Communicating Climate Change: Lessons from Sustained Programs

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Abstract

A central goal of the Worldview Network is to establish a common understanding among decision makers and concerned citizens around the planet about climate science and appropriate adaptation solutions. That baseline must stem from verifiable interpretation of scientific data. Sustained public programs from the American Museum of Natural History in New York City, USA, and the United States National Oceanic Atmospheric Administration provide lessons and point toward best practices for that process. The first step in this interpretation is to identify relevant scientific themes; this job is best done by an authoritative scientific expert. The second step is to render information in simple and understandable ways; this job is best done by experts in media production, such as artists and producers. For the Worldview Network, the production process will not end with publishing and disseminating visualized media. The third step involves working with decision makers and communities to understand scientific and social foundations before collaboratively devising climate adaptation strategies. These steps do not define a closed loop, for the third step will yield new realizations which may be aired through visualization and public discourse. Thus, the Worldview Network will literally help humans evolve new ways of understanding and solving problems at all scales, from local to global.

Introduction

Scientific data and concepts are essential for devising climate change adaptation strategies, for example by clarifying minimum or maximum rates of sea level rise in a given harbor or changing precipitation regime impacts in an agricultural region. Since the rate of relative sea level change (rise or fall) varies from location to location, scientific expertise will clearly be needed in order for city or regional planners around the world to make site-specific recommendations about adaptation strategies. In regions where relative sea level is rising rapidly, such as the mid-Atlantic coast of the United States, planners face different concerns than planners on portions of Alaska’s coast where Earth’s crust is rising due to the loss of mass from glaciers (isostatic rebound), thus causing a relative lowering of sea level. Since model projections of precipitation and temperature do not provide sufficient resolution to analyze parameters for a specific locale or year, accurate interpretation of climate models will be needed for agribusiness leaders to deliberate about disease resistance, timing of fertilization, and crop rotation times for agricultural regions. To evolve locally relevant societal responses, scientists must find ways to work directly with business leaders, planners, politicians, and others from all walks of life. Issues such as these are the impetus for launching the Worldview Network.

Others at the workshop have outlined major challenges for using visualization to inform climate change responses around the planet (Editorial, this volume; Vajjhala and Spadaro, this volume) as well as conceptual approaches to communicate complex ideas by helping audiences perceive complex concepts (McConville, Simmon, this volume). This essay focuses on practical considerations for translating specific scientific concepts for public audiences.

The first section establishes the importance of clarifying communication objectives when building geographic visualizations ("geovisualizations"). I draw on three examples from the American Museum of Natural History's Science Bulletins[1] video production group. Turning more explicitly to climate, I discuss how scientists and communicators within the U.S. government's National Oceanic and Atmospheric Administration (NOAA) plan to work with government and business leaders as well as a broader public. These examples demonstrate how the Worldview Network might work with collaborators around the world.

Science Media for Public Outreach

Science Bulletins produced geovisualizations about Earth's climate, atmosphere, land cover, and biosphere between 2000 and 2008 in collaboration with the U.S. National Aeronautics and Space Administration (NASA) and NOAA. The scientists who collaborated on these visualizations each provided expert interpretation of data they used in their own research. During pre-production of each visualization, I typically spent one or more hours talking with NASA principal scientists. During my first assignment, I sat with Claire Parkinson, the lead investigator of the Aqua satellite, one of NASA's Earth Observing System constellation of satellites. While describing climate phenomena and patterns that cause and result from changes in Arctic sea ice, Dr. Parkinson pointed to images graphics specialists had produced from her satellite observations since the late 1970s. Parkinson had relied on images to complement her quantitative analyses from even those early days when computers were not capable of generating images quickly and easily. Processing data from satellites requires specific skills. Each instrument has its own unique data structures. Although NASA made an effort to document those data formats so that any researcher could use them, processing thousands of sequential frames of images based on satellite images and data would have been very difficult without the direct assistance of programmers working with those NASA on a day-to-day basis. Documenting expert opinion and processing raw, authentic data became hallmarks of Science Bulletins visualizations.

Programming by Science Bulletins was distributed to 41 museums and science centers, mostly in the United States. Given that its audience was well defined, producers were able to cultivate best practices. Rather than meeting joint communications objectives for entertainment and education, the visualizations focused on translating current science topics *per se*. The editorial team included research scientists, whose jobs included identifying significant trends and scientific progress. After identifying and agreeing about core concepts to convey, artists and writers on the team devised ways to translate those concepts. Scientists on the team differentiated small discoveries in recent literature from fundamental concepts. Scientists can serve a crucial role communicating with society and decision makers by identifying and highlighting significant scientific discoveries.

