LONG-TERM GEOMAGNETIC ACTIVITY: RECENT PROBLEMS, DEVELOPMENTS AND CONSEQUENCES FOR SPACE CLIMATE

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Geomagnetic activity forms one of the most reliable and versatile ways to study the long-term change in the Sun and heliosphere, i.e., space climate. Continuous measurements of geomagnetic activity exist since the mid-19th century, covering more than 160 years. In addition to the long-term trend, geomagnetic activity depicts persistent patterns and periodicities, the most dominant of which are the solar cycle variation and the semiannual variation. Other significant fluctuations include the annual variation, 1.3-1.8-year variation and the 22-year variation. All these variations reflect some fundamental properties of the Sun and the Sun-Earth connection. Interestingly, although some of these patterns are known for a long time (e.g., the semiannual variation for nearly 150 years), they are properly understood only since recently. The overall level of geomagnetic activity has increased during the last 100 years although the exact amount of increase is still under debate. Also, geomagnetic activity based estimates about the long-term change of various solar and heliospheric parameters, like the intensity of the heliospheric magnetic field, the solar wind speed and the total solar irradiance, vary considerably. These differences are caused by problems in the quality of archival data, by inhomogeneities and errors in geomagnetic indices and by the unsatisfactory level of understanding the relations between solar, heliospheric and geomagnetic parameters. E.g., it has been noted recently that errors in archival data may lead to seriously flawed estimates of the centennial trend. Also, it is known that the longest and most used long-term geomagnetic index, the aa index, is inhomogeneous and depicts an excessively large centennial increase. Accordingly, all estimates based on the aa index yield excessively large centennial changes and need to be corrected.

Taking into account the crucial role of the Sun for, e.g., the global climate, the long-term change in solar activity has considerable social interest and should be evaluated as reliably as possible. Recently, new indices of long-term geomagnetic activity have been developed based on digitally available hourly values of the geomagnetic field. These indices allow for a detailed examination of their properties, being therefore more straightformward and more reliable than earlier indices. Here I will review the principles and status of the traditional and new indices of geomagnetic activity, discuss the present understanding of the various systematic patterns depicted by geomagnetic activity, including the centennial change of geomagnetic activity and its implications about the long-term change of the Sun.

Geomagnetic activity, geomagnetic indices, long-term solar chamge

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