The INSPIRE Journal

Volume 9 Number 1

November 2000

Observation Opportunities Continue

The MIR Space Station is still up and functioning and INTMINS operations will continue, too. Some modifications in the scheduling process have been necessary due to the fact that MIR is not manned continuously. INTMINS operations will be held when possible while MIR is manned. Since it is not known when operations will be possible, planning methods have been adjusted. Specifically, in the future the INTMINS schedule will be sent to participants using email. This will allow planning to take place later than in the past and will probably make adjustments in the plans less necessary than in the past. If you would like to receive information about observing opportunities, send a message to:

pine@mail630.gsfc.nasa.gov

INTMINS schedules will be determined about two weeks ahead of the operations and communicated immediately. Since the advance time is less than the 4-5 weeks we have had to use in the past, adjustments in the schedule should not be necessary. (See Page 7)

With the launch of the IMAGE satellite, there are other observation opportunities that may be available in the future. IMAGE has an instrument on board that emits VLF radio waves. We will try to determine if the signals are detectable on Earth. (See Page10)

The Coordinated Observation program will also continue as in the past. (See Page 9)

An international team made observations during the Leonid meteor shower on November 1998. They report the first VLF radio signals from meteors. (See Page 27)

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

Contributions to the *Journal* may be sent to:

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

email: pine@mail630.gsfc.nasa.gov
billpine@earthlink.net
Fax: 909 931 0392

Observation Schedules to be Communicated by email

Since MIR is no longer manned continuously, the INTMINS operation schedule we have used in the past will need to be modified. We have been assured by our Russian colleagues that INTMINS operations can still be scheduled during times when MIR is manned. We will just have to be ready to plan operations on a shorter time schedule than in the past. In order to accommodate this, from now on we will use email messages to communicate the schedule. The schedule will be sent out about 2 weeks in advance. If you would like to receive notification of the schedule when it becomes available, send a message to:

pine@mail630.gsfc.nasa.gov

Write for *The INSPIRE Journal*

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

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

We at INSPIRE are looking forward to hearing from you.

New email Addresses for the *Journal*

The editor of The INSPIRE Journal can now be reached at the following email addresses:

pine@mail630.gsfc.nasa.gov

Subscription Information Included on the Address Label

You can determine the status of your subscription to *The INSPIRE Journal* by looking at the address label. In the upper right corner of the label is a 2-digit number that indicates the year your subscription will expire. All subscriptions expire with the November issue. If your label shows "00", then this issue will be the last under this subscription. If your label shows "01", then your subscription is good through the November 2001 issue. If you have any questions or if you feel that the information shown is incorrect, please contact the editor.

Antenna Design Documents and Other Materials Available

Fred Fields, a retired electronics engineer and current radio amateur, has made available copies of documents relating to low frequency (LF) and very low frequency (VLF) communications with an emphasis on antenna designs.

The following is a partial list of the documents:

1. Naval Shore Electronics Criteria; VLF, LF and MF Communication Systems; NAVELEX 0101,113; 1972

    Foreword
    This handbook presents ready-reference criteria for planning, engineering, installation and checkout of VLF, LF, and MF communications equipment installed on Naval shore stations ...

2. Personal communications concerning the US Navy radio station, NPL. Topics include the history, shutdown and demolition of the station.

3. A large ring binder consisting of articles from various publications on a variety of topics. Tabbed sections include:
    - Broadcast band
    - Whistlers
    - Marine radio
    - Physical waves
    - LORAN
    - OMEGA
    - CONSOL/CONSOLAN
    - SANGUINE – ELF communications
    - Underground
    - WWVL / WWVE
    - Propagation
    - Historical

4. Another ring binder containing the following tabs:
    - VLF converter
    - Lists of radio stations in the following frequency ranges:
        - 10-150 kHz, 150-415 kHz, 415-550 kHz
    - TTY converter

5. Two articles on active antennas from 1983 issues of *Radio Electronics*.

Arrangements to obtain copies can be made by contacting the editor. Partial copies and samples can also be sent.

Observation Opportunities Using Space-based Platforms
Update on the Status of IMAGE and MIR

by Bill Taylor, Washington, DC
Bill Pine, Ontario, CA
The INSPIRE Project, Inc. Co-founders

Two opportunities for observing manmade VLF signals from space will be available to INSPIRE participants. One is a continuation of the INTMINS operations that have been conducted for the past four years. A significant change is required due to the fact that MIR will not be manned all of the time. To allow planning in a shorter time frame, operations will be planned for times when MIR is manned and the schedule will be communicated by email to participants. If you would like to receive the schedule, please send a message to:

pine@mail630.gsfc.nasa.gov

and your name will be added to the participant list. (Note: You do NOT have to be an active participant to be included on the email list!)

An additional observation opportunity has been added using the IMAGE satellite. IMAGE was launched in March and is currently gathering data about the magnetosphere and plasmasphere of Earth. ne of the instruments is being operated when IMAGE is at perigee to attempt to see if the VLF radio signal emitted by the instrument can be detected on the ground. See Bill Taylor's article on Page 10 for a description of how to determine observation times for your location.

The following is an update on the status of these two orbiting space platforms.

IMAGE

IMAGE was launched on March 25, 2000 into a polar orbit with an inclination to the equator of 90.01 degrees. Its closest approach to the Earth, perigee, is an altitude of 1000 km and its furthest, apogee, 46,004 km, or 7.2 Re (Re is Earth radii, about 6371 km). Its period is 14 hours, 16 minutes. The perigee is above the South Pole of the earth, so at northern latitudes IMAGE is at altitudes of a few thousand kilometers.

