Australian Government
Geoscience Australia

CSIRO

NCI
NATIONAL COMPUTATIONAL INFRASTRUCTURE

… but where do we run it?

Jonathon W. Ross, Geoscience Australia

Why did we build the AGDC?

- Collecting data since 1979 - important to deliver value to Government
- Mandate to support Australian Government objectives
- Key national objectives:
  - A national record of change – as it happens
  - Sustainable and productive resources and agriculture industries
  - **Disaster risk reduction**
  - **Marine and coastal jurisdiction management**
- Support the **region and regional engagement priorities** (APEC, ASEAN)
  - **Food security and sustainable livelihoods (incl aquaculture)**
  - **Climate adaptation**
  - **Disaster resilience**
- Space policy:
  - Give back to the international community
- Exploit multi-$100m national HPC/HPD

The key gap

Lots of data …
Plenty of good idea …
Interesting methodologies …
But where to run it?
And at scale?

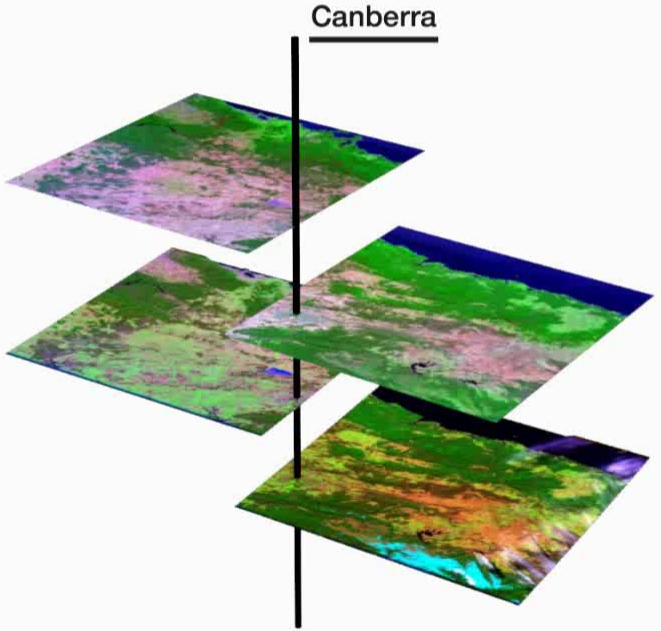
Information infrastructure for EOS

‘Analysis Ready Data’

Orthorectification

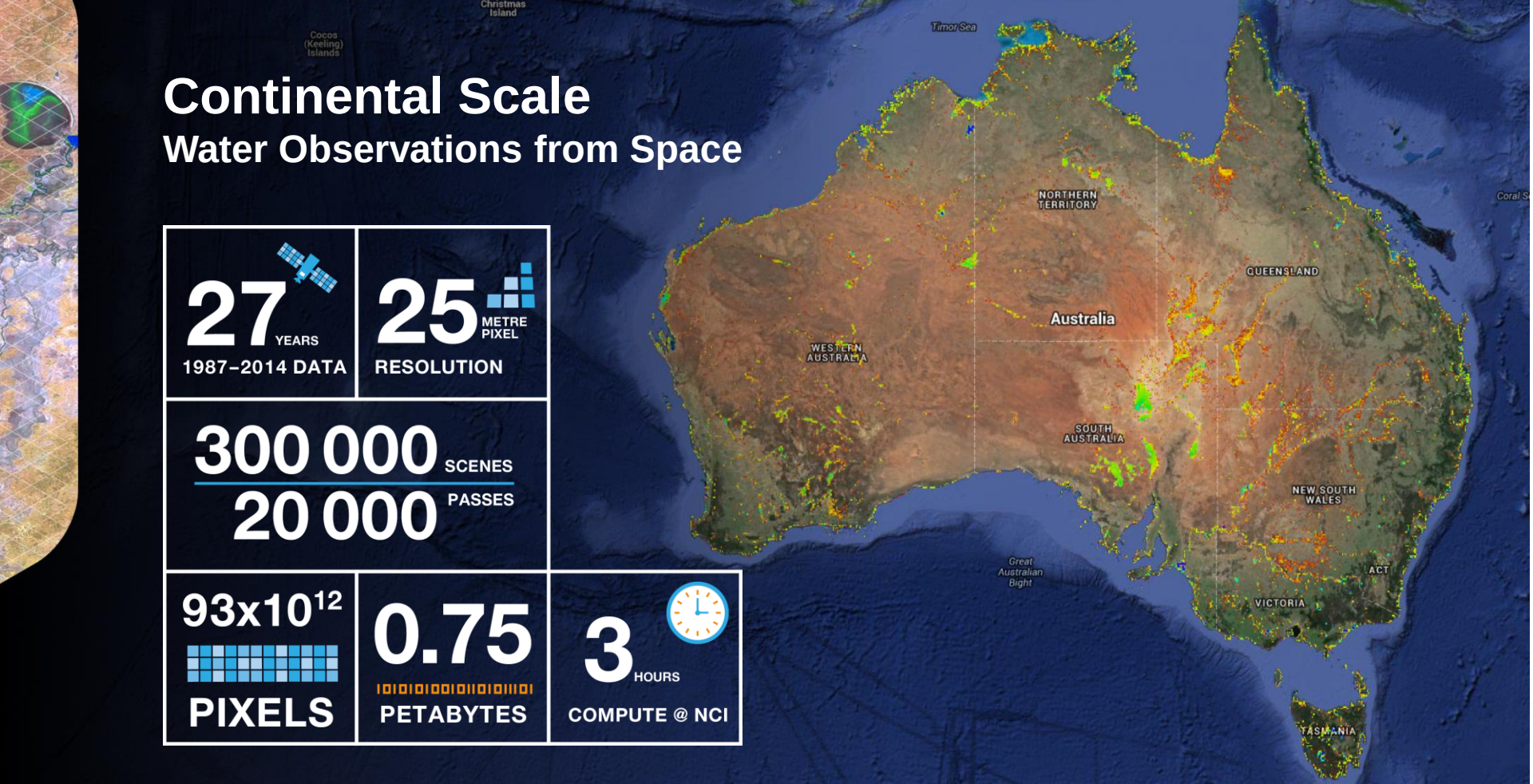
Calibration

Time series



Continental Scale

Water Observations from Space



27 YEARS
1987–2014 DATA

25 METRE PIXEL
RESOLUTION

300 000 SCENES
20 000 PASSES

93x10^{12}
PIXELS

0.75
PETABYTES

3 HOURS
COMPUTE @ NCI

Key lessons

- **Analysis ready data: the ‘goldilocks’ effect**
  - Exploit data density vs the “perfect scene”
- **Favour integration across sensors/data types**
  - Vs highly vertically integrated products
  - Data security and product depth
- **Engagement with end users is not negotiable**
  - Capacity dev for domain experts **is key**
  - Co-design good!
  - Avoid the “echo chamber” effect
  - Empower ‘users’ to work iteratively – in real time, with peers
  - Enable domain expert groups to support each other

Key lessons

- **Must be “seen to be believed” – agile is good!**
  - Something now -> better than something later
  - A head start + ability to tailor products to local needs -> ideal
- **Open source + commercial -> optimal**
  - Sovereignty and ownership are critical issues 4 industry/business
- **Avoid technology fixation**
  - If in five years other tech works -> hooray!

Australian Geoscience DATA CUBE

Learning from the lessons

Digital Earth AUSTRALIA

Australian Government Geoscience Australia

CSIRO

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We spend a lot of money on the environment

Digital Earth AUSTRALIA

- In 2016/17 announced $1.1 billion over 7 years for Australia's Landcare Program.
- We spend ~$150 million per year on environmental water in the Murray-Darling Basin
- We have $140 million dedicated to changing land management practices to protect the Great Barrier Reef

- Many of these make **almost no use** of EO Data at all
- Sometimes … we don't really have much quantitative evidence of the impact and efficiency of these interventions

Digital Earth Australia

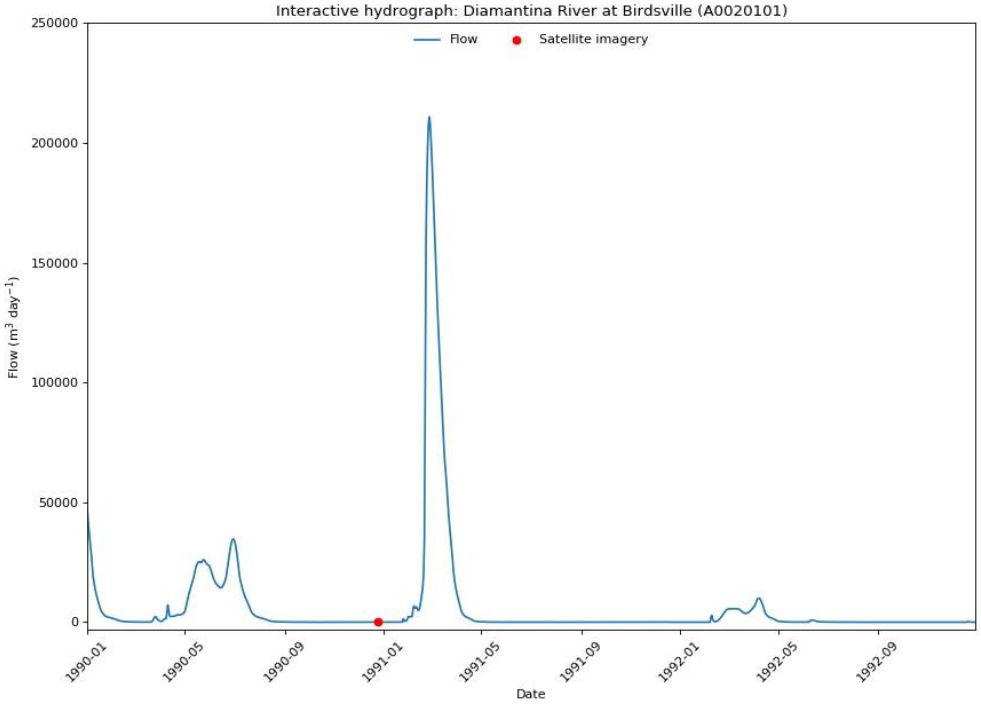
- Australian Government has provided Geoscience Australia with an additional **$15.3 million** to transform the pilot ‘AGDC’ into the operational **Digital Earth Australia**. **$28 million over 2 years.**
- Funding will support:
  - Co-designing and developing applications with agencies
  - Embedding products into government business processes
  - Support for new data streams (data richness and security)
  - Access for industry (e.g. app developers)
  - Further engagement with statistical communities
  - **Platform for GEO outputs to run**
  - **Foster open source community**

