Interoperable Challenges in Web Based GIS Applications: Solutions during the development of the Arctic Research Mapping Application (ARMAP)

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Fairbanks, AK
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Background

- Developed for NSF's Office of Polar Programs
- **Suite of tools** for program officers to enhance **research** and **logistic** planning, international **collaboration** and reporting.
- Now being adopted by US and some international researchers.
- ***Not a data archive*** - ARMAP is an information portal.

ARLSS

(Arctic Research & Logistics Support System)

- ARLSS is the primary source of project information for ARMAP.
- Database maintained by CPS since 1999.
- Information gathered from award database, award jacket, and data provided by PI.
- High-level project information (PI, abstract, project-related URLs, research lat/long, etc.).
- Mostly Arctic field projects funded by NSF, includes IPY and AON.
- Future ~ info from all US federally-sponsored Arctic field projects ~ some requests internationally.
- Project data constantly added and updated.

Development Highlights

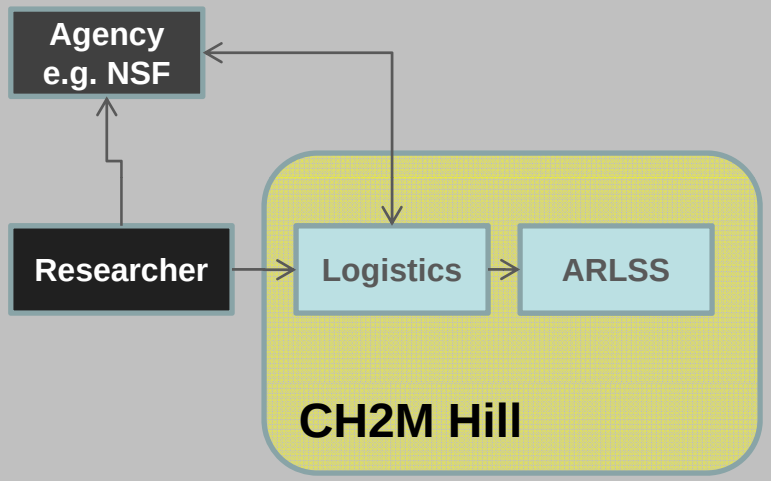
- 2006
  - IMS Visualization tool for ARLSS and ancillary data
  - No browser plug in
  - Regional polar views
- 2007
  - Network link for Google Earth
  - Added text based search interface with generates reports in rtf, pdf and txt. The same tool generates persistent XMLs
- 2008 - Comparison of 3D Geobrowsers (GE/AGX)
- 2009 - Testing interoperability and new visualization tools with other regional initiatives (NSSI, AMIS, NASA GCMD, CADIS AON)

*** ALL TOOLS REQUIRED WEEKLY UPDATES**

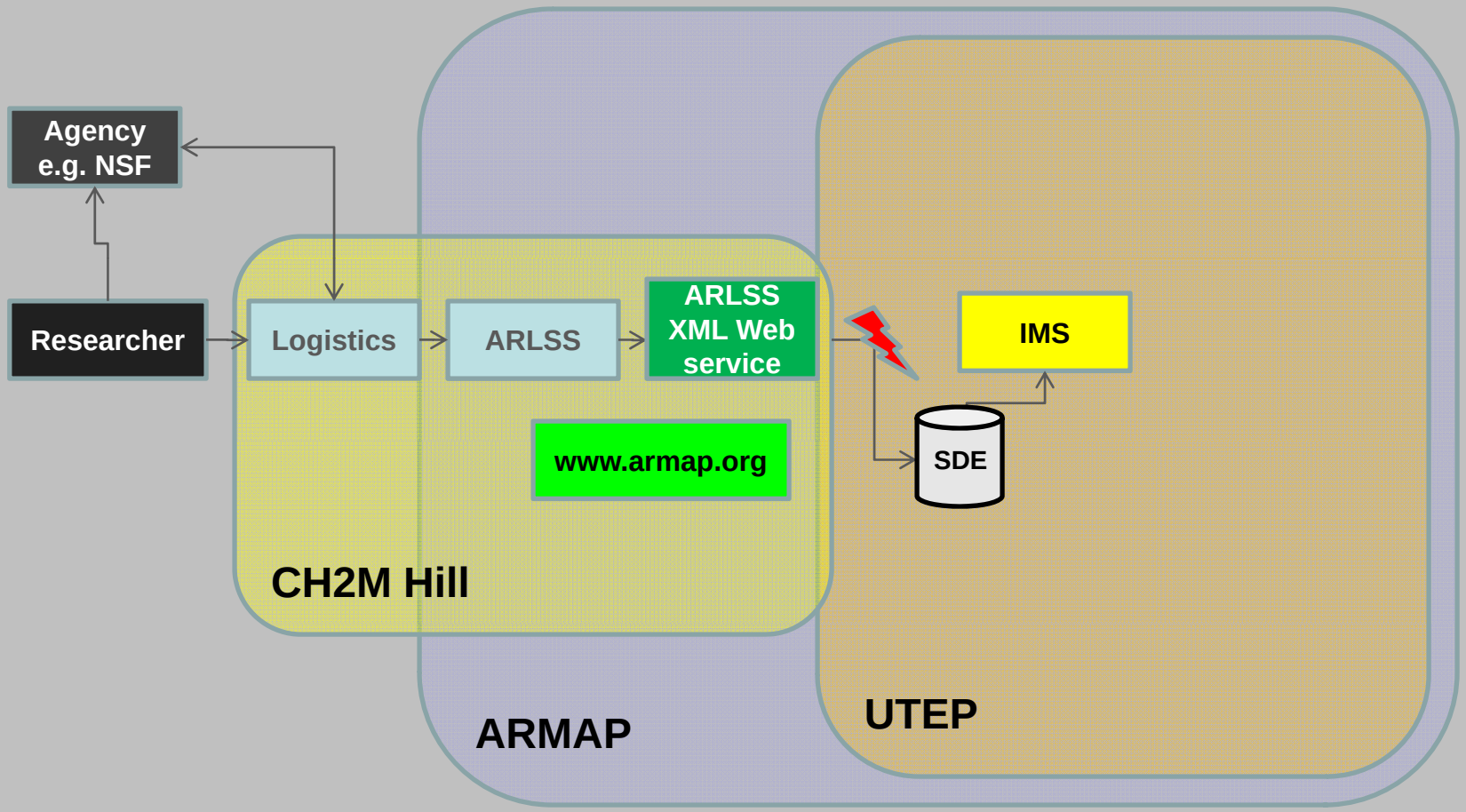
Challenge: Data Access

- Provide ***broad*** access to current information
- Address the needs of a varied audience
  - NSF Program Officers
  - Science logistics experts
  - Scientists
  - Educators
  - General public
- Streamline updates
- Ensure interoperability with other project tracking efforts

Data Access: Solutions Implemented



ESRI ArcIMS and ArcSDE (2006)



