Natural Radio

News, Comments and Letters About Natural Radio

October 2005

I'm starting to think about winter radio projects since I received my sample IC preamps from THAT Corp. (See last month's column). With these devices, I hope to spend some late fall and winter evenings experimenting with a loop antenna and low-noise preamp. But, the projects are still a while off as we're still enjoying the beautiful late September 80 degree weather.

This was the weekend of Chicago FM Club's Radio Expo and a good excuse to clean out the basement and all the rapidly obsolescing equipment I am acquiring at work. Radio Expo is one of the largest two-day hamfests in the Midwest, but attendance was way down this year, at least on Sunday, which sadly seems to be a trend at most hamfests. Nevertheless, sales exceeded my expectations and it was very enjoyable spending the morning sitting outside in the sunshine.

There was considerable activity this month with a surprising quantity of X flares. The geomagnetic storm on the morning August 24 triggered multi-hop whistlers – I was hearing 7 or 8 bounces even with all the hiss and summer spherics. Unfortunately, recorder problems prevented me from recording some of the stronger whistlers, but after a quick trip home for repairs, I was able to catch some of the weaker ones before they died out – I was still listening to them after 11 am.

Sunspot 798/808 produced an X-17 "super flare" on September 7, with the resulting CME producing geomagnetic storming and Auroras as far south as Arizona on September 10th and 11th. Unfortunately I was at a business expo that weekend and missed the whole event. From September 07 - 11 September this region went on to produce 14 M-class, and 7 X-class flares. This was a pretty good solar fireworks display to wrap up the last year of cycle 23.

Solar Cycle Surprises – This recent outburst of solar activity as we approach the bottom of Sunspot Cycle 23 has many scratching their heads and has of course provided lots of material to those pseudo-science folks who earn their living writing sensational doom-and-gloom books. So what's going on here, how does the sunspot cycle work and how significant is it to our Natural Radio listening?

Back in pre-science days, astrologers and other curious and insightful people read the skies and tried to put some meaning and order to natural celestial and earthly events. Years later their observations would be the beginnings of modern science.

Archeoastronomer and stellar physicist, David Dearborn, reports that around 28 B.C.E., astronomers in ancient China saw and systematically recorded the march of small dark patches across the surface of the sun. And from the fourth century B.C.E., Greek philosophers made reference to sunspots in some of their writings.

Moving ahead many centuries, and past the “dark ages”, the credit for the first Europeans to observe sunspots is shared by Galileo Galilei of Italy, Johannes Fabricus of Holland, Christopher Scheiner of Germany and Thomas Herriot of England. All of these observant astronomers and scientists studied sunspots through telescopes and made hand drawings of the spots as they progressed across the sun’s surface. Coincidentally, they all made their observations in 1611. At that time, no one really knew what the spots were, although Galileo speculated that they might be clouds.

The cyclical nature of sunspots was first noticed by an amateur astronomer, Heinrich Schwabe, in 1843. The average number of sunspots visible on the surface of the sun tends to vary over time, increasing and decreasing over a regular cycle that lasts between 9.5 and 11 years.

As science progressed, regular observations of sunspots were made and old data was reconstructed to plot the solar cycles back another 100 years or so. At some point the cycles were numbered, beginning with Cycle 1 in the 1750s. Each 11 year cycle has been numbered consecutively since that time. Figure 1 shows the sunspot cycles from about 1700 to the present time. We now have data that precedes Cycle 1, but the numbering has not changed.