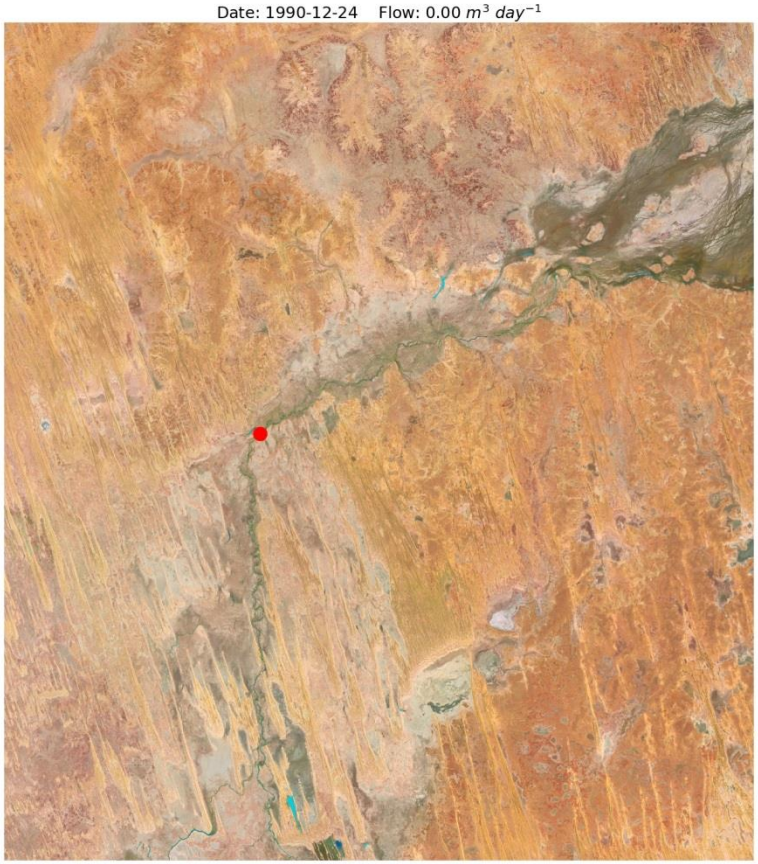
Lies
Darn Lies
And Statistics???

Probabilities vs Certainties

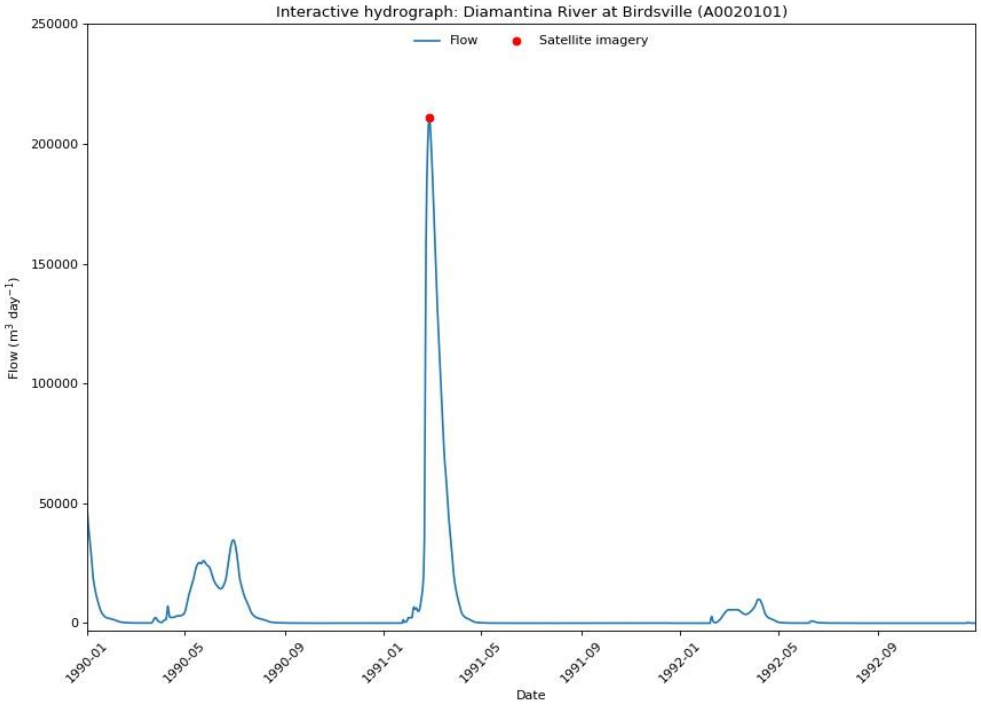
What happens when you give scientists Python Notebooks!

