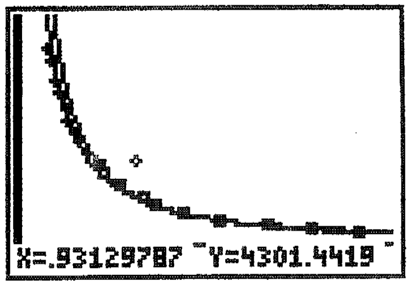
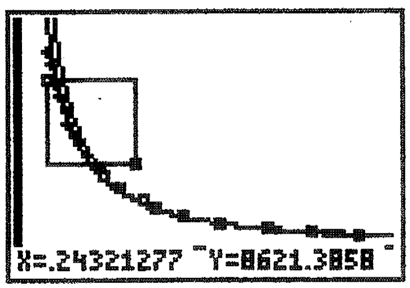
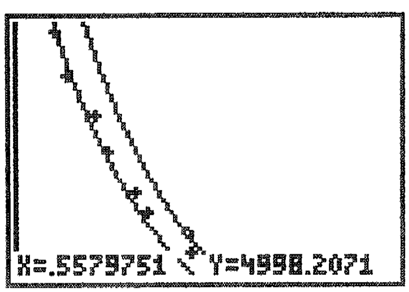
Press [ENTER] and your plot display returns with a crosshair that will be used to select the corners of the zoom box and a display of the X (time) and Y (frequency) coordinates of the crosshair. Our area of interest is around 5,000 Hz so place the crosshair to a time on the right side of the curves and a frequency less than 5,000 Hz as shown.



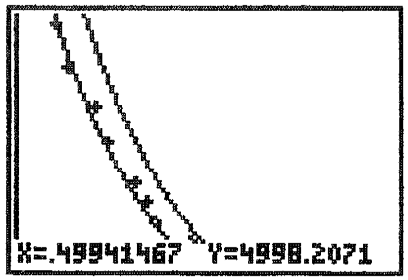
Press [ENTER] and move the crosshair to the upper left hand corner of the zoom box, to a time on the left side of the curves and a frequency greater than 5,000 Hz as shown. You will note that while you move the crosshair, the zoom box is depicted on the display.



Press [ENTER] again to display the magnified area of the display. Note that the X and Y coordinate values of the crosshair location are depicted at the bottom of the display. Move the crosshair to a point on the low-frequency curve at frequency of approximately 5,000 Hz, in this case 4998.2 Hz. Note that the time of arrival of this frequency is listed in X as .5579751 (.5580) seconds.



Now move the crosshair to the curve derived from all of the data at the same frequency using the [◀] key. The time of arrival of the 4998 Hz frequency on this curve is .4994147 (.4994) seconds.



The time difference of arrival between the two curves is .0586 seconds. This difference is comparable to the accuracy of the time and frequency measurement technique used to extract the data from the Spectrogram program plot. There appears to be a reasonable expectation that the curve fit method does provide an opportunity to extrapolate data outside of the collected frequency range. Though the fitted curves are not perfect, they are usable.

Part 2: Using whistler dispersion to calculate the time of the source lightning strike.

Armed with the analytical tools provided by the graphing calculator, we are now ready to tackle a mathematical model that will allow us to calculate the time of the lightning strike based on the arrival time of a specific frequency and the dispersion of the whistler wave form.

Very low frequencies in the range of whistlers do not travel at a consistent velocity. When these frequencies travel over great distances through a non-vacuum, non-homogeneous medium, the higher frequencies travel at a greater velocity and therefore arrive before the lower frequencies, which produces the whistler effect. The concept that different frequencies of a wave travel at different velocities is defined as the dispersion of the wave. Dispersion of a wave is a function of the length of the path and the electron density along the path (longer paths and/or higher electron density, the greater the dispersion). For the sake of this article I am going to ignore other factors that contribute to the dispersion of the wave such as heavy ion density, which arguably has a negligible contribution to wave dispersion of the frequencies being considered here.

Mathematically, dispersion is defined by:

$$D=t\sqrt{(f)}$$

Where **D** is the value of the wave dispersion, **t** is the time delay from the source of the frequency (the lightning strike), and **f** is the discrete frequency of the wave. The fact that a whistler is defined by this mathematical function can be verified by graphing the whistler data extracted from a collected whistler as $1/(\sqrt{(f)})$ versus **t**. This graph should reflect a straight line with a slope of **D**.

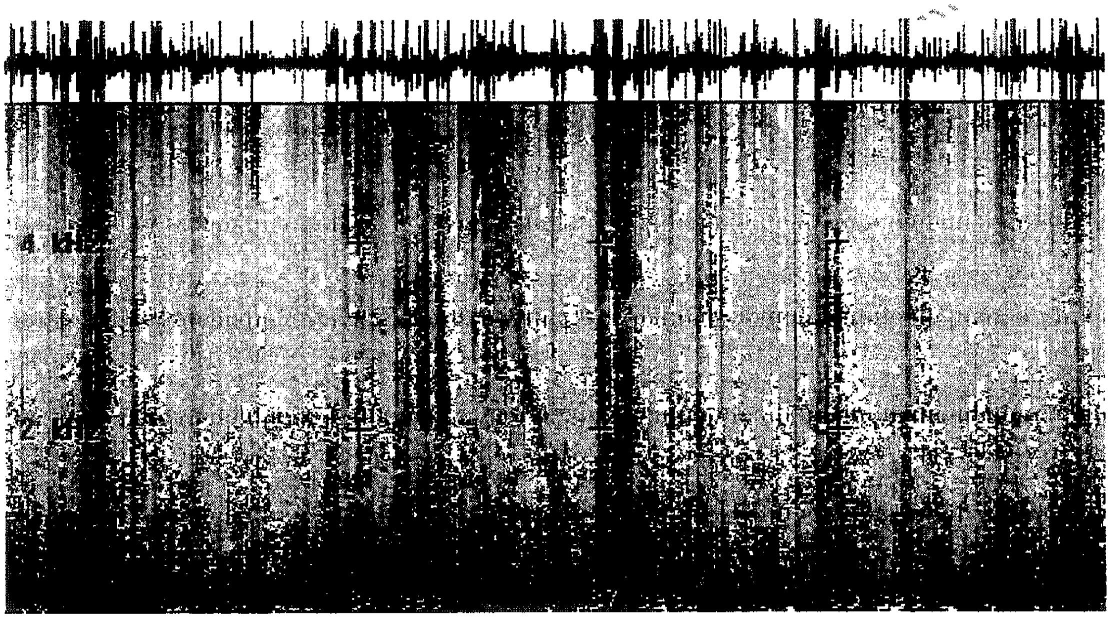
In the analysis that follows, I will use the example set by Stanford University researchers who used a standardized frequency of 5,000 Hz because the waves seemed to be strongest at this frequency; however, other convenient frequencies can be used.

If the source time is missing, dispersion can be estimated from the slope of the whistler curve at a specific frequency. Assuming that the dispersion is constant at a given value of $t\sqrt{f}$ then:

$$D=-2f^{3/2}dt/df$$

Where **dt/df** is the derivative (slope) of the whistler curve at the discrete frequency f. This gives the dispersion of the wave as a function of the slope and can be used when the time of origin of the source lightning strike cannot be determined otherwise.

I am fortunate to have an excellent location within 15 minutes drive of my home to collect whistler signals, and I receive numerous whistlers on virtually every excursion. Many times there are so many spherics associated with the whistlers that it is difficult to pick out the one strike that could be associated with a particular whistler but there have been enough quiet opportunities that I have been able to correlate collected whistlers with their probable source spheric to test the dispersion mathematical model. That process follows.



The whistler that I am using for this analysis is depicted in figure 2. A copy of the wave file is available for the asking via e-mail. One note of interest: I discovered that the Spectrogram software does not load the wave file at the same starting time each time a specific wave file is loaded and displayed. Therefore if you are going do this dispersion analysis to calculate the time of the source strike and then look for the source strike on the Spectrogram screen, you will need to use the same depiction of the whistler as the one that the data is extracted from so that the time reference is the same.

The data extracted from this whistler is contained in the following table.

Data Table for Whistler 06031030z at 85 seconds	
Time (ms)	Frequency (Hz)
85863	4275
85938	3456
86038	2918
86163	2358
86288	1906
86538	1303

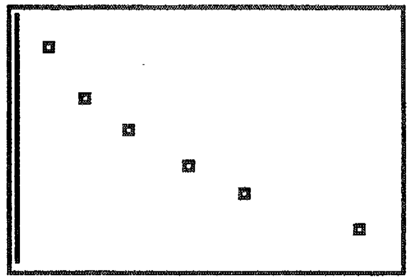
Table 2.

There are a number of calculations that will be accomplished based on the data and the resulting fitted curve. It is helpful to keep an organized log of the calculations so that the accumulation of data can be used later for further analysis. The table that I developed to help organize the calculations is at Appendix 1. I will refer to that table during the following calculations. The example table includes the results of this example calculation and the calculations using the whistler data from Part 1.

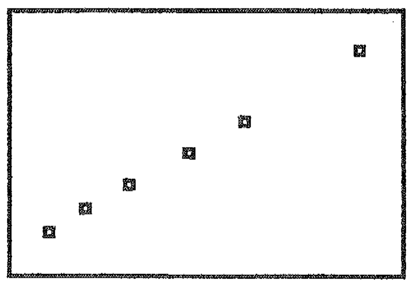
The overview of this procedure is as follows:

1. Enter whistler data points into calculator lists.
2. Normalize the time data to around 1 second.
3. Display the data to confirm data entered correctly.
4. Create a list of $1/(\sqrt{(f)})$ and display a plot of this list versus time, check for a linear relationship.
5. Fit a curve to the data and expand the display window to include the discrete frequency of interest (i.e., 5,000 Hz).
6. Determine the slope of the curve at the discrete frequency (**df/dt**).
7. Calculate the inverse of this slope (**dt/df**).
8. Calculate the dispersion of the wave.
9. Calculate the time from the arrival of the discrete frequency to the source strike.
10. Convert the source strike time to the Spectrogram plot time reference and look for the source strike on the display.

After entering the identification data on the specific whistler being analyzed into the ID columns of the log, the data points are entered into the graphing calculator as outlined in Part 1 of this article. Using the data in Table 2, the following plot depicts the data for this whistler.

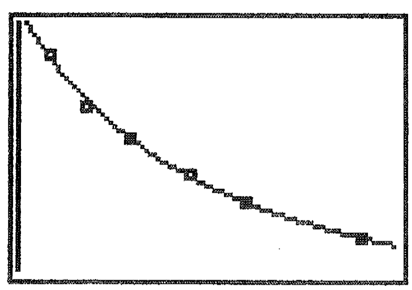


To test whether the whistler follows the inverse square model, enter the inverse square root of the frequency into one of the lists and then plot the data. Press 1[÷][2ND] [x²] (for square root) L? (list where frequency data is stored) [STO→] L? (list where square root data is to be stored for plotting) [ENTER]. The plot appears as follows.

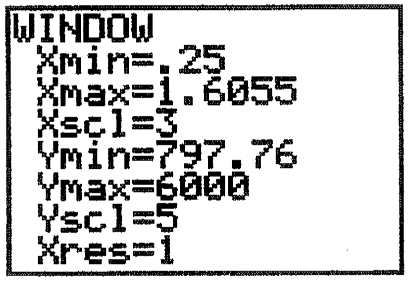


This plot is approximately linear and verifies that the whistler follows the inverse square of the frequency model.

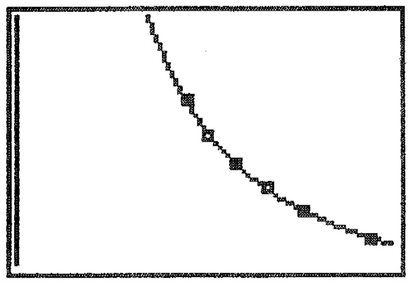
Now performing a curve fit on the whistler data results in this plot.



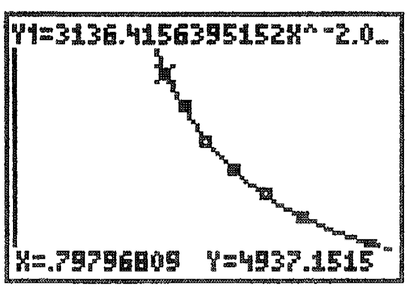
I chose this whistler because it was typical of the frequency range of the whistlers received at this latitude. The data point of the maximum usable frequency was approximately 4,300 Hz, a little short of the standard 5,000 Hz that is being used for the remainder of the calculations. This is where using the fitted curve allows us to extrapolate data outside of the received range of the whistler. To do this, the plot of the curve needs to be expanded to include frequencies greater than 5,000 Hz. Press [WINDOW] to obtain the display parameters. Change the **Xmin** (time) and the **Ymax** (frequency) as shown to expand the display to frequencies above 5,000 Hz.

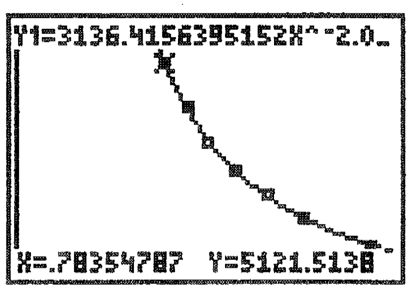


Now press **[GRAPH]** instead of **[ZOOM]** 9 to accept the modified display parameters. Pressing **[ZOOM]** 9 at this point would return the display parameters to the best-fit parameters based on the list data.

