Development and Integration of a Local Solar Atlas into a GEOSS compliant Global Spatial Data Infrastructure (GSDI)

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Abstract

In the framework of the Architecture Implementation Pilot - Phase 5 (AIP-5) of GEO (Group on Earth Observation) and with the support of the European Commission FP7-project (Seventh Framework Program) ENDORSE (ENergy DOwnstReam SErvices - Providing energy components for GMES; 2011-2013), we have developed a scenario to provide a free-access infrastructure to discover and exploit the solar potential of the Provence Alpes Cote d'Azur (PACA) region located in the South East of France. Several tens of calibrated maps of solar irradiation have been produced at a high spatial resolution (200 m) allowing to perform local level studies, i.e. at 1/250 000 scale. Providing online map and time series services offers an interesting trade-off between an educative and a fully expert approach to access solar radiation information as on-line local atlas. It is suitable for decision-support in solar energy policy planning and private investment as well as for educational purpose to promote solar energy. A Global Spatial Data Infrastructure (GSDI) has been developed that includes a community portal, a geographical server for hosting geospatial data, a geospatial data catalog allowing search and discovery of data of interest and a WebGIS client providing a user friendly application gathering in a single and dedicate GUI (Graphical User Interface) all data needed for practitioner to enable decision making for energy related projects. Thanks to the respect of international standards enabling interoperability, the components of the GSDI has been integrated and connected among others to larger international initiative such as GEOSS (Global Earth Observation System of Systems) and UNEP-GRID (United Nation Education Program) allowing a wider dissemination of the resources for the benefit of data providers on the one hand and of the renewable energy community on the other hand.

1 Introduction

The scenario developed in the GEOSS AIP-5 framework with the support of the FP7 ENDORSE project provides a local atlas suitable for local level analysis, namely 1/250 000. The selected region for the pilot study is the PACA (Provence Alpes Côte d'Azur) region in south east of France (Figure 1). The pilot among others exploits several services coming from the GMES (Global Monitoring for Environment and Security) Core Services. This include:

- MACC: HelioClim3 irradiance database
- SRTM elevation
- Geoland 2 land cover

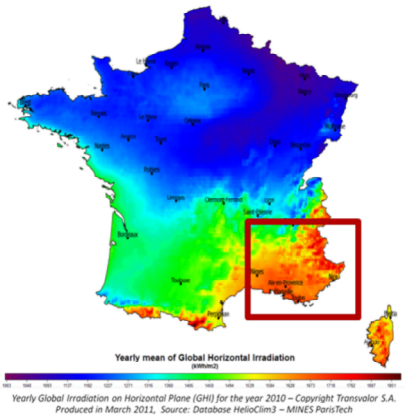

Figure 1: The PACA Region

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A portfolio of layers including high resolution (200 m) calibrated maps of solar irradiation (Figure 2) as well as ancillary meteorological data (e.g. temperature) and additional geospatial data (e. g. elevation, land cover, in-situ measurements) (Figure 3) has been provided and deployed on a geospatial web server (GeoServer).

