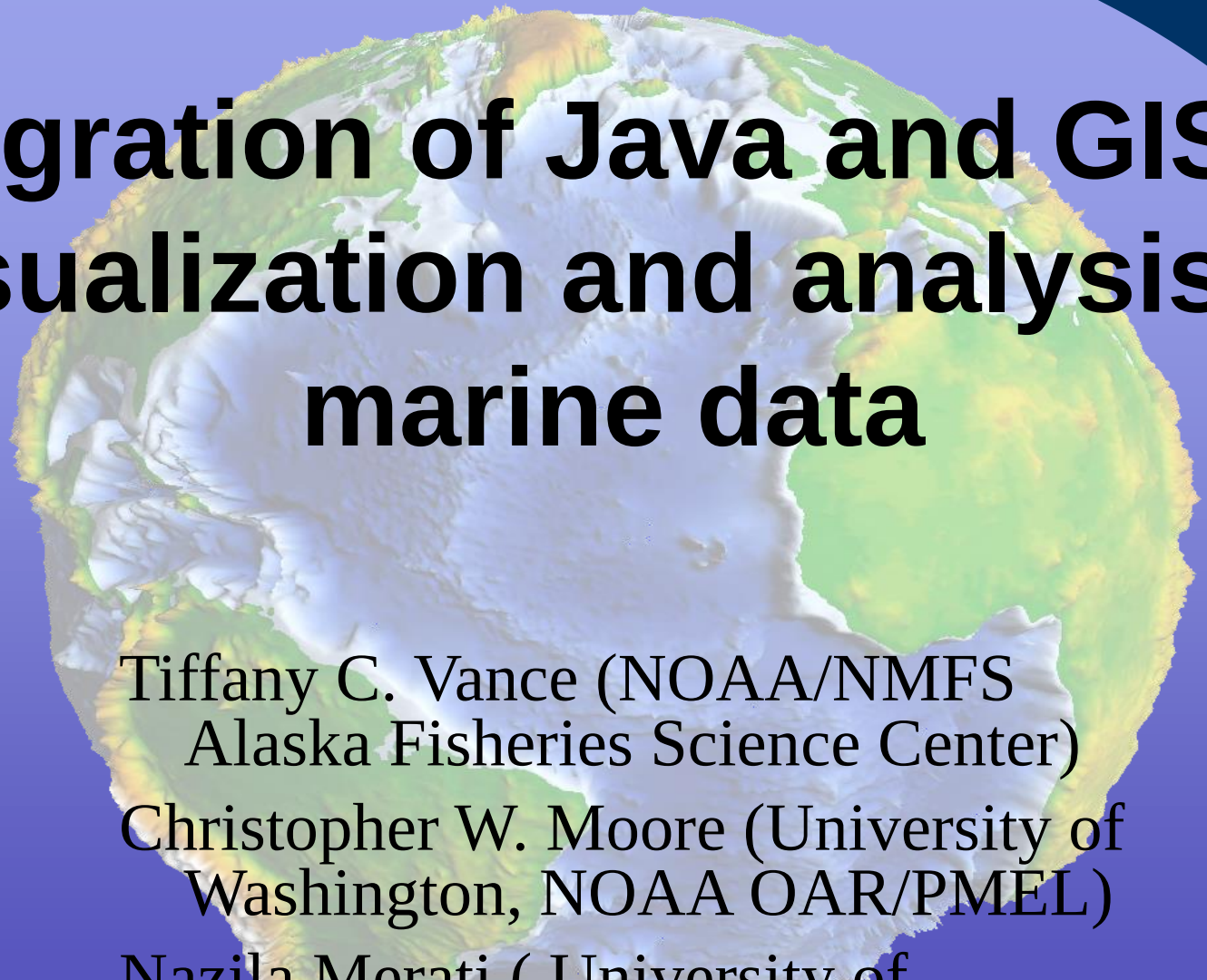
Integration of Java and GIS for visualization and analysis of marine data



Tiffany C. Vance (NOAA/NMFS Alaska Fisheries Science Center)

Christopher W. Moore (University of Washington, NOAA OAR/PMEL)

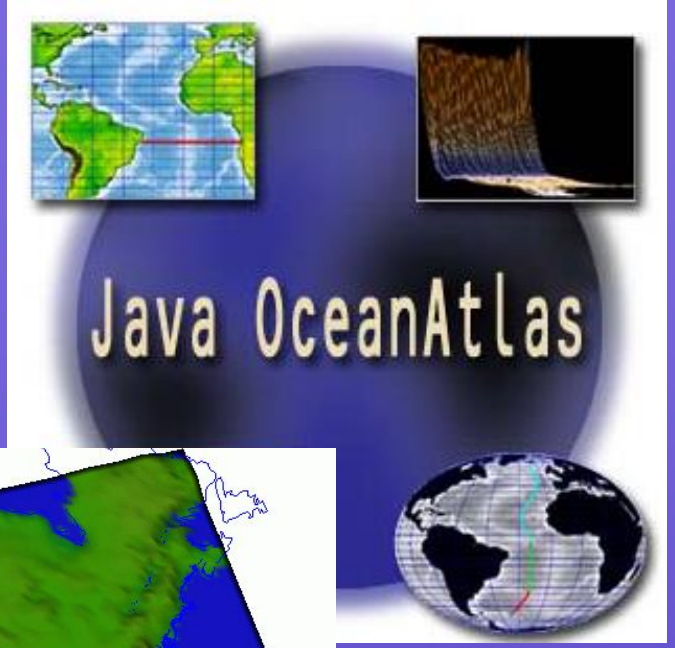
Nazila Merati (University of Washington, NOAA OAR/PMEL)

Introduction

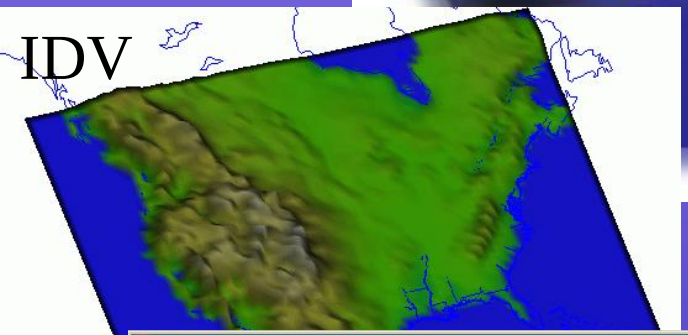
- Traditional geographic information systems provide spatial analysis tools, but the analyses are usually limited to 2.5 dimensions.
- New software tools are making it possible to integrate GIS with Java tools to provide a prototype of a ‘scientific GIS’ that can allow truly three-dimensional analyses.

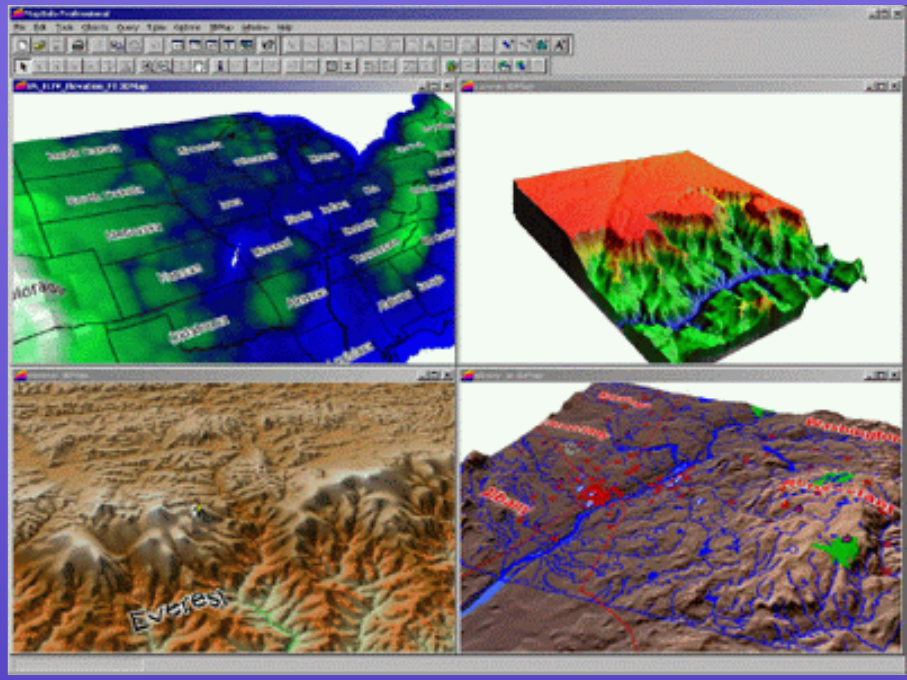
Pragmatic question - potential users

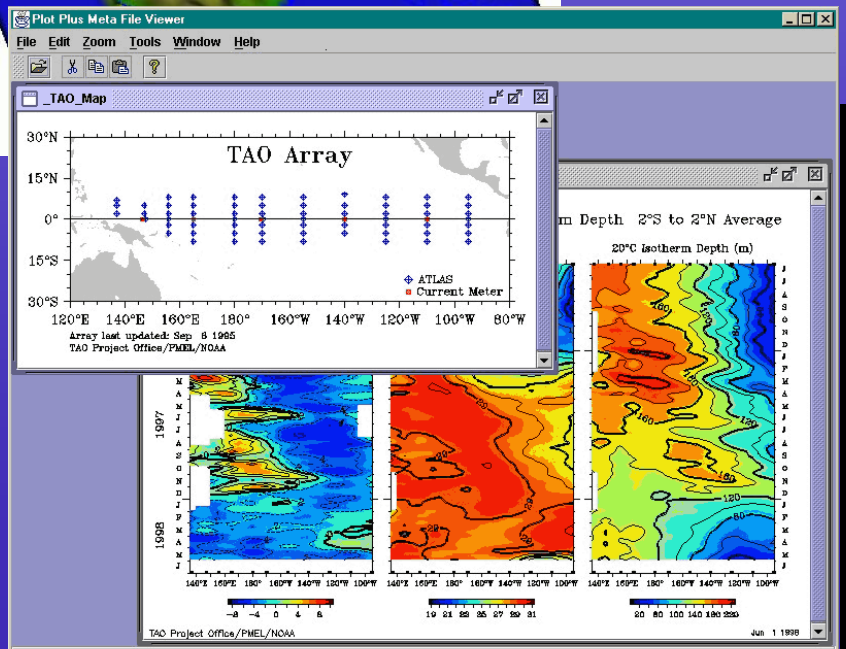
- Oceanographers who are familiar with scientific analytical tools – MATLAB etc.
- Fisheries biologists who are familiar with GIS – especially ESRI products
- Creating a common tool?

