The INSPIRE Journal

Volume 8 Number 1

November 1999

Whistlers Explained!

Whistlers were first observed early in this century after the advent of radio. Whistlers presented many questions for scientists:

Where do they come from?
Why do they sound the way they do?
Where has the signal traveled?

As scientists slowly unraveled the mysteries involved the answers were found. It was determined that lightning provides the signal that eventually becomes a whistler. Lightning consists of a broad band of frequencies being emitted at once. Dispersion of the signal results in the higher frequencies arriving before the lower frequencies.

The third question proved hardest to answer. The problem was that there were no known paths for the signal that were long enough to provide the observed dispersion. Multiple bounces between the Earth and the ionosphere simply could not provide a long enough path. In the early 1950s, the answer was found by Dr. Owen Storey. In January of 1956 an article appeared in *Scientific American* describing Dr. Storey's discovery. *Scientific American* has graciously given INSPIRE permission to reprint the article and it appears on Page 4. Dr. Storey, while semi-retired, is still active in the field of space plasma physics.

Table of Contents

The INSPIRE Journal
Volume 8 Number 1
November 99

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Contributions to the *Journal* may be sent to:

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Write for *The INSPIRE Journal*

The procedure for contributing articles for *The INSPIRE Journal* could not be simpler! Just send it in! Any format is acceptable. Electronic format is easier to work with: a Word file on disk for either the PC or Mac platform. An email message will work, too. If that does not work for you, a paper copy will do. Any diagrams or figures can be scanned in.

What about topics? Anything that interests you will probably interest most INSPIRE participants. As long as the topic is related to natural radio or the equipment used, it will get printed. The deadlines for submissions are March 1 for the spring edition and October 1 for the fall edition. Don't worry about the deadlines, though. If you miss a deadline, you will just be very early for the next edition!

We at INSPIRE are looking forward to hearing from you.

Back Issues Available

Back issues of *The INSPIRE Journal* are available for purchase. The price is $1 per issue with a $5 minimum order. Use the address found on the Order Form (Page 75 of this issue). Dates for previous volumes are:

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Volume 2 Number 1	November 1993
Volume 2 Number 2	April 1994
Volume 3 Number 1	November 1994
Volume 3 Number 2	April 1995
Volume 4 Number 1	November 1995
Volume 4 Number 2	April 1996
Volume 5 Number 1	November 1996
Volume 5 Number 2	April 1997
Volume 6 Number 1	November 1997
Volume 6 Number 2	April 1998
Volume 7 Number 1	November 1998
Volume 7 Number 2	April 1999

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Coordinated Observations – April/2000

Next spring the major emphasis will be on Coordinated Observations. Since there will probably be no more INTMINS Operations, Coordinated Observations will take place on the last **two** weekends of April. Procedures will be the same as in the past:

1. Record for 12 minutes at 8 AM and 9 AM **local time**. Record at those times for neighboring time zones if possible. Record additional time if you hear whistlers.
2. Place time marks on the tape every 2 minutes.
3. Keep a log of what you hear.
4. Use 60-minute tapes and label each.
5. Send your data to:

Bill Pine – Science
Chaffey High School
1245 N. Euclid Avenue
Ontario, CA 91762

Storey, L.R.O., *Whistlers*, Scientific American, January, 1956, p. 34-7.

WHISTLERS

They are musical sounds that may be heard in a radio receiver tuned to very low frequencies. Originating in the atmosphere, they provide a new method for exploring its outlying regions.

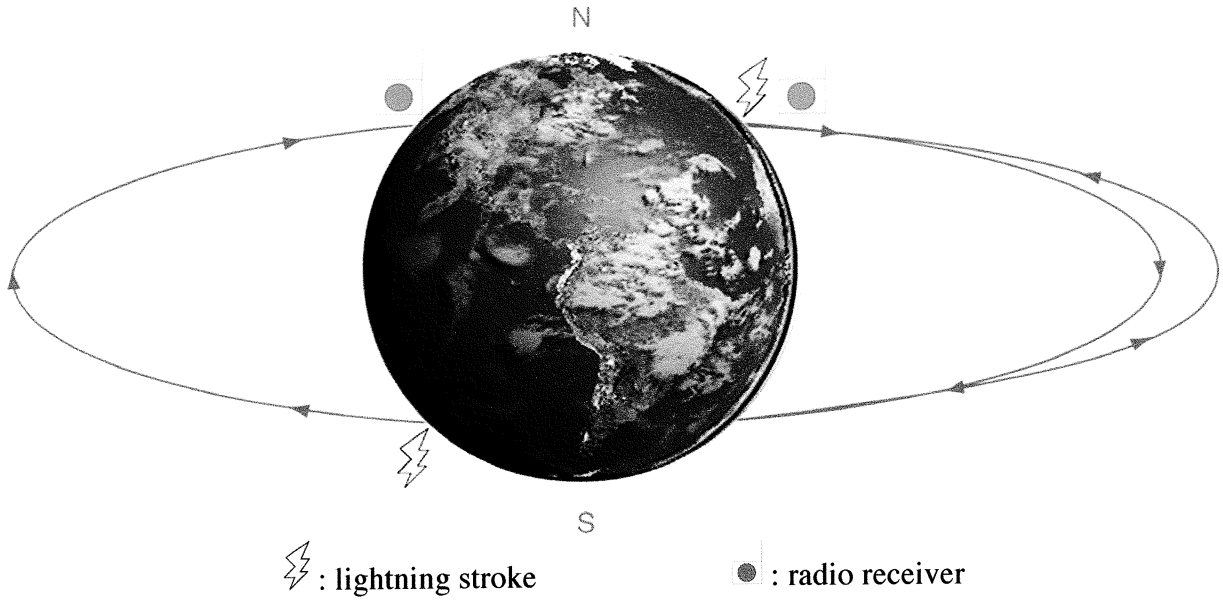
By L. R. O. Storey

As plans go forward for launching the first man-made satellites of the Earth, we have suddenly become confronted with a compelling need to know more about the outer reaches of our atmosphere. Where does the Earth's atmosphere end and space begin? What is the upper air composed of? What is its temperature, its density, its physical condition?

Up to about 200 miles the atmosphere has been thoroughly explored by radiosounding [see "The Ionosphere," by T. N. Gautier; **Scientific American**, September]. But beyond that the atmospheric "country" is still largely unknown. The ionosphere thins out so that it no longer reflects radio waves back to us. We have had no other instrument that could probe the outer regions. Recently, however, it was discovered that Nature herself is continually sounding the outer atmosphere in a way that we can follow, and thereby hangs the tale of this article.

The tale begins with an accidental observation on the battlefield during World War I. Behind the German lines the physicist Heinrich Barkhausen (discoverer of the Barkhausen effect in magnetism) was "wire tapping" Allied field telephone conversations at a distance with some ingeniously simple equipment. Two prods, stuck in the ground several hundred yards apart, picked up minute electric currents leaking into the ground from the Allied telephone wires; these signals were conveyed by cables to a sensitive amplifier, and Barkhausen was able to hear the telephone talk with headphones. During his eavesdropping he occasionally heard curious whistling sounds which completely swamped the military chatter. He was sufficiently impressed with the phenomenon to report it later in a paper: "A very remarkable whistling note is heard in the telephone. At the front it was said that one hears 'the grenades fly.' " Barkhausen's first reaction was that the whistles probably originated in his apparatus, but when all attempts to eliminate them failed, he decided that they must be coming from the atmosphere. He was right. It was to be many years, however, before much further attention was paid to them or anyone really understood what they meant.

In the form of static on the radio from a nearby thunderstorm, atmospheric radio signals are familiar enough. But the whistles Barkhausen heard were not in the ordinary broadcasting wavebands. They were low-frequency (long-wave) signals below the lowest broadcasting frequencies. Radio engineers now know that off this end of the broadcast spectrum various odd atmospheric signals are there for the hearing. Hearing is the right word, for the frequencies of these waves are so low that they fall within the sound range – the range of the human ear. To hear them we need only the simplest of apparatus: basically just an aerial to pick up the atmospheric electrical oscillations and an audio amplifier like the one in a phonograph to convert the oscillation directly into sound.



The curved lines represent Earth's magnetic field lines. The arrows indicate the direction of travel of the radio waves. The left show lightning originating in the Southern Hemisphere which is received in the Northern Hemisphere as a short whistler. On the right is lightning in the Northern Hemisphere which is heard, after the radio signal makes a round trip, as a long whistler.

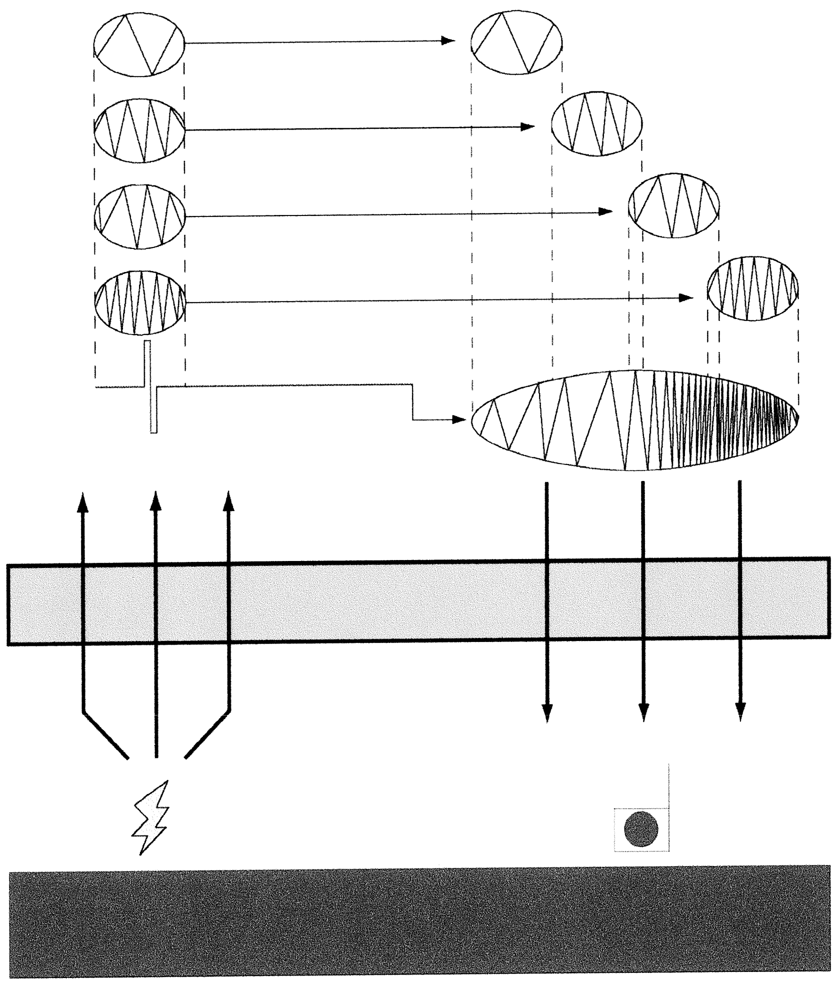
And what do we hear when we turn the amplifier on? Well, most of the time just the same clicks as in the broadcast bands. But now and again we are favored with relatively musical noises, which have acquired quaint onomatopoetic names. There is the "tweek" or "chink" – a brief, metallic note produced by waves bouncing up and down between the earth and the ionosphere. There is the "dawn chorus" – an unexplained twittering noise which occurs during a magnetic storm. And there are Barkhausens's whistlers.

Starting above the upper limit of hearing, the whistling tone falls steadily in pitch, at first rapidly, then more slowly at the lower frequencies. The sound sweeps down through several octaves in a second or two.

Whistlers were studied to some extent in the 1920s and 1930s, notably by E. T. Burton and E. M. Boardman at the Bell Telephone Laboratories and by T. L. Eckersley of the Marconi Wireless Telegraph Company in England. These workers noted that a whistler often (though not always) appeared about a second after a loud atmospheric click. Apparently whistlers were connected in some way with the clicks. The source of the clicks themselves was in doubt at the time, but in any case there was a promising lead to investigate. It seemed that the whistler might be an echo of the click, returning from the ionosphere. The question was: How could a click be converted into a whistler?

Barkhausen and Eckersley independently conceived an explanation which experiments later proved correct. It was clear that a click must be composed of a number of different frequencies, for the same click could be detected all over the broadcast band, and indeed in the range of sound waves as well. It was also known that radio waves of different frequency travel at different speeds through the ionosphere. Suppose that, as a click moved through the ionosphere, its component frequencies were spread out, the highest frequency traveling fastest and the lower ones strung out behind. If the click traveled far enough so that its frequencies were well separated, an observer should receive a drawn-out signal – a whistling tone of steadily falling pitch.

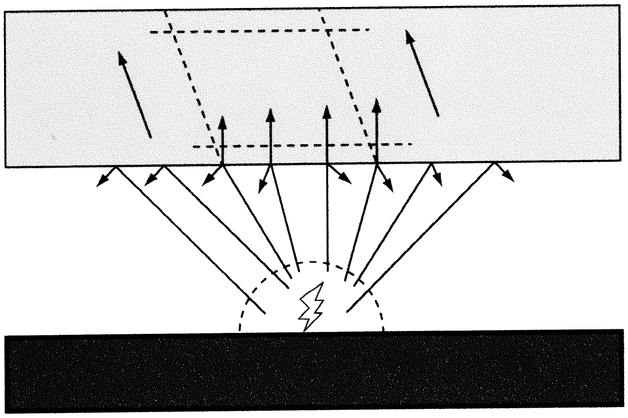
Eckersley proceeded to translate this conception into



The radio signal from the lightning stroke at the left is heard immediately by the receiver at the right as a click (as illustrated by the rectangular waveform above the lightning stroke) composed of the variety of waveforms shown above. In the ionosphere (gray area) shorter wavelengths (higher frequencies) travel faster than longer (lower) which results in a whistler heard seconds later at the same receiver.

numbers and equations. He calculated that a certain type of radio wave should pass through the ionosphere without being reflected by it, that it would be slowed in the ionosphere to one twentieth or less of its usual velocity, and that its speed should depend on several factors: its frequency, its direction of travel in relation to the Earth's magnetic field, the strength of the magnetic field and the density of the electrons in the region through which it was passing. Considering frequency alone, the speed of waves of this kind through the ionosphere should vary in proportion to the square root of the frequency: e.g., a wave of four times the frequency of another wave should travel with twice the speed, other things being equal. Thus in the case of the click traversing a given path through the ionosphere, the velocities of the component frequencies should have the simple square root ratio. This means that the time taken by the various frequencies to cover the course should vary inversely with the square root of the frequency.

To check this prediction, all one needs to do is to separate the frequencies in a whistler with a frequency analyzer and determine whether the several frequencies' times of arrival after the click do in fact obey the postulated ratio. Eckersley found that they did almost exactly.



The lightning stroke causes a radio disturbance that travels outward in all directions. When the signal encounters the ionosphere, some is reflected and some is refracted. The refracted waves are formed into a beam (horizontal dashed line) which then follows the Earth's magnetic field (up to the left).

The next important question was: How long is the path traveled by the whistler? The answer, of course, lies in the amount of dispersion of the frequencies (the length to which the whistling tone is drawn out). But it is impossible to make an exact estimate of the travel distance from this, because the dispersion also depends in part on the average electron density and magnetic field strength along the route, which are unknown quantities. However, we can compute very roughly the minimum distance whistlers must travel. Leaving the variation of the magnetic field out of the account and assuming the highest possible electron density throughout the route (equal to that of the densest layer in the ionosphere), one calculates the path length for whistlers showing a typical amount of dispersion. The answer is the astonishing figure of 15,000 miles. Apparently the whistlers go far beyond what has previously been thought to be the limits of the Earth's atmosphere.

When I began to look into whistlers in the Cavendish Laboratory at the University of Cambridge in 1950, there seemed to be two problems outstanding: firstly, what caused the clicks and secondly, where the path went and how the waves were reflected at the end of it.

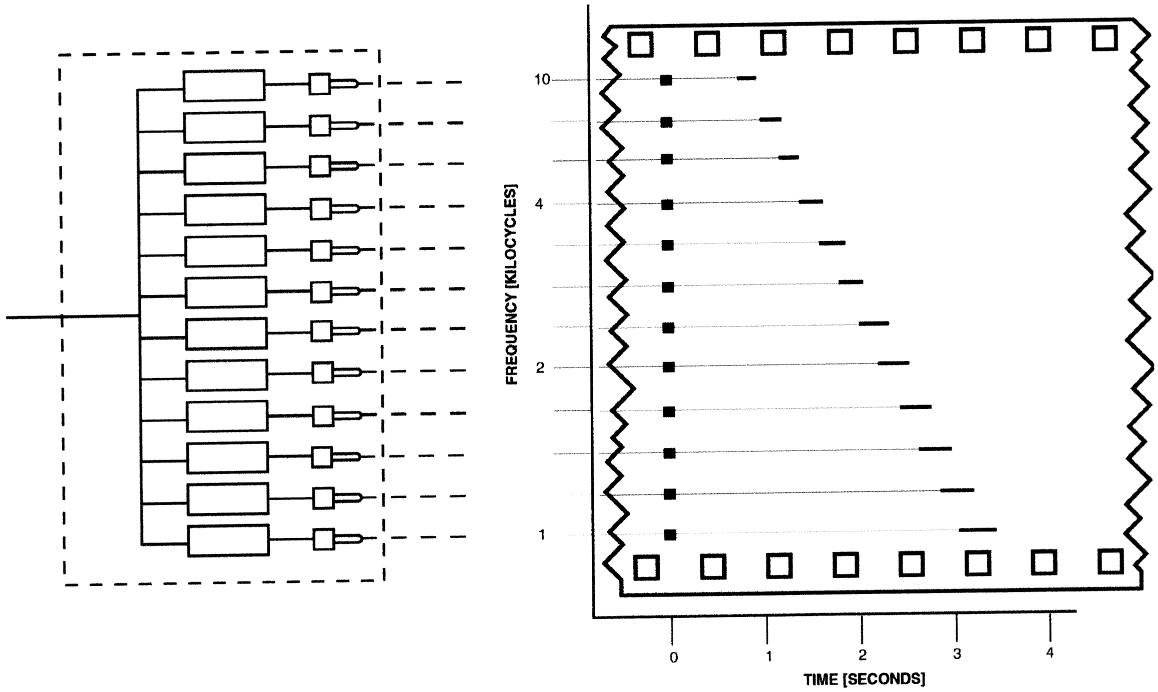
It appeared highly probable by this time that the clicks originated in lightning. To study them we enlisted the help of the British Air Ministry Meteorological Office which has a "Sferic" organization that monitors atmospherics to locate thunderstorms. Four widely-spaced stations in the United Kingdom pinpoint the sources of atmospheric clicks. We arranged to receive a telephone signal from these stations the moment the position of a click was fixed. We recorded these signals, noted whether a whistler followed each click, made a map of the fixes and later were able to correlate the loudness of each whistler with the distance of the click source from our receiver.

These observations and analysis of the wave forms left no doubt that the clicks were produced by lightning strokes. From lightning within 600 miles of us we invariably received loud whistlers; from points farther away the whistlers steadily grew weaker, until, beyond 1,200 miles, we seldom received any at all. That is to say, we could detect no echo from a click that originated more than 1,200 miles from us.

This was most curious. One would expect waves to spread out widely, yet here were waves which traveled at least 15,000 miles and after journeying that great distance returned as an echo to a limited area no more than 1,200 miles in radius. What mechanism in the atmosphere could focus them in this manner?

Let us try to trace their journey. When a lightning stroke occurs, it sends out radio waves in all directions, and some go upward to the ionosphere. When the radio rays traverse the boundary between ordinary air and the ionized region, they are bent, just as a ray of light is refracted when passes from air to some other medium. Whatever the angle at which the radio waves strike the ionosphere, all of them are bent toward the vertical. As we have already noted, the refractive (slowing) effect of the ionosphere on these waves is very pronounced. Consequently the rays coming from all angles are concentrated in a narrow vertical beam.

As it rises into the ionosphere, however, the beamed pulse of energy does not continue in the vertical direction. It follows the lines of the Earth's magnetic field,



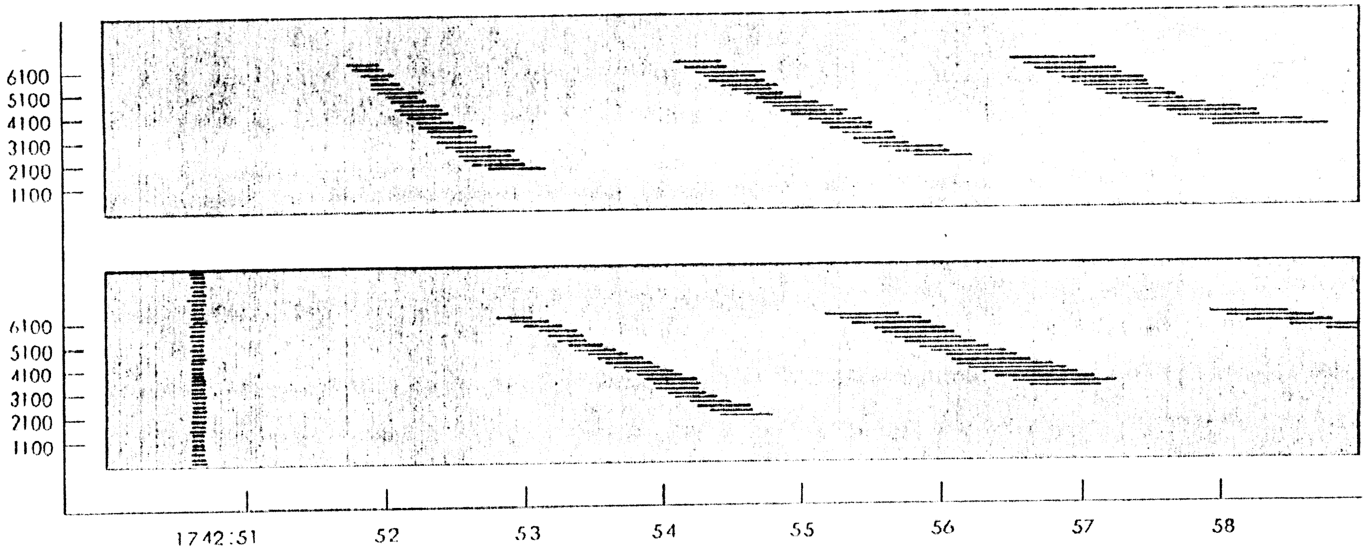
Sound spectrograph consists of a set of filters (rectangles) which each pass a narrow band of wavelengths. Each filter is connected to a small neon lamp (squares). A strip of photographic film is passed under the set of lamps. The click of nearby lightning appears on the film as a vertical row of spots (at 0 seconds). A whistler creates the diagonal row of marks as the higher frequencies arrive first followed in turn by the lower frequencies.

because this is the direction in which the waves travel fastest. And as it goes, the pulse or click is drawn out into a whistler.

If it is indeed true that the whistler follows a line of magnetic force, then we have some notion where the path will go. From the Earth's surface in England a line of magnetic force sweeps southward around the globe, crosses the magnetic equator at a height of about 7,000 miles and comes down to Earth again in the Southern Hemisphere. A whistler traveling this path might be reflected from the ground and return along the same line of force to the area in England from which it came.

The thought sends us back immediately to our records and our listening posts, and a fresh look at the evidence soon confirms the reasoning. Firstly, there is the hitherto puzzling fact that sometimes a whistler is heard without any preceding click. We can guess now that such a whistler comes directly from the Southern Hemisphere – not an echo but a single trip passage from a Southern lightning flash. The click itself, traveling in the lower atmosphere, is unheard because it is absorbed before it reaches us. If the whistler has made only one journey through the ionosphere, it should only be half as drawn out as one preceded by a click (which makes the round trip). Measurements confirm the prediction.

Secondly, almost from the beginning it was noticed that sometimes a single click fathers not one but a train of whistlers, each weaker than the one before. They follow one another at short, regularly-spaced intervals. Quite evidently these must be reverberations of the same echo, bouncing back and forth like a tennis ball between the two hemispheres. That this is the case has been verified by the finding that the lengthening of the successive whistlers is proportional to the number of trips: when they follow a click, the dispersion ratios are 2:4:6:8; when no click is heard,



SPECTROGRAPH RECORDS of an experiment by Millett G. Morgan and G. McK. Allcock are depicted in this drawing. The lower record was made in New Zealand on August 28. At its left is a click; at its right are a long whistler and two echoes. The upper record was made simultaneously in the Aleutian Islands. It shows a short whistler and two echoes from the same click. The numbers at the left give the frequency in cycles; those at the bottom, the time in seconds after 17 hours, 42 minutes, 51 seconds Greenwich Mean Time.

indicating that the signal started in the other hemisphere, the ratios are, as expected, 1:3:5:7.

Last summer, in a direct test, individual whistlers were actually caught bouncing back and forth by observers who made synchronized recordings at the two ends of a line of magnetic force – one in the Aleutian Islands, the other in New Zealand [see illustration above]. On each successive trip the whistler was drawn out further by the predicted amount.

`The biggest surprise is what whistlers tell us about the height of the atmosphere. It must extend out to at least 7,000 miles – several times farther than had previously been thought. The atmosphere was supposed to end at about 1,500 miles. But now it appears, from the dispersion of whistlers, that 7,000 miles out there must still be about 400 electrons per cubic centimeter. This may mean various things. If we suppose that the electrons come from ionization of gases typical of our atmosphere (oxygen and nitrogen), then to produce this ionization the temperature of the outer atmosphere would have to be at least 7,000 degrees – a figure far too high to be believed. J. W. Dungey of the University of Pennsylvania has suggested instead that the ions may come from outside the atmosphere: that in its passage through space the Earth picks up ionized hydrogen and holds it by the force of its magnetic field. Some recent estimates put the hydrogen content of "empty" space near Earth's orbit as high as 600 particles per cubic centimeter, so Dungey's theory seems reasonable. But the issue is far from settled.

The only certain thing is that whistlers still have much to tell us. During the forthcoming International Geophysical Year observers all over the world will be listening for these strange messages from the outer atmosphere.

The April 99 Monitoring Sessions

By - Robert Bennett
Las Cruces, NM

(Editor's note: The following was received from Robert Bennett as a field report of his April/99 observations.)

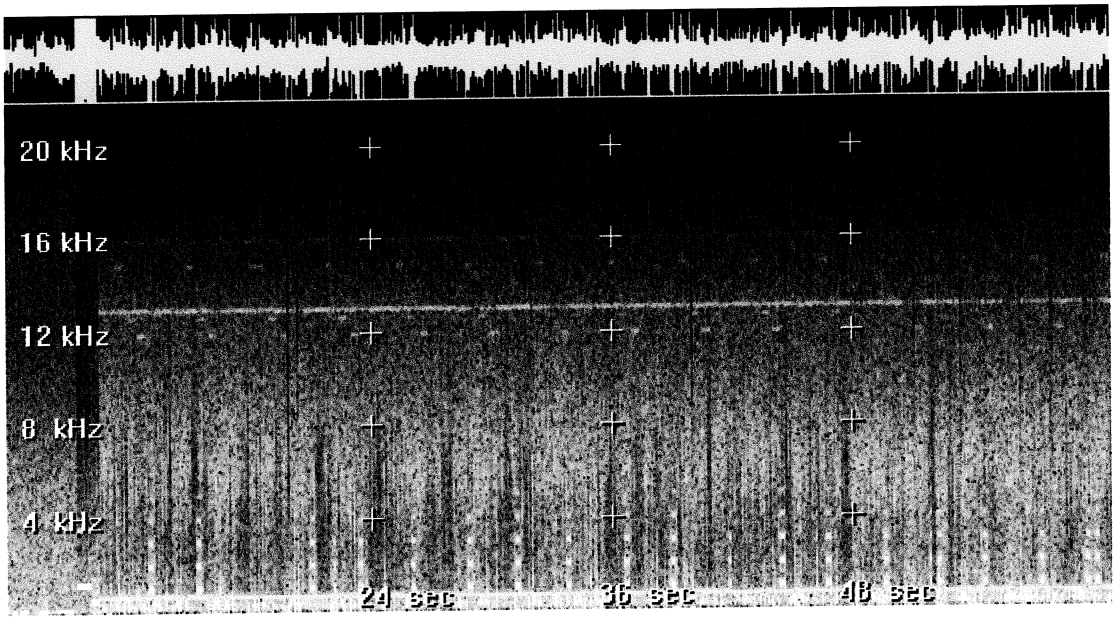
The audio recordings for the April monitoring session are enclosed. I have also enclosed ZIP disks containing WAVE and BMP files produced when I analyzed the recordings. The following paragraphs contain the results of my analysis. While I did not detect the ISTOCHNIK signal, I did find some interesting and unknown (at least to me) signals. If you have any idea what they are, I would like to know.

I also used a commercial software program (SPECTRAPLUS) to analyze some of the missions. This program provides a different view of the data. Instead of a frequency versus time display as provided by GRAM, this program gives a power density versus frequency display (that is, the signal is integrated over time). I have included plots from the program in this note.

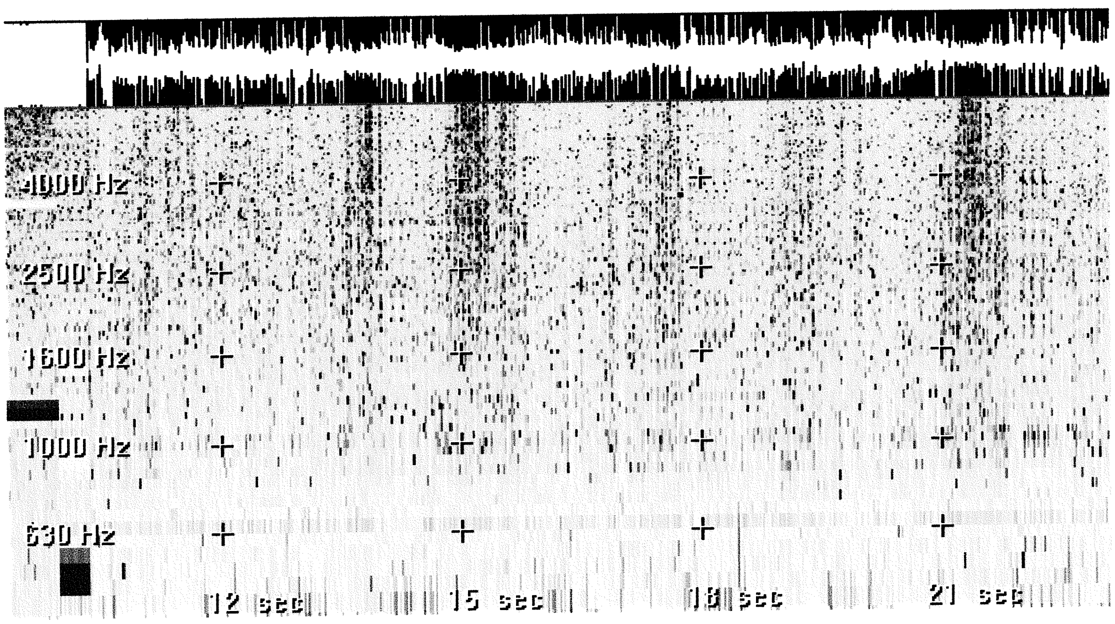
MISSIONS ON 17 APRIL 1999.

On 17 April, I was able to monitor and record missions 17-5, 17-6, and 17-7. The 17th was a very nice day for outdoor activities. The weather was dry, temperature in the mid 70's F, and no wind. However, I noticed that natural radio levels were abnormal this day. First, the levels were much higher than I normally observe during spring daytime in the desert. Also, I observed many bursts of noise and the noise levels in the lower part of the spectrum were quite high. I have never observed this noise activity before. Radio Station WWV said that the solar activity was low and the geomagnetic field unsettled. There was a magnetic storm at 2200Z on 16 April. Could the storm account for the noise activity? All recordings on 17th were made with a 120 ft longwire antenna orientated toward 175 degrees.

Mission 17-5.

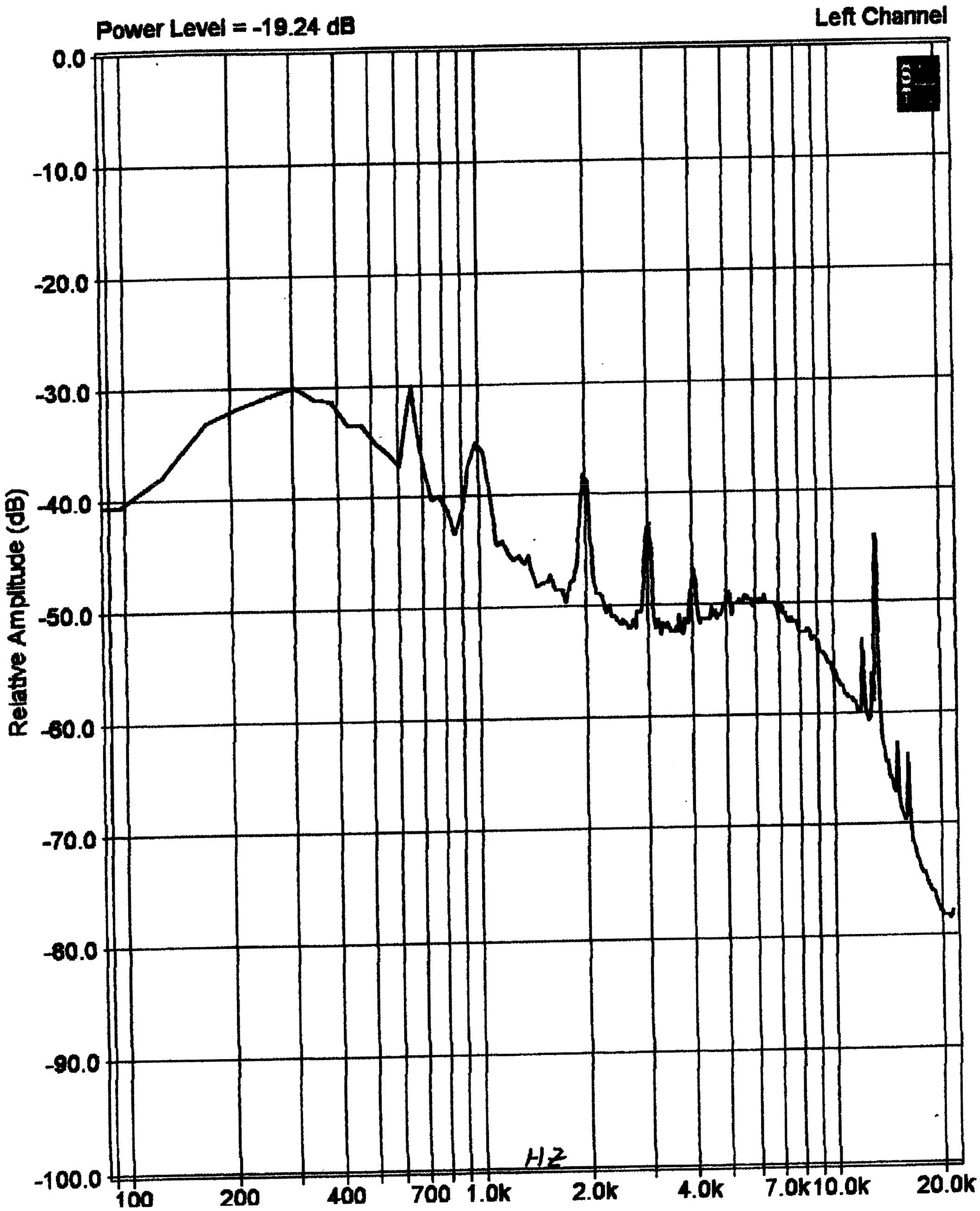


The above image shows the Loran signals very clearly as vertical sets of dots. The Russian Alpha signal is evident as dashes between 12 and 16 kHz as is a communications signal near 13 kHz. Also note the 60 Hz hum product near the bottom of the figure. There is no evidence of the ISTOCHNIK signal.



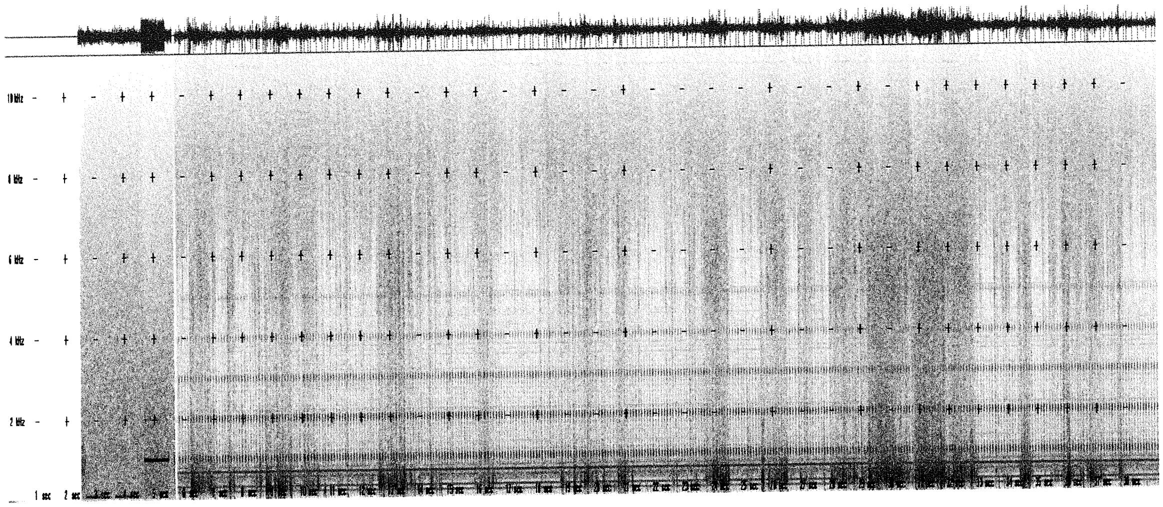
This image is the first few seconds of the operation in high resolution. Note the hum near 630 HZ and the high noise levels below 1 kHz.

The next figure is a plot produced by SpectraPlus. It is a spectrum analyzer like display showing signal amplitude (actually power) versus frequency. The Loran pulse signals are the peaks at 1, 2, 3 and 4 kHz. The spike between 600 and 700 HZ is a harmonic of the AC power line frequency. Note the communications signals between 10 and 20 kHz.



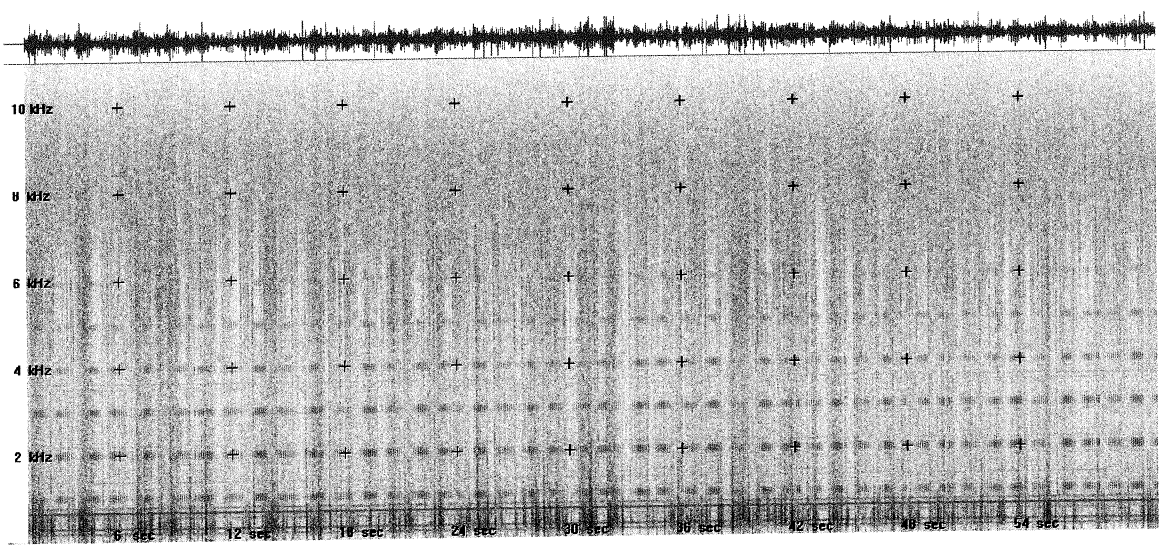
Mission 17-6.

