The mesopause is the coldest place in the Earth’s atmosphere with temperatures as low as -100°C, therefore, formation of ice particles contributes to the source of the dust layers in mesosphere. Since these dust layers are immersed in the earth’s upper atmosphere, they become charged due to collection of electrons and ions from earth’s ionospheric plasma and such regions may be described as a dusty plasma. Polar Mesospheric Summer Echoes (PMSE) are strong radar echoes that have been typically observed in the frequency range from 50MHz to 1.3GHz and in the altitude about 85Km and are a direct consequence of the sub-visible charged dust that exists at altitudes above NLC regions. Recently, experimental observations have shown that radar echoes from the irregularity source region associated with mesospheric dusty space plasmas may be modulated by radio wave heating with ground-based ionospheric heating facilities.

The first part of this presentation aims to investigate the effect of the positive dust particles on temporal evolution of electron irregularity amplitude during radiowave heating, and second part propose an alternative perspective for electron irregularities in the PMSE source region.

Recent in situ rocket measurement detected the signature of the positive charge in PMSE source region with significant number density which is unexpected from the theory of aerosol charging in plasma. It turns out that nucleation on the cluster ion is one of the most probable hypothesis for the positive charge on the smallest particles. The effect of the positive dust particles on the correlation and anti-correlation of fluctuations in the electron and ion densities is studied by adopting the proposed hypothesis of positive dust particles and a new generation mechanism for the correlation and anti-correlation of the fluctuations in the electron and ion densities. This hypothesis can be used as a diagnostic tool to estimate the size of ice particles as well as their charge state in mesospheric altitudes by measuring the fluctuations in the electron and ion densities. Variation of electron irregularity amplitude during radiowave heating and in the presence of positive dust particles is investigated.

Although it is widely believed that neutral air turbulence is responsible for electron irregularities in PMSE altitudes, this work introduces a new generation mechanism. Theoretical and computational models are extended to study basic physics of the evolution of relevant dusty plasma instabilities thought to play an important role in irregularity production in mesospheric dust layers. A key focus is the boundary layer of these charged dust clouds. Several aspects of the cloud’s structure (thickness of boundary layer, average particle size and density, collisional processes, and cloud expansion speed) and the ambient plasma are varied to determine the effect of these quantities on the resulting irregularities. It is shown that for high collision frequencies, the waves may be very weakly excited (or even quenched) and confined to the boundary layer. The excited dust acoustic waves inside the dust cloud with frequency range of 7-15Hz and in the presence of electron bite-outs is consistent with measured low frequency waves near 10 Hz by sounding rocket experiments over the past decade. The relevance of these results to past experimental observations in space and laboratory plasmas is discussed.