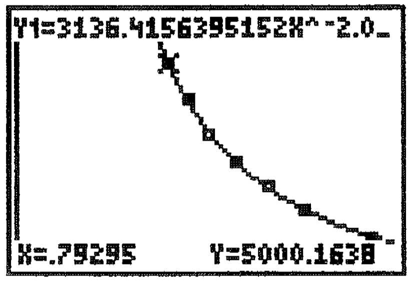


Pressing the **[TRACE]** key and then the **[▲]** key puts the calculator into the trace mode and tracing the curve as opposed to the actual data. Using the **[◀]** and **[▶]** keys move the crosshair to either side of the 5,000 Hz frequency coordinate as listed at the bottom for Y=, take note of the time of arrival (X=) of the points on either side of the 5,000 Hz frequency point. Here the right hand point is at frequency 4937 Hz arrived at .7980 seconds and the left hand point is at 5121 Hz at .7835 seconds.

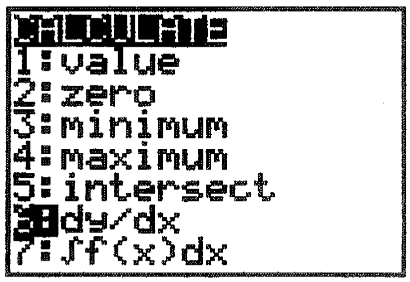




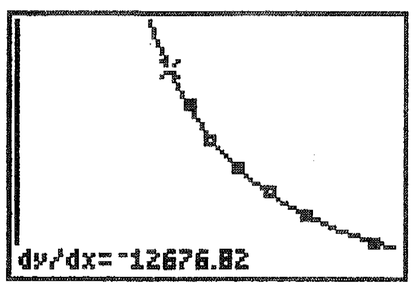
The following steps will take some trial and error to zero in on the time of arrival of the 5,000 Hz frequency. While still in the trace mode enter values between .7980 and .7835 seconds until you get as close to 5,000 Hz as possible. Here the arrival time of the 5,000 Hz frequency was a time of .79295 seconds.



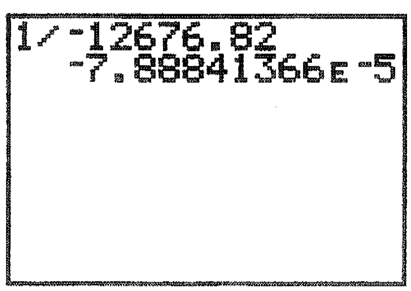
Note this time of arrival for the next step, determining the slope of the curve at 5,000 Hz. Press **[2ND] [TRACE]** to enter the CALC menu and select **dy/dx**.



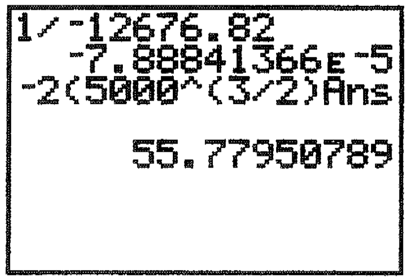
Press **[ENTER]** and you will return to your data and curve plot. Enter the time of arrival for the 5,000 Hz frequency (.79295) and press **[ENTER]**. The derivative result will be displayed at the bottom. Enter this number in the appropriate column on the whistler analysis data sheet attached.



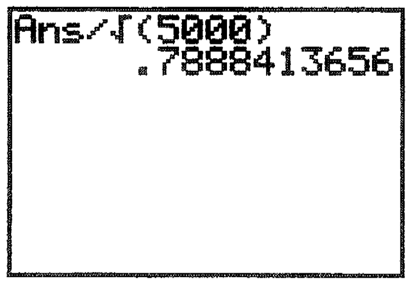
Next find the inverse of this slope (**dt/df**) and enter it into the data table.
Press **1/-12676.82 [ENTER]**.



Calculate the dispersion at 5,000 Hz by the following keystrokes. Press –
2(5000[▲] (3[÷] 2)) [2ND] [-][ENTER].



The dispersion returned is 55.77; enter that number in the appropriate column. Next calculate the time of the strike before the arrival of the 5,000 Hz frequency by calculating the dispersion divided by the square root of the frequency. Press **[2ND] [(-)][÷][2ND] [x²] 5000 [ENTER]**



The time of the strike before the arrival of the 5,000 Hz frequency was .7888 seconds. Add the time of the 5,000 Hz frequency (792.95milliseconds) to the time that you subtracted from the list time to normalize the data, in this case 85000 milliseconds, and finally subtract the strike time of arrival just calculated (788.8 milliseconds). The result is the time of the strike relative to the Spectrogram time reference, in this case 85004 milliseconds. You will note in the Spectrogram plot that there is a distinctive spheric at 84988 milliseconds. The difference between the calculated time of the source strike and the received time of the probable source strike is only 16.5 milliseconds. Record these values in the calculation log. I have also included in the log the calculations for the whistler that was used in Part 1 of this article.

I have tested this model for determining the time of the source strike numerous times and it appears to be a useful model when the source strike is not readily available. There should be some time delay between the source strike and the reception of the source strike depending on the distance the receiver is away from the strike.

Part 3: Testing the low frequency and high-density models.

One of the fascinating things revealed during my study of Helliwell's book was the description of nose whistlers. Nose whistlers have a definite frequency at which the time delay of the wave's travel at the nose frequency is a minimum. Frequencies above the nose frequency are more delayed, and as described earlier, the frequencies below the nose frequency are also more delayed. Helliwell provides excellent illustrations of nose whistlers. The program described here will produce graphic displays of nose whistlers and low-frequency model whistlers (the type normally seen) based on the gyro frequency of the electrons caught up in the magnetosphere. Apparently all whistlers are nose whistlers; just the lower frequency components are more readily received at the lower latitudes. After reading about nose whistlers, I reviewed my collection portfolio and I believe I have seen just the first hint of the nose in some of the whistlers that I have received at this latitude.

Helliwell presents two mathematical models of whistlers that I thought would be interesting to test using the graphing calculator. The first is the high-density approximation model:

$$T = \frac{1}{2\Lambda^{1/2}(1-\Lambda)^{3/2}} \text{ sec}$$

The second model is the low-frequency approximation model:

$$T = \frac{1}{2\Lambda^{1/2}} \text{ sec}$$

Where T is the time of arrival from the source strike of a discrete frequency and:

$$\Lambda = \frac{f_o}{f_h}$$

f_o is the discrete frequency, f_h is the electron gyro frequency.

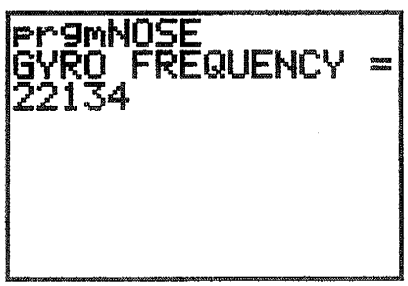
The TI-83plus program at Appendix 2 produces graphic displays of these two models given the gyro frequency. If we take the equation for the low-frequency model and rearrange it to solve for the gyro frequency, we can enter the time delay of the 5,000 Hz signal as calculated by the procedure in Part 2 of this article and solve for the gyro frequency.

$$f_h = 4T_o^2 f_o$$

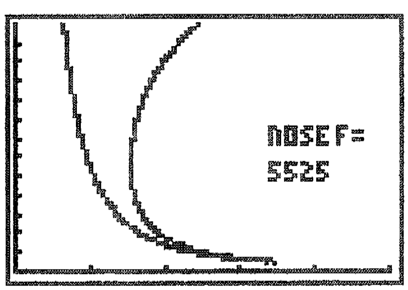
Where T_0 is the time of arrival of the discrete frequency (5,000 Hz). Using the time of strike calculated in Part 2, the gyro frequency is 12444. Using the time of strike calculated for the whistler presented in Part 1, the gyro frequency is 22134 Hz. Both of these values are entered into the calculation log at Appendix 1.

After you have debugged and entered the NOSE program into the graphing calculator, call and run the program. Press **[PRGM]**, select **NOSE**, and press **[ENTER]**.

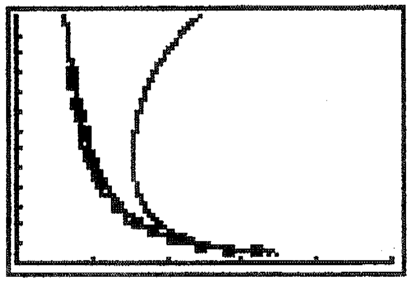
Press **[ENTER]** again to run the program. The program will ask for the gyro frequency, enter the gyro frequency for the whistler analyzed in Part 1, 22134 Hz.



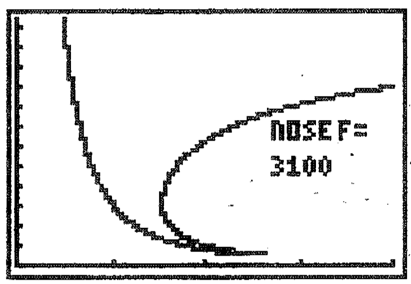
Press **[ENTER]** to continue the program. It will take a few moments so be patient. The display will look like this when the program is finished. The nose frequency will also be displayed.



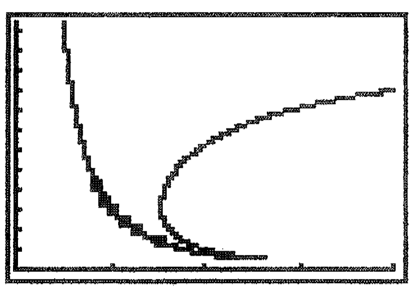
Obviously the nose frequency model is a little shy of being close, this whistler had a frequency range up around 10,000 Hz with no indication of nosing over. If you put the time normalized data for the whistler into lists L5 and L6, you can overlay the data on top of the mathematical models. This is what I have done here. There is a good correlation between the actual data and the low-frequency model.



Now try the whistler from Part 2. Run the **NOSE** program and enter the gyro frequency of 12,444 Hz. The mathematical predictions are depicted this way.



Again the high-density model does not appear to fit the whistler profile. Overlaying the time normalized data on top of the model produces this display.



The low-frequency model seems to provide a better fit for the actual data.

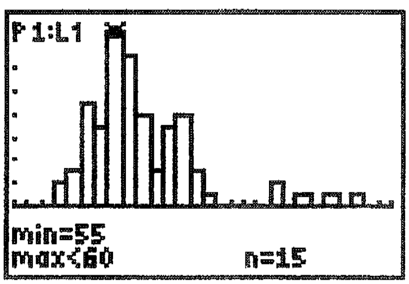
Using the high-density model to determine the gyro frequency is not as clean and simple using the graphing calculator. You would need to enter the algorithm of arrival time versus the gyro frequency based on a discrete frequency and use the trace function to solve the equation. In most cases the minimum of this algorithm was above the arrival time of the discrete frequency and therefore was not applicable.

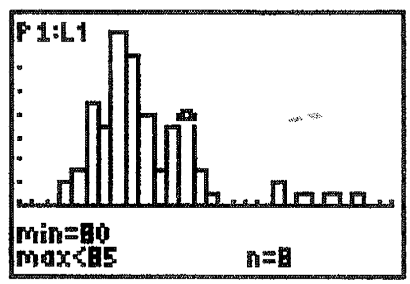
It would appear from the whistlers that are received at my latitude, that the low-frequency model provides a better predication.

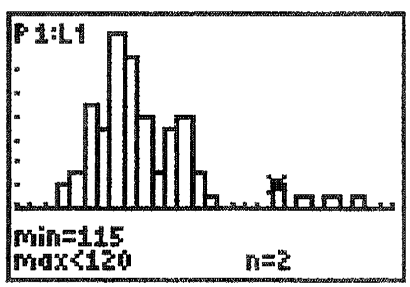
Concluding thoughts and speculations.

I have analyzed approximately 100 whistlers using the methods and procedures presented here. From this limited database I would like to present an observation. It would appear that strikes that produce tweeks do not produce whistlers. I speculate that this is because most of the energy of the strike is trapped and ducted beneath the ionosphere and insufficient energy escapes the ionosphere out into the magnetosphere to produce detectable whistlers.

I have also taken a look at the distribution of the dispersions of the whistlers that I have analyzed. The followung displays are TI-83 plus generated histograms of that distribution.







From the histograms it can be seen that there is a major cluster of dispersions that center around 55, there is a minor cluster centered around 80, and a very minor cluster centered around 115. If I assume that the first major cluster is made up of double hop whistlers, the added dispersion for each hop would be 27.5. Taking the center dispersion of 55 and adding 27.5 for one additional hop results in a dispersion of 82.5, remarkably close to the center of the minor cluster at 80. Finally, the very minor cluster at dispersion of 115 appears to be echoes of the major cluster at 55 (55 * 2 = 110). I do not know what to make of this limited data set yet, but I am working on it.

Where next?

Some of the things that I will be looking at in the future include:

1. Continue to gather data from whistlers to add to the database and the picture being developed.

2. Do some analysis of echo trains. I have received one at this location and I have the wave file of the super train received recently in Colorado.

