Forum for Operational Oceanography

New Advanced Computing Research Infrastructures to support Operational Oceanography

Roger Proctor & Ben Evans

IMOS Integrated Marine Observing System

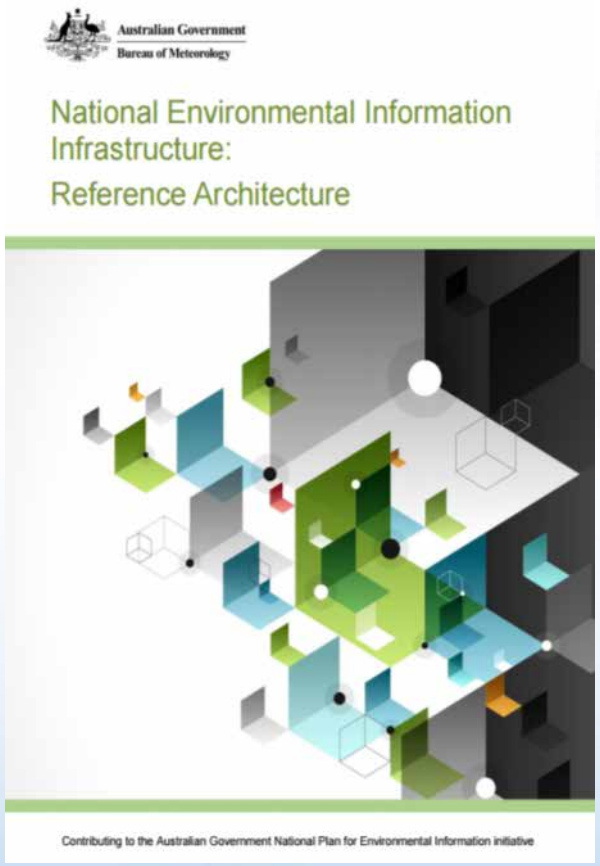
NCI

Although environmental information is abu[illegible]tential users are typically hampered by an inability to discover[illegible] and use the information. Information often exists only within indi[illegible]gencies to support internal business requirements, or within individual[illegible]mental domains. As a result, enabling discovery, access, and use across d[illegible]ains (e.g., air, land, oceans and water) remains challenging.

Environmental information difficult to obtain

Where data can be found, gaining access can introduce new challenges because not all agencies are equipped to provide data a[illegible] outreach services; data may uti[illegible]rietary file formats; or increasi[illegible]olumes makes delivering data [illegible]. And, finally, the absen[illegible]dards introduces a major c[illegible]ge when users attempt to use information and lack the domain specific understanding to make informed decisions around data quality and its fitness-for-purpose.

Environmental information difficult to use



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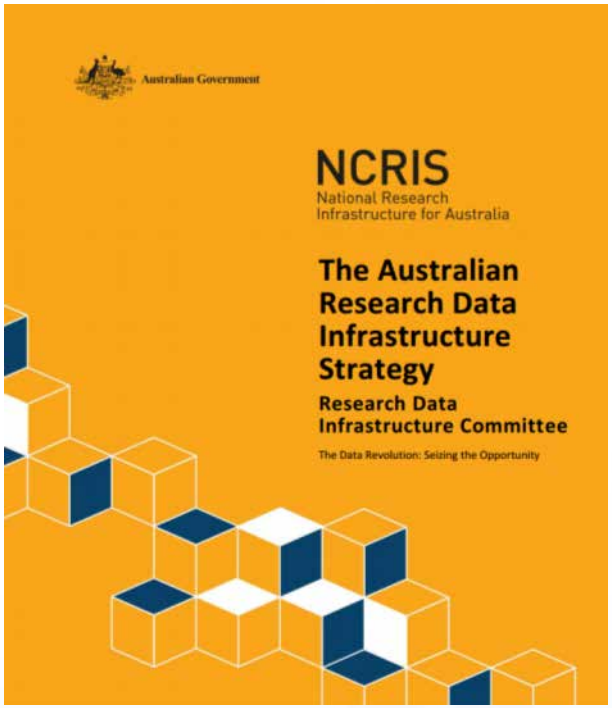
TARDIS

An Australian research data infrastructure system that *collects* data systematically and intentionally,

organises data to make it more valuable, and

uses data insightfully many times over



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More from the NEII …

Spatial Data Infrastructures (SDI) allow a network of datasets to be federated and interoperable by conforming to common data models, exchange formats, and standard network protocols, and by providing centralised catalogues of uniform metadata descriptions.

The SDI architecture represents state-of-the-art in large-scale environmental information systems and represents a low-risk path to realising an initial NEII capability.

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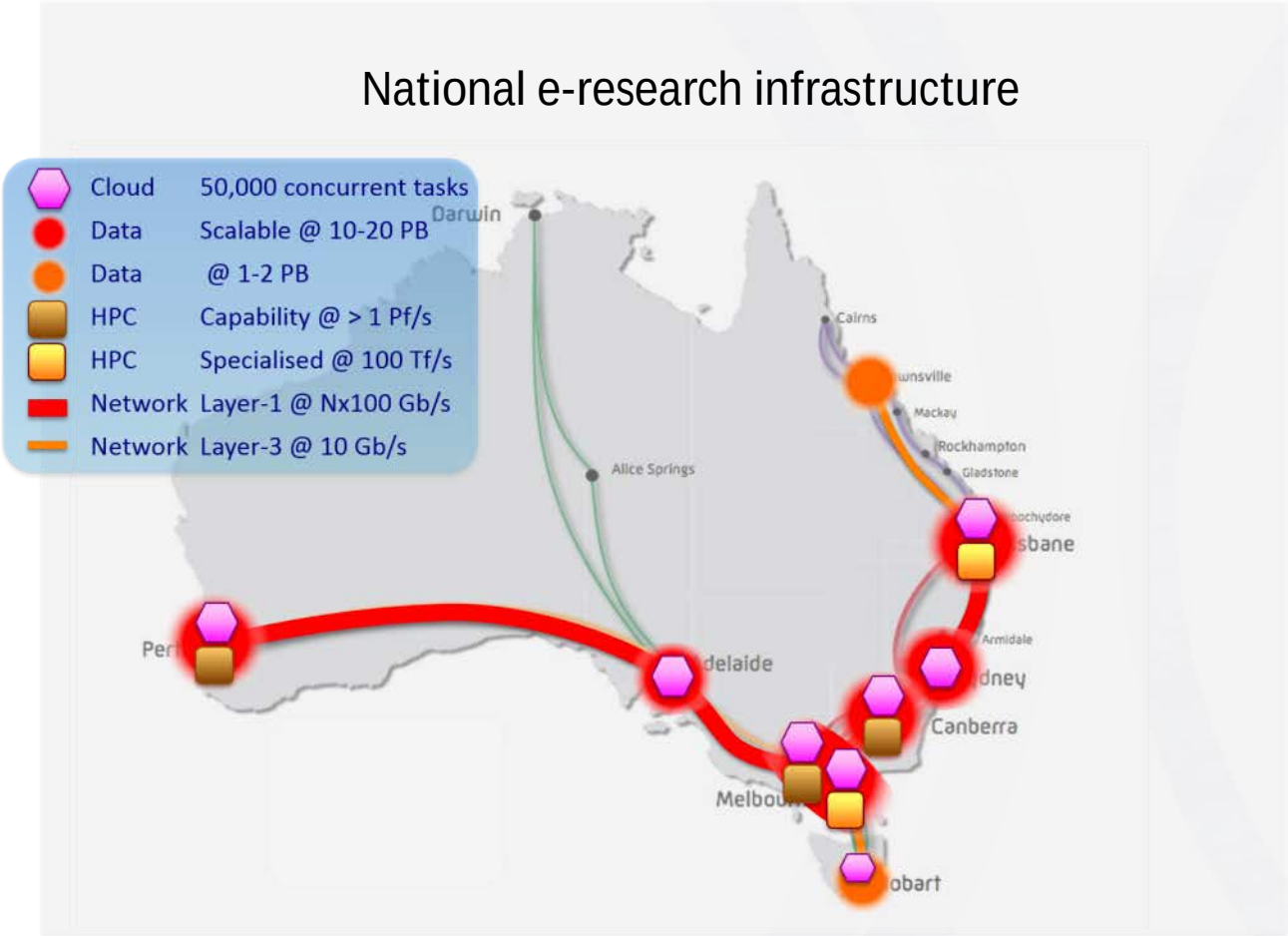
We are close to achieving this now …

