Advancing Earth Observation Forum

2022

Program Abstracts

***Note**: The AEO22 Forum program is subject to change, refer to [online program]() for the latest information.*
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Deep Learning for the Real World – A start to finish Workflow

Dr Dipak Paudyal[1]
[1]Apac Geospatial Pty Ltd, Brisbane City, Australia

Workshop: Deep Learning for the Real World - a start to finish workflow, August 22, 2022, 9:00 AM - 12:00 PM

***Biography**: Dr. Dipak Paudyal is Founder, Chief Scientist & Managing Director of APAC Geospatial, a remote sensing software, consulting, and geospatial services company. Dr Paudyal has practical experience in Remote Sensing, Image Processing and AI through intimately working in the past with well renowned and largest geospatial Imaging Software and services companies in the world such as L3Harris Geospatial, ESRI Australia and Leica Geosystems /Hexagon/ Intergraph/ ERDAS. Dipak is an expert in Remote Sensing Science and its application. Dipak, in his role of Chief Scientist, also provides strategic consulting in areas of Imagery and Remote Sensing.*

Not everyone is a deep learning expert and the ENVI Deep Learning module was developed with this in mind. The module has intuitive tools and workflows that don't require programming and enable users to easily label data and generate models with the click of a button.

Additionally, it is simple for seasoned imagery experts to fuse information layers such as spectral indices, elevation data or data transforms to create more robust classifiers.

The workshop will discuss the concept of Deep Learning applied to Imagery and provide participants a hands-on experience in using the commercial off-the-shelf ENVI Deep Learning module that is specifically designed to work with remotely sensed imagery to solve geospatial problems. The ENVI Deep Learning module removes the barriers to performing deep learning with geospatial data and is currently being used to solve problems in agriculture, utilities, transportation, defence, and many other industries.

Highlights:

1. Deep learning for Geospatial Imagery
2. Hands-on
3. Real World examples

Introduction to the Digital Earth Australia platform, datasets, and mapping portal

Dr Pablo Larraondo, Dr Claire Phillips[1]
[1]*Geoscience Australia, Canberra, Australia*

Workshop: Introduction to the Digital Earth Australia platform, datasets and mapping portal, August 22, 2022, 9:00 AM - 12:00 PM

Biography: *Claire Phillips is a remote sensing scientist with the Digital Earth Australia program at Geoscience Australia. Her research interests include marine and coastal remote sensing and applications, with a particular focus on improving the remote detection of Australian coastal habitats. She enjoys sharing her expertise and welcoming others to the field of environmental remote sensing and big data science and has helped to develop a range of resources to support and encourage new users to adopt the Digital Earth Australia platform for their Earth observation analyses.*

The Digital Earth Australia (DEA) platform, an implementation of the Open Data Cube, is a spatially and temporally curated archive of open-source Earth observation imagery, centred over continental Australia. This first of two workshops during the AEO Forum will introduce the DEA platform and support participants to examine its hosted datasets and derived products via an interactive exploration of the online DEA mapping portal, DEA maps. The session will conclude with a brief introduction to the DEA analysis platform, the DEA sandbox. Please note that the second DEA workshop during the AEO Forum will be exploring the sandbox platform in greater detail.

This workshop is aimed towards participants who are new to DEA or who wish to improve their understanding of the hosted datasets and capabilities of the online mapping portal. Participants in this first workshop require no prior experience but will need access to an internet-enabled laptop (preferably) or portable device.

Highlights:
1. Learn about Digital Earth Australia: an archive of Australian open-source Earth observation imagery and analysis platform
2. Examine the DEA datasets and data products
3. Explore the DEA mapping portal

Satellite meteorology training activities and resources of the BOM/BMTC Australian VLab Centre of Excellence

Bodo Zeschke[1]

[1]Bureau Of Meteorology Training Centre, Melbourne, Australia

Workshop: Satellite meteorology training activities and resources of the BOM/BMTC Australian VLab Centre of Excellence, August 22, 2022, 9:00 AM - 12:00 PM

Biography: *Bodo Zeschke (LinkedIn address https://au.linkedin.com/in/bodo-zeschke-85a14836) is a teacher at the Australian Bureau of Meteorology Training Centre, specialising in satellite meteorology, since 2009. Prior to this he worked for 8 years as an Operational Weather Forecaster at the Darwin Regional Forecasting Centre. Bodo has a master's degree in Satellite Meteorology.*

The Australian Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) Centre of Excellence (CoE) as hosted by the Australian Bureau of Meteorology Training Centre (BOM/BMTC) belongs to a global network of specialized training centres and meteorological satellite operators working together to improve the utilisation of data and products from meteorological and environmental satellites. Since 2013 the CoE has conducted monthly Regional Focus Group meetings to collaborate with Australasia-Pacific colleagues in disseminating the latest developments in satellite meteorology.

During this Workshop the VLab Point of Contact Bodo Zeschke will summarise the training and collaboration activities of the CoE. The author will also highlight the resources of this CoE. In particular:

- The author will introduce the archived Regional Focus Group meeting resources. These will include innovative satellite meteorology work that the CoE has been engaged in. Participants will have the opportunity to explore these resources.
- The author will give examples of the integration of this world class satellite meteorology into the training resources of the Bureau of Meteorology Training Centre's Graduate Diploma of Meteorology Course.
- Feedback will be sought regarding the wider involvement of the Australian satellite community in this training and collaboration initiative.
- There will be a final summary session in the style of a group discussion.

Interactivity during this workshop will be enhanced using the Socrative cloud-based learner response system. The author has used Socrative during teaching at the Australian Bureau of Meteorology Training Centre and during VLab and International Training Events since 2017.

The author will introduce the archived Regional Focus Group meeting resources. These will include innovative satellite meteorology work that the CoE has been engaged in. Participants will have the opportunity to explore these resources.

The author will give examples of the integration of this world class satellite meteorology into the training resources of the Bureau of Meteorology Training Centre's Graduate Diploma of Meteorology Course. Interactivity during this workshop will be enhanced using the Socrative cloud-based learner response system.

Validation of surface reflectance across vegetation

Dr Cindy Ong

Workshop: Validation of surface reflectance across vegetation, August 22, 2022, 9:00 AM - 12:00 PM

Optical Earth Observation are one of the most widely used satellite Earth Observation data in Australia. For terrestrial applications, the base product that most users employ to develop higher level information products is the surface reflectance or Level 2 product. Hence, ensuring that satellite-derived surface reflectance products are of sufficient quality for higher level product development is essential. Assessment of the quality is usually performed through validation, the process of assessing, by independent means, the quality of the data products derived from Earth Observation sensors. Methods for validation of satellite-derived surface reflectance products across bare, uniform cover types with low vegetation are less complex and have been developed over the years and are fairly well established. This includes a recent, Australian developed, international field-based guideline for such simple cover types. However, the validation of satellite-derived surface reflectance across vegetated landscapes with higher, denser, and heterogenous vegetation is more challenging.

The use of remote platforms, such as towers or Uncrewed Aircraft Systems (UAS), are potential promising options. Indeed, within the Committee on Earth Observation Satellites Working Group on Calibration and Validation (CEOS WGCV), an initiative (SRIX4VEG: Surface Reflectance Intercomparison Exercise for Vegetation) specifically focussed on the use of UAS for the collection of validation data for satellite-derived surface reflectance across vegetated area has recently been launched. In Australia, there has been significant developments related to the use of UAS to collect optical data for vegetation studies across academia, research institutes, government, and small to medium enterprises. Therefore, like the guidelines for field-based validation of surface reflectance, there is an opportunity for the Australian EO community to showcase Australian capabilities and to participate in the development of international guidelines for the validation of surface reflectance across vegetated cover.

This workshop provides a forum for discussing:

- Australian capabilities and state of the art for the use of UAS for vegetation and linkages to the validation of satellite-derived surface reflectance;
- Other platforms that may be relevant; and,
- Current challenges and opportunities for the further development of the collection of validation data from UAS and other related platforms for the validation of satellite-derived surface reflectance products;

Outcomes/Outputs from workshop:

- An outline of a plan for an Australian community approach/guideline for the collection of validation data from UAS and other platforms for the validation of satellite-derived surface reflectance products across vegetated areas; and,
- An outline of a scope of work for a field exercise in support of the development of the guidelines.

Building collaborations and capacity in remote sensing of bushfires

Dr Stefan Maier[1,2], Dr Marta Yebra[3], Dr Nicolas Younes[3]
[1]*maitec, Darwin, Australia,* [2]*James Cook University, Cairns, Australia,* [3]*Australian National University, Canberra, Australia*

Workshop: Building collaborations and capacity in remote sensing of bushfires, August 22, 2022, 1:00 PM - 4:00 PM

Biography: *Stefan is a graduated engineer in Applied Physics (Fachhochschule Isny, 1993) and has been awarded the degree of Doctor of Engineering (Technical University Munich, 2000). Stefan held Research Associate (1996-1999) and post-Doctoral (2000-2002) positions at the German Aerospace Center (DLR), Oberpfaffenhofen. From 2002-2007 he worked at Satellite Remote Sensing Services, Western Australian Land Information Authority, initially as Senior Research Officer and later as Manager. In 2007 Stefan took up a position as Principal Research Fellow Remote Sensing at Charles Darwin University, Darwin. In early 2015 he founded Maitec. Stefan has been involved in fire remote sensing for over two decades.*

Fire affects most ecosystems in Australia. Consequently, over the last three decades remote sensing has become a major tool for fire management and research in Australia. However, there is limited opportunity for Australian fire remote sensing experts to exchange experience and knowledge, and coordinate activities at the national level.

This workshop aims to bring together Australian fire remote sensing experts. It will provide the opportunity for information exchange, for raising and discussing issues to be tackled at the national level and achieve national coordination. Specifically, we will discuss the following topics:

- National fire remote sensing product validation: existing protocols and initiatives. Do we need national protocols and repositories?
- Consistent, long-term national fire mapping products (pre-fire, active fire, and post-fire): What should they look like? What are the requirements?
- User requirements for the next generation of space-borne and airborne sensors.

Highlights:

1. bringing together Australian fire remote sensing experts
2. achieving national coordination and collaboration
3. developing national standards

Earth Observation and Remote Sensing Toolkit. Simple and efficient geoprocessing using the Rust programming language

Leo Hardtke[1]

[1]*Department of Environment and Science, QLD, Brisbane, Australia*

Workshop: Earth observation and Remote Sensing Toolkit. Simple and efficient geoprocessing using the Rust programming language, August 22, 2022, 1:00 PM - 4:00 PM

Biography: *I was born in Buenos Aires, Argentina and moved to Patagonia to study Ecology. I came across remote sensing and open-source software early in my career and have applied them to answer ecological questions ever since. I moved to Australia in 2016 and have been working for the Department of Environment and Science of Queensland since 2018. My researchgate profile: https://www.researchgate.net/profile/Leonardo-Hardtke/*

Rust is an emerging general propose programming language that stands out for its excellent tooling, speed, memory efficiency and safety, rich type system and ownership model that eliminates many common bugs at compile time. Rust has a very healthy and ever-growing ecosystem of libraries (crates) but still lacks a crate to simplify writing geospatial processing code. The Earth Observation and Remote Sensing Toolkit (eorst) is an open-source library aiming to fill that void by taking inspiration from well-established python libraries such as rasterio, rios, xarray and dask and implements them in rust, enabling the programmer to focus on the geospatial process rather than the implementation details while taking advantage of the benefits of the rust programming language. Despite being in early stages of development eorst already offers a rich set of tools such as simple reading and writing of geospatial data into labelled arrays, on-the-fly projection and alignment of input data, partition input data into small blocks allowing computation on arrays larger than memory concurrently, efficient raster point sampling, simple band math, time series analysis and integration with 3rd party libraries like such as opencv to perform computer vision task and LightGBM and XGBoost for machine learning. The library is available in the official creates registry (https://crates.io/crates/eorst). Future work in the short term will be focused on the stabilization of the API and extending the documentation and examples, collaboration is welcome.

Highlights:

1. In this hands-on workshop participants will learn how to use this library with some real-world application samples.
2. Efficient geospatial coding with rust.

Introduction to the Digital Earth Australia analysis platform – the DEA Sandbox

Dr Pablo Larraondo[1], Mr Norman Mueller, Dr Claire Phillips[2]
[1]Australian National University, Canberra, Australia, [2]Geoscience Australia, Canberra, Australia

Workshop: Introduction to the Digital Earth Australia analysis platform – the DEA Sandbox, August 22, 2022, 1:00 PM - 4:00 PM

Biography: *Pablo Larraondo has an MSc in Distributed Systems (2011) from the University of Navarra and PhD in Computer Science (2019) from the University of the Basque Country, in Spain. His PhD research addressed the application of machine learning techniques to analyse weather forecasting data.*

Pablo has more than 15 years' experience as a scientific software developer. He started his career at the Spanish and European weather forecasting centres, and subsequently worked at CSIRO and the National Computational Infrastructure.

Pablo's research interests are in developing methodologies to understand the relationship between dynamic processes in the atmosphere and at the Earth's surface.

The Digital Earth Australia (DEA) platform, an implementation of the Open Data Cube, is a spatially and temporally curated archive of open-source Earth observation imagery, centred over continental Australia. This second of two workshops during the AEO Forum will introduce the DEA Sandbox, an interactive hosted platform for analysing DEA datasets. Participants will be supported to sign up to, and access, the Sandbox platform and will work through an interactive tutorial demonstrating how to access and analyse remote sensing data using Jupyter notebooks. The tutorials will provide a practical approach to using some of DEA's most popular datasets. Examples of common time series and spatial analysis will be provided in the context of the presented use cases. Attendees to this session will be able to follow along with and reproduce the examples using their own laptops.

Please note that the first DEA workshop during the AEO Forum will be exploring the DEA platform and datasets in greater detail. This workshop is ideal for participants who have an intermediate understanding of remote sensing science and who wish to customise their own analyses, using Earth observation data. A beginners understanding of programming with Python, or a similar language, will be highly beneficial. Participants will also need access to an internet-enabled laptop device.

Highlights:

1. An introduction to tailoring your own analyses using Digital Earth Australia datasets
2. Find and retrieve Earth observation data and build your own analysis
3. Use pre-prepared DEA workflows to further customise your analyses, or create your own Digital Earth Australia Sandbox

Open satellite data at the Bureau of Meteorology

Dr Caroline Poulsen[1], Dr Pallavi Govekar, Dr Luigi Renzullo
[1]*Bureau of Meterology, Melbourne, Australia*

Workshop: Open satellite data at the Bureau of Meteorology, August 22, 2022, 1:00 PM - 4:00 PM

Biography: *Caroline Poulsen is a research scientist in the Satellite Science group at the Bureau of Meteorology with 20 years of experience working with Meteorological satellites. She is a passionate advocate of satellite applications and an expert in cloud, aerosol, and solar radiance retrievals from Meteorological satellites. She began her career at the UK Met. Office working in satellite data assimilation before moving to Rutherford Appleton Space Laboratory where she worked on cloud and aerosol retrievals for the European Space Agency, Climate Change Initiative program, followed by short stints at DEFRA and Monash University.*

Most people will be familiar with the imagery provided by the JAXA operated Himawari geostationary satellite. Less familiar but just as critical are many of the derived Himawari satellite products.

Cloud properties, such as type, mask, height, temperature, optical depth, effective radius and phase when evaluated together provide time critical information on rapidly developing thunderstorms, potential flooding and aircraft icing conditions. This information is critical to enable better decision making by our forecasters for Australia.

In addition, the information about clouds is ingested, in near real time, into solar radiation models to provide surface solar radiation information, for the solar energy industry as well as for climate analysis.

After a short delay, these data sets are freely available to be used by the Earth observation community.

In this workshop we will introduce you to the newly released Himawari Geostationary satellite data that is publicly available through NCI's THREADDS server. We will provide an overview of the products available including BARRA reanalysis data, and then give you an opportunity to try them for yourself.

The workshop will provide python Jupyter notebooks to guide you in how to access, read and visualise the data. The notebooks will assume very little/no coding knowledge. Participants are encouraged to contribute questions and case studies, so that we can work through real life examples. We welcome feedback on requirements from the user community.

Data accessible at https://dapds00.nci.org.au/thredds/catalogs/ra22/catalog.html

Highlights:

1. Introduction to Bureau of Meteorology open satellite data sets.
2. Try then out using Python notebooks
3. Discuss and feedback to passionate satellite scientists.

The many faces of fractional cover: demonstrating methods of access and analysis

Dr Adrian Fisher[1]
[1]Univeristy of NSW, Sydney, Australia, [2]Joint Remote Sensing Research Program, Brisbane, Australia

Workshop: The many faces of fractional cover: demonstrating methods of access and analysis, August 22, 2022, 1:00 PM - 4:00 PM

Biography: *Adrian Fisher is a Lecturer in Remote Sensing at UNSW and a member of the Joint Remote Sensing Research Program. He has used Landsat fractional cover to study arid zone vegetation dynamics in the Simpson Desert, Strzelecki Desert and at the Fowlers Gap Arid Zone Research Station in western NSW. Most of his research uses fractional cover time series, field measurements, and drone data to better understand fractional cover models, and applications.*

This will be an interactive workshop, where you will learn about vegetation fractional cover models (unmixing pixels into photosynthetic vegetation, non-photosynthetic vegetation, and bare ground); how it is used by researchers, government monitoring programs, and industry; and how you can access and analyse pre-processed data. It will involve:

- Presentations from the creators and users of fractional cover data.
- Demonstrations of how to source, create, and analyse fractional cover, such as from the Terrestrial Ecosystem Research Network or Digital Earth Australia.
- The launch of a new (version 3) fractional cover model for Landsat data, and a dedicated Sentinel-2 fractional cover model.
- Sharing of code repositories with examples of how to create, access, and analyse fractional cover using python scripts or Jupyter notebooks.
- Bring your laptop and you can apply new methods to your own interest areas.

Highlights:

1. Hear how researchers use models of vegetation fractional cover across Australia.
2. Learn how to access and analyse fractional cover from several different sources.
3. See the future of fractional cover, with new models, and a multitude of possibilities.

Increasing uptake of Earth observation through user engagement

Dr Jasmine Muir, Dr Caitlin Adams, Phil Delaney, Dr Serryn Eagleson, Dr Lisa Hall

EO360 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Jasmine has a broad range of experience leading and developing Earth observation applications and products aimed at improving management decisions. At FrontierSI she is the Earth Observation Technical Lead and the Capability Demonstrator Lead for Aquawatch at SmartSat CRC. Jasmine has a PhD in Remote Sensing, a Masters in Geographical Information Science, and a Bachelor of Science (Ecology), from the University of Queensland.*

Research conducted by the World Economic Forum has identified that Earth observation data is not used to its full potential in Africa, with a significant gap between the number of current users and the number of potential users. The Digital Earth Africa program exists to process Earth observation data and produce decision-ready products, providing useful data for academia, businesses, and governments across the continent. But it is one thing to have the data, and another to grow its uptake.

In this project, FrontierSI partnered with NGIS and COOi Studios to complete user engagement, training, and awareness sessions to increase the speed of uptake of Digital Earth Africa's data products and infrastructure.

The team found that a combination of push and pull engagement strategies can help grow the impact of EO data in Africa; the push side is driven by the priorities of Digital Earth Africa, and the pull side is driven by end-user needs.

In this presentation, FrontierSI will outline these engagement strategies in the African context, which have been developed from the learnings of Digital Earth Africa's end-users.

Highlights:

1. Earth observation data is not used to its full potential in Africa.
2. Understanding end-user needs is a key part of designing an effective strategy for higher engagement with EO data.
3. FrontierSI worked with Digital Earth Africa, NGIS, and Cooi Studios to engage and understand users.

What can the Earth Observation community learn from Astronomy?

Professor Melanie Johnston-Hollitt

EO360 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Professor Melanie Johnston-Hollitt is an internationally prominent radio astronomer working in the space between astrophysics, computer science and big data. She is director of the Curtin Institute for Computation (CIC) and the Australian Space Data Analysis Facility (ASDAF). The Curtin Institute for Computation (CIC) is an interdisciplinary knowledge accelerator which applies data science and high-performance computing to collaboratively provide innovative solutions for real-world problems for government, industry, and academia. ASDAF was established to enhance Australian SMEs' and researchers' ability to use space data, particularly earth observation data, in multi-pathway strategies.*

Having spent 20 years as using instrumentation looking outward to the Universe, it was not such a shift to become director of the Australian Space Data Analysis Facility - which is helping industry and researchers to make use of freely available Earth observation data. I was immediately struck by the many similarities between the data used in astrophysics and Earth observations, including use of multi-frequency, multi-resolution data to uncover the physics of underlying processes both on Earth and in space. However, as I quickly discovered, the astronomical and EO communities have taken different approaches to the collection, management, and curation of these data. In this EO360 presentation I will bring my perspectives from astrophysics on how the EO community might draw on some of the lessons learnt in astronomy on ways to best leverage data from disparate instruments, resolutions & frequencies, to advance knowledge faster.

Highlights:

1. Lessons for EO from Astronomy
2. Data Standardisation
3. Knowledge Acceleration

Sustainable supply chain sourcing – the TraceMark solution

Mrs Brittany Dahl

EO360 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Brittany Dahl is a Solutions Engineer with over seven years of hands-on experience addressing business challenges with geospatial technology and earth observations. Brittany recently joined NGIS to help build meaningful and sustainable solutions with Google Cloud and Earth Engine, showing how global changes can aid in important and environmentally friendly data-driven decisions. Brittany is a high school STEM Coach with the Curious Minds program, and volunteers with WWF, SSSI, SSS-DLN, and GeoRabble.*

NGIS have been developing new methods to inform global supply chain monitoring using satellite data, weather model outputs, and on-the-ground observations of not only environmental, but also social considerations impacting supply chain risk and Environmental & Social Governance (ESG). We've teamed up with Google Cloud to analyse satellite images of the forests, biodiversity and water cycles that intersect supply chains, and a range of NGOs collecting data on social risks to deliver a full picture of ESG risk tailored to individual corporations' specific supply chains. It's a partnership that will help raise sustainability standards, allowing us to see a more complete picture (quite literally) of the ecosystems connected to the raw materials sourced from around the world. For example, one of the world's largest buyers of palm oil, Unilever, joined forces with Google and NGIS to raise sustainable sourcing standards for suppliers and bring Unilever closer to its goal of a deforestation-free supply chain by 2023. This session features a short talk on this collaboration.

Unilever reached out to NGIS in 2020 with a desire to track and trace every part of their supply chain, from growing fields to products on the shelves, and everything in between. Our team of GIS Analysts and Developers were able to compose a custom solution to address this challenge, giving rise to TraceMark. TraceMark enables organisations to take a data-driven approach to global supply chain sustainability, delivering metrics, mapping progress, and providing traceability, to enable organisations to address corporate sustainability and ESG commitments.

Highlights:

1. The CPG industry is faced with an opportunity to utilise world-leading technology to meet the consumers halfway and provide them with responsibly sourced products.
2. Our team of GIS Analysts and Developers have leveraged world-leading satellite imagery, combined with the processing power of Google Cloud and Google Earth Engine, to develop an end-to-end sustainability tracing tool that can map and monitor complex supply chains.
3. Our work is helping bring Unilever closer to its goal of a deforestation-free supply chain by 2023.

OzFuel – monitoring Australian forests, preventing loss, and advancing the space industry

Dr Nicolas Younes, Dr Marta Yebra

EO360 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Nicolas earned his PhD in Environmental Sciences from James Cook University in Queensland in 2020 where he investigated and modelled the phenology of mangrove forests using satellite imagery. He studied environmental engineering and has experience working in the oil and gas, construction, and consulting industries. At the Australian National University, he is part of the team developing OzFuel, a satellite specifically designed to detect changes in the flammability of Australian forests. As part of this efforts, he's compiling a combination of spectral and biochemical characteristics of eucalypt that will improve bushfire management across Australia.*

In 6 minutes, I'll present OzFuel, the importance for everyday Australians, its importance for bushfire management, and its importance to the Australian space industry.
Between 2019 and 2020 bushfires devastated communities, burned over 40 million hectares, killed 1 billion animals, chocked millions of people, and killed 33 people. When bushfires occur, they affect communities and landscapes for decade; but bushfires are a natural occurrence in Australia and we should aim to understand them, rather than fear them. OzFuel is a satellite designed to understand how easily forests could burn, thereby helping all government and non-government agencies understand the risk of bushfires. The risk of larger and more frequent mega-fires is only going to increase in future years. Allocating further ground resources to suppress fires is extremely costly and dangerous, and needs to be augmented with more effective prediction, prevention and mitigation strategies before an unforeseen ignition event burns out of control. Comprehensive fuel characterisation is a critical 'pre-fire' element for assessing bushfire risk, predicting fire behaviour, informing suppression efforts, and planning prescribed burns.
The OzFuel mission is unique as it will measure fuel properties as opposed to fire detection. By targeting the specific wavelengths related to dry matter and water content of eucalypts, OzFuel will provide a comprehensive characterisation of fuel loads at a continental scale.
OzFuel was featured by the Australian Space Agency as one of the pathfinder missions that will help strengthen develop Australia's space industry, increase space sovereignty, and provide services to all Australians.

Highlights:

1. Ozfuel will monitor the flammability of Australian forests,
2. OzFuel is being fully designed in Australia, for Australian conditions,
3. OzFuel will help strengthen develop Australia's space industry

Opportunities for working across knowledge systems with earth-observation: working with inter-planetary and indigenous approaches?

Professor Stuart Phinn

EO360 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Stuart is a scientist, educator, and leader who builds and applies methods to measure and understand how our environments are changing at multiple scales (www.rsrc.org.au). He has a strong track record of leading collaborative, multi-disciplinary teams and organisations to deliver quality science that draws upon fieldwork, satellite-image data, and modelling including founding directorships of national collaborative research infrastructure (www.tern.org.au) and a world-leading research to operational program that supports government environmental monitoring (www.jrsrp.org.au); and program leadership of industry-driven research. Stuart's work provides solutions to support sustainable development and resource use for all levels of government, various industries, and communities.*

Is satellite based, earth- or inter-planetary observations for measuring, monitoring, and understanding the earth and other planets, not accurate or use-able unless linked to some sort of "ground knowledge"? This question and how to address it beyond traditional-disciplinary, -professions and -knowledge systems, is the focus of the presentation. In this context earth observation (EO) is considered an enabling set of technologies and techniques, often linking across disciplines and professions to solve problems, e.g., in education, sciences, governments, industry, and defence. Adoption of EO in government and industry, and broader communities as an accepted source of accurate information for mapping-measuring-monitoring environmental features, requires it is based on sound science, detailed experiential knowledge of the ground/water/air/planet, collaboration, coordination, and communication. EO applications are well developed and adopted for monitoring Australia's vegetation, meteorology and climate, oceanography, and geology, but could be improved. The body of this presentation attempts to answer the question of, how can we improve our environmental understanding, management, custodial roles, and intrinsic links by sharing and integrating EO and traditional – indigenous approaches to environmental management, understanding environment and working with it. This would build partnerships using right-way partnerships and science. The approach potentially works with knowledge of environmental properties obtained from 10,000's year of on-country observation and accumulated knowledge, linked to repeated measurement over larger areas from EO. The approach presented is a starting point and suggests building partnerships and from areas with extensive indigenous engagement, such as fire management, and potentially water management.

Highlights:

- Earth observation for planetary sciences
- sharing and integrating EO and indigenous approaches to environmental management

Earth Observation Strategies that Deliver Tangible Results: Insights from New Zealand

Dr Dragos Bratasanu

Traditional 1 (Tues AM), Boulevard Auditorium, August 23, 2022, 11:00 AM - 12:30 PM

Biography: *DR. DRAGOS BRATASANU is an Earth Observation (EO) data and technical strategist with 12+ years of experience in the geospatial industry. He holds a Ph.D. in Artificial Intelligence for Earth Observation from the University of Siegen in Germany and has received several awards for his research and innovation in the EO industry. Dragos serves as Geospatial Data Lead for the Auckland Council and leads the development and deployment of several multi-million-dollar EO strategies for the organization. He previously served with DLR German Aerospace Centre as Science Manager for the largest Artificial Intelligence for Earth Observation centre in Europe, and with the Romanian Space Agency ROSA. He delivered significant research and innovations in the key Earth Observation project that led to ROSA becoming a European Space Agency (ESA) member state in 2011. His interests include strategy development and delivery, programme and project management, Earth observation research & innovation.*

Earth Observation data is a strategic asset. How do you develop and implement an Earth Observation (EO) data strategy that brings measurable change and delivers tangible results for an organization, a region, or a country? A good strategy always paves the way out of a difficulty, offers an approach to overcoming a specific challenge, and provides a controlled response to a significant problem. A good strategy is based on the clear understanding of the present reality that needs facing, anticipates the real-world difficulties that need to be overcome, removes fluff and philosophical words, and gets right to the point by providing precise solutions and the roadmap to get there. Developing a good EO strategy begins by discovering the critical factors in the current context. Then, optimal EO data and technical solutions are presented to meet the great majority of the users' requirements. Finally, tightly managing and coordinating the programmes, policies, and resources is critical to a successful delivery. Strategic execution and strong management control are key to the success of the strategy, and no amount of inspiration can replace the strict management of its deployment. This talk presents key insights from developing and delivering several Earth Observation strategies in Auckland, New Zealand.

Highlights:

1. understanding Earth observation user requirements across the landscape is the foundation for a good strategy.
2. Delivering state-of-the-art technical solutions in the most simple and user-friendly form will exponentially increase the number of users.
3. Tightly managing the delivery of the strategy over the course of the years is critical for success.