3. Most of the whistlers I have received and analyzed were collected during the prime collection window. I am going to expand my collection opportunities to include less than optimal time. I hope that the distribution of dispersions as a function of time of day will give an indication of the changes in the magnetosphere as a function of time of day. I must admit that this may try my patience waiting for whistlers to occur when the ionosphere is fully ionized.

Conclusion

I hope that you have found some of the material presented here of use and perhaps interesting. I know that some of my founding assumptions will be criticized and perhaps I have oversimplified the whistler phenomena, but I had fun crunching the numbers and trying to make some sense out of what is being given to us by whistlers. Happy listening and whistle while you work…or is it work while you're whistling?

Appendix 1

File I.D.	Time	df/dt (slope) at 5000 Hz	dt/df (slope) at 5000 Hz	Dispersion	Time of strike from 5000 Hz	Calculated time of strike	Time of strike on plot	Strike Time Differences	gyro freq.	Nose freq
06031030z	85	-12676.8	-7.888e-5	55.78	.7888	85004	84988	-16.5	12444	3100
04301130z	12	-9594.75	-1.052e-4	74.39	1.052	11498	11463	20	22134	5525

Appendix 2

File Name: NOSE.8XP   Type: Program   Protected: No
Comment:Program file dated 06/04/00, 18:07

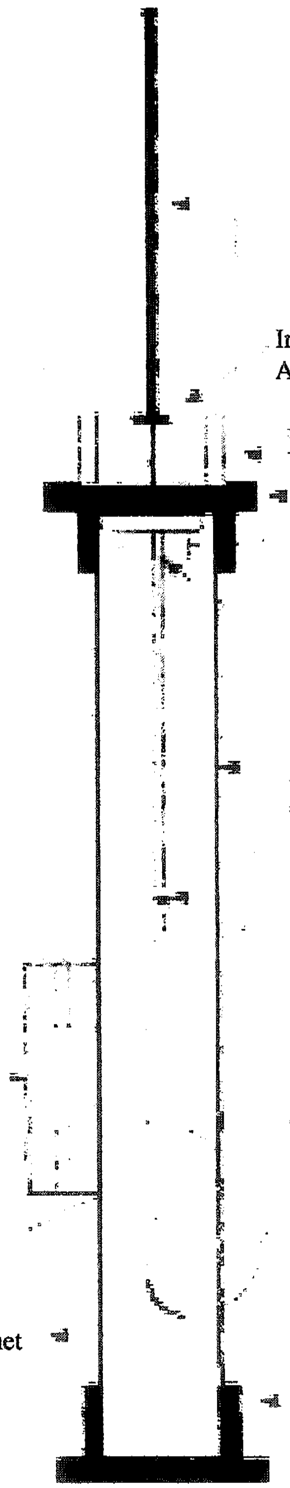
```
Input "GYRO FREQUENCY =“,H
1 Part ( (H-475) /25) -1→D
If D≥500 : 500→D
D→dim ( L1 )
D→dim ( L2 )
D→dim ( L3 )
475→F
For ( C, 1 , D, 1 )
F+25→F
1/(((2*√(F/H))*(l-(F/H) ) ^ (3/2)))→Z
F→L1 (C)
Z→L2 (C)
I/(2*√(F/H))→Z
Z→L3 (C)
End
0→Xmin
0→Ymin
F→Ymax
round(max( L3 ),0)+2→Xmax
I000→Yscl
1→Xscl
FnOff
Plotsoff
PIot 1 ( xyLine, L2 , L1 , - )
Piot 2 ( xyLi ne, L3 , L1 , - )
PlotsOn (1,2)
DispGraph
min( L2 )→M
For ( C, l, D, l )
If L2 (C)=M:L1(C)→N
End
Text(25,64,"NOSE F=")
Text(34,64,N)
```

An INSPIRE Antenna and Ground Rod

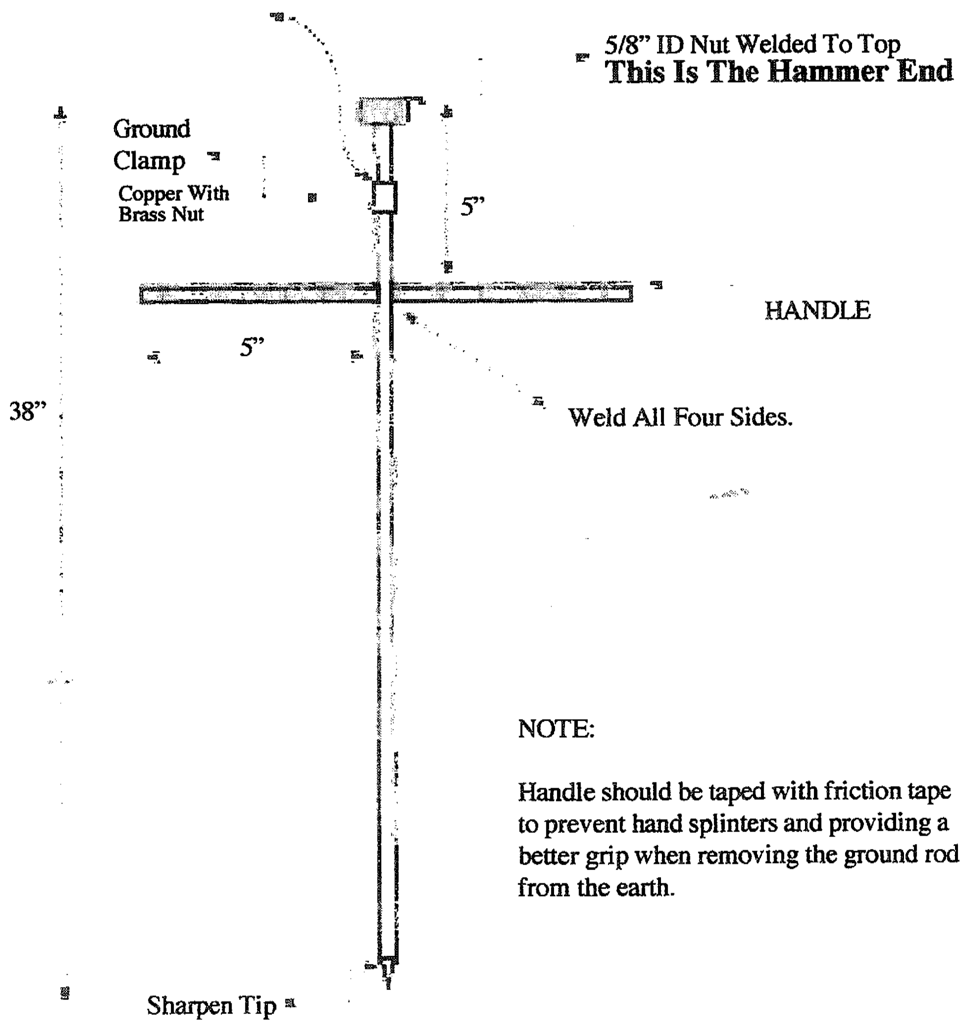
By Carl Chernan
Tarentum. PA

BM List:

1. 1 ea. Radio shack Antenna #270-1408A
2. 1 Section 3/4" - 36" Long PVC Pipe
3. 1 ea. Hubbell Strain Relief Connector
   Aluminum - 3/8" NPT Hub Size
   Grainger PN. 5D712
4. 1 ea. 3/8" Conduit Retaining Nut
5. 2 ea. 3/4" PVC Pipe Caps
6. 1 ea. 3/8" Rubber Grommet
7. 10' #20-22 Flex Stranded Wire
8. 1 ea. Insulated Spade Lug
9. Misc. - Tools, soldering iron, solder, PVC
   Pipe Cement, Electric Drill, RTV
   Silicone



Ground Rod



NOTE:

Handle should be taped with friction tape to prevent hand splinters and providing a better grip when removing the ground rod from the earth.

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.)

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. Vital, Quebec	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'
31	Lee Benson	Indianapolis, IN	86° 3' / 39° 23'
32	Shawn Korgan	Gilcrest, CO	104° 67' / 40° 22'

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	Zagreb, Croatia	
	Rudjer Boskovic Institute		
E9	Dr. Valery Korepanov	Lviv, UKRAINE	24° E / 50° N
	Lviv Center of Institute of Space Research of NASU		
E10	Sarah Dunkin	London, England	0° 02' E / 51° 40' N
	University College London		

INTMINS – April/2000
Data Analysis Report

by Bill Pine
Chaffey High School
Ontario, CA

The April/2000 INTMINS observations marked the eleventh 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

A limited number of operations was scheduled for April 2000. Paritipation was also limited.

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-April/00 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
E22-1	0555	Croatia	
E28-1	2159	Northern Italy	
E28-2	2337	Croatia	
E29-1	0245	Russia, south of Moscow	
E29-5	2212	Russia, south of Moscow	
E30-1	0119	Croatia	

North American Passes

Pass	ISTOCHNIK Start Time	Path during ISTOCHNIK Firing	Number of Observers Recording Data
22-2	1016	WA	
22-3	1331	NE, IA, MO, IL	1
22-4	1505	NM, TX	2
29-2	0400	MO, IL, IN	1
29-3	0528	So CA	1
29-4	0704	OR, WA,	
30-2	0239	NC, VA, DC, MD, NJ	2
30-3	0415	QC	1
30-4	0541	No CA	
30-5	1033	AR, MS, AL	
30-6	1205	AZ, NM, TX	

Summary of European Passes Recorded

Team/Pass	E22-1	E28-1	E28-2	E29-1	E29-5	E30-1

NONE

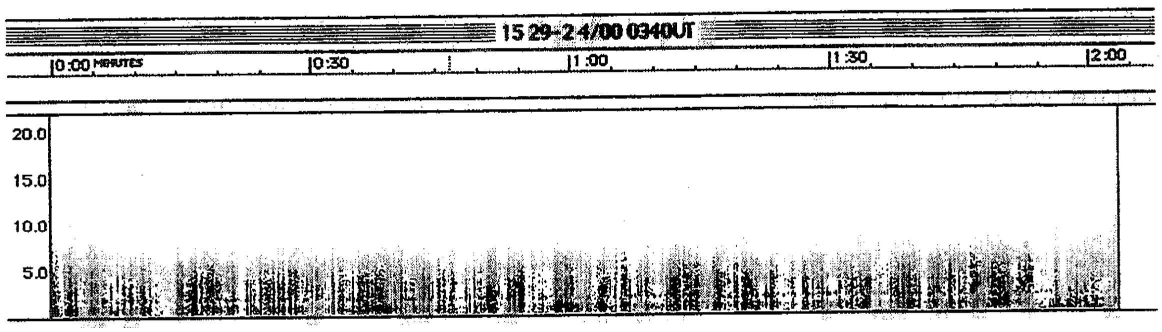
Summary of North American Passes Recorded

Pass	4/22			4/29			4/30				
	2	3	4	2	3	4	2	3	4	5	6
Team											
7									x		
15				x	x	x		x	x		

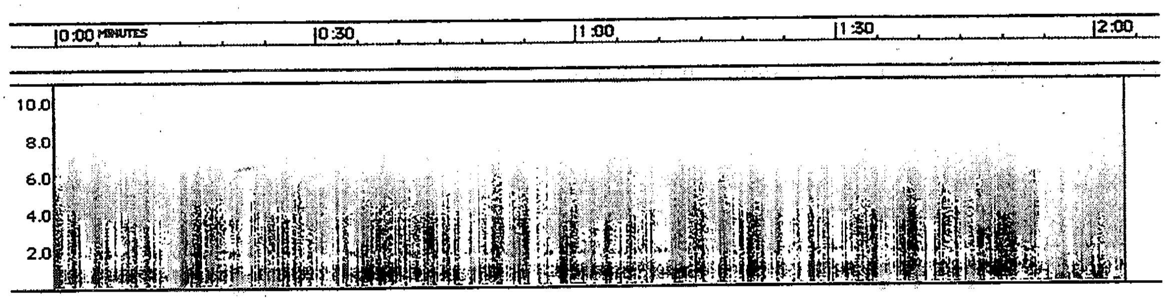
INTMINS Data

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. Unless otherwise noted, the start time of the cropped view is the same as the start time of the operation.

