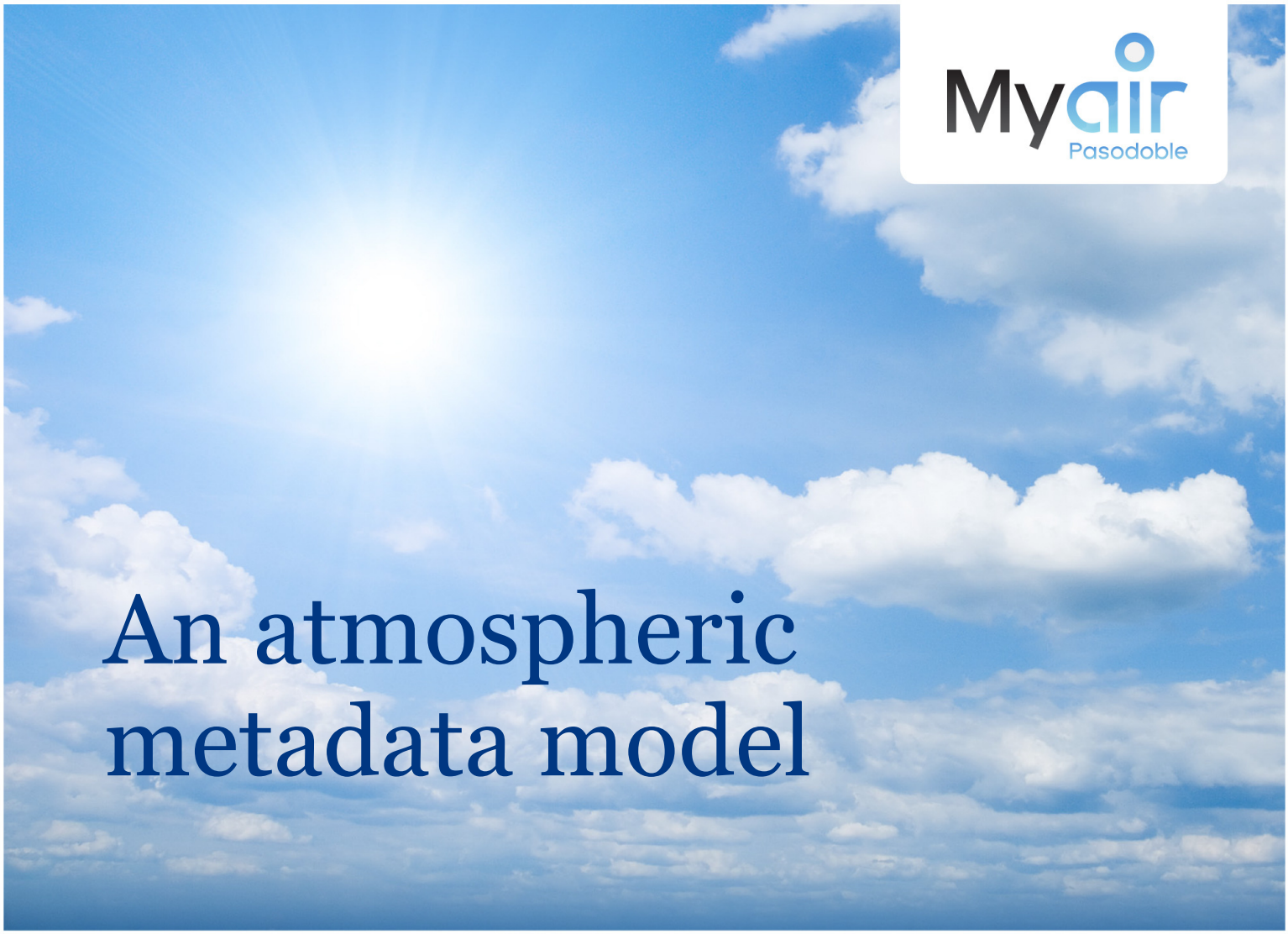

An atmospheric metadata model

Proposal for an INSPIRE-compliant metadata model suiting Air Quality service, product and user requirements

Internal report

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WP 8
D_CC-QUALITY_2.2
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Summary

This note proposes a metadata model for products distributed by the GMES Atmospheric Service, in particular Air Quality products, identifying which of its components will make it INSPIRE-compliant. The model is designed to suit PASODOBLE requirements. To ease its intelligibility, it is illustrated by an example.

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1 Introduction

1.1 Rationale

Metadata, or *data about the data*, include any piece of information pertaining to some dataset (which can be available in the form of isolated numbers, fields of numbers, images). They are essential to enable potential users to locate, identify and access the data they need, to assess their fitness for purpose, understand their meaning and limitations and actually use the data in particular applications. The importance of metadata for PASODOBLE follows from the previous statement.

Moreover, in order to allow the integration of PASODOBLE services to wider service networks (e.g. GMES, INSPIRE), it is desirable that the metadata fulfil applicable existing metadata standards, and mandatory that they comply with INSPIRE metadata rules and (future) data specifications. The metadata scheme proposed in Section 4 refers to international standards and to the following INSPIRE documents.

A INSPIRE Metadata Regulation [1] – denoted by IMR[1] in the following lines;

B INSPIRE metadata implementing rules draft guidelines [2] – denoted by IMIR.

Through its user interface, PASODOBLE will provide a searchable catalogue of its products that will include some description (that is, a set of associated metadata) of each product, which should allow potential users to check the existence and figure out the usefulness of the product for their particular purpose, and further direct them to the gateway to the actual product. Where appropriate, some products will be delivered accompanied by more specific metadata generated on the fly (*dynamical* metadata). This catalogue will rely on a metadata base that will be fed by the service providers through a metadata editor. The metadata editor and the metadata subset that will be available via the catalogue will reflect some underpinning metadata scheme or model – that is, a set of metadata fields structured by some classification and properties.

This note proposes a metadata model for the PASODOBLE services, which integrates a number of concepts and classifications to sort out metadata by genre, identifying which model components are – or make it – INSPIRE-compliant. The model is designed with a view of fitting needs of atmospheric products in general, which should allow homogeneity of approach between all GMES atmospheric services (in particular MACC services). To ease its intelligibility, the model is illustrated by an example.

1.2 Metadata quality

First of all, it is essential to note that the provision of metadata only contributes to the service and product quality at the condition that the metadata themselves meet certain quality criteria. “Good” metadata will be

- specific (addressing the level of detail required to an in-depth understanding);
- accurate (not leaving dark or fuzzy areas, ambiguities or room for misunderstanding);
- intelligible (formulated in a logically and grammatically correct language);
- explicit (avoiding coded information, abbreviations and undocumented conventions, and

[1] Acronyms are expanded in Section 7.

providing references where needed);

- complete (exhaustive enough to allow data discovery, assessment of fitness for purpose and proper use);
- consistent (organised and classified according to some sensible scheme, which will ease the metadata search).

1.3 Metametadata

The recognised importance of metadata for data exchange and use has given rise to initiatives to standardise their content, their formal expression and, for metadata filed with the data, their display. Since these standards rely on codes and conventions, they, in turn, need to be documented by *metametadata*.

The series of NASA Ames [3] data file headers (in ASCII), the Climate Forecast (CF) Metadata Convention [4] are examples of metadata standards used in atmospheric science. The ISO and OGC series include metadata standards applying to geographic data and to services.

The INSPIRE Directive [5], the scope of which encompasses any dataset or data-delivering service related to geographic locations or areas, is completed by a set of implementing rules (IR), among which some pertain to metadata: the INSPIRE Metadata Regulation [1] – in the process of being implemented by the ISO-based IMIR [2] – applies to discovery metadata, while the forthcoming *IR on data specifications for Annexes II and III data themes* [6] will standardise metadata more specifically related to data of a given nature. The main two INSPIRE data themes relevant to PASODOBLE are *Environmental Monitoring Facilities* and *Atmospheric Conditions* but many other INSPIRE data themes are somehow related to PASODOBLE services as well.

The metadata standard is not the only example of metametadata. The IMR [1] retains (and requires the provision of) three basic metametadata elements: the author of the metadata, their date of creation and the language in which they are expressed (see Section 5, Table 2, Point 10).

