About scope of OpenGIS technology in oceanographic data management and visualization

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What is GIS?

Geographic Information System (GIS) is technology used to create, manage, store, analyze and display data that have reference to geographical coordinates.

Factual, GIS is database management system + flexible tools for visualization geographic data. The ability to look as graphic images of some kind of data on object of research look, essentially helps researchers in their interpretation and drawing up of a complete scientific vision about object of research. It defines a wide distribution of GIS-technologies in the most various areas of people activity, including area of scientific researches.

Most of oceanographic data is georeferenced

Consequently GIS usage is very eligible in oceanography where almost all data is spatial.

For example:

1. Points – measurements at marine stations: temperature, salinity, etc.
2. Lines – typhoon tracks, fundamental crashes, etc.
3. Polygons – geological data, regions, etc.
4. Grid and coverage data – satellite images, raster maps, computed fields, etc.

Why using internet GIS

1. GIS based on internet-technologies is the most simple and widely available method of realization of multiuser work with GIS resources

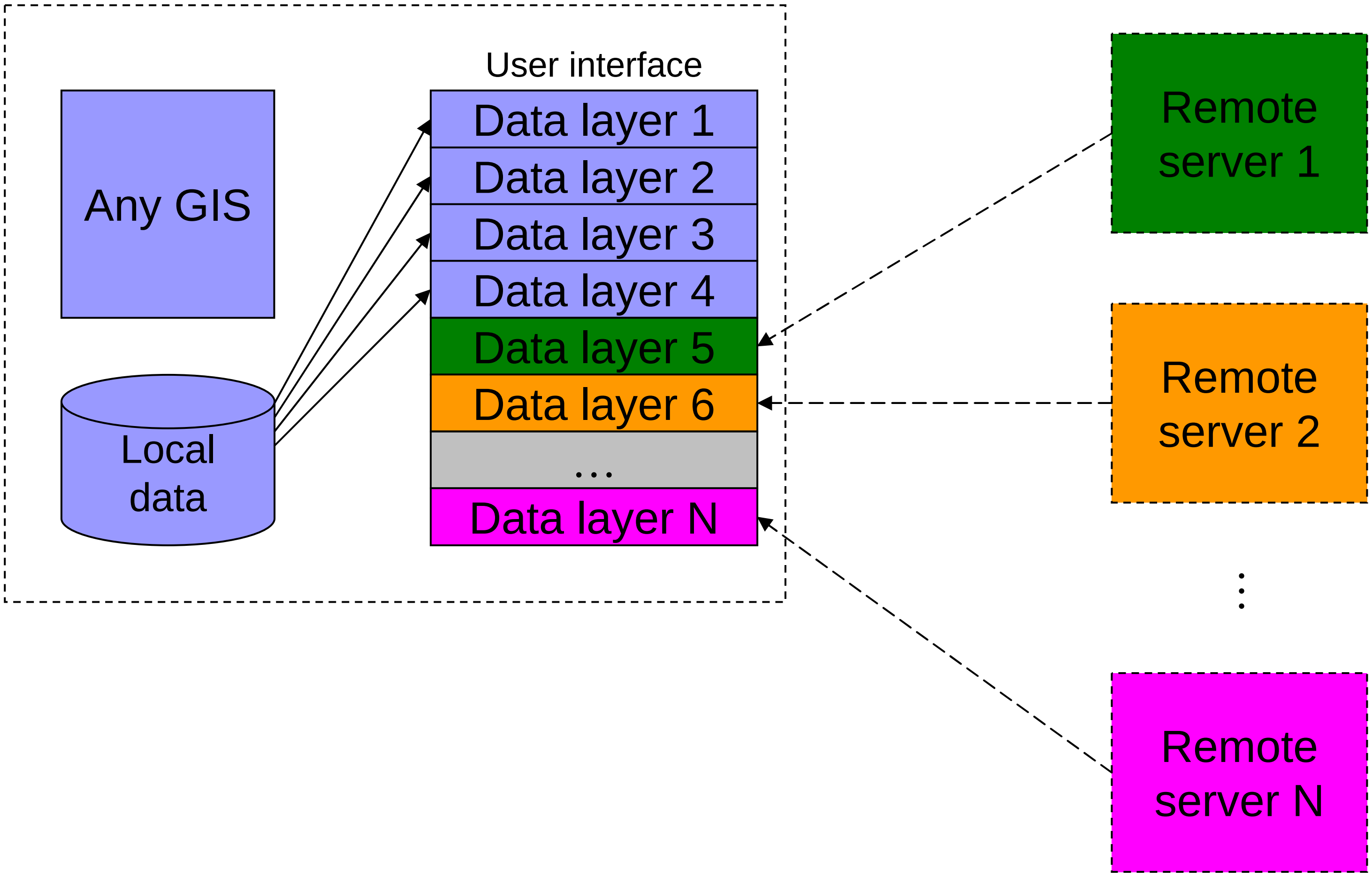
2. GIS with web-interface don’t require special user teaching because its interface usually very similar to common web-pages

3. GIS with web-interface don’t require regularly upgrade software – all new features will be accessible at next session of work

4. Grant access to unified data set, all new data will become accessible for all users right away

5. Possibilities of organize access to realtime data on remote servers

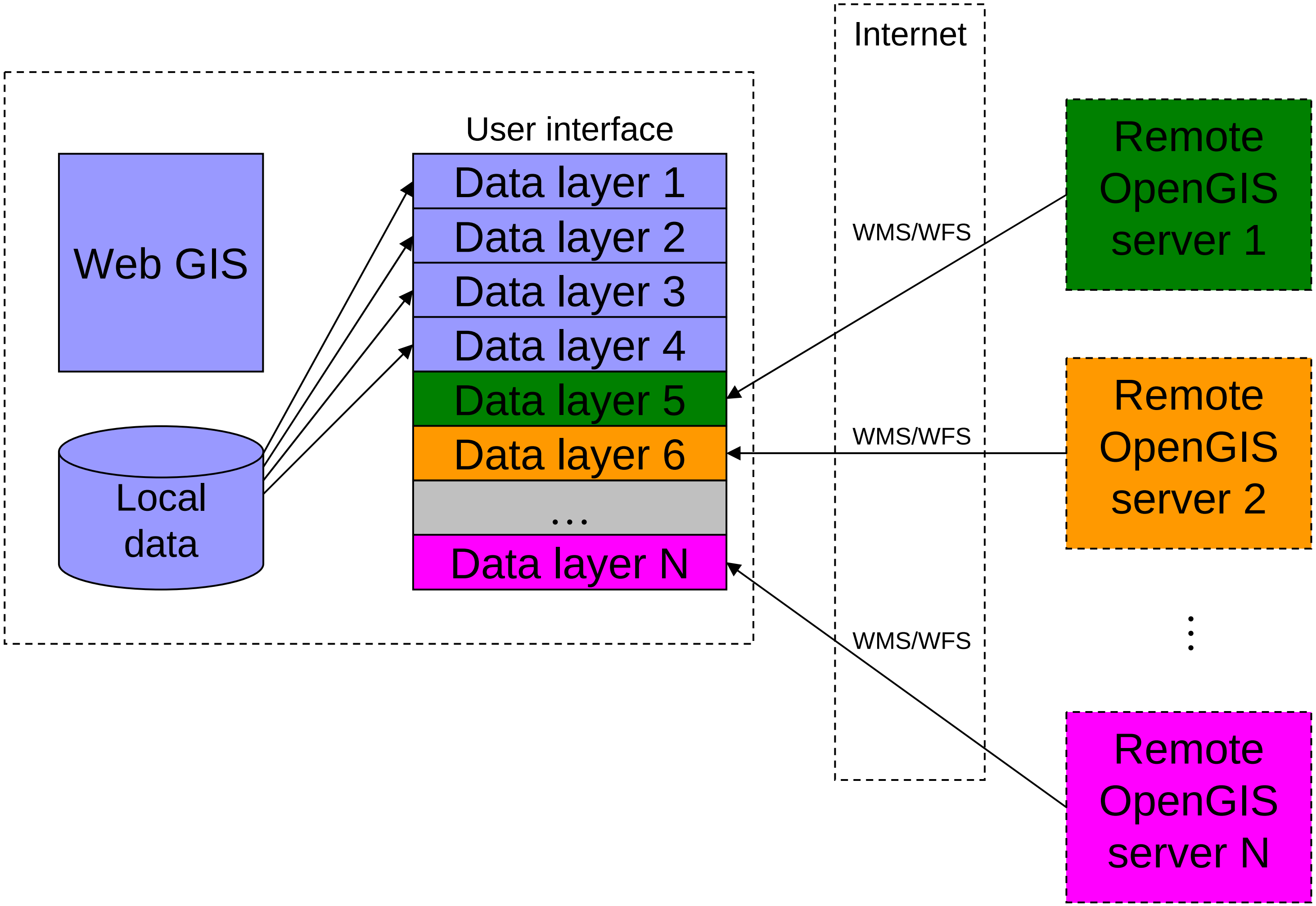
Integration of data layers in GIS



Base idea of integration GIS resource by internet

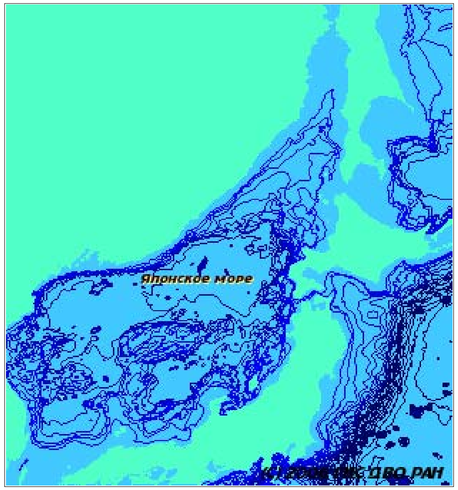
OpenGIS

OpenGIS – modern technology for Web-GIS resources integration



Base idea of OpenGIS technology

Sample of Support of OpenGIS – modern technology for Web-GIS resources integration