There isn't anything new on these plots that isn't evident on the ones for the previous mission. No evidence of ISTOCHNIK. The following is typical. It shows strong Loran, Alpha and noise bursts. The communications signal is not evident this time.



Mission 17-7.

This mission is much the same as the previous ones except that the natural radio emission levels seem to have dropped some. Also, I didn't detect Alpha or the communications signals in the plots. This mission takes place later in the day and the drop in levels is what I normally observe as the day progresses. I selected the following image because it has some "insect noise" on it. Otherwise it is identical to the others for this mission. No indication of ISTOCHNIK. This figure shows Loran and the noise bursts.

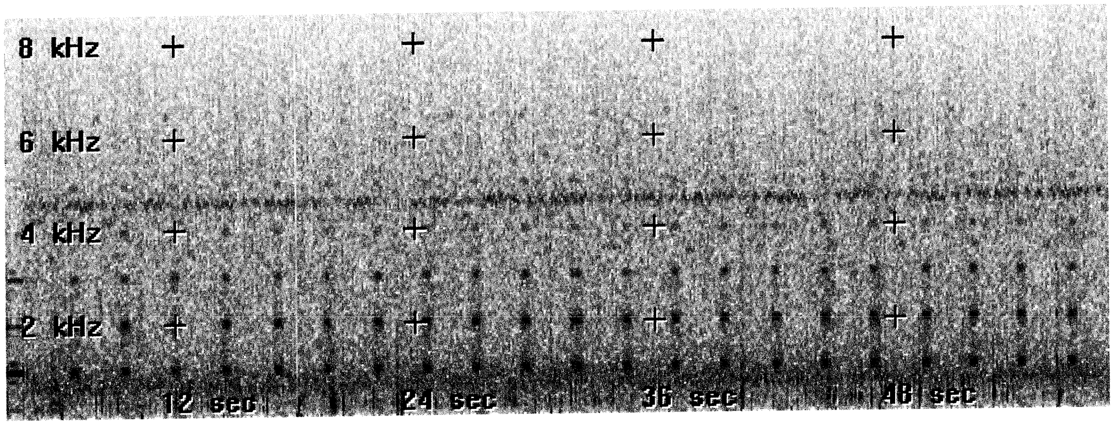


MISSIONS ON 18 APRIL.

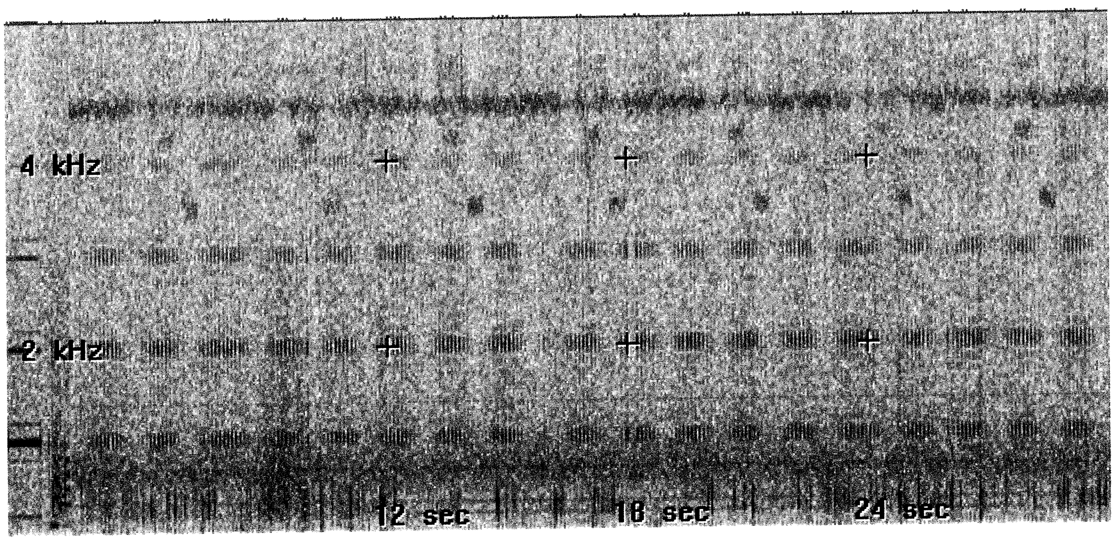
On the 18th I was able to monitor missions 18-4, 18-5, and 18-6. This day was also nice for outdoor activities. It was cool in the early morning and warmed up to about 70 degrees by mid morning. Conditions were dry, thin cloud cover, and no wind. I used the same longwire for these missions as I did on the 17th.

Mission 18-4.

Signal levels did not seem as strong as on the previous day. Loran is ever present; however, the communications signal near 12 kHz appears absent along with the Alpha signals. Note the presence of the signal near 5 kHz. This signal was present all the time during this mission and I don't know what it is.

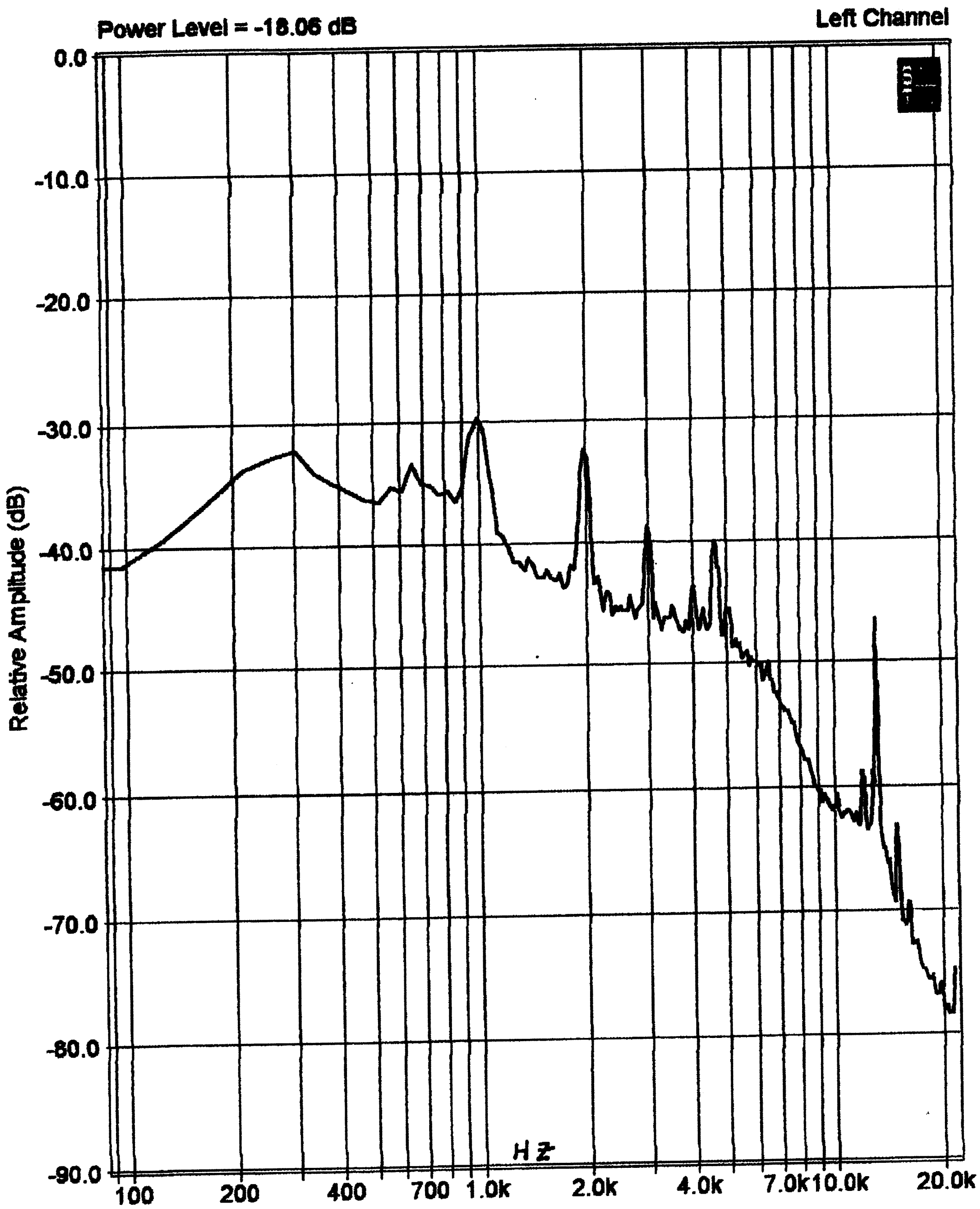


The following image is a higher resolution look at the strange signal.



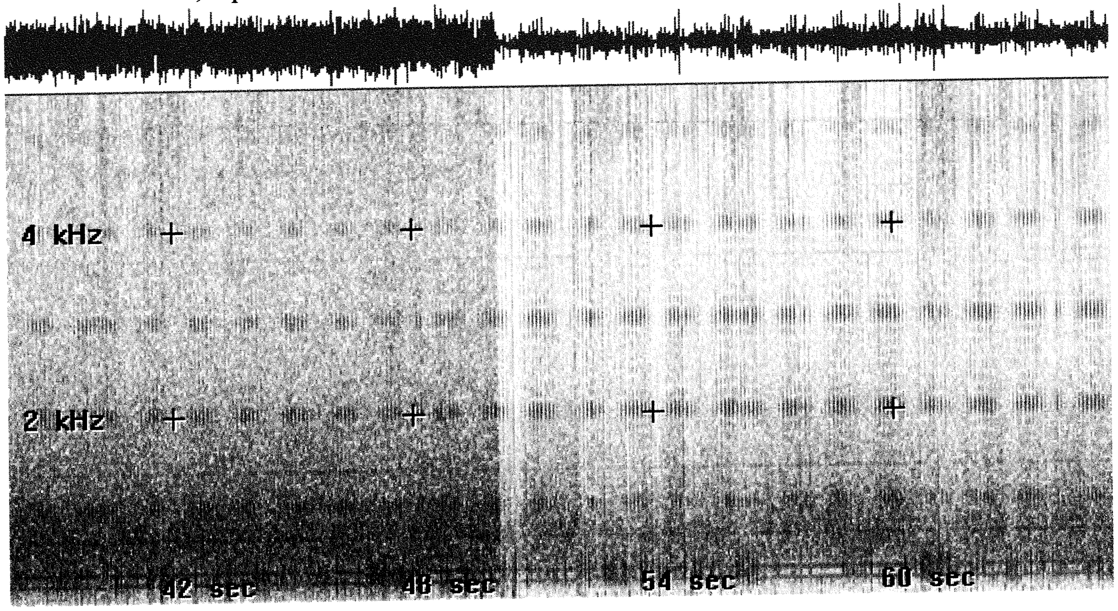
This figure shows that there is a steady signal at 4630 HZ, and a pair of periodic pulse signals at 4230 and 3500 HZ. The pulse repetition interval between the two signals is about 550 MS, and the two-signal group repeats every 3550 MS. Again, I have no idea what this signal could be. Also, note the high noise levels between about 500 and 1260 HZ.

The next figure is a plot from SpectraPlus. The chart shows a spectrum analyzer like display. Also, the signals at 1, 2 and 3 kHz are the components of the pulsed signal transmitted by Loran. Compare this chart with the one for mission 17-5. The unknown signals I discussed above are very evident between 4 and 6 kHz. Notice the presence of many communications signals between 10 and 20 kHz.



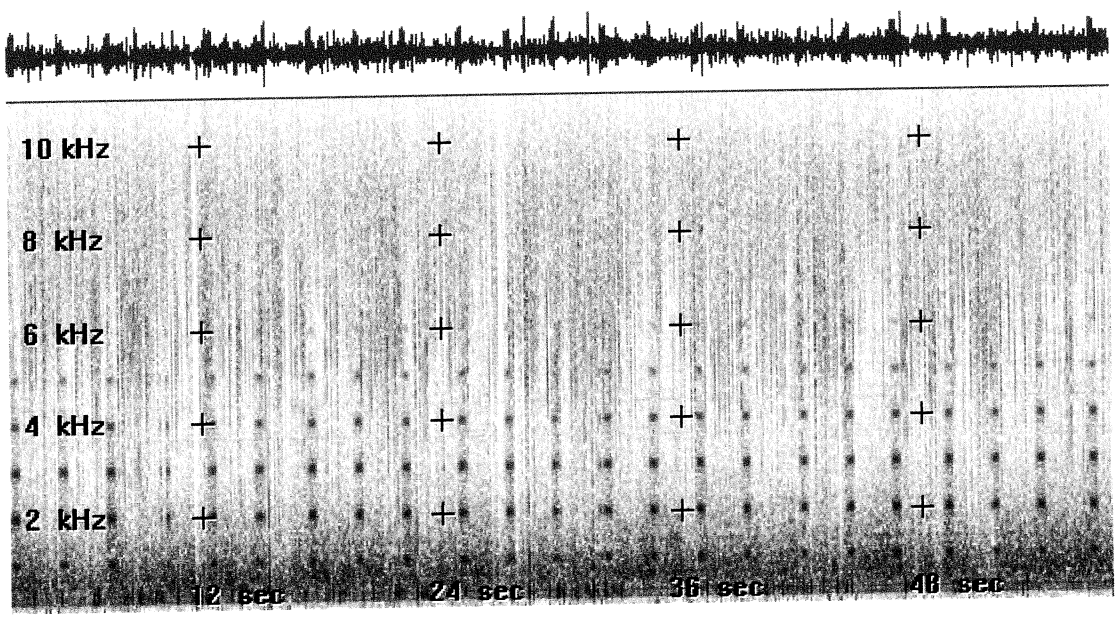
Mission 18-5.

In this mission, I started recording with the recorder limiter "out" and recorded for several minutes. Later, I put it "on" because of bad signal overload.



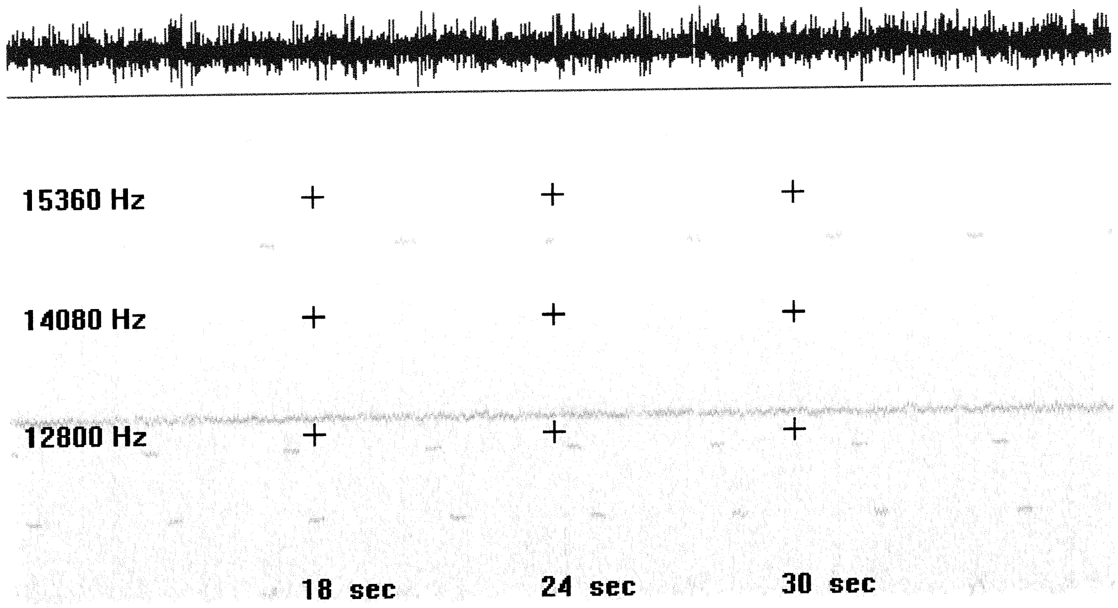
The above figure shows the effect of the recorder limiter. It was out in the first part of the recording up to about time 50 Sec then turned on. After the limiter was turned on, note the appearance of the faint signals at 1411, 3564 and 3693 HZ. The recorder was in saturation with limiter off and the above signals were not evident.

The next figure is during the ISTOCHNIK operation. Loran is very evident as is the unknown signal near 4 kHz. The intense low frequency noise is still present.

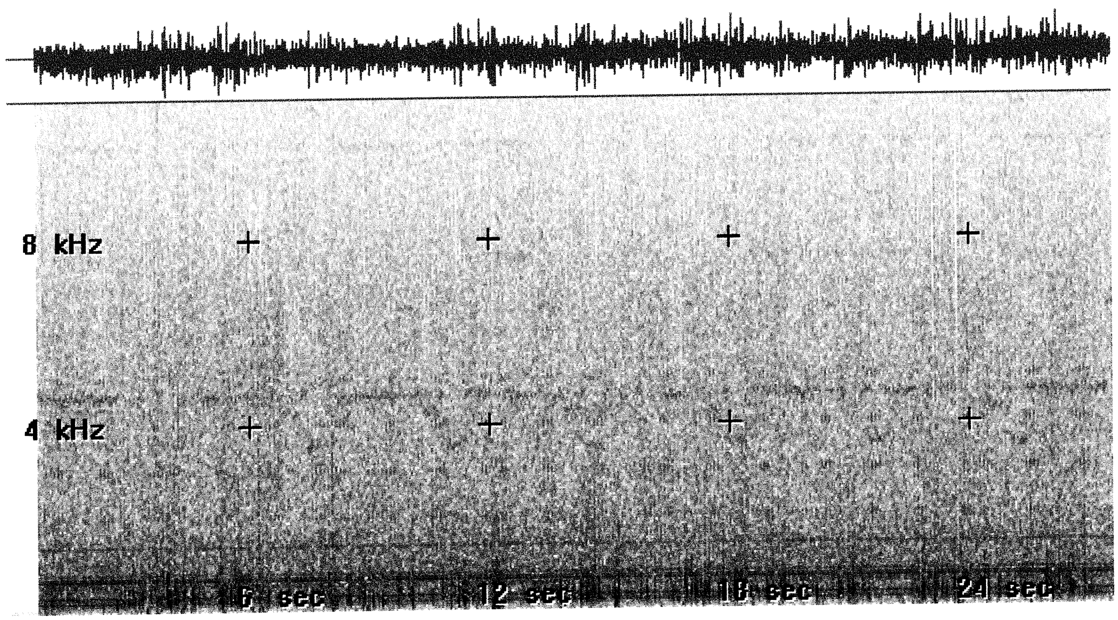


Mission 18-6.

The following image covers the high frequency end of the recording. This image, which used 2048 pts FFT and 50 MS resolution, gives a good view of the signals between 10 and 20 kHz. Note the presence of both a steady communications signal and Alpha signal pulses (dashes).



The next image is for the ISTOCHNIK operation for the first 30 seconds. The image is a 1024 PTS FFT with 50 MS resolution.

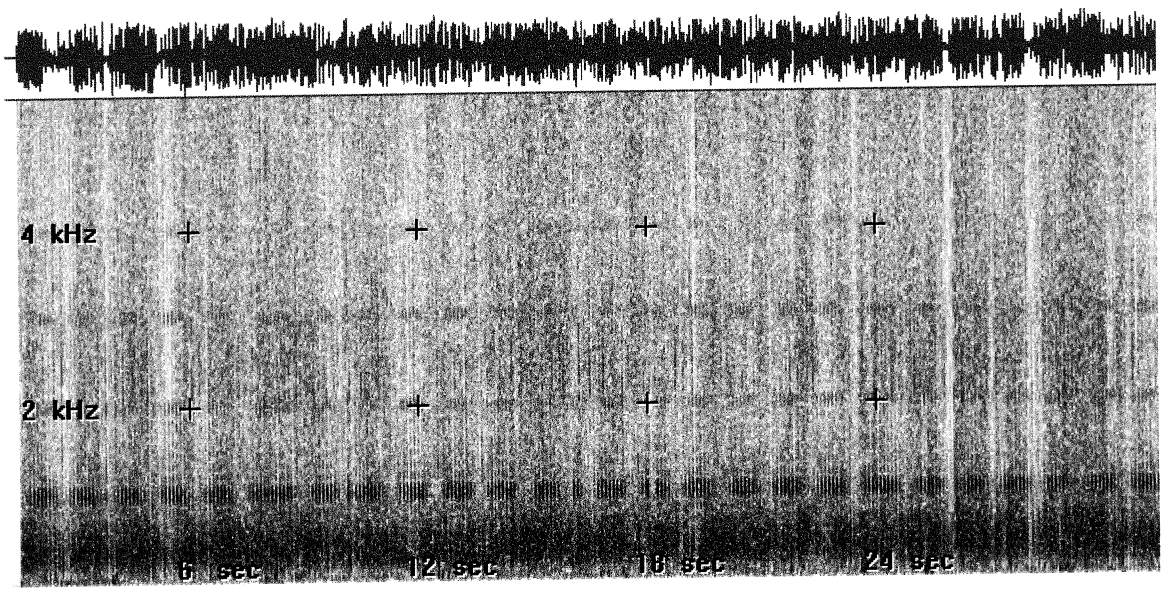


MISSIONS ON 24 APRIL 1999.

24 April was a difficult day for outdoor monitoring. A cold front passed through the area during the evening of the 23rd. The morning of the 24th was overcast, cool, with high winds and threatening rain. The wind and blowing dust/sand got steadily worse until I was forced to move my monitoring setup into the cab of my truck. Also, my long wire was unusable later in the morning due to the high wind and I was forced to use a 6' whip antenna. The wind started at about 20-25 MPH with gusts to 35 MPH and by noon when I was forced to leave the field, the wind was gusting to 50 MPH. I was forced to leave not because of the wind but because it started to rain. My monitoring site is about 4 miles off a gravel secondary road and the access is by a dirt trail. The 4-mile trail is impassable when wet. I managed to record missions 24-5, 24-6, 24-7 and 24-8. Mission 24-8 was a complete washout as my receiver decided to fail during the mission.

Mission 24-5.

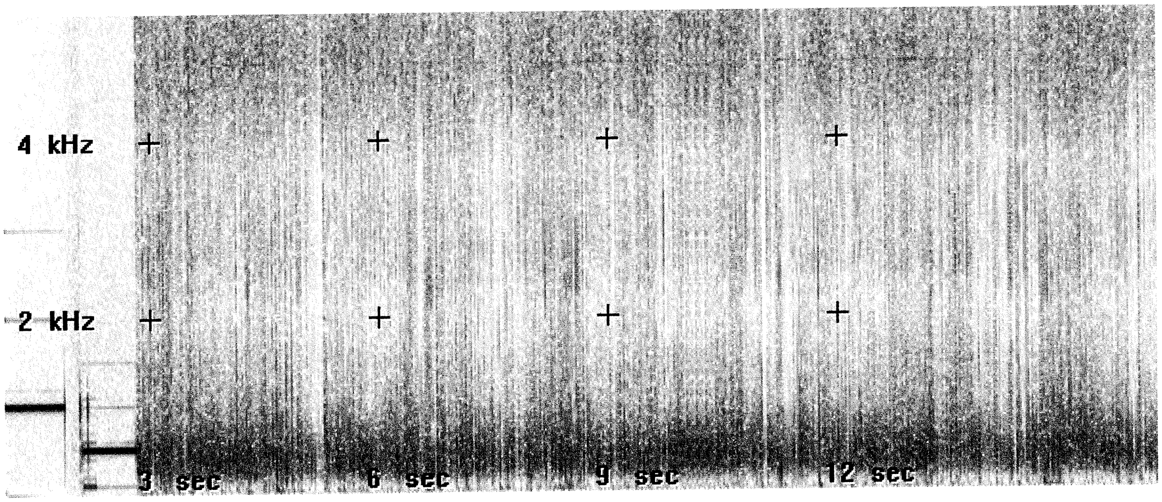
I was able to use the 120-foot longwire on this mission. The following figure shows the first 30 seconds of the operation using 1024 PTS FFT with 50 MS resolution



As can be seen in the figure, there isn't much out of the ordinary. There is intense natural radio activity and LORAN pulses but little else.

Mission 24-6.

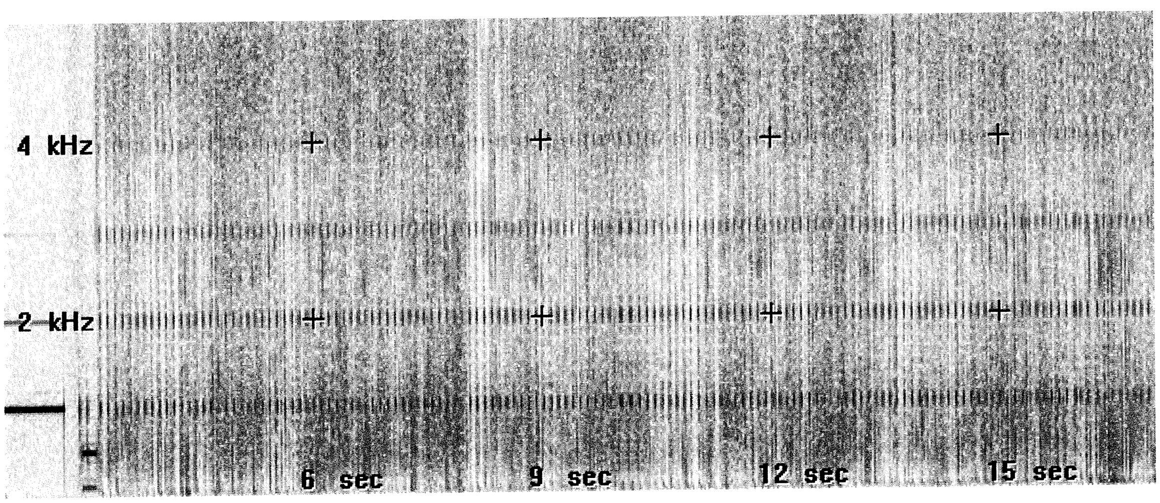
Mission 24-6 seemed to have lower LORAN levels than before. I am not sure if the levels are really lower or I was seeing the beginnings of the receiver failure. The following figure shows the first 12 seconds of the ISTOCHNIK operation using 1024 PTS FFT and 25 MS Resolution.



This image shows intense activity and an almost complete absence of Loran. The natural radio noise was strong enough to suppress the Loran signal. This is further illustrated with the SpectraPlus output shown on the next page. Note the complete absence of the Loran signals and the communications signals between 10 and 20 kHz. There is a strange "hump" in the spectra at about 5 kHz. This has the appearance of a noise-modulated signal. I suspect but haven't been able to prove, that my VLF-2 receiver is thermally unstable. It was in direct sunlight in my truck most of the morning and its case got very hot to the touch. I believe that one of the transistors went into thermal runaway and started oscillating at about 5 kHz and was being frequency modulated by the input natural radio noise.

Mission 24-7.

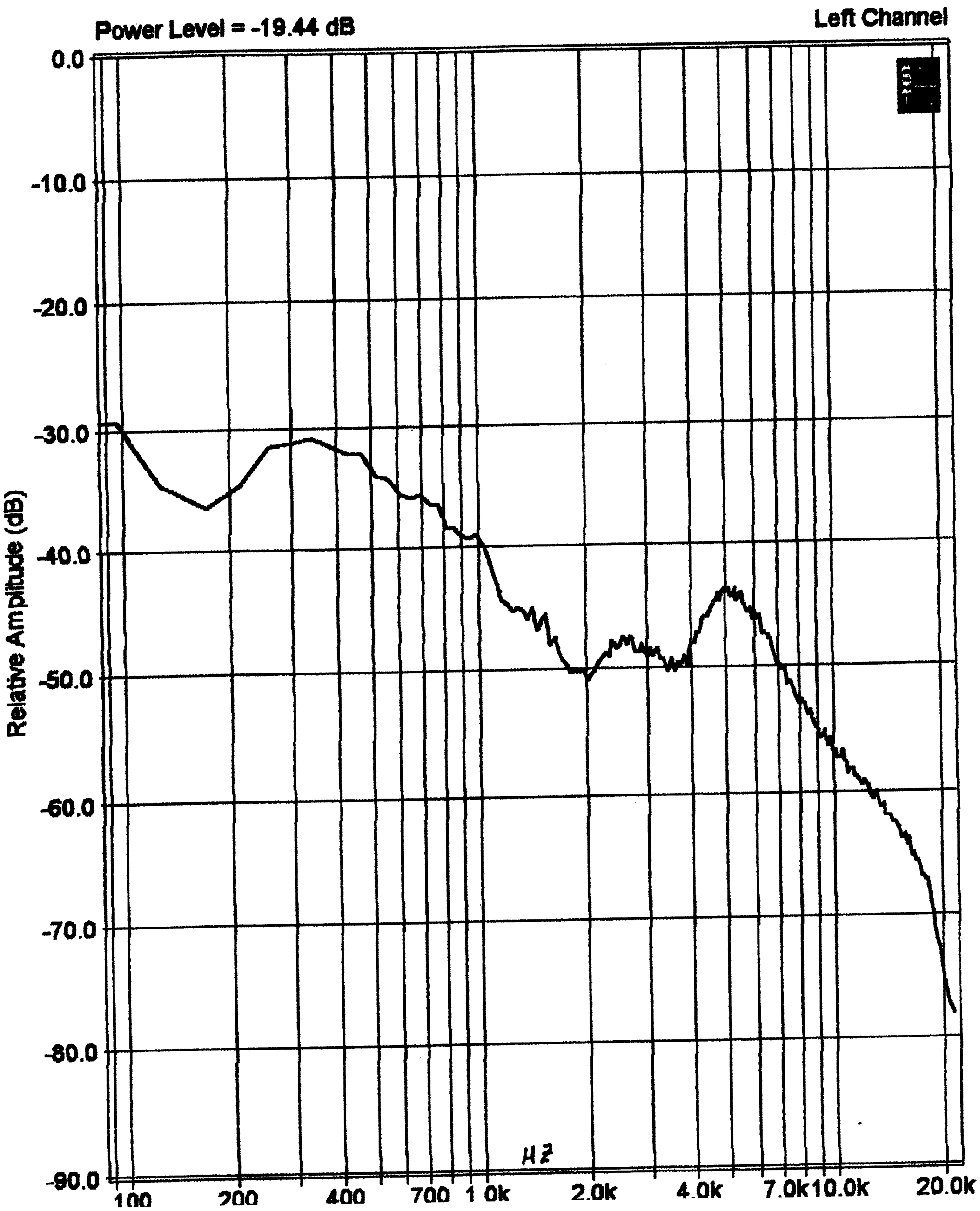
I changed to my backup receiver (RS-6) before this operation. I was using a whip antenna. The recordings seem more normal that the previous mission. There isn't anything of great interest in these files. The following image will serve as an example.



Mission 24-8.

This mission was recorded with the RS-6 and a whip antenna. The recording session started OK then after about one minute of recording, all output from the receiver was lost. The operation was a complete wash-up.

SpectraPlus Plot for Mission 24-6



INTMINS OBSERVERS

Roster Update

The following is a roster of INTMINS observers including first-time observers. Team number assignments are permanent and will be used to refer to teams in the future. (Unless noted otherwise, all longitudes are West and latitudes are North.)

North American observers:

Team #	Observer	Location	Longitude/Latitude
1.	John Lamb, Jr.	Belton, TX	97° 27' 50" / 31° 7' 45"
	University of Mary Hardin-Baylor		
2.	Stephen G. Davis	Fort Edwards, NY	73° 29' 30" / 43° 18' 00"
3.	Don Shockey	Oklahoma City, OK	97° 40' 5" / 35° 43' 30"
4.	Mike Aiello	Croton, NY	73° 46' 45" / 40°
5.	Jean-Claude Touzin	St. VitalQuebec	79° 10' / 48° 55'
6.	Bill Pine	Ontario, CA	117° 41' / 34° 14'
	Chaffey High School		
7	Dean Knight	Sonoma, CA	122° 33' / 38° 21'
	Sonoma Valley High School		
8	Mike Dormann	Seattle, WA	123.4° / 47.2°
9	Robert Moloch	Greentown, IN	85° 58' / 40° 28'
	Eastern Elementary School		
10	Bill Taylor	Washington, DC	77° 2' / 38° 54'
	INSPIRE		
11	Mark Mueller	Brown Deer, WI	87° 56' / 43° 10'
	Brown Deer High School		
12	Jon Wallace	Litchfield, CT	73° 15' / 41° 45'
13	Bill Combs	Crawfordsville, IN	86° 59' / 40° 4'
14	John Barry	West Lebanon, IN	87° 22' / 40° 18'
	Seeger High School		
15	Robert Bennett	Las Cruces, NM	106° 44' / 32° 36'
16	Leonard Marraccini	Finleyville, PA	80° 00' / 40° 16'
17	Kent Gardner	Fullerton, CA	117° 48' 30" / 34° 12' 13"
18.	David Jones	Columbus, GA	77° 07' / 35° 00'
19.	Larry Kramer / Clifton Lasky	Fresno, CA	119° 49' / 37° 01'
20.	Barry S. Riehle	Cincinnati, OH	84° 15' / 39° 7'
	Turpin High School		
21.	Phil Hartzell	Aurora, NE	98° 0' / 41° 0'
22.	Rick Campbell	Brighton, MI	83°50'2.7" / 42°16'43.7"
23.	Jim Ericson	Glacier, WA	121° 57.91' / 48° 53.57'
24.	Paul DeVoe	Redlands, CA	116° 52' / 34° 10'
	Redlands High School		
25	Norm Anderson	Cedar Falls, IA	92° 15' / 42° 20'
26	Brian Page	Lawrenceville, GA	83° 45' / 34° 45'
27	Ron Janetzke	San Antonio, TX	98° 47' / 29° 35'
28	Thomas Earnest	San Angelo, TX	100° 25' / 31° 16'
29	Janet Lowry	Houston, TX	95° / 29°
30	Linden Lundback	Watrous, Sask	105° 22' / 51° 41'

European observers:

Team #	Observer	Location	Longitude/Latitude
E1	Flavio Gori	Florence, IT	11° 50' 18" E / 43° 50' 18" N
E2	Silvio Bernocco	Torino, IT	7° 12' E / 44° 54' N
E3	Fabio Courmoz	Aosta, IT	7.7° E / 45.7° N
E4	Joe Banks	London, UK	0° / 50° 52' N
E5	Renato Romero	Cumiana, IT	7° 24' E / 49° 57' N
E6	Marco Ibridi	Finale E., IT	11° 17' E / 44° 50' N
E7	Alessandro Arrighi	Firenze, IT	10° 57' 50" E / 43° 43' 21" N
E8	Zeljko Andreic Rudjer Boskovic Institute	Zagreb, Croatia	
E9.	Dr. Valery Korepanov Lviv Center of Institute of Space Research of NASU	Lviv, UKRAINE	24° E / 50° N
E10.	Sarah Dunkin University College London	London, England	0° 02' E / 51° 40' N

New Observers (11/97):

31 Lee Benson — Indianapolis, IN

Longitude: 86° 3' W
Latitude: 39° 23' N
North Central Camp Atterbury, 50 miles S. of Indianapolis
Receiver: INSPIRE VLF-2
Recorder: Sony TCS-580V Stereo
Antenna: 4 ft. shielded loop, Top 11' AGL, 2nd part, 12 ft vert wire
WWV: Sony ICF-SW7600G

32 Shawn Korgan — Gilcrest, CO

Longitude: 104° 67' W
Latitude: 40° 22' N
Open area, 50 ft from paved road, one mile from power lines
Receiver: TL071 op-amp (home made)
Recorder: Sharp RT-22
Antenna: 8 foot whip mounted on car
WWV: PRO-60

INTMINS - April/99 Data Analysis Report

by Bill Pine
Chaffey High School
Ontario, CA

The April/99 INTMINS observations marked the ninth session in an ongoing series of operations conducted with the cooperation and assistance of the Russian Space Agency (IKI) and ENERGIA, the Russian space engineering organization. INTMINS is an attempt to detect manmade VLF radio waves emitted by instruments on the MIR Space Station.

INTMINS Status Report

The orbit of MIR remained stable during the time between the establishment of the operation schedule and the operations themselves. No modification of the start times was necessary.

The bottom line of the analysis remains unchanged: the VLF signal from the pulsed electron beam was not detected on the ground. This is not an unsurprising result since theoretical calculations of the signal of the power of ISTOCHNIK when propagated to the ground place the signal strength at just about the same as the background of natural VLF. We will continue with INTMINS as long as the Russian Space Agency (IKI) and MIR are able to provide observing opportunities for us. It is beginning to look like (even to an optimist!) the beam strength of ISTOCHNIK is inadequate to propagate a VLF signal to the ground that can be detected by our receivers. In the future, perhaps on the International Space Station, maybe a more powerful electron gun will be available for us to use in this ongoing investigation.

Data Analysis Procedure

The data analysis procedure used consisted of the following:

1. A sound file was created of the 2-minute period of ISTOCHNIK operation.

2. A spectrogram image was made of this file using a frequency range of 0-22.05 kilohertz so that the 12-15 kilohertz range could be examined for the presence of Russian Alpha navigation signals. The 1 kilohertz region of the spectrogram was examined for the 10 seconds on, 10 seconds off signal from ISTOCHNIK.

3. A one-minute portion of the file was cropped, enlarged and an image made using a 0-11.025 kilohertz frequency range. Again the 1 kilohertz region of the spectrograph was examined.

4. Finally, a 30-second portion was cropped, enlarged and an image made. A final examination of the 1 kilohertz region was made.

5. Additional sound files and spectrogram images were made of items of interest noted in the logs.

INTMINS-November/98 Operations Summary

(NOTE: All times are UT on the date indicated.)

