The INSPIRE Journal

Volume 14 December 2005

INSPIRE Mourns the Passing of Bill Taylor

William W. L. Taylor, co-founder of The INSPIRE Project and leader in space science education died of a heart attack July 16 at his home in Washington, DC. He was 62.

Dr. Taylor was President of INSPIRE, one of the pioneering successes in NASA Education and Public Outreach. INSPIRE (Interactive NASA Space Physics Ionosphere Radio Experiments) engages students and the public in observing and recording natural and manmade very low frequency (VLF) radio waves.

Bill received his BS in physics from the University of Redlands in California in 1965 and an MS in 1967 and PhD in 1973, both in physics, from the University of Iowa. His research focused on wave-particle interactions in space plasmas.

From 1975 tp 1978, Bill worked at NASA headquarters in Washington DC as program scientist for Spacelab 1. In 1978, he moved to Redondo Beach, CA, to work for TRW as department manager for space sciences. He returned to NASA headquarters in 1990 as chief scientist for Space Station Freedom. In 1996, Bill accepted a position with Raytheon as project manager for the Goddard Space Science Data Operations Office contract. He later moved to the QSS Group Inc. in the same position.

In 1992, students from nearly 1000 schools set up a network of ground stations across the country to record data from an experiment on the ATLAS-1 space shuttle mission. “It’s a great science fair,” Bill said at the time. “I don’t think anything like this has ever been done. The students are helping us do research in space physics to an extent not possible without them.”

This issue of *The INSPIRE Journal* is dedicated with admiration to the memory of Bill Taylor. The INSPIRE Project, Inc., will continue as his legacy.

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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).
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See the order form for subscription information.

Contributions to the *Journal* may be sent to the editor:

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The INSPIRE Journal On-line

This issue of The INSPIRE Journal is the first that will appear on-line on the INSPIRE web site:

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

An important feature of the on-line version of the Field Report article will be the inclusion of sound files for each data session and for any additional analysis that is done. All photos will also appear in color on-line. In the future it is hoped that the on-line version will be available in December of each year when the printed version is mailed. This year it will take some time to get the bugs ironed out, so the issue will appear on-line as soon as possible. Check the web site for new links to the on-line *Journal*. If you would like an email message when the on-line *Journal* is ready, send me a message at: pine@mail630.gsfc.nasa.gov

Observation Information Provided in the *Journal*

Schedules and log forms for observing are provided as the "Observer Packet" starting on Page 43.

Check Your *INSPIRE Journal* Subscription

Even though The INSPIRE Journal has changed its publishing schedule from two times per year to once per year, the number of issues on your subscription has not changed. The number of remaining issues on your subscription is shown on the right of the name line on your address label. Those whose subscriptions were scheduled to end with the November 2005 issue have one additional issue remaining – the December 2006 issue. Additional years of subscription have been credited at the rate of two issues per year of subscription. Please check your address label to make sure this has been done correctly for you. Contact the editor with any questions.

Write for *The INSPIRE Journal*

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

What about topics? Anything that interests you will probably interest most INSPIRE participants. As long as the topic is related to natural radio or the equipment used, it will get printed. The deadline for submissions is December 1. Don't worry about the deadlines though. If you miss a deadline, you will just be very early for the next edition! Articles will be placed on the web site as soon as they are prepared. The next issue of the *Journal* will gradually appear on the web site during the year.

We at INSPIRE are looking forward to hearing from you!

Contributions in Bill Taylor's Memory

INSPIRE is accepting tax-deductible contributions in memory of Bill Taylor. The memorial fund will be used to support student involvement in INSPIRE. Details will be reported in the *Journal*. Please make checks payable to "The INSPIRE Project, Inc." and mail to the editor at the address on the Order Form (Page 47).

My Thoughts About William W.L. Taylor and INSPIRE

Kathleen Franzen, Washington, DC
President, The INSPIRE Project, Inc.

Perhaps the best place to start is to let all of you know who I am. I am Bill Taylor's wife and I have always called him William. One of our very first dates was William introducing me to the magic of an aurora. And after that there was no looking back. William wanted me to know all about the atmosphere and beyond. He wanted to show me what he so respected in his space science world and truly found fascinating and merited exploration.

None of us reading this INSPIRE Journal wants to be reading anything from me because it signals a tragic loss and a major change in the organization. Our tall smiling cheerful big kid who had such a gift of curiosity is closer to his whistlers, chorus, hiss, tweeks and sferics. William is now in our memories like a very bright crackling bolt of lightning.

I want all of you to know that the last day William came home he was enthusiastic, very happy and looking forward to the weekend. There was nothing to indicate that something was wrong with him or that his death was so imminent. That evening he even treated himself to one of his favorite food things, a root beer float!

All of you are components of his respect and drive for making education and public outreach in science a life mission for him both professionally and personally. William's work achieving these goals must continue and this will become his much-deserved legacy.

When Bill Pine, co-founder of INSPIRE, asked me if I would consider becoming the President of INSPIRE I did not hesitate. When the INSPIRE Board gave me their vote of confidence to carry out William's role as president of INSPIRE I was indeed humbled and also gratified. I cannot take William's place nor would I presume to do so, especially in the area of Space Science. However, I can utilize my years in public relations, advertising and customer service to ensure our continuing participation in the DC Space Grant Consortium, maintaining our current corporate partners and actively identifying other science and partner opportunities.

To help me in the identification of other INSPIRE projects I am creating a Science Advisory Council. This Council will have participants from junior high, high school and college/university levels. I anticipate some respective teacher participation to assist the Council's success.

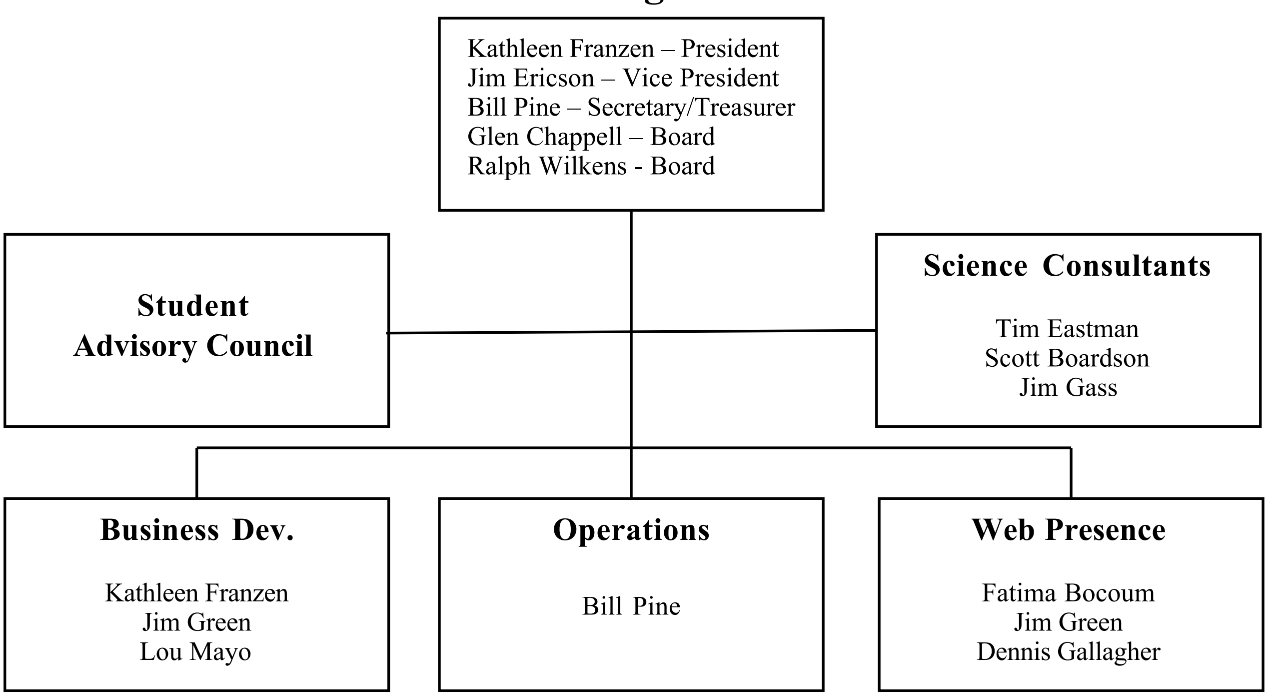
Our Science Advisory Council will have two responsibilities. The most important will be that our members, whose strong academic interests will be in science, physics and math, discuss their creative vision of earth and the atmosphere leading them to develop experiments that would be appropriate to the mission of INSPIRE. The second responsibility is for the members of the Council to learn corporate governance and teamwork involving several generations. This will be a solid experience for their future contribution to the workforce whether it is collegiate, corporate or entrepreneurial.

I am well aware that most people don't embrace change. Unfortunately some of our experience over that past few months cannot be changed. We can only re-commit to making INSPIRE William's legacy. We are fortunate to have in this effort the continuing partnerships of our members, colleagues, students and friends

Many thanks for all your work and many contributions. Your acknowledgements of support since William's death have been very appreciated. If you have any questions, please do not hesitate to send me an email at womanfriday@dcaccess.net.

Bill Pine and William spent a great deal of time around our dining room table in Redondo Beach in the first years of INSPIRE as it took shape. I will always feel privileged that I was included and that we all were able to see its success and contribution to education and public outreach. As the INSPIRE mission states, "Stimulating students to learn and understand science and technology is key to them fulfilling their potential in the best interests or our society." If we remind ourselves of this our work ahead will have clarity and indeed be inspired.

INSPIRE Organization



Remembering Bill Taylor

James L. Green, GSFC, Greenbelt, MD
"Celebrating William Event"
October 1, 2005

I first met Bill Taylor at the University of Iowa in 1975. I was getting my PhD under Stan Shawhan. Bill, who had graduated in 1973, was a Research Associate at the University of Minnesota. He was working on a paper with Stan who had been his advisor. He found me in the computer room and we chatted. He wanted to use a ray-tracing program that Stan and I had been working on and I was delighted to get him on the computers there. We hit if off right away. Was it because we had the same advisor, or that we were both deeply interested in magnetospheric plasma waves, but in thinking back it was probably because he had one of the most welcoming, engaging smiles that you can imagine. I remember his smile as he walked into the computer room. It is the type of smile that says, "I know something that you don't." You naturally want to get to know him right way because you want to know that secret. I finally figured it out. It is the secret of enjoying life in the moment, every moment, and he did.

As time went on we kept track of each other's career. I met Kathleen for the first time at a Radio Science Conference held in Florence, Italy, in 1984. A year later I was looking for a job and Bill gave me a job offer to work with him at then TRW in Redondo Beach. I vividly remember my conversation with Bill when I told him I had accepted the position to head the National Space Science Data Center (NSSDC) at Goddard Space Flight Center. He was delighted and tremendously supportive. He said that it was better for everyone if I went to the NSSDC than to TRW.

In 1988 Bill Taylor and Bill Pine started INSPIRE (Interactive NASA Space Physics Ionosphere Radio Experiments), a unique and important way for high school students to learn and get excited about science. In 1990 Bill came to NASA Headquarters as Chief Scientist for Space Station Freedom. Bill decided to talk to the NASA Public Affairs Office and see what they could do to help him with INSPIRE. At that time, the NASA Public Affairs Office was the only public outreach group in NASA. Bill briefed them on INSPIRE but was not prepared for the reception he got. His request for help was not only turned down but he was flatly told that he should not be doing this at all since he was not a professional educator and he knew nothing about how to deal with the public: that should be left to them. Since INSPIRE was not invented by PAO they were just not interested. But that didn't stop Bill. From this experience Bill learned what the educational standards were and found how INSPIRE would be able to fit in.

With Bill in the area we started working together on INSPIRE. The climate at NASA was changing; Education and Public Outreach was becoming important since NASA was trying to find relevance with the public. Bill and I were able to obtain a very small, but important set of funding for INSPIRE starting in 1994. This continued through several proposal cycles.

In addition to working with Bill on INSPIRE we formed a team and began to find ways to promote a unique science experiment, something that hadn't been done before, radio sounding in the magnetosphere. We performed simulations, gave presentations, and educated the science community on this new technique until finally the Radio Plasma Imager team (or RPI) was on the winning Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) satellite selected in 1995.

The RPI instrument went through some severe community criticisms, casting a major doubt as to whether this instrument could do something never before done. Throughout this period of intense discussions and community criticisms Bill was like a rock of strength helping us at every step. A Non-Advocate Review requested by NASA Headquarters was set up to determine if RPI would be on IMAGE or not. At the end of the review it was declared that RPI was a pioneering instrument that should be flown. RPI has been a tremendous success. It has produced over 65 science papers and that, on the average, is one paper per month since IMAGE was launched in March 2000. In many of these papers you will find major contributions from Bill Taylor. He was a careful, insightful, and outstanding magnetospheric scientist.

Another major contribution from Bill on the IMAGE mission was that he invented POETRY. POETRY stands for Public Outreach, Education, Teaching, and Reaching Youth. IMAGE was the first NASA mission with a fully funded Education and Public Outreach program and it was headed by Bill. The goal of POETRY is to explain how solar storms affect the Earth and why we have aurora. POETRY has been the model for every mission EPO program since.

At every science meeting Bill and I went to, during the breaks, Bill would dash outside and walk around with hand stretched out above his head with what looks like an old style '60s portable radio with a long expanding antenna jetting straight out (the iPOD in that era). Anyone who didn't know Bill would think he was trying to find the best reception for his AM radio, but instead of tuning into a station, he was tuning into the magnetosphere with a modified INSPIRE kit. He would always use two earpiece earphones so that if he heard some neat sferics or a whistler or two he would motion me over and I would listen. His eyes would light up and we both would smile then estimate how far these signals had come from. "That was a good one," he would say as we would listen for the return hop.

I must tell you that Bill and I with others just published a paper in the Journal of Geophysical Research and it showed that the lightning whistlers are probably responsible for shaping the Van Allen Radiation Belts into two major bands around the Earth. This answers one of the oldest questions in space physics: Why are there two electron radiation belts? The answer is that if it wasn't for lightning, there would only be one. Lightning carves one radiation belt into two halves and it is done by the whistlers that Bill constantly listened to and brought to students all over the world with INSPIRE.

In the mid-'90's, Bill became the project manager for a major contract at GSFC and this placed him in daily contact with me all the way up until his untimely death. As a contract manager, he was the best. Every morning Bill would stop by my office when he came in. We would discuss the upcoming day's activities and especially the challenges. In particular Bill would identify the top things that he would do for the organization. Some of Bill's top qualities were his ability to listen and his ability to get things done. Bill was an outstanding leader and manager.

Bill was like a brother to me. I learned a lot from Bill ranging from the physics of VLF emissions to how to manage major NASA projects and contracts. It is important to know that what Bill did mattered. It mattered here for many of us in NASA. What he did also matters for students in schools all across the country that use the INSPIRE receivers and are allowed to see our world in a different way. It matters in ways we may never know. Putting together INSPIRE kits inspired my son. Electrical engineering at the University of Maryland is his favorite topic. You can bet that is happening to kids all across the country.

To me, Bill was just irreplaceable and I will miss him every day in some way. Bill Taylor did live life to the fullest. He excelled at many things. This is a quality that few of us have. We each saw a different side of Bill. He was a true friend, colleague, husband, scientist, mentor, educator, innovator, leader, manager, businessman, and a pretty great human being all in one. It was a privilege to know him.

My Friend, Bill Taylor

Bill Pine, Upland, CA
Secretary/Treasurer and Co-Founder
The INSPIRE Project, Inc.

Note: The following is an approximate transcript of a talk given in Washington, DC, on October 1, 2005, at the Columbus Club in Union Station. The occasion was the remembrance gathering celebrating the life of Bill Taylor and the impact he had on so many.

I met Bill Taylor 44 years ago. It was a September weekend in 1961 as the new freshman class at the University of Redlands moved into their dorms. That morning I met my roommate, John Herrell, who is here tonight with his wife, Connie. That afternoon, John and I met Bill and his roommate, Toby Scott, who could not be here tonight. We sat around and talked for a while and then went to dinner together. The four of us went to dinner together almost every evening for the next four years.

We formed a special friendship that endures to the present. I hope you have formed friendships like this because then you will know how lucky we are.

Bill and I were half of the physics majors in our class at Redlands. We were lab partners in all of our physics labs. Lab partners have to work together to determine what equipment to use and what measurements to make to address the topic of each lab. This involves a lot of brainstorming and sometimes some disagreement about the exact procedure to use. Bill and I developed a procedure for resolving any issues that arose: we argued! Some weeks there was a lot of argument! A benefit of this process became evident later in our careers when we found ourselves once again working together – this time on education and public outreach projects. We found that we had developed the ability to divide responsibilities and trust the other to do the job the right way.

In our undergraduate years I noticed two defining characteristics that Bill had. One was his seemingly unlimited ability to learn. Bill knew more about more topics than anyone I know. The other characteristic was his willingness to work. There was no limit to the time and effort Bill would put into a project that was important to him.

I have done some thinking about what I could tell you about Bill Taylor that you might not know. Since most of you know him from graduate school in Iowa or from his career as a scientist, educator and manager, I thought back to our time at Redlands. You might not know that Bill was an athlete.

In our sophomore year Bill went out for football. That may not surprise you because Bill was a big man, built like the offensive tackle he was. What was surprising was that this was Bill's first experience with organized football. The first football team Bill was on was at the intercollegiate level. Bill was not a starter, but he played on special teams and few regular series. From the sidelines I could hear his teammates encourage him when he got in. They knew his level of experience at the start of the season and they were proud of his accomplishments.

