

NWGISS: The Web GIS Software Suite for Interoperable Access and Manipulation of EOS Data

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Introduction

- HDF-EOS is the standard data format for NASA EOSDIS. Huge amount of remote sensing data is being produced in this format.
- Make HDF-EOS data easily accessible to GIS and other users will greatly increase the utilization of EOSDIS data.
- There are three data models in HDF-EOS
 - Grid--Georectified raster data
 - Swath--potential georeferable raster data
 - Point-- point measurement

Open GIS Consortium(OGC)

- A membership organization consisting of 220 members from GIS industries, government, and universities.
- Promotion of the interoperability of GIS systems, data, and services in the network environment.
- The main work of OGC is to develop interface specifications for GIS interoperability through
 - Regular standard development procedure
 - Testbed activities

Web Mapping Testbeds (WMT) and OGC Web Services (OWS) Initiatives

- OGC has started a series of web-based interoperability initiatives since 1999.
 - WMT-I in 1999; WMT-II in 2000
 - OWS-1.1 in 2001; OWS-1.2 in 2002
 - GMU's LAITS has been participated in all those initiatives as one of OGC funded participants.
- The purpose of those initiatives is to develop a set of draft interoperability specifications for considering as official OGC specifications. Major specifications developed or being developed so far include:
 - Web coverage services specification (WCS)
 - Web feature services specification (WFS)
 - Web map services specification (WMS)
 - Web registries services specification (WRS)

Web Coverage Services (WCS)

Specification

- OGC Web Coverage Services Specification defines the interfaces between web-based clients and servers for accessing on-line multi-dimensional geospatial data in an interoperable way.
 - For raster(grid) data and multi-dimensional remote sensing imagery (e.g., multiple bands, time-series, etc)
- WMT-II developed the first version of WCS (0.4).
- DTD-based WCS 0.5 was the baseline version of WCS in OWS 1.1
- OWS-1.1 developed schema-based WCS 0.6 and 0.7.
- OWS-1.2 is improving the WCS through the image handling thread.

Web Feature Services (WFS) Specifications

- OGC Web Feature Services Specification defines the interfaces between web-based clients and servers for accessing feature-based geospatial data
 - Vector data, such as road network, political boundary, cadastral data, river, coastal lines, etc.
- WMT-I developed the first version of WFS.
- OWS-1.2 is improving the WFS through the feature handling thread.
- Most of NASA EOS data are not feature-based data.

Web Map Services Specification

- Define web interfaces for interoperability of map assembly and delivery middleware within a heterogeneous distributed computing environment over Internet.
- The initial version was tested in WMT-1 and is continuously improving and updating in the follow-on initiatives.
- It is one of the most widely implemented OGC specifications.
- The version 1.0 is an official OGC specification and is considered by ISO TC 211 as an international standard.

Web Registries Services Specification (WRS)

- Web Registries Services Specification defines the interfaces between web-based clients and servers for finding the required data or services from the registries.
- Originally, the WRS was called Catalog Interoperability Specification (State-less).
 - It was changed to WRS in OWS 1.1 to reflect that the specification can be used for registering data, services, algorithms, and other geospatial resources.
 - New version of WRS is being worked out by the OWS-1.2 common architecture group.

NASA HDF-EOS Web GIS Software Suite (NWGISS)

- NWGISS is a suite of software making HDF-EOS data easily accessible to GIS data users through OGC specifications.
- Currently NWGISS has following components:
 - map server
 - coverage server
 - catalog server
 - multiple protocol geoinformation client (MPGC)
 - Toolbox
- More components will be added
- Components are able to work independently and collaboratively.

OGC Interface Specifications Implemented in NWGISS Servers

- Web Map Services Specification (Map server)
 - GetCapabilities
 - GetMap
 - GetFeatureInfo
- Web Coverage Specification (Coverage server)
 - GetCapabilities
 - GetCoverage
 - DescribeCoverageType
- OGC Catalog Interoperability Specification (Catalog server)
 - CIP/Z39.50
 - Stateless

OGC Interface Specifications Implemented in NWGISS Multiprotocol Geoinformation Client

- Web Coverage Services Specification
 - finished
- Web Map Services Specification
 - finished
- Web Feature Services Specification
 - Near complete
- Web Registries Services Specification
 - Still working on it

NWGISS Map Server

- Enable GIS clients to access HDF-EOS data as maps.
- Work with three OGC web mapping interface protocols
 - GetCapabilities
 - Tell the client about the server capabilities as well as map layers.
 - GetMap
 - Extract the data from HDF-EOS file and convert it to a GIF map based on requirement specified by the client.
 - GetFeatureInfo
 - Be able to tell the client geographic feature associate with
- Work with all three HDF-EOS data models
 - On-the-fly georectification and resampling for swath
 - On-the-fly resampling for grid
 - Geographic coordinate based data subsetting and map making for all three data models.
- Comply with OGC WMS 1.1.0 and lower.

