Novel radar measurement techniques enabled by EISCAT 3D

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EISCAT 3D is a next generation all-digital multi-static phased array incoherent scatter radar, which is being built in Northern Fenno-Scandinavia, for the purpose of studying Earth's near space. The novel technical capabilities of this radar will enable several new types of measurements, which have not been possible before. There will be advances in capabilities for observing the neutral atmosphere, ionospheric plasma, the subsurface structure of the Moon, and observations of micrometeoroids entering the Earth's atmosphere. We will go through several case examples of envisioned observing modes of EISCAT 3D, which can be applied to studies of the fine-structure of: 1) electron precipitation, 2) electric fields, and 3) neutral winds within the high-latitude ionized upper atmosphere. The use of plasma-line profiles, will potentially allow very high temporal resolution characterization of electron density profiles during auroral precipitation within the E-region [VBH+16], as well as enable accurate electron density profiles of the ionospheric F-region. The multi-static multi-beam capability will allow unambiguous observations of a volumetric 3d ion drift vector velocity field, which can be used to invert the 3d electric field and neutral wind vector fields [HN08]. In addition to this, it should be plausible to directly measure the advection term $\nabla \cdot n_e \vec{v}_e$, and include this in the electron continuity equation, which is used to infer electron precipitation spectra [VGA+]. The technique of aperture synthesis imaging, combined with the Multiple-Input Multiple-Output (MIMO) radar technique [UCM+18], will allow very high resolution imaging of the radar scattering from high SNR polar mesospheric winter and summer echoes, as well as from auroral precipitation. This can be used for studies of volumetric neutral dynamics and precipitation in the MLT region.

References

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