



# The Australian DataCube and Carbon Accounting

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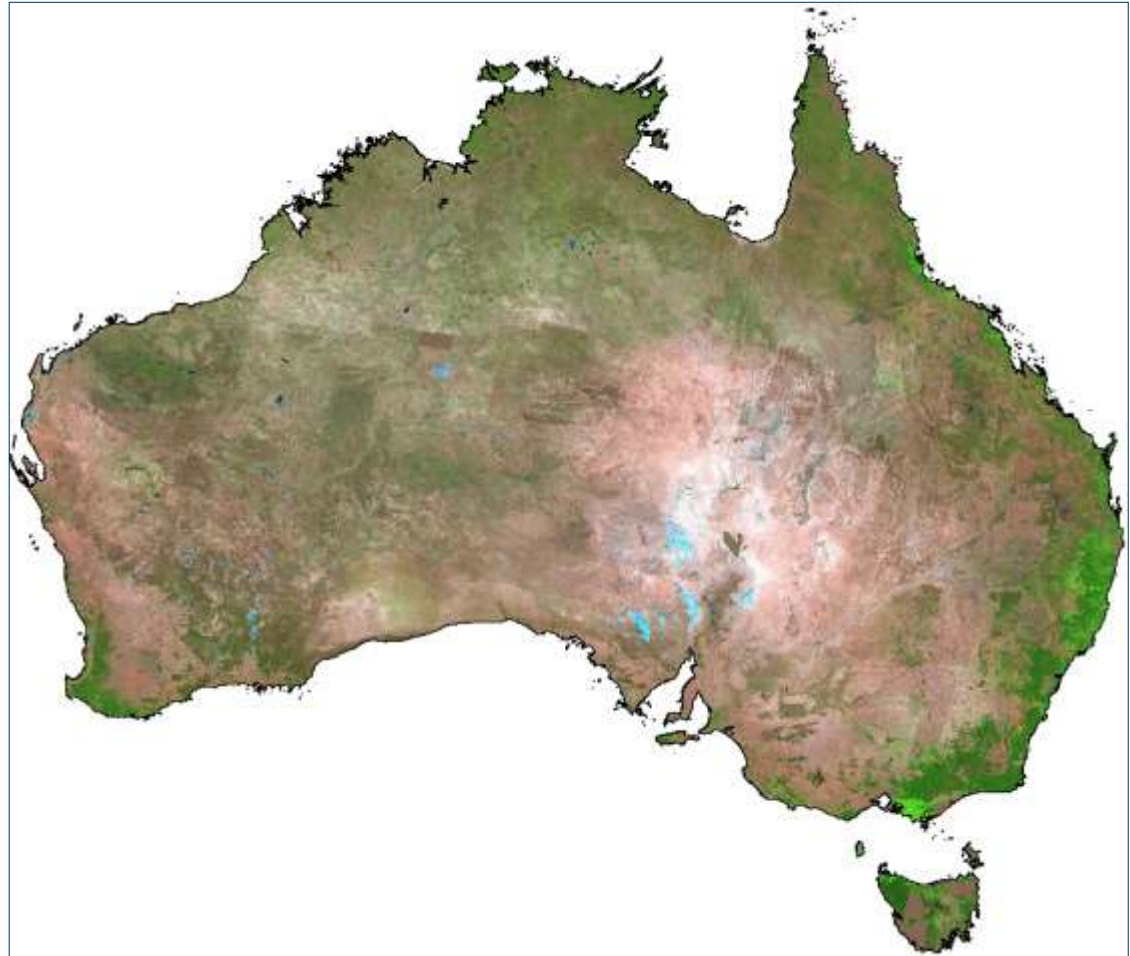
LAND AND WATER  
[www.csiro.au](http://www.csiro.au)



