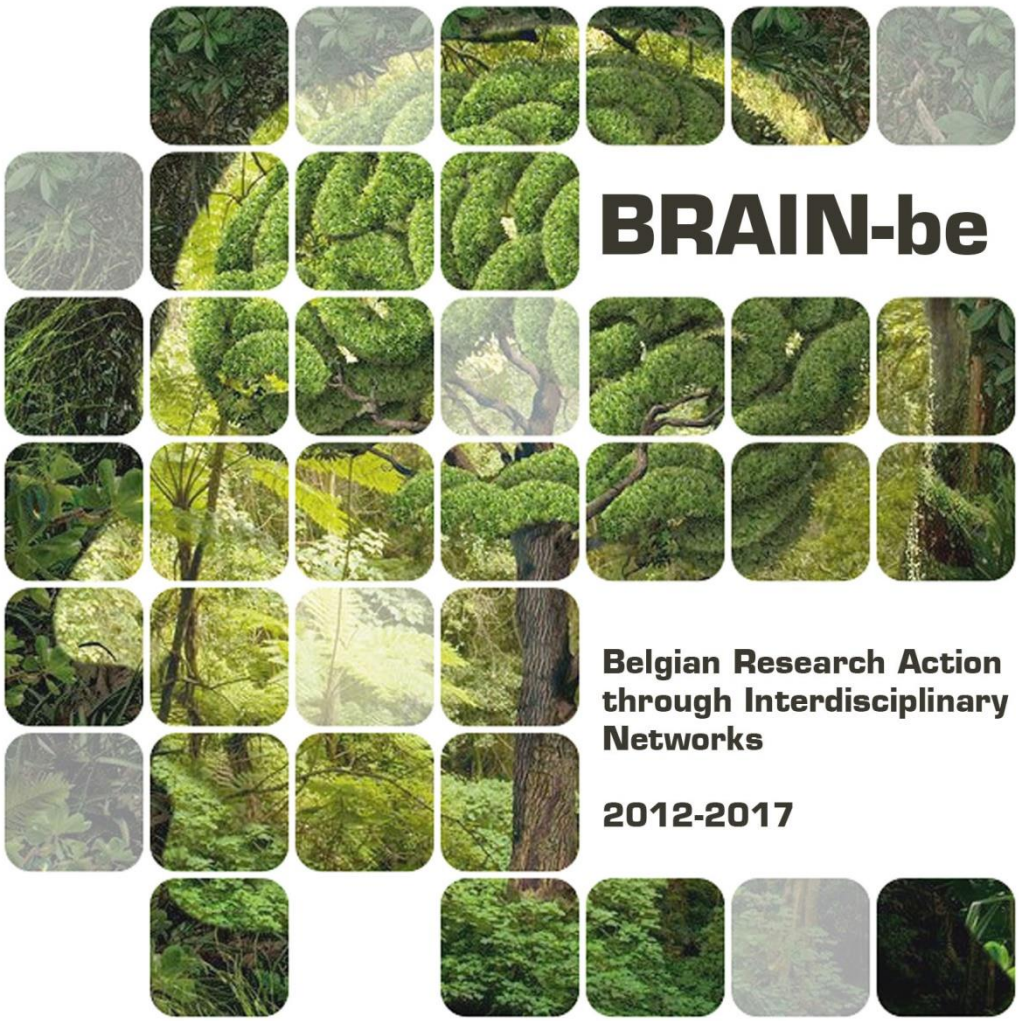

PAMIR

A Portal to Atmospheric and Marine Information Resources

Anne De Rudder (Royal Belgian Institute for Space Aeronomy) – Serge Scory (Royal Belgian Institute of Natural Sciences) – Roeland Van Malderen (Royal Meteorological Institute of Belgium) – Yves Christophe (Royal Belgian Institute for Space Aeronomy) – Thomas Vandenberghe (Royal Belgian Institute of Natural Sciences) – Jean-Christopher Lambert (Royal Belgian Institute for Space Aeronomy) – Maryna Lukach (Royal Meteorological Institute of Belgium)

Axis 6: Management of collections

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NETWORK PROJECT

PAMIR

A Portal to Atmospheric and Marine Information Resources

Contract - BR/132/A6/PAMIR

FINAL REPORT

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ABSTRACT

Context

The Global Earth Observation System of Systems (GEOSS) aims at providing decision makers worldwide with a wide range of information and decision-supporting tools in nine societal benefit areas (SBA), namely disasters, energy, agriculture, biodiversity, ecosystems, health, climate, water and weather. Europe contributes to the GEOSS through the European Global Satellite-Based Navigation System Galileo, the Programme for the Establishment of a European Capacity for Earth Observation Copernicus, and the Infrastructure for Spatial Information in the European Community INSPIRE.

