ESA Web Mapping Activities Applied to Earth Observation

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Thousands of Earth Observation satellite instrument products are generated daily, in a multitude of formats, using a variety of projection coordinate systems. This diversity is a barrier to the development of EO multi-mission-based applications and prevents the merging of EO data with GIS data, which is requested by the user community (value-added companies, service providers, scientists, institutions, commercial users, and academic users). The web mapping technologies introduced in this article represent an elegant and low-cost solution. The extraordinary added value that is achieved may be considered a revolution in the use of EO data products.

Introduction

Every day, ESA ground stations and processing centres acquire and process several gigabytes of raw instrument data, sensed by a wide variety of both ESA and non-ESA Earth Observation (EO) satellites, including Envisat, ERS, Landsat, Spot, JRS, NOAA AVHRR, Terra Modis, MOS, SeaWIFs and soon the Earth Explorer missions. While ESA has long and solid experience in the development of ground-segment systems (data acquisition and processing), the weakest elements in the end-to-end chain from satellite to user remain the user services, the product distribution, and the product handling by the users themselves.

Until recently, users have spent a significant amount of time developing their own software routines to read the products from each satellite mission, instead of focusing on the data exploitation. With the development of the Internet, our user community (scientists, institutional organisations, value-adding companies, services providers, private users, etc.) requires faster and easier access to the satellite instrument data products generated, as well as standard commercial or freeware tools to easily display and analyse those products. Taking advantage of the number of satellite missions now flying simultaneously, more and more user applications (e.g. oil-spill monitoring or Charter for Disaster Management tasks) require the combination of various instrument data products from several satellite missions, as well as their merging with both in-situ data and Geo-referenced Information Services (GIS) layers.

After presenting the typical problems encountered when trying to distribute satellite data, and browse products in particular, without relying on web mapping techniques and standards, this article describes how some of the OpenGis Consortium (OGC) services may streamline this activity. A description of the roles and functions supported by the main OGC components follows, including Web Map Servers (WMS), Web Feature Servers (WFS) and Web Coverage Servers (WCS). A practical implementation of a WMS at ESRIN is then described and examples are given of several further activities conducted following the successful outcome of the initial test case, including putting online a large database of active fires detected by ERS-2's ATSR-2 instrument.

A barrier to the full exploitation of ESA's EO products

In recent years, a large quantity of EO satellite products and associated information (e.g. catalogues of products, browse images) has been accessed by a wide community of users via the Internet. This includes, for instance, browse images from optical and radar sensors as well as higher level EO products such as global-ozone or sea-surface-temperature maps. Before the emergence of standard web mapping technologies, it was often the case that each category of product corresponding to different sensors and different projects was

distributed via dedicated web sites through heterogeneous and non-standard user interfaces based on a wide variety of proprietary software, imposing limitations on both data providers and users.

Data providers without web mapping servers
In the absence of a standard approach for accessing and distributing data, each new project team and application implementer had to 're-invent the wheel', designing in particular new interfaces between the user's web client and the provider's data server. The lack of powerful and re-usable mapping components also resulted very often in web sites with a static representation of the data and required trade-offs on geographic projections and – in the case of temporal datasets – on the time slices (weeks, months, years) used to display these data. The frequent overlaying of GIS information (coastlines, political boundaries, etc.) and annotations to support the data interpretation made the maps of little use beyond the mere scope of visualisation.

Furthermore, the scattering of products from a single distributor across different web sites using different interfaces and protocols has made it difficult to exploit the synergy between different sensors (e.g. active fires from an infrared sensor such as ATSR and NO_2 tropospheric emissions from a spectrometer such as GOME), making the whole dataset less attractive to the user community.

Users without web mapping support
Users needed to discover, search and access EO and GIS information spread over many different information systems, sometimes even when generated by the same data provider. They also needed to learn how to use the various corresponding user interfaces.

Often the information presented within a web site was self-standing and could not be combined with that from other data providers or with the user's own data for several reasons, such as different geographical projections, different sampling rates, and different formats. In the best case, when available, users had to download the raw data (ASCII tabulated values, binary products, etc.) and regenerate specific views suiting their purposes. Therefore, it was often simpler for users to discard data that were not crucial for them, as they could not be easily handled.

Breaking the barrier with web mapping services
Web mapping services provide an answer to most of the above problems by enabling a basic interoperability of simple map servers and clients. For the first time, users can access Geo-referenced Information Services in real-time, obtaining in a transparent way, space and non-space data coming from various data providers around the World. With access via the World Wide Web, users need no longer worry about the original formats of the data accessed, its location or its geographical projection. The data may be delivered to the users either in graphical form, as metadata or as binary data using either a Web Map Server (WMS), a Web Coverage Server (WCS), or a Web Feature Server (WFS). There are other types of services being offered by the OpenGis Consortium (OGC) TC211 group, but these are the main ones.

