Preface

Interplanetary medium and geophysical phenomena during geomagnetic storms

Geomagnetic storms and space weather are complex topics where the overall picture is assembled together from pieces derived from intense research by individual scientists at home institutions and by lively discussions of these results at scientific meetings. A two-day symposium GA 4.08 “Interplanetary Medium and Geophysical Phenomena During Geomagnetic Storms” was held at the 22nd General Assembly of the International Union of Geodesy and Geophysics (Birmingham, England, July 28–29, 1999), allowing scientists from all over the world to present their latest results. This special issue of the Journal of Atmospheric and Solar-Terrestrial Physics (JASTP) is a direct result of this symposium.

Over the last decade, we have learned a great deal about the space environment in which the Earth is immersed. Magnetic reconnection is the mechanism generally considered to be instrumental in causing solar flares and the formation and release of coronal mass ejections (CMEs). We know that the energetic particles, which represent a hazard for interplanetary and Earth-orbiting spacecraft and human space flight, come in three forms. There are the “prompt” particles that are accelerated at the flare site by various processes currently being debated, as well as particles that are accelerated at interplanetary shocks located upstream of fast interplanetary CMEs (ICMEs), and energetic magnetospheric particles that are accelerated by a number of different processes associated with magnetic storms caused by the ICME interaction with the Earth’s magnetosphere. To confuse matters, there is also shock acceleration of energetic particles during the declining/solar minimum phases of the solar cycle at the edges of corotating interaction regions (forward and reverse shocks). All of these particle sources have distinct characteristics.

ICMEs (only parts of CMEs may get into interplanetary space and they may also evolve as they propagate through space and thus are called ICMEs for obvious reasons) have been found to not only cause intense storms at Earth, but also cause periods of intense quiet at times. Again, magnetic reconnection (or lack thereof) has been found to be the key energy transfer process. The ICME and/or upstream sheath magnetic fields must be intense, southwardly directed, and have duration of hours in order to cause intense storms. If any of these three features are not met, the storm will not be particularly intense. The definition of storm “intensity” and the mechanism for particularly large Dst-index values have recently come into question. Do double (or triple) IMF B events lead to compound ring-currents and large Dst values? What are the interplanetary mechanisms for such events?

The following papers represent some further advances of various facets in our understanding of the magnetic storms and space weather problem. The first six papers included in this special issue are invited talks presented at the symposium by renowned scientists. These papers cover a sequence of topics starting from solar sources of CMEs, advancing through reviews of interplanetary and magnetospheric sources of magnetic storms, and ending with analysis of the magnetosphere–ionosphere coupling, ionospheric response, and geomagnetic field modeling during magnetic storms. A number of contributed talks included in this issue range from theoretical analyses of various storm-related mechanisms to experimental observations in the magnetosphere and on the Earth’s surface. CME release mechanisms/conditions, interplanetary causes and evolution of these features plus shock effects on the magnetosphere are reviewed. The energetic particle dynamics within the magnetosphere, related electric fields and ionospheric responses are also summarized. New results on the ionosphere and atmospheric storm-time dynamics, geotail and ring-current evolution, plus magnetic topology and variations are of particular interest.

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