Geoscience Australia Nomination for WGCV Vice-Chair

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

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

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

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 on Strategy 2028

- **10cm** positioning across Australia, and **3-5cm** in areas of mobile coverage
- Earth observation platform for **Government and business**
- Assuring streamlined access to satellite land imaging for the nation

Building Australia's resources wealth

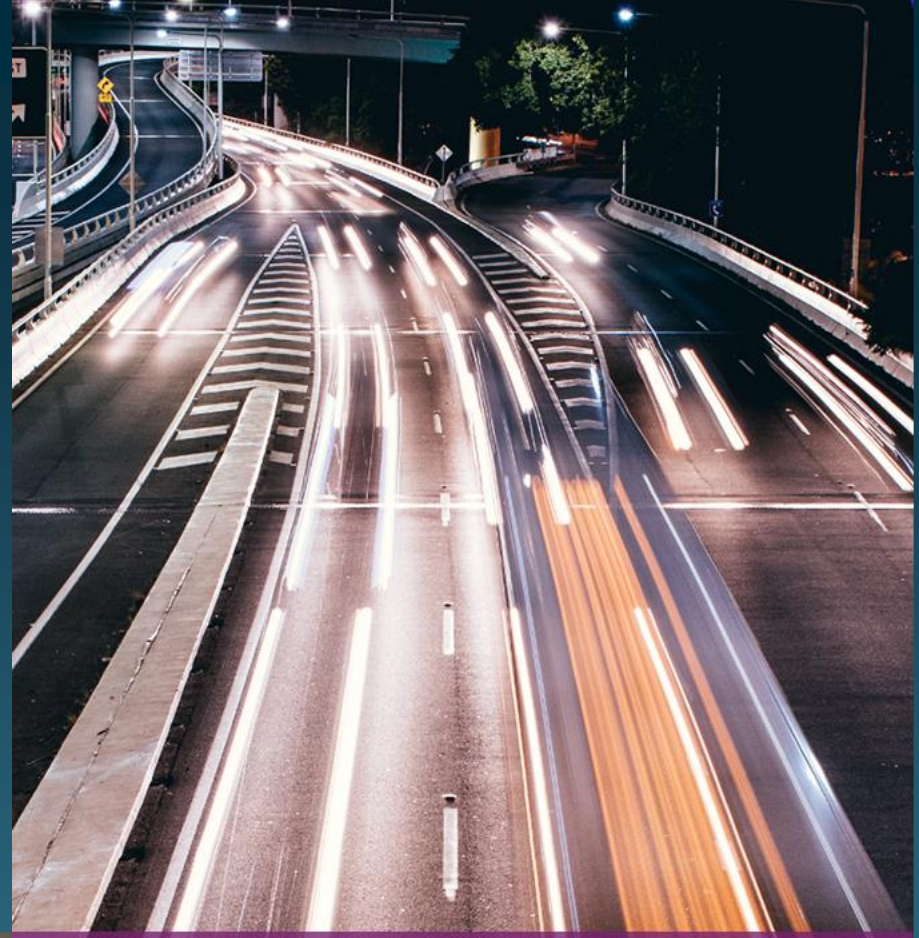
Supporting Australia's community safety

Securing Australia's water resources

Managing Australia's marine jurisdictions

Enabling an informed Australia

Ensuring a high performing organisation

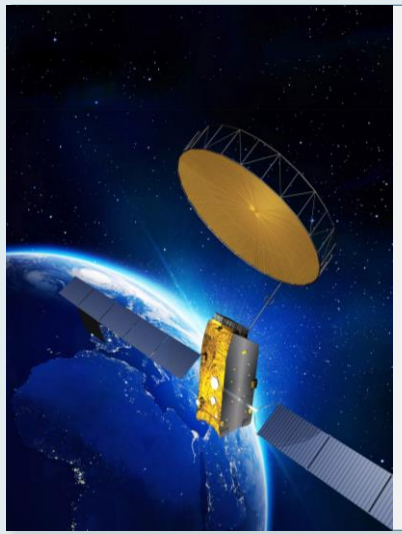


Creating a location-enabled Australia

Positioning Australia Branch

- **The national authority** on geodesy and position verification
- **Australian Government lead** for position and navigation
- Operate **world-class geodetic infrastructure** and applied geoscience research