European Passes

Pass	ISTOCHNIK Start Time	Path during ISTOCHNIK Firing	Number of Observers Recording Data
E17-1	0824	Central ITALY	0
E17-2	1004	RUSSIA, South of Moscow	0
E17-3	1133	ENGLAND	0
E17-4	1309	ENGLAND	0
E18-1	0853	RUSSIA, South of Moscow	0
E18-2	1028	RUSSIA, South of Moscow	0
E18-3	1201	CROATIA	0
E24-1	0622	West-Central ITALY	0
E24-2	0935	CROATIA	0
E24-3	1109	Northern ITALY	0
E25-1	0510	Central ITALY	1
E25-2	0650	RUSSIA, South of Moscow	1
E25-3	0819	ENGLAND	0
E25-4	0959	South of CROATIA	0

North American Passes

Pass	ISTOCHNIK Start Time	Path during ISTOCHNIK Firing	Number of Observers Recording Data
17-5	1425	TX, OK	4
17-6	1558	So. CA	4
17-7	1742	QUEBEC	3
17-8	2054	VA, NC, SC	0
17-9	2220	WA, OR	1
18-4	1318	VA, DC, MD, DE	4
18-5	1448	AZ, NM	2
18-6	1621	No. CA	4
18-7	1757	WA	1
18-8	1942	PA, MD	1
18-9	2116	MO, MS, AL, FL	1
24-4	1226	IA, WI	1
24-5	1355	No. CA	4
24-6	1532	WA	2
24-7	1716	PA, MD	1
24-8	1847	WY, NE, KS	2
25-5	1249	SD, MN	2
25-6	1427	QUEBEC	3
25-7	1602	QUEBEC	1
25-8	1737	IA, IL, IN	1
25-9	1912	TX	3
25-10	2043	CA	2

Summary of European Passes Recorded

Team/Pass	E17-1	E24-1	E24-3	E25-1	E25-2
E1				x	x
E5	x	x	x	x	

Summary of North American Passes Recorded

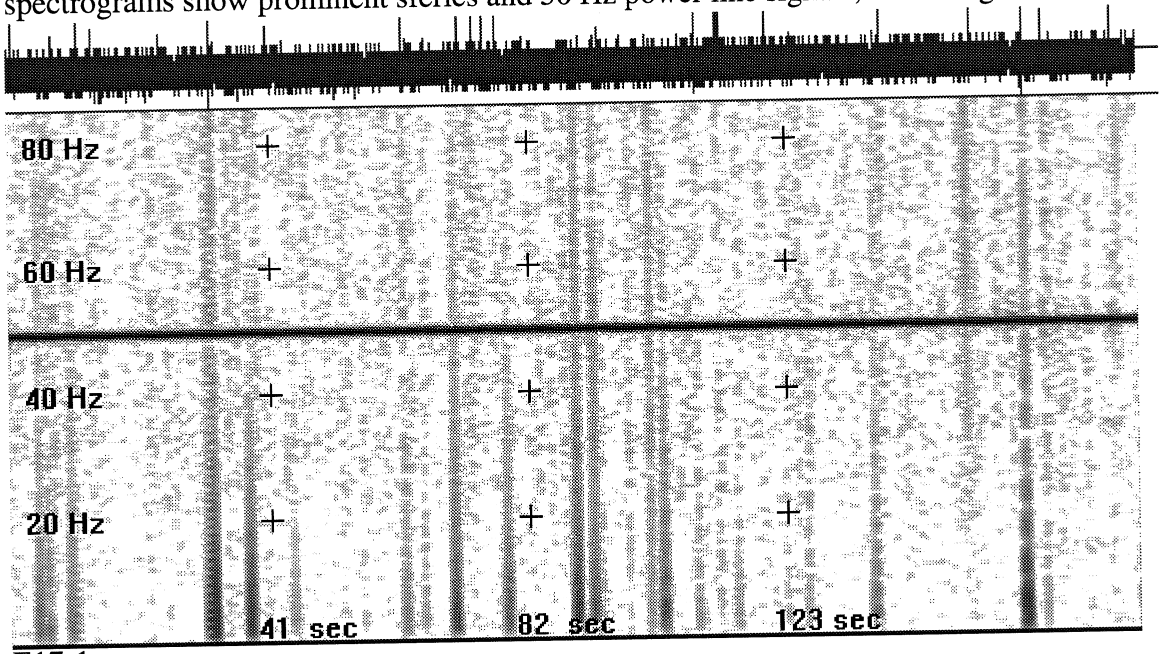
Pass	4/17					4/18						4/24					4/25					
	5	6	7	8	9	4	5	6	7	8	9	4	5	6	7	8	5	6	7	8	9	10
Team																						
1	x																				x	
5			x															x	x			
6		x						x					x									x
7		x						x					x									x
15	x	x	x			x	x	x					x	x	x	x						
16						x				x												
18						x					x										x	
21													x			x						
25												x										
27	x																					
28	x																				x	
30		x	x		x			x	x					x			x	x				
31																				x		
32						x	x										x	x				

INTMINS Data

The following spectrograms are taken from data tapes submitted by INSPIRE observers. The first view shown will be that of the entire two-minute interval analyzed. At the top of the image is the sound filename which consists of the Team Number, operation number, and the start time of the operation. Subsequent views will be of portions of the first. Use the time scale at the top to determine the length of the view. Use the frequency scale on the left to determine the frequency range used for that view. Unless otherwise noted, the start time of the cropped view is the same as the start time of the operation.

E17-1

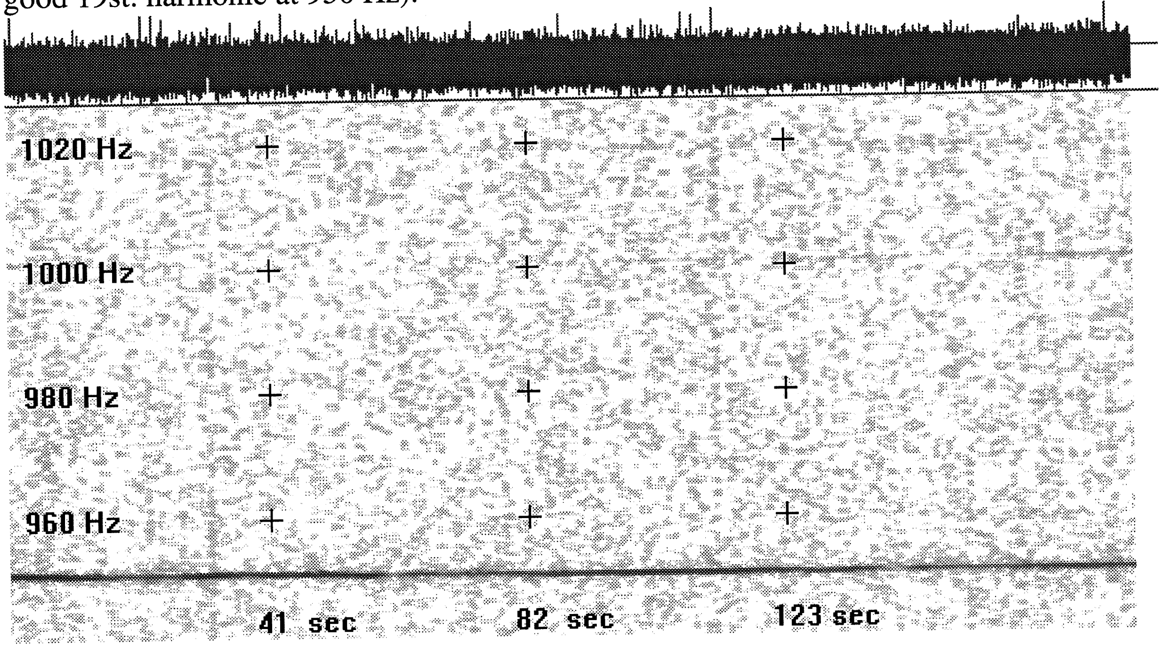
Renato romero, Team E5, submitted spectrograms of his data. He looked at the 10 Hz range and the 1 kHz range for the signals from Ariel and ISTOCHNIK, respectively. His spectrograms show prominent sferics and 50 Hz power line signals, but no signals from MIR



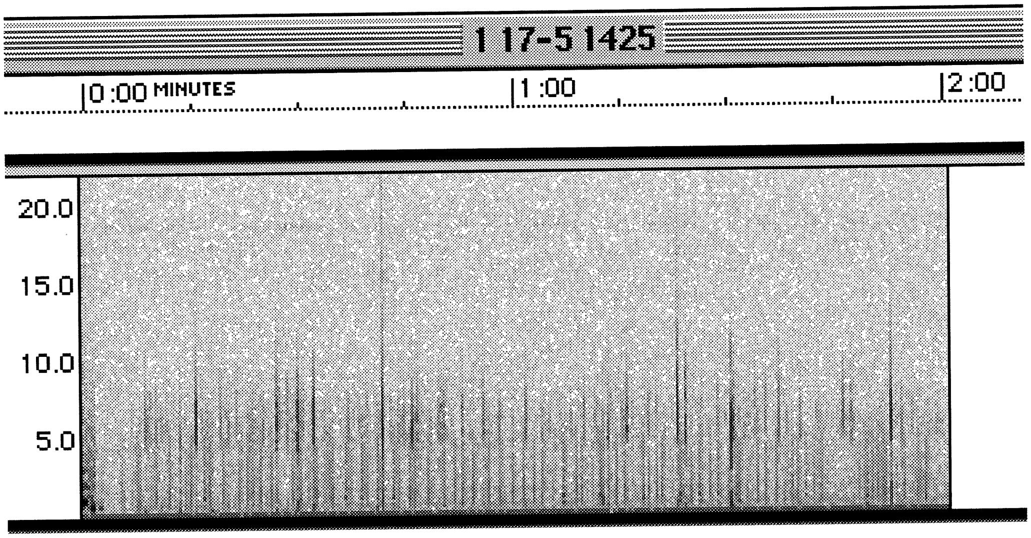
E17-1

Europe 5, R. Romero ñ Pass 17/1 ñ 17/04/99 from 08:24:00 to 08:27:00
Spectrum analisys: 0 ñ 86 Hz
Nothing at 10 Hz, strong 50 Hz tone.

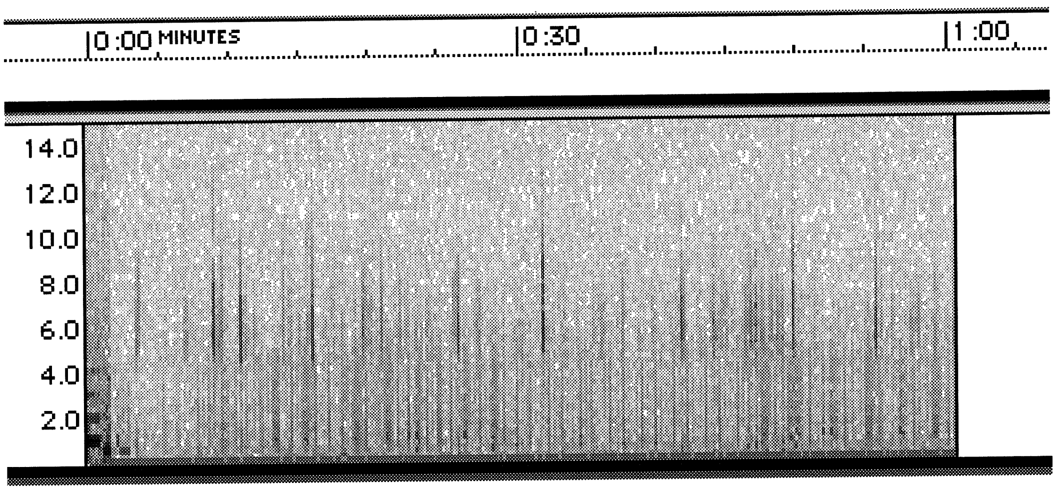
Europe 5, R. Romero ñ Pass 17/1 ñ 17/04/99 from 08:24:00 to 08:27:00
Spectrum analisys: 940 ñ 1030 Hz
Nothing at 1000 Hz (only a weak 20st.harmonic of 50 Hz at 1000 Hz at the end of sonogram, and good 19st. harmonic at 950 Hz).

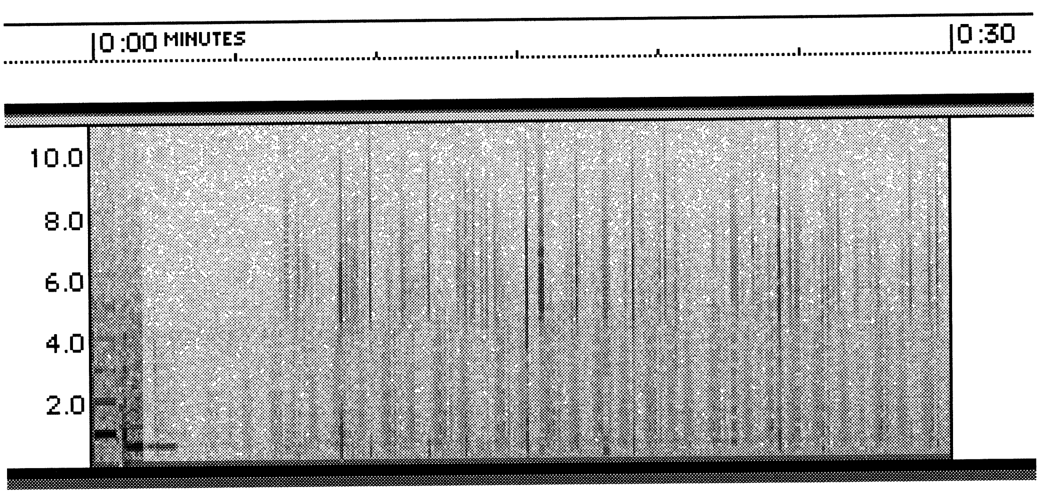


17-5

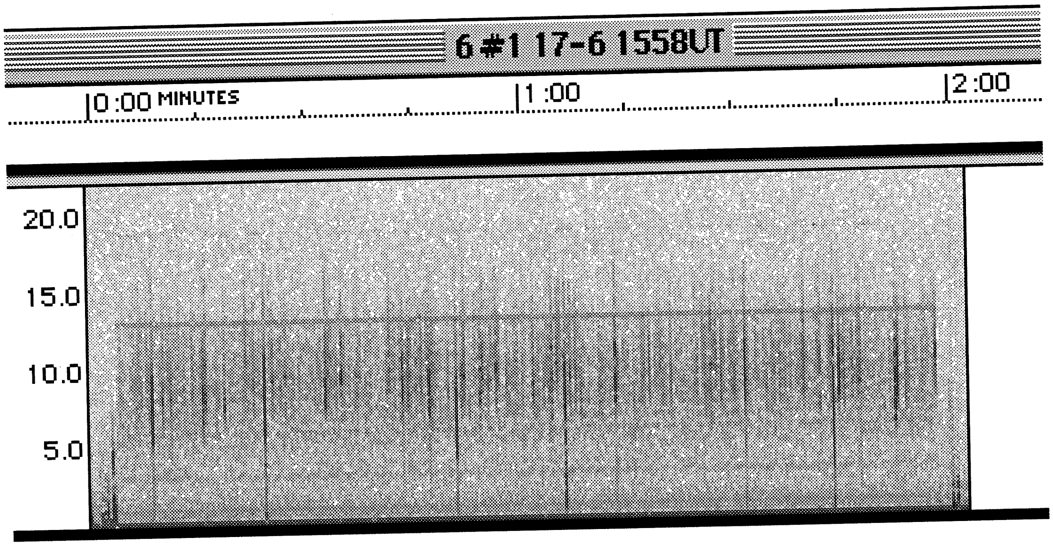


Team 1. Jack Lamb, Belton, TX
Good sferics shown. This was a quiet day in the middle of the country.

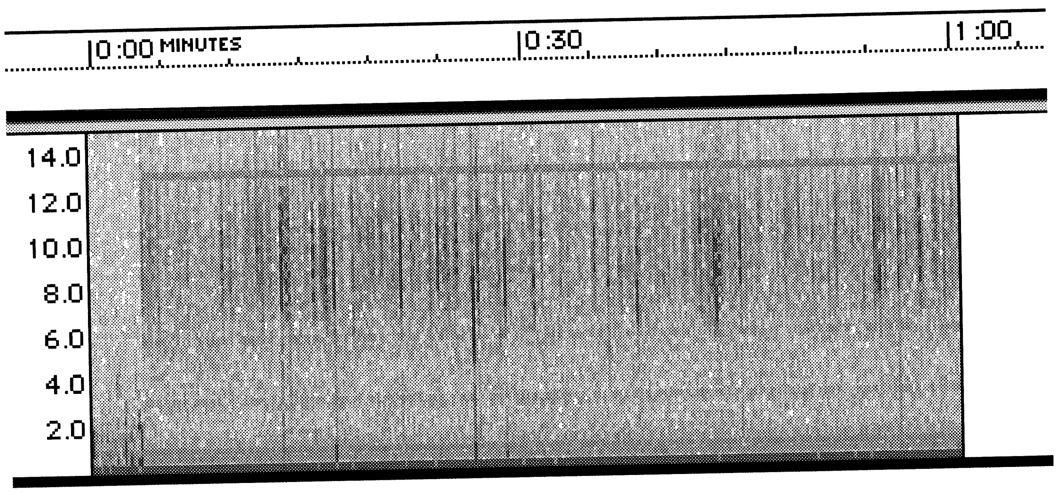




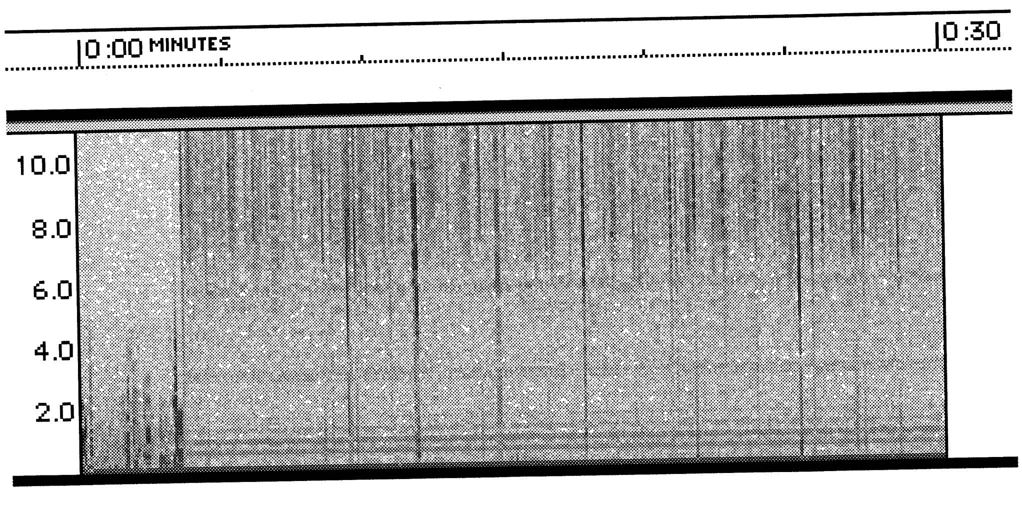
1425 UT WWV 1 kHz tone and several harmonics are present at the start.

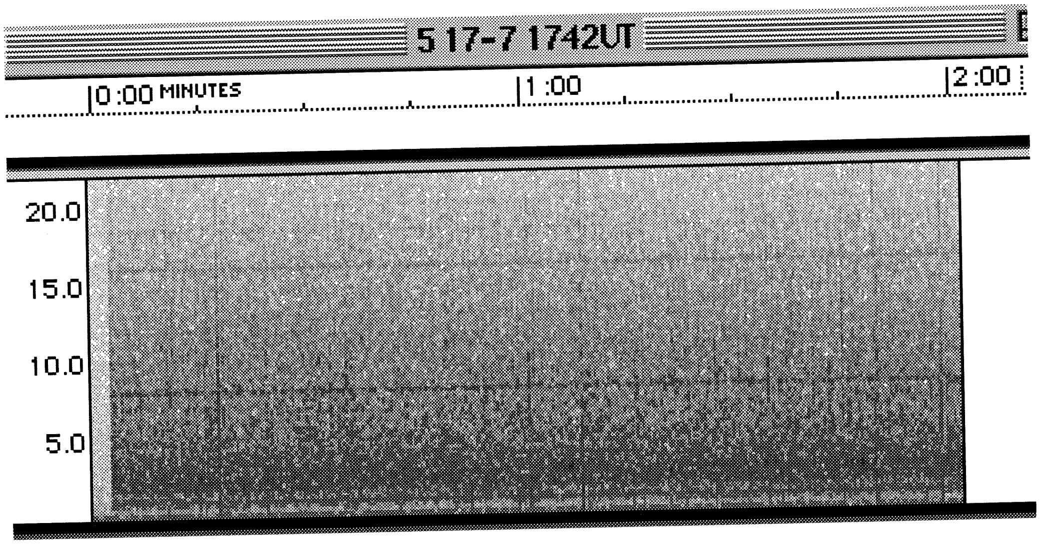


Team 6 Bill Pine, Chaffey High School, Ontario, CA
Receiver #1 is a B-field receiver with a 1 meter square loop with 90 turns, center tapped.
Quiet conditions.

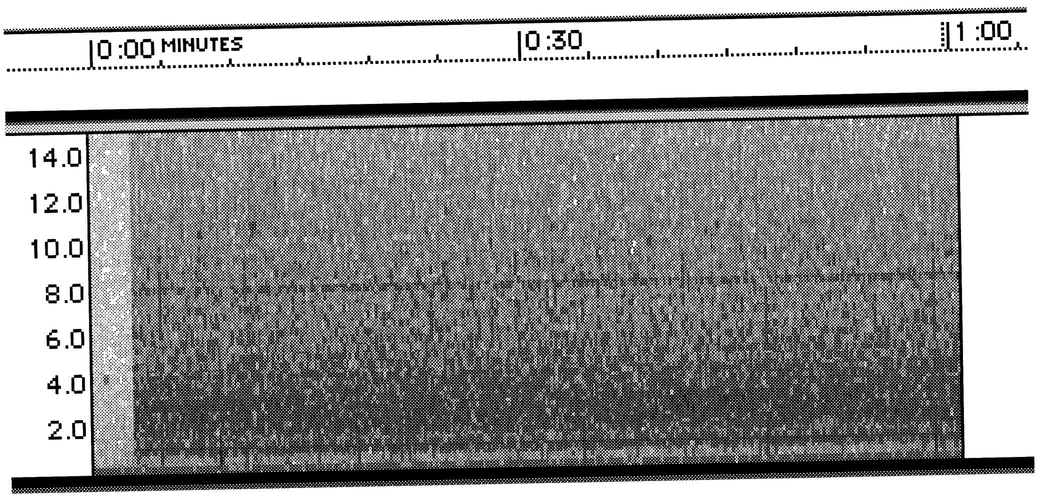


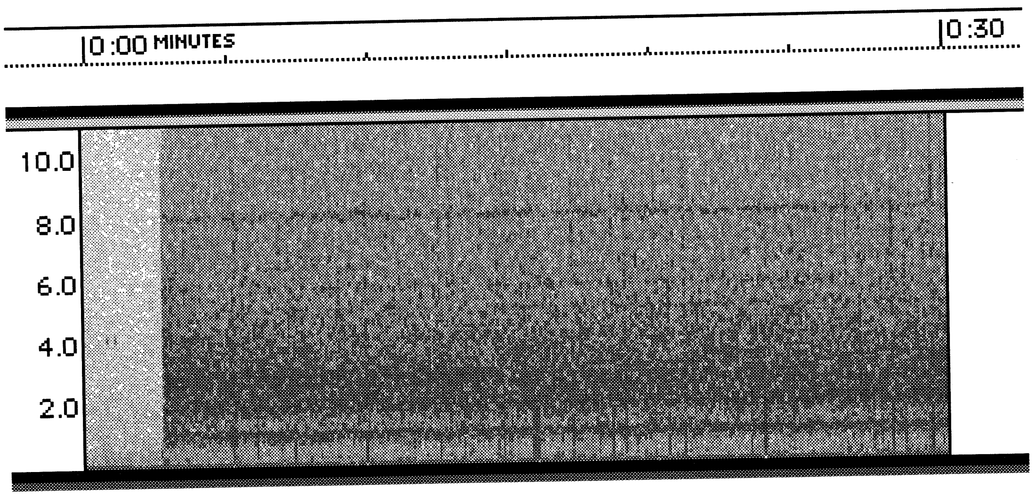
Strong sferics present, low density.





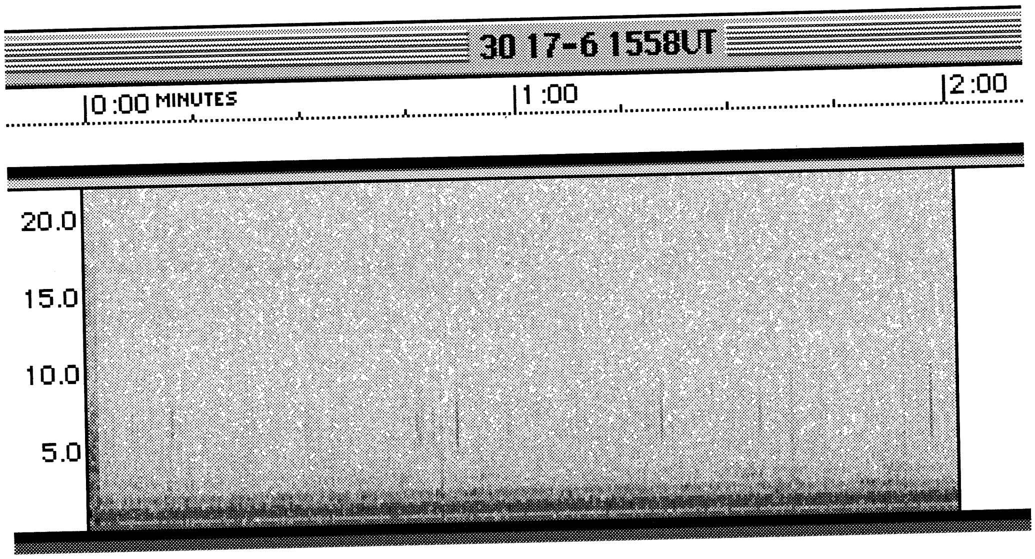
Team 5 Jean-Claude Touzin, St. Vital, Quebec, CANADA
Strong and persistent chorus was present during this session.



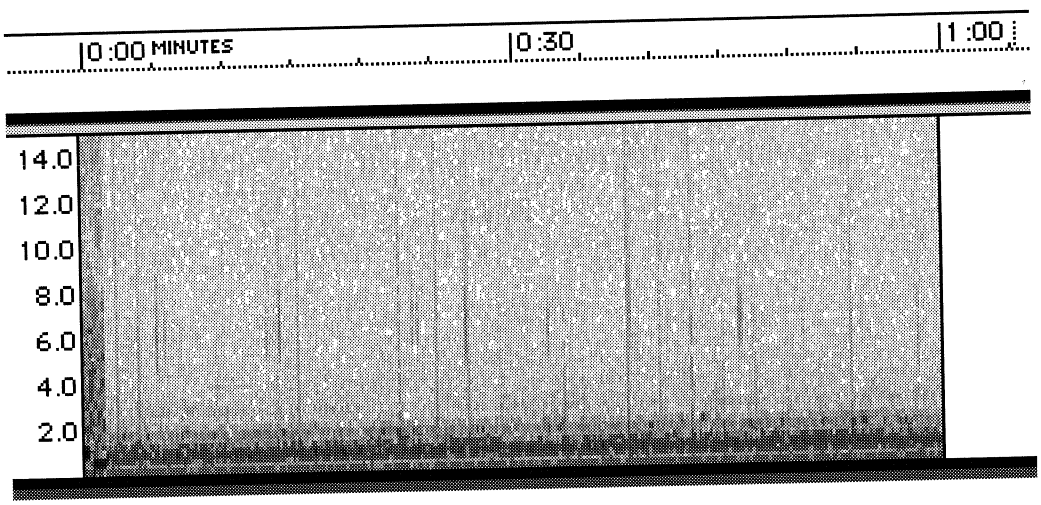


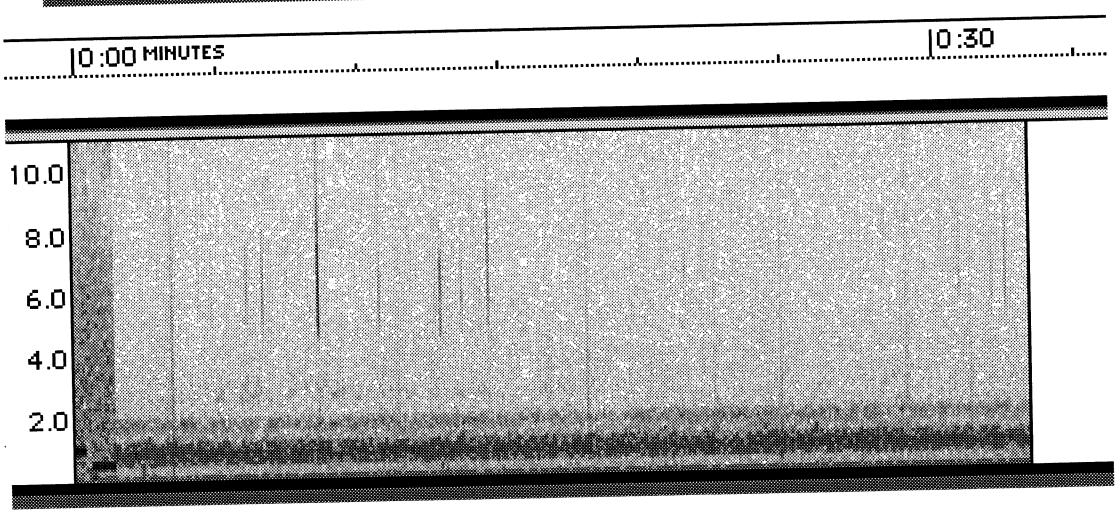
Chorus is not easy to see in spectrograms. This session had quite a bit of hiss-type noise that obscures the lower frequencies where chorus is found.

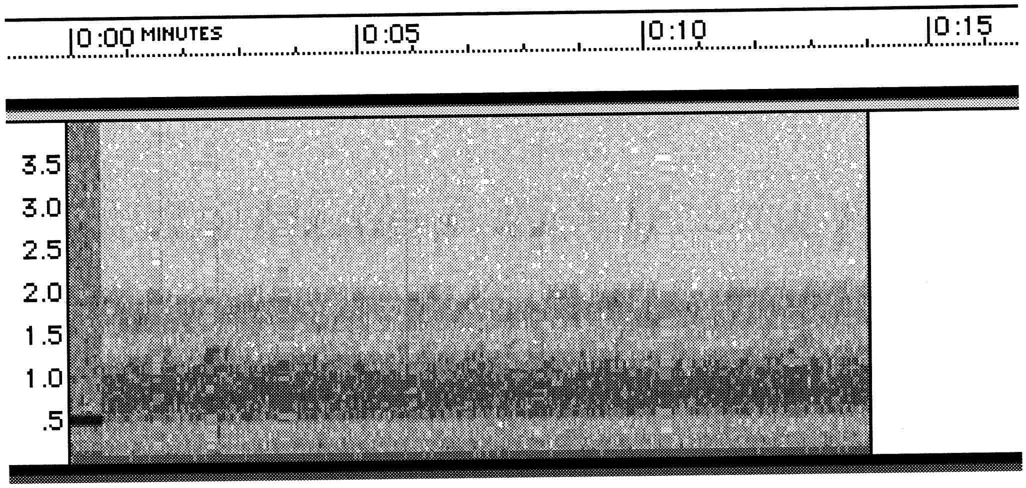
17-9



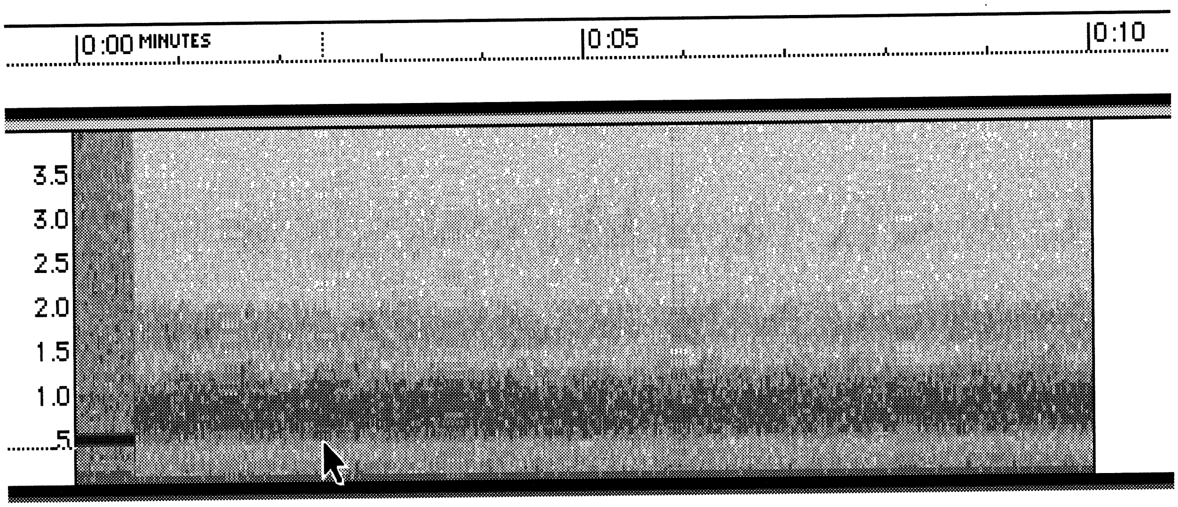
Team 30 Linden Lundback, Watrous, Saskatchewan, CANADA
Quiet sferics conditions with lots of chorus and risers. Some faint whistlers.



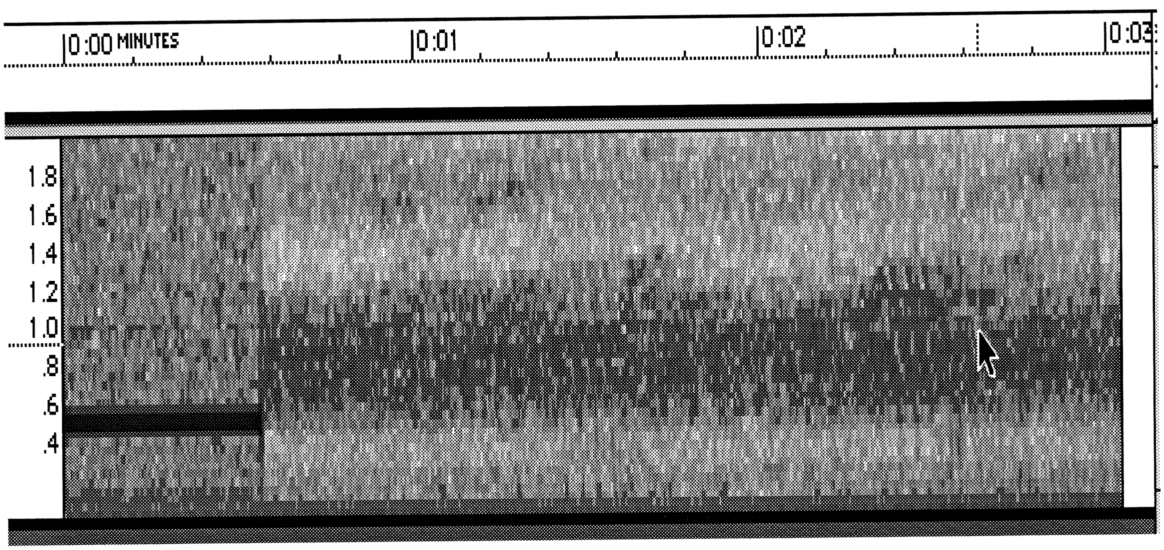




First few seconds of operation. Chorus is down below 2 kHz.

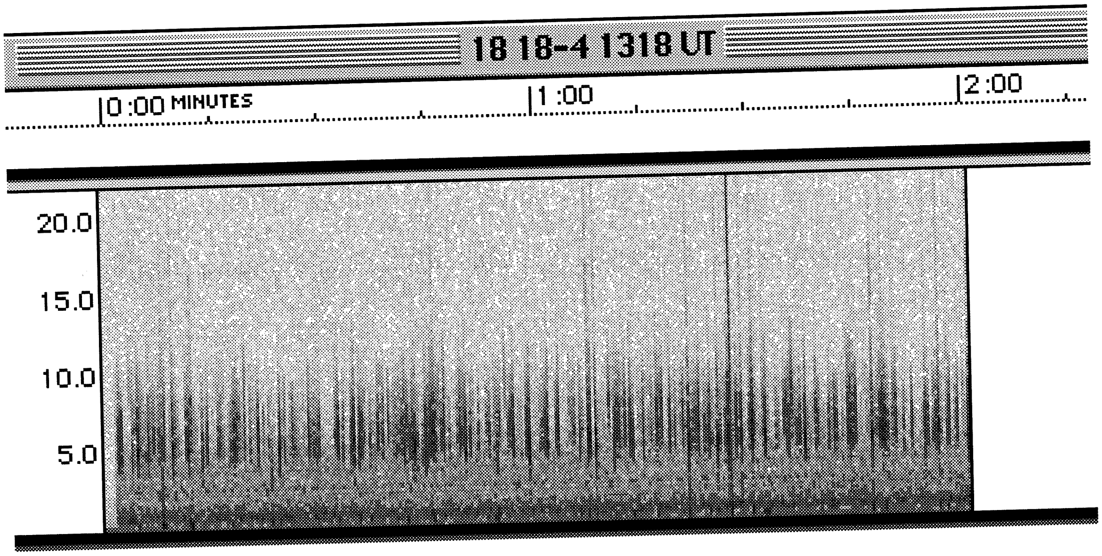


Arrow shows a riser. Note the signal up toward 2 kHz.

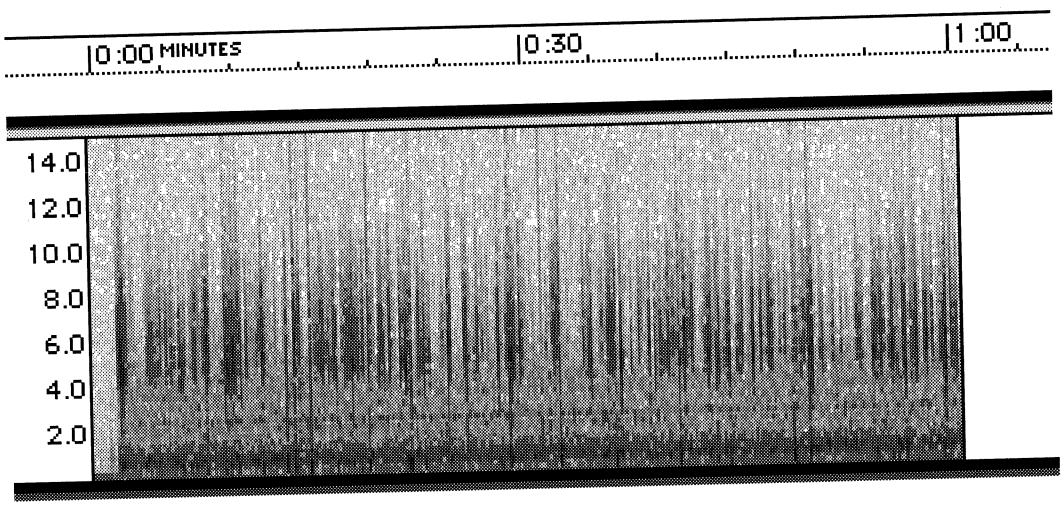


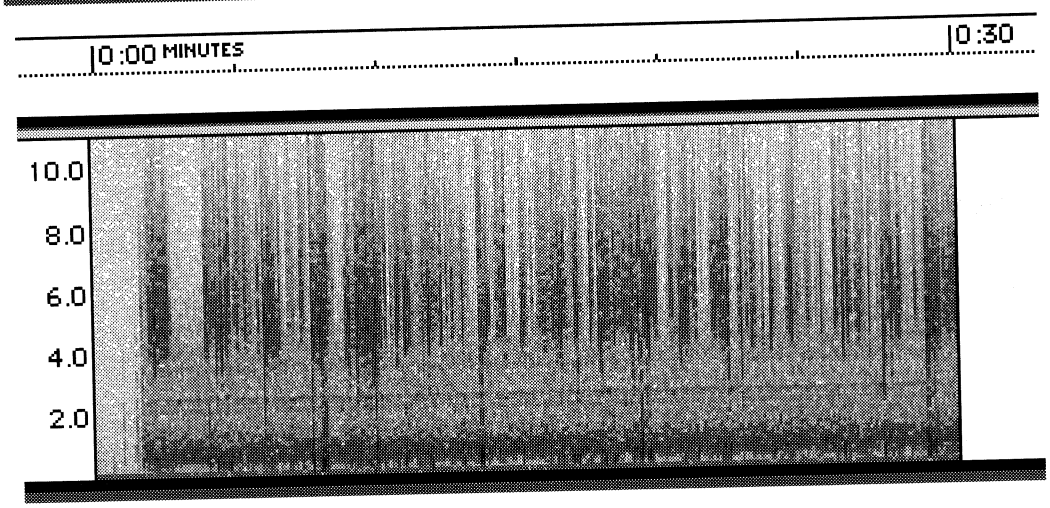
Closeup of riser. When the signal band bulges up in frequency, that is the riser.