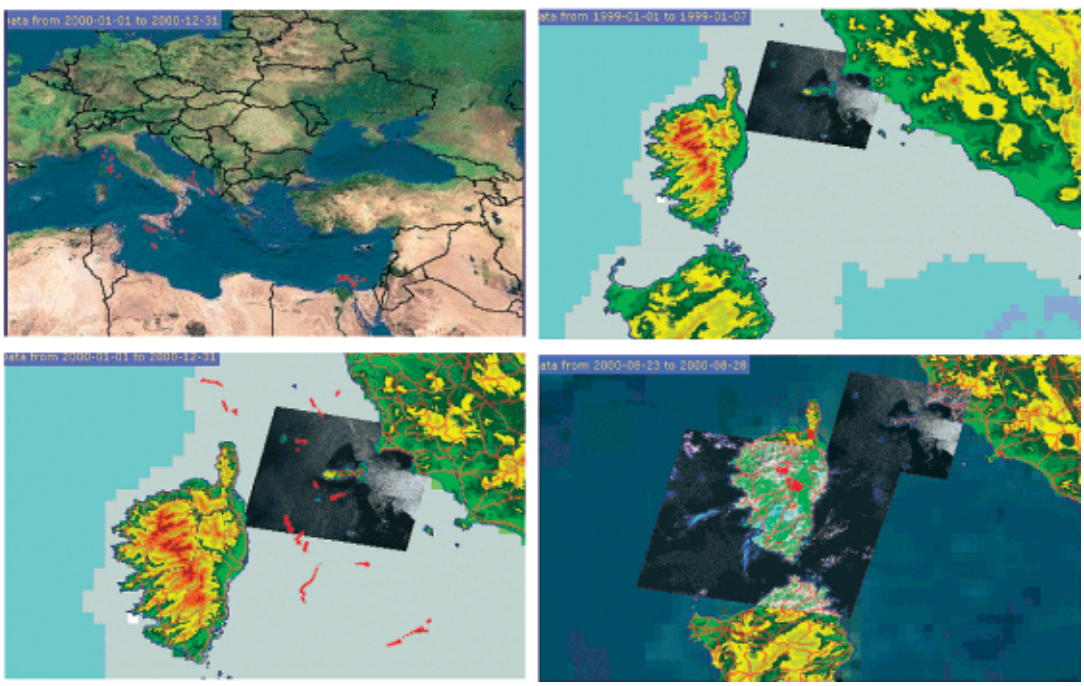


Figure 1. Examples of the combination of up to 7 GIS and EO satellite (Landsat TM, ERS-2 SAR) layers

They provide in particular:
- An easy and standard interface, allowing a simple web-browser client to access EO and GIS data distributed worldwide using a common and simple protocol. The interface is also well suited for automatic data retrieval (no need to manually interact via a web interface).
- Zooming, resampling, filtering and on-the-spot re-mapping of data with support for the most common geographical projections (Mercator, Lambert, UTM, Plate-Carrée, Orthographic).
- Separated thematic layers: the final overlaying is performed on the client side, allowing users to combine individual layers as needed for their particular application.

Being based on an Open Standard supported by a growing community of vendors such as Ionic, Cubewerx or ESRI, the list of distributed OGC-compliant servers is increasing, and already includes the larger space agencies such an NASA, NASDA and ESA, as well as international and national organisations such as USGS and JRC. Given data providers need only care for their own data, knowing that its users will automatically benefit from the wealth of additional GIS and EO information available from distributed servers around the World.

The OGC web mapping services

Standards and interoperability are becoming key factors in the development of information servers and services. In particular, the web mapping services as specified by the OpenGis Consortium (OGC) provide a flexible and low-cost method of combining data from several sources and presenting the combined information in a unified way, bringing significant added-value to the interpretation of satellite products.

Data visualisation: the Web Map Server (WMS)

In response to requests from a web client, a Web Map Server (WMS) generates 'pictures' of geo-referenced data, including EO data, in the form of images with standard formats. Independent of whether the underlying data are simple features (such as points, lines and polygons) or coverages (such as gridded fields), the WMS produces an image of the data that can be directly viewed with a graphical web browser or other picture-viewing software.

A WMS should handle at least two kinds of requests, to:
- list its capabilities (formats and projections supported, layers available, ..) (GetCapabilities request)
- deliver graphic files corresponding to one or more layers (GetMap request).

An additional type of request, GetFeatureInfo, that may provide additional information for a user-selected point of interest on a given layer, may also be included. We will now look at these three requests in more detail.

List of capabilities

In reply to the GetCapabilities request, a map server returns the list of all supported layers. This list is written in XML following strict rules (document type definition), so that besides being readable by a human, it can also be parsed by a catalogue system that could automatically index and update a set of available layers from a pre-defined list of Web Map Servers. For a given layer, the capabilities file specifies in particular the name of that layer to be used in subsequent queries, the geographic spread in one or more projection systems, and possibly the various representation styles available, and states whether the layer is queryable or not (see GetFeatureInfo below). Table 1 shows a fragment of a capabilities file for a layer providing coastlines.

```
<Layer queryable="0">
   <Name>COASTLINES</Name>
   <Title>Coastlines</Title>
   <Abstract>Coastlines from Digital Chart of the World</Abstract>
    <LatLonBoundingBox minx="-180" miny="-90" maxx="180" maxy="90" />
    <Style>
       <Name>BLACK</Name>
       <Title>BLACK</Title>
    </Style>
    <Style>
       <Name> DOTRED</Name>
       <Title>DOTRED</Title>
    </Style>
</Layer>
```

Table 1. Example of a layer description extracted from a 'capabilities file'

Map requests

A WMS client can specify via a specific request (GetMap) the information to be shown on the map (one or more 'layers'), possibly the 'styles' of those layers, what portion of the Earth is to be mapped (a 'bounding box'), the projected coordinate system to be used (the 'spatial reference system'), the desired output format, the output size (width and height), and the background transparency and colour. Typical output formats include Portable Network Graphics (PNG), Graphics Interchange Format (GIF), Joint Photographic Expert Group (JPEG), and Tagged Image File Format (TIFF).

