API Technique and Lower Ionosphere Diagnostics during Solar Eclipses

N.V. BAKHMETIEVA[(1)], E.E. KALININA[(2)], G.P. KOMRAKOV[(1)] and V.D. VYAKHIREV[(1)]

(1) Radiophysical Research Institute, Niznhy Novgorod State University, Bol'shaya Pecherskaya St. 25/12a, Niznhy Novgorod, 603950, Russia

(2) Niznhy Novgorod State University, Prospekt Gagarina 23, Nizhny Novgorod, 603950, Russia

Results of the lower ionosphere diagnostics during three partial solar eclipses are presented. Observations of the ionosphere in the eclipse periods and in control days were carried out by the method of resonant scattering of radio waves at artificial periodic irregularities (APIs) of the ionospheric plasma. The SURA heating facility (56.1° N, 46.1° E) has been used for APIs formation and diagnostics. In some cases the partial reflection technique based on radio wave scatter by natural irregularities in the D region was used.

Now it is proved that APIs form in the field of a powerful standing wave that forms as a result of the interference of the incident radio wave and the wave reflected from the ionosphere within the height range from the D region up to the height of the reflection of the powerful radio wave from the ionosphere. The ionosphere diagnostics bases on the measurements of the amplitude and the phase of the API scattered signal. Due to many ionospheric effects connected with the formation of the irregularities, the API technique can be used to determine various parameters of the ionosphere.

We observed the lower ionosphere reaction to solar eclipses. Variations of the electron density and characteristics of the API scattered signals were studied. An amplification of the turbulization of the lower ionosphere during the eclipse of August 11, 1999, the disappearance of artificial irregularities on August 1, 2008, due to the decrease during the eclipse of the F-region critical frequency to values below the operating frequency of the SURA facility, which formed irregularities, substantial intensification of the scattered signals in the D and E regions, and the appearance of an extra signal at the mesopause height during the eclipse of March 20, 2015 were observed. In the latter case a stratification of the D region was observed for an hour in the vicinity of the eclipse maximum phase. A decrease of the electron density in the D region up to a factor of 3–5 was found by the partial reflection technique. Above 88 km, the ionospheric response was delayed by 20–25 min relative to the moment of the eclipse maximum phase, whereas this delay in the lower part of the D region was 2–4 min. Wave motions with periods typical for internal gravity waves were presented in the temporal variations of the scattered signal characteristics.

Acknowledgement. The research is supported in part by Ministry of Science and Education of Russia under grant #5.8092.2017.