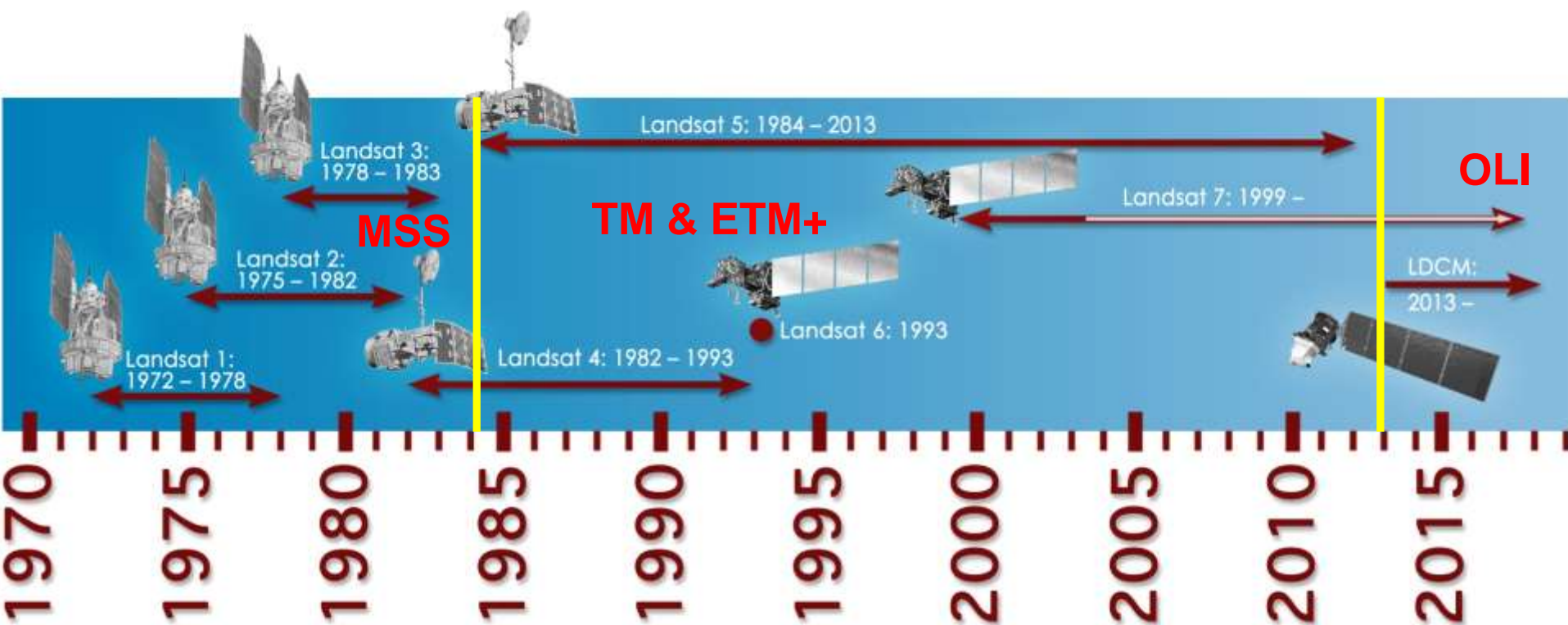
# The Australian National Carbon Accounting System uses Satellite Data to Detect Land Clearing and Regrowth

As part of the annual Greenhouse Gas report to the UN-FCCC, Australia undertakes continental scale monitoring of forest cover using remote sensing data at 25-meter resolution every year.