A key driving factor of the PAMIR project, the INSPIRE Directive applies to any dataset in electronic format which possesses a geographic extent or is related to some geographic location. Its double objective is to harmonise such datasets over the European continent and to make them available to the community (citizens, administrations, environment agencies, universities, research institutions, hospitals, doctors, policy makers, etc.) all over Europe, through a network of information facilities. The many data themes targeted by INSPIRE include atmospheric conditions, meteorological geographical features and oceanographic geographic features.

Objectives

PAMIR aimed at exploring common and specific aspects of atmospheric and oceanographic data validation and documentation in order to generate harmonised practice guidelines and tools in compliance with international standards. Its objectives included the elaboration of a metadata scheme virtually applicable to any scientific atmospheric or oceanographic dataset, with the purpose of providing Belgian federal scientific institutes with a consistent common framework to document such data holdings and to comply with their reporting obligations set by the applicable European directives.

It is in the nature of terrestrial physical processes to deploy themselves in the full four-dimensional spatiotemporal space. Variables describing the oceans and atmosphere extend along time and the vertical as much as over horizontal dimensions. The pressure gradient along the vertical is one of the major triggers of movement and chemical transformation of water and air masses at large scales. As for time, it is embedded in the notions of movement and transformation themselves. Moreover, by definition, monitoring changes in the Earth system (e.g. climate change) implies taking time into consideration. Based on actual examples, this project explored current possibilities of representing fully 4-dimensional Earth datasets, or datasets essentially depending on the vertical and/or on time, in the INSPIRE formalism, primarily designed to support the representation of data depending on longitude and latitude.

Methodology

Work was divided into the following tasks:

(1) Inventory the resources and practices in use in each partner's community.
(2) Derive common principles and identify domain-specific features.
(3) Build up an appropriate common conceptual scheme and map it to international standards.
(4) Test the validity of the scheme against use cases.
(5) Design and develop a practical instrument underpinned by the conceptual scheme (this task ended up to be replaced by the investigation of existing tools and the selection of one of them).
(6) Integrate the tool to the project website and populate it with examples.

Results

PAMIR has shown the ability of the ISO 19115 norm for geographic metadata to fit the needs of the atmospheric and oceanographic communities in Belgium. The INSPIRE implementing rules based on ISO 19115 leave open the possibility to make use of the full standard, only formulating guidance for the elements pertaining to the INSPIRE Regulation. Metadata elements of a general atmospheric metadata theoretical model have been mapped to the ISO 19115 standard, showing that the latter, already widely used by the marine community, is fit for purpose for air, meteorology and climate data.

PAMIR has investigated practical tools to edit and catalogue metadata. Based on various criteria, GeoNetwork was identified as the best suited existing instrument to document ocean and atmosphere datasets of the partners' institutes in an INSPIRE-compliant way. A deliverable of the project, the GeoNetwork multi-task tool was implemented and tested against example datasets, and was integrated to the project website at http://pamir.aeronomie.be/.

The project fostered the partner institutes' capacity to comply with their reporting duties set by the INSPIRE Monitoring and Reporting Decision and, for the marine environment, by the Marine Strategy Framework Directive.

Keywords

Interoperability / Metadata / Quality / Spatial data infrastructure

1. INTRODUCTION

Through linking together Earth observing systems around the world, the Global Earth Observation System of Systems (GEOSS), under the umbrella of the Group on Earth Observations (GEO), aims at providing decision makers worldwide with a wide range of information and decision-supporting tools in nine *societal benefit areas* (SBA), namely disasters, energy, agriculture, biodiversity, ecosystems, health, climate, water and weather. Europe contributes to the GEOSS through programmes of a wide stature: the European Global Satellite-Based Navigation System Galileo, the Programme for the Establishment of a European Capacity for Earth Observation Copernicus, and the Infrastructure for Spatial Information in the European Community INSPIRE.

