The INSPIRE Journal

THE INSPIRE PROJECT, INC | VOL. XVIII | JANUARY 2009

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Visit INSPIRE's new website:

www.TheINSPIREProject.org

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INSPIRE'S LEGACY

Dr. William (Bill) W. L. Taylor was a leader in the field of space science education and public outreach. He co-founded and was president of INSPIRE, one of the pioneering successes in NASA Sun Earth Connection Education. In July 2005, Goddard Space Flight Center honored the late William W. L. Taylor with an Excellence In Outreach Award for his accomplishments.

The INSPIRE Journal is a publication of The INSPIRE Project, Inc., a 501(c)(3) nonprofit educational scientific corporation. The INSPIRE Project, Inc. has both federal and tax exempt status (FEIN 95-4418628).

Letters to The INSPIRE Journal should be submitted to Kathleen Franzen, The INSPIRE Project, Inc., 518 Sixth Street SE, Washington, DC 20003 or emailed to Kathleen@theinspireproject.org.

MISSION

The INSPIRE Project, Inc. is a non-profit scientific, educational corporation whose objective is to bring the excitement of observing natural and manmade radio waves in the audio region to high school students. Underlying this objective is the conviction that science and technology are the underpinnings of our modern society, and that only with an understanding of science and technology can people make correct decisions in their lives, public, professional, and private. Stimulating students to learn and understand science and technology is key to them fulfilling their potential in the best interests of our society. INSPIRE also is an innovative, unique opportunity for students to actively gather data that might be used in a basic research project.
~ William W. L. Taylor and William E. Pine, Founders of The INSPIRE Project, Inc.

In 2006, The INSPIRE Project Inc. mission was expanded to develop new partnerships with multiple science projects. Links to magnetospheric physics, astronomy, meteorology, and other physical sciences are being identified.

To Our INSPIRE Journal Readers

Kathleen Franzen, President & Managing Editor

"If I have seen further than others, it is by standing upon the shoulders of giants."
~ Sir Isaac Newton (4 January 1642 - 31 March 1727)
Sir Isaac was a mathematician and physicist, one of the foremost scientific intellects of all time.

I continue to have the opportunity to be standing on the shoulders of all of our INSPIRE participants giants since we last published the INSPIRE Journal in July of 2008. Our organization is still focusing on its new dimensions and capabilities. I can assure you that I will be standing on some of these generous "shoulders" for many more months.

In Fall 2008, the first INSPIRE based university-level course was taught at University of Maryland Baltimore County (UMBC) as a result of winning the NASA New Investigator Award (NIP) submitted by Dr. Phillip Webb of Goddard Space Flight Center and UMBC. I was asked as the President of INSPIRE to be a guest lecturer at one of the classes and I could not have enjoyed my message or audience more. It was a blast. Once everyone heard I was not a scientist, although I was made an honorary physicist by our INSPIRE Goddard Space Flight scientist's last year, the class became an informal stage for my view of science and their questions of how it can be creative and not something that would be too difficult as they plan their next semester courses.

In October, INSPIRE launched its new website via the new URL, theINSPIREproject.org. If you have any feedback or would like to submit content for inclusion on the site, please email us.

A new program has been suggested by our Webmaster Eric L. Day. Through INSPIRE team members we are now campaigning to have an INSPIRE Ambassador at every appropriate high school, college and university in the greater metropolitan Washington area to get the INSPIRE message out on a one-to-one basis. We are also putting together a campaign internationally to have an INSPIRE Ambassador in every country in our vast INSPIRE world.

New Year's Eve at the Acropolis, courtesy of INSPIRE's Ambassador in Athens Georgios Pagkas (and Google).

INSPIRE has secured new VFL-3 receiver kit part manufacturers and a fulfillment house. As you may imagine this was not an easy task but it is timely. Not only to maintain continuing excellence in INSPIRE's customer service history but in meeting the new demand in VLF-3 receiver kit requests.

Our scholarship programs' deadlines have been extended because of so many requests from potential recipients with time challenges. All program deadlines have been extended to 16 March, with the exception of Goddard Internships that are ongoing. When you have the opportunity to talk with potential candidates, please do not hesitate to refer them to us for additional information or answer any questions.

INSPIRE was successfully represented at this year's American Geophysical Union (AGU) meeting in December in San Francisco. If any of you would like a copy of the poster paper that was represented, please email us through the customer service link on our website.

I wish you all a peaceful 2009. As always your support and contributions to the INSPIRE Project, Inc. are appreciated by the organization and everyone who continues to work for the good of this cause in education and public outreach in the STEM areas of our mission.

My best to all!

From the Editor

Fatima Bocoum

My first contact with the INSPIRE Project Inc. was in summer 2004 when I had the opportunity of interning at NASA Goddard in the *SSDOO Department (Code 630).* Dr. Timothy Eastman, my mentor at the time, introduced me to Dr. William W.L. Taylor; I was privileged enough to meet the co-founder and former president of The INSPIRE Project.

Dr. Taylor shared with me his desire of redesigning the INSPIRE website and wanted to know whether I had experience in web design. Subsequently I told him that I am always eager to learn new things and that given the opportunity and the time I could prove my abilities. Granting me the said opportunity, I was to redesign the INSPIRE Project home page for the remaining of my internship. Pleased with what I had done with the home page, Dr. Taylor selected me as the INSPIRE Webmaster, a position I held for 4 years with the organization.

In May 2008 I took on a new role at INSPIRE. Kathleen Franzen, the new president of INSPIRE, offered me the position of the INSPIRE Journal editor, which I was honored to accept. The July/August 2008 issue of the INSPIRE Journal reflects a new look and expanded content for the Journal.

Upon publication of the last issue, I left for a six-month consultancy with the International Telecommunication Union (ITU) in Geneva, Switzerland. Should my consultancy be extended, I envisage an INSPIRE office in Geneva to better assist and service our international participants with their VLF-3 Receiver Kits and introduce more participants to The INSPIRE Project and share their experience with others through the INSPIRE Journal and our website – www.TheINSPIREProject.org.

In celebration of our 20th Anniversary, INSPIRE is in the process of compiling a list of all INSPIRE's participants since its creation in 1989 and developing a global map showing where VLF observations have been made over these years. If you have participated in the INSPIRE Project, please contact me at editor@TheINSPIREProject.org so you can be included in this exciting project.

I look forward to your contributions and comments for the INSPIRE Journal. If you have an article or a publication for submission to the Journal and/or our website, please contact me at editor@TheINSPIREProject.org.

Thank you for your participation and interest in the INSPIRE Journal.

A Note from INSPIRE's Technical Intern

Justin Madigan

Hello to the entire INSPIRE Project team and friends. I am the new Technical Intern to the organization. I am currently studying political science at American University and I will graduate this spring. I have been working with INSPIRE since June of 2008. My job is to help INSPIRE President, Kathleen Franzen, advance the mission of the organization.

To date, I have helped publish the July and January *Journal*, updated the new the INSPIRE website, as well as collect kit orders and deal with customer service issues regarding kits. Since I began working with INSPIRE, there continues to be dramatic advances in the organization, including the new user-friendly website and the expanded *Journal.*

INSPIRE has recently established an Ambassador Program throughout universities within the District of Columbia and surrounding areas. The goal of this new program is to excite new students and teachers about INSPIRE's mission of bringing the excitement of science back to students of all ages. I am always interested in learning and trying new things, which is what led me to apply for the Technical Internship Program with The INSPIRE Project. The people involved with this organization are truly amazing; I have had the opportunity to meet many of the Board Members during the November Board meeting. I am extremely excited to be part of the team.

INSPIRE Opportunities, Events & Programs

Application Deadline Extended to March 16th

DR. WILLIAM W.L. "BILL" TAYLOR MEMORIAL SCIENCE SCHOLARSHIP COMPETITION

Application Deadline: March 16, 2009
Scholarship Awards: $5,000 per recipient

In honor of The INSPIRE Project, Inc.'s Dr. Bill Taylor, The INSPIRE Project, Inc. with its partners at the DC Space Grant Consortium, NASA/Goddard Space Flight Center and other science and technology organizations established this annual science scholarship competition. Scientifically oriented undergraduate and graduate college students and high school seniors who will be attending a DC metro area college or university in Fall 2009 are encouraged to apply.

Competition Objectives

This competition seeks to encourage students to conduct individual or group research that will focus on Space Physics, Astronomy, Meteorology, Geology and other Earth Sciences. While designing projects identify how it has a connection to INSPIRE's Very Low Frequency study of natural or manmade phenomena. Judging of research projects based on the criteria below:

- Creativity and design of the project
- Clear project goals and the methods used to accomplish those goals
- Analysis of project results and their relationship to project goals
- Clarity and quality of the project's written report
- Clarity and quality of the project's presentation (finalists only)

THE INSPIRE PROJECT, INC.
2009 NASA GODDARD INTERNSHIP PROGRAM

Application Deadline: Ongoing
Internship Awards: $5,000 per recipient, plus travel stipend

With support from NASA Goddard Space Flight Center, The District of Columbia Space Grant Consortium, Aries Scientific and Woman Friday, LLC, The INSPIRE Project, Inc. in conjunction with the Dr. Bill Taylor Memorial Science Competition is proud to announce the Paid NASA Internship Program.

Internship Description

The INSPIRE Project, Inc. is sponsoring part-time, paid internships at NASA Goddard Space Flight Center Two (2) part-time paid internships are available.

Students will be paired with a mentor at NASA Goddard Space Flight Center. Each student will work with their mentor to design a project that they will work on throughout the duration of the internship. Internships at NASA Goddard Space Flight Center will be focused on science and engineering research.

Hours & Compensation

Interns will work approximately 15-20 hours per week, and will be paid $5,000 after successful completion of the internship. Additionally, interns will receive a $400.00 travel stipend to aid in their commute to NASA Goddard Space Flight Center.

For complete information on INSPIRE opportunities, events and programs, please visit:
www.TheINSPIREProject.org.

Questions? Email Kathleen Franzen at president@TheINSPIREProject.org or call 202.547.1364.

The INSPIRE Project, Inc.
SPACE ACADEMY FOR EDUCATORS SCHOLARSHIP PROGRAM
JULY 2009 NASA Marshall Flight Center, Huntsville AL
Application Deadline: March 16, 2009

The INSPIRE Project Inc. has teamed up with the NASA Marshall Space Flight Center and the U.S. Space & Rocket Center in Huntsville, AL and is offering two full scholarships to Space Academy for Educators.

Space Academy for Educators is a 5-day program offered every summer in July for teachers from around the world to come and participate in 45 hours of intensive classroom, laboratory and training time, focusing on space science and space exploration. Teachers also take part in astronaut-style training and simulations, as well as activities designed to promote life-long learning in a classroom setting. All lessons and activities link to National Science and Math Standards and are ready to use in the classroom.

Workshop topics/activities include:

- Engineering Design Challenges
- Rocket Construction
- Math Workshops
- Living and Working in Space
- Orion Spacecraft and Ares Launch Vehicles
- Space History
- Hydroponics
- Mars & the Moon

Teachers participate in two simulated Space Shuttle Missions, simulate walking on the Moon and working in the frictionless environment of space on Astronaut Simulators, and weather permitting spend an afternoon at Aviation Challenge simulating parachute landings and helicopter rescues in the water.

INSPIRE Scholarship Includes:

- Roundtrip airfare from the DC metro area
- 6 Nights lodging & meals
- Meals (Monday breakfast through Friday dinner)
- Program materials, flight suit, t-shirt and tote bag
- Transportation *to/from the airport*

For more information on the Space Academy for Educators program, visit: http://www.spacecamp.com/educators/profdev/weeklong/eduacad.php.

The INSPIRE Project, Inc.
ROBOTICS WEEKEND WORKSHOP SCHOLARSHIP PROGRAM
JULY 2009 NASA Marshall Flight Center, Huntsville AL
Application Deadline: March 16, 2009

The INSPIRE Project Inc. has teamed up with the NASA Marshall Space Flight Center and the U.S. Space & Rocket Center in Huntsville, AL and is offering two full scholarships to their Robotics Weekend Workshop in July 2009.

As part of the Education Department of the U.S. Space & Rocket Center's professional development program, the Robotics Weekend Workshop is the perfect way to learn how to incorporate Lego Mindstorm / NXT Robotics equipment into your curriculum or as an after school program. This workshop is intended for teachers with very little experience in robotics.

For more information on the professional development opportunities and other resources offered by the U.S. Space & Rocket Center, visit: http://www.spacecamp.com/educators/profdev/.

INSPIRE Scholarship Includes:

- *Roundtrip airfare from the DC metro area*
- *3 Nights lodging & meals*
- *Program materials*
- Transportation to/from the airport

INSPIRE opportunities, programs and events are made possible through the generous support of the following organizations:

INSPIRE VLF-3 Kit Review & Rosedale VLF Notes

Michael Mideke, August 2008

The following materials outline my construction of an INSPIRE VLF-3 receiver kit and its testing in comparison with several other broadband VLF receivers. I will evaluate the VLF-3 in relation to other units and offer a few suggestions as to possible future design approaches. The other systems used at Rosedale will be mentioned briefly. Accompanying photographs and spectrograms illustrate the discussion.

Construction of the INSPIRE VLF-3

I constructed the VLF-3 kit during June and July. The circuit board is a very nice job and the instructions are logical and quite easy to follow. The only part missing in my kit was a 2-inch length of red wire. It was not a problem for me to find a substitute but even such a simple omission could be frustrating to a novice. Quite as bad, if not worse, was the presence of an extra 220 Ohm resistor. I cross checked the schematic, the parts list and the board and quickly resolved that it was just an extra resistor but the beginner might be in for a section of wholly unobserved self-doubt. Assembly went well. With the exception of a couple of capacitors (ceramic if I remember right), all the parts fit their holes nicely. The capacitor leads were a hair too fat and I had to pare them a bit with nippers.

