GHRSST R/G TS System Architecture

GSA

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Executive Summary

This document describes the agreed new framework for the Group for High Resolution Sea-Surface Temperature (GHRSST) Regional/Global Task Sharing (R/G TS). It describes the data management and distribution services, specifying the services that are required to implement it.

The first GHRSST Level 2P datasets were made available in December 2005. Since then the GHRSST R/G TS framework did not change up to 2019. A reorganisation of this framework is presented in this document. Datasets produced from the collection of international 14 Regional Data Assembly Centres (RDACs) were ingested by a Global Data Assembly Centre (GDAC), such as the US GDAC located at the NASA Jet Propulsion Laboratory, Physical Oceanography Active Archive Data Center (PO.DAAC). These data were made available for public distribution via a number of access protocols, tools and services, and also staged for ingestion. Final archiving and further distribution services were performed by the Long-term Stewardship and Reanalysis Facility (LTSRF) located at the NOAA National Centers for Environmental Information (NCEI). This initial GHRSST R/G TS Framework is presented in Figure 1.

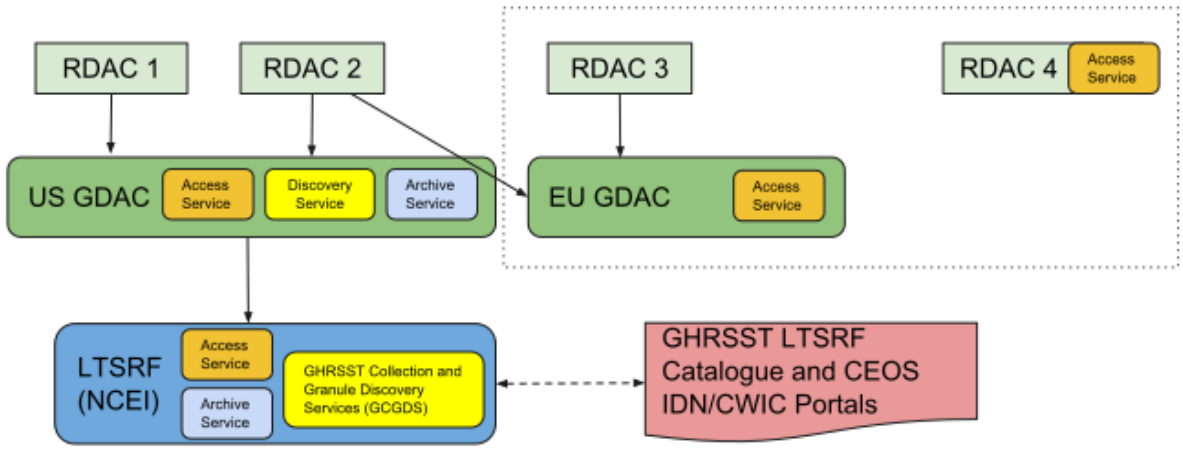

Figure 1: The initial (2006 to 2019) R/G TS framework. Data and metadata from data producers (RDACs) flow first to a GDAC (such as JPL GDAC or the less comprehensive EU GDAC). After 30 days this flow is also ingested by the NOAA LTSRF. The JPL GDAC has the most comprehensive metadata catalogue. LTSRF has the most comprehensive data archive. All GHRSST metadata are also ingested by the NASA CEOS CWIC repository.

Although this initial paradigm has functioned well, it has deviated from its initial design with the growing number of producers and datasets. As seen in the dashed box in Figure 1, a new GDAC was set-up in Europe, delivering products not available at the US GDAC, while other producers (e.g. CMEMS, Copernicus/EUMETSAT, and JAXA) are also now delivering products through their own services without any push to a GDAC. It was recognized by the GHRSST data management experts, through discussions from 2017 to 2019, and confirmed at the annual GHRSST science team meetings, that a more defined sharing of data management resources would be beneficial to the future growth of GHRSST and encourage more participation by other potential data producers.

The specification of the GHRSST data management paradigm for the next years is the focus of the next sections. It can be summarised by a more distributed system where no entity, but the GHRSST Project Office, plays a central role anymore, as shown on Figure 2.

In the new R/G TS framework, there are now only two types of entities: data producers (**GDP** or GHRSST Data Producers) and distributing centres (**DAC** or Data Assembly Centre). The two roles can be combined by a single institution (for example, EUMETSAT which produces and delivers Sentinel-3A & SB products). The GHRSST Project Office (GHRSST-PO) provides and maintains on its portal a central catalogue of all GHRSST datasets providing collection (dataset) level metadata, and federated search and discovery services. Each DAC must implement a minimum set of services for granule data access, search and discovery, production/distribution metrics and long-term archiving.

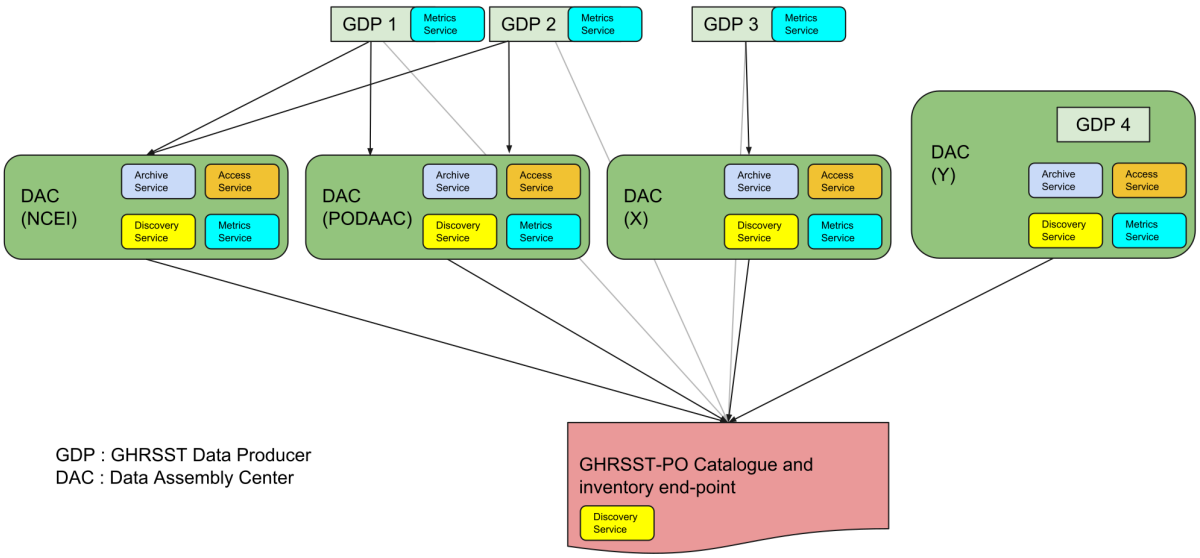

Figure 2: Revised architecture proposal. Multiple interfaces are now available to data producers. Each data node implements interface, distribution, archiving and metadata services for the datasets they are responsible for. Data and metadata from data producers (GDPs) flow first to a DAC (like PO.DAAC, before as the US GDAC). There is no more GDAC with the commitment to host all GHRSST datasets, it is now a shared task between DACs and some datasets can be distributed by several DACs. The GHRSST-PO portal allows the user to discover and search all GHRSST products and granules without prior knowledge of who is the producer or distributor.

This architecture is further specified in the following sections, providing the requirements for GHRSST operators to connect and be part of the GHRSST R/G TS system.

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1 The GHRSST R/G TS architecture

This section describes the overall new architecture of the GHRSST R/G TS: the contributing entities and their respective roles, services and interfaces with each other so that the GHRSST system works as a whole.

1.1 Goals

The fundamental goal of the R/G TS framework is to allow the current components of the GHRSST data management system to work both independently and to collaborate in the production, distribution, discoverability and archiving of GHRSST data products, whilst sharing the load of GHRSST products archiving and distribution.

The framework has the following aims:

1. Allow existing GHRSST data gateways such as the JPL/PO.DAAC, NOAA/NCEI, Ifremer/CERSAT, or any single entity serving its own (and/or others) products and metadata directly, to assume the end-to-end role of data management entities (nodes) responsible for the full lifecycle of data ingest, distribution, metrics, discoverability, and archiving.
2. Allow any GHRSST data assembly centres (DACs) to focus on datasets with which they have expertise or are of national/agency importance.
3. Maintain discoverability and access to all GHRSST datasets regardless of where they reside, or how many copies are available at different data nodes.
4. Provide a streamlined pathway for participation by new data providers and enhance future growth.

1.2 Architecture Specifications

The key aspect of this data management proposal is the division of labour for ingestion, management and curation of GHRSST datasets. The R/G TS Framework is presented in Figure 2.

It identifies three types of acting entities in the system:

- **The GHRSST Data Producers (GDP)** generating datasets compliant to GHRSST GDS specifications.
- **The Data Assembly Centres (DAC)** ensuring the distribution of these datasets along with some standards services.
- **The GHRSST project office (GHRSST PO)** maintaining a central catalogue and end-point access for search and discovery services (catalogues and inventories).

Each of the existing or new data assembly centres (DAC) is responsible for working with a defined collection of GHRSST data producers (GDP) for the full lifecycle of ingest, distribution and archiving. One motivation is to allow these DACs to focus on the datasets in which they have the most expertise and which they have an institutional requirement to manage. Additionally, data producers may wish to perform the data management lifecycle entirely themselves including distribution and archiving: a GDP can also be a DAC if it distributes its own products and implements the required capabilities and services of a DAC.

1.3 DAC Capabilities and Services

Each DAC shall maintain a core set of capabilities:

1. Data ingestion and logging from the GHRSST data producers (formerly known as RDACs but now as GDPs) or from its own internal production system.
2. Public distribution to the global community of GHRSST users. An institutionally required user registration system may be implemented if necessary.

3. Data discoverability and search; with an emphasis on improving discovery and search through use of standards.
4. Data archiving.
5. Data production status and metrics.

Each of these capabilities are discussed in more detail below, including recommendations and options for consideration.

Data Ingestion

Each DAC shall maintain a protocol or interface to data providers (GDPs) for the ingestion of GHRSST datasets including granules and checksums. Typically this is via SFTP push, or server pull mechanisms but the choice of optimum path is at the discretion of the data providers. Each DAC shall work with the providers to ensure new datasets are compliant with GDS2 requirements.

Data Distribution

Each DAC shall provide access via a minimum set of an FTP or HTTP(S) server, and an implementation of the OPeNDAP protocol (e.g. Hyrax). The provision of additional distribution services are encouraged such as THREDDS, OGC WCS and other web services.

Each DAC shall strive to ensure full public access to GHRSST datasets. In some cases, user registration may be an institutional requirement.

Each DAC shall collect and maintain dataset metrics including the number of files and dataset volumes accessed; the number of unique users of all tools and services; and the number of web site visits used to access GHRSST specified data.

Data Discovery and search

Each DAC (or associated GDP) shall maintain or create a metadata record at the dataset and granule level compliant with the GDS2 specifications and ISO 19115-3 (superseding ISO 19115-1 & ISO 19115-2), and provide these metadata to the central catalogue at GHRSST project office.

