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# A review of selected data-analysis techniques for determining ionospheric electrodynamic parameters on mesoscales

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We present a review of selected data-analysis methods that are applied in studies of ionospheric electrodynamics and magnetosphere-ionosphere coupling using ground-based and space-based data sets. At present, there is no single measurement device that can measure all ionospheric electrodynamic parameters directly and simultaneously, with good spatial and temporal resolution and coverage. Therefore data-analysis techniques are needed to combine different types of measured data and to obtain unobserved ionospheric parameters from the observed ones, possibly using some additional assumptions in the process. We concentrate on methods that are data driven and applicable to single events (not simulations or statistical models), and which can be used in mesoscale studies, where the analysis area is typically some hundreds or thousands of km across.

The primary focus of this review is in ionospheric electrodynamics, so we do not include variables like chemical composition, temperature, etc. in our discussion. Furthermore we concentrate on analysis techniques that have been developed to be used with data from the MIRACLE network (Magnetometers - Ionospheric Radars - All-sky Cameras Large Experiment) situated in Northern Europe, possibly in combination with satellite observations, such as Cluster or CHAMP. However, the techniques can be applied to data from any other mesoscale network with similar observations.

The full set of ionospheric electrodynamic parameters that we are interested in consist of the ionospheric horizontal electric field, height integrated Hall and Pedersen conductances, horizontal sheet current and field aligned current (FAC). Additionally, the ground magnetic perturbation is an important input parameter in many analysis methods.

Most of the reviewed methods are used in 2-dimensional (latitude - longitude) regions of the ionosphere, but some methods have also 1-dimensional variants. In 1D analysis it is assumed that ionospheric parameters vary only in one horizontal direction (e.g. as a function of geomagnetic latitude), so input data is required along a single chain or a satellite track only. The 1D methods are especially useful when analyzing data from an overpassing satellite or from a meridional magnetometer chain.

キーワード: Ionosphere, Ionospheric electrodynamics, Ionospheric currents, Data-analysis methods
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