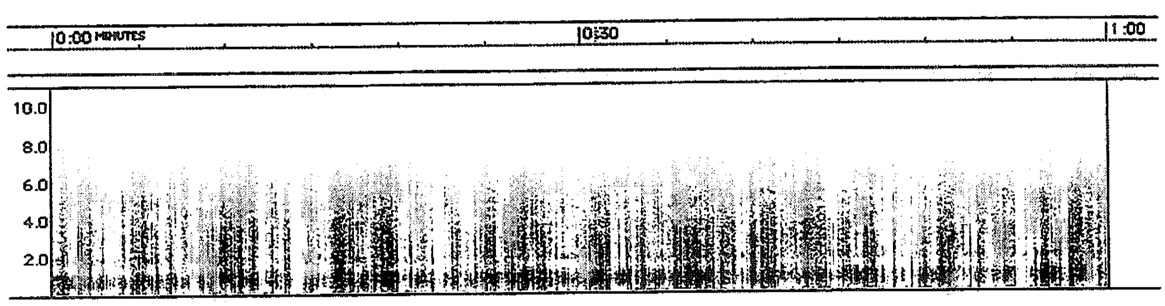
29-2



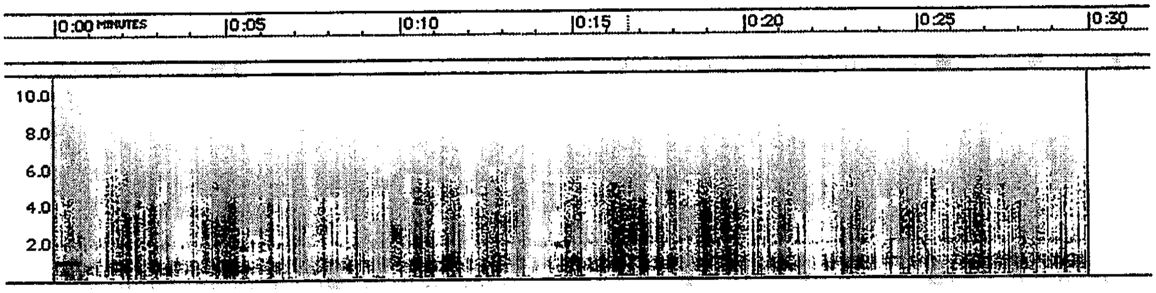
Team 15 Robert Bennett, Las Cruces, NM. This spectrogram shows intense, dense sferics. For this first view, a 0-22 kHz frequency range is used, the maximum range the software allows.



The same time interval as the first spectrogram, using a 0-11 kHz frequency range. The VLF2 receiver is designed to filter frequencies above 10 kHz, but the presence of signal above 10 kHz indicates very strong sferic signals at those frequencies.

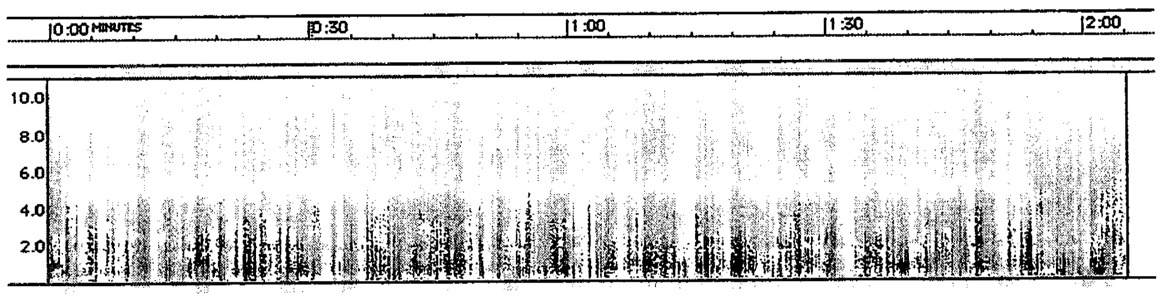


The first minute.

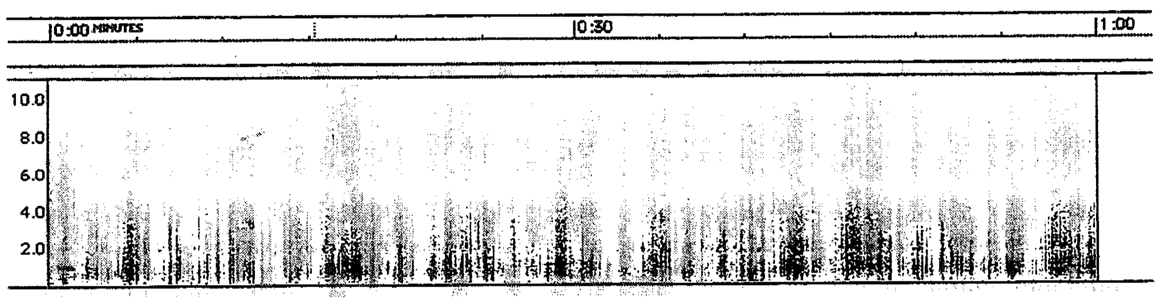


The first 30 seconds.

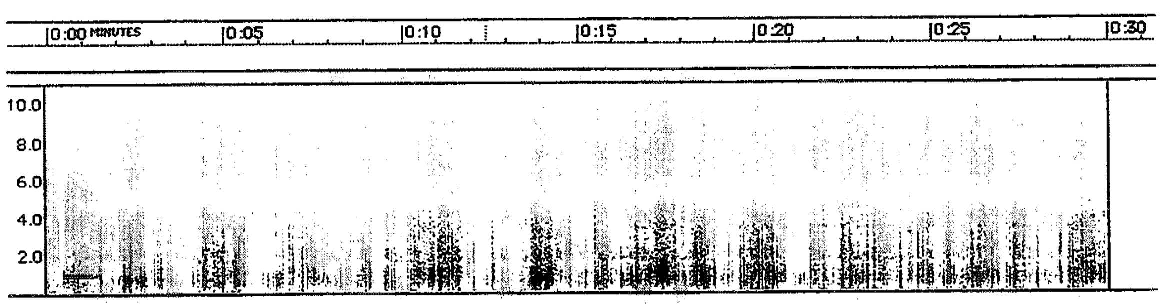
29-3



Team 15 Robert Bennett, Las Cruces, NM One orbit later (88 minutes), conditions are the same.

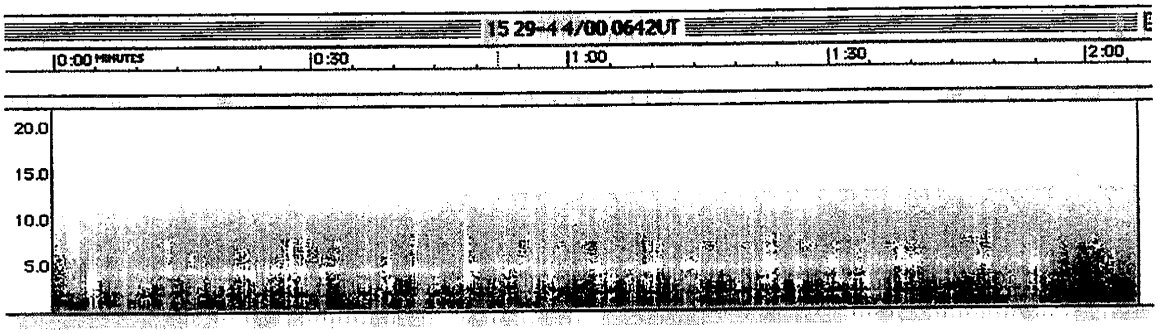


The first minute.

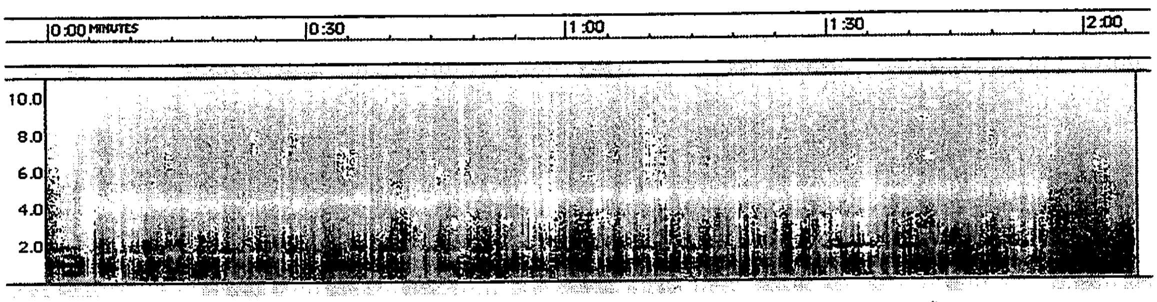


The first 30 seconds.

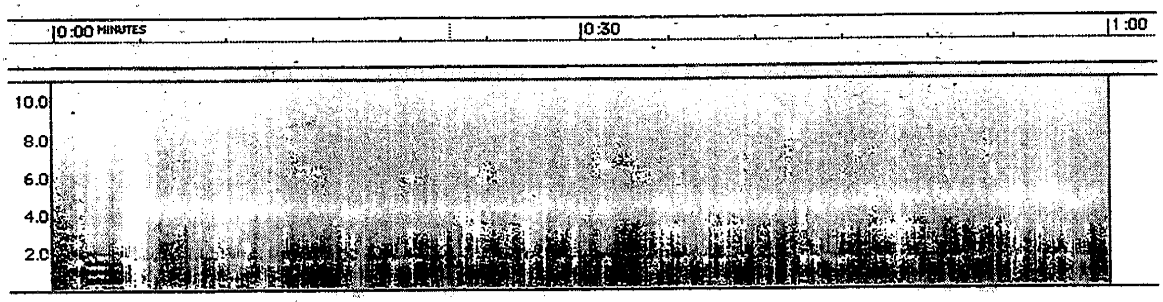
29-4



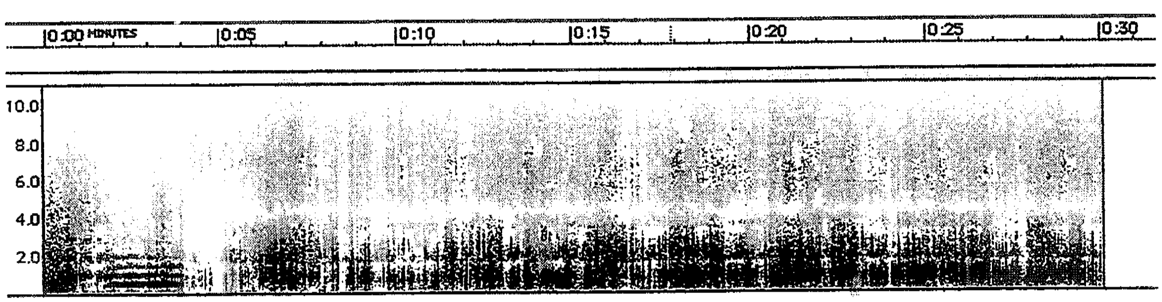
Team 15 Robert Bennett, Las Cruces, NM One orbit later, conditions are the same.



0-11 kHz.

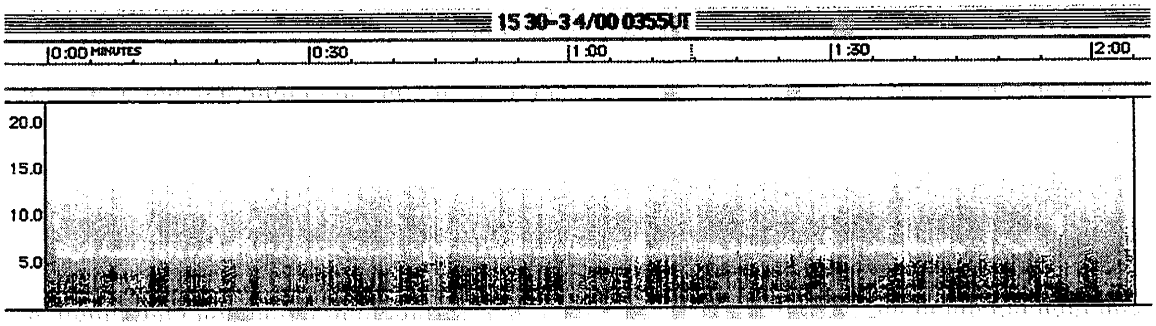


First minute.

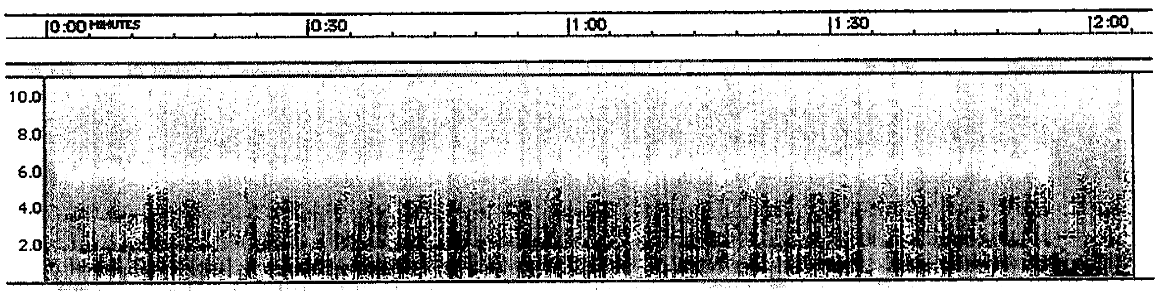


First 30 seconds.

