Ionospheric Tomography based on GPS and Beacon data within the TomoScand/MIRACLE project

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This presentation introduces the 'Mesoscale ionospheric tomography in Scandinavia (TomoScand)' project led by Finnish Meteorological Institute (FMI, Helsinki/Finland), PI: O. Amm. TomoScand is part of the Magnetometers-Ionospheric Radars - All-sky Cameras Large Experiment (MIRACLE) project, a 2D instrument network constructed for mesoscale studies of auroral electrodynamics, which is maintained and operated as an international collaboration under the leadership of FMI, and further consists of magnetometers, radars, and all-sky cameras. In comparison with other ionospheric tomography projects, TomoScand is characterized by the '3M' approach, that is: Mesoscale (localized for Scandinavia), Multi-frequency (combine Beacon and GPS), and MIRACLE (data integration with the other instruments of the network).

TomoScand has the following main scientific goals;

(a) Obtain 3D electron density distributions with a resolution of at least 50 km (horizontal), 5 km (vertical, for E layer), and ˜10 s (in time) over whole Fennoscandia.

(b) Get the E-layer correctly, and thus estimate ionospheric conductivities

(c) Combine the output with other MIRACLE data, in order to understand 3D ionospheric electrodynamics.

(d) Combine results with magnetospheric data using advanced M-I- coupling schemes [e.g., Yoshikawa et al., 2011]

The tomographic analysis is mainly based on a combination of data from GPS and Beacon data receiver networks. We present the data handling system for the GPS data, from which we directly obtain time series of vTEC maps of the vertically integrated electron density over Scandinavia. For the full tomography using Beacon and GPS data, a new statistical inversion algorithm [Norberg et al., 2013] has been developed that is optimized for mesoscale analysis, and for the inclusion of multiple data sources.

At present, the project members are working on further expansion of the 3D ionospheric tomography algorithm, establishing a new receiver network for Beacon satellites, and the unified analysis of GPS, Beacon, and other ground based measurements (MIRACLE). In this presentation we will show the progress of the project, especially showing the GPS data handling procedure, its outputs and applications.