What's Going On with 160-Meters?

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Early in January, I received an e-mail from Jim Wolf KR9U, one of the local 160-Meter aficionados here in Fort Wayne. He reported that 160-Meters was very good the night before, with arm chair copy on signals from Europe. My first thought was "it's about time".

With respect to "it's about time", it's been a while since I experienced strong signals from Europe on 160-Meters. I was hoping that the 2014 Stew Perry Topband Distance Challenge in late December (sponsored by the Boring Amateur Radio Club in Oregon – visit **http://www.kkn.net/stew/**) would provide some good opportunities to Europe (and elsewhere), but it was a bust for me. And based on the comments on the topband reflector after the Stew Perry contest, many others experienced poor propagation during this event.

But shouldn't we expect poor propagation on 160-Meters since we're at Cycle 24's solar maximum? That's the old adage – 160-Meters is best at solar minimum, which we're a long way from. Figure 1 shows contest QSOs and countries on 160-Meters versus recent years.

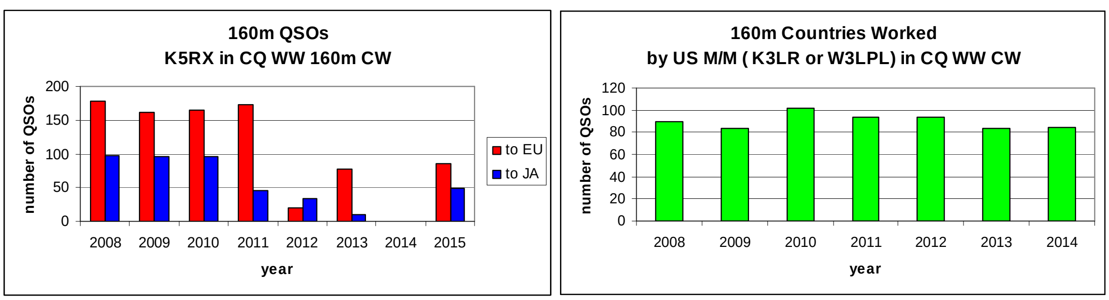

Figure 1 – Contest QSOs (left) and Countries (right) by Year

The K5RX QSO data on the left appears to confirm the old adage that 160-Meters is best around solar minimum. But the Multi/Multi countries data on the right is not as conclusive. This suggests that maybe there's more than just the ionosphere involved – there could be a human behavior issue. If we read that 160-Meters is not good at solar maximum, we'll not bother to get on during solar maximum. Thus it could be a self-fulfilling prophecy.

Before we run off thinking 160-Meters might be good throughout an entire solar cycle, we have to realize that there is a fundamental reason why 160-Meters should be better at solar minimum. And it's due to absorption. Both VOACAP and ray tracing with Proplab-Pro indicate that the signal power on a nighttime path in December from K9LA to Europe is 10 to 15 dB less at solar minimum than at solar maximum (see note 1 at the end of this feature for a comment about this issue). That's quite a bit, and certainly could account for the old adage that 160-Meters is best at solar minimum.

But Cycle 24's maximum is the lowest since Cycle 16 (maximum in 1928). Is there another parameter to look at to judge Cycle 24's impact to propagation on 160-Meters? Yes, there is – it is geomagnetic field activity. At solar minimum, the geomagnetic field is quieter than at solar maximum – suggesting a more stable ionosphere for 160-Meter RF (especially in the nighttime electron density valley thought to be responsible for ducting). Figure 2 looks at the number of days in the month when Ap (the planetary A index) is less than or equal to 7 – which equates to a quiet magnetic field.

