UNAVCO Annual Report

FACILITY SUPPORT OF THE WINSAR ARCHIVE FOR CRUSTAL DYNAMICS RESEARCH

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Annual Report for FY2009 (1 June 2008 – 31-March 2009)

EAR-0733437 UNAVCO Facility Support of the WInSAR Archive

1.0 Executive Summary

The activities of the Western North America InSAR (WInSAR) Archive and Consortium during the first year of Grant EAR-0733437 are described in this report. This Grant funds the UNAVCO Facility to operate the WInSAR Archive, including data acquisition mainly through purchase of SAR data, and archiving and distribution of InSAR archive data to the WInSAR Consortium members and data users. The Grant also funds an archivist to handle data and metadata archiving and data ordering; and a software developer to enhance the underlying archiving software and the user interface for data search, access, and delivery to the WInSAR community. The WInSAR Archive leverages the data purchased from mainly the European Space Agency (ESA) to maximize the number of users and the potential for exciting science results to be generated based on the data. The WInSAR Consortium membership has grown to 53 US Members and 17 Adjunct members from around the globe. The membership meets annually at the Fall American Geophysical Union meeting to conduct business and to elect the WInSAR Executive Committee.

During the report period, an additional 1,200 scenes were purchased from the European Space Agency and were archived and made available to WInSAR membership. The membership picked up 2,700 scenes during the report period. The WInSAR catalog also shows the Alaska Satellite Facilities L1 PALSAR data pool that is also available to WInSAR membership. The L1 data pool added close to 10,000 scenes during the report period.

WInSAR scientists have utilized the WInSAR archive to produce over forty publications since the WInSAR proposal was submitted; these publications detail innovations in WInSAR analysis methods and their application to a wide range of Earth science problems.

2.0 PI Science Investigations

The Western North America InSAR (WInSAR) Consortium is a collection of universities and public agencies created to manage the acquisition and archiving of spaceborne InSAR data. WInSAR is a collective organization coordinating the interests of many scientists in different fields. We concentrate primarily on geophysical investigation and modeling of shallow crustal processes such as earthquakes and volcanoes, but consortium members have ongoing research in hydrology, cryospheric studies, vegetation science, and oceanography, as well as sponsoring research in as yet untested application areas.

Technically, most of our innovation has been in the development of new data analysis methods and their application of geophysical problems. In particular, we have pioneered the use of advanced modeling and inverse methods, quantifying detailed deformation fields in order to learn about processes at depth in the crust. Much of our work involves numerical and analytical modeling of deformation phenomena, and now is moving toward incorporating extensive time series analysis into data reduction methods. Covering the breadth of several fields and incorporating large numbers of radar scenes leads to the large volume of data acquired under this proposal.

The main purpose of WInSAR is to facilitate research in these many areas using pools of shared data, enabling science to be accomplished without requiring each individual proposer to request data for each investigation. This approach saves considerable effort on the part of data providers in servicing requests from the U.S. research community, as WInSAR catalogs and maintains data for all consortium members. WInSAR's approach is also helpful for U.S. sponsoring agencies, as data requests are coordinated and internally peer-reviewed for adherence to WInSAR's goal of facilitating basic research, reducing the need for the agencies to conduct extensive reviews of many disparate requests.

The western part of North America is the focus of intensive scientific research into a variety of plate boundary processes including earthquakes, volcanism, mountain building, and micro-plate tectonics. The technique of spaceborne Interferometric Synthetic Aperture Radar (InSAR) provides an excellent means of observing deformation over broad areas. WInSAR members have used InSAR data for the following primary objectives:

- Monitor strain accumulation and release along the North American/Pacific Plate Boundary with an emphasis on the San Andreas Fault Zone.
- Monitor the deformation of volcanic systems in the western US.
- Monitor crustal deformations at selected sites in the Basin and Range province and along the Baja California peninsula.

The western part of North America is the focus of intensive scientific research into a variety of plate boundary processes including earthquakes, volcanism, mountain building, and micro-plate tectonics. For example, the characterization and more complete understanding of the plate boundary deformation system, and its relationship to the occurrence of earthquakes, is a rich scientific problem that may ultimately lead to a reduction in seismic risk. Other natural processes that induce surface deformation such as land subsidence induced by water or oil extraction are also at work in western North America. Increasingly, WInSAR members are also exploring InSAR data from actively deforming regions world-wide, and we expect that both the scope and membership of WInSAR will become increasingly global.

The technique of spaceborne Interferometric Synthetic Aperture Radar (InSAR) provides an excellent means of observing deformation over broad areas. It is capable of 10's of meters spatial resolution at monthly or greater intervals. InSAR has proven to be a powerful tool to characterize large-scale deformation associated with active faults. It also can resolve small-scale deformation features such as shallow creep, postseismic and interseismic deformation. And it is an ideal tool for measuring land subsidence and improving digital terrain models.

