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Discussion Paper

**Stations Metadata and WMO Core Profile
A way forward**

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Executive Summary

An issue that has been causing considerable confusion and angst among Climate Data Managers is that of understanding the relationship between Stations Metadata and the WMO Core Profile of ISO 19115 Metadata (SDI 'Discovery Metadata').

Discussions have typically been about 'metadata' without qualifying the context in which the term is used.

'Stations Metadata' is known in the Climate community as 'metadata'.

'Discovery Metadata' is known within the spatial data management and Spatial Data Infrastructure communities as 'metadata'.

This paper has explored both types of metadata in depth and concluded that they are distinctly different concepts.

In summary, 'Stations Metadata' is time series data about how and where meteorological observations were made and the conditions that they were made under. It is used to support a range of activities that allow climate professionals to understand the fitness for purpose of specific data and in many cases improve the quality of climate observations data.

In summary, SDI 'Discovery Metadata' is data describing a dataset and is intended to facilitate the discovery and assessment of a spatial dataset to determine if it is fit for re-use for a purpose that may be at odds with the reason that it was originally created.

In future, discussions using the term 'metadata' should qualify the context in which it is used to avoid unnecessary confusion.

This paper then explored a way forward that will allow a consistent data model and a common vocabulary to be developed describing combined Climate Observations data and Stations Metadata. This data model is independent of the internal structures used by data providers and provides a way forward that will facilitate future efficient and interoperable Climate Services.

This concept is called an 'Application Schema' and could be thought of as a Climate Profile of Observations and 'Stations Metadata', however the term 'profile' is deliberately not used to avoid further confusion about 'Profiles', particularly with the WIS effort to deploy the Climate Profile of ISO 19115 'Discovery Metadata'. The term 'profile' also has different meanings and context.

Relevant recommendations have been made.

Introduction

An issue that has been causing considerable confusion and angst among Climate Data Managers is that of understanding the relationship between Stations Metadata and the WMO Core Profile of ISO 19115 Metadata.

This issue has attracted passionate debate from people from a wide range of backgrounds and remains unresolved. The current situation was well summarised in WCDMP-73 2009 (p3), that summarised the 2009 Toulouse CCI Expert Team meeting looking at this issue:

“Discussions surrounding metadata, in particular station metadata, were complex and intense. Defining a station metadata format that uses existing standards, accommodates comprehensive station details and time series information, yet remains simple and accessible, is a difficult challenge. While a variety of groups, both within the WMO and in external organizations, have worked to address these issues, the work has often been independent and lacked coordination, and no clear solution yet exists.”

This issue remains unresolved. It is consuming valuable time from scarce volunteer resources and is distracting attention away from developing future effective and interoperable climate data services. It is time that it was resolved with a roadmap describing a way forward.

The word ‘metadata’ is ambiguous. It means different things to different people and its use should really be qualified to ensure each participant understands the context in which it is used.

This ambiguity appears to be the crux of the issue that is causing confusion in the Climate metadata / WMO Core Metadata issue. Proponents appear to be discussing different concepts, but using the same term, ‘metadata’, to describe their concepts.

This paper aims to compare and contrast both the Stations Metadata and the WMO Core Profile Metadata concepts and to provide ‘a’ way forward with this issue.

'Stations Metadata'

What is 'Stations Metadata'?

Climate Scientists and Data Managers are particularly concerned about the quality of the data that they utilise to ensure that it is suitable for future analysis of our climate, and to determine fitness of data for climate service delivery, climate monitoring and research.

Climate Observations data includes not only observations of a variety of meteorological and other relevant phenomena, but also how and where observations were made and the conditions that they were made under. This additional data about the observational data is often termed 'Stations Metadata'.

The guiding principle for the collection of 'Stations Metadata' is GCOS Climate Monitoring Principle #3 (GCOS 2003):

"The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e., metadata) should be documented and treated with the same care as the data themselves."

Plummer et al 2007 in WCDMP-60 Guidelines on Climate Data Management (pp 15-16) use the following conceptual example to describe 'Stations Metadata':

"... the innate structure of the metadata in an ideal system will be considerably more complex than the innate structure of the climate data itself. Consider a rainfall observation. Commonly, the essential information content of the data will be simply of the general form "at station x, for an elapsed period of time e, ending at time t, the precipitation was p mm." The associated metadata, which is needed to fully interpret the data, could include such things as the:

- *Reference date used by the database (GMT, time zone, others);*
- *Quality which has been ascribed to the observation;*
- *History of the values ascribed to the meteorological parameter and any associated flags;*
- *Instrument used to record the observation, together with more fine detail on its own maintenance programme, tolerances, internal parameters, etc;*
- *Name of the observer;*
- *Full details of the station and its history;*
- *Programme of observations in effect at the time and its history;*
- *Inventory of the elements stored in the database, their units, their boundaries; and*
- *Topographical and ground-cover details of the site, information on surrounding trees, buildings, etc, and how these have changed with time."*

Aguilar et al, 2003 in WCDMP-53, Guidelines on Climate Metadata and Homogenisation (pp 2-27) offer a more detailed treatment of what 'Stations

Metadata' is considered to be. They offer two distinct categories of 'Stations Metadata', including:

- Single Station Metadata (pp 3-17); and
- General Historical Network Information (pp 17-22).

The 2011 edition of the WMO Guide to Climatological Practices also provides a brief overview of the requirements for 'Stations Metadata', WMO-100 2011 (pp 2.16-2.17).

Table 1 at Appendix 1, derived from Aguilar et al 2003 (pp 25-26) summarises the type of 'data' to be stored for a meteorological station as 'Stations Metadata'. While this summary is not structured optimally for an information architect, it can serve as a starting point for future analysis.

The structure at Table 1 has been deliberately selected to retain the context and lineage from the excellent work by Aguilar et al and to allow comparison with WMO Core Profile of ISO 19115 Metadata presented later in this document.

Table 2 below outlines Stations Metadata elements. It has been derived from the Table 1 at Appendix 1. This alternate portrayal is used to facilitate later comparison with WMO Core Profile of ISO 19115 Metadata.

Stations Metadata Elements
Station Identifier
Station Geographic Location
Station Local Environment conditions
Station Instrumentation and Maintenance
Station Observing Practices
Data Processing
Historical Events
Communication and Correspondence

Table 2:
Summary of 'Stations Metadata' Elements

What is 'Stations Metadata' used for?

Good quality Observations data and 'Stations Metadata' are necessary to underpin rigorous analysis that results in high quality 'homogenised' time series data sets. Such data sets aim to ensure that the only variability that remains in the time series is that resulting from actual climate variability. This is expanded upon in Aguilar et al, 2003.

An excellent description of the techniques used to produce a regional high quality homogenized data set, the Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) may be found at Trewin 2012. Of note is that this dataset has been through an independent international peer review process.

Climate Data Managers also use 'Stations Metadata' to support a range of activities that improve the quality of climate data to different levels of quality, dependent on the intended use of the data as outlined by Plummer et al , 2007 (pp 11-12, 21-23). Differing levels of quality are often expressed using quality flags.

Summary: 'Stations Metadata'

In summary, 'Stations Metadata' is time series data about how and where meteorological observations were made and the conditions that they were made under.

Stations Metadata is used to support a range of activities that allow climate professionals to understand the fitness for purpose of specific data and in many cases improve the quality of climate observations data.

SDI 'Discovery Metadata and WMO Core Profile of ISO 19115

As Climate Scientists and Data Managers understand from their management of observations, derived data and 'stations metadata', spatial data can be expensive to create and maintain.

Also as Trewin 2012, has outlined with his description of the ACORN-SAT work, considerable effort is required to produce high quality data, in this case over three years effort by a team of specialists, using data maintained for over a century by specialists.

The Internet, organisations' data servers and desktop computers around the world are littered with spatial datasets. Many of these data sets are maintained by conscientious professionals and many are throw away datasets produced with little thought or effort. Some are of superior quality, e.g. the ACORN-SAT data.

A problem that many organisations face when undertaking an analysis process prior to making a business decision is in determining just what is appropriate data to use as the basis of this decision. Can the organisation capitalise on another organisation's prior work and investment? Is the data suitable for the intended purpose, or does the organisation have to capture and process suitable data prior to commencing the analysis phase of the process?

When presented with a list of files on a file system, how does the person undertaking the data assessment in the prior example actually determine the suitability of each data set as input to the process that results in a business decision? How does a quality dataset such as ACORN-SAT get discovered by other organisations as input into their decision making process?

Spatial Data Infrastructures

Globally, many governments and organisations are working together to develop a framework to help address these issues and to allow better reuse of spatial data using the Spatial Data Infrastructure (SDI) concept. Wikipedia-2 2012, defines an SDI as:

A spatial data infrastructure (SDI) is a data infrastructure implementing a framework of geographic data, metadata, users and tools that are interactively connected in order to use spatial data in an efficient and flexible way. Another definition is the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data.

A further definition is given in Kuhn (2005):

An SDI is a coordinated series of agreements on technology standards, institutional arrangements, and policies that enable the discovery and use of geospatial information by users and for purposes other than those it was created for.

There are a number of SDI in active use around the world. Some examples are:

- European Inspire Directive;
- Global Spatial Data Infrastructure;
- Australian Spatial Data Infrastructure;

- GEOSS; and
- WMO's WIS can also be thought of as an SDI.

Most SDI sponsors attempt to coordinate global SDI efforts via the Global Spatial Data Infrastructure organisation. GSDI-2 contains a set of links to a number of such SDI efforts.

SDI 'Discovery Metadata'

As can be seen from the SDI definition, the concept of 'Discovery Metadata' is a key component of an SDI. Several examples below will expand on the concept of this type of metadata.

GSDI 2012 (Chapter 3) provides a good overview of SDI 'Discovery Metadata' and related concepts. It describes metadata as follows:

We often hear the phrase "information is power," but with increasing amounts of data being created and stored (but often not well organised) there is a real need to document the data for future use - to be as accessible as possible to as wide a "public" as possible. Data, plus the context for its use (documentation, metadata) become information. Data without context are not as valuable as documented data. There are significant benefits to such asset management:

Metadata helps organise and maintain an organisation's investment in data and provides information about an organisation's data holdings in catalogue form

Coordinated metadata development avoids duplication of effort by ensuring the organisation is aware of the existence of data sets

Users can locate all available geospatial and associated data relevant to an area of interest

Collection of metadata builds upon and enhances the data management procedures of the geospatial community

Reporting of descriptive metadata promotes the availability of geospatial data beyond the traditional geospatial community

Data providers are able to advertise and promote the availability of their data and potentially link to on line services (e.g. text reports, images, web mapping and ecommerce) that relate to their specific data sets

A number of studies have established that although the value of geospatial data is recognised by both government and society, the effective use of geospatial data is inhibited by poor knowledge of the existence of data, poorly documented information about the data sets, and data inconsistencies. Once created, geospatial data can be used by multiple software systems for different purposes. Given the dynamic nature of geospatial data in a networked environment, metadata is therefore an essential requirement for locating and evaluating available data. Metadata can help the concerned citizen, the city planner, the graduate student in geography, or the forest manager find and use geospatial data, but they also benefit the primary creator of the data by maintaining the value of the data and assuring their continued use over a span of years. Over thirty years ago, humans landed on the Moon. Data from that era are still being used today, and it is reasonable to assume that today's geospatial data could still be used in the year 2020 and beyond to study climate change, ecosystems, and other natural

processes. Metadata standards will increase the value of such data by facilitating data sharing through time and space. So when a manager launches a new project, investing a small amount of time and resources at the beginning may pay dividends in the future.