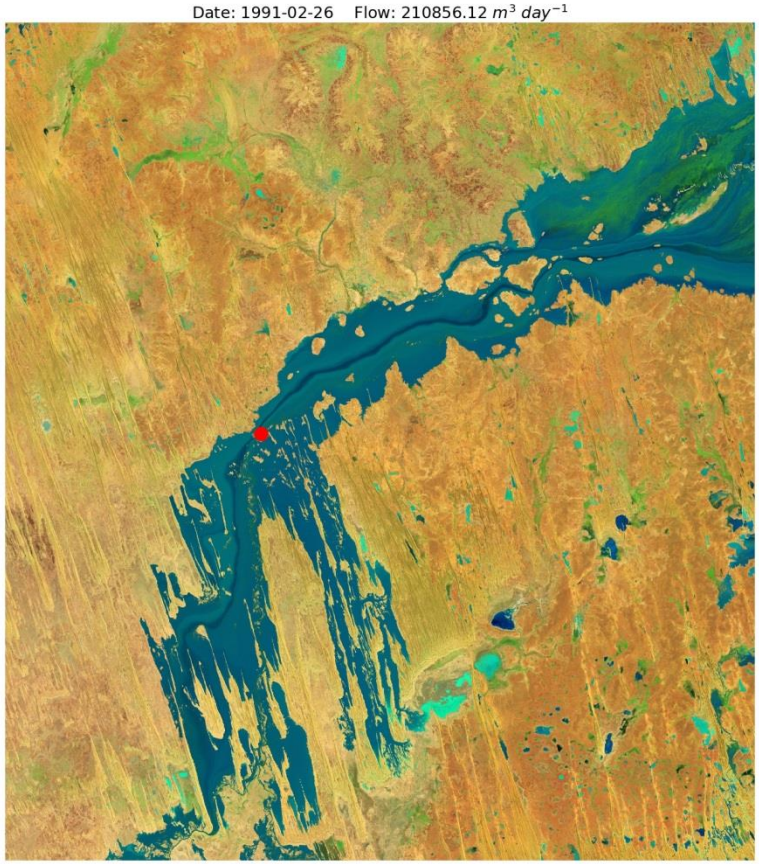
Understanding water resources



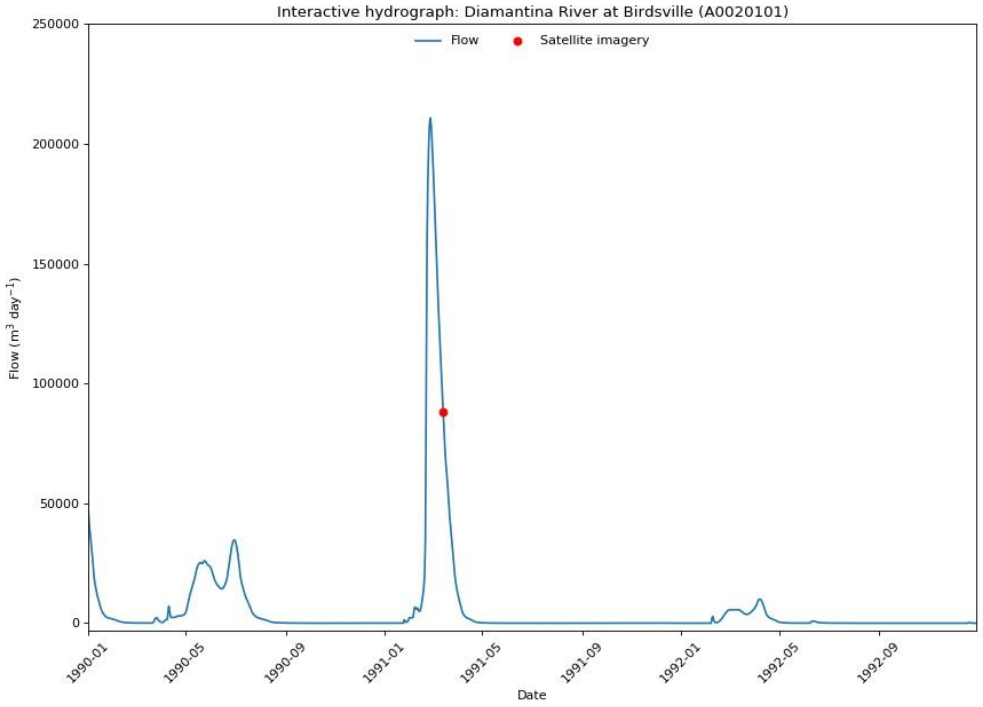


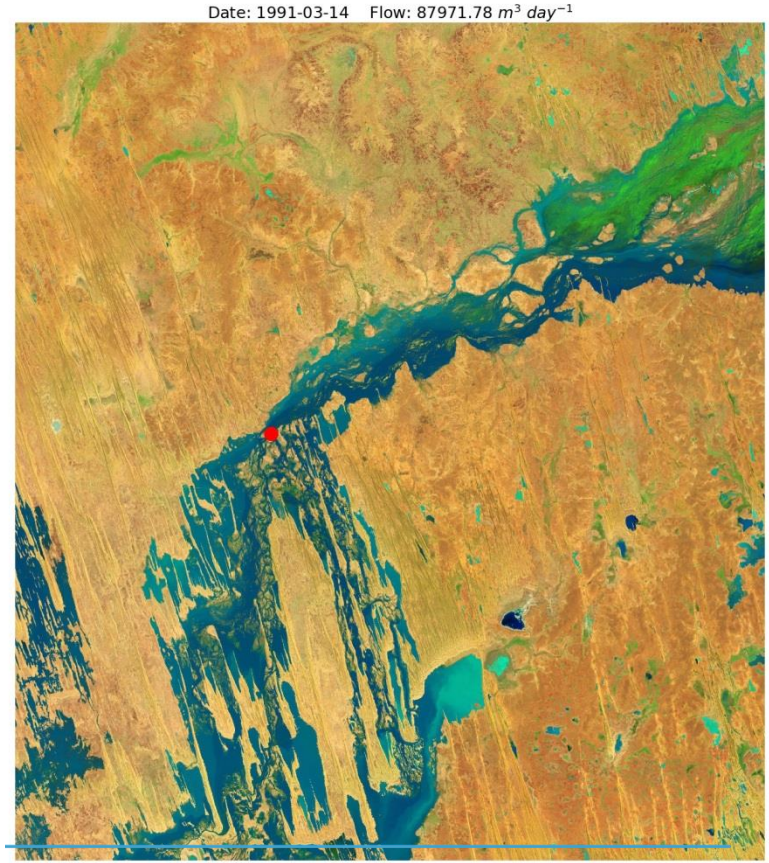
Understanding water resources





Understanding water resources





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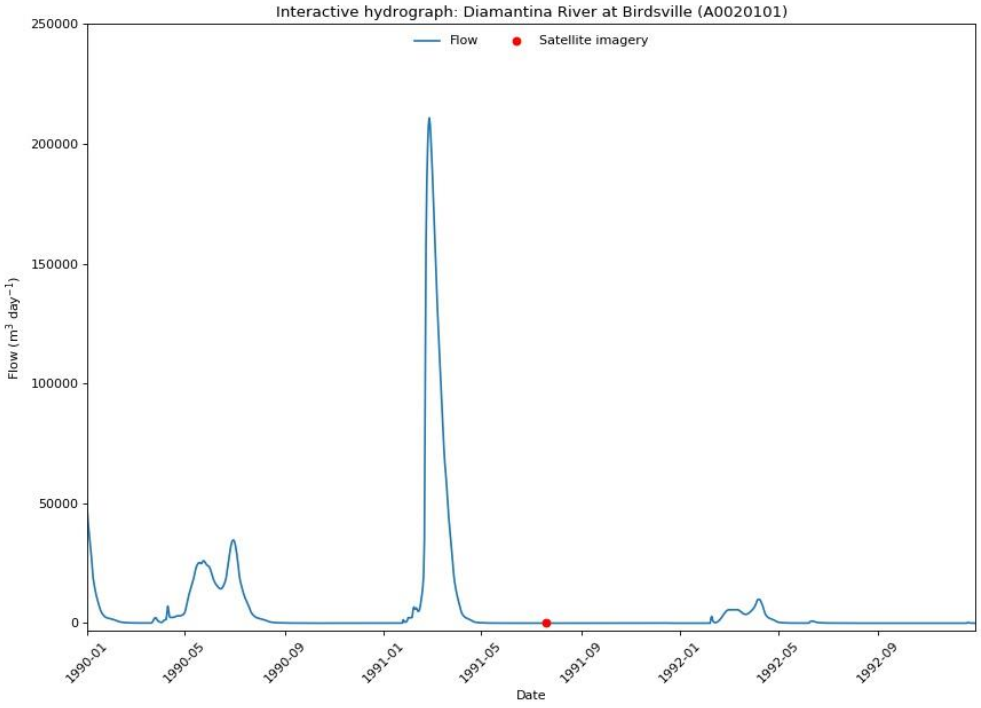

