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Ionosphere research with a HF/MF cubesat radio instrument

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New technology provides new possibilities to study geospace and 3D ionosphere by using spacecraft and computer simulations. A type of nanosatellites, CubeSats, provide a cost effective possibility to provide in-situ measurements in the ionosphere. Moreover, combined CubeSat observations with ground-based observations gives a new view on auroras and associated electromagnetic phenomena. Especially joint and active CubeSat – ground based observation campaigns enable the possibility of studying the 3D structure of the ionosphere. Furthermore using several CubeSats to form satellite constellations enables much higher temporal resolution.

At the same time, increasing computation capacity has made it possible to perform simulations where properties of the ionosphere, such as propagation of the electromagnetic waves in the medium frequency, MF (0.3-3 MHz) and high frequency, HF (3-30 MHz), ranges is based on a 3D ionospheric model and on first-principles modelling. Electromagnetic waves at those frequencies are strongly affected by ionospheric electrons and, consequently, those frequencies can be used for studying the plasma. On the other hand, even if the ionosphere originally enables long-range telecommunication at MF and HF frequencies, the frequent occurrence of spatiotemporal variations in the ionosphere disturbs communication channels, especially at high latitudes. Therefore, study of the MF and HF waves in the ionosphere has both a strong science and technology interests.

We introduce recently developed simulation models as well as measuring principles and techniques to investigate the arctic ionosphere by a polar orbiting CubeSat whose novel AM radio instrument measures HF and MF waves. The cubesat, which contains also a white light aurora camera, is planned to be launched in late 2017 (http://www.suomi100satelliitti.fi/eng). The new models are (1) a 3D ray tracing model and (2) a 3D full kinetic electromagnetic simulation. We also introduce how combining of the cubesat measurements to ground based measurements provides new research possibilities to study 3D ionosphere.