



HAL
open science

Radio Sounding of the Venusian Atmosphere and Ionosphere with EnVision

Silvia Tellmann, Yohai Kaspi, Sébastien Lebonnois, Franck Lefèvre, Janusz Oschlisniok, Paul Withers, Caroline Dumoulin, Pascal Rosenblatt

► **To cite this version:**

Silvia Tellmann, Yohai Kaspi, Sébastien Lebonnois, Franck Lefèvre, Janusz Oschlisniok, et al.. Radio Sounding of the Venusian Atmosphere and Ionosphere with EnVision. EPSC-DPS Joint Meeting, Sep 2019, Geneva, Switzerland. pp.EPSC-DPS2019-609-1. insu-02263195

HAL Id: insu-02263195

<https://insu.hal.science/insu-02263195v1>

Submitted on 3 Aug 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

Radio Sounding of the Venusian Atmosphere and Ionosphere with EnVision

Silvia Tellmann (1), Yohai Kaspi (2), Sébastien Lebonnois (3), Franck Lefèvre (4), Janusz Oschlisniok (1), Paul Withers (5), Caroline Dumoulin (6), and Pascal Rosenblatt (6,7)

(1) Rheinisches Institut für Umweltforschung, Abteilung Planetenforschung, Universität zu Köln, Cologne, Germany, (2) Department of Earth and Planetary Sciences, Weizmann Institute of Science, Rehovot, Israel, (3) LMD/IPSL, Sorbonne Université, CNRS, Paris, France, (4) LATMOS, CNRS/Sorbonne Université, Paris, (5) Astronomy Department, Boston University, Boston, MA, USA, (6) Laboratoire de Planétologie et Géodynamique, Université de Nantes, France, (7) Geoazur, Nice Sophia-Antipolis University, France, (silvia.tellmann@uni-koeln.de)

Abstract

EnVision is one of the final candidates for the M5 call of the Cosmic Vision program from ESA. It is dedicated to unravel some of the numerous open questions about Venus' past, current state and future. The Radio Science Experiment on EnVision will perform extensive studies of the gravitational field but also Radio Occultations to sense the Venus atmosphere and ionosphere at a high vertical resolution of only a few hundred metres. These radio occultations provide electron density profiles in the ionosphere and atmospheric density, temperature and pressure profiles in the upper troposphere and mesosphere. Additionally, they allow to study the H₂SO₄ absorption in the Venus cloud layer.

1. EnVision

EnVision is one of three mission concepts competing for an opportunity to launch in 2032 [1]. After a five-month cruise and 1-2 years of aerobraking phase, it will perform four Venusian days of measurements, helping to understand why Venus developed so differently from the Earth. Its main goal is to study the geological activity of Venus using a combination of radar, optical spectroscopy and gravity mapping. Additionally, radio occultations will be performed to study the atmospheric structure, the H₂SO₄ absorption and the ionosphere of Venus. This paper focuses on these radio occultations.

2. Radio Sounding of the Venusian Atmosphere and Ionosphere

Radio Occultations at Venus provide electron density profiles in the ionosphere and atmospheric density,

temperature and pressure profiles in the mesosphere and upper troposphere of Venus (~ 40 - 90 km). The first radio occultation experiment at Venus was conducted during the Mariner 5 flyby in 1967 [2], followed by Mariner 10 [3], several Venera missions [4], Magellan [5] and the Pioneer Venus Orbiter [6], and Akatsuki [7]. The most extensive radio occultation study of the Venus atmosphere so far was carried out by the VeRa experiment on Venus Express [8,9].

2.1 EnVision Radio Occultation studies

EnVision will use two coherent frequencies (X- and Ka-band) to separate dispersive and nondispersive effects. This allows to distinguish between ionospheric wave structures and other noise induced effects in the ionosphere.

The use of Ka-band, which has never been used to sense the Venus atmosphere before, allows to study the H₂SO₄ absorption in the Venus cloud layer due to its high sensitivity to sulfuric acid absorption. Ka-band is also sensitive to liquid H₂SO₄ which allows (in combination with X-band) to distinguish between gaseous and liquid H₂SO₄ absorption features on Venus for the very first time.

The short orbital period of EnVision in combination with its near polar orbit allows to cover all latitudes, longitudes, local times and solar zenith angles on Venus. Especially short-term variations caused by atmospheric waves can be identified to study traveling or stationary small-scale atmospheric structures.

References

- [1] Ghail, R., et al., EnVision: understanding why our most Earth-like neighbour is so different, ESA M5 mission proposal, ArXiv, 2017.
- [2] Stanford Mariner Group, Venus: Ionosphere and atmosphere as measured by dual-frequency radio occultation of Mariner V, *Science*, 205, 14– 19 1967.
- [3] Howard, H. T., et al., Venus: Mass, gravity field, atmosphere and ionosphere as measured by the Mariner 10 dual-frequency radio system, *Science*, 183, 1297–1301, doi:10.1126/science.183.4131.1297, 1974.
- [4] Yakovlev, O. I., S. S. Matyugov, and V. N. Gubenko, Venera-15 and-16 middle atmosphere profiles from radio occultations: Polar and nearpolar atmosphere of Venus, *Icarus*, 94, 493 – 510, doi:10.1016/0019- 1035(91)90243-M, 1991.
- [5] Jenkins, J. M., P. G. Steffes, D. P. Hinson, J. D. Twicken, and G. L. Tyler, Radio occultation studies of the Venus atmosphere with the Magellan spacecraft: 2. Results from the October 1991 experiments, *Icarus*, 110, 79– 94, doi:10.1006/icar.1994.1108, 1994.
- [6] Kliore, A., Recent results on the Venus atmosphere from Pioneer Venus radio occultations, *Adv. Space Res.*, 5(9), 41 – 49, doi:10.1016/0273-1177(85)90269-8, 1985.
- [7] Imamura, T., et al., Radio occultation experiment of the Venus atmosphere and ionosphere with the Venus orbiter Akatsuki, *Earth Planets Space*, 63, 493 - 501, 2011.
- [8] Häusler, B., et al., Radio science investigations by VeRa onboard the Venus Express spacecraft, *Planet. Space Sci.*, 54, 1315 – 1335, doi:10.1016/j.pss.2006.04.032, 2006.
- [9] Tellmann, S., Pätzold, M., Häusler, B., Bird, M.K., Tyler, G.L., Structure of the Venus neutral atmosphere as observed by the Radio Science Experiment VeRa on Venus Express. *J. Geophys. Res.* 114 (9), E00B36. 2009.