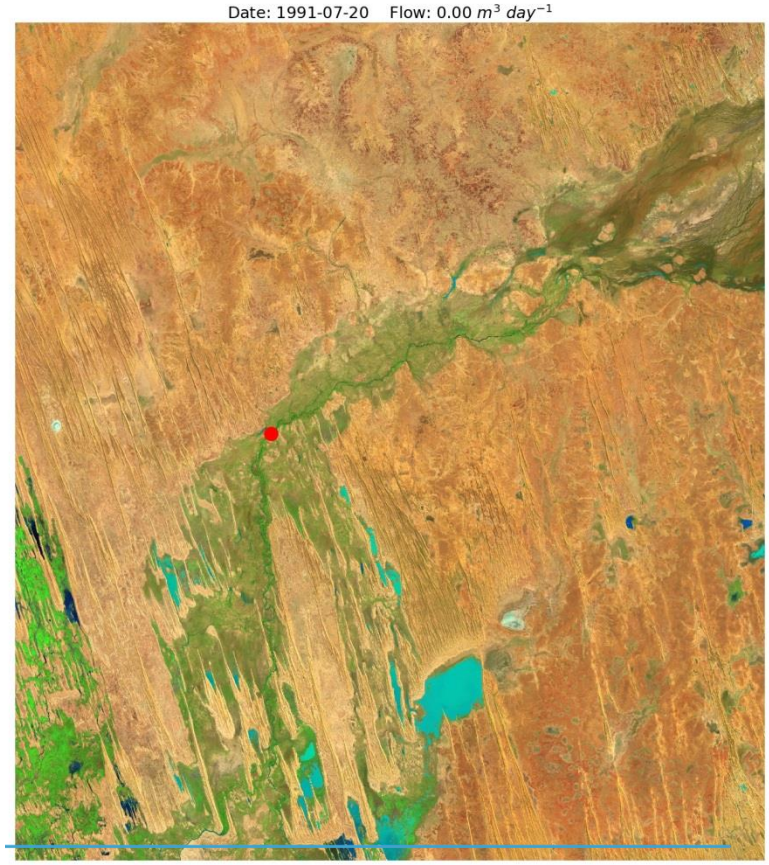

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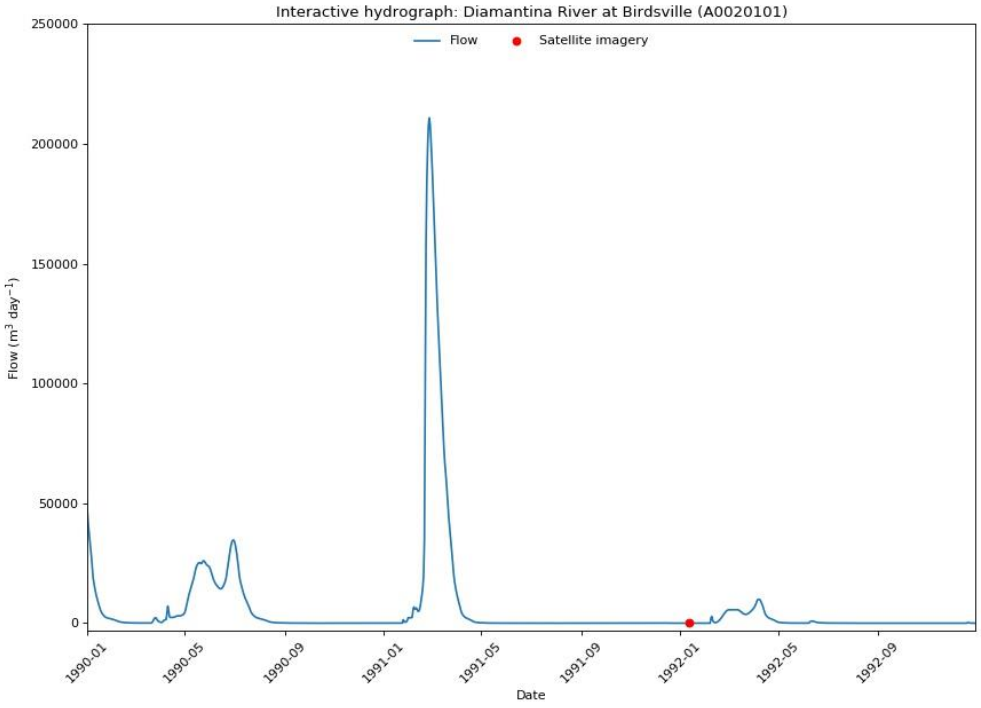
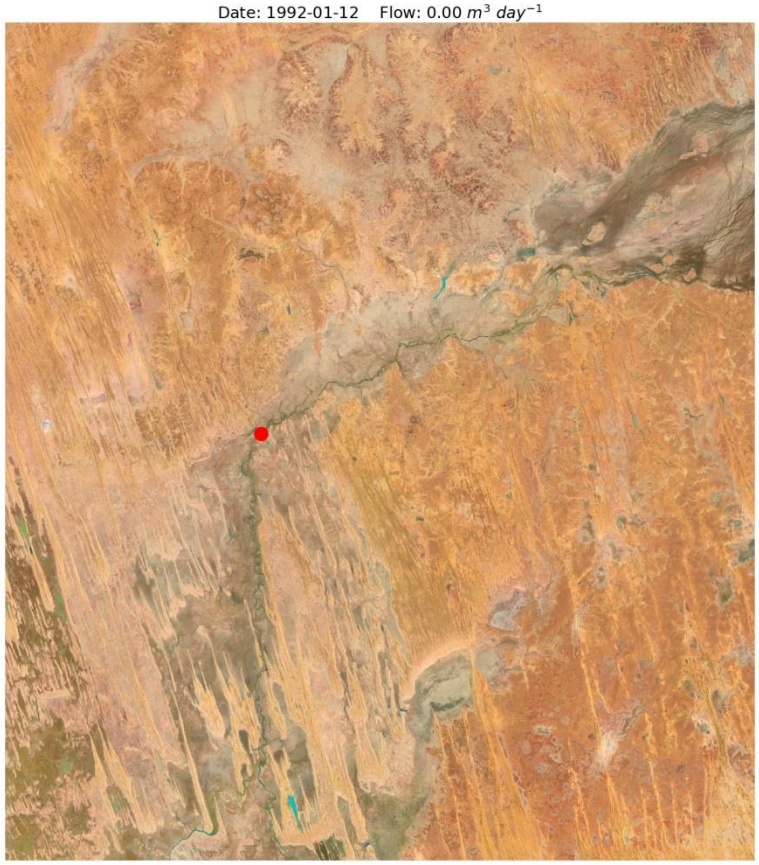
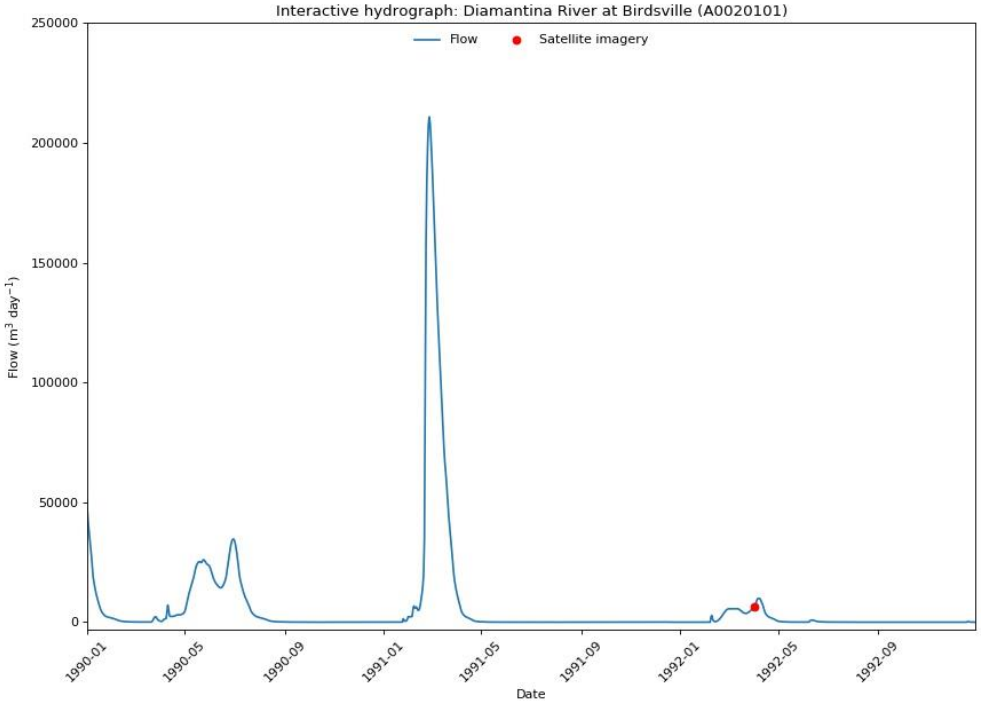
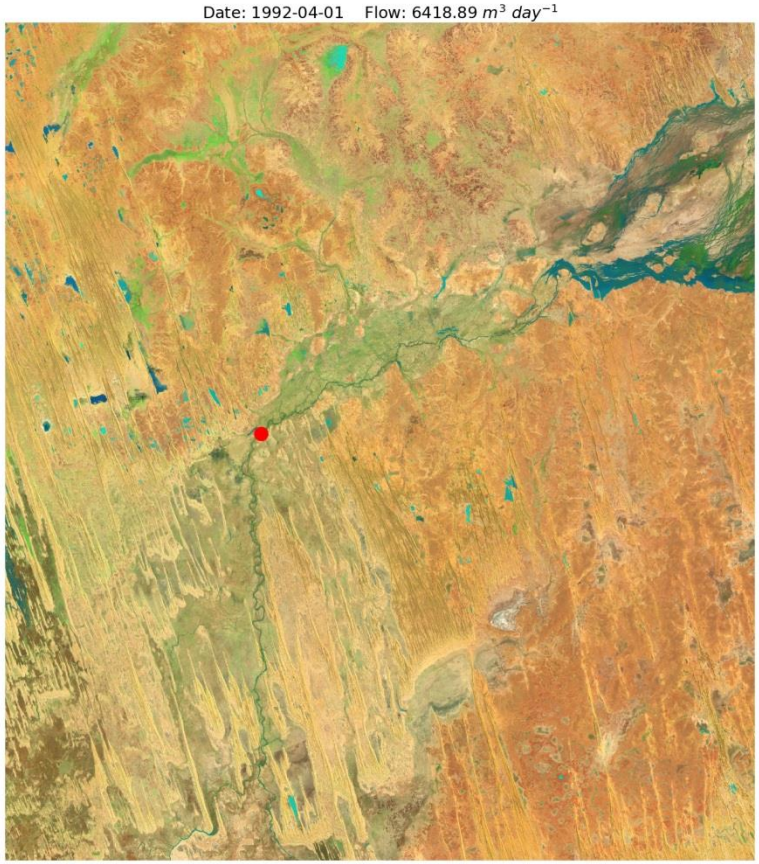


