South Dakota School of Mines and Technology
Institute of Atmospheric Sciences

Immersive Visualization in Interdisciplinary Research & Education : The Great Big Sandbox

Bill Capehart
Karl Lalonde
Kata McCarville
Patrick Kozak

Black Hills Advanced Visualization Lab

South Dakota School of Mines and Technology
Institute of Atmospheric Sciences

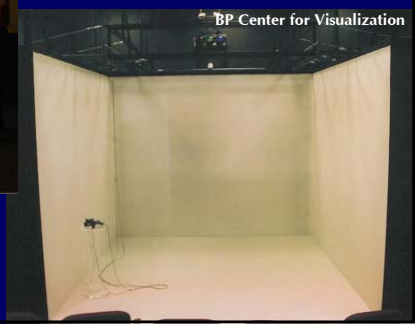
Why Immersion and Large-Scale Viz?

- Some 3D Datasets are so "dense" in information content and reality that it is actually easier to move through the data
  - E.g., vector fields
- Room-sized concretization of information into knowledge.
  - Real Estate Matters because…
- The ability to bring people together to look at a dataset
  - A Big screen for a Big Crowd

South Dakota School of Mines and Technology
Institute of Atmospheric Sciences

Immersive Environments

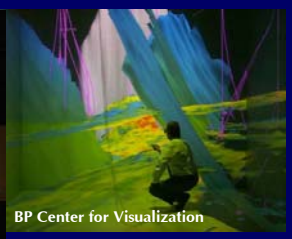
Fakespace Corporation



BP Center for Visualization

South Dakota School of Mines and Technology
Institute of Atmospheric Sciences

Immersive Environments



BP Center for Visualization

Fakespace Corporation

- Display Screens
  - Big, more than one, angled
- Stereo Vision
  - Active vs Passive
- Tracking
  - Moving the Environment
- Haptics
  - User Response

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Oh and Yeah....

BP Center for Visualization

- The Engine
  - To Throw the Information
  - Turn off the data
  - Move the Data
  - Flip Through the Data
  - And Generate the Data
- The Software
  - To Display the Data
  - To Liaise between User, Machine and Environment

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Where We Are

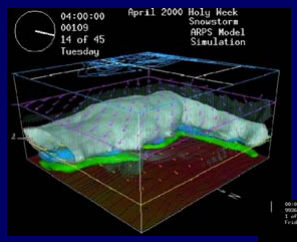
- An 8 x 18 foot Power Wall
- An older SGI Onyx (16 Processors)
- Intersense IS-900 head/wand Tracking
- Stereographics CrystalEyes glasses
- Various Free Utilities (Vis5D, SCIRun)
- VRCO vGeo Immersive Software
- TGS's AmiraVR Immersive PSE
- Building Alliances and Collaborations
- Oh, yeah … a 10 x 10 x 10 foot Immersive Visualization Environment
  - Sorry, we're keeping the wall.

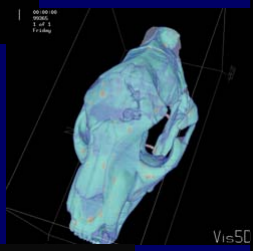
South Dakota School of Mines and Technology

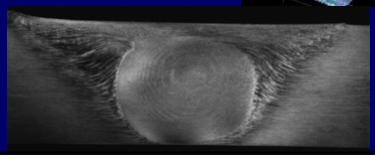
Institute of Atmospheric Sciences

Selected Examples

- Earth System Science
  - Meteorology
- Paleontology
  - Specimen Research
- Materials Science
  - Friction Stir Welding