Later that year, Bill was recruited by the soccer team as a goalie. Bill had no experience playing soccer at all. In 1963, soccer was not the popular sport in the US that it is today. Bill may have played goalie in the first game he ever saw. I know it was the first organized soccer game I ever saw. Bill's ability to learn and willingness to work turned him into an excellent goalie and he played on the team for two seasons.

Another example of Bill the athlete was when he became a surfer. I had been surfing for a few years when I got to college. Some friends and I surfed most Saturdays through the year. Bill decided he wanted to give it a try. Bill was from Oregon, so you can be sure he had not done any surfing there. Now winter surfing in California can be trying. The water is cold and the weather is often dreary, but Bill persevered. He had a 12 foot long surfboard (long even for the "longboard" days) that was painted orange. To see Bill cutting across a wave was a sight. He was probably the biggest surfer on the beach with the longest board … and the worst tan! For Bill, a tan just meant more freckles.

In 1988, over 20 years after we left Redlands, Bill to his career as a PhD physicist for NASA and TRW and me for my career as a high school physics teacher, we again found a chance to work together. We had gathered in San Francisco for the wedding of John and Connie's daughter. Bill and Kathleen and my wife, Beth, and I had a great time around town before the wedding. At the reception after the wedding, Bill said he had an idea he wanted to tell me about. He drew a block diagram on the wedding program showing a loop antenna, a preamplifier, an amplifier and headphones and he told me about natural radio. I had followed some of his research efforts when he was at Iowa, but I will admit I really did not understand much about wave behaviors in space plasmas, but it sounded interesting. Bill's idea was to make these radio receivers available to students – specifically high school students – and invite them to make observations of sferics, tweeks, whistlers and the other sounds of natural radio.

He had a simple question for me: Did I think high school teachers and students would be interested in participating? My answer was that I did not know if others would be interested, but I was. This conversation led to what became The INSPIRE Project.

There was much to be done and, once again, we were working together. A refreshing difference was that his time there were no arguments! The INSPIRE Project is organized around two features: all work is done by volunteers to keep overhead down and kits are sold at cost to make them affordable to more students.

When it came time to choose a name for our project, Bill and Kathleen had moved back to Washington DC, so our meetings were on the phone. We decided that we needed an acronym (after all, this is NASA…), so we agreed to work separately to come up with two good possibilities and meet again on the phone in a week. During that week I discovered that I was terrible at coining acronyms. What I found out on the next phone call was that Bill was really good at it. When we talked a week later, I had come up with two pitiful candidates for names and Bill said he had “one good one and one so-so one”. I suggested that he go first with his best name. He suggested INSPIRE; Interactive NASA Space Physics Ionosphere Radio Experiments. I said that sounded great. I never heard Bill’s “so-so” name and he certainly never heard my efforts!

Now, with Bill gone, the question arises: How can INSPIRE go on? In talking to Kathleen on that fateful Saturday morning, she expressed her desire that INSPIRE continue as Bill’s legacy. I said that I would do what I could to make that happen, but I knew that finding a replacement for Bill and all he did for INSPIRE would be nearly impossible. In talking with people at Goddard at the end of the summer it became clear that replacing Bill would require many people – but there were people willing to help. There was plenty of expertise available in the natural radio area; I would go on with my work in the day-to-day operation of the corporation, but we needed someone to act as President and represent INSPIRE within the NASA organization and on the DC Space Grant Consortium. After some consideration, a person came to mind who would be a perfect fit to lead the organization as it continues as Bill’s legacy. I am very pleased to announce tonight that the new president of INSPIRE is Kathleen Franzen, Bill’s wife.

I look forward to working with Kathleen and to the future of INSPIRE.

Finally, I would like to tell you what INSPIRE has meant to me. Last June I retired after 35 years of teaching, the last 34 at Chaffey High School in Ontario, California. INSPIRE came along about halfway through my career. I had often wondered how the latter part of my career would feel. Would I burn out and stop doing the kind of job that teaching deserves? I had seen this happen in some colleagues.

INSPIRE revitalized my career just when it might have gotten dull. INSPIRE changed the way I interacted with my students. Field trips to the mountains to record natural radio became treasured experiences that allowed me to know my students better and in a different way than is possible in the classroom. I had students who took physics so they could go on the mountain trips. I had students that performed better in the classroom because of their involvement in INSPIRE. My students packed kits for shipping and helped with all aspects of the operations. I looked forward to my last year, not because I was glad my teaching career was coming to an end, but because I was eager to see what would come next. My replacement as physics teacher at Chaffey is a former student who has taught freshman science for 12 years waiting for me to get out of the way. He will do a terrific job and Chaffey will go on just fine without me. And INSPIRE will go on as Bill Taylor’s legacy.

I owe all of this to Bill Taylor and I thank him.

Thank you for listening.

The Venture Crew Experiment on the 2005 Deep Space Test Bed High Altitude Balloon Flight

Jeremy Myers, Huntsville, AL
Dennis Gallagher, Huntsville, AL
MSFC Venture Crew

Introduction

Man aspires to travel to the farthest regions of the universe. Yet we are confined to the necessities of the environment in which we dwell here on planet earth. NASA has recognized these limitations and hopes to have an ever increasing hold on what systems must be in place to support life outside the confines of planet earth.

One of the dangers of space is the radiation levels. For this reason NASA has worked the past few years to create a test bed on which to test different sensor and material reactions to radiation. The Deep Space Test Bed (DSTP) is designed to fly by balloon to altitudes of 120,000 feet in the polar regions, areas with a large influx of radiation here on earth.

Weighing nearly 5000 pounds it is not a small structure, but contains a great amount of electronics and robust design to sustain launch and landing loads. The scientific balloon used to lift the test bed, when at full inflation, has a diameter of two football fields.

Background

In June of 2005 the NASA vehicle Deep Space Test Bed performed a test mission flying out of Fort Sumner, New Mexico. Since the purpose of this flight was to test the operability of the flight systems, NASA had no plans for payloads. However, any high altitude flight is a good opportunity for scientific data, therefore, a call for proposals was sent to students and educators on possible payloads. A portion of the Marshall Space Flight Center Venture Crew, (Sam Bryan, Debbie Chatterjee, Amit Chatterjee, and Carlos Perez-Silva, along with their NASA Mentors, Jeremy Myers and Tia Ferguson, DSTB Designers, and Dennis Gallagher, Space Scientist) assembled a plan to fly an INSPIRE VLF receiver (http://image.gsfc.nasa.gov/poetry/inspire/) and downward pointed video camera with real-time transmission of the video/audio signal to the ground. This would allow a comparison of VLF signals at altitude to those found on the ground. The Venture Crew made up of high school seniors is shown in Figure 1, where they are learning how to operate their VLF equipment in the field. That's literal in this case as they were practicing in the soccer field at Grissom High School in Huntsville, AL.

Figure 1:

The MSFC Venture Crew is shown practicing use of their VLF equipment at Grissom High School in Huntsville, AL. From the left are Amit Chatterjee, Sam Bryan, Debbie Chatterjee,, and Carlos Perez-Silva.

Along with the flight unit which flew at an altitude of about 38,000 meters, a third of the way to the ionosphere, it was planned for the students to build an INSPIRE VLF-3 receiver kit and operate it near their home in Huntsville, Alabama. The planned mission was announced to the Yahoo VLF discussion group (http://groups.yahoo.com/group/VLF_Group/) and two long-time VLF enthusiasts volunteered to perform separate recordings of their own. David Jones operated his receiver and recorder near Phoenix City, Alabama, (at 32.5n 85w) and Michael Mideke operated his equipment in Rosedale, New Mexico. The goal was for the students to gain experience building the receiver, participating in a flight experiment, and analyzing data. The data analysis involved comparing VLF data at altitude to that at various ground locations.

Setup and Flight

In building the experiment, a VLF-3 receiver kit (donated by the INSPIRE Project), a fifteen-foot single wire antenna, and a short ground stay were used. Before looking for a testing location, the crew learned how to operate the radio with the universal time code station, how to set up the antennae, and use a recording device (a Radio Shack cassette audio recorder). In order for the receiver to function correctly and pick up useful signal without much 60Hz interference, the crew found a site one mile from any power line. To accomplish locating this testing area, the crew utilized Google Earth software which provides 1 meter resolution for urban areas. Using these satellite photos, locating appropriate test locations which are a proper distant from power lines and their 60Hz hum was quite easy. At this resolution, buildings, roads, and high tension power lines are easily located. Therefore using a 2 mile diameter circle (Figure 2), a location was found on the banks of the Tennessee River in farm land close to Huntsville urban center (at 34.515n 86.5349w).

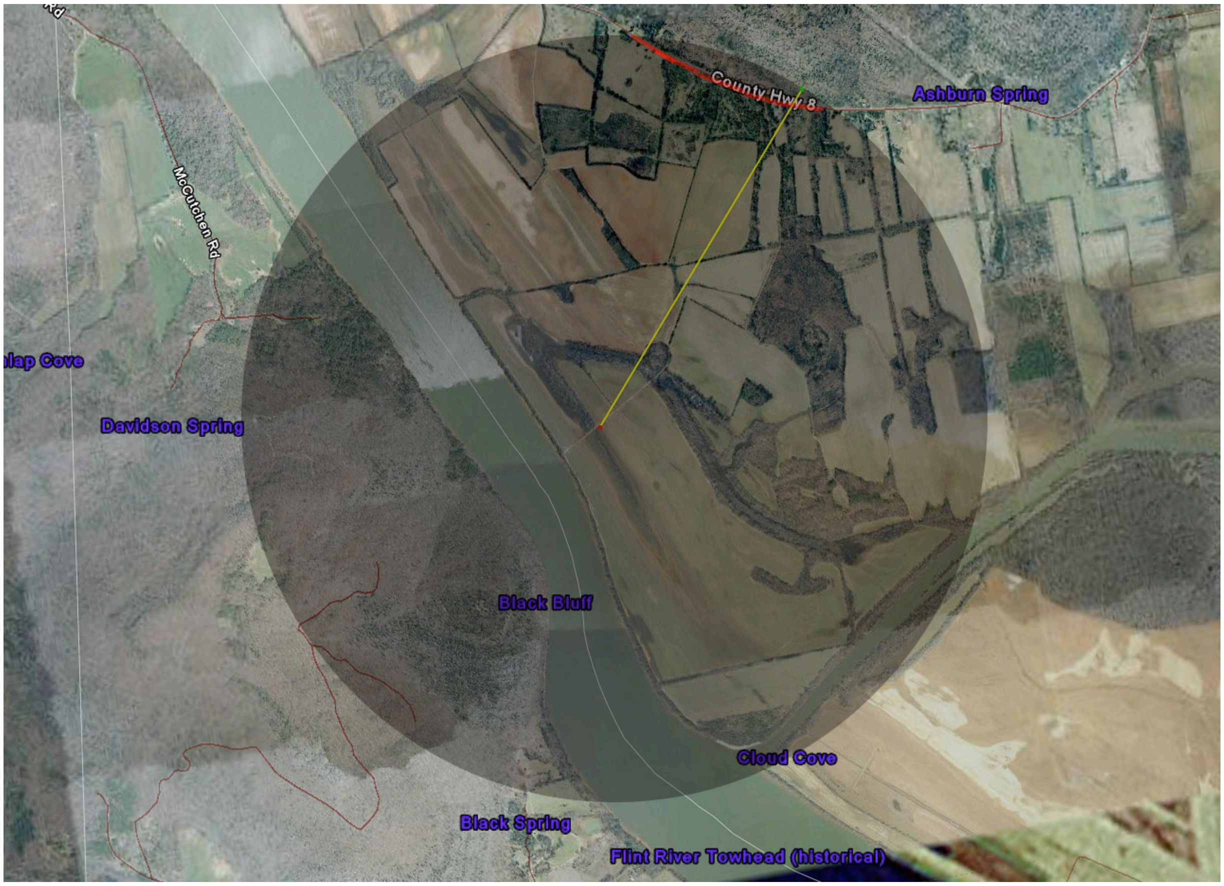


Figure 2: This shows Google Earth Software and its use in finding an appropriate recording location in an urban area.

Scientific Ballooning Flights require pristine conditions to ensure a safe flight. Therefore, flights were attempted for over a month before appropriate flight conditions appeared. Because of the nature of these flights and its dependence on hourly weather data, those recording at the three ground locations had to be ready at any time to head to the field to record their data. The DSTB flew for ten hours on June 18, 2005. During this flight it traveled nearly 450 km across the state of New Mexico (Figure 3).

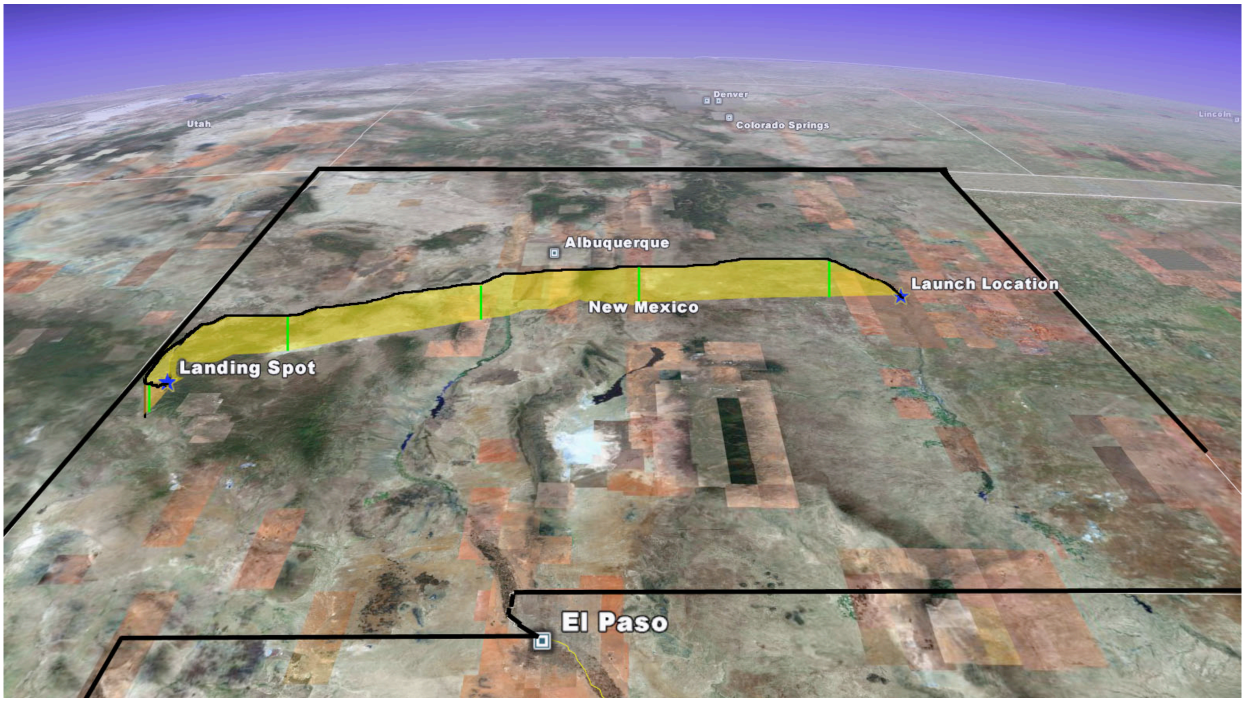


Figure 3: This shows the trajectory of the VLF receiver at altitude.
DSTB traveled across most the state of New Mexico.
The short-vertical green lines represent the location of the gondola
every 2 hours, indicating the changing speed during various portions of the flight.

Data transmission was achieved through the entire flight. The onboard camera and VLF receiver sent a live signal to the ground through two analog radio frequency transmitters provided by the National Scientific Balloon Facility (NTSB). The Venture experiment package also included a GPS receiver and video overlay board that was used to annotate corrected universal time, altitude, direction of travel and speed on the video signal. The output of the VLF receiver was carried on a separate transmitter to the NTSB Tower (through most of the mission) and to a secondary control ground station (late in the mission) where the two were combined into standard NTSC video/audio. Because of the nature of video transmission, some frames were lost for various reasons; however the audio transmission was maintained consistently through the entire flight. Since the times for VLF reception were derived from the overlaid time on the video transmission that caused some uncertainty in assigning time to the VLF. An uncertainty up to about a half second is thought to be the result. The error estimate was obtained by closely examining portions of the video, frame-by-frame, assuming the audio signal was uninterrupted.

The DSTB gondola launched on June 18, 2005 at about 9:45AM Mountain Time. As you might imagine, handling such a large payload and balloon takes large equipment. The launch vehicle on the day of flight is shown in Figure 4. Even though the balloon rose to an altitude well above 100,000 feet, it remained easily seen from the ground throughout flight. The Venture INSPIRE VLF receiver was operated with a 15 meter antenna. Large balloon packages are launched from a wheeled vehicle, because it is necessary to position the gondola directly below the balloon (after release of the balloon) to keep the gondola from crashing into the ground after release of the gondola and before the balloon has time to rise in altitude. As a consequence it is not possible to drag the antenna around on the ground while the launch vehicle is essentially "dancing" below the balloon just prior to release. The solution was to wind the antenna onto a reel that was held to one of the long gondola "arms" by a short string passing through a cutter that was driven by a small pyrotechnic device. The pyrotechnic was triggered by a radio signal from the ground while the balloon was still over the Fort Sumner, New Mexico, airport where the package was launched. The Venture video camera captured release of the antenna deployment reel. A frame showing the reel falling away from the gondola is shown in Figure 5. A one minute frequency versus time spectrogram is shown in Figure 6 that covers the release and extension of the antenna below the gondola. Clearly release of the antenna made a big difference in the ability of the VLF receiver to detect natural radio emissions.

