The INSPIRE Journal

Volume 7 Number 1
November 1998

Opportunities for VLF observation grow!

In this issue there are three opportunities to make VLF radio observations:

1. INTMINS continues into its fourth year. While the days of the MIR Space Station are numbered, INTMINS will continue as long as MIR remains in orbit. See Page 5.
2. Coordinated observations will continue. The Coordinated Observation Program was revived last spring in response to demand from INSPIRE participants. This program will continue into the future and provides an opportunity to gather and compare VLF data. See Page 7.
3. New for this November will be VLF observations during the Leonid Meteor Shower. See Page 8.

A new research project called Radio JOVE is being organized by radio astronomers from the University of Florida Radio Observatory (UFRO) and Goddard Space Flight Center (GSFC).. This project will be devoted to observing the radio emissions of Jupiter and the Sun. The observed frequencies are around 20 MHz, so a receiver designed for that frequency range will be required and a kit is in the process of being designed. INSPIRE is supporting this worthwhile and fun activity and it is hoped INSPIRE participants will want to join in. See Page 12.

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The INSPIRE Journal is a publication of The INSPIRE Project, Inc., a nonprofit educational/scientific corporation of the State of California. The purpose of the INSPIRE Project, Inc., is to promote and support the involvement of students in space science research. All officers and directors of the corporation serve as volunteers with no financial compensation. The INSPIRE Project, Inc., has received both federal and state tax-exempt status (FEIN 95-4418628). The *Journal* is published two times per year: November 1 and April 1.
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Contributions to the *Journal* may be sent to:

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

email: pine@ndadsb.gsfc.nasa.gov
pinebill@aol.com
Fax: 909 931 0392

INSPIRE Website Updated!

Last summer, INSPIRE's new webmaster, Scott Green, spent several days modifying and updating the INSPIRE site. Check out the results of Scott's work and drop him a line at the address contained in the site. The URL is:

http://image.gsfc.nasa.gov/poetry/inspire

Subscriptions to *The INSPIRE Journal* Due

All subscriptions to the *Journal* expire with the November issue each year. Please use the order form on the last page of this issue to renew your subscription.

California INSPIRE Team Has a Website

Larry Kramer of Fresno, California, sent word that he has recently established a website to support INSPIRE activities and to report on the activities of his team. Larry and Cliff Lasky are Team 19. They make their observations from Wide Awake Ranch in the Central San Joaquin Valley near Fresno. (The following is a reproduction of Larry's Home Page - but it does not include the beautiful photo background of Team 19's site!)

Larry's Very Low Frequency Site

- Team 19 Observations
- Equipment we use
- Projects
- Planned outings
- Contact Team 19
- Larry's Homepage
- Links
- Recordings of VLF

The Official Team 19 site for INSPIRE

This page and the links are currently under construction
This page is best viewed in 800x600 mode, 24 bit color
Last updated: 10/13/98

Time Mark Program Available for Laptop PCs

Mike Aiello of Croton, NY (Team 4) has written a program for the PC which outputs a time mark that can be recorded on VLF audio tapes. The operation of the program is described in the "Notes From the Field" article in this issue of the *Journal* . Mike sent a copy of the program which I installed on my PC and it is impressive. I do not have a laptop, so I have not had a chance to use this in the field. If you are interested, contact Mike at:

n2htt@bestweb.net

Orbit Tracking Program for the PC Available

Dave Ransom, the author of STSOrbit PLUS (STSPLUS), has retired to Sedona, Arizona, and has established a website at:

http://www.dransom.com

On this site you can download the freeware program STSPLUS. Dave designed this program years ago. It has a main screen that looks like the large world map display at Mission Control at Johnson Space Center. The program accepts Two Line Element sets (TLEs) which are available on the Web for many satellites and displays a real-time view of the position of the satellite which is updated several times per minute. There are many other features of this program. The instructions which come with the program are very clear and the program is easy to use.

Third Annual Washington DC Area INSPIRE Workshop

The Third Annual DC Area INSPIRE Workshop was held on October 10, 1998, at Gallaudet University in Washington, DC. Local host was Dr. David Snyder, physics professor at Gallaudet. Teachers from Washington, DC, and Maryland attended. The day included discussions about natural VLF radio, data taking procedures, operation of the VLF2 receiver and receiver construction. Natural radio observations were made after lunch on the soccer field at Gallaudet (definitely not a quiet site!). The afternoon was spent working on receiver construction. Workshop evaluations indicate that participants were very satisfied with the day.

Third Annual Washington DC Area INSPIRE Workshop Participants

Front Row: Kate Winterkorn, Elizabeth Cooney
Second Row: Angela Benjamin, Nicholas Velez, Kathryn Solorzano Lowell, Gayle Rawley
Back Row: Bill Taylor, Hosie Bryant, Bill Pine, Benjamin Stone, David Nelson

INTMINS-November/98 Operations Schedule

By Bill Taylor, Washington, DC
Stas Klimov, Moscow, Russia
Bill Pine, Ontario, CA

The November/98 INTMINS Operations schedule will be finalized soon. Operations will occur on the last two weekends: November 21-22 and November 28-29. Data gathered will be analyzed and reported on in the April 1999 issue of *The INSPIRE Journal*.

Gathering Data:

IMPORTANT NOTE: Data gathering procedures will remain the same as those used since April 1996.

Perhaps the most important ingredient in a successful data gathering session is what happens **before** you go out in the field. The following is the recommended procedure for data gathering including preparation prior to the date of the operation.

Step 0: Completely check out all equipment. A good method is to set up everything in your living room. All you will hear is household 60 Hz, but you will know the equipment is working. This is also a good time to fill out the log cover sheet (see the third from last page of the *Journal*).

Step 1: Define "T-time" as the starting time for operation of ISTOCHNIK.
Convert the UT time to local time.
Arrive at your site with time to spare.

Step 2: Start data recording at T minus 12 minutes.
Prior to this time place a brief voice introduction on the tape identifying the observers and the operation number.

Step 3: Place time marks on the tape at: T-12, T-10, T-5, T, T+3, T+8, T+13, and near the end of the tape. Use UTC times only. Note that this schedule brackets the scheduled time of operation of ISTOCHNIK with time marks. Use 60 minute tapes and place one operation per side.

Step 4: Keep a written log (see next to last page of the *Journal*) of time marks and descriptions of everything you hear.

Step 5: Review your tapes and revise your logs if necessary.

Step 6: Mail your tapes and logs to Bill Pine at the address shown on Page 2.
Your tapes will be returned to you.
Send in copies of your logs since they will not be returned.
You will receive a copy of the spectrograms made from your data.
Your data will be incorporated in the data analysis report article in the *Journal*.

Mode of Operation:

The two instruments on MIR are Ariel and ISTOCHNIK. Ariel is a plasma generator and operates for 5 minutes, alternating between axes. ISTOCHNIK is a modulated electron gun that accelerates a beam of electrons and emits them into space. The electron beam is turned on and off at frequencies of either 10 hertz or 1000 hertz (1 kHz), which should cause the radiation of electromagnetic waves in the VLF range at those two frequencies. ISTOCHNIK operates for a total of 2 minutes on the following schedule:

ISTOCHNIK mode:	10 seconds modulate at 10 Hz
	10 seconds modulate at 1000 Hz
	10 seconds modulate at 10 Hz
	10 seconds modulate at 1000 Hz
	repeat for 2 minutes of operation

On each pass, Ariel will either operate first or last, whichever gives the most coverage over INTMINS observers. Since the signal from ISTOCHNIK is more powerful, it is the one most likely to be detected. For that reason, the schedule emphasizes the operation of ISTOCHNIK.

Notes on Time Marks and Logging;

The purpose of putting time marks on the data tapes is twofold:

1. The obvious need to know what time is represented in each part of the tape,

2. also to provide a means of synchronizing the tape with actual time. Battery operated recorders tend to run slower as the batteries wear out. Some recorders run fast or slow because of the particular motor being used. By timing (with a stopwatch) the actual times between time marks, the speed of the analysis recorder can be adjusted to synchronize the data tape with actual time. This has the effect of adjusting the frequencies on the spectrogram to the proper values since incorrect tape speed on the data recorder will cause the frequencies to be out of position.

When time marks are put on the tape, they should include an announcement of the UT time and a mark (either by voice ("mark") or by WWV tone or some other means). Try to minimize the interruption to the data flow when putting on the time marks. This takes practice! Also, put the time marks on at least as often as is called for by the instructions. It is better to have more time marks than are called for than to have too few.

The purpose of the data log is to record the contents of the tape. The time of each time mark should be recorded. Anything else of interest should be noted on the log with the time indicated.

Tapes with incomplete or missing time marks and poor logs are nearly impossible to analyze. Your help in following good time mark and logging procedures is much appreciated.

INTMINS Schedule

The operation schedule had not been determined by press time. The schedule will be printed separately and mailed included with the *Journal* .

Coordinated Observation Schedule
November/98

By Bill Pine Ontario, CA

In response to requests in the INSPIRE Survey for observation opportunities at more convenient times, the INSPIRE Coordinated Observation Program was established in April/98 in conjunction with the INTMINS observations. The purpose of the coordinated observations is to provide an opportunity for INSPIRE observers to make recordings of natural VLF radio and to compare the resulting data. Ideally, a coordinated session would result in everyone hearing whistlers. That is exactly what happened during the April sessions. Because of the capricious nature of whistler propagation, not everyone heard the whistlers, but there were several instances of more than one observer recording the same whistler. (See "Report on Coordinated Observations 4/98" in this issue of *The INSPIRE Journal*.)

The procedure to use for coordinated observations will be as follows:

1. Use the Data Cover Sheet and Data Log as with the INTMINS observations.
2. Record for 12 minutes at the start of each hour that you can monitor on the specified days. Keep a detailed log of all signals that you hear and indicate any items of interest. When you submit your tapes, spectrograms will be made of any parts of the tape that you indicate.
3. Place a time mark on the tape on the hour and each two minutes for the next 12 minutes. Use Coordinated Universal Time (UTC) for all time marks.
4. Record at 8 AM and 9 AM **LOCAL** time.
5. In addition, record on other hours to compare results with those in neighboring time zones. For example, an observer in the Central Time Zone might record at 7 AM (8 AM EDT), at 8 and 9 AM CDT and at 10 AM (9 AM MDT).
6. Use 60 minute tapes (30 minutes per side) with two sessions per side. It is preferred that you record on one side of the audio tape only.
7. Label all tapes and logs to indicate the sessions monitored and send to:

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

8. Your tapes will be returned with spectrograms of your data. An article reporting on the results will appear in the next *Journal*..
9. SPECIAL NOTE: If you are hearing whistlers, replace the data tape after 12 minutes with a "Whistler" tape and continue recording with time marks every two minutes. If we get whistlers, this would be a good opportunity to try to determine the "footprint" of a whistler (the "footprint" is the geographical area where a whistler can be detected).

Specified Coordinated Observation Dates for November/98:

Saturday, November 28 and Sunday, November 29.

Leonid Meteor Shower
Observation Program for INSPIRE

By Bill Taylor, Washington, DC
and Bill Pine, Ontario, CA

During the morning of November 17, 1998 the Leonid Meteors will intercept the Earth and cause what might be the most intense meteor shower of the century. INSPIRE observers are encouraged to make observations during the shower to see if there are effects of the shower on natural radio.

There are several effects that might be caused by meteors. First, the passage of the meteors through the ionosphere and/or the enhanced ionization in the atmosphere due to the extreme heating of the meteor by friction, could generate waves at VLF. Second, if the shower is very intense, the lower edge of the ionosphere could be lowered significantly. This would cause the cutoff frequency of sferics to be higher than normal. There may be other effects as well. If meteors generate VLF directly, it would be very helpful if observers recorded a verbal indication of visual observations of meteors on the second track of their recordings in addition to carefully noting the exact time of intense meteors in their written log..

Besides observing VLF, this will give you the opportunity to observe a possibly intense meteor shower. Meteor showers are produced by the residue of comets that orbit through the solar system on the same paths that their parent comets followed. As a result, the showers come from the same part of the sky and at the same time of year every time they intercept the earth. One such meteor shower is the Leonids, which are the remnants of comet 55P/Temple-Tuttle and which appear to emanate from the Constellation Leo.

The maximum is estimated to be Tuesday, November 17 at 2000 UT (1500 EST, 1200 PST). That time is daytime in the United States so those of us who live here are not well situated to observe the maximum. INSPIRE observers in Europe are in better position to see the Leonid shower. Even so, INSPIRE is planning to conduct observations of the meteor shower with recording of the VLF spectrum at the same time to see if we can detect some correlation between meteor activity and VLF radio activity.

You might wonder why we would make observations when most of us are not in the right place on the globe (Eastern Asia) to see the maximum when it occurs. The answer is that there are some uncertainties in the predictions:

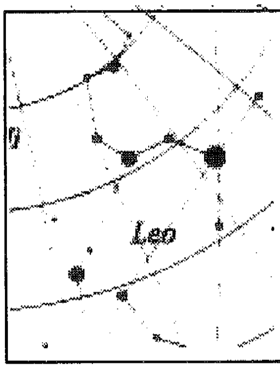
1. The time of maximum may not be accurate and the comet tail is broad. The assumed time of maximum is the time of crossing the middle of the comet tail path. While this time is probably pretty accurate, it is not certain that the time of maximum will be exactly then. If the time of maximum does not coincide with the crossing, then other places on earth will be in correct position to view the maximum. The total width of the tail is intercepted by the Earth between November 14-21.

