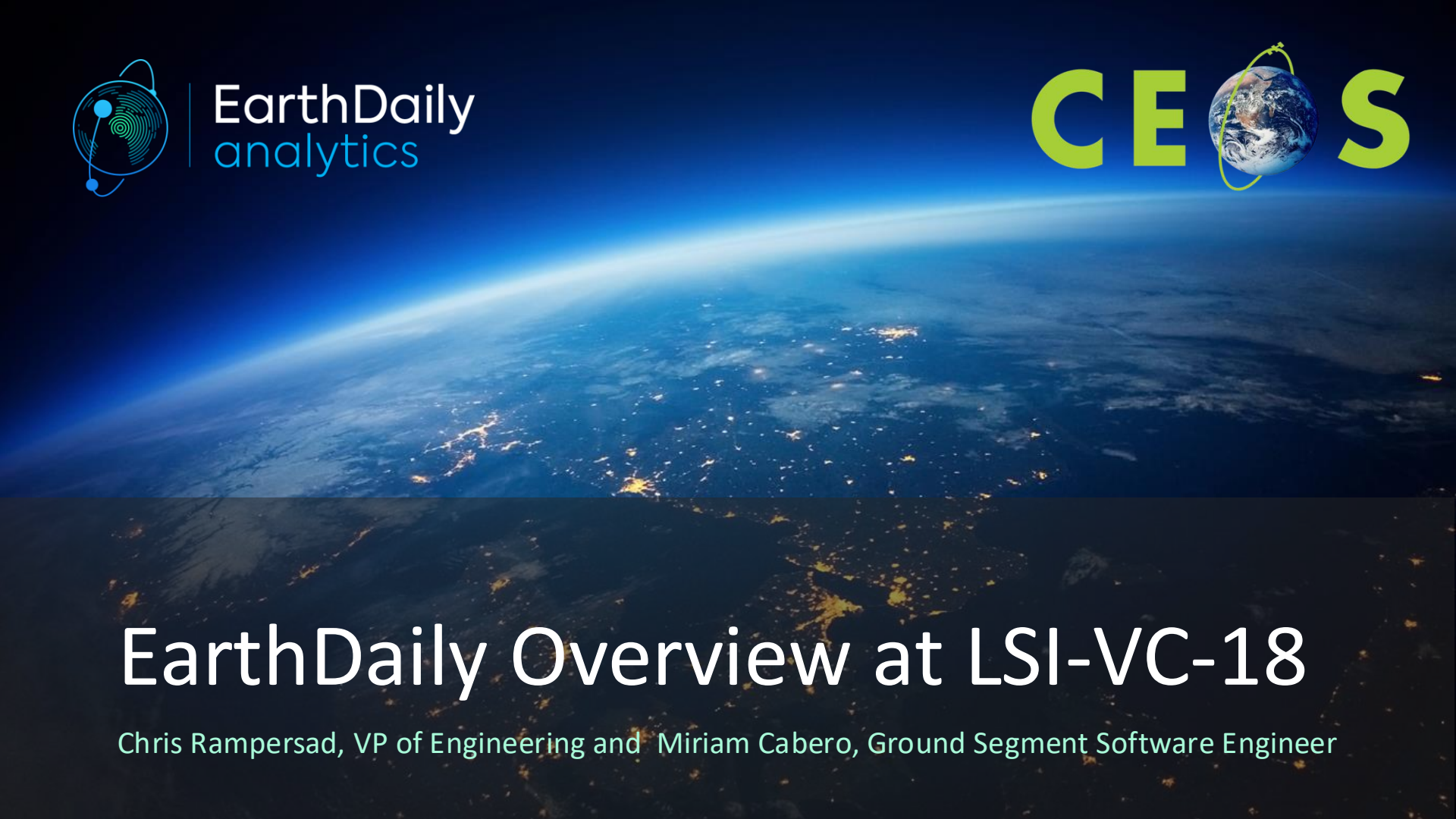


EarthDaily Overview at LSI-VC-18

Chris Rampersad, VP of Engineering and Miriam Cabero, Ground Segment Software Engineer

At EarthDaily,

Our mission is to revolutionize Earth Observation by providing actionable insights through advanced data and analytics.

We empower decision-makers and risk managers globally to tackle the biggest challenges facing businesses, governments, and humanity.

Vertically Integrated

We control every aspect from satellite design to data processing.

Innovative Technology

Utilizing cutting-edge AI and big data tools.

Global Reach

Delivering comprehensive coverage of the world's landmasses and maritime regions daily.

Track Record

Over 35 years of leadership and innovation in Earth Observation.

EarthDaily Constellation

Offering spectrally robust, analysis-ready data.