armap.org

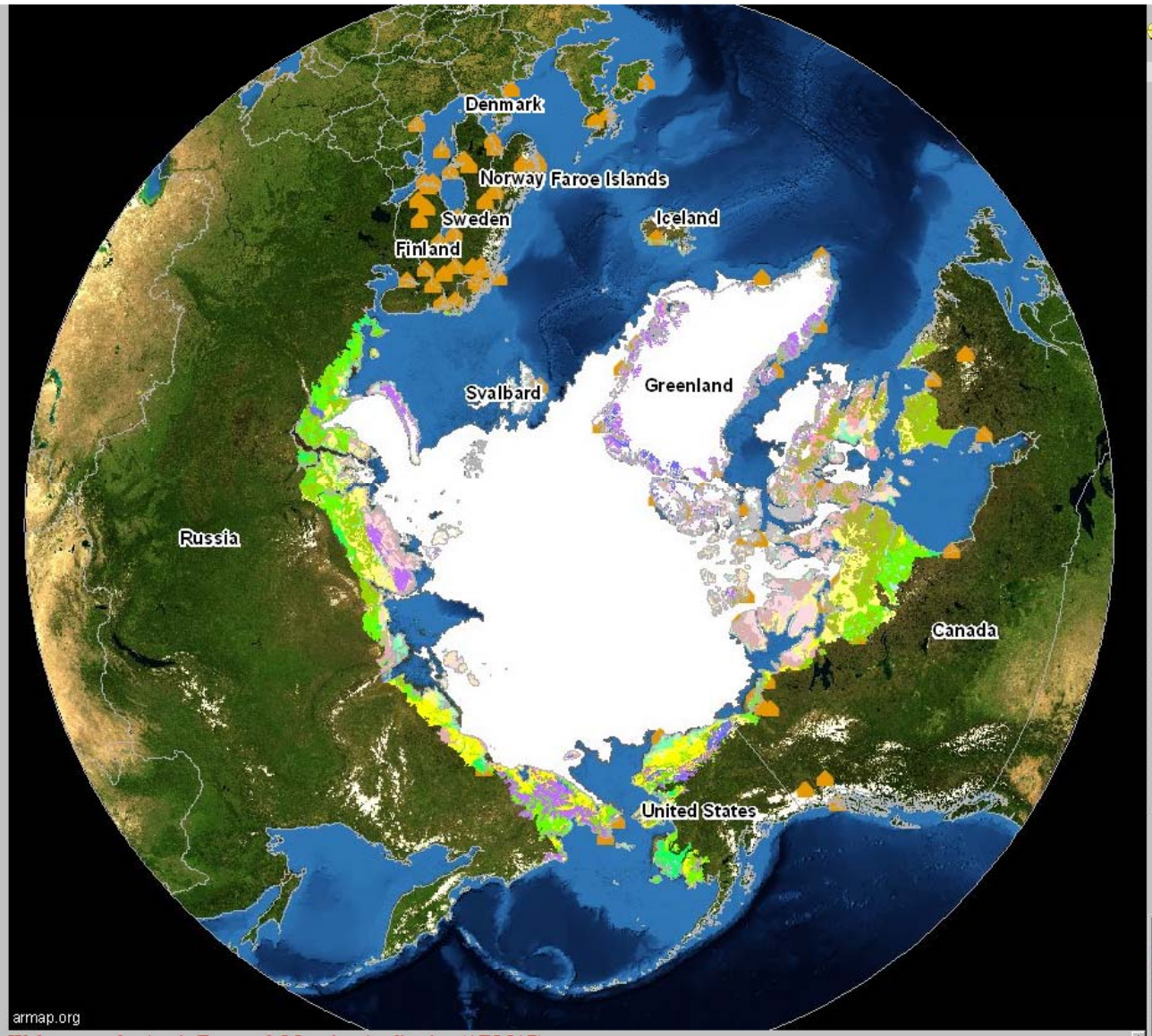
Zoom to....

Help....?

Layers | Legend

Toolbar

- Zoom In
- Zoom Out
- Pan
- Zoom to Last Extent
- Zoom to Active Layer
- Zoom to Full Extent
- Identify
- Find
- Select by Area
- Query
- Measure
- Set Units
- Buffer
- Select by Line/Polygon
- Clear Selection
- Print
- Save .jpg



Welcome to the Arctic Research Mapping Application (ARMAP)

ARMAP has been tested with Internet Explorer 6 and 7.

SOURCE LAYERS

- LAYERS
  - RESEARCH BY AGENCY
    - NSF
    - NASA
    - USGS
    - NOAA
    - Other Agencies
    - All Agencies
  - RESEARCH BY DISCIPLINE
  - RESEARCH BY INITIATIVE
    - IPY NSF Projects
    - IPY Other Federal Projects
    - IPY Endorsed Projects by the IPO
    - AON
    - GCMD
  - RESEARCH BY YEAR
  - RESEARCH BY REGION (NSF)
  - RESEARCH LOGISTICS
    - Permanent DGPS Basestations
    - Arctic Stations
    - FARO Members
    - IASC Members
  - BASE MAPS
  - BOUNDARIES
  - PLACES
    - Alaska USGS GeoNames
    - Field Research Site Names
    - Place Names Gazetteer
    - World Cities
  - TRANSPORTATION
  - WATER
  - SEA ICE
  - LAND
    - Permafrost
    - Terrestrial Biomes
    - Tree Line
    - Vegetation
    - Glaciers
  - ONLINE ARCTIC MAP SERVICES
  - OTHER