As part of the research and development efforts of WInSAR members we have; promoted the use and development of InSAR technology for scientific investigations, in particular but not limited to, seismic and magmatic processes, plate boundary deformation, land subsidence, and topographic mapping; provided value-added InSAR products and software for use by the scientific community; and advocated the open exchange of SAR data by seeking to enlarge the number of member organizations.

3.0 WInSAR Consortium

3.1 Executive Committee

The WInSAR Executive Committee (EC) holds regular teleconferences that include UNAVCO staff. With advice from UNAVCO on operational implications, the EC makes decisions regarding the use of WInSAR funds and the operational priorities for UNAVCO. WInSAR telecon notes are posted on the UNAVCO WInSAR website (http://winsar.unavco.org) “Documents” section, which also contains links to reports on InSAR research by WInSAR scientists to space agencies. The EC and UNAVCO collaborated during the report period to complete the revisions of the Charter and have it accepted by the UNAVCO Board and WInSAR membership. The EC and UNAVCO collaborated to submit a new Category-1 proposal ESA (Category-1 proposals are ESA’s mechanism to authorize data purchase and tasking requests for research purposes), which was accepted. The two predecessor Category-1 projects were closed and a final report was submitted to ESA.

UNAVCO hosted the WInSAR Annual Business Meeting at AGU.

3.2 Membership

Institutional membership stands at 70, including 53 full members (US institutions), 5 Adjunct I members (North American institutions outside of the US), and 12 Adjunct II Members (rest of the world). With approval by the EC, seven new full members, one Adjunct I member, and four Adjunct II members were added during the report period. There are 164 data users.

4.0 UNAVCO Data Support

The UNAVCO Facility provides administrative, operational, and data support to the WInSAR Consortium as described in the WInSAR Charter. For the report period, about half the budget covers data costs and half covers personnel costs, including activities of a data archivist to order and archive data and software development to enhance the archiving and distribution of WInSAR data.

Major activities during the report period included:

- ordering data, accounting for data deliveries, and reconciling invoices
- enhancing software for archiving data
- enhancing software for requesting data orders through the WInSAR website
- enhancing software for data access and distribution through the WInSAR website
- data user support for finding and accessing data
- participation in the planning and simulated execution of the InSAR data portion of ShakeOut, the simulated Southern California great earthquake.

4.1 Data Holdings

WInSAR data holdings at UNAVCO include 7,598 scenes available to the users through the UNAVCO WInSAR search website (http://winsar.unavco.org/search.php). Table 1 shows the total holdings within in each mission. Figure 1 shows Google Earth images of the SAR scene footprints for WInSAR holdings.

Table 1. WInSAR holdings by mission.

Satellite Mission	Scenes	Size, Gigabytes
ERS1	2025	371
ERS2	4505	687
ENVISAT	1068	220
Total	7598	1278