EarthDaily analytics

A Pressing Need for Global Change Detection

The greatest challenges the world faces require high-cadence, high-coverage, scientific-quality satellite imagery for AI-derived monitoring, change detection alerting, and predictive analytics, at scale:

- Natural Hazard Risks (Flood, Fire, Storm, etc.)
- Food Security & Farm Soil Protection
- Water Optimization
- Climate Change & Carbon Trading
- Deforestation
- Habitat Protection
- Defense and Border Security

Forestry

Environment

Agriculture

Natural Resources

Disasters

Insurance

Commodities

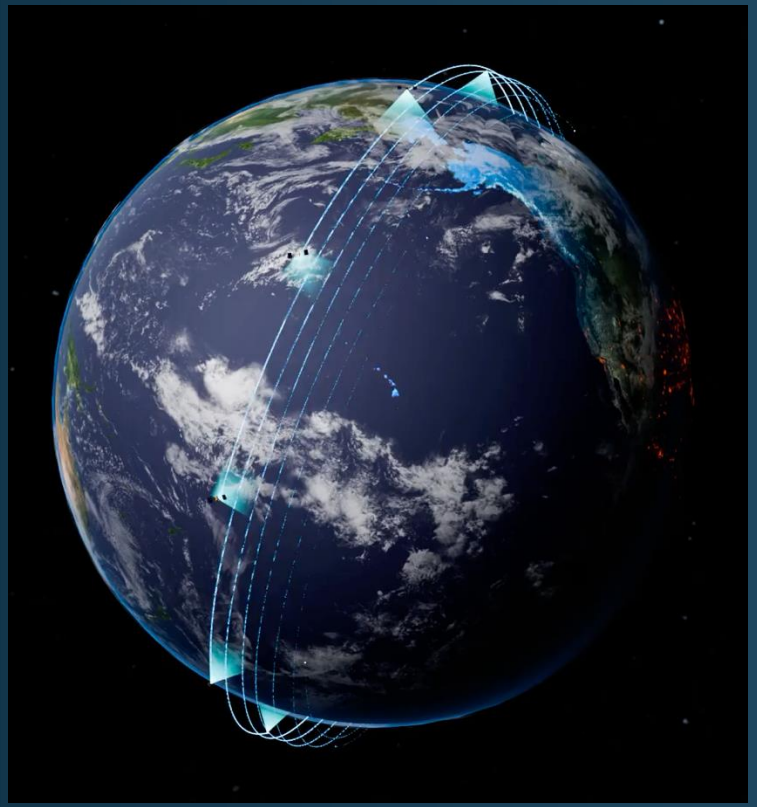
NGOs

A daily global Earth Observation mission with scientific quality would improve our ability to manage risk, forecast events, and provide key alerts

EarthDaily analytics

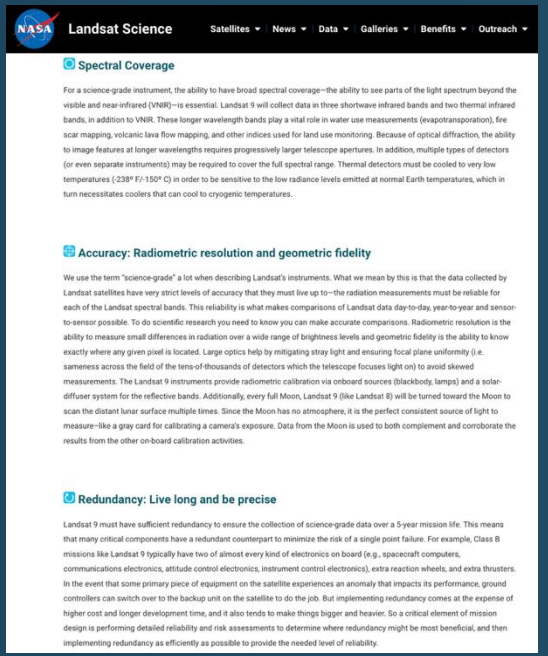
EarthDaily Constellation – Global Daily Scientific Monitoring Mission

Satellites	10
Launch Period	2025 / 2026
Size / Mass	215 Kg
Spacecraft	Arrow bus from Airbus
Design Life	10-years
Orbit	Sun-synchronous; 10:30 AM local time pass over
Orbit Control	Precisely maintained for consistent viewing over mission
Revisit	1 Day; daily coverage of ~100% of Earth's landmass
Resolution	VNIR: GSD 5.0m SWIR: GSD: 95m Thermal: GSD: 120m
Altitude	630km
Viewing Angle	Nadir (always)



NASA defines three key ingredients for science quality

- Spectral Coverage, Accuracy, Redundancy



Landsat Science

Satellites | News | Data | Galleries | Benefits | Outreach

Spectral Coverage

For a science-grade instrument, the ability to have broad spectral coverage—the ability to see parts of the light spectrum beyond the visible and near-infrared (VNIR)—is essential. Landsat 9 will collect data in three shortwave infrared bands and two thermal infrared bands, in addition to VNIR. These longer wavelength bands play a vital role in water use measurements (evapotransporation), fire scar mapping, volcanic lava flow mapping, and other indices used for land use monitoring. Because of optical diffraction, the ability to image features at longer wavelengths requires progressively larger telescope apertures. In addition, multiple types of detectors (or even separate instruments) may be required to cover the full spectral range. Thermal detectors must be cooled to very low temperatures (-238° F/-150° C) in order to be sensitive to the low radiance levels emitted at normal Earth temperatures, which in turn necessitates coolers that can cool to cryogenic temperatures.

Accuracy: Radiometric resolution and geometric fidelity

We use the term "science-grade" a lot when describing Landsat's instruments. What we mean by this is that the data collected by Landsat satellites have very strict levels of accuracy that they must live up to—the radiation measurements must be reliable for each of the Landsat spectral bands. This reliability is what makes comparisons of Landsat data day-to-day, year-to-year and sensor-to-sensor possible. To do scientific research you need to know you can make accurate comparisons. Radiometric resolution is the ability to measure small differences in radiation over a wide range of brightness levels and geometric fidelity is the ability to know exactly where any given pixel is located. Large optics help by mitigating stray light and ensuring focal plane uniformity (i.e. sameness across the field of the tens-of-thousands of detectors which the telescope focuses light on) to avoid skewed measurements. The Landsat 9 instruments provide radiometric calibration via onboard sources (blackbody, lamps) and a solar-diffuser system for the reflective bands. Additionally, every full Moon, Landsat 9 (like Landsat 8) will be turned toward the Moon to scan the distant lunar surface multiple times. Since the Moon has no atmosphere, it is the perfect consistent source of light to measure—like a gray card for calibrating a camera's exposure. Data from the Moon is used to both complement and corroborate the results from the other on-board calibration activities.