Redraw Map

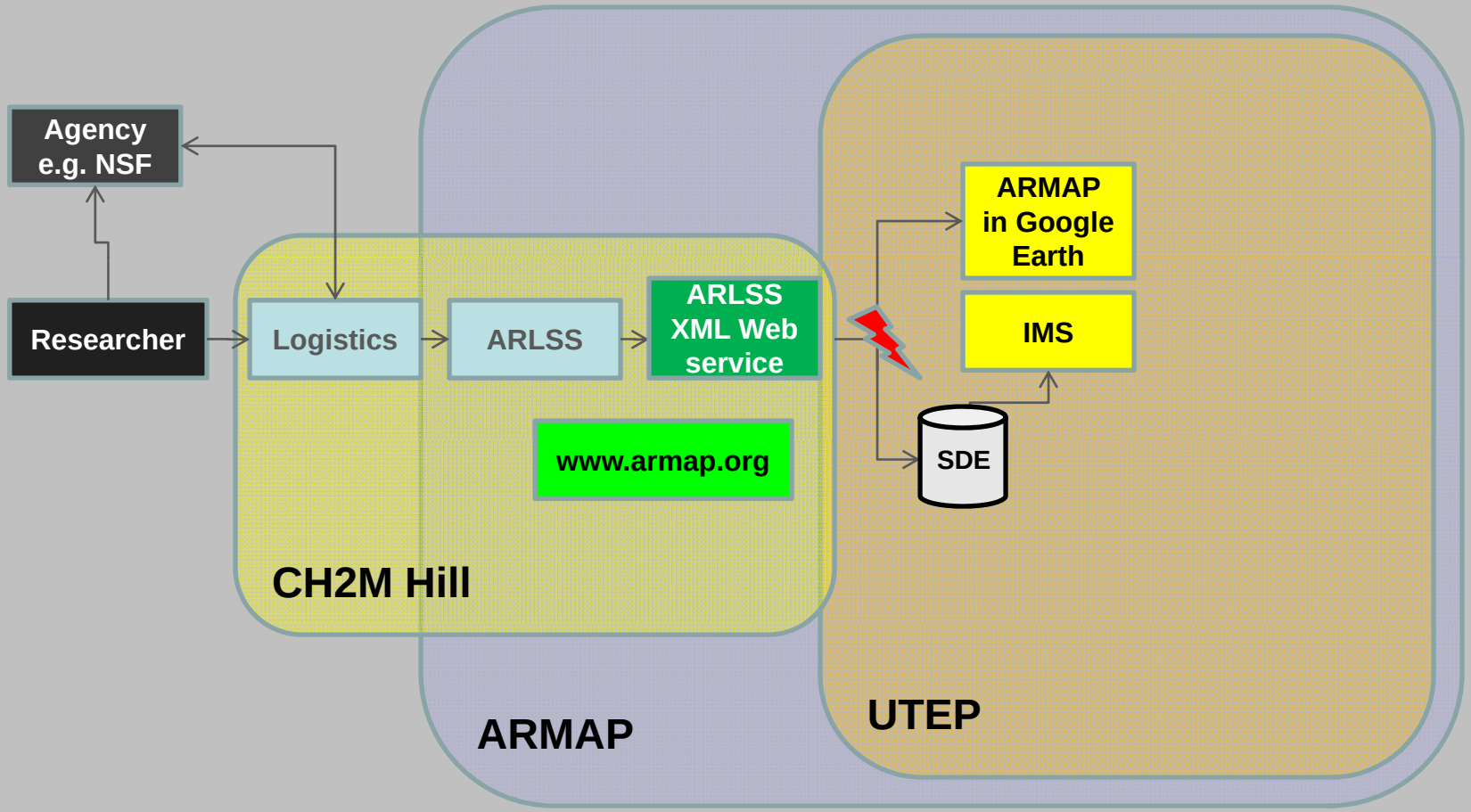
Auto Draw Map Layers

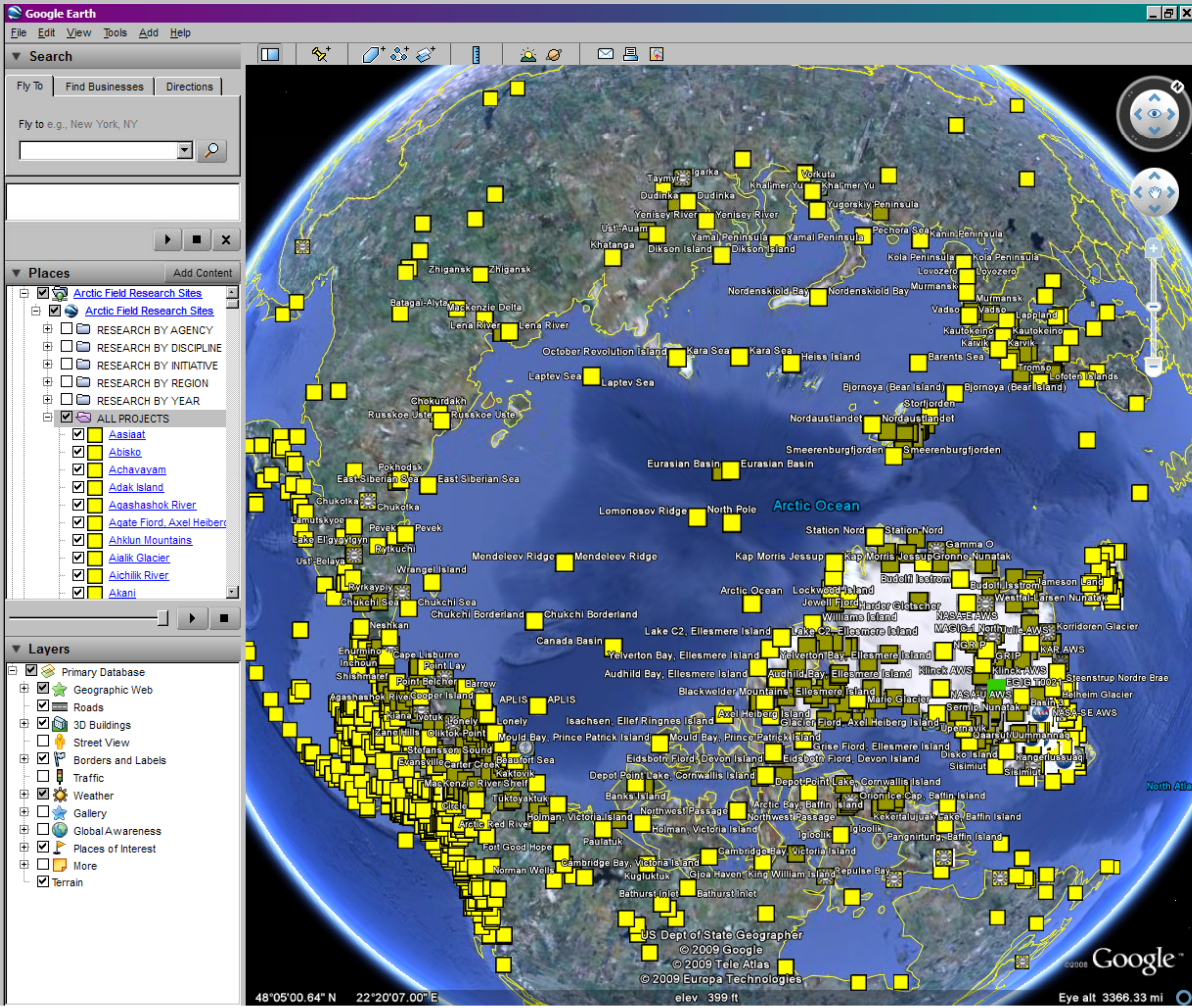
Help:

- A closed group, click to open.
- An open group, click to close.
- A hidden group/layer, click to make visible.
- A visible group/layer, click to hide.
- A visible layer, but not at this scale.
- A partially visible group, click to make visible.
- An inactive layer, click to make active.
- The active layer.

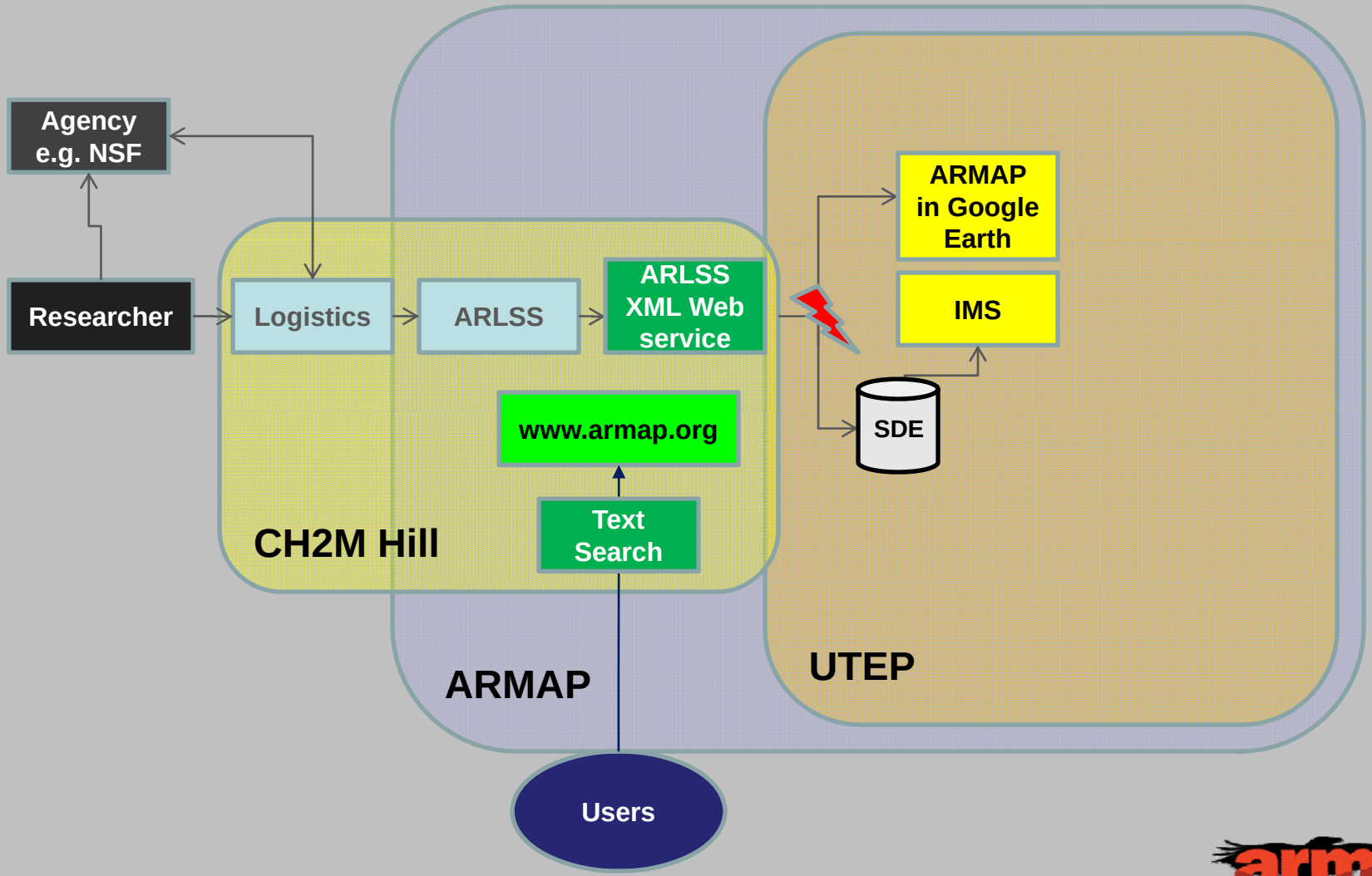
Zoom In

GE Network Link (2007)




Google Earth
File Edit View Tools Add Help
Search
Fly To
Find Businesses
Directions
Fly to e.g., New York, NY
Places
Add Content
Arctic Field Research Sites
Arctic Field Research Sites
RESEARCH BY AGENCY
RESEARCH BY DISCIPLINE
RESEARCH BY INITIATIVE
RESEARCH BY REGION
RESEARCH BY YEAR
ALL PROJECTS
Aasiaat
Abisko
Achavayam
Adak Island
Agashashok River
Agate Fiord, Axel Heiberc
Ahklun Mountains
Aialik Glacier
Aichilik River
Akani
Layers
Primary Database
Geographic Web
Roads
3D Buildings
Street View
Borders and Labels
Traffic
Weather
Gallery
Global Awareness
Places of Interest
More
Terrain
Arctic Ocean
North Pole
Lomonosov Ridge
Eurasian Basin
Mendeleev Ridge
Chukchi Borderland
Canada Basin
Laptev Sea
Kara Sea
East Siberian Sea
Chukchi Sea
Beaufort Sea
Barents Sea
Station Nord
Kap Morris Jessup
US Dept of State Geographer
© 2009 Google
© 2009 Tele Atlas
© 2009 Europa Technologies
Google
48°05'00.64" N 22°20'07.00" E elev 399 ft
Eye alt 3366.33 mi

Multi-format Text Search (2007)



ArcticResearchMappingApplication

Home
Map Gallery
Text Search
Links
Credits
Contact
Watch a Demo

To conduct text-only searches of arctic field-based research projects use the query interface below. Data are pulled directly from a database of arctic field projects maintained by NSF's Arctic logistics provider, CH2M HILL Polar Services. Most project information is available for NSF-funded projects that have been active in the Arctic since 1999. Please contact us if you'd like to add your project or correct information stored in the database.