NWGISS Coverage Server

- Enable GIS clients to access multi-dimensional, multi-temporal data in HDF-EOS.
- Work with three OGC web coverage protocols
 - GetCapabilities
 - Tell the client about the server capabilities as well as data achieves.
 - GetCoverage
 - Extract the data from HDF-EOS file based on spatial and temporal coordinates specified by the client and return the data back to client in one of the coverage encoding formats specified by the client.
 - Three coverage encoding formats, HDF-EOS, NITF, and GeoTIFF are defined in the specification.
 - DescribeCoverageType
- Work with HDF-EOS Swath and Grid data models
 - On-the-fly geo-rectification and re-sampling for swath.
 - On-the-fly data assembly and format conversion for all two data models.
- Comply with OGC WCS 0.5 and 0.6.
- Updating to version 0.7 and the new additions from OWS 1.2 are going on with resources from OGC and NASA.

NWGISS Catalog Server

- Enable GIS clients to search and find data, maps, and services available in a NWGISS site.
- Compliant with OGC Catalog Interface Implementation Specification.
 - CIP/Z39.50 profile.
 - Stateless

NWGISS Multi-protocol Geoinformation Client (MPGC)

- A comprehensive client that can work with multiple OGC specifications automatically.
 - Enable to access any OGC compliant servers, not just NWGISS.
 - Automatically handle different protocols so that data users only need to provide information about the data requirements.
 - Provide basic data preprocessing functions, such as reprojection, resampling, reformatting, subsetting and visualization of multi-dimensional geospatial data.
 - Provide data integration and analysis functions.
- Currently MPGC works with WCS and WMS. We are working on adding WFS and WRS.

NWGISS Toolbox

- Provide automatic data ingestion and catalog creation for data providers to make their data ready for NWGISS.
- At least two tools are available:
 - CreateCapabilities
 - Automatically create the XML-based capabilities description based on the NWGISS capabilities as well as data in HDF-EOS files.
 - It is a generic tool that can work with all HDF-EOS files.
 - Two way translators between HDF-EOS and GIS formats.
 - Arc Grid, Binary, GeoTiff, Erdas lan.

Make Your Data Accessible Through NWGISS Servers

- The data have to be on-line
- The data have to be in the HDF-EOS format
- Install NWGISS servers in your machine
- Run NWGISS tool to make the data capabilities XML document.

What Are Data Users Getting?

- Any OGC compliant GIS clients can access your data.
- On-the-flying reformatting, georectification, resampling, and subsetting (both spatial and parameters-based) are provided so that the data users can get the data in the form they want.
- By combining with NWGISS MPGC, users can assemble data from multiple data providers on-line in a form that exactly matches their requirement, we call it Interoperable, Personalized, On-demand data access and services (IPODAS)

Interoperable personalized on-demand data access and services

- Recognize that individual data users have their unique requirements to the data.
 - Interoperable means data users can obtain data from multiple sources and/or providers in the same form
 - Personalized will ensure data services will meet the individual users' needs.
 - On-demand means that data products have to be created on-demand because you don't know what the exact needs of data users.
- Provide data to users in the form that exactly matches user's requirement in term of format, spatial and temporal coverage, projection, and resolution.

Services functions required for providing the basic IPOGDAS

- Data service functions
 - Reformatting
 - Spatial/temporal/parameters coordinate-based subsetting
 - Resampling
 - Reprojection/georectification
- Execution of the combination of those functions based on users' requirement to the data will create on-demand products that exactly match users' needs.

NWGISS IPOGDAS Capability

- NWGISS MPGC can provide IPOGDAS, even an OGC WCS server does not have the capability
 - Provide all services that are optional in the specification so that it can provide IPOGDAS even with a minimum server.
 - Able to work with all OGC WCS compliant servers.
- NWGISS WCS server supports IPOGDAS even an OGC compliant WCS server does not have the capability.
 - Support all required service functions
 - Support all optional service functions
 - Provides data in any one of the twelve HDF-EOS supported projections by on-the-fly reprojections.
 - Supports multiple coverage encoding formats (HDF-EOS, GeoTIFF, and NITFF).
 - Geo-rectify swath data on-the-fly.
 - Work with all types of HDF-EOS data

NWGISS Demo Site

- Demo site for NWGISS map and coverage servers has been set up
 - Map server: <http://laits.gmu.edu/cgi-bin/NWGISS/NWGISS?request=capabilities&service=WMS>
 - Coverage server: <http://laits.gmu.edu/cgi-bin/NWGISS/NWGISS?request=capabilities&service=WCS>
 - MODIS level 1b, ASTR, AVRIS, TOMS ozone, etc. More data will be added.
- The map server can be accessed by map clients, e.g.,:
 - Cubewerx client. <http://209.217.120.146/wmt/cubeview/cubeview.cgi>
 - NASA Digital Earth Client: <http://viewer.digitalearth.gov>
 - Our one is called NASA-EOSDIS.
- Coverage access and services can be provided by NWGISS MPGC. A MPGC demo can show the access of both NWGISS and non-NWGISS coverage servers and map servers.