Redundancy: Live long and be precise

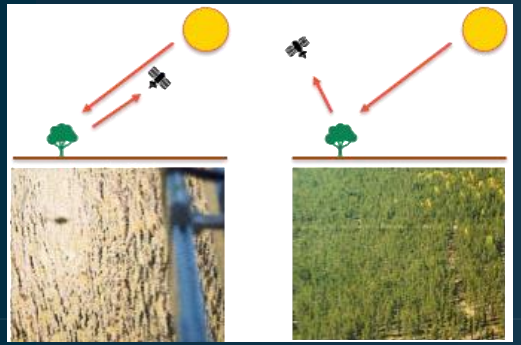
Landsat 9 must have sufficient redundancy to ensure the collection of science-grade data over a 5-year mission life. This means that many critical components have a redundant counterpart to minimize the risk of a single point failure. For example, Class B missions like Landsat 9 typically have two of almost every kind of electronics on board (e.g., spacecraft computers, communications electronics, attitude control electronics, instrument control electronics), extra reaction wheels, and extra thrusters. In the event that some primary piece of equipment on the satellite experiences an anomaly that impacts its performance, ground controllers can switch over to the backup unit on the satellite to do the job. But implementing redundancy comes at the expense of higher cost and longer development time, and it also tends to make things bigger and heavier. So a critical element of mission design is performing detailed reliability and risk assessments to determine where redundancy might be most beneficial, and then implementing redundancy as efficiently as possible to provide the needed level of reliability.

EARTH DAILY

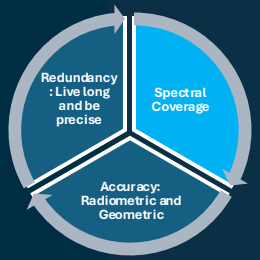
Consistent – Optimized for Change Detection

Controlled orbit

Same altitude
Same resolution
Same time
Same angle
Same shadows
Same calibrated sensors
Same over 10 years
Science-grade consistency with Sentinel-2 and Landsat



Science-Grade Satellite Data, Built for the AI Revolution

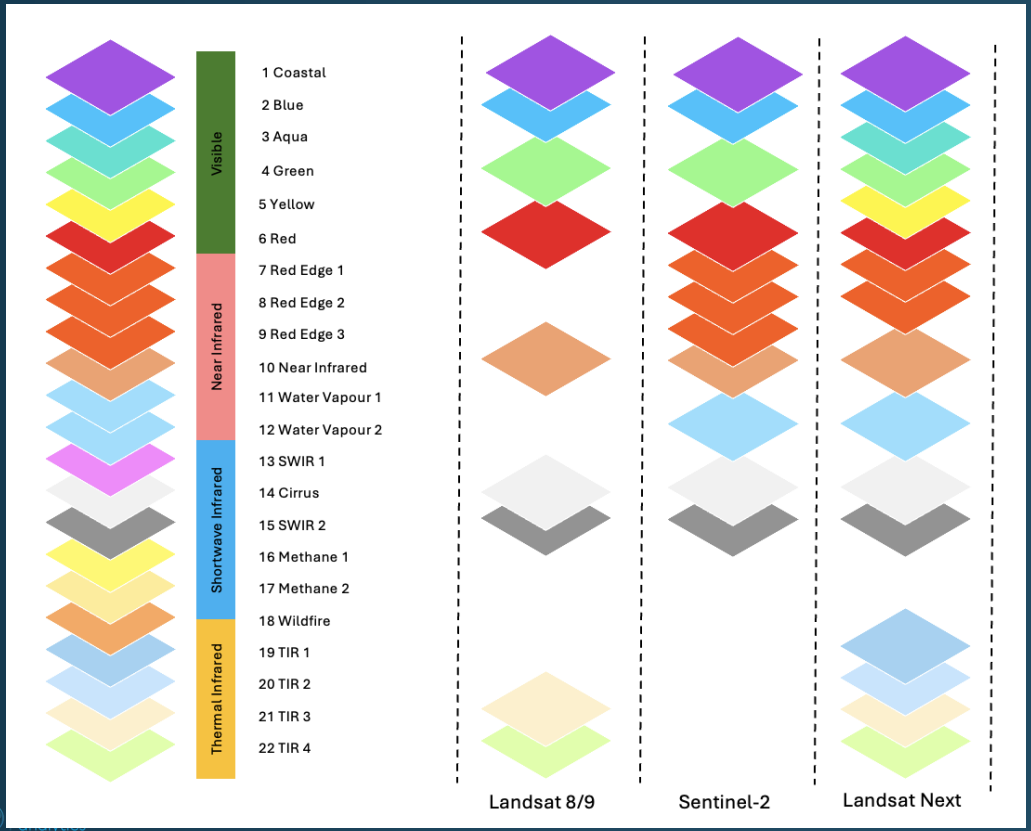


Spectral Coverage

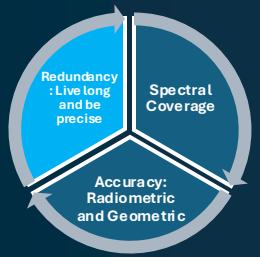
EarthDaily Constellation Everywhere. Everyday. ™

