Astronaut Photography of Coral Reefs

Astronauts have been photographing our planet through spacecraft windows ever since the beginning of human spaceflight. To date, nearly 400 000 photographs have been taken by astronauts on NASA missions using hand-held cameras. Most photographs are in natural color and, due to selective photography by astronauts, tend to have relatively low cloud cover. They are taken from a variety of look angles out of the spacecraft including near vertical views down at Earth, low oblique views at an angle, and high oblique views that include the horizon. Once converted to digital form, these images typically have pixel sizes of 20-80 m, depending on the lens used, look angle, and the resolution at which the image is scanned (see discussions of the images and database in Lulla et al. 1996, Robinson et al. in review).

Earth observation training for astronauts includes ecological, geological, geographic, oceanographic, environmental, and meteorological phenomena. Not surprisingly, the photographs they bring back to Earth are used by scientists of many different disciplines. Near-vertical or low-oblique angle photographs can be digitized at high resolution (2400 ppi, 10.6 µm/pixel) and used as three-band (red, green, blue) remote sensing images in the same way a scientist would use Landsat or SPOT data. Image processing techniques such as supervised and unsupervised classification and texture analysis can be applied to astronaut photographs to determine land use, land cover, or change over time (e.g., Webb et al. in press).

Concurrently, the nearly 30 000 photographs of coral reef areas taken by astronauts on board the Space Shuttle (Robinson et al. 2000) provide a valuable, but underutilized, data source for coral reefs scientists and managers. To facilitate the use of these public domain images, NASA's Earth Sciences and Image Analysis laboratory has been collaborating with the International Center for Living Aquatic Resources Management (ICLARM) to include astronaut-acquired photographs in *ReefBase: A Global Database On Coral Reefs* (McManus and Vergara 1998). Georeferenced Space Shuttle images were also used in a prototype for a ReefBase Geographic Information System (GIS), and provided an excellent visual tool for displaying spatial information related to coral reefs (Robinson et al. 2000).

Astronaut photographs of tropical coastal areas may contain information on submerged features, including coral reefs, up to depths of about 15 m in clear waters. Previous research efforts have shown that astronaut photographs can aid in estimating coral reef locations and extent on national, regional and global scales, and allow characterization of major geomorphological rim and lagoon features (Andréfouët et al. 2000, in preparation). They can be combined with traditional satellite data to help distinguish between clouds and lagoon features such as pinnacles (Andréfouët and Robinson, in review). Furthermore, astronaut photographs may provide reef scientists and managers with information on the location and extent of river plumes and sediment run off, or facilitate identification of land cover types, including mangroves (Webb et al., in press).

Photographs included in the section were selected based on several criteria. The primary consideration of the editors was that the photographs represent a worldwide distribution of coral reefs, have extremely low visual interference by cloud cover, and display a spatial scale reasonable for examining reef-related features. Once photographs were selected, they were digitized from 2nd generation copies. The color and contrast were hand corrected to an approximation of natural color (required to account for spectral differences between photographs due to the color sensitivities of films used, and differences in sun angle and exposure of the photographs). None of the photographs shown here have been georeferenced to correct them to a map projection and scale. Any distortions in features due to slightly oblique look angles when the photographs were taken through spacecraft windows remain. When feasible, near vertical photographs have been rotated so that north is toward the top. An approximate scale bar and north arrow have added using distinctive features on each photograph with reference to a 1:1,000,000 scale navigation chart.

Astronaut photographs provide a unique source of moderate resolution reef remote sensing data because of their global coverage and (immediate) availability in the public domain. The database of photographs can be searched an browsed online and high-resolution digital copies of photographs in this atlas can be accessed via the Website of Earth Science and Image Analysis at NASA's Johnson Space Center: http://eol.jsc.nasa.gov.

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Note: Depending on editorial preference and style, credits above may be modified.

References:

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Recommended photograph, if desired:
Legend: European Space Agency astronaut Gerhard P.J. Thiele photographs Earth from the Space Shuttle Endeavour in February 2000 (NASA photograph STS099-305-12).