NASA Science Visualizer Creates Earth from Hundreds of Images (w/ Video)

June 28 2010

Helen-Nicole Kostis, NASA scientific visualizer. Credit: NASA

The Earth floats delicately in space, sunlight illuminating the fluid mottling of white clouds suspended over its surface. The scene, the leading sequence in a recent NASA video about ship pollution and clouds, shows our planet from a perspective only a satellite or spacecraft could provide.

However, no camera captured that image of the Earth. The reason? It's not one image. Instead, the single cloud-scattered globe is a mosaic of 298 smaller images of close-up areas of our planet meticulously stitched together by Helen-Nicole Kostis, a NASA science visualizer.

At NASA Goddard Space Flight Center's Scientific Visualization Studio (SVS), Kostis works as part of a team of visualizers who take raw scientific data and translate that data into visual imagery. The visuals help both scientists and the general public better understand the data

NASA satellites and airborne missions provide in order to better comprehend complex phenomena invisible to the naked eye and "see" how the planet works. The imagery they create is scientifically accurate to a degree few others match.

Many Earth views we see in print and video are created by artistically splicing together various images from different satellite instruments, taken at different times and heights, in different wavelengths of light, and at different pixel resolutions. Using image-blending techniques, photo artists create a realistic-looking two-dimensional flat view from these disparate images. They then wrap this image layer, called a "texture," onto a sphere in a software program to create a view of Earth. While it makes for stunning imagery, the Earth depicted in these views is fictional -- a hodge-podge of different images created from a great deal of artistic license.

"There is so much stuff out there showing the Earth, and it's very easy to take a texture and put it on a globe, that I think people don't know that what you see from the SVS is not just another texture," said Kostis. "It's data, accurately projected, and we take into consideration day and night, where the stars are, and the sun. Sometimes during development, I feel like I am cruising into space."

To get a scientifically accurate Earth view for the video, Helen downloaded one day's worth of images taken from identical Moderate Resolution Imaging Spectroradiometer (MODIS) imaging instruments that fly on two different satellites. The first satellite, Terra, follows the morning light around the Earth, capturing images along a roughly north-south trajectory. The second satellite, Aqua, captures a similar view in the afternoon.

The first step in combining the hundreds of shots into a single image is to make sure they will lie correctly on the round surface of the globe.

Imagers aboard the satellite return two-dimensional, rectangular images similar to what our cameras back on Earth produce. As a result of the Earth's curvature, the land and ocean in the edges of the image curve away in a 2-D image. To correct the problem, SVS Director Horace Mitchell ran each image through a special software process that morphs the images' shape to lie properly when applied to the round surface.

The Earth's spherical shape also creates other photographic problems. As the satellites orbit along a north-south route around the Earth, the planet rotates underneath. As the planet revolves, areas near the equator rotate faster than areas near the poles. As a result, the satellite gets extra coverage of polar regions, while areas near the equator that are spinning faster often get missed between satellite passes.

To fix these data gaps, Kostis started with the single most important image -- in this case, a morning scene of the north Pacific taken from the Terra satellite. Then, working out from that area, she selected images that were taken close in time and with closely matching clouds. In areas where data was sparse or the clouds had changed enough between satellite passes that the Terra data was a poor match, she laid in imagery from the afternoon pass of the Aqua satellite.

"Horace calls this process weaving, and it is like that - like weaving a basket," Kostis said.

Once the planet was "woven" together, Kostis carefully scoured the resulting mosaic for areas where the stitching and weaving may have left tiny errors or holes. Then, using Photoshop blending tools, she carefully filled in those areas, taking care not to disturb the scientific data in nearby pixels. The result is a flawless flat image mosaic of the globe over a single 24-hour period.

Next, using a software program called Maya, she wrapped the flat image

mosaic -- a scientifically accurate “texture” -- onto a sphere representing the Earth.

“That’s actually the easiest part of all,” Kostis said.

The finished Earth with a smooth camera sweep looked like a completed project, but it still needed a backdrop of stars - including our closest star, the Sun. While many visualizers would drop in any image of stars, the call for scientific accuracy means Kostis needed to figure out what the stars looked like from the imaginary camera’s perspective on the date the data was gathered. She also needed to pinpoint the Sun’s accurate position relative to those stars and the Earth. Kostis and colleagues Greg Shirah and Ernest Wright poured over star catalogs to place the star field correctly, and not only situated the Sun in the correct place, but ensured it correctly illuminated the Earth and created accurate shadows as well.

After two weeks of full-time work, Helen debuted the result - a slow arc toward our cloud-strewn world, flanked by a Sun and stars, revealed as if by an orbiting satellite or perhaps a spacecraft headed home.

The final view is both science and art. And it was captured not by a satellite, but by a scientific instrument infinitely more sophisticated -- the human mind.

Provided by JPL/NASA