Future of Remote Sensing and Data Quality

Panel discussion at JACIE 2020

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Research and Development

MAXAR

Pixels / Services vs Orbit / Ground

- In Orbit
  - WorldView Legion
  - Why Quality Matters
- On the Ground
  - Interoperability and ARD
    - Absolute radiometric calibration
    - Atmospheric Compensation (AComp)
    - Registration
  - Advanced Products
    - High Definition (HD)
    - The Earth in 3D

In Orbit
WorldView Legion

Our next-generation satellites

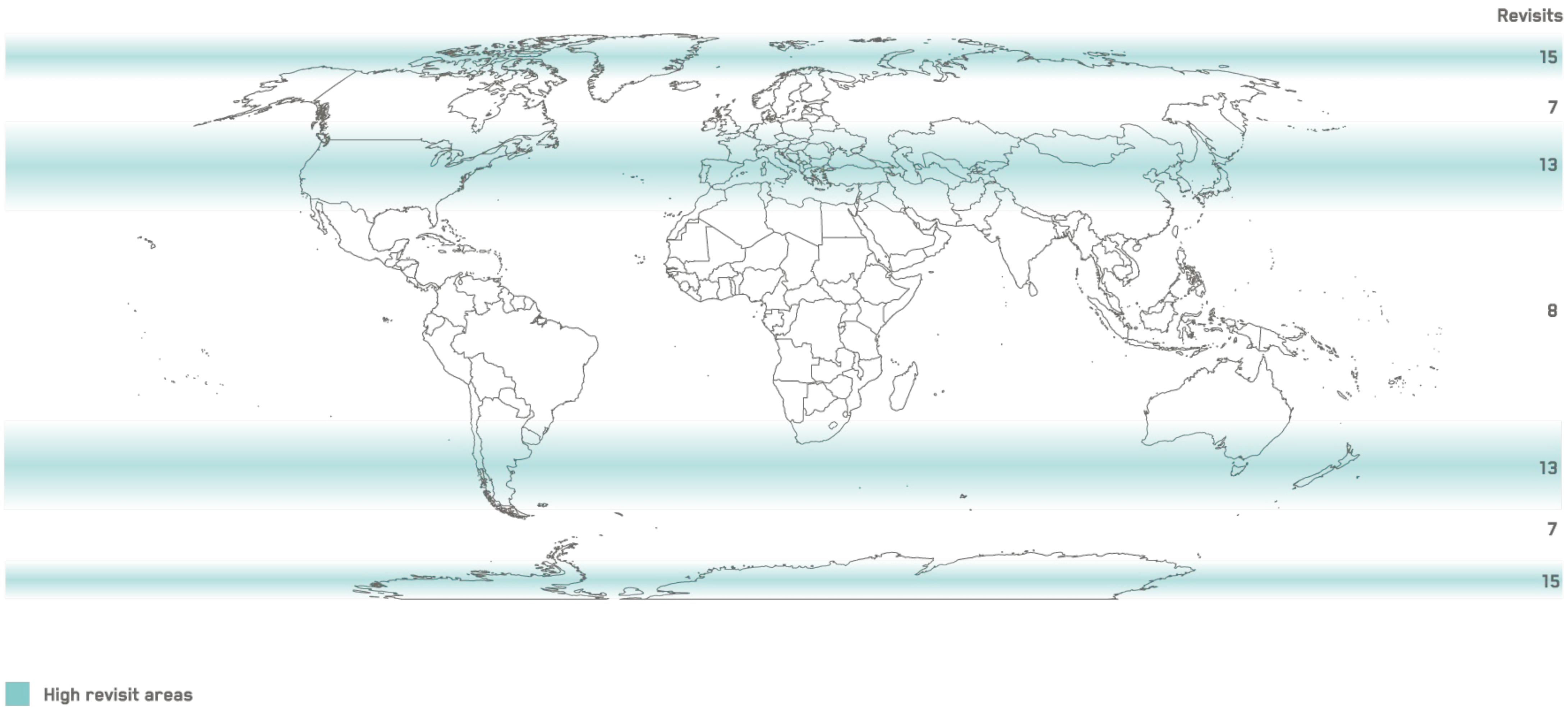
WorldView Legion is a fleet of six high-performing satellites that expands our ability to revisit the most rapidly changing areas on Earth to better inform critical, time-sensitive decisions.

- Launches in 2021
- Will enable up to 15 revisits per day
- Triples Maxar capacity to collect 30 cm imagery
- Triples our overall capacity over high-demand areas
- Highest image quality and geometric accuracy available
- Simultaneous tasking, image and downlink with customer ground stations

Satellite specifications

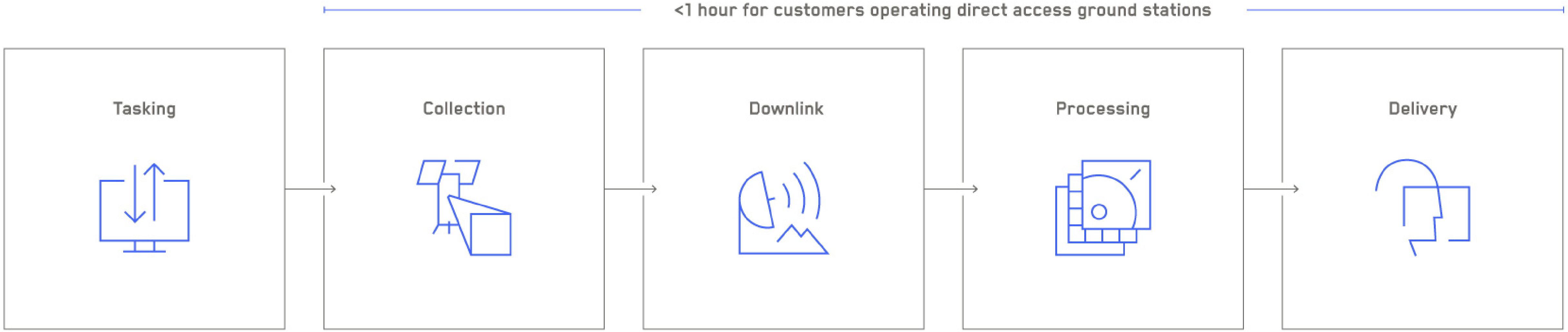
	Launch 1	Launch 2
Number satellites	2	4
Orbit	SSO	MIO
Resolution **Panchromatic** **8-band multispectral** **NIIRS rating**	 29 cm 1.16 m 5.9	 34 cm 1.36 m 5.7
Spacecraft size and mass	Size: 3 m tall x 2 m x 2 m (not including width of solar array) Wet mass: < 750 kg	
Sensor bands	Panchromatic: 450-800 nm 8 multispectral Coastal: Blue: 400-450 nm Blue: 400-510 nm Green: 510-580 nm Yellow: 585-612 nm Red: 630-690 nm Red Edge 1: 695-715 nm Red Edge 2: 730-750 nm Near-IR: 770-895 nm	
Swath width	At nadir: 9 km	
Geolocation accuracy (CE90)	< 5 m CE90 without ground control points	

Enabling up to 15 revisits per day



Low latency matters for an intelligence advantage

Reducing the time between collection and delivery makes intelligence more actionable.



In Orbit
Why Quality Matters

Native resolution matters for detailed insight

Legion class

1.5 m GSD
NIIRS 3.4

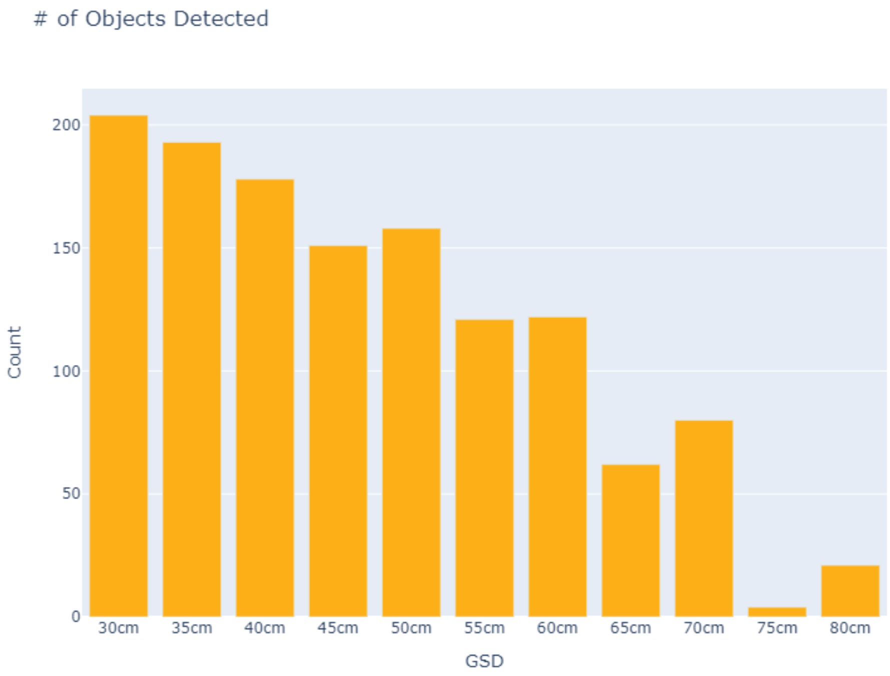
1.0 m GSD
NIIRS 4.0

0.5 m GSD
NIIRS 5.0

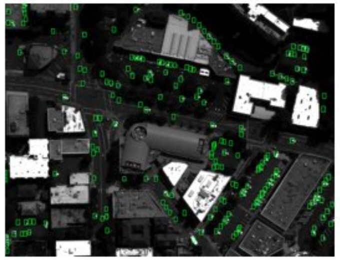
0.3 m GSD
NIIRS 5.7


80cm
75cm
70cm
65cm
60cm
Sensor Altitude vs

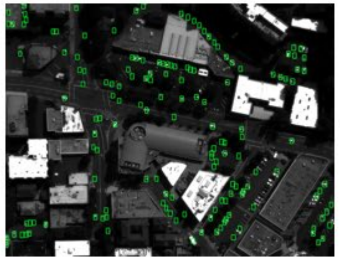
Native resolution matters for detailed insight