We have a backbone architecture enabling large scale data collections to be located next to large compute facilities

We have two centres which focus on environmental and climate data

- NCI, Canberra
- TPAC, Hobart



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aarnet

RDSI Research Data Storage Infrastructure

NCI Trusted Platforms

Providing Trusted Science Platforms:

- Trusted and stable release
- flexible approach to technology change
- Both Test/Dev/Ops and patches/rollback become BAU
- Sharable bundles
- Can tag release of software stacks
- Precondition for trusted software stacks
- Provenance - Scientific / gov policy scrutiny

Packages and analytics	Virtual labs	NERDIP
Software mgmt Infr.	NCI Puppet Bundles	HDF5
Raijin - Supercomputer	Tenjin - OpenStack	Lustre

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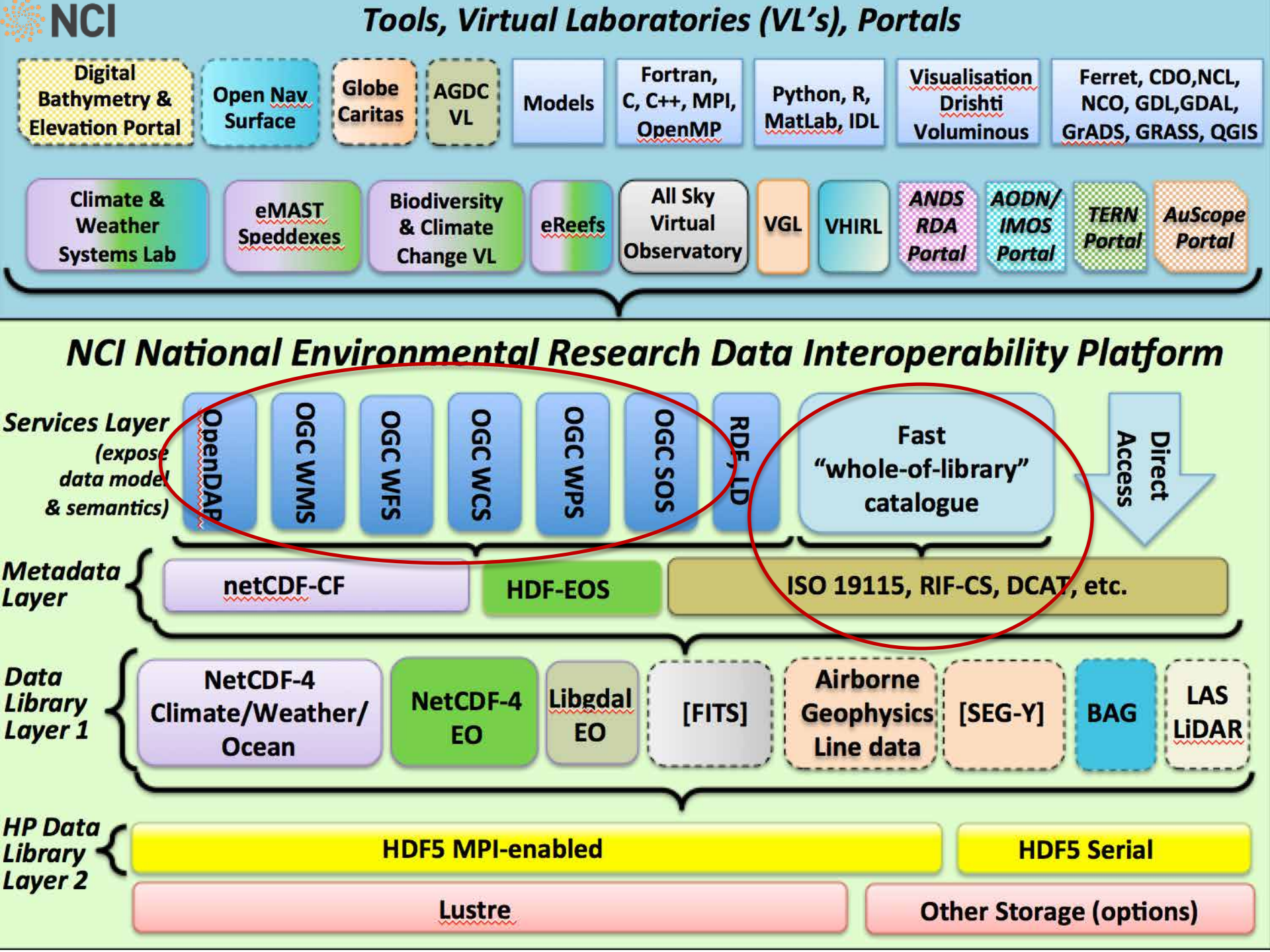
NCI
Tools, Virtual Laboratories (VL's), Portals
Digital Bathymetry & Elevation Portal
Open Nav Surface
Globe Caritas
AGDC VL
Models
Fortran, C, C++, MPI, OpenMP
Python, R, MatLab, IDL
Visualisation Drishti Voluminous
Ferret, CDO,NCL, NCO, GDL,GDAL, GrADS, GRASS, QGIS
Climate & Weather Systems Lab
eMAST Speddexes
Biodiversity & Climate Change VL
eReefs
All Sky Virtual Observatory
VGL
VHIRL
ANDS RDA Portal
AODN/ IMOS Portal
TERN Portal
AuScope Portal
NCI National Environmental Research Data Interoperability Platform
Services Layer (expose data model & semantics)
OpenDAP
OGC WMS
OGC WFS
OGC WCS
OGC WPS
OGC SOS
RDF, LD
Fast "whole-of-library" catalogue
Direct Access
Metadata Layer
netCDF-CF
HDF-EOS
ISO 19115, RIF-CS, DCAT, etc.
Data Library Layer 1
NetCDF-4 Climate/Weather/ Ocean
NetCDF-4 EO
Libgdal EO
[FITS]
Airborne Geophysics Line data
[SEG-Y]
BAG
LAS LiDAR
HP Data Library Layer 2
HDF5 MPI-enabled
HDF5 Serial
Lustre
Other Storage (options)

