Beyond Book Spines

Visualizing Library Complexity

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Core Integration
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NSDL Challenges

- Broad audience
  - Targeting for our vital constituents is difficult
- Large Volume
  - Resources
  - Users
- Broad content
  - Types of resources
  - Topics
  - Collection of collections
- Metadata Quality
  - Wildly inconsistent (what fields are used, what info is present)
  - Missing information
  - Inconsistent use of controlled vocabularies
- Disparate Quantities (by subject, by collection): 7 vs. 600,000 items
- Virtual Communities
  - Within communities, no agreement on needs
- Reduce human effort to keep costs down

Why Information Visualization?

- It's about the *USERS*
- GOAL: improve user satisfaction with digital library services and resources
- Narrower goal: improve online browsing

Search and Browse

- False dichotomy!
- Many different user tasks
- Multiple ways to present results to users
  - Should the presentation vary with quantity and/or context of results?
    - e.g, "browse" may be a certain presentation of subject search results

A Short List of User Tasks

- "Known Item Search" } Inputs may be fuzzy
- Single Item Search
- Answer to a Question
- x "Best" Resources
  - Most informative? Easiest to access? Most appropriate to 8th graders?
- *All* Germane Resources
- Sense of the Information Space
- Serendipitous Finds

… still looking for user needs and tasks analysis for information discovery …

Problem Narrowed Further

- Improve evaluation of resource relevance without having to "go there"
  - "See and Go Manifesto" Ramana Rao
  - Allow users to manipulate result presentation
- What do we miss when we can't walk through the stacks?
  - Sense of information space
  - Serendipitous finds

Information Organization

- Books, Bookcases, Book Spines, Catalogs all evolved over time
  - library staff/user needs
  - bookstore staff/customer needs
  - organized by subject
- We are taught how to use libraries
  - how resources are organized
  - how to use tools (card catalog, OPAC)

A Brief, Recent History of Information Discovery

- Card catalog (the world begins here)
- OPAC w/o keyword
- OPAC w/ keyword
- Internet, before WWW
- WWW before any cataloging
- Yahoo, Alta Vista, etc.
- Google

} Open vs. Closed Stacks

More Information Organization

- “binned” then
- (possibly) sub-binned then
- sorted (alphabetical, size, format …)
  - Note tension between linear ordering and hierarchical classification

- Location and Book Spine

Book Spines

- Aid information discovery while allowing efficient book storage
- Surrogate for book
  - surrogate closely related to resource
- Visual (color, size, shape …)
- Aimed at multiple audiences
  - Bookstore staff
  - Potential users
- NISO standard

Can We Improve Reality?

- A resource *can* be in multiple places at once
- 2 or 3 dimensional organization instead of linear
- Organization can be dynamic
  - User manipulable
  - Can use proximity to indicate relationships
- Can we make visual surrogate richer?
- Semantic zoom for resource?
  - Different users have different needs
  - Visual surrogate … user selected?
- Staff can alter organization of stored resources without affecting users' views
- Flexibility: organizing a very large collection has different constraints than organizing a small collection

The Big Questions

- How do we present shelves of book spine information to our users within a monitor screen?
- What should a virtual spine look like?

Design Notes

- Tension
  - intuitive, familiar ←→ new capabilities, change
- Semantic zoom
  - spec (partial bookspine info: color, position) →
  - bookspine info →
  - full metadata →
  - resource itself
- User manipulability
- Text issues
  - horizontal, not vertical
    - Most materials in English
  - default sort is alphabetical

Browse by Subject

- Prototype
  - Semantic zoom: spec (partial bookspine info: color, position) → bookspine info → full metadata → resource itself

- (demo)

Prototype Next Steps

- Click through for resource
- API
  - Any fielded data
    - Search results? Colored by rank?
  - Any tree structure for any fielded data
- Multiple field values
- Jitter
- Scaling
  - When too much, scroll it (a la spotfire)?
- Table view (sortable, selectable, searchable, like spotfire)

The Metadata Frontier

- Missing information
  - Automatically generated (full text, iVia, kth nearest neighbor, support vector … based on training set)
  - Supplied by community (ENC?)
- Controlled vocabularies
  - Automatic translation ?
- Data mining?

- Value-added services to motivate providers

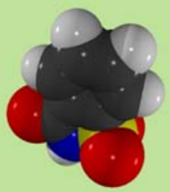
Content viz, continued

- Subject as graph (inherent relationships) – tree?
- Vastly uneven leaf levels
- Sparsely populated nodes in tree?
- To explore: items pertaining to multiple subjects at multiple levels in hierarchy – explore "interdisciplinary" items and topics ("see also") … what do they tell us?

Information Visualization of Complex Data

John C. Huffman

Reciprocal Net Distributed Molecular Database
(NSF Award - #0121699)

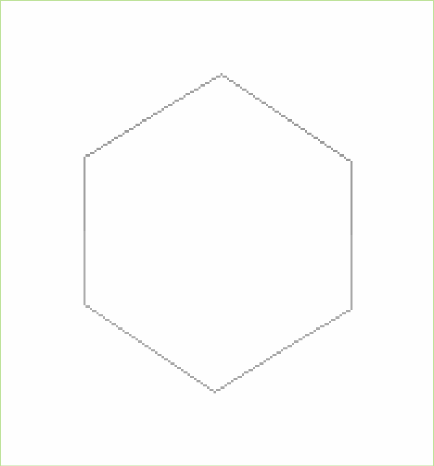


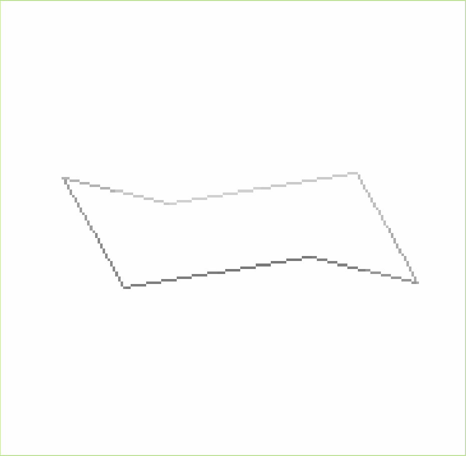
NSDL 2004

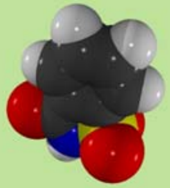
The Problem

C(1)	0.00000	0.00000	0.00000
C(2)	-1.47100	0.40500	0.17200
C(3)	-2.39200	-0.52700	-0.62900
C(4)	-1.99900	-0.54400	-2.11300
C(5)	-0.52700	-0.94800	-2.28500
C(6)	0.39400	-0.01600	-1.48400