There have been a number of SDI 'Discovery Metadata' standards over the past twenty years. The most widely used though, is ISO 19115 and its related standards. This standard forms the basis of the WMO standard, the **WMO Core Profile of ISO 19115**, the Inspire Directive, ANZLIC Metadata Standard and many others. The US Federal Geographic Data Committee is also in the process of moving to a standard based on ISO 19115.

The Europeans have moved further than most other regions in the world. As described at Inspire-1 2008, EC Commission Regulation 1205/2008 of 3 December 2008, the Europeans have legislated the use of metadata based on ISO 19115 to describe spatial data.

ISO 19115

ISO-1 2003, describes the intent of ISO 19115-2003 (p viii) as follows:

The objective of this International Standard is to provide a structure for describing digital geographic data. This International Standard is intended to be used by information system analysts, program planners, and developers of geographic information systems, as well as others in order to understand the basic principles and the overall requirements for standardization of geographic information. This International Standard defines metadata elements, provides a schema and establishes a common set of metadata terminology, definitions, and extension procedures. When implemented by a data producer, this International Standard will:

- 1) Provide data producers with appropriate information to characterize their geographic data properly.*
- 2) Facilitate the organization and management of metadata for geographic data.*
- 3) Enable users to apply geographic data in the most efficient way by knowing its basic characteristics.*
- 4) Facilitate data discovery, retrieval and reuse. Users will be better able to locate, access, evaluate, purchase and utilize geographic data.*
- 5) Enable users to determine whether geographic data in a holding will be of use to them.*

This International Standard defines general-purpose metadata, in the field of geographic information. More detailed metadata for geographic datatypes and geographic services are defined in other ISO 19100 series standards and user extensions.

As outlined at ISO-1 (p8) ISO 19115 metadata is designed to be used to describe spatial data, specifically:

- Individual datasets, for example;
 - a collection of time series meteorological observations.

- Collection of datasets, for example:
 - a consistent series of topographic data such as GeoScience Australia's GeoData 250K Topo Series 2 covering the Australian Continent, as described at GA 2004;
 - a collection of consistently processed Landsat 7 satellite data; or
- Individual records in a data set.

In recognition of the amount of work required to create and appropriately define a metadata record together with the ongoing maintenance burden of ensuring that these records remain current, practitioners typically store metadata at the highest possible level of aggregation. See also ISO-1 (pp 119-125).

ISO 19115 Metadata Profiles

Increasingly communities of practice are assessing what is appropriate for their uses of SDI 'Discovery Metadata' and agreeing on a subset of ISO 19115 records, together with a consistent set of terms defining their 'things' of interest (also known as a 'defined vocabulary'). This community of practice use of the standard when formalised is known as a 'Profile' of ISO 19115. See ISO-1 (Annex C), Tandy 2010 (p16-17) and ISO-2 for more information on 'Profiles'. An example of a profile is the WMO Core Profile of ISO 19115.

Typically communities of practice allow data managers to utilise the full suite of Metadata options, provided that the Profile's core requirements are met.

What type of information is recorded with 'Core' ISO 19115 SDI 'Discovery Metadata'?

For a good overview of the type of information that is typically recorded using SDI 'Discovery Metadata' see ANZLIC-1 2011 (pp 8-11) and WMO Core Profile (pp 3-8).

ISO-1 (p15) defines the type of 'core' data that ISO 19115 facilitates in a Discovery Metadata record:

*This International Standard defines an extensive set of metadata elements; typically only a subset of the full number of elements is used. However, it is essential that a basic minimum number of metadata elements be maintained for a dataset. Listed are the core metadata elements required to identify a dataset, typically for catalogue purposes. This list contains metadata elements answering the following questions: "Does a dataset on a specific topic exist ('what')?", "For a specific place ('where')?", "For a specific date or period ('when')?" and "A point of contact to learn more about or order the dataset ('who')?". Using the recommended optional elements in addition to the mandatory elements will increase interoperability, allowing users to understand without ambiguity the geographic data and the related metadata provided by either the producer or the distributor. **Dataset metadata profiles of this International Standard shall include this core.***

The Table 3 below outlines ISO 19115 Core Discovery Metadata elements. It has been derived from the table at ISO-1 (p16). This alternate portrayal is used to facilitate later comparison with Stations Metadata.

Discovery Metadata Element
Dataset title
Dataset reference date
Dataset responsible party
Geographic location of the dataset (by four coordinates or by geographic identifier)
Dataset language
Dataset character set
Dataset topic category
Spatial resolution of the dataset
Abstract describing the dataset
Distribution format
Additional extent information for the dataset (vertical and temporal)
Spatial representation type
Reference system
Lineage
On-line resource
Metadata file identifier
Metadata standard name
Metadata standard version
Metadata language
Metadata character set
Metadata point of contact
Metadata date stamp

Table 3: Summary of 'Discovery Metadata' Elements

Metadata Catalogues

Organisations typically store their SDI Discovery Metadata records describing their spatial data holdings within a (SDI Discovery) '**Metadata Catalogue**¹'.

Metadata Catalogues allow a user to search for SDI 'Discovery Metadata' describing spatial datasets using a wide range of search criteria. For more information on Metadata Catalogues see GSDI 2012 (Chapter 4).

Typically, such metadata catalogues operate in a federated manner and are registered with upstream SDI Metadata Catalogues allowing harvesting of their records.

The SDI Metadata Catalogues in turn, consolidate metadata records from many organisations allowing a user to search the spatial data holdings of many organisations with a single search.

Some examples of regional SDI Metadata Catalogues are:

- Australian Spatial Data Directory²;
- Inspire Geoportal³;
- US Geo.data.gov⁴

There is also an effort at establishing a global Metadata Catalogue:

- GEO Portal⁵

¹ A Metadata Catalogue should be thought of as an SDI 'Discovery Metadata' Catalogue in the context of this document.

As is explained later in this document, SDI 'Discovery Metadata' Catalogues are not appropriate for the storage of individual 'Stations Metadata' records.

² ASDD: <http://asdd.ga.gov.au/asdd/>

³ Inspire: <http://inspire-geoportal.ec.europa.eu/>

⁴ Geo.Data.Gov: <http://geo.data.gov/geoportal/catalog/main/home.page>

⁵ GEO Portal: http://www.geoportal.org/web/guest/geo_home

WMO Core Profile of ISO 19115

In simple terms, the WMO Core Profile can be thought of as a template for creating SDI 'Discovery Metadata' that is relevant for meteorological and climate purposes.

Effective use of the WMO Core Profile will ensure that the SDI 'Discovery Metadata' that an organisation creates is consistent with the type of information that it needs as well as the information that other meteorological, climate and related stakeholders need, to assess and determine whether data sets are appropriate for a particular use.

Specifically, the WMO Core Profile establishes the following for SDI 'Discovery Metadata' used by meteorological and related communities Tandy 2010 (p11):

- Common Terms;
- Common Definitions; and
- Common Structure.

Tandy 2010 explores WMO Core Profile SDI 'Discovery Metadata' in depth and is a good reference document. Be aware though, that while earlier sections of the document provide a good overview, later sections are quite technical and intended for use by Information Architects and IT systems implementers.

Appendix 3 contains Table 4 showing a summary of the types of SDI 'Discovery Metadata' records that are available for use to describe meteorological, climate and related datasets.

Table 4 contains data derived from:

- ISO 19115:2003;
- WMO Core Profile of ISO 19115 as described in Tandy (2010); and
- Adjusted for ISO 19115:2003 Corrigendum 1:2006

Noting that the full range of ISO 19115 metadata elements are available for use, if required, in addition to the WMO Core profile elements, Table 4 uses the following colour scheme:

- Bold, dark blue text represents Mandatory WMO Core Profile elements;
- Light blue text represents optional and conditional WMO Core Profile elements; and
- Light grey text represents additional ISO 19115 metadata elements that are available for use if required, but not included with the WMO Core Profile.

Examples SDI 'Discovery Metadata' report may be found at Appendices 2 and 4. Appendix 2 contains a sample 'Discovery Metadata' record for an Observations dataset. Appendix 4 contains a sample 'Discovery Metadata' record for 'Stations Metadata' dataset. These reports do not display the relevant XML codes to avoid overcomplicating issues. They are valid ISO 19115 Metadata records that comply

with the ANZLIC Profile of ISO 19115. This profile is very similar to the WMO Core Profile.

Summary: SDI Discovery Metadata

In summary, SDI 'Discovery Metadata' is intended to facilitate the discovery and assessment of a spatial dataset to determine if it is fit for re-use for a purpose that may be at odds with the reason that it was originally created.

Discussion

What is the difference between Stations Metadata and SDI Discovery Metadata?

'Stations Metadata' and SDI 'Discovery Metadata' have been defined in the above sections of this document.

In summary: 'Stations Metadata'

'Stations Metadata' is time series data about how and where meteorological observations were made and the conditions that they were made under. It is used to support a range of activities that allow climate professionals to understand the fitness for purpose of specific data and in many cases improve the quality of climate observations data.

In summary: SDI 'Discovery Metadata'

SDI 'Discovery Metadata' is data describing a dataset and is intended to facilitate the discovery and assessment of a spatial dataset to determine if it is fit for re-use for a purpose that may be at odds with the reason that it was originally created.

Comparison of Metadata summary elements

Discovery Metadata Element	Stations Metadata Elements
Dataset title	Station Identifier
Dataset reference date	Station Geographic Location
Dataset responsible party	Station Local Environment conditions
Geographic location of the dataset (by four coordinates or by geographic identifier)	Station Instrumentation and Maintenance
Dataset language	Station Observing Practices
Dataset character set	Data Processing
Dataset topic category	Historical Events
Spatial resolution of the dataset	Communication and Correspondence
Abstract describing the dataset	
Distribution format	
Additional extent information for the dataset (vertical and temporal)	
Spatial representation type	
Reference system	
Lineage	
On-line resource	
Metadata file identifier	
Metadata standard name	
Metadata standard version	
Metadata language	
Metadata character set	
Metadata point of contact	
Metadata date stamp	

Table 5: Comparison of 'Discovery Metadata' and 'Stations Metadata' Summary Elements

Table 5 provides an overview of the different types of data that is stored for both SDI 'Discovery Metadata' and 'Stations Metadata'.

Table 5 is a combination of Tables 2 and 3 above.

Comparison of Table 5, Table 1 (Appendix 1) and Table 4 (Appendix 3) will show that SDI 'Discovery Metadata' and 'Stations Metadata' are two distinctly different concepts.

An SDI 'Discovery Metadata' Catalogue may contain a metadata record describing a collection of 'Stations Metadata', e.g. the 'Discovery Metadata' record at Appendix 4.

Conversely, a 'Stations Metadata' collection will not contain a metadata record describing the SDI 'Discovery Metadata' collection.

'Stations Metadata' is a distinctly different concept to SDI 'Discovery Metadata'.

Therefore it is not appropriate to attempt to store Stations Metadata within a Profile of ISO 19115 Discovery Metadata. This would result in a lot of work with very little gain. It would also result in an inferior solution. Stations Metadata is better managed within a database as a distinct dataset in its own right. To do otherwise would severely limit the potential future use and utility of this essential data.

Is a Climate Profile of WMO Core Profile of ISO 19115 required?