National Environment Data Collections

1. Climate/ESS Model Assets and Data Products
2. Earth and Marine Observations and Data Products
3. Geoscience Collections
4. Terrestrial Ecosystems Collections
5. Water Management and Hydrology Collections

Data Collections	Approx. Capacity
CMIP5, CORDEX	~3 Pbytes
ACCESS products	2.4 Pbytes
LANDSAT, MODIS, VIIRS, AVHRR, INSAR, MERIS	1.5 Pbytes
Digital Elevation, Bathymetry, Onshore Geophysics	700 Tbytes
Seasonal Climate	700 Tbytes
Bureau of Meteorology Observations	350 Tbytes
Bureau of Meteorology Ocean-Marine	350 Tbytes
Terrestrial Ecosystem	290 Tbytes
Reanalysis products	100 Tbytes

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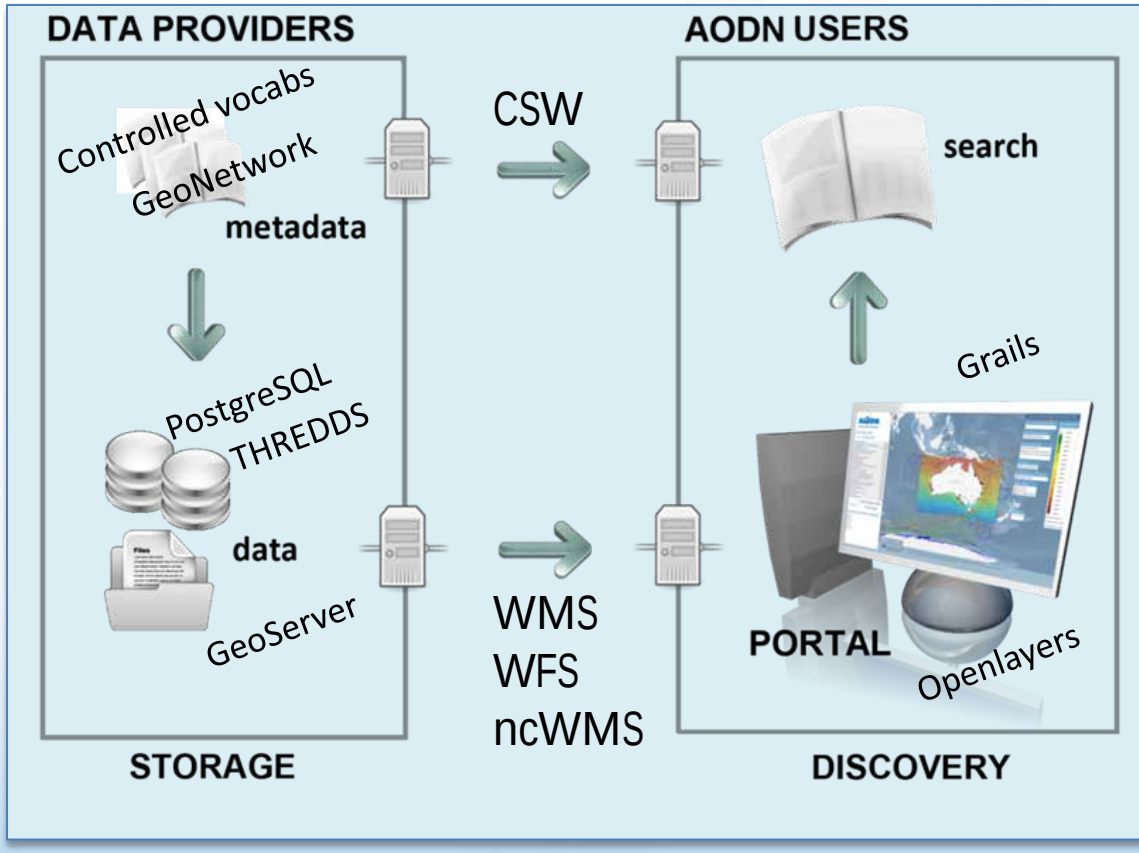
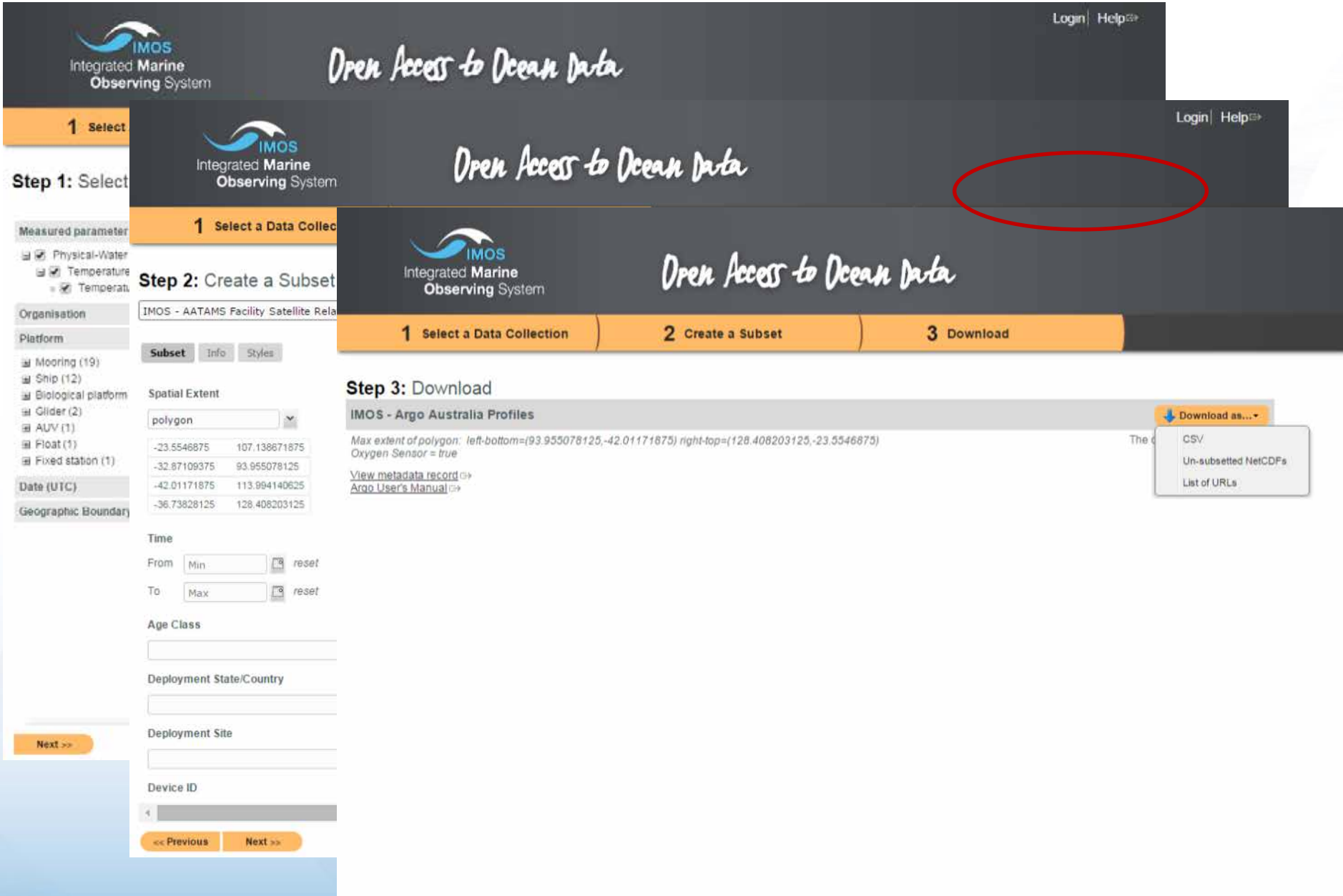
Australian Ocean Data Network