The Problem







Solutions

Depth queuing

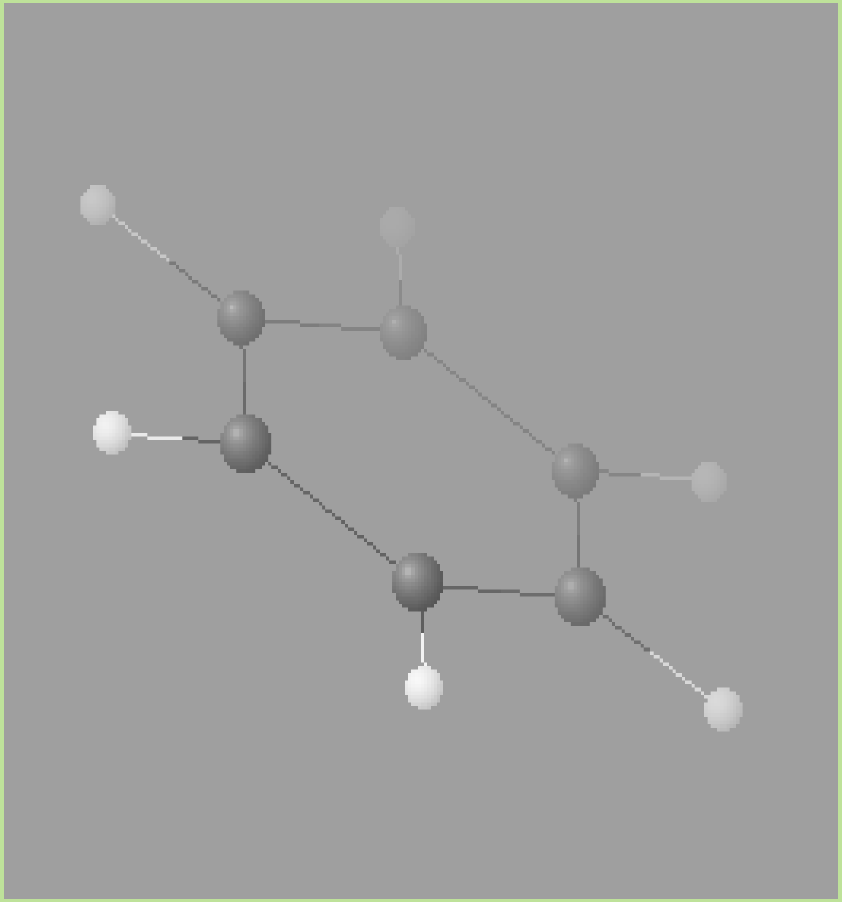
Shadows

Perspective

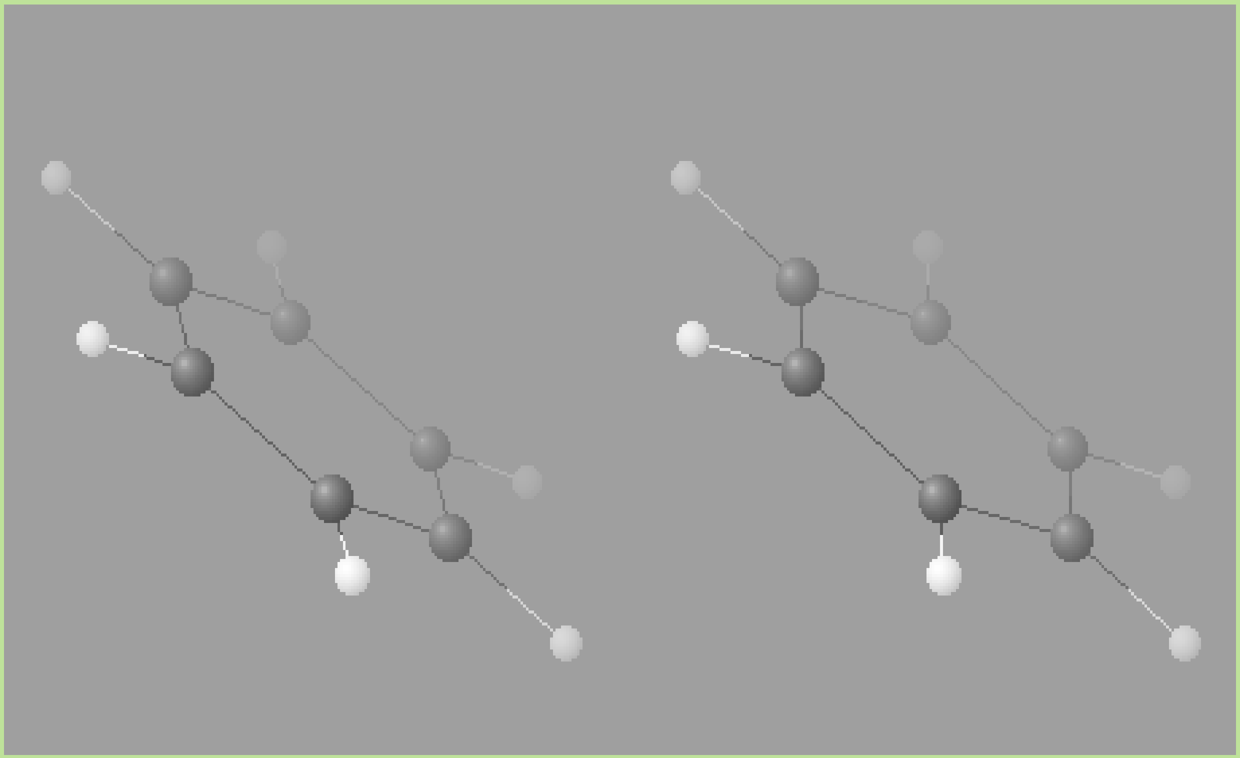
3D techniques

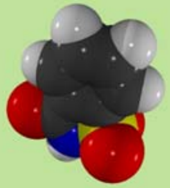
User manipulation

Solutions – Depth Queuing

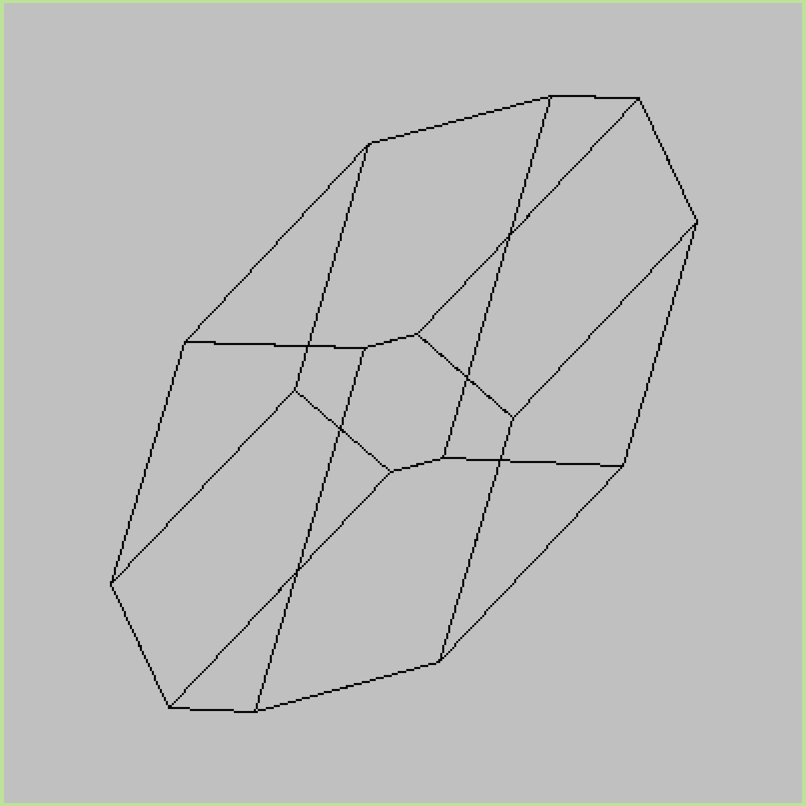


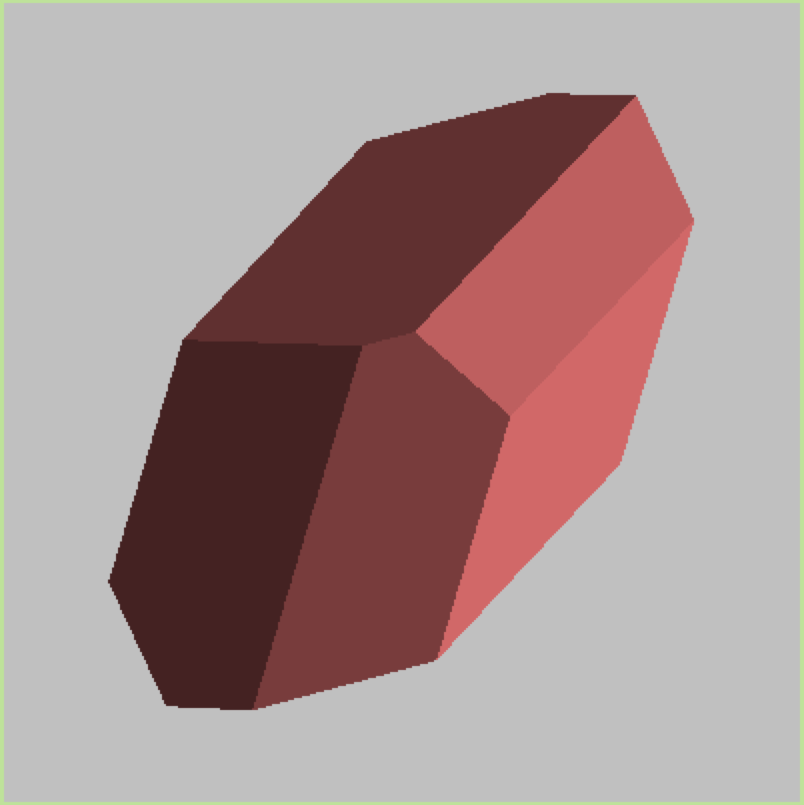
Solutions – 3D



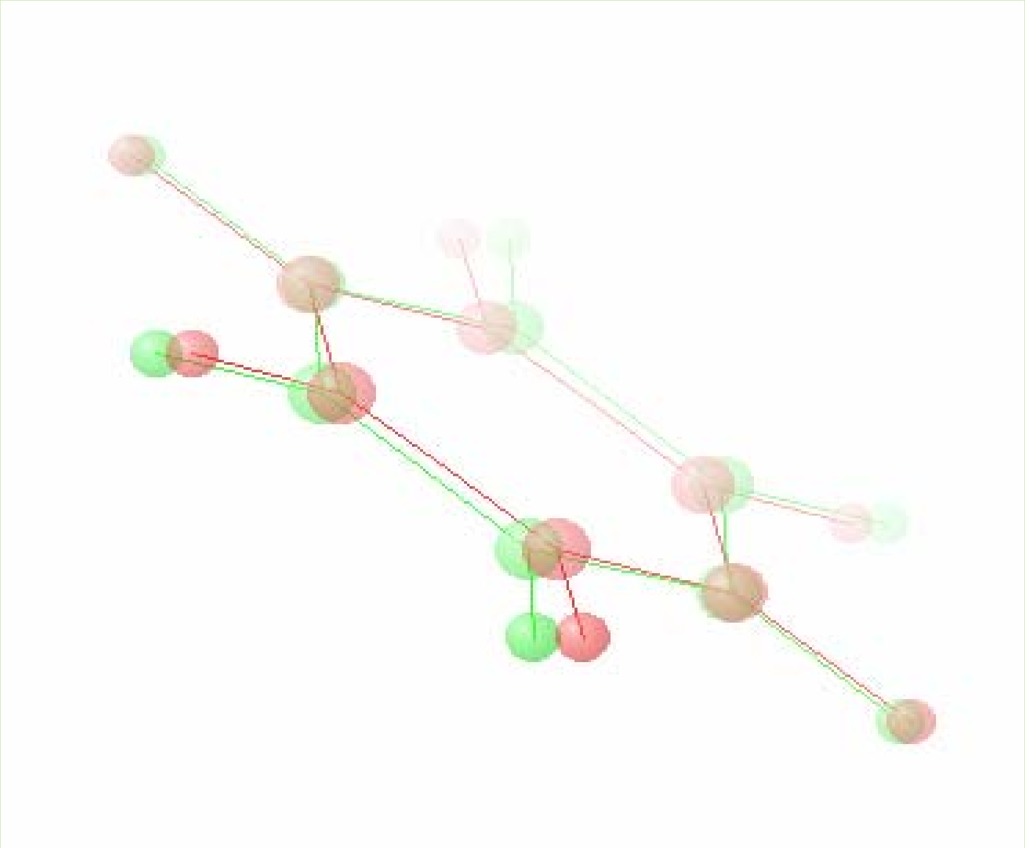


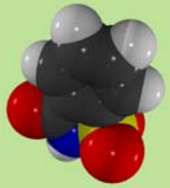
Solutions – Shading





Solutions – 3D





Other Solutions

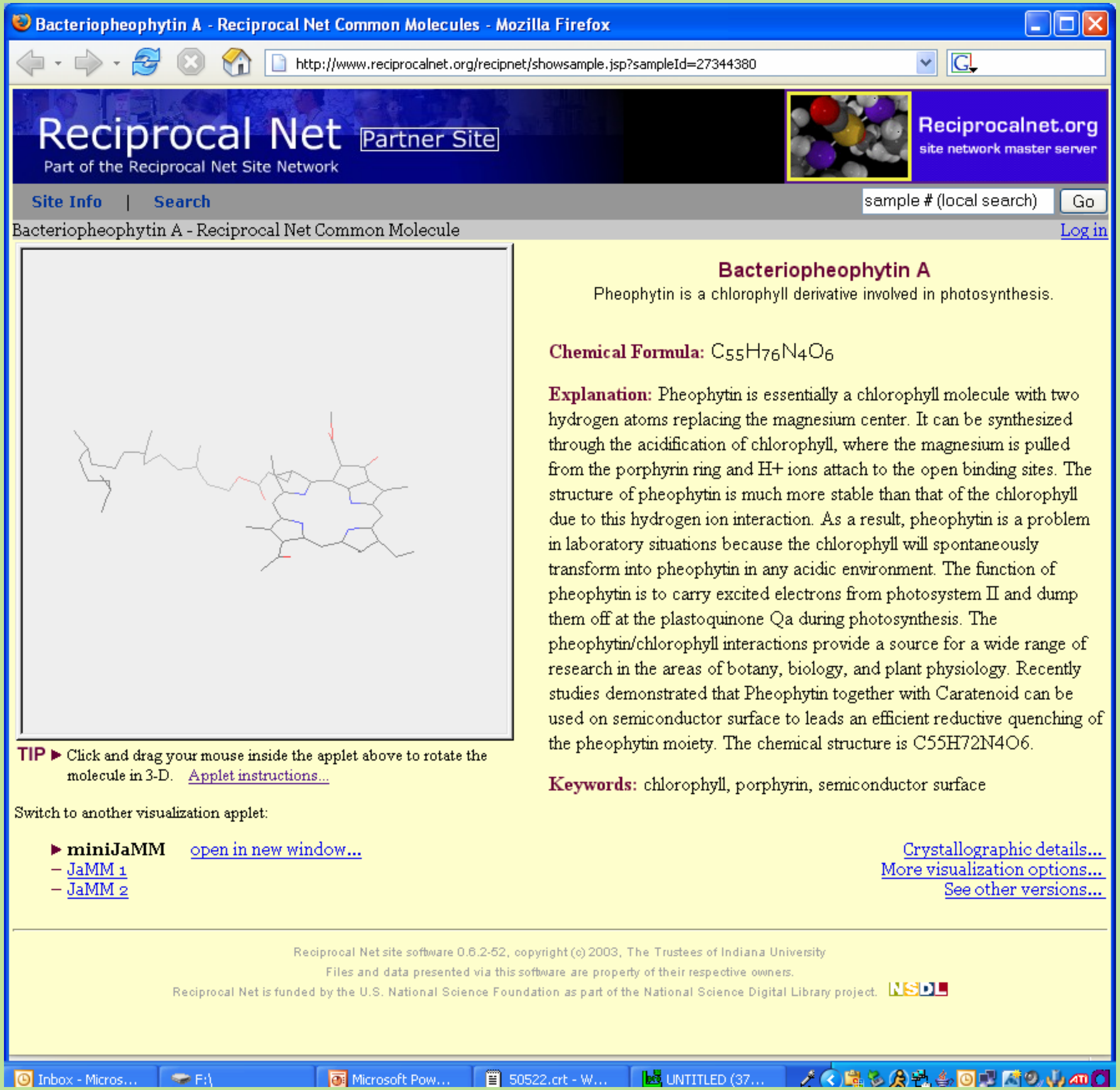
VRML

CHIME

RASMOL

JMOL

Reciprocal Net



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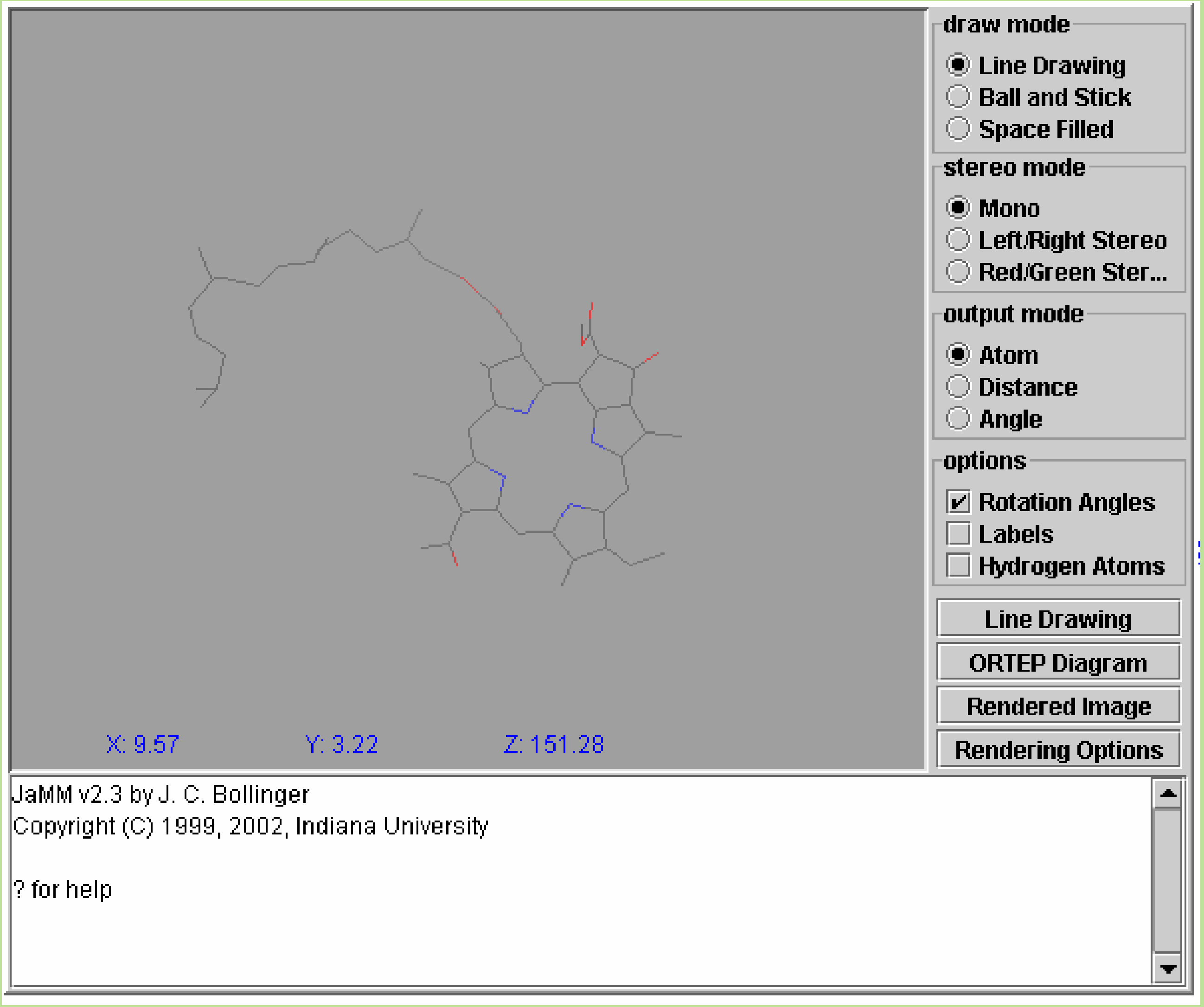
Reciprocal Net



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Reciprocal Net

Reciprocal Net home: http://reciprocalnet.org

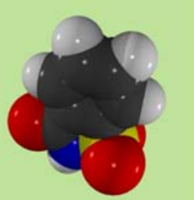
MiniJaMM page: http://www.reciprocalnet.org/recipnet/showsample.jsp?sampleId=27344380&sampleHistoryId=16086&level=8192&applet=jamm2&setApplet=1

JaMM2: http://www.reciprocalnet.org/recipnet/jamm.jsp?sampleId=27344380&sampleHistoryId=16086&jamm=JaMM2

Morphology: http://www.iumsc.indiana.edu/morphology/sucrose.html

Morphology: http://www.iumsc.indiana.edu/morphology/solids.html

DoubleJaMM: http://www.iumsc.indiana.edu/Symmetry/Octrahedral.html



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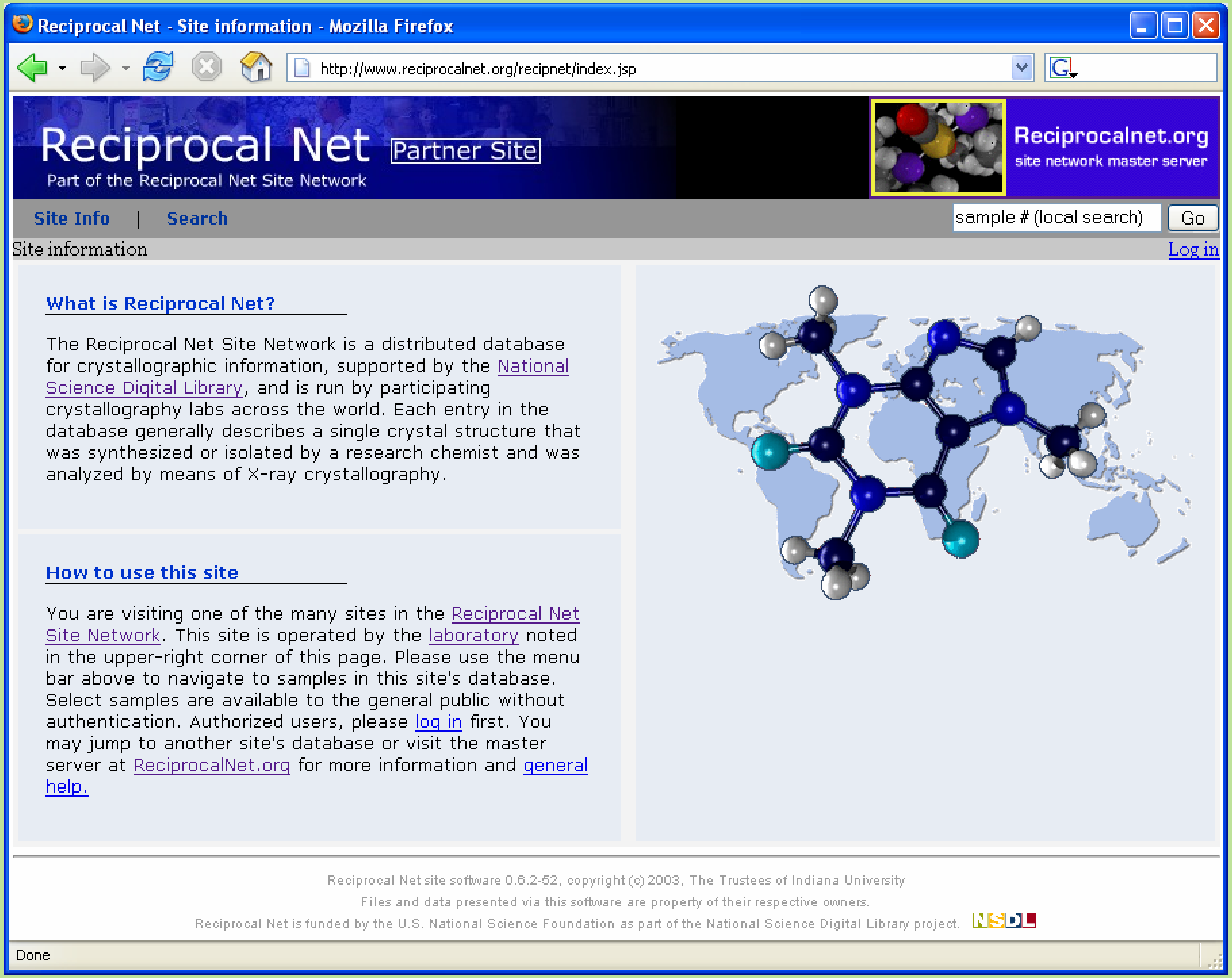