18-4

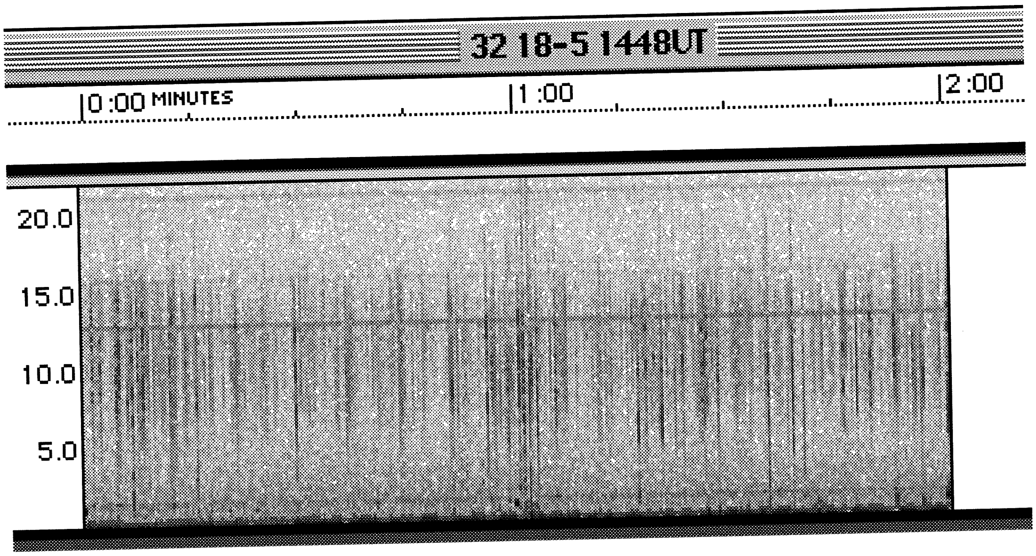


Team 18 David Jones, Columbus, GA
Good signal. Lots of whistlers.

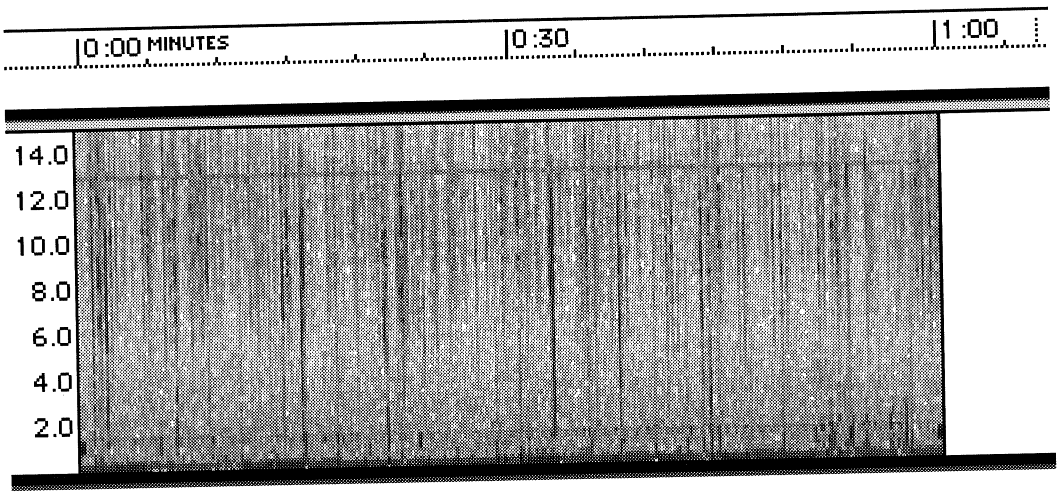


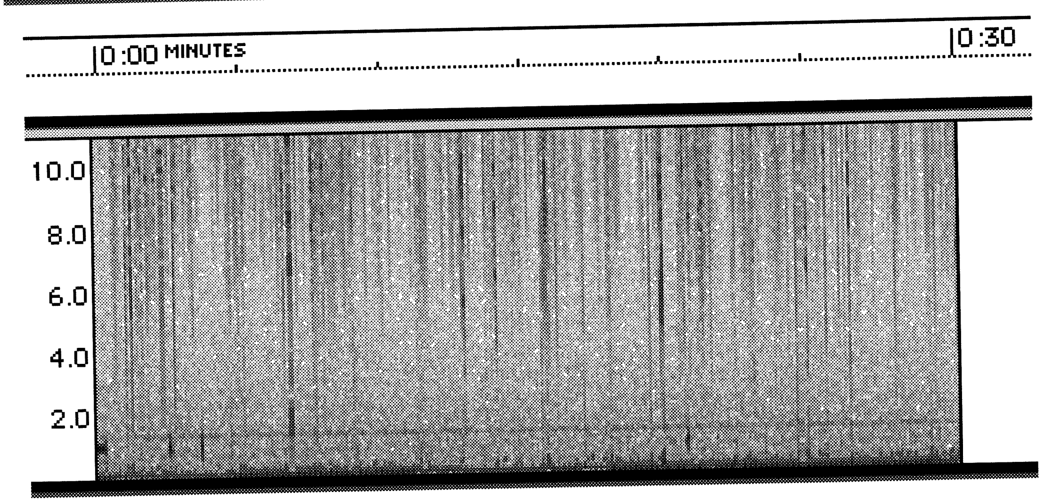


18-5

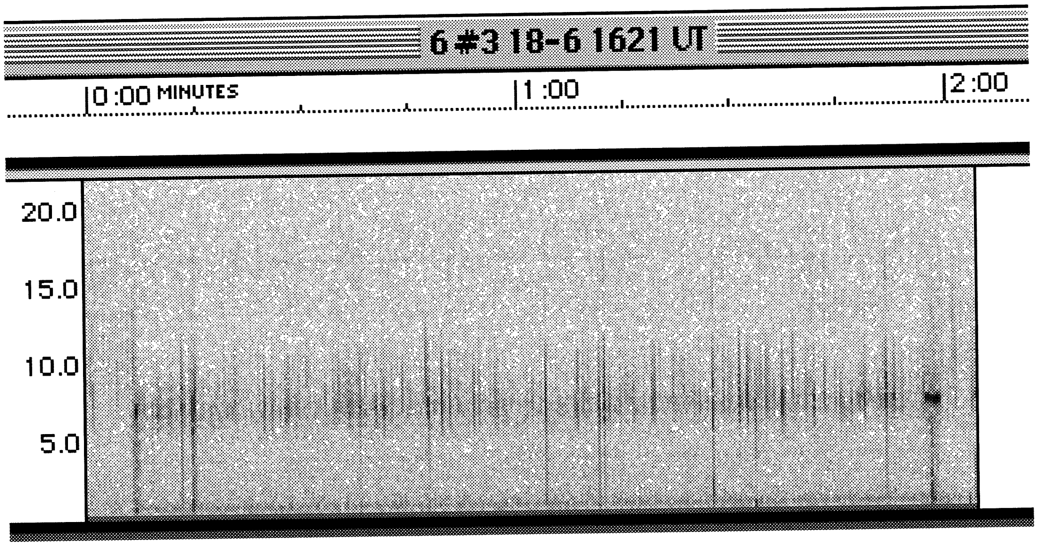


Team 32 Shawn Korgan, Gilcrest, CO
Strong signal. Whistlers present.

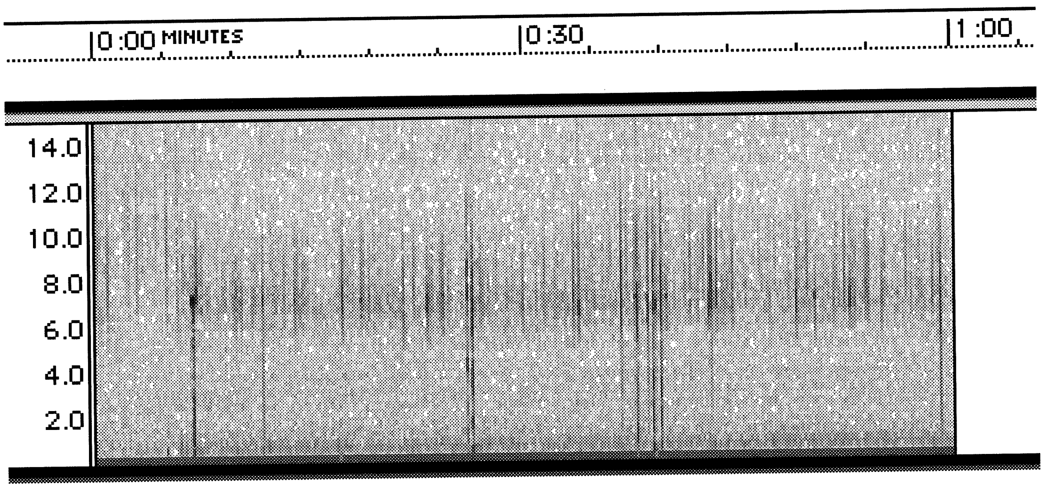


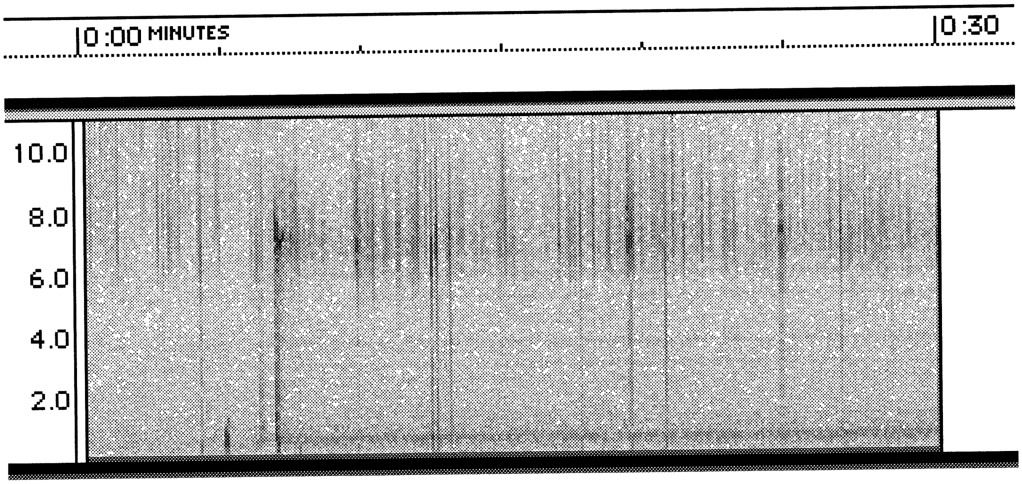


18-6

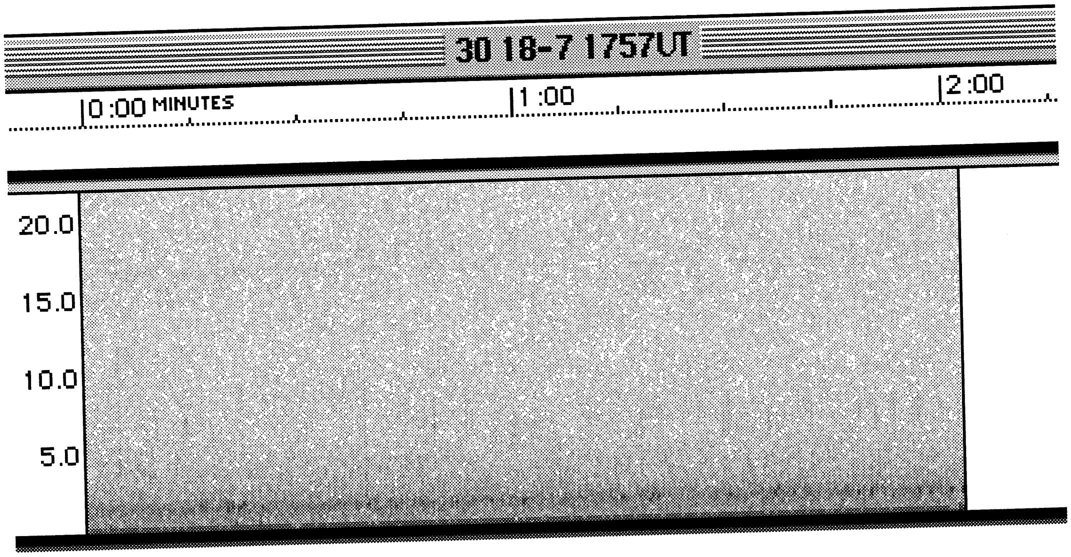


Team 6 Bill Pine, Chaffey high School, Ontario, CA
Quiet conditions.

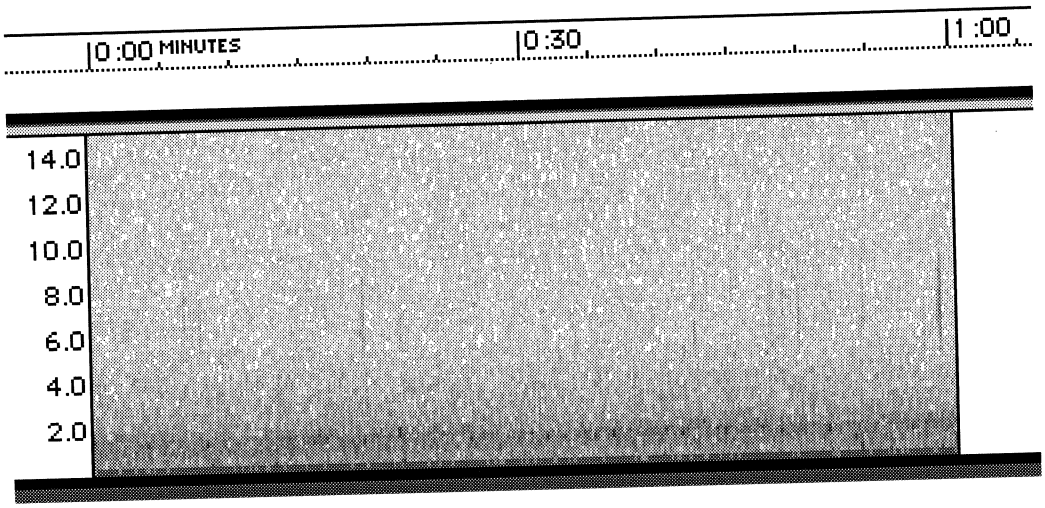


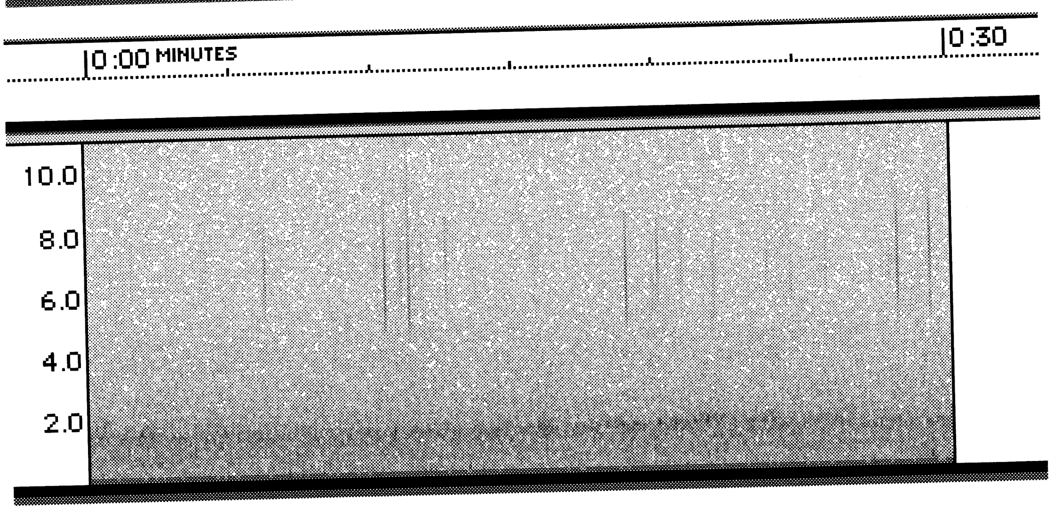


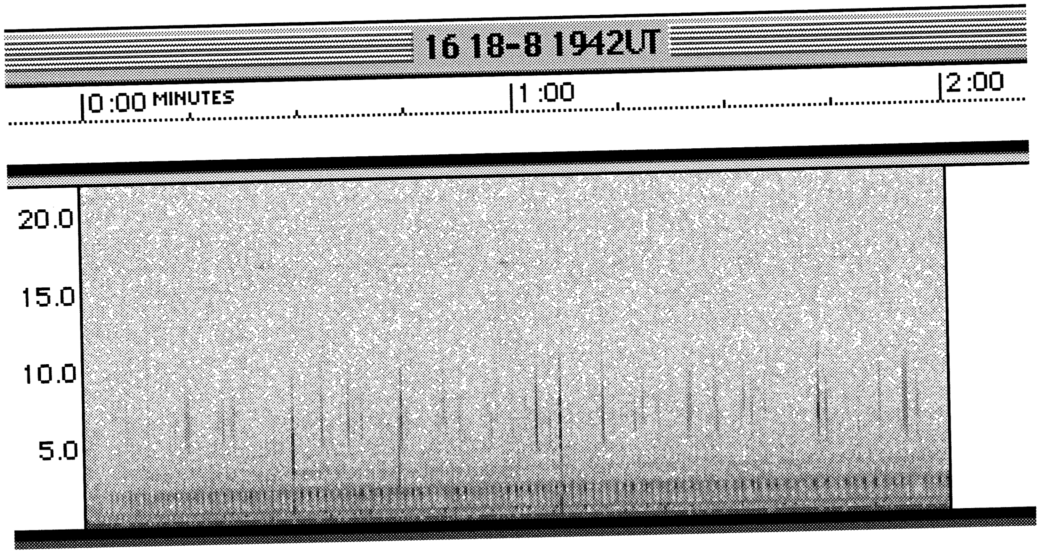
18-7



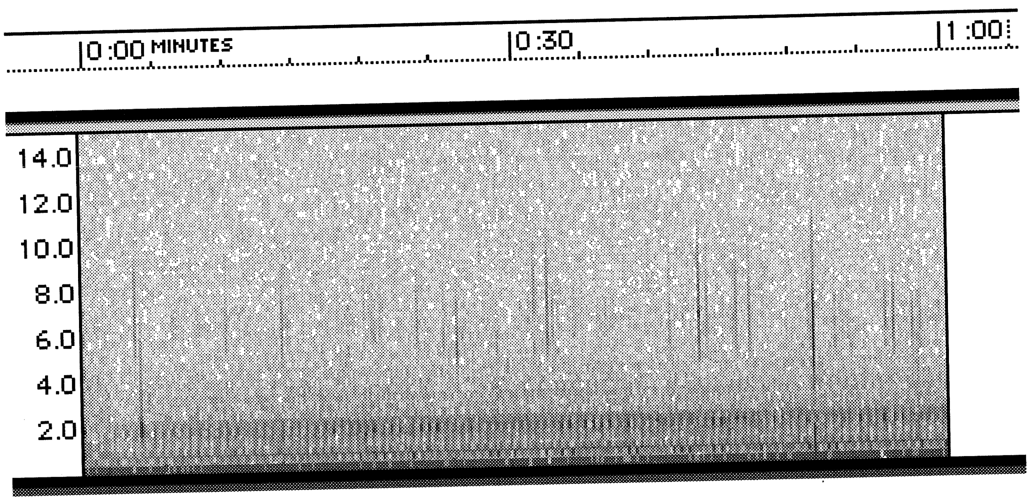
Team 30 Linden Lundback, Watrous, Saskatchewan, CANADA
Quiet conditions.

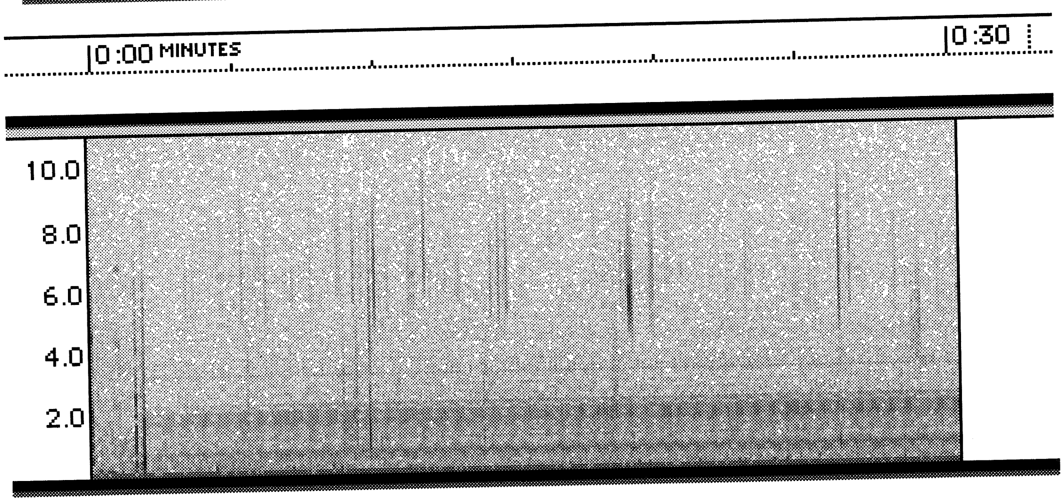




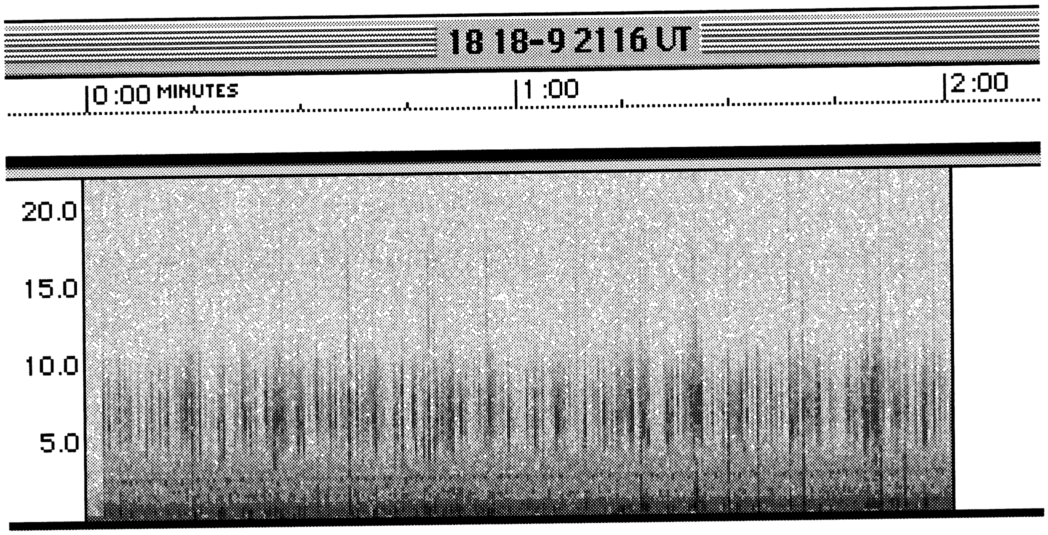


Team 16 Leonard Marraccini Finleyville, PA
Quiet conditions.

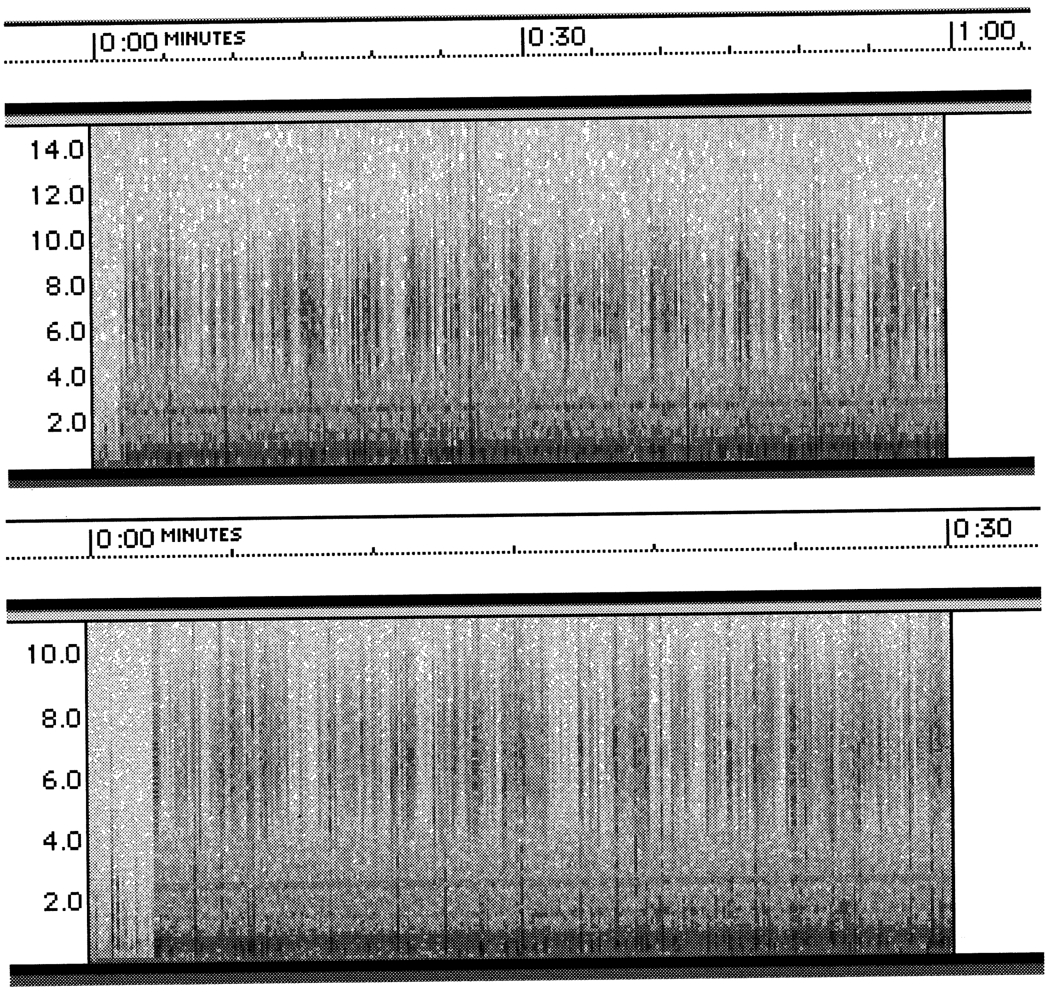




18-9

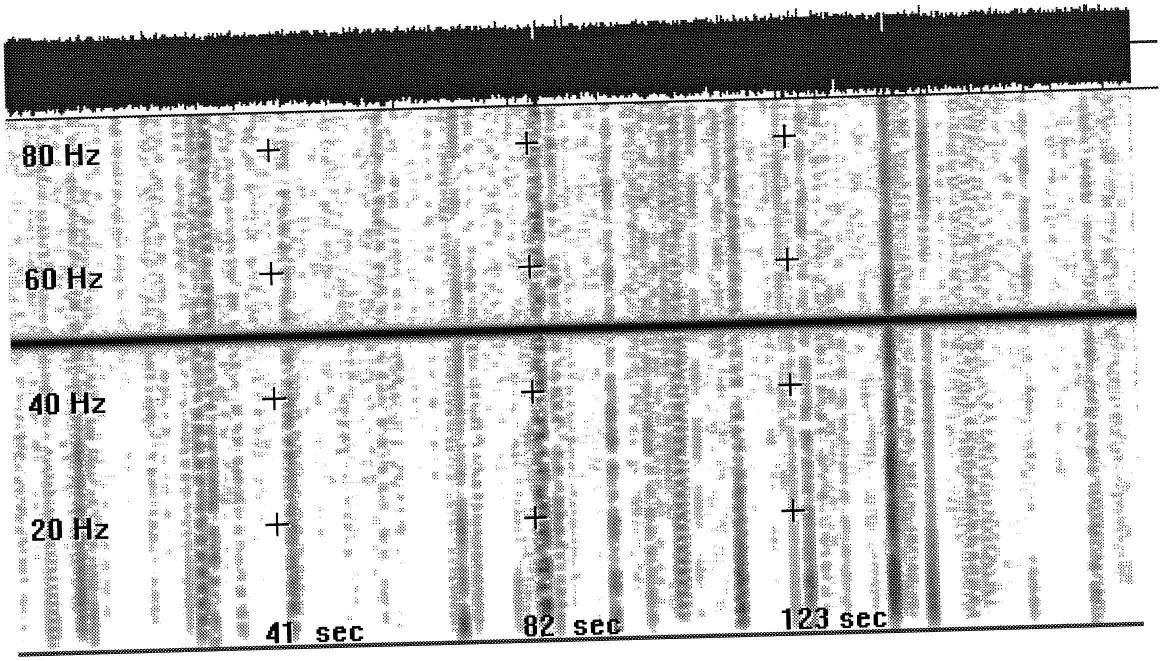


Team 18 David Jones, Columbus, GA
Strong signal. Many whistlers logged.



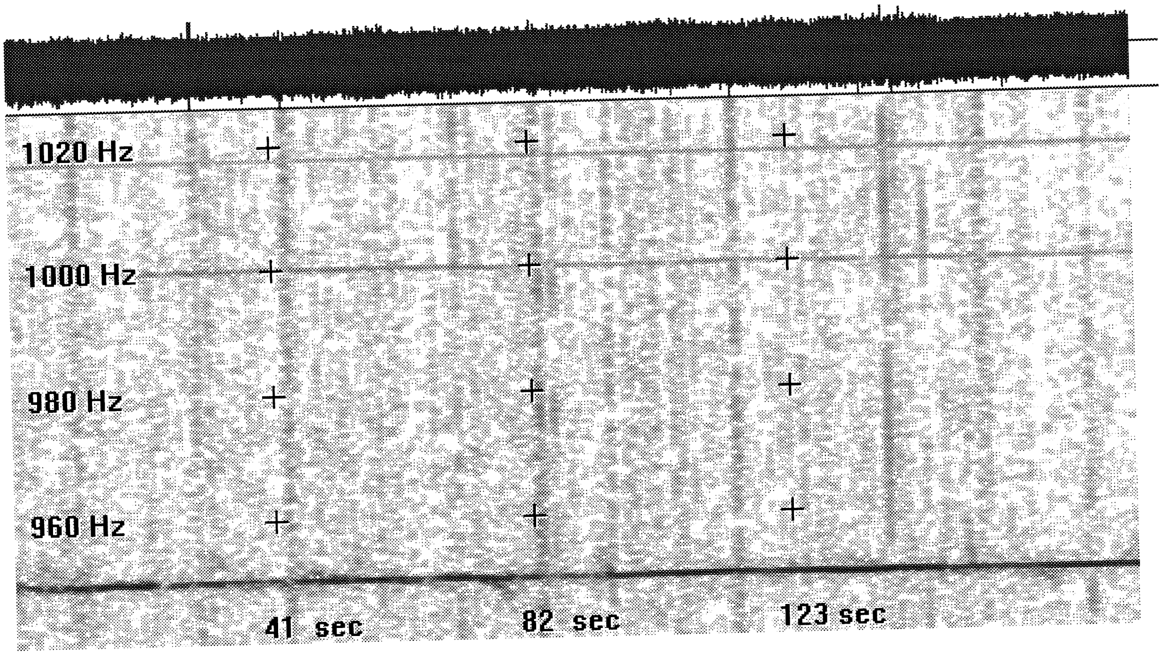
E24-1

Team E5 Renato Romero Cumiana, ITALY



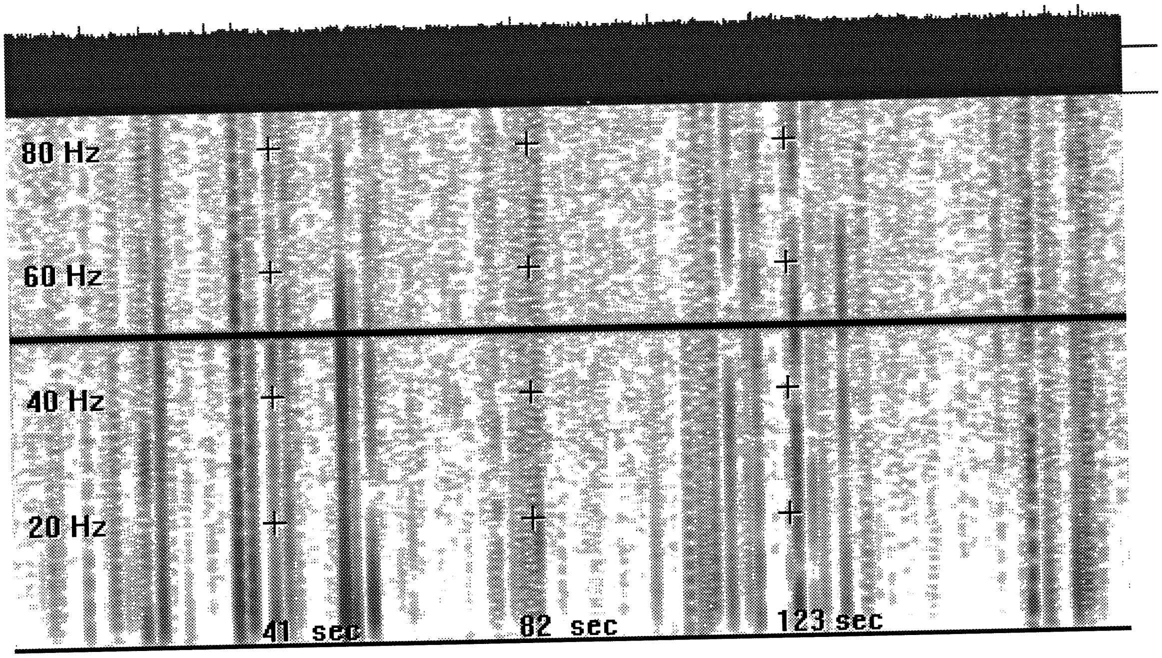
E24-1
Europe 5, R. Romero ñ Pass 24/1 ñ 24/04/99 from 08:22:00 to 08:25:00
Spectrum analisys: 0 ñ 86 Hz
Nothing at 10 Hz. Strong 50 Hz tone.

Europe 5, R. Romero ñ Pass 24/1 ñ 24/04/99 from 08:22:00 to 08:25:00
Spectrum analisys: 940 ñ 1030 Hz
Harmonics of 50 Hz at 950 and 1000 Hz. Continuos tone at 1018 Hz.



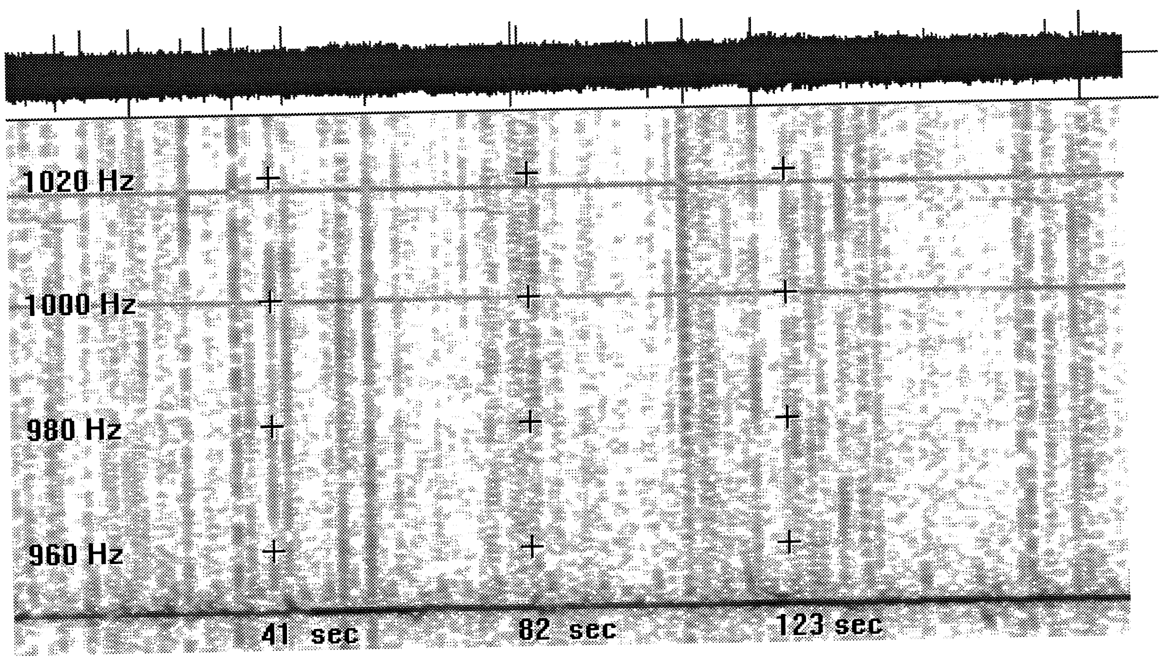
E24-3

Team E5   Renato Romero   Cumiana, ITALY

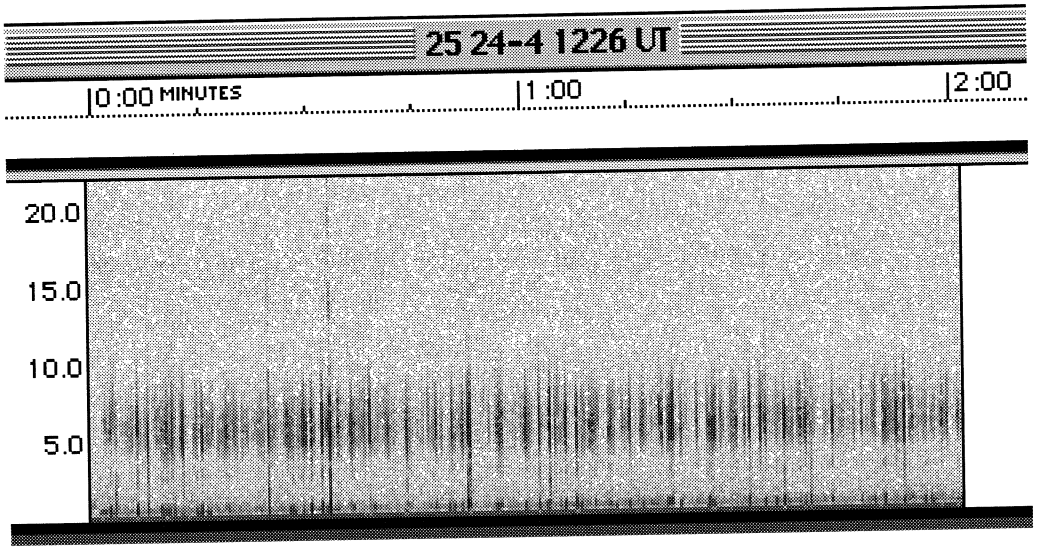


24-3
Europe 5, R. Romero ñ Pass 24/3 ñ 24/04/99 from 13:09:00 to 13:12:00
Spectrum analisys: 0 ñ 86 Hz
Nothing at 10 Hz. Strong 50 Hz tone.

