Investigation of the PMSE layers by artificial electron heating: the experiments and their interpretation.

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The discovery that the PMSE (Polar Mesospheric Summer Echoes) radar phenomenon can be strongly affected by artificial electron heating, has opened up the possibility of doing active experiments in this part of the atmosphere which is so difficult to access and to observe. In the most common application of this effects so far, the strength of the radar scattering is made to go through a sequence with a nearly instant decrease as the artificial heating is switched on, a moderate and slower variation during the time (10-20 sec) the heater is on, followed (most often) by a nearly instant increase (an overshoot) to a strength of up to 5-6 times that of the pre-heating PMSE strength, when the heater is switched off. With the heater off for a sufficient long time ($\sim$ 2-3 min) the PMSE strength will relax back to its undisturbed value and the sequence can be repeated. We will show results for the effects of artificial electron heating on the PMSE as observed by the EISCAT 224 MHz and 933 MHz radars. The most typical behavior is as described above but cases where the intensity variation can be quite different also exist.

The interpretation of the observations supports a model where the PMSE radar scattering is caused by electron density irregularities, which again are controlled by density irregularities in the background charged dust particle population, which apparently is a requirement for the PMSE phenomenon. Artificially increasing the electron temperature will lead to a rapid redistribution of the density of the electrons and ions. The electron density gradient will be weakened and this reduces the radar backscatter efficiency. The additional charging of the dust during the time the electrons are heated will also affect the PMSE strength and eventually cause that the dust, when the heater is switched off and the electrons cool, will force the electrons into a stronger density gradient than before the heater was switched on. This will lead to a stronger PMSE also – the overshoot. Model calculations can reproduce most of the observed PMSE overshoot intensity variations but an unambiguous interpretation is made difficult due to the many parameters which can influence on the plasma distribution and its variations. We will discuss recent efforts in analyzing the observed overshoot curves in a PMSE layer to find the dusty plasma conditions and also predictions on how the overshoot can change if observed at longer radar wavelengths.