When two or more maps are produced with the same bounding box, spatial reference system and output size, the results can be accurately layered to produce a combined/composite map. The use of image formats that support transparent backgrounds (e.g. GIF or PNG) allows the lower layers to be visible. Furthermore,

individual map layers can be requested from different servers. The WMS GetMap operation thus enables the creation of a network of distributed map servers from which clients can build customised maps.

Some geospatial information may be available at multiple times, such as an hourly weather map. Depending on the context, time values may appear as a single value, a list of values, or an interval.

A server may accept specific requests (e.g. for elevation or spectral band) as indicated in its capabilities file.

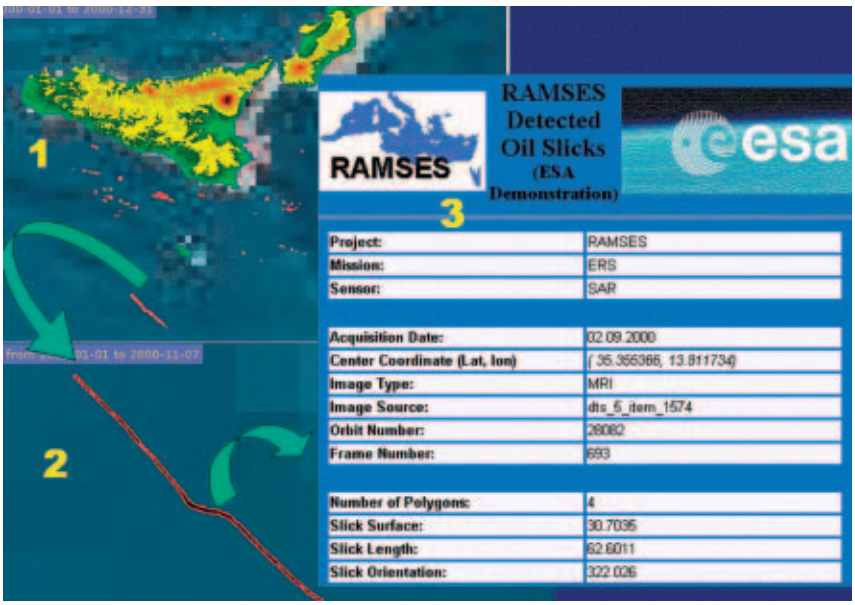


Figure 2. Feature information (3) relating to a specific oil slick (1 & 2)

Cascading Map Servers

Another very interesting feature of web mappers is 'cascading'. A Cascading Map Server can aggregate the contents of several distinct map servers into one service. It can also perform additional functions such as output-format conversion or coordinate transformation on behalf of other servers. If a client needs a layer from a provider in a projection not supported by that provider, the request may be issued to another WMS that will obtain the layer from the original provider and transform the image coordinates into the requested projection.

Information on a feature

Additional metadata information relative to a portion of a specific layer may be obtained. When invoking GetFeatureInfo, the client indicates which map is being queried and which location on the map is of interest. The source server is then queried to obtain the desired information. The WMS specification does not impose any specific constraint on the type of response to a GetFeatureInfo request. The decision is left to each particular application, which could, for example, return an image, an HTML or an XML file. An implementation of such a request is illustrated in Figure 2.

A WMS completely hides the underlying server architecture from the client, who always uses the same protocol to request layers. On the server side, GI data may be stored in several forms: database, flat files, images on a GIS server or generated by any program.

Because these servers are oriented towards web applications, where fast response times are expected, in order to give access to large data volumes, such as full-resolution EO images which can amount to several tens of megabytes per frame, some WMS implementations use various optimisation techniques including aggregation, i.e. the pre-calculation of the original image at various pre-defined scales in order to return any portion of the original image at any scale within a few seconds. The estimated overhead required by aggregation in terms of disk space is typically of the order of 20%.

Examples of requests

URL1 will return a map of the World consisting of a digital elevation model (GTOPO30) rendered with false colours, together with coastlines and political borders (digital chart of the World). For the sea surface, no data are requested and they will appear blue as requested by the BGCOLOR parameter. The map covers Europe as specified by the BBOX parameters. The projection is Plate-Carrée (EPSG code 4396). The returned image is reproduced in Figure 3.

URL1:
http://mapserv2.esrin.esa.it/cubestor/cubeserv/cubeserv.cgi?WMTVER=1.0.1&REQUEST=map&SRS=EPSG:4326&BBOX=-16.7,32.2,46.7,71.8&WIDTH=560&HEIGHT=350&LAYERS=GTOPO30:MapAdmin,COASTL_1M:MapAdmin,POLBNDL_1M:MapAdmin&STYLES=COLORMAP_GTOPO30,0X101040,BLACK&FORMAT=PNG&TRANSPARENT=FALSE&BGCOLOR=0x0000FF&EXCEPTIONS=INIMAGE

URL2 uses the same kind of layer combination, with just an extra bathymetry layer. The SRS parameter is AUTO:42003 this time, which corresponds to an orthographic projection. The centre point for the projection is 45ºN and 5ºE. For this kind of projection, the BBOX parameters express the map extent in metres from the centre point. Figure 4 shows the corresponding map returned by the server.