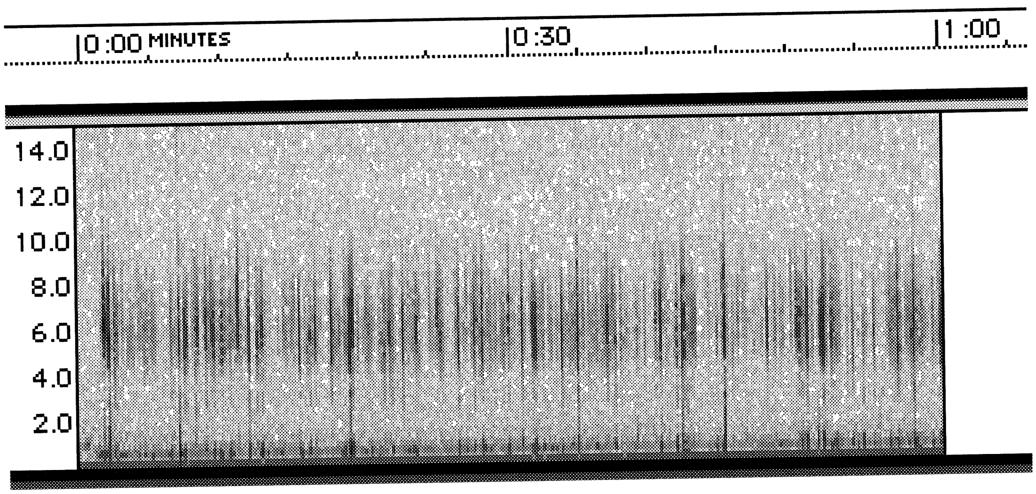
Europe 5, R, Romero ñ Pass 24/3 ñ 24/04/99 from 13:09:00 to 13:12:00
Spectrum analisys: 940 ñ 1030 Hz
Harmonics of 50 Hz at 950 and 1000 Hz. Continuos tone at 1018 Hz and weak unstable tone at 1015 Hz.

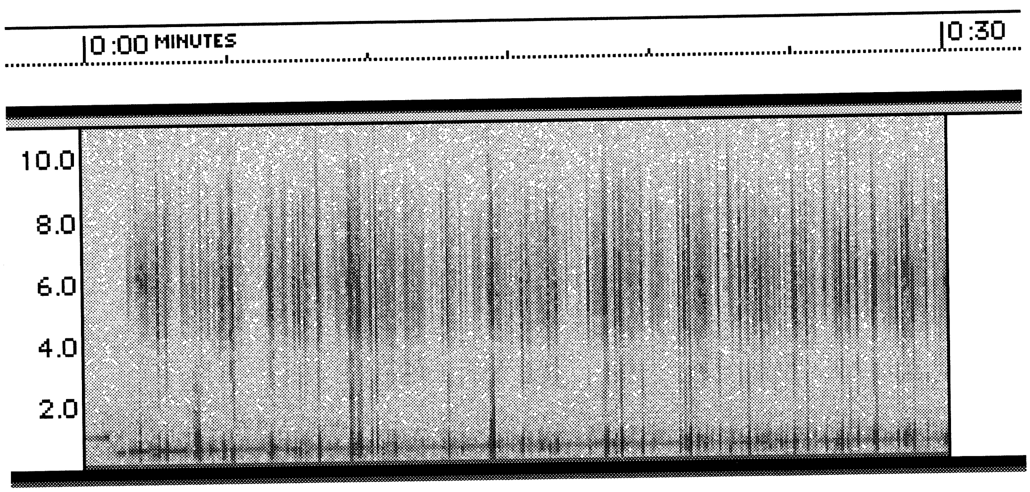


24-4

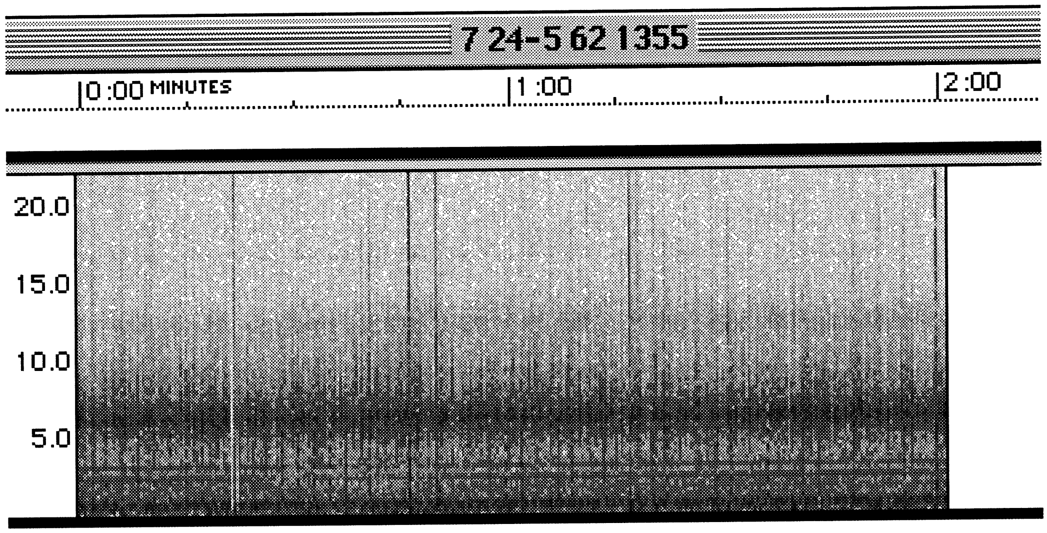


Team 25 Norm Anderson Cedar Falls, IA
Good sferics. Generally noisy conditions.

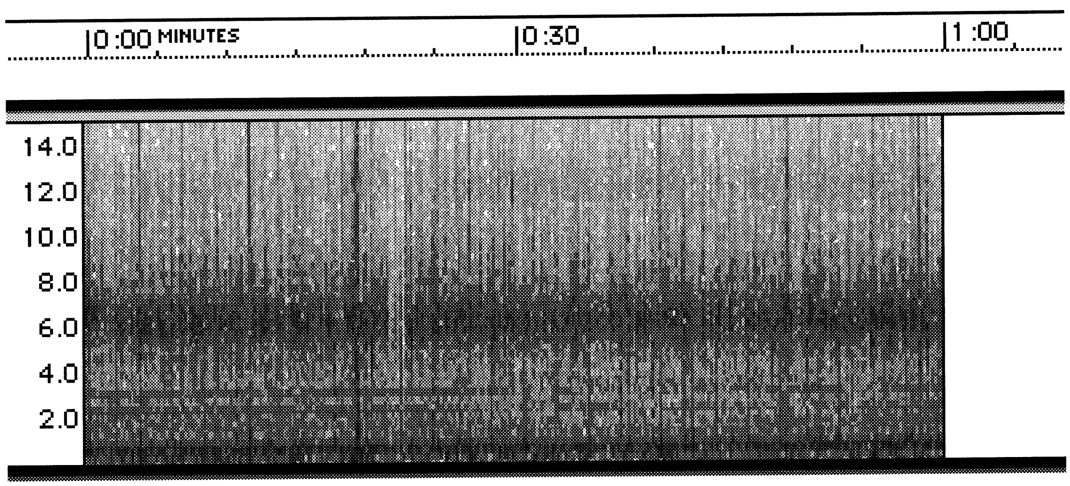


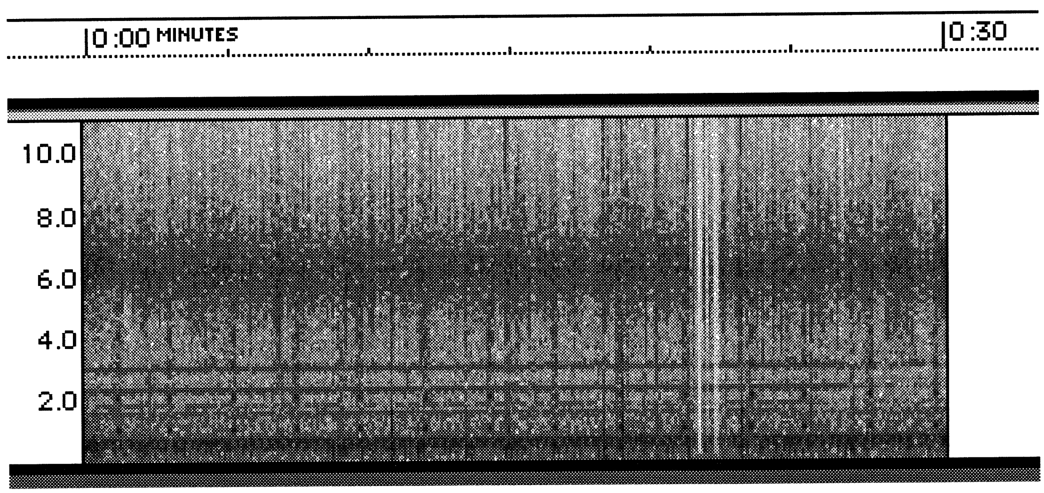


24-5

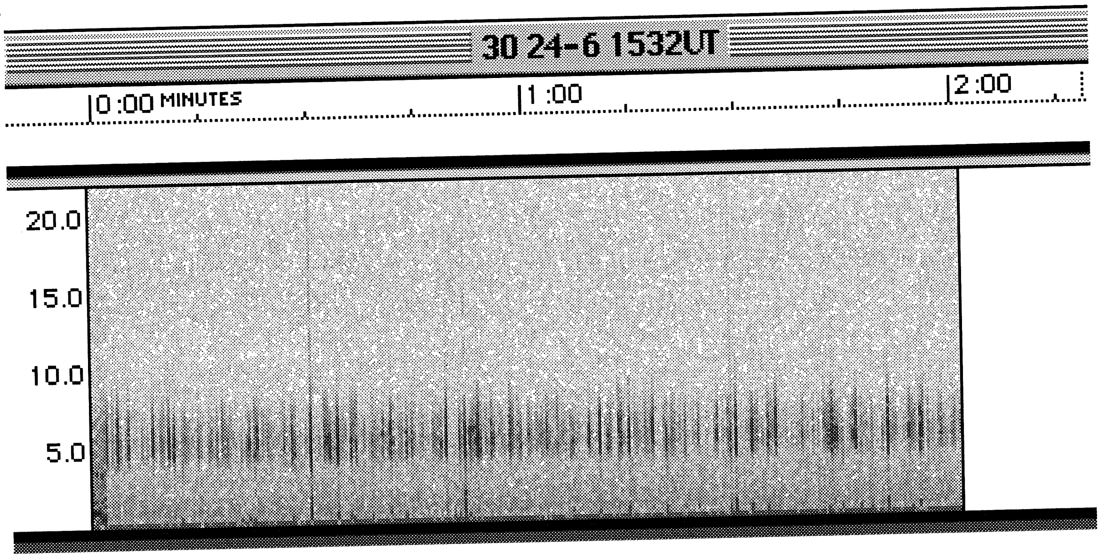


Team 7 Dean Knight Sonoma Valley High School, Sonoma, CA
Dense sferics. This receiver is very sensitive.
Note the hum lines even though the site is very quiet.

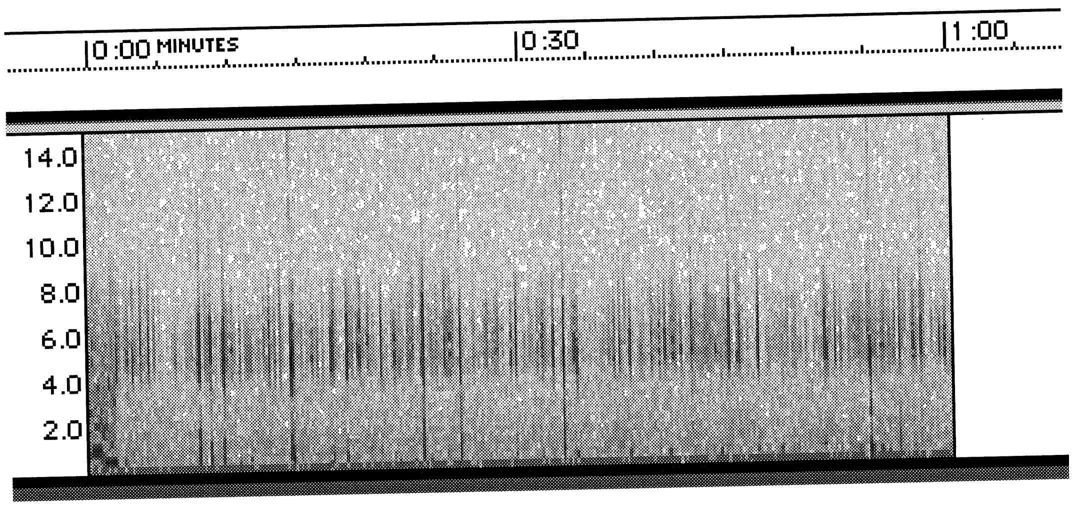


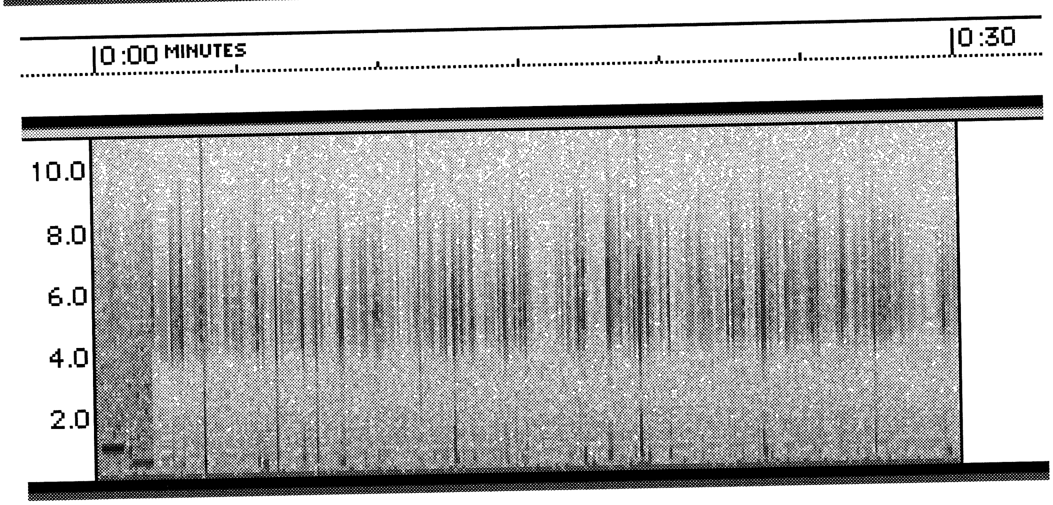


24-6

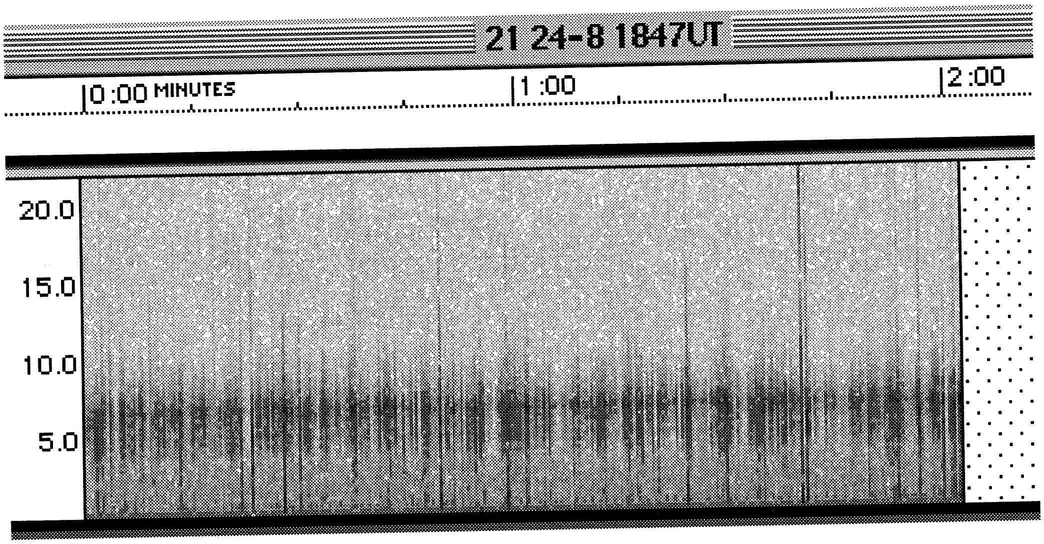


Team 30 Linden Lundback, Watrous, Saskatchewan, CANADA
Good sferics and chorus.

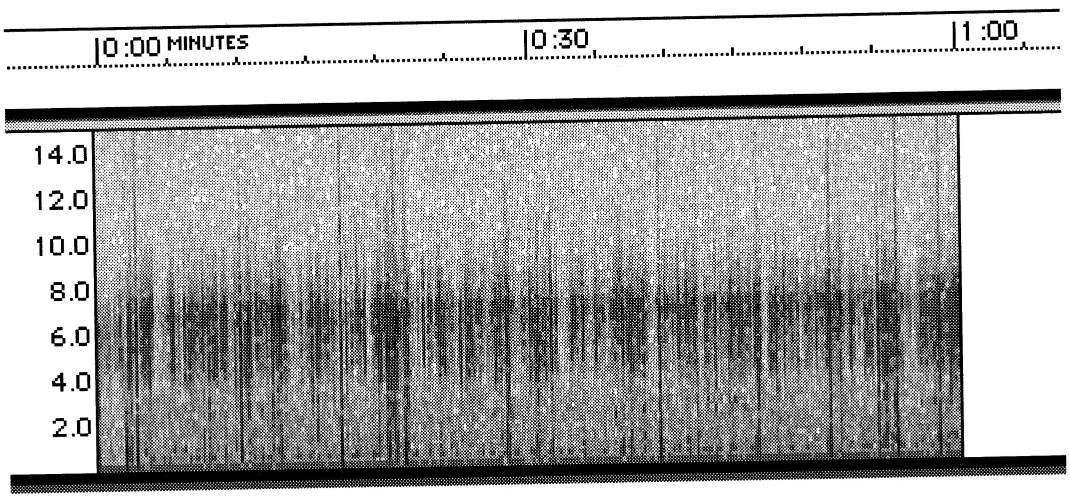


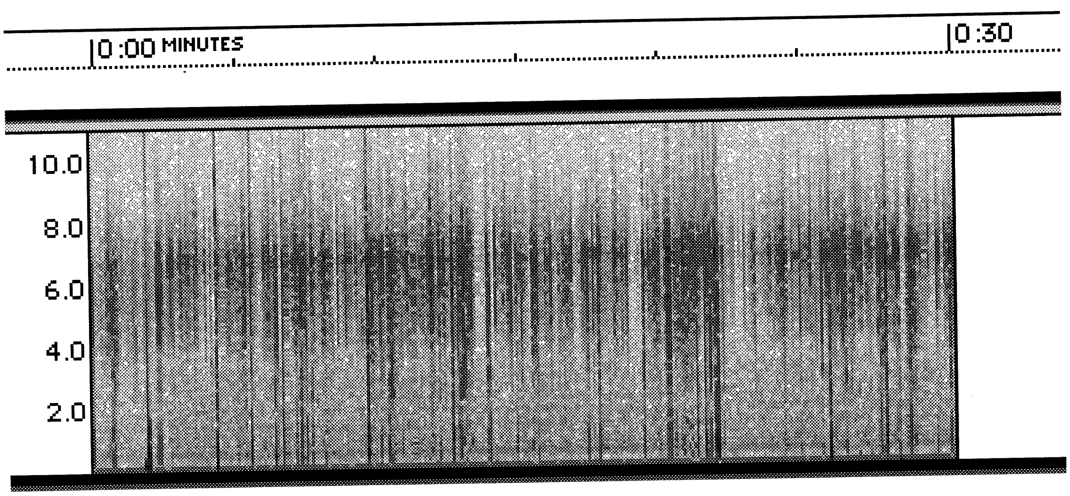


24-8

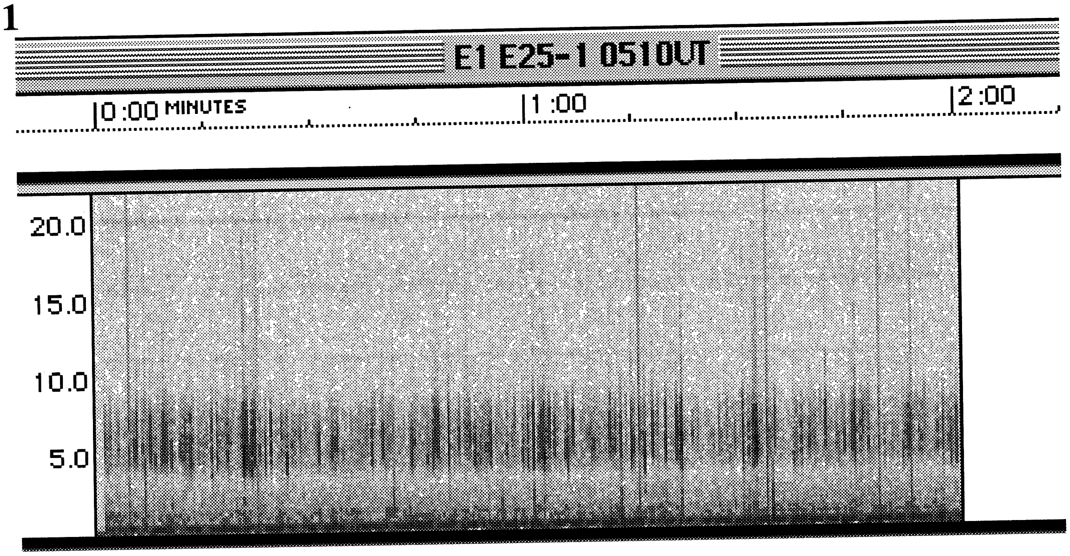


Team 21 Phil Hartzell Aurora, NE
Strong, dense sferics.

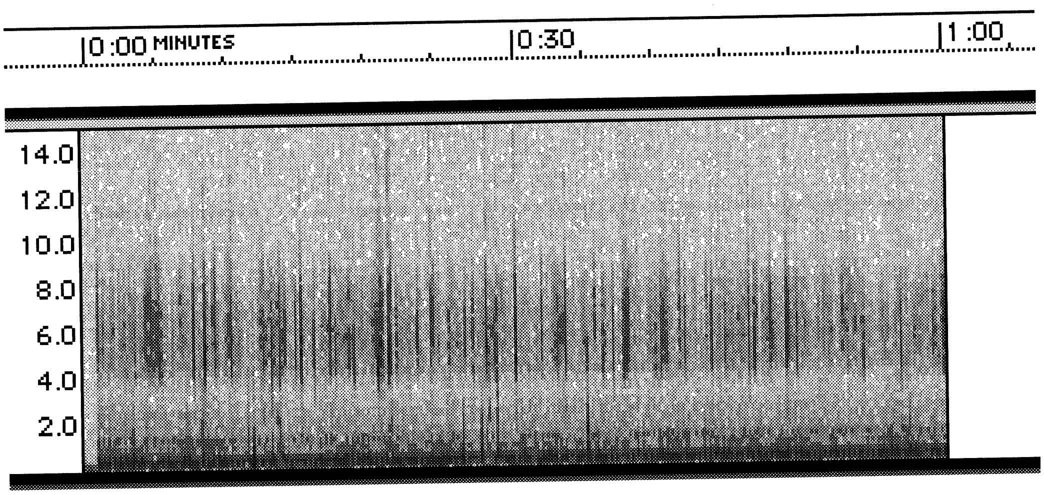


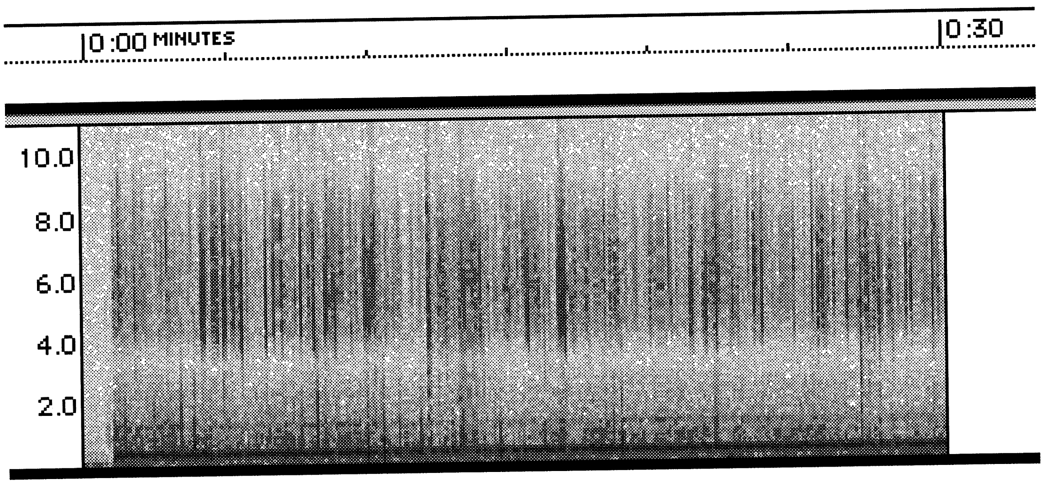


E25-1

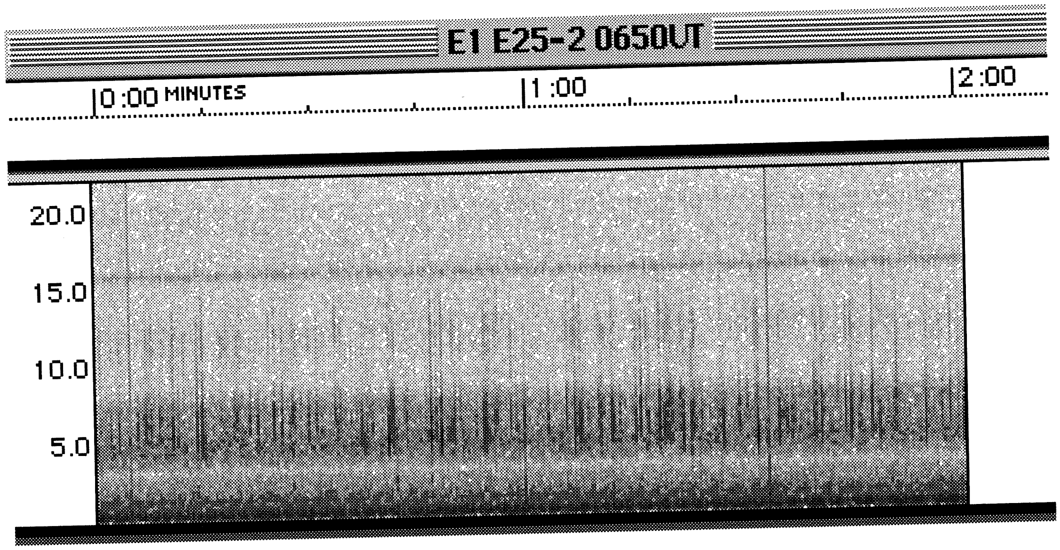


Team E1 Flavio Gori Florence, ITALY
Good signal with low powerline hum.

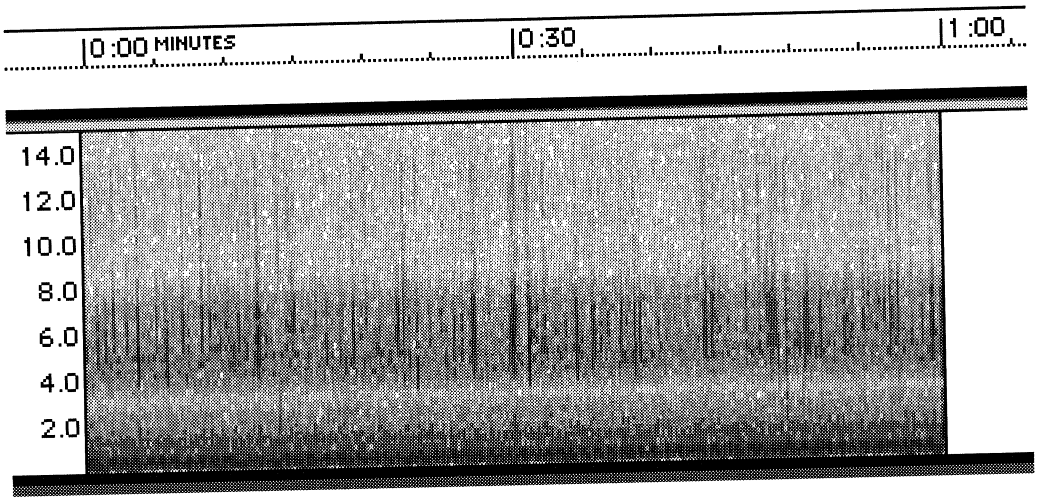


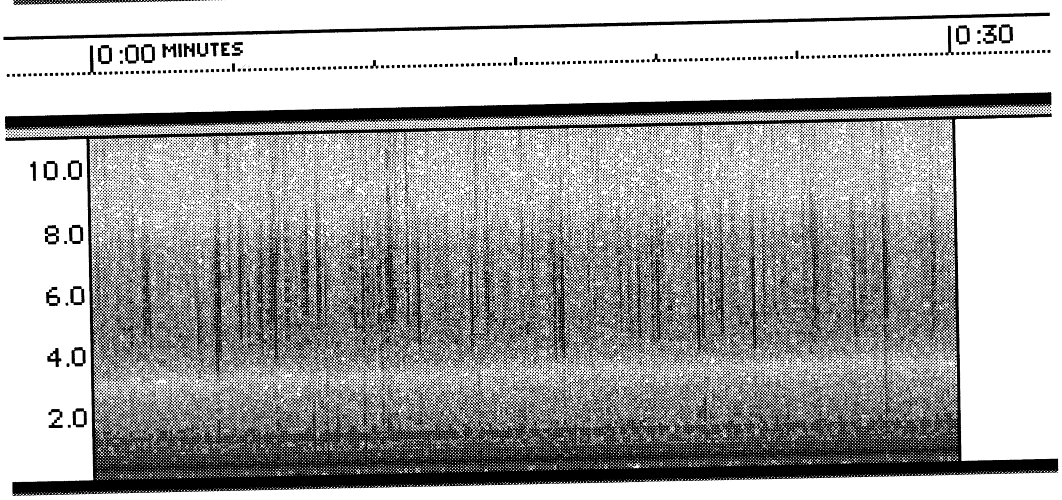


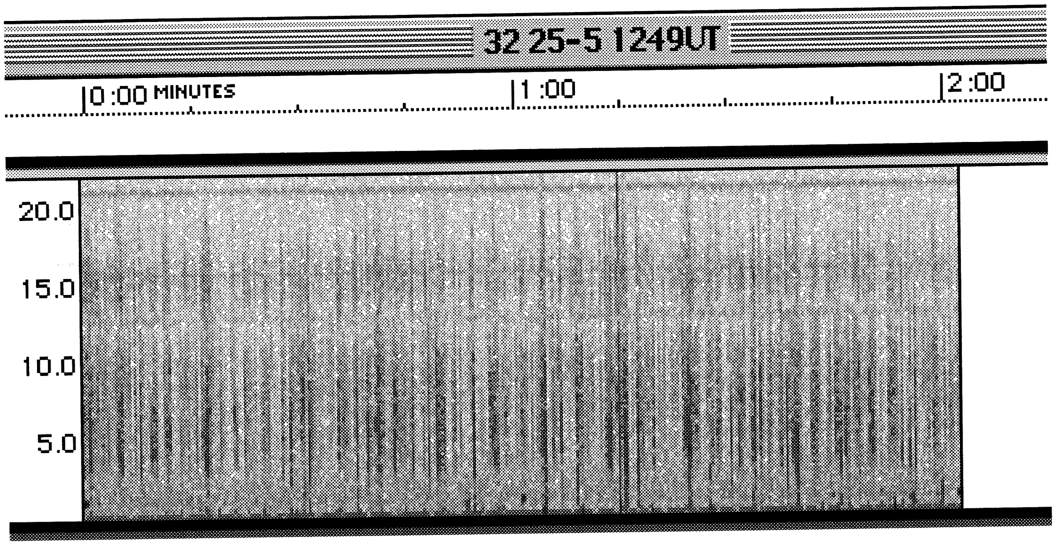
E25-2



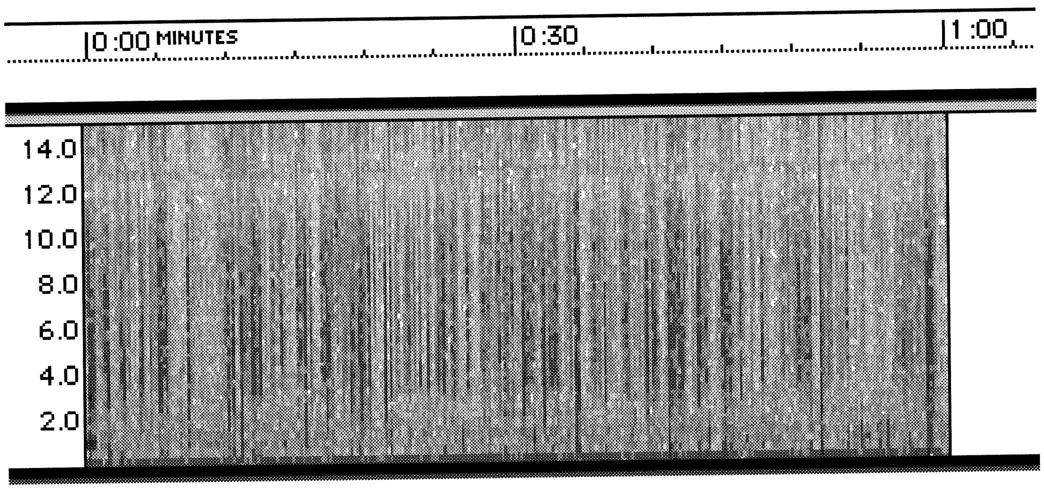
Team E1 Flavio Gori Florence, ITALY
Sferic level has picked up from prior operation.

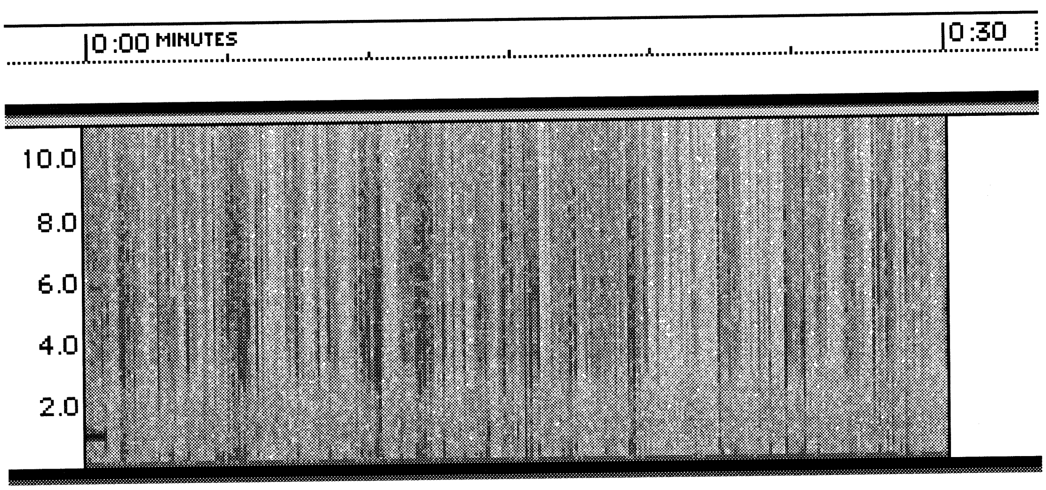




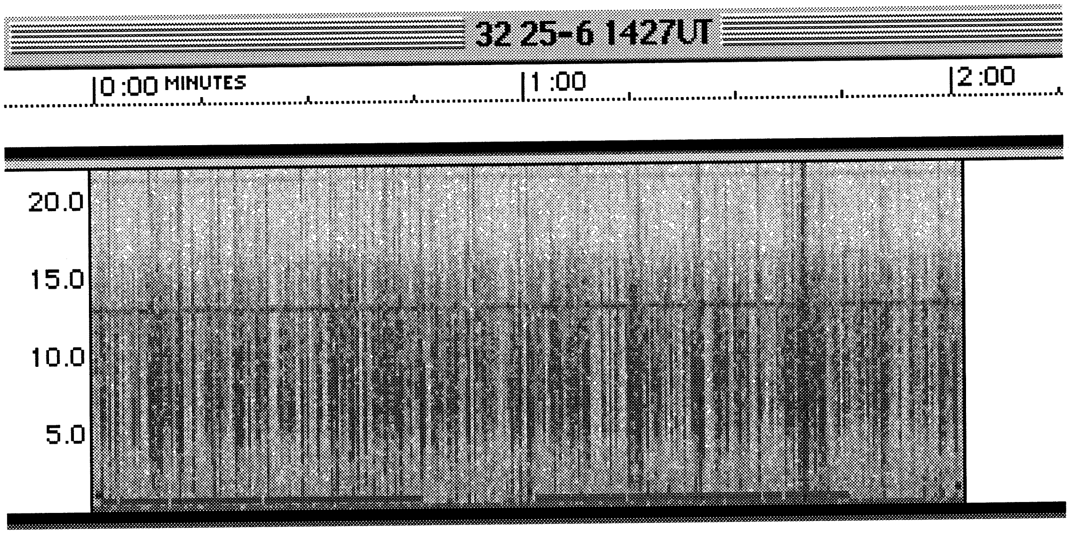


Team 32 Shawn Korgan, Gilcrest, CO
Strong, dense sferics.

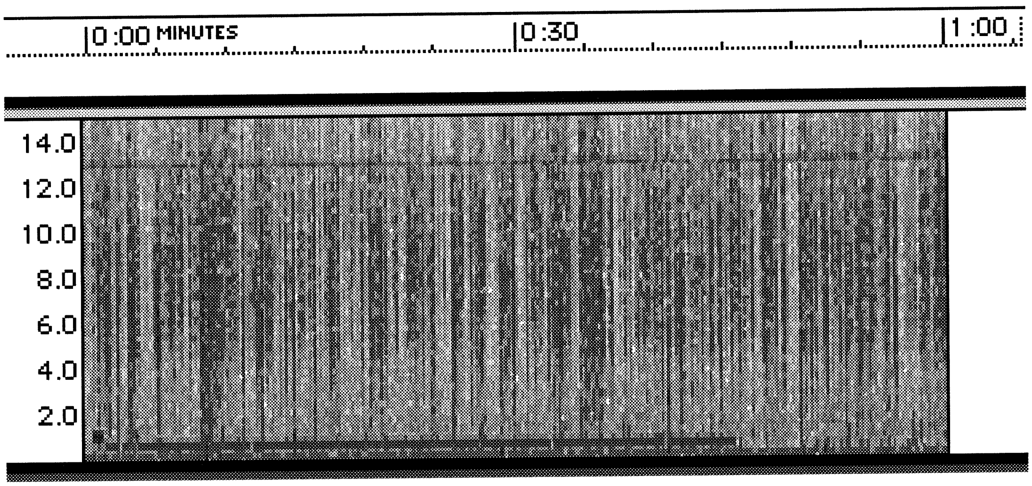


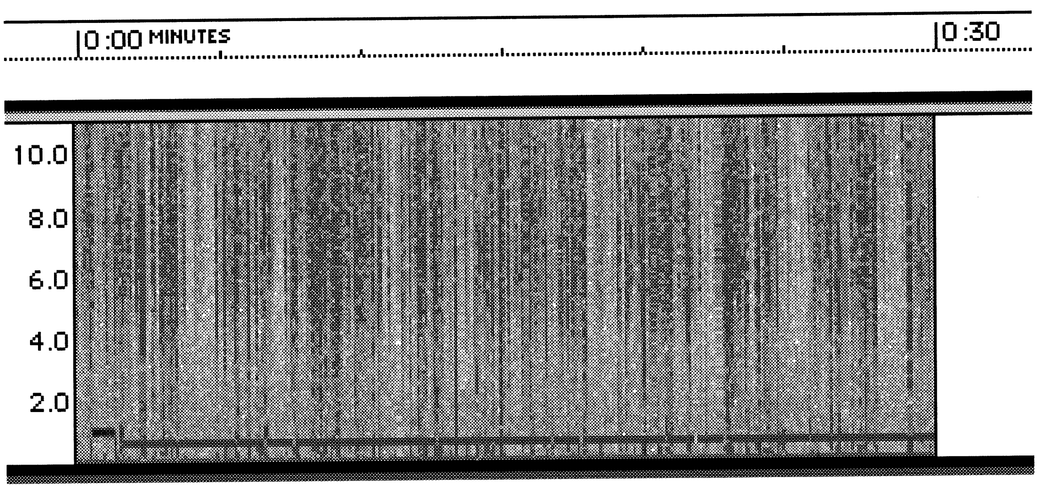


25-6

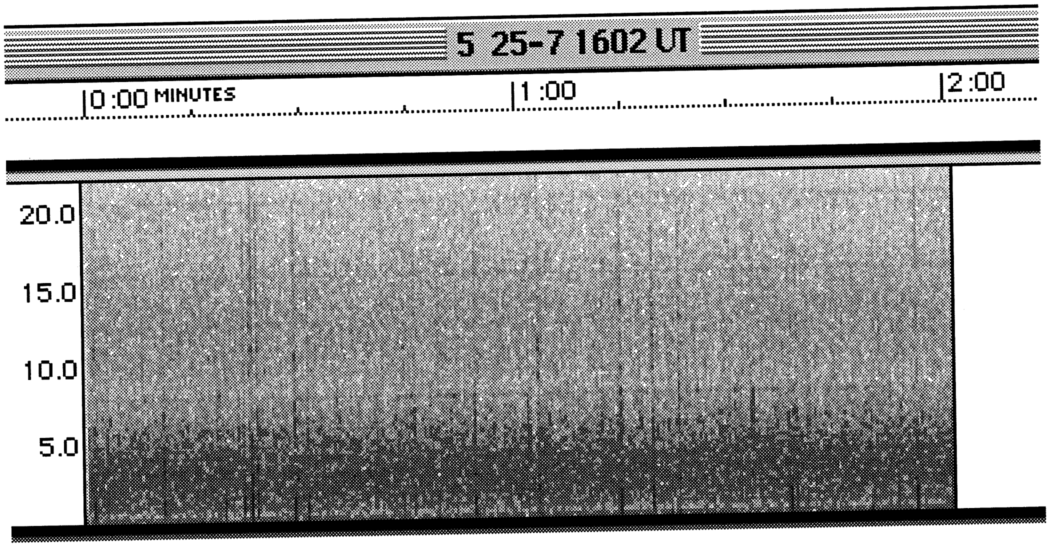


Team 32 Shawn Korgan, Gilcrest, CO
Strong, dense sferics and whistlers.

