Geoscience Australia Update

Medhavy Thankappan,
Geoscience Australia

Agenda Item B.4

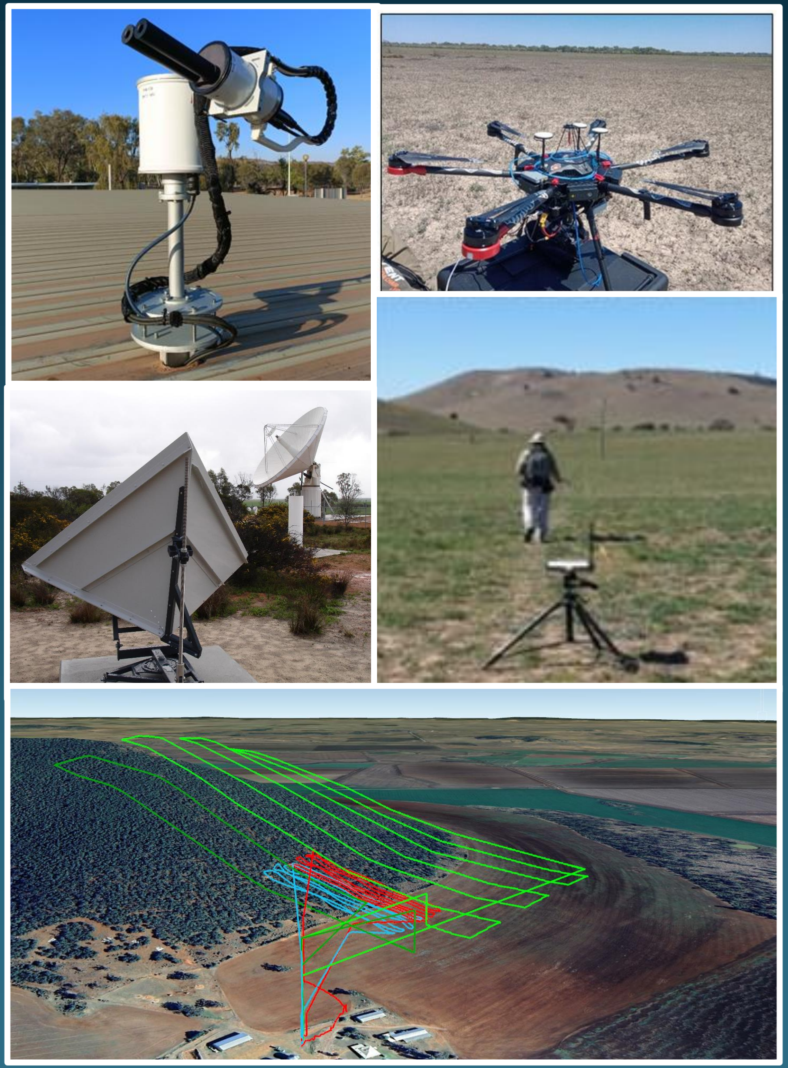
WGISS / WGCV Joint Meeting

15 & 18 October 2024

Sioux Falls, South Dakota, USA

CEOS
Committee on
Earth Observation Satellites

Australian Government
Geoscience Australia



GA Calibration Validation and Data Quality Update

Medhavy Thankappan

Director, Data Processing, Quality and Integrity

Satellite Land Imaging Collection Branch

Space Division

Geoscience Australia

- Australian Government (part of Industry Science Energy and Resources Portfolio)
- Australia’s national geoscience organisation
- 650+ staff, mostly based in Canberra
- Satellite Ground Station Facility in Alice Springs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Chief Executive Officer
Dr James Johnson

Office of the Chief Scientist	Minerals, Energy and Groundwater Division	Space Division	Place and Communities Division	Corporate Division
Chief Scientist Dr Steve Hill	**Chief of Division** Dr Andrew Heap	**Chief of Division** Alison Rose	**Chief of Division** Maree Wilson	**Chief of Division** Trent Rawlings
	Basin Systems Dr David Robinson	**Positioning Australia** Dr Martine Woolf	**Oceans, Reefs, Coasts and the Antarctic** Dr Jodie Smith	**Enterprise Data and Digital** Clive Rossiter
	Mineral Systems Marina Costelloe	**Satellite Land Imaging** Dr David Hudson	**National Location Information** Lisa Bush	**Enabling Services** Erika Taduran
	Advice, Investment Attraction and Analysis Kristina Anastasi	**Digital Earth** Leyla Alpaslan	**Community Safety** Dr John Dawson	**Organisational Investment** Mike Olive

National space-based geoscience leadership

Earth Observation

Digital images of the Earth's surface compiled from spectral data collected by sensors carried on satellites.

Position, Navigation and Timing

Accurate and precise determination of location and orientation three-dimensionally from global navigation satellite systems.

Geodesy

Accurate measurement of the shape, orientation and gravity field of the Earth and how it changes over time.

Delivering earth observations and precise positioning to enable a sustainable environment, resilient society and strong economy

Landsat Next Partnership

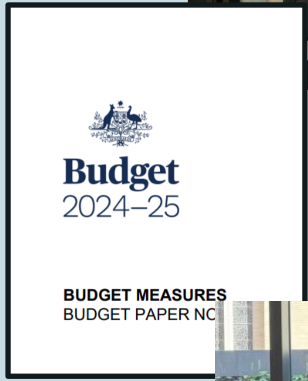
What is it?

- A full value chain partnership to ensure the full benefits of Landsat and Landsat Next are realised by Australians, Americans and the Indo-Pacific
- Backed by $AUD448.7 million of new investment by the Australian Government to FY2034-45 and then ~$AUD43.2m per year ongoing
- Backed by billions of dollars of U.S. Government investment

What will it achieve?

- **Guaranteed right to use current and future Landsat data**
  Any purpose; All users in Indo-Pac
- **Streamlined access to data fit for Australia and region**
  Collect and downlink priority
- **Deeper First Nations science, skills and tech partnerships**
- **New science, analytics and technology that drive impact**
  Including towards the National Science and Research Priorities
- **Platform for Indo-Pacific engagement**
  Including commercial and scientific partnerships
- **Opportunities for the Alice Springs region**
- **More sustainable Landsat program**
- **Investment in Australian capability**

The Hon Madeleine King MP, Minister for Resources and Northern Australia and Dr David Applegate, Director of USGS Mar 2024 in Washington, D.C.



