Arctic Research Mapping Application (ARMAP): An Interactive Online Service for Arctic Science

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Abstract

The Arctic Research Mapping Application (ARMAP) is a 2D internet map server focused on displaying information about federally funded field-based research projects in the Arctic (**Figure 1**). Users can zoom to areas of interest, and view or manipulate a variety of map layers such as topography, bathymetry, satellite imagery, cities, rivers, and sea ice. They are also able to search for research projects by location, year, funding program, keyword, investigator, and discipline, among other variables that are conveniently displayed at the bottom of the application. Information about each project is derived from the VECO Polar Resources Arctic Research Logistics Support Service (ARLSS) database of scientific field research projects for the Arctic region (45 degrees North Latitude and above). The database is focused on projects sponsored by the US National Science Foundation (NSF) Arctic Sciences Division, and is expanding to projects funded by other agencies. Users can access a summary table of information about each location, plus detailed project reports that are hyperlinked to each record (**Figure 2**). Metadata can be obtained for layers located in the table of contents of the

application by clicking any layer name (**Figure 3**). Metadata are based on the Federal Geographic Data Committee (FGDC) standard and include online links for accessing the associated datasets. Users can export tabular data and print or export maps for presentations or publications, and select from a "map gallery" of predefined images of interest. With special emphasis on the International Polar Year (IPY), this service is targeted to science planners, scientists, educators, and the general public. In sum, ARMAP goes beyond map display to analysis, synthesis, and coordination of Arctic research. ARMAP can be accessed over the internet via the gateway website at http://www.armap.org.

Paper Body

Technology choices were made to address the requirements put forth by the client (NSF) and to maximize accessibility of the ARMAP application for the end user community. ARMAP was designed using ESRI's ArcIMS software version 9.1. The application interface was programmed for an html client and does not require the user to download or install any special plug-ins. ARMAP features an interactive toolbar to control the map view, run queries, measure distance, print, among other GIS functions. Queries of the "Research by…" layers will produce a table located in the bottom frame. Users can choose one of six polar views focused on different Arctic nations. A series of 68 layers can be accessed from a user-friendly table of contents designed to mimic the Windows Explorer with a series of file folders. Layers can be turned on or off to address the user's needs. The layer listing can be toggled to show legend information for layers that are turned on. The interface also includes useful information embedded in a

scrolling banner, explanations of the layer listing icons and an online tutorial formatted as a series of frequently asked questions. In addition, a short narrated tour is available for download from the armap.org web site.

Challenges for the development team included addressing the client's requirement to be able to change the polar orientation of the map view, to acquire and ingest daily updates from the ARLSS database, plus to configure and maintain the application remotely. The implementation of a Spatial Database Engine (SDE) database provided the capacity for reprojecting the regional polar views on the fly and for automating updates to the research sites through Geodatabase versioning. Key fields from the ARLSS database are retrieved from a web service in XML format. These data are automatically downloaded and converted into feature classes in the Geodatabase. The application data are stored in a North Pole Lambert Azimuthal Equal Area map projection. The central meridian of this projection changes to re-center the view on Canada, Greenland, Northern Europe, Russia and Alaska. The user can access these views (or series of ArcIMS ArcMap Services) through a pull down "Zoom to…" menu located on the top frame. Numerous utilities provide remote access to the ARMAP server and promote online collaboration, including Virtual Private Network connectivity for off-campus access, Microsoft Remote Desktop, FTP and SKYPE.

Software and hardware were selected to leverage bulk purchasing agreements with Dell Computer Corporation and software licensing provided to educational institutions by the Environmental Systems Research Institute (ESRI) and the Microsoft Corporation. ESRI software was also a logical choice due to student expertise developed through undergraduate and graduate coursework using ESRI's ArcGIS package.

ARMAP is hosted on a high performance Dell blade server (running dual 3 GHz processors, 8 GB memory and 3 terabytes of storage) configured with Windows Server 2003, Microsoft Information Server 6.0, ArcIMS 9.1 and Jakarta Tomcat 5.0.28. Raster and vector data are stored in a Geodatabase within a Microsoft SQL and Arc Spatial Database Engine (ArcSDE) environment to maximize performance, allowing for on the fly reprojection of data and versioning. The application also benefits from Internet2 connectivity and 24 hour service support and administration within the University of Texas El Paso's primary server room.

