First use of ISS astronaut pictures for light pollution studies

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This image of Milan was acquired after the transition to LED technology in the center. The illumination levels appear to be similar or even brighter in the center than the suburbs, and the amount of blue light is now much higher, which suggests a greater impact on the ability to see the stars, human health and the environment. Since the European Space Agency's NightPod device was installed on the ISS in 2012, astronauts have been taken systematic night images. It incorporates a motorized tripod that compensates for the station's speed 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, NASA 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 ISS. This image was taken by Samantha Cristoforetti. Credit: NASA/ESA

Scientists are tapping into photographs taken by astronauts aboard the International Space Station (ISS) to reliably measure the amount of light pollution worldwide. This study not only includes the well-known signatures of cities and streets, but also the effects of faint indirectly scattered light, which up to now had not been measured quantitatively. The new results confirm that this diffuse glow, which is seen from space, is scattered light from streetlights and buildings. This is the component responsible for the brightening of the night skies in and around cities, which drastically limits the visibility of faint stars and the Milky Way. The team also concludes that European countries and cities with a higher public debt also have higher energy consumption for street lighting per inhabitant, and that the total cost of the energy consumption for street lights is 6300 million euros/year in the European Union.

In a remarkable new study, scientists from the Universidad Complutense de Madrid, Spain and the Cégep de Sherbrooke in Canada, together with members of the public, have worked on a project called Cities at Night. The aim is to produce a global colour map of the Earth at night from pictures taken by astronauts on the International Space Station using a standard digital camera.

Starting in July 2014, this huge project required the cataloging of over 130 000 images—the ISS's entire high-resolution archive—and geo-referencing them to place them on a map. The images were also calibrated using the stars in the background sky over the ISS, as well as

ground-based measurements of the night sky brightness.

Previously, light pollution measurements had to be done in situ and would contribute only a single measurement to the light pollution map. This new method, connecting space-based measurements of light pollution with ground-based night sky brightness measurements, makes it possible, for the first time, to map light pollution reliably over extended areas.

A diffuse light present around cities, in addition to the familiar bright lights from streets and factories, was previously detected by the Defense Meteorological Satellite Program, but its nature remained unknown; the satellite's low-resolution cameras could not distinguish it from other instrumental factors. However, the high-resolution images captured by the astronauts—in addition to an extensive sky brightness survey conducted around Madrid—have now allowed scientists to observe the direct relationship between the diffuse light observed and light pollution from artificial lights.

Using the ISS astronaut images, as well as data from the Defense Meteorological Satellite Program and the Suomi National Polar-orbiting Partnership Satellite, the researchers also discovered that European countries and cities that have a higher public debt also have a higher energy consumption of street lighting per inhabitant. The total cost of the energy consumption for streetlights is estimated by the study to be 6300 million euros/year in the European Union. The different ways of calculating streetlight energy costs across Europe previously made such an estimate impossible.

This citizen science project is vital for researchers from many scientific fields. Studying lighting technology from orbit is currently of even greater importance now than before due to massive transitions to LED technology . The ISS is the only place from which it is possible to

estimate the prevalence of the different types of lighting technologies used in cities around the world and to measure the impact of light pollution on the environment and human health.

"Until the advent of new satellites, astronaut photography was our only colour and high-resolution window on the Earth," says lead scientist Alejandro Sánchez de Miguel.

After gaining the initial support of multiple institutions and thousands of volunteers, the next phase of the Cities at Night project aims to gather funding to keep the project running, so it can extend its colour map of the nightside of the Earth.

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