- **Deliver precise positioning services** that are **reliable, accurate, nationally consistent**, and **openly accessible**
- Provides **key positioning infrastructure**, **computational tools**, **processing capability** and **trusted platforms.**



Regional Navigation Satellite System Constellations

4 Global

2 Regional

Geostationary payloads (coming)

2 Satellites

2 **SBAS uplink stations** (coming)

2 **Satellite Laser Ranging + 3 VLBI stations**

235 **GNSS reference stations**

15 **Absolute gravity ground stations**

3000+users

3.5cm Services across 96%of mobile coverage

Early 10cm Services this year to ~3.4BN devices

Digital Earth Branch

- **Provides continental-scale, time-series, medium-resolution, analysis ready Earth observation** (satellite land imaging) **data** and **derivative products.**
- **Enables** users to **monitor change** underpinned **by world-leading science**, **calibrated and validated** to allow **for country** and **continental conditions**.
- **Leads Digital Earth Australia Program** and recently-announced **Digital Earth Antarctica**.
- **Engages** with multiagency organisations that **promote the availability, access and use of Earth observations across Australian** and **international communities.**

2 Global Land Imaging Satellite System Constellations

OPEN DATA CUBE

2 Open processing environments

Each imaging the same location every **5-16** Days

4 Drones to calibrate satellite data

DEA

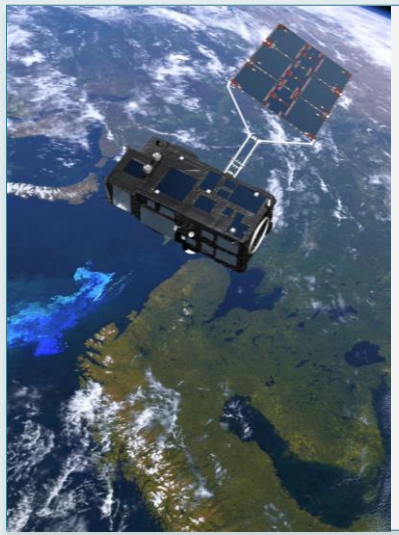
2,600 Registered Users

5.2PB Data in Storage

~600TB Growth per Year

Satellite Land Imaging Collection Branch

- **Assure the nation's streamlined access** to quality-assured imagery of lands and coasts
- **Deliver on international partnerships** with the United States, European Union and Japan
- Engage multi-laterally on standards and methods that **improve interoperability** between different foreign data sources and reduce risk
- Develop techniques to monitor the **quality and integrity** of foreign satellite imagery