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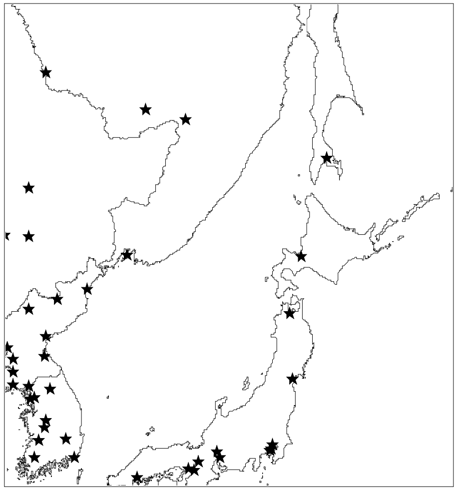

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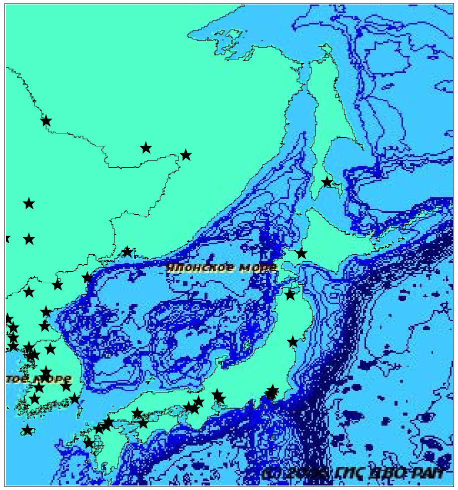


Remote WMS server

Local geodata

Result

OpenGIS Consortium

The Open Geospatial Consortium (OGC) is a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services.

The OGC is an international industry consortium of 331 companies, government agencies and universities participating in a consensus process to develop publicly available interface specifications. OpenGIS Specifications support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT. The specifications empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications.

The OGC maintains a Web site at http://www.opengis.org/.

Other standardization organizations

On a world scale the basic influence on area of spatial information standardization make:

- International Standard Organization (ISO, www.iso.org)
- Federal Geographic Data Committee (FGDC, www.fgdc.gov)
- US Geological Service (USGS, mapping.usgs.gov)
- American National Standards Institute (ANSI, www.ansi.org)
- National Imagery and Mapping Agency (NIMA, www.nima.mil)
- International Cartographic Association (ICA, www.geovista.psu.edu/sites/icavis)
- Open Information Interchange (OII, www.diffuse.org/oii/en/oii-home.html)
- etc

OpenGIS (Open Geodata Interoperability Specification)

OpenGIS is an adjective describing specifications and other products of OGC's consensus process that support transparent access to heterogeneous geodata and geoprocessing resources in a networked environment. The goal of OGC is to provide a comprehensive suite of open interface specifications that enable developers to write interoperating components that provide these capabilities.

OpenGIS Specifications are technical documents that detail interfaces or encodings. Software developers use these documents to build support for the interfaces or encodings into their products and services. These specifications are the main "products" of the Open Geospatial Consortium and have been developed by the membership to address specific interoperability challenges. Ideally, when specifications are implemented by two different software engineers working independently, the resulting components plug and play, that is they work together without further debugging. The documents are available at no cost to everyone.

What is an "open standard"?

OGC defines an open standard as one that:

1. Is created in an open, international, participatory industry process. The standard is thus non-proprietary, that is, owned in common. It will continue to be revised in that open process, in which any company, agency or organization can participate.
2. Has free rights of distribution: An "open" license shall not restrict any party from selling or giving away the specification as part of a software distribution. The "open" license shall not require a royalty or other fee.
3. Has open specification access: An "open" environment must include free, public, and open access to all interface specifications. Developers are allowed to distribute the specifications.
4. Does not discriminate against persons or groups: "Open" specification licenses must not discriminate against any person or group of persons.
5. Ensures that the specification and the license must be technology neutral: No provision of the license may be predicated on any individual technology or style of interface.
6. By this definition, a de facto standard established by one company or an exclusive group of companies or by a government is not an open standard, even if it is published and available for use by anyone at no charge. The Web, and the Spatial Web, cannot depend on proprietary standards.

Why does OGC often use the words "geospatial" instead of "geographic", "geoprocessing" instead of "GIS," and "services" instead of "software?"

It is necessary in the standards setting process for OGC's members to reach agreement on precise technical terms.

• "Geographic" is the right word for graphic presentation maps of features and phenomena on or near the Earth's surface. "Geospatial" (or "spatial") also refers to data about Earth features and phenomena, but the data are not necessarily graphically presented. Many geoprocessing applications do not involve a human-readable map on a display.

• "GIS" (Geographic Information System) is just one of many technologies used to create, manage, store, analyze and display geospatial data. "Geoprocessing" is more inclusive, referring to GIS and also to systems for Earth imaging, navigation, facilities management, digital cartography, Location Based Services, spatial database operations, and surveying and mapping. OGC addresses all of these.

• "Service" refers to a processing task that is invoked by a client software component and executed by a server software component, usually across a network. Much of the current work in OGC involves geoprocessing via the IT industry's Web Services standards framework. The OpenGIS Specifications that make this possible are referred to as "OGC Web Services."

How will OGC Web Services (OWS) change the World Wide Web?

Now that vendors of Web-based software are implementing interfaces conforming to OpenGIS Specifications, geoprocessing software of different kinds from different vendors is beginning to work together "one-to-many" on the Web. When OpenGIS Specification conformant interfaces have been adopted on a large scale (and this is happening) any client will communicate with any server as if they were in the same vendor family of products. So the Web will be full of maps and spatial services, just as it is now full of text and simple images, and all of this will be available to everyone (unless restricted by the owner). Catalogs conforming to the OpenGIS Catalog Services Specification will enable "spatial search engines" for discovery of both online geoprocessing services and online geodata sources. Geospatial portals based on OpenGIS Specifications will serve as hubs for users and providers of geospatial information to share data much more easily than before. This describes the "Spatial Web."

Some questions and answers?

Q: For whom are OpenGIS Specifications most relevant today?
A: Initially it was the large government users who become involved because of their critical strategic interest. At this point, it is critically important for all users of geoprocessing technology to insist on interoperable software products, because the Web's potential is only realized through interoperability. All software developers and integrators who provide geoprocessing software or who seek to integrate these capabilities into general purpose information systems are also, of course, affected by OpenGIS Specifications.

Q: Does membership in OGC help members with their own marketing efforts?
A: Yes. Technology providers and technology users meet frequently to discuss technical and business issues, and these meetings are very important in the marketing efforts of the technology providers and in the technology users' development of market awareness.

Q: Who will most benefit from this kind of interoperability on the Web?
A: Users -- a much larger population of users than currently use GIS and remote sensing software -- will benefit the most. Producers, owners, stewards, and resellers of geodata will also benefit. Software vendors will benefit because: the market will be much bigger; the Web server, tools, and applet markets will be strong; the geoprocessing software integration business will be booming; current users will buy the new versions of software that have OpenGIS Compliant interfaces; and sophisticated and specialized applications will proliferate. There will be new jobs for metadata and data semantics experts, geographers who help build and integrate geographic "content" for Web sites, data coordinators, etc. The Spatial Web will continue to spawn new businesses.

OpenGIS support in desktop GIS

The majority of modern desktop GIS software already support OpenGIS standards, among it:

ESRI ArcGIS, MapInfo Professional, etc

And so commercial software for development web mapping services:
ESRI ArcIMS, MapInfo MapXtreme, Autodesk Map Guide, etc

And free distributed software for development web mapping services:
UMN MapServer (University of Minnesota) and other

Only on OGC website registered about 350 software products, that can be used for developing OpenGIS-compatible applications. But so exists many web projects that used self-developed software for support OpenGIS standards.

OpenGIS support in RDBMS

In 1997, the Open Geospatial Consortium published the OpenGIS Simple Features Specifications For SQL, a document that proposes several conceptual ways for extending an SQL RDBMS to support spatial data.

Many Relational Database Management Systems (RDBMS) such as Oracle, DB2, MySQL and other implements spatial extensions following the OpenGIS specifications. Also exist many third-party software for support OpenGIS in other DBMS, for example ESRI ArcSDE, Oracle SDO, etc.

The set of geometry types proposed by OGC's SQL with Geometry Types environment is based on the OpenGIS Geometry Model. In this model, each geometric object has the following general properties:

• It is associated with a Spatial Reference System, which describes the coordinate space in which the object is defined.

• It belongs to some geometry class.

Primary OpenGIS specifications

- OpenGIS Web Map Service (WMS)
- OpenGIS Web Feature Service (WFS)
- OpenGIS Web Coverage Service (WCS)
- OpenGIS Grid Coverage Service
- OpenGIS Catalogue Service
- OpenGIS Geography Markup Language (GML)
- OpenGIS Styled Layer Descriptor (SLD)

OpenGIS Web Map Service (WMS)

The OpenGIS Web Map Service (WMS) Implementation Specification provides three operations (GetCapabilities, GetMap, and GetFeatureInfo) in support of the creation and display of registered and superimposed map-like views of information that come simultaneously from multiple remote and heterogeneous sources.

