

There are bargains galore in the radio spectrum's "sub-basement" of frequency values. W8FX concludes this two-part article by looking at areas that most of us never dreamed of or knew existed.

Longer Than Longwave

Part II—What's There and How To Find It

BY KARL T. THURBER, JR.*, W8FX

In this concluding part we begin with the topic of phenomena monitoring and early storm warning.

Phenomena Monitoring and Early Storm Warning

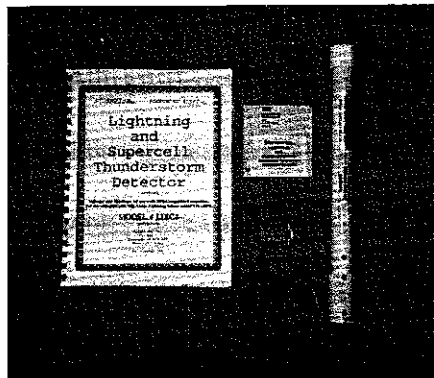
Solar Flare Monitoring. We've hinted at the profound effect the Sun has on the Earth, especially on its magnetosphere and ionosphere. The use of low frequencies (ULF through LF) for monitoring solar flares and their effects on propagation is a field wide open for experimentation. By monitoring these frequencies, you may observe important phenomena such as SIDs (Sudden Ionospheric Disturbances), SESs (Sudden Enhancement of Signals), and SEAs (Sudden Enhancement of Atmospherics), all of which are of interest to propagation buffs and researchers alike.

Earthquake Monitoring. Can sub-basement "rumblings" scientifically predict earthquakes? An interesting and speculative field involves monitoring the lowest bands to investigate EM radiation caused by "earthquake precursors." Both professionals and amateur experimenters alike are heavily involved with intriguing activities along these lines.

Reportedly, a west coast experimenter who operated an earthquake detection network noted radio and magnetic anomalies on January 15, 1994, two days prior to the big quake that caused so much damage in southern California. The experimenter was said to have predicted a quake exceeding 6 on the Richter scale.

If you're interested in scientific earthquake prediction and amateur geophysical experiments, the monthly publication *Geo-Monitor* offers earthquake prediction

*289 Poplar Drive, Millbrook, AL 36054-1674



The Stormwise Lightning and Supercell Thunderstorm Detector and Recorder includes a LSU-2001 Lightning Sensor Unit to detect emissions associated with thunderstorms. Its output is coupled optically to your PC's serial port, where the software lets you plot, graph, and analyze the activity on your PC screen. (Photo courtesy McCallie Mfg. Corp./Stormwise)

news and information on electronic equipment for earthquake precursors.

Lightning Stroke Static and Storm Early Warning. The more than 1 million lightning strokes (flashes) each day, from the 1500–2000 storms at any given time, make for wide-spectrum noise. Much of this noise is ominously close to home. Several firms, such as McCallie Mfg. Co., make storm sensors to warn you of approaching thunderstorms, some claiming several hours' warning that thunderstorms are approaching. The warning the sensors provide gives you time to shut down and/or disconnect your radio equipment and take other precautions (fig. 2).

In McCallie's Stormwise® designs, which use an ELF/VLF impulse detection

sensor, when storms are far away, the sensor sounds a buzzer for less than one second. As the storms draw closer, the buzzer sounds up to three or four seconds or more for each discharge. If the storms are severe, the alarm sounds almost continually until the activity dissipates. The sensor, which can register over 1000 detections per second, resets automatically.

The same firm recently began offering a software/hardware system to graph severe thunderstorms on your PC. This system detects the dangerous "supercell" type of thunderstorm and may even give an indication of hail and tornadic activity.

Some Mysterious Anomalies

Crop Circles. We don't want to get mixed up in the raging controversies regarding the authenticity of the "wheat field phenomena" called crop circles. Various theories regarding the causes have been advanced, from elaborate UFO theories to military exercises and underground EM forces. On the other hand, many observers suspect that the crop circles are no more than ingenious, artistic hoaxes. We just don't know the answer.

Some Natural Radio enthusiasts speculate that the energy to produce the crop circles in England could be caused by some powerful magnetospherically ducted, lightning-induced energy from storms originating in the Indian Ocean. It's conjectured that the energy from the storms, detectable as strong whistlers, might travel through the magnetosphere to cause a land disturbance on impact. It's a bit far-fetched, but one of the many possible explanations.

Red Sprites and Blue Blobs. For years high-altitude flight crews and astronauts have reported apparent cloud-to-space, upward-directed lightning and unusual

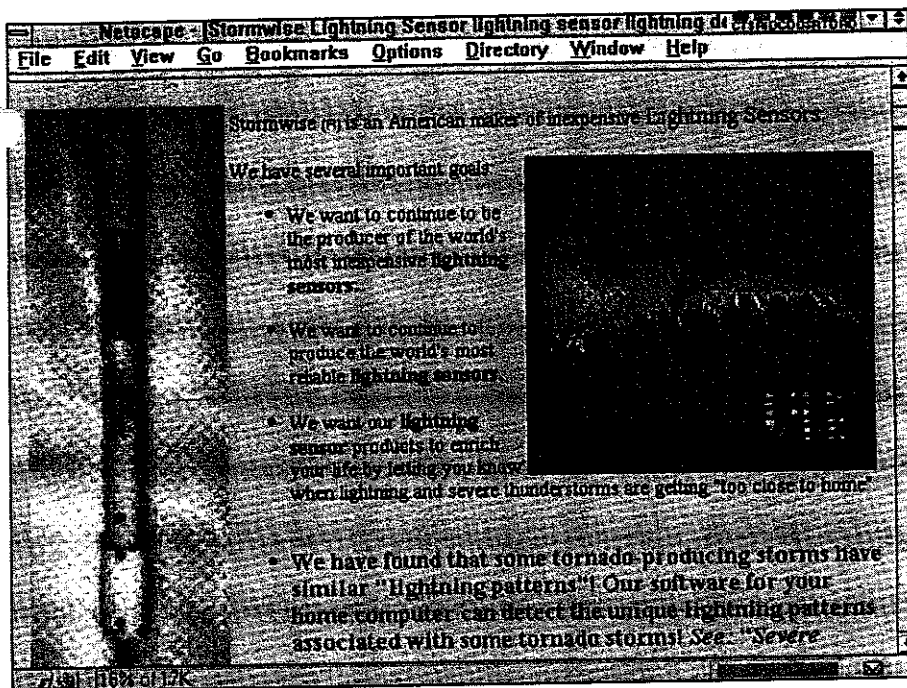


Fig. 2— Stormwise® makes lightning sensors that detect approaching thunderstorms. Recently the firm developed software to let you plot and analyze lightning data on your PC. Check out their Web page at <<http://www.stormwise.com>>.

