Radiation of a Satellite Array Antenna in Dispersive Atmospheric Environments

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It is important to analyze the wave propagation from the satellite to the earth station in military and multipurpose satellites. Recently, there have been many studies to investigate electromagnetic wave propagation considering the atmospheric environments. However, the theoretical analysis of the electromagnetic radiation from an array antenna of the satellites to earth stations considering atmospheric environments has not been presented. In this paper, we calculate the radiation from an array antenna of the satellites using the ray tracing technique, geometrical optics. Attenuation in troposphere and ionosphere is calculated using the dispersive effective refractive index and ITU-R P.531 recommendation, respectively.

Let us consider the electromagnetic radiation of a n x n array antenna of the satellite at the geostationary earth orbit (GEO). The electromagnetic fields radiated from each element of array antenna are calculated in atmospheric environments, and then it is synthesized at the observation point. We use the dispersive ionospheric absorptions, refraction, and scintillation data given by ITU-R P.531 recommendation to calculate the propagation in ionosphere. In the troposphere, the dispersive effective refractive index is calculated in terms of altitude by the weather information including temperature, pressure, and water vapor pressure. We use the ray tracing technique and geometrical optics to calculate the propagation in troposphere.

An extensive analysis is performed to illustrate the radiation characteristic of n x n array antenna of GEO satellite in atmosphere environments. The effects of frequency, refractive index of troposphere, and elevation angle on the radiation characteristic are discussed. The total attenuation from the satellite to earth is calculated considering dispersive atmospheric environments and the bore-sight error of array antenna in GEO satellite is computed in terms of elevation angle. Our computational method is useful to predict the electromagnetic radiation of the satellite array antenna in dispersive atmospheric environments.

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