Sunspots & Climate

Attempts to correlate the 11-year solar cycle with earthly things have given the subject a bad name. And that's perhaps putting it mildly. The last century's 'scientific literature' was replete with such stuff: attempts to correlate the average number of sunspots with the price of corn, the sex life of squirrels *etc*. None of the attempts has stood the test of time, but correlations with one aspect of nature, the weather, have been persistent.

It is fascinating to note that the Kodaikanal Solar Observatory, a prestigious institute in Southern India, owes its existence (mainly) to the fashion for a correlation of the weather with the average number of sunspots at any one time. By the 1870s there had been an observatory in Madras for many decades which had produced an extraordinarily fine catalogue of stars, but by this time it was in a state of some decline. There was a great famine in that part of India, also. The famine had been caused by the failure of the monsoon over consecutive years and 'the weather' was clearly a topic of life-and-death interest. The government had been led to believe that there was a connection between sunspots and rainfall, so it was natural they should decide that the observatory should concentrate on studies of the sun and be moved to a better site, Kodaikanal, where it is today.

Remarkably, despite the beautiful results from SOHO, the solar astronomy satellite that was recovered after a malfunction recently, the origin of the solar cycle is still not understood. The topic being examined is the relevance of the number of sunspots to global climate. There have been many claims for correlations, not least for very long period effects that perhaps relate to ice ages, where the solar activity of the past is inferred from proxy data (such as tree rings). But the problem is this: the change in solar irradiance due to changing sunspot numbers is absolutely minute, so why should we expect any effect on climate at all? Surely there can be no conceivable physical cause for an apparent correlation between, say, solar activity and mean global temperature?

However, the search for the physical mechanism that would relate solar activity to climate has recently thrown up some interesting ideas. One relates to my own research area, cosmic rays. It is well known, and well understood, that the cosmic ray intensity at ground level is modulated by the solar wind, which is closely related to sunspot number. Essentially, the low energy particles from distant parts of the galaxy are reduced in intensity by the magnetic field associated with the solar wind (high solar activity means low cosmic ray intensity). This 11-year modulation is some tens of percent and not the tiny fraction related to the solar output in total.

You might ask: *so what*? Well, cosmic rays produce ionization in the atmosphere and this, in principle, can have an effect on cloud cover. This is just what Danish physicists have found: a correlation between cloud cover over the oceans (where cosmic rays are a major source of ionization) and the cosmic ray intensity. Now, cloud cover and other climatic features are, of course, related so... Another fascinating discovery is that there seems to be a correlation between the incidence of solar cosmic rays and the ozone layer in the Arctic. 'Solar proton events' (low energy cosmic rays from the sun itself) appear to produce mini-holes in the ozone layer.

Conservative meteorologists are opposed to this view. They are very sceptical, pointing out, for example, that with cloud cover the atmosphere does not behave like a big cloud chamber, which is sensitive to penetration by ionizing particles—the degree of supersaturation in the atmosphere is very small. Nevertheless, it seems to me that the stakes are so high that much more work needs to be done in this area (which is the usual cry).

A related topic that makes me issue this plea for a serious hearing concerns the rate of rotation of the sun. Although sunspots had been known in antiquity (and it is perhaps surprising that Galileo got into such trouble for remarking on them when he used the newly invented telescope in 1609) it was not until the 1840s that their properties were studied adequately. This was by RC Carrington, working initially in Durham, and later at his own observatory in Redhill (both in the UK), who observed that their rate of apparent movement round the sun's disc depended on solar latitude, which means the sun is not behaving as a solid sphere.

Perhaps there is something else that we are not spotting about the nature and influence of the celestial body that is so near and dear to us?

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