The INSPIRE Journal

Volume 3 Number 2

May 1995

MIR and INSPIRE to Work Together in Space Physics Research!

An agreement between INSPIRE and IKI (The Russian Space Agency) has been reached on a program of space physics research using instruments on board the MIR Space Station and ground-based INSPIRE receivers. The plan calls for using a modulated electron beam to generate electromagnetic waves which can then be monitored on the ground. This is very similar to the Space Shuttle-based SEPAC mission of 1992.

The major scientific participants in the MIR-INSPIRE Project are Stanislav Klimov, William Taylor and Nicolay Antropov.

Stanislav (Stas) Klimov of the Space Research Institute in Moscow is the Head of the MIR-INSPIRE Project and Principal Investigator and Co-Investigator of numerous space physics projects, including INTERBALL and the Small Satellite Project, a mission to characterize the electromagnetic environment around the International Space Station Alpha.

William (Bill) Taylor is Director of Space Sciences at Nichols Research Corporation in Washington, DC, President of The INSPIRE Project, Inc., and Principal Investigator and Co-Investigator of numerous space physics projects, including SEPAC and Active.

Nicolay Antropov of the Research Institute of Applied Mechanics and Electrodynamics of the Moscow Aviation Institute is Head of his Department. He is a Principal Investigator and Co-Investigator of active space experiments on sounding rockets and the Space Station MIR. He is an expert on pulsed plasma source development for active space experiments and is in charge of the Ariel and Istochnik instruments which were installed on MIR eight years ago.

If you are interested in participating in MIR-INSPIRE, notify Bill Pine at the address on Page 2 or at email: pinebill@aol.com. Let me know how to contact you (preferably by email) so that you can be informed of the MIR-INSPIRE schedule. You will be contacted as soon as the MIR operation schedule is known. The format for the data taking will be specified at that time.

See Page 5 of the *Journal* for a copy of the agreement between IKI and INSPIRE.

Table of Contents

MIR and INSPIRE to Work Together in Space Physics Research!	1
PC-based Data Analysis Is Now Available, Eclipse Data Sampler Tape Is Available, Host an INSPIRE Workshop	3
Special Observation Schedule- MODIFIED, Receiver Kits Available Now Free Data Analysis Available, INSPIRE Is Now on World Wide Web	4
INTERBALL-MIR-INSPIRE AGREEMENT	5
VLF Observations in Croatia by Zeljko Andreic, Zagreb, CROATIA	10
Spectrogram 2.2: A Data Analysis Program for Microsoft Windows by Gregory Walker, Austin, Texas	12
Space Bang and Natural Radio Phenomena by Flavio Gori, INSPIRE European Coordinator, Florence, ITALY	15
Abbotsford, Wisconsin, Jr.-Sr. High School Report on Activities	18
Abbotsford Receives Grant for Project INSPIRE Equipment	21
A Test for Students Involved in Project INSPIRE Activities by Mike Schoenfuss (N9GHZ), Abbotsford, Wisconsin	22
5 kHz LPF Filter Mod for the INSPIRE Receiver by Mike Dormann, Seattle, Washington	23
Spring Equinox VLF Monitoring by Steve Ratzlaff, East Palo Alto, California	26
TAPESTRY Grant Supports the INSPIRE Project	28
An Eclipse Data Sampler by Bill Pine, Ontario, California	30
INSPIRE Order Form	42

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The INSPIRE Journal is the publication of The INSPIRE Project, Inc., a nonprofit educational/scientific corporation of the State of California. The purpose of The INSPIRE Project, Inc., is to promote and support the involvement of students in space physics research. All officers and directors of the corporation serve as volunteers with no financial compensation. The INSPIRE Project, Inc., has received both federal and state tax-exempt status. *The Journal* is published two times per year: November and May.

Contributions for the Journal may be sent to the editor at:

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Deadlines: October 1 and April 1

PC-based Data Analysis Is Now Available:

Elsewhere in the *Journal*, Greg Walker describes a new signal analysis program, called GRAM, for the PC. If you would like a copy of this program, send $5 to INSPIRE. Use the order form on the last page of the *Journal* and specify that you are ordering "GRAM".

Eclipse Data Sampler Tape Is Available:

I have made a tape of sample of the data gathered for Eclipse-94. The tape includes the "Data Analysis Sample Tape" that we have been using to evaluate data analysis software plus all of the eclipse segments used in the "Eclipse Data Sampler" article in this edition of the *Journal*.

This is not a professionally produced tape, but I think the quality is adequate. The price is $5 for the tape and a description of the Data Analysis Samples. The article in the *Journal* serves to describe the other segments on the tape. Use the order form on the last page of the Journal and specify that you are ordering the "ECLIPSE TAPE".

Host an INSPIRE Workshop:

Thanks to a grant from NASA matched by a generous grant from Hughes STX Corporation, INSPIRE will be able to offer INSPIRE VLF radio workshops in your local area. The following describes what is involved in acting as local host for an INSPIRE Workshop.

INSPIRE Workshop Host Responsibilities:

1. Apply to INSPIRE for a Saturday date at least three months in advance.
2. Arrange for Workshop facilities:
   - A. Classroom, multipurpose room or auditorium.
   - B. Overhead projector and screen.
   - C. VCR and monitor(s).
3. Publicize the Workshop to area schools.
   INSPIRE will provide school addresses and addresses of INSPIRE participants in your area.
   INSPIRE will also provide flyers, envelopes and stamps.
   Suggested workshop hours are from 9:00 AM to 5:00 PM with breaks between one hour sessions and a lunch break.
4. OPTIONAL: Provide refreshments on the day of the Workshop.

An INSPIRE Workshop host application have been provided with this issue of the *Journal* to those who requested one. If you would like an application or more information, please contact Bill Pine at the address shown on Page 2.

Special Observation Schedule - MODIFIED

The schedule for special observations described in the last issue of the *Journal* has been modified and extended. The revised schedule is:

Saturday, June 24	2:00 - 2:30 PM EDT
Saturday, June 24	8:00 - 8:30 PM EDT
Saturday, September 23	2:00 - 2:30 PM EDT
Saturday, September 23	8:00 - 8:30 PM EDT

Note that the sessions have been reduced to 30 minutes in length. Use one side of a 60 minute tape for each session. Put a time mark on the tape on the hour at the beginning of each tape and a time mark every 5 minutes until the end of the session. Send tapes to Bill Pine at the address on Page 2.

Receiver Kits Available Now:

INSPIRE RS4 receiver kits are now in stock and available for immediate delivery. Please use the INSPIRE order form on the last page of the *Journal.*

Free Data Analysis Available:

Chaffey High School is offering free data analysis to all INSPIRE participants. Just send your data tapes and logs to Bill Pine at the address listed on Page 2. Include any notes or comments that will help the analysts provide what you want. A written report complete with spectrograms will be sent. If you want your tapes returned, please include an envelope with the appropriate postage. Estimated turnaround time is 3-4 weeks. Please use this opportunity to find out how your receiver is working so that you can be ready for future data taking opportunities.

Data may be recorded at any time. If you follow the "Special Observation Schedule - MODIFIED" listed at the top of this page, your data will be included in a report in the *Journal*.

INSPIRE Is Now on World Wide Web:

The INSPIRE home page URL is:

http://www.gsfc.nasa.gov/education/inspire/inspire.html

INTERBALL-MIR-INSPIRE AGREEMENT

OBJECTIVES OF PROJECT

INTERBALL is a Russian space physics program to investigate the physics of magnetosphere processes. It has two satellites, Tail Probe and Auroral Probe. Each probe has a subsatellite. MIR is the Russian space station, currently in orbit. INSPIRE is a project to interest students in science and technology by making it possible for them to observe very low frequency (VLF, 3 to 30 kHz) radio waves. INTERBALL-MIR-INSPIRE (INTERMI) is a planned joint IKI/INSPIRE space physics research project, based on the Mir-INTERBALL program which is planned to start after the Tail Probe launch in June 1995. INTERMI will perform coordinated activities of MIR, INTERBALL, and INSPIRE.

The scientific objectives of MIR-INTERBALL are to:

- Study the interactions between the ionospheric plasma and the injected plasma and electrons.
- Understand the dynamics of the injected, artificial plasma in the ionosphere
- Investigate the initial phase of plasma instabilities, the resulting electromagnetic emissions and their propagation in the ionosphere, magnetosphere, and atmosphere
- Investigate effects of wave particle interactions

INSPIRE is a scientific/educational project to bring the excitement of observing natural and manmade VLF radio waves to students. Underlying this objective is the conviction that science and technology are the underpinnings of our modern society and that only with an understanding of science and technology can people make correct decisions in their lives, public, professional, and private. Stimulating students to learn and understand science and technology is key to them fulfilling their potential in the best interests of our society. INSPIRE also is an innovative, unique opportunity for students to actively gather data for basic research projects, such as INTERMI.

DESCRIPTION OF INTERMI EXPERIMENTS

Ariel and Istochnik instrumentation on the MIR station will inject plasma clouds and beams of electrons into the ionospheric plasma. Experiments will be performed to determine the effects of the injection angle with respect to the earth's magnetic field lines. Using plasma and wave instruments of the INTERBALL project and the observations of the VLF radio waves on the ground from the INSPIRE project, the scientific objectives listed above will be met.

INSTRUMENTATION DESCRIPTION

An electron gun (Istochnik) and plasma pulse generators (Ariel) have been installed on the KVANT module of MIR. Istochnik and Ariel are now being used in conjunction with the Freja satellite. In mid-June the Space Shuttle is to dock with MIR, and it is proposed that Istochnik and Ariel be operated after the docking. The INTERMI project will plan injector operations in June over the US, so that INSPIRE participants can attempt to receive the VLF waves that may propagate to the ground.

Details of the MIR instrumentation are given in Annex 1, INTERBALL instrumentation in Annex 2, and INSPIRE instrumentation in Annex 3.

SCHEDULE

Item	Planned Date
Launch of STS-71	May 24, 1995
Shuttle docking with MIR	Late May, 1995
Launch of the Tail Probe and its subsatellite	June 8, 1995
First period of MIR-INSPIRE operations	June 15-30, 1995
Possible meeting to discuss MIR-INSPIRE results	August/September 1995
Second period of MIR-INSPIRE operations	October 1995
Third period of MIR- INSPIRE operations	To be determined
Launch of the Auroral Probe and its subsatellite	March/April 1996

AGREEMENT

IKI and INSPIRE will make their best efforts to fulfill their obligations under this agreement, recognizing that resources to meet them may not be available.

The following factors will be taken into account for selecting time periods of the experiment operations:

- The MIR station must be above the US or on a magnetic field line in the southern hemisphere that passes through the US.

- Experiments will be preferably performed during the day.

- Experiments should be performed during undisturbed conditions in the ionosphere.

- The time schedule of the other global geophysical projects, e.g. the International Geophysical Calendar's Regular World Day (RWD), Regular Geophysical Day (RGD) and Incoherent Scatter Coordinated Observation Day, will be considered.

IKI will:

- Schedule experiment operations as early as possible.

- Inform INSPIRE of the experiment operations, as soon as they are scheduled, by electronic mail, including the Universal Time, geographic latitude, and geographic longitude of the start and stop times. If possible, plots of the orbit during operations will be sent by facsimile.

- Report the start and stop times of actual experiment operations to INSPIRE.

INSPIRE will:

- Publicize INTERMI in the INSPIRE Journal and elsewhere, and recruit INSPIRE observers.

- Notify INSPIRE observers of upcoming experiment operations.

- Provide selected recordings of INSPIRE observations during experiment operations to IKI.

A. A. Galeev Director, IKI	W. W. L. Taylor President, INSPIRE
S. I. Klimov Project Scientist	W. E. Pine Secretary/Treasurer, INSPIRE

Annex 1. MIR Instrumentation

The main technical parameters of Ariel and Istochnik are given below.

Ariel (Plasma pulse generator)	
Power consumption	130 watts
Maximum current	10 amperes
Pulse duration	10 E-4 seconds
Pulse repetition frequency	10 seconds
Source material	BaCl
Discharge channels:	
Electromagnetic channel (-Y axis)	
Ejection velocity	15 kilometers per second
Number of Ba ions in pulse	10 E 18
Total number of Ba ions	>10 E 19
Electron temperature	2-3 eV
Specific ionization	10%
Plasma density in jet	10 E 18 per cubic cm
Jet divergence	30 degrees
Thermal channel (+Z axis)	
Ejection velocity	3 kilometers per second
Number of Ba ions in pulse	5 x 10 E 18
Electron temperature	1-2 eV
Specific ionization	10%
Plasma density in jet	5 x 10 E 18 per cubic cm
Jet divergence	70 degrees
Istochnik (Electron gun)	
Electron energy	10 keV
Pulse duration	4 microseconds
Pulse current	0.7 amperes
Pulse frequency	10,140 and 1000 Hz

The experiment will be performed when the electron beam plasma blobs can be injected approximately along or perpendicular to the earth's magnetic field. There are three modes of operation of the instruments. The first two have different sequences of alternating plasma injections between the electromagnetic channel (-Y axis, approximately perpendicular to the magnetic field) and the thermal channel (+Z axis, approximately parallel to the magnetic field. The third mode, using the electron gun, will probably be the most likely to be observed on the ground. The pulsing frequency of 1000 Hz will generate plasma waves at 1000 Hz and its harmonics (2000 Hz, 3000 Hz, etc. . .). The harmonics are in the pass band of the INSPIRE VLF receiver.