DEA Land Cover: Operational continental-scale land cover mapping of Australia

Dr Chris Owers, Professor Richard Lucas, Dr Daniel Clewley, Belle Tissott, Sean Chua, Gabrielle Hunt, Mr Norman Mueller, Dr Carole Planque, Dr Suvarna Punalekar, Dr Pete Bunting, Peter Tan, Professor Graciela Metternicht

Traditional 1 (Tues AM), Boulevard Auditorium, August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Dr Chris Owers is an environmental scientist and specialist in spatial science. Chris' research involves developing transformative technology to enable rapid response to ecosystem change for more effective and efficient management. His expertise covers remote sensing and landscape geomorphology with an emphasis on land monitoring and management. Chris has recently joined the University of Newcastle as a lecturer, formerly with the CSIRO.*

To comprehensively support national and international initiatives for sustainable development, land cover products need to be reliably and routinely generated within operational frameworks. Here, we present DEA Land Cover, Digital Earth Australia's next generation of land cover mapping. DEA Land Cover provides consistent and continent-wide land cover mapping for Australia using historical satellite imagery. The approach utilises an internationally recognised taxonomy (United Nations Food and Agriculture Organisation Land Cover Classification System), open-source software (Open Data Cube), and freely available global-coverage satellite imagery (Landsat archive). DEA Land Cover classifications have been generated by combining quantitative (continuous) or qualitative (thematic) environmental information (referred to as Essential Descriptors; EDs) derived from Landsat satellite data. Several EDs have been generated previously by Geoscience Australia, whilst others have been developed more recently. These EDs have been combined to generate detailed, consistent, and expandable annual classifications of Australia's land cover (> 100 attributions) from 1988 through to 2020. This is an essential resource for input into national processes such as the System of Environmental Economic Accounting (SEEA) as well as implementation and compliance of national and international policy (e.g., State of Environment Reports, the National Voluntary Reports on the Sustainable Development Goals). This talk will provide an overview of the products available as well as a dive into the scientific and technical development of several EDs.

Highlights:

- **We developed an operational national land cover mapping framework for Australia using Digital** Earth Australia (DEA Land Cover)
- DEA Land Cover uses the FAO LCCS taxonomy with open-source software and Landsat satellite data
- DEA Land Cover products have been developed to support national and international reporting on land cover change

National EO Validation Campaigns – a proven capability to build on. The L8/L9 Underfly Example

Mr Guy Byrne, Dr Mark Broomhall, Mr Eric Hay, Mr Medhavy Thankappan, Dr Andrew Walsh, Dr Fuqin Li, Dr Tony Gill, Ms Heidi Mawbey, Geoff Dale, Dr Geoffrey Horn, Dr Rodrigo Garcia, Dr Brendon Mcatee, Ms Janet Anstee, Ms Gemma Kerrisk, Mr Nathan Drayson, Dr Jason Barnetson, Ian Samford, Dr Rob Denham

Traditional 1 (Tues AM), Boulevard Auditorium, August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Guy Byrne is a calibration validation scientist with Digital Earth Australia. He has worked in EO with a focus on field spectrometry and validation for over thirty years.*

The recent federal funding of the National Space Mission for Earth Observation is in no small part a recognition of the capability of the Australian EO community - and central to this is the ability to mount effective national scale field validation programs.

Landsat-9 launched on the 27 September 2021 and as it transitioned to its final orbit was scheduled to briefly fly 'under' its predecessor Landsat-8. The underfly provided the global EO community a once in mission lifetime opportunity to collect field validation data concurrently for both sensors.

The underfly over passes in Australia occurred between the 11th and 17th of November and Geoscience Australia (who have a longstanding partnership with the USGS on satellite Earth observation) put out a call to the Australian EO community for collaborators. Bearing in the mind the Australian deployments were one part of international validation effort.

Despite many obstacles, teams from CSIRO, Queensland DES, NSW DPIE, University of WA, University of Queensland, Frontier SI and Geoscience Australia were able to capture a total of six terrestrial and one water validation data sets - for three overpasses at six sites across three states.

This paper provides a description of this collaborative national validation effort and presents examples of the results.

Going forward the Australian EO community needs to maintain and build on these skills and capabilities such that the community can meet the future demands of not only our existing international EO collaborations but the imminent arrival Australian orbiting EO sensors.

Highlights:

1. National field validation of the landsat8/9 underfly.
2. Importance of standarised protocols and well calibrated instrumentation
3. Cooperation within the Australian EO community

The CSIRO Earth Analytics Science Innovation Hub (EASI)

Dr Robert Woodcock, Dr Matt Paget, Dr Ronnie Taib, Dr Amy Parker, G Squire, Dr Alex Held

Traditional 1 (Tues AM), Boulevard Auditorium, August 23, 2022, 11:00 AM - 12:30 PM

The CSIRO Earth Analytics Science Innovation Hub (EASI) is a highly scalable, cloud-native Earth Observation analytics platform that allows users to access and analyse decades of satellite Earth observation (EO) imagery from multiple satellites to monitor and measure changes to the landscape. EASI captures the opportunities presented by recent developments in global geospatial and EO data distribution including the Open Data Cube, Xarray, and machine learning software, the Committee on Earth Observation Satellites Analysis Ready Data standard, cloud-native data formats, and the Spatio-Temporal Asset Catalog (STAC) for discovery. EASI combines these with high-performance, high-scalability tools like Kubernetes and Dask, enabling continental-scale processing, increased productivity, reduced costs, and accelerated innovation that takes research advances from Lab to Industry and Government.

As one example, a CSIRO team using EASI combined two decades of high-resolution EO data from multiple sources to measure degradation in water quality concurrently at state, estuary, and offshore scales, correlating events like floods with sediment plumes 30 km off the coast [1]. These findings help government and local managers set policies and reduce risk for industries in the blue economy. These projects and others like them are reporting improved productivity in the conduct of their work.

The benefits of the CSIRO EASI platform have seen it grow to a global network with regional deployments for Australia, Chile, USA, and South-East Asia [2]. These deployments support a range of disciplines (e.g., marine, environment, water, minerals, aquaculture, forestry) and diverse users including CSIRO scientists, national and international Universities, SMEs, and a Fortune 500 company. EASI facilitates greater collaboration and accelerates innovation for large-scale, high-performance EO data analytics.

Footnote references:

[1] ECOS. 'Using Satellite Data to Unlock Water Quality Knowledge', 27 April 2022. https://ecos.csiro.au/using-satellite-data-to-monitor-water-quality/
[2] Parker, A. et al. 'Unlocking Earth observation data for South-East Asia using the Open Data Cube'. Abstract submitted to AEO 2022.

Highlights:

1. EASI is a highly scalable, cloud native EO analytics platform
2. EASI is used at CSIRO for paddock to continental EO data analysis globally
3. EASI has expanded to be a Global Network with our research and industry partners

Vegetation earth observation for improved earth system modelling at the Australian Bureau of Meteorology

Dr Luigi Renzullo, Dr Katayoon Bahramian, Dr Christoph Rudiger

Traditional 1 (Tues AM), Boulevard Auditorium, August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Dr Luigi Renzullo is a land surface modeller with expertise in the application of a range of satellite observations to carbon and water cycle science. His research career spans 20 years, mostly at CSIRO with the last 4 at the ANU, working on research topics involving model-data fusion with satellite data have played a pivotal role. More recently Dr Renzullo joined the Bureau of Meteorology to explore way in which satellite observations can help better parameterise land surface models and lead to improved hydrological prediction from catchment to continental scales.*

Since the advent of satellite monitoring of the earth system, vegetation has been a key focus of sensor development and applications. Vegetation earth observations (EO) cover a range of physical and biophysical characteristics, including cover type (class), extent, fraction, phenology, greenness, and structure. From the vantage point of space, satellite EO missions – legacy, current and planned – provide a comprehensive observational suite, with unparalleled spatial and temporal coverage, to enable better understanding of vegetation state and dynamics from regional to global scales.

In earth system modelling, the land surface provides the boundary condition for numerical weather prediction (NWP) and the fundamental backdrop for carbon, water, and energy cycle modelling. It stands to reason, therefore, that better characterisation of the vegetation components of land surface models through EO products will improve model prediction accuracy. However, vegetation products derived from EO are often not immediately suited to 'plug-and-play' with earth system models, and additional processing (e.g., fusion, translation, and aggregation) is necessary to match model requirements.

Here we describe efforts at the Bureau of Meteorology to use multiple vegetation EO products to improve the land surface modelling in our NWP system. We describe how we combined vegetation classifications (from Geoscience Australia's DEA), fraction cover (from CSIRO) and lidar-derived heights (from NASA) to define the land cover types in our land surface model (JULES) across Australia. We show how the new land cover information compares with previous versions used in JULES and demonstrate the improvements in modelling key water stores and fluxes.

Highlights:

1. Wide variety of satellite EO products enable comprehensive study of vegetation dynamics.
2. Satellite EO-derived vegetation classes, fraction cover and height are used to reparameterise JULES land surface model
3. JULES prediction of key water stores and fluxes compared with in situ observations

Evaluating the variation in vegetation, glaciers, and fauna distribution on Heard and McDonald Islands

Dr Shavawn Donoghue, Dr Dana Bergstrom

Traditional 2 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Shavawn Donoghue is glaciologist and terrestrial biologist at the Australian Antarctic Division with a keen interest in Heard Island. Since completing her PhD on the glaciers of Heard Island in 2010 she now uses remote sensing techniques to examine not just the glaciers but also the vegetation and animals that inhabit the island. She is looking forward to one day returning to this amazing part of the world.*

Heard and McDonald Islands (HIMI) are located in the southern Indian Ocean, 1,500km north of Antarctic, 4,000km south-west of Australia and 4,200 km south-east of South Africa. Heard Island, the larger of the two islands, is an intermittently active volcanic peak. It is covered in 29 glaciers, six vegetation communities, and breeding habitat for 15 species of flying birds, four species of penguins (including the world's largest macaroni penguin colony), and two species of seals. McDonald Island is located 44km to the west of Heard Island. Its most recent volcanic activity was between 1992 and the early 2000s when the island doubled in size. This dramatic change has altered the landscape and the colonies of birds and seals. The remote location of these two islands have resulted in very infrequent visits since the research station at Atlas Cove on Heard Island was closed in 1954. Since the early 2000s there has instead become an increased reliance on satellite imagery for science, heritage, and management outcomes for HIMI. In this study we look at several Very High-Resolution images of HIMI between the 1980s and 2020 to examine the possibility of measuring glacier retreat, changes in vegetation, coastal erosion, and colony mapping of penguins, flying birds and seals across both islands.

Highlights:

1. The glaciers on Heard Island have been retreating since the 1980s from an area of ~257 km2 to 236 km2 in the early 2010s.
2. As the glaciers retreat more ice-free area is available for vegetation colonisation. Vegetation is now found at higher altitudes compared to the last ground surveys in the early 2000s.
3. Although it is possible to identify some penguin colonies. Additional field work is necessary to identify the species at these colonies.

Fusing GEDI, Sentinel-1, Sentinel-2, elevation and land cover data for national-level forest biomass mapping

Dr Yuri Shendryk

Traditional 2 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography*: Yuri Shendryk is a GIS and Remote Sensing Specialist at Dendra Systems. Here he develops algorithms to process terabytes of satellite and airborne data – work that enables Dendra Systems to restore our complex and biodiverse ecosystems. Prior to that he spent multiple years working and studying in Ukraine, Sweden and Germany, and he earned his PhD degree in Geography and Remote Sensing from UNSW in 2017. Currently his research is centred around the integration of remote sensing and machine learning for monitoring reforestation and carbon farming projects.*

Accurate mapping of forest aboveground biomass (AGB) is critical for carbon budget accounting, sustainable forest management as well as for understanding the role of forest ecosystem in the climate change mitigation. In this study, spaceborne Global Ecosystem Dynamics Investigation (GEDI) LiDAR data were used in combination with Sentinel-1 synthetic-aperture radar and Sentinel-2 multispectral imagery as well as elevation and land cover data to produce a wall-to-wall AGB map of Australia and the United States for 2020. The gradient boosting machine learning framework was applied to predict AGB density and its uncertainty at the resolution of 100m and 200m. The predictive performance of models based on Sentinel-2 imagery and land cover (single-data source) and a fusion of Sentinel-2 with Sentinel-1 imagery as well as elevation and land cover data (multi-data source) were compared. Bayesian hyperparameter optimization was used to identify the most accurate Light Gradient Boosting Machine (LightGBM) model using 5-fold cross-validation. The single-data source analysis resulted in AGB density predicted with the coefficient of determination (R^2) of 0.62-0.74, root-mean-square error (RMSE) of 58-84 Mg/ha and root-mean-square percentage error (RMSPE) of 52-81%. Model performance improved substantially with the addition of Sentinel-1 and elevation data: AGB density prediction with R^2 of 0.69-0.79, RMSE of 52-77 Mg/ha and RMSPE of 43-64%. This research highlights methodological opportunities for combining GEDI measurements with satellite imagery and other environmental data toward global, fine-scale AGB mapping through data fusion.

Highlights:

1. GEDI fused with Sentinel-1 and Sentinel-2 as well as elevation and land cover data were used to produce fine-scale wall-to-wall AGB maps
2. Multi-data source (Sentinel-2, Sentinel-1, elevation, and land cover) models outperformed single-data source (Sentinel-2 and land cover) models
3. Near- and short-wave infrared bands derived indices as well as elevation derived slope and land cover were the most important in predicting AGB density

Exploration of radar and optical data for detecting and mapping woody regrowth in NSW, Australia

Dr Anthea Mitchell

Traditional 2 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Anthea Mitchell received the BSc degree in geography from the University of New South Wales (UNSW), Sydney, in 1999, and PhD from UNSW in 2004. From 2004 to 2018, she was a Research Fellow at UNSW. Her research interests include the development of remote sensing methods to support natural resource management and conservation outcomes. She is currently a Research Fellow with the Joint Remote Sensing Research Program (JRSRP) based at UNSW, and developing methods for state-wide mapping and reporting on woody regrowth in collaboration with the NSW Department of Planning and Environment (DPE).*

In this study, we evaluate the independent and combined use of synthetic aperture radar (SAR) and optical data for mapping areas of increasing woody vegetation cover. Knowledge of tree cover dynamics including biomass gains and losses is important for conservation and management. Spatial data on regrowth will complement the existing SLATS data which shows annual losses of woody vegetation cover.

Mapping of woody regrowth is a challenging task. Regrowth occurs gradually and change is more subtle compared to clearing, with a gradation from non-woody to woody over several years. Spectrally there is confusion in the earlier stages with other land covers, e.g., bare ground, grasses, and shrubs. Temporal fluctuations in green and understorey cover and variations in soil and canopy water content also make it difficult to detect regrowth.

The sensitivity of L-band radar (ALOS/ALOS-2 PALSAR) to woody vegetation permitted the retrieval of basal area, a surrogate for biomass. A basal area difference image was calculated for 2009-2016 and found to relate to known areas of increasing woody vegetation. Annual time-series of Landsat green and bare fractional cover showed increasing and decreasing trends respectively in regrowth areas. A state-wide regrowth map was produced via decision tree classification that utilised these structural and spectral trends.

Linear curve fitting of multi-temporal Landsat normalized burn ratio (NBR) presents an alternative approach to mapping regrowth. Non-woody start and woody end points are verified using Landsat foliage projective cover (FPC). The robustness of the approach is being tested across different landscapes and vegetation types.

Highlights:

1. Corrections for terrain slope and moisture content applied to single channel synthetic aperture radar (SAR) data made possible wide-area spatially consistent estimates of basal area.
2. Best classification results for regrowth were achieved using a combination of L-band radar and Landsat fractional cover data.
3. A lengthy time-series is needed to detect regrowth. Using the slope output from curve-fitting of time-series of Landsat normalized burn ratio (NBR) permitted the detection of woody regrowth, with confirmation of non-woody and woody status best achieved through the integration of L-band radar and optical data.

A Tale of Salt, Scale and Statistics: A multi-scaled approach to coastal habitat mapping

Mr James Cameron, Matthew Miles, David Thompson

Traditional 2 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography: *James has a Master of Science in Ecological Modelling specialising in the application of remote sensing to rangelands ecology and somehow ended up in the SA Department for Environment and Water for the past 27 years. James currently coordinates imagery and elevation procurement for DEW and SA Government and manages the department's preferred supplier panel.*

The Dry Creek salt fields and adjacent coastal ecosystems are situated on Gulf St Vincent, near the northern suburbs of Adelaide. The area includes nearly 2,700 hectares of mangrove and saltmarsh habitats alongside a series of over 3,500 salt evaporation ponds that ceased operation, after many decades of production, in 2014. These habitats have been recognised for their high conservation value and are within the Adelaide International Bird Sanctuary National Park – Winaityinaityi Pangkara (AIBS) and other protected areas.

In late 2020 a dieback of mangrove and saltmarsh habitats south of St Kilda in the vicinity of the Dry Creek salt fields was observed. The Department for Environment and Water (DEW) used a variety of mapping techniques and datasets to more accurately map the extent and composition of native vegetation dieback including:

- Multi-temporal high and medium resolution imagery
- Airborne hyperspectral imagery
- LiDAR
- Historic vegetation mapping
- Ground observations

Various remote sensing techniques were then used to assess and describe the impact on mangrove and saltmarsh habitats, including other land covers such as bare ground and open water, which are inherent within these settings.

This paper will describe the methodologies used and lessons learnt. New data acquisitions have captured a high-resolution baseline across the entire site for the first time. Datasets from this and future monitoring will be made available to researchers as contribution to understanding these ecosystems, monitoring technologies, and advising management actions.

Highlights:
1. Monitoring dynamic coastal environments.
2. Importance of temporal resolution.
3. Establishment of baseline datasets for future coastal research.

Mapping drought-induced forest decline in Southeast Australia using Harmonized Landsat Sentinel-2 timeseries

Mr Krishna Lamsal, Professor Arko Lucieer, Professor Zbyněk Malenovský, Dr. Tim Brodribb, Dr. Brendan Choat

Traditional 2 (Tues AM), August 23, 2022, 11:00 AM - 12:30 PM

Biography: *Krishna Lamsal is a PhD student in Geography, Planning, and Spatial Sciences at University of Tasmania, Hobart. He is interested in assessing vegetation functions using imaging spectroscopy and radiative transfer modelling, and monitoring of forest change dynamics using satellite data.*

Forest health decline and diebacks, induced and amplified by climate change stress events such as droughts, are expected to be more frequent. Remote sensing Earth observations allow for systematic mapping and monitoring of these forest health changes at multiple spatiotemporal scales. In this study, we combine field observations with timeseries of Harmonized Landsat Sentinel-2 (HLS) satellite data to explore warning signals of forest canopy dieback in southeast Australia. Different levels of forest canopy browning and dieback symptoms were visually evaluated in the field over 15 research plots. We hypothesize that the decline in health status, caused by a cumulative stress resulting from past drought with a recent intense 2019 drought acting as a significant canopy dieback trigger, can be detected, and monitored using multispectral HLS satellite image timeseries. In this study, time series of the Normalised Difference Vegetation Index (NDVI), Normalised Difference Moisture Index (NDMI) and Green Chlorophyll Vegetation Index (GCVI), derived from HLS data acquired between 2016 and 2020, were analysed to investigate forest stress trends. The relation between the satellite time series spectral components and forest dieback will be examined using additive mixed models. The developed remote sensing approach will demonstrate potential in harmonized spectral images of the two satellite missions and its improvement of forest health monitoring systems.

Highlights:

1. The decline in forest health status, caused by a cumulative stress can be detected, and monitored using satellite image timeseries.
2. Additive mixed models will be used to examine relationship between satellite time series and forest dieback.
3. The potential of harmonized spectral images of the two satellite missions for forest health monitoring systems will be evaluated.

We need to talk about maps

Dr Bethany Melville

EO360 (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

Biography: *Bethany is a lecturer in spatial sciences at the University of Tasmania specialising in remote sensing and GIS. Previously she has worked as a researcher in both Australia and Europe. She has also worked in the private sector alongside clients in the resources and agriculture sectors helping to deliver and develop remote sensing solutions.*

Maps are one of the most vital tools that we as spatial scientists have to communicate our work with a broader audience. Cartography as a discipline has a long and enduring legacy and has been fundamental in establishing the modern society we live in today. In spite of this ubiquity, very few people give a second thought to how the maps they see every day are made, and what goes into them. Most importantly however, the majority of people are never taught how to read maps critically, and to recognise when the information they see may be more complex or nuanced than meets the eye.

Everyone has encountered a truly terrible map in their time working in the spatial sector. In fact, I'd wager that the majority of maps you see on a daily basis are truly terrible. From missing legends, horrid colour ramps, bizarre symbol usage, to confusing and poorly thought-out layouts, there really are a million ways that things can go wrong. A less common consideration, however, is that the way we present information in our maps may actually be obscuring our message, or even giving a different one entirely.

This presentation aims to discuss some of the common issues we face every day when dealing with maps. It will also suggest ways that we as spatial practitioners can improve our cartography to deliver ethical, more accessible and less terrible mapped products.

Highlights:

1. Many people struggle to correctly interpret maps and have poor spatial literacy
2. The majority of maps produced by people working in the spatial sector are not fit for purpose, and can actually obscure information or potentially mislead readers
3. We have an ethical obligation to ensure that we present data in an unbiased and easily understandable way.

The Bass Strait Australian Calibration/Validation Facility for Satellite Altimetry

Dr Benoit Legresy, Dr Christopher WATSON, Jack Beardsley, Boye Zhou, Andrea Hay

EO360 (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

Biography: *Benoit LEGRESY has been involved with Satellite Earth Observation over the last 3 decades. His scientific work has been in Remote Sensing, Geodesy, Glaciology and Oceanography. He has been involved in a number of projects using various satellite data and in a number of satellite projects and satellite cal/val activities.*

The satellite altimetry calibration and validation facility in Bass Strait has provided a sustained contribution to the Jason-series altimeter missions which deliver the reference sea level climate data record over the last three decades. Over the last five years we have enhanced the facility to now routinely validate four satellites, now including the Sentinel-series satellite altimeters. Most recently, the facility has tackled the challenge of validating newer SAR-based altimeter missions including Sentinel-3A&B, and Sentinel-6, with a focus towards contributing to the next generation interferometric SAR mission, SWOT. These improvements have required the development of new in situ instrumentation (GNSS/INS equipped buoys, CWPIES moorings) to produce accurate in situ sea surface height, currents, water density and wave fields at the level required to respond to the satellite validation needs. Our approaches to deployments and related experiments ensure the highest impact at the mission level, yielding a dependable climate data record for regional and global studies. This presentation reviews the challenge of altimeter validation and details the in situ technical capabilities we've developed to provide a valued Australian contribution to satellite altimetry calibration/validation.

Highlights:

1. The Australian Calibration/Validation Facility for Satellite Altimetry.
2. Innovative in situ instrumentation for Calibration/Validation.
3. New Cal/Val strategies.

Challenges to implementation of extensive in situ sensor networks in support of satellite missions

Dr Tim Malthus, Dr Arnold Dekker, Dr Xiubin Qi, Mr Adam Macleod, Dr Nagur Cherukuru, Stephen Gensemer

EO360 (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

Biography: *Tim Malthus is Research Group Leader of the Applied Ecosystem Processes Group in the Coasts and Oceans Research Program in CSIRO Oceans and Atmosphere. Tim is an EO scientist combining satellite and field data to develop improved land and water monitoring for management and policy development.*

Tim's recent projects focus on novel low-cost optical sensors for warning systems for blue-green algal blooms in inland waters. He has particular interests in tlow-cost sensors for water quality sensing for more wide scale deployment and in the development of tools for citizen science. He is Scientific co-lead of the AquaWatch Australia Mission.

The joint SmartSAT CRC/CSIRO AquaWatch Australia Mission proposes a step change in monitoring technologies to support the scales and speeds at which our modelling is now required and to safeguard Australian inland water bodies. We are developing an integrated nationwide ground-to-space national monitoring platform incorporating satellite and in situ sensor observations together with a dedicated data analysis platform.

A nationwide in situ water quality monitoring sensor network requires Internet of Things (IoT) sensor nodes that are cost-effective to construct and operate, easy to maintain, to deliver timely and credible data to complement satellite observations for appropriate decision making. Central to the IoT concept are low-cost sensors; current suitable Commercial-Off-the-Shelf water quality sensors are expensive, poorly adapted to IoT and economically unviable for water quality management at scale. New sensors will need to be innovatively and robustly constructed for IoT systems that are characterised by resource constraints: in communication capabilities, energy, processing capabilities and limited data storage. Each of these constraints will influence sensor design, degree of maintenance and calibration, operation mode and sampling rate, on-board processing and type and rate of communication.

We will outline the challenges we face in the development of a nationwide water quality network in support of satellite monitoring and modelling efforts. New thinking will be required in water quality parameter detection, reliability, robustness and maintenance even in remote areas, and power and communication options. The challenge to integrate real-time data generated from a highly distributed and heterogenous sensor network will also need to be addressed.

Highlights:

1. Sensor networks are required to complement satellite missions
2. The Internet of Things presents an approach to meet the need for widely distributed water quality sensor networks.
3. Significant challenges remain to develop a nationwide water quality network in support of the AquaWatch Australia Mission

Modern Remote Sensing: Making Sense of Sensors, Information, and Automation

Cherie Muleh

EO360 (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

Satellite and airborne imagery are readily available, affordable, and a core source of valuable geospatial data to extract meaningful information. While imagery enables and enhances operational decision making, the challenge to unlocking the information in imagery and its associated data has been to make image processing and analysis easier and less time consuming, while still delivering accurate results.

When needing information for situational awareness or understanding large-scale environmental studies, such as estimating crop health or estimating the extent of a destructive fire, a rapid assessment of the landscape is necessary. Many applications analyze the spectral content of the imagery to accomplish land use and land cover mapping; measure, monitor and assess environmental conditions; perform object-based image analysis and identify vegetation types. The knowledge gained from these analyses is invaluable as input to many processes, including land development models and forecasts, planning departments and environmental impact assessments.

Hyperspectral sensors collect spectral information across a continuous spectrum by dividing the spectrum into many narrow spectral bands. There are more sensors coming online in the near future and as a result, interest in and understanding how to use this type of data has been growing. By using hyperspectral data, combining different modalities of data, users have can have even more accurate information than ever before.

Highlights:

1. ENVI uses scientifically proven analytics to deliver expert-level results.
2. Businesses and organizations choose ENVI software because it integrates with existing workflows, supports today's most popular sensors, and can easily be customized to meet unique project requirements.

Characterisation and calibration of a miniature imaging spectroradiometer

Dr Stefan Maier, Dr Tim Whiteside, Dr. Renee Bartolo

EO360 (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

Biography: Stefan is a graduated engineer in Applied Physics (Fachhochschule Isny, 1993) and has been awarded the degree of Doctor of Engineering by the Technical University Munich (2000). Stefan held Research Associate (1996-1999) and post-Doctoral (2000-2002) positions at the German Aerospace Center (DLR), Oberpfaffenhofen. From 2002-2007 he worked at Satellite Remote Sensing Services, Western Australian Land Information Authority. In 2007 Stefan took up a position as Principal Research Fellow Remote Sensing at Charles Darwin University, Darwin. In early 2015 he founded maitec. Stefan has been involved in the development, characterisation, and calibration of a number of ground-based, airborne and spaceborne spectroradiometers.

Recent advances in optics and microelectronics have allowed the development of miniature imaging spectroradiometers which can be deployed on uncrewed aerial systems and micro/nano satellites. To generate high quality data, these sensor systems have to be well characterised and calibrated. Checking the validity of any factory calibration is important. In addition, due to the demanding environment with large temperature variations encountered on these platforms, thorough characterisation of the sensors plays a critical role.

In order to do this the Supervising Scientist Branch has set up a calibration laboratory for optical sensors. Here we describe experiences and results of the characterisation and calibration of a Corning microHSI 410 SHARK miniature imaging spectroradiometer (400-1000 nm). We describe the experimental setup used to collect the required data, the challenges encountered and some of the many pitfalls to avoid.

We provide results of our dark signal assessment, including temperature and integration time dependence. We describe the spectral performance of the sensor, i.e., spectral resolution and smile, and their temperature dependence. We also provide an assessment of straylight effects. And finally, we show the radiometric performance, i.e., linearity, noise level and sensitivity (including temperature dependence).

The conclusion of our investigations is that some of the information on the sensor that is essential to produce high quality data is either not provided by the manufacturer or inaccurate. Therefore, it is unavoidable to characterise and calibrate each individual sensor. It is anticipated, the characterisation / calibration should be repeated, at least partially, over time.

Highlights:

1. cannot rely on manufacturer’s calibration
2. sensors characterisation before calibration is essential
3. deep understanding of sensor technology is important for sensor calibration

Detecting shipping containers in imagery using deep learning, to manage potential hitchhiker pests

Mr Joel Mckechnie, Mr Andy Clark

Traditional (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

An accurate methodology for the rapid detection and mapping of shipping container storage and holding locations within urban/peri-urban environments, using spatial information and remotely sensed data has been achieved by the Applied Agricultural Remote Sensing Centre (University of New England) as part of a project for the Australian Government Department of Agricultural Water and Environment.

Shipping containers are considered a high-risk pathway for transporting hitchhiking pests and weeds into Australia. However, once the containers arrive at our ports, there is little information available that helps authorities rapidly identify where they are being moved to and stored. This information is not only imperative for coordinating targeted ground-based surveillance, but in the event of an incursion, can be analysed with additional spatial data to track the movement of a threat and to establish containment zones in close to real time.

The algorithm was trained and applied over multiple types of imagery including RGB satellite and aerial imagery up to 0.3m resolution across several study areas in Brisbane, Townsville, Sydney, Melbourne and Perth. The model was able to infer shipping container locations with very high accuracy. Limitations of this methodology include computing power requirements, access to large quantities of accurate training data and high-resolution imagery (0.3m spatial resolution).