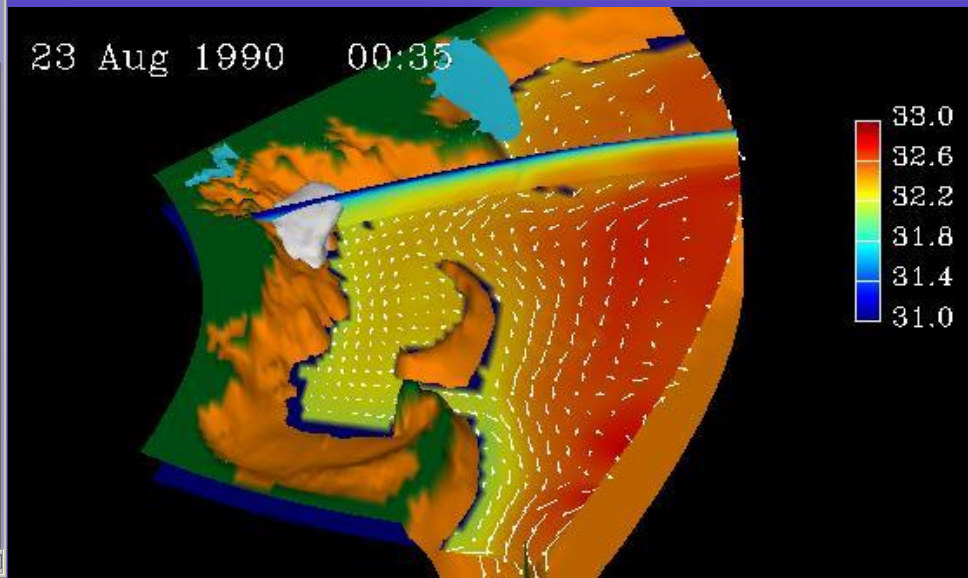

Java OceanAtlas

IDV




Everest

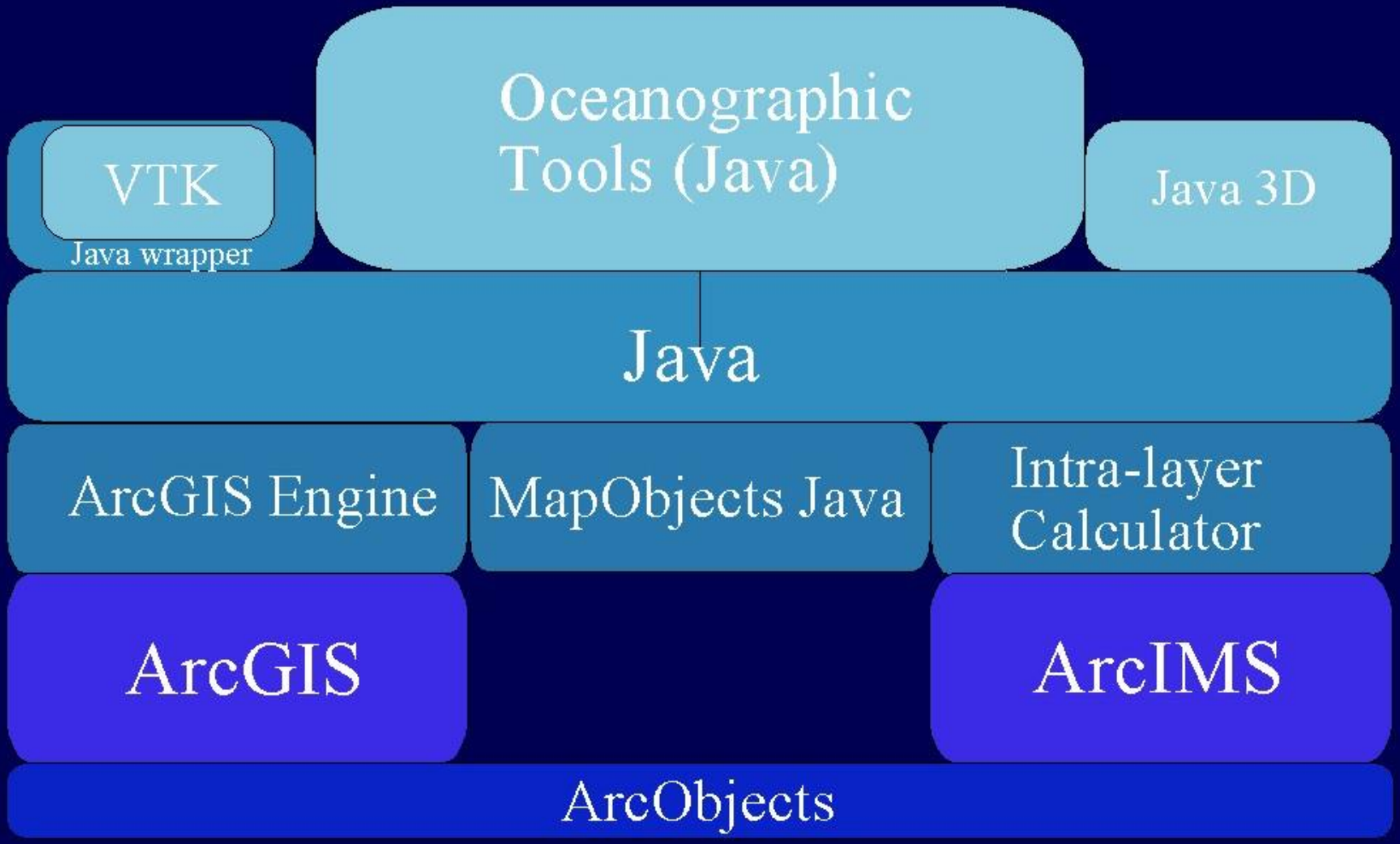

Plot Plus Meta File Viewer
File Edit Zoom Tools Window Help
_TAO_Map
TAO Array
30°N
15°N
0°
15°S
30°S
120°E 140°E 160°E 180° 160°W 140°W 120°W 100°W 80°W
ATLAS
Current Meter
Array last updated: Sep 8 1995
TAO Project Office/PMEL/NOAA
m Depth 2°S to 2°N Average
20°C Isotherm Depth (m)
1997
1998
TAO Project Office/PMEL/NOAA
Objects: 8898 size: (8.6x4.1625) scale: 0.75


23 Aug 1990 00:35
33.0
32.6
32.2
31.8
31.4
31.0

Programming options

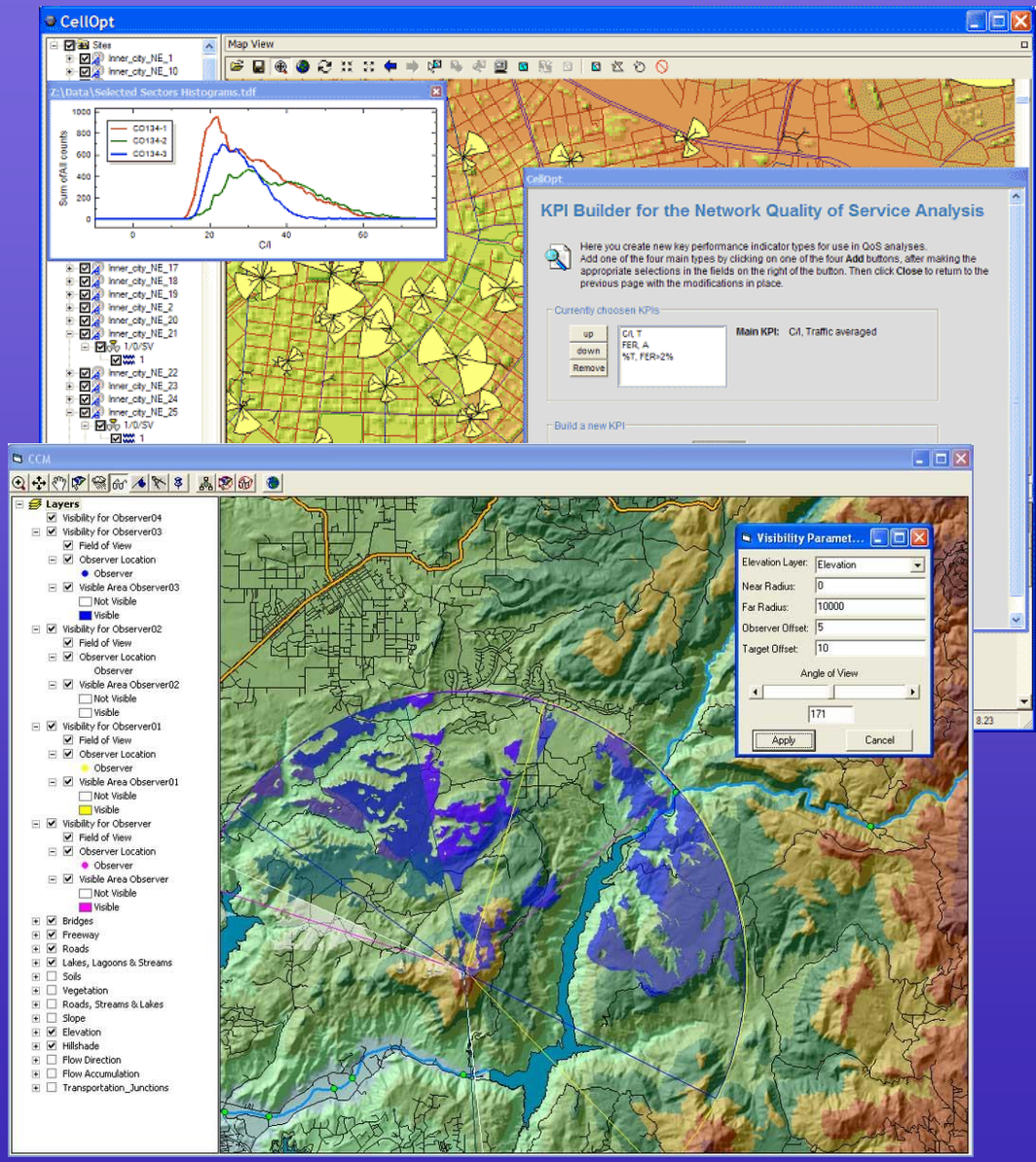
- ArcObjects/Visual Basic - limited to single platform, limitations of VB
- Java with ArcGIS Engine - platform independent, cost
- Open source GIS tools such as GRASS, MapServer, PostGIS, GeoTools and VisAD - documentation/support
- Java as link for existing tools

