Can Shortwave Radios Detect Earthquakes?

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Evidence has been mounting that it might be possible to detect earthquakes by measuring the changes in the ionosphere.

The RF-Seismograph – a live, off-air HF propagation tool created and maintained by Alex (www.ab4oj.com/rf_seismo/main.html) – measured spikes and signal dropouts on November 1 that could not come from space, due to solar inactivity.

It also caught the eye of the RF-Seismograph team so we investigated the phenomena and found a culprit: Earthquakes!

The RF-Seismograph team has been collaborating with Earthquakes Canada to find a possible correlation between HF propagation and earthquakes. Earthquakes Canada gave us a list from the US Geological Survey (USGS) with 171 Earthquakes M6+ for the four years the RF-Seismograph has been collecting data. We have recreated the data of the propagation and noise level measurements on days that have M6+ earthquakes to see how much of a change there was visible. We also believe that tsunamis create RF-signatures and will further investigate this.

The RF-Seismograph uses an HF radio, a LIF interface to decode the IF via a sound card and a 9-band vertical antenna to receive and record RF-background noise and log the data into files. For more information on LIF go to: http://users.skynet.be/myspace/mdsr/index.html

1) How do Earthquakes create Electromagnetic Fields that change propagation?

- Piezoelectric effect of rocks sliding and vibrating on top of each other.
- Micro-Fractures of rocks releasing vast amounts of free electrons.
- Electrons move up towards the surface or sea-floor and circulate around the quake area.
- Electromagnetic fields start to emerge out of the earth crust and move upward towards the ionosphere.
- Since the ionosphere contains charged particles, the magnetic field interacts with the ions and creates a hole or a dome of charged particles, affecting radio waves passing through (see Figure 1).

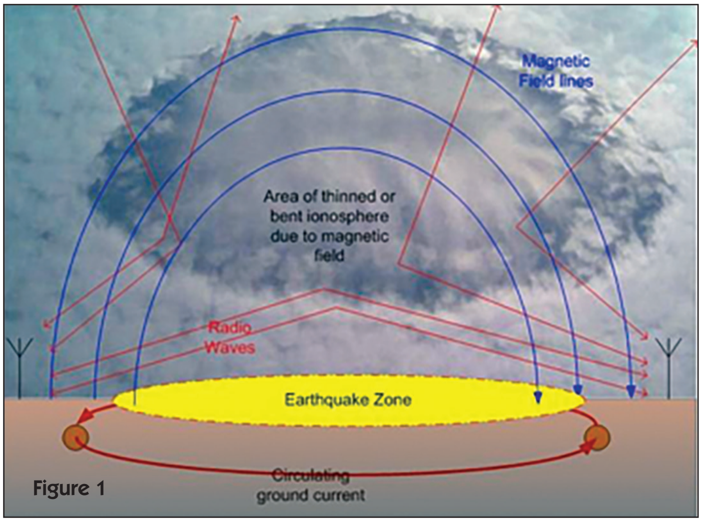


Figure 1

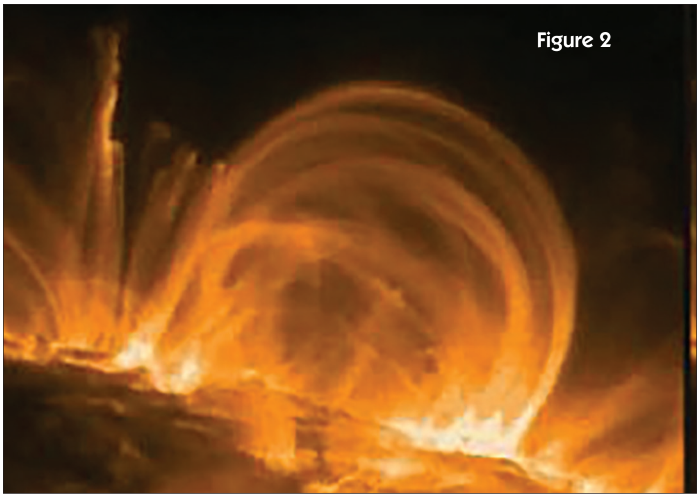


Figure 2

For more information see the article “Earthquakes in the Sky” by Erik Vance in the October 2018 issue of the *Scientific American.* It is available online at: http://www.ep.sci.hokudai.ac.jp/~heki/pdf/Scientific_American_Vance2018.pdf

2) A hole in the Ionosphere?

