Abstract. Some earlier investigations seem to indicate that sunspots show an average drift in latitude which varies sinusoidally with the period of the double sunspot cycle (about 22 years), while the same investigations do not show similar variability with the period of the single sunspot cycle (about 11 years). Other studies, however, show that the drift of sunspots varies with the period of the single sunspot cycle. There seems to be a discrepancy between the two results. The problem is re-investigated on the basis of long-lived sunspot groups, but treating the material in a way different from that used before. This procedure, which uses central values of the proper motions of the groups instead of their average values, gives an additional proof of the reality of the 11-year period of the drift. It also seems to produce the 22-year period, but there is such a difference between the variabilities of the drift found on the basis of the two methods that the 22-year cycle of the drift is made doubtful.

1. Introduction

Average drifts of sunspots in heliographic latitude have previously been studied from the following points of view:

(1) The average drift at different latitudes. It seems certain that, on the average, spots between about ±16° are drifting towards the equator, while spots outside these limits are drifting towards the poles. This drift is at the maximum about 0.01–0.02 degrees/day (Tuominen, 1941, 1952, 1955b; Richardson and Schwarzschild, 1953).

(2) It seems that above the said average drift there is a component varying as a function of latitude, the period of this variability being about 10° and the amplitude 0.0036 degrees/day (Tuominen, 1945, 1952, 1954, 1955a, 1955b).

(3) It seems that above the average drift there is a component varying sinusoidally in phase with the 22-year cycle of the sun (Tuominen, 1952, 1955b; Richardson and Schwarzschild, 1953). The investigations made by Richardson and Schwarzschild (1953) (cited from now on as R & S) and by Tuominen (1955b) seem to show this quite clearly and they give for this oscillation an average amplitude of about 0.005 degrees/day. However, the same investigations do not show variability of the drift in phase with the 11-year cycle of the sun.

(4) A variability with the 11-year cycle is shown, however, by the investigations made by Becker (1954) and by Tuominen (1961). And this variability is much more pronounced than the 22-year oscillation.

The main purpose of the present paper is to discuss the reason for the apparent discrepancy between the results of (3) and (4).
Fig. 1. The diagram derived by Richardson and Schwarzschild (1953) for the 22-year oscillation of the average drift of sunspots in latitude, the average being formed over all sunspot groups (at all distances from the equator). “The eight black symbols are derived from sunspot groups and the two circles from individual sunspots. Each full dot represents approximately 80 spot groups, the one small dot approximately 40 spot groups, and each circle approximately 150 individual spots”. (It must be noted that the groups of five, three and two dots in the figure each mean one average value.)

2. The Reason for the Apparent Discrepancy

From Figure 2 in the paper of R & S, reproduced here as Figure 1, it can be immediately seen that the average drift is determined mainly by spots around sunspot maximum. Spots near the minimum show large deviations from the sinusoidal curve but their number is small and therefore they do not much influence the result. This is similarly true in the result derived by Tuominen (1955b). In fact, the drift of sunspots around minima cannot be studied by treating all spots as one material.

The influence of different numbers of spots at different activity phases is eliminated when maxima and minima are separated, as has been done in the papers of Becker (1954) and Tuominen (1961). Figure 2 is a reproduction of their results. That the effect found is real is proved by the fact that the former paper is based on long-lived groups, while the latter is based on short-lived groups, both results being, however, nearly identical. The eleven year cycle found in these investigations is not based on the average drift of sunspot groups as is the result of R & S. In fact, as can be visually estimated from Figure 2, the difference between the drifts averaged over all spots, i.e. over spots at all latitudes, in the maximum and the minimum phase does not seem to be important enough to justify an assumption of an 11-year oscillation of the drift. In the investigations of Becker (1954) and Tuominen (1961) a possible 22-year cycle was not considered. Therefore they do not exclude the possibility of a 22-year oscillation.