ISO 19115 has been developed, refined and used for over a decade. It has been the subject of in depth analysis and peer review by a rigorous international process that has been managed by the International Standards Organisation. The standard is in widespread use around the world. It provides an excellent generic base for describing spatial data.

On the understanding that 'Stations Metadata' is best managed as a dataset in its own right, the WMO Core Profile of ISO 19115 provides an excellent basis for SDI 'Discovery Metadata' for the Climate and Meteorological communities.

Therefore a Climate specific profile of the WMO Core Profile of ISO 19115 **is not** required.

Is a Climate Profile of 'Stations Metadata' required?

Perhaps, however more work will be required prior to answering this question. Please see the next section of this document for more discussion on this issue.

Potential Future Directions for 'Stations Metadata'

Acknowledging that the WMO Core Profile is not an appropriate way forward with 'Stations Metadata', a way still needs to be found to effectively utilise this essential climate related data.

The examples below will help illustrate a potential future direction. They will also illustrate how 'Discovery Metadata' can be used.

Example Analysis

Consider the following analysis:

Select all precipitation observations of time interval 't' from country 'x' and country 'y', for the period between date: t1 and date: t2 where meteorological stations used sensor 'z' to capture observations.

This analysis would necessitate working with data from several data providers who would probably utilise different data structures, codes and data schema from each other. Outlined below are two approaches to undertaking this analysis.

Process 1: Current Discovery, Access, Retrieval (DAR) Approach

Using current approaches, an analyst would perhaps use the following (simplified) process to undertake this analysis:

- Data Discovery
 - Search a relevant (Discovery) Metadata Catalogue for observations data that may perhaps be suitable for the analysis within the area of interest;
 - Review the 'Discovery Metadata' records for each identified dataset to narrow down the selection to one or two datasets for further investigation;
 - If recorded in the 'Discovery Metadata' records, identify the related datasets that contain 'Stations Metadata' corresponding to the identified observations data;
 - If the relevant 'Stations Metadata' for the identified observations data is not recorded in their 'Discovery Metadata' records, search the (Discovery) Metadata Catalogue to try and find relevant 'Stations Metadata' records;
 - Review the 'Discovery Metadata' records for each identified 'Stations Metadata' dataset to narrow down the selection to determine the appropriate 'Stations Metadata' dataset for each selected 'Observation Dataset';

- Obtain Data
 - If present in the 'Discovery Metadata' record determine the online location for each of the identified observations datasets and corresponding 'Stations Metadata' dataset and download the required data;
 - If the data is not available online or to clarify issues, contact the relevant contact person for each dataset and request a copy of the data to be sent;
- Data Investigation
 - View the structure of each corresponding dataset to determine whether appropriate format, data structure, units of measure etc are available to undertake the required analysis;
 - If required, contact the relevant contact person for each dataset to clarify any required points;
- Data Analysis
 - If required, massage the data into a format that will allow the required analysis to be undertaken;
 - Analyse the data;
 - Document the results;
- Data Cleanup
 - Prepare 'Discovery Metadata' records for the dataset(s) supporting the analysis;
 - Either make available or archive the dataset(s) used in the analysis.

Process 2: Potential Discovery Access Retrieval with Application Schema Approach

There is a variant of the DAR approach that takes advantage of Open Spatial Standards developments in data interoperability.

Open Spatial Standards

There has been considerable development in (spatial) data interoperability for well over the last decade within the open spatial standards community.

The International Standard ISO 19115 that is used by the WMO Core Profile is but one of a number of standards that are aimed at supporting interoperable systems and data.

These standards have been developed by the International Standards Organisation's Technical Committee 211 and also increasingly by the Open Geospatial Consortium. ISO TC/211 and OGC have established a cooperative agreement that allows industry

standards that have been developed through OGC processes to be published as ISO Standards, see ISO-TC211-1 1999.

Application Schema (sometimes called 'profiles')

This variant of the DAR approach takes advantage of developments in one aspect of open spatial standards, called Application Schema. Wikipedia-2 2012 describes an application schema as supporting "...*data interoperability within a community of interest*". See also OGC Network 2012.

Typically an application schema, or 'profile' provides a common data model and related 'common vocabulary' that a community of interest uses to allow interoperable exchange of data.

Application schema can be implemented by organisations without affecting the structure of underlying technical systems.

Potential Discovery Access Retrieval with Application Schema Approach

This variant of the DAR approach takes advantage a **hypothetical** Application Schema that provides a common definition for combined observations data and 'Stations Metadata'. This hypothetical Application Schema will be called 'Climate Observations Application Schema' for the rest of this document.

Using a DAR and Application Schema approach, an analyst would perhaps use the following (simplified) process to undertake this analysis:

- Data Discovery
 - Search a relevant (Discovery) Metadata Catalogue for Climate Data **Services** that provide combined data for observations and 'stations metadata' that conform to the hypothetical 'Climate Observations Application Schema'.
 - Review the 'Discovery Metadata' records for each identified service to narrow down the selection to one or two appropriate services;
 - Determine the relevant Uniform Resource Identifiers (URI) for these services together with the appropriate syntax to filter the services to just provide the required data;
- Obtain Data
 - Obtain only the required data by issuing a request to the appropriate URI that filters the results based on the query parameters and requests the data to be returned conformant to the 'Climate Observations Application Schema';
- Data Investigation
 - Not required, as the services will provide data conformant to the requirements of the 'Climate Observations Application Schema';
- Data Analysis
 - If required, conduct further analysis on the data;

- Document the results of the analysis, together with the appropriate URI to replicate the data retrieval;
- Data Cleanup
 - Not required.

Comparison of Approaches

Both approaches would probably arrive at the same result containing climate observations data that had been filtered by specific 'Stations Metadata' requirements.

While both approaches are based on the current Discovery, Access, Retrieval approach adopted by WIS, the main difference between the two approaches is the amount of manual intervention required.

- Process 1, the Current Discovery, Access, Retrieval (DAR) Approach results in the following:
 - Significant manual intervention is required on the part of the analyst to understand the structure of the different data sets required and to then transform that data into a format suitable for the analysis;
 - There could well be a considerable demand on the time of a data provider to answer questions on and explain the structure of their data;
 - There could be a considerable time delay and impact on the data provider as required data is extracted and provided to the analyst; and
 - There is potential for error to be introduced into the resultant data and analysis through misunderstanding of the correct context of the source data.
- Process 2, Potential Discovery Access Retrieval with Application Schema Approach results in the following:
 - This process requires minimal manual intervention. It could potentially be automated as a climate service in its own right;
 - The data retrieved is conformant to the hypothetical 'Climate Observations Application Schema' with a known structure and common vocabulary, requiring no massaging or conversion. The fact that different data providers use different data structures and syntax is transparent to the end user;
 - The data can be filtered at the source, reducing the effort of the analyst with precisely the data required returned as well as reducing the impact on the provider's servers and internet bandwidth;
 - This process can be undertaken with minimal time delay; and
 - The analyst's time is better spent undertaking data analysis, rather than in data preparation.

Therefore, the approach using an Application Schema for combined Climate Observations and 'Stations Metadata' clearly has the best long term potential and will allow analysts to concentrate more on data analysis, rather than on data discovery and preparation.

Creating a 'Climate Observations Application Schema'

The term 'Application Schema' is used in preference to the term 'profile' to avoid confusion with the WMO Core Profile.

Creating a 'Climate Observations Application Schema' will take quite a bit of effort.

It's potential though in underpinning future Climate Services by providing a consistent data interface to Observations data and 'Stations Metadata' together with a consistent 'common vocabulary' should not be under-estimated. It will significantly reduce the costs associated with developing, maintaining and supporting future Climate Services.

In simple terms, the following will need to be undertaken:

- Interested communities will need to agree on what constitutes a climate observation, together with consistent common terms, units of measure and semantic syntax;
- Similarly, interested communities will need to do the same for 'Stations Metadata';
- A consistent data model will need to be prepared and agreed on;
- Semantic linkages with other communities of interest that overlap with the climate domain will need to be established; and
- The Application Schema will need to be endorsed by relevant authorities as 'the' way to exchange climate observations data and 'Stations Metadata'.

Building on solid foundations

While the above list looks deceptively small, it hides quite a bit of work. Fortunately, the work to establish a 'Climate Observations Application Schema' can be built on solid foundations, as a considerable amount of relevant effort has already been undertaken.

While it is beyond the scope of this document to explore these related efforts in detail, the following should be considered relevant:

- The Open Geospatial Consortium community has invested well over a decade into developing a solid theoretical base and data model for observations data. This includes facilities for recording data similar to 'Stations Metadata'. This work is known as 'Observations and Measurements' and is published as ISO 19156. See OGC-O&M 2010 for more information;
- Considerable effort has been invested into developing a climate application schema, called the Climate Science Modeling Language (CSML). CSML version 3 is based on 'Observations and Measurements'. While CSML does not cater for 'Stations Metadata', most of the application schema, the community's processes and learnings are very relevant. The CSML

community also tries to keep a level of consistency with the CF-netCDF community. CSML should be considered a starting point in the development of a climate application schema that combines observations data and 'Stations Metadata'. See CSML 2012 for more information.

- In Europe, the INSPIRE community are investing considerable effort into developing application schema for a number of domains. This community has developed expertise in establishing such concepts; and
- The Open Geospatial Community has established very effective collaborative processes for developing open spatial standards and for testing interoperability through regular projects. The hydrological community has recently used this process very effectively to develop an application schema for their community called WaterML v2. This community process will be a very good forum to use to develop a climate application schema, as it will provide a neutral forum for the many potential stakeholders who are not within the WMO community to collaborate and assist with its development. WMO will be able to utilise its relationship with OGC through the Memorandum of Understanding between WMO and OGC to facilitate this process. See WMO-OGC 2010.

Some guiding principles to be used in the development of an Application Schema for combined Observations data and 'Stations Metadata'

Several guiding principles should be adopted to guide the development of a climate application schema. The application schema should:

- allow Stations Metadata to be easily linked to relevant meteorological observations data;
- not enforce transmission of complete Stations Metadata concurrently with Stations observations;
- utilise an agreed data model that can be independent of underlying database structure to allow adoption by the largest number of organisations;
- be suitable for transmission via the internet to support future climate services;
- facilitate the use of Open Spatial services, e.g. OGC services to allow use via internet based services and consumption by a wide range of applications; and
- not enforce changes in existing data models used to manage 'Stations Metadata'.

Recommendations

Qualify the use of the term 'metadata'

- In future, discussions using the term 'metadata' should qualify the context in which it is used to avoid unnecessary confusion.

Endorse WMO Core Profile 'Discovery Metadata' for use climate data

- The use of the WMO Core Profile of ISO 19115 'Discovery Metadata' is appropriate for use with climate data.
- Its use allows climate and 'Stations Metadata' datasets to be found and reused.
- It is recommended that its use should be endorsed as is by ET-CDMS and by CCI.

Do not endorse a Climate Profile of the WMO Core Profile

- A Climate Profile of WMO Core Profile of ISO 19115 'Discovery Metadata' is not required.
- The WMO Core Profile is based on a solid 'Discovery Metadata' International Standard and is suitable for climate use.
- It is not appropriate to attempt to retrofit the WMO Core Profile or ISO 19115 to do something that it is not intended for. Its use is not appropriate for 'Stations Metadata'.
- It is recommended that any work leading towards a Climate Profile of the WMO Core Profile be stopped.