- Metadata standards
  - ISO compliant (19115-MCP2.0)
- Metadata exchange
  - Catalog services for the web (CSW)
- Controlled vocabularies
- Data format
  - NetCDF convention
  - Database guidelines
- Data visualisation
  - Web map service (WMS)
- Data download
  - Web feature service (WFS)
  - OPeNDAP
- Legal standards
  - Creative Commons

An online network of marine and coastal data resources delivered via standards



IMOS Ocean Portal



Shelf seas in-situ S and T 1995-2015– preparing for ANSR

Salinity and temperature measurements from many different sources have been assembled into a common data structure in a relational database.

Quality Control flags mapped to a common scheme and associated to each measurement.

Data Base
~25 million measurements

Data Atlas
¼ degree, 10 m vertical bins, monthly

- The Integrated Marine Observing System (IMOS)
  - Seals CTD profiles
  - Argo profiles
  - Glider deployments
  - Moorings
  - AUV deployments
  - Sensor networks in the Great Barrier Reef
  - Ship underway
  - CTD casts performed at National Reference Station
  - Real-time data collected at National Reference Station
- Royal Australian Navy (RAN)
  - Sea Surface Temperature measurements on the NSW coast
- The Australian Institute of Marine Science (AIMS)
  - CTD casts
- Defence Science and Technology Organisation
  - Glider deployments
- Charles Darwin University – Xavier Hoenner PhD study
  - Hawksbill turtles
- CSIRO Ocean and Atmosphere
  - Moorings
  - Trajectory
  - Ship underway
- Marine National Facility
  - Ship underway
- World Ocean Database 2013 (WOD) – Standard depth data products
  - XBT profiles (XBT)
  - CTD casts (CTD)
  - Surface only data (SUR)
  - Undulating Oceanographic Recorder (UOR)

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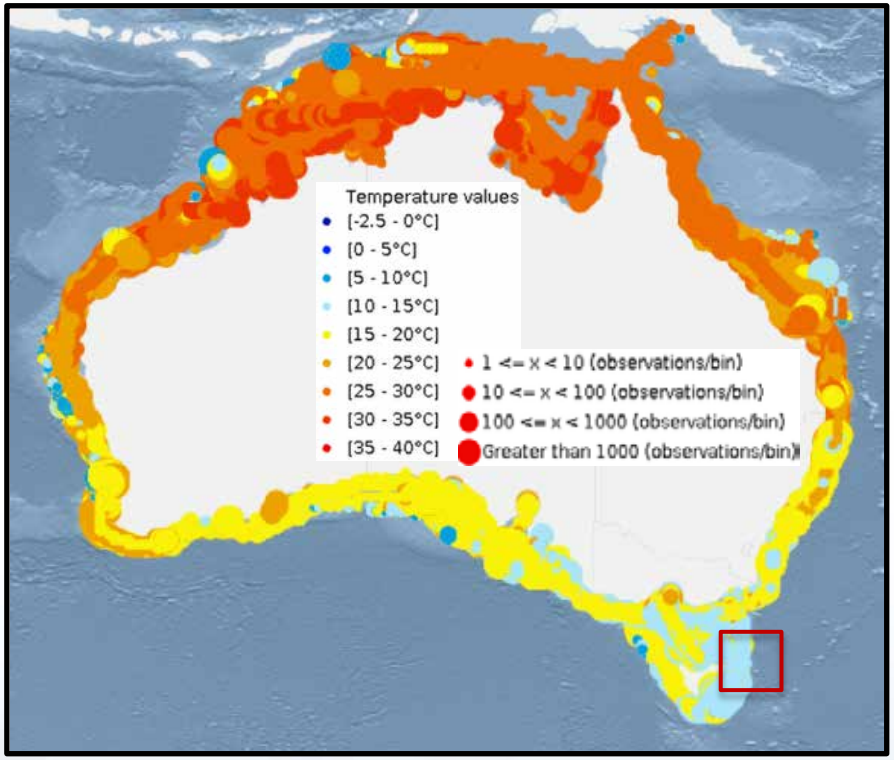
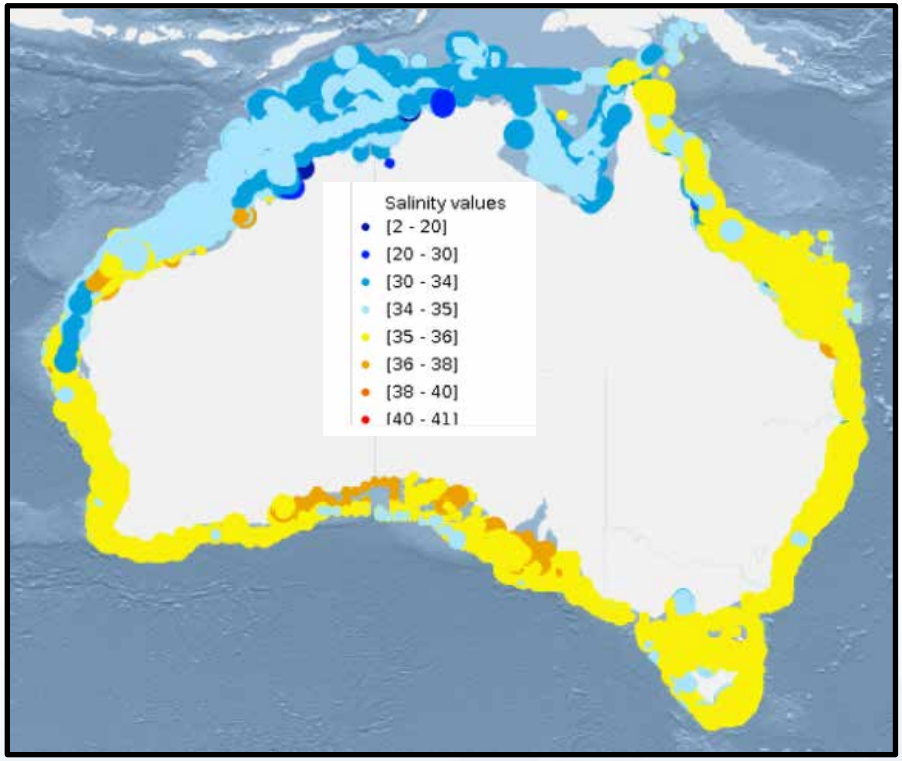
Shelf seas in-situ S and T 1995-2015– preparing for ANSR

Salinity and temperature WMS layers created in the IMOS portal, granule data accessible by WFS





