Solar Banners — A Propagation Resource

N0NBH's propagation banners list a slew of propagation parameters. Here's how to apply them to your ham activities.

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The web page opens and the banner catches your eye, with a burning globe of seething plasma — the source of all propagation — sitting amid a jumble of scientific slang. Since 1902, when Heaviside and Kennelly first discovered the Sun's secret of ionizing our atmosphere into radio-reflecting layers, the Sun's activities have been important to anyone with an interest in radio.

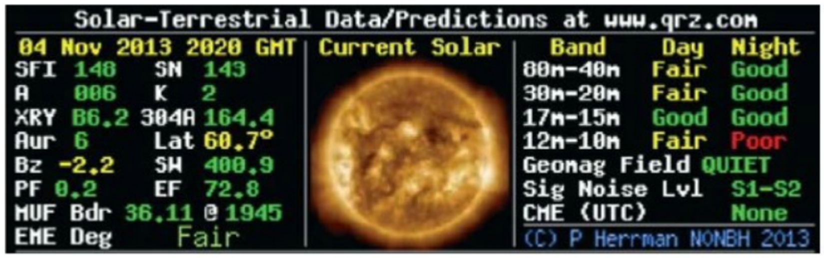

Figure 1 — Propagation banners such as this one can be found on the **QRZ.com** home page and other web pages. Provided by Paul, N0NBH, they display the current values for a variety of propagation related factors. [Paul Herrman, N0NBH, graphic]

The banners you see on various websites are a window into this secret. They are prepared by Paul Herrman, N0NBH. Paul served in the USMC as a radar/radio technician and has an AAS in Electronics. He is active in all forms of communications including packet (AX25), satellites, repeaters, HF, VHF, UHF, and EchoLink. He accumulates the information presented from various scientific sources and consolidates the radio-related data in his banners. Paul has 20 different types of banners on his website (**www.hamqsl.com/solar.html**), which are available for display on other web pages. The example shown in Figure 1 is the banner displayed on **QRZ.com**. It has 17 parameters listed, plus a list of high frequency (HF) band conditions covering 80 – 10 meters in four segments.

In all, Paul's banners can display 24 parameters in any of several different formats. Each of the 20 different banner formats lists a set of parameters. These parameters generally break down into solar parameters and geomagnetic parameters. It all looks very scientific and, perhaps a little daunting, but with some background information you will be able to understand what all this science lingo is telling you, and what you can expect from your favorite band.

Solar Parameters

The solar parameters on the banner display the levels of various types of electromagnetic and particle energies, generated by the Sun, that are striking the Earth. The Sun is the biggest, baddest boy on the block when it comes to energy production. Mr Sol throws off electromagnetic radiation from well down into the radio spectrum to well up into the X-ray spectrum. These form a continuous torrent of noise and ionizing energy. Our radiant friend also generates a deluge of particle radiation. The particle radiations that most affect propagation are the continuous streams of electrons and protons hitting the Earth's atmosphere and magnetic field — and also the occasional billion-ton blob of solar mass blown at us in those gigantic solar sneezes known as Coronal Mass Ejections (CME).

Let's take a close look at the information available on the banner shown in Figure 1.

Solar Flux Index (SFI)

The SFI is a measure of the 2800 MHz radiation (also known as the 10.7 cm flux) generated by the Sun. This value (148 in the figure) is measured each day at 1200 PST and normally varies from 60 – 300. This 2800 MHz noise doesn't directly affect propagation, but it correlates with the level of UV and X-ray radiation coming from the Sun and is more easily measured.

Sunspot Number (SN)

To the right of the SFI we have our old friend, the Sunspot Number (143). The SN is not simply the number of spots on the Sun. SN takes into account the size, number and grouping of sunspots. SN can vary from zero to 250. The higher the SN, the higher the level of UV and X-ray radiation that is striking our atmosphere. It is the ionizing effect of this radiation that generates the D, E, and F layers. As ionospheric ionization increases so does the Maximum Usable Frequency (MUF). So when the SN and the SFI increase, they signal an increase in E and F layer ionization, which, in turn, indicates improved HF propagation conditions.

Table 1
X-ray Intensity Scale

Class	Strength	Radio Blackout
B	$<10^{-6}$	None
C	10^{-6} to 10^{-5}	None
M	10^{-5} to 10^{-4}	R1-R2
X	$> 10^{-4}$	R3-R5

X-ray Intensity (XRY)

This is a measure of the intensity of high frequency X-rays hitting the Earth. In Figure 1 the XRY value is B6.2. The letter (B) represents the lowest class of X-ray activity with power levels measured in W/m^2. The number (6.2) represents the multiplier. Referring to Table 1, B6.2 translates to 6.2×10^{-6} W/m^2 of X-ray energy hitting the Earth.

These X-rays pass through the F layers of the ionosphere and are primarily responsible for ionization levels in the D layer and also, to some extent, the E layer. Normally, the D layer absorbs signals from 1.8–5 MHz. Signals from 7–10 MHz are attenuated, but they do pass through to the E and F layers. However, when the X-ray intensity rises to the M and X class levels, the D layer is greatly enhanced. The dayside D layer normally acts to absorb radio signals below 10 MHz, however, when it becomes enhanced by a high powered X-ray event, it can absorb radio signals throughout the HF spectrum and beyond. In extreme cases, a complete "blackout" of DX communication on the daylight side of the Earth can result, lasting for several hours.