When client and server software implements WMS, any client can access maps from any server. Any client can combine maps (overlay them like clear acetate sheets) from one or more servers. Any client can query information from a map provided by any server. While programmers need to write code to implement the specifications, end users can take advantage of products that include them to publish and access geospatial information. Software buyers can choose the best solution for their needs and not worry about if it will work with other solutions; if they all implement the same standard, WMS, they will all work together.

In particular WMS defines:
- How to request and provide a map as a picture or set of features (GetMap)
- How to get and provide information about the content of a map such as the value of a feature at a location (GetFeatureInfo)
- How to get and provide information about what types of maps a server can deliver (GetCapabilities)

OpenGIS Web Feature Service (WFS)

The OpenGIS Web Feature Service (WFS) Implementation Specification allows a client to retrieve and update geospatial data encoded in Geography Markup Language (GML) from multiple Web Feature Services. The specification defines interfaces for data access and manipulation operations on geographic features, using HTTP as the distributed computing platform. Via these interfaces, a Web user or service can combine, use and manage geodata -- the feature information behind a map image -- from different sources.

The following WFS operations are available to manage and query geographic features and elements:

- Create a new feature instance
- Delete a feature instance
- Update a feature instance
- Lock a feature instance
- Get or query features based on spatial and non-spatial constraints

OpenGIS Web Coverage Service (WCS)

The OpenGIS Web Coverage Service (WCS) Implementation Specification extends the Web Map Server (WMS) interface to allow access to geospatial "coverages" (raster data sets) that represent values or properties of geographic locations, rather than WMS generated maps (pictures).

The Web Coverage Service supports electronic interchange of geospatial data as "coverages" - that is, digital geospatial information representing space-varying phenomena. A WCS provides access to potentially detailed and rich sets of geospatial information, in forms that are useful for client-side rendering, multi-valued coverages, and input into scientific models and other clients. The WCS may be compared to the OGC Web Map Service (WMS) and the Web Feature Service (WFS); like them it allows clients to choose portions of a server's information holdings based on spatial constraints and other criteria.

Unlike WMS which filters and portrays spatial data to return static maps (rendered as geo-registered pictures by the server), the Web Coverage Service provides available data together with their detailed descriptions; allows complex queries against these data; and returns data with its original semantics (instead of pictures) which can be interpreted, extrapolated, etc. -- and not just portrayed.

Unlike WFS which returns discrete geospatial features, the Web Coverage Service returns representations of space-varying phenomena that relate a spatial-temporal domain to a (possibly multidimensional) range of properties.

OpenGIS Grid Coverage Service

The OpenGIS Grid Coverage Service Implementation Specification defines methods that allow interoperability between software implementations by data vendors and software vendors providing grid (raster) analysis and processing capabilities.

The term "grid coverages" refers to satellite images, digital aerial photos, digital elevation data, and other phenomena represented by values at each point in a "raster" coordinate system (as opposed to "vector" geodata, in which digital map information is represented using polygons and lines). The specification describes an open interface that provides communication between software systems for purposes of requesting, viewing, and performing certain kinds of grid coverage analysis such as histogram calculation, image covariance and other statistical measurements.

OpenGIS Catalogue Service

The OpenGIS Catalogue Service Implementation Specification defines a common interface that enables diverse but conformant applications to perform discovery, browse and query operations against distributed heterogeneous catalog servers.

Catalogue services support the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects. Metadata in catalogues describe resource characteristics that can be queried and presented for evaluation and further processing by both humans and software. Catalogue services are required to support the discovery and binding to registered information resources within an information community.

The document specifies the interfaces, bindings, and a framework for defining application profiles required to publish and access digital catalogues of metadata for geospatial data, services, and related resources. Metadata act as generalized properties that can be queried and returned through catalogue services for resource evaluation and, in many cases, invocation or retrieval of the referenced resource. Catalogue services support the use of one of several identified query languages to find and return results using well-known content models (metadata schemas) and encodings.

OpenGIS Geography Markup Language (GML)

Geography Markup Language is an XML grammar written in XML Schema for the modeling, transport, and storage of geographic information.

GML provides a variety of kinds of objects for describing geography including features, coordinate reference systems, geometry, topology, time, units of measure and generalized values.

A geographic feature is "an abstraction of a real world phenomenon; it is a geographic feature if it is associated with a location relative to the Earth". So a digital representation of the real world can be thought of as a set of features. The state of a feature is defined by a set of properties, where each property can be thought of as a {name, type, value} triple.

The number of properties a feature may have, together with their names and types, are determined by its type definition. Geographic features with geometry are those with properties that may be geometry-valued. A feature collection is a collection of features that can itself be regarded as a feature; as a consequence a feature collection has a feature type and thus may have distinct properties of its own, in addition to the features it contains.

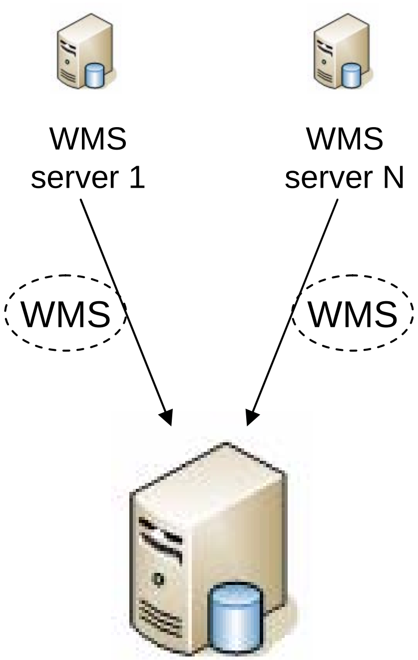
OpenGIS Styled Layer Descriptor (SLD)

The OpenGIS Styled Layer Descriptor (SLD) Implementation Specification is an encoding that extends the Web Map Service specification to allow user-defined symbolization of feature data. It allows users (or other systems) to determine which features or layers are rendered with which colors or symbols.

The importance of visual portrayal of geographic data cannot be overemphasized. This document addresses the need for geospatial consumers (either humans or machines) to control the visual portrayal of the data with which they work. The current OpenGIS Web Map Service (WMS) specification supports the ability for an information provider to specify very basic styling options by advertising a preset collection of visual portrayals for each available data set. However, while a WMS currently can provide the client with a choice of style options, the WMS can only tell the client the name of each style. It cannot tell the client what portrayal will look like on the map. More importantly, the client has no way of defining its own styling rules. The ability for a human or machine client to define these rules requires a styling language that the client and server can both understand.

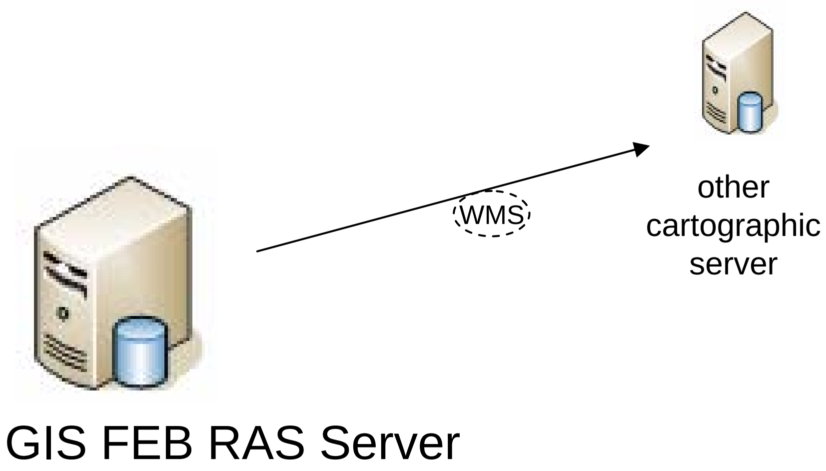
Defining this language, called the Styled Layer Descriptor (SLD), is the main focus of this specification which can be used to portray the output of Web Map Servers, Web Feature Servers and Web Coverage Servers.

