

A Statistical Study of the Relation between the Amplitude of Solar Cycle and the Area of Active Regions[†] *

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Abstract Based on the observational data of sunspots, the relation between the amplitude of solar cycle and the total area of all active regions occurred in a solar cycle has been investigated. The result shows that the amplitude of solar cycle has a good correlation with the total area of all active regions occurred in the solar cycle. The relation between the amplitude of solar cycle and the area of the largest active region during a solar cycle has also been investigated. The result shows that the amplitude of solar cycle has a poor correlation with the area of the largest active region during a solar cycle, and there is no fixed relation between the peak time of a solar cycle and the time when the largest active region occurred in the solar cycle.

Key words sun: activity, sunspots, methods: statistics

1. INTRODUCTION

It has been several centuries since the observation of sunspot numbers began. That there exists a period of about 11 yr in the solar activity may be apparently found out from the

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observational data. In general, the smoothed monthly mean values of sunspot numbers are adopted to describe the solar activity, and the interval between the two successive minimums of smoothed monthly mean values of sunspot numbers is defined as a solar activity cycle. The time when a minimum occurs is the end of the former solar cycle, and also the beginning of the next cycle. In this paper, the maximum of smoothed monthly mean values of sunspot numbers is known as the amplitude or intensity of the solar cycle. Some studies indicate that as the Schwabe period of solar activity is concerned, it is equivalent to adopt the sunspot number or the sunspot group number ^[1]. Besides the sunspot number or the sunspot group number, other parameters may be used to describe the solar activity, such as the solar radio flux at the wavelength of 10.7 cm ^[2], and the area of active regions ^[3], etc.. In a solar cycle a wealth of active regions may occur. What is the relation between the total area of all active regions in a solar cycle and the amplitude of the solar cycle? During each solar cycle, there exists an active region with the largest area. Is the area of the largest active region in an intense solar cycle bigger than that in a weak one? In other words, what correlation does exist between the amplitude of solar cycle and the area of the largest active region occurred in the solar cycle? This is the second subject of this paper. Besides, does there exist a fixed sequential relation between the time when the largest active region occurs in a solar cycle and the peak time of the cycle? This is the third subject to be studied in this paper.

2. DATA ANALYSIS

From the website <http://solarscience.msfc.nasa.gov/greenwch.shtml> the data of total modified area of all active regions in each month for some solar cycles are downloaded. Thus, are obtained the total area of all active regions, the area of the largest active region in each solar cycle, and the time difference between the time when the largest active region occurred in a solar cycle and the peak time of the same solar cycle for the 12th ~ 23rd solar cycles, which are listed in Table 1. In this table, the first column indicates the ordinal number of solar cycle, the second, the amplitude of solar cycle, the third, the total area of all active regions during the solar cycle, in units of one millionth of solar hemisphere (μh), the fourth, the area of the largest active region in the solar cycle, in units of μh , the fifth, the time difference between the time when the largest active region occurred and the peak time of the solar cycle, in units of month, with the sign $-$ showing advance ahead and the sign $+$, lag behind.

According to Table 1, is obtained a correlation between the total area of all active regions in a solar cycle and the solar cycle amplitude, which is shown in Figure 1. From Figure 1, it is evident that the correlation coefficient (CC) between the total area of all active regions in a solar cycle and the solar cycle amplitude is 0.966 with the confidence level higher than 99%. This demonstrates a very good correlation between them, namely, the more intense the solar cycle, the greater the total area of all active regions in the solar cycle. It may be concluded that an equivalence exists for describing the solar cycle amplitude

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