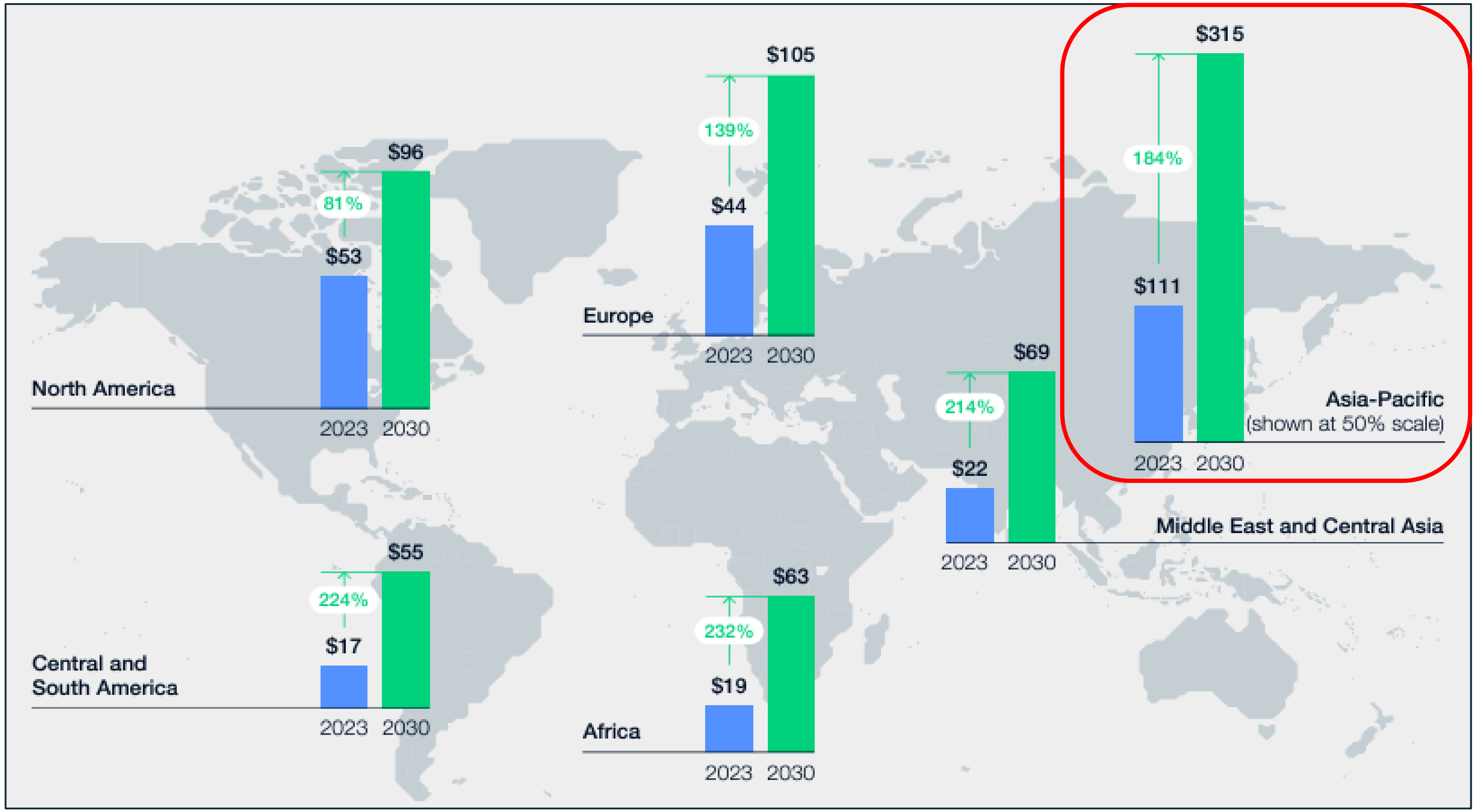
Alison Rose, Chief of Space Division, Geoscience Australia and Darcee Killpack, a/g Associate Director of USGS Aug 2024 in Washington, D.C.

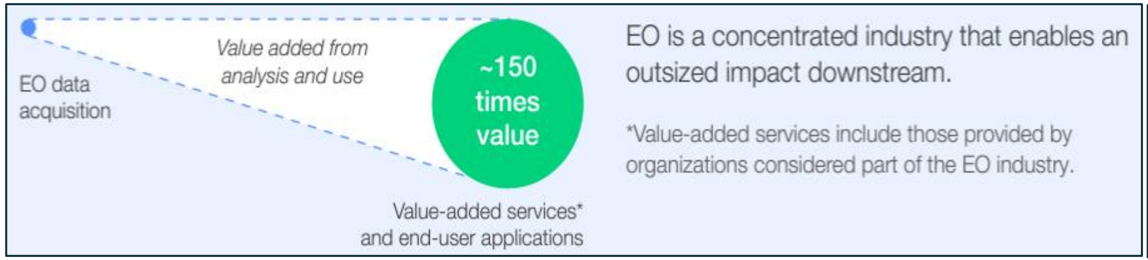
Senator the Hon Penny Wong, Minister for Foreign Affairs, and Antony Blinken, US Secretary of State. Aug 2024 in Washington DC

Landsat Next Partnership: Key elements

- **Enhanced Alice Springs Ground Station Capability**
  Ka/X/S-band, highly redundant
- **Permanent operational instrumented cal/val facilities**
  2 in Aus, 1 in Pacific
- **Indo-Pacific Regional Data Hub**
  Landsat, Sentinel and other high-quality trusted data
- **Operational Data Quality and Integrity Monitoring Facility**
  Foreign government and commercial missions
- **First Nations Technical Training and Research Programs**
  Including ground station skills
- **New, open, science and next-generation analytics technology**
  Including AI
- **Field data collection programs**
  Training and validation data
- **Interoperability engagement and uplift**
  Including through CEOS

Earth Observation Data - Value Creation Potential



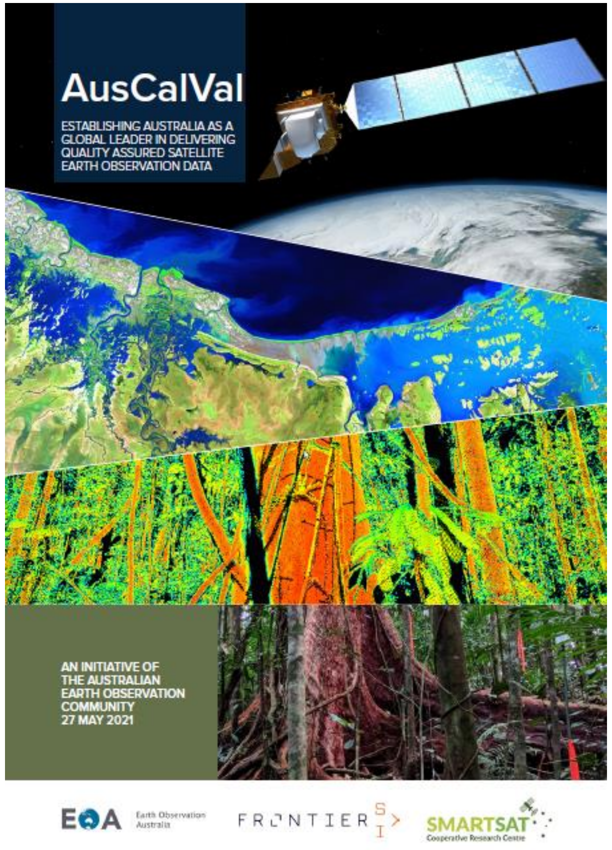


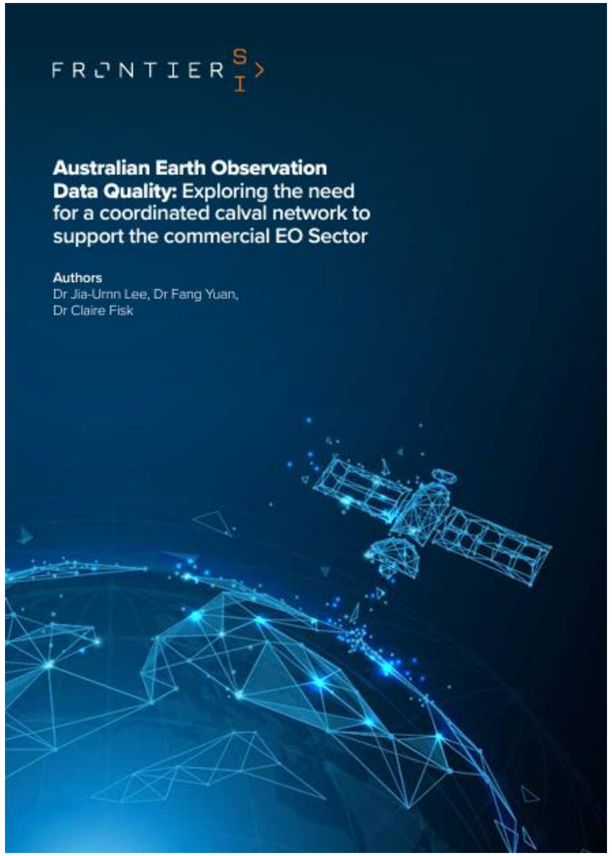
Source: Amplifying the Global Value of Earth Observation - Insight Report (May 2024)