Figure 4: The NTSB high altitude balloon launch vehicle is shown holding DSTB just prior to release of the balloon on the morning of June 18, 2005. The Venture Crew experiment package is the white box that can be seen on the right side of the gondola near the top.

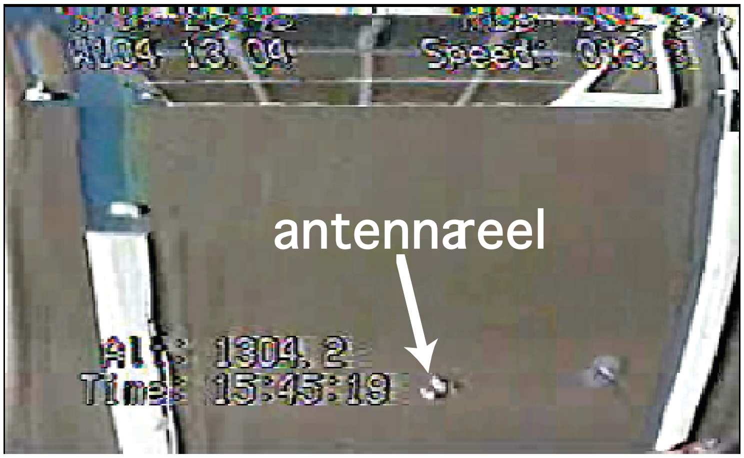


Figure 5: The Venture VLF antenna deployer reel is shown falling away from DSTB in this frame from the Venture flight video. The reel was release by a radio commanded pyrotechnic while still fairly low over the Fort Sumner, NM airport. The altitude shown is in meters and the time is corrected universal time.

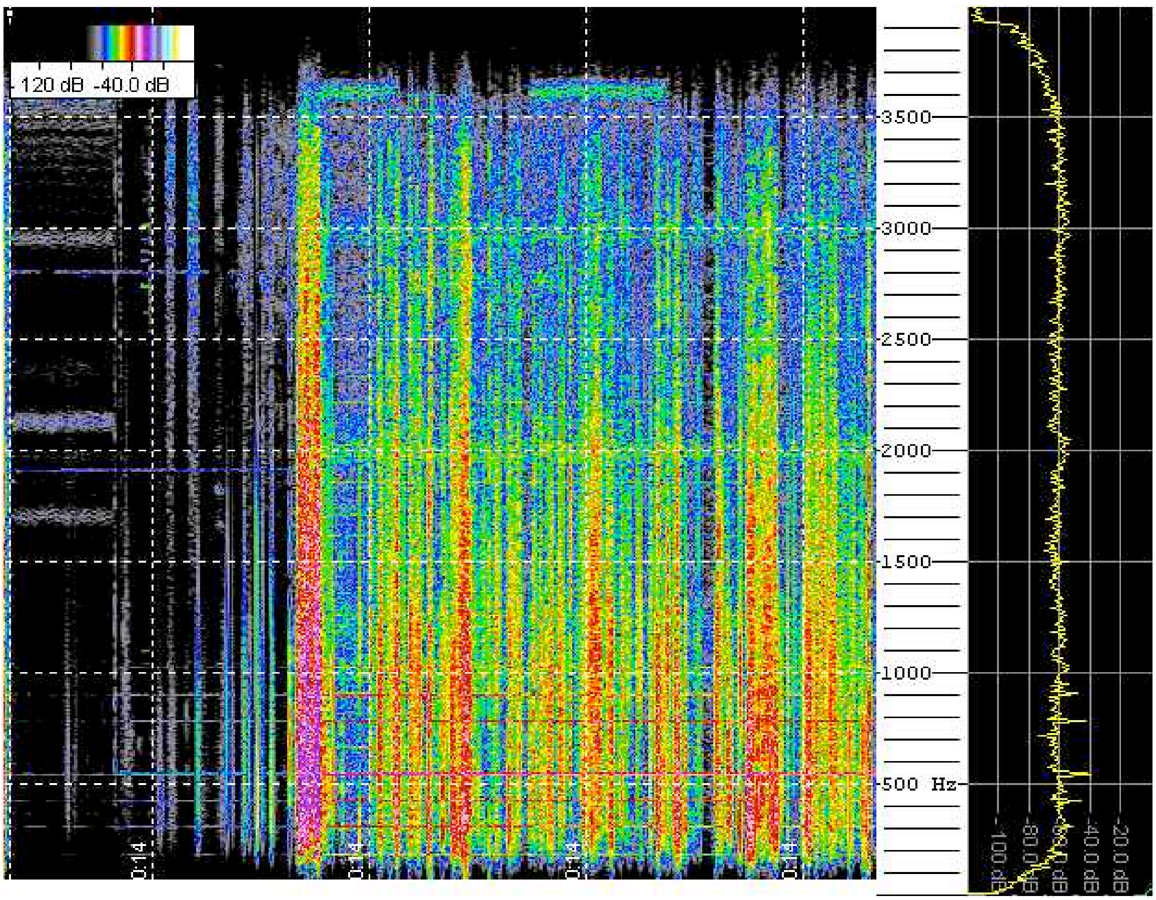


Figure 6: Spectrogram shows about one minute of VLF from DSTB during antenna deployment starting at 15:45UT. This spectrogram was made using Spectrum Laboratory (http://people.freenet.de/dl4yhf/spectra1.html).

In addition to recording VLF signals, Mideke also recorded video of the DSTB balloon during flight after the package reached its operating altitude. A frame from that video is shown in Figure 7.

Figure 7: This is a frame extracted from the video of DSTB during flight taken by Michael Mideke at Rosedale, NM. This frame was taken at about 22:26UT. Mideke recorded the video on a Sony TRV510 recorder.

Results

Whistlers were found in the Venture VLF flight recording at seven different times from 15:49:58 UT to 17:28:44 UT. All of these times were during the assent phase of the flight. Mideke's recordings are available to compare to all but the first two whistlers recorded on DSTB early in the flight. Whistlers were found in Mideke's recordings at nearly the same times as all of the remaining five times. The first and last of these are shown in Figures 8 and 9. Flight and ground recordings from New Mexico are compared in these figures. While it was attempted to extract VLF from exactly the same time intervals from both sources, there remains doubt about the accuracy of doing that from the flight VLF recording as mentioned above.

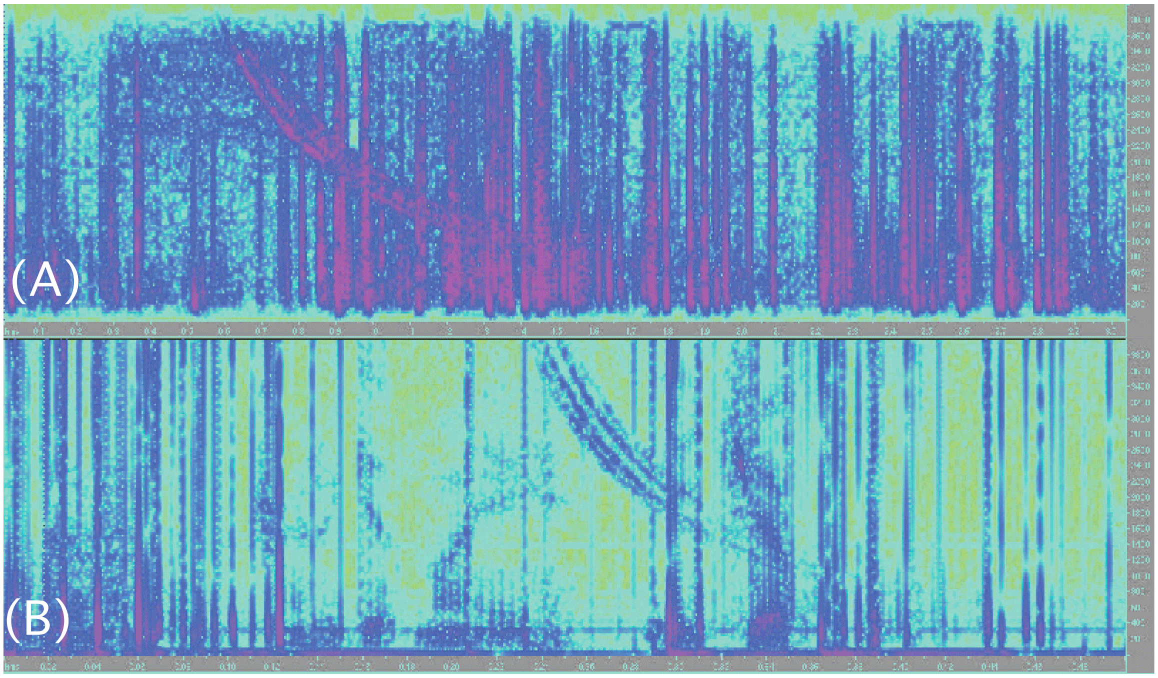


Figure 8: Panel A and B show frequency versus time spectrograms of a whistler observed by the Venture VLF receiver and Mideke's VLF receiver, respectively. Both are 3s displays starting at 16:40:31UT, extracted from longer recordings. The greater Mideke frequency content has been under sampled in order to display both with the same frequency scale. The ~1s difference in the start of the whistler is thought to be an error in identifying time in the Venture VLF, which uses overlaid video GPS information.

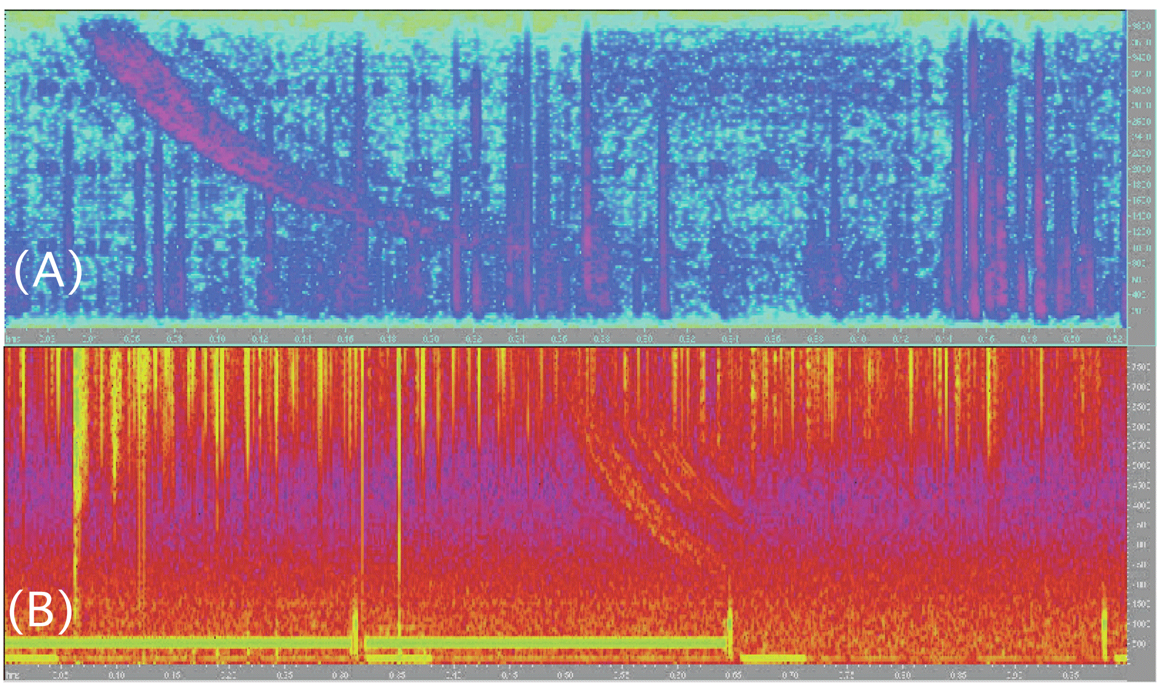


Figure 9: Panel A is from the Venture VLF receiver on DSTB and Panel B is from Mideke's VLF receiver on the ground in New Mexico. These 3s samples both start at 17:28:43 UT. Even given a possible error in the timing of the Venture DSTB recording, these whistlers clearly have different dispersions. The spectra shown in this figure and that in Figure 8 are obtained by screen capture from Cool Edit from Syntrillium Software Corporation.

The Panel A and B whistler signals in Figure 8 are very similar, but with approximately a 1s separation. The whistler signals in Figure 9 are not similar and must be from different whistlers received in flight and on the ground nearby. The first whistler comparison was made when the DSTB was at an altitude of about 18,932 meters, while the second was made at 31,949 meters height. During this time DSTB drifted about 25,000 meters down range. Five whistlers were found at about the same time in both these observations. None were found at exactly the same time and the Venture flight recording always leads the Rosedale recording. In only the first comparison, shown above in Figure 8, does the dispersion appear similar in the pair of compared whistlers. In all other cases, the flight whistler shows more dispersion than the one received on the ground. It is an interesting result that lacks a current explanation. One possibility is that the longer dispersion whistler is an odd multiple of the short dispersion whistler, which would result if one site recorded a one hop and the other a three hop whistler from the same lightning strike. Measurement of the dispersion has not yet been performed.

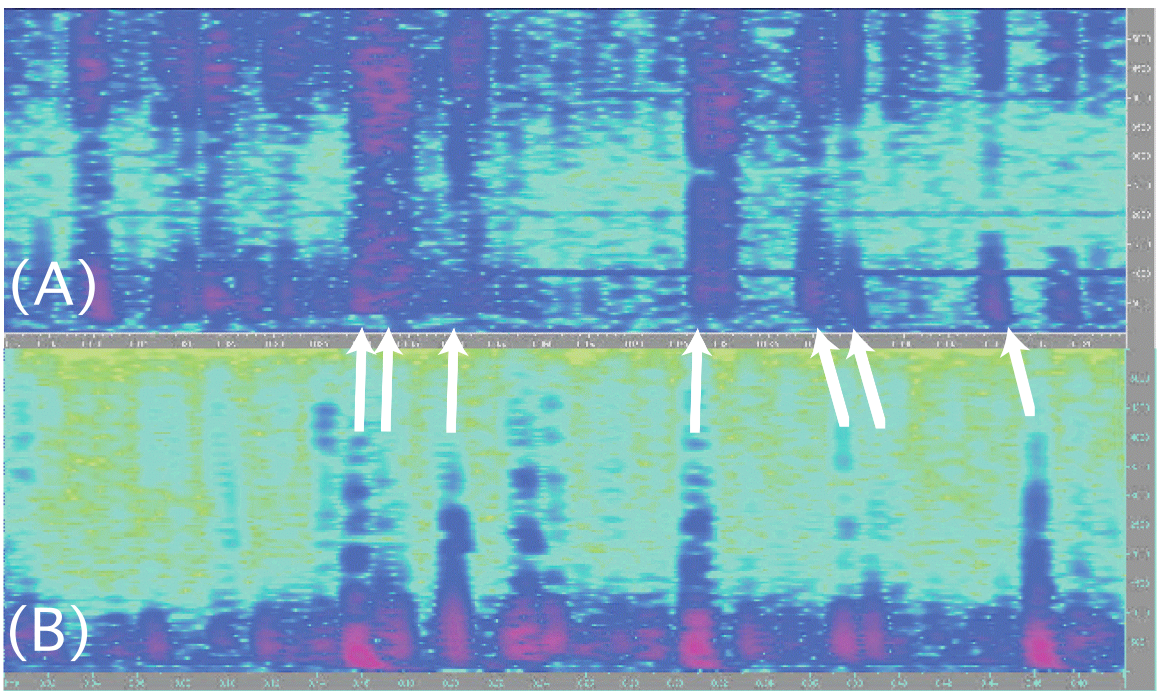


Figure 10: Frequency versus time excerpts are from the Venture ground recording in Huntsville, AL (A) and from the recording by David Jones just north of Phoenix City, AL (B). One half second of VLF is shown in both, starting at 18:30UT. The arrows point to spherics that may correspond between the two recordings.

No whistlers were observed at either of the two Alabama locations where VLF recordings were made on the ground during the flight of the DSTB. Since no whistlers were observed and plenty of spherics were, an attempt has been made to correlate spherics between the two locations. This is shown in Figure 10. The Huntsville recording is shown in Panel A and the Phoenix City recording in B. It wasn't immediately obvious when these spectrograms were first brought together that there was any correspondence. It was only after repeatedly listening to each of the half second clips that a repeated pattern of spherics appeared to be similar between the two. Arrows are drawn in Figure 10 calling out the spherics between the two panels that display this similar temporal pattern. While there are similarities in the general pattern, there are also differences in the details. There are spherics in each recording that are not present in the other.

