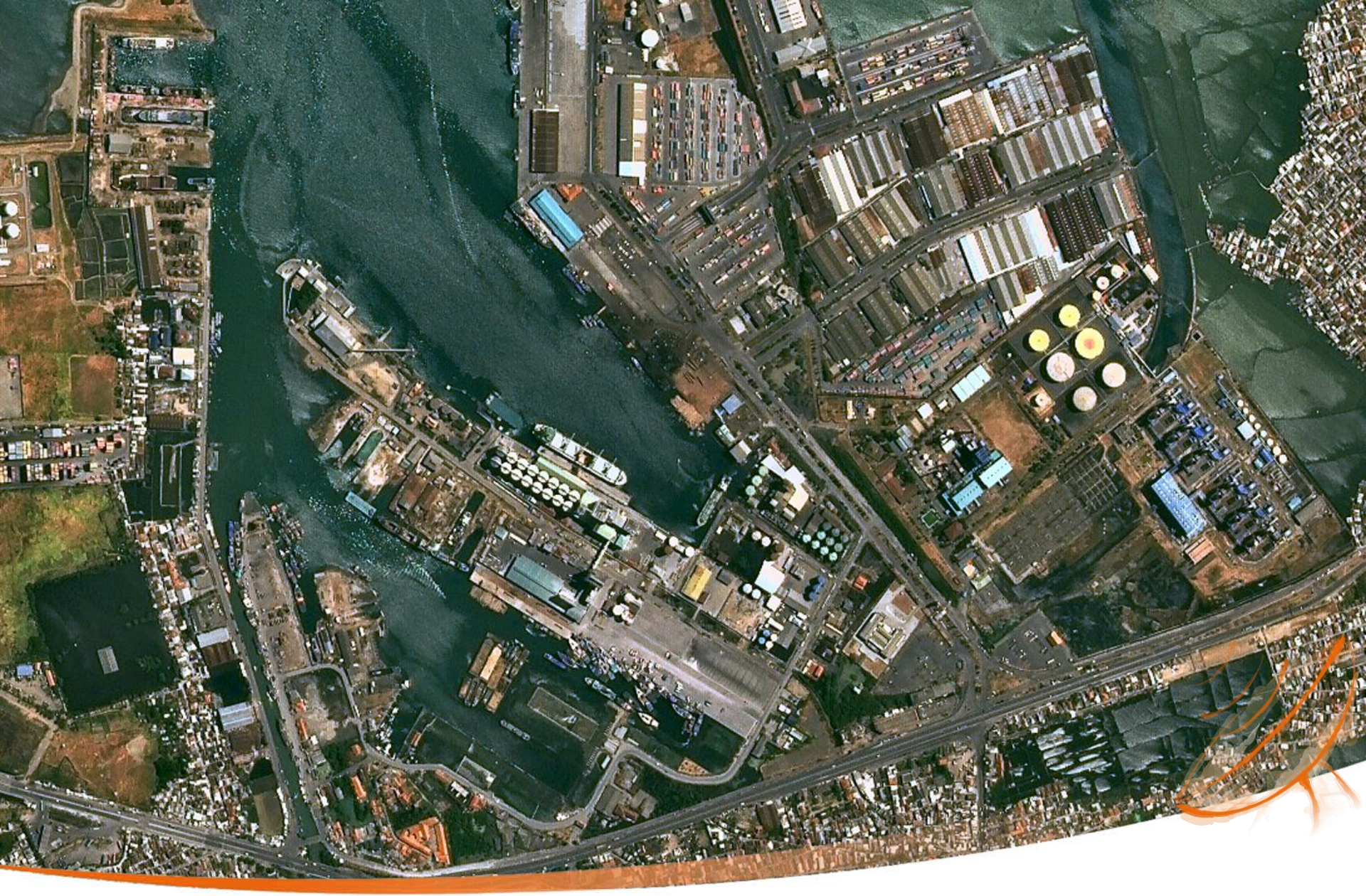

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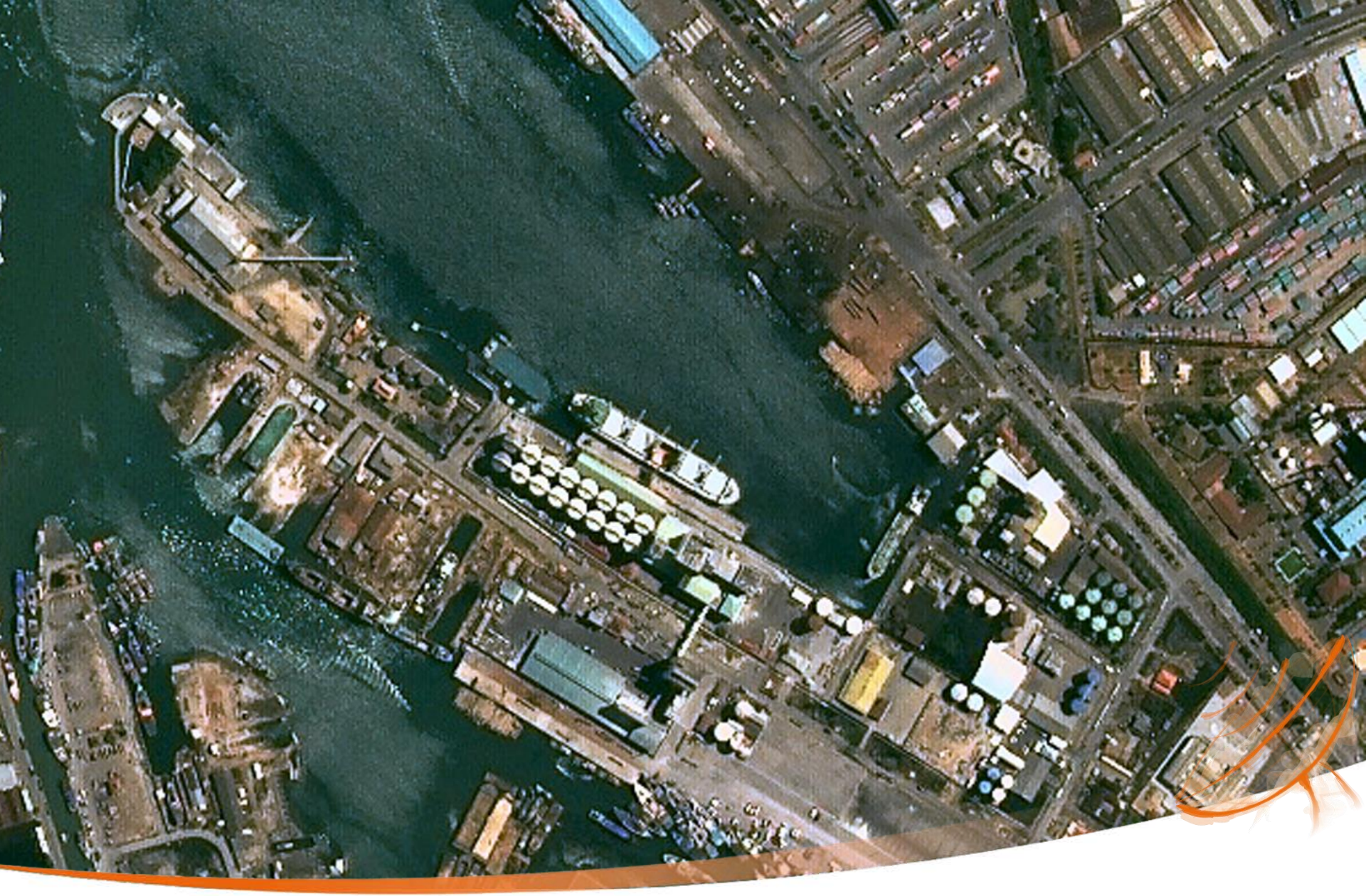

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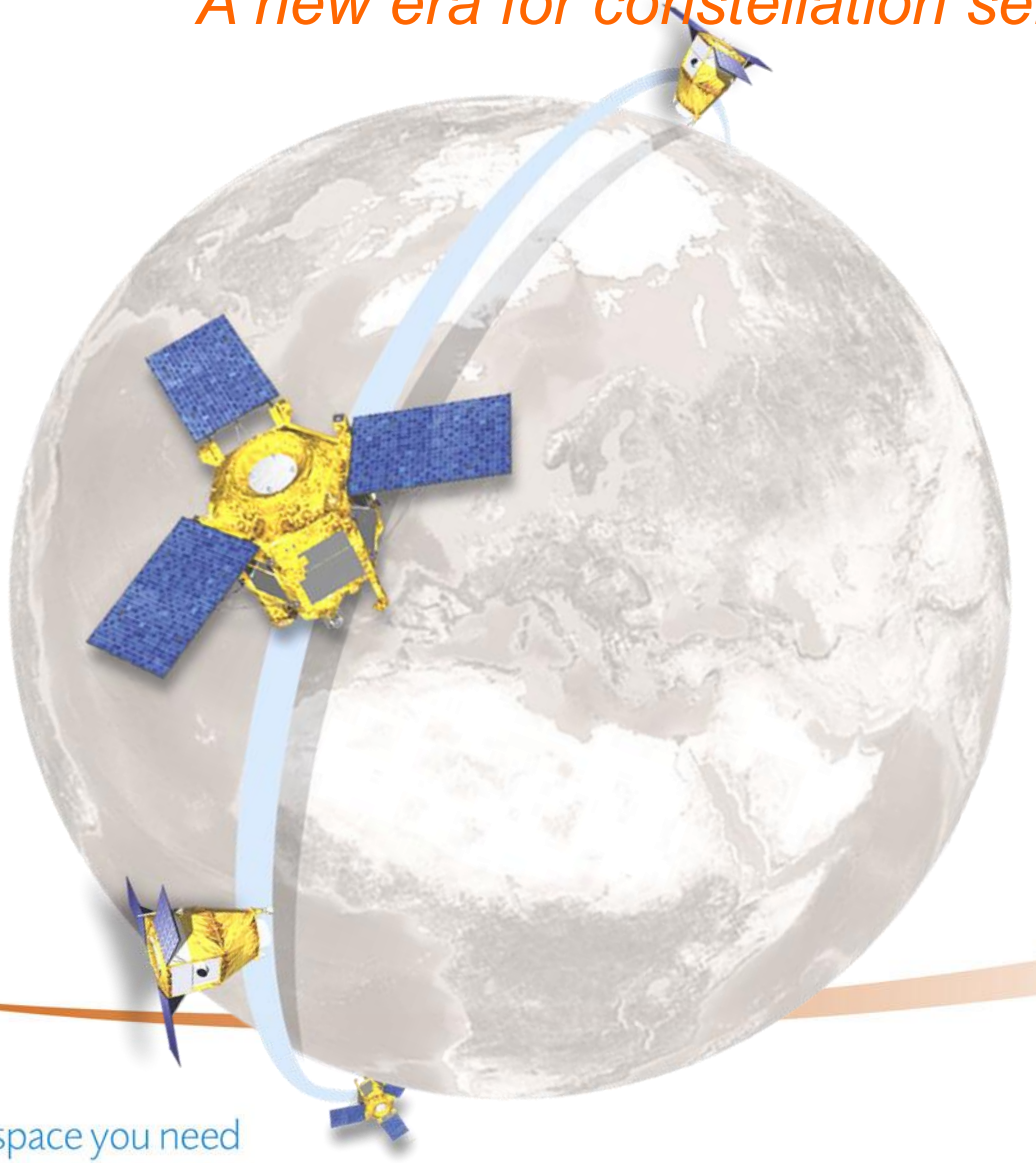
2011
Pléiades 1A
50cm
2012
SPOT 6
1.5m
2012
Pléiades 1B
50cm
2014
SPOT 7
1.5m