GIS Server can request data from remote WMS-servers

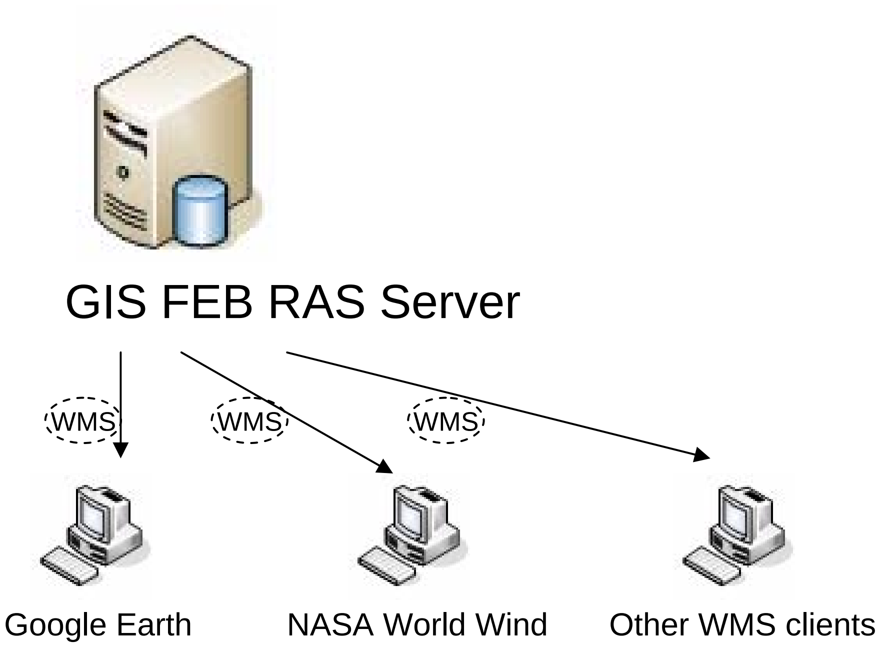


GIS FEB RAS Server

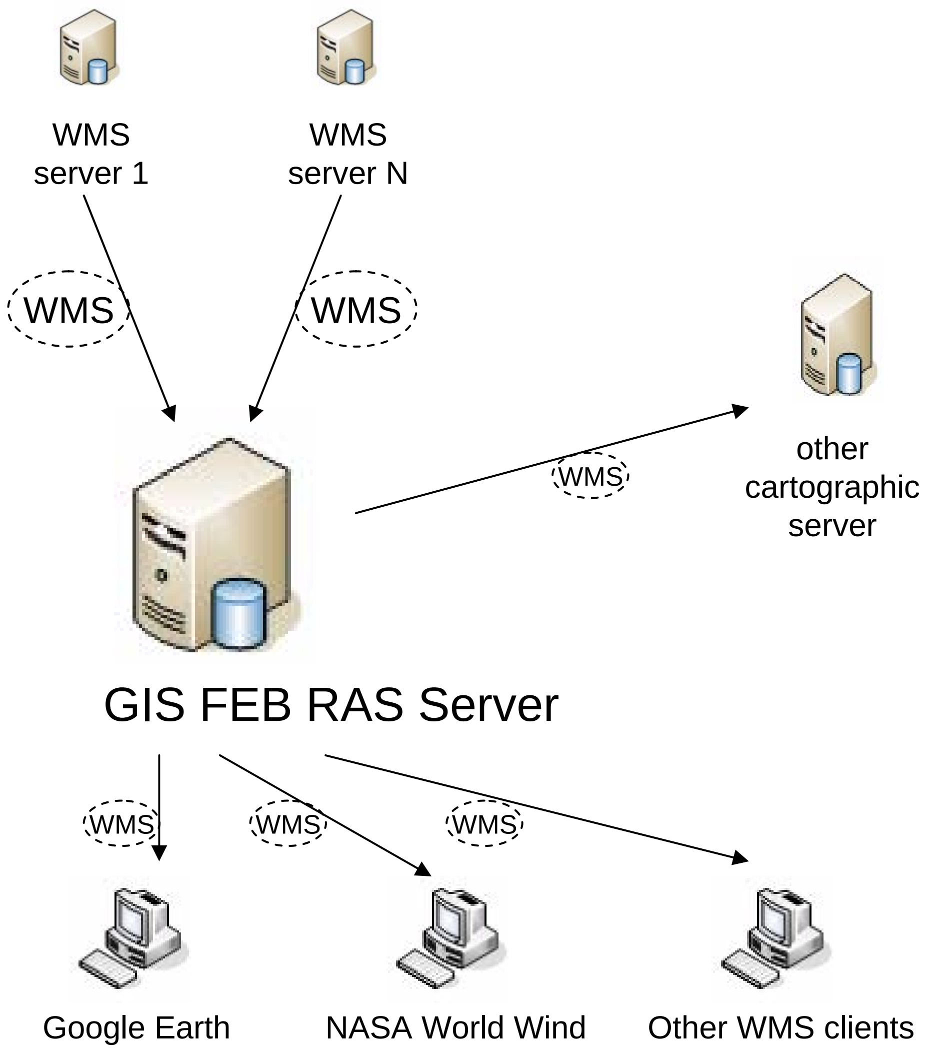
Remote WMS-server can request data from GIS Server



WMS-compatible clients can request data from GIS Server



Scheme of WMS-request between servers and clients



Corporative oceanographic GIS of FEB RAS

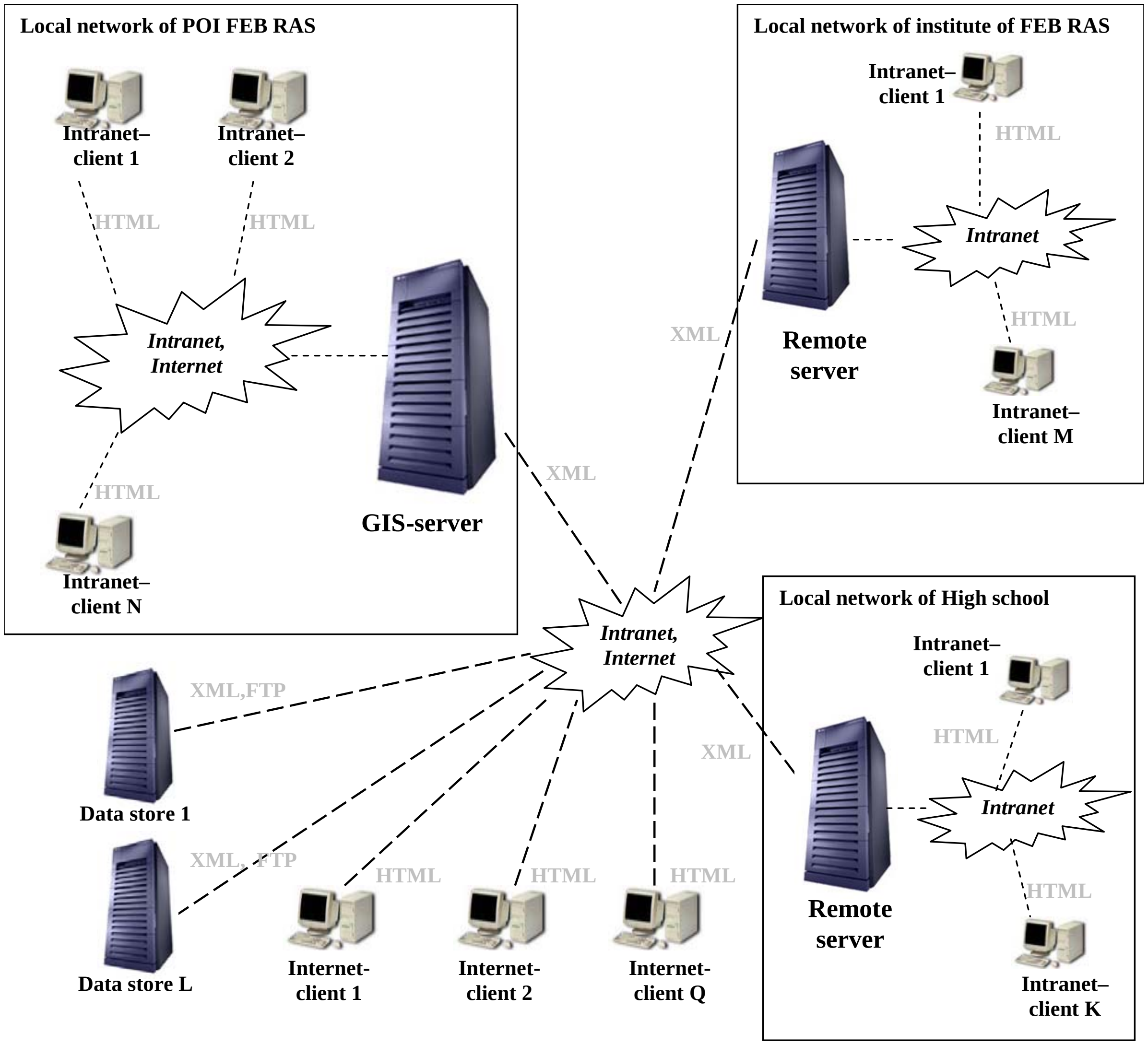
Corporative oceanographic GIS of FEB RAS

Primary task – “deliver to any scientist workplace:

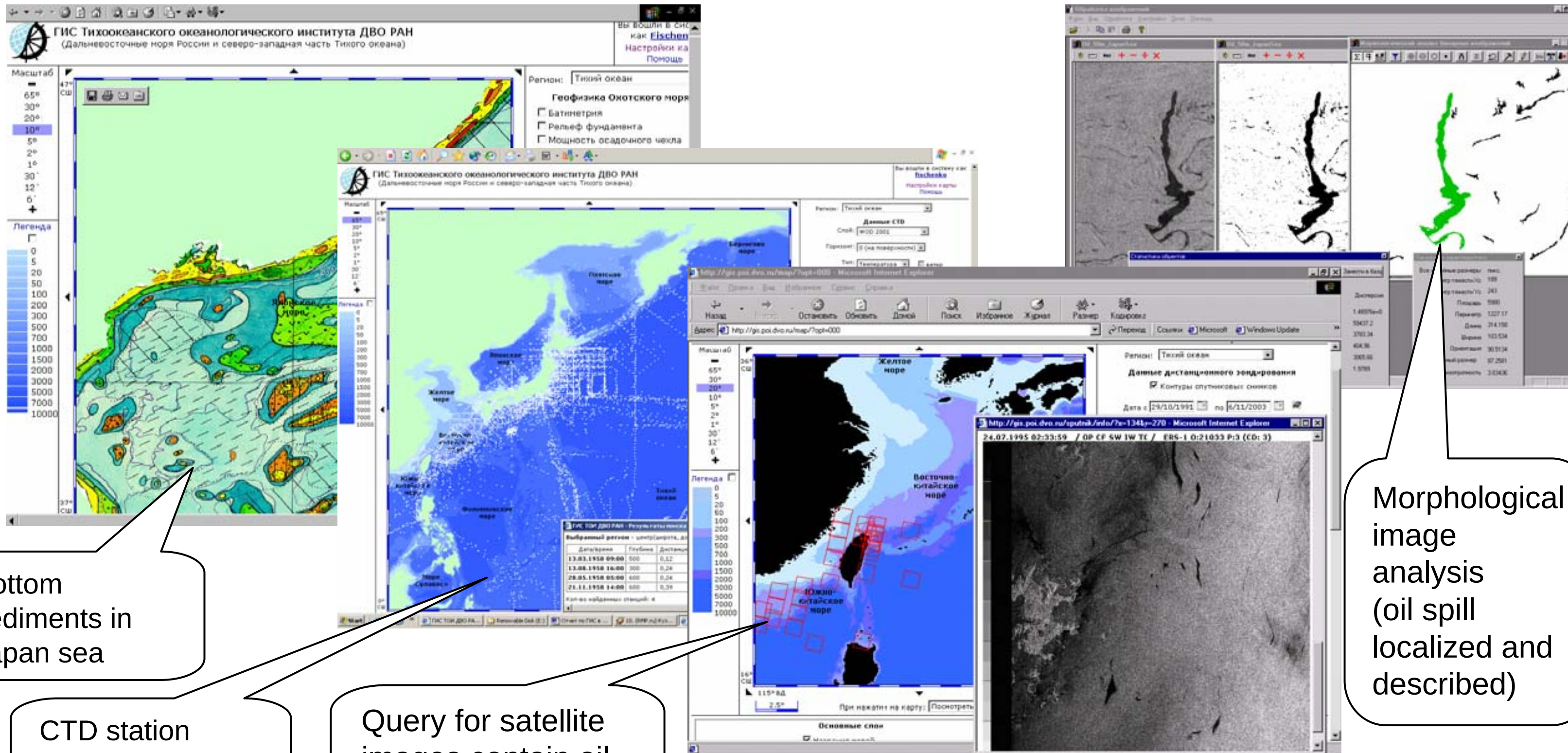
1. all available data about sea and atmosphere in region

2. obvious tools for joint cartographical and scientific data visualization and analytical data processing

3. possibility of use distributed computing resources of FEB RAS network for solving complex resource-intensive tasks”



Work with different data layers and types



Bottom sediments in Japan sea

CTD station locations in 1958

Query for satellite images contain oil spills

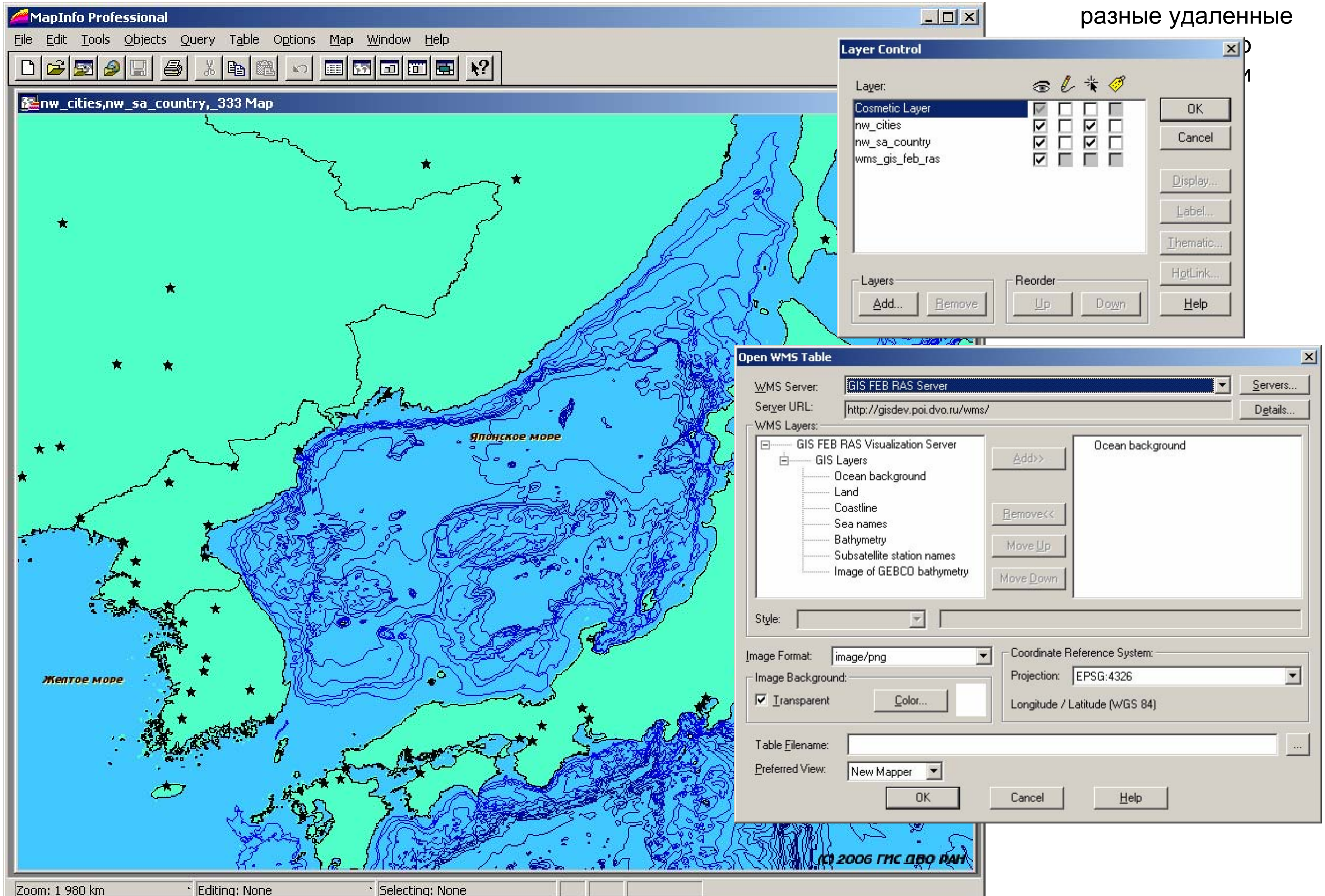
Morphological image analysis (oil spill localized and described)

Current status: 30 thematical layers, about 150 Gb of data, 5 software tools for analytical data processing, link to 3 remote data storage in FEB RAS network, monitoring of 5 oceanographic internet resources.