After about two months, the 500-meter tip-to-tip RPI (Radio Plasma Imager) antennas reached full extension and engineering tests began of the RPI. The data from these tests were somewhat useful for scientific research and slowly engineering testing has wound down and scientific studies have accelerated. A new set of onboard programs was uplinked to the satellite at the beginning of October. These programs were scientific and included programs to transmit VLF waves with the objective of testing propagation to the ground. These are the experiments that INSPIRE will support with observations.

Unfortunately, on October 3, 2000, the satellite suddenly started to wobble. Based on observations by some of the scientific instruments and measurements by the onboard star tracker, it has been concluded that about one half of one of the four 250-meter long antenna elements was lost. The most likely (although very unlikely) cause is the antenna being hit by a meteoroid.

Engineering will have to take over for a while to retune the antenna to be able to operate efficiently, even though one of its two elements is only half as long as it was! This may take a few months and propagation experiments will have to be delayed.

MIR

MIR (which means peace in Russian) has been in orbit 14 years, many years beyond its design lifetime. Over 20,000 space experiment sessions have been performed. As a result, MIR is considered a landmark on the road of scientific progress. Worldwide, the word MIR has become synonymous for the advancement of technology and the establishment of life in space in the late 20th century.

There have been reports that MIR may be deorbited early in 2001, but MIRCorp,

http://www.mirstation.com

the commercial operator of MIR, is determined that MIR will continue, and on October 3, announced that there would be an October 16 resupply mission to MIR.

Dr. Stas Klimov, the Russian Director of INTMINS, has assured us that when MIR is manned, we can plan operations of the plasma accelerators, for attempting reception by INSPIRE participants.

Future IMAGE and MIR operations

Since the exact schedules of operations of IMAGE/RPI and MIR/ISTOCHNIK and MIR/ARIEL are uncertain at this time and will probably change much more quickly that the twice yearly period of the *INSPIRE Journal*, INSPIRE has decided to notify participants by email of operations opportunities. Therefore, all observers must send a message to Bill Pine at:

pine@mail630.gsfc.nasa.gov

INSPIRE will then compile an email distribution list and will notify everyone on the list of upcoming observation opportunities.

INTMINS-April/2000 Operations Schedule

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

The November/2000 INTMINS Operations schedule will be finalized soon. Operations will occur at times consistent with the manned status of MIR. INSPIRE participants will be notified by email when the schedule is determined. If you would like to receive email notification of the schedule, send a message to:

pine@mail630.gsfc.nasa.gov

and your name will be added to the INSPIRE email list. Data gathered will be analyzed and reported on in the April 2001 issue of *The INSPIRE Journal.*

Gathering Data:

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

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

Step 0: Completely check out all equipment. A good method is to set up everything in your living room. All you will hear is household 60 Hz, but you will know the equipment is working. This is also a good time to fill out the log cover sheet (see Page 80 of the *Journal*).

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

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

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

Step 4: Keep a written log (see Page 81 of the *Journal*) of time marks and descriptions of everything you hear.

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

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

Mode of Operation:

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

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

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

Notes on Time Marks and Logging;

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

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

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

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

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

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

Coordinated Observation Schedule
November/2000

By Bill Pine Ontario, CA

In response to requests in the INSPIRE Survey for observation opportunities at more convenient times, the INSPIRE Coordinated Observation Program was established in April/98 in conjunction with the INTMINS observations. The purpose of the coordinated observations is to provide an opportunity for INSPIRE observers to make recordings of natural VLF radio and to compare the resulting data. Ideally, a coordinated session would result in everyone hearing whistlers. Whistlers were not detected last April, but interesting signals were heard nonetheless.

Since Coordinated Observations do not rely on platforms in orbit, the procedure for Coordinated Observations will not change.

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

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

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

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

Specified Coordinated Observation Dates for November/2000:

Saturday, November 18 and Sunday, November 19

Propagation Experiments from IMAGE to the Ground

By Bill Taylor
Co-Founder, The INSPIRE Project
Washington, DC

Introduction

IMAGE (Imager for Magnetopause-to-Aurora Global Exploration) is the first MIDEX or Medium-sized Explorer. It was launched on March 25, 2000 to study the global response of the Earth's magnetosphere to changes in the solar wind. IMAGE will use radio imaging, neutral atom, and ultraviolet techniques to: (a) identify the dominant mechanisms for injecting plasma into the magnetosphere on substorm and magnetic storm time scales; (b) determine the directly driven response of the magnetosphere to solar wind changes; and, (c) discover how and where magnetospheric plasmas are energized, transported, and subsequently lost during substorms and magnetic storms.

The radio plasma imager (RPI) will transmit and receive pulses from 3 kHz to 3 MHz allowing relative motions of the satellite and plasma to be determined to a resolution of 400 m/s and a time resolution as good as 4 s. A suite of three neutral atom imagers (NAI) will provide energy- and composition-resolved images at energies from 10 eV to 200 keV with a time resolution of 300 seconds. Two ultraviolet imagers, covering wavelength ranges from 120-180 nm (FUV) and 30.4 nm (EUV), provide coverage in the far and extreme ultraviolet.

One of the objectives of the RPI is to measure propagation of the radio waves that RPI emits. Planned observing instruments are INSPIRE receivers, other radio receivers on the ground, and radio receivers on satellites. Starting in August, RPI has been transmitting from 3-15 kHz for approximately the 2.5 hours closest to the Earth.

