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From Geomagnetism and Space Science to Space Weather

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Early studies of "geo-magnetism" dealt with the understanding of long-term developments and short-term disturbances in the geo-magnetic field as measured by magnetometers on ground level. Soon after the IGY the concept of several co-existing and globally or locally interacting ionospheric current systems (DP1 & 2) was born. Both systems seemed to respond differently to solar wind driving conditions and internal magnetospheric processes. Through continued global international study efforts, like e.g. the International Magnetospheric Study (IMS) and later the International Solar Terrestrial Physics program (ISTP) the 2-dimenional monitoring of geomagnetic "disturbances", now understood as complex signatures of different current systems within and beyond the upper atmosphere, became a powerful tool to monitor and study the complicated three-dimensional coupling of the magnetosphere to the upper atmosphere and its ultimate relation to certain solar wind drivers of magnetospheric conditions.

Geomagnetic observations, both globally and regionally, are today a valuable asset to put the very local measurements of magnetospheric satellites (even if "multi-point") into its proper context with respect to the dynamics of the magnetosphere. The ultimate goal of such measurements today is not only to identify the energy and activity state of the magnetosphere as such, but also to study the exact location, strength and spatio-temporal development of the most powerful short-lived magnetic disturbances that we know, the so-called magnetospheric substorms and the closely related intensifications of major magnetic storms.

The study of the physics of the geo-space environment in response to solar activity and solar wind driving has over the last twenty years matured to make first useful predictions of a large variety of plasma processes in near-Earth space, which have the potential to detrimentally affect human space exploration and human technological infrastructure both on ground and in space. The fast-growing research and operational field of **Space Weather** has stimulated new active research (including advanced model efforts) to get to the bottom of some of the most effective geo-space plasma phenomena, and to understand the variability of ionospheric currents, and their connection to the outer magnetosphere. This is at present one of the most intriguing scientific problems in the field of **Space Weather**. Potentially any conducting infrastructure on the ground can be detrimentally or catastrophically affected by fast changes in the magnetic field (dB/dt) via

geomagnetically induced currents (GICs). In parallel, the involved ionospheric current systems can cause further secondary impacts on space-borne communication and navigations systems via ionospheric plasma instabilities and atmospheric drag effects on satellite orbits.

In my presentation I will give a short background to the historical progress of space science with the help of magnetometer data, and then highlight a selection of recent research topics, where global and regional magnetometer networks (together with a multitude of dedicated space missions) represent a very important part of the systematic and coordinated study of the near-Earth plasma environment, **the coupled solar wind - magnetosphere - ionosphere – atmosphere "System of Systems".**