2. Even if the maximum prediction time is correct, the show for other parts of the world could still be good. If the maximum is 10,000 meteors per hour, which is one prediction, then there will still be between 20 and 40 visible per hour in the US during our scheduled observations. If they are bright meteors, it will be pretty spectacular.

3. The predicted maximum could be off by a factor of 10 either high or low. If the actual maximum is 10 times higher than the prediction, then between 200 and 400 meteors per hour will be visible in the US. That WILL be spectacular and can you imagine what it will look like in Asia!

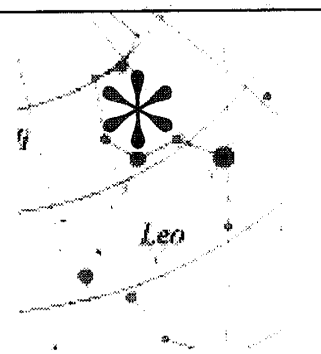
Looking to the future, the 1999 Leonid shower might be better than this year's. If the viewing region and the time are better for the US next year we will be ready. Since the predicted time of the maximum is during the day in the US, we will make observations during the two nights that bracket the maximum. The procedure for observations will be to record 6 minutes of VLF on the hour and on the half hour for the time during which you can observe. Time marks will be put on the audio tape every 2 minutes. In addition, a careful written log must be kept of the meteors seen. This log should include their brightness (an estimate of the magnitude), the time and any other features noted (length and persistence of track, etc.) This log can be done on paper, or dictated into a tape recorder or dictated onto the audio track of a video camcorder. While it is not obvious that a camcorder will be able to record the meteors, the audio track will provide a good time track. Be sure to put a time mark on at the beginning of the taping or carefully set the camcorder's internal time and include the time on the video recording.

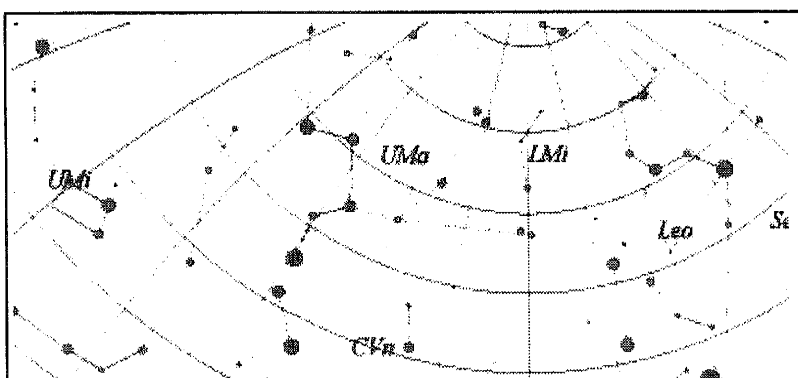
Leo will rise in the northeast at around midnight local time each night. Figure 1 is a star chart for Leo rising and Figure 2 is for dawn. Note that the moon will be very close to new, so it will not affect viewing! The star charts are almost exactly the same for all of the US, as measured in local time. (Here's a situation where we don't have to fuss with UT!) The charts show the sky as you look east, with the horizon on the curved bottom of the chart and the zenith at the top. In Figure 1, Leo is the constellation rising just to the north (left) of east. The radiant point, where the meteors will all seem to come, is inside the head of Leo. Figure 2 shows all of Leo, with a label. So from midnight local time to sunrise, the radiant point in Leo will rise from slightly north of east and will move toward the zenith, reaching an elevation of about 70 degrees at sunrise.



The constellation Leo. The brightest star is Regulus. The star shape for Leo is also called "The Sickle" because of the curved outline formed by the main stars. It has also been described as a backwards question mark.

To the right, the radiant point is indicated by an asterisk.





Locating Leo.

This view shows the North Star (Polaris) in the upper left, the Big Dipper (Ursa Major) in the center and Leo to the right. Note that the "pointer stars" of the Big Dipper point toward Polaris, but looking the other way a similar distance they point very close to Regulus.

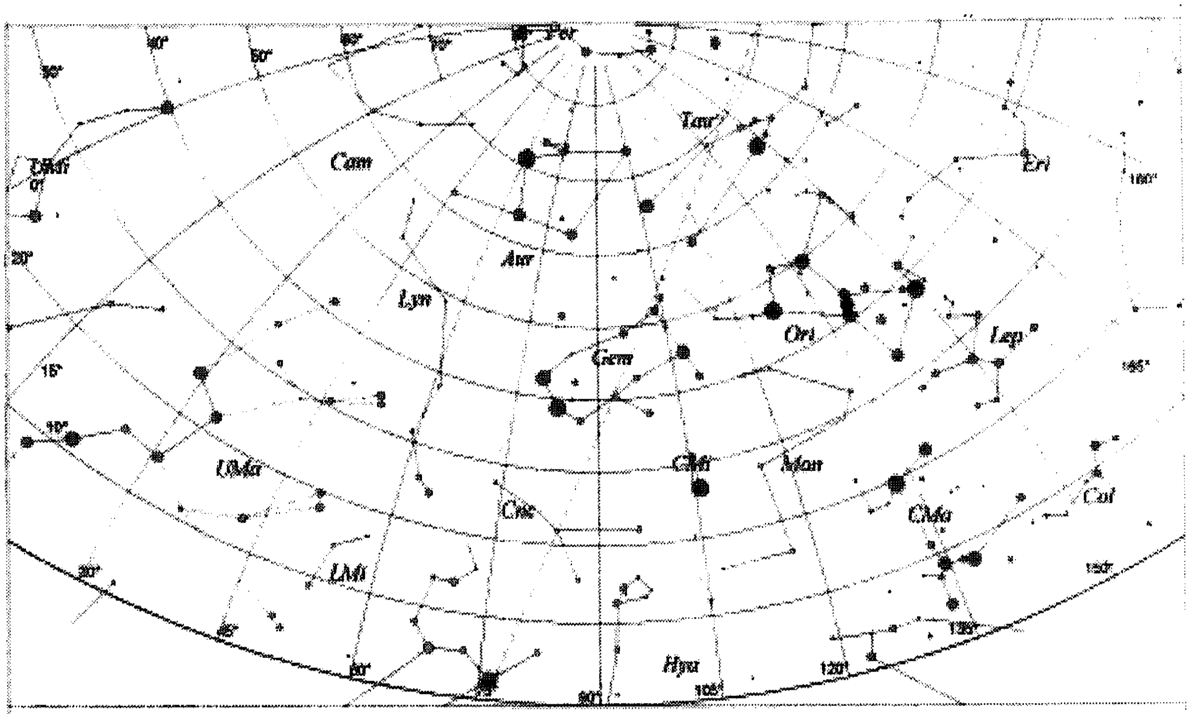


Figure 1. Leo rising. This is the view of the sky looking east as Leo rises around midnight local time. Regulus is the bright star at about 75° azimuth. Star charts courtesy of Lou Mayo (Goddard Space Flight Center) using SkyMap 3.1.

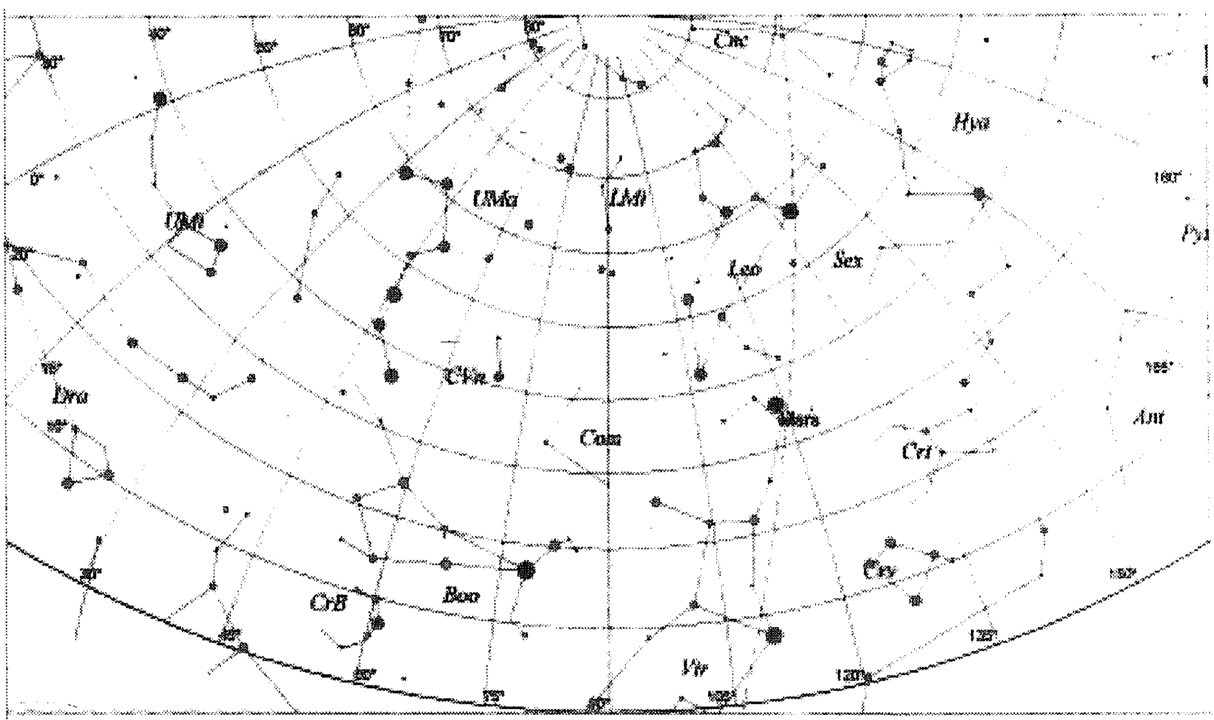


Figure 2. Leo at sunrise. This is the same view of the sky at about 5 AM local time. Leo is at about azimuth 120° and altitude 65°.

See the following URLs for more information on the Leonids and meteors in general:

http://web99.arc.nasa.gov/~leonid/history.html
http://www.skypub.com/meteors/leo96a.html
http://www.imo.net/
http://medicine.wustl.edu/~kronkg/leonids.html

Leonid Shower Observation Procedures

The strategy for the INSPIRE observation schedule is to bracket the time of the maximum with observations the night before and the night after the maximum. Each observer can record any or all of the schedule depending on time available and local weather.

Tuesday, November 17
(early morning local time)

3:00 AM	6 minutes
3:30 AM	6 minutes
4:00 AM	6 minutes
4:30 AM	6 minutes
5:00 AM	6 minutes

Wednesday, November 18
(starting at midnight Tuesday local time)

12:00 MID	6 minutes
12:30 AM	6 minutes
1:00 AM	6 minutes
1:30 AM	6 minutes
2:00 AM	6 minutes

All times are LOCAL time (on all logs, specify your time zone).

Dawn should be used to determine when observations should stop. When the sky is too light to see faint stars, it is time to quit. Each night's observations should be contained on one side of a 60 minute tape. Record on one side of the tape only. This will fill one side of a 60 minute tape. If you want to continue recording each half hour, use a separate tape.

After recording, listen to the VLF tapes and review your visual logs (or videotapes) and make observations.

Send audio tapes, logs and videotapes to:

Bill Pine
Chaffey High School
1245 Euclid
Ontario, CA 91762

Radio JOVE Science Education Project

By Chuck Higgins, Goddard Space Flight Center, Greenbelt, MD

Want to give your students another way to become interested in science? Why not have them listen to the radio? Radio JOVE is an exciting, new NASA education project that will bring the radio noise "sounds" of Jupiter and the Sun to students, teachers, and the general public via radio astronomy kits and a radio observatory on the Internet. In the spirit of the successful INSPIRE project, we plan to develop inexpensive radio receiver/antenna kits suitable for hands-on learning of solar and planetary radio astronomy. These kits can be assembled by high school science classes and used to collect data for laboratory experiments or for learning basic science concepts. Along with the kits available to the participating schools, wc plan to create an on-line radio observatory using the existing facilities at the University of Florida Radio Observatory (UFRO). UFRO is one of a few telescope facilities in the world that monitors the radio emission emanating from charged particles moving in Jupiter's powerful magnetic field. The telescopes can also be used to observe the numerous solar bursts that are expected as the sun approaches solar maximum around 2001.

A central web site will be created to support all the on-line observations allowing students to listen to Jupiter or the sun, store the archived data files, and access programs to plot data and perform lab exercises. The sounds of Jupiter and the sun will be presented real-time while the observations are taking place and the students will have some control over the selection of which frequency the telescope is monitoring. The site will also contain general information relevant to the understanding of radio astronomy and instructions on how to build and use the kits to make the observations. This web site will be the hub for contact between participating schools for comparison and sharing of data.

The goals of the JOVE project are many:

1. The Radio JOVE Online Observatory project is one part of an overall educational activity to increase K-14 science education, specifically grades 8-14.