- 22 spectral bands (visible to thermal infrared)
- Sovereign-capable data pipeline
- Secure, analysis-ready data for rapid intelligence
- Spectral alignment with Landsat/Sentinel for seamless integration

EarthDaily was designed to be future proofed with Landsat-Next spectral bands

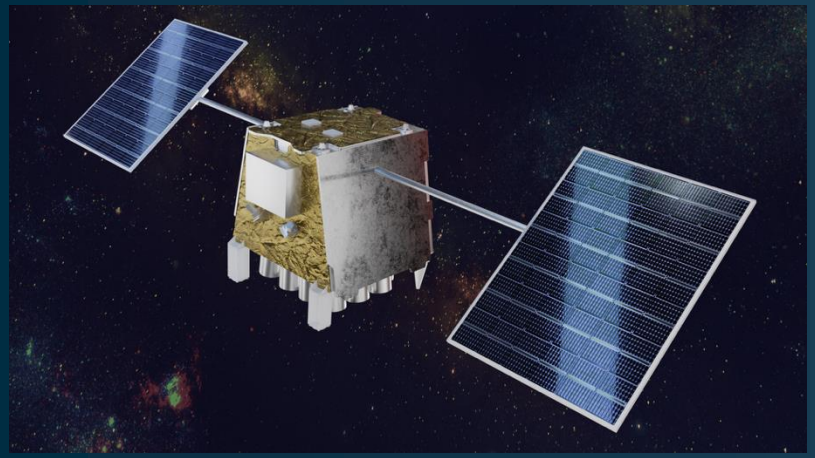


EARTH DAILY



Redundancy: Live long and be precise

System Designed for 10 years with redundant components, guaranteeing long-life



AIRBUS

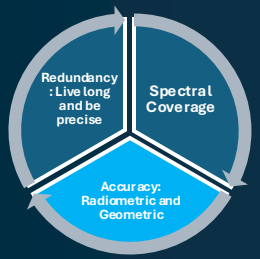
ABB

Xiphos Technologies

INO

LOFT ORBITAL

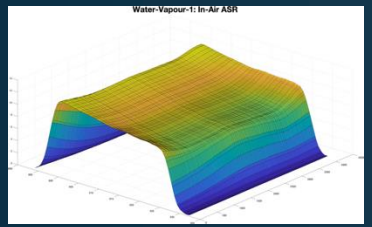
EARTH DAILY

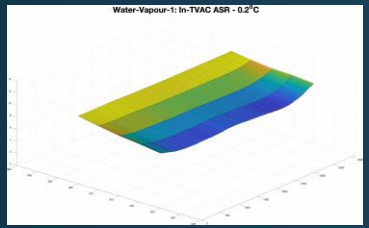


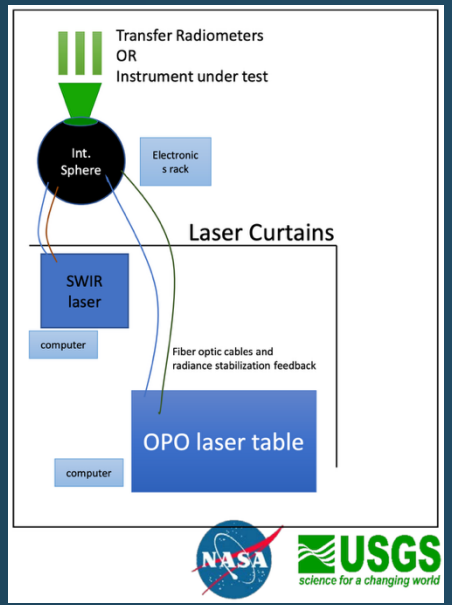
Accuracy Radiometric and Geometric

Pre-launch calibration using tunable lasers traceable to NIST standards to ensure scientific level calibration

Calibration by L1 (physicists and calibration) - experts who calibrated past NASA science missions







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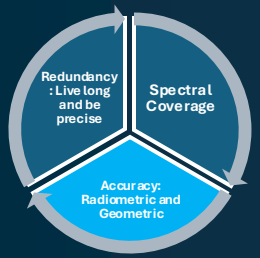
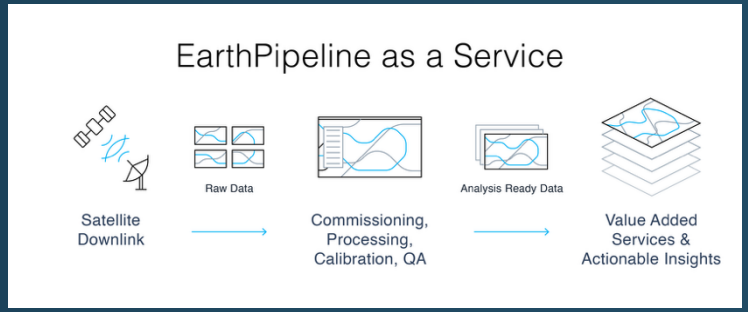