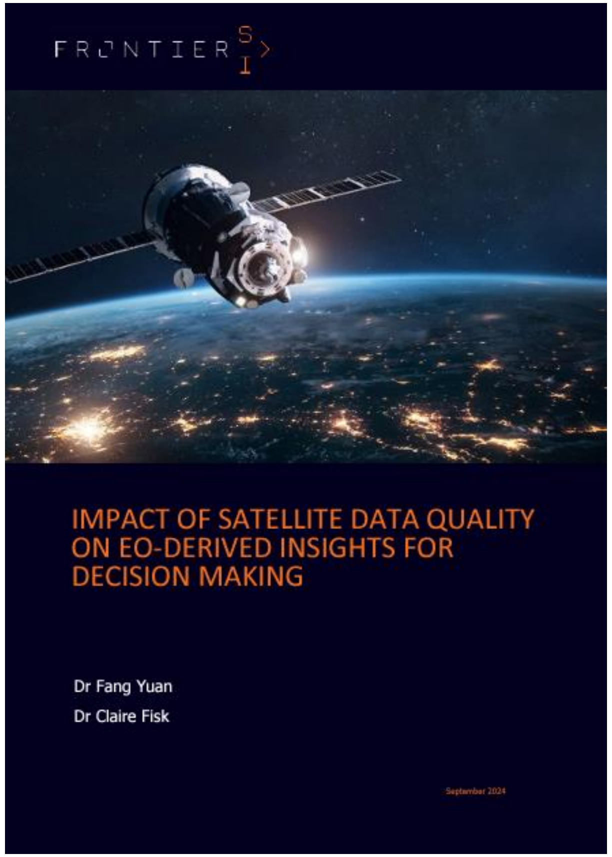
- **Value creation** results from **analysis and application** of EO data.
- From 2023 to 2030, future growth in **North America and Europe** projected to be **steady**.
- The **Asia Pacific** region projected to capture the **largest share of value with a potential of $315 billion**.

Quality Assurance Trust and Consistency

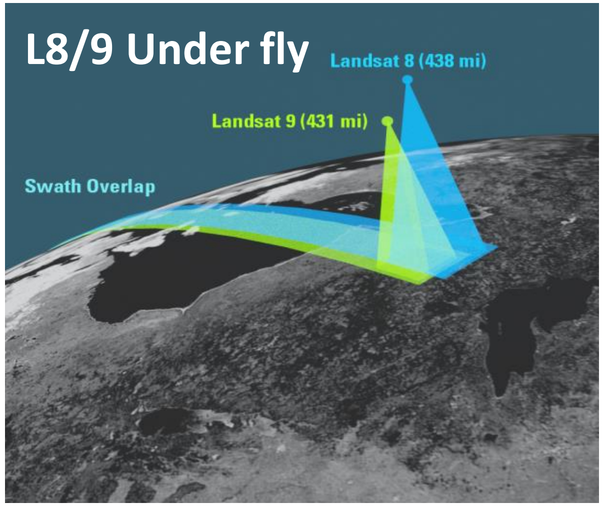
Quality, consistency, and trust in Earth observation data have been recurrent themes in recent studies of the sector.

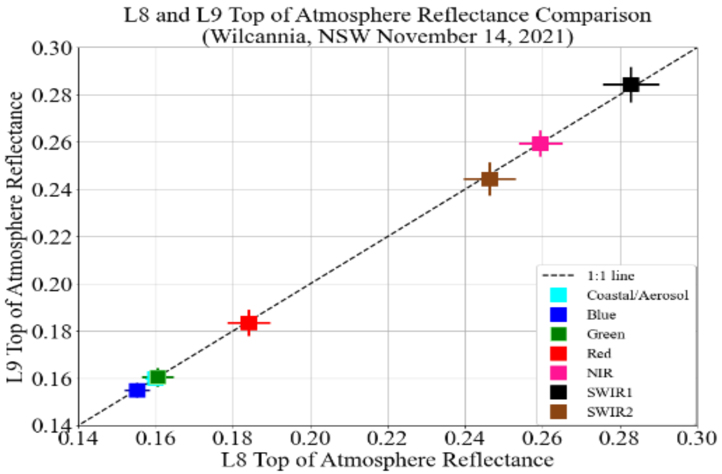


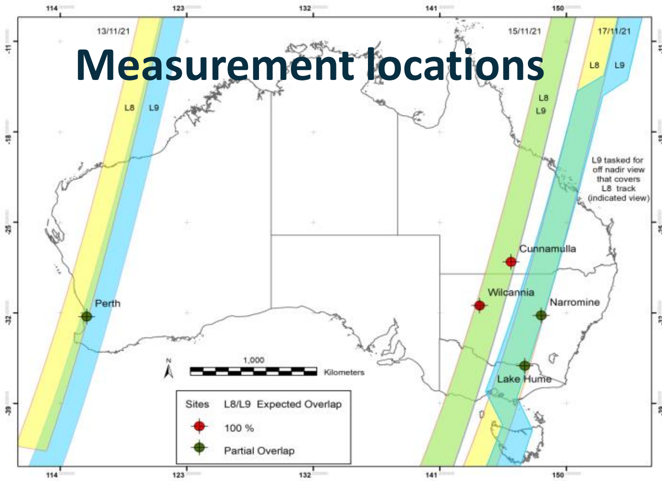




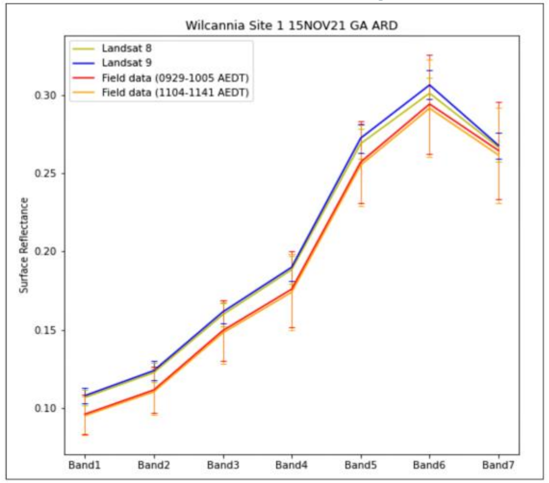
Coincident satellite overpasses: Landsat 8 / 9 under fly campaign