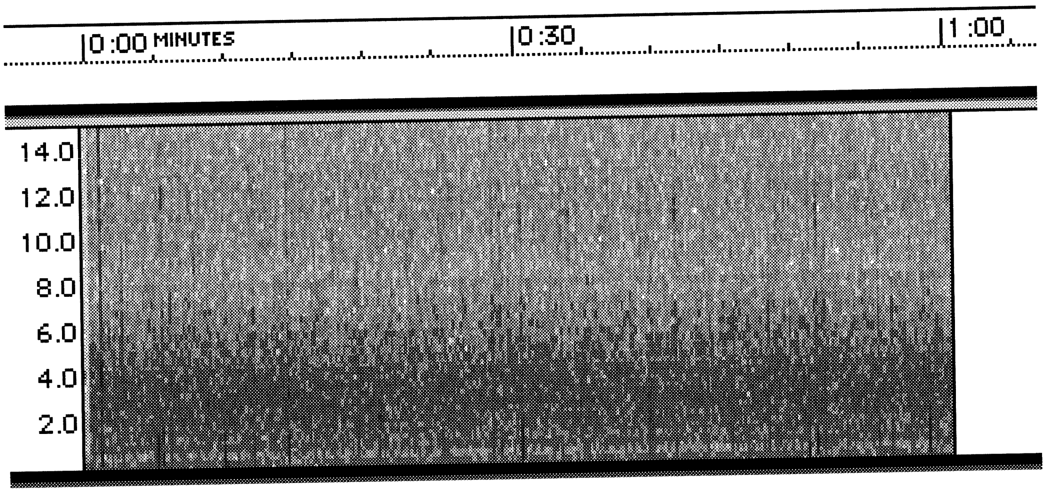


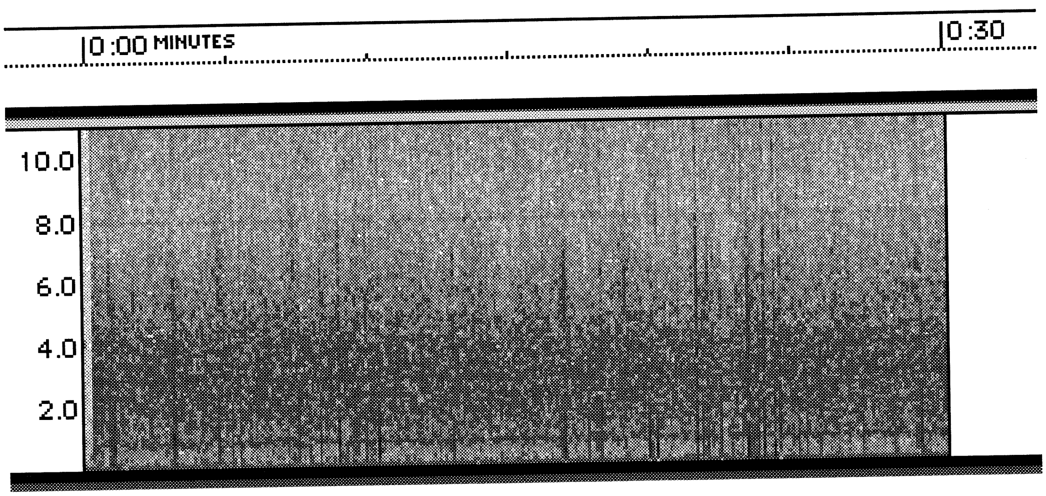


25-7

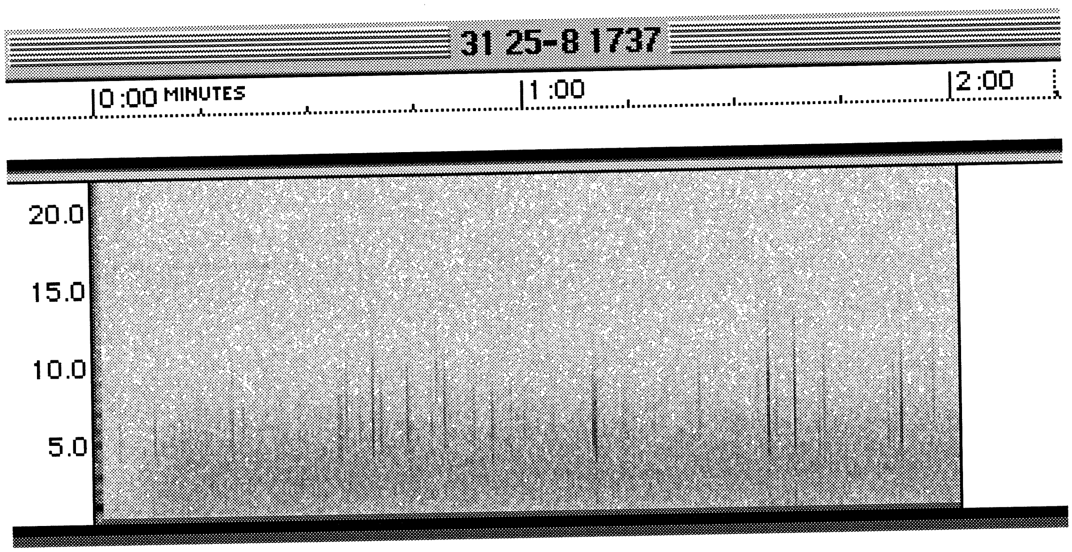


Team 5 Jean-Claude Touzin St. Vital, Quebec, CANADA
Lots of hiss-type noise with the sferics.

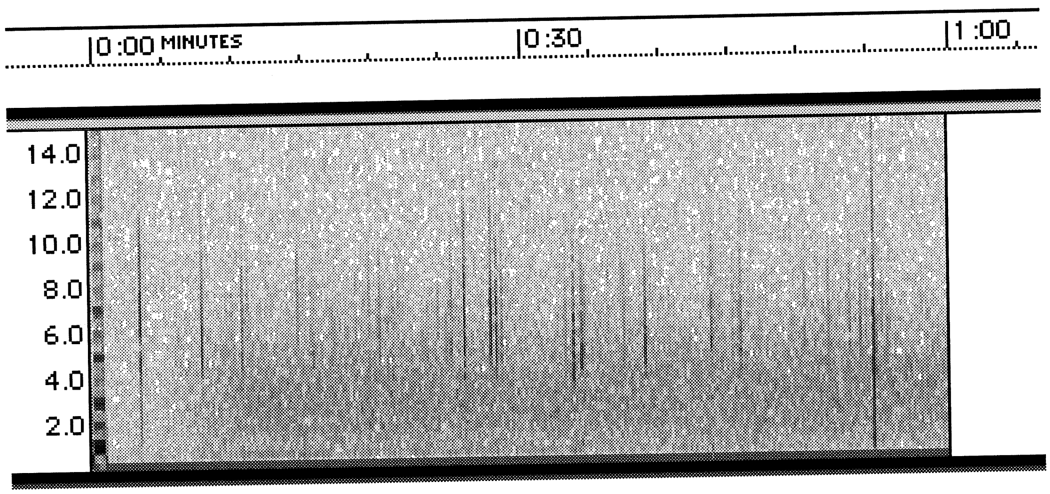


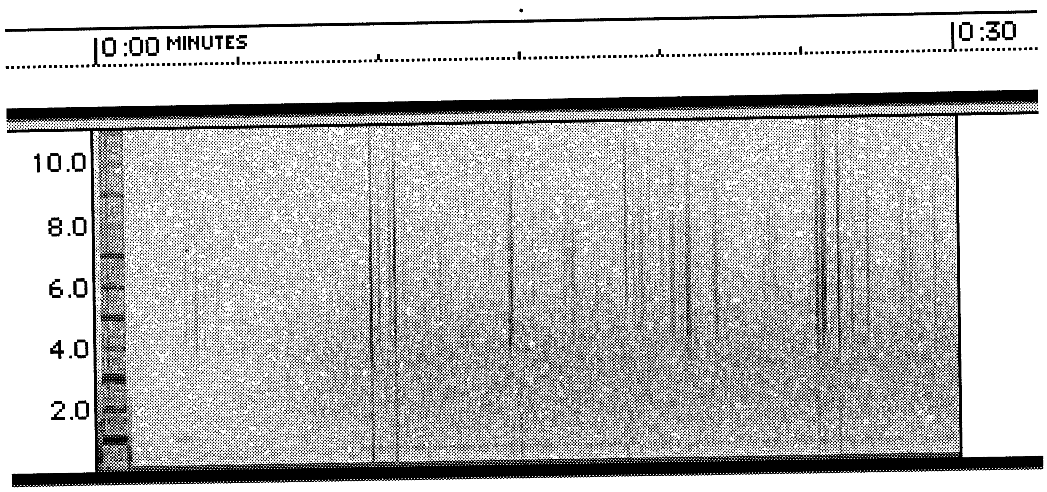


25-8

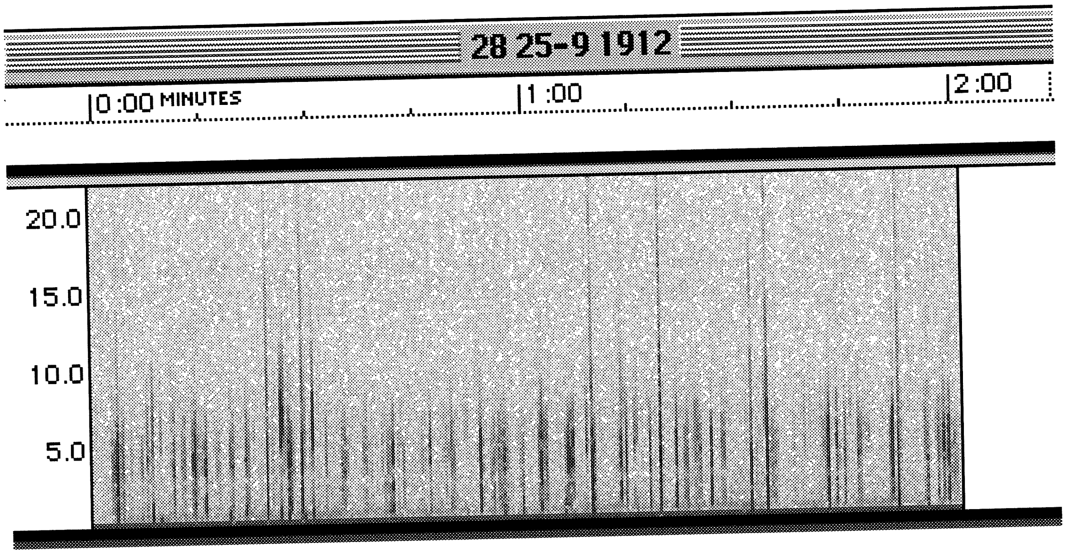


Team 31 Lee Benson Indianapolis, IN
Almost no hum, but the signal level is a little low.
This was a noisy day in the mid-US.

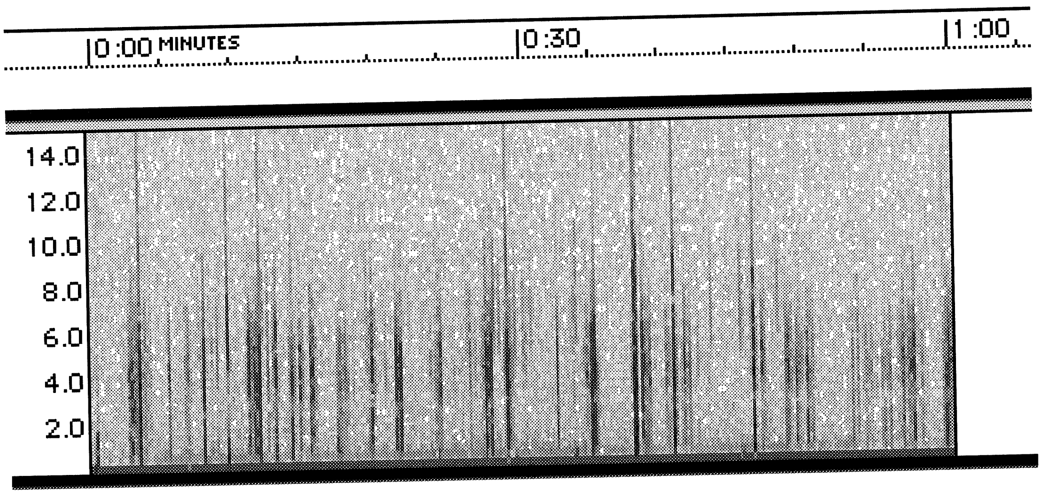


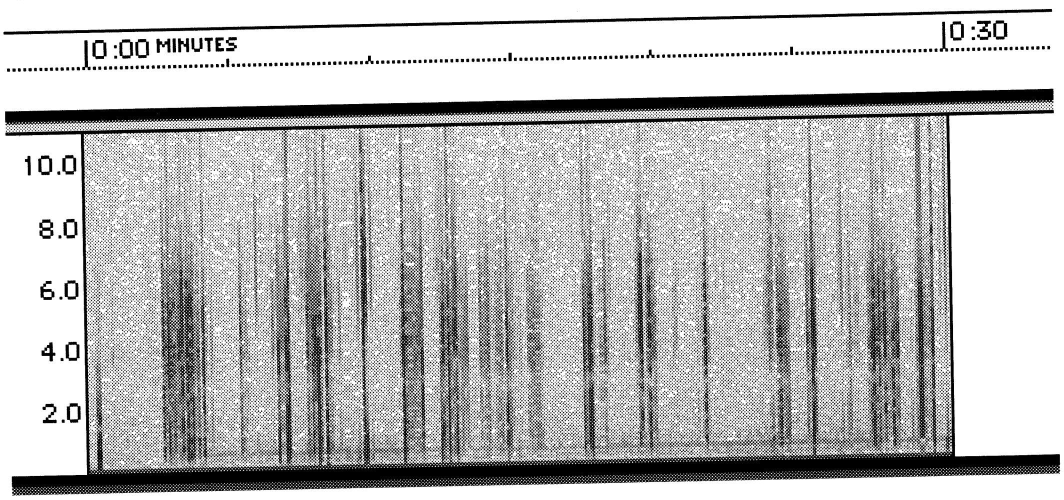


25-9

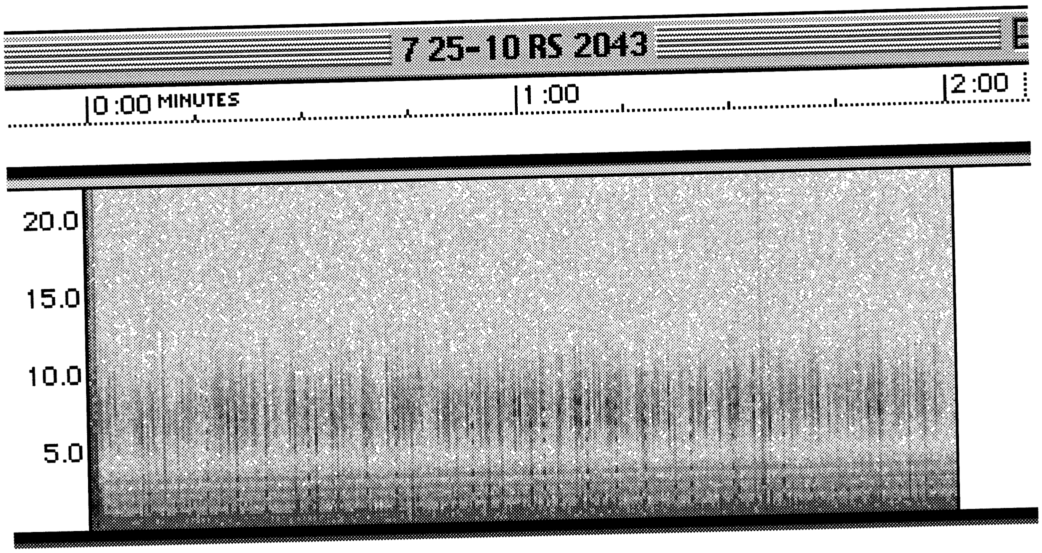


Team 28 Thomas H. Earnest San Angelo, TX
Noisy conditions with lots of "local" lightning.

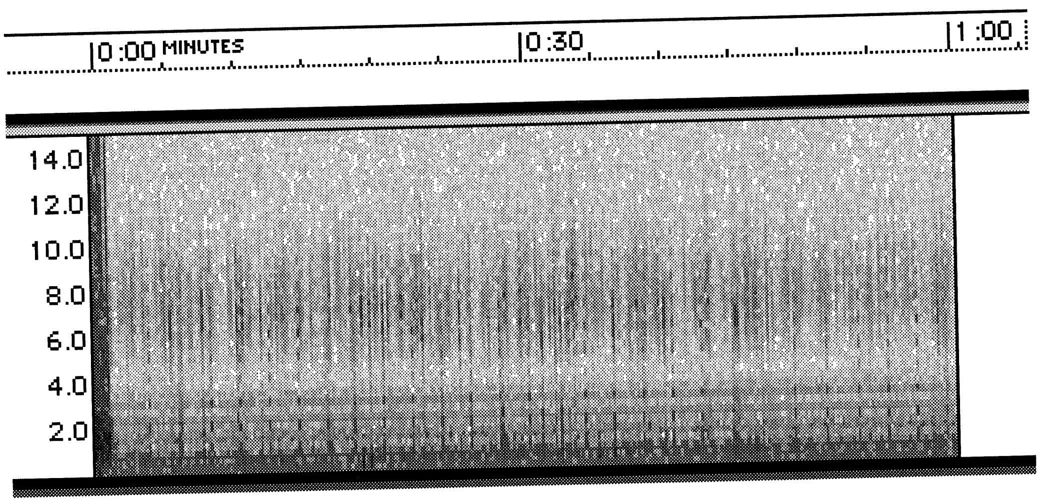


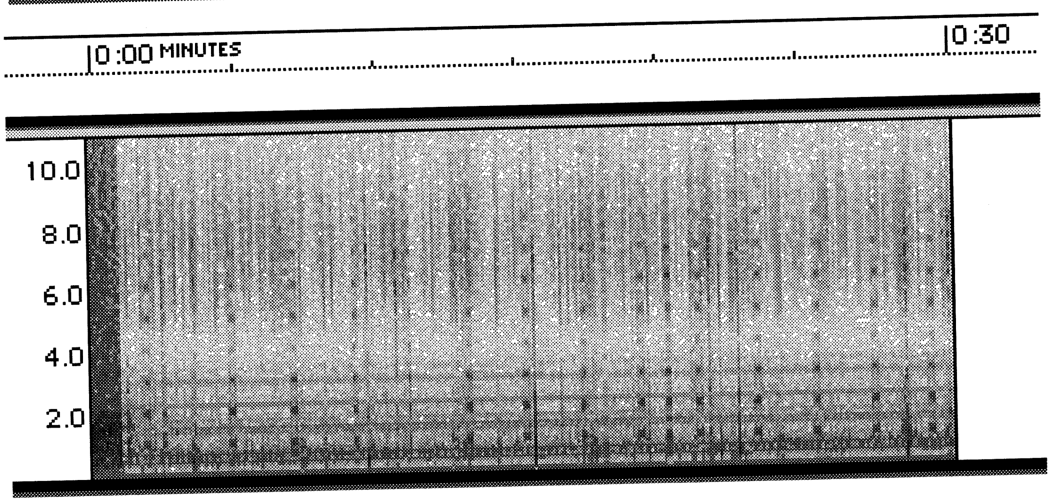


25-10



Team 7 Dean Knight Sonoma Valley High School, Sonoma, CA
Good sferics.





Report on Coordinated Observations 4/99

By Bill Pine
Ontario, California

The purpose of the Coordinated Observation Program is to provide an opportunity for INSPIRE participants to gather data at convenient times for purposes of comparing the resulting signals and attempting to interpret them. Since there is no manmade source of VLF that is being studied here, the signals of interest are those of natural origin. As in most natural radio listening, we would like to hear something "interesting". Most of that time that would be whistlers, but other sounds such as tweeks, chorus, triggered emissions and even hiss are also interesting. Whistlers, however, remain the prize for faithful listening. The problem with whistlers is that they are not the most common natural radio signal. Since coordinated listening schedules are determined arbitrarily and in advance of the listening sessions, it is only a matter of luck if whistlers are available to be detected. The experience of the author is that whistlers are heard about once every four or five morning sessions. When they are present, you will probably hear a lot of them until the rotation of the earth carries the ducting magnetic field lines into an unfavorable alignment. Luck was with us in April/99 as many whistlers were observed. The following report includes sample spectrograms from contributing observers.

This table summarizes the sessions monitored by observers.

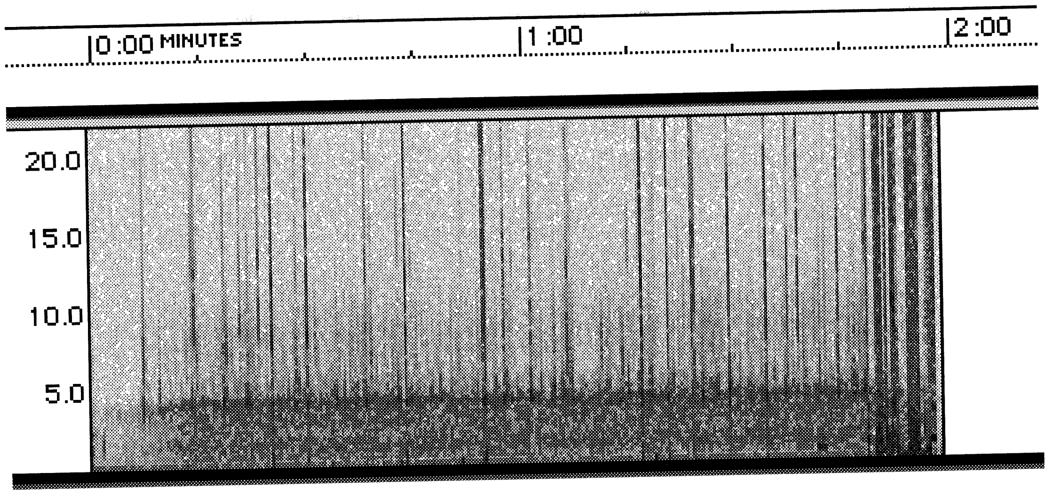
Date	4/24					4/25				
Time	1200	1300	1400	1500	1600	1200	1300	1400	1500	1600
Team										
1		C	C							
5						E	E	E		
6								P	P	P
11		C	C							
25		C	C							
29							C	C	C	
30			C		C		C	C	C	
31							C	C		
32						C	C			

The times indicated are UT times.
The letter in the box indicates the time zone of the observer:
E = EDT = UT-5, C=CDT = UT-6, M = MDT = UT-7 and P = PDT = UT-8

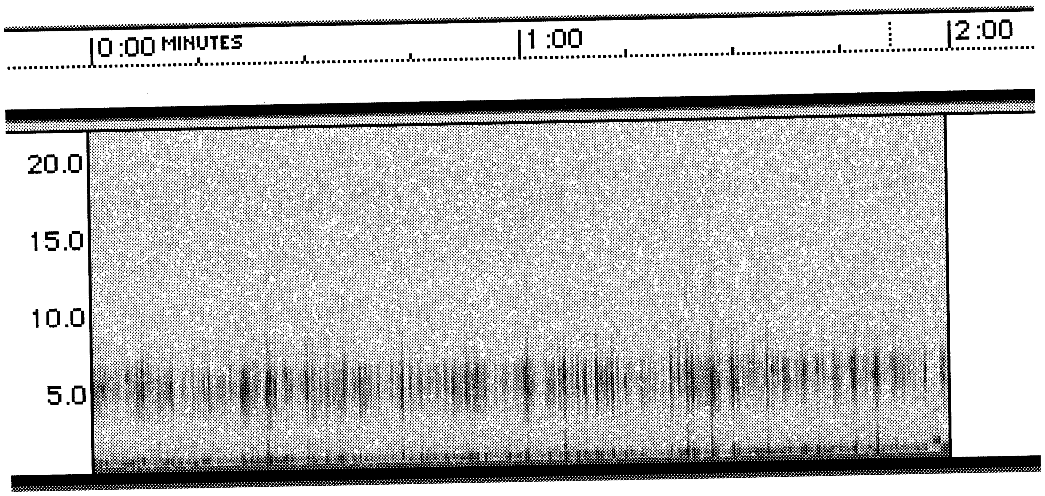
Observers:			
	Team 1	Jack Lamb, Belton, Texas	(CDT
	Team 5	Jean-Claude Touzin, St. Vital, Quebec, CANADA	(EDT)
	Team 6	Bill Pine, Chaffey high School, Ontario, CA	(PDT)
	Team 11	Mark Mueller, Brown Deer High School, Brown Deer, WI	(CDT)
	Team 25	Norm Anderson, Cedar Falls, Iowa	(CDT)
	Team 27	Ron Janetzke, San Antonio, TX	(CDT)
	Team 29	Janet Lowry, Houston, Texas	(CDT)
	Team 30	Linden Lundback, Watrous, Saskatchewan, CANADA	(CDT)
	Team 31	Lee Benson, Indianapolis, IN	(CDT)
	Team 32	Shawn Korgan, Gilcrest, CO	(MDT)

For analysis purposes, a spectrogram was made of the first two minutes of each 12-minute hourly session. Additional spectrograms were made of any items of interest and of any segments requested by the observer. Time marks were placed on the tape every two minutes and a complete log was made of each session.

4/24/99 1300 UT

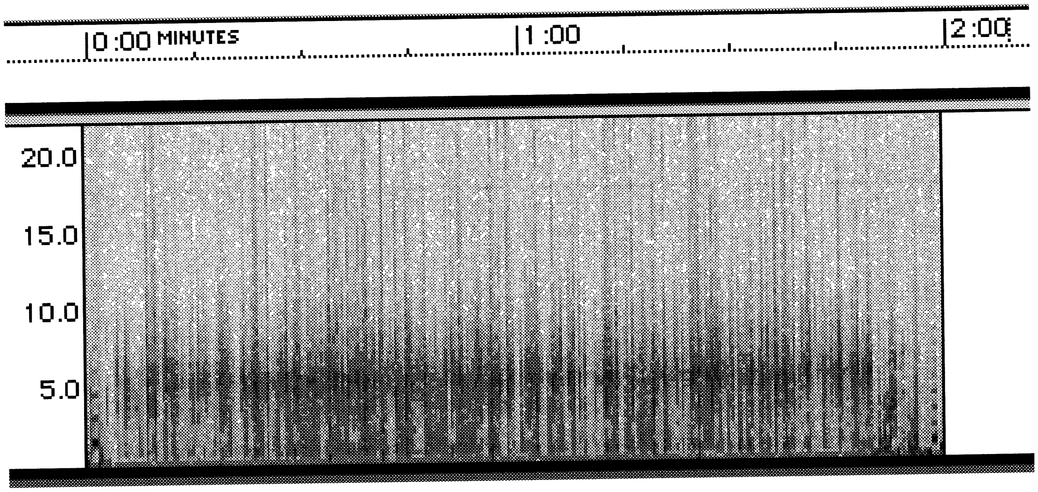


Team 11 Mark Mueller Brown Deer High School, Brown Deer, WI
Dense sferics with very little hum. Good data!

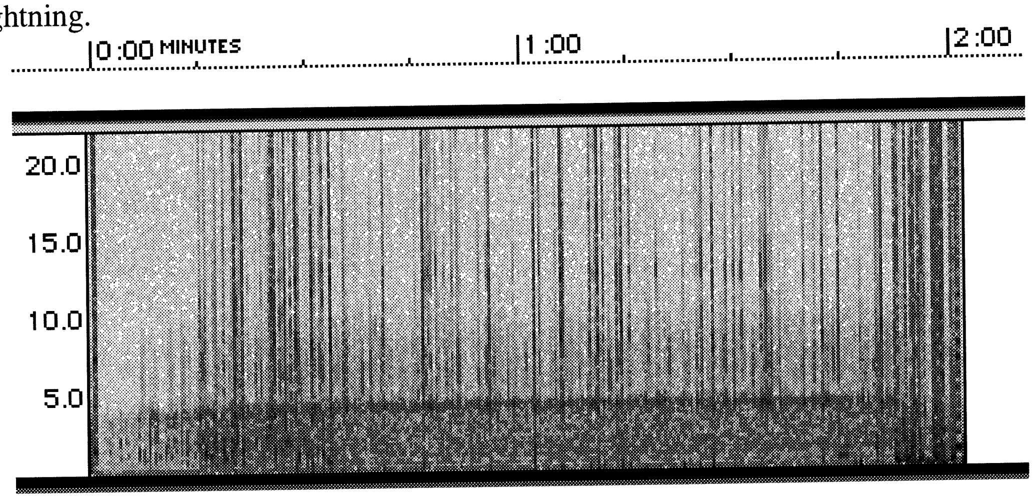


Team 25 Norm Anderson, Cedar Falls, IA
Receiver response strong below 7 kHz. Good sferics.

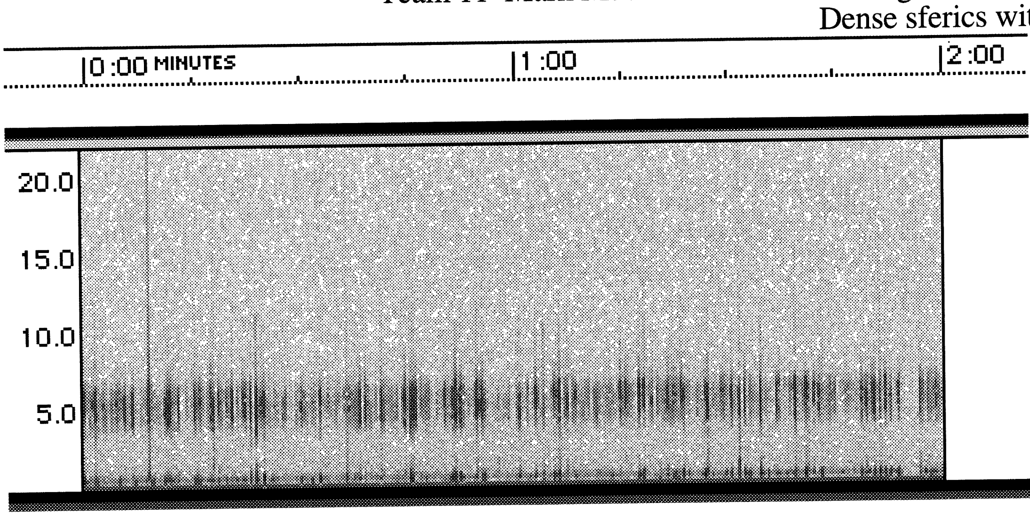
4/24/99 1400 UT



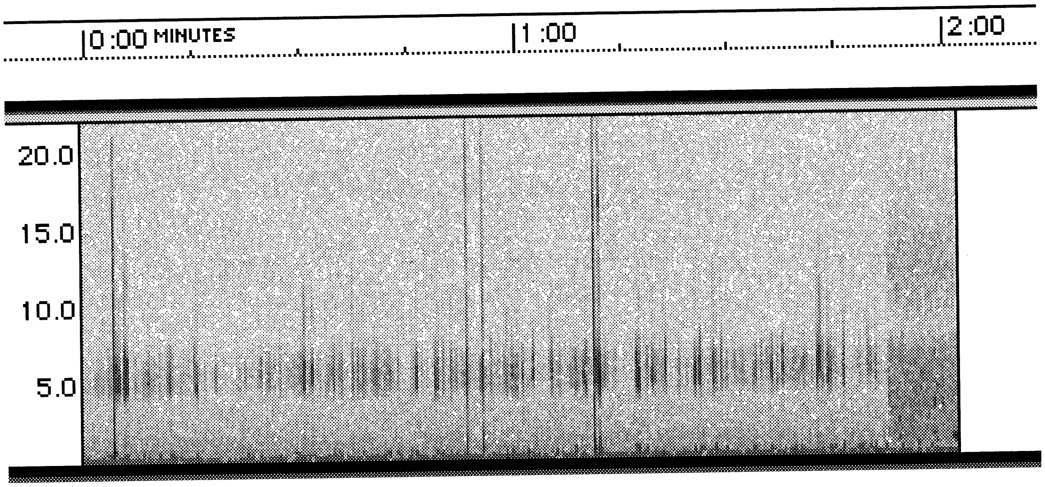
Team 1 Jack Lamb, Belton, TX
Lots of "local" lightning.



Team 11 Mark Mueller Brown Deer High School, Brown Deer, WI
Dense sferics with very little hum.

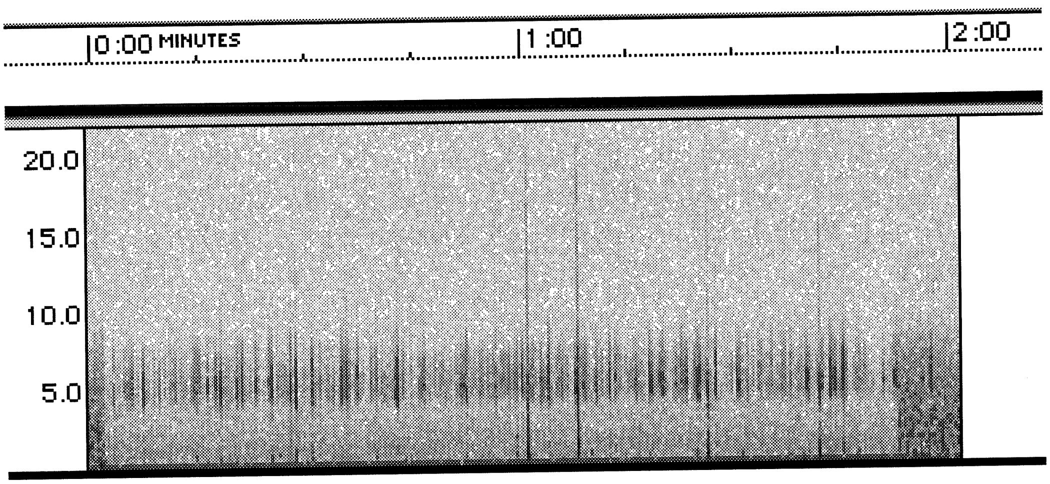


Team 25 Norm Anderson, Cedar Falls, IA

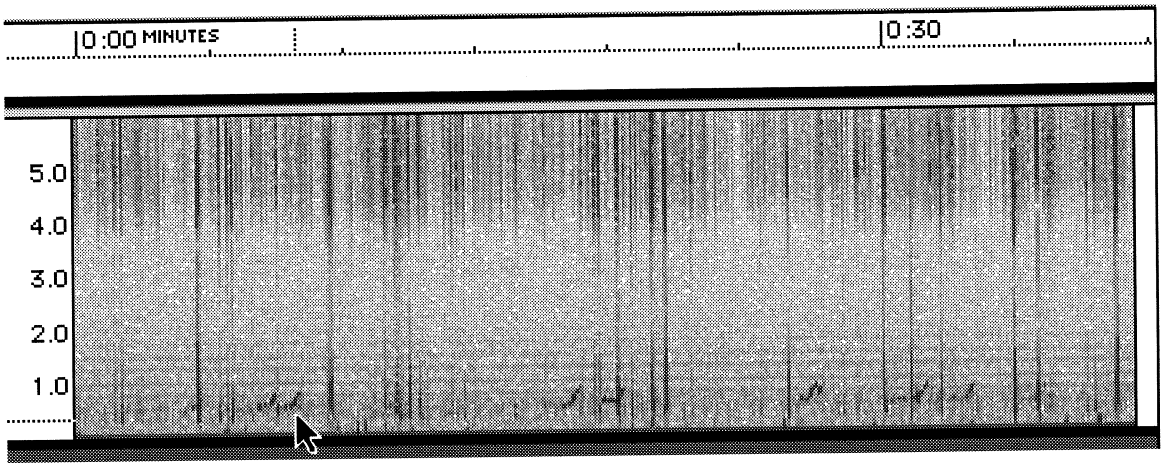


Team 30 Linden Lundback, Watrous, Saskatchewan, CANADA
Good sferics. Several low-level, breathy whistlers were heard, but did not show up on the spectrogram.

