Resolving the Problem of Atmospheric Statics Interference on Seismic Data during Seismic Recording Operation in Niger Delta, Nigeria

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Abstract: ***The problem of atmospheric statics interference on seismic data during recording operation has remained a challenge that the cost implication on contemporary Seismic exploration budget in Nigeria, staggers up and down seeking for solution and subsequent harmony between the seismic contractors and their clients. Atmospheric statics interferes with seismic data when there is statics build up which tears apart to form separate positive and negative charges that travel in opposite directions as electric current, neutralizing the original accumulation of charges. The discharge superheats the surrounding air giving rise to "bright flash". The air in the discharge channel is heated to such a high temperature (T) that it emits light by incandescence. The clap of thunder results from the shock wave generated when the superheated air expands explosively. The discharged bright flash cuts into the seismic data, interrupting the data flow transported along Receiver Line telemetry cables or at line box LAUX at the time of "bright-flash". The release of the bright flash within the first 7 seconds after detonation of a shot or daily test shot, will strike the seismic data of that shot at a time within the 7 seconds record length of the shot. Rejection of shots affected by "statics interference period" gives rise to delay or waiting or suspension of recording operation for some minutes sometimes ranging from 30 minutes to hour(s). It is tracked by the field Engineers by use of Skyscan statics tracking device, or checking on the pulsation until the statics cleared off the air to allow for normal recording operation without interference or line-breaks. Every hour of such a delay waiting for statics to clear in the atmosphere was regarded as "Chargeable Downtime" due to statics at a contractual rate of about $10,000 per Hour. Atmospheric statics discharge was a common cause of "Line-breaks" as excess charge was neutralized by the flow of charges to the surroundings, which cuts across the seismic data on its linear-transfer to instrument truck. A seismic data from a shot can successfully be transferred to the Recording Instrument/Truck and saved to memory without statics interference, while data from the next shot may be caught up with statics interference causing line-break midway in the course of transfer, being pre-mature to full-record-length delivery to the Sercel Instrument memory storage. The Recording Instrument over the years has advanced in functions and capabilities. The France-based seismic recording Sercel Instrument has developed from one version to a higher version with time. Thus, Sercel SN 338 of 1971 gave birth to SN348 (1981-1986), to Sercel SN408UL (2000-2009), to Sercel 428XL (2007 - 2012). Each latest version has a higher level capabilities and sensitivity, and the atmospheric statics build up gives rise to interference strikes on the seismic data and line-breaks on one or more Receiver Lines, spoiling production recording. There tends to be a predominance of statics Interference on seismic data occurring in the "Afternoons" of high air temperature changes (δT), compared to the paucity of statics cases in the early morning hours.***

Keywords: Atmospheric statics, interference, seismic data, chargeable downtime

1. Introduction

Atmospheric statics interference was seasonally noticed on the Receiver lines from the monitor CRT display of the Instrument truck, which contains two or more high capacity computers with monitors showing the status of the active spread of the six (6) or more Receiver Lines. A computer monitor was dedicated to display or show the status or the line conditions, deficiency on disconnection of receivers or problem station units, or geophone groups or bunched geophone station, dead or noisy receiver stations on the active spread of the six Receiver Lines on the ground, as the geophones were planted or pinned vertically into the earth. The condition of the transverse line which connects all receiver lines along the same designated station and channeling the signals to the Recording Instrument was monitored from the screen. At the event of statics interference, the previously achieved continuity status on the 6 RL's will suddenly vanish, amounting to line break and loss of seismic data. If a shot was taken and the data was on transmission to the Sercel Recorder or (Instrument Truck) that would result in loss of data or unsaved signals not stored in the computer memory.

The earth on which the receivers were laid, (geophone groups and bunched stations) or planted or pinned into the ground, and hydrophones dropped in rivers or water bodies constitute the lithosphere, hydrosphere, and the surrounding environment comprising the atmosphere, and biosphere. The overshadowing cover forms the cloud to ground lightning framework in the global atmospheric electrical circuit. This region comprises the ionosphere where lies the plasma. The plasma is a gas of positive ions and free electrons with approximately equal number of positive and negative charges (Rakov and Uman, 2003)[1]. Lightning discharges in the range tens of thousands of amperes, up to millions of volts, emitting light, radio waves, x-rays, and gamma rays. Plasma temperatures in lightning environment measure to the average range of tens of thousands Kelvin, (T) while electron densities measure to the tone of 1000/m3. The unique attribute of dynamic plasma characterized the properties of the matter that can interfere with seismic data signal to the truncation of incoming data.