System Diagram



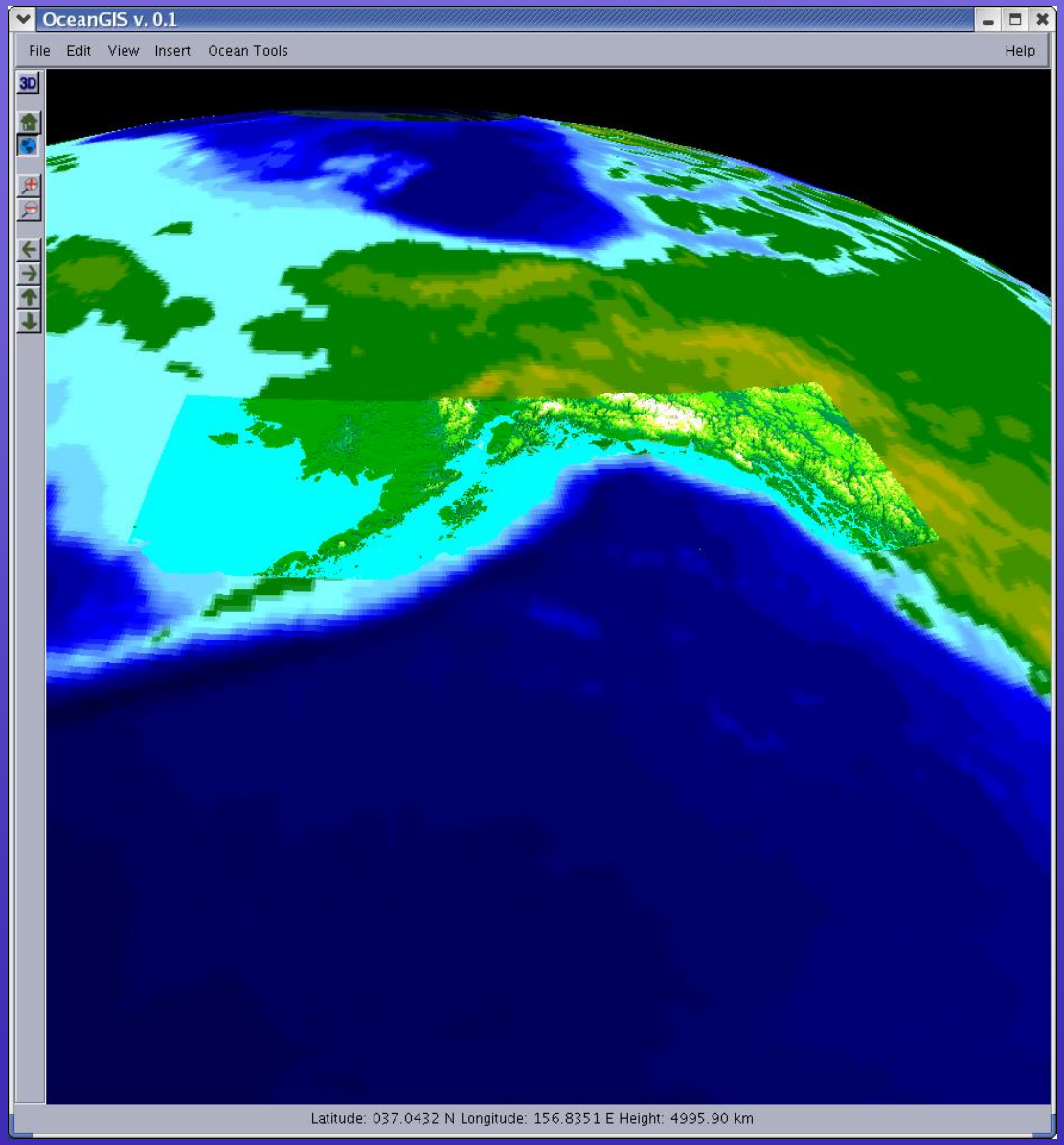
ArcGIS Engine developer kit

- Several application program interfaces (COM, Java, .NET, and C++)
- Cost-effective deployment requiring only an ArcGIS Engine Runtime or ArcGIS Desktop license per computer
- Developer controls available in ActiveX, .NET, and Java that simplify application development



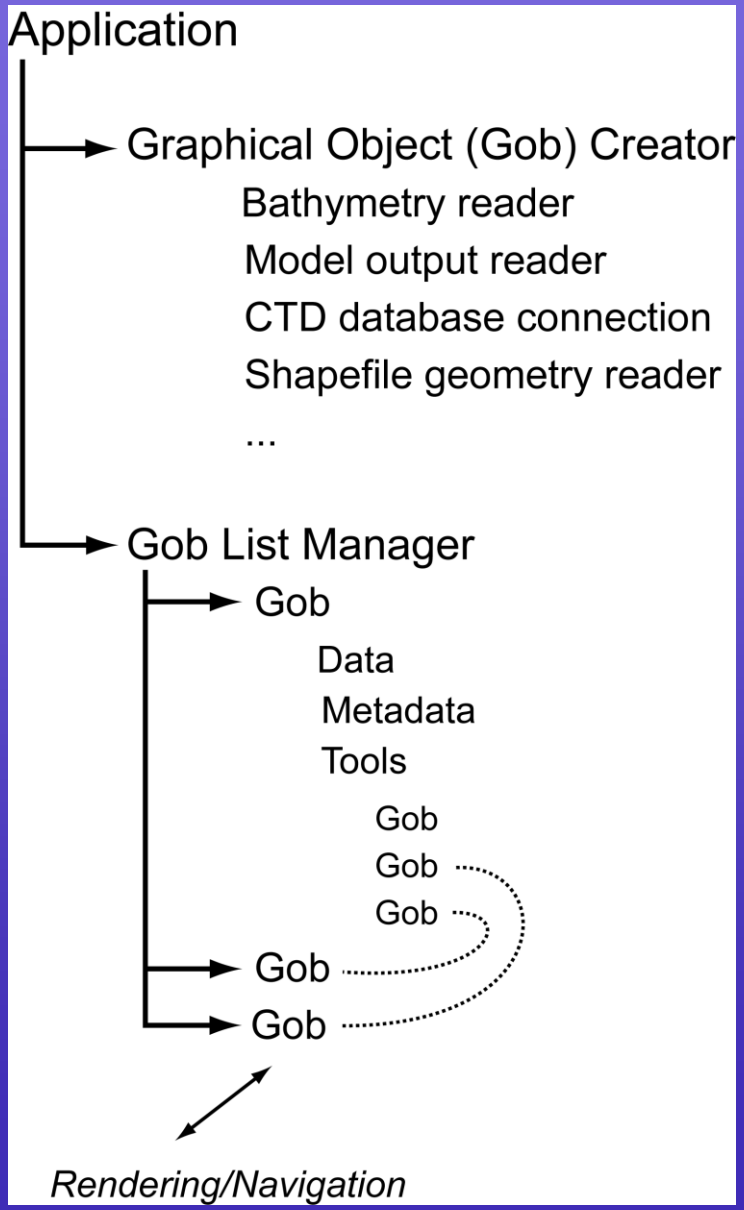
OceanGIS prototype

- Switch from 2D projections to 3D
- Read simple shape files
- Rotate/pan/zoom
- Hyperlink objects and 3D “picking”