Annex 2. INTERBALL Instrumentation

TAIL PROBE AND SUBSATELLITE SPACE PHYSICS INSTRUMENTS

Electromagnetic fields and waves	0 to 1.5 MHz
Particles	
Electrons	.01 to 400 keV
Protons	0 to 1000 keV
Ions	0 to 100 keV/Q
Xrays	2 to 200 keV

AURORAL PROBE AND SUBSATELLITE SPACE PHYSICS INSTRUMENTS

Electromagnetic fields and waves	0 to 240 kHz
Ion beam source	1 to 10 microamperes
Particles	
Electrons	0 to 400 keV
Protons	0 to 350 MeV
Ions	0 to 500 keV/Q
Optical	
Auroral emissions	130 to 160 nm
Xrays	2 to 200 KeV

Annex 3. INSPIRE Instrumentation

The VLF or INSPIRE receivers are high input impedance, band limited audio amplifiers with electric field (whip or long wire) antennas. They are sensitive to frequencies from about 3 kHz to 15 kHz. The lower frequency cutoff is to reduce the effects of noise from power lines, both the fundamental frequency (60 Hz in the US) and its harmonics (120 Hz, 180 Hz, . . .). The upper frequency cutoff is to reduce noise from man made radio transmitters. Other receiver/antenna combinations are also in use, such as the magnetic field antenna/receiver designed for the ACTIVE project. Data from the VLF receivers is recorded with a portable tape recorder. Time announcements or recordings of WWV (the US time standard short-wave radio station) provide coarse (within a few seconds) timing. More accurate timing can be achieved using the signals of the OMEGA (the 10 to 15 kHz radionavigation beacons which are recorded with the data on the tape) stations. Some information can be achieved by listening to the tape, but the best way to analyze the data is by making spectrograms from the data. Spectrograms are frequency time plots of the data, with intensities, at a frequency and time coded as colors in the z axis of the plot.

VLF Observations in Croatia

By Zeljko Andreic
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Croatia is a European country. It is located in the south eastern part of Europe, on the eastern coast of the Adriatic Sea. It borders with Italy, Slovenia, Hungary, Serbia and Bosnia. It is independent since 1990, after the breakdown of the Communistic regime in the former Yugoslavia. Unfortunately, the breakdown was very violent and a part of the country is still occupied by Serbian forces. Croatia has an area of 56,538 square kilometers, and about 4,600,000 inhabitants. The capitol of Croatia is the city of Zagreb with about 1,000,000 inhabitants. Amateur astronomy has a long tradition and has survived all the hardships of our time. Most amateurs are pupils and students and some astronomical activities in the schools are supported by the state. There are also about a dozen amateur astronomical societies scattered all over the country. The two most active are the Amateur Astronomical Society of Zagreb and the Visnjan Astronomical Society, both formed around public observatories in their cities.

I have been active in amateur activities for almost 20 years. I have worked with the Visnjan summer school of astronomy since it was organized 6 years ago. Meteors were always one of the main topics covered by this school and I entered the VLF world after I saw an article about possible VLF emissions from bright meteors in "Sky and Telescope" magazine (March 1992, p. 329-330). I built my first receiver using instructions from this article and during the 1992 Perseids I tested it. The receiver used a loop antenna and the output from the receiver was monitored by a chart recorder. The results were dubious.

The idea behind our work was to find whether bright meteors can produce VLF emissions. VLF emissions from very bright meteors, usually called fireballs, are known to exist, but, regardless of the extensive research in the past, our knowledge about them is not complete. Some theoretical done by the Russians indicates that the smallest bolides (meteoric fireballs) capable of producing VLF emissions are of about -9 stellar magnitude (about as bright as a first quarter moon!). We wanted to see whether we can detect some emissions from fainter bolides and bright meteors.

I soon built another, more sensitive, receiver and with the help of Korado Korlevic and others from Visnjan Observatory a new observing run was conducted during the Orionid meteor shower on the night of October 23, 1992. This time we observed from the Visnjan Observatory which is as quiet as it can be in the whole region. It is a few kilometers away from high voltage power lines and the nearest houses, yet there is a strong building with 220 V AC electricity connected to it by an underground cable. The strong interference from nearby thunderstorms (about 100 kilometers away) prevented us from obtaining any usable data. The radio observations were carried out simultaneously with the visual observation of meteors. The experience gathered in this observing run was used to improve the receiver and we repeated the observations during the Geminids on the night of December 13, 1992. We found no positive coincidence of visual observations and radio signals. The results were published in the Journal of the International Meteor Organization (Volume 21 number 2 page 69-71). This article had stirred a lot of discussion on the pages of IMO magazine with the positive effect of increased interest in the possible VLF emissions from meteors. It has also pointed out one serious mistake we made: the sensitivity of the loop antenna was incorrectly measured and the diagram published in the aforementioned article is wrong. The diagram should be rotated by 90 degrees to represent the actual sensitivity of the antenna.

A lot of effort was put into the new receiving scheme by the Visnjan Observatory. The idea was to catch and digitize the receiver signals with the help of a PC compatible and a Soundblaster card. Everything was ready for the big Perseid show of 1993, but bad weather prevented any testing of the equipment before the Perseids maximum on the night of August 12, 1993. That night was the first clear night after a week of clouds and thunderstorms and we had a remarkable visual show of Perseids. But, due to a bad battery connection, our radio equipment blew out , and we got no data. After that disaster all our receivers have a graetz rectifying circuit behind the battery connectors so connecting the battery in any possible way results in normal operation of the receiver. I strongly suggest using such a protective measure on any equipment which has to be connected to a power supply in the dark!

In the meantime, Visnjan Observatory made strong connections with the IMO (International Meteor Observers). They showed interest in the VLF work and we soon started cooperating with Paul Roggeman from IMO. I have built another, more sensitive, receiver and, with past experience, decided to test it with the headphones first. The test run was conducted during the 1994 Perseids and, although we had clear weather locally, strong thunderstorms over Italy and Slovenia at a distance of about 200 kilometers produced so much interference that we were not able to hear anything else. In the rare quiet moments OMEGA navigation signals were clearly heard but we had to discontinue the work after a few strong discharges almost blew my ears up. I had to visit my doctor afterwards, so another lesson learned was to use a power limiter even with the headphones! The cooperation with IMO will be continued and we were encouraged to learn about INSPIRE on the WWW (World Wide Web). I contacted INSPIRE by e-mail and soon a strong correspondence with Bill Pine was alive on the Internet. INSPIRE donated a printed circuit board and instructions for building the RS4 receiver and I am now testing it. We are planning to use the RS4 receiver for our work thus saving a lot of time that we would have to put into developing a receiver and data reduction procedures. Since our observers will be well placed, I am also trying to organize an INSPIRE observing session for the Italian tethered satellite experiment.

Spectrogram 2.2: A Data Analysis Program for Microsoft Windows

by Gregory Walker
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In the fall of 1994 I had the opportunity to help test a new program for creating spectrograms (also called sonograms) on a PC-compatible computer running Microsoft Windows 3.1. The program was written by Richard Horne, whose e-mail address is **rshorne@delphi.com.** Over the months of testing, I watched the program grow into a better data analysis tool than any I have seen for PC-compatible computers. In the spirit of generosity that makes hobby computing so rewarding, Richard has given away his program as "freeware," meaning that it can be distributed and used without charge.

The Spectrogram 2.2 has a number of features that make it useful for analyzing Project INSPIRE tapes:

1. Plots frequency versus time in color or 256-level gray-scale.
2. Can save the spectrogram plot as a Windows BMP file for printing.
3. Uses integer FFT for quick analysis on inexpensive processors.
4. Can handle any size input file in Windows WAV format.
5. Runs on a 386 with 4 Megabytes of memory.
6. Ability to record using an installed Windows sound card.

Spectrogram 2.2 is particularly easy to install: simply copy all files from the distribution diskette into a convenient directory, such as **c:\gram**. The program can be run by simply double-clicking on the file **gram.exe** in the Windows File Manager. There is also the program **longram.exe** in the same directory. It is used to display a longer segment of data at one time. The file **aareadme.txt** gives a quick introduction to using Spectrogram. The file **readme.txt** is the complete manual for the program.

When Spectrogram 2.2 starts up, you will see the program window looking like Figure 1.0. The File menu is where you start most operations of the program. When you open an input file, such as **sample.wav**, which is the first 20 seconds of Mike Mideke's whistler sample tape, a second control panel like Figure 2 will appear. It shows the resolution and sample rate of the input file and also the parameters the define the spectrogram. Clicking on the button labeled "gray scale" gives spectrograms much like those produced on the Macintosh.

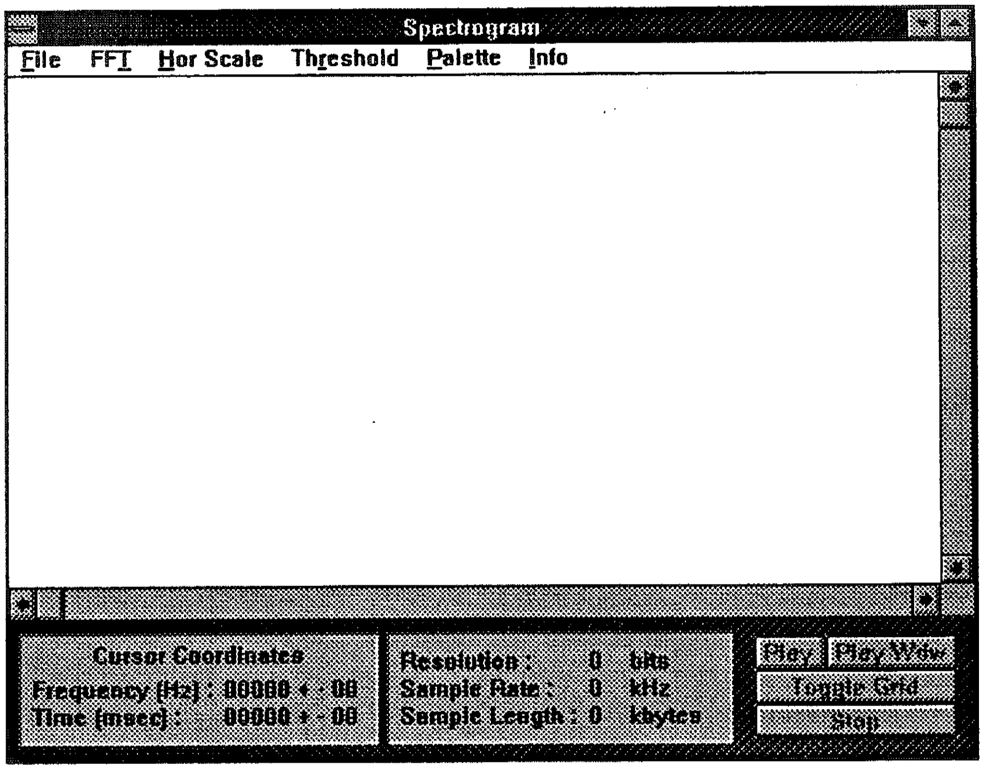

Figure 1: Spectrogram 2.02 Main Window.

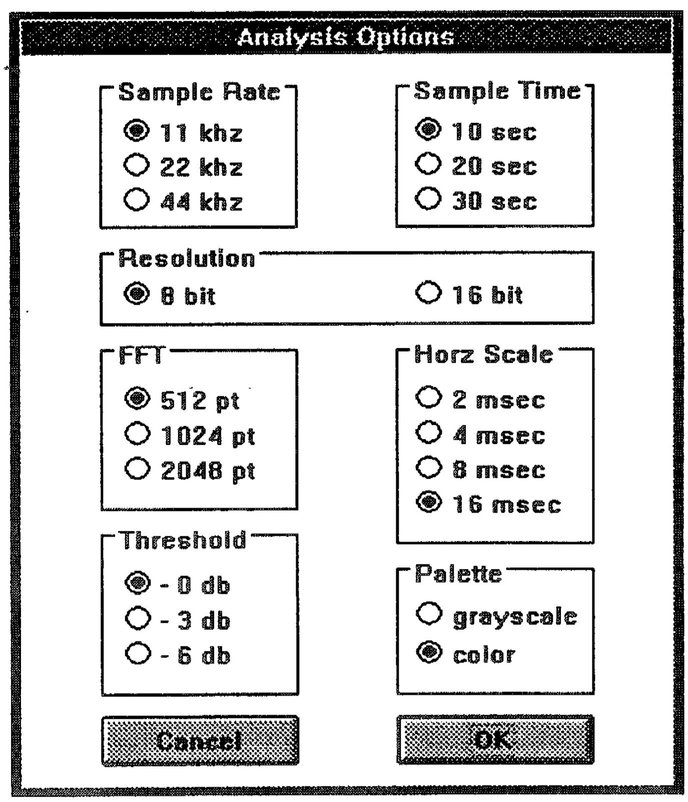

Figure 2: File Open Control Panel.

You can save a Windows bitmap (picture file) of the spectrogram that you see by selecting the Save Bitmap entry in the File menu. The bitmap file can then be viewed at a later date, printed out, or included in a word-processor document such as this. Unfortunately, it can only save a bitmap for the portion of the spectrogram that is displayed on the screen at one time. The program **longram.exe** is useful for showing more of the recorded sample at one time. Figure 3 shows a spectrogram of the entire 60 second whistler sample from Mike Mideke's sample tape. I have included the grid marks to show the time and frequency scales.

Spectrogram 2.2 will record a sound file from any sound card that has been installed under Windows 3.1. One limitation is that it can only record a sample length of either 10, 20, or 30 seconds. If you need to record more than 30 seconds of sound at one time, you will need to use the recording program that came with your sound card. The top of the spectrogram display makes it easy to set the proper playback volume on your tape player. Just record for 10 seconds and look at the waveform part of the displayed spectrogram. The central all-black area should only reach a little more than half-way from the center of the display to its edge whenever a whistler or other non-lightning signal is heard. The spikes that represent lightning can go all the way to the top or bottom of waveform display, but the main body of the waveform should never touch the edges.

In summary, Spectrogram 2.2 provides an easy, but powerful tool for data analysis of Project Inspire tapes. Since it can be freely distributed, there is no reason every member of Project Inspire with a PC running Windows cannot be using this program to analyze the data tapes. Use it, enjoy it, and pass it on. If you like it as much as I do and you have a computer account for sending e-mail, send a letter of thanks to Richard Horne at **rshorne@delphi.com**.