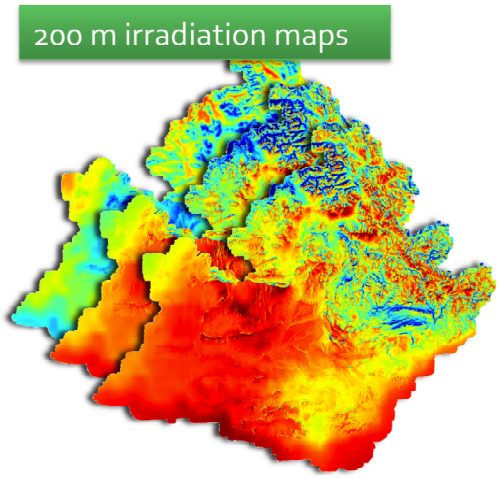

Figure 2: 200 m resolution calibrated irradiation maps

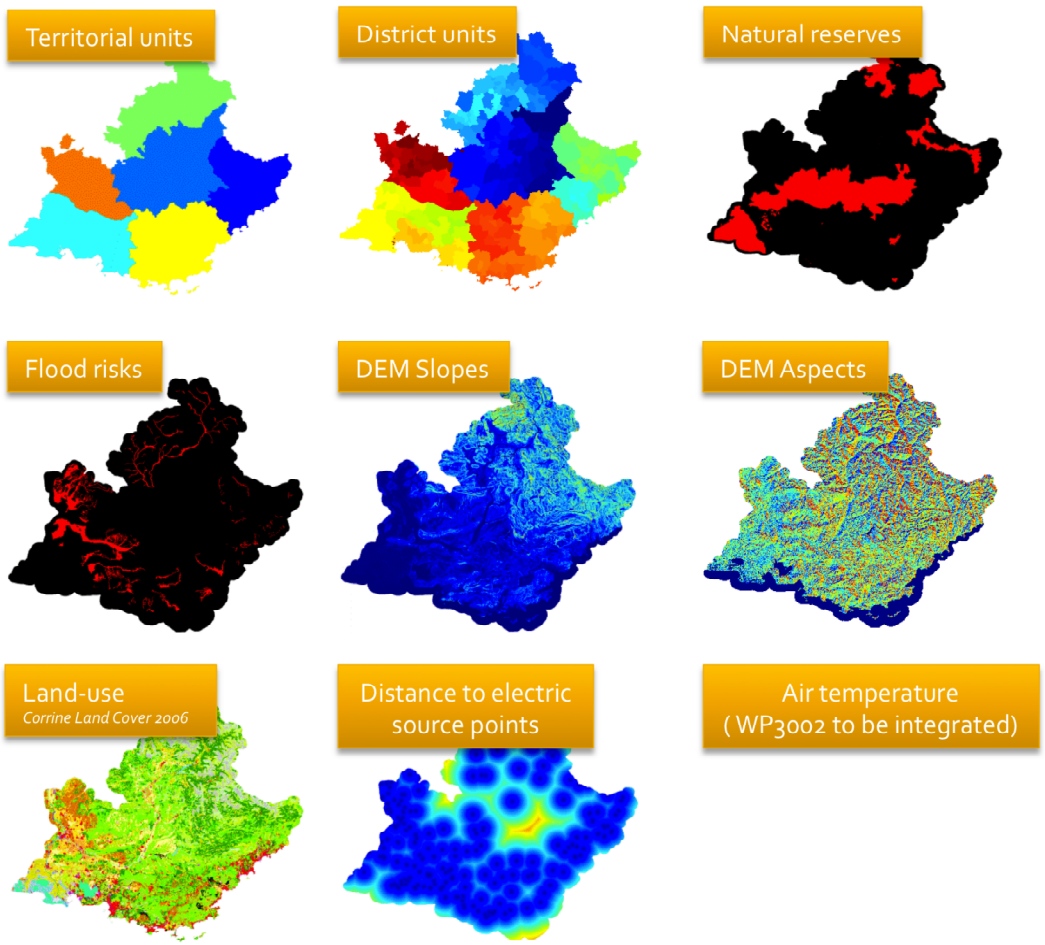

Figure 3: Ancillary maps

2 Local Atlas Methodology

The methodology for generating the local atlas make uses of detailed databases of surface solar irradiance on hourly basis as well as synthetic maps, e.g., monthly and annual mean values. It also includes meteorological data (wind speed, air surface temperature) as well as other information of other nature, such as physical, (orography, hydrography), administrative (cities, districts, protected areas, hazards…), or policies (regulation, incentives rules, plans).

2.1 State of the art

There are yet few examples of atlases at national scale, such as Australia, the United States of America, Canada or other countries in South America, Africa or Asia under the umbrella of the SWERA project of the UNEP. In Europe, the existing atlases, such as the European Solar Radiation Atlas of the European Commission, or the Photovoltaic Geographical Information System (PV-GIS) of the Joint Research Center, are a series of maps at scale of order 1/3 000 000.

2.2 Innovations

The major challenge is that there is no such atlas presently available that could be suitable for local level studies, i.e. at 1/250 000 scale. Several innovations have been carried-out to create such high-resolution atlas:

- The first innovation deals with the refinement in scale which will be suitable for local decisions.
- The second innovation is to combine irradiance and other meteorological data with data of various nature that is part of decision-making process.
- The third innovation is to allow the user to get the necessary data in just one request and not multiple as currently.
- The last innovation is that ENDORSE has developed replicable and scientifically-validated methods for creation of such atlases. In this respect, the current atlas can be seen as a first step towards more-founded methods and as a precursor of the proposed service.

Such an integrated tool will allow users and stakeholders to query, view, access and exchange the relevant information. Standardization of the process with respect to international standards and the definition of a modular content will ensure replicability of the service.