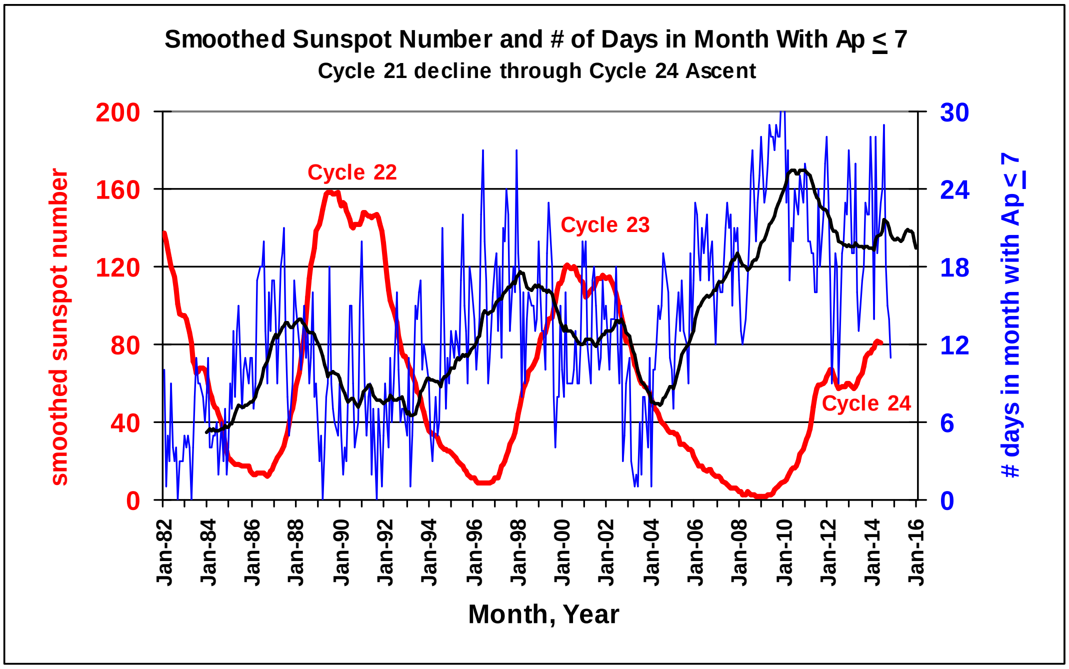

Figure 2 – Ap versus Smoothed Sunspot Number

The red line is the smoothed sunspot number from the decline of Cycle 21 thru the present. The blue line that is very spiky is the number of days in the month when the Ap index is less than or equal to 7. The black line is a running average trend line of the Ap data to smooth it out to better see the trend.

Focusing on the peak of the black trend line around January 1998, I can recollect many great nights on 160-Meters to Europe during the solar minimum period between Cycle 22 and Cycle 23 (1995-1998). The black trend line shows that the number of quiet days maximized in late 1997/early 1998, and I believe this contributed to the good propagation back then. I personally believe this was the period of the best 160-Meter propagation that I have experienced.

Note what happened after the solar minimum between Cycle 22 and Cycle 23. The number of quiet days bottomed out (the least amount of quiet days per month) during the decline of Cycle 23 (around January 2004), and then went to an unprecedented number of quiet days during the long solar minimum between Cycles 23 and 24. What's even more interesting is that the number of quiet days now still exceeds the number of quiet days during the solar minimum period from 1995-1998.

With so many quiet days now, why isn't 160-Meters at least as good as in the 1995-1998 period? Two possibilities exist. First, perhaps Ap isn't a good overall indicator of 160-Meter propagation. The Ap index (derived from eight 3-hour K indices) is essentially a mid latitude measure of the activity of the Earth's magnetic field. We also have the AE index (Auroral Electrojet), which is a high latitude measure of the activity of the Earth's magnetic field, and Dst (Disturbance - storm time), which is a low latitude measure of the activity of the Earth's magnetic field. We'll look at AE and Dst in a future monthly feature, including the correlation between all three.

Second, could the geomagnetic field be too quiet? Surprisingly, there is a physical basis behind this question. And it involves galactic cosmic rays (GCRs). At solar maximum, the Sun is more active, causing more geomagnetic field activity that is believed to be detrimental to 160-Meter propagation. Coupled with the Sun being more active is the fact that the Sun's magnetic field is stronger, which shields the Earth from galactic cosmic rays. Going the other way, when we're at solar minimum the Sun's magnetic field is weakest, letting in more cosmic rays.

Now cosmic rays are mostly high energy protons generated outside our solar system. They hit the top of our atmosphere causing secondary particles to rain down on us. These secondary particles could cause additional ionization down low in the atmosphere. Figure 3 gives cosmic ray data, in terms of neutron count (which is directly proportional to the number of galactic cosmic rays hitting Earth), from 1965 to the present.

Figure 3 – Neutron count

As can be seen in Figure 3, the neutron count is the lowest at solar maximum – except for Cycle 24 maximum. In fact, the neutron count now is on par with the neutron count at solar minimum. In other words, there are a lot of particles getting down to the lower atmosphere. And they're causing additional ionization down there.

How much additional ionization? Figure 4 shows ionization rates for cosmic rays at solar minimum and at solar maximum (from Velinov and Mateev, Journal of Atmospheric and Solar-Terrestrial Physics, Volume 70, 2008).

