Space Station sharper images of Earth at night crowdsourced for science

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North Korea (the dark area) and South Korea at night. Credit: NASA

A wealth of images of Earth at night taken by astronauts on the International Space Station could help save energy, contribute to better human health and safety and improve our understanding of atmospheric chemistry. But scientists need your help to make that happen.

The images are available to the public through The Gateway to

Astronaut Photography of Earth, the most complete online collection of images of Earth taken by astronauts. This database contains photographs beginning with those taken during Mercury missions in the early 1960s up to recent images from the station, with more added daily. As of August 2014, the collection included a total of nearly 1.8 million images, more than 1.3 million of them from the space station. Approximately 30 percent of those were taken at night.

The photographs taken by astronauts on the station are the highest-resolution night imagery available from orbit, according to William Stefanov, Ph.D., associate program scientist for Earth observations for the space station. Satellites collect data on a more regular basis, but those images typically have much lower resolution. This clarity is possible thanks to the European Space Agency's NightPod, installed on the station in 2012. It incorporates a motorized tripod that compensates for the station's speed—approximately 17,500 mph—and the motion of the Earth below. Before, that motion could blur images even though astronauts compensated with high-speed films and manual tracking. In 2003, astronaut Don Pettit's "barn door tracker"—a lower-tech precursor to NightPod using a motorized drill and assorted parts he accumulated on station—enabled the first motion-compensated night time imagery from the space station.

Now the pictures are clear, but their location may not be, which limits their usefulness. That's where citizen science comes in.

The Complutense University of Madrid (UCM) is leading a project called Cities at Night to catalog the images. It includes three citizen science components: Dark Skies of ISS, Night Cities, and Lost at Night.

This is the Iberian Peninsula at night, showing Spain and Portugal. Madrid is the bright spot just above the center. Credit: NASA

Dark Skies asks people to sort images into those of cities, stars and other objects. The simplest of the three projects, it requires no specific expertise. "Anyone can help," says Alejandro Sanchez, a Ph.D. student at UCM. "In fact, without the help of citizens, it is almost impossible to use these images scientifically. Algorithms cannot distinguish between stars, cities, and other objects, such as the moon. Humans are much more efficient for complex image analysis."

For Night Cities, citizen scientists use their knowledge of local geography to identify points in night images and match them to positions on maps. As Sanchez explains, a resident of a city can likely identify its features more easily than someone who does not live there. This geo-referenced data will be used to generate light maps of cities.

Lost at Night requires the most skill, seeking to identify cities in images encompassing a circle 310 miles around. "We don't know which direction the astronaut pointed the camera, only where the station was at the time the image was taken," explains Sanchez. "Some images are bright cities but others are small towns. It is like a puzzle with 300,000 pieces."

So far, hundreds of volunteers have classified nearly 20,000 images, but to ensure accuracy, each one should be classified by multiple individuals. One of the outcomes of the project will be determining the optimum number of people needed to inspect each image, but its primary goal is producing an open atlas of night time images available any time for use by the media, public, and scientists.

Scientists can, for example, use colors in images to estimate the types of light sources and, thus, the energy efficiency of a particular city. Researchers could use the data to compare the lighting and the economic health of a city as well. "A clear example is comparison of Madrid and Berlin," Sanchez says. "Madrid is the capital of Spain, a country facing a major economic crisis. It is much brighter in astronaut images than Berlin, the capital of Germany, the country with the healthiest economy in Europe. Perhaps that is an indication that Germany more efficiently manages its resources. The images can provide evidence and data to verify that."

Other potential applications include evaluating lighting for road and public safety and correlating light pollution with effects on human health and biodiversity.

The atlas is a collaboration of UCM, MediaLab-Prado, Spanish Light Pollution Research Network, European Cooperation in Science and Technology's Action Loss of the Night Network, Crowdcrafting, Celfosc and AstroMadrid.

NightPod also was used for Crew Earth Observations (CEO), an investigation for which astronauts photographed natural and human-made events on Earth, recording changes over time; atmospheric phenomena; and events such as storms, floods, fires and volcanic eruptions. Because astronauts can take images at a variety of resolutions and angles, their images provide atmospheric data, and because the station passes over different places on Earth at different times of day and night and with different a frequency than free-flying satellites, they also provide data on changes over time.

Astronauts on the station have made sharp images of Earth at night available to scientists. Now the public can help scientists put those images to better use.

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