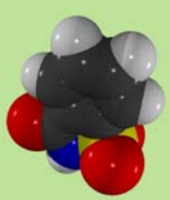

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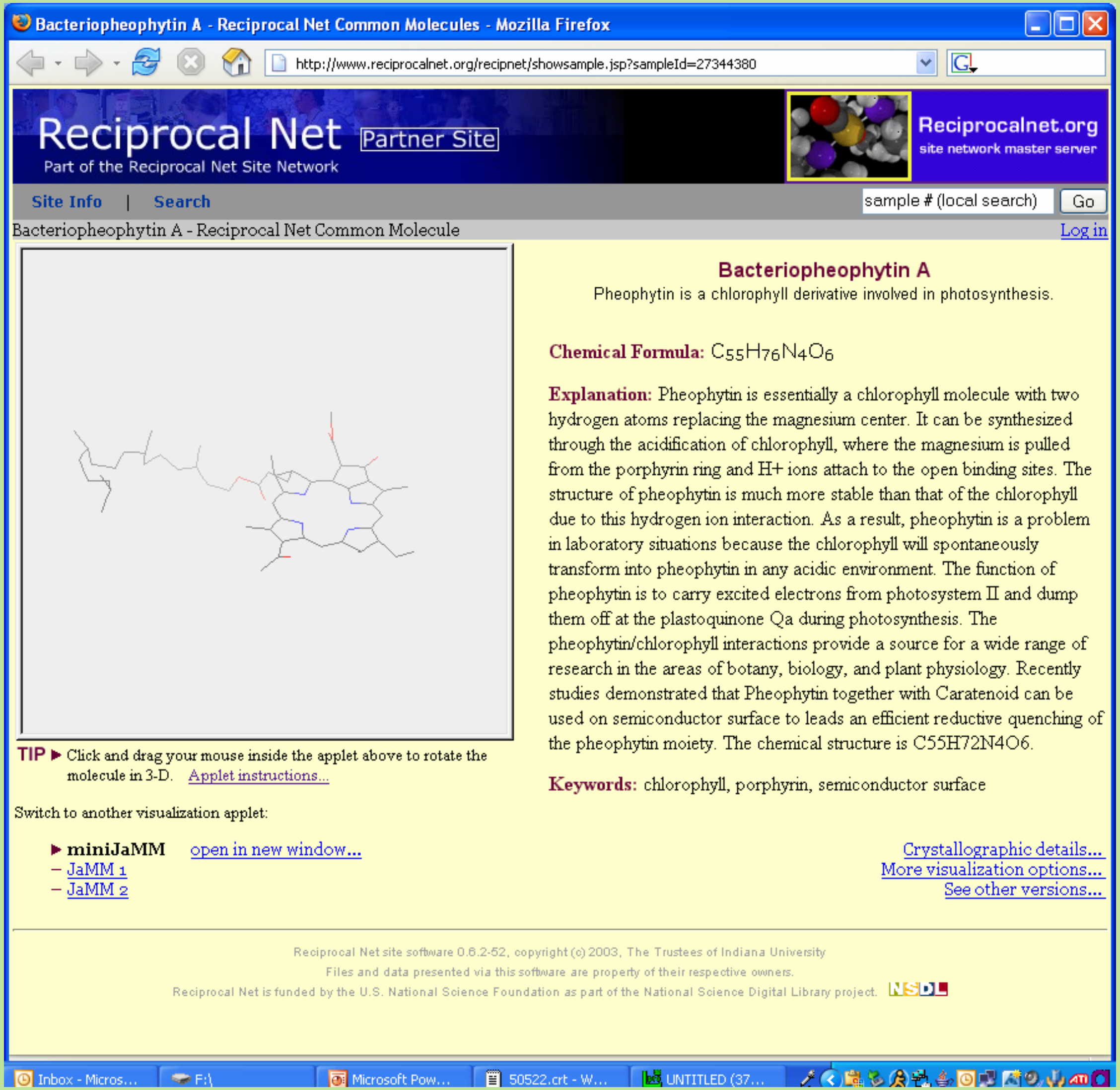

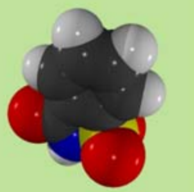

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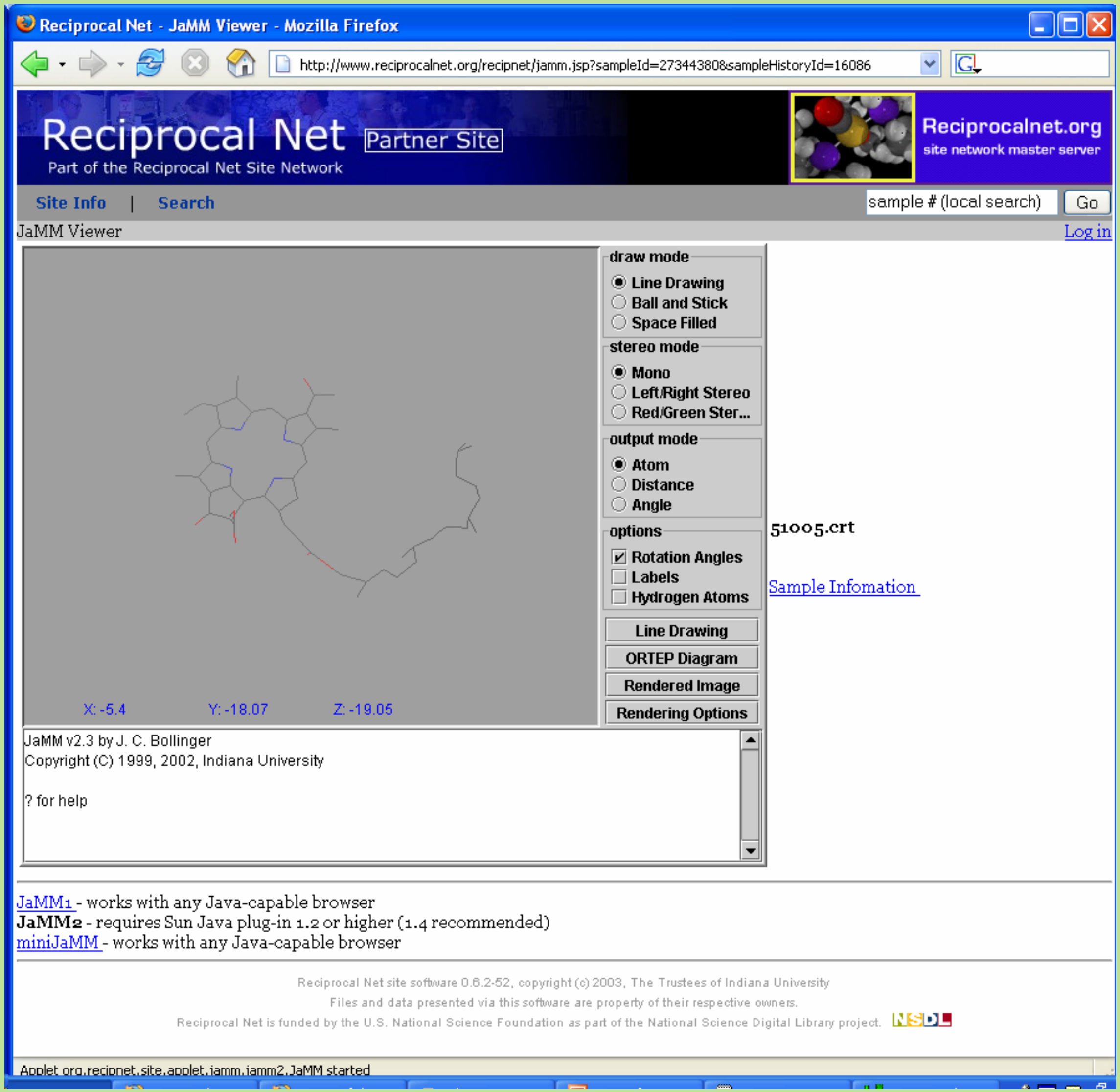

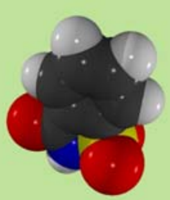

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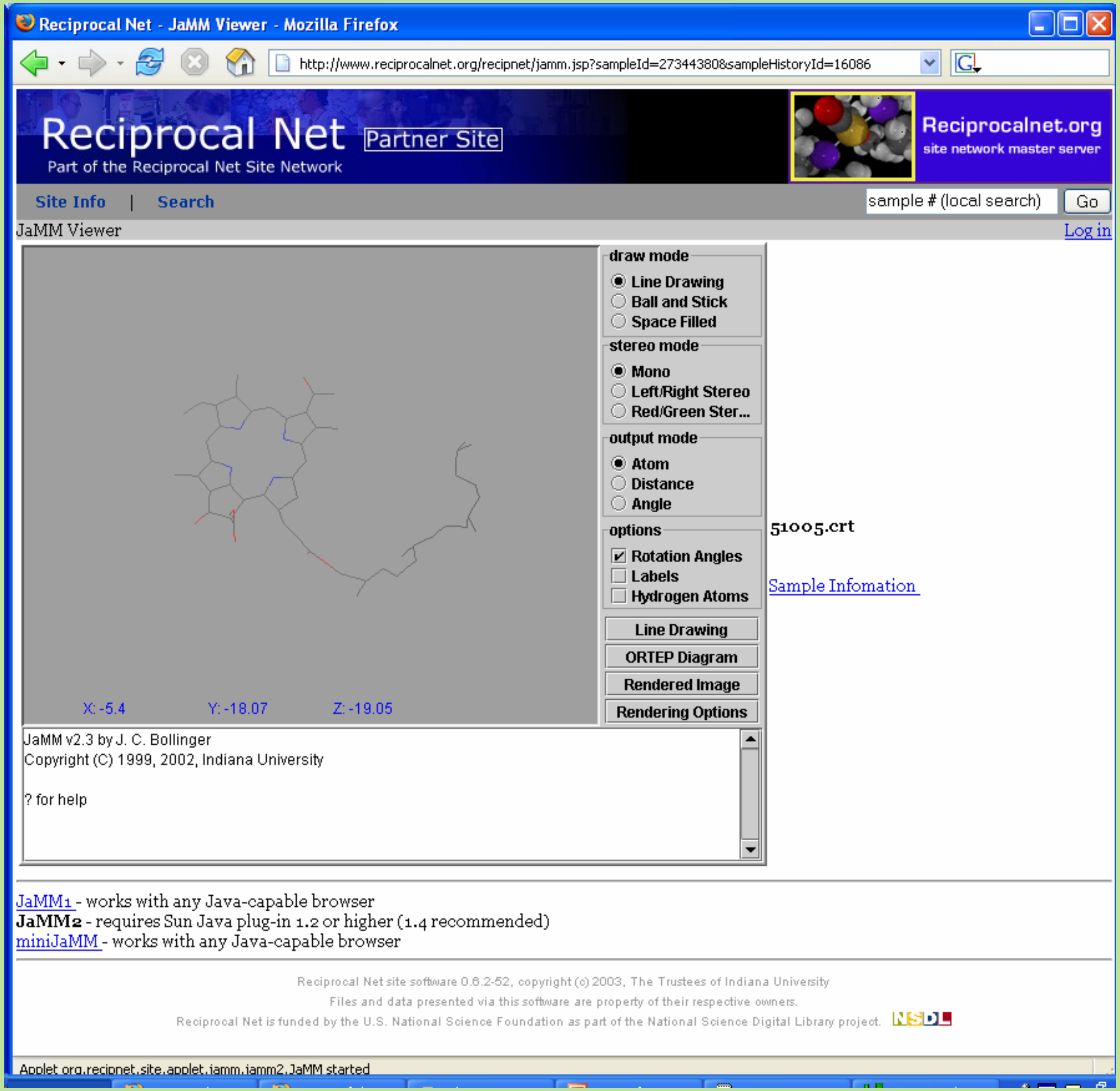

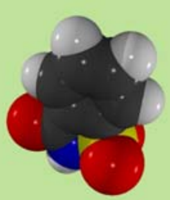

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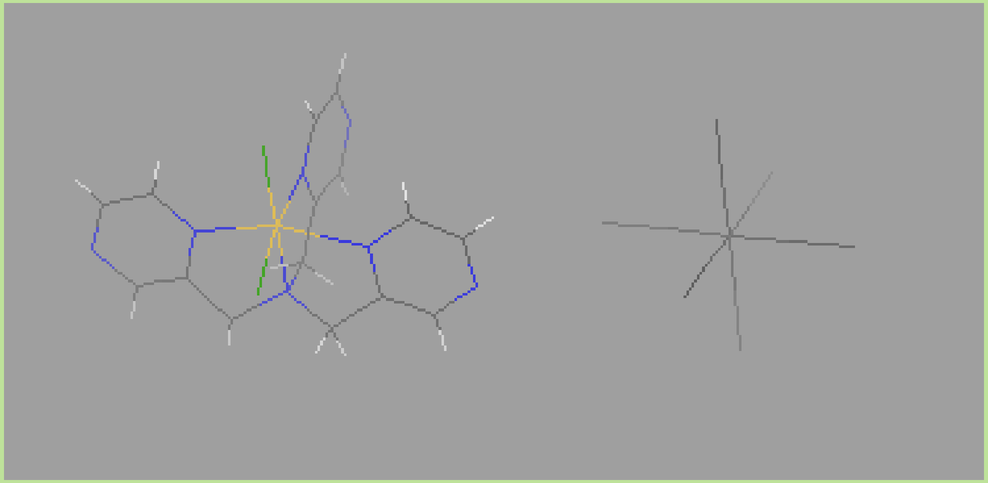

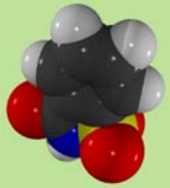

NSDL 2004

Reciprocal Net

For more information, contact

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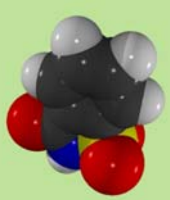
http://recipnet.org

http://reciprocalnet.org

http://www.iumsc.indiana.edu



DLESE
Digital Library for Earth System Education

Creating data exploration programs for educational use

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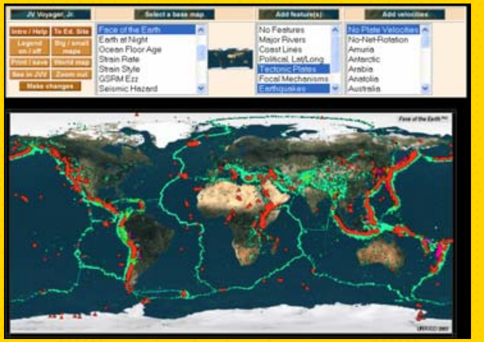
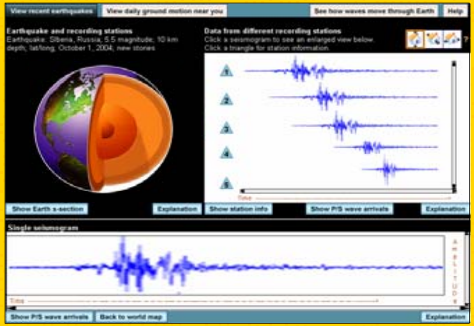
Instructional Designer, DLESE Program Center
http://www.dlese.org, support@dlese.org

Overview

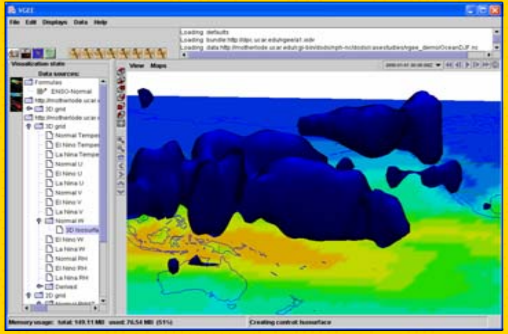
- A model of levels of learning / understanding and the types of digital resources that can support them



- 3 visualization programs that support higher-order levels of learning
  - All are reworks of existing programs – done to make them more user friendly and educationally useful



- Tips for designing effective, educational, exploration environments



www.dlese.org

Tying learning goals to resource types

<table>
<tr><th>Level of learning (from basic to complex) *</th><th>You want students to be able to:</th><th>Types of resources to look for in digital libraries</th><th>Frequently used teaching approaches</th></tr>
<tr><td>Knowledge (recall or recognize info, ideas, principles)</td><td>Gather facts about a topic, etc.