Pléiades 1A&1B, SPOT 6&7

A new era for constellation services



Multi-scale

Reactive

Available

Accurate & Multiscale

Sensors

Bands	1 panchromatic 4 multispectral
12 bits	Dynamic range per pixel at acquisition
Color Bundle	Standard mode acquisition

Products

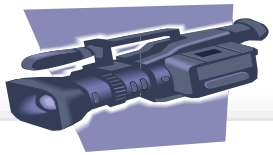
50cm	Pléiades
1.5m	Spot 6 & 7
Ortho rectified	Fully automatic processing, incl monopass mosaics for Pléiades
Per sq.km	Pléiades, SPOT 6 & 7

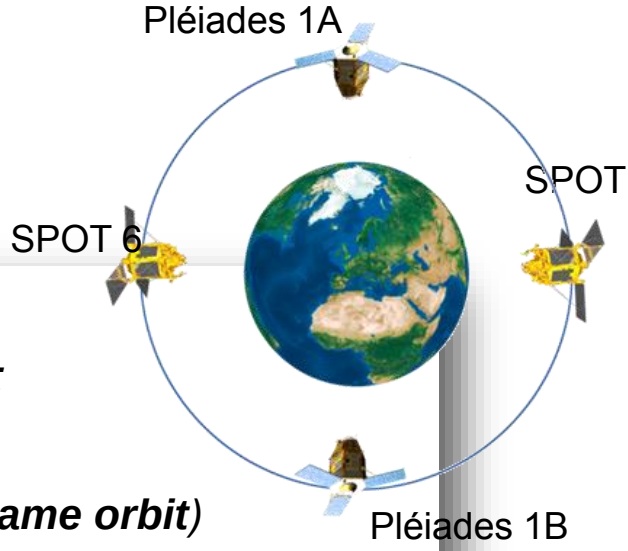
Reactive

Constellation

2X day	Revisit time with 4 satellites @ 45° incidence (equator) @ 30° incidence (Lat 40°)
Twins	2 X 2 IDENTICAL satellites
Phased orbit	90° one from each other, Same orbit

Phased orbit





***Two twins satellites**, featuring a true constellation:*

- *providing **the same high-quality product**,*
- *coherently operated (**180°** one from the other **on the same orbit**) through a single interface: full leverage of synergies, for*

✓ **Better reactivity,** with an acquisition opportunity every day whatever the location of a crisis or natural disaster,

✓ **Greater change detection,** up-to-daily monitoring to follow activity progress on a given site (industrial, military, civil engineering piece of work, mining…)

✓ **Twofold coverage and acquisition capacity** ideal for rapid coverage of large areas with twice more attemps possible then twice more opportunities for a cloud-free image

Reactive

Constellation

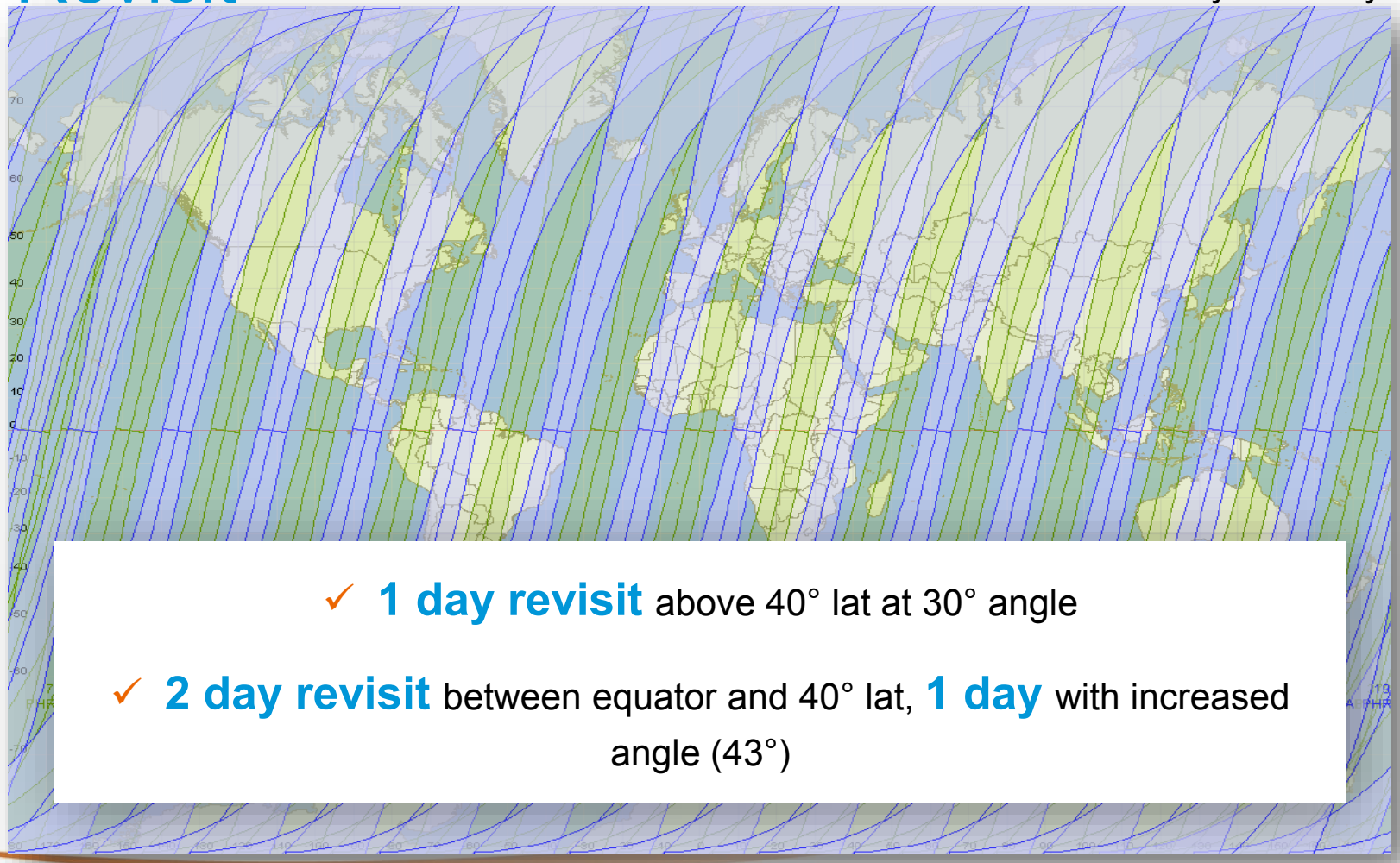
2X day	Revisit time with 4 satellites @ 45° incidence (equator) @ 30° incidence (Lat 40°)
Twins	2 X 2 IDENTICAL satellites
Phased orbit	90° one from each other, Same orbit

Operations

Multiple	Tasking plans per day

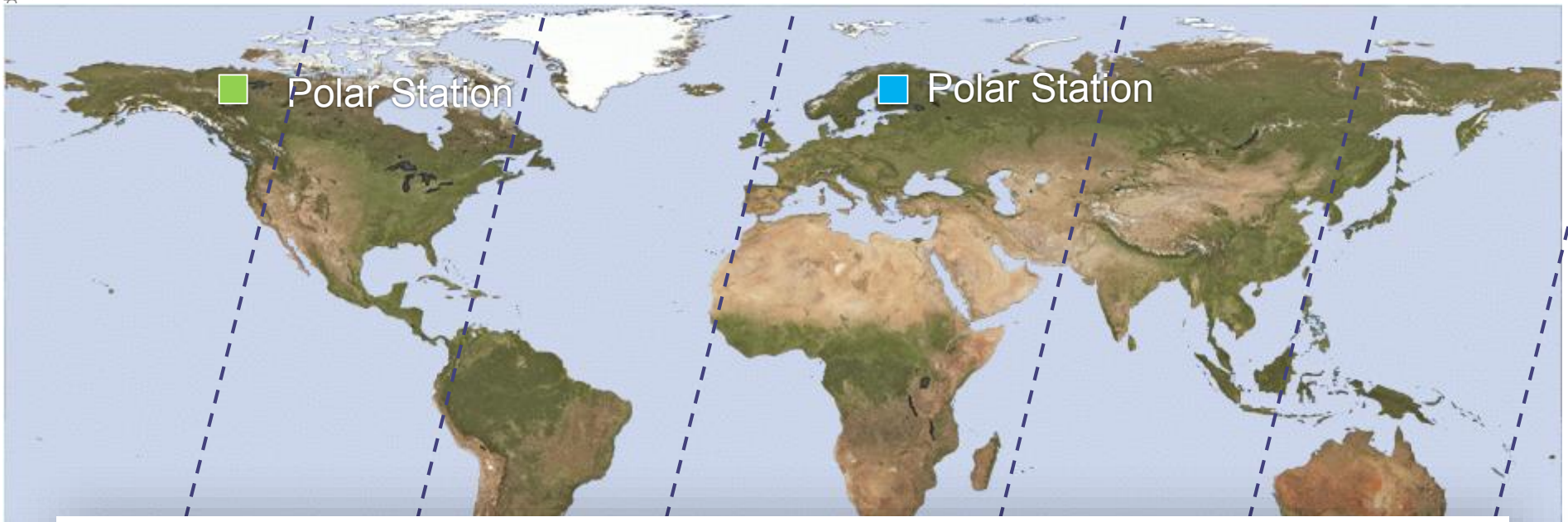
Revisit

Pléiades 1A&1B corridor of visibility for 1 day



- ✓ **1 day revisit** above 40° lat at 30° angle
- ✓ **2 day revisit** between equator and 40° lat, **1 day** with increased angle (43°)

Multiple tasking plans per day



Up to two hours before satellite enters into a new tasking area:

✓ Take into account **last-minute customer requests**

✓ Fine-tune tasking plan according to the most recent weather forecast for **increased success rate**

Reactive

Constellation

2X day	Revisit time with 4 satellites
Twins	2 X 2 IDENTICAL satellites
Phased orbit	90° one from each other, Same orbit

Operations

Multiple	Tasking plans per day

Processing

30 min	Pléiades 50 cm color ortho production of a 20x20 km area …
< 1 h	Spot 6 & 7 1,5 m color ortho production of a 60x60 km area
2-3 h	…for a 60 x 60 km monopass mosaic

Reactive

- Real **operational reactivity** for a first class level of service
- The **right information** at the **right time**
- Enhanced **image quality**

Available

Acquisition capacity

Up to 2M sq.km	Effective daily acquisition capacity for 2 Pleiades 1A-1B
Up to 6M sq.km	Effective daily acquisition capacity for SPOT6 & 7
20 km	Pléiades: widest swath on the VHR market
60 km	Spot 6 & 7 swath