Application diagram

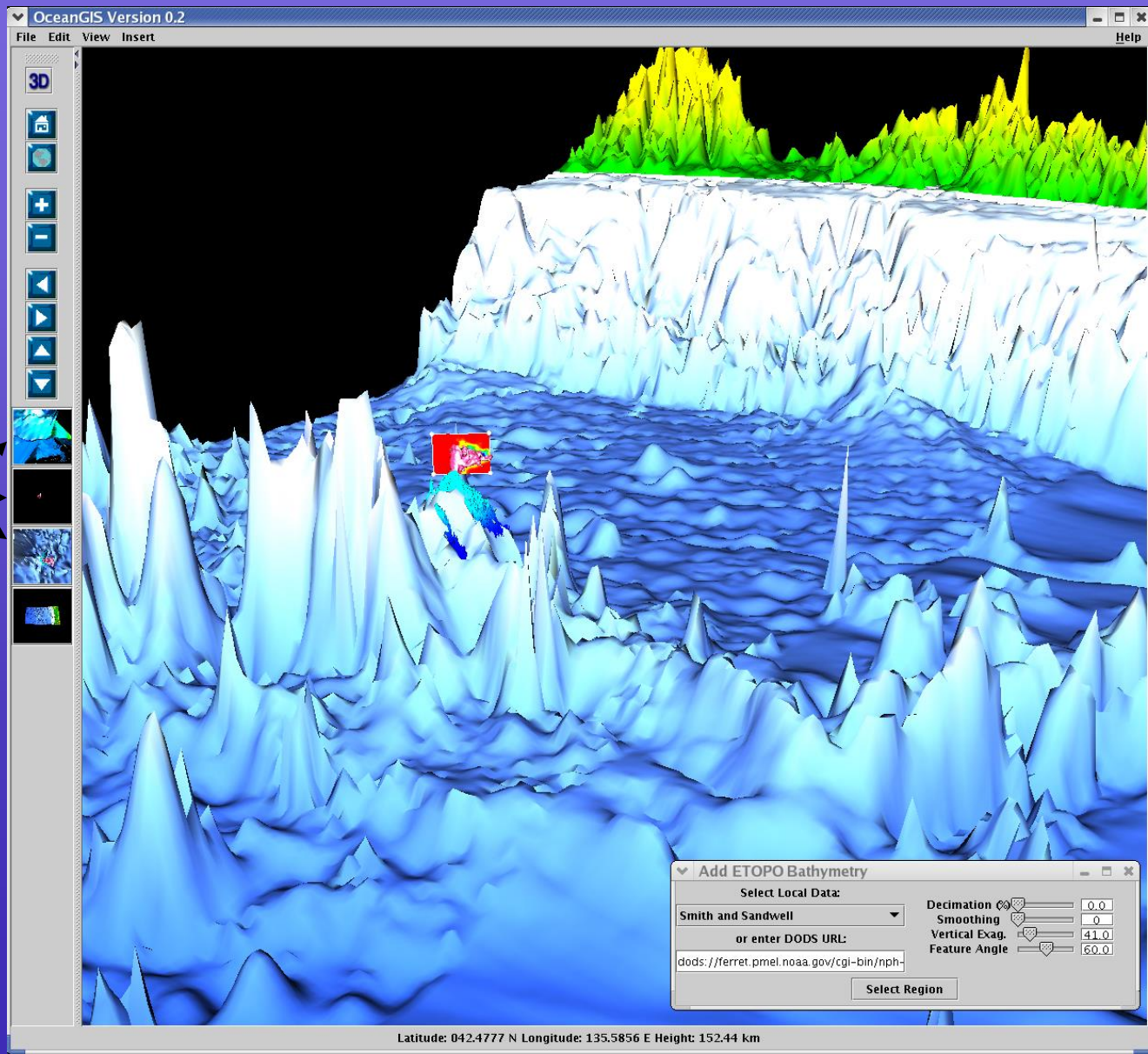
- Graphical objects (Gob) are created for various functions
- The GobListManager keeps track of objects
- Each Gob has specific functionality and tools



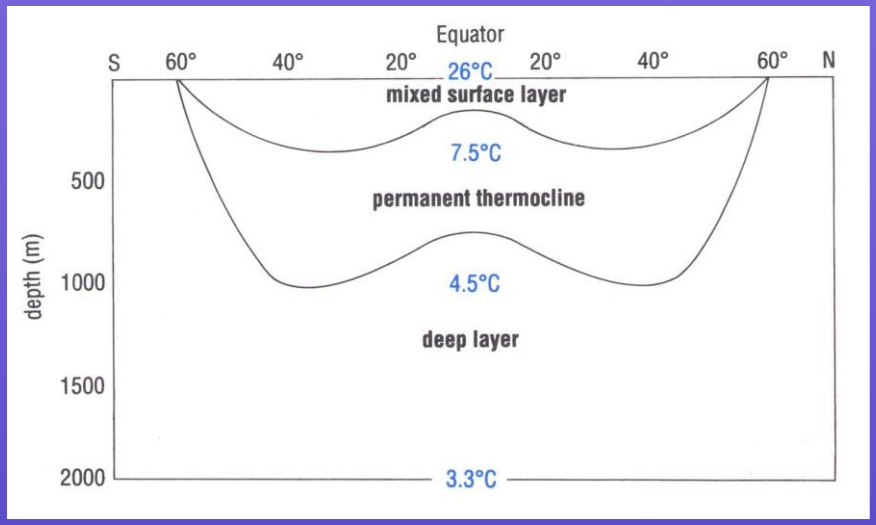
Graphical objects for tools

Data objects and tools are encapsulated, allowing a Graphical Object Manager API style

Graphical Objects, with associated tools and meta-data

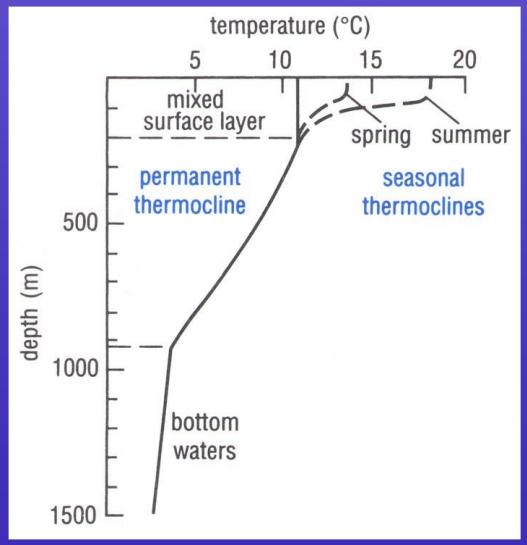


Test Case - mixed layer depth (MLD)



The depth to which water is well mixed. This has ramifications for fish and planktonic organisms, also for nutrients.

Surface layer sits above the thermocline. Defined as the layer where the temperature is within 0.5° of the average surface temperature or where the potential density is within 0.125 of the surface average

