AN EVALUATION OF LIGHTNING FLASH CHARACTERISTICS USING LDAR AND NLDN NETWORKS WITH WARM SEASON SOUTHEAST TEXAS THUNDERSTORMS

A Thesis

by

JOSEPH WILLIAM JURECKA

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2008

Major Subject: Atmospheric Sciences

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Approved by:

Chair of Committee,	Richard E. Orville
Committee Members,	Lawrence D. Carey
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ABSTRACT

An Evaluation of Lightning Flash Characteristics Using LDAR and NLDN Networks with Warm Season Southeast Texas Thunderstorms. (August 2008)

Joseph William Jurecka, B.S., Texas A&M University

Chair of Advisory Committee: Dr. Richard E. Orville

A comparison of flash parameters from the National Lightning Detection Network (NLDN) is made with data obtained from the Houston Lightning Detection and Ranging II (LDAR) network. This research focuses on relating the peak current and number of strokes in a negative flash (multiplicity) of lightning with the spatial extent and mean altitude of three-dimensional lightning in 1407 flashes as mapped by the LDAR network. It is shown that increasing negative multiplicities over the range two through ten exhibit, on average, a higher flash extent with higher multiplicities. Single-stroke flashes have mean heights of nearly 2 km greater. Higher order multiplicities (2 to 10+) were correlated with mean source heights near 8 km. Increasing multiplicity tends to be associated with greater flash extents increasing more horizontally than vertically with a 50% to 70% increase in flash extent. No obvious relationship between peak current and flash extent was observed. Examining peak current and mean height shows that low current flashes (<10kA) exhibit higher mean heights. However, this may be due to intra-cloud only flashes being reported as cloud to ground events by the NLDN. Bipolar flashes do not show much variation with height and flash extent with the exception of negative-first bipolar flashes, which exhibited mean flash extents twice that of other types. Finally, the flash detection efficiency is 99.7% within 60 km of the network center.

DEDICATION

This thesis is dedicated to my loving wife, Kimberley and my two children, Kathleen and Matthew.

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Numerous people who provided influence and guidance have impacted my life. This work is but part of the journey and represents, for me, the foundation of a new career path.

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Finally, thanks to my mother and father for being great parents and most of all to my wife for her patience, understanding, and love in what has been a rewarding change of careers.

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I. INTRODUCTION

Since the late 1980s, a National Lightning Detection Network (NLDN) for detecting cloud-to-ground strokes has been in place (Cummins et al, 1998 and Orville, 2008). More recently, technology has allowed the use of Very High Frequency (VHF) radio frequency emissions to detect individual energy sources within the flash. One such network is deployed, in the Houston area and is run by the Department of Atmospheric Sciences at Texas A&M University. The Houston network is formally known as the Houston Lightning Detection and Ranging (LDAR) network. Vaisala, Inc manufactures the sensors and central server.

By mapping the three dimensional information provided by the VHF network and combining the information with cloud-to-ground data, insight into the volumetric characteristics of total lightning becomes possible.

Many studies have analyzed NLDN and LDAR (or LMA) data. Generally, these examine single flashes or a small collection of events. However, a study analyzing throusands of comparisons between NLDN and LDAR data is newf. This thesis fills that gap and provides a comparison for observations using NLDN and the Houston LDAR network. Although the two networks capture uniquely different information, temporal and spatial synchronization facilitates comparison between the two networks. This combination allows the analysis of "total lightning" within the thunderstorm. Via total

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This thesis follows the form of the *Bulletin of the American Meteorological Society*.

lightning, we gain insight into storm structure, microphysical processes, and electrical nature of thunderstorms.

While the LDAR and NLDN data can be analyzed on a per-flash basis, this work focuses not on individual characteristics but rather the trends found among hundreds of flashes. As the research on this topic was ongoing, it was very apparent that lightning metrics exhibit significant flash-to-flash variance within the same storm a few seconds apart. As the storm matured, overall, events appeared to expand in extent along with the total volume of the storm. It is also recognized that different storm types will provide different signatures. For example, a summertime, low-shear thunderstorm along the Gulf Coast has a smaller volume than does a springtime mesoscale convective system. Even within a system, such as an MCS, there are differing characteristics within parts of the storm (Carey et al., 2005). This study is comprised of generally weakly forced multicell thunderstorms. Aggregating data from many flashes reveal trends between the NLDN and LDAR networks. Some relationships yield a nearly linear relationship. Others offer more complex characteristics such as anomalies associated with single-stroke flashes. Bipolar flashes, containing both positive and negative strokes, also appear to deviate from the characteristics of uni-polar events.

Southeast Texas is a climatologically active thunderstorm region throughout the year, which provides excellent opportunities for data gathering and analysis. Synoptic features, such as frontal convection as well as mesoscale influences such as the sea breeze, affect this region. The period of this study analyzes convection on selected days from May to July 2007. This time period, while providing near climatological averages of measurable rainfall, produced a higher than normal number of days with rainfall and therefore higher than average thunderstorm events. However, the individual thunderstorms themselves were typical of the season.

This analysis is best handled with discrete flashes that are often challenging to find in the cluster events of the season. However, with careful selection, it is possible to obtain isolated flash events within an otherwise chaotic lightning environment.

It seems logical that parameters collected by the NLDN, namely multiplicity and peak current, would be closely related to those determined by the LDAR network. There are a number of hypotheses that were tested with this work. Logic suggests that increasing peak current would require the support of increased flash extent. Likewise, an increase in multiplicity would also require the expanded flash extent. As charge regions have a finite charge capability, obtaining a larger volumetric charge region should enable the increased charge flow. Visual observation of spider lightning indicates that a large visible discharge occurs within the anvil region of mature thunderstorms spreading in a mostly horizontal extent. As a result, the flash extent is not expected to cubically grow with increasing flash extent but rather spread more horizontally. With these ideas in place, if multiplicity were increased, mean hight should increase since the LDAR detects the presence of most sources at the 10 km level. If flash extent increases, especially horizontally in a narrow veritical band such as an anvil, the mean height should increase. Likewise, one would expect an increase of mean height to increase with peak current as well.

With regard to differing flash types, one might expect negative flashes, with higher average multiplicity, to exhibit higher flash extents and mean altitudes than positive flashes. Taking this idea one more step, bipolar events, which contain both positive and negative strokes, would be expected to exhibit characteristics similar to negative flashes.

II. THE HISTORY OF THREE DIMENSIONAL LIGHTNING DETECTION BY RADIO FREQUENCY METHODS

In 1967, F. J. Hewett suggested that a hyperbolic array of radio receivers might yield the ability to track storms. From this suggestion, intracloud lightning positioning studies using radio frequency (RF) methods began with an analog network located in South Africa in the late 1960s. This five station network, operated by the South African National Institute for Telecommunications Research, was used by D.E. Proctor to create the first representations of intracloud flash extent by observing the demodulated signal output of five 250 MHz receivers spaced in nearly a perpendicular array. End to end, this network stretched for approximately 40 km in a north-south and 30 km east-west configuration. Receiver outputs were connected to a central observing station where time-relative measurements of each atmospheric burst were displayed on cathode ray tubes and captured on 35mm film as seen in figure 2.1 (Proctor 1971). Figures are located within appendix A.

The system was calibrated to eliminate internal propagation delays from the individual receivers to the observation point (Proctor 1971). After reception and film development, Proctor began the time-intensive task of manually associating each station's data with individual VHF sources based on the arrival time at each of the five sensors. By combining the data from the sensors, individual VHF source locations were derived and thus, the first three-dimensional mapping of intracloud lightning based on RF methods were produced as illustrated in figures 2.2 and 2.3. Both charts depict flashes occurring on March 26, 1970. While Proctor's work was time-intensive, his findings are remarkably similar to what is observed with today's lightning mapping networks. Horizontal accuracy was estimated to be on the order of 20m with a substantially larger (100m to 1km) vertical error. In addition to the main channel discharges, he was able to capture stepped-leader and dart leader features. While not directly related to this thesis, it would be interesting to compare the findings of Proctor dealing with step and dart leaders with the visual observations made possible by high speed camera lightning research by Tim Samaras (2008).

Yet another critical piece of information, related to RF based lightning networks was determined by Proctor (1981). By comparing the incoming waveforms of demodulated output at 2, 30, 250, 600, and 1430 MHz, he concluded that lightning generates wideband signals on the order of many GHz. Lightning radiation is therefore not oscillatory in nature, but results in a broadband pulse-like waveform. This finding showed that the exact frequency of operation was indeed not critical and thus gave researchers confidence to proceed with studying a number of different frequency bands. Proctor had taken great care to design the radio system, with a sensitivity of 0.5 μV/m for 10 dB signal to noise ratio, for adequate spurious and intermediate frequency (IF) rejection. The radio system IF frequency was 30 MHz and Proctor understood that lightning RF bursts were 20dB stronger at 30 MHz than at the primary reception frequency of near 250 MHz. This occurs because it takes more energy to generate radio waves at higher frequencies. Thus, given equal energy, higher frequency emissions are lower in amplitude.

Proctor also took into consideration that the “backhaul” network, which relayed the signal data from each site to the observation station, could be susceptible to impulse noise as well thus potentially contaminating the VHF signal. In the absence of present data technology, X-band (near 10 GHz) telemetry links using Frequency Modulation (FM) were used. Lightning induced RF signatures are 26 dB weaker at 10 GHz than the primary reception frequency (Proctor 1971). Furthermore, the use of FM further desensitizes the link from static crashes within the demodulation limiter in much the same fashion that FM broadcasts are far less susceptible to noise than AM broadcasts on an ordinary radio. Other means of avoiding contamination were also used, further emphasizing the need for careful engineering practices when designing a lightning detection network.

In the mid 1970s, C.L Lennon and team at the Kennedy Space Center (KSC), Florida created a seven sensor network near the KSC. This network, named the Lightning Detection and Ranging (LDAR) network, is the predecessor of the system used in Houston today. The network operated between 30 and 50 MHz with sensors located in two Y shaped networks with a diameter of 20km and a common central station. Logarithmic receivers provided digitized signal information over a 100-microsecond interval with a resolution of 50 nanoseconds (Krehbiel 1981). This network was capable of resolving several tens of events per flash and one such example appears in figure 2.4.

Further Refinements in RF based intracloud lightning continued and in the early 1990s, a second generation, seven site, LDAR system was developed at the Kennedy

Space Center, which featured improved temporal resolution and number of events per second which theoretically allows the locating of several thousand sources per second (Maier et al. 1995 and Mazur et al. 1997). The improvement in mapping ability is depicted in figure 2.5. This technology was subsequently licensed to Vaisala for commercial deployment and, with additional minor enhancements such as remote frequency control, is the basis for the Houston LDAR II Network. The Dallas / Fort Worth network uses the same equipment as the Houston network, but currently has nine sensors. The reader is directed to Ely et al. (2008) for additional details about the Houston network during its operation at 69 MHz. A discussion of the Dallas Network is found in Carey et al. (2005).

In the late 1990s, a ten-site Lightning Mapping Array (LMA) was developed and deployed in the desert of New Mexico by the New Mexico Institute of Mining and Technology. This system uses a 6 MHz-bandwidth receiver tuned to the Television Channel 3 spectrum near 63 MHz and is capable of capturing 50 ns time resolution data that is phase locked to a GPS (Rison et al. 1999). The LMA design has been used in many locations including the National Severe Storms Forecast Laboratory (Mach et al. 1986), University of Alabama at Huntsville (Goodman et al. 2005), in the Washington D.C. area (Krehbiel et al. 2006), as well as during the STEPS project in Colorado and Kansas (Wiens et al. 2005).

The sensitivity of the LMA system is significantly better than that of the LDAR II network in Houston. The LDAR system is intended as an operational network and not optimized to extract as much data as possible (MacGorman and Rust 1998). One of the primary external impediments for the Houston network is RF contamination from a wide variety of sources. Whereas the LMA network in New Mexico detected pulses near -90 dBm, the Houston network minimum detectable signal level ranges from -60 dBm during particularly noisy periods at the worst sites to -80 dBm at the best. For this reason, aircraft and balloon trails, caused by collisions with ice particles, have never been observed on the Houston LDAR II network as they have with both the New Mexico Network and STEPS network (Thomas et al. 2004). An example of an aircraft trail is presented in figure 2.6.

Regardless of the decreased sensitivity, in comparing the appearance and extent of flashes in the published literature, the LMA system appears to have flash extents similar in appearance to those detected with the Houston network. Most notably, the LMA system displays lightning maps comprised of a much denser array of resolved points. As a result, it would appear that the decreased sensitivity of the LDAR system in the Houston area, while affecting the density of plots, would not be expected to significantly change the resulting flash extents or altitudes. Arguably, with increased sensitivity, flash extents could increase somewhat, but the general trends found herein are expected to be similar to those found with an LMA network. That said, Mazur et. al. (1987) found that the detected three dimensional lightning data obtained using an interferometer showed a higher density of points at lower altitudes. Thus, is certainly appears that neither LDAR nor interferometric measurements individually capture all electromagnetic sources equally. As such, a bias is likely to exist when using LDAR data alone. In side by side comparisons, the LDAR data did appear to capture horizontal flash extent better than interferometers, but was poorer at more vertically oriented structures. It is believed, based on Mazur's findings that LDAR will likely capture horizontal flash extent more adequately, but a bias in the vertical may exist overall.

A number of studies have been conducted with the LMA/LDAR networks primarily to better understand the electrical nature of thunderstorms. In particular, several attempts to map the charge structure of storms have occurred including but not limited to the STEPS project in eastern Colorado and western Kansas in the summer of 2000 (e.g. Wiens et al. 2005).

Under the assumption that electrical breakdowns propagate into regions of opposing charge, it is possible to determine the charge polarity of different parts of the storm from the propagation of the flash in the cloud (e.g. Wiens et al. 2005). Figure 2.7 illustrates an LMA recorded flash after applying the polarity logic to a thunderstorm. With this effort, regions of positive and negative charge become clearly defined (Hamlin et al. 2003). Thunderstorms often display a tripole structure where there are two regions of positive charge (one near 0°C and one above -20°C) with a negative charge region sandwiched between these two at -10°C and -20°C. Some storms exhibit an inverted polarity structure as observed in Stolzenburg et al. (1998a) and Lang et al. (2004). Storms modify their structure, potentially becoming further stratified, during their lifetime with apparent dependencies on updraft strength (Wiens et al. 2005).

There are several articles in the literature that discuss charge polarity structures, flash rates, and flash patterns especially in individual storms. Wiens et al. (2005) examined several, mostly isolated, storms in Colorado and Kansas and hypothesized that the LMA system tends to more readily capture negative breakdown into positive regions. Thus, positive regions will appear to contain more sources than regions where positive charge is breaking down into negative charge regions. Caret et al. (2005), Ely et al. (2008) and Hodapp et al. (in press) looked at LDAR sources in MCS storms finding that the LDAR sources had an increased density both in the convective region as well as a cascading region sloping downward in the stratoform region toward the melting layer. It was also determined that different regions of a storm complex exhibited different flash characteristics such as higher peak currents in the stratoform region than in the convective core. Not discussed are the more general patterns that appear in comparisons between multiple storms in a given area and the relationship between intracloud data as provided by LDAR (or LMA) networks and the NLDN. It is emphasized that this work only examines flashes which were detected by the NLDN and that purely intracloud flashes are not part of this study.

As previously established by Orville et al. (2002), there are general relationships between multiplicity and peak current over a large sample space. Likewise, cloud to ground activity also displays relationships with respect to flash extent and mean heights of detected VHF sources.

III. ATMOSPHERIC RADIO FREQUENCY SOURCE POSITION DETERMINATION

Positioning via time-of-arrival methods is accomplished by establishing a geographically separated set of receivers and noting the time at which the radiation from a given impulse arrives at each station. If each station's precise latitude, longitude, and altitude above a reference geoid is known with a timekeeping means accurate to within a few nanoseconds, the resulting three-dimensional location of the point source may be determined via manipulation of equation 3.1. In this case, a radiation point source located at (x,y,z) is received at location (x_i,y_i,z_i) at time t_i where c is the velocity of propagation. The actual time that the source is emitted (t) is, at first glance, computed simply by iteratively solving for t using equation 3.1 for each sensor's location and timing information (Thomas et al, 2004).

$$c(t - t_i) = \sqrt{(x - x_i)^2 + (y - y_i)^2 + (z - z_i)^2} \qquad (3.1)$$

Unfortunately, an iterative convergence technique is not practical for real-time applications and therefore another method is preferred which creates a linear set of equations which may be solved via matrix manipulation techniques. The method of mathematically deriving each source's position is described in Thomas et al. (2004) and Koshak et al. (1996). A graphical representation of the geometry involved is depicted in figure 3.1.

The basic solutions provided by Koshak 1996 are intended to address positioning in a Cartesian space. The most significant errors to this method include altitude deviations caused by the Earth's curvature, which is well understood and correctable, and propagation anomalies induced by changes in the refractive index, which is also understood, yet difficult to measure. In the classic example, a nocturnal, highly stable and stratified boundary layer exists in association with a slow moving high pressure system. These conditions occur several times per year along the Gulf Coast of the United States. Warm and very moist air is present in the boundary layer capped by a strong temperature inversion and much drier air aloft. As a result, the atmosphere's index of refraction sharply changes in a short vertical space such that the velocity of propagation is altered significantly near the surface where the velocity of propagation is slower than in the drier air above. The velocity of propagation in the moist sector often slows by a factor of 0.035% as compared to the velocity of light in a vacuum whereas in the dry layer a few thousand feet above the surface may support velocities slowed by a factor of 0.025%. At 100km ranges, this can induce horizontal errors on the order of 10 meters or more. Vertical results can be grossly in error.

The illustration in figure 3.2 provides two example flashes. Source A travels primarily through the faster portion of the atmosphere whereas source B travels through the slower region. Relative to each other, even if A and B are above the same location on the earth's surface, source B will appear, to the network, farther from the network than source A due to the slower propagation time.

Under mixed boundary layer conditions, the transition from lower velocities near the surface to higher velocities above is markedly more gradual increasing to 0.02% slower than the velocity of light at 600mB (Thomas et al. 2004). Still, atmospheric profiles of temperature and dewpoint are not sampled at sufficient resolution temporally or spatially to eliminate these errors.

Thomas et al. (2004) describes a tendency for distant source solutions to increase in altitude. This characteristic is observed on the Houston network as well especially at distances of 150 km or more. Boccippio et al. (2007) found that theses anomalies were largely due to radial errors such that at distances of 200 km, 4 km height errors are common.

In addition to naturally induced anomalies of propagation, an accurate and stable timing reference within the sensor must be used to accurately determine the arrival time of lightning induced RF signatures. An error of 11μs roughly corresponds to an error of 300 meters. It is the author's experience that most GPS receivers produce a one pulse per second signal accurate to ± 1 μs. This results in a source of significant error if not mitigated. While the author has experience with GPS controlled timing references accurate to within a few parts per billion for frequency control, the LDAR sensors used in Houston do not contain an ovenized oscillator capable of producing this order of accuracy. Oscillators built into self regulating oven chambers experience less thermal drift and thus can produce, when combined with an adequate reference signal, such as GPS, a highly stable and accurate time base. The actual stability and accuracy of the internal LDAR II timing circuitry is proprietary and not known.

To further mitigate errors in positioning, the network uses a method of selecting the six "best" sites for each flash based on the minimization of the Chi-square (χ^2) error. The Reduced Chi-Square (RCS) value for each VHF source located is computed via equation 3.2 from the LP5000 User's Guide.

$$RCS = \frac{\sum_{j=1}^{n} \left[\frac{m_j - m_j*)^2}{e_j^{\ 2}} \right]}{x} \quad (3.2)$$

Where:

n = Total number of measurements

j = Measurement index

m_j = Measured value

m_j* = Calculated value based on optimum location

e_j = Theoretical measurement error (standard deviation)

x = Degrees of freedom

A study of the Lightning Mapping Array (LMA) in use during the STEPS project by Thomas et al. (2004) indicated typical RMS horizontal errors of 300 to 600 meters at distances of 100km from the network center. These findings were based on the tracks of aircraft and balloons capable of accurate geolocation fixes.

Houston LDAR performance, due to its line of site nature and relatively close spacing of the sensors performs best at ranges close in to the network. Based on general observations, including a study by Ely et al. (2008), the network detection of VHF sources is maximized within 90 km of the network center. Outside of this ring, network performance drops substantially as evidenced by comparisons of a mesoscale convective system which moved across the region on 31 October 2005. Thus, this work concentrates on events centered within approximately 60 km of the network center such that flashes extending in the region 60 km to 90 km from the center should provide good data.

Network VHF source position accuracy was also estimated in the 31 October 2005 case using geo metric model presented in Rison et al. (1999) and Thomas et al (2004). It was determined that the RMS timing error was on the order of 80 ns which corresponds to median three dimensional position error of about 250 m.

A comparison of LDAR and LMA networks was performed in Krehbiel et al (2008) for the Dallas/Fort Worth (D/FW) network. Over the past few years, it was noticed that the LMA system tended to show a much denser cluster of VHF source points. It was speculated that a system minimum detectable signal level was approximately 15 dB better for the LMA network. For this analysis, LMA sensors were deployed alongside four existing LDAR sensors in the D/FW area. The resulting calculated noise floor of the network was about -63 dBm for the LDAR network and -78 dBm for the LMA at the Mesquite site. In contrast, due to high noise levels and automatic threshold adjustments on the LMA, the LDAR sensor at the Federal Aviation Administration site was 8 dB better. Thus, the LDAR may demonstrate advantages in noisy electromagnetic environments. Insofar as accuracy, the two networks appear very close.

A comparison was also examined between cloud-to-ground and intracloud events between the LDAR and LMA networks. The LMA, as expected due to higher sensitivity, better detected the cloud-to-ground event in addition to also detecting corona discharge. As such some bias, with flash extent, may be possible due to sensitivity concerns.

Overall, the D/FW LDAR network exhibited good flash detection efficiency for intra-cloud and positive cloud-to-ground flashes. However, negative cloud-to-ground flashes and the intra-cloud lower charge region appear to not be handled as with the same robust nature as the LMA (Krehbiel et al., 2008).

Naturally, these biases will also appear in the Houston network as well since the D/FW LDAR system uses the same equipment. Nevertheless, this work is still considered of value with the caveat that instrument errors must be considered.

IV. THE NATIONAL LIGHTNING DETECTION NETWORK

Late in the 1970s, data began to be collected on cloud to ground lightning discharges with the deployments of a number of networked lightning sensors in the Western United States and Alaska to aid in forest fire mitigation. This network was comprised of low frequency loop antennas in an orthogonal configuration plus an electric field antenna to obtain unambiguous azimuthal information with an accuracy of two degrees or better (Krider et al. 1980). Shortly thereafter, other networks were established in the United States. In the northeastern United States, a network, with an operations control center at the State University of New York at Albany, was initiated in the spring of 1982. A year later, a total of ten sensors were deployed with coverage roughly extending from North Carolina to extreme southern Quebec (Orville et al. 1983).

A mid-western network, with four sensors, was operated by the National Severe Storms laboratory in Oklahoma to complement ongoing electric field studies (Mach et al. 1986). The Oklahoma network was uniquely positioned to sample severe and tornadic thunderstorms.

By 1989, all three networks had expanded and were merged into the National Lightning Detection Network (NLDN) providing coverage for the contiguous United States. The system was upgraded in 1994 through 1995 with roughly half the sensors incorporating time-of-arrival and magnetic direction finders known as improved accuracy from combined technology (IMPACT) sensors. After the upgrade, the network included 106 sensors with an average baseline near 300 km (Cummins et al. 1998). In

2004, all sensors were upgraded to more sensitive IMPACT-ESP units and additional sensors were added to the network (Biagi et al. 2004). Today, the network covers the United States (114 sensors) and much of Canada (87 sensors) and is known as the North American Lightning Detection Network (NALDN). Figure 4.1 contains the most recent map of NLDN locations in the contiguous United States. Vaisala, Inc. in Tucson, AZ provides ownership, operations and maintenance for the network.

Post-processed archive NLDN data are received monthly at Texas A&M and provide raw stroke data which includes geolocation information, stroke current (including polarity) and nanosecond-resolution timing. Using geolocation and timing information, flash multiplicity is derived. With the addition of peak current, these data provide four useful metrics to describe the characteristics of C-G lightning (Biagi et al. 2007).

V. THE HOUSTON LIGHTNING DETECTION AND RANGING NETWORK

While NLDN data provide insight into cloud-to-ground flashes, lightning also exhibits a volumetric distribution in thunderstorms that cannot be mapped by low frequency (1 kHz to 1 MHz) systems. However, VHF systems are able to obtain details about the structure of lightning flashes by measuring radio frequency burst on the order of a few microseconds (Mazur et al. 1997). By using multiple, geographically spaced, receivers, the location of the pulse origin may be found using Time of Arrival (TOA) methods assuming line of sight propagation at the speed of light through the atmosphere. While errors due to change in velocity of propagation are possible, primarily induced by the variation of vertical gradients in moisture (Freeman 1987), these errors, especially in the domain on the order of 100 km, are normally small when thunderstorms actively mix the environment.

The Department of Atmospheric Sciences at Texas A&M University has deployed a network of twelve TOA lightning detection and ranging (LDAR) sensors in the Houston area. A photograph of the Williams Airport site is included in figure 5.1. The network is centered at 29.79 N, 95.31 W. These sensors are arranged in an outward spiral with average baseline of 25 km between sensors and an average network radius of 75 km. Figure 5.2 provides an overview of the sensor locations throughout the Houston area.

Each sensor has a power supply, Linux based mini-computer, vertically diversified set of three antennas, GPS receiver for synchronization and radio receiver. The receiver, based on testing with RF equipment, has a nominal bandwidth of 6 MHz and employs an amplitude detector. The sensor decimates real-time data in 200μs bins (up to 10,000 transients per second). However, under quiescent conditions, the sensor is adjusted for 5% to 10% detected amplitude (500-1000) transients (from the noise floor) for optimal sensitivity. Undecimated data are stored on 80GB hard drives located at each of the twelve sites. Every few months, disk drives are collected from the sites and returned to College Station for reprocessing. The data from the disks are copied to the LDAR storage array. Storm activity days are logged for reprocessing, subsequent display and analysis.

The frequency of operation and sensor gain is remotely adjustable. The Houston network has operated on a total of three RF frequencies during its lifespan. The original deployment operated near 69 MHz, a vacant television channel in the immediate area. However, with the occurrence of troposphere propagation enhancement along the Gulf Coast, the radio frequency noise floor often increased substantially during the night due to the reception of distant television stations. E-layer "skip" propagation also contributes to an increased noise level especially during active solar conditions. Paging transmitters in the Houston area above 70 MHz also contribute to interference and regularly impact the network.

To counteract the interference faced by operating within the VHF-TV band, a move was made to 113 MHz in the normally quiet aeronautical navigation band. Unfortunately, strong noise transients were observed at several locations on this band. The source of the transients was never identified, but the decision was made to try a lower frequency band as it was not known how well the sensors would perform at higher frequencies.

In March 2007, a move to 40 MHz was made and this band has proven to be the most stable, from a noise level perspective—at least while solar activity is relatively low. Additionally, a substantive improvement in distant source detection was realized with this change. For the first time, sources as distant as the Dallas/Fort Worth area were detected.

Ensuring that the sensors are optimized from an RF perspective is one of the most time-consuming tasks with the network. Adjusting the gain of the receivers must optimally be performed each day so as to maintain adequate sensitivity without consuming excessive disk space. Various methods for automatically adjusting the gain have been discussed, but no technique has been implemented to date. If too short a time constant is selected, long duration thunderstorm events will be adversely affected by a decrease in sensitivity after gain reductions are initiated. With a longer time constant, excessive disk usage will remain an issue albeit less than via manual intervention.

The number of sensors required for VHF source solutions is configurable within the network, but is nominally set for a minimum of six. The allowable minimum and maximum altitudes for solutions are set at 0 km and 20 km respectively. Solutions falling outside these ranges are rejected as erroneous. Thus, while it may be possible to capture sources from transient luminous events, such as sprites, blue jets and elves, this network is not configured to capture any information from these phenomena.

The Houston network provides a three dimensional perspective of each detected source with geolocation, timestamp, and signal strength information. A large flash may be comprised of hundreds of sources thus revealing the structure of the flash as well as flash extent.

Prior to this work, the Vaisala software, Total Electrification Display (TED), was primarily used to analyze flash data. A single flash is provided in figure 5.3 with dots indicating the derived location of lightning sources. Unfortunately, the software is not optimized for a flash-by-flash analysis of VHF source data and is cumbersome and slow to navigate across multiple flashes.

To manually correlate NLDN stroke data with LDAR data would be difficult. Therefore, new software was developed to specifically correlate LDAR data to NLDN data and display the results on a two dimensional map. The user may then graphically, based on the temporal and spatial nature of the two datasets, accept or reject the flash and its characteristics including horizontal and volumetric extent, mean altitude, multiplicity, and other metrics. While the back-end functionality is better suited for this study, the graphical display of the new software is similar to the main window of the TED display without map overlays. However, both CG and VHF sources are simultaneously displayed. CG sources are indicated by a “-” or “+” and LDAR sources are represented by dots as shown in the TED screenshot.