Landsat time series data from 1972-2015



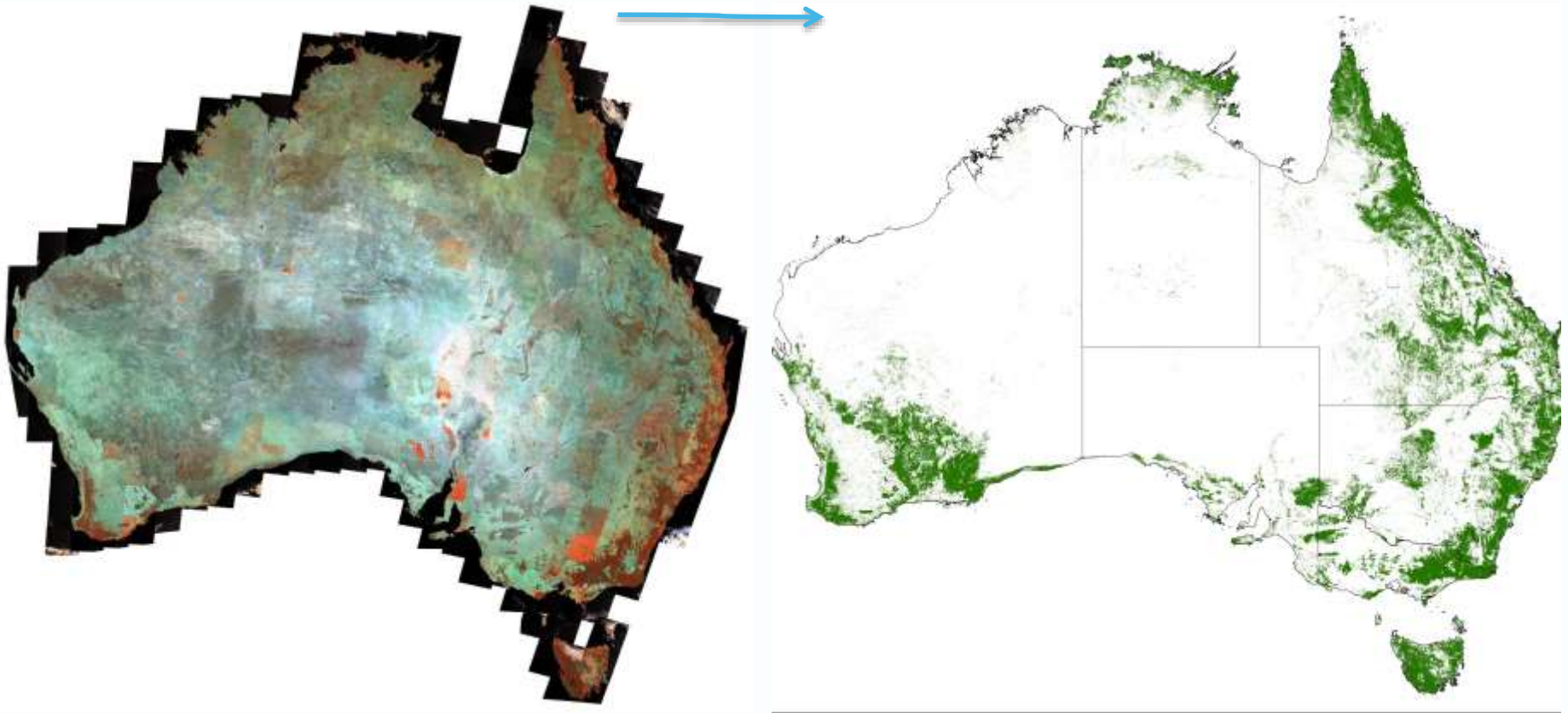
# National Carbon Accounting Systems require Data Continuity of time-series at suitable spatial resolution



- 8 Landsat satellites (NASA – USGS)
- Two major sensor changes over the inventory time series
  - MSS to TM transition
  - TM / ETM+ to OLI



**System uses ~ 400 Landsat scenes per year to map forest cover and change across 7.5 million km<sup>2</sup> for last 19 years**



Source: Australian Department of Environment & CSIRO



Australian Government

# *Goal is to map changes in forest cover at sub-hectare basis across the continent*



1995

conversion

2000

Mapping of Forest change: **Deforestation and re-forestation**





Native Forest

Fire

Post-Fire  
Regrowth

Clearing

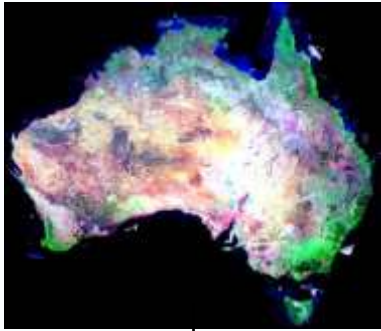
Fire

Regrowth

Harvesting



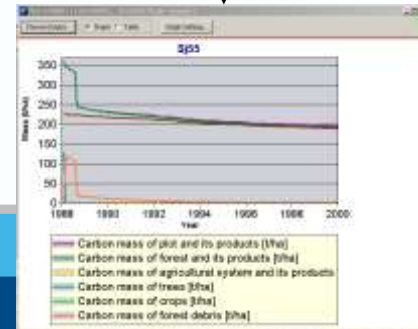
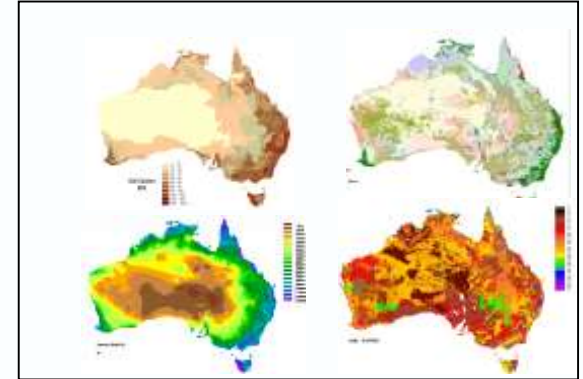
Input - remote sensing – forest cover change



