CALIBRATION AND VALIDATION FOR INTERNATIONAL SATELLITE IMAGING SPECTROSCOPY MISSIONS: AUSTRALIA'S CONTRIBUTION

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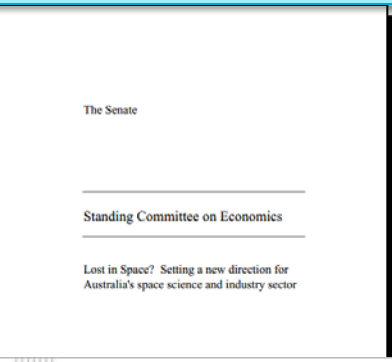
IGARSS 2014
www.csiro.au

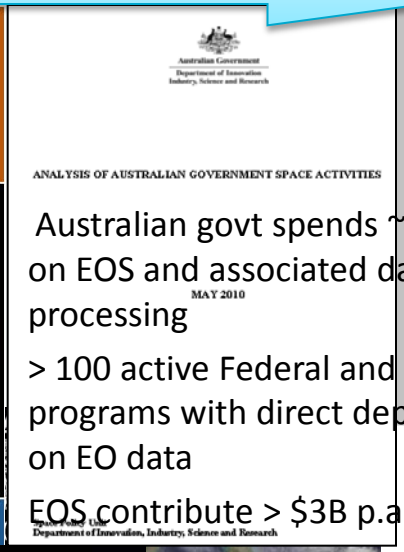
CSIRO

2014

2020



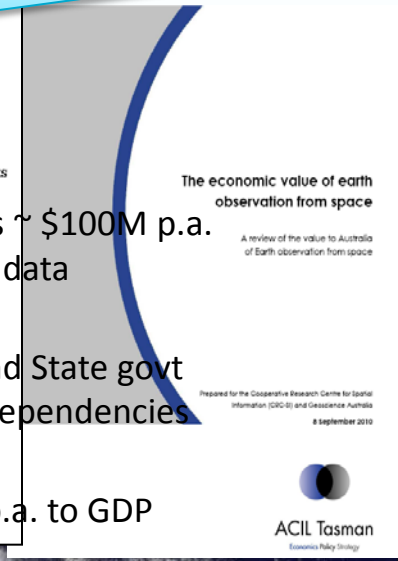
Au has been receiving EOS for > 50 yrs , developed world-class scientific, environmental and emergency management EOS applications

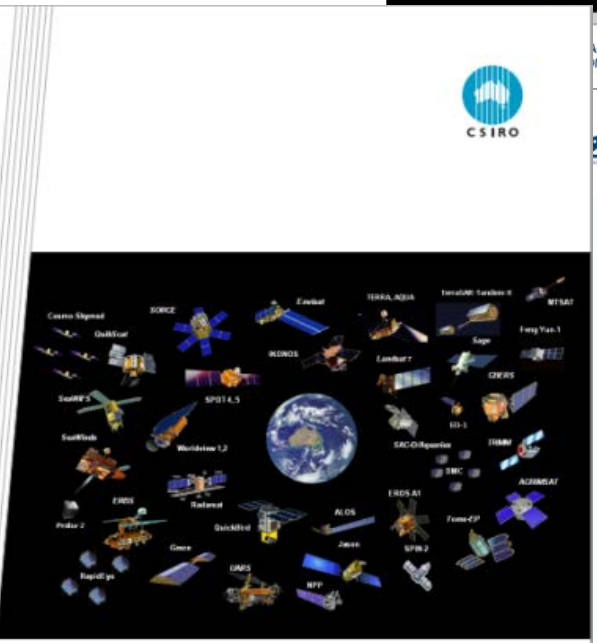


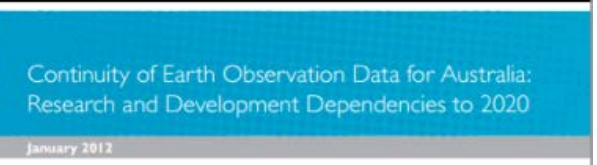
Australian govt spends ~ $100M p.a. on EOS and associated data processing

> 100 active Federal and State govt programs with direct dependencies on EO data

EOS contribute > $3B p.a. to GDP







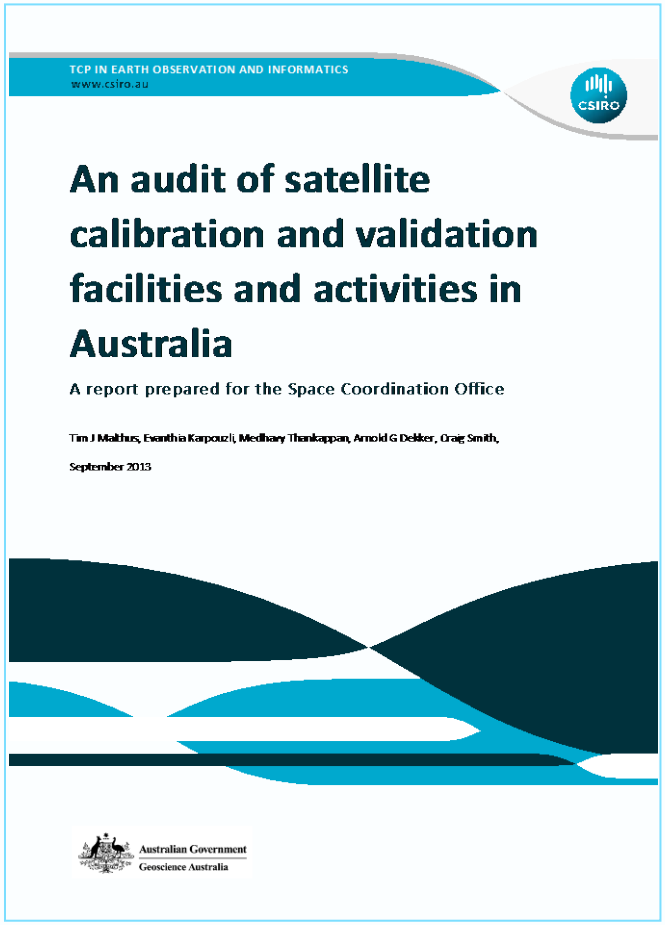
R8: That national EOS calibration and validation infrastructure be established.

Survey of national Cal-Val capabilities

Funded by Space Coordination Office and the TCP

Supports NEOS-IP recommendation 'That national EOS calibration and validation infrastructure be established'

- Audited existing Australian cal-val facilities and activities (survey and SWOT analysis)
- Provided recommendations on the path forward for the future of cal-val activities in Australia
- Report soon to be released



Survey findings

Significant infrastructure and activities exist upon which future activities can be developed. 11 calibration (8 optical, 6 in CSIRO), 12 validation (all for value added products). Some long-term.

