

**INVESTIGATING AIRBLAST FEATURES ON THE VENUSIAN SURFACE USING MAGELLAN AND ARECIBO RADAR DATA.** J. A. Kelly<sup>1,2</sup>, and N. R. Izenberg<sup>1</sup>, Campbell, B. A.<sup>3</sup> <sup>1</sup>Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA (joshua.kelly@jhuapl.edu) (noam.izenberg@jhuapl.edu), <sup>2</sup>Liberty High School, Eldersburg, Maryland, USA <sup>3</sup>Smithsonian Institute, Washington, DC, USA.

**Introduction:** Splotches, or airblast features, on the surface of Venus are primarily caused by the atmospheric pressure wave created by the disintegration and incineration of intermediate sized impactors (meteorites or comets of ~200 m to 3 km diameter depending on composition and velocity) above the surface due to Venus' thick atmosphere [1]. They were documented and mapped globally in synthetic aperture radar (SAR) data from the Magellan mission (1989-1994) [2]. Of the 401 cataloged splotches, 138 are also visible from earth via the Arecibo Observatory radar system [3]. While Magellan observed Venus' surface transmitting and receiving linearly polarized S-band radar (usually horizontally polarized transmit and receive, or HH), the Arecibo system transmits circular polarized S-band, and receives both same sense (SC) and opposite sense circular (OC) polarization radar reflections from Venus' surface.

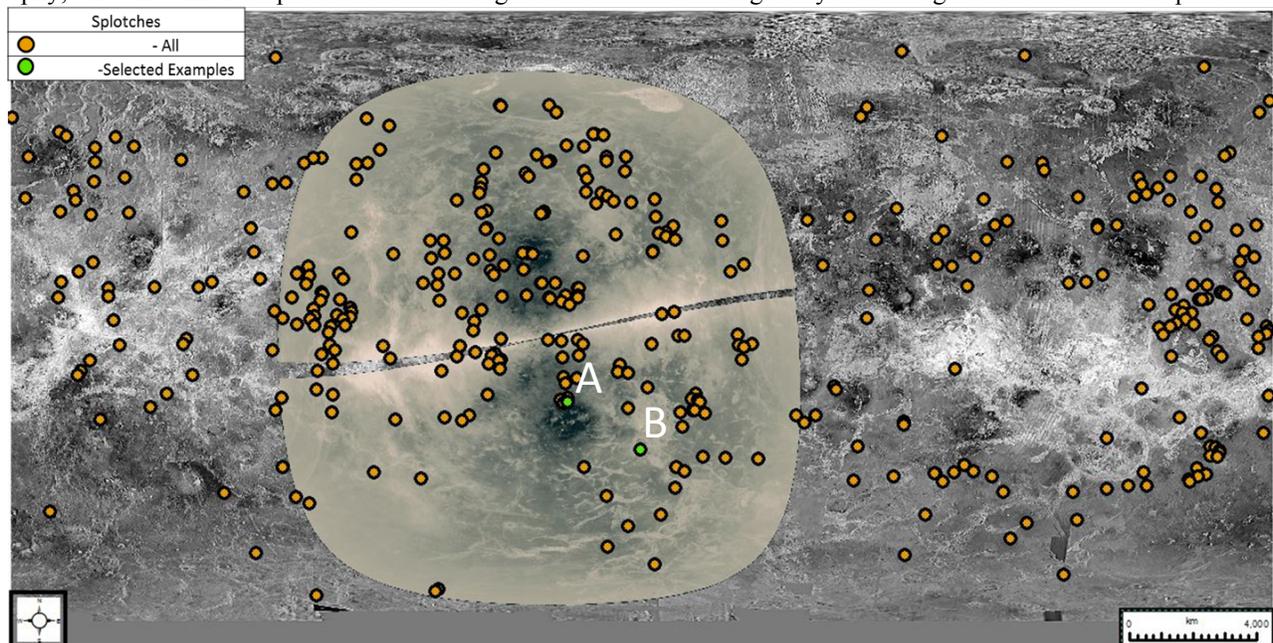
We analyzed the differences in radar return signal for select splotches on Venus between Magellan (HH) and Arecibo (SC and OC). Using Arc GIS (Geographic Information System), we then created profile graphs of each splotch on both Magellan and Arecibo images and evaluated the differences in splotch shape, brightness, and location on all three maps.

