UNDERSTANDING THE THRESHOLD OF DETECTION IN MAGELLAN SYNTHETIC APERTURE RADAR DATA USING VENUSIAN AND TERRESTRIAL DUNE FIELDS. L. X. Rader, B. J. Thomson, C. M. Fedo, and M. C. McCanta, Dept. of Earth and Planetary Science, University of Tennessee Knoxville, Knoxville, TN 37996 (lrader2@utk.edu).

Introduction: Experience with crater counts indicates that surface features need to be greater than 10 to 18 pixels across for reliable identification and characterization in remotely sensed data [e.g., 1]. The Magellan synthetic aperture radar (SAR) data have a spatial resolution of 75 m/pixel, which obfuscates features below about a kilometer in scale while allowing analysis of larger-scale features [2]. These smaller-scale features are important for describing long-term surface conditions (e.g., weathering, deposition). Aeolian bedforms that can reach up to a few kilometers in size on Venus are just at the threshold of detectability in the Magellan SAR images due to the SAR spatial resolution. In order to properly detect and describe any aeolian features on the surface of Venus, and get a handle on their implications (e.g., for long-term wind patterns), we must understand the unique, diagnostic characteristics of aeolian features for low resolution SAR images and how these Magellan images can be interpreted.

Aeolian features of the scale observed on Venus are also found often in hyper-arid desert regions on Earth, with this study focusing on the Simpson Desert in Australia [3]. Dune fields on this scale (10–100 km) have also been referred to as mega-dune fields, ergs, sand seas, or draa fields, but this study will refer to them as dunes and dune fields [4]. This work seeks to identify the diagnostic characteristics of terrestrial dune fields at both visible and radar wavelengths and quantify the differences between them, using Earth as an analog for Venus to aid in the interpretation of Magellan SAR data.

Background: Dune fields have been recognized on several planetary surfaces, including Earth, Mars, Venus, and Titan [e.g., 5]. On Earth, there are several different types of dunes, including barchan or crescentic dunes, star dunes, dome dunes, and parabolic dunes [4-5]. On Venus, the dune types that have been observed to date are linear or transverse, which imply bi-directional or uni-directional winds, respectively [5-7]. Venusian surface conditions have been modeled using the Venus Wind Tunnel [8]. These experimental results, coupled with wind speed measurements from the Venera landers, demonstrates that grain saltation is feasible and aeolian bedforms can form in such an environment [9].

The terrestrial analog site consider here is the Simpson Desert, with inland longitudinal dunes with average wavelengths of 12 m and average lengths of 250 km [10]. The dune field is on alluvial plains at the edge of Lake Eyre [10].

Methods: SAR data of this dune field has been acquired by the European Space Agency's Sentinel-1B mission; optical (VIS) satellite imagery has been compiled by ESRI in the World Imagery Layer [11]. The Sentinel-1B radar data have a spatial resolution of 5 m/pixel [11], and the ESRI World Imagery Layer has been converted to images that have an average spatial resolution of 3.5 m/pixel. The SAR images were downloaded from the European Space Agency (ESA) open source data tool (https://scihub.copernicus.eu/dhus/#/home) using the Sentinel-1B Single Look Complex Interferometric Wide swaths as raw images [12]. Using the ESA Sentinel Application Platform (SNAP), each image was pre-processed through radiometric calibration, Terrain Observation with Progressive Scans SAR (TOPSAR) deburst, multilook averaging, and geometric terrain correction [13]. The Sentinel-1 radar images are exported in geotiff format with a spatial resolution of 13.5 m/pixel. From there, the images were loaded into in ArcGIS and the linear features were mapped at the full resolution. Then the geotiffs were downsampled from 13.5 m/pixel to 75 m/pixel and mapped a second time to match the spatial resolution of Magellan SAR data [2].

The optical imagery was clipped to a polygon highlighting the region of interest. Within the Simpson Desert, the linear features are mapped at the high

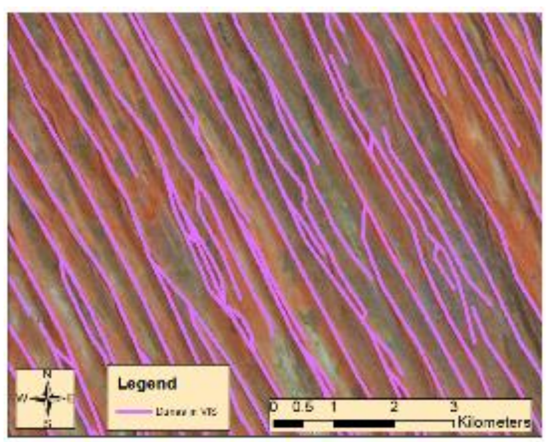

Figure 1. An example area of the Simpson Desert in VIS mapped at 0.5 m/pixel. Dune crestlines are mapped with solid purple lines.

resolution of [0.5 m/pixel] and used as a control image for the true location and visibility of the bedforms.

Results: *Simpson in VIS at 0.5m/pixel:* The Simpson desert in VIS has visible dune crestlines that are long and linear. The features exhibit sinuosity with bifurcation and stand out against the lighter inter-dune areas (Figure 1).

