

Mitigation for Disturbances to Propagation

We've all heard the phrase "everyone talks about the weather, but no one does anything about it." It's true that we can't do anything about the weather, but we can perhaps move (maybe just temporarily) if we don't like the weather in a particular locale. Snow and lots of rain are examples that may cause us to think about moving.

That phrase is also applicable to space weather – the extra-terrestrial weather that affects propagation. And just like terrestrial weather, we can do something about space weather – not change it, of course, but change our operating habits to hopefully minimize its impact.

Adverse space weather, also known as disturbances to propagation, can be categorized into three general areas: geomagnetic storms, solar radiation storms, and radio blackouts. The Space Weather Prediction Center in Boulder (Colorado) defined these three categories, and they are abbreviated G, S, and R, respectively. Visit <http://www.swpc.noaa.gov/NOAAscales/> for more details. Figure 1 depicts the effects of disturbances to propagation on a global scale.

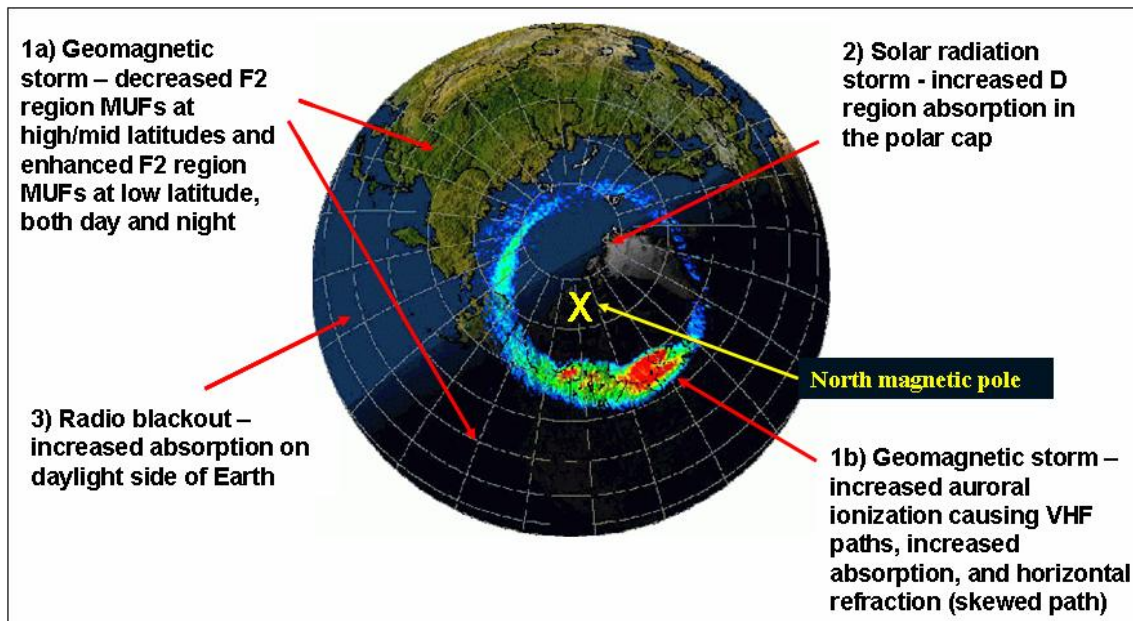


Figure 1 – Global impact of disturbances to propagation

Geomagnetic storms are caused by coronal mass ejections (CMEs – mostly occurring around solar maximum) and coronal holes (mostly occurring during the decline of a solar cycle). CMEs and coronal holes can result in increased geomagnetic field activity, which we see as higher A and K indices. This can cause electrons that are trapped in the Earth's magnetosphere to precipitate into the auroral zones, resulting in increased D and E region ionization. Generally a similar effect is seen in both auroral zones since the precipitating electrons come from within the

Earth's magnetosphere (they don't come directly from the Sun). Thus as the A and K indices go higher (for example, a K index greater than 5 or so), check for auroral VHF propagation.

An elevated K index would also be a good time to check for skewed paths on the low bands – especially 160-Meters since the amount of refraction by a given electron density profile is inversely proportional to the square of the frequency (the lower the frequency, the more the bending). For more details, visit http://k9la.us/160m_Skewed_Path.PDF.

Additionally, when the K index is high, F2 region ionization generally is depleted at mid and high latitudes, thus moving down in frequency may minimize the impact to propagation. F2 region ionization can also be enhanced at the low latitudes during geomagnetic storms, so check for enhanced low latitude (equatorial) propagation.

Geomagnetic storms are the most detrimental storms with respect to propagation, and can last for many days. In other words, it can take the ionosphere a long time to recover. Geomagnetic storms can affect the entire globe, day and night. For an example of the effect of a geomagnetic storm, visit http://k9la.us/CMEs_at_W4ZV.PDF.

Solar radiation storms are caused by very energetic protons from large flares (mostly X-Class flares and big M-Class flares). These protons coming from the Sun can funnel into the polar caps to increase D region absorption on over-the-pole paths (for example, the USA Midwest to India). Since these protons come from outside the Earth's magnetosphere, they do not necessarily affect the polar caps the same (unlike geomagnetic storms, which do). If your over-the-pole path is degraded, try the other way around.

Solar radiation storms are in the middle with respect to their impact to propagation. They can last for a couple days, but they only affect over-the-pole paths.

Radio blackouts are caused by electromagnetic radiation at X-ray wavelengths from large flares (again mostly X-Class flares and big M-Class flares). This radiation causes additional D region ionization on that portion of the Earth in sunlight. Since the amount of absorption incurred is inversely proportional to the square of the frequency, the lower frequencies are affected the most. In other words, the higher frequencies recover first. So if you suspect a big flare has made the bands quiet, go higher in frequency and wait a bit for the recovery. Paths in darkness are not affected, so you may want to try a darkness path (for example, on 20-Meters where the MUF might be high enough even in the dark ionosphere).

Radio blackouts are the least disruptive with respect to propagation. Their duration is only a couple hours. The higher bands are affected least, and radio blackouts only affect the daylight side of the Earth. But if they happen during a contest they can wreak havoc with your score. For example, two flares in November 2000 likely prevented Dan N9XX at ZF2RR from setting a new (at the time) North American 10-Meter Low Power record in CQ World Wide DX CW. You can read about this at http://k9la.us/Solar_Flares_at_ZF2RR.PDF.

In summary, understanding the sources of disturbances to propagation and their effects on the ionosphere may offer some alternatives to turning the radio off. There's no guarantee of success as disturbances are very dynamic, but it's worth a shot.

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Geomagnetic storms – Check for auroral propagation at VHF. Check for skewed paths on 160-Meters. On HF paths across mid and high latitudes, move down in frequency. Look for enhanced low latitude paths at HF (for example, southern USA to VK/ZL).

Solar radiation storms – Effect not necessarily similar in the polar caps, so for paths over the poles try long path if the short path is degraded or try short path if the long path is degraded.

Radio blackouts – Try the higher frequencies. Look for paths that are in darkness.