VI. DATA AND METHODOLOGY

At the time of the study, the LDAR system operated most optimally, based on current noise/interference levels, at a frequency of 40 MHz. The study was therefore performed exclusively with 40 MHz data collected from May to July 2007. Data were collected with typically 10 to 12 sensors providing input to VHF source solutions.

When the sensor detects issues, such as poor GPS information, or a lack of synchronization pulses, it alerts the user to the anomaly such that data corruption is minimized. Nevertheless, maintenance issues sometimes appear rendering sensors fully inoperative and unavailable for data. As six sensors are required for locations, the extra sensors merely serve to increase the accuracy and detectability of individual sources.

As thunderstorms during the period March through May occur most frequently as part of mesoscale convective systems containing large expanses of intense lightning data, this period of time is not optimal for capturing single flash events. In order to help mitigate the effects of storm environment, a number of storm days were examined. The period used in this study was characterized as an extended wet period caused by a mid-level weakness between the virtually stationary Bermuda and Southwestern US high pressure areas. Several days provided useful data and while isolated storms would have been the easiest to analyze, they are not typical across Southeast Texas. Quite often, the sea-breeze initiates thunderstorm activity with storms forming nearly simultaneously along the sea-breeze axis. During the study period, synoptic forcing was quite weak as evidenced by upper level charts from that time. Most of the storms in the analysis were of the multi-cell variety and thus yielded high percentages of unusable flashes primarily due to sympathetic lightning, as described in Mazur (1982). Additionally, other nearby storms could independently generate an unrelated flash. It is recognized that this induces a potential bias in the results, but without the ability to separate such events in a timely manner; contaminated flashes will not be considered. That is certainly not to say that they are not significant, but rather hard to measure.

Each month Vaisala sends NLDN data that have been post-processed and are of a higher accuracy than the real-time NLDN feed. LDAR data are also collected in real time in a decimated (lossy) format. However, every few months, the disk drives, located within the sensor, are collected and all flash data are reprocessed using the complete non-decimated data. Any data gaps are filled using decimated data.

It should be noted that Vaisala has filtered all positive flashes with median peak currents of less than 15 kA after March of 2006. This was verified by examination of the dataset on-hand at Texas A&M University. These were determined to largely be comprised of intracloud-only flashes. This limit consideration started based on initial work by Wacker et al. (1999a and 1999b) and Cummins et al. (1998) recommending a 10 kA lower threshold for discriminating between intra-cloud and cloud to ground flashes. The threshold was later modified to 15 kA after subsequent findings of Biagi (2007) whereby it appears that NLDN positive strokes of less than 10 kA appear to be mostly intracloud discharges and those above 20 kA tend to be mostly cloud-to-ground discharges. The 10 kA to 20 kA region appears to be a transition zone where ambiguity exists. Therefore, as a compromise, yet indefinite solution, 15 kA became the lower limit of positive strokes in the NLDN dataset. No data exclusions are apparent for negative flashes.

A box, defined as the region with upper left coordinate of (30.3N, 95.77W) and lower right coordinate of (29.3N, 94.77W), hereafter known as the NLDN domain, was defined to geographically select NLDN derived cloud-to-ground flashes for analysis. This area constitutes the peak performance region for the Houston LDAR network. Since spatially large flashes of over 75km in length have been observed in the network (Ely et al, 2008 and Hodapp et al., 2008), a much larger area was chosen to search for LDAR sources corresponding to the location and time of the cloud-to-ground flash. This larger area, bounded by an upper left coordinate of (31.8N, 97.27W) and lower right coordinate of (27.8N, 93.27W) served as the LDAR domain. The geographic extent of both domains is presented in figure 6.1.

Unfortunately, the complexity surrounding temporal and spatial patterns of lightning results in characteristics that are not trivially solved with computer algorithms. While some automation may be possible, such an exercise exceeds the scope of this work. Therefore, manual analysis of each flash was performed to ensure an accurate representation of total lightning characteristics.

Using the software, with source code shown in Appendix A, NLDN data corresponding to a known thunderstorm period are extracted for analysis. All strokes that fall within the NLDN domain during the elected time period are stored in a file. For a given storm day with activity within the NLDN domain, the cloud-to-ground flashes were analyzed sequentially, in time. For each NLDN detected CG found within the domain, a corresponding search of LDAR data was made within two seconds of the first CG stroke. The user is then provided a graphical plan-view representation of all NLDN strokes and LDAR sources found during that time. Source by source text data are also available at decision time to ensure that no obvious temporal gaps exist in the discharge pattern. NLDN negative strokes are represented by a white "+" and positive strokes are shown as a red "+". LDAR sources, being much more numerous, are depicted as yellow dots. The user is then able to accept or reject each flash based on the data presented checking for continuity both spatially and temporally. All accepted flashes appeared to be comprised of one lightning flash. The rate of acceptable to unacceptable flashes, for those examined in the study, is estimated to be 1 in 5 to 1 in 10.

In this thesis, the following criteria were used in accepting flashes. Every NLDN stroke must be located within 10 km of subsequent strokes and have inter-stroke timing of less than 0.5 seconds as used in Orville et al. (2002). It is desired that NLDN flashes must not be contaminated with sympathetic flashes (described in Mazur, 1982) in attempt to focus on single events. This may introduce a bias, but in light of the issues surrounding much greater reported flash extents when nearby storms flash simultaneously, it is believed that the elimination of contaminated flashes is justified. Prior NLDN detected flashes must be separated by at least 2 seconds from the flash under analysis. LDAR sources must appear to qualitatively appear to be the result of a single flash with no significant (more than a kilometer or two) breaks in branching. LDAR sources are examined for two seconds either side of the NLDN determined flash event. Thus, we establish a qualitative spatial and quantitative temporal restriction on events.

A two second flash analysis time was selected as certain flashes (especially "anvil crawlers") tend to have long life spans and the intent is to not artificially reduce the flash extent by limiting the maximum time of the flash. While comprehensive data regarding the duration of VHF source events were not available, two seconds either side of the NLDN event was chosen as a reasonable compromise based on previous visual lightning observations, the high flash rates observed, as well as the findings of Carey et al., (2005) who found flash durations of just over three seconds. Thus, the four second window chosen here is believed adequate to cover most cases. Height information was extracted from LDAR data and the average height of all detected VHF sources, for each flash, was obtained.

If no LDAR sources were found to correlate with the NLDN flash, the flash was marked as a "miss" for detection efficiency calculations. In this case, correlate means that a LDAR flash event was not observed with a corresponding NLDN flash event within 10 km of the LDAR flash extent or within two seconds before or after the NLDN flash. In this case, two possibilities exist: Cloud-to-ground flashes occurred without creating any VHF sources or, more likely, cloud-to-ground flashes occurred that were too weak to detect with the LDAR network.

To obtain a metric for flash extent, a geographic 200 by 200 bin horizontal grid system was developed over the LDAR domain. This grid results in a North / South height of 2.22 km and East / West width of 1.93 km at grid center resulting in an area of roughly 2.1 km^2. In the vertical, the atmosphere was cut into layers of 1 km from 0 to 20 km. These grids are hereafter referred to horizontal bins and volumetric bins. When a VHF source was detected in a bin that bin was marked as active and the analysis of additional sources continued. When the LDAR entire flash period was parsed, the resulting active bins indicate the horizontal and volumetric extent for that flash. The software automatically calculates the horizontal and volumetric extent as well as the mean altitude for each manually accepted flash.

The analysis of flashes with multiplicities greater than ten is hampered by the low occurrence of such flashes. To make some use of the acquired data, flashes exhibiting multiplicity greater than 10 were aggregated into a category named “10+.”

In southeast Texas, the ratio of positive to negative flashes typically runs near 10% annually with higher positive rates during the winter (Orville et al. 2002). Statistics were collected on positive and bipolar (positive first, then negative and negative first, then positive) flashes and then compared with the more common negative-only flashes.

In order to verify multiplicity and peak current, after the flashes were manually selected, Microsoft Excel was used to validate cloud-to-ground stroke multiplicity and peak flash current. Correlation of LDAR flash extent with individual cloud-to-ground strokes is, at best, a difficult undertaking especially when well over one thousand flashes have been selected. Therefore, peak current was chosen to represent the amount of discharge in each flash. After the post-processing exercise with Excel, the values of location, time, peak current, multiplicity, horizontal and volumetric extent, and mean VHF source altitude are available.

Analysis of the data was performed with tools in Microsoft Excel using macros for median, mean, standard deviation and trending.

A sanity check on the dataset was performed, using average multiplicity, peak currents, and percent positive flashes, comparing the findings of Steiger et al. (2002). Values were found to be within reasonable range of the annualized averages obtained previously for southeast Texas taking into consideration the time period of this study.

It should be mentioned however, that the LDAR system tends to prefer detection of events into positive charge regions (Wiens et al., 2005). These regions tended to exist near 5 km and 10 km in most storms in this study as well as other storms observed along the Texas Gulf Coast. A comparison of interferometric systems, which tend to detect fast negative break downs (characteristic of stepped-leaders) versus the slow breakdowns that are well detected, with LDAR demonstrates that the LDAR sources detected are higher than those detected by the interferometer. Neither system detects all of the activity in a given flash (Mazur et al., 1997). Therefore, some positive height bias in the LDAR results is possible.

VII. RESULTS

A total of 1407 flashes were analyzed as part of this study with comparisons of each of the five variables under investigation: multiplicity, peak current, horizontal flash extent, volumetric flash extent, and mean altitude.

576 single-stroke flashes were collected along with a total of 831 multi-stroke flashes with a mean multiplicity of 3.3 and standard deviation of 3.1. A pseudo-exponential decay in events vs. multiplicity is evident in the graph in figure 7.1. 56 Flashes contained at least one positive stroke and 29 flashes were single stroke positive events. All flashes with multiplicity of 10 or greater were aggregated into a single category: “10+”.

Comparing the non-weighted median height of all negative flash VHF sources detected by the LDAR network with multiplicity reveals that single-stroke flashes exhibit significantly greater vertical extent than those with two or more strokes. The results of these data are shown in figure 7.2a. While deviation was generally limited to +/- 500m on flashes with multiplicity greater than two, single stroke flashes averaged almost 2 km higher. Mean heights closely follow the trends revealed with median heights, but have slightly less variation among multiplicities. The variability of VHF source heights decreases with increasing multiplicity with standard deviation values of single stroke flashes near 3 km generally decreasing to near 2 km with ten or greater strokes per flash. VHF source heights were not binned, but rather depict the detected heights of all flashes as indicated by the LDAR network for each corresponding value of multiplicity. Positive and bipolar flashes had a similar trend with multiplicities greater than three. However, the lack of a significant number of sample flashes precludes inclusion in this thesis.

At the 2008 AMS Conference in New Orleans, Dr. Kyle Wien suggested looking at median height in addition to mean height. From that recommendation, it was seen that the single stroke deviation was somewhat greater as compared to greater multiplicities. In effect, it shows a slightly more pronounced signal in this case. However, the mean and median heights are highly correlated and are assumed to be interchangeable. The median is not always higher or lower than the mean and the deviations appear to be the result of statistical noise. As the goal of this work is to demonstrate trends with many flashes, mean values are used for the remainder of the work.

Figures 7.2a and 7.2b compare the same two metrics, but figure 7.2b display all available mean height information from all negative flashes,. Not only do single stroke flashes have a greater mean and median height, but they also have the greatest overall height in the sample set. As every flash under consideration in this study had a ground contact point, it is believed that an examination of lowest heights is not legitimate as all flashes are assumed to have ground contact. As Krehbiel et al (1984) found, low altitude sources are not detected as readily because the LDAR system has a tendency to locate sources close to the positive end of the discharge. As positive flashes, especially between 15 kA and 20 kA may be falsely indicating ground contact, there is the potential for bias. However, the analysis of multiplicity and peak currents with height included herein are made with negative-only flashes outside of tables 7.1-7.3.

One of the most anticipated metric comparisons for this study was the relationship between multiplicity and flash extent and this exercise yielded results in line with expectations. The network was divided into 2 km by 2 km bins horizontally with 2 km by 2 km by 1km volume bins. The results are shown in figure 7.3 and are the basis for flash extent comparisons. Only negative flashes were used in this figure. Inclusion of positive flashes did not significantly change the results.

As expected, variance among individual flashes was high. A trend toward increasing flash extent, both horizontally and volumetrically is shown via trend lines. Both horizontal and volumetric trends data track very similarly with only a nearly constant factor between the two. That is, the number of volumetric bins is roughly twice that of number of horizontal bins.

Based on these data, it appears plausible that single stroke flashes are more vertically oriented. General observations of negative flash observations of 2006 and 2007 warm season thunderstorms reveal a marked peak in the occurrence of VHF sources near 10 km. A significantly lower amplitude secondary peak near 5 km, in a multiple charge layer configuration, is also evident as described in Marshall and Rust (1991). It is therefore theorized that flashes of higher multiplicities tend to propagate more readily within the anvil positive charge region drawing from a larger region from which to support multiple strokes. As the relationship of 2-D to 3-D bins is not cubic, but rather a factor of two, the flash spreads more horizontally than vertically. The tortuous extent of the flash, based on these data, spreads most readily in the anvil region within a narrow vertical corridor.

Figures 7.4 and 7.5 illustrate the data gathered comparing flash extent with the absolute value of peak current. The scatter plots presented in these two figures have significant flash-to-flash variance. Unfortunately, no detectable signal was observed and as such, there appears to be no correlation between peak current and flash extent.

The flash data gathered in this study were 96% negative with the large majority of positive flashes being single stroke. The NLDN detected positive flashes yielded a different signature where current peaked with a flash multiplicity of two. Orville et al. (2002) found that increasing multiplicity yields increasing peak currents for negative flashes via NLDN. The trend of 1998-2000 data shows a linear relationship with multiplicity and flash extent and is presented in figure 7.6. Multiplicity and flash extent appear to be directly related. It is plausible that, for aggregated measurements of Southeast Texas flashes, some assumptions may be valid inferring an average flash extent especially given peak flash current. The relationship, while not as linear, appears also to hold between multiplicity and flash extent. This is not to say that flashes of high multiplicity always yield large flash extents. However, given the number of sample flashes, a relationship appears to exist.

The average height of VHF sources trends downward with increasing peak current, at least with peak current values of less than 100 kA. There is low confidence in the noted trend with flashes of peak current greater than 100 kA, shown in figure 7.7, as only eight flashes exceeded this threshold. The lower threshold for peak current for the flashes examined was -4 kA, which had average VHF source heights above 10 km. The trend analysis quickly brings the mean height down to near 8 km with -15 kA flashes.

This 8 km level holds through about -60 kA before beginning a downward trend. As mentioned before, it is theorized that flashes with increasing current spread horizontally in the anvil region and the trend noted here could plausibly support that assumption. Previously, ambiguity was discussed for low-current positive flashes. Only negative flashes were considered with the height vs. peak current analysis. There are no known issues with incorrect NLDN detection of negative flashes as intra-cloud lightning.

It appears that the height maximum seen with multiplicity and peak current match trends implied by flash extent analysis as supported by the horizontal and volumetric bin data and theory that with increasing multiplicity and extent flashes tend to spread more evenly in the anvil region. Once again, low multiplicies or peak currents point to higher, perhaps more vertical flash events.

During the sample storms, a total of 57 flashes contained at least one positive stroke within the flash. Of these, 29 flashes were single stroke, 3 were multi-stroke positive, 12 had at least one negative stroke followed by at least one positive stroke, and 13 had one positive stroke followed by at least one negative stroke. Flashes that contain both positive and negative strokes are called bipolar flashes. It is believed that the bipolar flashes detected with the NLDN are of type iii as defined in Rakov and Uman (2003) with return strokes of opposite polarity. All documented flashes of this type are upward propagating. A cursory check of bipolar flash positions was reviewed with the locations of known obstacles in the Federal Aviation Administration digital obstacle database. A number of bipolar flashes occurred within 0.4 km a known tower. Note that towers under 61 meters are not included in this database. The argument can certainly be made that additional positive flashes are required to gain confidence in trends. Nevertheless, the data are included here for completeness. Positive flash data came almost uniformly for all study days and both the median and mean data were virtually identical.

If all flashes are examined, flashes with positive strokes have a 0.4 km greater mean altitude. This could be related to the positive flash / intracloud flash ambiguity with the NLDN. However, negative flashes also exhibit higher mean heights with lower multiplicities and no known ambiguities exist for negative flashes. Given the findings in this work, since positive flashes tend to have low multiplicities, one would expect mean positive heights to be greater than negative flashes in general. With a low number of flashes, the intra-flash variance is also higher with positive flashes.

If all bipolar flashes are eliminated, a significant jump in mean height is observed. The 32 positive only flashes averaged 1.1 km higher than all negative flashes. With the high percentage of single stroke events, the primary cause for this jump is believed to be low multiplicity and not factors that are specific to the microphysics of positive strokes. That is not to say that differences exist, but rather, that the trends at this level of analysis point toward multiplicity.

Of all bipolar flashes, positive first flashes had lower mean heights than negative first flashes by about 0.5 km. Positive first bipolar flashes had a lower mean multiplicity of 3.8 versus negative first bipolar flashes with mean multiplicity of 4.6. This trend is opposite that seen with other data. Clearly some other mechanism may be at work with bipolar flashes and analysis of these types of data is certainly an area for future study.

Isolating single-stroke flashes, with the exception of greater mean heights for positive flashes, flash extents, both horizontal and volumetric are quite comparable. These data are presented in table 7.1. On average, positive flashes are 0.7 km higher with a slightly greater standard deviation at 2.7. Bipolar flashes with the positive stroke first have a lower mean height.

Table 7.1 Mean height summary for negative, positive, and bipolar flashes.

All Flashes		
	Avg Hgt (km.)	**StdDev (km.)**
Negative average height	8.3	2.3
All positive average height	8.7	2.7
Positive only average height	9.4	2.8
Bipolar average height	7.7	2.2
Positive first bipolar avg height	7.2	2.2
Negative first bipolar avg height	8.2	2.1

Table 7.2 Single stroke summary for negative and positive, single stroke flash characteristics.

Single stroke flashes		
	Avg Hgt (km.)	**StdDev (km.)**
Negative average height	9.1	2.2
Positive average height	9.8	2.7
	Horz Bins	**StdDev**
Negative horizontal extent	17	18
Positive horizontal extent	18	17
	Vol Bins	**StdDev**
Negative volumetric extent	35	38
Positive volumetric extent	35	31

Table 7.3 Summary of flash extents based on type of flash both based on horizontal and volumetric extent.

Flash Extents		
Horizontal Flash Extent	**Horz Bins**	**StdDev**
Negative	18	18
Positive	17	16
Negative first bipolar	24	22
Positive first bipolar	15	11
Volumetric Flash Extent	**Vol Bins**	**StdDev**
Negative	35	37
Positive	31	29
Negative first bipolar	49	42
Positive first bipolar	31	24

Examining single stroke flashes, both with mean height and flash extent as shown in table 7.2, positive flashes tend to have greater heights. This is likely due to the low multiplicity nature of positive flashes. However, from a flash extent perspective, there is virtually no difference between negative and positive flashes on the whole.

Making a comparison between the flash extents between all flash types examined yields very similar results with one exception. As seen in table 7.3, negative first bipolar flashes tend to near 50% greater flash extent than other types. Presumably, these flashes make a different use of the overall charge structure of the storm. As noted in Hamlin et. al, (2003), the charge structure of individual flashes should be obtainable based on the breakdown pattern. This method may allow a means for some explanation of this phenomenon but is outside the scope of this work.

Finally, VHF source detection efficiency was evaluated by assuming that the NLDN detected flashes are ground truth for the occurrence of cloud-to-ground lightning. NLDN flashes which temporally and spatially correlated to LDAR sources were considered a hit. NLDN flashes, which had no corresponding LDAR sources, were misses. Two ranges of efficiency were evaluated. The first range was a circle from 0 to 30 km from the network center. The second range extended from 30 to 60 km from the network center. The Houston LDAR network exhibited a detection of 99.6% within 30 km and 96.8% in the outer ring compared to the NLDN dataset.

While hundreds of intracloud flashes were detected by the LDAR network that where not detected by the NLDN (as expected), intracloud evaluations were outside the scope of this study. Nevertheless, the two networks are complementary. By noting the time of ground flash, corresponding VHF sources can be analyzed keeping in mind that low current, positive flashes may be incorrectly reported as a cloud-to-ground event.

Thunderstorm characteristics also change somewhat depending on the maturity of the storm. Qualitatively, in the early period of a storm's lifetime, flash extents tend to be lower in altitude and exhibit limited flash extents. This is due to the spatially limited nature of the still non-mature storm. As the storm matures and the anvil becomes established and spreads, average height and flash extents increase with the addition of small, positively charged ice especially at anvil levels.

VIII. CONCLUSIONS

An examination was conducted of lightning flashes for warm-season Southeast Texas thunderstorms from May to July 2007. The data collected by this analysis identify several key findings of total lightning characteristics based on the 1400 flashes analyzed. While inter-flash variance is quite high, trends are evident in the data.

Single stroke flashes are unique in that they have greater median and mean flash heights than their multi-stroke counterparts. While some variations exist with multi-stroke flashes, these multi-stroke events were centered near 7.5 km while single stroke events were centered near 9 km. The standard deviation among flash events tended to decrease (become less variant) with higher order multiplicities.

Flash extent trends upward with increasing multiplicity. Horizontal and volumetric trends were offset by a nearly constant delta for all multiplicities. This implies that with increasing multiplicity, flashes tent to increase more horizontally than volumetrically. Flashes with ten or greater strokes are 50% more expansive volumetrically than single stroke flashes and 2.1 times more expansive horizontally than single stroke flashes.

Flash extent, both volumetrically and horizontally appears to be unrelated to absolute peak current.

It has been shown by Orville et al. (2002) that negative flash currents increase monotonically with multiplicity. This work was comprised of 96% negative flashes. There appears to be a direct relationship also with peak current, multiplicity and flash extent.

Mean VHF source height was shown to be higher for low peak current flashes (especially under -10 kA) than greater values of peak current which trend near 8 km with -10 kA to -50 kA flashes. Data, in flashes with peak currents of -75 kA or greater, were fairly sparse and while a downward trend is observed in figure 7.7, a lack of sample data leads to a low confidence in this trend. Due to the scant number of positive events and highly variant data, results are not shown here.

Comparing positive, bipolar, and negative flashes yields similar results suggesting that subtle differences exist in the flash extent or heights of such events. The outlier appears to be the greater average height of positive-only (multi-stroke) flashes as well as much greater flash extents with negative-first bipolar flashes. The positive only deviation is likely due to the enhanced vertical structure of single-stroke flashes as most positive flashes in this study were of this type. The deviation in flash extent of negative only flashes may be due to the charge structure of the storm and the means in which these types of events are triggered. Additional flashes would be required to verify this trend statistically and provide enough data to establish a theory.

Detection efficiencies, while seemingly quite high, using NLDN as a baseline, are less than what is possible with an LDAR network in a less noisy environment. Great care was taken with site selection to mitigate radio-frequency noise problems. However, Houston subjects an elevated radio noise floor to the network. Contributing to this noisy environment are electrical distribution systems, impacts from two-way and paging systems, close proximity of mass media broadcast transmitters at some sites, automobile ignition systems nearby and many others. Additionally sporadic distant sources of radio frequency contamination may occur due to ionospheric enhancements. The Houston LDAR network exhibited an average detection efficiency of 99.7% within 60 km of the network center.

With a quieter environment, the detection efficiency would improve with the added benefit that many more sources per flash could be resolved. Software techniques, internal to the LDAR system, may also have room for improvement. Somewhat larger horizontal and volumetric flash extents are possible with increased network sensitivity, but changes in the trends found herein are not expected.

Overall, the findings of this study match well with theoretical expectations with the exception of the elevated heights and flash extent of single-stroke events as well as the relationship between peak current and flash extent. Since single-stroke flashes are very common, accounting for over forty percent of the dataset examined here, it is difficult to theorize that special microphysical process exists for just these events. Nevertheless, single-flash events and intra-cloud discharges are two areas of worthwhile study enabled by LDAR networks.

Certainly, there remain many unanswered questions in the study of total lightning. Questions such as why single-stroke flashes tend to be more vertical and what causes the apparent greater flash extent with negative first bipolar flashes remain unresolved, but certainly worthwhile to consider for future work. Most importantly, while my understanding in lightning is very limited compared to many in the field, in the course of this study, I have learned a great deal about the subject. I hope that the data gathered here is useful for the continued research of nature's battery charger.

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APPENDIX A

FIGURES

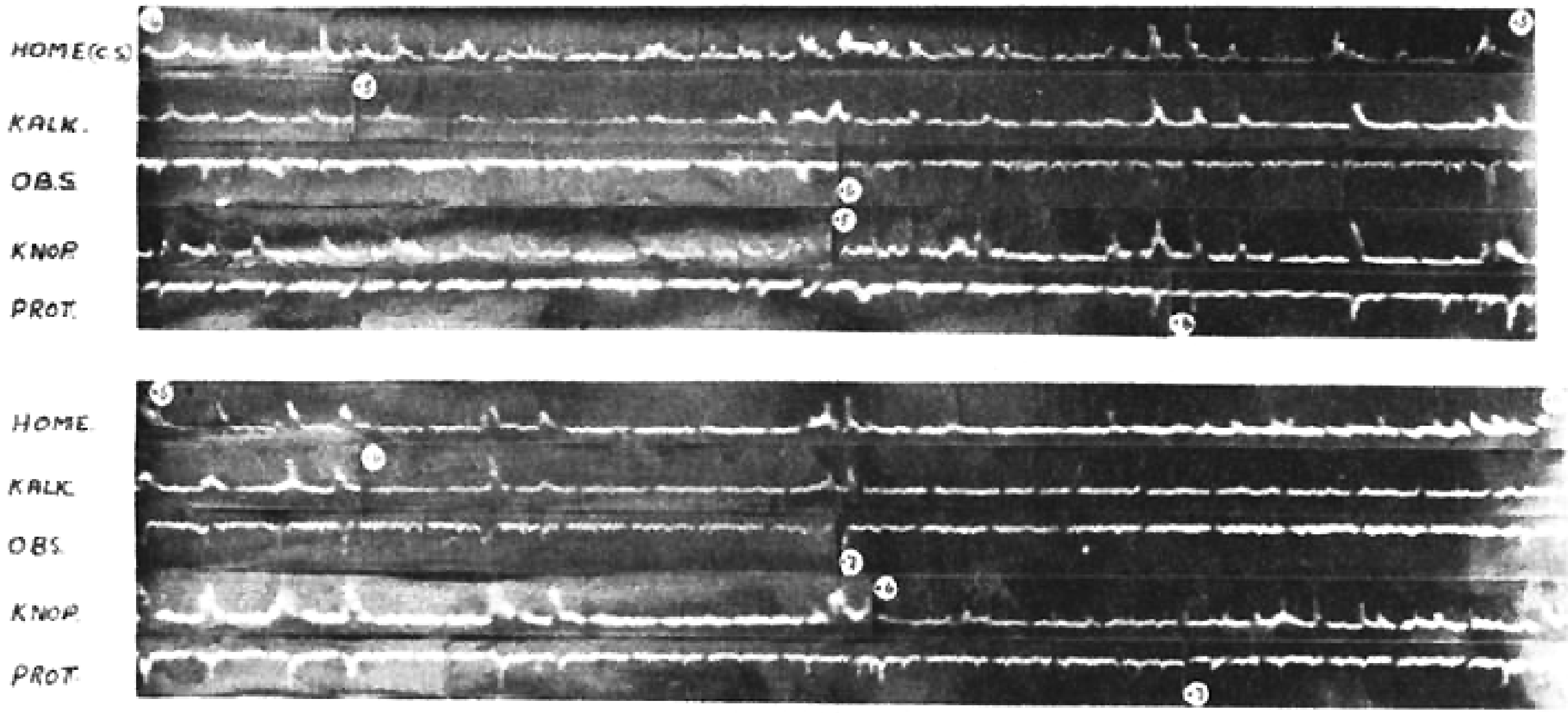

Figure 2.1 Received signals from single flash. Propagation delays from each of the five receiving sites has been removed [Source: Proctor 1971.]

