Propagation, NZ Net and Local Contests

In recent local contests, such as the Jock White Field Day, 40m propagation became very interesting. At the start of the contest on the Saturday afternoon, contacts to the upper North Island from Christchurch were reasonably easy to achieve with good signal strengths, but contacts to the lower North Island and Upper South Island were more difficult. Local contacts on 40m were almost impossible to achieve.

A look at the parameter known as f_0f_2 explains why this occurred. F_0f_2 is the highest frequency that can be reflected back from the ionosphere when a signal is transmitted directly upwards at 90°. At the date this was written (June 2020), the mid-afternoon f_0f_2 figure in Canterbury is often between 4 and 5 MHz.

What this tells us is that any signal above 4 to 5 MHz such as 40m signals at 7MHz will not be reflected but will almost completely pass straight through the ionosphere when transmitted directly upwards. Only a very small amount of signal may be reflected back down again as a result of local scattering.

However for those same 40m signals, if we change the angle that the signal enters the ionosphere away from 90°, say to 45° more of the signal will be refracted back towards the ground again. Another way of putting this is that the Maximum Useable Frequency or MUF for a signal that is refracted from the ionosphere at an angle will be higher than the f_0f_2 frequency.

The calculation for the Maximum Useable Frequency (MUF) is

$$MUF = f_0f_2/\sin(\alpha)$$

Where $f_0f_2$is the maximum frequency that will be reflected vertically and α is the angle of incidence to the ionosphere. The angle can be approximated by

$$\propto = tan^{-1}({}^{h}/_{d/2})$$

Where α = the angle, h = the height of the ionosphere, and d is the distance between Tx and Rx

For example, consider a transmitter in Christchurch and a receiver in Taupo. The direct distance is 611km. If the ionosphere is at a height of 250km and f_0f_2 is 4.5 MHz, the MUF to Taupo becomes 7.1 MHz.

Similarly, for a receiver in Auckland, the distance is 763 km, and with the same conditions as before, the MUF for that path would be 8.2 MHz. Blenheim on the other hand, is only 249 km, and the MUF is 5.02 MHz.

We can see that as the distance increases from the transmitter the MUF increases as well. But unless we are transmitting at a frequency below the MUF very little of our signal will reach the intended destination.

For the examples above, the Christchurch JWFD stations found it very difficult to work the closer stations on 40m (such as Blenheim), but stations further away were easier with stations from Taupo and beyond easily S7 or greater. As the evening progressed however, the f_0f_2 frequency fell, and the situation became worse. Stations in the lower North Island became very difficult to work and only those stations around Auckland or further north had strong signals.

Of course, the 80m stations had a completely different situation. In their case, the transmitter frequency was always less than f_0f_2 so they could easily work close in stations as well as those further away.

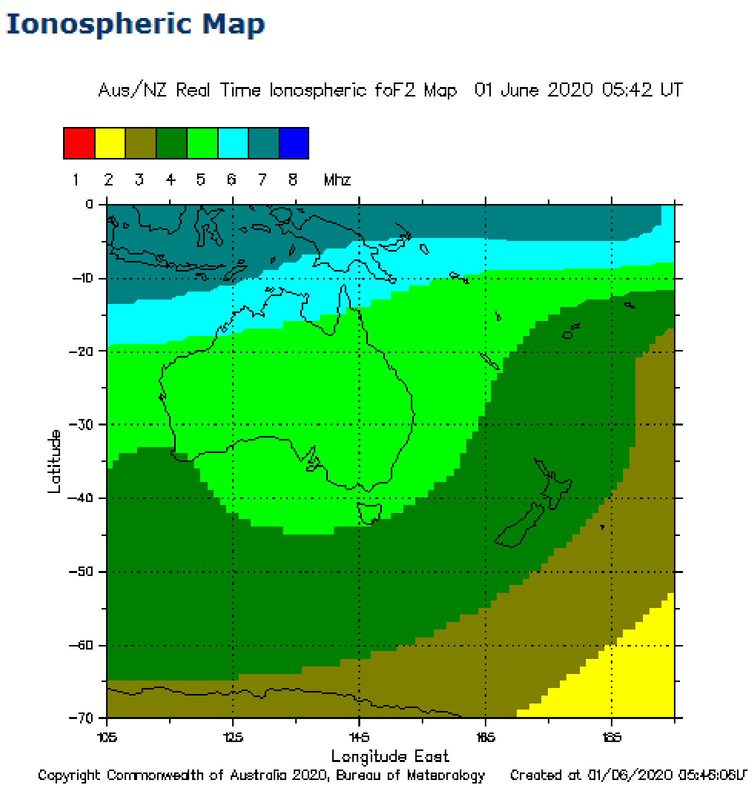
The logs confirmed this with more 80m stations worked over a wider part of NZ than the 40m stations. This situation was consistently demonstrated at both the Br68 (North Canterbury) station and the Br05 (Christchurch) station. In contrast, Br22 Marlborough had a different problem. Where in past years Br22 were well positioned in the middle of the field as it were, now they were too far north. The closest stations they could reliably work on 40m were 250km further north than the ones Christchurch could work, so in the early afternoon they would have been able to work Auckland and the Far North. But as the evening got later, the closest workable stations would slowly "move" even further north. Whilst this would normally be balanced out by working stations Christchurch could not work further south, unfortunately for Blenheim, there were fewer southern stations operating in the last couple of years.