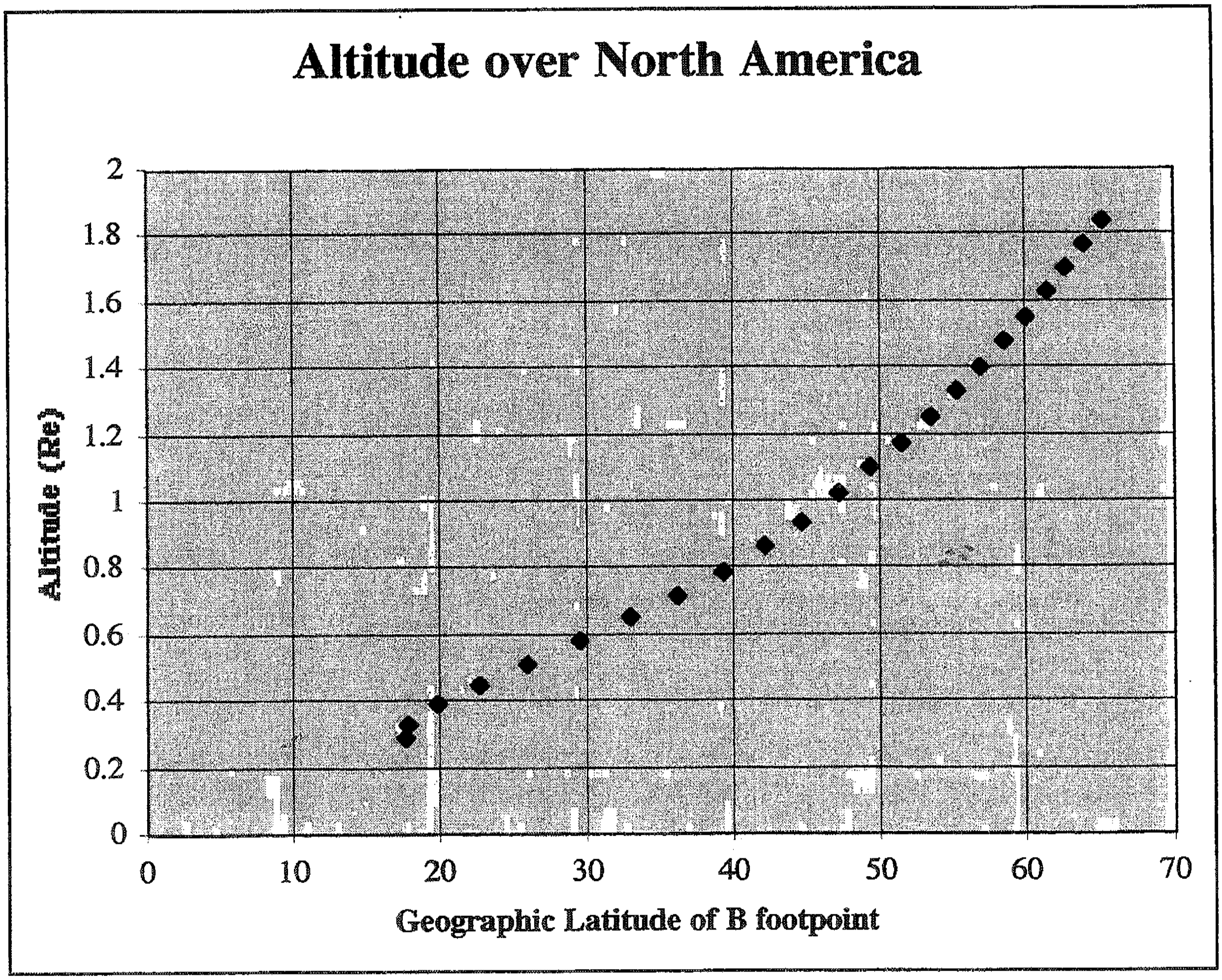
On August 3, 2000, the WIND satellite received signals from RPI at a frequency of 828 kHz during a special experiment when WIND and IMAGE were aligned.

This article is designed to lead INSPIRE observers through the simple process of determining when they should observe. I will show what I did to be prepared for observations I made in Washington, DC on August 12, 2000. The only thing required is access to the internet and the World Wide Web.

IMAGE Orbit

IMAGE is in a polar orbit with an inclination to the equator of 90.01 degrees. Its closest approach to the Earth, perigee, is an altitude of 1000 km and its furthest, apogee, 46,004 km, or

7.2 Re (Re is Earth radii, about 6371 km). Its period is 14 hours, 16 minutes. The perigee is above the South pole of the earth, so at northern latitudes IMAGE is at altitudes of a few thousand km. Figure 1 shows the altitude of IMAGE as a function of the geographic latitude of the B footpoint. The B footpoint is the point where the magnetic fieldline that passes through IMAGE reaches the surface of the earth.



SSCWeb Tabular Data

To find the best times for INSPIRE observers to record data go to the NASA/Goddard Space Flight Center web site for the National Space Science Data Center's Satellite Situation Center:

http://sscweb.gsfc.nasa.gov/

and Figure 2 shows what you will see.