URL2:
http://mapserv2.esrin.esa.it/cubestor/cubeserv/cubeserv.cgi?WMTVER=1.0.1&REQUEST=map&SRS=AUTO:42003,9001,5,45&BBOX=-6400000,-6400000,6400000,6400000&WIDTH=300&HEIGHT=300
&LAYERS=ETOPO5:MapAdmin,GTOPO30:MapAdmin,COASTL_1M:MapAdmin,POLBNDL_1M:MapAdmin
&STYLES=COLORMAP_ETOPO5,COLORMAP_GTOPO30,0X101040,BLACK
&FORMAT=GIF&TRANSPARENT=TRUE&BGCOLOR=0x0000FF&EXCEPTIONS=INIMAGE

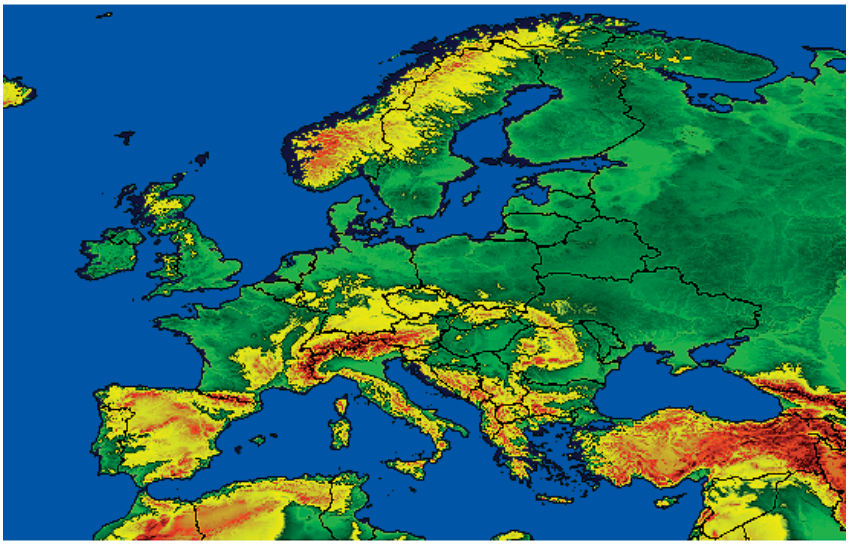


Figure 3. Image returned by URL1

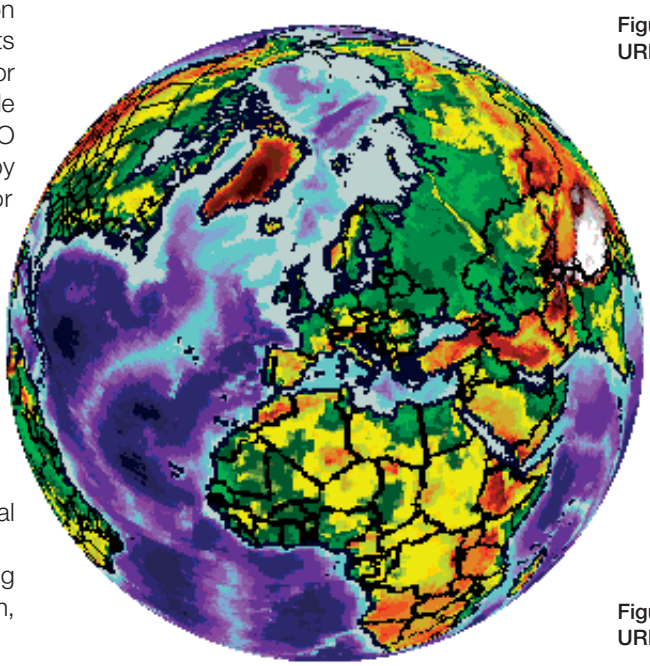


Figure 4. Image returned by URL2

Access to the product data and metadata
The WMS provides a graphical representation of GI and EO data in particular, using formats such as GIF or JPEG which are not suited for further processing because they do not provide the metadata available in standard EO products, lose track of engineering values by applying a simple colour code (GIF), or introduce degradation (JPEG). To allow users to access the underlying scientific data, the OGC introduces two additional components:

Web Feature Servers (WFS)
A WFS offers access to the geographic features (points, lines, and polygons) in a data store. In the context of EO applications, they may for example correspond to:
– the location of active fires with additional metadata (detection time, sensor, etc.)
– the detection of oil spills by remote-sensing radars (detection time, length, area, orientation, etc.)
– in-situ measurements.

A WFS does not provide a graphical representation of the requested features, but generally returns them in Geographical Markup Language (GML), which is XML based. For each feature, the GML structure provides the corresponding geographic information and associated metadata. The information returned to the user is extracted from a data store (e.g. Oracle database). The WFS also allows authorised users and applications to modify the server's database (create, update and delete records). In the case of active fire data, this GML content could be directly ingested into an atmospheric assimilation model.

As is the case for WMS, a WFS supports the GetCapabilities query with a similar syntax. The GetMap Query is replaced by the GetFeature query which, besides additional filtering specifications relevant to features only, accepts parameters very similar to the WMS GetMap, in particular for the specification of the time window and the geographic bounding box. It is therefore very easy to imagine a client that first allows a user to refine a particular query in a graphical mode relying on a WMS server, and then requests the data themselves in GML format, this time submitting the request to a WFS server, but using the same selection parameters as used with the WMS.