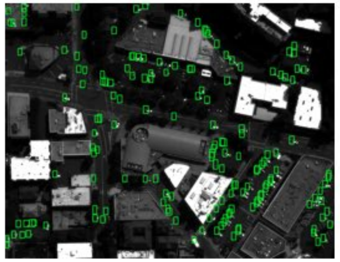



30cm
204/212 96.23%


35cm
193/212 91.04%

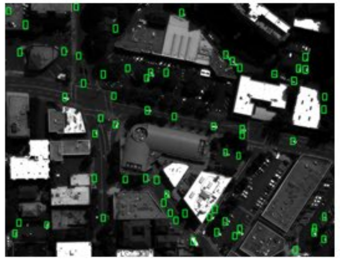

40cm
178/212 83.96%


45cm
151/212 71.23%


50cm
158/212 74.53%

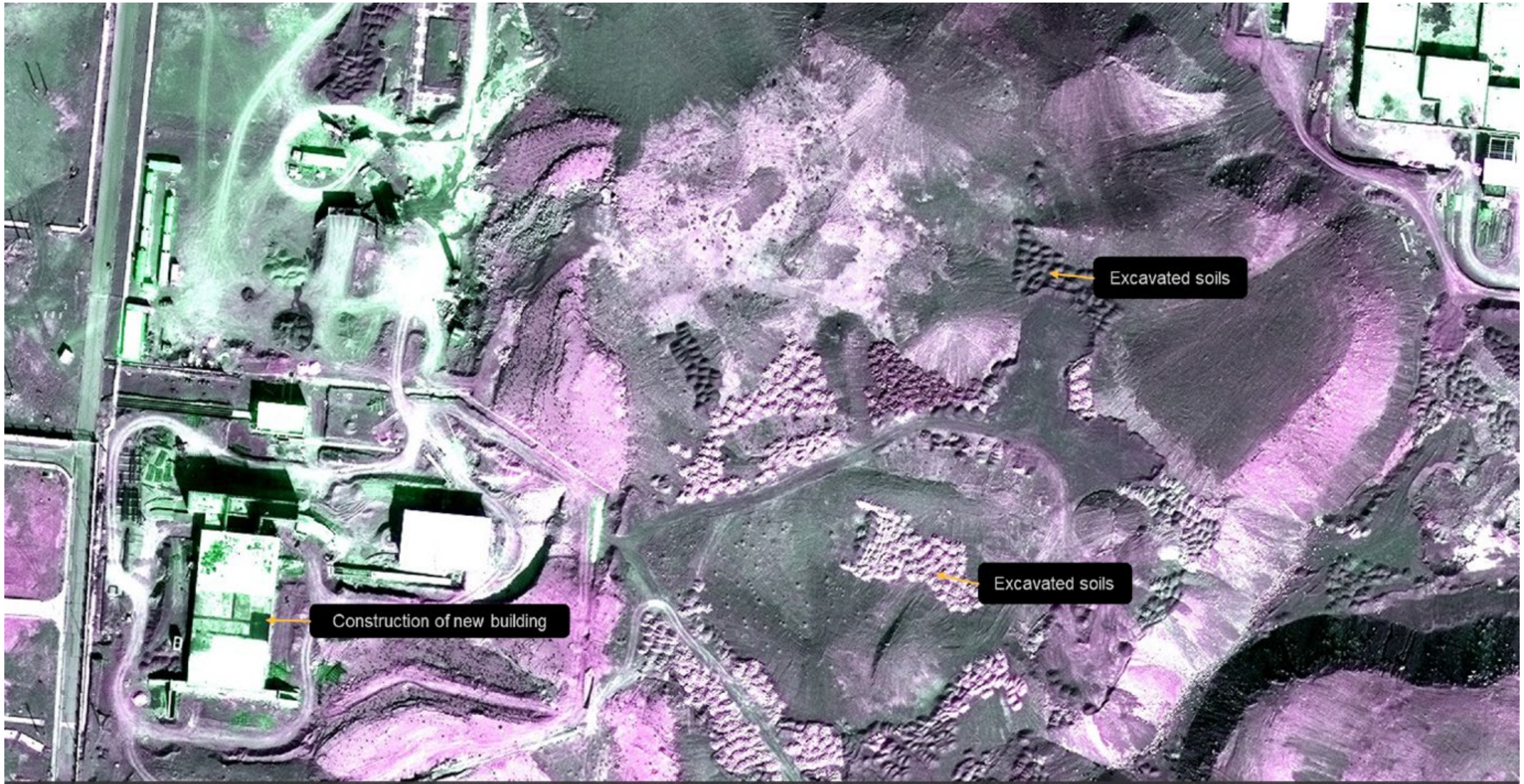

55cm
121/212 57.08%


60cm
122/212 57.55%


65cm
62/212 29.25%


70cm
80/212 37.74%

Spectral richness matters for seeing hidden details



FALSE COLOR | NEW CONSTRUCTION AT ENRICHMENT FACILITY | NATANZ, IRAN | FEBRUARY 10, 2017 | WORLDVIEW-3

Geolocation accuracy matters for precision mapping

5 M ACCURACY
20 M ACCURACY
100 M ACCURACY

High agility matters for challenging collections

WorldView Legion will dramatically slew to collect the maximum number of images and at the most extreme angles.

Monitoring throughout the day

Increased collection opportunities over areas of high interest, unlocking monitoring and change-detection capabilities.

WorldView-3 image 31-cm resolution

WorldView-2 image 46-cm resolution

GeoEye-1 image 41-cm resolution

MAXAR

Analytics at scale

Combining the most advanced geospatial analytics and expertise available with a continuous feed of current imagery will equip customers with unrivaled insights and answers for a competitive edge. This wave of fresh, detailed content will redefine how we enable significantly more accurate, comprehensive, and timely pattern-of-life and human geography analysis.

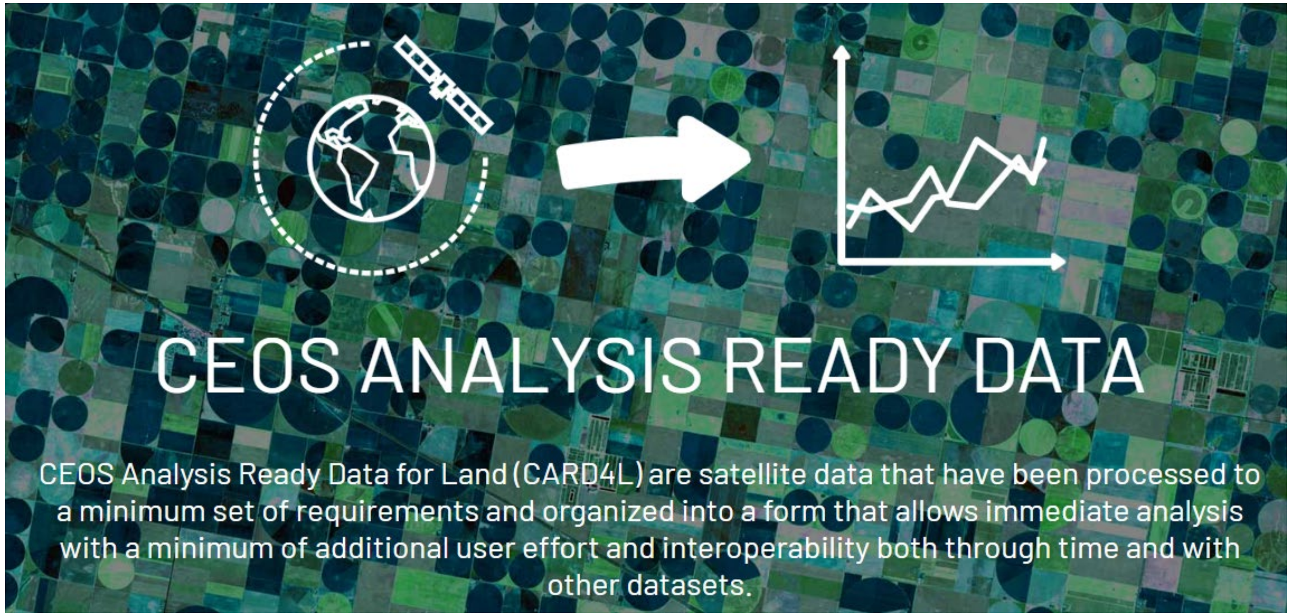
EL PASO TEXAS | AUGUST 14 2019

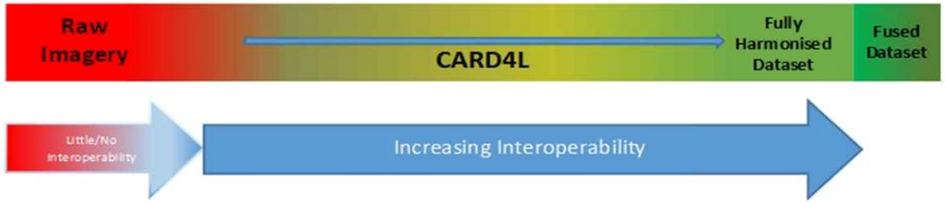
EL PASO TEXAS | NOVEMBER 18 2019

On the Ground
Interoperability and ARD

CEOS CARD4L

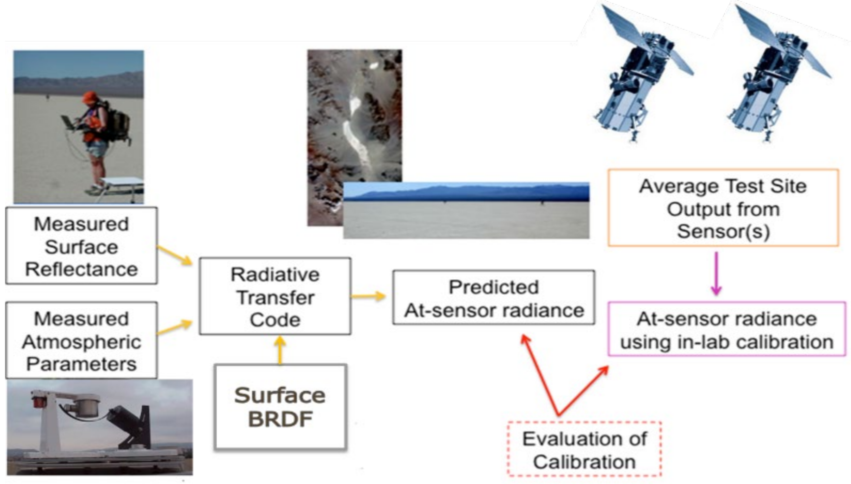
calibration, traceability, surface reflectance, accuracy, uncertainty

