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## Long-term predictability of solar activity and discreteness of the amplitude

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First, it is shown that the average of the sunspot number (SSN) over a cycle is well correlated with the maximum SSN in the cycle. Yoshida and Yamagishi (2010) showed that the correlation between the monthly smoothed SSN and the maximum SSN of the succeeding cycle is highest for the SSN at a point three years before the minimum. This proves also to be the case for the monthly smoothed SSN and the average SSN. That is, the correlation coefficient between the average SSN over a cycle and the smoothed SSN at a dividing point becomes largest when cycles are cut at a point three years before the minimum. Further, the best correlation between the average SSN and the maximum SSN is also obtained when solar cycles are divided at a point three years prior to the minimum. These facts suggest that the SSN in the final several years of a cycle may include some critical information about the amplitude of the following cycle. Here, we would like to emphasize that the correlation coefficient between the SSN at a dividing point and the amplitude of the following cycle becomes larger when the average SSN is taken as the amplitude. We take all of these results to suggest that the average SSN over the course of a cycle is a proper quantity for representing the amplitude of a cycle and the point three years prior to the minimum may be the most appropriate point at which to define a cycle beginning/ending point. Taking the average SSN as representative of the amplitude of a solar cycle, we show that a number of intriguing phenomena become visible. A most remarkable finding is that the average SSN over a cycle tends to take discrete values, i.e., integral multiples of 20. Further, it is shown that there exists a positive correlation in the amplitude between even-numbered cycles and succeeding odd-numbered cycles and an inverse correlation between  $(2n+1)$  cycles and  $(2n+4)$  cycles where  $n$  represents an integer. If these two correlations are combined, it turns out that there exist two mutually independent series of cycles which do not mix or merge. It is rather extraordinary that using the relationships between the cycles belonging to each of the two series, we can perform long-range prediction of the amplitude of solar activity.

Keywords: sunspot number, average over a cycle, amplitude of solar activity, discreteness, correlation between cycles, long range predictability