1.4 Document structure

Following this introduction, the present note includes two sections, the purpose of which is to explicit some questions related to metadata, to which the various possible answers are usually implicit assumptions made by participants to discussions on the subject. Being aware of these issues will hopefully help to figure out and build up an appropriate metadata scheme. Section 2 reviews common metadata classifications; Section 3 points to a number of issues related to the INSPIRE metadata scheme.

A metadata model for PASODOBLE is proposed for discussion in Section 4. It refers to – and encompasses – the INSPIRE metadata scheme summarised in Section 5.

References appear under Section 6 and abbreviations used in this document are listed in Section 7.

2 Metadata classifications

Depending on the sources, metadata are classified into categories defined by broad types of properties. These properties can relate to the intended function of the metadata (e.g. *discovery* versus *usage*), to their generation process (e.g. *static* versus *dynamical*), to the nature of the "product" to which they pertain (e.g. *data* versus *service*), etc. The common systems of classifications quoted in the literature are overviewed below.

2.1 Discovery versus usage

Metadata have a threefold role:

- to allow potential users to know about the existence of some dataset;
- to allow potential users to assess whether the dataset suits their needs and find out how to access it;
- to allow actual users to read, understand and use the data properly.

Discovery metadata are usually meant to encompass the first and sometimes the second types of metadata. The third type could be called *usage* metadata, although this name is not standard; usage metadata play the role of a manual for a piece of apparatus.

The borders between the three categories are not precisely defined. To a large extent, they depend on the user's expectations, which will determine the type of information he/she will first look for, that will serve as criteria for the rejection or further exploration of the data resource. For example, the data resolution may be crucial to assess their fitness-for-purpose for some application and may be unimportant for another application; the geographic coverage might be indifferent – although for PASODOBLE it is likely to be a key discovery metadata piece in most (but not all) cases. Nevertheless, the distinction is useful even if it would be closer to the truth to speak of a continuum of metadata layers, the user progressively discovering the product as he learns more about it, from superficial to in-depth information.

The INSPIRE Metadata Regulation [1] only tackles what is considered by INSPIRE as discovery metadata.

2.2 Series versus dataset

The IMR makes a formal but seemingly basic distinction between a *dataset* and a *dataset series*: a *spatial dataset series* is *'a collection of spatial data sets sharing the same product specification'* ([1], Annex, Part A, Section 1). However, it is said nowhere in the IMR [1] or the IMIR [2], supposed to implement the IMR, whether such a *product specification* is made of a part of the metadata – and, in this case, which part – or made of all of it. Obviously, if the datasets of a *dataset series* share the whole product specification, the distinction between *dataset* and *dataset series* is pointless, which tends to imply that the authors of the IMR mean a *product specification* to be a subset of the metadata set.

On the other hand, all occurrences of *dataset series* in the IMIR are found, with no single exception, in association with the term *dataset*, the two expressions being bound to each other by a conjunctive or disjunctive connector: any piece of metadata defined in the draft for a dataset series is always defined for both *a "dataset and/or a dataset series"*. Only at the

very end of the annex to the draft does the reader find out that, after all, *"There is no significant difference between the metadata of a dataset and the metadata of a dataset series. See A.11.1."* ([2], Annex, Section A.12.2), a sentence referring to some inexistent *Section A.11.1* and leaving doubt about how to interpret "significant", since from the text it should rather be understood that there is no difference at all.

As a conclusion to the above considerations, the rhetorical distinction made in the IMR between *dataset* and *series*, borrowed from ISO Standard 19115 [2], is not retained in the scheme presented under Section 4.

2.3 Service versus data

By extension, the term *metadata* is being more and more often applied to information about services. The word "service" is used with two different meanings. Services can be facilities delivering (data) products (which is, for example, the way "PASODOBLE services" must be understood); bound together by connections within some overarching structure (e.g. GMES), they form *service networks*. In the INSPIRE terminology, however, services (sometimes qualified as *network services*) are data-processing functionalities offered by these (or other) facilities, providing "added value" to some targeted data, such as online visualisation tools, etc. Irrespective of the acceptation of the word, the remark made above about the pair *{discovery, usage}* also holds for the pair *{product, service}*: the border between the two categories is even fuzzier in this case. It could be argued, for example, that the data format can be considered as an element of metadata related to the delivered data as well as to the delivery service.

The metadata scheme presented in Table 1 (Section 4) includes metadata pertaining to services in the sense of facilities distributing products (*Product availability, distribution and usage*) and to services in the sense of additional functionalities offered by these facilities (*Support*). Both types of information are meant to be part of any single product metadata set, since (network) services are supplied to support the use of the product – although it may happen that no service is associated to some actual data product, and although the reverse might even be true. This somehow differs from the approach adopted in INSPIRE, for which datasets and services are possibly unrelated entities, a product (or *resource*) being either a *dataset*[3] or a *service*. The difference, however, is only methodological and does not impede the compliance of PASODOBLE metadata with INSPIRE.

2.4 Generic versus specific

Another way to classify metadata is according to their degree of abstraction, or to the domain of validity of their value relatively to a given context – an approach already adopted by Péchinot and Baghi, 2010 [7] for the PASODOBLE user requirements. For PASODOBLE, generic metadata could include any metadata pertaining to the project services and products as a whole, while specific metadata would characterise a particular dataset. Intermediate degrees can be identified: thematic metadata would relate to groups of services (e.g. the PASODOBLE four service lines). The level of generality or specificity of a piece of metadata is of course relative and the *generic / thematic / specific* hierarchy therefore moveable.

[2] As confirmed by the IMIR statement "If the value of MD_Metadata.hierarchyLevel[1] is not **service**, **dataset** or **series**, the metadata set is out of scope of the directive" ([2], Section 1.2, § SC4).
[3] Or a *dataset series*.

2.5 Static versus dynamical

Metadata can be defined once and for all by the data producers (“static” metadata) or be generated *on the fly* (“dynamically”), that is, every time a regular dataset or a dataset instance is produced – which implies some automation. In general, the more specific the metadata, the more likely they are of being generated dynamically. For example, a forecast (or NRT) product can be described by a set of static (generic) metadata while the actual date and time of the forecast, or the particular conditions of the NRT measurement (specific metadata) would be generated every time a specific instance of the product is issued. But dynamical metadata may also include pieces of metadata with common (unchanged) values, which are simply repeated every time the data is emitted.

It is foreseen to enable automatic generation of PASODOBLE metadata provided that they are encoded in NetCDF file headers and follow the CF Convention [4]. On agreement of a metadata model for PASODOBLE, the list of metadata will be circulated among the product providers so that they can tick the pieces of metadata that can be generated on the fly in their particular case.

3 Compliance with INSPIRE

Before presenting the proposal for a PASODOBLE metadata model, it is necessary to say a few words of the IMR and of the consequences entailed by the constraint of complying with its rules, which are summarised in Table 2 (Section 5).

3.1 Terminology

Whereas PASODOBLE speaks of "products", the entities envisaged by INSPIRE are called "resources". As regards the metadata, we can consider that the two concepts are equivalent.

The highest level classification between resources, reflected by the value domain {*dataset, series, service*} of the Resource Type metadata element, may be put in correspondence with the PASODOBLE {*data, non-data*} distinction, keeping in mind the remark made above (Section 2.2) and the restriction discussed below (Section 3.3). In order to allow a precise mapping to INSPIRE, the Product Type metadata element included in Table 1 takes its value in {*Data, Service, Other*}.

Finally, the INSPIRE *space* must be understood as the two-dimensional geographic space.

3.2 INSPIRE internal consistency

The INSPIRE metadata model itself includes a few ambiguities or inconsistencies that the user must be aware of. Below is a short list of the most obvious ones.

- There is no detectable logical thread underlying the overall metadata classification in ten chapters.
- The third value that Resource Type may assume is actually not *service* but *services* (Table 2, Item 1.3). It is hence unclear whether a metadata set may apply to only one service (as the uniqueness of the Service Type value would imply – see Table 2, Item 2.2) or to several services (as the multiplicity of the Keyword value would imply – see Table 2, Item 3.1).
- One chapter is devoted to information related to resource classification (Table 2, Section 2) but surprisingly the Resource Type is found in the chapter "Identification" (Table 2, Section 1).
- The IMR makes it mandatory to use longitude and latitude (in decimal degrees) to describe the geographical coverage – Table 2, Item 4.1 – but to use lengths (or a length ratio) to describe the geographical resolution – Table 2, Item 6.2.
- The chapter called "Temporal reference" (Table 2, Section 5) includes two types of metadata of utterly different natures. On one hand, dates (of creation, revision, publication) which inform on the work done and are a sort of time stamp of the product (comparable to the "best before" stamp of consumption products). On the other hand, the time coverage, using any relevant time scale and unit, which is intrinsic in the product and is a characteristic of its domain of definition. The confusion is even reinforced by the fact that only one of these pieces of information is required and that any of them will do – as if what mattered was not the informative part of the metadata

(the meaning of its content) but a formal property ("having to do with time"). A potential user may only be bewildered by results returned by a search engine using such an underpinning scheme.