Example: What are the different types of clouds and how are they formed?</td><td rowspan="2">• Tutorials and modules
• Presentations and demonstrations
• Text materials: articles, etc.
• Activities: classroom, computer, lab, and field
• Visuals: graphics, illustrations, animations

For comprehension, add:
• Case studies and simulations (basic)</td><td rowspan="2">For basic types of learning, the teacher typically organizes the learning, teaches the information and concepts (or points students to sources), and guides the activities

Technology can be used to increase knowledge and comprehension

Assessment is often straightforward (knowledge and comprehension questions)</td></tr>
<tr><td>Comprehension (interpret or comprehend information)</td><td>Understand an Earth system process

Example: How does wave strength influence erosion?</td></tr>
</table>

* Bloom, B.S., Engelhart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain. New York: Longman.

Higher order thinking skills…

Level of learning (from basic to complex)	You want students to be able to:	Types of resources to look for in digital libraries	Frequently used teaching approaches
Application (select, transfer, and use data and principles to complete a problem with minimal direction)	Apply the scientific process, etc. Example: How does the Gulf Stream affect biological productivity in the ocean?	• Case studies • Simulations • Visualizations and data sets, particularly within exploration environments • Activities (classroom, computer, lab, field) • 'Ask an expert' services • Discussion forums	For increasingly complex types of learning, students play a more active role in the learning process Collaborative work can help students tackle problems and tasks
Analysis (distinguish, classify, or relate assumptions, hypotheses, evidence)	Analyze a problem Example: How is water quality determined and how does it affect biological (including human) communities?	Helpful keywords: • Analyze, assess, choose, classify, compare, convince, decision, infer, measure, summarize	Teacher is more of a facilitator; scaffolds the amount of structured, didactic instruction and direction (provides less as students work more independently) Supports the philosophy that students construct their own knowledge
Synthesis (originate, integrate, and combine ideas)	Prepare for a discussion, role-play, or debate on an issue, etc. Example: Develop and defend a possible solution to global warming.	Helpful keywords: • Synthesize, integrate	Learning is problem or inquiry based, contextual, and uses real data and problems when possible Encourages problem solving, creativity, and intellectual curiosity

Examples of resources that support different levels of understanding

Level of learning (from basic to complex)	You want students to be able to:	Types of resources to look for in digital libraries	Frequently used teaching approaches
Knowledge (recall or recognize info, ideas, principles)	Gather facts about a topic, etc. Example: What are the different types of	• Tutorials and modules • Presentations and demonstrations • Text materials: articles, etc.	For basic types of learning, the teacher typically organizes the learning, teaches the information and concepts
Comprehension (interpret or comprehend information)			

Geologists came to the conclusion in the 1960's that the Earth's rigid outer layer (crust and outer, rigid layer of the mantle) was not a single piece, but was broken up into about 12 large pieces called plates. The red lines on the map of the world above indicate

1. *Convergent boundaries* - two plates collide to form mountains or a subduction zone.
2. *Divergent boundary* - two plates are moving in opposite directions as in a mid-ocean ridge.
3. *Transform boundary* - two plates are sliding past each other as in the San Andreas fault of California. A transform boundary is like a tear in the Earth's crust. These plates move very slowly across the surface of the Earth as though they were on a conveyor belt. The convection currents in the much hotter mantle continually move the plates about 1/2 to 4 inches per year.

When the plates move they collide or spread apart allowing the very hot molten material called lava to escape from the mantle. When collisions occur they produce mountains, deep underwater valleys called trenches, and volcanoes. As mountains and valleys are being formed natural disasters such as earthquakes and volcanic activity can occur

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Targeting higher-order skills: Jules Verne Voyager

Exploring images and features of the Earth

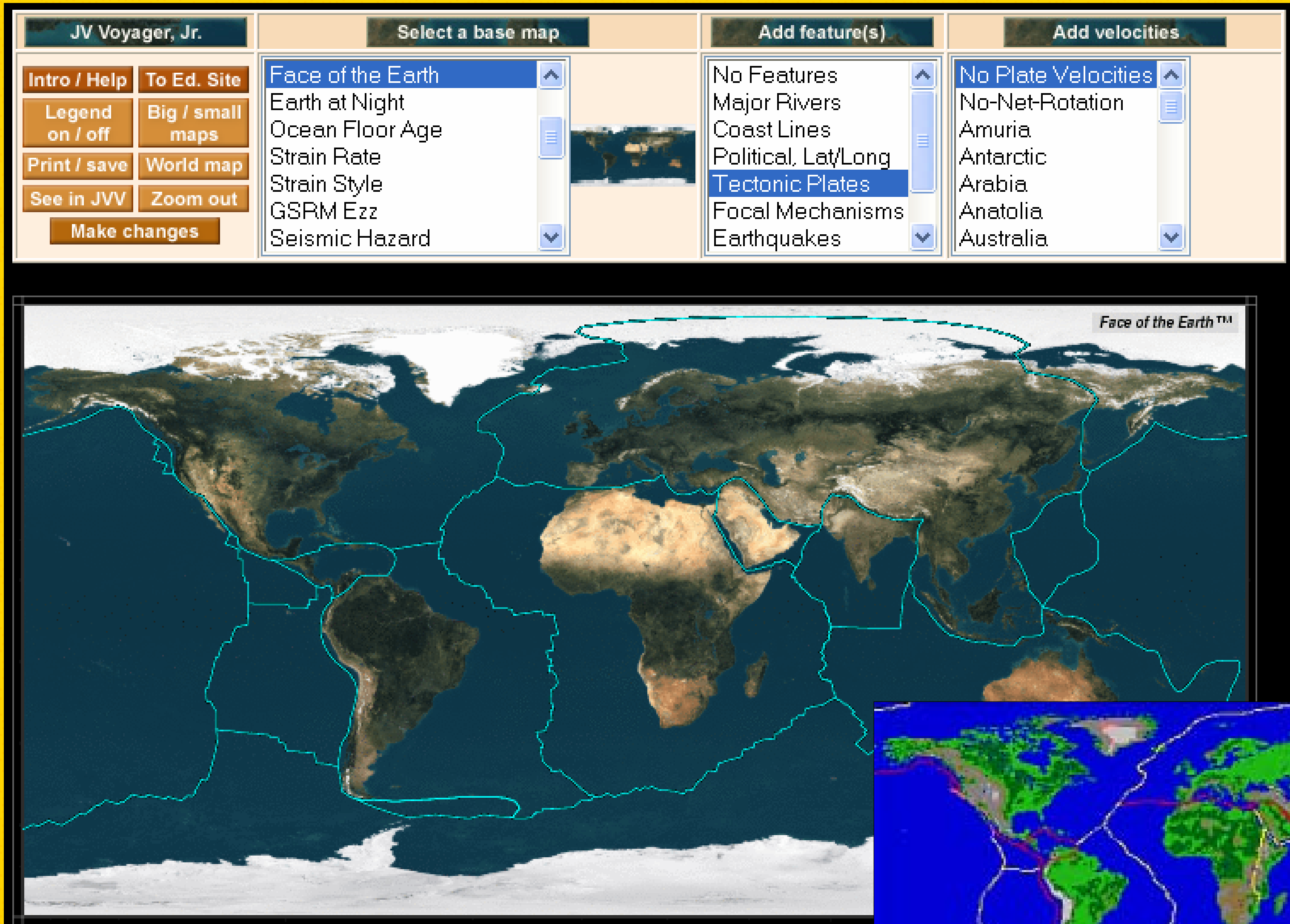

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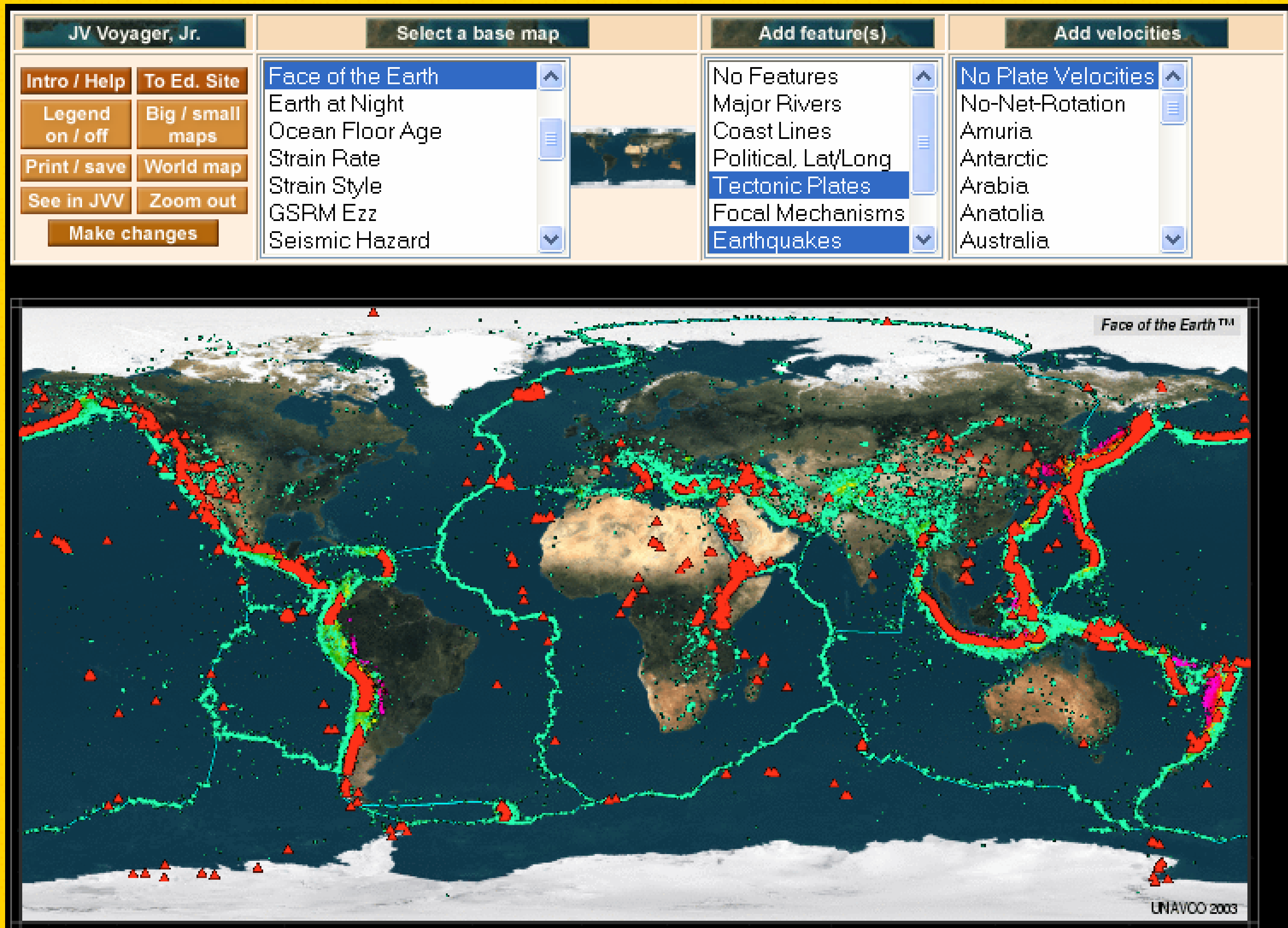
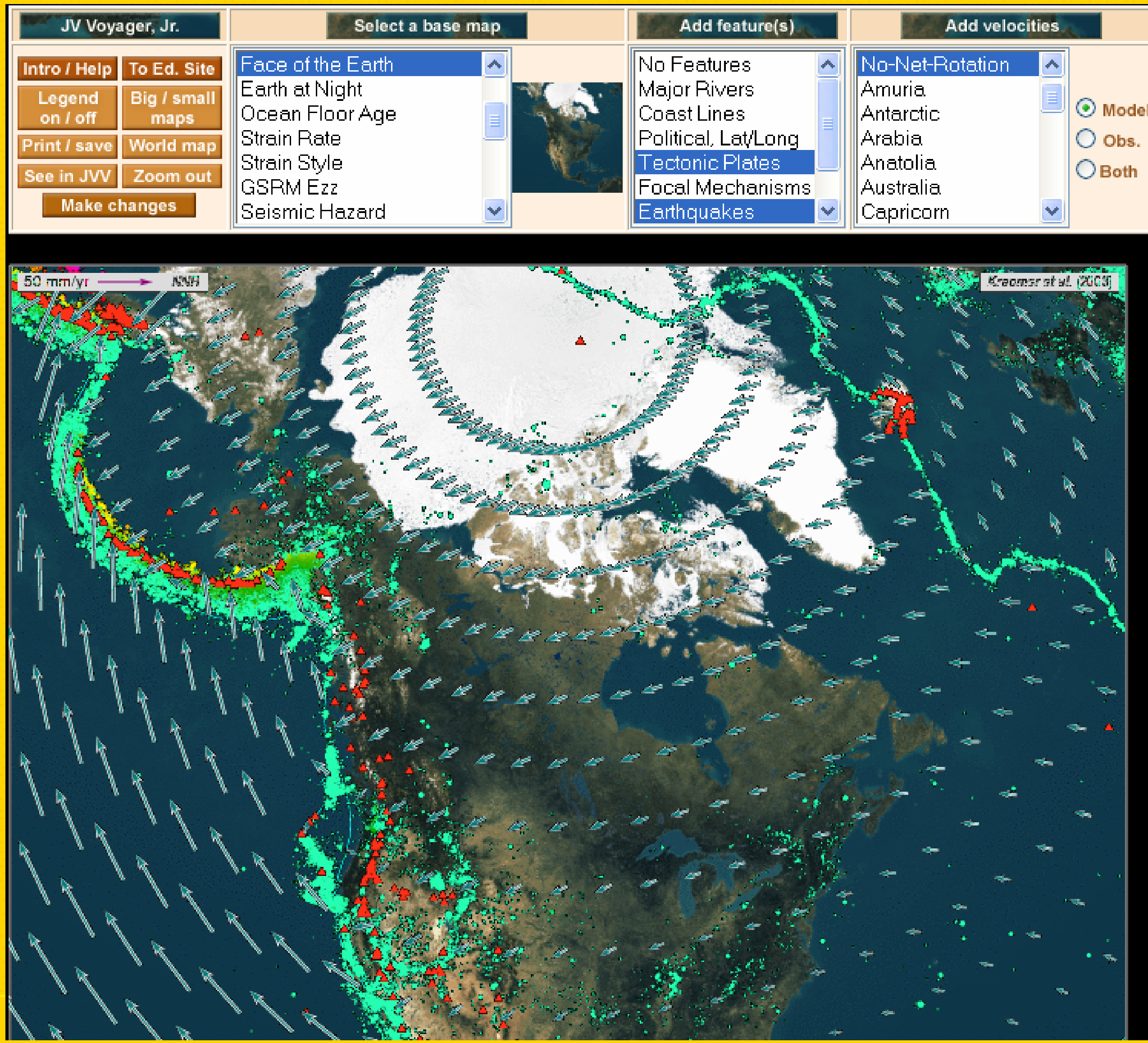
Plate boundaries, earthquakes, volcanoes – aha!