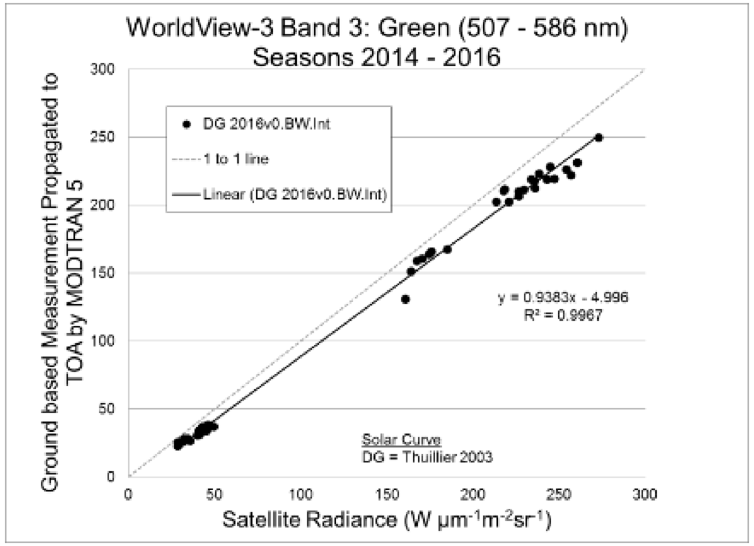




Absolute radiometric calibration

- We employ the reflectance-based vicarious calibration approach developed by the University of Arizona in the late 80’s and employed by NASA and other international agencies
- This method uses in-situ measurements of surface reflectance (of spectrally and spatially homogenous targets) and atmospherics in a radiative transfer model to predict at-sensor radiance for validation and calibration efforts
- Many measurements/dates are used in a regression to determine required adjustments to the pre-launch calibration

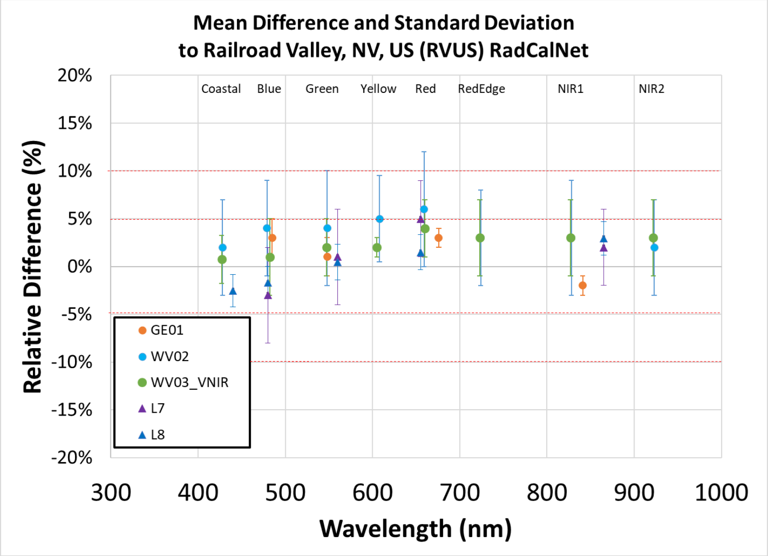




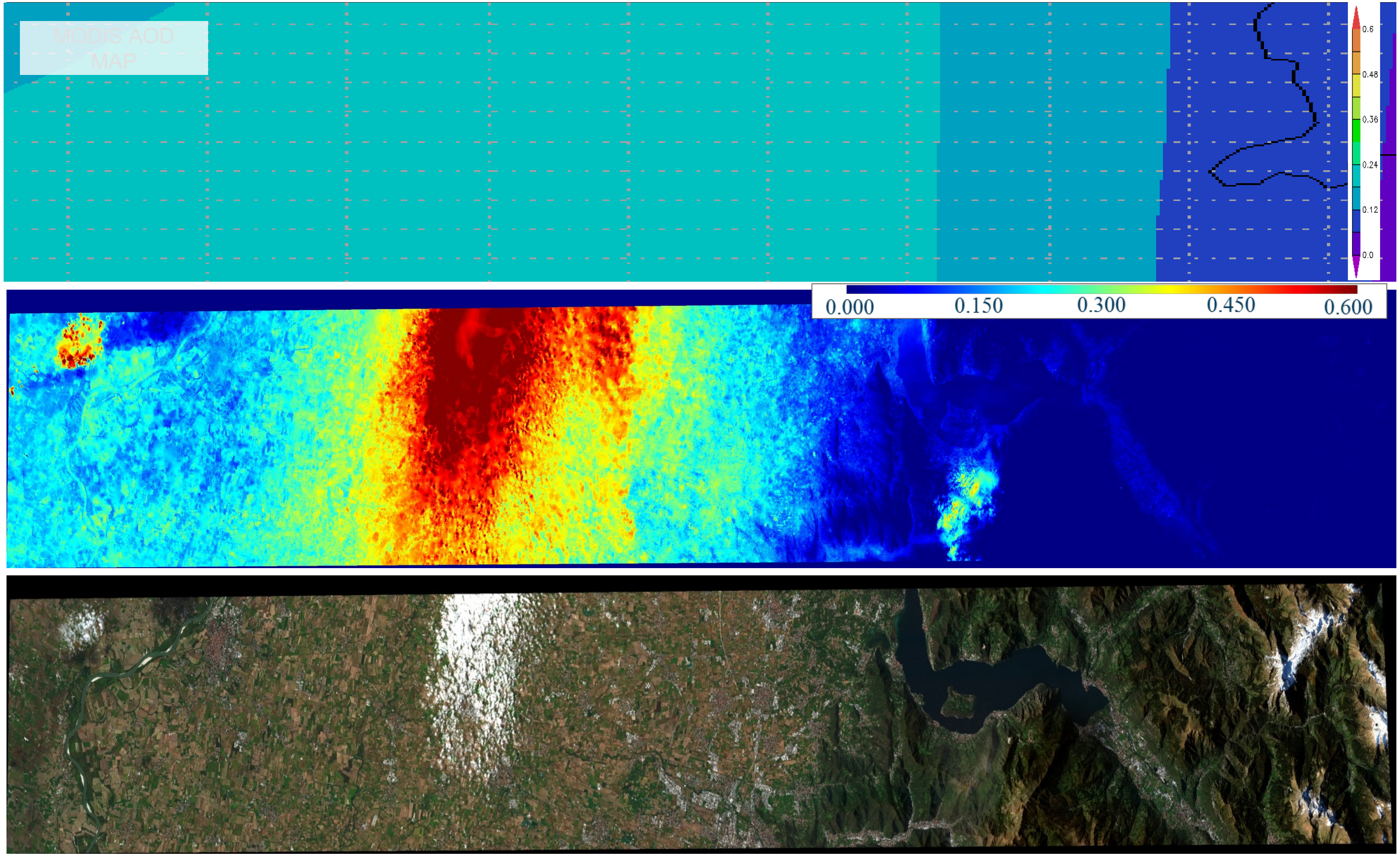
MAXAR

Radiometric agreement with Landsat 7/8

- RadCalNet data are given at Nadir. MAXAR sensors will typically have an ONA of 5 - 30 degrees. Variation in ONA will increase the variability in MAXAR data due to surface BRDF and longer atmospheric path and < 10% is considered good
- GeoEye-1, WorldView-2, and WorldView-3 data shows good correlation with Landsat 7 & 8 data, shown here at Railroad Valley, NV, USA RadCalNet site
- WV02 is showing a relative difference of < 6%, and WV03 and GE01 are < 5%. Comparable Landsat bands are within 5%



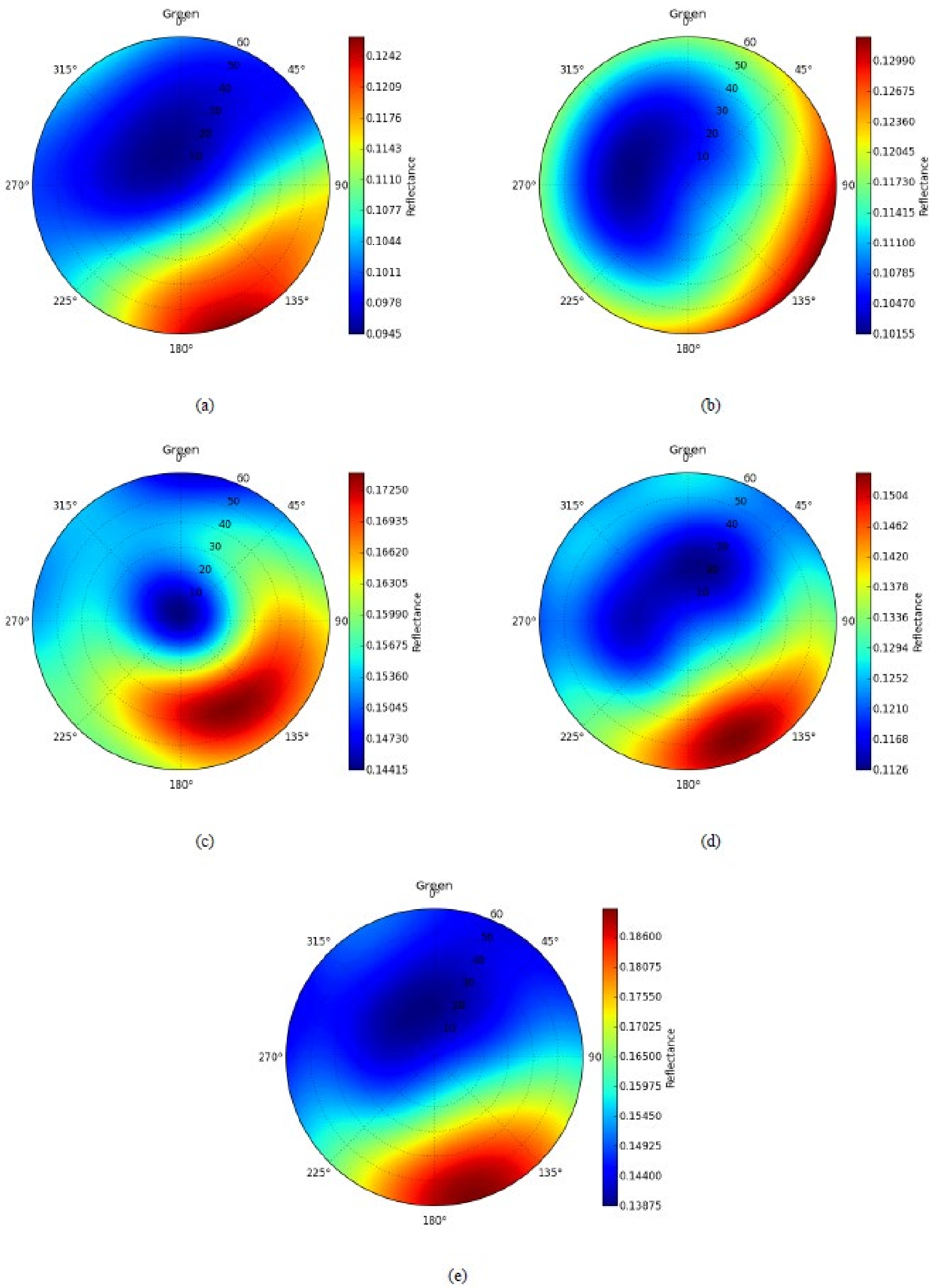
Atmospheric Compensation (AComp)