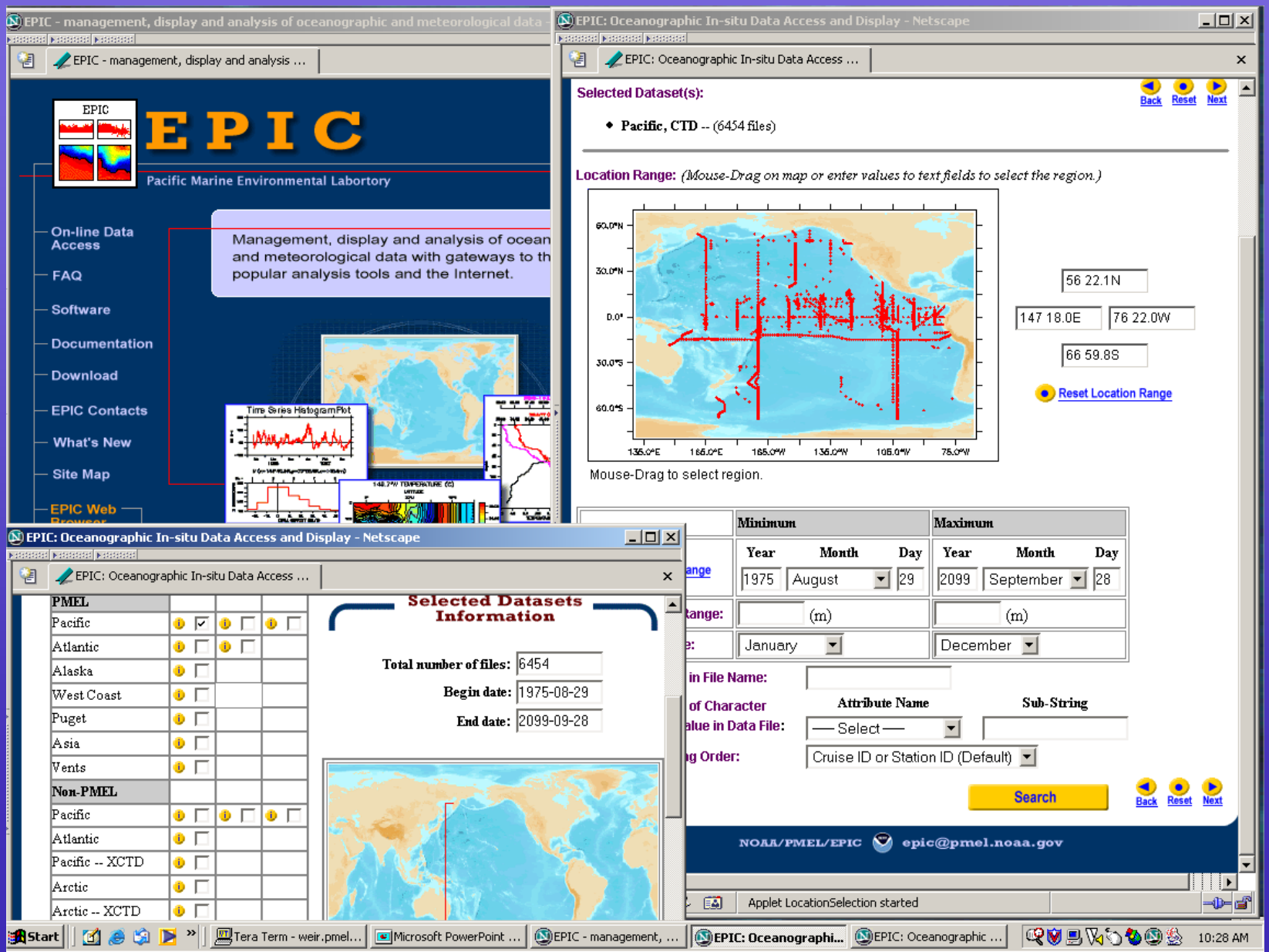


www.fd.ntou.edu.tw/5CTemperature201025.doc

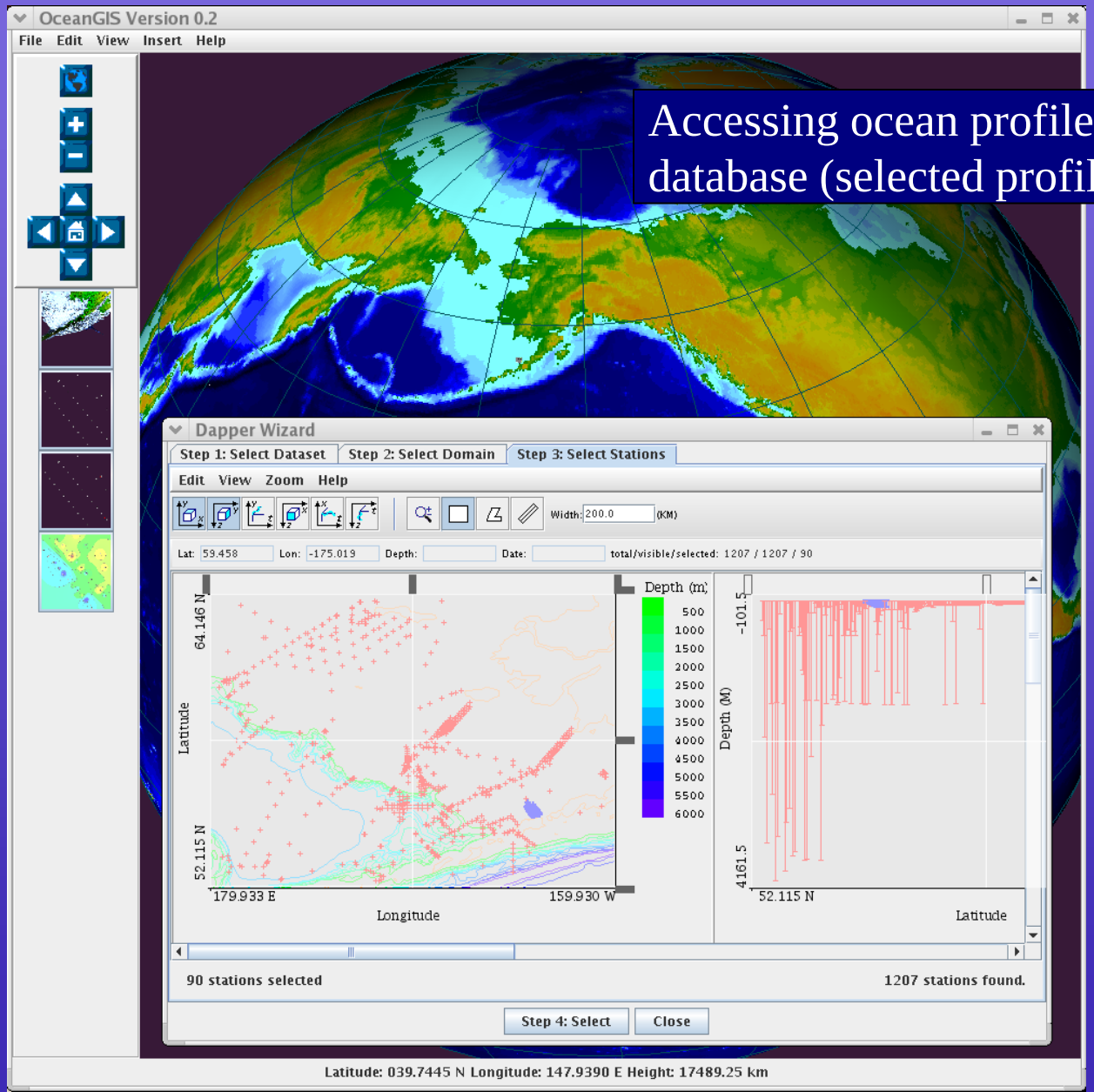
Java implementation

- MLD algorithm from VB to Java
- GeoTools toolkit shapefile reader (Java) used to read shapefile
- Created a new application in Java to calculate the MLD and output a VTK OpenGL window
- VTK wrapped in Java
- Can also display MLD shapefile created in ArcGIS version

Conductivity-temperature-depth (CTD) data



Dapper data access



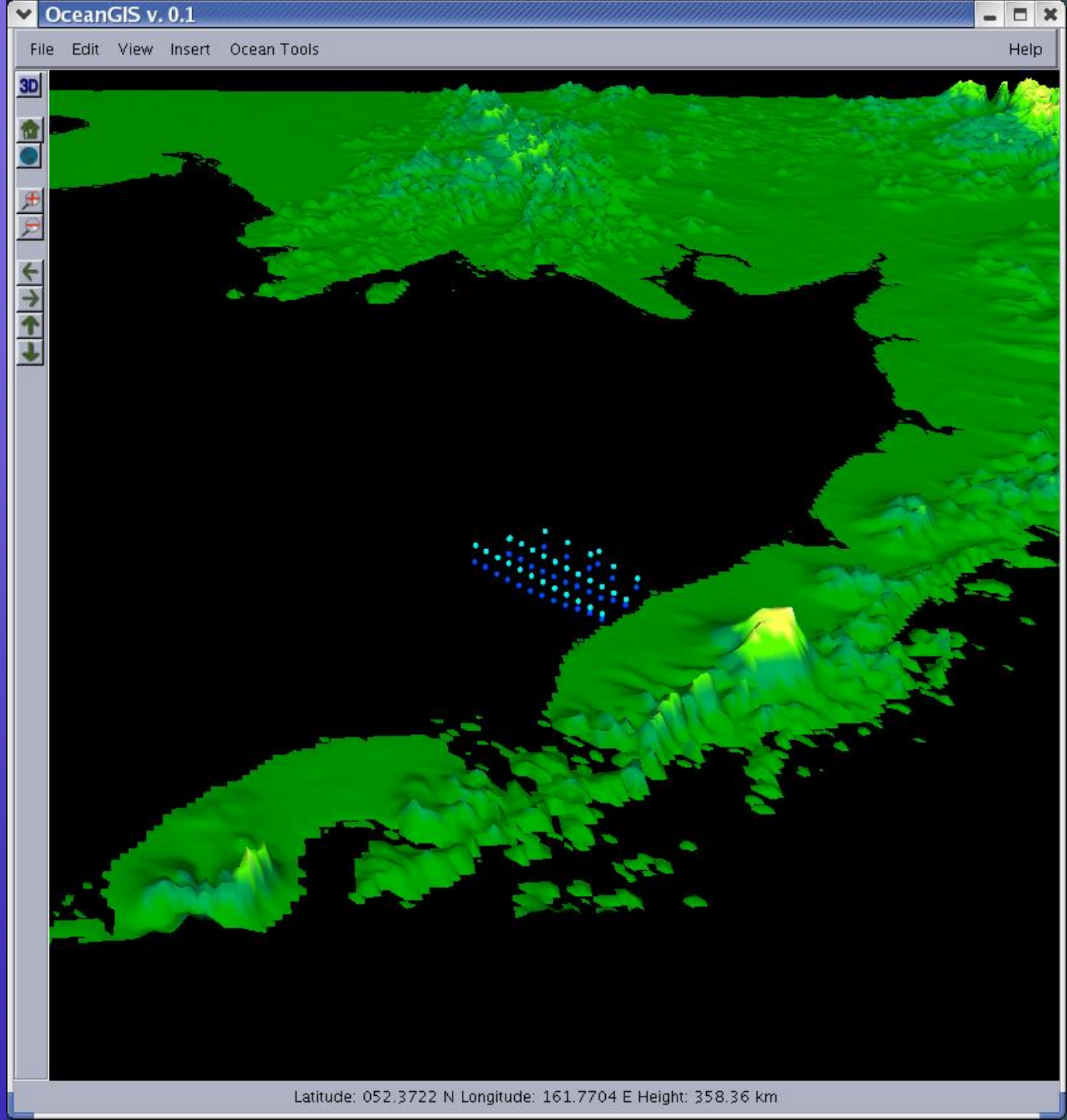
Accessing ocean profile sensor data from database (selected profiles in blue)

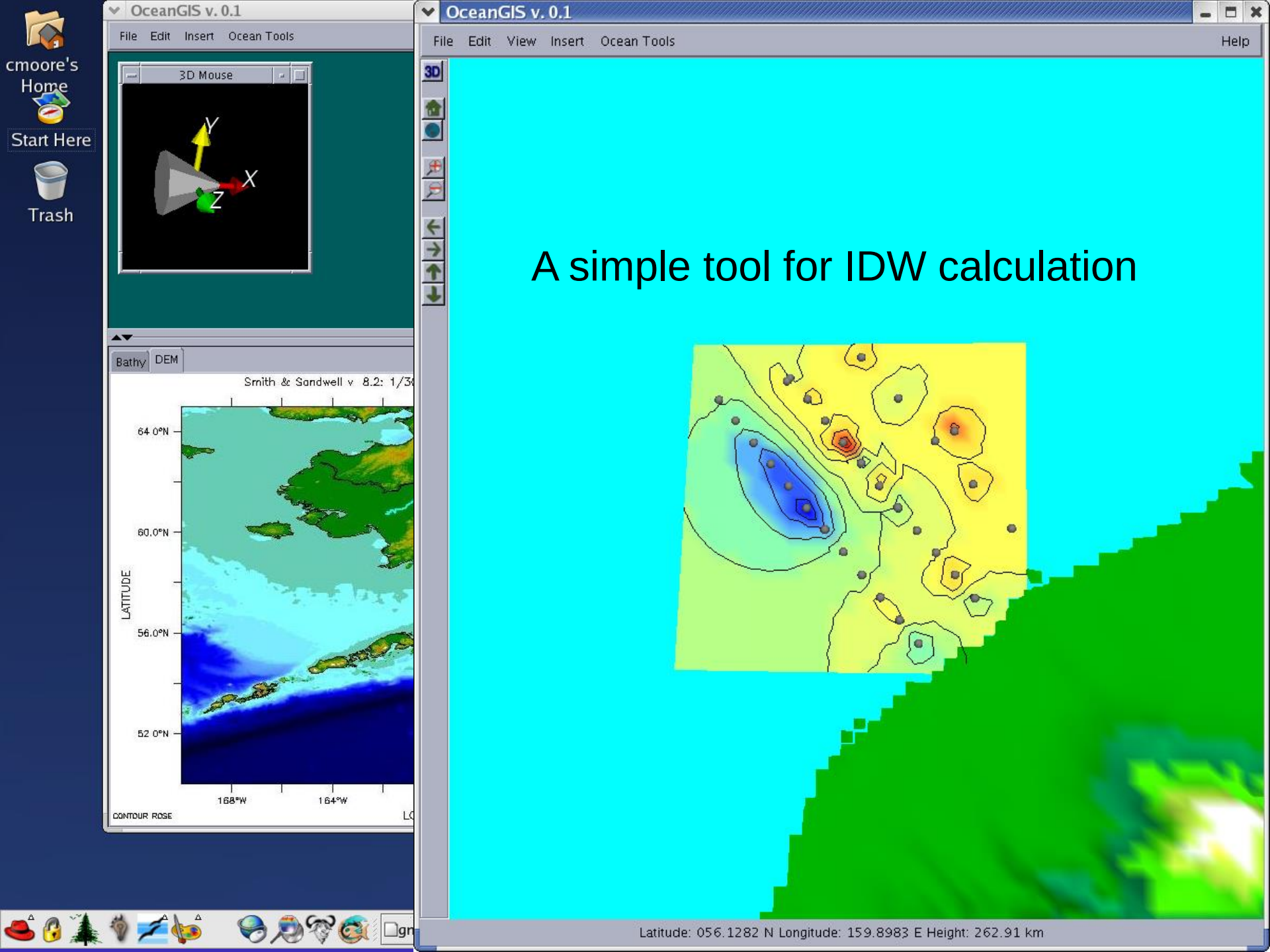
Ocean analysis algorithms

- UNESCO routines for water properties
- Oceanographic Analyst (ArcView 3.2) http://www.absc.usgs.gov/glba/gistools/
- MATLAB tools - SEA-MAT package http://woodshole.er.usgs.gov/operations/sea-mat/
- VTK toolkit - for volume analysis http://public.kitware.com/VTK/

