NASA’s Scientific Visualization Studio

Horace Mitchell

with lots of help from

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The Scientific Visualization Studio

- Founded in 1988 as a movie-making facility for scientists at NASA Goddard Space Flight Center
- Primarily focused on the creation of animations and images from remote sensing and model data
- Some development work on real-time visualization applications and systems, usually for specific venues
  - GLOBE on-line visualization system
  - “Earth Today” exhibit at Smithsonian Air & Space
  - Digital Earth program
- In 1997, the SVS began a major project to produce visualization products specifically for NASA outreach
  - Significant aspects of this project will be described here
NASA Earth Science Media Project

**Official Goal:** To disseminate knowledge of Earth Science Enterprise missions to the widest practicable audience

**Unofficial goal:** To weave Earth Science images into the everyday fabric of American life

Our unique approach was to use a tripod of individuals, each of whom could represent an important aspect of the outreach

- **Scientist - The Story**
- **Producer - The Customer**
- **Visualizer - The Impact**
Customer: Who do we aim for?

- Broadcast news media - (national, local, cable)
- Independent producers (PBS, Discovery)
- Web media outlets (CNN.com, etc.)
- Education content providers
- Museums and other informal education outlets
- General public
- Potential users of NASA Earth Science data products
- Internal requests (HQ, Congress, OSTP)

Strategy: How do we do it?

- Produce and distribute absolutely compelling visuals to communicate the success and excitement of NASA’s results
- Select newsworthy topics that target the media and generate demand from other customers
- Produce products that are useful to the entire spectrum of our customers
Visualization Technology

As the requirement for compelling, high-quality visuals developed, the SVS changed its application base from traditional Scientific Visualization to a broader base:

- Robust applications to manipulate and transform data
- Applications producing the highest quality output with distributed rendering

<table>
<thead>
<tr>
<th>DATA</th>
<th>IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific Visualization Application (AVS)</td>
<td></td>
</tr>
</tbody>
</table>

| Data Manipulation Application (IDL) | 3D Modeling and Rendering Application (Lightwave) |
El Niño Products

- Our first major success came during the 1997-998 El Niño
- NASA’s Earth Science researchers were fielding a significant number of media requests about the causes of El Niño
- The scientist provided the data and the content requirements for animations to be used on-air to explain El Niño
- The visualizer designed the look of the visual products and updated the products as new data became available
- The producer critiqued the product for public accessibility and orchestrated the media releases and live shot campaigns
Pipelines

• Certain specialized products have achieved a level of popularity and immediacy that requires them to be produced very rapidly for breaking news stories
• When this occurs, we develop a Pipeline:
  – a defined set of procedures to produce a well-defined product on a set schedule
• Example: TRMM 3D Hurricanes
  – TRMM’s precipitation radar takes 3D measurements of precipitation in the tropics
  – When notified in the morning of a significant hurricane or cyclone, the TRMM pipeline allows the combination of TRMM PR and GOES IR cloud imagery to produce a finished animation of storm data for that evening’s news broadcasts.
To determine if there is a storm and which satellites see it:  http://kauai.nrlmry.navy.mil/tc-bin/tc_home

To process the TRMM Real-Time Data:
-----------------------------------
1. write orbit down - on the quicklook, look where the swath crosses the equator
...
4. ftp trmmrt.gsfc.nasa.gov
...
15. IDL> .run trmm_visu
...
20. Retrieve images from GOES for context:   http://rsd.gsfc.nasa.gov/goes/
...
22. Current configuration is located  at /svs/projects/trmm/idl/
...
24. IDL>.run trmm_ctrl
...
28. Startup LightWave 3D; Load scene file generated above
...
31. Send mpeg and images to earthobservatory for their Natural Hazards section.

TRMM Pipeline:
a documented set of procedures, utilities, and data used to produce a final product
In a 3D visualization program, a shader determines what the surface of an object looks like. Simple shaders add lighting, colors, textures, and imagery:

A critical change in our processes was the move to Renderman software and the ability to use procedural shaders.

A procedural shader is a user-written program that calculates what a point on an object looks like. It adds enormous flexibility and is routinely used within the computer graphics industry for solving difficult problems, such as realistic fur and hair.
In 2000, the NASA Landsat Project Scientist asked the SVS to create a zoom from the ground to space out of satellite data to illustrate the scales at which remote sensing data is acquired.

The primary data sets to be used were:
- Terra/MODIS at 4000 meter resolution
- Terra/MODIS at 250 meter resolution
  - Landsat at 15 meter resolution
  - IKONOS at 1 meter resolution

The precise registration and image control required for this project made procedural shaders a necessity.
Visualization Technology

Requirements for high-performance, large data volume visualizations have now led us into our next stage of visualization technology: **Procedural plug-ins**
Compositing:
for more complex animations, each element is rendered as a separate layer so element timing can be adjusted easily

MISR stereo imagery shows smoke plume height

Come see this 5-minute animation of fire-related data at the NASA EOSDIS booth
The SVS Web Archive
http://svs.gsfc.nasa.gov

- The SVS Web archive was designed as a public repository for as much of the imagery and associated metadata as could be captured during the animation process.