A key driving factor of the PAMIR project, the INSPIRE Directive (EC, 2007) entered into force in 2007. Its scope includes any dataset which possesses a geographic extent or is related to some geographic location. Its double objective is to harmonise such datasets over the European continent and to make them available to the community (citizens, administrations, environment agencies, universities, research institutions, hospitals, doctors, policy makers, etc.) all over Europe, through a network of information facilities. The *data themes* targeted by INSPIRE, of a wide diversity, are listed in three annexes to the Directive. Items 13, 14 and 15 of Annex III are respectively *atmospheric conditions*, *meteorological geographical features* and *oceanographic geographic features*. The INSPIRE Directive is completed by a series of regulations, implementing rules (IR) and technical guidance documents addressing practical aspects of datasets and associated services.

PAMIR has endeavoured to bring its stone to this edifice by developing a metadata scheme and implementing and testing a multi-task online tool compatible with the INSPIRE requirements. Initially a chapter of the project proposal, harmonisation of data validation procedures did not lead to the establishment of a common formal protocol, partly challenged by the fundamentally different conditions and practice applying to marine and atmospheric data collection, partly due to staffing issues that forced the partners to reframe their objectives so as to focus on metadata. The project improved and fostered the partner institutes' capacity to comply with their reporting duties set by the INSPIRE Monitoring and Reporting Decision (EC, 2009) and, for the marine environment, which falls directly under the responsibility of the federal government, by the Marine Strategy Framework Directive (EC, 2008a).

2. STATE OF THE ART AND OBJECTIVES

In the prospective of GEOSS, data quality, validation, documentation and cataloguing are essential. Driven by the wish to enable users to assess the extent to which some given scientific information is *fit for purpose*, the Quality Assurance Framework for Earth Observation (QA4EO), endorsed by the Committee on Earth Observation Satellites (CEOS), contributes to this endeavour by striving for harmonisation and dissemination of best practices in use in the Earth Observation (EO) communities, and by providing guidance in this area. The QA4EO consists of seven distinct very general key guidelines linked through an overarching document, the QA4EO Principles (QA4EO task team, 2010). The guidelines are meant to apply to any collected (or computed) Earth science data.

While the INSPIRE Interoperability Regulation (EC, 2010) specifies which services are expected to support data distribution and which conditions they must meet, the INSPIRE Metadata Regulation (EC, 2008b), of particular interest for this project, defines the minimum mandatory information (or *metadata*) expected to be provided along with any dataset. The Metadata Regulation is complemented by technical Data Specifications specific to each INSPIRE data theme.

The purpose of the PAMIR project was to explore common and specific aspects of atmospheric and oceanographic data validation and documentation in order to generate harmonised practice guidelines and tools in compliance with the above international standards. Its objectives included the elaboration of a validation protocol and a metadata scheme virtually applicable to any scientific atmospheric or oceanographic dataset, with the purpose of providing Belgian federal scientific institutes with a consistent common framework to validate and document such data holdings. Apart from very general approaches such as the QA4EO and INSPIRE guidelines, no known attempt to harmonise marine and atmospheric validation and documentation had been tried previously.

It is in the nature of terrestrial physical processes to deploy themselves in the full four-dimensional spatiotemporal space. Variables describing the oceans and atmosphere extend along time and the vertical as much as over horizontal dimensions. The pressure gradient along the vertical is one of the major triggers of movement and chemical transformation of water and air masses at large scales. As for time, it is embedded in the notions of movement and transformation themselves. Moreover, by definition, monitoring changes in the Earth system (e.g. climate change) implies taking time into consideration. An objective of the project was to explore possibilities of representing fully 4-dimensional Earth datasets, or datasets essentially depending on the vertical and/or on time, in the INSPIRE formalism, primarily designed to support the representation of data depending on longitude and latitude.

Previous work to set up protocols touching the subjects tackled in PAMIR had been carried out in the two communities separately.

In atmospheric and climate sciences, validation methods and protocols had been – and continue to be – elaborated and improved in the framework of European projects that have supported the making of the Copernicus Atmosphere and Climate Services CAMS and C3S.