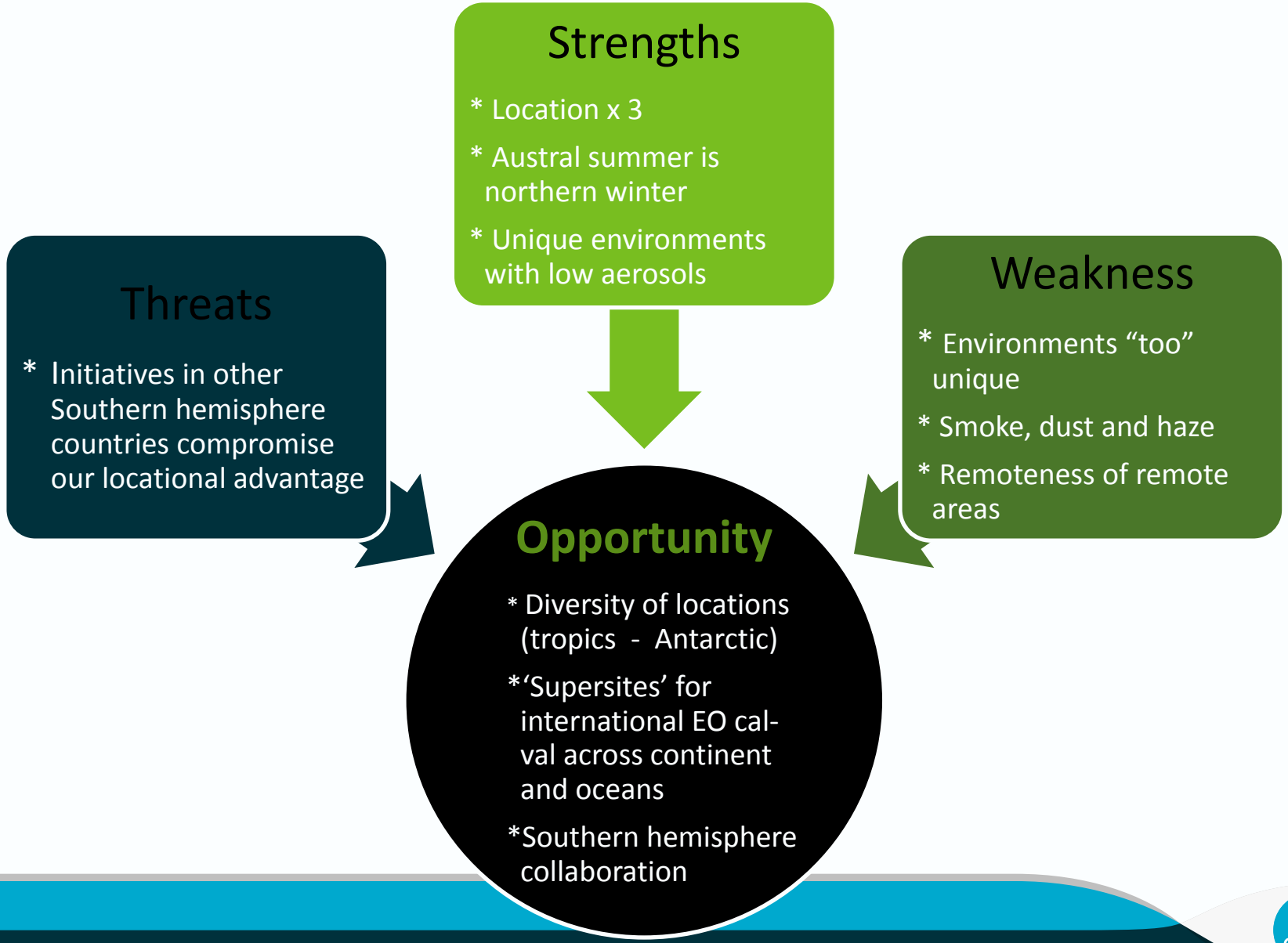
Recent NCRIS funding (TERN, IMOS and AusScope) has been a significant stimulant (infrastructure and diversity) ($59.6M, maintenance $6M)

Good examples of best practice cal-val (e.g. ocean altimetry, ABARES Groundcover validation)