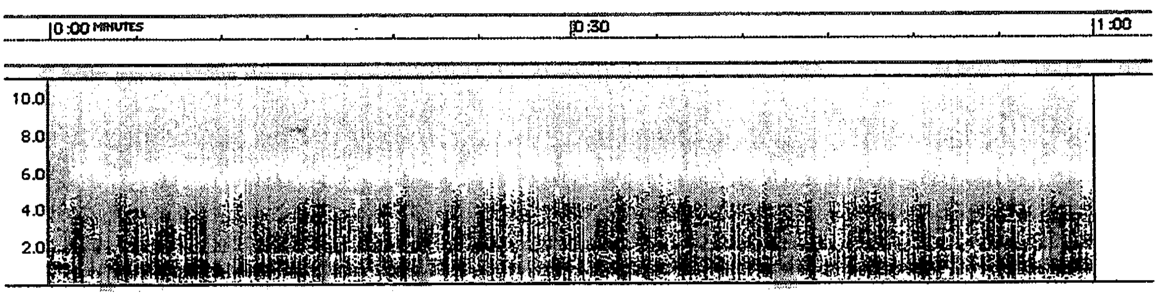
30-3



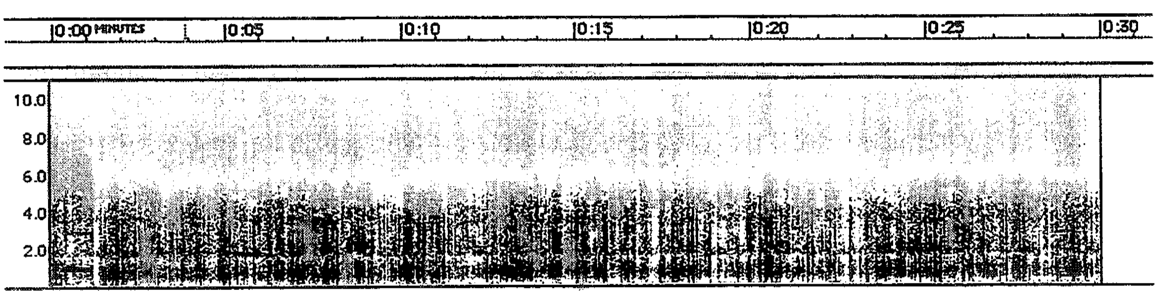
Team 15 Robert Bennett, Las Cruces, NM Dense sferics are present again on the 30th.



0-11 kHz



First minute.



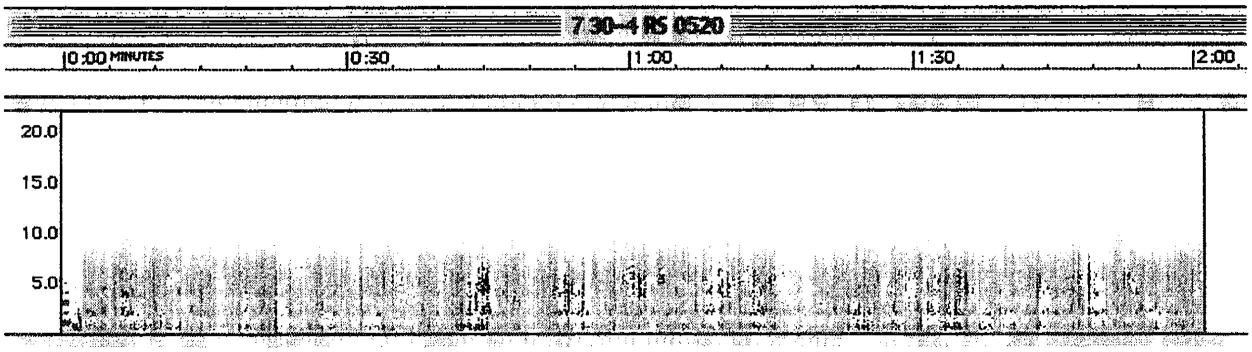
First 30 seconds.

30-4

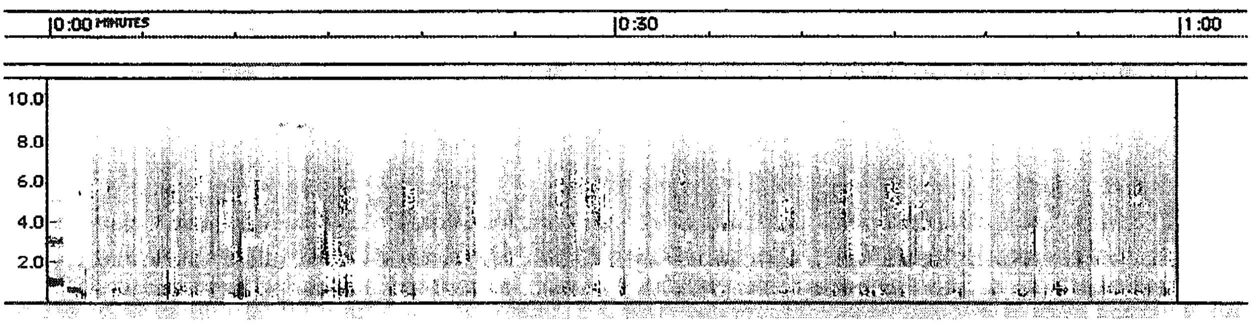
Team 7 Dean Knight, Sonoma Valley High School, Sonoma, CA

The Sonoma Valley High School team sets up three receivers. During the Operation 30-4 session, several whistlers were detected with each receiver. It is a little unusual to hear whistlers and tweeks at the same time. The sferic density was generally high during the recording time.

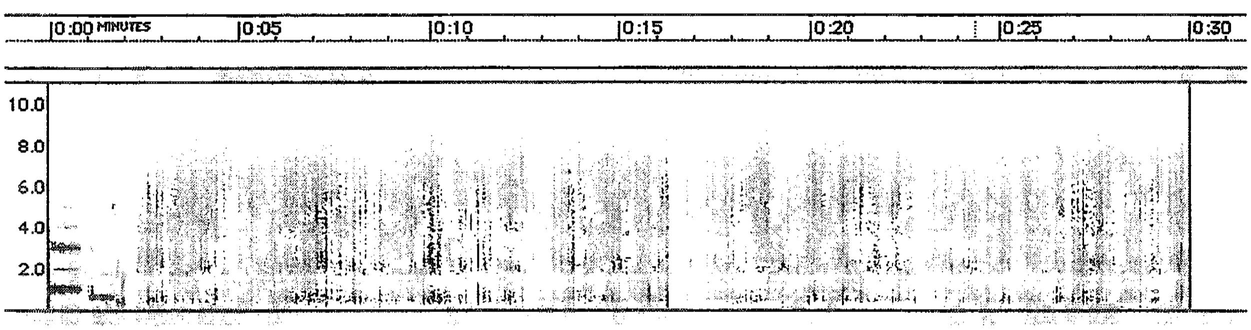
Receiver RS: Jenny Chesley



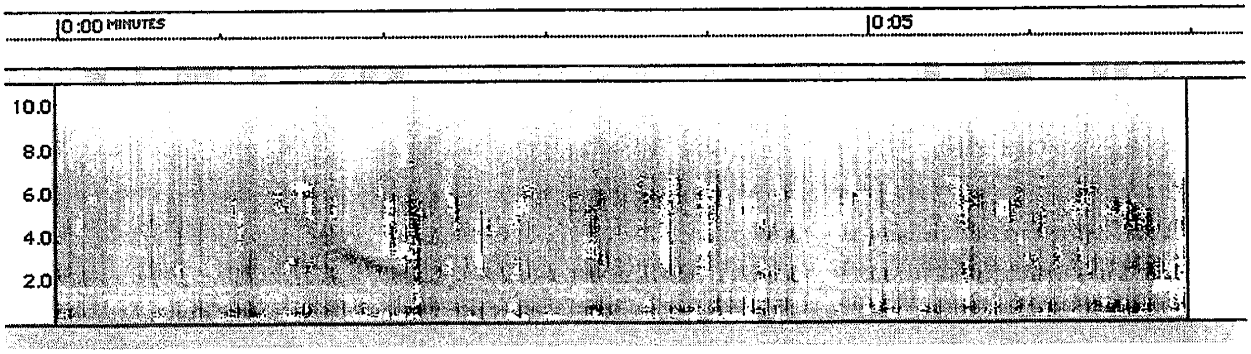
The spectrogram starts with the 0520 WWV dash.



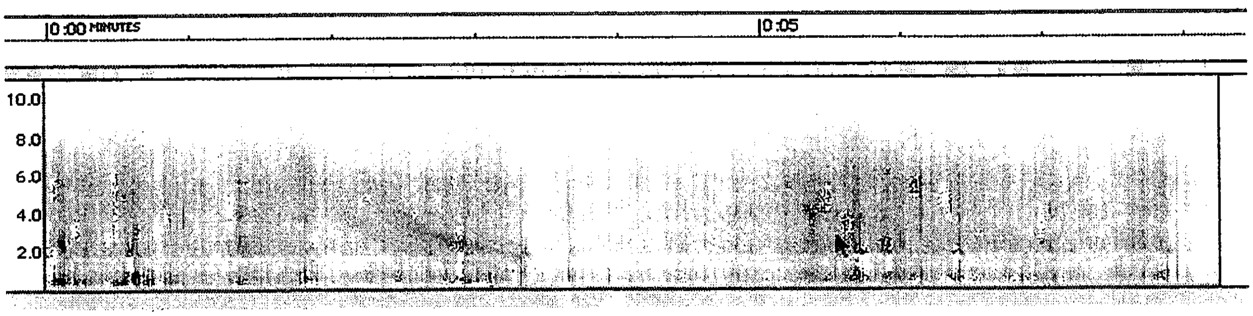
First minute, 0-11 kHz range. Tweeks show up as a horizontal band at about 2 kHz.



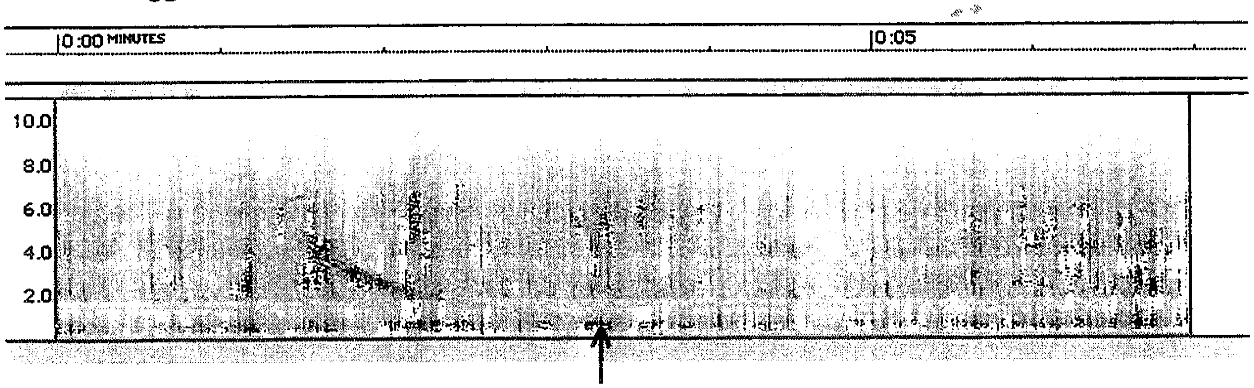
First 30 seconds.



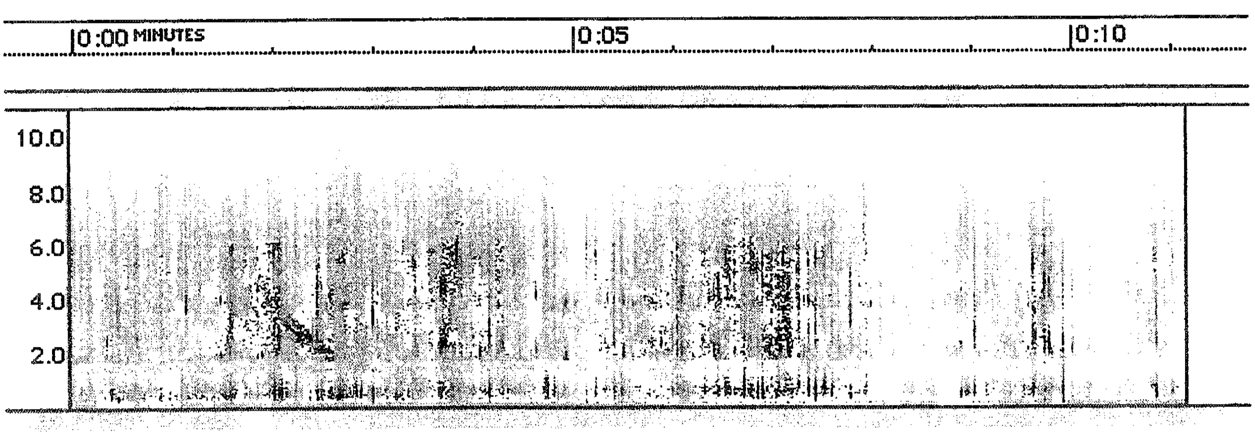
Whistler logged at 0532.



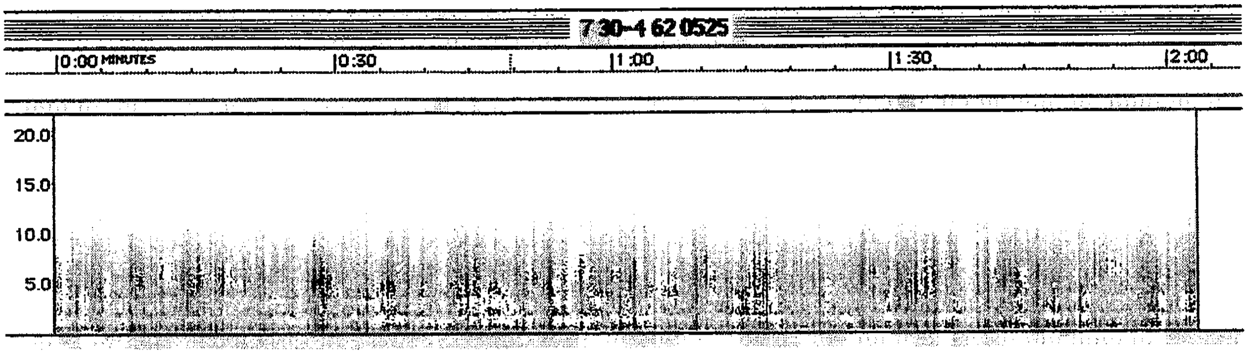
Whistler logged at 0530. Arrow points to what I think is a weak echo.