Despite being a rather recent specification, a WFS has already been implemented at ESRIN using commercial off-the-shelf (COTS) software from Ionic Software. This demonstration serving a large database of active fires detected by the ATSR-2 instrument onboard ERS-2 is further described below.

Web Coverage Servers (WCS)
A WCS offers access to the actual numeric values of gridded geo-referenced data or imagery (other, more sophisticated types of coverages are not addressed in the initial WCS specification). A WCS client can issue a

GetCoverage request to obtain these numeric values for further processing or rendering on behalf of the user. A WCS offers one or more layers, just like a WMS, but does not render them for the user and therefore does not offer 'styles'. GetCoverage includes the desired SRS, bounding box, and output format, but does not include a width or height because these apply only to images.

Possible output formats include GeoTIFF, NASA's Hierarchical Data Format implementation for the Earth Observing System (HDF-EOS), and an extension of GML for coverages that has been proposed to allow XML encoding of metadata about the coverage object and numerical values either stored online or referenced by link to an external file.

These servers allow users to request coverages directly, which in the case of EO could correspond to products from imaging sensors (including all bands) or level-3 products such as global ozone concentration maps (access to the ozone values and associated metadata). As in the case of the WFS, the WCS specification closely follows the one for Web Map Servers: i.e. it supports the GetCapabilities request and the GetCoverage request accepts parameters similar to the WMS GetMap request (BBOX, SRS …). Moreover, the GetCoverage requests accept additional parameters for, for example, selecting a limited number of bands from spectral sensors.

Some current ESRIN application projects

The ERS ATSR Active Fires Atlas

To demonstrate the adequacy and the interest of web mapping for EO applications, ESRIN decided to implement a first prototype to access, from a standard web browser, a large existing database spanning over 5 years of active fires (> 300 000 fires), originally produced for the Global ATSR Fire Atlas project. The fire-detection algorithm uses the 3.7 micron band of the ATSR-2 instrument on the ERS-2 satellite.

The test implementation has been based on the COTS software from the Belgium company Ionic, which consists of a combined OGC-compliant WFS/WMS server written in Java and a client application written in HTML and Javascript. With their technical assistance, a first version of the complete server also supporting the GetFeatureInfo request was put in place in less than one working week. In addition to the short time needed, another important feature is that the original existing Global ATSR Fire Atlas system did not have to be modified. Only a very basic and simple interface routine between the Global ATSR Fire Atlas and the Web Mapping Testbed had to be developed. The preserving of the original structure of the databases and the original formats of data/metadata is one of the strong features of the web mapping technology.

The individual ATSR fire hot spots are ingested into an Oracle 8i database. When receiving an OGC compliant query, the WMS/WFS performs the following steps:

- Extraction of fire data from the Oracle database according to the user-specified bounding box and time window, and generation of a GML (Geographic Markup Language) stream.
- Portrayal of fire hot spots: application of drawing or thematic rules (style sheets or other methods), which determine the graphical aspect of the geographic elements (point in this case). Several rules may be defined to allow different representations or styles of the same object, for example at different scales. The transformation also takes into account the requested projection. The output of the portrayal step is an SVG (Scalable Vector Graphic) stream. In the particular case of this demonstration, fires can be rendered as red dots, blue circles or small fire icons.
- Rendering of the SVG stream to generate a GIF or JPEG image that can be easily displayed on any web client.

Compliance with OGC standard interfaces (WMS, WFS) enables online access and the combination of map information coming from one or more distributed Web Mapping Servers. It only takes a few minutes to configure the client application to access new layers from any OGC-compliant server.

The GetFeatureInfo is supported, and by simply clicking on the map a user can obtain the metadata information relating to a particular fire. The fire information is returned in the form of a dynamically generated HTML page. The information page also provides geographical context maps which are themselves generated by additional calls to Web Map Servers.

An additional internal development is the link to the ESRIN Multi-mission User Services (MUIS) catalogue and browse servers, which include a large collection of browse images from ESA and third-party missions (more than 7 million entries and 200 000 passes of browse imagery). Using a dedicated bridge, the user can receive a list of all available browses within the MUIS catalogue that match a selected fire in time and geographical coverage. This system shows, in particular, the original ATSR frame used for the detection, but also the matching frames from other sensors (ERS SAR and Landsat TM), fostering the synergy between various missions.

Eventually, browse satellite images can be directly overlayed on a map, providing a quick and easy way of performing a first interpretation of satellite data by combining it with online GI context information. To illustrate the benefits of such a function, Figure 5 shows a typical case that could easily result in a misinterpretation. The image shows three fire hot spots detected in Northern Spain. Looking at the corresponding ATSR frame initially leads to the conclusion that the smoke from the fires was visible on the image. It was only after integrating the frame into the Web Map Server that it became obvious that the cold features that are visible do not actually match up with the locations of the hot spots and are more likely to be clouds.

Following the successful initial test using the ATSR active database, further activities have been conducted using web mapping techniques, examples of which are described below.

Detection of fires In Southeast Asia

In October 2000, the CEOS Working Group on Information Systems and Services (WGISS) established, in collaboration with GOFC (Global Observations of Forest Cover), a task team (WGISS Test Facility GOFC) to prototype and demonstrate the use of inter-operable data and services to improve the work of the GOFC scientists. The 2000 fire season in Southeast Asia, and in particular Northern Thailand, was selected as the demonstration area. ESRIN participated in the activities of this team, bringing the ATSR fire database served by the IONIC WFS/WMS server and by ingesting into the server additional active-fires information derived from NOAA/AVHRR and DMSP/OLS provided by other WTF/GOFC participants. The integration of external data from NOAA and NASDA was completed in a few hours thanks to the standard and simple web mapping protocol.