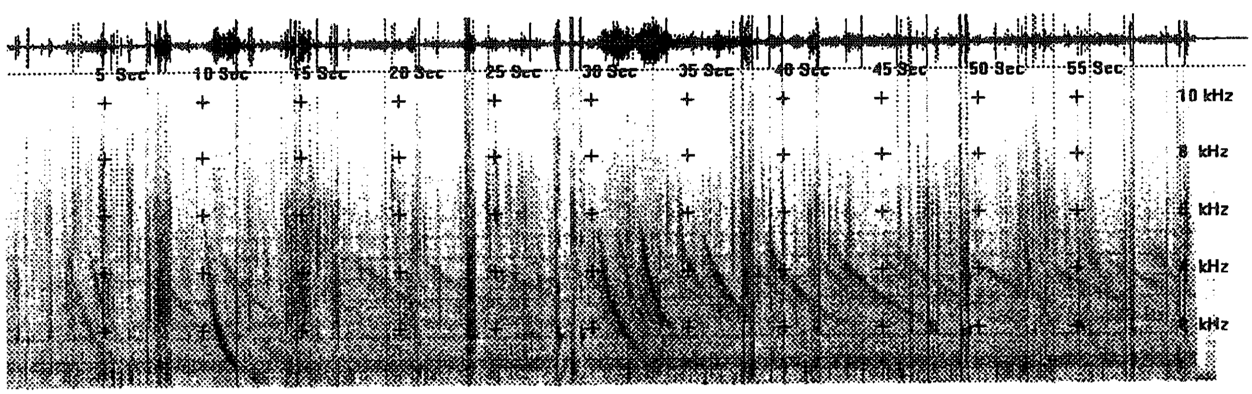

Figure 3: Entire 60 second whistler sample from Mike Mideke's tape, displayed by longram.exe on 1024 x 768 display.

Space Bang and Natural Radio Phenomena

by Flavio Gori, Florence, Italy,
INSPIRE European Coordinator

As we wrote in another volume of this *Journal*, the Italian teams for Natural Radio worked on 10 May, 1994, for the Eclipse and soon after that phenomenon, they became the organization for the recording sessions dedicated to the Space Collision between Jupiter and the Shoemaker-Levy comet, forecast for the middle of July 1994.

The same people who worked on the Eclipse also worked on the comet collision, but we had some more friends involved in the natural radio range. Though they were not equipped with VLF receivers, they worked with their HF-VHF-UHF receivers, thinking that the very big release of electromagnetic waves from the impact should be able to stimulate in many ranges of frequency.

We all know that Jupiter emits, naturally, in the 18-28 MHz range and other people were planning to record that range, so we planned to listen and record (in addition to the VLF range) at 10, 20, 40, 72, and 115.2 Mhz. In the last range, we have a VOR at the local airport here in Florence. At 10 and 20 Mhz, as you well know, we can hear some time signal stations (WWV). In the other ranges we usually can't hear anything. So we expected to hear any change in signal strength, increase in noise or something else at the time of some of the crashes.

Marco Ibridi, Fabio Courmoz, Silvio Bernocco and I were recording the VLF waves: Marco near Bologna in the central-north; Courmoz in the Aosta Valley in the north-west; Bernocco near Torino in the north-west and I in the High Val Badia in the Dolomiti Mountains in the north-east of Italy. (See Figure 1.)

We decided to record from 15 to 20 July covering the day before the collisions and some days in the collision time. We hoped to verify if the collisions could cause some change in electromagnetic propagation and to see if we could catch it. The times were 17.00 to 18.00 UTC. Everybody in the net did record 15 minutes (17.00 to 17.15 and so on), both VLF and the shorter waves. When we found out that the two main events were to occur on 18 July at 19.30 and 20 July at 20.00, we decided to cover those collisions too.

In the shorter wavelengths, our friends at work were Francesco Stumpo at Bologna, Lorenzo Fano in Trieste and Nader Javaheri in Florence. (See Figure 1.) *INSPIRE Journal* readers know that the Italian meteo-seismic net has worked with us since the time of the Eclipse. Again in July they could monitor the radio activity. Roberto Pozzo, chief of the net, and Alessandro Arrighi of Empoli, near Florence, were able to record in the VLF for the first time using their WR-3 receiver.

These friends have all kept their tapes and only Courmoz has been able to send me his first impressions about the sessions. He recorded using his station (RS4 modified by himself, Sanyo recorder) in a place near his site during the Eclipse time. As happened to me and Pozzo, Fabio was hit by severe weather conditions (not common here in Italy in July) and his recording tapes show many sferic (as do ours). At the moment, we cannot say anything about the Jupiter action from our tapes, though we believe it should be unlikely that we could hear anything with this much atmospheric noise.

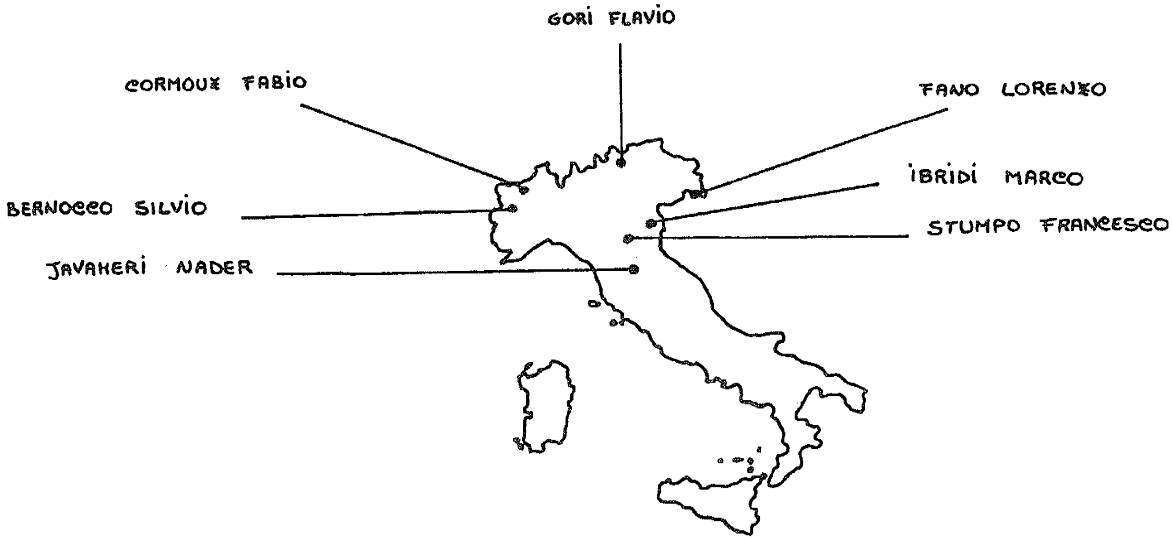

Figure 1. Italian INSPIRE Station Positions During the Space Collision, in July, 1994.

Map by Edy Palazzeschi

While Fabio Courmoz was able to finish his job as scheduled, I was not, since the very bad weather forced me to record in some other ranges: one lower (150 kHz) and one higher (70 Mhz), trying to avoid the big noise. It was not a success.

Lorenzo Fano in Trieste, north-east Italy, very close to the ex-Yugoslavia countries, had the same weather problems and decided to record in the 42 Mhz region. Only during the 07/19/94 session was he able to record the 20 Mhz region and he did catch a strange S.I.S. at 19550.0 kHz in the night during one bang. Was this from the space collision? We don't know.

Marco Ibridi with his AE software (about which I wrote in the November 1994 issue of the *Journal*) is still working over his tapes, trying to understand what he did record.

In the higher frequencies nobody recorded anything strange during the sessions. No S.I.S., no rumors, nothing changed. But, I wonder, are we able to monitor and understand that kind of signal coming from space collisions? Frankly, I do not think so. The reason that we can't find anything on our tapes is probably that we don't know what to look for. Is it wrong to admit this? Anyway, our works go on, hoping to get better.

In the middle of August our net was again in the field to record three nights (9-10-11 August) in coordination with the S. Lorenzo night, with its stars "coming down". That job is still under control but, as happened during the past three years, we probably did not find any connection with this phenomena. Often we did find other strange things in the VLF range. Of course we can't always expect to hear interesting things to give more "salt" to our research, but it did happen in this case.

In 1994 we had many jobs to do, but not all of them had wonderful results for us and our curiosity. The lack of results probably comes from the lack of "real" signals that we are looking for. We believe that our technical "weak link" is the portable recorder that creates so much noise in the receiver and recording station, with its nonmetallic box. Of course, our worst problem is the lack of knowledge about the VLF/ULF propagation and the related physics phenomena. We are still working on these areas, trying to get better.

Fortunately, a professional researcher, Dr. Luigi Ciraolo of the I.R.O.E. (Electro-magnetic Waves Research Institute) in Florence, involved in the study of electromagnetic waves for the Italian Council of Research, seems to be interested in our amateur work. After some hours of discussion about what we are doing and what we need and some months of work he introduced us to a software program he wrote that is able to deal with VLF signals coming from a receiver in real time or from tapes. This program is able to define a threshold by which we can decide what kind of signals to let go in or out, specifying an upper and lower frequency value. In theory (while we did not work it this way now) we could in the future record our VLF/ULF sessions simple in our home, without going out in the winter night to a quiet site for recording. That does not sound bad. Moreover (and just as in a dream), we could record directly to the PC disk. The whole session could not be recorded on disk as too many bytes would be required, but some signals that we could define by software with a big savings of memory. Again, not bad, though we think that this kind of results is not easy to get in the near future. Anyway, the threshold itself can save so much memory space on the disk.

That work is going on and we meet with Dr. Ciraolo al least one time per week to coordinate his work with our needs in VLF recording and data storage. At this time (end of February 1995) Dr. Ciraolo has produced four software releases including two for low resolution. This software uses a digital interface to display signals of natural radio on a portable PC like the Compaq LTE/LITE 386 that I use. There is no need for an audio card like SoundBlaster.

Using a very small external interface it can do a good job displaying, recording and reproducing the digital signals from 0 to 10 kHz. Using our Compaq during the sessions we are able to see the sferics, tweeks and whistlers directly on the PC screen at the moment they are coming in. Great.

In the past years, Dr. Ciraolo, with his colleagues Cesidio Bianchi and Carlo Scotto in the National Institute for Geophysical Study in Rome, has monitored the OMEGA signals (10-14 kHz). They have been recording phase and amplitude of signals transmitted by the stations of Norway, Liberia and La Reunion. the receiving stations are equipped with a multifrequency software receiver that is useful for investigating the lower ionosphere. I am really fascinated by this study and I hope to place something similar (maybe just for one OMEGA channel) in my home, which now resembles a small electro-magnetic laboratory. We could monitor VLF propagation from 10.2 kHz down to 100 Hz for some months, maybe years, collecting a lot of information that may be useful for more than one subject.

In our next report in the next *Journal*, we will update you.

ABBOTSFORD, WISCONSIN JR.-SR. HIGH SCHOOL

REPORT ON SPRING, 1995 INSPIRE ACTIVITIES

By Mike Schoenfuss (N9GHZ), Advisor
Abbotsford, Wis. High School INSPIRE Team

Preparations for the INSPIRE Spring, 1995, coordinated VLF observation/recording session began at Abbotsford Jr.-Sr. High School the week of March 13th-17th. During that week, in-class instruction was provided.

The first day covered the history of the INSPIRE program as well as electromagnetic radiation, radio wave and radio propagation basic theory. The next day the students listened to sample recordings of various different natural and man-made VLF emissions. On the third day, they practiced setting up and operating the equipment to be used and learned about the use of UTC time.

After a cold and snowy start to March, it looked like we were going to get an early Spring here in Wisconsin this year, as temperatures soared into the 50's and 60's towards the middle of the month, melting most of the snow that was still hanging around. I was hopeful the weather would hold through Saturday, March 18th, the date of the coordinated VLF observation and recording activities, and even after they forecast a chance of snow and colder for that day, I held out some hope that they might just be wrong.

Plans called for taking two groups of Physics class students(Seniors) out for the recording sessions, one group for the 1800-1900 UTC session and the other for the 2200-2300 UTC session. We did warn the students to dress warmly.

The morning of the 18th was overcast, but otherwise didn't seem too bad, and as we left the high school in the school van for our site on Lake 19 Road in the Chequamegon National Forest northwest of Medford, there was not a single snowflake to be seen.

About 10-15 miles down the road, however, things changed pretty quickly, and by the time we reached our site, a 45-minute drive from Abbotsford, the road was completely covered with snow. Fortunately, I did prepare for the worst, and had plastic wrap covers for all of the equipment, to prevent it from getting covered with snow and getting wet.

Despite the gloomy weather, the first team completed the entire hour of recording and the second team also made it up to the site and put in their full hour. Both teams were treated to a stop at McDonald's in Medford on the way back home.

Figure 1. Pictured above are students from the 1994-95 Physics Class (all Seniors) at Abbotsford, Wis. High School, who participated in the coordinated INSPIRE VLF monitoring/recording session on Saturday, 3/18/95 for the 1800-1900 UTC time period. The location is the Chequamegon National Forest, northwest of Medford, Wis. The big white blobs in the picture are falling snowflakes (note the plastic wrap in place over the equipment). Pictured(l-r) are: Chris Sipiorski, Ryan LaSee, Renee Gonshorowski, Eric Olson, Jessie Schultz, instructor LaVerne Harrison, Andy Melvin, Ed Schmollinger and Adam Conrad.

The following week saw the students back in class, working on assembling electronics projects kits and learning about proper soldering techniques, electronic components and some basic electronics theory. One of the two kits assembled by the Physics class was the Baker Development Co. AD12-X1 analog/digital audio analysis card for the IBM PC. In the future, it will give us here at Abbotsford the ability to do some of our own data analysis.

Classes participating in this Spring's INSPIRE activities included the Senior High Physics class instructed by LaVerne Harrison, and 2 blocks of 7th Grade science instructed by Eric Elmhorst. Students in the Physics class include: Scott Griesbach, Ed Schmollinger, Leah Richardson, Chris Sipiorski, Missy Schraufnagel, Janeen Bollech, Renee Gonshorowski, Tracy Nelson, Martin Shaw, Jessie Schultz, Adam Conrad, Eric Olson, Ryan LaSee and Andy Melvin.