- Since the SVS operates in a shared UNIX environment, an integrated system was created to allow each visualizer to control and update both the media and metadata files which would migrate to the public web site upon project completion.

- Python-based processes turn these files into web pages and various search and index pages.
"What's New?"

- **African Dust**
  - 03/07/2003

- **Earth Rotation**
  - 03/04/2003

- **Seasonal Ice Flow**
  - 03/04/2003

- **Terra/Aqua Snow Sequence**
  - 02/26/2003

- **North Atlantic Oscillation**
  - 02/25/2003

- **Snow Cover**
  - 03/21/2003

The SVS has produced 2092 visualizations, totaling 108272 seconds.
All of them are available on this site.

**Additional SVS Work**

- **Great Zooms**
- **High Definition Animations**
Looking for glacier:

There are 32 exact matches for glacier.
2482 [Byrd Glacier Exhibit](#)
Animation depicting a virtual view of the Byrd Glacier model

2344 [Pine Island Iceberg Formation](#)
This is a time series animation starting on September 8, 2001 and ending on Nov 12, 2001. It shows the transformation of the Pine Island Glacier ice shelf into two icebergs.

2146 [AGU Press Briefing May 29th: Global Land Ice Measurements from Space. (Dobbin Glacier Zoom)](#)
Taking a closer look at Dobbin Glacier.

2145 [AGU Press Briefing May 29th: Global Land Ice Measurements from Space. (Dobbin Glacier Zoom)](#)
Zooming down to the Dobbin Glacier in Alaska.

2102 [Iceland Glacier Recession 1997 to 2000](#)
Zoom down to area of recession and transition from 1997 to 2000

2101 [Iceland Glacier Recession 1973 to 2000, Glacier Terminus contrast emphasized](#)
Glacier Recession 1973 to 2000 Movie

2100 [Light Iceland Glacier Recession 1973 to 2000](#)
Glacier Recession years 1973 to 2000

2074 [ASTER Dataset Zoom Down](#)
Flying over an Aster data set of the Pine Island Glacier crack. The dataset was taken back in December 12th, of 2000.

2070 [ASTER Dataset Flyover](#)
Flying over an Aster data set of the Pine Island Glacier crack. The dataset was taken back in December 12th, of 2000.

2069 [Zoom down to the Pine Island Glacier](#)
A faster zoom down to Antarctica's Pine Island Glacier where a crack has formed, minus the second zoom. Using Landsat 7 data showing 2000 and 1/4/01

2068 [Zoom down to the Pine Island Glacier (faster)](#)
A faster zoom down to Antarctica's Pine Island Glacier where a crack has formed. Using Landsat 7 data showing

2067 [Zoom Down to the Pine Island Glacier](#)
A slow zoom down to Antarctica’s Pine Island Glacier where a crack has formed. Using Landsat 7 data showing

1384 [Changes in Glacier Bay, Johns Hopkins Glacier](#)
Changes in Glacier Bay's Johns Hopkins Glacier from 1973 to 1986

0992 [Antarctica Lambert Glacier Fly-over](#)
Close up fly-over animation of Lambert Glacier
Looking for glacier:

There are 32 exact matches for glacier.

2482 Byrd Glacier Exhibit

This is a time series animation starting on September 8, 2001 and ending on Nov 12, 2001. It shows the transformation of a glacier into an iceberg.

Previous Animation

Pine Island Iceberg Formation

This animation is a sequence showing the formation of the Pine Island iceberg. This animation is a series of MISR images on top of the continental radar view of Antarctica.

Next Animation

View the entire online movie.

320x240 MPEG-1, 1 MB
Click here for information on how to view this media element.
November 11, 2001

View the print resolution image
2880x1944 TIFF, 16 MB

November 12, 2001

View the print resolution image
2880x1944 TIFF, 16 MB

Video ID: SVS2002-0008
Animator: Lori Perkins
Date Completed: 01/15/2002
Duration: 320 frames, 10.0 seconds
Scientist: Bob Bindschadler (NASA/GSFC), Dave Diner (NASA/JPL)
Instrument: Terra/MISR, RADARSAT-1/SAR
Animation Series: Antarctica