Download and Install Apache Server

- The NWGISS servers require an http server.
- NWGISS client (MPGC) does not require http server.
- Apache sever and installation instructions are available at: <http://www.apache.org/>

Download NWGISS (Severs and Client)

- Go to NWGISS Download Site:
<http://laits.gmu.edu/>
- Click “download” and you will see the download main page:
<http://laits.gmu.edu/DownloadInterface.html>
- Select the NWGISS components (WMS, WCS, Catalog, MPGC, and toolBox)

Install NWGISS Servers

- Copy NWGISS servers (WCS, WMS, Catalog) into the http server's cg-bin directory, e.g., apache/cgi-bin/
- Copy the toolbox (createCapabilities) and color style palette files into the same directory

Install NWGISS Servers (cont.)

- Put sample data sets into the http server's htdocs/hdf/ directory, e.g.,
apache/htdocs/hdf
- Run the createCapabilities tool against the sample files
- Move the resultant xml capabilities files to the http server's cgi-bin directory, e.g.,
apache/cgi-bin/

Install NWGISS Servers (cont.)

- Upon completion of the installation, you'll have the a set of files in your http server's cgi-bin and htdocs directories:
- In `apache/cgi-bin/`: server executable files, Xml capabilities files, and color palette files (see next slide).
- In `apache/htdocs/hdf/`: sample HDF-EOS data files (see next slide).

Install NWGISS Servers (cont.)

- apache/cgi-bin/:

NWGISS, webMap, catalog, createCapabilities, capabilities_wcs.xml, capabilities_wms.xml, and color palette files with “pal” extension name.

- apache/htdocs/hdf/:

MOD021km.A2002151.1120.003.2002152002801.hdf,

Access NWGISS Servers

- NWGISS Servers can be accessed by two methods: a) through http query and b) through a client such as the MPGC.
- http queries can be sent from any http browser but constructing a query is tedious. This method is usually used for test rather than for operational use.

Access NWGISS Servers (cont.)

- Query examples (get WCS capabilities):

`http://laits.gmu.edu/cgi-bin/NWGISS/NWGISS?request=capabilities&service=WCS`

- Query examples (get a specific coverage layer):

`http://laits.gmu.edu/cgi-bin/NWGISS/NWGISS?REQUEST=COVERAGE&BBOX=-120.102,21.742,-90.69297,42.9564&SRS=EPSG:4326&Band_1KM_Emissive=1/16/5&LAYERS=mod2.hdf:SWATH:MODIS_SWATH_Type_L1B:EV_1KM_Emissive&format=HDF-EOS&exception=XML`

Access NWGISS Servers (cont.)

- Accessing NWGISS Servers through a client, such as MPGC, requires a client being installed.
- Install the NWGISS MPGC is easy.

Install NWGISS Client (MPGC)

- Double click the downloaded MPCG executable, mpgc.exe, to install it.

- Note that:

MPGC runs on Windows platforms.

JDK1.3 must be installed in your machine.

The user must have administrator privilege

Start NWGISS MPGC

- **Double click the MPGC icon on your desktop or go to the MPGC working directory and double click the mpgc.bat file.**
- **The main MPGC window will pop out**

