УДК 621 DOI: https://doi.org/10.30837/IYF.IRTTPI.2024.62

ABOUT THE METEOR RADAR MODELING PROBLEM

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The work examines the prospects of not only recovery, but also simultaneous modernization of meteor radars, which are situated in Balakliia Geophysical Complex. They were created in the 70-80s and are now morally and physically obsolete. It seems inevitable that some parameters of meteor radars will change during modernization. The influence of these parameters on the capabilities of meteor radars is considered. The necessity of using mathematical modeling before the meteor radars modernization “in hardware” is substantiated.

In [1], the relevance of meteor research and the need to restore meteor radars, created in the 70-80s of the last century, located in the Balakliia Geophysical Complex (BHC) were shown. Although the BGC is an object of the national scientific heritage of Ukraine, the question is not about the restoration of the complexes as historical value, but about their restoration as working equipment.

But due to a significant upgrade of the element base, the emergence of new opportunities for the formation and processing of the signal, it becomes obvious that we can talk not just about the restoration, but one-time modernization of MRLS with some changes in their parameters.

The question arises: which changes are acceptable, which are not, and which, on the contrary, are desirable. To answer this question, it is necessary to have a good understanding of how the individual parameters of an MPLS affect its characteristics. Let us briefly consider these dependencies.

Operating Frequency. Currently, the operating frequencies of VETA and MARS are 36.9 and 31.1 MHz, respectively. For other known MRLS these frequencies are in the range from 17 to 70 MHz If we refer to [2], it is noted that more meteors can be detected at lower frequencies because of the higher signal intensity. But there is also more interference, including interference from the ionosphere (the so-called return-tilt interference). On the other hand, the higher the frequencies, the lower the number and intensity of signals, but also less interference. The size of antennas with the same width of radiation pattern is significantly smaller. In addition, at higher frequencies it is possible to register an interesting phenomenon, the so-called head echo. This is a reflection directly from the region where the meteor particle is breaking up.

Shape and orientation of antenna radiation patterns (RP). Currently, the MARS MRLS antenna is oriented eastward, with the maximum radiation at an angle of 45˚ to the horizon. Taking into account the patterns of diurnal and orbital motion of the Earth, this provides the maximum number of meteors on average per day. The VETA MRLS antennas have a RP width in the azimuthal plane of 54˚, in the angular plane of 26˚. The angle of the location of the maximum of the spectrum is 30˚. The fixed shape and direction of the antennas' boresight simplifies its design and signal processing.

In [3], the shape and orientation of the RP of antennas of meteor communication systems in short paths are considered. It is shown, among other things, that at different times of the day different sides of the world are optimal from the point of view of maximum abundance. Meteor radar is close to the propagation of radio waves along a short path. Therefore, it can be said that the possibility of rotating the RP of antennas along the azimuth (and, perhaps, and the angle of place) will allow to fix meteor particles from those radiant for which the conditions of reflection are fulfilled at different times of the year and day in different directions. This will make it possible to obtain information about meteor particles and meteor streams, which are less noticeable when their position is fixed.

As for the signal parameters, the MARS and VETA MRLSs currently use rectangular pulses with a duration of 30 μs and a repetition rate of 500+100 Hz. This is a simple signal, both in terms of its formation and processing, and in terms of its capabilities.

In [4] the possibility of using complex signals (signals with a large base) for meteor radar. They have a number of advantages: they allow simultaneous measurement of a number of meteor parameters, have good noise immunity and allow operation in conditions of ionospheric interference. Their disadvantages are in the wide occupied frequency band, complexity of formation and processing.

Complexity and multifaceted influence of parameters on technical capabilities, cost of creation and operation of complexes, its spatial dimensions and other factors do not allow to take everything into account visually or analytically. Therefore, for a reasonable choice of parameters of modernized meteor radars it is proposed to apply modeling.

The model should be implemented as a computer program, presumably using Java programming language. This programming language is multiplatform, which will allow creating only one version of the program for all available platforms at once. The program should also have an intuitive and functional interface that allows setting all the necessary starting parameters of the simulation.

The user should be able to select the location of the MRLS by geographic coordinates, signal frequency, power, antenna configuration, which will affect the radiation patterns. The starting time of day and time of year can be determined automatically via the Internet according to geolocation data. If the MRLS design involves real-time antenna rotation, this functionality should also be implemented. Also, the program will have an extensive database of signals of different forms, with the possibility of adding new ones. In addition, to increase the realism of the simulation, the program will implement a system of atmospheric interference and take into account the impact on the radar of other signal sources.

The developed computer program for modeling the operation of MRLS should allow us to quickly perform calculations of the capabilities of the installation at different parameters. Such a model should take into account the distribution of meteoric matter in the solar system, the process of meteor trace formation, its physical parameters, conditions of signal emission, conditions of reflection at different frequencies and conditions of its reception. The model of remote sites can also be considered separately. This will significantly reduce time and financial costs when modernizing or designing new meteor radars.

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