Search Options

Click on the drop down buttons and select parameters you wish to view or type in your search parameters in the "Search by Free-Text" textbox. Click the Submit button to complete your search and view relevant information contained within the database.

	Search by Dropdown	Search by Free-Text
Region		
SubRegion		
Location		
Season		
Agency		
Discipline		
Grant#		
PI	Sturm, Matthew	
Institute		
IPY	All	

Select Report Type HTML Submit Reset Help

HTML
RTF
PDF
XML

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Web Services | Citation | Disclaimer | Browser Comaptibility | Text Only Site

armap ArcticResearchMappingApplication

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Select Report Type HTML Submit Reset Help

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Arctic Field Projects

Project Title: SGER: Using Photogrammetry to Assess 50 Years of Change in Arctic Vegetation: A Feasibility Study (Award# 0084345)

PI: Sturm, Matthew (msturm@crrel.usace.army.mil)
Phone: (907) 353.5183
Institute/Department: Cold Regions Research and Engineering Laboratory,
IPY Project? NO
Funding Agency: US\Federal\NSF\OD\OPP\ARC\ARCSS
Program Manager: Dr. Michael Ledbetter (mledbett@nsf.gov)
Discipline(s): | Biology |

Project Web Site(s):
Media: http://www.hq.usace.army.mil/cepa/pubs/mar02/story10.htm
NSF_Award_Info: http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0084...
Media: http://www.uaf.edu/seagrant/NewsMedia/01ASJ/06.01.01shrubs.h...
Logistics: http://www.uaf.edu/toolik/

Science Summary:
This project will collect low altitude aerial photographs at sites in northern Alaska where photographs were previously taken in 1948 and 1949. The new photographs will be examined for evidence of decadal changes in vegetation and landscape that may have occurred in response to a significant climatic warming that has taken place in the Alaskan Arctic over the past two decades. The purpose of the comparison is: 1) to determine if ecological change has occurred and 2) if oblique aerial photography can be used to detect the changes. The results of this feasibility study could be useful as demonstration of a technique that could be applied to a widely distributed set of aerial photographs taken fifty years ago over much of the Arctic Slope in Alaska.

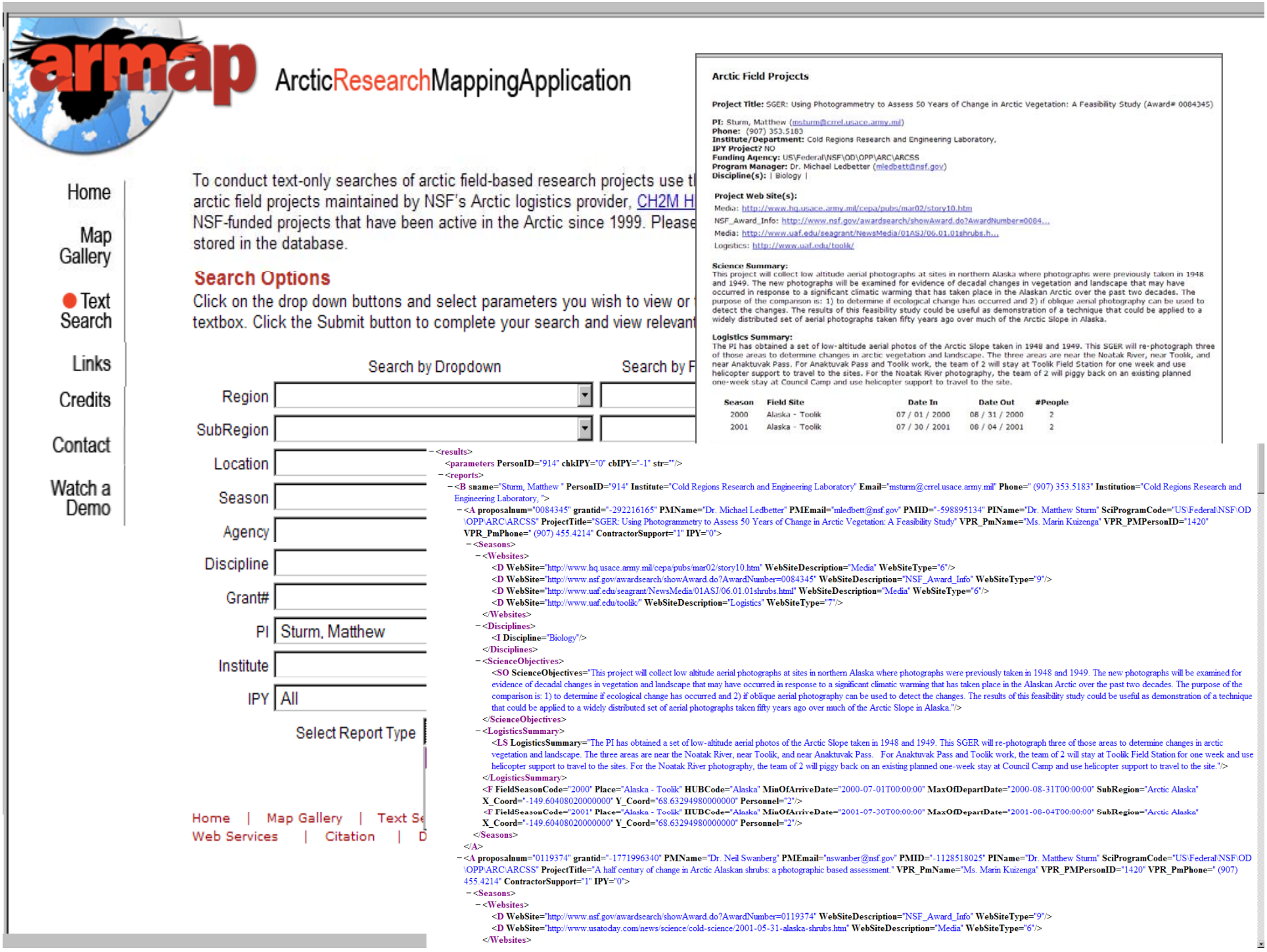
Logistics Summary:
The PI has obtained a set of low-altitude aerial photos of the Arctic Slope taken in 1948 and 1949. This SGER will re-photograph three of those areas to determine changes in arctic vegetation and landscape. The three areas are near the Noatak River, near Toolik, and near Anaktuvak Pass. For Anaktuvak Pass and Toolik work, the team of 2 will stay at Toolik Field Station for one week and use helicopter support to travel to the sites. For the Noatak River photography, the team of 2 will piggy back on an existing planned one-week stay at Council Camp and use helicopter support to travel to the site.