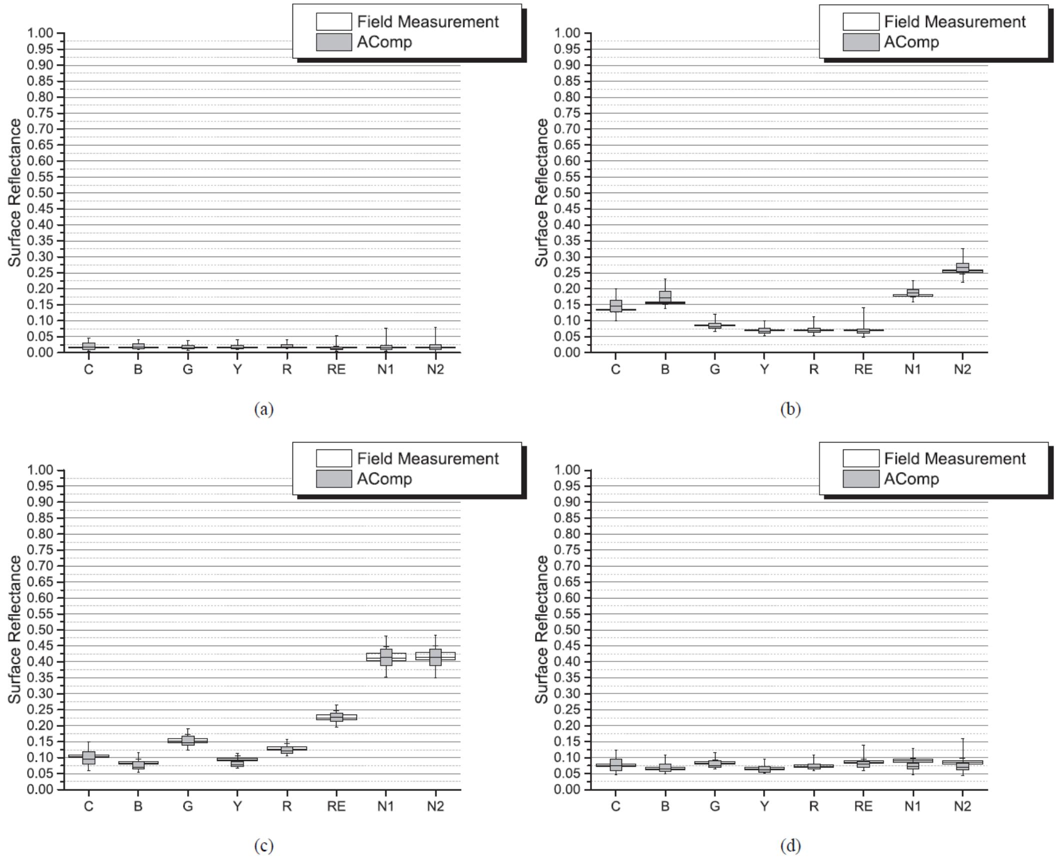
ASD Spectrometer Measurements

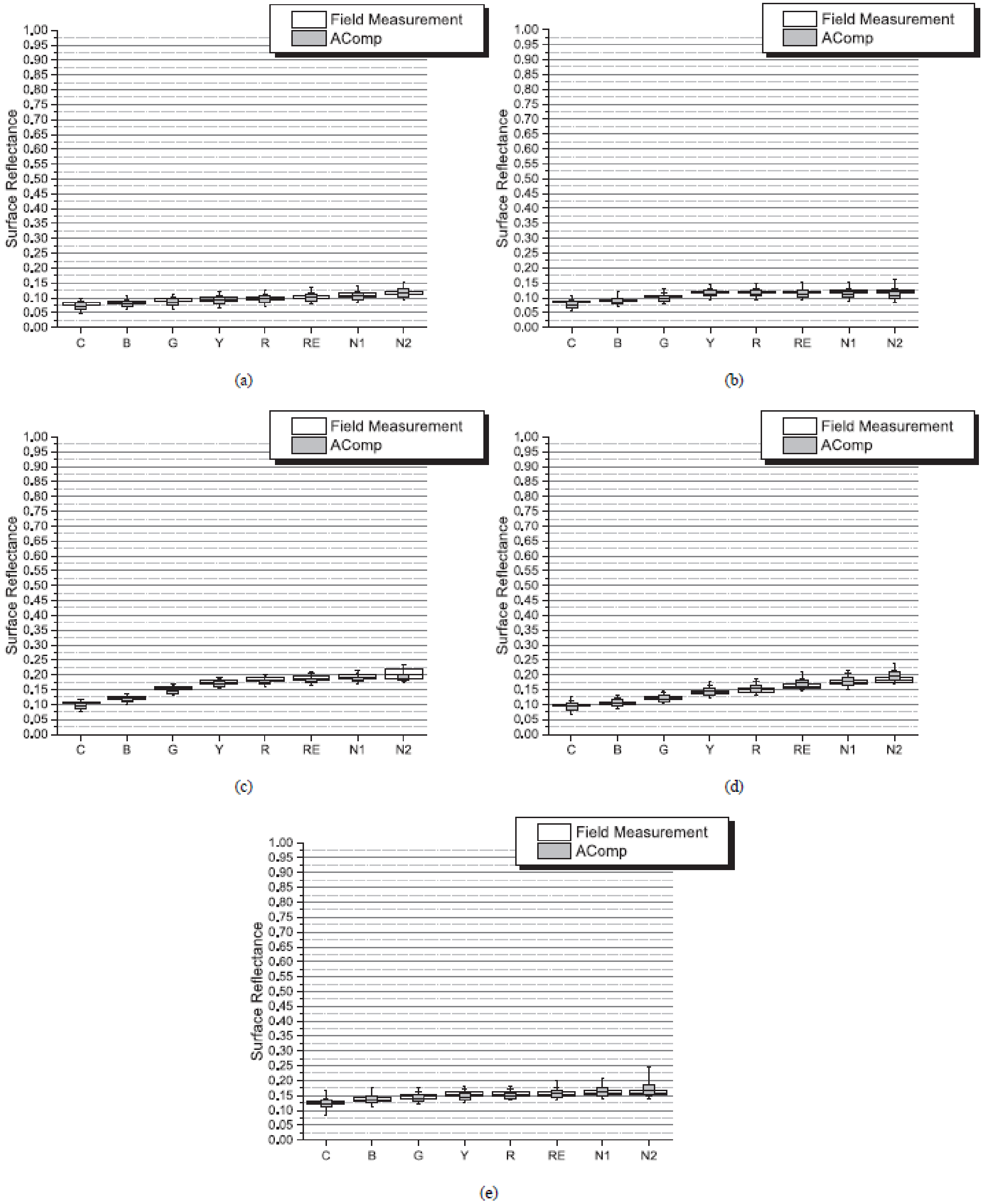
Measurements at equinox:

- asphalt surfaces (mainly large roads and parking lots)
- concrete
- tar materials (running tracks, basketball and tennis courts)
- sand (beach volleyball courts)

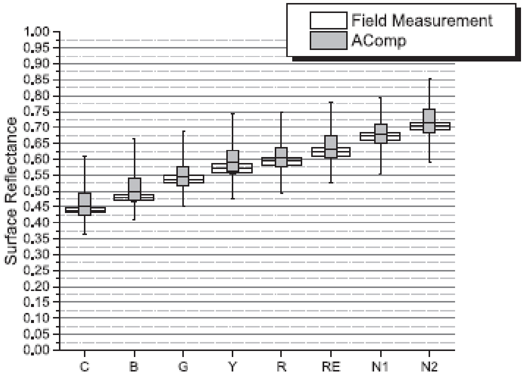


Validation (1/2)

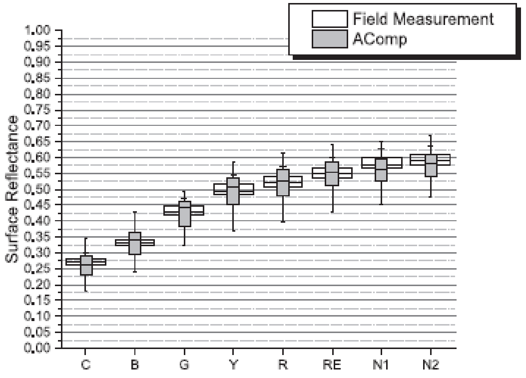




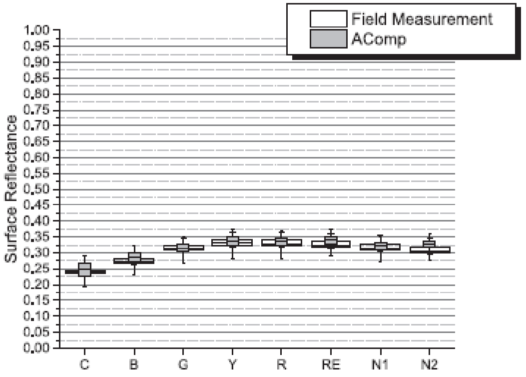
Validation (2/2)



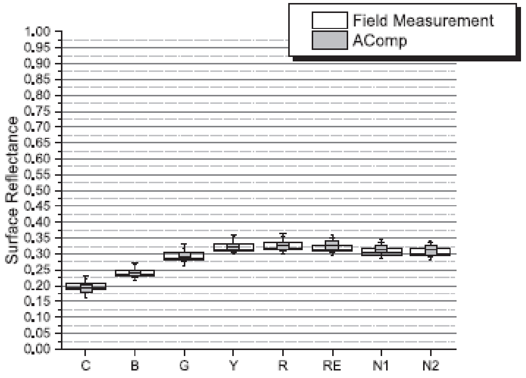
(a)