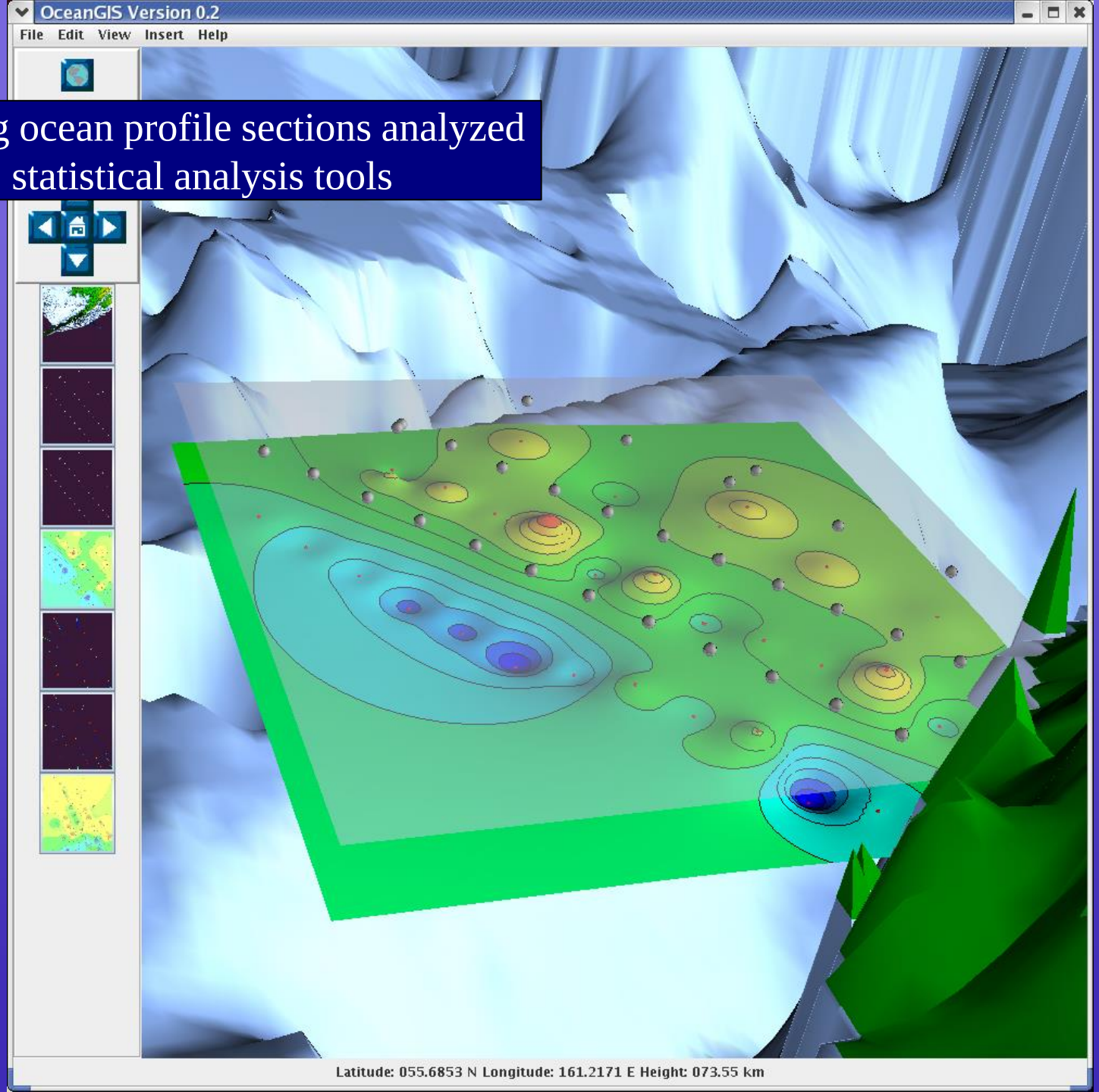
CTD cast location (light blue)

Mixed-layer depth (dark blue)




cmoore's Home
Start Here
Trash
OceanGIS v. 0.1
File Edit Insert Ocean Tools
3D Mouse
Y
X
Z
Bathy DEM
Smith & Sandwell v 8.2: 1/3
64.0°N
60.0°N
56.0°N
52.0°N
LATITUDE
168°W
164°W
CONTOUR ROSE
OceanGIS v. 0.1
File Edit View Insert Ocean Tools Help
3D
A simple tool for IDW calculation
Latitude: 056.1282 N Longitude: 159.8983 E Height: 262.91 km

Resulting ocean profile sections analyzed with GIS statistical analysis tools

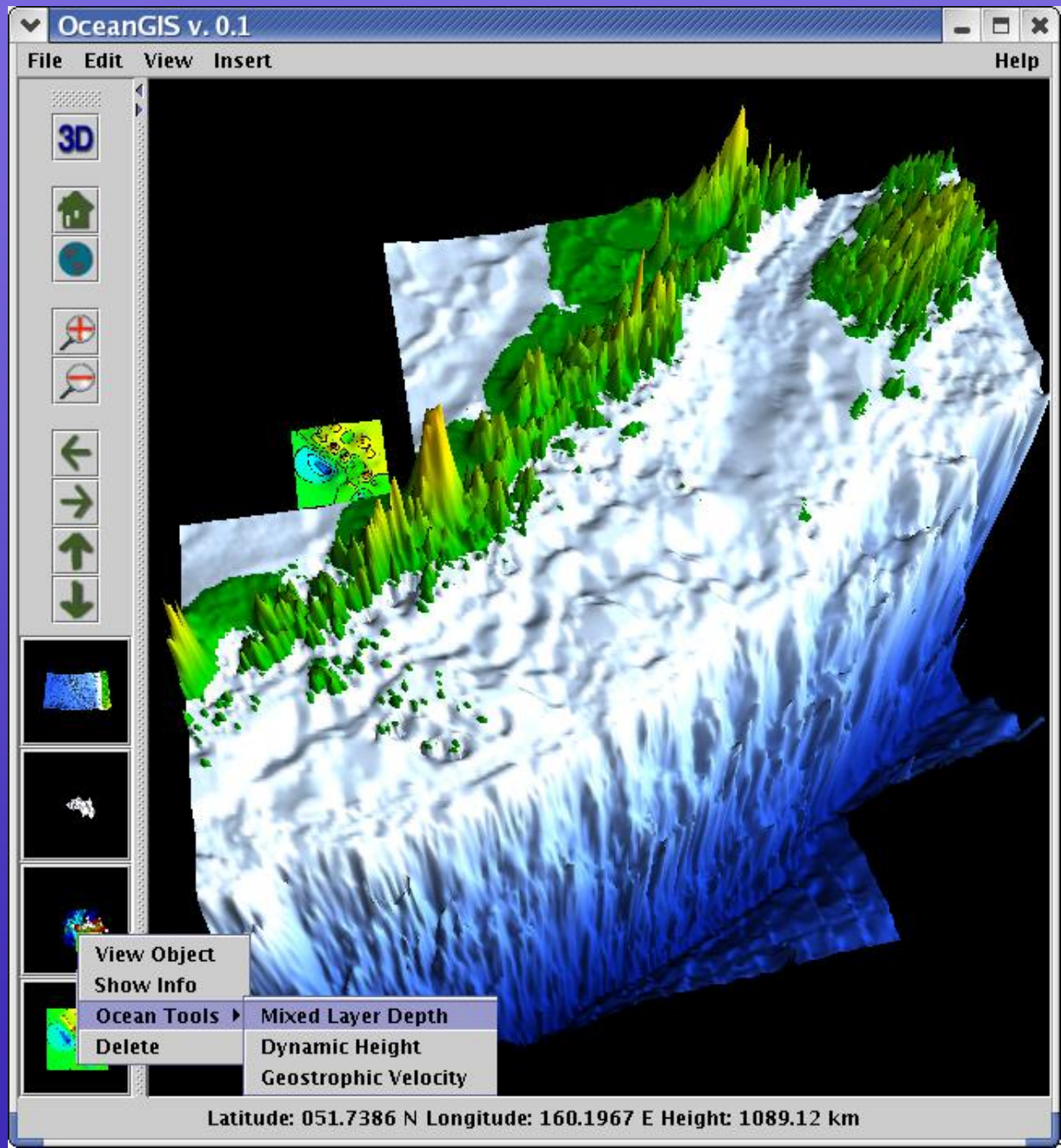


Initial integration with ArcGIS:

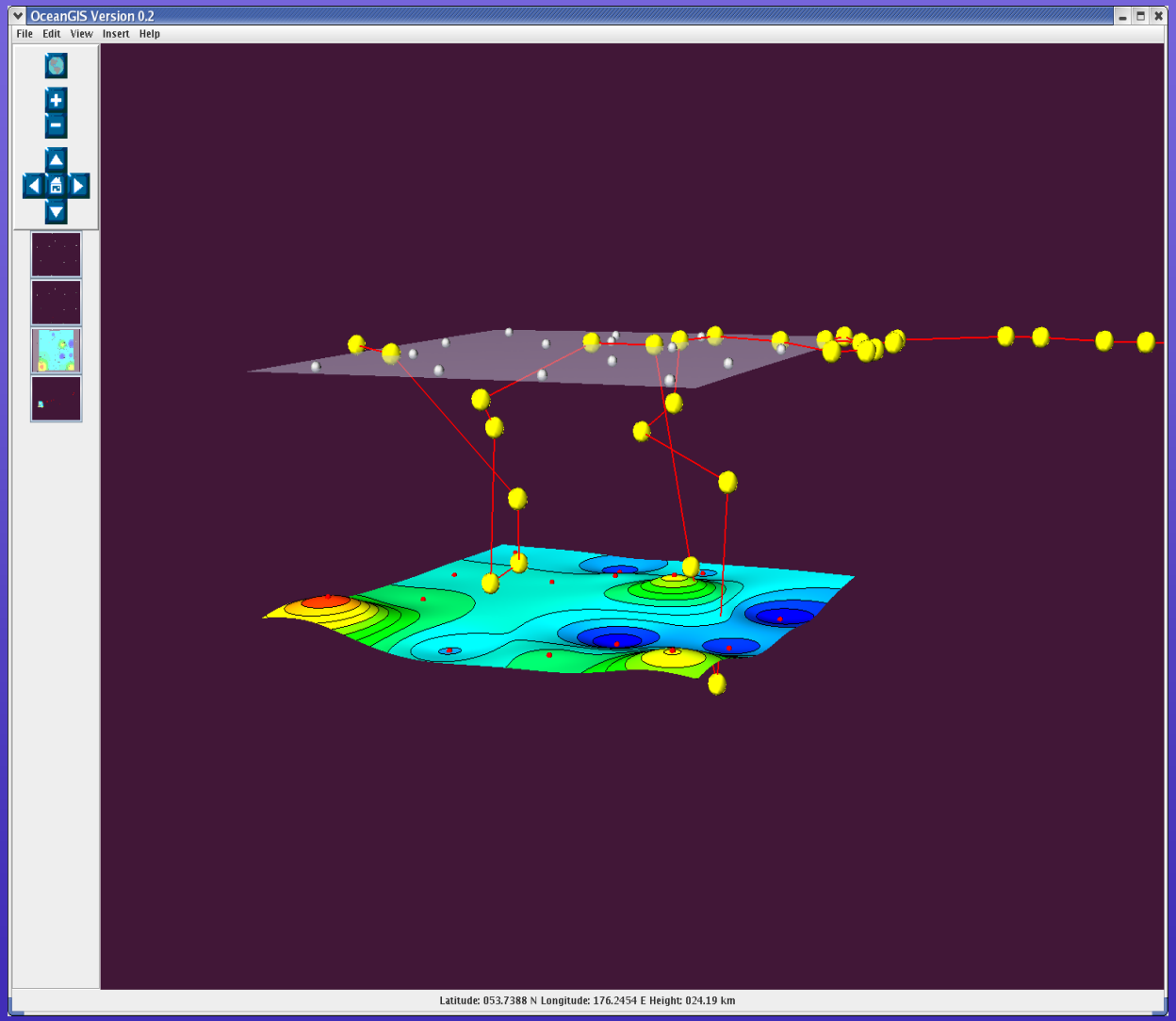
The Java API allows re-use of code.

Our oceanographic tools are embedded in a graphical object data model.

ArcGIS Engine will allow us to embed ESRI statistical analysis tools (or any ArcObject tool) as well



Example one: Marine mammal path through isosurface

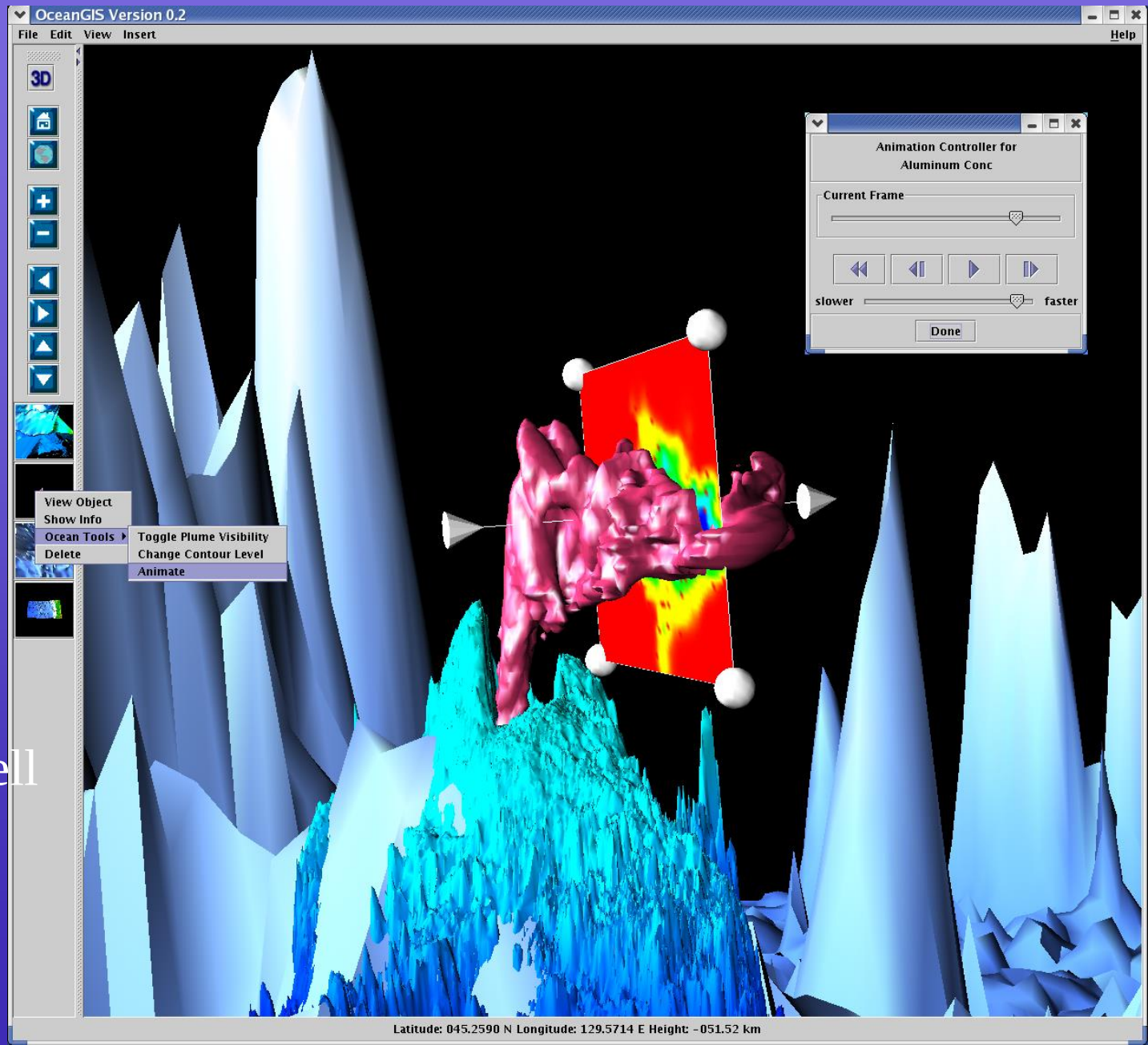


- VTK functions to calculate intersection of line and surface
- Above/below the surface
- Generalize to inside/outside a volume

Example two: Hydrothermal plume model output

VTK/Java3D allows volume calculations, rendering, and analysis.

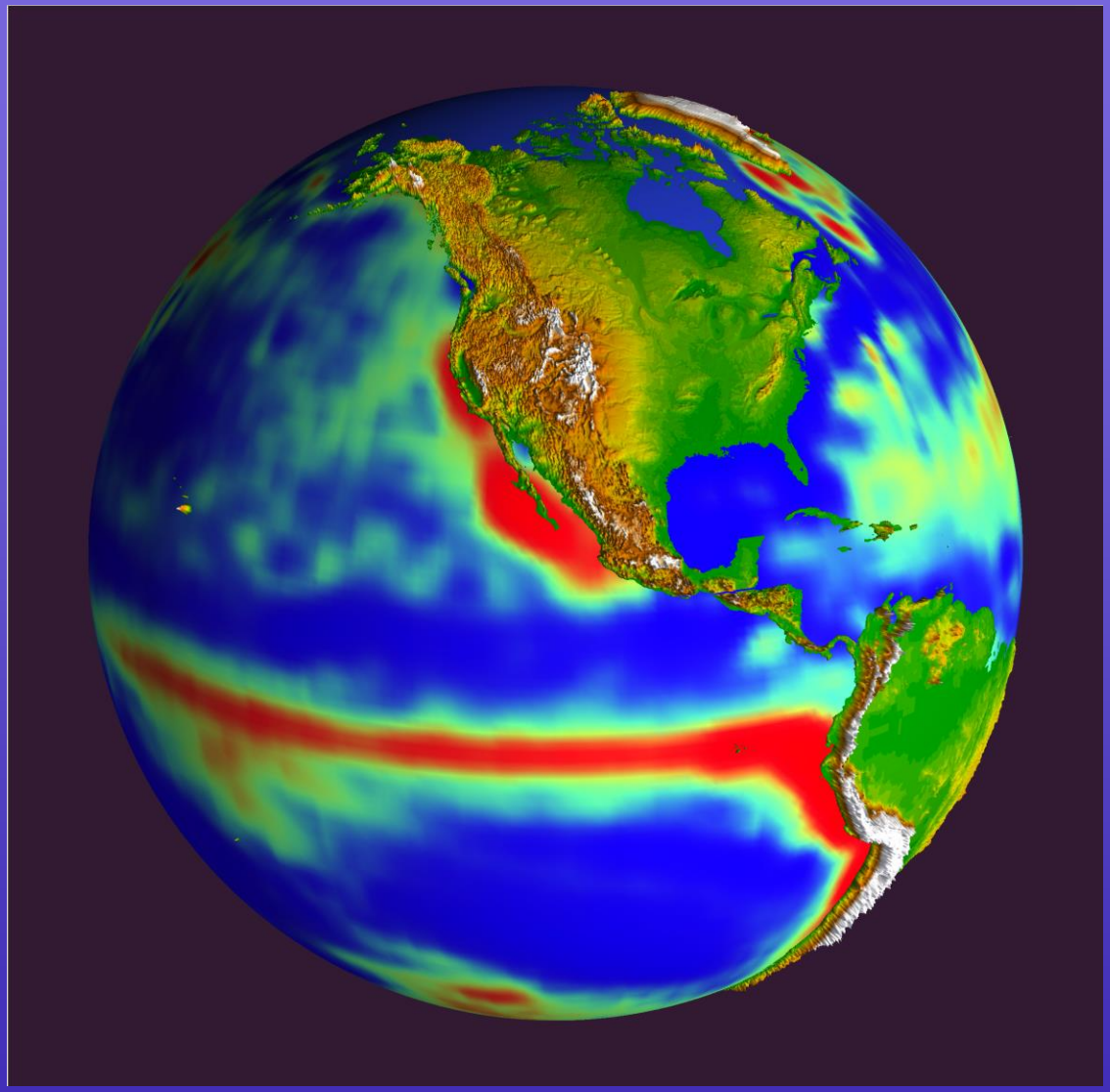
- 3D probe
- animation
- bathymetry
  - multibeam
  - Smith/Sandwell