Figure 2. It has become tradition at Abbotsford, Wis. Jr.-Sr. High School to include, as part of the annual INSPIRE Project activities, the assembling of an electronic project kit(s). This enables the students to learn proper soldering techniques and a little about basic electronic circuitry and components. Pictured in the foreground above, assembling one of the kits, are (l-r): Missy Schraufnagel, Leah Richardson and Janeen Bollech. Pictured in the background, assembling the Baker Development Co. AD12-X1 analog/digital audio analysis card for the IBM PC, are (l-r): Scott Griesbach, Ryan LaSee and Eric Olson. All are students in LaVerne Harrison's 1994-95 Physics class.

As this article was being written, plans still called for a field trip out to the monitoring site for a group of 7th grade students and their teacher, on Saturday, April 1st. Before the school year is out, it is also hoped that the AD12-X1 will have been calibrated and students(and teachers) given a chance to become familiar with its use.

ABBOTSFORD HIGH SCHOOL RECEIVES GRANT FOR PROJECT INSPIRE EQUIPMENT

By Mike Schoenfuss (N9GHZ), Advisor
Abbotsford, Wis. High School INSPIRE Team

Thanks to a generous $100.00 grant from local business All Metal Stamping, Inc. of Abbotsford, Wis., and its owner, Jack LaSee, Abbotsford Jr.-Sr. High School was able to procure the Baker Development Co. AD12-X1 analog/digital audio analysis card for the IBM PC.

The card was purchased in kit form and was assembled by members of LaVerne Harrison's 1994-95 Physics class(Seniors) in March. As of this writing, it has been installed in the PC but has yet to be calibrated and tested. Faculty members and students will hopefully soon become proficient in its use, which will result in expanded INSPIRE activities at the school.

A TEST FOR STUDENTS INVOLVED IN PROJECT INSPIRE ACTIVITIES

By Mike Schoenfuss(N9GHZ), Advisor
Abbotsford, Wis. High School INSPIRE Team

This school year, for the first time since I first became involved in Project INSPIRE activities with my local high school, I was requested by one of the teachers I work with to come up with a written test(quiz) that he could administer to his students as part of their involvement in the project.

The test would serve a two-fold purpose. It would help to measure how well students were paying attention to and picking up on the theory behind Project INSPIRE studies, and it would provide actual "points" towards the student's final grade for the class.

What I came up with was a 10-question test/quiz using both fill-in-the-blank and multiple choice questions. I assigned a point value to each answer with a total of 100 points possible, but point values could certainly be customized for individual applications. The test covers electromagnetic radiation, radio wave and radio propagation theory.

The test was administered by both the Senior High School Physics instructor and the 7th Grade science teacher. In both cases, they chose to give it as an "open notes" test, and to count the test as part of the students' grade for the class.

If any teachers out there are interested in having a copy of this test (and the answer key) I would be happy to make it available to them. Just send me an SASE with 35 cents postage. Or, if you have access to an IBM compatible PC and you prefer it, send me a 3.5" diskette (formatted low OR high density) and sufficient return postage, and I'll send you the actual disk files which you can easily edit as needed. The documents were created using Microsoft Windows Write.

My mailing address is: P.O. Box 401, Abbotsford, WI 54405-0401.

5 KHZ LPF FILTER MOD FOR THE INSPIRE RECEIVER

By Mike Dormann
Seattle, WA

I have used the INSPIRE receiver since I received it during the space shuttle experiment. It has worked without a hitch, and I have used it to record some very interesting signals, from Hawaii to Canada.

Most locations require a low pass filter between the receiver and the recorder (Radio Shack CTR-69) to keep the VLF/MLF from distorting the recordings. The filter that I normally use to reject out of band interference is made in a Danish Butter Cookie tin. My mother and mother-in-law buy these cookie tins in great quantities (the cookies taste good and the can has a good RF seal and takes solder well).

I measured the response of the INSPIRE receiver and decided that a little more filtering between the FET input transistor and the amplifying transistor would be a good place for increased filtering. I replaced the original inductor with three 25 mH toroids (125 turns wound on surplus bobbins) and added two .05 uF capacitors for the internal ladder connections, making a pseudo chebyshev 7-pole passive filter. I kept the filter impedance the same and kept the original circuit's input and output capacitors, rolling off the filter at about 5 kHz as my main interest is in recording tweek tails.

Figure 1 shows the modifications done to the receiver and Figure 2 plots the normalized original receiver response, the modified response with an intermediate 5-pole filter, and the as-built 7-pole filter, located between the first and second transistor stages.

Figure 3 shows a spectrogram of the modified receiver capturing a tweek on the 11th floor of the Waikiki Reef hotel (not all field trips require difficult journeys through mud and storms!). Figure 4 shows the time waveform of the Waikiki spectrogram. figure 5 and 6 show a time spectrogram and corresponding time waveform taken using the unmodified receiver a year earlier on the Kona Coast (filed trips are always good excuses to go to Hawaii!).

All in all, the modified filter does an adequate job of blocking the higher frequency hash from reaching the cassette recorder. If I do another mod, will another field trip be in order? Hmmmmmm, I've never been to Fiji .....

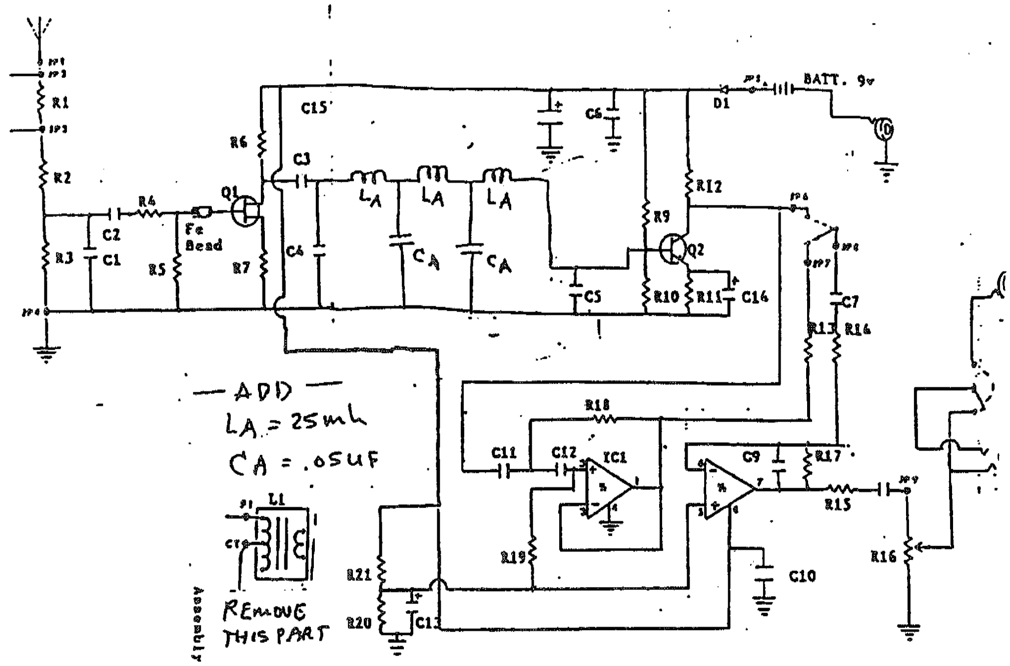

Figure 1. Receiver Modification

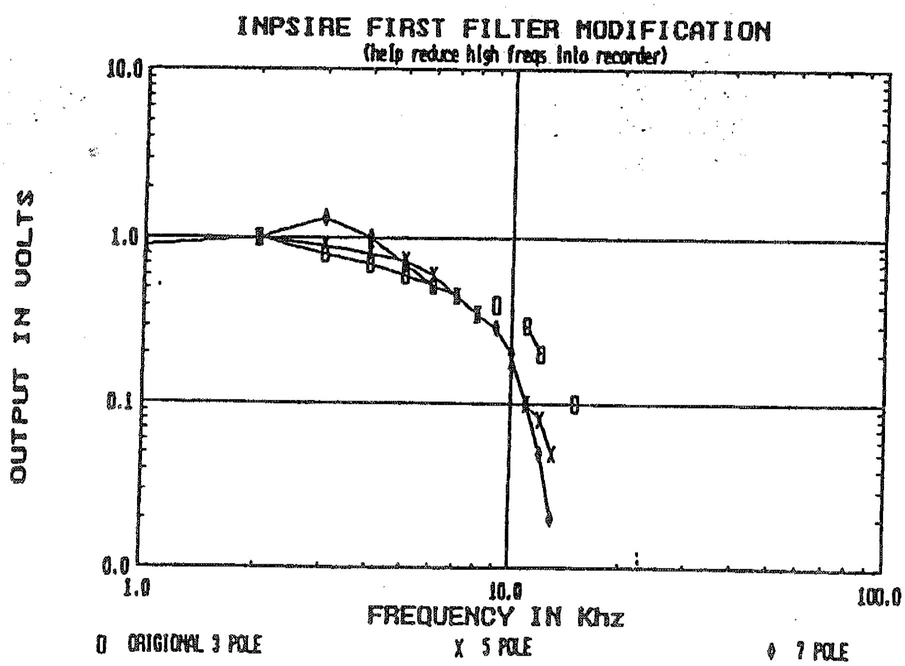

Figure 2. Plotted Response

Waikiki, Hawaii 9 Jan 1995, 04xxut

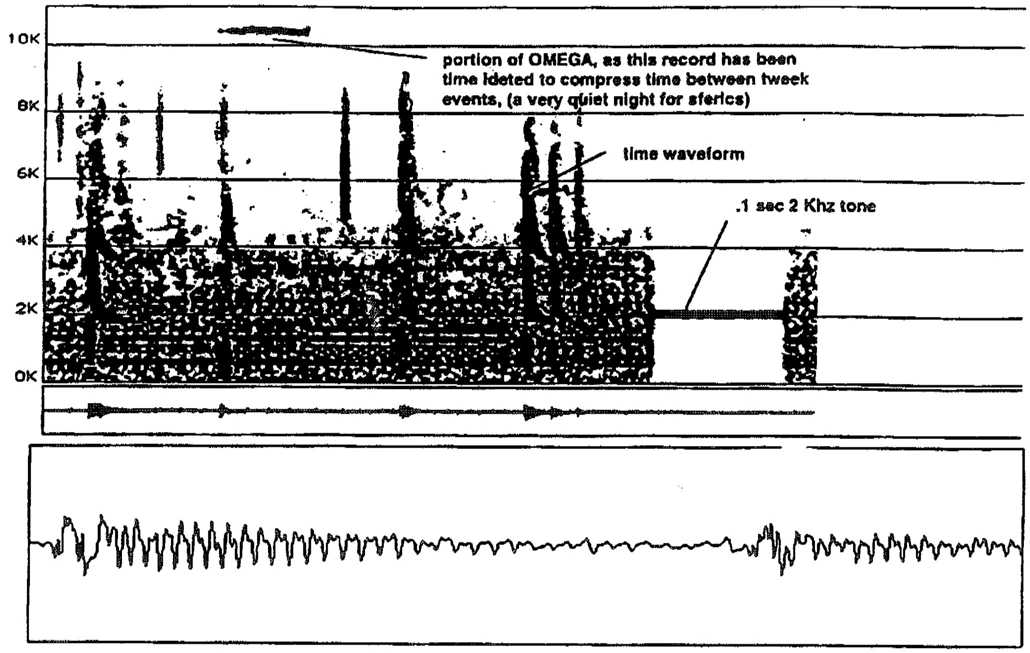

Figure 3, 4 Waikiki Plotted Recordings

Kona, Hawaii 12 Dec 1993, 04xxut

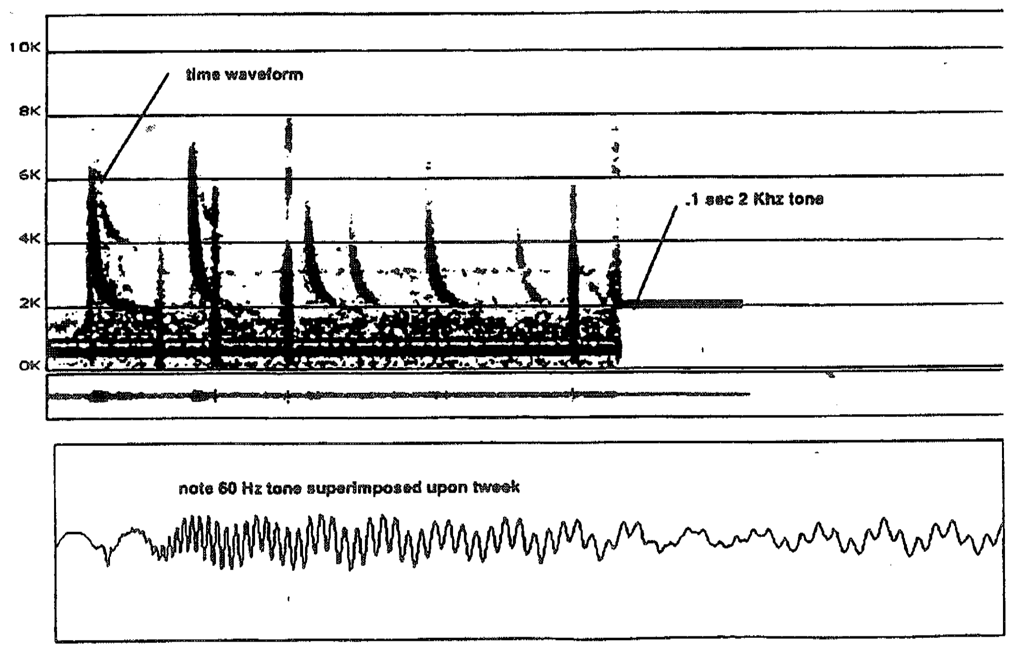

Figure 5, 6 Kona Coast Plotted Recordings

Spring Equinox VLF Monitoring

By Steve Ratzlaff
East Palo Alto, CA

For several years now I have been involved in VLF monitoring. I became interested in it mainly through Mike Mideke's articles in the hobby newsletter LOWDOWN. I have gradually refined my equipment and technique so that I can reliably set up my gear and make recordings. Finding a quiet place to listen is the hardest part. I have been planning my vacations around the equinoxes lately, when I go to my parents' place in northeast Oregon. They live near a National Forest and Boise Cascade timberland. Fifteen minutes driving from their home I can be at a decent listening site, about 4 miles from the nearest power line. At first I set up my large loop antenna within sight of the remote logging road and left it up for the week's listening. After being vandalized twice in two years, with the antenna taken down and removed, I learned that "out of sight" was the only solution to semi-permanent antenna installations. I now go 1/4 mile up a logging spur, out of sight of the "main" road. I have had no further problems with vandalism - knock on wood!