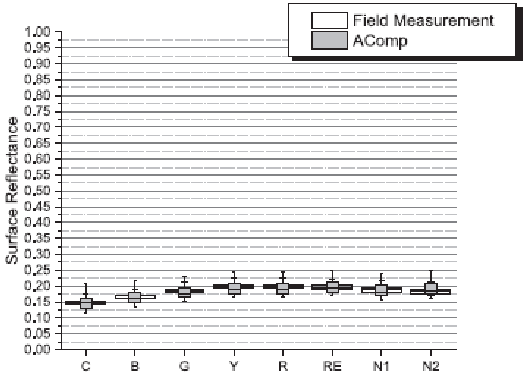
(b)



(a)

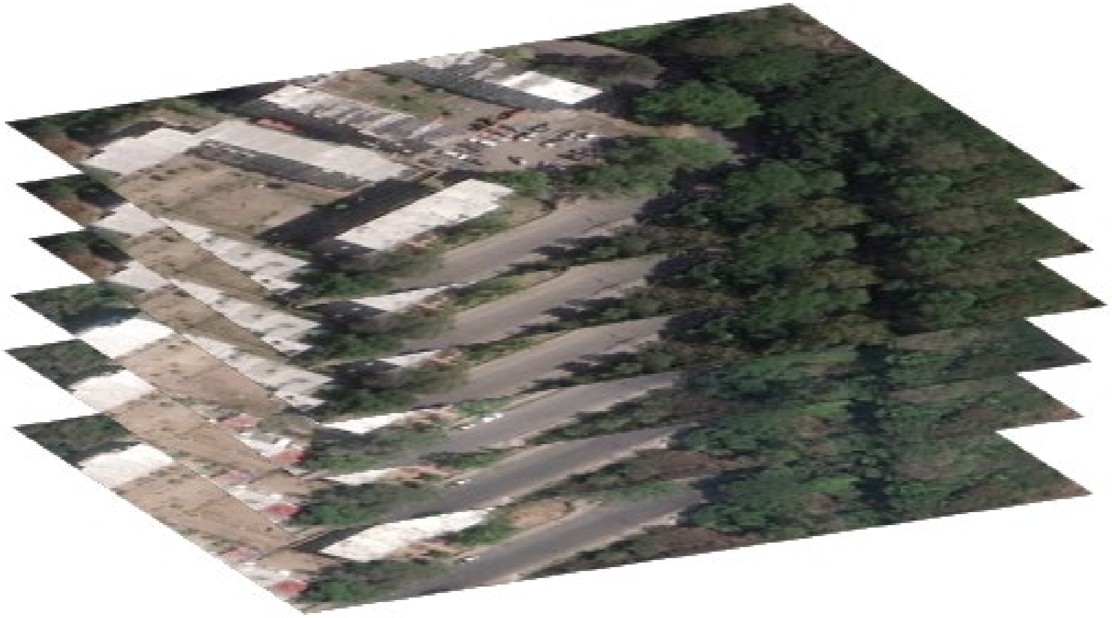


(b)



(c)

ARD as a stack of images ..

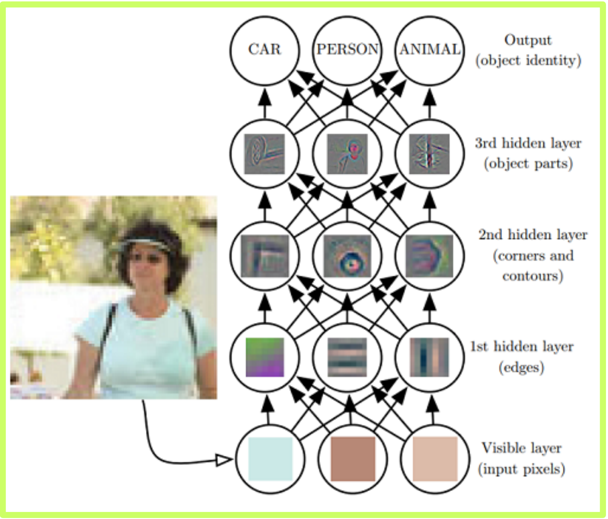


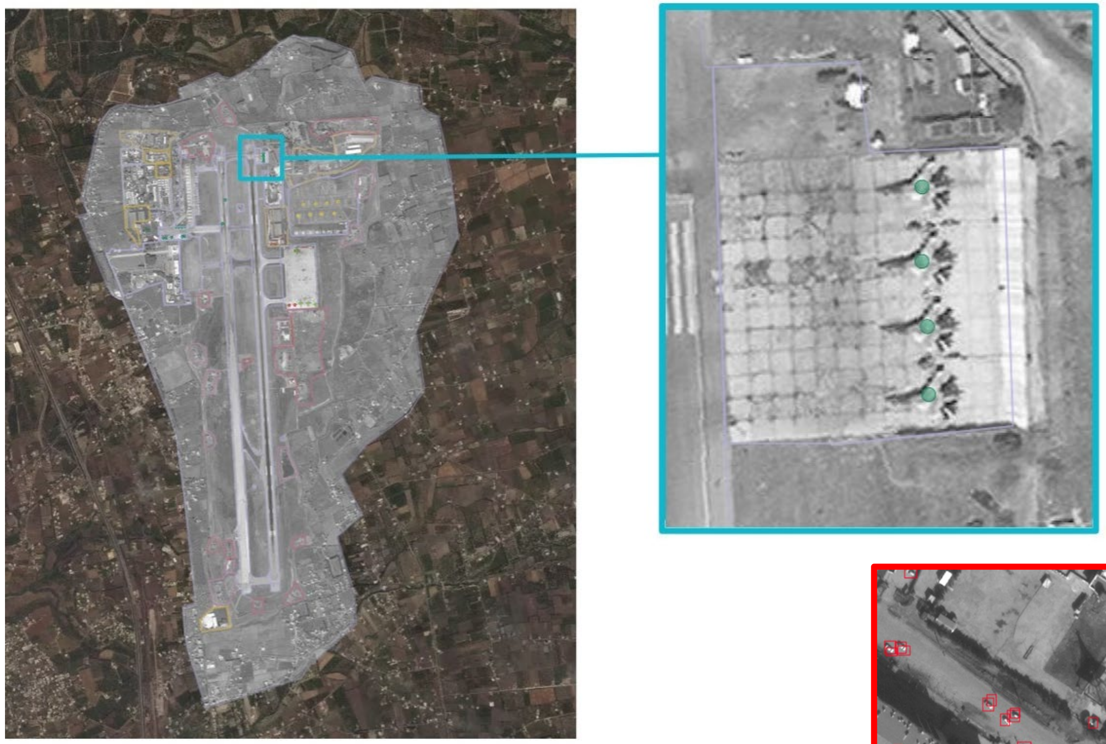
Orthorectification without/with registration