Radar returns are affected by surface properties including surface roughness at the scale of the radar wavelength (12 cm for S-band), composition, and stratigraphy, and the different polarizations of Magellan and

Arecibo radar observations may reveal more details about the origins, relative ages, and evolution of splotch features.

**Methods:** Using Arc, GIS we co-registered geographically the 2015-Arecibo SC [5] map (at 1.5-2 km/pixel) to the Magellan global HH radar map (75 m pixel) (Fig. 1). We then labeled all splotches cataloged by [1] and created a list of which were visible on both maps. Next, using the list of splotches, we selected several for a more detailed investigation. Selection was first based on location. Arecibo spatial resolution decreases away from the sub-earth point, and radar incidence angle is very high near sub-earth, and low near the horizon. The region intermediate to sub-earth and the edges of the Arecibo has a good compromise between viewing geometry and spatial resolution. Next, we narrowed our selections down to those which had the largest qualitative differences between Magellan and Arecibo. This could indicate that each radar was responding to different properties of the features. We initially selected seven candidates for more detailed investigation using the highest Arecibo resolution (0.89 km/pixel) and both SC and OC polarization, beginning with North-South and East-West profiles of radar return across the target splotches in all 3 data sets [5]. Initial analysis of three of these seven are shown here (Figs. 2-5).

**Observations:** The Magellan global map tends to have higher dynamic range than the Arecibo maps. Both



*Fig. 1. Equidistant Cylindrical Map of Magellan (75 m/pixel) SAR, overlaid by Arecibo (1.5-2 km/pixel), recolored for better visibility. All splotches are labeled, with the examples in Fig. 2 and Fig. 4, highlighted and marked A and B respectively.*

maps tend to track each other (radar brightness increasing and decreasing similarly over the same spatial profile) but in some instances, they appear to diverge. For example, on the N-S profile graph of splotch #320 (Fig. 3), just south of the spike in brightness at splotch center, Arecibo data appears to have a decreasing brightness trend from south to north, outside the splotches, while Magellan appears to have a near constant background. The differences in the two radar backgrounds may be due to a smooth subsurface resulting in a consistent reflectivity for Magellan due to Snell’s Law, and a more accurate reflectivity observed from the greater incidence angle of Arecibo, or due a thickening mantle of fine material better captured by SC and OC radar. [3]. The location of the splotches #320 and #321 slightly overlaps the outskirts of the radar-dark “Crater Farm” centered at -27.5, 339.0E, and may be influenced by diffuse fine material from that region.

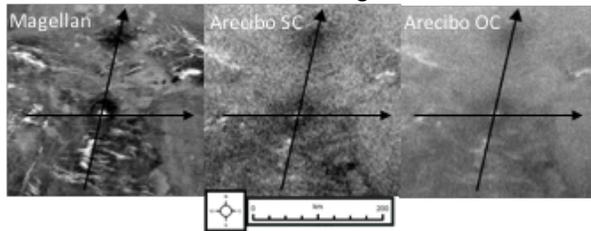


Fig. 2. Radar images from Magellan and Arecibo (SC and OC) of splotch #320 (-20.6, 338.8E) and #321 (-20.8, 337.5E). S-N and E-W profile lines are marked. Left: Magellan, Middle: Arecibo SC, Right: Arecibo OC. (Scale Bar 0-200 km)