Land Cover Mapping

Below I describe three visualizations and fundamental principals relating remote sensing to biodiversity science. The first figure (Figure 1a) focused attention on how optical remote sensing is used to map both wildlife habitats and human impacts on those habitats. Colleagues from the University of Maryland and Woods Hole Research Center spent several years mapping roads and land cover in the Congo rainforest bordering the Central African Republic, Republic of Congo, and Cameroon. In many parts of the world such as this region of the Congo, ground surveys are impractical, so remote sensing provides one of the only ways to map natural and man-made features. Optical remote sensing techniques underlie efforts to

1 http://sciencebulletins.amnh.org.

describe both biodiversity and land cover change, so I was determined to teach audiences about the concepts underlying remote sensing. In the first figure below, you see six bands of data from Landsat 7, one of the main instruments that biodiversity researchers use to map remote regions of the planet.

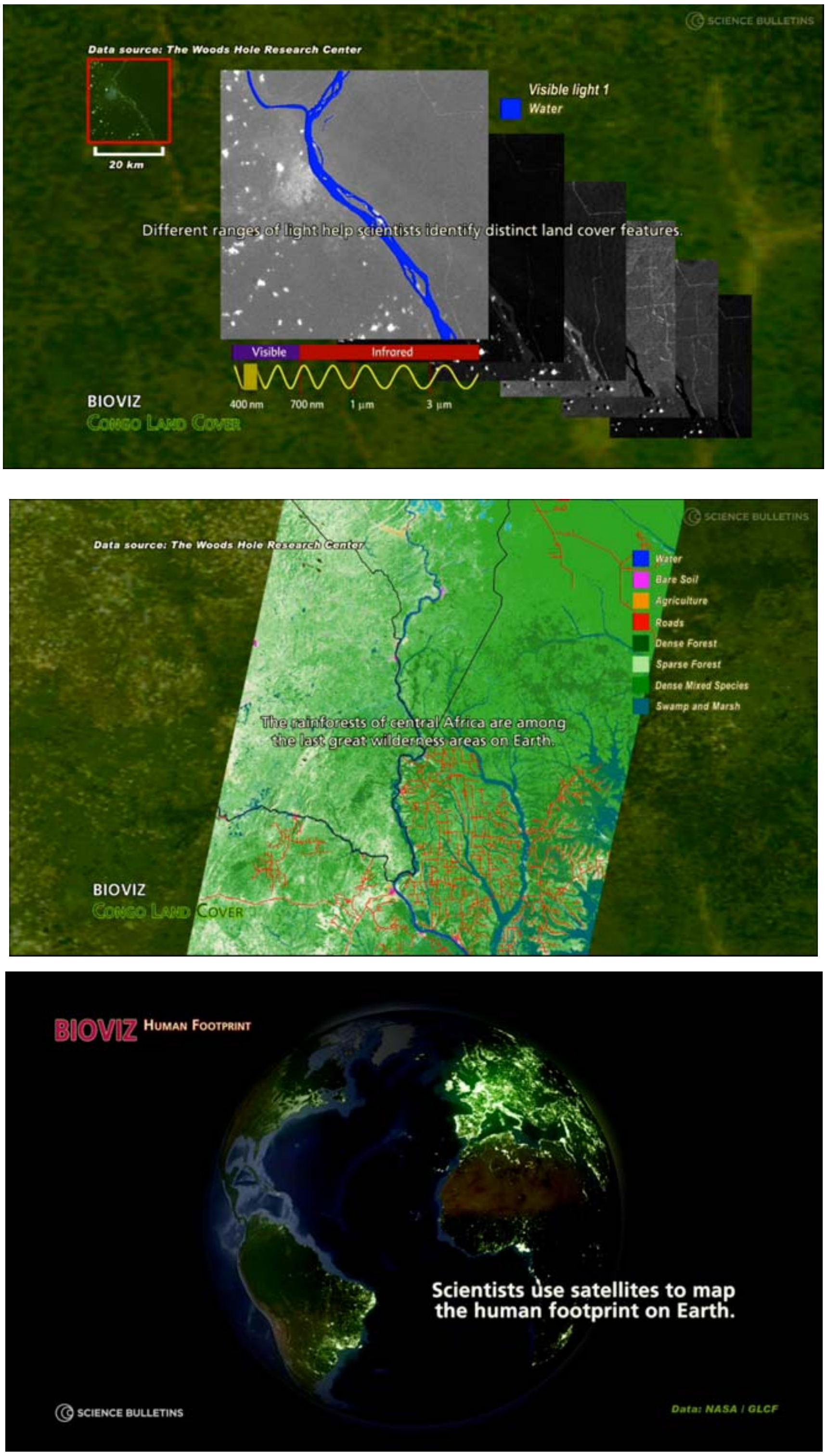


Figure 1. (a) Multispectral optical remote sensing data from Landsat 7 provided researchers information about (b) land cover and roads in Congo's rainforest. (c) Heat signatures from cities are detectable from space, and these data allow us to visualize the human footprint on a planetary basis.