Such projects include the ESA GMES Service Element projects PROMOTE (2004-06) and PROMOTE2 (2006-09), and the EU FP7 and H2020 projects GEMS (2005-09), GEOMon (2007-11), MACC (2009-11), EVOSS (2010-13), PASODOBLE (2010-13), MACCII (2011-14), NORS (2011-14), MACCIII (2014-15), QA4ECV (2014-17), GAIA-CLIM (2015-18). The EU FP7 project CLIPC (2013-16) also addressed issues related to the computation and provision of quality indicators (QI) – e.g. uncertainties – and the definition of quality metrics, especially in relation to communication to the public. Quality-wise, the focus of these scientific projects, which all referred to the QA4EO principles, was not only the quality of the numerical data – related to the provision of information on the retrieval algorithms and of estimators of the data "closeness to truth" – and the quality of the datasets (completeness, continuity, transportability), but also the quality of the documentation accompanying the data (i.e. the metadata) and the quality of the associated services (e.g. timely delivery, availability of comparison or statistical tools, etc.).

Ocean science has an early tradition of developing metadata compliant with international geographic standards and has taken the INSPIRE rules on board at an early stage. Highly concerned by interoperability, the SeaDataNet project (Pan-European Infrastructure for Ocean and Marine Data Management) has adopted the ISO 19115 geographic metadata standard for its directories (see Annex) and has set up its own quality control and flagging protocols.

3. METHODOLOGY

The project initial methodology was

(1) to inventory resources and practices in use in each partner's community;

(2) to derive common principles applicable to the considered fields of research and identify domain-specific features;

(3) to build up consistent conceptual systems compliant with international standards;

(4) to test the validity of these systems against use cases;

(5) to design and develop practical instruments underpinned by these conceptual systems;

(6) to integrate these into the project web portal.

Regarding metadata, the project followed the outlined methodology rather faithfully. Regarding validation, it soon met obstacles inherent to the difference in technical collection methods applied in ocean and atmosphere sciences (see next section).

4. SCIENTIFIC RESULTS AND RECOMMENDATIONS

After overviewing their respective data validation practices in WP2 (Data validation and model evaluation), the project partners came to the conclusion that, due to the different collection techniques and associated orders of magnitude of collected data amounts, except very general principles already enunciated in documents such as the QA4EO guidelines, too few “common principles applicable to the considered fields of research” could be identified and compiled into a common validation protocol. In atmospheric science, error and uncertainty analysis also benefits from older interest and expertise than it does in oceanography. It appeared that the hope to come up with a common protocol (Task 2.3) was not realistic in the framework of a project of the size of PAMIR.

The project therefore concentrated on metadata (WP3), on data cataloguing (WP4) and on INSPIRE data reporting, not initially a project task.

Practical deliverables include the project website (http://pamir.aeronomie.be/) and its integrated INSPIRE-compliant metadata editor and catalogue (WP5). Some examples of marine, meteorological and atmospheric datasets have been documented in the catalogue in order to test its functionality.

We have detailed the methodology and the outcome of Work Packages 3, 4 and 5 in the Annex, with an emphasis on WP 3.

Below is a summary of the work done and the conclusions. Since the project gave rise to additional initiatives that were not planned in the proposal but are closely connected to PAMIR (INSPIRE monitoring and reporting, internal documentation projects), these are also reported below.

Metadata and catalogue

The PAMIR project has shown the feasibility of the ISO 19115 norm[1] to fit the metadata needs of the atmospheric and oceanographic communities in Belgium. A quality metadata scheme should go beyond discovery and usage metadata, namely fields and elements that identify the data by what it is about (both in general and specific terms), which variables it measures, when, where and how this was done, who the involved parties and projects are, where and how the data files themselves can be found, and how the data can be read once accessed. It should also inform users on how the data has been processed, what its origins are, what general and specific quality measures have been taken and it should do this preferably for each variable. A metadata scheme should try not to sacrifice depth of meaning for thematic broadness and its fields and its elements should be chosen to be as generic as possible without leaving accuracy.

[1] The ISO 19115-1:2014 standard defines the ISO schema to describe geographic information and services by means of metadata. It provides information about the identification, the extent, the quality, the spatial and temporal aspects, the content, the spatial reference, the portrayal, distribution, and other properties of digital geographic data and services. https://www.iso.org/standard/53798.html

At first glance the mandatory metadata fields of the INSPIRE Metadata Regulation (EC, 2008b) do not do justice to metadata, but the implementing rules based on ISO 19115 leave open the possibility to make use of the full ISO standard, only formulating guidance for the elements pertaining to the Regulation. During the course of the project, metadata elements wished for by the IASB-BIRA and RMIB, and published in the PASODOBLE metadata model (De Rudder, 2011), have been mapped to the ISO 19115 standard as much as possible. The mapping has revealed that the ISO 19115 standard is fit for purpose for PASODOBLE. Through previous projects BMDC is associated in (notably SeaDataNet), the marine community acknowledges the usability of the ISO standard. We have made the following observations:

- Around 20% of the fields in the PASODOBLE Model cannot be modeled in ISO 19115; their priority has to be assessed;
- All the larger entities emphasised in PASODOBLE can be modeled in ISO 19115:
    - Service metadata, both separate from and within a data metadata document
    - Quality metadata is repeatable, typable (eg. Format consistency, topological consistency and many others) and referenceable (citation to the evaluation procedure) for each quality procedure taken. Confidence interval information cannot be stored atomically and without ambiguity (ie. outside of free text boxes)
    - With regard to Lineage metadata, ISO can state each process step (with a.o. the responsible parties associated) and it is more flexible than PASODOBLE in this respect;
- The ISO model is found to be lacking with regard to the quality per dependent variable, but several solutions exist, some of which are complicated (the use of Coverages) or warrant an extension with a community profile (cf. the Marine Community Profile). More specifically, no fields specifically denoting confidence levels per variable have been found in the ISO 19115 standard;
- The ISO model adequately describes the independent variables;
- Sometimes the ISO model provides other fields, that may be as relevant for discovery, usage, quality or lineage metadata as the fields proposed in PASODOBLE.

The WP3 leader recommends that future initiatives on the adoption of metadata standards in the federal portfolio adopt a more distributed approach, not one in which a single central infrastructure is a goal onto itself, but something that independently works towards the exposure and appeal of the partners' data holdings. This also allows the partners to valorise the definition of their metadata on their own accord and independently from the other partners. This could have been feasible in the PAMIR project by letting a central PAMIR GeoNetwork instance harvest from the partner systems[2], who could have been implemented

[2] GeoNetwork is an open source catalogue application to manage spatially referenced resources.

with several different technologies (ranging from home-made provided there is an ISO 19115 translation, to THREDDS[3] or GeoNetwork).

Legally required dataset reporting

According to the INSPIRE Monitoring and Reporting Decision (EC, 2009), EU Member States have to report annually a number of indicators for monitoring the implementation and use of their infrastructures for spatial information. The information provided includes a list of spatial data sets and services belonging to those infrastructures. The three PAMIR partner institutes actively interact with their federal INSPIRE contact point, the National Geographic Institute (NGI), either to report annually the datasets currently identified to fall under the INSPIRE Directive rule, or to receive annual feedback about such datasets.

According to the same Decision (EC, 2009), a report including information on the coordinating structures, on the use of the infrastructure for spatial information, on data-sharing agreements and on the costs and benefits of implementing the INSPIRE Directive, is prepared and submitted every three years, starting in 2010. During the project, the PAMIR partners also contributed to the 3-yearly report covering the time period 2013-2015, compiled by NGI (Member State Contact Point Belgium, 2015).

With regard to INSPIRE reporting, ocean, atmospheric and climate sciences are again in somewhat asymmetric situations, corresponding to their different ratios of in situ measurement volumes versus satellite-based observational and computational model data amounts. Several meetings and exchanges involving IASB-BIRA, KUL and NGI took place in the course of the project to discuss the relevance of reporting datasets generated or held by IASB-BIRA. The issues addressed at the occasion of these discussions were not only the global or continental coverage of satellite observations, but also the fact that collected or computed atmospheric data are generated by communities of scientists in the context of international collaborations. This does not easily fit the country-based view of INSPIRE, which assumes that Member States own data relating to their national territories, and that they provide them to the community in order to recreate European datasets in the manner of a jigsaw. At an international scale, the INSPIRE promotors had to recognise the inadequacy of the concept of political borders to climate science. Therefore, provided that atmospheric or climate data are already archived and made available somewhere (e.g. through the Copernicus services), they agreed that such datasets needed to be reported only once (by any Member State). Moreover, as far as we know, the CF Conventions[4], often applied to climate data archived in NetCDF, were accepted as a valid alternative to INSPIRE-compliant metadata, at least for the datasets distributed through the Copernicus CAMS and C3S services[5]. These clarifications, still to be formally confirmed, considerably reduced the

[3] The THREDDS Data Server (TDS) is a web server that provides metadata and data access for scientific datasets, using a variety of remote data access protocols.
[4] The Climate and Forecast (CF) Conventions, originally associated to the NetCDF electronic format, define documentation rules recommended for Earth science gridded data. The climate community has adopted CF-compliant NetCDF as one of its standards for formatting and documenting data.
[5] Paul Smits (JRC), private communication, 2013.

number of atmospheric datasets considered as having to be reported by IASB-BIRA to INSPIRE. Currently, one IASB-BIRA dataset, the solar index observations by the SUVIM network, has been identified as INSPIRE-relevant and is being reported. The discussions led by KUL, NGI and IASB-BIRA about this last dataset further suggested that the INSPIRE designers did not actually intend to target the scientific data themselves, but only geographic, technical and legal information (which can also be considered as forming datasets) on the devices used to collect the data.