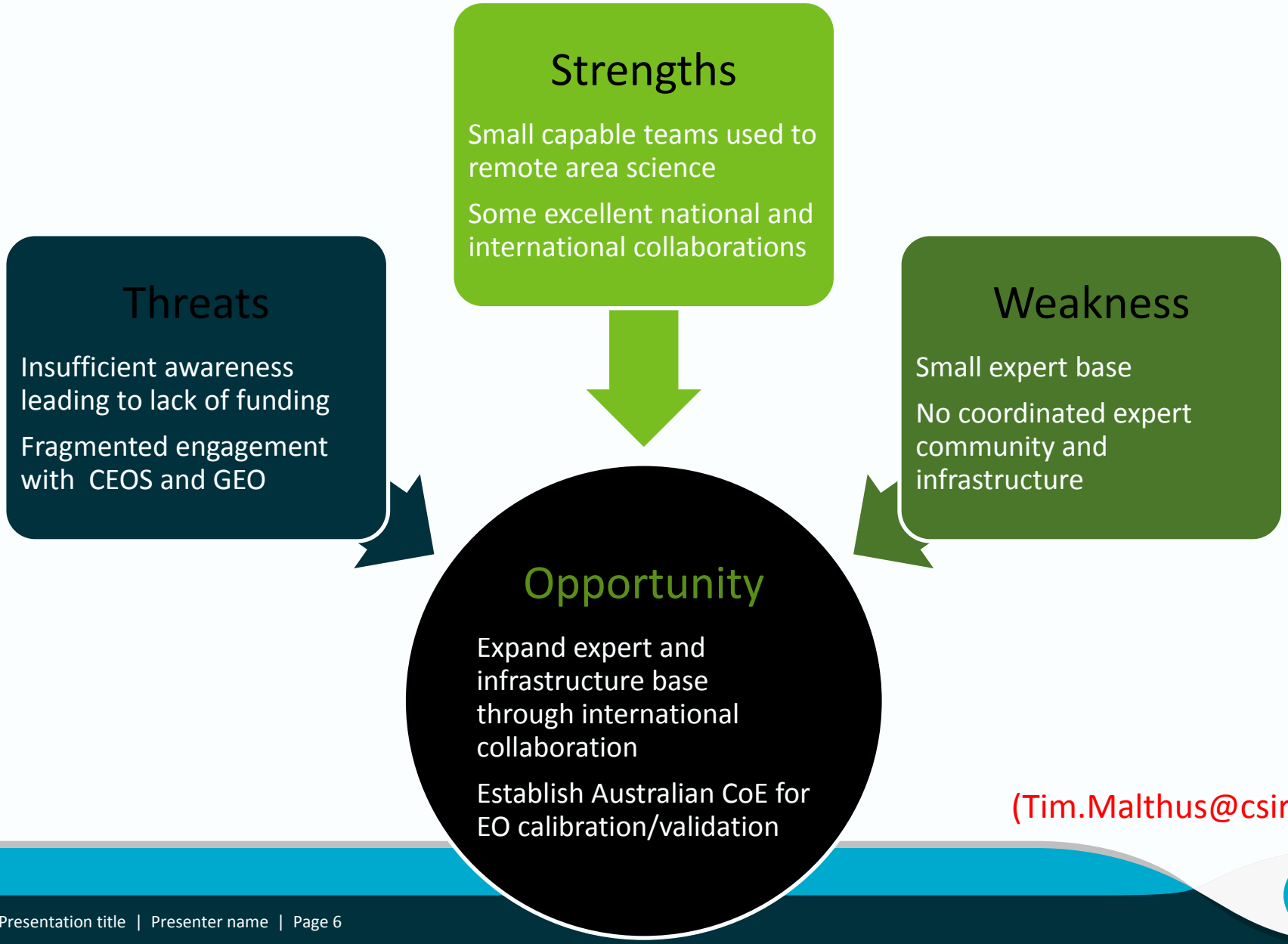
Duplication of effort low

Many strong international connections

SWOT - Geography



SWOT – Capability

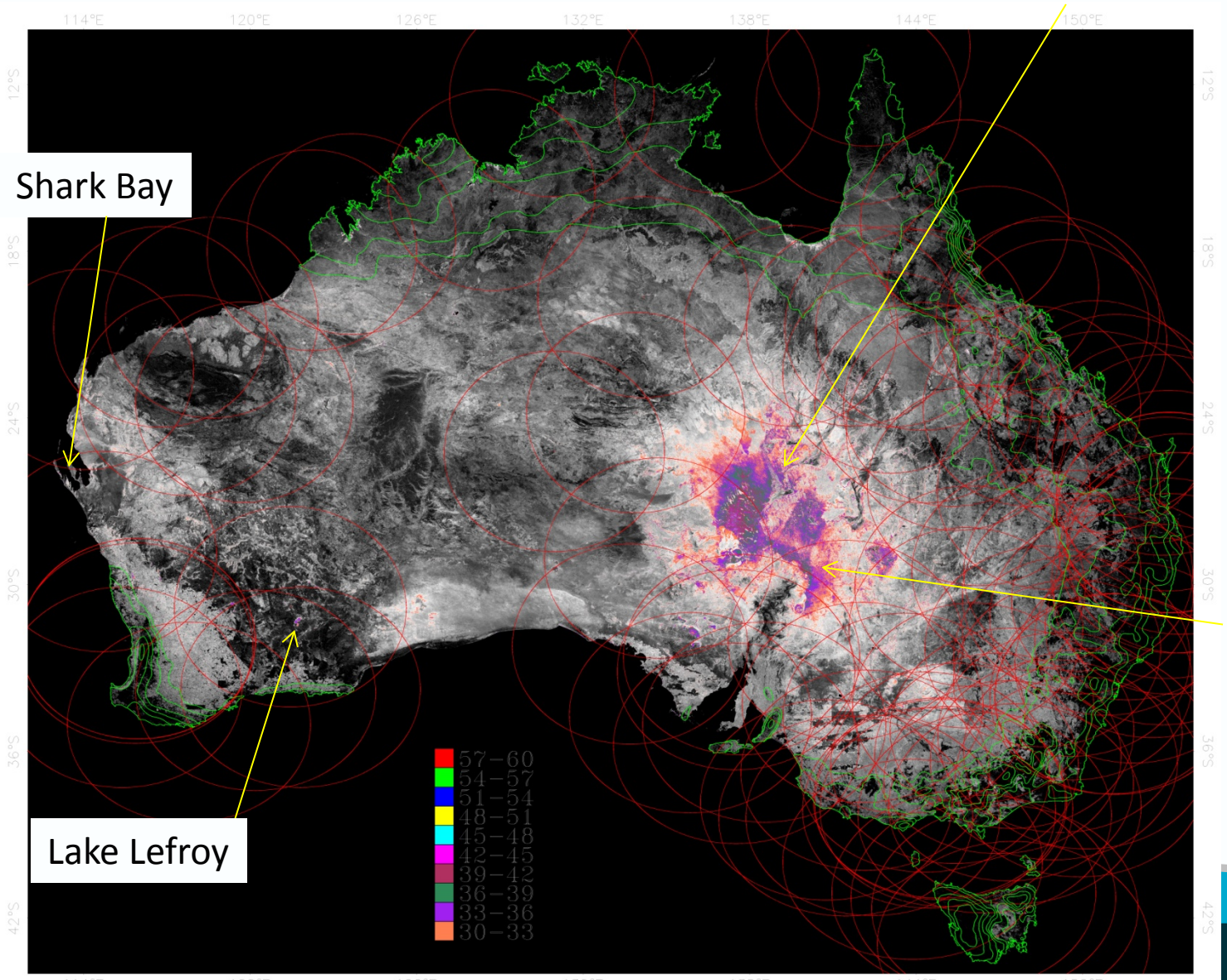


(Tim.Malthus@csiro.au)

Search for vicarious calibration sites

- Landsat TM 5 from Geoscience Australia archive
  - period 2003-2010;
  - total of 824 1 x 1 degree spatial tiles;
  - 40-60 images per tile;
- Data processing delivered by GA
  - physics-based surface reflectance correction (Nadir BRDF Adjusted Reflectance - NBAR);
- Additional data processing
  - "bare areas" retrieved by masking out green veg using NDVI >0.3
  - masked for standing water (B4/B1)
  - Masked out cloud (from GA PQA layer)
  - only summer months of no to low rainfall were used; processing partitioned to approximate two climatic zones – sub tropical and temperate separated by the Tropic of Capricorn (-23.5S). Temperate dry season: November to March, Sub tropical zone dry season:May to October
  - Calculated temporal mean, standard deviation and coefficient of variation for average albedo across VNIR-SWIR, VNIR and SWIR separately