UNAVCO, http://jules.unavco.org/VoyagerJr/Earth

Set plate velocities to see how plates move in relation to each other (reason for EQs + volcanoes)



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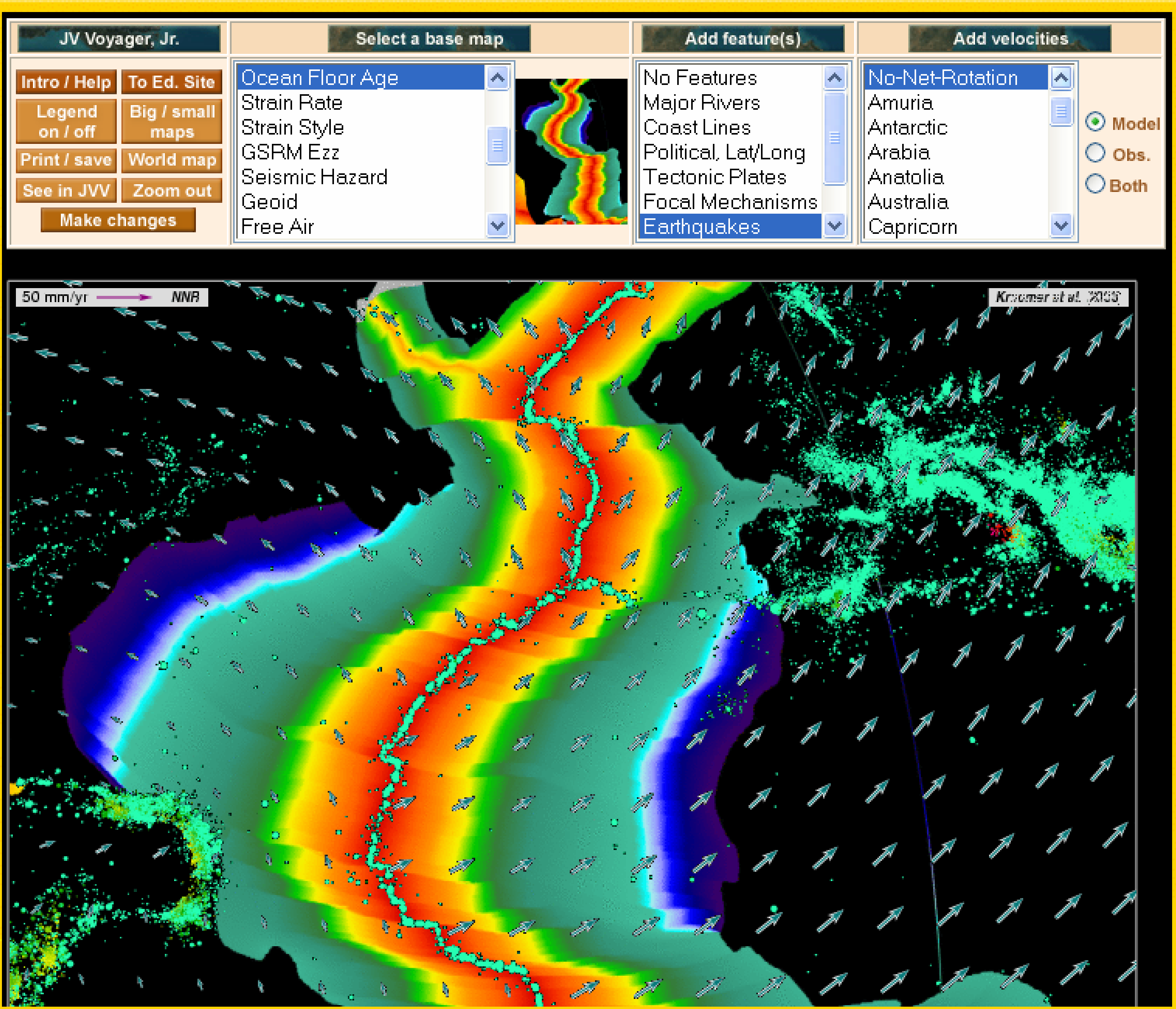
Sea floor spreading – Mid-Atlantic Ridge



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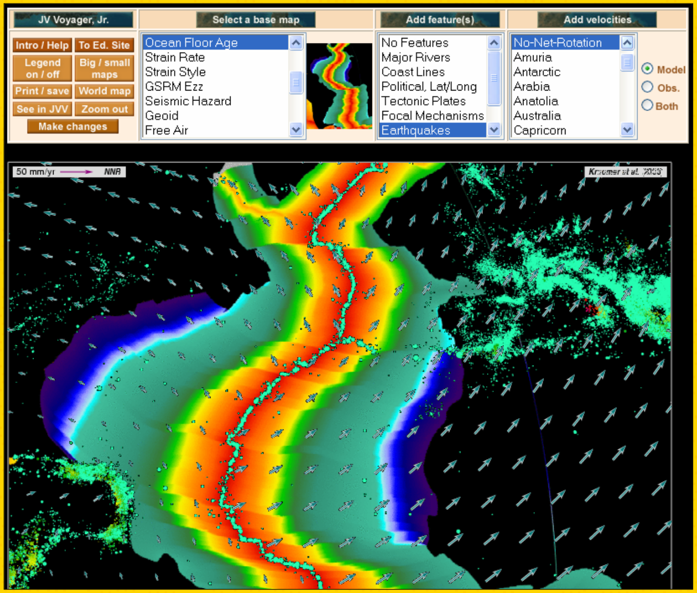
Types of educational supports

- Structured curriculum activities
- Questions to explore
  - Guide users in their exploration of the program
- ‘Did You Know’s
  - Info about particular locations and phenomena

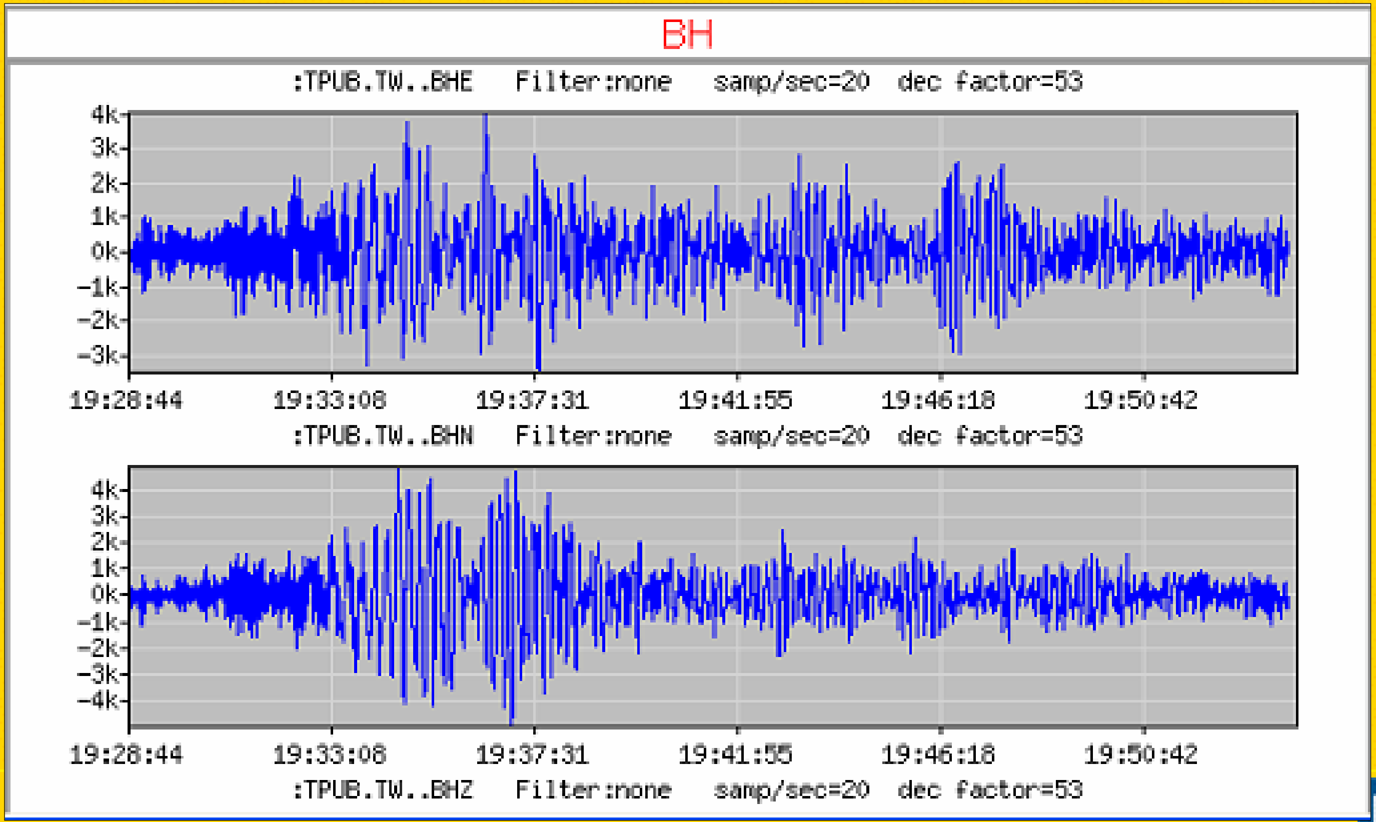


Help

- Technical information
  - Legends, how to interpret the maps, data sources
- Explanatory information
  - What the maps and overlays mean, putting them in context

Seismograms (recordings of seismic activity)

- Various websites provide current earthquake information
- My concerns when asked to help rework one
  - How do users make sense of it, what it means
  - What are seismograms used for -> a major way of learning about Earth's structure



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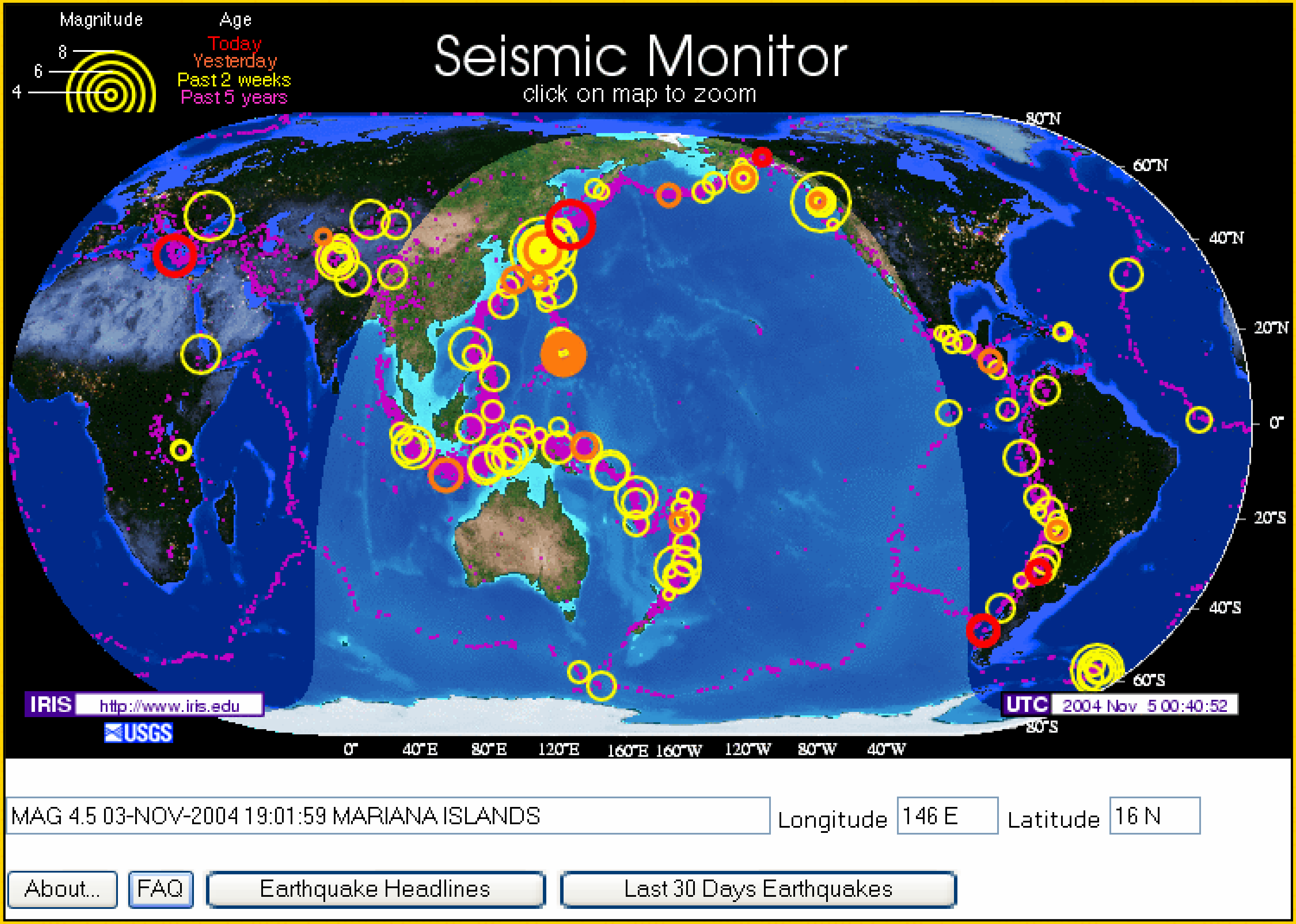
Major program for finding current EQ information



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IRIS, http://www.iris.edu/seismon/

DLESE

Getting to the data…

Up to 30 Recent Earthquakes

(within 10 degrees of LON=119.11, LAT=15.5682)

Return to Zoom Map

Close & Return

DATE links are into the IRIS WILBER system where you can see seismograms and request datasets.