Input - land management information



Input – climate data

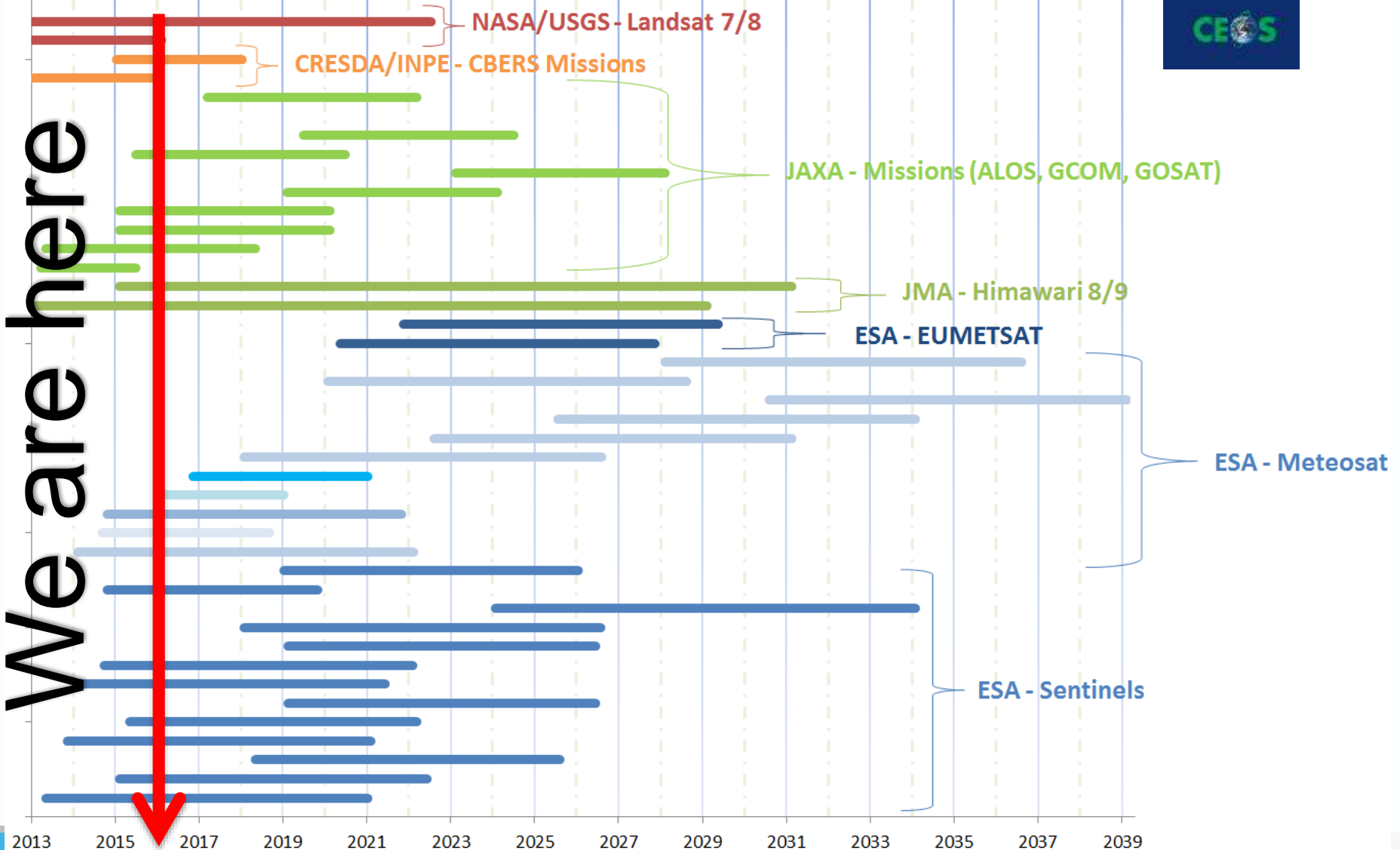


Carbon stock outputs

# Challenge: How best to integrate multiple satellite data streams to enrich the Landsat data

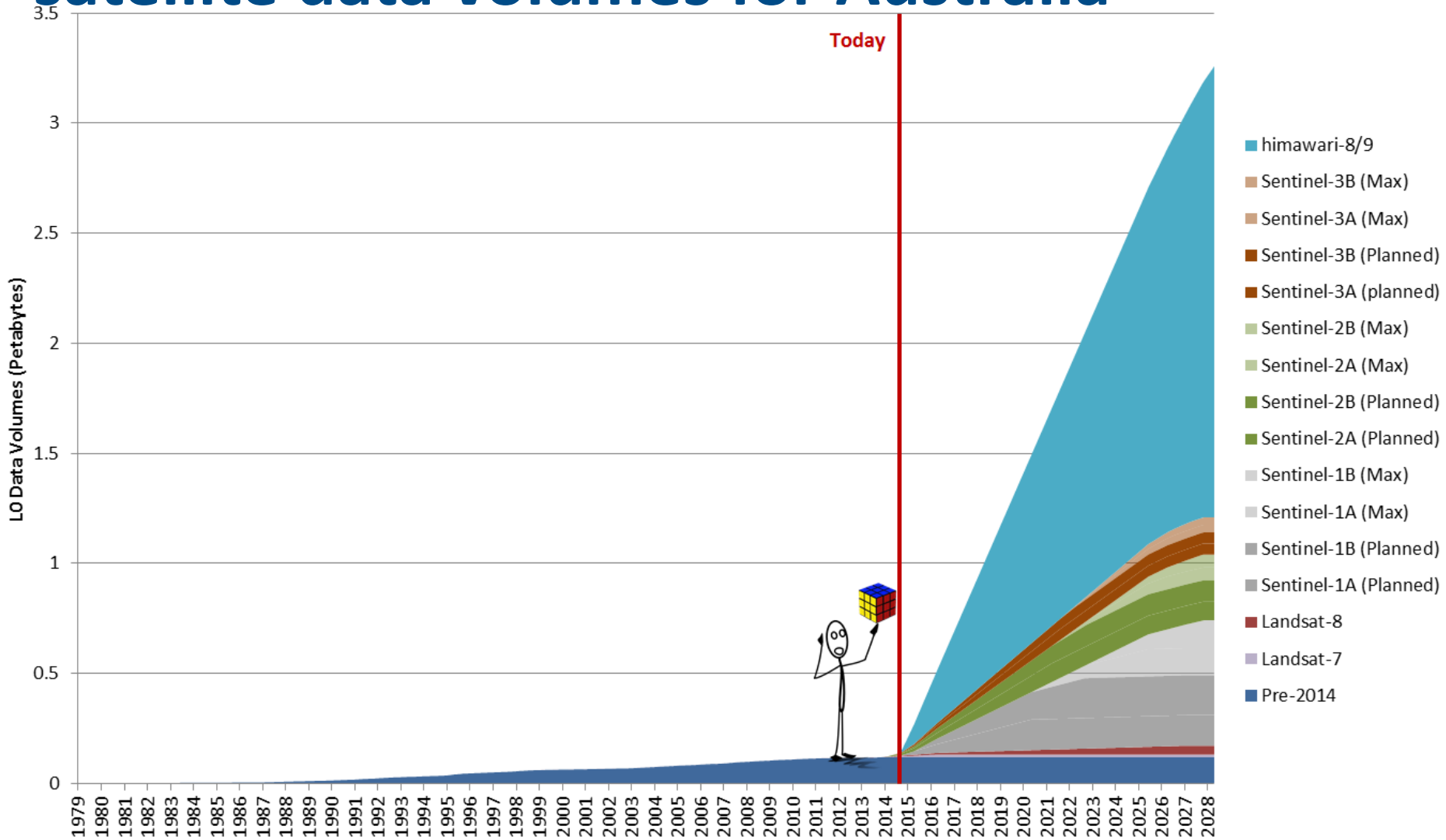


We are here





# How to efficiently managed massive satellite data volumes for Australia

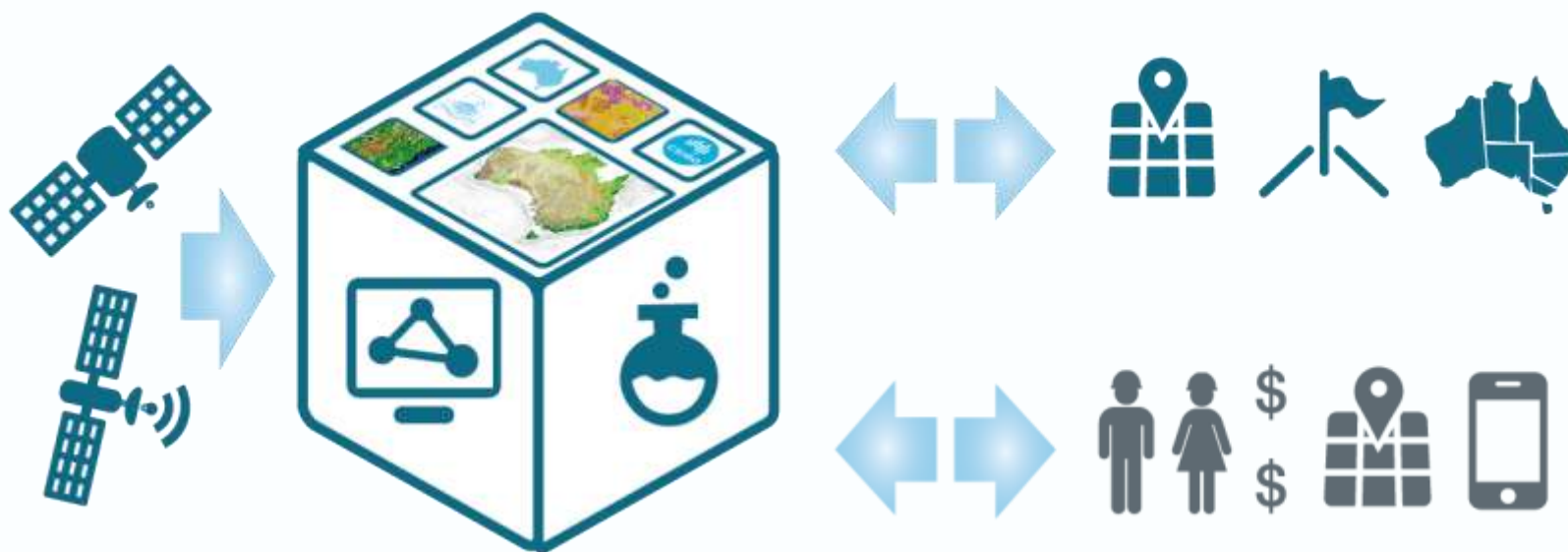


# Traditional remote sensing product process - now everyone





**New Data Cube remote sensing paradigm is to provide a single source of “analysis ready data” to end-users, saving about 80% of the work and costs required by separate agencies to get the satellite data to such a level.**



# Computational Capacity

## - The National Computational Infrastructure (NCI)

- Raijin @ National Computational Infrastructure
- 57,472 cores (Intel Xeon Sandy Bridge technology, 2.6 GHz) in 3592 compute nodes;
- 160 TBytes (approx.) of main memory;
- 10 PBytes (approx.) of usable fast filesystem (for short-term scratch space).

37	Research Institute for Information Technology, Kyushu University Japan	QUARTETTO - HA8000-tc HT210/PRIMERGY CX400 Cluster, Xeon E5-2680 8C 2.700GHz, Infiniband FDR, NVIDIA K20/K20x, Xeon Phi 5110P Hitachi/Fujitsu
38	National Computational Infrastructure, Australian National University Australia	Fujitsu PRIMERGY CX250 S1, Xeon E5-2670 8C 2.600GHz, Infiniband FDR Fujitsu
39	Purdue University United States	Conte - Cluster Platform SL250s Gen8, Xeon E5-2670 8C 2.600GHz, Infiniband FDR, Intel Xeon Phi 5110P Hewlett-Packard



