



Geoscience Australia Report on Cal/Val Activities

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Geoscience Australia

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Working Group on Calibration and Validation





Overview

1. Update on calibration / validation activities at GA
2. National initiatives
3. International collaboration





Earth Observation at Geoscience Australia



SECURING
 AUSTRALIA'S
 WATER
 RESOURCES

MANAGING
 AUSTRALIA'S
 MARINE
 JURISDICTIONS

PROVIDING
 FUNDAMENTAL
 GEOGRAPHIC
 INFORMATION

MAINTAINING
 GEOSCIENCE
 KNOWLEDGE
 AND CAPABILITY

BUILDING
 AUSTRALIA'S
 RESOURCE
 WEALTH

ENSURING
 AUSTRALIA'S
 COMMUNITY
 SAFETY

Improve the frequency, reliability, quality and impact of Earth observations for Australia

Working Group on Calibration and Validation



CEOS WGCV ACIX Workshop #1

- Geoscience Australia participated in the 1st ACIX Workshop in June 2016
- GA-PABT module is a coupled atmospheric, BRDF and terrain illumination correction module
- Based on primary inputs of Landsat data pre-processed by LPGS and Sentinel-2 L1C tiles; aims to provide consistent products suitable for time series analysis
- Outputs are: (i) Lambertian surface reflectance; (ii) BRDF corrected surface reflectance normalized to a nominated solar angle in low relief areas; (iii) terrain illumination corrected surface reflectance product in higher relief areas

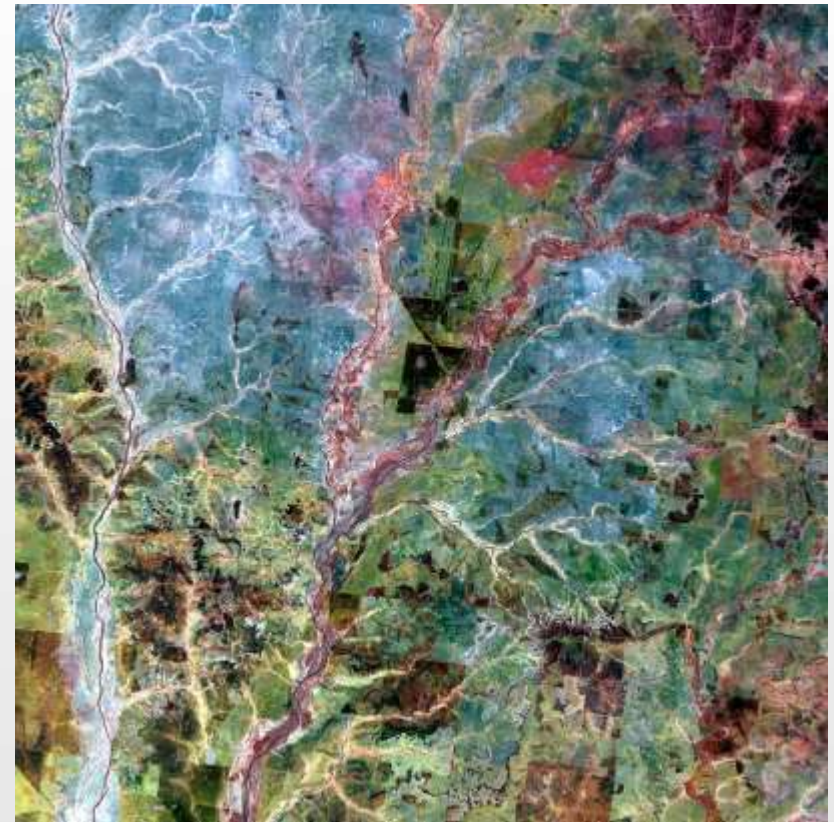
Li, F., Jupp, D.L.B., Reddy, S., Lymburner, L., Mueller, N., Tan, P. and Islam, A. (2010). An evaluation of the use of atmospheric and BRDF correction to standardize Landsat data. *The IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 3, 257-270

Li, F., Jupp, D.L.B., Thankappan, M., Lymburner, L., Mueller, N., Lewis, A. and Held, A. (2012). A physics-based atmospheric and BRDF correction for Landsat data over mountainous terrain. *Remote Sensing of Environment*, 124, 756-770



