



Digital Antarctica

B2. Refined Current State

April 2022

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Version information

| Version | Description | Author | Date |
|---------|--|--------------|------------|
| 1.0 | Initial Release Version | Rob Jennings | 4/3/2022 |
| 2.0 | Release version after DARG review | Rob Jennings | 27/04/2022 |
| 3.0 | Added Metadata standards table after external review | Rob Jennings | 15/7/2022 |

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Executive summary

This document provides information on the data holdings and data patterns of the Australian Antarctic Program Partnership (AAPP) organisations individually and the AAPP as a whole. For each organisation, it details the organisation's general data sharing practises, as well as specific data statistics. Across the AAPP, it includes collated statistics, some analysis of research categories and data formats, and a wider data pipeline to show the interconnectedness of the AAPP organisations.

Each organisation within the AAPP houses data which reflect the specialisation of the organisation in question. For example, the Bureau of Meteorology mainly houses climate data while IMAS mainly houses ocean data. The entire partnership holds data that span most of the GCMD Earth Science categories, but when viewed together, certain patterns do emerge. Most organisations host ocean data, and so across the partnership the AAPP has a notably high instance of ocean data. There are also significant numbers of atmosphere, biosphere climate, and biological datasets.

Likewise, data formats vary across the organisations and the research types however patterns can be found. A large amount of data in the AAPP are stored in some form of table (e.g. a spreadsheet, CSV, or database), or as some form of spatial data format (e.g. netCDF).

When looking for areas of early success, *Digital Antarctica* could concentrate on developing standards for recording these research and data formats to ensure the greatest impact.

Introduction

This document defines the current state of Antarctic data within the context of the AAPP and within the data scope of *Digital Antarctica*. It will be used to help identify the areas of concern to be addressed in the future documents.

This document is the culmination of a number of workshops held with the *Digital Antarctica* reference group (as a group and individually) and is based off the earlier high-level current state document, which defined the current state of each of the data centres represented by the reference group without specifically focussing on the scope of the *Digital Antarctica* project. The prior high-level document is not a pre-requisite to this current document: all content and concepts from the high-level document which are relevant to the scope of *Digital Antarctica* are represented in this refined document.

Data centre data scope

Each section below briefly covers the scope of the data centres within the AAPP and provides a view of the data holdings in context of GCMD keyword and file format.

See the *Research categories* and *Data file formats* sections within the *Collated statistics* section below for information on the research categories, the data format categories, and how these data were gathered and arranged.

Note that, as the scope of *Digital Antarctica* is in serving existing data, this document will not focus on the acquisition and processing of data. The previous high-level document contains additional detail for how each data centre obtains and processes its data.

Australian Antarctic Division

Organisation overview

The Australian Antarctic Division (AAD) is a division of the Department of Agriculture, Water, and the Environment, and undertakes and administers research projects in and around Antarctica and the Southern Ocean. The Australian Antarctic Data Centre (AADC) is the primary data centre for the AAD and hosts most of the data recorded for Australian Antarctic Program science projects. The AADC hosts around 2,000 datasets of Australian Antarctic and Southern Ocean data, encompassing any science data relating to the Australian Antarctic Program.

Data and metadata

All data available via the AADC have associated metadata. The AADC uses the DIF metadata standard¹, using the AADC's internal DIF profile (developed to ensure compatibility with other standards, including the Marine Community Profile (MCP) and ISO 19115-1). Each metadata file in the AADC's catalogue is enriched with schema.org tags to ensure that the metadata records are discoverable via Google's Dataset Search.

Most data available via the AADC portal are available to the general public. Of those available data, some require an email address to be delivered and some may be subject to an embargo period during which data may not be made publicly available. As per the AADC data policy, a small number of datasets are not made public as they are sensitive or commercial-in-confidence (although commercial data may undergo generalisation to render the data publishable in some circumstances).

The AADC website hosts a general data discovery portal for data consumers to search for research data, as well as specialised data portals such as

- the Automated Weather System,
- Map Catalogue and
- Gazetteer.

Data are also available via OGC web services on GeoServer² and RESTful APIs, which have associated documentation on their use³. Files are stored in, and delivered via, Amazon S3 services, which can support other cloud services and applications.

¹ For more information on DIF, see <https://earthdata.nasa.gov/esdis/eso/standards-and-references/directory-interchange-format-dif-standard>

² See <https://data.aad.gov.au/geoserver/web/>

³ For an example, see <https://data.aad.gov.au/aws/api/docs/>

Statistics

Based on GCMD Keywords, the top 5 research types at the AADC are Biological, Oceans, Biosphere, Atmosphere and Cryosphere. The AAD datasets mainly contain tabular data.

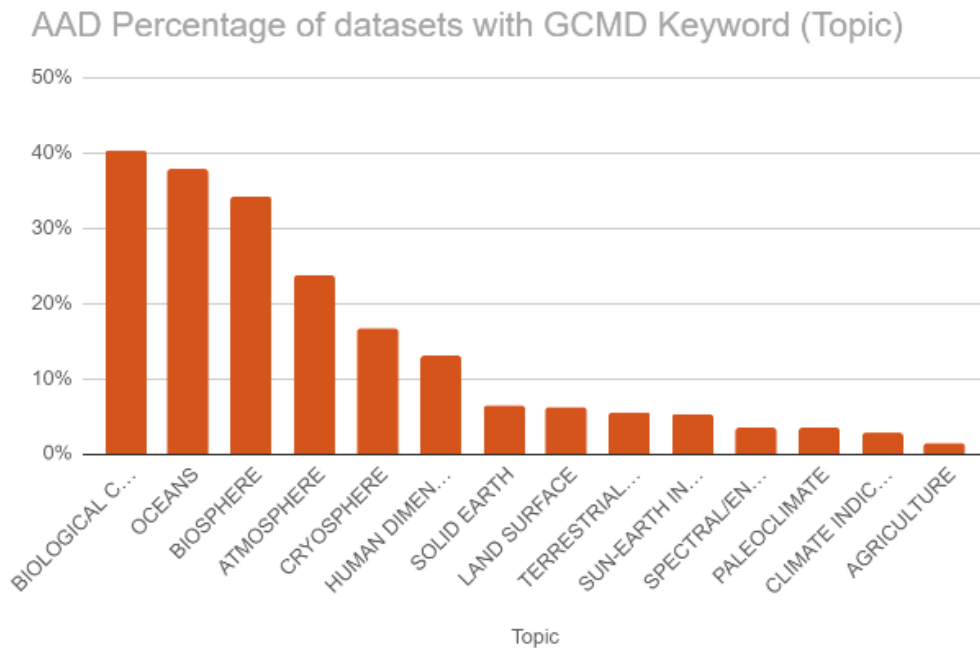


Figure 1 - Number of AAD datasets containing data of each GCMD topic, represented as a percentage of total AAD datasets. E.g. 40.36% of AAD datasets contain "Biological Classification" data.

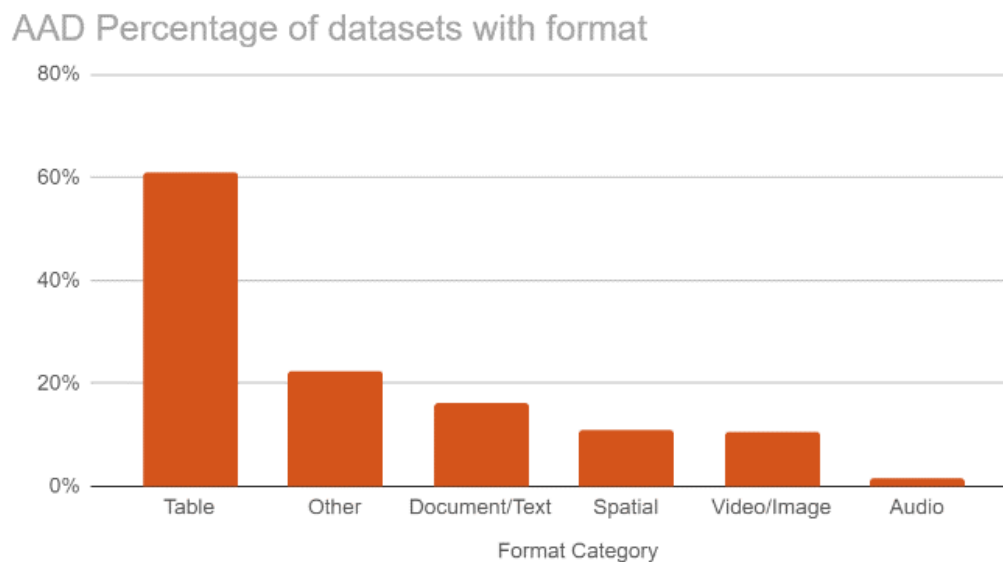


Figure 2 - Number of AAD datasets of a particular file format category, represented as a percentage of total AAD datasets.

Data pipelines

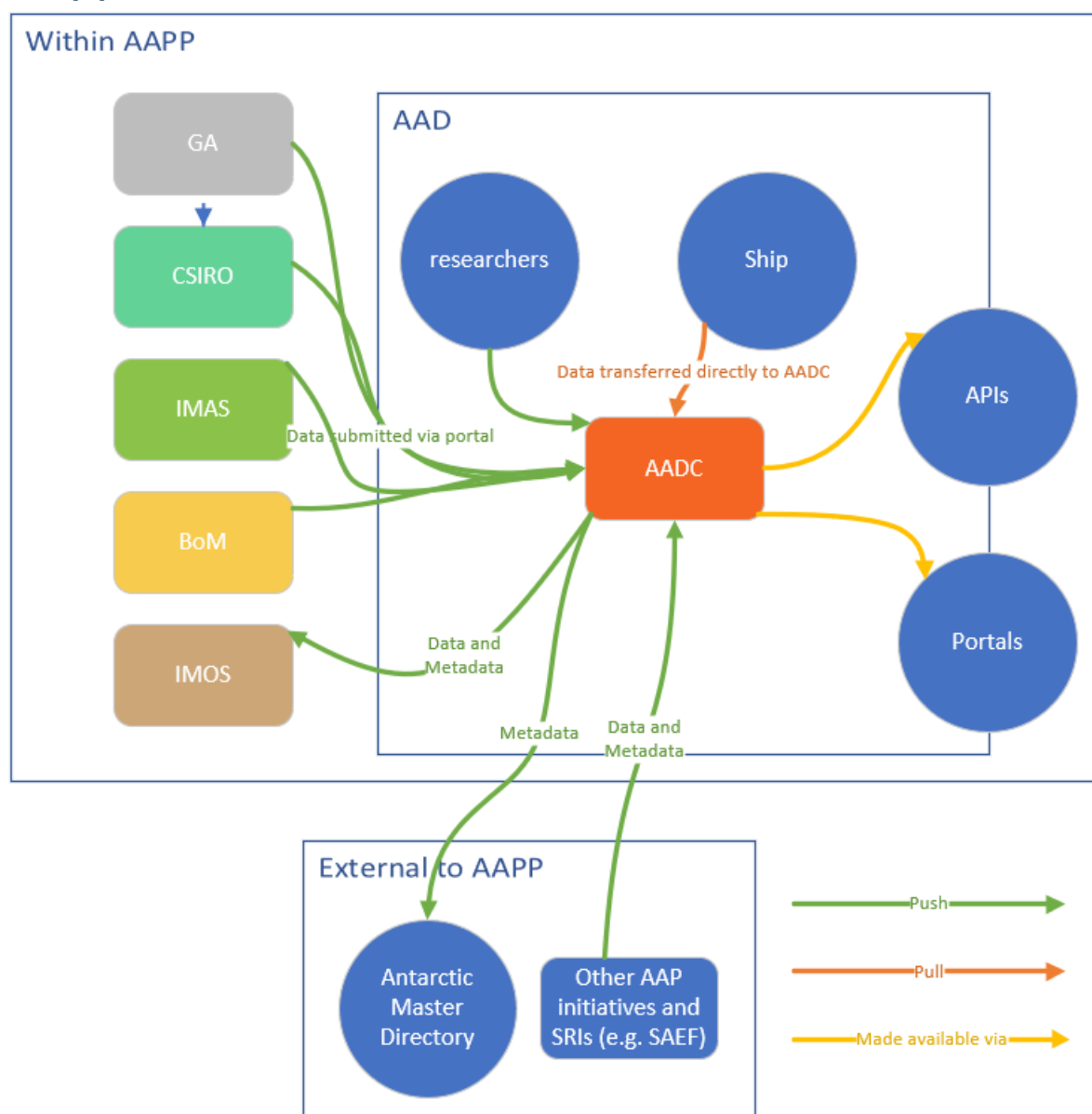


Figure 3 - Data flow within the AAD, between the AAD, the AAPP Partners and between external entities

Bureau of Meteorology

Organisation overview

The Bureau of Meteorology (the Bureau) is Australia's national weather, climate, and water agency, providing a wide range of products and services to support informed decision-making by governments, emergency services, industry, and the community. The Bureau's products and services include a range of observations, forecasts, warnings, analyses, and advice covering Australia's atmosphere, water, ocean, and space environments.

Data and metadata

Metadata for Bureau data are created using internal standards based on ISO 19115.

Data and data products are findable via the Bureau's metadata catalogue⁴ which provides access to all of the Bureau's data that have associated metadata. Real-time weather observations and forecasts

⁴ <http://www.bom.gov.au/metadata/catalogue/index.shtml>

are available via the Bureau's main website⁵ and their publicly available Android and iOS apps⁶. Archived observations are also available through the website's Climate Data Online portal⁷, which provides a search of the Bureau's data recorded at stations using standard spatial data search facilities. Data are also available to find and download directly via FTP⁸, via their WIS catalogue,⁹ and the Weather Station Directory¹⁰.

Statistics

Much of the Bureau's data are observational data which covers a broad range observation types and parameters and may be used by others for specific research in a number of different fields. As such, specific GCMD Earth Science keywords may not apply to the data. However, based on the general intent of the collections, the following trends can be determined.

