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High Resolution Reconstruction of the Ionosphere for SAR Applications

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Caused by ionosphere's strong impact on radio signal propagation, high resolution and highly accurate reconstructions of the ionosphere's electron density distribution are demanded for a large number of applications, e.g. to contribute to the mitigation of ionospheric effects on Synthetic Aperture Radar (SAR) measurements. As a new generation of remote sensing satellites the TanDEM-L radar mission is planned to improve the understanding and modelling ability of global environmental processes and ecosystem change. TanDEM-L will operate in L-band with a wavelength of approximately 24 cm enabling a stronger penetration capability compared to X-band (3 cm) or C-band (5 cm). But accompanied by the lower frequency of the TanDEM-L signals the influence of the ionosphere will increase. In particular small scale irregularities of the ionosphere might lead to electron density variations within the synthetic aperture length of the TanDEM-L satellite and in turn might result into blurring and azimuth pixel shifts. Hence the quality of the radar image worsens if the ionospheric effects are not mitigated.

The Helmholtz Alliance project "Remote Sensing and Earth System Dynamics" (EDA) aims in the preparation of the HGF centres and the science community for the utilisation and integration of the TanDEM-L products into the study of the Earth's system. One significant point thereby is to cope with the mentioned ionospheric effects. Therefore different strategies towards achieving this objective are pursued: the mitigation of the ionospheric effects based on the radar data itself, the mitigation based on external information like global Total Electron Content (TEC) maps or reconstructions of the ionosphere and the combination of external information and radar data.

In this presentation we describe the geostatistical approach chosen to analyse the behaviour of the ionosphere and to provide a high resolution 3D electron density reconstruction. As first step the horizontal structure of the ionosphere is studied in space and time on the base of ground-based TEC measurements in the European region. In order to determine the correlation of measurements at different locations or points of time the TEC measurements are subtracted by a base model to define a stationary random field. We outline the application of the NeQuick model and the final IGS TEC maps as background and show first results regarding the distribution and the stationarity of the resulting residuals. Moreover, the occurred problems and questions are discussed and finally an outlook towards the next modelling steps is presented.