blue and red lights above thunderstorm clouds, at about the same time lightning flashes were seen in the clouds below. Recent videotapes show that there often are massive red and blue bursts of lights, having durations of about 0.1 second, that occur some 20–30 miles above storms. There also are reports of intense, short-duration gamma ray flashes emanating upward from the thunderstorms.

The "sprites and blobs" are intriguing to Natural Radio listeners, especially since the signals associated with these phenomena, when played through an audio system, sound much like the crackling noises with which Natural Radio listeners are familiar. There's also some indication that sprites and blobs may be seen at about the same time as whistlers are noted.

There seems to be a direct coupling between the lower ionosphere and the fields associated with nearby lightning flashes. This realization, along with the observations of lightning extending upward from thunderclouds, has led to the identification of ionospheric heating caused by VLF transmitters and natural lightning. These discoveries are producing a new understanding of how the ionosphere may be modified by lightning.

The Brain Bands. We're just now beginning to understand how the human brain works, and we're finding out that it operates within a fairly narrow band of ULF/ELF frequencies. The predominate brain wave sub-basement frequencies tend to indicate the particular type of activity taking place in the brain.

There are four groups of waves associated with the brain's activities. Beginning with the lowest frequencies, these

are: (1) Delta waves (0.5–3 Hz), the very slow waves that occur when a person is in deep sleep; (2) Theta waves (4–7 Hz), which are associated with mental imagery and focus; (3) Alpha waves (8–12 Hz), which indicate relaxation; and (4) Beta waves (13–35 Hz), associated with most "normal" daily mental activities.

It's possible for ULF/ELF signals to stimulate or manipulate the brain, driving it to new patterns of brain "outputs"—a person's emotions and thought patterns, for example. Some critics of HAARP (the High Frequency Active Auroral Research Program) are concerned with the possible effects of the project's VLF/ELF signals on people living in affected regions, especially since some signals reportedly may be pulsed in the range 1–20 Hz. Government scientists say that the signal levels used in the project are too low to be dangerous. More on HAARP later.

Sub-Basement Propagation

Groundwave Dominance. How do signals propagate here? Much depends on just how low the frequencies are. Groundwave normally is the dominant mode as you go lower and lower in frequency.

Generally, LW signals follow the Earth's curvature, the ionosphere acting as a waveguide and duct. These and other characteristics make LW well suited for

RADIO WORKS

Antenna Fever

SuperLoop 80, 112' long, 80-10 m. Want the best? \$96.95

SuperLoop 40, 56' long, 40-10 m. Ready for DX \$84.95

CAROLINA WINDOM 80, 80-10 m, 132' long \$84.95

CW 40, 40-10, 66', helped set 40 m records - terrific! \$82.95

CAROLINA BEAM 80, 80-10m, 100' long, Powerful \$105.95

CAROLINA WINDOM 160, 160-10m, 252' Big Bang \$119.95

BigSig 40, 3/2 wave loop, 40 m, 110' A Sizzler \$69.00

G5RV Plus, 80-10m, 102'+ High Power Current Balun \$57.95

Current Baluns

B1-2K 1:1 2 KW 80-10 m Current Balun \$20.95

B1-5K 1:1 5 KW 160-10 m Precision \$31.95

B1-1KV 1:1 1 KW 15-2 m VHF Current Balun \$25.95

Y1-5K 1:1 5 KW 160-10 m The YagiBalun™ \$33.95

B4-1KXV 4:1 1 KW 15-2 m VHF Current Balun \$29.95

B4-2KX 4:1 2 KW 160-10 m 4:1 Current Balun \$42.95

RemoteBalun™ High Power, Current-type, 4:1, 160-10 m \$49.95

NEW! RFI Quick-Fix

T-4G

For really tough RFI and RF feedback problems, you can't beat the new T-4 and T-4G Ultra Line Isolators. It's isolation factor is 50% higher than previous models. The T-4G goes even further with a built-in ground strap for direct Line Isolator grounding. Before coax enters your station, stray RF is shunted directly to ground. Use with vertical antennas, install two T-4's between transmitter, linear and tuner to break up ground loops. Use the T-4 with any antenna to reduce feedline radiation. This is the RFI Big GUN. T-4G \$33.95

New! VHF Baluns

B1-1KV 1:1 and B4-1KXV 4:1 Line Isolators T-6 and T-6G

Line Isolators, 50 Ohms, High power

T-4 Ultra Line Isolator, maximum RFI protection \$29.95

T-4G Identical to T-4G without direct grounding \$33.95

T-6 VHF version of T-4 15-2 meters, 1 KW \$25.95

4K-L Line Isolator, SO-239 in and out \$19.95

New! 6 meter BigSig 6™ High Performance Wire Loop

Radiation pattern is in the background on this page. Only 13' long, 7' high. Low SWR. 2:1 SWR bandwidth is 4 MHz. Special, high efficiency VHF matching transformer. Great 6 m performance, and it's easy to put up. Only \$50, two for \$89.95

