3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Space Weather Impact on Navigation and Remote Sensing in the High Arctic

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Space weather hazards like Solar Flares, Solar Radio Bursts or Solar Storms can heavily disturb GNSS services due to severe temporal and spatial changes of the electron density in the ionosphere. Such irregularities can affect Global Navigation Satellite Systems (GNSS) signals, which are crucial to provide positioning results for many applications and services [1]. The solar wind and solar storm impact are particularly strong in the polar region and related disturbances are more frequent at high latitudes than elsewhere due to the topology of the earth geomagnetic field. The dynamics of the ionosphere at high latitudes with its high local and spatial variability is not completely understood and subject of current research. Due to the climate change and the related reduction of the arctic shelf ice, the Arctic region becomes relevant for maritime traffic and resource exploitation. Space Weather can therefore occasionally cause complications in businesses of several economic sectors e.g. oil, gas and mineral industries, fishery, forestry, and tourism, which need accurate and continuous services for navigation, communication and environmental monitoring. New GNSS remote sensing techniques, using reflected signals, are under development with potential for Arctic ocean monitoring and sea-ice characterization [2]. A deeper understanding of small-scale ionospheric disturbances and their effects at GNSS receiver level will help to ensure safe GNSS based navigation and to foster GNSS based remote sensing in the Arctic. Hence, a comprehensive data base of scintillation events with samples of scintillation affected GNSS signals are of high importance. We will present results from scintillation measurements done with high rate GNSS stations and onboard of the German research vessel Polarstern during its polar ice drift mission MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate). The Polarstern sailed and drifted with the sea ice through the Siberian Sector, the Central Arctic crossing North pole and Fram Strait between September 2019 and September 2020. Data from two GNSS receivers and a recording (bitgrabber) system were continuously collected [2][3]. The recorded signals also serve as basis for the development of new GNSS algorithms to mitigate scintillations and to compare the performance of different receivers and algorithms under comparable, real-world ionospheric conditions.

Figure 1. Antenna and scintillation recorder onboard of the Polarstern vessel [3]

We will present and discuss the effect of space weather on GNSS in the polar region using data from permanent GNSS stations as well as from the MOSAiC measurement campaign during 2019-2020.

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