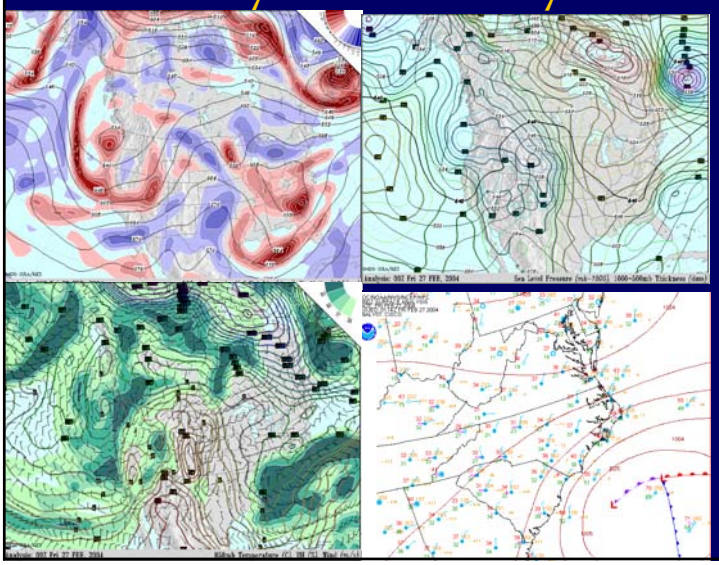




South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

What they won't show you on WGN



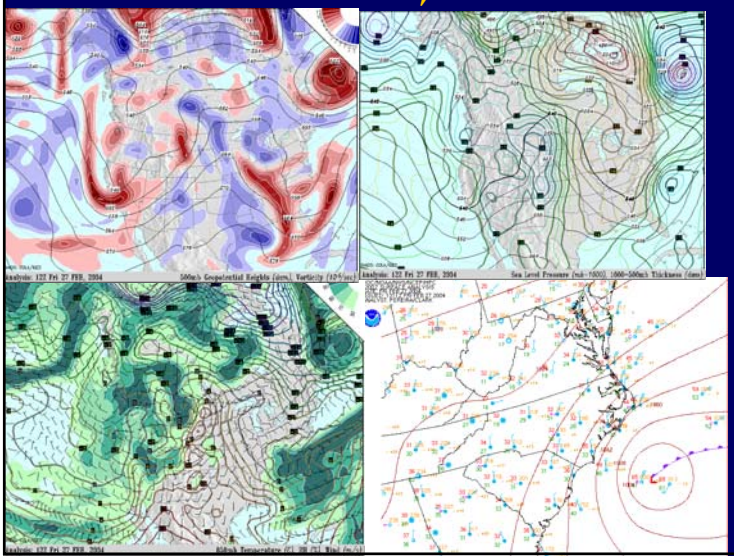
0000 Z
7pm EST
Last Night

MAPS From NWS-HPC and COLA-IGES

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Or for that matter, the Weather Channel



1200 Z
7am EST
Last Night

MAPS From NWS-HPC and COLA-IGES

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Meteorology Research and Education

The Weather Weenie Water Cooler

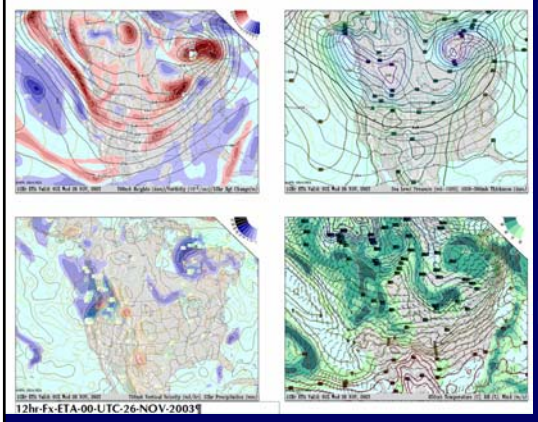
- The Old Way
  - The Map Wall
  - Information literally at Your Fingertips
  - Information Optimized and Economized to *Common* Essentials
  - Analog Browsing
  - Manual Annotation and "Animation"
  - Rather Fumy in the Old Days
  - A Fantastic Collaborative Environment!