Antenna Wire and Parts

PL-259ST Silver-Teflon, USA SALE \$1.00

PL-259GT Gold-Teflon, USA \$1.49 or \$30/pk of 25

N/9913 For 9913, 9086, Flexi, etc. \$3.25

N/9913S As above but Silver & Teflon \$4.25

N-200 'N' Silver-Teflon, installs like PL-259 \$3.00

Coax & Cable Prices <100'/100'+

RG-8X Premium grade, 95% braid, SALE 19¢/14¢

RG-8X Plus 95% shield, type IIA non-contaminating 26¢/22¢

RG-213 Plus Enhanced, 96%+ super jacket 45¢/38¢

RG-213 Top Quality, 95% ^{base on 100' or more} 35¢

ExtraFlex Flexible, 9913 type 57¢

RT Rotator 8 conductor (2 x #18, 6 x #24) SALE 26¢/20¢

R2 Rotator 8 conductor (2 x #16, 6 x #18) SALE 47¢/35¢

#14 HD Stranded, 7 x 22 hard-drawn 8¢

#14 FlexWeave™ 168-strand, bare for any wire ant. 14¢

#12 FlexWeave™ 259-strand, excellent for longer runs 19¢

450 Ladder #16 stranded cond, windows SALE 22¢/16¢

450 Ladder New! #14 stranded cond, poly SALE 30¢/24¢

1/2" Braid Tinned copper, for ground systems 65¢

Pulleys - for antenna support rope. Highest quality, small, lightweight sailboat type for fibrous rope - for 3/16" rope \$11.95 or 5/16" rope \$14.95

Antenna Support Line

MilSpec Dacron, single braid, solid, fungus & sun resistant line. 3/16" 700# test 100' hanks \$8

Kevlar - no stretch, .075" dia. 500# test, Dacron jacket 200 sp# \$15.95

The RADIO WORKS

Orders & Technical (757) 484-0140
FAX (757) 483-1873

Order Hotline (800) 280-8327
Box 6159, Portsmouth, VA 23703

VISA and MC welcome. Give card #, exp. date, signature.
Add shipping (figure 10%, \$7 min) Prices subject to change.

email - jim@RadioWorks.com

visit us at <http://www.RadioWorks.com>

NEW! General Catalog 981 80 pages of HF and VHF baluns, Line Isolators, high performance wire antenna systems, wire, cable, coax, connectors, station accessories, tuners, coax switches, support line, etc. If you don't shop here, you won't get the best prices! Free, allow 2-3 weeks for bulk mail or send \$2 for Catalog by Priority Mail

CIRCLE 68 ON READER SERVICE CARD

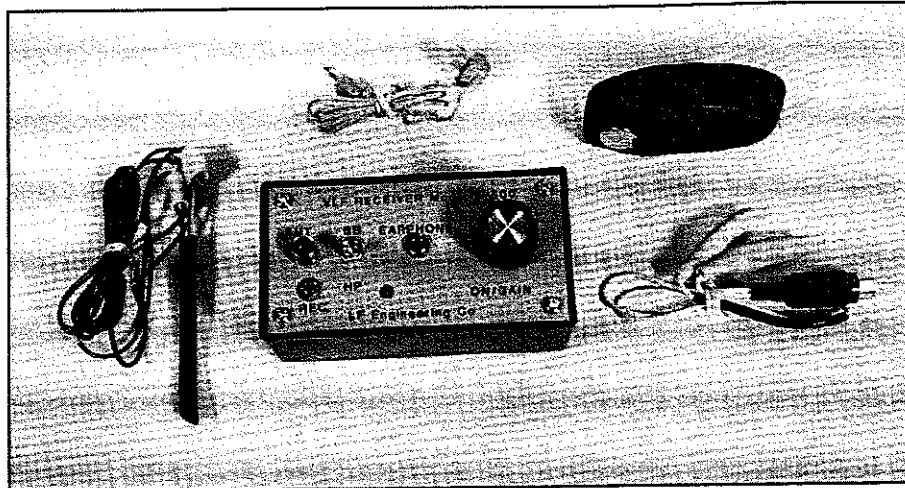
Say You Saw It In CQ

February 1998 • CQ • 39

the ultrareliable, fail-safe worldwide communications that the military and government often require. However, power must be high and antennas large. At the very lowest frequencies very long antennas may be run between mountains or even buried in the earth itself. The lowest frequencies easily can travel halfway around the world and even penetrate a short distance beneath the surface of the ocean.

Natural Radio Propagation. The behavior of Natural Radio-associated signals can tell us a great deal about how ULF, ELF, and VLF signals propagate. It's generally assumed that some of the energy from lightning strokes in the "right" location gets ducted into channels formed along the lines of the Earth's magnetic field, traveling into near space and to the opposite hemisphere, where they are heard as short, fast whistlers.

At about 50–55 miles (80–88 km) in altitude, the ionospheric E-layer acts like a mirror to sub-basement radio waves. The Earth's surface and the two "sides" form a pipeline which channels VLF signals. Impulses from distant storms travel better at night in this pipeline, but below a certain frequency there's an abrupt cutoff where the pipeline effect ceases. This occurs at about 1700 Hz, which also happens to be the frequency at which most of the ringing and pinging sounds of tweeks take place.



The LF Engineering L-500 ELF/VLF longwire receiving system lets you explore Natural Radio and other sub-basement phenomena. The system is used with ear-phones and is connected to a 10 foot or longer wire antenna. The system's frequency response is 300 Hz to 5 kHz; it's \$79. (Photo via LF Engineering Co., Inc.)

The energy of the original lightning stroke may make several hops between the hemispheres in its travel along the Earth's magnetic field lines-of-force, creating audibly long whistler "echo trains." Each echo is proportionally longer and slower in its downward sweeping pitch and also is progressively weaker.