Simpson in SAR at 13.5 m/pixel: The Simpson dune field in SAR is seen as a radar-dark field with radar-bright features. The features are linear, slightly sinuous with visible bifurcation. The dune crestlines are clearly visible against the radar-dark inter-dune areas (Figure 2a).

Simpson in SAR at 75 m/pixel: In the 75 m/pixel spatial resolution image of the Simpson Desert in SAR crestlines are still visible with minimal sinuosity. The edges are blurred and indistinct, however, with radar-bright spotty streaks over a radar-dark field (Figure 2b). The mapped features are still visible, though most points of bifurcation evident at higher resolution are not identifiable at 75 m/pixel (Figure 2). The low resolution image has more noise than the high resolution image that makes the inter-dune area less consistently radar-dark and the linear features with more gaps between radar-bright pixels (Figure 2).

Venusian Feature Fields: Recognized venusian aeolian fields show radar bright streaks on top of a radar dark field. Features can be visually identified, however the Aglaonice dune field is unclear and speckled. The Fortuna-Meskhent dune field has clearer linear features that are radar-bright on a radar-dark background. There are also other features that have been identified as wind streaks [6], that have a relationship with the linear features, consistently intersecting perpendicular to the wind streaks, regardless of orientation.

Discussion: The terrestrial dune fields show a loss of the smallest characteristics from the high-resolution images to the low-resolution images and a muddling of their more pronounced morphologic characteristics. Sinuosity of the crestlines is smoothed and dunes that formed within a close proximity to each other merged into one, with bifurcation also becoming unclear and difficult to accurately delineate. Venusian dune fields have been mapped [14] and compared to the Simpson Desert images, showing a similar lack of detail around the edges of dunes and with the smaller characteristics. The distinct pattern of radar-bright linear features with a slight sinuosity show the dune field on a radar-dark surface on both Earth and Venus [14]. Future work will be exploring a second terrestrial analog site and outgroup testing other surface features that could create a population of radar-bright linear streaks on a radar-dark background.

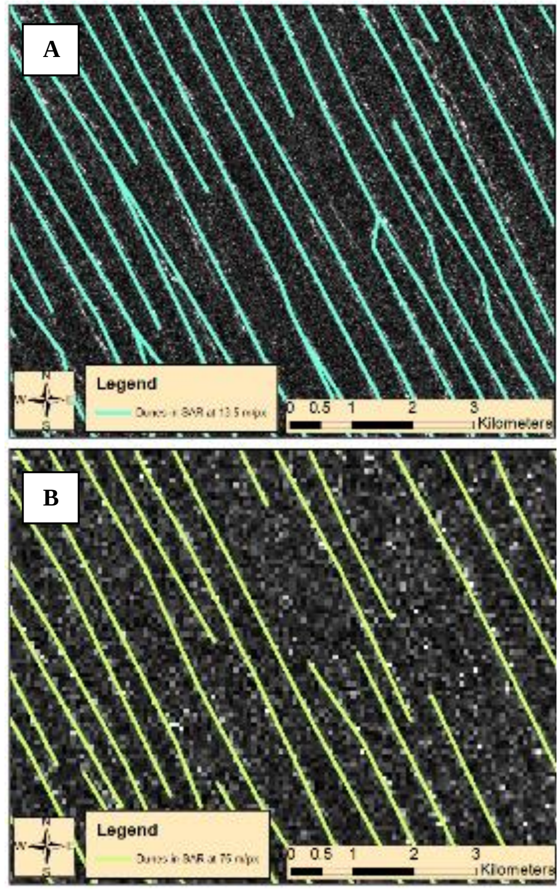

Figure 2. (A) Example area of the Simpson Desert given in Fig. 1 in SAR with dune crestlines mapped at 13.5 m/pixel. (B) Same example area of the Simpson Desert in SAR with dune crestlines mapped at 75 m/pixel.

References: [1] Robbins S.J. et al. (2014) *Icarus*, *234*, 109-131. [2] Saunders R.S. et al. (1991) *Science*, *252*, 249-252. [3] Lancaster N. (2009) *The Geological Society of America*, 1-25. [4] Nichols G., (2009) *Sedimentology and Stratigraphy*. John Wiley & Sons. [5] Diniega S. et al. (2017) *Aeolian Research, 26*, 5-27. [6] Greeley R. et al. (1992) *JGR*, *97*, 13319-13345. [7] Weitz C.M. et al. (1994) *Icarus*, *112*, 282-295. [8] Greeley R. et al. (1984) *Icarus, 57*, 112-124. [9] Iversen J.D. and White B.R. (1982) *Sedimentology, 29*¸111-119. [10] Folk R.L. (1971) *Sedimentology*, *16*, 5-54. [11] Torres R. et al. (2012) *Rem. Sen. Enviro.*, *120*, 9-24. [12] Prats-Iraola, P. et al. (2015) *IEEE Int. Geosci. and Rem. Sen. Symp.*, 5247-5251. [13] Veci, L. et al. (2014) *IEEE Int. Geosci. and Rem. Sen. Symp,* 1-3. [14] Rader L.X. et al. (2019) *LPSC L*, Abstract #2979.