2. Literature Review

Atmospheric electricity abounds in the environment above the surface of the earth. Some traces of it are found less than a meter (<1m) above the land and water surfaces, it becomes clearer on rising to greater heights (Masahiko, 2012). During fine weather, the air above the surface of earth is positively charged, while the earth's surface charge is negative. Significantly, the occurrence of electrical action in Earth's atmosphere du**e** to the accumulation of static charges generated by friction of the air upon itself, released to ground in an instant, in a massive down-rush of current (moving electronic charges) the moment the accumulated charge exceeds the breakdown voltage of air. It is this released massive down-rush of current, which cuts across the seismic data signal line or flow of continuity, and constitutes an interference or line-break. Supportive sources of atmospheric charge include the following, i) Evaporation of water from earth's surface. ii) Chemical reactions that take place on earth's surface releasing charged particles into the atmosphere. iii) Expansion or condensation of moisture contained in the atmosphere due to variation of temperature (T).

Measurement of atmospheric electricity is congruous to measurement of difference in potential between a point of the earth's surface, and a point somewhere in the air above it. The electrostatic field and the difference of potential of the earth field in summer is about 60 to 100volts, while in winter is about 300 to 500volts per meter of difference in height (Alfred, 1884). Atmospheric electricity has been found to have effect on electrical communications, and during storms, disruptions and electrical discharges inevitable (George, 1860; US patent, 1925).

Moisture in the atmosphere acts in a different manner in the cold months of winter from the hot months of summer. At elevations above the clouds, atmospheric electricity forms a continuous and distinct element called electrosphere, in which the earth is surrounded. It is tens of km above the earth's surface to the ionosphere. The potential difference between the ionosphere and the earth is maintained by thunderstorms' pumping action of lightning discharges. Scientists have studied the root causes of lightning as ranging from atmospheric perturbations (wind, humidity, and atmospheric pressure), to the impact of solar wind, and accumulation of charged solar particles. Ice inside a cloud is thought to be a key element in lightning development, which can cause a forcible separation of positive and negative charges within the cloud, thus assisting in the formation of lightning. (Micah, 2007).

The high magnitude of frequency of those statics interference matched with the conception of the German Physicist Henrich Rudolf Hertz, who in defining the number of waves that pass by per second, as frequency (Hz). One of the theories of the earth's origin, called The Cosmos as a homogenous primordial vapour, holds "that the nucleus of the cosmos originally was a swirling chaos of homogenous primordial vapour containing free electrons and other sub-atomic particles, which in time may have combined to form atoms of the chemical elements, first of which was hydrogen." The dust-cloud hypothesis advanced that as a result of gravitational attraction (which prevailed throughout the universe) and perhaps too because of the delicate pressure exerted by the light from neighbouring stars, masses of thin hydrogen gas and rarefied clouds of dust in interstellar space might have been drawn together into a cloudlike spinning ball with vortices and eddies floating around it. The attribute of the dust-cloud matter containing a thin mass of hydrogen forming cloudlike spinning ball and eddies, has the tendency to adopt electronic speed to transcend and interfere with seismic signals, with high level of changing temperatures.

Professor Hannes Alfv'en of Stockhalm's Royal institute of Technology held the view that the great bulk of the universe was made up of ionized gases whose atoms have electric charges caused by the effects of heat and radiation. These are influenced by the magnetic fields that pervade space. He believes that when the sun formed in the heart of hot ionized cosmic cloud, its powerful magnetic field fended off the distant electrically charged parts of the clouds, may eventually have condensed to form the planets. However, in our contemporary times, the hot ionized cosmic cloud under powerful magnetic field fended off distant electrically charged parts of the clouds into statics that fends off surges of static electrical charges as interference on seismic data signals.

The earth-ionosphere cavity, the electric field and conduction current in the lower atmosphere are primarily controlled by ions. These ions have characteristic mobility, lifetime, and rate of generation which changes with altitude. The formation of the earth and lithosphere was followed by the formation of the hydrosphere and biosphere. The fact that the atmosphere serves as a blanket of gases surrounding the earth, provides the connection with the seismic active spread, or line equipment, the receivers - geophones planted into the ground i.e. lithosphere, and the hydrophones laid in the water portions of the earth, including the seas, rivers, lakes, water vapour, and water droplets.

3. Aim of Study

The problem of atmospheric statics interference in the seismic industry is quite a "hot" and "sensitive" subject because of the dimension of controversy it generates between the Client Site Representatives (CSR's), and the seismic operator/contractor management. Sometimes in the Niger delta the problem of statics interference to seismic data results in loss of data prior to "saving to Instrument memory storage", loss of production, loss of production time and/or man-hours. Sometimes atmospheric static electricity causes inability of the Recording of daily instrument tests, thus hindering the start recording production, causing Chargeable Downtime due to weather that may range from minutes to hours, and days at extreme cases of consecutive prevalence. The cost of the chargeable downtime due to statics interference or weather, of hourly-rate of $10,000 (USD) excluding the Naira (or local currency) component, poses serious problem and tension between the Seismic Operators' management and the Client's CSR, that solution earnestly required.