HAARP. HAARP, the High Frequency Active Auroral Research Program, is a government-military project to study the ionosphere. It's gearing up to use multi-megawatt transmitters and large antennas in Alaska. Although mainly an HF program, pulsed VLF and ELF signals also are part of the program and will be coord-

1998 Charlotte

HAMFEST AND COMPUTERFAIR

March 7 & 8, 1998 - Charlotte Merchandise Mart - Charlotte, NC



- Over 120 commercial exhibit booths
- All major manufacturers will be here
- 8 ft. swap tables by pre-registration only
- 104,000 sq. ft. of indoor exhibit space
- Parking for 3,500 cars
- Largest indoor HAMFEST in the Southeast
- VEC Exams on Saturday

**Dealer Booth
INFORMATION**
Ken Boyd-WA4UNZ
Don Negus-N0SU
(704) 377-8873



For more ticket information, write to:
Charlotte Hamfest and Computerfair
P. O. Box 221136
Charlotte, NC 28222-1136
Or call: (704) 948-7373
Visit our website:
www.w4bfb.org

ARRL SANCTIONED HAMFEST

minated closely with the Navy ELF communications system.

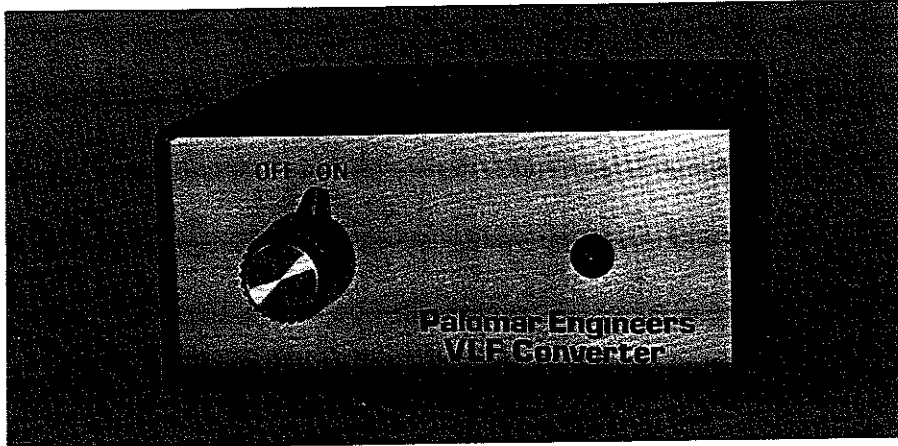
The experimental program has highly ambitious civilian and military purposes. The VLF/ELF frequencies involved are important to HAARP, since these waves can travel around the world with little loss. The potential to heat and alter the ionosphere using EM pulses through "coherent interaction" with particles in the Earth's radiation belts suggests possible unknown effects on the environment and humans. A campaign is being waged against the program by environmentalists, who see great potential for harm.

Equipment for ULF/ELF/VLF

Communications equipment capable of tuning the sub-basement is a prerequisite to low-band exploration. But while many radios tune LW, relatively few actually tune to the ULF/ELF/VLF sub-basement. Let's look at some of the possibilities.

Surplus and Older Commercial LW Receivers. Many surplus receivers popular with amateurs tune down to 100 or 50 kHz or so, but few reach into the tens of kHz. Many surplus radios require restoration, and most need modification to be compatible with 120 volt, 60 cycle AC. Also, most tube-type surplus sets are pretty old and tired now. Most sets just aren't suitable.

However, the R-389 URR, made for the



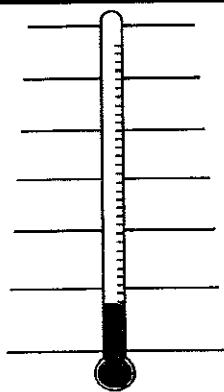
The Palomar Engineers VLF Converter lets you enter the world of VLF radio for about \$80; all you need is a communications receiver and an antenna. Covering 10 to 500 kHz, the Model VLF-A converts VLF signals to the 80 meter amateur band, while the Model VLF-S converts signals to 4010-4500 kHz for general-coverage shortwave receivers. (Photo courtesy Palomar Engineers)

government by Collins Radio in the 1950s, is an excellent receiver the coverage of which extends to VLF. And the Hammarlund VLF Super Pro, also known as the SP-600-VLF, tunes as low as 10 kHz.

New Sub-Basement Receivers. Typically, most solid-state communications receivers tune down to 100 kHz, some to 30 kHz. There also are recent sets that tune to the sub-basement, although

they're expensive. These include the Watkins-Johnson HF1000 and WJ-8711, the AOR AR-5000 and AR-7030, and the Bearcat DX-1000. Most of these sets tune as low as 10 kHz, although the Watkins-Johnson receivers nosedive to 5 kHz and the AR-7030 reportedly tunes all the way down to 0 (zero) Hz. For these deluxe sets get out your checkbook.

Receivers for Natural Radio. The



Attention UHF/VHF Weak Signal Enthusiasts: Checked your antenna's temperature lately?

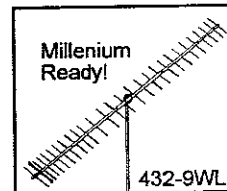
No, not Fahrenheit or centigrade. We're talking Kelvin (K) thermodynamic temperature. At radio frequencies this means *noise*. Ever wonder what a low Kelvin temperature does for an antenna? Take a guess from the multiple choice answers below:

- A. Low °K means low system noise.
- B. Works with your state-of-the-art low-noise preamp, not against it.
- C. Helps you cut through the hype surrounding antenna performance
- D. Enhances tropo, meteor scatter, moonbounce...any weak-signal work.
- E. Minimizes sky noise, earth noise, man-made noise (power lines, etc).
- F. Ensures cleaner E and H plane patterns.
- G. All the above.