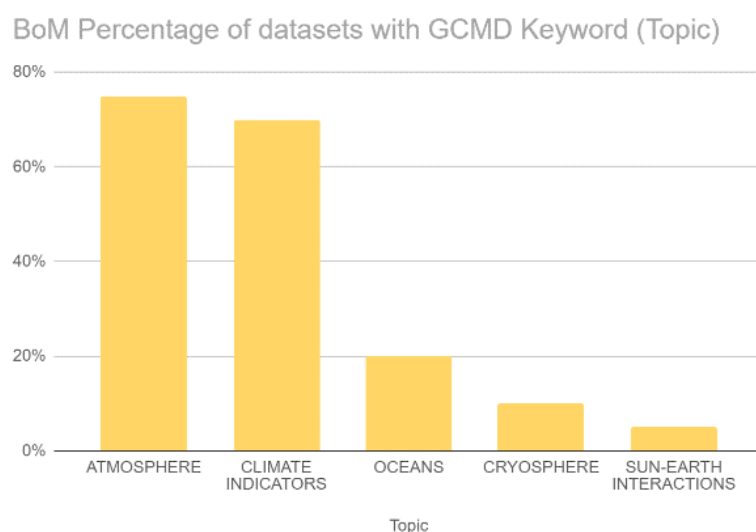


Figure 4 - Number of BoM datasets containing data of each GCMD topic, represented as a percentage of total BoM datasets.

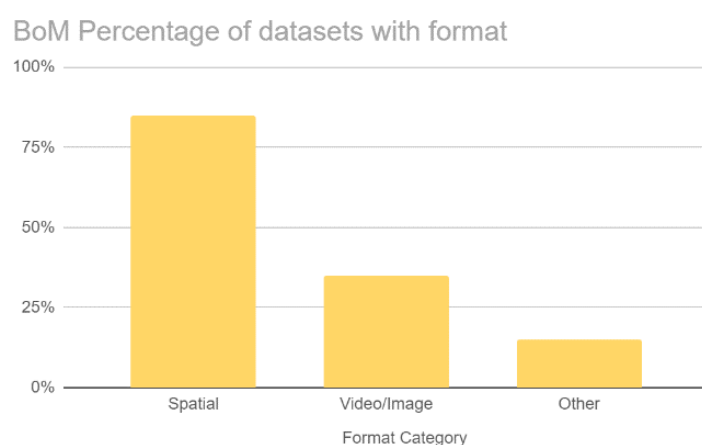


Figure 5 - Number of BoM datasets of a particular file format category, represented as a percentage of total BoM datasets.

⁵ <http://www.bom.gov.au/>

⁶ <http://www.bom.gov.au/app/>

⁷ <http://www.bom.gov.au/climate/data/>

⁸ <http://www.bom.gov.au/catalogue/anon-ftp.shtml>

⁹ <http://wis.bom.gov.au/openwis-user-portal/srv/en/main.home>

¹⁰ <http://www.bom.gov.au/climate/data/stations/>

Data pipelines

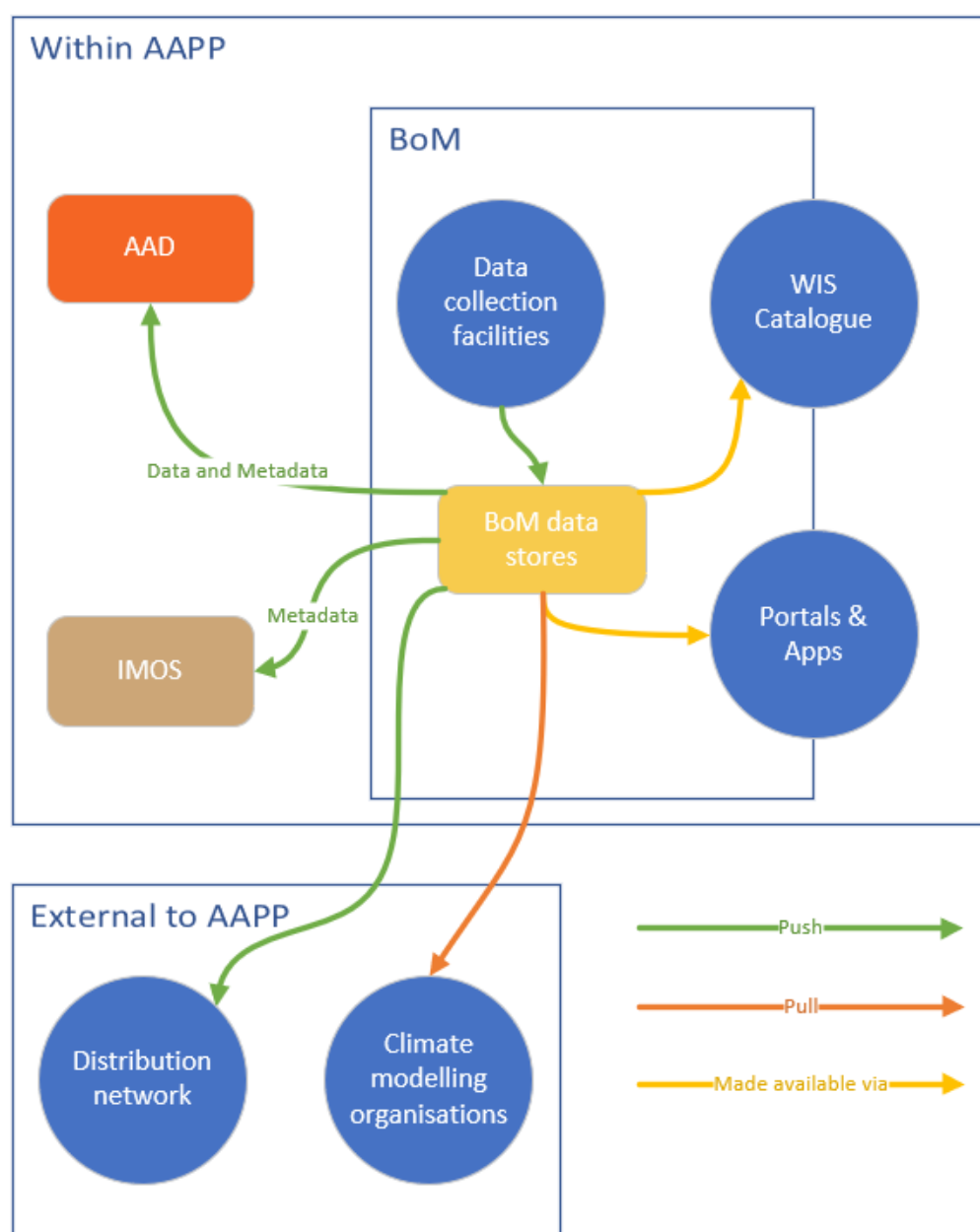


Figure 6 - Data flow within BoM, between the BoM and the AAPP Partners, and between external entities

Commonwealth Scientific and Industrial Research Organisation Organisation overview

The CSIRO works with industry, government, and the research community to solve Australia's greatest challenges through innovative science and technology. The Marine National Facility (MNF) provides a blue-water research capability to the Australian research community and their international collaborators. The Australian Government funds the MNF, which is owned and operated by the CSIRO. The MNF operates the ocean-class Research Vessel (RV) Investigator, capable of supporting biological, oceanographic, hydrographic, geological, and atmospheric research.

The Information and Data Centre (IDC) team, part of CSIRO's National Collections and Marine Infrastructure (NCMI) business unit, manages data collected by the MNF, including the RV Investigator and other vessels, following standards-based data management and globally-agreed data

principles. The IDC team disseminates CSIRO marine data through national and international channels (such as the Australian Ocean Data Network and the Ocean Biodiversity Information System), ensuring and enhancing FAIR access to CSIRO marine data.

Data and metadata

The IDC creates metadata records in the ISO 19115-3 standard, using the MCP where relevant, and makes use of vocabularies provided by other organisations such as BODC and AODN.

CSIRO marine data are available on a number of different portals within and outside of CSIRO. MNF's primary metadata portal is MARLIN¹¹, and the IDC runs a number of other portals for CSIRO marine data, available at their data page¹². CSIRO marine data are also available via external portals, including Geoscience Australia's AusSeabed, the AODN, and the Atlas of Living Australia and are also used by the Bureau of Meteorology in its operations.

CSIRO marine data are also available via Australia's Ocean Biodiversity Information System (OBIS) Node. The IDC hosts these data, which involves collecting and processing those data from various organisations and hosting them on behalf of OBIS. These data include biological datasets from Antarctica and the Southern Ocean.

The IDC also publishes a number of Web Services which enable the discovery of different data, including real-time tracking of the *RV Investigator*¹³. It provides links to the CSIRO NCMI GeoServer site¹⁴ and OBIS Australia¹⁵, which includes CSIRO marine data.

Statistics

CSIRO IDC data are overwhelmingly focussed on Ocean data, but are spread very broadly across the various data types.

CSIRO-IDC Percentage of datasets with GCMD Keyword (Topic)

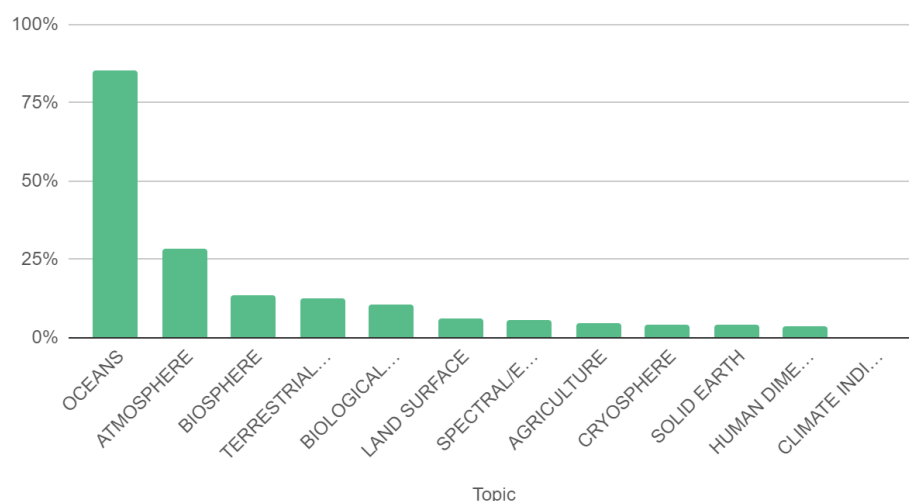


Figure 7 - Number of CSIRO-MNF datasets containing data of each GCMD topic, represented as a percentage of total CSIRO-MNF datasets.

¹¹ <https://marlin.csiro.au>

¹² <https://mnf.csiro.au/en/MNF-Data>

¹³ <https://www.marine.csiro.au/data/services/>

¹⁴ <http://www.cmar.csiro.au/geoserver/web/>

¹⁵ <http://www.obis.org.au/>

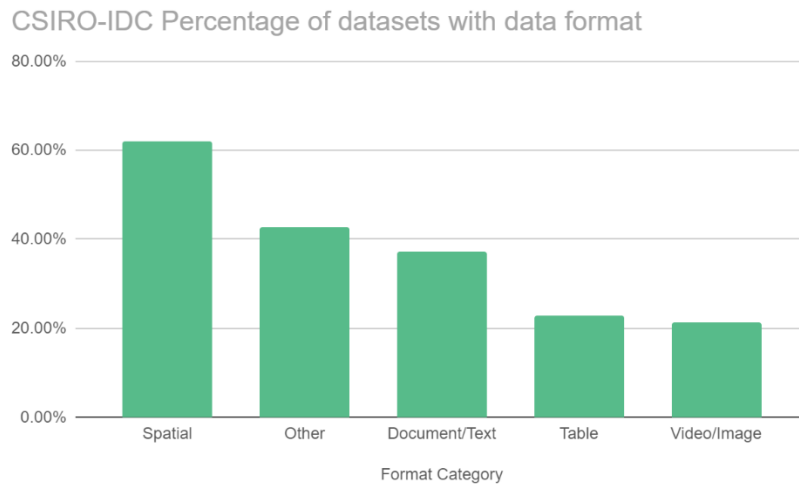


Figure 8 - Number of CSIRO-MNF datasets of a particular file format category, represented as a percentage of total CSIRO-MNF datasets.

Data pipeline

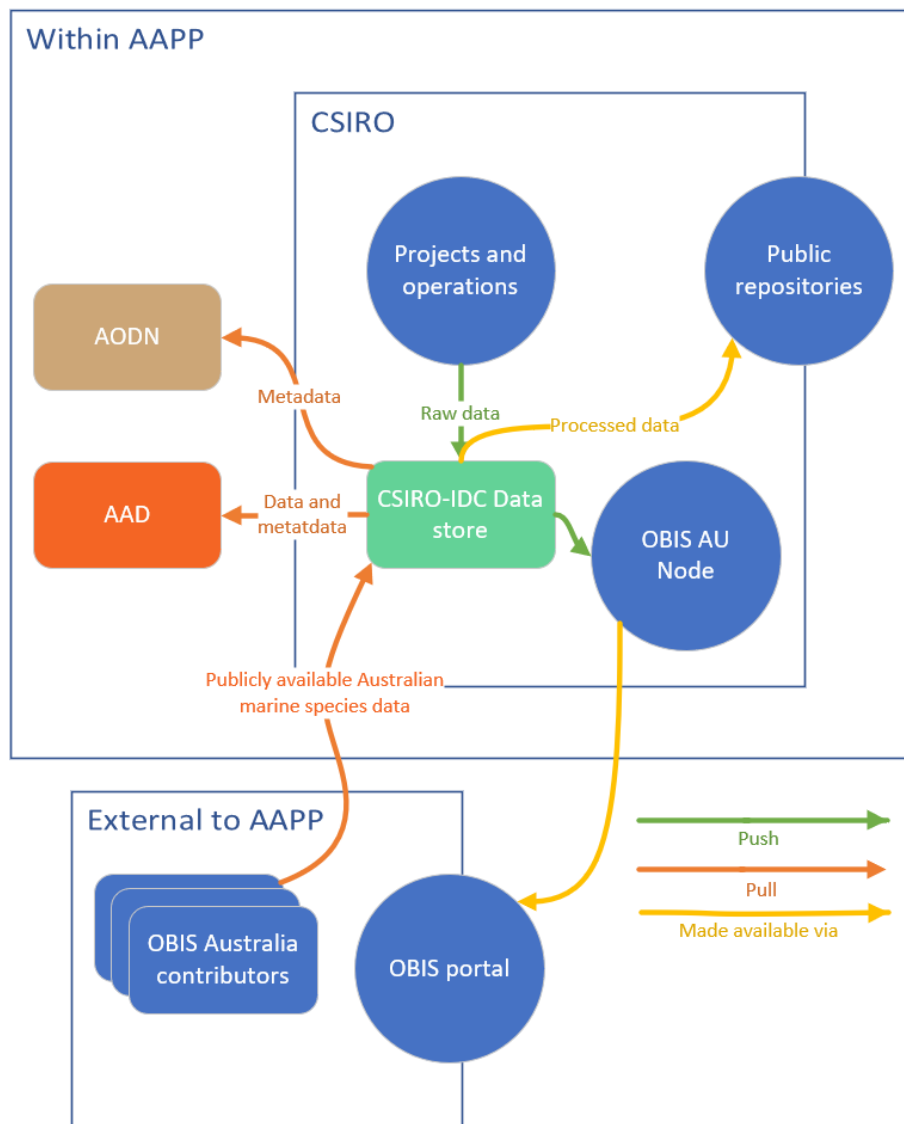


Figure 9- Data flow within CSIRO, between CSIRO and the AAPP Partners and between external entities

Geoscience Australia

Organisation overview

Geoscience Australia¹⁶ (GA) gathers and provides a wide range of geological and geographic data to meet the Australian Government's geoscience requirements. GA's remit includes all Australian jurisdictions, including marine and Antarctic regions. The types of data that it provides include, but are not limited to, marine data, geology, geophysics, geochemistry, satellite imagery, and other imagery.