2. To educate students, teachers, and the general public about planetary and solar radio astronomy, space physics, and the basic concepts of the scientific method.
3. To create the first ever on-line radio observatory which will have multiple uses:
   a) provide real time data for Jupiter and solar observations to those with Internet capabilities
   b) allow participants to display and download files from radio data archives
   c) improve the scientific capability and utility of UFRO to the scientific community by software modifications and allowing remote control of the facility
4. To provide teachers and students with hands-on learning of radio astronomy as a science curriculum support activity. This will include laboratory exercises and teaching tools for participating schools
5. To provide teacher training to several target high school teachers as a method to best incorporate these science endeavors into the classroom and to provide important feedback, lessons learned, and an overall evaluation metric for this project.

Interested in learning more? Stay tuned to JOVE! We are the Great Red Spot on your radio dial! For more information please contact:

Dr. Jim Thieman, Dr. Chuck Higgins, or Dr. Bill Taylor at:

NASA/GSFC
Code 630.0
Greenbelt, MD 20771.

Email: thieman@nssdc.gsfc.nasa.gov
higgins@nssdc.gsfc.nasa.gov
taylor@nssdc.gsfc.nasa.gov.

For more information about radio astronomy and to hear audio samples of Jupiter radio emissions, check out the UFRO web site at:

http://www.astro.ufl.edu/radio/

Near the bottom of the Home Page you will find buttons for the sound samples:

The Sounds of Jupiter

- A brief introduction (308183 bytes)
- The Galactic Background Radiation (255195 bytes)
- L-Bursts (415045 bytes)
- S-Bursts (312469 bytes)
- S-Burst 128:1 slowdown (725450 bytes)

Variations in Orbital Predictions from NASA Two Line Elements
or
Why Isn't MIR Always Where We Think it Should Be?

by Bill Taylor Washington, DC
and Bill Pine Ontario, CA

While INSPIRE has been participating in INTMINS, there always seem to be changes in operations times. We have been asked many times why the operation times cannot be just set and then not changed. We have asked that question ourselves, and haven't always been satisfied with the answer we've given. So we decided to do a little more systematic analysis of the problem.

The conclusion that we have come up with is that there are apparently random errors in

1) The measurements that are used to calculate the TLEs (Two Line Elements). The measurements are from cameras and radar that the US Space Command (part of the US Air Force) uses as data.

2) The calculations from the measurements. The calculations are done with computers, but there may be rounding errors in the calculations.

3) The prediction programs we use to calculate the position of MIR in the future. OrbiTrack and STS Orbit are two that are used.

NASA Two Line Element sets (TLEs) consist of a group of numbers that completely describe the motion of a satellite. TLEs are derived from observations made from the ground using the appropriate equations. A more complete explanation of TLEs is available from Johnson space Center at:

http://shuttle-mir.nasa.gov/shuttle-mir/ops/mir/tracking/vector.txt

Figure 1 is the TLE set for the MIR Space Station for March 13, 1998. You can identify the date in the "Epoch time" element since March 13 is the 72nd (072) day of 1998 (98) - 98072.

It is apparent from examining the elements that rounding has occurred. While this will not make a very big difference in the present location of the satellite, when an orbit tracking program is used with these elements as input, significant errors can arise in the *prediction* of the location of the satellite at a later date. The further into the future the prediction is made, the greater the discrepancies that will result. For INTMINS planning, predictions extend about four to six weeks into the future.

Figure 2 shows a map of Europe with one minute of predicted path for one of the INTMINS days in April 1998. The different tracks are identified by the TLE epoch day. So the one labeled 072 was the TLE with 98072.xxxx in the epoch field. Note that the predicted orbit tracks are essentially the same for all of the TLEs, but that the position along the orbit changes slightly. The track shifts generally to the east, but there is a large random component in the motion of the track..

USSPACECOM TWO LINE MEAN ELEMENT SET

Mir Day 072 Vector

mir
1 16609U 86017A 98072.48706534 .00008380 00000-0 94427-4 0 8423
2 16609 51.6585 170.5473 0005492 113.9440 246.2285 15.62658878689090

Satellite: mir
Catalog number: 16609
Epoch time: 98072.48706534 = yrday.fracday
Element set: 842
Inclination: 51.6585 deg
RA of node: 170.5473 deg
Eccentricity: .0005492
Arg of perigee: 113.9440 deg
Mean anomaly: 246.2285 deg
Mean motion: 15.62658878 rev/day
Decay rate: 8.38000E-05 rev/day^2
Epoch rev: 68909

Figure 1. Two Line Element set for MIR on March 13, 1998

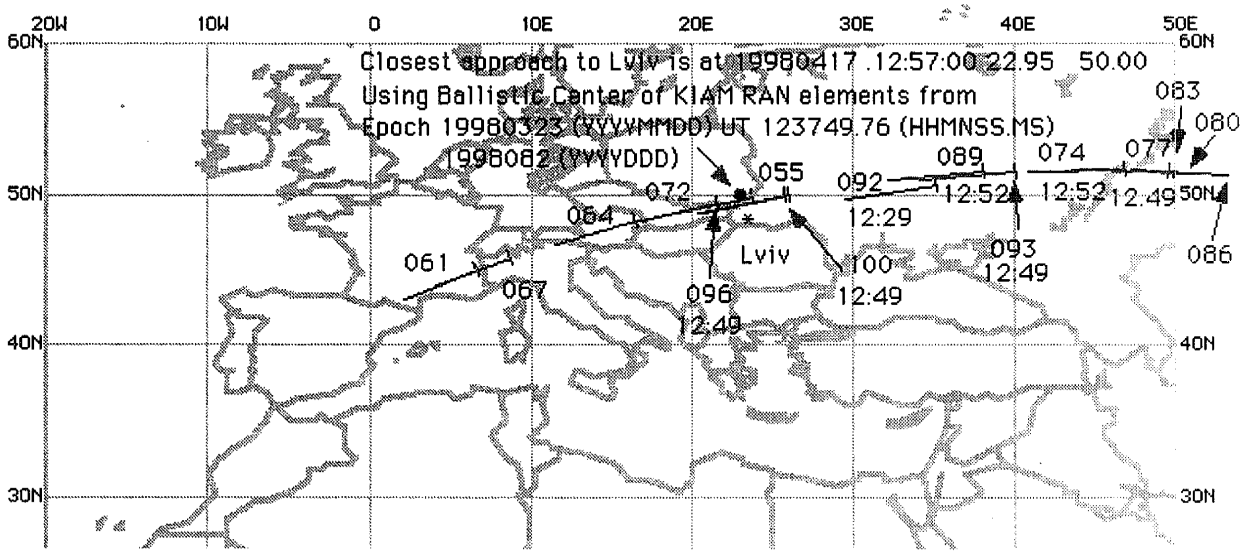


Figure 2. Sample of predictions of the MIR track for the closest approach to Lviv, Ukraine. The square black box is the closest approach using Russian Ballistic Center of KIAM elements from March 23 to predict this closest approach on April 17, 1998. The other tracks are using NASA TLEs and the OrbiTrack software to predict the track near Lviv on April 17. The first prediction was made using Day 055 (February 24) elements. This predicted a closest approach at 1255 UT. Other tracks show the predicted track for MIR at 1255 UT on April 17 using TLEs from other days. Day 061 is furthest west; Day 086 is furthest east. Days after 086 use times earlier than 1255 since the track had progressed to the east off this map. The final prediction was based on Day 100 using a time of 1249 UT. There was not much change in track from Day 096 to Day 100. This final prediction was 7 days prior to the target date - April 17, 1998 (Day 107).

O.PE.RA.

Osservatorio Permanente sulle Radioemissioni di Origine Naturale (Permanent Observatory on Natural Radio Emission)

By Renato Romero Cumiana , ITALY

In order to study natural radio signals, more than just the fascinating listening, there is the attempt of identifying the origin of the signals. The goal of the present research, which lasted about a year, was to determine the link between natural radio signals with their originating physics phenomena.

GOALS OF OPERA

During the year which was chosen for the research, several hundreds of listening sessions in the 100 Hz - 10 kHz band have been done at predeterminate times in order to collect, during the whole year, a minimum indispensable quantity of data to quantify the number of whistlers which occur and when they occur.

Besides the work of data collecting through the reception of the electrical field and the magnetic field of the natural radio signals, research was done about other physical data related in some way to the natural radio phenomena. The meteorological conditions at the geomagnetic conjugate point, including maximum and minimum temperatures, were recorded every day.

Daily values of the solar radio flux were also recorded as were descriptions of the geomagnetic activity produced by the solar wind and the number of sunspots.

The goal of the research was to identify every possible link between the observed quantities and to verify the possibility of giving a forecast about the presence of radio signals of natural origins even if in a short time terms. Last but not least was to be able to alert interested observers in the event exceptional conditions of the propagation in VLF and ELF natural radio signals.

DETERMINATION OF CGM (Geomagnetic Conjugate Point)

The receiving station was based in the northern part of Italy, near Turin, at geographic coordinate 44° 57' North, 7° 25' East.

As is well known, geographic coordinates differ from the geomagnetic ones which are in slow but continuos evolution. The simple determination of the geographic conjugate point doesn't give the correct position of the geomagnetic conjugate point. The first operation so was to determine the geomagnetic coordinates of the receiving site in order to get the CGM, that is the point where most of the whistlers that are occasionally received originate. The exact determination of the point was given by a calculation given on Internet at NASA site of NSSDC (National Space Data Center) at address:

http:10/19/98/ndssbc.gsfc.nasa;gov/space/cgm/cgm.htm/

To get a huge quantity of data including that of the present research you have to input your own geographic coordinates and the current date. For the receiving station coordinates (near Turin) the result is that the CGM is a few kilometers from Cape Town, South Africa. But if you refer to the latest geomagnetic maps found in Italy, it is the one published by the military cartography which date back to 1967; so this is not current enough to be valid for the purposes of our research.

RESEARCH DATA ON CGM METEOROLOGICAL CONDITIONS

The determination of CGM is necessary to find out which geographic place must be monitored about meteorological conditions for the compared data collecting. So once it has been found out that the place wasn't that far from Cape Town the meteorological data of that town were taken as valid ones. The first attempt of using meteorological maps sent from polar satellites was quickly abandoned: the given images don't allow one to deduce the ground meteorological conditions. Instead the data given by INTELLICAST were adopted at Internet site:

www.intellicast.com/weather/cpt/content.shtm

The data about meteorological conditions include even minimum and maximum temperatures and three-days-after-requested-date forecasting as well.

THE DATA COLLECTING ON SOLAR ACTIVITY

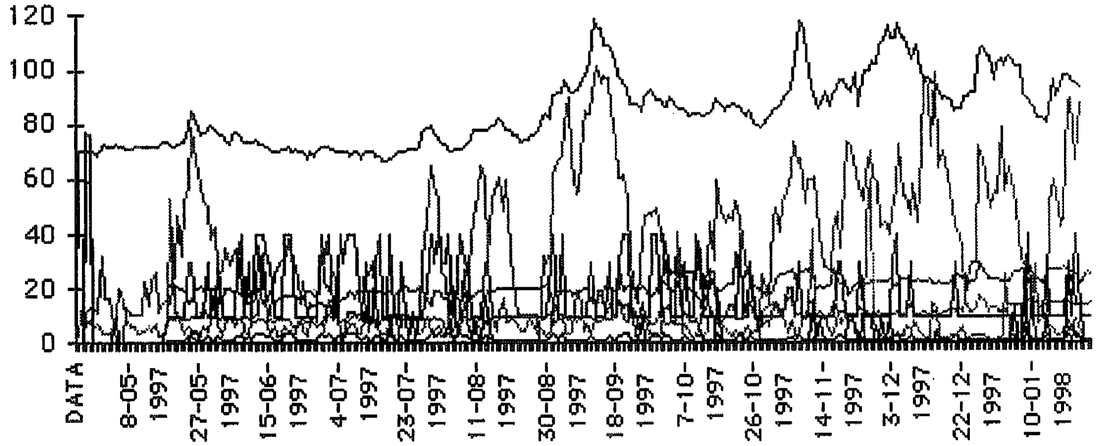
The collected data have been included in an Excel page specifying the followings items:

A: listening date
B: maximum temperature at CGM (°C)
C: minimum temperature at CGM (°C)
D: meteorological conditions at CGM (1=clear, 2 = cloudy, ... 5 = storm)
E: solar radio flux (observed at Penticton on 10,7 cm at 2000 UT)
F: sun spot numbers
G: solar wind (AP index)
H: number of whistlers per minute listened in sessions
I: value of column WX (Column D) multiplied by 10
J: square root of number of whistler multiplied by 10

A	B	C	D	E	F	G	H	I	J	K
O.Fe.Ra, Osservatorio Permanente Radioemissioni di origine naturale										
DATA	**T max**	**T min**	**WX**	**FLUX**	**SSN**	**AP**	**W/min**	**WX*10**	**Eq W*10**	**Note**
3-11-1997	26	11	3	110	66	3	0	30	0	
4-11-1997	26	11	1	118	68	9	0	10	0	
5-11-1997	27	9	1	114	51	9	0	10	0	tw debolissimi
6-11-1997	26	15	1	105	60	12	0	10	0	tw debolissimi
7-11-1997	29	16	1	94	60	42	2	10	14	w debolissimi
8-11-1997	20	11	1	90	61	4	0	10	0	
9-11-1997	21	12	1	86	40	9	0,5	10	7	
10-11-1997	20	10	1	89	28	10	0	10	0	
11-11-1997	21	9	1	92	28	6	0	10	0	
12-11-1997	22	12	1	87	26	3	0	10	0	
13-11-1997	27	15	1	90	41	4	0	10	0	
14-11-1997	23	11	3	93	48	11	0	30	0	pochi tw
15-11-1997	22	12	3	96	35	7	0	30	0	pochi tw

The last two columns have been automatically calculated by the program and allowed to have a value which can be graphically compared to other values without further elaboration.
The table, which only shows a few days observations, has been secondarily translated in a graphic form as shown in the following graphic. You can't deduce many relations between values but you can easily and efficaciously visualize the quantity of data which has been compared.
For more practical comparisons graphics have been done on monthly periods on a limited number of values each time.