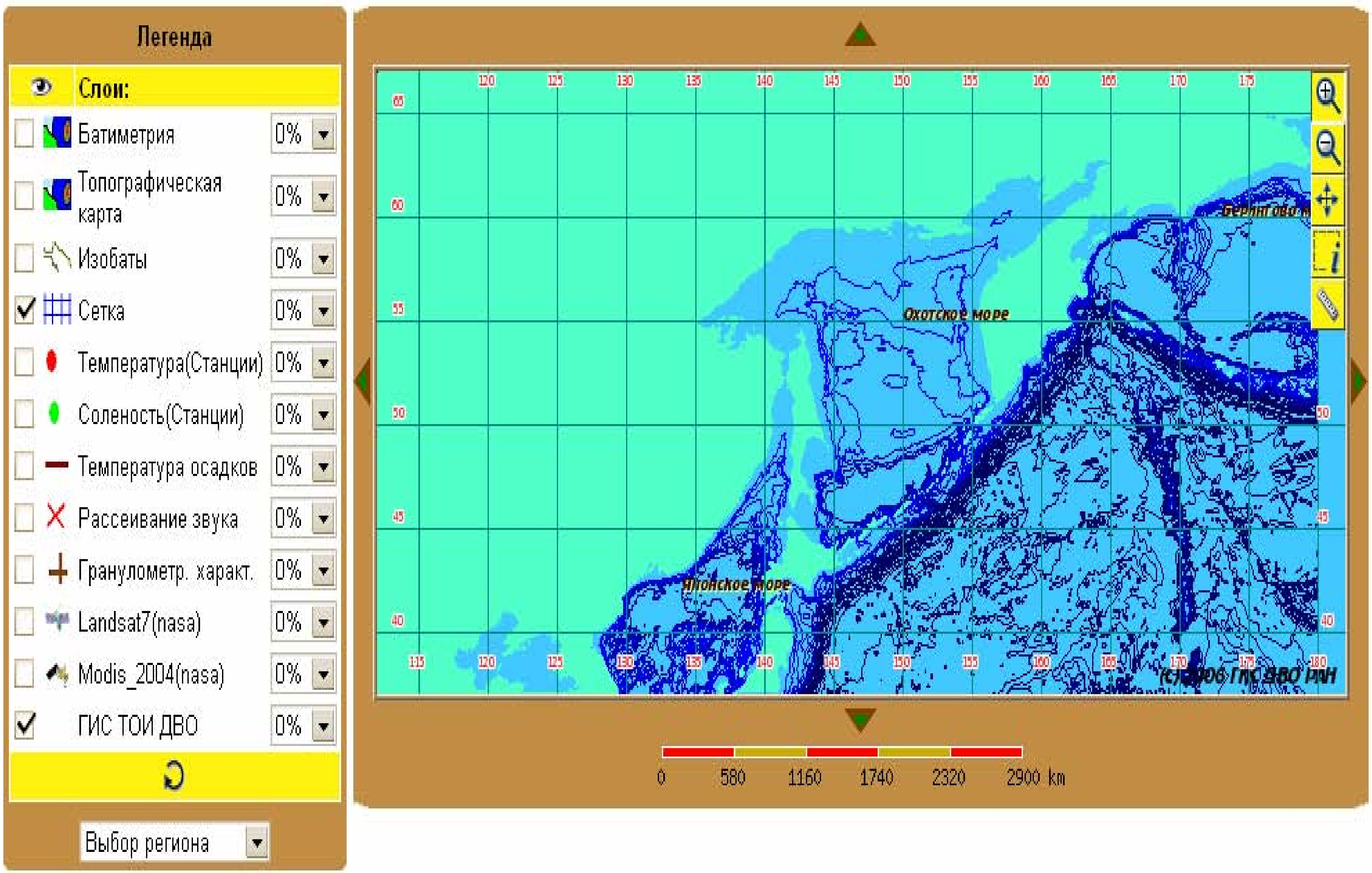
Samples of using WMS of GIS FEB RAS

Sample in MapInfo

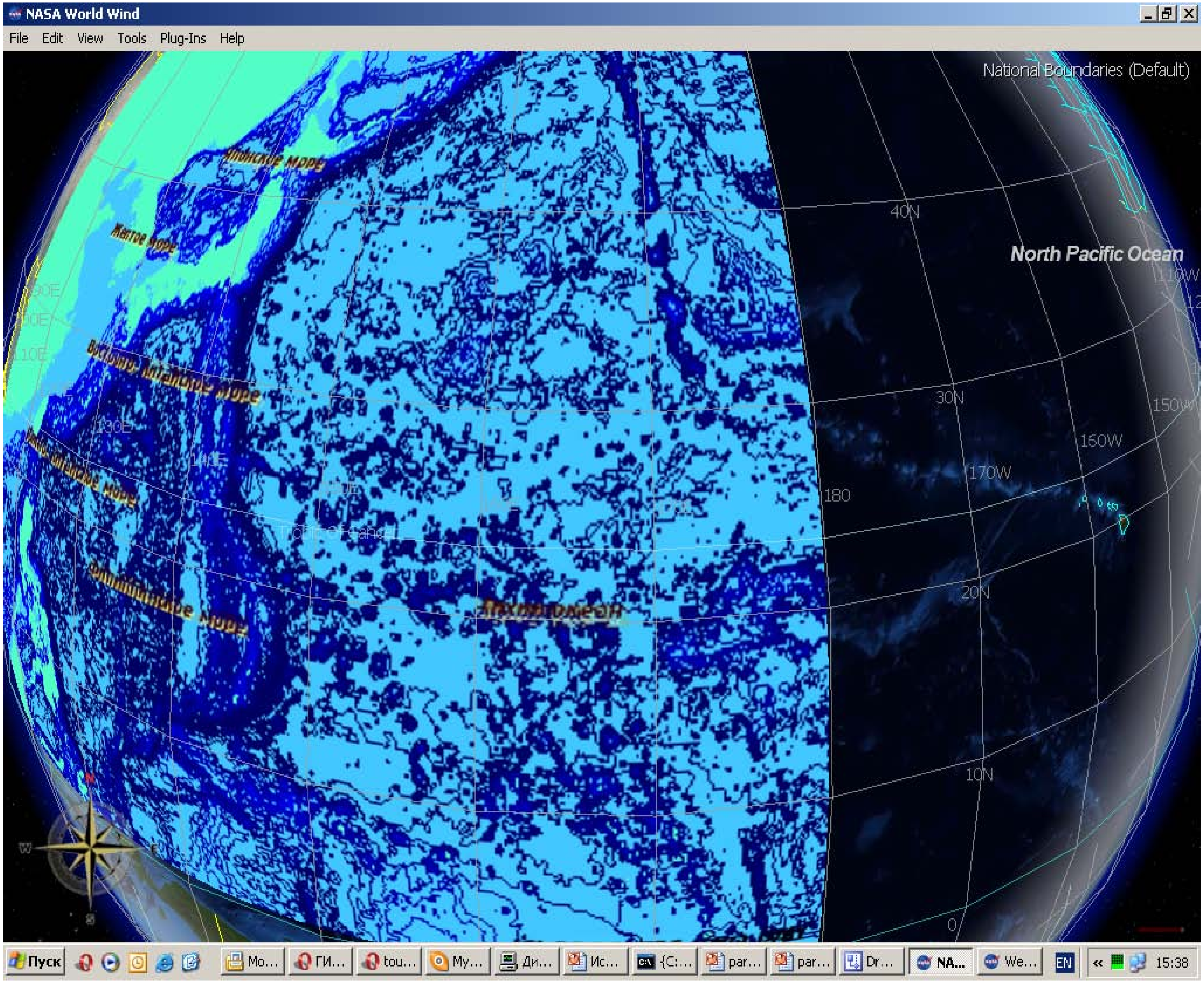
Картинка где есть
окно обычной ГИС
в котором
добавляются
разные удаленные



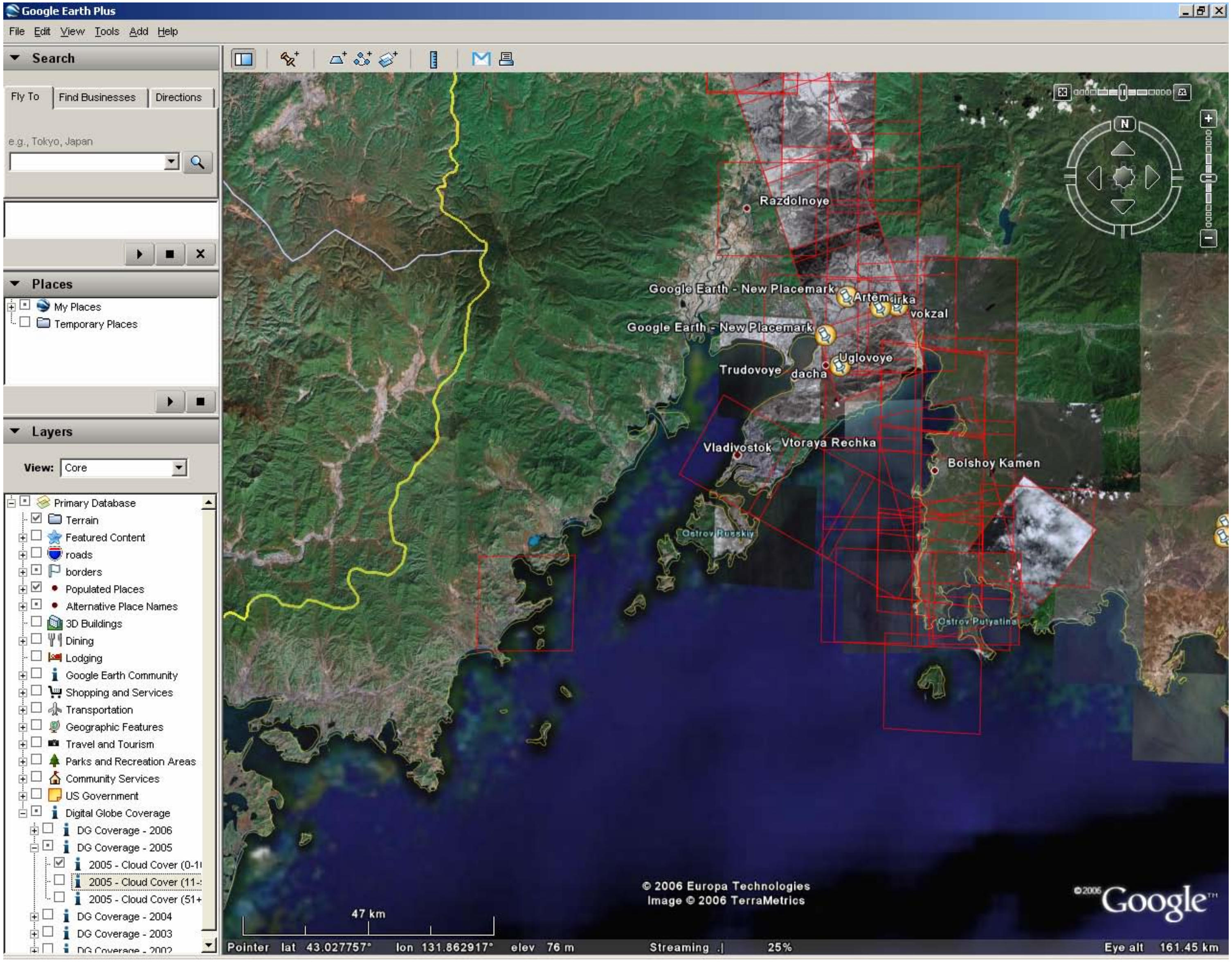
Export of GIS FEB RAS data layers to Chukchi Sea GIS project