The most frustrating problem, which caused me some still unresolved self-doubt, came in the final assembly when the front panel is attached to the circuit board. I found that this operation could not be performed because the unused mounting plate on the “Audio Power” switch was blocked by the body of the “Data” jack – regardless of how that jack was oriented. I was able to find no alternative to cutting off the offending flange of the switch. Since at this point the switch was securely soldered to the double-sided circuit board in six places I performed the operation with the switch on the board. Sadly, that resulted in some minor damage to the fragile switch, whose action is now quite stiff. I’m afraid it won’t survive a lot of use. I fear I’ve missed something really obvious. But IF such an operation is for some reason necessary it should be clearly set forth in the construction sequence at a point prior to the mounting of the switch.

The completed unit functioned on first test so no debugging was necessary. As an aid to debugging it might be good to make a table of typical voltages at various points in the circuit. Also provide figure for normal power drawn at specified supply voltage and control settings.

Evaluation

Working in the open, using whip antennas ranging in length from 4 to 8 feet, listening on headphones from the “Audio Out” jack, sensitivity appeared to be reasonably good though inferior to my early model WR-3 with its smaller package, simpler design and shorter antenna. Using whip antennas, no overload was experienced from manmade VLF sources. I’m pretty far from the big military stations in the 20 kHz region so this is no indicator of what others might find. At Rosedale I tried the receiver with a low wire about 70 feet long and that produced nasty overload from Loran C on 100 kHz. I believe there’s a loran C outlet near Las Cruces, roughly 100 miles from my site.

Engagement of the “Filter” seemed to cut sensitivity overall while increasing circuit noise. “Filter” was ineffective against the Loran C overload. At Rosedale I operated with the filter off. On August 2 I made recordings of Filer “out” and “in” states from near the Waldo Mine gate, a moderately low-hum site handy to my home. I used 6-foot whip with its base in the clear, about 7 feet above the ground, feeding the VLF-3 via 10 feet of 50 Ohm coax. Spectrograms 11 and 12 show the results, though the difference is considerably more dramatic to the ear than the printer shows. The filter clearly works to reduce levels in the upper half of the frequency spread. However there seems to be considerable “insertion loss” extending clear to the bottom of the range. Increasing “Data” level only brought signal and noise up together. (Note that Spectrograms 11, 12, and 13 were all made at the same receiver and recorder level settings and no level changes have been introduced to WAV files or spectrograms.)

For the above filter test I used the same 10 ft coaxial cable between the VLF-3 and the whip base that was employed at Rosedale. After doing the filter recordings at Waldo Gate I substituted about 45 ft of military grade (stranded center conductor) RG174 coax for the short cable. This resulted in a dramatic decrease in signal level, illustrated in Spectrogram 13 raising questions as to how performance may be compromised by interposing even 10 feet of cable between whip and pre-amp. I seem to recall that G.W. Forgey, with a similar front-end design, felt that the advantages of using up to 10 feet of cable outweighed the losses to shunt capacitance.

All test recordings were made with a Zoom H2 recorder set to capture 16 bit data at 44 kHz. Following the instructions, VLF-3 “Data” output was supplied to recorder “Mic” input (unbalanced, nominal 600 Ohms). Plenty of signal was available in this configuration. The recorder’s display produced audible buzz that was tricky to minimize with the system ungrounded. Careful experimentation with placement and orientation of the recorder brought buzz to a very low level. But, addition of a small ground rod earth connection simplified matters to where there seemed to be no problem unless the recorder was brought close to the antenna.

Spectrograms 3, 8, and 9 show decent response all the way up to 22 kHz, with good traces of the MSK signals at the top. Spectrogram 9 shows the Alpha radio navigation sequence from former Soviet Asia quite well. However, when Spectrograms 2 and 3 are compared (#2 is output of approximately 4 ft whip with preamp stage attached applied directly to the line input of the recorder while #3 is an 8 ft whip attached to VLF-3, data output applied to Mic input of recorder – recordings made in the same place, a few minutes apart) I find myself wondering just what we’re accomplishing with all the electronics inside the VLF-3!

The VLF-3 works well in the typical environment of strong sferics, but under quiet conditions it seems noisy and lacking sensitivity. It seems to me that much of this trouble might be attributed to the large resistance and inductance values in series with the antenna. These elements may be vestiges of our original need to prevent overload to following receiver stages and to protect cassette recorders from the now defunct Omega navigation signals. The inductor L1 may thwart attempts to improve the signal-to-noise ratio by use of longer wire antennas, as it will produce resonances at higher frequencies where very strong signals (such as Loran C and WWVB) may be present, potentially overloading circuit elements all down the signal path, starting with the FET. The lowpass filter (L2, C6, C7) is likewise a vestige of earlier times. We probably need something like that there, but for most users it could probably be pulled up at least a couple of kHz.

Where the VLF-3 enjoys a distinct advantage, over simpler units such as the WR-3, is in its support of recording and provision for supplementary inputs such as commentary and timecode.

Recommendations

The basic VLF-3 design could be improved electrically and physically into a quieter, more rugged, more sensitive receiver.

The front-end, with its “Filter” option needs to be reconsidered. Given a suitable FET properly biased it seems like the large series resistance could be reduced and the 3.9 mH series inductor eliminated. The “Filter” may protect the FET from overload in severe VLF environments and I realize its performance may be predicated on having the whiop directly mounted on the BNC connector – an inconvenience worth trying to avoid. In the cut-and-try process of developing the original INSPIRE receiver I spent a lot of time substituting various values and combinations of series resistance and shunt capacitance at the antenna input. It was possible to get clean results and decent signal-to-noise ratio with everything from short whips to wires more than 2,000 feet long, but no single solution would optimize more than a narrow range of signal and antenna conditions. It is interesting to note that one of the most listened to natural radio recordings in the world was made by me with a pair of INSPRE receiver prototypes (one built by me, the other by Jim) attached to canyon-bottom wires of 1200 feet or more. A couple of the outboard preamps for the RS-6 were built with the switches allowing the setting of both series R and shunt C from nothing to lots; fussy to set up, but very flexible.

The tradeoffs between simplicity and flexibility will always be of concern. Beginners will want something simple and understandable; addicts like me want a full lab that fits in a knapsack!

The passive low pass filter (L2, C7, C8) might be tuned higher.

It might be worthwhile to replace the LM358 with something quieter.

If we were to contemplate a redesign of this basic unit, I would recommend replacing the slide switches with small toggle units. Also smaller knobs on the two potentiometers and, if they can be found anymore, the most rugged jacks money can buy. At least on the “Data Level” pot we might want to replace the “fatter equal louder” indicator with an arbitrary 1-10 scale to facilitate accurate resetting of recording levels.

Imagining an ultra-deluxe model, I think it would be great to offer both built-in and out board pre-amps to combine flexibility of a “carry everywhere” unit with the virtue of being able to easily get the sensitive antenna/preamp combo into the clear and away from the work area. (See photo of RS-6 antenna and preamp atop mast at Rosedale Camp) But maybe we can be a bit more radical in considering redesign; more of this later.

As noted above, it is impractical to place an un-preamplified whip at much distance from the receiver. An obvious alternative is to keep the receiver and antenna together, feeding the output to the monitoring/recording site. Tom Becker is doing this with his streaming system in Florida. Weatherproofing and control issues come to the foreground with this approach, which may be more practical for permanent installations than in causal field use.

The value of the Assembly Instructions could be enhanced by adding a table of typical voltage values to be found at a few points in the circuit. Another good thing would be to diagram the unit in functional blocks and provide nice, relatively non-technical descriptions of what goes on inside each one; perhaps referencing texts that further elucidate. This could make users, including rank beginners feel more comfortable with their receiver and its functioning as a fairly simple sequence of basic circuits.

Other Rosedale Tests

In addition to the VLF-3 I used the following receivers:

WR-3	(Spectrogram 4)
RS6	(Spectrogram 6)
Orthogonal Loop	(Spectrogram 5)
Big Loop	(Spectrogram 1, 7) with Ratzlaff and Stanford preamps
Line-Out Whip Preamp	(Spectrogram 2) “Whip Direct”
Loop Direct	(Spectrogram 10) Bigloop, Stanford preamp to recorder line input

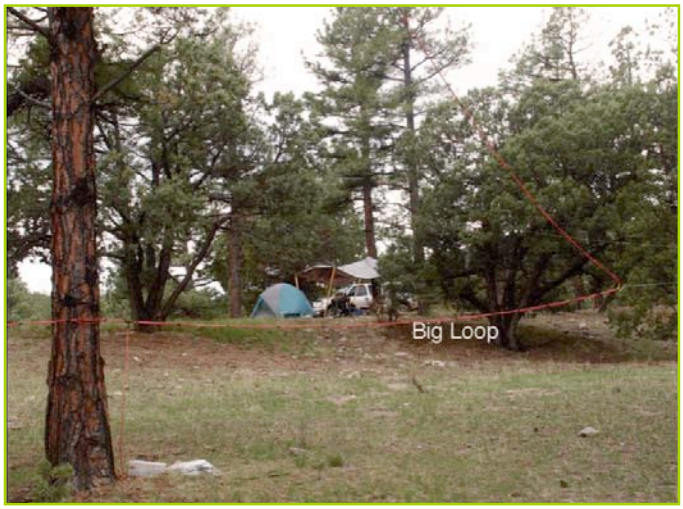
They all worked. Quite a lot of whistlers (hundreds) were heard on the loops. For me the orthogonal loop system with its pair of 56 ft circumference 5 turn 14 ga loops was the most interesting listening, with decided dimensional effects in the stereo headphones. The experimental “Big” loop (4T, 84 ft circumference, 14 ga) with either preamp was clearly the most sensitive of the lot. I’ll be making another one to have a pair for the orthogonal receiver when I leave for Keeler later this month.

Future Systems

My experiments with applying both whip and loop preamps directly to the line input of the Zoom H2 recorder have led to thoughts of abandoning the receiver concept in favor of an active antenna approach. Let impedance conversion, essential bandpass filtering and suitable degree of amplification happen right at the antenna. Use transmission line or wireless ling to a largely passive patch board that flexibly interfaces antenna output along with voice announcements, timecode and any other data streams to appropriate recorder input. E field and H field sources should be equally compatible with the interface and could be used simultaneously if so desired. Given clean output from the active antenna, any further pre-recorder signal processing would be a matter of staying within the recorder’s limitations. With a maximum of information captured the user can then nondestructively perform any desired modification of the content – from playing it into a narrowband receiver to subtracting hum or subtracting everything BUT hum.

The Rosedale Session

It was early afternoon on July 15 when I got the first receiver running. It happened to be the Big loop because I’d just built the thing and was really eager to hear how it worked. Within a few seconds of putting on the headphones I heard a 2-hop whistler. And another, a not very distant thunderclap with whistler returning. And so it went on through the afternoon, into the evening and through the night. Whistlers continued until nearly noon on the 16th; thousands of them. My first experience of really active whistler conditions since moving to the Southwest more than eight years ago. Compare this to that previous session at Rosedale when I recorded nine continuous hours with the big 12 ga Stanford Loop for the balloon overlight – ONE little whistler, somewhere around hour five as I recall!



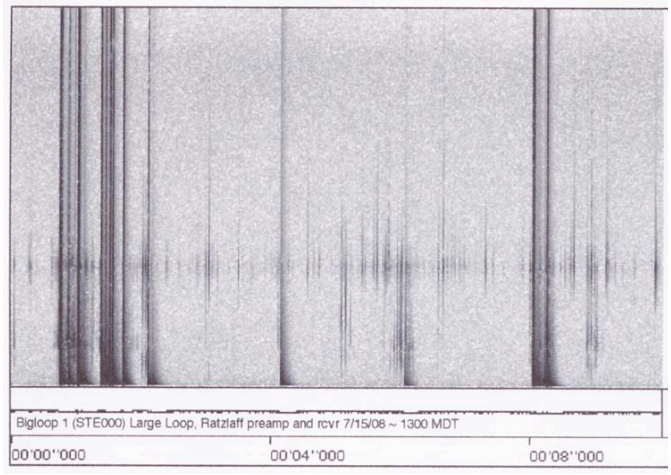
At times during the evening of the 15th practically every sferic that sounded “local” (likely the Southwestern region) was producing a 2-hop whistler return. There was a lot of lightning in the region and often the whistlers were coming several to the second. These were not strong whistlers; I’d class them 3 or weaker on the

Shawn Korgan scale. My assumption is that they were entering the earth-ionosphere waveguide somewhere north of the Canadian border and naturally fairly weak upon reaching the region of their origin. As best I could tell through the roar of local sferics this was not a “whistler storm” as the whistlers seemed to be full-spectrum events, rather diffuse and starting (or becoming sortable from the sferics) at a fairly low pitch. (“Whistler Storm” whistlers are band-limited fragments, only part of the spectrum coming through.) Not a “Storm” but the whistler count was high enough and I can’t help wondering whether somewhere else on the globe a band-limited cloud of whistlers was arriving with no trace of initiating sferics.