Data Archiving

Each node shall employ robust data archiving strategies including ensuring at least one full backup (data redundancy) for all data within their archive. Specific recommendations for archive design can be found in the reference model of the Open Archival Information System (OAIS) that has been adopted by NOAA and NASA.

Data production status and metrics

Obtaining an integrated view of the overall R/G TS system health and usage is of primary importance. The system shall therefore be able to collect, centralize and aggregate the relevant metrics for the GHRSST PO. These metrics shall be produced and exchanged in a standardised and consistent manner within the system.

1.4 Ensuring standard and federated data distribution, search and discovery

In order to ensure the interoperability of all GHRSST components, the implementation of the GHRSST data discovery, search and access system is a key component and it relies on international standards.

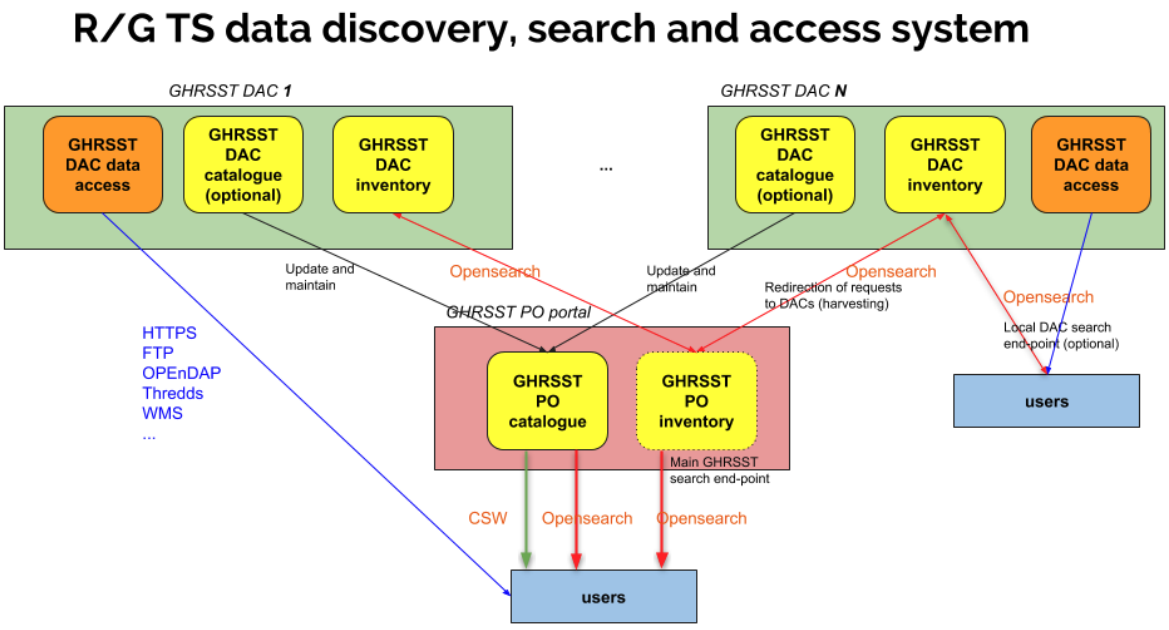

Figure 3: R/G TS data discovery, search and access system.

In our context:

- **Data discovery** is the service providing and displaying the list of GHRSST datasets and granules, either as an online human readable catalogue or a web service for machine-to-machine interface.
- **Data search** allows the fine selection of relevant datasets or granules with respect to some criteria (like time frame and geographical area), either through a web form or a web service for machine-to-machine interface. It is complementary to discovery.
- **Data access** is the actual way to download or remotely read the data files.

Data discovery and search can be performed on two types of metadata:

- **Collection** (or **dataset**) metadata: a **catalogue** of the available datasets provided by producing agencies. This was formerly implemented for instance through the JPL/PO.DAAC catalogue though it was restricted to the available datasets at GHRSST US GDAC and was not fully comprehensive. We want the new GHRSST catalogue to be comprehensive and not related to the physical storage or access of all data at a specific entity.
- **Granule** metadata: an **inventory** of all the available granules (data files) that can be accessed from any provider.

The GHRSST PO portal is the federated access end-point for the discovery and search of GHRSST datasets (**catalogue** service) and granules (**inventory** service). A user accessing these services from the GHRSST PO can search and discover all endorsed GHRSST datasets, their location and related services. No provider source (DAC) is privileged in the returned search results. This central access point means users need not care about the actual location of the data.

A **GHRSST DAC** (any GHRSST entity providing access to GHRSST data without necessarily producing them: PO.DAAC, NOAA, EUMETSAT, JAXA, Ifremer, CMEMS, etc.) interacts with the GHRSST PO portal by

ensuring its services and dataset metadata are documented and up-to-date in the GHRSST PO catalogue (main metadata repository).

Users connecting to **the GHRSST PO portal** can access the list of documented GHRSST datasets endorsed by **the GHRSST PO**. They can also search for GHRSST granules (and their related access URLs) without any knowledge of which **DAC**(s) is (are) distributing them.

1.5 Contributing entities

The following table gives an overview of the existing GHRSST entities and their identified role in this proposed R/G TS organization. The table gives examples and is not comprehensive with further additions possible. It underlines the complexity of the GHRSST R/G TS network of partners and products.

Table 1: The role, products and connections of some existing GHRSST entities in the proposed R/G TS organization.

Organization	If a GDP, available products	If a DAC, related GDPs
EUMETSAT	Sentinel-3A & S3B L2P	self
JPL PODAAC	JPL JPL_OUROCEAN VIIRS L2P (OBPG/Miami)	self REMSS NAVO JAXA CMC
NCEI		OSPO STAR NCEI ABOM UFRJ
Ifremer	L4 Medspiration Med Sea L4 Medspiration Brazil L4 Medspiration South-Africa	self OSI SAF NAVO REMSS
CMEMS	L3S Global L3S European Seas L3S Mediterranean L3S Black Sea L3C European Seas (all available sensors) L4 Global OSTIA L4 North Western Shelves L4 Baltic L4 Arctic L4 Med L4 Black Sea	
JAXA	Himawari	
OSI SAF	L2P Metop-A AVHRR	

	L2P Metop-A IASI L3C Metop-A AVHRR Global L3C Metop-A AVHRR NAR L2P Metop-B AVHRR L2P Metop-B IASI L3C Metop-B AVHRR Global L3C Metop-B AVHRR NAR L3C VIIRS AVHRR NAR L3C MSG L3C GOES L3C MSG reprocessed L3C GOES reprocessed	
NEODAAS		
OSPO	X	
ABoM	L2P Himawari-8 L2P AVHRR HRPT L3U AVHRR HRPT L3C AVHRR HRPT L3S AVHRR HRPT L2P AVHRR HRPT reprocessed L3U AVHRR HRPT reprocessed L3C AVHRR HRPT reprocessed L3S AVHRR HRPT reprocessed L3C VIIRS L3S VIIRS+AVHRR L3C VIIRS reprocessed L3S VIIRS+AVHRR reprocessed L3U MTSAT-1R reprocessed L4 RAMSSA L4 GAMSSA	
UFRJ		
NAVO	VIIRS L2P	
CMC	CMC L4	
REMSS		

References

The following references are relevant for the specification of GHRSST R/G TS services:

RD.1 CEOS OpenSearch - Best Practice Document, v1.2

https://cdn.earthdata.nasa.gov/conduit/upload/6918/CEOS-OPENSEARCH-BP-V1.2.pdf

RD.2 OGC Extensions OpenSearch spatial

http://docs.opengeospatial.org/is/13-026r8/13-026r8.html

RD.3 OpenSearch core specifications

http://www.opensearch.org/Specifications/OpenSearch/Extensions/Parameter/1.0

RD.4 CEOS OpenSearch Client Guide

http://ceos.org/document_management/Working_Groups/WGISS/Projects/CWIC/OpenSearch/CWIC_OpenSearch_Client-Guide.pdf

RD.5 OGC® Catalogue Services 3.0 - General Model

http://docs.opengeospatial.org/is/12-168r6/12-168r6.html

RD.6 CSW

http://www.opengeospatial.org/standards/cat

RD.7 Querying EarthData CSW service

https://cmr.earthdata.nasa.gov/csw/collections#get-records-get

2 GHRSST Access Requirements

This section describes the list of services that are recommended in this new version of the GHRSST R/G TS to give access to a GHRSST collection. It provides some constraints on these services to favour interoperability, consistency between GHRSST DACs and ultimately transparent access to all GHRSST collections by users. Many of these services were already available at some DACs in the previous system and have been kept or discarded since.

These services include:

- **HTTP**(S): HTTP access is **mandatory**, meaning at least one http(s) access must be provided by some DAC for a GHRSST collection to be part of the GHRSST collection portfolio.
- **FTP**: FTP is **strongly recommended**, as still widely used, but not absolutely mandatory (FTP access has been discarded by some institutions for security reasons).
- **OPeNDAP**: OPeNDAP is **recommended**, allowing remote subsetting of the data prior to any download by users, thus limiting the consumed network bandwidth. It may be provided through a THREDDS or Hyrax server.
- **WMS**: WMS map service (and WCS) are **recommended** for L3/L4 collections to encourage integration of GHRSST data into Geographical Information Systems (GIS).

Other services (remote computing capabilities, Jupyter notebooks, visualization, etc.) are also encouraged.

2.1 HTTP(S)

- The requirements for a GHRSST HTTP(S) data access service are as follows:
- Each GHRSST collection shall have **at least one** associated HTTP(S) service to be part of GHRSST collection portfolio. This is a minimum condition.
- Each file available through a HTTP(S) data access service shall be accessible through a unique and permanent URL (no dynamic URL).
- Each file URL provided through this service shall be discoverable through an OpenSearch inventory search.
- Authentication to access the data is allowed but not mandatory. It shall be opened to anybody.
- The recommended file organization is through a <year>/<day in the year> subfolder hierarchy.
- The service shall be documented in the GHRSST Central Catalogue. If authentication for the service usage is required, the catalogue shall describe where and how to get the credentials.

2.2 FTP

The requirements for a GHRSST FTP data access service are as follows:

- Each file available through a FTP data access service shall be accessible through a unique and permanent URL (no dynamic URL).
- Each file URL provided through this service shall be discoverable through an OpenSearch inventory search.
- Authentication to access the data is allowed but not mandatory.
- The recommended file organization is through a <year>/<day in the year> subfolder hierarchy.
- The service shall be documented in the GHRSST Central Catalogue. If authentication for the service usage is required, it shall describe where and how to get the credentials.

2.3 OPeNDAP

The requirements for a GHRSST OPeNDAP data access service are as follows:

- Each file URL provided through this service shall be discoverable through an OpenSearch inventory search.
- The recommended file organization is through a <year>/<day in the year> subfolder hierarchy.
- For gridded products (L3, L4) it is recommended to provide file aggregation (allowing access and subsetting of a collection as a three dimensional dataset).
- The service shall be documented in the GHRSST Central Catalogue. If authentication for the service usage is required, it shall describe where and how to get the credentials.

2.4 WMS/WCS

- This service serves data maps on the fly: it is recommended for gridded products (L3, L4) allowing integration with Geographical Information Systems (GIS).