The spherics suggested to have a common origin are shifted in time. If these spherics are related, the implication is that the shift is due to small differences in the path taken by the radio noise to the two locations. That difference can be accounted for by a difference in the direction of arrival and the distance from the lightning strike responsible for the spheric. While it isn't done here, it is possible in principle to draw arcs across the globe along which a single lightning strike must have occurred in order to account for two related spheric signals where there is a small delay in the time of arrival. Seven spheric pairs are suggested that can be used to draw seven arcs. The spheric pairs that most differ in their time of arrival are the fifth and sixth noted in the Figure. They differ by 0.008s and 0.013s in their arrival times at the two sites. If the same lightning strike caused both spherics, then the closest the lightning could be to Alabama is approximately 2400km and 3900km, respectively, along a line between the two sites. Since these two spherics arrived at the Huntsville location first, this "closest" location would be north of Alabama 6% to 10% of the way around the planet's circumference. Were the lightning along that line, and it need not be of course, then the lightning would have taken place almost to the North Pole. The arc described above starts at this high latitude in the North American continent and extends both east and west at ever increasing distance from the receiving sites. Given the uncertainties in the timing of these signals (time code signals are difficult to impossible to verify in some of the recorded cassettes) and the limited overlap in time between the two recordings, it does not make sense to pursue this analysis any further. The receipt of spheric signals has been used for many years to triangulate the location of lightning strikes, so doing it here would not be new in any event.

Summary

Neither text space nor time permits a full analysis and discussion of all the recorded VLF audio and flight video obtained during the Venture Crew experiment on the DSTB flight in the summer of 2005. The results presented demonstrate that interesting observations of natural low frequency radio emissions can be made at high altitude and can be used to compare to recordings on the ground at varying separations. These results also demonstrate what can be accomplished by high school students given the opportunity to learn about electronics, engineering, and science. While it was especially exciting for all involved to participate in such a large-scale high altitude flight experiment, we hope our readers realize that small payloads can be carried into the stratosphere by weather balloons permitting much the same experience as gained in our Venture Crew experiment on the DSTB. A few universities in the USA and possibly elsewhere in the world are engaged in amateur, instrumented weather balloon flights, some involving VLF receivers. We hope to hear about their VLF experiences in future editions of *The INSPIRE Journal.*

Acknowledgements

This article is dedicated to Bill Taylor, co-founder of the INSPIRE Project and former Chief Scientist of NASA's Space Station Freedom.

The Venture Crew's participation on the 2005 DSTB flight was sponsored by the NASA Marshall Space Flight Center Education Office. Much thanks for this opportunity must be extended to them and their interest in inspiring young students to pursue careers in engineering and science. The Venture students and mentors also wish to thank the DSTB project for allowing their participation in the test flight, to the INSPIRE Project for their support and willingness to publish this article, and to Michael Mideke and David Jones who volunteered for many hours of VLF field recording and many days waiting on stand-by for flight of the DSTB.

Field Notes – 2005

Robert Bennett
Las Cruces, NM

Editor's note: Bob is a faithful observer and reports here on his activities in 2005. Spectrograms and analysis, provided by the editor, will be incorporated in this report.

2005 has been a hectic year for me. I have spent most of my time dealing with health problems, trying to settle my father's estate, visiting my grandchildren and I have made several trips to the East Coast to attend weddings and visit relatives. These activities have left little time for Natural Radio monitoring.

So far his year, I have only managed two trips to a quiet location for natural radio monitoring. The first was 22-23 April and the second was on 21 August. Hopefully my schedule will be less hectic in October and November and I can return to my quiet site for more monitoring.

Check out the Journal-On-Line. The INSPIRE home page will soon contain a link to the on-line version of the *INSPIRE Journal*. The on-line version will include sound files for each spectrogram and color photos.

22-23 April 2005 Monitoring

During a site survey the previous summer, I discovered a good Natural Radio monitoring site in South Central New Mexico. The site is located in the Cibola National Forest near the Springtime primitive camp ground. Access to the site is by way of unimproved dirt roads and in some places the road is little more than a dirt trail. The road crosses several normally dry streambeds. Immediately after a rain, the streambeds have water in them and crossing them can be dangerous. The site is not accessible in wet weather without a four-wheel drive vehicle and when the roads are dry, cars, RVs and campers have trouble negotiating the steep dirt roads. From my home it takes about 4 hours to reach the site. The monitoring site is located at 33.5^{o} North and 107.3^{o} West. The site elevation is 6500 feet AGL and is on a flat area surrounded by mountains.

I arrived at the site on Friday 22 April at about 2 PM. I planned to spend two nights and return home on Sunday Morning. I spent an hour or so setting up camp and then spent the rest of the afternoon testing a large loop antenna. I did side by side comparisons using the loop and a modified INSPIRE VLF-2 receiver. The loop was used with a preamp. I compared the loop to a reference set-up. The reference set-up used a 6-foot vertical whip and the INSPIRE VLF-3 receiver. The following photograph shows the loop and test set-up. The loop receiving system performed very poorly in comparison to the reference system. I plan to write an *INSPIRE Journal* article about my loop antenna experiments as soon as I find time.

"Reading" Natural Radio Spectrograms

On the following spectrograms, the filename is shown at the top of the spectrogram. Sample filename:

1022051119U0519M02m
MMDDYYHHMMUHHMMM02m

The filename includes:

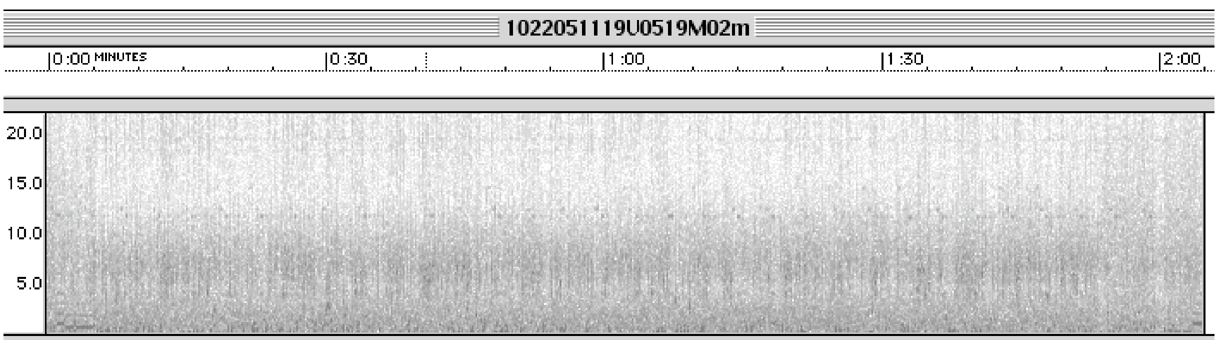
MMDDYY: month, day and year of observation.

HHMMSSU: the Universal time of the start of the file including the hour (HH), minute (MM) and second (SS). If fewer than six digits are shown, then the missing digits (MM and/or SS) are zeroes.

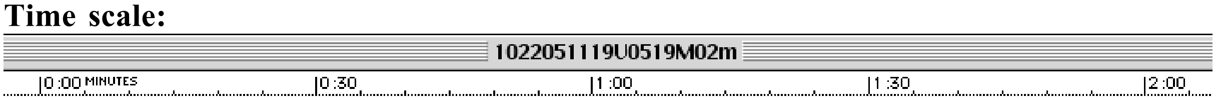
HHMMSSM: Mountain Daylight Time (Bob observes in New Mexico) of the start of the file. (Again, missing digits are zeroes.)

The final three characters are "02m" indicating that the length of the file is 2 minutes.

Also on the spectrogram

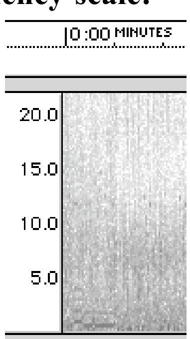


Time scale:



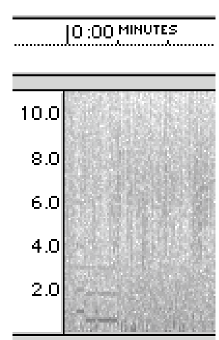
Typical lengths are 2 min, 1 min and 30 sec. Other lengths are possible.

Frequency scale:

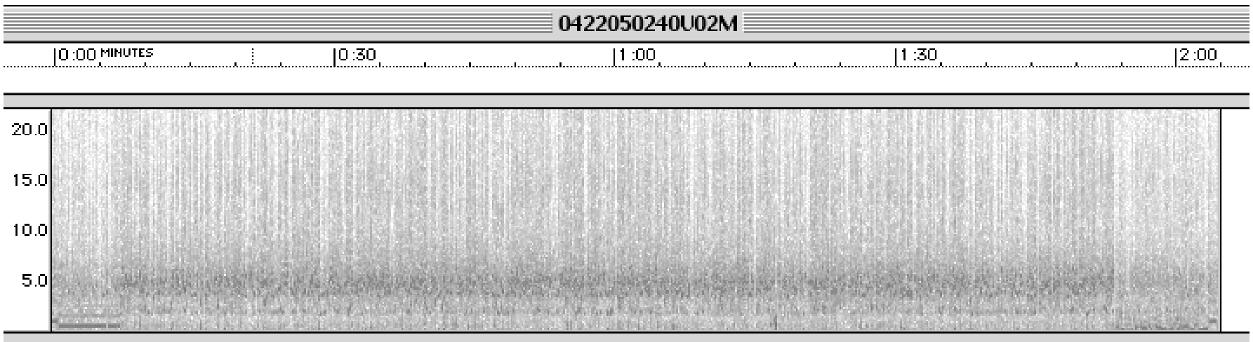


(Left) 0-22 kHz is the maximum frequency range of the software.

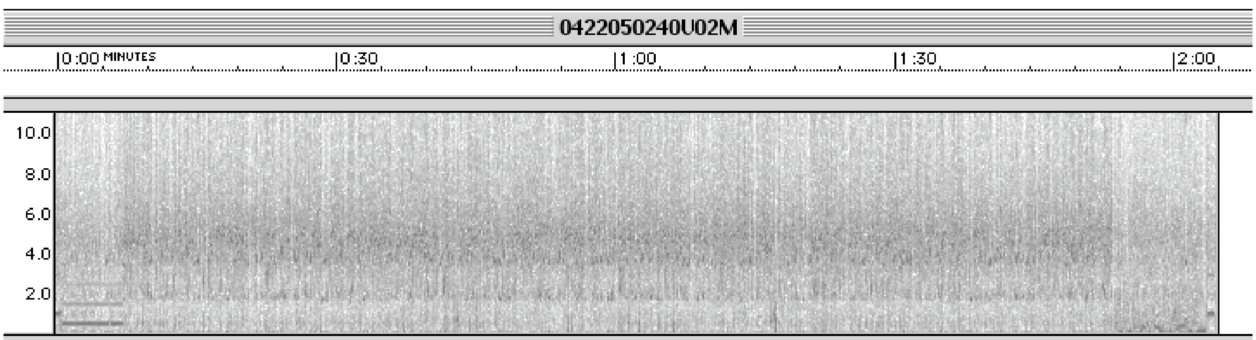
(Right) 0-11 kHz is the approximate frequency range of natual radio and the nominal frequency range of the VLF-3 receiver.



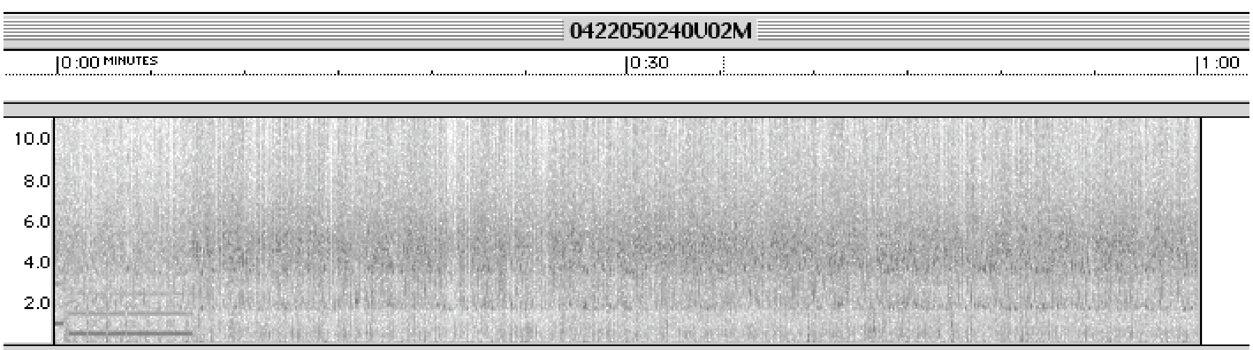
After dinner, at about 8:30 PM local time, I conducted a test recording using the VLF-3 and a 6-foot whip antenna. I was surprised to detect a whistler after about 10 minutes. I monitored natural radio signals until about 9 PM, checked in with my wife via amateur radio (there is no cell phone coverage at the site) and went to bed.



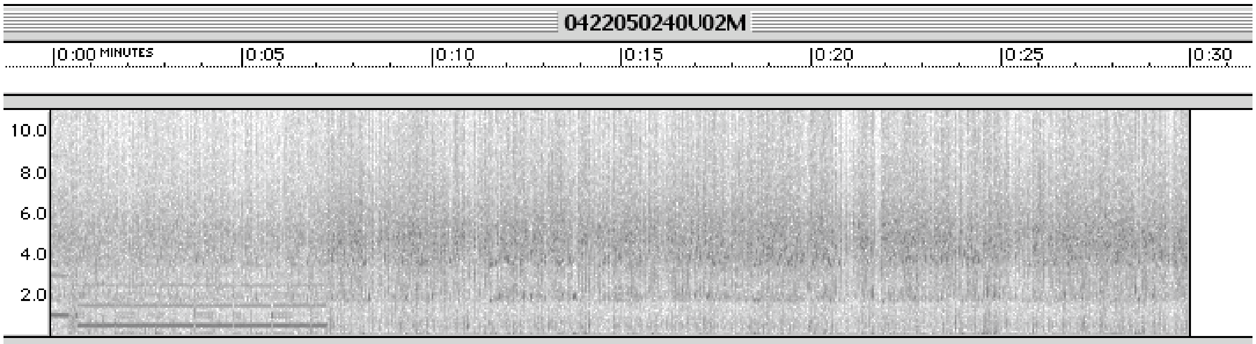
Two-minute spectrograms are created for each data session. This data is from the testing session on Friday, April 22. Additional spectrograms of various lengths are made of anything special, such as whistlers, and anything else noted by the observer or the analyst. The full 0-22 kHz range of frequencies is used on the first spectrogram.



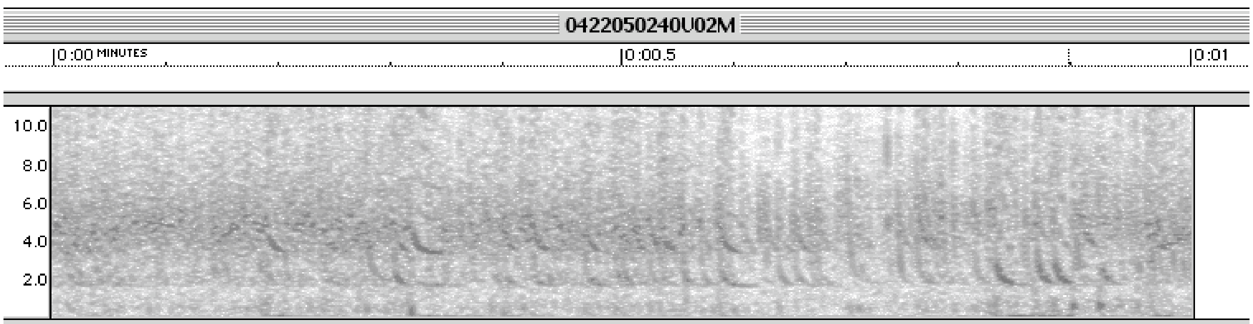
The second spectrogram created is using a 0-11 kHz frequency range. This range more closely matches the audio-range of natural VLF radio signals. The dash at the beginning of the spectrogram is the 1 kHz WWV tone at 0240 U. About 5 seconds of WWV content follows before WWV is switched out.



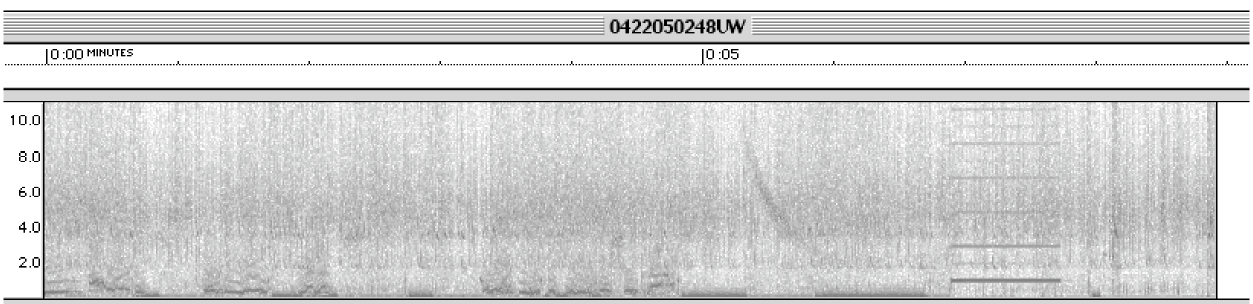
The third spectrogram is of the first minute of the session, using the 0-11 kHz range.



The fourth spectrogram is of the first 30 seconds of the session, using 0-11 kHz frequency range.



This is a one-second interval showing dense tweeks. Notice the bottoms of the hooks at about 2 kHz with harmonics of the stronger tweeks appearing at about 4 kHz.