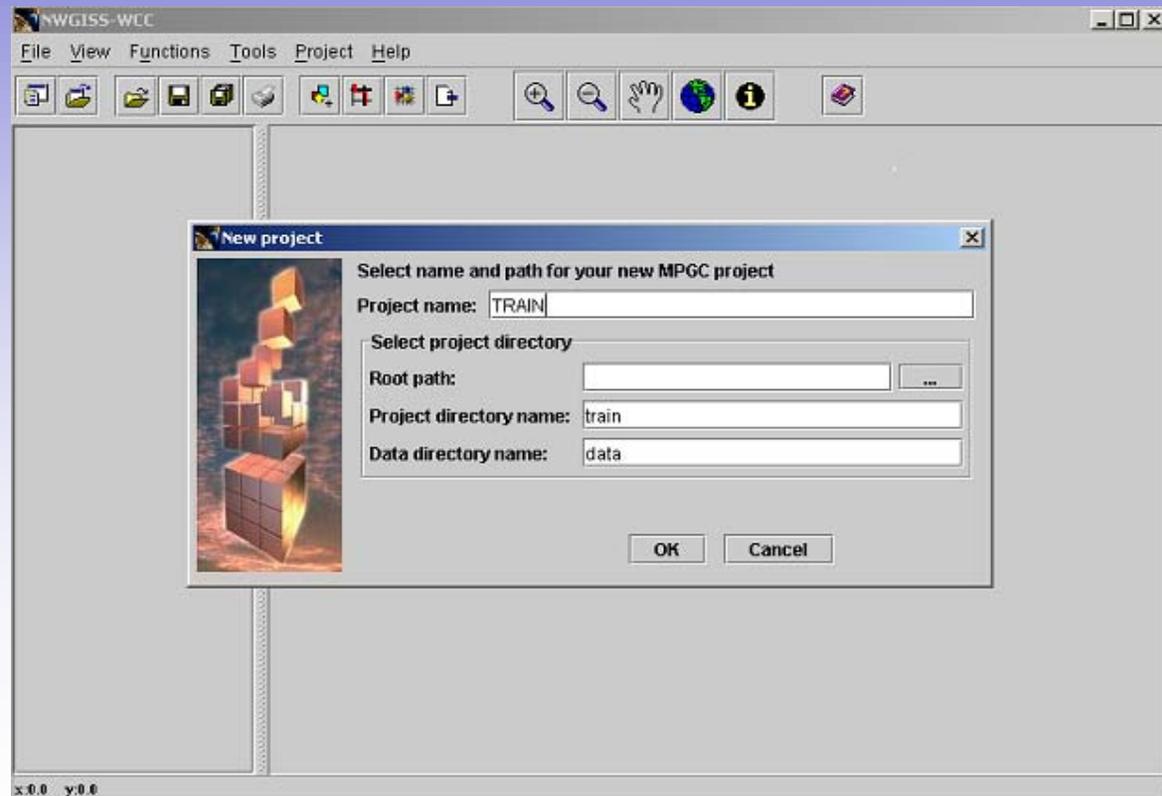
MPGC Use Case

Scenario #1 Project Management

- **Create a new project**
- **Add data into the project**
 - Add data obtained from a remote OGC compliant server
 - Add local data
- **Save Project**
- **Open Project**

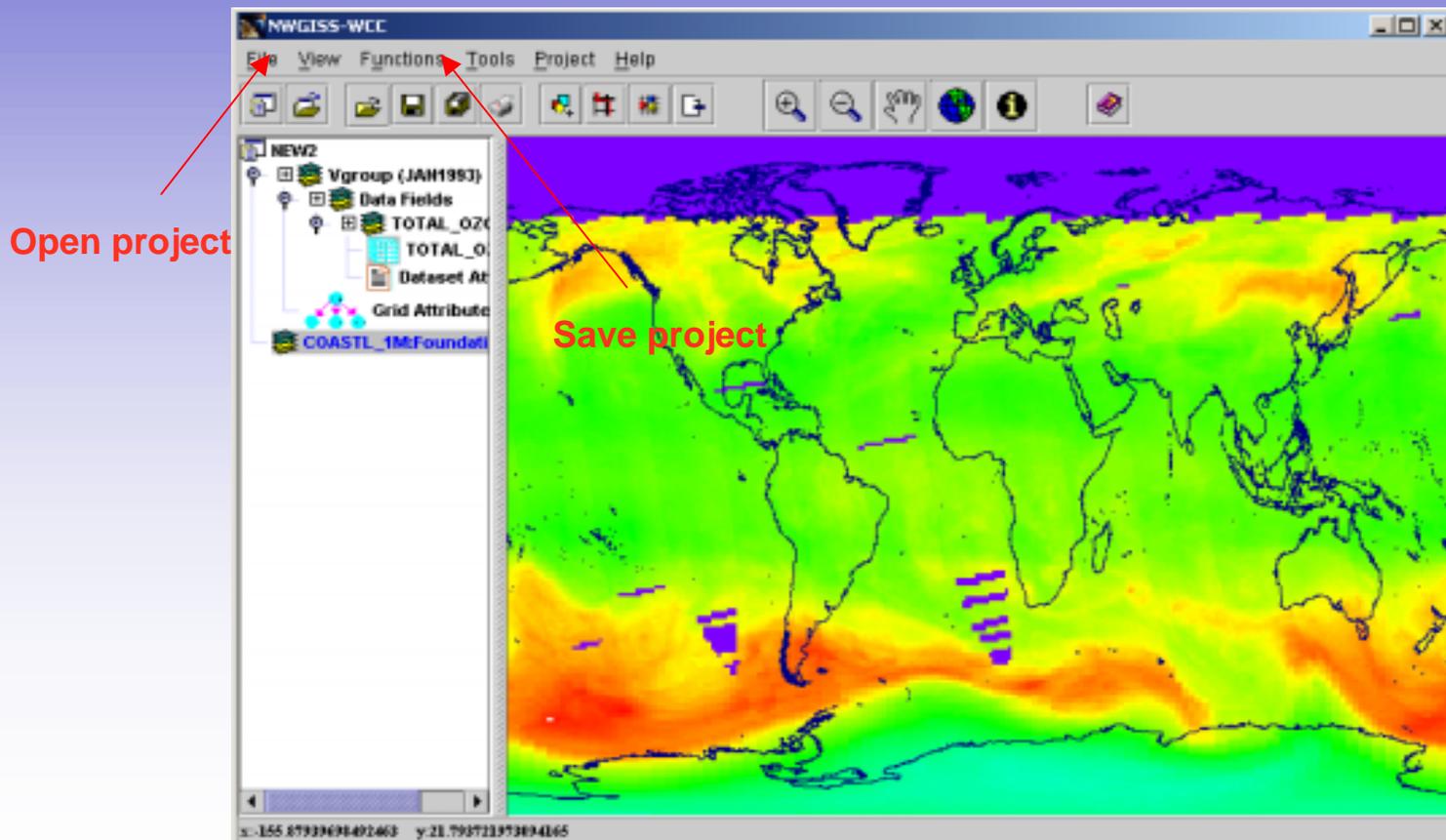
MPGC Use Case (cont.)