My equipment consists of a loop antenna, 147 feet in circumference, about 25 feet tall, mounted in a triangular configuration, feeding a remote preamp at the base. A feedline from the preamp connects to the receiver inside my car where I do the monitoring. I record on a Marantz PMD 201 monaural cassette recorder. The preamp and receiver were designed by me, based on the Stanford portable VLF receiver by Ev Paschal. I can switch high and low pass filters in or out as desired. For recording, the low pass filter must be switched in otherwise severe intermodulation distortion from the 10.2 kHz OMEGA occurs in the recorder. Using a loop antenna has the advantage that it can be erected in dense forest; a clear area is needed for an E-field receiver. In addition, rain does not produce precipitation static and resultant noise in the receiver.

I just spent a week in Oregon over the spring equinox. Here is a daily summary of what I heard. (I only went out in the morning before sunrise, not at sunset.)

<u>Monday</u>, 3/20/95, 1321 UT start (0521 a.m. PST)

> 62 whistlers noted in 60 minutes monitoring. Hiss emissions gradually increased until about 1350 UT to 1429 UT. Hiss was moderately loud, obscuring the weaker sferics. Mixed single- and double-hop whistlers noted at weak to faint levels. WWV propagation at 1345 UT: F84, A2, K1.

<u>Tuesday</u>, 3/21/95, the morning after the equinox, 1304 UT start

> Good tweek activity but only 6 whistlers noted in 47 minutes monitoring, all weak and single-hop. WWV propagation forecast F89, A2, K0.

Wednesday, 3/22/95, 1308 UT start

145 whistlers heard in 82 minutes, mostly single-hop. Some double whistlers were heard, about 0.3 seconds between them; some high pitched short whistlers followed 0.2 second later by longer lower pitched whistlers. All were weak. As sunrise approached, activity decreased and levels became faint. After sunrise (about 1400 UT) activity increased and also levels increased until about 1430 UT when everything pretty much disappeared. There were also hints of faint chorus around 1400 UT for several minutes. WWV propagation F90, A2, K2.

Thursday, 3/23/95. 1302 UT start

128 whistlers in 78 minutes were heard with most weak to faint except several medium to loud. Most were diffuse with a few purer-note whistlers heard. I heard no double whistlers this session. WWV propagation F94, A2, K2.

Friday, 3/24/95, 1300 UT start

86 whistlers in 65 minutes were heard. There were few tweeks and a very quiet background so even the faint whistlers could be heard. All were weak or faint, as usual, except for 2 medium level ones. Two main types were noted: double whistlers -- long, diffuse; and shorter, higher pitched, purer note single whistlers. On some of the double whistlers, the second whistlers would end in a warbly note. WWV propagation F94, A6, K1

Overall, this equinox did not offer very exciting activity. Quite a few whistlers were heard but levels were weak to faint. I've been pursuing a theory of my own that says VLF activity is related to the A index of the WWV propagation forecast, with levels of 10 and greater possibly indicating definite VLF activity. So far I've come to no definite conclusions one way or another, but all the A indices this Spring equinox were uniformly low, and VLF activity was also poor with weak levels heard. When I was home in Oregon for the Fall 1994 equinox conditions were quite different. I heard many medium to loud whistlers, whistler storms, and exciting chorus and emissions; in general what I would hope to hear during the start of an equinox. The WWV A indices ranges between 14-19 on some days when VLF activity was good, but also were 2-7 on other good activity days, proving nothing definite for my theory so far!

TAPESTRY Grant Supports The INSPIRE Project

By Bill Pine
Ontario, CA

Since the 1992 Space Shuttle mission, a need has grown in INSPIRE for data analysis capability. Software existed in the form of "SoundEdit" from Macromedia. The main problem was that the computer system required was a high-end Macintosh with a price tag of over $4000.

In the fall of 1993, I received the annual description of the TAPESTRY (Toyota's Appreciation Program for Teachers Reaching Youth) grant program that is funded by Toyota Motor Sales, USA and administered by the National Science Teachers Association. The grants are for up to $10,000 in the areas of physical science and environmental science. I had received these notices annually for the past few years and had always thought that $10,000 would be nice, but I had never had an idea around which to build a grant application ... until INSPIRE.

The grant application is fairly straight forward although a little tedious and repetitious. An important section of the application is the budget. Completing this section required an extensive shopping process. Starting with the software, SoundEdit, dictated the computer platform - Macintosh. My only experience with computers prior to that time had been with PCs. Some inquiries led me to select a Quadra system including a printer. Add in some computer upgrades, a couple of digital audio tape (DAT) recorders and a good quality tape recorder for the lab and I submitted a budget of $9978, well under the maximum.

The application was turned in January, 1994, and I was notified a few weeks later that I was one of the 40 recipients nationwide. In addition to feeling honored, I was about to find out how hard it is to spend $10,000 well.

Coincidentally, in January, 1994, Apple introduced its new line of PowerMacs. The description sounded really promising, but I was leery about buying a "new" technology. My shopping process returned to ground zero. With much help from some NASA folks back at Goddard Space Flight Center, I finally decided to go with the PowerMac system.

The next development surprised me: the PowerMac cost less than the Quadra - and has more computing power! The system I eventually bought was:

- PowerMac Teacher Solution Bundle
  - PowerMac 6100/60 AV
  - 14" color monitor with speakers
  - 500 Mb internal hard drive
  - 24 Mb RAM upgrade
  - Clarisworks software
- Laserwriter Select 360 600 dpi printer
- LaCie Tsunami 2 Gigabyte external hard drive

In addition to this, I purchased:

2 Sony TCDD7 portable DAT recorders
Marantz PMD 430 stereo tape recorder

The only problem was the timing. My system was not completely delivered until November, 1994. I had received the grant money at the NSTA convention in April and I had assumed that the system would be up and running by the start of the summer. I had planned to spend time during the summer working on my part of the eclipse data analysis. Instead, I spent Christmas vacation trying to get the system to work. Remember my reservations about getting involved with new technology? This experience was about as bad as I had feared. Nothing seemed to work quite right. Couple this with the fact that I had limited experience with Macs and perhaps you can understand my frustration.

One example: the SoundEdit software would not print spectrograms in high resolution mode. When attempting to do this (a seemingly simple procedure) I would get error messages sometimes and just a long wait with no results other times. After several calls to the technical support line (Techie: "Try this." Me: "Doesn't work." Techie: "Try that." Me: "Still nothing." Techie: "You don't have enough memory ... Bye.") I was getting nowhere. With 24 Mb of RAM, I could not accept that a memory shortage was the problem. After trying several versions of printer drivers with no luck, I settled on a plan.

I wrote a letter to the company and included a self addressed stamped envelope for their reply. I asked them to describe step-by-step how to print in high resolution. A couple of weeks later I found out two things: first, SoundEdit cannot print in high resolution; second, high tech companies do not like communicating by US mail. I was told to use email, fax, BBS, or the technical support line, but to never, ever write them a letter. So now you know how to get even with a high tech company: force them to deal with you in a low tech way!

A way around the printing problem had already been found thanks to one of my middle daughter's boyfriends, so at this point (end of January, 1995) I was finally ready to go. By this time I had also made another relevant discovery: during the school year I do not have enough time to listen to and analyze hours of VLF tapes. I finally found the time to finish up during spring break and as I write this (Easter Sunday, April 16!) the reports are ready and will be received by the (patient?) observers a few days before the first anniversary of Eclipse-94.

So how do I feel about this experience? Nothing but positive! The Toyota people are great and the NSTA people are equally so. The grant includes an expense paid trip to the NSTA convention and a nice dinner at which they present the grants. I had never spent more than a day at a convention before and it was a great experience. I plan to go to the NSTA convention in St. Louis next spring. I will be making a presentation on INSPIRE. I hope to see you there. And if you wonder if you should apply for a TAPESTRY grant - you should!

An Eclipse Data Sampler

By Bill Pine
Ontario, CA

The data tapes that were submitted for INSPIRE/Eclipse-94 have been received and preliminary analysis is complete. The original question that we hope to answer was: "What is the effect of the eclipse on the propagation of VLF natural radio waves?" As of this time, no definitive effect has been found. The natural radio conditions on the day of the eclipse were quite noisy in the US due in large part to a major thunderstorm system in north central Texas. Italian observers, while not near the eclipse track, also experienced noisy conditioned due to a large storm in northern Italy. If the eclipse were to produce subtle effects, they would be hard to detect in noisy conditions.

As the title of this article indicates, I would like to illustrate some of the natural radio phenomena that were recorded by INSPIRE observers. Before looking at some spectrograms, I would like to describe the process of data analysis. Since each analyst would have their own specific procedure, I will describe the procedure I used on the data submitted by teams 16-31 (as described in *The INSPIRE Journal*, Volume 3, Number 1, Pages 22-44).

The first step is to listen to the data tape while referring to the data log submitted by the observer. The counter on the tape recorder is zeroed at the start of the tape and counter readings are noted for each time mark and other event logged. Using counter readings makes it possible to quickly fast forward later to any desired position (time) on the data tape. While the tape is being monitored, notes are taken specifying good places for further analysis.

After listening to all of the data tapes, decisions were made on specific time segments to analyze. The decisions about what particular times would be selected were based on several criteria:

1. One segment on the eclipse tape was centered on the E-time.

2. Two other segments on the eclipse tape were selected, one before ("pre") the eclipse and one after ("post") the eclipse. These segments were chosen to try to illustrate interesting events on the tape.

3. Two segments on the supplemental tape were selected in a similar manner to the "pre" and "post" segments.

4. On the baseline tape, the segment was centered on the E-time.

The basic unit of time sampled for each segment was three minutes. This length of time was chosen for practical reasons: three minutes is the length of time that fits on the screen using SoundEdit software. Longer time periods can be recorded but it is necessary to scroll through the file. Also, a three minute sound file sampled at 44.1 kHz (the CD sampling rate) takes up 15 megabytes of memory. My computer has 24 Mb of RAM and a 2 gigabyte (2000 Mb) hard drive for storing files, so large files are no problem, but files much larger than 15 Mb would be cumbersome to handle.

Where possible, I tried to use intervals that start with a time mark so it would be possible for the observer to locate the appropriate position on the tape to review their data in conjunction with the spectrogram.

As the sound files were made for each three minute segment, any special events (whistlers, etc.) were noted. Further sound files were made of shorter intervals to take a closer look at the interesting parts. The additional files were 30 seconds in length and then perhaps 5 or 10 seconds.

Creating hard copy of the spectrograms was a bit of a challenge. It turns out that the print function of SoundEdit does not work in the high resolution mode (the mode required for our analysis). The method devised was to use the screen capture key combination of the Mac which copies the screen into a drawing-type file. That file then has to be converted to a paint file so the spectrogram can be trimmed from the screen image and then placed in the document to be printed.

Keeping track of all of the data from all of the teams was also a challenge. A folder was created for each team. The sound files placed in these folders were named using the following format (for example):

18 E pre 1500-1503

18:	team number		
E:	Tape identification:	E	eclipse
		S	supplemental
		B	baseline
pre:	segment identifier:	pre	pre-eclipse segment
		E	centered on the E-time
		post	post-eclipse
	(not used for S or B tapes)		
1500-1503	Time interval (UT)		

On the spectrogram, the frequency appears on the vertical axis. The software is able to record up to 22.05 kHz, but the area of interest to us is 10 kHz and below. I have selected a vertical scale with a maximum of 12 kHz so that some of the OMEGA lines are visible. The presence of OMEGA lines is a pretty good indicator that the receiver is working well. On rare occasions, OMEGA may be absent due to adverse propagation conditions for that frequency range.

The time scale is displayed across the top of the spectrogram. On the three minute segments, the scale unit used is the minute. On the shorter segments the scale unit is usually the second. Carefully note the time units as you compare related spectrograms.

Signal intensity is indicated by the darkness of the area on the spectrogram: the blacker the print, the stronger the signal which created it. For most spectrograms, the software gain control was kept constant (at 24 dB). Where gain was increased for analysis of low level recordings, the gain change is noted.

Here is what to look for in a spectrogram:

1. Vertical lines are individual sferics (static pops).

2. Horizontal lines are manmade. The series of dashes between 10 kHz and 12 kHz are signals from OMEGA navigation stations. The WWV minute tone is 1 kHz, but from one to three harmonic lines will appear at multiples of 1 kHz.

3. Anything that repeats at regular intervals is manmade.

4. Diagonal and curved lines are interesting. A line that falls in frequency from left to right represents a descending tone - a whistler. A line that moves upward in frequency from left to right represents an ascending tone - a riser. Risers are associated with chorus.

The following are sample spectrograms from data submitted by teams 16-31.

