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New Digital Imagery from Historic 1978 Seasat Satellite

by Tom Logan, Alaska Satellite Facility

A new suite of digital imagery featuring historic views of Earth's oceans, sea ice, volcanoes, forests, glaciers and more will be available for the first time from ASF in mid-summer 2013. The products will be derived from data collected nearly 35 years ago by NASA's Seasat satellite — the earliest orbital synthetic aperture radar (SAR) ever gathered. Although it suffered a catastrophic power failure in its fourth month of operation, in 106 days Seasat collected more information about the ocean surface — its original focus — than had been acquired in the previous 100 years of shipboard research. ASF's suite of products from the mission, available to users under NASA's open-access data policy, will surely prove invaluable to a range of scientific disciplines.

On June 27 GMT, 1978, NASA undertook a momentous task: To demonstrate the feasibility of orbital remote sensing for ocean observations, it launched the Seasat satellite. This platform hosted an L-band SAR sensor that collected imagery with a resolution of 25 meters, obtained in 100 km-wide swaths covering

much of North America, Northern Europe and the adjacent seas. Seasat's SAR images detected surface waves, internal waves, the Gulf Stream system, the California Current, the North Pacific subtropical front and various other coastal phenomena. More than 100 passes were recorded over the Beaufort Sea, providing insight into major morphological features, structural changes and drift motion of sea ice. Even with the power failure on October 10 of the launch year, Seasat succeeded in its primary goal of taking oceanography into space.

During operation, Seasat utilized two basic orbital configurations. The primary initial observational phase was a 17-day repeat cycle. On September 10 GMT, the satellite was maneuvered into an exact 3-day repeat. Years later, these repeat-pass data enabled scientists to pioneer the now nearly ubiquitous technique of interferometric SAR analysis, showing that Seasat data are applicable to much more than just ocean observations. Other, non-interferometric applications may include the following:

 Seasat data could be compared to boreal forest maps from the Japanese Earth Resources Satellite 1 (JERS-1) to identify land cover changes between 1978 and 1997,



Figure 1: Seasat image of Los Angeles obtained July 21, 1978. Processed by ASF April 2013.

- the seven orbit cycles of 3-day repeat data may be useful to show whether rates of deformation over known active faults in North America and Pacific Rim volcanoes are consistent with observations today and
- the data acquired in 1978 over Norway and Alaska could be utilized for glacial change observations, establishing a much older baseline than is currently available from other sensors.

Since Seasat was not equipped with an onboard recorder, during the mission three U.S. ground stations (Fairbanks, Alaska; Goldstone, California; and Merritt Island, Florida) collected data in real time. Two international stations also came online about midway through the mission (Shoe Cove, Newfoundland, and Oakhanger, United Kingdom). To ensure that this valuable archive was preserved, the raw data tapes were first duplicated in 1988 and again in 1999.

During the second transcription, the data were transferred from older 39-track tapes to more modern SONY SD1-1300L 19mm tapes. It is from these 13-year-old tapes that ASF's online Seasat archive was obtained during the fall of 2012. Although *Continued on page 2*



Figure 2: ASF Seasat coverage map.

some data have degraded beyond usability, data from all five of the ground stations are in ASF's holdings, and newly created coverage maps match favorably to the older coverage maps obtained from NASA's Jet Propulsion Laboratory (JPL). Beyond this, the European Space Agency (ESA) has asked NASA to process any additional or higher-quality Seasat data the agency may be able to provide—a task that ASF's Seasat processing system will be uniquely positioned to accomplish. While much of the data collected in the U.S. were processed optically, only an estimated 3 to 15 percent of Seasat data was ever digitally processed. In the 1980s, JPL's technology was able to process only one image a day. Today, ASF, which has the only current processing system for Seasat data, can easily produce an image in less than 30 minutes. For nearly 35 years, the majority of the SAR dataset from this historic mission has been unprocessed, and it has spent the last 14 years residing on tapes in the ASF archives, basically unavailable to scientists in the 21st century.

Until now.

