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Model Calculations on the Influence of Charged Mesospheric dust on the Incoherent Radar Spectrum

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Detection of charged dust in the spectrum of incoherent radars has previously been proposed and examined to some degree. These dust particles are of nanometer size and reside at mesospheric altitudes due to incoming ablating meteors. They are difficult to detect and thus their influence on atmospheric processes is hard to determine. Theoretical studies suggest that charged nanometer sized dust in the mesosphere can be successfully detected in the radar spectrum. However, current radar systems like EISCAT are not capable to distinguish adequately the dust signal from the main signal because the influence is small. We expect however, that the upcoming new EISCAT_3D radar will improve the observation conditions. We here present model calculations to examine the influence of the charged dust component on the radar signal, a so-called dusty plasma effect. Instead of the previously assumed one size dust component, we simulate the incoherent scatter spectrum including a large set of dust size bins. We show that different sizes, number density and charge of dust influence the signal in different ways, either causing a narrowing or broadening of the spectrum. Here the results are presented in a systematic way and specific conditions identified that provide the largest chance of dust detection in the signal. A simple charging model is used to model the most probable charge and altitude dependence to simulate realistic dust distributions that are then used as input to the radar spectrum model. These results can then be used to compare with actual radar measurements. Off which the new EISCAT_3D radar system, ready in 2022, might provide the adequate resolution for these requirements.