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Investigation of the atmosphere and surface of Venus by use of reanalysis of the radio occultation data of Venera-9, 10, and 15, 16 satellites

Alexander Pavelyev, Alexander Zaharov, and Oleg Rzhiga

Kotelnikov Institute of Radio Engineering and Electronics of Russian Academy of Sciences, (IRE RAS), Fryazino, Vvedenskogo sq. 1, 141120 Moscow region, Russia

The insertion of the Venera-9,10 and -15,16 spacecraft into orbits around Venus affords the opportunity to make the bistatic and monostatic radar experiments on Venus. The main objective of these experiments is to study the topography and to measure the ground density of the planet. However, besides this objective, new data were obtained during the bistatic radar experiments on conditions of refraction of radio waves through the entire thickness of the atmosphere of Venus. The possibility of measuring refraction effects arose because the bistatic radar was done immediately before the spacecraft passed into occultation by the planet. Therefore, the incident angle at reflection of the radio waves from the surface was small, and the refraction effects were more strongly evident. It should be noted also that the periodically repeated monostatic radar observations of Venus from Earth give no information on refraction, since the main part of the power reflected in the Earth direction is generated by a small region of the surface of the planet for which the incident angle is close to 90°. The purpose of the contribution is to describe the method and the results of the experiments to measure the refraction of radio waves in the atmosphere of Venus by means of bistatic radar. The authors present measured values of the refractive angle and the coefficient of generalized spherical divergence of radio waves reflected from the surface of Venus. The measurements were made at wavelength 32 cm in the bistatic scheme using the Venera-9,10, and 15,16 spacecraft. Both the refraction angle and the reflection coefficient were determined in the experiment from the measured frequency difference between the direct and the reflected signals as a function of time, using the trajectory data on spacecraft positions. The results of the measurements agree with the theory of propagation of radio waves in the atmosphere of Venus. The work was partly supported by grant of Russian Fund of Basic Research No. 10-02-01015-a.