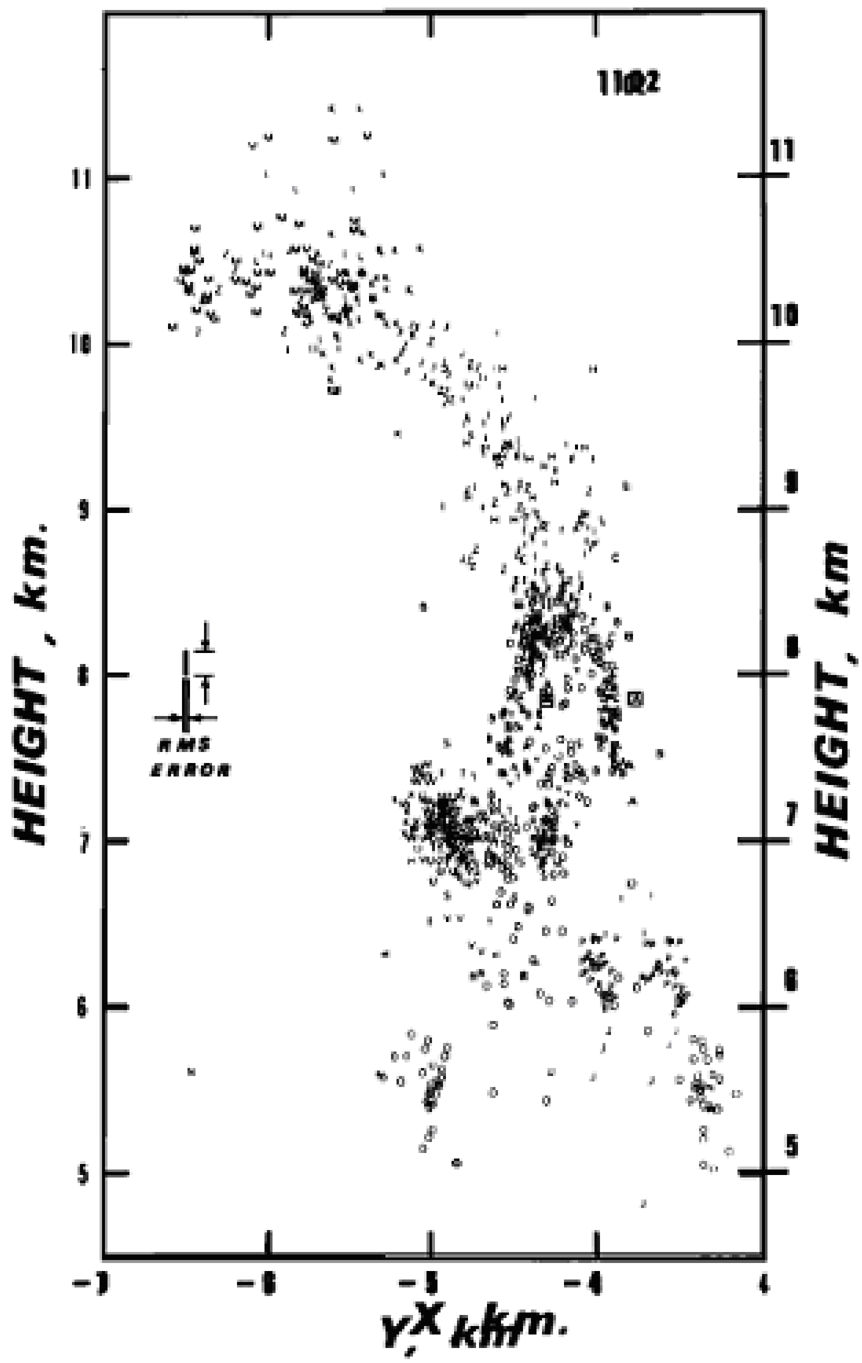

Figure 2.2 Derived projection of point sources shown for a single flash. The source of the first pulse to be received has been enclosed by a square [Source: Proctor 1981.]

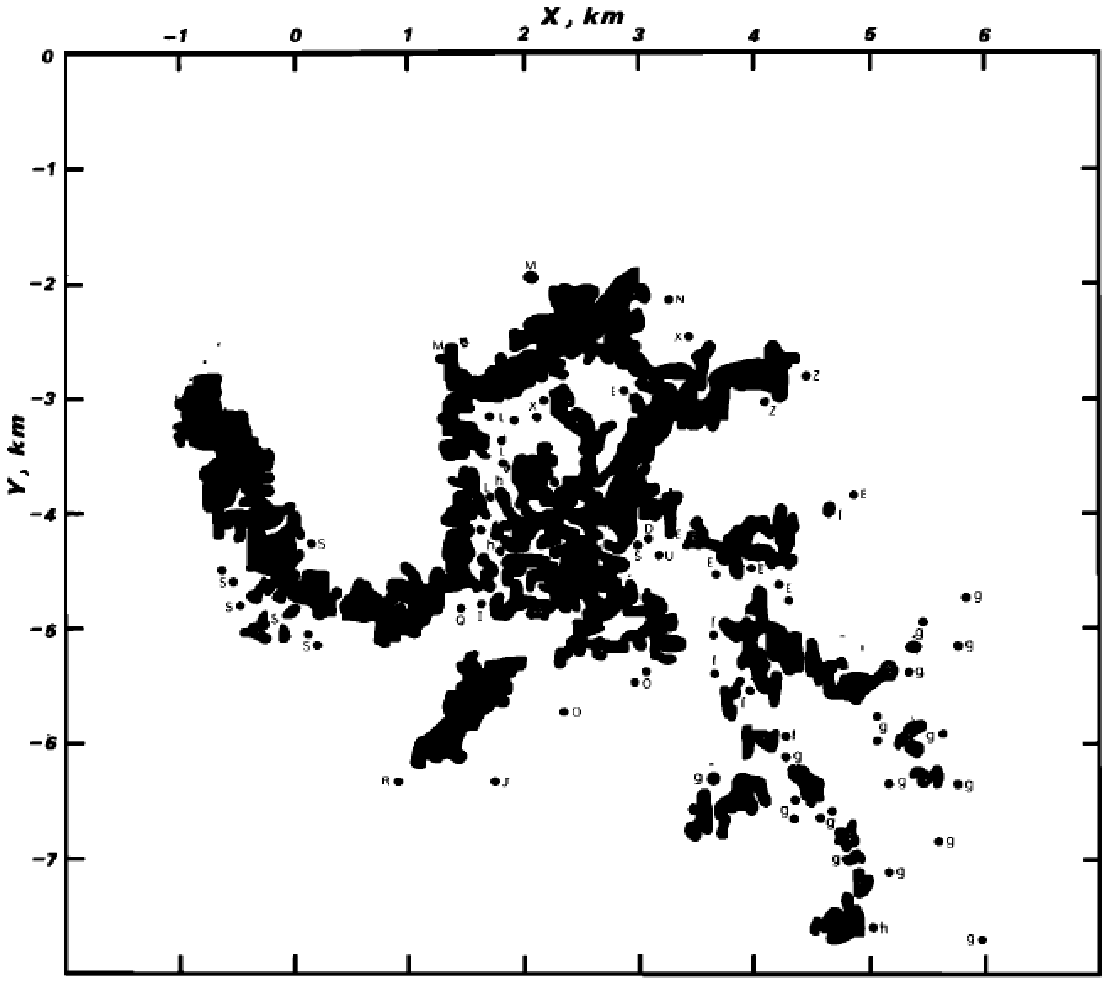

Figure 2.3 Plan view of flash obtained by locating 2640 point sources. In this map, isolated sources are shown as dots. The alphabetical symbols do not themselves represent the positions of sources [Source: Proctor 1981.]

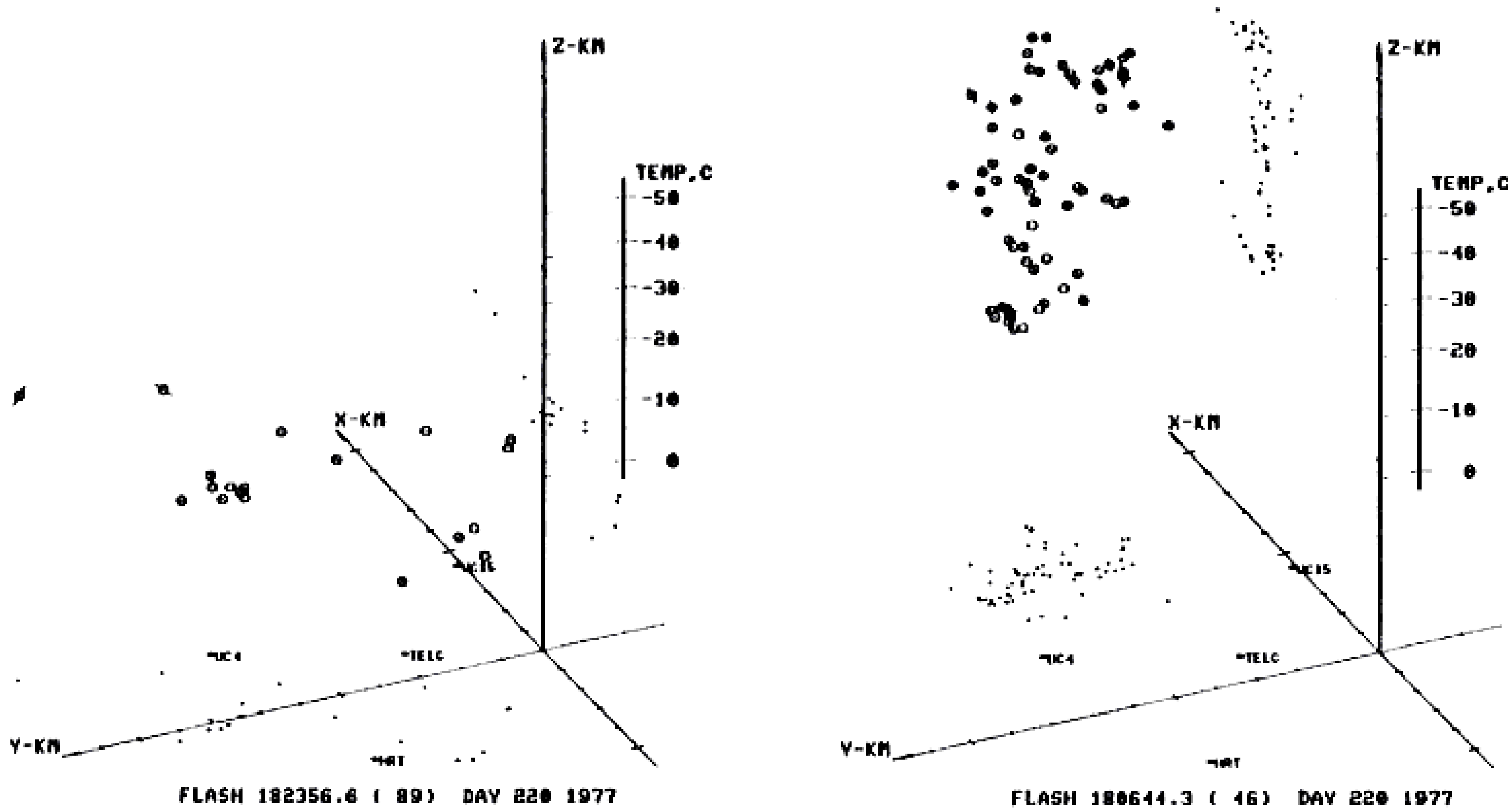

Figure 2.4 Example flashes from the early Kennedy Space Center Network. The X-Y axes illustrate the plan-view perspective with vertical extent displayed along the Z axis [Source: Krehbiel 1981.]

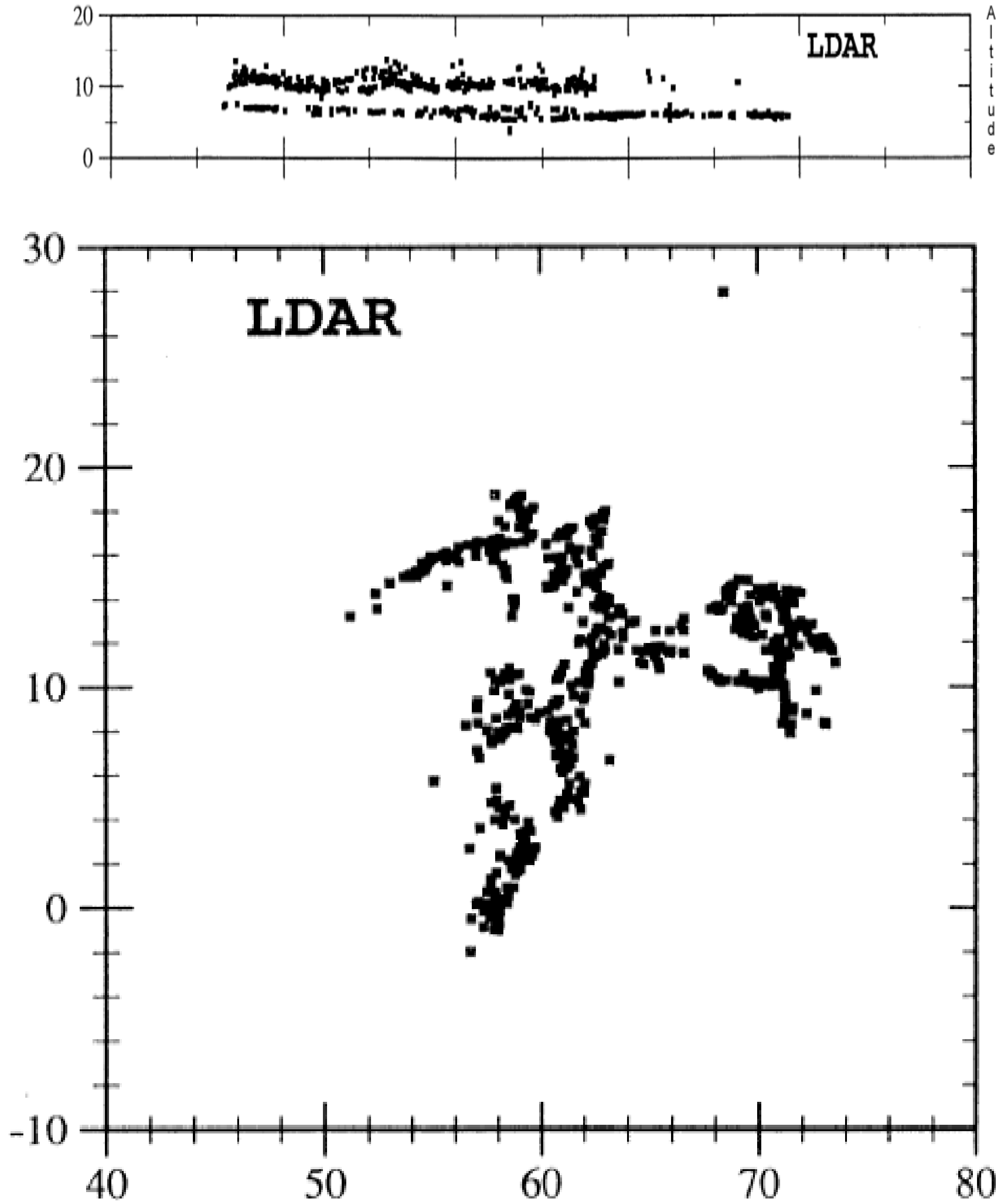

Figure 2.5 Example of LDAR detected flash. The top portion depicts activity in the vertical. Plan view depiction is located in the bottom portion. Plan view axes indicate the distance, in km, from the center of the network [Source: Mazur et al., 1997.]

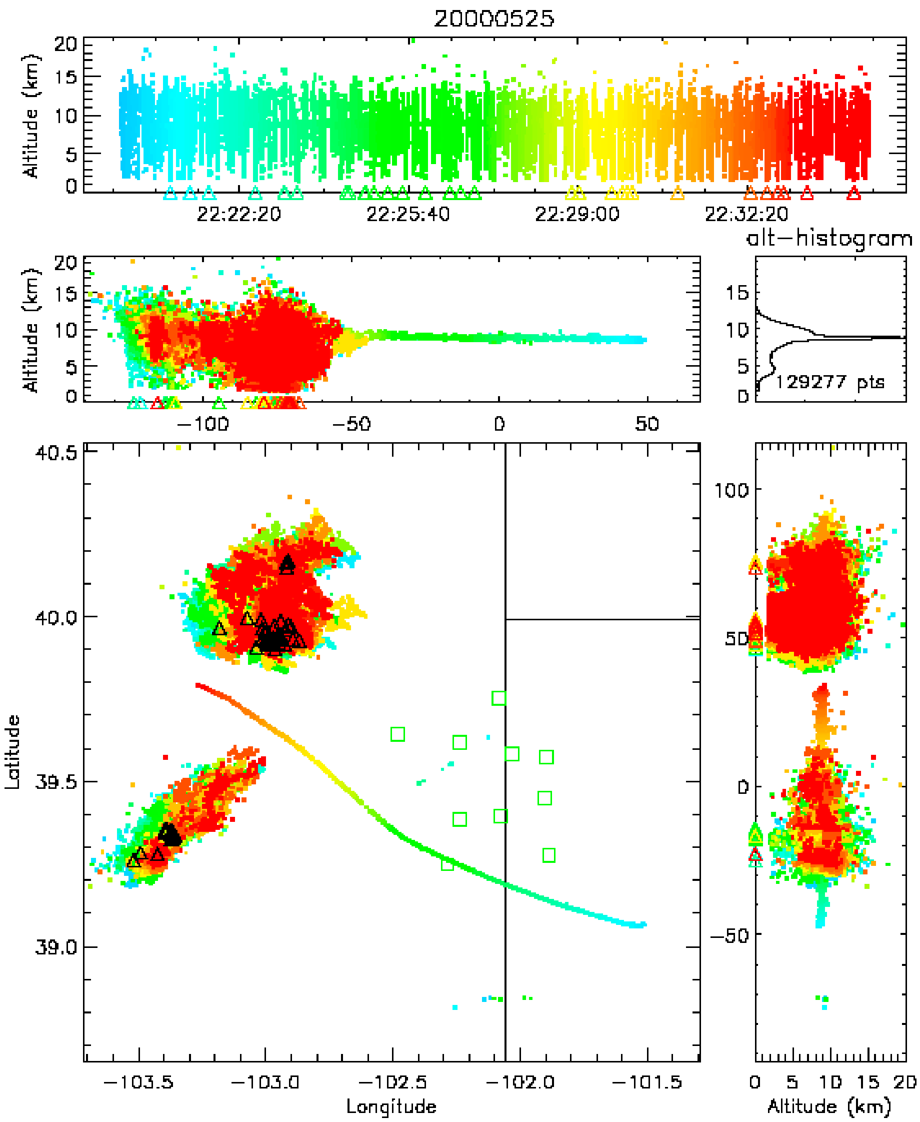

Figure 2.6 Aircraft track over Kansas and Colorado on 25 May 2000. The plane was flying from east to west at about 9 km altitude (29.5 left) and vectored between two electrically active storms. The airplane was tracked by the LMA because it was flying through an ice crystal cloud downwind of the storms that caused it to become charged and give off a steady stream of small sparks. The plane was tracked for 13 min over a 170 km distance and was presumably a commercial aircraft. Two other aircraft were more weakly detected over the center and to the south of the mapping network. The squares indicate the operational stations on this day; only sources located by seven or more stations are shown. The triangles indicate the location of negative polarity ground discharges. The distance scales are in latitude and longitude in the plan view and in kilometer units in the vertical projections [Source: Thomas et al. 2004.]

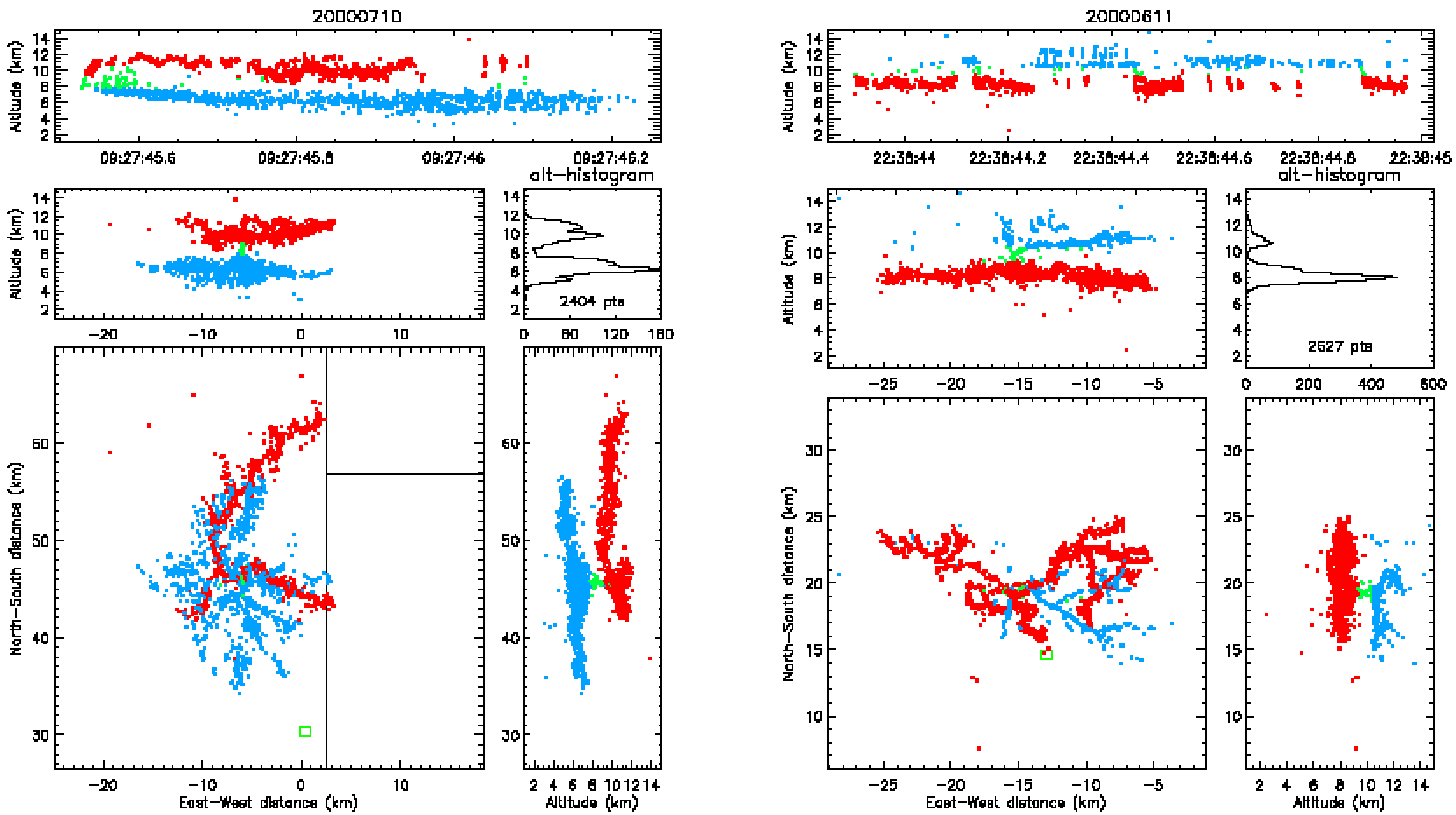

Figure 2.7 Example of two individual discharges detected by the LMA. The flash on the left is a classic, normal-polarity bi-level IC, while the right is an inverted polarity IC. The positive charge regions are colored by red/dark-gray points, and the negative by blue/light-gray [Source: Hamlin et al. 2003.]

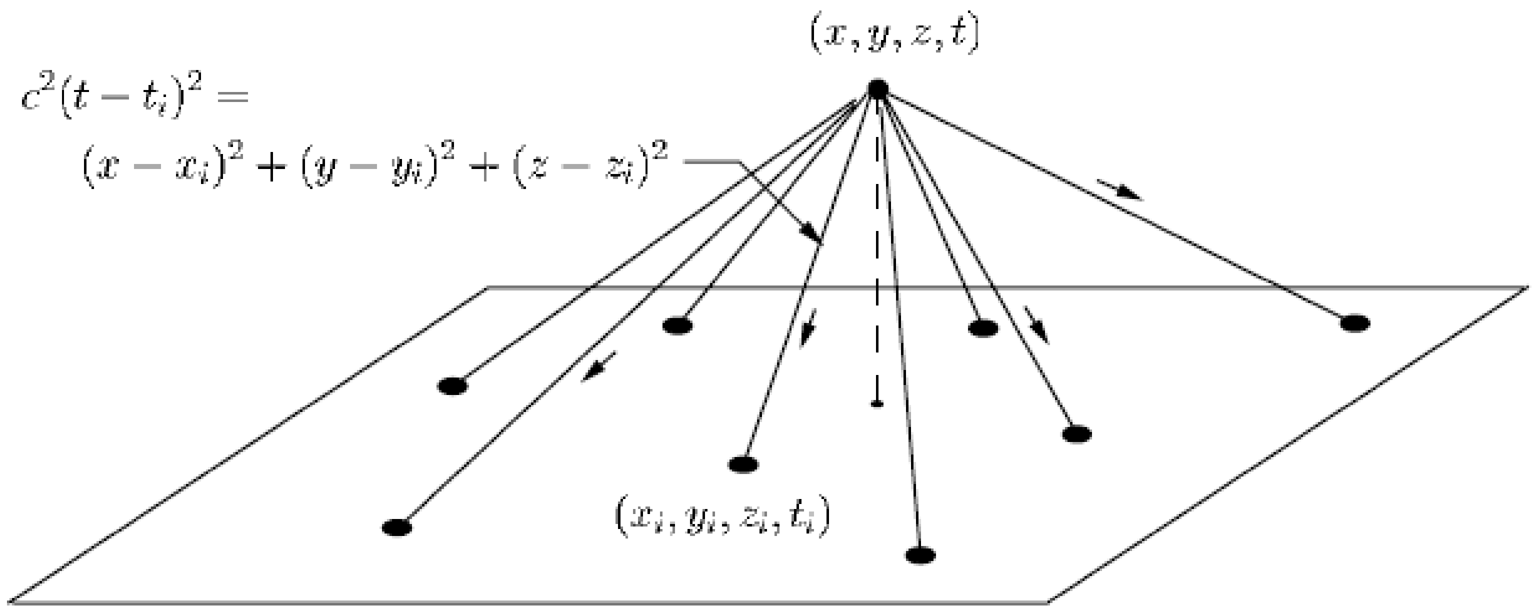

Figure 3.1 Basic TOA technique. Measurements of the arrival times t_i at N≥4 locations are used to determine the location and time of the source event(x,y,z,t) [Source: Thomas et al. 2004.]

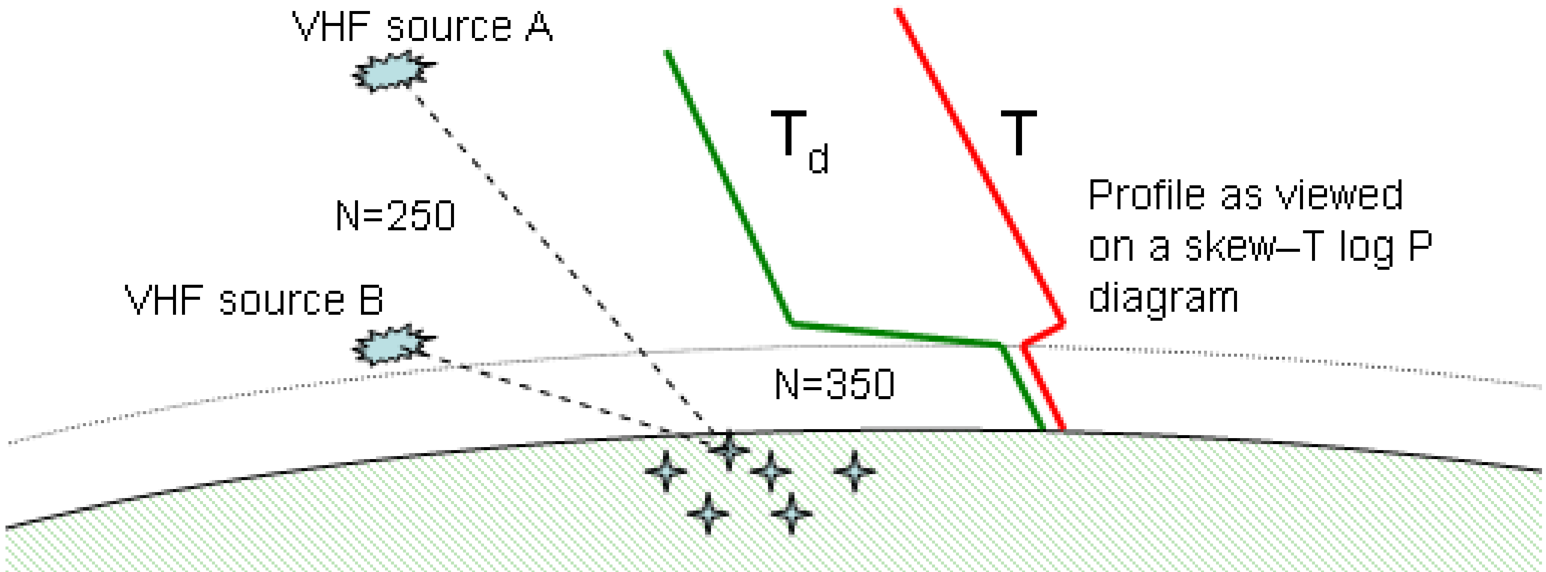

Figure 3.2 Geometry of propagation velocity anomalies due to vertical temperature and moisture gradients. Values of N represent a reduction of velocity equivalent to (N)·(10^{-6}) the speed of light.

