Radar Images of the Earth and the World Wide Web

By

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NASA's Jet Propulsion Laboratory is known to most of the public as a center of planetary exploration, and has lead the world in its efforts to explore the solar system. JPL has sent spacecraft to every planet in the solar system (with the notable exception of Pluto). Less well known to the public, JPI, has also been studying our home planet, the Earth. One of the important discoveries of unmanned planetary exploration has been the realization that you can find out a lot about a planet from a couple hundred miles up.

Recently, with the imaging radar on-board the Magellan spacecraft, NASA/JPL was able to see through the clouds which mask our neighbor planet, Venus, and map '35% of the surface of Venus at a resolution of about 100 meters (328 feet). This was an enormous accomplishment, especially when one considers that a similar map does not exist for the land surface of the Earth (only one quarter of the land surface area of Venus!).

global image of Venus

However, NASA, and other international space agencies such as the European Space Agency (ESA) and the Japanese space agency (NASDA) have been quietly pursuing similar remote sensing endeavors aimed at the Earth. While we do not yet have a global radar map of the Earth's land surface, a significant fraction of the Earth has been imaged, often at a resolution of better than 25 meters (82 feet).

These radar maps have some advantages over conventional maps obtained through ground and airborne surveys, and optical imagery from orbiting satellites. Because imaging radar works by illuminating the Earth with radio waves, we may image during the day or night, and we may peer through clouds with little effect, allowing us to map areas that are perpetually shrouded in clouds. We may map areas that are quite inaccessible to ground and aerial surveys for either geographic or political reasons. And finally, radio waves interact with objects on the surface of the Earth differently than visible light, and sometime tell us things that would not be

image data of: topography or height contours, small-scale change in topography, the motion and thickness of sea ice in the Arctic, the length and direction of ocean waves, surface current speed in the ocean, snow cover properties, vegetation type and biomass content, moisture levels in soil and surface roughness. In the future, this research will make it easy for people around' the world to usc imaging radar data. in the meantime, the radar images still provide a great deal of information.

Pasadena perspective view
new long valley comparison image

Everyone has probably heard of NASA's efforts to spin off technology to the private sector (Teflon is the famous example). In the case of imaging radar technology, i t is maps and images that NASA and JPL are spinning off. The NASA/JPL Imaging Radar Home Page has recently been put on the World Wide Web (WWW). The WWW is part of the internet that may be navigated with powerful software such as Mosaic and Netscape. If you don 't currently have access to the WWW, you may want to make a trip to your local bookstore or library. There, you will probably find several references on procedures for gaining access to the internet and the World Wide Web.

If you do have access to the WWW, the NASA/JPL Imaging Radar Home Page is located at the following "URL":

http: / /southport.jpl.nasa. gov/

screen dump of the imaging radar home page

The imaging radar home page is geared to three audiences: scientific and commercial investigators of imaging radar data, educators looking for innovative teach ing tools, and the general internet community. Scientific and commercial investigators may access the home page to find out about availability of data at specific areas; for instructions on obtaining software for analyzing radar data; for on-line access to low resolution data products (advantages: no waiting for data to be sent through the mail; reduce likelihood of getting the wrong data; users may "browse" through data products);

and for communication to users of radar data through a bulletin board.

first page of sir-ted teachers guide

Educators may find a link to on-line educational CD-ROMS written both before and after the launch of SIR-C courtesy of the Educational Resources Information Center (AskEric) with high school level teaching guides, software tools, interact ive activities, and suggested problems for students to solve. Instructions are also given on obtaining the CD-ROMs through the mail, along with example student activities, and forthcoming materials. The general internet community may find radar images of their home town; 3-D animations of flights through Death Valley, the Galapagos Islands, and an erupting volcano in Kamchatka, Russia; 3-D perspective views of Pasadena, California and Mt. Pinatubo, Philippines; Anaglyphs of Mt. Everest (which require 3-D glasses); and contour maps of Mammoth Mountain, California. Clearly, each of the three target audiences will have overlapping interests in the materials. At the imaging radar home page, users will be able to find out the answers to questions such as : How can I get data? How can 1 get data over my site? How can I get data over my site when I want it? How do I handle the data when I get it?

These are difficult questions to answer. Each user has different requirements for coverage and different levels of expertise in handling radar image data. The NASA/JPL Imaging Radar Home Page site on the World Wide Web was set up to try to answer some of these questions. The NASA/JPL imaging radar home page potentially makes radar data available to a vastly larger audience than before.

The most immediate needs are to direct users of the home page to the resources that they desire to obtain, set up sample data sets, and indicate to users the potential usefulness of this information server. The long term objective is to provide a location where radar remote sensing data can be obtained easily over the internet, along with educational resources to broaden the commu nit y that may use the data. A typical future user could access the home page, click on a map of the world, and find, on-line, radar images from that site from a variety of instruments, and in a variety of data presentations.

screen dump of EDC coverage map

For years NASA/JPL projects have stirred the imagination of countless millions around the world. The Earth remote sensing endeavors being led by JPL can similarly strike a chord with the public, if given the exposure that the planetary data has been given. Using the internet to disseminate the images provides an unprecedented window through which the public can see the Earth from space.

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apparent on a photograph. With racial, we may observe not only rivers, mountain features, lava flows, deforestation, and glacier movements, but also in dry desert areas, radar penetrates beneath the surface to see ancient river beds. Over the oceans, we see currents and weather fronts. With radar images of agricultural fields, different crops and their state of growth may be distinguished and water drainage patterns identified.

Unlike the map of Venus, which is of substantial scholarly interest (scientists are excitedly poring over these maps, hoping to divine the mechanisms that created many unusual geologic features, and even more importantly, asking how Venus was created, and why it differs so much from the Earth), the radar images of the Earth, besides their scientific value, are of immediate practical benefit to people here on Earth. With the flights of the Space Shuttle Endeavour in April and October, 1994, JPL's Spaceborne Imaging Radar (SIR-C) imaged volcanoes violently erupting, the Amazon river flooding its banks, and man's encroachment upon the habitat of the endangered Gorilla's in the jungles of Africa, among other things, while mapping 10% of the Earth's land surface. Some of these images were published in this magazine (December 1994).

picture of SIR-C in the cargo bay of' the space shuttle

The results from this mission are the fruition of years of work. The imaging radar program at NASA's Jet Propulsion Laboratory began almost twenty years ago with a series of experimental radars flown on rockets and aircraft. This program has led to a number of notable technical achievements, including the development of the world's first spaceborne imaging radar, the discovery of buried river channels in the Sahara desert using imaging radar, the Magellan imaging radar that mapped over 95% of the surface of the Planet Venus (1990-1 994), and the first multi--polarization, multi-frequency imaging radar flown in space (SIR-C/X- SAR, 1994). in addition, a parallel airborne radar development program has resulted in the enormously successful NASA/JPL imaging radar known as AIRSAR that has flown missions to collect radar image data and topographic data for scientists all over the world since 1988.

picture of volcanoes in the Philippines

Currently, researchers at JPL and research centers around the world are studying new techniques for generating maps from radar