The magnetic field lines reach into the ionosphere and disturb or bend the layers, breaking existing radio paths. The signals that the Seismograph receives drop out!

The equivalent of a magnetic field shooting out of the surface of the sun (see Figure 2 below).

Because of the hot plasma, the field lines are visible. This process on the sun is much more energetic than an earthquake here on earth, but the physics are the same.

3) What is visible on the RF-Seismograph?

The following items are the different stages of the quake as seen by the RF-Seismograph – based on the Case study for M5.0 event, 256 kilometres southwest of Port Hardy, Vancouver Island North in British Columbia (see Figure 3 on page 34):

1) Energy buildup – noise increases on 80m (red) starting at 000UTC.

2) Disruption of 40, 30 and 20m band – communication dropout (lines go flat).

3) Quake releases at 0423 UTC.

4) The energy buildup and blackout continues with most quakes for approximately the same time as before the quake (two to three hours) for a total of four to six hours.

5) After the energy is released, the ionosphere starts to rebuild slowly and normal communication continues.

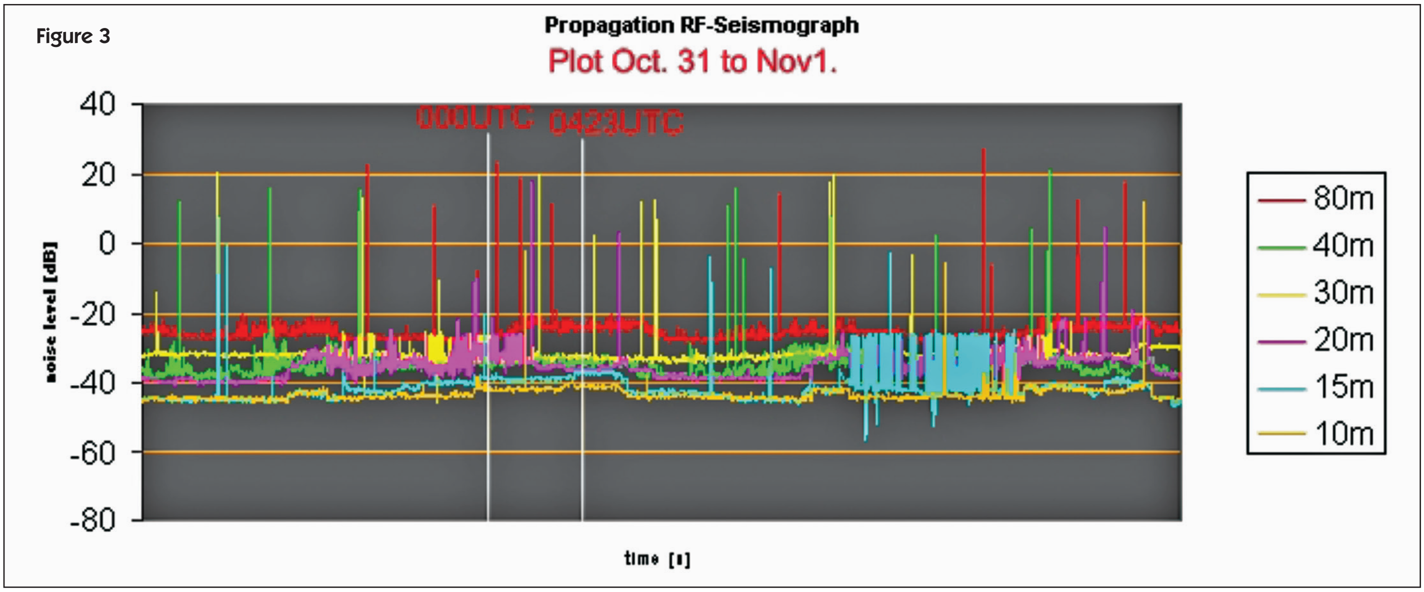
The Four-Year Propagation vs Earthquake Study

Why is it so difficult to prove that earthquakes have electromagnetic properties?