3 Implementation of the Global Spatial Data Infrastructure (GSDI)

The outcome of the AIP-5 scenario is an on-line atlas, therefore we need to provide the relevant portfolio of maps to the end users and accordingly deploy all the granular layers and associated information to be discoverable and accessible. As a result we've provided a GSDI that comprises interoperable components respecting GEOSS recommendation on interoperability including:

- A Community Portal
- A GeoServer hosting OGC (Open Geospatial consortium) compliant Web Services
- A Catalog providing standard ISO Metadata for dissemination
- Web-based Geodata Visualization client aka WebGIS client

3.1 The GEOSS Energy Community Portal

The GEOSS Energy Community Portal (www.webservice-energy.org) (Figure 4) is an effort carried out by the Center Observation, Impacts, Energy (O.I.E.) of MINES ParisTech / ARMINES towards the Energy and Environmental Community. It allows end-users to access a collection of Web services, data and applications in the field of renewable energy, environment and environmental impact assessment. Since 2009 it is registered as a GEOSS Energy Community Portal in the GEOSS registry.

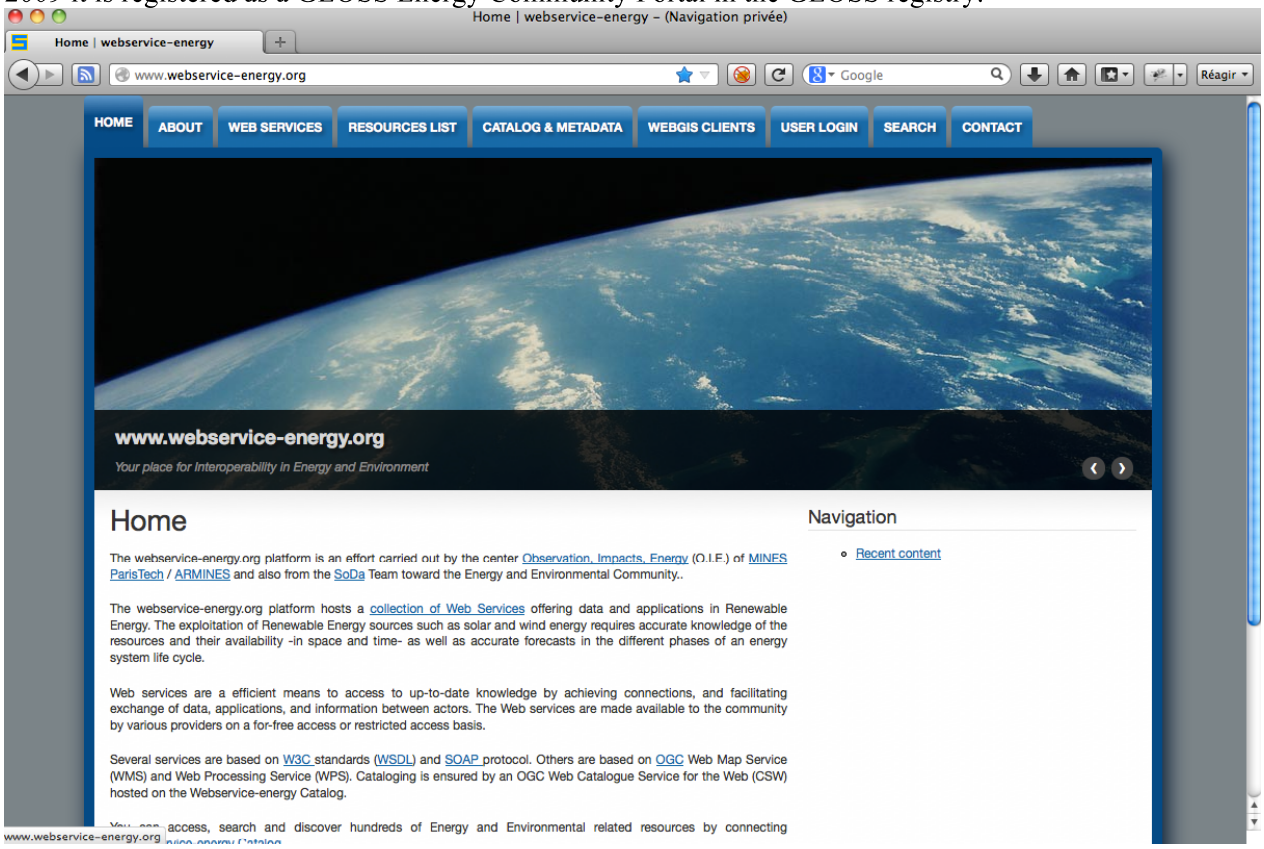

Figure 4: The GEOSS Energy Community Portal

3.2 The Geographical Server

All granular layers needed to implement the scenario have been provided as a form of interoperable resources following GEOSS recommendation. The GEOSS Energy Community Portal hosts a dedicated GeoServer (Figure 5) that provides several hundreds of interoperable resources as OGC Web Map Services (WMS) and Web Feature Service (WFS).