Data and metadata

Public metadata are applied to all datasets that are published and available via GA's enterprise catalogue (known internally at GA as eCat¹⁷), which uses the ISO 19115 standard. GA uses their published profile for ISO 19115¹⁸ to ensure that metadata are recorded consistently within the ISO standard. Additionally, GA is working on creating and using defined vocabularies based on NASA's GCMD¹⁹.

Data publication and availability

GA provides a number of data portals through which public consumers can find and retrieve data. Most GA datasets are stored in the cloud via Amazon Web Services (AWS) or other services for distribution and an increasing amount of data processing is occurring in the cloud. Data may also be accessed directly via HTTP and other file protocols for certain users, as well as on request.

There are over 140 web services available, providing a combination of OGC and ESRI map services. A list of many of the public web services that GA provides can be found on their services website²⁰.

Statistics

GA's Antarctic and Southern Ocean Data focusses mainly on the oceans, with some focus on Solid Earth data, and the majority of the data are available as spatial data (e.g. via Shapefile).

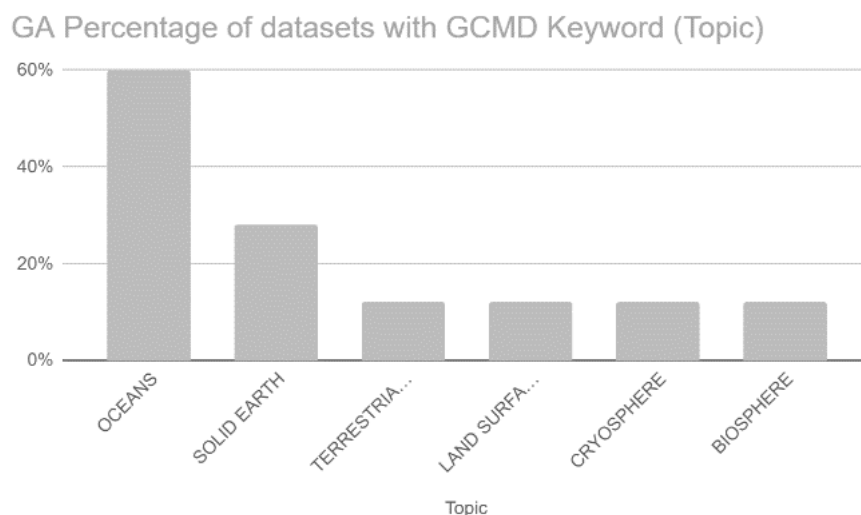


Figure 10 - Number of GA datasets containing data of each GCMD topic, represented as a percentage of total GA datasets.

¹⁶ <http://www.ga.gov.au/>

¹⁷ <https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/home>

¹⁸ <http://dx.doi.org/10.11636/Record.2018.026>

¹⁹ <https://earthdata.nasa.gov/earth-observation-data/find-data/idn/gcmd-keywords>

²⁰ <http://services.ga.gov.au/>

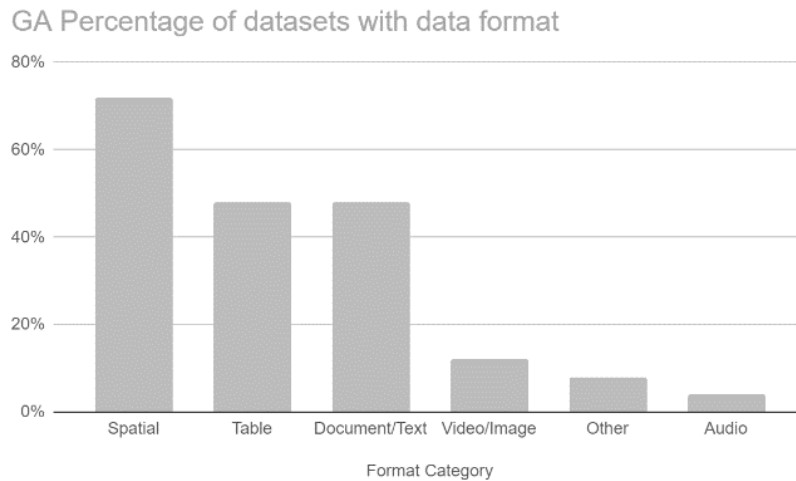


Figure 11 - Number of GA datasets of a particular file format category, represented as a percentage of total GA datasets.

Data pipeline

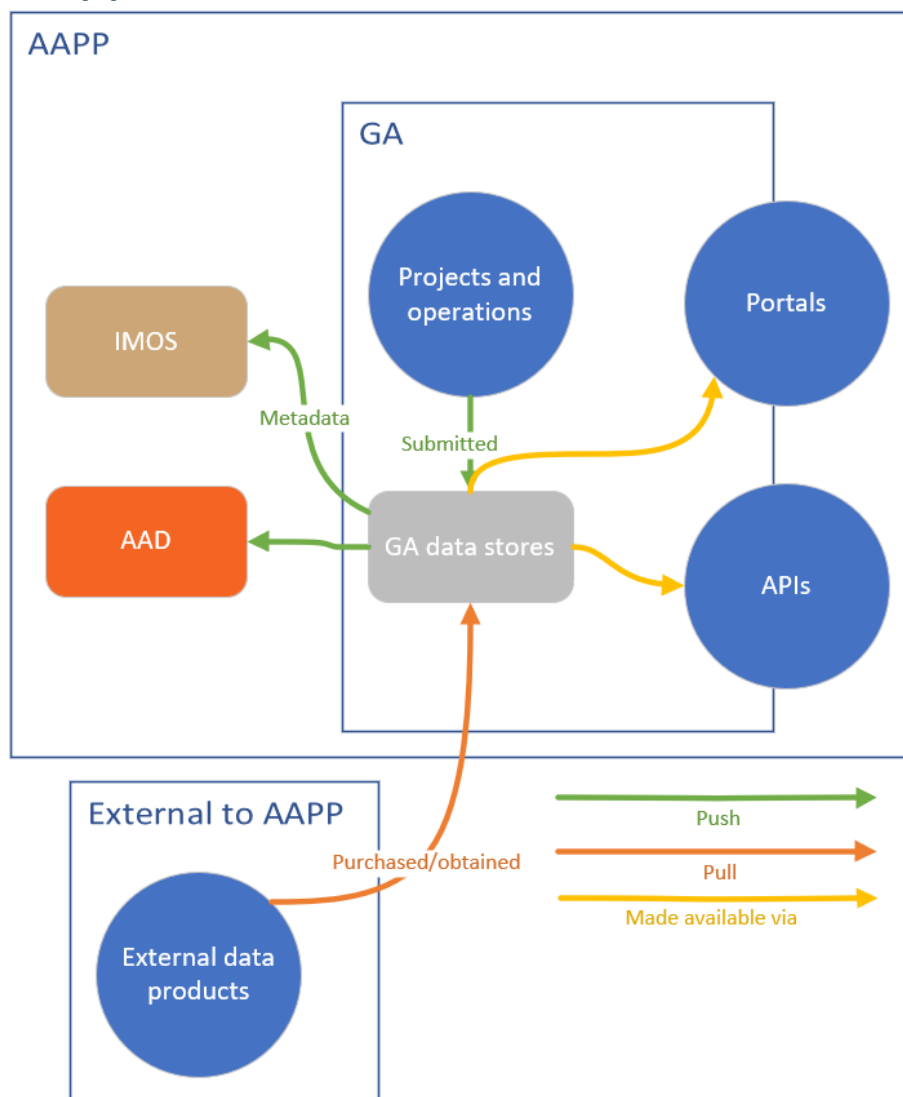


Figure 12 - Data flow within GA, between GA and the AAPP Partners, and between external entities

Institute for Marine and Antarctic Studies

Organisation overview

The Institute for Marine and Antarctic Studies (IMAS) is the University of Tasmania's research facility dedicated to Marine and Antarctic science and education. IMAS gathers research data from expeditions and via its laboratories and on-site facilities.

Data and metadata

IMAS uses the ISO 19115-3 metadata standard, with standard vocabularies sourced from AODN and international standards.

IMAS has a data discovery portal²¹ which is an IMAS-hosted and branded installation of the AODN Open Geospatial portal. Metadata are also available on the IMAS GeoNetwork²². IMAS also hosts a large number of OGC web services on GeoServer²³ and has a small collection on THREDDS²⁴.

IMAS hosts *Seamap Australia*, an online data portal housing Australian seafloor habitat data and collating other datasets of national interest for marine management and providing basic analytics. Seamap also hosts the Australian Benthic Habitat Classification Scheme, and the nationally synthesised and uniformly classified National Benthic Habitat Layer. Seamap Australia has a wide range of users including marine researchers, management authorities, biosecurity agencies, and recreational divers and fishers.

Statistics

IMAS's top 3 research categories by GCMD Earth Science Topics are Oceans, Biosphere and Climate Indicators, and their data are primarily in tabular or spatial format.

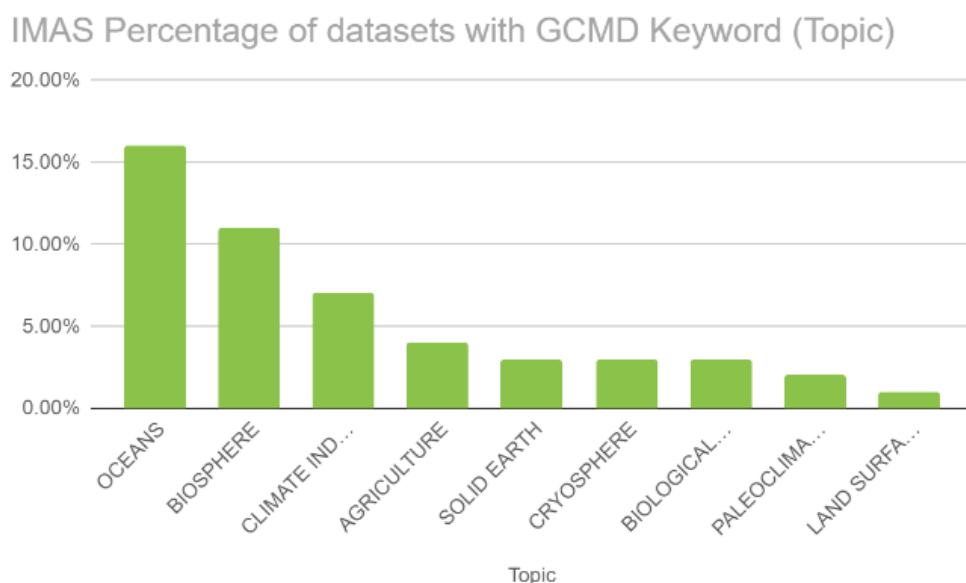


Figure 13 - Number of IMAS datasets containing data of each GCMD topic, represented as a percentage of total IMAS datasets.

²¹ <https://data.imas.utas.edu.au/portal/search>

²² <https://metadata.imas.utas.edu.au/>

²³ <https://geoserver.imas.utas.edu.au/>

²⁴ <https://thredds.imas.utas.edu.au>

IMAS Percentage of datasets with data format

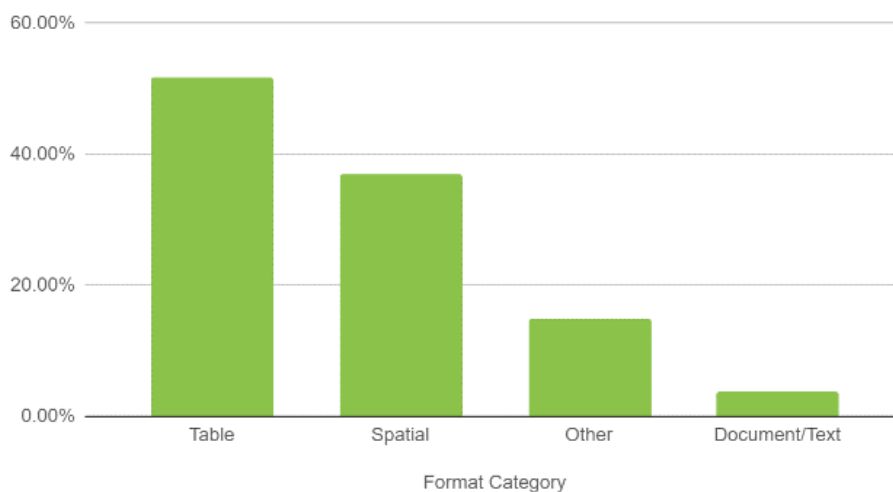


Figure 14 - Number of IMAS datasets of a particular file format category, represented as a percentage of total IMAS datasets.

