TOPOGRAPHIC DATA ACQUISITION FOR THE VERITAS 2023 ICELAND FIELD CAMPAIGN. Erwan Mazarico[1], Daniel C. Nunes[2], Gael Cascioli[3,1], Suzanne E. Smrekar[2], Jeffrey Andrews-Hanna[4], Nils Müller[5], Luciano Iess[6], Akin Domac[5], Jennifer L. Whitten[7], Debra L. Buczkowski[8], Lauren M. Jozwiak[8], Gaetano Di Achille[9], Marco Mastrogiuseppe[6], Christopher W. Hamilton[4], Gro Pedersen[10]; [1]NASA Goddard Space Flight Center (erwan.m.mazarico@nasa.gov), [2]NASA Jet Propulsion Laboratory, [3]University of Maryland Baltimore County, [4]University of Arizona, [5]German Aerospace Center (DLR), [6]University of Rome La Sapienza, [7]Smithsonian Institution, [8]Johns Hopkins University Applied Physics Laboratory, [9]INAF - National Institute for Astrophysics, [10]University of Iceland.

Introduction: The NASA Discovery mission VERITAS (Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy) will explore Venus in the early 2030s, acquiring foundational global datasets that will reshape our understanding of planetary evolution [1]. In addition to a gravity science investigation [2] and a near-infrared spectrometer (VEM) [3], a synthetic aperture radar (VISAR) [4] will globally map the surface at X-band wavelength (~4 cm). To better interpret the radar backscatter measurements, relate them to physical properties such as surface roughness, and intercompare them with other radar datasets (Magellan S-band and EnVision VenSAR S-band), the VERITAS science team conducted a field campaign in Iceland, in collaboration with a multi-band radar mapping airborne campaign by the German Aerospace Center (DLR) [5,6].

Field Campaign: The field campaign took place in early August 2023 over two weeks, split between the volcanic flows in the Holuhraun/Askja region in the central highlands and the 2021-2022-2023 eruption sites at Fagradalsfjall in the Reykjanes Peninsula (Figure 1). Specific locations were selected for their diverse set of morphologies, based on preparatory analysis of airborne and satellite data [7]. The ground team collected several types of scientific data and samples, such as permittivity [8] and near-infrared emittance [9]; here we focus on the high-resolution elevation data collected with lidar by three ~3-person teams.

Data Collection Strategy: Three small portable terrestrial laser scanners (TLS), namely Leica BLK360 units owned by NASA JPL (2) and NASA GSFC GIFT (1), were used to collect millimetric-accuracy altimetric ranges. Each scan was recorded at the highest resolution setting (~6 million points over 360° azimuth and ±45° elevation), with ancillary visible and thermal panoramas, which allows each laser point to be later visualized in real colors and can facilitate registration and analysis steps. Each scan was recorded on the onboard 32GB memory chip and could be synchronized to iOS/Android phones and tablets in the field for backup. The transfer of the scan data to computers and backup drives represented a significant challenge given poor software and download speeds.