Orthorectification without/with registration

Orthorectification without/with registration

ARD: There is no one-size-fits-all solution

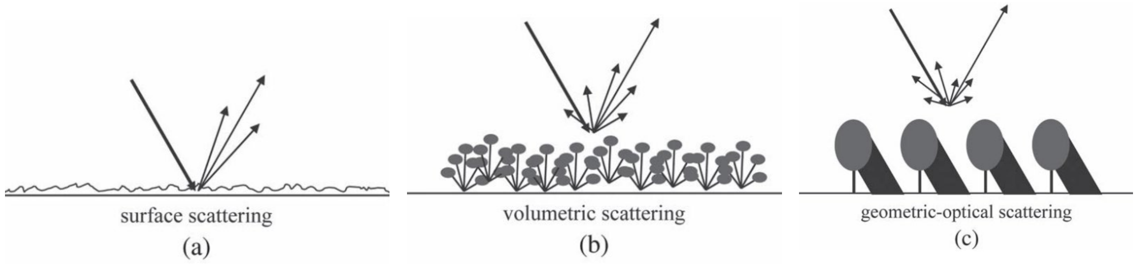




bidirectional reflectance distribution function

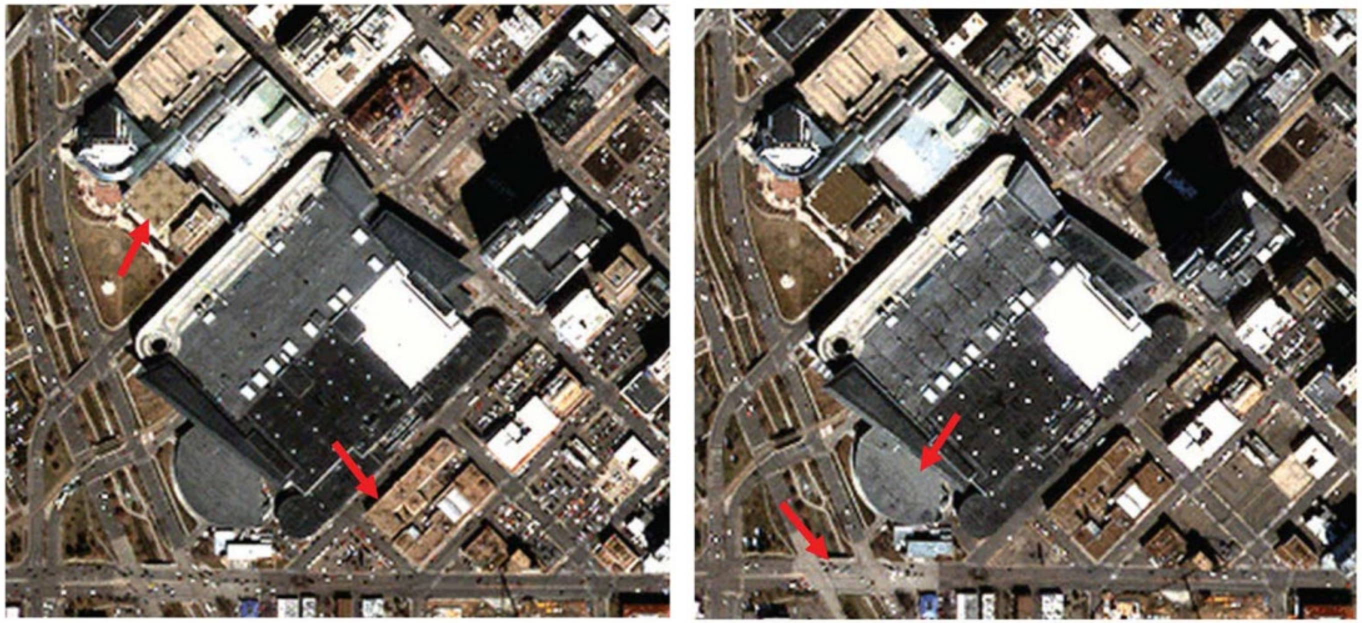
no calibration surface reflectance

ARD: There is no one-size-fits-all solution

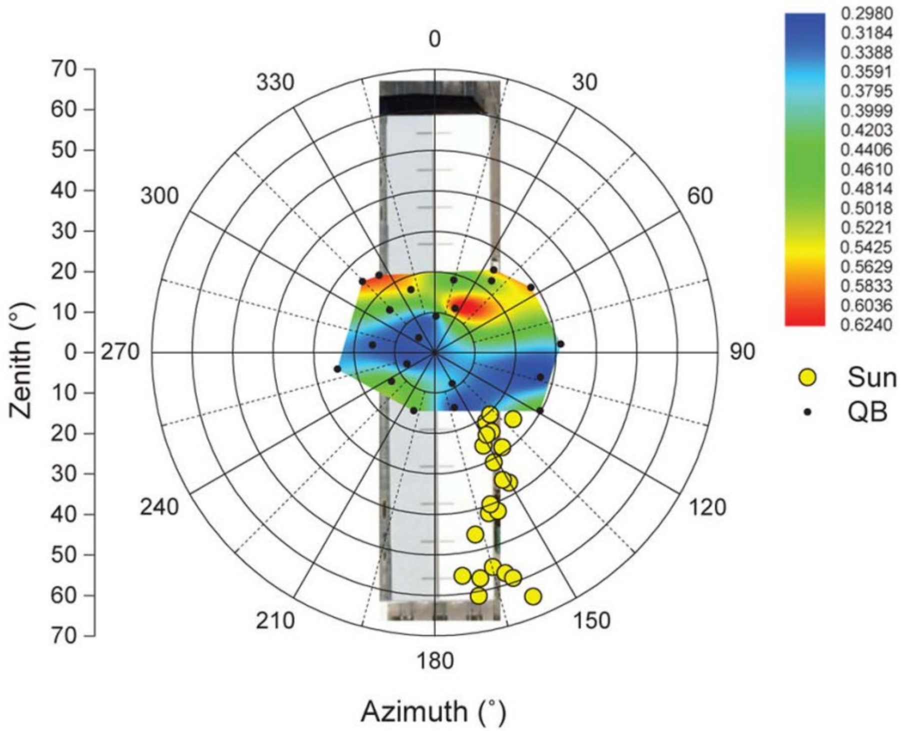


BRDF:

- sun-viewing geometry
- material
- structure



(a) (b)



MAXAR

ARD: READY for what?

- users in established markets (agriculture, maritime) are very familiar with data (either optical/hyperspectral, SAR, LiDAR, etc..), and expect greatest quality in terms of sensor calibration, accuracy, and uncertainty

- users in new markets (insurance, finance) often do not necessarily understand (or care) about these characteristics, and all they need are insights.
  - If insights are not available when needed, then no application will be impactful

Imagery

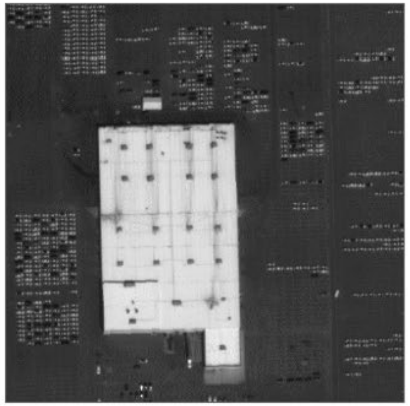
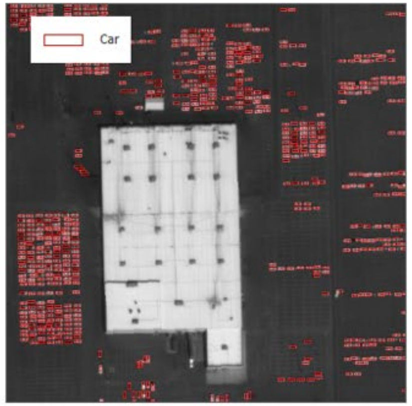


Image of parking lot

Information



Global database of cars in "all" parking lots

Insight

Info Services offerings
- Retail traffic volume
- Competitor intelligence
- Factory output

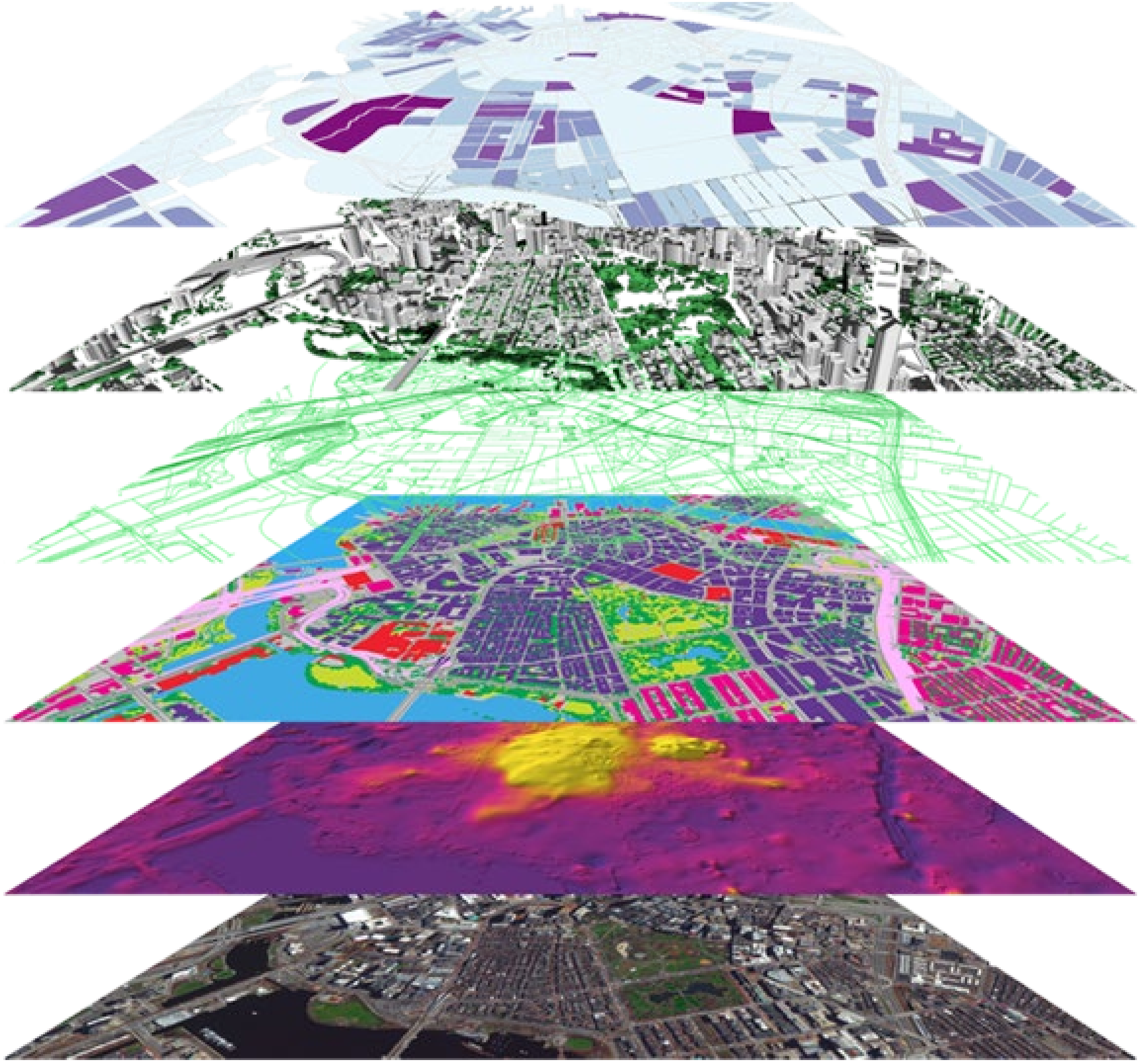
Customer segments
- Financial Services
- Retail
- Manufacturing

ARD: Different needs

- Civil Government vs Industry vs Intelligence
  - different missions, timelines, requirements
  - different users and skills

- Key characteristics for datasets

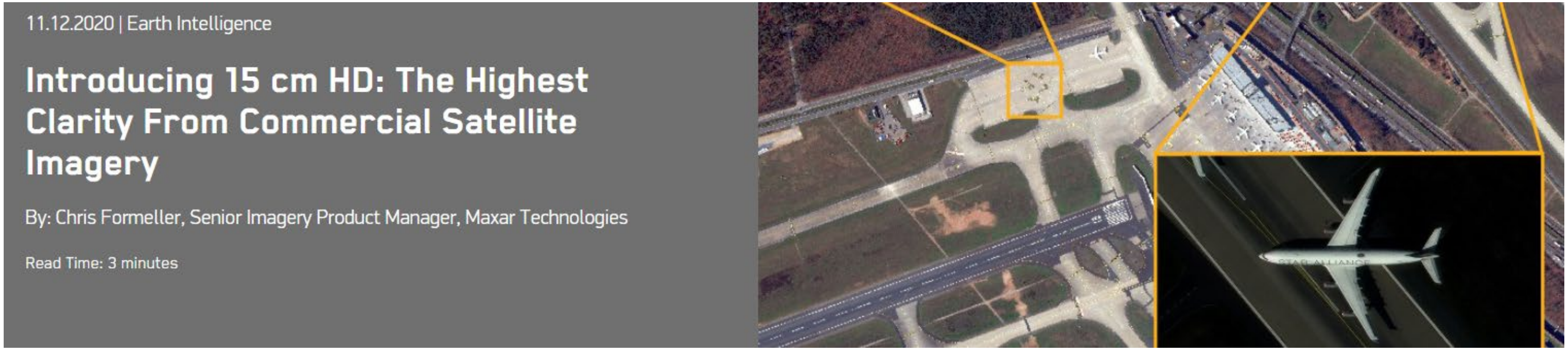
Quality | Availability | Accessibility | Interoperability