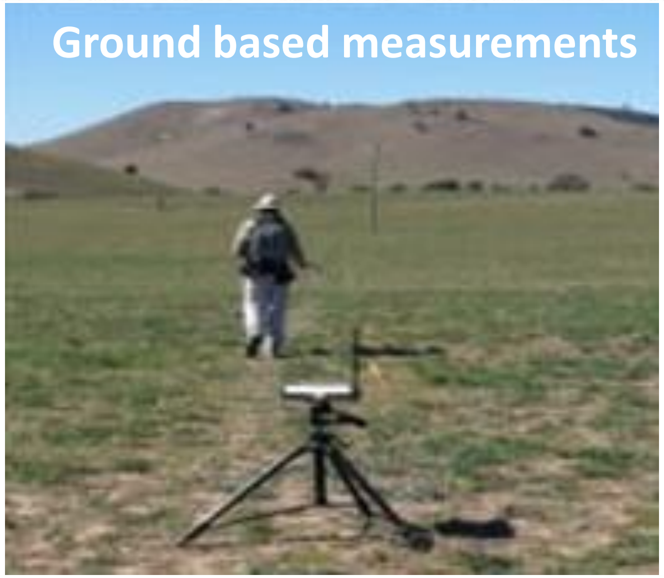






Data match-up



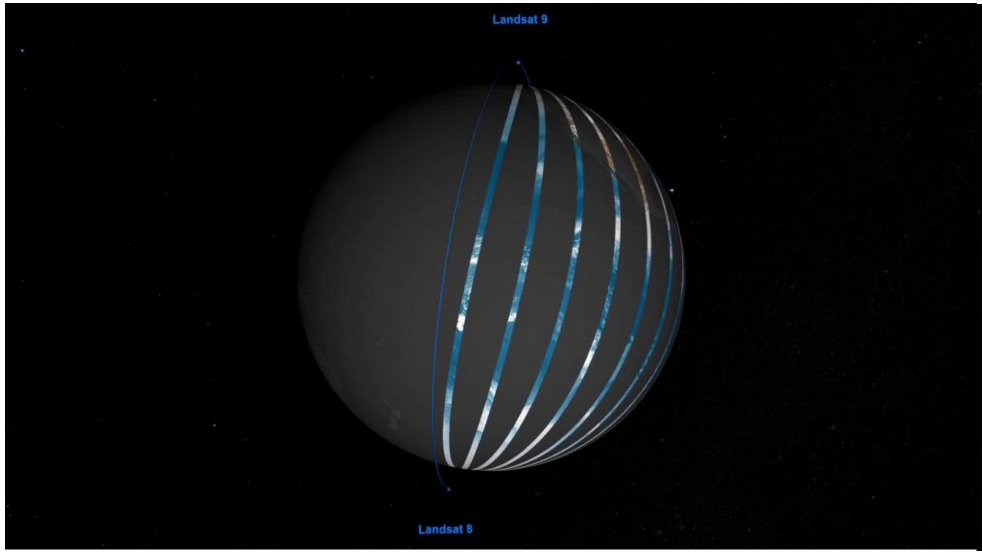


Byrne, G.; Broomhall, M.; Walsh, A.J.; Thankappan, M.; Hay, E.; Li, F.; McAtee, B.; Garcia, R.; Anstee, J.; Kerrisk, G.; et al. Validating Digital Earth Australia NBART for the Landsat 9 Underfly of Landsat 8. Remote Sens. 2024, 16, 1233. https://doi.org/10.3390/rs16071233

Alternative approach to field data collection for SR validation

- Our continental SR validation campaigns relied on teams undertaking field measurements over specific sites at the time of satellite overpass. We still use fixed sites to test equipment and protocols, while this approach has advantages, we have been exploring other approaches.
- With two Landsat satellites (8/9) and two Sentinel-2 satellites (A/B), there are areas where the Landsat and Sentinel-2 swaths overlap.