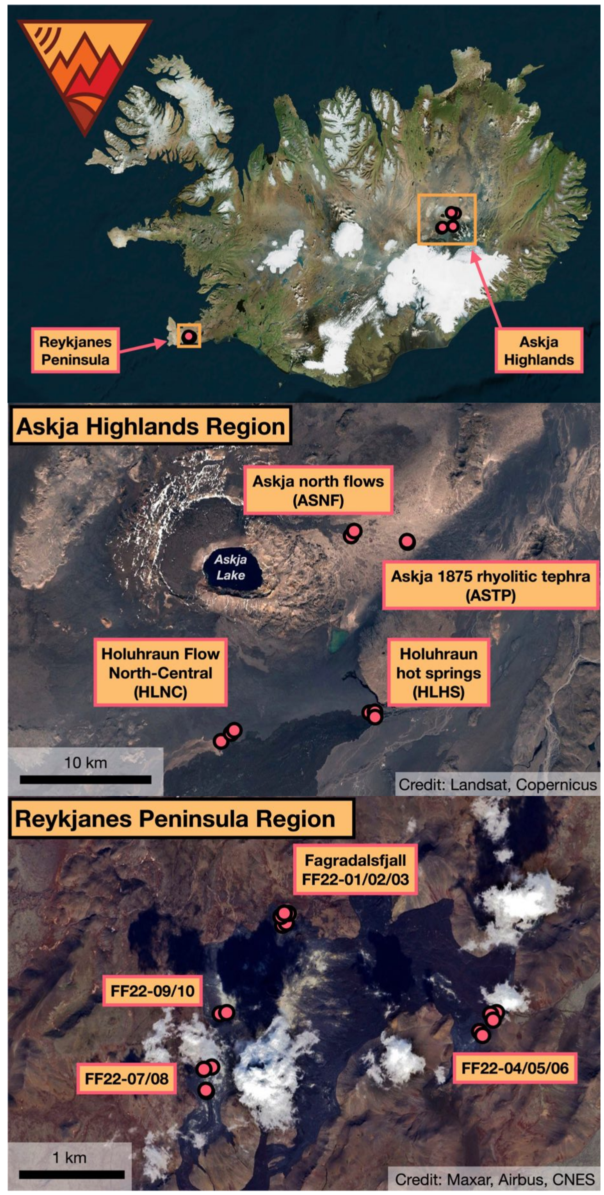

Figure 1. Context map of Iceland with the two regions where the field campaign took place. The maps of the highlands near Askja and of the Fagradalsfjall area in the Reykjanes Peninsula show the individual sites where topographic TLS data were collected.

At each site, the goal was to collect 5×5m DEMs with maximal spatial coverage (*i.e.*, inner gaps due to consistent shadowing over the individual scans were minimized). This was achieved by performing 8-10 scans at each site from various stations. Prior to the campaign, raytracing simulations were conducted to test various station patterns (Figure 2), leveraging 5-cm DEM data previously collected over part of the Holuhraun flow [10]. Given the need not to disturb the surface at mm-cm scale between the lidar scanning and airborne mapping, no station was placed inside the target 5×5m area. The two main patterns that were used, depending on team, site conditions, and navigability, are shown in Figure 2. Depending on schedule and weather, each team could collect 1-3 patches per day.

Differential GPS (dGPS) data to georeference the individual scans and combined patches were collected using Emlid Reach RS+ (1) and RS2+ (2) units, as well as a Geode connected to a laptop. Except in limited cases where line-of-sight visibility and distances prevented it, one of the RS2+ was setup for ~10 hours as the 'base' antenna, from which 'rover' units could get relative ~cm relative positioning. Post-processing of the recorded base RINEX files through Precise Point Positioning (PPP) services can then lead to absolute ~cm positioning in WGS-84 coordinates. For details on the data processing and preliminary analysis, refer to a companion abstract [11].

Data Collection Results: The TLS data collection effort matched or exceeded the pre-deployment expectations. In total, 328 individual scans were collected among 41 5×5m patches. Raw data extracted from the TLS scanners amount to ~300 GB in the proprietary Leica format, which we later converted to E57 and LAS formats. Table 1 summarizes the overall data collection results, etc. Refer to Figure 1 to match the site name to its geographic location.

Conclusion: The VERITAS 2023 Iceland field campaign was successful in acquiring topographic data that will yield mm-cm resolution DEMs. This will enable their use to understand the radar response of volcanic flows, and support the interpretation of the data to be collected by VERITAS at Venus.

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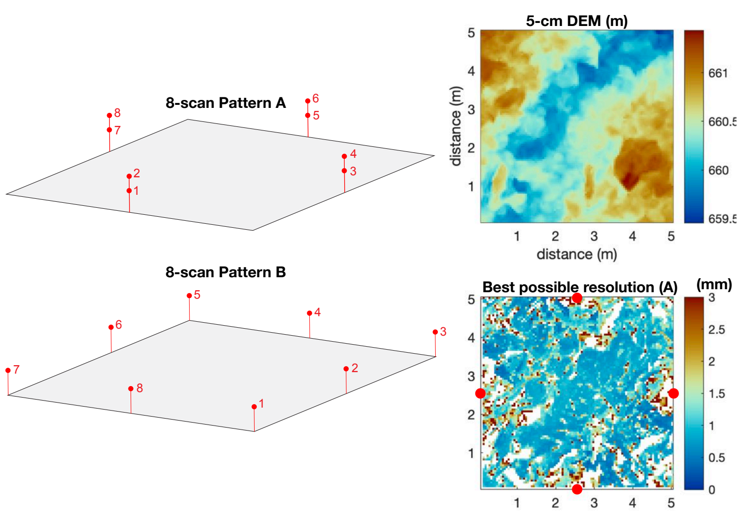

Figure 2. (left) Main TLS scan patterns used in the field to map the 5×5m patches, depending on site conditions (roughness and potential for shadowing; accessibility). (right) Pre-campaign simulation based on 5-cm DEM to evaluate shadowing and resolution for different pattern configurations. Pattern A shown here.

Table 1. Summary table of collected TLS data.

Group Name	Number Patches	Date
ASNF	4	8/3
HLHS	7	8/4
HLNC	4	8/5
DYSS	5	8/6
ASTP	2	8/6
FF22	19	8/9–12