The ESRIN WMS client was also used to combine dynamically in a single map the active fire information from these various sensors, as well as layers from remote WMS servers, including in particular fire-risk maps and burn scars available from a NASDA server and a full-resolution Landsat image over Northern Thailand from a USGS server. Figure 6 is an example of such a combined map, which also includes extra layers taken from servers not linked to the WTF/GOFC activities. These extra layers include in particular the city names from a server in the Netherlands (DEMIS) and water bodies and roads from a Canadian server (Cubewerx). An interesting piece of information, unknown until the implementation of the Web Map Server, was discovered thanks to overlaying the three fire-detection layers (ERS ATSR, NOAA/AVHRR and DMSP/OLS). The spots discovered by each sensor did not correspond to those detected by the other two. This is vital information for scientists and engineers that remains to be explored and explained.

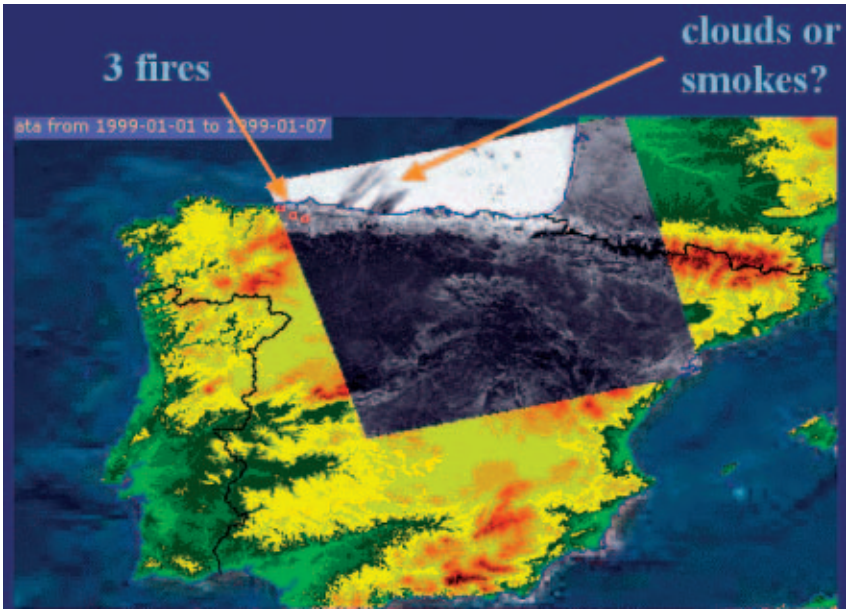


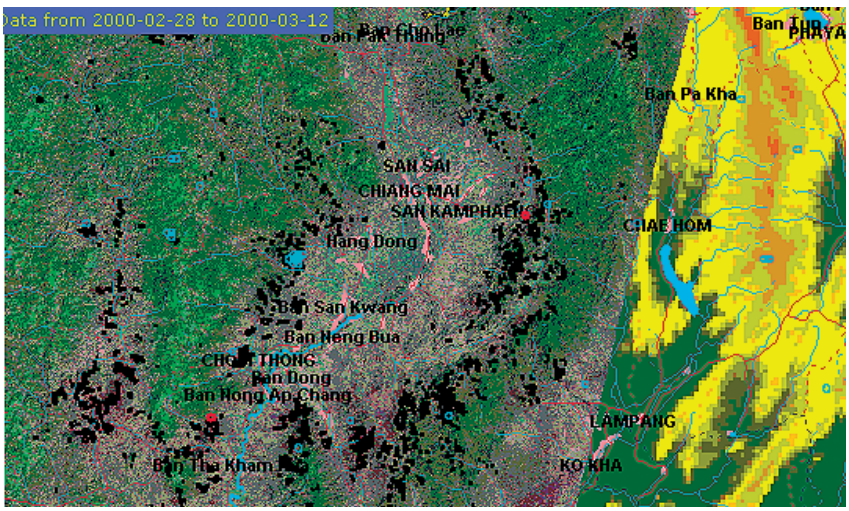
Figure 5. Possible case of misinterpretation: it is only by overlapping the ATSR frame with the detected hot spots that it becomes obvious that the cold features that are visible cannot be smoke from the detected hot spots

The ESA Web Mapping Testbed constitutes the cornerstone of the demonstration given at the last CEOS Plenary meeting, in Kyoto in November 2001. The success of that demonstration shows that the various CEOS members certainly appreciate the great benefit and added value of web mapping technology in the promotion and greater use of EO data.