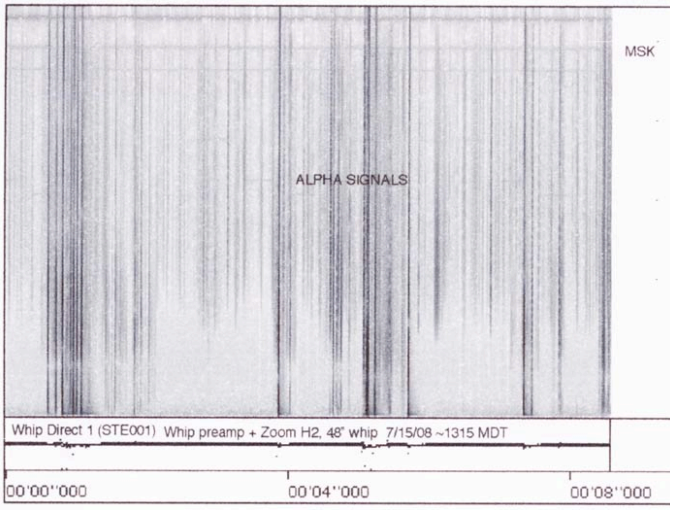
The Rosedale Site

Rosedale is the location of a long defunct mining community on the lower eastern slopes of the San Mateo Mountains in west central New Mexico. Follow NM 197 (dirt road) about 22 miles South from Magdalena, turn West on USFS Road 330 and continue about 7 miles. Coordinates are: 33 deg. 48.436N by 107 deg. 24.591W. The nearest 60 Hz power line is a rural service, probably around 10 kV, paralleling Hwy 107 and about 6 miles from Rosedale at the nearest point. Next nearest would be a similar line 15 or more miles distant on the West side of the San Mateos. The site is accessible in nearly any weather, combines tall pines for hanging loops with open spaces for whips. A fine place to camp – during my two days in July not a soul passed by on the Forest road. That will change for the worse from mid-August until sometime after Christmas. Elk season opens and the place fills with a hundred or more camps, one or more ATVs per camp and the best spot of all, which I’ve named Radio Ridge, turns out to be the spot where they all go to use their cell phones. Elk mortality from this camp’s activity seems to be pretty low. I suspect the stink and roar of all those ATVs heading out at dawn reminds the elk to seek cover in the abundant steep, shattered terrain where no wheel will ever go.

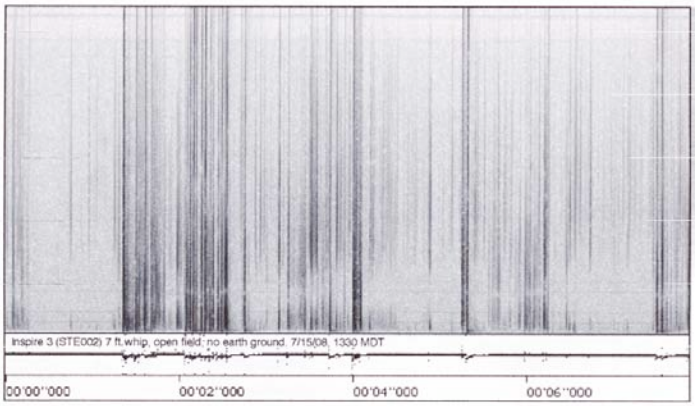
Spectrogram 1
July 15, 2008 1300 MDT



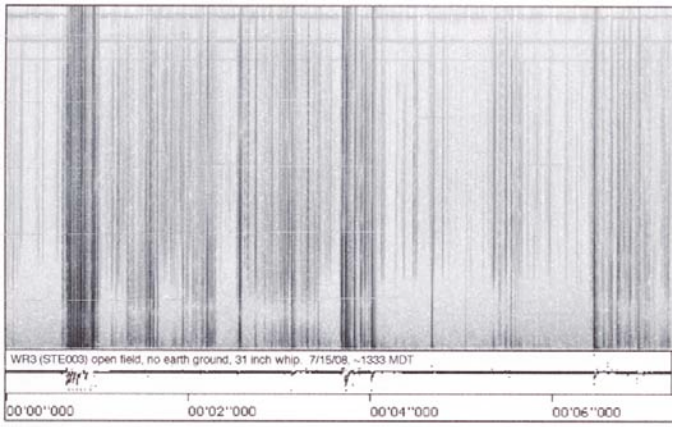
Spectrogram 2
July 15, 2008 1315 MDT



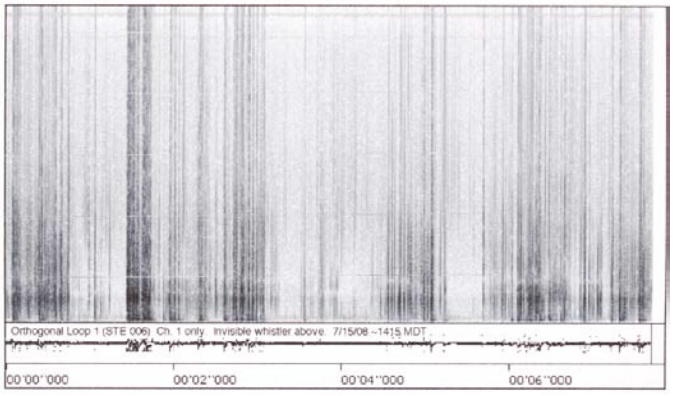
Spectrogram 3
July 15, 2008 1330 MDT



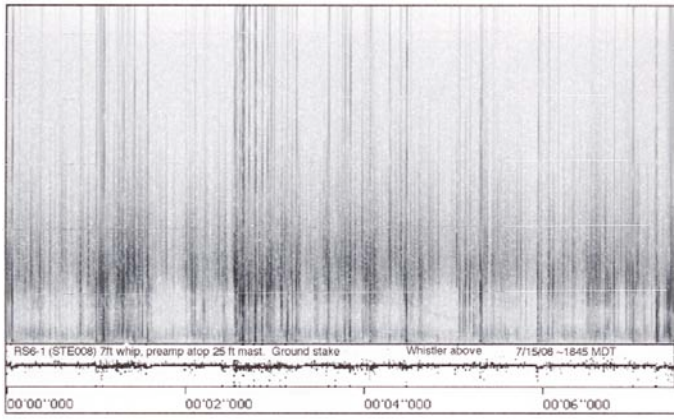
Spectrogram 4
July 15, 2008 1333 MDT



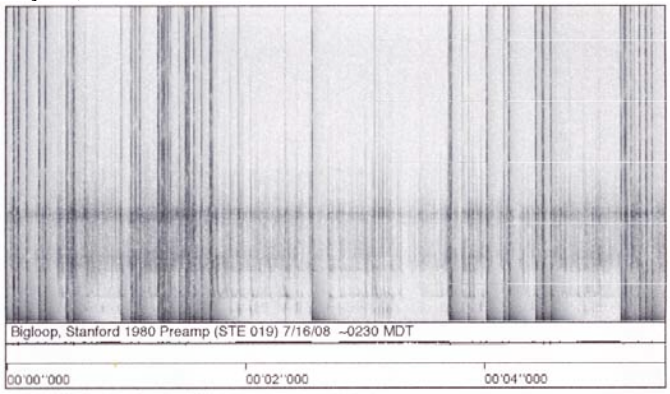
Spectrogram 5
July 15, 2008 1415 MDT



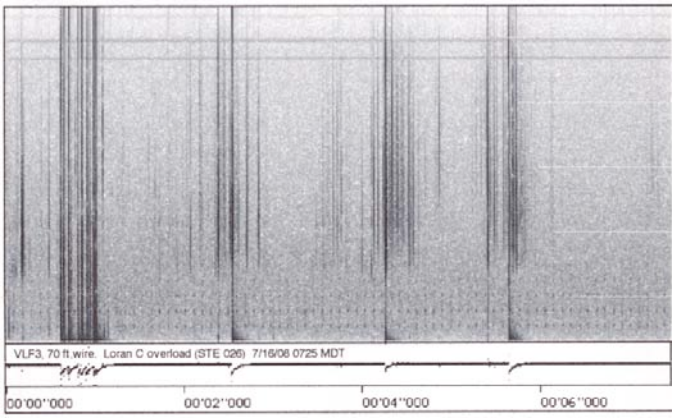
Spectrogram 6
July 15, 2008 1845 MDT



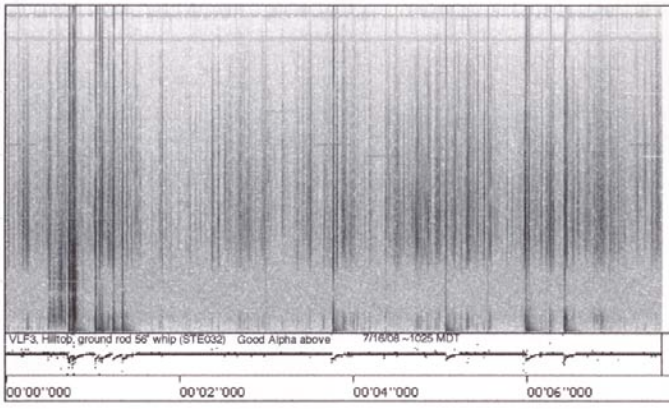
Spectrogram 7
July 16, 2008 0230 MDT



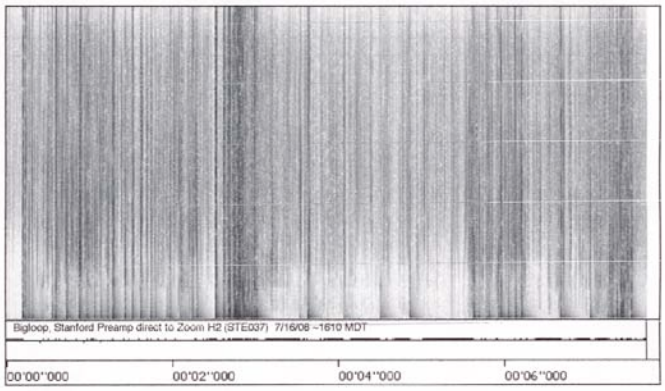
Spectrogram 8
July 16, 2008 0725 MDT



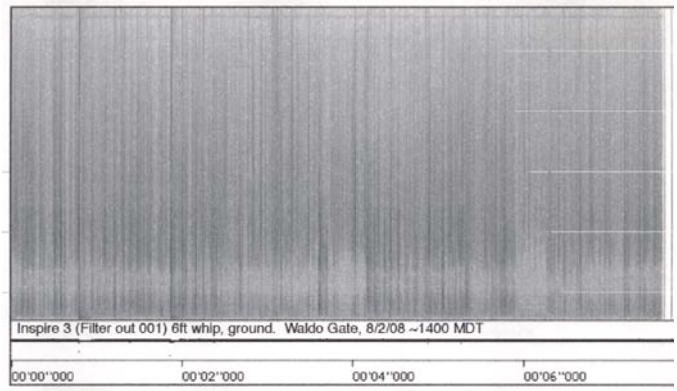
Spectrogram 9
July 16, 2008 1025 MDT



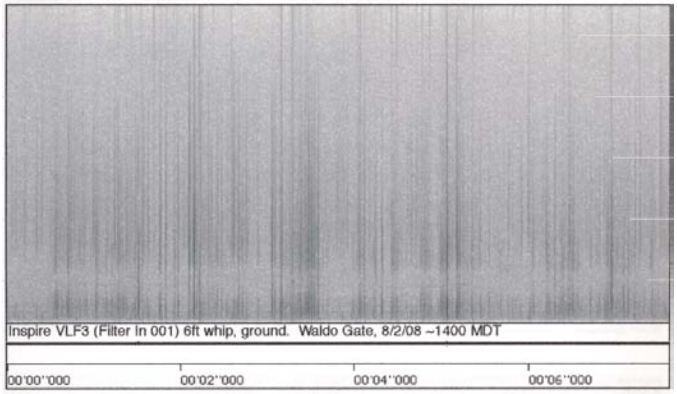
Spectrogram 10
July 16, 2008 1610 MDT



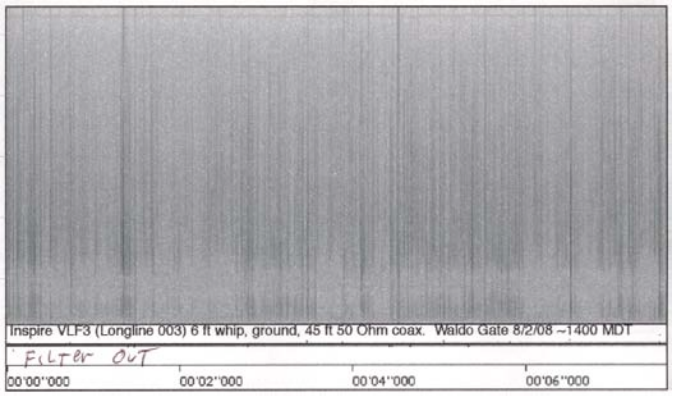
Spectrogram 11
August 2, 2008 1400 MDT

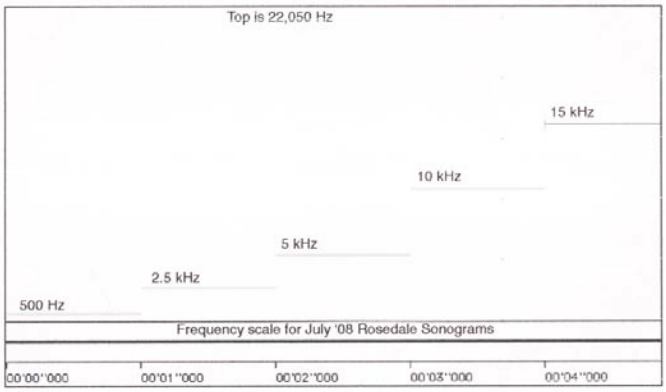


Spectrogram 12
August 2, 2008 1400 MDT



Spectrogram 13
August 2, 2008 1400 MDT





Field Notes for Natural Radio Observations

Robert Bennett, Las Cruces, NM, 17 – 19 October 2008

On Friday evening, Saturday morning and evening and Sunday morning I monitored natural signal from one of my favorite “quiet spots”. The spot I selected for monitoring is located in a primitive area of the Cibola National Forest in south central New Mexico. The site is about 120 miles north of my home. I had several goals for this outing. First, I wanted to get away from the daily routine at home for a few days. It had been almost a year since I was last able to monitor natural radio signals and I wanted to restart monitoring. Finally, I wanted some uninterrupted time to devote to amateur radio and short wave listening (SWL).