Please give credit for this visualization to NASA/Goddard Space Flight Center Scientific Visualization Studio
<?xml version="1.0" encoding="iso-8859-1" ?>
<!-- Animation Template for SVS Animation Database -->
<!-- Version 1.0b - October 2000 -->
<animation>
<!-- Place Animation ID here -->
<animationid>2344</animationid>
<!-- Video ID Format = SVSyyyy-nnnn -->
<!-- where yyyy is current year -->
<videoid>SVS2002-0008</videoid>
<!-- Video Time codes -->
<!-- Format: HH:MM:SS:FF -->
<starttimecode>01:00:09:00</starttimecode>
<endtimecode>01:01:21:28</endtimecode>
<!-- Place title of animation here -->
<title>Pine Island Iceberg Formation</title>
<!-- Enter a description of the animation here. -->
<!-- Note that this information will appear on any -->
<!-- public web page generated for this animation -->
<abstract>This animation is a sequence showing the formation of MISR images on top of the continental Radarsat view of A</abstract>
<!-- Animator/Visualizer(s) who developed this product -->
<animator>Lori Perkins</animator>
<writer />
<narrator />
<!-- Date animation is completed YYYY/MM/DD -->
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<!-- Animation length in frames -->
<duration>320</duration>
<durationseconds>10.000000</durationseconds>
<!-- Embargo date format: YYYY/MM/DD -->
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"What's New?"

- African Dust 03/07/2003
- Earth Rotation 03/04/2003
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- Snow Cover 02/21/2003

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Additional SVS Work

- Great Zooms
- High Definition Animations
Search the SVS pages for words or phrases:

View indices of SVS animations:

- **Keywords** - locations, instruments, datasets, subject matter, and other keywords
- **Instruments and Datasets** - used as subject matter or for data content
- **Animation Series** - groups of animations with a similar theme or style
- **Scientists** - technical contacts for animation content
- **Animators** - SVS creators and others whose work has appeared in SVS projects
- **Identification Numbers** - animations numbered in rough chronological order
- **Video Tapes** - animations grouped by tape content in the SVS library

About our animation pages:

The basic element of our site is a page describing an individual animation. Each animation page contains the entire animation in reduced resolution MPEG-1 format and/or web and print resolution still images. Most animations are not yet available on this site in their full video resolution.
Atmospheric Infrared Sounder (AIRS)

For more information on the Atmospheric Infrared Sounder, visit [airs.ipl.nasa.gov](airs.ipl.nasa.gov)

- 2411 AIRS Volumetric Temperature Data (Fly In)
- 2412 AIRS Volumetric Temperature Data (Fly Out)
- 2413 AIRS Volumetric Cloud Data (Fly In)
- 2414 AIRS Volumetric Cloud Data (Fly Out)
- 2415 AIRS Volumetric Temperature Data with Gradient Background
- 2416 AIRS Volumetric Temperature Data with Gradient Background
- 2417 AIRS Volumetric Cloud Data with Gradient Background
- 2418 AIRS Volumetric Cloud Data with Gradient Background
"What's New?"

- **African Dust**
  - Date: 03/07/2003

- **Earth Rotation**
  - Date: 03/04/2003

- **Seasonal Ice Flow**
  - Date: 03/04/2003

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"What's New?"

Science Stories Archive

- **Saharan Dust**
  - Release Date: 03/06/2003

- **The Earth's Rotation**
  - Release Date: 03/04/2003

- **North Atlantic Oscillation**
  - Release Date: 02/25/2003

- **Snow Covers Eastern US**
  - Release Date: 02/25/2003

- **El Niño Forecasts**
  - Release Date: 01/29/2003

- **China Haze**
  - Release Date: 01/10/2003

Other Science Story Archive Years

- 2003
- 2002
- 2001
- 2000
Saharan Dust Off West Africa

An intense African dust storm sent a massive dust plume westward above the African deserts and then out across the Atlantic, reaching the Gulf of Mexico, and the decline of the coral reefs off of Florida.

These March 2 and 4 true-color images, acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument aboard NASA's Terra satellite, show large dust plumes (light brown) blowing westward over a span of days during the intense storm.
"What's New?"

- African Dust: 03/07/2003
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El Niño and La Niña

El Niño and La Niña are more known more generically as ENSO (El Niño/Southern Oscillation) events.

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>002646</td>
<td>El Niño-La Niña Cross-section of Temperature and Height Anomalies: June, 1998</td>
</tr>
<tr>
<td>002626</td>
<td>El Niño 'Golfball' for National Geographic's Atlas of the Oceans</td>
</tr>
<tr>
<td>001370</td>
<td>El Niño Zoom to Cross-section of Temperature and Height Anomalies: July 1997 through October 1998</td>
</tr>
</tbody>
</table>
Linkages

A number of projects are under development to automatically link the SVS database to larger repositories of image and outreach material.
Issues to be resolved

- How to serve up full resolution movies that can be used by both the public and third-party producers
- How to improve linkages to fulfillment sites

Videos were produced by GSFC in support of its Earth Science and Space Science missions for NASA. Copies of these videos are available directly from Interface Video Systems (IVS) at minimal cost to cover reproduction and distribution charges.

Jolema Gamble
Duplication Manager
Interface Video Systems
1233 20th Street, NW
Washington, DC 20036
Phone - (202) 861-0500
Fax - (202) 785-3216

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Each tape has been assigned a Goddard-unique library number such as 699-001. Please use that number when referring to Goddard tapes. The video