10 years of ASTER Operation: Accomplishments

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The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is a high spatial resolution multi-spectral imaging radiometer on NASA's Terra satellite launched in December 1999. The ASTER program is a cooperative effort between NASA and Japan's Ministry of Economy, Trade and Industry (METI), with the collaboration of scientific and industry organizations in both countries. The ASTER instrument provides the next generation in remote sensing imaging capabilities compared with the older Landsat Thematic Mapper, and JERS-1 OPS scanners. ASTER has three spectral bands in the visible and near-infrared (VNIR), six bands in the short-wave-infrared (SWIR), and five bands in the thermal infrared (TIR) regions, with 15, 30, and 90 m spatial resolution, respectively. The VNIR subsystem has one backward-viewing band for stereoscopic observation in the along-track direction (Yamaguchi et al., 1998).

ASTER data acquisitions are based upon requests by users. There are three data collection categories for the science data: 1) local observations by individual users, 2) regional monitoring mainly by the ASTER Science Team, and 3) global mapping as background data acquisition. A global prioritization map was prepared by the ASTER Science Team by using inputs from various discipline working groups representing wide user communities. As data acquisition efficiency decreases when the global mapping target areas become patchy, we have repeated four global mapping cycles by modifying the observation parameters.

Currently ASTER is acquiring approximately 450 scenes per day. As of September 2010, ASTER had acquired about 1,800,000 scenes, of which about 600,000 scenes had been assessed as less than 20% cloud cover. In addition to the Level 1A and 1B products, the ASTER Ground Data System (GDS) in Japan and Land Processes Distributed Active Archive Center (LP DAAC) in U.S.A. generate higher level standard data products in response to requests from users. These are calibrated, geophysical parameters derived from the data; including surface radiance, surface reflectance, surface temperature, surface emissivity, digital elevation model (DEM), and orthorectified radiance at sensor.

The availability of an up-to-date, high resolution global digital elevation model (DEM) has been a priority of the Earth observation community for a long time. Until now, the best publicly available data set is the 90 m SRTM topography, covering 60 degrees north to 57 degrees south latitudes. The ASTER Project, under the auspices of Japan's METI and the United States NASA, has produced a global DEM (GDEM) from the entire ASTER image archive (Abrams et al., 2009). At the November 2007 GEO Ministerial Summit, NASA and METI were invited by GEO to contribute this global DEM to GEOSS. Both countries accepted the invitation. The ASTER GDEM was created by stereo-correlating the 1,400,000-scene ASTER archive; stacking and averaging the individual DEMs; cloud screening; and filling voids or holes using SRTM 100 m data where available; and validating the GDEM against higher resolution DEMs. Since June 2009, the ASTER GDEM has been available at no charge to users worldwide. It is packaged in 1°-by-1° tiles, and covers land surfaces between 83°N and 83°S (Figure 1) with estimated accuracies of 20 m for vertical data and 30 m for horizontal data. It is distributed by both METI's ERSDAC organization in Japan, and NASA's LPDAAC data center in the US.