This behaviour can also be seen on the NZ Net on 80m. At night the f_0f_2 falls and has been as low as 2MHz in the early evening. This has meant that stations close in suddenly become hard to work (unless they are in ground wave distance) but further away stations can be more readily copied.

For stations as far as Invercargill from Christchurch (464 km), and f_0f_2 of 3.0 MHz the MUF is 4.1 MHz – just above 80m. Indeed the NZ Net frequency of 3535 kHz would still be under the MUF for an Invercargill to Christchurch path even if the f_0f_2 dropped to about 2.6MHz.

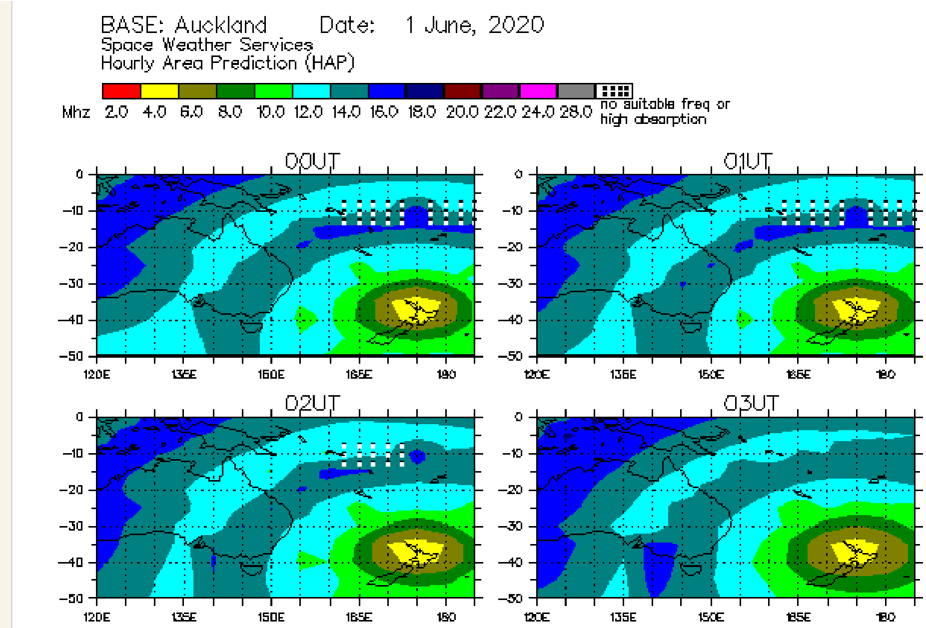
Real time information on the value of f_0f_2 can be obtained by checking the Australian Space Weather Site at http://www.sws.bom.gov.au/HF_Systems/1/4

An example of the ionospheric map for f_0f_2 is shown here



This information is updated every 15 minutes. On the same site, it is possible to generate Half Hourly prediction charts – these are maps showing the ideal working frequencies based on a particular location.

Unfortunately the only NZ locations that can be elected is Auckland or Waiuoru, but the map generated shows the same information as outlined above. An example of such a map is given below



These maps can be generated from the URL http://www.sws.bom.gov.au/HF_Systems/1/1/2

The Australian Space Weather Site has a tremendous amount of valuable information for HF operations and is well worth a browse. The main HF pages can be accessed here http://www.sws.bom.gov.au/HF_Systems

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