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Meteorology Research and Education

- The Old Way



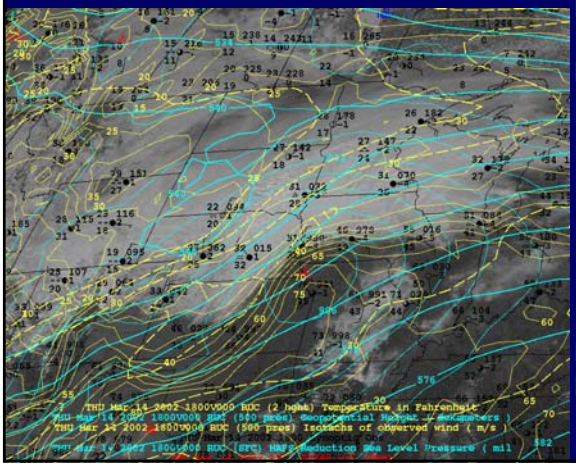
- Set Products
  - Set Vertical Levels
  - All weaned on 'em
- Community Accepted
  - Not perfect for all scenarios
- (Were Black and White)
- Great for Operations
  - Not so great for teaching the actual processes

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Meteorology Research and Education

- The Current Way

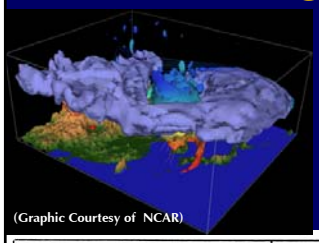


- PC and Workstation Environments
- Overlaying lots of information
  - (Maybe too much)
  - Keep the classics
    - Station Models
    - Strategic Isopleths
  - Contouring a breeze
  - Lotsa Color
  - Bad for xeroxing
- Animation Possible
- A crowded or lonely collaborative experience.

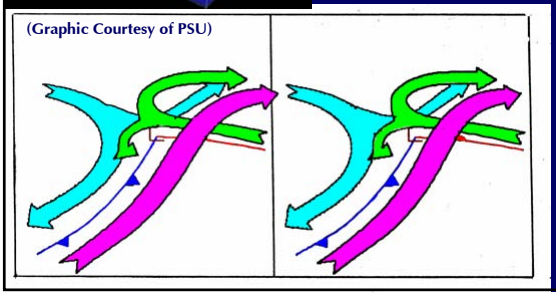
South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Meteorology Research and Education



(Graphic Courtesy of NCAR)



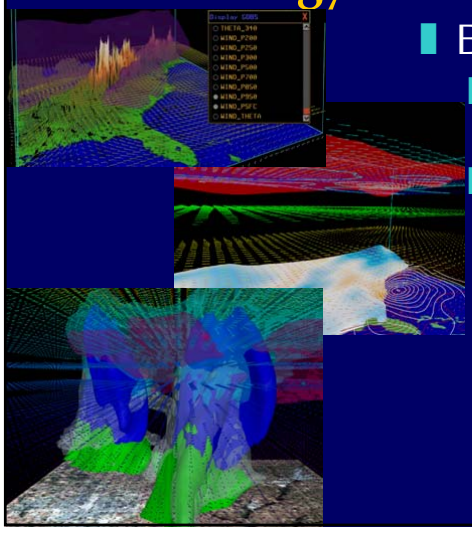
(Graphic Courtesy of PSU)

- When 3D became Interesting…
  - Surfaces that move through the full depth atmosphere…
    - Isentropic Surfaces
    - Potential Vorticity
    - Conveyer Belts

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Meteorology Research and Education



