Image Detective 2.0: Engaging Citizen Scientists with NASA Astronaut Photography. Melissa Higgins, Paige Valderrama Graff, James Heydorn, Amy Jagge, Lisa Vanderbloemen, Jacobs @ NASA Johnson Space Center; William Stefanov, Susan Runco, NASA Johnson Space Center; Cory Lehan, Pamela Gay, Astronomical Society of the Pacific (ASP).

Image Detective 2.0 engages citizen scientists with NASA astronaut photography of the Earth obtained by crew members on the International Space Station (ISS). Engaged citizen scientists are helping to build a more comprehensive and searchable database by geolocating this imagery and contributing to new imagery collections.

Image Detective 2.0 is the newest addition to the suite of citizen scientist projects available through CosmoQuest, an effort led by the Astronomical Society of the Pacific (ASP) and supported through a NASA Science Mission Directorate Cooperative Agreement Notice award. CosmoQuest hosts a number of citizen science projects enabling individuals from around the world to engage in authentic NASA science. Image Detective 2.0, an effort that focuses on imagery acquired by astronauts on the International Space Station, builds on work initiated in 2012 by scientists and education specialists at the NASA Johnson Space Center. Through the many lessons learned, Image Detective 2.0 enhances the original project by offering new and improved options for participation. Existing users, as well as new Image Detective participants joining through the CosmoQuest platform, gain first-hand experience working with astronaut photography and become more engaged with this valuable data being obtained from the International Space Station.

Citizens around the world are captivated by astronauts living and working in space. As crew members have a unique vantage point from which to view our Earth, the Crew Earth Observations (CEO) online database, referred to as the Gateway to Astronaut Photography of Earth (https://eol.jsc.nasa.gov/), provides a means for crew members to share their unique views of our home planet from the ISS with the scientific community and the public. Astronaut photography supports multiple uses including scientific investigations, visualizations, education, and outreach. These astronaut images record how the planet is changing over time, from human-made changes like urban growth and agriculture, to natural features and landforms such as tropical cyclones, aurora, coastlines, volcanoes and more. This imagery provides researchers on Earth with data to understand the planet from the perspective of the ISS, and is a useful complement to other remotely sensed datasets collected from robotic satellite platforms.

Every image in the CEO database includes specific metadata automatically associated with each image once it is downlinked from ISS. This metadata includes the date and time the image was taken, camera information (camera used and focal length), sun elevation angle, sun azimuth, spacecraft altitude, and the ISS nadir point (projected onto the Earth's surface as latitude and longitude coordinates). While this information is valuable, it does not provide a user with the geographic center point location of the image itself, which is the only means of locating an image unless descriptive geographic feature metadata has been added, both of which must be completed through a manual cataloging process. Contributing to the complexity of this manual process is the fact that, as crew members on the ISS acquire each image using a hand-held camera (as opposed to a mounted camera with known pointing direction), the orientation and look angle for each image can vary significantly. For example, an image can be taken looking nadir from the vehicle or obliquely, with views of the Earth limb and space. These oblique views help provide unique and valuable imagery of Earth, typically not possible to obtain from other Earth-orbiting sensors without pointing capability. Oblique imagery acquired by the crew can be especially challenging to manually work with and catalogue as the center point location is at an unknown distance and unknown direction from the ISS nadir point.

There are currently over 2 million photographs of Earth that have been taken by astronauts from space, with numbers increasing with each mission. This has led to a growing need to catalogue specific attributes and metadata for each image in order to enable this expansive database to be searched easily and effectively. This can only be accomplished through a manual cataloguing process for each individual image. This manual process takes significant time and effort, and is one that can be contributed to, in large part, by citizen scientists participating in Image Detective 2.0.

There are two primary goals of Image Detective 2.0. The first is to enable citizen scientists around the world to participate in a unique opportunity to enhance the publically accessible database of NASA Crew Earth Observations imagery. The second is to directly engage citizen scientists with data being obtained from the International Space Station, thus highlighting the valuable work being done from the ISS and enabling citizen scientists to utilize the imagery as part of their own investigations or projects of interest. To achieve these goals, involved citizen scientists use the newly refined set of mapping tools developed through CosmoQuest, designed to assist them in determining and adding valuable metadata to imagery within the NASA Crew Earth Observations database. Using these tools, citizen scientists have the option of completing two tasks. The first is to bin images into preselected features categories, which will contribute to the enhancement of the CEO Collections database. The second is to identify three specific types metadata for each image: 1) the geographic center point of the image; 2) named geographic features visible in the image (i.e. “Mississippi River” or the “Sahara Desert”); and 3) percentage of cloud cover visible in an image.

In addition to the two primary goals, involvement in Image Detective 2.0 has additional benefits. It provides citizen scientists with access to a unique NASA dataset; access to Science, Technology, Engineering, and Mathematics (STEM) experts; and the opportunity to enhance their own knowledge and understanding of STEM-related content including geography, geology, environmental science, planetary science and more. This exposure to rich STEM content helps promote potential STEM career options, especially for participants considering future career directions. Image Detective 2.0 also offers opportunities for individuals seeking to personalize their own learning, in addition to providing classroom teachers and their students with easy access to authentic data they can incorporate into classroom activities. Additionally, as citizen scientists make contributions to Image Detective 2.0 and the NASA CEO database, they are gaining skills that will contribute to a growing number STEM-literate individuals around the world.

With the help of motivated and skillful citizen scientists looking at and cataloguing this extensive number of astronaut images of Earth, we expect the project to result in a significantly more useful dataset. Completion of either or both of the Image Detective 2.0 tasks will help enhance the CEO database by increasing the capability of an individual to search for specific data that meets their needs. This will ultimately make this NASA imagery database more useful to scientists and the public. Image Detective 2.0 participants will be able to access their work and the work of others through the CosmoQuest website, with the entire database of catalogued imagery being housed on the Gateway to Astronaut Photography of Earth website. The project team from the NASA Johnson Space Center (JSC) Earth Science and Remote Sensing (ESRS) Unit have expertise in Crew Earth Observations imagery, earth science and remote sensing, and have extensive experience with the exploration of Earth from space, and are fully engaged with astronauts on the International Space Station. This experience and expertise will enhance the team’s ability to work with Image Detective 2.0 citizen scientists involved in this effort and ensure a quality product will be produced. This resulting product will be an unprecedented and enhanced online database of astronaut imagery of the Earth —created *by* users worldwide, *for* users worldwide.