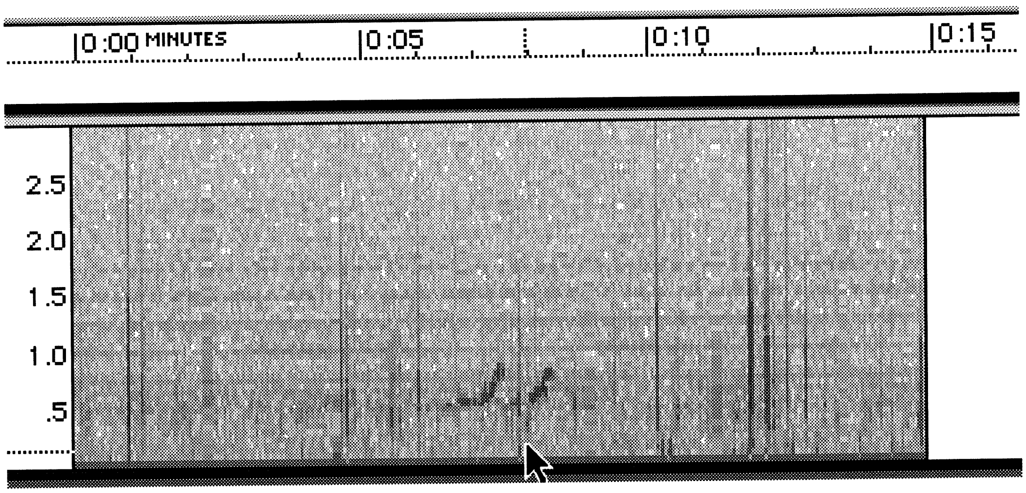
4/24/99 1600 UT



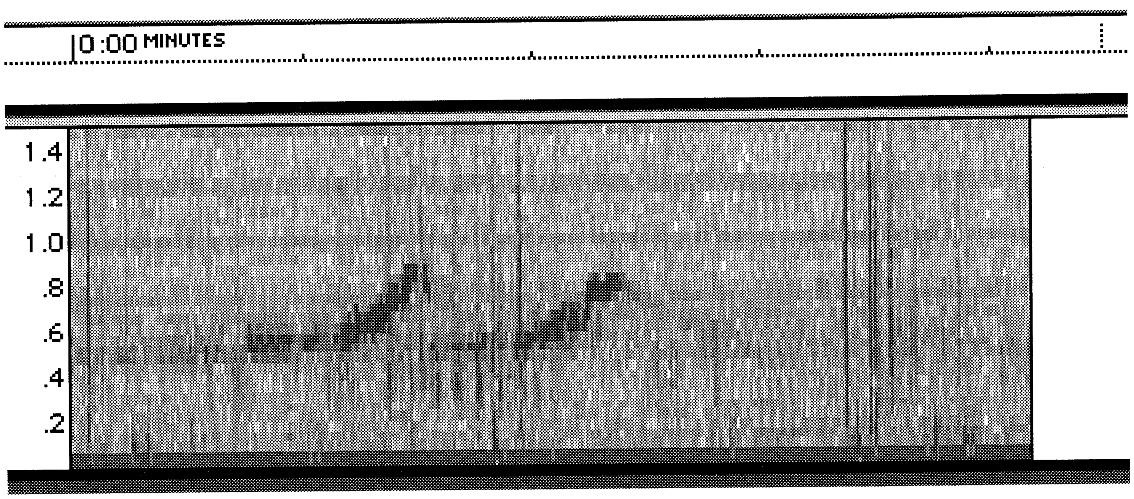
Team 30 Linden Lundback, Watrous, Saskatchewan, CANADA
This data contained risers or "whoops", which are similar to chorus.



This is 40 seconds starting at 160420 UT. The arrow points to a pair of whoops, but many others show up during this interval. They reside below 1 kHz and would be hard to hear if the site were not so quiet!

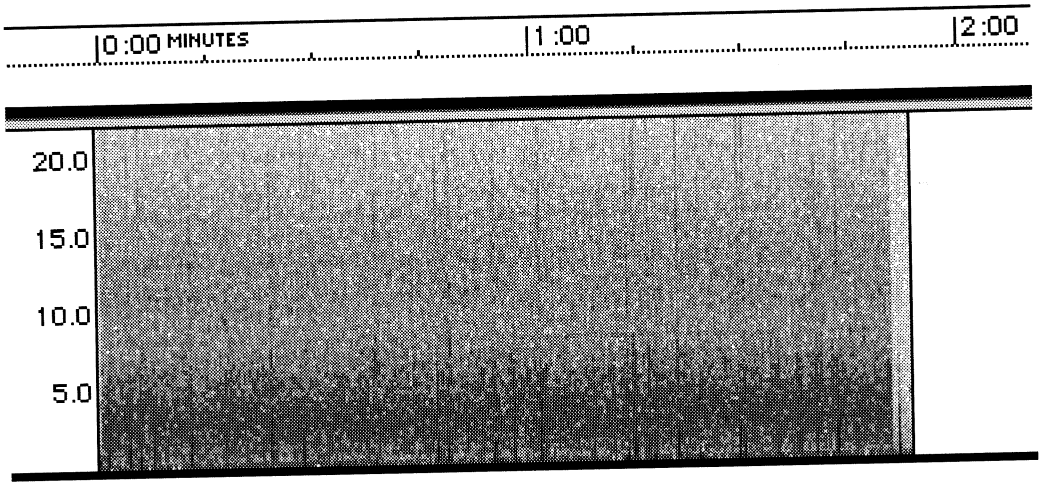


Frequency range 0-3 kHz.

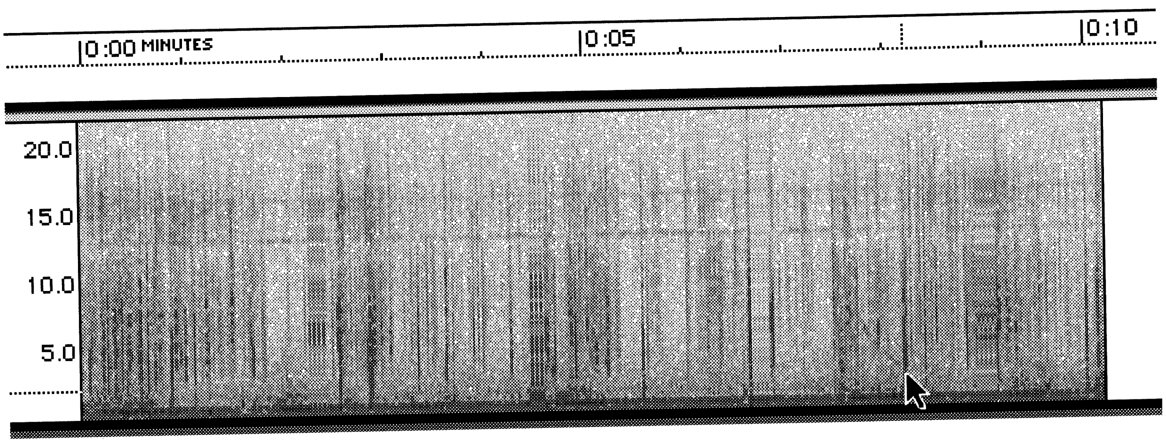


Extreme closeup using 0-1500 Hz range. Very neat!

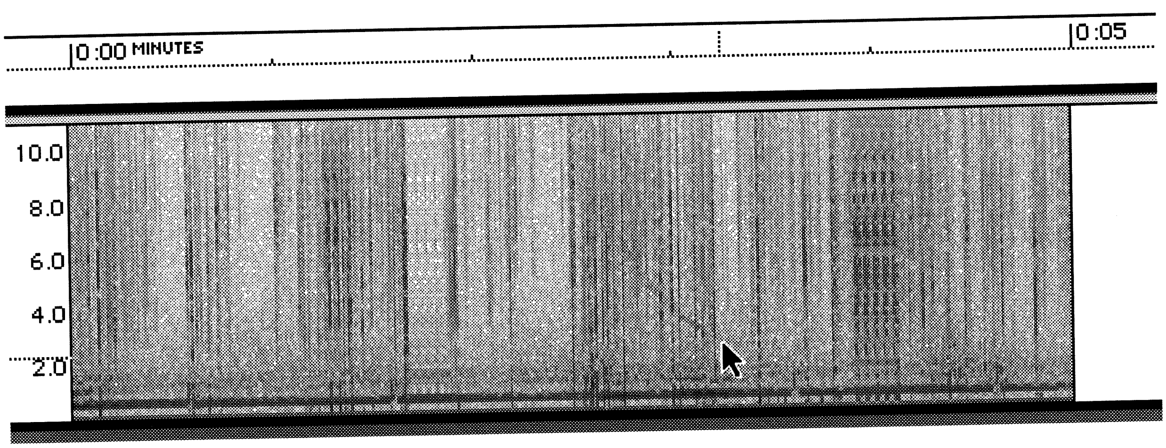
4/25/99 1200 UT



Team 5 Jean-Claude Touzin, St. Vital, Quebec, CANADA
Dense sferics with hiss.

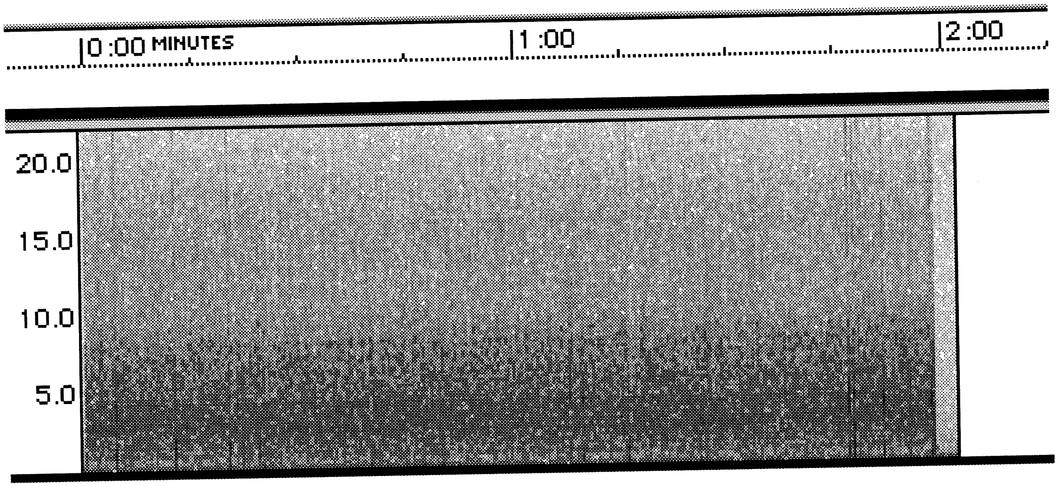


Team 32 Shawn Korgan, Gilcrest, CO
Arrow points to a pure note whistler at 12:06:09 UT.

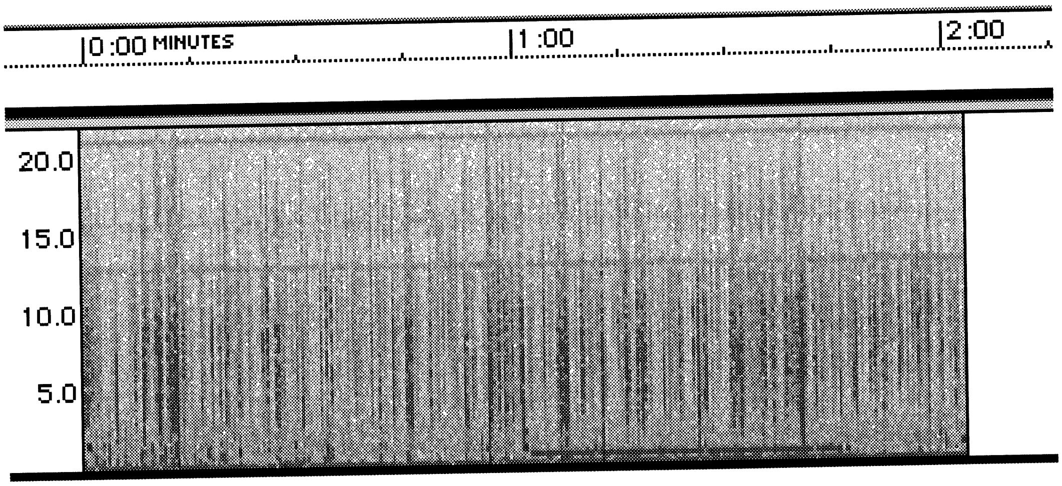


Arrow points to the whistler.

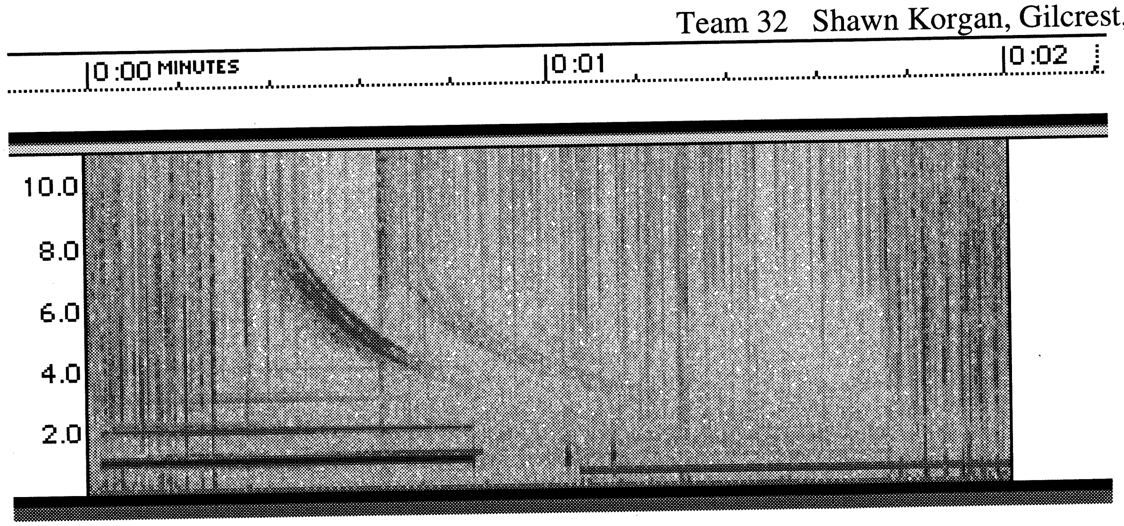
4/25/99 1300 UT



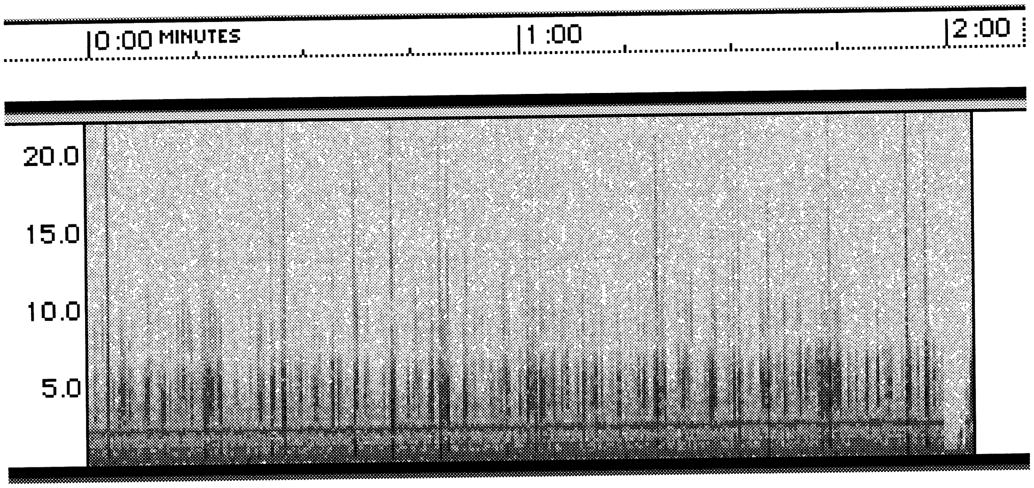
Team 5 Jean-Claude Touzin, St. Vital, Quebec, CANADA
Conditions unchanged from 1200 UT.



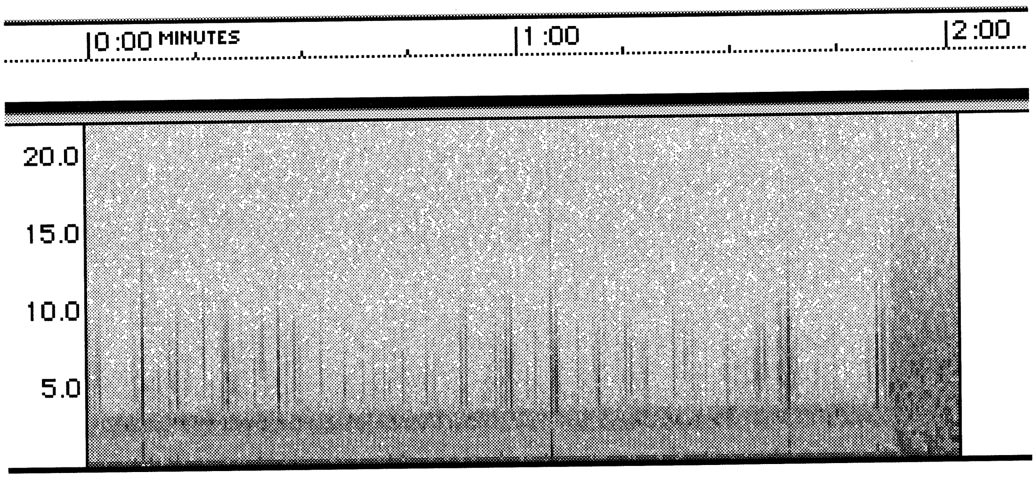
Team 32 Shawn Korgan, Gilcrest, CO



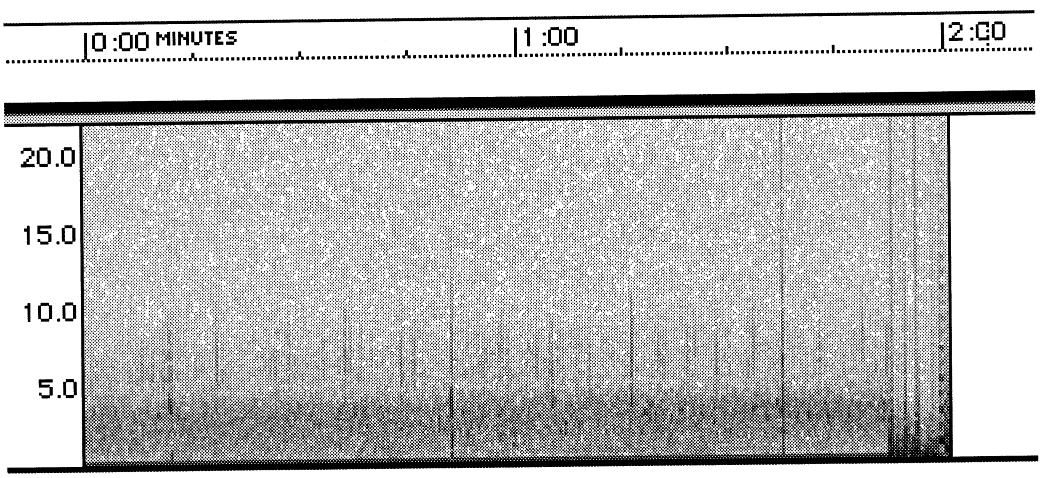
Whistler at 13:06:00. Horizontal line at 1 kHz is the 1306 UT WWV tone.



Team 29 Janet Lowry, Houston, TX
Some low level hum, but the sferics come through loud and clear.

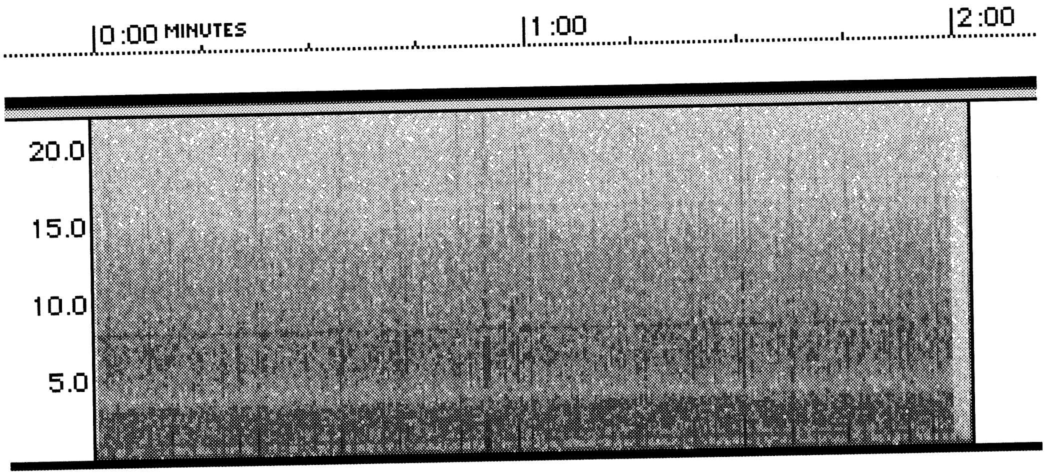


Linden Lundback Watrous, Saskatchewan, CANADA

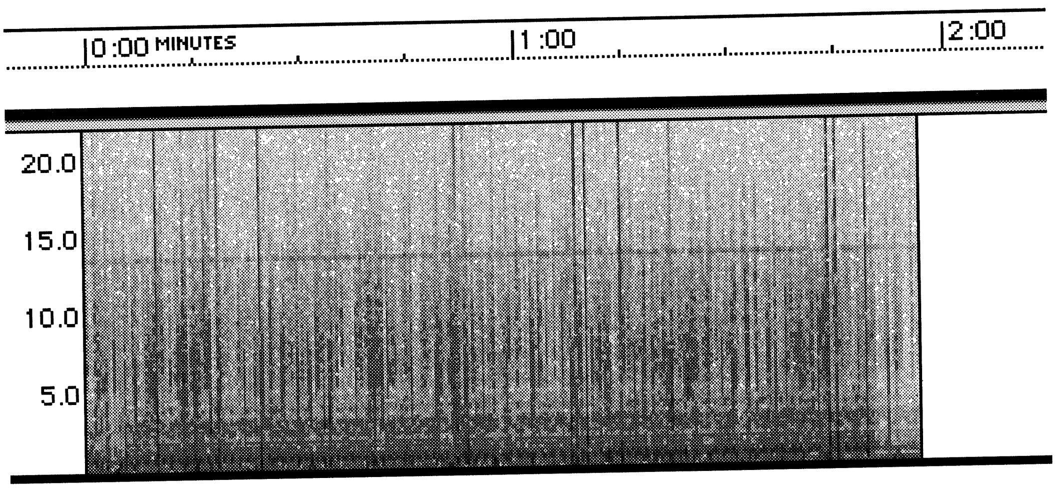


Team 31 Lee Benson, Indianapolis, IN

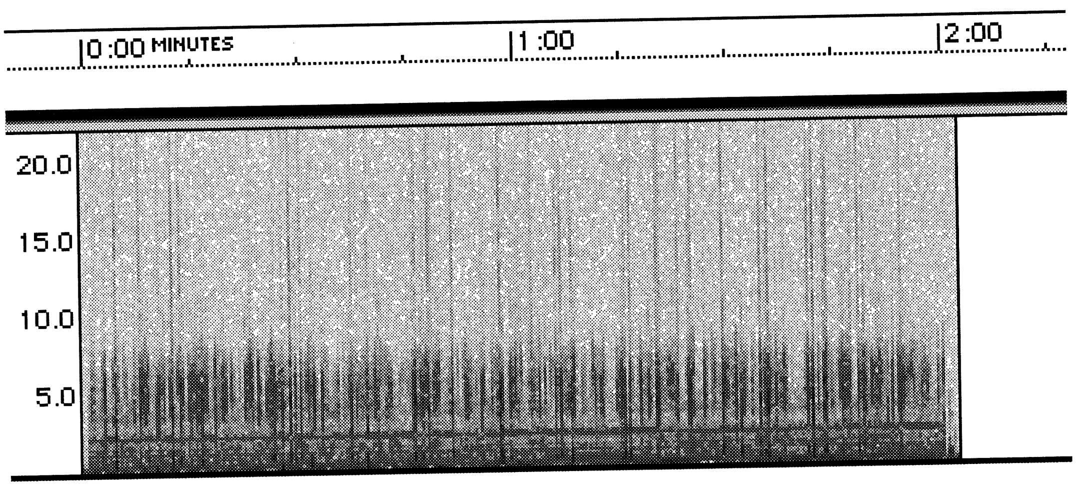
4/25/99 1400 UT



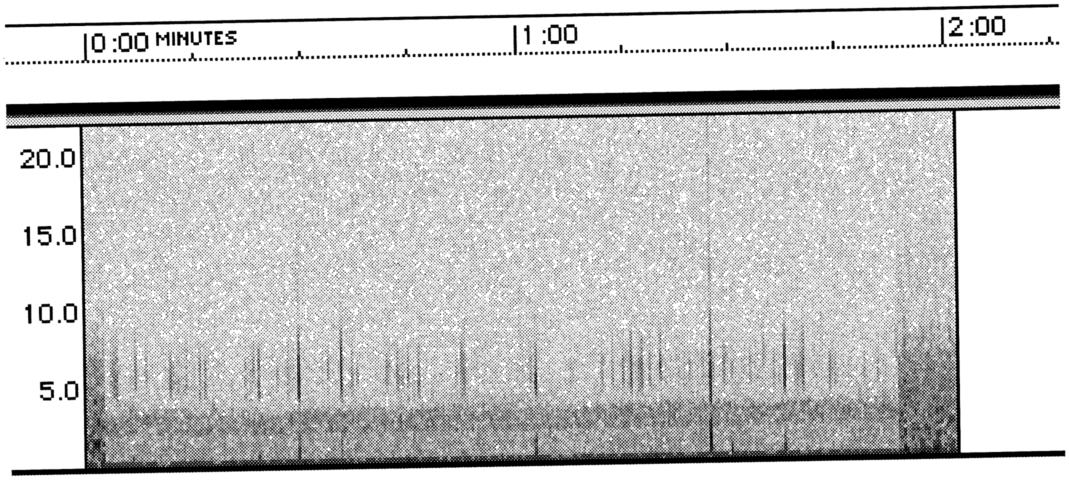
Team 5 Jean-Claude Touzin, St. Vital, Quebec, CANADA



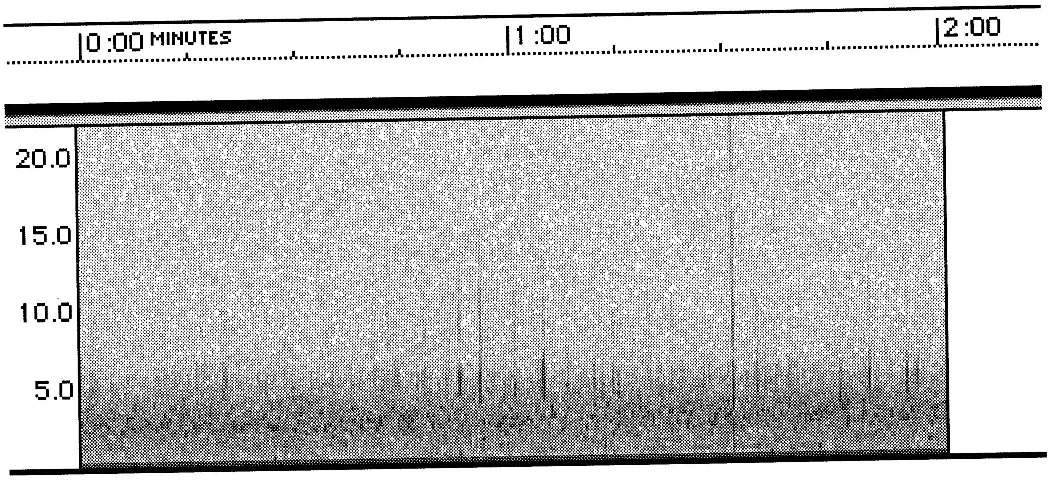
Team 6 Bill Pine, Chaffey High School, Ontario, CA



Team 29 Janet Lowry, Houston, TX

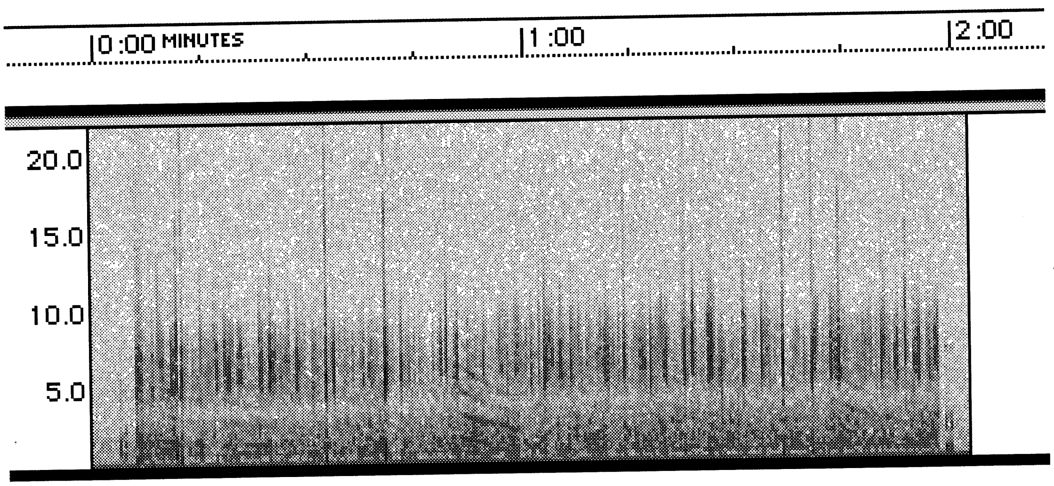


Team 30 Linden Lundback, Watrous, Saskatchewan, CANADA

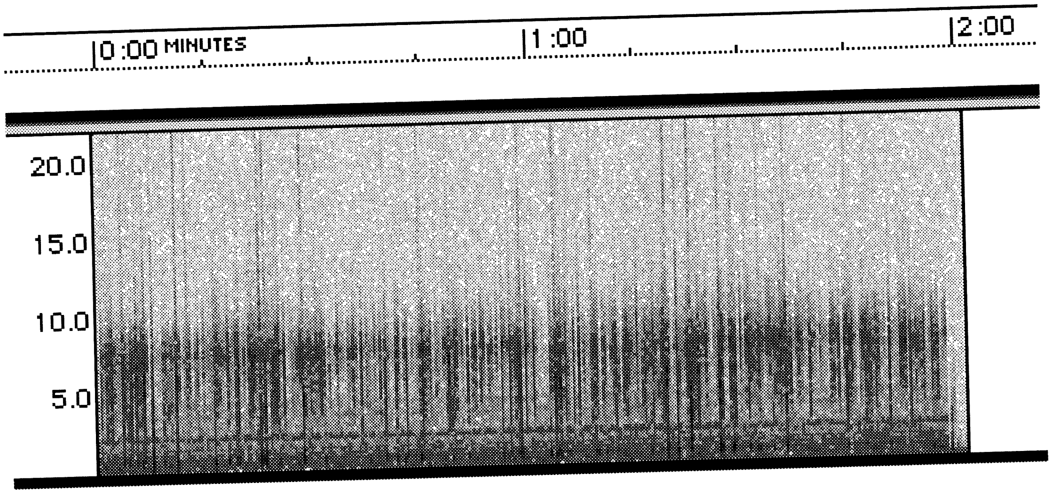


Team 31 Lee Benson, Indianapolis, IN

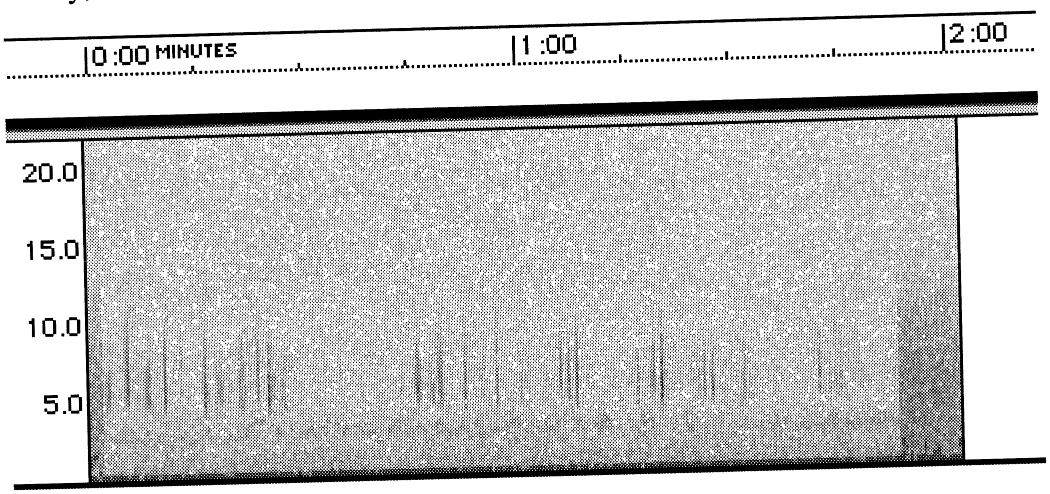
4/25/99 1500 UT



Team 6 Bill Pine, Chaffey High School, Ontario, CA

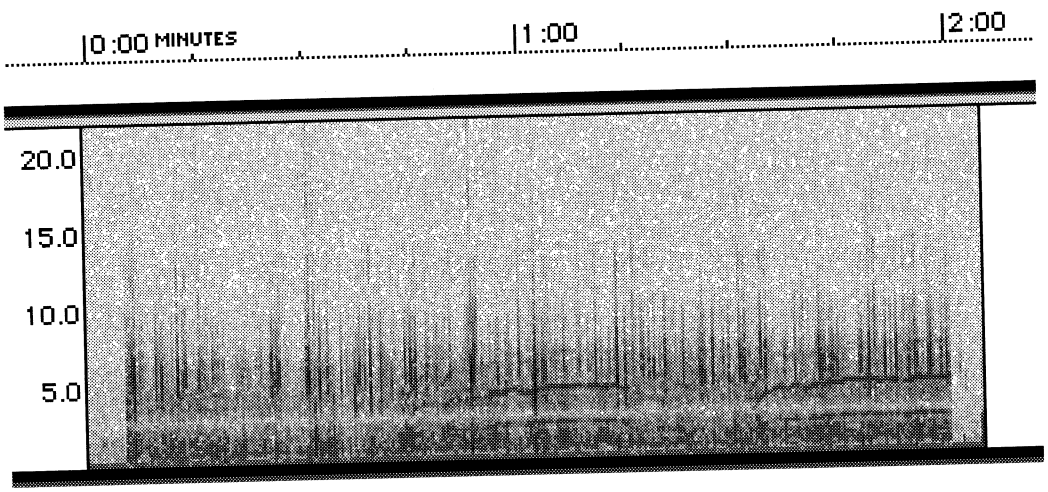


Team 29   Janet Lowry, Houston, TX

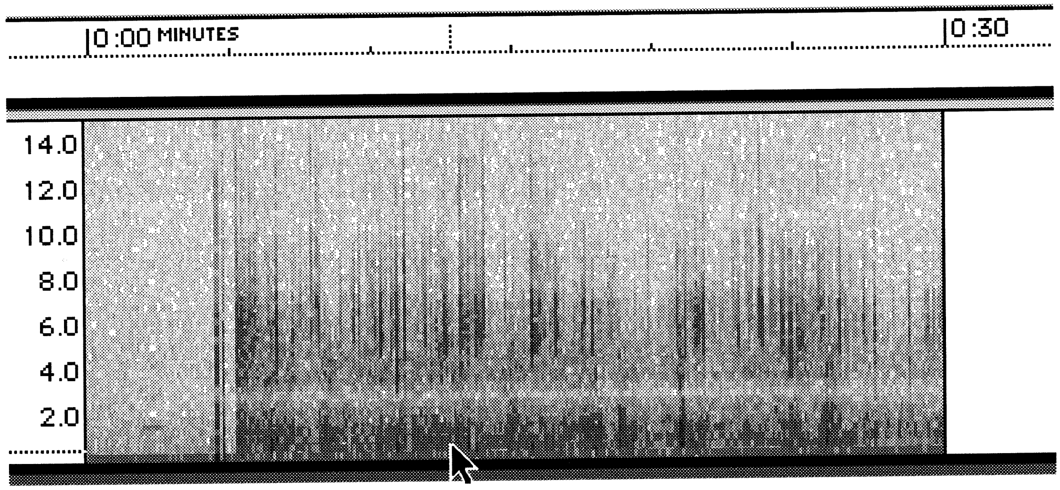


Team 30   Linden Lundback, Watrous, Saskatchewan, CANADA

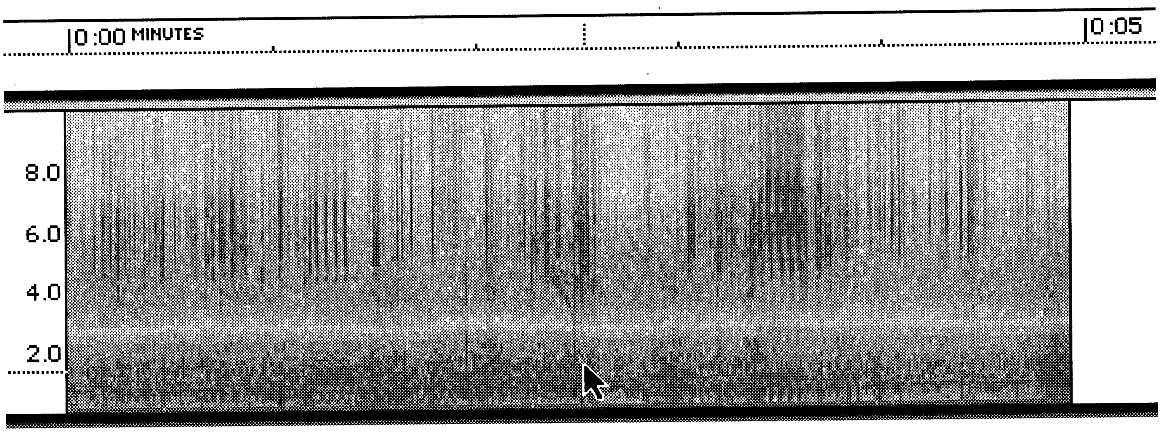
4/25/99   1600 UT



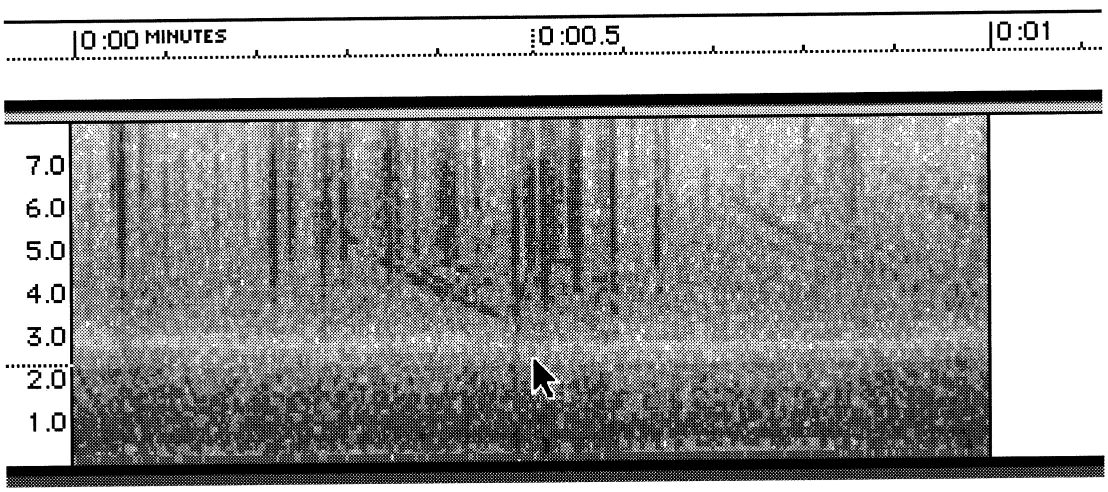
Team 6   Bill Pine, Chaffey High School, Ontario, CA
There were many faint whistlers during this session.



The arrow points to a whistler at about 16:00:13 UT



Five seconds centered on the whistler.



One second interval showing the whistler followed by fainter ones.

Notes From the Field

Communications from INTMINS Participants

Edited by Bill Pine
Chaffey High School
Ontario, CA

Data submissions are often accompanied by notes and messages from INTMINS participants describing various aspects of their experiences as observers. As an ongoing feature, some of these communications will be summarized in *The INSPIRE Journal*. The following summaries are in the approximate order in which the data was received by INSPIRE. In addition, some communications will be included from INSPIRE participants who did not record and submit data.

Team 1 Jack Lamb Belton, TX

Jack continues his record of being the most faithful INSPIRE observer. His record dates back unbroken to the SEPAC missions of 1992.

Team 31 Lee Benson Indianapolis, IN

I am new to INSPIRE and it appears I have just finished my radio in time to see the demise of MIR. Maybe they will get some money because I really need another chance.

My latest antenna was not quite ready yet. It is based on the design by Will Payne at www.altair.org. I would have been ready but got confused with all of the different AD620 amplifiers. I have the copper octoloop finished but didn't get the wire pulled in time for these INSPIRE passes. I was researching Schumann Resonance and found Will's WWW page which first lead me to INSPIRE.

