Spatial structure of giant jets

Sklizkov G.V., Shelobolin A.V.

Lebedev Physical Institute of the Russian Academy of Sciences, Moscow, Russia

Giant blue jets (GBJ) are known to be the multichannel discharges produced along cone elements between a thunderstorm cloud and an ionosphere [1, 2]. The registration time resolution of this phenomenon is about 17 ms. The range of absolute altitudes above the sea level is from 15 km to 90 km, which corresponds to air density from 1018–1019cm–3 to 1014 cm–3 and neutral gas temperature in the range of 200–280 K. Spatial resolution of ~10-100 m was achieved during the on-land measurements.

The main issues to be explained during analysis of GBJ photographs are the following:

- Why are the GBJ channels located at almost azimuthal equidistance along cone elements?

- Why are the GBJs observed in equatorial latitudes only?

- Why is the upper boundary of GBJ not the same for [1] and [2]?

- Why there is a wide halo on ionosphere in [1], and what is its physical meaning?

The first of these issues proves to be the main one, since it fundamentally distinguishes GBJ from all EGB waves. The azimuthal equidistance of GBJ channels cannot be explained within framework of a conventionl EGB theory, which treats any of the channel waves as a frontal ionization wave. In [3], a nonlinear plasma-waveguide model (NPWM) was proposed. One of its provisions suggests that cylindrical regions of increased ionization and plasma waveguides should be formed in the volume of a neutral gas or a weakly ionized plasma, at a preliminary stage. The GBJ problem presupposes:

1. Above a boundary section of a thundercloud shaped as a circle of D = 50 km, a curvature is formed of the ionosphere ionization surface. The source of such a curvature is the radiation of the ocean-cloud generator, operating in a free-running mode at the minimum frequency of radio measurements of the ionosphere ν = 1 MHz, corresponding to the limiting ionization density of the D-layer of the ionosphere 104 cm–3. Thundercloud represents a translucent mirror.
2. A concave ionization surface of the ionosphere and a flat surface of a thundercloud produce a hemispherical resonator, in which plasma waveguides are formed.
3. The generator radiation may be due only to the electron bremsstrahlung, which is initiated by the kinetic energy electron distribution shift in an external field.

These provisions are justified on the basis of the open resonators theory [4] and give a satisfactory agreement with experiment. In addition, the generation threshold is estimated through the electron density in the atmosphere and is not higher than 108 cm–3, and the required density of intracavity radiation is at the level of 10–6–10–5 W/cm2.

References

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