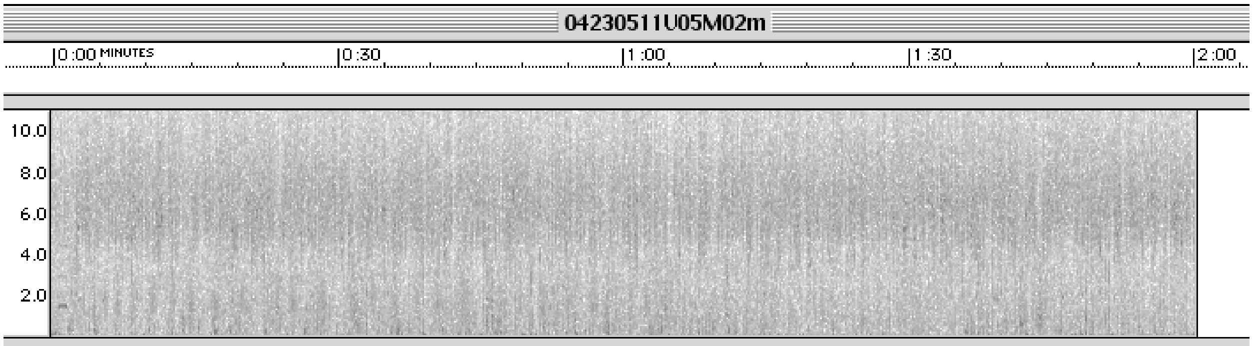
Whistler logged at 0248 U on Friday, 4/22.

The temperature dropped to about 40^{o} F over night and there was some light rain. I got up at 4 AM, built a fire to warm myself, had breakfast and started monitoring at 5 AM. My efforts were immediately rewarded by strong whistlers. I recorded 14 of them between 5 and 6 AM. Unfortunately, I did not bring many blank tapes with me so had to reduce my recording to the first 15 minutes of each hour. I recorded at 7, 8 and 9 AM. I recorded some very strong whistlers and several pairs of whistlers. By 9:15, the whistlers had just about stopped. At 10 AM, light rain started again and I took down my antennas just in case there was lightning. I planned to wait out the minor thunderstorm and monitor again that night and the next morning. However, a forest ranger stopped by and advised that I leave the area. He said that some of the dry streambeds were running water and if I delayed, I would be stranded. I am very glad I departed. It rained all Saturday night and very heavily on Sunday. If I had stayed, I would have been stranded until late Monday. I had a very enjoyable natural radio monitoring session.

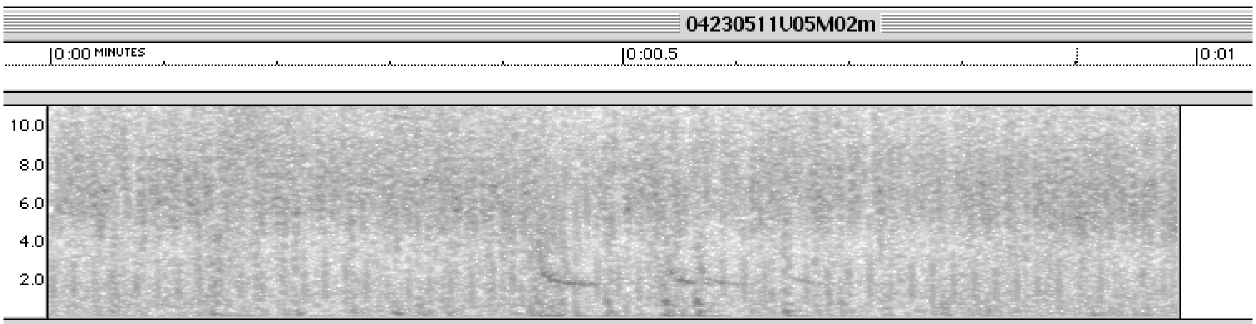
Figure-1. Large loop antenna (right rear) under test. The surrounding mountains may be seen in the background.

Figure-2. Testing the loop antenna(foreground). The loop preamp is on the ground under the loop and 25 feet of connecting coax runs to the modified VLF-2 on the table.

Data and whistlers from 4/23/05.

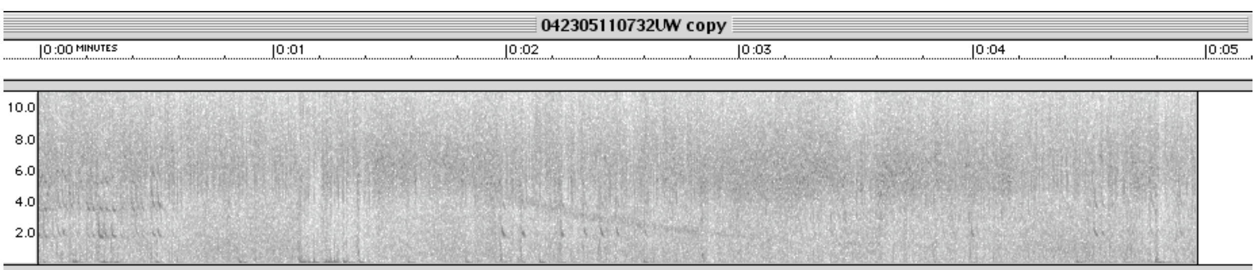


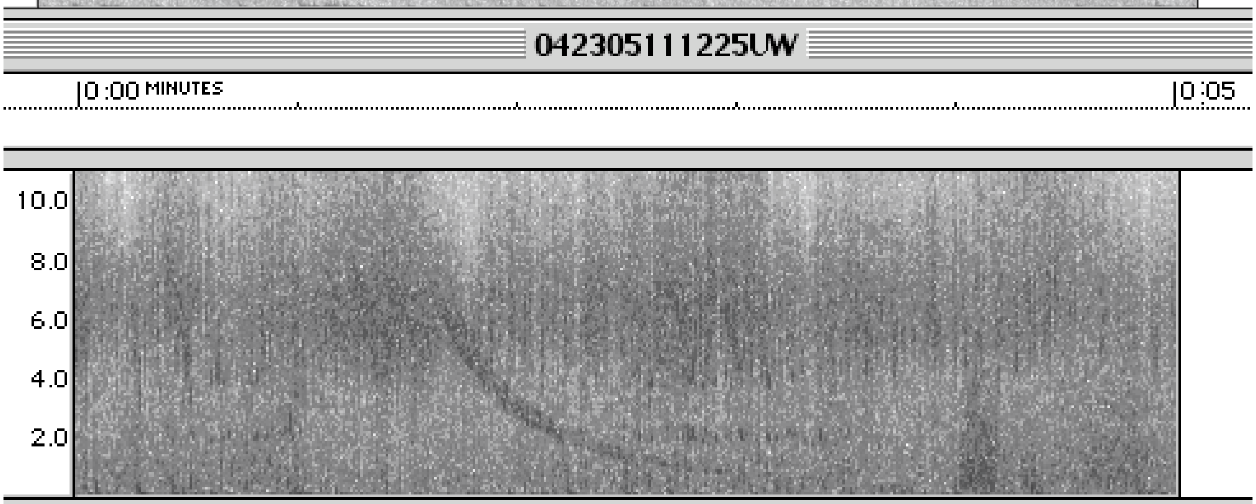
Data from 11U / 05 M.

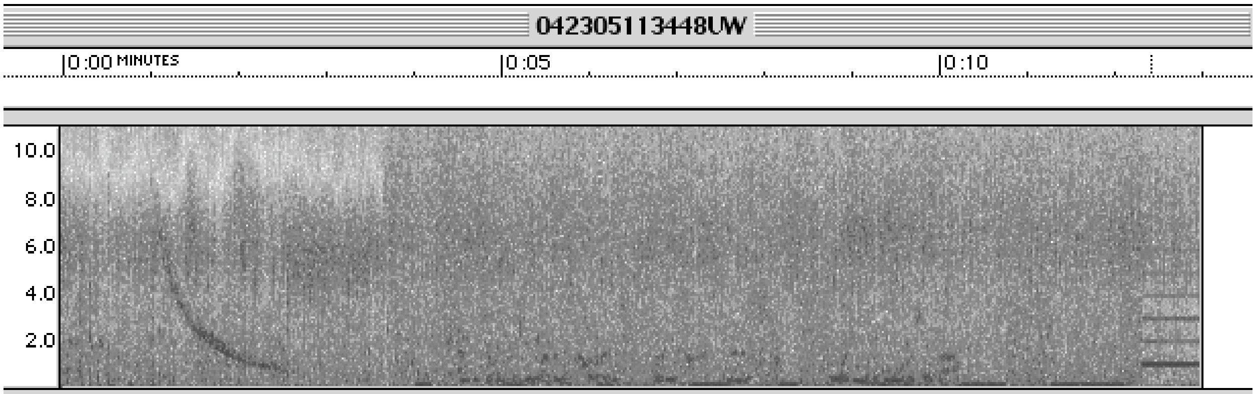


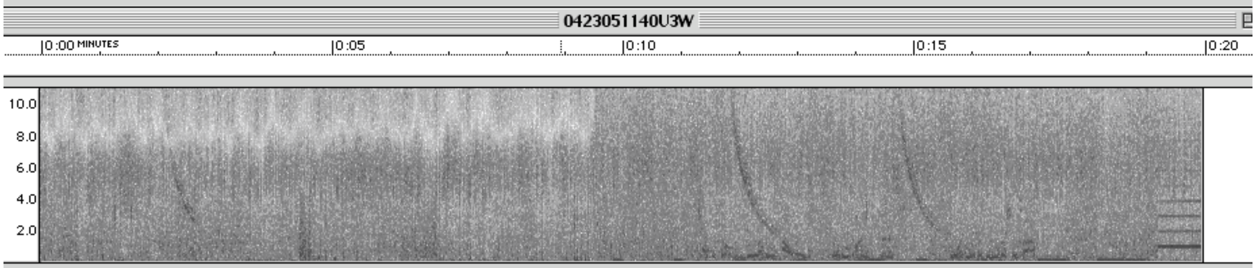
Strong tweeks in the interval :05 - :06 seconds from above.

A collection of whistlers from this session: (Note the time of each in the filename.)

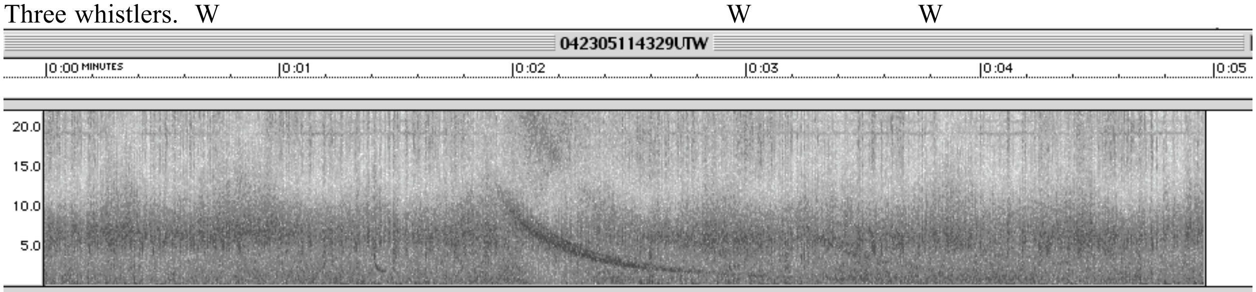






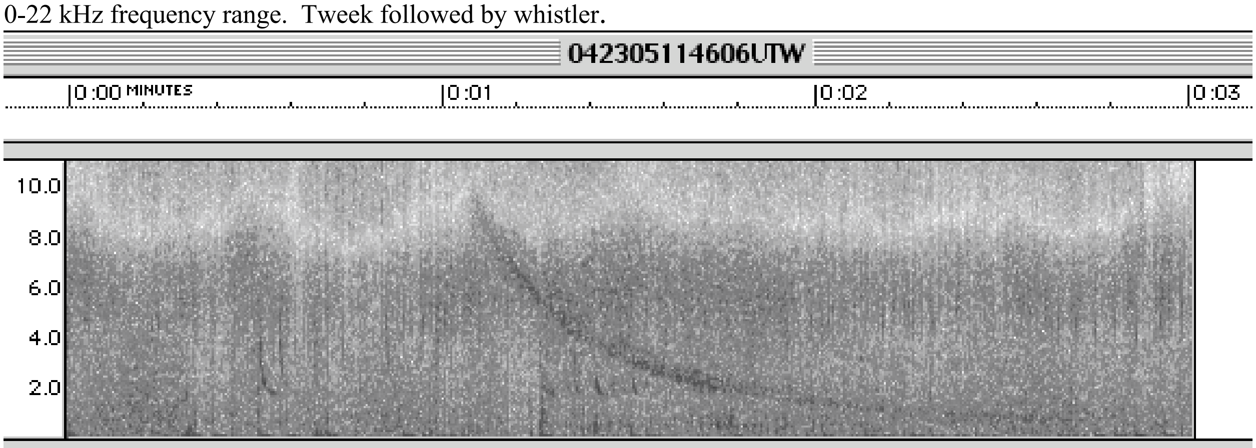


Three whistlers. W W W



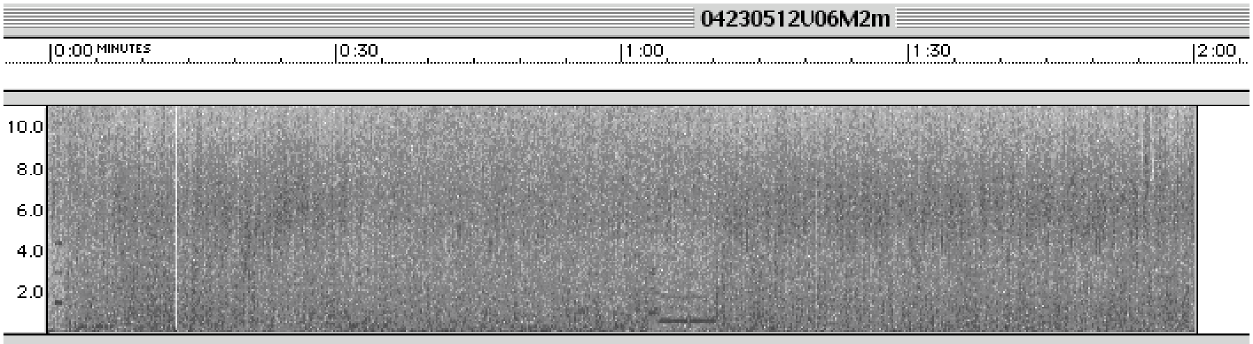
T W

0-22 kHz frequency range. Tweek followed by whistler.

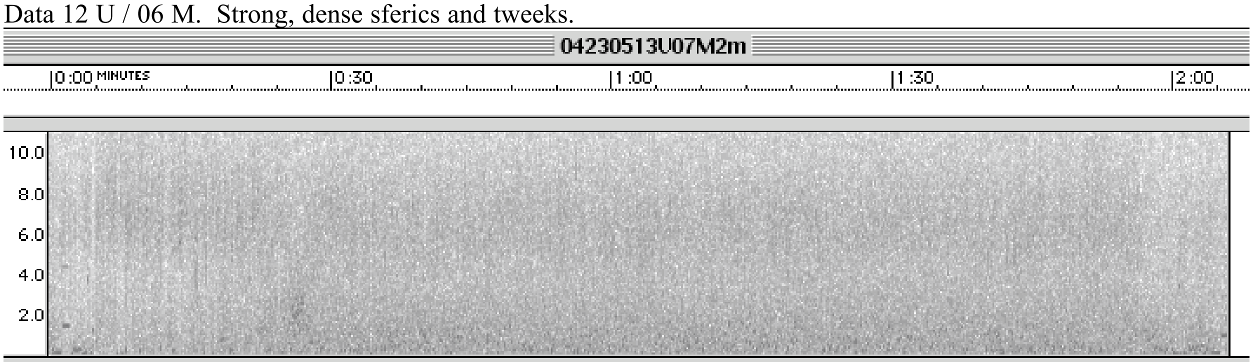


T W

Another tweek followed by whistler. The whistler is probably the result of the same lightning that caused the tweek. The tweek propagated within the ionosphere while the whistler traveled a much longer path along a magnetic field line in the magnetosphere. The way to recognize this phenomenon is to note when whistlers follow strong tweeks (or strong sferics) by the same time delay. Since lightning is random in timing, it is unlikely that the two would be coincidental in timing several times in a session. The two examples above confirm the observer's conclusion that the tweek and whistler are from the same lightning stroke.

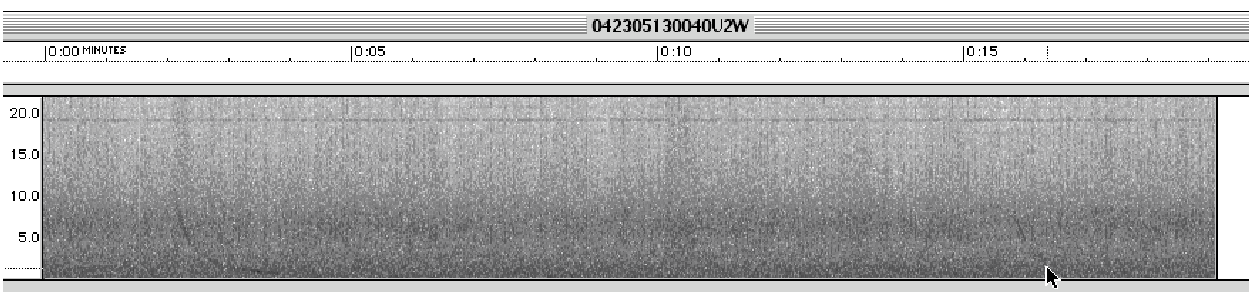


Data 12 U / 06 M. Strong, dense sferics and tweeks.