- Likewise, spatial resolution (Table 2, Item 6.2), which is also a characteristic of the domain of definition of the variable(s) or the model constituting the product, is presented as an element informing on the product quality, which is erroneous (see comment in Section 3.3.1, 3rd §).
- The "Lineage" metadata element (Table 2, Item 6.1) is a rag bag containing miscellaneous pieces of information as diverse as the product history, a statement on whether the product has been validated, an overall assessment of the product quality (would "good" – or "bad" – be such assessment?), how "official" the product can be considered and a statement on its "legal validity" – anyone of these heterogeneous pieces of information satisfying the provision requirement.

3.3 Issues related to compliance with the INSPIRE metadata scheme

This section overviews divergences between the PASODOBLE and the INSPIRE viewpoints and outlines how they have been reconciled in the PASODOBLE metadata scheme proposal presented in Section 4.

3.3.1 Classification, dimensionality and quality

The most striking inconsistencies underlined in Section 3.2 derive from the absence, in the INSPIRE model, of any underlying notion of what the object and method of science are.

More precisely, the INSPIRE metadata scheme, which makes an extensive usage of the term "dataset", ignores what a dataset is, namely a set of variables (or functions), the data, depending on a set of independent variables (or coordinates) and defined over some subset of the coordinate values (domain of definition). This ignorance lies at the origin of the dispersion, in Table 2, of the little information about the domain of definition that INSPIRE considers without knowing that it relates to the domain of definition. The model proposed for PASODOBLE gets round this drawback as explained in Section 4.

Due to the same lack of basic knowledge, the question of quality is tackled by INSPIRE in an inappropriate way. On one hand, the tightening of the geographical resolution of a dataset is considered by INSPIRE as a factor of quality, based on the naïve and dangerously wrong belief that the more detailed the representation, the truer the information conveyed. On the other hand, any vague statement on quality will fulfil the required provision of a value for the remaining quality metadata element (called "lineage"), as satisfactorily as its "legal validity" alternative. Quality information about PASODOBLE products should be established following the criteria defined in the PASODOBLE Service Validation Protocol [8], which points to QA4EO ([9], [10], [11], [12], [13], [14], [15]) as a standard of reference. The central principle of the QA4EO guidelines [11] is the provision of one or several quality indicators (QI) assessing the closeness of the measurement to the actual value of the measurand – requirement which is absent from INSPIRE.

To be a valuable tool for its users, the PASODOBLE metadata model must fulfil basic rational criteria. As an output of an FP7 project, it must comply with INSPIRE. The approach adopted in Table 1 to solve the challenge posed by this double requirement has been to adopt a logical classification and a scientifically based definition of the metadata, while incorporating additional "purely" INSPIRE metadata elements where they best fit. As a result, all INSPIRE

mandatory elements will be found in Table 1, but under headers different from those in Table 2 and sometimes as indicators of a different type of information. Provided that it complies with INSPIRE format requirements, any set of metadata supplied by filling in Table 1 is given the possibility of complying with the INSPIRE scheme, as long as compliance means "provision of all required fields".

3.3.2 Services

Resources considered by INSPIRE are essentially of two types – datasets and services – expected to be described by separate metadata sets.

Services offered by PASODOBLE will usually accompany data products, which is why they have been included in Table 1 as pieces of metadata associated to the described product. They may nonetheless be documented separately if desired.

However, service providers should be aware of the following INSPIRE specificity. For a service, at least one required keyword must be borrowed from the IMR list of service categories and subcategories ([1], Annex, Part D, Section 4), which does not necessarily embrace all conceivable categories. Contrary to what happens for the value domain of Service Type, the list does not provide for any "Other" value. The constraint is less obvious for a dataset, since the source of at least one keyword must in this case be the GEMET thesaurus [16], which has been made broad enough to cover INSPIRE data themes.

3.3.3 Borderline products

Some products developed and distributed by atmospheric services, such as models, cannot be assimilated to data products. It is for example the case of the PASODOBLE local pollution model evaluation tools. Whether these products can be classified as what INSPIRE calls (*network) services* is arguable, since they are supplied *per se* – they do "add value", but to something owned by the user, which itself is not a dataset (in the above example, a local pollution model). Furthermore, whether they belong to the INSPIRE scope is arguable since, although obviously related to geography in some way, they are not related to any specific geographic location or area[4]. From the INSPIRE viewpoint, they can either be considered as out of scope of the Directive (as not being a *dataset*, a *series* or a *service* or as not being of a *spatial* nature), or be assimilated to services with a *serviceType* property value equal to "Other" – allowed additional values of this property being "Discovery", "View", "Download", "Transformation" and "Invoke Spatial Data" ([2], p. 10]. Even this last possibility does not guarantee compliance with INSPIRE since at least one keyword must be a *service category* borrowed from a provided list ([1], Annex, Part D, Section 4) that does not include anything related to a model validation tool.

A choice must be made here by the PASODOBLE community. In any case, metadata must also be defined for these products in order to document PASODOBLE offers fully. The pieces of metadata in Table 1 which typically pertain to datasets will not be applicable to these products, but some will, such as the provider's identification, the intended application, etc.

[4] However, it must be underlined that, by making the provision of a service geographic bounding box mandatory only if relevant (Table 2, Item 4.1), INSPIRE does accept services that are not related to any particular geographic area.

4 PASODOBLE metadata model proposal

This section essentially lists elements to be integrated to the PASODOBLE metadata model (Table 1). This list is provided as a suggestion and may be augmented – or reduced – after discussion within the project. Metadata listed in Column 1 are in plain English in an attempt to be as immediately intelligible as possible – but the adopted terminology is open to suggestions for changes. Column 2 provides explanations where necessary.

Some of the metadata below will not be applicable in all cases, some will; some will at a certain stage of development of the service. Some pieces of metadata may be made mandatory for certain types of products, but it is essential to let the product metadata provider state that some (and perhaps most) requested pieces of information do not apply to his/her particular product. For example, the notions related to dimensionality will not apply to the model validation tools.

The list is divided into four main sections, respectively dealing with (A) product characterisation, (B) product generation, (C) product distribution and associated services, and (D) metadata. The first three categories may be considered as relatively arbitrary to the extent that they somewhat overlap. They are further divided into subcategories as follows.

A Product
- A.1 Identification and nature
- A.2 Domain of definition
- A.3 Domain of values
- A.4 Quality
- A.5 History
- A.6 Presentation, coding, format
- A.7 References

B Product generation
- B.1 Developer
- B.2 Derivation chain and intermediate validation
- B.3 References

C Product availability, distribution and usage
- C.1 Provider
- C.2 Applications
- C.3 Maintenance and update
- C.4 Delivery
- C.5 Terms and conditions
- C.6 Support
- C.7 References

D Metadata

To each piece of metadata is associated a “depth” (Column 3) corresponding to a level of discovery of the data set by the user, from 1 to 3. Depth 1 metadata form the minimum set of elements that should feed a searchable catalogue (by keyword, geographic area, etc.), usually called *discovery* metadata (see Section 2.1). Depth 2 metadata are additional metadata likely needed to enable a potential user to determine whether the data is suited to the envisaged application. Remaining metadata are said of Depth 3. Again, this choice is relatively arbitrary and open to discussion within the project.

Column 4 establishes a correspondence between the suggested metadata and the INSPIRE mandatory metadata set up in the IMR [1]. The code appearing in Column 4 is the IMR reference number of the corresponding INSPIRE metadata element, as recalled in Column 1 of Table 2 (Section 5). Conditions that the considered piece of metadata must fulfil in order to comply with INSPIRE requirements will also be found in Table 2.

