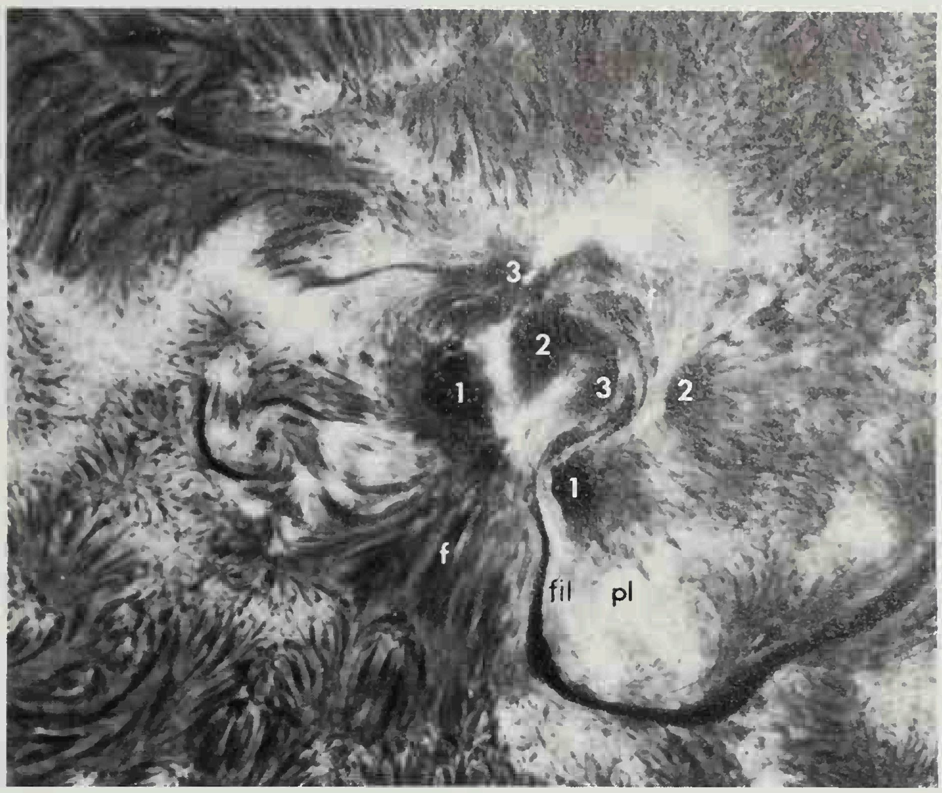
magnetic storms originating on the surface of the Sun, producing such dramatic and spectacular features as eruptive, loop and quiescent prominences, plages, plumes and **solar flares**. The latter are brilliant outbursts of light in the atmosphere of the Sun and emanate from a concentrated burst of energy, usually associated with the disruption of the solar magnetic field in the proximity of an active region. The flares emit extremely intense X-rays and ultraviolet radiation and a blast of high energy particles. It is the interaction of the latter with the magnetic field and the atmosphere of the Earth which, two days later, causes the appearance of our aurorae. Thus, we immediately have direct evidence of solar effects on our atmosphere.

What of climatic variations? This intriguing question leads us back to the solar surface to a study of the well-observed phenomenon of **sunspots**, the only form of solar activity which may occasionally be seen with the naked eye. Sunspots appear as dark blemishes against the bright solar disc, not because they are black but because they are about 2 000° cooler than the rest of the photosphere. The black central region is termed the umbra while the brighter periphery is the penumbra. Spots come in a range of sizes, the largest being around 100 000 km across but a more usual size is 10 000 km. They frequently appear in groups or clusters which may persist on the disc for a week or more. By studying the motion of sunspots across the disc, the rotation rate of the solar surface may be found. Galileo was the first to do this in 1611 and obtained 26 days for the equatorial rotation, a figure which we still believe is correct. Because the Sun is gaseous, it does not rotate like a rigid body and the polar regions rotate much more slowly, taking 37 days to make a complete revolution.

Records of the sunspots' occurrence rate have led to very useful and intriguing conclusions. We now know that sunspots are yet another form of solar magnetic activity, and it is believed that they are the result of magnetic fields generated by some form of circulating electric current in the solar interior. What seems to happen is that while solar magnetic fields are uniform and lie parallel to the solar surface, because of the turbulence of the gas in the convection zone, the field can become tangled. When this occurs the field bursts through the photosphere surface forming a sunspot in which, as observations show, the magnetic field emerges vertically. Sometimes the field forms a loop and then the two linked sunspots are termed bipolar. The number of sunspots is directly related to the general activity of the Sun.



