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Investigations on the GOCE EGG measurement errors over the Northern Polar Region using ionospheric proxies

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We investigated the unknown source of the disturbances that were detected in the GOCE cross-track gravity gradient over the geomagnetic Polar Regions. External data such as the interplanetary electric field and equivalent ionospheric currents are used to understand the source of the disturbances during geomagnetically active days. Equivalent ionospheric currents are computed from magnetic field disturbances measured at terrestrial stations and are used to represent the main ionospheric currents here and also as a marker of main dynamics in the ionosphere. Our analyses showed that the gradiometer measurement disturbances are in coherence with increased ionospheric dynamics. By reason of physical processes in the thermosphere, we calculated the Poynting energy flux from equivalent ionospheric currents and vertical electric currents that represent the electric currents coming into and drifting away from the ionosphere. Poynting energy flux represents the main characteristics of the ionospheric electromagnetic activity and helps to understand and study the effect of main ionospheric dynamics on GOCE measurements.

Our hypothesis is that the ionospheric dynamics in terms of the electromagnetic energy flux is the dominating reason for the disturbances in the EGG cross-track measurements and perturbations by other sources are within the noise level of the instrument. Based on this hypothesis we developed a dynamic input/output system in terms of the cross-track Poynting energy flux component and the gravitational gradient tensor trace, respectively. We estimated an autoregressive exogenous model which describes the main characteristics of the relationship between the ionospheric dynamics and the GOCE EGG disturbances from an individual satellite track which features a high signal to noise ratio. Then, this empirical model is used to predict the disturbances in other tracks and to eliminate them from the trace of the EGG measurements for an exemplary 2-month period, namely March-April, 2011. So far, over Canada and Greenland, an improvement of 20 – 30% noise reduction is reached by using this technique which will be incorporated to improve the quality of the cross-track gradients in future work.