Scenario #1 Project Management New project



MPGC Use Case (cont.)

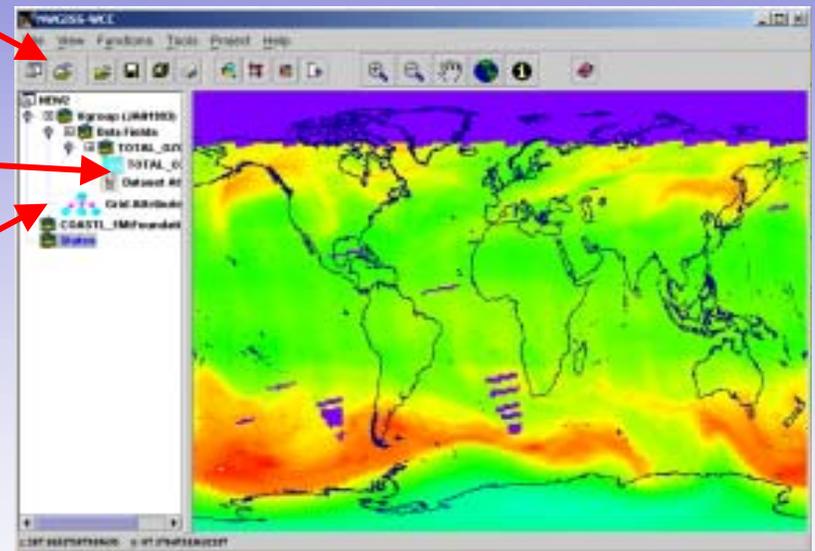
Scenario #1 Project Management Open and save project



MPGC Use Case (cont.)

Scenario #2 WCS,WFS,WMS overlay

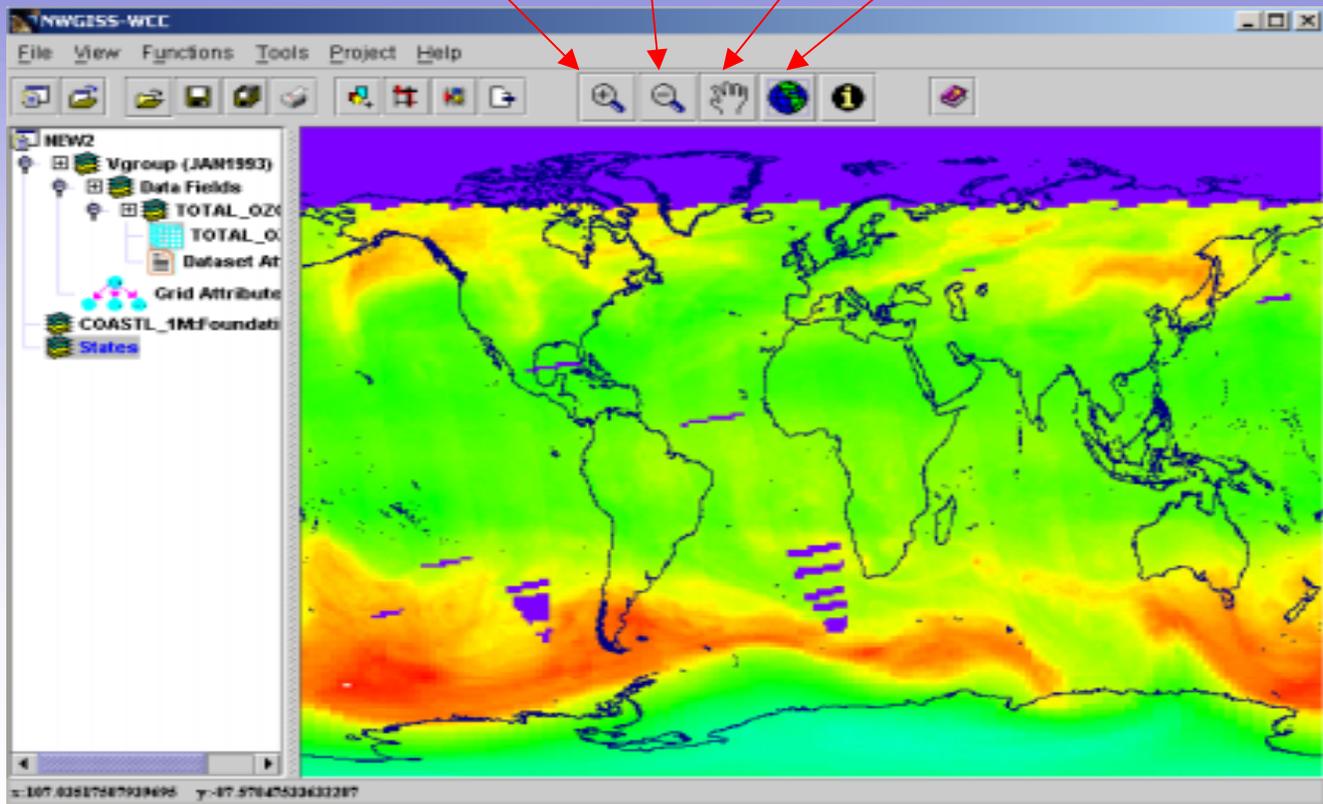
- WCS: HDFEOS
- WCS: IMAGE (GIF OR JPG)
- WFS: GML