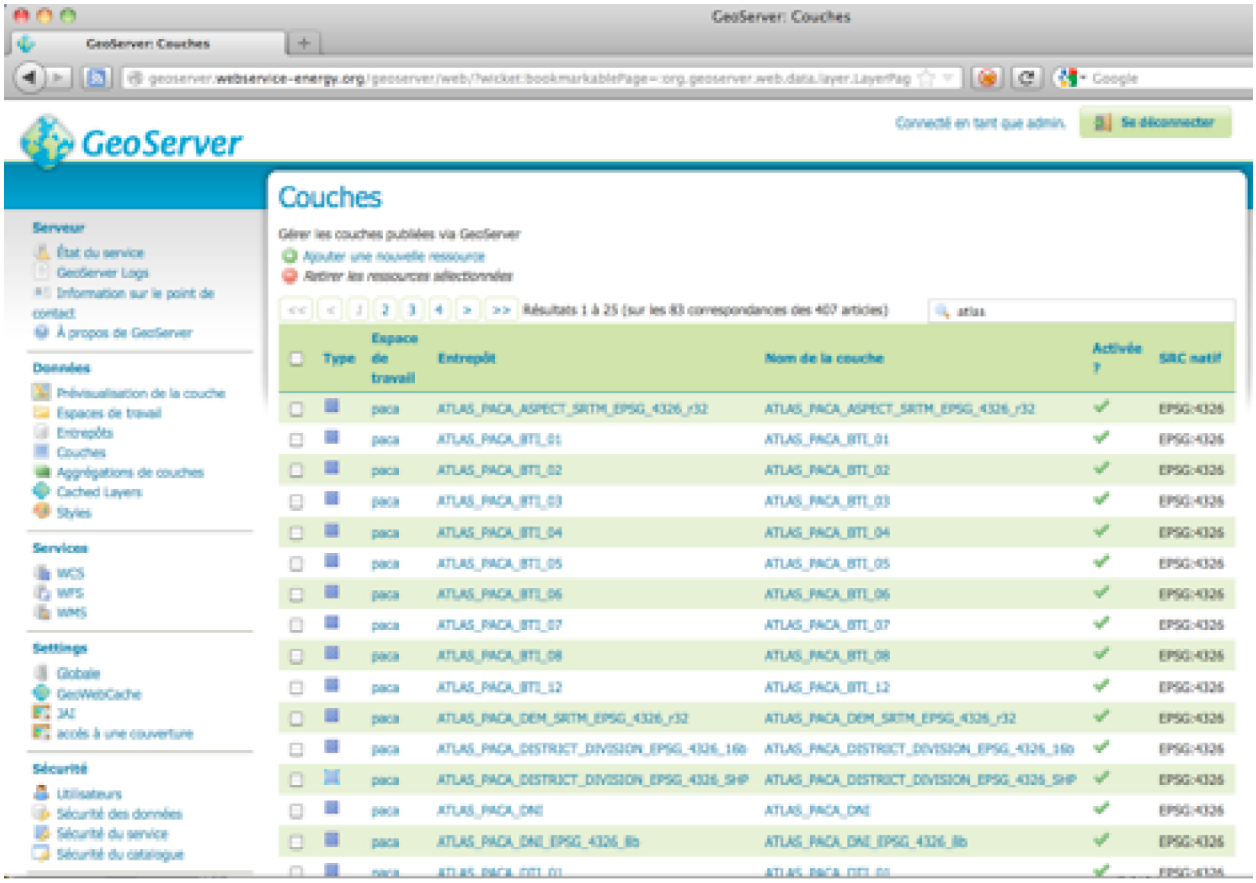

Figure 5: The webservice-energy.org GeoServer

3.3 The OGC Catalog

During the AIP-5 framework, MINES ParisTech has deployed an OGC Catalog Service for the Web (CSW) (Figure 6). This catalog offers a single Internet access point for users seeking data, datasets, services, maps, imageries, algorithms… related to energy and environment relevant to all parts of the globe. The Webservice-energy catalog is built upon the GeoNetwork catalog application (http://geonetwork-opensource.org/).

Figure 6: The webservice-energy.org OGC Catalog

3.4 The WebGIS Client

In order to allow users to select and display geographic layers of the PACA region for any thematic granular information dataset of interest MINES ParisTech has developed a customized geographic WebGIS client (http://www.webservice-energy.org/viewer/heron/applications/atlas-paca/) (Figure 7). This WebGIS client is based on the Heron Mapping Client (MC) available under the GNU GPL v3 license (http://heron-mc.org/index.html) that facilitates the creation of browser-based web mapping applications with the GeoExt JavaScript toolkit.