As can be seen in Table 2 (Columns 7, 8, 9), some INSPIRE metadata values are made of three components: a numerical identifier, a textual name and a conventional name (plus an optional free text description). The values of the metadata in Table 1 are only made of free text. In order to achieve compliance with INSPIRE, values in Table 1 must be completed by their corresponding additional components (INSPIRE numerical identifier and conventional name).

It is desirable that the PASODOBLE metadata model embeds the INSPIRE model. All INSPIRE pieces of metadata have therefore somehow been included in Table 1, where they are highlighted in yellow. A metadata scheme including all the "yellow" pieces of metadata in Table 1 will be INSPIRE-compliant (provided that the information is supplied and formatted as required in Section 5). Such a scheme will actually overachieve INSPIRE compliance, since the provision of INSPIRE "mandatory" elements is often conditional to the element pertinence or to the provision of a substitute. For example, only one of the metadata elements 5.1 to 5.4 must be provided in order to satisfy INSPIRE requirements; likewise, only one (any) constitutive piece of Element 6.1 is mandatory; etc.

A few rows of Table 1 are redundant. Namely, the Geographic Bounding Box and the Geographic Resolution repeat information that may be found in the characterisation of the domain of definition further below in the table. These rows have been introduced in order to ease compliance with INSPIRE. Redundancy presents the advantage of enabling the metadata provider to keep the information on the geographic boundaries and resolution consistent in at least the section devoted to the independent variables, thus compensating for the INSPIRE deficiency underlined in Section 3.2 (4th bullet point).

Likewise, the "INSPIRE Category" metadata element of Table 1 has no other purpose than to locate the product within the INSPIRE network.

Some INSPIRE metadata elements actually cover a large amount of information which is distributed, in Table 1, among several (coupled or uncoupled) metadata elements. In this case, the corresponding INSPIRE reference number (in Column 4) will be repeated in several rows of Table 1. The INSPIRE metadata elements in this situation are the following.

6.1 Lineage (split up into a number of heterogeneous elements)
7 Conformity (split up into product conformity and metadata conformity)
8.1 Conditions applying to access and use (split up into conditions on access and conditions on use)
9.1 Responsible party (split up into organisation names and e-mail addresses)
10.1 Metadata point of contact (split up into organisation name and e-mail address)
10.2 Date of creation or update of the metadata (split up into date of creation and date of last update)

Inversely, some metadata of Table 1 will account for different metadata elements of Table 2. INSPIRE metadata which end up being grouped in this way in Table 1 are the following.

- Topic category (2.1) and service type (2.2)
- Conditions applying to access (8.1) and limitations on access (8.2)

Included in Table 1 are key metadata (e.g. units, accuracy expressed by QI, room for the vertical coordinate or any independent variable different from the "usual" 4-D space coordinates) that are not included in the INSPIRE model.

Features listed under the section devoted to quality (Table 1, Section A.4) should be derived according to the principles developed in the PASODOBLE Service Validation Protocol [8]. For a set of observational data, quality indicators (QI) – as required by QA4EO [11] – provide an estimate of how close to the truth the measurement likely is (accuracy), for example through an estimate of how scattered the measurements are (precision). Quality indicators also include numerical estimators of the accuracy or precision of the independent variables on which the measured quantity depends (which INSPIRE does theoretically recognise as one quality factor but which is not included in the mandatory metadata considered in the IMR). Standard metrology definitions and methods are to be found in the VIM [17] and GUM [18]. For theoretical results, other methods will provide quality indicators, e.g. statistical estimates, comparison with observation, etc. These indicators can be completed by "flags" (indicating missing or suspicious data, or particular conditions of observation, or data that have been subject to some particular processing, etc.). In Table 1, such flags are also considered as quality indicators, although they do not strictly meet the QA4EO definition. For all sorts of QI, Table 1 makes a distinction between those that vary from data point to data point, i.e. which are a function of the same independent variables as the data itself (*individual QI*) and those which characterise the dataset as a whole (*global QI*). Most global QI can of course be derived from individual QI (e.g. by averaging them over the dataset). It is imaginable to define QI for some non-data products as well, that would, for example, measure the performance of a model or tool (by their rate of success or otherwise). These QI and their methods of calculation (for example, when they are based on samples) need to be defined precisely. Additional quality information such as the description of the validation method, validation datasets and summary of the information content analysis may be provided as text.

In these and other matters, Column 5 refers to best practice standards with which compliance is recommended. Best practice may in some cases be in contradiction with the INSPIRE rules. When the metadata element has been deliberately incorporated to Table 1 with the purpose of making the scheme INSPIRE-compliant, the standards quoted in Column 5 include the applicable INSPIRE document of reference.

Table 1 also reflects a logical organisation sensibly different from the INSPIRE metadata classification. Notable examples include the following.

- The temporal extent of a dataset appears in Table 1 as a component of its domain of definition and not, as in Table 2, as a time stamp of the same kind as a date of publication, revision or creation.
- Likewise, the geographic resolution is an attribute of the domain of definition of a geo-referenced spatiotemporal dataset (Table 1), and not an indicator of quality (Table 2).
- Table 1 provides, at the end of each high-level section, room for references to standards applicable to the section topic. As a consequence, the aspects related to the conformity to some standard, grouped in one single section in Table 2, happen to be separated in Table 1 into conformity of the product and conformity of the metadata, which are foreign to each other by essence.
- Due to the classification of metadata according to the topic to which they pertain (product, product development, product distribution), the information about the actors and their roles is distributed, in Table 1, among Sections B (product development) and C (product distribution), while in Table 2 this information gets regrouped under a single *ad hoc* section (Point 9).
- Since PASODOBLE services are viewed as entities distributing products according to defined modes and specifications, a special section (Section C) is devoted to describe the service (i.e., the product provider) and the associated features supplied with the product (*services* in the INSPIRE sense). This approach is "product-centred". It offers the advantage of providing a description of the supplied services without multiplying

the metadata sets, while remaining INSPIRE-compliant. However, if so wished, it is still possible to use the same model to produce independent metadata sets describing the supplied services as different resources. This is the only situation in which the "target data product URI" (INSPIRE metadata 1.6) will find its use.

For data products, Table 1 assumes that one product is made of one (observed or calculated) physical quantity (plus its associated quality indicators). This implies that one complete set of metadata is provided per variable, with the consequence of having to repeat metadata that are common to several variables. This approach may be judged inadequate where several variables are "packaged" into what is presented as one single product – for example, variables that are measured simultaneously and / or are stored together in the same file. In this case, the proposed model may be extended by providing room for several variables. Metadata in Sections A.1 to A.4 of Table 1 would then accept multiplicities higher than 1.

Finally, the scheme is illustrated by an example (Column 6) borrowed from the PROMOTE project. As mentioned in the last line of Table 1, the example is INSPIRE-compliant – provided that the metadata pieces are completed by their numerical identifier and conventional name where relevant, as explained above.

Table 1. List of proposed metadata for PASODOBLE products with mapping to INSPIRE metadata IR.

Metadata element	Description / Value / Comments	Depth	INSPIRE reference number	Best practice / International standard(s) of reference	Example
A Product					
A.1 Identification and nature					
Product name	/	1	1.1	/	AirCast Level 1 Ozone
Product type	[value] = 'Data' / 'Service' / 'Other'	1	1.3	/	Data
Definition / Description	Summary of the product content. When the product is data-based and the data not a commonly used physical quantity, a rigorous definition or description of how the quantity is computed (what its components are and how they are combined) and /or what it represents should be provided. If the product is a model, description of the model including, when relevant, modelled physical processes, parameterisations, boundary and initial conditions, diagnostic variables.	1	1.2	/	Daily maximum of the hourly mean ozone concentration from the ground level measurement station Portuguese network interpolated on a 1 x 1 km^2 grid
Keyword(s)	/	1	3.1	► CF standard names[5] [4] ► PCMDI names of atmospheric variables[6] ► GEMET thesaurus [16]	• atmospheric composition • troposphere • atmospheric ozone