The second figure (Figure 1b) shows a map produced by analyzing those data. We produced several visualizations similar to this one to explain how scientists use remote sensing to inform conservation efforts around the world. The third pane (Figure 1c) shows the distribution and influence of humans around the world based on thermal signatures from cities.

Fire

Because of their comprehensive perspective, satellites are also used to map phenomena with a broad distribution but that are difficult to track because of their sporadic behavior. In the example depicted below (Figure 2), one can examine fires caused by lightning in boreal regions. Later in the video from which this image was extracted, one sees that people have changed fire regimes in the tropics, where fire is used to clear agricultural lands over large regions. Further, the piece explains that fires in northern California have become more deadly and costly in recent decades because people have built houses and moved into forested landscapes in California's arid, windy Mediterranean climate. This visualization about fire shows global, regional, and local examples of natural and human-altered fire regimes. More importantly, the visualization demonstrates in clear terms the relationship between land uses (i.e., tropical agroforestry or California suburbanization) and fire regimes around the planet. Geovisualization uniquely provides a window into phenomena occurring at multiple spatial and temporal scales.

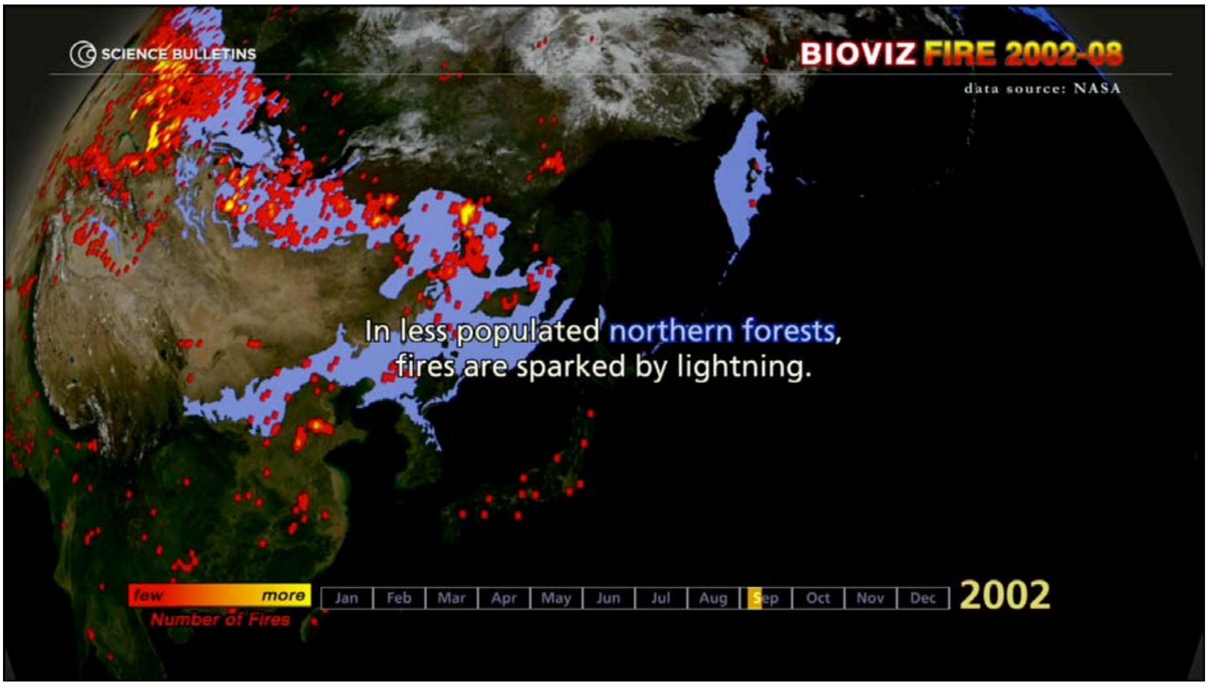


Figure 2. Satellites provide maps of fires daily basis and on a planetary scale. This visualization demonstrates several causes and effects of fires in three terrestrial biomes.