Highlights:

1. Shipping containers are automatically detected and classified with high accuracy using deep learning and computer vision
2. The algorithm works on both satellite and aerial imagery – up to a resolution of 0.3m
3. This was developed for the Australian Government to prioritise biosecurity efforts against hitchhiker pests (invasive species transported on shipping containers)

Satellite derived ocean surface wind and wave products with a SAR focus

Salman Saeed Khan

Traditional (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

Biography: *Salman Khan is a Research Scientist at CSIRO, Oceans and Atmosphere, specialised in satellite remote sensing of the ocean surface. His current research covers developing and using satellite products of ocean surface wind and waves, in combination with in-situ wind and wave observations and numerical weather prediction models to address emerging challenges and scientific questions in the marine and coastal zones especially pertaining to climate variability and change, environmental change, extreme/impactful events, and emerging opportunities such as in marine renewable energy sector.*

Knowledge of current and future ocean surface conditions is essential to a variety of sectors including offshore operations, safety and navigation, design of marine and coastal structures, coastal management, and public recreation etc. Numerical weather prediction (NWP) models provide us with future predictions whose accuracy in part depends on in-situ measurements and satellite-based observations and their quality. Several satellite instruments such as Radar Altimeters, Scatterometers, and Radiometers, each with their specific characteristics, provide global and multi-decadal measurements from which ocean surface wave and wind variables can be derived. In this presentation, however, we keep a focus on the higher resolution imaging SAR measurements and products of ocean surface wind and waves in the context of the more traditional, aforementioned satellite instruments. Imaging SAR satellites, such as Sentinel-1 SARs, capture high resolution images of the ocean surface (both nearshore and offshore) regularly, and can be exploited to derive higher resolution wind and wave fields compared to traditional systems, especially in the coastal zones. Such measurements can be quite useful in coastal areas particularly where ocean surface conditions change frequently at low spatial scales. Offshore, SAR special wave mode provides more comprehensive wave measurements, capturing how wave energy is distributed in different directions and at different periods with some limitations. The presentation will capture the details of these various ways how SAR satellites capture ocean surface wind and wave information, and how these data are being increasingly utilised to address scientific questions and provide up-to-date information of ocean conditions.

Highlights:

1. High resolution and comprehensive ocean surface wind and wave information from SAR
2. Fusing ocean wind and wave data from in-situ, satellite, and models to provide up-to-date information on ocean conditions.
3. SAR captures changes in ocean conditions at small spatial scales.

Oil features' automated detection in synthetic aperture radar satellite imagery of the Great Barrier Reef

Dr David Blondeau-Patissier, Thomas Schroeder, Gopika Suresh, Foivos Diakogiannis, Zhibin Li, Christian Witte, Paul Irving, Andy Steven

Traditional (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

The timely detection of oil floating on the ocean's surface, particularly in protected marine parks such as the Great Barrier Reef, is critical for the monitoring and protection of coastal environments. Oil slicks are best detected from Synthetic Aperture Radar (SAR) satellite sensors, such as Sentinel-1 SAR operated by the European Space Agency, which provide imagery at medium spatial resolution (10-20 m), day and night and in any weather condition.

The surface signatures, whether actual oil slicks or "look-alikes" caused by wind or the reef bathymetry for instance, have a dark backscatter appearance that contrasts with the brighter surrounding waters in the grey-scaled SAR images. Automatically distinguishing oil slicks from look-alikes in Sentinel-1 SAR imagery of the Great Barrier Reef is no easy feat. A convolutional neural network-based deep learning classifier was extensively trained on a dataset of more than 5,000 samples of past events that have occurred both in the Great Barrier Reef and around the world. Despite the classifier achieving a detection accuracy >90% on unseen data, a second opinion using a rule-based empirical algorithm is required to avoid triggering recurrent false alarms.

This detection system, developed by the Oceans and Atmosphere Aquatic Remote Sensing team (in collaboration with both internal and external CSIRO partners), is now operationally deployed within the multi-agency eReefs project for the routine monitoring of the Great Barrier Reef, but the system can be relocated anywhere else around the country for further monitoring, including ports.

Highlights:

1. Novel system is now operational and provides a better monitoring of the marine park
2. Machine learning detection-based system with an empirical component
3. Can be redeployed to other coastal regions around the world

Aquatic Earth observation: State-of-the-art, case studies, and looking forward

Dr. Magnus Wettle

Traditional (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

Biography*: Magnus Wettle is the Managing Director of EOMAP Australia, and has more than 18 years experience in aquatic remote sensing research and applied solutions. He has previously held positions at CSIRO, Geoscience Australia, and the University of Queensland.*

Aquatic earth observation (EO), with important applications in sectors such as navigation, defence, oil and gas, and environmental management, can be broadly divided into two areas: mapping the seafloor and monitoring water quality.

Mapping the seafloor, and in particular estimating water depth, using optical EO has been in development since the 1970s, but it is in the last decade that the required algorithms and workflow systems have become sufficiently robust to offer an operational service - applicable worldwide with known accuracies - without the requirement for a priori, in situ field data.

Monitoring water quality using optical EO has traditionally been done using relatively coarse spatial resolution sensors and applications have typically been in open ocean waters, being limited by the optical complexities of inland and coastal waters.

Here, we present a selection of case studies with government agencies, research institutes, and industry which illustrate the state-of-the-art in mapping water depth and benthic habitats as well as the operational monitoring of inland and near coastal waters.

Having moved from the research domain to being a proven data source for aquatic professionals, aquatic EO is now reaching the next stage: the development of analytical software that enables in-house capabilities for agencies. A selection of such software will be presented.

The next generation of platforms -including unmanned aerial vehicles (UAVs) capable of carrying multi- and hyper-spectral sensors - together with big data and advancements in AI will further drive applications. The potential opportunities and pitfalls for these will be briefly addressed.

Highlights:

1. aquatic earth observation
2. industry perspective
3. state-of-the-art

Bio-optical Inland Water Quality - a national approach for water quality assessment

Ms Janet Anstee, Mr Nathan Drayson, Ms Gemma Kerrisk, Dr Hannelie Botha, Mr Stephen Sagar, Dr Eric Lehmann, Dr Phillip Ford, Ms Marlee Hutton, Mr James McLaughlin, Dr Bozena Wojtasiewicz

Traditional (Tues PM), August 23, 2022, 1:30 PM - 3:00 PM

Biography*: Janet Anstee is the Research Team Leader of the Aquatic Remote Sensing Team in CSIRO Oceans and Atmosphere. Her current research is in the application of validated bio-optical models to enable improved discrimination of aquatic water quality and habitat (where optically shallow). She is a passionate citizen scientist and leads the CSIRO Eye on Water – Australia project which brings together her earth observation skills and interest in aquatic systems with citizen science. She is the author of 11 journal articles, 6 book chapters, more than 30 reports and over 80 conference papers.*

The Inland Water Quality (IWQual) collaborative project aimed to implement a physics-based adaptive linear matrix inversion model (aLMI) to retrieve optically active water quality variables such as chlorophyll, non-algal particulates (sediments) and coloured dissolved organic matter (CDOM). aLMI seemed to be a well posed solution for the Digital Earth Australia platform but limited by the lack of in situ observations to parameterise the model appropriately. Initially, the IWQual project was to undertake a gap analysis to identify potential knowledge-gaps in the existing bio-optical data and flag locations for potential field campaigns.

After the gap analysis, a substantial national field campaign acquired data during a period of logistical complexities, which included bushfires and pandemic restrictions. When weather conditions allowed, the data acquired consisted of in situ bio-optical measurements coincident with satellite overpasses (Sentinel-2A/B and Landsat 8).

This presentation will outline the IWQual results including the sensitivity analysis of the aLMI model undertaken using the diverse set of bio-optical measurements using three assessments methods.
It was found that the atmospheric correction had a significant effect on the aLMI results, and while there was broad agreement between in situ radiometric measurements and Sentinel-2 spectral shape, deviations were observed at many sites. Where there was good agreement in spectral shape between the in situ radiometry and satellite ARD products there was also greater accuracy in aLMI retrievals indicating that improvements in atmospheric correction are likely to achieve greater accuracy in retrievals of optically active constituents.

Highlights:

1. Development of a gap analysis for national assessment of water quality (where can and can't the model work?)
2. Acquisition of unique bio-optical properties of Australian waters, in challenging time (bush fires and pandemics)
3. Analysis of the suitability of satellite analysis ready data for water quality assessment.

Simulated terrestrial LiDAR data for the improvement of vegetation point classification models

Mr Timothy Devereux, Dr William Woodgate, Professor Stuart Phinn, Dr Shaun Levick

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography: *Tim is a PhD candidate with the UQ Remote Sensing Research Centre (RSRC) and has a background in Environmental and Computational Sciences. His research is focused on the development of high-fidelity digital representations of Australian forests for next generation sensor simulation. Currently, Tim is exploring the potential of using simulated LiDAR as neural network training input for the classification of vegetation attributes.*

Using point clouds from terrestrial laser scanning (TLS), novel software tools can produce accurate and comprehensive 3D models of trees that can be used to automate the calculation of detailed vegetation structural metrics. These tools enable researchers to measure the structure of single trees or entire forest plots with great accuracy without using destructive sampling methods or relying on inaccurate allometric equations. A significant problem when reconstructing trees from TLS data is the overestimation of volume when fitting surfaces to tree point clouds under leaf on conditions. To overcome this, several algorithms have been developed to classify leaf and wood points with varying degrees of accuracy and efficiency. Importantly, none provide consistently accurate results is varying vegetation types partly due to the laborious task of manual training data collation. This research proposes that simulated LiDAR, using detailed vegetation models, sensor configurations and spectral properties could automate the generation of large volumes of perfectly labelled training data for the classification of leaf and wood points. By addressing this bottleneck, the developed classification methods could help to further realise the automated generation of accurate plot level vegetation structural metrics and 3D model generation.

Highlights:

1. High fidelity 3D vegetation reconstructions can be used for the generation of synthetic LiDAR training data for vegetation point classification.
2. Synthetic LiDAR training data is perfectly labelled and automatically generated.
3. Developed classification methods could help realise the automated generation of detailed 3D models for radiative transfer simulations or to compute accurate vegetation structural metrics.

Using current generation computing hardware to improve the development and processing of earth observation data streams

Dr Jim Watson, Mr Tim Danaher, Professor Stuart Phinn

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography: *Dr James Watson is a member of the Joint Remote Sensing Research Program (https://www.jrsrp.org.au/). James received a PhD in Computer Science from the University of Queensland and has previously worked at the Institute for Climate and Atmospheric Science (University of Leeds, United Kingdom) and the Queensland Alliance for Agriculture and Food Innovation (UQ). He is a contributing author of the Fifth Assessment Report of the IPCC and has developed a number of novel feature detection algorithms. James is experienced in high performance computing, dynamic visualizations, and the calibration and programming of hyperspectral, LIDAR, GPS and thermal sensors.*

Processing remote sensing data into useable, accurate and appropriate information is often an iterative process of: idea -> data processing -> validate + analyse -> idea refinement -> repeat. This process can combine disparate inputs of spatial and non-spatial data in novel ways and may produce substantial spatial data sets that improve understanding, but don't need to be archived.

If the data volumes are large and the analyses are computationally demanding, as is often the case with time-series, continental and global scale analyses, researchers have traditionally used multiple CPU's (central processing units) to batch-process tiled data. In the batch/tiled approach, iterative workflows can become disjointed due to time spent waiting for batch queues and data transfers – a significant impediment to progress in EO research. An alternative is distributed / cloud computing frameworks that allow continued interaction and are able to scale with problem and data set sizes. This alternative workflow enables iterative testing, revision, and development without breaking researcher flow. Examples of this distributed approach are Digital Earth Australia and the Pangeo project. However, many remote sensing researchers cannot repeatedly interact with these frameworks at the required temporal and spatial scales due to limited cloud-computing budgets or usage quotas.

Here we describe complementary work that enables interactive processing by leveraging current-generation Graphics Processing Unit (GPU) resources. Using this approach to produce historical assessments of vegetation disturbance across NSW, we demonstrate that interactive analysis is possible where lengthy batch tasks or large usage quotas are otherwise required.

Highlights:

1. We demonstrate a prototype of dynamic, on-demand data products that enables interactive assessments of historical vegetation disturbance in NSW.
2. This has been achieved by using current-generation GPU hardware and a custom on-disk data layout.
3. The prototype is accessed and controlled by standard desktop software.

Terrestrial Laser Scanning – NSW Field Program

Dr Geoffrey Horn, Mr Tim Danaher, Ms Heidi Mawbey

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography: *Geoff undertook his honours thesis fieldwork at Fowlers Gap research station in far western NSW, studying the various methods of estimating ground cover in the field. Subsequently Geoff worked on segmentation of multi temporal radar imagery for wetland inventory in Kakadu NP for his Ph.D. Geoff has worked for the NSW government for the last 19 years based in the central west of NSW with a particular focus on western NSW and field validation of broad scale remote sensing products. Geoff is happy to talk all things western NSW and field based, particularly technology driven.*

The NSW Terrestrial Laser Scanner Field Program supports both the biomass and structural metrics projects currently in progress. The program maims to stratify site acquisition across a range of sites and environments across NSW in the next few seasons. Site selection was stratified based on a series of complimentary surfaces including plant community type, foliage projective cover (FPC), landscape position, aspect, and slope. In addition to these surfaces, layers containing information relating to vegetation condition are used to plan and select sites for laser scanning.

A secondary aspect to the plan is to select sites that have had a significant disturbance prior to capture. Additional sites are planned to be scanned in areas where a foreseeable recovery or long-term change are to be expected in vegetation structure, biomass, or condition. These include new exclosures and additions to the national park estate.

The NSW TLS Field program also acts as a training tool for staff in both vegetation metrics as well as application of new technologies to facilitate vegetation research. The capture of additional sites as validation points for agencies with a collaborative relationship and other external programs is also an important part of the plan. Within the department there is also significant interest around the potential of TLS to assist in measurement of other risks including landslip and assist with bushfire fuel load modelling. The NSW TLS field plan aims to build strength and collaboration within and without the department and assist other programs where possible.

Partnering to boost Earth observation capability in Vietnam

Dr Amy Parker, Dr Minh Nguyen, Summer Locke, Dr Matt Paget, Dr Vu Anh Tuan, Dr Nguyen Lam Dao, Dr Nguyen Hong Quang, Phan Ngoc Chieu Linh, Dr Zheng-Shu Zhou, Ms Janet Anstee

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography: *Dr Amy Parker is the Acting Director the CSIRO Centre for Earth Observation and Vice President of Earth Observation Australia Inc.*

In 2020, a collaboration between Boeing, Australia's national science agency CSIRO, and the Vietnam National Space Center (VNSC) was launched, with the aim of supporting the growth of Vietnam's Earth observation analytics sector.

The three joined forces to connect Vietnamese private and public sector stakeholders who work with satellite data; assess barriers to satellite-related research and business growth; and identify how advanced satellite datasets and new computer technologies can enable groups to overcome challenges and develop new satellite data tools and products.

This presentation will describe the outcomes of this project including applications of new Earth observation datasets and methods for agricultural monitoring, and findings from a series of in-person and virtual workshops that have forged new connections amongst the Vietnam geospatial community.

The joint project leverages long-standing collaborations between CSIRO and VNSC, which includes the establishment of the Vietnam Data Cube in 2018, a data analytics platform that improves useability and interoperability of satellite images for environmental research. Boeing and CSIRO have worked on cooperative research and development projects for more than 33 years, but this program is the first demonstrator of extending the global reach of that partnership beyond Australia and the U.S.

Highlights:

1. Three countries partner to support the growth of Vietnam's Earth observation analytics sector.
2. New connections are forged through a series of in-person and virtual workshops that explore barriers to growth and opportunities from new Earth observation technologies.
3. Pilot case studies demonstrate application of new Earth observation datasets to agriculture and other key sectors.

Aerial monitoring of turtle nesting activity in the Coral Sea Marine Park

Mr John Prichard

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography*: John has worked in the Marine and Island Parks Branch of Parks Australia since January 2008. He joined the Coral Sea Marine Park (CSMP) team in January 2021 and is responsible for assessing and monitoring the health of the 67 islets and cays in the CSMP. Prior to joining the CSMP team John had flown in 178 compliance surveillance flights over the Australian Marine Parks along the east and south-east coasts of Australia. The opportunity to utilise aerial photogrammetry capabilities to monitor the health of turtle populations in the CSMP provides a new outlook for the use of aerial capabilities.*

The Coral Sea Marine Park (CSMP) team within Parks Australia has coordinated the first aerial monitoring of turtle nesting activity on the cays and islets of the CSMP.
In January 2022 the team contracted a commercial aerial photogrammetry company to undertake a series of four flights during February covering a total of 39 individual cays and islets. Twenty of these cays and islets are within the important Coringa-Herald and Lihou Reefs and Cays Ramsar site in the central region of the marine park.

The early results of the project have exceeded expectations, with over 2,200 separate turtle tracks and nesting activities identified across all the islands. The high resolution of the photogrammetry has also allowed identification of individual marine debris items, while also providing excellent data on island vegetation coverage and health. Its use for longer-term sea-level monitoring is being examined.
The survey methodology is described as Structure from Motion ('SfM') Photogrammetry. Advances in computing power, computer vision and image analysis have generated innovative developments in geo-science fields and provide high-value for coastal and marine environment managers.

The Contractor utilised two Canon 5DSR cameras, both NADIR, with one using 85mm focal length (1.25 cm pixel resolution) and the other 50mm focal-length (0.75 cm pixel resolution). The images captured by these cameras were decompiled into a three dimensional '3D' point cloud and recompiled into a true orthophoto mosaic by using the derived Digital Elevation Model ('DEM'). The islands were flown in corridor style transects, with the primary focus on beaches only.

Perth is no longer cool - monitoring and managing urban temperatures using remote sensing

Timea Kovacs-Ledo, Dr Robert Archibald

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

***Biography**: Senior Remote Sensing Analyst at Astron Environmental Services. Providing technical support to Astron's Earth Observation team since 2019. Has special interest in technical, analytical aspects of Earth Observation, including photogrammetry, LiDAR, InSAR and big data processing.*

A map of average change in land surface temperature (LST) for Perth in summer from 1987-88 to 2020-21 was produced using all available cloud free Landsat thermal data. On average, temperatures have increased by 2.0°C over this 34-year period. The suburbs that have recorded the greatest average increase were all on the northern fringe where recent extensive clearing has taken place. Marked increases in temperature are also associated with some wetlands which have become drier over the period. Interestingly, many of the cool spots are associated with industrial roofs. When treated with special coatings, roofs will be much cooler than their surrounds in the heat of the day. Cool roofs and urban forests are key to preventing urban heat islands. Urban forests provide a range of additional ecosystem services in addition to cooling such as biodiversity conservation and visual amenity.

Remote sensing data are invaluable to the monitoring and management of urban heat effects. In addition to LST from Landsat, aerial imagery enables the extent and condition of urban forest to be monitored. Four-band aerial data from overlapping imagery enables canopy cover and height to be quantified. The inclusion of the near-infrared band also enables the early detection of canopy decline, enabling city managers to investigate and treat potential problems before they become irreversible. A figure displaying examples of height, cover and health metrics from aerial imagery is displayed.

Highlights:

1. Conclusive finding revealed by study – significant increase in temperature
2. Topical – climate change and urban health effects
3. Methods have wide application – all cities in Australia and overseas.

Use of multispectral imagery to enhance aquaculture operations

Mr Avik Nandy, Dr Simon Albert, Professor Stuart Phinn, Dr Alistair Grinham

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography: *I am a geospatial scientist specialising in remote sensing and GIS applications. I completed my master's in Geographical Information Science from the University of Queensland in December 2019. During my study, I dealt with various projects, involving critical analysis of the environment using multispectral imageries. I held several positions in the past as a research officer, GIS data specialist and team leader, cartographer, teaching assistant, academic mentor, and Town Planner. My experience also provides a strong background in urban planning and fieldwork. My hobbies include painting, cooking, playing the piano, baking, photography, image editing and exploring nature.*

The ability of remote sensing to infer water quality properties is dependent on the optical characteristics of the water body. Research shows that more than 80% of the global water bodies belong to case-I (open-ocean) waters which are dominated by scattering and absorption associated with phytoplankton in the water column. Most of the previous studies have shown a significant match-up between satellite-based retrieval methods and field measured concentrations and optical properties. However, a major gap has been identified for studies based on Australian water and specifically for managing water quality associated with aquaculture operations. In general, it is found that a combination of the red-NIR (650-760nm) band is more successful in the chlorophyll retrieval process compared to the blue-green (440-561nm) region in turbid productive water (case-II) with average chlorophyll-a concentration ranging between 3-5 mg/m3. Current field data shows maximum absorption peaks around 400-430nm and 640-680nm for both case-I and case-II waters, but case-I water displayed a significantly lower peak. The primary objective of the project is also to develop a cloud-based geospatial analysis platform by eliminating manual and repetitive image processing tasks to increase model efficiency and reliability. The time-series analysis created by linking in-situ data with different satellite platforms will provide critical information related to seasonal variations, trend analysis, disaster preparedness and effective monitoring of aquaculture operations. The overall contribution to knowledge by the project is to facilitate a multi-sensor water quality function using a machine learning approach to monitor water quality in coastal waterbodies around Australia.

Highlights:

1. Minimising the research gap for Australian waters
2. Using radiative transfer theory to extract surface water information
3. Using a global satellite data archive to automate image processing

Estimating habitat condition using satellite-based remote sensing and reference sites

Ms Cassandra Malley, Mr Peter Lyon, Mr Dwaipayan Deb, Dr Kristen Williams

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography: *Cassandra Malley is a Spatial Analyst within the Data and Analytics Office at the Department of Agriculture, Water, and the Environment, with a strong background in geospatial and environmental sciences. She works collaboratively with a range of business areas across the department and external organisations to improve capture of critical spatial data and produce spatial analytics tools to support robust decision making. Her previous experience includes working with the Environment Protection and Biodiversity Conservation Act 1999, agricultural policy, and sustainable practices.*

Since 2015, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Government Department of Agriculture, Water and the Environment have collaborated on developing a remote sensing-based Habitat Condition Assessment System (HCAS). The objective was to develop a consistent, flexible national monitoring platform that can be continuously improved as site data, satellite imagery and statistical modelling methods advance. Earlier, habitat condition was typically accessible from ground-based observations through measurement of essential biodiversity variables relevant to an ecosystem's structure, function, and composition. Satellite imagery now offers the ability to scale from sites to whole landscape but is limited by what can be 'seen' from space. The novel HCAS approach, a significant advance over previous national approaches to habitat condition assessment (e.g., The Landscape Health Index; Morgan 2001), progresses how remote sensing data can be applied in condition assessment. First described in 2016 (Harwood et al. Methods in Ecology and Evolution, 7:1050, https://doi.org/10.1111/2041-210X.12579), it has since been substantially revised, and version 2.1 can be accessed via CSIRO's Data Access Portal (https://data.csiro.au). The datasets are already being used in a wide range of applications, including the 2021 Australian State of Environment report and selection of agricultural-biodiversity stewardship projects. While there are various opportunities for improvement, the work to date demonstrates the feasibility of linking site data with remote sensing to estimate habitat condition for the entire continent of Australia. We will present results from the current work, demonstrate how condition assessment can be used and outline areas for collaboration and future development.

Highlights:

1. The Habitat Condition Assessment System (HCAS) is a nationally consistent, repeatable framework and method, made possible by remote sensing
2. The HCAS is a significant advancement from previous approaches and is unique among the variety of possible ways to remotely monitor habitat condition
3. The HCAS demonstrates the feasibility of linking site data with remote sensing to estimate habitat condition for all of the Australian continent.

fly4EO: Flight Dynamics System for EO Missions

Dr Murray Kerr ,Mr Federico Letterio, Mr Gonzalo Vicario

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography: *Dr. Murray Kerr is head of Flight Engineering at Deimos Space. He has a Doctorate in Mechanical Engineering from the University of Queensland, Australia. He has over 20 years of experience in the space and aeronautic industry, working in ESA, EU and private programs. Since 2007, he has been working on GNC/AOCS, avionics and autonomous systems at Deimos Space for a variety of systems, including re-entry and launch vehicles, and micro-satellites, being involved in DEIMOS satellite programs and ESA programs such as IXV, SPACERIDER, EXOMARS, Proba3 and Lunar Lander. He is currently managing the DEIMOS SAT4EOCE programme.*

fly4EO is a complete, flight-proven, reliable and robust affordable solution for LEO missions FDS.
fly4EO is a stand-alone product conceived to perform all the required FDS operations: LEOP, orbit propagation, orbit determination, manoeuvre planning and calibration, events generation, collision avoidance risk assessment and strategy computation, and end-of-life planning.

It relies on modern design paradigms that make it extremely scalable (e.g., to support multi-satellite missions) and flexible, to be easily customized and adapted to interact with third-party Ground Segment components.

It is platform independent and it can be deployed in a distributed environment.

fly4EO exposes an API to allow its automatic orchestration, but also provides a user-friendly powerful GUI with secure multi-user access, 3D view, reports, plots, alarm panel, among other features.
fly4EO leverages the Deimos company heritage in Flight Dynamics and it has been flight qualified for the DEIMOS-1 mission. It has been further upgraded for the VHR agile DEIMOS-2 and for INPE Âmazonia-1 missions.

fly4EO is one of the major components of gs4EO, the Deimos suite of products composing a complete on-ground facility to control, monitor and commercially exploit space missions, being especially optimized for Earth Observation missions. gs4EO products work in a coherent and synchronized way, although all of them can also be used as independent applications. Each application communicates with the remaining GS using well-defined interfaces, easing its integration with other external solutions.

Deimos Space forms part of the Elecnor Group, with the affiliate Elecnor Australia operating in Australia since 2013.

Highlights:

1. Flight Proven
2. Multi-mission
3. Multi-satellite

Exploring accuracy and unmixing error of vegetation fractional cover in drylands

Mr. Andres Sutton, Dr Adrian Fisher, Professor Graciela Metternicht

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

***Biography**: PhD candidate at University of New South Wales. Looking into applications of satellite multispectral remote sensing in dryland ecosystem monitoring. Specifically interested in spatiotemporal analysis of vegetation cover and how it impacts landscape function. Before moving to Australia in 2021, I completed a BSc of Environmental science in Argentina. My thesis was focused on the use of MODIS products to understand how land use change affects energy balance in grasslands and semi-arid forests of South America.*

Satellite derived vegetation fractional cover (VFC) has shown to be a promising tool for dryland ecosystem monitoring, providing information on ecosystem health and landscape function. VFC depicts the sub-pixel proportion of photosynthetic vegetation (PV), non-photosynthetic vegetation (NPV) and bare soil (BS). The distinction between NPV and BS makes it particularly important for drylands, as these fractions often dominate. Two VFC products are available for the Australian continent: the original Joint Remote Sensing Research Program (JRSRP), and a newer Digital Earth Australia (DEA). They have similar validation statistics: root mean square error (RMSE) values from 11% to 17% for each fraction with NPV>BS>PV, although accuracy is spatially variable. Here, we used a large field dataset (3878 sites) to compare accuracy across Australian drylands, with detailed spatial and temporal analysis conducted on some areas of interest. Our results show that the JRSRP and DEA products were very similar (RMSE = 4.00–6.59). BS and NPV are less accurate in drylands, although this is not consistent across all regions. Close to a quarter of the sites examined show large errors in estimating bare soil fraction (difference between observed and estimated > 15%). These errors appear partially related to increased albedo. Nevertheless, VFC effectively tracked total ground cover change over time. Furthermore, analysis of spatial patterns of unmixing errors conducted show that unmixing errors are higher as groundcover increases, even more so for the green vegetation fraction.

Highlights:

1. Validation metrics and unmixing model error were explored in Australian drylands.
2. Bare soil and non-green vegetation are less accurately estimated in drylands in contrast to overall continental validation.
3. Despite large errors, the model correctly tracked changes in total ground cover.

Comparison of two spectral indices NDWI and mNDWI to evaluate water surface extraction of storages

Dr Sikdar Rasel, Dr Yi Lu, Dr Vaibhav Gupta, Mr Mustak Shaikh

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Floodplain harvesting is when the water that flows across the floodplains during a flood is collected and used later. This water stored within On-Farm Storages (OFSs) is an important component to meeting irrigation needs for farmers. Although Floodplain harvesting has been regulated in NSW under the Cap system since 1995, measuring water take pose number of challenges. To better account for water taken during floodplain harvesting, attempt is made to monitor changes in volume within OFSs using surface water extent. The objective of this study is to evaluate the performance of two spectral indices, normalized difference water index (NDWI) and modified normalized difference water index (MNDWI) for extracting surface water extent of OFSs in New South Wales.

Two catchments of NSW named Namoi and Macquarie were monitored during February 2021. The methodology was divided into two parts: At first Google Earth Engine (GEE) was used as a platform for pre-processing Sentinel-2 imagery and deriving surface water extent using mNDWI and NDWI. Then water surface area was validated against PlanetScope imagery and water volume was estimated of OFSs using an aerial survey (LiDAR) derived storage capacity curve.

It was found that the number of wet storages increased throughout the various stages of the flood event. By measuring water surface area changes, both indices were able to estimate the volume of water take in OFSs. However, the surface water extraction features were more enhanced with mNDWI and performed better than the NDWI in both valleys. This trend was consistent for both valleys.

Highlights:

1. On farm Storages (OFS)
2. Remote sensing
3. Google Earth Engine (GEE)

Can fine scale phenological differences be used to map structurally similar dryland vegetation communities?

Al Healy

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography: *Al is using near and remote sensing in his PhD work mapping small productive patches within the drylands of Queensland's Channel Country.*

In drylands, different vegetation functional types respond at different speeds to rainfall, however direct observation of vegetation response is complicated by remoteness and access difficulties. Near continuous ground observation through digital repeat photography (i.e., phenocams) can capture phenological data, such as changes in greenness, at fine temporal detail at relatively low cost. The recent development of earth observation systems with high spatial resolution and high temporal frequency provides the potential to map fine scale variation in greening across broad extents. By combining detailed ground observations with satellite data, we can more accurately map, monitor and model dynamic vegetation communities in drylands. In this study, we use a network of phenocams coupled with three years of remote sensing data to characterise the greening response of vegetation in the Channel Country grasslands of Queensland, Australia. The research phenocams in this region complement the extremely limited number of other systems across the diverse landscapes of dryland Australia. We analysed phenological metrics using the green chromatic coordinate (GCC) from phenocam data and the green fraction of Sentinel-2 derived fractional cover product. We predicted there would be measurable differences in the start of growing season and the rate of growth for perennial and annual-dominated grassland systems, with these fine spatial and temporal scale differences observable both in phenocams and satellite imagery. Analysing these differences will assist us to improve understanding of greening dynamics in drylands, improve land surface phenology products, and create fine scale maps of vegetation response and habitat resources.