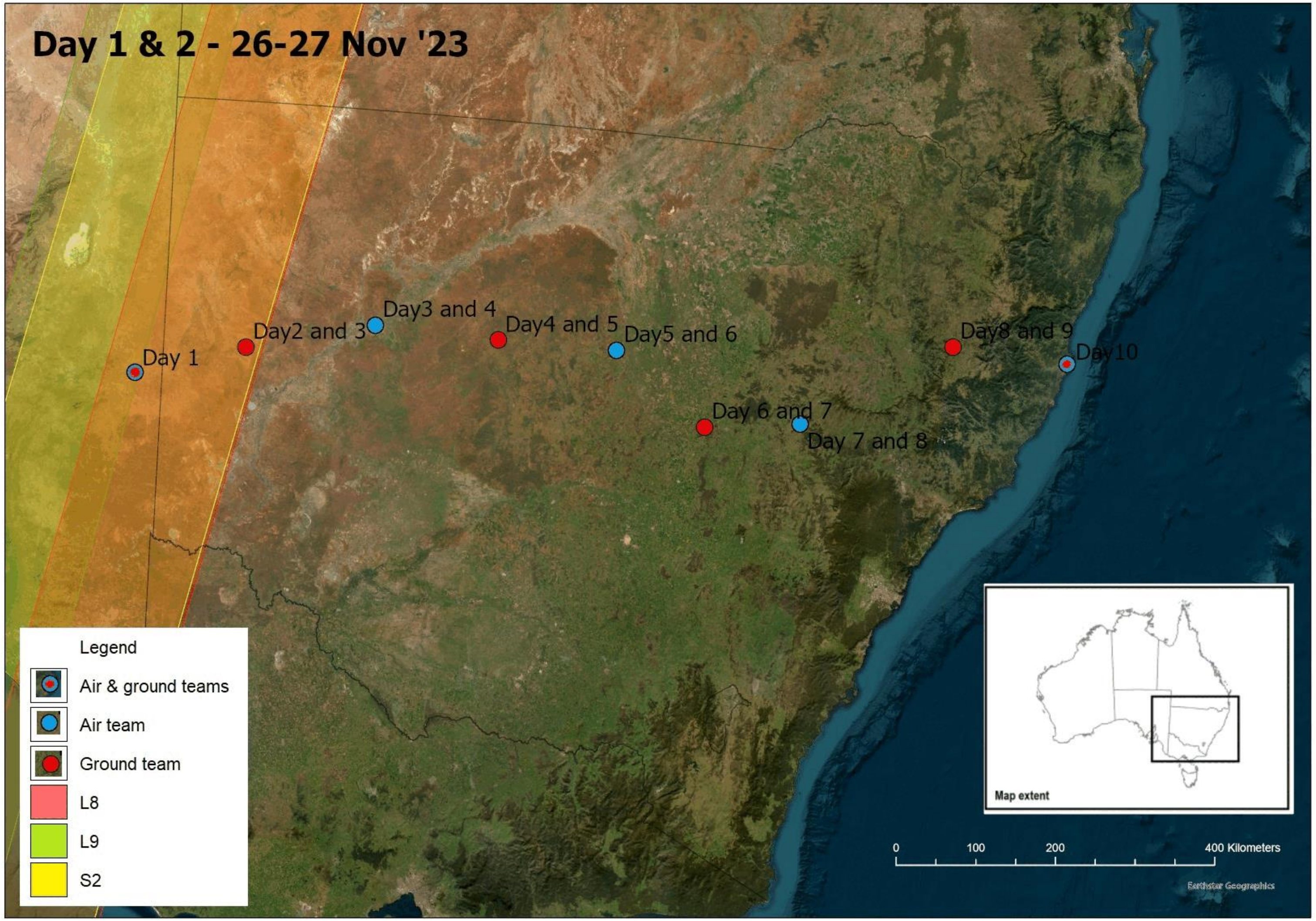
Landsat 8 / 9



Sentinel-2 A / B

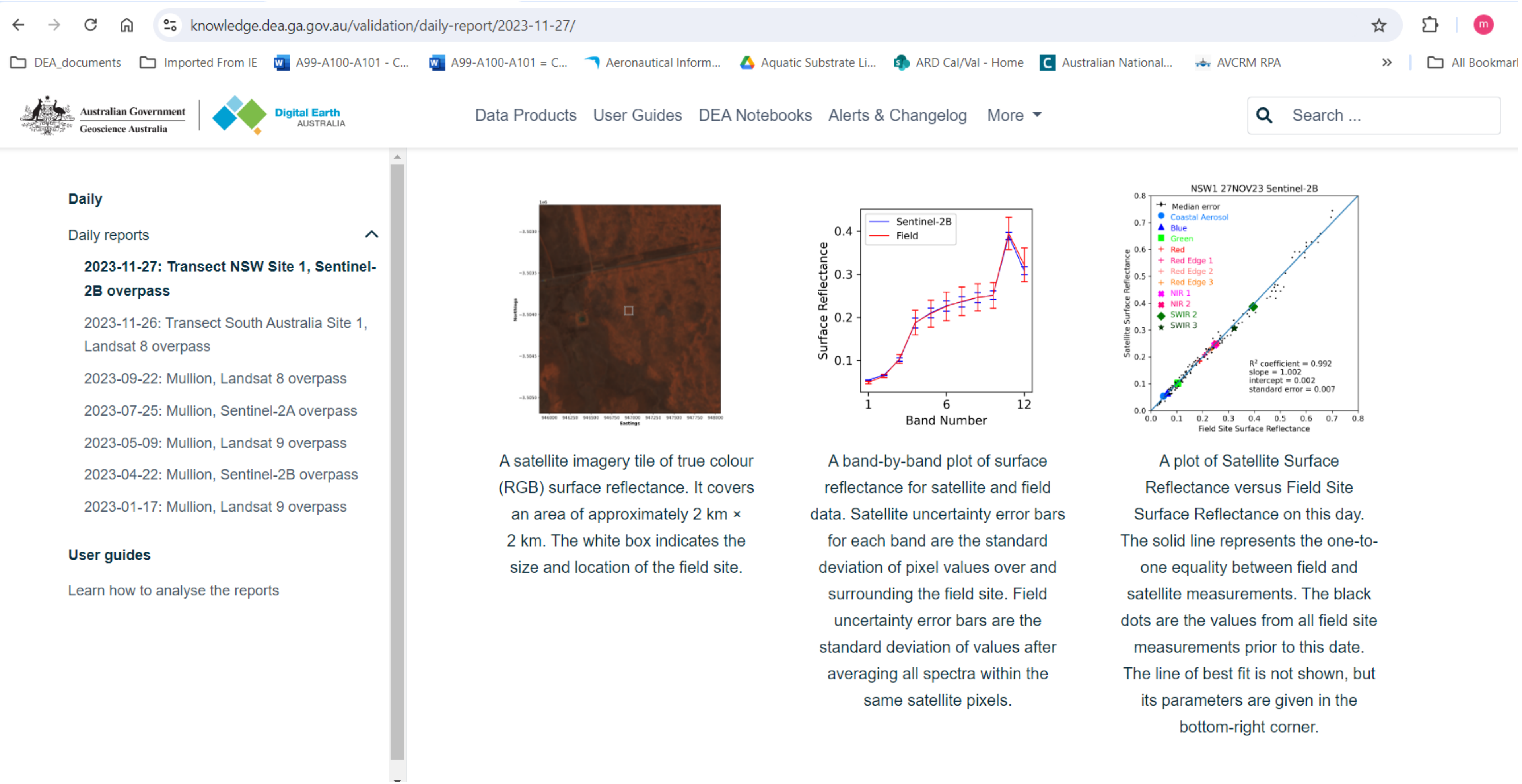
Validation transects in satellite overlap areas

- Overlap zones are around 50km for Landsat and 60km for Sentinel-2 in central NSW, up to 24 matchups are possible in a 10-day period.
- A campaign in June/July yielded 11 matchups, weather and technical issues restricted capture of the full 24 possible match-ups.
- Increasingly, we use teams to collect data across these overlap zones along transects to get the most out of field validation data collection.

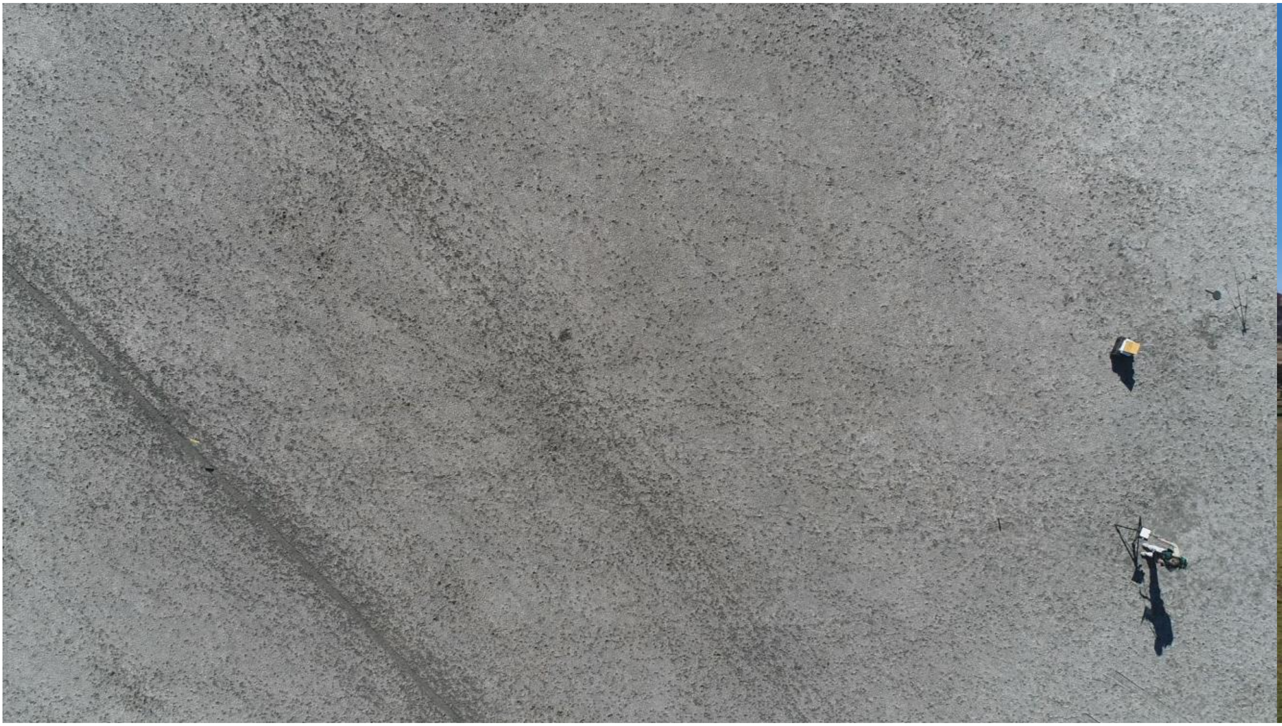


National Spectral Database

- Access to the field data from the National Spectral Database https://knowledge.dea.ga.gov.au/data/product/australian-national-spectral-database/



New capability for field spectroscopy



Manual field spectroscopy

UAV based field spectroscopy.
Advantages

- Can be deployed over almost any surface
- Repeatable measurements
- Configurable measurement protocols

remote sensing

MDPI

Article

Validating Digital Earth Australia NBART for the Landsat 9 Underfly of Landsat 8

Guy Byrne [1,*], Mark Broomhall [1], Andrew J. Walsh [1], Medhavy Thankappan [1], Eric Hay [1], Fuqin Li [1], Brendon McAtee [2], Rodrigo Garcia [3], Janet Anstee [4], Gemma Kerrisk [5], Nathan Drayson [5], Jason Barnetson [6], Ian Samford [6] and Robert Denham [7]

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Abstract: In recent years, Geoscience Australia has undertaken a successful continental-scale validation program, targeting Landsat and Sentinel analysis-ready data surface reflectance products. The field validation model used for this program was successfully built upon earlier studies, and the measurement uncertainties associated with these protocols have been quantified and published. As a consequence, the Australian earth observation community was well-prepared to respond to the United States Geological Survey (USGS) call for collaborators with the 2021 Landsat 8 (L8) and Landsat 9 (L9) underfly. Despite a number of challenges, seven validation datasets were captured across five sites. As there was only a single 100% overlap transit across Australia, and the country was amidst a strong La Niña climate cycle, it was decided to deploy teams to the two available overpasses with only 15% side lap. The validation sites encompassed rangelands, chenopod shrublands, and a large inland lake. Apart from instrument problems at one site, good weather enabled the capture of high-quality field data allowing for meaningful comparisons between the radiometric performance of L8 and L9, as well as the USGS and Australian Landsat analysis-ready data processing models. Duplicate (cross-calibration) spectral sampling at different sites provides evidence of the field protocol reliability, while the off-nadir view of L9 over the water site has been used to better compare the performance of different water and atmospheric correction processing models.