Figure 4.1 Current NLDN map. System is comprised of 114 lightning sensors locations across the continental US [Source: Vaisala, 2004.]

Figure 5.1 LDAR sensor at the Williams Airport in far north Houston

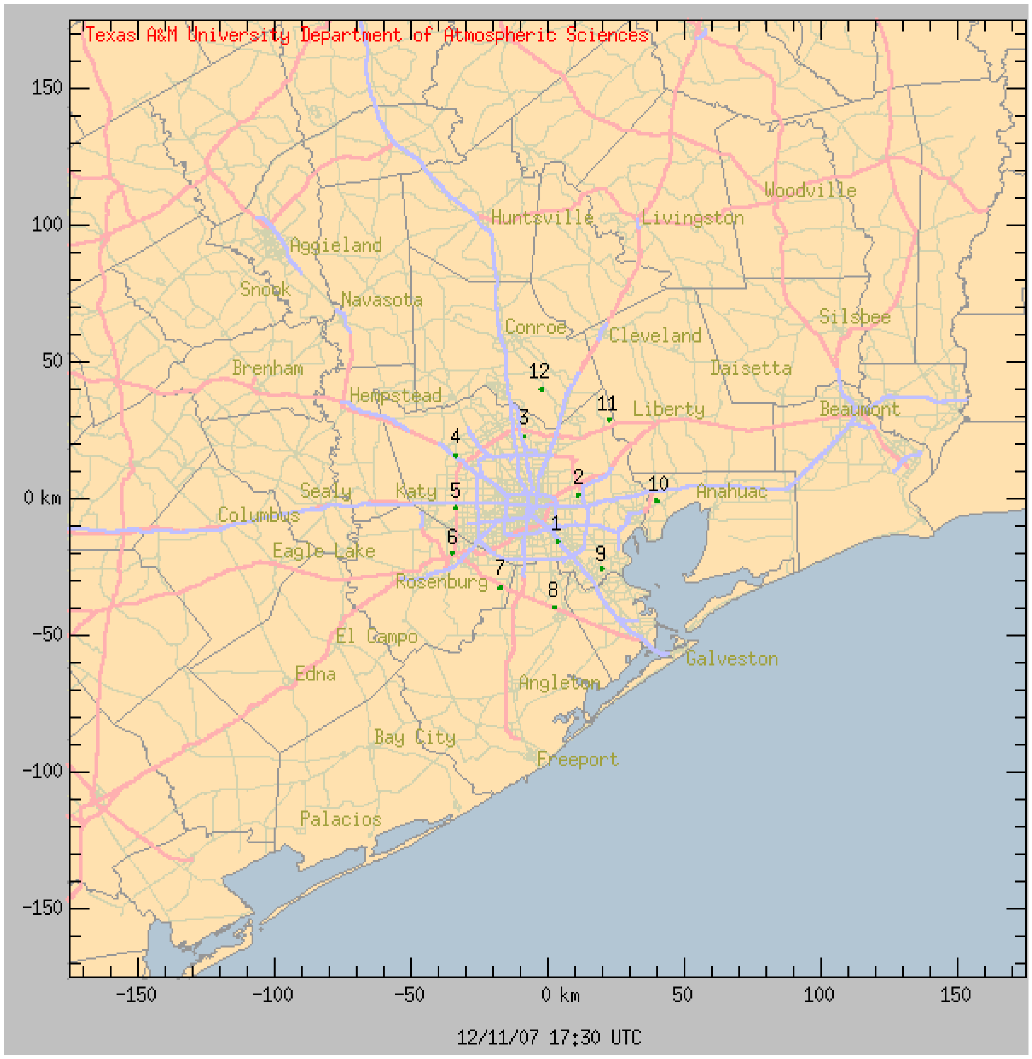

Figure 5.2 Location of LDAR sites around Houston, TX

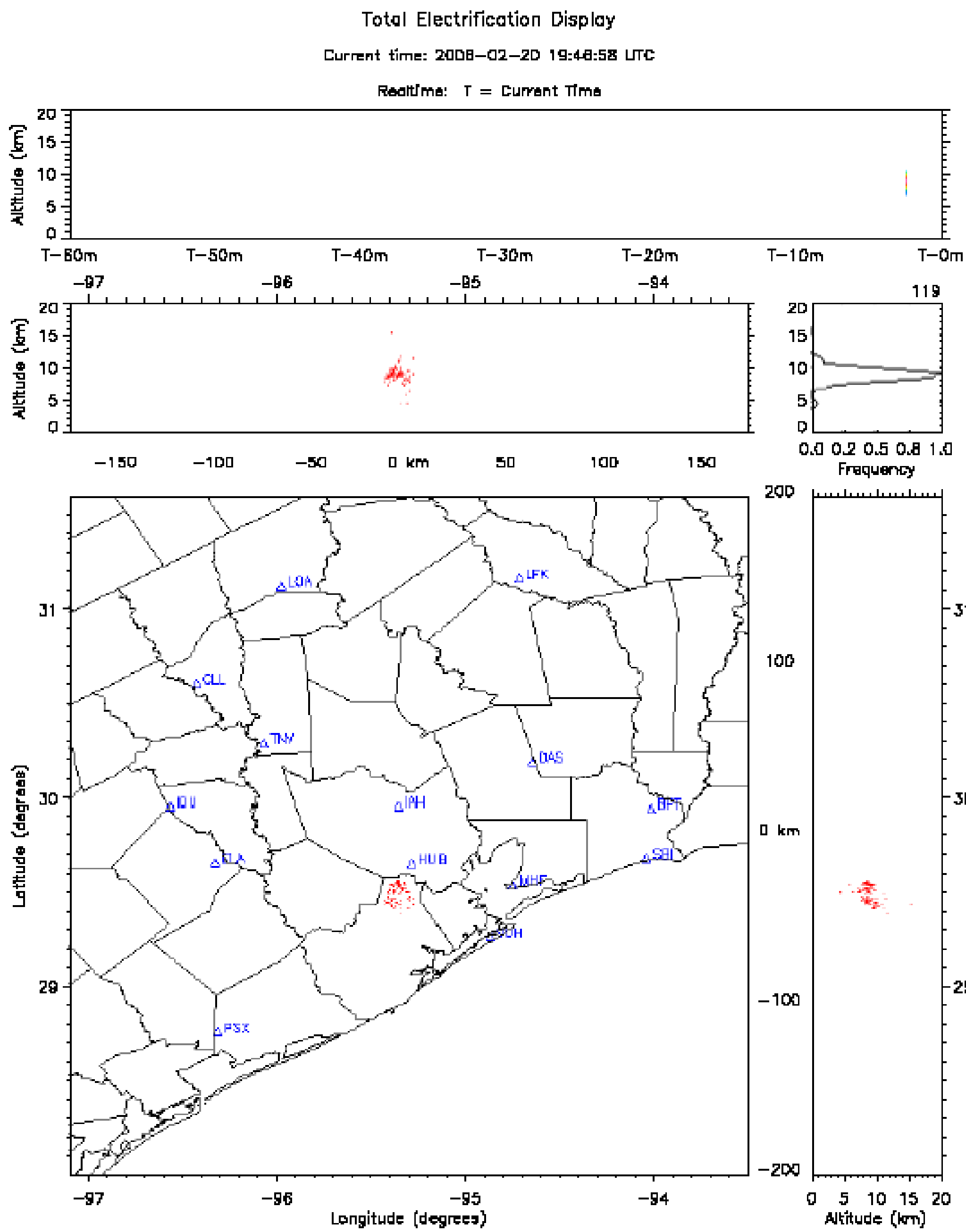

Figure 5.3 A single flash example on the TED display.

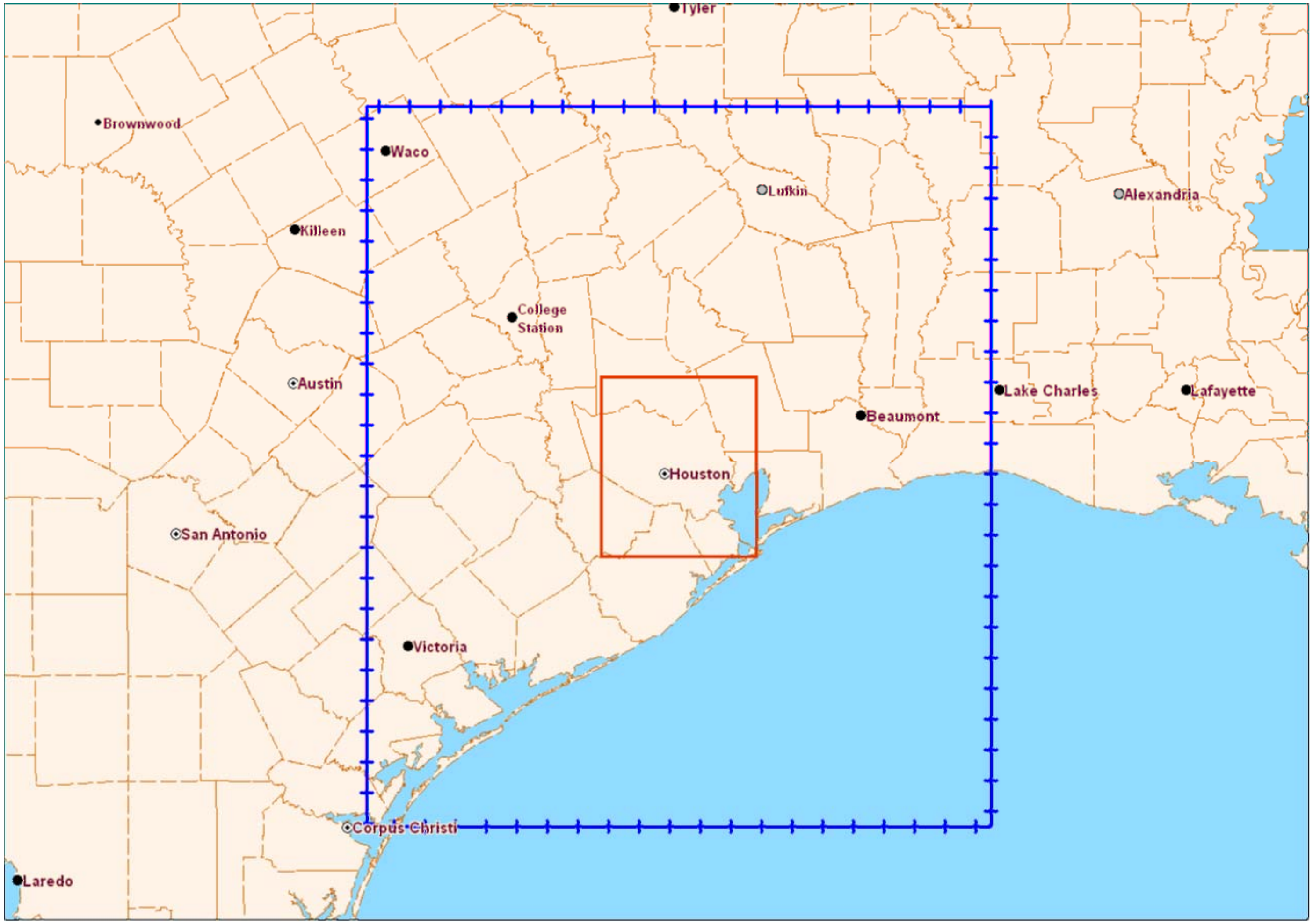

Figure 6.1 NLDN and LDAR domains. NLDN flashes which occurred in the red box were selected for analysis for comparison to LDAR sources detected within the blue box.

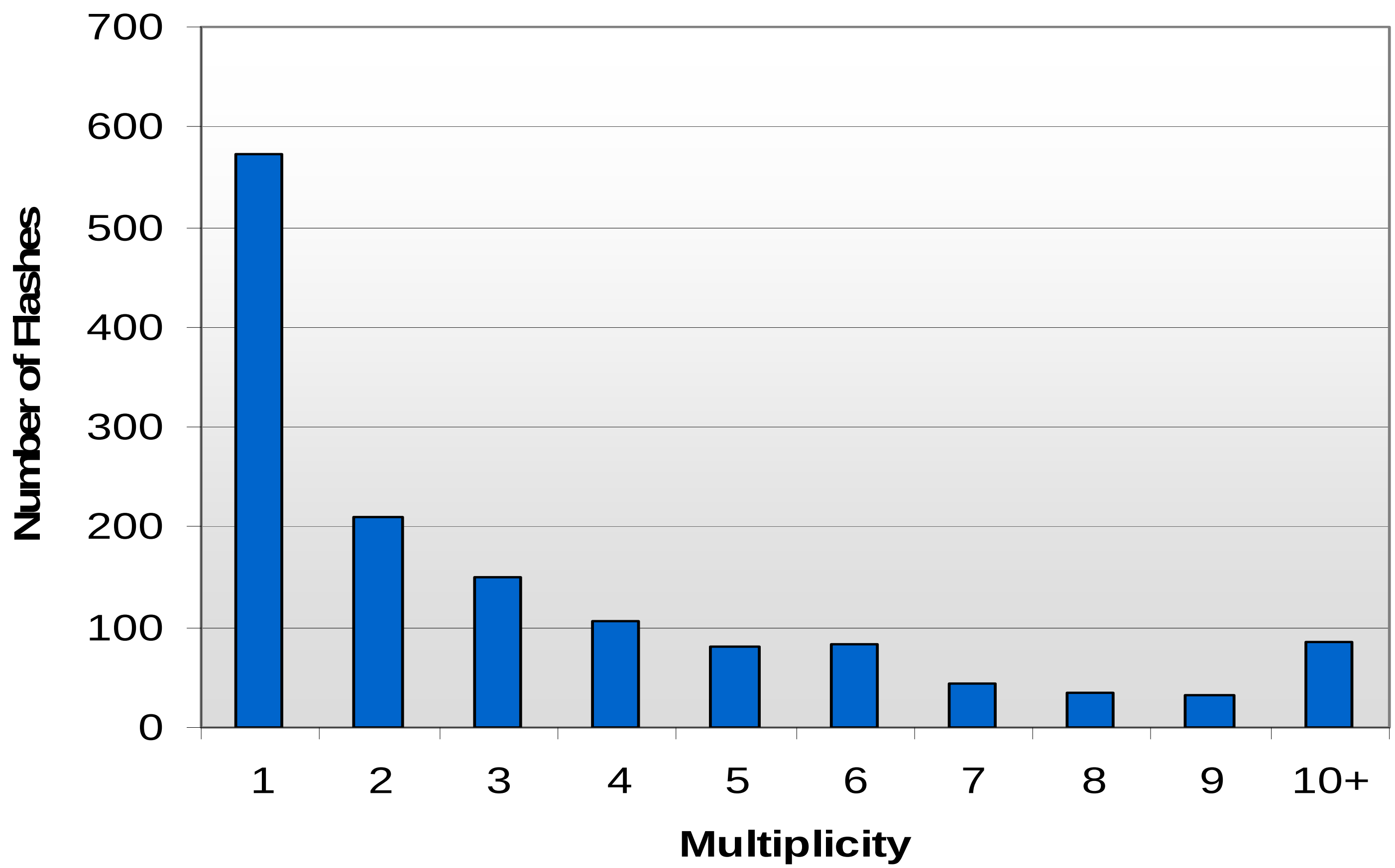

Figure 7.1 Histogram of multiplicity for all flashes analyzed in this study. Flashes with multiplicities greater than 9 are grouped into the 10+ category. Of the flashes shown here, 56 contained at least one positive stroke.

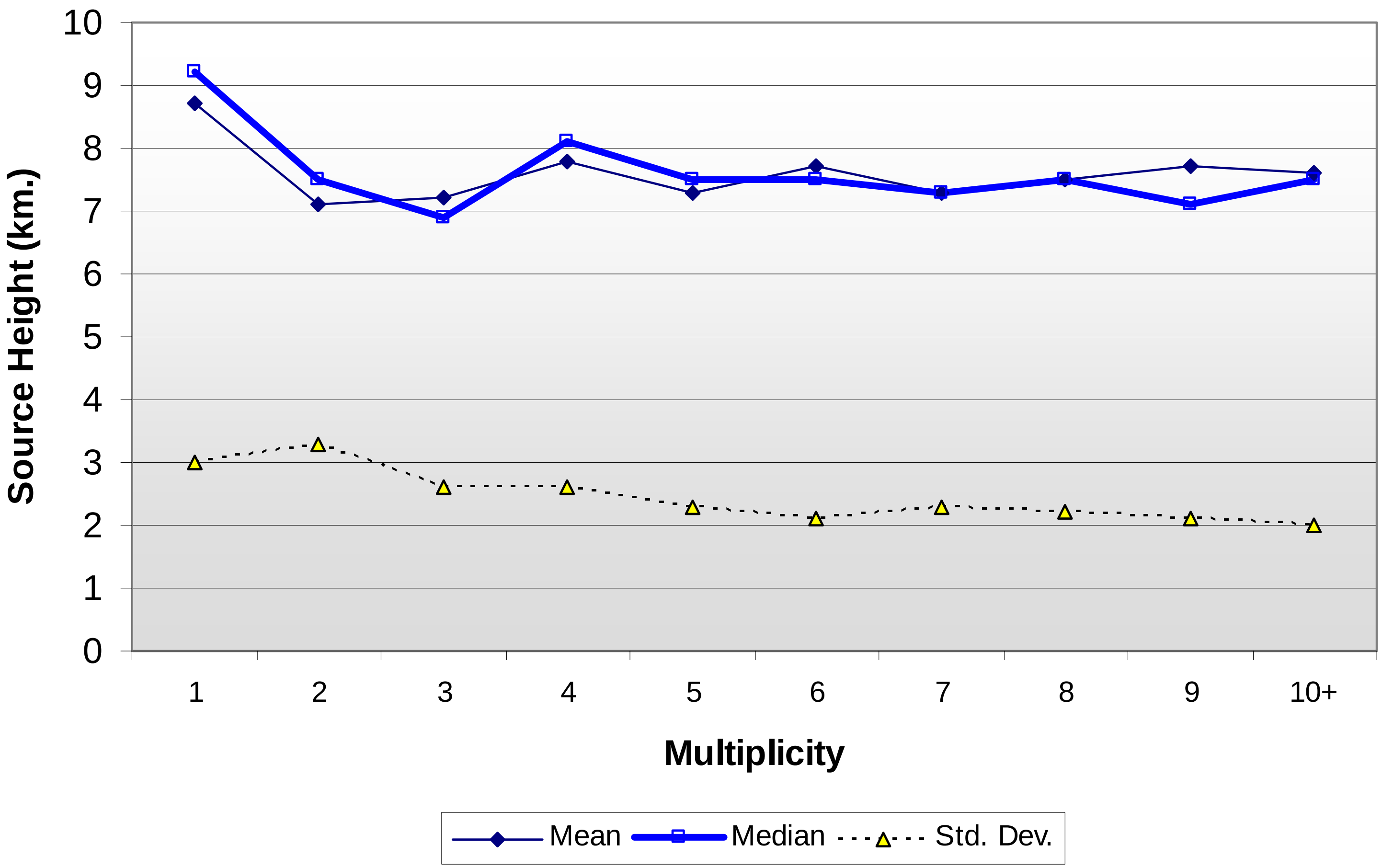

Figure 7.2a Negative flash multiplicity versus the median, mean, and standard deviation of all VHF sources detected by LDAR. Notice the substantial deviation for single-stroke flashes with multiplicities 2-10+ being fairly flat.

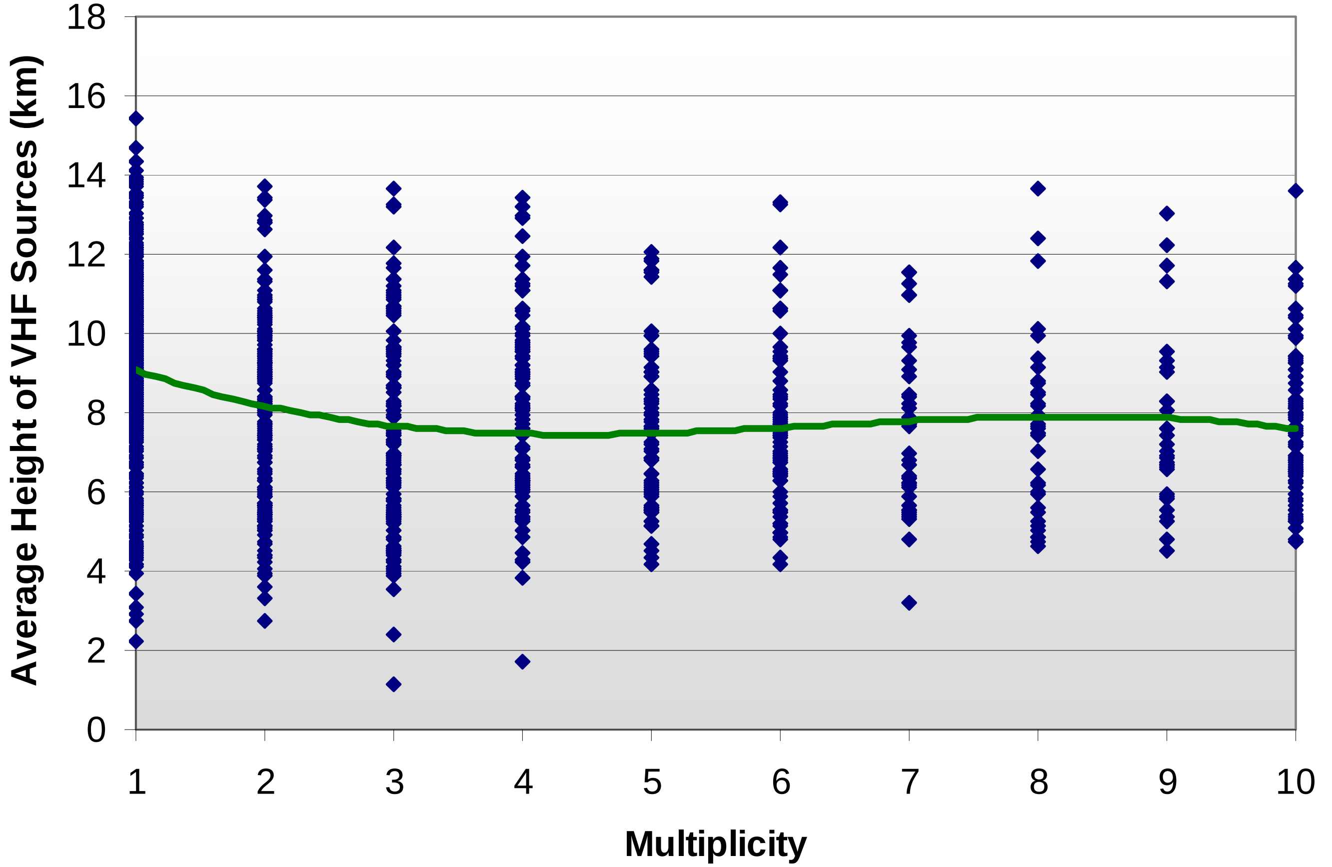

Figure 7.2b Scatter plot of negative flash mean height VHF sources vs. multiplicity. The solid green line indicates a sixth-order polynomial. Not the relative flatness of multiplicities 2-10+ and the increase associated with single stroke flashes.

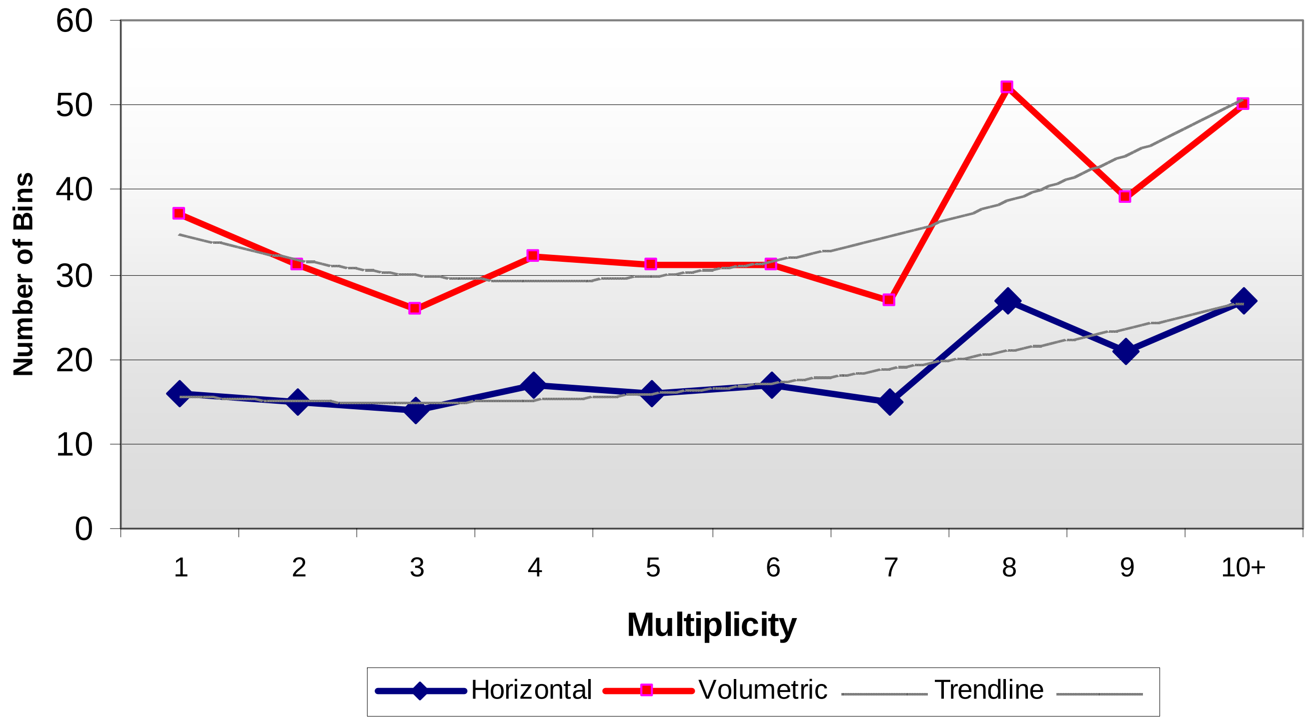

Figure 7.3 Negative flash multiplicity vs. flash extent. The red line indicates volumetric bins. The blue line indicates horizontal bins. Two second-order polynomial trend lines are provided corresponding to each curve above.

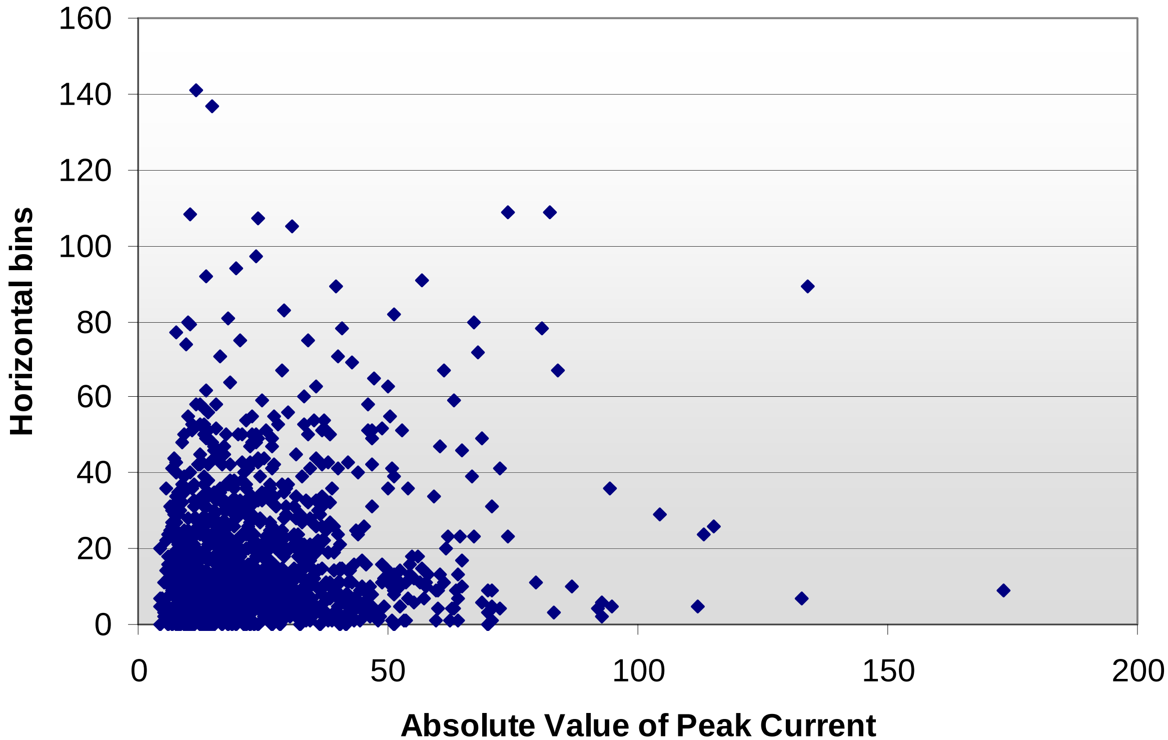

Figure 7.4 Scatter plot of the number of horizontal bins for negative flash VHF sources vs. peak current.