Endorse a Climate Application Schema (Climate Profile) for interoperable Climate Services that require combined Climate Observations and 'Stations Metadata'

- To facilitate efficient and interoperable Climate Services, a Climate Application Schema is required that provides a common data model for observations data and 'Stations Metadata' and includes a common vocabulary.
- This will allow Climate Services a consistent view of Climate Data, regardless of the underlying structure that is used by the data provider on their internal systems.
- It is recommended that a group be established to guide and fast track the establishment of a Climate Application Schema. This body should perhaps include representatives with an interest in observations data and stations metadata to facilitate reuse of the application schema. Tasks for this group should include;
 - Establish a definitive data model describing 'Stations Metadata';
 - Establish a definitive data model describing observation data;
 - Establish a common vocabulary for climate data use;
 - Base the application schema on ISO 19156 Observations and Measurements and the Climate Science Modeling Language; and
 - Establish a process that allows continuous engagement with, and participation by, stakeholders via OGC processes.

Conclusion

An issue that has been causing considerable confusion and angst among Climate Data Managers is that of understanding the relationship between Stations Metadata and the WMO Core Profile of ISO 19115 Metadata (SDI 'Discovery Metadata').

This paper has explored both types of metadata in depth and concluded that they are both different concepts.

In summary: 'Stations Metadata'

'Stations Metadata' is time series data about how and where meteorological observations were made and the conditions that they were made under. It is used to support a range of activities that allow climate professionals to understand the fitness for purpose of specific data and in many cases improve the quality of climate observations data.

In summary: SDI 'Discovery Metadata'

SDI 'Discovery Metadata' is data describing a dataset and is intended to facilitate the discovery and assessment of a spatial dataset to determine if it is fit for re-use for a purpose that may be at odds with the reason that it was originally created.

This paper then explored a way forward that will allow a consistent data model and a common vocabulary to be developed describing both Climate Observations data and Stations Metadata. This data model is independent of the internal structures used by data providers and provides a way forward that will facilitate future efficient and interoperable Climate Services.

Relevant recommendations have been made.

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Appendix 1

'Stations Metadata'

Table 1: Stations Metadata

No.	Category	Metadata Type	Description
	Station Identifier		Clearly identify the station and whose responsibility it is. It is very important to do so by reporting all the different codes, as some times WMO codes are not used locally and national codes are not known abroad. It is also useful to know which networks a station is included in.
		Local Code	
		WMO Code	
		Name and aliases	
		Active/Closed	
		Beginning/End Date	
		Type of Station	
		Responsible Organization	
		Manual/AWS	
		Time zone	
		Networks	
	Geographical Data		Geographical coordinates and exact dates of relocations along with other topographical details. Care must be taken in differencing N/S latitudes and E/W latitudes as well as with reporting fractions of degree (minutes and seconds or thousandths of degree)
		Latitude	
		Longitude	
		Elevation	
		Dates of relocation	
		Topographical Information	

No.	Category	Metadata Type	Description
		Method of deriving lat/long	
		Resolution of lat/long	
	Local Environment		Document the station environment and instruments exposure: obstacles, e.g. land use, population growth, obstacles, exposure site land cover, etc.
		Local land use/land cover	
		Instruments exposure	
		Soil type	
		Site condition	
		Photographs	
		Site plans	
		Skyline diagrams	
	Station Instrumentation and Maintenance		Report the characteristics of the instruments in use and their sheltering, accuracy, calibration and maintenance; indicate how data are transmitted. Carefully note any changes in instrumentation.
		Type of instruments	
		Observer level of training	
		List of observed elements	
		Observing times	
		Units used	
		Observation instructions	
		Routine maintenance operations	
		Disposable items replacement	
		Corrections made by observer	

No.	Category	Metadata Type	Description
	Observing Practices		Keep documented what elements are observed and when, with special care to the enforcement of daylight saving times; report the exact moment of maintenance operations and any corrections made to data
		Observer information	
		Observer level of training	
		List of observed elements	
		Observing times	
		Units used	
		Observation instructions	
		Routine maintenance operations	
		Disposable items replacement	
		Corrections made by observer	
	Data Processing		Report units in use and give conversion factors if they don't belong to the metric system. Indicate special codes used and their meaning; mention in the metadata any amendment made to the recorded data: calculations, corrections, qc, homogenization and data interpolation. Report criteria for missing data, and if more than one instrument for the same element, which is considered the primary instrument.
		Units	
		Special codes	
		Calculations	
		Algorithms	
		QC applied? (yes/no)	
		Other details on QC	

No.	Category	Metadata Type	Description
		Homogenization applied? (yes/no)	
		Other details on homogenization	
		Data recovery effort? (yes/no)	
		Other details on data recovery	
		Treatment of redundant data	
	Historical Events		Add to metadata any significant changes in the station context that may affect data collection
		Changes in the social, political and institutional environment	
		Daylight savings dates	
	Communication		General correspondence such as e-mail between station operators and observers can include potentially valuable information about the quality of observations.
		Signal transport/data transmission	
		General correspondence	

**Appendix 2 Example SDI 'Discovery Metadata' report:
Observations Data**

General Properties

File Identifier E85E8F95-CC33-41C3-8738-0FB25AB8A4EA
 Hierarchy Level **dataset**
 Hierarchy Level Name **dataset**
 Standard Name **ANZLIC Metadata Profile: An Australian/New Zealand Profile of AS/NZS ISO 19115:2005, Geographic information - Metadata**
 Standard Version **1.1**
 Date Stamp **2012-04-05**
 Resource Title **Australian Data Archive for Meteorology**
 Alternate Resource Titles

ADAM

ASDD Title: To be confirmed

WIS Title: To be confirmed

Format Name *.xml
 Format Version Unknown

Key Dates and Languages

Date of creation 1994-06-30
 Date of publication 1994-06-30
 Date of revision 2012
 Metadata Language eng
 Metadata Character Set utf8
 Dataset Languages eng
 Dataset Character Set utf8

The Australian Data Archive for Meteorology (ADAM) – is a relational database storing meteorological and related data considered necessary to meet the present and future national and international needs for climate data. The data stored in ADAM forms the basis of the Australian Bureau of Meteorology's climate record. ADAM stores observations data dating back to 1832. Most historical surface synoptic data prior to 1957 has not been digitised from field books. ADAM stores a wide range of meteorological observations that have been captured by both the Bureau and by third parties. The Bureau claims Intellectual Property rights to the data stored and maintained within ADAM. ADAM stores observations data that has been subject to a range of quality assurance processes. Not all data is quality assured. Potential users of the data should take into account the relevant quality flags. Example observations include: surface synoptic weather data; aviation / upper air data; marine data e.g. tsunameter, floating buoys, sea level; solar radiation; rainfall intensity. Frequency of observations varies with the source data and may range from 1 minute, 3 hourly and daily observations with associated derived statistics, e.g. monthly summaries. This data should be used in conjunction with relevant 'stations metadata' to understand any conditions that may affect the integrity of observations.

Abstract

ADAM is designed to meet the Bureau's need for archival of meteorological and climatological data types from a range of observing systems. ADAM is the data source of record that is used by most official climate related products.

Purpose

Metadata Contact Information

Name of Individual **Name withheld**
 Organisation Name **Australian Bureau of Meteorology**
 Position Name **SRCC**
 Role **pointOfContact**
 Voice
 Facsimile
 Email Address **srcc@bom.gov.au**
 Address

Australia**Resource Contacts**

Name of Individual **Phil Shinkfield**
 Organisation Name **Australian Bureau of Meteorology**
 Position Name **a/SRDM**
 Role **pointOfContact**
 Voice
 Facsimile
 Email Address **srdm@bom.gov.au**
 Address

Australia

Name of Individual **Bill Wright**
 Organisation Name **Australian Bureau of Meteorology**
 Position Name **STCD**
 Role **custodian**
 Voice
 Facsimile
 Email Address **stcd@bom.gov.au**
 Address

Australia

Name of Individual **David Walland**
 Organisation Name **Australian Bureau of Meteorology**
 Position Name **STCS**
 Role **distributor**
 Voice
 Facsimile
 Email Address **stcs@bom.gov.au**
 Address

Australia

Lineage Statement
ADAM is the fourth generation of Climate Database that has been used at the Bureau. Previous systems include: - Hollerith Punch Cards from the late 1940s to early 1970s; - IBM 360/65 based electronic versions of punch cards stored on magnetic tape from the early 1970s; and - From 1982, a Fujitsu FACOM system was used also using electronic versions of punch cards stored on magnetic tape. From 30th June 1994 an approach adopting a relational database using Oracle on HP/UX servers was implemented with data transferred from the FACOM system. On 10th January 2012, ADAM was migrated to an Intel based server running Redhat Linux and Oracle. Details of observations practices, data ingest and quality control processes to be added.

Jurisdictions

Australia
Australian Capital Territory
International
New South Wales
New Zealand
Northern Territory
Queensland
South Australia
Tasmania
Victoria
Western Australia

Search Words

ATMOSPHERE
ATMOSPHERE-Pressure
CLIMATE-AND-WEATHER
CLIMATE-AND-WEATHER-Meteorology

	CLIMATE-AND-WEATHER-Radiation
	CLIMATE-AND-WEATHER-Rainfall
	CLIMATE-AND-WEATHER-Temperature
	OCEANOGRAPHY
	MARINE
	MARINE-Meteorology
Themes and Categories	
Topic Category	climatologyMeteorologyAtmosphere
Status and Maintenance	
Status	onGoing
Maintenance and Update Frequency	continual
Date of Next Update	
Reference system	
Reference System	EPSG::EPSG::4019 0
Schedule	
	schedule
Metadata Security Restrictions	
Classification	unclassified
Authority	
Use Limitations	
Dataset Security Restrictions	
Classification	unclassified
Authority	
Use Limitations	
Dataset Access Constraints	
Identifier	copyright
Annotation	
Identifier	license
Annotation	
Identifier	intellectualPropertyRights
Annotation	
Dataset Use Constraints	
Identifier	copyright
Annotation	
Identifier	license
Annotation	
Identifier	intellectualPropertyRights
Annotation	
Metadata Access Constraints	
Identifier	copyright
Annotation	
Metadata Use Constraints	
Identifier	copyright
Annotation	
Extent - Geographic Bounding Box	
North Bounding Latitude	10
South Bounding Latitude	-84
West Bounding Longitude	50
East Bounding Longitude	180
Distribution Information	
Distributor 1	
Distributor 1 Contact	

Name of Individual	David Walland
Organisation Name	Australian Bureau of Meteorology
Position Name	STCS
Role	distributor
Voice	
Facsimile	
Email Address	stcs@bom.gov.au
Address	
	Australia
<i>Distributor 1 Format Information</i>	
Name of the format	comma delimited text
Version of the format	n/a
Amendment number	
Specification	
File decompression technique	
<i>Distributor 1 Digital Transfer Options Information</i>	
Units of distribution	per station
Transfer size	
<i>Distributor 1 Online information</i>	
Linkage	http://www.bom.gov.au/climate/data
Protocol	
Application profile Name	Climate Data Online
Description	OGC Services are also in development, e.g. Web Feature Services and Web Map Services
Function	

Appendix 3 WMO Core Profile of ISO 19115
(including changes from ISO 19115:2003/Cor.1:2006(E))