If you picked any answer A through F, you're ahead of the curve on understanding the importance of low Kelvin temperatures for antennas. If your answer was G, you probably already own an M² antenna or two! M² is pioneering Kelvin temperature ratings because of their importance in getting the most out of modern low-noise UHF/VHF equipment. If you've invested in a preamp with a great noise figure or you're just looking for improvement in your signal-to-noise ratios, remember this: **choosing the right low K antenna is critical to realizing the total potential of your system.**

To put this in historical perspective: Not so long ago, a typical noise figure for 432 was 2 dB (170°K). The noise temperature for an average yagi antenna of the day, at 100°K, had virtually no effect on a receive system's performance. Today, a preamp noise figure of .36 dB (26°K) is not unusual, and requires a matching low temperature antenna to break even. An old-style 100°K yagi antenna could take a shocking 5 dB off this modern receive system's S/N ratio! To ensure maximum receive system performance, a state-of-the-art low K antenna, like the M² 432-9WL, is essential! M² antennas are the ideal companions for the low-noise equipment of today and the next millenium.

Watch for °K and G/T (gain/temp.) ratings on the spec-sheets for all M² UHF/VHF high performance antennas. Want to know more? Contact us!



7560 N. Del Mar Ave., Fresno, CA 93711
(209) 432-8873 Fax: 432-3059 Em: K6MYC @ AOL.com



Visit our website at www.m2inc.com

- Rohn distributor
- Turnkey systems



RESOURCES: BOOKS, NEWSLETTERS, AND OTHER PUBLICATIONS

Are you interested in learning more about sub-basement radio? Check out these interesting sub-basement resources

Books

The World Below 500 KiloHertz. A good, one-stop tutorial on LW is "The World Below 500 KiloHertz," by L. Peter Carron, Jr., W3DKV. The 64-page, 1985 booklet, probably the only available beginner's book on LW, offers a good (though somewhat dated) overview of the longwaves and introduces its inhabitants and users. It's published by Universal Radio for \$4.95 plus \$2 s/h.

Communications Receivers, 3rd Edition. Raymond S. Moore has a great deal of data on general-coverage receivers from 1932 to 1981. He covers National, Hallicrafters, Hammarlund, Collins, and others, including variations on the 400 receivers profiled, over 700 sets are covered, including military surplus. The 125-page book is published by RSM Communications at \$19.95 plus \$2.50 s/h.

Shortwave Receivers Past and Present. Don't let the word "shortwave" in the title fool you. This 1997 book by Fred J. Osterman, N8EKJ includes several excellent receivers suitable for sub-basement monitoring. The 350-page publication covers tube and solid-state communications receivers from 1945 to 1996. Over 500 receivers are featured, along with commentary on some 400 variants. It's \$19.95 plus \$2 s/h from Universal Radio.

Angels Don't Play This HAARP. This 1995 book by Nick Begich describes the High-Frequency Active Auroral Research Program (HAARP), which involves HF and VLF/ELF studies. The 215-page book, which says that HAARP is up to no good, explains the program and gives information on the potential to manipulate the environment. The speculative book is by Earthpulse Press and is distributed by CRB Research Books (\$14.95 plus \$2 s/h).

Underground Bases and Tunnels. This book by Richard Sauder digs into America's "secret" underground installations. The conjectural work, which says the government has something to hide, includes chapters on base locations, tunneling technology, military designs, nuclear testing facilities, and more. There is info on underground communications using sub-basement frequencies. It's from Adventures Unlimited Press and is distributed by CRB Research Books (\$15.95 plus \$2 s/h).

Journals and Magazine Columns

Popular Communications. *Popular Communications* serves an eclectic mix of radio monitoring interests including shortwave radio, VHF/UHF scanning, mediumwave DXing, pirate radio, amateur radio and radio resources. There's no dedicated column for LW or sub-basement interests, but they're served by the magazine's more than 15 monthly columns. One-year domestic subscriptions are \$25.95 from CQ Communications.

Below 500 kHz Column in Monitoring Times. For over five years Kevin Carey, WB2QMY, has conducted a LW-related column in *Monitoring Times*. Kevin's column is called "Below 500 kHz" and is subtitled "DXing the Basement Band." Check it out, or contact Kevin at <kevinc@mdsroc.com>. Domestic subs to *Monitoring Times*, which covers radio listener and hobbyist interests across almost the entire spectrum, are \$23.95 from Grove Enterprises.

Speleonics. The Communications and Electronics Section of the National Speleological Society publishes *Speleonics* several times a year; it's especially useful to cave explorers interested in practical alternative methods of cave communications. Information on *Speleonics* is available from Frank Reid, W9MKV.

Geo-Monitor. A monthly publication, *Geo-Monitor* offers information on the science of earthquake prediction, provides a forum for discussion, and assists amateur scientists in geophysical monitoring and experiments. The publication also has covered speleological (cave exploring) and some "borderland" theories. One-year domestic subs (12 issues) are \$20.

Audio Resources

McGreevy Natural VLF Radio Recordings. Want to hear what

whistlers and other Natural Radio emissions actually sound like before buying or building a receiver to hear them? You can download a wide variety of sound files from a University of Iowa Web server at <<http://www-pw.physics.uiowa.edu/mcgreevy>>. Several audiotape cassettes also are available; these can be ordered from Steve McGreevy, N6NKS's Radio Receiver and Recording Info Page, which you'll find at <<http://www.triax.com/vlfradio/wr3e.htm>>.

Double CD Album of Natural Radio Recordings (UK). The British firm Irdial Discs has a double CD set of McGreevy's Natural Radio VLF recordings entitled "Electric Enigma." You can order the CD set directly from These Records, a British company; they cost £18.50 (about \$28.35), plus £1.50 shipping. Major credit cards can be used. (More information is available from McGreevy's Radio Receiver and Recording Info Page at the same <<http://www.triax.com/vlfradio/wr3e.htm>>.)

Internet Resources

There are a significant number of UHF/ELF/VLF-oriented Web pages for you to explore. Here are just a few to feed to your browser in search of more information on the sub-basement.

The Art Bell Web Page. This Web page supplements W6OBB's popular and entertaining, but often eccentric late-night radio talk shows. It's found at <<http://www.artbell.com>>.

Cave Radio & Electronics Group (U.K.). This British site is found at <<http://www.sat.dundee.ac.uk/~arb/creg>>.