O.PE.RA.



PREDETERMINATION OF RECORDING TIMES

Two daily sessions have been planned on the observatory timer, one session corresponds to the maximum sun time and the other when the receiver was in the center of the dark zone. Every recorded session lasted for a minute. At the end of the year have been finally noted more than 700 sessions.

Every session was recorded in two different ways: electrical and magnetic. For every session spectrograms of the natural radio signals have been made, noting the origin and the quantity of the observed signals.

ADDITIONAL SESSIONS

The automatic session described in the previous paragraph are not the only ones: two or three sessions per day have been done but not recorded on tape, lasting from five to twenty minutes.

For each session observations have been noted on the observed phenomena. These supplements of listening have permitted the validity control of the criteria planned during the automatic sessions for the quantification of whistlers.

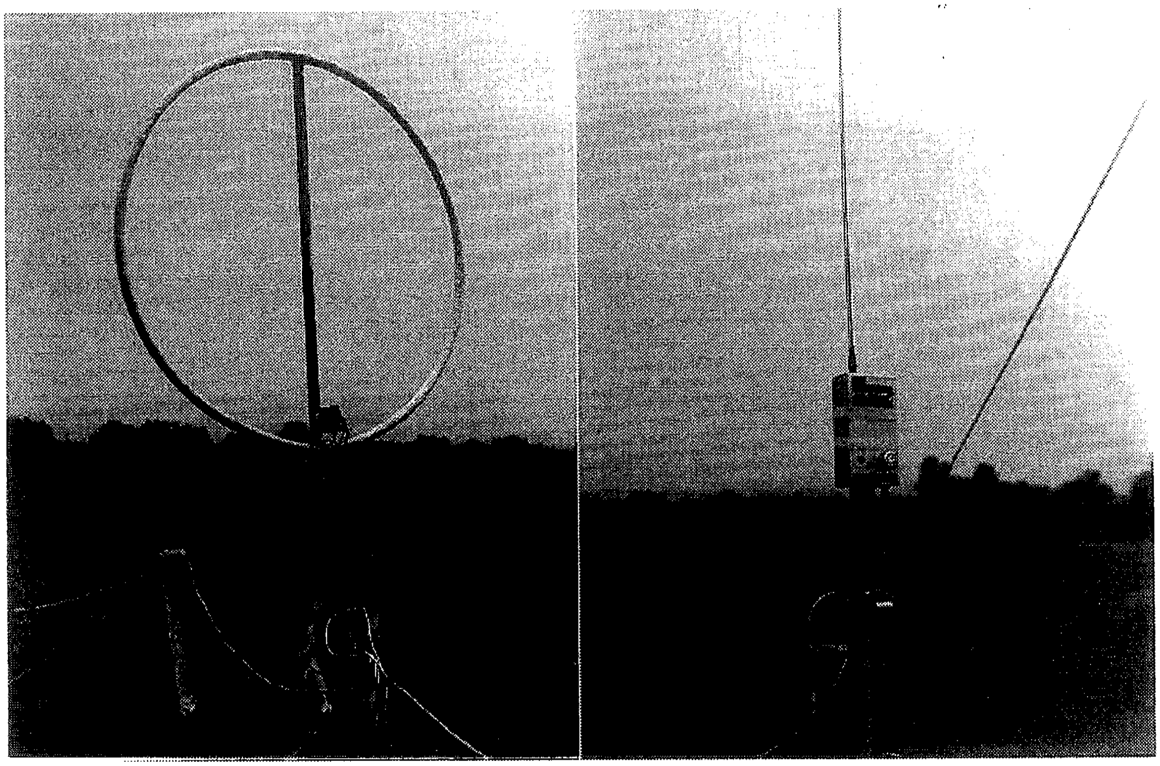
By comparing data it was found that the error rate was below 5%. That meant that two sessions of one minute per day were considered enough in order to determinate the presence or the absence of whistlers.

So, supplementary sessions have permitted us to obtain even more precise data.

THE RECEIVERS USED

The research utilized two receivers: one of electric field, the RS4, used with a remote antenna of a one meter based 4 meters high from the ground, in an open field. The second receiver is a magnetic field type with a multiturn loop antenna of 75 cm of diameter based two meter high from the ground situated very close to the RS4. The two receivers have been remote powered with a 100 meters multi-core shielded wire, the same wire which has transported the signals received inside the station.

The two signals have been sent to two channels of a stereo recorder already arranged in order to make an automatic recording starting from the programmed timer. The goal of all of this automation was to reduce the manual operations of data collecting to allow time to analyze the same data.



Photos showing the field setup.

DATA TAKING

The data collecting was done in two different ways: the first one with audio sessions in compact cassette, the second one using numerical data about the solar activity, meteorological conditions at the CGM, and the number of whistlers observed on the Excel workpage.
Once a tape was completed, the complete spectrogram was done and the obtained data were included in the computer workpage completing the data necessary to the research.

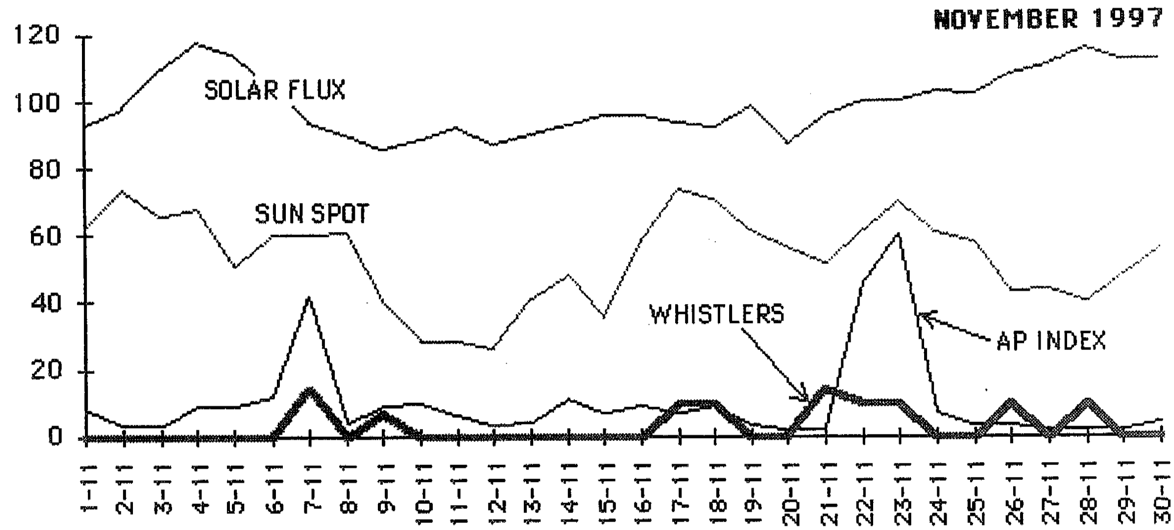
LACK OF CORRELATION WITH SOLAR DATA

The first result coming from the collected data is the absence of possible links between whistlers and the other observed values (See the following graph for November 1997).

It is well known that whistlers originate from discharges electric storms related to the magnetic ways (formed by solar activity) and so these values are related and linked between themselves.

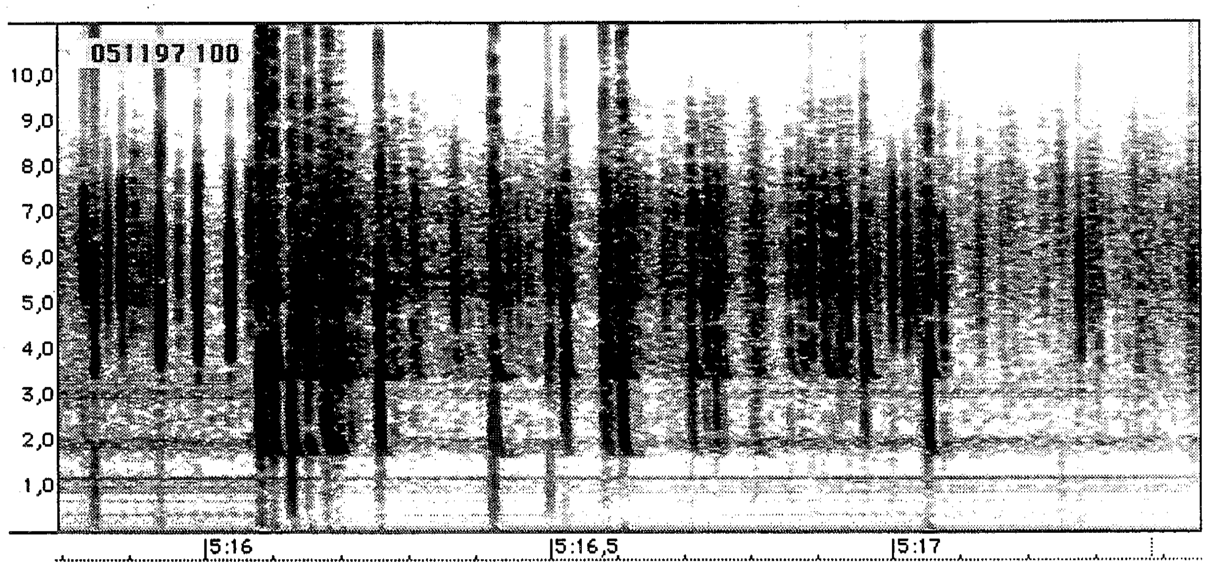
Comparing the collected data we couldn't find any information about that. This doesn't mean that this link doesn't exist, but it simply means that a single operator, with his own means, also via Internet, can't prove the existence of this link.

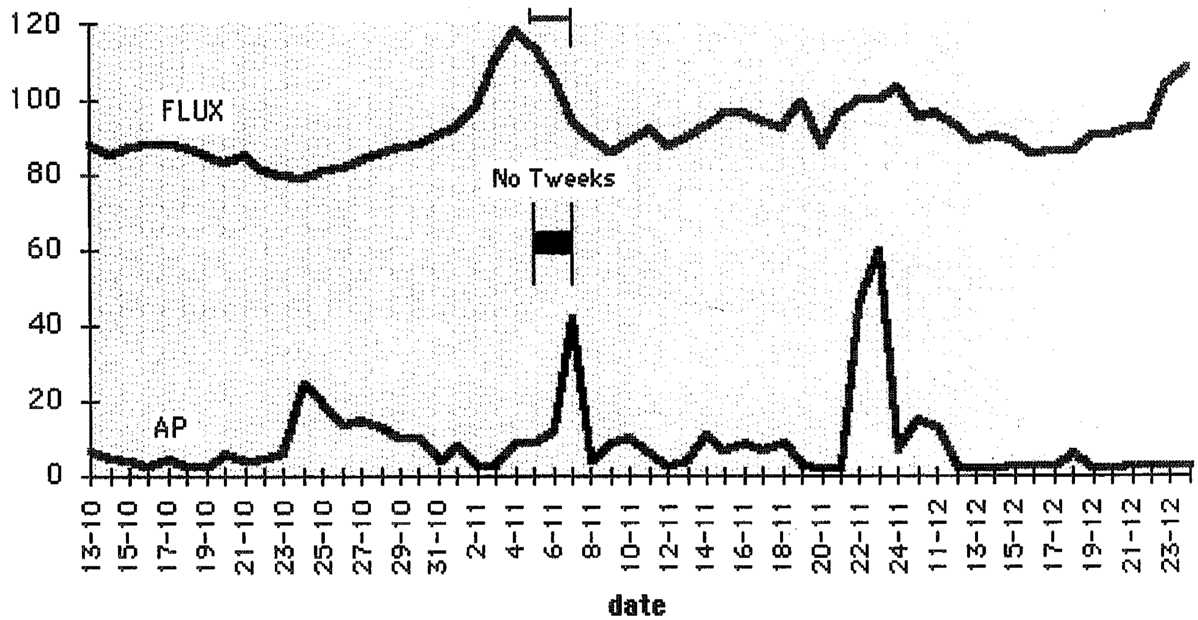
So, the collected data doesn't allow one to forecast anything about the whistlers and their happening even in shorter times.