THE PLAN

The first objective was to monitor and record natural radio signals in the pre-dawn hours on Saturday and Sunday (18 and 19 October).

The second objective was to conduct some experiments. The first experiment was to test a modified H-Field (loop) receiver. I attempted to use this system in October 2007 and the receiver’s performance was not to my likening so I modified it. (I reported on the Oct 2007 test results in a previous issue of the INSPIRE Journal.)

The next set of experiments involved recorders. I am looking for a replacement for my main cassette recorder which is a Marantz model CP-430. The CP-430 is a professional grade portable stereo recorder that was very expensive when I purchased it in 1994. The recorder is excellent for natural radio applications, I have used it frequently and it has given me outstanding service. However, it is showing signs of age. Two years ago the rewind mechanism failed and I returned the recorder to the factory for repair. They repaired it but warned me that the recorder was no longer in production, replacement parts were almost depleted and they might not be able to repair it in the future.

Another problem that developed over the last two years is difficulty finding the recommended 60-Minute cassette tapes. Quality audio cassette tapes are becoming difficult to find in my local area. Most stores that use to stock the tapes have either stopped or sell only cheap imported tapes. I now have to either travel to El Paso TX or order from Internet sellers.

Given this development, I began searching for a replacement. I started by looking at the analog recorders available in local stores and via mail order. I have yet to find a unit that will adequately replace the Marantz. I reached the conclusion that quality portable analog stereo recorders with line inputs are no longer being made.

My next activity was to evaluate portable DAT recorders. My research found that professional grade portable stereo DAT recorders were still being made and their specs indicated that they should be useful for natural radio applications. I purchased a new SONY TCD-D8 DAT recorder from a seller on EBay for evaluation. I used the recorder in my workshop for several months and found that it is suitable for natural radio recordings. One feature I really like is the SPDIF output port. Using this port I can download the recorder into a file on my computer without going through another A/D conversion in a sound card. However, I uncovered several negative features about the recorder and found through research that they are common to most DAT recorders. My Sony DAT recorder eats batteries quickly. A set of four AA-cells will last for approximately three hours of recording. The tape transport mechanism is fragile and if a tape sticks in the mechanism, major disassemble is required to free it. I usually record from remote locations in the desert and sand and dust are a problem. I found that even a small amount of grit in the mechanism will cause problems. There is no source for DAT Tapes in my area state. I have found only two national distributors that maintain a stock of tapes. Also, from Internet research I get the impression that DAT recorders are on the way out. Even though the recorder has the features useful for natural radio recording, I don’t believe it is a long-term solution.

I next investigated the so called IC Recorders. I purchased two of them (a Sony ICD-ST10 and a Zoom H2). The ICD-ST10 can record about an hour before its memory is filled. Also, bench testing showed that the ST10 is designed for voice recording and has an upper cut off frequency of 8 KHZ. The H2 has a removable memory module and my taking along several spare modules, duration of recording is not an issue. Initial testing indicated that the H2 is suitable for natural radio recording. The H2 is a little small for my likening and given that it has a plastic case, I have reservations about it being rugged enough for long-term use in the field. My Internet research led me to believe that the future of field recording is to use a sound card on a portable computer. I have never tried using a computer for natural radio recording.

So my monitoring experiments consisted of consecutive recordings of natural radio signal using the Marantz recorder (for reference), then the DAT recorder, the H2 then finally the computer sound card. The final objective was to perform some SWL and amateur radio actives on Saturday.

RESULTS

I arrived on site Friday, 17 Oct, at approximately 1600 MDT. Conditions were very good, no wind, clear skies and temperature about 65˚ Fahrenheit. I had about three hours before dark in which to set up my tent, setup camping equipment, install antennas, build a fire and cook my evening meal. By 2000 MDT, the wind had picked up and was 5-10 MPH out of the north and the temperature had dropped to 50˚ Fahrenheit.

A. I conducted my first monitoring session at 2000 MDT (0300 UTC 18 Oct). This session was a test to insure that all equipment was working correctly. Everything worked properly and I recorded 13 Minutes of natural radio. I noted intense and frequent tweaks and continuous sferics at levels 4-5. I did not detect any whistlers. The only problem I had was that the WWV signal experienced a lot of fading. The only useful frequency was 2.5 MHZ.

B. After the above test, I spent the next two hours doing experiments. I first tried the magnetic loop system. It was a total failure. I only detected high level random noise. The system did not work at all. I obviously made a mistake in installing the modifications and will have to trouble shoot the receiver. After repair I will take the system to the field again for testing.

After the above failure, I successfully recorded 15 minutes of VLF-3 output on the TCD-D8 recorder, the H2 IC recorder and finally on my computer (IBM T-21 ThinkPad) using the T-21's on board sound system. One thing I observed using the computer as a recorder was that I had to separate the computer and VLF-3 by at least 3-feet to prevent the VLF-3 from picking up interference from the computer.

I thought I had gathered useful data from the recorder experiment but analysis of the recordings after I returned home proved otherwise. The DAT recording had both stereo channels present including the WWV markers. However, there was a two-minute blank space on both channels right after a WWV marker and I don't know why. Also the recording contained feedback on it in a few places which means that I did not set the receiver and recorder levels correctly thus overloading the recorder.

The computer sound card based recording was a disappointment. I thought I was recording stereo but upon further analysis found that only one channel actually recorded. The wave file was in Mono mode. IBM claims that the sound system will support stereo operations; however, the manual did not mention that all the native software (sound recorder, etc) only produce mono recordings. I will have to install additional software (AUDACITY for instance) and try again. I did determine that the mono wave file produced during the experiment was almost as good as one of the stereo channels recorded on the Marantz. The major difference was that the computer sound system has more signal attenuation above 10 KHZ than does the Marantz. Another problem that I need to address is that the wave file produced by the computer was almost 300 MB in size. I don't have enough disk space on my old laptop to leave many files of this size on the computer. I need to determine how to extract segments of the wave file for analysis and the best way to archive the whole file.

The H2 IC recorder looks good after a cursory examination. I had to defer further examination of this recording due to some pressing problems.

C. The next natural radio monitoring session occurred at 0500 MDT on Saturday 18 Oct (1100 UTC). The temperature inside my tent when the session started was 45˚ Fahrenheit and it was very windy outside. I had major problems with this session. I could not get the WWV markers to record on the second track of the Marantz recorder. I ended up with only a single WWV marker on the recording near the end of the session. I tried to trouble shoot the receiver setup, monitor the receiver output and fill out the log sheet at the same time. I had to time the events of interest using my watch and I know some of the entries are not too accurate. I did note 4 weak whistlers during the session. I checked the VLF-3 after sunrise and found that the slide switch that inserts the WWV markers into the output audio stream had broken. All things considered, this was a very frustrating recording session.

D. The next session occurred at 0600 MDT on Saturday. I substituted a backup receiver (the older INSPIRE RS-4) for the VLF-3 for this session. I had a successful recording session. I noted one weak diffuse whistler. I also noted the presence of some strange signals. About half way through the session, I reduced the RS-4 level to see if the strange signals would go away. It did help but upon detail analysis of the recording at home, I found the signals still present. My analysis found a pulse like signal at 1344 HZ with approximate PRI of 630 MS and PD of 250 MS. I have no idea what it is. I also noted a strong steady signal at 3986 HZ. I don't know what these signals are but there are two

possibilities. First, the RS-4 may be picking up radiation from the Marantz recorder. Second, the two mystery signals could be caused by intermodulation from a strong signal outside the pass band of the RS-4.

E. The next session for Saturday occurred at 0700 MDT (1300 UTC). I used the RS-4 for this session. I did not detect anything of interest. I noted that the sferic levels plus the frequency of occurrence and intensity of tweaks decreased significantly during this session. Sunrise occurred at approximately 0713 MDT. I normally note a drop in natural radio activity just after local sunrise.

F. The final session for Saturday started at 2045 MDT (0245 UTC, 19 Oct). I made hasty repairs to the VLF-3 receiver and this was an unplanned session to test the repaired receiver. I detected another unknown interfering signal during this session. I noticed a short "beep" occurring every few seconds. Analysis at home revealed that I was actually receiving a pulsed signal centered at 5064 HZ with a PRI of about 5 seconds. I have no idea what this could be. Other than this mystery, I didn't detect anything else of great interest. The sferic level was about 5, and tweaks were at level 5 and very frequent. No Loran or 60~ hum was noted. It was very windy outside the tent and the temperature was about 45˚ Fahrenheit.

G. The first session on Sunday 19 Oct started at 0600 MDT (1200 UTC). I planned to start recording at 0500 MDT but I overslept! This session was outstanding! I recorded a whistler storm. In my 20 years of natural radio monitoring, I have recorded only one other session as notable as this one. I recorded for 25 minutes and noted 52 whistlers. Most were level 2 -3 and somewhat diffuse. A few were level 5. In several cases I heard the generating tweak and then the resulting whistler. Many of the whistlers were dual. Propagation conditions were strange as I noted Loran pulses. I don't normally receive Loran at this site. I used the VLF-3's built in filter to successfully remove the interference. I would have continued recording until the whistler storm ended but I was down to my last tape and my recorder was warning of a low battery.

H. The final natural radio recording session occurred at 0700 MDT on Sunday (1300 UTC). The wind had decreased a lot from the conditions at 0600. I used the VLF-3 receiver again and was pleasantly surprised to find that the whistler activity was still on going. I recorded for 26 minutes until my recorder battery failed. I recorded a total of 23 whistlers.

Data Log Cover Sheet

Field Monitoring

DATE: 17, 18, 19 oct 2008

INSPIRE Observer Team _ROBERT BENNETT_

Equipment: Receiver _VLF-3 and RS-4_

Recorder Marantz CP-430_

Antenna 6-Ft Vertical whip elevated 10 Ft above ground level

WWV radio _Yupiteru MVT-7100_

Site description: _Primitive campground in a valley surrounded by mountains. _Located in the Cibola National Forest near T-or-C NM. Site Elevation is 7000 Ft ASL.

Longitude: 107° _21' **W** **Latitude:** 33° _33' **N**

Personnel: _____ _____ _____

Team Leader Name: _Robert Bennett_

Mailing Address: _5675 Shadow Hills Rd

City, State, Zip, Country: _ Las Cruces, NM 88012, USA_

Email: _RPBENNETT1@COMCAST.NET

Local Time to UT Conversion Table

MST + 7 = UT MDT + 6 = UT

INSPIRE Data

Friday Evening

INSPIRE Observer Team ROBERT BENNETT

Observation Date: 17 oct 2002 Receiver VLF-3

Tape Start Time (UT) 0300 Tape Start Time (Local) 2100 MDT

Local weather: 45°F, clear, wind 5-10mph

Code: **M** – Mark (WWV or Voice)
S – Sferics
T – Tweek
W – Whistler
A – Alpha
C – Chorus

Sferic Density: D: 5 Scale of 1-5 (1 – Very Low, 3 – Medium, 5 – Very High)

Time (UT)	Entry	Density	Comment	Counter
0300	M-WWV (M-V) S T C W	D: 5	Voice Announcement	8
0306	(M-WWV) M-V S T C W	D:		14
0306-0307	M-WWV M-V S T C W	D:	Level adjustments.	
0307	(M-WWV) M-V S T C W	D: 5	Many strong tweaks occurring	36
0311	(M-WWV) M-V S T C W	D:		105
0313	(M-WWV) M-V S T C W	D:		138
0315	(M-WWV) M-V S T C W	D:		167
0316:06	M-WWV M-V S T C W	D:	unknown "beep" detected	212
0319	(M-WWV) M-V S T C W	D:	End of recording	223
	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:	Nothing of great interest	
	M-WWV M-V S T C W	D:	detected during this session.	
	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:		

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INSPIRE Data

Saturday morning

INSPIRE Observer Team _ROBERT BENNETT_

Observation Date: 18 oct 2008 Receiver VLF-3

Tape Start Time (UT) 1400 Tape Start Time (Local) 0500 MDT

Local weather: clear, windy, cool - Temp about 40°

Code: M – Mark (WWV or Voice)
S – Sferics
T – Tweek
W – Whistler
A – Alpha
C – Chorus

Note: WWV marker failure, times given are approximate

Sferic Density: D: 5 Scale of 1-5 (1 – Very Low, 3 – Medium, 5 – Very High)

Time (UT)	Entry	Density	Comment	Counter
	M-WWV (M-V) S T C W	D:	voice Announcement	224
1107:40	M-WWV M-V (S) C W	D:	Recording start tones	226
	M-WWV M-V (S) T C W	D: 5	Strong tweaks are occurring	
1114:48	M-WWV M-V S T C (W)	D: 9		290
1117:03	M-WWV M-V S T C (W)	D: 1	weak diffuse whistler	310
1120:30	M-WWV M-V S T C (W)	D: 3		346
1123	(M-WWV) M-V S T C W	D:	only WWV marker on tape	394
	M-WWV M-V S T C W	D:		
1125	M-WWV M-V S T C W	D:	Recording ends	418
	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:		

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INSPIRE Data

INSPIRE Observer Team ROBERT BENNETT

Saturday morning

Observation Date: 18 Oct 08 Receiver RS-4

Tape Start Time (UT) 1200 Tape Start Time (Local) 0600 MDT

Local weather: Clear, cool, Light wind

Code: **M** – Mark (WWV or Voice)
S – Sferics
T – Tweek
W – Whistler
A – Alpha
C – Chorus

Sferic Density: D: 5 Scale of 1-5 (1 – Very Low, 3 – Medium, 5 – Very High)

Time (UT)	Entry	Density	Comment	Counter
	M-WWV (M-V) S T C W	D:	Voice Announcement	0-9
	M-WWV M-V (S) T C W	D: 4-5		12
1200	(M-WWV) M-V S T C W	D:	~~Weak diffuse whistler~~	29
1201:30	M-WWV M-V S T C (W)	D: 1-2	weak diffuse whistler	46
1202	(M-WWV) M-V S T C W	D:		63
1204	(M-WWV) M-V S T C W	D:		99
1205	(M-WWV) M-V S T C W	D:		117
1207	(M-WWV) M-V S T C W	D:		150
1207:30	M-WWV M-V S T C W	D:	Reduced RS-4 gain to check on feedback	152
1209	(M-WWV) M-V S T C W	D:		171
1211	M-WWV M-V S T C W	D:		211
	M-WWV M-V S (T) C W	D: 3-4	for last 2 min, tweek density	
	M-WWV M-V S T C W	D:	seems to be decreasing	
1213	(M-WWV) M-V S T C W	D:		240
1215	(M-WWV) M-V S T C W	D:		268
	M-WWV M-V S T C W	D:	End of Session.	269
	M-WWV M-V S T C W	D:	Note: Not much of interest on	
	M-WWV M-V S T C W	D:	this recording except for one	
	M-WWV M-V S T C W	D:	weak whistler	
	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:		

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INSPIRE Data

Saturday evening

INSPIRE Observer Team ROBERT BENNETT

Observation Date: 18 oct 08 Receiver VLF-3

Tape Start Time (UT) 0247 (19 oct) Tape Start Time (Local) 2047 MDT

Local weather: clear, strong wind gusts, temp about 48.