✓Cloud cover **optimization**

✓ Genuine **order book**

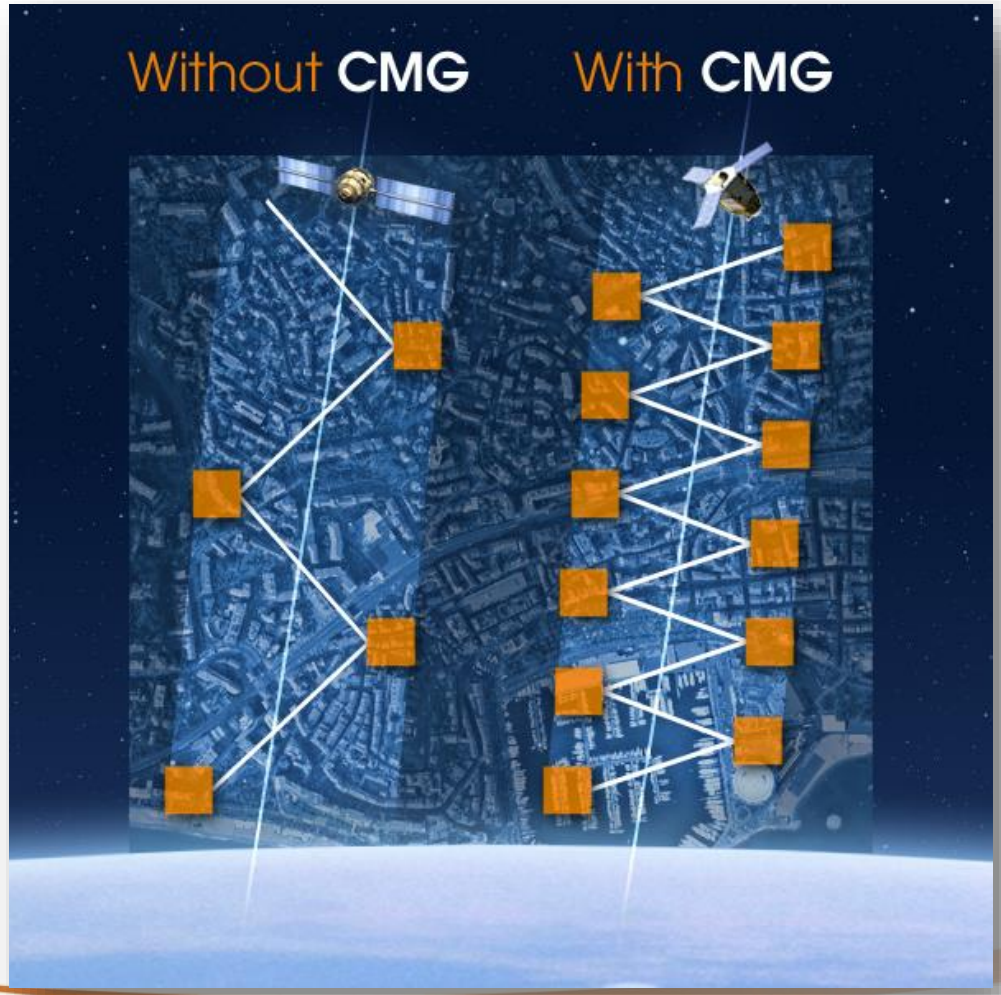
✓ Full benefit of the **constellation's agility**

✓ **Optimized** production

✓ **Easier** data handling

✓ **Maximized** information on target and surroundings

A state of the art agility



- **Twice** as many images collected as satellites without CMGs during the same orbit slot

Increase acquisition opportunities, and probability of success:

Shortened average acquisition window

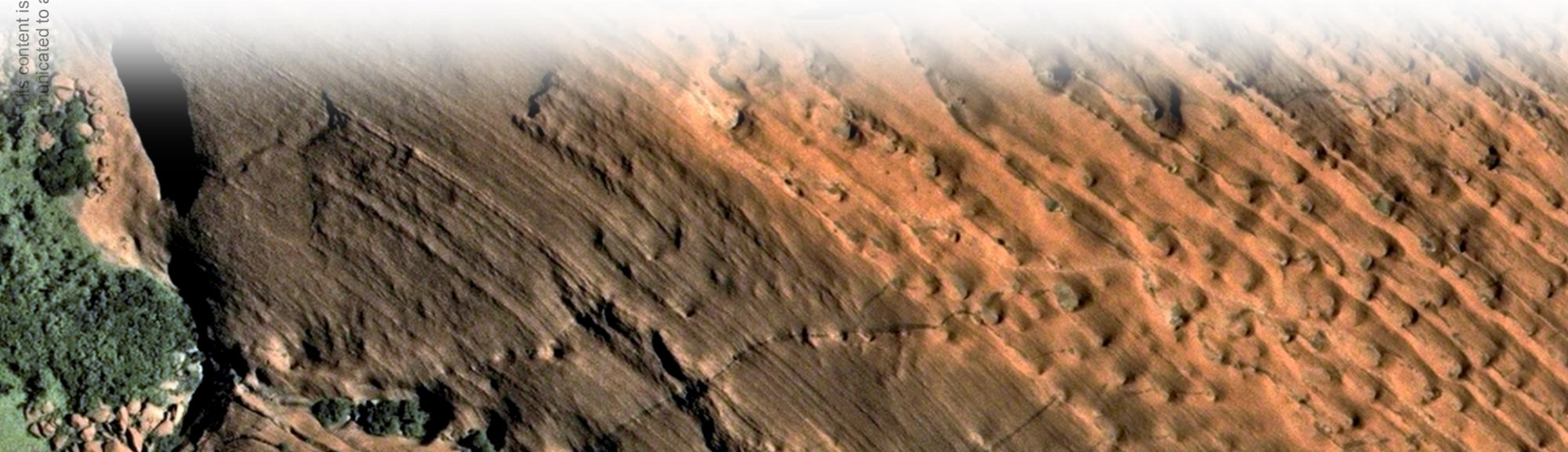
Available

Acquisition capacity

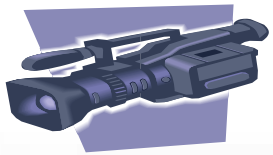
6M sq.km	Effective daily acquisition capacity for 4 satellites
20 km	Pléiades: widest swath on the VHR market
60 km	Spot 6 & 7 swath

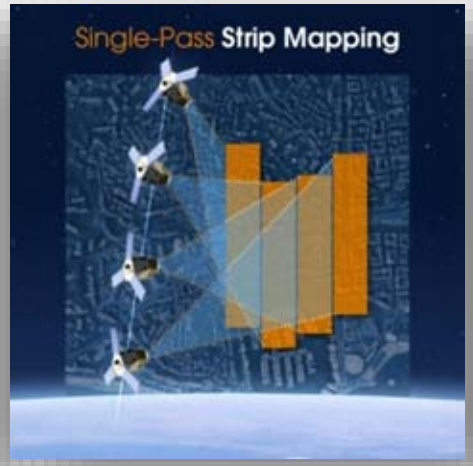
Agility

4	CMGs
Monopass collection scenarios	Multi-target, Mosaic, Stereo, tristereo, Border / coastal / corridor



Monopass collection scenarios





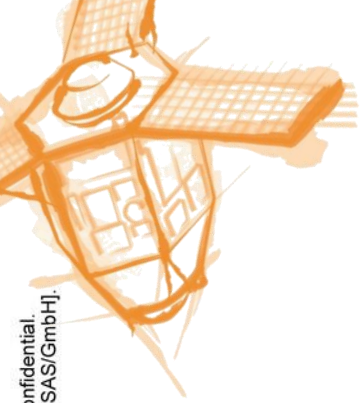
Typically **20 targets** over 1,000 km within a +/-30 deg corridor for Pléiades, **600 km-long** strips with Spot 6 & 7

Up to **100 x 150km** with Pléiades, **240 x 240km** with Spot 6 & 7

To compute **accurate 3D** Models

To enhance **photo interpretation** (avoiding hidden items)

To follow **linear targets** such as coasts, borders, roads, pipelines, rivers



Overview of

A PLÉIADES PRODUCT

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Processing levels

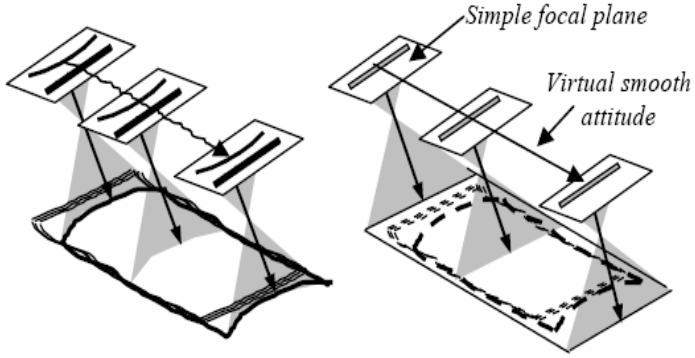
- Primary level (~ 1A SPOT 5 – sensor geometry) - *Automatic*
  - Radiometric corrections (radiocorrection and panchro restoration)
  - Geometric corrections restoring perfect linear conditions of acquisition

    *Equivalent of a sampled **linear single** array*

    Perfect P and MS registration

    Corrected attitude: virtual smooth attitude

    Corrected ephemeris: perfect datation



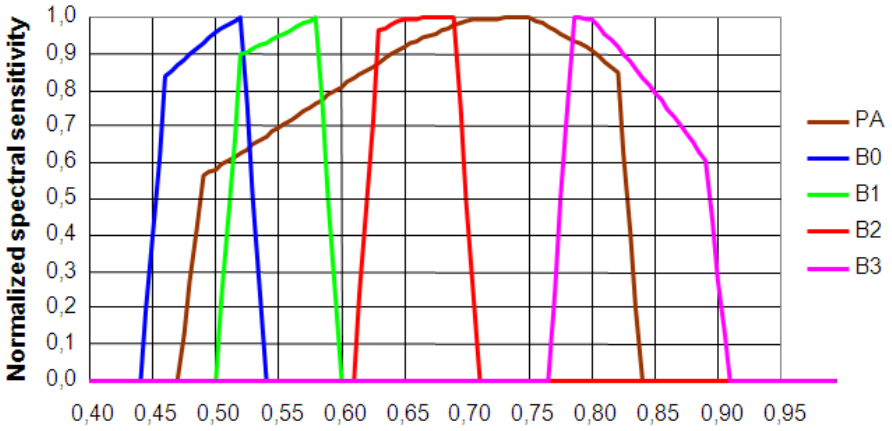
- Ortho level (georeferenced) - *Automatic*
  - Primary level corrections
  - Projection (most of the current projections)
  - Terrain corrections

    Applied thanks to a DTED2-class DEM such as Reference3D (with or w.o. GCPs)
  - Automatic processing of orthomosaics up to 1 sq degree (seamless)

- Tailored Orthos for increased precision
  - Custom DEM, GCPs ingestion available upon request

Products resolution and spectral bands

- Panchromatic (50 cm)
  - 470 – 830 nm
- Multispectral (2 m)
  - Blue: 430 – 550 nm
  - Green: 500 – 620 nm
  - Red: 590 – 710 nm
  - Near infrared: 740 – 940 nm



- Pan & MS acquired simultaneously
- On board telemetry coded over 12 bits
- Deliverable
  - Pan only, MS only, Bundle, Pansharpened 3 or 4 bands
  - Resolution < 1 m up to 30° acquisition angle (combined pitch&roll)

12 bits?