\*<http://top500.org/>



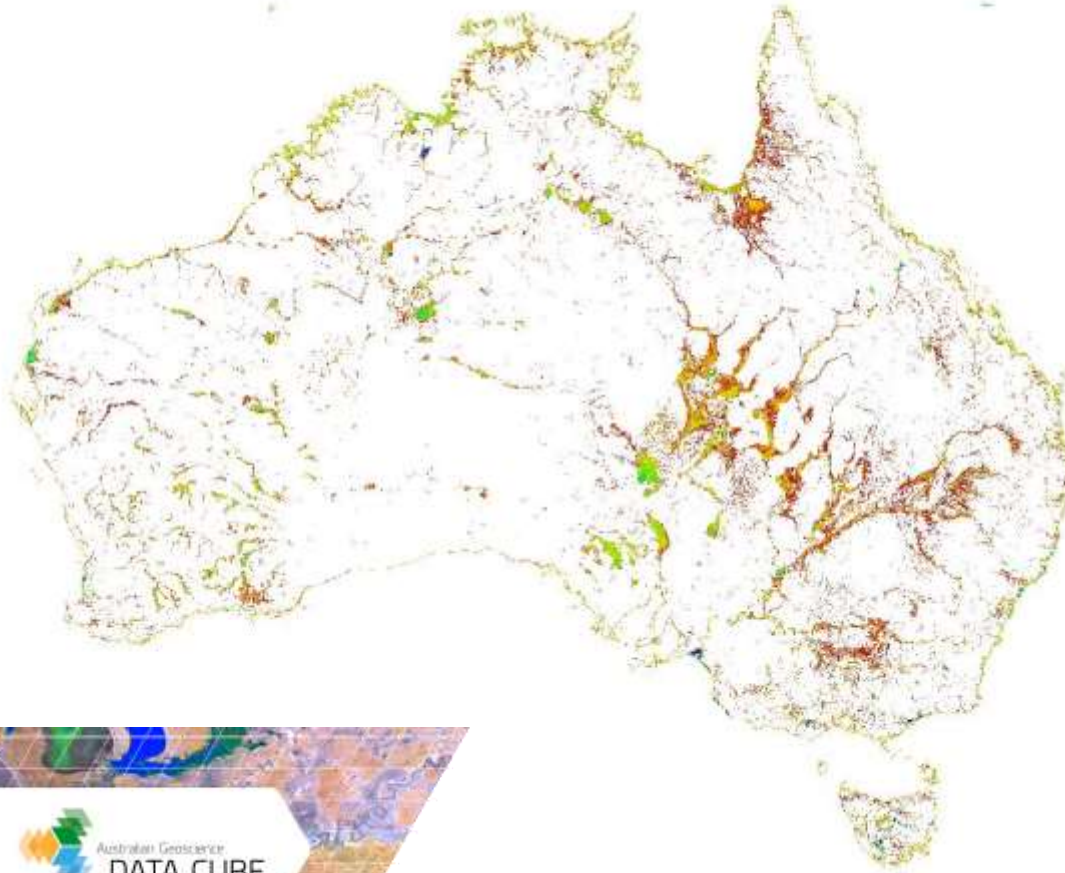
# First tests of new “DataCube” technology in Australia: Mapping historical floods and inland water



# Continental Surface Water

## NFRIP water detection

- **15 Years** of data from LS5 & LS7(1998-2012)
- **25m** Nominal Pixel Resolution
- Approx. 133,000 individual ARG-25 scenes in ~12,400 passes
- Entire archive of 1,312,087 ARG25 tiles =>  **$21 \times 10^{12}$**  pixels visited
- **3 hrs** at NCI (elapsed time) to compute.







# Kenya Data Cube Project



- The **Kenya Data Cube Project** is led by NASA-SEO and the Australian Government (Geoscience Australia, CSIRO and the Dept. of the Environment).
- The project has a large number of **stakeholders and funders** ... Australian Government, NASA, USGS, United Nations REDD+ and FAO, Gates Foundation, Clinton Foundation (CCI and SLEEK), SilvaCarbon.
- The project brings together large number of **CEOS groups** ... Space Agencies (satellites), NASA-SEO (data tools), SDCG for GFOI, LSI-VC, WGISS (data archives), WGCapD (training) and GEOGLAM.



Food and Agriculture Organization  
of the United Nations



# Kenya and Colombia CEOS DataCubes – Testing Integration of Interoperable Optical and Radar



The screenshot shows the 'Kenya Data Cube Portal' interface. At the top, there are navigation links: Home, Map Tool, Graph Tool, Task Manager, and Comparison Tool. The main area is a map of Kenya with a false-color mosaic overlay. The mosaic shows a central region with a mix of green and purple, indicating forest areas. Labels on the map include 'Marsabit', 'Nairobi', and 'Kitui'. On the left side, there are several panels for user interaction:

- Options**: A section for configuring the data source and date range.
- Source Options**: Includes a dropdown for 'Data Products' with 'Landsat 7 SP', 'ALOS2', 'Spot 6', and 'MODIS 250m' options. Below it are fields for 'Image Date', 'Season' (set to 'No Restriction'), 'Start Date' (2010-10-10), and 'End Date' (2010-11-11).
- Shape**: Includes radio buttons for 'LatLong' (selected), 'Bounding Box', and 'Shape Selector'. Below are input fields for 'Longitude' (Min: 37, Max: 38) and 'Latitude' (Min: 0, Max: 1).
- Preview Options**: Includes a 'Product Type' dropdown set to 'False Color' and buttons for 'Sample Task', 'Submit Task', and 'Clear Mosaic'.
- Output Options**: Includes a 'Show missing pixels' checkbox and an 'Export format' dropdown set to 'GeoTIFF' with a 'Download product' button.