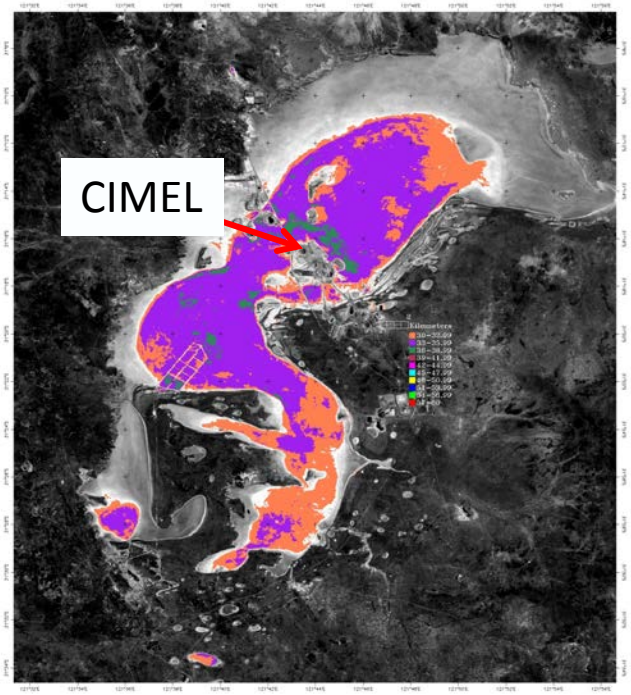
VNIR-SWIR temporal means

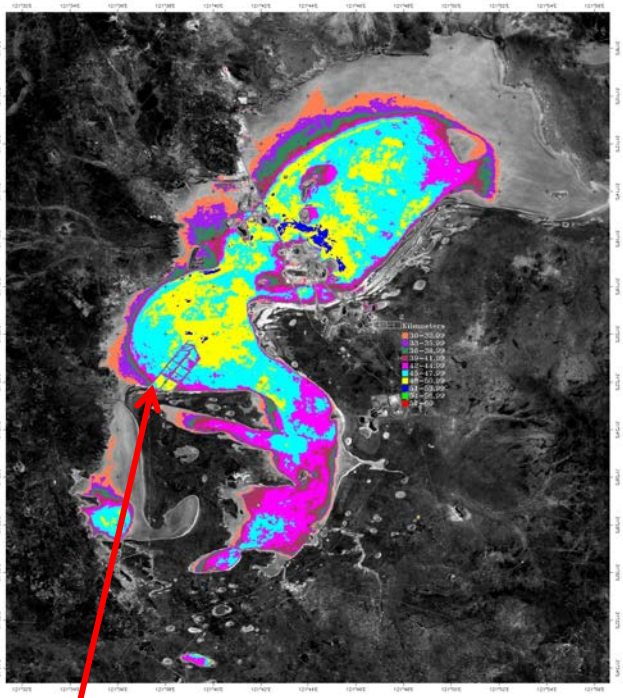


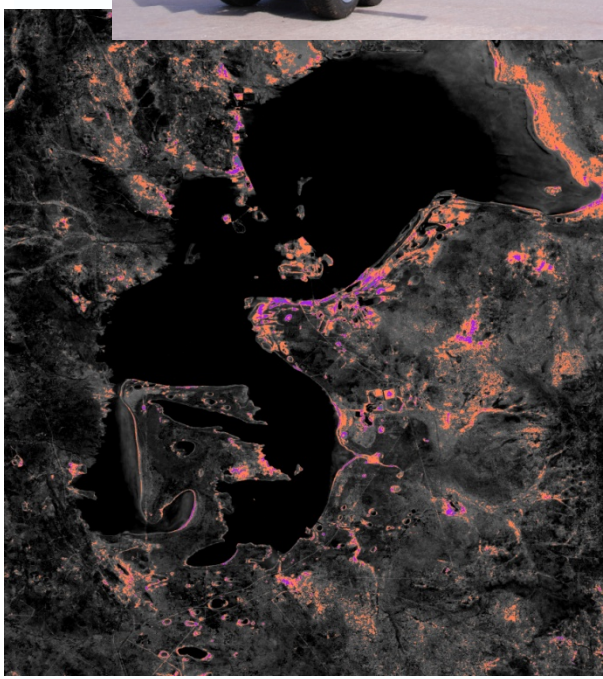
- Green vectors show high rainfall zone >600 mm pa
- Red circles show radius of 400 km (half day's drive) from major airport
- Image is VNIR-SWIR temporal means