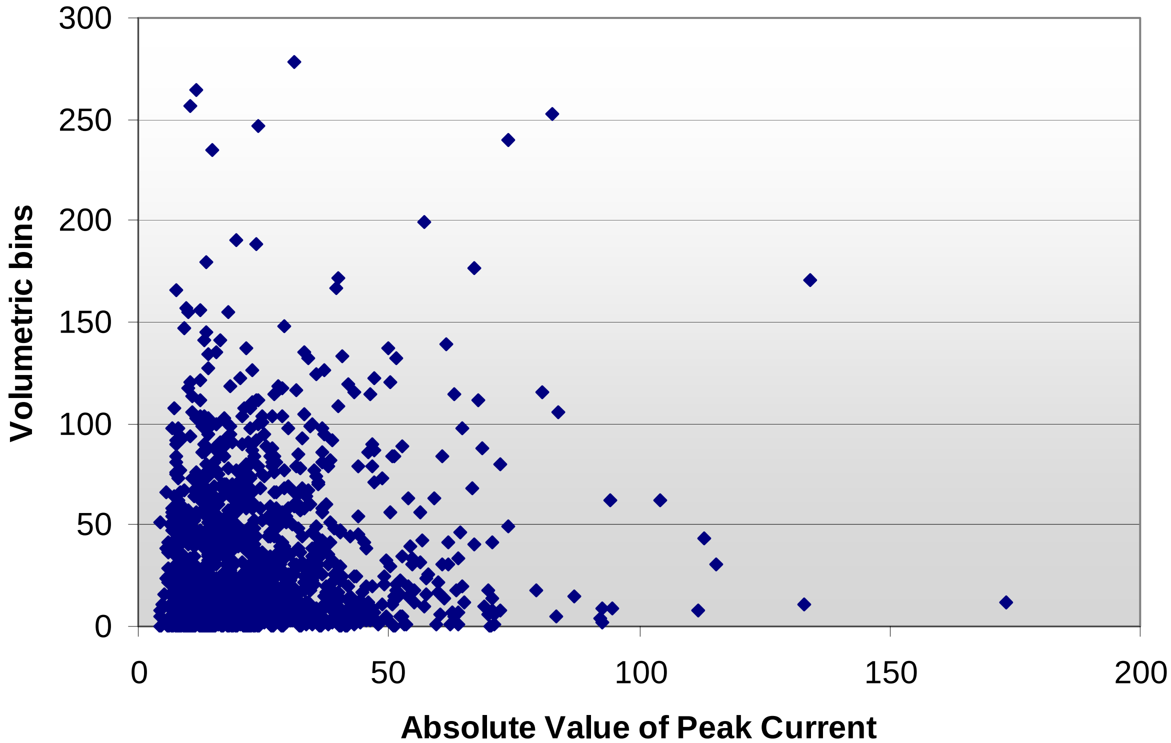

Figure 7.5 Scatter plot of the number of volumetric bins for negative flash VHF sources vs. peak current. The green line indicates a second-order polynomial trend line.

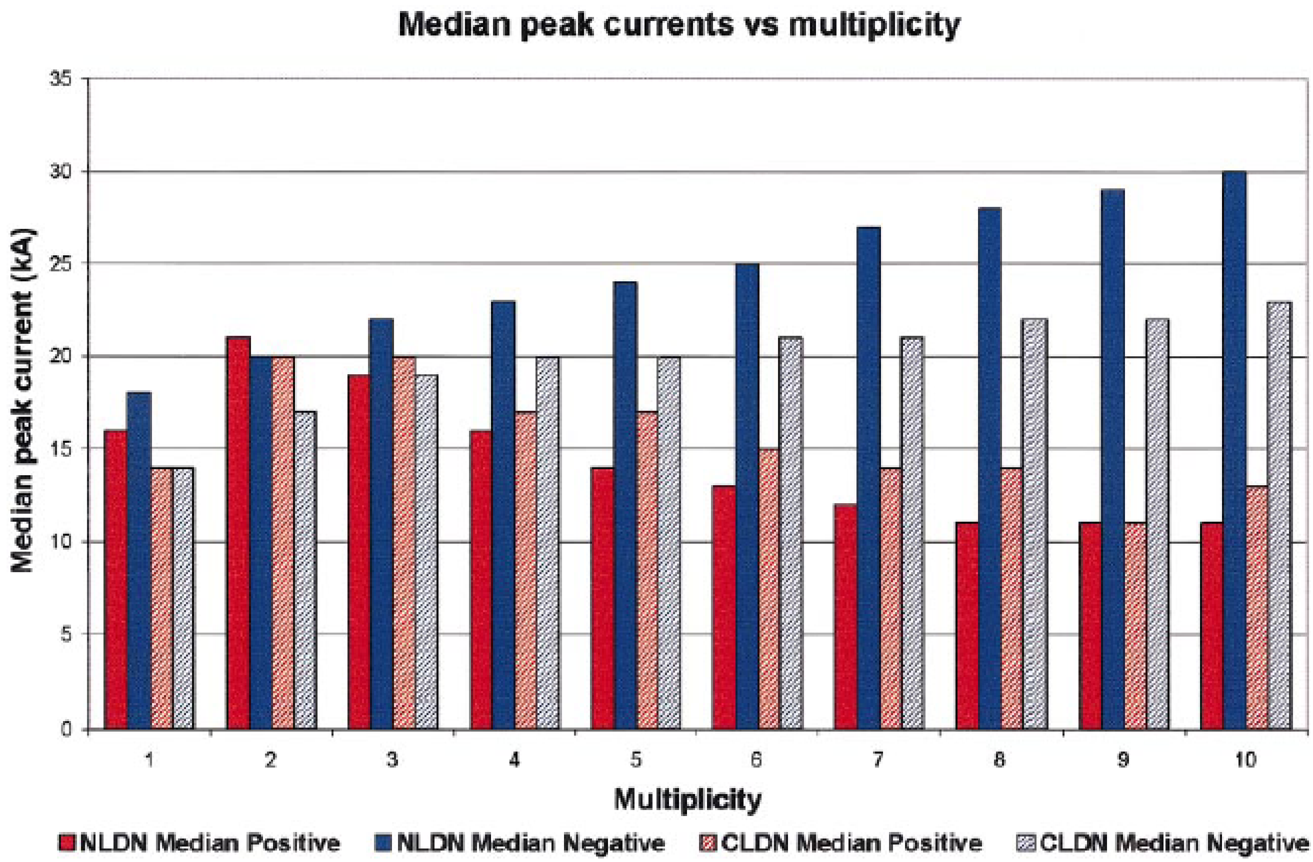

Figure 7.6 Median peak current plotted as a function of the flash multiplicity for each polarity. Information provided for both networks-- the NLDN and the CLDN [Source: Orville et al. 2002.]

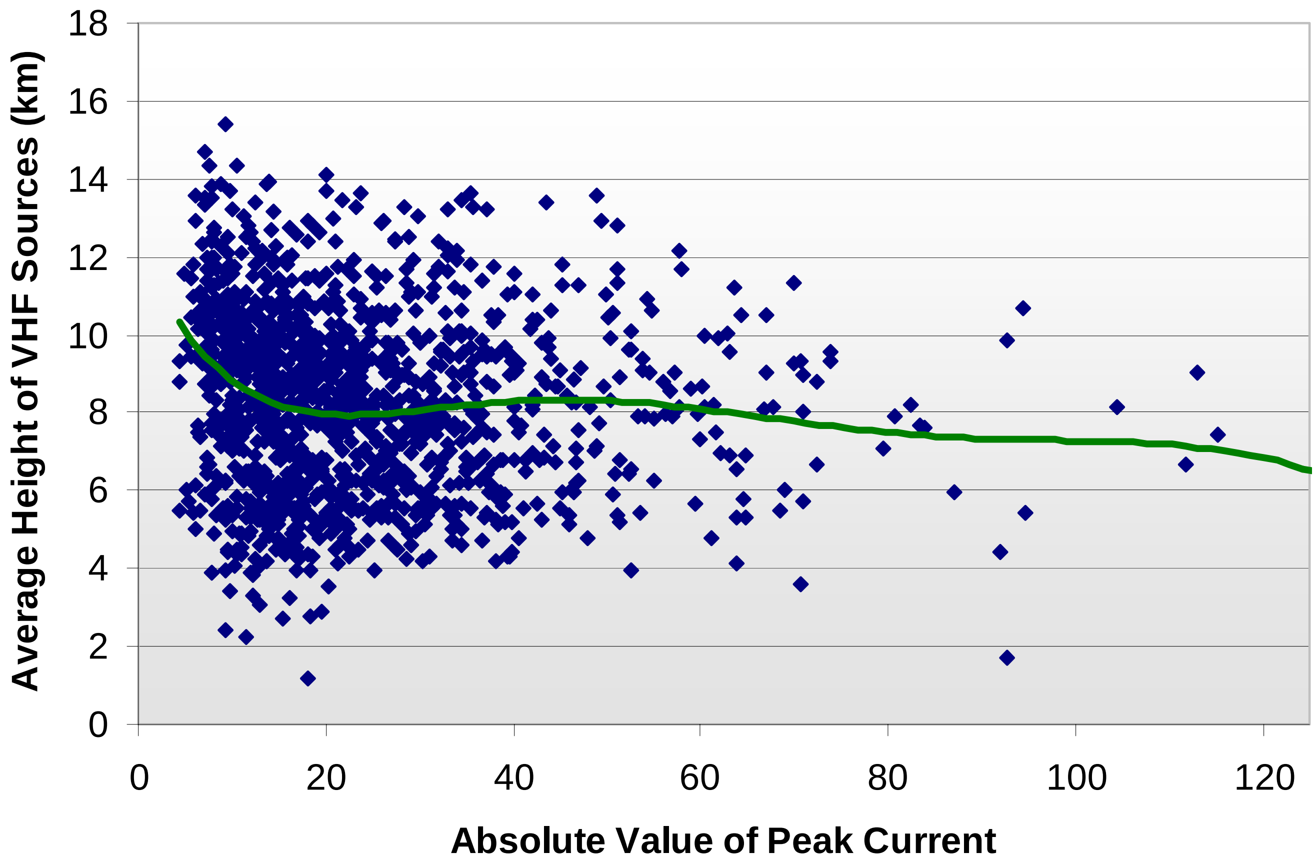

Figure 7.7 Scatter plot of mean height of negative flash VHF sources vs. peak current. The solid green line indicates a sixth-order polynomial trend. Only eight flashes occurred with peak current greater than 100 kA and thus flashes exceeding 125 kA are removed.