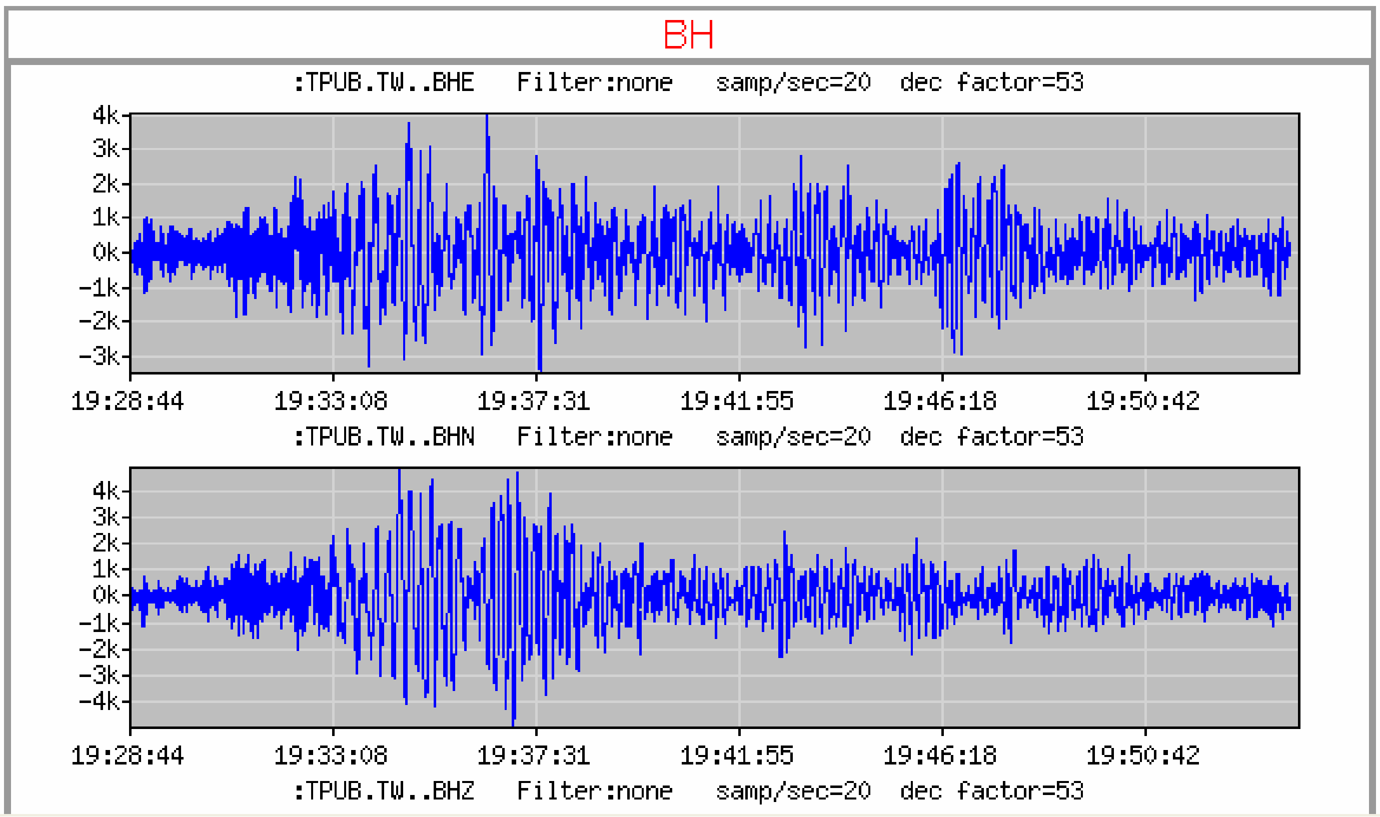
DATE	LAT	LON	MAG	DEPTH	REGION
29-OCT-2004 19:28:59	15.57	119.11	5.6	40.2	LUZON, PHILIPPINE ISLANDS
26-OCT-2004 02:05:29	13.86	120.72	4.6	147.0	MINDORO, PHILIPPINE ISLANDS
22-OCT-2004 13:44:17	25.02	128.05	4.9	43.0	RYUKYU ISLANDS
21-OCT-2004 13:45:57	9.66	126.66	4.9	72.0	MINDANAO, PHILIPPINE ISLANDS
19-OCT-2004 03:51:16	20.75	122.06	4.8	171.0	PHILIPPINE ISLANDS REGION
15-OCT-2004 11:44:53	18.50	122.29	4.9	30.0	LUZON, PHILIPPINE ISLANDS
15-OCT-2004 04:08:50	24.52	122.67	6.6	94.4	TAIWAN REGION
14-OCT-2004 18:35:47	13.82	120.78	4.9	114.0	MINDORO, PHILIPPINE ISLANDS
13-OCT-2004 00:04:38	8.82	126.24	4.8	51.0	MINDANAO, PHILIPPINE ISLANDS
12-OCT-2004 09:40:44	13.76	120.81	4.6	129.0	MINDORO, PHILIPPINE ISLANDS
11-OCT-2004 08:58:50	15.58	119.55	5.1	17.0	LUZON, PHILIPPINE ISLANDS
09-OCT-2004 15:49:59	13.78	120.67	4.7	130.0	MINDORO, PHILIPPINE ISLANDS
08-OCT-2004 14:36:05	13.87	120.59	6.5	105.0	MINDORO, PHILIPPINE ISLANDS
05-OCT-2004 22:10:04	24.83	125.14	4.5	81.0	SOUTHWESTERN RYUKYU ISLANDS
05-OCT-2004 18:13:02	20.03	121.41	4.8	69.0	PHILIPPINE ISLANDS REGION

Here's the data. For non-scientists, what's it mean?

Station: TPUB - TA-PU
Network: TW - Broadband Array in Taiwan for Seismology
Lat: 23.30 Lon: 120.63 Elev: 370.00
Event Name: 20041029_192859.3.spyder
Available Channels: BHE,BHN,BHZ,LHE,LHN,LHZ
Available Locations:

Sample Seismograms

Close Window



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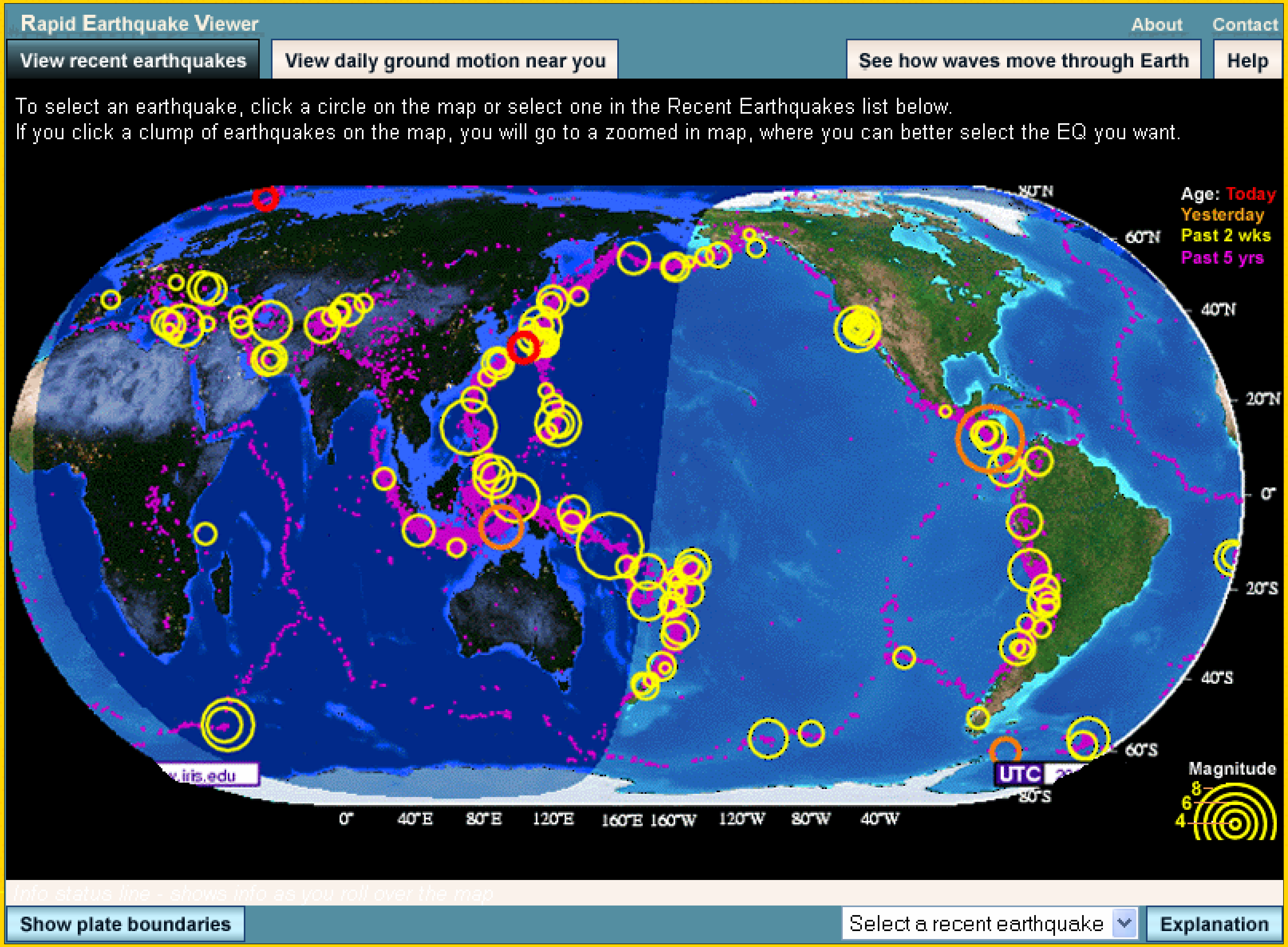
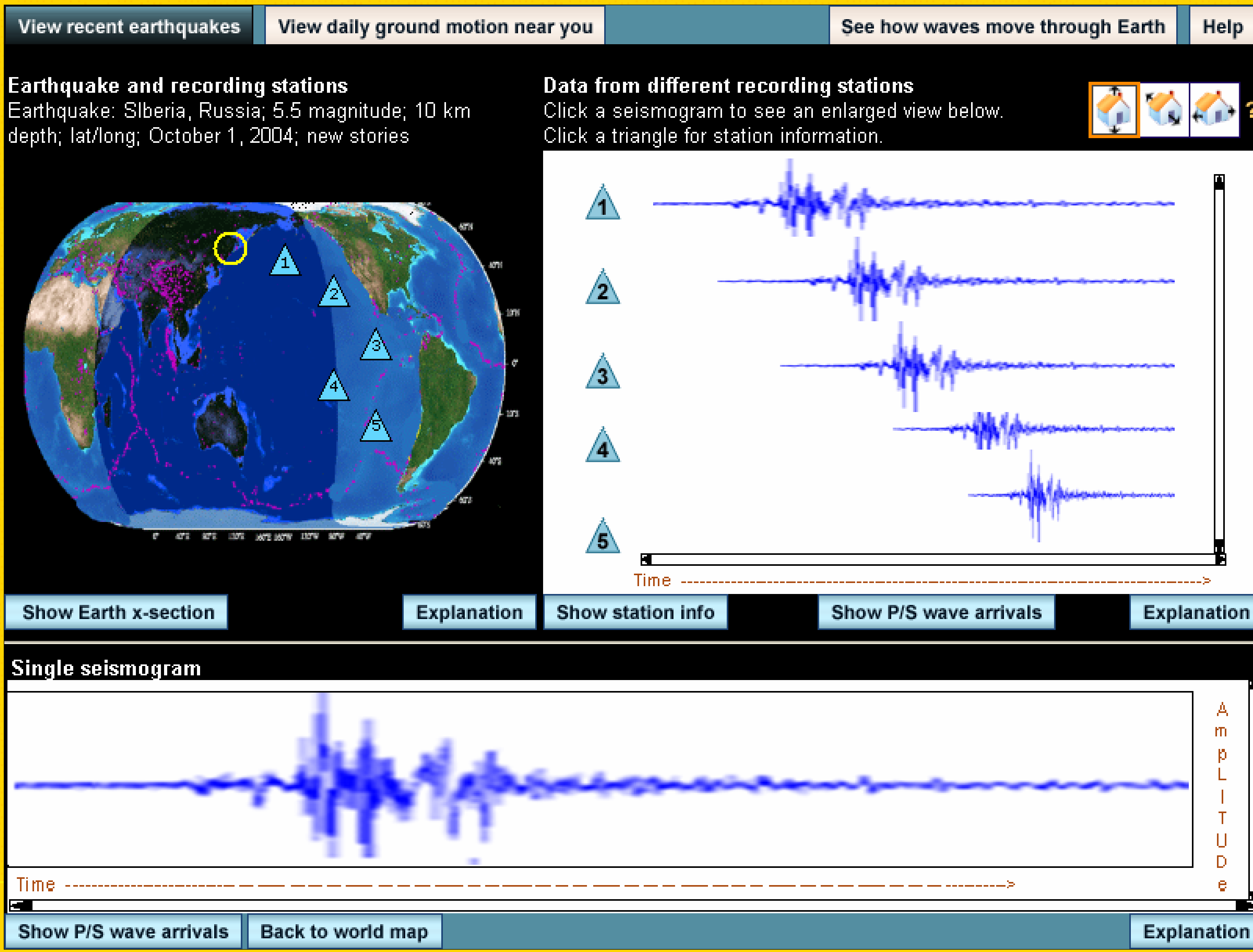
Revised version: Adding context to the data

Seismograms are 1 – 2 map clicks away



Location of EQ and stations, how waves move thru Earth, types of waves, explanations…