LINKS BETWEEN TWEEKS AND SOLAR FLUX

More than once it was evident that some links exist between the presence of tweeks and the intensity of the solar radio activity. For twice in fact, during a very intense and anomalous solar activity lasting a few days, tweeks disappeared from the night sonograms. Their number is strictly related to the number of sferics but their intensity strongly seems related to the magnetic storms. The following spectrogram shows an active night with 4-harmonic tweeks; the graph shows the absence of tweeks related to high solar activity.

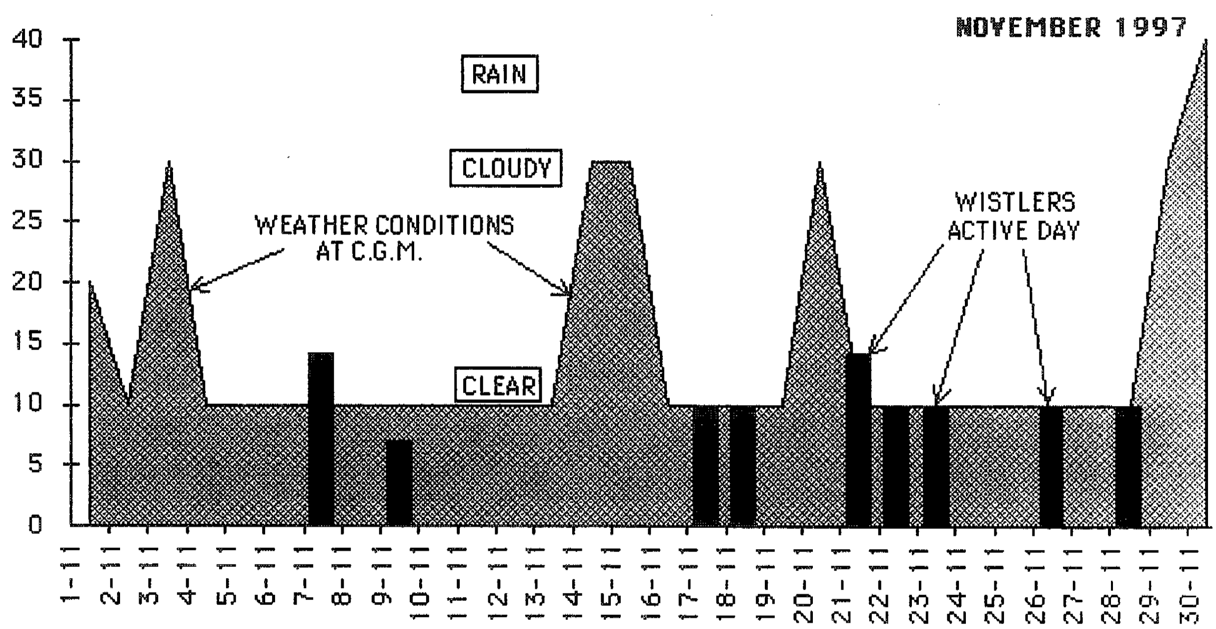




Absence of tweeks corresponds to high solar activity.

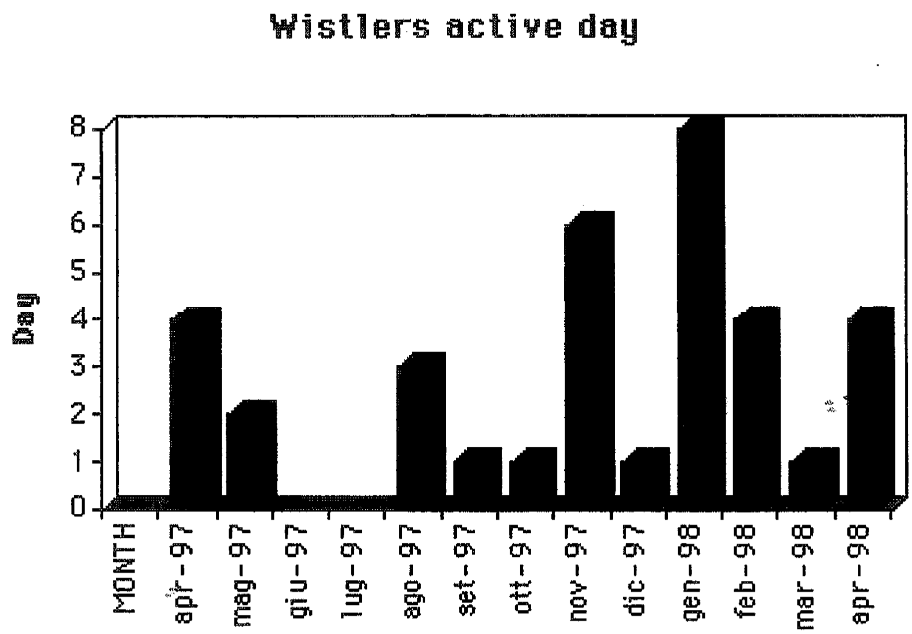
NON CORRELATION WITH WEATHER AT THE CGM

It is certain that at the beginning and origin to whistlers there must be a storm, but apparently the collected data about weather and CGM conditions, in our case in Cape Town, are not reliable enough. Data are related to the forecasting which, even if very accurate, leave space to a certain doubt because of the atmospheric weather. More than this, during bad weather periods conditions can change in as short distance as a few kilometers making the data not very much reliable. The data collected during the whole year didn't show particular links between the weather at the CGM and the number of whistlers observed.



STATISTICS OF THE ACTIVE DAYS MONTH PER MONTH

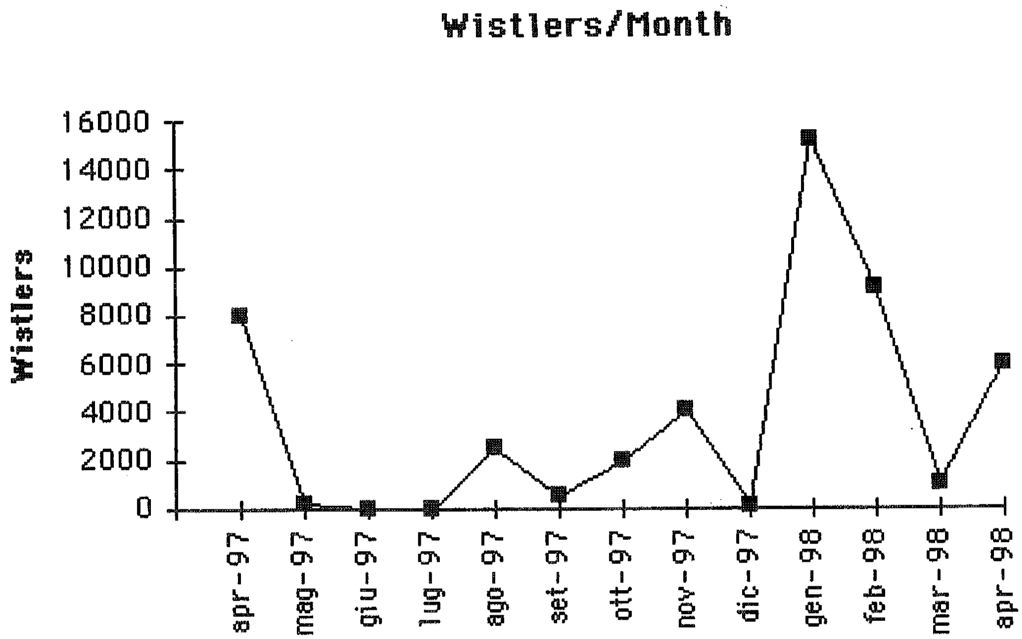
A very interesting data which came out from OPERA experience was the number of days during the year when is possible to listen to whistlers. If, for instance, you are planning listening sessions during the month of February, how many possibilities are they that during a single week you can really get in touch with whistlers? The following graphic gives you this answer. It is clear and obvious in fact that winter months are more favorable for the whistlers listening, knowing as well that the possibility of periods of complete inactivity even for quite long periods can happen.



STATISTICS NUMBER OF WHISTLERS PER MONTH

According to the previous data some rules have been established in order to value, in a approximate way, the quantity of whistlers receivable per single month. Since the sessions happened about every six hours, a hypothesis was made that the type of the intensity of the phenomenon was sinusoidal, and this was obtained by calculating the quantity of whistlers every six hours and multiplying the result gotten from the listening per 360 total minutes and dividing this value by 1.4.

Because of these calculations we can suppose that during the observation period lasting a year we observed a total of 48500 whistlers. Then, if we subdivide this value for the whole year we get a medium value of 133 whistlers every day: a whistler every 11 minutes. In these statistics it must be considered that the receiving station was not located in a completely isolated zone, and so we must consider that the 50 Hz noise could prevent reception of very weak signals. Even if not a totally exact calculation or forecast, this value gives anyway a very practical idea of the general tendencies of the phenomenon. As is shown by the following graphic the winter periods are more favorable for whistlers listening.



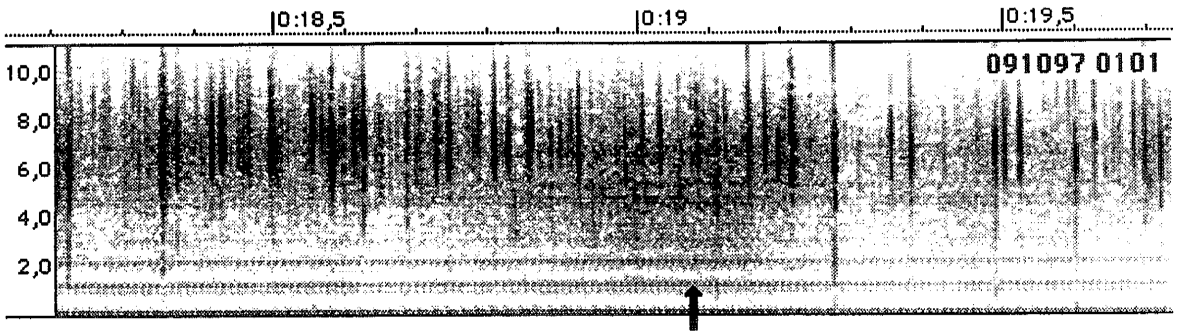
STATISTICS ABOUT THE WHISTLERS RECEPTION TIMES

Even if the presence of whistlers is detectable during both day and night time, it is much easier to get these signals during night time, and this is most valuable during the summer time when automatic listening session have never received whistlers signal during the day. Long listening periods, while these phenomena were present confirmed this tendency.

SIGNALS LINKED TO SEISMIC PHENOMENA

During the listening session for OPERA a very sad event unfortunately hit the Italian peninsula which is a high seismic risk zone. The very high number of earthquakes has maybe given its contribution to a lucky connection: when a very powerful earthquake is close to happening, emissions in magnetic mode and in electric mode have been recorded, and this happened 15 minutes before the first shake. The signal is very similar to a cellophane sheet that, when wrinkled produces a wide-band noise in an RS4 receiver. In certain moments it has even rose above the signals of sferics present in bands. This signal has been received with stronger intensity in the magnetic receiver compared to the electric one. The distance from the earthquake was about 500 kilometers.

The peculiarity of the recording is that also another Italian operator, living near the epicenter, could record, in the same period, very similar signals with even higher frequency. In the following picture is shown the spectrogram of a part of this signal.



THOSE WEIRD SIGNALS

There were always rumors about natural radio signals that they had origins even from aliens and ghosts. In order to deny a connection of spiritual powers to natural VLF, we must say that in more than 1500 listening sessions done in a year, particularly strange signals never have been found. Everything observed and recorded was part of the natural radio signals studied. The only exception to this rule is the previous paragraph about an earthquake: those signals are not fully explained yet, despite, several studies that have been done about this complicated matter. All of this makes stronger and stronger the wish men have to give a complete explanation of the physics rules which govern our universe.

CONCLUSIONS

After the year of research it was possible to conclude:

1) It's easier to listen to whistlers during the night than in the day time.
2) It's easier to listen to whistlers during winter than summer time.
3) Making a random listening of a few minutes in a winter night, you have 20% greater probability of receiving whistlers; if the same operation takes place in summer time the probability goes down to 3%.
4) Tweeks are happening practically every night even if with different intensity and frequency.
5) While solar storms are happening, tweeks can attenuate or even totally disappear for a few days.
6) In the data collected from OPERA it is not evident that a direct link exists between the received whistlers and the CGM meteorological conditions data
7) Finally there does not seem to be a direct correspondence between solar activity data and the number or received whistlers.

MANY THANKS TO

Prof. Ezio MOGNASCHI, for technical support.
Dott. Andrea BERTOCCHI, for translation.

SOUND SOFTWARE UPDATE

By Flavio Gori Florence, ITALY

Last March, some letters appeared in the scientific magazine, NATURE, which were about Low Frequency Active Sonars (LFAS), which seems to be a problem for whales causing them to lose their way, going on a beach, and dying. Those LFAS are in the VLF/ELF radio waves kingdom. The entire article on this topic is in NATURE (5 March 1998).

This time I'll write about a type of PC technical software. I heard about these programs from a BioAcoustic Internet mailing List. (listmgr@ornith.cornell.edu) Sometimes it can be extremely useful for us, too, believe me.

The software for this article was found not by me but by Dr Steven L. Hopp of the Department of Ecology and Evolutionary Biology Biosciences West, University of Arizona (shopp@U.Arizona.EDU). We all have to thank him for his fantastic job.

