Natural Radio

News, Comments and Letters About Natural Radio

May 2005

Thunderstorms and Whistlers – Not Quite So Simple

After months of cabin fever, warm weather finally descended on Illinois and with it the first spring thunderstorm rolled through. My wife and I hastily assembled a dinner of bread, fruit and cheese and a couple glasses of wine and sat on the front porch and immersed ourselves the passage of the storm, celebrating the advent of warmer weather and enjoying that wonderful time between the arrival of spring and the arrival of mosquitoes. As I watched this first awesome lightning display of the season, my thoughts drifter over to Natural Radio and the relation between the position of a thunderstorm and the possible occurrence of whistlers.

The simple theoretical explanation for where a whistler can occur is that if there is a thunderstorm going on at the conjugate magnetic point we can hear single hop whistlers. Remember that the conjugate magnetic point is the point in the opposite hemisphere that has the same magnetic latitude and longitude as our location. Magnetic latitude and longitude are different than geographic latitude and longitude because the earth's magnetic poles don't coincide with the geographic poles.

If there are thunderstorms near us, we can hear two hop whistlers as the impulse from the lightning travels to the conjugate point and back. (We can hear multi-hop whistlers in both cases if the conditions are right.)

When I hear single hop whistlers here in Illinois, my conjugate point is about 650 miles off the west coast of Chile, out in the Pacific Ocean. Typically, there aren't as many thunderstorms out in the ocean as there are on land, which might explain the lack of whistlers in the Midwest. However, the conjugate point for the Western U.S. is several thousand miles off the West Coast of Chile, out in the middle of the South Pacific, yet listeners in the west end of the U.S. tend to hear more whistlers than we do here. Also, we often hear single hop whistlers when there aren't thunderstorms at the conjugate point, so what is going on?

Simple theoretical explanations usually don't describe reality very well, because we ignore many of the complicating factors that would allow us to create a better model of the phenomenon.

So, what are some of these complicating factors? First of all, when a whistler leaves the duct in the magnetosphere and propagates through the earth-ionosphere waveguide, it can travel quite a distance before it reaches our receiver. Robert Helliwell, back in the 50's, determined that stations up to about 1000 miles apart could hear the same whistler.

On the originating end, the spheric from a lightning stroke can propagate quite a way through the earth-ionosphere waveguide before it enters a whistler duct in the magnetosphere. So there may be a fuzzy area of about 1000 miles or more at each end of the duct where whistlers can originate and be heard.

Now, what about the field lines and the ducts? Last month's *Scientific American* had an article about two scientists who were using computer models of the earth's magnetic field to try to predict the next polarity reversal. The earth's magnetic field is primarily generated by the motion of the liquid iron in the core. Within the core the magnetic field lines become twisted, jumbled and very complex; resembling the complex magnetic fields on the surface of the sun.

Above the earth, though, the magnetic environment is less complex with the field lines approximating a dipole field. If you remember the science experiments of your youth, a dipole field is what you see when you lay a simple bar magnet under a piece of paper and sprinkle iron filings on the paper – symmetrical filed lines arching out between the north and south poles of the magnet.

But again, the field lines of the earth only *approximate* a dipole field. The earth's magnetic field varies in strength and direction over different points of the globe and the magnetic poles don't line up with the geographic poles, thus the need for variation or magnetic declination charts to correct the readings of a magnetic compass.

Diurnal variations as we rotate through the solar wind compress the field lines on the day side and stretch them out on the night side. The way the field is compressed and stretched varies during the year, the compression and stretching being more symmetric at the equinoxes when the solar wind is directed at the equator. Might this be related to the noted increase of whistlers around the equinoxes?

And of course Coronal Mass Ejections and geomagnetic storms twist and bend the field lines. For example, during the geomagnetic storm of October 28, 2003, the compass variation at Lerwick, UK changed by 5.1 degrees in only 25 minutes at about 0630 UT.

Finally, two-hop and multi-hop whistlers can follow a different whistler duct for each hop, further complicating the issue.

The point is that while the simple explanation makes it easy to understand the theory of how whistlers originate and propagate, we don't necessarily need a thunderstorm at our assumed conjugate point or right near our listening location to hear whistlers. And that's a good thing. If whistlers were totally and easily predictable, it would take a lot of fun out of this hobby.

E-mail Problems Fixed, I Hope – After almost a year of erratic E-mail problems and address changing I have moved the hosting of my website and associated E-mail accounts to SBC-Yahoo who also is my DSL service provider. This seems to have cleaned up the problems I was having, most recently on the sending end. My apologies for the erratic service and missed E-mails over the past 9 months.