These findings, of course, do not reduce the interest – and, one should say, the societal duty – of documenting federal scientific datasets and making this information available to the public... and do not prevent, while doing so, from trying to be as compliant as possible with INSPIRE metadata rules without degrading the relevance of the information provided.

Infrastructural work

The Belgian Marine Data Centre (BMDC), as part of the Biodiversity & Ecosystems Data & Information centre of RBINS, has been appointed for 2017 as responsible for the performance indicator of increasing the visibility of the RBINS datasets. INSPIRE compliance, where relevant, was an explicitly stated goal. This is achieved by creating an institute-wide metadata publication platform. This platform is hosted at geonetwork.bmdc.be, and through URL redirection datasets are available via metadata.naturalsciences.be/id.

In order to capture metadata from other platforms, interoperability layers need to be created between systems. For instance in terrestrial and oceanographic biodiversity data, metadata is commonly described in the Ecological Modelling Language (EML). The Institute publishes these datasets to GBIF, the Global Biodiversity Information Facility. In the cadre of the PAMIR project, a scheduled job has been written that creates ISO 19115:2003 metadata by iterating over the EML files of these datasets; its output is then harvested by the geonetwork.bmdc.be node.

BMDC has since 2015 its own in-house developed metadata catalog system web application named DITS (Data Ingestion and Tracking System), which has been developed for the 4Demon BRAIN project and whose elements have been mapped to ISO 19115:2003 during the PAMIR project. DITS contains references to all oceanographic datasets containing in-situ data and transects (no time-series data). Striving for INSPIRE compliance has been essential, as a good part of these datasets are for (past) monitoring obligations and thus enter into INSPIRE. The following changes were made to DITS:

- addition of the tables and fields needed for INSPIRE and ISO 19115:2003;
- addition of the possibility to create hierarchical datasets, according to the ISO 19115:2003 gmd:aggregationInfo element;
- creation of a java library to generate ISO 19115:2003 metadata from basic java objects, based on the Geotoolkit.org and Apache SIS libraries;

- creation of a web service that consumes this java library.

For its part, IASB-BIRA has embarked on two internal projects related to metadata, that have interacted with PAMIR. One, prompted by the IT department, consists in making a rational inventory of its data holdings; the other one, prompted by the librarian, in offering scientists an online form to apply for digital object identifiers (DOI) associated to documents or datasets, IASB-BIRA being an accredited DOI Registration Agency (RA). The two projects are ongoing. Relying on the expertise gained in PAMIR, it was suggested to combine the two initiatives in order to document datasets only once, using a metadata scheme including all the metadata fields required by INSPIRE and DOI. A metadata scheme has been defined for this purpose.

5. DISSEMINATION AND VALORISATION

The PAMIR project was introduced to Belgian INSPIRE stakeholders at the INITGeoBE workshop coordinated by NGI (Brussels, Belgium, January 2014) and was presented at the INSPIRE 2014 annual conference (Aalborg, Denmark, June 2014):

De Rudder, A., J.-C. Lambert, S. Scory, R. Van Malderen, L. Delobbe and C. Tricot, A Portal to Atmospheric and Marine Information Resources (PAMIR), INITGeoBE workshop, Brussels, January 30, 2014.

De Rudder, A., J.-C. Lambert, S. Scory, M. Nemry, R. Van Malderen and L. Delobbe, Towards a Portal to Atmospheric and Marine Information Resources (PAMIR), INSPIRE Conference 2014, Aalborg, Denmark, 18-20 June 2014.

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7. ACKNOWLEDGEMENTS

The PAMIR partners thank the members of the follow-up committee for the advices that they kindly provided along the project. Due to lack of resources and time, no dedicated meeting was set up to collect the committee members' feedback, but information on the project progress and views on various issues were rather exchanged at the occasion of national and international workshops and conferences. Issues that were discussed included the general approach to harmonisation, metadata, quality metrics and examples of software.