Lake Lefroy temporal means

CIMEL



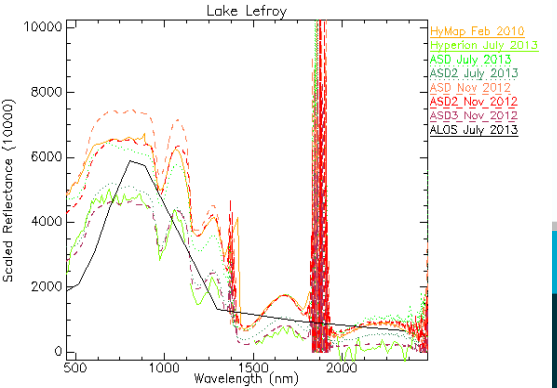




VNIR-SWIR

VNIR

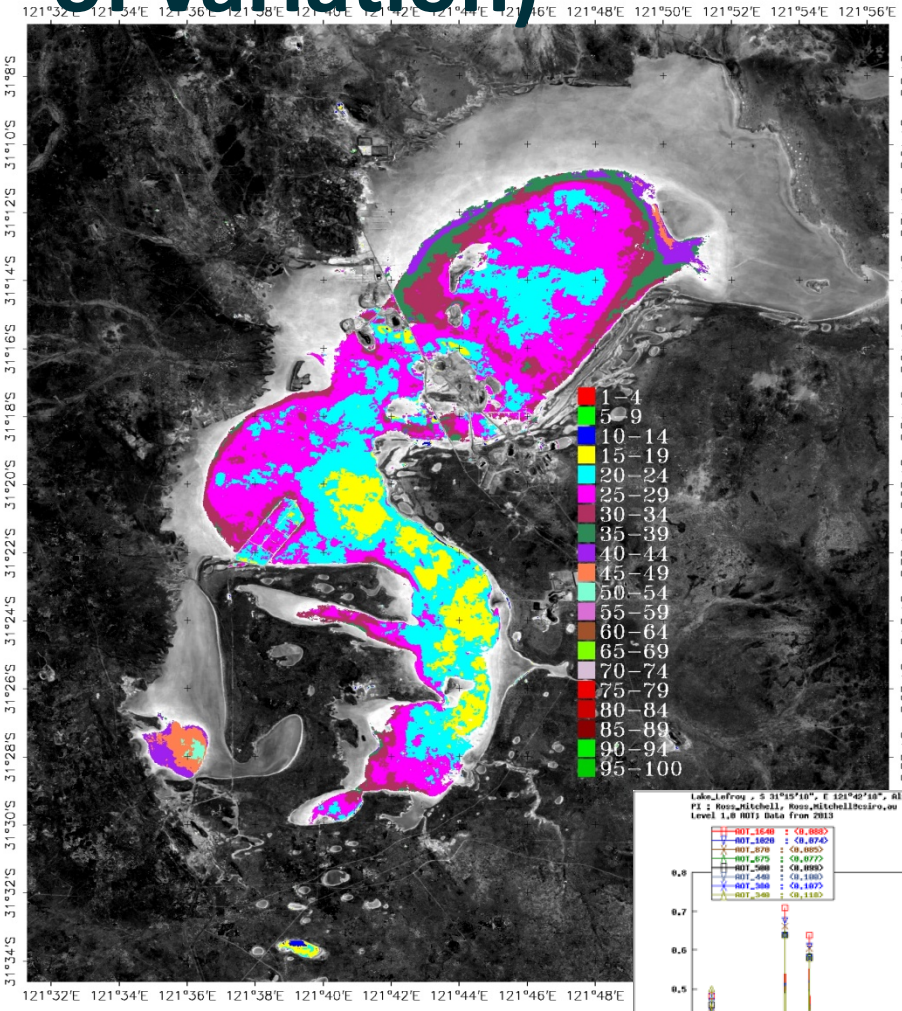
SWIR



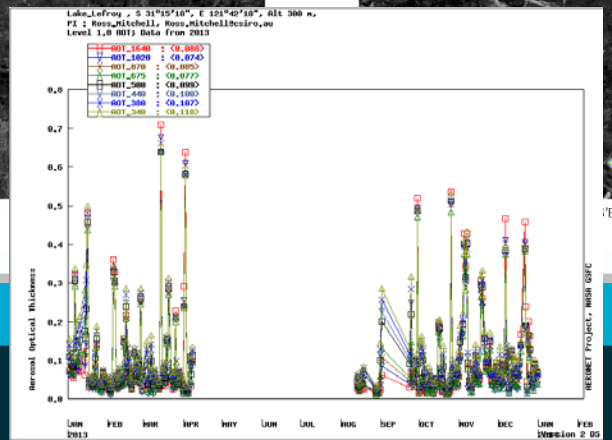
Current
Field
Site

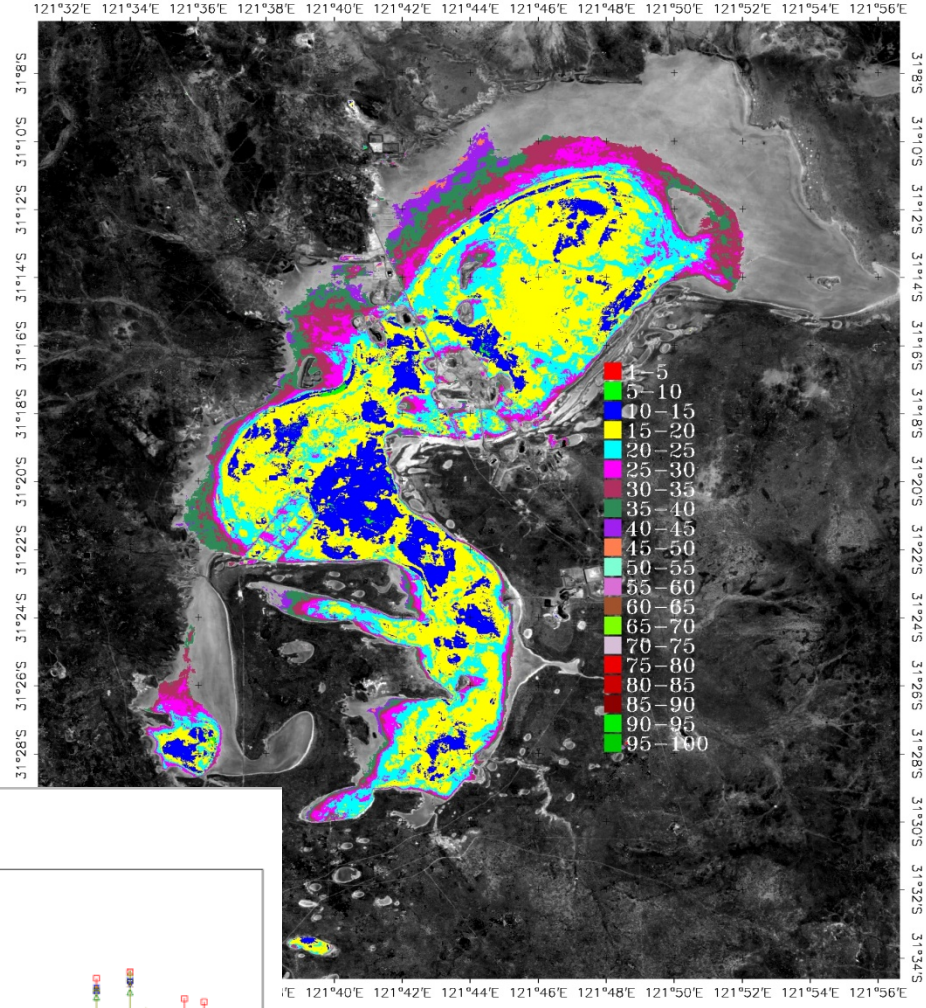
CSIRO

Lake Lefroy temporal variations (coefficient of variation)



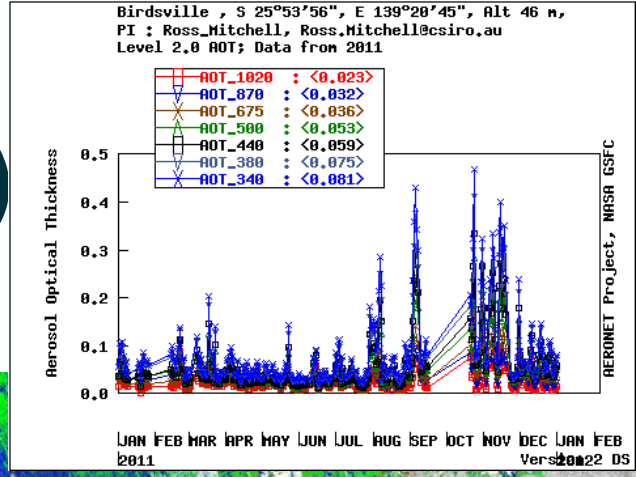
VNIR-SWIR

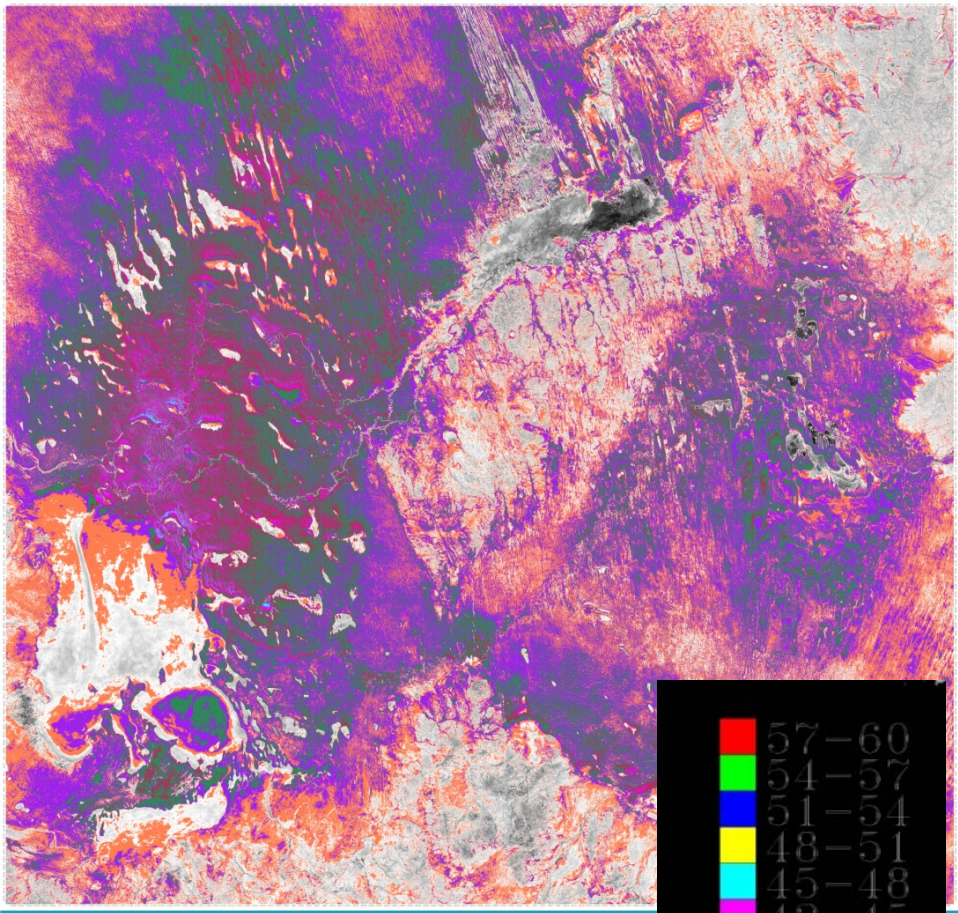




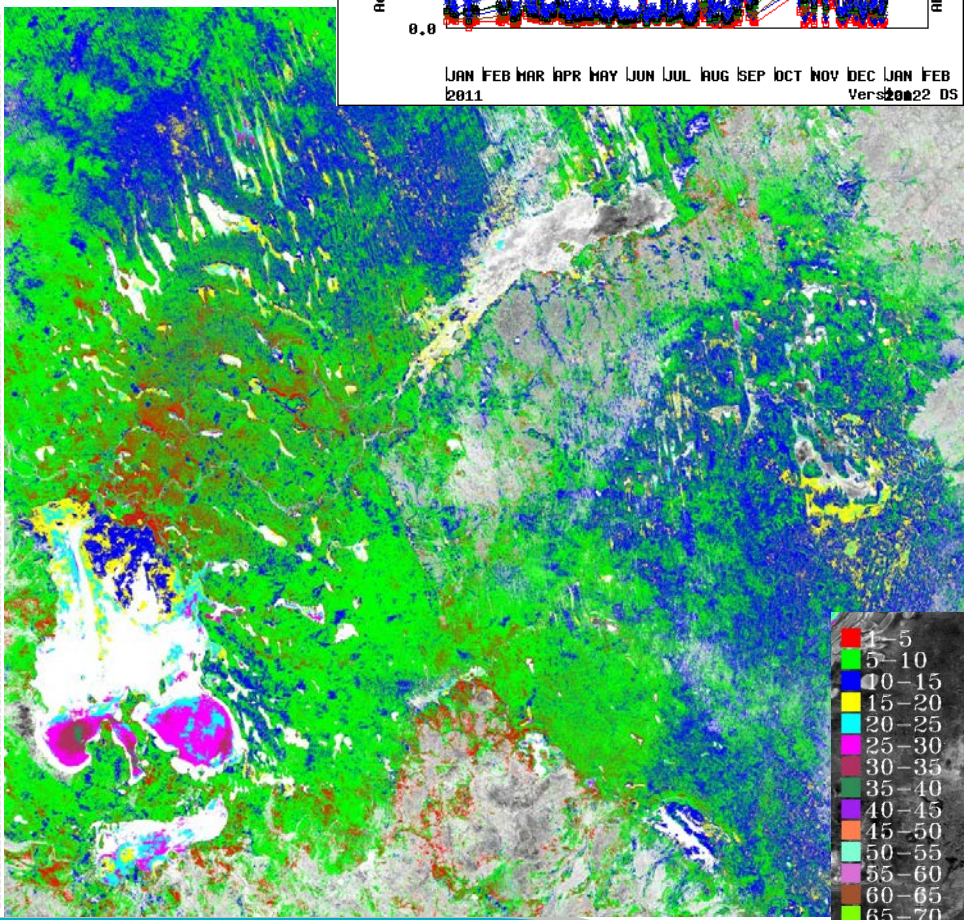
VNIR

Desert temporal means and coefficient of variations (VNIR-SWIR)