Standard terminology	For each keyword provided, if the keyword is borrowed from a vocabulary standard, citation of this standard	3	3.2	/	• GEMET Thesaurus, 2011, http://www.eionet.europa.eu/gemet/ • idem • idem
INSPIRE category	INSPIRE topic category or categories (for a data product) or (unique) service type (for a non-data product)	3	2.1 2.2	IMR [1]	• Climatology / Meteorology / Atmosphere • Environment • Geoscientific Information • Health • Imagery / Base Maps / Earth Cover
For a non-data product:					
URI of the target data product(s)	If the product is a tool intended to support some specific data product(s)	1	1.6	IMR [1]	/
For a data product:					
Nature of physical quantity	/	1	/	► CF standard names[5] [4] ► PCMDI names of atmospheric variables[6]	Molecular concentration of ozone in air
Unit	For dimensionless variables, [value] = 'Dimensionless' unless the considered quantity is measured by a ratio (e.g. flat angle, relative humidity, mass or volume mixing ratio, etc.), involving or	2	/	SI[7] [19]	cm^{-3}

[5] http://cf-pcmdi.llnl.gov/documents/cf-standard-names/standard-name-table/18/cf-standard-name-table.html
[6] http://cf-pcmdi.llnl.gov/documents/cf-standard-names/pcmdi-name-cf-standard-name-mapping

	not involving a multiplication factor (examples: [value] = '%'; 'ppv'; 'ppmv'; 'ppbv'; 'µg/g'; etc.).				
Type of data sourcing (high level)	[value] = 'Observation' / 'Derived from indirect measurement' / 'Combination of measurements' / 'Combination of measurement and simulation' (data assimilation) / 'Model simulation'. *NB Data sources are described in more detail under Section B - Product generation.*	1	/	/	Observation
Immediacy	[value] = 'Data record' / 'Running NRT' / 'Forecast'.	1	/	/	Record and NRT
Spatial representativeness	Point data / summed or averaged in space (e.g. along height, longitude; over area).	1	/	/	Ground level
Temporal representativeness	Instantaneous / averaged over time.	1	/	/	Hourly average
Value range representativeness	Minimum, maximum, other…	2	/	/	Daily maximum

A.2 Domain of definition					
Spatiotemporality	[value] = 'Spatiotemporal' if the product	1	/	/	Spatiotemporal

[7] Note that *g*, *cm* & *number of molecules* do not belong to SI (*kg*, *m* & *mole* do). The SI unit for a flat angle (the measure of which is the ratio of two lengths) is the radian (rd). However, SI recognises the usage of degrees, minutes, seconds and even, for longitude and latitude, of decimal degrees.

	(dataset or model) is defined over a portion of a subspace of the 4-D geophysical space. [value] = 'Not spatiotemporal' otherwise, i.e. if the independent variables are not horizontal, vertical and/or time coordinates. If the product cannot be described in terms of variables, the answer would be "not applicable".				
Geographic bounding box	Irrespective of the product spatiotemporality, the product may be defined or valid over a certain (possibly not connex) geographic area – if the product is a geo-referenced spatiotemporal dataset, the area is its geographic domain of definition. The geographic bounding box is the tightest longitude/latitude spherical rectangle circumscribing this area. It is given by its westbound and eastbound longitudes, and southbound and northbound latitudes (in decimal degrees with a precision of at least two decimals).	1	4.1	IMR [1]	9,48° Long W 6,19° Long W 37,01° Lat N 42,13° Lat N
Geographic resolution	If relevant, the geographic resolution of the product should be provided as a set of distances or map equivalent scales. If the product is a geo-referenced spatiotemporal dataset, this piece of metadata will possibly repeat information provided below for the horizontal independent variable(s).	1	6.2	IMR [1]	1 km 1 km

Number of independent variables (IV)	If the number of independent variables (IV) is equal to *n*, the attributes *Name, Unit, Boundaries, Resolution* will be provided below for each of the *n* IV (in the example, three times).	1	/	/	3
► **IV n° 1**					
Name	/	1	/	/	Distance eastward from 9,48° Long W
Unit	/	2	/	SI[7] [19]	km
Boundaries	Limits of the definition interval (linear bounding box) or series of intervals. For example: S-N limits of a group of cities or areas, a country, a region (e.g. a coastal region); start and end dates of a record, running NRT or running forecast; duration of a theoretical scenario; start date of an ongoing record; ...	2	/	/	0 – 293 km
Resolution	E.g. value of linear / logarithmic discrete interval; or number of subdivisions of the interval defined above; or the axis scale definition (e.g. t, t+6h, t+12h, t+18h); etc.	2	/	/	1 km
► **IV n° 2**					
Name	/	1	/	/	Distance northward from 37,01° Lat N
Unit	/	2	/	SI[7] [19]	km

Boundaries	See IV n° 1.	2	/	/	0 – 569 km
Resolution	See IV n° 1.	2	/	/	1 km
► **IV n° 3**					
Name	/	1	/	/	Time
Unit	/	2	/	SI[7] [19]	day
Boundaries	See IV n° 1.	2	5 (5.1)	/	1995-01-01 – 2009-12-31
Resolution	See IV n° 1.	2	/	/	1 day

A.3 Domain of values					
Confidence level	Probability that a data value belongs to the confidence interval (e.g. 90%).	2	/	/	?
Confidence interval	Estimated boundaries of an interval including most data values (the probability that a data value is included in the confidence interval is equal to the confidence level set up above). Expressed in the same unit as the data unit.	2	/	/	?

A.4 Quality					
Existence of quality assessment	If the product quality is assessed in any way. [value] = 'Validated' / 'Not validated'	1	6.1	QA4EO [9]	Validated

Validation method	Where applicable, description of how the product is validated	2	/	PASODOBLE Validation Protocol [8]	/
Validation dataset(s)	Citation and description of dataset(s) used for validation	3	/	PASODOBLE Validation Protocol [8]	?
Validation result	Summary of product performance against defined criteria	2	6.1	/	/
Content analysis	Summary of content analysis	3	/	PASODOBLE Validation Protocol [8]	/
Quality indicators (QI)					
Number of quality indicator(s) (QI)	If the number of quality indicators (QI) is equal to *n*, the attributes *Name, Definition, Unit, Relevance, etc.* will be provided below for each of the *n* QI (in the example, one time).	2	/	/	1
► **QI n° 1**					
QI name	/	2	/	VIM [17]	Normalised root mean square error (NRMSE)
QI definition	Definition and / or calculation formula. For a model or service, definition of the QI measuring the product performance.	2	/	► QA4EO [12], [13] ► VIM [17] ► GUM [18]	$\frac{\sqrt{\frac{1}{N}\sum_i (M_i - O_i)^2}}{\sum_i O_i}$ with N the number of observations and modeled values, M_i the model value and O_i the corresponding observation value.

QI unit	For dimensionless QI, [value] = 'Dimensionless' unless the QI is a ratio involving a multiplication factor.	2	/	SI[7] [19]	Dimensionless
QI relevance	[value] = 'Individual' if the QI is defined for each data point (e.g. absolute or relative error, etc.). [value] = 'Global' if the QI is defined for the whole dataset (i.e., it assumes a unique value), irrespective of the determination method (i.e. whether determined from a sample, from the entire population, from error budget considerations, etc.). *NB A global QI may be derived from individual QI (e.g. the mean or maximum uncertainty, etc.).*	1	/	/	Global
For an individual QI:					
QI confidence interval	Estimated boundaries of an interval including most QI values (the probability that a QI value is included in the confidence interval is equal to the confidence level set up below). Expressed in the same unit as the QI unit. Example: if the QI is the relative uncertainty of an individual measurement and if the uncertainties lie between 5 and 15% with a 90% frequency (confidence level), a valid QI confidence interval would be 5-15%.	2	/	/	/
QI confidence level	Probability that a QI value belongs to	2	/	/	/

	the confidence interval (e.g. 90% in the above example).				
For a global QI:					
QI value	/	2	/	/	20%

A.5 History					
Date of creation	/	3	5 (5.4)	ISO 8601	2008-06-15
Version number	/	1	6.1	/	3
Version issue date	/	1	5 (5.3)	ISO 8601	2009-06-15
Change between current and previous versions	/	1	6.1	/	?