1 Copernicus Regional Data Hub

6.3 Petabytes of high-quality data available to users

25 Nations served in South-East Asia and the Pacific

3 Landsat missions supported with command/control

4 Antennas at our Alice Springs Satellite Ground Station Facility

40+ Years of reliable operation

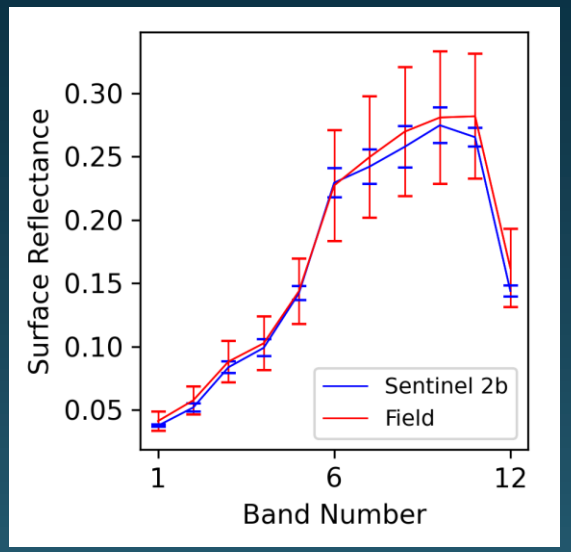
Digital Earth

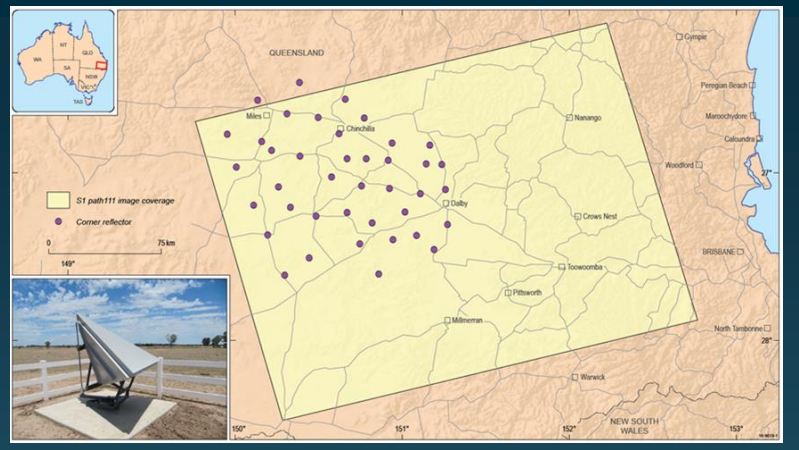
For processing, analysis and access

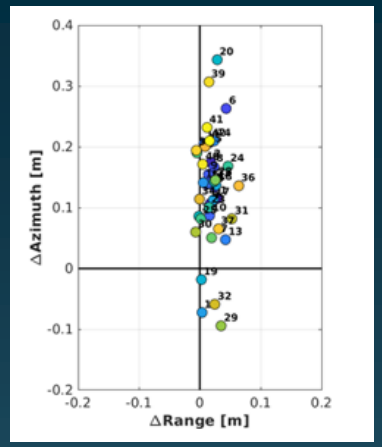
Other users

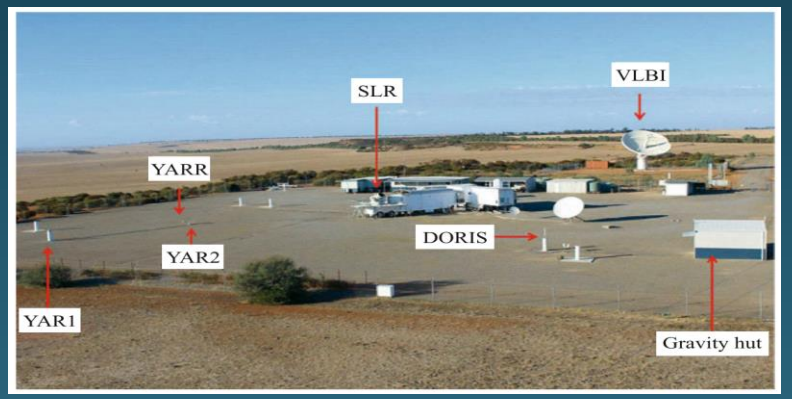
Businesses, government agencies, researchers, communities

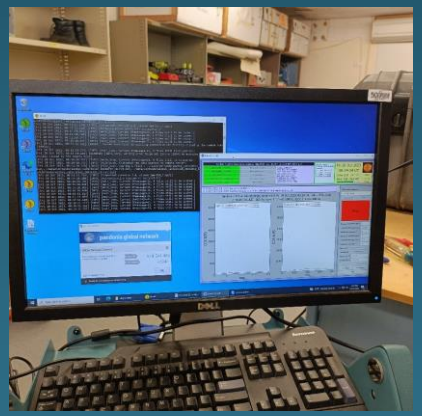
Cal Val @ Geoscience Australia











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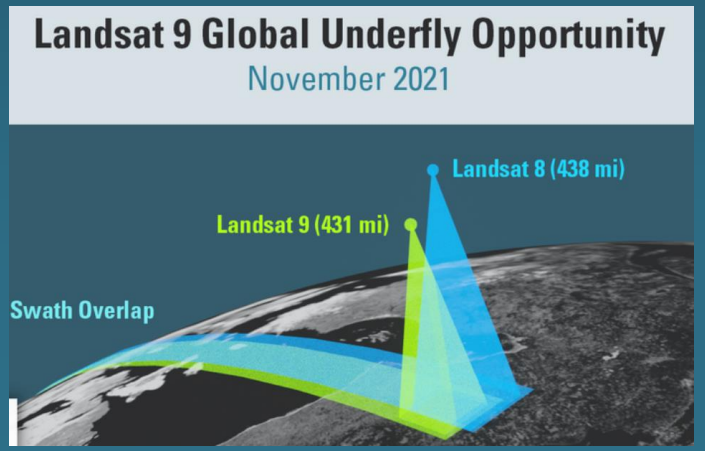


CEOS ANALYSIS READY DATA

CEOS Analysis Ready Data (CEOS-ARD) are satellite data that have been processed to a minimum set of requirements and organized into a form that allows immediate analysis with a minimum of additional user effort and interoperability both through time and with other datasets.

