MAPPING THE TOPOGRAPHY OF MAXWELL MONTES USING GROUND-BASED RADAR INTERFEROMETRY.

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Introduction. One of the major unsolved puzzles about the surface of Venus is the composition and formation process of the radar-bright, low emissivity material that covers much of the high altitude terrain. Maxwell Montes, centered at a latitude of 65° N, is the tallest structure on Venus with elevations 12 km above the mean planetary radius (MPR) [1]. In the case of Maxwell Montes, the emissivity decreases for elevations greater than about ∼5 km above the mean radius and shifts back towards normal, plains-type values at elevations greater than ∼9 km [2]. The onset of the high Fresnel reflectivity at high altitudes suggests that a temperature and/or pressure dependent process is responsible for the changes; for example, alteration of a mineral phase or condensation of atmospheric constituents [3, 4].

Although the general trend in emissivity vs. height is known for Maxwell [5, 6, 7], it is not entirely clear whether the onset of the low emissivity occurs at a fixed altitude across the entire mountain, and whether the transition back to normal emissivities also occurs at a specific altitude. The Magellan altimeter data have a spatial resolution of about 10 by 30 km at the latitude of Maxwell, and although the nominal height resolution is ∼20 m, the digital elevation model (DEM) produced by the altimeter has unrealistic values for very steep and very rough areas of the mountains. Figure 1 shows the Magellan DEM for Maxwell, overlaid onto a Magellan Synthetic Aperture Radar (SAR) image for comparison. The low resolution and problems with measuring altitudes across steep slopes make it difficult to study local changes in the emissivity with altitude. For example, the transition to plains like emissivities at very high altitudes on Maxwell does not appear to follow a constant topographic level [6]. This might be due to post-emplacement tectonic activity or to temporal variability in the amount of condensate available, but it could also be due to errors in the altimetry [6].

Radar interferometry can be used to measure topography, and ground-based radar has been used previously to measure topography of lunar craters [8]. We use similar interferometric observations to derive a topographic map of Maxwell Montes with a higher spatial resolution than is available from Magellan.

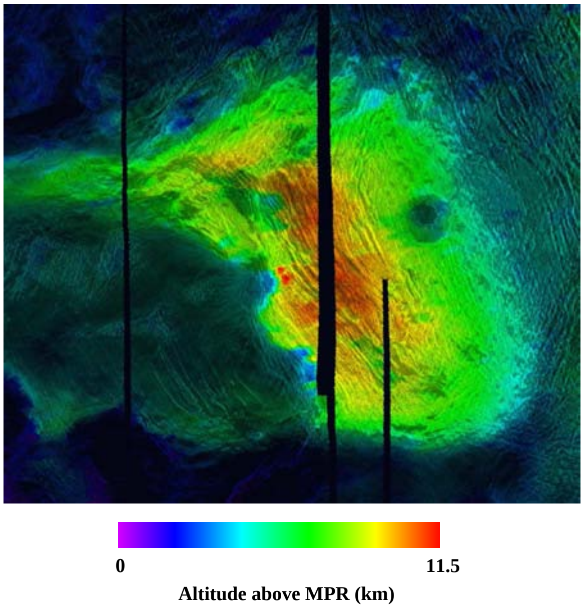

Figure 1: Magellan altimetry of Maxwell Montes overlaid onto a SAR image.

Observations. We used the Arecibo Observatory and Green Bank Telescopes to obtain interferometric observations of Venus. The Arecibo radar was used to transmit a circularly polarized 12.6 cm wave, and we received the echo at both telescopes. The delay-Doppler images were mappped to Mercator projection and registered. We then computed the complex product of images from each telescope to produce maps of the fringe phase across the mountain, and removed the phase contributions from the spherical surface of Venus.

The resulting maps have a spatial resolution of 1–2 km, and the height resolution of the topography is about 200 m, which corresponds to a 30° change in the fringe phase. We acquired data in 2001 and 2004; changes in viewing geometry and improvements to the Arecibo telescope increased the signal-to-noise for the later observations.