MPGC Use Case (cont.)

Scenario #3 Basic spatial operation

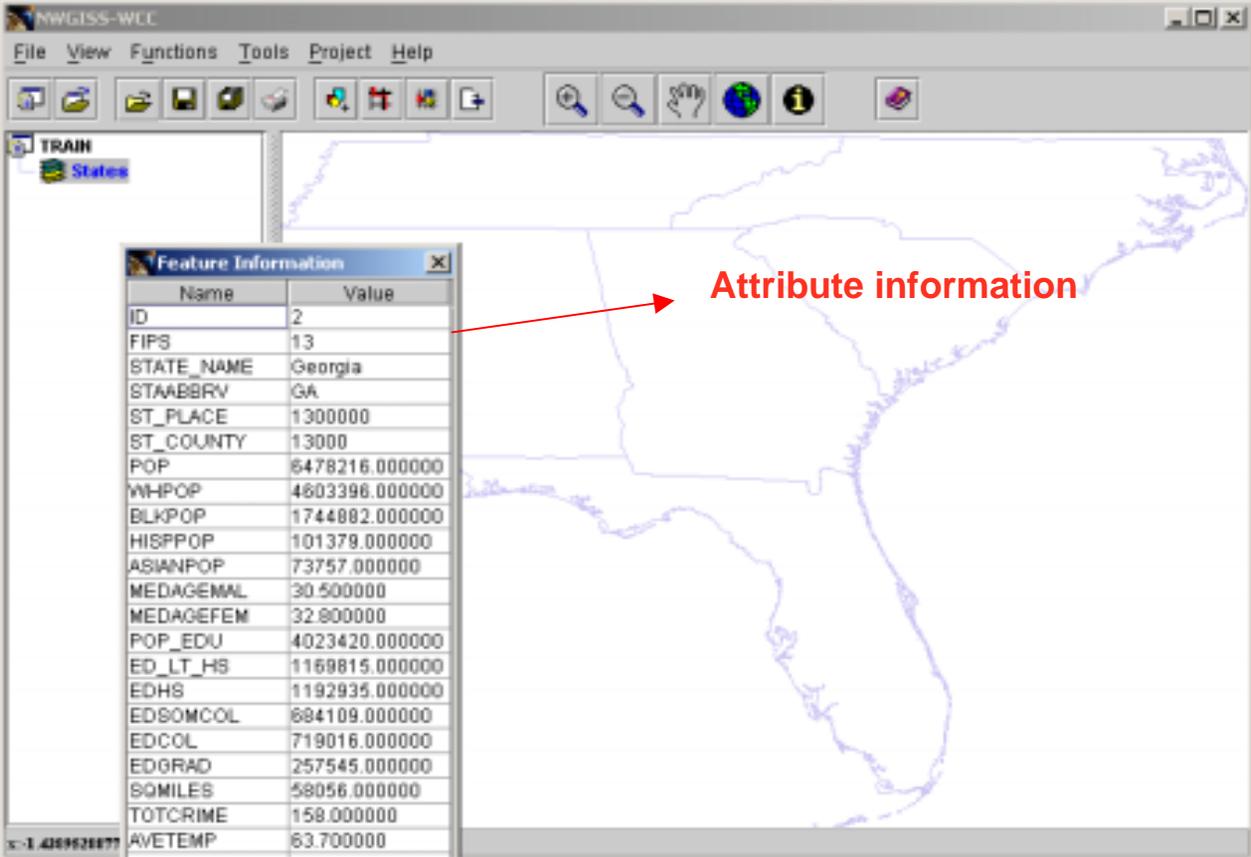
Zoom in Zoom out Pan Full



MPGC Use Case (cont.)