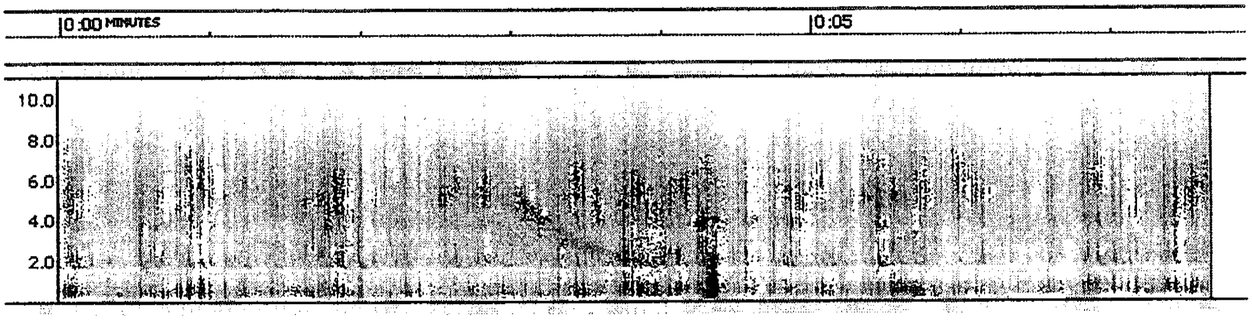


Whistler logged at 0532. Strong whistler and echo (arrow).

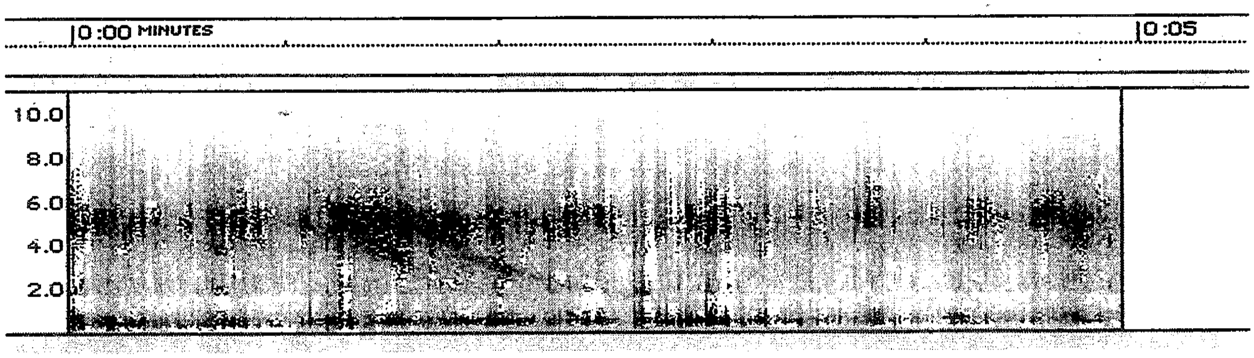


Whistler logged at 0535. The echoes for these whistlers are hard to hear since the general level of sferics and tweeks is so high.

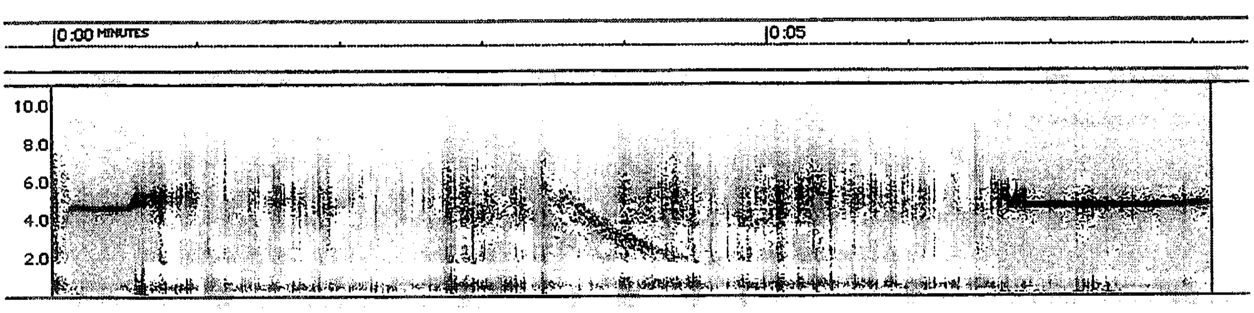




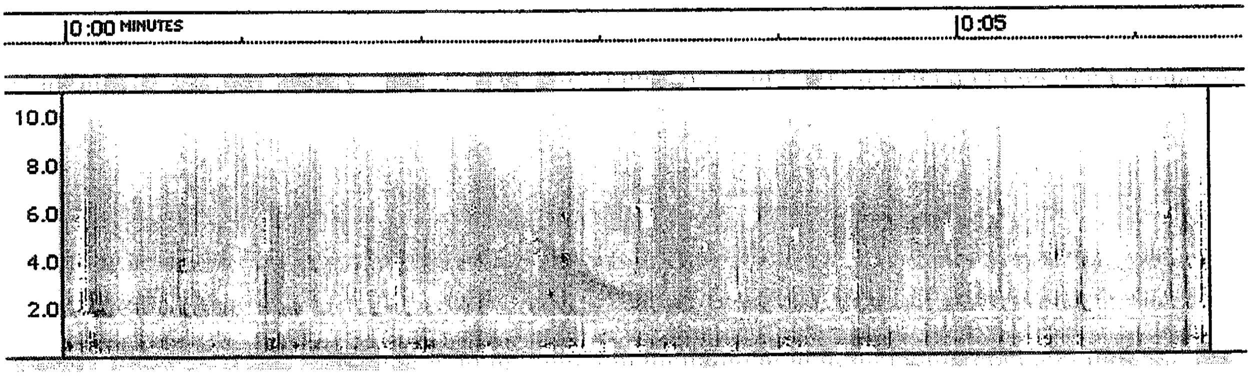
Whistler logged at 0514.



Whistler logged at 0530 UT.

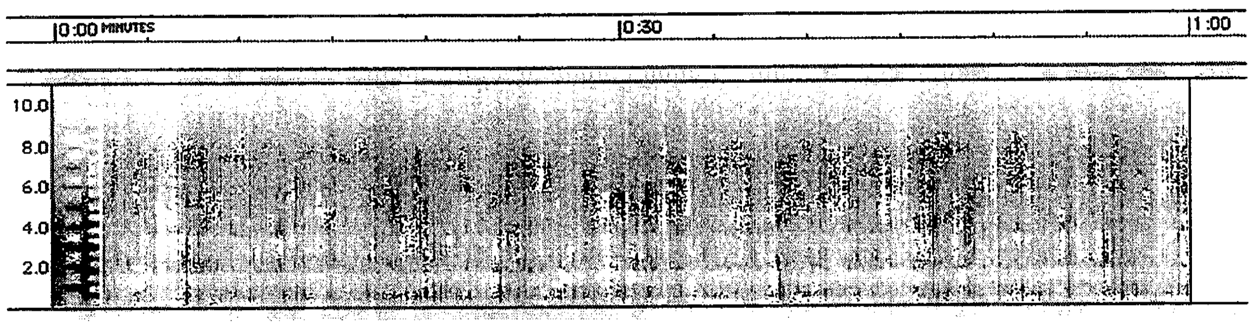


Whistler logged at 0532 UT. Horizontal signals at about 4 kHz are due to receiver oscillation.

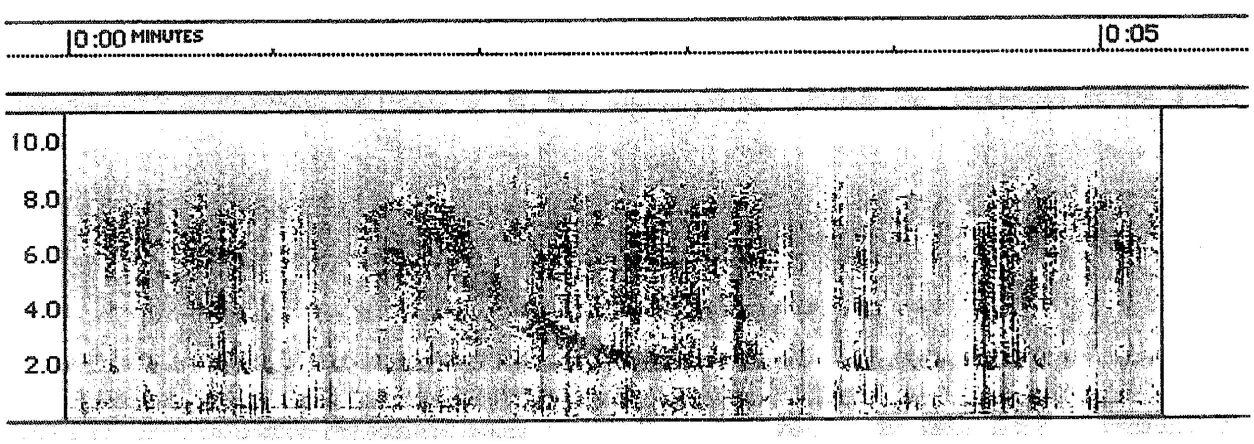


Whistler at 0535 UT.

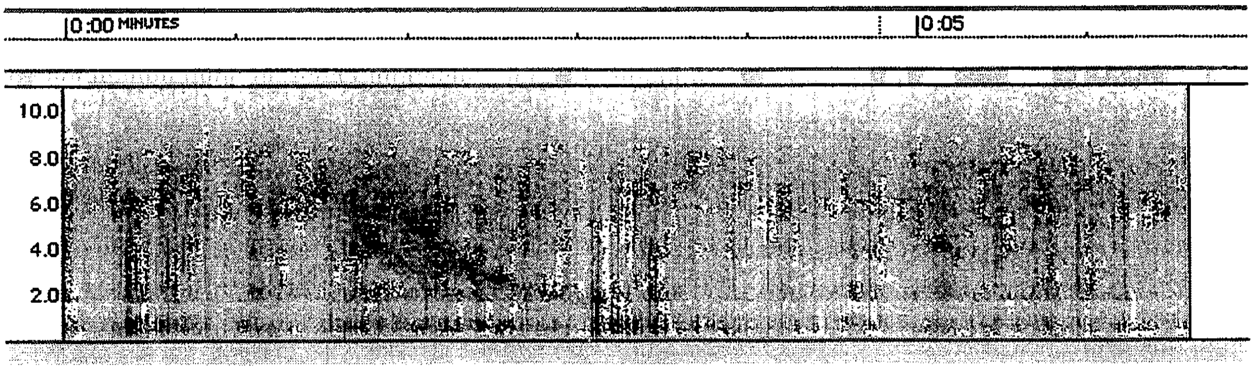
Receiver #65 Marisa Short, Alex Cali, Eric Israel, Lauren Klenow
Dana Peterson, Lauren Clementino, Maggie Sowell, Anna Hiser



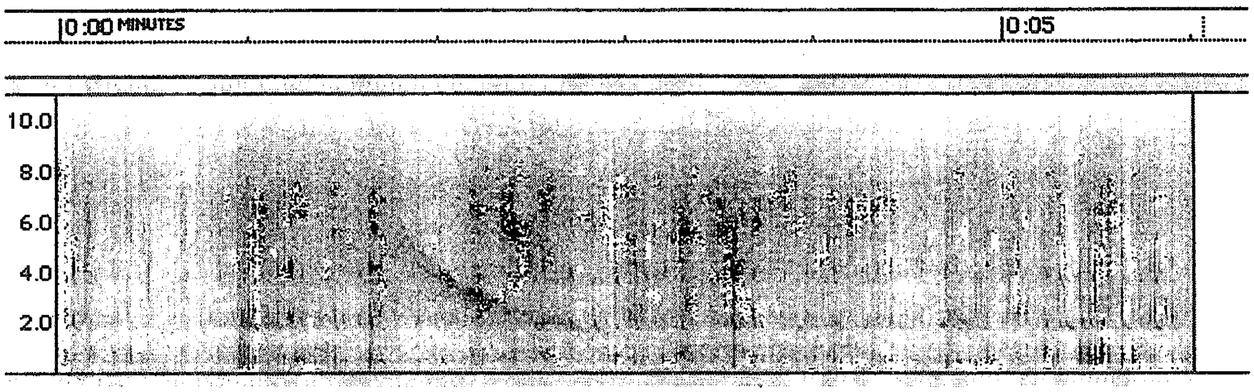
First minute of the operation. Note the harmonics of the 1 kHz WWV tone at the beginning. You can slso see the band of tweeks at 2 kHz with a harmonic at 4 kHz.



