SOLAR CYCLE - BASICS

Definition

The **solar cycle** is the main source of periodic solar variation on Earth which drives variations in space weather and to some degree weather on the ground and possibly climate change.

Basics

The **solar cycle**, or the **solar magnetic activity cycle**, is the dynamical engine and energy source behind all solar phenomena driving space weather. Powered by a hydro magnetic dynamo process relying on the inductive action of internal solar flows, the solar cycle

- structures the sun's atmosphere, corona and wind;
- modulates the solar irradiance;
- modulates the flux of short-wavelength solar radiation, from ultraviolet to X-Ray;
- modulates the occurrence frequency of flares, coronal mass ejections, and other geoeffective solar eruptive phenomena;

- Indirectly modulates the flux of high-energy galactic cosmic rays entering the solar system.

History

The solar cycle was discovered in 1843 by Samuel Heinrich Schwabe, who after 17 years of diligent observations of the sun noticed a periodic variation in the average number of sunspots seen from year to year on the solar disk. Very much impressed by Schwabe's discovery, Rudolf Wolf compiled and studied earlier observations, and managed to reconstruct the cycle back to 1745, eventually pushing these reconstructions to the earliest observations of sunspots by Galileo and contemporaries in the opening decades of the seventeenth century. Because sunspots come in many sizes and different levels of grouping, starting with Wolf solar astronomers have found it useful to define a standard sunspot number index, which continues to be used today.

The average duration of the sunspot cycle is 11.1 years, but cycles as short as 9 years and as long as 14 years have been observed. Significant variations in amplitude also occur. Solar maximum and solar minimum refer respectively to epochs of maximum and minimum sunspot counts.

Individual sunspot cycles are partitioned from one minimum to the next.

Following the numbering scheme established by Wolf, the 1755-1766 cycle is traditionally numbered "1". The period between 1645 and 1715, a time during which very few sunspots were observed, is a real feature, as opposed to an artifact due to missing data. This epoch is now known as the Maunder minimum, after Edward Walter Maunder, who extensively researched this peculiar event, first noted by Gustav Spörer. In the second half of the nineteenth century it was also noted (independently) by Richard Carrington and by Spoerer that as the cycle progresses, sunspots appear first at mid-latitudes, and then closer and closer to the equator until solar minimum is reached. This pattern is best visualized in the form of the so-called butterfly diagram, first constructed by the husband-wife team of E. Walter and Annie Maunder in the early twentieth century. Images of the sun are divided into latitudinal strips, and the monthly-averaged fractional surface of sunspots calculated. This is plotted vertically as a color-coded bar, and the process is repeated month after month to produce this time-latitude diagram.

The physical basis of the solar cycle was elucidated in the early twentieth century by George Ellery Hale and collaborators, who in 1908 showed that sunspots were strongly magnetized (this was the first detection of magnetic fields outside the

Earth), and in 1919 went on to show that the magnetic polarity of sunspot pairs:

- is always the same in a given solar hemisphere throughout a given sunspot cycle;
- is opposite across hemispheres throughout a cycle;
- reverses itself in both hemispheres from one sunspot cycle to the next.

Hale's observations revealed that the solar cycle is a magnetic cycle with an average duration of 22 years. However, because very nearly all manifestations of the solar cycle are insensitive to magnetic polarity, it remains common usage to speak of the "11-year solar cycle".

Half a century later, the father-and-son team of Harold Babcock and Horace Babcock showed that the solar surface is magnetized even outside of sunspots; that this weaker magnetic field is to first order a dipole; and that this dipole also undergoes polarity reversals with the same period as the sunspot cycle. These various observations established that the solar cycle is a spatiotemporal magnetic process unfolding over the sun as a whole.

Source: http://www.juliantrubin.com/encyclopedia/electronics/solar_cycle.html