A.6 Presentation, coding and format					
Display	Table of numbers / Picture / etc.	1	/	/	Image
Computer format	ASCII / binary file; NetCDF / HDF / etc.; Text / PDF; JPEG / PNG / etc.	1	/	/	PNG
Computer language	Computer language used within the product (for a model, the language of the code)	3	/	/	/
Language	Natural language used within the product	1	1.7	ISO 639-2	por

Unique resource identifier (URI)	/	3	1.5	/	http://air.dcea.fct.unl.pt/projects/aircast/aircast1.html

A.7 References					
Standard(s) of reference	Standard(s) applicable to the product, the product specifications or the product validation	3	7.1	/	Directive 2008/50 CE of the European Parliament and Council of 21 May 2008 on ambient air quality and cleaner air for Europe, Annex I (Data Quality Objectives), Official Journal of the EU, 2008-06-11, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF
Degree of conformity to the standard	For each standard quoted above	3	7.2	IMR [1]	Conformant
Publication(s)	Reference(s) of publication(s) describing, using or referring to the product or its validation	3	/	/	/

B Product generation

B.1 Developer(s)

Product developer(s)	Organisation(s) involved in the development of the product	1	9.1 9.2	/	Departamento de Ciências e Engenharia do Ambiente, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa
Contact person(s)	/	2	/	/	Dr Nuno Grosso
Contact e-mail address(es)	/	2	9.1	/	ncsg@fct.unl.pt
Contact telephone #	/	2	/	/	/
Programme or project name(s)	Project(s) under the umbrella of which the product was developed or is made available	1	/	/	PROMOTE http://www.gse-promote.org/
Project principal investigator(s) (PI)	For each project	3	/	/	Dr Thomas Holzer-Popp
PI's affiliation(s)	For each PI	3	9.1 9.2	/	Deutsches Zentrum für Luft- und Raumfahrt (DLR)
PI's e-mail address(es)	For each PI	3	9.1	/	thomas.holzer-popp@dlr.de

B.2 Derivation chain and intermediate validation					
Derivation chain	Successive intermediate products and algorithms used to transform a stage to the next one. The information below will be provided for each stage (including final product)	3	6.1	PASODOBLE Validation Protocol [8]	?

► **Stage n° 1**					
Source	Description of source product, including the following (for intermediate product, reference to previous stage). Nature, coverage, version, origin, reference citation. Model / instrument / platform name, location, operator. Measurement technique.	3	/	/	/
Algorithm	Algorithm / model used to derive resulting product from source	3	/	/	/
Product name and description	Description of resulting product (for a dataset, level, grid, etc.)	3	/	/	/
Product validation	Validation means including reference datasets, methods, QI and results. (For final product, reference to information provided under A.4)	3	/	PASODOBLE Validation Protocol [8]	/

B.3 References					
Standard(s) of reference	Standard(s) applicable to aspects of the product development	3	7.1	/	/
Degree of conformity to the standard	For each standard quoted above	3	7.2	IMR [1]	/
Publication(s)	Reference(s) of publication(s) describing the product development	3	/	/	/

C Product availability, distribution and usage

C.1 Provider					
Service name	/	1	/	/	AirCast
Service provider	/	1	9.1 9.2	/	Departamento de Ciências e Engenharia do Ambiente, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa
Provider acronym	/	1	/	/	DCEA / FCT / UNL
Provider country	/	1	/	ISO 3166	Portugal (PT)
Contact person	/	1	/	/	Nuno Grosso
Contact e-mail	/	1	9.1	/	ncsg@fct.unl.pt
Contact telephone #	/	1	/	/	/
Service operation start date	/	3	5 (5.2)	ISO 8601	2008-06-30

C.2 Applications					
Service purpose	/	1	/	/	Urban AQ monitoring and forecast for Portugal
Targeted application(s)	/	2	/	/	Support to local and regional integrated PM monitoring and forecast

Example(s) of actual application					
Number of examples	If the number of applications is equal to *n*, the attributes *Description, User name, User acronym* will be provided below for each of the *n* applications (in the example, one time)	3	/	/	1
► **Example n° 1**					
Description	/	3	/	/	Local PM forecast
User name	/	3	9.1 9.2	/	Agência Portuguesa do Ambiente
User acronym	/	3	/	/	APA
User e-mail address	/	3	9.1	/	dilia.jardim@iambiente.pt

C.3 Maintenance and update					
Update frequency	Frequency at which new data are incorporated to the product.	2	/	/	Daily
Update delay	Mean time between data production and availability.	1	/	/	1 day
Revision frequency	Frequency at which the data product is reassessed.	3	/	/	?
Backup frequency	/	3	/	/	?
Archive maintenance	[value] = 'Archive maintained' / 'No archive maintained'	3	/	/	Archive maintained

Archive coverage	Time period covered by the archived data.	3	/	/	1995-01-01 to 2009-12-31
Archive availability	Is the maintained archive partially or totally available? [value] = 'Archive available' / 'No archive available'	2	/	/	Archive available
Available archive time coverage	Time period covered by the available historic data.	2	/	/	2002-01-01 to 2009-12-31

C.4 Delivery					
Delivery mode(s)	[value] = 'Push mode' / 'Pull mode' / 'Consultation'	2	/	/	• Consultation • Pull mode
Delivery channel(s) or medium(s)	Internet download / FTP / E-mail / SMS / CD / etc.	2	/	FTPS	Web download
URL	/	1	1.4	/	http:// air.dcea.fct.unl.pt/ projects/aircast/ aircast1.html
Delivery frequency		2	/	/	/
Delivery delay	Mean time between product request and provision.	2	/	/	/

C.5 Terms and conditions					
Usage conditions or restrictions	E.g. non commercial, non military, acknowledgement of provider, offer of	2	8.1	/	Under SLA

	co-authorship, etc.				
Access conditions	E.g. fee, password protection, online agreement with terms and conditions, signature of agreement, etc.	2	8.1 8.2	/	/

C.6 Support					
Language(s) used to provide support	/	2	/	/	Portuguese
Additional service(s) provided	[value] = 'Instructions' (on format, software, ...) / 'Search engine' / 'File format reader' / 'File format converter' / 'Data extractor' (subsetting) / 'Visualisation' (plotting) / 'Data handling' / 'Alert' / 'Help desk' / 'Other service'	2	/	/	• Data extractor • Visualisation
Alternative formats that can be automatically generated	If a file format converter is provided, which formats does it handle?	3	/	/	/
Data handling options provided	Types of data manipulations allowed online, if any. Examples: averaging, interpolation, comparison with other datasets, difference calculation, etc.	3	/	/	/

Help desk telephone	/	3	/	/	/
Help desk e-mail	/	3	/	/	/
Other	Description of other service(s) provided	3	/	/	/

C.7 References					
Standard(s) of reference	Standard(s) applicable to the development of the services associated to the product	3	/	/	/
Publication(s)	Reference(s) of publication(s) describing the services associated to the product	3	/	/	/

D Metadata

Author(s)	Organisation(s) responsible for the creation and maintenance of the metadata	2	10.1	/	Departamento de Ciências e Engenharia do Ambiente, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa
Contact e-mail address(es)	For queries about the metadata	2	10.1	/	ncsg@fct.unl.pt
Date of creation	Date of creation of the metadata	3	10.2	ISO 8601	2009-06-15
Date of last update	Date of last update of the metadata (e.g. in the case of dynamical	2	10.2	ISO 8601	2009-06-15

	metadata)				
Language	Language in which the metadata are expressed	1	10.3	ISO 639-2	eng
Standard(s) of reference	Standard(s) applicable to the metadata	3	7.1	/	Commission Regulation (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata, Official Journal of the EU, 2008-12-04.
Degree of conformity to the standard	For each standard quoted above	3	7.2	IMR [1]	Conformant

5 INSPIRE mandatory metadata

INSPIRE mandatory metadata are listed in Table 2, which is a compact display of the contents of Parts B, C and D of the Annex to the IMR [1]. It is to be noted that "mandatory" has to be understood in a broad sense, namely that the provision of many metadata elements is conditional, for example, to the fact that the required information is defined, exists and is meaningful (conditions stated in Columns 5 and 6). Complementary information on the INSPIRE conventions and rules, as well as comments, are provided as footnotes. Further detail on some metadata values are to be found in the IMR Annex [1].