As a result of the aforementioned challenge, research efforts were directed to proffer solution to statics interference to seismic data during recording operation rampant at advent of the rainy reason and in the harmattan period in the region of the Niger Delta of Nigeria (Figure 1). The occurrence was prevalent along the equatorial region more than when there is a departure from the equatorial region to the tropic of cancer. Visible or invisible lightning or atmospheric strikes interfered with seismic data, or interrupted and truncated the record length to become short of contractual specification. For instance, statics interference at 2.0 seconds destroyed the remaining 5seconds' data for a production shot record 7 seconds (normal record length). The challenge was to record optimal production without loss of shots due to statics interference that reduced quality or integrity of data.

4. Methodology

Since the last few decades, the Seismic acquisition has mostly been acquired by 3-D Cross Spread technique that utilized symmetrical split spread of 6 Receiver Lines x 240 channels x 120 shots per Source Line, to achieve a stipulated subsurface coverage of 60 folds, or 6000% multiplicity. The active recording spread consisted of 6 Lines of 1,440 channels cumulative. Data Recording using contemporary highly sensitive Sercel Instrument which has the capacity for sampling and obtaining high integrity seismic data signals, and high resolution data. Sercel Instruments of current millennium including 408UL, 408XL, and 428XL, with geophone groups and hydrophone receivers connected to station units/boxes or LAUX units which are in turn connected to telemetry cables laid on active spread of the 6 or more receiver lines RLs in the field.

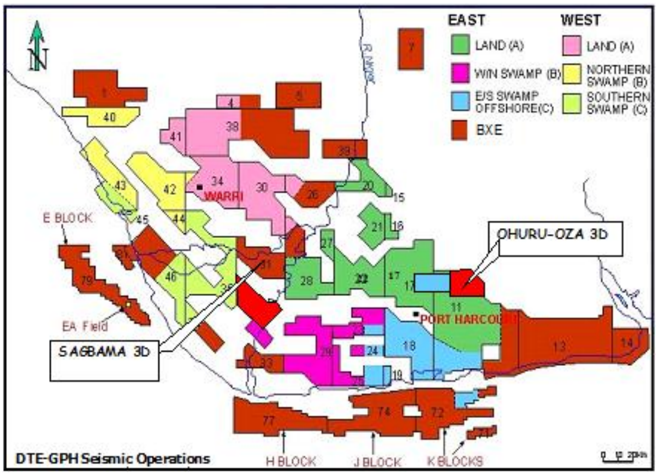


Figure 1.1: The Oil Mining Lease of Niger Delta showing the study areas

Seismic data acquisition involved active spread laid out in the field, on 3-D technique with the telemetry cables on the six receiver lines all being linked along the Transverse line to the Instrument/Recording Truck. The Source Lines (SL) run orthogonal to the Receiver Lines (RL), but the transverse line, one of the Source Lines, which bears the location of the cross station unit (CSU), that receives input of data from all 6 Receiver Lines (RLs), before relaying to the Recorder/Instrument Truck. The CSU operates a temporary storage memory capacity that assembles data from all 6 RLs, and sends to the Recording Instrument. The data in the CSU is open to interference before termination of the 7 seconds duration of a record length. The RL spacing averagely 300m to 500m in the Niger Delta can differ from that of Source Lines, depending on pattern configuration. The receivers are made up of geophone/hydrophone stations interval at intervals of 50m.

Figure 2: Exterior view of typical Seismic Recording Instrument Truck

A typical geophone group was made up of a string of 18 geophones in series (i.e. 18 jugs of SM4, 10Hz model) at 2.98m spacing. A Hydrophones used at marine stations were MP24, 10Hz model. With the Sercel 428XL, 4 receiver stations are assigned to a station unit or box of LAUX, while the stations along every Receiver Line are powered with 12V batteries at power stations, to propel data to the Instrument Truck. Events of Chargeable Downtime due atmospheric statics while seismic data recording was in progress with sensitive Sercel 428XL were logged. The dominance of statics Interference cases was found to occur in the "Afternoons" of high air temperature changes (δT) as seismic data recording spanned from 07:00hrs to 17:00hrs, (morning to evening).

Atmospheric electrostatics principle holds that statics has a relationship with atmospheric pressure ($\mathcal{P}$), Air temperature difference (δT), and Ionized air density (ϱ) by a certain Constant of proportionality $\mathcal{R}$ which represents the gas constant for air, prevalent as from the set-in of rainy season. After explanations of the statics behavior and the working of the thermodynamic variables, the observers - field engineers/Recorders began to function with the principle.

Atmospheric Statics $\mathcal{P} = \int \mathcal{R} * \varrho * \delta T$

Where δT represents Air Temperature difference, that controlled statics flux' energy, which is minimal at night/dark to early morning hours, but escalated as temperature increases in the face of high relative humidity.