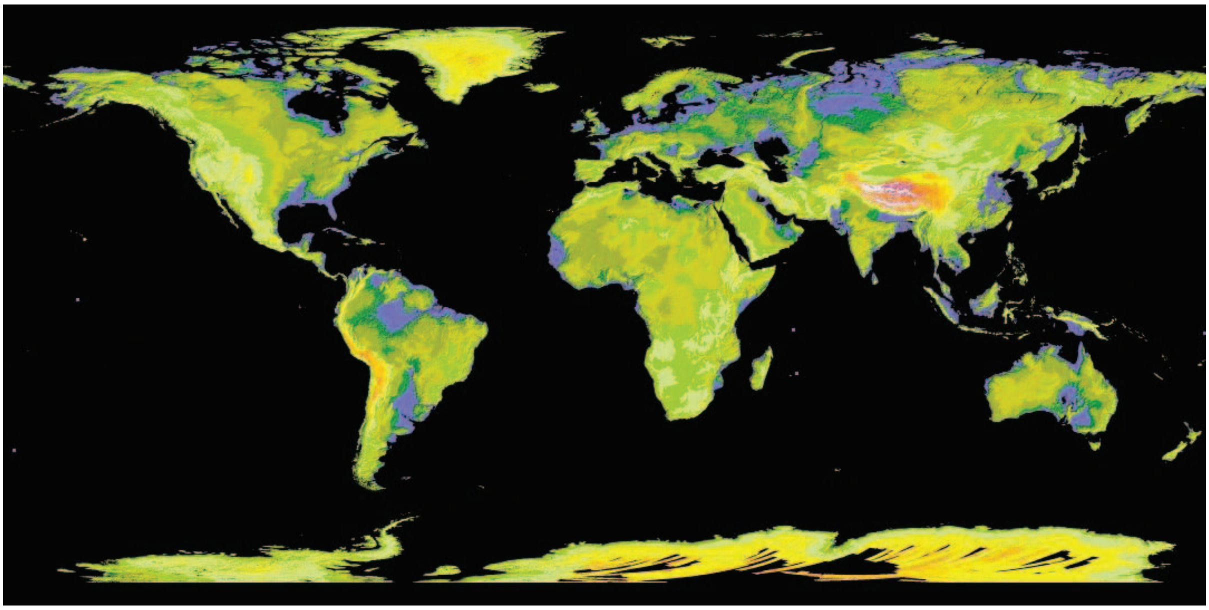

Figure 1. Color-coded ASTER GDEM. Highest elevations are white, lowest are dark blue.

A significant use of ASTER data for long-term monitoring of surface change is a joint effort with the US Geological Survey's Global Land Ice Monitoring from Space (GLIMS). In cooperation with over 60 institutions world-wide, GLIMS project is using ASTER data to monitor the spatial extent, velocity fields, and other glaciological parameters for thousands of glaciers around the world (Kargel et al., 2005). In addition, GLIMS develops tools to aid in glacier mapping, and maintains a centralized data base for images and analysis results. The National Snow and Ice Data Center maintains the GLIMS data base. Applications of GLIMS include: 1) global change detection--GLIMS' mission is to establish a global inventory of ice; monitoring glaciers across the globe and understanding not only the cause of those changes, but the effects, will lead to a greater understanding of global change and its causes; 2) hazards detection and assessment--Glacial changes may represent hazards for communities living near them. Outburst floods, landslides, debris flows, and debris avalanches can destroy property and take lives in a sudden rush of water, ice, sediment, rock, soil, and debris. It is not clear yet whether some of these hazards are a normal part of glacier behavior, or whether they signal dramatic new threats from a changing cryosphere; 3) glacier monitoring-- understanding glaciers leads to a greater understanding of our climate system, climate change, the formation of ice ages, and effects of global warming. Through the long-term monitoring of the world's glaciers GLIMS is able to build a base of historical data, detect climate changes early, and predict and avoid hazards to human communities living in the proximity of glaciers.

At the inception of the ASTER project, a strong emphasis was placed on monitoring active volcanoes. ASTER was tasked to observe ~1500 active volcanoes at least 2 times/year; some volcanoes were targeted every opportunity, including nighttime thermal infrared observations. The images are separately accessible from the ASTER Volcano Archive (AVA; http://ava.jpl.nasa.gov/default.htm), that provides 40,000+ ASTER images for the ~1500 active volcanoes listed in the Smithsonian Global Volcano Catalog. The data have been used to monitor the North Pacific (Ramsey et al, 2009), an area that includes Alaska and Kamchatka and is over-flown by hundreds of aircraft every day. Improved detection of eruption plumes, and better understanding of volcanic behavior prior to eruptions is the goal of several projects that use ASTER data.

The above are a few examples of the accomplishments of ASTER’s 10-year observation program. Hundreds of publications in the peer-reviewed literature describe an incredibly wide-ranging number of applications, spanning numerous and disparate disciplines.

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