Accuracy Radiometric and Geometric

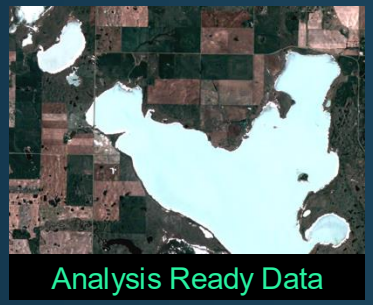
EDA brings together decades of international experience delivering ground segments, commissioning, and calibrating of multiple satellite missions

- EDA is actively working with CEOS on for ARD surface reflectance compliance (to be discussed later)




Raw Downlinked Data

Automatically transforms raw downlinked data into ARD


Analysis Ready Data

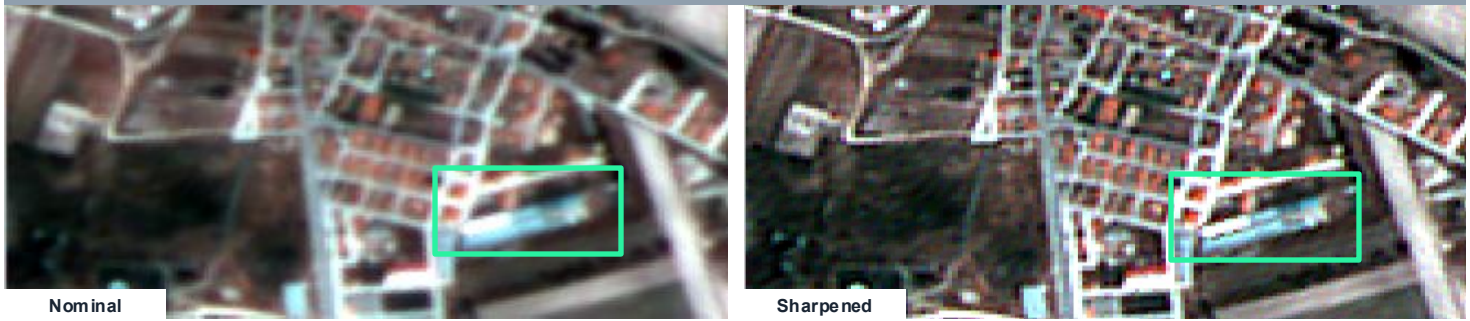
EARTH DAILY

EarthPipeline Maximizes Scientific Quality

Substantially Improves Resolution, and Geometric and Radiometric Quality

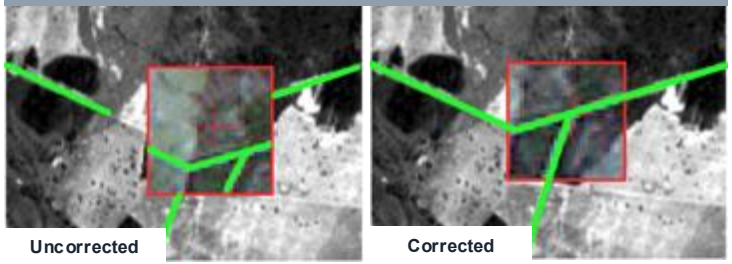
Resolution

Theia Medium-Resolution Sensor



Geometric Quality

CBERS-4 (red box) overlaid on S2



Radiometric Quality

Theia scenes overlaid on S2

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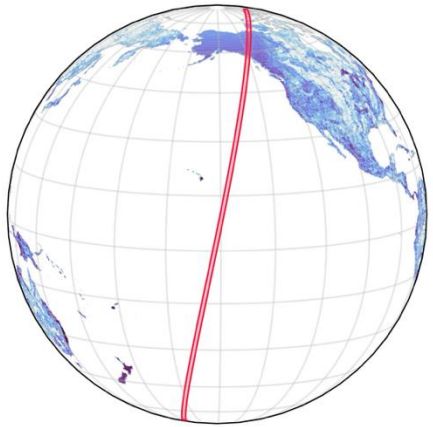
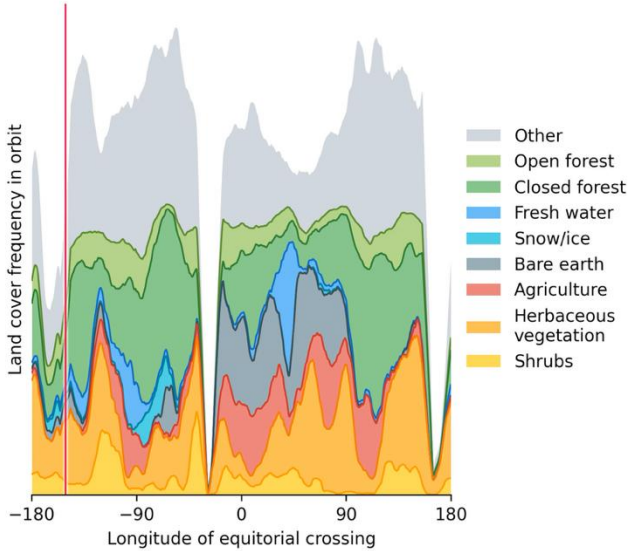
EarthDaily Payload Post-Launch Calibration

Maintaining science-grade products demands high-quality characterization

- Without an on-board calibration source we rely on well characterized globally distributed calibration sites
- To us ”science-grade” is about modelling all the details that matter
- Constructing detailed rigorous models of the imagers