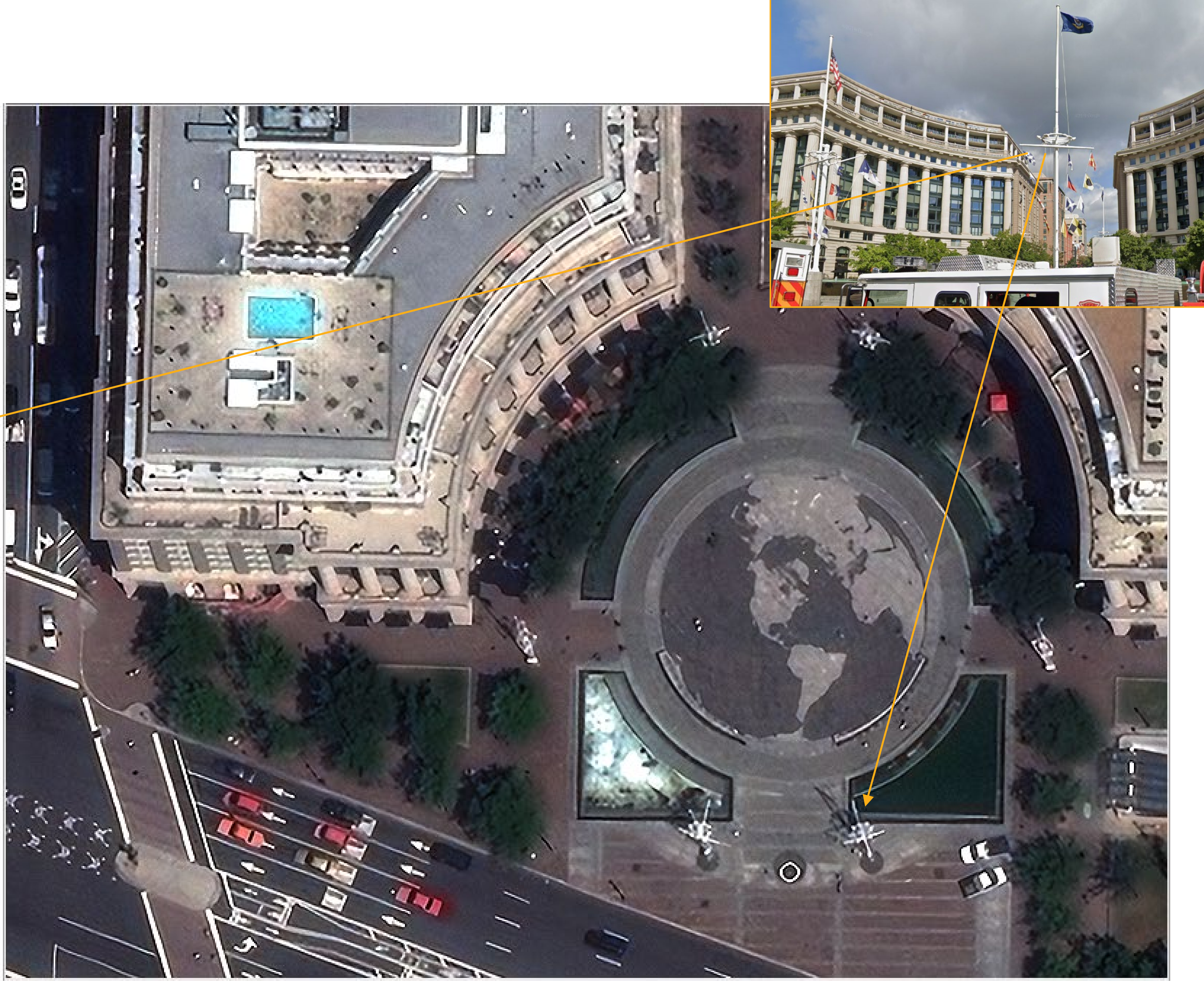
On the Ground - Advanced Products
High Definition (HD)

High Definition

- The HD technology is a proprietary technique developed by Maxar that improves the visual clarity ("acutance") of an image
- The improved clarity means there is less visual clutter and pixelation that can distract or confound interpretation by human eyes or computer algorithms
- By using this technology, Maxar enables faster and more accurate data extraction from images collected by our satellite constellation.

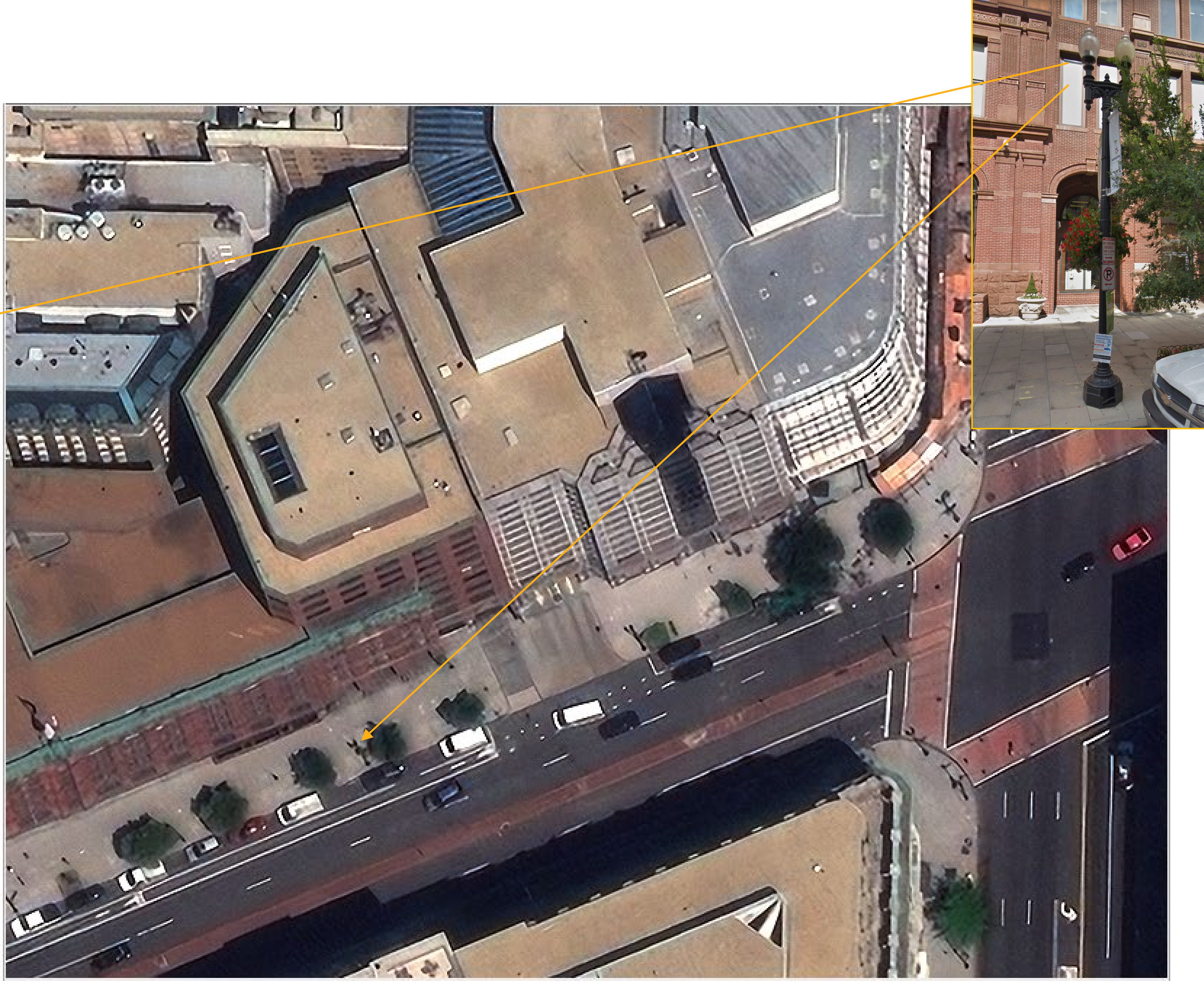


Native (30 cm)

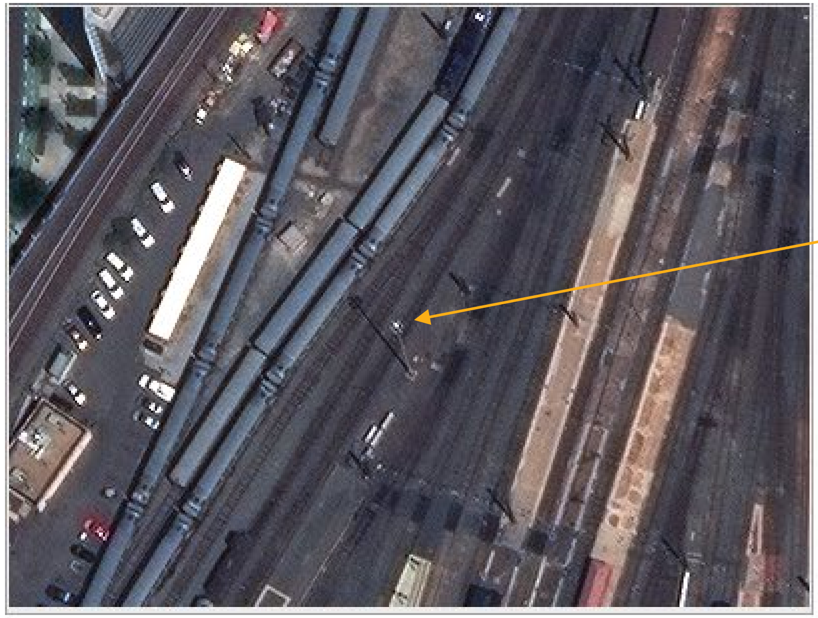


HD (15 cm)

Native (30 cm)

