**POSITION STATEMENT**

# Space-borne Synthetic Aperture Radar

**(Approved by the IEEE-USA**
**Board of Directors, 20 June 2014)**

Space-borne Synthetic Aperture Radar (SAR) and Inteferometric Synthetic Aperture Radar (InSAR) are invaluable resources for such critical applications as monitoring tectonic plate movements; measuring glacier shrinkage; charting ocean currents; tracking ground water depletion; all-weather surveillance of vegetation conditions; surveying man-made structures, such as dams and levees; and observing changes in urban development. At present, several foreign operational civil radar imaging satellites exist, but there are none in the United States.

Even though U.S. engineers and scientists launched the first SAR satellite mission, the past four decades have seen no U.S. civil space-borne SAR missions. The Department of Defense operates all U.S. space-based SAR and InSAR missions, and classifies them top secret. U.S. civilian remote sensing researchers are dependent on foreign operational satellite SAR programs. In addition, some foreign agencies require financial resources to purchase data from their missions. These circumstances have led to decreased SAR research and expertise at U.S. universities and national laboratories, a shortage of students working in this area and an aging science and engineering workforce skilled in SAR research. As a result, the United States is falling behind other countries in this important research discipline.

To keep pace with growing foreign remote sensing capabilities, the U.S. government should adopt policies that will promote the resurgence of an efficient, internationally competitive, civil remote sensing enterprise- one that uses SAR and InSAR instrumentation - and space missions that balance private sector growth with public sector capabilities.

IEEE-USA recommends that NASA, NOAA and the DOD:

- Support development of dedicated civilian SAR and InSAR remote sensing technologies and capabilities, including a space-borne, synthetic aperture radar system.

- Create a funding initiative to stimulate SAR and InSAR research at U.S. universities and government labs and bring students and researchers into this critical area of research and development.

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- Develop SAR and InSAR remote sensing policies and research programs that encourage private investment in U.S. commercial space ventures.

- Facilitate the dissemination of data products from civil, space-borne SAR and InSAR remote sensing missions and encourage foreign governments to make data from their satellite programs more readily available to U.S. academic institutions.

- Declassify DOD SAR and InSAR data and authorize its distribution to remote-sensing engineers and scientists, after a hiatus as recommended by the National Academy of Sciences and the DOD.

These recommendations correspond closely to a 2005 National Research Council recommendation that "NASA significantly expand existing technology development programs to ensure that new enabling technologies for critical observational capabilities, including interferometric synthetic aperture radar, are available to support potential mission starts over the coming decade."[1]

This statement was developed by the IEEE-USA's Committee on Transportation and Aerospace Policy, and represents the considered judgment of a group of U.S. IEEE members with expertise in the subject field. IEEE-USA advances the public good, and promotes the careers and public policy interests of the more than 206,000 engineers, scientists and allied professionals who are U.S. members of the IEEE. With more than 400,000 individual members in 160 countries, IEEE is the world's largest technical professional society. Positions taken by IEEE-USA do not necessarily reflect the views of IEEE, or its other organizational units.

**BACKGROUND**

There are many civil radar-imaging satellites throughout the world, but U.S. civilian agencies don't operate any of them. The U.S. Department of Defense also deploys airborne and space-borne SARs, but shares very little of the resulting data and measurements with civilian researchers. There haven't been any dedicated civilian synthetic aperture radar (SAR) satellite programs since the NASA/National Geospatial-Intelligence Agency Shuttle Radar Topographic Mission (SRTM) in 2002. Its purpose was to produce a three-dimensional image of 90% of the earth, using inter-ferometric synthetic aperture radar (InSAR) technology. Nor have any operational civilian satellites carried a SAR since the short-lived SEASAT program in 1978.

[1] "Earth Science and Applications from Space: Urgent Needs and Opportunities to Serve the Nation," Committee on Earth Science and Applications from Space: A Community Assessment and Strategy for the Future, National Research Council (2005), p. 6. On-line at: http://www.nap.edu/catalog.php?record_id=11281

SAR and InSar remote sensing technologies can be used for many important purposes. One is to monitor earth movements with accuracies approaching centimeter scales, with some measurements approaching millimeters. InSAR satellite data available today enables geophysicists to estimate the slip rate of the San Andreas Fault.

Researchers have also used SAR and InSar imaging technologies to map residential subsidence caused by ground water depletion; measure the shrinkage of polar glaciers and ice caps; monitor changes in ocean currents; track tropical hurricanes and cyclones; produce high resolution ocean surface wind maps; identify ice bergs and glaciers that may threaten navigation; and survey the health of man-made dams and levees. These applications all require SAR/InSAR data products not readily available to civilian investigators in the United States.

Many non-U.S., space-based radar satellites routinely collect this data. Europeans obtain SAR data from the European Union's ERS 1, ERS-2 and ENVISAT satellites. Canadians get SAR data from their RADARSAT and RADARSAT-2 satellites. Germany's TerraSAR-X and Tandem-X satellites have very high resolution mapping capabilities. Italy uses a constellation of x-band SARs in its COSMOSKYMED program, which produces both SAR and InSAR images. Japan is advancing its SAR technology and using it in new science applications. China's Yaogan 1, 2, and 3 satellites are all equipped with space-based synthetic aperture radar (SAR) systems.

U.S. investigators are currently handicapped by having to depend on foreign agencies for SAR and InSAR data products. Fortunately, European Space Agency data is free and readily accessible online. Japanese data is also free. German TerraSAR-X data costs a few hundred dollars for a number of scenes. Others require significant financial resources that are often beyond the reach of U.S. academic researchers.

In 2005, the National Research Council conducted a survey of the earth and environmental sciences communities about the adequacy of related research programs at U.S. overnment agencies. A principal finding was that the paucity of satellite missions undercuts the observational capabilities needed to sustain a strong enabling technology base. Of particular concern was the vitality of fields which depend on vigorous research and analysis programs to attract and train engineers and scientists, provide opportunities to exploit new technologies and use new theoretical understandings in discovery and high priority applications. A cited example was the lack of programs needed to take advantage of SAR and InSAR technologies.

The U.S. academic community has been hampered by the paucity of space-borne SAR and InSAR data needed to conduct research, attract and train students, and strengthen U.S. civilian capabilities in SAR and InSAR technologies. It is particularly difficult to secure funding to train U.S. graduate students in the application of SAR data acquired from foreign sources. This problem is exacerbated by the extensive use of space-based SAR and InSAR satellites by Canada, Japan, China and many European nations. These programs are able to exploit facilities and provide data that are not readily available to U.S. researchers. As a result, the United States conducts very little SAR research.