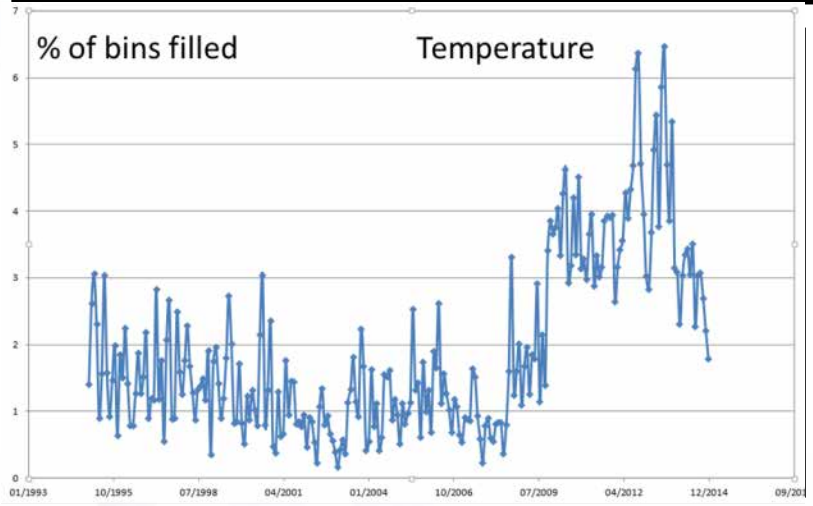
Example WFS request for S & T data between Oct 2010 and Jan 2011 at 20m depth

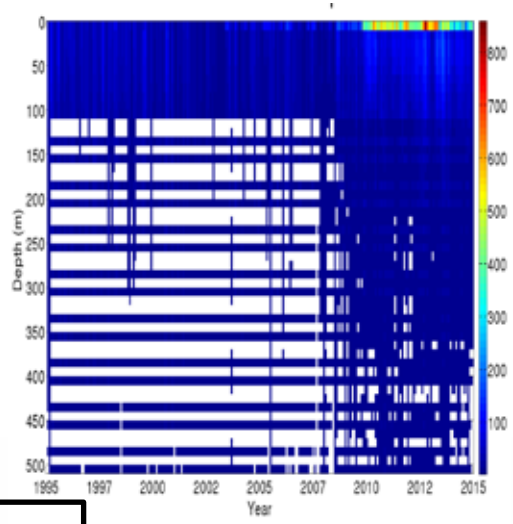
http://geoserver-123.aodn.org.au/geoserver/imos/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=imos:marvl3_atlas_data&cql_filter=INTERSECTS(geom_bin, POLYGON((148 -43 , 149 -43, 149 -41.5, 148 -41.5, 148 -43))) and TIME_bin >= '2010-10-01' and TIME_bin <= '2011-01-31' and DEPTH_bin = 20&outputFormat=csv

Shelf seas in-situ Salinity and Temperature Atlas

Bins: ¼ degree, 10 m depth (0-500m), monthly
Statistics: mean, standard deviation, minimum, maximum

Temperature – total number of bins with data





Impact of IMOS clearly seen from 2009 onwards

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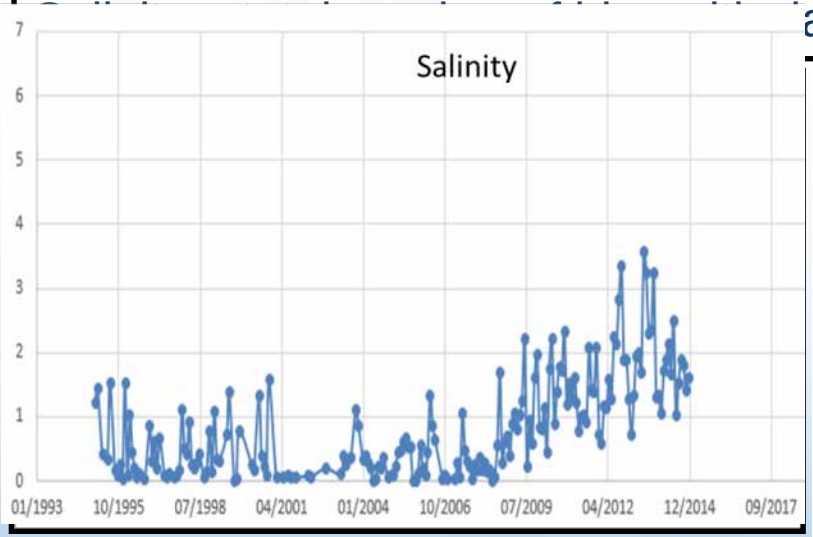
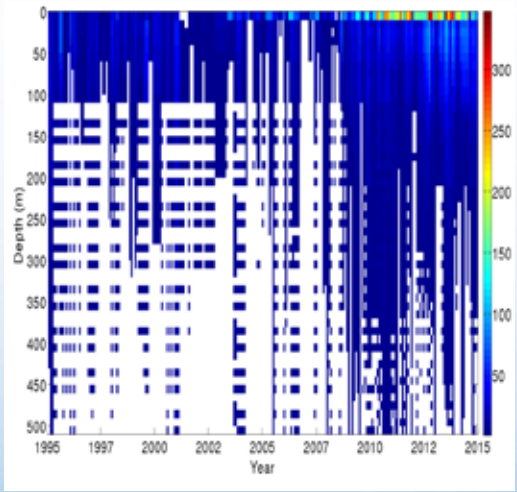
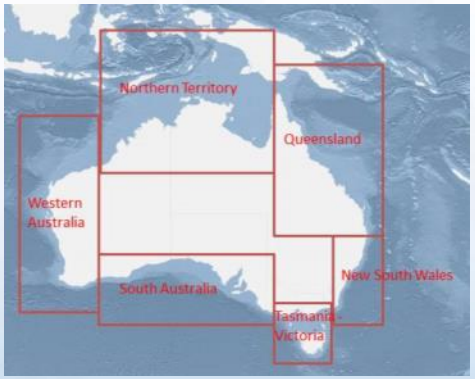




Impact varies from region to region, greater in QLD, SA & Tas-Vic



The Marine Virtual Laboratory

MARVL allows a non-specialist, through a web browser,
to configure and run a model,
automating many of the modelling preparation steps needed
to bring the researcher faster
to the stage of simulation and analysis.

User specifies:
- à Time-space domain
- à Model grid
- à Model (ROMS, SHOC, MOM4, SWAN, WaveWatch3)
- à Parent ocean model
- à Met forcing
- à Deployment option:
  - à Take-away
  - à Nectar Cloud
  - à HPC

Generic model configuration (boundary conditions, forcing, etc.)

Data-extracter and re-gridder

Parent ocean model datasets: BRAN3, GLORYS, FOAM, OFAM, ...