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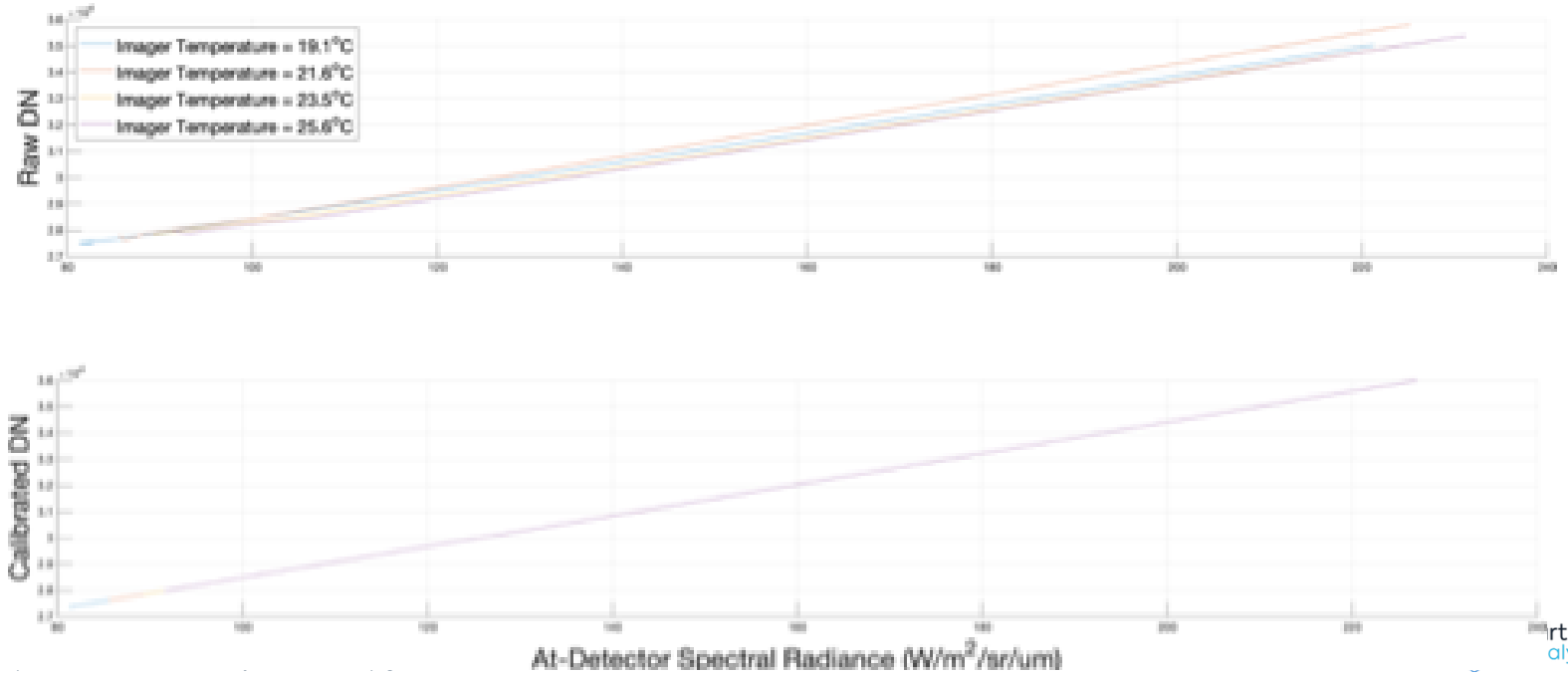
EarthDaily Payload Pre-Launch Calibration

Achieving science-grade products demands high-quality calibration

- Tested up to 450°C



12

EDA Surface Reflectance Approach

Overview of ARD processing

- Geometric refinement using ground control points against geometric reference (Sentinel-2 derived)
- Orthorectification using rigorous sensor model (COPDEM vertical reference)
- Cloud, shadow, water, snow/ice identification
- Water vapour, aerosol retrieval (ozone and surface pressure from auxiliary reference)
- Remove atmospheric contribution with radiative transfer model
- Advanced corrections in R&D: haze/cirrus removal, adjacency effect correction, cloud de-shadowing, hillshade correction, BRDF

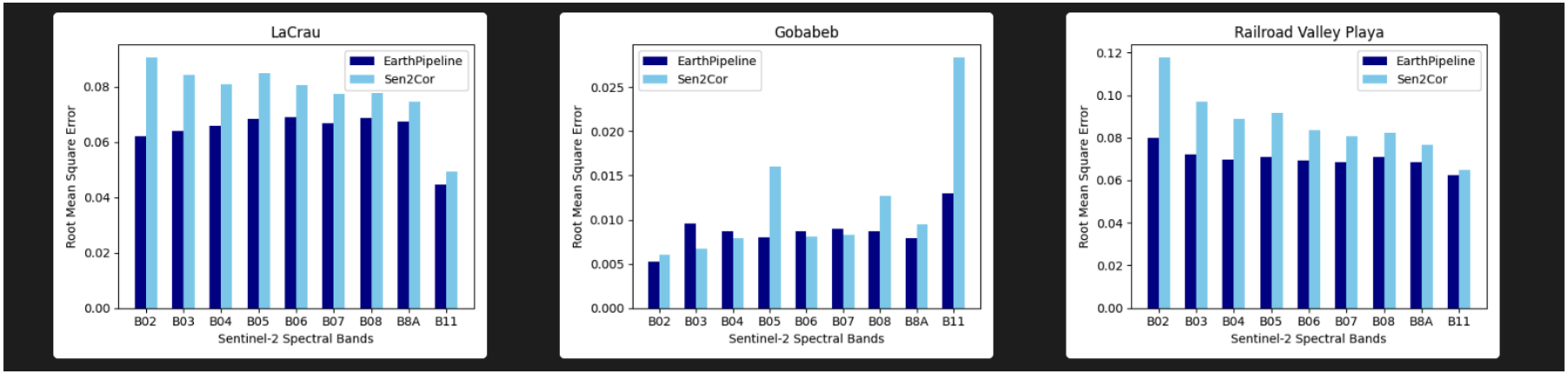
Atmospheric Correction Validation

Using RadCalNet surface reflectance measurements as ground truth we compare EDA's BOA derived from S2 L1C against ESA's S2 L2A product