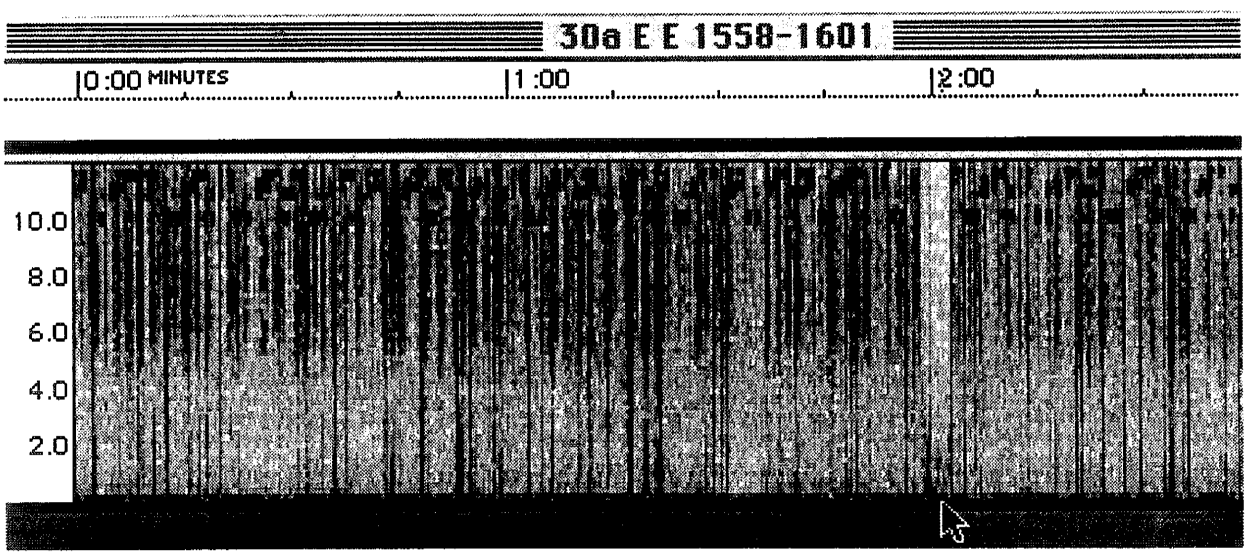

Figure 1A. California

Figure 1A shows a three minute segment with E-time at 1600 UT (2:00 minutes on the spectrogram). The arrow points to a voice time mark of "1600 UT Mark". Note the blurry OMEGA dashes at 10 kHz and above.

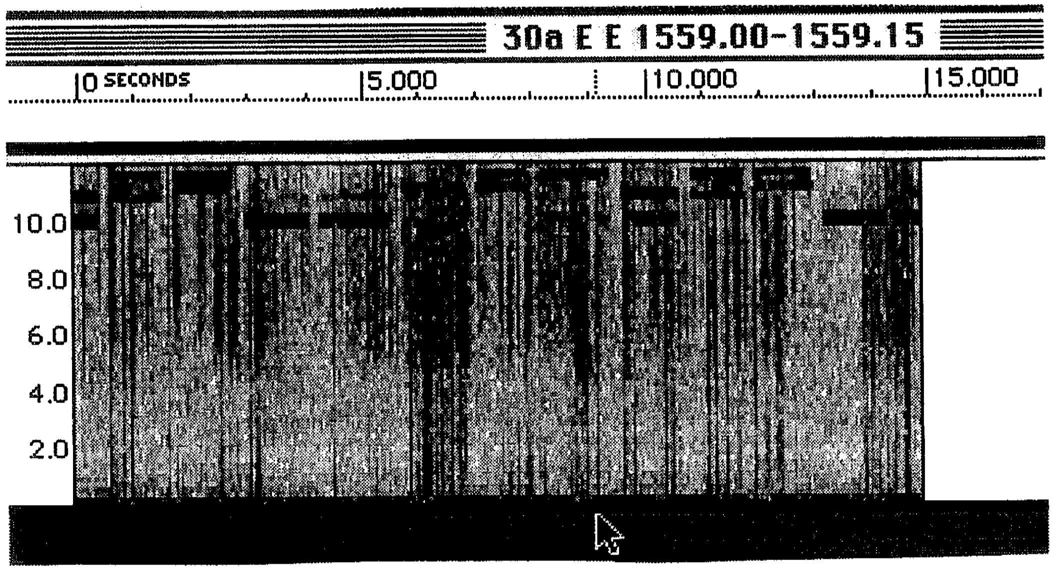

Figure 1B. CA

This is a 30-second interval from 1:00 - 1:30 of Figure 1A. Note that the OMEGA dashes are longer with this time scale. More than one OMEGA station appears on this spectrogram. The arrow points to a whistler that is not easily visible on this time scale.

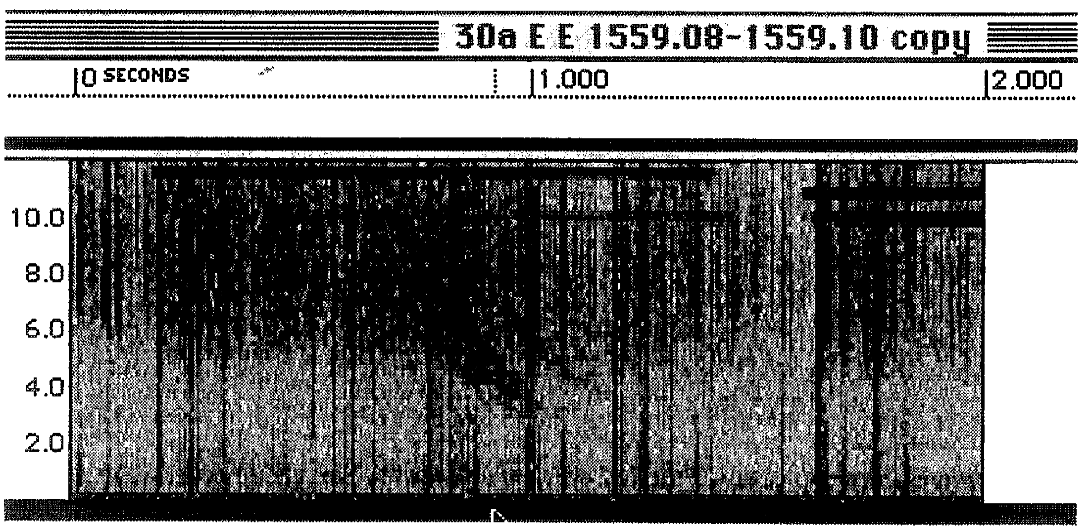

Figure 1C. CA

This is a two second interval from Figure 1B. The arrow points to a whistler. Note that the duration of the whistler as the frequency falls from 8 kHz to below 4 kHz is about .5 seconds.

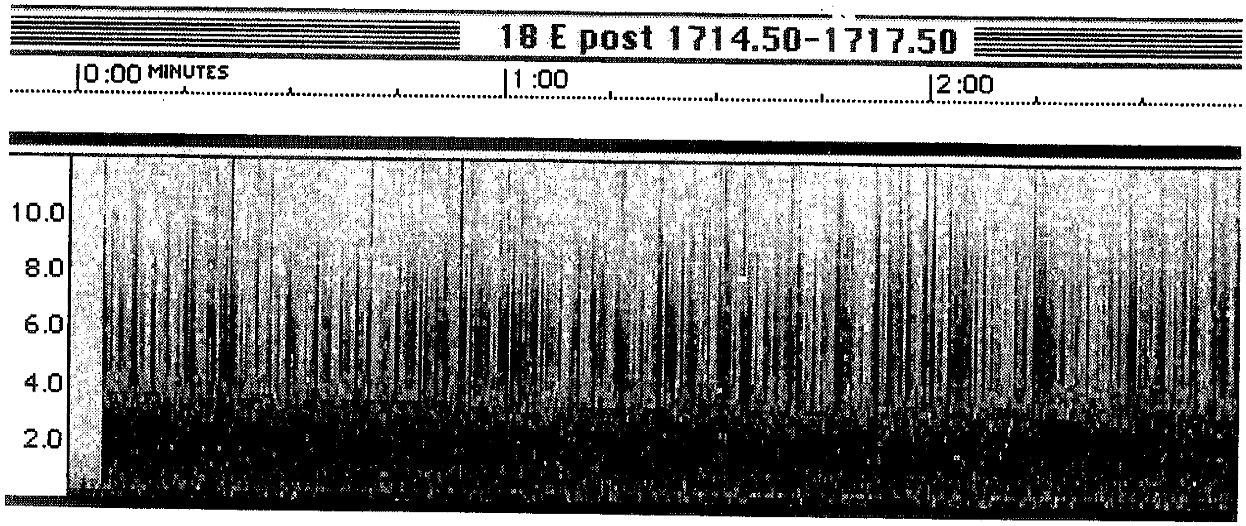

Figure 2A. Michigan

The band of signal that runs horizontally across the spectrogram from about 1 kHz to a little above 3 kHz is called chorus, because it sounds like a flock of birds singing. At the beginning of the segment is a voice "mark" at 1714:50 UT placed at the beginning of the tape immediately after flipping it over. Note the absence of OMEGA even though the receiver is performing very well.

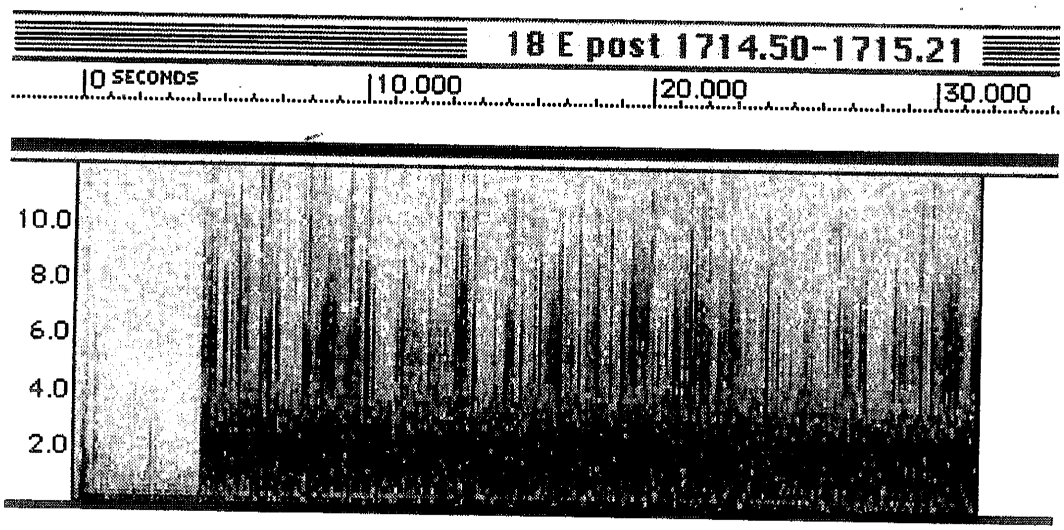

Figure 2B. MI

Figure 2B is the first 30 seconds of Figure 2A.

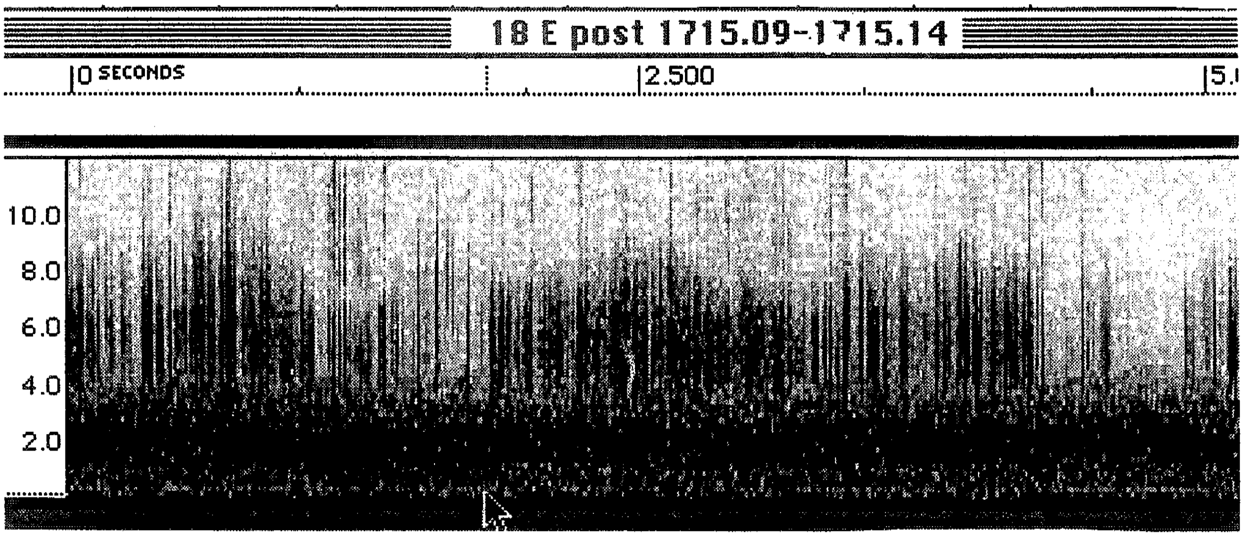

Figure 2C. MI

This shows a five second segment from Figure 2B. The arrow points to a small group of quickly rising tones (risers). They are faintly visible as a darker slash within the chorus band at about 2 kHz.

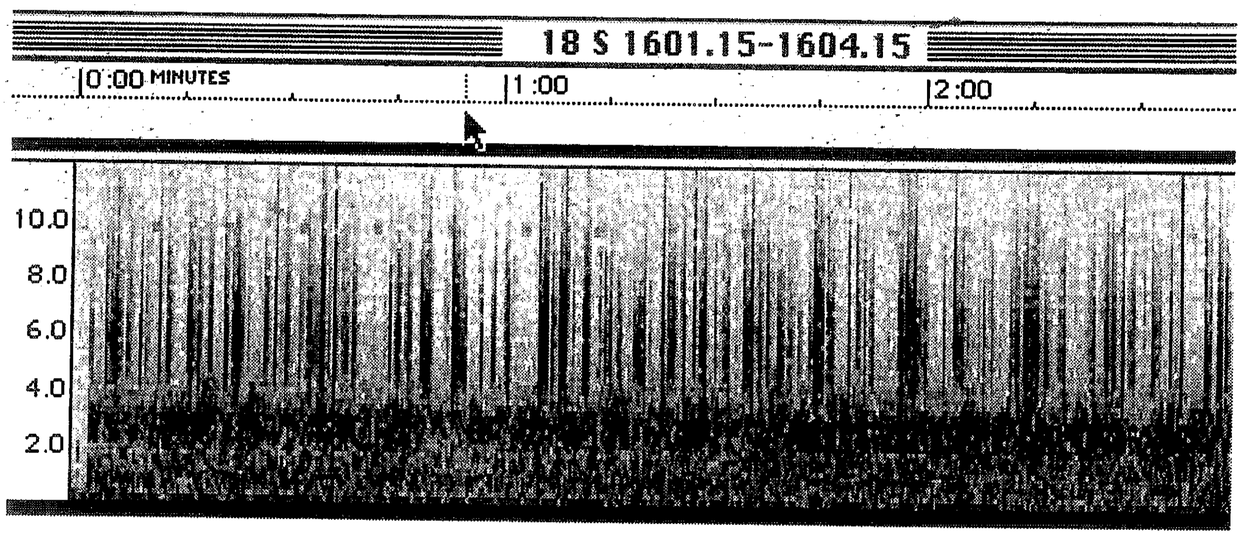

Figure 3A. Michigan

This is another three minute segment of chorus. Notice that OMEGA is faintly present.

