

Effect of charges carried by atmospheric particles on radar monitoring

Radar is an active device in that it carries its own transmitter and does not depend on ambient radiation, as do most optical and infrared sensors. Radar can detect relatively small targets at near or far distances and can measure their range with precision in all weather, which is its chief advantage when compared with other remote sensors. The ratio of the receiving power to the transmitting power (RPR) of a well-designed radar system is determined by the absorption and scattering of materials coming into contact with radar waves along the propagating path of the radar wave. In atmospheric detection by a radar system, the RPR is mainly determined by the absorption and scattering of atmospheric particles. Atmospheric particles are commonly charged; e.g., sand/dust particles, droplets, foggy particles and so on. Many studies conducted out indicated that the charges carried by these particles have a significant effect on the scattering of electromagnetic waves (EMWs). There is no doubt that knowledge of the optical properties of electrically charged particles can be applied to diverse fields of science, e.g. in characterizing water droplets in various media, ice crystals in thunderstorms, atmospheric aerosols, pollution, dust, and, cosmic dust. But few literatures study the effect of charges carried by atmospheric particles on the radar detection wave in atmospheric.

Motivated by this, the effect of charges carried by atmospheric particles on the RPR was investigated. It was found that charges carried by particles result in the RPR being greater than the RPR without consideration of the contribution of the charges to the receiving power, and the RPR increases with the surface charge density for a given particle radius. The increment of RPR due to the surface charges carried by particles is also related to both the particle size and radar emission frequency. At present, the contribution of charges to the received power is not considered in radar detection, resulting in the overestimation of particle properties.

In addition, when radar is used to detect objects in the atmosphere such as target objects monitored by military radar in dust weather and severe haze weather, the charge carried by atmospheric particles will also have a significant effect on the radar cross section. If the effect of charges carried by particles on the received power of radar is ignored, it will reduce the accuracy of radar monitoring, and even make a wrong identification. In the future work, we will focus on the effect of the charges carried by the atmospheric particles on the radar detection distance.