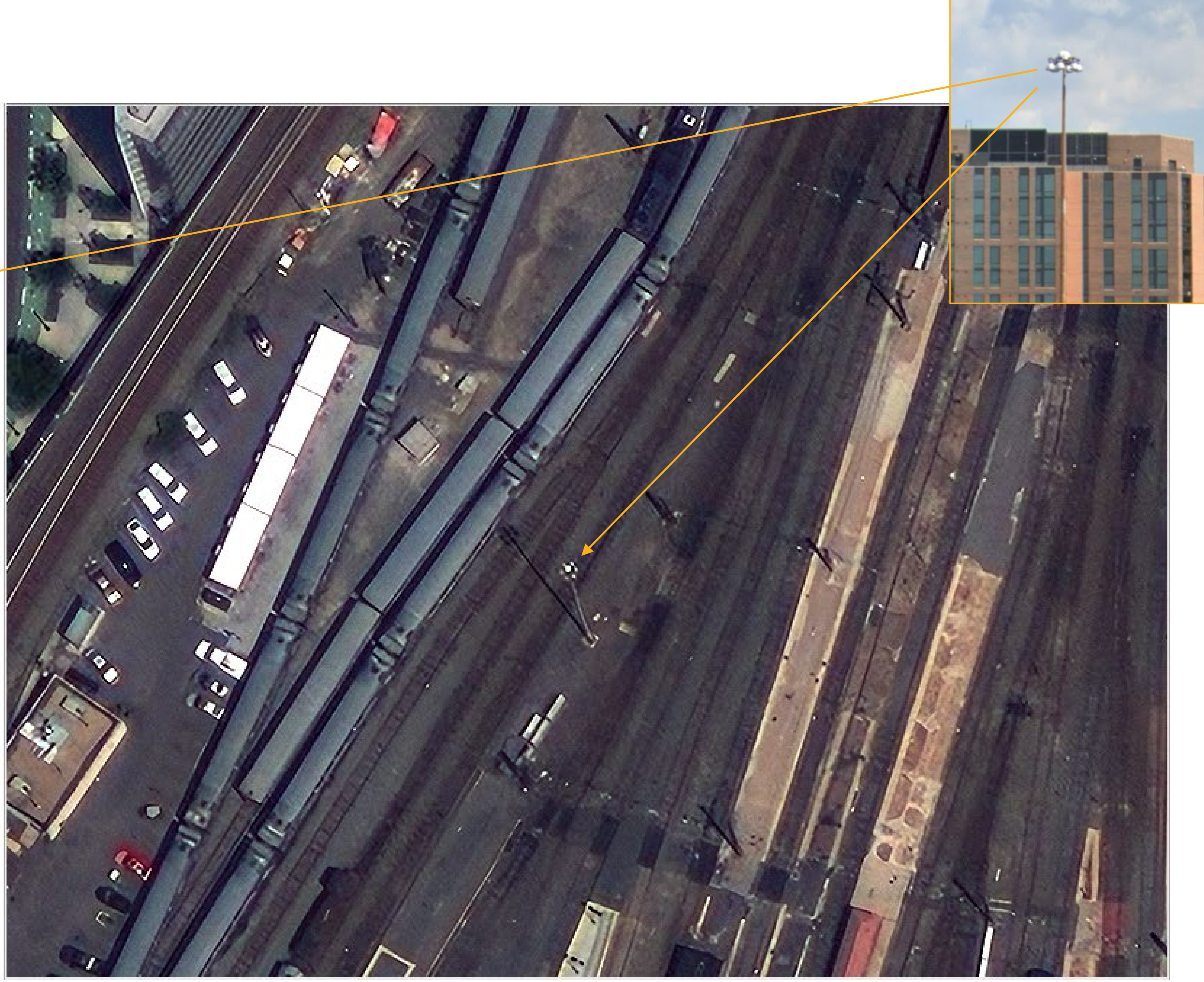


HD (15 cm)



Native (30 cm)

HD (15 cm)



Native (30 cm)

HD (15 cm)

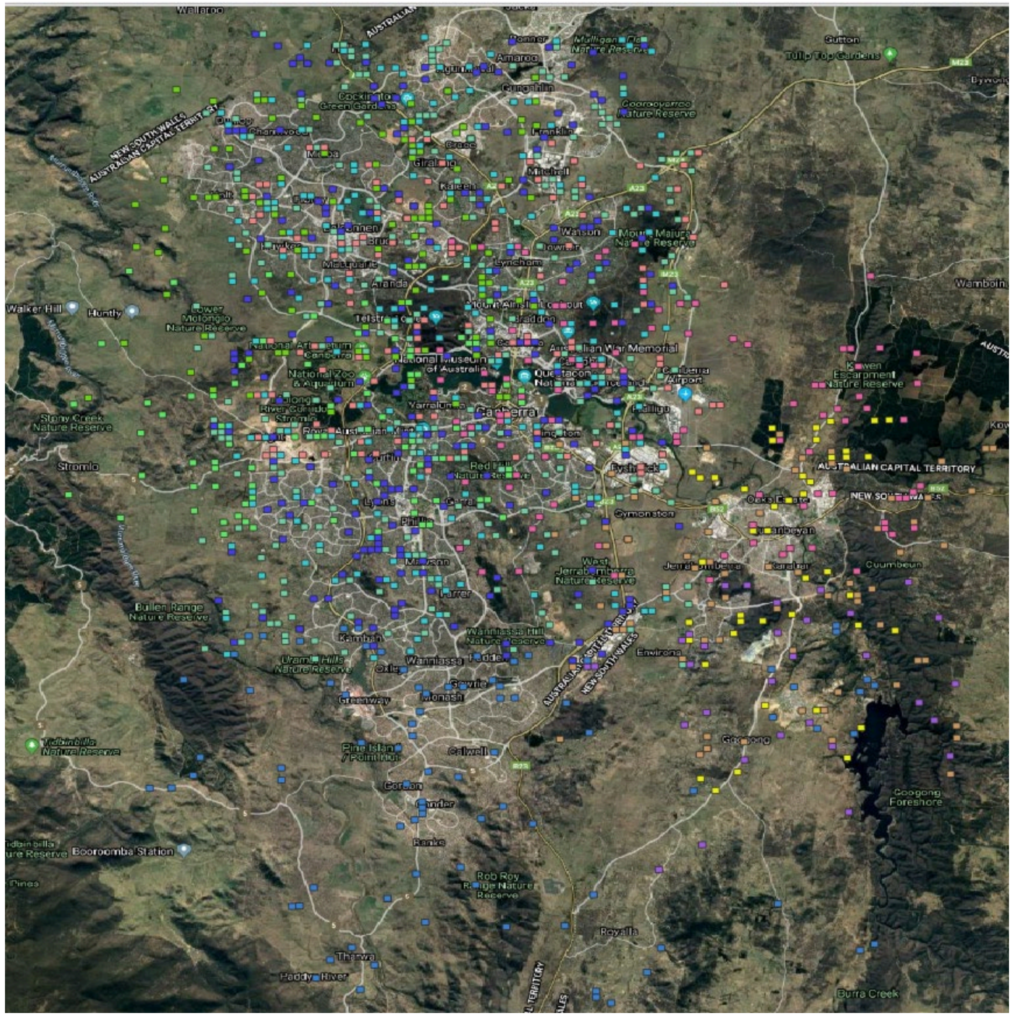
How to measure quality and improvements?

- Question:
  - Compared to 50 cm native resolution imagery, can HD imagery objectively improve the outcomes of detecting objects using machine learning?

- Methodology:
  - Holding everything constant except HD processing, train two new object detection models and compare performance

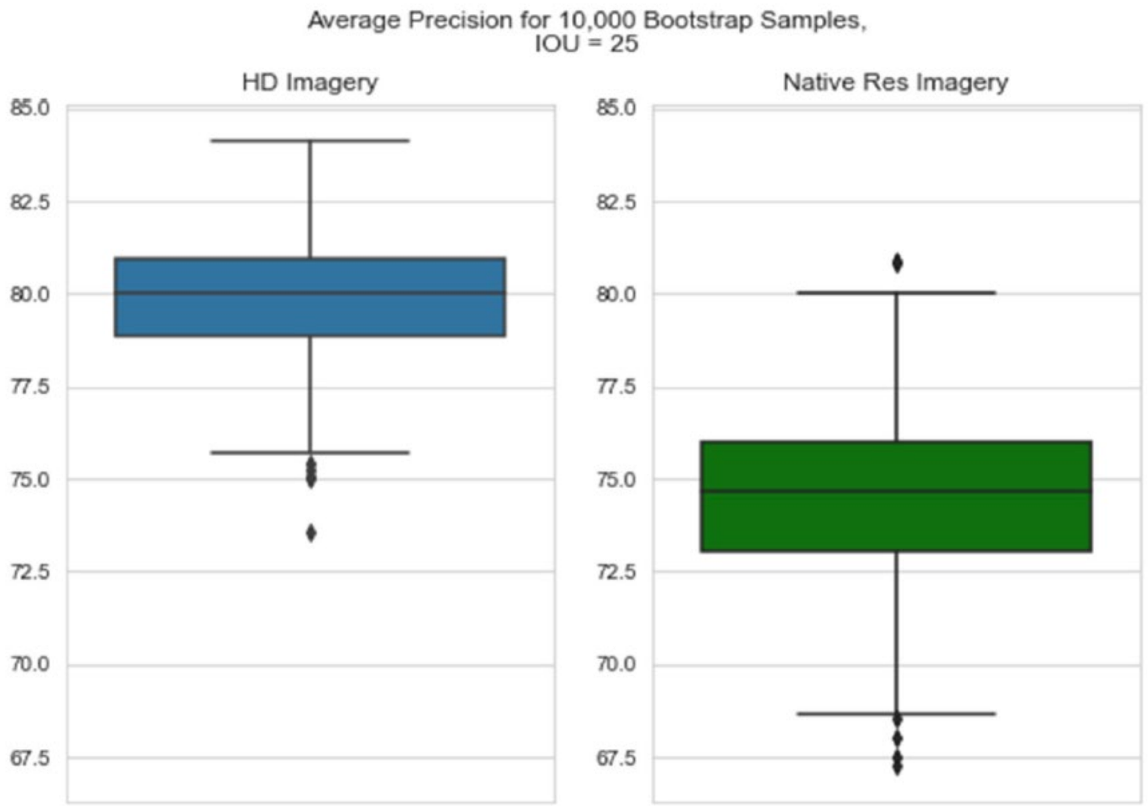
Imagery Sources and Preparation

- 11 catalog images at native 50 cm resolution
  - ~50% WorldView2, ~50% GeoEye1
- Two versions of each image strip prepared: one at 50cm (native resolution) and one at 25cm (HD)
- All images prepared in the same way:
  - 50cm and HD image pairs are pixel aligned and consistently colored (AComp, DRA, Ortho, all consistent)
- Random spatial sample of image chips from used to cover geographic and image variability



Model Training

- Model architecture
  - Faster RCNN Model
- Model training
  - Separate models trained on both HD and native resolution using same model parameters



(IOU: intersect-over-union)

On the Ground - Advanced Products
The Earth in 3D

The Earth in 3D

WorldView Legion's agility and stereo capabilities will substantially increase our ability to model the Earth in 3D.

The Earth in 3D

WorldView Legion's agility and stereo capabilities will substantially increase our ability to model the Earth in 3D.

The Earth in 3D

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Thank you!