- 647 scenes from 2020-23 acquired within 4 hours of a RadCalNet observation

RadCalNet (www.radcalnet.org) – Ran validation similar to ACIX-II

- Measures surface and atmospheric parameters to model TOA reflectance
- Sites: La Crau, France (LCFR); Gobabeb, Namibia (GONA); Railroad Valley Playa, US (RVUS)



EDA's BOA Has Comparable Root Mean Square Error (RMSE) to ESA

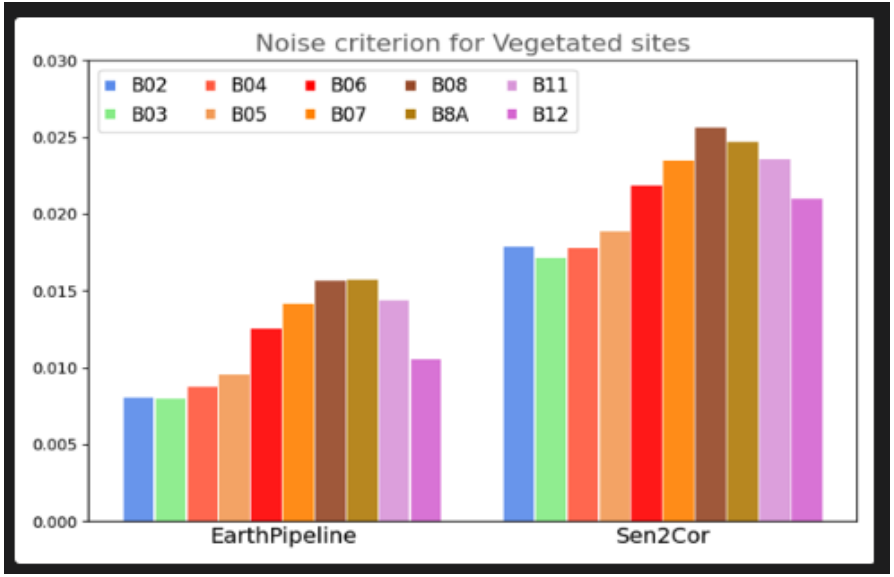
	All	B02	B03	B04	B05	B06	B07	B08	B8A	B11
EDA	5.8%	6.3%	5.9%	5.9%	6.0%	5.9%	5.8%	6.0%	5.8%	4.9%
ESA	7.3%	9.3%	8.0%	7.4%	7.7%	7.1%	6.9%	7.0%	6.6%	5.3%

Atmospheric Correction Validation

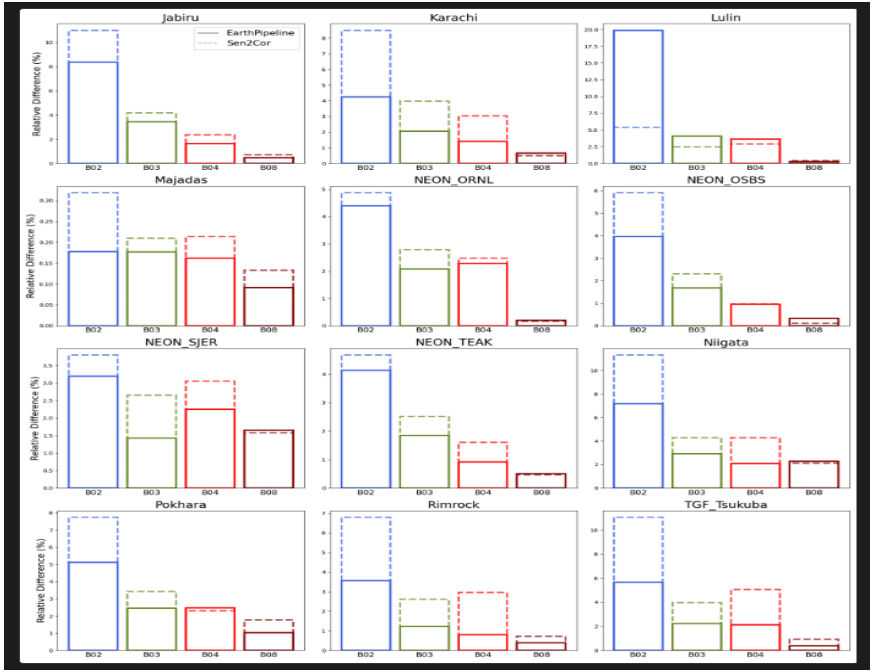
Using AERONET (https://aeronet.gsfc.nasa.gov/) sites, we compared the temporal and spatial consistency of EDA's BOA derived from S2 L1C against ESA's S2 L2A product

- 68 AERONET sites over tree covered and cropland land type
- Sentinel-2 between Oct 2022-Sept 2023

