Solar Flux, Sunspots, and Ionizing Radiation

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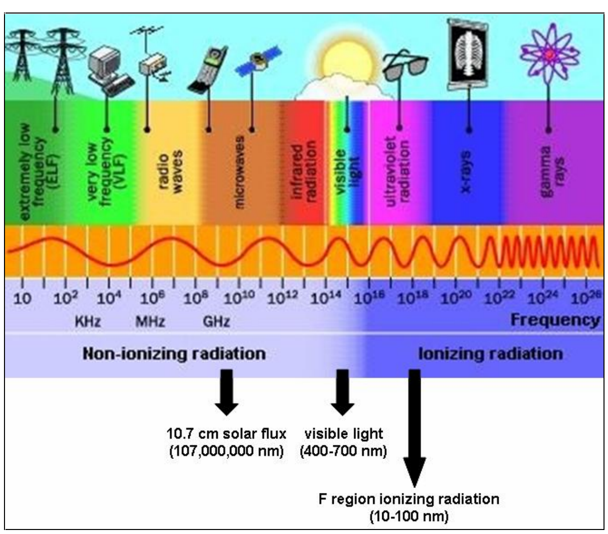
Our propagation prediction programs allow us to input either 10.7 cm solar flux or sunspot numbers. The purpose of this article is to discuss the relationship between 10.7 cm solar flux, sunspots, and ionizing radiation.

We do most of our HF DXing via the F_2 region. The F_2 region is ionized by extreme ultraviolet radiation at wavelengths from 10 to 100 nanometers. The process of ionization involves absorption of radiation at these wavelengths by atmospheric constituents.

Since radiation at these wavelengths is absorbed as it progresses downward through the atmosphere, we can't measure it on the ground. Until the space age came along with satellites, we had no idea how much extreme ultraviolet radiation was impinging on our atmosphere. We needed a proxy measurement for extreme ultraviolet in order to develop our propagation prediction programs. That proxy was sunspots, as sunspots are associated with areas on the Sun that emit copious amounts of extreme ultraviolet radiation.

The counting of sunspots is somewhat subjective – how do you handle small spots versus large spots, and small areas of spots versus large areas of spots? A scientist by the name of Rudolph Wolf devised a mathematical expression to address this issue – in essence he created a common standard to count sunspots. But it's still somewhat subjective, as human interpretation is still involved in calculating the sunspot number.

The desire to have an objective measurement that could be measured on the ground drove scientists to the measurement of radiation from the Sun at a wavelength of 10.7 cm (2800 MHz). This wavelength penetrates the atmosphere unimpeded, and thus is easily measured by ground stations. But its drawback is its long wavelength compared to extreme ultraviolet. Solar radiation at 10.7 cm is about one million times less energetic than extreme ultraviolet, and thus solar flux does not contribute an iota to the ionization of the F_2 region (that's also why it penetrates unimpeded through the atmosphere).



The image shows the relationship between 10.7 cm solar flux and the radiation that ionizes the F_2 region on a chart of the electromagnetic spectrum.

Now that we know why we use sunspots and solar flux in our predictions programs (they are proxies for the measurement of the true ionizing radiation), we have to make sure we use the correct "version" of these two parameters – in other words, we need to make sure the correlation between sunspots/solar flux and what the ionosphere is doing is high.

It would have been nice if the daily sunspot number or the daily solar flux was well correlated to what the ionosphere is doing on that day. But it isn't. The developers of our propagation prediction programs determined that the only acceptable correlation was between the smoothed sunspot number or smoothed solar flux and monthly median ionospheric parameters. Thus we have predictions that are statistical over a month's time frame. We do not have daily predictions.