Data Management in the Coastal Observing System COSYNA

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The Coastal Observing System for Northern and Arctic Seas COSYNA has the aim to obtain a synoptic description of the key state variables of coastal seas and their physical, chemical and ecological drivers and responses. A comprehensive, synoptic picture of the North Sea is achieved by a network of in situ observations, remote sensing, and coastal predictions systems, and by melding data and numerical models. COSYNA will apply methods that have been tested and proved in the North Sea to coastal waters in the Arctic regions. Some of the COSYNA observation platforms are depicted in Fig. 1.

![COSYNA observation platforms](image)

**Fig. 1:** COSYNA observation platforms.

The workflow of measured data is shown in Fig. 2. Depending on the type of data the observational data are formatted either as Oracle database record in the case of time-series data or as netCDF file in the case of gridded data. The automatic checks applied in near real-time are depicted as QCPO (quality control pre operational) whereas the full quality control (QC) will be applied in delayed mode. Direct access to time-series data is offered using
OGC’s Sensor Observation Service (SOS) GetObservation-command URL. NetCDF files were created CF\textsuperscript{1} compliant with some additional COSYNA specific global attributes.

**Fig. 2: Workflow of observational data**

The creation of metadata is shown in Fig. 3. For every COSYNA platform a metadata record is created which contains information about the sensors, the parameters including estimated accuracies and the mapping of the internal sensor parameters to CF standard names. Also information about the principle spatial coverage as well as the start and stop time is stored there.

**Fig. 3: Creation of metadata.**

\textsuperscript{1} Climate-Forecast conventions: http://cf-pcmdi.llnl.gov/documents/cf-conventions/1.5/cf-conventions-multi.html
The metadata about sensors are not yet linked to SensorML and to the DescribeSensor request of SOS. This will be realised in forthcoming versions. The scheme for platform metadata is a development by German agencies (Lehfeldt, Reimers 2009) and is not yet included into ISO19115.

COSYNA platform metadata are also created for models. The model at a glance is described by the platform method. Input parameters needed to drive the model are summarised into a sensor named ‘input’. The calculated parameters are summarised into a sensor named ‘output’.

For every platform a mapping of CF standard names to the internal sensor parameter name is defined. Only the CF standard names are used internally.

Beside the platform metadata with information about platforms, sensors and parameters, metadata are created to describe the observations of a platform or the calculated parameters of a model. For fixed in-situ platforms one metadata record describes the whole time series measured at that platform. Observations at moving platforms like ships and remote sensing platforms need a single metadata record per observation. These metadata are created in near-realtime using automatically started Java code to combine the manually edited static templates for data from these platforms with dynamically metadata read from the recent observations. Every new model run is treated similarly.

COSYNA consists currently of about 30 platform metadata records and about 7000 metadata records describing data. These metadata records are read by Geoserver WFS\(^2\) to communicate the metadata to the COSYNA data portal named CODM. In principle other portals could read these metadata as well. A project called MaNIDA\(^3\) is started in August 2011, which will use these methods.

The data describing metadata are fully ISO19115 and INSPIRE compliant. For a research project like COSYNA such compliances aren’t necessary but standardisation helps and simplifies future construction of interoperable systems. Moreover as COSYNA's mission is to develop and test analysis systems for monitoring purposes German monitoring agencies like BSH might adapt or take parts of the systems for their tasks. For these agencies the INSPIRE compliance is needed.

A new development by COSYNA is that web-service URLs are part of the metadata. This means that for every parameter of every data describing record a set of URLs exist which calls the web service for downloading, chart display if appropriate, map display if appropriate and metadata display of this special data. Because this URL links direct to the chart, map or download no particular description of the web services as service is needed inside the metadata.

The concept of data management and user interaction in COSYNA is shown in Fig. 4. The access to metadata from the portal is provided using an OGC WFS which is automatically synchronised with the metadata stored in the database as described above. All parts of this modular concept are interchangeable. Instead of CODM portal another portal could access

\(^2\) OGC’s Web Feature Service created by the Open Source software tool Geoserver http://geoserver.org/

\(^3\) Marine Network for Information and Data Access
data and metadata. The WFS could be fed by another metadata system and the stored web service URLs could link to different web services.

![Diagram of COSYNA data management and interaction with users](image)

**Fig. 4:** Modular concept of the COSYNA data management and the interaction with users.

The challenge for COSYNA data management is to create an integrated view of data independent of the data type. The modular concept with function oriented web services is the answer to that challenge. Every data point from COSYNA could be downloaded by a web service. This download service is OPeNDAP (Cornillon 2009) for data stored in netCDF format or SOS for database stored data. An OGC WMS\(^4\) is used to create maps of the data. This WMS is ncWMS (Blower 2009) for netCDF based data and a COSYNA developed java servlet for time integrated database data of transects. The standard WMS makes it possible to combine the maps of different sources into an integrated map. An example of such an integrated map is shown in Fig. 5.