Below you'll find all these e-sites, extremely valuable. Try them and let the rest of us know.

http://www.cisab.indiana.edu/CSASAB/index.html#DOS/Windows
http://www.mbari.org/~dave/ASA/index.html
http://birds.cornell.edu/brp/BRPcanary.htm

Additional Bioacoustics Links at:

http://www.biologie.uni-halle.de/~bzopn/l_acoust.html

Dolphin Study Group: Software page

http://dsg.sbs.nus.edu.sg/datasoft.html

Bat research group:

http://www.bahnhof.se/~pettersson/psonan.html#sysreq

Some systems specifically designed for animal research:

Signal: From engineering Design (Probably the most thorough animal-oriented system out there)

http://www.noldus.com

Avisoft Home page (they have a "lite" version available for download)

http://home.t-online.de/home/raimund.specht/avisoft_.htm

A freeware that does simple spectrograms (actually not too bad)

Spectrum/Sono Program (research-developed)

http://bul.eecs.umich.edu/~phillipv/signal/

Recently developed software for animal work:

http://www.unipv.it/~webcib/softw.html

TFR-Commercial System

http://www.avaaz.com/tfr.html

Science Systems Audioscope:

http://www.sciencesw.com/

The area of speech research has a LOT to offer, but it requires a bit of background/familiarity, and not designed for animal work per se, although most will do many of the things we require. The Comp-speech page provides a general listing and is useful to see what Speech-research site, with software listings:

http://www.itl.atr.co.jp/comp.speech/Section1/Labs/sfs.html
http://www.itl.atr.co.jp/comp.speech/

A few speech-oriented systems:

Commercial speech analysis program:

http://www.tigerelectronics.com/SpeechAnay2.html
http://www.tigerelectronics.com/index.html

Speech Program Download (DOS)

http://www.phon.ucl.ac.uk/resource/sfs.htm

Spectra-Plus is a system that does a lot of signal analysis. They have a 30-day trial download.

http://www.telebyte.com/pioneer/

Two programs designed for "windows-based" sound editing, sound effects, simple analyses, etc:

http://www.syntrillium.com/10/cool.htm
http://www.goldwave.com/

A "signal management" program with a lot of options: filtering, editing, analyses: They have a "student" version available for download:

http://www.dadisp.com/
http://www.setileague.org/software/software.htm

Finally, a General Audio site with many software links

http://www.mit.edu:8001/people/weaponh/audio.html

I would like thank so much Steve Hopp for his kind permission to post on this *Journal* this information.

See you in the next *Inspire Journal.*

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. East Texas State University	Belton, TX	95° 53' 59" / 33° 14' 49"
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 Chaffey High School	Ontario, CA	117° 41' / 34° 14'
7	Dean Knight Sonoma Valley High School	Sonoma, CA	122° 33' / 38° 21'
8	Mike Dormann	Seattle, WA	123.4° / 47.2°
9	Robert Moloch Eastern Elementary School	Greentown, IN	85° 58' / 40° 28'
10	Bill Taylor INSPIRE	Washington, DC	38° 54' / 77° 2'
11	Mark Mueller Brown Deer High School	Brown Deer, WI	87° 56' / 43° 10'
12	Jon Wallace	Litchfield, CT	73° 15' / 41° 45'
13	Bill Combs	Crawfordsville, IN	86° 59' / 40° 4'
14	John Barry Seeger High School	West Lebanon, IN	87° 22' / 40° 18'
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 Turpin High School	Cincinnati, OH	84° 15' / 39° 7'
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 High School	Redlands, CA	116° 52' / 34° 10'
25	Norm Anderson	Cedar Falls, IA	92° 15' / 42° 20'

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):

26 Brian Page — Lawrenceville, GA

Longitude: 83° 45' W
Latitude: 34° 45' N
Roadside pullout in the Chattahoochee National Forest
Receiver: INSPIRE RS-4
Recorder: Magnavox AZ8210
Antenna: 2.6 meter whip
WWV: -

27 Ron Janetzke — San Antonio, TX

Longitude: 98° 47' W
Latitude: 29° 35' N
Roadside in State Natural Area
Receiver: INSPIRE RS-4
Recorder: Radio shack SCR-39, Stereo
Antenna: 5' telescoping antenna on top of 8' pole
WWV: DAK MR-101 (10.0 MHz)

28 Thomas H. Earnest — San Angelo, TX

Longitude: 100° 25' W
Latitude: 31° 16' N
Public road through rolling pasture land.
Receiver: INSPIRE RS-4
Recorder: Radio Shack SCR-59 Model 14-1205
Antenna: 3 meter vertical
WWV: Realistic 12-148

INTMINS - April/98
Data Analysis Report

by Bill Pine
Chaffey High School
Ontario, CA

The April/98 INTMINS observations marked the seventh 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

Orbital corrections that occurred after the April/98 INTMINS schedule was distributed required a slight modification in the operation schedule. All operations were moved 2 mintues earlier than the scheduled time. This resulted in a ground track for all operations that was essentially unchanged from the operations schedule maps. Since this modification was well within the recording window used in the data taking procedure, there was no need to notify observers of this change. The time analyzed on the tapes was, of course, changed to reflect the changed operation of the modulated electron gun, ISTOCHNIK.

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 optomist!) 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 electon 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 0-11.025 kilohertz. 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. 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/97 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
E18-1	1145	Central Italy	2
E18-2	1324	Russia, south of Moscow	1
E18-3	1455	Southern England	1
E18-4	1631	Southern England	0
E25-1	0926	Northern Italy	2
E25-2	1106	Russia, south of Moscow	1
E25-3	1240	Croatia	1

North American Passes

Pass	ISTOCHNIK Start Time	Path during ISTOCHNIK Firing	Number of Observers Recording Data
18-5	1927	MN	1
19-1	1650	AL, TN, VA	1
19-2	1826	NE, IA, MN	1
19-3	2005	Quebec	0
19-4	2141	Quebec	0
19-5	2318	OH, PA, DC	1
20-1	0052	KS, OK, AR	2
20-2	0223	CA	2
25-4	1528	NM, TX	3
25-5	1702	No. CA	2
25-6	2024	NY	1
25-7	2157	NE, MO	1
25-8	2333	NM, TX	3
26-1	1428	TX, AR	0
26-2	1601	So. CA	2
26-3	2057	MN, WI, IL, IN	2
26-4	2227	WA, OR, ID	1

Summary of European Passes Recorded

Team/Pass	E18-1	E18-2	E18-3	E18-4	E25-1	E25-2	E25-3
E5	x	x	x		x	x	x
E6	x				x		

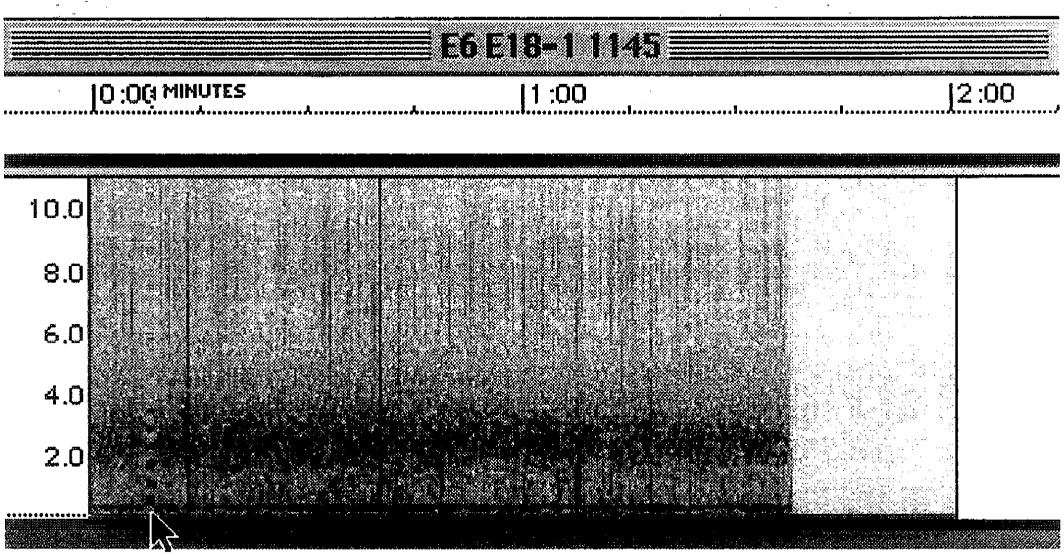
Summary of North American Passes Recorded

Pass	4/18	4/19					4/20		4/25					4/26			
	5	1	2	3	4	5	1	2	4	5	6	7	8	1	2	3	4
Team																	
5											x						
6														x			
7								x		x					x		
8																	x
11																x	
15							x	x	x	x			x				
16						x											
25	x		x									x				x	
26		x															
27							x		x				x				
28									x				x				

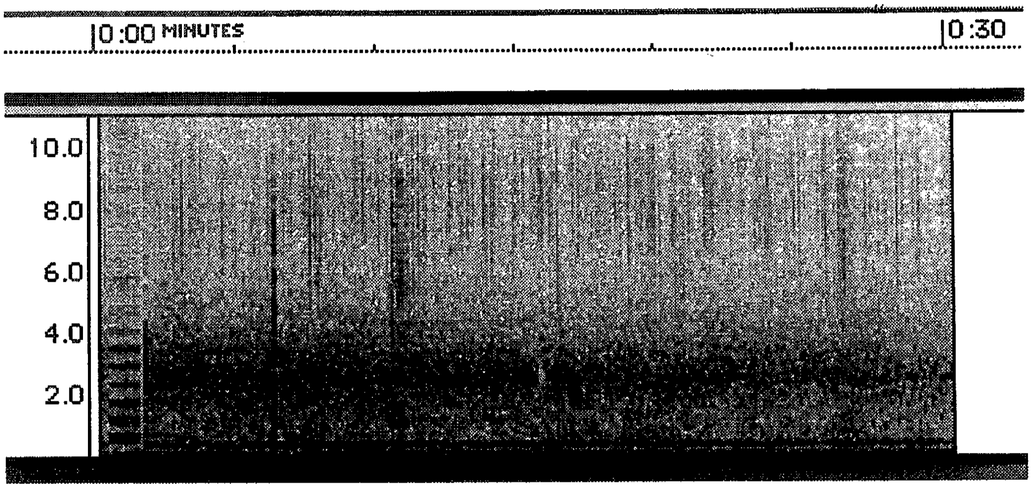
INTMINS Data

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.

E18-1

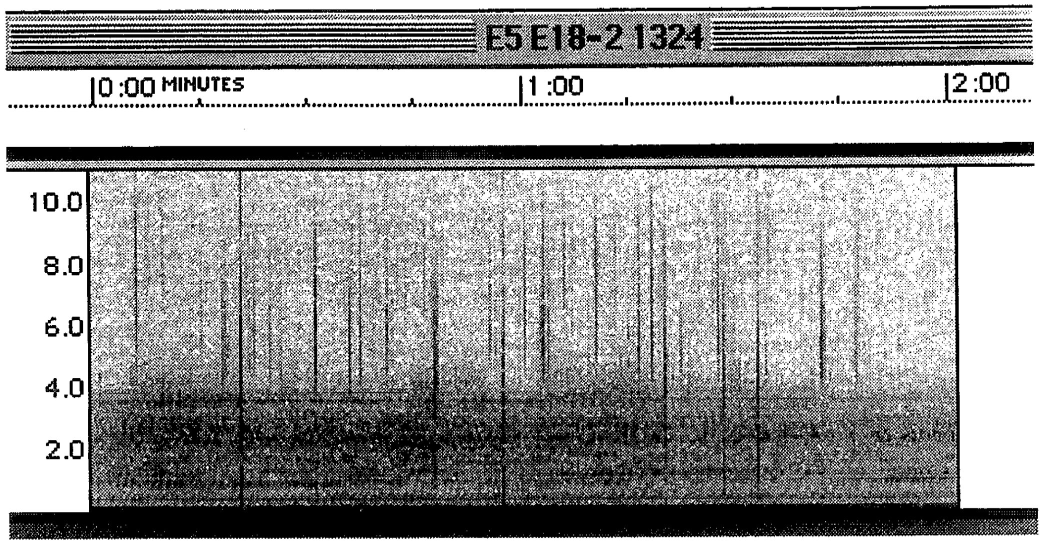


Team E6 Marco Ibridi, Finale Emilia, ITALY The arrow points to the 1145 time tone. Strong, dense sferics are present with a low level of 60 Hz noise. The signal dropped about 1.5 minutes into the operation for an unknown reason.