Table 4: Discovery Metadata

No.	Package	Entity	Name	Element	Description	Comments
1	Metadata entity set information	MD_Metadata	Metadata	MD_Metadata	root entity which defines metadata about a resource or resources	
2			Metadata File Identifier	fileIdentifier	unique identifier for this metadata file	
3			Metadata Language	language	language used for documenting metadata	
4			Metadata Character Set	characterSet	full name of the character coding standard used for the metadata set	
5			Metadata Parent Identifier	parentIdentifier	file identifier of the metadata to which this metadata is a subset (child)	from ISO 19115:2003/Cor.1:2006(E)
6			Metadata Hierarchy Level	hierarchyLevel	scope to which the metadata applies	
7			Metadata Hierarchy Level Name	hierarchyLevelName	name of the hierarchy levels for which the metadata is provided	
8			Metadata Point of Contact	contact	party responsible for the metadata information	
9			Metadata Date Stamp	dateStamp	date that the metadata was created	
10			Metadata Standard Name	metadataStandardName	name of the metadata standard (including profile name) used	
11			Metadata Standard Version	metadataStandardVersion	version of the metadata standard (version of the profile) used	from ISO 19115:2003/Cor.1:2006(E)
11.1			Dataset URI	dataSetURI	Uniformed Resource Identifier (URI) of the dataset to which the metadata applies	
11.2			Locate	loc	Provides information about an alternatively used localized character string for a linguistic extension	from ISO 19115:2003/Cor.1:2006(E)

No.	Package	Entity	Name	Element	Description	Comments
12			Spatial Representation Information	Role name: spatialRepresentationInfo	digital representation of spatial information in the dataset	
13			Reference System Information	Role name: referenceSystemInfo	description of the spatial and temporal reference systems used in the dataset	
14			Metadata Extension Information	Role name: metadataExtensionInfo	information describing metadata extensions	
15			Identification Information	Role name: identificationInfo	basic information about the resource(s) to which the metadata applies	
16			Content Information	Role name: contentInfo	provides information about the feature catalogue and describes the coverage and image data characteristics	
17			Distribution Information	Role name: distributionInfo	provides information about the distributor of and options for obtaining the resource(s)	
18			Data Quality Information	Role name: dataQualityInfo	provides overall assessment of quality of a resource(s)	
19			Portrayal Catalogue Information	Role name: portrayalCatalogueInfo	provides information about the catalogue of rules defined for the portrayal of a resource(s)	
20			Metadata Constraints	Role name: metadataConstraints	provides restrictions on the access and use of metadata	
21			Application Schema Information	Role name: applicationSchemaInfo	provides information about the conceptual schema of a dataset	
22			Metadata Maintenance	Role name: metadataMaintenance	provides information about the frequency of metadata updates, and the scope of those updates	

No.	Package	Entity	Name	Element	Description	Comments
23	Identification information (includes data and service identification): <u>General</u>	MD_Identification	Identification	MD_Identification	basic information required to uniquely identify a resource or resources	from ISO 19115:2003/Cor.1:2006(E) Inferred by the use of 'citation', 'pointOfContact', 'abstract' and several other
24			Identification Citation	citation	citation data for the resource(s)	IPET-MDI to check: WMO Core has this element belonging to MD_DataIdentification
25			Identification Abstract	abstract	brief narrative summary of the content of the resource(s)	IPET-MDI to check: WMO Core has this element belonging to MD_DataIdentification
26			Identification Purpose	purpose	summary of the intentions with which the resource(s) was developed	
27			Identification Credit	credit	recognition of those who contributed to the resource(s)	
28			Identification Status	status	status of the resource(s)	
29			Identification Point of Contact	pointOfContact	identification of, and means of communication with, person(s) and organization(s) associated with the resource(s)	

No.	Package	Entity	Name	Element	Description	Comments
30			Resource Maintenance	Role name: resourceMaintenance	provides information about the frequency of resource updates, and the scope of those updates	
31			Graphic Overview	Role name: graphicOverview	provides a graphic that illustrates the resource(s) (should include a legend for the graphic)	
32			Resource Format	Role name: resourceFormat	provides a description of the format of the resource(s)	
33			Descriptive Keywords	Role name: descriptiveKeywords	provides category keywords, their type, and reference source	
34			Identification Specific Usage	Role name: resourceSpecificUsage	provides basic information about specific application(s) for which the resource(s) has/have been or is being used by different users	
35			Resource Constraints	Role name: resourceConstraints	provides information about constraints which apply to the resource(s)	
35.1			Aggregation Information	Role name: aggregationInfo	provides aggregate dataset information	
36		MD_DataIdentification	Data Identification	MD_DataIdentification	information required to identify a dataset	
37			Spatial Representation Type	spatialRepresentationType	method used to spatially represent geographic information	
38			Data Scale	spatialResolution	factor which provides a general understanding of the density of spatial data in the dataset	
39			Data Language	language	language(s) used within the dataset	
40			Data Character Set	characterSet	full name of the character coding standard used for the dataset	

No.	Package	Entity	Name	Element	Description	Comments
41			Topic Category	topicCategory	main theme(s) of the dataset	
42			Intentionally left blank			
43			Intentionally left blank			
44			Environment Description	environmentDescription	description of the dataset in the producer's processing environment, including items such as the software, the computer operating system, file name, and the dataset size	
45			Extent	extent	extent information including the bounding box, bounding polygon, vertical, and temporal extent of the dataset	
46			Supplemental Information	supplementalInformation	any other descriptive information about the dataset	
47		SV_ServiceIdentification	Service Identification	SerIdent	identification of capabilities which a service provider makes available to a service user through a set of interfaces that define a behaviour - See ISO 19119 for further information	from ISO 19115:2003/Cor.1:2006(E)
48	Identification information: Browse graphic information	MD_BrowseGraphic	Browse Graphic	MD_BrowseGraphic	graphic that provides an illustration of the dataset (should include a legend for the graphic)	
49			Browse Graphic File Name	fileName	name of the file that contains a graphic that provides an illustration of the dataset	

No.	Package	Entity	Name	Element	Description	Comments
50			Browse Graphic File Description	fileDescription	text description of the illustration	
51			Browse Graphic File Type	fileType	format in which the illustration is encoded Examples: CGM, EPS, GIF, JPEG, PBM, PS, TIFF, XWD	
52	Identification information: Keyword information	MD_Keywords	Keywords	MD_Keywords	keywords, their type and reference source	
53			Keyword	keyword	commonly used word(s) or formalised word(s) or phrase(s) used to describe the subject	
54			Keyword Type	type	subject matter used to group similar keywords	
55			Thesaurus Name	thesaurusName	name of the formally registered thesaurus or a similar authoritative source of keywords	
56	Identification information: Representative fraction information	MD_RepresentativeFraction	Metadata Representative Fraction	MD_RepresentativeFraction	derived from ISO 19103 Scale where MD_Representative Fraction.denominator = 1 / Scale.measure And Scale.targetUnits = Scale.sourceUnits	
57			Reference Denominator	denominator	the number below the line in a vulgar fraction	
58			Intentionally left blank			
59	Identification information: Resolution information	MD_Resolution	Resolution	MD_Resolution	level of detail expressed as a scale factor or a ground distance	
60			Equivalent Scale	equivalentScale	level of detail expressed as the scale of a comparable hardcopy map or chart	
61			Scale Distance	distance	ground sample distance	

No.	Package	Entity	Name	Element	Description	Comments
62	Identification information: Usage information	MD_Usage	Usage	MD_Usage	brief description of ways in which the resource(s) is/are currently or has been used	
63			Specific Usage	specificUsage	brief description of the resource and/or resource series usage	
64			Usage Date & Time	usageDateTime	date and time of the first use or range of uses of the resource and/or resource series	
65			User Determined Limitations	userDeterminedLimitations	applications, determined by the user for which the resource and/or resource series is not suitable	
66			User Contact Information	userContactInfo	identification of and means of communicating with person(s) and organization(s) using the resource(s)	
66.1	Identification information: Aggregation information	MD_AggregateInformation	Aggregate Information	MD_AggregateInformation	aggregate dataset information	
66.2			Aggregate Dataset Name	aggregateDataSetName	citation information about the aggregate dataset	
66.3			Aggregate Dataset Identifier	aggregateDataSetIdentifier	identification information about aggregate dataset	
66.4			Association Type	associationType	association type of the aggregate dataset	
66.5			Initiative Type	initiativeType	type of initiative under which the aggregate dataset was produced	
67	Constraint Information (includes legal and security)	MD_Constraints	Constraints	MD_Constraints	restrictions on the access and use of a resource or metadata	

No.	Package	Entity	Name	Element	Description	Comments
68			Use Limitation	useLimitation	limitation affecting the fitness for use of the resource or metadata. Example, "not to be used for navigation"	
69		MD_LegalConstraints	Legal Constraints	MD_LegalConstraints	restrictions and legal prerequisites for accessing and using the resource or metadata	
70			Access Constraints	accessConstraints	access constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the resource or metadata	
71			Use Constraints	useConstraints	constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations or warnings on using the resource or metadata	
72			Other Constraints	otherConstraints	other restrictions and legal prerequisites for accessing and using the resource or metadata	
73		MD_SecurityConstraints	Security Constraints	MD_SecurityConstraints	handling restrictions imposed on the resource or metadata for national security or similar security concerns	
74			Classification	classification	name of the handling restrictions on the resource or metadata	

No.	Package	Entity	Name	Element	Description	Comments
75			User Note	userNote	explanation of the application of the legal constraints or other restrictions and legal prerequisites for obtaining and using the resource or metadata	
76			Classification System	classificationSystem	name of the classification system	
77			Handling Description	handlingDescription	additional information about the restrictions on handling the resource or metadata	
78	Data quality information: General	DQ_DataQuality	Data Quality	DQ_DataQuality	quality information for the data specified by a data quality scope NB: Element is Mandatory if claiming INSPIRE compliance	
79			Data Quality Scope	scope	the specific data to which the data quality information applies	
80			Data Quality Report	Role name: report	quantitative quality information for the data specified by the scope	
81			Data Lineage	Role name: lineage	non-quantitative quality information about the lineage of the data specified by the scope	
82	Lineage information: General	LI_Lineage	Lineage	LI_Lineage	information about the events or source data used in constructing the data specified by the scope or lack of knowledge about lineage	
83			Statement	statement	general explanation of the data producer's knowledge about the lineage of a dataset	

No.	Package	Entity	Name	Element	Description	Comments
84			Process Step	Role name: processStep	information about events in the life of a dataset specified by the scope	
85			Data Source	Role name: source	information about the source data used in creating the data specified by the scope	
86	Process step information		Process Step	LI_ProcessStep	information about an event or transformation in the life of a dataset including the process used to maintain the dataset	
87			Description	stepDesc	description of the event, including related parameters or tolerances	
88			Rationale	stepRat	requirement or purpose for the process step	
89			Date & Time	stepDateTm	date and time or range of date and time on or over which the process step occurred	
90			Processor	stepProc	identification of, and means of communication with, person(s) and organization(s) associated with the process step	
91			Processor Source	Role name: Source	information about the source data used in creating the data specified by the scope	
92	Source information	LI_Source	Processor Source	LI_Source	information about the source data used in creating the data specified by the scope	
93			Description	srcDesc	detailed description of the level of the source data	
94			Scale Denominator	srcScale	denominator of the representative fraction on a source map	