Capacity building and student involvement are a major focus of the ARMAP project. Graduate and undergraduate students gained hands on experience in all aspects of the server configuration, application development, outreach, metadata and documentation. ARMAP provides a unique real world experience for student developers to apply theoretical knowledge gained in GIS, remote sensing and computer science course work.

The ongoing development of ARMAP includes the adoption of additional best practices for increasing the availability and exchange of data through Open Geospatial Consortium (OGC) standards [**1**], Arctic Spatial Data Infrastructure [**2**] and the IPY Data and Information Service. These include: employing Web Map Services and Web Feature Services for the integration of additional layers hosted by several data centers and the promotion of further data discovery through metadata publication. A Web Accessible Folder for metadata harvesting by GeoData.gov has been established and metadata are also published on ESRI's Geography Network. The North Pole Lambert Azimuthal Equal Area map projection and the regional variations were recently accepted

by the Oil and Gas Producers Surveying and Positioning Committee formerly the European Petroleum Survey Group (EPSG) which will allow ARMAP to embed OGC services including Web Feature Services and Web Coverage Services from regional data centers such as the National Snow and Ice Data Center and the Geographic Information Network of Alaska.

The ARMAP project also includes the development of 3D tools which will provide for access to the ARLSS database in virtual globes. A Keyhole Markup Language (KML) file has been developed for Google Earth.. [**3**]. Testing is also underway with the new KML service provided by ArcServer 9.2. In addition, ArcServer will be employed for the launch of a customized ArcGIS Explorer application.

Acknowledgements

Development of ARMAP benefited from numerous ideas, scripts and suggestions provided by the GIS community in the ESRI Knowledge Base, ArcScripts and User Forums. The ARMAP development team would like to specifically like to acknowledge Dave Bollinger (San Joaquin County, CA) for the table of contents script and Chris Clough with the Kenai Peninsula Borough for assistance with the code that enables the user to seamlessly change the map service. We would also like to thank the Geospatial Center at the University of Texas at El Paso and The University of Redlands for the support and help with the configuration of our server.

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the INSTAAR QGIS Laboratory, and VECO Polar Resources. Comments are appreciated at info@armap.org.

Appendixes

Figure 1. Overview of the ARMAP interface.