Highlights:

1. We compared phenological parameters from phenocams and Sentinel-2 imagery over dryland vegetation communities.
2. We observed fine scale differences in the spatial and temporal response to variable rainfall over three years
3. This method shows potential to derive phenology estimates from Sentinel-2 in highly variable landscapes.

Advancing broadscale spatial evapotranspiration modelling by incorporating sun-induced chlorophyll fluorescence measurements

Dr Sicong Gao, Dr Tanya Doody

Poster Connect 1, Boulevard Auditorium Foyer, August 23, 2022, 4:45 PM - 6:00 PM

Biography: *Dr Sicong Gao is a postdoc working at CSIRO's Land and Water in Adelaide. His research is to advance techniques to evaluate woody floodplain vegetation responses to drought and environmental flow actions. The focus of his research is to integrate new approaches involving remote sensing and measurement of evapotranspiration and advance understanding of floodplain ecosystem function across broad climatic zones and scales. He also focuses on radiative transfer model, sun-induced chlorophyll fluorescence (SIF), ecological functions and their applications for detecting the vegetation responses to environmental stresses across various spatial and temporal scales.*

Evapotranspiration (ET) describes the sum of water transfer from the ground surface through soil evaporation and water loss from leaf stomata into the atmosphere, which are critical factors to link the global water cycle and carbon cycle. Evapotranspiration models based on remote sensing data provide spatially continuous estimates of ET, however, leaf photosynthetic information is critical to ensure accurate ET estimates although difficult to measure from space. Sun-induced chlorophyll fluorescence (SIF) is a proxy of photosynthetic activity that has been found to have high performance in predicting plant transpiration (T), which accounts for more than 65% of terrestrial and riverine ET. Hence, SIF has the potential to improve the accuracy of ET estimation globally. In this study, ET was estimated by using remotely sensed SIF from the TROPOMI satellite to replace T, stomatal resistance, and vegetation indices to create a new spatial ET dataset with higher accuracy of ET estimation compared to field measured ET of floodplain tree species. The new modelled ET was validated using long-term field measured ET in the southern Murray-Darling Basin floodplain at a monthly temporal scale, advancing on a recently reported method that combined national remotely sensed ET data, field data and machine learning. Further comparison was undertaken using additional remote sensing datasets such as MODIS ET. Improving estimates of tree water use is critical to assist catchment and regional water management, particularly in arid and semi-arid areas at risk of future climate change driven reductions in rainfall.

Highlights:

1. A new ET dataset is proposed using SIF measurements.
2. The ET dataset is validated with field measurements of ET and remote sensing ET datasets.
3. Estimations of the SIF-based ET model are more accurate than traditional ET models.

A mobile app for monitoring and forecasting health risks from cyanobacteria blooms in lakes

Dr Mark Matthews

EO360 1 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography: *Dr. Mark Matthews is the founder and director of CyanoLakes Australia, and inventor of the CyanoLakes Mobile App, who's mission is to enhance the protection of public health by providing near real-time information using free and open satellite remote sensing data. He has a PhD and has authored numerous peer-review articles, book chapters and report contributions. He lives in Sydney with his wife and two children.*

We present a new mobile application that can be used to track cyanobacteria blooms in the world's lakes using satellite imagery. The CyanoLakes Mobile App (available on iOS and Android) provides cyanobacteria health risk levels based on World Health Organisation guidelines in near real-time from satellite imagery. The App provides actionable information in near real-time to enhance decision making by government agencies and water utility companies through advanced features, notifications, and alerts. Using novel algorithms applied to high-resolution satellite imagery, we provide stunning visualisation tools that enhance response actions and situational awareness. A forecasting approach taking advantage of logical decomposition univariate statistical methods, provides 1-week forecasts with up to 75% accuracy. Peer-reviewed algorithms, applied to various satellite imagery types, provide both quantitative estimates of chlorophyll-a concentrations and derivative cell counts and toxin estimates, as well as the ability to distinguish between potentially toxic cyanobacteria blooms, and harmful algal bloom (HAB) events. The CyanoLakes App is being used by the public and industry to reduce the turnaround time between event detection and response, and to reduce negative health impacts from cyanobacteria toxins and water pollution in lakes in Australia and around the world.

Highlights:

- A novel mobile app for tracking cyanobacteria blooms in near real-time using satellite imagery
- Powerful visualisation using Sentinel-2 data
- Notifications and alerts in near real-time

Assessing the effects of environmental variability on remotely sensed fire severity mapping in semi-arid vegetation

Ms Stephanie Johnson

EO360 1 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

***Biography**: Stephanie Johnson is as a PhD candidate at La Trobe University undertaking a PhD in Fire Ecology.*

Fire severity is an important determinant of structure and function in fire-prone ecosystems. Mapping tools that reliably quantify fire severity patterns are essential for fire scientists and land practitioners to support research and management. Spatial patterns of fire severity are typically assessed at broad scales using remotely sensed indices. However, factors including changes in vegetation condition during fire seasons and more visible soil backgrounds may influence the reliability of these approaches in detecting fire severity in arid and semi-arid systems. This study sought to develop a reliable workflow to map fire severity across a productivity gradient within semi-arid vegetation of south-eastern Australia. Here, we examined the effect of temporal offsetting and soil information on the accuracy of fire severity mapping within the study region. Landsat imagery and fire severity data from 46 fires was used to train and evaluate the performance of eight random forest models established a-priori to test the effects of temporal offsetting and soil information. All eight models exhibited a high classification accuracy (89 - 92%). Applying a temporal offset to spectral indices resulted in no improvement in model accuracy. Incorporating soil information resulted in a slight (1.8-2.7%) improvement in classification accuracy relative to baseline models. Such gains, although modest, will represent a large area of correctly classified fire severity in fire seasons with substantial fire activity (i.e., >100,000 ha burnt). Fire severity mapping derived from our tool has the potential to improve understanding of the spatial and temporal patterns in fire severity and their environmental drivers.

Highlights:

1. Fire severity patterns in the semiarid region of south-eastern Australia can reliably be mapped with high accuracy.
2. Assessment's show including soil information produces some minor non-significant improvements.
3. This tool has the potential to improve understanding of the spatial and temporal patterns in fire severity and their environmental drivers.

Improving burn severity estimates using fusion of active and passive satellite and airborne sensors measurements

Associate Prof David Bruce, Mr Marcio DaSilva, Dr Sam Holt

EO360 1 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography: *David is an Associate Professor in GIS and remote sensing at Flinders University, an Adjunct Professor in the University of South Australia, and a faculty member of the International Space University. David has had a long career in Earth Observation and geographical information science in both government and academia; in the latter he has taught, and continues to teach, at the undergraduate and postgraduate levels, supervise PhD students and undertake research, which is currently focused on the analysis of high spatial resolution satellite multi-spectral and multi-polarimetric SAR images for environmental applications, particularly in vegetation assessment.*

Common EO methods for detecting burnt area and severity use multi-spectral band pairs in indices such as differenced NDVI, Normalised Burn Ratio and variants thereof. Issues with the use of such indices over varying land-cover types, vegetation density and soil types have been reported in literature. To deal with the latter two issues, a modified Forest Disturbance Index (MFDI), utilising brightness, greenness and wetness axes from the Tasselled Cap Transform, was reported in 2021. However, differing land-cover still presents an issue to all spectral indices used in burn severity estimation. Active sensors (satellite SAR and airborne LiDAR) provide structural information which can be used to improve MFDI and validate burn severity in differing land-covers. This presentation illustrates the enhancement of MFDI through the incorporation of structural and moisture information derived from Sentinel 1, C Band SAR imagery using a case study of the 2019 / 2020 bushfires in Kangaroo Island, SA. Validation data consisted of vegetation metrics derived from LiDAR. Results over differing land-cover types illustrate the positive impact of using SAR data to augment optical Earth observation data. The use of C Band SAR (predominantly VH polarization) could be improved through the incorporation of other wavelengths, for example X, S and L. We encourage audience discussion around this point and how automation can occur, especially when only a few of the currently available satellite image data are available in cloud repositories such as the Open Data Cube. We also promote discussion of LiDAR to assess change in burn severity.

Highlights:

1. Optical and SAR data combine to improve burn severity estimates
2. Burn severity over differing land-cover better estimated
3. Airborne LiDAR metrics used in validation

Automating Victoria's Vegetation Mapping Through Machine Learning

Dr Caitlin Adams, Catherine Gilbert, John White

EO360 1 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography: *Caitlin is a deeply creative thinker with a passion for solving the complex problems humanity faces. After completing a Bachelor of Science (Honours) at the University of Queensland, Caitlin obtained her Ph.D. in Astrophysics at Swinburne University of Technology. Caitlin works as a Senior Data Scientist at FrontierSI, applying machine learning to remote sensing data to improve the development of spatial data in Australia and internationally.*

The availability of accurate and up-to-date vegetation mapping for all of Victoria is critical for understanding urban heat in cities, monitoring national parks, and supporting emergency response and fire hazard assessment. Prior to this project, this mapping had not been updated for 20 years.

To address this gap, FrontierSI worked closely with the Victorian Department of Environment, Land, Water and Planning (DELWP) to automate the creation of vegetation products by applying machine learning to aerial imagery and elevation data. The outcome was three new products: state-wide tree canopy extent, state-wide tree spatial density, and individual tree points in urban areas, each of which can be updated by DELWP when new imagery and elevation data becomes available.

For the state-wide products, the team processed 37.5 terabytes of aerial imagery on AWS cloud-computing services. Without this level of automation, the team estimated that it would have taken a staff of 100 FTE two years to produce the equivalent state-wide products manually.

This presentation will cover the incredible role that machine learning can play in the creation of useful derivative products from Earth observation data, as well as the challenges that come with it.

Highlights:

1. FrontierSI worked with the Victorian Department of Environment, Land, Water and Planning (DELWP) to automate the creation of vegetation datasets through machine learning.
2. FrontierSI processed 37.5 terabytes of aerial imagery to produce two state-wide vegetation products.
3. The automated pipeline created as part of the project means that DELWP will be able to update the vegetation datasets whenever new imagery becomes available.

3D change detection in natural and urban environment

Fabrice Marre

EO360 1 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography: *Fabrice Marre is Head of Research and Development at Aerometrex, an Australian geospatial tech company. He obtained a master's degree in remote sensing and image processing from University Paul Sabatier, France. He has worked as a geospatial engineer in the public and private sector in Australia and overseas. His professional interests include Artificial Intelligence, 3D photogrammetry, real-time visualisation and analysis techniques, and emerging geospatial technologies.*

Our natural and urban environment is constantly changing. Mapping technologies such as aerial photogrammetry and airborne LiDAR provide accurate 3D spatial data to better measure and understand those changes in horizontal and vertical structures.

By performing a spatial difference between multiple 3D datasets taken at different time, it is possible to quantify the changes over natural and urban environments.

In this highly engaging presentation supported by visual examples, we will show examples of 3D change detection and analysis over coastlines in South Australia, Northern Territory and New South Wales. Based on high resolution 3D mesh models, we will also show how our Australian cities are changing both at the suburb level but also at the property level.

Highlights:

1. 3D change analysis
2. Erosion mapping
3. Measuring change over time

Pseudo Satellite Prototype Flight to Demonstrate CSIRO Space Optics Capabilities

Craig Ingram, Dr Joshua Pease, Stephen Gensemer, Ms Chloe Faulks, Adithya Rajendran, Oliver Kirkpatrick

EO360 2 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography: *Craig Ingram's research is focused on optics and imaging, past outputs including working with LIGO developing methods for measurement of optical absorption, and thermal distortion in low-loss optics. He has a strong applied focus, using his knowledge of photography and experimental physics to design and develop optical systems and imaging spectrometers. He is currently the principal optical engineer and visiting research scientist at the CSIRO Space Optics Laboratory at Adelaide University. This role includes the developing optical instrumentation and subsystem manager for the Cyanosat payload a pathfinder mission for Aquawatch, a mission to monitor Australia's waterways.*

The CSIRO Space Optics lab, currently based at the University of Adelaide, is developing numerous hyperspectral sensors to help advance Australian sovereign capability to design and manufacture optical payloads for earth observation in satellite, pseudo satellite and other airborne systems. This capability is also intended to help Australian EO scientists by building sensors to target specific data required for Australian needs not currently delivered by other EO platforms such as Sentinel 3 and Landsat
CSIRO's recently collaborated with LUX Aerobot in a stratospheric launch of a prototype hyperspectral imager above western Victoria to record data and test various subsystems. This flight was conducted as a trailbreaker project to further develop and evolve the CSIRO Space Optics Lab's capabilities.

Foremost this presentation explores the design, rapid prototyping, and flight of the high-altitude sensor. We address the progress made, learnings and future development pathways. We will also showcase several other sensors and technologies under development at the CSIRO Space Optics Lab, including the onboard image processing capabilities of our first satellite hyperspectral imager, dubbed Cyanosat, to be launched in early 2023.

Highlights:

1. Developing sovereign capability for design and manufacture of hyperspectral images within Australia

Help design a hyper-efficient space-based rapid data acquisition prototype

Dr Lee Spitler

EO360 2 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography: *Dr. Lee Spitler is Project Scientist at the Australian Astronomical Optics (AAO), a special application-foused Department within Macquarie University in Sydney, Australia. Spitler leads projects related to the design, assembly and integration of bespoke space-based optical projects in areas related to Earth Observations, Space Domain Awareness and astronomy applications. Spitler's research interests include the use of innovative technology in the area of optical instrumentation. Spitler led a space telescope CubeSat astronomy mission.*

Inspired by a technical challenge from the CSIRO/SmartSat Aquawatch mission, we designed an optomechanical module that can rapidly switch between targets. Within a fraction of a second, the module is able to acquire high-resolution data from a location on the other side of the continent. The module can be used on space or high-altitude platforms and is scalable in terms of telescope aperture size to meet user requirements.

Project is fully funded for a particular use case. We ask you to join a short brainstorm to identify other potential commercial or scientific uses for this device.

Highlights:

1. A game-changing device that quickly gathers high-resolution data from sparsely distributed targets.
2. Exceptionally efficient, it is able to switch between targets within a fraction of a second.
3. Contribute to the design of a really cool optomechanical prototype.

Aquatic Bio-optical Properties of Australian Inland Waterbodies: A Dataset for Satellite Calibration/Validation and Algorithm Development

Mr Nathan Drayson, Ms Janet Anstee, Dr Hannelie Botha, Mr Stephen Sagar, Ms Gemma Kerrisk, Dr Phillip Ford, Dr Bozena Wojtasiewicz, Mr James McLaughlin, Dr Eric Lehmann

EO360 2 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography: Nathan is an Experimental Scientist. He is currently working on the validation of bio-optical models used to predict water quality in Australia. Nathan is part of a field-team establishing a nationally applicable database of in situ bio-optical measurements of Australian waterbodies. Nathan has a keen interest in applications of remote sensing in environmental data science.

The Inland Water Quality (IWQual) collaborative project vastly extended range and accessibility of unique bio-optical data for Australian waterbodies. Several international databases are available which contain large numbers of observations of optical properties for inland waters. However, very few observations of Australian inland waterbodies have been included in these databases. A database was constructed which now provides access for researchers to a standardised set of observations of optical water properties collected under fixed, transparent protocols. The dataset contains 316 sets of observations made at 38 inland waterbodies in Australia. The data were sampled under diverse bio-optical regimes and include examples of phytoplankton blooms, ash deposition from bushfires and conditions of extreme absorption and scattering.

The data was collected over the period 2013-2021 and are comprised radiometric measurements; optical backscattering; absorption; algal pigments including chlorophyll-a (CHL-a); organic and inorganic total suspended solids (TSS); as well as total and dissolved organic carbon concentration. Data collection coincided with Sentinel-2 or Landsat 8 overpasses. The unique data set greatly enhances the national capability to characterize the bio-optical capabilities of Australian water bodies. It is being used now to validate a semi-analytical algorithm and as a training dataset for the development of a neural-network algorithm.

Highlights:

1. Significant improvement in the range of bio-optical data describing Australian waterbodies,
2. Diverse bio-optical conditions,
3. Algorithm development and validation

Insight4EO: on-board payload processing and intelligence solution for small satellite missions

Dr Murray Kerr

EO360 2 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography: *Dr. Murray Kerr is head of Flight Engineering at Deimos Space. He has a Doctorate in Mechanical Engineering from the University of Queensland, Australia. He has over 20 years of experience in the space and aeronautic industry, working in ESA, EU and private programs. Since 2007, he has been working on GNC/AOCS, avionics and autonomous systems at Deimos Space for a variety of systems, including re-entry and launch vehicles, and micro-satellites, being involved in DEIMOS satellite programs and ESA programs such as IXV, SPACERIDER, EXOMARS, Proba3 and Lunar Lander. He is currently managing the DEIMOS SAT4EOCE programme.*

Insight4EO is a Hardware and Software product, designed and qualified to be deployed on-board satellites as part of the flight segment, for the purpose of satellite on-board intelligence and processing.

Insight4EO is designed to meet the current and future needs for satellite autonomy, for on-board payload processing (including SAR and Optical payloads and missions) and generally to facilitate the new breed of intelligent and interconnected satellites that are now requested in the market. In particular, the product responds to market needs and trends towards (semi-)autonomous satellites and real-time responsive services from Earth Observation satellites.

Insight4EO is a standalone hardware/software product developed by DEIMOS, exploiting edge computing and the great advances in satellite computing achieved over the last decade. It provides the complete Earth observation payload processing until L1B/C, a software environment for user apps (including AI) execution, and services for satellite re-tasking and responsive operations.

The product is compatible with and complementary to DEIMOS' existing GS4EO product suite for ground segment commercial solutions, allowing for the transparent and integrated deployment of satellite and mission control services between the flight and ground segment of Earth observation missions.

The intended market for this product is broad. It is focused on satellites, for multiple markets including Earth observation, Space Safety and Communications.

A first version of the product is planned to fly in Q4 2022 or Q1 2023, allowing for the flight qualification of the hardware and software elements of the product in a LEO environment.

Highlights:

1. On-board processing for optical and SAR payloads
2. hardware/software product for LEO Earth observation missions
3. Increased satellite autonomy and ROI

Why you can't access high resolution satellite imagery

Mr Sebastian Chaoui

EO360 2 (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

The potential value of high-resolution satellite imagery across all industries is incalculable, however accessibility is still a barrier to scalable adoption. From measuring the impacts of climate change, to helping driverless cars navigate growing cities, high resolution satellite imagery is becoming a necessity to modern infrastructure.
Every year, thousands of new geospatial applications are being created off the back of high-resolution satellite imagery. Venture backed start-up companies, university researchers and large enterprises are building highly scalable applications that can ingest and process petabytes of imagery to provide new insights to users. This novel way of utilising satellite imagery has led to growth in the sector and represents a new opportunity for businesses, researchers, and governments.
The problem is that despite this new interest in the Earth observation industry, it is still incredibly difficult to access commercial, high resolution satellite imagery in a useful and scalable manner. Many new satellite based remote sensing companies are launching spacecraft into orbit. Although new supply is growing, there is no single point of access to the data that these systems generate. The business models that each of these data vendors implement has not been modernised and their user licence models are quite restrictive. In addition to this, the technical cost required to integrate with and standardise data archives is quite high. This means most application developers typically only choose to work with a limited number of vendors, in order to reduce project costs.

In addition to this, modern pay as you go business models are being implemented by companies such as Arlula. Traditionally, most vendors have sold imagery with large minimum purchase orders that made it prohibitively expensive for new users to adopt Earth observation data. By implementing innovative business models and licensing agreements, this will allow new users to enter the market.
As new application developers enter the market, the need for creating a modern solution to address these issues is becoming clearer. A system that leverages modern web-based technologies such as APIs and cloud computing solutions to process, standardise and distribute large quantities of satellite imagery from multiple vendors, has the potential to drastically reduce the barriers to entry for new users.
This presentation will focus on existing problems that the Earth observation industry is facing, and how they will be solved by implementing modern and innovative technical and business solutions.

Highlights:

1. EO application development
2. Changing the commercial EO industry
3. Easy access to satellite data

Using cloud computing and AI for wildfire mapping with Copernicus Sentinel-2

Mr Ian Pilling

Traditional (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Wildfires are a natural component of the Earth system, important for nutrient release and vegetation growth. However, in recent years the destructive impact of wildfires has becomes more obvious with the recent extensive wildfire events such as the devastating Australian bushfire season of 2019-2020 known as the Black Summer causing significant human, economic and environmental damage.

Quantifying and monitoring wildfires is fundamental in mitigating their effects on the environment and society, but also for the study of climate change because of significant wildfire contributions to global atmospheric emissions.

As such, the European Space Agency (ESA) commissioned CGI UK and the University of Leicester to develop a new burned area mapping service that utilises recent advances in cloud computing, more frequent EO data through programmes like the Copernicus Sentinel missions and advances in AI capabilities. Using the extensive wildfire database created within the ESA Climate Change Initiative (CCI) programme enabled multiple ML solutions to be created which are automatically selected by the service based on the time and location of the input Copernicus Sentinel-2 images to provide burned area and fire severity maps.

The resulting service has been deployed onto the Earth Observation for Sustainable Development Lab (EO4SD Lab) portal. It has been evaluated by key users in both France (ONF France) and Australia (coordinated by GeoScience Australia), with positive feedback. GeoScience Australia said "The EO4SD on-demand fire mapping service showed significant potential to assist in bushfire management in Australia". This on-demand service remains freely available to all users.

Development of a ML-enabled service trained on a large number of previous wildfire events.
Deployment of the resulting AI for Burned Area Mapping (AIBAM) service onto the freely accessible EO4SD Lab.

Testing and evaluation of the AIBAM on European and Australian wildfires with key users such as GeoScience Australia and ONF France.

Solar Radiation measurements over Australia

Dr Caroline Poulsen, DR Leon Majewski, Dr. Christopher Griffin, Vincent Villani, Harrison Cook

Traditional (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

***Biography**: Caroline Poulsen is a research scientist in the Satellite Science at the Bureau of Meteorology with 20 years of experience working with Meteorological satellites. She is a passionate advocate of satellite applications and an expert in cloud, aerosol, and solar radiance retrievals from polar and geostationary satellites. She began her career at the UK Met. Office working in satellite data assimilation before moving to Rutherford Appleton Space Laboratory where she worked on cloud and aerosol retrievals for the European Space Agency, Climate Change Initiative program, before joining BoM she was seconded to DEFRA and lectured remote sensing at Monash University.*

Solar power is a rapidly expanding industry in Australia, the solar capacity of Australia is amongst the highest in the world and solar energy now accounts for over 10% of Australia's total electrical energy production. Increased solar capacity is pushing demand for accurate high resolution surface solar irradiance (SSI) measurements. The measurements are used to aid with siting of new solar plants and monitor the output. Nowcasts are becoming essential to estimate demand and control the network.

At the Bureau of Meteorology (BoM), we have recently implemented the surface solar irradiance Heliosat-4 algorithm for Himawari-AHI. A regional bias correction was developed using machine learning techniques. The data has been processed from the beginning of the Himawari AHI-8 mission in 2015 to the present. The new SSI measurements provide better temporal and spatial resolution and now extend to coastal regions of Australia, so the diurnal cycle of solar insolation can now be studied for sensitive marine regions such as the Great Barrier Reef.

The results have been validated over land using the BoM surface network and over the ocean using ship measurements from the Integrated Marine Observing System (IMOS). In this presentation we will outline the applications for solar irradiance data, present some validation results and some key statistics for the Australian region.

Data can be downloaded from https://dapds00.nci.org.au/thredds/catalogs/rv74/satellite-products/arc/der/himawari-ahi/solar/solar.html

Highlights:

1. Near Real time observations of surface solar irradiance produced for all of Australia and coastal regions, every 10 minutes.
2. Products have been validated and perform well
3. Data is available on NCI and THREDDS

Remote sensing analysis of the drivers of Australia's Black Summer fires

Prof Noam Levin, Dr Marta Yebra, Professor Stuart Phinn

Traditional (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

The summer season of 2019–2020 has been named Australia's Black Summer because of the large forest fires that burnt for months in southeast Australia, affecting millions of Australia's citizens and hundreds of millions of animals and capturing global media attention. This extensive fire season has been attributed to the global climate crisis, a long drought season and extreme fire weather conditions. Our aim in this study was to examine the factors that have led some of the wildfires to burn over larger areas for a longer duration and to cause more damage to vegetation. To this end, we studied all large forest and non-forest fires (>100 km2) that burnt in Australia between September 2019 and mid-February 2020 (Australia's Black Summer fires), focusing on the forest fires in southeast Australia. For each of the wildfires, we calculated 10 response variables, which served as proxies for the fires' extent in space and time, spread and intensity, and computed more than 30 climatic, vegetation and anthropogenic variables based on remotely sensed derived variables, climatic time series and land cover datasets, which served as the explanatory variables. Altogether, 391 large fires were identified for Australia's Black Summer. Australia's Black Summer forest fires burnt for more days compared with non-forest fires. The two response variables that were best explained by the explanatory variables used as proxies for fires' extent, spread and intensity across all models for the Black Summer forest and non-forest fires were the change in Photosynthetic Vegetation due to fire (median-adjusted R2 of 69.1%) and the change in Vegetation Health Index due to fire (median-adjusted R2 of 66.3%). Amongst the variables we examined, vegetation and fuel-related variables (such as previous frequency of fires and the conditions of the vegetation before the fire) were found to be more prevalent in the multivariate models for explaining the response variables in comparison with climatic and anthropogenic variables. This result suggests that better management of wildland–urban interfaces and natural vegetation using cultural and prescribed burning as well as planning landscapes with less flammable and more fire-tolerant ground cover plants may reduce fire risk to communities living near forests, but this is challenging given the sheer size and diversity of ecosystems in Australia.

Highlights:

1. We segmented VIIRS and MODIS burn dates and mapped 391 wildfires > 100 km2 which burnt during Australia's Black Summer
2. We studied 10 response variables to characterize the wildfires properties and their impacts on vegetation
3. We found that vegetation and fuel-related variables were more important in explaining the wildfires impacts, compared with climate and anthropogenic variables

A Case Study of Measurement Uncertainty in Field Spectroscopy

Dr Andrew Walsh, Mr Guy Byrne, Dr Mark Broomhall

Traditional (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography:
Dr Walsh has 25 years experience as an astrophysicist and 4 years experience as a remote sensing scientist. He specialises in field calibration and validation of Landsat and Sentinel surface reflectance products.

A novel approach to measuring in situ field uncertainties in surface reflectance will be presented. This work is an outcome of a national campaign by Geoscience Australia to validate our analysis ready Landsat 8 and Sentinel-2 surface reflectance products. Various aspects of the field site methodology that were expected to contribute significantly to uncertainties were identified and tested. These aspects included the instrumental uncertainty, the use of a rest to stabilise the spectroradiometer fore-optic, the repositioning of the panel used for calibrating reflectance and uncertainties introduced by the operator of the equipment, following a standard methodology. Results for two field sites will be presented, which consistently show that approximately 95% of the overall uncertainty is a result of inherent variability in the ground surface reflectance. Typically, 5% of the uncertainty is introduced by a combination of the instrumentation and methodology.

Highlights:

1. A novel approach is used to quantify field uncertainty contributions.
2. A rest has proven to be beneficial for reproducible panel measurements.
3. The majority of measured uncertainty is a result of inherent variability in the ground surface.

Improving Satellite Aerosol Retrievals During Extreme Fire Events

Mr Daniel Robbins, Dr Caroline Poulsen, Steven Siems, Simon Proud, Andrew Prata

Traditional (Wed AM), August 24, 2022, 11:00 AM - 12:30 PM

Biography: *Daniel is a PhD student at Monash University working on improving aerosol retrievals of extreme biomass plumes, specifically those from the 2019/2020 Black Summer bushfire season that affect SE Australia, using machine learning and optimal estimation techniques.*

The 2019/2020 Black Summer bushfire season in Australia led to large swaths of land being burnt. Events of this type are set to become more common as the climate changes. The fires released significant amounts of water vapour, particulates, and gases into the atmosphere. The biomass plumes from these fires, which had optical thicknesses (OD) > 5, travelled over many towns and cities, leading to drops in air quality and had a significant impact on the radiation budget. Retrievals of the properties of these biomass plumes using satellite instruments help inform people on air quality and can be used within local weather predictions. However, during this period the satellite retrievals were generally less accurate or failed due to the extreme nature of the plumes. Therefore, improved retrievals for extreme biomass burning plumes over Australia are needed for future events.

In this study, we present such an improved biomass burning retrieval algorithm using a combined machine learning and optimal estimation-based approach. We investigate retrieval sensitivity to biomass optical properties using the Optimal Retrieval of Aerosol and Cloud (ORAC) algorithm for the Advanced Himawari Imager (AHI) instrument onboard the Himawari-8 satellite. ORAC retrievals are validated against AERONET and CALIOP data and compared against MODIS aerosol products, as well as JAXA's aerosol property retrieval product (ARP) for AHI over land and ocean.

Highlights:

1. Improved property retrievals of optically thick biomass plumes in AHI scenes.
2. Improvement of property retrievals of extreme bushfires that are likely to become more common with climate change.
3. Comparison of aerosol property retrieval products during extreme biomass burning events.

