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EISCAT_3D SCIENCE TOPICS RELATED TO THE ARCTIC GEOSPACE

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EISCAT_3D will be a uniquely versatile research radar infrastructure that will bring together scientists and topics from a multitude of areas. As detailed in this presentation, several of today's scientific problems in atmosphere and geospace research can be condensed into an issue of the importance of spatial structure over multiple scales and their temporal evolution. The volumetric imaging and interferometric capability of EISCAT_3D, together with its high time resolution and sensitivity, are at the core of the different types of measurements required to advance our present understanding of the atmosphere and geospace environment.

One fundamental problem to address is the quantification of coupling between the different atmospheric layers in terms of energy, momentum and minor constituent exchange. How does this interaction affect climate? How does climate change affect this interaction? EISCAT_3D will enable tracking the evolution of the wave spectrum from the lower- through the middle atmosphere to the ionosphere. This allows quantifying the wave forcing from below and how it is coupled to solar activity and climate. The coverage of the EISCAT_3D imaging volume above the Abisko region in the Scandinavian mountain range will offer a unique chance for studying and comparing long-term atmospheric parameter variations to changes in the terrestrial and aquatic high-latitude ecosystems studied there.

EISCAT_3D will be located at the edge of the polar vortex, which makes it suitable for testing transport models of meteoric smoke particles (MSPs). MSPs are important for a variety of atmospheric phenomena such as metal layers, heterogeneous chemistry and others. For example, they are the most likely candidates for the nuclei of mesospheric ice particles that play a crucial role for polar mesospheric summer echoes and noctilucent clouds, which may be indicators of climate change. Today the evidence of their existence comes from a few rocket experiments, from incoherent scatter radar studies and from satellites. The high power and volumetric imaging capability of EISCAT_3D will enable measurements of MSP properties as well as spatial and temporal variability in ways that are not possible with present instruments.

One consequence of solar wind interaction with planetary atmospheres and ionospheres is atmospheric loss through ion outflow. The outflow can constitute a significant loss of atmospheric constituents into interplanetary space and be a significant source of magnetospheric plasma. Despite the presence of a strong geomagnetic field, the ionospheric loss from the Earth is of the same order of magnitude as from the unmagnetised planets Mars and Venus. With EISCAT_3D volumetric imaging it will be possible to determine the spatial and temporal dynamics of upflow, as well as the stages that lead to outflow, e.g. if the transport of plasma into the upflow region is a limiting factor determining the total ion escape from a planet.