Season	Field Site	Date In	Date Out	#People
2000	Alaska - Toolik	07 / 01 / 2000	08 / 31 / 2000	2
2001	Alaska - Toolik	07 / 30 / 2001	08 / 04 / 2001	2

Project Title: A half century of change in Arctic Alaskan shrubs: a photographic based assessment. (Award# 0119374)

PI: Sturm, Matthew (msturm@crrel.usace.army.mil)
Phone: (907) 353.5183
Institute/Department: Cold Regions Research and Engineering Laboratory,
IPY Project? NO
Funding Agency: US\Federal\NSF\OD\OPP\ARC\ARCSS
Program Manager: Dr. Neil Swanberg (nswanber@nsf.gov)
Discipline(s): | Biology | Meteorology and Climate |

Project Web Site(s):


armap
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Media: http://www.hq.usace.army.mil/cepa/pubs/mar02/story10.htm
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Alaska - Toolik
07 / 01 / 2000
08 / 31 / 2000
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Alaska - Toolik
07 / 30 / 2001
08 / 04 / 2001
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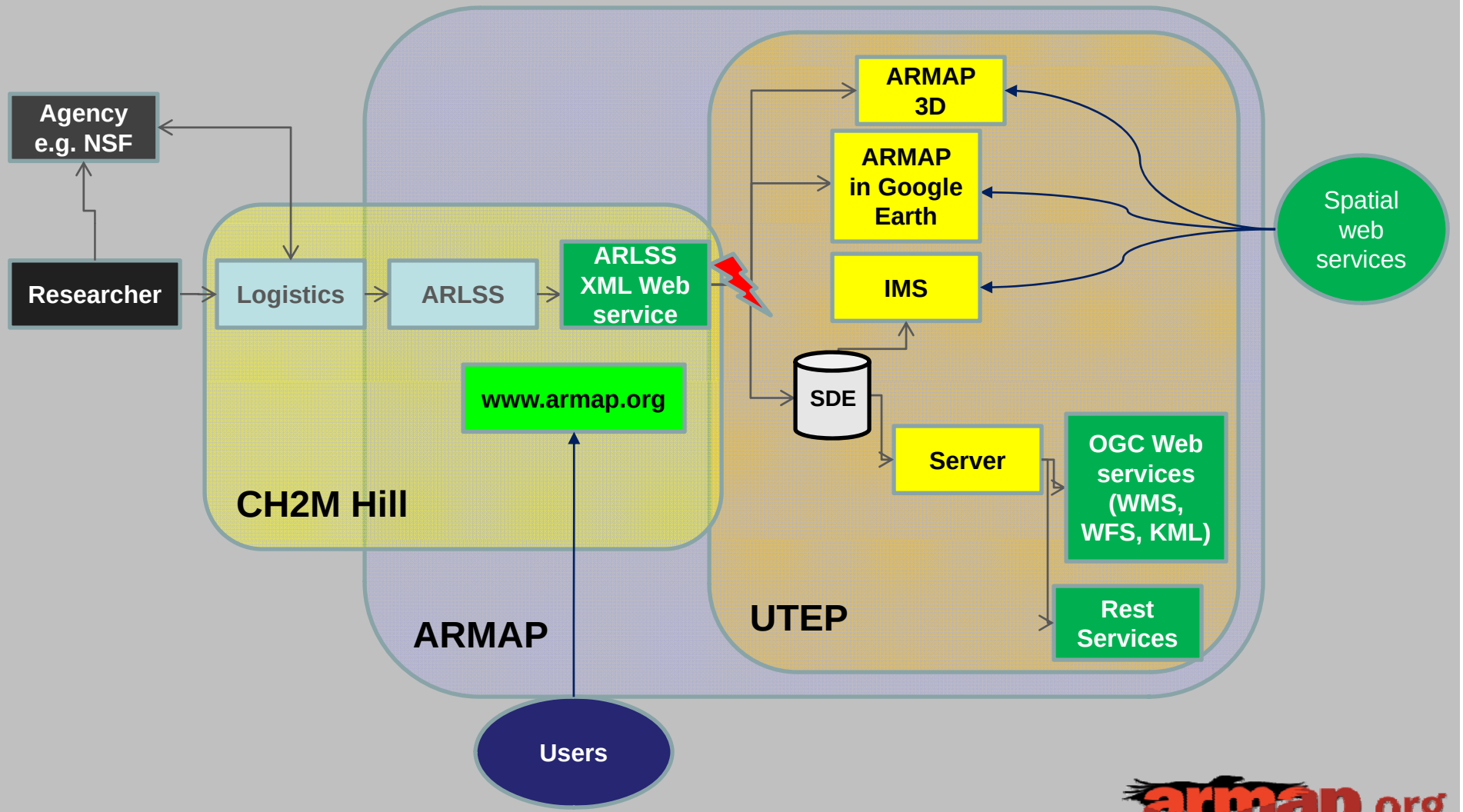
ArcServer and ArcGIS Explorer (2008)



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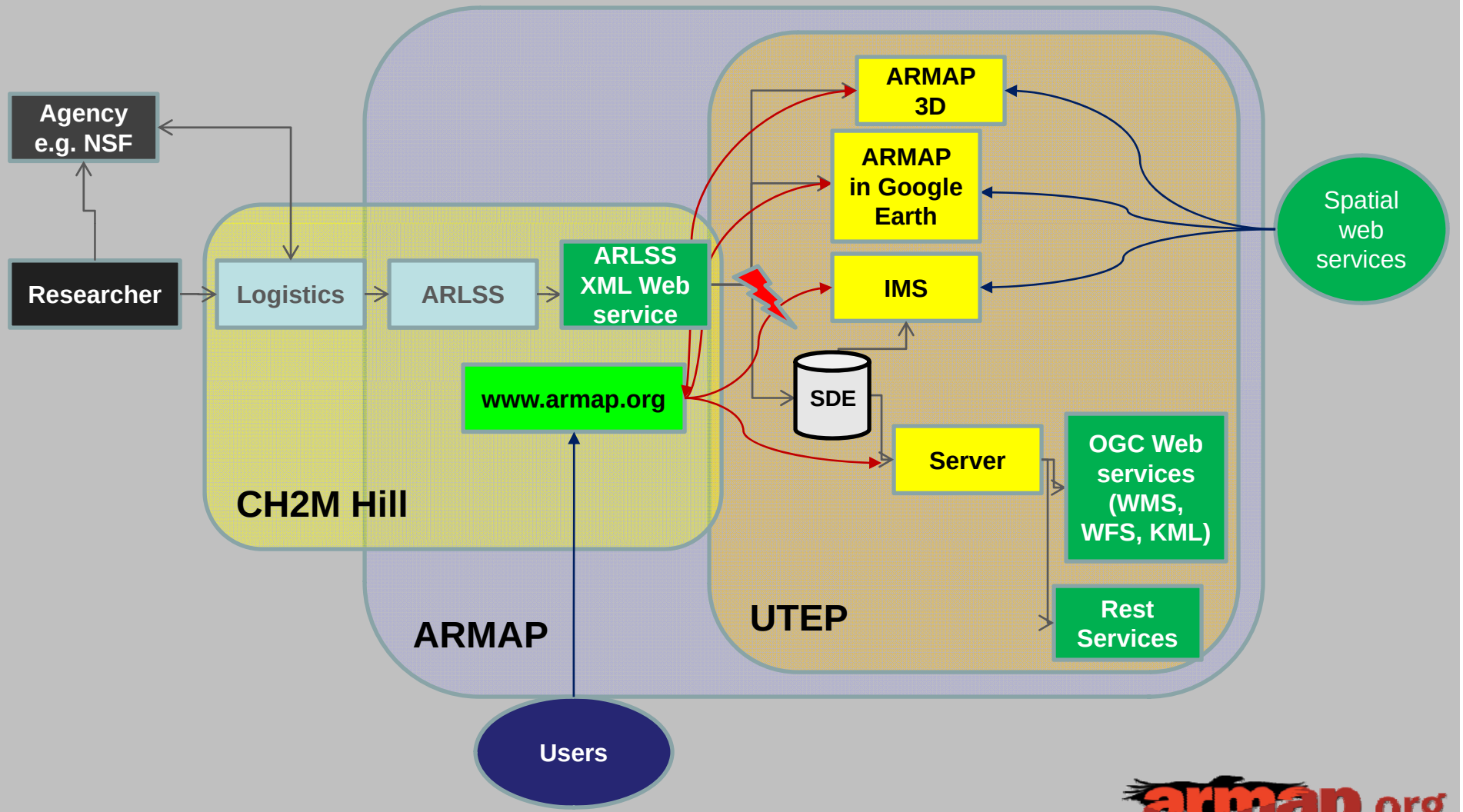
User access


