VISAR: A Next Generation Inteferometric Radar for Venus Exploration, S. Hensley[1], S. Smrekar[1], S. Shaffer[1], M. Paller[1], H. Figueroa[1], A. Freeman[1], R. Hodges[1], P. Walkemeyer[1], [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr, Pasadena, CA, 91109, Scott.Hensley@jpl.nasa.gov

Introduction: Magellan, a NASA mission to Venus in the early 1990's, mapped nearly the entire surface of Venus with an S-band (12 cm) synthetic aperture radar and microwave radiometer and made radar altimeter measurements of the topography, [1]. These measurements revolutionized our understanding of the geomorphology, geology and geophysical processes that have shaped the evolution of the surface of Venus. However, the lack of finer resolution imagery and topography of the surface than that obtained by the Magellan mission has hampered the definitive answer to key questions concerning the processes and evolution of the surface of Venus. The Venus Emissivity, Radio Science, InSAR Topography And Spectroscopy (VERITAS) Mission is a proposed mission to Venus designed to obtain high resolution imagery and topography of the surface using an X-band radar configured as a single pass radar interferometer (called VISAR) coupled with a multispectral NIR emissivity mapping capability.

Science Objectives: VERITAS has as major scientfic goals to: 1) understand Venus' geologic evolution, 2) determine what geologic processes are currently operating, and 3) find evidence for past or present water.

Mission Overview: VISAR will operate from slightly eceentric nearly polar orbit, 88.5° inclination angle orbit, with an average altitude of approximately 220 km. Operating for a period of three Venus days or cycles (3x243 Earth days) VISAR will generate imagery and topography globally for the surface of Venus. VISAR will map surface topography with a spatial resolution of 250 m and 5 m vertical accuracy and generate radar imagery with 30 m spatial resolution globally and 15 m resolution for approximately 15% of the planet surface. These capabilities represent an order of magnitude or better improvement of the Magellan system and are expected to reveal definitive information on key geologic processes not possible with the Magellan data.

Intrument Overview: The VISAR instrument is an X-band, 3 cm wavelength interferometric radar designed to meet the topographic mapping and imagery requirements. Wavelength selection was predicated on overcoming the losses due to transmission through the thick Venus atmosphere (loss goes as f^2 in dB) and working with a constrained interferometric baseline length of 3.1 m, the maximal achievable on the spacecraft without going to a deployment mechanism. We found an optinal wavelength of about 3.8 cm when operating with a look angle (angle from nadir) of 30°. The radar operates with a bandwith of 20 MHz which gives a range resolution of about 7.5 m or 15 m when projected onto the ground. The azimuth or along-track resolution is about 2 m, hence we have at least 7-8 looks for imagery and around 1800 looks for topographic products. In order to be able the downlink the data required to make a global product it is necessary to do onboard image formation and interferogram generation which provides an approximate 1000 fold reduction in data volume compared to the raw radar data. By collecting both asecending and descending orbits everywhere we expect to get nearly global coverage with only minor gaps due to layover and shadow. Extremely steep slopes can also be constrained with high resolution imaging. We will use tiepoints between overlapping orbits for ephemneris improvemnts and a "bundle adjustment procedure" in order to seamlessly mosaic the 14.4 km image strips in final topographic and image products.

In addition to the single pass interferometry for topographic measurement we also intend to use repeat pass observations of selected targets (e.g. 200 by 200 km) to look for currently active deformation of the Venus surface. Using repeat pass obsevations we can detect surface deformation at the centimeter scale and detect sub-wavelength distrubances to the surface between observations. Although there will be 243 days between observations we know the atmosphere and surface allow such observations based on experience with Magellan data [2].

References:

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