Crop Circle Connector. This British site is the home for the International Crop Circle Database. You'll find it on the Web at <http://alpha.mic.dundee.ac.uk/ft/crop_circles/anasazi/connect.html>.

Electric Enigma: The VLF Recordings of Stephen P. McGreevy. It's found at <<http://www.ibmpcug.co.uk/~irdial/vlf.htm>>.

ELF Band Designators/Navy's ELF Communications System. Go to <<http://server5550.itd.nrl.navy.mil/projects/haarp/elf/elf.html>>.

HAARP Main Page. You'll find this military Web site at <<http://server5550.itd.nrl.navy.mil/projects/haarp/index.html>>.

LWCA Home Page. The Long Wave Club of America is found at <<http://users.aol.com/lwcanews/index.html>>.

McGreevy's Natural VLF Radio Home Page. You'll find it at <<http://www.triax.com/vlfradio/natradio.htm>> (see fig. 2).

Sounds of the Aurora. You'll find these sounds of the aurora at <<http://www.tp.umu.se/Space/AuroralSounds.html>>.

STARLab VLF Group Home Page. You'll find this VLF site at <<http://www.star.stanford.edu/~vlf/Welcme.html>>.

Swedish Radio Station Grimeton. Check out this Web page at <<http://www.telemuseum.se/Grimeton/Grimeton.HTML>>.

University of Iowa VLF Site. You'll find this Web page at <<http://www-pw.physics.uiowa.edu/mcgreevy>>.

Very Low Frequency Radio Project. The VLF Page is found at <<http://ananke.advanced.org/2784>>.

Other Resources

McGreevy VLF Guides. The "WR-3 and WR-3E VLF Receiver Listening Guide" is an excellent source of detailed information on how to receive and listen to Natural Radio sounds. You can download Stephen P. McGreevy, N6NKS's "Guide" from the Internet at <<http://www.triax.com/vlfradio/wr3gde.htm>>. Also available for download is McGreevy's "The VLF Story"—a lengthy, three-part, comprehensive treatise on most aspects of ELF/VLF Natural Radio emissions—at <<http://www.triax.com/vlfradio/vlfstory.htm>>.

The Longwave Club of America. Since 1974 longwave listeners have had a forum in the LWCA. It promotes DXing, experimenting on frequencies below 530 kHz, and 1750 meter band experimenter activity. The LWCA publishes "The LOWDOWN" newsletter monthly. The several active columns and features are devoted to beacons, LW loggings, the 1750 meter band, and special-interest pursuits such as scientific earthquake precursors and sub-basement happenings. Membership information is available from LWCA.



Palomar Engineers offers an amplified loop antenna system that lets you DX from your kitchen table. The LA-1 Loop Amplifier (\$99.95) can be used with any of six plug-in loops, each costing \$89.95; three of these cover LW. One covers 10-40 kHz (for Omega); a second covers 40-150 kHz (for WWVB); and a third covers 150-550 kHz. Other loops encompass the AM broadcast band, 160 and 80 meters, and HF to 16 MHz. (Photo courtesy Palomar Engineers)

most basic "receiver" required to pick up Natural Radio signals is an audio amplifier connected to a very long wire antenna. In practice, this crude radio will likely also intercept local AM Broadcast Band and other signals, and it probably won't have adequate sensitivity.

Despite the specialized and esoteric nature of Natural Radio listening, there

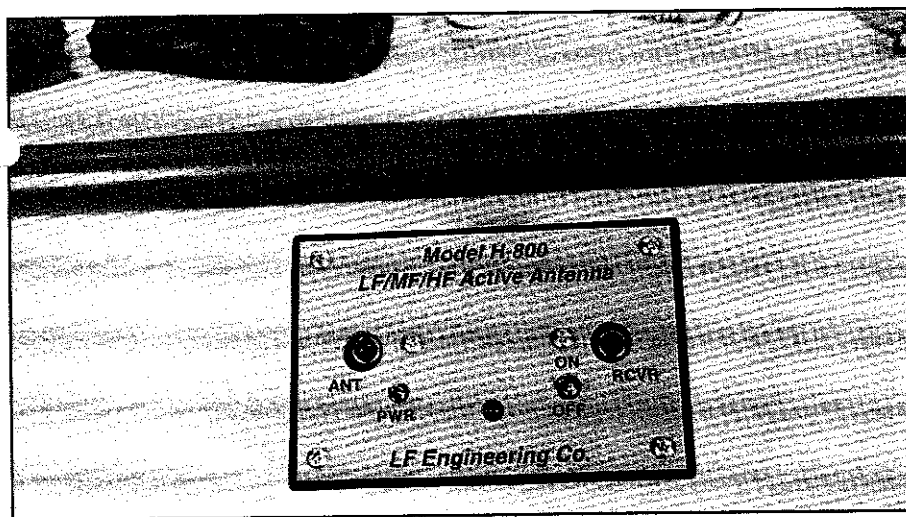
are radios designed for that purpose. S.P. McGreevy Productions manufactures and distributes two handheld portable radios, the WR-3 basic VLF receiver (\$59.95) and the enhanced WR-3E receiver (\$95). Both sets are designed for listening to whistlers and other Natural Radio sounds. Both sets come with the comprehensive *WR-3 and WR-3E VLF Receiver Listening Guide* (you can download it and save \$5, and several cassettes of Natural Radio sounds are available from McGreevy's Web pages). Also, the "ELF/VLF longwire receiving system," the L-500, is offered by LF Engineering Co.

Frequency Converters. There's another way to get started listening to base-band signals: Buy a VLF frequency converter and hook it up to your present amateur band or general-coverage communications receiver.

The Palomar Engineers VLF-A Converter is \$79.95. It uses a crystal-controlled local oscillator and a mixer to heterodyne or translate the 10-500 kHz range to the 80 meter amateur band, from 3510 to 4000 kHz. The converter is inserted between a receiving antenna and the antenna input of any amateur band or general-coverage receiver that covers the 80 meter band. The similar Model VLF-S converts VLF to 4010-4500 kHz to work specifically with general-coverage short-wave receivers.