Globally consistent, transparent, and repeatable mapping of the world's tropical coral reefs

Dr Mitchell Lyons

EO360 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

Biography: *My research can be described as a mixture of geography, ecology, and statistics. Technically speaking, my expertise lies in remote sensing and ecological modelling (statistics and machine learning), and I generally take a computational programming approach (R and Python specifically, and JavaScript on the Google Earth Engine). I am a postdoc at the University of Queensland and the University of New South Wales, though I live in a rural area where I also run a small farm.*

Coral reefs are intimately connected to social, environmental, and economic wellbeing of tropical coastal areas right across the globe. Across many different cultures, we've devoted huge efforts to both exploring and understanding them over the centuries. They are threatened worldwide, and yet they remain one of the few ecosystems for which there is no framework for mapping and monitoring at the global scale, in a consistent, transparent, and repeatable manner. The Allen Coral Atlas was conceived to fill this gap, aiming to develop high resolution globally consistent coral reef maps, which feed into a high-resolution coral bleaching monitoring system. The first version of the global geomorphic zonation and benthic habitat maps were completed in September 2021 - bringing together millions of satellite images, millions of training samples and information gathered from almost 500 contributors. This talk will outline some of the key findings in context of the extent and distribution of coral reefs globally, as well as some of the downstream analysis and applications that are already being performed. The talk will also touch on the upcoming completion of version two, including technical improvements as well as the broader advantages of a global mapping framework that is not only transparent but also repeatable in the short term.

Highlights:

1. Global coral reef mapping via Google Earth Engine
2. Integration of Planet (5m), Sentinel-2 (10m) and derived data sets (bathymetry and waves)
3. Integration of local scale in situ data for global scale mapping, in a transparent repeatable mapping framework

National Land Cover and Crop Mapping through Digital Earth Africa Platform

Dr Qingxiang Liu

EO360 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

Biography: *Lavender (Qingxiang) Liu holds a bachelor's degree in Geodesy and Geomatics Engineering, and a PhD in Remote Sensing. She has work experience in both industry and academia. Her project experience includes aerial and satellite remote sensing data analysis for environmental applications, including vegetation, wetlands, land cover and coastal change monitoring.*

Food and Agriculture Organization of the United Nations' (FAO) Hand-in-Hand (HiH) is an evidence-based, country-led, and country-owned initiative to accelerate agricultural transformation and sustainable rural development to achieve the Sustainable Development Goals (SDG): eradicate poverty (Goal 1) and end hunger and all forms of malnutrition (Goal 2). The HiH is deploying a set of existing and novel approaches, data sources, platforms, and analytical tools as well as robust partnerships with public, private and third sector entities to drive agricultural innovation.

There are limited resources to collect, analyse and disseminate agricultural statistics on regular basis. Earth Observation (EA) data come in the picture as an ideal solution to fill this gap and strengthen the capacity to timely generate crop statistics at national and subnational level and feeding this to the SDG indicators. However, access, storage, pre-processing, and analysis of big EO data are limiting their use and uptake in countries.

In order to break such technical barriers and accelerate innovation under the HiH initiative, FAO established collaboration with FronteriSI to develop an open-source user-friendly solution that will facilitate countries in Africa and local organisations in the mapping of land cover and crop types. This project will empower two HiH countries to implement an integrated, cost-effective, and sustainable land use and crop monitoring supporting the estimation of crop acreage and yield statistics using the Digital Earth Africa platform and satellite imagery. In this presentation, FrontierSI will outline the objectives, current work, and outputs of this project.

Highlights:

1. Producing new national land cover mapping through Digital Earth Africa platform.
2. Crop monitoring supporting estimation of crop acreage and yield statistics.
3. Building capacity in use of EO data for African countries.

SWOT: The mission set to revolutionize surface water and ocean topography

Dr Benoit Legresy, Dr Christopher WATSON

EO360 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

***Biography**: Benoit LEGRESY has been involved with Satellite Earth Observation over the last 3 decades. His scientific work has been in Remote Sensing, Geodesy, Glaciology and Oceanography. He has been involved in a number of projects using various satellite data and in a number of satellite projects and satellite cal/val activities.*

The Surface Water and Ocean Topography (SWOT) mission is due to launch in November 2022. This next generation mission will herald a step change in the satellite altimetry observational record, driving the spatial resolution in Sea Level Anomaly maps from ~25 km (or worse) to just 2 km. The interferometric SAR capability of the satellite will also deliver an improved temporal repeat in many areas. On top of greatly improving the quality of the ocean signals resolved by satellite altimeters for existing applications, the horizontal scales resolved by SWOT opens the way for new understandings of ocean dynamics. In particular, SWOT will provide a lens into the region of the ocean where the physics transitions from “mesoscale” (~70 km) to “sub-mesoscale” (~10km). The sub-mesoscale is where many of the mixing processes operate – it is also the region which matters most for the coupling between the ocean and the atmosphere, the surface and interior of the ocean, as well as the physics and biogeochemistry of the ocean. When not covering the ocean, SWOT will be monitoring inland waters with unprecedented accuracy and resolution. This presentation provides a prelaunch vision of what this significant new satellite mission will deliver.

Highlights:

1. The new SWOT satellite,
2. the new possibilities in oceanography,
3. the opening of satellite altimetry to inland waters

Mapping regrowth for the Queensland State-wide Landcover and Trees Study

Mr Kaveh Shahi, Mr Dan Tindall, Mr Andrew Morgan, Mr Ian Sandford, Ms Lisa Collett, Dr Robert Denham, Mrs Caroline Teutsch

EO360 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

Biography*: Kaveh Shahi has been working in the remote sensing centre at the Department of Environment and Science since 2020 as a Scientist. He received his Ph.D. in Remote sensing from the University of Putra Malaysia in 2017 after completing a Master programme in Remote sensing & GIS at the same university in 2011.*

The Queensland Government has used earth observation for vegetation monitoring programs since the 1990s. Satellite and airborne imagery have played an integral role in different programs for observing and recording changes in native vegetation across Queensland.

The State-wide Landcover and Trees Study (SLATS), has historically monitored woody vegetation change from land clearing to address a range of policy requirements and land management decisions in government and industry. Recently, the Queensland Government has implemented an enhanced SLATS methodology to provide a more accurate representation of the state's woody vegetation extent using the latest satellite technology and scientific capabilities.

A new program of work currently being undertaken in Queensland is to monitor woody vegetation regrowth. This program aims to provide a more comprehensive account of Queensland's woody vegetation change. Initial research involved a machine learning approach using Conditional Random Fields (CRF) to produce a state-wide woody regrowth prediction based on high resolution (10m) satellite imagery.

A streamlined editing framework was developed to assess and modify the CRF output to produce a highly detailed map of regrowth for Queensland. Operationalising the outcome of research and development presents a range of challenges. This presentation will aim to provide an overview of the workflows associated with converting a prediction derived from research into an accurate state-wide product, ranging from developing mapping specifications, developing data management frameworks, and integration with existing datasets.

Highlights:

1. Enhanced methodology to map woody vegetation change,
2. Operational research and development,
3. Remote sensing of Queensland's environment.

From Earth observation derived insights to impact for Africa

Dr Fang Yuan, Dr Meghan Halabisky, Chad Burton, Edward Boamah, Dr Adam Lewis, Dr Lisa Hall, Dr Cedric Jorand

EO360 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

Biography*: Dr Fang Yuan has a PhD in Physics from University of Michigan and has a wide range of expertise across optical, high-energy and radar remote sensing, image analysis, automation and big data. As an astrophysicist, Fang studied cosmic explosions and discovered some of the most luminous supernovae known to date. As an Earth observation scientist, Fang has led development of satellite imagery-based products for natural resources mapping, disaster management and land cover change monitoring for Australia and Africa. In Digital Earth Africa, Fang works with a diverse and multidisciplinary team to deliver services to help address sustainable development challenges.*

Digital Earth Africa (DE Africa) is a continental scale platform, delivering Earth observation (EO)-based services to support decision making across the African continent. A user-focused approach, combined with open data, continental-scale information products, and open-source tools, helps us to achieve impact. In this talk, I will present an overview of the platform and our journey in developing continental services to support environmental monitoring and address development challenges.

All DE Africa services are co-developed with partners and users. DE Africa's Water Observations from Space service and the Fractional Cover service use algorithms first developed in Australia, with experts from across Africa engaged to validate and evaluate the product. We have recently released a continental cropland extent map at 10 m resolution, for which many partners directly contributed to data collection, model development, and evaluation and are committed to using the product to support further application development. A high-resolution monthly NDVI Anomaly service, selected and designed with African partners, is in development.

In addition to the information services, we provide analysis tools to help users at different technical levels to learn and develop customised solutions. For example, DE Africa services have been used to understand water availability and changes in the Okavango delta, the Rift Valley, and Lake Chad. The Ghana Statistical Service has used DE Africa data and services to produce a Natural Capital Assessment report that resulted in a logging ban and other activities to reduce deforestation.

Digital Earth Africa is providing operational EO-based information services, co-developed with users, to address development challenges and drive impact across Africa.

Easy and reliable access to analysis ready data significantly speeds up the development of information products, allowing application developers to focus on addressing user needs.

Highlights:

1. Access to analysis ready data and open-source tools opens up opportunities for non-expert users to use EO data,
2. supports capacity building,
3. drives innovation across sectors.

Deployable Optics for high resolution imaging from a compact platform

Prof Mark Casali, Dr Noah Schwarz, Dr Jean-Francois Sauvage

Traditional 1 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

Biography: PhD at University of Melbourne, Five years at UK Observatory in Hawaii, 12 years at UKATC, Edinburgh, UK, 14 years at ESO, Munich, Germany, Currently Director of AAO at Macquarie University.

The spatial resolution achieved on the ground from an orbiting optical platform is fundamentally limited by diffraction arising from the finite size of the optical aperture. Unfortunately, increasing the aperture size to improve ground resolution usually results in a proportional increase in satellite size and mass. A way out of this dichotomy is through the use of deployable optics in which the main aperture is made up of a number of independent segments which are deployed and co-phased to nanometre precision after launch. The JWST is the first spectacular example of this technique. However, smaller designs of much lower cost have been investigated for some years, most recently for cubesat size satellites.
A collaboration between AAO and several European institutes is aiming to test, and space qualify this concept for earth observation purposes. A sparse aperture prototype of 300mm diameter has been built and co-phased in the lab, with the 4-petal design acting as a single larger aperture. Although the sparse design results in a point spread function with relatively high flux in diffracted side-lobes. relatively straightforward deconvolution has been shown to recover most of the resolution in images with moderate to good sign-to-noise ratio.
If deployable apertures can be shown to be robust and reliable in orbit, they will be able to dramatically increase optical performance for any given mass class of satellite.

Highlights:

1. Deployable optics can achieve high ground resolution in a small package
2. A sparse-aperture 4-petal design has been prototyped and meets specifications
3. Ground resolution can be improved by at least 3x

Drone remote sensing for terrestrial ecosystem surveillance

Professor Arko Lucieer, Ms Poornima Sivanandam, Matt Stenson, Tom Vanniel, Associate Professor Ben Sparrow

Traditional 1 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

Biography*: Arko Lucieer is the Head of School of Geography, Planning, and Spatial Sciences at the University of Tasmania, Australia, and Professor in Remote Sensing. He leads the TerraLuma research group, focusing on the development and application of drones, sensor integration, and image processing techniques for environmental, agricultural, and high-precision aerial mapping applications.*

TERN supports observation and monitoring of terrestrial ecosystem attributes from the continental scale to the field level at representative sites. However, there is a challenging gap linking satellite and field-based measurements that must be addressed for effective ecosystem monitoring. Drone surveys can fill this gap and provide unique insights into ecosystem function. The overarching aim of the TERN drone sub-project is to add drone capacity to plot-based surveillance through:

1. Field deployment of the latest drone hardware (DJI Matrice 300 RTK) with RGB, multispectral and Lidar sensors (DJI Zenmuse P1, Micasense RedEdge-MX and DJI Zenmuse L1) with specific focus on testing the direct georeferencing accuracy (without ground control points).
2. In collaboration with TERN Data Services, refine a data delivery system fit-for-purpose for sharing, visualisation, and exploration of ultra-high resolution drone data and analysis-ready products.
3. Standardised collection and data processing workflows essential to make the best use of drone data. Data collection protocols being developed, include pre-field and on-field checklists, and settings tuned for vegetation structural complexity. Processing workflows include steps to automatically co-register RGB and multispectral imagery and generate analysis-ready data products (RGB, multispectral orthomosaic; vegetation indices; 3D structural metrics, and plot summary metrics from lidar).

We will also provide an update on the field campaign conducted in collaboration with TERN Surveillance to collect drone RGB, multispectral and lidar data across a range of TERN plots with varying structural complexity around Calperum Station, South Australia.

Highlights:

1. Direct georeferencing accuracy of 2-3 cm horizontal, 10 cm vertical achieved using RTK GNSS onboard drone and drone oblique imagery. This removes the need for ground control points, saves a significant amount of time (1+ hour per site) enabling more rapid and efficient data collection.
2. Automated workflow to co-register RGB and multispectral data collected simultaneously. Processing pipelines to (semi)automatically generate analysis-ready data products from imagery and 3D lidar point clouds.

3. Field campaign in Calperum Station, South Australia for drone data collection in a range of TERN plots including grasslands, shrublands, mallee and eucalypt woodlands and saltmarsh.

Non-contact River Discharge Derived from Drone-based Doppler Velocity and Ground-penetrating Radars

Dr Tim Whiteside, Dr. Renee Bartolo, Jan Francke, John Fulton, John Lane

Traditional 1 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

***Biography**: Tim Whiteside is a remote sensing scientist within the Drone Operations and Technology Support team, Supervising Scientist Branch (Department of Agriculture, Water, and the Environment). Tim's research expertise is in analysing very high spatial resolution remotely sensed imagery to characterise vegetative land cover within tropical landscapes, including savanna and wetlands. In recent years, he has specialised in the integration of sensors on drones and the establishment of a sensor calibration laboratory for multispectral and hyperspectral drone-based sensors.*

The U.S. Geological Survey (USGS) and the Australian Department of Agriculture, Water, and the Environment (DAWE) are researching next-generation small, uncrewed aircraft systems (sUAS or drone) for measuring non-contact river discharge. This initiative is important in ungauged basins and river reaches that lack infrastructure. By coupling discharge algorithms with sensors, which record surface velocity and river depth, streamgages can be established and discharge determined in regions where data collection was previously impractical.

The first-generation drone platform was developed by the USGS and consisted of a Doppler (velocity) radar, which was mounted and integrated on a 3DR© Solo drone. The drone records along-track surface velocities in a river transect, which coincides with the maximum surface-velocity location. The surface velocity is translated to a mean-channel (mean) velocity using a computationally efficient algorithm called the probability concept (PC). Discharge is computed using the PC-derived mean velocity and channel area associated with a stage-area rating. Five science flights were conducted on four United States rivers of varying sizes and dynamics to evaluate the extensibility of the method. The results were encouraging when compared to conventional streamgaging methods.

The second-generation drone platform, which will include a ground-penetrating radar (GPR), is a collaboration between the DAWE, Groundradar, Inc, and the USGS. Three GPRs will be trialed from bridges and boats in the United States and then integrated on a drone by DAWE to measure the non-contact channel area. Coupling a drone-mounted velocity radar and GPR will provide a fully non-contact platform for measuring river discharge.

International collaboration to research next-generation small, uncrewed aircraft systems (sUAS or drone) for measuring non-contact river discharge.

Developing Sovereign Capabilities for Manufacture of Earth Observation Platforms at CSIRO

Craig Ingram, Dr Joshua Pease, Stephen Gensemer, Mr Nick Carter, Ms Chloe Faulks, Mr Roshan Dodanwela, Associate Professor Martin O'Connor, Mr Arpit Saxena

Traditional 1 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

***Biography**: Craig Ingram's research is focused on optics and imaging, past outputs including working with LIGO developing methods for measurement of optical absorption, and thermal distortion in low-loss optics. He has a strong applied focus, using his knowledge of photography and experimental physics to design and develop optical systems and imaging spectrometers. He is currently the principal optical engineer and visiting research scientist at the CSIRO Space Optics Laboratory at Adelaide University. This role includes the developing optical instrumentation and subsystem manager for the Cyanosat payload a pathfinder mission for Aquawatch, a mission to monitor Australia's waterways.*

The CSIRO Laboratory for Satellite Optics opened in early 2020 and houses optical metrology equipment to aid in the development, testing and calibration of Earth Observation (EO) sensors, such as hyperspectral and infrared cameras.

The laboratory has commenced development of a number of novel, customised EO sensors for deployment to address critical data needs. This includes the development and testing of the CSIROSat-1 sensor, which is a simple, compact shortwave infrared hyperspectral imager.

In collaboration with The University of Adelaide and The University of South Australia, the laboratory is developing new sensors for water quality imaging from orbital satellites and high-altitude pseudo satellites. Currently, there are multiple sensors in various stages of development, including high resolution sensors (~2.5nm spectral resolution) and compact push frame devices. We are currently undertaking airborne trials of many of these sensors, with a launch target of our first satellite payload in Q4 2022.

Notably, we will discuss the development of our image processing capability. This will be used onboard to minimise data downlink and improve the accuracy of reflectance data in hyperspectral imagery. We will also explore a novel method to aid in the elimination of wave-induced sun glint that can seriously impede the accuracy of airborne remote sensing.

We thank our valuable collaborators at The University of Adelaide, The University of South Australia and the CSIRO Space Technologies FSP and CSIRO Centre for Earth Observation for the funding to support the establishment of the laboratory and our sensor development work.

Highlights:

1. Discuss the role Australia can play in building a sovereign capability to design and manufacture satellites for Earth Observation
2. We will show the current developments of The CSIRO Space Optics team and where they are in regard to developing and testing hyperspectral EO payloads
3. discuss future developments and plans for EO satellite developments in Australia

Drone-based RGB images and machine learning to detect invasive Siam weed in northern Australia

Dr Deepak Gautam, Louis Elliott, Mr. David Loewensteiner, Dr Tim Whiteside, Thomas Price, Phil Hickey, Simon Brooks, David Green, Dr. Renee Bartolo

Traditional 1 (Wed PM), August 24, 2022, 1:30 PM - 3:00 PM

Biography: *Deepak Gautam is a lecturer in remote sensing at Charles Darwin University. His research theme is on the development of tools and algorithms for quantitative remote sensing of vegetation using drones, satellites, and state-of-the-art sensors. His current focus is on the use of optical and thermal remote sensing to map, monitor and model the environment (natural and built) and agriculture.*

Siam weed (Chromolaena odorata) is an invasive plant species first recorded in Australia near Tully in north Queensland during the mid-1990s. This perennial shrub is widely regarded as one of the world's worst weeds with phenomenal growth rates and massive seed production. Siam weed causes significant environmental and economic impacts on tropical ecosystems. It outcompetes and degrades areas of native vegetation and smothers horticultural crops, forestry plantations and pastures. Dense infestations pose a major fire hazard and restrict animal movement. Significantly the weed is toxic to livestock and a known allergen to many humans. In 2019 Siam weed was detected in the western Top End of the Northern Territory. Planning for effective weed management necessitates baseline knowledge of Siam weed distribution at a catchment or regional level. Mapping of the weed incursion at this scale requires accurate detection of the weed by aerial survey most effectively achieved in a semi/fully automated fashion. Here, we present a drone remote sensing and machine learning approach to detect and map the weed presence over a large catchment scale. Drone-based visible (RGB) images acquired from eight known incursion sites in the Townsville region of Queensland were used to train a machine learning model (YOLOV5). Our early learning and preliminary results suggest the significant capability of the model to detect the weed from aerial images. The model has the potential to enable the detection and mapping of Siam weed across northern Australia by upscaling to helicopter/aircraft surveys supporting the Northern Territory Government's weed management goals.

1. Images acquired under sunny conditions were not ideal to detect the white flowers of the Siam weed.
2. YOLOV5 demonstrated the significant capability of detecting Siam weed on landscapes (accuracy to be quantified).
3. Different models within YOLOV5 (YOLOV5s, YOLOV5m, YOLOV5l, and YOLOV5x) will be tested and reported.

Quantitative monitoring of native grassland vegetation condition employing Sentinel-2 NDVI time series

MSc Diego Guevara, Dr Bertram Ostendorf, Dr Jose Facelli

Traditional 2 (Wed PM), B3, August 24, 2022, 1:30 PM - 3:00 PM

Biography: *Diego is a biologist from Peru and a PhD candidate at the University of Adelaide studying the monitoring and restoration of native temperate grasses of South Australia. As a member of the Spatial Sciences Group, my PhD project explores new ways to improve vegetation assessments in native grasslands by employing satellite images and drones. The project focuses on the Iron grassland, an ecological community of high conservation value considered endangered in South Australia.*

Monitoring natural ecosystems is essential to identify changes in vegetation conditions that may indicate environmental threats such as the expansion of invasive species. However, monitoring heterogeneous environments is extremely difficult due to the subtle changes in the surface reflectance produced by a complex mix of plant species with different proportions of heterogeneous soils. Moreover, a background of high spatial and temporal variability in such environments limits the statistical detectability of changes.

Extracting vegetation phenology patterns from high spatiotemporal resolution time-series imagery represents an opportunity to monitor changes in plant community composition. We aim to evaluate the utility of Sentinel-2A time series to assess the condition of natural heterogeneous grasslands. This study focuses on the "Iron-grass Natural Temperate Grassland of South Australia", an ecological community dominated by the native perennial iron grass (Lomandra effussa) and severely affected by the invasive annual wild oat (Avena barbata).

We developed a seasonality index approach that allows the extraction of growth strategy patterns from the NDVI time series to predict iron grass tussock abundance. Model development employed 200 field observations from 2020. The model enables us to conduct a quantitative condition assessment across years irrespective of rainfall patterns, showing consistency when applied to the 2019 and 2021 NDVI time series. Our study demonstrates the potential of Sentinel-2A time series to extract quantitative plant community characteristics to assess the condition of heterogeneous grasslands and contribute to their conservation and monitoring.

Highlights:

1. We present a spatio-temporal NDVI analysis that is based on ecological observations that distinguish native perennial vegetation from invasive annual species
2. We are able to extract quantitative plant community characteristics of heterogeneous grasslands
3. Our model can be parameterized using current field observations but can also be used to predict conditions using past satellite imagery

Extending vegetation condition metrics beyond the site; The Spatial BioCondition Framework.

Leo Hardtke, Chris Pennay, Shannon Hudson, Dan Ferguson, Annie Kelly, Dr Robert Denham, Teresa Eyre

Traditional 2 (Wed PM), B3, August 24, 2022, 1:30 PM - 3:00 PM

Biography*: I was born in Buenos Aires, Argentina and moved to Patagonia to study Ecology. I came across remote sensing and open-source software early in my career and have applied them to answer ecological questions ever since. I moved to Australia in 2016 and have been working for the Department of Environment and Science of Queensland since 2018. My researchgate profile: https://www.researchgate.net/profile/Leonardo-Hardtke/*

Native vegetation sustains biodiversity and underpins our socio-economic systems by providing critical functions and services. Changes in vegetation condition through degradation have a great impact on ecosystem services and are recognized as a cause of global biodiversity decline. The Spatial BioCondition framework (SBC) presented here, is a method for the systematic and repeatable spatial representation of vegetation condition. SBC was developed to align with the field based Biocondition assessment framework, which is underpinned by the premise that condition can be measured as the departure of a site from its reference state. Accordingly, in SBC, the condition at a given site is modelled by comparing the remote sensing (RS) characteristics at the site with the characteristics of reference sites in the same environmental domain. SBC requires three types of input data: the environmental domain mapping, predictor variable (Sentinel2 data) and the response variable, a continuous score, ranging from 100 (intact and functional vegetation) to 0 (highly modified vegetation), derived from field measured attributes. The relative difference in the RS space between each training point and its reference was used to fit a gradient boosting decision tree model. The method was successfully applied to map vegetation across Queensland using a total of 23.526 training site scores, that providing sufficient data to produce an SBC model output covering 89% of the state. Results showed that low-quality sites were characterised by high temporal variation, often non-woody and frequently bare while high-quality sites were largely the opposite, stable over time, with dense and woody vegetation.

USGS NUPO: Establishing sUAS for Scientific Research and Remote Sensing Applications

<u>Dr. Matthew Burgess</u>, Mr Lance Brady, Mr. Jeff Sloan, Mr Mark Bauer, Ms. Victoria Scholl, Mr. Joe Adams, Mr. Todd Burton, Ms. Jill Cress

Traditional 2 (Wed PM), B3, August 24, 2022, 1:30 PM - 3:00 PM

Biography: *Dr. Matthew A. Burgess is a UAS mission operator/geospatial analysist at the United States Geological Survey (USGS) National Uncrewed Systems Project Office (NUPO). USGS NUPO leads the uncrewed systems research and integration activities for both USGS and the US Department of the Interior. Matthew was previously the Program Coordinator of the University of Florida Unmanned Aircraft Systems Research Program where he led a team for nearly a decade to design, field, and evaluate small uncrewed systems for science. Dr. Burgess earned a B.Sc. Zoology, an M.Sc. Interdisciplinary Ecology, and Ph.D. in Wildlife Ecology and Conservation from the University of Florida.*

Since its inception in 2008, the United States Geological Survey's (USGS) National Uncrewed Systems Project Office (NUPO) has made significant progress in developing small Uncrewed Aircraft Systems (sUAS) into scientific data collection tools. Tasked with nearly all aspects of sUAS integration including implementation of operator training and best practices, development of data processing techniques, researching, and testing new sensors, performing data accuracy assessments and calibration, and conducting routine projects in novel areas of natural resources management, USGS NUPO has helped establish sUAS technology as a means for scientifically collecting remotely sensed data. This presentation will provide a brief overview of our group, explore several recent projects, discuss certain challenges we face, and look at our current pursuits.

Highlights:

1. United States civilian federal UAS entity.
2. UAS scientific research since 2008.
3. Applied remote sensing with diverse applications.

Challenge-Based Virtual Open Data Cube Capability Development in South East Asia

Dr Caitlin Adams, Dr Brendon Mcatee, Mr George Dyke, Dr Serryn Eagleson, Miss Rachel Horwood, Dr Eric Lehmann, Ms Emma Luke, Dr Matt Paget, Dr Amy Parker, Dr Ronnie Taib, Ms Roshni Sharma, Leila Fetter, Nic Prassopoulos

Traditional 2 (Wed PM), B3, August 24, 2022, 1:30 PM - 3:00 PM

***Biography**: Caitlin is a deeply creative thinker with a passion for solving the complex problems humanity faces. After completing a Bachelor of Science (Honours) at the University of Queensland, Caitlin obtained her Ph.D. in Astrophysics at Swinburne University of Technology. Caitlin works as a Senior Data Scientist at FrontierSI, applying machine learning to remote sensing data to improve the development of spatial data in Australia and internationally.*

Strengthening regional Earth Observation (EO) collaboration has been estimated to provide an increase in the value of EO services to the Asia Pacific region by more than 18% to US$1.48 trillion by 2030. This reflects the fact that EO user maturity levels across the region are largely low, while at the same time there is a growing realisation of the true cost to economies that challenges like climate change represent.

This presentation will describe a project which aims to grow market opportunities for Australian EO products and services in South East Asia (SE Asia) based on a scalable form of Open Data Cube technology, that can assist Australian businesses to develop geospatial products and services in the rapidly growing SE Asian market. Through this challenge-based project, working with Small to Medium Enterprises, NGOs, technology providers, and the research sector, each of which have a footprint in SE Asia, it is anticipated that the development and delivery of new EO capabilities for the region will enable Australian businesses to create real and positive business relationships and impacts in the region as the market for EO develops.

EO market internationalisation and capability development in SE Asia

Global Coral Reef Habitat Mapping: Communication, Collaboration, Cooperation, Inclusiveness and Diversity

A/prof. Chris Roelfsema, Dr Mitchell Lyons, Dr. Kat Markey, Ms Chantel Say, Professor Stuart Phinn, Miss Brianna Bambic, Miss Paulina Gerstner, Prof. Greg Asner, Dr. Helen Fox

Traditional 2 (Wed PM), B3, August 24, 2022, 1:30 PM - 3:00 PM

Biography*: A/Prof Chris Roelfsema (University of Queensland) has +20 years of experience in integrating field data, citizen science, physical attributes and earth observation science to map, model and monitor coral reef and seagrass habitats from local to global scales. He leads a team of coral and seagrass ecologists and earth observation specialists that, collect and analyse field data, develop, and implement habitat mapping and monitoring approaches. He leads the: 1) Great Barrier Reef Habitat Mapping project through GBRMPA; 2) The global coral reef verification and mapping component of the Allen Coral Atlas 3) long term monitoring seagrass and coral reefs habitats.*

Reliable and informative maps of coral reef habitat can extend our capabilities coral reefs to manage and sustain them. In 2021 the first globally consistent, high-thematic and -spatial resolution maps of geomorphic and benthic zones for shallow coral reefs (above 10m) were made freely accessible through the www.AllenCoralAtlas.org. Here we discuss the technical, scientific, and collaborative efforts to produce this unique global resource by linking communities across borders and cultures. The habitat mapping approach combines over 2 million satellite scenes, physical geospatial data (depth, slope, wave climate) and over 500 reference field data sites, using machine learning and object-based analysis. This approach required an international team of experts and collaboration with the communities that worked through times zones, a global pandemic, and across various cultures and backgrounds. Reaching out to over 1000 people globally to request existing field data to inform and validate the classifier. This required license agreements and data formatting with input from the various data providers. The mapping process included an internal and external reviews by experts in the field. For the external review we gathered feedback from local experts within each of the 30 mapping regions spread out over different countries and crossing languages barriers. The global mapping component of the Allen Coral Atlas is a unique example of what is possible by using science and a common challenge to enable communication, collaboration, cooperation, inclusiveness, and diversity, to be harnessed to solve a problem.

Highlights:

1. Maps connecting people to help save reefs
2. Highest thematic and spatial coral reef habit map of any ecosystem
3. True collaborative effort crossing borders and incorporating various data sets.