3 GHRSST Central Catalogue

The GHRSST Central catalogue gives the users access to search and discovery capabilities on all the GHRSST datasets approved by the GHRSST Project Office. It is the only global catalogue of GHRSST products, recording and storing the descriptions of all the GHRSST approved datasets in a single place in a standalone manner (no connection to any other cataloguing system).

The implementation of these services follow community standards, in particular **ISO 19115** for describing the datasets with metadata and **CSW** for interfacing with the GHRSST Central Catalogue search and discovery services. It is to be noted that these standards are quite general: their goal is to provide standard query and response structures, not the actual attributes and taxonomies.

This section provides specifications for the full implementation of this service.

3.1 Functions

The GHRSST Central Catalogue must provide the following functions:

- A database to store the GHRSST collections metadata.
- An online web interface to remotely create, edit and maintain the GHRSST collections metadata.
- User authentication and permission management in order to restrict the metadata editing to assigned curators of each dataset.
- An online web interface for users to search for GHRSST collections with respect to some predefined search criteria (time frame, mission, sensor, level, etc.) and visualize a full description of these collections.
- A CSW web service to query GHRSST dataset metadata in ISO-19115 format.

3.2 Responsibilities

The GHRSST Project Office, or alternative coordinating facility, together with the support of the Science Team technical task team, should be responsible for:

- Implementing, operating and sustaining the central catalogue and its search and discovery services (on whatever host).
- Approving the publication of any submitted dataset.
- Ensuring submitted dataset is compliant with GHRSST GDS specifications and providing support to the data producers in this regard.

GHRSST data producers are responsible for:

- The compliance of their products to GHRSST GDS specifications.
- Creating, editing and keeping up to date the description of the datasets they produce for GHRSST.

GHRSST data assembly centres are responsible for:

- Creating, editing and keeping up to date the description of the data access services they offer for the datasets they host and distribute for GHRSST.

3.3 GHRSST collections metadata profile

A GHRSST collection is described through a set of fields that are presented in Table 2. The underlying metadata standard used for metadata exchange through CSW services is **19115-3:2018**. The mapping of the GHRSST collection description fields to this standard is provided in Annex 3.

Table 2: GHRSST collection metadata fields.

Field	Description	Cardinality
Title	Name of the dataset	1
Abstract	Description of the dataset	1
Collection id	Identifier of the dataset	1
DOI	Data object identifier associated with the dataset	0|1
Source		1+
Platform	Identifier of satellite, as in http://database.eohandbook.com/database/missiontable.aspx	1
Sensor	Identifier of instrument, as in http://database.eohandbook.com/database/instrumenttable.aspx	1
Dataset Properties		1
Level	Processing level (L2P, L2C, L3C, L3S, L4)	1
Feature type	Type of product feature (swath, grid)	1
Acquisition pattern	The way observation are split or grouped (3-min granule, orbit, pass, composite, etc.)	1
Compositing	The way the product is composed from other observation products (uncollated, collated, interpolated,...), applied only to gridded products (geostationary, L3+)	0+
Latency	Delay for product availability (less than 6 hours, etc…)	1
Temporal Properties		1
Begin date	Date of the first observation available for the dataset	1

End date	Date of the last available observation of the dataset if it is a terminated product (or with very long update rate)	0|1
Resolution	Temporal resolution of the dataset if it is periodic (3-hourly, daily, etc…)	0|1
Spatial Properties		1
Resolution	Spatial resolution in km or degrees	1
Projection	Projection code (EPSG,...), applies only to gridded dataset	0|1
Geographic area	Bounding box of dataset coverage	1
Spatial Properties		1
Main instrumental or geophysical parameters	Main parameter (GCMD code): Ocean Temperature	1
Keywords (GCMD)	Specific parameter (GCMD code): Sea Surface Temperature	
Authorship		1+
Role	Role of author (funder, principal investigator, distributor, point of contact, etc.)	1
Institution	Organization the author belongs to	1
Electronic mail address	Email of author	0|1
Name	Name of author	1
Access		1
Access policy	Data distribution policy (Unrestricted, Restricted, Licence, etc.)	1
Format name	Type of format: netCDF	1
Edition	Format version: 4	1
Convention	Format conventions used: CF-1.7, ACDD-1.4, GDS-2.1, etc.	1+
Usage		
Usage policy	Describes the conditions for data usage (ex: free and open)	1

Required citation	The statement to insert when using the dataset in a publication or application	1
Online resources		0+
Resource type	Type of resources associated to the dataset: Download / FTP Download / HTTP Download / THREDDS Service / OPeNDAP Service / WMS ...	1
URL	URL of the resource	1
Documents		0+
Type	User manual, validation report, ATBD, etc.	1
URL	URL of the document	1
Updates		0+
Description	Description of a change in the dataset or processing	1
Date	Date of the change in the dataset or processing	1
Issues		0+
Description	Description of a specific issue with the dataset	1
Start date	Date at which the issue started	0|1
End date	Date at which the issue ended	0|1
Versions		
Description	Description of the dataset version	1
Identifier	Version number	1
Date	Date of release	1

3.1 GHRSST dataset metadata editing rules

A new metadata profile shall be created for a new release of a collection with major changes or replacing the files of the previous version. If it is a minor update continuing the existing time series without replacing any previous files, the same metadata profile can be kept (simply updating the version history)

3.2 CSW (Catalogue Services for the Web)

In order to comply with existing standards in the oceanographic community and to interoperate with other similar services or GIS clients, the GHRSST central catalogue shall be searchable through CSW protocol, returning collection metadata in ISO19115-3 format.

CSW is an OGC standard for accessing catalogue services. It is widely used, and is implemented by several software solutions and also allows federated and interoperable catalogues.

As stated in [RD.6]:

Catalogue services support the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects. Metadata in catalogues represent resource characteristics that can be queried and presented for evaluation and further processing by both humans and software. Catalogue services are required to support the discovery and binding to registered information resources within an information community.

OGC Catalogue interface standards specify the interfaces, bindings, and a framework for defining application profiles required to publish and access digital catalogues of metadata for geospatial data, services, and related resource information. Metadata act as generalised properties that can be queried and returned through catalogue services for resource evaluation and, in many cases, invocation or retrieval of the referenced resource. Catalogue services support the use of one of several identified query languages to find and return results using well-known content models (metadata schemas) and encodings.

A CSW service relies on the metadata of the datasets and services, usually stored in a database (metadata repository). For R/G TS, it will then require a complete, accurate and up-to-date description of each endorsed GHRSST dataset.

A CSW service provides several types of requests, which are not always all implemented by a given service. The most common ones are listed below in Table 3 and also described in [RD.7].

Table 3: Most common request types to a CSW service.

GetCapabilities	Allows CSW clients to retrieve service metadata. The response to a GetCapabilities request is an XML document containing service metadata about this server.
GetRecords	The primary means of resource discovery in the general model are the two operations search and present. In the HTTP protocol binding these are combined in the form of the mandatory GetRecords operation, which does a search and a piggybacked present. The search portion of the GetRecords operation is encoded using the Query element. The Query element includes the parameters typeName and Constraint. The typeName parameter is used to specify which entities, from the information model of the catalogue, shall be queried. The Constraint parameter is used to specify which query constraints shall be applied to identify the request set. The present portion of the GetRecords operation is encoded using the outputSchema parameter and the ElementName/ElementSetName parameter(s). The outputSchema parameter indicates which schema shall be used to generate the response to the GetRecords operation. The ElementName or ElementSetName parameter is used to specify which properties of the outputSchema to include in each record in the GetRecords response.
GetRecordDescription	This request retrieves the default representation of catalogue records using their identifier. This operation is an implementation of the Present operation from the general model. This operation presumes that a previous query has been performed in order to obtain the identifiers that may be used with this operation. For example, records returned by a GetRecords operation may contain references to other records in the catalogue that may be retrieved using the GetRecordById operation. This operation is also a subset of the GetRecords operation, and is included as a convenient short form for retrieving and linking to records in a catalogue.
GetRecordById	Allows clients to examine the anatomy of output schemas supported by this CSW by responding with the corresponding XML Schema document. The CMR CSW implementation supports the root element of the supported output schemas and does not allow separate retrieval of individual schema elements. As a consequence, one or more requested schemas will be returned in their entirety. Example: https://cmr.earthdata.nasa.gov/csw/collections?request=GetRecordById&service=CSW&version=2.0.2&outputSchema=http://www.isotc211.org/2005/gmi&ElementSetName=full&id=C1331862393-PODAAC

3.1 Implementation

Available software that can be used to implement both CSW and OpenSearch capabilities for catalogue services (collection level) are listed in Table 4 below:

Table 4: Software that can be used to implement CSW and OpenSearch capabilities.

Name	CSW	OpenSearch	Comment	Licensing
pycsw http://pycsw.org	2.0.2 3.0.0	1.0	Python implementation No GUI for editing Include INSPIRE plugin	MIT
GeoNetwork https://geonetwork-opensource.org	2.0.2	Unclear (mentioned in documentation but undocumented)	Complete editing/harvesting/portal online solution Support INSPIRE	GNU General Public License 2.0
GeoPortal https://www.esri.com/en-us/arcgis/products/geoportal-server/overview	2.0.2	yes	Open source version from a commercial company (ESRI) Support INSPIRE	Apache 2.0
GeoServer http://geoserver.org/	2.0.2	no		GNU General Public License 2.0

4 GHRSST Granule Inventory

As shown in Figure 1, the GHRSST granule files are stored and accessed at different DACs. The GHRSST granule inventory is therefore distributed among all the DACs: The GHRSST inventory is the union of all the local DAC's inventories. It can be queried through a single end-point search service, also complying with OpenSearch protocol, that federates all GHRSST DAC inventories. It does not host itself any inventory database, it just acts as a broker.

The GHRSST granule inventory service allows the users to discover, search and locate GHRSST granules (or files) for any collection from a single access point. A request to this web service does not return any file, just the file names and metadata of each found granule matching the user request, including at least one URL for each of them (that can be used by a user for the actual download).

GHRSST granule files are hosted at DACs but a GHRSST granule may be hosted at different DACs. Besides, a GHRSST granule may be served through different access protocols (FTP, HTTPS). An inventory search may therefore return different results for the same granule (like different URLs for different protocols and/or locations).

Each GHRSST DAC, providing some access to GHRSST data files, maintains its own DAC inventory of the granules it hosts and serves through its access services, which must be searchable.

4.1 DAC granule inventory

Inventory content

Each DAC inventory shall record all the granules of the GHRSST collections it serves. A GHRSST DAC inventory therefore consists of:

- A database containing all the hosted granules and their properties.
- A search API complying with OpenSearch protocol to select granules within this database.

For each recorded granule, the following **mandatory** information shall be registered by each GHRSST DAC:

- File name of the granule.
- GHRSST collection identifier it belongs to.
- Footprint of the granule as a geographical polygon.
- Time extent of the granule: start and end acquisition time.

Additional properties may be registered, to ease the identification and traceability of the granules, or for other purposes (DACs are free to define any properties they deem to be relevant):

- creation date of the granule
- version number
- etc.

Inventory search service

The inventory search service must be implemented by each DAC on its inventory. It consists of a web service exposed to all users, and compliant with OpenSearch standards. This specifies the way queries and query results shall be expressed and formatted.