Net Primary Productivity

The air humans and all other oxygen-requiring organisms breath derives from plants on land and in the ocean. How many people on the planet know this? Working with a graduate student in Switzerland and research groups at Oregon State University and the University of Montana, we compiled carbon dioxide uptake estimates based on remote sensing data from both land and ocean (Figure 3). Because those uptake rates share the same units, we were able to demonstrate to our audiences that land and ocean both produce oxygen. Furthermore, we demonstrated that plant carbon uptake rates vary with the seasons outside the tropics. Thus, boreal spring is offset by six months from austral spring. These two seasons are clearly visible in the greening up of the land and ocean. That greenup, representing carbon dioxide uptake by plants, is followed by a decrease in plant productivity several months after the greenup. Using a schematic representation of the Earth-sun relationship, we demonstrated that the seasons themselves are caused by Earth's tilt and consequent differential lighting in the northern and southern hemispheres.

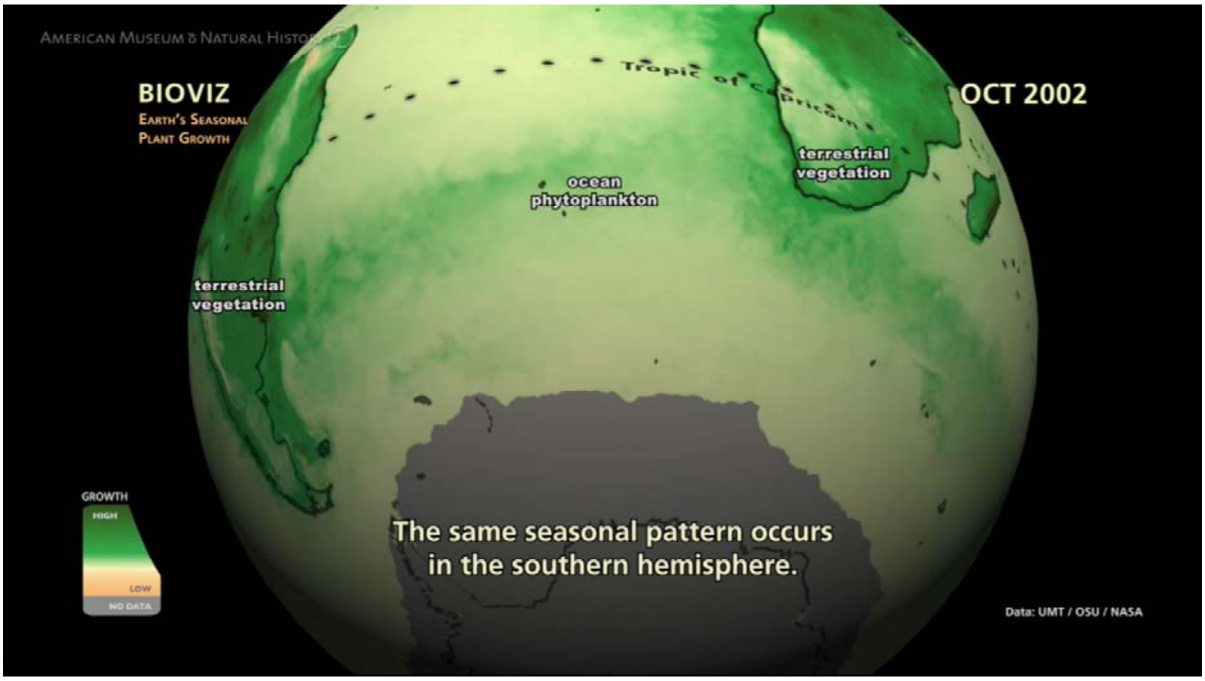


Figure 3. Plant productivity on land and in the ocean can be modeled based on satellite observations and represented using colors to depict rates of carbon uptake by photosynthesis.

