Investigations on Solar Wind-Magnetosphere-Ionosphere coupling during storms and supersubstorms

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Abstract

This thesis aims to quantitatively analyse the effects of solar wind-magnetosphere-ionosphere (SW-M-I) coupling on the near-Earth space environment and enhance the current understanding of both large and small-scale coupling processes and mechanisms in the SW-M-I system during extreme transient events of supersubstorm and geomagnetic storms. At the first, robust quantitative analyses with regard to the SW-M-I coupling during all the three supersubstorm events (i.e. May 2011, March 2012, and September 2017) of solar cycle 24 are carried out. The observations from the L1-point and network of magnetometer and radars are included in comparative assessments and investigations of different coupling functions and the most significant parameters known to define the SW-M-I coupling. The in situ observations from the MMS, Cluster, and THEMIS missions are additionally used to investigate the ion and electron scale coupling during the geomagnetic storm of 31 December 2015.

The thesis consists of six chapters, out of which the first chapter gives the introduction, motivation, and aim of the thesis, and the second chapter gives the details of the observations and methodology. Chapters three, four, and five provide details of results obtained under three aimed objectives. The sixth chapter provides a summary and future directions. Overall, the thesis work has led to three publications in peer-reviewed international journals.

The main results showcase the quantification of the solar wind drivers, energy sources, and sinks in the magnetosphere-ionosphere system during both short and long periods, along with the percentage share of the major energy sinks in the magnetosphere-ionosphere system during the growth and recovery phases during supersubstorms, and intriguing trends of substorms of different intensities. The major results of another study on the latitude-dependent H and D-component responses during the Storm Sudden Commencement (SSC) and the latitude-dependent anomalies and similarities during the main phases, indicate the complex interplay of different spatially and temporally varying current systems in the magnetosphere-ionosphere system. The investigations on the kinetic scale coupling bring about a few very interesting results regarding the carriers of the field-aligned currents and different ideal and non-ideal terms of the total electric fields. The in situ observations of different plasma and field parameters at the magnetopause and magnetotail have provided a broad overview of the multi-scale dynamics of the two reconnection regions in near-earth space.