- Pléiades pixel depth at acquisition is 12 bits (2 power 12)
  - For each spectral band, each pixel can take one value out of 4096.
  - Other VHR sensors have a pixel depth at acquisition of 11 bits (2 power 11), meaning that each pixel can take one value out of 2048, thus displaying less capacity when distinguishing subtle nuances.
  - This is excellent for photointerpretation!
    - In shaded areas, it is more likely to detect objects in the darkness of the shadow of a building or a mountain, as more nuances can be taken by each pixel
    - In very light environment (sand, nearly white ground), according to the same principle as more saturation problems are avoided.
  - 12 bit pixel depth makes the images easier to work with, as playing with extreme values do not degrade the rest of the image.
  - This also widen the range of « good images »: even during winter, humid weather, or with cloud shadows, images are more likely to provide meaningful information

Options for standard products

- Mono / stereo / tristereo or n-stereo (up to 25 images in the same pass)
  - Mono: primary / ortho
  - Stereo, tristereo: primary only
- AOI based
  - 25 sq.km minimum order size for archive (primary or ortho)
  - 100 sq.km minimum order size for new image (primary or ortho)
- Delivering and formatting
  - Media: DVD, FTP, USB stick, hard drive, Streaming (soon)
  - File format: DIMAP V2 or NITF [under development]

    Image format in DIMAP V2 file: JPEG 2000 or GeoTIFF

    JPEG 2000 compression ratio: Optimized (3.5 bits / pixel) or Regular (8 bits/ pixel)
  - Delivery: routine / rush
  - Refined Attitude: integrated per default except in rush delivery mode
  - Pixel encoding: 8 or 12/16 bits
  - Dynamic Streching: auto / none (or custom) for pixel encoding of 8

Pléiades products format: DIMAP V2

Imagery file

JPEG 2000	GeoTIFF
Dynamic range 12 bits • Optimized compression (~3,5 bits / pixel) • Regular compression (~8 bits / pixel)	**Dynamic range 16 bits** • Without compression
Dynamic range 8 bits • Optimized compression (~3,5 bits / pixel) • Regular compression (~8 bits / pixel)	**Dynamic range 8 bits** • Without compression

Metadata

- DIMAP with RPC
- Masks: Technical Quality, clouds, snow, ROI

Image format: JPEG 2000 and GeoTIFF

- 50 cm, Pansharpened 4 bands (R, G, B, NIR), 20 x 20 km

JPEG 2000 **Bit-depth12 bits**	**GeoTIFF** **Bit-depth 12 bits** *(storage 16 bits)*
• Optimized: 2.6 GB • Regular: 6 GB (max)	• 12 GB
Bit-depth 8 bits	**Bit-depth 8 bits**
• Optimized: 2.6 GB • Regular: 6 GB (max)	• 6 GB

✓ JPEG 2000 **optimizes file size** (up to 5 times less!), combining **excellent preservation of the information** content with **high compression rates**

OVR Option

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Definition & market needs

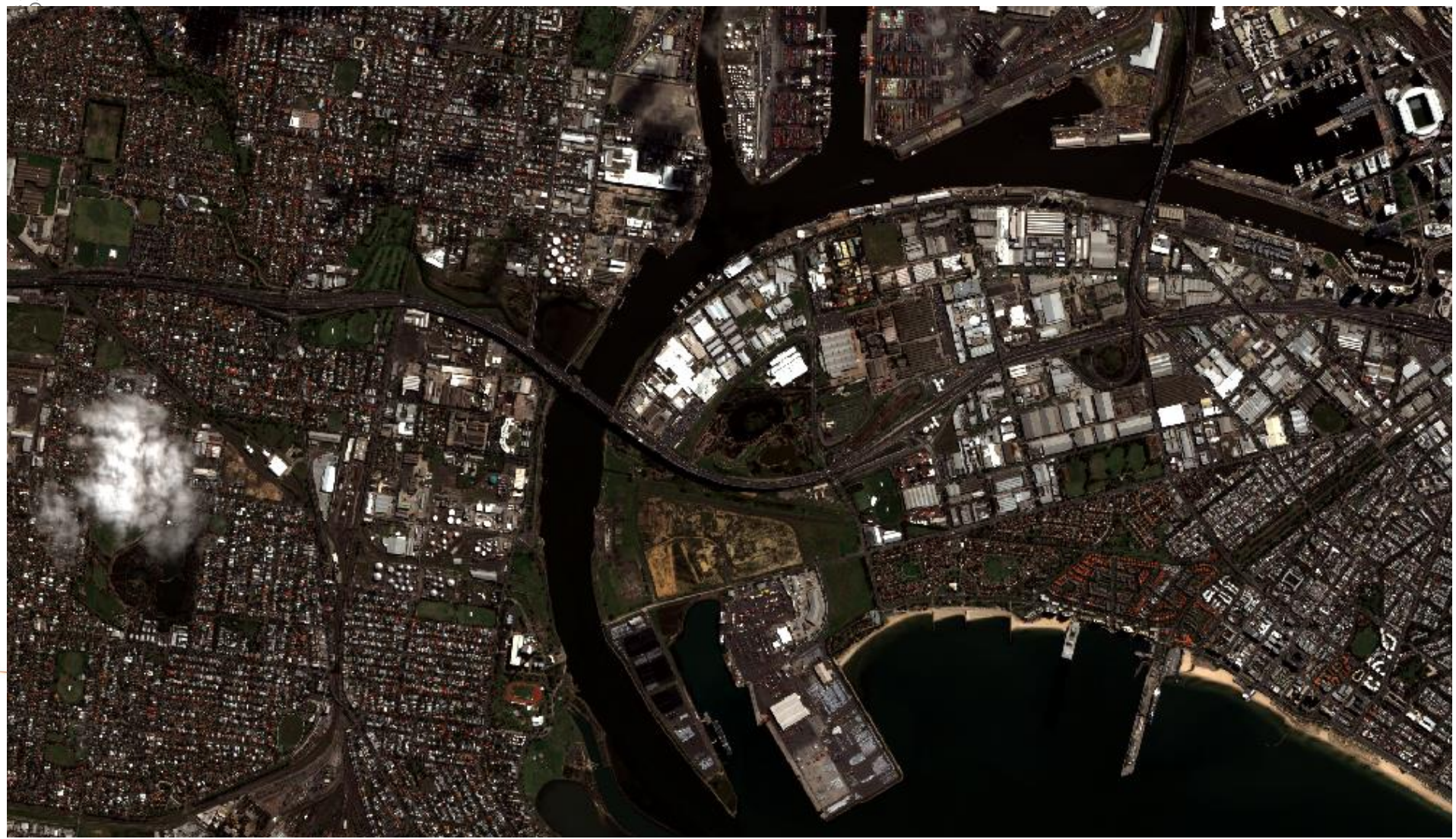
OVR – Optimized Visual Rendering – Radiometric enhancement

- What is it?
  - OVR is an option for visual radiometric enhancement and visual improvement that is color correction, brightness and contrast enhancement.
  - Includes adjustments in terms of Brightness, Contrast and Atmospheric Conditions.
- Needs
  - Brightness & contrast automatic adaptation for a direct display in standard image display SW/GIS

Samples

OVR – Optimized Visual Rendering

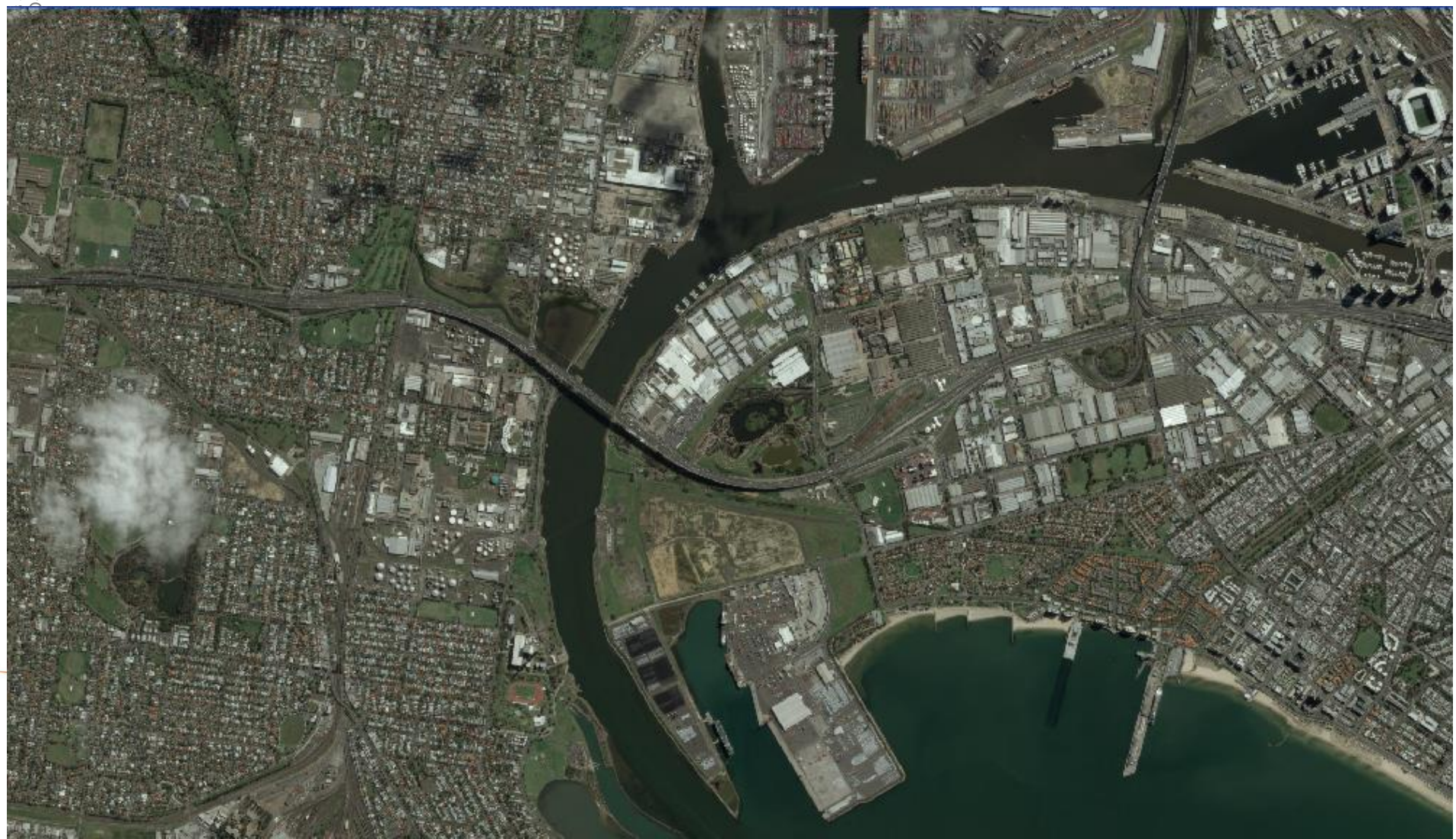
- **12-bit product on Melbourne : display with auto-linear adaptation**



Samples

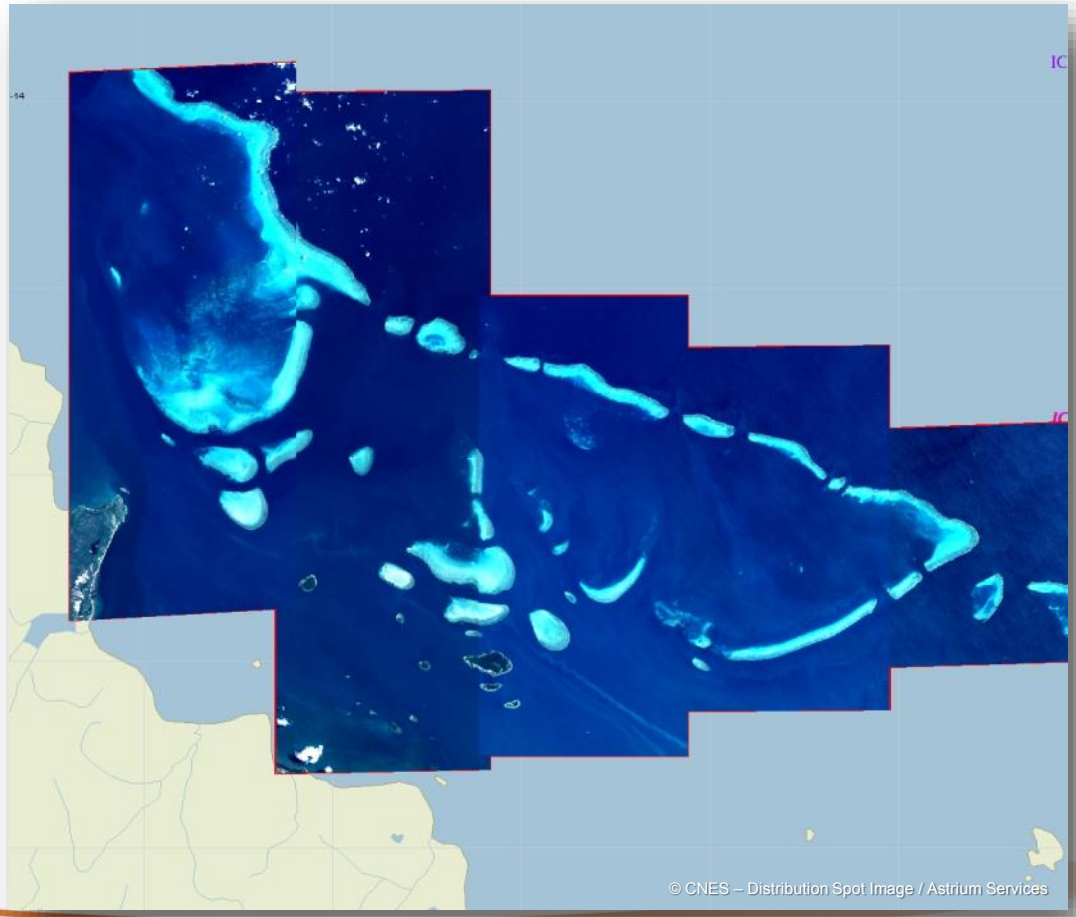
OVR – Optimized Visual Rendering

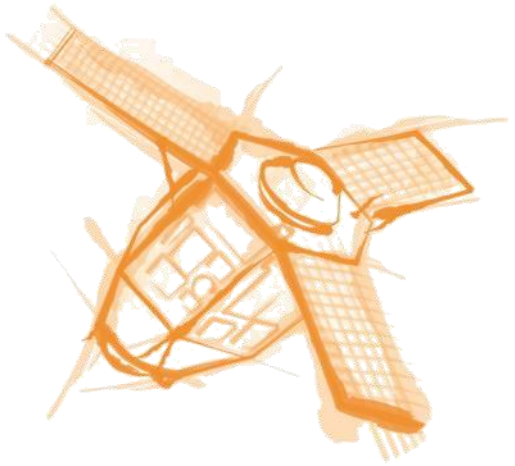
- **16-bit product with OVR on Melbourne**