OpenSearch is a simple specification for executing search requests and the sharing of search results.

The OpenSearch description document format can be used to describe a search engine so that it can be used by search client applications.

The OpenSearch response elements can be used to extend existing syndication formats, such as RSS, JSON and Atom, with the extra metadata needed to return search results.

OpenSearch base specification is complemented by a set of **extensions** refining some aspects (keywords, format, etc.) often used by and relevant to existing EO search systems:

- The *Geo and Time extensions* [OGC 10-032r8] specify a series of query parameters that can be used to geographically and temporally constrain search results. Parameters include: bounding box, geometry, and start/end of a temporal extent. It also defines a set of response elements to be used to express geographical and temporal context in the search results. The extension for EO Products [OGC 13-026r8] defines query parameters that allow the filtering of search results with the fields that are unique to EO products, e.g. platform (satellite), sensor, processing centre, etc.
- The OpenSearch query parameters defined in this document are aligned with O&M EO Profile [OGC 10-157r4] that describes EO products metadata.
- The OpenSearch *Parameter* Extension [Param] sets rules to describe valid range and entries for query parameters in OSDD. This extension is not an OGC standard.

A comprehensive set of recommendations for OpenSearch was released by CEOS [RD.1] based on a joint effort from several agencies (JAXA, CNES, ESA, NASA, NOAA, CCMEO). It is used as the core set of requirements for GHRSST end-point inventory search service.

It is also recommended for any GHRSST DAC inventory search service. However we acknowledge the fact that many institutions may already host such a service which complies with their own national, governmental or organizational requirements. We do not want to duplicate these services but build upon them. Interfaces have to be implemented to allow the federation and interoperability of each DAC inventory: this aspect is addressed by the GHRSST end-point inventory search service.

Ideally, for R/G TS implementation, we would rely on existing services that may already be implemented in existing GHRSST DACs. However these implementations differ from one to another.

Table 5 shows the minimum set of search terms required for a DAC OpenSearch service, and examples of known discrepancies found among existing implementation of OpenSearch search services for EO data. It is not comprehensive and only displayed as an illustration of what can be expected.

Table 5: Required search terms for a DAC OpenSearch service. The search terms defined for GHRSST central end-point service are listed in the left column. Other columns provide the corresponding search terms in some known existing OpenSearch services for EO data. A DAC may implement its own syntax for search terms (though this is not encouraged) but must provide an equivalent for each of the GHRSST search terms.

GHRSST search term	CWIC	Fedeo	CNES/PEPS	Eumetsat/CODA
From namespace: http://a9.com/-/spec/opensearch/1.1/				
startPage Index number of the set of search results desired by the search client	`cursor={os:startPage?}`	`startPage={startPage?}`	`page={startPage?}`	`start={os:startPage?}`
startIndex Page number of the set of search results desired by the search client	`offset={os:startIndex?}`	`startRecord={startIndex?}`	`index={startIndex?}`	
count Number of search results per page desired by the search client	`numberOfResults={os:count?`	`maximumRecords={count?}`	`maxRecords={count?}`	`rows={os:startPage?}`
From namespace: http://a9.com/-/opensearch/extensions/geo/1.0/				
box Geographic bounding box	`geoBox={geo:box}`	`bbox={geo:box?}`	`box={geo:box?}`	`footprint="Intersects(POLYGON((...)))"`
From namespace: http://a9.com/-/opensearch/extensions/time/1.0/				
start *A string describing the start of the temporal interval to search (bigger or equal to)*	`timeStart={time:start}`	`startDate={time:start?`	`startDate={time:start?}`	`beginPosition={time:start?}`
end *A string describing the end of the temporal interval to search (smaller or equal to)*	`timeEnd={time:end}`	`endDate={time:end?}`	`completionDate={time:end?}`	`endPosition={time:end?}`
From GHRSST namespace				

datasetId *the identifier of the GHRSST collection to which granules belong to*	`keyword={os:searchTerms?}`	`parentIdentifier={eo:parentIdentifier}`		`q={str}`

As a result of a query, each DAC inventory search service shall return, in one of the allowed OpenSearch output formats, the list of granules matching the criteria expressed in the query. The returned fields of information shall include:

- The properties recorded for the select granule(s) as defined in the inventory content above
- The access URL(s) for the granule and associated protocol (FTP, HTTPS, OPeNDAP, etc.)

Implementation

A granule inventory can be implemented by a DAC using its own data warehouse system, relying on whatever technology (database, NoSQL engine, etc.) it is familiar with or bound to, **as long as it records the above properties and provides an OpenSearch inventory search API**.

DACs having no such granule inventory can also benefit from existing software that allows implementation of such a service. Table 6 lists the software that has been surveyed by the R/G TS task team. The software we selected come with an OpenSearch search API complying with GHRSST requirements for the R/G TS.

Table 6: Software selected with an OpenSearch search API which complies with GHRSST requirements.

Service	Example of end-point URL	Software on which it is based
CWIC	http://cwic.wgiss.ceos.org/opensearch/	based on Elasticsearch
Fedeo	http://fedeo.esa.int/opensearch/request	Unknown
PEPS CNES	https://peps.cnes.fr/resto/api/collections/S3/	https://github.com/jjrom/resto
DataHub ESA EUMETSAT	https://coda.eumetsat.int/search https://codarep.eumetsat.int/search	http://sentineldatahub.github.io/DataHubSystem/
EDGE (JPL/PODAAC)	Not tested	https://github.com/apache/incubator-sdap-edge

As for any internet web service, the effort and challenges DACs will face when implementing such a service may include:

- Deploying one of the above solutions or implementing an internal equivalent (and compliant) service.
- Making the OpenSearch service accessible to external (internet) users (or at least the GHRSST central inventory broker service) which will involve some security aspects.
- Populating continuously the inventory with newly produced granules.

- Fault-tolerance and performance considerations to address the number of recorded granules and of user queries.
- Monitoring and maintenance of the inventory and search service.

4.2 GHRSST End-point Inventory search service

Requirements

The GHRSST end-point inventory search service is the central access point where any user can search for granules through the whole GHRSST R/G TS system, without any prior knowledge of which DACs serve specific collection subsets. A user querying this service will be returned a result consolidating the individual responses of each DAC. This service acts as a broker to the DACs granule inventory search services, offering one single syntax and format for the queries and returned results.

Specifically, the GHRSST end-point inventory search shall not host or use any central granule inventory: it does nothing but redirect the user search requests to each connected DAC and assemble the result before returning it to the user.

Therefore the GHRSST PO shall design, implement, deploy and operate an end-point inventory search service that:

- Complies with OpenSearch v1.1 protocol.
- Is able to redirect to and assemble the results from each connected DAC individual inventory search service.
- Translate internally the user requests and DAC responses to enable interoperability despite the discrepancies existing among the different DAC inventory search services.
- Be fault tolerant and handle possible error cases: time-out of a DAC response, too large result, unexpected result, etc.
- Support large queries and multiple users at the same time.

In order to interoperate with the DACs OpenSearch services, the GHRSST PO OpenSearch end-point service shall implement the minimal set of search keywords listed in Table 7.

Table 7: Minimal set of search keywords to be implemented by the GHRSST PO OpenSearch end-point service.

Keyword	Syntax
From namespace: http://a9.com/-/spec/opensearch/1.1/	
startPage Index number of the set of search results desired by the search client	`startPage={os:startPage?}`
startIndex Page number of the set of search results desired by the search client	`startIndex={os:startIndex?}`
count Number of search results per page desired by the search client	`count={os:count?}`

From namespace: http://a9.com/-/opensearch/extensions/geo/1.0/	
box Geographic bounding box	`box={geo:box?}` The box is defined by "west, south, east, north" coordinates of longitude, latitude, in a EPSG:4326e decimal degrees
From namespace: http://a9.com/-/opensearch/extensions/time/1.0/	
start A string describing the start of the temporal interval to search (bigger or equal to)	`start={time:start?` Character String; must match the RFC-3339
end A string describing the end of the temporal interval to search (smaller or equal to)	`end={time:end?}` Character String; must match the RFC-3339
From GHRSST namespace	
datasetId the identifier of the GHRSST collection to which granules belong to	`datasetId={ghrsst:datasetId?}` the collection identifier as defined in GHRSST central catalogue

The GHRSST inventory search service acts as a broker to each DAC inventory service. As the DAC inventories may be implemented in a different manner, supported by different software and data warehouse systems, discrepancies are expected in the query syntax. The GHRSST inventory search service shall therefore be able to convert a query to the GHRSST end-point service into the syntax expected by each connected DAC.

Similarly the results from each DAC collected by the GHRSST end-point service shall be consolidated into an aggregated result, which requires as a preliminary step the translation of the response from each DAC into a common syntax and content.

5 GHRSST Archiving Requirements

The purpose of the archiving requirements is to ensure that GHRSST specified data are preserved in the long-term. It addresses issues such as backup and open access to historical archives.

The GHRSST R/G TS will be implemented in different stages and these requirements are still to be defined and agreed by the R/G TS task team.

For now, the requirements in terms of archiving to GHRSST R/G TS entities are as follows:

- Producers shall ensure there is at least a back-up copy of the data they produce. This can be implemented through a third party entity (such as a DAC).
- Long-term preservation systems such as tape libraries are recommended for this back-up.
- Producers shall ensure historical data (past data) can be restored.
- Specific recommendations for archive design can be found in the reference model of the Open Archival Information System (OAIS) and are highly recommended to GHRSST data producers.

6 GHRSST Metrics Requirements

The integration of the different GHRSST entities (GDPs, DACs and GHRSST PO) requires that the health and status of the system, as well as its usage, are monitored in a consistent manner in order to allow both local reporting of each individual entity and an overall view at system level. We will define here the metrics, their definition and format, as well as their exchange protocol, required to achieve this objective.

The GHRSST R/G TS will be implemented in different stages and these requirements are still to be defined and agreed by the R/G TS task team.

7 Specific requirement for GHRSST R/G TS entities

7.1 Requirements for GHRSST Data Producers (GDP)

The main function of a **GHRSST producer** is to produce GHRSST compliant Sea Surface Temperature collections. This section describes the requirements for a data producer to be part of the GHRSST R/G TS system.

A **GHRSST producer** (functioning as a DAC or not) shall:

- Ensure it provides directly or through a related DAC entity (or several) all the mandatory access, discovery, archiving and metrics services required for a GHRSST data collection.
- Liaise with the GHRSST PO so that its dataset is endorsed (accepted as part of GHRSST collections portfolio). The acceptance of a collection to be part of the GHRSST portfolio requires:
    - Sufficient description of the collection properties and validation references.
    - Compliancy of collection files to the GHRSST format and content specifications (GHRSST GDS), verified through a GHRSST checker tool and peer review by UDS TAG.
    - Availability of the required GHRSST access and archiving requirements (possibly implemented through a closely related DAC but only one).
- Properly edit and maintain the metadata related to its collections on the GHRSST Central Catalogue. These metadata shall include a set of information (complying with a standard e.g. ISO19139-3) that are defined by the GHRSST UDS-TAG: description and content of the dataset, related satellite/instrument, version changes, contact points, etc. These information shall be submitted or updated through a user interface to be implemented and operated by the GHRSST PO.

