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A PREDICTION FOR THE 24TH SOLAR CYCLE

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Abstract. The aim of the present analysis is to forecast the strength of the next solar maximum of the 24th cycle. We correlate the relative sunspot numbers in the epochs of solar activity minima and maxima. Using this method, the estimated relative sunspot number (also called the Wolf number) of the next solar maximum is in the range 67 - 81, i.e., about 40 % below the peak sunspot number of 121 for cycle No. 23.

Key words: solar activity - prediction - solar cycle strength

1. Introduction

At present there are two basic classes of methods for the solar cycle predictions: the empirical methods and methods based on dynamo models (e.g., Schüssler, 2007). The empirical methods (e.g., Hathaway, Wilson, and Reichmann, 1999) can be further divided into two subgroups, the statistical methods based on extrapolation (e.g., Kane, 2007b) and precursor methods (e.g., Wilson, 1990). The other class of methods is based on various dynamo models (e.g., Cameron and Schüssler, 2007; Choudhuri, Chatterjee, and Jiang, 2007; Dikpati, 2007; Jiang, Chatterjee, and Choudhuri, 2007), but can also be combined with some precursor features (e.g., polar magnetic

field of the Sun around solar minimum, Svalgaard, Cliver, and Kamide, 2005).

In our recent paper (Brajša *et al.*, 2009) we applied three different methods for solar cycle predictions and reconstructions. These are the calculation of the asymmetry of the ascending and descending solar cycle phases, the correlation of the relative sunspot numbers in the epochs of solar activity minima and maxima and the estimation of the parameters of an autoregressive moving average model (ARMA). In the present analysis we use the minimum - maximum method taking into account the low actual relative sunspot numbers in the present minimum of the solar activity.

2. The Data Set and the Reduction Method

We have used the monthly smoothed relative sunspot numbers beginning from 1750, which can be found at the Solar Influences Data Analysis Center (SIDC) of the Royal Observatory of Belgium (SIDC-team). The minimum - maximum method is based on the assumed linear relationship between relative sunspot numbers in the minimum (at the beginning of the activity cycle, $R_{\min}$ and in maximum epochs $R_{\max}$ of solar cycles (e.g., Wilson, 1990).

Correlating all available data, while excluding the data point from the anomalous solar cycle No. 19, we obtained the following linear relationship (Brajša *et al.*, 2009):

$$R_{\max} = 67.4(\pm 10.6) + 6.9(\pm 1.5) R_{\min} \ , \qquad (1)$$

with the correlation coefficient of 0.72. This Equation enables a prediction of the amplitude of the next solar activity maximum, if the $R_{\min}$ is known (or can be estimated).

3. Results, Discussion and Conclusion

For the estimated $R_{\min}$ values in the current solar minimum of 5, 4, and 3, Brajša *et al.* (2009) obtained $R_{\max}$ values of 102, 95, and 88, respectively, for the next maximum, according to Equation (1). However, in July and August 2008, the determined monthly relative sunspot number was only 0.5 and in December 2008 it was 0.8 (SIDC-team). In September, October, and November 2008 and in January and February 2009 the monthly relative

sunspot number was between 1.1 and 4.1. So, we now make a new prediction of $R_{\max}$ using lower $R_{\min}$ values. In the present paper we use only the non smoothed actual relative sunspot numbers. According to Equation (1), for the $R_{\min}$ values in the current solar minimum of 2, 1, and 0 we get $R_{\max}$ values of 81, 74, and 67, respectively.

Based on the minimum - maximum method, our prediction for the next solar maximum in the range from $R_{\max} = 67$ to $R_{\max} = 81$, is in agreement with some other predictions obtained applying the empirical or precursor methods (Schatten, 2005; Svalgaard, Cliver, and Kamide, 2005; Javaraiah, 2007; Svalgaard and Schatten, 2008). Some further predictions obtained applying the empirical or combined methods are slightly above our upper limit (Schatten, 2003; Kane 2007b), or significantly above it (Lantos, 2006; Du and Du, 2006; Kane 2007a; Hiremath, 2008). Our prediction is in a qualitative agreement with a forecast based on a dynamo model (Choudhuri, Chatterjee, and Jiang, 2007; Jiang, Chatterjee, and Choudhuri, 2007). It is in a qualitative and quantitative disagreement with predictions based on other dynamo models (Dikpati and Gilman, 2006; Dikpati, de Toma, and Gilman, 2006; 2008) and with one empirical forecast (Hathaway and Wilson 2006). However, we note that D. H. Hathaway has lowered his prediction based on geomagnetic activity to 105 (http://solarscience.msfc.nasa.gov/predict.shtml).

To check whether we are currently in the prolonged solar minimum, we should wait at least for the complete monthly values of the relative sunspot number for the year 2009 and observations during subsequent years will enable to determine the amplitude of the next solar maximum and prove the reliability of the current prediction.

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