Proven example #2

Unprecedented collection capabilities

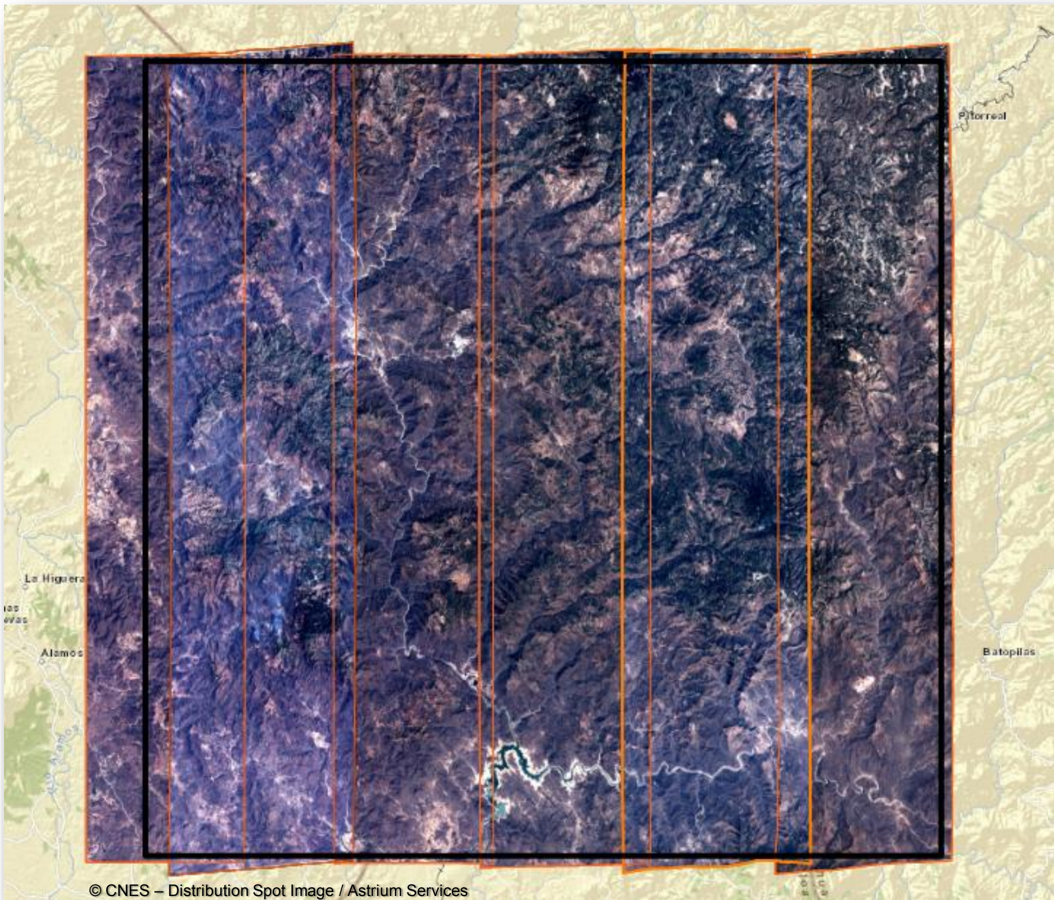


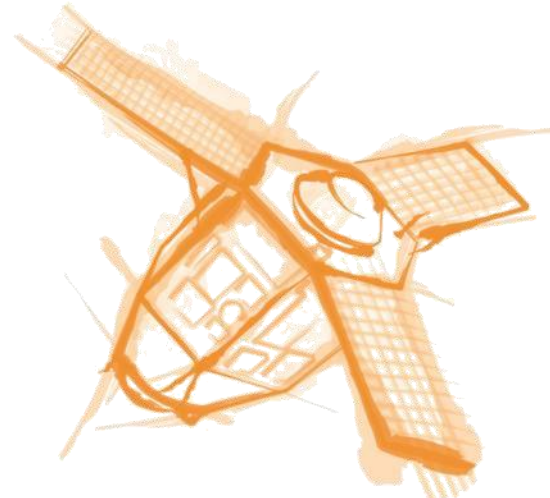


✓ The **Great Barrier Reef** collected in a **single pass** of the satellite.

Proven example #3

Unprecedented collection capabilities





✓ An **entire geocell**, over 10,000 km2, was collected over Mexico in **one pass** of the satellite, with all the segments within +/-20°

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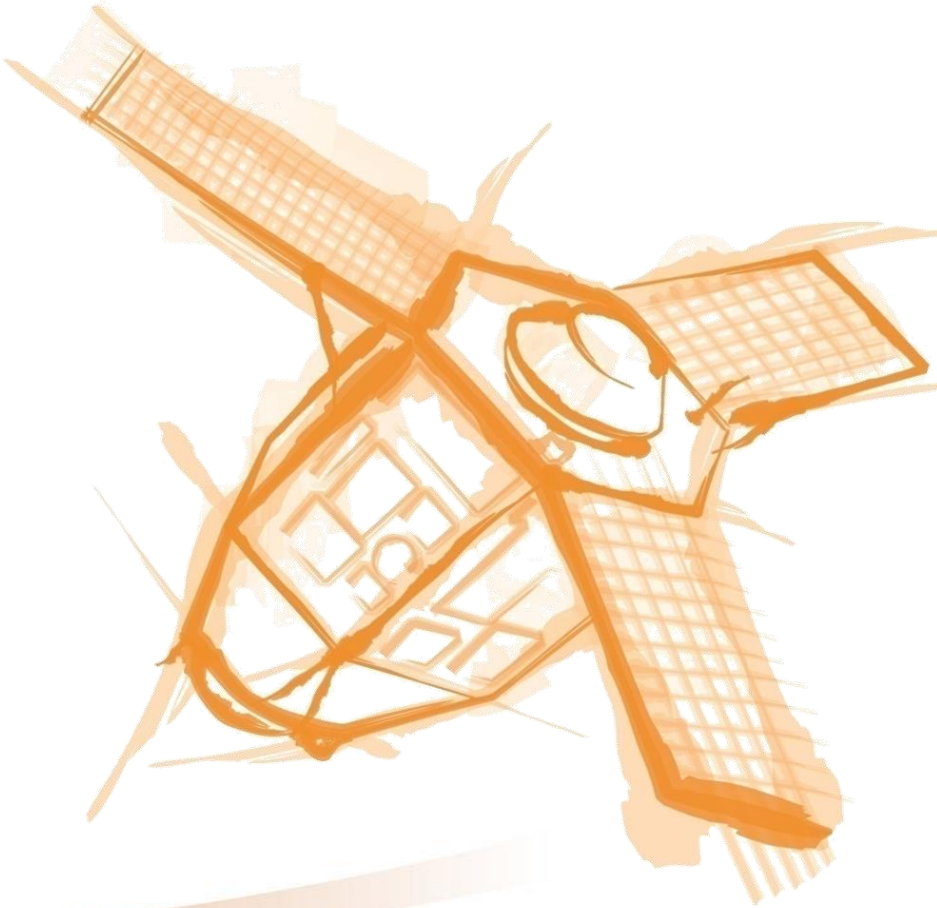

Overview of
SPOT 6-7

All the space you need

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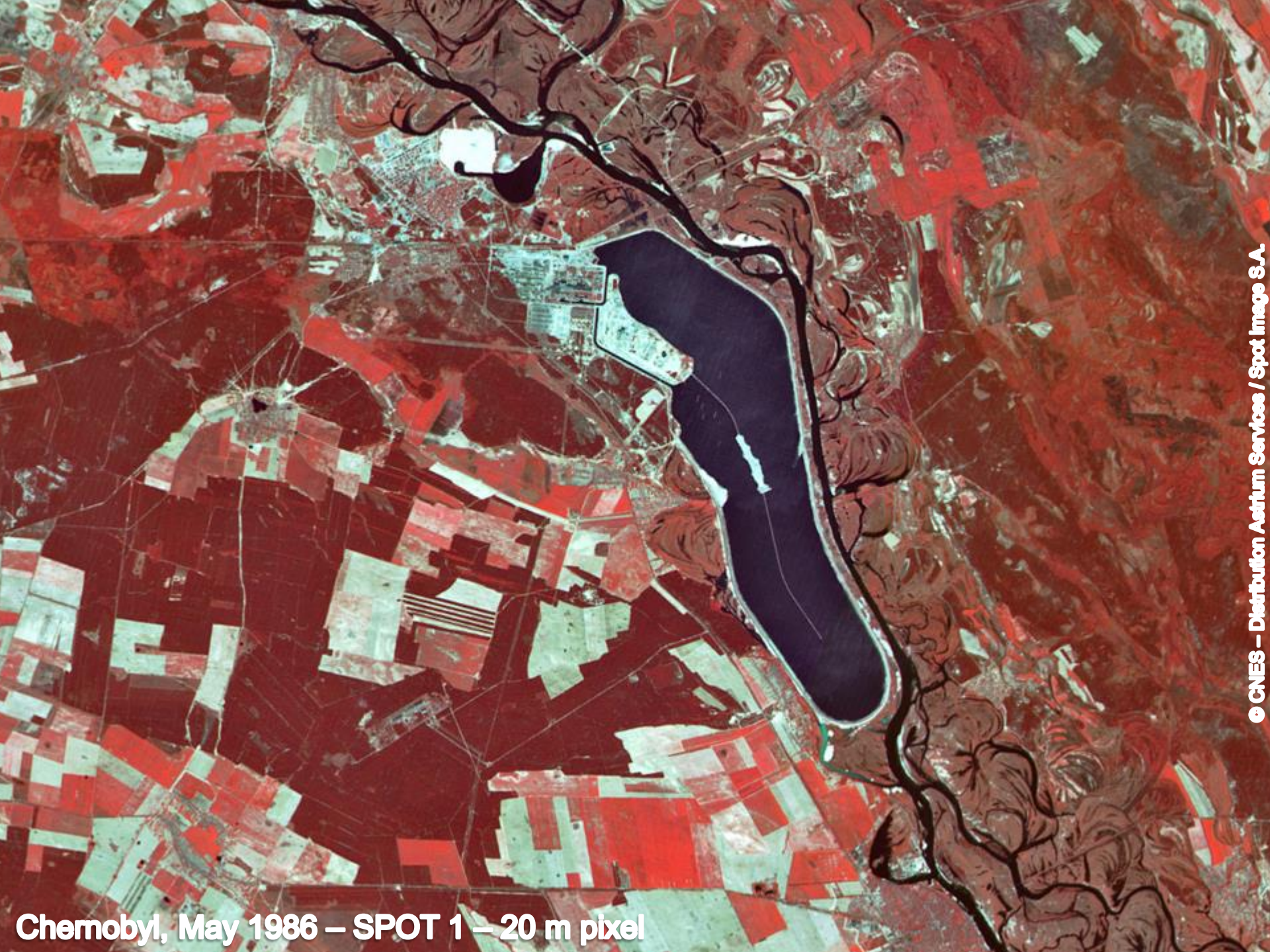