Agency
e.g. NSF
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(WMS,
WFS, KML)
Rest
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UTEP
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web
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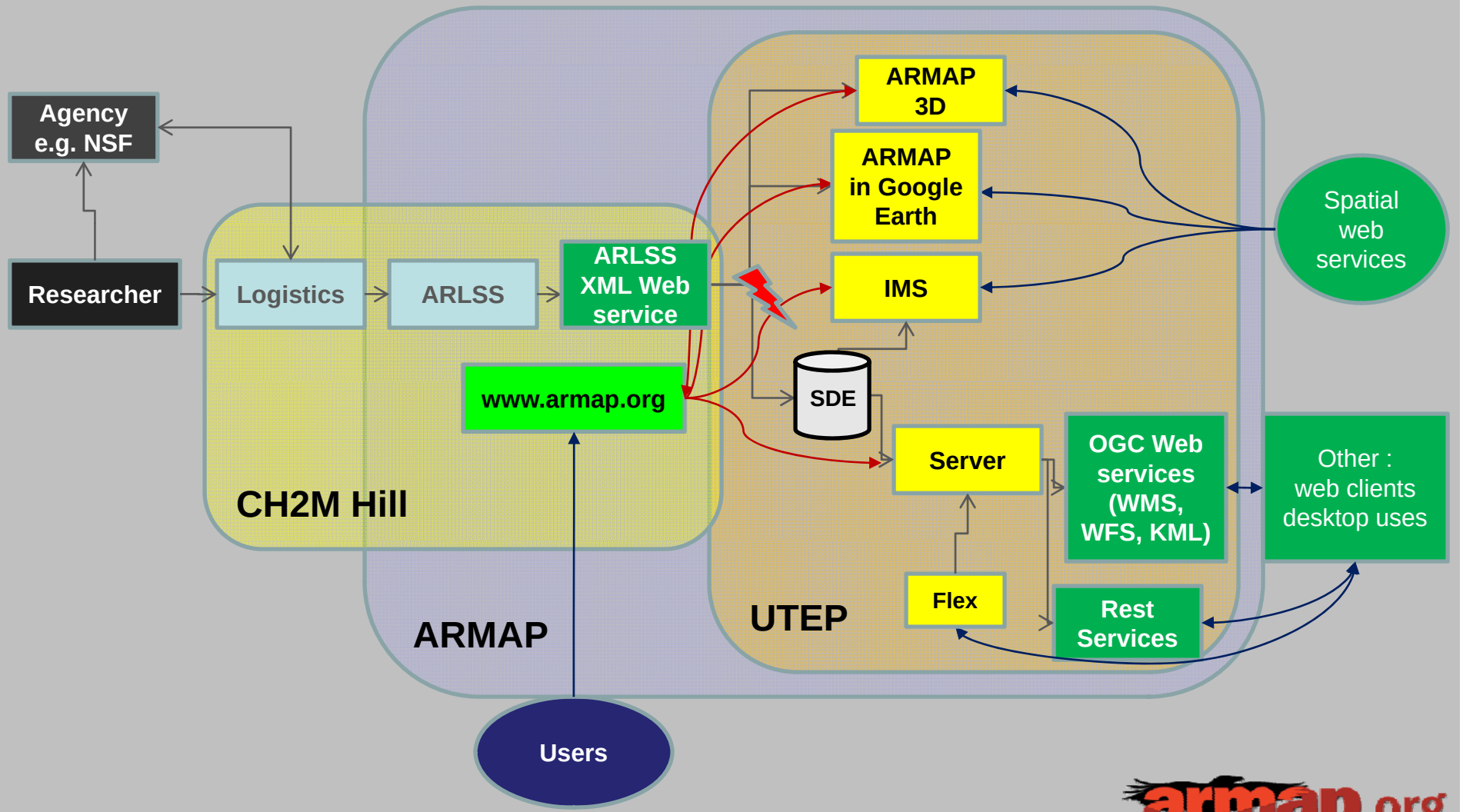
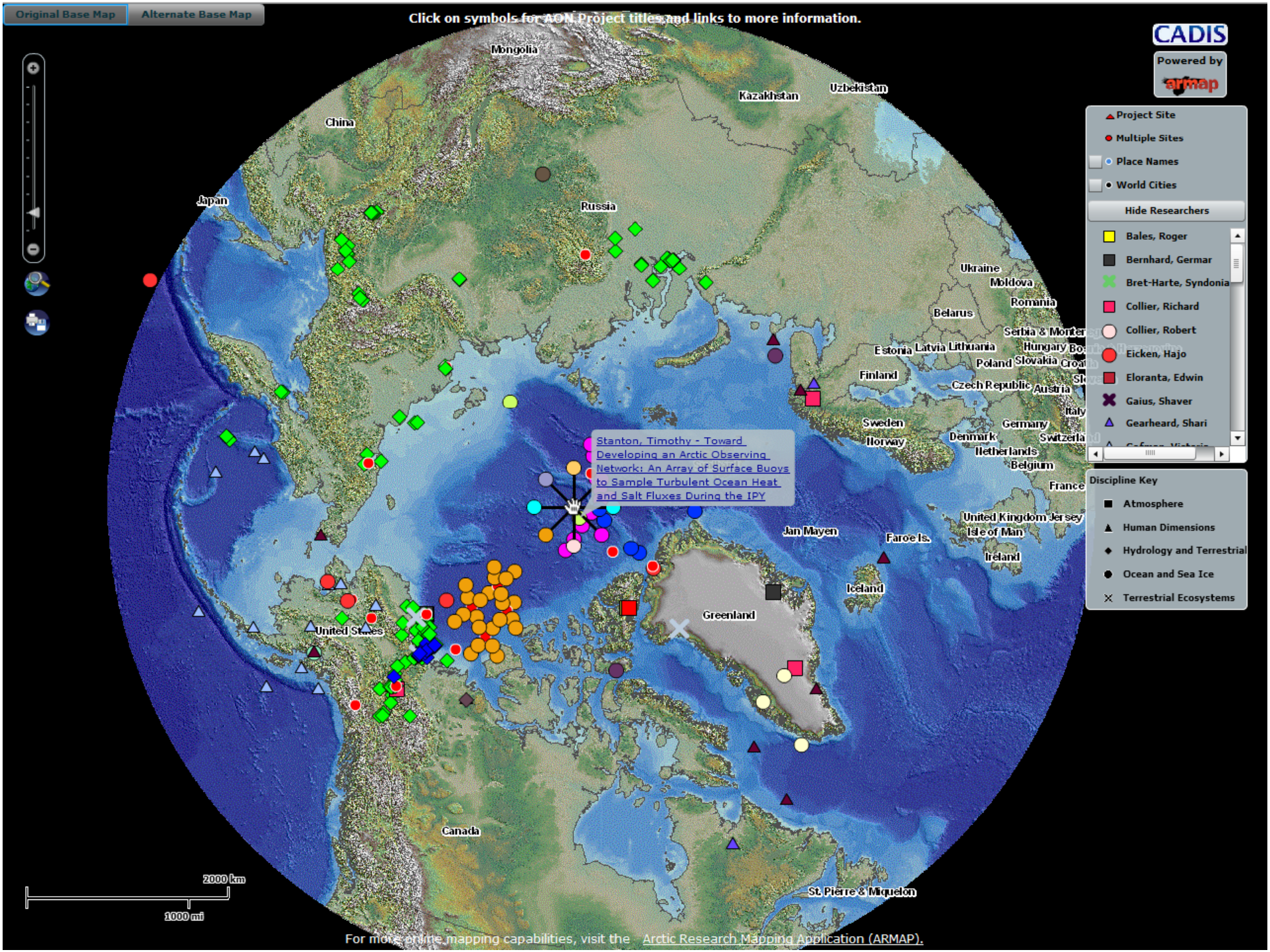
Users

Suite of Interoperability Services




Original Base Map
Alternate Base Map
Click on symbols for AON Project titles and links to more information.
CADIS
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Project Site
Multiple Sites
Place Names
World Cities
Hide Researchers
Bales, Roger
Bernhard, Germar
Bret-Harte, Syndonia
Collier, Richard
Collier, Robert
Eicken, Hajo
Eloranta, Edwin
Gaius, Shaver
Gearheard, Shari
Stanton, Timothy - Toward Developing an Arctic Observing Network: An Array of Surface Buoys to Sample Turbulent Ocean Heat and Salt Fluxes During the IPY
Discipline Key
Atmosphere
Human Dimensions
Hydrology and Terrestrial
Ocean and Sea Ice
Terrestrial Ecosystems
Mongolia
China
Kazakhstan
Uzbekistan
Japan
Russia
Ukraine
Moldova
Romania
Belarus
Estonia
Latvia
Lithuania
Poland
Slovakia
Finland
Czech Republic
Austria
Sweden
Norway
Germany
Denmark
Netherlands
Belgium
France
United Kingdom
Jersey
Isle of Man
Ireland
Jan Mayen
Faroe Is.
Iceland
Greenland
United States
Canada
St. Pierre & Miquelon
2000 km
1000 mi
For more online mapping capabilities, visit the Arctic Research Mapping Application (ARMAP).