Code: M – Mark (WWV or Voice)
S – Sferics
T – Tweek
W – Whistler
A – Alpha
C – Chorus

Sferic Density: D: 5 Scale of 1-5 (1 – Very Low, 3 – Medium, 5 – Very High)

Time (UT)	Entry	Density	Comment	Counter
0246	M-WWV (M-V) S T C W	D: 4-5	Voice Announcement	0-5
	M-WWV M-V S T C W	D:	WWV Tones for about 1 min	5-30
0247	(M-WWV) M-V S T C W	D:	-	33
	M-WWV M-V S T C W	D:	I am receiving periodic "beeps"	
	M-WWV M-V S T C W	D:	every few seconds.	
	M-WWV M-V S (T) C W	D: 5	Strong frequent tweaks	
0249	(M-WWV) M-V S T C W	D:		71
0251	(M-WWV) M-V S T C W	D:		106
0253	(M-WWV) M-V S T C W	D:		140
0255	(M-WWV) M-V S T C W	D:		172
0257	(M-WWV) M-V S T C W	D:		202
0259	(M-WWV) M-V S T C W	D:		231
0301	(M-WWV) M-V S T C W	D:		259
0303	(M-WWV) M-V S T C W	D:		286
	M-WWV M-V S T C W	D:	Recording Ends.	287
	M-WWV M-V S T C W	D:		
	M-WWV M-V S T C W	D:	There are NO interesting Natural	
	M-WWV M-V S T C W	D:	Radio Signals on this recording.	
	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:		

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INSPIRE Data

Sunday morning

INSPIRE Observer Team ROBERT BENNETT

Observation Date: 19oct 08 Receiver VLF-3

Tape Start Time (UT) 1200 Tape Start Time (Local) 0600 MDT Page 1 of 3

Local weather: very windy, cool, clear skies.

Code: M – Mark (WWV or Voice)
S – Sferics
T – Tweek
W – Whistler
A – Alpha
C – Chorus

Sferic Density: D: 5 Scale of 1-5 (1 – Very Low, 3 – Medium, 5 – Very High)

Time (UT)	Entry	Density	Comment	Counter
1158	M-WWV (M-V) S T C W	D:	Voice Announcement	287-289
	M-WWV M-V S (T) C W	D: 4-5	strong frequent tweaks	
	M-WWV M-V S T C W	D:	Loran signal detected - placed filter in	
1158:12	M-WWV M-V S T C (W)	D: 3-4		292
1158:48	M-WWV M-V S T C (W)	D: 4	strong double whistler	303
1159	(M-WWV) M-V S T C W	D:		312
1159:30	M-WWV M-V S T C (W)	D: 5		318
1159:41	M-WWV M-V S T C (W)	D: 5	double whistler	321
1200:45	M-WWV M-V S T C (W)	D: 2-3		330
1201	(M-WWV) M-V S T C (W)	D: 2	Also weak whistler under WWV marker	336
1201:05	M-WWV M-V S T C (W)	D: 4		338
1201:40	M-WWV M-V S T C (W)	D: 3		347 ~~354~~
1202:15	M-WWV M-V S T C (W)	D: 1-2		354
1203	(M-WWV) M-V S T C W	D:		361
1203:15	M-WWV M-V S T C (W)	D: 3	dual whistlers one level 4-5	369
1209:15	M-WWV M-V S T C (W)	D: 1-2		378
1209:40	M-WWV M-V S T C (W)	D: 2		381
	M-WWV M-V S T C W	D:	Wind Noise becoming noticeable	384
1205:40	M-WWV M-V S T C (W)	D: 1-2		400
1207	(M-WWV) M-V S T C W	D:		407
1207:45	M-WWV M-V S T C (W)	D: 2		418
1207:50	M-WWV M-V S T C (W)	D: 5		419
1209	(M-WWV) M-V S T C [illegible]	D:		429

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INSPIRE Data

INSPIRE Observer Team ROBERT BENNETT

Observation Date: 19oct 08 Receiver VLF-3

Tape Start Time (UT) _____ Tape Start Time (Local) 0600 MDT Continued Page 2 of 3

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				Density	Comment	Counter
1209:25	M-WWV	M-V	S T C	(W)	D: 1-2		435
1209:30	M-WWV	M-V	S T C	(W)	D: 1		436
1210:10	M-WWV	M-V	S T C	(W)	D: 4		445
1211	(M-WWV)	M-V	S T C	(W)	D: 1	whistler under WWV	451
1211:17	M-WWV	M-V	S T C	(W)	D: 5		455
1212:10	M-WWV	M-V	S T C	(W)	D: 3		466
1212:30	M-WWV	M-V	S T C	(W)	D: 3-4		470
1213	(M-WWV)	M-V	S T C	W	D:		472
1213:45	M-WWV	M-V	S T C	(W)	D: 4	dual whistlers	483
1213:50	M-WWV	M-V	S T C	(W)	D: 4	[redacted] whistlers	489
1214:10	M-WWV	M-V	S T C	(W)	D: 3-4	dual whistler	488
1215	(M-WWV)	M-V	S T C	W	D:		493
1215:15	M-WWV	M-V	S T C	(W)	D: 5		496
1215:45	M-WWV	M-V	S T C	(W)	D: 1,3	dual whistlers	504
1216:	M-WWV	M-V	S T C	(W)	D: 5	very strong	507
1217	(M-WWV)	M-V	S T C	(W)	D: 5	also whistler	514
1217:05	M-WWV	M-V	S T C	(W)	D: 5		515
1217:10	M-WWV	M-V	S T C	(W)	D: 5		516
1217:40	M-WWV	M-V	S T C	(W)	D: 1		522
1217:45	M-WWV	M-V	S T C	(W)	D: 4	two whistlers	523
1219	(M-WWV)	M-V	S T C	W	D:		533
1219:10	M-WWV	M-V	S T C	(W)	D: 5		535
1219:20	M-WWV	M-V	S T C	(W)	D: 4		537

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INSPIRE Data

INSPIRE Observer Team ROBERT BENNETT

Observation Date: 19oct08 **Receiver** _____

Tape Start Time (UT) 1200 **Tape Start Time (Local)** 0600 MDT continued

Local weather: _____ Page 3 of 3

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					Density	Comment	Counter
1220:	M-WWV	M-V	S	T	(W)	D: 1		547
1220:05	M-WWV	M-V	S	T	(W)	D: 1		548
1220:35	M-WWV	M-V	S	T	(W)	D: 5		551
1222:30	M-WWV	M-V	S	T	(W)	D: 2		567
1222:45	M-WWV	M-V	S	T	(W)	D: 5		570
1223	(M-WWV)	M-V	S	T	C W	D:		572
1223:15	M-WWV	M-V	S	T	(W)	D: 5		575
1225	(M-WWV)	M-V	S	T	C W	D:		591
1225:15	M-WWV	M-V	S	T	(W)	D: 1		594
	M-WWV	M-V	S	T	C W	D:	End of recording	600
	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:		

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INSPIRE Data

INSPIRE Observer Team ROBERT BENNETT

Observation Date: 19 oct 08 Receiver VLF-3

Tape Start Time (UT) 1300 Tape Start Time (Local) 0700 MDT

Local weather: clear, windy, temp about 55°

Page 1 of 2

Code: M – Mark (WWV or Voice)
S – Sferics
T – Tweek
W – Whistler
A – Alpha
C – Chorus

Sferic Density: D: 4 Scale of 1-5 (1 – Very Low, 3 – Medium, 5 – Very High)

Time (UT)	Entry	Density	Comment	Counter
	M-WWV (M-V) S T C W	D:	Voice Announcement	0-6
	M-WWV M-V S T C W	D:	Loran still present, filter in	
1259:45	M-WWV M-V S T C (W)	D: 4		12
1300	(M-WWV) M-V S T C W	D:		16
1301:40	M-WWV M-V S T C (W)	D: 5	whistler pair	47
1302	(M-WWV) M-V S T C W	D:		55
1302.37	M-WWV M-V S T C (W)	D: 2		67
1302:40	M-WWV M-V S T C (W)	D: 5		106
1306	M-WWV M-V S T C W	D:		123
1308	(M-WWV) M-V S T C W	D:	whistlers decreasing in frequency of	159
	M-WWV M-V S T C W	D:	occurrance	
1308:25	M-WWV M-V S T C (W)	D: 2		161
1309:10	M-WWV M-V S T C (W)	D: 4		176
1310	(M-WWV) M-V S T C W	D:		182
1311:10	M-WWV M-V S T C (W)	D: 1		207
1312	(M-WWV) M-V S T C (W)	D:		210
1319:15	M-WWV M-V S T C (W)	D: 2		252
1316	(M-WWV) M-V S T C W	D:		260
1316:45	M-WWV M-V S T C (W)	D: 1		275
1318	(M-WWV) M-V S T C W	D:		284
1318:30	M-WWV M-V S T C (W)	D: 5		294
1320	M-WWV M-V S T C W	D:		307
1320:22	M-WWV M-V S T C (W)	D: 4		314

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INSPIRE Data

INSPIRE Observer Team ROBERT BENNETT

Observation Date: 19 Oct 08 Receiver _____

Tape Start Time (UT) 1340 Tape Start Time (Local) 0700 MDT continued

Local weather: _____ Page 2 of 2

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					Density	Comment	Counter
1320:25	M-WWV	M-V	S T C	(W)		D: 4		315
1320:53	M-WWV	M-V	S T C	(W)		D: 4	three whistler close together	324
1322	M-WWV	M-V	S T C	W		D: [illegible]		329
1322:40	M-WWV	M-V	S T C	(W)		D: 3	dual whistlers	342
1322:53	M-WWV	M-V	S T C	(W)		D: 2		346
1324	(M-WWV)	M-V	S T C	W		D:		351
1324:06	M-WWV	M-V	S T C	W		D: 4	dual whistlers	353
1326	(M-WWV)	M-V	S T C	W		D:		372
1326:05	M-WWV	M-V	S T C	(W)		D: 5	dual whistlers	373
1326:08	M-WWV	M-V	S T C	W		D:	End Recorder battery failed	374
	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:		

