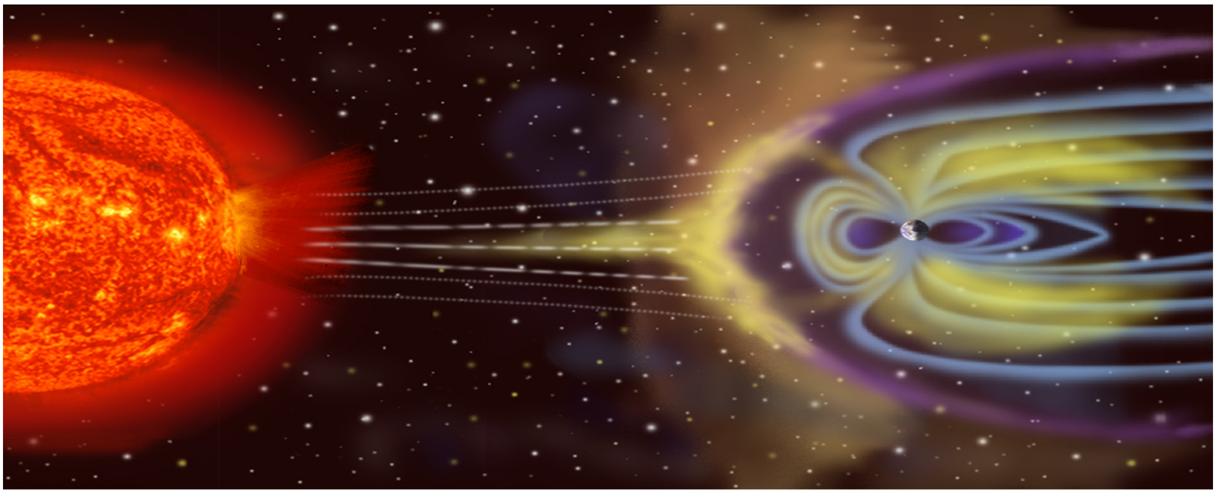

Seeing the good in Solar winds at the bottom of the sun cycle.

It is normal that strong ionised particles escape the sun during a solar flare-up. The number of sunspots (bright spots visible on the sun) that indicate the flare-ups vary over a cycle which can be as short as 7 years or as long as 11. More sunspots equate to a consistent re-charging of the Earths Ionosphere and hence better DX conditions around the globe within the Ionosphere.

However, charged winds can also be sent from the sun when a shockwave on the sun creates rising gas clouds of solar particles, which get ejected from the sun. These are not Solar Cycle related and are called Coronal Mass Ejections, or CMEs. These travel outwards from the sun at speeds from supersonic to the speed of light and could strike the earth if the trajectory is correct. Often if a "Coronal Hole" appears on the part of the surface of the sun facing the earth, this is also an indication of an earthbound CME.

The CME is made up of:

1. A Solar wind of ionizing radiation, electrons and protons travelling at the speed of light (these arrive at the Earth almost immediately and continue for the duration of the event)
2. A shockwave that rides along with the solar wind at supersonic speeds.
3. Dense particles behind the shockwave that arrive at the Earth 2-3 days after the start of the event.

Signs that a CME event is taking place are noise bursts, buzzing sounds and sudden QSB. These effects are seldom seen on frequencies <10 MHz so look out for these tell-tale signs on 20 metres. It is often worth watching the solar wind speed which after the event has happened on the sun but before the gas cloud hits the earth often drops below its normal 400 km/sec and as the particles are hitting the earth until the storm passes is above the 400, often above the 500 km/sec mark. This information can be found at spaceweatherlive.com.

Most radio amateurs will tell you that Coronal Mass Ejections from the sun are bad for radio communications and can cause the noise floor to raise dramatically or even cause a total HF communications black out. This is correct. However, there are times during these events when radio propagation actually IMPROVES. If you can be around at the right times on the right bands some good contacts are to be made.
The effects on HF bands above 10MHz (30m through 10m) are different from the changes in radio wave propagation below 10MHz.

Effect on radio communications above 10MHz.

A general rule I went by when starting in HF communications around 2014 (when we were on the peak of Solar Cycle 24), was SFI (the Solar Flux Index which is an indicator of the radiation hitting the earth from the sun) must be over 100 and the K-Index should be 3 or under for the HF bands to be open. Well now in 2018/19 we are at the bottom of Solar activity Cycle number 24 and SFI rarely gets over 70. An SFI of 100 is a dream these days, so it's important to look at what is possible, despite the "doom and gloom" figures.

SFI or Solar Flux Index is a measure of the ionizing radiation from the sun, and an indicator of the electron density of our ionosphere. The higher the electron density, the more reflective the ionosphere is to HF signals, and the higher the maximum usable frequency (MUF) is. Signals sent out above the MUF travel out into space and don't get reflected to the Earth.

The Kp value indicates the current activity (noise) level in the Ionosphere. The K-Index value is calculated every 3 hours based on the Kp values. The K-indices are averaged over 24-hours to form the A-Index.