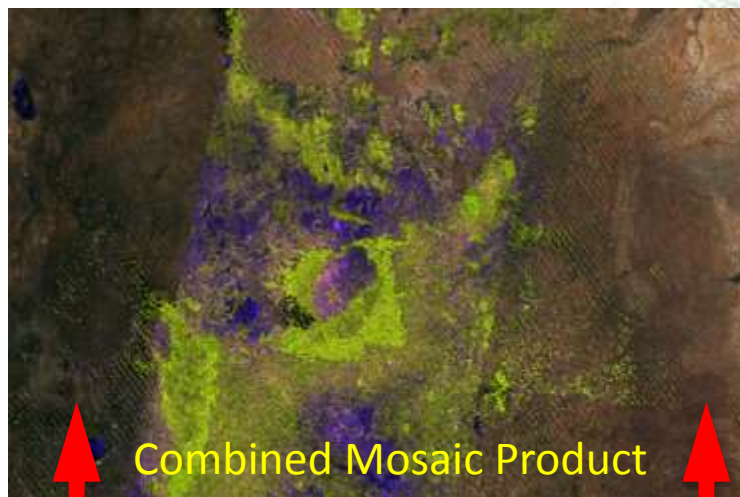
- Kenya **Data Cube** project plans to integrate optical and radar data within the same user interface.
- **Landsat-7** mosaics and **ALOS PALSAR** mosaics (example on the left) can be utilized together for improved forest classifications in persistent cloudy regions.
- **ALOS** data provides unique information about vegetation structure and biomass especially in low density and regrowing forest regions.



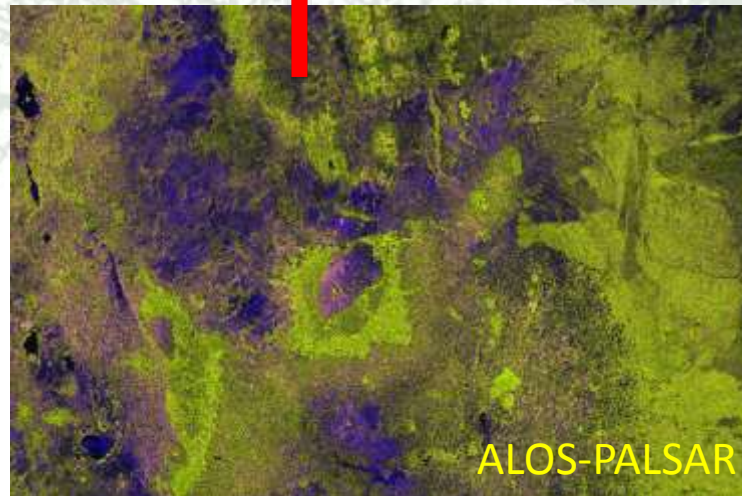
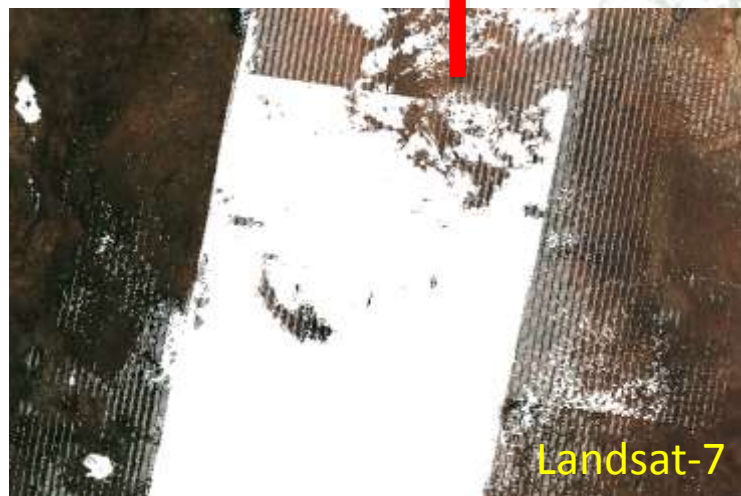
# Landsat-ALOS Mosaic Example



An integrated mosaic was created with the Data Cube over central Kenya for Oct-Nov 2010 using Landsat-7 and the 2010 ALOS-PALSAR 25m mosaic.



ALOS-PALSAR data can be used to fill areas of cloud cover and scan line “banding” within the Landsat-7 imagery for improved forest classification and biomass information.



# Conclusions

- Australia has an operational system in place to meet the UNFCCC reporting
- Our systems are subject to ongoing improvement and innovation
- DataCube technologies offer a new approach for petabyte-scale satellite data analysis and improved access to large archives by developing countries.
- We are testing the DataCube and latest research to improve future national estimates of greenhouse gas emissions

Thank you

ありがとう (Arigatou)