Antennas for The Sub-Basement

It's hard to construct an efficient receiving antenna for the sub-basement because the wavelengths involved preclude erecting anything larger than a small fraction of a wavelength long. Various short wire,



The LF Engineering H-800 Skymatch is a broadband active antenna that covers 10 kHz through 50 MHz. Its active components are housed in a 26 inch sealed probe and powered via a coax feed from a remote coupler at the receiver. The system is an alternative to a longwire in which restricted space or local noise would prohibit its effective use. It's \$109. (Photo courtesy LF Engineering Co., Inc.)

POWERPORT™

Put Your OLD BATTERY HERE!



The simple addition of your automotive battery means the PowerSafe will provide everything you need for a 75-200 amp uninterrupted power supply. At home, in the field, in daily use, as well as in emergencies this clean, portable unit will keep your station fully powered.

Three models designed for light, medium or heavy use come with triple DC outlets and automatic chargers. The Deluxe model provides 500 Watts peak (300 W continuous) AC power. Size: 18" x 10.5" x 9.5". Big enough to fit a large battery, small enough to fit under your desk. Prices start at \$65.95.



CUTTING EDGE ENTERPRISES
1803 MISSION #546 SANTA CRUZ CA 95060
ORDERS 800: 206-0115

PP 147 \$140	PP 50 \$120	PP 73 \$77	RF 35 JR \$165
START AT \$66	PP JR \$60	PP 259 \$180	RF 35 \$180

CIRCLE 47 ON READER SERVICE CARD

GORDON WEST HAM TEST PREP TAPES BOOKS • SOFTWARE • VIDEOS

Prepare for your ham test with "Gordo" WB6NOA as your personal instructor.

- **THE THEORY** on audio cassettes
 - No-Code Technician (6 tapes)\$29.95
 - General Class (2 tapes)\$ 9.95
 - Advanced Class (4 tapes)\$19.95
 - Amateur Extra Class (4 tapes)\$19.95
 - **THE CODE** on audio cassettes
 - Learning CW (6 tapes)\$29.95
 - General Class CW (6 tapes)\$29.95
 - Extra Class CW (6 tapes)\$29.95
 - **STUDY MANUALS** by "Gordo"
 - No-Code Technician (2&3A)\$12.95
 - General Class (3B)\$ 9.95
 - Advanced Class (4A)\$11.95
 - Extra Class (4B)\$11.95
 - **IBM SOFTWARE** with manual
 - No Code Technician (2&3A)\$29.95
 - General Class (3B + Code)\$29.95
 - Advanced Class (4A + Code)\$29.95
 - Extra Class (4B + Code)\$29.95
 - Morse Software Only\$ 9.95
 - **VIDEO** VHS with 2&3A manual
 - No-Code Tech Video Course\$29.95
- Add \$3.00 shipping charge - 3 day service
VISA, MasterCard, Discover & AMEX Accepted.

The W5YI Group, Inc.
P.O. Box 565101 • Dallas, TX 75356

Call Toll Free 1-800-669-9594

CIRCLE 75 ON READER SERVICE CARD

SOFTWARE

DSP Blaster 2.0 uses your PC and sound card to provide tunable highpass, lowpass, and bandpass filters, autotracking CW peaking filter, automatic notch filter, coherent phase-locked CW processor with stereo output, adaptive noise reduction, and AGC. **DSP Blaster** graphs the audio waveform, envelope, spectrum, and CW phase. It can run in the background. \$125. **RITTY 2.0** is a high-performance DSP modem for RTTY and PACTOR. The limiterless front-end, sharp BPF, autotuned optimal filters, ATC, numerical flywheel, packet repair, and memory-ARQ recover signals other modems can't. **RITTY** features an FFT spectral tuning indicator, waveform displays, adjustable frequencies, precision AFSK, and FSK & PTT outputs. \$150. 486DX, VGA, and 16-bit Creative Labs sound card required (no "compatibles").

AO 6.5 automatically optimizes antenna designs for best gain, pattern, impedance, SWR, and resonance. **AO** features 3-D pattern and geometry displays, 2-D polar and rectangular plots with overlays, automatic wire segmentation, automatic frequency sweep, skin-effect modeling, symbolic dimensions and expressions, current sources, and polarization and near-field analysis. **NEC/Wires 2.0** models true earth losses, surface waves, and huge arrays with the Numerical Electromagnetics Code. Best for elevated radials, Beverages, wire beams, giant quads, delta loops, and LPDAs. **TA 1.0** plots elevation patterns for HF antennas over irregular terrain. **TA** accounts for hills, valleys, slopes, focusing, shadowing, reflection, diffraction, and ground constants. Use **TA** to optimize antenna height and siting for your particular QTH. **YO 6.5** automatically optimizes monoband Yagi designs for maximum forward gain, best pattern, minimum SWR, and impedance. **YO** models stacked Yagis, dual driven elements, tapered elements, mounting brackets, matching networks, skin effect, ground reflection, and construction tolerances. **YO** runs hundreds of times faster than NEC or MININEC. **NEC/Yagis 2.5** provides reference-accuracy modeling of individual Yagis and large arrays. Best for EME arrays. One antenna program, \$70; three, \$120; five, \$200. 386+387 and VGA required.

Visa, MasterCard, Discover, check, cash, or money order. Add \$5 overseas. k6stt@n2.net

Brian Beezley, K6STI - 3532 Linda Vista
San Marcos, CA 92069 - (760) 599-4962

loop, and active antenna systems predominate. Even huge government and military VLF antennas using arrays of masts hundreds of feet tall and with earth ground mats covering acres achieve efficiencies of only about 1 percent.

Wire Receiving Antennas. Variations on singlewires, longwires, end-feds, Marconis, and combination vertical and horizontal L's are common. As a rule, with a wire antenna you should get as much wire as possible in the air. Even so, at sub-basement frequencies you may have difficulty getting the antenna a sufficient distance from AC line hum and noise, so listening at remote sites often is the only practical solution.