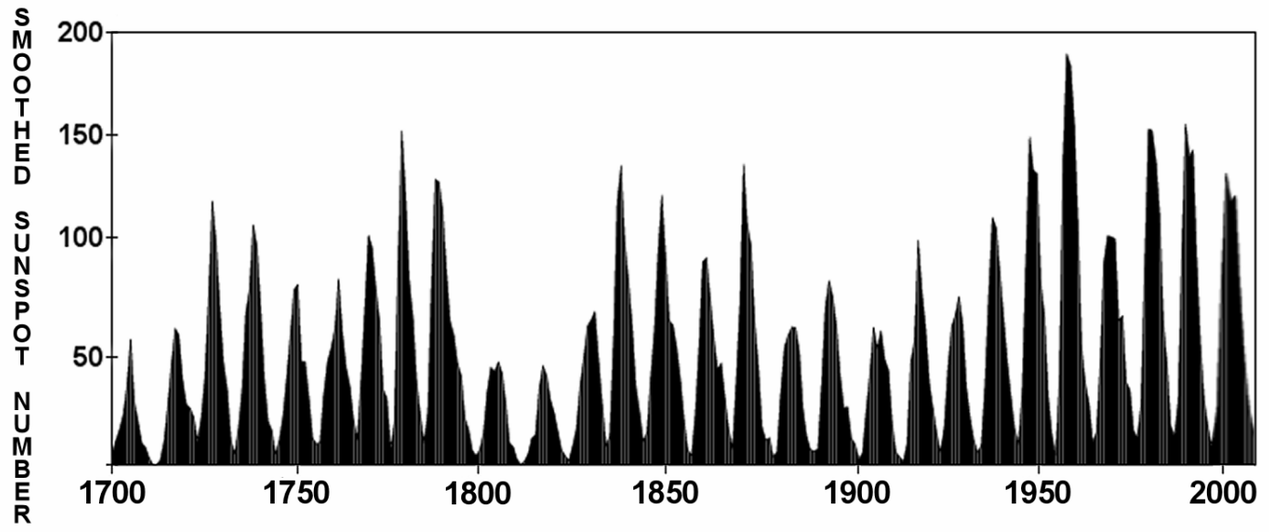

Figure 1 - Smoothed sunspot number from 1700 to the current Cycle 23.

As better instrumentation developed, space scientists also discovered that the 11 year cycle is really part of a 22 year cycle in which the magnetic poles of the sun flip 180 degrees and back.

The calculation of sunspot numbers is complex, and there are different methods used that may produce slightly different results. Calculation begins with observation of the solar disk and the counting of distinct groups and spots. For a daily count, scale factors are applied and statistical averaging is done compensate for observational errors. Smoothed sunspot numbers are calculated by doing a statistical average of the raw sunspot numbers over many months, centered on the date of interest. Again, there are several methods used depending on who is doing the counting. In any case, the smoothed numbers make better looking graphs and make it easier to see the upward or downward trend in the numbers. Because of the way the numbers are averaged, a

smoothed sunspot number for today might not be available for 6 months or so. This is also why the Solar Max and Solar Minimum are determined considerably after the fact.

What exactly is a sunspot? George Fischer, a solar astronomer at the University of California, defines a sunspot this way: "A sunspot is a dark part of the sun's surface that is cooler than the surrounding area. It turns out that it is cooler because of a strong magnetic field there that inhibits the transport of heat via convective motion in the sun. The magnetic field is formed below the sun's surface, and extends out into the sun's corona."

Sunspots are important to us because their twisted magnetic fields produce solar flares and the Coronal Mass Ejections (CMEs) that often cause geomagnetic storms on earth. Also, increased sunspot activity means more Ultra-Violet emission from the sun which enhances the ionosphere and makes for good long distance shortwave communications via skip. This is especially important to Ham Radio operators, shortwave listeners and other users of high-frequency radio communications.

As natural radio listeners we are more interested in geomagnetic storms than we are in sunspot numbers per se. It's the geomagnetic storms that cause VLF emissions and other interesting listening. I know that if there is a geomagnetic storm in progress, I am pretty much guaranteed of hearing chorus for at least 3 or 4 hours past sunrise.

There is less correlation between geomagnetic storms and whistlers, as whistlers often occur under calm geomagnetic conditions. My own observations are that I have often heard whistlers well into the late morning hours during a geomagnetic storm.

In the 1930's it was theorized that geomagnetic storms were caused by some type of plasma cloud being ejected by the sun, but it was not until the early 1970's that these clouds, later to be called Coronal Mass Ejections (CMEs) were observed by the NASA Orbiting Solar Observatory 7, and a coronagraph aboard Skylab.