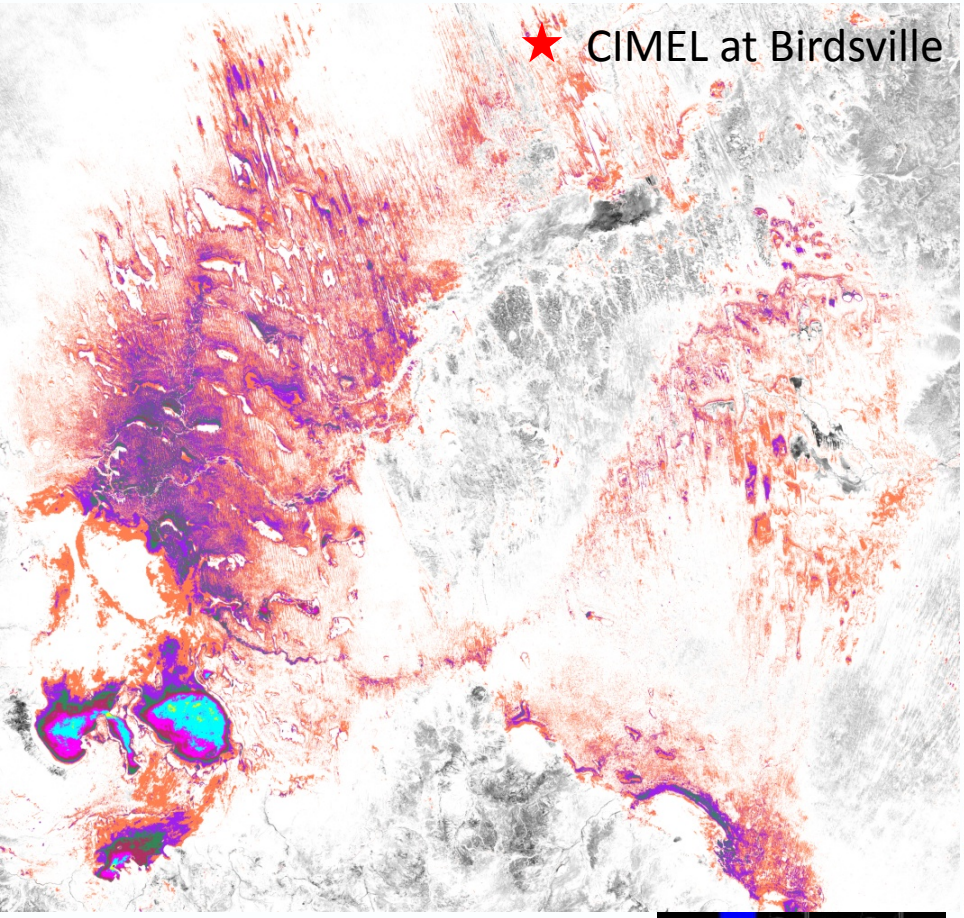
Means



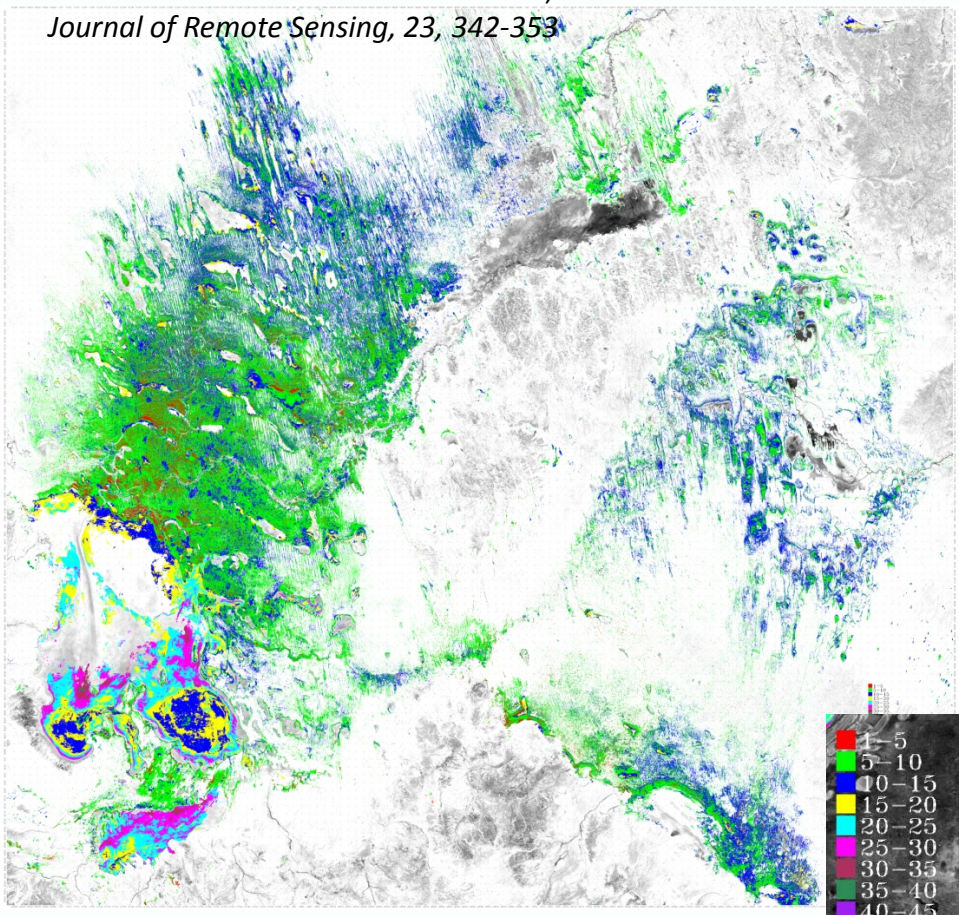
Coefficient of variation

Desert temporal means and coefficient of variations (VNIR)

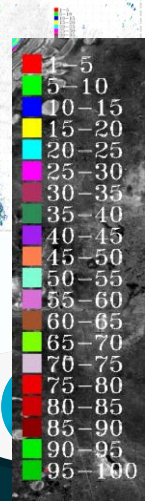
Mitchell, R.M., O'Brien, D.M., Edwards, M., Elsum, C.C., & Graetz, R.D. (1997). Selection and initial characterisation of a bright calibration site in the Strzelecki Desert, South Australia. *Canadian Journal of Remote Sensing, 23, 342-353*



