VISUALIZING THE ENVIRONMENT: PROCESSING NOAA DATA AND IMAGERY INTO EFFECTIVE COMMUNICATION, MEDIA, AND EDUCATION PRODUCTS

Daniel Pisut*[1], Tim Loomis [1], Al Powell[2], Marc Pulliam[1]
[1]I.M. Systems Group,[2]NOAA/NESDIS Center for Satellite Applications and Research

1. INTRODUCTION

Founded in 1999 to help improve the outreach capability of NOAA, the Environmental Visualization Laboratory (EVL) has developed into a program that serves the communications, education, and outreach needs of NOAA in support of its mission for increasing environmental literacy. Situated in the NOAA Center for Satellite Applications and Research, but a resource for all NOAA lines and offices, the EVL is the only program dedicated to producing news, education, and media products on a fulltime basis. Because of the demand for visualizations—a term we will more full describe later—to support informal education, the EVL has worked closely on several large-scale projects, such as the Smithsonian National Museum of Natural History's Ocean Hall, NOAA 200th, International Polar Year, and the upcoming International Year of the Reef. The EVL specializes in a variety of visualization products, including animations, posters, pamphlets, interactive kiosks, and specialty displays such as the Science on a Sphere and Magic Planet. This paper will describe some of the methods the EVL staff uses to most effectively distill information and communicate science with the general public in visualized forms.

2. DEFINING *VISUALIZATION*

Many NOAA programs invest in visualization—the practice of displaying data in graphical forms. The National Weather Service's AWIPS is a form of data visualization, but not one that will be treated here. All forms of visualization discussed in this paper are products intended for communicating, not analyzing data, especially for non-scientific audiences. Visualization for analysis is critical for understanding complex environmental phenomena, but so is the need to simplify that data to interest future generations in science and engage the general public in the discussion of environmental phenomena. To achieve this engagement, simplification is almost always necessary. For example, AWIPS would baffle the public if forced to use it to determine the weather for tomorrow, but they can easily incorporate that information into their daily activities once the display of it has been simplified into products shown on weather.gov/com and the news sources.

We separate visualization in terms of level of data involved in the production. Data-dependent visualizations are the simplest to create, as they rely entirely on data elements to convey a story. An example would be an animation of a hurricane. In this case, the quality of the visualization often hinges on the spatial and temporal

---

* Corresponding author: Daniel Pisut, 1335 East-West Hwy, SSMC1 rm 5232, Silver Spring, MD 20910; email: dan.pisut@noaa.gov

resolution of the data—an animation of GOES 1-km rapid scan visible imagery is much more interesting (and informative) than GOES 4-km routine scan infrared imagery. Like the hurricane example, data-dependent visualizations are most often used to show significant events or detailed processes over a long time series. Data-independent visualizations are quite different, and rely on the skill of the person developing the visualization to simplify a complex base of knowledge into an understandable story. We are all familiar with depictions of the water cycle from school text books—these visualizations are guided not by the actual data, but our assimilation of that data. Because of the inherent subjectivity, data-independent visualizations require greater levels of collaboration with scientists and reviewers to ensure accuracy, and as a result take longer to produce.

3. CREATING SIMPLIFIED DATA VISUALIZATIONS

The EVL has identified some other best practices that guide the production of data visualizations. To start, there is no shortage of data in NOAA, but the key is finding the right data for the story. Resolution (temporal and spatial), regional scale, understandability, and format are just some of the considerations. But without a doubt, the most critical component of the visualization process is first identifying the audience—something that is not necessarily considered by other visualization groups in NOAA, but is necessary to ensure the usefulness of the visualization. Table 1 describes some of the constraints of visualization based on its final intended use.

Audience	Time	Annotation	Complexity	Sound
News media	< 10 sec	None	Low	No
Museum	< 2 min*	Minimal	Variable	Sometimes
Classroom	Any	Yes	High	Sometimes
Website	< 5 min**	Yes	Variable	No

Table 1 Comparison of visualization constraints as a function of the audience type.

Retention time for most museum exhibits is less than two minutes.
*** Longer times increase file sizes, making files unviewable to those with slow internet connections.*

A hurricane animation for the classroom might include data elements such as the geostationary satellite imagery, hurricane path, annotation indicating the intensity of the storm at different points along the path, and the dates of the imagery. The same visual for the news would show only the satellite imagery—less is more when the run time is only 5-10 seconds.