Topography (global 1km)

Meteorological forcing: NCEP, ACCESS

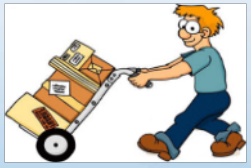
Ocean Observations from Integrated Marine Observing System

Take-away bundle compiled

Take-away bundle delivered to user

HPC deployment

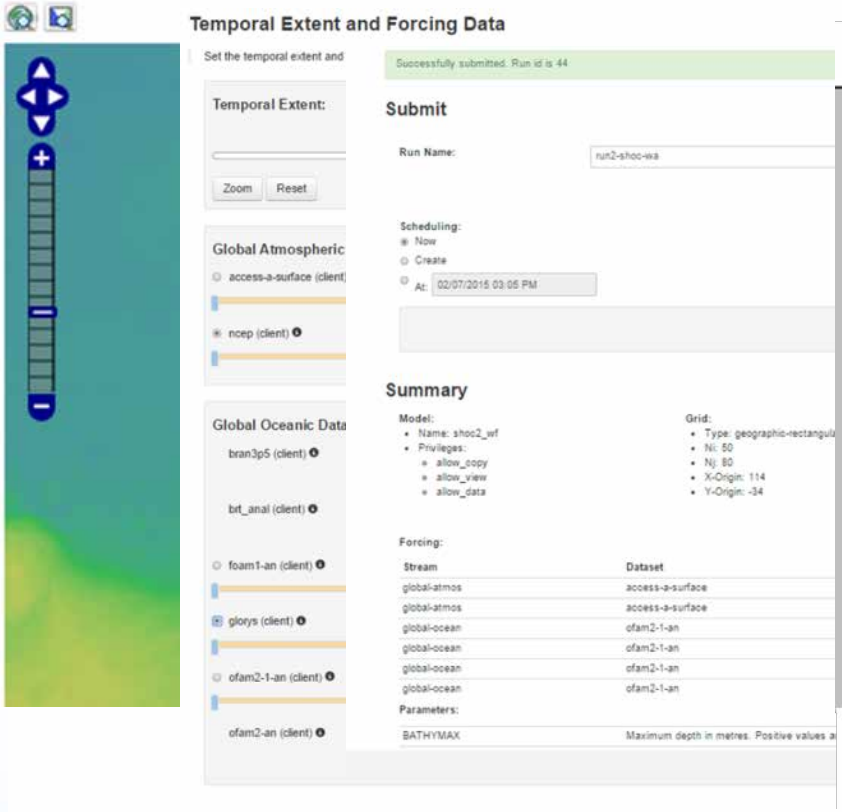
Cloud deployment

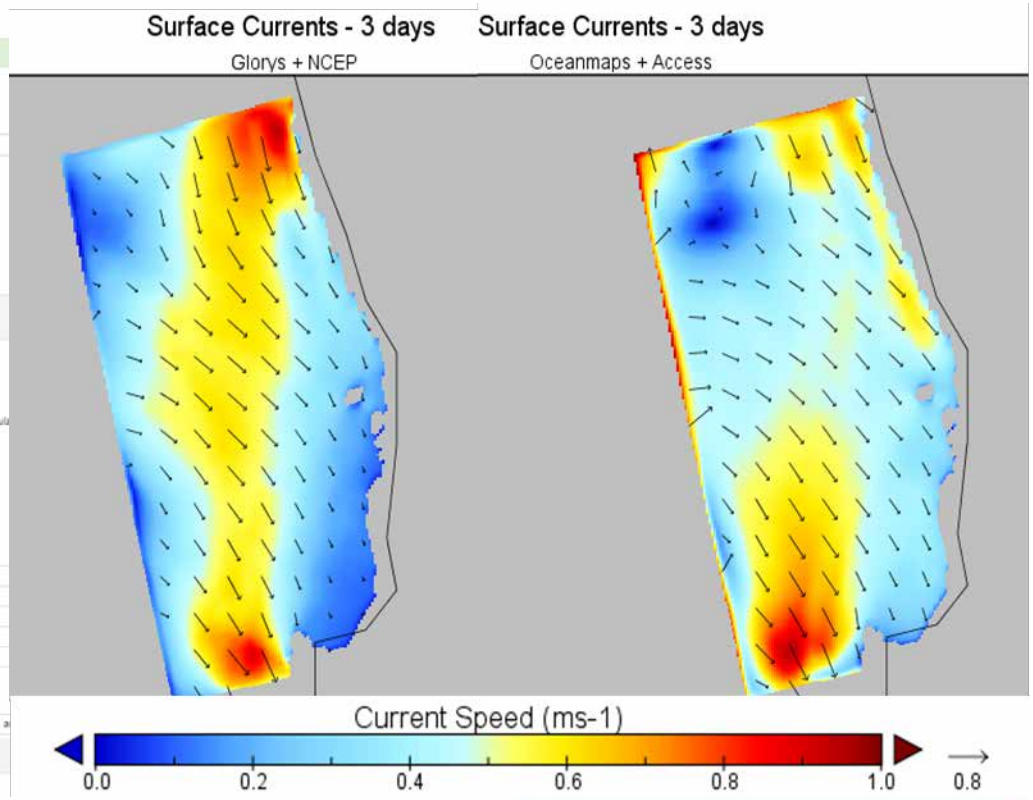


SHOC, SWAN

Grid Definition

Origin is large white circle, Longitude and Latitude are WGS84





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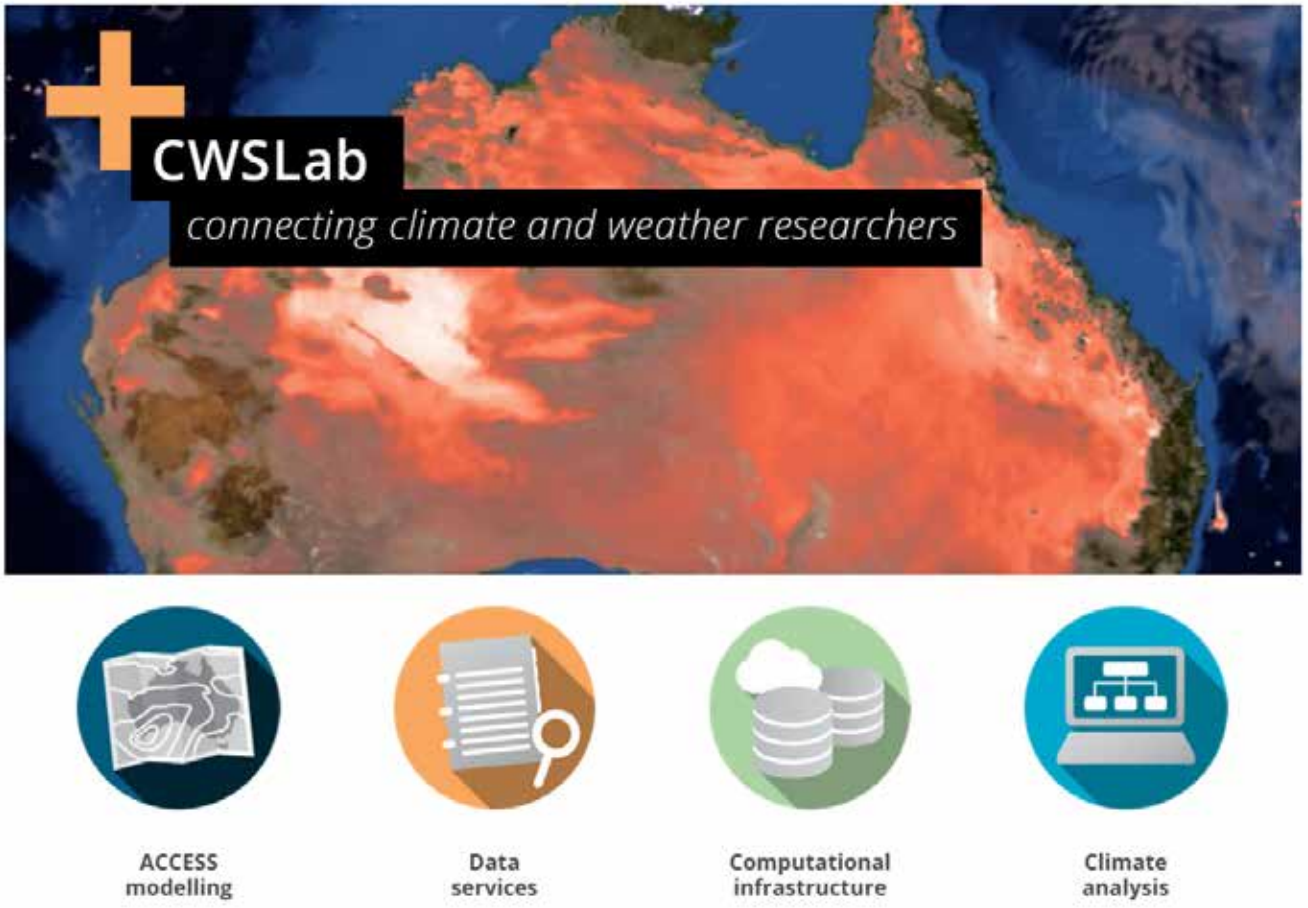
Climate and Weather lab