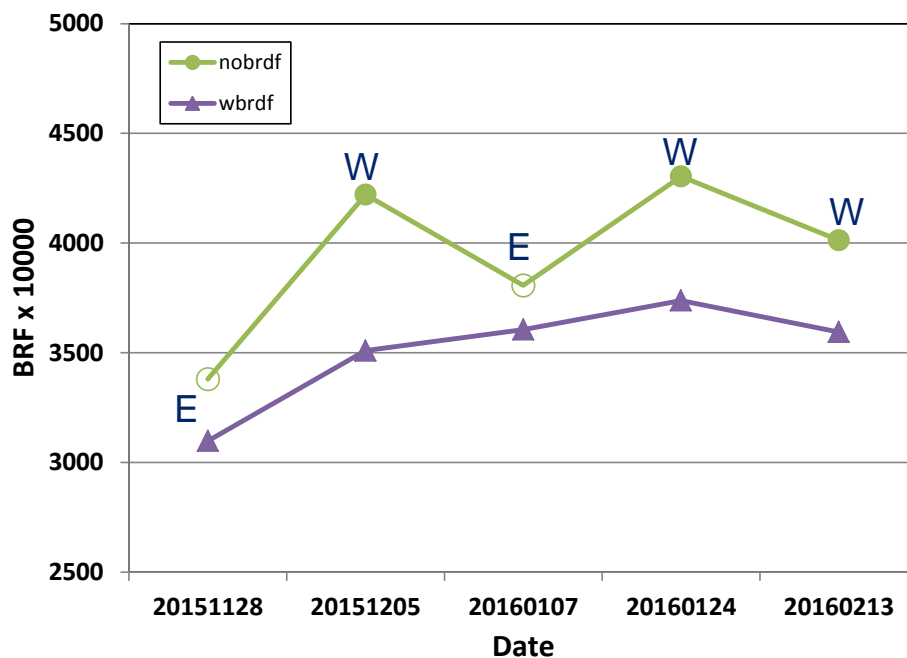
Sentinel-2 Surface Reflectance

- Based on workflow developed for Landsats 5, 7, 8
- Sentinel-2 surface reflectance products for time series analysis, including:
 - atmospheric correction
 - normalization to nadir view, and 45 degree solar angle
 - terrain illumination correction





BRDF correction: combined view and solar angle effects for Sentinel-2 data, Queensland, Australia



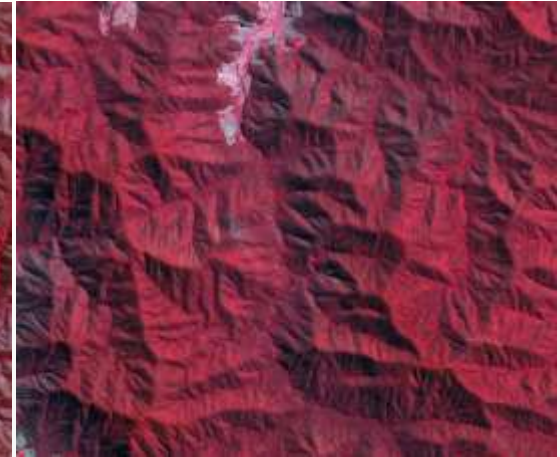
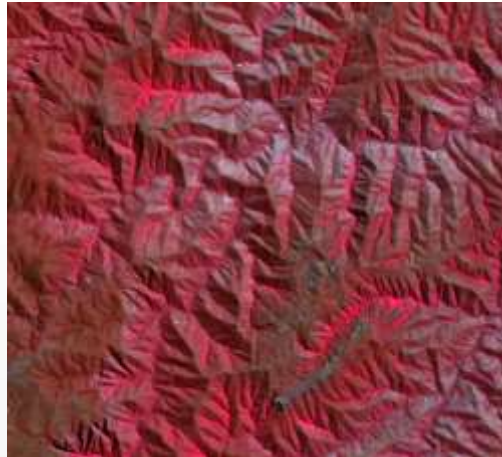
Date	Solar Zenith (°)	View Zenith (°)	View azimuth (°)
20151128	19.3	8.4	279.3 (E)
20151205	22.8	10.	99.3 (W)
20160107	24.1	8.4	279.3 (E))
20160124	28.2	10.1	99.3 (W)
20160213	30.5	10.1	99.3 (W)

E: East edge of the satellite scene
W: West edge of the satellite scene)

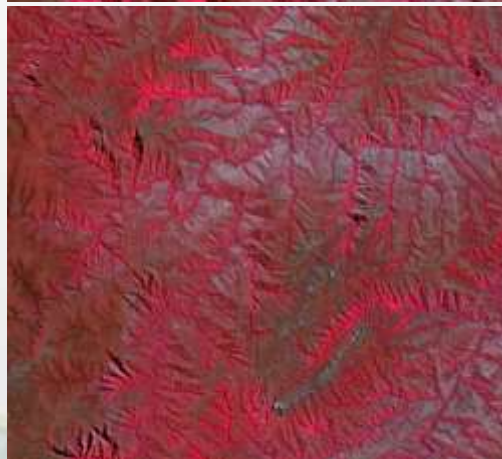


Terrain correction of Landsat 8 and Sentinel-2

Without terrain
 correction



With terrain
 correction



Landsat 8 (20131011, $\theta_s \sim 38^\circ$)
 images in the Blue Mountain area
 (residual features are nulls for cast
 shadows)