Lessons Learned

The Science Bulletins visualization program was successful because of its stable, end-to-end production process. We were able to work directly with other scientists to digest data, generate image sequences, interpret those images, render them artistically, and refine messages based on scientifically vetted concepts. Bringing together these diverse talents allowed the program to convey complex concepts and innovate methods in geovisualization. The Worldview Network intends to facilitate communication among many audiences. The examples from Science Bulletins demonstrate a functional model for producing content. The integration of scientific expertise into production is a useful benchmark for the Worldview Network.

Reaching Out, Making Decisions

Reaching decision makers will require that Worldview members innovate communication techniques. An efficient pathway for using visualization in climate change discussions is an end-to-end process whereby scientists perform data exploration with the same data and tools that policy makers use for discussing adaptation scenarios. If properly interpreted, these data and visualization products can be used to communicate through media outlets with broad, public audiences. Beyond visualization tools and techniques, we will need to evolve qualitative methods for communicating science concepts and adaptation strategies.

One interdisciplinary collaborative model is emerging from NOAA's Climate Program

Office. Our “Community Conversations on Climate” program brings together climate science experts, communicators, and community members to examine and discuss issues relevant to a given locality. The first event was May 9 in Phoenix, Arizona and focused on water in the desert southwestern United States. Using SCISS’ Uniview software, we worked with the Elumenati to build a visualization and lecture. The second Community Conversations on Climate event took place at the Chabot Science Center in Oakland, California October 10, 2009.

One of the most challenging aspects of explaining climate concepts to non-scientists is helping people understand vast time and space scales over which climate and Earth processes change. A practical way to contextualize spatial and temporal scaling is to navigate through the digital atlas of the universe. Zooming to the edge of the known universe and back to planet Earth allows one to speak directly to the vastness of space and the long duration of time over which the universe has been evolving.

Navigating back to a view of Earth, one may describe general circulation patterns before focusing on a more specific region. I described the sub-tropical high pressure ridge at 30 degrees north—the boundary between Hadley Cells and mid-latitude Ferrel Cells. This basic concept and global circulation patterns help explain aridity at this latitude, the predicted expansion of Hadley Cells with climate change, and predicted warming and drying. By first describing and emphasizing the processes that give rise to phenomena, it is possible to relate a variety of more specific features that arise from those processes. Once people understand the process of air circulation as we observe it today, they are more apt to understand how circulation patterns are likely to change in the future.