The France-based Seismic Recording Sercel Instrument has tremendously developed from one version of a given age to a higher version at another age. Thus, Sercel SN 338 of 1971 gave birth to SN348 (1981-1986), Sercel SN366 (1987-1990), Sercel SN368 (1991-1996), Sercel SN388 (1996-1999), Sercel 408UL (2000-2009), or Sercel

408XL (2003-2009), Sercel 428XL (2007 - 2012). Each latest version has higher level capabilities, data management, sensitivity and functions than the former.

5. Results and Analysis

The operation time (in hours) lost to atmospheric statics' disruption of recording was classified as "Downtime" due to weather. Though most of the period was without rainfall, the atmospheric build up of statics resulted in interference strikes on the seismic data signals, and in some cases resulted in line-breaks along one or more or all 6 Receiver Lines, preventing production recording. There was a preponderance of statics Interference on seismic data occurring in the "Afternoons" of high air temperature changes (δT), compared to the paucity of statics cases in the morning hours, (Table 1 & Figure 3).

The statistics in a harmattan month as November/December showed predominant statics interference in the afternoons when temperature (T) changes in the atmosphere was prevalent (Table 1), activating discharges in the presence of accumulated plasma in the ionosphere (atmosphere). This suggested that operation during quiet weather conditions will thrive productively in such calm atmosphere of the morning hours than during "hot afternoon's" erratic temperature changes (δT).

Atmospheric statics interferes with seismic data when there is statics build up which tears apart to form separate positive and negative charges that travel in opposite directions as electric current, neutralizing the original accumulation of charges. The discharge superheats the surrounding air giving rise to "bright flash". The air in the discharge channel is heated to such a high temperature (T) that it emits light by incandescence. The clap of thunder results from the shock wave generated when the superheated air expands explosively. The discharged bright flash cuts into the seismic data, interrupting the data flow transported along Receiver Line telemetry cables or at line box LAUX at the time of "bright-flash". The release of the bright flash within the first 7 seconds after detonation of a shot or daily test shot, will strike the seismic data of that shot at a time within the 7 seconds record length of the shot. Whenever statics bright flash interfered with or cut across a shot data earlier than the expiration of the client's stipulated record-length, for instance 7seconds, that shot data or record will be classified as a "bad shot" and an unacceptable file. Rejection of shots affected by "statics interference period" gave rise to delay or waiting or suspension of recording operation for some minutes sometimes ranging from 30 minutes to hour(s). It is tracked by the field Engineers by use of skyscan statics probing device, or checking on the pulsation status until the statics cleared off the air to allow for normal recording operation without interference or line-breaks. Every hour of such a delay waiting for statics to clear in the atmosphere was regarded as "Chargeable Downtime" due to statics at a contractual rate of about $10,000 per Hour. Atmospheric statics discharge was a common cause of "Line-breaks" as excess charge was neutralized by the flow of charges to the surroundings, which cuts across the seismic data on its linear-transfer to instrument truck. A seismic data from a shot can successfully be transferred to the Recording Instrument/Truck and saved to memory without statics interference, while data from the next shot may be caught up with statics interference causing line-break midway in the course of transfer, being pre-mature to full-record-length delivery to the Sercel Instrument memory storage. The Recording Instrument over the years has advanced in functions and capabilities. The France-based seismic recording Sercel Instrument has developed from one version to a higher version with time. Thus, Sercel SN 338 of 1971 gave birth to SN348 (1982-1986), to Sercel SN408UL (2000-2009), to Sercel 428XL (2007 - 2012). Statics discharge resulting in line breaks was common during the harmattan season. The practical appreciation of statics situation was effected by use of windstrip playback over the RLs spread, even the active spread was adopted in preference to use of random shots.

- The principle and key emphasis is to optimize use of early morning hours for optimum production.
- Another factor was the monitoring and tracking of statics discharge at pulse rate and selection of threshold time, (Report Meta, 2010) so as to pick the right timing to take a shot before the next statics discharge pulsation (figures 4 and 5).
- It became essential for the engineers to track the "decay-time threshold" of statics discharge-show on screen, as to go for the next shot as discharge-show dies down.
- By this approach, a good result emerged and eliminated the occurrence of zero-production-day due to statics.

It became a partial solution to the statics weather problem, and the "early morning-hours target" became a self-driven goal by crew field engineers. However, old and defective line equipment (cables and power stations) was found to be contributory, (Stewart, 2007) degrading impact of line equipment about statics on the Receiver Lines, underscoring the rule of the thumb that, "the strength of the chain is on its weakest link." Thus, good condition or high integrity of line equipment is inevitable, (In Compliance, 2014).