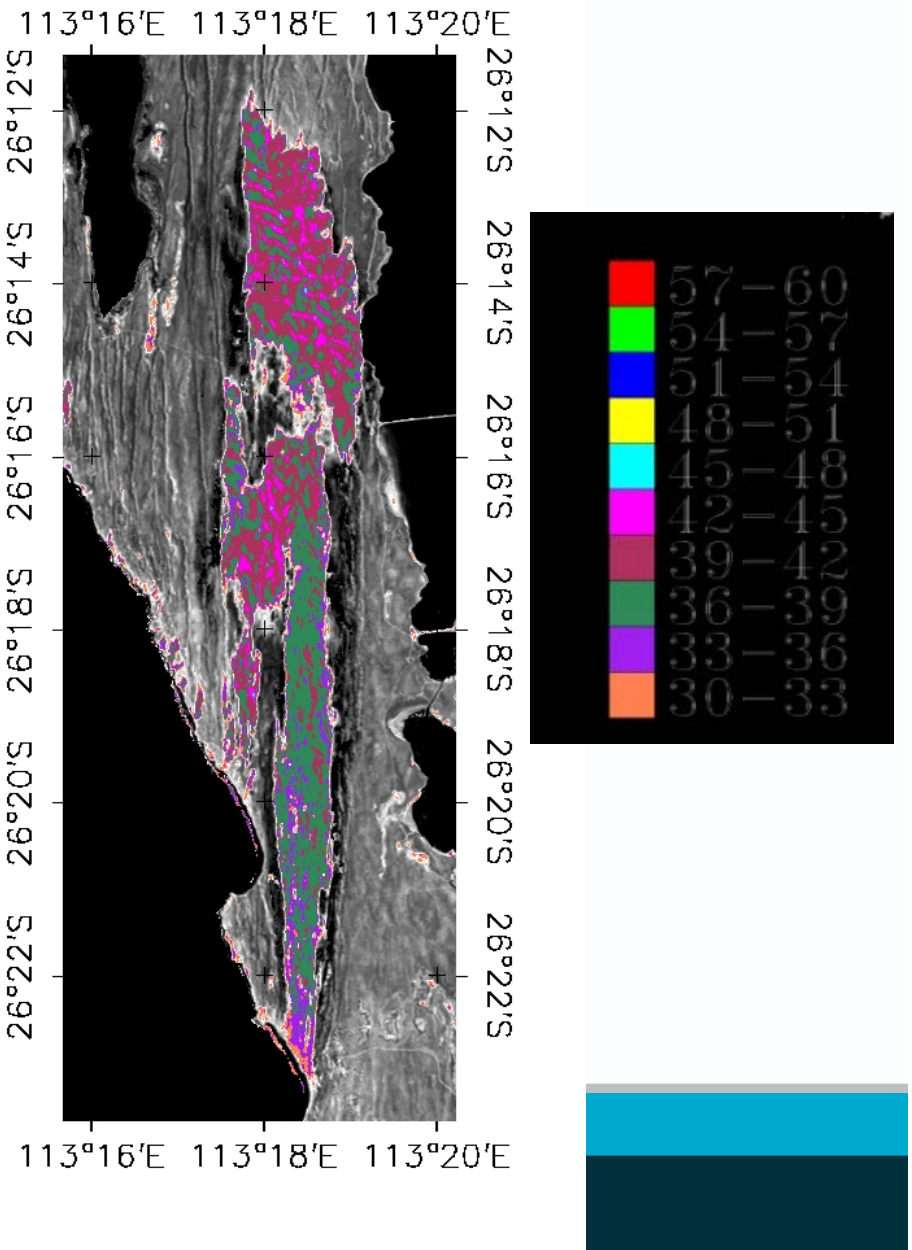
Means

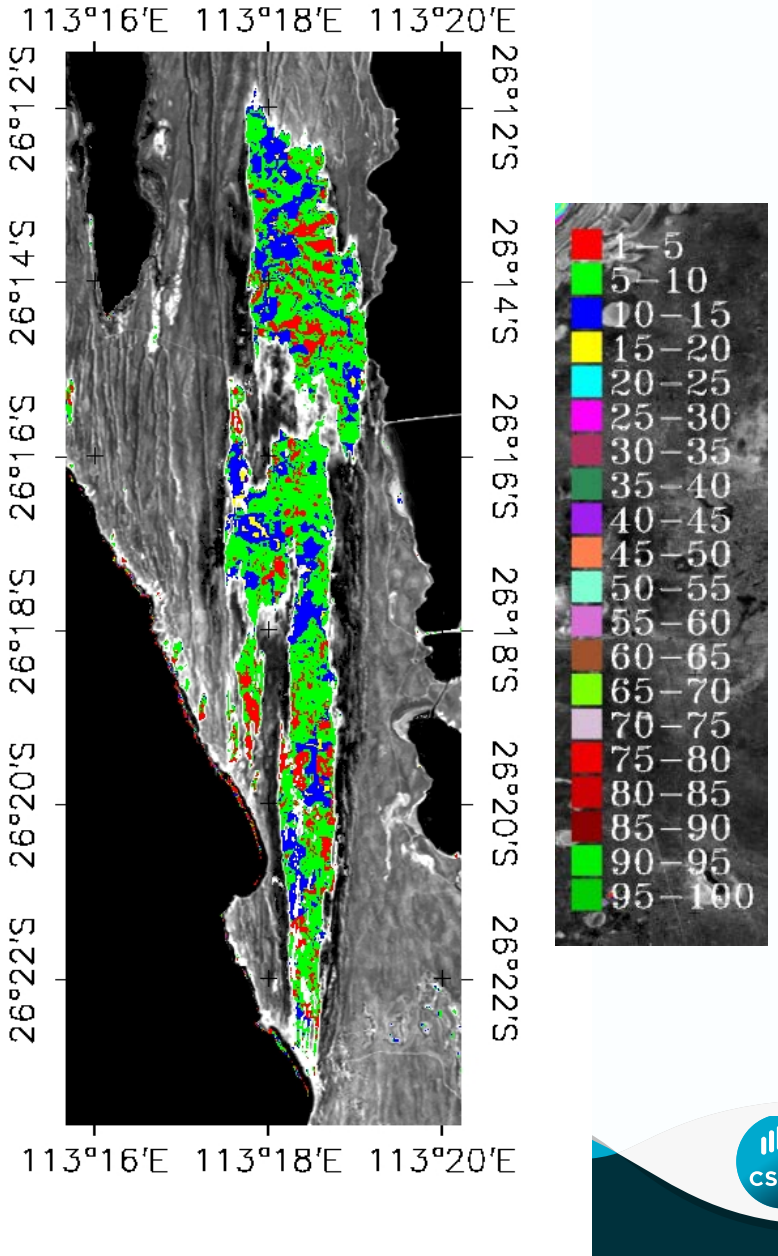


Coefficient of variation



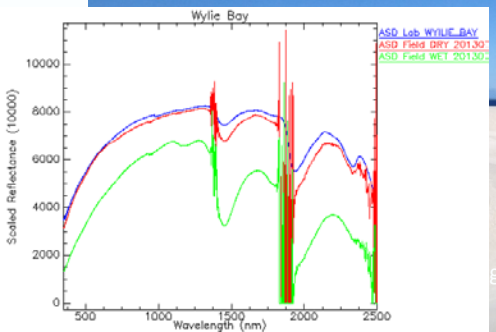
Coastal sand

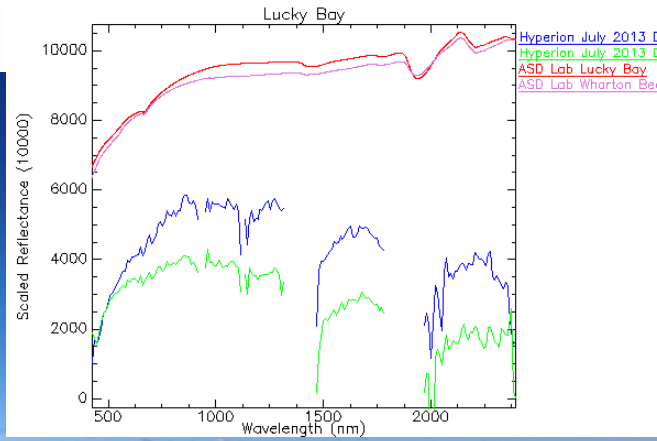




Pure Quartz Sand?