Oil-spill monitoring in the Mediterranean

RAMSES is a project financed by the European Commission, the main objective of which is to detect oil slicks over the Mediterranean Sea using ERS SAR medium-resolution images. Over more than two years, SAR images have been acquired on an almost daily basis over seven regions of interest in the Mediterranean Sea. A database of over 500 oil slicks has been

Figure 6. Example of a map generated by the ESRIN WMS client in the framework of the WTF/GOFC activities. It combines ATSR fires (red dots) and AHVRR (light-blue dots), and black areas correspond to burn scars. ATSR and AVHRR fires cover the period 28 February to 12 March 2000



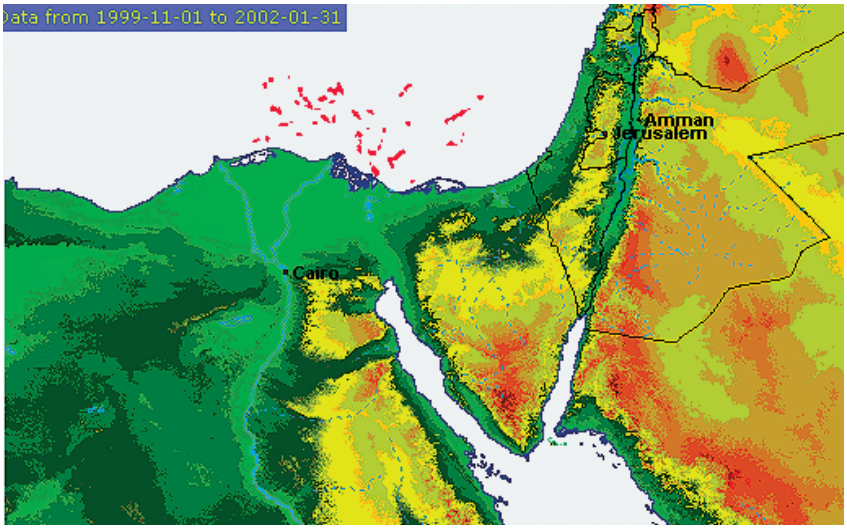


Figure 7. RAMSES oil-slick database for the Egyptian region of interest as seen from the ESRIN map server

built up, providing for each slick its geographic coverage in the form of a polygon as well as metadata (area, main orientation, radiometric values, etc.).

In the framework of this project, a dedicated browser application has been developed in Java. Despite providing the required functionality, this solution presents several problems: not least the interface between the client and the RAMSES server is proprietary and relies on a CORBA/IIOP protocol, which may cause access problems for users behind firewalls and makes it very difficult for these users to develop their own client application in order to merge the RAMSES oil-slick information with their own data, for example.

Considering the above limitations, the complete RAMSES database was ingested into the ESRIN WFS/WMS server. Data can now be viewed from anywhere using a simple web browser. Users can access metadata for each individual oil slick simply by clicking on that particular slick. Users can also download the 'raw' data in GML format. Another interesting advantage of the web mapping services is that the same software and hardware architecture used for the two projects described previously (Global ATSR Fire Atlas and the CEOS WGISS WTF GOFC) is fully reusable. The great strength of web mapping is that it is universal and can be used for a multitude of applications.

Once again, making the oil-slick information available online took less than one working week.

Client improvement

The improvement of the Web Mapping Testbed client interface is an on-going activity, reflecting the evolution of our Web Map Server environment. For instance, the selection of layers, illustrated in Figure 8, has been organised into categories and subcategories to cope with the ever-growing number of available layers. The selection window now also provides layer background information specifying geographic and time coverage, as well as hyperlinks to the projects from which the data originate.

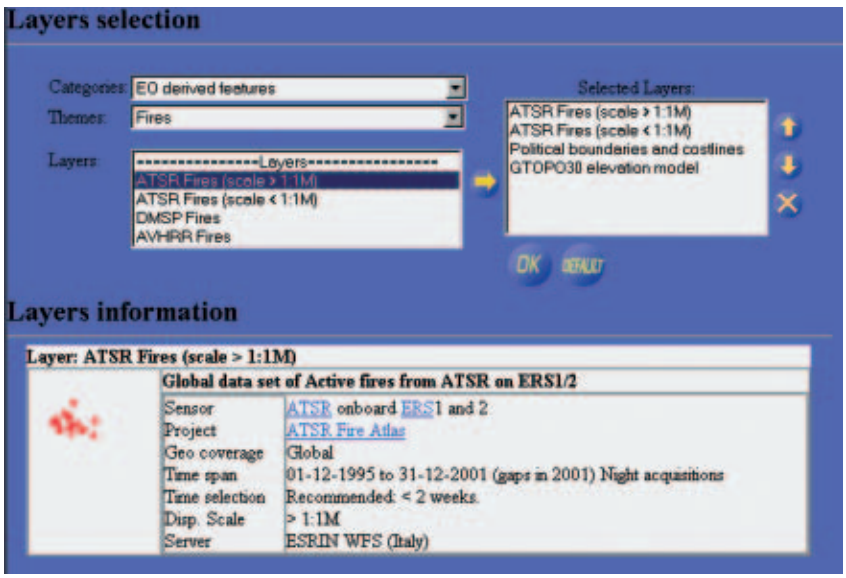


Figure 8. The selection window in the ESRIN WMS with background information on the ATSR fire layer

The ESA EO Multi-Mission User Services

EOLI is the Java-based web interface to the ESA Earth Observation Multi-mission User Services (MUIS, URL: http://odisseo.esrin.esa.it/eoli/eoli.html). Via EOLI, users may query the Product Catalogue and the Browse and Product servers, which contain millions of products. Authorised users may then order products using EOLI.

The EOLI interface (client and server) has been chosen for the Envisat User Services. DLR (D) has also installed the MUIS suite of servers and is currently adapting the EOLI interface for its own User Services. MUIS and EOLI will become the nucleus of a multi-provider distributed system. In its original version, the EOLI interface overlays the frames of the various instruments matching the request, on a layer providing basic and fixed information including land/sea masks, political borders, major city names, hydrology.