When a CME or Coronal Hole event occurs on the sun it sends winds out and those that come in our direction add charged ions to our Ionosphere (the protective invisible "skin" around the Earth). We can think of the protective "skin" as being like an onion with several layers. The ones that interest us are the outside F1 and F2 layers and the inside D layer. The F1 and F2 layers are the ones that reflect the radio waves back to the earth and the more ionised these are, the more effective they are at reflecting the signals. The D-layer is not our friend as it absorbs our radio signals a little (from 2 to 6dB, depending on how well charged it is) and that's twice for each bounce of the signal off the F layers. (6 dB is one S-point of signal, so go through it twice and your signal is down 2-S points at the receiving station).

Night time is simpler as not only do the F1 and F2 layers combine into one F layer, the D layer disappears, removing the signal loss in the path. Unfortunately, this combined F layer has a lower electron density than daytime levels, which lowers the Maximum frequency of signals reflected by the F layer at night, meaning the "DX bands" like 20 metres don't work at night for DX contacts, only 40 metres and below keep bouncing signals off the Ionosphere.

So again, it's important to be on at the right time, on the right band to get those good contacts.

Opportunity Number 1 – immediately after the explosion on the Sun up to dusk.

Once a CME has been spotted on its speed of light (2-3 minutes) way to Earth you should check the higher bands for DX openings for several hours. During this time all the ionisation of the F1 and F2 layers is happening: not only do signals "bounce" better (creating a better signal-to-noise ratio) but the maximum usable frequency also increases. This makes the use of bands above 20 metres possible, where higher gain antennas may be used and there are fewer competing stations.

As some of the ionising X-rays will get through the F layers to the D layer, the best time to try for DX on the higher bands is from the point the Solar flare hits up until dusk (when the MUF drops making 20m and up unusable) on the same day. By the next day the D-layer will also have stored some ionisation and it will attenuate your signals on the way to the F layers more than usual. That's not to say that the second day will not be better than the day before the CME hit, but it won't be <u>AS GOOD</u> as the first day.

Unfortunately following a CME, at a much slower (but still supersonic) speed, behind a shockwave is a gas cloud of particles which generate wideband noise from 10-20MHz called a Type IV Continuum Storm. This raises the noise floor making the bands very difficult to use. This "Natural Interference" (QRN) can last several hours before it finally clears the Earth to continue on its way farther out in space. At this point in time, disturbances to the solar wind, from a solar flare or coronal hole, can cause serious disruptions to HF by triggering a geomagnetic storm, that in turn can cause radio blackout conditions on HF at higher latitudes. A major geomagnetic storm (K>6) can last 12–24 hours.

Opportunity Number 2 – The LF & MF Bands during the time the storm is hitting the ionosphere.

While a geomagnetic storm causes operation on HF to be difficult, this is an excellent time to work 60–2200M due to very low noise levels on those bands during the storm.

The dense particles in the gas cloud can also include "hard x-rays", these are classified as "hard" by having > 30 kev of radiation, which strike the Earth's atmosphere, while showering the earth with ionizing radiation. X-rays from very large events can also penetrate our atmosphere (inside the protective shell), and travel all the way to the ground (this is called a GLE, or ground level event). This can highly ionize the D-layer causing an HF radio blackout through increased attenuation for several tens of minutes.

Effect on radio communications below 10MHz.

The solar flux does not affect the 40metre band and below, whereas the K-index, is more important to us on the <10MHz bands as it indicates the geomagnetic conditions that cause the background natural radio noise.

Geomagnetic Indices & Conditions

	K Index	Ap Index	Geomagnetic Conditions	HF Noise	Aurora
NORMAL	0	0–2	Very Quiet	S1–S2	None
	1	3–5	Quiet	S1–S2	None
	2	6–9	Quiet	S1–S2	Very low
	3	12–19	Unsettled	S2–S3	Very low
	4	22–32	Active	S2–S3	Low
STORM	5	39–56	MINOR storm	S4–S6	High
	6	67–94	MAJOR storm	S6–S9	Very high
	7	111–154	SEVERE storm	S9+	Very high
	8	179–236	SEVERE STORM	Blackout	Extreme
	9	300–400	EXTREME storm	Blackout	Extreme

Opportunity Number 3 – Better DX on the lower HF bands immediately after the Storm has passed.

As soon as the solar storm ceases (i.e. it has passed the Earth), the Kp Index will drop and night time conditions on 80 & 40M can be excellent as natural noise levels on 40-80M will often be lower than normal.

Opportunity Number 4 – increasing Critical frequency enabling shorter range contacts.

The effect of the CME from the sun and its extra ionisation of the layers on short distance contacts is measured through the Critical frequency (aka FofF2 or CF).

Opportunities don't always have to mean better DX contact possibilities. On the bands below 10MHz when a Solar strike is happening the Critical Frequency can approach the frequency you are transmitting on. The closer the critical frequency gets to your operating frequency the shorter the "skip distance" becomes. For example, when operating on 40m when the CF is at 5MHz or lower, contacts are only possible from about 4-500 km away, as the CF rises to 6MHz the skip distance reduces and contacts from about 300 km away become possible. When the CF hits 6.5MHz closer stations at 200km away are workable and finally when the CF is the operating frequency contacts at 100km or even closer become possible.

This is particularly useful for SOTA, WWFF-Parks, some IOTA and Maidenhead Square chasers. DX contacts are not possible on these bands in these conditions but more locations than otherwise are in the "no-contact area" between ground wave and sky wave distances become reachable as NVIS propagation takes place.

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