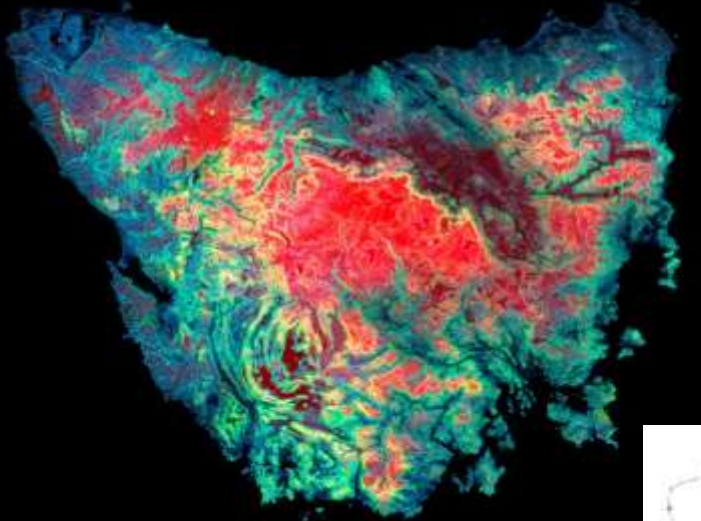
Sentinel-2 (20160314, $\theta_s \sim 45^\circ$)
 images in the Australian Alps
 (residual features are cast shadows
 and terrain details not in the DSM)



Terrain Illumination Correction with TanDEM-X IDEM

- IDEM 12/30 used for terrain illumination correction
- Results from IDEM were compared to that from SRTM

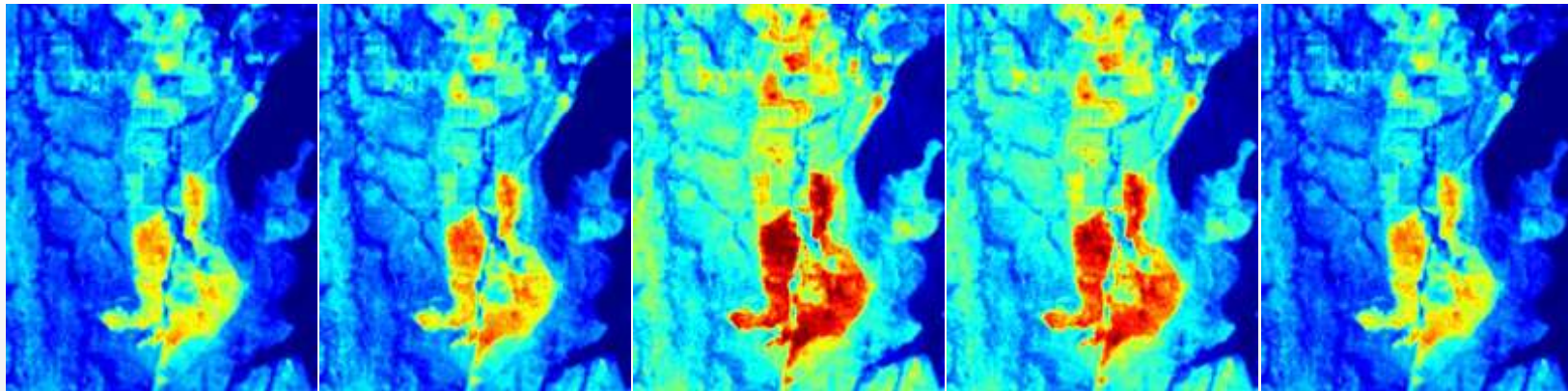
Terrain altitude, slope and curvature based on IDEM30 data and SRTM30 data in the areas where IDEM data was not available, and water areas masked





Land Surface Brightness Temperature (K) from Landsat

Li et al., MODSIM 2015 Land surface brightness temperature retrieved from Landsat data



Balloon

NCEP1

NCEP2

MERRA

ECMWF

300 305 310 315 320

- NCEP1, NCEP2, MERRA and ECMWF generally give satisfactory T_B products meeting 1 K accuracy demanded by many practitioners
- The ECMWF data set performs best; Root Mean Square Difference (RMSD) for 9 days and 3 test sites are within 0.4 K compared to T_B products estimated using ground-released radiosonde measurements.