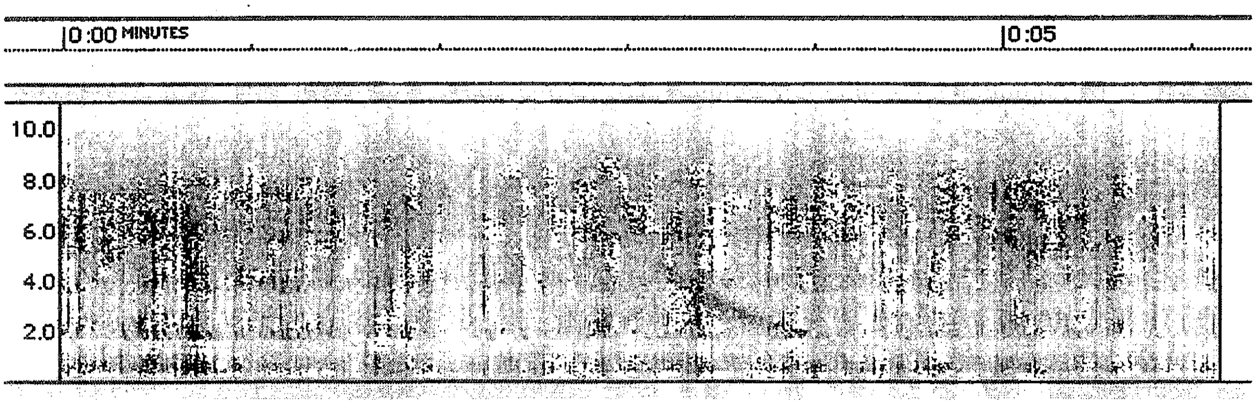
Whistler at 0514 UT.



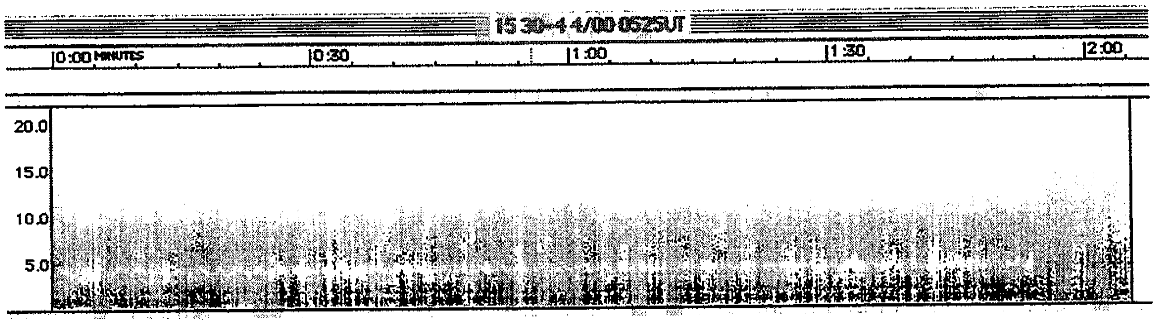
Whistler at 0530 UT



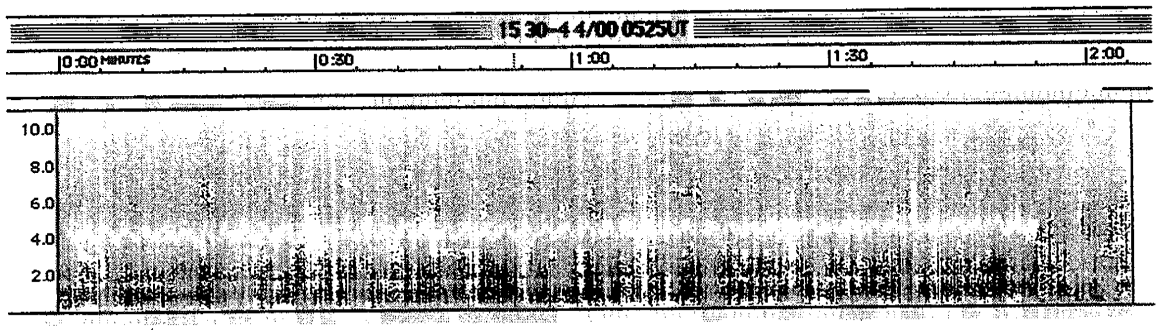
Whistler at 0532.



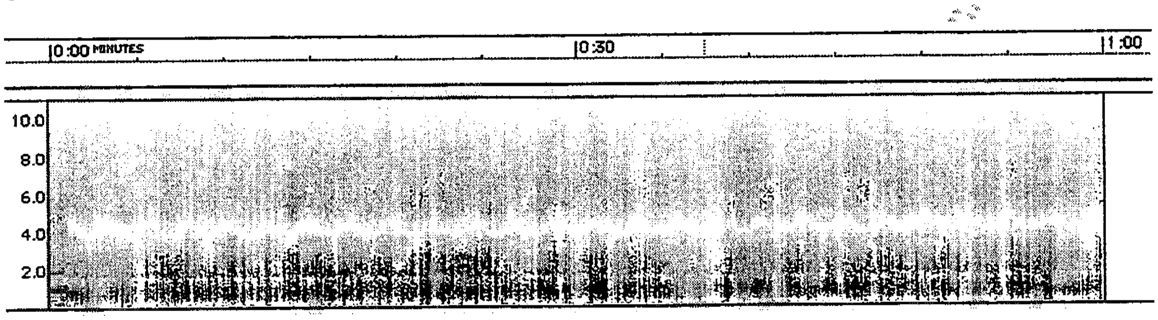
Whistler at 0535 UT.



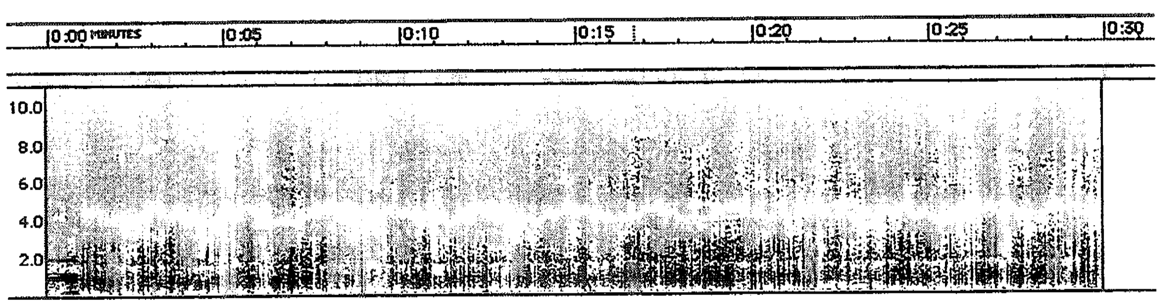
Team 15. Robert Bennett, Las Cruses, NM. Dense sferics, but no whistlers in New Mexico!



0-11 kHz.



First minute.



First 30 seconds.

Report on Coordinated Observations 4/2000

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 the time that would be whistlers, but other sounds such as tweeks, chorus, triggered emissions and even hiss are also interesting. Observing whistlers, however, remains 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. Conditions during April 2000 varied. There were some interesting signals observed including chorus. The following report includes sample spectrograms from contributing observers.

This table summarizes the sessions monitored by observers.

Date	4/29					4/30				
Time	1200	1300	1400	1500	1600	1200	1300	1400	1500	1600
Team										
26	E	E								
29							C	C		
30			M	M				M	M	
6				P	P				P	P

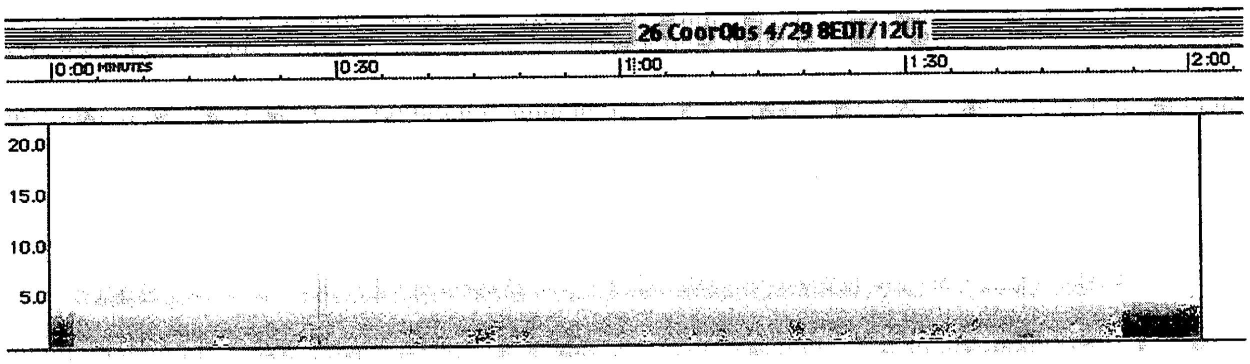
The times indicated are UT times.
The letter in the box indicates the time zone of the observer:
E = EDT = UT-4, C=CDT = UT-5,
M = MDT = UT-6 and P = PDT = UT-7

Observers:	Team 26	Brian Page, Lawrenceville, GA	(EDT)
	Team 29	Janet Lowry, Houston, TX	(CDT)
	Team 30	Linden Lundback, Watrous, Saskatchewan, CANADA	(CST)
	Team 6	Bill Pine, Chaffey High School, Ontario, CA	(PST)

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.

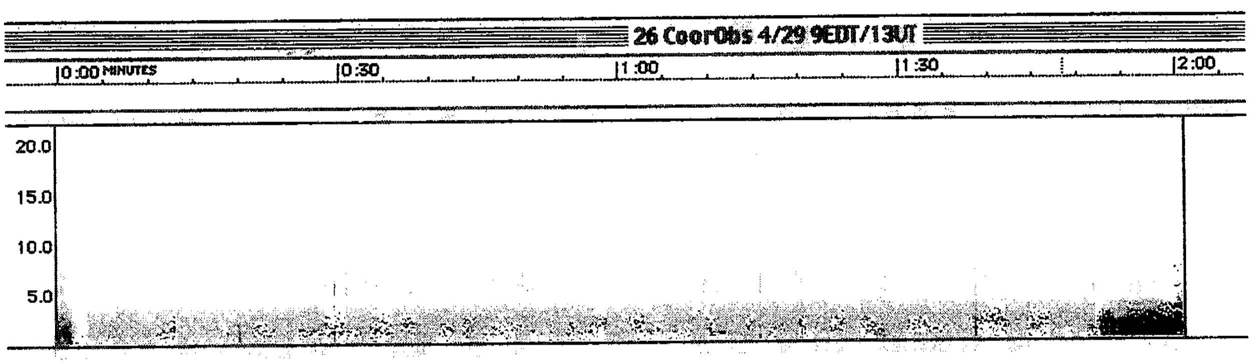
4/29/00 1200 UT

Brian Page led off at 8 AM EDT.



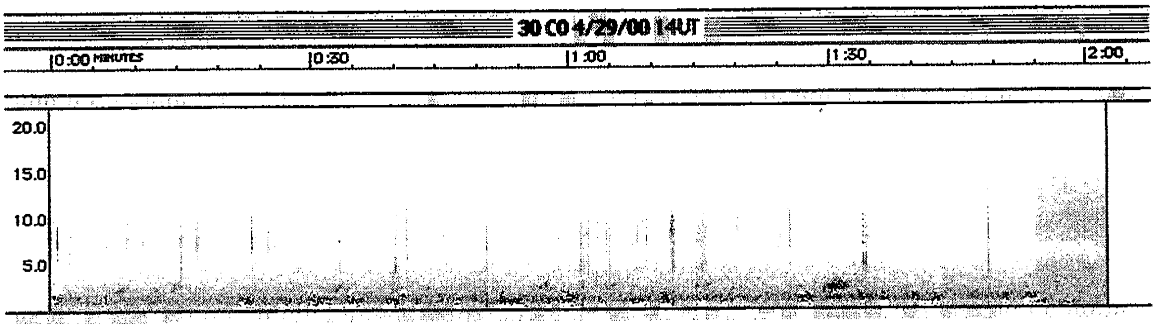
Team 26. Brian Page, Lawrenceville, GA. Quiet conditions, but sferics are present.

4/29/00 1300 UT

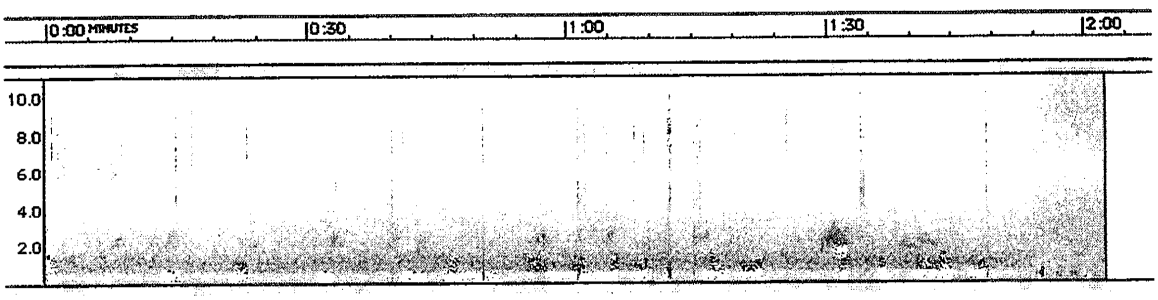


Team 2. Brian Page, Lawrenceville, GA. Conditions very similar to the previous hour.