EDA's BOA Has Strong Temporal Consistency

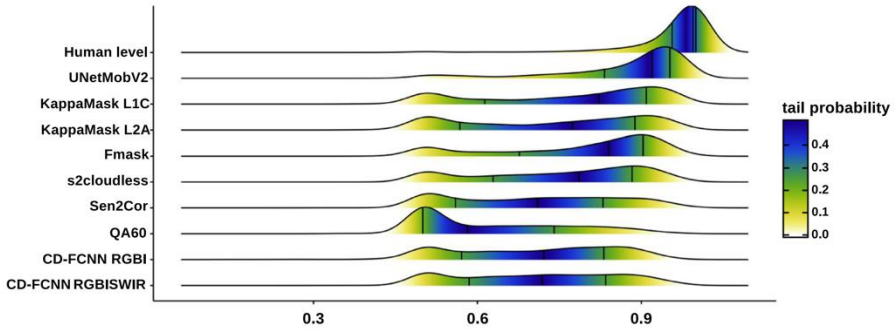


EDA's BOA Has Strong Spatial Consistency Over Tile Overlaps



Powering Change Detection with Smart Preprocessing

EDA Has Developed a State-of-the-Art Cloud, Haze and Shadow Detection to Support Data Analytics



Metrics (Higher=Better)	EDA	UnetMobV2
BPA (Accuracy > 90%)	65.6	51.2
BUA (Precision > 90%)	64.4	40.0

ESA's Cloud Detection works well but can have errors

Sentinel-2

EDA's Cloud Detection is robust to ground features

Resolution Example

Sentinel-2 (10m)

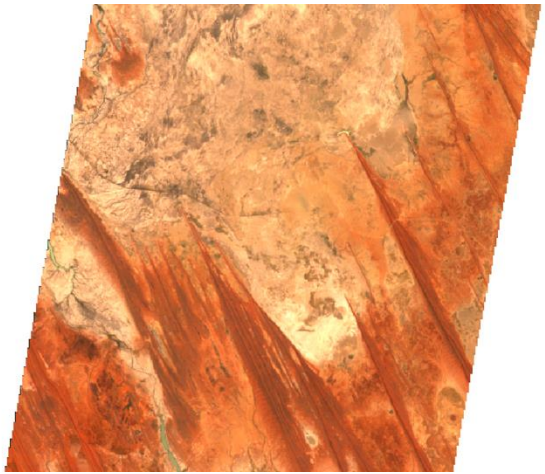
Venus (EDC representative) (5m)

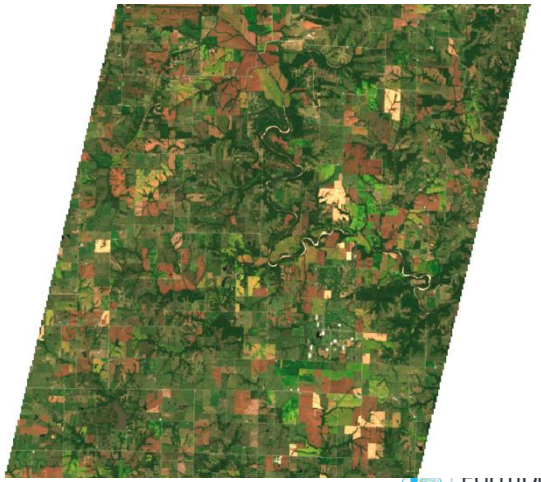
CEOS-ARD Conformance

- EDA's intention is to produce surface reflectance products conforming to the CEOS-ARD Surface Reflectance specification
- Products are STAC compliant and include metadata conforming to the CEOS-ARD STAC extension, including
  - Descriptive metadata
  - Information on auxiliary data used, geometric accuracy measured
  - Quality metrics (including mask of saturation, cloud, cloud shadow, haze, cirrus, water, snow)
  - Solar and viewing geometry
  - Radiometric corrections applied
- We plan to follow-up with CEOS-ARD Aquatic and CEOS-ARD Surface Temperature Products, and CEOS-ARD Goals

CEOS-ARD Conformance – Application Status

- Currently finalizing product specification documentation
- Sample datasets and metadata generated using simulated EDC data for a variety of landcover types
- Threshold self-assessment completed





Thanks for your interest!

For more information, please contact chris@earthdaily.com

EarthDaily analytics

Discussion: Limitations with Goal Requirements

Item	Goal (Desired) Requirements	EDA Limitations
1.11 Sensor Calibration	Sensor calibration parameters are identified in the metadata, or can be accessed using details included in the metadata. Ideally this would support machine-to-machine access. *Note 1: Information on sensor calibration should be available in the metadata as a single DOI landing page.*	As a commercial company, our calibration parameters are proprietary
1.14 Auxiliary Data	[…] information on auxiliary data should be available in the metadata as a single DOI landing page and is also available for free online download, contemporaneously with the product or through a link to the source.	Commercial sources can't be made freely available for download

Discussion: Perspectives on Data Quality

Item	Goal (Desired) Requirements
1.12 Radiometric Accuracy	The metadata includes metrics describing the assessed absolute radiometric uncertainty of the version of the data or product, expressed as absolute radiometric uncertainty relative to appropriate, known reference sites and standards (for example, pseudo-invariant calibration sites, rigorously collected field spectra, PICS, Rayleigh, DCC, etc.) *Note 1: Information on radiometric accuracy should be available in the metadata as a single DOI landing page.*
2.5 Cloud	As threshold, information on cloud detection should be available in the metadata as a single DOI landing page.