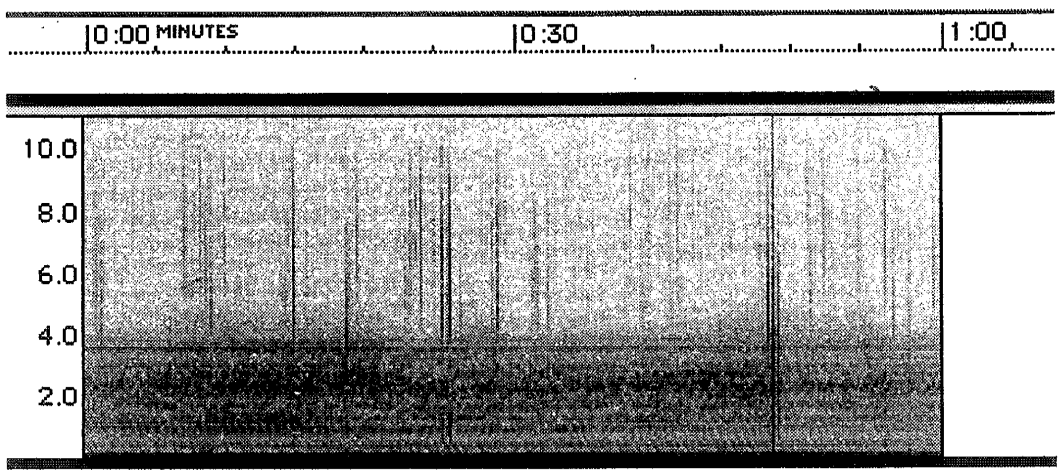


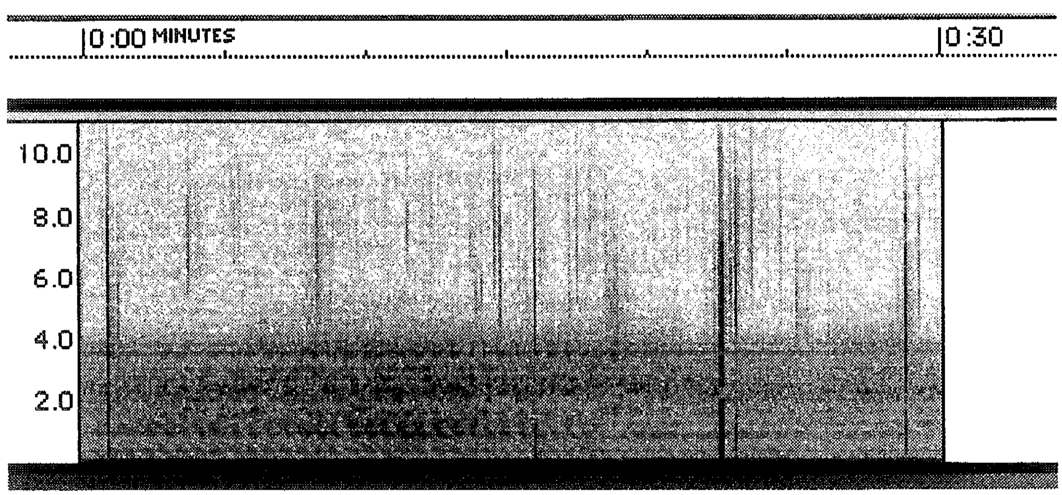
The first 30 seconds of operation. Note the harmonics present on the time tone.

E 18-2

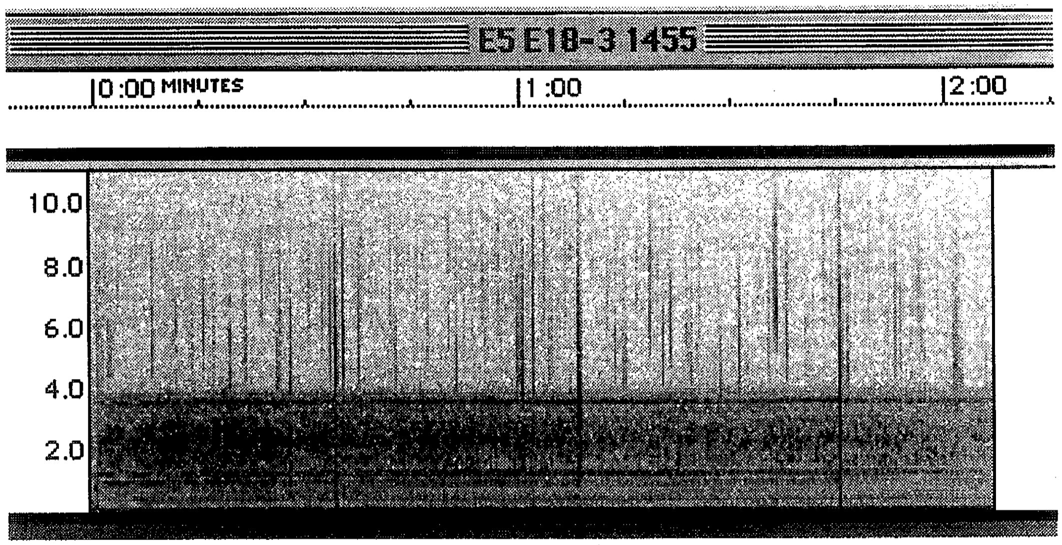


Team E5 Renato Romero, Cumiana, ITALY Prominent sferics with significant 60 Hz noise present. Following views are of the first minute and first 30 seconds.

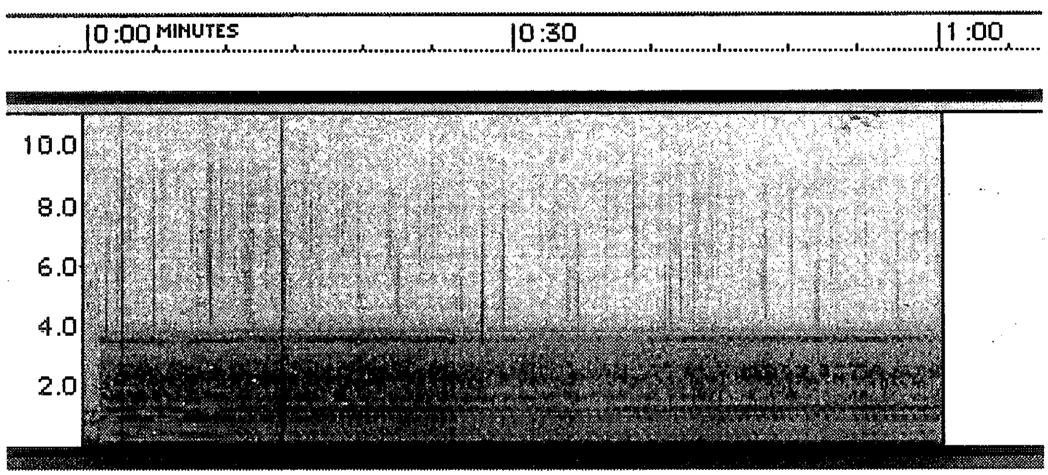


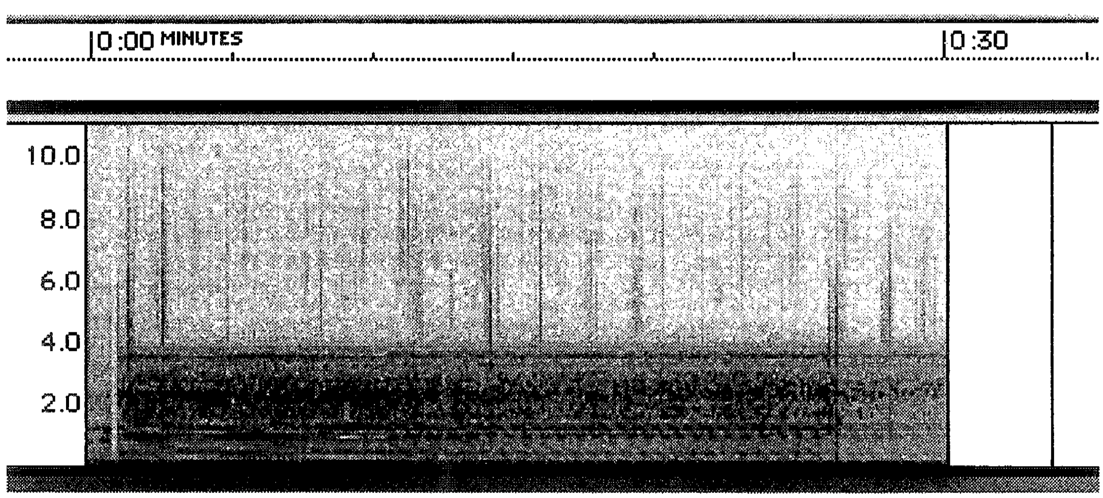


E18-3

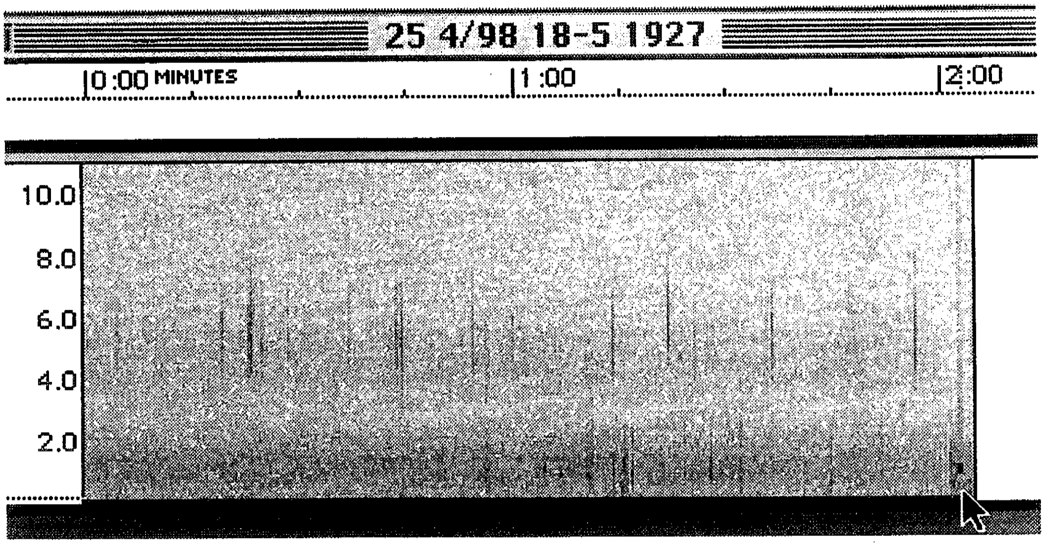


Team E5. Renato Romero, Cumiana, ITALY. Strong manmade signal below 4 kilohertz.