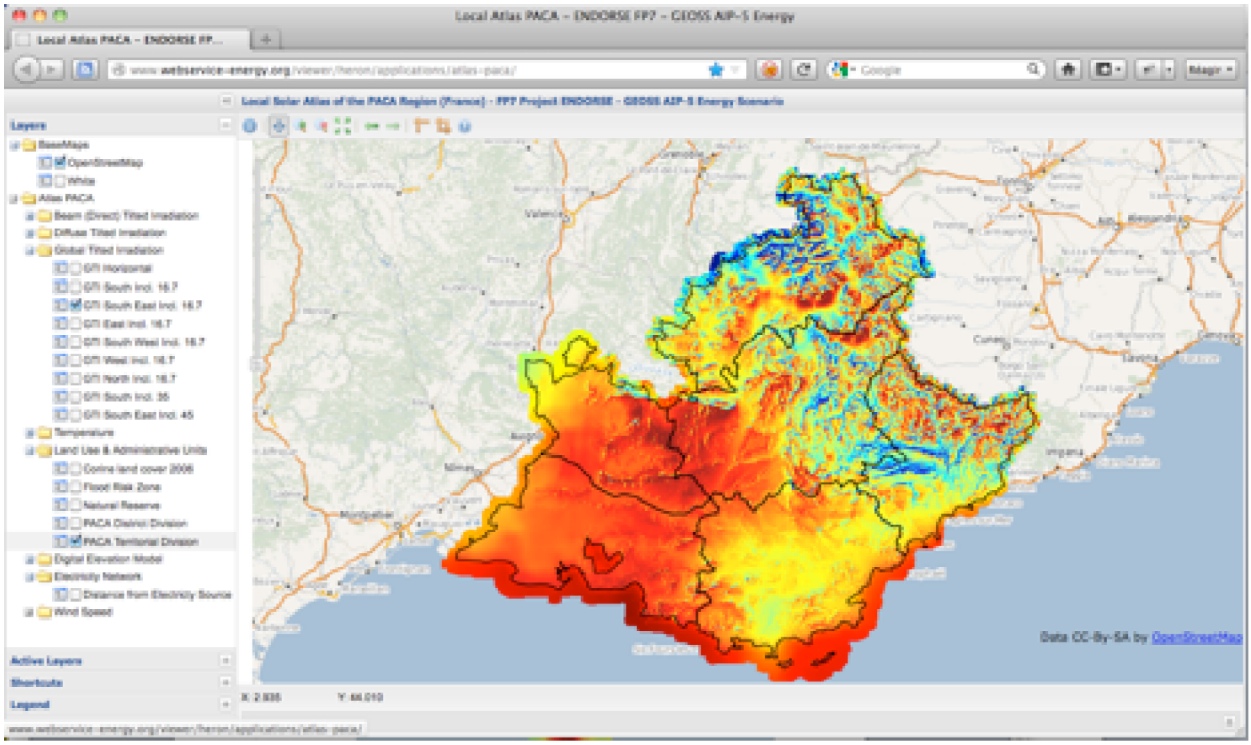

Figure 7: The PACA Region Local Solar Atlas WebGIS Client

4 Towards GEOSS integration

The Group on Earth Observation (GEO) is coordinating the development of GEOSS (Global Earth Observation System of Systems) and promotes interoperability. Interoperability has been defined as *the capability of the user interface and administrative software of one instance of a service to interact with other instances of same type of services* (Khalsa/Nativi/Geller 2009), (CEOS 2008). GEOSS addresses interoperability by providing guidance and recommendations on "interoperability arrangements" that promote the convergence of Earth observing systems. Following such guidance during the development of the GSDI has permitted the integration and the connection of the GSDI components to larger international initiative such as GEOSS and also to UNEP-GRID (United Nation Education Program). Having enabled such approach allows a wider dissemination of the resources promoted in the GSDI for the benefit of data providers on the one hand and of the renewable energy community on the other hand.

4.1 Connection to the GEOSS Common Infrastructure (GCI)

The global GEOSS architecture is build upon the GEOSS Common Infrastructure or GCI (Figure 8). The GCI is designed and deployed to:

- Allow GEOSS resources (e.g. systems, data, services) to be easily discovered and accessed.
- Improve interoperability for existing and future observation systems.
- Build an Open Infrastructure in accordance with the GEOSS Data Sharing Principles.

