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Advances in Synthetic Aperture Radar for Geologic Studies

Diane L. EVANS (California Institute of Technology /JPL, USA)

Data from the Spaceborne Imaging Radar and X-band Synthetic Aperture Radar (SIR-C/X-SAR), the European Space Agency's Remote Sensing Satellites (ERS-1/2), and Japan's Earth Resources Satellite (JERS-1) have advanced the state-of-the-art in utilization of multiangle, multifrequency, multipolarization, and multitemporal SAR observations for geologic applications. Specific examples include studies of past climate changes and their impact on the land surface; studies of soil processes such as erosion, transportation, deposition and degradation; and investigations of natural hazards such as floods, earthquakes and volcanic eruptions. Key parameters of interest include surface roughness, topography and topographic change.

Surface roughness maps derived from SAR data have been found to be useful for lithologic discrimination, particularly when combined with maps of compositional information derived from sensors operating in the visible, short-wave infrared, and thermal infrared portions of the electromagnetic spectrum. SAR-derived topographic information has the potential for making major advances in our understanding of geologic processes and natural hazards. Cross-track SAR interferometry, in which two measurements are obtained at slightly different look angles, can be used for height measurement on the order of 1-5 m. Combining one cross-track interferornetry data pair with a third measurement, obtained at a different time, allows the measurement of centimeter-scale shifts in the Earth's surface over time. This technique, known as differential interferometry, can be used to map the effects of earthquakes, volcanic expansion, and ice sheet motion over large areas.

Cloud-penetrating capabilities have made SAR an important sensor for studies during floods and volcanic eruptions. In addition, the ability to penetrate through a thin veneer of sand cover has resulted in the use of SAR data for several arid region investigations.

Speaker's name and mailing address: (Please type)
Diane Evans
180-703 JPL Pasadena, CA 91109--USA
Tel: 818-354-2?18 Fax: 818-393-1492 E-mail: evans@berlin.jpl.nasa.gov

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