Update on National Spectroscopy Database



- Development of Aus-SPECCHIO, a spectroscopy database was led by University of Wollongong (UoW), supported by ANDS funding.
- A useful national resource for calibration and validation
- Consolidation of versions has been completed; plan to migrate Australian instance of SPECCHIO from UoW to GA is being discussed
- Long-term management plan is aligned with GA's role as the custodian of national EO datasets.



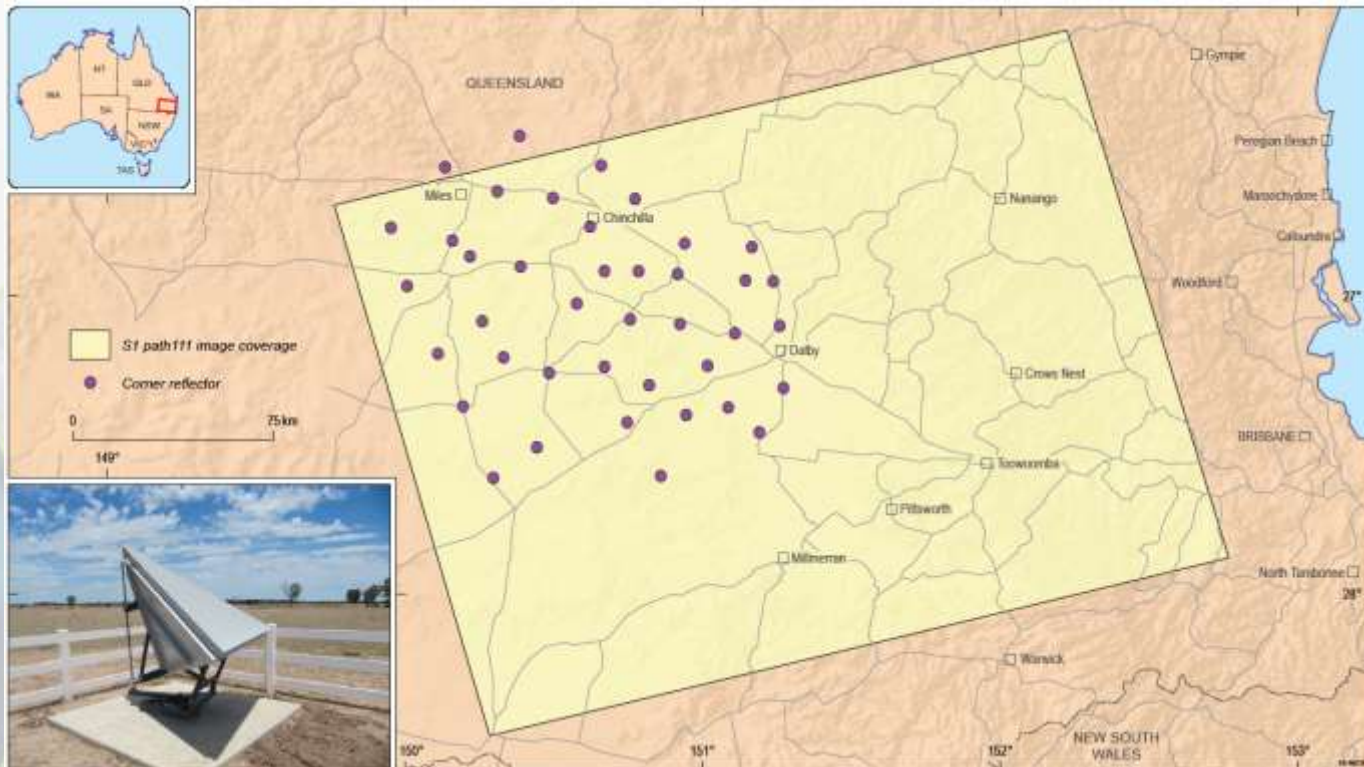
Corner Reflectors for SAR Calibration

- 40 CRs of 1.5, 2.0 and 2.5m sizes deployed in Queensland, Australia; some CRs individually characterised for RCS; designed to support SAR calibration
- Ongoing data acquisition over array with X, C and L-band SAR systems for calibration (TerraSAR-X, Sentinel-1, ALOS-2, RISAT)
- Sentinel-1A radiometric calibration (IW and SM): stability of CRs assessed for VV and HH; RCS variability attributed to CR elevation / azimuth offsets with boresight
- Sentinel-1A geometric calibration IW and SM: scatter plots for SM and IW are similar; some observed anomalies are being investigated
- The 2.0m / 2.5m CRs are optimally oriented for ongoing calibration of ALOS-2; flexibility to support specific missions
- ISRO/NASA interested in using CRs for the NISAR mission