Scenario #3 Basic spatial operation

Spatial attribute



The screenshot displays the NWGIS-WCC software interface. The main window shows a map of Georgia with a red arrow pointing to the state boundary, labeled "Spatial attribute". A "Feature Information" dialog box is open, showing a table of attributes for a selected feature. A red arrow points from the "Attribute information" label to the table.

Name	Value
ID	2
FIPS	13
STATE_NAME	Georgia
STAABRV	GA
ST_PLACE	1300000
ST_COUNTY	13000
POP	6478216.000000
WHPOP	4603396.000000
BLKPOP	1744882.000000
HISPPOP	101379.000000
ASIANPOP	73757.000000
MEDAGEMAL	30.500000
MEDAGEFEM	32.900000
POP_EDU	4023420.000000
ED_LT_HS	1169815.000000
EDHS	1192935.000000
EDSOMCOL	684109.000000
EDCOL	719016.000000
EDGRAD	257545.000000
SQMILES	58056.000000
TOTCRIME	158.000000
AVETEMP	63.700000

MPGC Use Case (cont.)

Scenario #3 Basic spatial operation

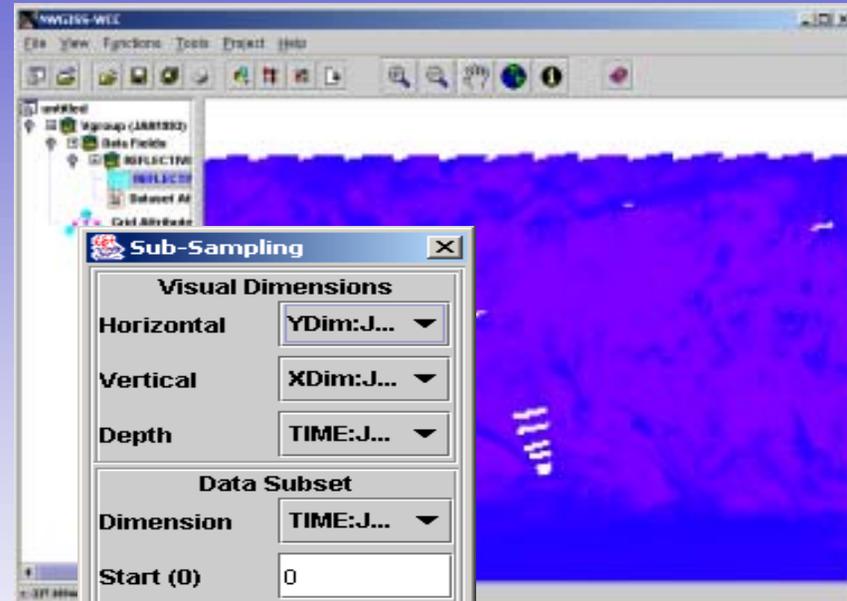
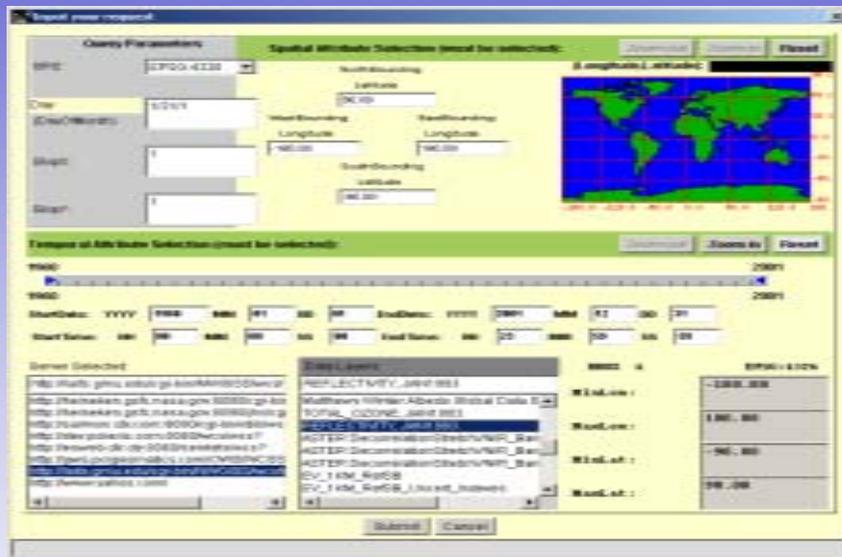
The screenshot shows the NWGIS-WCC application interface. The main window displays a map with a color-coded spatial distribution. A context menu is open over the map, showing options like 'SubSampling...', 'SDS Global Attribute', and 'Display...'. A red arrow points from the 'SDS Global Attribute' menu item to a detailed attribute table on the right side of the window.