APPENDIX B

SOURCE CODE

dffparse.cpp

```
/***************************************************************************
 *   Copyright (C) 2007 by Joe Jurecka   *
 *   n5pyk@tamu.edu   *
 *                                                                         *
 *   This program is free software; you can redistribute it and/or modify  *
 *   it under the terms of the GNU General Public License as published by  *
 *   the Free Software Foundation; either version 2 of the License, or     *
 *   (at your option) any later version.                                   *
 *                                                                         *
 *   This program is distributed in the hope that it will be useful,       *
 *   but WITHOUT ANY WARRANTY; without even the implied warranty of        *
 *   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the         *
 *   GNU General Public License for more details.                          *
 *                                                                         *
 *   You should have received a copy of the GNU General Public License     *
 *   along with this program; if not, write to the                         *
 *   Free Software Foundation, Inc.,                                       *
 *   59 Temple Place - Suite 330, Boston, MA  02111-1307, USA.             *
 ***************************************************************************/


#ifdef HAVE_CONFIG_H
#include <config.h>
#endif

#include <iostream>
#include <cstdlib>
#include "definitions.h"
#include "stdio.h"
#include "endianswap.cpp"
#include <string>
#include <math.h>
#include <stdlib.h>
#include <GL/freeglut.h>
#include <GL/freeglut_std.h>
#include <GL/freeglut_ext.h>


int init=0;
int Quit;
void prompt(int argc, char *argv[]);
void entercoordinates(void);
void enterstarttime(void);
```

```
void enterstoptime(void);
void loadoptions(void);
void saveoptions(void);
void nldnfilename(void);
void ldarfilename(void);
void nldnoutputfilename(void);
void ldaroutputfilename(void);
void help(void);
void show(void);
void procnldn(void);
void procldar(void);
int withinbox(float lat,float lon);
int withintime(void);
void tailnldn(void);
void tailldar(void);
void convtimestamp(TIMESTAMP &time,long julian,char type);
void gregtojul(TIMESTAMP time, long & juliansecs);
void initgrids(void);
void grids(void);
void ExitGlut(void);
void glutStop(void);
void setgrids(void);
void ConvertToLMA(void);
int stopthisglut=0;
double zoom=1;
void FastProcess(int argc, char * argv[]);
int Accepted;
int AvgHeight;
int Volbins;
int Horbins;
int BREAKFROMFP=0;

int  graph(int argc, char *argv[]);
void showgrids(void);
void moreldar(void);
int incrementgrid(double lat,double lon,int alt);
double ComputeDistance(double lat1, double lon1, double lat2, double lon2);
void centertime(void);
OPTIONS opts;
static void Draw(void);
//static void Key(unsigned char key, int x, int y);
void cbKeyPressed(   unsigned char key,    int x, int y);
double avgheight=0;
void glEnable2D();
void glDisable2D();
```

```
//if we have 4 deg by 4 deg box, we have 111*4 or 444 km per side.  Yielding
GRID grid[2000][2000];
double gridresolution=1;  //1 km
double timetosec(int hour,int minute,int second,long nano);
void ComputeAzimuthRadians(double lat1, double lon1, double lat2, double
lon2,double &distance,double &azimuth);
void ConvertToLMA(void);
void plotCg(void);
int Window_ID=0;
int Window_Width=600;
int Window_Height=600;

using namespace std;
//////////////////////////////////////////////////////////////////////////////
/////
int main(int argc, char *argv[])
{
//vga_init();
                glutInit(&argc,argv);
                glutInitWindowSize(Window_Width, Window_Height);
                glutInitWindowPosition(10,10);
                glutInitDisplayMode(GLUT_RGBA | GLUT_DOUBLE);
loadoptions();
opts.flashtimewindow=1000000;
opts.flashspatialradius=10;
opts.flashinterstroketime=500000;
opts.flashbinflushtime=1500000;
opts.maxmultiplicity=15;
opts.multiplicitycalc=0;
Quit=0;
  printf("LDAR / NLDN data extraction software x86\nCopyright 2007 Joe
Jurecka\n\n");
  show();
  initgrids();
  while(!Quit)
  prompt(argc, argv);
  return EXIT_SUCCESS;
}
//////////////////////////////////////////////////////////////////////////////
/////
void loadoptions(void)
{
FILE * infile;
int res;
infile = fopen( "dffprefs.dat", "rb" );
```

```
if(!infile) return;
res=fread( &opts, sizeof(opts), 1, infile);
fclose(infile);
if(!res) return;
}
////////////////////////////////////////////////////////////////////////////////
/////
void saveoptions(void)
{
FILE * outfile;
int res;
outfile = fopen( "dffprefs.dat", "wb" );
if(!outfile) return;
res=fwrite( &opts, sizeof(opts), 1, outfile);
fclose(outfile);
if(!res) return;
}
////////////////////////////////////////////////////////////////////////////////
/////
void prompt(int argc, char *argv[])
{
                char temp[GENSIZE];
                char * singlechar;
                printf(">");
                //gets(temp);
                singlechar=fgets( temp, sizeof(temp), stdin );
                if(strncmp(temp,"box",3)==0) entercoordinates();
                else if(strncmp(temp,"starttime",strlen("starttime"))==0)
enterstarttime();
                else if(strncmp(temp,"stoptime",strlen("stoptime"))==0)
enterstoptime();
                else if(strncmp(temp,"centertime",strlen("centertime"))==0)
centertime();
                else if(strncmp(temp,"ldarinfile",strlen("ldarinfile"))==0)
ldarfilename();
                else if(strncmp(temp,"ldaroutfile",strlen("ldaroutfile"))==0)
ldaroutputfilename();
                else if(strncmp(temp,"nldninfile",strlen("nldninfile"))==0)
nldnfilename();
                else if(strncmp(temp,"nldnoutfile",strlen("nldnoutfile"))==0)
nldnoutputfilename();
                else if(strncmp(temp,"help",strlen("help"))==0) help();
                else if(strncmp(temp,"showgrids",strlen("showgrids"))==0)
showgrids();
                else if(strncmp(temp,"show",strlen("show"))==0) show();
```

```
                else if(strncmp(temp,"procnldn",strlen("procnldn"))==0)
procnldn();
                else if(strncmp(temp,"procldar",strlen("procldar"))==0)
procldar();
                else if(strncmp(temp,"grids",strlen("grids"))==0) grids();
                else if(strncmp(temp,"more ldar",strlen("more ldar"))==0)
moreldar();
                else if(strncmp(temp,"lma",strlen("lma"))==0) ConvertToLMA();
                else if(strncmp(temp,"quit",4)==0) Quit=1;
                else if(strncmp(temp,"exit",4)==0) Quit=1;
                else if(strncmp(temp,"tail nldn",8)==0) tailnldn();
                else if(strncmp(temp,"tail ldar",8)==0) tailldar();
                else if(strncmp(temp,"pl",strlen("pl"))==0) procldar();
                else if(strncmp(temp,"pn",strlen("pn"))==0) procnldn();
                else if(strncmp(temp,"g",strlen("g"))==0) graph(argc,argv);
                else if(strncmp(temp,"c",strlen("c"))==0) centertime();
                else if(strncmp(temp,"setgrids",strlen("setgrids"))==0)
setgrids();
                else if(strncmp(temp,"ls",strlen("ls"))==0) system("ls -la");
                else if(strncmp(temp,"e",strlen("e"))==0) ExitGlut();
                else if(strncmp(temp,"fp",strlen("fp"))==0) FastProcess( argc,
argv);
                else
                {
                   printf("Invalid Input\n");
                }
}
//////////////////////////////////////////////////////////////////////////////
/////
void show(void)
{
  printf("Now using coordinates:\n");
  printf("          %.6f\n",opts.maxlat);
  printf("%.6f            %.6f\n",opts.minlon,opts.maxlon);
  printf("          %.6f\n",opts.minlat);
  printf("Extraction start:  %02i-%02i-%04i
%02i:%02i:%02i\n",opts.start.month,opts.start.day,opts.start.year,opts.start.h
our,opts.start.minute,opts.start.second);
  printf("Extraction stop:  %02i-%02i-%04i
%02i:%02i:%02i\n",opts.stop.month,opts.stop.day,opts.stop.year,opts.stop.hour,
opts.stop.minute,opts.stop.second);
if(opts.ldardfffilename[0]) printf("LDAR Input File :
%s\n",opts.ldardfffilename);
if(opts.ldaroutfilename[0]) printf("LDAR Output File:
%s\n",opts.ldaroutfilename);
```

```
if(opts.nldndfffilename[0]) printf("NLDN Input File :
%s\n",opts.nldndfffilename);
if(opts.nldnoutfilename[0]) printf("NLDN Output File:
%s\n",opts.nldnoutfilename);
printf("Number of grids per side >%i",opts.gridsize);
  printf("\n");

}
/////////////////////////////////////////////////////////////////////////////
///////////////////////
void setgrids(void)
{
                char temp[GENSIZE];
                memset(&temp,0,sizeof(temp));
                printf("Number of grids per side of LDAR horizontal extent>");
                fgets( temp, sizeof(temp), stdin );
                opts.gridsize=atoi(temp);
                printf("Now using %i grids on a side\n\n",opts.gridsize);
                saveoptions();
//Calc N-S grid length
double azimuth,distance;
ComputeAzimuthRadians(opts.centerlat,opts.centerlon,opts.centerlat+(opts.maxla
t-opts.minlat)/opts.gridsize,opts.centerlon, distance, azimuth);
printf("N-S grid width %0.3f km    ",distance*1.852);
ComputeAzimuthRadians(opts.centerlat,opts.centerlon,opts.centerlat,opts.center
lon+(opts.maxlon-opts.minlon)/opts.gridsize, distance, azimuth);
printf("E-W grid with %0.3f km \n",distance*1.852);

}
/////////////////////////////////////////////////////////////////////////////
/////
void ldarfilename(void)
{
                char temp[GENSIZE];
                memset(&temp,0,sizeof(temp));
                memset(&opts.ldardfffilename,0,sizeof(opts.ldardfffilename));
                printf("LDAR Input Filename (full path)>");
                fgets( temp, sizeof(temp), stdin );
                strncpy(opts.ldardfffilename,temp,strlen(temp)-1);
                printf("LDAR Input Filename now: %s\n",opts.ldardfffilename);
                saveoptions();
}
/////////////////////////////////////////////////////////////////////////////
/////
void ldaroutputfilename(void)
```

```
{
                char temp[GENSIZE];
                memset(&temp,0,sizeof(temp));
                memset(&opts.ldaroutfilename,0,sizeof(opts.ldaroutfilename));
                printf("LDAR Ouput Filename (full path)>");
                fgets( temp, sizeof(temp), stdin );
                strncpy(opts.ldaroutfilename,temp,strlen(temp)-1);
                printf("LDAR Input Filename now: %s\n",opts.ldaroutfilename);
                saveoptions();
}
/////////////////////////////////////////////////////////////////////////////
/////
void nldnfilename(void)
{
                char temp[GENSIZE];
                memset(&temp,0,sizeof(temp));
                memset(&opts.nldndfffilename,0,sizeof(opts.nldndfffilename));
                printf("NLDN Input Filename (full path)>");
                fgets( temp, sizeof(temp), stdin );
                strncpy(opts.nldndfffilename,temp,strlen(temp)-1);
                printf("NLDN Input Filename now: %s\n",opts.nldndfffilename);
                saveoptions();
}
/////////////////////////////////////////////////////////////////////////////
/////
void nldnoutputfilename(void)
{
                char temp[GENSIZE];
                memset(&temp,0,sizeof(temp));
                memset(&opts.nldnoutfilename,0,sizeof(opts.nldnoutfilename));
                printf("NLDN Ouput Filename (full path)>");
                fgets( temp, sizeof(temp), stdin );
                strncpy(opts.nldnoutfilename,temp,strlen(temp)-1);
                printf("NLDN Output Filename now: %s\n",opts.nldnoutfilename);
                saveoptions();
}
/////////////////////////////////////////////////////////////////////////////
/////
void help(void)
{printf("DFF extrator help\n\nbox - define the lat/lon box area to extract
data\n");
printf("starttime - start time for data search\nstoptime - stop time for data
search\n");
printf("centertime (ct)-Set the center of the time windows\n");
printf("ldarinfile - define file path for ldar input file\n");
```

```
printf("ldaroutfile - define file path for ldar output file\n");
printf("nldninfile - define file path for nldn input file\n");
printf("nldnoutfile - define file path for nldn output file\n");
printf("procnldn (pn)- Process NLDN file\n");
printf("procldar (pl)- Process LDAR file\n");
printf("tail nldn - View last few lines of processed NLDN data\n");
printf("tail ldar - View last few lines of processed LDAR data\n");
printf("more ldar - View entire ldar output file\n");
printf("show - View parameters\n");
printf("lma - Translate data from procldar to lma format > lma.txt \n");
printf("setgrids - Set the number of grids on a side within the box\n");
printf("g - Graph the current LDAR sources\n");
printf("\tQ - Exit graphics modes\n");
printf("\tL - Swap Buffers in graphics mode\n");
printf("\tC -Plot CGs in graphics mode\n");
printf("\tR - Redraw LDAR sources\n");
printf("\t =/- zoom in / out\n");
printf("quit - exits the program\n");
}
///////////////////////////////////////////////////////////////////////////////
/////
void entercoordinates(void)
{
char temp[GENSIZE];
int valid=0;
while(!valid)
                {
                printf("Maximum Latitude[%.4f]>",opts.maxlat);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.maxlat=atof(temp);
                if((opts.maxlat>20.0)&&(opts.maxlat<80.0)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Minimum Latitude[%.4f]>",opts.minlat);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.minlat=atof(temp);
                if((opts.maxlat>20)&&(opts.maxlat<80)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Minimum Longitude[%.4f]>",opts.minlon);
                fgets( temp, sizeof(temp), stdin );
```

```
                if(strlen(temp)>1) opts.minlon=atof(temp);
                if((opts.minlon>-150)&&(opts.minlon<-40)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Maximum Longitude[%.4f]>",opts.maxlon);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.maxlon=atof(temp);
                if((opts.maxlon>-150)&&(opts.maxlon<-40)) valid=1;
                }
saveoptions();
initgrids();
printf("Now using coordinates:\n");
printf("          %.6f\n",opts.maxlat);
printf("%.6f          %.6f\n",opts.minlon,opts.maxlon);
printf("          %.6f\n\n",opts.minlat);
}
//////////////////////////////////////////////////////////////////////////////
/////
void centertime(void)
{
int valid=0;
char temp[GENSIZE];
while(!valid)
                {
                printf("Year (1983-2100)[%i]>",opts.centertime.year);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.centertime.year=atoi(temp);
                if((opts.centertime.year>1983)&&(opts.centertime.year<2100))
valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Month (1-12)[%i]>",opts.centertime.month);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.centertime.month=atoi(temp);
                if((opts.centertime.month>0)&&(opts.centertime.month<=12))
valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Day (1-31)[%i]>",opts.centertime.day);
```

```
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.centertime.day=atoi(temp);
                if((opts.centertime.day>0)&&(opts.centertime.day<=31))
valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Hour (0-23)>[%i]",opts.centertime.hour);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.centertime.hour=atoi(temp);
                if((opts.centertime.hour>=0)&&(opts.centertime.hour<=23))
valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Minute (0-59)[%i]>",opts.centertime.minute);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.centertime.minute=atoi(temp);
                if((opts.centertime.minute>=0)&&(opts.centertime.minute<=59))
valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Seconds (0-59)[%i]>",opts.centertime.second);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.centertime.second=atoi(temp);
                if((opts.centertime.second>=0)&&(opts.centertime.second<=59))
valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Center width (sec) (0-59)[%i]>",opts.centerwidth);
                fgets( temp, sizeof(temp), stdin );
                if((strlen(temp)>1)&&(atoi(temp)))
opts.centerwidth=atoi(temp);
                if((opts.centerwidth>=0)&&(opts.centerwidth<=59)) valid=1;
                }
memcpy(&opts.start,&opts.centertime,sizeof(opts.start));
memcpy(&opts.stop,&opts.centertime,sizeof(opts.stop));
opts.start.second=opts.start.second-opts.centerwidth;
opts.stop.second=opts.stop.second+opts.centerwidth;
```

```
saveoptions();
printf("Extraction start now set to:  \n%02i-%02i-%04i
%02i:%02i:%02i\n",opts.centertime.month,opts.centertime.day,opts.centertime.ye
ar,opts.centertime.hour,opts.centertime.minute,opts.centertime.second);
}
//////////////////////////////////////////////////////////////////////////////
////////////////////////////
void enterstarttime(void)
{
int valid=0;
char temp[GENSIZE];
while(!valid)
                {
                printf("Year (1983-2100)[%i]>",opts.start.year);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.start.year=atoi(temp);
                if((opts.start.year>1983)&&(opts.start.year<2100)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Month (1-12)[%i]>",opts.start.month);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.start.month=atoi(temp);
                if((opts.start.month>0)&&(opts.start.month<=12)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Day (1-31)[%i]>",opts.start.day);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.start.day=atoi(temp);
                if((opts.start.day>0)&&(opts.start.day<=31)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Hour (0-23)>[%i]",opts.start.hour);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.start.hour=atoi(temp);
                if((opts.start.hour>=0)&&(opts.start.hour<=23)) valid=1;
                }
valid=0;
while(!valid)
```

```
                {
                printf("Minute (0-59)[%i]>",opts.start.minute);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.start.minute=atoi(temp);
                if((opts.start.minute>=0)&&(opts.start.minute<=59)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Seconds (0-59)[%i]>",opts.start.second);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.start.second=atoi(temp);
                if((opts.start.second>=0)&&(opts.start.second<=59)) valid=1;
                }
saveoptions();
printf("Extraction start now set to:  \n%02i-%02i-%04i
%02i:%02i:%02i\n",opts.start.month,opts.start.day,opts.start.year,opts.start.h
our,opts.start.minute,opts.start.second);
}
//////////////////////////////////////////////////////////////////////////////
/////
void enterstoptime(void)
{
int valid=0;
char temp[GENSIZE];
while(!valid)
                {
                printf("Year (1983-2100)[%i]>",opts.stop.year);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.stop.year=atoi(temp);
                if((opts.stop.year>1983)&&(opts.stop.year<2100)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Month (1-12)[%i]>",opts.stop.month);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.stop.month=atoi(temp);
                if((opts.stop.month>0)&&(opts.stop.month<=12)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Day (1-31)[%i]>",opts.stop.day);
                fgets( temp, sizeof(temp), stdin );
```

```
                if(strlen(temp)>1) opts.stop.day=atoi(temp);
                if((opts.stop.day>0)&&(opts.stop.day<=31)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Hour (0-23)[%i]>",opts.stop.hour);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.stop.hour=atoi(temp);
                if((opts.stop.hour>=0)&&(opts.stop.hour<=23)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Minute (0-59)[%i]>",opts.stop.minute);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.stop.minute=atoi(temp);
                if((opts.stop.minute>=0)&&(opts.stop.minute<=59)) valid=1;
                }
valid=0;
while(!valid)
                {
                printf("Seconds (0-59)[%i]>",opts.stop.second);
                fgets( temp, sizeof(temp), stdin );
                if(strlen(temp)>1) opts.stop.second=atoi(temp);
                if((opts.stop.second>=0)&&(opts.stop.second<=59)) valid=1;
                }
saveoptions();
printf("Extraction stop now set to:  \n%02i-%02i-%04i
%02i:%02i:%02i\n",opts.stop.month,opts.stop.day,opts.stop.year,opts.stop.hour,
opts.stop.minute,opts.stop.second);
}
////////////////////////////////////////NLDN////////////////////////////////
/////////
void procnldn(void)
{
DFFDATA data;
char filename[FNAMESIZE];
memset(&data,0,sizeof(data));
long stopjul;
long startjul;
gregtojul(opts.start,startjul);
gregtojul(opts.stop,stopjul);
FILE * infile;
FILE * outfile;
```

```
int res=1;
TIMESTAMP timestamp;
strncpy(filename,opts.nldndfffilename,strlen(opts.nldndfffilename));
infile = fopen(opts.nldndfffilename, "rb" );

if(!infile)
{                printf("***Invalid NLDN input filename****\n");
                 return;
}
//printf("Valid filename\n");
outfile = fopen( opts.nldnoutfilename, "wt" );
if(!infile)
{                printf("Error opening NLDN output filename\n");
                 return;
}
printf("Working...Please be patient\n");
fseek(infile,0,SEEK_SET);
long int idx=0;
long int foundidx=0;
double lasttimesec=0;
double currenttimesec=0;
double delta=0;

while((res)&&(!opts.multiplicitycalc))
{
                 res=fread( &data, 44, 1, infile);
                 convtimestamp(timestamp,LongSwap(data.time_stamp),1);
                 //printf("+");

                 if(
                     withinbox(FloatSwap(data.lat),FloatSwap(data.lon))
                     &&(LongSwap(data.time_stamp)>startjul)
                     &&(LongSwap(data.time_stamp)<stopjul)
                   )
                     {
                            foundidx++;

                 //if(((double)LongSwap(data.signal)*0.0185>0)&&((double)LongSw
ap(data.signal)*0.0185<16))

                 printf("%i,%04i,%02i,%02i,%02i,%02i,%02i,%09i,%.4f,N,%.4f,W,%4
.2f
kA\n",idx,timestamp.year,timestamp.month,timestamp.day,timestamp.hour,timestam
p.minute,timestamp.second,LongSwap(data.nano),FloatSwap(data.lat),FloatSwap(da
ta.lon),(double)LongSwap(data.signal)*0.0185);
```

```
                                // old
fprintf(outfile,"%i,%04i,%02i,%02i,%02i,%02i,%02i,%09i,%.4f,N,%.4f,W,%.2f,kA\n
",foundidx,timestamp.year,timestamp.month,timestamp.day,timestamp.hour,timesta
mp.minute,timestamp.second,LongSwap(data.nano),FloatSwap(data.lat),FloatSwap(d
ata.lon),(double)LongSwap(data.signal)*0.0185);
                                //the following line was added to help Chas

                    currenttimesec=timestamp.day*86400+timestamp.hour*3600+timesta
mp.minute*60+timestamp.second+(double)LongSwap(data.nano)/1000000000;
                                delta=currenttimesec-lasttimesec;

                    fprintf(outfile,"%05i,%04i,%02i,%02i,%02i,%02i,%02i,%09i,%3.4f
,N,%4.4f,W,%4.2f,kA,%.3f,dSec"
,foundidx,timestamp.year,timestamp.month,timestamp.day,timestamp.hour,timestam
p.minute,timestamp.second,LongSwap(data.nano),FloatSwap(data.lat),FloatSwap(da
ta.lon),(double)LongSwap(data.signal)*0.0185,delta);
                                if(delta<.75) fprintf(outfile," |\n");
                                else fprintf(outfile,"\n");

                    lasttimesec=timestamp.day*86400+timestamp.hour*3600+timestamp.
minute*60+timestamp.second+(double)LongSwap(data.nano)/1000000000;
                        }
                    idx++;
                    //printf("%i\n",idx);
}


fclose(infile);
fclose(outfile);
printf("\nDone!\n");
}
////////////////////////////////////LDAR////////////////////////////////////
/////////////////
void procldar(void)
{
DFFDATA data;
initgrids();
char filename[FNAMESIZE];
memset(&data,0,sizeof(data));
long stopjul;
long startjul;
gregtojul(opts.start,startjul);
gregtojul(opts.stop,stopjul);
FILE * infile;
FILE * outfile;
```

```
int res=1;
TIMESTAMP timestamp;
strncpy(filename,opts.ldardfffilename,strlen(opts.ldardfffilename));
infile = fopen(opts.ldardfffilename, "rb" );

if(!infile)
{                printf("***Invalid LDAR input filename****\n");
                 return;
}
outfile = fopen( opts.ldaroutfilename, "wt" );
if(!infile)
{                printf("Error opening LDAR output filename\n");
                 return;
}
printf("Working the LDAR data...Please be patient\n");
fseek(infile,0,SEEK_SET);
int idx=0;
int countidx=0;

double lastlat,lastlon;
avgheight=0;
while(res)
{
                 res=fread( &data, 44, 1, infile);
                 convtimestamp(timestamp,LongSwap(data.time_stamp),1);
                 //printf("%i,%04i,%02i,%02i,%02i,%02i,%02i,%09i,%.4f,N,%.4f,W,
%d,m\n",idx,timestamp.year,timestamp.month,timestamp.day,timestamp.hour,timest
amp.minute,timestamp.second,LongSwap(data.nano),FloatSwap(data.lat),FloatSwap(
data.lon),(LongSwap(data.extended)>>16)-5000);
                 if(
                    withinbox(FloatSwap(data.lat),FloatSwap(data.lon))
                    &&(LongSwap(data.time_stamp)>startjul)
                    &&(LongSwap(data.time_stamp)<stopjul)
                   )
                    {countidx++;

                 if((countidx>1)&&(ComputeDistance(FloatSwap(data.lat),FloatSwa
p(data.lon),lastlat,lastlon))>10)
                              {
                              printf("May have distance discrepancy %.1f
km\n",ComputeDistance(FloatSwap(data.lat),FloatSwap(data.lon),lastlat,lastlon)
);
                              }

                 fprintf(outfile,"%i,%04i,%02i,%02i,%02i,%02i,%02i,%09i,%.4f,N,
```

```
%.4f,W,%d,m,%.1f\n",countidx,timestamp.year,timestamp.month,timestamp.day,time
stamp.hour,timestamp.minute,timestamp.second,LongSwap(data.nano),FloatSwap(dat
a.lat),FloatSwap(data.lon),(LongSwap(data.extended)>>16)-
5000,ComputeDistance(FloatSwap(data.lat),FloatSwap(data.lon),lastlat,lastlon))
;

                 incrementgrid(FloatSwap(data.lat),FloatSwap(data.lon),(LongSwa
p(data.extended)>>16)-5000);
                    avgheight=(((avgheight*(countidx-
1))+((double)(LongSwap(data.extended)>>16)-5000)))/countidx;
                    lastlat=FloatSwap(data.lat);
                    lastlon=FloatSwap(data.lon);
                    }
                 idx++;
}
//printf("Average height %.1f",avgheight);
AvgHeight=(int)avgheight;
fclose(infile);
fclose(outfile);
//printf("\nDone!\n");
grids();
}
//////////////////////////////////////////////////////////////////////////////
/////
int withinbox(float lat,float lon)
{
if
((lat<opts.maxlat)&&(lat>opts.minlat)&&(lon<opts.maxlon)&&(lon>opts.minlon))
return 1;
return 0;
}
//////////////////////////////////////////////////////////////////////////////
/////
void tailnldn(void)
{
char line[GENSIZE];
sprintf(line,"tail %s",opts.nldnoutfilename);
system(line);
}
//////////////////////////////////////////////////////////////////////////////
/////
void tailldar(void)
{
char line[GENSIZE];
sprintf(line,"tail %s",opts.ldaroutfilename);
```

```
system(line);
}
//////////////////////////////////////////////////////////////////////////////
/////
void moreldar(void)
{
char line[GENSIZE];
sprintf(line,"more %s",opts.ldaroutfilename);
system(line);
}
//////////////////////////////////////////////////////////////////////////////
/////
void convtimestamp(TIMESTAMP &time,long julian,char type)
{
memset(&time,0,sizeof(time));
double refdate;
if(type==2) refdate=2444298.5;           //nldn base
if(type==1) refdate=2440587.5;          //ldar base
long nDays=(long)(julian/(86400));
double julDay=nDays+refdate;
long z=(long)(julDay+0.5);
long w=(long)((z-1867216.25)/36524.25);
long x=(long)(w/4);
long a=(long)(z+1+w-x);
long b=(long)(a+1524);
long c=(long)((b-122.1)/365.25);
long d=(long)(365.25*c);
long e=(long)((b-d)/30.6001);
long f=(long)(30.6001*e);
time.day=b-d-f;
time.month=e-1;
if (time.month>12) time.month=time.month-12;
time.year = c-4716;
if (time.month<3) time.year=time.year-1;

long seconds=julian-nDays*86400;
time.hour=(int)(seconds/3600);
time.minute=(int)(seconds/60-time.hour*60);
time.second=(int)(seconds-time.minute*60-time.hour*3600);

}
//////////////////////////////////////////////////////////////////////////
void gregtojul(TIMESTAMP time, long & juliansecs)
{
int y = time.year;
```

```
if (time.month<3) y=y-1;
int a=(int)(y/100);
int b=(int)(a/4);
int c=2-a+b;
int e=(int)(365.25*(y+4716));
int f=(int)(30.6001*(time.month+1));
double jd=c+time.day+e+f-1524.5;

jd=(jd-2440587.5)*86400;
jd=jd+time.hour*3600;
jd=jd+time.minute*60;
jd=jd+time.second;
juliansecs=(long)jd;
//printf("Julian Seconds %d\n",juliansecs);
}
////////////////////////////////////////////////////////////////////////////
void initgrids(void)
{
 opts.centerlat=(opts.maxlat+opts.minlat)/2;
 opts.centerlon=(opts.maxlon+opts.minlon)/2;
double top=opts.maxlat;
double bottom=opts.minlat;
double left=opts.minlon;
double right=opts.maxlon;
int x=0,y=0;
while(x<opts.gridsize)
{
                 y=0;
                 while(y<opts.gridsize)
                 {
                     grid[x][y].lllat=(double)(y)*(opts.maxlat-
opts.minlat)/opts.gridsize+bottom;
                     grid[x][y].lllon=(double)(x)*(opts.maxlon-
opts.minlon)/opts.gridsize+left;
                     grid[x][y].value=0;
                     memset(&grid[x][y].layer,0,sizeof(grid[x][y].layer));
//printf("%.3f %.3f\n",grid[x][y].lllat,grid[x][y].lllon);
                     y++;
                 }

x++;
}
}
////////////////////////////////////////////////////////////////////////////
void grids(void)
```

```
{
int x=0;
int y=0;
int count=0;
int volcount=0;
while(x<opts.gridsize)
{
                y=0;
                while(y<opts.gridsize)
                {
                   if(grid[x][y].value)
                   {
                          count++;
                          int j=0;
                          while(j<MAXHEIGHTBIN)
                          {
                                 if(grid[x][y].layer[j]) volcount++;
                                 j++;
                          }
                   }
                   y++;
                }

x++;
}
printf("Total of %d grid boxes reported activity\n",count);
printf("Total of %d volume boxes reported activity\n",volcount);
printf("Average Height %.0f\n",avgheight);
Horbins=count;
Volbins=volcount;

}
//////////////////////////////////////////////////////////////////////////
void showgrids(void)
{
int x=0;
int y=0;
int count=0;
int volcount=0;
while(x<opts.gridsize)
{
                y=0;
                while(y<opts.gridsize)
                {
                   if(grid[x][y].value)
```

```
                    {
                          printf("%fN
%fW\n",grid[x][y].lllat,grid[x][y].lllon);
                          count++;
                          int j=0;
                          while(j<MAXHEIGHTBIN)
                          {
                                if(grid[x][y].layer[j]) volcount++;
                                j++;
                          }
                    }
                    y++;
                 }

x++;
}
printf("Total of %d grid boxes reported activity\n",count);
printf("Total of %d volume boxes reported activity\n",volcount);
}
//////////////////////////////////////////////////////////////////////////
double timetosec(int hour,int minute,int second,long nano)
{
double seconds;
seconds=seconds+hour*3600+minute*60+seconds+((double)nano/1000000000);
return seconds;
}
///////////////////////////////////////////////////////////////////////////
int incrementgrid(double lat,double lon,int alt)
{
int x=0,y=0;
while(x<opts.gridsize)
{
                 y=0;
                 while(y<opts.gridsize)
                 {
                    if(
                    (lat>=grid[x][y].lllat)&&(lat<grid[x][y+1].lllat)&&
                    (lon>=grid[x][y].lllon)&&(lon<grid[x+1][y].lllon)
                    )
                          {
                          grid[x][y].value++;
                          int level=(int)((double)((alt))/1000);  //break it
into 1000 m levels
                          grid[x][y].layer[level]++;
                          }
```

```
                y++;
            }

x++;
}
return 0;
}

/////////////////////////////////////////////////////////////////////////////////
///////////////
double ComputeDistance(double lat1, double lon1, double lat2, double lon2)
{
        double dlon = (lon2-lon1) * degToRad;
        lat1 *= degToRad;
        lat2 *= degToRad;
        // good algorithm
        double la = sin((lat2-lat1)/2);
        double lo = sin(dlon/2);
        double x = la*la + cos(lat1) * cos(lat2) * lo*lo;
        return(2*earthRadius*asin(sqrt(x))/1852);

}

int graph(int argc, char *argv[])
{
                stopthisglut=0;
                zoom=1;
                char name[1024];
                sprintf(name,"dffparser visual display %i",init);
//if(!init)
{
                Window_ID = glutCreateWindow( name);
                init++;
}

                glutKeyboardFunc(&cbKeyPressed);  //define callback for if a
key is pressed
                glutDisplayFunc(&Draw);  //define callback for if the window
is to be drawn
                glutCloseFunc(&glutStop);
                glutSetOption(GLUT_ACTION_ON_WINDOW_CLOSE
,GLUT_ACTION_GLUTMAINLOOP_RETURNS);
                //glShadeModel(GL_SMOOTH);
                // Enable Smooth Shading
```

```
                glClearColor(0.0f, 0.00f, 0.05f, 0.1f);
                   // Black Background
                glClearDepth(1.0f);
                // Depth Buffer Setup
                //glHint(GL_LINE_SMOOTH_HINT, GL_NICEST);
                   // Set Line Antialiasing
                //glEnable(GL_BLEND);
                // Enable Blending


                while(!stopthisglut)
                {
                glutMainLoopEvent();  //the main glut loop
                }
   return EXIT_SUCCESS;

}



void cbKeyPressed(   unsigned char key,    int x, int y)
{
   switch (key) {
      case 113: case 81: case 27: // Q (Escape) - We're outta here.

     //glutLeaveMainLoop();
      glutDestroyWindow(Window_ID);
      //exit(1);
      break; // exit doesn't return, but anyway...

   case 108: case 76:  // L - buffer swap

     glutSwapBuffers();
      break;

                case 114: case 82:  //R - Redraw
                Draw();
                break;
//
    case 65:case 97: // A
                glClearColor(0.0f, 0.5f, 0.0f, 1.0f);
                break;

                case 67:  case 99:  //C
                plotCg();
                break;
```

```
                case 89:  case 121:  //Y
                Accepted=1;
                glutDestroyWindow(Window_ID);
                break;

                case 78:  case 110:  //N
                Accepted=0;
                glutDestroyWindow(Window_ID);
                break;

                case 24:
                printf("Hard Exit\n");
                exit(1);
                break;


                case 61:
                zoom=zoom*1.3;
                Draw();
                break;

                case 45:
                zoom=zoom/1.3;
                Draw();
                break;


   default:
      printf ("KP: No action for %d.\n", key);

      break;
    }
}

static void Draw(void)
{
//intf("%.3f %.3f\n",opts.centerlat,opts.centerlon);
glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);                // Clear
Screen And Depth Buffer

//DRAW THE GRID
int xi=0;
int yi=0;
int count=0;
```

```
int volcount=0;
glColor3f(0.2,0.2,0.2);   //Set Color to gray
while(xi<opts.gridsize)
{
                glColor3f(0.2,0.2,0.2);   //Set Color to gray
                yi=0;
                while(yi<opts.gridsize)
                {
                   double x1,y1;
                   x1=(grid[xi][yi].lllon-opts.centerlon)/(opts.maxlon-
opts.centerlon)*zoom;
                   y1=(+opts.centerlat-grid[xi][yi].lllat)/(opts.maxlat-
opts.centerlat)*zoom;
                   glBegin(GL_LINES);
                   glVertex2d( -1,y1);                          //
horizontal lines
                   glVertex2d( 1,y1);
                   glEnd();

                   yi++;
                }
                yi=0;
                glColor3f(0.0,0.2,0.2);   //Set Color to gray
                   double x2,y2;
                   x2=(grid[xi][yi].lllon-opts.centerlon)/(opts.maxlon-
opts.centerlon)*zoom;
                   y2=(+opts.centerlat-grid[xi][yi].lllat)/(opts.maxlat-
opts.centerlat)*zoom;
                   glBegin(GL_LINES);
                   glVertex2d( x2,-1);                          //Vertical
Lines
                   glVertex2d( x2,1);
                   glEnd();
                //printf("%.3f \n", grid[xi][yi].lllon);
xi++;
}

//DRAW THE POINTS DETECTED
FILE * file;
file=fopen(opts.ldaroutfilename,"r");
char buffer[1024];
char * ch;
ch++;
char * PacketPtrs[20];
double lat,lon;
```

```
double x,y;
int sources=0;

                glColor3f(1.0f,1.0f,0.0f);
                   // Set Color To Yellow
                glBegin(GL_POINTS);                                  //
Start Drawing Our Player Using Lines
                while(ch)
                {
                   ch=fgets( buffer, sizeof(buffer), file);
                   BreakPacket(buffer,PacketPtrs,20);
                   //printf("%s\n",buffer);
                   lat=atof(PacketPtrs[8]);
                   lon=atof(PacketPtrs[10]);
                   x=(lon-opts.centerlon)/(opts.maxlon-opts.centerlon)*zoom;
                                       //2 is width of window in degrees
                   y=(lat-opts.centerlat)/(opts.maxlat-opts.centerlat)*zoom;
                                       //2 is width of window in degrees
                   glVertex2d( x, y);
                   //printf("%.3f %.3f  x=%.3f y=%.3f\n",lat,lon,x,y);
                   sources++;

                }
                glutSwapBuffers();
                glEnd();

fclose(file);
printf("%i sources\n",sources);
glFinish();
return;
}


int BreakPacket(char * s, char * * a, int max)
{

                int num=0;
                char *p;
                while(1)
                {
                   p=strchr(s,',');  //the character to split with
                   a[num++]=s;
                   if(!p) return num;
                   * (p++)='\0';
                   s=p;
```

```
                if(num==max) return num;
            }

            return 0;
}

void ExitGlut(void)
{
printf("Trying to Kill glut...\n");
glutDestroyWindow(Window_ID);

}

void glutStop(void)
{
stopthisglut=1;
}

void ComputeAzimuthRadians(double lat1, double lon1, double lat2, double
lon2,double &distance,double &azimuth)
{
            //routine for detemining great circle distance and azimuth.
            double dlon = (lon2-lon1) * degToRad;
            lat1 *= degToRad;
            lon1 *= degToRad;
            lat2 *= degToRad;
            lon2 *= degToRad;
            // calculate bearing in case anyone cares
            azimuth = atan2(sin(dlon), (-sin(lat1)*cos(dlon) +
tan(lat2)*cos(lat1)));
            double la = sin((lat2-lat1)*0.5);
    double lo = sin(dlon/2);
    double x = la*la + cos(lat1) * cos(lat2) * lo*lo;
    distance=(2*earthRadius*asin(sqrt(x))*0.000539956803);
}

void plotCg(void)
{
glutSwapBuffers();
//DRAW THE POINTS DETECTED
FILE * file;
file=fopen(opts.nldnoutfilename,"r");
char buffer[1024];
char * ch;
ch++;
```

```
char * PacketPtrs[20];
double lat,lon;
double x,y,pol;
int sources=0;
                                                     // Start Drawing Our
Player Using Lines
                while(ch)
                {
                   memset(&buffer,0,sizeof(buffer));
                   ch=fgets( buffer, sizeof(buffer), file);
                   BreakPacket(buffer,PacketPtrs,20);
                   //printf("%s\n",buffer);
                   lat=atof(PacketPtrs[8]);
                   lon=atof(PacketPtrs[10]);
                   //printf("%.3f %.3f  %.2f / %.2f\n",lat,lon,x,y);
                   pol=atof(PacketPtrs[12]);
                   if(pol<0) glColor3f(1.0f,1.0f,1.0f);  //white
                   if(pol>0) glColor3f(1.0f,0.0f,0.0f);  //red
                   x=(lon-opts.centerlon)/(opts.maxlon-opts.centerlon)*zoom;
                                       //2 is width of window in degrees
                   y=(lat-opts.centerlat)/(opts.maxlat-opts.centerlat)*zoom;
                                       //2 is width of window in degrees
                   glBegin(GL_LINES);
                   glVertex2d(x,y-0.01);
                   glVertex2d(x,y+0.01);
                   glEnd();
                   glBegin(GL_LINES);
                   glVertex2d(x-0.01, y);
                   glVertex2d(x+0.01,y);
                   glEnd();

                   sources++;

                }
fclose(file);
glFinish();

//glutSwapBuffers();
//glFinish();

}

void ConvertToLMA(void)
{
FILE * file;
```

```
FILE * outfile;
file=fopen(opts.ldaroutfilename,"r");
outfile=fopen("lma.txt","w");
char buffer[1024];
char * ch;
ch++;
char * PacketPtrs[20];
double lat,lon;
double x,y;
int sources=0;
int firsttimethru=1;
char line[1024];
// Data Start Time: mm/dd/yy hh:mm:ss

fputs(line,outfile);

                while(ch)
                {
                    ch=fgets( buffer, sizeof(buffer), file);
                    BreakPacket(buffer,PacketPtrs,20);
                    //printf("%s\n",buffer);
                    lat=atof(PacketPtrs[8]);
                    lon=atof(PacketPtrs[10]);
                    double alt=atof(PacketPtrs[12]);
                    x=(lon-opts.centerlon)/(opts.maxlon-opts.centerlon)*zoom;
                                        //2 is width of window in degrees
                    y=(lat-opts.centerlat)/(opts.maxlat-opts.centerlat)*zoom;
                                        //2 is width of window in degrees
                    double
utdelta=atoi(PacketPtrs[4])*3600+atoi(PacketPtrs[5])*60+atoi(PacketPtrs[6])+(d
ouble)atoi(PacketPtrs[7])/1000000000;
                    if(firsttimethru)
                    {
                          char temp[1024];
                          fputs("\nHouston LDAR II Network\n",outfile);
                          sprintf(temp,"Data Start time: %02i/%02i/%02i
%02i:%02i:%02i\n",atoi(PacketPtrs[1]),atoi(PacketPtrs[2]),atoi(PacketPtrs[3]),
atoi(PacketPtrs[4]),atoi(PacketPtrs[5]),atoi(PacketPtrs[6]));
                          fputs(temp,outfile);

                          sprintf(temp,"*** data ***\n");\
                          fputs(temp,outfile);
                          firsttimethru=0;
                    }
```

```
                    sprintf(line,"%.9f %.6f %.6f %.1f 1.01
12\n",utdelta,lat,lon,alt);
                    printf(line);;
                    fputs(line,outfile);
                    sources++;
                }


fclose(file);

fclose(outfile);
}

void FastProcess(int argc, char *argv[])
{
Accepted=0;
Horbins=0;
AvgHeight=0;
Volbins=0;
char * PacketPtrs[30];

FILE * nldninput;
FILE * alloutput;
char line[1024];
char * dch;
dch=(char *) 1;

//printf("Hey, I got to file process\n");
//open the daynldn.csv file
nldninput=fopen("/home/n5pyk/dff/daynldn.csv","r");
if(!nldninput)
{
printf("***Error opening daynldn.csv***\n\n");
return;
}
alloutput=fopen("/home/n5pyk/dff/alloutput.csv","w");
if(!alloutput)
{
printf("***Error opening alloutput.csv***\n\n");
return;
}

while((dch)&&!(BREAKFROMFP))
{
                dch=fgets(line,sizeof(line),nldninput);
```

```
//read in the daynldn.csv file
                BreakPacket(line,PacketPtrs,20);
                int flashnum=atoi(PacketPtrs[0]);
                opts.centertime.year=atoi(PacketPtrs[1]);
                opts.centertime.month=atoi(PacketPtrs[2]);
                opts.centertime.day=atoi(PacketPtrs[3]);
                opts.centertime.hour=atoi(PacketPtrs[4]);
                opts.centertime.minute=atoi(PacketPtrs[5]);
                opts.centertime.second=atoi(PacketPtrs[6]);
                int nano=atoi(PacketPtrs[7]);
                opts.centerwidth=2;
                double tdelta=atof(PacketPtrs[14]);
                if(tdelta>1.0)
                {
                //set the centertime to the time of the line in the csv file's
flash time with a width of 2 seconds

                    memcpy(&opts.start,&opts.centertime,sizeof(opts.start));
                    memcpy(&opts.stop,&opts.centertime,sizeof(opts.stop));
                    opts.start.second=opts.start.second-opts.centerwidth;
                    opts.stop.second=opts.stop.second+opts.centerwidth;
                    //printf("Extraction start now set to:  \n%02i-%02i-%04i
%02i:%02i:%02i\n",opts.centertime.month,opts.centertime.day,opts.centertime.ye
ar,opts.centertime.hour,opts.centertime.minute,opts.centertime.second);

                    procldar();
                    if((Horbins!=0)||(Volbins!=0))
                    {
                          procnldn();
                          graph(argc,argv);
                          if(Accepted)
                          {
                          printf("Accepted\n");
                          char text[1024];

                sprintf(text,"%i,%04i,%02i,%02i,%02i,%02i,%02i,%09i,%.4f,N,%.4
f,W,%.2f,kA,%.3f,dSec, , ,%i,%i,%i,1\n"
,flashnum,opts.centertime.year,opts.centertime.month,opts.centertime.day,opts.
centertime.hour,opts.centertime.minute,opts.centertime.second,nano,atof(Packet
Ptrs[8]),atof(PacketPtrs[10]),atof(PacketPtrs[12]),tdelta,Horbins,Volbins,AvgH
eight);
                          fputs(text,alloutput);
                          }
                          else
                          {
```

```
                    char text[1024];

            sprintf(text,"%i,%04i,%02i,%02i,%02i,%02i,%02i,%09i,%.4f,N,%.4
f,W,%.2f,kA,%.3f,dSec, , , , , ,0\n"
,flashnum,opts.centertime.year,opts.centertime.month,opts.centertime.day,opts.
centertime.hour,opts.centertime.minute,opts.centertime.second,nano,atof(Packet
Ptrs[8]),atof(PacketPtrs[10]),atof(PacketPtrs[12]),tdelta);
                    fputs(text,alloutput);
                    printf("Not Accepted\n");
                    }
                }
                else
                {   char text[1024];

            sprintf(text,"%i,%04i,%02i,%02i,%02i,%02i,%02i,%09i,%.4f,N,%.4
f,W,%.2f,kA,%.3f,dSec, , , 0,0,-1 ,0\n"
,flashnum,opts.centertime.year,opts.centertime.month,opts.centertime.day,opts.
centertime.hour,opts.centertime.minute,opts.centertime.second,nano,atof(Packet
Ptrs[8]),atof(PacketPtrs[10]),atof(PacketPtrs[12]),tdelta);
                    fputs(text,alloutput);
                }

            }
            if(tdelta<=1.0)
            {
                char text[1024];

            sprintf(text,"%i,%04i,%02i,%02i,%02i,%02i,%02i,%09i,%.4f,N,%.4
f,W,%.2f,kA,%.3f,dSec, , , , , ,0\n"
,flashnum,opts.centertime.year,opts.centertime.month,opts.centertime.day,opts.
centertime.hour,opts.centertime.minute,opts.centertime.second,nano,atof(Packet
Ptrs[8]),atof(PacketPtrs[10]),atof(PacketPtrs[12]),tdelta);
                fputs(text,alloutput);
            }

            //printf(" Flash %i HB=%i VB=%i
AH=%\n",atoi(PacketPtrs[0]),Horbins,Volbins,AvgHeight);

//run the ldar algorithm pl
//run the nldn algorihtm pn
//graph the results

//if the flash is accepted, set the field item to indicate as such
//fill in the ldar parameters captured //volbins/horzbins/avgheight
}
```

```
fclose(nldninput);
fclose(alloutput);
AvgHeight=0;
Horbins=0;
Volbins=0;
}
```

definitions.h

```
/*************************************************************************
 *   Copyright (C) 2007 by Joe Jurecka   *
 *   n5pyk@tamu.edu   *
 *                                                                       *
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 *                                                                       *
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 *   along with this program; if not, write to the                         *
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 *   59 Temple Place - Suite 330, Boston, MA  02111-1307, USA.             *
 *************************************************************************/
#define GENSIZE 255
#define FNAMESIZE 1024
#define MAXHEIGHTBIN 30
#define degToRad 0.0174532
#define PI 3.141592653875
#define degToMeters (10001750.0 / 90.0)
#define earthRadius 180*degToMeters / PI

 struct DFFDATA
{
     long time_stamp;
     long nano;
     float lat;
     float lon;
     long signal;
     unsigned long flags;
     unsigned short chi_square;
     unsigned short ell_semimajor_axis;
     unsigned short ell_semiminor_axis;
     unsigned short ell_angle;
     char freedom;
     char multi;
     char num_dfrs;
```

```
     char secidx;
     unsigned short risetime;
     unsigned short max_rate_rise_val;
     unsigned long extended;
 };

struct TIMESTAMP
{
                int year;
                int month;
                int day;
                int hour;
                int minute;
                int second;
                long nano;
};

//Grid for discharges
struct GRID
{
                double lllat;  //lower left corner latitude of box
                double lllon;    //lower left corner longitude of box
                float value;   //determines if a source occurred within this
grid box
                float layer[30];    //further refines which altitude bin (1km
levels) the source occurred
};

struct OPTIONS
{
                double minlat;
                double maxlat;
                double minlon;
                double maxlon;
                char nldndfffilename[FNAMESIZE];
                char ldardfffilename[FNAMESIZE];
                char nldnoutfilename[FNAMESIZE];
                char ldaroutfilename[FNAMESIZE];
                TIMESTAMP start;
                TIMESTAMP stop;
                char multiplicitycalc; //1 or 0
                int maxmultiplicity;  //int
                int flashtimewindow; //microseconds
                float flashspatialradius; //km
                int flashinterstroketime; //microseconds
```

```
                int flashbinflushtime; //microseconds
                TIMESTAMP centertime;
                int centerwidth;
                double centerlat;
                double centerlon;
                int gridsize;
};

int BreakPacket(char * s, char * * a, int max);
```

endianswap.cpp

```
/**************************************************************************
 *   Copyright (C) 2006 by Joe Jurecka   *
 *   jurecka@ariel.met.tamu.edu   *
 *                                                                         *
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 *   along with this program; if not, write to the                         *
 *   Free Software Foundation, Inc.,                                       *
 *   59 Temple Place - Suite 330, Boston, MA  02111-1307, USA.             *
 ***************************************************************************/

short ShortSwap( short s );
float FloatSwap( float f );
int LongSwap (int i);
```