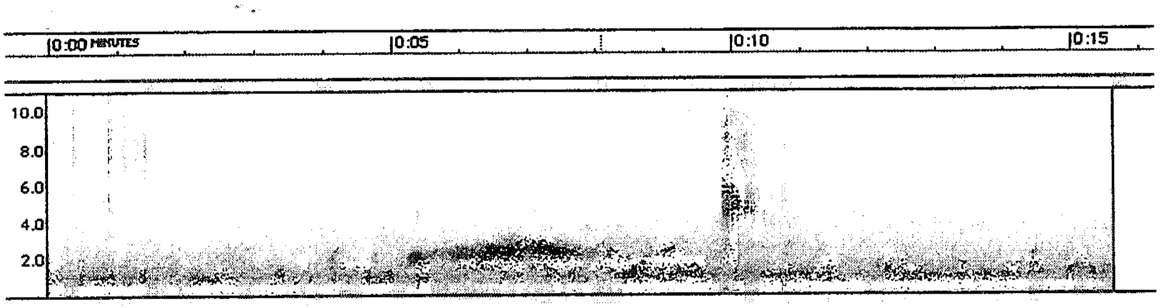
4/29/00 1400 UT



Team 30. Linden Lundback and Brian Cowan, Watrous, Saskatchewan, CANADA
First two minutes at 1400 UT on 4/29/00. Risers, a type of chorus, were prominent.

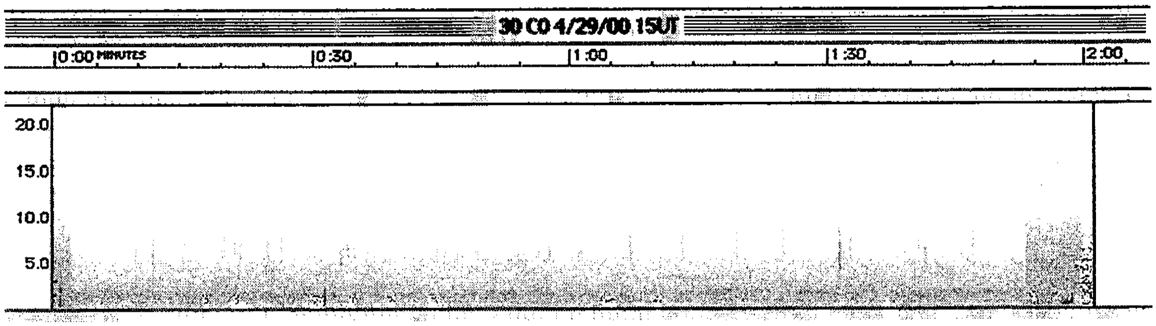


The same interval using a 0-11 kHz frequency range.
The risers are the dark smudges above 2 kHz.



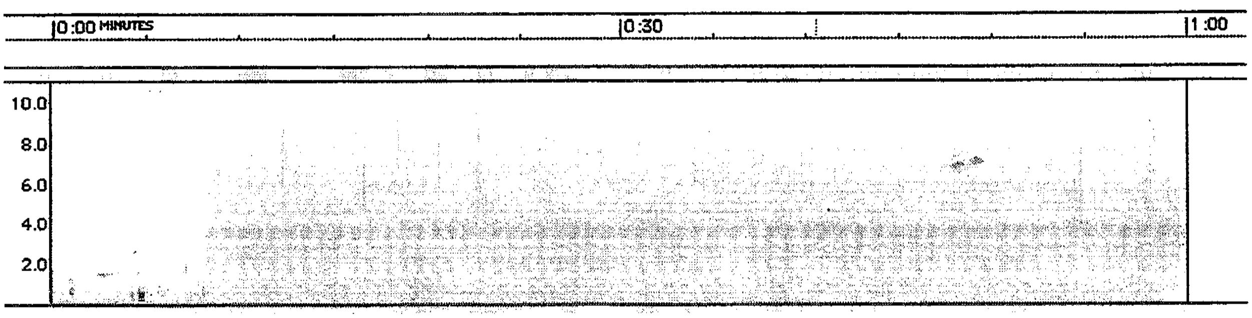
Close-up of the strong riser shown at about 1:30 above.

4/29/00 1500 UT



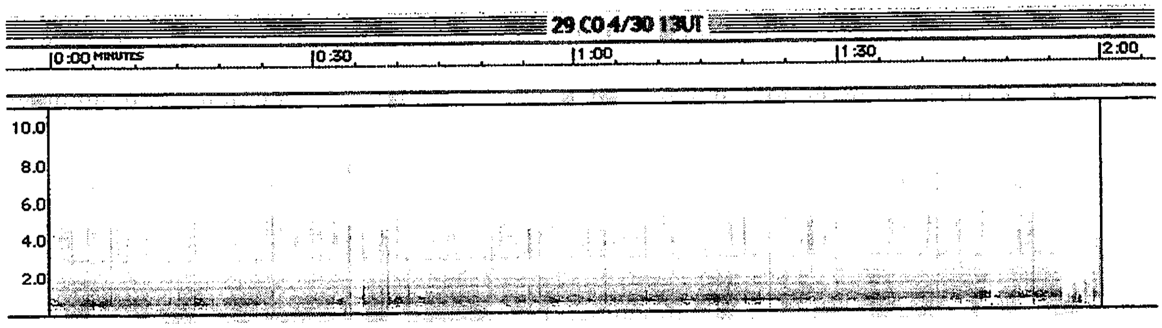
Team 30. Linden Lundback and Brian Cowan, Watrous, Saskatchewan, CANADA
Same site as the previous hour. Very quiet. What a difference an hour makes!

4/29/00 1600 UT



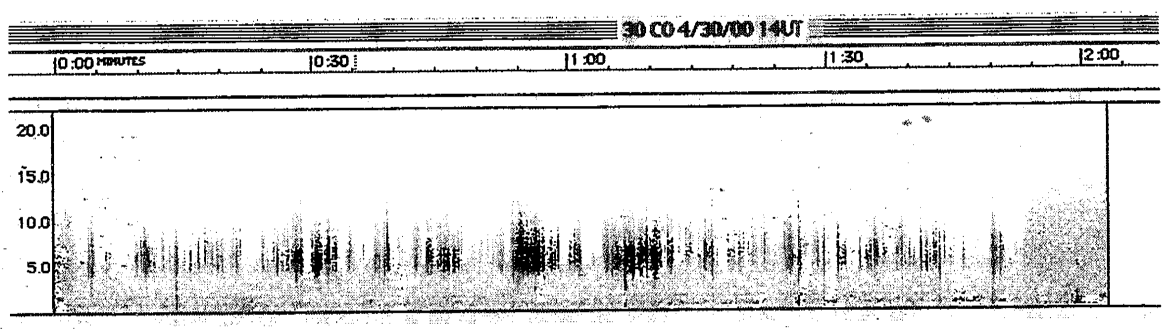
Team 6. Bill Pine, Chaffey High School, Ontario, CA
We tried a test of the DAN filter during a session conducted on campus. Switching in the DAN made a difference in the hum level, but hum still predominates in the recording. I think the problem was an electronic billboard on the side of the science building about 20 meters away. The signal did not sound like pure 60 Hz and the DAN was not able to remove the hum completely. The stronger sferics can be seen above the hum bands. Assisting in the data taking were Autumn Gomez, Miriam Aguirre and Jose Alvarado.

4/30/00 1300 UT

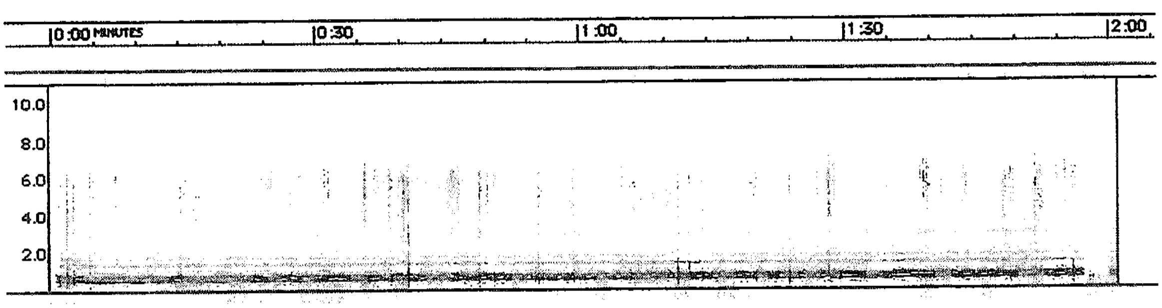


Team 29. Janet Lowry, Houston, TX
Janet tried a new site and noticed some hum. Sferics were easily audible on the tape and they appear prominently on the spectrogram. The hum appears as bands below 2 kHz.

4/30/00 1400 UT

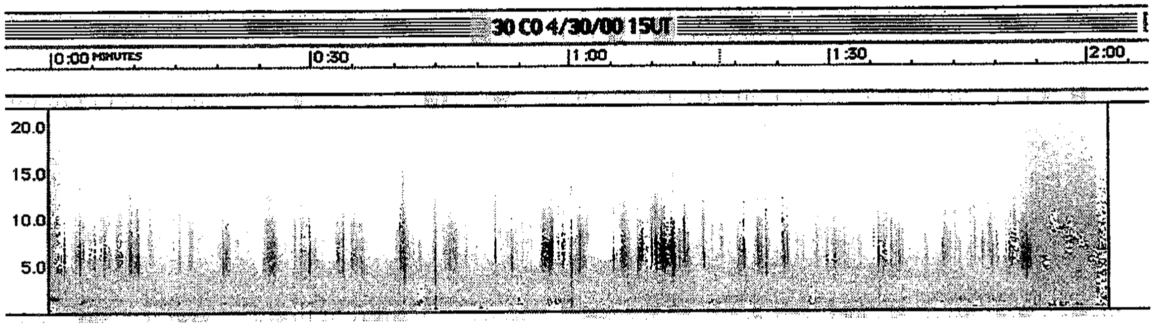


Team 30. Linden Lundback and Brian Cowan, Watrous, Saskatchewan, CANADA
Strong, dense sferics.



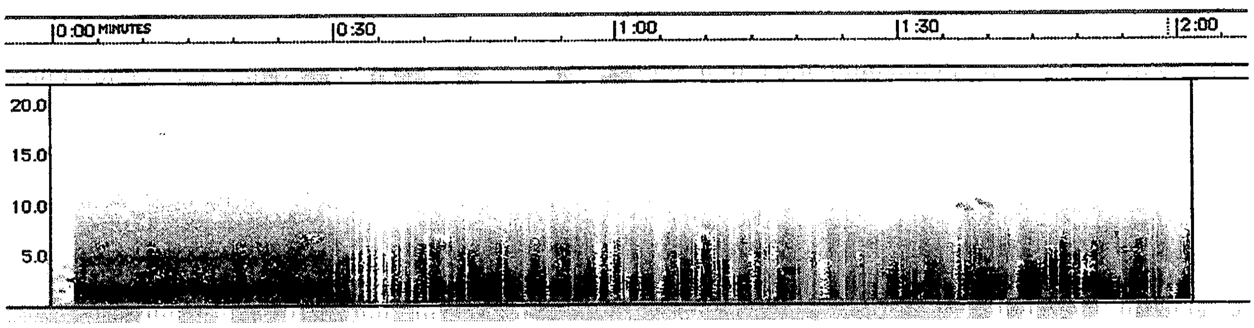
Team 29. Janet Lowry, Houston, TX
One hour later, the sferic density and strength were higher in Houston and the spectrogram looks very similar to the natural radio heard far to the north in Saskatchewan..

4/30/00 1500 UT



Team 30. Linden Lundback and Brian Cowan, Watrous, Saskatchewan, CANADA

4/30/00 1600 UT



Team 6. Bill Pine, Chaffey High School, Ontario, CA
Assisting in the data taking was Danica Cruz.

Data Log Cover Sheet (copy as needed)

INSPIRE Observer Team ______________________ Receiver ________

Operation ____________

Date __________ Tape Start Time (UT) _________

****
****

Operation details:

Tape start time:	________	UT	________	local
Operation start time:	________	UT	________	local
Operation type:	____________________			
Operation stop time:	________	UT	________	local
Tape stop time:	________	UT	________	local

Equipment:

		WW V reception:
Receiver	______________________	
Recorder	______________________	____________
Antenna	______________________	____________
WWV radio	______________________	____________

Site description: ____

Longitude: _____° _____ ' W Latitude: _____° _____ ' N

Local weather: ____

Personnel: ______________ ______________ ______________

______________ ______________ ______________

Team Leader address:

Name ______________________

Street ______________________

____

City, State, Zip, Country ______________________

INSPIRE Data (copy as needed)

INSPIRE Observer Team ______________________ Receiver ________

Operation ____________

Date __________ Tape Start Time (UT) __________

****

Code: S - sferics 0 1 2 3 4 5 M - Mark T - tweek W - whistler O - OMEGA C - chorus
L M H

Time	Entry		Observer
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______
______	________________________	S: 0 1 2 3 4 5	______