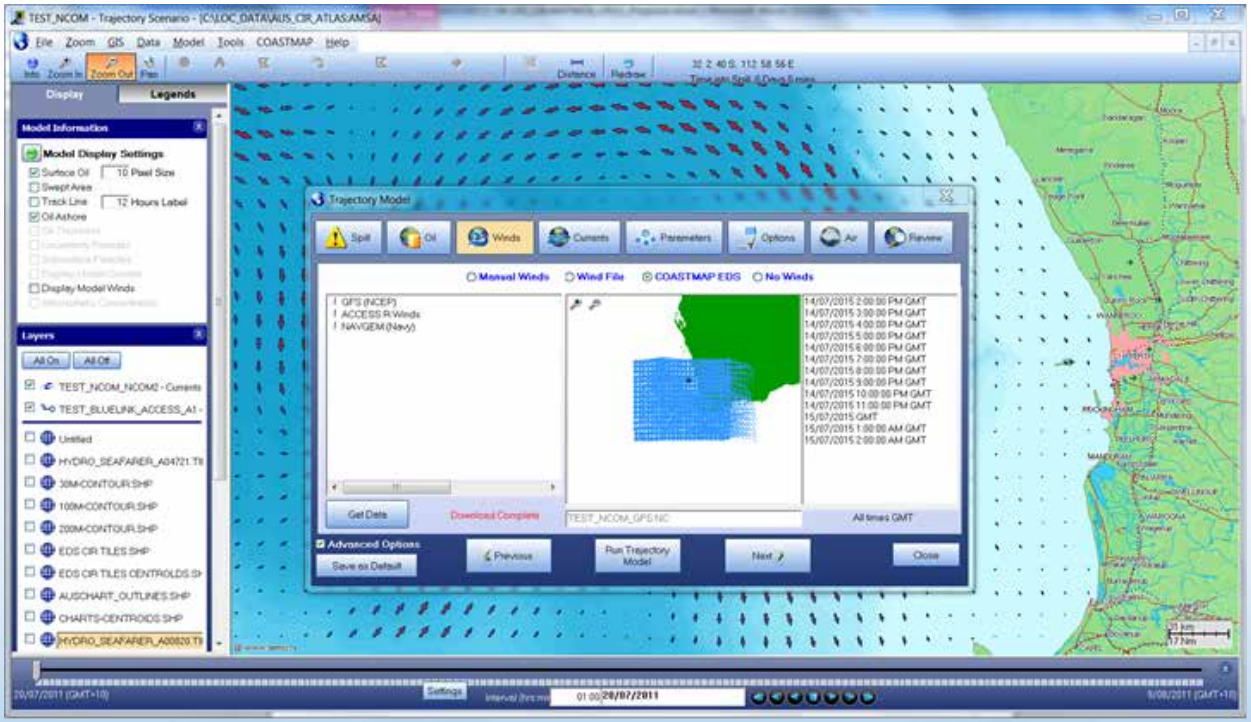
The Climate & Weather Science Laboratory (CWSLab) is an innovation in climate data analysis enabled at NCI – http://cwslab.nci.org.au/