Chernobyl, May 1986 – SPOT 1 – 20 m pixel

SPOT 6 - First image – Sep 2

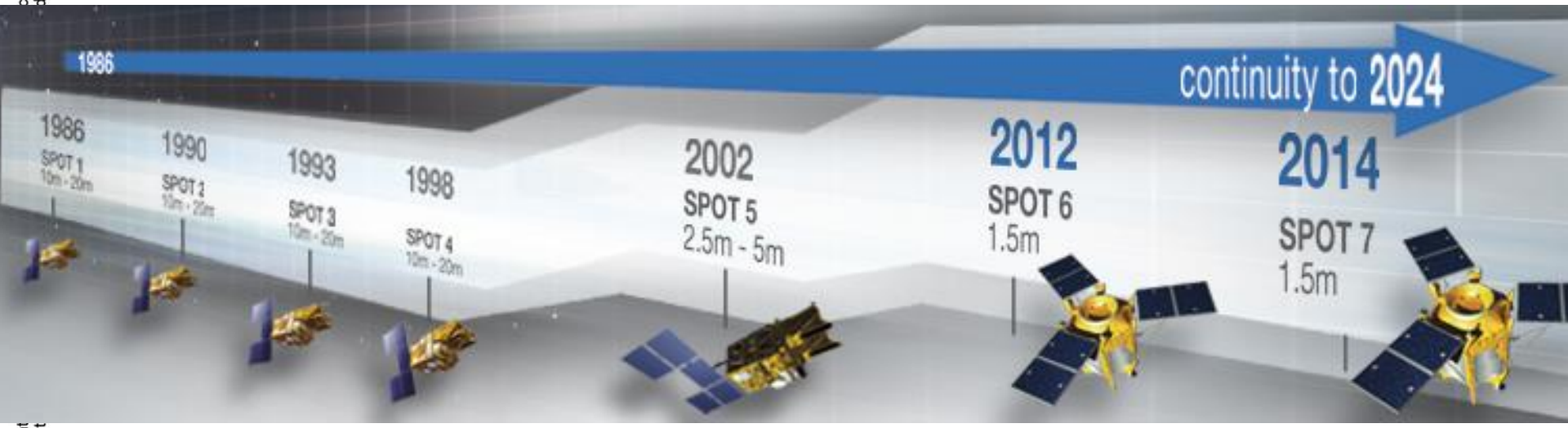
Bora-Bor a)

Extract of p

SPOT 6 - First image – September 12th, 2012

Bora-Bora (French Polynesia)

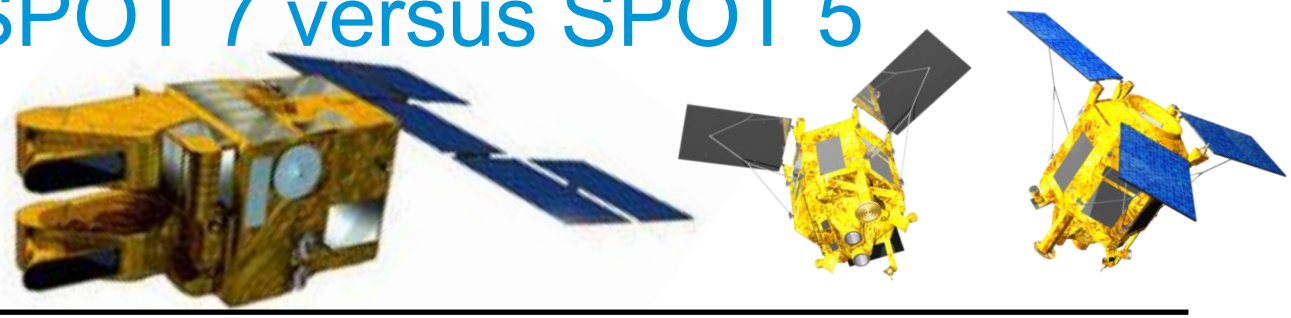
Extract of a 60kmx120km strip



SPOT 6 and SPOT 7

A new generation bringing innovation to the SPOT series

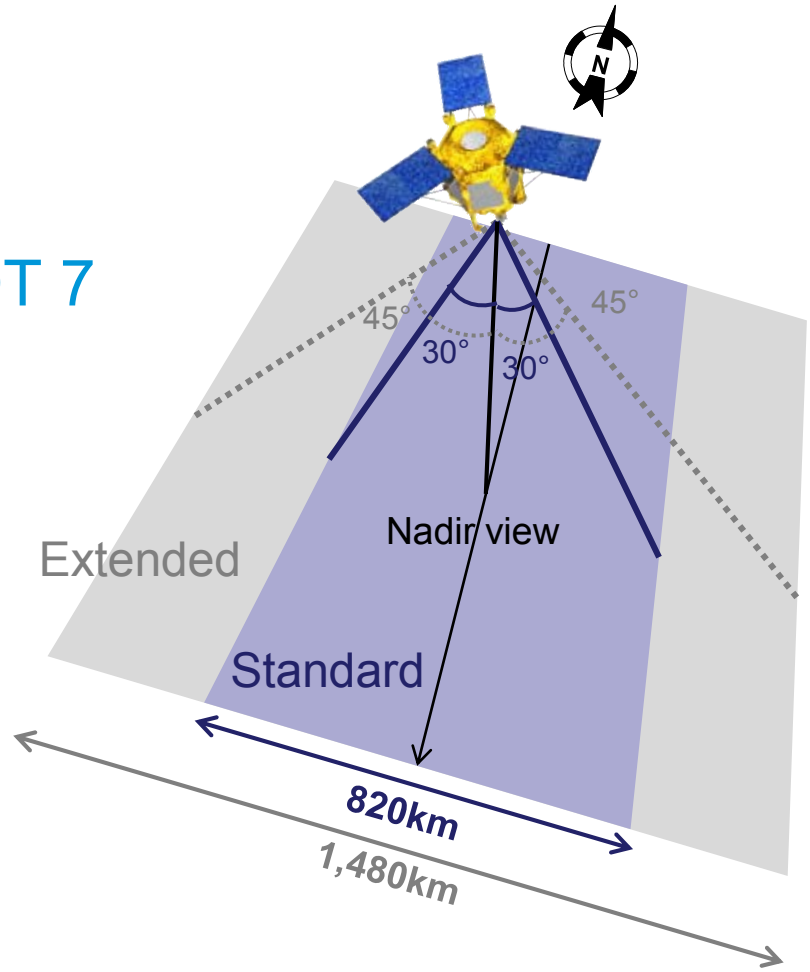
SPOT 6 | SPOT 7 versus SPOT 5



	SPOT 5	SPOT 6 | SPOT 7
Launch mass	3 000 kg	712 kg
Size	Body: 3.1 x 3.1 x 5.7 m Solar array wingspan 8 m	Body: ~ 1.55 x 1.75 x 2.7 m Solar array wingspan 5,4 m2
Design Lifetime	5 years	10 years
Product resolution / swath	2. 5 m / 2 x 60 km	1.5 m / 60 km + multi-strip in single pass capacity
Daily image acquisition capability in HR mode (i.e. HRG only)	up to 3 Mkm² / day in operation 2 Mkm² / day average	up to 3 Mkm² / day in operation/sat 2.2 Mkm² / day average/sat
Agility	Roll only (mirrors), 30° in 8 s	All axes (platform), 30° in 14 s
Single pass stereo capability	Only through HRS	Single pass stereo and tri-stereo
Geolocation	50 m without GCP	35 m without GCP; 10 m with Reference3D
System tasking reactivity	1 mission plan / day	6 missions plans / day / satellite

Viewing angle

- The agility of SPOT 6 and SPOT 7 allows them to move viewing angle in roll and pitch:
  - Standard: +/- 30°
  - Extended: +/- 45°

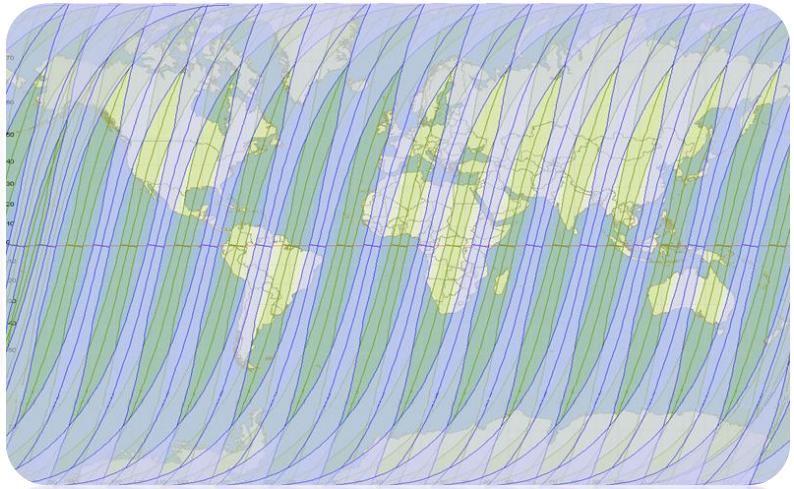


Geometric distortion may occur for extended viewing angles.

This capacity is mainly used in case of emergency requests.

SPOT 6 | SPOT 7 revisit capacity

Viewing angle	SPOT 6 only	SPOT 6 and SPOT 7
5°	26 days	13 days
20°	7 days	4 days
30°	5 days	2 days
45°	2 days	**1 day**



SPOT 6 (blue) and SPOT 7 (green) combined corridor of visibility for a given day (viewing angle +/-30°)

Any place on Earth can be seen everyday by either SPOT 6 or SPOT 7 with a viewing angle of 45°

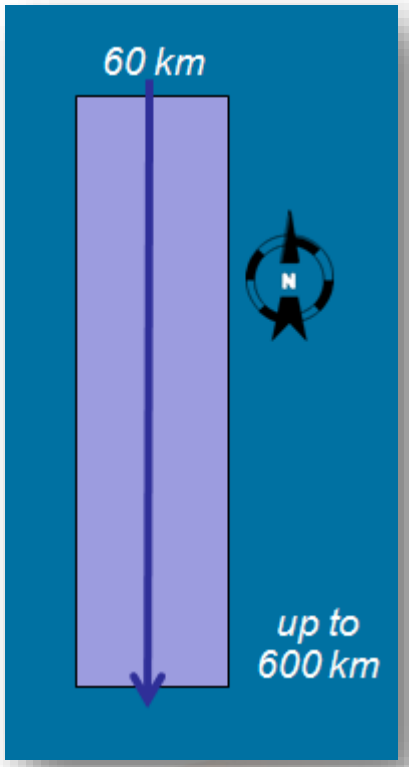
Any place over 40° latitude can be seen everyday by either SPOT 6 or SPOT 7 with a viewing angle of 30°

Acquisition capacity

- Collection capacity
  - Up to **6 million sq.km per day** with the 2 satellites
- Agility
  - Thanks to Control Moment Gyroscopes, SPOT 6 and SPOT 7 have the same agility than Pleiades.
  - SPOT 6 and SPOT 7 can quickly shoot at any point within ~1500km of their position.