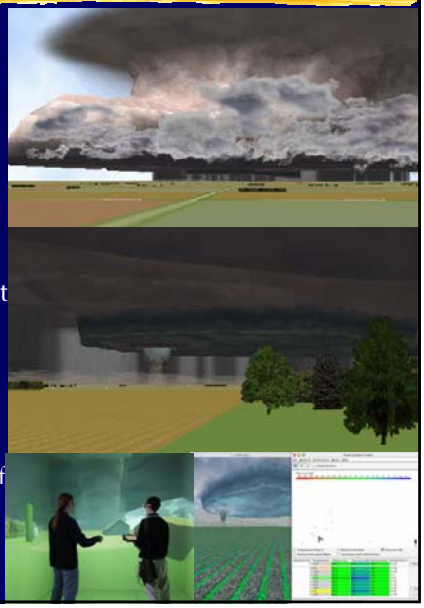
- Enter 3D and Immersion
  - No longer limited to the traditional levels
  - You can move through the information
    - Full 3D fields no longer a problem
    - Plus, the advantages of the workstation environment with research collaborative ability preserved!
    - Not quite ready for operations

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

And the Killer App...

- A VR Storm Simulator Environment Developed at Iowa State
- Gallus, Jr., W.A., C. Cervato, C. Cruz-Neira, G. Faidley and R. Heer, 2004: A virtual tornadic thunderstorm enabling students to construct knowledge about storm dynamics through data collection and analysis, AMS 13th Symposium on Education, Seattle, WA, 11-15 January 2004, paper 4.2.
- http://ams.confex.com/ams/pdfpapers/65036.pdf



South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Paleontology Research

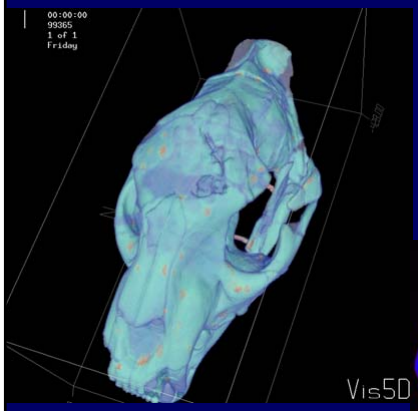
- The Old Way
  - Sections and Photography
  - Destructive or Superficial
- (our incubator case)

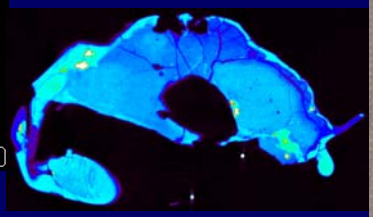
South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Paleontology Research

- Immersive and 3D Rendering
- That's a Meteorology package to the Left!
  - We started with the Vis5D weather viewing package.





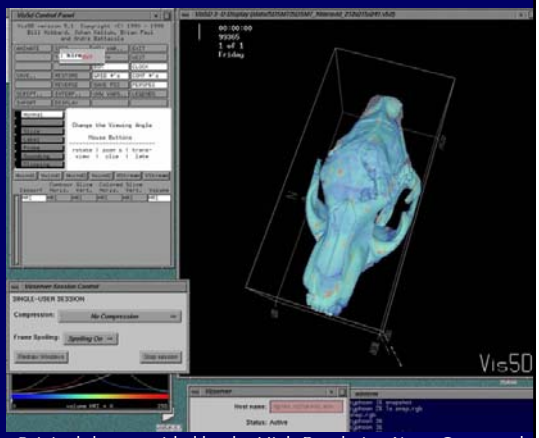
Original data provided by the High-Resolution X-ray Computed Tomography Facility of the University of Texas at Austin

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Paleo from a Distance

- This output could [and should] be viewable at a remote location as well as the commanding terminal given sufficient bandwidth and processing power.
- This is a screenshot from a 'Tech workstation but generated and pushed through the Internet from a station at the bp Visualization Lab at UC-Boulder