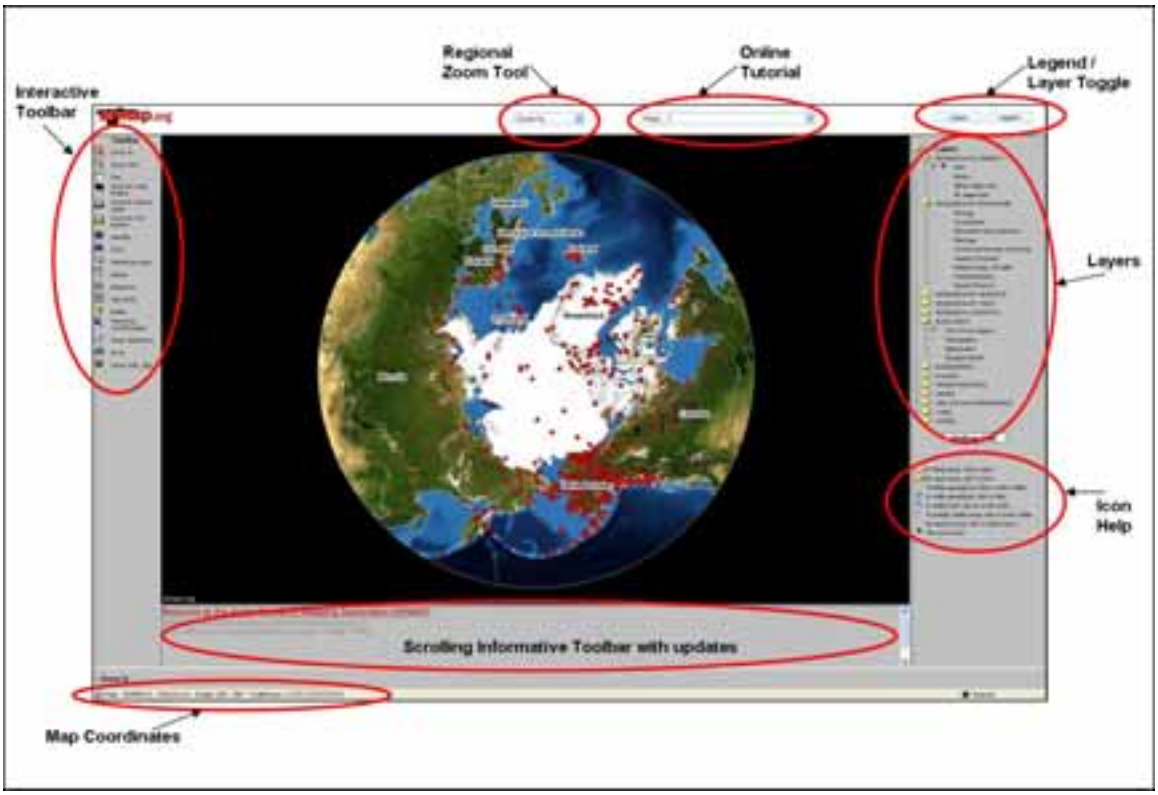


Figure 2. Award Info is hyperlinked from the query results to display detailed project reports derived from the ARLSS database.