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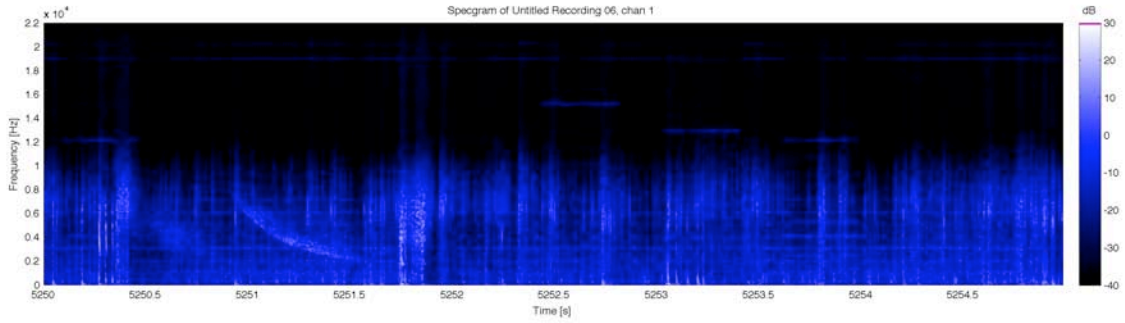
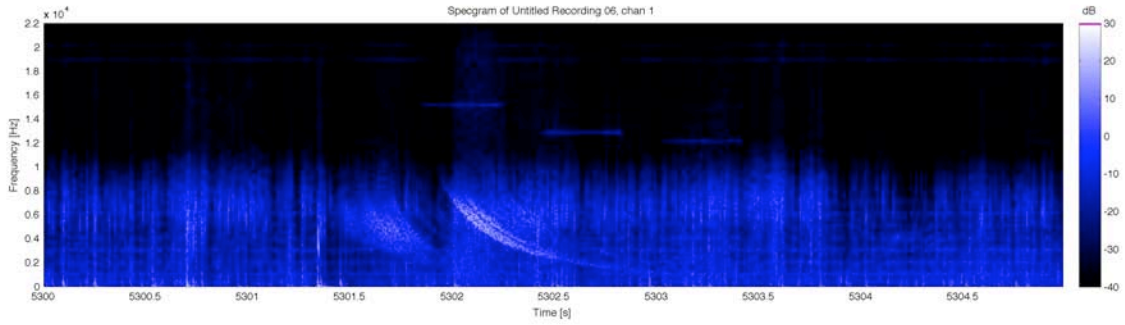
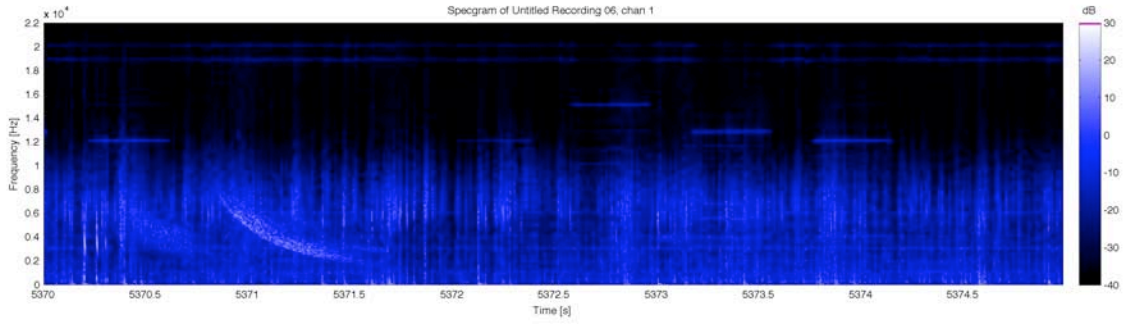
Spectrogram 1
October 18, 2008 0600 MDT - *There are three points worthy of note. First, there are several strong tweaks present (5250.5 and 5251.75 for example). Second, there is a whistler at 5251. Third, the Russian hyperbolic navigation signals are present and very strong. The signals are the three horizontal lines at frequencies 11.905, 12.649 and 14.881 KHZ. This navigation system is known as "ALPHA" to the Natural Radio Community. The real nomenclature of the system is RSDN-20.*



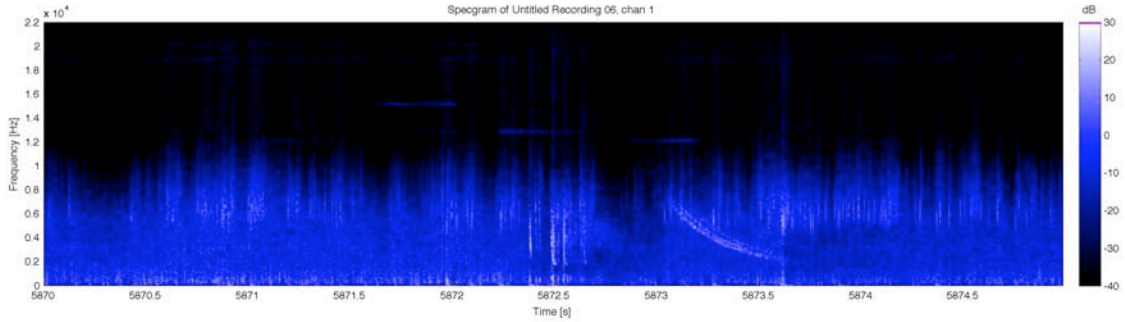
Spectrogram 2
October 18, 2008 0601 MDT - *Contains an example of a very strong (level 5) diffuse whistler.*



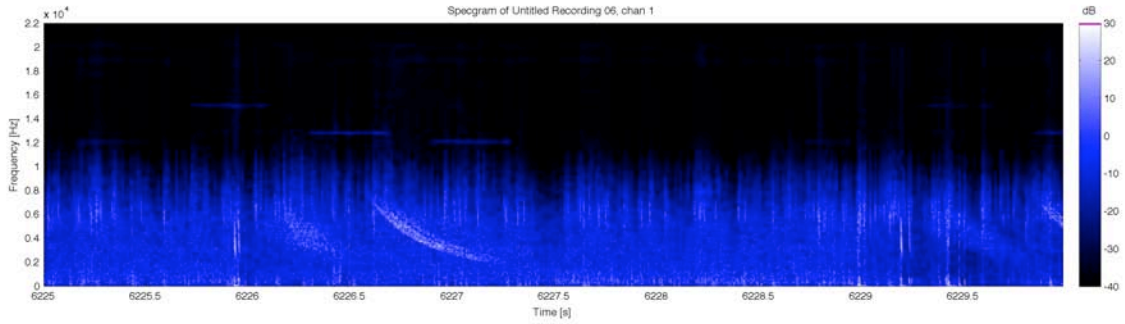
Spectrogram 3
October 18, 2008 0602 MDT - *An example of a weak diffuse whistler.*



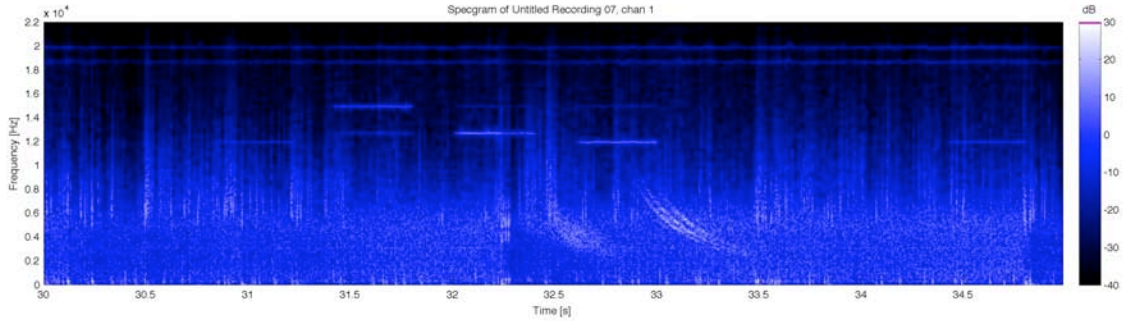
Spectrogram 4
October 18, 2008 0610 MDT - *Example of some strong tweaks and a whistler.*



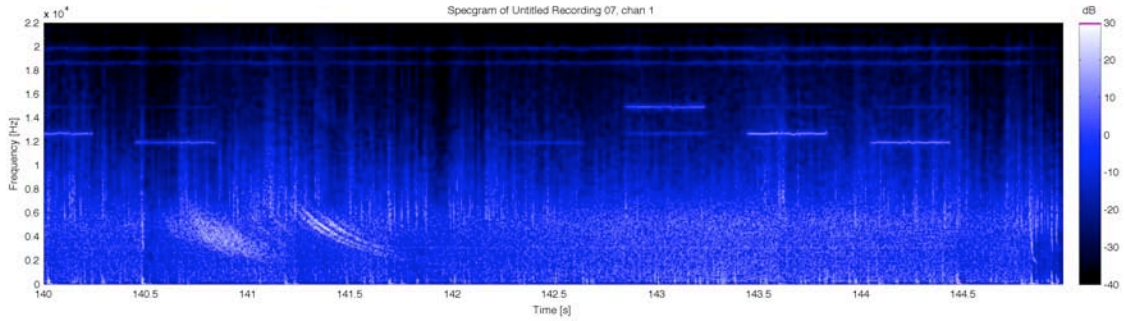
Spectrogram 5
October 18, 2008 0616 MDT - *Example of a strong whistler along with the tweak that generated it.*



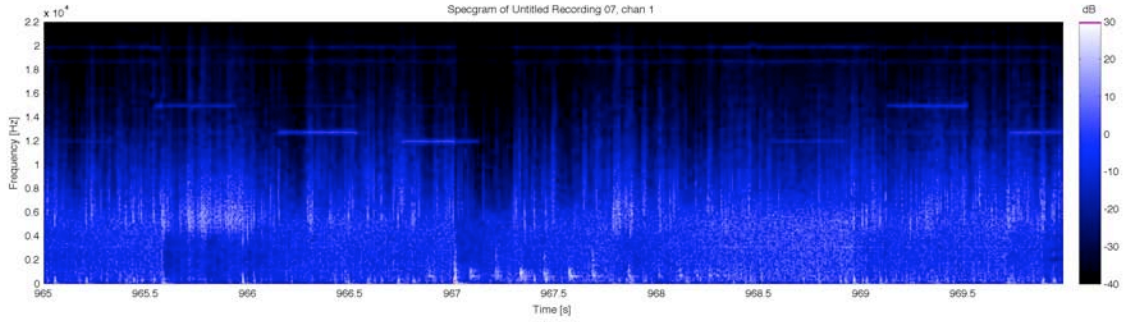
Spectrogram 6
October 19, 2008 0700 MDT - *This image shows a pair of diffuse whistlers, The strong RSDN-20 signals and two communications signals at 18.871 and 20.116 KHZ. The communications signals appear as straight horizontal lines.*



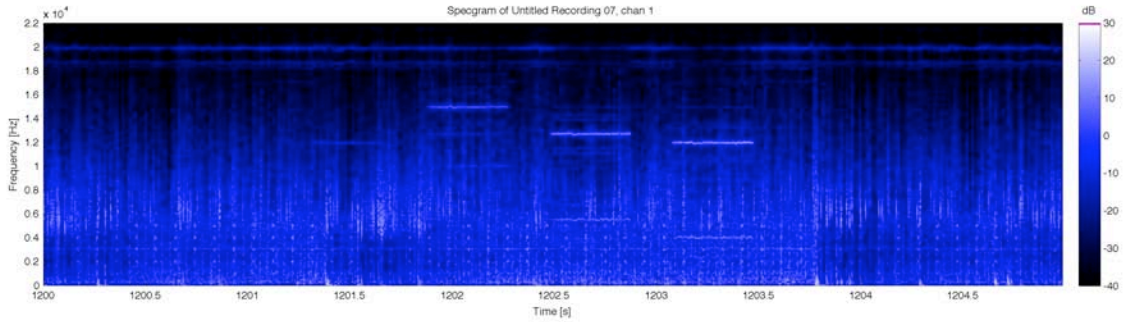
Spectrogram 7
October 19, 2008 0702 MDT - *A pair of whistlers.*



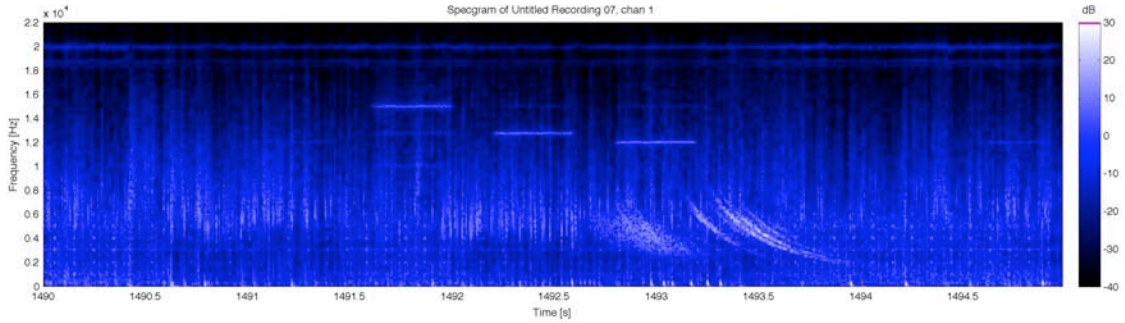
Spectrogram 8
October 19, 2008 0716 MDT - *A group of strong tweaks.*



Spectrogram 9
October 19, 2008 0720 MDT - *A good example of Loran interference. (The vertical rows of dots.)*



Spectrogram 10
October 19, 2008 0724 MDT - *This is strongest whistler I recorded this session.*



Chasing Lightning: Sferics, Tweeks & Whistlers

Phillip Webb

Introduction

We all know what lightning looks like during a thunderstorm, but the visible flash we see is only part of the story. This is because lightning also generates light with other frequencies that we cannot perceive with our eyes, but which are just as real as visible light. Unlike the visible light from lightning, these other frequencies can carry the lightning's energy hundreds or thousands of miles across the surface of the Earth in the form of special signals called "tweeks" and "sferics". Some of these emissions can even travel tens of thousands of miles out into space before returning to the Earth as "whistlers".

During the Fall 2008 semester, the first INSPIRE based university-level course was taught at University of Maryland Baltimore County (UMBC) as part of its First-Year Seminar (FYS) series. The FYS classes are limited to 20 first-year students per class and are designed to create an active-learning environment that encourages student participation and discussion that might not otherwise occur in larger first-year classes. This article covers some of the experiences gained from using the INSPIRE kits as the basis of a university course. This includes the lecture material that covers the basic physics of lightning, thunderstorms and the Earth's atmosphere, as well as the electronics required to understand the basic workings of the VLF kit. It will also cover the students' assembly of the kit in an electronics lab (some soldering required!) and the subsequent field trips to both local and more distant sites to listen for the sferics, tweeks and whistlers using the assembled kit.

Origin of the Chasing Lightning Course

The origins for the course was the winning by the first author of a NASA New Investigator Award (NIP) in 2005 that, as its education component, included the teaching of a graduate course in the Physics Department at UMBC based on the INSPIRE VLF receiver kit. However, the graduate level course did not find any interest from the graduate students, it was decided to offer a general 1st year course as part of UMBC First Year Seminar (FYS) series jointly with Dr Philip Rous from the Physics Department, who has run this type of course before. The FYS target audience is non-physics students, with one of the aims being to attract these students into a course that they find enjoyable and thus opens their minds to the possibility of a more scientific orientated course of study in the following years. Each FYS is limited to 20 students; the small number helps to encourage an interactive teaching environment between the students and the instructor. A FYS course proposal entitled "Chasing Lightning: Sferics, Tweeks and Whistlers" was submitted in December 2007 to the FYS Faculty Review Committee and the Undergraduate Council at UMBC and in April 2008 the course was accepted. The teaching goals will be similar to those of the graduate level course, but necessarily at a level appropriate for a 1st year undergraduate course. The INSPIRE Project organization feels that this type of undergraduate course will potentially have a much broader appeal to more universities than the original graduate level course, and could also be used by community colleges and thus widen its potential audience even further.