Table 2. INSPIRE mandatory metadata

Part B			*Part C*			*Parts B & D*		
#	**Name**	**Description**	**Multiplicity**[8]	**Definition restriction**	**Condition(s)**[9]	**Value domain**[10]		
						Numerical identifier (N)	**Textual name**[11] **(T)**	**Conventional name**[12] **(C)**
1. Identification								

[8] The multiplicity is the allowed number of occurrences of the metadata element characterising a single resource. INSPIRE has its own code to represent multiplicities, defined in Part C of the IMR Annex. Here, we indicate the set of the allowed multiplicity values, regardless of definition restrictions. Consequently, where some restriction applies, the set of multiplicity values will include "0". If, for example, the restriction is RTCN = *service*, the multiplicity value will indeed be 0 for RTCN = *dataset*.
[9] If no condition applies, the provision of the metadata element is mandatory where defined (when applying, definition restrictions are stipulated in Column 5). Otherwise, it is mandatory at the specified condition(s).
[10] Each value in the domain is a quadruplet {N, T, C, D} where N is the numerical identifier, T the textual name, C the conventional name and D an optional free-text description or definition of the value. Depending on the metadata element, some (but not all) of the components N, T, C and D can be empty.
[11] "Free" text which may be translated into a "natural language" different from English.
[12] Character string or set of character strings.

1.1	Resource title	Characteristic and often unique name by which the resource is known	1	/	/	/	*Free*	/
1.2	Resource abstract	Brief narrative summary of the content of the resource	1	/	/	/	*Free*	/
1.3	Resource type[13]	Type of resource being described by the metadata	1	/	/	1.1	Spatial data set series	series
						1.2	Spatial data set	dataset
						1.3	Spatial data service[14]	service[14]
1.4	Resource locator	Link(s) to the resource and/or to additional information	{0, 1, …}	/	If existing	/	/	*URL*
1.5	Unique resource identifier (URI)	Value uniquely identifying the resource	{1, …}	/	/	/	/	*{code, namespace}*
1.6	Coupled resource	URI of the target spatial data set(s)	{0, 1, …}	RTCN = *service*	If existing	/	/	*{code, namespace}*

[13] The resource type conventional name will be abbreviated as RTCN in this table.
[14] In the IMR Annex, *T = Spatial data services* and *C = services* (plural). We suspect that this might be a mistake since anywhere else in the IMR a resource is said to be a *data set*, a *data set series* or a (= one) *service* (singular). To be investigated.

1.7	Resource language	The language(s) used within the resource	{0, 1, …}	RTCN = *dataset* or *series*	• If the resource includes textual information • Language(s) must belong to the ISO 639-2[15] list	/	/	*3-letter character string as defined in the ISO 639-2 standard*[15]

2. Classification of spatial data and services

2.1	Topic category	High-level class(es) of the INSPIRE topic classification scheme – to assist in the topic-based search of available spatial data resources	{0, 1, …}	RTCN = *dataset* or *series*	/	2.1	Farming	farming
						2.2	Biota	biota
						2.3	Boundaries	boundaries
						2.4	Climatology / Meteorology / Atmosphere	climatologyMeteorologyAtmosphere
						2.5	Economy	economy
						2.6	Elevation	elevation
						2.7	Environment	environment
						2.8	Geoscientific Information	geoscientificInformation
						2.9	Health	health

[15] For sale at http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=4767 ; viewable (for example) at http://www.loc.gov/standards/iso639-2/php/code_list.php

						2.10	Imagery / Base Maps / Earth Cover	imageryBaseMapsEarthCover
						2.11	Intelligence / Military	intelligenceMilitary
						2.12	Inland Waters	inlandWaters
						2.13	Location	location
						2.14	Oceans	oceans
						2.15	Planning / Cadastre	planningCadastre
						2.16	Society	society
						2.17	Structure	structure
						2.18	Transportation	transportation
						2.19	Utilities / Communication	utilitiesCommunication
2.2	Spatial data service type	Class of the INSPIRE service type classification scheme – to assist in the search of available services	{0, 1}	RTCN = *service*	/	3.1	Discovery Service	discovery
						3.2	View Service	view
						3.3	Download Service	download
						3.4	Transformation Service	transformation
						3.5	Invoke Spatial Data Service	invoke

						3.6	Other Service	other

3. Keyword								
3.1	Keyword	Word, formalised word or phrase commonly used to describe the resource subject – to help narrowing a full text search	{1, …}	/	/	If RTCN = *dataset* or *series* :		
						/	*Free but at least one concept from the GEMET thesaurus* [16]	/
						If RTCN = *service :*		
						/	*Free but at least one concept from the IMR Annex* [1], *Part D, Section 4. For example:*	/
						602	Temporal subsetting service	temporalSubsettingService
3.2	Originating controlled vocabulary	Citation of the controlled vocabulary from which the keyword value is borrowed (if borrowed from a	{1, …}	For every keyword value provided	If relevant	/	*Citation including at least the title and reference date of the controlled vocabulary*	/

		controlled vocabulary)						

4. Geographic location

4.1	Geographic bounding box	Extent of the resource in the geographic space, given as a bounding box	{0, 1, …}	/	For RTCN = *dataset* or *series*, always mandatory For RTCN = *service*, mandatory if relevant	/	*Westbound and eastbound longitudes, southbound and northbound latitudes, in decimal degrees with a precision of at least two decimals*	/

5. Temporal reference

5.1	Temporal extent	Time period covered by the content of the resource	{0, 1}	/	If no value is given for 5.2, 5.3 & 5.4 [16]	/	*Individual date or interval of dates or mix of individual dates and intervals*	/

[16] At least one of the metadata elements 5.1 to 5.4 must be provided.
[17] The default temporal reference system shall be the Gregorian calendar with dates expressed in accordance with ISO 8601 – cf. http://dotat.at/tmp/ISO_8601-2004_E.pdf

							+ citation of temporal reference system used if not Gregorian & ISO 8601[17]	
5.2	Date of publication	Date(s) of publication or date of entry into force	{0, 1, …}	/	If no value is given for 5.1, 5.3 & 5.4 [16]	/	*Date(s)* *+ citation of temporal reference system used if not Gregorian & ISO 8601*[17]	/
5.3	Date of last revision	Date of last revision	{0, 1}	/	• If relevant • If no value is given for 5.1, 5.2 & 5.4 [16]	/	*Date + citation of temporal reference system used if not Gregorian & ISO 8601*[17]	/
5.4	Date of creation	Date of creation	{0, 1}	/	If no value is given for 5.1, 5.2 & 5.3 [16]	/	*Date + citation of temporal reference system used if not Gregorian & ISO 8601*[17]	/

6. Quality and validity

6.1	Lineage	Process history and/or overall quality, optionally including 'Yes/No' statement on whether the data set has been validated or quality assured, whether it is the official version and whether it has legal validity	1	RTCN = *dataset* or *series*	/	/	*Free*	/
6.2	Spatial resolution[18]	Level of detail[19] of the data set	{0, 1, …}	/	• For RTCN = *dataset* or *series*, if feasible • For RTCN = *service*, if "a restriction exists on the spatial resolution"	/	*Set of zero to many resolution distances*[20] *or equivalent scales*[21]	/

7. Conformity

[18] This is actually the geographic resolution. N.B. No variable different than length is allowed. E.g., no angular distance is allowed (while angular distances are mandatory for the bounding box).
[19] This is actually the level of geographic detail of the data set.
[20] "A resolution distance is expressed by a numerical value associated with a unit of length".
[21] "Equivalent scale is generally expressed as the (integer) value of the scale denominator".

7.1	Specification	Citation of specification(s) to which the resource conforms[22]	{1, …}	/	/	/	*Citation(s) including at least the specification title and reference date*	/
7.2	Degree	Degree of conformity to the specification	{1, …}	For every specification provided	/	5.1	Conformant	conformant
						5.2	Not conformant	notConformant
						5.3	Not evaluated	notEvaluated

8. Constraint related to access and use

8.1	Conditions applying to access and use	Conditions for access and use including, where applicable, corresponding fees[23]	{1, …}	/	/	/	*Free.* *Alternatives:* • no conditions apply • conditions unknown	/
8.2	Limitations on public access	Limitations on public access imposed by an EU Member State under Article 13	{1, …}	/	/	/	*Free.* *Alternative:* no limitation on public access	/

[22] Including, if applicable, implementing rules adopted under Article 7(1) of the INSPIRE Directive.
[23] As required by Articles 5(2)(b) & 11(2)(f) of the INSPIRE Directive.

		of the INSPIRE Directive, and reasons for them						

9. Organisation responsible for the establishment, management, maintenance and distribution of spatial data and services

9.1	Responsible party	Organisation(s)[24] responsible for the establishment, management, maintenance and distribution of the resource	{1, …}	/	/	/	*Organisation name*	*Organisation e-mail address*
9.2	Responsible party role	Role of responsible organisation	{1, …}	For every responsible party named	/	6.1	Resource provider	resourceProvider
						6.2	Custodian	custodian
						6.3	Owner	owner
						6.4	User	user
						6.5	Distributor	distributor
						6.6	Originator	originator
						6.7	Point of contact	pointOfContact
						6.8	Principal investigator	principalInvestigator

[24] The IMR speaks of « the organisation ». Since, on the other hand, it specifies that the multiplicity of this metadata element is “at least one”, it is to be assumed that several organisations may be named (e.g. in the case of distributed roles).