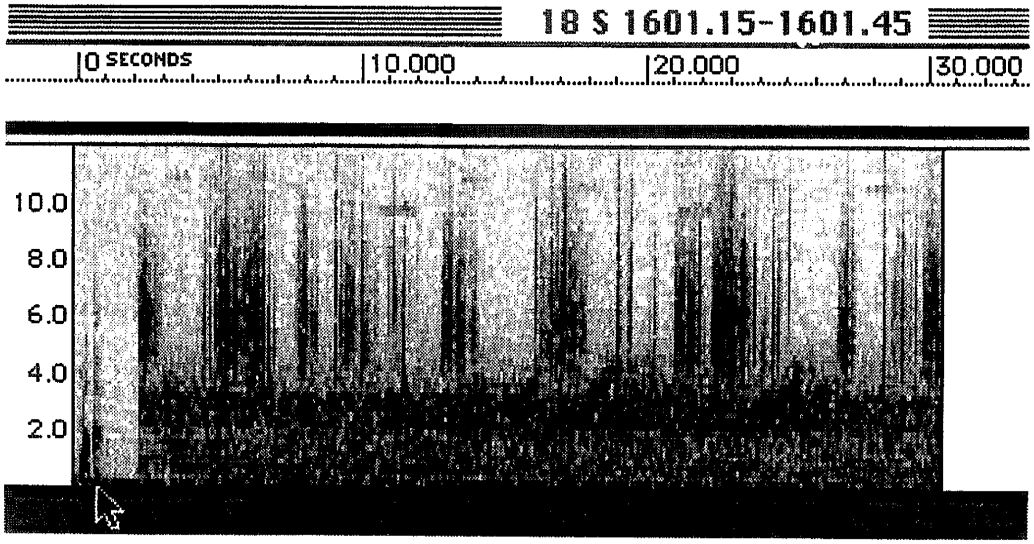

Figure 3B. MI

The arrow in this spectrogram points to "mark" at 1601.15. The fuzzy diagonal band from 18-20 seconds is a series of risers called triggered emissions. These sound like a flock of birds chirping at an increasing pitch over the two second interval. Several other triggered emissions are visible on this spectrogram.

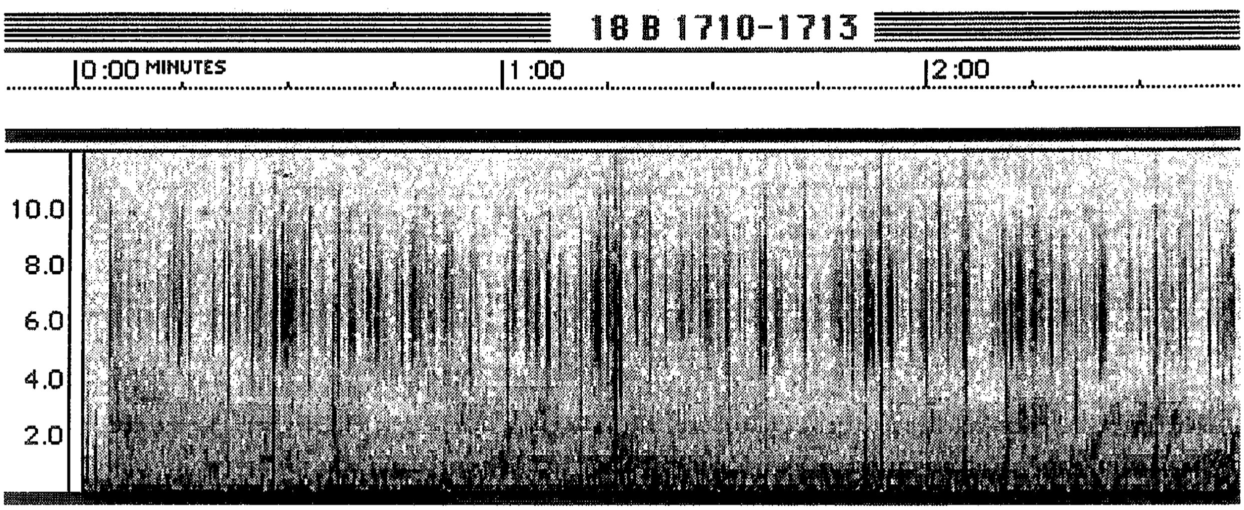

Figure 4A. Michigan

This spectrogram is from the same site as Figure 3 A-C, but from the day after the eclipse. Conditions are generally quieter as indicated by the fainter and less dense sferic lines. OMEGA is very faint. Chorus shows up as a smudge running intermittently between 2 kHz and 3 kHz.

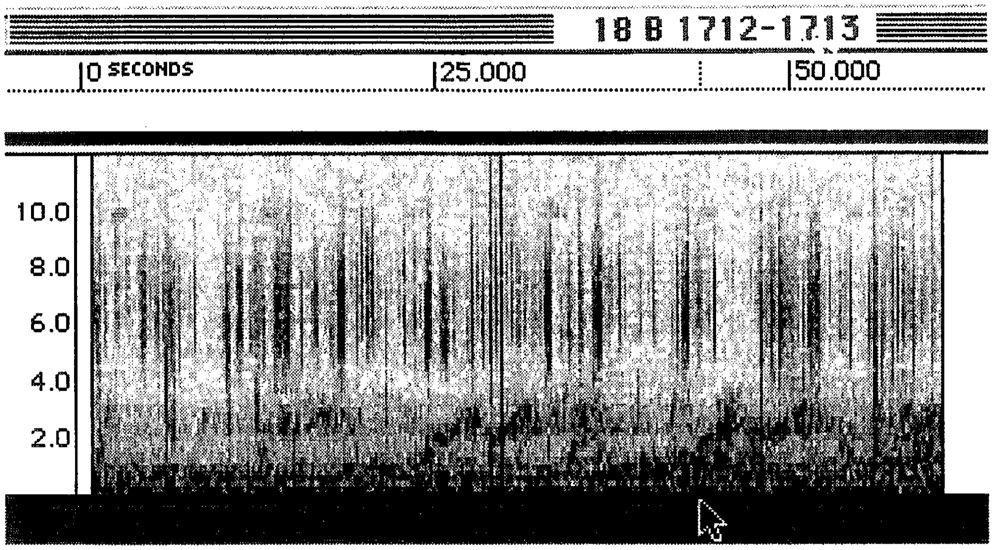

Figure 4B. MI

This shows the last minute of Figure 4B. The arrow points to a prominent set of triggered emissions, with another half dozen triggered emissions also visible. OMEGA is faint.

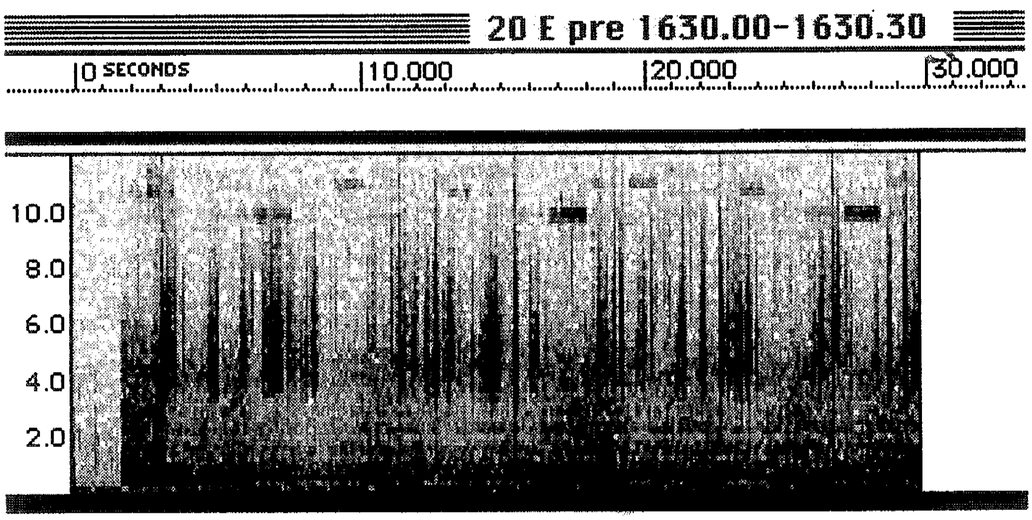

Figure 5A. Alabama

Notice the dark band below 1 kHz. This is 60 Hz hum and its harmonics. OMEGA is strongly present indicating that the receiver is working well.

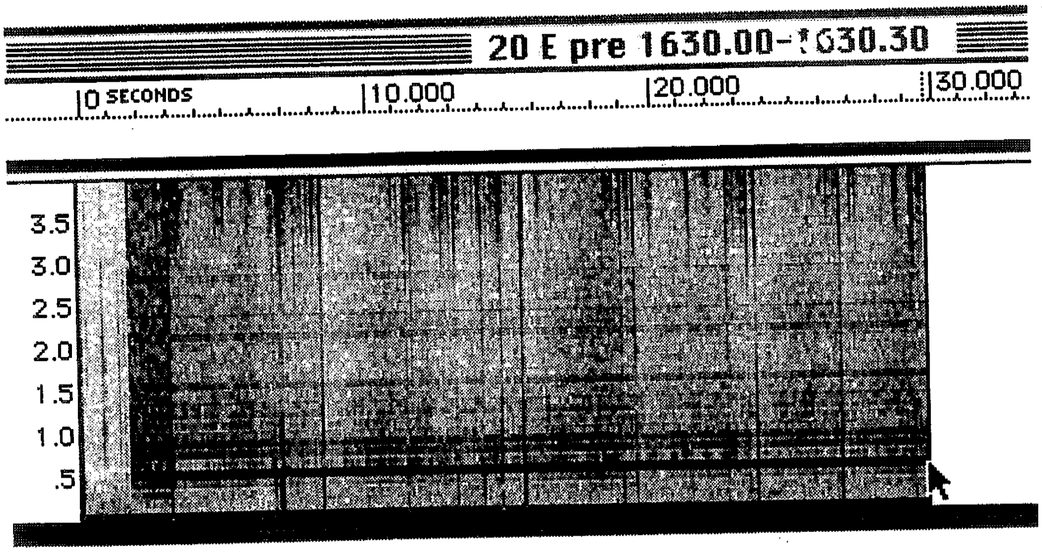

Figure 5B. AL

Here the frequency scale has been adjusted to show the detail of the 60 Hz hum. The arrow indicates a prominent harmonic just above 500 Hz (540 Hz?). Notice the lower harmonics have been effectively filtered by the receiver using the HP filter "IN" switch.

The 60 Hz hum is prominently audible at this site, yet even faint whistlers would be heard and seen on the spectrogram since whistlers start at a much higher frequency. This is an example of a "noisy" site that is still very good - especially since it is located on the shore of a beautiful lake!

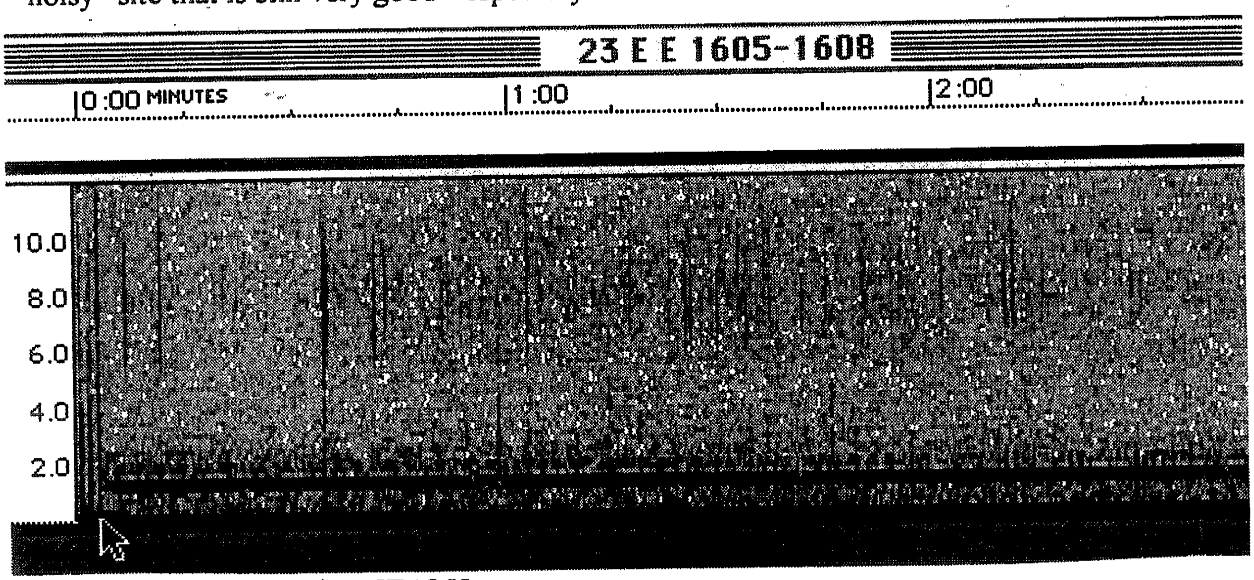

Figure 6A. Torino, ITALY

This spectrogram is darker because the software gain was turned up. The signal on the tape was very low level. The arrow points to a time "peep" at 1605 UT. A hum associated with the horizontal band between 1 and 1.5 kHz is plainly audible on the tape and is of unknown origin. It does not interfere with VLF reception.