APPENDIX C

FLASHES USED IN THIS STUDY

Guide to interpreting flash data

```
YEAR MO  DY  HR  MN  SE  NANO LAT  LON PK CUR  MULT   H   V   AVG HGT
```

YEAR:	Four digit year of flash
MO:	Month
DY:	Day
HR:	Hour
MN:	Minute
SE:	Second
NANO:	Nanosecond
LAT:	Latitude (WGS-84)
LON:	Longitude (WGS-84)
PK CUR:	Peak current of all strokes in flash
MULT:	Multiplicity, or number of strokes in flash
H:	Horizontal extent bins
V:	Volumetric extent bins
AVG HGT:	Mean height of VHF sources detected

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	5	10	23	59	7	242910257	29.8016	N	-95.523	W	-18.33	kA	1	10	20	2746
2007	5	10	23	59	19	438414289	29.7515	N	-95.5631	W	-11.99	kA	3	9	16	3886
2007	5	10	23	57	45	974891435	29.7964	N	-95.5499	W	-16.37	kA	3	15	20	4511
2007	5	10	23	56	44	725746102	29.897	N	-95.4276	W	-15.23	kA	1	6	7	4629
2007	5	10	23	48	48	215585391	29.6942	N	-95.5838	W	-12.1	kA	1	9	9	4940
2007	5	10	23	55	32	495431178	29.7424	N	-95.5544	W	-66.43	kA	7	11	14	5112
2007	5	10	23	53	33	359658418	29.7589	N	-95.6102	W	-39.05	kA	6	3	3	5222
2007	5	10	23	43	46	585831060	29.6906	N	-95.6134	W	-51.08	kA	4	8	13	5375
2007	5	10	23	50	28	488187458	29.7079	N	-95.5717	W	-37.22	kA	7	10	11	5413
2007	5	10	23	54	31	736796439	29.7411	N	-95.571	W	-69	kA	5	1	1	7254
2007	5	10	23	46	36	557768222	29.7831	N	-95.5886	W	-17.43	kA	1	20	34	8205
2007	5	11	0	1	0	5940197	29.7903	N	-95.5211	W	-9.29	kA	3	9	12	2400
2007	5	11	0	1	49	831639689	29.776	N	-95.5202	W	-19.55	kA	1	4	5	2894
2007	5	11	0	7	17	665182699	29.725	N	-95.5995	W	-13.8	kA	1	2	2	4193
2007	5	11	0	6	25	947158071	29.7814	N	-95.4689	W	-20.02	kA	3	31	40	5448
2007	5	11	0	8	0	7397952	29.8216	N	-95.5546	W	-17.37	kA	9	17	26	5890
2007	5	11	0	0	24	64376122	29.8254	N	-95.5514	W	-55	kA	7	12	18	7871
2007	5	11	0	7	27	781638056	29.8188	N	-95.5406	W	-8.12	kA	2	15	23	7987
2007	5	11	0	4	18	386296904	29.82	N	-95.5686	W	-23.53	kA	4	20	28	8417
2007	5	11	0	6	41	711231699	29.736	N	-95.4099	W	-8.16	kA	1	6	10	9844
2007	5	11	5	7	28	539055418	29.7798	N	-95.3653	W	-20.37	kA	3	3	3	3566
2007	5	11	5	13	30	280112624	29.7051	N	-95.3831	W	-70.71	kA	2	5	8	3623
2007	5	11	5	25	34	420412194	29.7233	N	-95.0901	W	-7.86	kA	2	1	1	3909
2007	5	11	5	9	49	983518446	29.7136	N	-95.371	W	-52.48	kA	2	11	16	3959
2007	5	11	5	26	18	395053877	29.7704	N	-95.3	W	-63.9	kA	3	7	7	4113
2007	5	11	5	6	2	422104925	29.8166	N	-95.3579	W	-132.94	kA	6	7	11	4144
2007	5	11	5	31	3	471319794	29.7575	N	-95.2797	W	-13.71	kA	1	7	8	4192
2007	5	11	5	18	44	675640130	29.7141	N	-95.3458	W	31.28	kA	2	9	10	4270
2007	5	11	5	11	15	993291112	29.8044	N	-95.3357	W	-28.62	kA	1	1	1	4271
2007	5	11	5	11	52	491990427	29.7189	N	-95.3458	W	-39.63	kA	6	9	12	4315
2007	5	11	5	17	1	28285541	29.7033	N	-95.368	W	-16.52	kA	5	11	17	4338
2007	5	11	5	17	15	821161191	29.7746	N	-95.366	W	-14.73	kA	3	7	9	4490
2007	5	11	5	6	49	131253775	29.782	N	-95.369	W	-61.23	kA	15	11	14	4782
2007	5	11	5	28	20	715402435	29.7259	N	-95.2347	W	-29.64	kA	6	3	4	4951
2007	5	11	5	7	8	701896715	29.804	N	-95.3648	W	-27.36	kA	3	5	8	5338
2007	5	11	5	17	24	900773007	29.9027	N	-94.7909	W	-9.32	kA	4	1	1	6246
2007	5	11	5	53	29	527899994	29.707	N	-95.2013	W	-35.11	kA	3	54	77	6568
2007	5	11	5	40	52	241003936	29.7712	N	-95.2076	W	-23.4	kA	3	7	8	6696
2007	5	11	5	50	56	472779880	29.7391	N	-95.1927	W	-20.16	kA	1	50	70	6768
2007	5	11	5	24	57	475299509	29.6854	N	-95.4309	W	-51.36	kA	4	82	132	6809

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	5	11	5	56	14	499765722	29.7252	N	-95.0459	W	-17.93	kA	2	23	29	6886
2007	5	11	5	15	44	908595151	29.714	N	-95.3758	W	-48.84	kA	4	52	73	7144
2007	5	11	5	30	13	780391293	29.7186	N	-95.2385	W	-9.1	kA	2	39	53	7296
2007	5	11	5	15	38	278388940	29.6813	N	-95.1362	W	-16.32	kA	1	16	20	7313
2007	5	11	5	29	14	73940944	29.552	N	-95.3923	W	-37.89	kA	1	43	79	7436
2007	5	11	5	26	59	408296653	29.7459	N	-95.2092	W	-8.62	kA	6	37	49	7437
2007	5	11	5	37	43	262710858	29.7341	N	-95.1019	W	-21.53	kA	3	33	47	7449
2007	5	11	5	42	31	362976064	29.7806	N	-95.2055	W	-115.18	kA	3	26	31	7458
2007	5	11	5	19	45	142779758	29.7728	N	-95.3515	W	-61.72	kA	3	20	31	7468
2007	5	11	5	5	6	103941768	29.685	N	-95.3467	W	-13.84	kA	2	56	95	7549
2007	5	11	5	37	20	628626040	29.6898	N	-95.3749	W	-11.36	kA	1	31	52	7600
2007	5	11	5	36	24	629951852	29.6886	N	-95.3631	W	-83.93	kA	4	67	106	7609
2007	5	11	5	38	42	744492590	29.6733	N	-95.3579	W	30.47	kA	1	70	107	7611
2007	5	11	5	34	15	521211936	29.6966	N	-95.3198	W	-40.79	kA	1	78	133	7643
2007	5	11	5	6	17	274801836	29.777	N	-95.3689	W	-19.13	kA	2	36	59	7653
2007	5	11	5	18	15	932019808	29.6	N	-95.4945	W	-11.08	kA	1	37	64	7795
2007	5	11	5	35	6	153448730	29.7179	N	-95.1916	W	-13.32	kA	1	50	69	7818
2007	5	11	5	10	32	281260268	29.7217	N	-95.3587	W	-80.62	kA	4	78	115	7926
2007	5	11	5	28	1	274777431	29.6718	N	-95.3994	W	-36.72	kA	1	51	98	7954
2007	5	11	5	40	13	528327796	29.6809	N	-95.2963	W	-70.85	kA	1	31	41	8028
2007	5	11	5	14	38	229908812	29.6983	N	-95.4056	W	-29.01	kA	1	83	148	8047
2007	5	11	5	8	2	836920114	29.7771	N	-95.3885	W	-67.82	kA	4	72	112	8120
2007	5	11	5	20	45	565076304	29.7654	N	-95.4206	W	-10.4	kA	1	79	120	8157
2007	5	11	5	41	42	301779856	29.7635	N	-95.0873	W	-22.26	kA	1	33	46	8182
2007	5	11	5	16	37	494697228	29.7885	N	-95.3416	W	-14.19	kA	1	51	77	8355
2007	5	11	5	17	28	432678559	29.6911	N	-95.4276	W	-15.1	kA	1	35	55	8525
2007	5	11	5	26	22	549520368	29.7292	N	-95.1232	W	-10.05	kA	2	76	124	8546
2007	5	11	5	27	26	701520624	29.9361	N	-94.8409	W	-30.27	kA	1	12	17	8713
2007	5	11	5	19	2	661902746	29.7058	N	-95.1249	W	-57.16	kA	4	7	10	9029
2007	5	11	5	12	6	317637246	29.691	N	-95.1403	W	-9.4	kA	2	4	4	10067
2007	5	11	5	13	44	10908298	29.6946	N	-95.1411	W	-19.26	kA	3	2	2	11382
2007	5	11	5	16	1	8238873	29.3196	N	-94.9493	W	-15.56	kA	1	5	6	11946
2007	5	11	6	14	22	577029997	29.5744	N	-95.3712	W	23.16	kA	2	6	6	3698
2007	5	11	6	20	36	414821182	29.613	N	-95.2579	W	19.52	kA	1	14	18	5625
2007	5	11	6	1	39	499576696	29.6624	N	-95.0981	W	22.74	kA	1	47	57	6193
2007	5	11	6	37	27	530070096	29.5347	N	-95.2782	W	-15.6	kA	1	6	6	6202
2007	5	11	6	24	56	647968399	29.538	N	-95.3077	W	-24.96	kA	1	11	15	6386
2007	5	11	6	6	53	514916891	29.7786	N	-95.0095	W	47.4	kA	1	5	5	7005
2007	5	11	6	2	59	349707899	29.7093	N	-95.0747	W	33.89	kA	1	15	17	7110
2007	5	11	6	8	26	394758425	29.7214	N	-95.0636	W	31.14	kA	2	4	4	7387

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
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2007	5	21	17	1	25	424735090	30.1048	N	-95.0678	W	-9.93	kA	1	9	11	8464
2007	5	21	18	57	11	965804059	29.6234	N	-95.6645	W	-15.56	kA	1	1	1	4352
2007	5	21	18	59	53	769038403	29.6235	N	-95.6591	W	-17.69	kA	1	3	3	5414
2007	5	21	18	57	22	57419006	29.3097	N	-95.4344	W	-17.35	kA	1	6	8	7096
2007	5	21	19	34	43	700586148	30.0762	N	-95.478	W	-12.25	kA	4	2	3	3834
2007	5	21	19	1	34	792668942	29.646	N	-95.6273	W	-15.58	kA	1	1	1	4485
2007	5	21	19	42	39	560029555	30.1243	N	-95.5	W	-16.34	kA	3	3	4	4592
2007	5	21	19	37	52	780232591	30.0968	N	-95.458	W	-13.84	kA	2	4	6	5044
2007	5	21	19	46	17	673609696	29.3547	N	-95.4214	W	-30.52	kA	2	3	3	5128
2007	5	21	19	0	57	979547951	29.6466	N	-95.6413	W	-16.56	kA	3	1	1	5425
2007	5	21	19	36	14	611102245	30.0905	N	-95.4125	W	-14.84	kA	5	1	1	5481
2007	5	21	19	58	36	659708463	30.2198	N	-95.3534	W	-29.82	kA	6	6	6	5493
2007	5	21	19	36	26	585676948	30.0946	N	-95.4656	W	-20.52	kA	4	2	3	5864
2007	5	21	19	41	4	290308219	30.1212	N	-95.4639	W	-21.72	kA	7	6	7	5892
2007	5	21	19	38	29	248699277	30.1172	N	-95.5164	W	-12.95	kA	8	3	4	5976
2007	5	21	19	41	55	803599247	30.2529	N	-95.5406	W	-9.4	kA	3	1	1	6268
2007	5	21	19	58	58	699743602	30.2094	N	-95.4484	W	-13.36	kA	3	3	3	6487
2007	5	21	19	40	47	109507476	30.1183	N	-95.5079	W	-19.5	kA	6	13	17	6512
2007	5	21	19	27	56	243146983	30.0552	N	-95.5161	W	-7.46	kA	1	4	4	6608
2007	5	21	19	42	53	244884740	29.9264	N	-95.6024	W	-10.29	kA	1	15	23	6638
2007	5	21	19	35	10	336317946	30.0914	N	-95.4169	W	-18.48	kA	3	1	1	6797
2007	5	21	19	41	37	330447701	30.1239	N	-95.5192	W	-14.73	kA	3	7	8	6841
2007	5	21	19	45	2	913101228	30.144	N	-95.4479	W	-15.52	kA	1	3	3	6854
2007	5	21	19	38	58	936075949	30.1016	N	-95.3991	W	-12.56	kA	1	1	1	6877
2007	5	21	19	29	18	204103446	30.068	N	-95.505	W	-10.79	kA	2	15	20	7097
2007	5	21	19	11	42	400192051	29.4619	N	-95.5553	W	-14.43	kA	1	9	24	7251
2007	5	21	19	37	30	74969949	29.3957	N	-95.4386	W	-22.79	kA	1	29	58	7262
2007	5	21	19	43	29	751876077	30.1269	N	-95.4945	W	-13.54	kA	3	13	27	7287
2007	5	21	19	42	5	4465773	30.1306	N	-95.4505	W	-28.93	kA	6	1	1	7843
2007	5	21	19	25	43	800152169	30.0405	N	-95.5591	W	-10.1	kA	1	8	8	7936
2007	5	21	19	39	34	875963544	30.1246	N	-95.4799	W	-20.55	kA	3	6	10	8168
2007	5	21	19	45	39	491267972	30.1399	N	-95.4562	W	-35.87	kA	7	21	35	8442
2007	5	21	19	37	50	386688761	30.2269	N	-95.5627	W	-15.06	kA	1	6	13	8547
2007	5	21	19	45	10	557621846	29.367	N	-95.4486	W	-14.61	kA	1	22	43	8641
2007	5	21	19	40	10	49681183	30.1964	N	-95.58	W	-13.13	kA	1	5	8	8863
2007	5	21	19	59	10	285724056	29.721	N	-95.5589	W	-17.57	kA	1	9	21	8942
2007	5	21	19	34	27	733003487	30.0497	N	-95.4781	W	-7.77	kA	2	10	23	9230
2007	5	21	19	34	19	545860961	30.1796	N	-95.5118	W	17.74	kA	1	4	4	9356
2007	5	21	20	10	3	446929668	29.6347	N	-95.3702	W	20.76	kA	3	9	20	3986

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2007	5	21	20	30	27	5661688	30.1494	N	-95.2372	W	-10.43	kA	3	1	1	4479
2007	5	21	20	7	59	816545585	30.2468	N	-95.4403	W	-34.59	kA	8	1	1	4604
2007	5	21	20	4	49	997040569	30.2015	N	-95.4315	W	-21.9	kA	7	15	15	4773
2007	5	21	20	11	47	632833140	30.2756	N	-95.3538	W	-6.1	kA	1	2	2	5044
2007	5	21	20	27	48	861790138	29.7187	N	-95.313	W	15.95	kA	1	31	46	5206
2007	5	21	20	0	56	272376525	30.2388	N	-95.4364	W	-21.59	kA	9	1	1	5243
2007	5	21	20	5	55	990434070	30.2695	N	-95.4075	W	-11.49	kA	7	3	3	5309
2007	5	21	20	17	42	243172232	30.2919	N	-95.4083	W	-53.54	kA	1	1	1	5402
2007	5	21	20	13	0	494533543	30.2799	N	-95.3116	W	-31.34	kA	4	6	6	5548
2007	5	21	20	3	34	114429387	30.2595	N	-95.4276	W	-29.82	kA	10	3	3	5567
2007	5	21	20	8	59	1308781	30.2776	N	-95.4068	W	-17.26	kA	3	1	1	5618
2007	5	21	20	0	18	81217074	30.2132	N	-95.4373	W	-31.89	kA	13	5	5	5649
2007	5	21	20	45	3	698900627	30.1202	N	-95.3071	W	-12.19	kA	2	42	47	5673
2007	5	21	20	7	7	990135	30.2809	N	-95.3621	W	-15.41	kA	1	5	6	5677
2007	5	21	20	18	35	378593686	30.2717	N	-95.3095	W	-5.29	kA	1	3	3	5722
2007	5	21	20	0	15	489391618	30.0014	N	-95.6808	W	-11.58	kA	1	3	5	5761
2007	5	21	20	43	27	44267694	30.1069	N	-95.2969	W	-11.47	kA	2	3	4	5801
2007	5	21	20	6	57	941802187	30.261	N	-95.4387	W	-7.9	kA	1	4	5	5802
2007	5	21	20	10	13	286358359	30.2723	N	-95.3775	W	-7.07	kA	1	2	2	5918
2007	5	21	20	40	16	274508362	30.1172	N	-95.3166	W	63.88	kA	3	13	15	5923
2007	5	21	20	41	28	63162695	30.0644	N	-95.288	W	47.82	kA	1	5	6	5930
2007	5	21	20	7	26	183181041	30.2608	N	-95.4158	W	-14.78	kA	12	1	1	5949
2007	5	21	20	2	11	186952308	30.202	N	-95.4383	W	-46.14	kA	2	6	6	6043
2007	5	21	20	2	53	793121084	30.2318	N	-95.46	W	-31.19	kA	15	14	19	6100
2007	5	21	20	10	6	761740074	30.2534	N	-95.4048	W	-33.36	kA	3	2	2	6116
2007	5	21	20	15	26	866446287	29.6657	N	-95.3863	W	-22.09	kA	1	41	91	6134
2007	5	21	20	6	13	443134828	30.2537	N	-95.4095	W	-37.65	kA	8	3	3	6161
2007	5	21	20	52	49	185056084	30.1796	N	-95.2493	W	-10.95	kA	1	5	5	7377
2007	5	21	20	11	11	553675339	30.288	N	-95.4155	W	-6.36	kA	1	4	5	7491
2007	5	21	20	32	48	650178089	30.1604	N	-95.1987	W	-12.78	kA	1	27	39	8294
2007	5	21	20	16	39	1050937	30.1169	N	-95.2745	W	-15.61	kA	1	7	12	8769
2007	5	21	20	36	23	918312930	30.1921	N	-95.1785	W	-16.96	kA	1	5	6	8810
2007	5	21	20	16	32	793321959	30.2795	N	-95.414	W	-23.85	kA	12	33	34	8898
2007	5	21	20	12	23	319163457	30.2623	N	-95.3916	W	-8.62	kA	1	4	5	8904
2007	5	21	20	14	12	907893537	30.2945	N	-95.4242	W	-13.06	kA	1	3	4	9104
2007	5	21	20	46	45	813841018	30.1555	N	-95.2875	W	-14.95	kA	1	10	14	9453
2007	5	21	20	5	16	100501095	30.2111	N	-95.4246	W	-26.81	kA	1	26	51	9581
2007	5	21	20	1	17	258794801	30.1805	N	-95.5245	W	-35.54	kA	3	44	74	9663
2007	5	21	20	11	55	828436238	30.2921	N	-95.2012	W	-16.28	kA	1	11	16	9744

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2007	5	21	20	13	58	561680486	30.2998	N	-95.3458	W	-7.94	kA	1	17	27	10220
2007	5	21	20	7	37	721236179	30.2955	N	-95.4594	W	-13.95	kA	1	34	48	10228
2007	5	21	20	0	34	977626605	30.2632	N	-95.4168	W	-6.97	kA	1	27	49	10252
2007	5	21	21	7	11	971916486	30.2535	N	-95.1651	W	-37.11	kA	1	2	2	6446
2007	5	24	19	50	56	789737591	30.0978	N	-95.6962	W	-15.98	kA	1	7	19	7769
2007	5	24	19	59	17	362357983	29.7255	N	-95.5721	W	-16.24	kA	1	20	46	8273
2007	5	24	19	57	2	451515534	29.645	N	-95.5699	W	-15.28	kA	1	17	39	8280
2007	5	24	19	51	18	703154633	29.6923	N	-95.488	W	-19.44	kA	2	17	43	8321
2007	5	24	19	54	1	598289161	29.7143	N	-95.5014	W	23.05	kA	1	17	33	8702
2007	5	24	19	45	13	482623059	30.0427	N	-95.7206	W	-15.98	kA	1	8	19	8806
2007	5	24	19	47	39	497354045	29.6911	N	-95.4694	W	-15.8	kA	1	8	16	9252
2007	5	24	19	55	55	113047271	29.7111	N	-95.5024	W	-18.68	kA	1	10	23	9540
2007	5	24	20	11	43	323050569	30.0167	N	-95.7502	W	20.02	kA	1	1	1	4861
2007	5	24	20	13	43	45328150	30.0532	N	-95.7125	W	-41.18	kA	7	2	3	5534
2007	5	24	20	1	24	750316055	30.1357	N	-95.7552	W	-7.99	kA	4	2	2	6103
2007	5	24	20	3	1	565318113	30.1002	N	-95.7657	W	-11.3	kA	2	2	2	6271
2007	5	24	20	2	43	138442749	30.1326	N	-95.7576	W	-27.12	kA	7	5	5	6338
2007	5	24	20	14	54	595779086	30.0591	N	-95.7206	W	-72.3	kA	9	4	8	6688
2007	5	24	20	5	59	768484430	30.1939	N	-95.7643	W	-33.24	kA	2	16	22	9415
2007	5	24	20	11	32	828616174	30.0683	N	-95.7161	W	-8.99	kA	4	3	3	9421
2007	5	24	20	13	15	787828940	30.0583	N	-95.7182	W	-32.25	kA	1	2	3	9591
2007	5	24	20	11	8	594533914	30.0612	N	-95.714	W	-24.85	kA	1	21	37	10357
2007	5	24	20	22	44	844896390	30.1168	N	-95.7562	W	-10.91	kA	1	10	13	10458
2007	5	24	20	3	43	748233103	30.134	N	-95.7516	W	-8.05	kA	1	7	16	11975
2007	5	24	20	29	1	493945387	29.973	N	-95.6813	W	-13.99	kA	1	2	3	13950
2007	6	14	17	40	12	140346565	29.99	N	-95.31	W	16.95	kA	3	2	2	3942
2007	6	14	17	42	23	623342374	30.01	N	-95.33	W	-13.06	kA	3	2	4	4075
2007	6	14	17	43	21	497097685	30.02	N	-95.32	W	-18.11	kA	1	4	5	4364
2007	6	14	17	53	13	454258112	30.07	N	-95.33	W	-9.53	kA	1	2	3	4479
2007	6	14	17	39	20	299661947	30	N	-95.33	W	-16.78	kA	2	3	4	4530
2007	6	14	17	41	30	20753265	29.99	N	-95.31	W	-15.98	kA	1	2	3	4621
2007	6	14	17	56	9	375273074	30.06	N	-95.33	W	-14.06	kA	1	1	2	4865
2007	6	14	17	53	46	329052811	30.1	N	-95.38	W	-25.99	kA	3	4	5	5315
2007	6	14	17	53	37	678954096	30.05	N	-95.31	W	-23.55	kA	8	7	12	5490
2007	6	14	17	46	28	788833794	30.01	N	-95.33	W	-22.79	kA	1	9	12	5532
2007	6	14	17	52	1	712456805	30.03	N	-95.32	W	-29.21	kA	2	4	7	6110
2007	6	14	17	47	32	783938215	30.04	N	-95.33	W	-22.51	kA	1	4	5	6239
2007	6	14	17	56	58	117770736	30.07	N	-95.29	W	-69.91	kA	1	3	6	9257
2007	6	14	17	54	9	33584016	30.12	N	-95.35	W	-14.26	kA	1	5	10	9728
2007	6	14	18	11	56	230773120	29.96	N	-95.36	W	-17.06	kA	4	3	7	4235
2007	6	14	18	2	1	575727256	29.91	N	-95.39	W	-12.41	kA	2	6	12	4244
2007	6	14	18	1	26	939296047	29.94	N	-95.41	W	-21.11	kA	1	2	7	4488
2007	6	14	18	13	39	523912706	29.95	N	-95.37	W	-21.48	kA	3	6	10	4622
2007	6	14	18	28	29	520355159	29.99	N	-95.41	W	-29.06	kA	1	7	10	4632