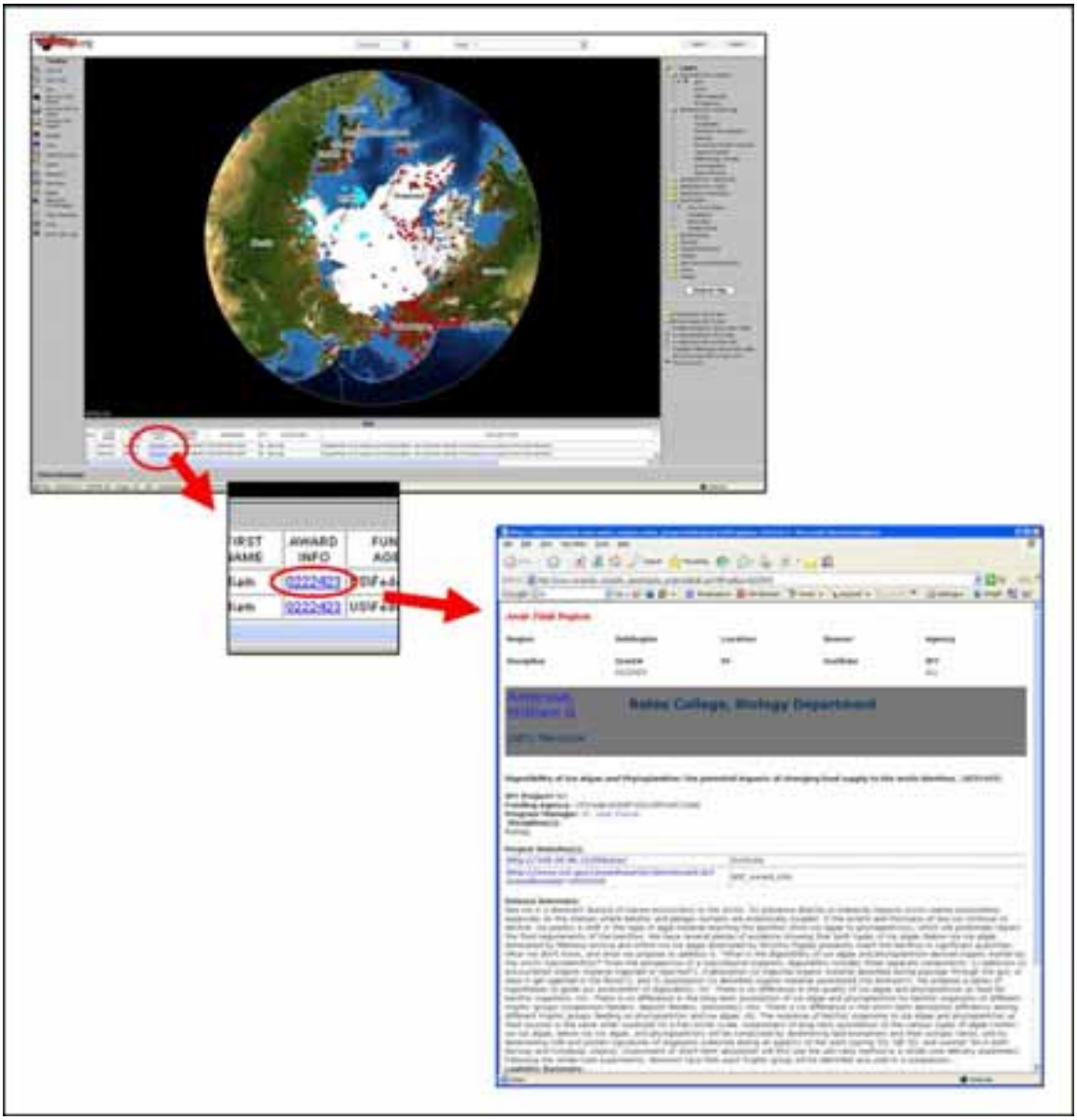
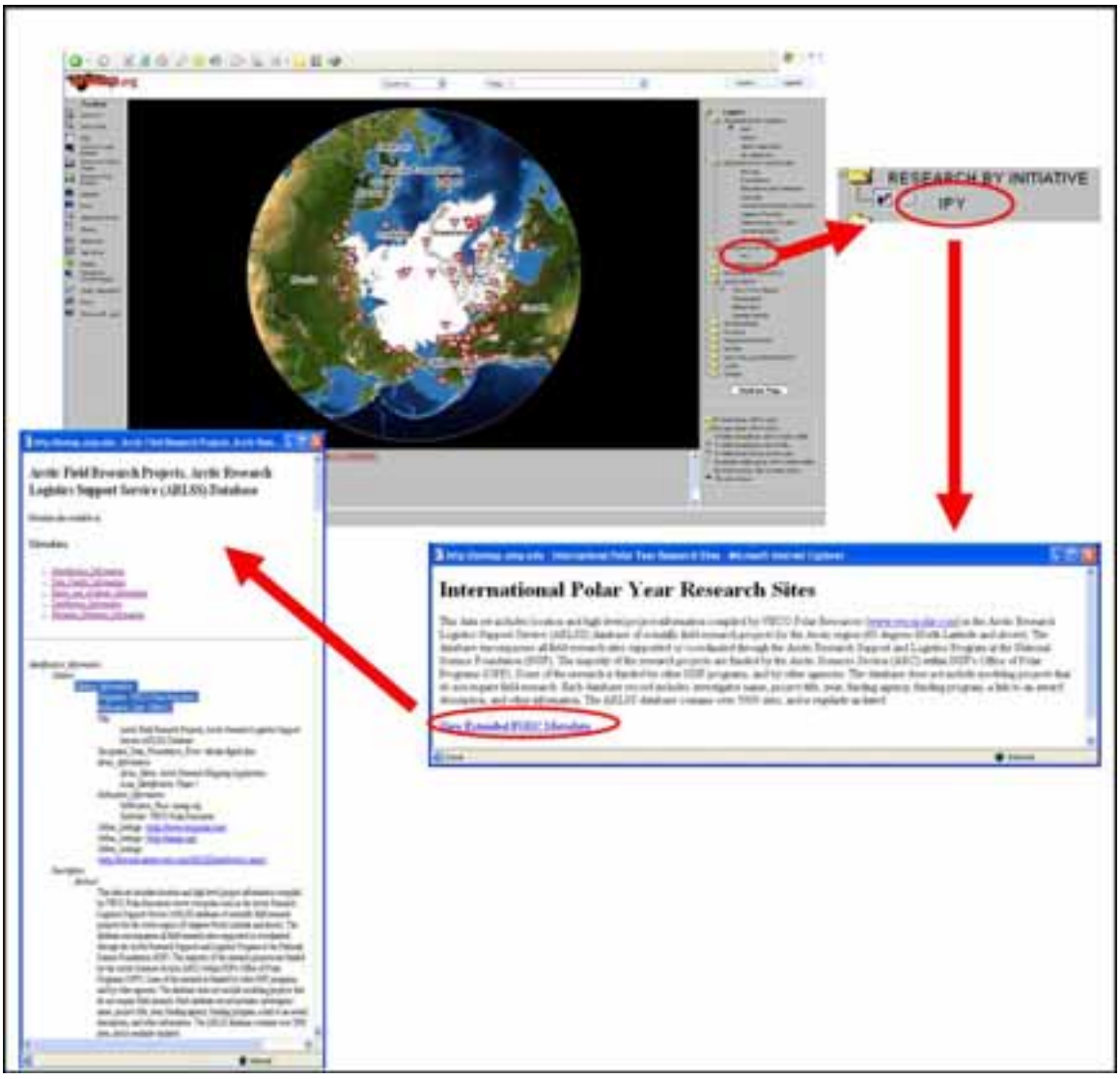


Figure 3. Metadata are linked to each layer in ARMAP. Initially, a brief description is accessed allowing the user requiring additional information to "View Extended FGDC Metadata."



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