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The Large-Scale Magnetic Field and Sunspot Cycles

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Extended abstract

We report on the correlation between the large scale magnetic field and sunspot cycles during the last 80 years that was found by Makarov *et al.* (1999) and Makarov & Tlatov (2000) in H-α spherical harmonics of the large scale magnetic field for 1915-1999. The sum of intensities of the low modes l = 1 and 3, A(t), was used for comparison with the Wolf number, W(t). It was shown that the large scale magnetic field cycles, A(t), precede the sunspot cycles, W(t), by 5.5 years.

Let us consider the behaviour in time of the harmonics with low numbers l = 1 and 1 = 3. The radial component B(r) of the magnetic field may be expanded in terms of the spherical harmonics

$$B(r) = \sum_l \sum_m P_l^m (g_l^m \cdot \cos(m\phi) + h_l^m \cdot \sin(m\phi)),$$

where θ and ϕ are the latitude and longitude, P_1^m 1are Legendre polynomials and g_1^m and h_1^m are coefficients of expansion on the spherical functions.

$$g_l^m = \frac{(2l+1)}{2\pi} \cdot \frac{(l-m)!}{(l+m)!} \int_0^{2\pi} \mathrm{d}\phi \cos(m\phi) \int_0^{\pi} B_r(\theta,\phi) P_l^m(\cos(\theta)) \sin(\theta)\, \mathrm{d}\theta.$$

$$h_l^m = \frac{(2l+1)}{2\pi} \cdot \frac{(l-m)!}{(l+m)!} \int_0^{2\pi} \mathrm{d}\phi \sin(m\phi) \int_0^{\pi} B_r(\theta,\phi) P_l^m(\cos(\theta)) \sin(\theta)\, \mathrm{d}\theta.$$

The magnetic moments of a dipole (l = 1) and an octopole (1 = 3) are determined by the following equations:

$$\mu_1 = \left(\sum_{m,l=1} (g_l^m g_l^m + h_l^m h_l^m) \right)^{1/2}, \quad \mu_3 = \left(\sum_{m,l=3} (g_l^m g_l^m + h_l^m h_l^m) \right)^{1/2}.$$

Let us enter the parameter describing their intensity,

$$\mathrm{A(t)} = (\mu_1{}^2 + \mu_3{}^2/3)^2.$$

The distribution of A(t) and W(t) is represented in Fig. 1 for 1915-1999. Both indices A(t) and W(t) have a cyclic character with a period of about 11-years. The phase shift between A(t) and W(t) is about 5.5 years. A comparison of the index A(t)

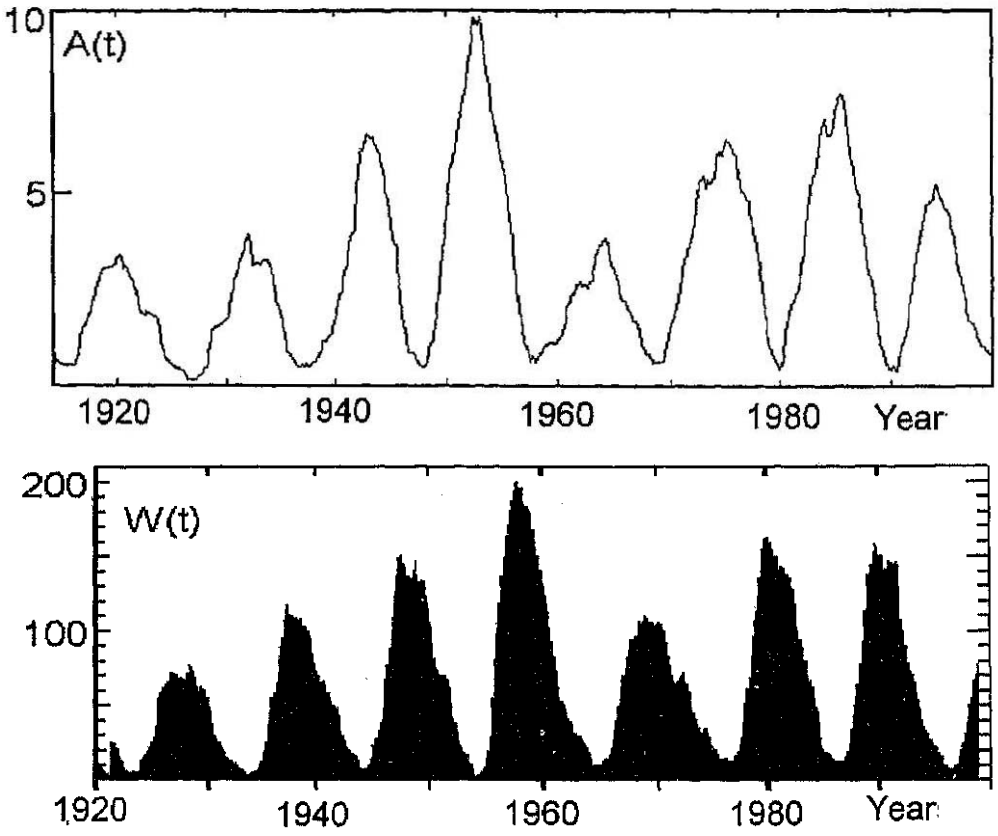

Figure 1. A(t) - the large-scale magnetic field cycles according to H-α magnetic charts for 1915-1999, W(t) - the sunspot solar cycles for 1920-1999.

with W(t) shows the possibility to forecast solar activity. The current cycle 23 is expected to be less than cycle 22 and will make $W_{max} \approx 130 \pm 10$.

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References

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