A new methodology for an operational state-wide burnt area mapping program for Queensland

Mr Tom Franz

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

Millions of hectares of Queensland's landscape burn every year, presenting a significant challenge for fire planning and management, land management, and contributing significantly to greenhouse gas emissions. The increasing need for timely, accurate and consistent burnt area information in Queensland for a range of applications has necessitated the development of a medium- to high-resolution operational burnt area mapping program for the state. Scientists in the Department of Environment and Science and Joint Remote Sensing Research Program have developed an automated method to detect burnt areas using Sentinel-2 imagery. This builds on previous work which mapped Queensland's fire history using Landsat imagery.

Observations of burned areas showed that fires produce an increment in the Bare soil fraction (BSF) component of the fractional cover index (FC). The methodology developed has three main stages of processing which include: identification of seed pixels using differenced indices; region growing using difference FC products to capture the extent of the burnt area; and a decision tree classification to identify areas that have likely been burnt.

Following the production of the automated output, the data is checked and edited manually to ensure a quality product is available for end-users. This requires efficient and consistent data management and editing within an operational context to produce monthly composites of burnt area for the state. The program has implemented the approach within a high-performance computing environment using open-source software solutions to achieve these operational requirements.

Highlights:

1. burned area mapping,
2. fractional cover,
3. operational program

Using remote sensing to support vegetation management compliance in Queensland

Jeremy Anderson, Peter Lazzarini, Dr Joanne Hansen, Mr Dan Tindall

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

Biography: Jeremy Anderson is a Senior Scientist with the Remote Sensing Centre (Queensland Department of Environment and Sciences). His work focuses on using remote sensing technology to support compliance applications including vegetation management and coal seam gas development.

The vegetation management framework regulates clearing in Queensland. It is underpinned by mapping based on remotely sensed data and relies heavily on satellite imagery to identify changes in vegetation cover, and to support compliance actions.

The Statewide Landcover and Trees Study (SLATS) and Early Detection System (EDS) use Sentinel-2 imagery to identify change in vegetation cover. Sentinel-2 imagery is ideal because captures are systematic, regular, and reliable; spatial, spectral, and temporal resolutions are appropriate; and data is readily accessible. Once clearing is identified, authoritative datasets available through Open Data, together with permit data, are used to assign all clearing into one of three compliance status categories: exempt, permitted, or unexplained clearing.

Using additional data specific to the region or property, Department of Resources (DoR) prioritises unexplained clearing events and decide on further action. Actions may include stakeholder engagement, targeted education campaigns, investigations, or enforcement actions. Queensland's Survey and Mapping Infrastructure Act 2003 requires that a library containing the remotely sensed images of land and coastal waters of the State be kept. The same legislation allows for images within the library to be admissible as evidence via a certificate stating its attribution. To support a prosecution, remote sensing scientists use a dense image time-series from the library to delineate cleared areas and determine when clearing events occurred. This evidence is critical to define the 'where', 'when' and 'how' elements of a clearing event. This presentation details how satellite imagery plays a key role to identify vegetation clearing and support compliance actions.

Highlights:

1. The vegetation management framework in Queensland is underpinned by mapping products based on satellite imagery
2. Satellite imagery is necessary to detect clearing events
3. For many compliance outcomes, satellite imagery is used to delineate, date and classify clearing events

Comparison and scaling of morphological forest traits for biodiversity assessment

Leonard Hambrecht, Professor Arko Lucieer, Professor Zbyněk Malenovský, Dr Bethany Melville, Ana Patricia Ruiz Beltran, Professor Stuart Phinn

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

Biography: *PhD candidate at the University of Tasmania since 2019.*

Global biodiversity is threatened by man-made changes to the biosphere. Essential Biodiversity Variables (EBVs) have been proposed by the earth observation and biodiversity communities to enable robust monitoring of ecosystems. An important component of the EBV framework is vegetation structure, which describes the physical structure of habitat such as forest. Structural traits need to be ecologically meaningful. The scale of observation and the type and size of the ecological target unit need to be considered. There is a growing need for information on the ecological function of individual tree and their surrounding ecosystem.

To distinguish one tree from another and extract enough detail from an individual tree to calculate meaningful traits, the spatial resolution is important. Lidar has been proven a reliable tool to extract structural traits at a range of spatial scales, from terrestrial to space-borne lidar. Drone lidar provides a new opportunity to capture data which provides enough detail to distinguish between individual trees while at the same time being more efficient compared to terrestrial and mobile laser scanning. Drone lidar has the potential to fill in scale gap between ground-based and aerial lidar platforms.

The focus of my poster is on the comparison of ecological meaningful traits derived from drone lidar, either applied on an area-based approach typical for airborne platforms, and individual trees, typical from ground-based platform. This comparison provides insight into the scaling of traits between the different approaches and thereby identifies traits that are suitable for true scale independent approaches of assessing biodiversity.

Highlights:

1. forest,
2. traits,
3. biodiversity

A novel hyperspectral imager for sensing cyanobacterial algal blooms from a cube-sat

Dr Joshua Pease, Craig Ingram, Stephen Gensemer, Ms Chloe Faulks, Mr Nick Carter, Mr Roshan Dodanwela, Mr Arpit Saxena, Mr Markus Wiedemann, Mr Jared Waterman, Associate Professor Martin O'Connor, Dr Marta Llusca Jane, Dr Jebum Choi, Industry Associate Professor Colin Hall

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

***Biography**: Joshua Pease is a Visiting Research Scientist at the CSIRO Laboratory for Satellite Optics based at the Institute of Photonics and Advanced Sensing (IPAS). His research encompasses the design, prototyping and manufacture of optical sensors, and extends to applications in the defence, environmental management, and energy industry sectors. Joshua completed his PhD thesis on the development of an airborne lidar system for sensing anthropogenic sources of methane. Currently, he is responsible for developing Hyperspectral sensors for small satellites. Currently, Joshua is responsible for the design, prototyping and manufacture of Earth Observation sensors.*

We present a hyperspectral Earth Observation (EO) sensor developed for the CyanoSat mission at the CSIRO Laboratory for Satellite Optics. The laboratory was opened in early 2020 and houses optical equipment for the assembly, testing and calibration of EO sensors operating from the visible to the infrared.

CyanoSat is a precursor satellite mission for the Aquawatch remote sensing system under development by CSIRO and the SmartSat CRC. This novel EO sensor is designed to distinguish between cyanobacterial and green algal blooms, and to detect these harmful algal blooms at concentrations below those considered unsafe for public health. With the ultimate aim of providing actionable water quality data to end users to trial uptake in practical water management.

The 3U imaging payload consists of a customised three-mirror anastigmat telescope and two co-registered imagers. The first, a compact hyperspectral sensor, uses a customised linear-variable filter spanning the visible to the near infrared (NIR) and prioritizes a high signal-to-noise ratio in key wavelength bands. The second is a NIR monochromatic sensor which monitors, and corrects for, direct water surface reflectance.

We thank our valuable collaborators at the University of Adelaide, the University of South Australia and the CSIRO Space Technologies FSP and thank the CSIRO Centre for Earth Observation for providing funding to support the establishment of the laboratory and the sensor development work.

Highlights:

1. Development of a compact hyperspectral imager optimised for the remote sensing of cyanobacteria
2. Design and manufacture of a three-mirror anastigmat telescope offering a high resolution and wide field-of-view.
3. Development of on-board processing routines through drone and high-altitude balloon flights.

Using Deep Learning to Detect an Arid Shrub Species in Ultra-High-Resolution UAV Imagery

Mr Angus Retallack, Dr Graeme Finlayson, Dr Bertram Ostendorf, Prof Megan Lewis

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

Biography: I am undertaking my PhD programme at the University of Adelaide in collaboration with Bush Heritage Australia (BHA). My research aims to take advantage of the ever-increasing quality of remotely sensed Earth observation data to develop a simple, reliable, and inexpensive remote-sensing-based method for BHA to monitor vegetation change on their rangeland reserves through a conservation lens. BHA's South Australian reserves, Bon Bon and Boolcoomata, serve as the study locations for my research, with outcomes being applicable on a wider scale.

Traditionally, indicators used for inferring ecosystem condition and biodiversity are measured using on-ground techniques, although with rapid advances in remote sensing, there is increasing scope for these indicators to be measured with imagery. While methods for broad-scale vegetation monitoring using satellite imagery are widely developed and accepted, approaches for assessing indicators of biodiversity at fine scales are less developed.
In particular, the measurement of species composition in operational monitoring programmes is currently limited to on-ground assessment. Using ultra-high-resolution UAV imagery and deep learning object detection models, there is potential to automatically locate and identify key indicator plant species.
This research tests this approach in the South Australian rangelands, investigating the accuracy of several deep learning approaches for detecting the arid shrub pearl bluebush (Maireana sedifolia) in 0.8 cm, 2 cm, and 3 cm UAV colour imagery. Results indicate accuracies (F1 score) of around 0.75 for the best-performing models, with neither image resolution nor convolutional neural network depth having an effect on the accuracy of these models. Objects were detected with recall (producer's accuracy) values up to 0.82 and precision (user's accuracy) values up to 0.75. Site differences significantly influenced F1 score, with the six vegetation monitoring sites falling into three distinct accuracy groups.
These results indicate great potential for the implementation of deep learning object detection into arid vegetation monitoring programmes for plant species identification. Further research may lie in the inclusion of additional species or improving detection accuracy through expanded training datasets for pearl bluebush.

Highlights:

1. Both UAV colour image resolution (0.8 cm, 2 cm, and 3 cm imagery) and convolutional neural network depth had no significant effect on arid shrub species detection accuracy for the best-performing models. Reducing computational intensity can therefore be prioritised without sacrificing detection accuracy.
2. This approach is a step towards better implementation of remote sensing for monitoring compositional indicators of biodiversity, an aspect of ecological monitoring still dominated by on-ground sampling techniques.
3. Continued development and eventual implementation of this method for arid conservation monitoring would allow sampling of much larger areas with significantly reduced time, effort, and cost than current on-ground approaches.

Identification of irrigated crop areas in Lachlan catchment using remote sensing and Evapo-Transpiration (ET)

Dr Yi Lu, Dr Sikdar Rasel, Dr Vaibhav Gupta, Mr Mustak Shaikh

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

Biography: *I am a senior remote sensing analyst in the NSW Department of Planning and Environment, Water. I have extensive experience in remote sensing and GIS for water resource management and environmental science. I have used advanced remote sensing techniques in mapping, surface and groundwater modelling and water monitoring. Projects include implementing state-wide irrigated crop mapping, farm dam mapping, inundation mapping and water compliance auditing.*

Regular and accurate information on time series of irrigated crop areas is important for the development, calibration and updating of hydrologic models used by DPE Water Group. Such information is essential in supporting adaptive water resource management through the development, implementation, and revision of water access rules. Knowledge of the spatial location and extent of irrigated crops and change in water usage over time provides foundation knowledge to help assess the effects of water resource development on ecosystem processes and ecological assets.

The methodology for identification of irrigated crop areas was developed to report 30-years of summer irrigated crop areas from 1990 to 2021 in NSW's Lachlan catchment. The Google Earth Engine (GEE) analytics is used to process and analyse images. Images in GEE are calibrated and normalised to keep data consistent for time series analysis, monitoring, and evaluation. The user defined analytics operations can be developed and implemented using GEE scripts which improves the mapping and reporting efficiency. Actual evapotranspiration (AET) information is important for irrigation and environmental management and for monitoring water use or plant stress conditions. The AET dataset, which has 30 m resolution and monthly frequency from February 2020 to present day, was developed by CSIRO. The developed method integrates AET to improve the accuracy of the output products since the AET dataset provides another line of evidence for the verification of the irrigated crop areas. The validated product demonstrates the method is an effective and robust way to identify time series irrigated crop areas.

Highlights:
1. Irrigated crop mapping,
2. Evapo-Transpiration,
3. Google Earth Engine (GEE).

Unlocking Earth observation data for South-East Asia using the Open Data Cube

Dr Amy Parker, Dr Matt Paget, Ms Emma Luke, Dr Eric Lehmann, Dr Ronnie Taib, Miss Rachel Horwood

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

***Biography**: Amy is the Acting Director of the CSIRO Centre for Earth Observation and Vice President of Earth Observation Australia.*

Australia’s national science and geoscience agencies, the Commonwealth Scientific Industrial Research Organisation and Geoscience Australia, are supporting the growth and implementation of Earth observation-based products and services in South-East Asia.

The ‘Earth Observation for Climate Smart Innovation’ initiative (EOCSI) has built a new regional Earth observation analysis platform powered by CSIRO’s Earth Analytics Science and Innovation hub and Open Data Cube technology. The platform leverages the wealth of open-access Earth observation data and Amazon Web Services Singapore cloud infrastructure. Users can easily access pre-indexed data allowing them to focus on the analysis instead of sourcing and assembling Earth Observations (semi-)manually. The platform is also pre-loaded with data applications developed by Australian scientists and tailored for South-East Asian environments, including for instance: in-land and coastal water quality assessments; land cover classification; and water body mapping. These applications build upon the tools available via Geoscience Australia’s Digital Earth Australia platform.

Regional Earth observation collaboration allows us to share infrastructure, data, knowledge, expertise, and ideas to address shared challenges. Through training and business opportunities, we are building new and closer relationships between Australian Earth observation practitioners and South-East Asian counterparts to strengthen regional science relations, support climate resilience, and promote sustainable growth and development.

This presentation will showcase the platform, early adopters, and their case studies, plus provide information on how others can get involved.

Highlights:

1. New Earth observation analysis platform to link Australian and South-East Asia
2. Showcase of applications from early adopters that use Earth observation for climate smart innovation
3. Opportunities for the audience to get involved in the initiative

Can we improve above ground biomass estimates in Australian woodlands and forests from drone-LiDAR, Terrestrial Laser Scanner Data, and Tree Models?

Ana Patricia Ruiz Beltran, Professor Stuart Phinn, Dr Shaun Levick

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

Traditional methods of mapping Above Ground Biomass (AGB) are often calibrated and validated against field estimates derived from allometric equations, leading to biased results. Given that allometric equations are developed based on tree measurements derived from destructive sampling, the number of samples used is typically small, and hence lack representativeness to account for naturally occurring structural variability of trees within the same species and growth variations due to different environmental conditions. Here, we use unoccupied aerial system (UAS) based Light Detection and Ranging (LiDAR) data and machine learning to map AGB based on two different calibration data sets, i.e., AGB estimated from allometric models using DBH as inputs; and quantitative structure models (QSM) using Terrestrial Laser Scanning (TLS) data combined with measurements of wood density as inputs. Structural parameters, including canopy height, crown area, and LiDAR ratio layer, for a sub-tropical woodland site in eastern Australia, were measured from the UAS-based LiDAR data and used as predictor variables for the two models. Initial results indicated that results from both models are significantly different. As AGB is highly based on tree structural parameters, these were both captured by the TLS and indirectly by the UAS-based LiDAR data, whereas the allometric AGB did not. Future applications of UAS-based LiDAR combined with TLS-based QSMs may bridge the gap between AGB field estimations and remote sensing models from current and future satellite missions such as GEDI, NiSAR and BIOMASS.

Highlights:

1. Drone based LiDAR data and machine learning approaches were used to map Above Ground Biomass in an Australian woodland
2. Two different calibration methods used, allometric models with DBH as input, and quantitative structure models using Terrestrial Laser Scanning data
3. Tree structural parameters were accurately estimated by Terrestrial Laser Scanning data and indirectly by the UAS-based LiDAR data, whereas the allometric did not estimate these accurately

APPIDE: Increasing the performance and reducing time and cost for the inspection of photovoltaic plants

Dr Murray Kerr, Michael Wilby, Simone Centuori, Marcos Quintana

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

***Biography**: Dr. Murray Kerr is head of Flight Engineering at Deimos Space. He has a Doctorate in Mechanical Engineering from the University of Queensland, Australia. He has over 20 years of experience in the space and aeronautic industry, working in ESA, EU and private programs. Since 2007, he has been working on GNC/AOCS, avionics and autonomous systems at Deimos Space for a variety of systems, including re-entry and launch vehicles, and micro-satellites, being involved in DEIMOS satellite programs and ESA programs such as IXV, SPACERIDER, EXOMARS, Proba3 and Lunar Lander. He is currently managing the DEIMOS SAT4EOCE programme.*

APPIDE (Automatic Photovoltaic Plant Inspection and Data Inspection) automates and improves photovoltaic plant drone inspection by applying novel technologies such as Thermography, Artificial Intelligence, Edge Computing and Geolocation. This service has been developed and it is now commercialized by Deimos Space UK, with the support of ESA. APPIDE reduces the human cost (overall inspection cost is reduced at least 10% for small plants) and response time (reduced from weeks to one day) required for manual photovoltaic plant inspection. The system employs techniques from different domains, such as Computer Vision, Artificial Intelligence, Geolocation, Data Mining and Embedded Systems. The service workflow starts by ingesting the required data structure of the photovoltaic plant and visual and thermal imaging captured from a UAV including geolocation. The state of the service can be monitored by a Front-End managed by the maintenance operator where all the related data is available for querying purposes. The output of the system is an inspection report available in different formats, including the description of the faults and the impact in the performance of the plant. The first release of APPIDE is already available and the second will be available in September 2023 and will be directed towards real-time services. Elecnor is contributing to the commercial strategy of APPIDE, as an End User through its presence in the photovoltaic market, especially in Australia. Australia is a very suitable area in terms of environmental conditions, deployment of solar farms and investment in new technologies for the deployment of APPIDE. Technology-based maintenance products for the renewable energy sector. Real-time embedded processing for UAVs. Insights generation and performance optimization by Artificial Intelligence.
Precise navigation and timing, User experience, asset monitoring, Computer Vision, Thermography.

Earth observation in support to oyster aquaculture industry in Australia

Prof David Antoine, Dr Bisun Datt, Dr Kathryn Barker, Mr Steven Gill, Mr Dan Woodrow, Mr Paul Sheridan, Ms Shaye Carman, Ms Aisling Fontani, Mr Trent Kershaw, Ms Dani Bramante, Mr Riley Lum

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

Biography: *Prof. David Antoine currently leads the Remote Sensing and Satellite Research Group at Curtin university, Perth (RSSRG; http://rssrg.org). He holds a PhD in oceanography from the University Pierre et Marie Curie, Paris. His research over years has encompassed a number of topics from marine optics to satellite remote sensing, all together aiming at better quantifying phytoplankton in the oceans, their productivity, and their long-term changes in response to environmental changes.*

There is enormous opportunity to grow the market of the aquaculture sector in Australia, currently valued at over $90m annually but based mainly in NSW, Tasmania, and S. Australia. For this to happen, producers need solutions to the challenge and vast expense of identifying suitable sites, matching the physical and environmental parameters that maximise growth of oysters. Earth Observation (EO) products have the potential to assist this process and negate the need for costly field sampling.

This pilot project is investigating the feasibility of developing and validating novel merged EO products, with the long-term vision of minimising or eliminating the requirement for in-situ sampling in remote sites. Spatially (Sentinel-2, S2) and spectrally (Sentinel-3, S3) optimised EO products will be developed for two remote WA sites and validated with in-situ data collected in near real time (NRT) by marine buoy systems fitted with Internet of Things (IoT) satellite communication technology. A prototype software, ingesting EO, in-situ and model data will be trialled by end-users (producers e.g., Maxima and regulators e.g., DPIRD) to assess the usefulness of such a tool for NRT site monitoring and determining suitability of future sites.

Through the pilot application of a number of unique methodologies, this solution is to evolve towards an EO-based farm site-monitoring tool:

- IoT communications and In-situ sensors: uniquely combining IoT technology with state-of-the-art underwater optical instrumentation.
- EO Data fusion: spatially and spectrally optimised EO products for two remote WA site
- Targeted validation: collected from on-situ instrumentation, for quality control.

Highlights:

1. Unique combination of IoT technology with state-of-the-art underwater optical instrumentation.
2. Spatially and spectrally optimised EO products through EO data fusion.
3. Targeted validation using on-situ instrumentation for quality control.

Satellite Imagery within the Environment Compliance Branch, Department of Agriculture, Water & the Environment

Adam Wade, Bianca Kallenberg

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

Biography: Assistant Director, Compliance Section, Environment Compliance Branch – Compliance & Enforcement Division

The Environment Compliance Section of the Department of Agriculture, Water and the Environment focuses on serious non-compliance for a range of legislation including the Environment Protection and Biodiversity Conservation Act 1999, for the protection of threatened plants, animals and ecosystems, as well as regulating waste and emissions to the atmosphere, via the Ozone Protection and Synthetic Greenhouse Gas Management Act 1989. This includes monitoring compliance with conditions of approvals granted under these types of legislation, with our compliance work focussing on activities that help to achieve identified outcomes.

The Compliance Section uses systems that are capable of monitoring and providing overlays that show substantial change in landscape to identified areas of interest. To identify priority compliance outcomes, data is collected and analysed from a range of information sources. High-resolution imagery from satellites and drones play an increasingly important role, and the application of machine learning is being tested to help identify non-compliance, which may include land clearing via agricultural, mining or construction activities.

Highlights:

1. Identify change remotely and early
2. Apply machine learning to identify change
3. Overlay spatial layers and imagery to identify change

Remote sensing of phytoplankton biomass in reservoirs of South-East Queensland

Mr Jas Singh

Poster Connect 2, Boulevard Auditorium Foyer, August 24, 2022, 4:45 PM - 6:00 PM

***Biography**: Jas Singh is currently a PhD candidate at Griffith University undertaking his research under Australian Rivers Institute. He has completed his Bachelor of Engineering with class I honours in Environmental Engineering. His honours project focused on Forest Lake; a water body prone to algal blooms during the summer season since 2017. The work analysed the dynamics of water quality when treatment options were planned for use. The analysis was undertaken using DYRESM CAEDYM, a 1D hydrodynamic and water quality model.*

Remote sensing has been extensively used for various fields globally. Multiple freshwater studies analysing water quality parameters such as chlorophyll-a reflectance for phytoplankton variation analysis have used Sentinel-2A/2B, Landsat 8 and MODIS satellites (Caballero & Navarro 2021; Deng et al. 2017; Huovinen et al. 2019; Ndungu et al. 2013; Wang et al. 2020a). However, very few studies have analysed the spatial and temporal behaviour of Optically Active Constituents (OACs) in lakes of SEQ to develop climatologies for the region. The research is aimed to quantity spatial and temporal behaviour of OACs in multiple lakes of SEQ to understand the spatial and temporal trends and to understand whether there is any synchronicity in the inter-lake analysis. This will be undertaken by utilising an airborne spectroradiometer to obtain spectral reflectance properties of various water bodies as a means of validation against satellite data. Monitoring buoys and field campaigns will also be utilized for validation. The main hypothesis for this study, in relation to the temporal aspect, there will be synchronous trends in the lakes as the lakes are situated in the same region however the lakes may vary spatially due to the individuality of the lake in regard to morphology and land use. The airborne spectroradiometer portion of the study will assist in the formation of the acquirement of spectral information of various water bodies in SEQ. This research will be significant as it will contribute help develop climatologies of water bodies in SEQ and will also assist in research towards CSIRO's AqusWatch mission.

Highlights:
1. Spatial and temporal analysis of water quality in lakes across south-east Queensland
2. Drone coupled with spectroradiometer to obtain spectral properties of multiple water bodies as validation tool
3. Multiple algorithms to be analysed for analysis of best performance for optimal water quality retrieval of SS and chlorophyll-a

Do you really need a perfect orthomosaic for your drone images?

Ms Joan Li

EO360 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

Biography*: Joan believes technology is the key. As a data scientist at GeoNadir, she is currently focusing on unlocking the endless information from nadir angle using artificial intelligence. With a background in marine science and strong interests in remote sensing, her previous adventure involves detecting sea cucumbers from drone images with state-of-the-art object detection model. She would love to get more people on board to explore the potential of drone data!*

Aerial surveying with drones has swiftly gained attention in the environmental monitoring community as drones have become cheaper and lighter with longer battery life. Unlike the steady development behind drone technology, the photogrammetry software used to process drone images still requires significant computational time and resources, particularly for feature detection and matching. However, certain survey applications do not require or cannot achieve perfect orthomosaic maps and instead may favour rapid but less accurate georeferenced outputs. This work presents a rapid georeferencing approach that may have utility for time critical surveying missions, such as disaster relief efforts, or challenging datasets where feature matching does not yield acceptable results.

Highlights:

1. rapid georeferencing,
2. computationally efficient,
3. photogrammetry alternatives.

Offline imagery checks for remote drone usage

Dr Roxane Francis, Dr Justin McCann

EO360 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

Biography*: Roxane Francis is a Post Doctorate Researcher in the Centre for Ecosystem Science at the University of New South Wales, Sydney, Australia. Her work is highly varied and includes waterbird monitoring and management in Australia and Botswana, the use of pXRF, SIA and ICPMS to explore diets and toxins, and the use of drones to collect ecological data. She enjoys remote sensing, and is highly capable in the field, having lived and worked in many parts of the world with fauna such as freshwater and marine turtles, waterbirds and lizards.*

Drones are increasingly used for a wide range of applications including mapping, monitoring, tracking and videography. Drone software and technology, however, is still predominantly created for “urban” use such as property photography or roof inspections. As a result, much of the third-party software is reliant upon an internet connection and has built in services to allow for the mosaicking of imagery as a direct part of the image collection process. Another growing use for drones is in conservation, where drones are monitoring species and habitat change. Naturally, much of this work is performed remotely, in areas without internet connection. Working remotely increases field costs, and time in the field is often aligned with specific ecological seasons. As a result, pilots in these scenarios often have only one chance to collect appropriate data and an opportunity missed can mean failure to meet research aims and contract deliverables. We provide a simple but highly useful piece of code allowing drone pilots to quickly plot their captured photos and assess the necessary image collection requirements for the reliable production of a mosaic. Most importantly this process can be performed in the field with no reliance on an internet connection, and as a result can highlight any missing sections of imagery that may need recollecting before the opportunity is missed. Code is provided on a github repository for download and can be integrated into a pilot’s standard image capture process for the dependable production of mosaics and general QAQC of drone collected imagery.

Highlights:

1. We provide open-source code to quality check drone imagery for mosaic creation, regardless of drone model or software.
2. Our method can be conducted whilst in the field, completely free of an internet connection in a matter of minutes.
3. This simple piece of code can help users avoid common data collection mistakes, saving large amounts of time and costs in the field, and producing a better image mosaic, assisting users in meeting research aims and contract deliverables.

Drone photogrammetry to measure boat wake erosion on the River Murray

Mr Thom Gower, Dr Christine Arrowsmith

EO360 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

Bank erosion caused by vessel wake is a common problem in inland waterways that would otherwise experience minimal wave action. The River Murray downstream of Corowa (NSW) is one such waterway, where recreational boating is popular and widespread active bank erosion well-documented. Previous monitoring indicates impacts from boat wakes can combine with (and exacerbate) erosion linked to other sources, including river flows. However, it has not been possible to fully unpick the relationship between erosion severity, vessel wake and river flow, due to a lack of frequency and resolution in the data provided by traditional monitoring methods. To solve this problem, a field experiment utilising drones was conducted to measure bank erosion in response to different vessel types and operating modes under different river flow scenarios. Erosion was measured across a section of riverbank using very high-resolution, close range drone photogrammetry in response to multiple vessel types and operating modes, and different river flows. Bank form was captured in 3-D with the drone before and after multiple discrete tests, each involving 50 wake-generating passes from a single vessel type and operating mode. The resolution of the results was sufficient to differentiate impacts from different vessel types, operating modes, and flows, something that has not been possible with previous monitoring. Furthermore, the experiment demonstrated that high-resolution drone photogrammetry is suitable for monitoring bank erosion caused by vessel wake and is a valuable addition to the riverbank monitoring toolkit in the River Murray, and elsewhere.

Highlights:

1. Very high-resolution repeat drone photogrammetry was able to accurately measure bank erosion on the River Murray.
2. The erosion impact of different vessel types, operating modes, and river flows was captured during a full-scale field experiment.
3. The work highlights the value of drones for assessing riverbank erosion and this approach should become part of the monitoring toolkit for waterway managers.

Mapping Plant Biodiversity in Australia from Landsat: A Deep Learning Approach

Dr Yiqing Guo, Dr Karel Mokany, Dr Peyman Moghadam, Dr Simon Ferrier, Dr Shaun Levick

EO360 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

***Biography**: Yiqing Guo received his bachelor's and master's degrees from Beihang University, in 2012 and 2015, respectively, and his PhD degree from the University of New South Wales, Canberra Campus, in 2019, all in remote sensing. After one and a half years of industry experience, he joined the Commonwealth Scientific and Industrial Research Organisation as a Postdoctoral Research Fellow. His research is focused on remote sensing and machine learning, and their applications to ecological and agricultural problems.*

Australia has globally distinct ecosystems comprising diverse species of terrestrial vascular plants. Timely and accurate mapping of plant diversity across the continent helps with conservation efforts in protecting vulnerable and threatened species. For many years in-situ field surveys have been regarded as the gold standard to measure plant species richness, with a large amount of samples having been gathered through arduous field work over the past decades. These surveys contain valuable information, but they only represent a limited percentage of the spatial and temporal extents, especially for regions and years with a sparse sample coverage. In this study, we extrapolated the knowledge provided by on-ground samples to the national scale via remote sensing. Landsat 5 and 8 multispectral images were queried within CSIRO's implementation of the Open Data Cube. A deep convolutional neural network with three convolutional layers was constructed to learn the relationship between Landsat observations and on-ground richness measurements. The national maps of plant species richness were produced for the years from 1986 to 2020, by inference of plant species richness from annual Landsat observations with the network. Assessment of the mapping results was conducted against ground truth measurements on the test set, with the Root-Mean-Squared Error (RMSE) between modelled and true species richness being 14.2. Our study demonstrates that remotely sensing imagery shows potential for large-scale mapping of plant biodiversity. Further development of plant species richness maps produced in this study can serve as a quantitative reference for guiding conservation activities and land-management decisions in the future.

Highlights:

1. A deep learning approach was proposed to map plant species richness in Australia from 1986 to 2020.
2. A deep convolutional neural network was built to infer plant species richness from Landsat observations.
3. Assessment of the maps against ground truth demonstrated the effectiveness of the proposed method.