In the months of June to August, the atmosphere in the tropics naturally accumulates the charges to high relative humidity and subsequently a heavy rainfall comes to clear the atmosphere of perturbations, after which, normal recording will continue with little or no atmospheric statics to interfere with seismic data, (figures 7-10). However, from the transition months of September to October, and even to November or throughout the harmattan, of December and January, accurate planning or management of time is required to optimize the use of stable-temperature hours, for a good recording production, Tables 1& 2 and Figure 3.

Table 1: Chargeable Weather Downtime Due to Statics, Nov-Dec 2010

Downtime Claims November / December 2010						
	Date	*Weather/ Statics Downtime Claimed*	*Crew's Claimed Time-range for STATICS INTERFERENCE*	*Sercel Instrument Time- range (Binout): AM/PM*	*Actual Downtime (Hrs)*	*Remarks*
1	25-Nov	1:15	14:50 - 16:05			Niger delta harmattan
2	26-Nov	4:10	15:25-16:45	PM – AFTERNOON	4.17	
3	30-Nov	1:31	12:53-13:26; 13:32-14:30	PM-AFTERNOON	1.52	
4	6TH DEC 10	1:09	14:41-15:50	PM-AFTERNOON	1.15	
5	21/12/10	1:46	15:44-17:30	PM-AFTERNOON	1.77	
6	22/12/10	4:45	08:50 – 10:01, 10:07 – 10:54, 11:07 – 13:07, 13:46 – 14:53	MORNING TILL AFTERNOON (AM/PM)	4.75	
7	25/12/10	1:17	14:13-15:30	AFTERNOON- PM	1.28	
8	26/12/10	10:00	7:00-17:00	MORNING TILL AFTERNOON (AM/PM)	10	
9	28/12/10	0:49	10:05-10:54	MORNING (AM)	0.82	
10	30/12/10	10:00	7:00-17:00	MORNING TILL AFTERNOON (AM/PM)	10	
		36.71hrs				

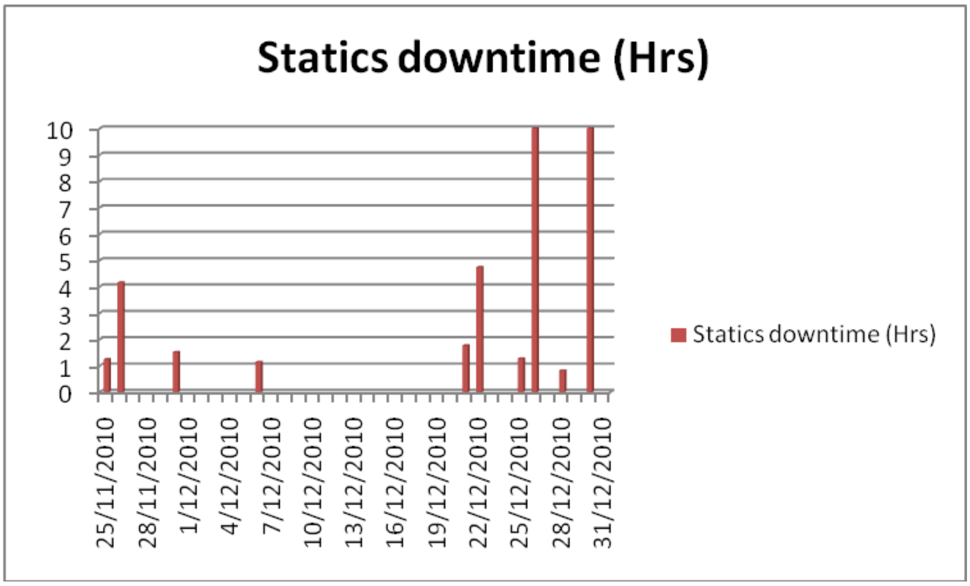


Figure 3: Plot of chargeable downtime due to statics, Nov-Dec 2010

Statics discharge, resulting in line breaks, constitutes a challenge throughout many recent surveys, and results in loss of at least one day of production on a monthly basis, except in rare cases of careful optimization of early morning, low-stable-temperature hours.

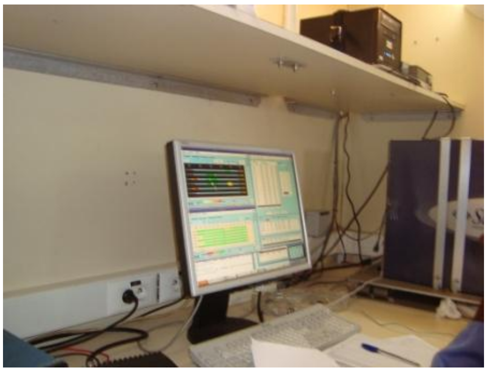


Figure 4: Inside Recording Truck: Recording Instrument Sercel 408UL Displaying 6 RLs; Statics shown in red on 5 out of 6 Receiver Lines; Yellow Skyscan for statics monitoring

Bad shots due Line-Breaks (Weather or Statics Interference)

One of the major challenges encountered during the Recording operation was specifically that of atmospheric statics, which resulted in loss of shots disqualified as a result of line-breaks sometimes, in the count of fifty to sixty in a day, if the field engineer manning the Instrument was inexperienced about tropical weather. In a prospect, 1454 bad shots were lost to this occurrence during Recording operations.