Data pipeline

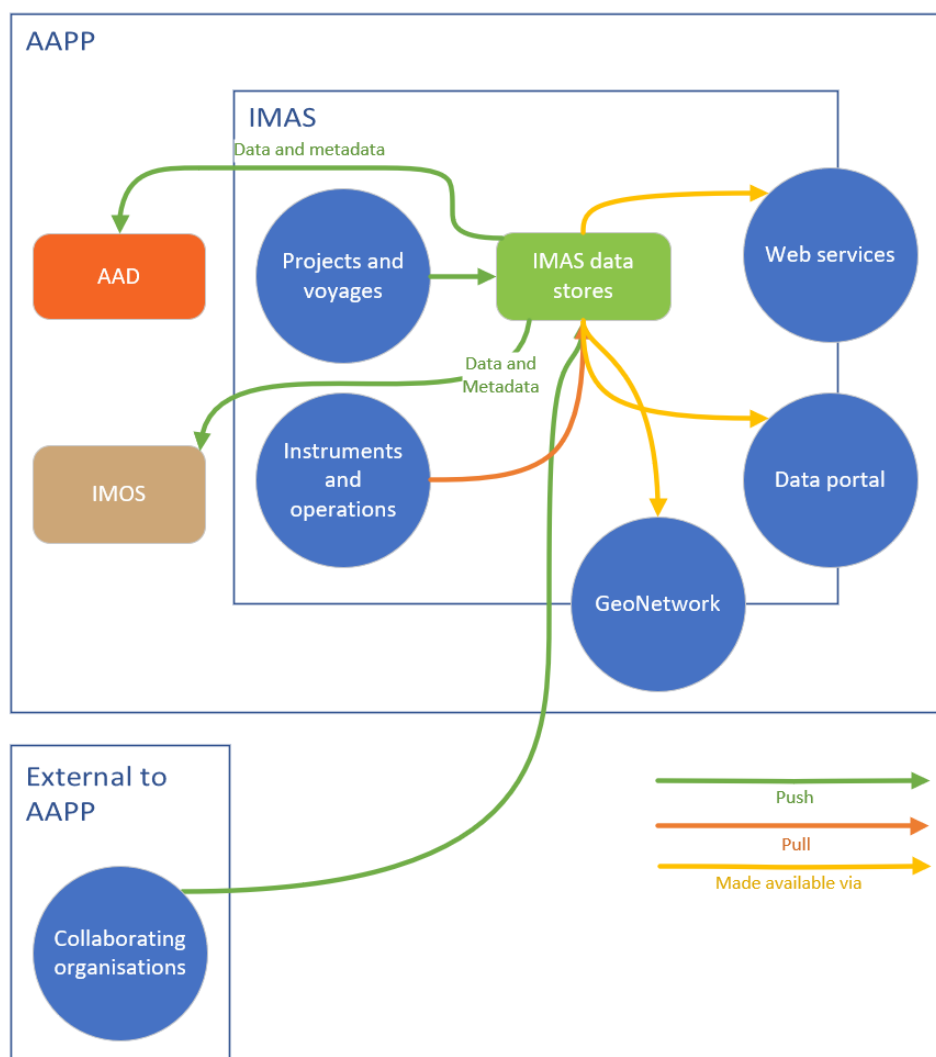


Figure 15 - Data flow within IMAS, between IMAS and the AAPP Partners, and between external entities

Integrated Marine Observing System

Organisation overview

Australia's Integrated Marine Observing System (IMOS) provides a national, multi-institutional capability to undertake systematic and sustained observing of the marine environment, from the open ocean onto the continental shelf and into the coast, and across physical, chemical, and biological variables. All IMOS data are made discoverable by its data facility, the Australian Ocean Data Network (AODN) and its data portal. Increasingly, even more data are being made available via AODN from a wide range of partner organisations – research institutions, Federal and State Government departments, and private industry.

Data and metadata

The AODN hosts all publishable IMOS data, as well as data from some AODN partners, individuals, and other groups (e.g. organisations with limited data management capabilities). It also federates data hosted by other AODN partners via web services to be made available via the AODN portal. For data to be discoverable via its portal, the AODN requires an ISO 19115-1 compliant metadata record. The AODN also uses published controlled vocabularies²⁵ within the ISO standard to assist in data discovery.

The AODN also hosts a large number of netCDF files from a number of different organisations on its THREDDS catalogue²⁶. These files are available through the AODN portal, but can be accessed through an interface in the browser or can be integrated directly into GIS software.

The AODN publishes a list of web services²⁷ to enable integration of AODN data and AODN services.

Statistics

IMOS primarily shares Ocean spatial data.

IMOS Percentage of datasets with GCMD Keyword (Topic)

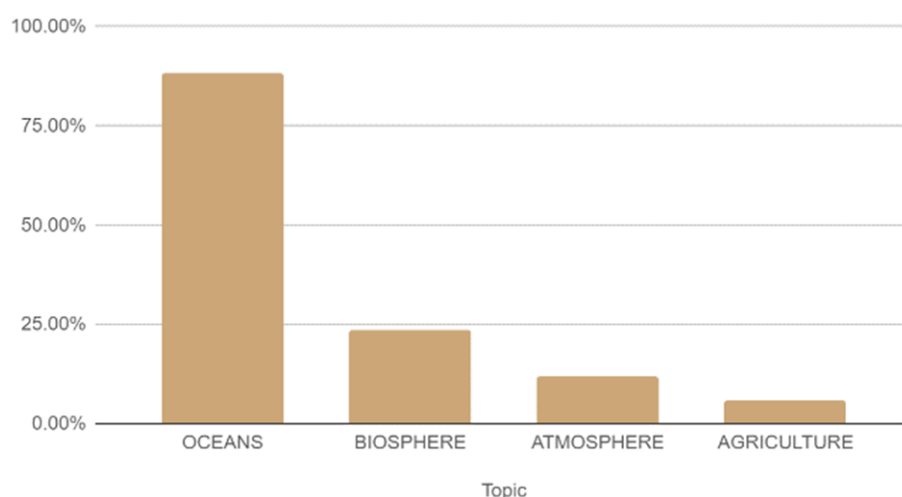


Figure 16 - Number of IMOS datasets containing data of each GCMD topic, represented as a percentage of total IMOS datasets.

²⁵ <https://vocab.ardc.edu.au/#/?q=AODN>

²⁶ <http://thredds.aodn.org.au/thredds/catalog.html>

²⁷ <https://help.aodn.org.au/web-services/>

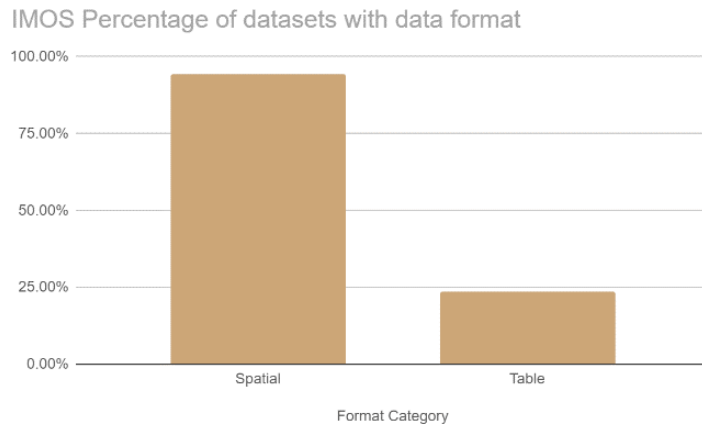


Figure 17 - Number of IMOS datasets of a particular file format category, represented as a percentage of total IMOS datasets.

Data pipeline

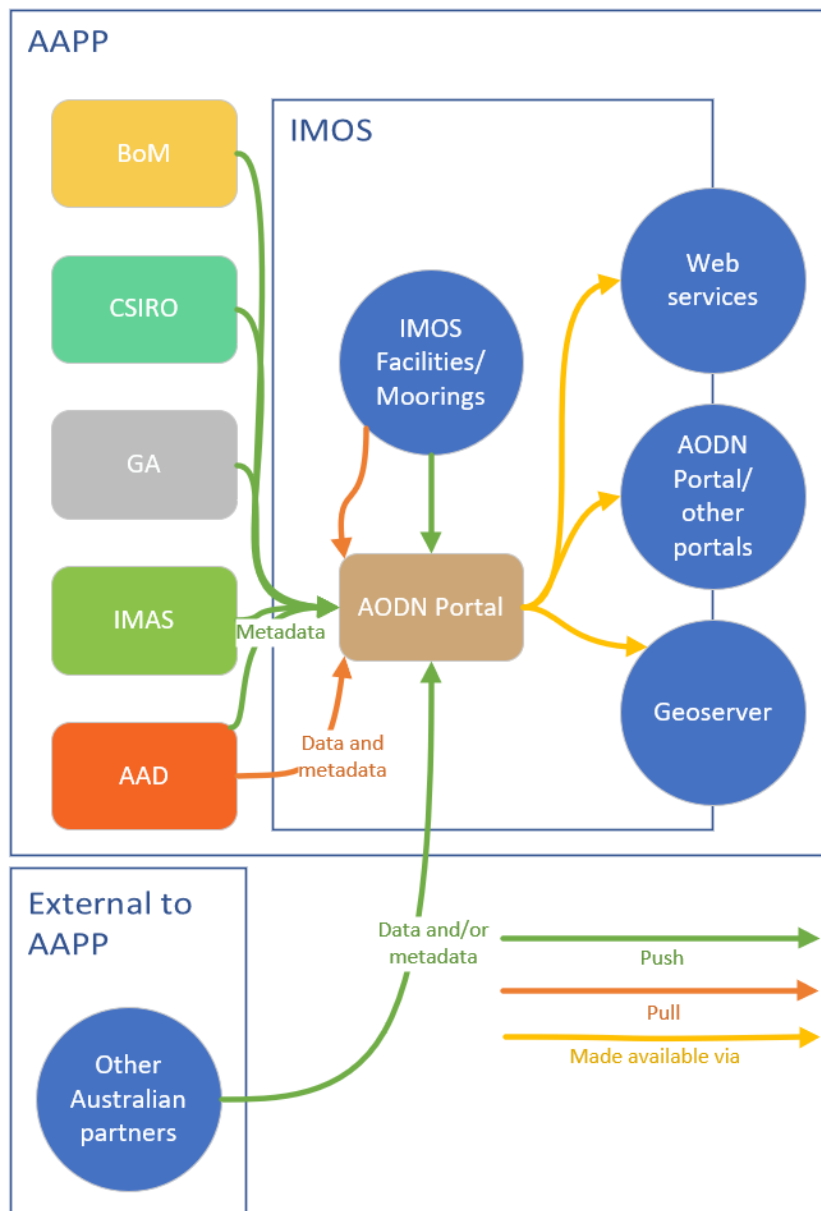


Figure 18 - Data flow within IMOS, between IMOS and the AAPP Partners, and between external entities

Collated statistics

The AAPP data centres were asked to provide an overview of what fields of research and what data formats they held (within scope of *Digital Antarctica*). This was to help find the most common data types, and how they intersected (from both a research and a format point of view). The following graphs and tables represent those data collected from the data centres.²⁸

Different data centres provided different levels of information, depending on how that information was obtained by the data centre. This included direct extracts from storage directories, outputs from scripts run over web services, or manually created lists of data holdings. This information was, in turn, entered into a standardised table representing datasets, research types and data formats.

Datasets

While there is no set definition for a “dataset”, the data within the information provided by each data centre have been arranged into logical groups, depending on the on how the data are presented. This could include:

- The physical location of the data (i.e. a folder or folder structure)
- A web service end point for the data
- Whether data has a shared metadata record
- The instrument collecting the data
- A logical collection of the data as determined by the data centre

This means that some organisations, like the AADC, have many datasets and others, like BoM, have very few, even though the amount of data in each dataset differs greatly:

| AAD | BoM | CSIRO | GA | IMAS | IMOS |
|------|-----|-------|----|------|------|
| 1759 | 20 | 620 | 25 | 27 | 17 |

Table 1 - Total number of in-scope datasets per organisation

This makes directly comparing the number of datasets difficult, however trends can be seen and established over the whole. As such, when data for data centres are broken up into research categories or file formats below, they may be represented either as a percentage of the data centre's holdings, or in real numbers, depending on the context.

Research categories

Most data centres already use NASA's GCMD keywords²⁹ to help enrich their metadata, and so these were used as a baseline for defining the research type. An individual dataset may have more than one keyword assigned. A dataset will be represented in all graph bars and table cells where that dataset has a matching GCMD keyword assigned.

GCMD keywords are broken into 6 hierarchical tiers: Topic, Term, Variable_Level_1, Variable_Level_2, Variable_Level_3, and Detailed_Variable. The AAPP Data centres use anywhere up to Variable_Level_3 of these tiers to define the research in their data. The graphs and tables in this document only use the highest level, Topic, to break down the research categories, however the raw data have more granularity and is available on request.

The top level GCMD Earth Science topics have been truncated in the figures for the sake of readability. Those categories, in full, are:

- Biological classification

²⁸ All data collated from the data centres is available here:

https://docs.google.com/spreadsheets/d/18Wz5JxcA8TTA55l2Plhfgo5YcFjA7QpjOFhgh9GG9_c/edit?usp=sharing

²⁹ <https://gcmd.earthdata.nasa.gov/KeywordViewer/>

- Oceans
- Biosphere
- Atmosphere
- Cryosphere
- Human dimensions
- Solid earth
- Land surface
- Terrestrial hydrosphere
- Sun-earth interactions
- Spectral/engineering
- Paleoclimate
- Climate indicators
- Agriculture

Date file formats

Likewise, data formats were provided at a granular level, but have been rolled up into data format categories of Audio, Document/Text, Spatial, Table, and Video/Image. The following table shows an example of the categorisation.

| Format Category | Description | Example Format in Category |
|-----------------|---|---|
| Audio | Any audio recording | WAV |
| Document/Text | Any file that is primarily used to store text, either formatted or unformatted | HTML, PDF, RTF, TXT |
| Spatial | Any file that is designed to be used and viewed natively in spatial tools such as a GIS or NetCDF viewer. | ArcINFO, CDF, GeoTIFF, GRID, NC, NetCDF, SHP, WFS |
| Table | Any file that provides data in simple tabular format, including spreadsheets, CSVs and database tables | ACCDB, CSV, MDB, TSV, XLS, XLSX |
| Video/Image | Any file that displays a visual image, either still or moving. | AVI, BMP, GIF, JPG, MKV, MOV, MP4, PNG |

Where a data type could not be rolled up into a category (either because it is non-standard or because the number of records is not significant) they have been given the category “Other”.