Improving canopy height models from point clouds: examples using lidar and drone data

Dr Adrian Fisher

EO360 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

Biography*: Adrian Fisher is a Lecturer in Remote Sensing at UNSW and a member of the Joint Remote Sensing Research Program. He conducts research to improve measures of vegetation structure derived from lidar, drone and satellite data for forests, woodlands and rangelands across Australia.*

Airborne lidar surveys create 3-dimensional point clouds from which it is common to derive gridded products of ground elevation and canopy height. Drone surveys that acquire overlapping aerial imagery also provide 3D point clouds, when processed with structure from motion algorithms used to create orthorectified mosaics. For drone surveys in areas where the ground is visible between the vegetation, such as in arid rangelands, it is possible to derive digital elevation models and determine vegetation height.
Canopy height models (CHM) from lidar data have two common problems: canopy pits (depressions caused by the penetration of lidar pulses in canopy gaps) and bird strikes (local maxima far greater than the tree canopy). CHMs from drone point clouds can be overly smoothed, due to difficulties in separating ground and vegetation when classifying the point cloud. Fully automated methods to overcome these problems have been developed and tested on lidar acquired over forests and woodlands, and drone data acquired over arid shrublands. The methods are based on adaptive filtering and progressive morphological filtering and have been applied using open-source software.
Adaptive filtering can remove pits and bird strikes in canopy height models derived from airborne lidar point clouds.

Highlights:

1. Progressive morphological filtering can improve ground classification in drone point clouds, in open areas such as arid shrublands.
2. The improved canopy height model methods are implemented using open-source software.

Drone-based fuel hazard assessment in SE Queensland commercial pine plantations

Dr Sanjeev Srivastava, Kim Penglase, Tom Lewis

Traditional 1 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

Increased demand for sustainable timber products has resulted in large investments in agroforestry in Australia, with plantations growing various Pinus species, selected to suit a plantation's environment. Juvenile Pinus species have a low fire tolerance. With Australia's history of wildfires and the likelihood of climate change exacerbating that risk, the potential for a total loss of invested capital is high unless cost-effective targeted risk minimisation is part of the forest management plan. Based on the belief that the understory profiles within the juvenile plantations are a major factor determining fuel hazard risks, an accurate assessment of these profiles is required to effectively mitigate those risks. At present, assessment protocols are largely reliant on ground-based observations which are labour intensive, time-consuming, and therefore expensive. This research project investigates the effectiveness of using geospatial analysis of drone-derived data collected in the commercial pine plantations of south-eastern Queensland as a cost-saving alternative to current fuel hazard risk assessment practices. Understory composition was determined using supervised classification of orthomosaic images together with derivations of canopy height models (CHMs). The CHMs were subjected to Marker Controlled Watershed Segmentation (MCWS) analysis isolating and removing the plantation pine trees, thereby enabling the quantification of understory fuel profiles. The methods used proved highly applicable to immature forest environments with minimal canopy closure but became less reliable for aged plantations with closed canopies.

Highlights:

- Mapping understory fuel distribution in commercial pine plantation.
- Using drone-based photogrammetry for fuel mapping.
- Using marker-controlled watershed segmentation (MCWS) for individual tree mapping.

Using UAV-derived LiDAR to Monitor and Assess Ecosystem Restoration

Mr. David Loewensteiner, Dr. Renee Bartolo, Mr. Andrew Esparon, Dr Tim Whiteside

Traditional 1 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

***Biography**: Dave has a keen interest in evaluating, developing, and using technology to monitor and evaluate ecosystems and ecological processes. He previously worked at the University of Maryland and Charles Darwin University engaging with technology developers to identify key information gaps in data collection in environmental monitoring platforms and autonomous systems. The challenges presented in collecting high-quality data in marine and tropical savanna ecosystems have translated to applying technologies to develop ecologically appropriate metrics and monitoring tools for mine site rehabilitation to improve restoration outcomes.*

From the continental and global-scale insights of forest ecosystems derived from GEDI to using Terrestrial Laser Scanners to quantify the intricate architectures of individual trees, LiDAR provides a data rich method to measure three-dimensional aspects of the natural world. In the middle of this range of capabilities are airborne (UAV and plane) LiDAR platforms that are ill-equipped to answer some of the big-picture ecological questions of space borne sensors and can't yet provide the rich detail of terrestrial scanners. During the UN Decade of Ecosystem Restoration, nations have pledge to restore 10 million square kilometres of land. These efforts are being undertaken at a range of scales and UAV-based LiDAR may be a useful measurement tool for tracking structural changes at sites that are upwards of 1000 hectares. We use UAV derived LiDAR to guide and monitor the progress of mine restoration in the tropical savannas of northern Australia, which is a vast ecosystem interspersed with important restoration projects. The presented use cases (Ranger, Nabarlek and Jabiluka mine sites) have varied site histories and represent different temporal stages of mine site restoration. The structural information derived from the UAV LiDAR data collected at these sites can be used to effectively monitor and assess ecosystem restoration across spatial extents that are not particularly feasible to cover for field ecologists. These tools may be well-suited to map the progress of ecosystem restoration that are aligned with the goals of the UN Decade of Ecosystem Restoration.

Highlights:

1. Monitoring the progress of restoration during the UN's Decade of Ecosystem Restoration is an important undertaking that may be well-suited for UAV-derived LiDAR in many instances.
2. Many aspects of monitoring the progress of mine site restoration can be achieved using UAV-derived LiDAR.
3. UAV-derived LiDAR data is especially useful for tracking growth and fate of trees over time to better understand the trajectory of restoration at a site.

Acacia dominated vegetation cover and above-ground biomass mapping in Queensland's Arid Lands

Dr Jason Barnetson, Dr Robert Denham, Professor Stuart Phinn

Traditional 1 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

***Biography**: I have worked in the fields of Environmental and Rangeland Management for over 20 years. As a Rangelands Scientist with the Queensland Department of Environment and Science, I have undertaken numerous projects in the environment fields involving research into the various techniques and methods developed to remotely sense arid landscapes.*

The aim of this research is to expand the development of methods to map both cover and above-ground biomass of arid-adapted wooded vegetation. Spatially explicit and accurate information of the foliage percent cover of wooded vegetation in these landscapes is needed for the further development of property scale tree and shrub biomass estimation for carbon stock assessment. This study developed deep learning predictive models of both cover and biomass, as percent cover (%) and as tonnes per hectare (tha), from drone-based systems and terrestrial laser scanning. Coincidental drone collections of both hyperspectral signatures and structure from motion photogrammetry provided measures of vegetation photosynthetic response and canopy height. These measurements were used as an input to the deep-learning classification of foliage projected cover and was assessed against a manual hold out dataset and reported an overall accuracy of 95% across a range of cover densities. Further predictive modelling was utilised to estimate above ground wooded tree and shrub biomass from the relationship of foliage projected cover and terrestrial laser scan measures of tree volume. Accuracy of the predictive modelling estimates of above ground biomass ranged from 0.8 to 1.8 (tha). These results indicated that the practical application of remotely piloted aircraft system derived measures of foliage projected cover can, with some limitations, be used to provide more spatially explicit measures of the above ground biomass in arid wooded vegetation. Use of both photogrammetric, hyperspectral, and Terrestrial Laser scanning techniques.

Highlights:
Application of a series of Deep learning models to predict both Wooded vegetation cover and above ground biomass.

Measuring volumetric change in waste stockpiles using remote sensing technologies

Dr Joanne Hansen, Dr Jason Barnetson, Dr Nick Goodwin

Traditional 1 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

Biography: *Joanne Hansen is a Principal Scientist at Queensland Department of Environment and Science's Remote Sensing Centre, interested in remote sensing analysis and photogrammetry from satellite, aerial and terrestrial sensors.*

With the introduction of the Queensland waste levy, waste operators are required to complete annual volumetric surveys within licensed landfills. These surveys have traditionally been conducted using on-ground measurement techniques. This paper evaluates a set of remote sensing technologies to measure volumetric change. Surface heights were measured across the waste facility using remotely piloted aircraft (RPAS) imagery, RPAS lidar, airborne lidar and satellite imagery on two dates. Differencing these repeat surveys determined volume change over time.

The study showed that stockpile volumes can be successfully mapped using remote sensing technologies and has benefits of minimising safety concerns within potentially hazardous environments and improving objectivity and repeatability in estimates. Data captured on RPAS and manned aircraft are suitable for monitoring regional landfills. However, stereo satellite imagery was less suitable due to their limited spatial resolution. The preferred data capture method for waste management needs to balance the combination of accuracy, achievable timeframes, site size, data quality, cost, data processing, and legislative requirements.

Both imagery and lidar sensors on a RPAS would be suitable to measure volume changes. For targeted sites with known locations, RPAS can be cost-effective and timely. If the requirement is to cover a large number of landfills within close proximity of each other, using a airborne lidar may be an efficient approach. It is important that rigorous workflows and comprehensive documentation is developed to ensure reliability and transparency of results. This is particularly important if the results will be used for compliance and regulation purposes.

Highlights:

1. Very high-resolution data from remotely piloted aircraft can be successfully used to monitor waste stockpiles within regional landfills.
2. Lidar data from piloted aircraft can be used to monitor volumetric change over entire waste facilities.
3. Satellite stereo imagery is limited in its ability to monitor waste stockpile changes.

Collecting UAS LiDAR point clouds of the East Troublesome Fire in Granby, Colorado, USA

Mr Mark Bauer

Traditional 1 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

***Biography**: Mark Bauer has been with U.S. Geological Survey for twenty years as a geospatial analyst and currently works with the National Unmanned Aircraft Systems Project Office. Mark holds a Bachelor of Science in geography in natural environmental systems from Northern Illinois University. For the last six years, his research has covered the strengths and limitations of UAS lidar technology, its market trends, and its data processing techniques.*

Recent advancements in UAS technology have seen an increase in small LiDAR payloads for surveying and forestry applications. As this technology continues to grow, it's important to understand the strengths and weaknesses of these data acquisitions. The U.S. Geological Survey's, National Unmanned Aircraft Systems Project Office, provides research and recommends best practices for UAS LiDAR acquisitions. This presentation explores the validation methods used to generate large-scale, high-density LiDAR point clouds using the Yellowscan VX20-100 lidar scanner.

Highlights:

1. This presentation explores ground control validation methods using reflector targets for lidar point clouds.
2. The data examples highlight areas of post-burn wildfire conditions of lodgepole pine, limber pine, and aspen forest.
3. This presentation highlights a few key lidar scanner specifications, covering scan angle and beam divergence and their effects on precision and accuracy.

Change detection accuracy in highly dynamic landscapes: how much are we missing?

Dr Lucia Morales-Barquero, Dr Robert Denham, Dr Jordan Graesser

Traditional 2 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

***Biography**: Dr Lucia Morales is a spatial ecologist and remote sensing scientist. Currently, she works at the Queensland Government, at the Remote Sensing Centre and the Herbarium There she has focus her work on the assessment of the quality map products particularly of woody vegetation change and vegetation condition maps. She is interested on how to answer ecological questions using different sources of remote sensing data, especially looking at the application of remote sensing for the monitoring of vegetation condition, forest conservation and forest carbon.*

Providing accuracy statements for land cover change (LCC) maps and producing unbiased estimates of LCC area is challenging. In this work, we aimed to address two main issues concerning the evaluation of LCC maps. Firstly, we propose a more efficient stratification for identifying areas where missed change is most likely to occur. By using a series of ancillary data, we target areas that showed a decrease in woody probability and increase the sample size on areas associated with other clearing events. This stratification approach, besides delivering an unbiased estimate of the total area cleared, is aimed to increase precision. Secondly, we integrate the temporal dimension of the reference data into the accuracy analysis, which is critical in highly dynamic landscapes. We have developed a regression model that considers the time difference between the reference data and the acquisition of the satellite imagery used to produce the map to estimate the probability of agreement, given that an area is cleared. We have applied these two concepts in a pilot study area in southern Queensland, using very high-resolution data to evaluate three consecutive years of woody vegetation change maps that were produced by the Statewide Landcover and Trees Study. We found that the efficient stratification addresses missed clearing more effectively, with an estimated unbiased area cleared that is 8% higher than what was mapped. Our work advances accuracy analysis for LCC and reflects on how to take advantage of the increasing availability of highly accurate reference data sources to improve LCC estimations.

Highlights:

1. In highly dynamic landscapes considering the time difference between the map and the reference data is critical to obtain an accurate assessment of the area cleared.
2. Incorporating timeseries analysis of woody probability greatly improves the detectability of missed clearing.
3. Sample based assessment provide an unbiased estimate of the area cleared that was 8% higher than the area of woody vegetation cleared derived from the map.

Mapping the Potential for Urban Agriculture

Isobel Hume, Dr David M Summers, Professor Timothy Cavagnaro

Traditional 2 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

Biography: I am a PhD candidate at the University of Adelaide who is interested in the future of urbanisation and the multi-functionality of urban greenspaces. Currently, I am using spatial modelling to research the capabilities of sustainable urban agriculture in Adelaide, South Australia.

Engineering sustainable food systems for a growing population will be one of the greatest challenges of the coming decades. With more than half of the world's population residing in cities, there has been intense interest in urban agriculture's contribution to sustainability and self-sufficiency. Critical to understanding the viability of urban agriculture, and ensuring its environmental sustainability, is the intersection of available land and agricultural inputs. Here, we use a combination of spectral and LiDAR imagery to model the food production and rainwater harvesting potential of residential properties, using Adelaide, South Australia, as a case study. The resulting model is combined with productivity and irrigation data from a previous citizen science project. Approximately two-thirds of residential properties were found to contain enough available land to provide dietary self-sufficiency of vegetables, while capturing and storing adequate rainwater for irrigation - even in the modelled Dry year scenario. The modelled edible garden and associated storage tank would occupy around half of the lawn space in a typical residential block. Furthermore, Denitrification-Decomposition (DNDC) modelling was used to compare the biogeochemistry of a poly-culture vegetable garden to an urban lawn. Early results indicate that replacing urban lawns with vegetable production significantly reduces greenhouse gas emissions of urban soils.

Highlights:

1. High-resolution spectral and LiDAR imagery was used to map urban lawn area and residential roof space.
2. The dietary self-sufficiency potential of homes was modelled using a land-use classification and productivity data from urban growers.
3. Urban agriculture can produce meaningful amounts of food, while diverting rainwater from waste streams, and reducing the global warming potential of urban soils.

Evaluating the accuracy of Sentinel-2 MSI and Landsat-8 OLI fusion product for land cover mapping

Ms Monique Greco, Dr Robert Denham

Traditional 2 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

***Biography**: Monique is an undergraduate student in a Bachelor of Science majoring in Geography & Applied Mathematics at The University of Queensland. As part of her degree, she completed a research project at the Department of Environment and Science looking at a new fusion approach for Sentinel-2 and Landsat-8 data. Monique is expected to graduate December 2022 and hopes to use her skills and background to continue contributing to the Australian Earth Observation Science community.*

Clouded optical imagery hinders the ability to map over periods of environmental change. This study aims to evaluate the performance and accuracy of Sen2Like, a data fusion and harmonisation procedure that increases the theoretical number of acquisition dates through transforming Sentinel-2 and Landsat-8 scenes. The purpose of this study is to assess the accuracy of the approach by comparing the Landsat-8 fused products with near co-incident Sentinel-2 imagery. The fused Sentinel vs. Landsat surface reflectance points had a mean slope of 1.008 for 10m bands and 1.018 for 20m bands, indicating no apparent bias. Additionally, image quality of fused Landsat imagery displayed close visual resemblance to Sentinel-2 imagery. The Sen2Like product was then used to create a dense time series during a period of significant landcover change. Fraser Island (K'gari) was selected as the study site for the duration of a bushfire event spanning October to December 2020. Future work can focus on testing the accuracy and image quality of Sen2Like by performing comparison tests on different areas and over longer periods of time.

Highlights:

1. Sen2Like data fusion product tested on transforming Landsat-8 to Sentinel-2 style imagery at a temporal frequency of combined Landsat-8 and Sentinel-2 acquisitions,
2. Reflectance values sampled from the fused Landsat-8 vs Sentinel-2 had no apparent bias, indicating high accuracy
3. Data fusion technique used to densify a time series over an area of significant landcover change

Efficient exploration for critical metals using hyperspectral and multispectral spaceborne imagery

Dr Carsten Laukamp

Traditional 2 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

Biography*: Carsten Laukamp is a principal research geoscientist at CSIRO Mineral Resources (Perth, Australia) and leading the AuScope National Virtual Core Library Infrastructure Program. Carsten explores the potential for combined use of reflectance spectroscopy, geochemistry and geophysics for 3D mineral mapping and exploration through cover.*

Securing access to critical metals is essential for the transition of the fossil fuel-based energy sector to a sustainable, renewable energy future. The Australian continent is highly prospective for critical metals such as Li, Co and Sc, but also major commodities of Ni and Cu that are necessary to make this transition happen. However, exploring for critical metals and their extraction is very energy intensive. Approximately 80% of the Australian land surface is covered by regolith, hindering the exploration for mineral deposits. Earth observation is the most cost-effective method of exploring for mineral deposits at a continental to regional scale. Multispectral spaceborne imagery, such as collected by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER; NASA/JSS), have enabled continental-scale mineral mapping and regional to district-scale mapping of regolith landforms. However, only the recent advent of hyperspectral spaceborne imaging instruments with a sufficient signal-to-noise ratio, such as the PRecursore IperSpettrale della Missione Applicativa (PRISMA; ASI), allow mapping of key minerals at the required detail.
This paper provides the latest examples of CSIRO Mineral Resources' evaluation of hyperspectral and multispectral spaceborne imagery for critical metals exploration and ore body characterisation. Sensor specifications, including wavelength range and band width, are compared with the physicochemistry underlying spectral signatures of the targeted minerals. This is to clarify which materials actually can be directly identified by the respective spaceborne sensors and to minimise false positives, which is a common issue in EOI, limiting the acceptance of spaceborne sensors by the mineral resources sector.

Highlights:

1. Hyperspectral spaceborne sensors are evaluated for critical metals exploration.
2. Not all hyperspectral sensors can be used for critical metals exploration.
3. Mineral physicochemistry should be used to design appropriate sensors.

Automating land use classifications using aerial photography and deep learning across different environments and crops

Mr Andy Clark, Professor Andrew Robson, Mr Craig Shephard, Mr Joel Mckechnie, Professor Stuart Phinn, Dr Peter Scarth

Traditional 2 (Thurs AM), August 25, 2022, 11:00 AM - 12:30 PM

Biography: *Andy is a Senior Research Fellow in the University of New England's Applied Agricultural Remote Sensing Centre (AARSC) and has 17 years of professional experience in the application of earth observation data. He has worked on numerous projects including the mapping and monitoring of woodlands, riparian vegetation, and land use. His research interest is in applying deep learning techniques to earth observation data for automated classifications of landscape attributes which led him to commence a PhD in 2019. Andy is currently involved in numerous mapping projects including mapping horticulture tree crops; protected cropping systems; soybean crops; and shipping containers.*

Traditional remote sensing classification techniques using individual pixel values cannot successfully separate Land Use Land Cover (LULC) classes in very high spatial resolution (<1m) imagery. Numerous studies have compared shallow learning techniques like random forest to deep learning approaches such as Convolutional Neural Networks (CNN) and have found a significant increase in accuracy using deep learning. However, there is a lack of real-world deep learning applications which cover a range of environments or are limited to benchmarking different CNN architectures on a standard set of training images. This work was conducted across a range of Australian environments using blue-green-red aerial image data.

We have shown deep learning methods using very high spatial resolution (<1m) can achieve accurate results (kappa and F1-Score >80%) on applications including tree crops, protected cropping systems, sugarcane crops and shipping containers and other LULC when applying a trained model to different time periods, geographical areas, and sensors. The results presented demonstrate practical applications of deep learning to real-world problems – providing data insights to government and industry.

We found that a stratified training data selection strategy and random image augmentations have the largest impact on the model generalisation and classification accuracies. As a result, a model trained on aerial photography can be applied to satellite imagery in a different geographical. Increasing model complexity results in higher accuracy but significantly increase the training time.

Limitations include the access to large amounts of quality training and validation datasets and the computing power required to process the data.

Highlights:

1. We have optimised a methodology for applying deep learning to classify the location and extent of land use and land cover features in very high spatial resolution (<1m) imagery.
2. The method has been successfully applied to a range of applications including tree crops, sugarcane crops, protected cropping structures and shipping containers using imagery from satellite and aerial photography.
3. Results indicate a stratified random sample to produce training patches, patch augmentations and more complex models increase classification accuracy.

Generating an automated early warning system for Australian plantation forest health issues

Mr Marcio DaSilva, Associate Prof David Bruce, Dr Stephen Stewart

EO360 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

***Biography**: Marcio DaSilva is a PhD candidate at Flinders University in South Australia. His PhD research is focused on monitoring disturbances and the evolution coastal dunes with various remote sensing methods and resolutions. His research interests include UAV photogrammetry, cloud processing of satellite imagery, disturbances in forestry, post-fire dunefield evolution and coastal geomorphology.*

Australian forest planation managers currently use a variety of methods to detect atypical changes in forest condition. These range from human observation from aircraft with manual recording, through airborne LiDAR data capture and processing, to the use of differing optical satellite image processing, often provided at cost by a third party. Typically, the majority of these methods are performed annually at a point in time which best exhibits issues in forest condition due to agents such as drought, storm, excessive water, insect and disease infestation, and animal interference. This presentation illustrates how the Forest Disturbance Index (FDI), utilising brightness, greenness and wetness axes from the Tasselled Cap Transform, is being applied to Sentinel 2 MSI imagery to detect atypical forest health. Thus far the index has been applied to pine forests in SE Queensland and the Green Triangle in SA / Western Victoria. Forest GIS data permits exclusion of non-forest land and allows for forest units to be grouped into species-age classes. Pixel FDI is statistically compared with all pixels in the species-age class and atypically low values of FDI are explored through time to detect atypical temporal variation. Successful demonstrations across selected plantation compartments have been extended to regional scale in via the cloud, first in Google Earth Engine, through work undertaken at CSIRO, thence to DEA Sandbox and currently to a high-performance computer at Flinders University, utilising the Open Data Cube. We encourage audience discussion re the extension of this work to other forest and agriculture types.

Highlights:

1. Early automated detection of forest disturbances
2. Cloud computing using satellite imagery over large spatial extents
3. Monthly analysis replaces yearly aircraft observations

What have we learnt about SME-Government partnerships to create impact with EO?

Dr Brendon Mcatee, Mr Trent Kershaw, Phil Delaney, Dr Serryn Eagleson

EO360 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

A comprehensive industry research study has been conducted across four industry sectors (Agriculture, Mining, Finance and Insurance and Urban Planning) which each have the potential to benefit from greater utilisation of Earth Observation (EO) data. This project applied a design-led customer empathy-based approach to the four industry sectors to develop profiles of key users of EO data within each industry, identify the key problems they need to solve, and understand the industry-cultural characteristics which shape their views on EO, ultimately to inform how SMEs and Government should work together to maximise the impact from EO within industry.

Outcomes from the project highlight that

1. a user-focused approach is essential to accelerate the uptake of EO-based products and services and create business value within other industries outside the spatial sector.
2. while there are some common challenges, each industry reviewed has unique problems to solve and will use EO-based tools differently as a result.
3. in order to maximise the impact of EO within industry, engagement between Government and SMEs should be tailored to the different drivers of each industry sector.

This presentation will discuss how these findings should shape opportunities and constraints to SME-government partnerships for EO activities.

Highlights:

1. Different drivers of industry sectors
2. barriers to use greater use of EO in industry
3. What different industry sectors need from EO

A picture paints 1000 words: The value of FAIR earth observation data to science communication

Miss Anne Crosby

EO360 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

Biography*: Anne Crosby is the chief storyteller for GeoNadir, a platform dedicated to enabling FAIR sharing of drone mapping data. She gets to interview people from all over the world who have uploaded data to GeoNadir and tell the stories behind their amazing work.*

It's an ongoing challenge for many scientists, but especially those working in the environmental space, for their work to have impact beyond academia. Doing so often involves conveying complex, nuanced topics in a way that still garners the interest and engagement of the general public and decision-makers. Yet in the earth observation space we are underutilising one of the greatest tools in our kit: pictures. The saying "a picture paints a thousand words" is just as true for science as it is for any other field, and it's arguably even more valuable when trying to engage a non-specialist audience with a complex scientific concept. Earth observation science has the luxury of having all kinds of breathtaking pictures to help us tell our stories. But so many of these pictures never go further than the program that is used to analyse them for research, robbing us of valuable sources of inspiration and stimulus for important discussions. Findable, accessible, interoperable, and reusable (FAIR) data is slowly becoming more prevalent in the world of remote sensing, and while it has been recognised for its ability to contribute to rigorous, transparent science, its potential to contribute to science communication has largely been unrecognised. Here, we discuss the value of FAIR earth observation data for opening and encouraging ongoing discourse of environmental issues, particularly outside the academic space.

Highlights:

1. Earth observation images are a valuable source of stimulus and inspiration for engaging non-specialist audiences in scientific topics.
2. FAIR data sharing principles around earth observation data and images opens these images to more extensive audiences, encouraging discussion and discourse from both specialists and non-specialists and drawing attention to environmental issues.
3. Encouraging open discourse across a diversity of backgrounds and disciplines is important for addressing environmental issues sustainably and equitably with impacts beyond academia.

Rapid Assessment of Mine Rehabilitation Areas with Airborne LiDAR and Deep Learning: Bauxite Strip Mining.

Mr Xavier Murray, Prof Armando Apan, Professor Ravinesh Deo, Professor Tek Maraseni

EO360 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

Biography: *Xavier Murray is a Ph.D. researcher at the University of Southern Queensland and the GIS Administrator for Rio Tinto Aluminium. As well as supporting the global environment and closure teams in all things GIS and remote sensing. Xavier has a keen interest in integrating automation into workflows in the mining industry and sees the combination of artificial intelligence derivates and remote sensing to be the obvious solution for successful mine remediation.*

Rehabilitation of disturbed sites is a complex process requiring constant monitoring and assessment, with current methods being somewhat obsolete, manual, and rather fraught with risk in terms of beneficial outcomes of the evaluation. This study challenges the status quo of manual assessments and builds a new methodology to recognise a clear need for a quasi-automated and reliable remote sensing method to achieve rapid mine rehabilitation monitoring. The aim of this study was to innovate and develop an ensemble analytic methodology for the use of airborne LiDAR, in conjunction with deep learning, to rapidly evaluate the rehabilitation status of post-mined areas.

Airborne LiDAR datasets, obtained via an Optech ORION m/c 200 sensor, were collected over bauxite mining operations on the western coast of Cape York Peninsula, Queensland, Australia. These datasets were processed into a 3D point cloud using the Esri ArcGIS Pro platform. An ensemble analytical approach was developed, leading with a Convolutional Neural Network (CNN) algorithm, which was trained to recognise, then classify images of the reference site (natural ecosystems) and active rehabilitation areas. The result of this classification was then leveraged, training, in turn, a support vector machine (SVM) algorithm which assessed the entire LiDAR collection, resulting in a predictive surface of rehabilitation status. This surface, as the final analytical product, was assessed for validity using ground-truth plot data and an ordinary least squares regression model, as well as comparison to subject matter expert evaluation through a Delphi expert panel assessment, confirming a statistically significant correlation.

Highlights:

1. Successful methodology for remote sensing of rehabilitation monitoring.
2. Deployment of accessible deep learning for mine remediation.
3. Employment of LiDAR and 3D for the augmented reality collaboration of rehabilitation experts.

Enabling Climate Change through Space and Digital Technology

Mr Dharshun Sridharan, Miss Nipuni Silva

EO360 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

Biography*: By day, Dharshun is an Associate Director within Technology Advisory at KPMG. With over ten years of experience, he has amassed a great wealth of knowledge and experience across the technology domain, with coverage over several organizations, sectors, and industries. His focus relates to Emerging & Operational Technology services namely Artificial Intelligence, Robotics and IoT, with a sector focus on Space and Energy and Natural Resources. By night, Dharshun is completing his Masters in Robotics Engineering via WPI, with a Graduate Certificate in Space Operations via ADFA/UNSW, having just completed SHSSP with ISU, and a Graduate Certificate with UniSA.*

The concept of Climate Change is not new. Acting to mitigate or reverse its impact, unfortunately, is. Inaction brought about due to conflicting interests together with the long-term nature of this issue, brings about its downfall.

Humanity has the technologies now, to start the fightback. Earth Observation Satellites, Internet of Things and Digital Twins form the Technology response. Culture and the way people perceive Climate Change, together with global policies and procedures, form the Process and People perspectives. Climate Change can be solved but requires a co-ordinated multi-jurisdictional response across the dimensions of People, Process and Technology.

The associated research looks to demonstrate how Earth Observation coalesced with Digital Technology may enable proactivity, but also transparency and visibility to the damaging effects of Climate Change. The ideology presented relates to the fusion of the Earth Observation data from Satellites, together with sensor-driven data from Industrial Internet of Things, mapped onto a Digital Twin (nicknamed CyberEarth), would allow for a real-time view of the Earth's condition, trends, and scenarios.

Together with a regulatory framework or regime instantiated, this CyberEarth platform may incentivise entities to change to more sustainable methods of operating. The one thing that is for certain, however, is that Climate Change is happening, and inaction now, means humanity will not have the ability to act later. It is truly a 'strike now or forever hold your peace' type of scenario humanity lives in, and action is required now more than ever before, and this is a potential way forward.

Highlights:

1. Space can be a tool to foster climate adaption and mitigation.
2. Technology will be the enabler to monitor, adapt and resolve the effects of climate change.
3. It's not just technology, but culture that will dictate our future.