The above responsibilities may be delegated to a closely related DAC (for producer only entities) but only a single one.

7.1 Requirements for Data Assembly Centres (DAC)

This section describes the requirements of a data distributor to be part of GHRSST R/G TS system.

Responsibilities

The main function of a DAC is to provide user access and services to GHRSST collections. Any GHRSST entity that provides such services for GHRSST collections can be considered as a GHRSST DAC if it fulfils the following requirements:

- access to GHRSST collections through one of the following protocols and services:
    - HTTP(S)
    - FTP
    - OPeNDAP/THREDDS

Implementation of data inventory service

A **GHRSST DAC** (distributing GHRSST data through specific access services) shall:

- Liaise with GHRSST PO and other implementers as relevant, so that these services are discoverable on the GHRSST portal. These services are to be documented and maintained in the GHRSST catalogue (the datasets and related services are documented in the same system and searchable through the same interfaces). Examples of such services include:
    - FTP
    - HTTP(S) – mandatory
    - THREDDS
    - OPeNDAP
    - WMS
    - WCS
- OpenSearch for inventory – mandatory
- Implement the minimum set of services expected from a GHRSST DAC
    - An **HTTP** or **HTTPS** access to the GHRSST granules it disseminates. The corresponding end-point shall be documented in the GHRSST service and dataset catalogue.
    - An **OpenSearch** service for the discovery of the granules: this OpenSearch service shall comply with the minimum set of requirements defined in this document

7.2 Requirements for GHRSST Project Office

The **GHRSST PO** shall:

- Implement a central dataset and service catalogue offering CSW and possibly OpenSearch interfaces accessible to all users
- Allow access to this catalogue for editing by the authorised GHRSST producers and/or distributors (DACs) responsible for the maintenance of the metadata related to their offered datasets or services.
- Implement a federated inventory search end-point, offering an OpenSearch interface, accessible to all users.
- Implement a human-readable catalogue and inventory interfaces (relying on these CSW and OpenSearch search results) through a web GUI for a more interactive and user-friendly discovery (not requiring any specific CSW or OpenSearch client).
- Implement and organize a publishing workflow so that the edited collection metadata are checked and approved before being released publically.

The GHRSST catalogue and inventory interfaces may be physically implemented anywhere, at a single location, but preferably in an organization already maintaining such services (existing DAC for instance).

8 Design justification: data discovery and search services

This section explores the rationale behind the choices made for the discovery and search services, and in particular the architecture and exchange protocols selected. They have also been validated through a pilot project (the results of the pilot project were given in a presentation, "Evolution of the R/G TS" at the GHRSST Science Team Meeting in Frascati, Italy on 5th June 2019, the presentation is available on the GHRSST website at https://www.ghrsst.org/agenda/g-xx/).

One key requirement in the new architecture from a user perspective is that all GHRSST datasets and their granule access end-points (e.g. FTP/HTTP locations) must be discoverable and searchable in a consistent manner, regardless of where they are distributed from.

8.1 Shortcomings of existing federated services and recommendations

Outdated metadata

In the existing services surveyed by GHRSST R/G TS Task Team, the collected **catalogue level** metadata in DACs for a given dataset are often incorrect or outdated.

It is not possible for a provider to check the metadata maintained by several third-party (re)distributors. A GHRSST catalogue service would benefit on having the producer/provider directly involved in the maintenance and editing of the metadata of its own offered datasets and dissemination services at a single place.

Recommendation 1: the metadata describing a dataset, as appearing in the GHRSST portal, shall be maintained by the original producer (or directly associated provider) of the dataset. The description of the services related to a given dataset shall be maintained by the DAC(s) offering these services.

Duplicated metadata

While today's technologies allow harvesting of metadata from multiple distributed catalogues, this would mean that the same dataset may be hosted at different DACs resulting in two or more dataset descriptions returned by a federated query. While being possibly confusing for the user, there is also a high risk of inconsistencies (with metadata not up-to-date in each returned record for the same dataset).

Recommendation 2: the GHRSST catalogue shall return a single description of a GHRSST dataset, and that shall be the one curated and maintained by the producer (or primary distributor).

From the analysis of these possible shortcomings, we recommend:

Recommendation 3: the metadata describing a dataset shall be maintained at a single place by the original producer (or directly associated provider) of the dataset. To avoid duplicates and inconsistencies, we recommend not to use federated queries for the dataset catalogue but rather implement and maintain a physical GHRSST metadata repository offering a catalogue of the datasets and related services that can be remotely edited by GHRSST partners.

This does not prevent a DAC from implementing and exposing its own catalogue of the datasets and services it provides (which will very likely, in large organisations, include non-GHRSST datasets as part of an internal data warehouse system).

Maintenance of data inventories

Regarding the **inventory level** metadata (for granule search and localization), each DAC has the knowledge of the characteristics of its copy of each granule (spatial and temporal extent, etc…) and access links (URL), etc…). There is no benefit to the setting up of a central control or consistency check of inventory level metadata.

Recommendation 4: the exact content and control of the granule inventories shall be maintained independently by each DAC.

As a consequence, a central GHRSST inventory search end-point cannot be centrally implemented and better fits a distributed model.

Recommendation 5: the central GHRSST inventory search service shall federate queries to each connected DAC.

Single end-point access

There currently exist standard protocols to implement inventory searches (and to format the returned results), from which we have selected **OpenSearch**. However, as demonstrated in our survey of existing implementations, there are many variants and complete interoperability of these variants is not fully possible.

Recommendation 6: in order to perform the federated query and to assemble the return records, a set of common minimal requirements shall be defined, with which each DAC OpenSearch inventory service shall comply.

The set of minimum requirements for the inventory service is defined from a survey of the main existing EO search services providing an OpenSearch interface. The results of the survey are reported in Annex 2. As an example, the common search arguments identified among these surveyed services are listed in **Error! Reference source not found.**.

Table 8: The common search arguments identified in a survey of EO search services.

Core (GeoSpatial Service)	{searchTerms} {geo:box}, {startIndex} {count}
Temporal Search core	{time:start} {time:end}

8.2 User perspective

Examples of data portals offering both catalogue and inventory services based on OpenSearch are widely available and illustrate the services that will be provided by the R/G TS:

- NASA : https://cmr.earthdata.nasa.gov/search/site/collections/directory/eosdis
- NASA : https://search.earthdata.nasa.gov/search
- NOAA : https://data.noaa.gov/onestop
- CNES/Copernicus : https://peps.cnes.fr/
- EUMETSAT/Copernicus : https://coda.eumetsat.int/

A detailed example of interaction with such a service in OpenSearch, for machine-to-machine search types, is presented in Annex 1.

8.3 Design recommendations

Collection discovery

Experience proved that metadata maintained independently at different places (in different catalogues) for the same items (description of collections) tend to quickly exhibit inconsistencies and information becomes quickly outdated and heterogeneous. We believe the metadata related to the description of GHRSST collections must be maintained solely by those developing and producing them. Similarly, the services provided on top of these data collections (distribution, visualization, etc...) must also be created and maintained by those providing these systems. To avoid duplication, we therefore recommend to host and maintain the description of all GHRSST data and services, and their associated search and discovery capabilities, at a single place, which does not prevent DACs to provide their own services providing some of these functions on the data they host.

Therefore a central catalogue will be hosted and operated at a single place. It will provide remote editing and publishing functions so that all GHRSST entities can populate and maintain the information on the data and services they are responsible for. This way, we ensure there is no duplicated definition of a GHRSST collection for instance and that the information is kept up to date.

Granule discovery

Maintaining a central inventory of all granules (data files) provided by all GHRSST producers would be a tedious and hardly maintainable task (as this would rapidly lead to inconsistencies with what is actually accessible at a particular provider) while not bringing much advantages in terms of user services.

Our recommendation is that each GHRSST DAC shall expose its own list of accessible granules through a public granule discovery web service (or **inventory**) following OpenSearch protocol (and a set of common search arguments described later). This web service shall be referenced in the collection level metadata (in the central GHRSST catalogue).

Note: the same granules may be accessible through different providers, each one exposing its own copy through its inventory web service: a single collection in the central catalogue can therefore reference one or several inventory services for this collection.

8.4 Design proof: GHRSST pilot project (2018-2019)

In order to validate these principles and assess the ability to implement the proposed system, a pilot project was developed by Ifremer, JPL/PO.DAAC and NOAA/NCEI, consisting in a small scale pilot of the envisaged federated search and discovery system, based on existing services already in place:

- A central catalogue editable and accessible by all partners: reusing Ifremer *Sextant* catalogue, used in various European projects such as SeaDataNet. It offers CSW interfaces and ISO 19139-3 compliant editable forms for entering new datasets.
- Existing granule search services compliant with OpenSearch provided by NASA and NOAA.

The pilot project demonstrated visually the potential of these services for human interaction and implemented example of federated granule queries (for instance returning aggregated results over datasets available at different DACs).

The results of the pilot project were demonstrated to the GHRSST Science Team at GHRSST XX (Evolution Of The R/GTS) prior to finalizing the R/G TS interface requirements and specifications.

9 Roadmap

The following sections provides the short and longer term actions to be performed in order to fully implement the new R/G TS. These are an indicative schedule and dependent on the start of the implementation activities:

- Jan/Feb 2020
  - Review the R/G TS architecture document with the GHRSST R/G TS task team.
  - Provide an additional scenario (or recipe) detailing the actions and workflow a data producer must fulfil before their dataset is accepted by GHRSST. The scenario will detail a review and decision process between the producer and the GHRSST R/G TS Task Team and GHRSST-PO rather than technical requirements.
- Feb 2020
  - Release the reviewed R/G TS document to existing DAC and data producer's (GDPs) points of contact.
  - Start implementation of GHRSST catalogue, to be completed by autumn 2020.
  - Start implementation of GHRSST inventory search service, to be completed by early 2021.
- GHRSST XXI
  - Kick off R/G TS implementation at DACs and GDPs.
  - Discuss production/usage metrics and archiving requirements.
- End 2020
  - Publish updated version of R/G TS architecture document including user feedback and new metrics & archiving requirements.

Annexe I: Full scenario using CSW and OpenSearch protocols

This scenario describes how a user would discover products (collections), search related granules using OpenSearch protocol and finally download them.

CSW and OpenSearch are more intended for machine-to-machine interfaces, for instance to set-up a periodic search and download of the latest data granules over a specific area. It is unlikely, that in real life, a user would interact directly this way with a discovery service, but it is rather what they would implement as a script (or what an on-the-shelf client would do for them). User web interfaces will be provided for human discovery.

A I.i: Catalogue search

There will be one single URL for the GHRSST catalogue of datasets and services, hosted and maintained by the GHRSST PO or alternative coordinating facility that can be used for instance to recover the list of GHRSST collections.