A note on collated figures

When collating all datasets across the AAPP by both GCMD keyword and file format, a dataset may be represented multiple times, once for every combination of keyword and format. For example, a dataset with 2 GCMD keywords and 3 file formats will be represented with 6 entries, one for each combination of keyword and file format.

Graphs

Datasets by GCMD

Collated datasets, by GCMD classification (as percent of Data Centre holdings)

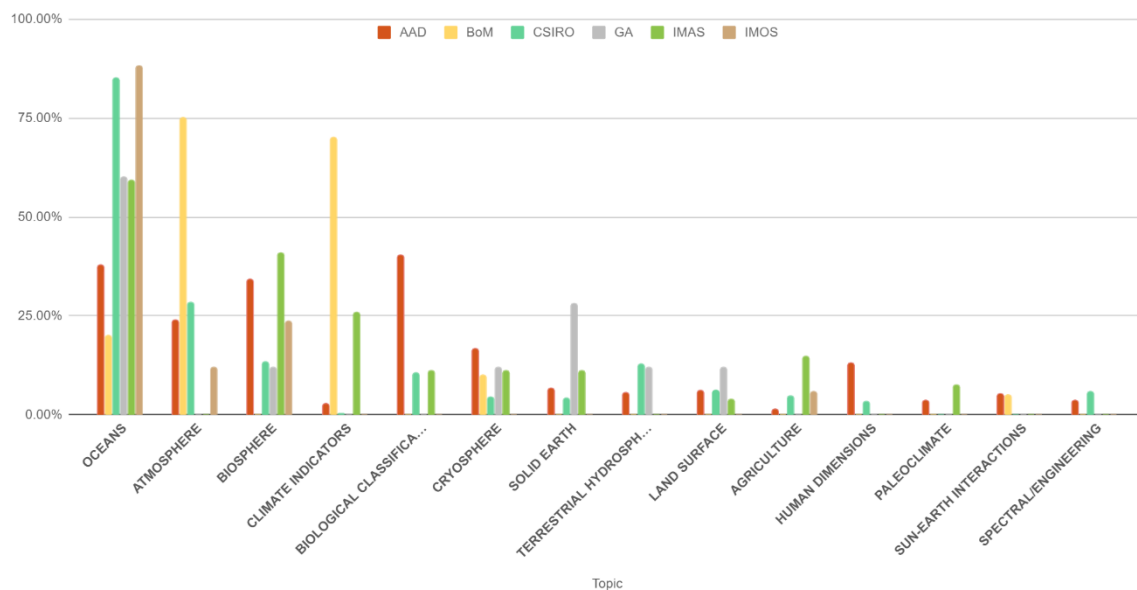


Figure 19 - Datasets by GCMD Topic, expressed as percentage representation within each Data centre (e.g. 38% of AAD datasets have the OCEAN topic). See Table 2 for corresponding data.

Collated datasets, by GCMD classification (counted)

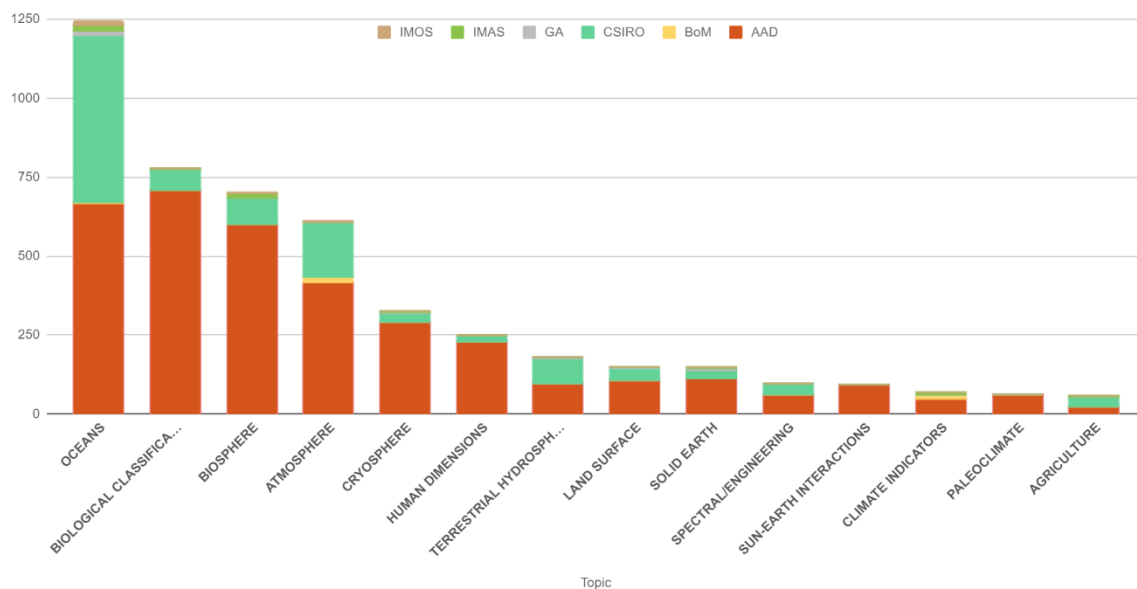


Figure 20 - Datasets by GCMD Topic, expressed as number of datasets within each Data centre. See Table 3 for corresponding data

Datasets by file format

Collated datasets, by file format (as percent of Data Centre holdings)

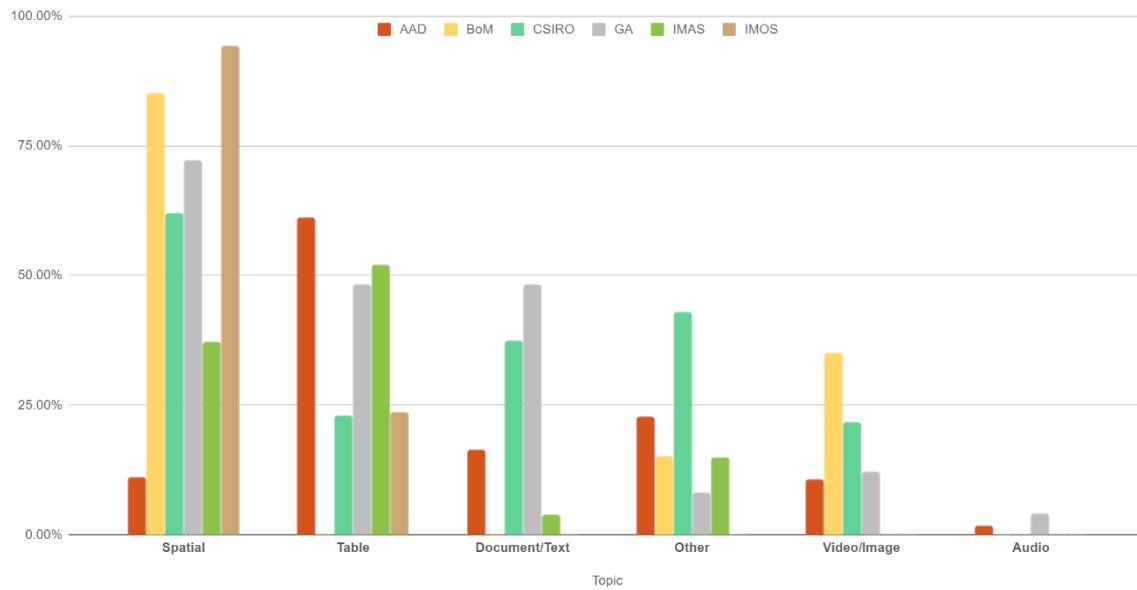


Figure 21 - Datasets by file format, expressed as percentage. See Table 4 for corresponding data

Collated datasets, by file format (counted)

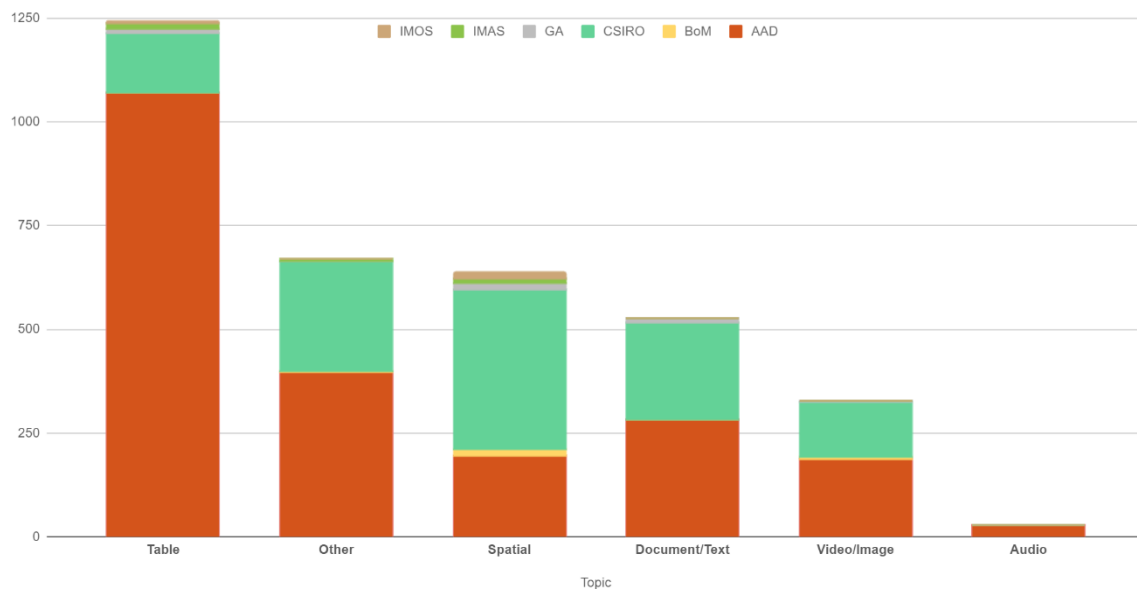


Figure 22 - Datasets by file format, expressed as number of unique datasets per data centre. See Table 5 for corresponding data

File format and GCMD Topic

File format (split by topic)

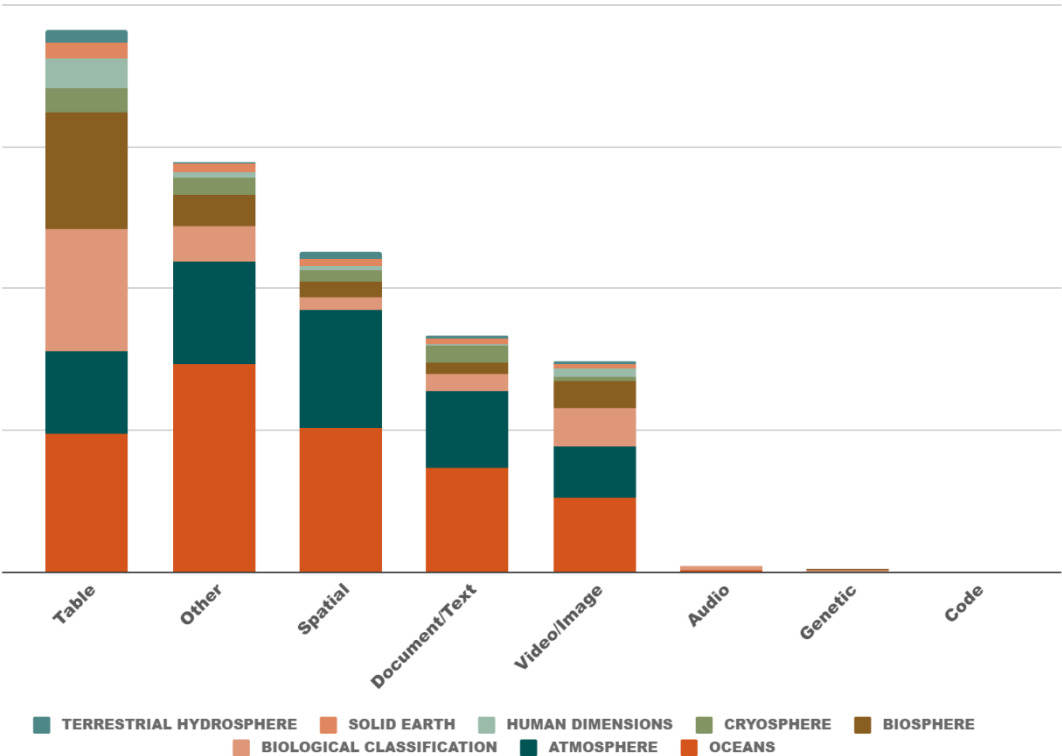


Figure 23 - File format categories, split by GCMD Topic. See Table 6 for corresponding data

Topic (Split by file format)

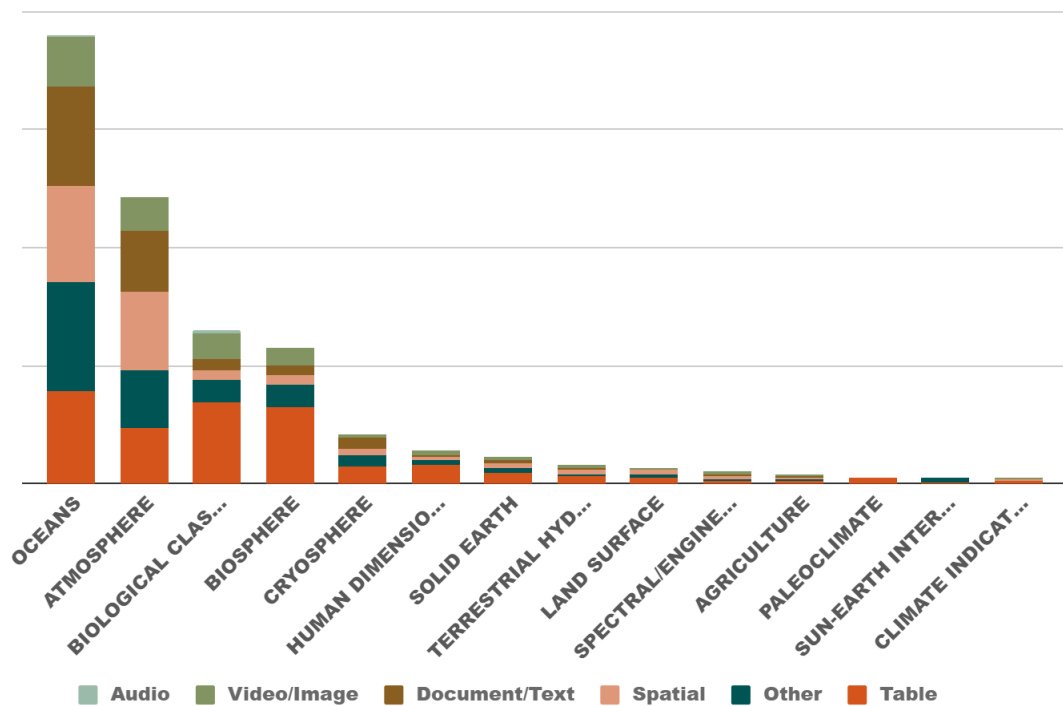


Figure 24 - GCMD Topics, File format category. See Table 6 for corresponding data