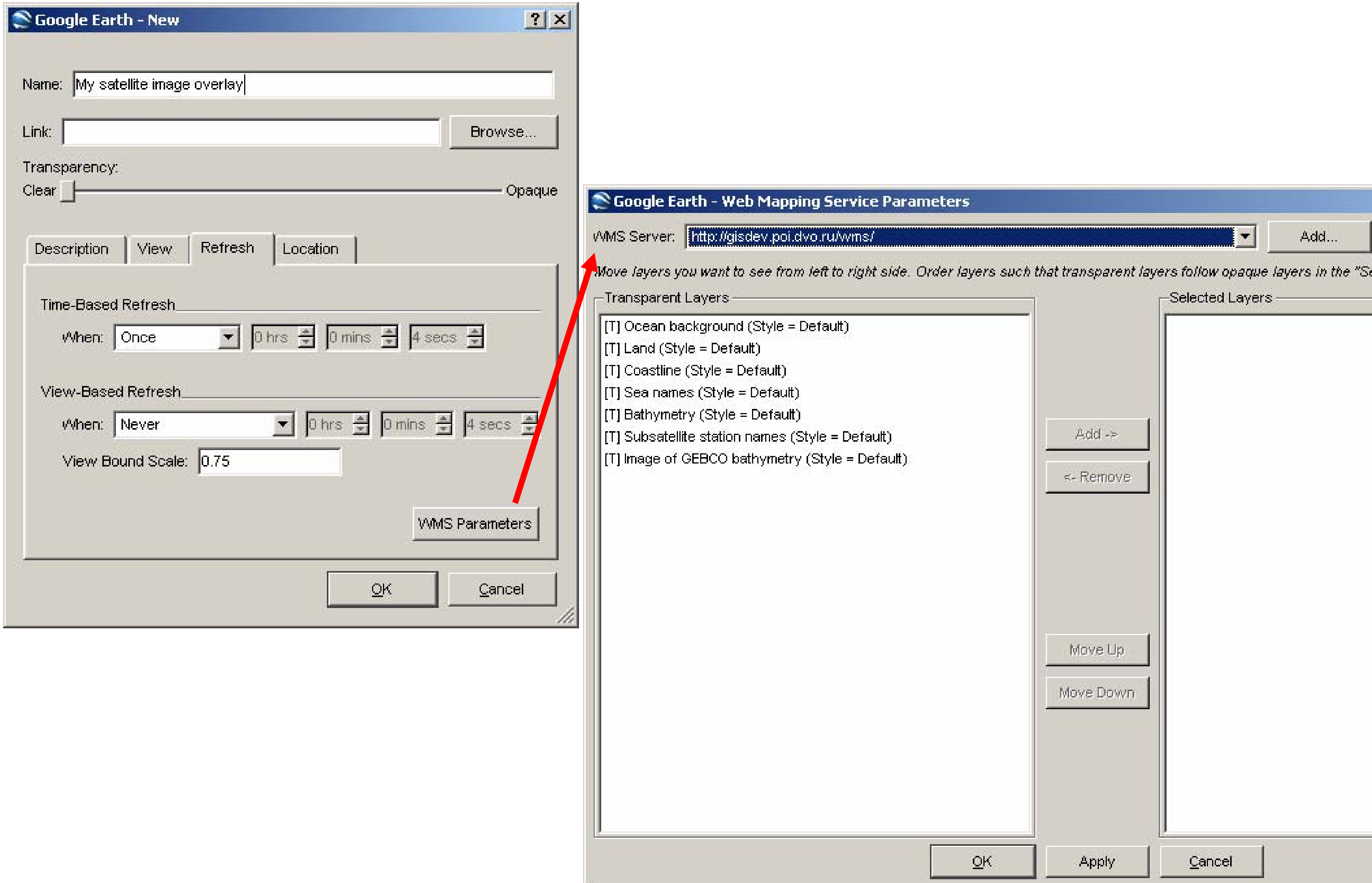
Export of GIS FEB RAS data layers to NASA World Wind



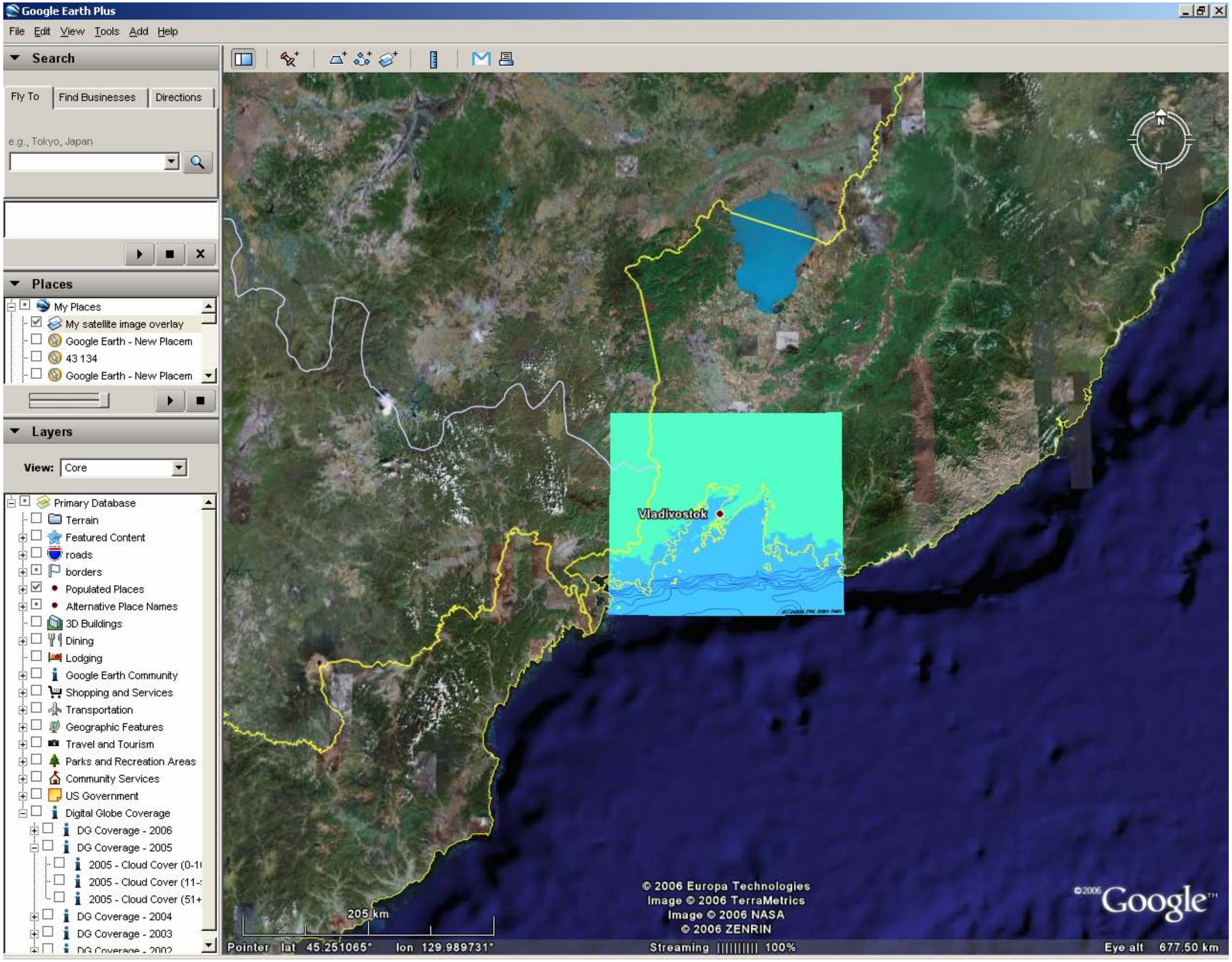
Since 13 September 2006 Google Earth also support OpenGIS technology



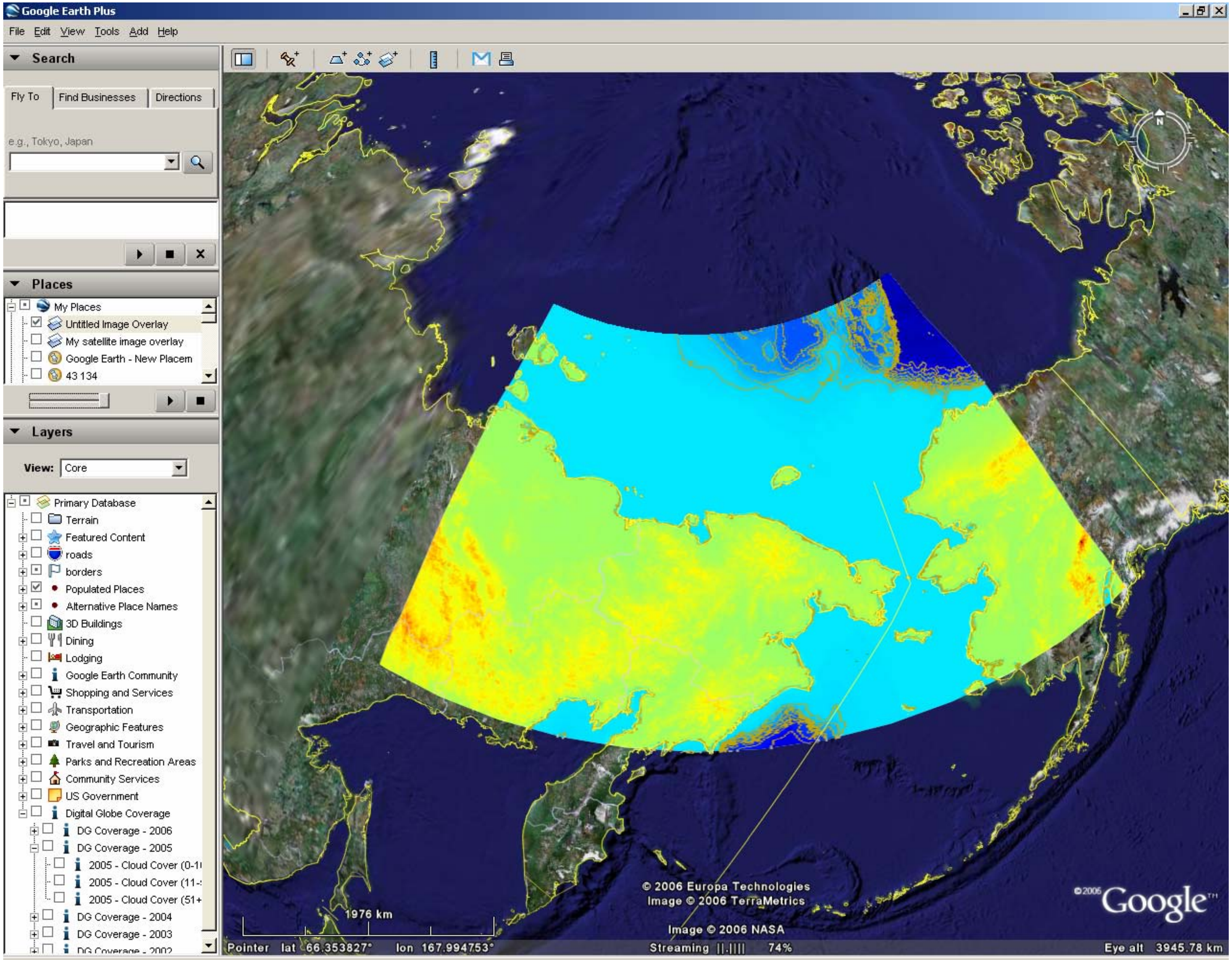
Adding GIS FEB RAS WMS-layers to Google Earth



