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Polar Mesospheric Summer Echoes (PMSE) during artificial heating

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Polar Mesospheric Summer Echoes (PMSE) are regions of enhanced radar backscatter at 80 to 90 km that are assumed to form in the presence of neutral air turbulence and charged ice particles as a result of spatial variations in the electron density. Changes in the electron temperature, as can be generated by the EISCAT heater, influence the electron diffusivity as well as the charging of the ice particles and both are parameters that influence the radar scattering. In many cases, an overshoot effect [1] can be observed when the backscattered power is reduced during heater-on and rises above the initial signal during heater-off. We present observations made on the 11-12 and 15-16 of August 2018 with the EISCAT VHF radar during PMSE conditions. The EISCAT heating facility, operated at 5.423 MHz, was run in identical cycles where the heater was on for 48 seconds and off for 168 seconds. The observations clearly show the overshoot effect, caused by the cyclic heating of PMSE. The surface charge of the ice particles increases during the heater-on intervals because of the higher electron temperature. As the heater is turned off the electrons are quickly cooled. The dust particles, however, still carry a higher charge, i.e. more electrons, so that the electrons cannot immediately obtain the initial density distribution. The typical result is that the electron density gradients are increased, which in turn lead to increased radar scattering, an overshoot. During the heater off phase, dust and plasma conditions are expected to relax back to undisturbed conditions. A theory was developed by Havnes [1] to explain the overshoot and we use a dusty plasma code [2] based on this theory to calculate the overshoot curves. They agree well with the average of the observational data. There is clear indication that during high precipitation the PMSE cloud is not affected by the heater and accordingly does not show an overshoot effect.

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2. Biebricher, A., Havnes, O., Hartquist, T. W., & LaHoz, C. (2006). On the influence of plasma absorption by dust on the PMSE overshoot effect. *Advances in Space Research*, 38(11), 2541-2550.