As the operating frequency increases, more familiar types of antennas are found. There are many types of horizontal and dual-polarized antennas you can adapt, although very little has been written about them in recent years. *The ARRL Antenna Book* will give you some basic principles and ideas.

Small Loops and Whips. Certainly not new, having been in use from the earliest days of radio, receiving loops are enjoying new-found acceptance. This is because loops can be physically small yet work well, they can be resonated or tuned to a particular frequency, and they can be rotated to take advantage of their directivity to peak and null signals. Most loops give a figure-eight pattern similar to that of a halfwave dipole.

Loops tend to be quieter than single-wire outdoor antennas, are less prone to swamping by strong local broadcast stations, and can be used to null out noise and interference. However, some hobbyists report poor results with indoor loops as a result of noise magnetically radiated from household wiring.

Palomar Engineers offers an excellent preamp/loop, adjustable in azimuth and elevation, for its VLF converter or any low-band receiver. The amplifier can be used with several plug-in loops to extend coverage to the AM Broadcast Band and well into the shortwaves. LF Engineering Co. sells a basement-band resonant loop receiving system that covers 300 Hz to 8 kHz.

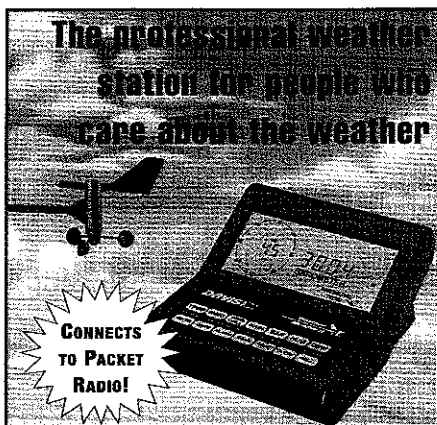
Active gain antennas using a steel whip or wound coil element and an antenna-mounted preamp also are very popular; several designs are offered by Curry Communications, LF Engineering Co., and others. Typically such systems are mounted outdoors, away from noise and distracting objects. The amplified signal is routed to the receiver through coax.

Summary

This article explored the sub-basement of the radio spectrum by surveying the ULF, ELF, and VLF regions lying below 30 kHz. The article presented signals you're likely to encounter, including natural, man-made, and dangerous radio emissions. It also covered underground communications; phenomena and storm warning; ULF/ELF/VLF propagation, equipment, and antennas; and some mysterious anomalies. Various resources were listed.

At the bottom line, we hope we've shown that there's a great deal more to the lower reaches of the electromagnetic spectrum than we amateurs normally experience. And while much contemporary interest focuses on ever-higher frequencies and shorter wavelengths, there's a lot going on in the radio sub-basement. Check it out; you won't be disappointed. ■

The professional weather station for people who care about the weather



CONNECTS TO PACKET RADIO!

Davis Instruments has a complete line of weather stations affordable enough for home and hobby use. Connect the station to packet radio using shareware program available on Davis' Web Site and BBS.

Features Include:

- Inside & Outside Temps
- Wind Speed & Direction
- Barometer
- Time & Date
- Inside Humidity
- Wind Chill
- Alarms
- Time & Date
- Rainfall Option
- Instant Min/Max Conversion
- Outside Hum. & Dew Point Output
- Optional PC Interface

For a free catalog, call
1-800-678-3669
or visit us at
<http://www.davisnet.com>

M-F 7 a.m. to 5:30 p.m. Pacific Time
FAX 1-510-670-0589
M/C and VISA • One-year warranty
30-day money-back guarantee • CQR0298

Davis Instruments

3465 Diablo Avenue, Hayward, CA 94545 • www.davisnet.com

NAMES AND NUMBERS

Adventures Unlimited Press, 303 Main St., P.O. Box 74, Kempton, IL 60946 (815-253-6390).
CRB Research Books, Inc., P.O. Box 56, Commack, NY 11725-0056 (516-543-9169).
Curry Communications, 737 North Fairview St., Burbank, CA 91505 (818-846-0617).
Earthpulse Press, P.O. Box 201393, Anchorage, AK 99520 (907-249-9111).
Electronic Equipment Bank, 325 Mill St. N.E., Vienna, VA 22180 (703-938-8105).
Geo-Monitor, Charles R. Patton, Editor, 21490 Camino Arriba, Murrieta, CA 92562 (909-698-9657).
Grove Enterprises/*Monitoring Times*, P.O. Box 98, 7540 Highway 64 West, Brasstown, NC 28902-0098 (1-800-438-8155).
LF Engineering Co., Inc., 17 Jeffrey Rd., East Haven, CT 06513 (203-248-8851).
Longwave Club of America, 45 Wildflower Rd., Levittown, PA 19057 (215-945-0543).
McCallie Mfg. Corp./Stormwise, P.O. Box 8631, Greenville, TX 75404-8631 (902-883-3684).
S.P. McGreevy Productions, 604 North F St. #1, Lakeview, OR 97630-1127 (541-947-5508).
National Speleological Society, Inc., 2813 Cave Ave., Huntsville, AL 35810 (205-852-1300).
RSM Communications, P.O. Box 1046, Key Largo, FL 33037-1046 (305-853-0379).
Speleonics, Frank Reid, W9MKV, P.O. Box 5283, Bloomington, IN 47407-5283.
Popular Communications, 76 N. Broadway, Hicksville, NY 11801-2953 (516-681-2922).
Palomar Engineers, P.O. Box 462222, Escondido, CA 92046 (619-747-3343).
Frank Reid, W9MKV, Box 5283, Bloomington, IN 47402-5283.
These Records, 112 Brook Dr., London SE11 4TQ, U.K.
Universal Radio, Inc., 6830 Americana Parkway, Reynoldsburg, OH 43068-4113 (1-800-431-3939).