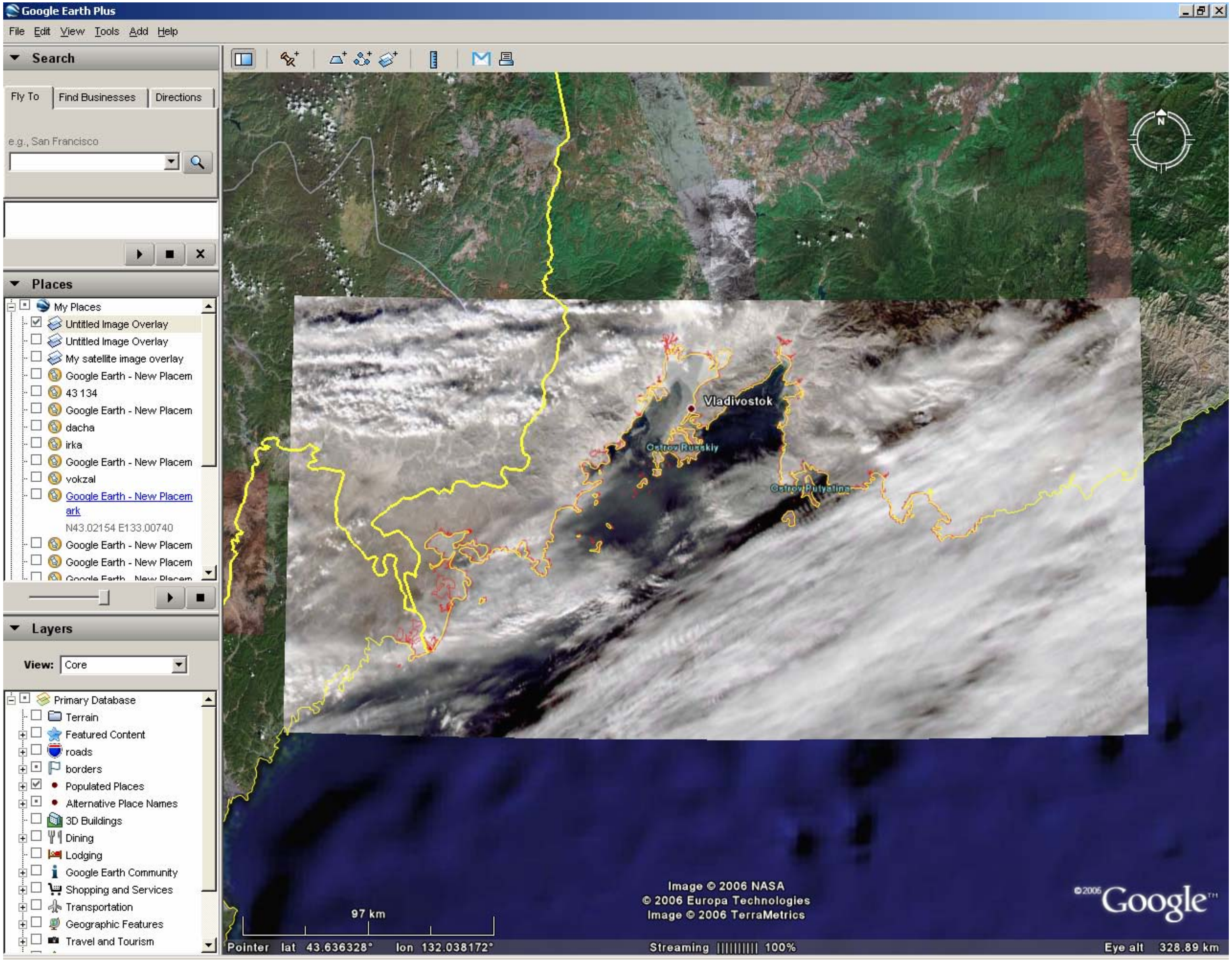
Export of GIS FEB RAS data layers to Google Earth



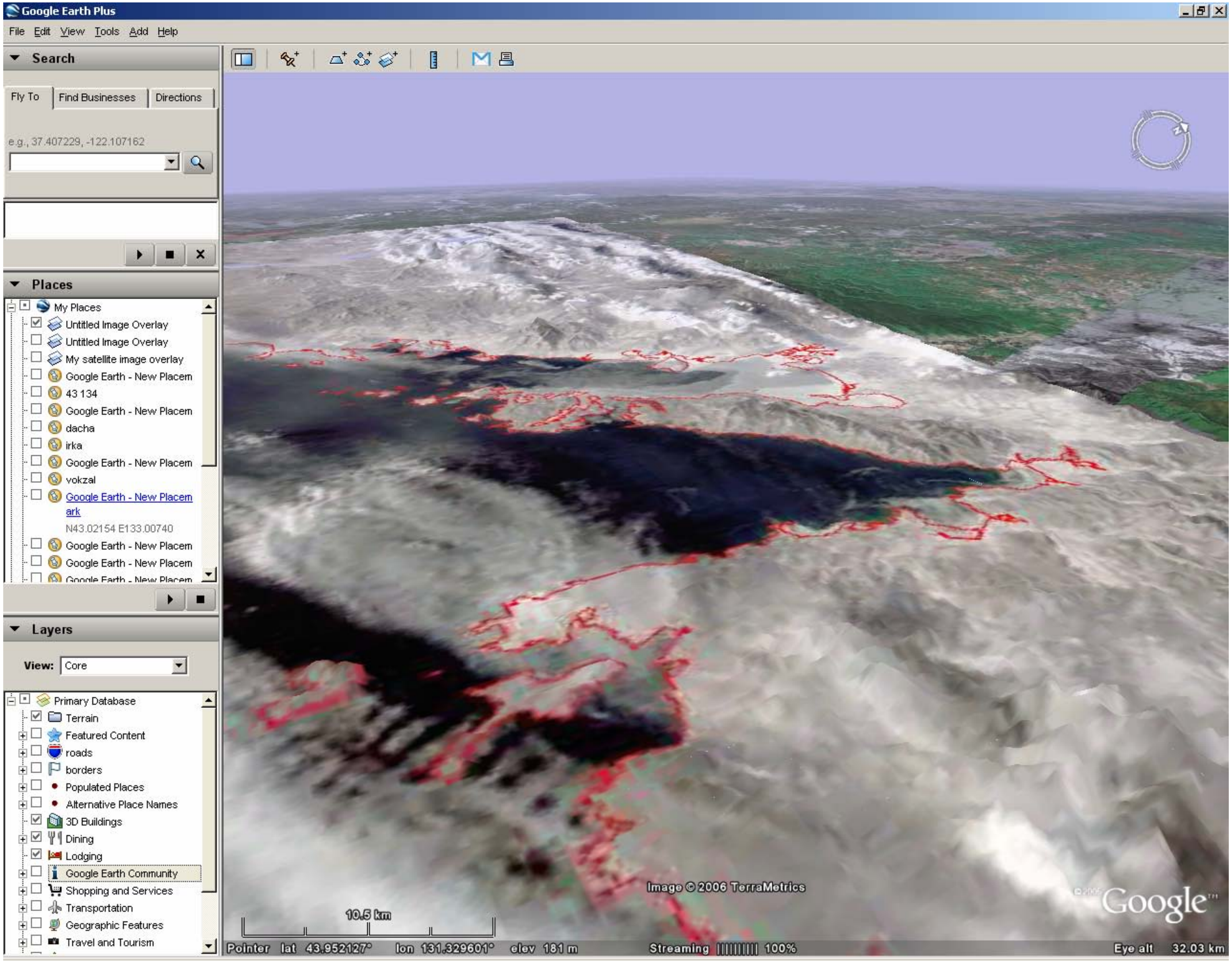
Export of Chukchi Sea GIS data layers to Google Earth



Mapping MERIS satellite image to Google Earth



Mapping MERIS satellite image to Google Earth (3D-visualization)



Results

- OpenGIS standards open incredible possibilities for scientific interoperability
- In FEB RAS already developed OpenGIS-compatible mapping services
- PICES is a good instance of such international association, and such GIS resources integration would be exceptionally useful.

Thank you for your attention!