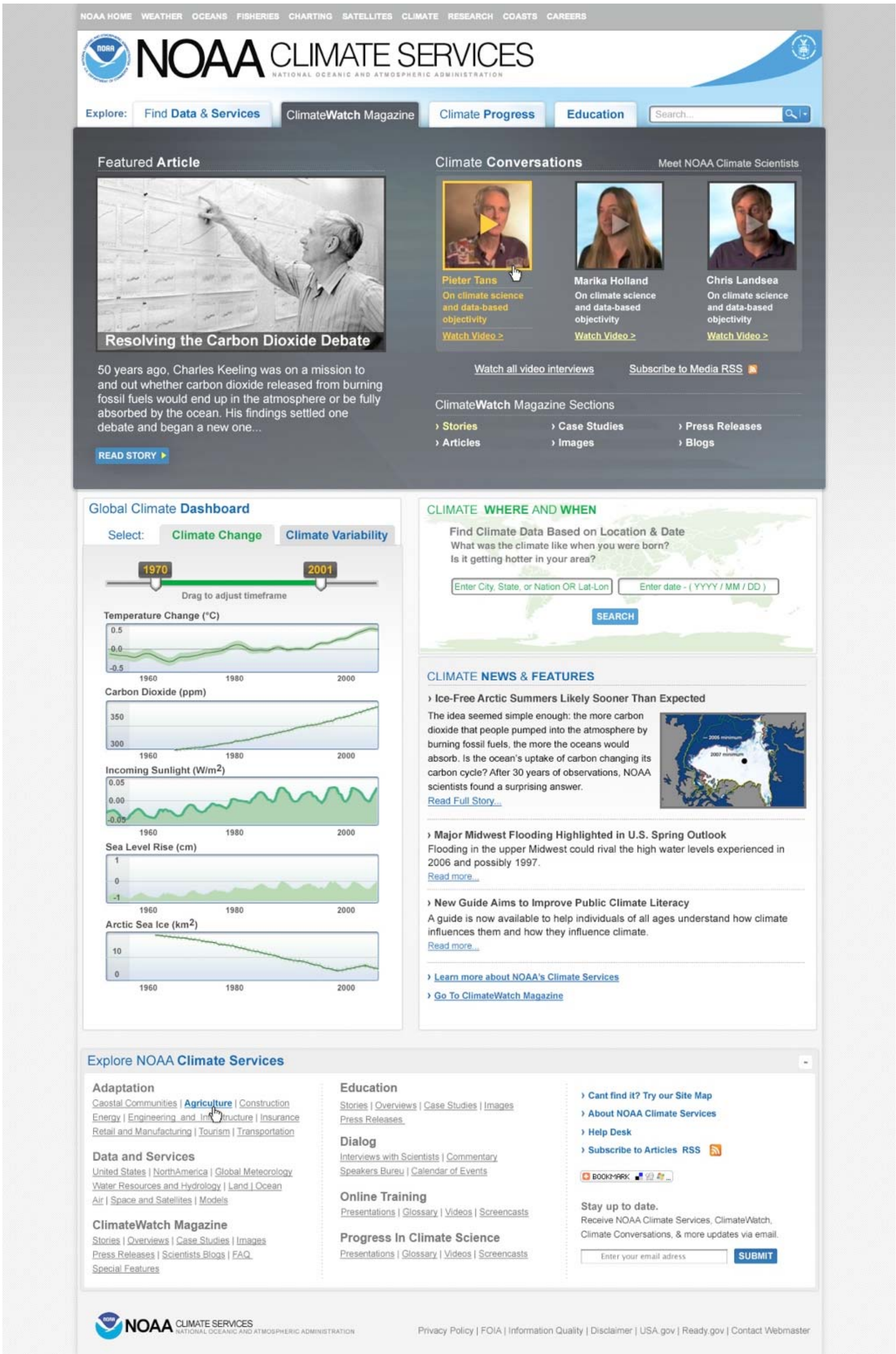
For Arizonans, past climate provides insight into wise precautions for adapting to future climate conditions. At our event on May 9, we focused specifically on water supply. Presenting tree core data, I showed how researchers from NOAA’s National Climatic Data Center have pieced together a 400-year record of water levels in the Colorado River, which supplies Arizona nearly half its fresh water. That reconstruction established that water was more available in the 20th century than at any time in the previous three hundred years. With population growing, groundwater withdrawal rates exceeding infiltration rates, and land uses generating ever more demand for water, citizens were eager to interact more with regional experts about the future of their water supplies.

Access point: portal

There is increasing pressure for scientists to work with media, educators, citizens, business leaders, decision makers, and politicians to address societal responses to climate change. At NOAA, we will document the methods, data, and stories that help communities understand climate change effects on their own regions through the NOAA Climate Services Portal. This web site (Figure 4) will provide an outlet for the Worldview Network to share its own assets and examples.

Conclusions for WorldView

WorldView’s visualization and communication strategy will incorporate diverse talents of physical, biological, and social scientists alongside media experts, artists, producers, and writers. Through their interaction, interdisciplinary team can render and articulate complex ideas. Participants in the network will clarify their communications objectives and target audiences and will innovate strategies for helping people grapple with and learn from concepts or ideas that may be unfamiliar or complex. The network will profit from successful examples but will necessarily forge new production and communications methods to establish its role as an honest broker of climate information that is simultaneously facile with bringing together citizens, decision makers, and scientists to engender collaborative solutions to the challenges brought by climate change.



Biography

I am an ecologist trained in landscape ecology, geographic information systems, and remote sensing. Nearing graduation, I surveyed the efforts of my mentors and realized they spent about as much energy defending voiceless ecosystems as they did studying their intricacies and publishing papers that several hundred people on the planet would ultimately read. When offered an opportunity to help design and build a public program aimed at improving museum vistors' understanding of biodiversity and Earth system science, I realized this was perhaps a more direct route to improving humans' understanding of the processes that sustain us all. After several years invested in the production of high definition visualizations about biodiversity and Earth systems science, I shifted my attention to climate issues, where the world stage is set to focus and take action more aggressively than on other global change issues. Working as a contractor to the National Oceanic and Atmospheric Administration, I am now working to translate and clarify climate concepts, data, and services that the United States government generates and provides to the world.