SDS Global Attributes

Name	Value
HDFEOSVersion	HDFEOS_V2.7
StructMetadata.0	GROUP=SwathStructure
END_GROUP=SwathStructure	
GROUP=GridStructure	
GROUP=GRID_1	
GridName	"JAN1993"
XDim	288
YDim	180
UpperLeftPointMtrs	(-180000000.000000,90000000.0
LowerRightMtrs	(180000000.000000,-90000000.0000
Projection	GCTP_GEO
GridOrigin	HDFE_GD_UL
PixelRegistration	HDFE_CENTER
GROUP=Dimension	
OBJECT=Dimension_1	
DimensionName	"TIME"
Size	31
END_OBJECT=Dimension_1	
END_GROUP=Dimension	
GROUP=DataField	
OBJECT=DataField_1	
DataFieldName	"TOT"
DataType	DFNT_INT1
DimList	("TIME","YDim
END_OBJECT=DataField_1	

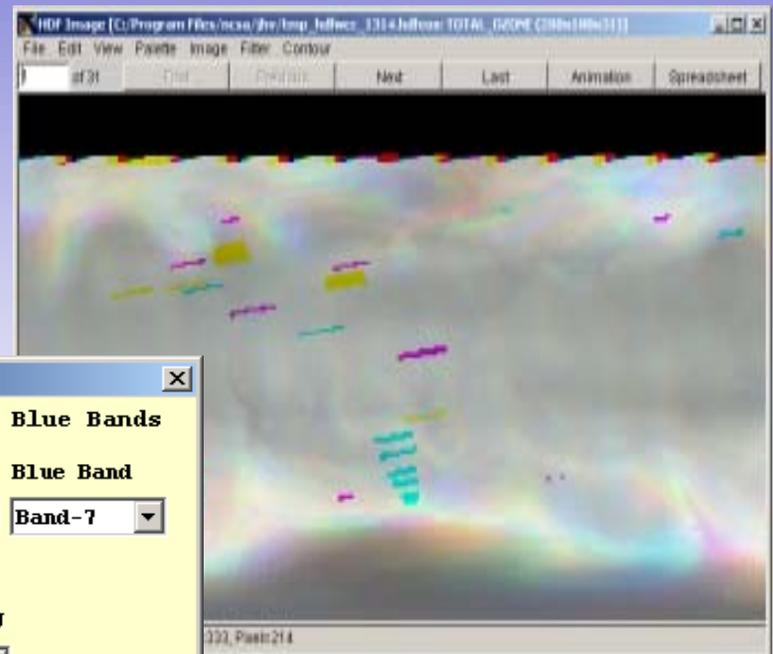
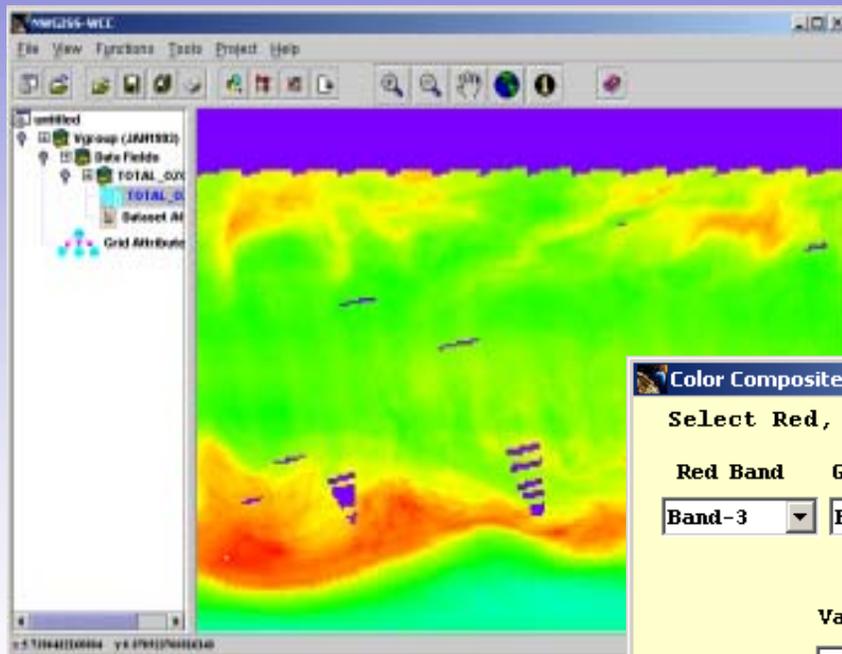
MPGC Use Case (cont.)

Scenario #4 Basic image operation Sub-Sampling



MPGC Use Case (cont.)

Scenario #4 Basic image operation Color Composite



Color Composite

Select Red, Green And Blue Bands

Red Band	Green Band	Blue Band
Band-3	Band-5	Band-7

Value scaling

None

None

Linear

Com Histogram equal