Challenge: Lack of good regional data

- Excellent data sources for base maps, imagery and infrastructure available for Lower 48 US and Europe but not for the Arctic
- If data exists, there could be timely delay when requesting data
- No metadata
- Many different projections for regional datasets

Solution: Lack of good regional data

- Acquire the best data available, house in SDE, created “grouped” layers for serving and re-host (i.e. roads, airports, hydrology in ARMAP 2D IMS)
- Create regional Spatial Web services (WMS, WFS, KML, REST)
- Use standard regional projections for services
  - Alaska Albers
  - LAEA Alaska
  - North Pole Lambert Azimuthal Equal Area

Challenge: Polar Projections

- Most global map services (OGC and Arc Online) are available in geographic map projections and other projections that don't work well at the poles
- Google Maps API does not support polar projections
- Reprojecting global data to polar projections **decreases performance** and often results in **artifacts** along the date line, a hole at the pole, etc.
- Some services embed place names as fused layers which are turned upside down when reprojected.

Solution: Polar Projections

- Gained adoption for a series of Polar Lambert projections to the EPSG

LAEA: Alaska, Canada, Greenland, North Europe, Russia

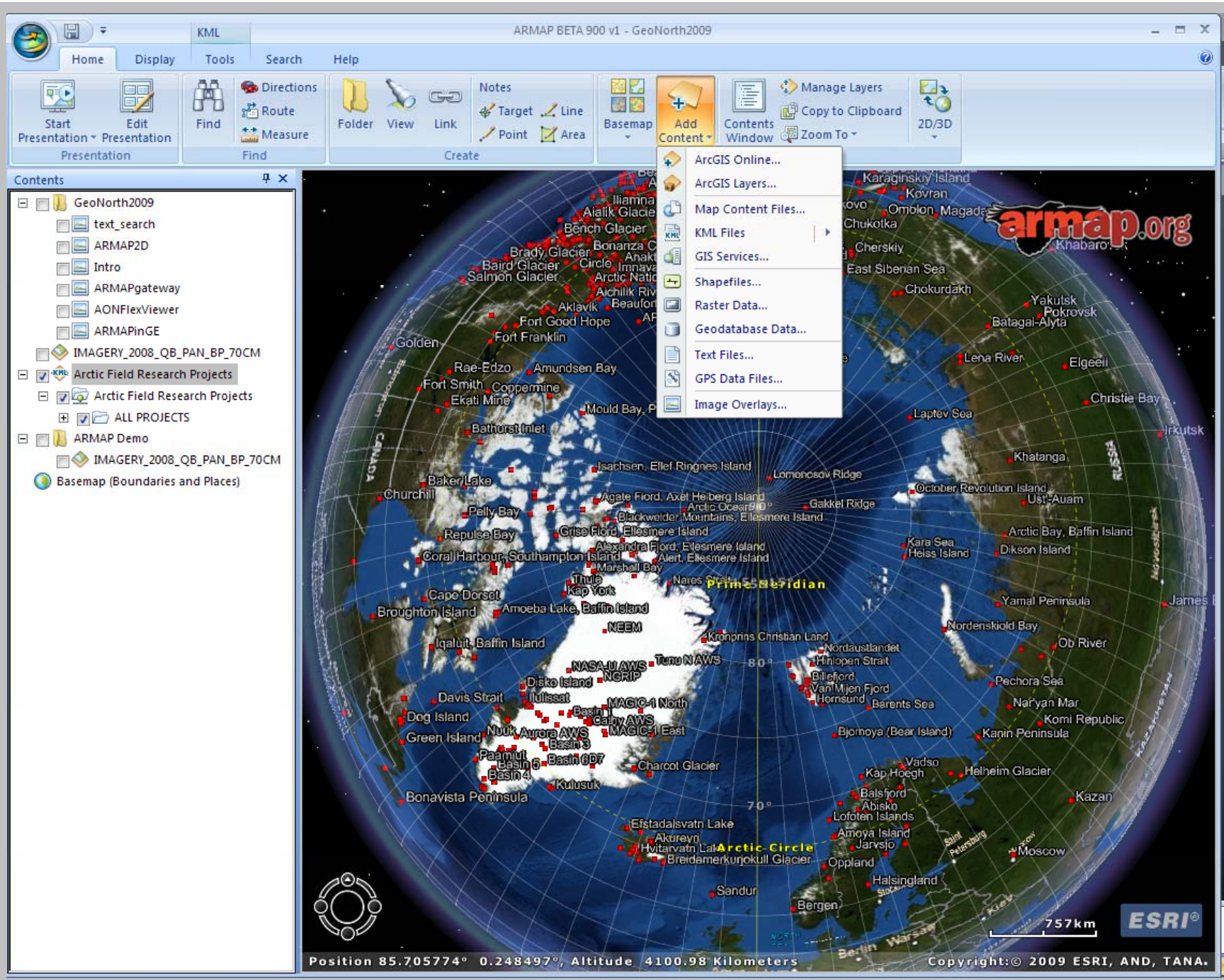
- Provide to software vender and service providers such as the NSIDC (Atlas of the Cryosphere), GINA (AlaskaMapped), and ESRI (9.3.1)
- Use virtual globe to drape polar data (i.e. AGX to import local data or link to web data)
- Lightweight 2D GIS APIs (Adobe FLEX)

Challenge: Evolving Standards

- Support for OGC standards improves with each software release
  - -ArcIMS 9.2 (image based services *.axl) import WMS and Publish WMS/WFS (vector only)
  - -ArcIMS 9.2 (ArcMap Services) import WMS - does not publish services
  - -ArcGIS Server 9.3 imports and serves OGC services (WMS, WFS, WCS, KML) and REST
- With WEB 2.0, new Geobrowsers offer more dynamic user experience than the old IMS technology
- Too many interfaces could confuse audience
- Services are resource intensive

Solution: Evolving Standards

- Upgrade software to support new OGC specs
- Upgrade UI to enhance usability
- Support lightweight web user interfaces (move from 2D IMS to 2D Flex browsers)
- Use 3D Geobrowsers that support interoperable services
- Distribute services to improve load balancing