Tables

| Topic | AAD | BoM | CSIRO | GA | IMAS | IMOS |
|---------------------------|--------|--------|--------|--------|--------|--------|
| OCEANS | 37.92% | 20.00% | 85.16% | 60.00% | 59.26% | 88.24% |
| BIOLOGICAL CLASSIFICATION | 40.36% | 0.00% | 10.65% | 0.00% | 11.11% | 0.00% |
| BIOSPHERE | 34.11% | 0.00% | 13.39% | 12.00% | 40.74% | 23.53% |
| ATMOSPHERE | 23.76% | 75.00% | 28.23% | 0.00% | 0.00% | 11.76% |
| CRYOSPHERE | 16.54% | 10.00% | 4.35% | 12.00% | 11.11% | 0.00% |
| HUMAN DIMENSIONS | 13.02% | 0.00% | 3.39% | 0.00% | 0.00% | 0.00% |
| TERRESTRIAL HYDROSPHERE | 5.51% | 0.00% | 12.74% | 12.00% | 0.00% | 0.00% |
| LAND SURFACE | 6.14% | 0.00% | 5.97% | 12.00% | 3.70% | 0.00% |
| SOLID EARTH | 6.48% | 0.00% | 4.03% | 28.00% | 11.11% | 0.00% |
| SPECTRAL/ENGINEERING | 3.52% | 0.00% | 5.65% | 0.00% | 0.00% | 0.00% |
| SUN-EARTH INTERACTIONS | 5.23% | 5.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CLIMATE INDICATORS | 2.67% | 70.00% | 0.16% | 0.00% | 25.93% | 0.00% |
| PALEOCLIMATE | 3.47% | 0.00% | 0.00% | 0.00% | 7.41% | 0.00% |
| AGRICULTURE | 1.42% | 0.00% | 4.68% | 0.00% | 14.81% | 5.88% |

Table 2 - Datasets containing GCMD Keyword Topic – expressed as percentage of total datasets at data centre. Table sorted by total number of datasets across all data centres, per topic.

| Topic | AAD | BoM | CSIRO | GA | IMAS | IMOS | Total |
|--|------|-----|-------|----|------|------|-------|
| OCEANS | 667 | 4 | 528 | 15 | 16 | 15 | 1245 |
| BIOLOGICAL CLASSIFICATION | 710 | 0 | 66 | 0 | 3 | 0 | 779 |
| BIOSPHERE | 600 | 0 | 83 | 3 | 11 | 4 | 701 |
| ATMOSPHERE | 418 | 15 | 175 | 0 | 0 | 2 | 610 |
| CRYOSPHERE | 291 | 2 | 27 | 3 | 3 | 0 | 326 |
| HUMAN DIMENSIONS | 229 | 0 | 21 | 0 | 0 | 0 | 250 |
| TERRESTRIAL HYDROSPHERE | 97 | 0 | 79 | 3 | 0 | 0 | 179 |
| LAND SURFACE | 108 | 0 | 37 | 3 | 1 | 0 | 149 |
| SOLID EARTH | 114 | 0 | 25 | 7 | 3 | 0 | 149 |
| SPECTRAL/ENGINEERING | 62 | 0 | 35 | 0 | 0 | 0 | 97 |
| SUN-EARTH INTERACTIONS | 92 | 1 | 0 | 0 | 0 | 0 | 93 |
| CLIMATE INDICATORS | 47 | 14 | 1 | 0 | 7 | 0 | 69 |
| PALEOCLIMATE | 61 | 0 | 0 | 0 | 2 | 0 | 63 |
| AGRICULTURE | 25 | 0 | 29 | 0 | 4 | 1 | 59 |
| | | | | | | | |
| Total number of datasets at data centre | 1759 | 20 | 620 | 25 | 27 | 17 | 2468 |

Table 3 - Datasets containing GCMD Keyword Topic – expressed as raw number of unique datasets. Table sorted by total number of datasets across all data centres, per topic.

| Topic | AAD | BoM | CSIRO | GA | IMAS | IMOS |
|---------------|--------|--------|--------|--------|--------|--------|
| Spatial | 11.03% | 85.00% | 61.94% | 72.00% | 37.04% | 94.12% |
| Table | 60.94% | 0.00% | 22.74% | 48.00% | 51.85% | 23.53% |
| Document/Text | 16.15% | 0.00% | 37.26% | 48.00% | 3.70% | 0.00% |
| Other | 22.51% | 15.00% | 42.74% | 8.00% | 14.81% | 0.00% |
| Video/Image | 10.57% | 35.00% | 21.45% | 12.00% | 0.00% | 0.00% |
| Audio | 1.59% | 0.00% | 0.00% | 4.00% | 0.00% | 0.00% |

Table 4 - Datasets containing data of a particular file format category - expressed as a percentage of the total unique datasets in the corresponding data centre

| Topic | AAD | BoM | CSIRO | GA | IMAS | IMOS | Grand total |
|---------------|------|-----|-------|----|------|------|-------------|
| Table | 1072 | 0 | 141 | 12 | 14 | 4 | 1243 |
| Other | 396 | 3 | 265 | 2 | 4 | 0 | 670 |
| Spatial | 194 | 17 | 384 | 18 | 10 | 16 | 639 |
| Document/Text | 284 | 0 | 231 | 12 | 1 | 0 | 528 |
| Video/Image | 186 | 7 | 133 | 3 | 0 | 0 | 329 |
| Audio | 28 | 0 | 0 | 1 | 0 | 0 | 29 |

Table 5 - Datasets containing data of a particular file type category - expressed as number. Table sorted by total number of datasets across all data centres, per file format category

| Topic | Table | Other | Spatial | Document/ Text | Video/ Image | Audio |
|---------------------------|-------|-------|---------|-------------------|-----------------|-------|
| OCEANS | 1962 | 2297 | 2040 | 2107 | 1047 | 26 |
| ATMOSPHERE | 1183 | 1200 | 1665 | 1313 | 721 | 0 |
| BIOLOGICAL CLASSIFICATION | 1727 | 482 | 178 | 267 | 541 | 56 |
| BIOSPHERE | 1631 | 447 | 226 | 183 | 380 | 2 |
| CRYOSPHERE | 352 | 234 | 153 | 229 | 68 | 0 |
| HUMAN DIMENSIONS | 414 | 87 | 71 | 25 | 119 | 1 |
| SOLID EARTH | 237 | 86 | 92 | 76 | 73 | 1 |
| TERRESTRIAL HYDROSPHERE | 174 | 23 | 96 | 48 | 43 | 0 |
| LAND SURFACE | 131 | 49 | 99 | 7 | 38 | 0 |
| SPECTRAL/ENGINEERING | 69 | 36 | 56 | 45 | 67 | 0 |
| AGRICULTURE | 63 | 42 | 23 | 21 | 29 | 0 |
| PALEOCLIMATE | 110 | 2 | 7 | 9 | 12 | 0 |
| SUN-EARTH INTERACTIONS | 41 | 73 | 1 | 11 | 6 | 0 |
| CLIMATE INDICATORS | 46 | 11 | 37 | 9 | 16 | 0 |

Table 6 - Combined GCMD Keyword and file format, by number

Metadata standards

This summary shows the metadata standard employed by the data centre, including any relevant profile that may be in place.

- P – Primary standard used for public data
- S – Secondary standard. This standard may be used as a reference in creating the primary standard, or may be used alongside the primary standard for the purposes of cross compatibility or for internal use

| | DIF | ISO 19115 | ISO Profile? | Internal |
|-------|-----|-----------|----------------------|-------------------|
| AAD | P | S | MCP | DIF profile |
| BoM | | S | | P |
| CSIRO | | P | MCP (where relevant) | |
| GA | | P | Internal | S (internal data) |
| IMAS | | P | | |
| IMOS | | P | | |

Overall data pipelines

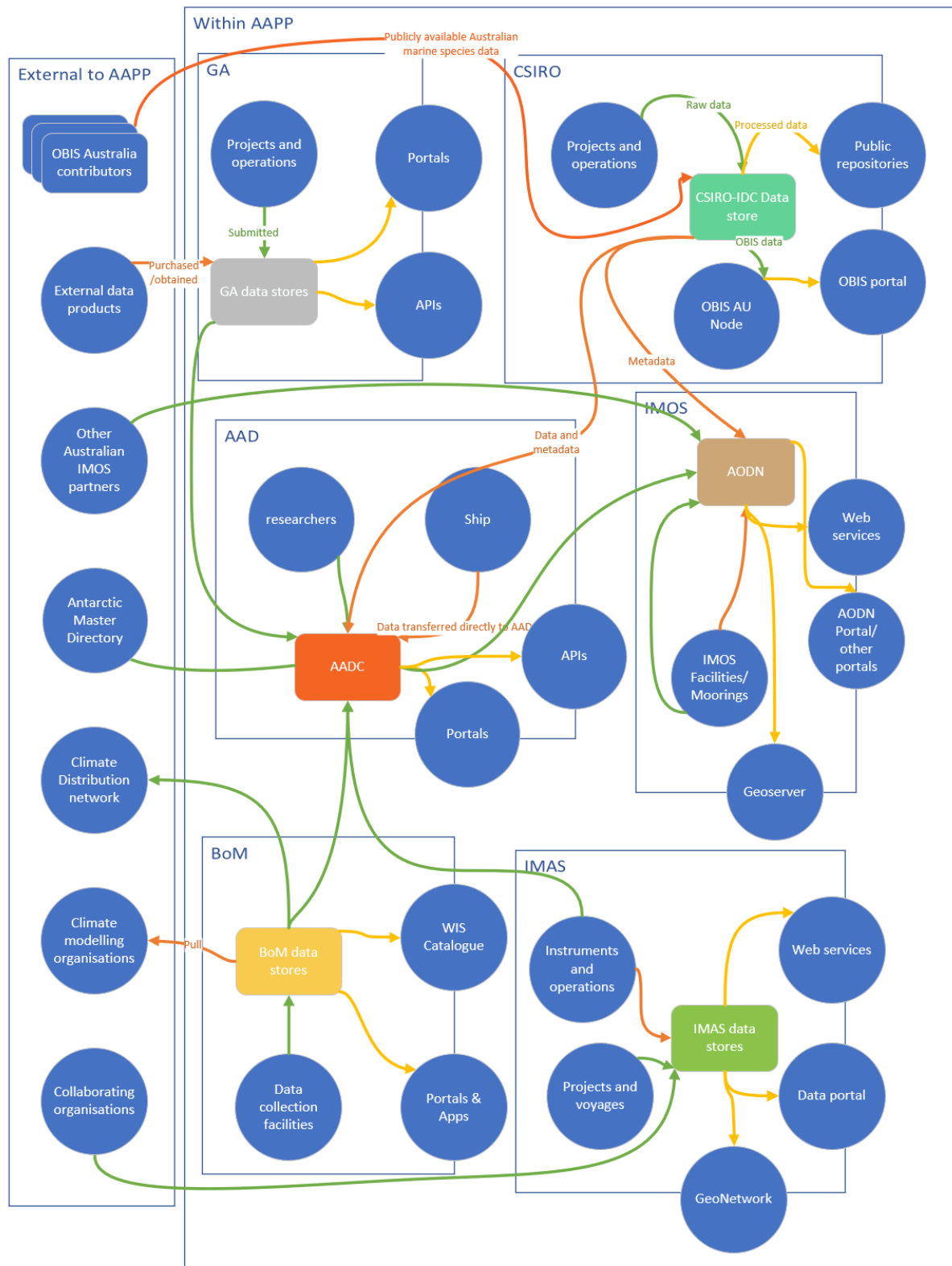


Figure 25 - Overall diagram showing data flows within the AAPP and to and from external organisations

Similar services

(see below the table for the Category and Scope keys)

| Service | Provider | Description | Category | Scope |
|-----------------------------------|----------|--|---------------|----------|
| RAAD Tools | AAD | R based Tools for reading, plotting, and manipulating spatial data used at the Australian Antarctic Division (AAD). | DA DH | AA |
| AODN | IMOS | The AODN Portal provides access to all available Australian marine and climate science data and provides the primary access to IMOS data including access to the IMOS metadata. | DPH DPF DH MA | AA OA OI |
| AAD Data portal | AAD | The AAD Data portal provides access to all data collected through the Australian Antarctic Science program. | DPH DH | AA |
| SOOSMap | SOOS | SOOSmap serves up curated and standardised observation data from oceanographic and Antarctic research programs from many nations and scientific discipline | DPF | AA AI |
| SCAR portal directory | SCAR | A directory of Antarctic, and related, data portals compiled by SCAR | PD | AA |
| Antarctic Master Directory | NASA | A collection of over 7700 dataset descriptions from 25 countries, hosted by the Global Change Master Directory (GCMD) of the CEOS-IDN network. | DPF MA | AA |
| Data ONE | dataONE | A network of interoperable data repositories, focussed mainly on North America. | DPF MA | OI |
| Digital Atlas of Australia | GA | A new service in development, to "deliver spatial information for better decision making". It will include data about Australian land, built environment, and people, and will include analytical tools and data downloads. | DPH DPF | OA |
| Atlas of Living Australia | CSIRO | A collaborative, digital, open infrastructure that pulls together Australian biodiversity data from multiple sources, making it accessible and reusable. | DA DPH | AA OA |
| AusSeaBed | GA | Data are collected and uploaded from a variety of platforms, such as ships, autonomous underwater vehicles, deep-tow equipment, satellites, and fixed wing aircraft, and made available via the AusSeaBed data portal | DA DPH | AA OA |
| OBIS | OBIS | More than 20 OBIS nodes around the world connect 500 institutions from 56 countries. Collectively, they have provided over 45 million observations of nearly 120 000 marine species, from Bacteria to Whales, from the surface to 10 | DA DPH DPF | AA AI |

| | | | | |
|-------------------------|------|--|------------------|----------------------|
| | | 900 meters depth, and from the Tropics to the Poles. | | OA OI |
| GBIF | GBIF | GBIF—the Global Biodiversity Information Facility—is an international network and research infrastructure funded by the world's governments and aimed at providing anyone, anywhere, open access to data about all types of life on Earth. | DPF MA | AA AI OA OI |
| SeaMap Australia | UTAS | Collates all national benthic habitat mapping data, and presents them as a spatial data product. Also provides links to other non-habitat data sources | DA DPH DPF MA | OA |

| Category | Scope |
|-----------------------------|--|
| DA Data Aggregator | AA Antarctic and/or Southern Ocean – Australian |
| DH Data Host | AI Antarctic and/or Southern Ocean - International |
| DPH Data Portal (hosted) | OA Other - Australian |
| DPF Data Portal (federated) | OI Other - International |
| MA Metadata Aggregator | |
| PD Portal Directory | |

Portals, web services and tools

Below is a list of the data acquisition methods that each organisation offers, that are in-scope of the *Digital Antarctica* initiative.