Results and Discussion. Results from interferometric observations in 2001 gave good fringes around the outer perimeter of the high-reflectivity area of Maxwell and allowed us to calculate slopes in regions that are very noisy in Magellan data. Figure 2 shows a Mercator projection map of the fringes obtained on March 25, 2001 as well as a Magellan image for comparison. For the 2001 data set, it is not possible to track the phase through the very rough central areas of the mountain, which prevents the generation of a complete DEM. For local regions, especially near the structure's periphery, our results give slopes consistent with the Magellan data. A comparison of the fringe map with Figure 1 shows that the interferometic data does a better job of measuring altitudes along the steep western part of Maxwell.

From the 2001 observations we can determine whether the onset of the low-emissivity terrain occurs at a con-

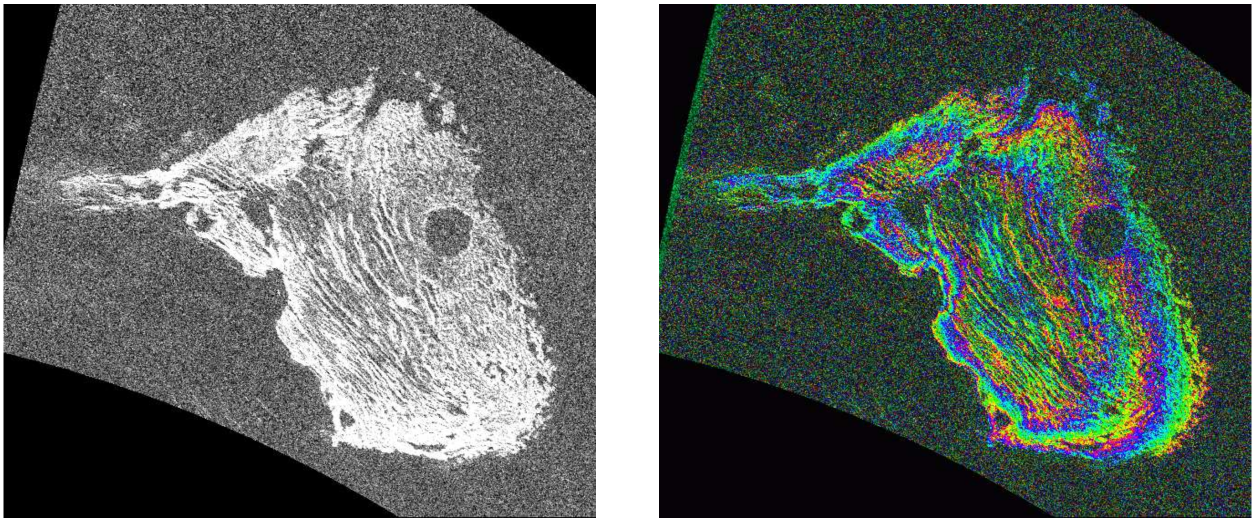

Figure 2: Interferometry data from March 2001. *Left:* An Mercator projection total power image of Maxwell Montes from data received at the Green Bank Telescope. *Right:* An interferometric fringe image of the same area. It is possible to track the fringe phase around the outer perimeter of Maxwell, including the steep western portion. The fringe image was masked using the total power image in order to highlight the fringes; the signal-to-noise off the high-reflectivity portion of Maxwell is too low to allow for topographic measurement.

stant altitude on all sides of Maxwell, and we can measure local slopes around the outer margin of the high-reflectivity region. The experiment was repeated in 2004 to acquire data with better signal-to-noise that could potentially allow us to track the fringe phase across central areas of Maxwell. These data are currently being processed. We hope to produce a topographic map for Maxwell that can be used for more localized studies of the high-reflectivity, low emissivity behavior, as well as for measurement of steep slopes and for tectonic studies.

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