Permanent Location of AGOS CRs

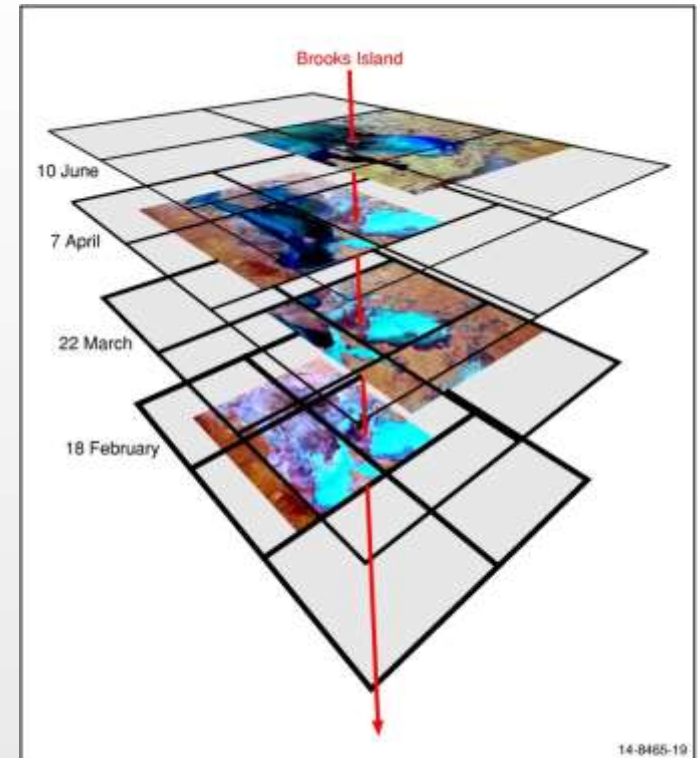
- 40 corner reflectors spread over 100km x 100km
- Details of individual CR sites available from the Point and Distributed Targets Database maintained by the CEOS WGCV SAR Subgroup at http://sarcv.ceos.org/targets/target_group/4/





Australian Geoscience Data Cube - Update

- All Earth Observation data are calibrated to surface reflectance observations and to a standard spatial grid framework
- The consistent data standard and high speed processing access in the AGDC enables one analysis to be applied to every observation through space and time
- This enables continent-scale analyses of environmental features through time
- Collaboration between GA, CSIRO and ANU - NCI



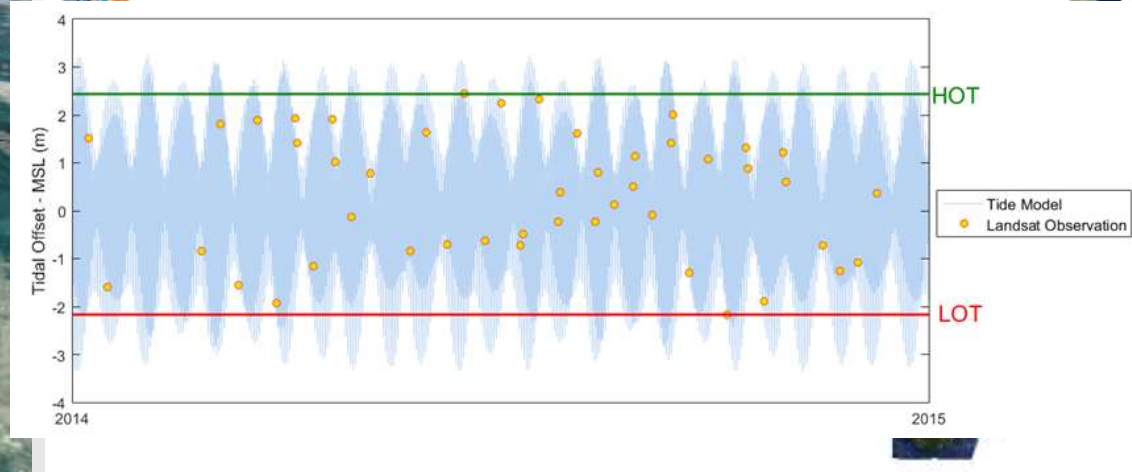
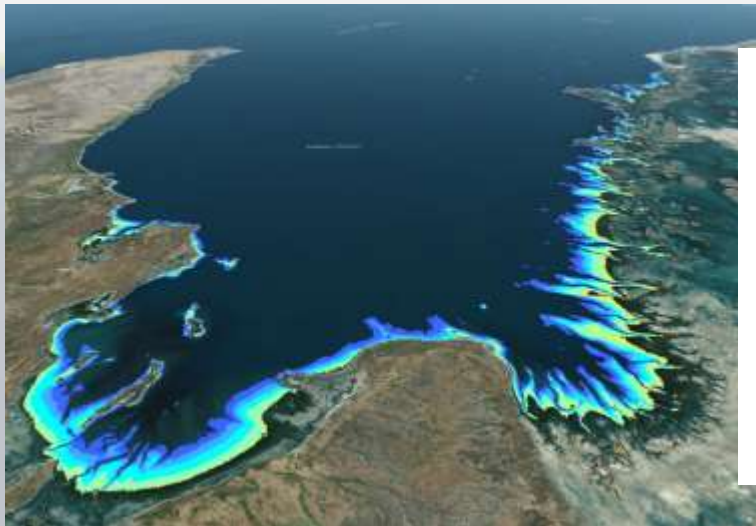
Lake Eyre from February to June 2011