Note that many of the Geoscience Australia web services are available as MapServer, WMS, WFS and WCS web services, each with a unique address. For the sake of brevity only one of each of these services is listed below.³⁰

| Org. | Service Name | Type | Description | Link |
|------|--|-----------------|---|---|
| AAD | AAD Data Portal | Portal | The AAD's primary data portal | https://data.aad.gov.au/ |
| AAD | Australian Antarctic Map Catalogue | Portal | A catalogue of all known Antarctic and subantarctic maps and charts published by the Australian Government. | https://data.aad.gov.au/map-catalogue |
| AAD | SCAR Map Catalogue | Portal | Allows users to search for maps and charts of Antarctica, the Southern Ocean and subantarctic islands from over 26 countries. | https://data.aad.gov.au/aadc/mapcat/ |
| AAD | SCAR Feature Catalogue | Tool | A catalogue of feature names to use in data and metadata. Includes data quality information, terminology, database types and attribute options that will apply to any GIS. | https://data.aad.gov.au/aadc/ftc/ |
| AAD | Aerial Photograph Catalogue | Portal | A search tool to view Antarctic aerial photography flight lines within a specified spatial coverage | https://data.aad.gov.au/aadc/aerial/ |
| AAD | Satellite image catalogue | Portal | A search tool to view Antarctic satellite imagery within a specified date range, region or spatial coverage | https://data.aad.gov.au/aadc/satellite/ |
| AAD | Survey control database | Portal | The Survey Control database contains coordinate, height, access and other information relating to survey control marks located at sites in the Australian Antarctic Territory, at Macquarie Island and in the Territory of Heard Island and McDonald Islands. | https://data.aad.gov.au/aadc/survey/ |
| AAD | Australian Antarctic Gazetteer | Portal | A catalogue of Australian Antarctic place names | https://data.aad.gov.au/aadc/gaz/ |
| AAD | SCAR Composite Gazetteer of Antarctica | Portal | A composite catalogue of Antarctic place names. | https://data.aad.gov.au/aadc/gaz/scar/ |
| AAD | Geoserver | Web Service/API | Geoserver web services | https://data.aad.gov.au/geoserver/web/ |

³⁰ A full list of services, including out-scope-services and duplicated services of a different type, is available at (note, link may not work from Word. Copy and paste into browser): <https://docs.google.com/spreadsheets/d/18dPCQvBkMljwPzv0HvIWRlq5nLFYA03LOxIAyzpmKNQ/edit?usp=sharing>
<https://docs.google.com/spreadsheets/d/18dPCQvBkMljwPzv0HvIWRlq5nLFYA03LOxIAyzpmKNQ/edit?usp=sharing>

| Org. | Service Name | Type | Description | Link |
|-----------|--|-----------------|--|---|
| AAD | AAD GBIF Integrated Publishing Toolkit | Tool | AAD instance of its GBIF data | https://data.aad.gov.au/ipt/ |
| BoM | Bureau Data Catalogue | Portal | The Australian Bureau of Meteorology data catalogue, containing metadata records describing a range of data available from the Australian Bureau of Meteorology. | http://www.bom.gov.au/metadata/catalogue/index.shtml |
| BoM | FTP Public Products | File access | FTP access to various climate data products | ftp://ftp.bom.gov.au/anon/gen/ |
| BoM | WIS Catalogue | Portal | WIS Catalogue of WMO-related data mirrored by the Bureau | http://wis.bom.gov.au/ |
| BoM | NCI Resources | File access | A number of Datasets available via NCI | https://nci.org.au/ |
| CSIRO-MNF | Marlin | Portal | | https://marlin.csiro.au/ |
| CSIRO-MNF | Marlin API | Web Service/API | A collection of APIs for accessing Marlin data | https://marlin.csiro.au/geonetwork/doc/api/ |
| CSIRO-MNF | Near Realtime Underway Data (NRUD) | Portal | NRUD is an interactive geospatial platform for viewing the ship position and underway data collected by the MNF. It contains a subset of the raw sensor data collected by RV Investigator in near-real time. | https://mnf.csiro.au/en/MNF-Data |
| CSIRO-MNF | Data Trawler | Portal | The Data Trawler is a portal to query and download public data from CSIRO voyages and projects. | https://www.marine.csiro.au/data/trawler/index.cfm |
| CSIRO-MNF | Codes for Australian Aquatic Biota | Tool | CAAB encodes taxonomic identifiers for Australian marine organisms. | https://www.cmar.csiro.au/data/caab/ |
| CSIRO-MNF | CSIRO Data Access Portal (DAP) | Portal | The DAP contains MNF raw voyage data and can host data sets processed by MNF technicians, voyage participants, and partners or service providers. | https://data.csiro.au/?redirected=true |
| CSIRO-MNF | Geophysical Survey and Mapping | Portal | The GSM allows users to search hydrographic survey, geophysics, bathymetric mapping and visualisations by survey, region, depth and instrument. | http://www.marine.csiro.au/data/gsm/ |
| CSIRO-MNF | CTD/Hydrology point data | Web Service/API | CTD and hydrology data at a given point/date/depth/survey | https://www.marine.csiro.au/data/trawler/getPointData.cfm |
| CSIRO-MNF | OBIS Australia biodiversity | Web Service/API | List of CSIRO datasets from OBIS Australia | https://www.marine.csiro.au/data/services/obisau/ |

| Org. | Service Name | Type | Description | Link |
|-----------|--|-----------------|--|---|
| CSIRO-MNF | Multiple CAAB Species records | Web Service/API | Retrieve many species records from Codes for Australian Aquatic Biota (CAAB) | https://www.marine.csiro.au/data/services/caab/ |
| CSIRO-MNF | Single CAAB Species record | Web Service/API | Retrieve single species record from Codes for Australian Aquatic Biota (CAAB) | https://www.marine.csiro.au/data/caab/api/ |
| CSIRO-MNF | MNF Voyage data | Web Service/API | List of Datasets from MNF voyages | https://www.marine.csiro.au/data/services/datasets/?records=10 |
| CSIRO-MNF | MNF Voyage Publications | Web Service/API | List of Publications from MNF voyages | https://www.marine.csiro.au/data/services/pubs/?records=10 |
| CSIRO-MNF | RV Investigator position | Web Service/API | Latest position of the RV Investigator | https://www.marine.csiro.au/data/services/underway/ |
| CSIRO-MNF | Oceans and Atmosphere Geoserver | Web Service/API | CSIRO National Collections & Marine Infrastructure data | https://www.cmar.csiro.au/geoserver/web/ |
| GA | Data and Publications search (Sometimes referred to as eCat) | Portal | Data and publication search across the whole of Geoscience Australia | https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/home |
| GA | GA Product Catalog | Web Service/API | OGC:CSW: This OGC Catalogue Service for the Web (CSW) provides access to Geoscience Australia's official catalogue of geoscientific and geospatial resources. | https://ecat.ga.gov.au/geonetwork/srv/eng/csw?request=GetCapabilities&service=CSW |
| GA | Data & Publications | Portal | A catalogue of GA Data portals and tools | https://www.ga.gov.au/data-pubs |
| GA | AusSeabed Survey Coordination Tool | Web Service/API | OGC:WMS This service presents the outgoing data services from the AusSeabed Coordination Tool. | https://coordination.ausseabed.gov.au/map/wms?request=GetCapabilities&service=WMS |
| GA | Australian Bathymetry and Topography | Web Service/API | ESRI:ArcGIS:MapServer (Also available: OGC:WMS, OGC:WCS) The Australian Bathymetry and Topography web service includes the topography of Australia and the bathymetry of the adjoining Australian Exclusive Economic Zone. The area selected does not include data from Australia's marine jurisdiction offshore from the Territory of Heard and McDonald Islands and the Australian Antarctic Territory. The 2009 bathymetry data were compiled by Geoscience Australia from multibeam and single beam data, and along wit...<p> | https://services.ga.gov.au/gis/rest/services/Bathymetry_Topography/MapServer |

| Org. | Service Name | Type | Description | Link |
|------|--|-----------------|---|---|
| GA | Bathymetry Derivatives Map of Australia | Web Service/API | OGC:WMS (Also available: ESRI:ArcGIS:MapServer) The National Bathymetry Derivatives Map of Australia Web Map Service contains national scale bathymetric derivatives - hillshaded bathymetry and topography, slope, aspect, topographic relief and topographic rugosity, which are available for download on Geoscience Australia's website. | https://services.ga.gov.au/gis/services/Bathymetry_Derivatives/MapServer/WMSServer?request=GetCapabilities&service=WMS |
| GA | Digital Elevation Model (DEM) Shuttle Radar Topography Mission (SRTM) 1 Second over Australian Bathymetry Topography | Web Service/API | ESRI:ArcGIS:MapServer (Also available: OGC:WCS, OGC:WMS) This service represents a combination of two data products, the DEM_SRTM_1Second dataset and the Australian_Bathymetry_Topography dataset. | https://services.ga.gov.au/gis/rest/services/DEM_SRTM_1Second_over_Bathymetry_Topography/MapServer |
| GA | Gazetteer of Australia | Web Service/API | ESRI:ArcGIS:MapServer (Also available: OGC:WFS, OGC:WMS) The Australian Gazetteer service provides authoritative information on the location, and spelling of approved place names. The Australian Gazetteer is a subset of information held by the relevant State, Territory and Commonwealth naming authorities. Additional authoritative information has also been sourced from the Australian Hydrographic Service, Australian Antarctic Division and Geoscience Australia. | https://services.ga.gov.au/gis/rest/services/Australian_Gazetteer/MapServer |
| GA | Geochronology And Isotopes | Web Service/API | OGC:WFS (Also available: OGC:WMTS, OGC:WMS, OGC:WCS) This web service provides access to the Geoscience Australia (GA) ISOTOPE database containing compiled age and isotopic data from a range of published and unpublished (GA and non-GA) sources. | https://services.ga.gov.au/gis/geochronology-isotopes/wfs?service=wfs&request=GetCapabilities |
| GA | Geological Field Sites, Samples and Observations | Web Service/API | OGC:WMS (Also available: OGC:WFS) This web service delivers geological observations and sample descriptions from field sites associated with GA's geological mapping surveys in Australia and Antarctica. | https://services.ga.gov.au/gis/field-geology/wms?service=wms&request=GetCapabilities |
| GA | Geomorphic Features of Australia's Marine Jurisdiction | Web Service/API | OGC:WFS (Also available: ESRI:ArcGIS:MapServer, OGC:WMS) The Geomorphic Features of Australia's Marine Jurisdiction web service brings together various datasets produced by Geoscience Australia that describe the distribution and types of geomorphic features found on the seabed of Australia's marine jurisdiction. | https://services.ga.gov.au/gis/services/Marine_Geomorphic_Features/MapServer/WFSServer?request=GetCapabilities&service=WFS |
| GA | Geomorphic features of the Antarctic margin and Southern Ocean 2012 | Web Service/API | OGC:WFS (Also available: OGC:WMS, ESRI:ArcGIS:MapServer) Publicly available bathymetry and geophysical data has been used | https://services.ga.gov.au/gis/services/Geomorphic_Features_Of_The_Antarctic_Margin_2012 |

| Org. | Service Name | Type | Description | Link |
|------|--|-----------------|---|---|
| | | | to map geomorphic features of the Antarctic continental margin and adjoining ocean basins at scales of 1:1-2 million. | 2/MapServer/WFSServer?request=GetCapabilities&service=WFS |
| GA | Geoscience Australia Product Catalogue | Web Service/API | OGC:CSW This OGC Catalogue Service for the Web (CSW) provides access to Geoscience Australia's official catalogue of geoscientific and geospatial resources. | https://ecat.ga.gov.au/geonetwork/srv/eng/csw?request=GetCapabilities&service=CSW |
| GA | Inorganic Geochemistry | Web Service/API | OGC:WFS (Also available: OGC:WMS) This service provides access to inorganic geochemistry data obtained from chemical analyses of rock and regolith samples collected during mapping and sampling programs in Australia. | https://services.ga.gov.au/gis/inorganic-geochemistry/wfs?service=WFS&request=GetCapabilities |
| GA | Marine Survey - Geomorphology | Web Service/API | ESRI:ArcGIS:MapServer (Also available: OGC:WMS) The Marine Survey Geomorphology Web Map Service contains the local scale (1:10 000) interpreted geomorphology maps available for download on Geoscience Australia's website. | https://services.ga.gov.au/gis/rest/services/Marine_Survey_Geomorphology/MapServer |
| GA | Marine Survey Multibeam Backscatter | Web Service/API | OGC:WMS (Also available: ESRI:ArcGIS:MapServer) The Marine Survey Multibeam Backscatter Web Map Service contains the highest-resolution multibeam backscatter grids available for download on Geoscience Australia's website. | https://services.ga.gov.au/gis/services/Marine_Survey_Multibeam_Backscatter/MapServer/WFSServer?request=GetCapabilities&service=WMS |
| GA | Marine Survey Multibeam Bathymetry | Web Service/API | OGC:WMS (Also available: ESRI:ArcGIS:MapServer) The Marine Survey Multibeam Bathymetry Web Map Service contains the highest-resolution multibeam bathymetry grids available for download on Geoscience Australia's website. | https://services.ga.gov.au/gis/services/Marine_Survey_Multibeam_Bathymetry/MapServer/WFSServer?request=GetCapabilities&service=WMS |
| GA | National Base Map | Web Service/API | OGC:WMTS (Also available: ESRI:ArcGIS:MapServer) The National Base Map service provides seamless topographic colour mapping for the whole of Australia, including the outer islands of Norfolk, Lord Howe & Macquarie Islands, the external territories of Cocos (Keeling), Christmas, Heard and McDonald Islands and the Australian Antarctic Territory. | https://services.ga.gov.au/gis/rest/services/NationalBaseMap/MapServer/WMTS/1.0.0/WMTSCapabilities.xml |
| GA | National Base Map - GreyScale | Web Service/API | ESRI:ArcGIS:MapServer This service provides seamless topographic greyscale mapping for the whole of Australia, including the external territories of Cocos (Keeling) Islands, Christmas Island, Norfolk Island and Lord Howe Island. The service consists of | https://services.ga.gov.au/gis/rest/services/NationalBaseMap_GreyScale/MapServer |