A display of data versus time called chart display is used for data from fixed platforms as well as for data of moving platforms.

As mentioned above the SOS web service is used primarily as download service by the GetObservation-command for data stored in the database. Until now there is no connection between the COSYNA metadata and the metadata obtained by SOS-DescribeSensor. The

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\(^4\) Web Mapping Service
SensorML (SensorML 2007) response of DescribeSensor is produced with the internal parameter names and other independent information from the database.

In near future we will produce the SensorML response from the metadata directly leading to standard names as parameter names. In addition it is planned to use the OGC SWE (SWE 2006) framework for integrating new sensors into COSYNA. In that case we will use SOS directly at the sensors.

![Maps for chlorophyll-a (mg/m^3)](image)

**Fig. 5:** Comparison of Chlorophyll-a values obtained from Remote Sensing and with in-situ fluorescence measurements around May 1st 2011.

The entry page of the CODM portal\(^5\) is presented in Fig. 6. Due to the parameter orientation of the CODM portal the user has first to select a parameter and the time region. In a forthcoming version the parameters will be grouped together into several categories like meteorology, bio-geochemical parameters, wind and waves. The parameter names are CF standard names in the actual version. If the standard name is very long or too complicated an easier name is used which is well known in the community.

With the selection of the shown map the spatial search region is defined. All platforms located in the selected map region, gathering the selected parameter during the selected time regions were shown in the list and were marked in the map. Moving the mouse above a single platform will highlight the platform in the map.

\(^5\) http://kofserver2.hzg.de/codm/
Fig. 6: The CODM portal entry page with its main elements explained.

With a click on the icon on the left of the platform name, the most interesting platform metadata including the sensor information are shown. The integration of the depth as searchable coordinate will come with the forthcoming version. Then it will be possible to select the data quality of the data shown by the CODM portal. With “Get Data” all metadata records describing the data are requested. This is shown in Fig. 7.

The icons ![icon] ![icon] ![icon] ![icon] have following meanings from left to right: Displaying the data as map, displaying as chart plot, data download and displaying metadata. Map display or chart display may be greyed out if not appropriate.

In case of netCDF files the icons change to ![icon] ![icon] ![icon]. The leftmost icon still reflects a map display but for netCDF files this icon leads to Godiva2 the user interface of ncWMS, which is outside the direct scope of the CODM portal. With the “Show map” or “Show charts” buttons on the bottom of Fig. 7 all

Fig. 7: Result of a search for Chlorophyll-a in the German bight between the 1.7.2011 and the 6.7.2011
selected and appropriate data are combined in a window with maps (like Fig. 5) or in a window with chart plots.

A result of COSYNA’s aim to integrate observations with models is presented in Fig. 8 also showing the Godiva2 user interface (Blower 2009) of ncWMS.

![Godiva2 interface](image)

**Fig. 8:** Godiva2 user interface showing reanalysed water currents originating from the data assimilation of measured HF-Radar currents into the Getrm (Burchard 1999) model.

### Summary and Outlook

Data management in COSYNA supports the integrated and synoptic view of COSYNA. But there are still some open issues to fulfil the main requirements by the users. The ability to search for data in 3 dimensions is already mentioned. Also mentioned is the grouping of parameters into categories for the CODM portal. The next version of data management will handle quality flags transparently for the user. The user may select if all data are shown or for example only data with the quality flags “probably good data” and better. This selection will be used for map displays and chart plots. Data download always includes all data qualities but also the values of the quality flag.

For the downloads 2 different versions will be possible: A direct download for binary netCDF files or SOS results as xml-file and an ASCII download which is more human readable.

It will be possible to configure the map results. Layers could get switched on and off and some features of Godiva2 will be integrated into the CODM portal. With a time slider the maps could be varied within the selected time region. User selected fixed platforms will be marked in the map display and it will be possible to compare the time series of netCDF files at the location of the fixed platform with the time series of this fixed platform.
Nevertheless the CODM portal will remain as a search and display tool for COSYNA. Any further analysis should be done offline with optimised user tools. The main aspect of the CODM portal is the integrated view on data from different sources. A user interested in only one type of data should use the special portals for time series, Ferryboxes and remote sensing data, which remain accessible. The COSYNA data management will be part of the German MaNIDA project which aims for a ‘German Marine Research Data Portal’.

References