Do you know of any professional sites, like NASA, that have looked at these passes? If so, are their results available anywhere? [I don't know of any other observers. - ed.]

General Comments:

Based on earlier recordings today [4/25], I decided to go with the shielded loop because it sounded on the phones like there was less hum. I had never seen the output from the loop on the spectrogram so I really didn't know what I was getting. I switched to the wire for the last two minutes just for the comparison.

I obviously have more hardware work to do on my loop. I didn't get much time to tune it and had not intended to use it at all for this pass. I have an air capacitor and a transformer that will eventually tune it, but I just had the first components I found in the junk box attached to experiment with. When I got there, the site had more noise than I thought and I decided that the loop was the best of bad choices. I switched to the normal wire at 1744 just to make sure that I had a variety of signals, even if they had hum. The first day I scouted this site it had rained the night before and it now appears that the site appeared quieter on 4/24 than it turned out to be on 4/25. There was also bleed-thru of signal on the WWV radio even with the switch off. I could not hear that in the phones. The "wind" sounds were associated with the local wind rather than the solar wind because I could feel and hear the gusts. I assume it came from the antenna wire vibrating but I could not eliminate it during this time.

I was not at all happy with the results of this trip but this was the best I could do at the time with what I had.

Team 27 The Amigos San Antonio, TX

Ron Janetzke and Mike Miller make up this team.

Team 7 Dean Knight Sonoma, CA
Sonoma Valley High School

Dean and his students set up 3 RS4 receivers with different antenna arrangements and different recorders. Receiver "RS" uses a Radio Shack CCR-81 recorder and a 91 foot long wire antenna oriented East-West. Receiver "#62" uses a Bell and Howell Model 3185-A recorder and a 198 foot long wire antenna oriented North-South. Receiver "#65" also uses a Bell and Howell Model 3185-A recorder and a 145 foot long wire antenna oriented East-West. Sonoma Valley High School Team members are indicated below.

	17-6	18-6	24-5	25-10		17-6	18-6	24-5	25-10
Loni Adams		x			Joel Kuschner	x	x		
Michelle Bertrand			x	x	Austin Love	x			
Meitra Bozorgzadegan	x	x	x	x	Scott Mathison	x	x	x	
Robin Brown-Ward	x	x	x	x	Abrie Maze		x		x
Ben Casias		x	x	x	Anna Neubacher	x	x		
Amelia Dang	x	x	x	x	Laura Neves	x	x		x
Ariana Du Floth	x	x	x		Tevor Nuccio				x
Spencer Falor-Ward	x	x	x	x	Stuart Price			x	x
Courtney Geissinger	x	x			Cooper Quintin				x
Dana Gillespie	x				Michelle Riggs			x	x
Nathan Goddard	x		x		Tom Sanders		x	x	
Annika Gustafsson	x	x	x	x	Christine Schneider	x	x	x	x
Nicole Hatley	x	x	x	x	Josue Solis	x	x		x
Ty Horner	x			x	Megan Spence	x	x		
Kendall Jarvis			x		Casey Stober	x	x	x	x
Stephanie Jensen	x		x		Meghan Sullivan	x	x		
Sarah Kay	x	x	x	x	Abby Swann		x		
Julliane Krauss		x			Jared Traub	x	x		x

Notes from the data analyst:

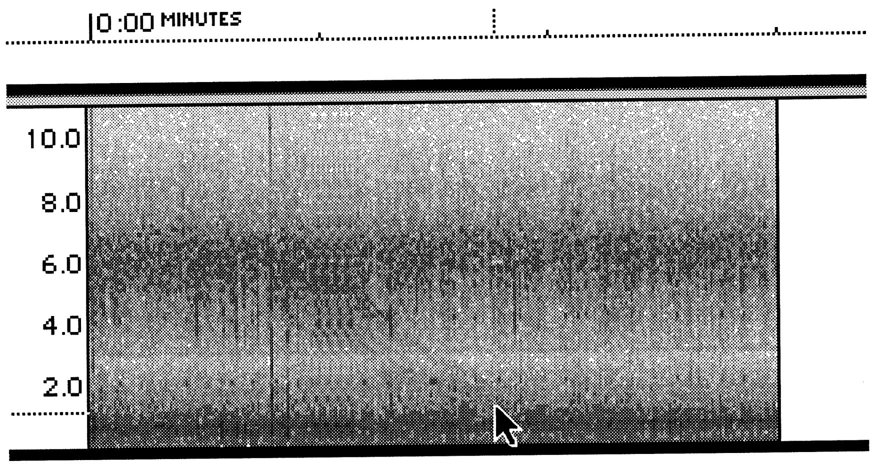
A Whistler Sampler from 4/24

There were many great whistlers on the tapes. I picked out four of the strongest from the RS tape and tried to find them on the other tapes for comparison. The 62 tape had much more manmade interference (LORAN and hum), but the whistlers boomed through! If I had looked first on this tape, I would have been hard pressed to pick a small number of good ones. The 65 tape showed much less sensitivity, but also less hum and no LORAN. Could be because of the orientation of the long wire. One of the whistlers did not show up on the spectrogram. The whistlers chosen were:

W #1	1344:19 UT
W #2	1345:55 UT
W #3	1347:41 UT
W #4	1351:11 UT

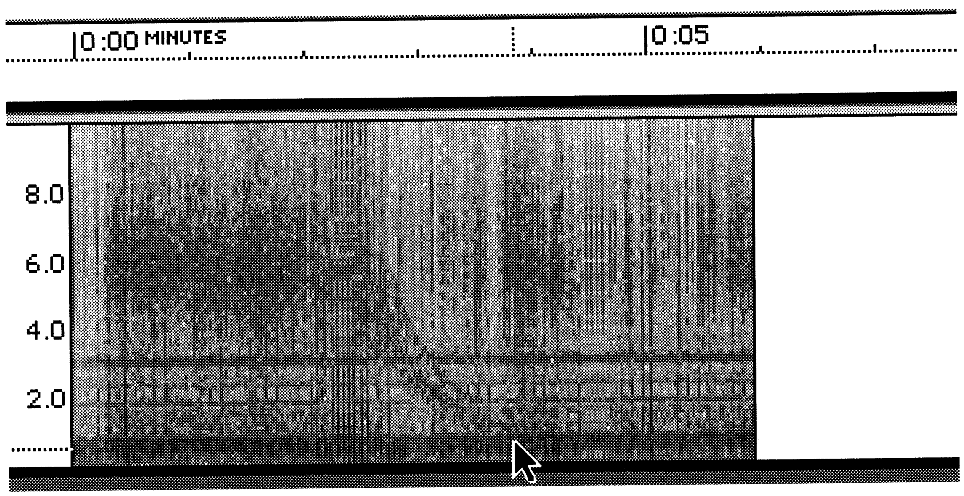
None of these whistlers was very strong in Southern California.

RECEIVER 64 (RS)



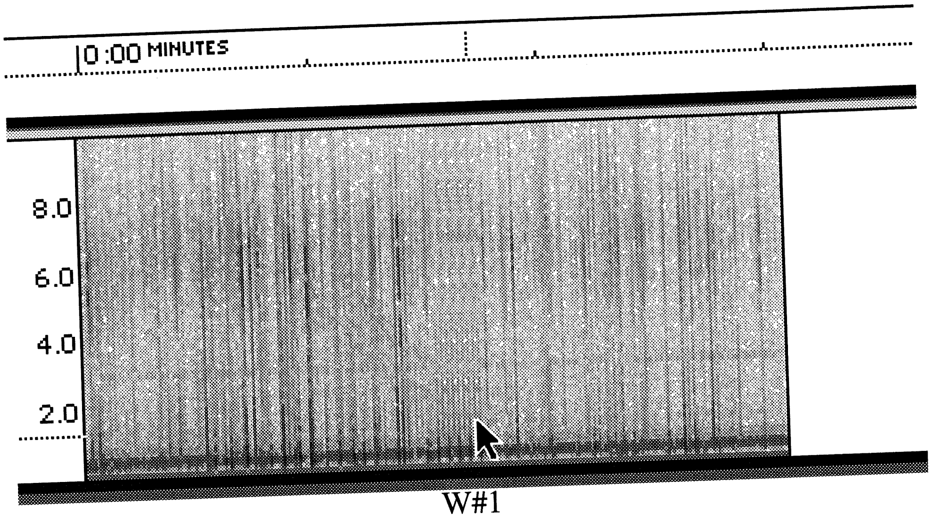
Arrow points to the bottom of a breathy whistler at 1344:19. (W#1)

RECEIVER #62



W#1 (0-10 kHz)

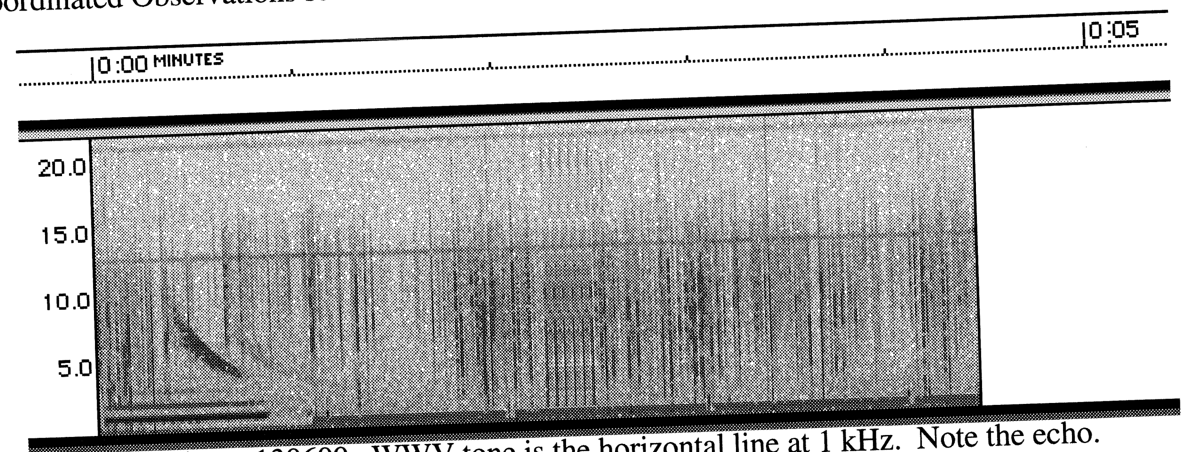
RECEIVER #65



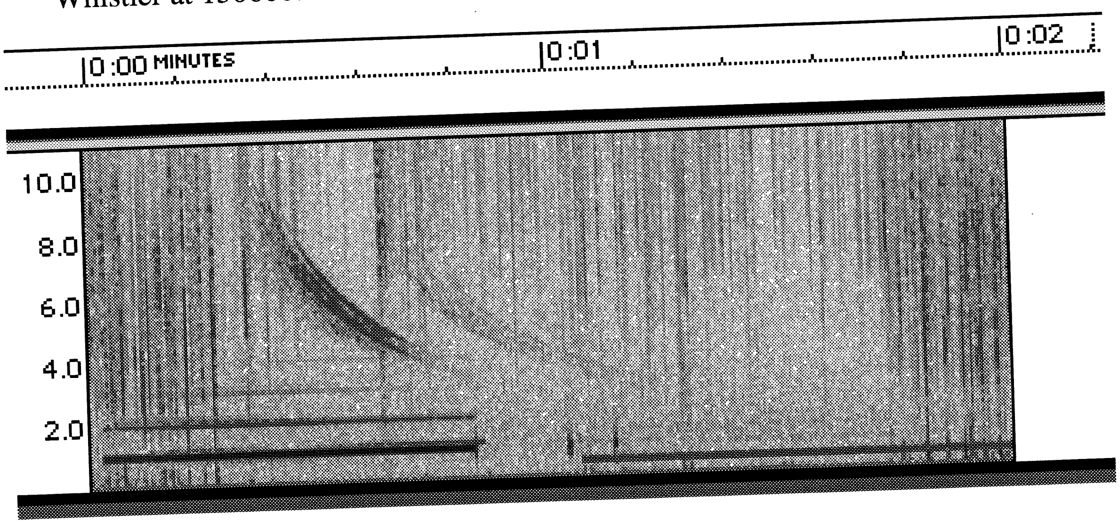
W#1

Team 32 **Shawn Korgan** **Gilcrest, CO**

Shawn really got into the whistlers in April! One of the best occurred during the Coordinated Observations session on 4/24 at 6 AM MDT (1300 UT) at the 1306 UT time mark.



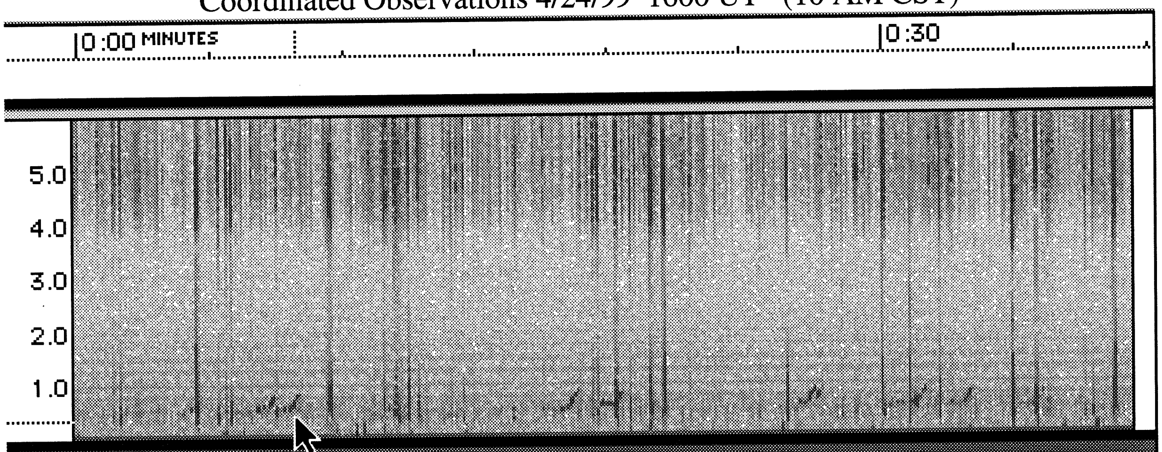
Whistler at 130600. WWV tone is the horizontal line at 1 kHz. Note the echo.



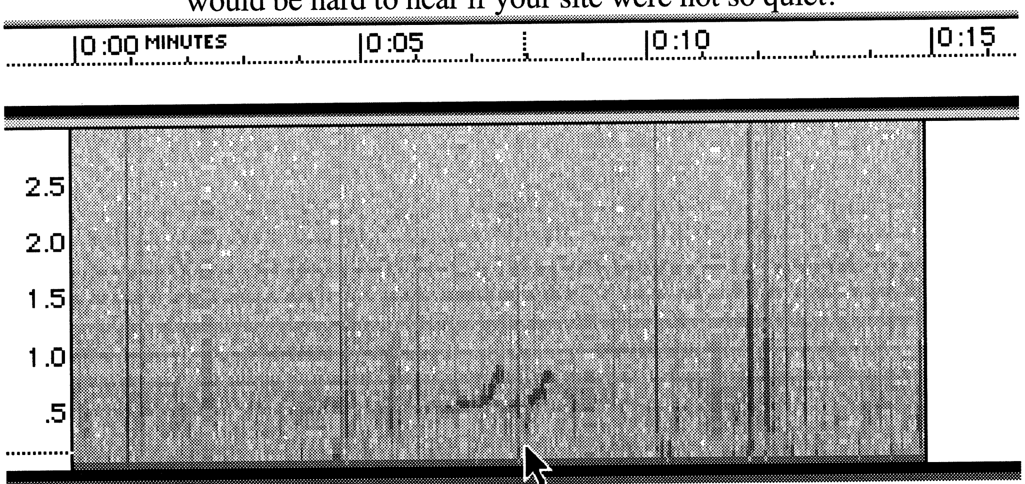
Team 30 Linden Lundback Watrous, Sask, CANADA

Linden and Teammate Brian Cowan recorded several whistlers during their sessions, but what they got that was unique was a lot of chorus complete with rising tones (risers). they also noticed a difference among the risers with some being quick (which they dubbed "whoopers") and the longer lasting risers. The following show samples and illustrate the differences.

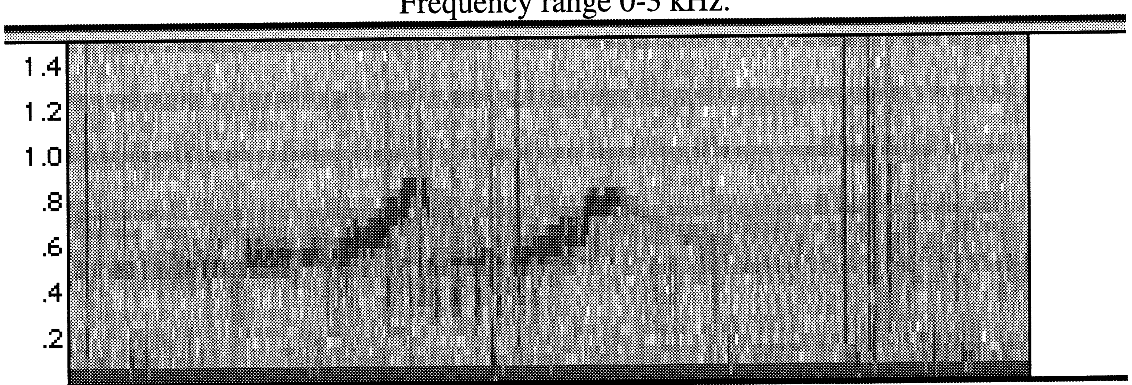
Coordinated Observations 4/24/99 1600 UT (10 AM CST)



This is 40 seconds starting at 160420 UT. The arrow points to a pair of whoops, but many others show up during this interval. Whoopers last about .5 seconds. They reside below 1 kHz and would be hard to hear if your site were not so quiet!

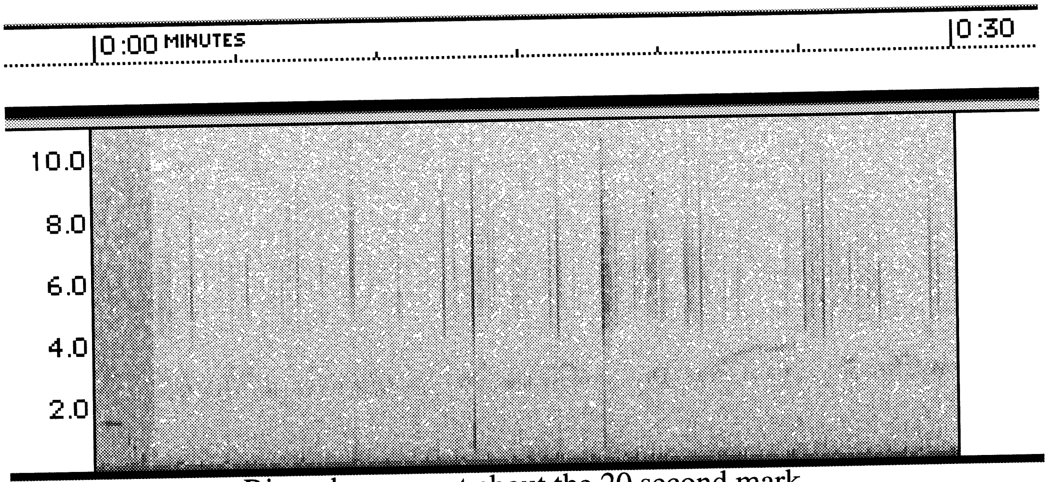


Frequency range 0-3 kHz.

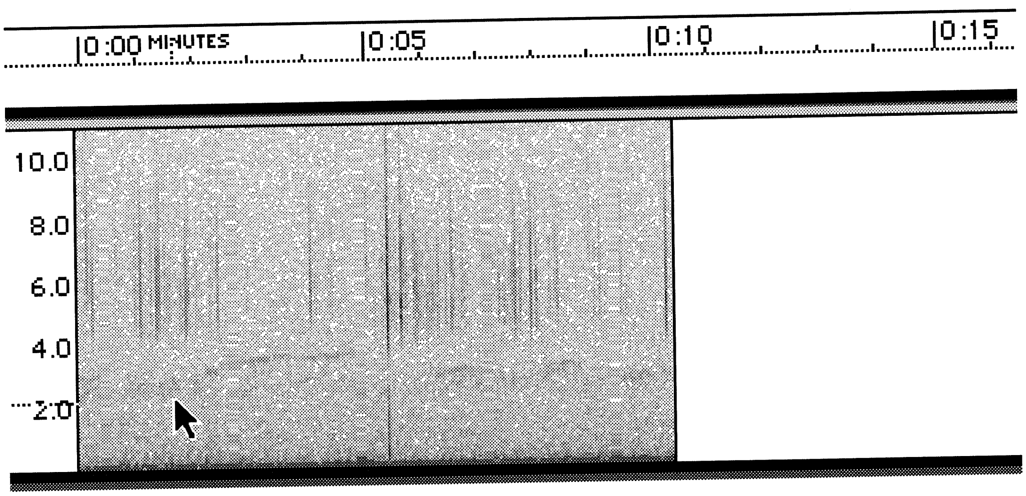


Extreme closeup using 0-1500 Hz range. Very neat!

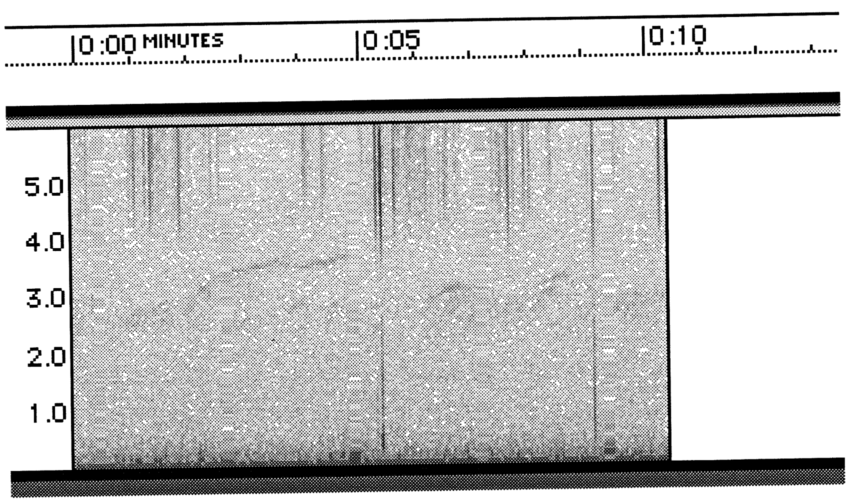
Coordinated Observations 4/25/99 1500 UT (9 AM CST)



Riser shows up at about the 20 second mark.



This is the last 10 seconds of the previous spectrogram. The arrow points to one of several risers. Notice that this is at a higher frequency than the whoopers. Notice also that these are longer and more drawn out.



Team 21 **Phil Hartzell** **Aurora, NE**

Date: 4/25/99

Hello Dedicated Inspire Participants:

A few notes on my recording sessions. First and foremost, this was the first session I had where I did not have one solitary thought on Omega. Maybe I am finally getting over the fact that the old venerable girl is gone and time heals all wounds. Seriously, I like the fact that I don't have her in the background to distract me when I am recording.

I had the chance to record sessions 24-4 and 24-8. The 24-4 session went very well. My loop performed wonderfully, nulling the sometimes overpowering ac hum very well. The central area of the midwest had many strong to severe thunderstorms to my south. This resulted in many sferics, recorded as a nearly constant barrage. With the shear number of sferics heard, came an equal number of whistlers. Most of my whistlers were about the same signal strength as the sferics. Quite a few did rise above the background level or they came through during the short breaks between crashes. I do believe I have recorded some of my loudest whistlers with this loop. I like it better than the long wire and my whip.

My 24-8 started out on a weird note. I drove up to my usual spot above the pond, back behind the trees in my little whistler spot. I've did it hundreds of times. I climbed out and noticed some voices coming from the pond. (it's not really a pond, more of an irrigation mudhole!). I walked down through the trees about 500 feet and noticed about a hundred people gathered around having a wedding! I was surprised because I see very few people in the area. I was concerned that the ignition noise would be present if people began to leave. They must drive around a corner and cars get within a couple hundred feet of me.

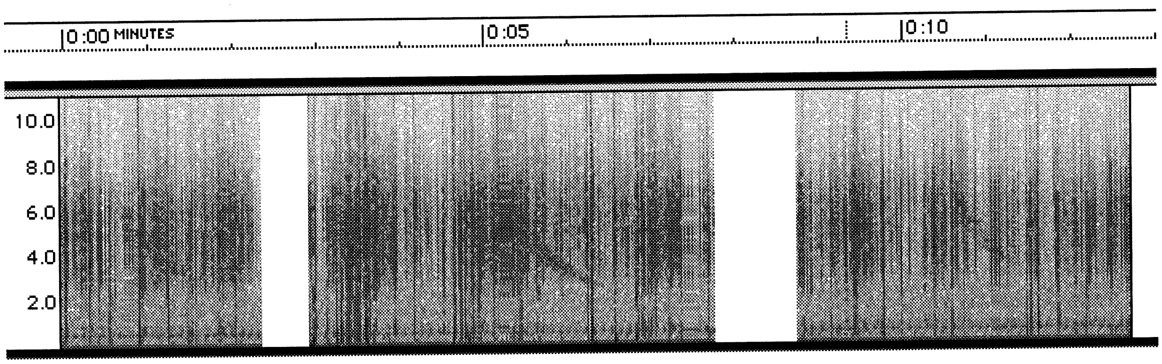
Well, a few did leave at about T-time, and I recorded everyone of them. The session was very uneventful anyway, I may have had a few whistlers but nothing to great. No signal from Mir. I did have fun listening to the different sounds various cars have from the ignition systems. The smaller the engine or car, the higher pitched the ignition whine. The loudest and lowest pitch was a midsize Buick LeSabre of about mid- 80's vintage. Probably had a small V-8. I noticed when I walked down the hill during setup, that I could see a half-dozen vintage1930's to 50's Harley motorcycles in the group. I sure wish one of them would have drove by during the session. I wonder what ignition sound they would create. Thanks! See what the fall brings!

Happy Whistling,

-Phil

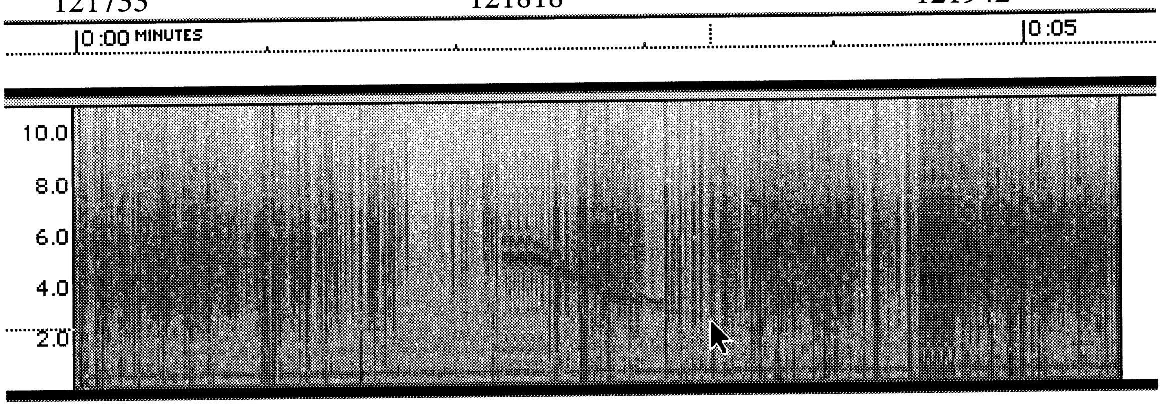
Phil got several whistlers and a couple of samples are shown here.

4/24/99 Operation 24-4 1226 UT
(Whistlers prior to operation)

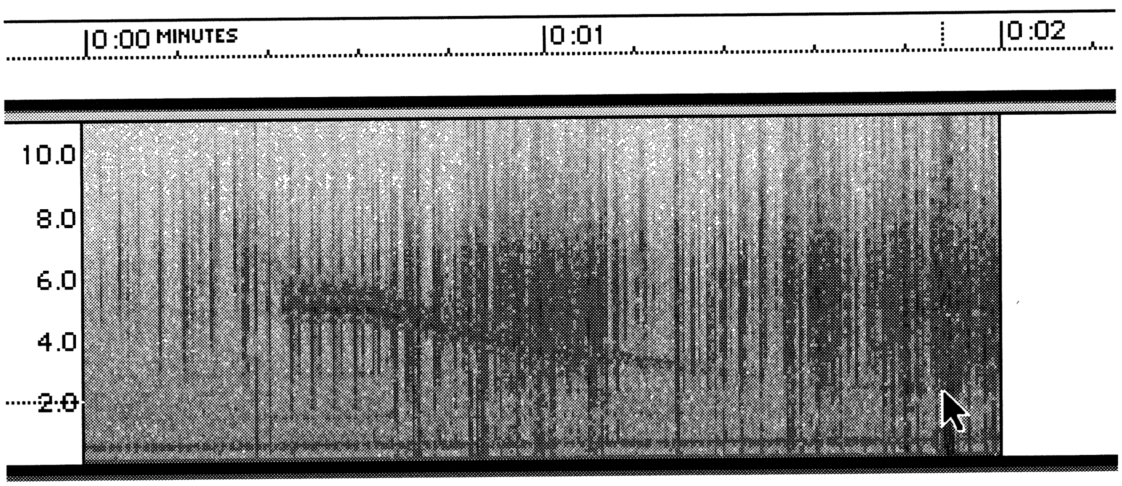


Three whistlers (of many) - these are the ones you boxed in your log.

121733 121818 121942



This is the one logged at 123423 as Very Strong and Very Loud. It is!



Closeup shows the dispersion extending from above 8 kHz down almost to 2 kHz.

Team 16 Leonard Marraccini Finleyville, PA

Enclosed with this brief letter are two tape cassettes and log sheets for operations 18-4 and 18-8. I hesitated sending these to you due to "Murphy's Law" which occurred during that day. I had gone to my favorite location to tape the 18-4 operation. This site is located in a county park where a pleasant stream runs through a quiet, open valley. I FORGOT that April 18 was the second day of opening trout fishing season here in Pennsylvania! I had to contend with HORDES of trout fishermen, etc. As a consequence, the first 9 minutes of tape included instrumentation problems - feedback squeal from a Realistic mini speaker/amp and a bad connection between the RS-4 and the tape recorder resulting in a dead data link. The remainder of the tape was acceptable.

As a result of my "Murphy's Law" morning, I decided to change location for the taping of operation 18-8. I moved to an isolated hilltop, still in the park but remote from the trout stream and fishermen. Peace and quiet finally. However, at this site I received electrical interference (hum) from some unknown source. this is evident throughout the tape session.

Thus both tape recordings I consider as below standard! I hope something can be salvages.

Team 29 Janet Lowry Houston, TX

There was much more activity than I've heard before, and I'm wondering if it's all in the category of 'sferics' or if you hear other kinds of sounds. During some of the recording time I heard sounds that sounded almost like a sweet, sucking sound. then there were sounds more like crashing through dry brush. Perhaps it's just my aural imagination that tries to categorize each in a different way.

[Sferics is a general term for natural VLF and also refers specifically to the sharp crackling of lightning (dry brush?). Other sounds do occur and are classified by how they sound to the observer: tweeks, whistlers, chorus, risers, whoops, etc. There is little standardization to most of this, so observers are free to give descriptive names to what they hear! - ed.]

I'm really enjoying this and am looking forward to both learning and recording more. I've just bought a folding kayak, and if I can ever figure out how to assemble it I'm hoping to use it as a way to reach some quiet recording spots.

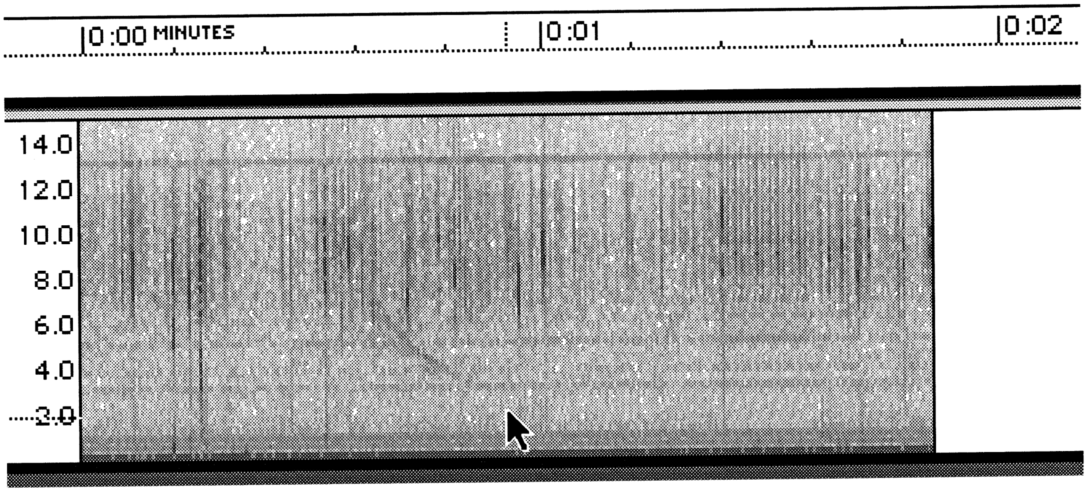
Team 7 Kent Gardner Fullerton, CA

I discovered something that may be useful in putting time marks on the tapes and eventually on the printouts. While recording some MIR passes, I noticed that when I put my quartz sweep second hand watch close to the receiver, the tick-tick could be heard through the earphone/speaker. When printed out they produced clean time marks, the first being slightly longer in length, then it would repeat. Such marks could be used for a second by second visual indicator, probably without masking or destroying potential data impressions. It was fun experimenting with it anyway. I also got some interesting recordings of internal oscillations of my digital voltmeter.

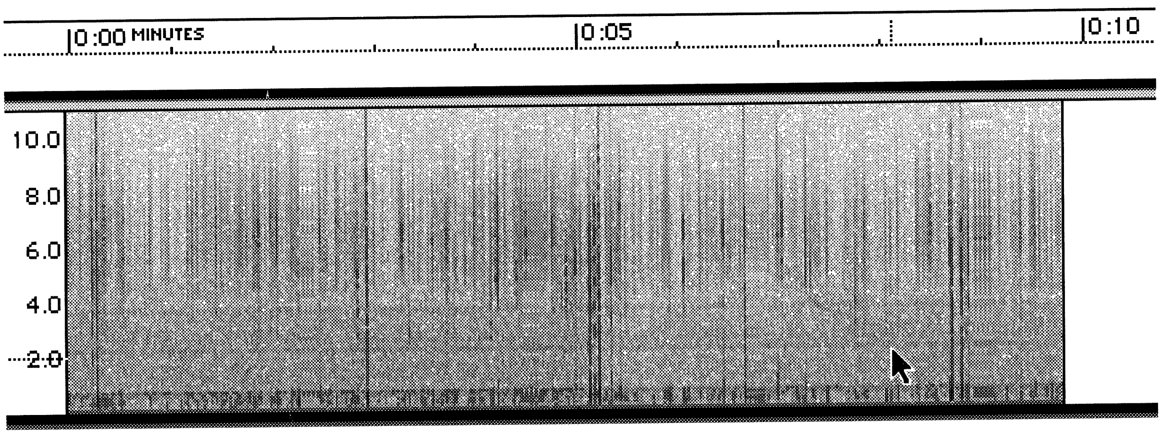
Team 6 Bill Pine Chaffey High School Ontario, CA

The Chaffey High School INSPIRE team set up three receivers for observations at our site on Glendora Ridge Road in the San Gabriel Mountains overlooking our valley. Annually, there is a sort of competition to see who can hear the first whistler, the most whistlers, the strongest whistler, etc. Last year we got through the entire fall with no whistlers - a first. We hoped for better in the spring. Did we ever get it! We don't know who heard the first one, but everyone who went heard many, many whistlers. The following are some samples.

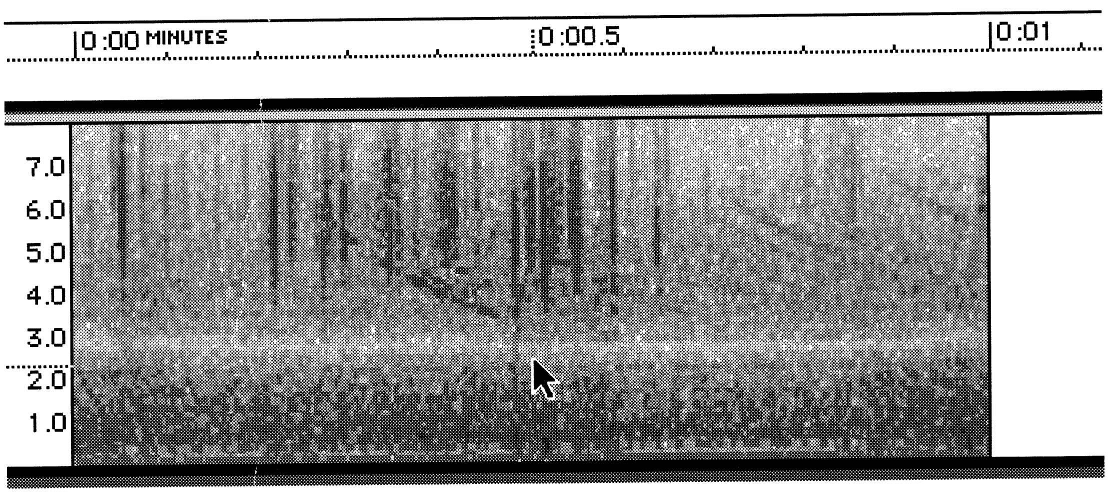
4/17/1999 Erin Hoppe



4/18/1999 140810 UT Minh Diep

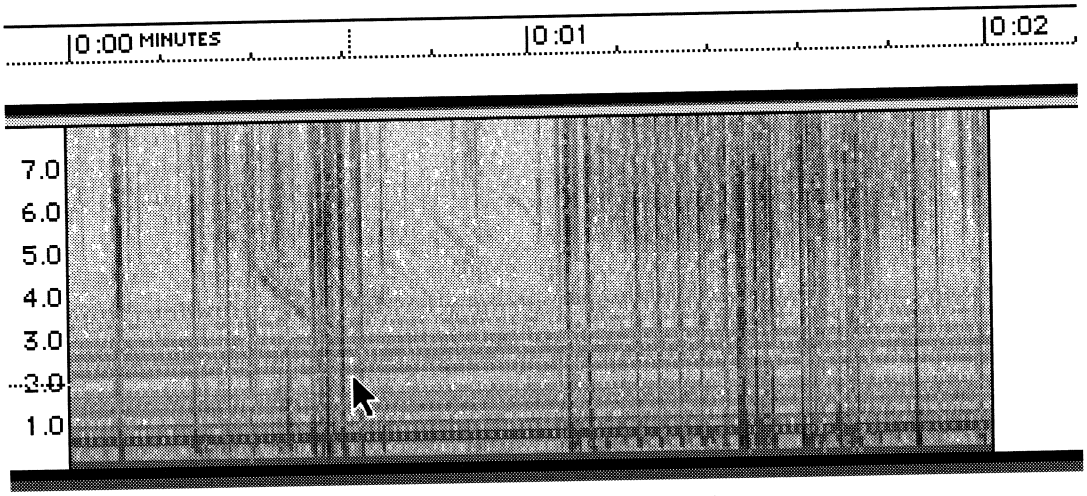


4/25/1999 160013 UT Erin Hoppe Receiver #2 (RS-4)



Note the echoes.

4/25/1999 160013 UT Philip Hirz Receiver #3 (VLF2)



The same whistler as the previous spectrogram.