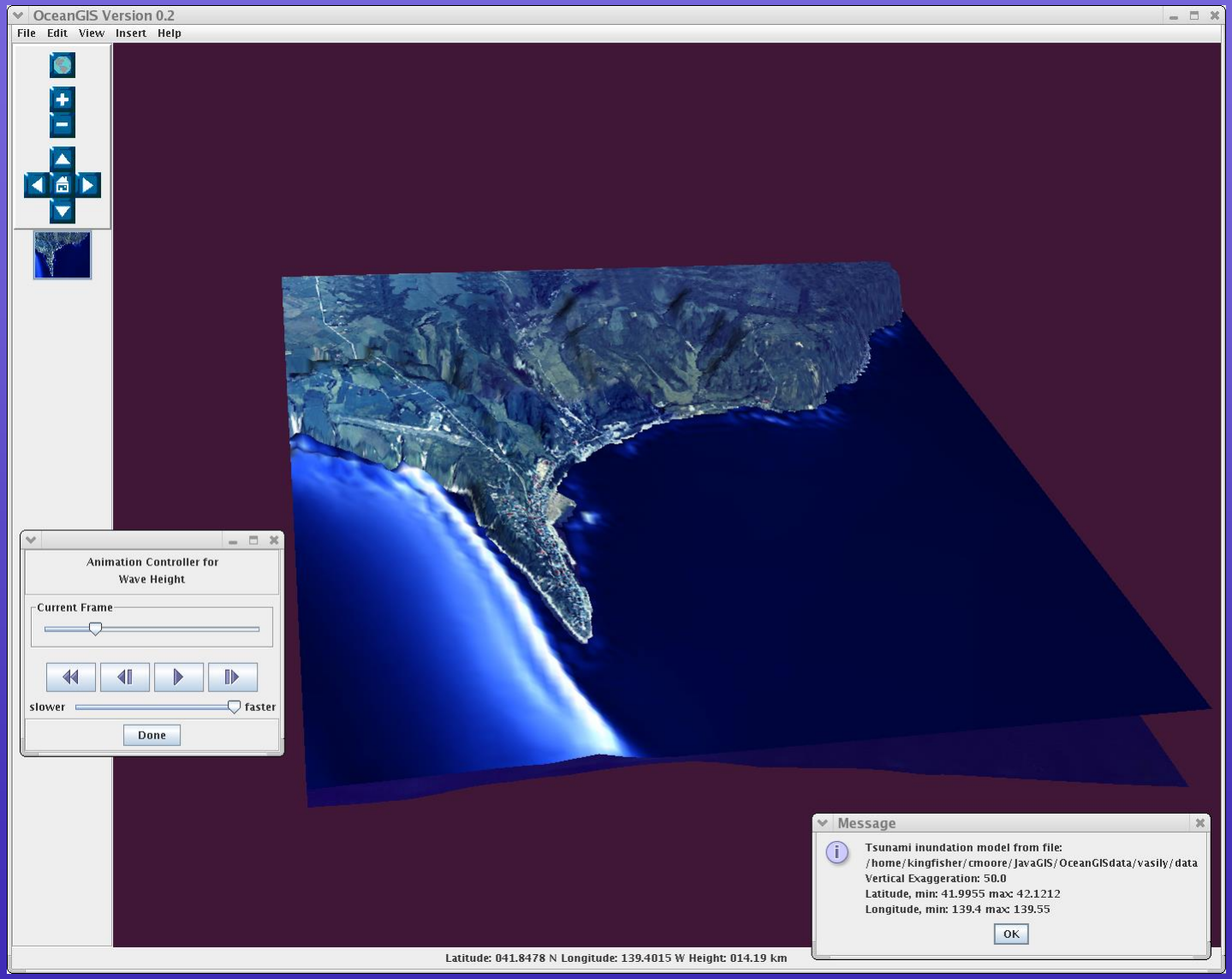
Example three: Global gridded data

Reynolds SST anomaly
January 1989

(overlayed with etopo05)

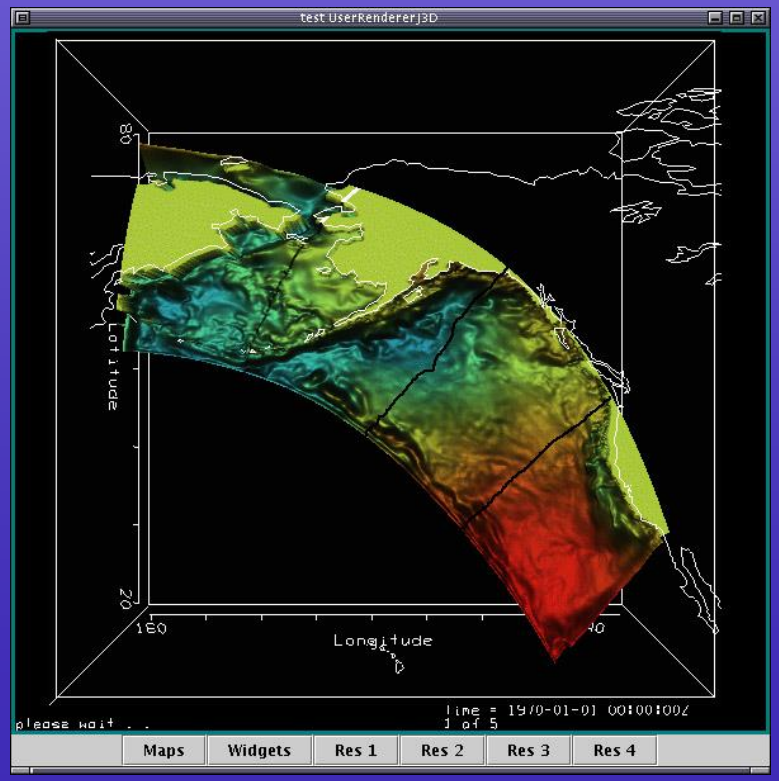


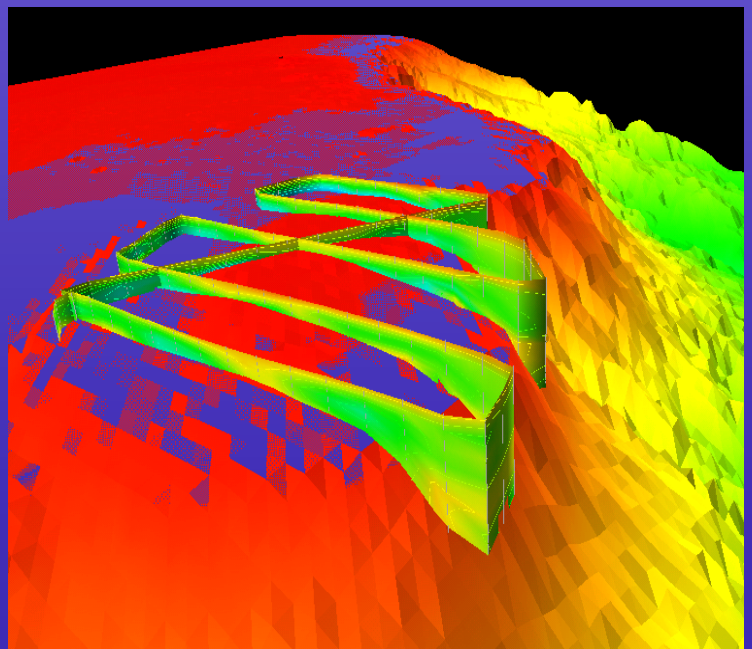
Example four: Tsunami visualizations ported from the ImmersaDesk:



Integrating 3D visualization and GIS

- Parallel-platform rendering
- Oceanographic in-situ data importing
- Immersive environments
- Viz cluster/composite rendering





Future work

- Use of ArcGIS Engine to allow traditional GIS analysis
- Integration of more GIS-based analytical tools
- Implementation of more VTK-based 3D analyses
- Integration with simulation models to allow model driving via a visual interface
- Linking with models as a graphical front end

Credits and Contacts

- The NOAA HPCC program for funding

- Christopher.Moore@noaa.gov
- Nazila.Merati@noaa.gov
- Tiffany.C.Vance@noaa.gov

For more details:
www.pmel.noaa.gov/vrl/OceanGIS

Questions???

Ocean Analysis Algorithms

- UNESCO routines for water properties
- Oceanographic Analyst (ArcView 3.2)
  http://www.absc.usgs.gov/glba/gistools/
- Matlab tools - SEA-MAT package
  http://woodshole.er.usgs.gov/operations/sea-mat/
- USGS sedx package
  http://woodshole.er.usgs.gov/staffpages/csherwood/sedx_equations/sedxinfo.html
- VTK toolkit - for volume analysis
  http://public.kitware.com/VTK/