Mathematical Model to Estimate the Probability of Formation of the Meteor Trails with a Specular Reflection

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Abstract – **In this paper a mathematical model meant for the estimation of formation probability of meteor trails with a point of specular reflection for the arbitrary point of radio visibility zone, based on the zenith angles probability distribution knowledge and the formulaic relations is proposed, which make possible to set the entry point of a meteor and the meteor trail orientation in the space for the given zenith angle. The model allows the one to determine the most probable area of the formation of meteor trails suitable for the communication.**

Keywords - **the meteor trail, specular reflection, radiant, zenith angle.**

I. INTRODUCTION

The purpose of the article is to present the mathematical model for the calculation of probability of the meteor trail with the specular reflection point occurrence in the arbitrary point of the zone of radio visibility, which allows the one to determine the most probable area of meteor trails formation suitable for the communication.

II. BASIC RELATIONS

In order to solve the given task it is necessary to perform the following sequence of operations:

1. Determine the entry point of the meteor in the meteor region.
2. Set the spatial orientation of the meteor trail connected to the value of the zenith angle γ_z and the azimuth α.
3. Determine the coordinates of the exit point of the meteor from the meteor region.
4. Determine the presence of the specular point in the meteor trail for the given parameters of the meteor trail through the sequential sorting of the angles γ_z and the corresponding angles α. The sign of the availability of the specular point is the vanishing of the cosine of the angle between the direction of the meteor trail and the normal to one of the family of ellipsoids with focuses at the points of receiving and transmitting [3].
5. Determination of probability that the meteor caught in a vicinty of the given point M_{en} with the zenith angle γ_z and the azimuth α, forms the meteor trail with specular reflection point.

In the article the expressions for the fixed entry point of the meteor, given in the Cartesian coordinates and converted into the polar coordinates, and the coordinates of the corresponding exit point M_{ex} obtained.

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If during different γ_z and the corresponding to them angles α the changing of the sign is observed for the cosine of the angle between the direction of the meteor trail and the normal one of a family of ellipsoids with focuses at the points of receiving and transmitting for the entry and the exit points, then the existence of specular reflection point is being fixed.

The probability that the meteor caught in a vicinty of the given point $M_{en}(x_{en},y_{en},z_{en})$ with the zenith angle γ_z and the azimuth α, form the meteor trail with the specular reflection point will be determined by the expression

$$P\left(x_{en\,ji},y_{en\,ji},z_{en\,ji}\right) = \int_{\gamma_{min}}^{\gamma_{max}} w\left(\gamma_z\right) \int_{\alpha_{min}(\gamma_z)}^{\alpha_{max}(\gamma_z)} w\left(\alpha/\gamma_z\right) d\alpha\, d\gamma_z \quad (6)$$

where $w\left(\gamma_z\right)$ - the density of probabilities of the zenith angles of sporadic meteors,

$\left[\gamma_{min},\gamma_{max}\right]$ - the interval of the zenith angles, during those the point of specular reflection is, for the given entry point of the meteor in the meteor region.

$w\left(\alpha/\gamma_z\right)$ - the conditional probability that the meteor trail with zenith angle γ_z has the reproduced azimuth α,

$\left[\alpha_{min}\left(\gamma_z\right),\alpha_{max}\left(\gamma_z\right)\right]$ - the interval of the zenith angles during those the point of specular reflection is for the given γ_z .

III. CONCLUSION

As opposed to the known methods of calculation the probability of occurrence in the given field of suitable for the communication meteor trails, the proposed mathematical model allows the one just only not to define the average probability of occurrence of corresponding trace, but, also, to estimate the probabilistic contribution in the each point of the zone of radio visibility. This provides the possibility of constructing of zones which are most probable for the occurrence of the meteor trails with the specular reflection point, the location of those determine the basic parameters of antennas and the directions of theirs orientation.

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