



## **Ionosphere research with a MF/HF radio instrument on Suomi100 cubesat**

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Modern technology provides new possibilities to study Earth's ionosphere by using small spacecraft and 3D 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 give 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 present computational simulation and 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 1 Unit (10 cm x 10 cm x 10 cm) Suomi100 cubesat, which contains also a white light aurora camera, is planned to be launched in March 2018 (<http://www.suomi100satelliitti.fi/eng>). We introduce 3D simulations which have been developed to study the propagation of the radio waves, both ground generated man-made waves and space formed space weather related waves, through the 3D arctic ionosphere with (1) a new 3D ray tracing simulation and (2) a new 3D full kinetic electromagnetic simulation. We also introduce the Suomi100 CubeSat mission and its payload which will be used to derive information about the 3D ionosphere and its spatial and temporal variations.