For instance, the following CSW query to CEOS/CWIC catalogue returns the list of products recorded in this catalogue:

curl -XGET
https://cwic.wgiss.ceos.org/cwicv1/discovery?service=CSW&request=GetCapabilities&version=2.0.2

Among the returned results, there are a few GHRSST collections, with their related metadata, such as this one (GHRSST RAMSSA L4):

```
...
<cwic:dataset id="C1215196632-NOAA_NCEI">
   <cwic:title>GHRSST Level 4 RAMSSA Australian Regional Foundation Sea Surface Temperature Analysis</cwic:title>
   <cwic:valids>
      <gmd:EX_GeographicBoundingBox>
         <gmd:westBoundingLongitude>
            <gco:Decimal>60</gco:Decimal>
         </gmd:westBoundingLongitude>
         <gmd:eastBoundingLongitude>
            <gco:Decimal>-170</gco:Decimal>
         </gmd:eastBoundingLongitude>
         <gmd:southBoundingLatitude>
            <gco:Decimal>70</gco:Decimal>
         </gmd:southBoundingLatitude>
         <gmd:northBoundingLatitude>
            <gco:Decimal>20</gco:Decimal>
         </gmd:northBoundingLatitude>
```

```
        </gmd:EX_GeographicBoundingBox>
        <gmd:EX_TemporalExtent>
            <gmd:extent>
                <gml:TimePeriod gml:id="tp_C1215196632-NOAA_NCEI">
                    <gml:beginPosition>2008-04-
01T00:00:00Z</gml:beginPosition>
                    <gml:endPosition>unknown</gml:endPosition>
                </gml:TimePeriod>
            </gmd:extent>
        </gmd:EX_TemporalExtent>
    </cwic:valids>
</cwic:dataset>
...
```

A I.ii: Inventory search

Knowing an OpenSearch granule inventory end-point, we can then query for instance the granules from 2009-01-01 to 2009-01-10. The following example is based on the existing CEOS/CWIC inventory and the OpenSearch syntax is slightly different from the one that will be implemented for the GHRSST Inventory Service but the logic is the same.

curl -XGET http://cwic.wgiss.ceos.org/opensearch/granules.atom?datasetId=C1215196632-NOAA_NCEI&timeStart=2009-01-01&timeEnd=2009-01-10&clientId=foo

Returns 9 found granules as seen in:

```
<opensearch:totalResults>9</opensearch:totalResults>
```

Look at the first returned granule description:

```
<entry>
    <title>C1215196632-NOAA_NCEI:GHRSST-ABOM-L4HRfnd-AUS-
RAMSSA_09km.20090102-ABOM-L4HRfnd-AUS-v01-fv02_0-RAMSSA_09km.nc.bz2</title>
    <id>http://cwic.wgiss.ceos.org/opensearch/granules.atom?uid=C1215196632
-NOAA_NCEI:GHRSST-ABOM-L4HRfnd-AUS-RAMSSA_09km.20090102-ABOM-L4HRfnd-AUS-
v01-fv02_0-RAMSSA_09km.nc.bz2</id>
    <dc:identifier>http://cwic.wgiss.ceos.org/opensearch/granules.atom?uid=
C1215196632-NOAA_NCEI:GHRSST-ABOM-L4HRfnd-AUS-RAMSSA_09km.20090102-ABOM-
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- ; , ; - Email: NODC.DataOfficer@noaa.gov - Phone: 301-713-3272 - FAX:
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<dc:date>2009-01-02/2009-01-03</dc:date>

<link title="Preview graphic" rel="icon" type="application/octet-
stream"
href="http://data.nodc.noaa.gov/las/ProductServer.do?xml=%3C%3Fxml+version%
3D%221.0%22%3F%3E%3ClasRequest+href%3D%22file%3Alas.xml%22%3E%3Clink+match%
3D%22%2Flasdata%2Foperations%2Foperation%5B%40ID%3D%27Plot_2D_XY_zoom%27%5D
%22%3E%3C%2Flink%3E%3Cproperties%3E%3Cferret%3E%3Cview%3Exy%3C%2Fview%3E%3C
land_type%3Edefault%3C%2Fland_type%3E%3Cset_aspect%3Edefault%3C%2Fset_aspec
t%3E%3Cmark_grid%3Eno%3C%2Fmark_grid%3E%3Ccontour_levels%3E%3C%2Fcontour_le
vels%3E%3Cfill_levels%3E%3C%2Ffill_levels%3E%3Ccontour_style%3Edefault%3C%2
Fcontour_style%3E%3Cpalette%3Edefault%3C%2Fpalette%3E%3Cdeg_min_sec%3Edefau
lt%3C%2Fdeg_min_sec%3E%3Cmargins%3Edefault%3C%2Fmargins%3E%3Cuse_graticules
%3Edefault%3C%2Fuse_graticules%3E%3Csize%3E0.5%3C%2Fsize%3E%3Cimage_format%
3Edefault%3C%2Fimage_format%3E%3Cinterpolate_data%3Efalse%3C%2Finterpolate_
data%3E%3Cexpression%3E%3C%2Fexpression%3E%3C%2Fferret%3E%3C%2Fproperties%3
E%3Cargs%3E%3Clink+match%3D%22%2Flasdata%2Fdatasets%2Fid-
b75979a55f%2Fvariables%2Fanalysed_sst-id-
b75979a55f%22%3E%3C%2Flink%3E%3Cregion%3E%3Cpoint+type%3D%22t%22+v%3D%2202-
Jan-2009%22%3E%3C%2Fpoint%3E%3Crange+type%3D%22y%22+low%3D%22-
70%22+high%3D%2219.964%22%3E%3C%2Frange%3E%3Crange+type%3D%22x%22+low%3D%22
60%22+high%3D%22189.948%22%3E%3C%2Frange%3E%3C%2Fregion%3E%3C%2Fargs%3E%3C%
2FlasRequest%3E&stream=true&stream_ID=plot_image"/>

<link title="HTTP" rel="enclosure" type="application/octet-stream"
href="http://data.nodc.noaa.gov/ghrsst/L4/AUS/ABOM/RAMSSA_09km/2009/002/200
90102-ABOM-L4HRfnd-AUS-v01-fv02_0-RAMSSA_09km.nc.bz2"/>

<link title="FTP" rel="enclosure" type="application/octet-stream"
href="ftp://ftp.nodc.noaa.gov/pub/data.nodc/ghrsst/L4/AUS/ABOM/RAMSSA_09km/
2009/002/20090102-ABOM-L4HRfnd-AUS-v01-fv02_0-RAMSSA_09km.nc.bz2"/>

<link title="THREDDS OPeNDAP" rel="enclosure" type="application/octet-
stream"
href="http://data.nodc.noaa.gov/opendap/ghrsst/L4/AUS/ABOM/RAMSSA_09km/2009
/002/20090102-ABOM-L4HRfnd-AUS-v01-fv02_0-RAMSSA_09km.nc.bz2.html"/>

<link title="THREDDS(TDS)" rel="enclosure" type="application/octet-
stream"
href="http://data.nodc.noaa.gov/thredds/catalog/ghrsst/L4/AUS/ABOM/RAMSSA_0
9km/2009/002/catalog.html?dataset=ghrsst/L4/AUS/ABOM/RAMSSA_09km/2009/002/2
0090102-ABOM-L4HRfnd-AUS-v01-fv02_0-RAMSSA_09km.nc.bz2"/>

```
    <link title="Live Access Server (LAS)" rel="enclosure"
type="application/octet-stream"
href="http://data.nodc.noaa.gov/las/ProductServer.do?xml=%3C%3Fxml+version%
3D%221.0%22%3F%3E%3ClasRequest+href%3D%22file%3Alas.xml%22%3E%3Clink+match%
3D%22%2Flasdata%2Foperations%2Foperation%5B%40ID%3D%27Plot_2D_XY_zoom%27%5D
%22%3E%3C%2Flink%3E%3Cproperties%3E%3Cferret%3E%3Cview%3Exy%3C%2Fview%3E%3C
land_type%3Edefault%3C%2Fland_type%3E%3Cset_aspect%3Edefault%3C%2Fset_aspec
t%3E%3Cmark_grid%3Eno%3C%2Fmark_grid%3E%3Ccontour_levels%3E%3C%2Fcontour_le
vels%3E%3Cfill_levels%3E%3C%2Ffill_levels%3E%3Ccontour_style%3Edefault%3C%2
Fcontour_style%3E%3Cpalette%3Edefault%3C%2Fpalette%3E%3Cdeg_min_sec%3Edefau
lt%3C%2Fdeg_min_sec%3E%3Cmargins%3Edefault%3C%2Fmargins%3E%3Cuse_graticules
%3Edefault%3C%2Fuse_graticules%3E%3Csize%3E0.5%3C%2Fsize%3E%3Cimage_format%
3Edefault%3C%2Fimage_format%3E%3Cinterpolate_data%3Efalse%3C%2Finterpolate_
data%3E%3Cexpression%3E%3C%2Fexpression%3E%3C%2Fferret%3E%3C%2Fproperties%3
E%3Cargs%3E%3Clink+match%3D%22%2Flasdata%2Fdatasets%2Fid-
b75979a55f%2Fvariables%2Fanalysed_sst-id-
b75979a55f%22%3E%3C%2Flink%3E%3Cregion%3E%3Cpoint+type%3D%22t%22+v%3D%2202-
Jan-2009%22%3E%3C%2Fpoint%3E%3Crange+type%3D%22y%22+low%3D%22-
70%22+high%3D%2219.964%22%3E%3C%2Frange%3E%3Crange+type%3D%22x%22+low%3D%22
60%22+high%3D%22189.948%22%3E%3C%2Frange%3E%3C%2Fregion%3E%3C%2Fargs%3E%3C%
2FlasRequest%3E"/>

    <summary type="text">Granule metadata for C1215196632-NOAA_NCEI:GHRSST-
ABOM-L4HRfnd-AUS-RAMSSA_09km.20090102-ABOM-L4HRfnd-AUS-v01-fv02_0-
RAMSSA_09km.nc.bz2</summary>

</entry>
```


It provides several URLs corresponding to different ways of accessing the granule, for instance an HTTP URL:


```
<link title="HTTP" rel="enclosure" type="application/octet-stream"
href="http://data.nodc.noaa.gov/ghrsst/L4/AUS/ABOM/RAMSSA_09km/2009/002/200
90102-ABOM-L4HRfnd-AUS-v01-fv02_0-RAMSSA_09km.nc.bz2"/>
```


that can be used to download the granule:

curl -XGET http://data.nodc.noaa.gov/ghrsst/L4/AUS/ABOM/RAMSSA_09km/2009/002/20090102-ABOM-L4HRfnd-AUS-v01-fv02_0-RAMSSA_09km.nc.bz2

Annexe II: Survey of existing inventory search services

In this section we look at existing implementations of OpenSearch inventory search services. The main goal is to identify the level of interoperability (and the discrepancies) between existing implementations, in particular identifying the core set of search keywords on which federated queries could be implemented and work. It serves also as a source of real-life examples for DACs having to implement their own service or GHRSST users wanting to explore and learn how to interact with such services. Table 9 lists the surveyed services, with their **granule discovery end-point** URL and the software used for implementation.

Table 9: The surveyed services, their granule discovery end-point URL, and the software used for implementation.

service	End-point URL example	Implementation
CWIC	http://cwic.wgiss.ceos.org/opensearch/datasets/osdd.xml?clientId=cwicClient	? (based on Elasticsearch)
Fedeo	http://geo.spacebel.be/opensearch/description.xml?parentIdentifier=ENVISAT.ASA.IMS_1P	?
PEPS (CNES)	https://peps.cnes.fr/resto/api/collections/S3/describe.xml	https://github.com/jjrom/resto
DataHub (ESA, EUMETSAT)	Not found online (invalid OpenSearch access?) Cf: https://coda.eumetsat.int/manual/CODA-user-manual.pdf	http://sentineldatahub.github.io/DataHubSystem/
EDGE (JPL/PODAAC)	Not tested	https://github.com/apache/incubator-sdap-edge

Commonly used OpenSearch extensions in these services are listed in Table 10 (W3 and OpenSearch standards in bold; community or project specific extensions are in normal font).

Table 10: Commonly used OpenSearch extensions in the surveyed services.

Namespace of extension	CWIC	Fedeo	PEPS
xmlns="http://www.w3.org/2005/Atom"	x		
xmlns:opensearch="http://a9.com/-/spec/opensearch/1.1/"	x		
xmlns:geo="http://a9.com/-/opensearch/extensions/geo/1.0/"	x	x	x
xmlns:georss="http://www.georss.org/georss"	x		
xmlns:dc="http://purl.org/dc/terms/"	x	x	

xmlns:time="http://a9.com/-/opensearch/extensions/time/1.0/"	x	x	x
xmlns:cwic="http://cwic.wgiss.ceos.org/opensearch/extensions/1.0/"	x		
xmlns:esipdiscover="http://commons.esipfed.org/ns/discovery/1.2/"	x		
xmlns:eo="http://a9.com/-/opensearch/extensions/eo/1.0/"		x	x

Table 11 shows the query template for **dataset discovery** (**catalogue**) returned by the surveyed service end-points:

Table 11: The query template for dataset discovery returned by the surveyed service end-points.

CWIC	`<os:Url type="text/html" rel="collection" params:method="GET" template="https://cmr.earthdata.nasa.gov/opensearch/collections.html?keyword={os:searchTerms?}&instrument={echo:instrument?}&satellite={eo:platform?}&boundingBox={geo:box?}&geometry={geo:geometry?}&placeName={geo:name?}&startTime={time:start?}&endTime={time:end?}&cursor={os:startPage?}&numberOfResults={os:count?}&offset={os:startIndex?}&uid={geo:uid?}&hasGranules={echo:hasGranules?}&isCwic={echo:isCwic?}&isGeoss={echo:isGeoss?}&isCeos={echo:isCeos?}&isEosdis={echo:isEosdis?}&provider={echo:provider?}&clientId=cwicsmart">`
Fedeo	`<Url indexOffset="1" pageOffset="1" rel="results" template="http://fedeo.esa.int/opensearch/request/?httpAccept=application/atom%2Bxml&parentIdentifier={eo:parentIdentifier}&query={searchTerms?}&startRecord={startIndex?}&startPage={startPage?}&maximumRecords={count?}&startDate={time:start?}&endDate={time:end?}&bbox={geo:box?}&name={geo:name?}&lat={geo:lat?}&lon={geo:lon?}&radius={geo:radius?}&uid={geo:uid?}&recordSchema={sru:recordSchema?}" type="application/atom+xml">`

From above, we can see that the only common search terms in granule level requests shared by each protocol, though with different naming, are those in Table 12.

Table 12: Common search terms in granule level requests.

	CWIC	**Fedeo**	**CNES/PEPS**
startPage Index number of the set of search results desired by the search client	`cursor={os:startPage?}`	`startPage={startPage?}`	`page={startPage?}`
startIndex Page number of the set of search results desired by the search client	`offset={os:startIndex?}`	`startRecord={startIndex?}`	`index={startIndex?}`

count Number of search results per page desired by the search client	`numberOfResults={os:count?`	`maximumRecords={count?}`	`maxRecords={count?}`
box	`geoBox={geo:box}`	`bbox={geo:box?}`	`box={geo:box?}`
start	`timeStart={time:start}`	`startDate={time:start?`	`startDate={time:start?}`
end	`timeEnd={time:end}`	`endDate={time:end?}`	`completionDate={time:end?}`

Annexe III: Example of a GHRSST metadata profile for a collection

This section proposes an ISO19115-3 compliant metadata profile for GHRSST products, as it would be defined in the GHRSST central catalogue and returned by a CSW query.

```
<?xml version="1.0" encoding="UTF-8"?>
<mdb:MD_Metadata  xmlns:mdb="http://standards.iso.org/iso/19115/-3/mdb/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:cat="http://standards.iso.org/iso/19115/-3/cat/1.0"
xmlns:gfc="http://standards.iso.org/iso/19110/gfc/1.1"
xmlns:cit="http://standards.iso.org/iso/19115/-3/cit/2.0"
xmlns:gcx="http://standards.iso.org/iso/19115/-3/gcx/1.0"
xmlns:gex="http://standards.iso.org/iso/19115/-3/gex/1.0"
xmlns:lan="http://standards.iso.org/iso/19115/-3/lan/1.0"
xmlns:srv="http://standards.iso.org/iso/19115/-3/srv/2.1"
xmlns:mas="http://standards.iso.org/iso/19115/-3/mas/1.0"
xmlns:mcc="http://standards.iso.org/iso/19115/-3/mcc/1.0"
xmlns:mco="http://standards.iso.org/iso/19115/-3/mco/1.0"
xmlns:mda="http://standards.iso.org/iso/19115/-3/mda/1.0"
xmlns:mds="http://standards.iso.org/iso/19115/-3/mds/2.0"
xmlns:mdt="http://standards.iso.org/iso/19115/-3/mdt/2.0"
xmlns:mex="http://standards.iso.org/iso/19115/-3/mex/1.0"
xmlns:mmi="http://standards.iso.org/iso/19115/-3/mmi/1.0"
xmlns:mpc="http://standards.iso.org/iso/19115/-3/mpc/1.0"
xmlns:mrc="http://standards.iso.org/iso/19115/-3/mrc/2.0"
xmlns:mrd="http://standards.iso.org/iso/19115/-3/mrd/1.0"
xmlns:mri="http://standards.iso.org/iso/19115/-3/mri/1.0"
xmlns:mrl="http://standards.iso.org/iso/19115/-3/mrl/2.0"
xmlns:mrs="http://standards.iso.org/iso/19115/-3/mrs/1.0"
xmlns:msr="http://standards.iso.org/iso/19115/-3/msr/2.0"
xmlns:mdq="http://standards.iso.org/iso/19157/-2/mdq/1.0"
xmlns:mac="http://standards.iso.org/iso/19115/-3/mac/2.0"
xmlns:gco="http://standards.iso.org/iso/19115/-3/gco/1.0"
xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:xlink="http://www.w3.org/1999/xlink"
xsi:schemaLocation="http://standards.iso.org/iso/19115/-3/mds/1.0
http://standards.iso.org/iso/19115/-3/mds/1.0/mds.xsd">
  <mdb:metadataIdentifier>
    <mcc:MD_Identifier>
      <mcc:code>
        <gco:CharacterString>b140eac4-ebfa-4d06-8285-
942e6aaedb77</gco:CharacterString>
      </mcc:code>
      <mcc:codeSpace>
```

```
        <gco:CharacterString>urn:uuid</gco:CharacterString>
      </mcc:codeSpace>
    </mcc:MD_Identifier>
  </mdb:metadataIdentifier>
  <mdb:defaultLocale xmlns:geonet="http://www.fao.org/geonetwork">
    <lan:PT_Locale id="EN">
      <lan:language>
        <lan:LanguageCode codeList="http://www.loc.gov/standards/iso639-2/"
codeListValue="eng" />
      </lan:language>
      <lan:characterEncoding>
        <lan:MD_CharacterSetCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
9_Schemas/resources/codelist/ML_gmxCodelists.xml#MD_CharacterSetCode"
codeListValue="utf8" />
      </lan:characterEncoding>
    </lan:PT_Locale>
  </mdb:defaultLocale>
  <mdb:parentMetadata          xmlns:geonet="http://www.fao.org/geonetwork"
uuidref="84ac5086-2b90-4cbb-97cd-f243f6fb1e5d" />
  <mdb:contact xmlns:geonet="http://www.fao.org/geonetwork">
    <cit:CI_Responsibility>
      <cit:role>
        <cit:CI_RoleCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
9_Schemas/resources/codelist/ML_gmxCodelists.xml#CI_RoleCode"
codeListValue="editor" />
      </cit:role>
      <cit:party>
        <cit:CI_Organisation>
          <cit:name>
            <gco:CharacterString>CERSAT Exploitation</gco:CharacterString>
          </cit:name>
          <cit:contactInfo>
            <cit:CI_Contact>
              <cit:address>
```

```
                <cit:CI_Address>
                  <cit:electronicMailAddress>
<gco:CharacterString>fpaf@ifremer.fr</gco:CharacterString>
                  </cit:electronicMailAddress>
                </cit:CI_Address>
              </cit:address>
            </cit:CI_Contact>
          </cit:contactInfo>
        </cit:CI_Organisation>
      </cit:party>
    </cit:CI_Responsibility>
  </mdb:contact>
  <mdb:dateInfo>
    <cit:CI_Date>
      <cit:date>
        <gco:DateTime>2019-08-07T11:24:29</gco:DateTime>
      </cit:date>
      <cit:dateType>
        <cit:CI_DateTypeCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
9_Schemas/resources/codelist/ML_gmxCodelists.xml#CI_DateTypeCode"
codeListValue="revision" />
      </cit:dateType>
    </cit:CI_Date>
  </mdb:dateInfo>
  <mdb:dateInfo xmlns:geonet="http://www.fao.org/geonetwork">
    <cit:CI_Date>
      <cit:date>
        <gco:DateTime>2018-03-31T19:13:30</gco:DateTime>
      </cit:date>
      <cit:dateType>
        <cit:CI_DateTypeCode    codeList="codeListLocation#CI_DateTypeCode"
codeListValue="creation" />
      </cit:dateType>
```

```
    </cit:CI_Date>
  </mdb:dateInfo>
  <mdb:metadataStandard xmlns:geonet="http://www.fao.org/geonetwork">
    <cit:CI_Citation>
      <cit:title>
        <gco:CharacterString>ISO 19115-3</gco:CharacterString>
      </cit:title>
    </cit:CI_Citation>
  </mdb:metadataStandard>
  <mdb:metadataLinkage xmlns:geonet="http://www.fao.org/geonetwork">
    <cit:CI_OnlineResource>
      <cit:linkage>

<gco:CharacterString>https://sextant.ifremer.fr/geonetwork/srv/eng//metadat
a/bdb4a75c-7c4c-4907-bc5b-341ba3eb9481</gco:CharacterString>
      </cit:linkage>
      <cit:function>
        <cit:CI_OnLineFunctionCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
9_Schemas/resources/codelist/ML_gmxCodelists.xml#CI_OnLineFunctionCode"
codeListValue="completeMetadata" />
      </cit:function>
    </cit:CI_OnlineResource>
  </mdb:metadataLinkage>
  <mdb:spatialRepresentationInfo
xmlns:geonet="http://www.fao.org/geonetwork" />
  <mdb:referenceSystemInfo xmlns:geonet="http://www.fao.org/geonetwork">
    <mrs:MD_ReferenceSystem>
      <mrs:referenceSystemIdentifier>
        <mcc:MD_Identifier>
          <mcc:code>