No.	Package	Entity	Name	Element	Description	Comments
95			Source Reference System	srcRefSys	spatial reference system used by the source data	
96			Source Citation	srcCitatn	recommended reference to be used for the source data	
97			Source Extent	srcExt	information about the spatial, vertical and temporal extent of the source data	
98			Source Step	Role name: sourceStep	information about an event in the creation process for the source data	
99	Data quality element information	DQ_Element	DQElement	DQ_Element	aspect of quantitative quality information	
100			Name Of Measure	nameOfMeasure	name of the test applied to the data	
101			Measure Identification	measId	code identifying a registered standard procedure	
102			Measure Description	measDesc	description of the measure	
103			Evaluation Method Type	evalMethType	type of method used to evaluate quality of the dataset	
104			Evaluation Method Description	evalMethDesc	description of the evaluation method	
105			Evaluation Procedure	evalProc	reference to the procedure information	
106			Date and Time	measDateTm	date or range of dates on which a data quality measure was applied	

No.	Package	Entity	Name	Element	Description	Comments
107			Measure Result	result	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	
108			Data Quality Completeness	DQ_Completeness	presence and absence of features, their attributes and their relationships	
109			Data Quality Completeness Commission	DQ_CompletenessCommission	Use obligation from referencing object	
110			Data Quality Completeness Omission	DQCompOm	data absent from the dataset, as described by the scope	
111			DQ_LogicalConsistency	DQ_LogicalConsistency	degree of adherence to logical rules of data structure, attribution and relationships (data structure can be conceptual, logical or physical)	
112			DQ_ConceptualConsistency	DQ_ConceptualConsistency	adherence to rules of the conceptual schema	
113			Data Quality Domain Consistency	DQ_DomainConsistency	adherence of values to the value domains	
114			Data Quality Format Consistency	DQ_FormatConsistency	degree to which data is stored in accordance with the physical structure of the dataset, as described by the scope	

No.	Package	Entity	Name	Element	Description	Comments
115			Data Quality Topological Consistency	DQ_TopologicalConsistency	correctness of the explicitly encoded topological characteristics of the dataset as described by the scope	
116			Data Quality Positional Accuracy	DQ_PositionalAccuracy	accuracy of the position of features	
117			Data Quality Absolute External Positional Accuracy	DQ_AbsoluteExternalPositionalAccuracy	closeness of reported coordinate values to values accepted as or being true	
118			Data Quality Gridded Data Positional Accuracy	DQ_GriddedDataPositionalAccuracy	closeness of gridded data position values to values accepted as or being true	
119			Data Quality RelativeInternal Positional Accuracy	DQ_RelativeInternalPositionalAccuracy	closeness of the relative positions of features in the scope to their respective relative positions accepted as or being true	
120			Data Quality Temporal Accuracy	DQ_TemporalAccuracy	accuracy of the temporal attributes and temporal relationships of features	
121			Data Quality Accuracy Of A Time Measurement	DQ_AccuracyOfATimeMeasurement	correctness of the temporal references of an item (reporting of error in time measurement)	
122			Data Quality Temporal Consistency	DQ_TemporalConsistency	correctness of ordered events or sequences, if reported	
123			Data Quality Temporal Validity	DQ_TemporalValidity	validity of data specified by the scope with respect to time	

No.	Package	Entity	Name	Element	Description	Comments
124			Data Quality Thematic Accuracy	DQ_ThematicAccuracy	accuracy of quantitative attributes and the correctness of nonquantitative attributes and of the classifications of features and their relationships	
125			Data Quality Thematic Classification Correctness	DQ_ThematicClassificationCorrectness	comparison of the classes assigned to features or their attributes to a universe of discourse	
126			Data Quality Non Quantitative Attribute Accuracy	DQ_NonQuantitativeAttributeAccuracy	accuracy of non-quantitative attributes	
127			Data Quality Quantitative Attribute Accuracy	DQ_QuantitativeAttributeAccuracy	accuracy of quantitative attributes	
128	Result information		Data Quality Result	DQ_Result	generalization of more specific result classes	
129			Conformance Result	DQ_ConformanceResult	Information about the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	
130			Conformance Specification	specification	citation of product specification or user requirement against which data is being evaluated	
131			Conformance Explanation	explanation	explanation of the meaning of conformance for this result	
132			Conformance Pass	pass	indication of the conformance result where 0 = fail and 1 = pass	

No.	Package	Entity	Name	Element	Description	Comments
133			Data Quality Quantitative Result	DQ_QuantitativeResult	the values or information about the value(s) (or set of values) obtained from applying a data quality measure	
134			Value Type	valueType	value type for reporting a data quality result	
135			Quantitative Value Unit	valueUnit	value unit for reporting a data quality result	
136			Error Statistic	errorStatistic	statistical method used to determine the value	
137			Quantitative Value	value	quantitative value or values, content determined by the evaluation procedure used	
138	Scope information		Data Quality Scope	DQ_Scope	extent of characteristic(s) of the data for which quality information is reported	
139			Scope Level	level	hierarchical level of the data specified by the scope	
140			Scope Extent	extent	information about the horizontal, vertical and temporal extent of the data specified by the scope	
141			Scope Level Description	levelDescription	detailed description about the level of the data specified by the scope	
142	Maintenance information: General		Maintenance Information	MD_MaintenanceInformation	information about the scope and frequency of updating	
143			Maintenance and Update Frequency	maintenanceAndUpdateFrequency	frequency with which changes and additions are made to the resource after the initial resource is completed	
144			Date of Next Update	dateOfNextUpdate	scheduled revision date for resource	

No.	Package	Entity	Name	Element	Description	Comments
145			User Defined Maintenance Frequency	userDefinedMaintenanceFrequency	maintenance period other than those defined	
146			Maintenance Update Scope	updateScope	scope of data to which maintenance is applied	
147			Update Scope Description	updateScopeDescription	additional information about the range or extent of the resource	
148			Maintenance Note	maintenanceNote	information regarding specific requirements for maintaining the resource	
148.1			Maintenance Contact	contact	identification of, and means of communicating with, person(s) and organization(s) with responsibility for maintaining the metadata	
149	Scope description information		Metadata Scope Description	MD_ScopeDescription	description of the class of information covered by the information	
150			attributes	attribSet	instances of attribute types to which the information applies	from ISO 19115:2003/Cor.1:2006(E)
151			features	featSet	instances of feature types to which the information applies	from ISO 19115:2003/Cor.1:2006(E)
152			Feature Instance Set	featureInstances	feature instances to which the information applies	
153			Attribute Instance Set	attributeInstances	attribute instances to which the information applies	
154			Dataset Set	dataset	dataset to which the information applies	
155			Other	other	class of information that does not fall into the other categories to which the information applies	

No.	Package	Entity	Name	Element	Description	Comments
156	Spatial representation information (includes grid and vector representation): General		Spatial Representation	MD_SpatialRepresentation	digital mechanism used to represent spatial information	
157			Grid Spatial Representation	MD_GridSpatialRepresentation	information about grid spatial objects in the dataset	
158			Number of Dimensions	numberOfDimensions	number of independent spatialtemporal axes	
159			Axis Dimension Properties	axisDimensionProperties	information about spatial-temporal axis properties	
160			Cell Geometry	cellGeometry	identification of grid data as point or cell	
161			Transformation Parameter Availability	transformationParameterAvailability	indication of whether or not parameters for transformation between image coordinates and geographic or map coordinates exist (are available)	
162			Georectified	MD_Georectified	grid whose cells are regularly spaced in a geographic (i.e., lat / long) or map coordinate system defined in the Spatial Referencing System (SRS) so that any cell in the grid can be geolocated given its grid coordinate and the grid origin, cell spacing, and orientation	
163			Check Point Availability	checkPointAvailability	indication of whether or not geographic position points are available to test the accuracy of the georeferenced grid data	
164			Check Point Description	checkPointDescription	description of geographic position points used to test the accuracy of the georeferenced grid data	

No.	Package	Entity	Name	Element	Description	Comments
165			cornerPoints	cornerPts	earth location in the coordinate system defined by the Spatial Reference System and the grid coordinate of the cells at opposite ends of grid coverage along two diagonals in the grid spatial dimensions. There are four corner points in a georectified grid; at least two corner points along one diagonal are required. The first corner point corresponds to the origin of the grid.	from ISO 19115:2003/Cor.1:2006(E)
166			Center Point	centerPoint	earth location in the coordinate system defined by the Spatial Reference System and the grid coordinate of the cell halfway between opposite ends of the grid in the spatial dimensions	
167			Point in Pixel	pointInPixel	point in a pixel corresponding to the Earth location of the pixel	
168			Transformation Dimension Description	transformationDimensionDescription	general description of the transformation	
169			Transformation Dimension Mapping	transformationDimensionMapping	information about which grid axes are the spatial (map) axes	
170			Georeferenceable	MD_Georeferenceable	grid with cells irregularly spaced in any given geographic/map projection coordinate system, whose individual cells can be geolocated using geolocation information supplied with the data but cannot be geolocated from the grid properties alone	
171			Control Point Availability	controlPointAvailability	indication of whether or not control point(s) exists	
172			Orientation Parameter Availability	orientationParameterAvailability	indication of whether or not orientation parameters are available	
173			Orientation Parameter Description	orientationParameterDescription	description of parameters used to describe sensor orientation	
174			Georeferenced Parameters	georeferencedParameters	terms which support grid data georeferencing	

No.	Package	Entity	Name	Element	Description	Comments
175			Parameter Citation	parameterCitation	reference providing description of the parameters	
176			Metadata Vector Spatial Representation	MD_VectorSpatialRepresentation	information about the vector spatial objects in the dataset	
177			Topology Level	topologyLevel	code which identifies the degree of complexity of the spatial relationships	
178			Geometric Objects	geometricObjects	information about the geometric objects used in the dataset	
179	Dimension information		Dimension	MD_Dimension	axis properties	
180			Dimension Name	dimensionName	name of the axis	
181			Dimension Size	dimensionSize	number of elements along the axis	
182			Resolution	resolution	degree of detail in the grid dataset	
183	Geometric object information		Geometric Objects	MD_GeometricObjects	number of objects, listed by geometric object type, used in the dataset	
184			Geometric Object Type	geometricObjectType	name of point or vector objects used to locate zero-, one-, two-, or three-dimensional spatial locations in the dataset	
185			Geometric Object Count	geometricObjectCount	total number of the point or vector object type occurring in the dataset	
186	Reference system information (includes temporal, coordinate and geographic identifiers): General	MD_ReferenceSystem	Reference System	RefSystem	information about the reference system	from ISO 19115:2003/Cor.1:2006(E)
187			Reference System Identifier	referenceSystemIdentifier	name of reference system	from ISO 19115:2003/Cor.1:2006(E)
188			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
189			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)

No.	Package	Entity	Name	Element	Description	Comments
190			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
191			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
192			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
193			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
194			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
195		RS_ReferenceSystem	Reference System	RefSys	description of the spatial and temporal reference systems used in the dataset	from ISO 19115:2003/Cor.1:2006(E)
196			Reference System Name	name	name of reference system used	from ISO 19115:2003/Cor.1:2006(E)
197			Domain of Validity	domainOfValidity	range which is valid for the reference system	from ISO 19115:2003/Cor.1:2006(E)
198			Intentionally left blank			
199			Intentionally left blank			
200			Intentionally left blank			
201			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
202			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
203			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
204			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
205	Identifier information		Metadata Identifier Data Type	MD_Identifier	value uniquely identifying an object within a namespace	from ISO 19115:2003/Cor.1:2006(E)
206			Identifier Authority	authority	person or party responsible for maintenance of the namespace	