Data Cube: Intertidal Extents Model (ITEM v1.0)

Sagar et al. 2016 In Prep.

The Intertidal Extents Model (ITEM v1.0) product is a gridded dataset characterising the spatial extents of the exposed intertidal zone, at intervals of the observed tidal range. The current version (v1.0) utilises all Landsat observations (5,7, and 8) for Australian coastal regions (excluding off-shore Territories) between 1987 and 2015 (inclusive)





AGDC v2 development

Including but not limited to:

- NetCDF4-CF1.6 storage support (GeoTIFF in v1)
- multiple sensor support / blending capability
- multiple dimension support
- GUI / pixel drill / data interaction and retrieval
- cross platform support
- support for existing v1 API functions and workflows
- analytics and execution engine
- extensible ingest and access
- native support for basic provenance

AGDC Web: <http://www.datacube.org.au>

AGDC Wiki: http://www.datacube.org.au/wiki/Main_Page

Code repository: <https://github.com/data-cube/agdc-v2/tree/develop>

Read the docs: <http://agdc-v2.readthedocs.org/en/develop/>

Command line tools: <http://agdc-v2.readthedocs.org/en/develop/tools.html>

datacube-search, datacube-config, datacube-ingest

Australia's Regional Copernicus Data Access/Analysis Hub

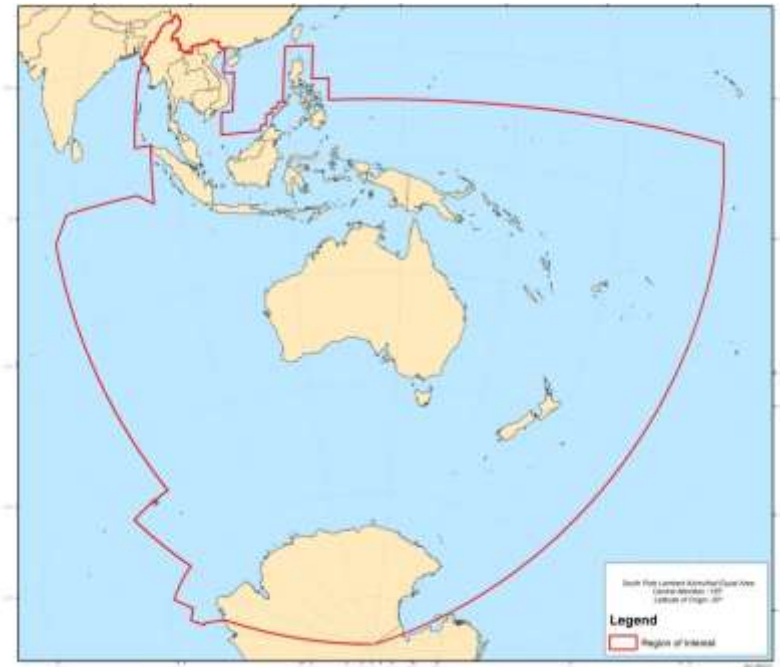
An integrated 'Team Australia' approach to Support government information requirements.

Support the broader objective of enhancing access to satellite Earth observation data by research, industry and civil society.

Facilitate collaboration between Australians, Europeans and inhabitants of the South-East Asia-South Pacific region in exploitation of Earth observation data.

Benefits for: Australia, the region, EC/ESA/EUMETSAT, and the global satellite EO community.