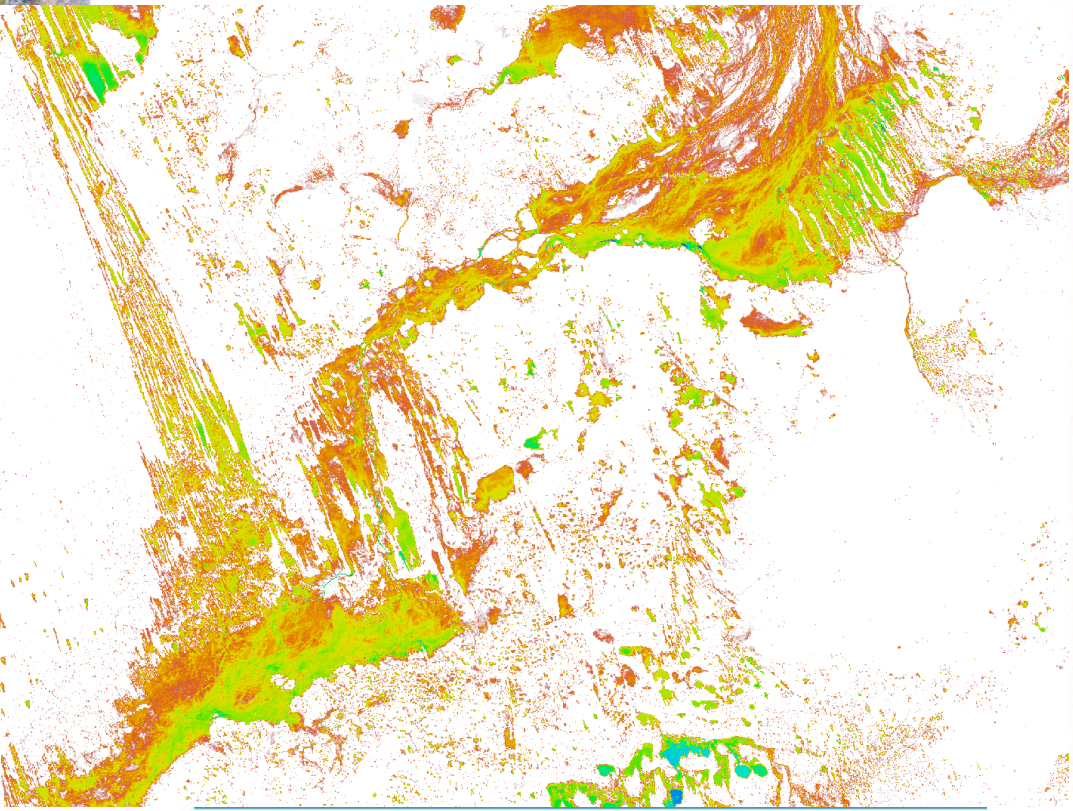


Understanding water resources





Understanding water resources



green

dry

soil

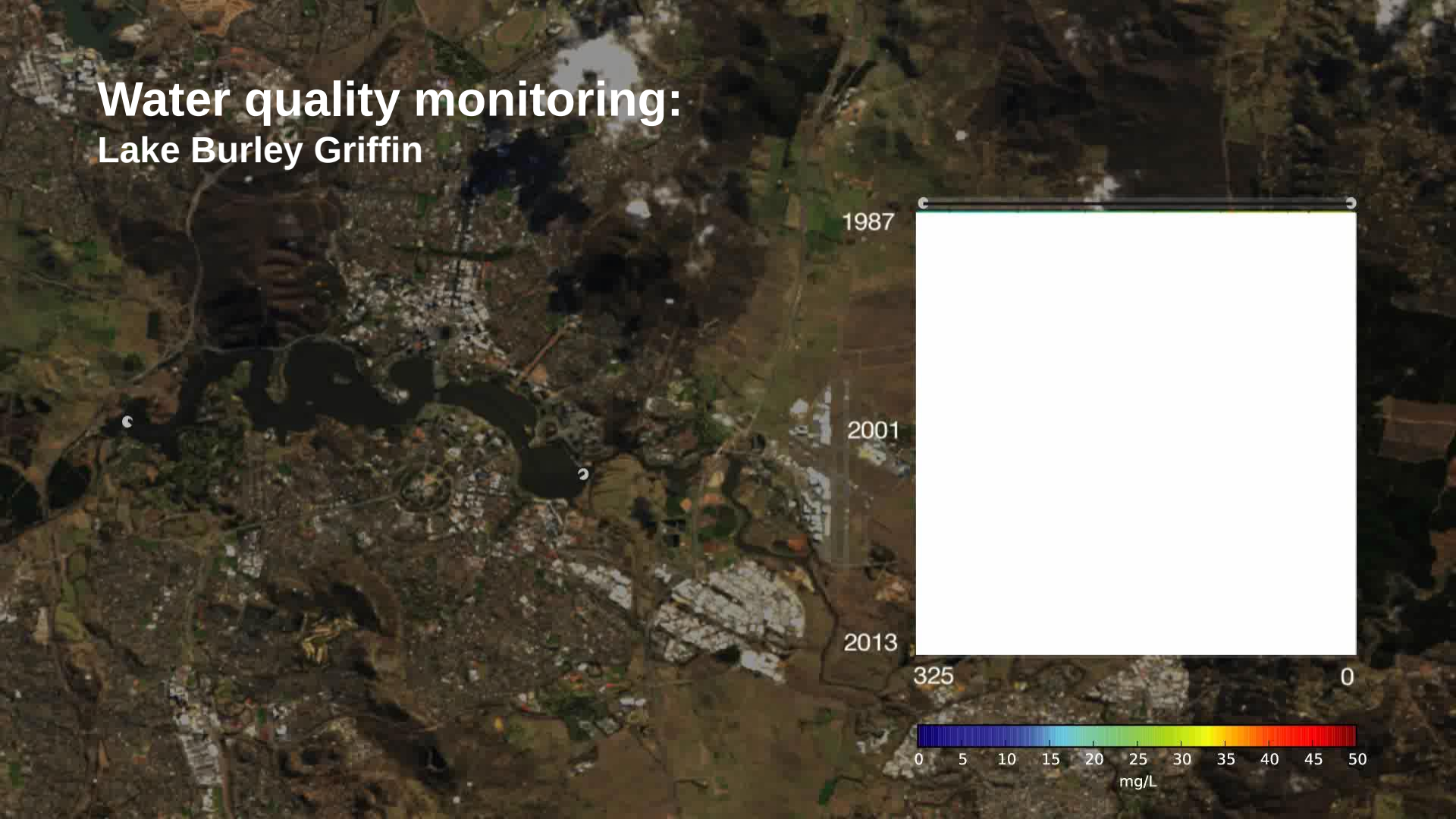
1988

2000

2006

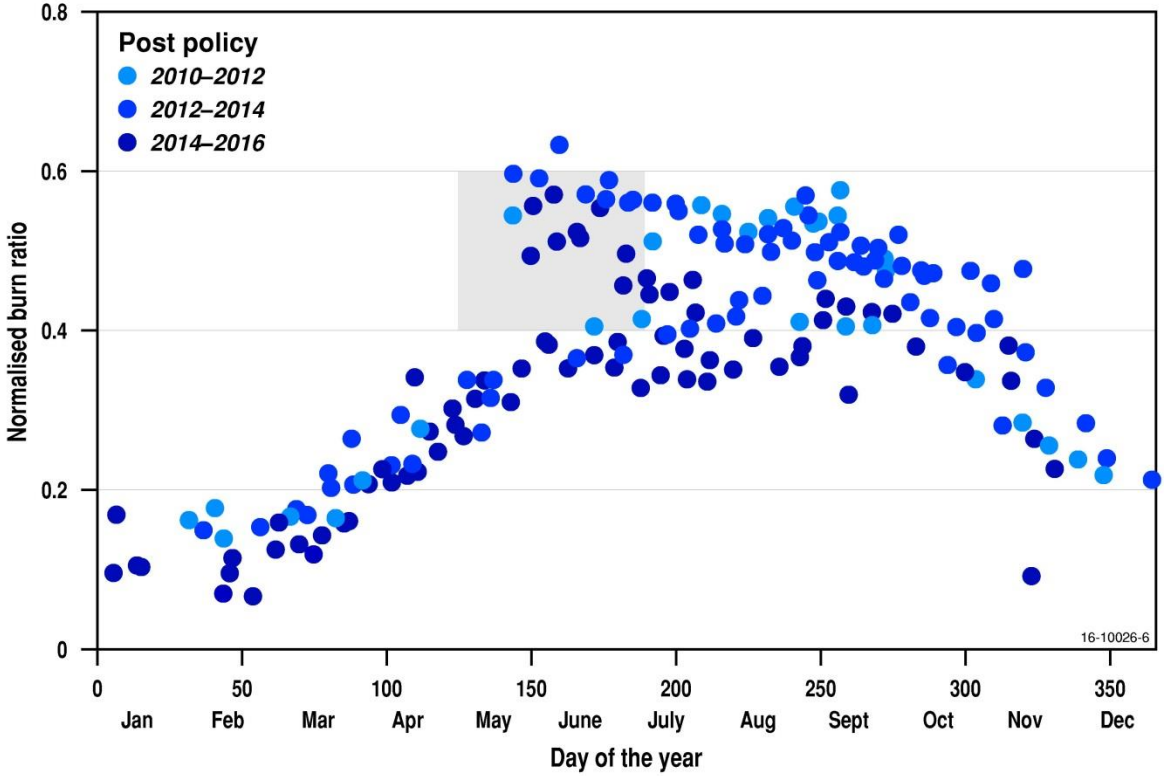
2014

Water quality monitoring:
Lake Burley Griffin



Changes in fire management practices

Image courtesy of Jamie Lankford



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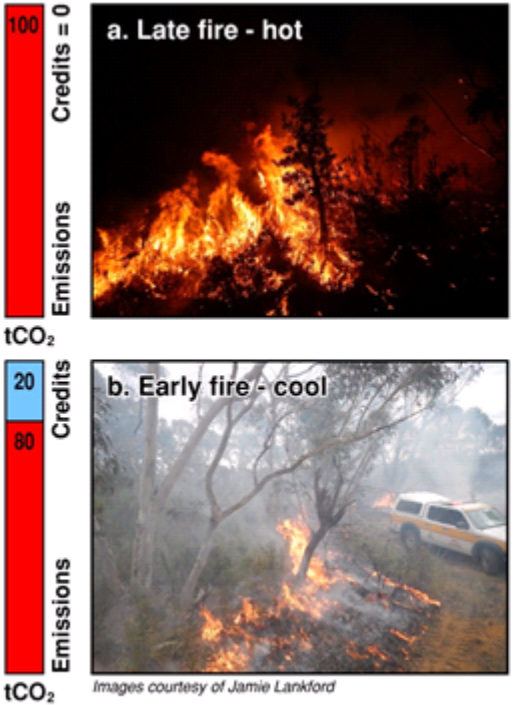
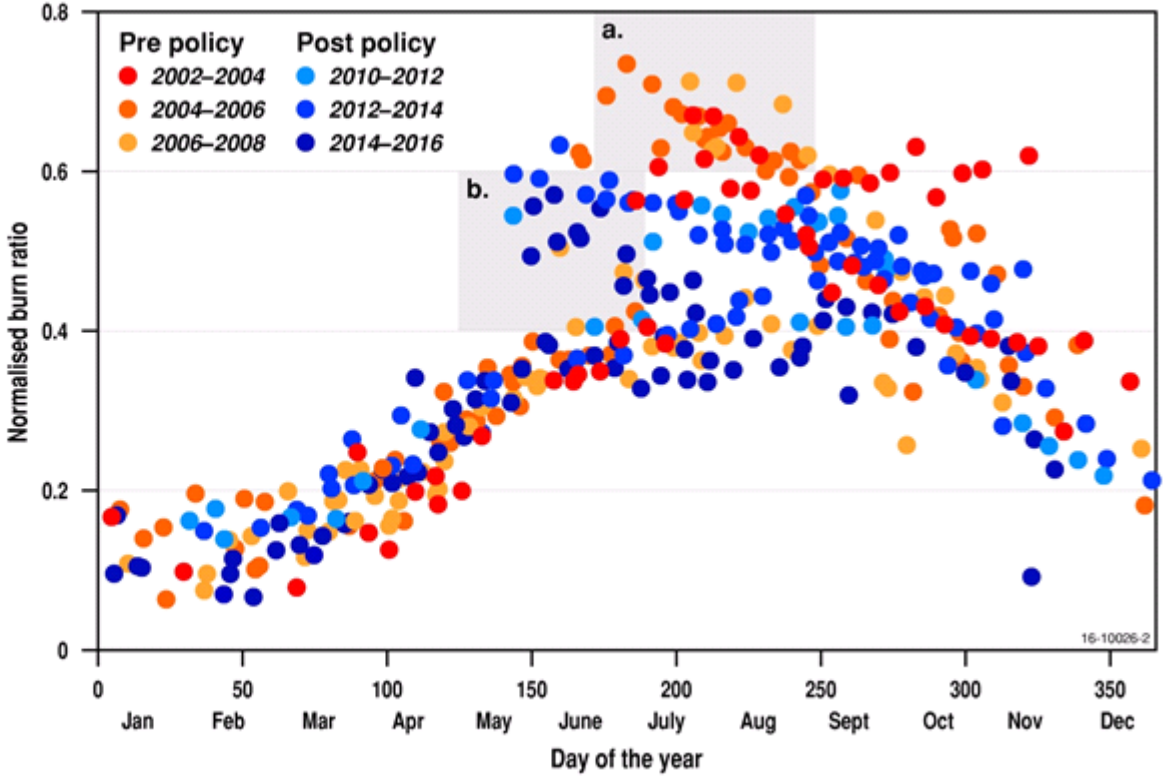
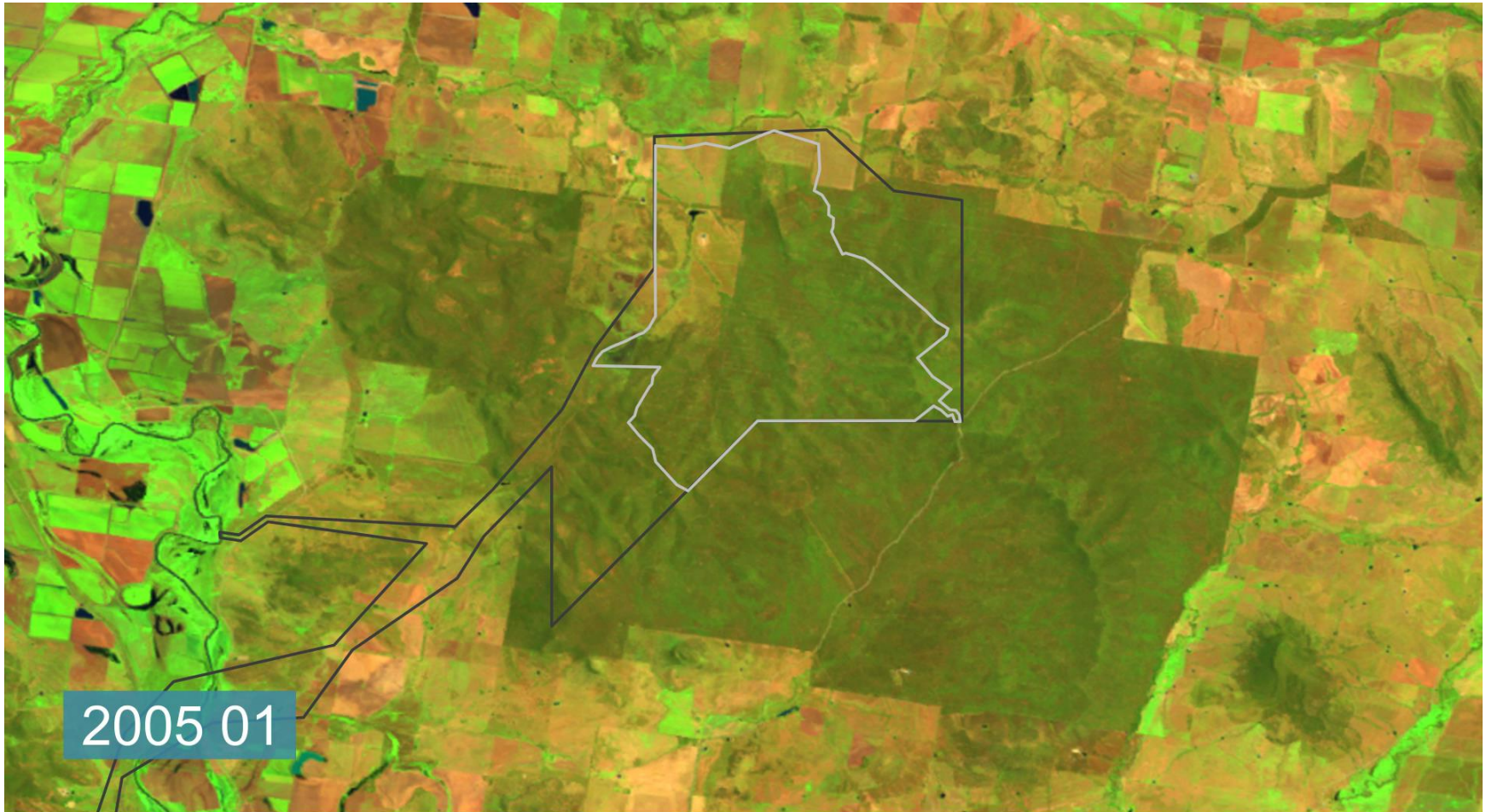