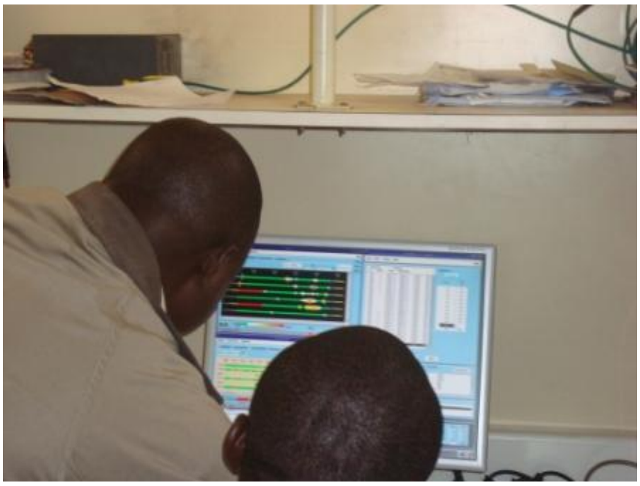
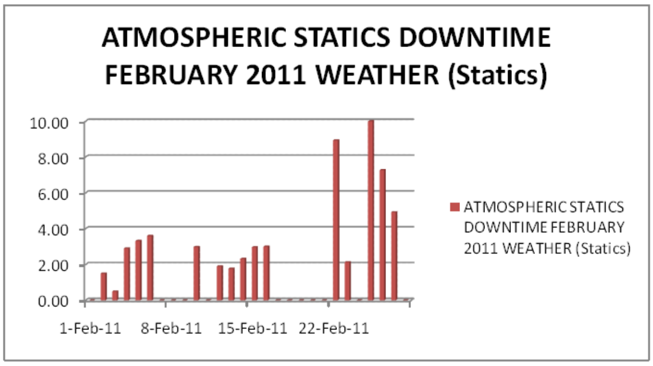


Figure 5: Statics Interference on 2 Receiver Lines out of 6RLs at detonation of a shot, rendering the shot a bad shot due to loss of 50 channels, and track pulse decay, time next shot

Table 2: Statics Interference to Recording Production In February 2011

ATMOSPHERIC STATICS DOWNTIME FEBRUARY 2011

Date	WEATHER (Statics)	WEATHER	
1-Feb-11	0.00	0:00	
2-Feb-11	1.50	1:30	
3-Feb-11	0.50	0:30	
4-Feb-11	2.90	2:54	
5-Feb-11	3.32	3:19	
6-Feb-11	3.60	3:36	
7-Feb-11	0.00	0:00	
8-Feb-11	0.00	0:00	
9-Feb-11	0.00	0:00	
10-Feb-11	2.98	1:59	
11-Feb-11	0.00	0:00	
12-Feb-11	1.90	1:54	
13-Feb-11	1.77	1:46	
14-Feb-11	2.32	2:19	
15-Feb-11	2.97	2:52	
16-Feb-11	3.00	3:00	
17-Feb-11	0.00	0:00	DT not approved
18-Feb-11	0.00	0:00	DT not approved
19-Feb-11	0.00	0:00	DT not approved
20-Feb-11	0.00	0:00	DT not approved
21-Feb-11	0.00	0:00	DT not approved
22-Feb-11	8.93	8:56	
23-Feb-11	2.13	2:08	
24-Feb-11	0.00	0:00	
25-Feb-11	10.00	10:00	
26-Feb-11	7.27	7:16	
27-Feb-11	4.92	4:55	
28-Feb-11	0.00	0:00	
Total	60.01		



From the Table 2 above, there are cases of atmospheric Statics Downtime in February, when the rainy season has not set in, rather closing of harmattan season and boundary period for start of rainy season. Indications show gathering of population of charges in the ionosphere filled with plasma at that dry season temperatures (δT), prevalent in the afternoons.

Whenever it rains heavily, the statics build up exercises a natural discharge, and relieves the atmosphere of the forceful plasma ground move that flows to cut across or interfere with the seismic data. The result of this activity is that after a heavy rainfall, there follows a good recording production that suffers little or no interruption or interference of atmospheric statics.

6. Conclusion

In the months of June to August, the atmosphere in the tropics naturally accumulates the charges to relative humidity and subsequently a heavy rainfall comes to clear the atmosphere of perturbations, after which, normal recording will continue with little or no atmospheric statics to interfere with seismic data. However, from the transition months of September to October, and even to November or throughout the harmattan, of December and January, accurate planning or management of time is required to optimize the use of stable-temperature hours, for a good recording production.