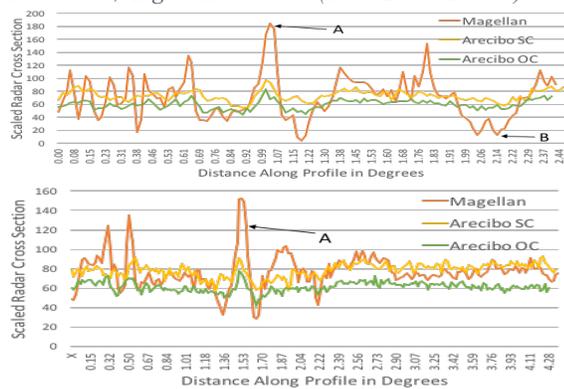


Fig. 3. Profile graphs of splotch #320 (A) and #321. (B) Top: N-S profile crosses both splotches, Bottom E-W profile. Center of splotches are marked with arrow.

For splotch #348 (Fig. 4), the profiles (Fig. 5) reflect the lower SAR contrast of Arecibo vs. Magellan within the splotch itself. The Magellan E-W profile shows a significant rise in SAR return east of the splotch center not seen by Arecibo. This may be due to Magellan’s greater resolution and sensitivity to sub-km scale topography. Additionally Arecibo SC and OC returns for this region are significantly more offset than for #320 and #321.

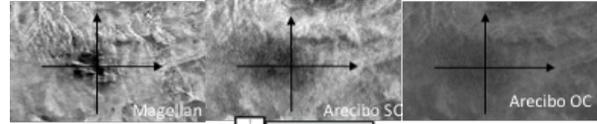


Fig. 4. Radar images of splotch #348 (-34.1, 359.5E) with profile lines indicated as in Fig. 2 (Scale Bar 0-200 km)

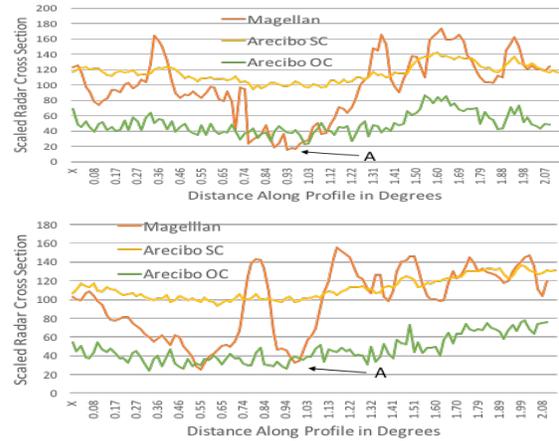


Fig. 5. Profile graphs of splotch #348 (A). Top: N-S profile, Bottom E-W profile. Splotch center is marked with arrow.

**Ongoing Analysis:** We are continuing to compare the images and profiles of our initial splotch data set to improve understanding of their stratigraphic and physical relationships to their surroundings. We also hope to learn more about how these features alter with time to see if they each is stratigraphically the youngest feature in its locality, and if there is a definable age progression for splotches like there is for impact craters [6]. Arecibo radar can often reveal subsurface material, previously undetected. This penetrative property may allow for further analysis of surface weathering. We will also derive linear polarization and SC/OC ratios to help understand surface and subsurface properties.

**Conclusion:** Many airblast features found on the Venusian surface appear to differ between Arecibo and Magellan maps. The Arecibo maps have more muted contrasts and lower spatial resolution, due primarily to viewing geometry and distance, but some differences between Arecibo and Magellan radar signals are likely due to physical makeup, stratigraphy, and/or composition of the splotch features. These differences in radar return may prove informative in determining the nature and history of a given splotch, and of the utility of splotches in interpreting the history of the regions in which they are located.

**References:** [1] Allen (2000) University of Arizona PhD Thesis. [2] Saunders et al. (1992) *JGR*, 97 E8, 13067-13090. [3] Carter et al. (2004). *JGR*, 109, E06009. [4] Carter et al. (2006). *JGR*, 111(E6) E06005. [5] Campbell, B. A. (2017) Pers. Comm.. [6] Izenberg et al., (1994), *GRL*, 21 (4) 289-292