All Sentinel Products For



Supporting

Consortium

Partners

Collaborators



EO Calibration & Validation in Tasmania

- The **Tasmanian Land Cover Program** is currently partnered with the Queensland Remote Sensing Centre (QRSC) to deliver and exploit Landsat and Sentinel data products
- A strategic field campaign is due to commence over the 2016 – 2017 summer period (December – March) aimed at calibration/validation of processed products supplied via the QRSC processing system i.e. Fractional Cover and Foliage Projective Cover. Initially around 10 - 15 sites will be surveyed with a similar number to be added each year thereafter
- A stratified random sampling approach has been adopted to identify the most beneficial sites for sampling. Primary selection parameters are; accessibility, vegetation type, soil properties and landscape position
- Field survey will follow the SLATS Star Transect protocol and will be timed to coincide with Landsat and/or Sentinel overpass as far as practicable within given time and weather constraints



2700+ 1ha Vegetation Cover Transect Sites

Used for operational Landsat, MODIS and Sentinel 2 products:

Fractional cover

Tree cover

Ground cover

Supported by State and Federal government
Average cost of \$1000 each.

Ongoing. NT has collected 1234 sites as of last week.
Vic and Qld currently collecting data coincident with Sentinel 2

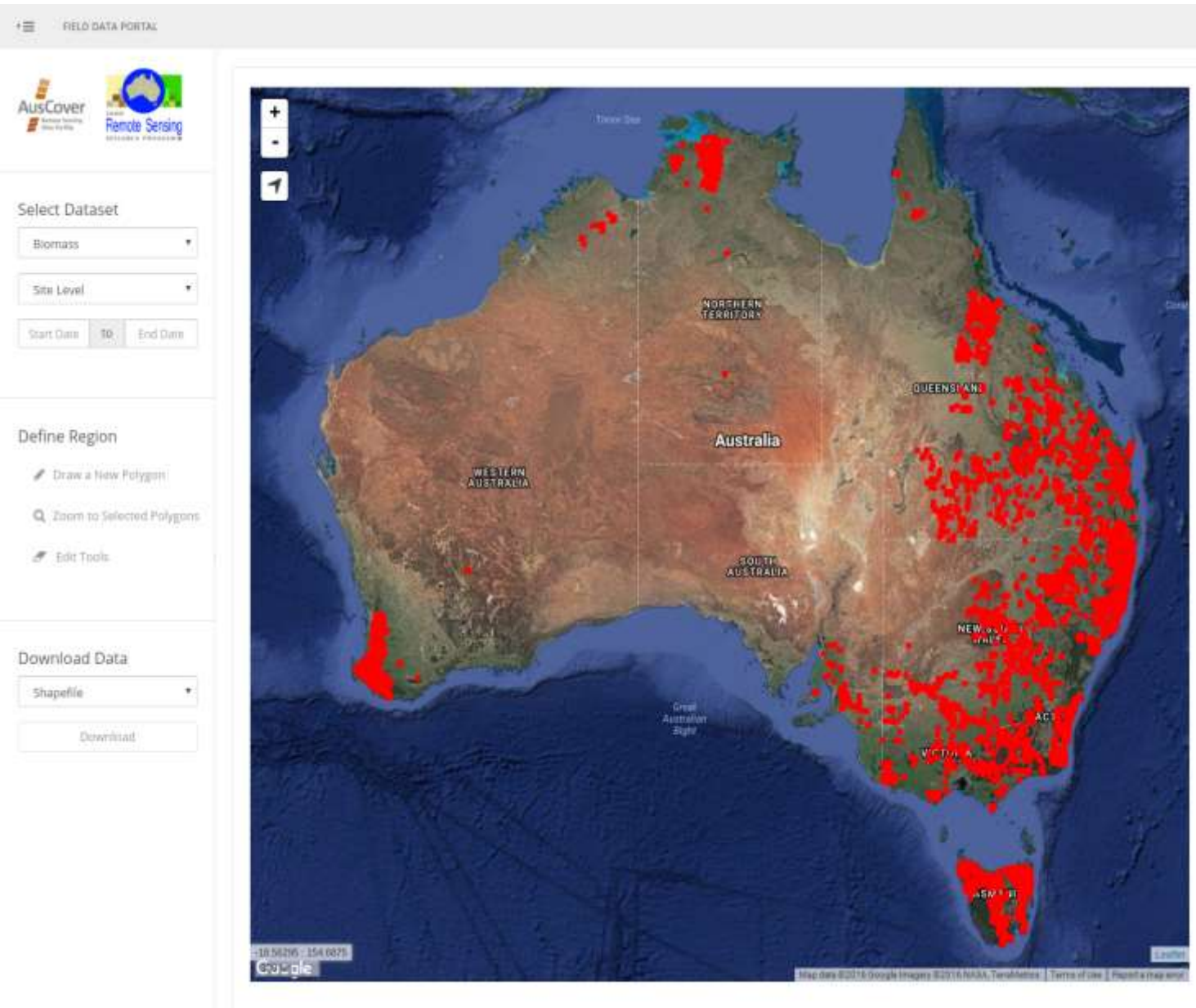
National Fractional Cover Field Sites

Field Sites

- < 3% Bare
- 3% - 10% Bare
- 10% - 25% Bare
- 25% - 50% Bare
- > 50% Bare



15,000 Biomass Plots



Comprising over
1,000,000 tree
samples

Complied with