The ability to understand the overall behavior of the atmospheric statics in the tropics, the recording crew to set-off and target early-start of recording operations in the early morning hours and optimize early morning temperature stability, and target optimum production within the window of stable temperature before perturbation changes in the hot afternoons, then good recording production would be achieved before temperature irregular changes in the hot afternoons.

The challenge of putting the Recording crew out for optimum daily production, only to be limited by atmospheric statics while there is no saturation of relative humidity to precipitate to heavy rainfall, but patches of accumulation of charges continuing to build up, and/or enforce separation of negative and positive charges, superheating the surrounding air or plasma explosively to emit bright flashes and strikes that interfere with seismic data signals causing line-breaks, and loss of shots has a near solution of understanding the tips and of this paper.

Table 5: Showing Weather Downtime due to statics/Rainfall in June 2011 (Rainy Season)

JUNE 2011 DOWNTIME	WEATHER / STATICS DOWNTIME	REMARKS
1-Jun-11	0	
2-Jun-11	0	
3-Jun-11	0	
4-Jun-11	0	
5-Jun-11	0	
6-Jun-11	0	
7-Jun-11	0	
8-Jun-11	0	
9-Jun-11	0	
10-Jun-11	0	
11-Jun-11	0	
12-Jun-11	0	
13-Jun-11	0	
14-Jun-11	0	
15-Jun-11	0	
16-Jun-11	0	
17-Jun-11	1.23	Rainfall disturbance during Recording
18-Jun-11	2.00	Rainfall disturbance during Recording
19-Jun-11	0	
20-Jun-11	0	
21-Jun-11	0	
22-Jun-11	2.65	Rainfall disturbance during Recording
23-Jun-11	0	
24-Jun-11	0	
25-Jun-11	0	
26-Jun-11	4.33	Rainfall disturbance during Recording
27-Jun-11	0	
28-Jun-11	0	
29-Jun-11	0.72	Rainfall disturbance during Recording
30-Jun-11	0	
	10.93	**Total weather downtime for June'11.**

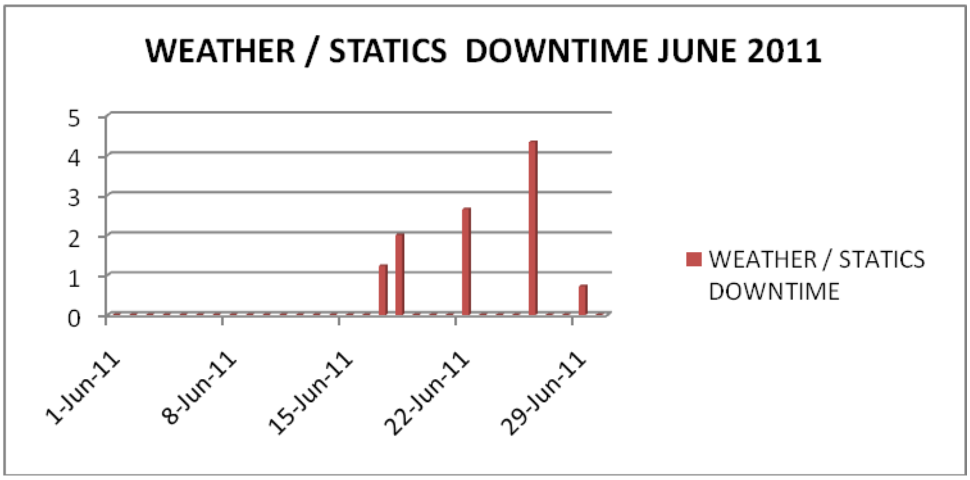


Figure 7: Weather Downtime due to statics/Rainfall in the Rainy Season, downpour clears the air of plasma and atmospheric statics buildup

Days	Down time
5/7/2011	1:02
6/7/2011	4:26
20/7/2011	1:23
23/7/2011	1:30
25/7/2011	0:59
26/7/2011	2:30
TOTAL	11:50

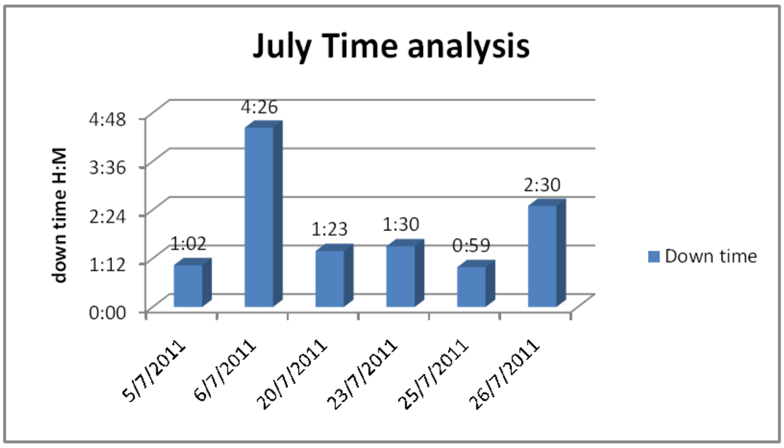


Figure 8: Weather Downtime due to statics/Rainfall in July 2011 (Rainy Season – less statics build up as rainfall clears off atmospheric statics buildup)

