Geophysical Research Abstracts
Vol. 16, EGU2014-11203-1, 2014
EGU General Assembly 2014

Reconstruction of Geomagnetic activity and near-Earth interplanetary conditions over the past 167 years.

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Records of geomagnetic activity have previously been used to reconstruct the conditions in near-Earth space, such as the interplanetary magnetic field (IMF), solar wind speed (Vsw) and open solar flux (OSF). Reliable geomagnetic activity records exist back until the mid-1800's, and these data provide one of the few means of inferring variations in the conditions in near-Earth space before the advent of the space age. However, there are challenges in using geomagnetic activity records to reconstruct interplanetary conditions. In particular it is necessary to ensure, as best as is possible, the homogeneity and reliability of any geomagnetic indices used. This becomes increasingly difficult further back in history, as both the quality of the data and the number of observing stations decreases.

A new geomagnetic activity index, the IDV(1D) index, is presented, which is designed to be as homogeneous in its construction as possible (Lockwood et al. 2013a). This is achieved by only combining data that, by virtue of the locations of the source observatories used, have similar responses to solar wind and IMF variations. IDV(1d) employs many of the principles of the IDV index (Svalgaard and Cliver (2010)), inspired by the u index of Bartels (1932). The index uses interdiurnal variation data from Helsinki for 1845– 1890 and 1893–1896 and from Eskdalemuir from 1911 to the present. The gaps are filled using data from the Potsdam (1891–1892 and 1897–1907) and the nearby Seddin observatories (1908–1910) and intercalibration achieved using the Potsdam–Seddin sequence. The index is compared with independent, early data from European-sector stations, as well as the composite u index and the IDV index. Agreement is found to be extremely good in most cases. IDV(1D) does not suffer from the poor homogeneity of the IDV index, and is more highly correlated with the IMF, consequently it yields a more reliable reconstruction (Lockwood et al 2013b).

For completeness, we use 4 different combinations of the IDV(1D), IDV, aa and IHV geomagnetic indices to reconstruct the near-Earth IMF, Vsw, and the OSF from 1845 to 2013. Although each of the different indices is constructed using different data and algorithms the results are very similar and consistent for all 4 combinations of parameters. The OSF variation derived is shown to be very similar indeed to that obtained using the method of Lockwood et al. (1999). This reaffirms one of the key findings from Lockwood et al. (1999), that the OSF approximately doubled over the period 1902-1955. Furthermore, this reconstruction shows that the OSF in the minima of solar cycle 23 and rise phase of solar cycle 24 is the lowest in approximately 100 years, being comparable to levels last experienced in solar cycle 14 (1902-1913).