No.	Package	Entity	Name	Element	Description	Comments
207			Identifier Code	code	alphanumeric value identifying an instance in the namespace	
208			Reference System Identifier	RS_Identifier	identifier used for reference systems	
208.1			Reference System Code space	codeSpace	name or identifier of the person or organization responsible for namespace	
208.2			Identifier Version	version	version identifier for the namespace	
209			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
210			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
211			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
212			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
213			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
214			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
215			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
216			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
217			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
218			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
219			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
220			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)

No.	Package	Entity	Name	Element	Description	Comments
221			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
222			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
223			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
224			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
225			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
226			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
227			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
228			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
229			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
230			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
231			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
232	Content information (includes Feature catalogue and Coverage descriptions): General	MD_ContentInformation	MD_ContentInformation	ContInfo	description of the content of a dataset	
233			Feature Catalogue Description	MD_FeatureCatalogueDescription	information identifying the feature catalogue or the conceptual schema	

No.	Package	Entity	Name	Element	Description	Comments
234			Compliance Code	complianceCode	indication of whether or not the cited feature catalogue complies with ISO 19110	
235			Catalogue Language	language	language(s) used within the catalogue	
236			Included with Dataset	includedWithDataset	indication of whether or not the feature catalogue is included with the dataset	
237			Catalogue FeatureTypes	featureTypes	subset of feature types from cited feature catalogue occurring in dataset	
238			Catalogue Citation	featureCatalogueCitation	complete bibliographic reference to one or more external feature catalogues	
239		MD_CoverageDescription	Coverage Description	MD_CoverageDescription	information about the content of a grid data cell	
240			Attribute Description	attributeDescription	description of the attribute described by the measurement value	
241			Content Type	contentType	type of information represented by the cell value	
242			Coverage Dimension	Role name: dimension	information on the dimensions of the cell measurement value	
243			Image Description	MD_ImageDescription	information about an image's suitability for use	from ISO 19115:2003/Cor.1:2006(E)
244			Illumination Elevation Angle	illuminationElevationAngle	illumination elevation measured in degrees clockwise from the target plane at intersection of the optical line of sight with the Earth's surface. For images from a scanning device, refer to the centre pixel of the image	
245			Illumination Azimuth Angle	illuminationAzimuthAngle	illumination azimuth measured in degrees clockwise from true north at the time the image is taken. For images from a scanning device, refer to the centre pixel of the image	

No.	Package	Entity	Name	Element	Description	Comments
246			Imaging Condition	imagingCondition	conditions affected the image	
247			Image Quality Code	imageQualityCode	specifies the image quality	
248			Cloud Cover Percentage	cloudCoverPercentage	area of the dataset obscured by clouds, expressed as a percentage of the spatial extent	
249			Processing Level Code	processingLevelCode	image distributor's code that identifies the level of radiometric and geometric processing that has been applied	
250			Compression Generation Quantity	compressionGenerationQuantity	count of the number of lossy compression cycles performed on the image	
251			Triangulation Indicator	triangulationIndicator	indication of whether or not triangulation has been performed upon the image	
252			Radiometric Calibration Data Availability	radiometricCalibrationDataAvailability	indication of whether or not the radiometric calibration information for generating the radiometrically calibrated standard data product is available	
253			Camera Calibration Information Availability	cameraCalibrationInformationAvailability	indication of whether or not constants are available which allow for camera calibration corrections	
254			Film Distortion Information Availability	filmDistortionInformationAvailability	indication of whether or not Calibration Reseau information is available	
255			Lens Distortion Information Availability	lensDistortionInformationAvailability	indication of whether or not lens aberration correction information is available	
256	Range dimension information (includes Band information)	MD_RangeDimension	Range Dimension	MD_RangeDimension	information on the range of each dimension of a cell measurement value	

No.	Package	Entity	Name	Element	Description	Comments
257			Sequence Identifier	sequenceIdentifier	number that uniquely identifies instances of bands of wavelengths on which a sensor operates	
258			Dimension Descriptor	descriptor	description of the range of a cell measurement value	
259			Band	MD_Band	range of wavelengths in the electromagnetic spectrum	
260			Maximum Value	maxValue	longest wavelength that the sensor is capable of collecting within a designated band	
261			Minimum Value	minValue	shortest wavelength that the sensor is capable of collecting within a designated band	
262			Value Units	units	units in which sensor wavelengths are expressed	
263			Peak Response	peakResponse	wavelength at which the response is the highest	
264			Bits Per Value	bitsPerValue	maximum number of significant bits in the uncompressed representation for the value in each band of each pixel	
265			Tone Gradation	toneGradation	number of discrete numerical values in the grid data	
266			Scale Factor	scaleFactor	scale factor which has been applied to the cell value	
267			Offset	offset	the physical value corresponding to a cell value of zero	
268	Portrayal catalogue information	MD_PortrayalCatalogueReference	Portrayal Catalogue Information	MD_PortrayalCatalogueReference	information identifying the portrayal catalogue used	

No.	Package	Entity	Name	Element	Description	Comments
269			Portrayal Catalogue Citation	portrayalCatalogueCitation	bibliographic reference to the portrayal catalogue cited	
270	Distribution information	MD_Distribution	Distribution	MD_Distribution	information about the distributor of and options for obtaining the resource	
271			Distribution Format	Role name: distributionFormat	provides a description of the format of the data to be distributed	
272			Distributor	distributor	provides information about the distributor	
273			Distribution Transfer Options	Role name: transferOptions	provides information about technical means and media by which a resource is obtained from the distributor	
274	Digital transfer options information	MD_DigitalTransferOptions	Digital Transfer Options	MD_DigitalTransferOptions	technical means and media by which a resource is obtained from the distributor	
275			Units Of Distribution	unitsOfDistribution	tiles, layers, geographic areas, etc., in which data is available	
276			Transfer Size	transferSize	estimated size of a unit in the specified transfer format, expressed in megabytes. The transfer size is > 0.0	
277			Online Source	onLine	information about online sources from which the resource can be obtained	
278			Offline Media	offLine	information about offline media on which the resource can be obtained	
279	Distributor information	MD_Distributor	Distributor	MD_Distributor	information about the distributor	
280			Distributor Contact	distributorContact	party from whom the resource may be obtained. This list need not be exhaustive	

No.	Package	Entity	Name	Element	Description	Comments
281			Distribution Order Process	Role name: distributionOrderProcess	provides information about how the resource may be obtained, and related instructions and fee information	
282			Distributor Format	Role name: distributorFormat	provides information about the format used by the distributor	
283			Distributor Transfer	Role name: distributorTransferOptions	provides information about the technical means and media used by the distributor	
284	Format information	MD_Format	Format	MD_Format	description of the computer language construct that specifies the representation of data objects in a record, file, message, storage device or transmission channel	
285			Format Name	name	name of the data transfer format(s)	
286			Format Version	version	version of the format (date, number, etc.)	
287			Format Amendment Number	amendmentNumber	amendment number of the format version	
288			Format Specification	specification	name of a subset, profile, or product specification of the format	
289			File Decompression Technique	fileDecompressionTechnique	recommendations of algorithms or processes that can be applied to read or expand resources to which compression techniques have been applied	
290			Format Distributor	Role name: formatDistributor	provides information about the distributor's format	
291	Medium information	MD_Medium	Medium	MD_Medium	information about the media on which the resource can be distributed	

No.	Package	Entity	Name	Element	Description	Comments
292			Medium Name	name	name of the medium on which the resource can be received	
293			Medium Density	density	density at which the data is recorded	
294			Medium Density Units	densityUnits	units of measure for the recording density	
295			Medium Volume	volumes	number of items in the media identified	from ISO 19115:2003/Cor.1:2006(E)
296			Medium Format	mediumFormat	method used to write to the medium	
297			Medium Note	mediumNote	description of other limitations or requirements for using the medium	
298	Standard order process information	MD_StandardOrderProcess	Standard Order Process	MD_StandardOrderProcess	common ways in which the resource may be obtained or received, and related instructions and fee information	
299			Resource Fees	fees	fees and terms for retrieving the resource. Include monetary units (as specified in ISO 4217)	
300			Planned Available Date Time	plannedAvailableDateTime	date and time when the resource will be available	
301			Ordering Instructions	orderingInstructions	general instructions, terms and services provided by the distributor	
302			Order Turnaround	turnaround	typical turnaround time for the filling of an order	
303	Metadata extension information: General	MD_MetadataExtensionInformation	Metadata Extension Information	MD_MetadataExtensionInformation	information describing metadata extensions	
304			Extension Online Resource	extensionOnLineResource	information about on-line sources containing the community profile name and the extended metadata elements. Information for all new metadata elements	

No.	Package	Entity	Name	Element	Description	Comments
305			Extended Element Information	Role name: extendedElementInformation	provides information about a new metadata element, not found in ISO 19115, which is required to describe geographic data	
306	Extended element information	MD_ExtendedElementInformation	Extended Element Information	MD_ExtendedElementInformation	new metadata element, not found in ISO 19115, which is required to describe geographic data	
307			Extended Element Name	name	name of the extended metadata element	
308			Extended Short Name	shortName	short form suitable for use in an implementation method such as XML or SGML. NOTE other methods may be used	
309			Extended Domain Code	domainCode	three digit code assigned to the extended element	
310			Extended Element Definition	definition	definition of the extended element	
311			Extended Element Obligation	obligation	obligation of the extended element	
312			Extended Element Condition	condition	condition under which the extended element is mandatory	
313			Element Data Type	dataType	code which identifies the kind of value provided in the extended element	
314			Extended Element Maximum Occurrence	maximumOccurence	maximum occurrence of the extended element	
315			Extended Element Domain Value	domainValue	valid values that can be assigned to the extended element	

No.	Package	Entity	Name	Element	Description	Comments
316			Extended Element Parent Entity	parentEntity	name of the metadata entity(s) under which this extended metadata element may appear. The name(s) may be standard metadata element(s) or other extended metadata element(s)	
317			Extended Element Rule	rule	specifies how the extended element relates to other existing elements and entities	
318			Extended Element Rationale	rationale	reason for creating the extended element	
319			Extended Element Source	source	name of the person or organization creating the extended element	
320	Application schema information	MD_ApplicationSchemaInformation	Application Schema Information	MD_ApplicationSchemaInformation	information about the application schema used to build the dataset	
321			Application Schema Name	name	name of the application schema used	
322			Application Schema Language	schemaLanguage	identification of the schema language used	
323			Application Schema Constraint Language	constraintLanguage	formal language used in Application Schema	
324			Application Schema Ascii	schemaAscii	full application schema given as an ASCII file	
325			Application Schema Graphics File	graphicsFile	full application schema given as a graphics file	
326			Application Schema Software Development File	softwareDevelopmentFile	full application schema given as a software development file	
327			Application Schema Software Development File Format	softwareDevelopmentFileFormat	software dependent format used for the application schema software dependent file	

No.	Package	Entity	Name	Element	Description	Comments
328			Intentionally left blank			
329			Intentionally left blank			
330			Intentionally left blank			
331			Intentionally left blank			
332			Intentionally left blank			
333			Intentionally left blank			
334	Data type information Extent information: General	EX_Extent	Extent	EX_Extent	information about horizontal, vertical, and temporal extent	
335			Extent Description	description	spatial and temporal extent for the referring object	
336			Geographic Extent	Role name: geographicElement	provides geographic component of the extent of the referring object	
337			Temporal Element	Role name: temporalElement	provides temporal component of the extent of the referring object	
338			Vertical Extent	Role name: verticalElement	provides vertical component of the extent of the referring object	
339	Geographic extent information	EX_GeographicExtent	Geographic Extent	EX_GeographicExtent	geographic area of the dataset	
340			Extent Type Code	extentTypeCode	indication of whether the bounding polygon encompasses an area covered by the data or an area where data is not present	