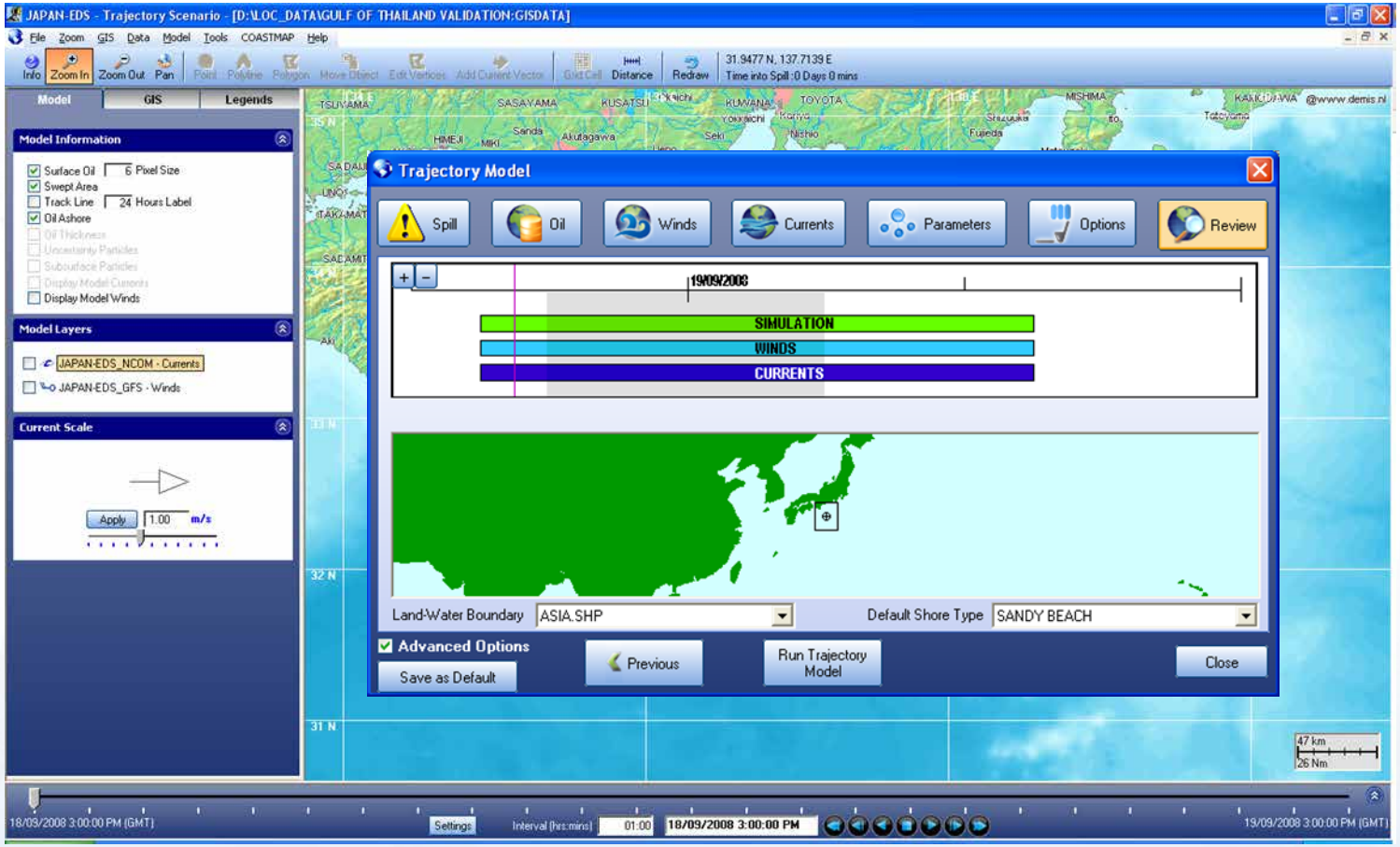
COASTMAP-EDS

(Environmental Data Server)

ASA's dedicated emergency marine response system (OILMAP, CHEMMAP, SARMAP) connects to on-line, daily updated (live) forecasting systems using the COASTMAP Environmental Data Server (EDS) that integrates observation data (in-situ meters, sea surface radar, etc.) and global, national, and regional weather forecasts.



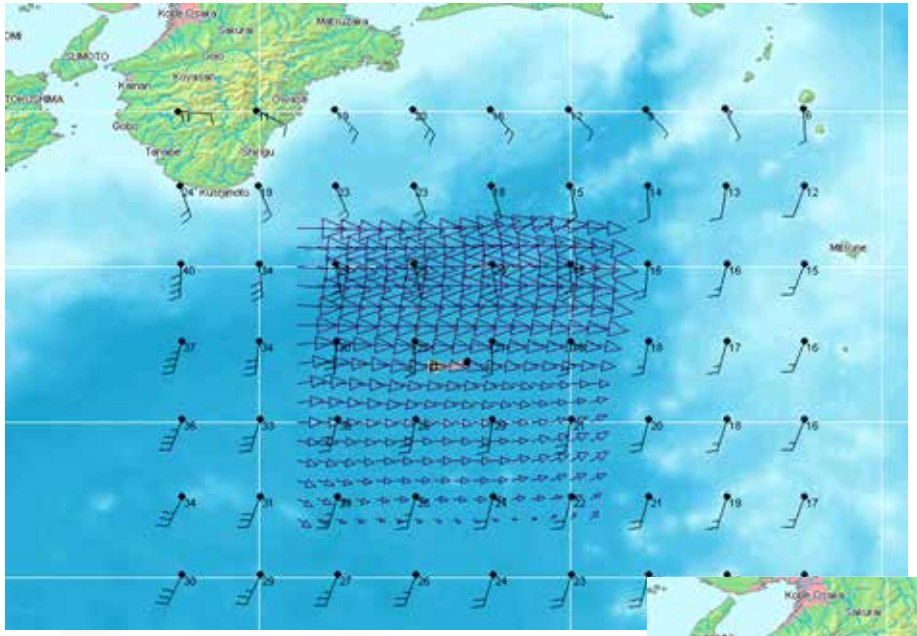
EDS has options for downloading different forcings and tides, and ensuring synchronisation



End-user can then choose to run, for example, a trajectory simulation

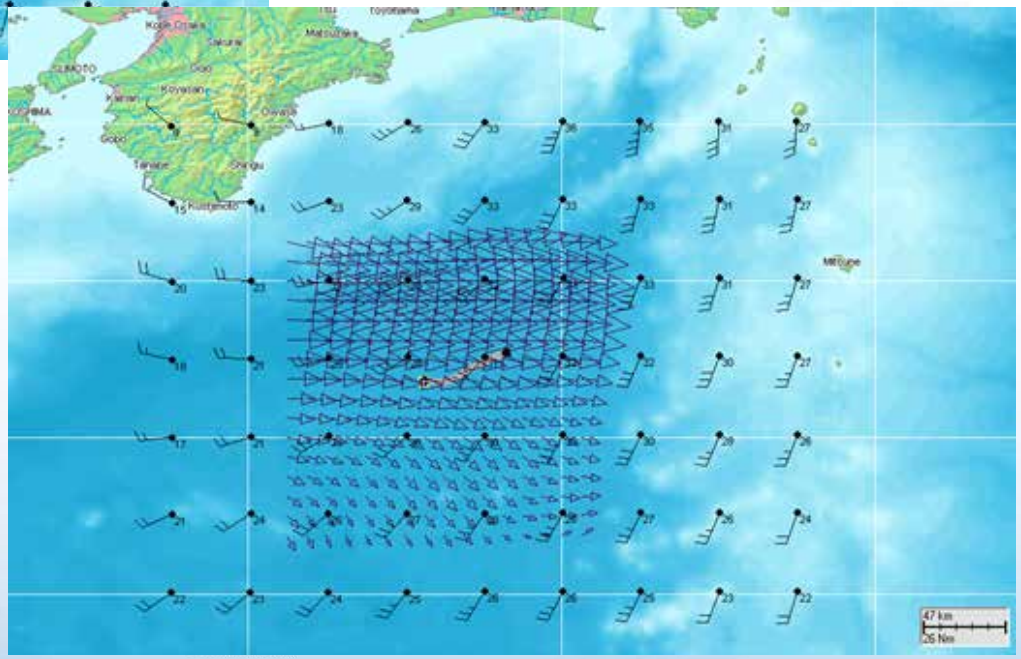
Thanks to Brian King

+ 12 hrs drift



This is very fast and allows the user to make a prediction in a matter of minutes without needing to manually enter data

+ 24 hrs drift



The data are now useful for some practical purpose eg drift prediction

Where is the world headed? Interoperability

Projects and forums are many for developing common approaches to data structures and metadata conventions

- Ø Ocean Data Interoperability Platform (ODIP, www.odip.eu)
  - EU-US-AUS project developing prototypes of interoperability for mutual activities
- Ø Earth Science Information Partners (ESIP, www.esipfed.org)
  - 200 organisations developing interoperable solutions
- Ø Research Data Alliance (RDA, https://rd-alliance.org)
  - Building the social and technical bridges that enable open sharing of data through Interest Groups and Working Groups; 3000 individuals from 102 countries
- Ø OGC, W3C, …

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Where is Australia headed?

- Recognised the importance of adopting international standards – working with international communities
- Recognised the need for seamless interconnected large data stores and compute infrastructure – a national backbone
- Enabling search, discovery and access to standardized collections within compute environments – virtual laboratory examples
- These attributes emphasised in the Bureau Marine Strategy and the new National Marine Science Plan (release August 2015)

All providing important stepping stones for developing Operational Oceanography in Australia

Forum for Operational Oceanography

Thanks for listening

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Ben Evans – ben.evans@anu.edu.au

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