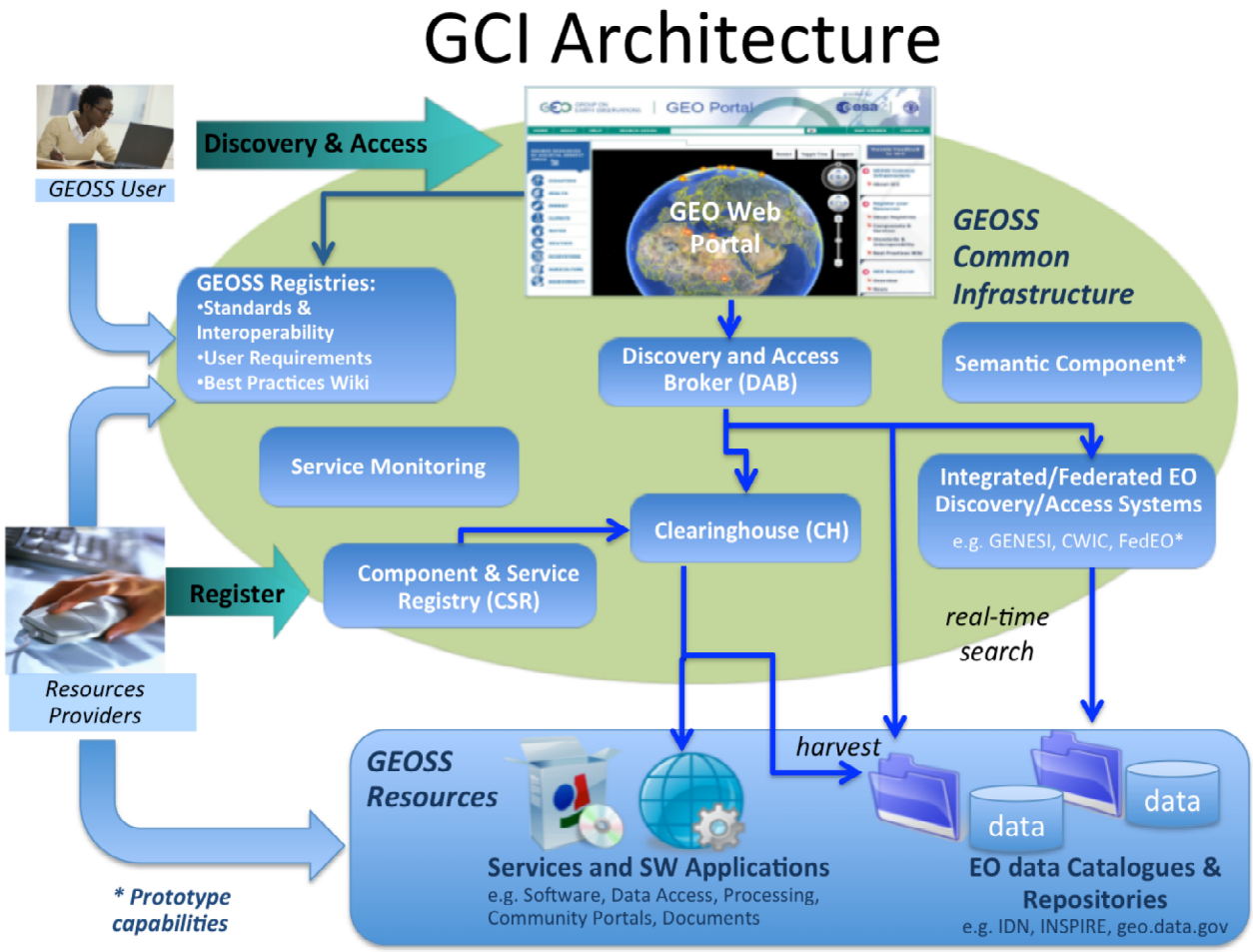

Figure 8: The GEOSS Common Infrastructure (GCI)

The catalog deployed in the GSDI has been integrated as a new available resource in the GCI through the GEO Discovery and Access Broker (GEO DAB). The catalog is accessible through a Catalog Service for the Web (CSW/ISO) standard interface. The content of the catalog is harvested by the GEO DAB. A set of check-test has been performed in order to assess the correctness of the integration of the metadata discovered via the GEO DAB. After this assessment, the catalog was integrated in the operational GCI. Presently the catalog provides around 400 records to be possibly discovered by the GEO DAB and consequently made available to the GEOSS community through the GEO Web Portal (GWP).

In the framework of the AIP-5 some research has been conducted to implement the use of Helper Applications. When the user place a query in a catalog and finds a dataset of interest, it is often the case that he is not provided with any tool which is able to access and exploit that dataset. A Helper Application is a client application that is bind to a given dataset and that is able to access and/or visualize it through:

- One or more web service protocols;
- One or more encoding formats.