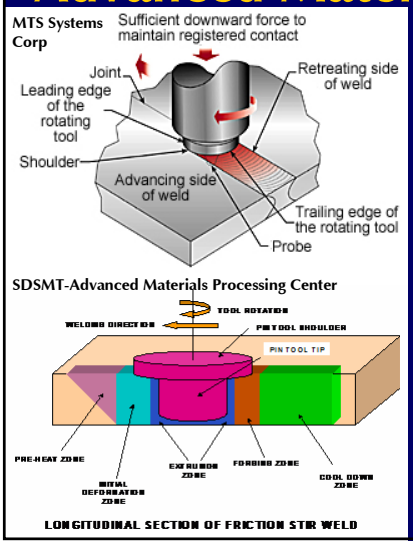


Original data provided by the High-Resolution X-ray Computed Tomography Facility of the University of Texas at Austin

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Advanced Materials Processing



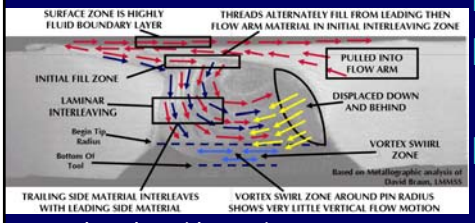
- Friction Stir Welding
  - Aluminum alloys must be joined
  - The Trick: They must NOT melt
  - Drive a spinning pin tool into the joint
  - The tool heats the weld zone enough for the metals to be pulled around the spin zone

South Dakota School of Mines and Technology

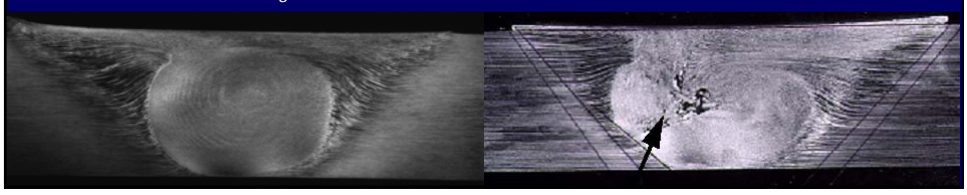
Institute of Atmospheric Sciences

Advanced Materials Processing

- Friction Stir Welding
  - Classical Fluids Models
  - Cutting of metal to examine the weld
  - Fluid Mechanic Model Visualizations



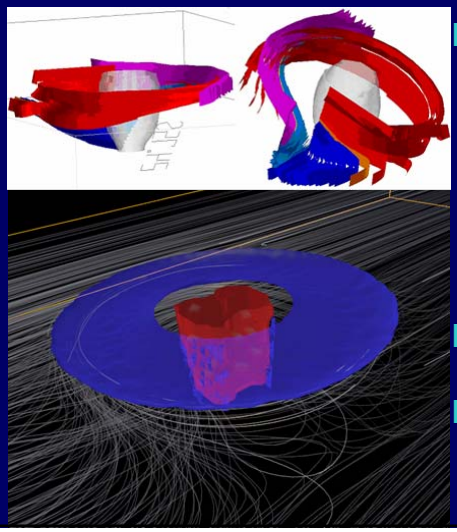
SDSMT-Advanced Materials Processing Center



South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

Advanced Materials Processing



- Let Us Play With it Guys…
  - Fluid Velocity Fields = Wind Fields
  - Temperature Fields = Temperatures Fields
  - Pressure Fields = Pressure Fields
  - What's the difference?
    - (Besides the Obvious)
- Our most successful on-campus collaboration.
- Next up:
  - Better FSW Models
  - Laser Deposition…

South Dakota School of Mines and Technology

Institute of Atmospheric Sciences

In Closing

- Immersive Visualization can provide an extension of classical viewing methods
  - But not necessarily a replacement of analog treasures
  - Some applications are great for Pedagogy and Training but not for Operations
- Large end visualization approaches require friends
  - This is NOT a bad thing
    - Different disciplines develop packages with disparate rendering efficiencies (e.g., Volumes vs. Isosurfaces)
    - Cross-seeding facilitates new and surprising fields of play
- "Opportunity is missed by most people because it is dressed in overalls and looks like work."

  Thomas Edison