Geophysical Research Abstracts
Vol. 20, EGU2018-16205, 2018
EGU General Assembly 2018

GGOS Focus Area on Geodetic Space Weather Research

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Space weather means today an own, very up-to-date and interdisciplinary field of research. It describes physical processes in space mainly caused by the Sun's radiation of energy. The manifestations of space weather are multiple, for instance, the variations of the Earth's magnetic field or the changing states of the upper atmosphere, in particular the ionosphere and the thermosphere.

The most extreme known space weather event happened at September 1, 1859 – the Carrington storm. Other prominent recent, but much weaker events have been the Halloween storm at October 28 – 30, 2003, or the St. Patrick's storm at March 17, 2015. The strength of these events, their impacts on modern society and the possibility of much stronger future events have brought several countries such as US, UK, Japan, Canada and China to recognize the necessity of studying these impacts scientifically, of developing protection strategies and procedures and to establish space weather data centres and space weather services. As a consequence of these activities the Focus Area on Geodetic Space Weather Research (FA GSWR) was initiated. The main objectives of the FA GSWR are (1) the development of improved ionosphere models, (2) the development of improved thermosphere models and (3) the study of the coupled processes between the thermosphere and the ionosphere.

Objective (1) aims at the high-precision and the high-resolution (spatial and temporal) modelling of the electron density. This finally allows to compute a signal propagation delay, which will be used in many geodetic applications, in particular in positioning, navigation and timing (PNT). Moreover, it is also important for other techniques using electromagnetic waves, such as satellite- or radio-communications. Concerning objective (2), satellite geodesy will obviously benefit when working on precise orbit determination (POD), but there are further technical matters like collision analysis or re-entry calculation, which will become more reliable when using high quality thermosphere models. Objective (3) links the first two objectives by introducing physical laws and principles such as continuity, energy and momentum equations and solving partial differential equations. Consequently, these investigations are fundamental research, particularly when intending to detect and to survey structures of the ionosphere, e.g. bubbles, or when studying special phenomena like electro-jets.

Summarizing, geodetic space weather research must be based on the use and combination of all space-geodetic observation techniques, on geodetic methods for real-time modelling and forecast approaches. Assimilation strategies must be developed to consider additional information such as Sun observations. Consequently, geodetic space weather research comprises the basic ideas of GGOS.

In this introductory presentation first investigations within the framework of the FA GSWR will be shown.