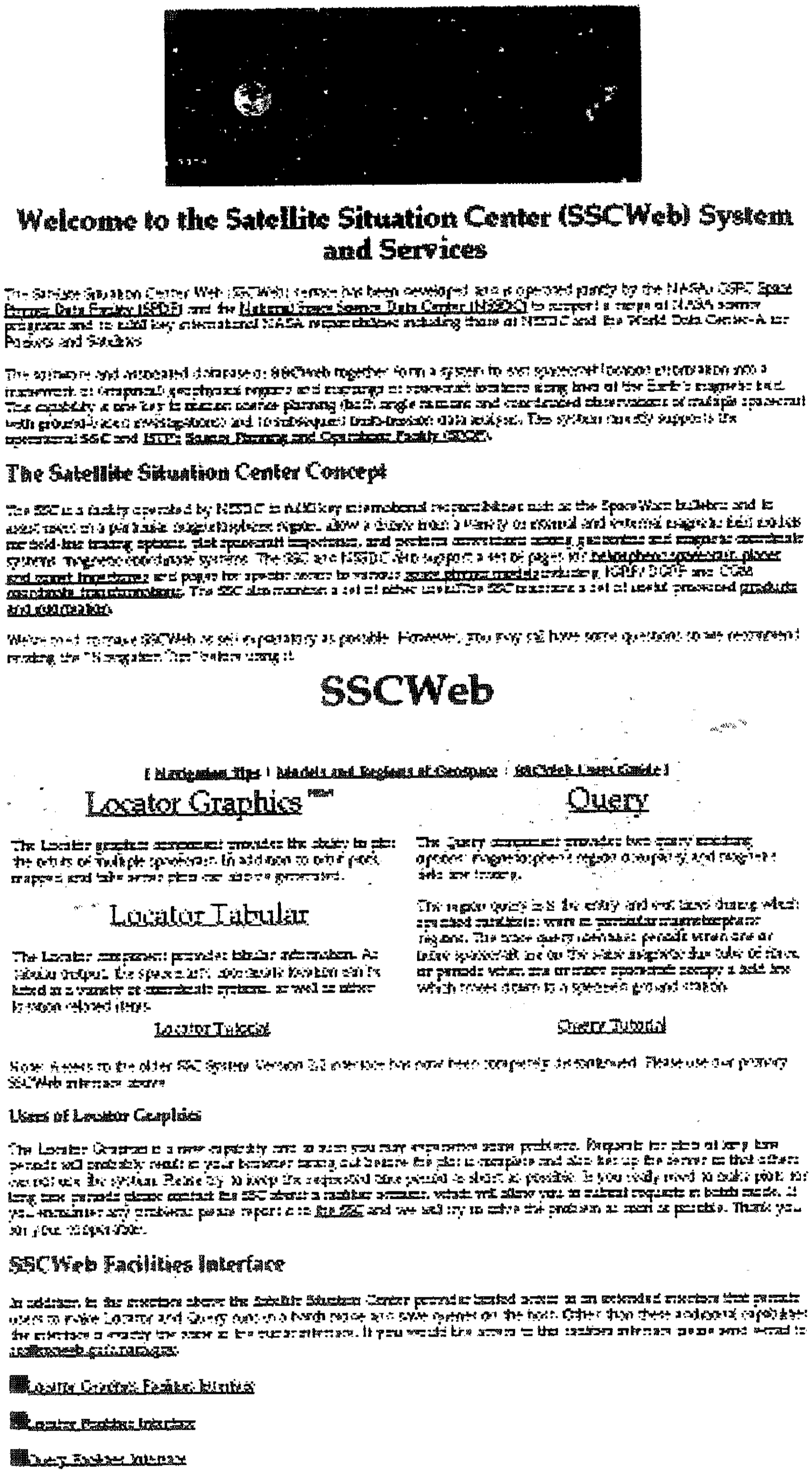


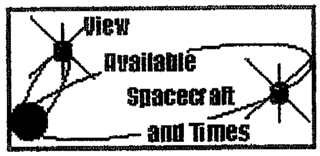
Figure 2. The main page of SSCWeb.

The first thing to do is to click on Locator Tabular. You will get Figure 3.

SSC Locator Form

Standard Interface

Spacecraft/Time Range Selection



Satellites	Time Range
DMSP-10 DMSP-11 DMSP-12 DMSP-13 DMSP-14 DMSP-8 DMSP-9 Equator-S FAST Freja Geotail GMS-3 GOES-10 GOES-11 GOES-6 GOES-7 GOES-8 GOES-9 Hawkeye IMAGE	**Valid Date/Time Formats:** **Date** yyyy ddd / yyyy/mm/dd / yyyy-mmm-dd **Time (Optional)** hh.hhhh / hh:mm:ss / hh:mm **Start Time (inclusive)** 2000 214 00:00 **Stop Time (inclusive)** 2000 244 23:59 **Display 1 out of every** 1 points.

Command Menu

1 REQUIRED SETTINGS
[Output Options]

OPTIONAL SETTINGS
[Filtering Options]
[Output Units/Formatting]

2 INPUT SUMMARY
[Input Summary]

3 EXECUTION OPTIONS
[Submit query and wait for output]
[Prepare query to be saved locally]

Interface Style [Standard] [Advanced]

[Undo changes just made - this page only] [Clear entire form (all input settings, all pages)]

Figure 3. The top Locator Tabulator form.

Click on IMAGE in the Satellite box, fill in the time period of interest, I chose August, 2000, and click on the Output Options box. You will get Figure 4.