| Org. | Service Name | Type | Description | Link |
|------|---|-----------------|---|---|
| | | | Geoscience Australia data at smaller scales and OpenStreetMap data is used at larger scales. The service contains layer scale dependencies. | |
| GA | National Base Map - without labels | Web Service/API | ESRI:ArcGIS:MapServer (Also available: OGC:WMTS) The National Base Map - without labels service provides seamless topographic colour mapping for the whole of Australia, including the outer islands of Norfolk, Lord Howe & Macquarie Islands, the external territories of Cocos (Keeling), Christmas, Heard and McDonald Islands and the Australian Antarctic Territory. | https://services.ga.gov.au/gis/rest/services/NationalBaseMapNoLabels/MapServer |
| GA | Seas and Submerged Lands Act 1973 | Web Service/API | OGC:WFS (Also available: ESRI:ArcGIS:MapServer, OGC:WMTS, OGC:WMS) The Seas and Submerged Lands Act (SSLA) 1973 is the Australian legislation that provides the domestic legal framework for Australia to declare its international offshore maritime zones, as provided for by the United Nations Convention on the Law of the Sea (UNCLOS) to which Australia is a party. | https://services.ga.gov.au/gis/services/SSLA_1973/MapServer/WFSServer?REQUEST=GetCapabilities&SERVICE=WFS |
| GA | Treaties - Australian Maritime Boundaries | Web Service/API | OGC:WFS (Also available: OGC:WMS, ESRI:ArcGIS:MapServer) The service contains all maritime boundaries treaties signed by Australia (NOT ALL ARE IN FORCE). | https://services.ga.gov.au/gis/services/Treaties_Australian_Maritime_Boundaries/MapServer/WFSServer?request=GetCapabilities&service=WFS |
| GA | World Bathymetry Base Map | Web Service/API | OGC:WMTS (Also available: ESRI:ArcGIS:MapServer) World Bathymetry Base Map tile cache. The service includes world bathymetry data, and ocean, country, population and natural features. | https://services.ga.gov.au/gis/rest/services/World_Bathymetry_Base_Map/MapServer/WMTS/1.0.0/WMTSCapabilities.xml?REQUEST=GetCapabilities&SERVICE=WMTS |
| GA | World Bathymetry, Imagery and Hillshade | Web Service/API | OGC:WMTS (Also available: ESRI:ArcGIS:MapServer) This service includes world bathymetry, elevation (hillshade), and satellite imagery data, and ocean, country, population and natural features. | https://services.ga.gov.au/gis/rest/services/World_Bathymetry_Imagery/MapServer/WMTS/1.0.0/WMTSCapabilities.xml |
| GA | AUSPOS - Online GPS Processing Service | Tool | AUSPOS is an online GPS data processing facility provided by Geoscience Australia and takes advantage of both The IGS Stations Network and the IGS product range. | https://www.ga.gov.au/applications/auspos-online-gpsd-processing-service |

| Org. | Service Name | Type | Description | Link |
|------|--|--------|--|---|
| GA | AusSeabed Marine Data Portal | Portal | The AusSeaBed Portal provides access to publically available acoustic datasets such as bathymetry, backscatter, side scan sonar data and other marine-related products, as well as a suite of analytical assessment tools to maximise the value of the data. | https://www.ga.gov.au/applications/ausseabed-marine-data-portal |
| GA | Australian Marine Spatial Information System | Tool | The Australian Spatial Information System (AMSIS) is a web based interactive mapping and decision support system that improves access to integrated government and non-government information in the Australian Marine Jurisdiction. | https://www.ga.gov.au/applications/australian-spatial-information-system |
| GA | Australian Stratigraphic Units Database | Portal | The objectives of the Australian Stratigraphic Units Database are to provide the primary national standard for geological names in Australia and to improve the efficiency and effectiveness of communication of geological unit information. | https://www.ga.gov.au/applications/australian-stratigraphic-units-database |
| GA | Geographic to Grid - Redfearn's Formulae | Tool | Geodetic Calculations - Redfearn's Formulae, Geographic to Grid Given Latitude and Longitude, calculate Easting, Northing, Zone for a Universal Transverse Mercator (UTM) projection, Grid convergence and Point Scale Factor. | https://www.ga.gov.au/applications/geographic-to-grid-redfearns-formulae |
| GA | Interactive Maps | Portal | Interactive Maps is a discovery and exploration view of Geoscience Australia's geospatial services. | http://maps.ga.gov.au/interactive-maps/#/ |
| GA | K Indices from Australia | Tool | The k index is a quasilogarithmic index of geomagnetic activity relative to an assumed quiet day curve for the recording site | https://www.ga.gov.au/applications/k-indices-from-australia |
| GA | Moonrise and Moonset Times | Tool | Compute Moonrise and Moonset Times. | https://www.ga.gov.au/applications/moonrise-and-moonset-times |
| GA | National Geospatial Reference System | Portal | The GNSS database contains metadata and data quality statistics for continuous operating GNSS stations in Australia, its Territories and the South Pacific. | https://www.ga.gov.au/applications/national-geospatial-reference-system |
| GA | Place Name Search | Portal | Place Name Search allows the user to search for locations of places in Australia. | https://www.ga.gov.au/applications/place-name-search2 |
| GA | Sun, Moon Azimuth and Elevation | Tool | Sun, Moon Azimuth and Elevation | https://geodesyapps.ga.gov.au/azimuth |
| GA | Sunrise, Sunset and Twilight Times | Tool | Computes sunrise, sunset and twilight times using the National Gazetteer of Australia. | https://geodesyapps.ga.gov.au/sunrise |

| Org. | Service Name | Type | Description | Link |
|------|--------------------------------------|-----------------|--|---|
| GA | Vincenty's Formulae - Direct Method | Tool | Geodetic Calculations - Vincenty's Formulae, Direct Method Given the latitude and longitude of a point (1) and the forward geodetic azimuth (1-2) and ellipsoidal distance to a second point (2), calculate the latitude and longitude of the second point and the reverse azimuth (2-1). | https://www.ga.gov.au/applications/vincentrys-formulae-direct-method |
| GA | Vincenty's Formulae - Inverse Method | Tool | Geodetic Calculations - Vincenty's Formulae, Inverse Method Given latitude and longitude of two points, calculate the ellipsoidal distance and forward and reverse azimuths between the points. | https://www.ga.gov.au/applications/vincentys-formulae-inverse-method |
| GA | World Wind - 3D Viewer | Tool | Geoscience Australia's 3D Data Viewer is an application developed using NASA's World Wind Java Software Development Kit (SDK) to display Australia's continental data sets. The viewer allows you to compare national data sets such as the radioelements, the gravity and magnetic anomalies, and other mapping layers, and show the data draped over the Australian terrain in three dimensions. | https://www.ga.gov.au/applications/world-wind-3d-viewer |
| IMAS | IMAS Portal | Portal | Access to Ocean data from across australia | https://data.imas.utas.edu.au/portal/search |
| IMAS | IMAS GeoNetwork Search | Portal | IMAS GeoNetwork data | https://metadata.imas.utas.edu.au/geonetwork/srv/eng/catalog.search#/search |
| IMAS | IMAS Antarctic specific data | Web Service/API | IMAS Antarctic specific web service end point | https://metadata.imas.utas.edu.au/geonetwork/srv/eng/csw-IMAS-ANTARCTIC |
| IMAS | OGC Web services | Web Service/API | GeoServer web services | https://geoserver.imas.utas.edu.au/geoserver/web/ |
| IMAS | THREDDS Catalogue | File access | IMAS THREDDS Catalog | https://thredds.imas.utas.edu.au/thredds/catalog.html |
| IMOS | AODN Portal | Portal | Access to Ocean data from across australia | portal.aodn.org.au |
| IMOS | IMOS User Code Library | Tool | Multiple code libraries (e.g Jupyter notebooks) for integrating code | https://github.com/aodn/imos-user-code-library |
| IMOS | IMOS Matlab Toolbox | Tool | Automated, easy to use interface for converting raw instrument data into IMOS compatible Quality Controlled netCDF files | https://github.com/aodn/imos-toolbox/wiki |
| IMOS | IMOSThredds Catalog | File access | The inventory of available netCDF datasets. | http://thredds.aodn.org.au/thredds/catalog.html |

| Org. | Service Name | Type | Description | Link |
|------|---------------------------|-----------------|--|---|
| IMOS | GeoNetwork Catalogue | Portal | The GeoNetwork portal for specific IMOS data | https://catalogue-imos.aodn.org.au/geonetwork/srv/eng/catalog.search#/home |
| IMOS | GeoNetwork API | Web Service/API | Web services to access IMOS GeoNetwork | https://catalogue-imos.aodn.org.au/geonetwork/doc/api/index.html#/ |
| IMOS | AODN GeoNetwork Catalogue | Portal | The GeoNetwork portal for AODN data | https://catalogue.aodn.org.au/geonetwork/srv/eng/catalog.search#/home |
| IMOS | AODN GeoNetwork APIs | Web Service/API | Web services to access AODN GeoNetwork | https://catalogue.aodn.org.au/geonetwork/doc/api/index.html#/ |
| IMOS | IMOS S3 Bucket | File access | Publicly available data available via Amazon AWS | http://imos-data.s3-website-ap-southeast-2.amazonaws.com/ |

Appendix 1 – Glossary

| Term | Description |
|--------------------------|---|
| AAD | Australian Antarctic Division |
| AADC | Australian Antarctic Data Centre |
| AAPP | The Australian Antarctic Program Partnership. A partnership of Australian Antarctic research organisations with the goal of better understanding the role of the Antarctic Region. The partnership includes the following partner agencies: <ul style="list-style-type: none"> • University of Tasmania • Institute for Marine & Antarctic Studies • The Australian Antarctic Division • CSIRO • Bureau of Meteorology • Geoscience Australia • Tasmanian Government |
| AODN | Australian Ocean Data Network |
| API | Application Programming Interface – an interface for machine to machine communication. |
| API | Application Programming Interface – an interface for machine to machine communication. |
| BODC | British Oceanographic Data Centre |
| BoM | Bureau of Meteorology |
| Bureau | Bureau of Meteorology |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CSV | Comma Separated Value - a plain text filetype used to store tables of data |
| DIF | Directory Interchange Format, a metadata standard developed by NASA for describing Earth science data. |
| ESRI | Environmental Systems Research Institute |
| FTP | File Transfer Protocol – a protocol for transferring files over a network |
| GA | Geoscience Australia |
| GCMD | Global Change Master Directory. NASA's international data collection resource. Now available via https://idn.ceos.org/index.html The GCMD also hosts a repository of keywords that can be applied to metadata to help categorise it. A user interface to browse those keywords is available here: https://gcmd.earthdata.nasa.gov/KeywordViewer/scheme/all?gtm_scheme=all |
| GeoServer | A web enabled server that allows users to connect to geospatial data. http://geoserver.org/ |
| HTTP | Hypertext Transfer Protocol |
| IMAS | Institute for Marine and Antarctic Studies |
| ISO | International Organisation for Standardisation |
| ISO 19115 | Standard for recording geographic information. ISO 19115-1 is used to record fundamental geographical information ISO 19115-2 is used to record extensions for acquisition and processing of geographic information ISO 19115-3 defines an integrated XML implementation of ISO 19115-1, ISO 19115-2 and some elements of ISO 19139 ISO 19115 standards may be implemented in their raw state, or may have a profile (such as the MCP) applied to them. |
| Marine Community Profile | A profile applied to the ISO 19115 standards to suit the needs of the marine community |
| MCP | See Marine Community Profile |
| MNF | Marine National Facility |

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|------------------|---|
| NASA | The National Aeronautics and Space Administration, an independent agency of the U.S. federal government responsible for the civilian space program, as well as aeronautics and space research. |
| netCDF | Network Common Data Form – a form of array-oriented scientific data. |
| OBIS | Ocean Biodiversity Information System |
| OGC Web services | Web services built to the standards defined by the Open Geospatial Consortium including: OGC: WCS: Web Coverage Service for geospatial information (space/time coverage) OGC: WFS: Web Feature Service for geographical features OGC: WMS: Web Map Service for map information OGC: WMTS: Web Map Tile Service for map tile information |
| OGC Web services | Web services built to the standards defined by the Open Geospatial Consortium including: OGC: WCS: Web Coverage Service for geospatial information (space/time coverage) OGC: WFS: Web Feature Service for geographical features OGC: WMS: Web Map Service for map information OGC: WMTS: Web Map Tile Service for map tile information |
| Web Service | A web enabled API that facilitates machine to machine communication across the internet. |
| WIS | WMO Information System |
| GeoNetwork | Software for cataloguing geospatial data |
| THREDDS | Thematic Real-time Environmental Distributed Data Service – a service that provides human and machine access to data files, including netCDF files. |
| IMOS | Integrated Marine Observing System |