Breakdown of the Students in the Class

The FYS classes are limited to 20 first-year students per class and are designed to create an active-learning environment that encourages student participation and discussion that might not otherwise occur in larger first-year classes. The FYS 103K class comprised 19 students, after one student dropped out in the first week due to a course clash. No further students dropped the class. The class comprised approximately two-thirds freshmen and one-third sophomores. While a couple of the students were physics majors, the majority were either undecided or non-physics majors in areas such as dance, geography, graphic art design and computer science. The class consisted of approximately 40% female and 60% male students.

Lecture Component of Course

Each lecture was scheduled for 90 minutes and they were generally held once a week. The following are the topics covered during each lecture:

1. Introduction & Course Material Overview
2. Physics 101
3. Electronics
4. Basic Circuit Theory
5. Atmospheres
6. Climate & Weather
7. Overview of Thunderstorms, Lightning & Thunder
8. Earth's Ionosphere
9. Lightning
10. Sferics, Tweeks & Whistlers

Assembling & Testing the INSPIRE VLF Kit

Alternating with the weekly lectures, the students also spent approximately the same number of weeks working hands-on in the UMBC Physics Department Electronics Laboratory. Each of these labs was also 90 minutes in length. In the lab the students made use of equipment such as soldering irons to assemble the INSPIRE kits through to digital multimeters for testing of the kit components, among others. The students worked in pairs, with each pair assembling one INSPIRE VLF kit.

Since most of the students had no experience soldering, the first lab was spent teaching them how to do so using a relatively inexpensive commercially available circuit board from ApogeeKits (www.apogeekits.com) with just a handful of electronic components including two LED, called the "Flashing LEDs". This allowed the students to learn the art of soldering with a kit that was less than one tenth of the value of the INSPIRE kit, so increasing the chances of successfully assembling the INSPIRE kit in future labs based on their experience with the LED kits. Furthermore, the LED kit could be assembled in one lab session, so allowing the students to produce the completed kit and, importantly, to see it working by the end of the lab. This allowed them to build up the confidence that they could, in fact, successful solder and thus move onto the more expensive and complex INSPIRE VLF kit in the coming weeks.

Over the following weeks the students, working in pairs, assembled the INSPIRE VLF kits. This took approximately five lab sessions. Once the kits were assembled, a number of lab sessions were then required for testing to determine why various assemble kits were not working properly. In most cases this was determined to be due to one or more poor soldering connections and was corrected by redoing the soldering at various component joints. In one or two cases, it was found that the problem was due to a faulty component and it was replaced.

Once the kits were assembled and working in the lab some initial trials were conducted near the parking lot, by the UMBC Physics building. While this was not the ideal environment due to potential electromagnetic noise from the surround buildings, it was still possible to detect both sferics and tweeks.

Field Trip to Green Bank Telescope in West Virginia

To further the goal of expanding the students' exposure to science, a two-day field trip was organized to visit the National Radio Astronomy Observatory (NRAO) in Green Bank, West Virginia (www.gb.nrao.edu). The trip occurred in mid-November, leaving on Friday 14th in the afternoon and returning on Saturday afternoon, so as to minimize clashes with the students other classes. NRAO is located about four hours drive from UMBC, and provides very affordable bunkhouse accommodation for groups who wish to stay overnight. NRAO is home to the Robert C. Byrd Green Bank Telescope (GBT), the world's largest fully steerable single aperture antenna, as well as a number of smaller telescopes. While visiting the NRAO to see the GBT in action is very impressive in itself and alone made an impression on the students, the NRAO also offered something useful to the INSPIRE course. The NRAO is centered in the National Radio Quiet Zone, a 13,000-square-mile area established by the Federal Communications

Commission 50 years ago where electromagnetic emissions of pretty much all types are keep to a minimum. While this was set up for the benefit of the telescope observations, it was also the perfect place to take the assembled INSPIRE VLF kits and to undertake observations in an area away from pretty much any interference. We therefore took our kits out for an evening of observations (late evening and early morning are normally the best time to undertake INSPIRE observations) once we arrived at NRAO after dark and got some very nice and clean results of sferics and tweeks. Several students thought that they may have heard one or two whistlers, but their records did not show them. The following morning we were given a tour of the NRAO facility including the GBT and the visitor's center, before returning to UMBC in the afternoon. As one student said afterwards, the trip was a lot more "fun and interesting" than she thought it would be! It is possible that the students that did not make the trip thought that it might be otherwise!

Guest Speakers

The UMBC FYS classes are designed to create an active-learning environment that encourages student participation and discussion that might not otherwise occur in larger first-year classes. To this end, four guest speakers that the instructor personally knew through work at the Goddard Space flight Center were invited to each present a full lecture talk about a topic broadly related to the FYS 103K course, to be followed by a question and answer session about both the talk and speaker themselves. The goal of this was both to expose the students to some broader topics than that of the course itself, as well as to show the "human side" of science and the people behind it. The following were the guest speakers who spoke and the topic of their presentation.

- Kathleen Franzen, President of the INSPIRE Project – The INSPIRE Project and how science can be "fun"
- Dr. Leonard Garcia, Researcher at GSFC – Radio JOVE Project and the detection of natural radio signals from Jupiter
- Dr. Robert Benson, Civil Servant Scientist at GSFC – Personal experiences on the first "Wintering Over" Expedition to the South Pole in 1957
- Dr. Jim Green, Head of NASA's Planetary Division – Lightning on Other Planets in the Solar System

Student Presentations

It has been the instructors' experience that getting students to undertake written assignments alone is often not the best way to learn and with easy access to information on the Internet, it is too easy for plagiarism issues to arise. One way to overcome this problem is to combine written essays with student presentations to the rest of the class, which includes both the presentation by the speakers followed by a question and answer time from both the instructor and the both students. The question time is an especially useful way to determine whether a student actually knows what they are talking about or whether they just copied the material from the Internet with no real understanding of what it means. The students got to choose their presentation topic from a list of topics related to the INSPIRE Project, which included issues such as Air Traffic Control, Benjamin Franklin, through to Lightning and the Gods of the Ancient World. The students worked in pairs (different pairs from the lab) on the presentations, to teach them about collaboration, which is an important skill to learn in the "real world". While this did not always work out, with some pairs not working well together, it was still an important learning exercise for all involved! Getting the students to work collaboratively as part of a team using Google Docs – this was partially successful but sometimes did not work as well as I would have liked (how do you randomly pair-up students).

Other Evaluations

Beyond the student research topic and accompanying presentation, the students were asked to occasionally undertake pop quizzes at random intervals, they were asked to provide input into the lectures themselves in terms of how they could be improved, how the lab and the INSPIRE kit assembly instructions in particular could also be improved. The course finished with a short exam consisting of multiple choice and short answers.

Student Feedback

The following are some quotes from students in the FYS 103K class:

Heather D'Ambrosio: "The INSPIRE program is a really cool way to learn about lightning. I never knew anything like sferics, tweeks, and whistlers existed before this class. I'm a hands-on person so getting to make my own kit and then listen to the radio waves it made was much cooler than just listening to the waves of some other machine. I am also a welder and haven't been able to weld since I arrived at college, so learning that we were going to get to solder was a pleasant surprise. Overall, I had a great experience in this program."

Jon Airey: "I am currently undeclared, but I am leaning towards becoming a Public Policy and Administration major. I really enjoyed my time in the "Chasing Lightning" class taught by Dr. Phillip Webb that featured the INSPIRE VLF kits. It was fascinating to find out that lightning that we can see also generates low frequency radio waves, and being able to hear them. Some of my favorite things about being in the class were learning to solder and assembling the INSPIRE kit, as well as having a small class size that featured an individualized experience where you could interact with the instructor. This class really allowed you to both learn and to meet and make friends with your classmates while collaborating on projects and other classroom assignments. Overall I would strongly recommend taking a class like the one I took with Dr. Phillip Webb to other young college students."

Katie Heasley: "I am a physics major at UMBC, but when I first started college I wanted to study languages; being in this class made me realize my love of physics. I had always wondered how electronics worked; and when I found out that we would be assembling the INSPIRE kits in class I was excited. Building the kit was a lot of fun, despite making rookie mistakes during the construction of it. When we finally got to test the kits, I was amazed to finally be able to hear for myself all of the sferics and tweeks. I plan on utilizing my kit in the future and I hope to one day hear a whistler. I hope the INSPIRE Project keeps going strong, I plan to buy the next version of the kit as soon as it is made available."

Sean Latta, Theatre Major: "Coming into this class I was not quite sure what to expect, I didn't know much about lightning and I wasn't really a science person, so I was a little bit worried about how I would do in this class and if I made the right decision to take it. Looking back on the class now I can honestly say that this class has been one of the most interesting, hands on, at times hilarious class that I have ever taken. I am so glad that I took this class. One of the things I believe that makes this class so successful is the addition of labs, sure we could have just gotten our inspire kits already made but this would take the skill out of it. Integrating skills like soldering and being able to identify components used to make this kit and following the directions to make your own inspire kit and actually having it work is extremely gratifying. The combination of the lectures in class that teach us what we are picking up with these kits along with other subjects pertaining to the earth's atmosphere and being able to put these lectures and the information that we learned to use is really fun. I think this class is a great addition to the "first year" program at UMBC, one of the reasons it is so successful is due to the classroom environment, Phillip Webb and Paul Schou did an excellent job teaching us the different subjects in this class and helping us make these inspire kits. I always looked forward to this class because of this and since it was such a good classroom environment I made a lot of new friends. Also a really cool aspect of this class was the guest speakers, really top notch, Jim Green, Director, Planetary Science Division of NASA was really an interesting guest speaker. I have never taken a class like this and if I had the chance I would probably take it again, the field trip was a lot of fun as well, I don't remember a field trip I had so much fun on. If I had to say any negative about this class I would just say that at times the lectures could get a little boring however I think little could have been done to modify this since this information was important to know in order to be successful in this class. Again I really enjoyed this class and I am glad I had the opportunity to take it."

Franki Trout, Dance Education Major: "The course Chasing Lightning proved to be an excellent learning experience. With a small class and an interesting topic, science became about more than just learning facts. Working in partners, we built our own Very Low Frequency receivers that could actually be used to collect data. In the process of building the VFL receivers, we discussed circuit boards and learned how to solder, a skill I would otherwise never know. The lectures were also relevant to the labs and interesting. Overall, I would definitely recommend this course to other incoming freshmen."

Philip Chu: "This course was the best course I took this semester. I got to do research in an area I was interested in, play with electronics and we even went on a field trip. Even though I chose one of the given topics, I really liked that we had so much leeway on what we were to write the paper about. This was the first (and unfortunately probably the only) time I actually got to do anything with my hands in college. I feel like the things we learned in this seminar, like presenting PowerPoint's and even soldering, were, in a way, more useful than many things we're learning in other parts of school, because they are more (and this is a relative term) practical in everyday life after school."

Conclusions

The FYS 103K Chasing Lightning course was the first time that an INSPIRE Project based course had been taught at a university level. For many years previously many hundred of INSPIRE kits had been used as the basis of teaching high school students about space physics, but often only as an add on to the regular teaching. The FYS 103K Chasing Lightning course taught during the Fall 2008 semester was different in that it was the first fully structured course to be taught based on the INSPIRE kits. As the student comments above testify to, even given its prototype nature the course was very successful and one that the students very much enjoyed undertaking. One of the strengths of this course was its broad nature, as it touched on a number of different topics from space physics, atmospheric physics, hands-on electronics assembly in a laboratory environment, through to field trips. As such, the students found this to be an interesting course in at least some regard, no matter what their background was. And perking their interest in science because they found the course interesting is in many ways one of the goals of the UMBC First Year Seminar program. It is planned to freely provide an edited version of the lectures used during the FYS 103K course online at The INSPIRE Project website in the near future. INSPIRE VLF kits can be currently purchased from The INSPIRE Project, Inc. via their website – www.TheINSPIREProject.org.

Acknowledgements

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Innovative Technologies for Future Cities

Timothy Eastman, Ph.D.

Lecture by Dr. Eastman given at the "International Conference of Toward a Sustainable Urbanization," October 17, 2006, Suzhou, China

Networks of Relationships and Emergence

Alfred North Whitehead emphasized the importance of networks of relationships in his philosophy of organism, and developed a comprehensive, speculative philosophy providing for both reduction and emergence in a way that is highly consistent with contemporary research results. For many scientific fields (including biophysics, non-equilibrium chemistry, electrodynamics and plasmas, ecology, atmospheric chemistry, nonlinear dynamics, complexity and nanotechnology) quantitative research has demonstrated the importance of networks of relationship, which is essentially the same as Whitehead's perspective. These networks of relationships include examples of intrinsic structural elements, self regulation, and emergent properties even though the scientific process leading to such results emphasizes methodological reduction. Further, many interpreters of science have continued to argue for forms of ontological reductionism even while the evidence for genuine emergence continues to rise. Examples of such emergence include the quantum Hall effect, superconductivity, phase transitions, crystallization, collective instabilities, and hydrodynamics, among others (Laughlin, 2005). Ellis (2005) adds quantum measurement, DNA coding, social creations, and economics. To this list, I would add plasmas.