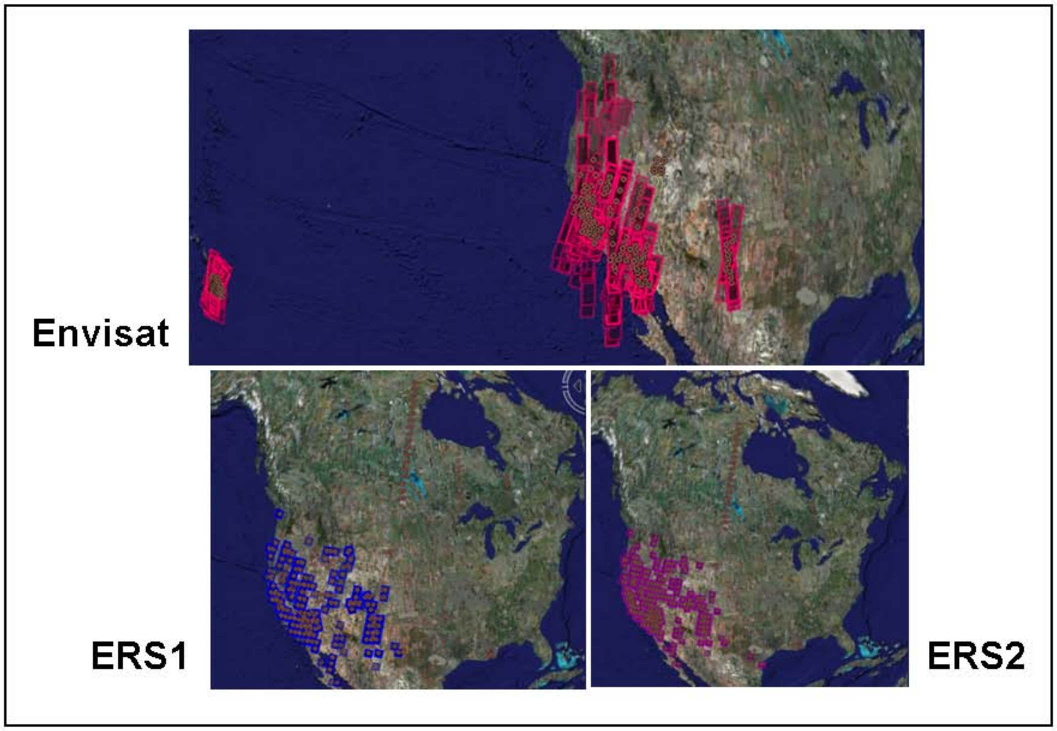

Figure 1. Google Earth images of data holdings in the WInSAR Archive for the ESA Envisat, ERS1, and ERS2 missions.

Placement of orders to ESA and regular downloads and ingests are executed regularly. During 2008, holdings for WInSAR to increase by 16% due to regular orders. Table 2 shows the data ordered and received during calendar year 2008. In addition to ordering archived scenes, UNAVCO executed several tasking orders to add to data available for ordering from ESA. As part of the ShakeOut exercise, UNAVCO created ESA shopcarts with maps and posted them on the website to assist with response simulation.

Many WInSAR users are particularly interested in the ALOS PALSAR data pool at the Alaska Satellite Facility for their research. Though not part of WInSAR holdings, UNAVCO assisted with diagnosing data quality and system availability with the data pool in coordination with ASF staff. UNAVCO facilitates WInSAR scientists' ability to search the data pool catalog by holding metadata from the data pool in the WInSAR database which then be searched trough the WInSAR website search interface. ASF makes this metadata freely available, which helps facilitate this operation.

Table 2. Data purchases for calendar year 2008.

Satellite Mission	Scenes	Size, Gigabytes
ERS1	226	48
ERS2	488	85

ENVISAT	499	104
Total	1,213	237

For achieving the goals of the GeoEarthScope project as well as WInSAR, UNAVCO has cultivated a strong, respectful relationship with ESA. This has helped to ensure continued special pricing for data ordered by UNAVCO for WInSAR scientists. With the approval of the WInSAR Executive Committee, as a favor to ESA UNAVCO performed some scripting and made a server available to ESA for testing of their SuperSites data delivery model.

4.2 Data Pickups

Data pickups by WInSAR data users during calendar year 2008 are summarized in Table 3. The table does not reflect a separate process for synchronizing large quantities of data with several of the former WInSAR peer nodes that occurs on a regular basis.

As part of the ShakeOut exercise, UNAVCO created packages of data from the WInSAR archive covering the simulated epicentral area for pickup by participating InSAR scientists.

Table 3. Data pickups by WInSAR users for calendar year 2008.

Satellite Mission	Scenes	Size, Gigabytes
ERS1	445	86
ERS2	1,391	223
ENVISAT	831	172
Total	2,667	481

4.3 WInSAR Data Management Software and Web Site

UNAVCO continues to enhance the information and user interfaces for WInSAR users. The WInSAR web site at UNAVCO is the focal point for the membership to gain information about WInSAR activities, for users to search and gain access to data holdings, and for users to place order requests. The documents area of the website was kept updated with reports, proposals, and summary presentations by WInSAR scientists. The publications section of the web page was reorganized.

The WInSAR Archive operates through a Mysql database, PHP website software, data ingestion scripts (to store metadata in the database catalog, making the holdings searchable), and miscellaneous data management scripts. A key component of the archiving process is the Mysql database, which holds metadata about WInSAR data holdings, ESA's track and frame information, WInSAR order requests, and WInSAR users and members. Improvements to the database such as incorporating relational constraints, which had been omitted in the original design because of MySql limitations, were implemented in 2008. Database security procedures were enhanced. Improvements to the regular backup procedures were also implemented in late 2008. A test instance of the database and a second development web server were also set up so that development work could go forward without impacting the production activities. The ingestion software, which handles metadata extraction from incoming data files for storing in the database, must continually be updated as the data providers make changes in data formats or data file naming. UNAVCO added computation and database storage of incoming file checksums; this allows long term file integrity monitoring based on the checksums.

During the report period, UNAVCO enhanced the website in several ways. The interface for requesting data frames or swaths to be ordered from ESA was enhanced so that users can select individual Envisat scenes for ordering through the WInSAR interface (previously the users needed to use the ESA Eoli interface to create an Eoli shopcart if they wished to request Envisat ordering). This ordering interface also was enhanced to show GeoEarthScope holdings along with WInSAR holdings so that users recognize that there is no need to order data that is already in the GeoEarthScope collection. Finally, software development work has been initiated to replace the java map interface in the WInSAR search web Graphical User Interface with a GoogleMaps based spatial search capability.

UNAVCO's software, database, and website enhancements are ongoing.

5.0 Science Publications by WInSAR Researchers Since 2005

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