The members of the PAMIR follow-up committee were

Henk Eskes, Royal Netherlands Meteorological Institute (KNMI), The Netherlands;

Peter Thijsse, Marine Information Service (MARIS B.V.), The Netherlands;

Nathalie Delattre, National Geographic Institute (NGI), Belgium;

Thomas Loubrieu, IFREMER / Informatique et Données Marines, France.

8. ACRONYMS AND WEBSITES

BMDC	Belgian Marine Data Centre
BRAIN	Belgian Research Action through Interdisciplinary Networks https://www.belspo.be/belspo/brain-be/
CAMS	Copernicus Atmosphere Monitoring Service https://atmosphere.copernicus.eu/
CEOS	Committee on Earth Observation Satellites http://ceos.org/
CF	Climate and Forecast http://cfconventions.org/
CLIPC	Climate Information Platform for Copernicus http://www.clipc.eu/
C3S	Copernicus Climate Change Service https://climate.copernicus.eu/
DITS	Data Ingestion and Tracking System
DOI	Digital Object Identifier https://www.doi.org/

EML	Ecological Modelling Language
EO	Earth Observation
ESA	European Space Agency https://www.esa.int/
EU	European Union https://europa.eu/
EVOSS	European Volcano Observatory Space Services
FP7	Seventh Research and Development Framework Programme https://ec.europa.eu/research/fp7/
GAIA-CLIM	Gap Analysis for Integrated Atmospheric ECV Climate Monitoring
GBIF	Global Biodiversity Information Facility https://www.gbif.org/
GEMS	Global and Regional Earth-System Monitoring using Satellite and In-Situ Data
GEO	Group on Earth Observations https://www.earthobservations.org/
GEOMon	Global Earth Observation and Monitoring
GEOSS	Global Earth Observation System of Systems https://www.earthobservations.org/geoss.php
GMES	Global Monitoring for Environment and Security (previous name of Copernicus)
H2020	Horizon 2020 Research and Development Framework Programme https://ec.europa.eu/programmes/horizon2020/
IASB-BIRA	Royal Belgian Institute for Space Aeronomy http://www.aeronomie.be/
IFREMER	Institut français de recherche pour l'exploitation de la mer https://wwz.ifremer.fr/
INSPIRE	Infrastructure for Spatial Information in the European Community https://inspire.ec.europa.eu/
IR	Implementing Rule(s)
ISO	International Organisation for Standardisation https://www.iso.org/
IT	Information Technology
JRC	Joint Research Centre https://ec.europa.eu/jrc/

KNMI	Royal Netherlands Meteorological Institute http://www.knmi.nl/
KUL	Catholic University of Leuven https://www.kuleuven.be/
MACC	Monitoring Atmospheric Composition and Climate
MARIS	Marine and Ocean Data Management https://www.maris.nl/
NGI	National Geographic Institute http://www.ngi.be/
NORS	Demonstration Network of Ground-Based Remote Sensing Observations in Support of the GMES Atmospheric Service
PAMIR	A Portal to Atmospheric and Marine Information Resources http://pamir.aeronomie.be/
PASODOBLE	PROMOTE Air Quality Services Integrating Observations – Development of Basic Localised Information for Europe
PROMOTE	Protocol Monitoring for the GMES Service Element on Atmospheric Composition
QA4ECV	Quality Assurance for Essential Climate Variables
QA4EO	Quality Assurance Framework for Earth Observation http://qa4eo.org/
QI	Quality Indicator(s)
RBINS	Royal Belgian Institute of Natural Sciences https://www.naturalsciences.be/
RMIB	Royal Meteorological Institute of Belgium https://www.meteo.be/
SBA	Societal Benefit Area(s)
SeaDataNet	Pan-European Infrastructure for Ocean and Marine Data Management https://www.seadatanet.org/
SUVIM	Solar Ultraviolet - Visible Irradiance Monitoring http://uvindex.aeronomie.be/
TDS	THREDDS Data Server
THREDDS	Thematic Real-time Environmental Distributed Data Services https://www.unidata.ucar.edu/software/thredds/current/tds/
WP	Work Package(s)
4Demon	Four Decades of Belgian Marine Monitoring: uplifting historical data to today's needs

ANNEX: PAMIR REPORT ON METADATA

See document in annex.