Keywords: Landsat 8; Landsat 9; surface reflectance; validation; underfly

Citation: Byrne, G.; Broomhall, M.; Walsh, A.J.; Thankappan, M.; Hay, E.; Li, F.; McAtee, B.; Garcia, R.; Anstee, J.; Kerrisk, G.; et al. Validating Digital Earth Australia NBART for the Landsat 9 Underfly of Landsat 8. *Remote Sens.* **2024**, *16*, 1233. https://doi.org/10.3390/rs16071233

Academic Editors: Cody Anderson, Lawrence Ong, Michael Choate, Esad Micijevic and Kathryn Ruslander

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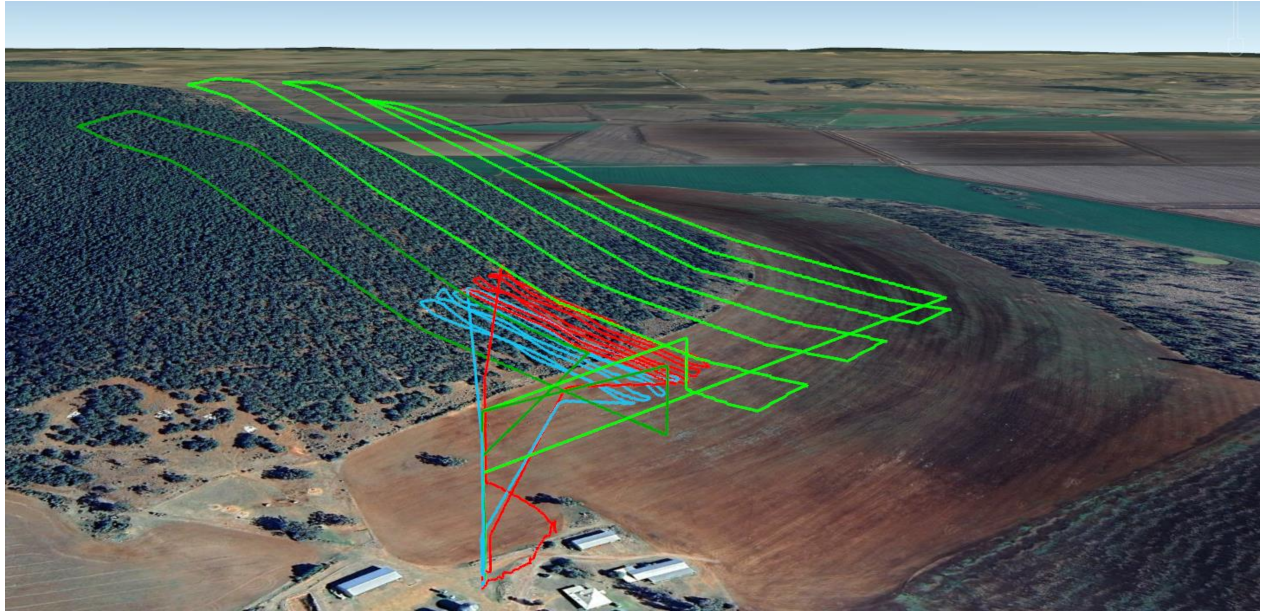
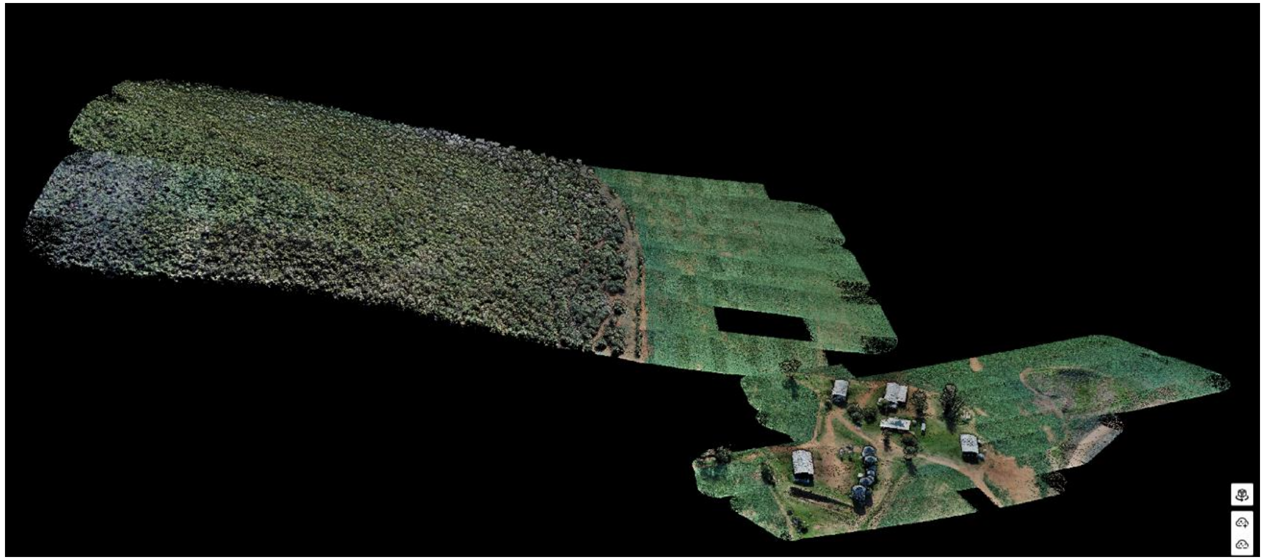
1. Introduction

How appropriate a particular dataset is and which validation framework is best are essential questions in earth observation (EO) science [1]. The Committee on Earth Observation Satellites (CEOS) Quality Assurance Framework for Earth Observation (QA4EO) states that 'Data and derived products shall have associated with them an indicator of quality to enable users to assess their suitability for particular applications, i.e., their "fitness for purpose" [2]'. The framework also suggests that 'comparisons are an essential tool within any quality assurance (QA) framework as they provide a source of unequivocal information