Tree species classification at multiple scales using Unmanned Aerial System RGB and multispectral imagery

Ms Poornima Sivanandam, Professor Arko Lucieer

Traditional 1 (Thurs PM), Boulevard Auditorium, August 25, 2022, 1:30 PM - 3:00 PM

***Biography**: Poornima Sivanandam graduated with a Master of Applied Science in Environmental Management and Spatial Sciences from University of Tasmania (UTAS) in 2021. Her research thesis, as part of the Masters coursework, was on tree species classification using drone RGB and multispectral imagery in a dry sclerophyll forest in the East Coast region in Tasmania. This study was focused on identifying approaches that could potentially be transferable to other study sites. She currently works as a Research Associate in Remote Sensing in the TERN drone project in TerraLuma research group at UTAS.*

Information on tree species and forest composition is necessary to understand species-specific responses to climate change, and to develop conservation strategies. In mixed species forests, conventional remote sensing analysis methods developed with assumptions about uniform tree canopy structure often fail, and methods usually involved site-specific parameter tuning to detect and classify tree species. Eucalyptus-dominated forests occur in large areas on the Australian continent but there have been few studies on mapping tree species in these forests. The main aim of this research was to identify effective methods for species classification from ultrahigh-resolution Unmanned Aerial System (UAS) data of a mixed, dry sclerophyll forest in Tasmania, Australia. Tree canopies were delineated at three spatial scales: i) superpixels representing smaller elements in the canopy, ii) canopy objects generated using conventional segmentation technique, multiresolution segmentation (MRS), and iii) individual tree bounding boxes using deep learning based DeepForest package. The impact of these scales on classification was evaluated using RandomForest classifier. Highest overall accuracies were achieved at the superpixel scale (0.84). Despite the extensive parameter tuning involved with MRS, classification accuracy at the object scale was 0.77. Accuracy at the bounding box scale was 0.69 and with Eucalyptus classes grouped improved to 0.77. The DeepForest and superpixel approaches demonstrated in this study have the potential to offer transferable solutions that can be applied in other forests. High resolution tree species maps derived using these approaches can be used to establish a baseline dataset and to monitor changes in forest composition over time.

Highlights:

1. The highest overall classification accuracy was achieved at the superpixel scale with the Eucalyptus classes aggregated (0.93). Highest accuracies at the individual tree bounding box and object scales were similar with Eucalyptus classes grouped underscoring the potential of tree detection using DeepForest that used only RGB, compared to site-specific tuning with multiresolution segmentation (MRS) using additional inputs.
2. The scale of analysis had varying impacts on class-specific accuracies. While closed canopy forms like Callitris rhomboidea were classified with high accuracies across the three scales, both the Eucalyptus species were better classified at the object level likely indicating the appropriate scale of analysis for these species. At all scales, spectral indices based on the multispectral imagery, and canopy height were identified as the most useful features for classification.
3. While classification accuracies were high, there was high uncertainty in the predictions highlighting the spectral similarity between the tree species in this forest. Improvements might be achieved using finer spectral resolution data, or through integrating LiDAR-derived canopy metrics.

Drone-based surveys of tree spatial pattern in savanna reference sites: implications for ecological restoration

Mr Mitchel Rudge, Dr. Renee Bartolo, Dr Shaun Levick, Prof Peter Erskine

Traditional 1 (Thurs PM), Boulevard Auditorium, August 25, 2022, 1:30 PM - 3:00 PM

***Biography**: Mitch applies science and technology to better protect and restore ecosystems – particularly those with trees. Mitch is the final year of a PhD with the University of Queensland, where he uses drones to reveal insights into the ecology of north Australian savanna tree populations, which will help to inform mine-site restoration. Mitch also develops drone-based biodiversity assessment methods with Bush Heritage Australia, and leads the UQ geospatial analysis community of practice, an open-source geospatial skill-share.*

Ecological restoration counteracts both biodiversity loss and climate change, and surveys of intact reference sites can inform objective targets to guide restoration projects. In forests and savannas, the spatial patterns formed by trees are immediately recognizable; and pattern relates to important ecological processes like competition, recruitment, and dispersal. Yet tree pattern is rarely included in reference site surveys or restoration targets. Spatially explicit tree surveys can be conducted with handheld GPS, but the scale of field surveys (≈1ha) may misalign with the scale of tree pattern, which is driven by processes that operate at a range of scales. Drones can conduct spatially resolved tree surveys over areas at least 10x larger than field surveys, which could provide new insights into the tree patterns of reference sites and the processes that drive them. In this work, we conducted ≈10ha drone surveys over reference sites in north Australian savanna woodlands. We characterized the spatial patterns of trees, assessed how pattern changed with spatial scale, and identified relationships between pattern and ecological processes. The findings of this work may help to inform process-oriented restoration projects that resemble the tree patterns of remnant ecosystems.

Highlights:

1. drones
2. pattern
3. savanna

UAS imaging spectroscopy to map functional diversity of canopy physiological traits in open sclerophyll forests

Dr Emiliano Cimoli, Professor Arko Lucieer, Professor Zbyněk Malenovský, Dr Darren Turner, Dr William Woodgate, Professor Stuart Phinn

Traditional 1 (Thurs PM), Boulevard Auditorium, August 25, 2022, 1:30 PM - 3:00 PM

***Biography**: Dr Emiliano Cimoli is a postdoctoral research fellow in remote sensing working at the TerraLuma research group as part of the Australian Research Council (ARC) Discovery project "Ultrahigh-resolution remote sensing for assessing biodiversity hotspots". He is interested in the development and application of optical remote sensing methods to map fine-scale biophysical systems and processes across land and sea. Emiliano Cimoli completed his PhD at the Institute of Marine and Antarctic Studies of the University of Tasmania working on the development of underwater and under-ice hyperspectral imaging and digital photogrammetry to map keystone Antarctic ice algal ecosystems and their environment.*

Functional diversity (FD) is a component of the forest biodiversity paradigm linking plant functional traits to ecosystem processes and services. As forest ecosystems face increasing climate and anthropogenic pressures, advancing remote sensing capabilities to monitor FD across various spatio-temporal scales is one of the key research endeavours.

We investigate the capability of unoccupied aerial systems (UASs) and imaging spectroscopy of high spatial (<0.1 m) and spectral (<5 nm, 170 bands) resolutions, to map forest FD (i.e., richness, evenness, and divergence) at plot-scale level (<0.2 km^2). Selected physiological traits, such as contents of foliar photosynthetic pigments, were mapped based on narrow-band spectral indices, allowing to produce FD metrics from the UAS imagery utilising novel kernel-based Trait Probability Density (TPD) approaches. The combination of high-resolution imagery and TPDs bypasses the traditional need for taxonomic information, alleviates pixel-based spectral mixing issues, and accounts for inter- and intra-specific trait variability that is found within individual tree crowns. An open-source parallel computing Python package was developed to facilitate operational method implementation. Preliminary results revealed that the method is capable of mapping FD drivers for two research sites having contrasting topography, species composition, and water availability.

As one of the first studies deriving physiological FD from UAS-borne imaging spectroscopy data, it paves the way for a flexible and robust FD monitoring framework, capable of linking fine-scale FD metrics to ecosystem process (i.e., productivity and resilience). In addition, our method has the potential to support future validation of large-scale but lower resolution airborne and satellite products.

Highlights:

1. We developed a new framework combining UAS and imaging spectroscpy to map forest functional diversity (FD) at the plot-scale at unprecendented spatial scales.
2. The combination of high-resolution imagery and trait probability density approaches allows to bypass the traditional need for taxonomic information, alleviates pixel-based spectral mixing issues, and accounts for trait variability that is found within individual tree crowns.
3. The study paves the way for a flexible and robust FD monitoring framework, capable of linking fine-scale FD metrics to ecosystem process, assess its environmental drivers and premises to support future validation of large-scale airborne and satellite products.

Detection of weed species using high-resolution drone imagery

Prof Peter Erskine, Mr Phill McKenna, Dr Lorna Hernandez-Santin

Traditional 1 (Thurs PM), Boulevard Auditorium, August 25, 2022, 1:30 PM - 3:00 PM

Biography: *Peter is the director of the Centre for Mined Land Rehabilitation at the University of Queensland. Over the last two decades he has worked on ecosystem function, landscape forest restoration and revegetation techniques nationally and internationally. He has worked closely with mining companies and government agencies to develop monitoring methods to assess environmental impacts of mining and quantify completion criteria for mine closure.*

Two weed species, Athel Pine (Tamarix aphylla) and Parkinsonia (Parkinsonia aculeata), thrive within certain areas of coal mine rehabilitation in central Queensland. Parkinsonia grows in dense stands and displaces palatable species which are critical for the final land use of grazing. Both species were targeted using ground assessments and a quadcopter drone to capture RGB and multispectral imagery of selected areas totalling up to 1,000ha. Overlapping individual images were mosaicked for each area and corresponding digital surface and terrain models were obtained. Three classification approaches were tested to map the target weeds in these data. Specifically, Support Vector Machine (SVM), Object Based Image Analysis (OBIA) and Random Forest (RF) were compared for overall mapping accuracy and for detecting each species. Our experimental results conducted using the high-resolution red-green-blue (RGB) imagery (pixels ~4.5cm), and the random forest approach was able to yield an overall map accuracy of between 94 and 97% and user and producer accuracy averages of between 97% and 93% respectively for the Parkinsonia class. The results indicate that the RF algorithm can be used on RGB imagery in combination with vegetation indices and canopy height models to identify and target Parkinsonia in mine rehabilitation.

Highlights:

1. Weed species, such as Athel Pine and Parkinsonia need to be managed in landscapes of central Queensland.
2. Utilisation of data collected by drones allows locations of weed species to be identified at high-resolution.
3. The inclusion of vegetation indices and canopy height models has the potential to improve classifications to detect weeds.

Can Citrus Tree Parameters Be Measured Through Protective Netting Using Remote Sensing?

Mr Matt Clearwater

Traditional 1 (Thurs PM), Boulevard Auditorium, August 25, 2022, 1:30 PM - 3:00 PM

Biography: *I am an honours student at the Applied Agricultural Remote Sensing Centre at the University of New England. I also work as a horticulture agronomist based in the Riverina of NSW with a focus on citrus and tree nuts. I have a keen interest in precision agriculture and finding exploring new ways to increase input efficiency.*

Netting is used in citrus production to protect trees from climatic extremes and enable a higher quality fruit. The uptake of netting in citrus orchards is increasing globally due to consumer demands and a changing climate. The purpose of this project is to determine how netting impacts remote sensing based assessment of spatial variability of citrus tree parameters such as leaf area index (LAI), leaf nutrient estimation and yield. The project was undertaken in 2021 and 2022 comparing netted and un-netted Afourer mandarins in Murrami, NSW. Three sample trees in each of high, medium and low NDVI zones were located using Planet satellite imagery in both netted and un-netted blocks.

Leaf tissue samples were taken from each tree for nutrient analysis. Vegetation indices (VI) were created using data from a MicaSense Red Edge camera mounted on an uncrewed aerial vehicle (UAV). Results were correlated with the highest correlation between zinc and NDVI in the un-netted block and copper and the near infrared (NIR) reflectance in the netted block. Overall, the correlations were not significantly different between netted and un-netted blocks.

LAI was measured using a Decagon devices LP-80 ceptometer and correlated with VI's in the netted and un-netted blocks. Little difference was seen between blocks. The average NDVI in the netted block was 0.66 while un-netted was 0.86. Further measurements of different parameters are to be undertaken to further examine how remote sensing can be used to describe the variability of netted citrus orchards.

Highlights:

1. Netting did not have an effect on leaf nutrient estimation.
2. NDVI values in netted blocks are lower compared to un-netted blocks but measured tree parameters remain at similar levels.
3. Netting did not have an effect on leaf area index estimation

Towards an Earth Observation Data Quality Toolkit

Dr Jasmine Muir, Mr Stephen Ward, Mr George Dyke, Mr Matthew Steventon

Traditional 2 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

***Biography**: Jasmine has a broad range of experience leading and developing Earth observation applications and products aimed at improving management decisions. At FrontierSI she is the Earth Observation Technical Lead and also the Capability Demonstrator Lead for Aquawatch at SmartSat CRC. Jasmine has a PhD in Remote Sensing, a Masters in Geographical Information Science, and a Bachelor of Science (Ecology), from the University of Queensland.*

Historically, in the Earth observation (EO) end-user market, data quality issues haven't been a big problem. Users have primarily accessed EO imagery characterised through well-funded calibration and validation campaigns of international space agency missions from NASA, ESA, and others. However, users now have a lot more choice when paying for and using the plethora of commercial CubeSat EO satellite imagery that has hit the market in recent years. They must first assess the benefits against the costs of one EO satellite image source over another. At first glance, the quality of data from these images and fitness for a purpose is not apparent. To know if the data is going to be useable and beneficial, it is necessary to examine and report back on data quality at both the mission and image level. This talk will outline existing systems for assessing data quality at the mission and image level, explored during the UK-AU Spacebridge Project and the SmartSat Cooperative Research Centre EO Testbed Project. We will also discuss steps as to how these gaps could be addressed to further develop a data quality tool kit for EO satellite data.

Highlights:

1. Data quality of Earth observation imagery is becoming more important as many new EO satellites are being launched globally.
2. It is difficult for end-users to understand the data quality of EO imagery prior to purchase.
3. An open-source toolkit can help assess EO data quality.

New IMOS Himawari-8 and Multi-sensor Sea Surface Temperature products

Dr Pallavi Govekar, Dr. Jonathan Mittaz, Dr. Christopher Griffin, Dr Helen Beggs

Traditional 2 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

***Biography**: Pallavi Govekar works with Bureau of Meteorology on improving the Bureau's suite of operational, satellite-derived, sea surface temperature (SST) products. This involved adding new satellite data streams as they became available, accounting for sensor-specific calibrations and error characteristics. Her interest includes remote sensing, Sea Surface Temperature, clouds, radiative transfer models etc.*

Sea surface temperature (SST) products within a few kilometres of coasts that can resolve fine-scale features, such as ocean upwelling, are increasingly in demand. The Australian Bureau of Meteorology (Bureau) currently produces operational, real-time SST from the Himawari-8 geostationary satellite every 10 minutes at ~2 km spatial resolution. For ease of use, these native resolution SST data have been composited to hourly, 4-hourly and daily SST products and projected onto the rectangular Integrated Marine Observing System (IMOS) 2km grid. In response to user requirements for gap-free, highest spatial resolution and highest accuracy SST data, the Bureau composites the geostationary Himawari-8 data with data from the Visible Infrared Imaging Radiometer Suite (VIIRS) and Advanced Very High-Resolution Radiometer (AVHRR) satellite sensors installed on polar-orbiting satellites to construct new "Geo-Polar Multi-sensor L3S" products on the IMOS grid. The compositing reduces data gaps due to clouds and presents an opportunity for easy-to-use, more gap-free SST data. The Himawari-8 data have been reprocessed back to the year 2015 and hourly, 4-hourly, and daily Himawari-8 SST products are available to users along with reprocessed Geo-Polar Multi-sensor SST products via the NCI (project qm43). The new Himawari-8 and Geo-Polar Multi-sensor L3S SST products are expected to provide improved data for applications such as IMOS OceanCurrent and the Bureau's ReefTemp Coral Risk Monitoring service, and studies of marine heatwaves and ocean upwelling in near-coastal regions. We will present validation of the Geo-Polar Multi-sensor L3S SST against in-situ SST data and demonstrate applications for the new products.

Bureau has developed new Himawari SST products in collaboration with the University of Reading, Geo-Polar Multi-sensor SST products are made by compositing Geostationary Himawari-8 data with data from polar orbiters and the new Himawari-8 and Geo-Polar Multi-sensor L3S SST products are expected to provide improved data for applications such as IMOS OceanCurrent and the Bureau's ReefTemp Coral Risk Monitoring service.

Drones for 4D Contaminated Site Characterisation and Clean-up in Antarctica

Dr Daniel Wilkins, Dr Rebecca McWatters, Mr Jeremy Richardson, Mr Tim Spedding

Traditional 2 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

Four-dimensional (4D) site characterisation characterises a site in 3D, with the added dimension of time. We discuss a case study from an Antarctic diesel fuel-affected site as it is excavated, characterised, and backfilled over a period of months, as reconstructed using a Phantom 4 RTK drone and photogrammetry software (Pix4D/ Site Scan for ArcGIS).

A mission was defined in the DJI Pilot App and re-flown eleven times over four months with a Phantom 4 RTK drone (RPA). Images were processed in ESRI SiteScan to derive digital surface models, visualise the site, calculate volumes, and monitor and report on progress.

An additional case study will be briefly presented which combines drone acquired Digital Surface Models (DSM's) with sub-surface data from passive vapour monitoring at a diesel spill site with 6m of ice cover.

Highlights:

1. Drone photogrammetry (DJI P4RTK and Site Scan) as a standard workflow
2. Visualising an active remediation site in 4D over an Antarctic Summer
3. Potential for integrating novel sensors and technology

The Droniometer: Measuring spectral BRDF for the validation of DEA Analysis Ready Data

Dr Mark Broomhall, Dr Andrew Walsh, Mr Guy Byrne, Mr Eric Hay, Mr Medhavy Thankappan

Traditional 2 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

***Biography**: Dr Mark Broomhall is the Assistant director for Calibration and Validation for the Digital Earth Australia program within Geoscience Australia, where he has been for the last three years. Mark and the team operate a number of spectrometer instruments both human-portable and drone-mounted primarily for the validation of surface reflectance products for Landsat and Sentinel-2 satellite sensors.*

Previously Mark has worked for the Bureau of Meteorology and Curtin University on atmospheric, marine and land remote sensing product developments and well as validating these products in the field.

Mark has interests in validation, atmospheric correction and algorithm development.

Digital Earth Australia (DEA) delivers Analysis Ready (ARD) Data through their open data cube infrastructure to both internal and external stakeholders so that they can generate products directly without the need for further processing by the user.
DEA ARD is corrected using a BRDF model derived from MODIS data. In order to test this, we need to be able to measure BRDF in the field. Traditionally this was done using a very cumbersome goniometer apparatus.

The 'droniometer' consists of a drone mounted spectrometer and a gimbal with the ability to be pointed at a precise angle. A hemispherical flight path is programmed into the drone with several waypoints where the drone will pause and point at a central point on the ground, thus replicating the behaviour of the goniometer. Flying the same flight pattern over the day will allow multiple solar illuminations to be sampled for each of the viewing positions. These observations are used to fit a new BRDF model. The MODIS-derived and droniometer-derived models can then be compared to assess the pixel level model and the scene level model differences to validate the NBAR correction.

Highlights:

1. Virtual drone gomiometer (Droniometer),
2. BRDF measurement,
3. Validation of key surface reflectance parameters

Digital Earth Australia Coastlines: Mapping Australia's dynamic coastline using three decades of satellite imagery

Dr Robbi Bishop-Taylor, Dr Rachel Nanson, Mr Stephen Sagar, Dr Leo Lymburner

Traditional 2 (Thurs PM), August 25, 2022, 1:30 PM - 3:00 PM

Biography: *Dr Robbi Bishop-Taylor is a Coastal Earth Observation Scientist from the Digital Earth Australia Program at Geoscience Australia. He holds a Doctor of Philosophy in Geospatial Science for research mapping multidecadal surface water dynamics using satellite imagery. At Geoscience Australia, Robbi works as part of an interdisciplinary team responsible for developing the first continent-wide maps of Australia's vast intertidal zone, and the recently released Digital Earth Australia Coastlines dataset that maps Australia's dynamic coastline using three decades of satellite imagery.*

Accurate, robust and consistent coastline mapping is critical for characterising and managing the impacts of coastal change. Satellite remote sensing provides an unparalleled source of freely available data for studying dynamic coastlines through time and across large extents. However, previous approaches have been challenged by the low spatial resolution of freely available satellite data, and the influence of tides that can obscure long-term patterns of coastal change. Here we present DEA Coastlines, a new continental dataset documenting three decades of coastal change across Australia. We combine subpixel waterline extraction with tidal modelling to map the most representative position of the shoreline at a consistent tide datum each year from 1988-2020. By suppressing the short-term influence of tide and sub-annual shoreline variability, we characterise multi-decadal trends of coastal change at unprecedented spatial scale and resolution and validate these results using extensive independent coastal monitoring datasets spanning the last three decades. 22% of Australia's non-rocky coastline has retreated or grown significantly since 1988, with 16% changing at over 0.5 m/year. Although retreat and growth were closely balanced across the Australian continent, our results highlight significant regional variability and extreme local hotspots of coastal change. Our results provide new insights into patterns and trends of coastal change across Australia and highlight the critical value of long term in-situ coastal monitoring data for evaluating satellite-derived coastal datasets. DEA Coastlines is made available to scientists, coastal managers and policy makers as free and open interactive tools and code to support future coastal research and management.

Highlights:

1. A new remote sensing method for mapping coastal change at continental scale
2. We combine 33 years of Landsat data from Digital Earth Australia with new sub-pixel and tidal modelling methods
3. Long-term rates of coastal change were accurately quantified across the Australian coastline

The National Spectral Database - An introduction for remote sensing scientists.

Mr Eric Hay[1], Dr Mark Broomhall[1], Dr Arnold Dekker[2], Dr Laurie Chisholm[3]
[1]Geoscience Australia, Symonston, Australia, [2]SatDek, Canberra, Australia, [3]University of Wollongong, Wollongong, Australia

Workshop: The National Spectral Database - An introduction for remote sensing scientists, August 26, 2022, 9:00 AM - 12:00 PM

***Biography**: Eric Hay is the Spectral data quality officer at Geoscience Australia and has been instrumental in adapting AusSpecchio to run cloud infrastructure and is the principle contact for access to the NSD. Dr Laurie Chisholm, one of the principle scientists responsible for AusSpecchio, with a long history in the use of field spectroscopy data and a champion of metadata standards. Dr Arnold Dekker has had a long career in remote sensing, water quality and aquatic biota and has recently been working with Geoscience Australia on compiling an Aquatic substrate library for the NSD.*

Earth Observation (EO) provides unique opportunities to undertake quantitative analysis for a wide range of applications across terrestrial and aquatic ecosystems. High quality field spectral data for calibration, parameterisation and validation of the EO datasets and algorithms used for these applications are crucial, however these valuable and costly datasets often suffer from poor discoverability or documentation and, lack of measurement standards limiting their use by the broader scientific community.

The National Spectral Database (NSD) is built on the Aus-Specchio database funded by ANDS and was formerly hosted by the University of Wollongong. The NSD is an implementation of the University of Zurich Specchio database system, which is designed to provide powerful search tools using extensive and standardised metadata fields that can be tailored for almost any application involving field spectrometers. These include data from ASD, Spectral Evolution, Ocean Insight with collections for aquatic to terrestrial applications and different collection methods, such as UAV platforms. The NSD is hosted by Geoscience Australia as a high value dataset and repository of optical field and laboratory spectra for the Australian EO community. It is designed as an open/public repository where the Australian EO community can readily contribute and retrieve data. The intention is that the NSD system will adapt to meet the needs of the Australian earth observation community where required in future.

This workshop will present an introduction to the database, use cases and an interactive workshop on contributing to and retrieving data from the NSD. It will feature presenters from Geoscience Australia, who maintain and contribute to the NSD, the University of Wollongong, who setup and maintained Aus-Specchio for the last decade, CSIRO who have collaborated and contributed to Aus-Specchio since its inception and a range of contributors including the Aquatic Substrate Library and Terrestrial Vegetation and Mineral Libraries with experience utilising the NSD system.

Participants will be provided with an introduction to the NSD, demonstration of its functions including search and data retrieval, data upload, and data attribution properties via GA's DOI minting. The usage and datasets ingested for some key applications will be shown. Participants will have the opportunity to contribute their data, inputs, and ideas towards future developments.

Workshop attendees will need to bring their own laptop and are encouraged to sign up for the NSD beforehand. The instructions for sign up can be found here: https://cmi.ga.gov.au/data-products/dea/643/australian-national-spectral-database#access

Presenters:

- Laurie Chisholm (Uni of Wollongong)
- Cindy Ong (CSIRO)
- Ian Lau (CSIRO)
- Arnold Dekker (SatDek Pty Ltd)
- Mark Broomhall (Geoscience Australia)
- Eric Hay (Geoscience Australia)

Highlights:

1. National Spectral database for the remote sensing research community
2. community driven
3. long-term support

AI for Drone Imagery Applications

Dr. Renee Bartolo

Workshop: AI for Drone Imagery Applications, August 26, 2022, 10:00 AM - 4:00 PM

This will be an experiential workshop where participants will generate a training dataset with their own data and train deep learning models for image recognition. This workshop will provide you with:

- An introduction to AI approaches and considerations for drone data capture.
- How to get a project set up in Azure Machine Learning and commence labelling.
- How to train your AI model and use it to make predictions with new (test) imagery.

You will need to bring a laptop and an image dataset (~100 images) with targets you want to train an AI model for (individual images no larger than 6MBs). If you don't have your own imagery, images will be provided.

Planned Australian Earth Observation Satellite Missions

Dr Jasmine Muir[1], Dr Nicolas Younes[2], Dr David Hudson[3], Mr Reece Biddiscombe[4], Dr Arnold Dekker[5], Stephen Gensemer[6], Mr Adam Macleod[6], Professor Stuart Phinn[7], Mr George Dyke[8], Ms Agnes Lane

[1]FrontierSI, Perth, Australia, [2]Australian National University, Canberra, Australia, [3]Geoscience Australia, Canberra, Australia, [4]Australian Space Agency, Canberra, Australia, [5]SatDek, Canberra, Australia, [6]CSIRO, , Australia, [7]University of Queensland, Brisbane, Australia, [8]Symbios Communications, Sydney, Australia

Workshop: Planned Australian Earth observation satellite missions, August 26, 2022, 10:00 AM - 3:00 PM

Biography*: Jasmine is the Earth Observation Lead at FrontierSI and is currently on secondment to Smartsat CRC to lead the development of the Aquawatch satellite mission for monitoring water quality. She enjoys using Earth Observation technology for solving problems, and transitioning research into operational uses. Jasmine has a PhD in Remote Sensing, a Masters in Geographical Information Science, and a Bachelor of Science (Ecology), from the University of Queensland.*

Recently the Federal Government has announced $1.2 billion in funding to support the National Space Mission for Earth Observation (NSMEO), led by the Australian Space Agency in partnership with CSIRO, Geoscience Australia, the Bureau of Meteorology, and the Department of Defence. The Australian Earth Observation (EO) from Space Roadmap explains where the industry is expected to grow and the activities for Australia in the next 10 years. The NSMEO will deliver on the vision in the EO Roadmap – that Australia increases its sovereign capability by designing, testing, and launching Australian EO instrument payloads while supporting economic and industry growth.

Australia has a long history of using EO data for generating insights. For example, The Bureau of Meteorology currently uses data from over 30 satellites in its weather, ocean and hydrology prediction and visualisation systems.

This workshop will consider the observation requirements, technologies, research, and workforce required to achieve the ambition articulated in the Australian Space Agency's EO Roadmap of an Australian satellite program for civilian applications. It will cover planned missions in water quality, fuel management, cross-calibration, and meteorological applications, and:

- Provide an overview of each of the planned missions
- Explain the planning and design process
- Present the characteristics and requirements of planned imager payloads
- Provide a practical exercise in end-user requirements gathering for an EO satellite mission
- Discuss proposed data products from each mission

Highlights:
1. We'll present and describe the planned end user-driven Australian Earth observation satellite missions to the AEO community,
2. We expect to interact with designers, experts, industry, and additional end-users,
3. Opportunity for the wider AEO community to provide feedback, ideas, and requirements for the satellite missions.

Choosing and using a satellite sea surface temperature product

Dr Helen Beggs, Dr Pallavi Govekar
[1]Bureau Of Meteorology, Docklands, Australia, [2]Bureau of Meteorology, Docklands, Australia

Workshop: Choosing and using a satellite sea surface temperature product, August 26, 2022, 1:00 PM - 4:00 PM

***Biography**: Dr Helen Beggs is a Senior Research Scientist, specialising in sea surface temperature (SST) product development, in the Satellite Science Team at the Bureau of Meteorology. She has worked at the Bureau since 2003, following four years at the CSIRO Marine Research, Hobart, and four years as Upper Atmosphere Physicist at the Australian Antarctic Division. Since 2007, Helen has led the IMOS Satellite Remote Sensing SST Products and Ship of Opportunity SST Sensors Sub-facilities. Helen obtained her PhD in Oceanography at University of Tasmania in 1995, and her MSc in Theoretical and Space Science at La Trobe University in 1989.*

Sea surface temperature (SST) is a vital parameter across a range of marine and climate sciences. Because SST strongly modulates air-sea fluxes it is an essential parameter in weather prediction and atmospheric model simulations. It is also of great importance to the biodiversity and biogeochemistry of the oceans as well as marine ecosystem dynamics. SST measurements benefit a wide spectrum of operational applications, including ocean, weather, climate and seasonal monitoring/forecasting, military defence operations, validation of atmospheric models, marine animal tracking, evaluation of coral bleaching, and management of marine parks, tourism, and commercial fisheries.

There are a multitude of SST data products produced by the Bureau of Meteorology from sensors on geostationary and polar-orbiting satellites as a contribution to the Integrated Marine Observing System (IMOS). Selecting the most appropriate product for your application can be very confusing. There is a trade-off in spatial and temporal resolution, time of day, depth, composition/interpolation method, cloud contamination and accuracy.

This workshop aims to help the user select the most appropriate SST product and show how to locate and download these products from the National Computing Infrastructure (NCI), the Australian Ocean Data Network (AODN) and other portals. We will demonstrate a range of useful web-based tools for visualising and sub-setting the data. Participants are encouraged to contribute questions and case studies, so that we can work through real life examples.

The Bureau of Meteorology's IMOS satellite SST products can be accessed via:
- NCI projects qm43 and gy24
- and via OPeNDAP: https://opus.nci.org.au/pages/viewpage.action?pageId=141492230
- AODN: http://thredds.aodn.org.au/thredds/catalog/IMOS/SRS/SST/ghrsst/catalog.html

Highlights:
1. There are many SST data products produced by BoM as a contribution to IMOS.
2. This 2-hour workshop aims to assist users to select the most appropriate SST product for their application.
3. We will show users how to access and subset the SST data and work through some real-life case studies of SST applications.