Thanks to the simplicity of the OGC web mapping technologies, it was possible within just a few working days to extend the range of thematic backgrounds, as shown in Figure 9. Each background is itself made up of a combination of several layers provided by both local and remote OGC-compliant Web Map Servers. The possibility to choose various thematic backgrounds will help the user in the selection of particular EO frames. For example, the provision of a soil-moisture layer may be useful for the selection of an ERS SAR frame for particular applications, whereas a daily-cloud-

cover layer may help a user to select data from optical sensors when only footprints and no browses are available to perform the selection.

Future evolution

Our servers are now ready to be fed with a wider range of data. Short-term and mid-term future activities include:

– Extending data sets offered by the WMS, in particular:

  • Adding a basic WMS wrapper layer to the MUIS catalogue and browse servers to provide a OpenGis-compliant access to all Envisat, ERS, Landsat, MODIS and other browse products available in native projection in the MUIS Product and Browse Data Server. This concerns in particular the Envisat ASAR, MERIS and AATSR browse products.
  • Transparent access to data from meteorological organisations.

– Integrating level-3 and higher products from the various data-processing servers located at ESRIN in order to provide a single uniform and harmonised client to access all kinds of data such as:
  • ERS/ATSR SST (Sea-Surface Temperature)
  • ERS/GOME global ozone and nitrogen maps.

– Visualisation of ESA and non-ESA satellite ground tracks and sensor swaths.

– Improving the time selection of datasets by:
  • Generating animation for a specified time window and periodic interval.
  • Performing on-the-spot averaging of datasets (e.g. monthly average ozone figures starting from daily datasets).

– Improving the user interface, by providing:
  • Legends.
  • Custom user interfacing for layer selection (possibility to discover, add and remove) from the selection window.
  • The possibility to navigate by specifying geographic names (cities, regions, countries …).
  • A 'layer search' function, allowing users to discover layers by specifying thematic keywords.

– Performing an automatic indexing of selected WMS and WFS to extend and update the list of worldwide available GI and EO layers. The automatic parsing of capabilities files from a pre-selected list of Web Map Servers in order to offer users an up-to-date list of most layers available worldwide, as well as providing the possibility for users to customise their layer selection to best suit their field of application.

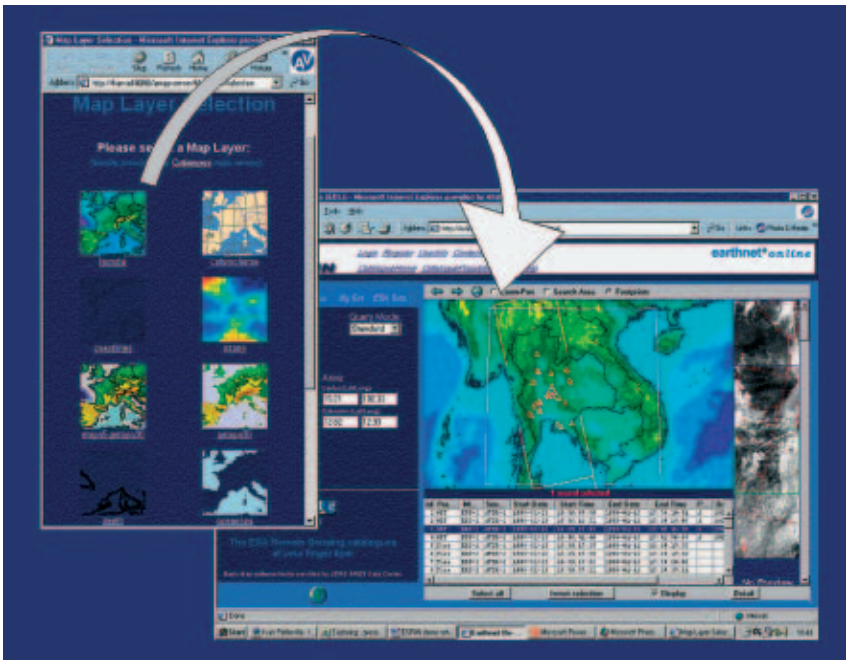


Figure 9. Selection of a thematic background generated by OGC Web Map Servers for the EOLI interface

– Implementing simple online post-processing functions that may be triggered by the user, e.g. data-format conversion allowing users to select the format for data to be retrieved via the WCS from those most commonly used (ERS and Envisat formats, HDF-EOS, GeoTIFF, ..).

– Implementing web registry services allowing users to discover more easily the web mapping services available at ESA and to build their own applications, chaining the basic services available at ESRIN.

Conclusion

The prototypes developed at ESA using the latest OpenGIS-compliant web mapping techniques have demonstrated the promising benefits for Earth Observation. The use of web mapping technology may be considered a small revolution in terms of the habits of the EO user community and a boost for EO exploitation. Essentially, users (value-adding companies, service providers, scientists, institutions, commercial users, academic users, etc.) no longer have to worry about the location, the format or the projection of the original data. The web mapping technologies now available enable the development of new multi-mission-based applications, for instance in the field of disaster management. Never before have users been able to combine space, geographical and in-situ data so easily. For both the data providers and the application developers, there are obvious advantages in using a standard and powerful technology that preserves the existing infrastructures and allows the quick development of new solutions.

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