ARMAP BETA 900 v1 - GeoNorth2009
KML
Home
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Search
Help
Start Presentation
Edit Presentation
Presentation
Find
Directions
Route
Measure
Find
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View
Link
Notes
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Line
Point
Area
Create
Basemap
Add Content
Contents Window
Manage Layers
Copy to Clipboard
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Text Files...
GPS Data Files...
Image Overlays...
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Intro
ARMAPgateway
AONFlexViewer
ARMAPinGE
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Arctic Field Research Projects
ALL PROJECTS
ARMAP Demo
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Basemap (Boundaries and Places)
armap.org
Prime Meridian
Arctic Circle
757km
ESRI
Position 85.705774° 0.248497°, Altitude 4100.98 Kilometers
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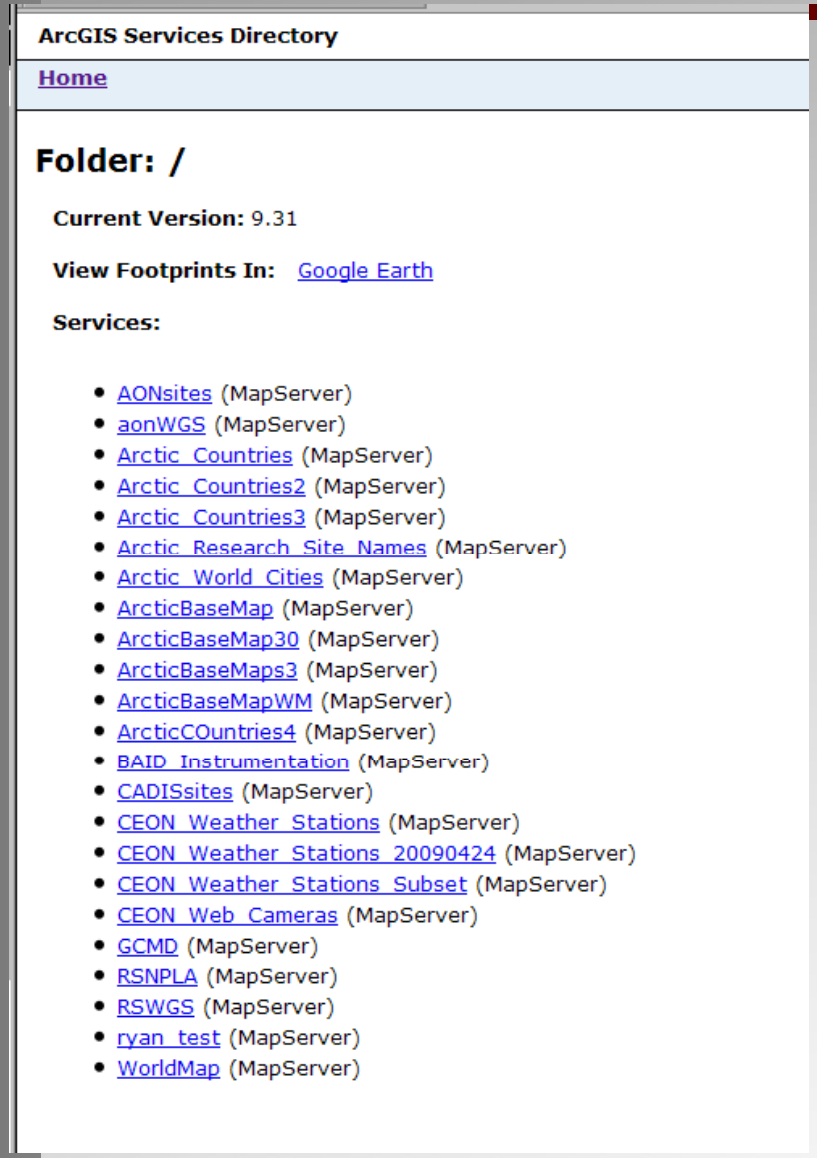
Challenge: Distributed Data

- Services are resource intensive; embedding and reprojecting too many can drag down application performance.
  - ARMAP 2D IMS – 6 regional map services with 126 layers each (total = 756 layers)
- Many global services are oversubscribed and/or not cached and performance is poor.
- Caching and Re-hosting data is resource intensive & a grey area in terms of licensing and providing proper credit.
  - NASA Blue Marble, NSIDC Atlas of the Cryosphere, CADIS AON, ESRI data and maps)
- Metadata for services is scarce

Solution: Distributed Data

- Limit the number of services that are included in each application and choose only those that are reliable and cached (we've had the best success with ArcOnline base maps and Alaska services from UAF's GINA.)
- Avoid caching and Re-hosting data as services (store in local SDE database. *Ex. NASA Blue Marble Next Gen*)
- Create FGDC ISO compliant metadata for all layers in ARMAP; publish services for unique data sets only
- Publish metadata Web Accessible Folder (WAF) for data unique to ARMAP

Solution: Distributed Data



- Publish ARMAP layers in services directory

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ARMAP Services

- 2D Maps
  - Internet Map Server (IMS)
  - Adobe Flex Viewer
- 3D Globes
  - Google Earth KML network link (GE)
  - ArcGIS Explorer (AGX)
- Text Searches
  - Plain Text (*including free text search*)
- Map Gallery
  - Series of predefined maps
- OGC services (WMS, WFS, and KML)
- REST services

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Comparison of ARMAP Applications

	ArcIMS (html viewer)	ArcGIS Explorer	Google Earth 5	Adobe Flex API	Comments
3D Geobrowser	**No**	**Yes**	**Yes**	**No**	Both AGX and GE require download
Open Source	**No**	**Yes**	**No**	**Yes**	
WMS / WFS client (Open Geospatial Consortium standards)	**Yes**	**Yes**	**Yes***	**Yes**	GE requires specialized programming to use OGC services
Supplies default imagery	**No**	**Yes**	**Yes**	**No**	Base imagery largely provided by developer with Arc products. GE has superior default base imagery.
Supplies default framework data such as roads, placenames, terrain	**No**	**Yes**	**Yes**	**No**	Custom terrain easily integrated into Arc products.
Widespread appeal	**Yes**	**Unknown**	**Yes**	**Yes**	GE most widely used 3D Geobrowser
Performance	**Varies**	**Varies**	**Excellent**	**Excellent**	Performance for Arc products varies due to imagery used, WMS, database performance, server capacities, internet hosting, etc.
Can make complex searches, GIS Functionality	**Yes**	**Yes**	**No**	**Yes**	
KML support	**No**	**Yes**	**Yes**	**No**	
Operating System	Windows/ Mac	Windows	Windows/ Mac*	Windows/ Mac/ Linux	*GE Plug-in works in both Microsoft Windows (2000, XP, and Vista) and Apple Mac OS X 10.4 and higher (Intel and PowerPC)
Web Browser	IE6+/ Firefox 1+/Safari	None	Plug-in*	IE6+/ Firefox2+/ Chrome1+/ Safari/ Opera	*Plug-in works in browsers on both Windows (Chrome 1.0+, Internet Explorer 6+, Firefox 2.0+, Flock 1.0+) and Mac (Safari 3.1+, Firefox 3.0+)

Conclusion

- ARMAP was developed under contract to NSF-OPP to improve capacities for science, logistics and coordination in US arctic research.
- ARMAP suite of applications take full advantage of developer expertise, user friendly tools, software packages, interoperable tools and services.
- Future developments in the ASDI initiative will expand the data and information available to users, increase speed and stability, and develop collaborations between Arctic stakeholders

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Development Team

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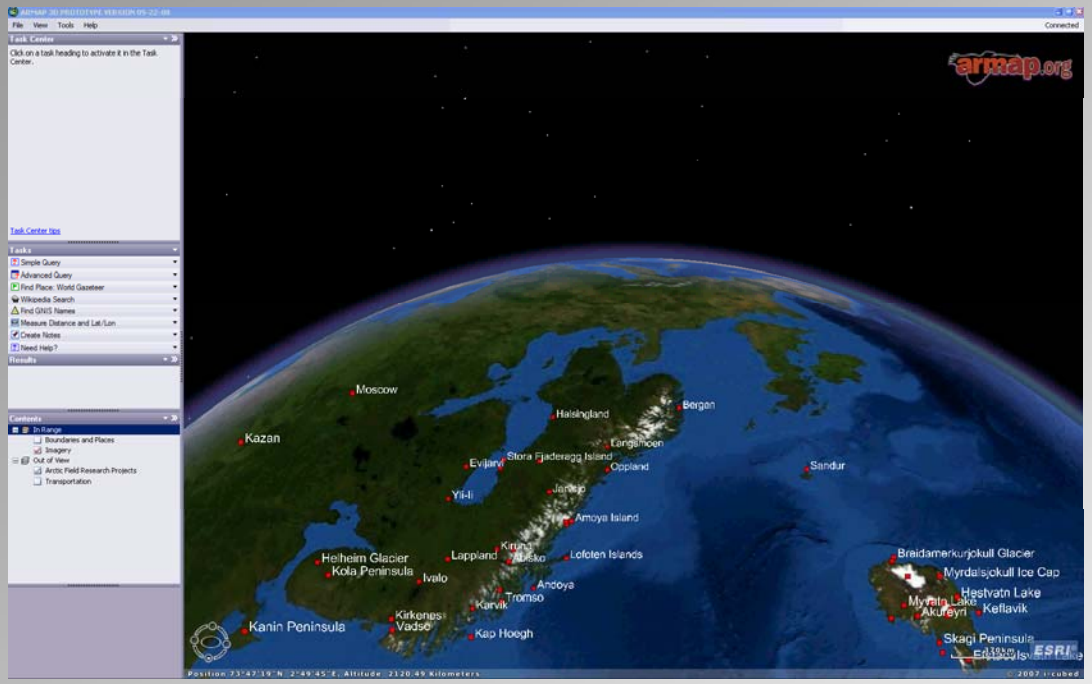
  - William Manley

Thanks for watching…..



…..any ?s

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