X-ray observation of the sun by NOAA satellites began in 1975, so we have good scientific data on only 3 cycles of solar activity. With this small amount of data it is difficult to predict the "normal" behavior of a solar cycle.

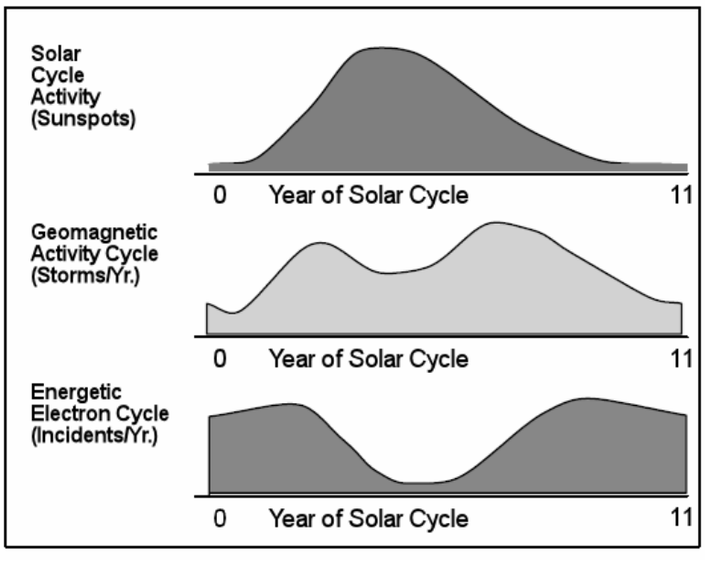

Figure 2 – Solar Cycle, Geomagnetic Cycle and Energetic Electron Cycle

As you can see in Figure 2, geomagnetic activity coordinates with the sunspot cycle, with a peak on the upward side of the sunspot cycle and a larger peak on the downward side of the sunspot cycle. This graph shows average storms/year, but doesn't say anything about the intensity of the storms.

You can also see from figure 2 that the incidents of energetic electrons are about 180 degrees out of phase with the sunspot cycle.

In short, while the position on the solar cycle may indicate the *probability* of a geomagnetic storm, large flares and other geomagnetic storm causing events can occur at any time during the cycle as indicated by last month's X17 flare. Although our knowledge of the earth-sun connection and plasma physics has made quantum leaps in the past 30 years, the behavior of the sun is still quite unpredictable and that makes Natural Radio listening all that much more exciting.

Our whistler receivers don't have to go up on blocks during the Solar Minimum, because there is always a possibility of a large flare with an associated CME and possibly a geomagnetic storm. I can't wait for the solar minimum next year and the activity that it will bring!

As an endnote to the discussion of sunspots, when you are looking at sunspot data, you may have noticed that the active regions have an identifying number. Here is NASA's explanation of the numbering system.

> While there is no naming or numbering system for sunspots, there is a system for numbering active regions. An active region can contain one or more spots. The National Oceanic and Atmospheric Administration (NOAA) numbers active regions consecutively as they are observed on the Sun. According to David Speich at NOAA, an active region must be observed by two observatories before it is given a number (a region may be numbered before its presence is confirmed by another observatory if a flare is observed to occur in it, however).
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> The present numbering system started on January 5, 1972, and has been consecutive since then. An example of an active region "name" is "AR5128" (AR for Active Region) or "NOAA Region 5128". Since we only see active regions when they are on the side of the Sun facing the Earth, and the Sun rotates approximately once every 27 days (the equator rotates faster than the poles), the same active region may be seen more than once (if it lasts long enough). In this case the region will be given a new number. Thus, a long-lived active region may get several numbers.
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> On June 14, 2002, active region number 10000 was reached. For practical, computational reasons, active region numbers continue to have only four digits. Therefore, the sequence of numbers is 9998, 9999, 0000, 0001, and so on. Active region number 10030, for example, is AR0030. This region will often simply be referred to as region number 30, with 10030 implied.

Some References for Sunspot & Solar Activity

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