Radio Sounding of the Venusian Atmosphere and Ionosphere with EnVision

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Abstract

EnVision is a 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 Venusians 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 H_2SO_4 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 H_2SO_4 absorption in the Venus cloud layer due to its high sensitivity to sulfuric acid absorption. Ka-band is also sensitive to liquid H_2SO_4 which allows (in combination with X-band) to distinguish between gaseous and liquid H_2SO_4 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.

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