Journal of Atmospheric and Solar-Terrestrial Physics 71 (2009) 1717–1726

Contents lists available at ScienceDirect

Journal of Atmospheric and Solar-Terrestrial Physics

journal homepage: www.elsevier.com/locate/jastp

Does sunspot number calibration by the "magnetic needle" make sense?

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ARTICLE INFO

Article history:
Accepted 18 April 2008
Available online 10 May 2008

Keywords:
Sunspot numbers
Geomagnetic declination
Long-term change

ABSTRACT

It has been suggested recently that early sunspot numbers should be re-calibrated and significantly corrected using the observed daily range of the geomagnetic declination (so-called rY values). The suggested "correction" method makes an a priori detrending of the rY series and then extends the linear regression between rY and sunspot numbers established for the last 25 years to earlier times. The suggested "correction" of sunspot numbers by roughly 30% goes far beyond the traditional estimates of observational uncertainties of sunspots. Concentrating here on Zürich sunspot numbers (R_z), we demonstrate that the rY values do not actually imply that the observed R_z values in the 19th century are systematically underestimated. Rather, we find that the R_z numbers are fairly uniform after mid-19th century. The suggested "correction" is largely induced by the detrending of the rY series, which enhances the rY-based sunspot activity in the 19th century relative to later times. We also show that while the annually averaged declinations have a rough relation between sunspots and other related solar parameters, this relation is strongly seasonally dependent and, therefore, not sufficiently accurate or uniform to allow annually averaged rY values to be used as a very reliable proxy of solar activity in early times.

1. Introduction

The evolution of solar activity during the last 100 years is very well known, based on both direct sunspot observations as well as on some independent proxies. Sunspot numbers depict a fairly steady increase of cycle amplitudes from the start of the 20th century until SC 19 in the mid-20th century, with a more variable but still larger than average level thereafter. This evolution is supported by studies based on proxies of solar activity like geomagnetic activity and cosmogenic isotopes. For example, based on the geomagnetic *aa* index it was derived (Lockwood et al., 1999) that the strength of the heliospheric magnetic field was more than doubled during the last century, in agreement with a solar magnetic field model and the observed sunspot numbers (Solanki et al., 2000, 2002). The increasing centennial trend found in solar and geomagnetic activity is further supported by studies using cosmogenic isotopes (Usoskin et al., 2003; Solanki et al., 2004).

Despite this consistency, some doubt was raised on the centennial increase in geomagnetic activity. Introducing a new index of geomagnetic activity, the so-called IHV (inter-hour variability) index, Svalgaard et al. (2004) claimed that there is no long-term increase during the 20th century. However, it was shown soon thereafter that when the effect of the changing data sampling method in the early century is taken into account, the IHV indices of all studied stations show a clearly increasing centennial trend (Mursula and Martini, 2006). The centennial increase was recently further verified using

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doi:10.1016/j.jastp.2008.04.017