In order to provide users with Helper Applications, it is needed to enrich providers' metadata record with the needed information to access the data with one or more Helper Applications. Moreover, when the discovered metadata record already provides a Helper Application, this should be marked as the provider's recommended Helper Application. As a results Helper Application provides additional capabilities upon a

dataset, a service or a given resource discovery process. An additional capability could for example link a remote URL based WebGIS client to a metadata record in order to enable such resources to be bind with the most appropriate client as specified and advertise by the resource provider upon metadata creation.

In AIP-5, new developments have been carried out in order to enhance the capability of the catalog to provide the users with such information if made available by the resource provider.

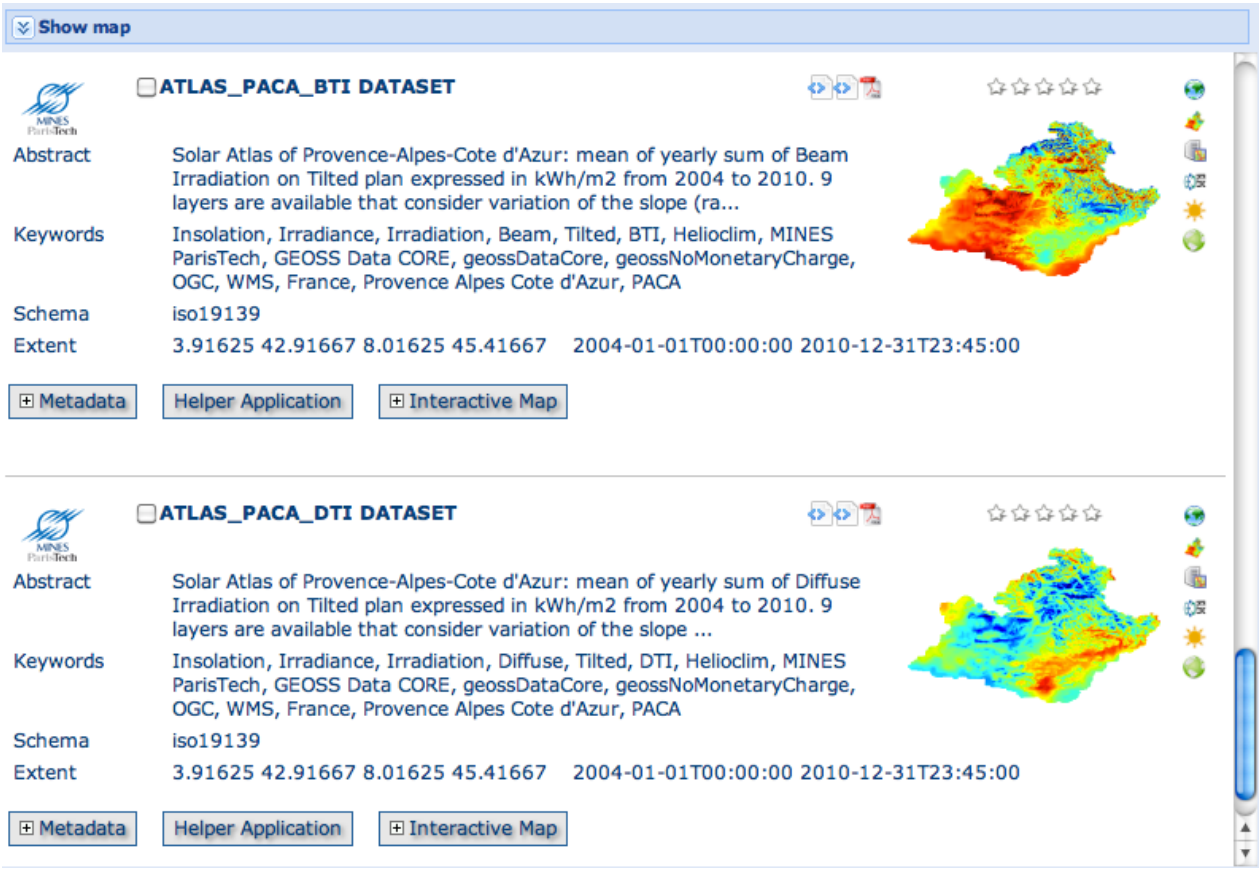

Figure 9: Implementation of Helper Application as an ISO 19139 Metadata Tag

5 Metadata Consistency Analysis

An analysis for consistency presentation of original metadata when searched and displayed in the GEO Web Portal (GWP) has been conducted. As GEOSS is based on a distributed approach, it's content, as available in the GEO Portal, is provided from harvested remote resources such as legacy catalog, database, repositories, etc…The webservice-energy catalog is regularly harvested by the GEO Discovery and Access Broker (DAB). Though a global coherence exists, there are still some discrepancies of presentation in the GWP compared to the original metadata presentation in the webservice-energy catalog.