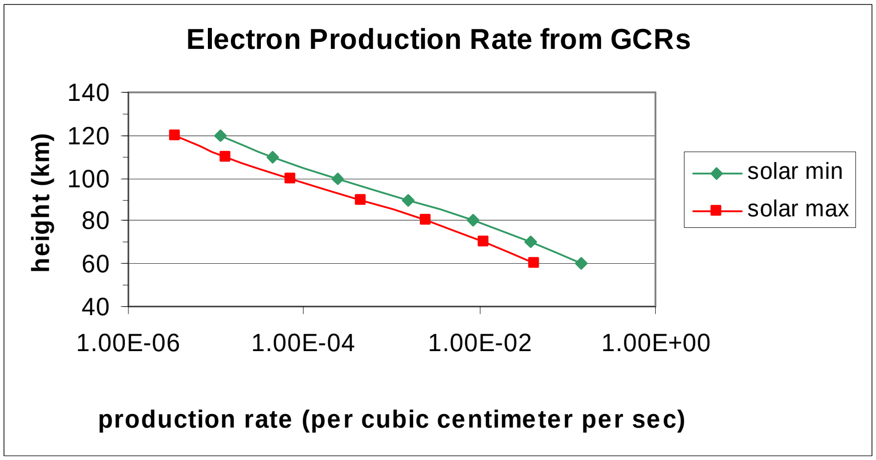

Figure 4 – GCR production rates

Indeed, the electron production rate by GCRs is greater at solar minimum than at solar maximum due to more GCRs entering our atmosphere at solar minimum – or under conditions similar to the solar maximum we are seeing now.

From the data in Figure 4, we can do a back-of-the-envelope estimate of the additional electron density due to GCRs. Figure 5 shows the electron density (in blue) of the lower ionosphere at nighttime at the mid point of the path from K9LA to G in December at solar maximum without the influence of GCRs. Also included is the additional electron density (in pink) due to GCRs estimated from the production rate data in Figure 4.

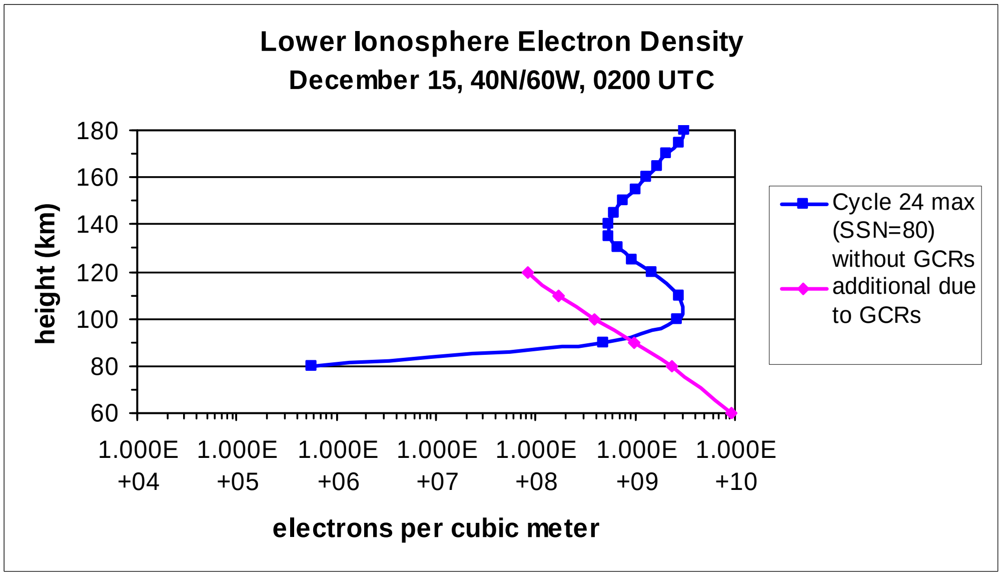

Figure 5 – Impact of GCRs

What the data in Figure 5 suggests is that the additional ionization due to GCRs is on the order of the magnitude of the ionization in the lower ionosphere where absorption occurs. This means more absorption could occur due to the GCR process. Remember that this is my back-of-the-envelope calculation, but it appears to be in the ballpark to affect absorption.

In summary, we've looked at a lot of stuff. On one hand, we should have good 160-Meter conditions because the Earth's magnetic field appears to be very quiet. On the other hand, we may be experiencing more absorption that makes 160-Meters worse because the Sun's magnetic field appears to be letting in more GCRs that cause more absorption. The only sure thing I can say is the best thing to do is be on 160-Meters as much as you can to catch those short openings for which 160-Meters is known.

Note 1 – More absorption at solar maximum sounds reasonable. But we do our DXing on 160-Meters in the dark ionosphere. There will be more absorption near the terminator as solar radiation of sufficient energy can scatter into the dark atmosphere from the dayside atmosphere, causing more absorption. But as soon as we get away from the terminator, the absorption at solar maximum should be very similar to solar minimum. Additionally, W8JI worked over 200 countries and all forty CQ zones around the peak of Cycle 23 (which was higher than Cycle 24). So is 160-Meters really as bad as believed at solar maximum? Or are we just conditioned not to get on at solar maximum?