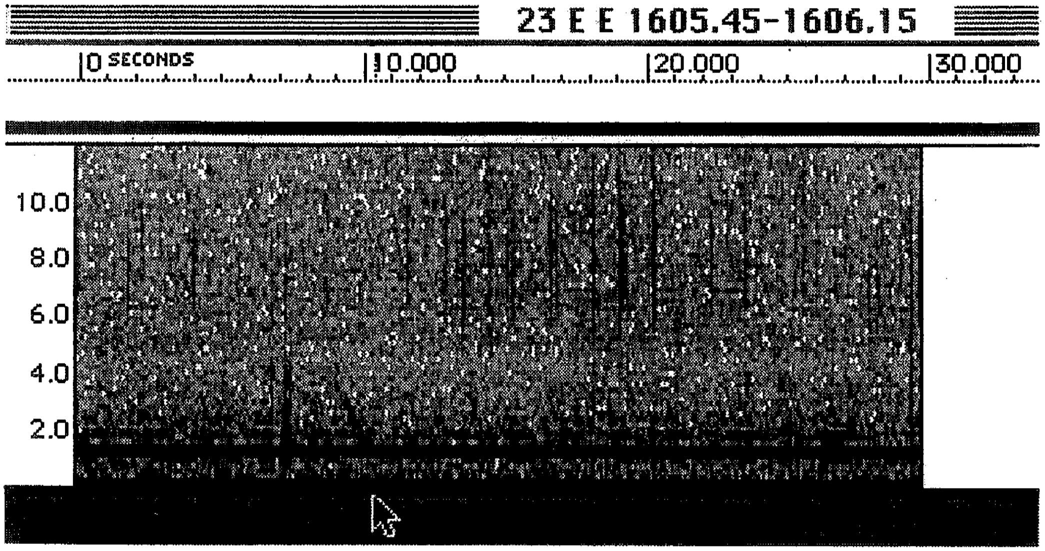

Figure 6B. ITALY

This is 30 seconds from Figure 6A. The arrow points to a whistler. Notice the strong sferic to the left of the arrow at about 7 seconds.

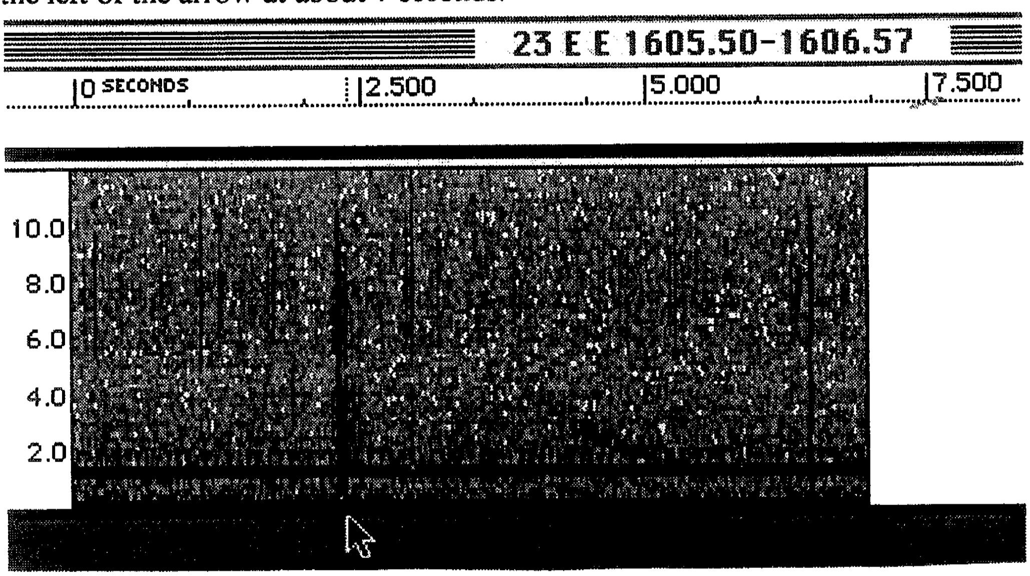

Figure 6C. ITALY

The arrow indicates the strong sferic; the whistler is to the right. Compare this whistler with the one in Figure 1C. In Figure 1C, the duration of the whistler is about .5 seconds - a quick, short whistler. In Figure 6C, the duration is about 2 seconds; this whistler is more dispersed. The greater dispersion indicates a greater travel time for the signal. The whistler is a two-hop whistler produced by the strong sferic. The whistler in figure 1C with its smaller dispersion and correspondingly shorter travel distance is a one-hop whistler which originated in the southern magnetic hemisphere.

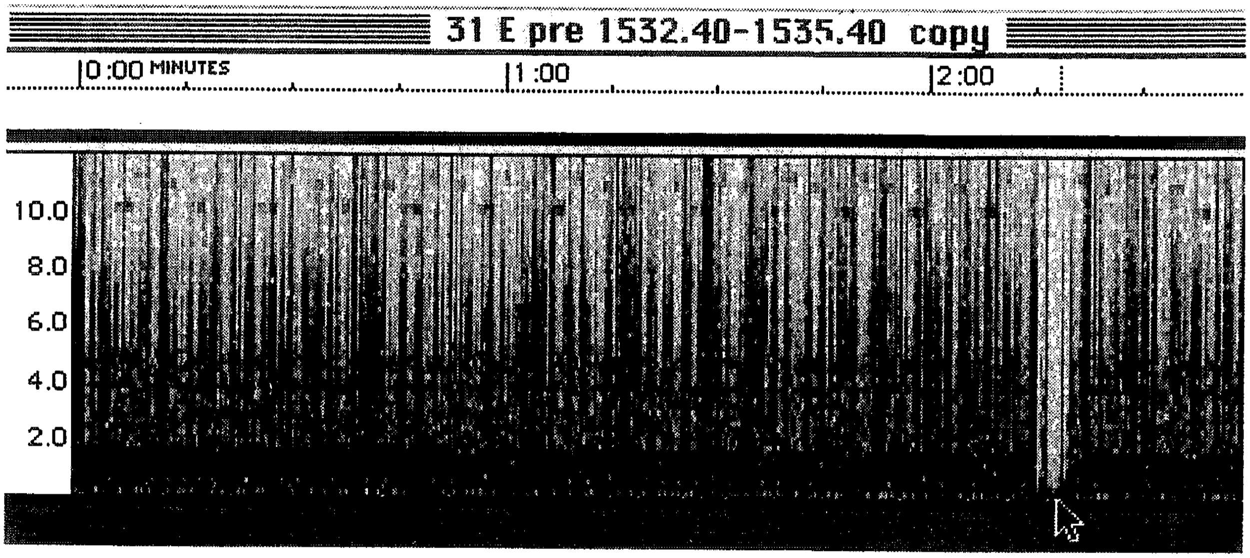

Figure 7. Texas

This spectrogram shows very dense sferics. The arrow points to "1535 UT mark". This station was set up in the eclipse track just east of El Paso. The north Texas thunderstorm was visible from this site on the southern horizon. Notice the strong OMEGA signal and the prominent 60 Hz hum band across the bottom.

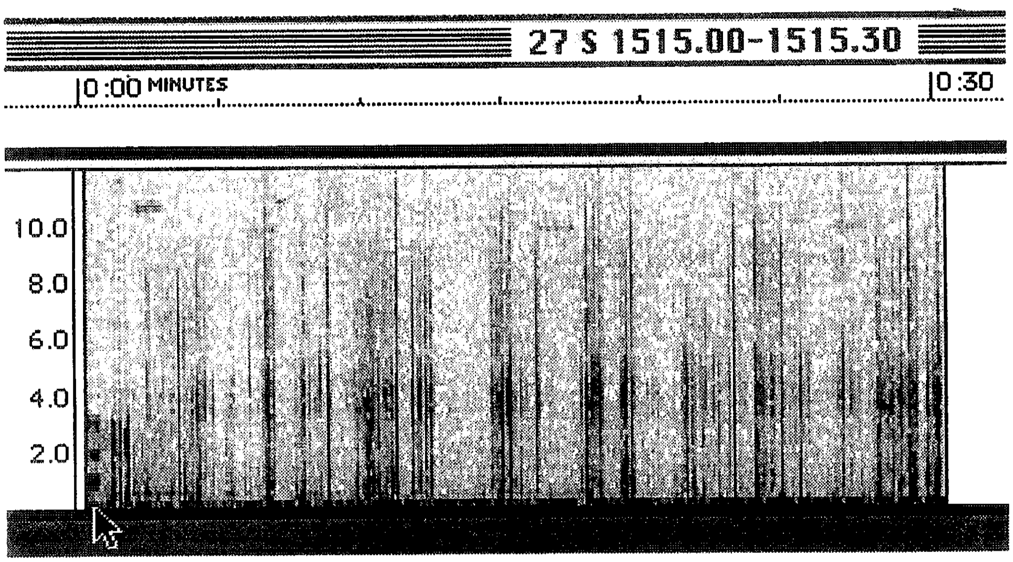

Figure 8. Texas

To finish up, here are some examples of non-natural signals. In Figure 8, the arrow points to the 1515 UT WWV minute tone. The tone is 1 kHz and two harmonics are visible. Notice the faint OMEGA and absence of 60 Hz hum. This is a very quiet site!

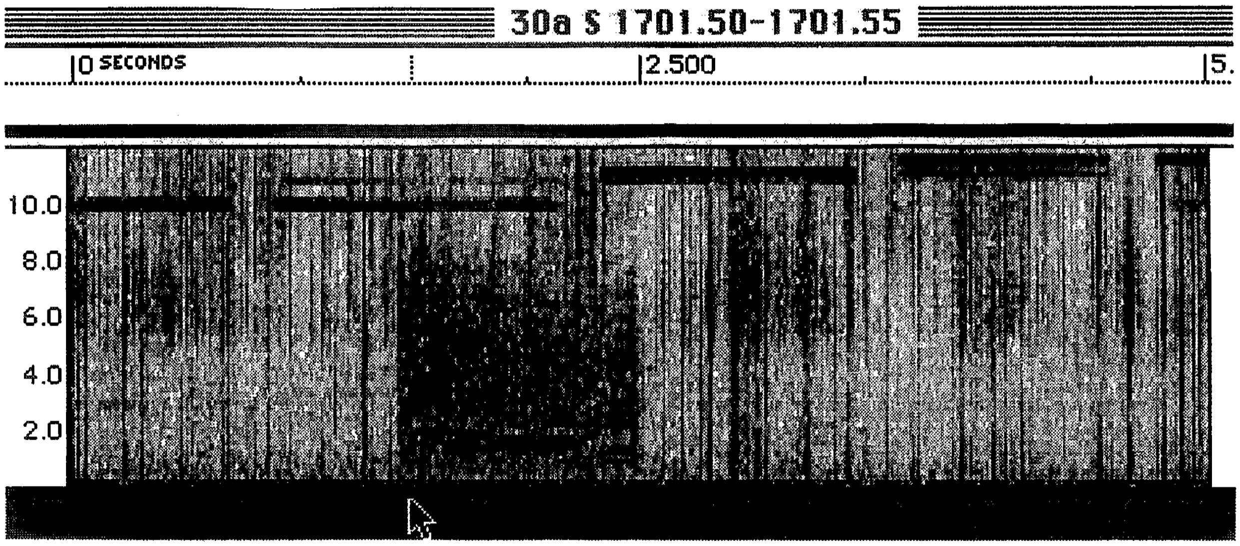

Figure 9. California

The arrow points to the beginning of the signal given off by the film advance motor in my camera. The receiver is a B-field model with a loop antenna. The loop antenna is especially sensitive to fields given off by motors, the generators of passing cars and OMEGA.

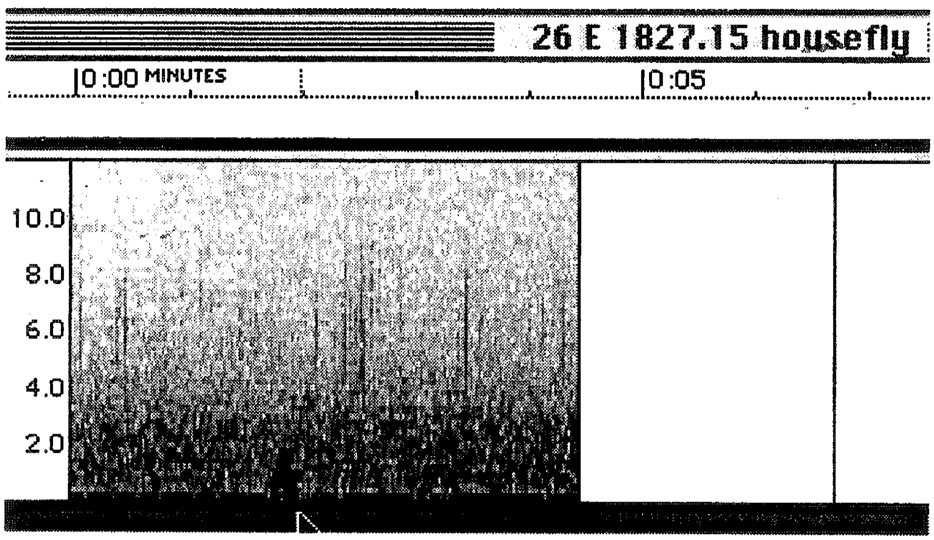

Figure 10. New York

This signal was logged as a "housefly", and when the tape is played it sounds exactly like a fly buzzing in your ear. Insect noises are commonly heard by VLF receivers. A good question, it seems to me, is "What is it about a fly that emits a signal that can be picked up by VLF receivers?"