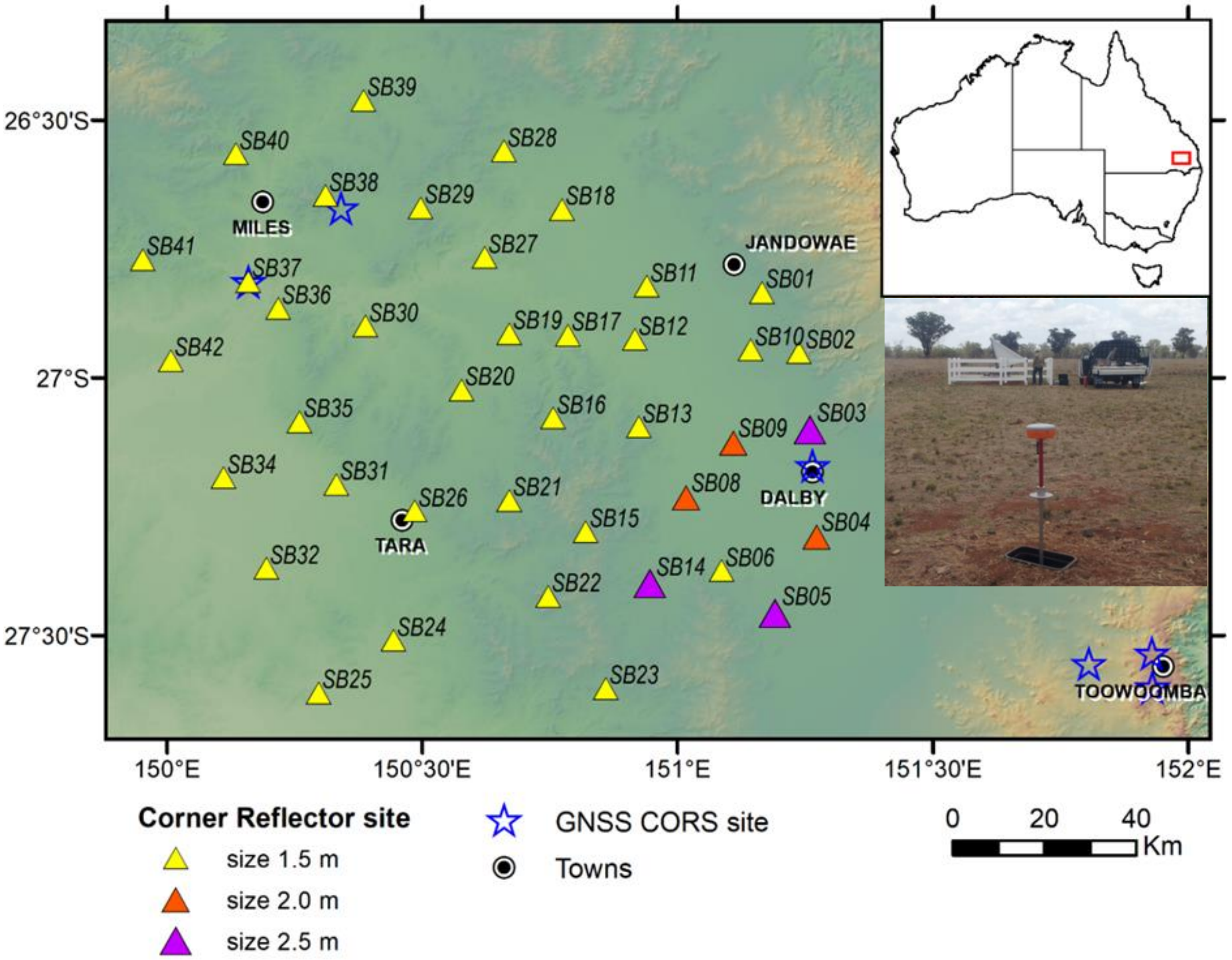


Queensland Corner Reflector Array (QCRA) - Support for FRM4SAR

- Geoscience Australia operates the QCRA, 40 CRs spread over 100km x 100km in South-east Queensland, Australia

- Enables consistency in the quality of SAR data from multiple sensors, and will be a key contribution to the SARCalNet initiative

- The QCRA has supported calibration of several SAR missions including Sentinel-1 since 2014



Permanent SAR corner reflectors at Yarragadee

- Yarragadee is one of the few fundamental geodetic co-location stations in the world.
- One ascending and one descending trihedral CRs (1.5m), permanently installed in August 2018
- Permanent Yarragadee CR coordinates independently verified by TSX 3D SAR solution, results within 2 cm

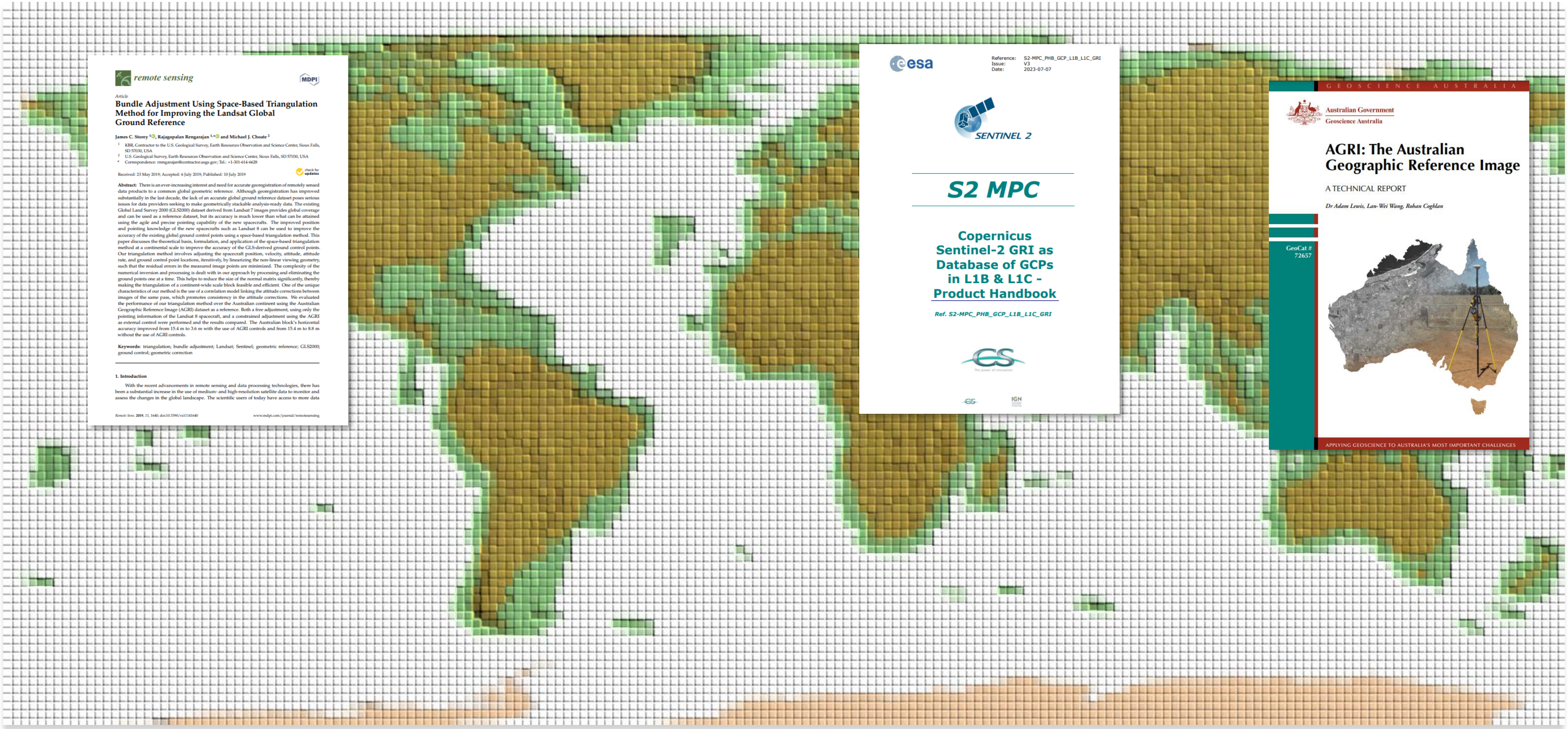

CR at Yarragadee Geodetic Observatory

Pandora – Support for FRM4AQ

- Pandora #129 at Alice Springs is part of the Pandonia global network supporting reference measurements for atmospheric composition

- Geoscience Australia has supported the operation of the Pandora at Alice Springs since 2018 (FRM4AQ)