ASF researchers are processing Seasat SAR archives into imagery products. A telemetry decoding system is in production, ASF's Seasat holdings have been captured to disk and the data have been filtered into readily processable signal files, in spite of the many metadata problems resulting from multiple transcriptions and 35 years of "bit rot." In concert with this decoding effort, engineers at ASF are developing a robust processing system to generate a) raw signal swaths, b) processed single look complex and c) detected georeferenced products in HDF5 format with ISO 19115 compliant metadata in XML format. When the beta version products become available in summer 2013, remote sensing scientists will have access to one of the most groundbreaking and unique datasets ever collected—the newest oldest SAR data around.



Figure 3: Seasat images of the Kuskokwim Delta, Alaska. Processed by (a) JPL, May 1987 and (b) ASF, April 2013. Image artifacts include the calibration pulse (which appears as a solid line in the range direction) and some banding resulting from raw data loss.

ASF Wetlands Data Portal Provides Suite of Web Resources for Exploring Derived SAR Data Products

by Angela R. Allen, Alaska Satellite Facility

Fine-resolution maps of critical wetland regions and new tools for accessing their data, available since January on the Alaska Satellite Facility (ASF) website, have become search-engine favorites. In three months, the interactive portal (Figure 4) has become one of the top three Google results for "wetland data"—out of millions of search results.

Despite the importance of global wetland ecosystems in climate change and the cycling of carbon and water, their extent and dynamics are poorly understood. ASF's new Wetlands datasets and tools tap the power of spaceborne synthetic aperture sensing (SAR) in filling this gap. SAR is particularly sensitive to surface water and vegetation structure and allows monitoring of large inaccessible areas over time regardless of atmospheric conditions or solar illumination.

The online suite of resources, available through computers and mobile online devices, includes the following:

- time series animation that enables easy visualization of global wetland inundation dynamics (Figure 5),
- a time series data analysis tool that allows users to select a geographic location and generate a graph of water inundation and snow cover for an area of interest (Figure 6),
- a data download service that offers image mosaics, maps and other data products on selected regions of the Earth for immediate download and
- a clearinghouse of photos, videos, audio and social media intended to familiarize users with wetlands, their role in the environment, and conservation issues related to the rapid degradation and loss of these vulnerable ecosystems.



Figure 5: Time series animation allows visualization of wetlands data.



Figure 4: ASF's Wetlands data portal.

The ASF team serving the NASA project Making Earth Science Data Records for Use in Research Environments (MEaSUREs) developed these resources using two types of regional-to-global scale data products from the project's Inundated Wetlands Earth Science Data Record.

The first type of product features 100-meter maps of wetland extent, vegetation type and seasonal inundation dynamics derived from SAR for continental-scale areas. The maps were created with newly available data (HH/HV) from the Phase Array L-Band SAR sensor mounted on the Advanced Land Observing Satellite built and operated by the Japan Aerospace Exploration Agency. The data were processed using algorithms based on an object-oriented image segmentation approach and a statistically based decision-tree classifier.

The second product type consists of global, 10-day mappings of inundation extent at ~25 km resolution derived from multiple



Figure 6: Time series data analysis tool allows users to generate graphs showing water and snow dynamics.



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Continued from page 3

satellite remote sensing observations including passive and active microwave sensors and optical data sets optimized specifically for inundation detection. A clustering model and a mixture model comprise the classification and fractional inundation calculations of the algorithm used. Monthly data were used to construct annual products including maximum spatial distribution and area, and annual inundation duration of inundated wetlands.

To begin wetlands data discovery, go to portal.asf.alaska.edu/ wetlands.

NASA EOSDIS User Registration System at ASF

Starting in late May, ASF users are asked to login before downloading SAR Data Center products and software tools. User authentication is conducted by the NASA EOSDIS User Registration System (URS), which is fully integrated into ASF systems. The transition was designed to have as little impact as possible on the ASF user community while simultaneously providing access to additional EOSDIS data and services available to URS account holders.

Submissions and Subscriptions

This newsletter provides detailed information about special projects and noteworthy developments, as well as science articles highlighting the use of ASF data.

With the next edition, *ASF News & Notes* will be published only online. It will be available at www.asf.alaska.edu, and readers can receive the newsletter via email by emailing our User Support office at uso@asf.alaska.edu. Back issues are also available on the ASF website.

Submissions to *ASF News* & *Notes* and suggestions about content are always welcome. If you are interested in contributing materials, please call or send an email to the editor:

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