SSC Locator Form

Standard Interface

Output Options

	X Y Z	LAT LON	X	Y	Z	LAT	LON	LOCAL TIME
GEI/TOD	☐	☐	☐	☐	☐	☐	☐	
GEI/J2000	☐	☐	☐	☐	☐	☐	☐	
GEO	☐	☑	☐	☐	☐	☐	☐	☑
GM	☐	☐	☐	☐	☐	☐	☐	☐
GSE	☐	☐	☐	☐	☐	☐	☐	☐
GSM	☐	☐	☐	☐	☐	☐	☐	
SM	☐	☐	☐	☐	☐	☐	☐	☐

Additional Options

Regions	Values	Distance From
☐ Spacecraft Regions	☑ Radial Distance	☐ T95 Neutral Sheet
☐ Radial Traced Footpoint Regions	☐ B Field Strength	☐ P93 Bow Shock
☐ North B Traced Footpoint Regions	☑ Dipole L Value	☐ RS93 MPause
☐ South B Traced Footpoint Regions	☐ Dipole Inv Lat	☐ B GSE X-Y-Z

B Field Trace Output Options

	Footpoint Latitude	Footpoint Longitude	Field Line Length
GEO NORTH	☑	☑	☑
GEO SOUTH	☐	☐	☐
GM NORTH	☐	☐	☐
GM SOUTH	☐	☐	☐

Command Menu

1 *REQUIRED SETTINGS* [Spacecraft/Time Range Selection]

OPTIONAL SETTINGS [Filtering Options] [Output Units/Formatting]

2 *INPUT SUMMARY* [Input Summary]

3 *EXECUTION OPTIONS* [Submit query and wait for output] [Prepare query to be saved locally]

Interface Style [Standard] [Advanced]

Figure 4 The second page of the Locator Tabular.

Click on the boxes with checks in them in Figure 4 and click on Filtering Options. You will get Figure 5.

SSC Locator Form

Standard Interface

Go to the command menu

Filtering Options

● Must pass all specified range filters
○ Must pass at least 1 specified range filter

Spacecraft Location Filters

Distance Units are in	● R_E - Earth Radii ○ Km - Kilometers
Lat/Lon units are in	degrees.
Valid local time formats (24 hour clock):	hh.hh hh:mm:ss hh:mm

		Return:		Return values that are...	
		Min	Max	greater than:	less than:
GEO	X	☐	☐		
	Y	☐	☐		
	Z	☐	☐		
	LAT	☐	☐		
	LON				
	Local Time				

Additional Location Filters

Distance Units are in ● R_E - Earth Radii ○ Km - Kilometers

	Return:		Return values that are...	
	Min	Max	greater than:	less than:
Distance From Center of the Earth	☐	☐		4
Dipole L value	☐	☐		

Figure 5. The third page of the Locator Tabular. Command Menu has been cut.

Enter 4 in the upper right hand box of the Additional Location Filters to get only the low altitude information, and click Submit query and wait for output. You will get 341 kB of data. This can be reduced by changing the number in the Display 1 out of every ___ points box in Figure 3. Five is a good number.

You will get the output shown in Figure 6, in which I have just included the headers and the first few lines of the table:

SSC Locator Form

Standard Interface

Output is sent as generated; please allow server to complete transfer if full time range is desired.

```
LOCATOR_GENERAL OUTPUT:
  User: websrvr
  Date: Mon 14-Aug-2000 (227) 14:02:33
 Status: request completed successfully


GROUP 1   Satellite  Resolution  Factor
            image       120        1

           Start Time        Stop Time
           2000 214  0.00000   2000 244 23.98333


Coord/          Min/Max   Range Filter     Filter
Component  Output Markers  Minimum   Maximum   Mins/Maxes
GEO Lat     YES     -      -       -         -
GEO Lon     YES     -      -       -         -
GEO LT      YES     -      -       -         -


Addtnl          Min/Max   Range Filter     Filter
Options   Output Markers  Minimum   Maximum   Mins/Maxes
dEarth      YES     -      -      4.00       -
L_Value     YES     -      -       -         -


Perform the following magnetic field traces:
  North trace for GEO footpoint; Output: lat, lon, arclen.

Magnetic field model:
   Internal: IGRF
   External: Tsyganenko 89C     Kp:  3-,3,3+
   Stop trace altitude (km):   100.00

Output - File:
       lines per page: 0

Formats and units:
   Day/Time format: YYYY DDD HH:MM
```

Degrees/Hemisphere format: Decimal degrees with 2 place(s).
Longitude 0 to 360, latitude -90 to 90.
Distance format: Earth radii with 2 place(s).

image

Time	GEO		geoLT	NorthBtrace GEO			Radius	
yyyy ddd hh:mm	Lat	Long	hh:mm	Lat	Long	ArcLen	(RE)	DipL-Val
2000 214 00:00	24.07	243.55	16:14	42.73	247.64	0.95	1.83	2.5
2000 214 00:02	27.60	243.09	16:14	45.43	247.29	1.01	1.90	2.8
2000 214 00:04	30.86	242.62	16:14	47.94	246.95	1.07	1.98	3.2
2000 214 00:06	33.88	242.15	16:15	50.26	246.62	1.14	2.06	3.6
2000 214 00:08	36.68	241.69	16:15	52.42	246.31	1.21	2.13	4.1

Figure 6. The first part of the tabular output of SSCWeb. GeoLT is the solar time, approximately local time. Radius means the distance from the center of the earth to the satellite in earth radii. NorthBtrace GEO means the geographic latitude and longitude of the magnetic field line that passes through the satellite, where it passes through the surface of the earth. ArcLen is the distance along the magnetic field from the satellite to the surface of the earth.

Low altitude passes are clustered into 5 groups of longitude around the earth. The passes in each group are separated by about one hour less than three days, and advance eastward about 9.5 degrees in longitude in those three days. A particular place on the earth will have a close pass approximately every 18.4 days. Figure 7 shows the B footpoints of a group over North America during July and August, 2000.