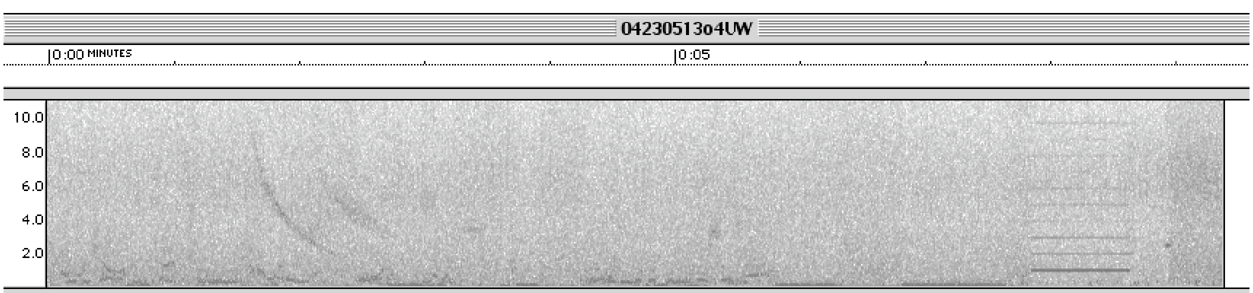


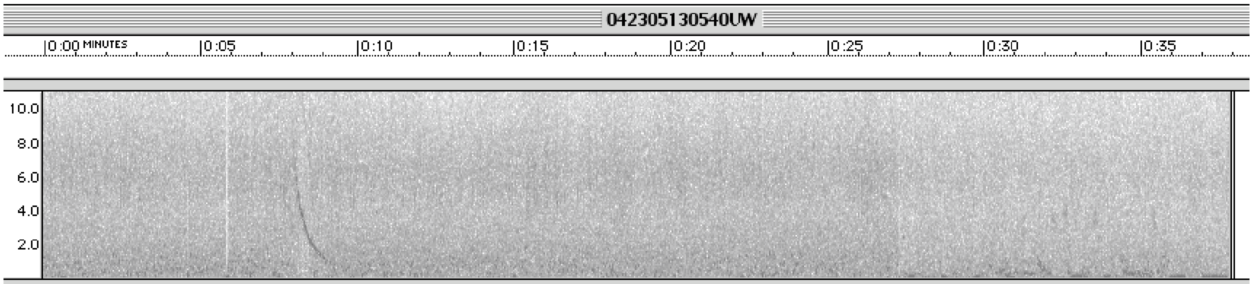
Data 13 U / 07 M.

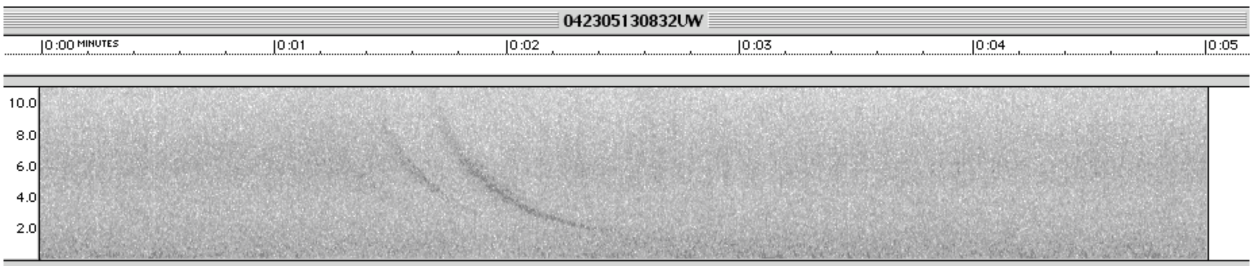
Whistlers from this session. (Note the time in the filenames.)



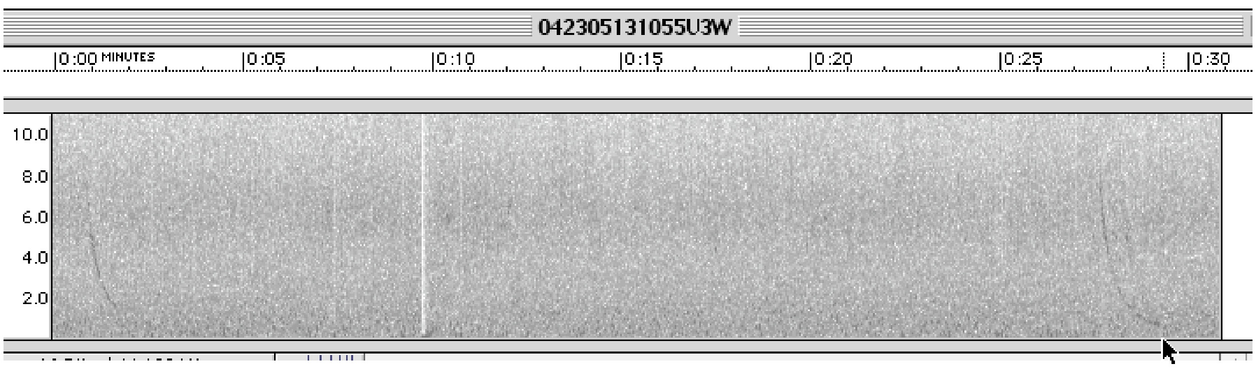
2 whistlers. The first is at :02 seconds; the second is at the arrow.





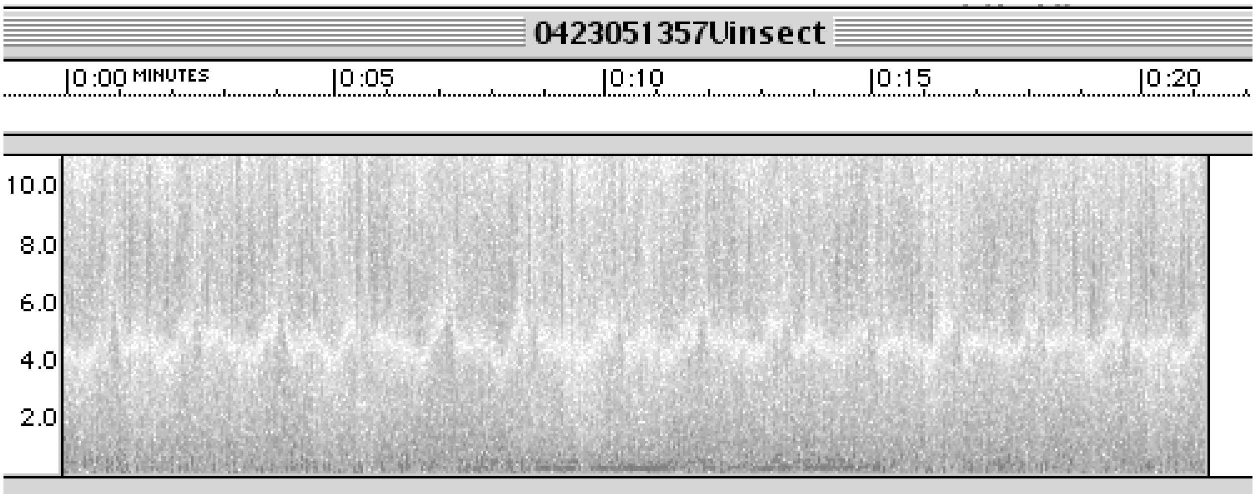


Double whistler.

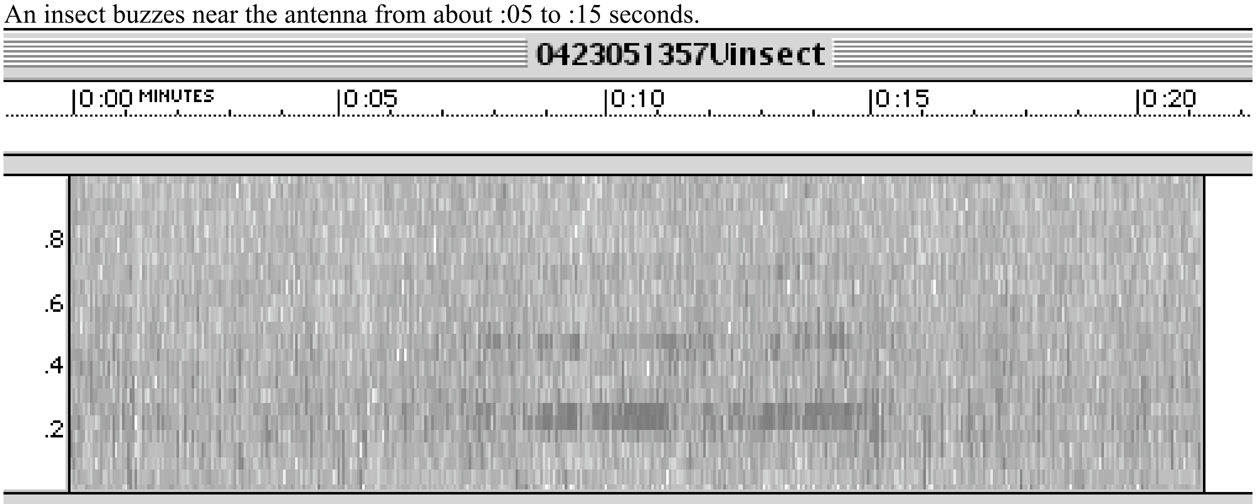


Single W at :01 second and a double whistler (two separate whistlers at the arrow).

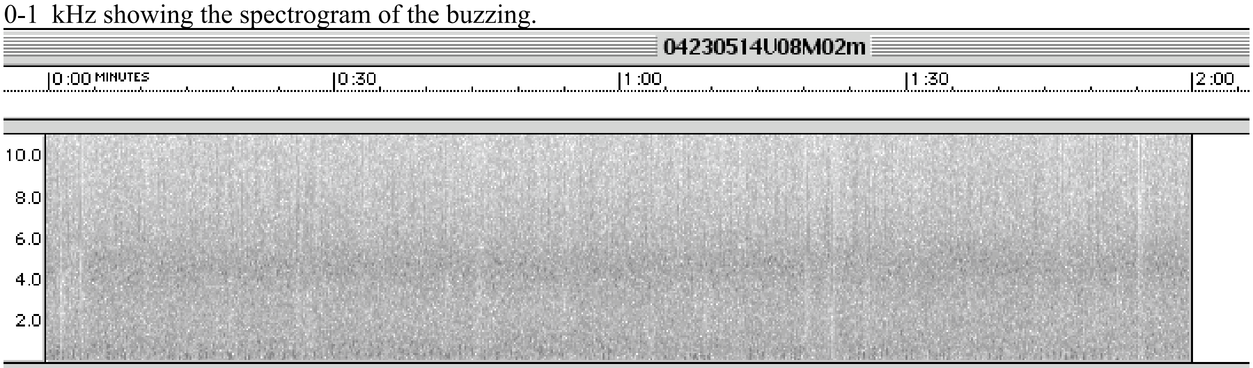
A closeup of the double whistler. Notice that the dispersion (slope) is similar for the two indicating two separate whistlers rather than an echo of the first whistler.



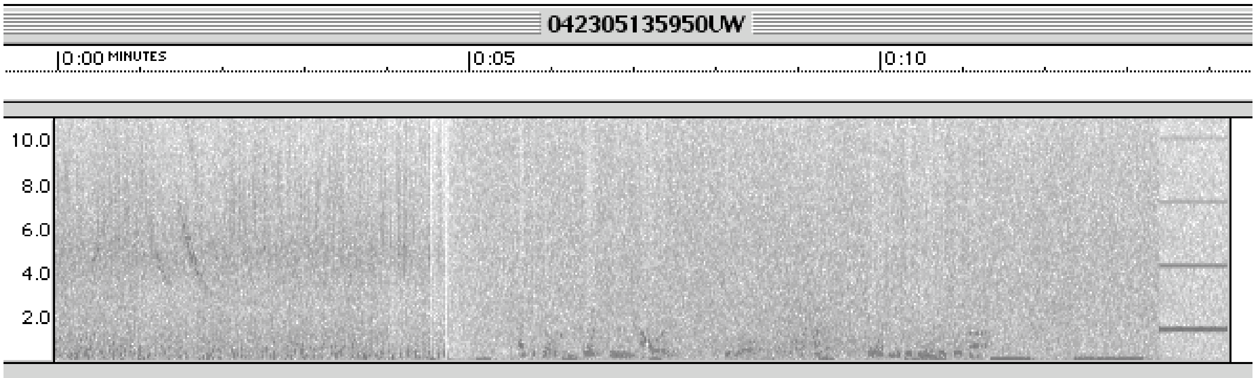
An insect buzzes near the antenna from about :05 to :15 seconds.



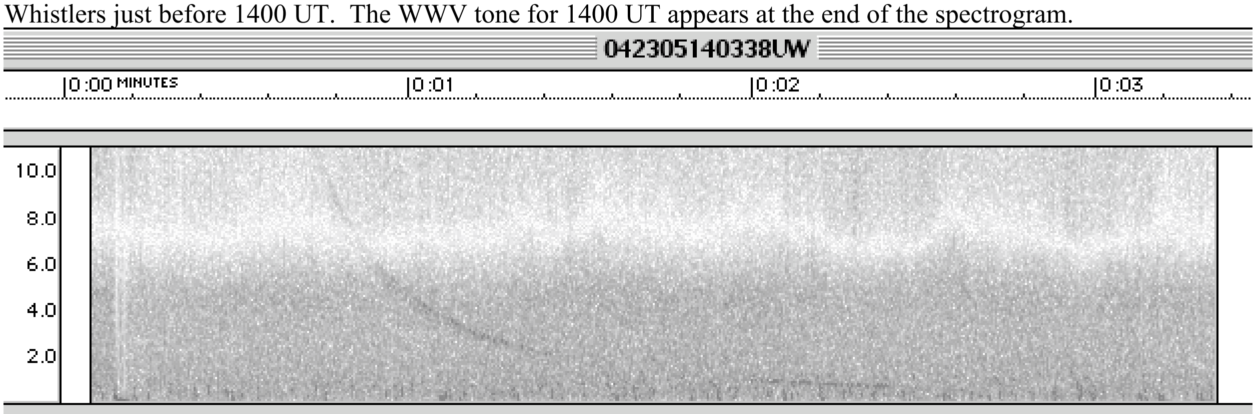
0-1 kHz showing the spectrogram of the buzzing.



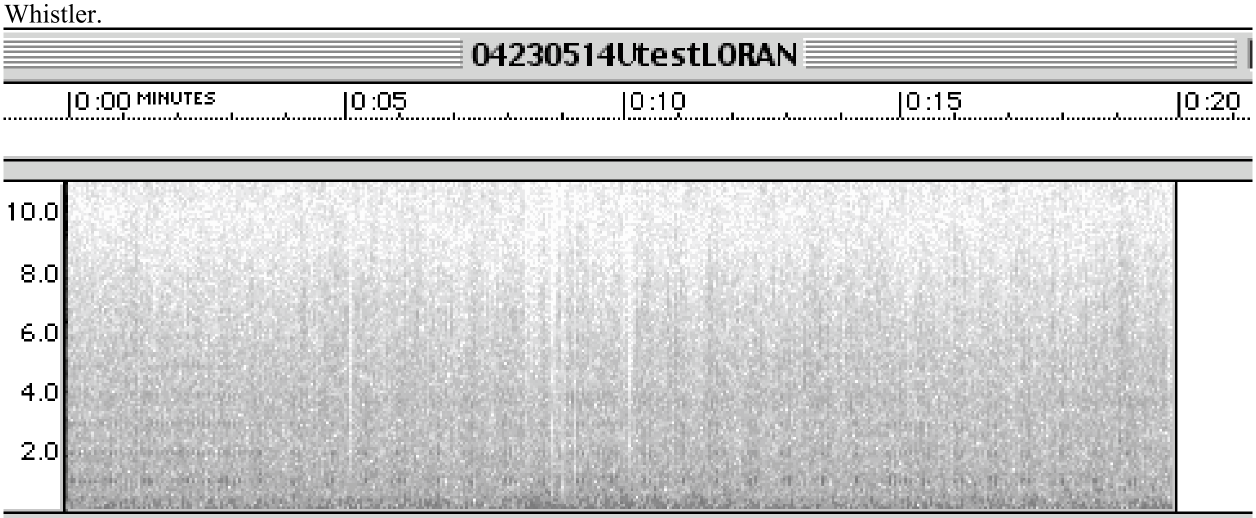
Data: 14U – 08 M



Whistlers just before 1400 UT. The WWV tone for 1400 UT appears at the end of the spectrogram.



Whistler.



Strong LORAN signal. LORAN appears on the spectrogram as horizontal rows of dots. On tape it sounds like rapid clacking.