Plasmas

Plasmas, sometimes referred to as the fourth state of matter, are systems of charged particles, neutrals, electric and magnetic fields that can carry electrical currents and exhibit collective effects (which is to say emergence is built into the very definition of plasmas!). More than 99% of the visible universe is made up of plasma (Peratt, 1991). In addition to the study of space plasmas, fusion plasma studies have pursued the long-term goal of creating energy the way the Sun does, which would provide a relatively clean and practically unlimited source of energy. Practical fusion energy, however, remains several decades in the future and will always remain just one among several options for energy supply. For the needs of future cities, the most important aspect of electromagnetism and plasmas is the recent major expansion in plasma-based technologies that cover a broad range of applications including air, water and surface cleaning, waste processing, and lighting, among others. At the websites www.plasmas.com and plasmas.org, I maintain a comprehensive list of about 200 plasma-related topics and applications (see also Eastman, 1998). In many cases, the same characteristics that make plasmas difficult to control and model are the same features that provide high potential for important applications: anisotropy or directionality, electrical currents, responsiveness to magnetic fields, non-equilibrium particle and fields distributions, and high energies per particle.

The Tarantula Nebula is a diffuse cloud of plasmas and dust with multiple shock waves.

Technologies for Future Cities

Here is a list of some innovative technologies with important potential for future cities, some of which are discussed in more detail below:

Infrastructure

- Embedded systems monitoring; self-annealing infrastructure
- Carbon nanotube reinforcement
- Robotics
- Adaptive control systems
- Microclimate management

Energy Supply

Superconducting transmission lines
Solar and wind power
Fusion power

Conservation

Hybrid vehicles
Fuel preprocessing (such as plasmatron)
High-efficiency lighting
Energy conserving technologies
High-density, mixed-use land usage

Waste Management

Plasma-enhanced waste processing; elimination of landfills
Surface cleaning and modification (such as plasma spray)
Air and water cleaning (such as plasma-enhanced systems), including electron scrubbing of flue gases
Hazardous chemical processing
Convection towers for power and pollution reduction
Desalinization

Communications

Global cellular communications
Automated channel links
Broad-band internet
XML-based, web-enabled electronic publication
Interoperable, UNICODE-based search capability
Knowledge discovery

Transportation

High-speed electromagnetic rail
Multi-scale transportation network with efficient links to avoid excessive dependence on any one mode (such as auto)

Embedded Systems and Adaptive Control

One of the great revolutions of our time is the smallest. Micromechanical components are now being fabricated by etching away parts of silicon wafers or by adding layers to form micromechanical or electromechanical device components. Such micro-machining is done compatible with the fabrication of electronics using integrated circuit process methods. These Micro-Electro-Mechanical Systems (MEMS) make possible sensor nets that provide spatially and temporally dense couplings to any physical system in which each microsensor can be untethered with storage, control and telemetry functions. Combining such sensor nets with networking for selforganized, power-sensitive communication to carry out higher-level tasks results in an integrated, embedded system. Embedded systems technology is just beginning but has great promise in a wide variety of fields, many of which are relevant to sustainable cities. Just a few such applications are the following: (1) infrastructure monitoring and response systems (buildings, roads, water and air), (2) environmental monitoring for response systems (efficient water management, heating and cooling control, precision agriculture), (3) real-time adaptive systems (elder care, vehicle safety, security…), and (4) integrated robotics.

Carbon Composites, and Carbon Nanotube Technology

Carbon composites and carbon fibers are rapidly growing in applications requiring high strength with low weight (airplanes, cars, buildings). For example, The architect Peter Testa has designed a 40-story skyscraper that would use a carbon fiber lattice instead of steel for the structure. Even stronger carbon nanotubes are under development and theory indicates that they would be lightweight yet 100 times stronger than steel, which would even more dramatically affect options for building and infrastructure design. For example, such materials could enable urban designs that provide for efficient above- or below-ground level transportation systems or imbedded convection towers that remove air pollution and simultaneously provide supplementary electricity.

Superconducting Transmission Lines

Continued research in zero-loss superconducting transmission lines is critical because 10% to 15% of generated electricity is dissipated by resistive losses in standard transmission lines. Brookhaven National Laboratory, for example, has demonstrated with a prototype that 1000 MW of power, the entire output of a large power plant, can be transported within one 40 cm diameter transmission line. Such a system could operate with low-voltage DC versus conventional high-voltage AC, which requires large transformer banks and highvoltage transmission lines.

Energy Conserving Technologies

Important energy saving technologies include hybrid vehicles; heat pumps; efficient heating and cooling; infrared camera checks; controlled-spectrum windows; house wrap; architecture; multi-scale, efficient transportation networks (such as urban design to encourage walking, bicycles or light rail). For example, infrared camera images revealing heat loss locations systematically applied to homes and commercial buildings and combined with low-cost repair or corrections of such heat loss can substantially reduce heating bills.

Desalinization

Only about 1% of Earth's water is fresh water and increasing human water needs are continuing to create great demands for water than can be met by the supply. Although direct distillation is too costly in energy for converting salt water or sea water into drinkable fresh water, a variety of new techniques are emerging that promise to significantly reduce the net cost relative to direct electrolysis methods. Examples of such technologies are reverse-osmosis (RO) membranes; electrodialysis (combining a membrane and electric potential gradient); and convection and diffusion towers.

Plasma-enhanced Systems for Sustainable Cities of the Future

Fuel preprocessing

A plasma-boosted fuel reformer has been successfully tested that operates on less than one kilowatt. This "plasmatron" system converts diesel, kerosene or any hydrogen-rich biocrude fuel in a hydrogen-rich gas, which then can be used to increase engine efficiency and reduce key pollutants. For example, NOx is reduced by more than a factor of 100 (or a factor of 10 if a catalytic converter is already being used). Optimum efficiency appears to be obtained if about 25% of the gasoline is converted into hydrogen-rich gas. The goal of researchers at MIT is to have the plasmatron in production and in vehicles by 2010.

Lighting

The high efficiency of plasma lamps, such as fluorescent bulbs, has led to their prominent use worldwide. Such lamps are usually based on mercury, sodium and The Ecozoic Reader Vol. 4, No. 4 24 metal halide gas. However, recent developments in plasma lighting have led to even greater efficiency and versatility for applications. For example, electronic ballasts reduce power consumption by 10 to 15% with reduced flicker, less weight and noise than standard magnetic ballasts. Using inductive coupling of radio frequency power, new electrodeless plasma lamps provide for high efficiency, long lifetimes, and natural light spectra.

Earth's city lights are dominated by plasma-based lightning systems, being mostly arc lamps or fluorescent lights. (Source: NOAA-NGDC and NASA)

Waste processing

Typical fossil fuel incineration generates temperatures of about 1500 degrees C or less; in contrast, core temperatures of plasma plumes can exceed 10,000 degrees C. Whereas conventional furnaces cannot destroy dioxins and other PCBs, plasma furnaces operate on little or no oxygen and generate temperatures that completely dissociate the molecules of waste materials. At the same time, plasma-enhanced systems generate a synthesis gas that can run high-efficiency turbines, which is an option available for most municipal solid wastes and can eventually eliminate solid-waste landfills.

Materials processing

Plasma-aided manufacturing has rapidly advanced within the past decade with applications in thin- and thick-film deposition, surface modification, plasma etching, and other materials processing technologies. Welding (both DC and AC) methods sometimes utilize and always create plasmas as part of the welding process, and welding is critical to the world's infrastructure. Plasma-enhanced materials processing includes the following techniques, among others: plasma spray coating of metals, ceramics and composites; plasma thin-film coatings, including diamonds; plasma chemical synthesis, including synthesis of Fullerenes; surface cleaning and modification (such as plasma spray); plasma electrolysis for surface engineering; air and water cleaning, including electron scrubbing of flue gases; and hazardous chemical processing.

Envisioning a Sustainable City of the Future

The best designs for a sustainable city of the future need to reflect the networks of relationships that constitute the real world of finite energy, resources, and pollution. Solutions need to reflect an organic interplay of living spaces at the individual, family, group, and regional levels analogous to the interplay of life between family, group, and regional levels that is central to Chinese traditions. Some of the new technologies that I have summarized provide important possibilities for sustainable cities. Although Western countries have developed some technologies and efficiencies that are worthy of consideration, many mistakes have also been made (such as excessive use of automobiles!) primarily due to false assumptions about resources and sustainability issues (Daly and Farley, 2003; Daly, 1996; Daly and Cobb, 1994). I hope that Chinese citizens and planners will learn well from both our mistakes and our successes. In turn, we can all learn from the organic, correlative approach that I understand is such a deep tradition in Chinese culture (Hall and Ames, 1995).

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The INSPIRE Project, Inc. & International Space University

Fatima Bocoum

International Space University (ISU) aims to develop future space leaders through its graduate-level training by offering a multidisciplinary educational program for students and space activity professionals in an international and multicultural environment.

In its two-month Space Studies Program and one-year Masters Program ISU offers, with the support of the world space community, a unique Core Curriculum covering all disciplines related to space programs and enterprises – space science, space engineering, systems engineering, space policy and law, business and management, and space and society. These graduate programs prepare professionals of all sectors to meet the present and future challenges of international space cooperation, as well as the challenges implied by the restructuring of the space sector.

ISU Summer Session Program

The Summer Session Program (SSP) arranged by the International Space University is an intensive two month course teaching space professionals, graduate students, and space enthusiasts about a wide range of space relate topics. To date, there have been twenty-one SSPs which are normally hosted in a different county each year. Occasionally the program returns to the ISU Central Campus located in Strasbourg, France.

The INSPIRE Project, Inc. & ISU

The INSPIRE Project, Inc. has had the privilege of having INSPIRE Board Member Dr. Jim Green, Director of Planetary Sciences Division, NASA Headquarters, teach INSPIRE lab-based workshops at eleven respective Summer Sessions. Below is a list of the distinguished institutions that INSPIRE workshops have been held at throughout the world:

SSP08 - Barecelona, Spain
06/30/2008 – 08/29/2008
UPC Universitat Politecnica de Catalunya
http://www.upc.edu/es

SSP07 - Beijing, China
06/25/2007 – 08/28/2007
Beihang University
http://ev.buaa.edu.cn

SSP02 - Pomona, California
06/30/2002 – 08/31/2002
Cal Poly Pomona
http://www.csupomona.edu/

SSP01 - Bremen, Germany
07/14/2001 – 09/15/2001
ZARM Center of Applied Space Technology and Microgravity
http://www.zarm.uni-bremen.de/

SSP2000 - Vina Del Mar & Valparaiso, Chile
06/24/200- - 09/02/2000
UTSFM Universidad Tecnica Federico Santa Maria
http://www.utfsm.cl/

SSP99 - Nakhon Ratchasima, Thailand
06/26/1999 – 09/04/1999
SUT Suranaree University of Technology
http://www.sut.ac.th/indexen.html

SSP98 – Cleveland, Ohio
06/17/1998 – 08/22/1998
Cleveland State University
http://www.csuohio.edu/

SSP97 - Houston, Texas
06/07/1997 – 08/15/1997
Rice Institution
http://www.rice.edu/

SSP96 - Vienna, Austria
07/02/1997 – 09/05/1996
Austrian Society for Aerospace Medicine
http://members.aon.at/asm-austrian_soc_f_aerospace_medicine/

SSP95 – Stockholm, Sweden
06/11/1995 – 08/18/1995
KTH Royal Institute of Technology
http://kth.se/cm/start?l=en_uk

SSP92 – Kitakyushu, Japan
06/16/1992 – 08/26/1992
Kitakyushu International Conference Center
http://www.convention-a.jp/eng/cpg/

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.

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:

   The INSPIRE Project
   518 Sixth Street SE
   Washington, DC 20003
   Attn: Kathleen Franzen

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).

Sample Spectrograms:

Local Time to UT Conversion Table

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

Frequency _____

Range _____

Time _____

Scale _____

Frequency _____

Range _____

Time _____

Scale _____

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

INSPIRE Observer Team _____

Equipment: Receiver _____

Recorder _____

Antenna _____

WWV radio _____

Site description: _____

Longitude: _____o _____' W Latitude: _____o _____.'N

Personnel: _____ _____ _____

_____ _____ _____

Team Leader Name: _____

Mailing Address: _____

_____

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 Sheet

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: ___ _____

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INSPIRE VLF-3 Receiver Kit Order Form

INSPIRE VLF-3 Receiver Kits can be ordered online at: www.TheINSPIREProject.org.
Or please complete this order form and submit with payment to the address below.

INSPIRE is pleased to announce that it has a new manufacturer and fulfillment house to ensure complete kits are received within 6 weeks of order placement. The result of this change is reflected in the new pricing.

INSPIRE VLF-3 is the third version of the popular receiver used by students and other participants to observe Natural Radio and other Low Frequency emissions. This receiver is very flexible in setup and has the controls and enhancements necessary to make recordings that can be properly logged for further study. The VLF-3 is available in kit form only. We are currently looking at the possibility of offering pre-assembled receivers in the future.

If you have any questions regarding current orders or general kit inquiries, please email customerservice@TheINSPIREProject.org. Enjoy your experience with your VLF receiver and thank you for participating in The INSPIRE Project!

INSPIRE VLF3 Radio Receiver Kit $120.00
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Item:	**Quantity**	**Price**	**Subtotal**
VLF-3 Receiver Kit	_____	$120.00	$ _____
Shipping Charge: US & Canada - $12.00 All other countries - $20.00	_____	_____	$ _____
Sales Tax *(CA residents please add 7.75% sales tax, $9.30 per kit)*	_____	$ 9.30	$ _____
		TOTAL:	$ _____

Ship To:
(Please complete all requested information below.)

Name: _____

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Attn: Kathleen Franzen

Payment may be made by check, money order or purchase order made payable to: The INSPIRE Project, Inc. *Please allow up to 6 weeks for delivery.*

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