Days	Down time
14/8/2011	1:30
21/8/2011	2:00
22/8/2011	2:48
26/8/2011	2:20
TOTAL	8:38

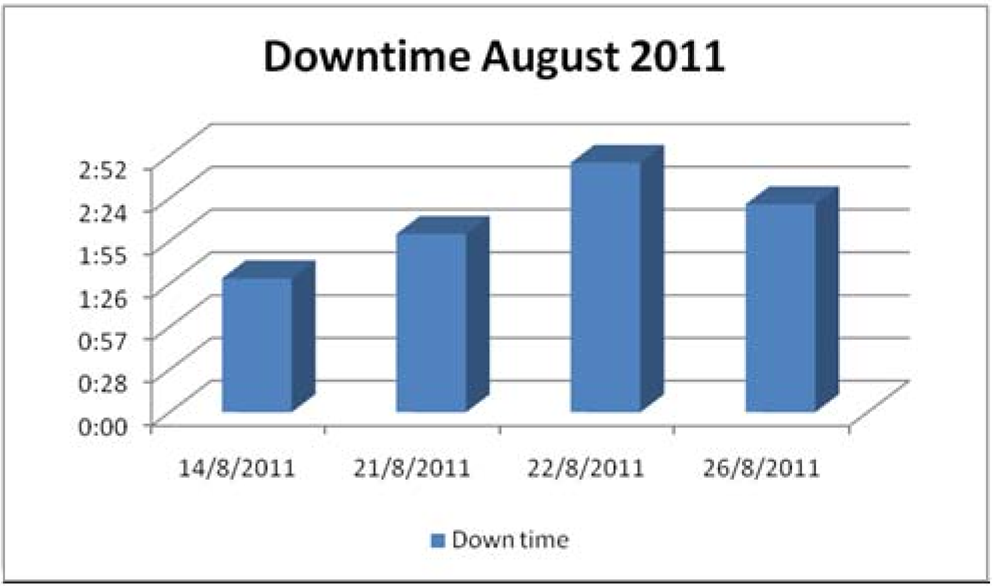


Figure 9: Weather Downtime due to Statics/Rainfall in August 2011 (Rainy Season – less statics build up as rainfall clears off statics accumulation /plasma in the atmospheric)

Table 6: Downtime September 2011

Days	*Downtime (hr:min)*
9/9/2011	1:12
11/9/2011	0:45
12/9/2011	0:39
14/9/2011	2:30
15/9/2011	2:00
16/9/2011	1:41
18/9/2011	2:56
19/9/2011	1:20
22/9/2011	2:55
25/9/2011	1:20
29/9/2011	0:30
TOTAL	**17:48**

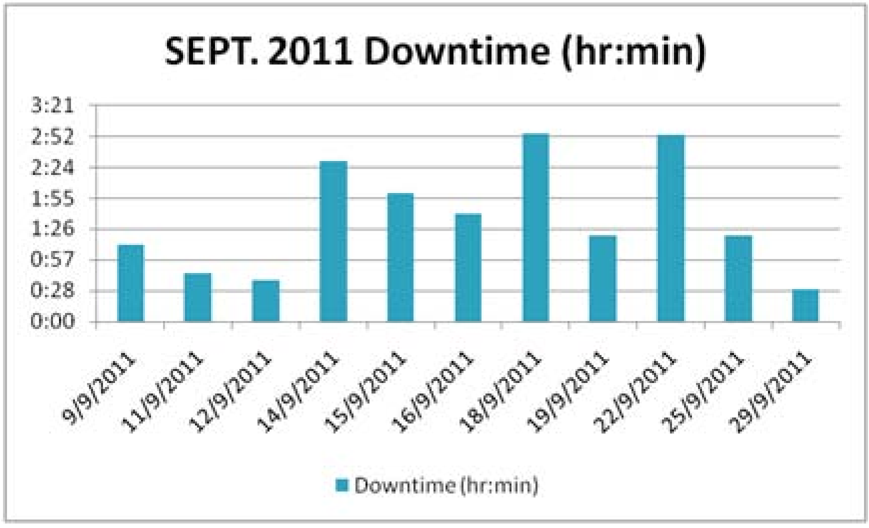


Figure 10: Time Analysis showing Downtime due to Statics in September 2011 (Tapering-off of rainy season)

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