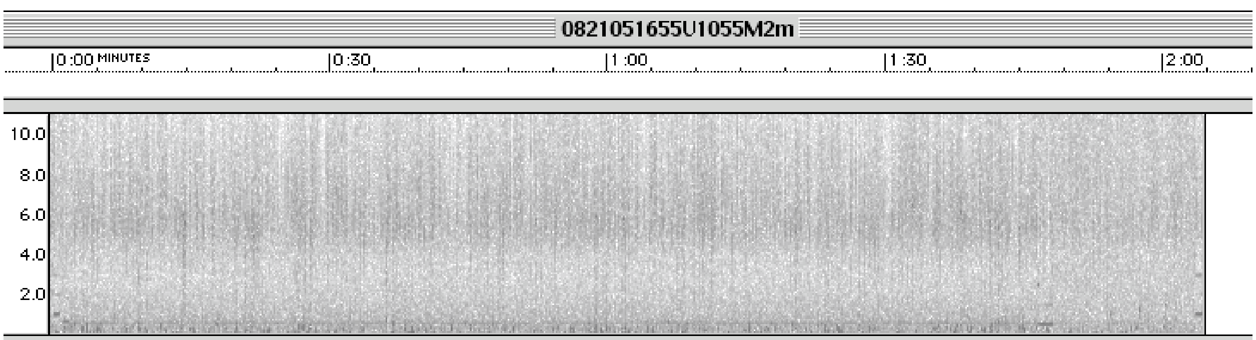
21 August 2005 Monitoring

On 19-20 August I visited Albuquerque to attend an Amateur Radio meeting. I decided before I left home to detour to a quiet place on my way home on Sunday 21 August for some natural radio monitoring. I planned to monitor only Sunday morning as August is our monsoon season and it rains almost every afternoon.

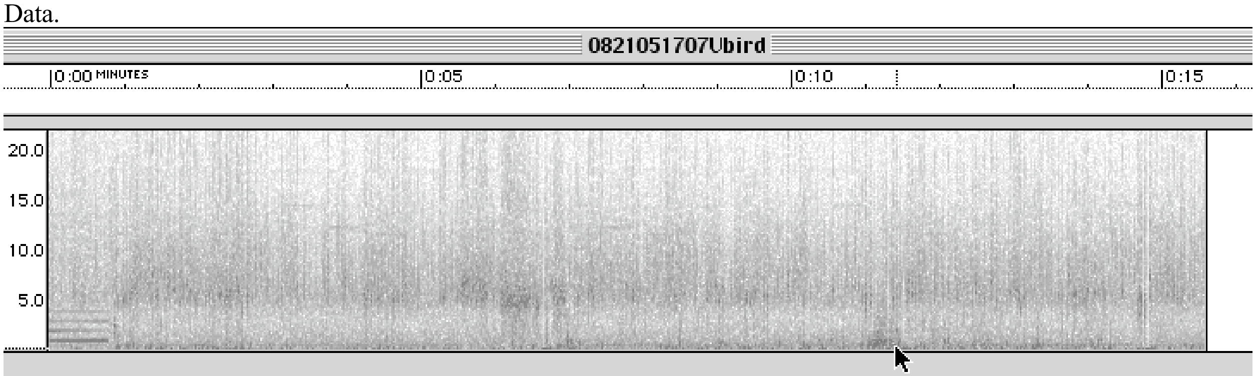
I decided to monitor along an isolated rural road called Quebrades Back Country Byway and continue monitoring along the El Camino Real Scenic Trail. Both of these "roads", if one can call them that, are little more that dirt trails through the mountains. For my first monitoring session, I selected a site on top of a high hill with a scenic view of the Rio Grande valley and the town of Socorro. The river and town are about 20 miles from the monitoring site. The site elevation is 5100 feet. The following photograph shows the view from the site. I started recording at about 11 AM. The site was very quiet. I didn't detect any Loran and 60~ hum was almost undetectable. I noted that sferics and tweek levels were much higher than I normally observe in the daytime.

Figure-3. View from the first monitoring site looking West.
The Rio Grande valley is the green patch at the foot of the distant mountain.

Figure-4. Photograph of the road that I drove over to get to the first two monitoring sites.



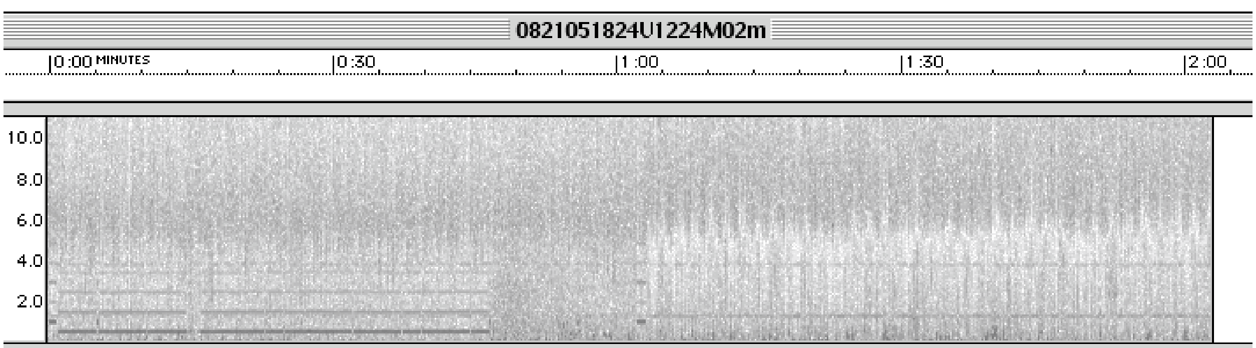
Data.



Bird hitting the antenna (arrow).

For my second monitoring session, I selected a site in a valley surrounded by mountains. This site was about 5 miles from my previous site. The elevation was 4850 feet. A photo of the site follows. I started monitoring at about 12 noon. I was surprised to find that the second site had higher levels of sferics and tweeks than the first. Also, the weak 60~ hum I noted at the first site had disappeared. I didn't detect any whistlers but did record many very strong static clashes from the thunderstorms visible on the horizon.

Figure-6. My second monitoring site in a valley surrounded by hills.



Data at second site. Note the WWV time mark in the middle of the interval.

It took me over an hour to reach my third selected site along the El Camino Real. However, there were now thunderhead clouds near me and lightning flashes were visible. I decided it would be a good idea to get out of the backcountry and find a good road before the rain started. So, I cancelled further monitoring attempts and started home.

I made one significant mistake during the 21 August monitoring. I underestimated how long it would take to reach the first site from Albuquerque. I planned for an hour and a half and expected to arrive around 9 AM. It took almost three hours!

21 October 2005 Monitoring

This natural radio monitoring occurred during a campout in the Cibola National Forest. The area I chose for the campout is located at a primitive campground in the San Mateo Mountains. The site is located about 30 miles northwest of Elephant Butte, NM.

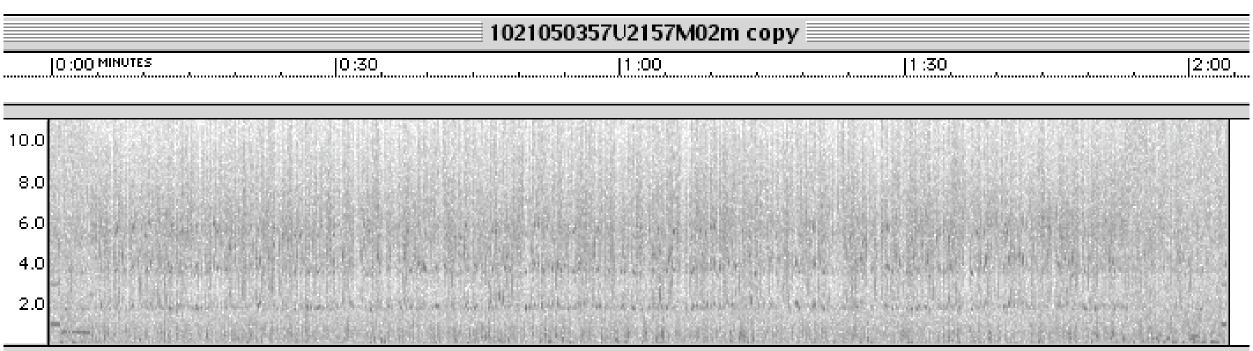
I arrived at the campground (if one can call it a campground) about 1300 local time (MDT) on Friday afternoon, 21 Oct 2005. I spent the next several hours setting up my camp, hooking up radio equipment and deploying antennas. I deployed not only a natural radio antenna but also a 500 foot long Beverage antenna for DXing and a two-meter amateur antenna for emergency communications.

Camping conditions were ideal. There was no wind to contend with, daytime high temperature was 72^{o} F and nighttime low temperature was 36^{o} F. The elevation of the campsite was about 7000 feet MSL. The next two pictures show my camp and a view toward the east.

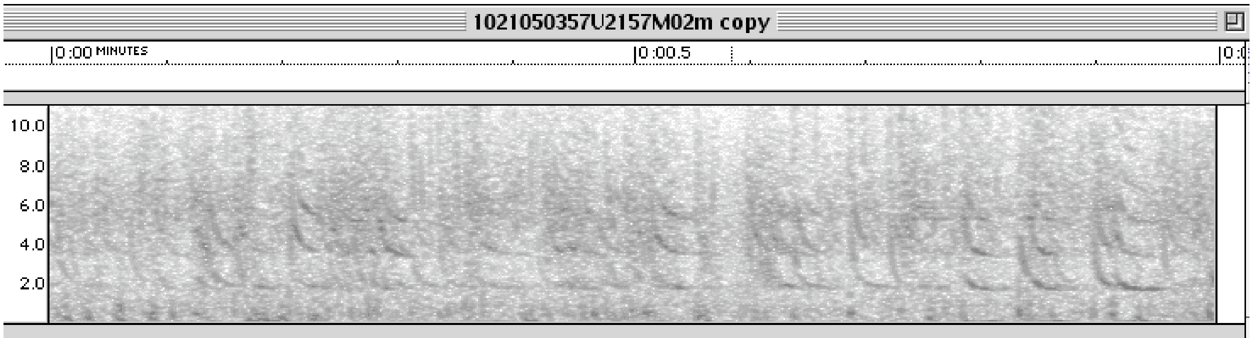
Figure-7. This is a picture at my campsite looking toward the north.
My radios are set up on the table and powered by a 12-Volt deep cycle battery
(the black object on the right of the table).

Figure-8. This is a picture from my campsite looking toward the east.
The mountain range in the distance is on the White Sands Missile Range.
This photo was taken late in the afternoon just before sunset.
The road to the camp site is the trail between the two mountains.

My first natural radio monitoring session occurred Friday night at about 2200 MDT (0400 UT on 22 Oct.). I did not detect either LORAN interference or 60~ hum. No whistlers were detected but the tweeks were intense and frequent. The general sferics level was high to very high.

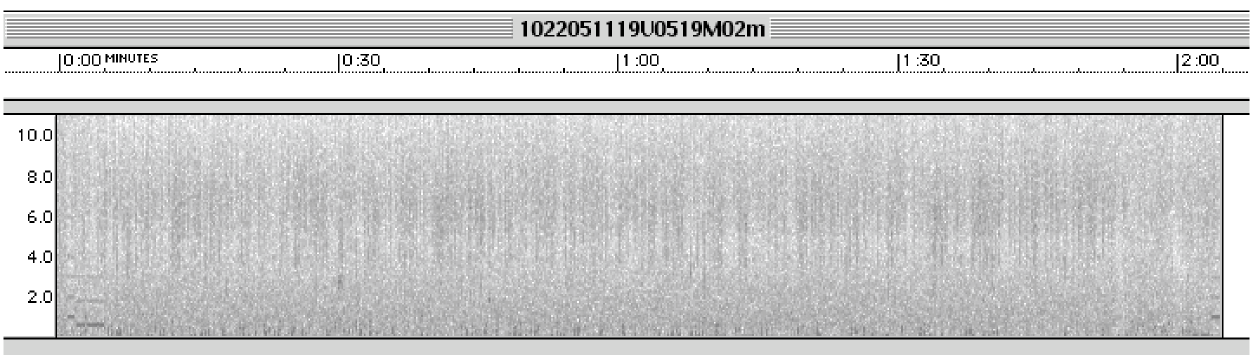


Data from first session on Friday, October 21. Dense, strong sferics and tweeks.



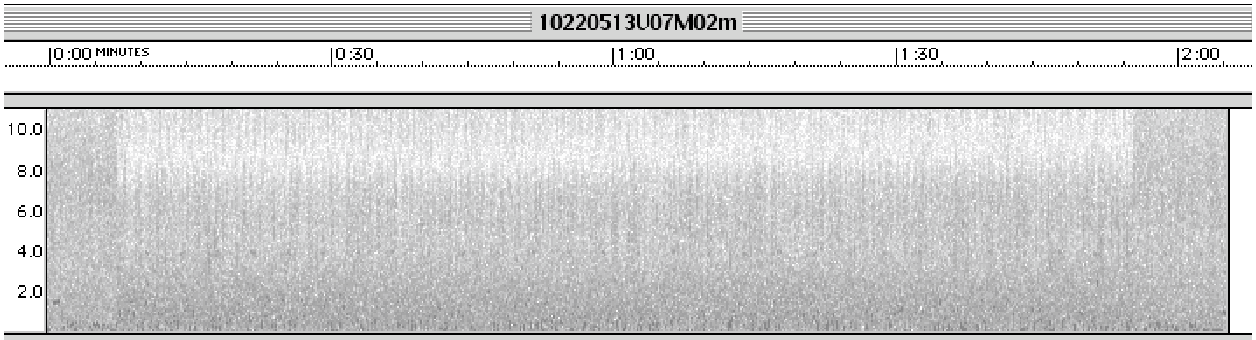
One second sample showing dense sferics and tweeks. Note the multiple harmonics on the strong tweeks.

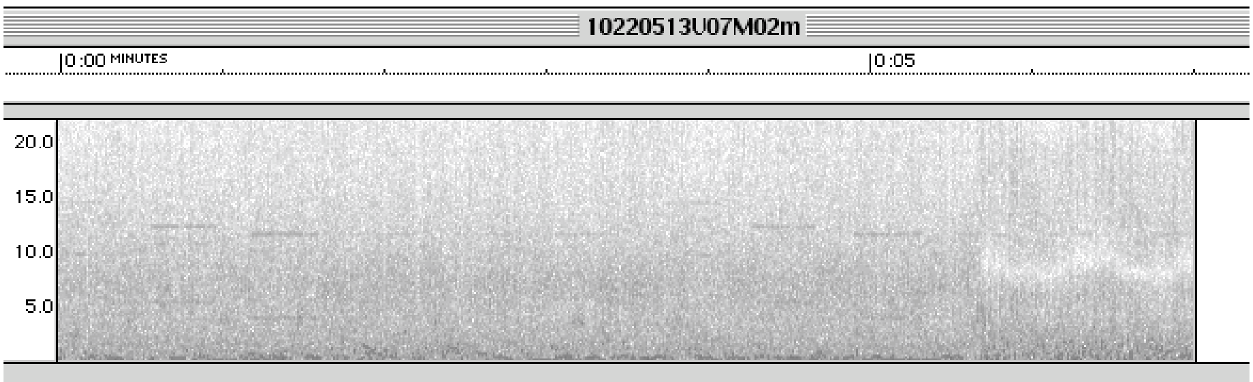
The second session started at 0520 MDT Saturday morning. The sferic levels were very high and the tweeks were strong and frequent. I noted one whistler while recording. When I listened to the tape after returning home, I noted that I had missed two whistlers. This session was plagued with equipment problems. The audio patch cord from the WWV receiver to the VLF-3 developed an internal open circuit. I did not have a spare cable (LESSON LEARNED!). By experimentation I found that I could establish connectivity by bending the cable into a near circle at a specific point. Troubleshooting was difficult because it was still dark. Sunrise would not occur for another hour and I was wearing a heavy coat and gloves. The outside temperature was 38^{o} F. Because of the outside temperature, I moved the natural radio receiving set-up into the cab of my truck for the other sessions.



I tried to monitor again at 0600 MDT but had additional equipment problems. After spending 30 minutes checking all my equipment, I found the problem, which should have been obvious to me immediately. The antenna lead-in had shorted to the receiver metal case!

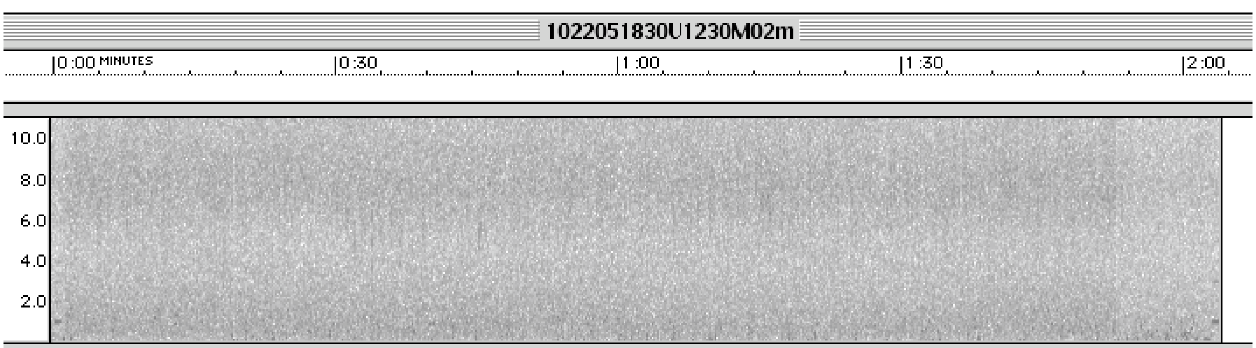
The third session finally occurred at 0700 MDT. The first thing I noted was that all natural radio levels had decreased significantly from the 0520 session. I did not detect any signals of great interest during this session.