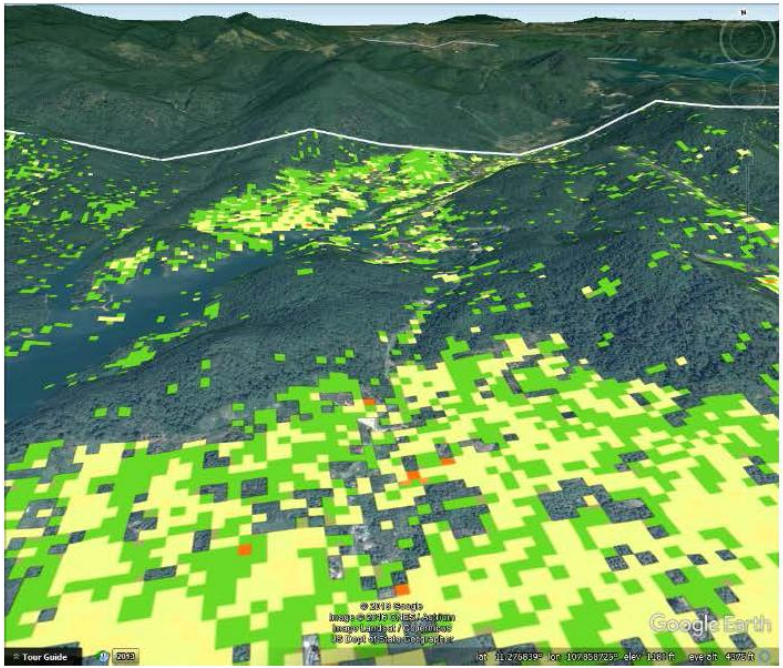
Images courtesy of Jamie Lankford

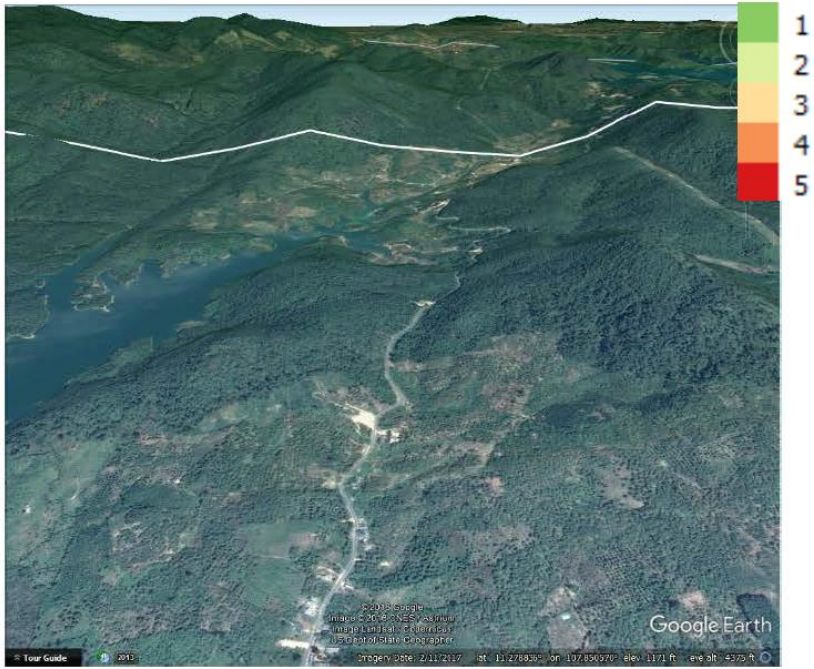


Tracking development conditions:- clearance



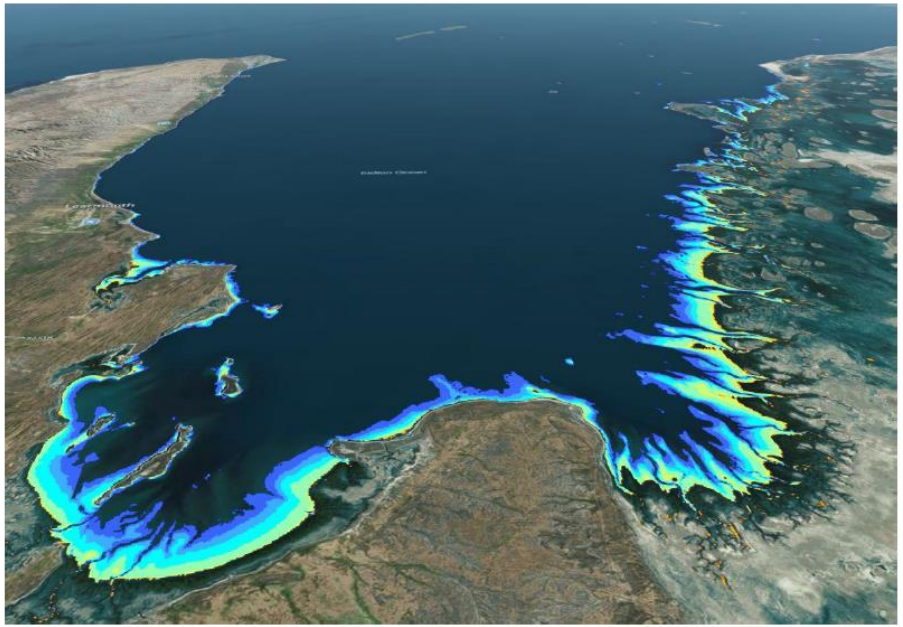
Continuous Change Detection and Classification





And, of course … the coastal zone

The Intertidal Extent Model (ITEM) v.1



Objective: To model the extent and topography of the intertidal flats of Australia's coastline utilising 28 years of the Landsat archive

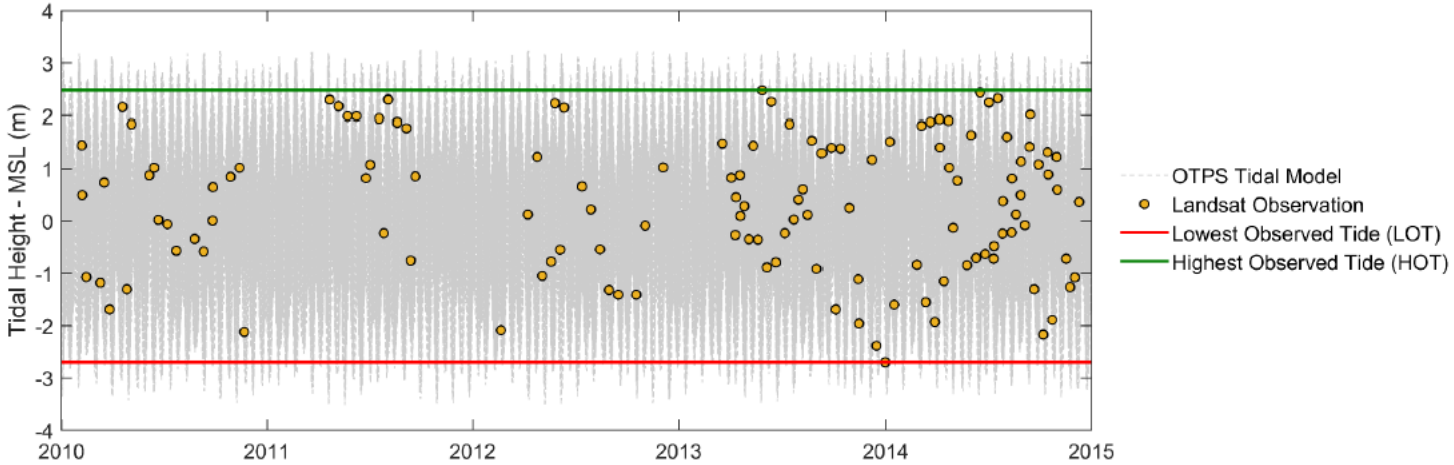
Credit: Geoscience Australia (Sagar et al)

Sun-synchronous sensors and the Observed Tidal Range

A sun-synchronous sensor – observes at the around the same time of the day for each observation

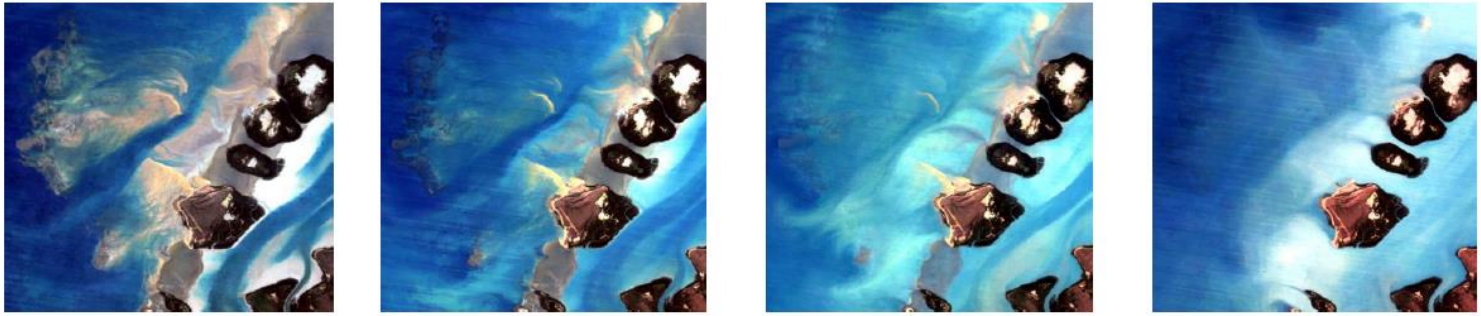
This means that even with tidal variations, we most likely will only observe a portion of the full tidal range

We can characterise this as highest (HOT) and lowest (LOT) observed



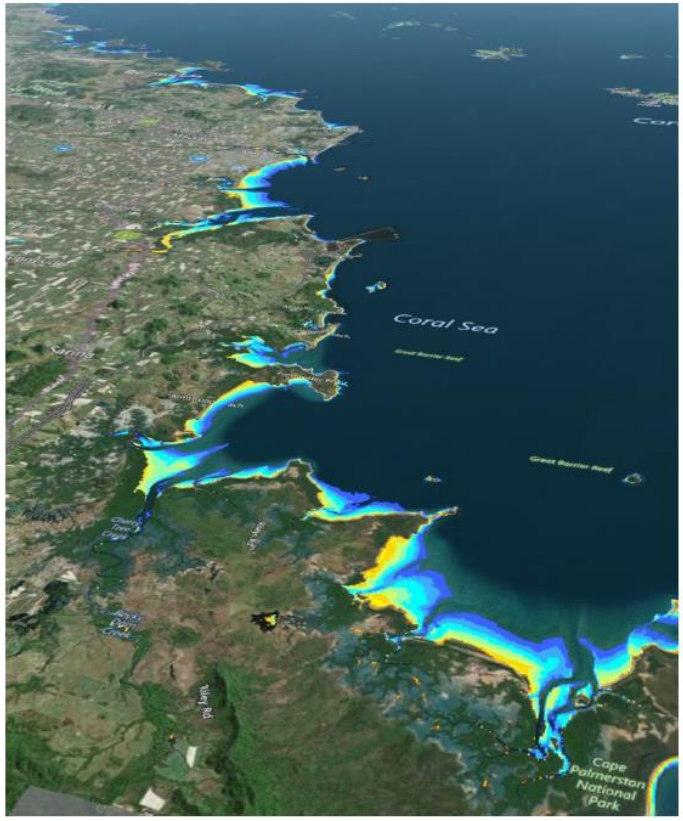
The Intertidal Extents Model (ITEM) Process

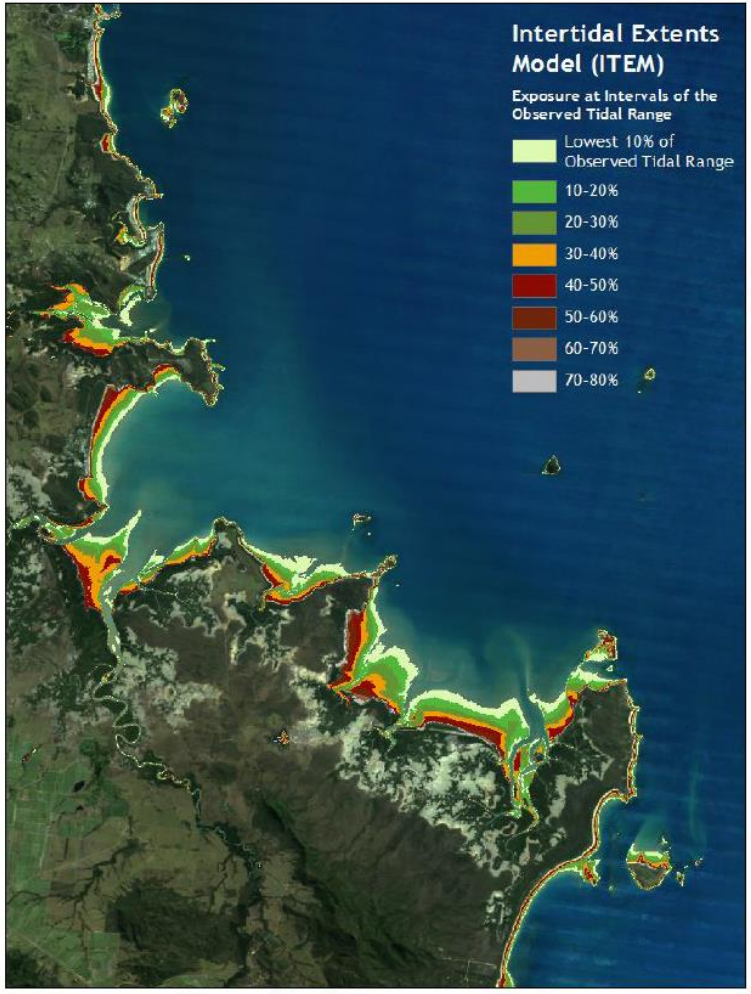
- Each tile stack of observations is attributed with a tidal height utilising the OTPS model
- Observations are the reordered based on tidal height rather than time