cooperation from
governments and
researchers
across Australia

Supported by
JAXA K&C
Initiative

Freely accessible
and downloadable
from the
AusCover Field
Portal



International collaboration

- European Space Agency (ESA): Collaboration on cal/val, next telecon planned for 10 October 2016 to discuss areas of collaboration for MoU chapter on cal/val; hosting Pandora Spectrometers; work on geometric calibration with corner reflectors dedicated for Sentinel-1 (joint work with DLR / University of Zurich)
- USGS: Collaboration on the AGDC; GA is represented on the Landsat Science Team
- NASA: Kenya Cube; Landsat Project Office is gathering requirements from the user community for Landsat 10, GA will coordinate inputs through the Australian Earth Observation Community Coordination Group





‘SAR’ Data Cube

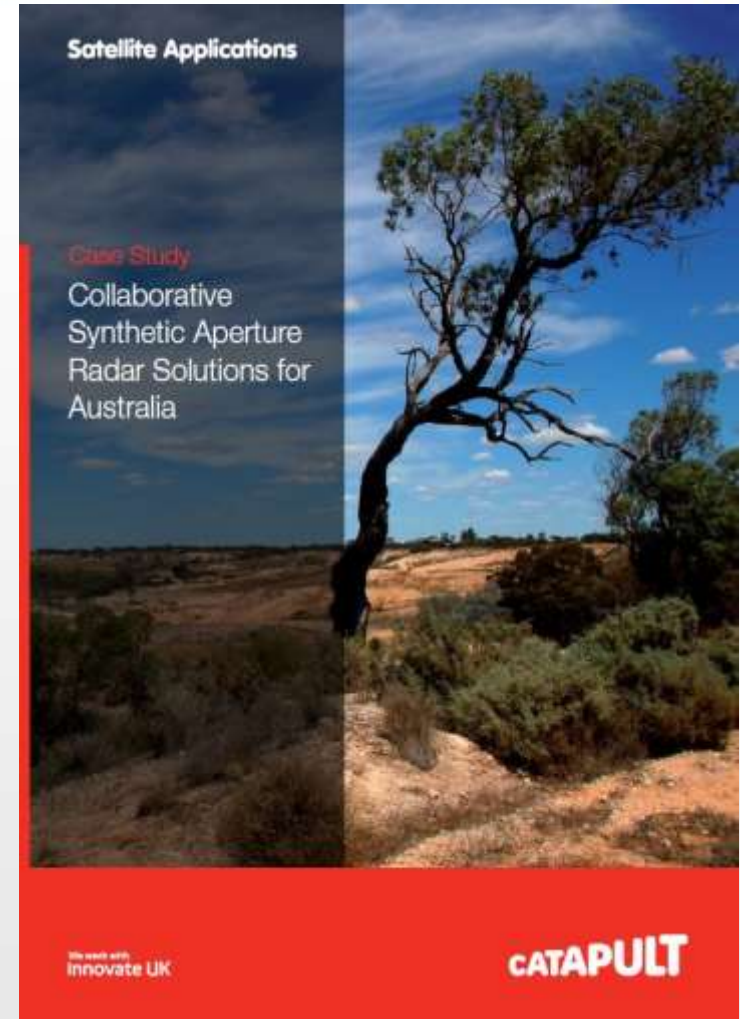
Geoscience Australia, the UK Satellite Applications Catapult, and NPA Satellite Mapping collaborated to assess the viability of building a “Data Cube” for the storage and analysis of Synthetic Aperture Radar (SAR) data.

One of the key components being, well corrected, consistent data that can be analysed regardless of when or where it was acquired.

The project was able to demonstrate synergistic use of SAR data for surface water mapping with optical data in a data cube environment

<https://sa.catapult.org.uk/wp-content/uploads/2016/07/C223925-Collaborative-SAR-CS-4WS.pdf>

Working Group on Calibration and Validation





Thank you

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41st Plenary Meeting CEOS Working Group on Calibration & Validation,
Tokyo, Japan 5-7 September 2016