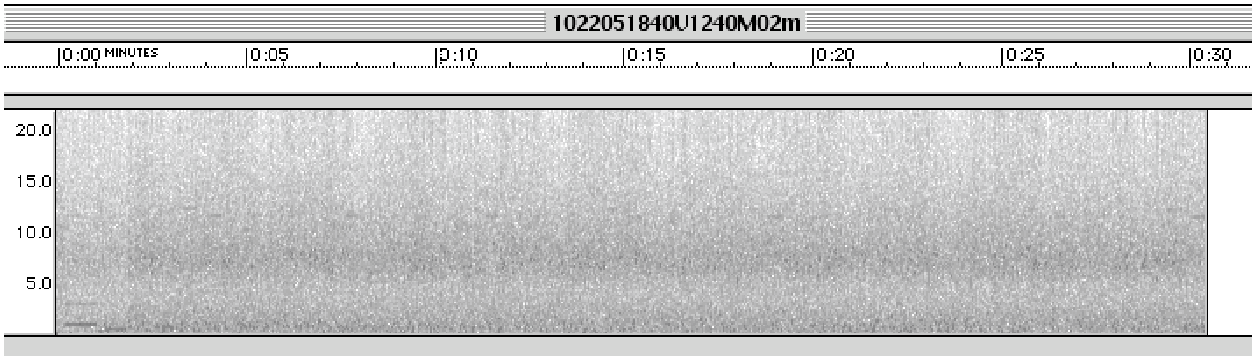




This spectrogram is of about 7 seconds from the above session. The horizontal dashes between 10- and 15-kHz are tones from the Russian ALPHA navigation system If you look carefully at the strongest tones, you will see another dash right below, at about half the frequency. This is "aliasing", which results from strong signals. The actual tones (10- to 15-kHz) are too high frequency for many people to hear. The alias signals are well within the audio range and can be heard.

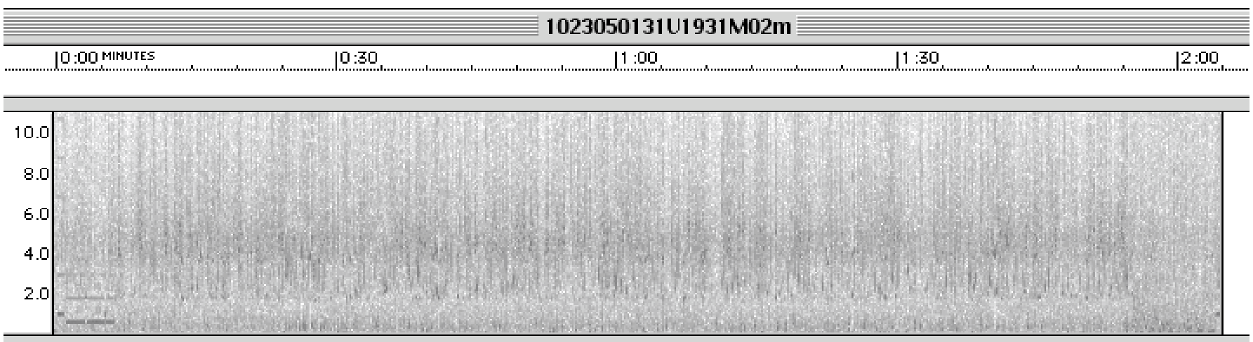
The next session occurred after lunch on Saturday at about 1230. All the natural radio levels were significantly lower than in the morning. The sferic level was at best weak. I detected a few tweeks and one weak whistler.

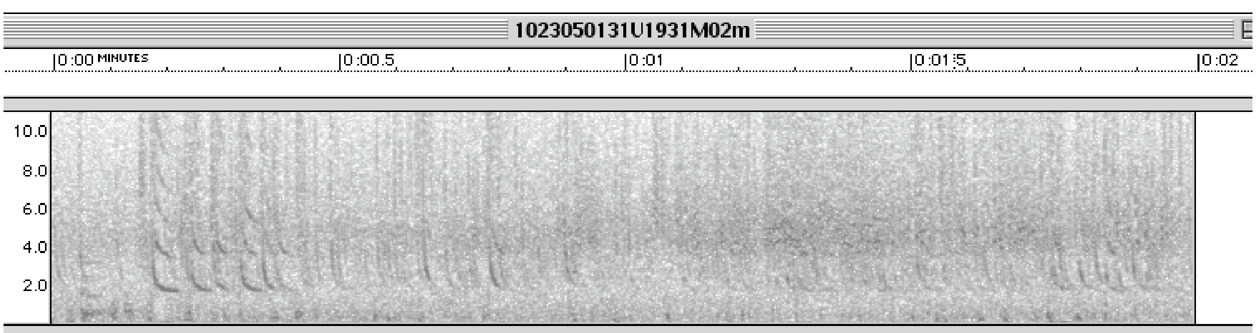




A 30 second, 0-22 kHz sample showing more Russian ALPHA signals.

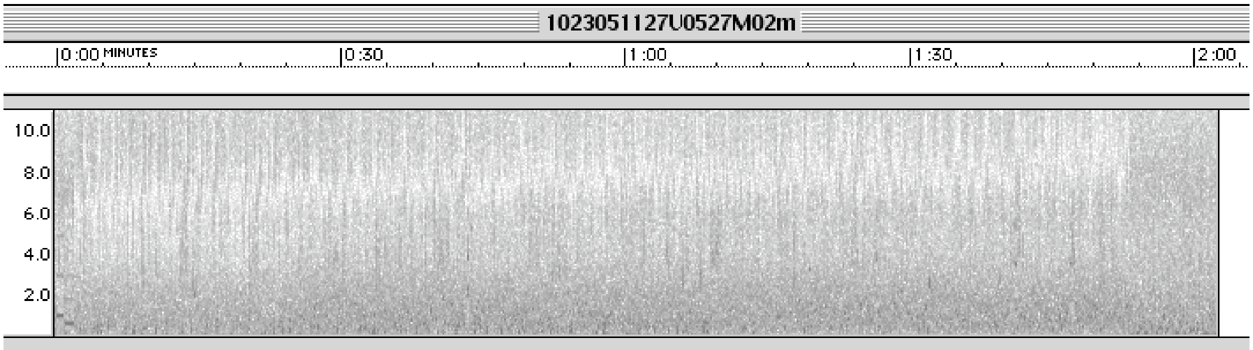
I next monitored after dinner on Saturday at 1930 MDT. All the natural radio signal levels were still depressed and I didn't detect anything of interest.



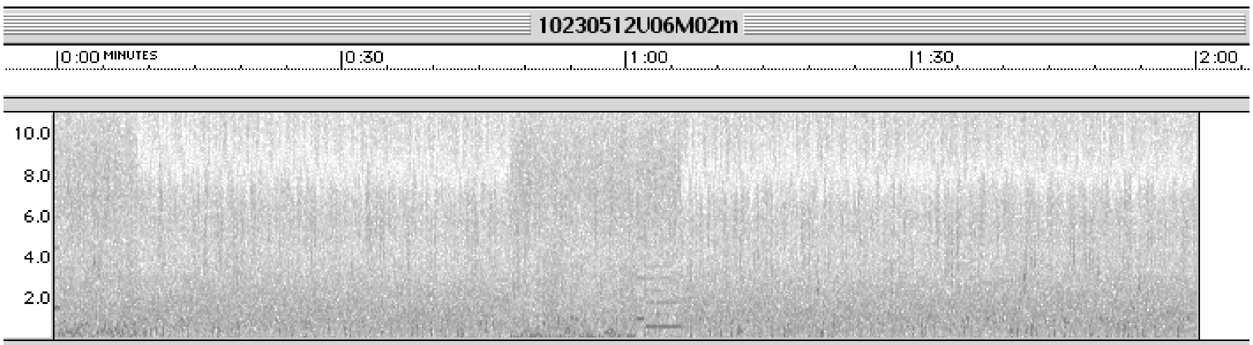


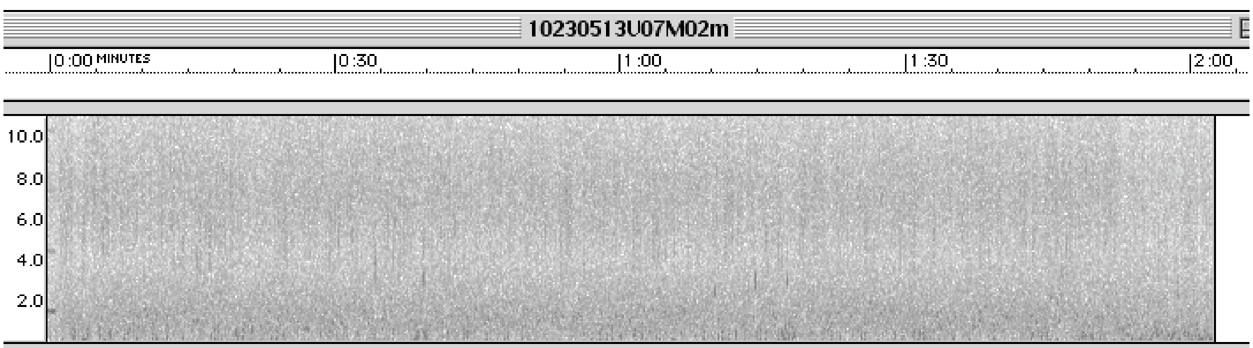
Two seconds showing tweeks.

The next monitoring session was on Sunday morning, 23 Oct. at about 0530 MDT. I again monitored from the cab of my truck. Signal levels were higher than the previous evening but not as intense as they were early Saturday morning. When I reviewed the tapes after returning home, I noted that the Russian "Alfa" navigation signals were absent. This is the first time I have monitored when they were off the air. The only natural radio signals of interest I noticed were some very strong tweeks.



My last monitoring sessions occurred at 0600 and 0700 MDT Sunday morning. I didn't notice any natural radio signals of interest.





All things considered, I had a good natural radio observing experience. I learned two lessons. One: I need to carry some spare audio patch cords. And two: I need more practice filling out log sheets. When I compared the log sheets for this session with ones I made in the past, it appears that I am getting a little sloppy. I had a great time camping.

Coordinated Observation Schedule

The Coordinated Observations will be held on the first weekend of October and the last weekend in April. This schedule will apply to all future Coordinated Observations. All data is welcome and should be submitted even if the conditions are quiet. Any data you can contribute is valuable. The procedure to use for Coordinated Observations will be as follows:

1. Use the Data Cover Sheet and Data Log forms found at the end of the *Journal*. (Make copies as needed.)
2. Put a voice introduction at the start of each session indicating your name, your INSPIRE Team name, the date, local time and UT time.
3. Record for 12 minutes at the start of each hour that you can monitor on the specified days. Keep a detailed written 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.
4. 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.

Local Time to UT Conversion Table

EDT + 4	=	UT
CDT + 5	=	UT
MDT + 6	=	UT
PDT + 7	=	UT

Next Coordinated Observations:

April 29 – 30, 2006
October 7 – 8, 2006

5. Record at 8 AM and 9 AM **LOCAL** time.
6. 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).
7. 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.
8. Label all tapes and logs to indicate the sessions monitored and send to:

   Bill Pine
   1348 Quince Avenue
   Upland, CA 91786

9. Your tapes will be returned with spectrograms of your data. An article reporting on the results will appear in the next *Journal*.
10. 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).

Field Observation Schedule

Field observations may be made according to the following schedule:

ANY TIME !

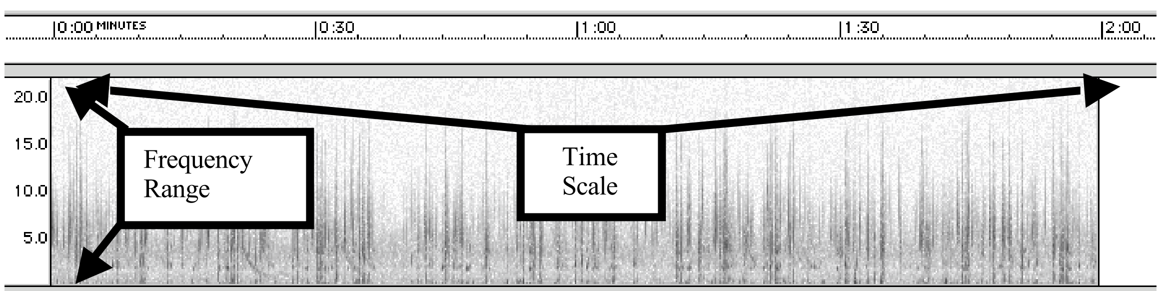
In addition to an article reporting on the Coordinated Observations, will be an article on Field Observations. These observations may be made at any time and submitted for inclusion in the next *Journal*.

Use the same procedure as described for Coordinated Observations (previous page). Since field observations can be made any time of year, the following table is provided for conversion from local time to Coordinated Universal Time (UTC).

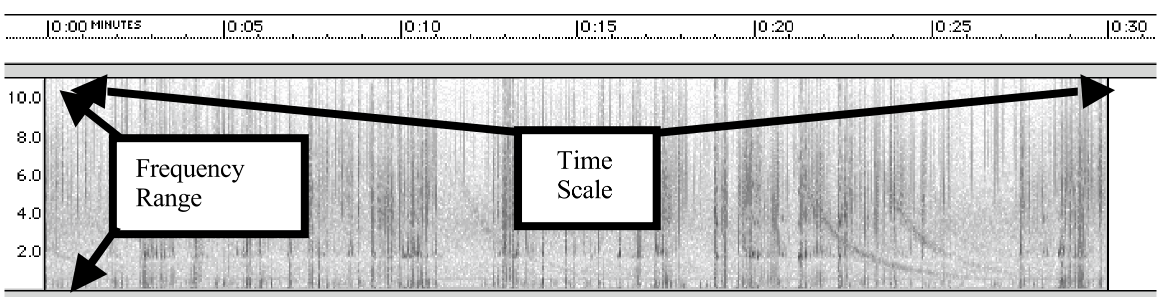
Local Time to UT Conversion Table

EST + 5 = UT	EDT + 4 = UT
CST + 6 = UT	CDT + 5 = UT
MST + 7 = UT	MDT + 6 = UT
PST + 8 = UT	PDT + 7 = UT

Sample Spectrograms:



This spectrogram is for two minutes using a frequency range of 0 - 22 kHz.



This spectrogram is for 30 seconds using a frequency range of 0 - 11 kHz.

Data Log Cover Sheet (copy as needed)

INSPIRE Observer Team ______________________________

Equipment: Receiver ______________________________

Recorder ______________________________

Antenna ______________________________

WWV radio ______________________________

Site description: ____

Longitude: _____° _____′ W Latitude: _____° _____′ N

Personnel: ____________________ ____________________ ____________________

____________________ ____________________ ____________________

Team Leader address: Name ______________________________

Street ______________________________

____

City, State, Zip, Country ______________________________

email: ______________________________

Local Time to UT Conversion Table

EST + 5 = UT	EDT + 4 = UT
CST + 6 = UT	CDT + 5 = UT
MST + 7 = UT	MDT + 6 = UT
PST + 8 = UT	PDT + 7 = UT

INSPIRE Data (copy as needed)

INSPIRE Observer Team ______________________________

Observation Date: _____________ Receiver ________

Tape Start Time (UT) _____________ Tape Start Time (Local) _____________

Local weather: ____

Code: M - Mark (WWV or Voice) S - sferics T - tweek W - whistler A - Alpha C – chorus
Sferic Density: D: ___ Scale of 1-5 (1 – Very Low, 3 – Medium, 5 – Very High)

Time (UT)	Entry		Observer
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________
___________	M-WWV M-V S T C W___________________________	D: ___	_____________

INSPIRE Order Form

1. Subscription to *The INSPIRE Journal*: 1 year, 1 issue per year (December);

USA, Canada, Mexico	$	4
All other countries	$	6

2. INSPIRE VLF3 Radio Receiver Kit: $ 80
   (includes assembly instructions, components and printed circuit board)
   For domestic shipping charge, please see Domestic Shipping Rate Table
   For foreign shipping charge, please see Foreign Shipping Rate Table

Payment may be made by check, money order or purchase order made payable to: The INSPIRE Project. Credit cards are not accepted.

Send orders to: Bill Pine, Science
1348 N. Quince Avenue
Upland, CA 91786

Items requested:	**Quantity**	**Price**	**Subtotal**
1. Subscription	_____	_____	_____
2. VLF3 Receiver Kit	_____	$ 80	_____
Shipping Charge	_____	_____	_____
Tax (CA residents please add 7.75% sales tax: $6.20 per kit.)			_____
email: ______________________		TOTAL:	_____

Ship to: (Please print clearly.) (Please allow 2-3 weeks for delivery.)

Name ______________________

Address ______________________

____

City, State, Zip, Country ______________________

Domestic Shipping Rate Table (Find first 3 numbers of your zip code)

$6.00	**$5.50**	**$5.00**	**$4.50**	**$4.00**
005-349	506 – 507	505	840 – 853	864
360-364	509	508	865	889 – 891
367-368	520 – 535	510 – 516	873 – 874	900 – 939
373-374	582	570 – 581	893 – 896	950 – 953
376-379	600 – 639	583 – 599	940 – 949	
385	650 – 653	640 – 649	954 – 966	
398-418	700 – 708	654 – 693	975 – 976	
425-459	712 – 717	710 – 711		
467-468	719 – 715	718		
470-473	728	726 – 727		
480-497	776 – 777	729 – 775		
967-969	998 – 999	778 – 838		
995-997		870 – 872		
		875 - 885		
		970 – 974		
		977 – 994		

Foreign Shipping Rate Table

Canada	$6.50
Mexico	$10.00
All Other Countries	$15.00