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

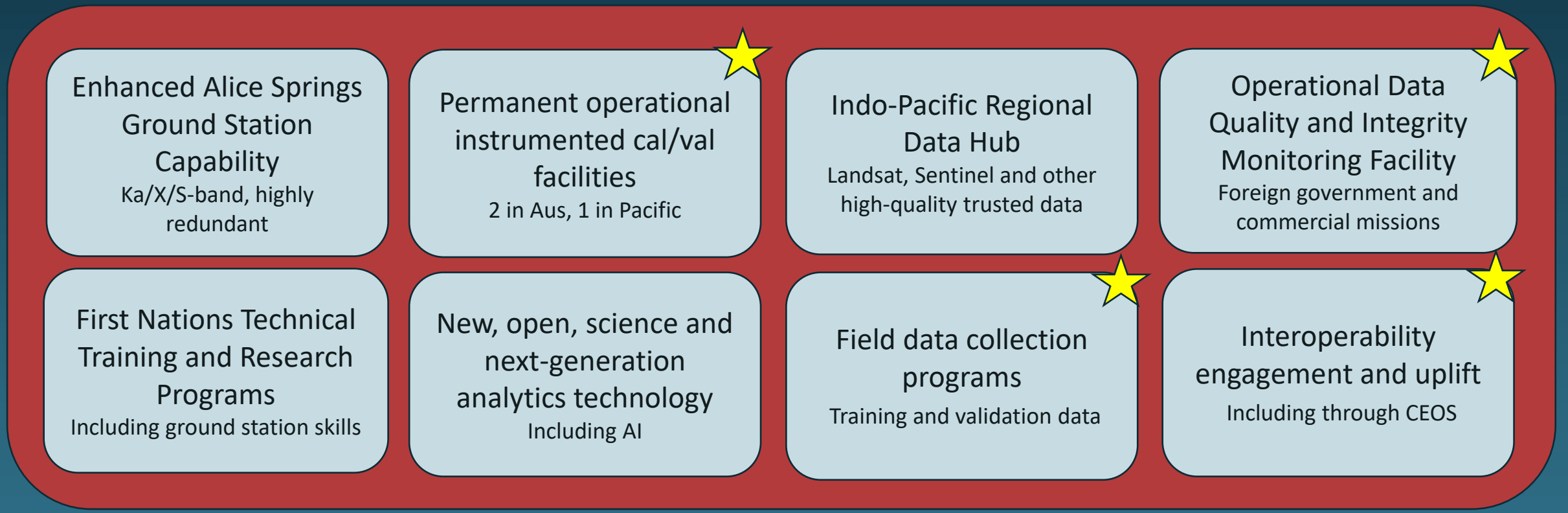
Investment in Australian capability

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



Personal introduction

- Associated with EO from space for ~ 35 years
- Experience in EO Cal / Val straddling optical and microwave domains
- Utilisation of EO data for applications across terrestrial and marine environments
- Scientific publications in several remote sensing journals (*citations 1093, h-index 17, i10-index 27*)
- Current role: Director, Data Processing, Quality and Integrity at Geoscience Australia, based in Canberra
- Represented GA at CEOS-WGCV since the 2012 plenary in Brisbane

Professional qualifications / roles (*more detail in CV*)

- Master of Management, Australian National University
- Graduate Certificate in Management, University of Western Sydney
- Master of Science, University of Allahabad
- Bachelor of Science, University of Allahabad

- Director, Data Processing, Quality and Integriy, GA
- Director, Satellite Data Quality Assurance and Science, GA
- Director, Calibration and Validation, GA
- Section Leader, Earth Observation Science , GA
- Remote Sensing Scientist, GA
- Remote Sensing Product Manager, GA
- Remote Sensing Account Manager, GA
- EO Scientist, Space Applications Centre, ISRO