						6.9	Processor	processor
						6.10	Publisher	publisher
						6.11	Author	author

10. Metadata on metadata

10.1	Metadata point of contact	Organisation(s)[24] responsible for the creation and maintenance of the metadata	{1, …}	/	/	/	*Organisation name*	*Organisation e-mail address*
10.2	Metadata date	Date of creation or update of the metadata record	1	/	/	/	*Date conform to ISO 8601*[25]	/
10.3	Metadata language	Language in which the metadata are expressed	1	/	/	/	*Name of an official language of the EC expressed in conformity with ISO 639-2*[15]	/

[25] Cf. http://dotat.at/tmp/ISO_8601-2004_E.pdf

6 References

1 Commission Regulation (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata ("INSPIRE Metadata Regulation"), Official Journal of the European Union, December 4, 2008.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:326:0012:0030:EN:PDF

2 INSPIRE, Draft Guidelines – INSPIRE metadata implementing rules based on ISO 19115 and ISO 19119, April 25, 2008.
☞ http://inspire.brgm.fr/Documents/MD_IR_and_ISO_20080425.pdf

3 Gaines, S.E. and R.S. Hipskind, Format Specification for Data Exchange, Version 1.3 ("NASA Ames Format"), June 18, 1998.
☞ http://espoarchive.nasa.gov/archive/docs/formatspec.txt

4 NetCDF Climate and Forecast (CF) Metadata Convention.
☞ http://cf-pcmdi.llnl.gov/

5 Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) ("INSPIRE Directive"), Official Journal of the European Union, April 25, 2007.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:108:0001:0014:en:PDF

6 EC, INSPIRE Consultation on the draft legal act on the harmonization and interoperability of environmental information as defined in Annexes II and III of the INSPIRE Directive.
☞ http://inspire.jrc.ec.europa.eu/index.cfm/pageid/201/consultation/45851

7 Péchinot, J.-M., and Q. Baghi, User Requirements Report, Version 6, PASODOBLE Deliverable D_I-USERS_2.1, November 1, 2010.

8 J.-C. Lambert, Air Quality Services Validation Protocol, PASODOBLE Deliverable D_CC-QUALITY_1.3, June 2011.

9 CEOS Cal/Val Portal, QA4EO, A Quality Assurance Framework for Earth Observation.
☞ http://calvalportal.ceos.org/cvp/web/guest/qa4eo

10 QA4EO, The Guide.
☞ http://qa4eo.org/docs/QA4EO_guide.pdf

11 QA4EO, A Quality Assurance Framework for Earth Observation: Principles, January 2010.
☞ http://qa4eo.org/docs/QA4EO_Principles_v4.0.pdf

12 QA4EO, A guide to expression of uncertainty of measurements, QA4EO-QAEO-GEN-DQK-006, v3, May 2009.
☞ http://qa4eo.org/docs/QA4EO-QAEO-GEN-DQK-006_v3.0.pdf

13 QA4EO, A guide to establish a Quality Indicator on a satellite sensor derived data product, QA4EO-QAEO-GEN-DQK-001, v4, March 2010.
☞ http://qa4eo.org/docs/QA4EO-QAEO-GEN-DQK-001_v4.0.pdf

14 QA4EO, A guide to establishing validated models, algorithms and software to underpin the Quality Assurance requirements of QA4EO, QA4EO-QAEO-GEN-DQK-005, v4, March 2010.
☞ http://qa4eo.org/docs/QA4EO-QAEO-GEN-DQK-001_v4.0.pdf

15 QA4EO, A guide to content of a documentary procedure to meet the Quality Assurance requirements of GEO, QA4EO-QAEO-GEN-DQK-002, v3, May 2009.

☞ http://qa4eo.org/docs/QA4EO-QAEO-GEN-DQK-002_v3.0.pdf

16 EIONET GEMET Thesaurus.
☞ http://www.eionet.europa.eu/gemet

17 JCGM, International Vocabulary of Metrology – Basic and general concepts and associated terms (VIM), v3, JCGM 200:2008, 2008.
☞ http://www.bipm.org/en/publications/guides/vim.html

18 JCGM, Evaluation of measurement data – Guide to the expression of uncertainty in measurement (GUM), v2, JCGM 100:2008, 2008.
☞ http://www.bipm.org/en/publications/guides/gum.html

19 BIPM, International System of Units (SI), Eighth edition, 2006.
☞ http://www.bipm.org/utils/common/pdf/si_brochure_8_fr.pdf

7 Abbreviations & acronyms

ASCII	*American Standard Code for Information Interchange*
BIPM	*Bureau International des Poids et Mesures – International Bureau of Weights and Measures* ☞ http://www.bipm.org/
CEOS	*Committee on Earth Observation Satellites* ☞ http://www.ceos.org/
CF	*Climate and Forecast* [4]
EC	*European Commission* ☞ http://ec.europa.eu/
EIONET	*European Environment Information and Observation Network* ☞ http://www.eionet.europa.eu/
EO	Earth Observation
ESA	*European Space Agency* ☞ http://www.esa.int/
EU	European Union
FP7	*Seventh Framework Programme* of the EC ☞ http://ec.europa.eu/research/fp7/
FTPS	*Secure File Transfer Protocol*
GEMET	*General Multilingual Environmental Thesaurus* [16] ☞ http://www.eionet.europa.eu/gemet
GEO	*Group on Earth Observation* ☞ http://www.earthobservations.org/
GMES	*Global Monitoring for Environment and Security*, joint initiative of the EC and ESA for the establishment of a European capacity for EO ☞ http://www.gmes.info/
GUM	*Guide to the expression of uncertainty in measurements* [18]
IMIR	*INSPIRE Metadata Implementing Rules* draft [2]
IMR	*INSPIRE Metadata Regulation* [1]
INSPIRE	*Infrastructure for Spatial Information in the European Community* ☞ http://inspire.jrc.ec.europa.eu/
IR	Implementing Rule(s)
ISO	*International Organization for Standardization* ☞ http://www.iso.org/
IV	Independent Variable
JCGM	*Joint Committee for Guides in Metrology*
MACC	*Monitoring Atmospheric Composition and Climate* ☞ http://www.gmes-atmosphere.eu/
NASA	*National Aeronautics and Space Administration* (USA) ☞ http://www.nasa.gov/
NetCDF	*Network Common Data Format*

	☞ http://www.unidata.ucar.edu/software/netcdf/
NIST	*National Institute of Standards and Technology* (USA) ☞ http://www.nist.gov/
NRT	Near-Real Time
OGC	*Open Geospatial Consortium* ☞ http://www.opengeospatial.org/
PASODOBLE	*PROMOTE Air Quality Services Integrating Observations - Development of Basic Localised Information for Europe*, FP7 project (May 2010 – April 2013) ☞ http://www.myair-eu.org/
PCMDI	*Program for Climate Model Diagnosis and Intercomparison* ☞ http://www-pcmdi.llnl.gov/
PROMOTE	*Protocol Monitoring for the GMES Service Element Atmosphere*, project supported by the ESA (July 2006 – December 2009) ☞ http://www.gse-promote.org/
QA4EO	*Quality Assurance for Earth Observation* ☞ http://calvalportal.ceos.org/cvp/web/guest/qa4eo
QI	Quality Indicator
RTCN	Resource Type Conventional Name
SI	*Système international d'unités – International System of Units* [19] ☞ http://physics.nist.gov/cuu/Units/units.html
URI	Uniform Resource Identifier(s)
URL	Uniform Resource Locator(s)
VIM	Vocabulaire international de Métrologie – International Vocabulary of Metrology [17]
WP	Work Package(s)