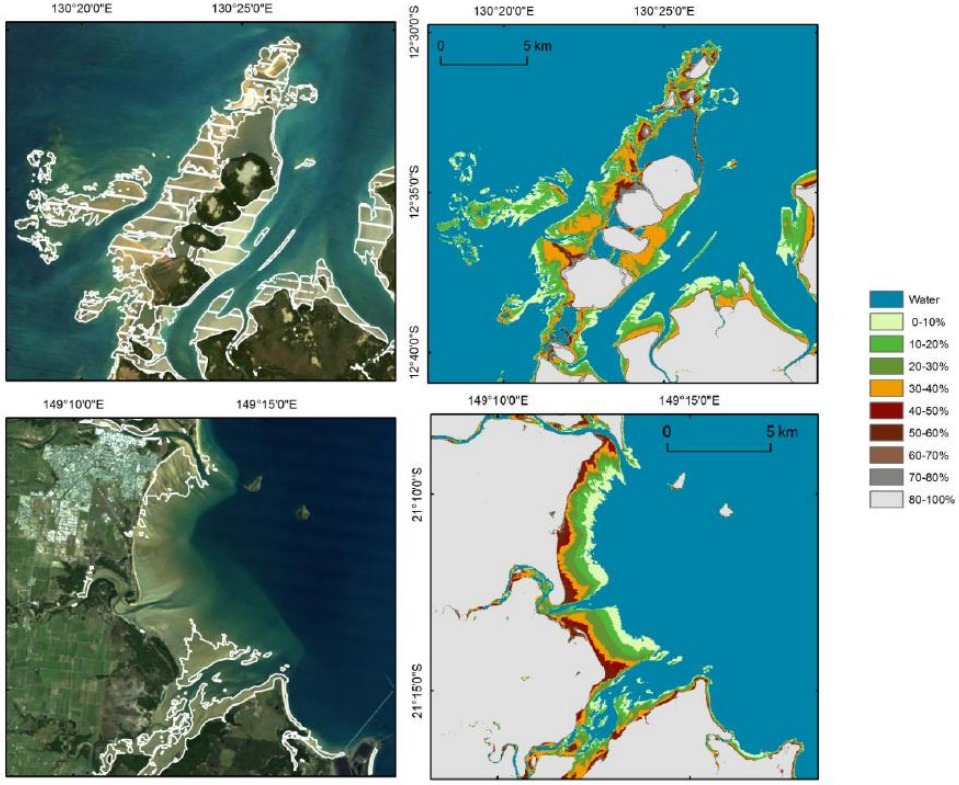
- The Observed Tidal Range is divided into 10 equal interval buckets to create ensemble stacks of observations for each 10% of the range

ITEM Model Examples

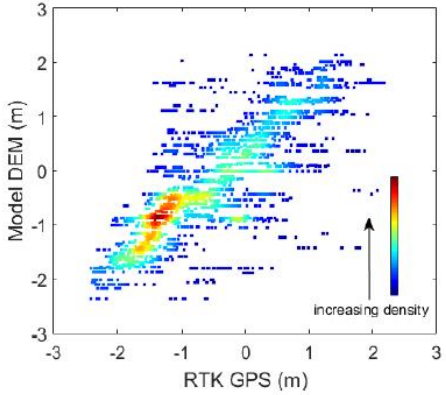




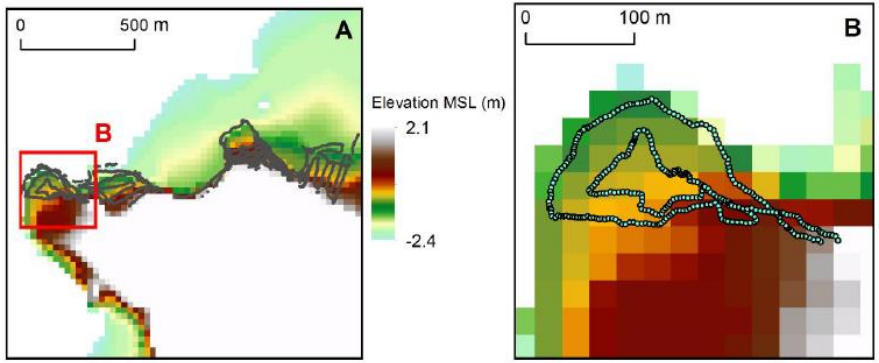
Benefits over a paired scene approach

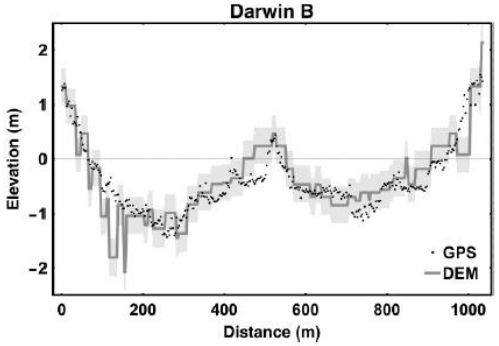


Model Validation - Darwin Harbour, Northern Territory

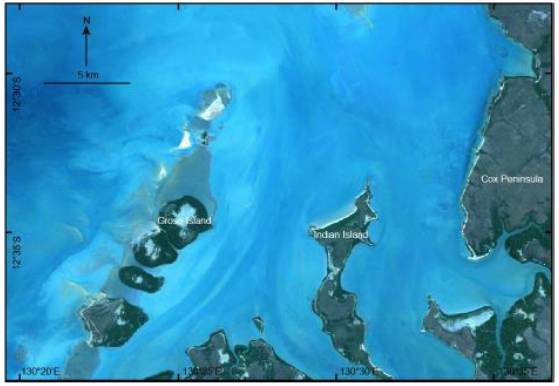


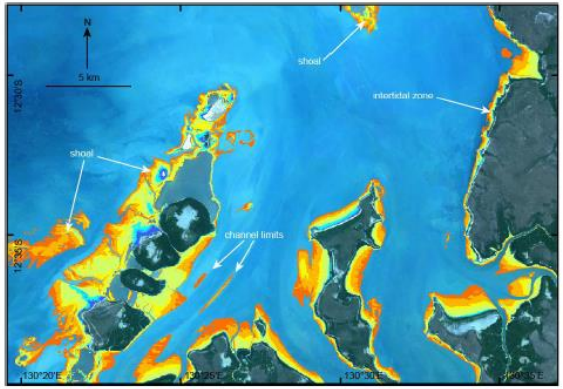
Mean Absolute Height Residual = 0.57m



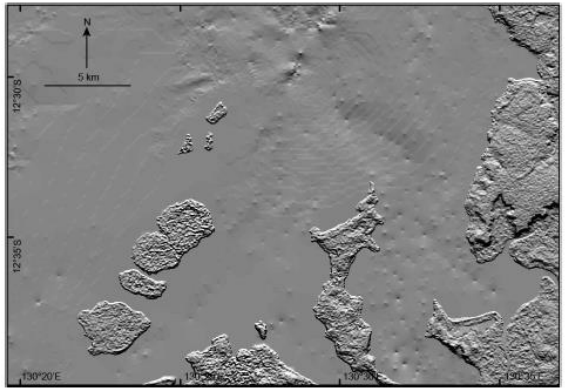


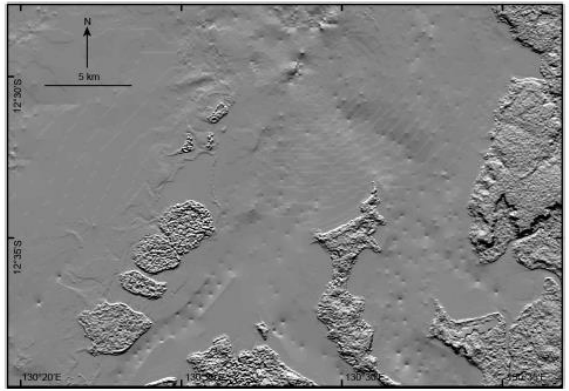
Integrating the Intertidal DEM in the Northern Australian 100m Bathymetry Grid