1. Investigated potential new vicarious calibration site
   - Esperance
   - Wylie Bay Sand Dunes
   - Wharton Bay Beach
   - Lucky Bay Beach (whitest sand)
   - Collected 4 buckets of samples (1 Wharton, 2 Wylie, 1 Wharton, I Lucky)
   - Analysed mineralogy of samples: VIS-SWIR, TIR, XRD, Cathode Luminescence (fluorescence of carbonate minerals (aragonite and calcite)), LOI experiments





Some insights

Salt lakes

- Most salt lakes are similar with high spatial homogeneity (overall within 6% for VNIR-SWIR and 9% for VNIR with large patches of within 3% reflectance difference);
- Temporal variations are higher than coastal and inland sand sites (lakes are mostly <25% difference for VNIR. NB. This is between dates not reflectance) ;
- Meets albedo threshold criteria (>30%) for VNIR but signal low for SWIR (water);

Coastal sands

- Spatial homogeneity not as good as salt lakes (up to 15% reflectance value difference);
- Temporal variations low (<10%);
- Meets albedo threshold criteria for all wavelengths;
- Have to consider issues related to aerosols, spatial extent and topography;

Inland sand dunes/deserts

- Spatial homogeneity similar to coastal sands (up to 12% reflectance value difference);
- Temporal variations low similar to coastal sands;
- Meets albedo threshold criteria for all wavelengths;
- Have to consider issues related to access/remoteness and topography;

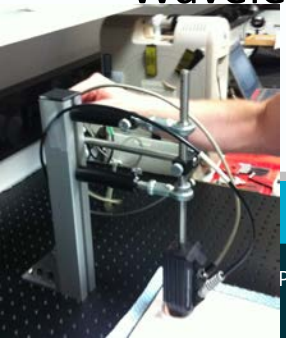
CSIRO calibration and validation laboratories in East and West of Australia

Instrumentation, mirrored at each facilities at Canberra and Perth:

- Calibrated, stable current power supply (Precision current source Gooch and Housego)
- Calibrated irradiance source (OL-FEL-C lamp)
- Calibrated radiance source (Custom 20 inch integrating sphere Labsphere)
- Calibrated 99% reflectance targets (Spectralon™ Labsphere)
- Optical breadboard and mounting accessories
- ASD FieldSpec spectroradiometers (Mk2,3,4)
- ASD Contact probe measurement apparatus
- Calibrated wavelength standards (doped

(rare earth and talc) sintered Fluorilon by Avian Tech

- Wavelength calibration lamps (HgAr)

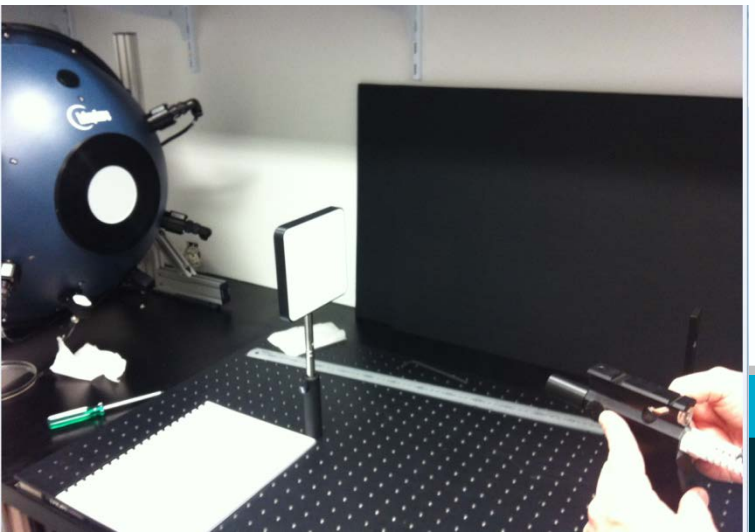


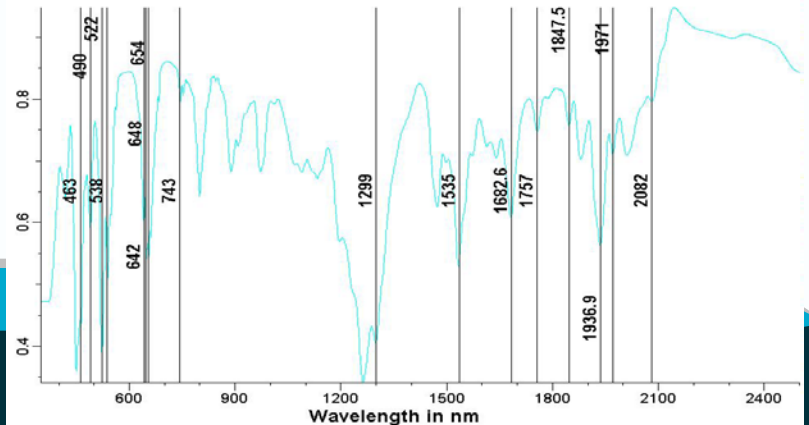
Calibration and validation laboratories – protocols

(Ian.Lau@csiro.au;Nandika.Thapar@csiro.au)

Protocols have been written for

- Spectrometer baseline calibration
- Spectrometer performance (SNR, NER, NEdL, wavelength)
- Reflectance target checking and calibration
- Cross calibration of reflectance targets
- Cross calibration of irradiance and radiance sources





Summary

- Significant infrastructure already exist;
- Southern hemisphere advantages;
- Good climatic conditions for a large part of the country;
- Large expanse of land away from “interferences”; temporal analysis shows quite a number of potential sites that will be further investigated;
- Significant capabilities and experience;
- Backed up by NEOS-IP (approved by Australian government).

Vicarious Cal - Lake Lefroy ongoing upgrade

Climate

- rainfall @ Kambalda (on lake shore) mean 266.2 mm, lowest 13.7 mm (June), highest 69.5 mm (January);
- Temperature @ Kalgoorlie (60 km away) mean 25.3°C, highest 33.6°C (January), lowest 16.7°C (July);
- average number clear days is 151.1, annual average cloudy days 89.2.

Landscape/Landform

- medium-sized playa lake within Lefroy Palaeodrainage on Yilgarn Craton of Western Australia;
- bed of Lake Lefroy is extremely flat, mean elevation of the lake bed approximately less than 286 m, crust is halite up to 10 cm thick, but often no more than 1-2 cm in thickness. Halite covers approximately 64% of the lake bed, the crust becomes thinner towards the lake shore and lake islands.

Vegetation

- No vegetation on lake bed but surrounding vegetation consists of 50 vascular plant species with the predominant families of species being Chenopodiaceae, Asteraceae, Aizoaceae, Poaceae, Portulacaceace and Frankeniaceae.

Instrumentation

- CIMEL (on Aeronet);
- Weather station (to be upgraded this year);
- Cosmic Ray probe (moisture);