Harmonised CEOS GCP Database



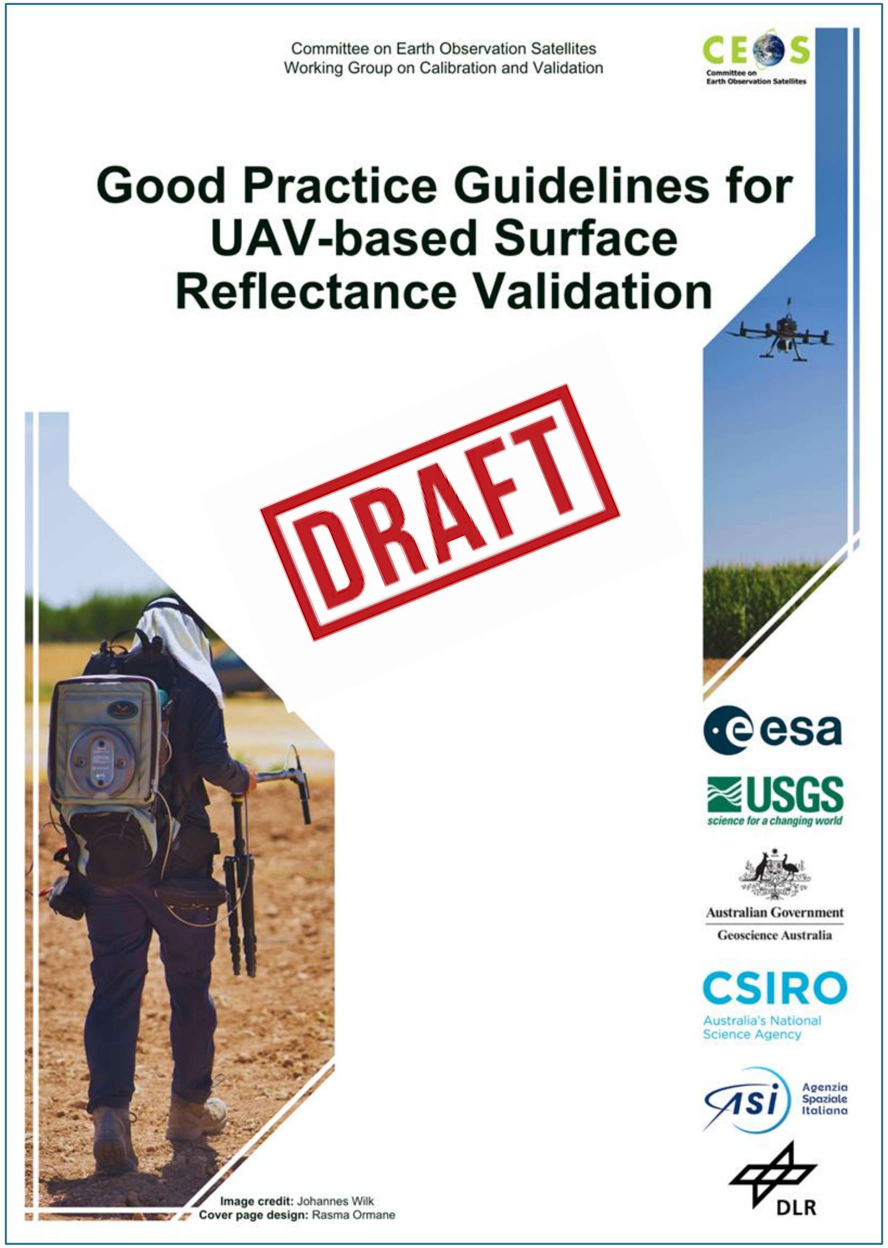
SRIX4VEG - Support for FRM4VEG

Surface Reflectance Intercomparison for Vegetation (SRIX4VEG)

SRIX4VEG Workshop 2 at ESRIN, Frascati (23-24 Nov 2023)

- GA and CSIRO supported the SRIX4VEG campaigns on UAV-based protocols for validation of surface reflectance products
- SRIX4VEG II field campaign was in Australia (March 2024)

fiducial reference measurements for vegetation



Concept of a Satellite Cross-calibration Radiometer (SCR)

remote sensing

IMPACT FACTOR 4.2

CITESCORE 8.3

Article

Concept of a Satellite Cross-Calibration Radiometer for In-Orbit Calibration of Commercial Optical Satellites

Medhavy Thankappan, Jon Christopherson, Simon Cantrell, Robert Ryan, Mary Pagnutti, Courtney Bright, Denis Naughton, Kathryn Ruslander, Lan-Wei Wang, David Hudson et al.

Special Issue

Space-Borne Earth Observation Data for Monitoring Natural and Anthropogenic Phenomena: A Look towards Climate Change and Advanced Processing Methods

Edited by
Dr. Marco Polcari, Dr. Letizia Anderlini and Dr. Antonio Montuori

MDPI

https://doi.org/10.3390/rs16081333

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Article

Concept of a Satellite Cross-Calibration Radiometer for In-Orbit Calibration of Commercial Optical Satellites

Medhavy Thankappan [1,*], Jon Christopherson [2], Simon Cantrell [2], Robert Ryan [3], Mary Pagnutti [3], Courtney Bright [4], Denis Naughton [1], Kathryn Ruslander [2], Lan-Wei Wang [1], David Hudson [1], Jerad Shaw [2], Shankar Nag Ramaseri Chandra [2] and Cody Anderson [5]

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Abstract: The satellite Earth observation (EO) sector is burgeoning with hundreds of commercial satellites being launched each year, delivering a rich source of data that could be exploited for societal benefit. Data streams from the growing number of commercial satellites are of variable quality, limiting the potential for their combined use in science applications that need long time-series data from multiple sources. The quality of calibration performed on optical sensors onboard many satellite systems is highly variable due to calibration methods, sensor design, mission objective, budget, or other operational constraints. A small number of currently operating well-characterised satellite systems with onboard calibration, such as Landsat-8/9 and Sentinel-2, and planned future missions, like the NASA Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder, the European Space Agency (ESA)'s Traceable Radiometry Underpinning Terrestrial and Helio Studies (TRUTHS), and LIBRA from China, are considered benchmarks for optical data quality due to their traceability to international measurement standards. This paper describes the concept of a space-based transfer calibration radiometer called the Satellite Cross-Calibration Radiometer (SCR) that would enable the calibration parameters from satellites such as Landsat-8/9, Sentinel-2, or other benchmark systems to be transferred to a range of commercial optical EO satellite systems while in orbit. A description of the key characteristics of the SCR to successfully operate in orbit and transfer calibration from reference systems to client systems is presented. A system like the SCR in orbit could complement SI-Traceable satellites (SITSats) to improve data quality and consistency and facilitate the interoperable use of data from multiple optical sensor systems for delivering higher returns on the global investment in EO.

Keywords: cross-calibration; hyperspectral; multi-sensor interoperability; radiometric calibration

check for updates

Citation: Thankappan, M.; Christopherson, J.; Cantrell, S.; Ryan, R.; Pagnutti, M.; Bright, C.; Naughton, D.; Ruslander, K.; Wang, L.-W.; Hudson, D.; et al. Concept of a Satellite Cross-Calibration Radiometer for In-Orbit Calibration of Commercial Optical Satellites. *Remote Sens.* **2024**, *16*, 1333. https://doi.org/10.3390/rs16081333

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1. Introduction

The number of Earth observation (EO) missions is growing rapidly, generating ever-increasing volumes of satellite data with immense potential for global applications across multiple science domains. Sustainable access to quality EO data from multiple satellite systems is fundamental for many environmental monitoring programs ranging in scale from regional to global. The ability to use data interoperably from multiple satellite systems from both the civil and commercial sectors enhances the frequency of observations for time-series applications where transient events could be missed due to fewer opportunities for observation by a single system. Scientists often use multiple optical remote sensing sensor systems to obtain datasets for their research, which makes it necessary to comprehend how differences between the datasets can affect the results for various scientific purposes. In

USGS science for a changing world

KBR

I2R

CSIRO

Thank you

Further information

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