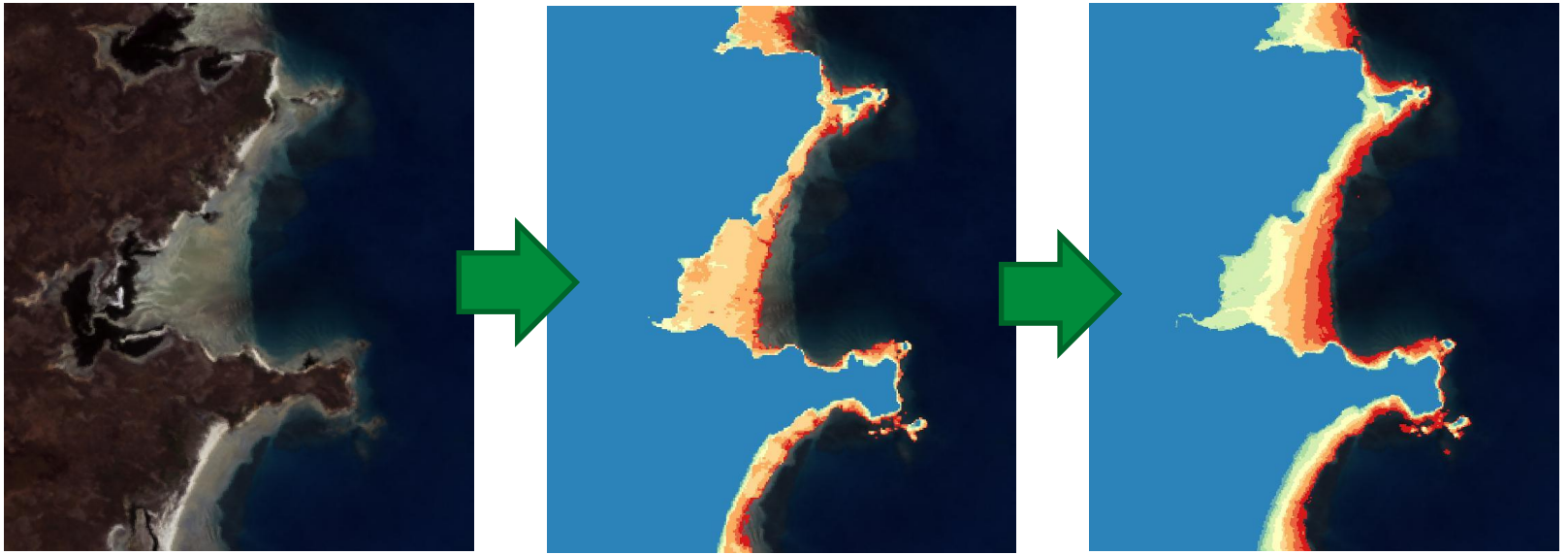
Before





After

Agility at Work – From .1 to .1.1



Sharing is caring

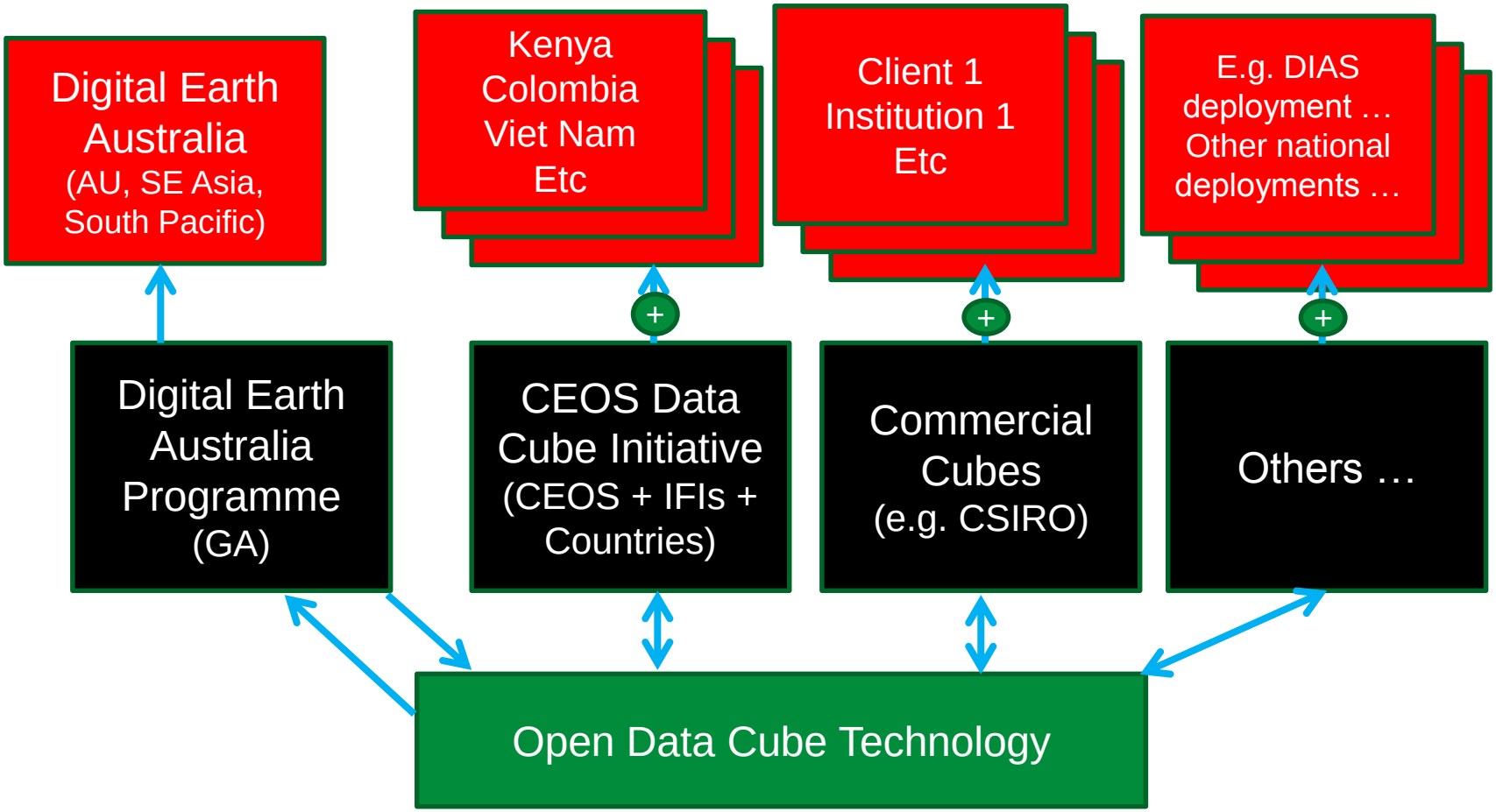
Open Data Cube – Global Open Source Community

- Engaging others in exploiting, and enhancing, the technology
  - build more applications (e.g. engage GEO Initiatives)
  - incorporate more satellites (e.g. engage space agencies, private sector)
  - More platforms

- Inclusive community governed democratically by the ‘contributors’

- Being clear this is not just ‘our thing’

- ‘Backbone’ community support from GA, CSIRO, USGS, NASA and CEOS



Key directions

- More **open source** apps ☺
- **Sensor ignorance** - draw on CEOS work
  - Express requirements – let ODC map to data
  - ‘Like’ sensors (OLI/MSI) and cross-scale (OLCI/MSI)
- **Marine/shallow water atcor**
  - We think ARD will be different (water leaving radiance)
- Integrating **new satellite data**
  - Sentinel-3 data (GA partnership w/ EC/ESA/EUMETSAT)
  - Himawari-8 data (BOM partnership with JMA)

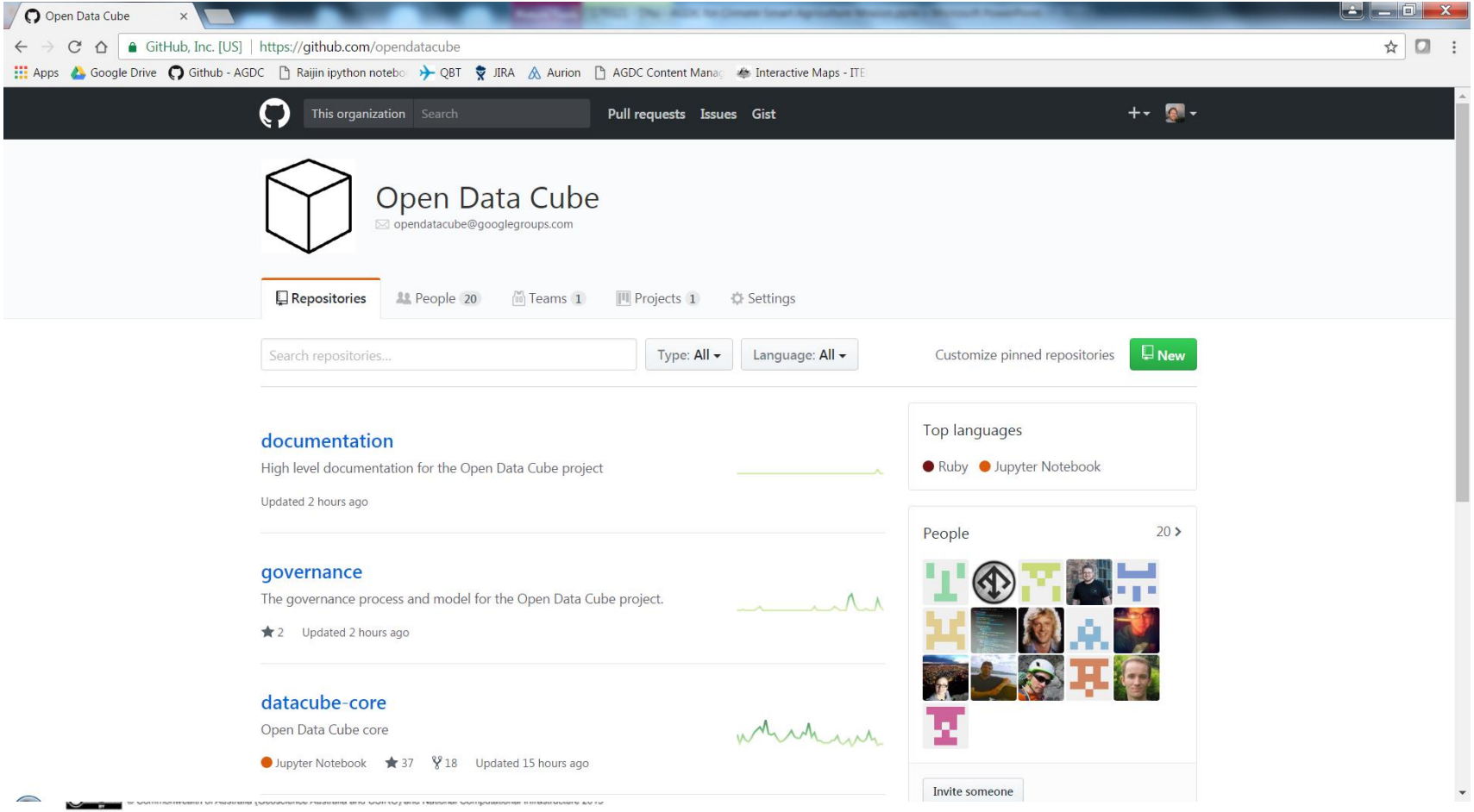
Key directions

- **Engaging the community**
  - Guidelines to enable development of ‘cube ready’ portable algorithms, modules, science code
  - More non-space data (IMOS a very strong foundation)
- **Provide opportunities to “plug in” new missions/datasets**
  - Support CEOS Agency goals
  - Local datasets
  - ‘Exposure” for niche/commercial missions
- **Support industry**
  - Trade storage vs CPU (‘on the fly’ vs cached ARD)
  - Scalable business models

Key directions

- **Deployability on more platforms**
  - HPC vs Commercial cloud vs local cloud vs PC
- **DGGS integration to support stats community**
- **Packaged ‘turnkey’ versions**
  - Open Source GEOSS-In-A-Box?
  - ‘Cube ready’ open source science code to give countries a head start while empowering them to adapt to local conditions
  - Guides for the community

Open Data Cube – Global Open Source Community



CEOS Data Cube Initiative

- Lead: NASA CEOS Systems Engineering Office
- Target of 20 countries with operational cubes
- Platform that supports deploying outcomes of GEO initiatives e.g:
  - GEOGLAM, GFOI, GEO-DARMA …
  - BluePlanet
- More data sets available from CEOS Agencies
- Engagement **in country** (user agencies, support agencies)
- Engagement **of key investors** e.g. development banks, foundations, national aid programmes
- Helping countries to **help each other** (and advocate to each other)
- Foster development of Open Data Cube technology

Thank You

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http://www.ga.gov.au/about/projects/geographic/digital-earth-australia

www.opendatacube.org
www.github.com/opendatacube