An active region observed in August 1972, just after the maximum in the 11 year solar cycle. Features which may be identified are a plage (pl), surrounded by the ribbon-like filament (fil). Three bipolar sets of sunspots (1–3) are visible and long fibrils (f) separate the polarities and follow the magnetic field pattern. The photograph was taken in the light of Hα.

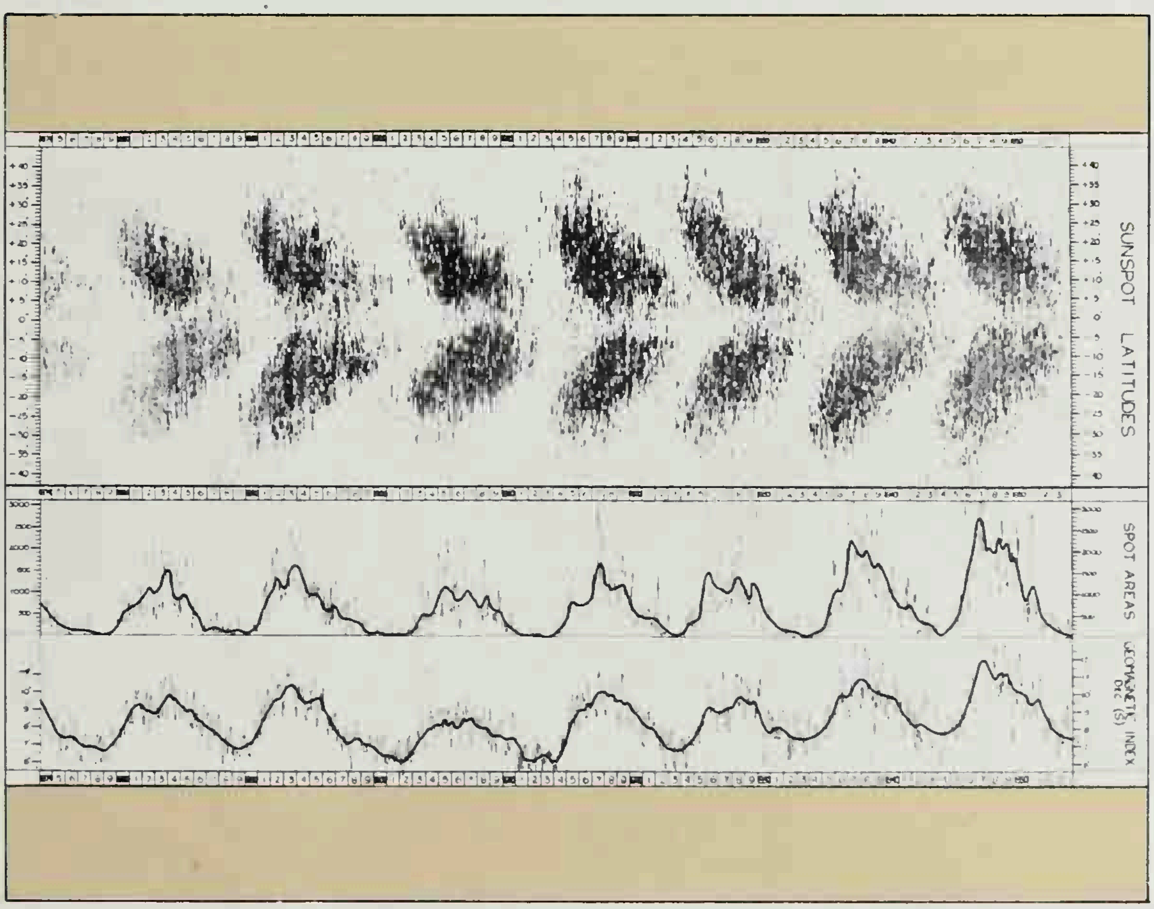


Fig. 4·1 Sunspots appear to occupy lower latitudes on the Sun as the phase of the 11 year cycle of activity progresses from one minimum to the next. A plot such as this is referred to as a Maunder butterfly diagram.