Besides the global rendering of metadata in the GWP, two particular items have been analyzed:

1. The above mentioned Helper Application capability
2. The GEOSS Data CORE label

The GEOSS Data Collection of Open Resources for Everyone (Data-CORE) is a distributed pool of documented datasets, contributed by the GEO community under the following principles:

- The data are free of restrictions on re-use;
- User registration or login to access or use the data is permitted;
- Attribution of the data provider is permitted as a condition of use;
- Marginal cost recovery charges (i.e., not greater than the cost of reproduction and distribution) are permitted.

Resources provided in the webservice-energy catalog are recorded as ISO 19139 metadata. Keywords fields are available. Keywords recommended by GEOSS to tag information as GEOSS Data CORE are: *geossDataCore*, *geossNoMonetaryCharge*. These fields have been use to tag relevant resources as GEOSS Data-CORE (Figure 10). By doing so, resource provider enable the necessary information regarding the use and constrains attached to its resources to be harvested by the DAB (Figure 11) and consequently available to GEOSS user on the GWP (Figure 12).

Figure 10: GEOSS Data CORE keywords in ISO 19139 Metadata on webservice-energy catalog

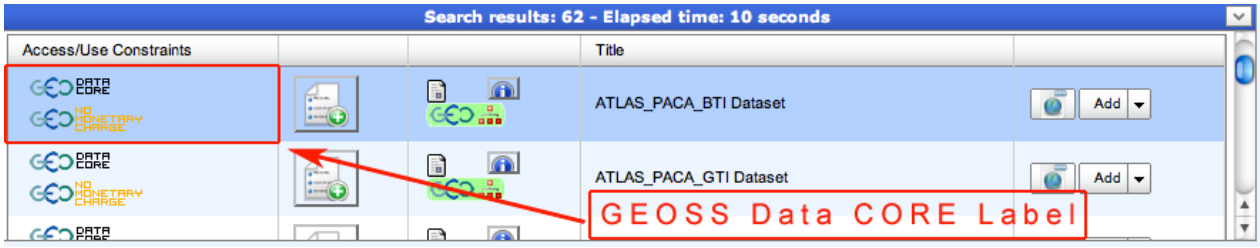

Figure 11: GEOSS Data CORE label as rendered in the GEO Discovery and Access Broker (DAB)

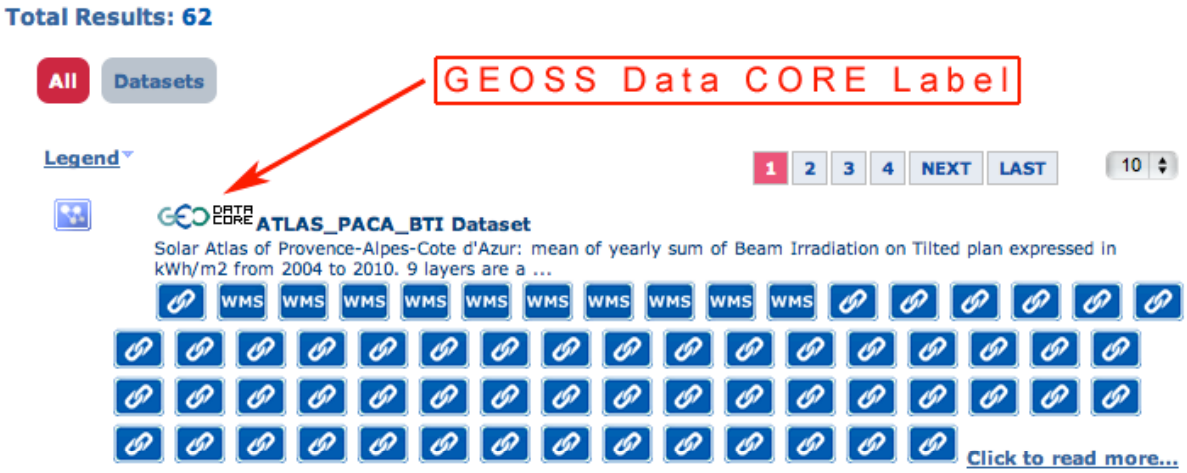

Figure 12: GEOSS Data CORE label as rendered in the Geo Web Portal (GWP)

As we've seen, the GEOSS Data CORE information is globally disseminated through the standard GEOSS GCI workflow. Nevertheless on can note that the *geossNoMonetaryCharge* label is missing on the GWP. This issue has been reported to the GWP development team and will be fix in next GWP releases. Despite this missing label it worth notice that starting from the original keywords embedded in the ISO 19139 Metadata, through a harvest from the DAB, to the final destination on the GWP, GEO labeled information are flawlessly retained.

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