Standard data collection mode: Long strips

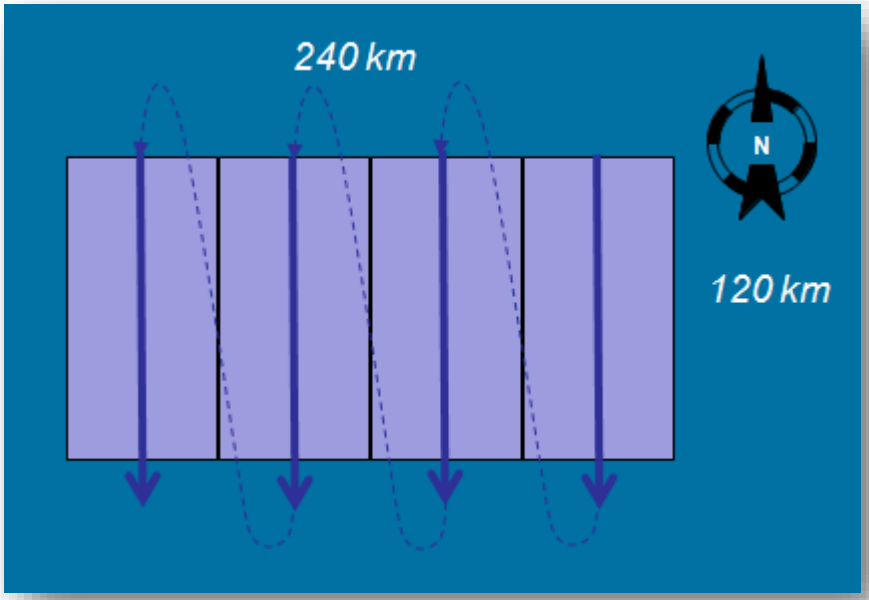
- North-South acquisitions
- Swath: 60km
- Length: between 20km and 600km



Covering large surfaces in the most efficient manner

Single pass: Multi-strip collection

- North-South acquisitions
- Covering medium-size surfaces in a single pass:
  - 240kmx120km
  - 180kmx180km
  - …

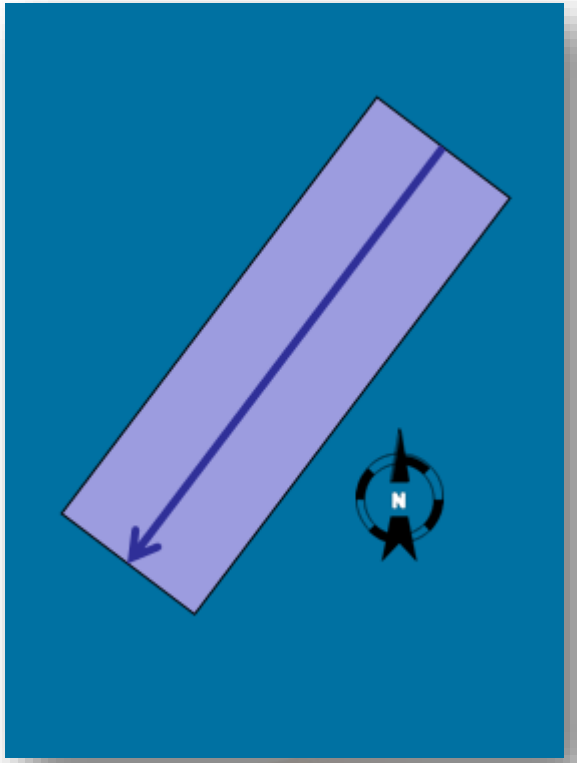


Avoid variation of conditions (atmospheric, seasonal effects…)

Optimize coverage when weather conditions are favourable

Single pass: Corridor collection

- Non North-South acquisitions
- Max. length of the corridor depends on the direction



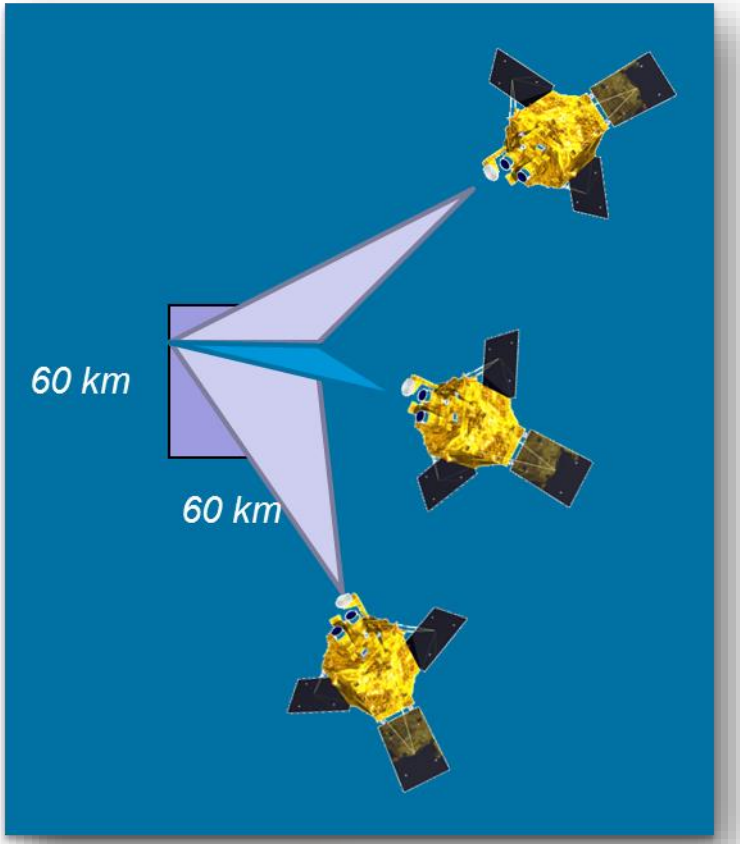
Optimize the delay to cover an area of interest

Geometric distortion may occur according to the direction and length of the corridor.

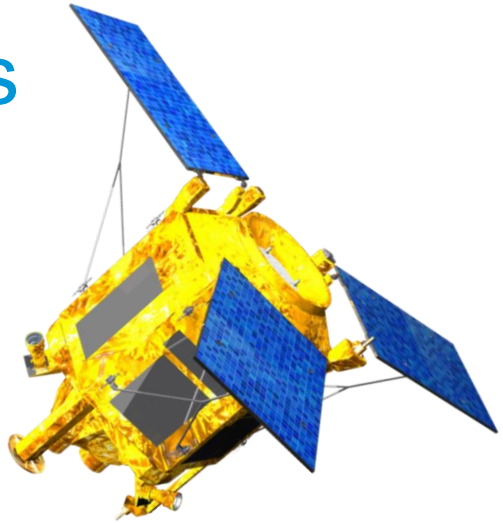
Corridor collection capacity is mainly used in case of emergency requests.

Stereoscopic capabilities

- Stereo pairs:
  - 2 images – fore and aft – acquired along the same pass.
  - Stereo viewing considers moves in roll and pitch
  - Maximum length depends on B/H ratio (typically 200km)
- Stereo triplet:
  - 3 images – fore, nadir and aft – acquired along the same pass.



Optical instrument characteristics



- Swath: 60 km
- Systematic and simultaneous acquisition of Pan+4MS bands
- High location accuracy:

  < 35m CE90 without GCP

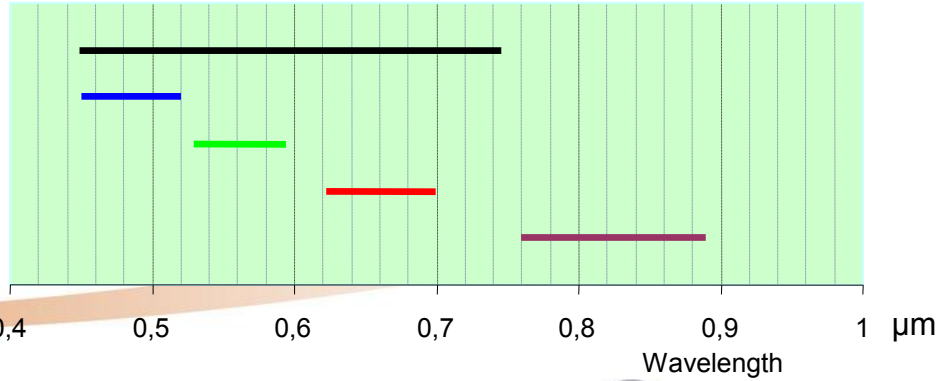
Panchromatic: 0.455µm – 0.745µm

Blue: 0.455µm – 0.525µm

Green: 0.530µm – 0.590µm

Red: 0.625µm – 0.695µm

Near Infrared: 0.760µm – 0.890µm



SPOT 6 Vancouver (Canada)

Focus over the urban area

SPOT 6 Vancouver (Canada)

Full resolution

Access to information - Geostore

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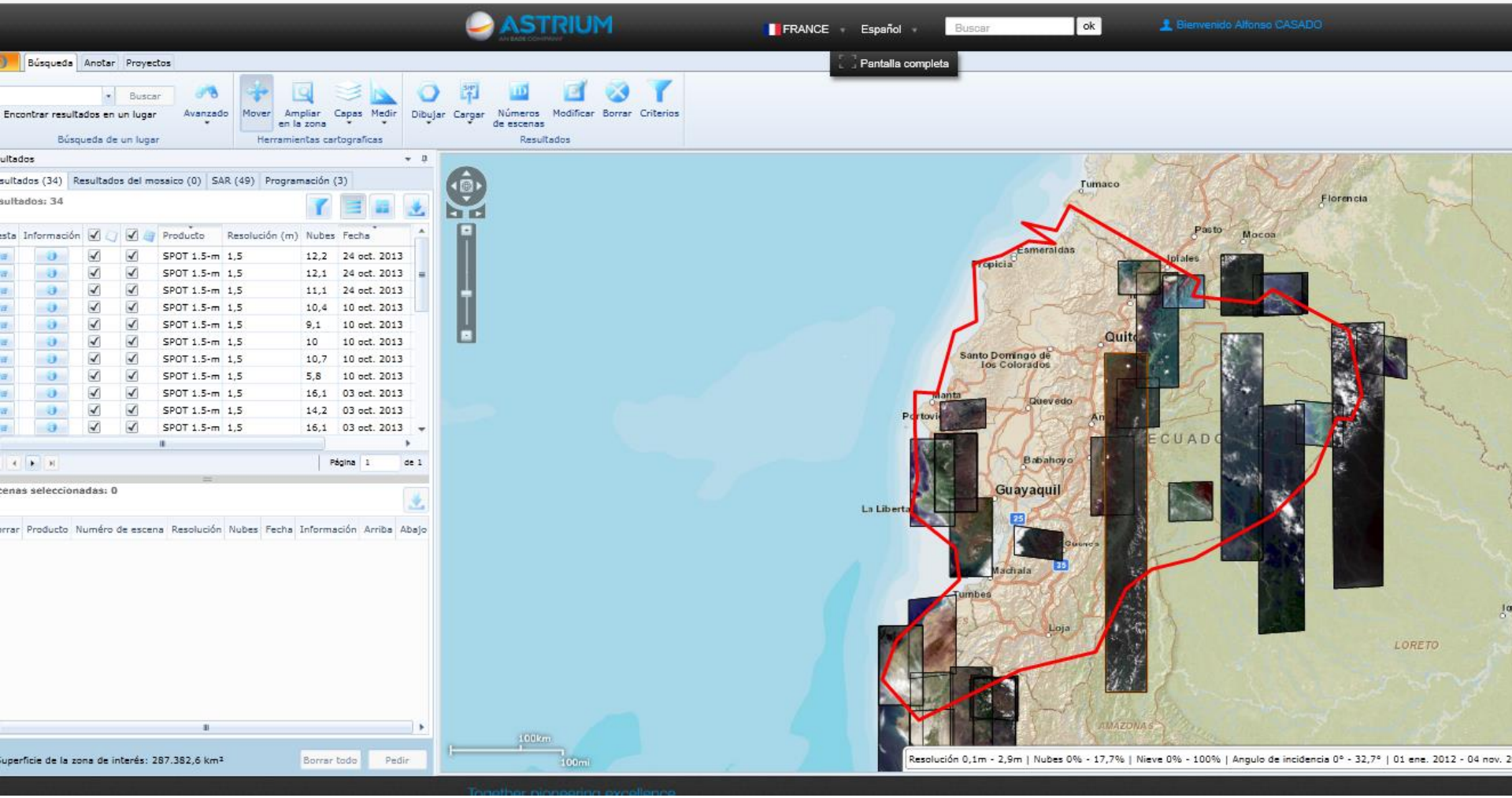