<gco:CharacterString>http://www.opengis.net/def/crs/EPSG/0/4326</gco:Charac
terString>
          </mcc:code>
          <mcc:description>
```

```
            <gco:CharacterString>WGS 84 (EPSG:4326)</gco:CharacterString>
          </mcc:description>
        </mcc:MD_Identifier>
      </mrs:referenceSystemIdentifier>
      <mrs:referenceSystemType>
        <mrs:MD_ReferenceSystemTypeCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
9_Schemas/resources/codelist/ML_gmxCodelists.xml#MD_ReferenceSystemTypeCode
" codeListValue="" />
      </mrs:referenceSystemType>
    </mrs:MD_ReferenceSystem>
  </mdb:referenceSystemInfo>
  <mdb:identificationInfo xmlns:geonet="http://www.fao.org/geonetwork">
    <mri:MD_DataIdentification>
      <mri:citation>
        <cit:CI_Citation>
          <cit:title>
            <gco:CharacterString>AVHRR on METOP-A Level 2P Sea Surface
Temperature at 1 km resolution</gco:CharacterString>
          </cit:title>
          <cit:alternateTitle>
            <gco:CharacterString>OSI-204</gco:CharacterString>
          </cit:alternateTitle>
          <cit:date>
            <cit:CI_Date>
              <cit:date>
                <gco:Date>2018-10-17</gco:Date>
              </cit:date>
              <cit:dateType>
                <cit:CI_DateTypeCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
9_Schemas/resources/codelist/ML_gmxCodelists.xml#CI_DateTypeCode"
codeListValue="creation" />
              </cit:dateType>
            </cit:CI_Date>
          </cit:date>
```

```
        <cit:editionDate>
          <gco:Date />
        </cit:editionDate>
        <cit:identifier>
          <mcc:MD_Identifier>
            <mcc:code gco:nilReason="missing">
              <gco:CharacterString />
            </mcc:code>
          </mcc:MD_Identifier>
        </cit:identifier>
      </cit:CI_Citation>
    </mri:citation>
    <mri:abstract>
      <gco:CharacterString>The European Organization for the Exploitation
of Meteorological Satellites (EUMETSAT), Ocean and Sea Ice Satellite
Application Facility (OSI SAF) is producing SST products in near realtime
from AVHRR/3 onboard Metop-A. Global AVHRR level 1b data are acquired at
Meteo-France/Centre de Meteorologie Spatiale (CMS) through the
EUMETSAT/EUMETCAST system. SST is retrieved from the AVHRR infrared channels
(3.7, 10.8 and 12.0 m) using a multispectral algorithm. Atmospheric profiles
of water vapor and temperature from a numerical weather prediction model,
together with a radiative transfer model, are used to correct the
multispectral algorithm for regional and seasonal biases due to changing
atmospheric conditions. This product is delivered at full resolution (about
1 km) in satellite swath projection as granules corresponding to 3 minutes
of acquisition. This allows a global coverage of the earth. The quality of
the products is monitored regularly by daily comparison of the satellite
estimates against buoy measurements. The product format is compliant with
the GHRSST Data Specification (GDS) version 2.


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by registering on the OSI SAF web site (http://www.osi-saf.org) in order to
get access to useful information, documentation and links, news, service
messages, and to the help desk.</gco:CharacterString>
    </mri:abstract>
    <mri:pointOfContact>
      <cit:CI_Responsibility>
        <cit:role>
```

```
            <cit:CI_RoleCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
9_Schemas/resources/codelist/ML_gmxCodelists.xml#CI_RoleCode"
codeListValue="principalInvestigator" />
          </cit:role>
          <cit:party>
            <cit:CI_Organisation>
              <cit:name>
                <gco:CharacterString>Meteofrance</gco:CharacterString>
              </cit:name>
              <cit:contactInfo>
                <cit:CI_Contact>
                  <cit:address>
                    <cit:CI_Address>
                      <cit:electronicMailAddress>

<gco:CharacterString>stephane.sauxpicart@meteo.fr</gco:CharacterString>
                      </cit:electronicMailAddress>
                    </cit:CI_Address>
                  </cit:address>
                </cit:CI_Contact>
              </cit:contactInfo>
              <cit:individual>
                <cit:CI_Individual>
                  <cit:name>
                    <gco:CharacterString>Stéphane                    Saux-
Picart</gco:CharacterString>
                  </cit:name>
                </cit:CI_Individual>
              </cit:individual>
            </cit:CI_Organisation>
          </cit:party>
        </cit:CI_Responsibility>
      </mri:pointOfContact>
      <mri:pointOfContact>
```

```
        <cit:CI_Responsibility>
          <cit:role>
            <cit:CI_RoleCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
9_Schemas/resources/codelist/ML_gmxCodelists.xml#CI_RoleCode"
codeListValue="pointOfContact" />
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Desk</gco:CharacterString>
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saf.helpdesk@meteo.fr</gco:CharacterString>
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              </cit:contactInfo>
            </cit:CI_Organisation>
          </cit:party>
        </cit:CI_Responsibility>
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9_Schemas/resources/codelist/ML_gmxCodelists.xml#CI_RoleCode"
codeListValue="distributor" />
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            <cit:party>
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                </cit:name>
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                  <cit:CI_Contact>
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                      <cit:CI_Address>
                        <cit:electronicMailAddress>
<gco:CharacterString>cersat@ifremer.fr</gco:CharacterString>
                        </cit:electronicMailAddress>
                      </cit:CI_Address>
                    </cit:address>
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          </cit:CI_Responsibility>
        </mri:pointOfContact>
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codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
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9_Schemas/resources/codelist/ML_gmxCodelists.xml#CI_RoleCode"
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                    <gco:CharacterString />
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      <mri:spatialRepresentationType>
        <mcc:MD_SpatialRepresentationTypeCode
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peCode" codeListValue="grid" />
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</mri:temporalResolution>
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</mri:topicCategory>
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        </gex:westBoundLongitude>
        <gex:eastBoundLongitude>
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        </gex:eastBoundLongitude>
        <gex:southBoundLatitude>
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        </gex:southBoundLatitude>
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                  <gml:beginPosition>2007-11-26</gml:beginPosition>
                  <gml:endPosition     indeterminatePosition="now">2016-11-
23</gml:endPosition>
                </gml:TimePeriod>
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b140eac4-ebfa-4d06-8285-942e6aaedb77/attachments/20120627-EUR-L2P_GHRSST-
SSTsubskin-AVHRR_METOP_A.png</gco:CharacterString>
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          <mri:type>
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features</gco:CharacterString>
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codeListValue="theme" />
          </mri:type>
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1.0</gco:CharacterString>
              </cit:title>
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d?ref=external.theme.httpinspireeceuropaeutheme-
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theme</gcx:Anchor>
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              </cit:identifier>
            </cit:CI_Citation>
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codeListValue="theme" />
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Parameter</gco:CharacterString>
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                  </cit:date>
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d?ref=local.theme.cersat_parameter">geonetwork.thesaurus.local.theme.cersat
_parameter</gcx:Anchor>
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codeListValue="theme" />
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                <cit:title>
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Dparameter</gcx:Anchor>
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      </mri:descriptiveKeywords>
      <mri:descriptiveKeywords>
        <mri:MD_Keywords>
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Imagery</gco:CharacterString>
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codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_1913
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9_Schemas/resources/codelist/ML_gmxCodelists.xml#MD_KeywordTypeCode"
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theme</gcx:Anchor>
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9_Schemas/resources/codelist/ML_gmxCodelists.xml#MD_KeywordTypeCode"
codeListValue="theme" />
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level</gco:CharacterString>
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9_Schemas/resources/codelist/ML_gmxCodelists.xml#CI_DateTypeCode"
codeListValue="publication" />
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              </cit:date>
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val.ifremer.fr/geonetwork/srv/eng/thesaurus.download?ref=external.theme.cer
sat_processing_level">geonetwork.thesaurus.external.theme.cersat_processing
_level</gcx:Anchor>
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codeListValue="validityBegins" />
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codeListValue="validityExpires" />
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codeListValue="otherRestrictions" />
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          <mco:otherConstraints>
            <gco:CharacterString>All intellectual property rights of the OSI
SAF products belong to EUMETSAT. The use of these products is granted to
every interested user, free of charge. If you wish to use these products,
EUMETSAT's copyright credit must be shown by displaying the words "copyright
(year) EUMETSAT" on each of the products used.</gco:CharacterString>
          </mco:otherConstraints>
          <mco:otherConstraints>
            <gco:CharacterString>Registration needed</gco:CharacterString>
          </mco:otherConstraints>
        </mco:MD_LegalConstraints>
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        <mri:MD_AssociatedResource>
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              <cit:title>
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2019</gco:CharacterString>
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            </cit:CI_Citation>
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9_Schemas/resources/codelist/ML_gmxCodelists.xml#DS_AssociationTypeCode"
codeListValue="" />
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    <mrc:attributeDescription>
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    </mrc:attributeDescription>
    <mrc:processingLevelCode>
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        </mcc:code>
        <mcc:version gco:nilReason="missing">
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Meteo-France/Centre de Meteorologie Spatiale (CMS) through the
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(3.7, 10.8 and 12.0 micrometer) using a multispectral algorithm. Atmospheric
profiles of water vapor and temperature from a numerical weather prediction
model, together with a radiatiave transfer model, are used to correct the
multispectral algorithm for regional and seasonal biases due to changing
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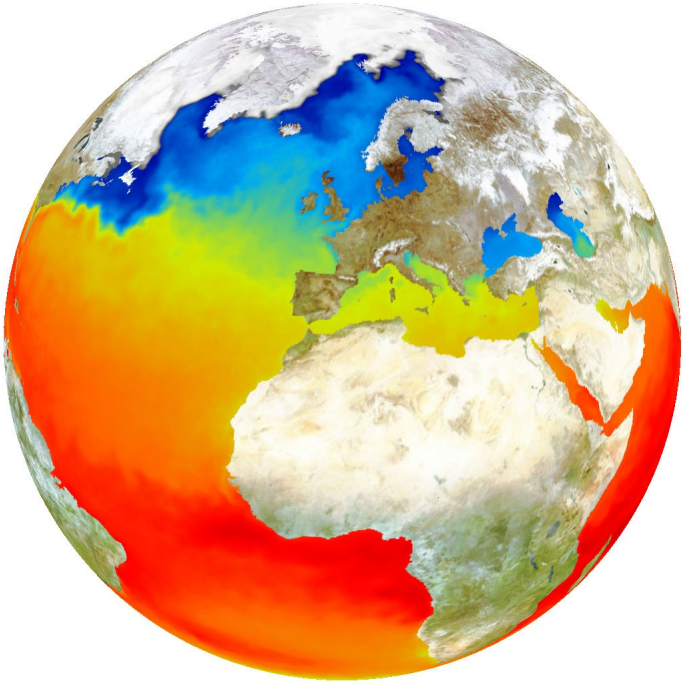
How to find out more about GHRSST:

A complete description of GHRSST together with all project documentation can be found on the GHRSST website at https://www.ghrsst.org



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