In previous studies the measurements were done on location. They were mostly done using VHF radios and only one specific quake was measured. This makes it very hard to catch the quake in its act.

In order to actually measure the effect on propagation, one has to be at least 500 kilometres (300 miles) away from the quake. This is necessary because we want to measure the radio signals that bounces back from the disturbed ionosphere and if one stands right in the field dome and transmits radio waves, they are at a steep angle to the field lines and will not bounce back easily.

Figure 3



Why is this study different?

Once we realized the very chaotic nature of earthquakes and linked this to the RF-noise they generate (which is electromagnetic white wideband noise – to almost 0 Hz), we understood why it was possible to study almost all earthquakes from one location (besides triangulation). By using HF and considering the fact that earthquakes can create RF signals that have several M-Watts of power output (possibly even more), they are easy to pick up. One only needed to correlate the time of the quake and look for the changes in propagation.

1) 171 total Earthquakes were studied: All M6+ events from the beginning of our recording (August 2016) to today. Events were provided by the USGS and the quality of the data is high.

2) 961 days of recorded data, 171 Quakes M6+, that amounts to one major quake every 5.6 days. Approximately 17.3% of background noise is affected by these strong events. Since we only looked at 6+ events, we can conclude that a lot of the background noise we monitor is created by smaller seismic events as well (and there are a lot more of them). If one looks at smaller quakes the (< M3.0) the earth really never stops shaking. There is a lot of energy even in small quakes and they are the major source of the rumble one hears when an HF rig is set to 160m or 80m.

3) Only 15 quakes did not have RF noise associated with them.

4) 1 day out of 961 was not recoverable due to data loss.

5) In 26 cases the time of the disturbance did not match the time stated in the USGS report.

6) In 122 Quakes (72%) we were able to see a noise increase of the 80m either before, after and before, and after the quake released. The "before and after" is the most common one. More analysis is needed.

For more information please see the article "Introduction and Study of Earthquakes" (and the References on the right):

http://www3.telus.net/public/bc237/MDSR/IntroductionRF-SeismographandEarthqakes.pdf

The study is still continuing and we need your help to set up more monitoring stations.

Conclusion

Now we come to the big question: Is it possible to predict earthquakes and evacuate people before they release?

With the provided measurements it seems that most earthquakes have a precursor noise level that could be detected and used to alarm a region. It will certainly add another useful tool to the measurements of earthquakes and it will create more certainty that a region is actually getting shaken to a level that causes damage and cost of life. Combined with regular seismographs, it could improve prediction, but clearing an area and then have nothing happen is the worst nightmare of any official; or even worse, after the all clear is given, disaster strikes!

References

Scientific American, October 2018: "Earthquakes in the Sky" http://www.ep.sci.hokudai.ac.jp/~heki/pdf/Scientific_American_Vance2018.pdf

Earthquakes Canada: http://www.earthquakescanada.ca

US Geological Survey: https://www.usgs.gov/

Access to Study for 2017, 2018 (2019 is part of 2018):

http://www3.telus.net/public/bc237/MDSR/Matches-RF-Seismograph and Seismic data for 2017.pdf

http://www3.telus.net/public/bc237/MDSR/Earthquakes visible with RF-Seismograph 2018.pdf

Download and Install RF-Seismograph for Linux and Raspberry Pi: https://groups.io/g/MDSRadio/wiki/home

Download MDSR software for PC from:

http://users.skynet.be/myspace/mdsr/

Alex Schwarz, VE7DXW, has been an Advanced Amateur since 1990 and he is a graduate of the Höhere Technische Lehranstalt (HTL) in Innsbruck. In Austria he held the call sign OE7BBT from 1987 to 1990. He moved to Vancouver in 1990 and has since been involved in professional communication systems (LDR trunking) and digital point to point wireless network systems. In 2005 he started work in the Biomedical Engineering Department at C&W Hospital in Vancouver. He can be reached by email at: alexschwarzalexschwarz@telus.net.