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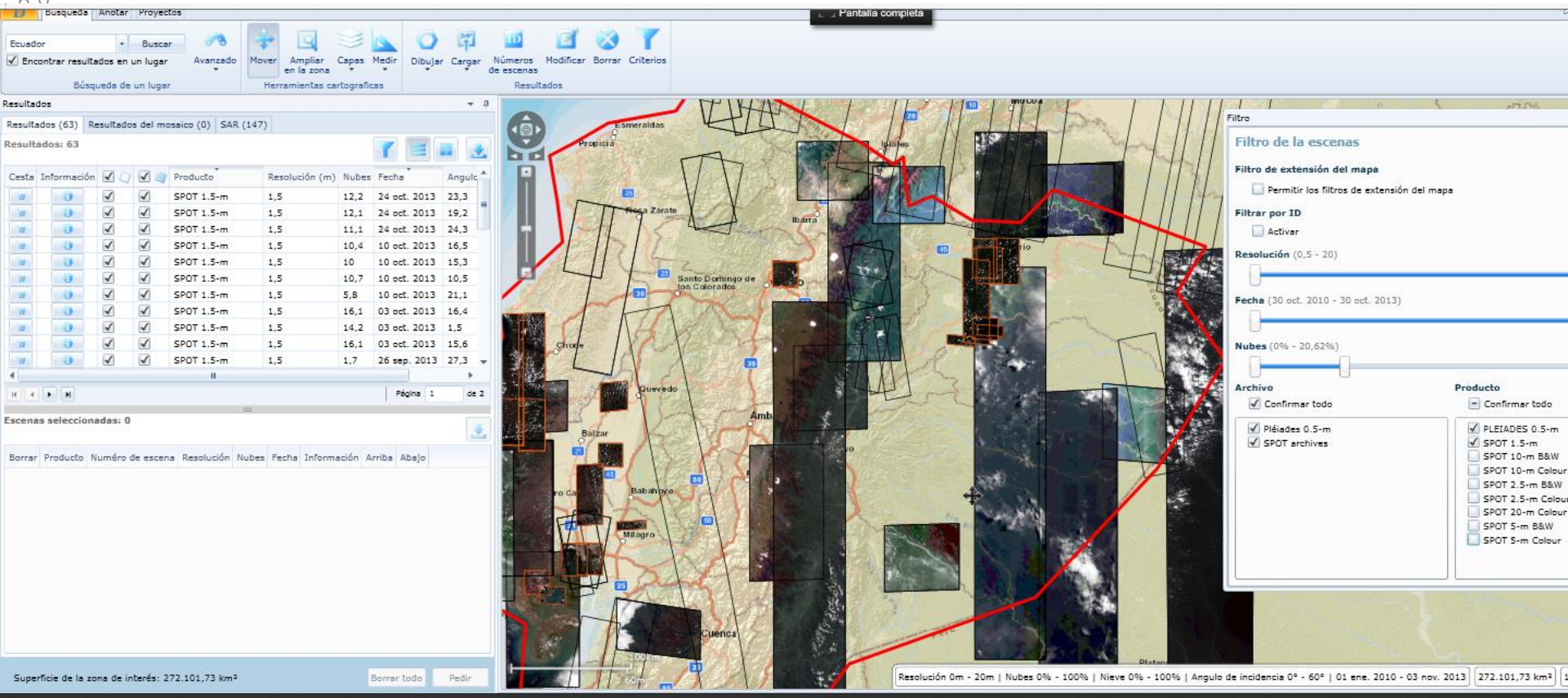

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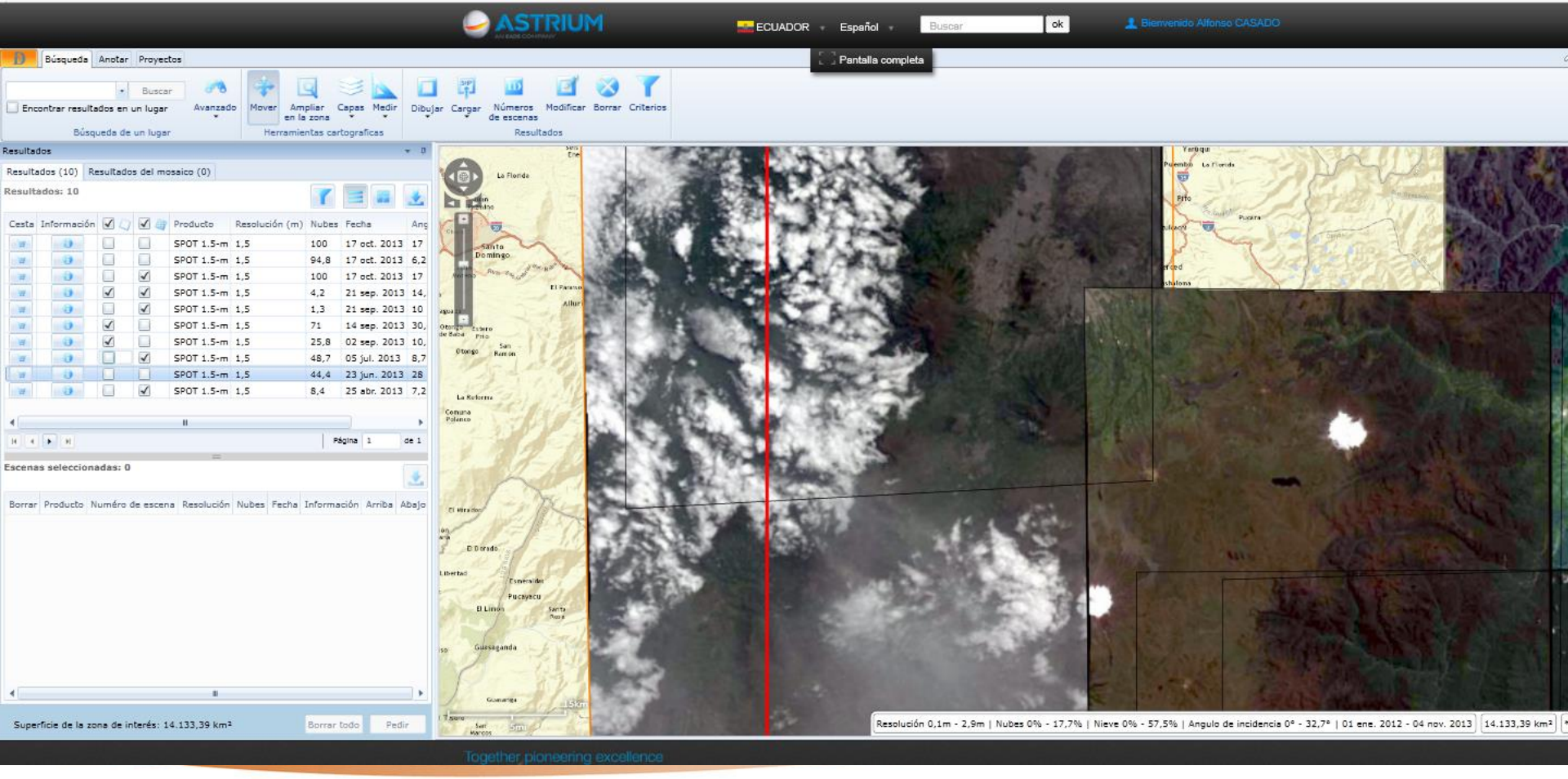

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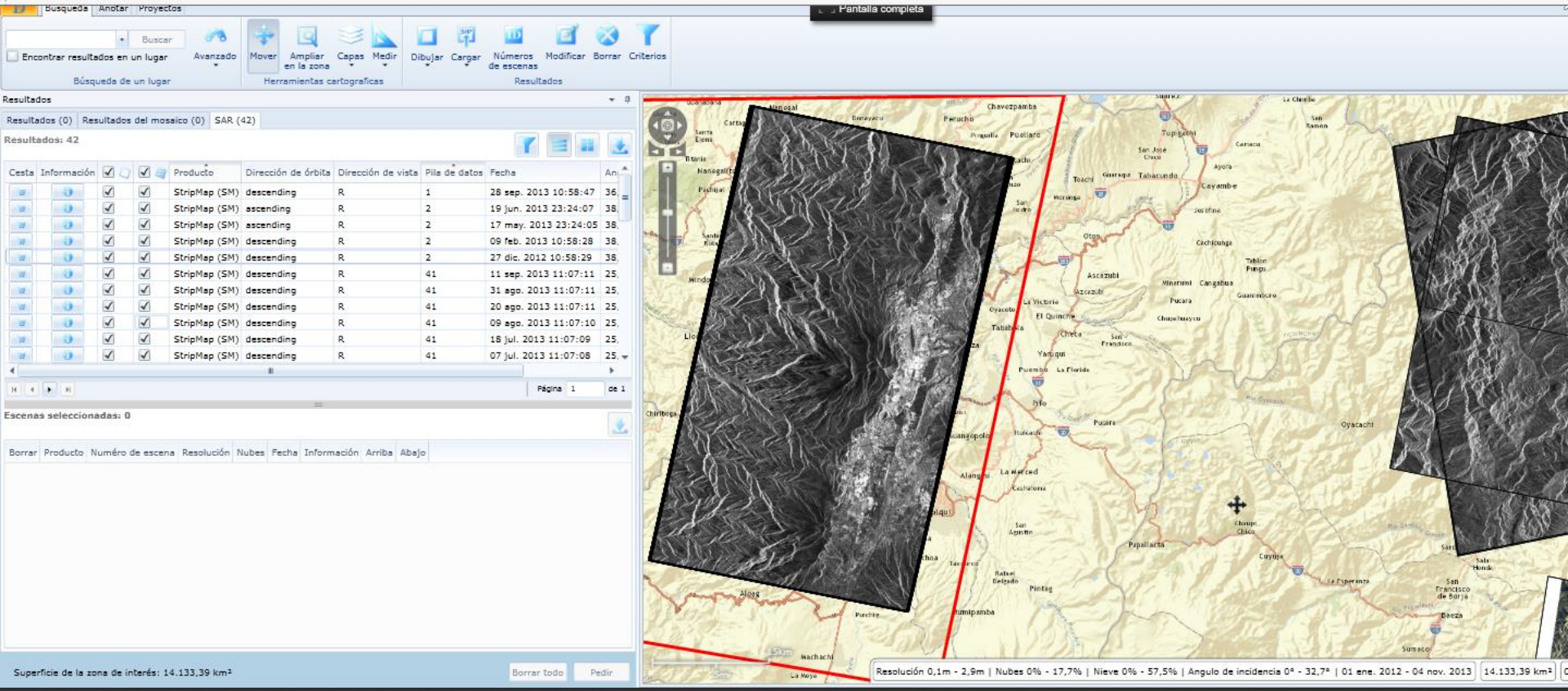
Ahora también radar




Gracias por
su atención

alfonso.casado@infoterra.es

info@agroprecision.net

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