Though standard televisions display images around 720 x 540 pixels, more and more households and stations are using the high definition formats of 1280 x 720 or 1920 x 1080 pixels. The ability of NOAA to reach these audiences resides in the ability of data products to be scaled to such viewing dimensions without degrading the image quality, and should be considered when assessing the needs of certain data products.

The graphical depiction of data from the standpoint of something simple like color is also incredibly important. False coloration can easily confuse audiences. In general, red is interpreted as 'bad' or 'intense,' whereas blue and cooler colors indicate the opposite. Deviation from these schemes requires greater time for the viewer to digest the information, or a clear explanation (two things that are not always available given the duration of the visualization). Layering or showing multiple datasets in sequence only complicates this issue, but can be resolved (in some cases) by reducing the color intensity of underlying data layers. Depicting some data layers as a function of 3-D height instead of color intensity is also a viable option, but often requires sophisticated visualization methods not available to all scientists.

Masking out data not critical to the story is also important—remember, these visualizations are used to convey a simplified concept, and thus simplified data is necessary. For example, low level clouds are removed from hurricane visualizations, as are non-equatorial or barely anomalous sea surface temperatures in ENSO visualizations (Figure 1). The result allows the viewer to easily identify to focus of the story/visual without being distracted by 'superfluous' data. Related to simplifying the data that is presented is also showing the viewer where to look. This direction is often accomplished by panning and zooming into special features of the data, and is also why having the highest possible resolution is needed.
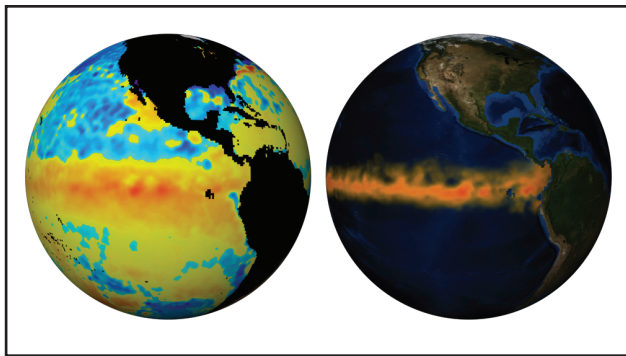

Figure 1
Original SST anomaly image (left) compared to image with extraneous data removed (right).

4. THE VISUALIZATION PROCESS

Originally specializing in the visualization of hurricanes and other cloud data, the EVL has long used Boeing Autometric's Edge software, however, as the demand for more diversified products has increased, the EVL is becoming more and more reliant on more flexible packages with greater flexibility and API development capability—such as Autodesk Maya. This software allows for complex 2-D and 3-D modeling and image creation, along with advanced rendering functions. However, Maya is not a stand-alone software, and often requires programs such as Adobe AfterEffects to generate properly formatted imagery, with realistic Earth layers and coloring effects. AfterEffects is also used to generate the aforementioned pans, zooms, explanatory annotations, and output the final product in the dimensions determined by the final display mode. It is recommended that other programs in NOAA interested in developing visualization capabilities use similar software so that collaboration is possible between visualization groups.

5. MEDIA FOR THE MASSES

The EVL has long-standing relationships with all of the major television, web, and print media outlets, resulting in high exposure of its products, along with repeat customer requests for a variety of products. However, to maximize its product distribution, the EVL partners closely with NOAA offices such as the Offices of Education and Communication, along with external groups including the Digital Library for Earth System Education, The Bridge, and The Smithsonian Institution. The EVL's web presence is also one of the greatest in NOAA, with its sites :
www.nnvl.noaa.gov
www.orbit.nesdis.noaa.gov/star/EVP_education.php
www.youtube.com/NOAAVisualizations.

6. THE FUTURE OF NOAA VISUALZIATION

Graphics are rapidly evolving—just compare the special effects quality of a movie from ten years ago and today. Likewise, the public demand an ever increasing level of realism and image quality in how weather and other environmental data are depicted. The EVL is constantly trying to improve its products, and greatly welcomes any collaboration in visualization development within NOAA in either the fundamental aspects of software development, or best practices for effective communication and educational output. We are also striving to increase our capability to handle the many disparate forms of data that NOAA produces, and to visualize them effectively without resorting to purchasing unique softwares for each data type. By partnering with our parent company, I.M. Systems Group, we hope to be able to more efficiently develop visualization solutions to meet any need in NOAA.