GLOBAL GEODETIC OBSERVING SYSTEM

GGOS Focus Area 4: Geodetic Space Weather Research
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Introduction
• Space weather is a very up-to-date and interdisciplinary field of research.
• It describes physical processes in space mainly caused by the Sun’s radiation of energy.
• There are multiple manifestations of space weather, e.g. (1) variations of the Earth magnetic field, (2) the polar lights in the northern and southern hemisphere, (3) the variations of the ionosphere and thermosphere due to coupled processes, (4) the solar wind, (5) the interplanetary magnetic field, and (6) the electric currents.
• The most extreme known space weather event happened at September 1, 1859 – the Carrington storm.
• Prominent recent events are the Halloween storm at October 28 – 30, 2003, the Bastille Day Event at July 14, 2000 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 centers and space weather services.

Geodetic Monitoring of the Ionosphere and the Thermosphere
• Figure 1 gives an overview about the space-geodetic observation techniques which provide valuable information about the state of the ionosphere.
• Satellite Geodesy has to deal with the thermosphere, since thermospheric drag is the most important force acting on Low-Earth Orbiting (LEO) satellites and objects in the re-entry stage.
• Figure 2 illustrates symbolically the coupled processes between magnetosphere, ionosphere and thermosphere.
• Geodesy has a long history and large experience in developing and using sophisticated analysis techniques and modelling approaches.

Conclusion: Space Weather is a geodetic topic as well!

Consequences
Geodetic space weather research must be based on
• the use and combination of all space-geodetic observation techniques,
• 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.

Objectives of Focus Area 4

The main objectives are:
• improvement of positioning and navigation by developing high-precision and high-resolution models of the electron density,
• improvement of precise orbit determination (satellites and space debris) by developing high-precision and high-resolution thermospheric drag models.

Joint Study Groups (JSG) related to the Focus Area 4
For the realization of the objectives at least 2 new GGOS JSGs have to be installed:
• JSG 1: Electron density modelling of the ionosphere including space weather effects from the combination of space-geodetic measurement techniques.
• JSG 2: Improvement of thermosphere models including physics-based realizations of coupled thermosphere-ionosphere processes, in particular for applications to LEO precise orbit determination (POD).

Figure 1: Space-geodetic observation techniques in the context of satellite missions monitoring solar events.

Figure 2: Events effecting different parts of the atmosphere including the coupling processes from the lower to the upper atmosphere.