ADVANCING VENUS GEOPHYSICS WITH THE NF4 VENUS ORIGINS EXPLORER (VOX) GRAVITY INVESTIGATION. E. Mazarico[1], L. Iess[2], F. de Marchi[2], J. C. Andrews-Hanna[3], and S. E. Smrekar[4], [1]NASA Goddard Space Flight Center, Greenbelt MD, 20771, USA (erwan.m.mazarico@nasa.gov); [2]Sapienza University of Rome, Rome, Italy; [3]Lunar and Planetary Laboratory, University of Arizona, Tucson AZ, 85721, USA; [4]Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA, 91109, USA.

Introduction: The Venus Origins Explorer (VOX) is a JPL-led New Frontiers 4 mission [1] to answer critical questions about the origin and evolution of Venus. Venus stands out among other planets as Earth's twin planet, and is a natural target to better understand our own planet's place, in our own Solar System but also among the ever-increasing number of exoplanetary systems. Here, we focus on the VOX radio science investigation, which will make use of the Ka-band telecom unit provided by the Italian Space Agency (ASI) to map the global gravity field of Venus to much finer resolution and accuracy than current knowledge based on the NASA Magellan mission [2].

Science Goals: An improved gravity field of Venus is necessary to address essential questions, particularly the root causes of the divergent evolutionary paths of Earth, with its recycling of the crust through plate tectonics, and of Venus, with its diverse tectonics and potentially active regions. The tesserae features, uniquely found on Venus, are hypothesized to be continent-like remnants, but studies based on Magellan data have not been conclusive. The determination of gravity over global scales with sufficient accuracy to reveal differences in elastic and crustal thickness over the tesserae terrain will constrain thermal evolution of Venus' crust. This will inform their origin and composition and determine the relative importance of tectonism and subduction.

Additional science investigations will of course be enabled by an accurate global gravity field. In particular, gravity gradiometry techniques applied to the Magellan field over very limited areas have shown hints of interesting structures [3], such as folding in Ovda Regio, a major tesserae plateau, and active rifting in Hecate Chasma. Just detectable at degree 80 with gravity gradiometry techniques [3], they are not visible at degree 60, which characterizes the existing resolution over much of the planet.

Science Requirements: Although the Magellan gravity field was calculated to degree and order 180 [2] to avoid aliasing of high-frequency power, its actual resolution is much lower (~70 on average). The Magellan field was also hampered by the non-uniform coverage. Numerous areas of high interest have poor Magellan coverage and elude quantitative gravity interpretation: Artemis Chama (*l*~55, a possible subduction zone); Parga Chasmata (*l*~60-75); high VIRTIS emissivity areas such Imdr, Themis, and Dione Regio (l=45-70); tesserae plateaus such as Alpha Regio and Lakshmi Planum and low-elevation planitia that could host buried structures (l=40-70).

The minimum gravity resolution requirement for VOX (*l*=95) was chosen to be near the highest Magellan degree strength (*l*~100), which was only realized over a very small fraction of the planet in that dataset [2]. It follows that what has been learned from Magellan in the very limited areas of good gravity coverage can be extended to the entire planet. The VOX resolution requirement is the minimum needed to perform robust analysis and to answer geophysical questions that could only be partially studied by even the best Magellan data [4]. However, the actual VOX performance will exceed this requirement, and will very likely enable unanticipated advances and discoveries.

Comprehensive simulation: We performed comprehensive simulations of gravity field recovery with VOX data, with the NASA GSFC orbit determination and geodetic parameter estimation software GEODYN, using a realistic mission scenario, tracking schedule, and high-fidelity Doppler tracking noise model.

GEODYN is the orbit determination and geodetic parameter estimation software developed and maintained at NASA GSFC [5]. It relies on a number of models to integrate the spacecraft trajectory (force models) and to determine a computed observation to be compared with the actual observable (measurement models). GEODYN incorporates state-of-the-art models to enable high-accuracy geodetic studies such as that of VOX.

We assess the quality of the recovered gravity solution by comparing the estimated spatially-resolved uncertainties to the actual errors (differences with the truth). These uncertainties and a resolution map, derived through a clone-mapping method [6], demonstrate the VOX requirements to conduct the science investigations are met.

Conclusions: The capable Ka-band telecom onboard VOX enables a robust, highly-accurate gravity science investigation that will answer profound questions related to Venus' evolution.

References: [1] Smrekar et al. (2017), *VEXAG 15*. [2] Konopliv et al. (1998) *Icarus*, *25*, 3743–3746. [3] Andrews-Hanna J. C. et al. (2016) *LPS XLVII,* Abstract #2907. [4] James et al. (2013*) JGR*, *118*, 859–875. [5] Pavlis et al. (2013), Contr. Rep. [6] Lemoine et al. (2014) *GRL*, *41*, 3382–3389.