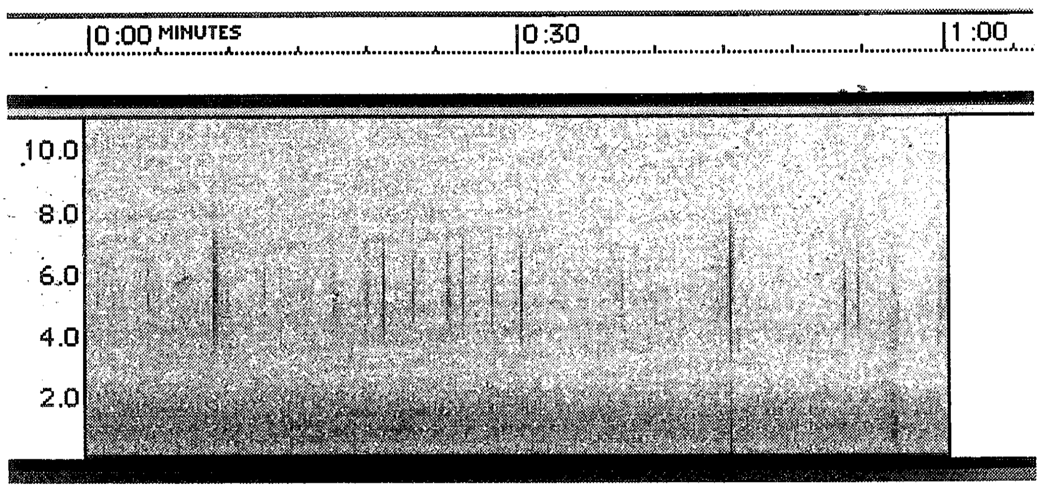


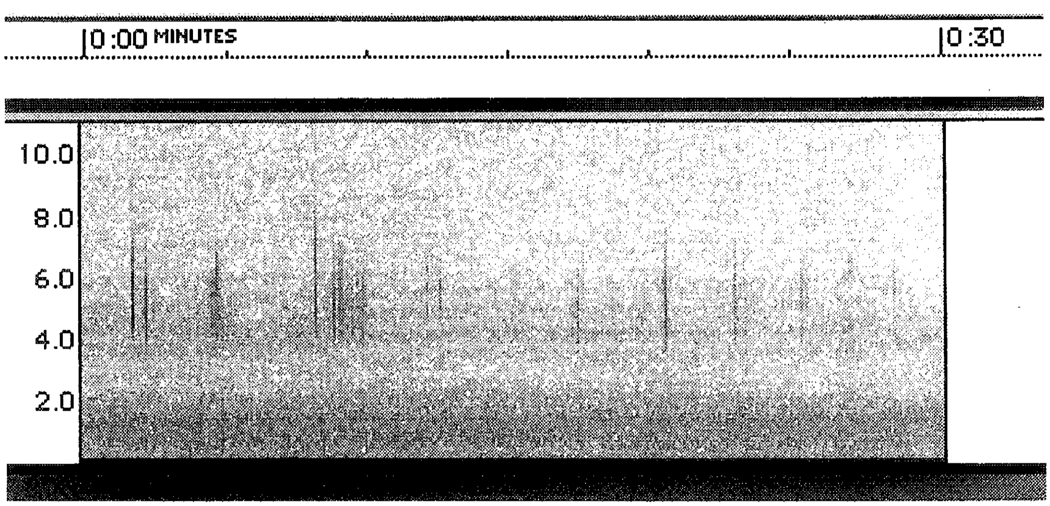


18-5

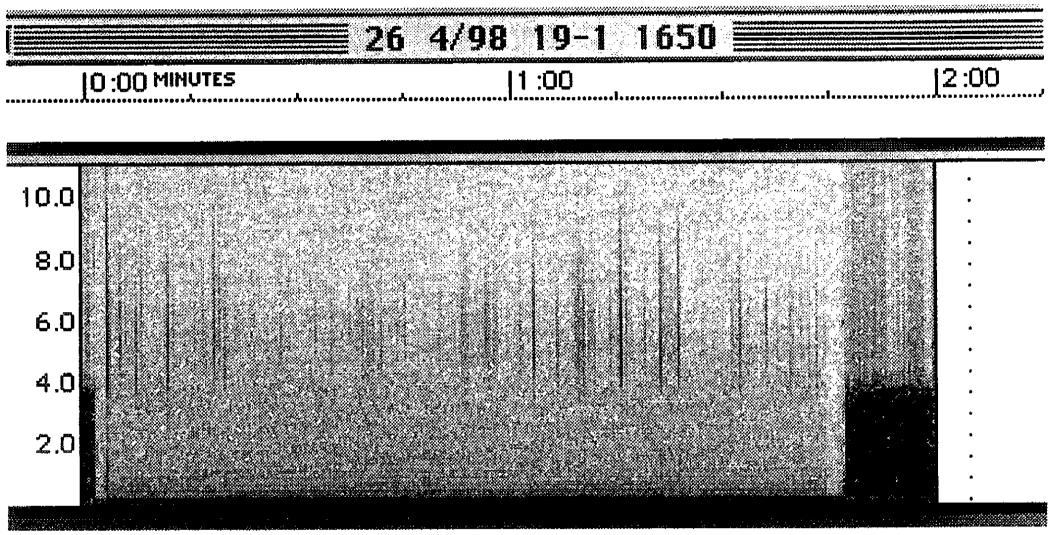


Team 25 Norm Anderson, Cedar Falls, Iowa. Quiet conditions, but good sferics on the tape. The arrow points to the 1929 WWV tone (the original T-time).

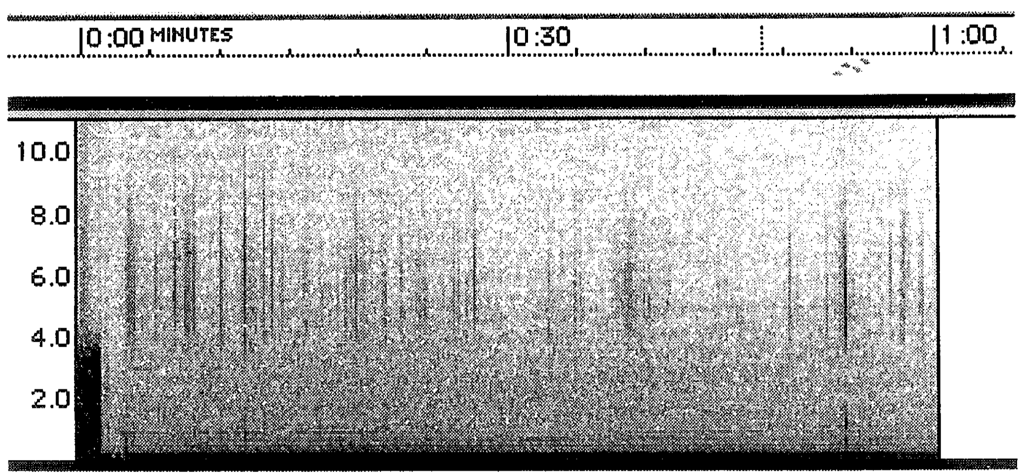


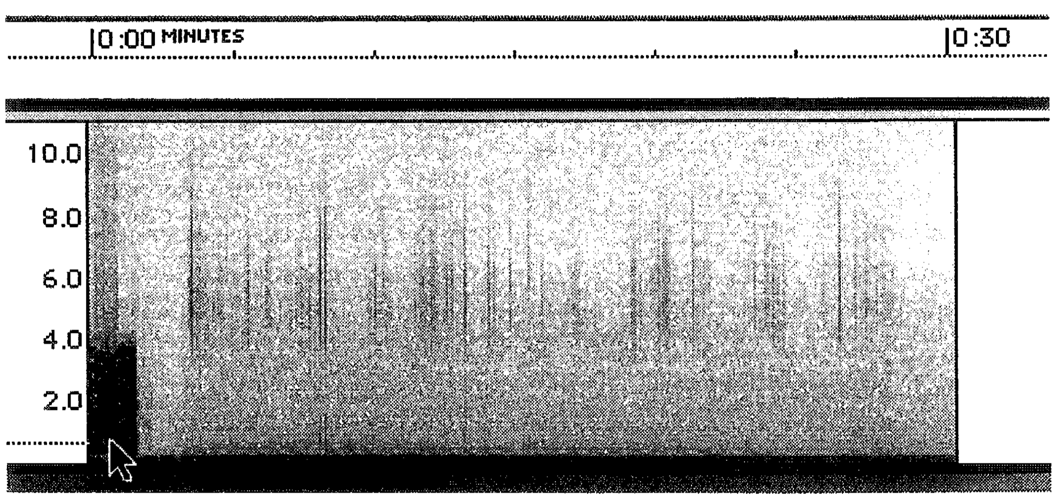


19-1

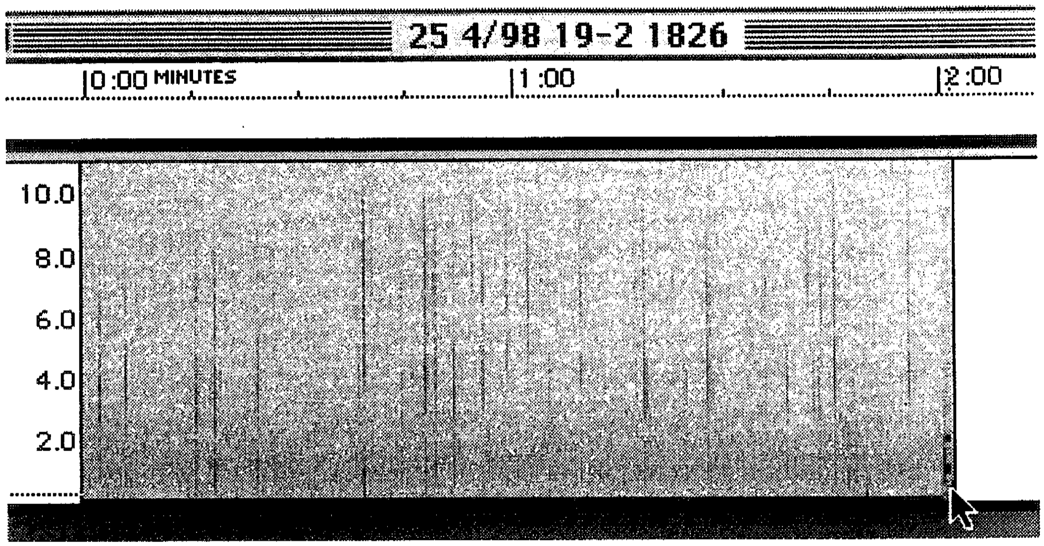


Team 26 Brian Page, Lawrenceville, Georgia. File begins and ends with WWV time marks. Good sferics, but low density indicates quiet conditions.

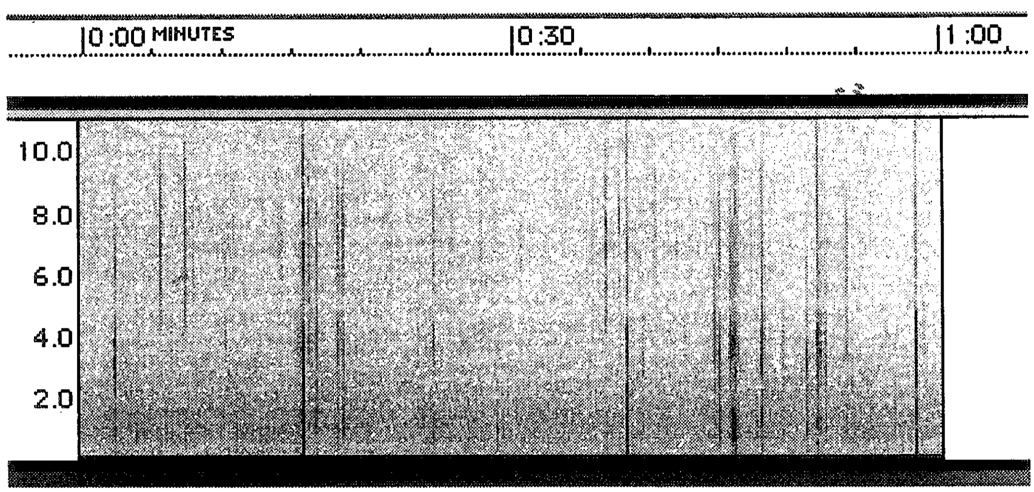


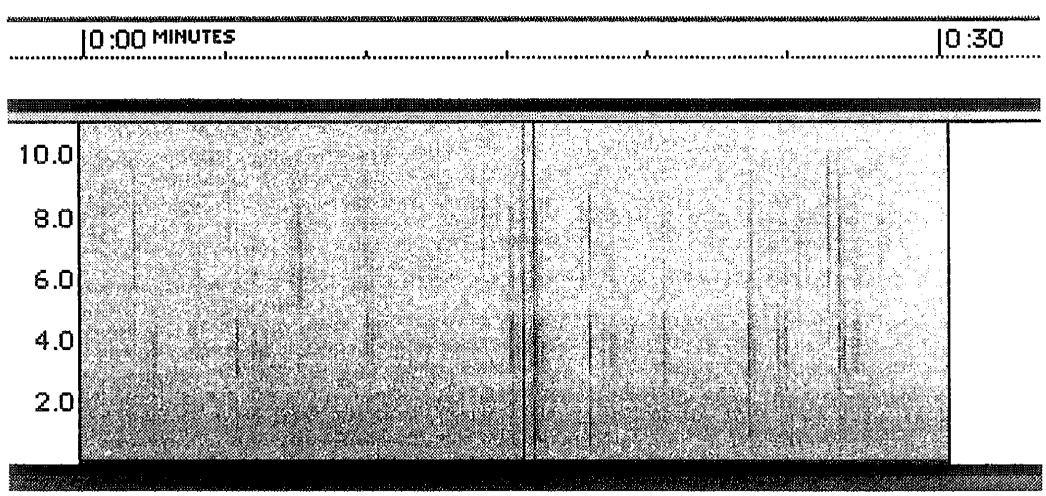


19-2

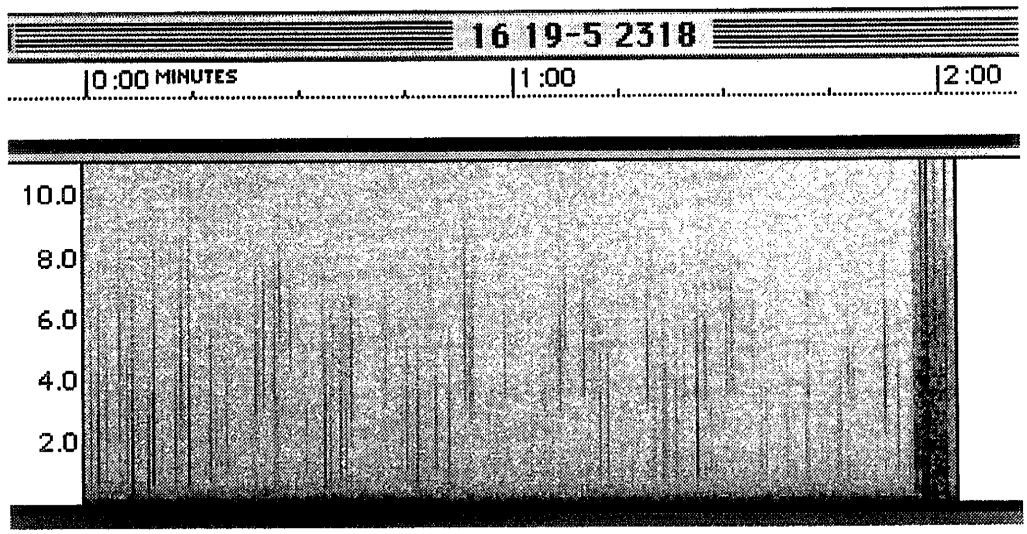


Team 25 Norm Anderson, Cedar Falls, Iowa. Quiet conditions, good signal. Arrow points to WWV time tone at 1828 UT (the original T-time).





19-5



Team 16 Leonard Marraccini, Finleyville, Pennsylvania. Quiet conditions continue on the 19th. The file ends with the 2329 WWV time tone.