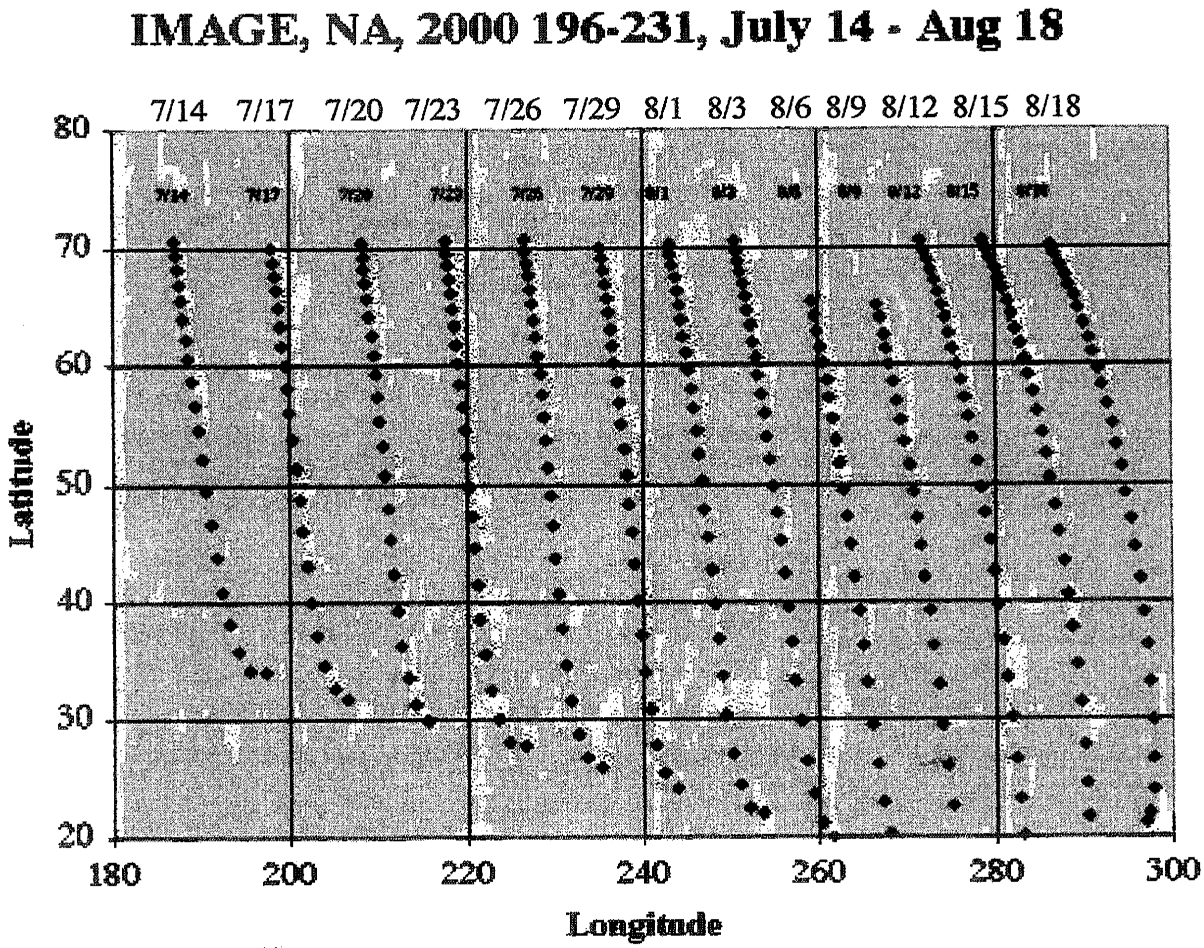


Figure 7. The footpoints of a group of low altitude IMAGE passes over North America.

To see when there is an appropriate pass two criteria could be used. The first is when the spacecraft is overhead. The second is when the magnetic field line that passes through the spacecraft is near. If the waves travel in a straight line, the first criterion would be best. VLF waves, 3-15 kHz in this case, in the ionosphere are traveling in the whistler mode and waves in the whistler mode tend to follow the magnetic field line, so the second criterion is probably better.

Washington, DC, where I live, is at approximately 77 degrees west longitude (= 283 degrees east longitude, the way SSCWeb denotes longitude) and 39 degrees north latitude.

There was a good pass for me on August 12, 2000, Day 225 at about 20:40 UT. I've included the SSCWeb for about 40 minutes below:

Time			GEO		geoLT	NorthBtrace GEO			Radius		
yyyy	ddd	hh:mm	Lat	Long	hh:mm	Lat	Long	ArcLen	(RE)	DipL-Val	
2000	225	20:20	-28.84	286.40	15:26	18.96	284.19	1.20	1.26	1.4	
2000	225	20:22	-21.30	285.98	15:26	17.58	283.91	0.95	1.30	1.3	
2000	225	20:24	-14.26	285.54	15:26	18.24	283.58	0.81	1.35	1.4	
2000	225	20:26	-7.73	285.10	15:26	20.41	283.18	0.74	1.40	1.4	
2000	225	20:28	-1.72	284.65	15:27	23.43	282.75	0.73	1.46	1.5	
2000	225	20:30	3.81	284.20	15:27	26.83	282.29	0.74	1.53	1.6	
2000	225	20:32	8.87	283.74	15:27	30.30	281.82	0.77	1.59	1.8	
2000	225	20:34	13.51	283.28	15:27	33.68	281.34	0.81	1.67	2.0	
2000	225	20:36	17.77	282.82	15:27	36.89	280.85	0.86	1.74	2.2	
2000	225	20:38	21.68	282.35	15:27	39.89	280.37	0.92	1.81	2.5	⇐
2000	225	20:40	25.28	281.89	15:28	42.68	279.88	0.98	1.89	2.9	
2000	225	20:42	28.60	281.42	15:28	45.26	279.40	1.05	1.96	3.3	
2000	225	20:44	31.68	280.96	15:28	47.65	278.92	1.11	2.04	3.7	
2000	225	20:46	34.53	280.49	15:28	49.87	278.45	1.18	2.12	4.2	
2000	225	20:48	37.18	280.02	15:28	51.93	277.98	1.25	2.19	4.8	
2000	225	20:50	39.66	279.55	15:28	53.83	277.52	1.32	2.27	5.5	⇐
2000	225	20:52	41.97	279.09	15:28	55.62	277.07	1.39	2.35	6.3	
2000	225	20:54	44.14	278.62	15:28	57.27	276.62	1.46	2.42	7.2	
2000	225	20:56	46.18	278.15	15:29	58.82	276.17	1.53	2.50	8.2	
2000	225	20:58	48.10	277.69	15:29	60.27	275.73	1.60	2.57	9.4	
2000	225	21:00	49.91	277.22	15:29	61.62	275.29	1.67	2.64	10.7	

By the overhead criterion, the best time would be centered around 20:50 UT. The satellite is at an altitude of 1.27 Re or 8091 km.

By the field line criterion, the best time would be centered around 20:38 UT. The distance along the field line to the satellite at that time is 0.92 Re or 5861 km.

I recorded data from about 20:30 to 21:00 UT.

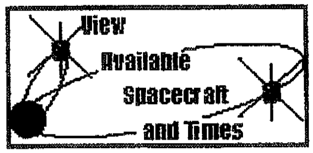
SSCWeb Graphics

Another way to get orbital data from the SSCWeb is from the Graphics section, which can be found by clicking on Locator Grpahics on the main SSCWeb page shown in Figure 2. What you get is shown in Figure 8.

SSC Locator Graphics Form

Standard Interface

Spacecraft/Plot Type Selection



Satellites	Plot Type
DMSP-10 DMSP-11 DMSP-12 DMSP-13 DMSP-14 DMSP-8 DMSP-9 Equator-S FAST Freja Geotail GMS-3 GOES-10 GOES-11 GOES-6 GOES-7 GOES-8 GOES-9 Hawkeye IMAGE	○ Orbit Plot ● Mapped Projection Plot ○ Time Series Plot

Time Range Selection

Please use time ranges of less than 30 days.

Time Range Specification			
		Valid Date/Time Formats:	
Start Time (inclusive)	Stop Time (inclusive)	Date	yyyy ddd yyyy/mm/dd yyyy-mmm-dd
2000 225 20:22	2000 225 21:00	Time (Optional)	hh.hhhh hh:mm:ss hh:mm

Figure 8. The main page of the Locator Graphics part of SSCWeb.

I decided to make a plot above of the projection of the magnetic field line for the pass discussed. Scroll down and click on "Plot Options" and you will get Figure 9.

SSC Locator Graphics Form

Standard Interface

Mapped Projection Plot Options

Plot Parameters	Selections	Other Options
Spacecraft Track	○ Radial ● B Trace North ○ B Trace South	
Coordinate System	● GEO with Continents ○ GEO without Continents ○ GM without Continents ○ SM (Radial & Cyl. only)	
Projection	**Equatorial** ● Cylindrical ○ Mercator ○ Molleweide **Polar** ○ Stereographic ○ Orthographic ○ Azimuthal	**Map Limits** Min Lat: [20.0] Max Lat: [70.0] Min Lon: [-170.0] Max Lon: [-60.0] **Polar Map Orientation** ○ North Pole ○ South Pole Longitude plotted as vertical down: [0.0]

Plot Title: [Mapped Plot]

Command Menu

1 *REQUIRED SETTINGS*
[Spacecraft/Plot Type Selection]
OPTIONAL SETTINGS
[Other Options]

2 *INPUT SUMMARY*
[Input Summary]

3 *EXECUTION OPTIONS*
[Plot]
[Prepare query to be saved locally]

Interface Style [Standard] [Advanced]

[Undo changes just made - this page only] [Clear entire form (all input settings, all pages)]

Figure 9. The second page of Locator Graphics.

I confined the plot to the US. Make your choices on this page and click on Plot. You will get Figure 10.

SSC Locator Graphics Form

Standard Interface

LOCATOR_GRAPHICS_GENERAL OUTPUT:

MAPPED_IMAGE

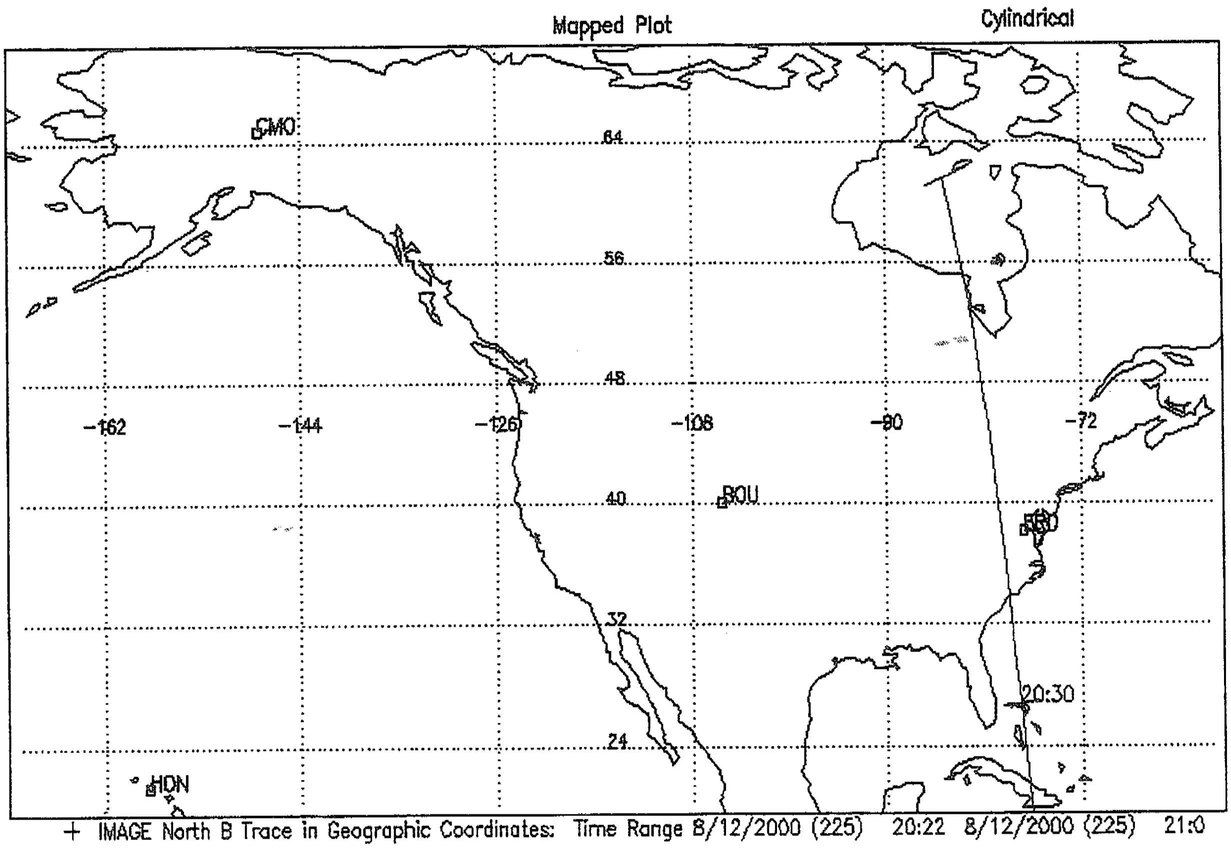


Figure 10. The path of the B footpoint of a low altitude pass over North America on August 12, 2000.

This is the pass that I recorded.

A Triggered Emission
September 17, 2000

By Shawn Korgan
Team 32
Gilcrest, CO

It's 11:00 o'clock in the evening and once again I'm off to my favorite quiet spot in the Rocky Mountains - Trail Ridge Road, at an elevation of over 12,000 feet. I realize I have a two-hour drive ahead of me so I begin to relax and enjoy the ride. As I do so, my thoughts begin to wander back to the previous month.

It was then that I received an email from Steve Ratzlaff informing me of an upcoming coordinated listening session being conducted by Mark Karney (naturalradio@norwest.net) via *The LOWDOWN*, a monthly publication on low-end radio frequencies (including periodically Natural Radio articles.) I'm always ready for a coordinated listening session when it comes to natural radio, so I am naturally excited to hear that one is occurring in the month of September. In the next few days I send off my subscription for *The LOWDOWN* so I will not miss any of the last-minute details. (It's a good thing that I did because at the last minute the dates were changed to include Sept. 16th and 17th and to exclude the dates of Sept. 30th and Oct. 1st.)

I reach my destination around 12:45 a.m. (6:45 GMT) in the morning and begin to set up the equipment. First I begin by running the 400-foot longwire antenna and then by interconnecting the VLF receiver, tape deck and WWV receiver. This being done, I flip on the VLF receiver to check the conditions. At the moment things sound rather calm, so I decide not to record. As I'm sitting there listening, all of a sudden a loud wavering tone, some sort of periodic emission, is heard. It lasts approximately five seconds in duration and is not heard again the rest of the evening. I decide from that point on that tonight I will record even when there is nothing spectacular going on -- I had already missed one good event.

I notice faint whistlers beginning around 7:00 GMT. These whistlers continue to strengthen as the first coordinated listening session of the evening draws closer. At 8:55 GMT I begin recording for the coordinated listening session. I am recording simultaneous WWV audio on one track while at the same time recording the live VLF feed on the other. By 9:00 GMT there are numerous loud whistlers occurring. This is always a good sign during a coordinated listening session!

At 9:02:34 GMT I hear a strange emission that instantly commands my attention. It is one of those VLF events that sounds a little unusual, a little out of the ordinary and unlike all the rest of the activity occurring that evening. I think to myself, if this is all the activity I catch this evening it was worth it to hear just that one odd-sounding event. I thank God for the catch and continue to monitor under the beautiful Milky Way / star-studded heavens, enjoying both the beauty and the sounds of nature.

Conditions continue to get even better as the night progresses. By the time the 10:00 GMT listening session rolls around, there are now whistlers occurring with multiple echoes along with periodic emissions and bits of chorus. Things get even better when, by 11:30 GMT, I begin to hear multi-path whistlers. Can things continue this way? Sure enough, by 13:06 GMT faint sounds of a coming whistler storm are captured on tape. By around 13:35 GMT a full-blown whistler storm is in progress. The whistler storm is still in progress as I'm leaving for work at 14:45 GMT. Talk about a night!