- Member, AusCalVal Technical Advisory Group
- Member, Editorial Board, Journal of Geomatics
- Member, Editorial Advisory Board, Journal of the Indian Society of Remote Sensing
- Life Member, Indian Society of Remote Sensing and Indian Meteorological Society

Recent Publications (*complete list in CV*)

remote sensing MDPI

Article

Choice of Solar Spectral Irradiance Model for Current and Future Remote Sensing Satellite Missions

Fuqin Li [1,*], David L. B. Jupp [2], Brian L. Markham [3], Ian C. Lau [4], Cindy Ong [4], Guy Byrne [1], Medhavy Thankappan [5], Simon Oliver [1], Tim Malthus [6] and Peter Fearns [7]

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7 Curtin Medical School, Curtin University, Bentley, WA 6102, Australia; p.fearns@exchange.curtin.edu.au
* Correspondence: fuqin.li@ga.gov.au

Abstract: The accuracy of surface reflectance estimation for satellite sensors using radiance-based calibrations can depend significantly on the choice of solar spectral irradiance (or solar spectrum) model used for atmospheric correction. Selecting an accurate solar spectrum model is also important for radiance-based sensor calibration and estimation of atmospheric parameters from irradiance observations. Previous research showed that Landsat 8 could be used to evaluate the quality of solar spectrum models. This paper applies the analysis using five previously evaluated and three more recent solar spectrum models using both Landsat 8 (OLI) and Landsat 9 (OLI2). The study was further extended down to 10 nm resolution and a wavelength range from Ultraviolet A (UVA) to shortwave infrared (SWIR) (370–2480 nm) using inversion of field irradiance measurements. The results using OLI and OLI2 as well as the inversion of irradiance measurements were that the more recent Chance and Kurucz (SA2010), Meftah (SOLAR-ISS) and Coddington (TSIS-1) models performed better than all of the previous models. The results were illustrated by simulating dark and bright surface reflectance signatures obtained by atmospheric correction with the different solar spectrum models. The results showed that if the SA2010 model is assumed to be the "true" solar irradiance, using the TSIS-1 or the SOLAR-ISS model will not significantly change the estimated ground reflectance. The other models differ (some to a large extent) in varying wavelength areas.

Keywords: solar irradiance models; Landsat; atmospheric correction; sensor calibration; solar diffuser; reflectance panel

check for updates

Citation: Li, F.; Jupp, D.L.B.; Markham, B.L.; Lau, I.C.; Ong, C.; Byrne, G.; Thankappan, M.; Oliver, S.; Malthus, T.; Fearns, P. Choice of Solar Spectral Irradiance Model for Current and Future Remote Sensing Satellite Missions. *Remote Sens.* **2023**, *15*, 3391. https://doi.org/10.3390/rs15133391

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1. Introduction

An accurate normalized solar spectral irradiance model at the top of the atmosphere (TOA) is very important for atmospheric correction and sensor calibration of Earth observation data [1]. It is also an important boundary condition used in computing the energy balance, heating and cooling of the atmosphere [2] and total solar radiation estimation and is a key factor in models used to invert irradiance data for atmospheric parameters and field estimation of reflectance. Li et al. [3] showed how different choices of the solar spectral irradiance model at mean Sun–Earth distance (in this paper simply called the solar spectrum), at environmental satellite spectral resolution, can significantly impact

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

check for updates

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

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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

remote sensing MDPI

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

Motivation for WGCV Vice-Chair nomination

Long history and strong track record of EO calibration and validation in Australia and active contributions through CEOS entities

Australia is reliant on space data providers for its national EO data needs

Step-up Australian contribution in support of coordinated global effort on cal / val

Increasing recognition of the importance of cal / val for increasing trust in EO data

Engagement on standards and methods for interoperability between different data sources, improves trust and reduces risk to data access from individual sources

Aligned with the Australian Government strategic framework for international space engagement activities

Areas of interest

- Advancing multi-sensor, multi-platform interoperability
- Analysis Ready Data, securing buy-in from the commercial sector
- SI-Traceable Satellites (SITSats), coordination and information sharing
- Calibration and Validation networks, participation and contribution

Thank you

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