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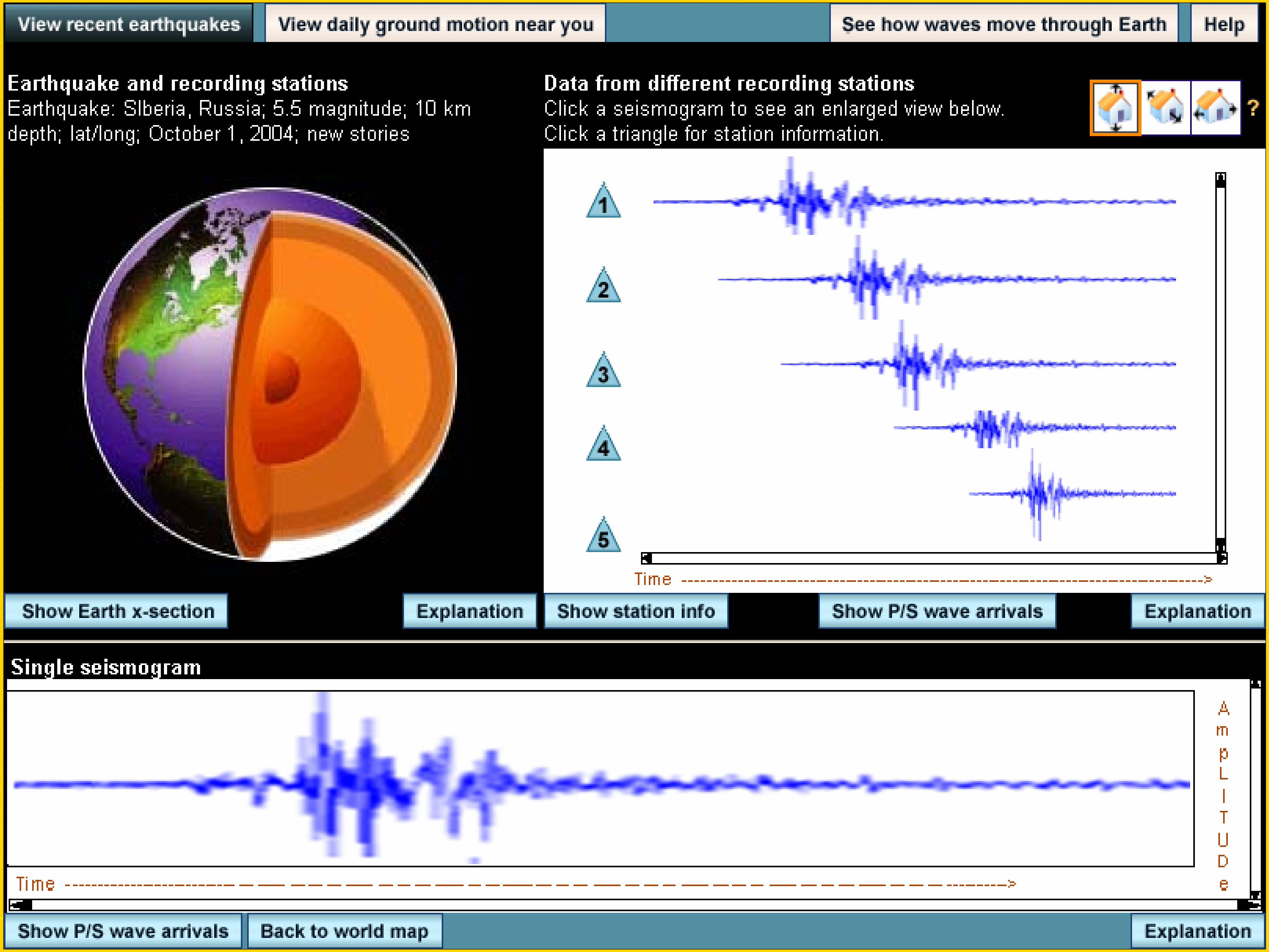
Cross-section will show waves moving thru Earth



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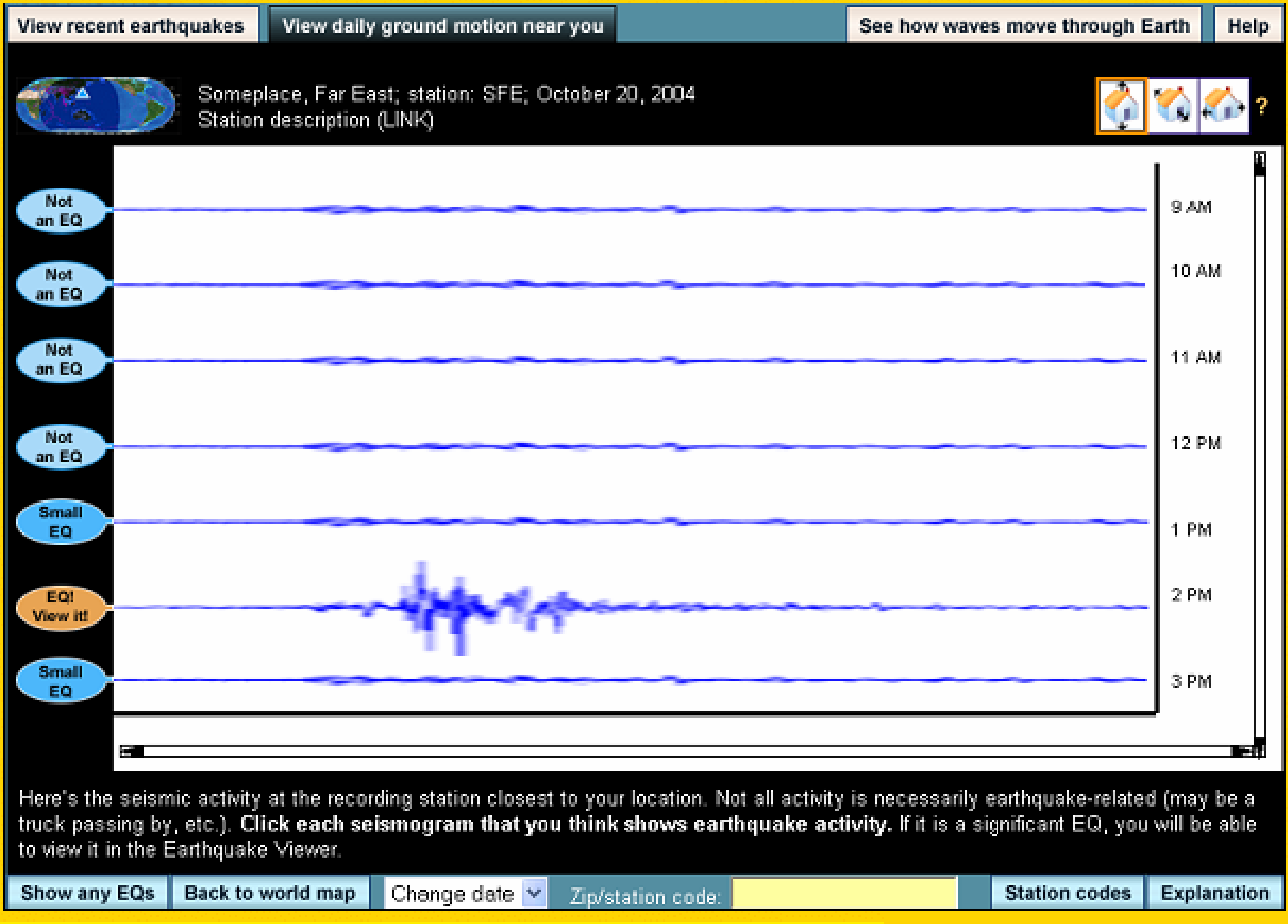
24-hr data at one location (are there any EQs?)



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Challenges in teaching meteorology

Classroom challenges identified by professor

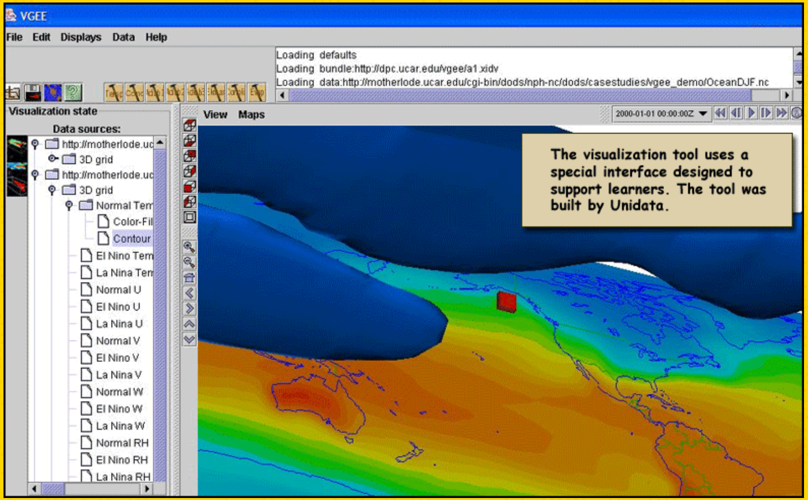
- Even after studying a phenomena in class, students often had a fragile and incomplete understanding of the underlying physical processes
- Students had difficulty using scientific tools and data, especially in inquiry environments
- Professors encountered real practical and technological hurdles when using data

Data challenges

- Data access needed to be linked to appropriate tools and guided by relevant educational context

Visual Geophysical Exploration Environment (VGEE)

- Inquiry-based curriculum to guide student exploration
- Learner-centered interface to a scientific visualization tool
- Concept models to help students understand scientific principles and their role in data
- A suite of El Niño-related data sets adapted for student use (and connections to real-time data)



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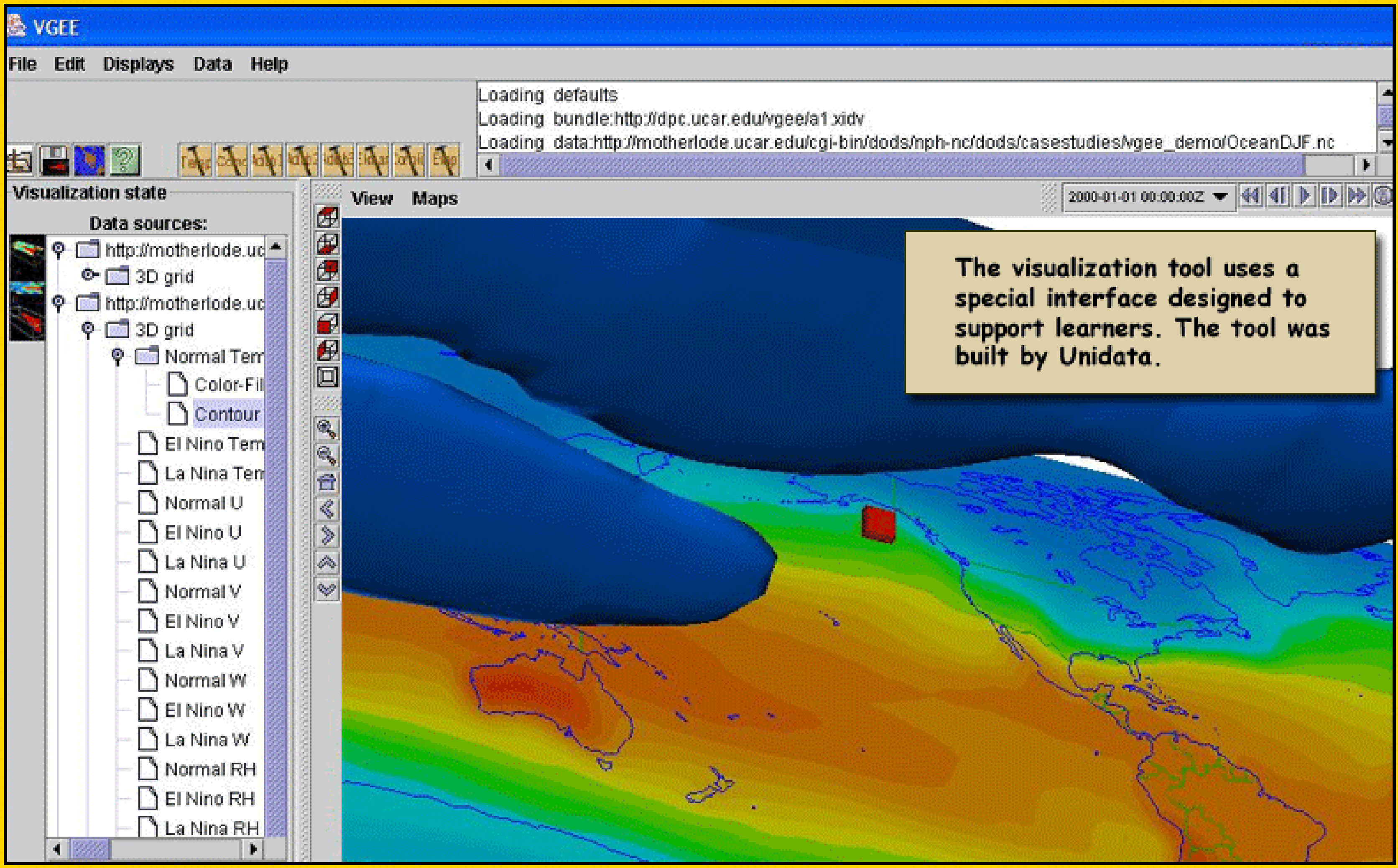
http://www.dpc.ucar.edu/vgee/index.htm

A scientific visualization tool (Integrated Data Viewer) customized for educational use



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DLESE

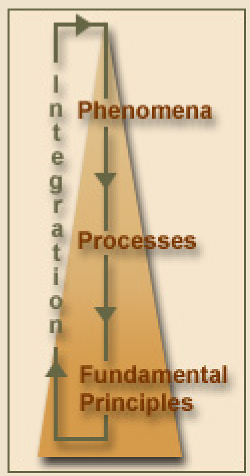
VGEE philosophy & approach

VGEE Visual Geophysical Exploration Environ. Home

VGEE Philosophy & Approach

TOOLS FOR LEARNING

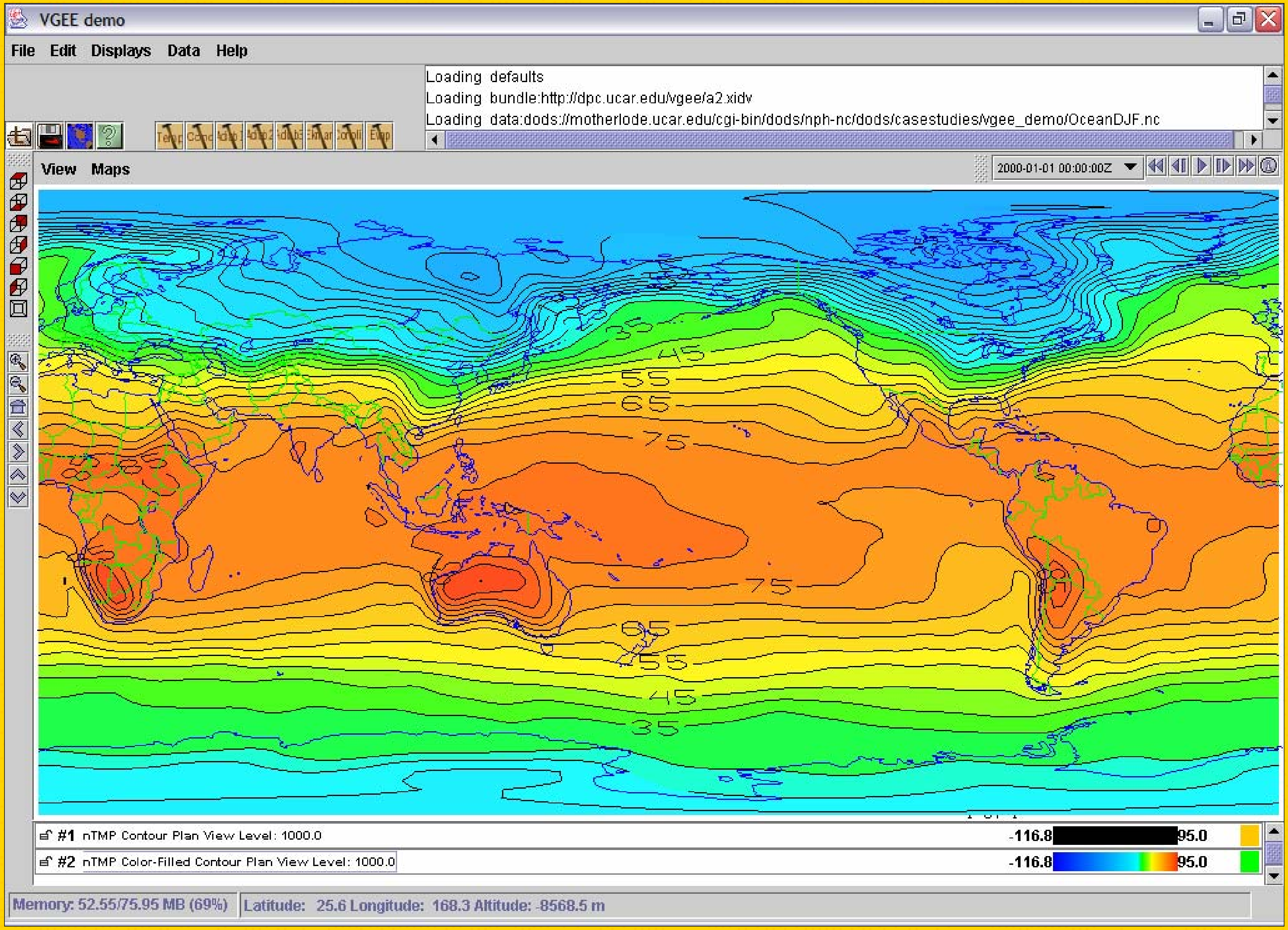
In the phenomenon level of the pyramid, learners construct visualizations using geophysical datasets in the Visualization Environment and use the visualizations to discover underlying processes. They then explore fundamental principles using concept models (probes in idealized environments). Finally, they return to the Visualization Environment and use probes to investigate the visualizations and integrate the fundamental principles with the phenomena.