No.	Package	Entity	Name	Element	Description	Comments
341		EX_BoundingPolygon	Bounding Polygon	EX_BoundingPolygon	boundary enclosing the dataset, expressed as the closed set of (x,y) coordinates of the polygon (last point replicates first point)	
342			Polygon	polygon	sets of points defining the bounding polygon	from ISO 19115:2003/Cor.1:2006(E)
343		EX_GeographicBoundingBox	Geographic Bounding Box	EX_GeographicBoundingBox	geographic position of the dataset NOTE This is only an approximate reference so specifying the coordinate reference system is unnecessary	
344			West Bounding Longitude	westBoundLongitude	western-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degrees (positive east)	from ISO 19115:2003/Cor.1:2006
345			East Bounding Longitude	eastBoundLongitude	eastern-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degrees (positive east)	from ISO 19115:2003/Cor.1:2006
346			South Bounding Latitude	southBoundLatitude	southern-most coordinate of the limit of the dataset extent, expressed in latitude in decimal degrees (positive north)	from ISO 19115:2003/Cor.1:2006
347			North Bounding Latitude	northBoundLatitude	northern-most, coordinate of the limit of the dataset extent expressed in latitude in decimal degrees (positive north)	from ISO 19115:2003/Cor.1:2006
348		EX_GeographicDescription	Geographic Description	EX_GeographicDescription	description of the geographic area using identifiers	
349			Geographic Identifier	geographicIdentifier	identifier used to represent a geographic area	
350	Temporal extent information	EX_TemporalExtent	Temporal Extent	EX_TemporalExtent	time period covered by the content of the dataset	

No.	Package	Entity	Name	Element	Description	Comments
351			Extent Temporal	extent	date and time for the content of the dataset	
352		EX_SpatialTemporalExtent	Spatial Temporal Extent	EX_SpatialTemporalExtent	extent with respect to date/time and spatial boundaries	
353			Spatial Extent	Role name: spatialExtent	spatial extent component of composite spatial and temporal extent	
354	Vertical extent information	EX_VerticalExtent	Vertical Extent	EX_VerticalExtent	vertical domain of dataset	
355			Minimum Vertical Value	minimumValue	lowest vertical extent contained in the dataset	
356			Maximum Vertical Value	maximumValue	highest vertical extent contained in the dataset	
357			Intentionally left blank			from ISO 19115:2003/Cor.1:2006(E)
358			Vertical Coordinate Reference System	Role name: verticalCRS	provides information about the vertical coordinate reference system to which the maximum and minimum elevation values are measured. The CRS identification includes unit of measure.	from ISO 19115:2003/Cor.1:2006(E)
359	Citation and responsible party information: General	CI_Citation	Citation	CI_Citation	standardized resource reference	
360			Resource Title	title	name by which the cited resource is known	
361			Resource Alternate Title	alternateTitle	short name or other language name by which the cited information is known. Example: "DCW" as an alternative title for "Digital Chart of the World"	
362			Resource Reference Date	date	reference date for the cited resource	
363			Resource Edition	edition	version of the cited resource	

No.	Package	Entity	Name	Element	Description	Comments
364			Resource Edition Date	editionDate	date of the edition	
365			Citation Identifier	identifier	value uniquely identifying an object within a namespace	
366			Intentionally left blank			
367			Cited Responsible Party	citedResponsibleParty	name and position information for an individual or organization that is responsible for the resource	
368			Presentation Form	presentationForm	mode in which the resource is represented	
369			Dataset Series	series	information about the series, or aggregate dataset, of which the dataset is a part	
370			Other Citation Details	otherCitationDetails	other information required to complete the citation that is not recorded elsewhere	
371			Collective Title	collectiveTitle	common title with holdings note NOTE title identifies elements of a series collectively, combined with information about what volumes are available at the source cited	
372			International Standard Book Number (ISBN)	ISBN	international Standard Book Number	
373			International Standard Serial Number (ISSN)	ISSN	international Standard Serial Number	

No.	Package	Entity	Name	Element	Description	Comments
374		CI_ResponsibleParty	Responsible Party	CI_ResponsibleParty	identification of, and means of communication with, person(s) and organizations associated with the dataset	
375			Responsible Party Individual Name	individualName	name of the responsible person surname, given name, title separated by a delimiter	
376			Responsible Party Organisation Name	organisationName	name of the responsible organization	
377			Responsible Party Position Name	positionName	role or position of the responsible person	
378			Responsible Party Contact Information	contactInfo	address of the responsible party	
379			Role	role	function performed by the responsible party	
380	Address information	CI_Address	Address	CI_Address	location of the responsible individual or organization	
381			Delivery Point	deliveryPoint	address line for the location (as described in ISO 11180, Annex A)	
382			City	city	city of the location	
383			Administrative Area	administrativeArea	state, province of the location	
384			Postcode	postalCode	ZIP or other postal code	
385			Country	country	country of the physical address	from ISO 19115:2003/Cor.1:2006(E)
386			Email Address	electronicMailAddress	address of the electronic mailbox of the responsible organization or individual	
387	Contact information	CI_Contact	Contact	CI_Contact	information required to enable contact with the responsible person and/or organization	

No.	Package	Entity	Name	Element	Description	Comments
388			Contact Phone	phone	telephone numbers at which the organization or individual may be contacted	
389			Contact Address	address	physical and email address at which the organization or individual may be contacted	
390			Contact Online Resource	onlineResource	on-line information that can be used to contact the individual or organization	
391			Contact Hours	hoursOfService	time period (including time zone) when individuals can contact the organization or individual	
392			Contact Instructions	contactInstructions	supplemental instructions on how or when to contact the individual or organization	
393	Date information	CI_Date	Date Reference	CI_Date	reference date and event used to describe it	
394			Reference Date	date	reference date for the cited resource	
395			Reference Date Type	dateType	event used for reference date	
396	OnLine resource information	CI_OnLineResource	OnLine Resource	CI_OnLineResource	OnLine resource information	
397			Linkage	linkage	location (address) for on-line access using a Uniform Resource Locator address or similar addressing scheme such as http://www.statkart.no/isotc211	
398			Protocol	protocol	connection protocol to be used	
399			Application Profile	applicationProfile	name of an application profile that can be used with the online resource	

No.	Package	Entity	Name	Element	Description	Comments
400			Online Resource Name	name	name of the online resource	
401			Online Resource Description	description	detailed text description of what the online resource is/does	
402			Online Resource Function	function	code for function performed by the online resource	
403	Series information	CI_Series	Dataset Series	CI_Series		
404			Series Name	name	information about the series, or aggregate dataset, to which a dataset belongs	
405			Issue Identification	issueIdentification	name of the series, or aggregate dataset, of which the dataset is a part	
406			Article Page	page	details on which pages of the publication the article was published	
407	Telephone information	CI_Telephone	Telephone	CI_Telephone	telephone numbers for contacting the responsible individual or organization	
408			Voice Number	voice	telephone number by which individuals can speak to the responsible organization or individual	
409			Fax Number	facsimile	telephone number of a facsimile machine for the responsible organization or individual	

**Appendix 4 Example SDI 'Discovery Metadata' report:
'Stations Metadata'**

General Properties

File Identifier 0D308746-5DC0-47D4-94AC-EFD7DFB5965D
 Hierarchy Level dataset
 Hierarchy Level Name dataset
 Standard Name ANZLIC Metadata Profile: An Australian/New Zealand Profile of AS/NZS ISO 19115:2005, Geographic information - Metadata
 Standard Version 1.1
 Date Stamp 2012-04-10
 Resource Title Stations Metadata
 Alternate Resource Titles
 SitesDB
 Sites Database
 Format Name *.xml
 Format Version Unknown

Key Dates and Languages

Date of creation 1994-06-30
 Date of publication 1994-06-30
 Date of revision 2012
 Metadata Language eng
 Metadata Character Set utf8
 Dataset Languages eng
 Dataset Character Set utf8

Abstract

The Sites Database (SitesDB) holds information that directly supports meteorological data collected at a particular location. The information, where data was measured (lat, long, height), what took the measurement (equipment details), when when that device was last checked, etc is known as 'metadata'. This information is of great importance in forecasting and reasearch. SitesDB maintains an historical record of this data; allowing retrieval of metadata as at a specific date. This is not only useful to reasearchers, but can greatly assist the management of observation networks. Network information stored in the database includes station details, equipment types and versions, calibration dates, and reporting programs. In addition, it is possible to attach actions agains equipment. These acions could be fault reports or simply requests for tasks to be performed on the next visit to the station. This information is also known as 'Stations Metadata'. Not all historical information relating to stations has been captured to date.

Purpose

SitesDB maintains an historical record of 'Stations Metadata'; allowing retrieval of metadata as at a specific date.

Metadata Contact Information

Name of Individual Name withheld
 Organisation Name Australian Bureau of Meteorology
 Position Name SRCC
 Role pointOfContact
 Voice
 Facsimile
 Email Address srcc@bom.gov.au
 Address

Australia

Resource Contacts

Name of Individual Leigh Allan
 Organisation Name Australian Bureau of Meteorology
 Position Name SRIS
 Role custodian
 Voice
 Facsimile

Email Address	sris@bom.gov.au
Address	Australia
Name of Individual	Leigh Allan
Organisation Name	Australian Bureau of Meteorology
Position Name	SRIS
Role	pointOfContact
Voice	
Facsimile	
Email Address	sris@bom.gov.au
Address	Australia
Lineage Statement	SitesDB is the Bureau's main software application and database for recording 'Stations Metadata'. A significant number of historical paper based records have been captured and are stored in the database. There are also many paper based records that have yet to be captured.
Jurisdictions	Australia Australian Capital Territory International New South Wales New Zealand Northern Territory Queensland South Australia Tasmania Victoria Western Australia Other
Search Words	CLIMATE-AND-WEATHER CLIMATE-AND-WEATHER-Meteorology MARINE OCEANOGRAPHY PHOTOGRAPHY-AND-IMAGERY
Themes and Categories	
Topic Category	climatologyMeteorologyAtmosphere
Status and Maintenance	
Status	onGoing
Maintenance and Update Frequency	continual
Date of Next Update	
Schedule	schedule
Metadata Security Restrictions	
Classification	unclassified
Authority	
Use Limitations	
Dataset Security Restrictions	
Classification	unclassified
Authority	
Use Limitations	
Dataset Access Constraints	
Identifier	copyright

Annotation	
Identifier	license
Annotation	
Identifier	intellectualPropertyRights
Annotation	
Identifier	otherRestrictions
Annotation	
Dataset Use Constraints	
Identifier	copyright
Annotation	
Identifier	patentPending
Annotation	
Identifier	intellectualPropertyRights
Annotation	
Identifier	otherRestrictions
Annotation	
Metadata Access Constraints	
Identifier	copyright
Annotation	
Metadata Use Constraints	
Identifier	copyright
Annotation	
Extent - Geographic Bounding Box	
North Bounding Latitude	10
South Bounding Latitude	-84
West Bounding Longitude	50
East Bounding Longitude	180