304A

This value (164.4) is the relative strength of total solar radiation at a wavelength of 304 angstroms (or 30.4 nanometers), which is within the ultraviolet spectrum. The radiation at this wavelength is responsible for about half the ionization of the F layer. The value of 304A also correlates with the SFI, so increases in 304A tend to signal improved F layer propagation.

Interplanetary Magnetic Field (Bz)

Bz (−2.2) indicates the strength and orientation of the interplanetary magnetic field, which normally varies from +50 to −50. A positive value indicates that the interplanetary magnetic field is oriented in the same direction as the Earth's magnetic field and negative values indicate a polarity opposite to the Earth's. When the interplanetary field is negative it "fights" the Earth's magnetic field, reducing its shielding effect, and increasing the effect of solar particles (electrons and protons). This, in turn, will cause an increase in any related ionospheric and geomagnetic disturbances.

Solar Wind (SW)

Solar Wind is the speed, in kilometers per second (km/s), of the charged particles passing the Earth. The SW varies from 0 – 2000 but typically is near 375. The higher the speed, the greater the pressure exerted on the ionosphere. When the SW rises above 500 km/s it can disturb the Earth's magnetic field, which then disrupts the F layer and generally leads to a reduction in ionization and poor HF conditions.

Proton Flux (PF)

PF value (0.2) is the density of protons within the Earth's magnetic field. These protons strike the Earth's magnetic field and follow the field lines to the Earth's poles. The normal PF level is under 10. As the level increases, the increasing numbers of protons striking the Earth's magnetic field are funneled toward the poles where they increase the ionosphere's density in the polar regions. At a PF level of 10,000 the signal paths that go over the poles will begin experiencing degraded conditions. If the PF continues to rise, levels of 100,000 and above are considered an S5 — Extreme Solar Radiation Storm. At S5 levels, polar paths will experience partial to complete communications blackouts.

Note that paths that do not go over the poles are not affected by PF levels. But remember, to correctly determine if a path you want to use crosses the poles, you must use a map based on an azimuthal equidistant projection, and not the more familiar Mercator projection. Some software programs that display RF propagation paths using Mercator projection maps indicate the location of the polar zone and/or if a propagation path is a polar path.

Electron Flux (EF)

Electron Flux (72.8) is the intensity of electrons within the Earth's magnetic field. The ionospheric effect of EF is similar to PF, with auroral path degradation occurring when EF levels reach or exceed 1000.

Signal Noise Level

This value (S1 – S2) indicates how much noise (in S-units) is being generated by the solar wind as it interacts with the Earth's magnetic field.

Coronal Mass Ejection (CME)

This value (None) is the date and time of a predicted Earth bound CME event. In Figure 1, no CME is currently predicted. When CMEs are predicted, the prediction is color coded for severity, where green is minor, yellow is moderate, and red is severe.

Geomagnetic Information

Information on the state of the Earth's geomagnetic field is important for propagation in two ways. An increasing level of disturbance in the Earth's magnetic field has a detrimental effect on the F layer, causing HF propagation to suffer. However, at the same time, the chance of auroral activity increases, so VHF auroral propagation may be enhanced.

A and K Indexes

In Figure 1, the state of the geomagnetic field is represented by the *A index* and the *K index*.

The K index (2) is derived by averaging the values of geomagnetic disturbance taken every 3 hours at eight magnetic observatories around the globe. These eight values represent the average level of disturbance in the Earth's magnetic field. The K index values are converted to a logarithmic integer value between 0 and 9. A rising K index indicates increasing instability in the Earth's magnetic field. If the value of K increases above 4, this indicates a geomagnetic storm is in progress.

The A index value (006) comes from the K index. The value of the K index taken during each 3 hour period is scaled mathematically and converted to a linear value that varies from 0 – 400. The A index is essentially the global value of geomagnetic disturbance during the previous UTC day, whereas the K index is what is happening now.

Aurora (AUR)

The AUR value (6) is a value from 1–10 that is derived from the number of gigawatts of energy striking the polar region. As this energy level increases, the level of ionization of the F layer at the poles also increases. A rising value of AUR indicates that the auroral oval is shifting to lower latitudes and the possibility of northern/southern lights increases. The presence of an active aurora can provide improved propagation for signals from 10 meters to 70 centimeters, but it can also mean that polar path blackouts for HF can occur.

Latitude

Aurora latitude indicates the lowest latitude that an auroral event will reach.

Maximum Usable Frequency (MUF) Bdr

This is the MUF (36.11) as measured at Boulder, Colorado, at the UTC time indicated (1945).

Earth-Moon-Earth Degradation (EME Deg)

This is the amount of attenuation, in dB, along the Earth-Moon-Earth radio path. EME degradation ("Fair") is defined as Very Poor (>5.5 dB), Poor (>4 dB), Fair (>2.5 dB), Good (>1.5 dB), Excellent (<=1.5 dB).

Geomagnetic Field

The Geomag Field ("Quiet") value indicates how quiet or active the Earth's magnetic field is based on the K index value. The scale has nine levels, varying from Inactive to Extreme Storm. When Major, Severe, or Extreme Storm levels are reached, the HF bands can experience blackouts and auroral events will occur.

The Physics Pileup

As you can probably tell, there is a lot going on up there. The Sun and the Earth interact in a messy confusion of physics that is similar to the pileup for a rare DX station. I hope this article has taken some of the awe and mystery out of the propagation banners you find on various web pages and has given you a few clues to understand the mystery of our ionosphere.

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