Pyramid levels	Tools	Topics
Identify phenomena	Visualization Environment	1
Discover underlying processes	Visualization Environment	2, 3, 4
Explore fundamental principles	Concept models	2, 3, 4
Integrate fundamental principles and phenomena	Probes in the Visualization Environment	5 & 6

DLESE

Step 1: Identify phenomena and patterns



Students notice that the Western Pacific is considerably warmer than the East

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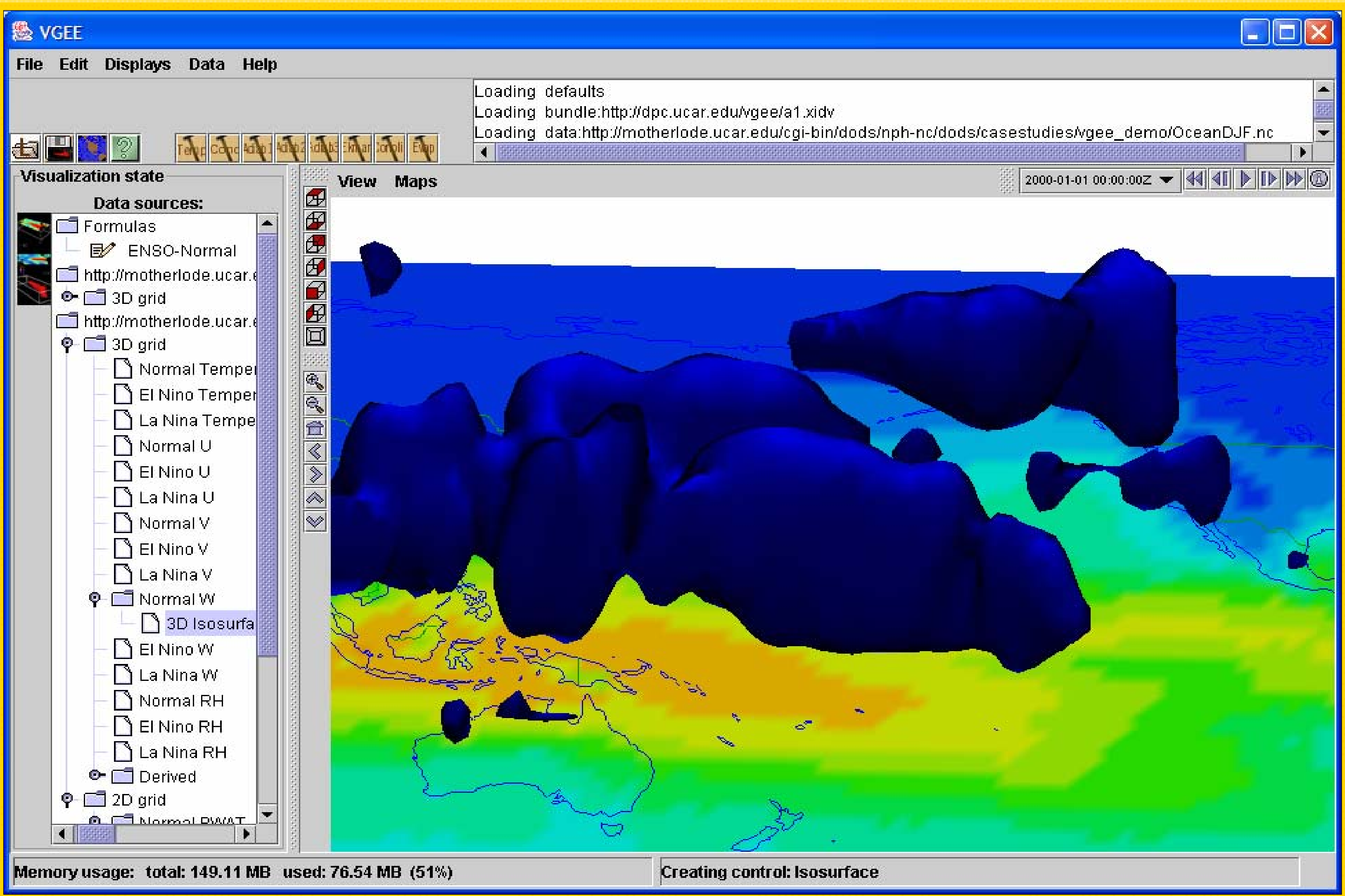
Step 2: Relate patterns



Learners explore relationships (in this case, that upward motion, above average precipitation, and warm SST all occur together)

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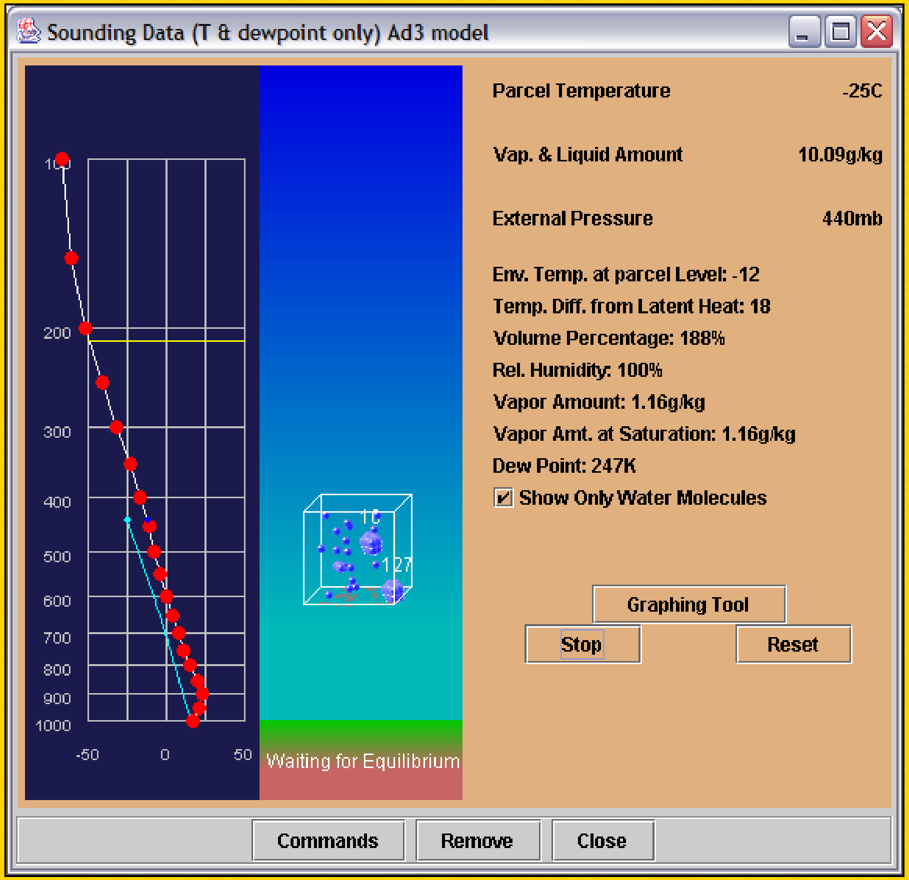
Step 3: Explain patterns

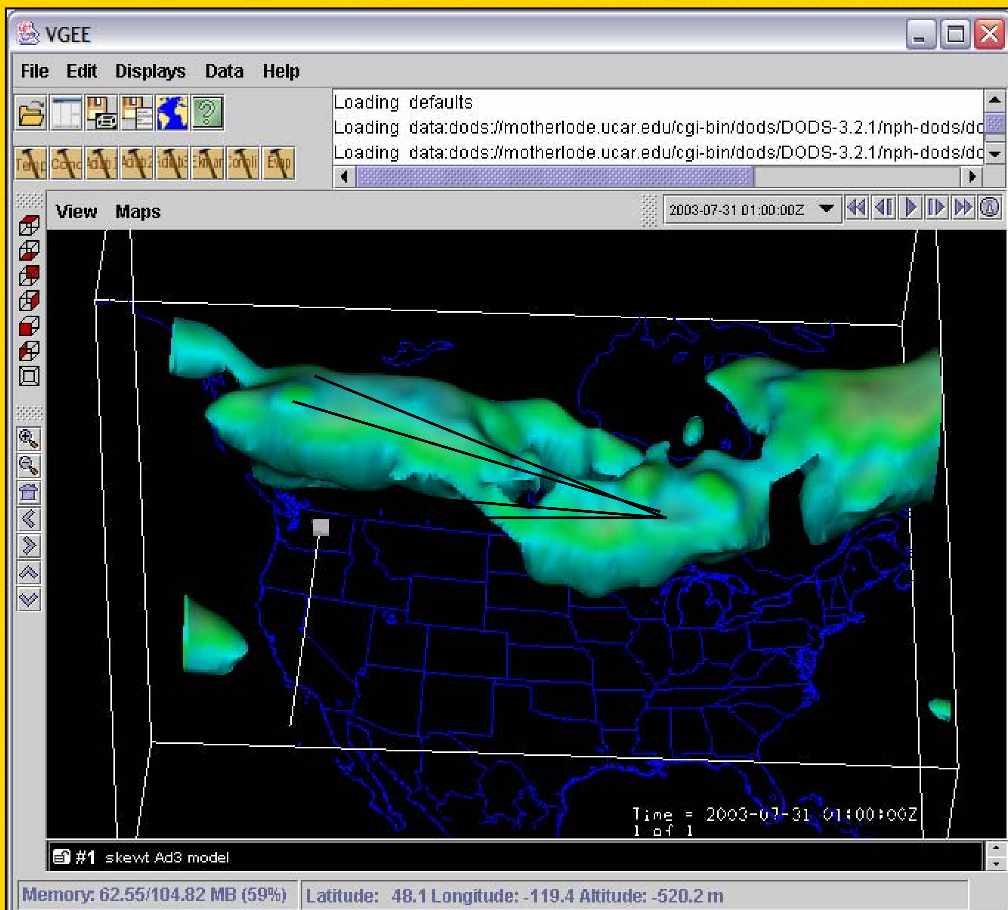
Concept models are used to explore and explain relations in an idealized context

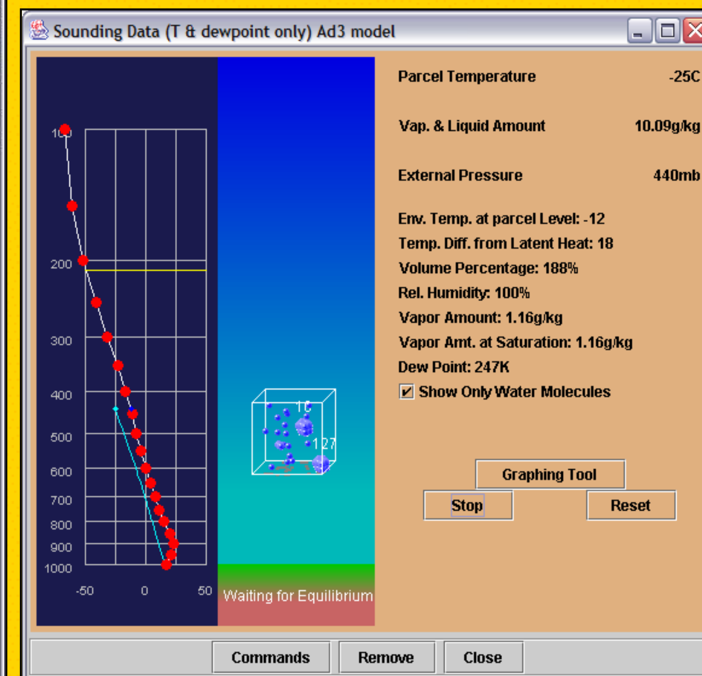


Atmospheric sounding: Vertical profile of atmospheric temperature and moisture

Step 4: Integrate understanding

Concept models are used to probe the data. Helps students apply basic physics toward understanding geoscience data





Creating educationally useful visualization and data exploration environments

Impetus:

- Funding sources increasingly want scientific organizations and research grants to have an educational component
- Scientists may want to take existing research programs and convert them for educational use

Problems:

- Can be hard to redesign programs for use by non-experts
- Programs may have obscure features and options
- Designs may be too complex and hard to understand
- May be insufficient help and educational supports

Suggestions for creating effective programs

Follow a design process

- Define your audience
  - May be able to address a broader audience than you think by making adaptations to your program
- Define your goals
  - What you want users to be able to do & learn
  - **Use that info to define your features/capabilities**
- Create your design (on paper, PPT…). Test it!!!!!!!!!
- Plan your educational materials and supports; test them; start development
- Create the interface pieces – graphical elements, navigational system
- Do the programming and assemble the pieces
- Test, revise, retest…

Design tips

- If you want a broad audience, consider having basic vs. advanced features and functions
- Avoid ‘feature creep’ – just because you can do something doesn’t mean you should put it in your program (stay focused on your audience and goals!)
- Writing issues:
  - Be concise (users tend not to read lots of text)
  - Write clearly – informal, active voice (very different from writing an article)

Educational activities

- Provide a range of educational activities
  - **Structured curriculum for teachers to use**
    - Particularly useful for new teachers and those teaching out of discipline
    - Also useful when programs, concepts, and data are difficult to understand
    - For K-12 levels, tie your curriculum to educational standards - you'll get FAR more use!
  - **Open-ended questions that help users explore and work with the program**
    - Provide ideas and suggestions for what to explore – makes users feel more comfortable, gives them a sense of the kinds of things they can explore

User interface

- Have a well-designed interface (easy to use)
  - Create standards for how things work and where things go
    - Keep menu items and buttons in same place…
  - If users have trouble, consider if it's a design problem (things aren't clear enough or users don't know where to go or what to do next…)

User interface and TESTING!

- Keep technical terms to a minimum (unless they're necessary for technical or educational reasons, in which case provide an explanation/common term)
- Always provide legends – and make them easy to understand and use

- TEST, TEST, TEST throughout the development process. You'll be amazed at what you find!
  It's MUCH easier to catch and fix things at the beginning than later on!!!!!!!!!!!!

Pedagogical Knowledge:
What are the important concepts to learn?

Data Knowledge:
What data is available?

Data Knowledge:
What does this data represent

Pedagogical Knowledge:
What is the best way to help students learn from this data?

Tool Knowledge:
What are the appropriate tools for the data?

Tool Knowledge:
What are the appropriate tools for students?

Technical Expertise:
How can I modify the tools to support students?

Technical Expertise:
How can I get the data into the right format for the tools I need?

Evaluation Expertise:
How can I tell if it was worth the work?