Using Vondrak smoothing method to improve the prediction of Sunspot Maximum

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About 11-year cycle of solar activity is the most significant quasi-periodic component, which largely represents the strength of solar activity and is the basis for dividing solar cycle. Many studies have proven that solar activity can affect the developing process of many phenomena on the Earth, such as climate, geophysical and marine changes etc. In order to meet the demands of heliophysics and solar activity variation characteristics studies, especially, for the demand of Solar Terrestrial Relations studies and space science development, studies of solar activity characteristics and prediction are getting more attention. Some authors summerized a variety of methods for the maximum predictions of 22nd, 23rd, 24th solar cycles, the incomplete statistics are 63, 54 and 75 cases respectively, results of the methods, which the difference between forecasting and observed values within the range of ±15%, are 27.0%, 25.9% and 24.3% respectively. Using the 13 points smoothed value of monthly sunspot numbers, we studied correlation between sunspot number rising rate of the first 24 months of the solar cycle and the coming cycle maximum, published forecasting result that the maximum value was 139.2 ±18.8 for 23rd solar cycle (Han et al., 2000), and the observed value is 120.8, the error is about 15.2%. The present paper introduces our improved forecasting methods. Vondrak smoothing method is used to deal with the monthly sunspot numbers. It is studied that the relationship between the rise rate of earlier months of sunspot numbers of this smoothed sequence and the coming maximum value in each solar cycles. The results show that the first 22, 23, 24 months rise rate of sunspot numbers are highly related with the coming maximum values, and simulated prediction of maximum for 22~24 cycles show that using the 22-month rise rate of three solar cycles, the maximum forecasting error is about 13.2%, using 23-month rise rate, the maximum error is about 11.2%, while using 24-month rise rate, the maximum error is only about 9.3%. The new method can make the forecasting time in advance at least half a year than the common method using 13 points monthly smoothed value, which the difference between prediction and observed values within the range of ±15%. The results also show that the maximum error is about 20% if we use 18-month rise rate, and it can make the forecasting time in advance at least one year than the common method using 13 points monthly smoothed value.

Keywords: Sunspot Maximum, Prediction