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	6	14	18	21	58	140810587	29.92	N	-95.38	W	-26.7	kA	1	4	8	4703
2007	6	14	18	12	27	784016782	29.95	N	-95.37	W	-24.49	kA	2	7	17	4739
2007	6	14	18	3	28	32930964	29.92	N	-95.41	W	-14.93	kA	1	5	7	4748
2007	6	14	18	39	29	938203087	29.96	N	-95.43	W	-19.39	kA	8	9	13	4753
2007	6	14	18	19	6	57679543	29.96	N	-95.39	W	-40.7	kA	3	2	2	4781
2007	6	14	18	59	26	499553322	30.01	N	-95.52	W	-17.22	kA	6	14	22	4856
2007	6	14	18	26	5	2469360	29.91	N	-95.38	W	-28.97	kA	8	13	26	4873
2007	6	14	18	1	34	568049245	29.98	N	-95.32	W	-10.97	kA	3	4	4	4874
2007	6	14	18	15	42	35209997	29.94	N	-95.37	W	-20.5	kA	2	3	9	4920
2007	6	14	18	38	30	462890283	29.97	N	-95.45	W	-20.83	kA	6	7	11	4964
2007	6	14	18	6	16	867395122	29.95	N	-95.35	W	-22.48	kA	1	6	9	5001
2007	6	14	18	10	34	752289483	29.95	N	-95.37	W	-18.54	kA	3	6	14	5013
2007	6	14	18	7	44	164687860	29.96	N	-95.38	W	-16.65	kA	1	6	9	5038
2007	6	14	18	14	38	60286963	29.96	N	-95.36	W	-33.93	kA	2	6	8	5107
2007	6	14	18	18	10	292558151	29.96	N	-95.38	W	-21.53	kA	5	6	9	5129
2007	6	14	18	5	12	374458423	29.95	N	-95.36	W	-19.54	kA	1	4	7	5150
2007	6	14	18	11	32	184874045	29.95	N	-95.37	W	-19.55	kA	2	7	17	5167
2007	6	14	18	15	30	974220288	29.96	N	-95.39	W	-39.94	kA	3	5	10	5191
2007	6	14	18	12	18	831872718	29.96	N	-95.42	W	-20.33	kA	5	9	16	5254
2007	6	14	18	28	55	590686283	29.99	N	-95.45	W	-24.7	kA	3	4	5	5257
2007	6	14	18	13	55	831317100	29.94	N	-95.35	W	-18.57	kA	4	9	19	5312
2007	6	14	18	15	2	698263403	30.01	N	-95.28	W	-33.73	kA	3	5	8	5362
2007	6	14	18	17	6	537581156	29.99	N	-95.27	W	-12.23	kA	3	13	22	5437
2007	6	14	18	30	31	870448290	29.99	N	-95.43	W	-16.28	kA	6	5	6	5463
2007	6	14	18	31	23	362506746	29.99	N	-95.4	W	-13.75	kA	2	3	6	5463
2007	6	14	18	27	47	147364145	30	N	-95.31	W	-4.5	kA	1	7	8	5465
2007	6	14	18	42	11	992754015	30.18	N	-95.32	W	-6.57	kA	1	3	4	5471
2007	6	14	18	7	16	687252875	29.94	N	-95.38	W	-22.77	kA	3	1	3	5486
2007	6	14	18	26	57	836804031	29.98	N	-95.41	W	-16.74	kA	2	4	8	5486
2007	6	14	18	5	53	316211506	29.95	N	-95.35	W	-11.91	kA	2	7	11	5534
2007	6	14	18	15	12	910312268	29.93	N	-95.37	W	-25.34	kA	5	15	25	5539
2007	6	14	18	16	39	567946511	29.98	N	-95.4	W	-24.09	kA	5	7	13	5558
2007	6	14	18	30	12	76250836	30.02	N	-95.22	W	-16.54	kA	3	14	18	5571
2007	6	14	18	13	20	365985181	29.93	N	-95.36	W	-17.63	kA	5	6	13	5594
2007	6	14	18	6	55	812698633	29.96	N	-95.37	W	-30.47	kA	1	5	7	5652
2007	6	14	18	32	2	234701160	30	N	-95.26	W	-13.06	kA	2	6	8	5666
2007	6	14	18	54	27	26168343	30.01	N	-95.54	W	-16.13	kA	2	6	8	5882
2007	6	14	18	36	25	67474302	29.97	N	-95.44	W	-17.85	kA	2	2	5	6053
2007	6	14	18	37	47	725022055	29.97	N	-95.4	W	-20.37	kA	5	3	6	6057
2007	6	14	18	35	36	978353399	30.02	N	-95.24	W	-34.24	kA	4	7	10	6200
2007	6	14	18	14	46	544307739	29.95	N	-95.4	W	-35.3	kA	5	5	7	6214
2007	6	14	18	37	40	469915137	30.03	N	-95.22	W	-20.28	kA	3	9	12	6253
2007	6	14	18	6	44	209149050	29.96	N	-95.38	W	-36.35	kA	5	5	7	6271
2007	6	14	18	55	44	390872729	29.96	N	-95.48	W	-16.56	kA	6	7	14	6277
2007	6	14	18	37	5	320011492	29.99	N	-95.4	W	-11.43	kA	1	6	9	6480
2007	6	14	18	16	19	101809541	30.09	N	-95.35	W	-17.08	kA	1	18	27	6767

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	6	14	18	20	16	777852381	29.97	N	-95.38	W	-36.76	kA	9	15	26	6837
2007	6	14	18	32	20	134838385	29.99	N	-95.42	W	-26.92	kA	9	14	23	7021
2007	6	14	18	9	53	234260507	29.94	N	-95.41	W	-15.43	kA	1	9	24	7106
2007	6	14	18	45	50	346670848	29.93	N	-95.45	W	-26.51	kA	2	5	13	7155
2007	6	14	18	46	22	172791832	29.92	N	-95.39	W	-12.78	kA	3	25	57	7264
2007	6	14	18	18	4	98252914	29.98	N	-95.39	W	-59.88	kA	3	9	22	7310
2007	6	14	18	8	59	162274624	29.96	N	-95.35	W	-15.26	kA	1	12	33	7417
2007	6	14	18	20	48	655098081	29.94	N	-95.4	W	-27.16	kA	5	10	18	7476
2007	6	14	18	54	35	371249171	29.98	N	-95.5	W	-37.06	kA	6	6	10	7488
2007	6	14	18	55	22	309369314	29.98	N	-95.52	W	-22.16	kA	6	20	37	7523
2007	6	14	18	52	19	369966350	30.02	N	-95.54	W	-18.72	kA	8	6	11	7588
2007	6	14	18	53	2	510709428	29.99	N	-95.51	W	-24.03	kA	5	13	27	7647
2007	6	14	18	0	38	861441642	30.06	N	-95.37	W	-18.39	kA	1	16	39	7749
2007	6	14	18	2	14	862395600	30.12	N	-95.41	W	-30.97	kA	1	13	26	7841
2007	6	14	18	5	46	788426840	30.03	N	-95.35	W	-14.5	kA	1	12	25	7857
2007	6	14	18	42	15	752406582	29.97	N	-95.4	W	-10.34	kA	1	11	29	7870
2007	6	14	18	46	56	424262756	29.99	N	-95.49	W	-12.89	kA	1	10	16	7915
2007	6	14	18	40	31	200488443	29.97	N	-95.41	W	-28.29	kA	4	7	15	7921
2007	6	14	18	53	50	770803529	30.07	N	-95.55	W	-57.66	kA	1	10	24	8171
2007	6	14	18	50	57	302419336	30	N	-95.57	W	-20.81	kA	4	24	43	8206
2007	6	14	18	52	53	875532821	30.06	N	-95.58	W	-31.65	kA	1	6	15	8598
2007	6	14	18	0	31	835200889	29.94	N	-95.4	W	-7.09	kA	1	5	14	8738
2007	6	14	18	55	32	327947352	29.99	N	-95.51	W	-9.79	kA	1	4	7	8765
2007	6	14	18	23	33	120651193	29.98	N	-95.22	W	-8.94	kA	1	8	21	8772
2007	6	14	18	56	24	384963297	29.98	N	-95.59	W	-29.49	kA	1	20	37	8815
2007	6	14	18	9	19	241115941	29.97	N	-95.29	W	16.06	kA	2	12	31	9007
2007	6	14	18	11	42	899128114	30.02	N	-95.28	W	-14.34	kA	1	8	14	9059
2007	6	14	18	48	57	335697485	29.97	N	-95.46	W	-27.08	kA	7	12	29	9085
2007	6	14	18	21	48	954530623	30.01	N	-95.27	W	-26.79	kA	5	41	88	9117
2007	6	14	18	56	9	98944781	29.93	N	-95.43	W	-7.14	kA	1	19	46	9308
2007	6	14	18	14	25	969559588	29.97	N	-95.25	W	-4.31	kA	1	20	51	9311
2007	6	14	18	33	55	186191297	30.01	N	-95.25	W	-13.45	kA	1	5	13	9343
2007	6	14	18	50	38	69788629	29.97	N	-95.48	W	-18.65	kA	4	14	30	9345
2007	6	14	18	14	0	453966871	29.99	N	-95.28	W	-22.33	kA	1	9	20	9384
2007	6	14	18	18	15	476871608	30.02	N	-95.26	W	-7.07	kA	1	5	12	9673
2007	6	14	18	51	11	255242262	29.97	N	-95.49	W	-24.7	kA	1	7	12	9863
2007	6	14	18	51	25	306170607	30.01	N	-95.54	W	-9.32	kA	1	3	6	10440
2007	6	14	18	57	7	97679092	30.01	N	-95.52	W	-23.77	kA	3	7	13	10657
2007	6	14	18	45	28	396177672	30.02	N	-95.56	W	-9.38	kA	1	4	7	10760
2007	6	14	18	51	27	689896544	29.99	N	-95.5	W	-7.23	kA	1	8	18	11411
2007	6	14	18	50	48	429150375	30.01	N	-95.58	W	-23 kA	1	9	14	11498	
2007	6	14	18	53	5	549023238	30	N	-95.52	W	16.8	kA	1	6	12	11586
2007	6	14	19	42	48	865876380	30.14	N	-95.53	W	-21.4	kA	1	10	12	4138
2007	6	14	19	30	9	333102943	30.13	N	-95.61	W	-9.45	kA	1	1	1	4414
2007	6	14	19	25	30	873009486	30.06	N	-95.55	W	-16.8	kA	4	10	13	4430
2007	6	14	19	28	16	771385963	30.11	N	-95.54	W	-27.68	kA	9	15	26	4496

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	6	14	19	28	29	805987461	30.1	N	-95.55	W	-27.42	kA	5	8	10	4522
2007	6	14	19	45	29	505420472	30.09	N	-95.54	W	-13.02	kA	3	9	15	4594
2007	6	14	19	28	2	103761398	30.08	N	-95.56	W	-33.56	kA	2	2	2	4705
2007	6	14	19	3	54	358954581	30.05	N	-95.53	W	-14.95	kA	10	22	30	4768
2007	6	14	19	36	40	552800522	30.01	N	-95.6	W	-11.82	kA	1	2	3	4855
2007	6	14	19	40	57	485592826	30.09	N	-95.53	W	-8.03	kA	3	12	14	4881
2007	6	14	19	42	15	745544199	30.13	N	-95.56	W	-17.19	kA	4	12	16	5050
2007	6	14	19	40	25	780448343	30.2	N	-95.5	W	-13.84	kA	10	9	11	5059
2007	6	14	19	36	10	335188932	30.11	N	-95.52	W	-38.33	kA	8	27	41	5118
2007	6	14	19	8	24	800142390	30.05	N	-95.54	W	-15 kA	5	17	23	5239	
2007	6	14	19	20	5	275917592	30.03	N	-95.59	W	-13.73	kA	4	9	15	5240
2007	6	14	19	15	43	309371316	30.03	N	-95.61	W	-17.11	kA	11	13	23	5260
2007	6	14	19	8	23	69746627	30	N	-95.59	W	-14.12	kA	1	6	8	5271
2007	6	14	19	10	17	707158132	30.01	N	-95.62	W	-9.25	kA	2	8	9	5276
2007	6	14	19	54	8	462482553	30.19	N	-95.54	W	-14.6	kA	10	17	19	5284
2007	6	14	19	1	36	683461453	30.07	N	-95.54	W	-26.75	kA	10	14	22	5319
2007	6	14	19	49	0	540042500	30.2	N	-95.51	W	-37.02	kA	2	10	11	5319
2007	6	14	19	25	8	168787242	30.06	N	-95.56	W	-8.23	kA	4	19	30	5367
2007	6	14	19	12	43	292150208	30.04	N	-95.6	W	-12.15	kA	2	1	3	5420
2007	6	14	19	30	48	316117744	30.12	N	-95.53	W	-25.27	kA	1	2	2	5468
2007	6	14	19	23	48	737887362	30.09	N	-95.53	W	-16.58	kA	5	9	13	5573
2007	6	14	19	2	45	957481010	30.06	N	-95.53	W	-9.01	kA	2	5	6	5576
2007	6	14	19	12	56	534460790	30.08	N	-95.53	W	-27.42	kA	7	10	16	5651
2007	6	14	19	28	44	715266302	30.12	N	-95.54	W	-34.61	kA	4	4	7	5675
2007	6	14	19	43	52	854978638	30.13	N	-95.51	W	-17.61	kA	2	19	22	5726
2007	6	14	19	37	20	712498600	30.13	N	-95.61	W	-12.1	kA	6	18	22	5729
2007	6	14	19	24	4	870172340	30.06	N	-95.57	W	-15.69	kA	1	10	13	5746
2007	6	14	19	29	47	357833110	30.11	N	-95.55	W	-30.64	kA	6	9	13	5868
2007	6	14	19	15	9	809974393	30.03	N	-95.59	W	-7.29	kA	2	10	18	5912
2007	6	14	19	9	45	139951389	30.06	N	-95.61	W	-19.15	kA	2	1	1	5918
2007	6	14	19	27	27	525411137	30.08	N	-95.57	W	-15.69	kA	5	25	31	6143
2007	6	14	19	17	46	846850626	30.03	N	-95.59	W	-14.84	kA	7	12	17	6212
2007	6	14	19	31	37	430209574	30.14	N	-95.52	W	-23.12	kA	7	22	38	6240
2007	6	14	19	41	20	321180115	30.1	N	-95.57	W	-13.21	kA	4	13	18	6280
2007	6	14	19	20	24	363626939	30.13	N	-95.57	W	-18.57	kA	4	13	19	6305
2007	6	14	19	30	21	580233182	30.14	N	-95.53	W	-21.74	kA	7	15	25	6346
2007	6	14	19	33	22	625244340	30.14	N	-95.57	W	-10.86	kA	4	3	4	6357
2007	6	14	19	0	45	432290424	30	N	-95.52	W	-12.69	kA	6	14	26	6376
2007	6	14	19	16	8	648743617	30.08	N	-95.51	W	-16.54	kA	4	18	21	6430
2007	6	14	19	13	45	964166374	30.04	N	-95.55	W	-24.68	kA	2	9	13	6456
2007	6	14	19	46	7	171053286	30.2	N	-95.52	W	-19.54	kA	14	11	12	6574
2007	6	14	19	28	35	796416396	30.08	N	-95.57	W	-26.03	kA	1	3	4	6719
2007	6	14	19	37	31	601356300	30.12	N	-95.57	W	-25.62	kA	6	9	14	6762
2007	6	14	19	50	11	738480892	30.19	N	-95.5	W	-40.05	kA	2	5	6	6767
2007	6	14	19	35	24	222144108	30.14	N	-95.57	W	-32.89	kA	6	20	32	6929
2007	6	14	19	21	5	751192230	30.08	N	-95.59	W	-16.06	kA	3	2	2	6932

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2007	6	14	19	39	15	748843007	30.1	N	-95.53	W	-24.83	kA	3	33	52	7411
2007	6	14	19	33	10	909889900	30.11	N	-95.54	W	-36.59	kA	9	29	56	7591
2007	6	14	19	46	34	911190933	30.15	N	-95.59	W	-6.29	kA	7	25	50	7670
2007	6	14	19	28	59	63604599	30.11	N	-95.52	W	-31.51	kA	7	13	31	7792
2007	6	14	19	37	56	31250283	30.01	N	-95.61	W	-18.74	kA	2	17	39	7810
2007	6	14	19	52	55	18867292	30.2	N	-95.5	W	-21.89	kA	4	2	2	7844
2007	6	14	19	57	5	748575892	30.18	N	-95.54	W	-16.13	kA	3	1	1	7863
2007	6	14	19	50	44	803107008	30.11	N	-95.58	W	-20.83	kA	10	50	90	7895
2007	6	14	19	17	18	356723813	30.02	N	-95.64	W	-12.67	kA	1	5	10	7929
2007	6	14	19	29	11	676366918	30.12	N	-95.54	W	-14.47	kA	6	28	41	7955
2007	6	14	19	26	7	431888783	30.07	N	-95.58	W	-35.63	kA	5	19	39	7957
2007	6	14	19	3	23	568695175	30.1	N	-95.57	W	-18.98	kA	1	3	6	8003
2007	6	14	19	59	41	125277981	30.13	N	-95.58	W	-14.34	kA	3	22	42	8061
2007	6	14	19	8	47	619731786	30	N	-95.6	W	-22.87	kA	4	4	5	8115
2007	6	14	19	27	43	310326646	30.1	N	-95.54	W	-30.51	kA	5	10	16	8120
2007	6	14	19	27	8	578363187	30.11	N	-95.55	W	-42.12	kA	8	11	15	8176
2007	6	14	19	19	17	871684573	30.02	N	-95.59	W	-29.84	kA	8	12	22	8238
2007	6	14	19	11	6	214744106	29.94	N	-95.54	W	-26.47	kA	1	20	44	8387
2007	6	14	19	27	32	362454581	30.1	N	-95.55	W	-25.49	kA	6	9	16	8443
2007	6	14	19	24	52	341769615	30.08	N	-95.6	W	-12.89	kA	8	9	21	8488
2007	6	14	19	21	52	333579050	30.01	N	-95.57	W	-14.08	kA	1	8	19	8493
2007	6	14	19	42	59	383417151	30.13	N	-95.55	W	-31.63	kA	11	45	116	8585
2007	6	14	19	48	10	57634743	30.19	N	-95.57	W	-37.91	kA	4	19	31	8681
2007	6	14	19	55	35	173936497	30.21	N	-95.6	W	-8.75	kA	1	10	17	8748
2007	6	14	19	13	22	760428014	30.02	N	-95.5	W	-11.17	kA	1	23	45	8794
2007	6	14	19	37	53	328628315	30.14	N	-95.52	W	23.25	kA	9	33	64	8903
2007	6	14	19	27	34	876207668	30.13	N	-95.59	W	-14.6	kA	1	12	24	8999
2007	6	14	19	9	20	357734298	30.03	N	-95.6	W	-19.28	kA	4	14	32	9013
2007	6	14	19	7	49	456213783	30.01	N	-95.62	W	-20.96	kA	2	23	61	9042
2007	6	14	19	0	17	204376382	30.08	N	-95.56	W	-9.79	kA	1	1	2	9058
2007	6	14	19	56	20	909255107	30.23	N	-95.55	W	-8.34	kA	9	12	22	9162
2007	6	14	19	5	52	319737234	29.97	N	-95.52	W	-22.42	kA	1	47	98	9196
2007	6	14	19	35	9	502132620	30.1	N	-95.47	W	-14.19	kA	2	17	41	9238
2007	6	14	19	20	36	292467785	30.05	N	-95.61	W	-9.34	kA	7	21	48	9328
2007	6	14	19	31	10	195023499	30.13	N	-95.6	W	-11.14	kA	1	6	12	9363
2007	6	14	19	58	46	62561456	30.18	N	-95.62	W	-12.45	kA	1	24	44	9487
2007	6	14	19	3	15	732595861	30.01	N	-95.48	W	-12.12	kA	1	18	44	9905
2007	6	14	19	30	32	553943950	30.05	N	-95.49	W	-15.32	kA	2	29	64	9905
2007	6	14	19	31	3	164708740	30.1	N	-95.54	W	-11.84	kA	1	13	29	9957
2007	6	14	19	24	42	144679633	30.14	N	-95.58	W	-9.4	kA	1	7	15	10073
2007	6	14	19	25	42	817732094	30.08	N	-95.58	W	-9.05	kA	1	9	26	10225
2007	6	14	19	33	33	289344139	30.12	N	-95.54	W	-20.83	kA	3	10	17	10848
2007	6	14	19	32	49	190104276	30.14	N	-95.53	W	-54.35	kA	3	16	39	10923
2007	6	14	19	29	23	377191580	30.07	N	-95.57	W	-23.64	kA	2	18	44	10944
2007	6	14	19	24	11	495259508	30.06	N	-95.54	W	21.05	kA	1	10	24	11103
2007	6	14	19	33	20	366823750	30.04	N	-95.48	W	21.09	kA	1	13	35	11189

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2007	6	14	20	17	6	991230502	30.22	N	-95.68	W	-12.89	kA	1	1	1	5236
2007	6	14	20	4	27	503924205	30.24	N	-95.52	W	-10.42	kA	6	2	3	5544
2007	6	14	20	0	41	422471193	30.08	N	-95.56	W	-11.64	kA	1	11	23	7769
2007	6	14	20	15	36	705470532	30.27	N	-95.62	W	-19.55	kA	1	6	7	7902
2007	6	14	20	7	53	761556147	30.25	N	-95.58	W	-13.84	kA	1	12	22	8042
2007	6	14	20	1	26	15851460	30.21	N	-95.47	W	-66.67	kA	4	39	68	8091
2007	6	14	20	21	32	484030582	30.26	N	-95.68	W	-7.73	kA	1	7	14	9069
2007	6	14	20	58	31	316670861	29.89	N	-94.85	W	-15.89	kA	1	3	6	10294
2007	6	14	20	57	47	832262833	30.28	N	-94.85	W	-17.41	kA	1	12	21	10789
2007	6	14	20	35	31	948326991	30.24	N	-94.88	W	-10.43	kA	1	2	4	10925
2007	6	14	20	54	1	132625878	30.23	N	-94.86	W	-10.34	kA	4	8	10	11082
2007	6	14	20	49	3	638322180	30.23	N	-94.88	W	-8.92	kA	1	3	3	12246
2007	6	14	21	45	57	490967822	29.9	N	-94.92	W	-18.22	kA	3	1	2	1161
2007	6	14	21	50	18	396173182	29.91	N	-94.95	W	-12.86	kA	1	2	3	3096
2007	6	14	21	48	44	131534861	29.92	N	-94.97	W	-12.34	kA	2	2	3	3286
2007	6	14	21	58	3	838601482	29.77	N	-95.1	W	-11.1	kA	1	7	10	4572
2007	6	14	21	46	40	807379784	29.92	N	-95.02	W	-10.71	kA	1	2	3	4927
2007	6	14	21	55	34	464164969	29.76	N	-95.1	W	-16.8	kA	1	3	3	5370
2007	6	14	21	0	52	387129187	29.87	N	-94.81	W	-14.52	kA	2	1	1	5871
2007	6	14	21	34	42	312149970	29.86	N	-94.98	W	-31.89	kA	6	5	8	6396
2007	6	14	21	29	17	265258285	29.91	N	-94.89	W	-18.33	kA	1	2	3	6471
2007	6	14	21	38	2	360659634	29.93	N	-94.9	W	-21.55	kA	10	13	14	6539
2007	6	14	21	47	42	530701244	29.9	N	-94.94	W	-25.64	kA	2	5	8	6590
2007	6	14	21	17	56	140146079	29.88	N	-94.9	W	-30.75	kA	3	3	3	6663
2007	6	14	21	9	37	261674933	30.28	N	-94.81	W	-37.98	kA	7	1	1	6679
2007	6	14	21	33	22	929737443	29.92	N	-94.94	W	-41.42	kA	5	8	8	6800
2007	6	14	21	30	13	71258922	29.91	N	-94.91	W	-9.51	kA	1	3	4	7149
2007	6	14	21	31	22	794009050	29.93	N	-94.96	W	-21	kA	6	5	5	7250
2007	6	14	21	27	49	600079102	29.92	N	-94.93	W	-30.65	kA	14	11	13	7480
2007	6	14	21	25	23	452589627	29.91	N	-94.9	W	-13.38	kA	7	8	11	7734
2007	6	14	21	45	29	851603948	29.94	N	-95	W	-8.94	kA	1	1	2	7836
2007	6	14	21	24	49	546169631	29.89	N	-94.89	W	-15.32	kA	11	10	13	8208
2007	6	14	21	5	25	214582891	30.29	N	-94.81	W	-13.54	kA	6	1	1	8346
2007	6	14	21	34	22	188321056	29.9	N	-94.89	W	-16.34	kA	5	9	14	8583
2007	6	14	21	38	53	54459485	29.85	N	-95.05	W	-20.29	kA	3	15	22	8616
2007	6	14	21	44	17	12312279	29.93	N	-94.91	W	-11.27	kA	4	10	15	8971
2007	6	14	21	20	47	668908978	29.89	N	-94.91	W	-19.13	kA	9	16	22	9048
2007	6	14	21	36	5	147266231	29.8	N	-94.97	W	-40.27	kA	1	14	30	9118
2007	6	14	21	29	43	254278456	29.92	N	-94.96	W	-28.9	kA	2	4	5	9248
2007	6	14	21	21	22	322280741	29.92	N	-94.96	W	-18.63	kA	9	9	16	9311
2007	6	14	21	41	49	863634369	29.9	N	-95.06	W	-6.2	kA	3	10	16	9467
2007	6	14	21	28	1	987606584	29.92	N	-94.98	W	-21.44	kA	3	7	12	9581
2007	6	14	21	35	24	945732440	29.91	N	-94.9	W	-14.32	kA	4	13	20	9660
2007	6	14	21	2	36	892942628	30.24	N	-94.88	W	-5.12	kA	1	11	16	9740
2007	6	14	21	51	52	763215544	29.9	N	-94.93	W	-43.09	kA	7	7	10	9771

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2007	6	14	21	54	27	314140390	29.9	N	-94.99	W	-60.48	kA	4	13	31	9959
2007	6	14	21	15	40	341167787	29.88	N	-94.87	W	-22.27	kA	3	3	5	10032
2007	6	14	21	57	52	477827218	29.9	N	-94.96	W	-8.82	kA	1	32	55	10313
2007	6	14	21	21	50	156435031	29.9	N	-94.95	W	-17.76	kA	2	2	3	10331
2007	6	14	21	36	49	987557574	29.94	N	-94.95	W	-67.1	kA	1	23	40	10476
2007	6	14	21	29	36	620297894	29.91	N	-94.91	W	-37.63	kA	13	11	17	10477
2007	6	14	21	53	47	601797066	29.91	N	-94.97	W	-25.86	kA	1	13	23	10504
2007	6	14	21	41	44	233725	29.91	N	-94.86	W	-6.7	kA	1	26	47	10649
2007	6	14	21	21	40	763572822	29.89	N	-94.98	W	-18.72	kA	1	12	18	10677
2007	6	14	21	10	5	508500143	30.3	N	-94.79	W	15	kA	1	10	12	10779
2007	6	14	21	0	38	285072308	30.28	N	-94.78	W	-10.29	kA	2	9	18	10836
2007	6	14	21	30	43	841401593	29.92	N	-94.97	W	-21.33	kA	1	6	12	10861
2007	6	14	21	37	30	827002430	29.88	N	-94.86	W	19.83	kA	1	21	46	10952
2007	6	14	21	29	3	119715108	29.91	N	-94.93	W	-14.24	kA	1	7	14	11347
2007	6	14	21	30	2	707081541	29.93	N	-94.96	W	-37.91	kA	4	7	14	11735
2007	6	14	22	18	43	812976964	29.82	N	-95.09	W	-24.88	kA	2	1	3	5439
2007	6	14	22	48	58	230731180	29.84	N	-95.28	W	-32.8	kA	5	21	44	5639
2007	6	14	22	31	36	122649130	29.82	N	-95.21	W	-21.66	kA	2	5	6	5706
2007	6	14	22	39	3	214146208	29.82	N	-95.27	W	-31.39	kA	1	3	6	5711
2007	6	14	22	16	49	31045580	29.79	N	-95.17	W	-27.18	kA	2	16	25	5895
2007	6	14	22	55	17	670131114	29.81	N	-95.27	W	-39.18	kA	10	14	23	5925
2007	6	14	22	39	53	136675225	29.83	N	-95.26	W	-37.54	kA	5	11	20	5988
2007	6	14	22	58	43	343024763	29.82	N	-95.31	W	-25.79	kA	7	23	44	6122
2007	6	14	22	40	18	393814743	29.83	N	-95.26	W	-28.49	kA	3	8	17	6218
2007	6	14	22	39	38	233126716	29.8	N	-95.26	W	-27.01	kA	1	12	18	6224
2007	6	14	22	42	33	451121831	29.79	N	-95.23	W	-24.99	kA	16	21	32	6259
2007	6	14	22	32	32	606631877	29.81	N	-95.21	W	-25.47	kA	3	7	13	6279
2007	6	14	22	14	10	16017794	29.81	N	-95.2	W	-25.22	kA	9	8	15	6571
2007	6	14	22	1	52	605937916	29.78	N	-95.09	W	-16.95	kA	4	7	8	6619
2007	6	14	22	56	43	562830030	29.8	N	-95.28	W	-26.38	kA	7	14	30	6789
2007	6	14	22	54	51	46432038	29.84	N	-95.28	W	-38.98	kA	6	10	17	6791
2007	6	14	22	38	44	473608518	29.82	N	-95.19	W	-18.19	kA	12	26	45	6801
2007	6	14	22	51	6	797112250	29.83	N	-95.21	W	-15.17	kA	3	18	44	6947
2007	6	14	22	33	40	634968013	29.83	N	-95.26	W	-29.23	kA	3	12	27	6987
2007	6	14	22	56	57	625441265	29.82	N	-95.28	W	-26.42	kA	2	17	35	7002
2007	6	14	22	30	36	698117366	29.8	N	-95.22	W	-44.38	kA	10	9	13	7148
2007	6	14	22	29	30	142548516	29.82	N	-95.25	W	-34.43	kA	5	21	32	7277
2007	6	14	22	38	40	482260933	29.79	N	-95.25	W	-25.47	kA	2	11	27	7405
2007	6	14	22	54	35	218878008	29.81	N	-95.33	W	-10.03	kA	2	14	21	7423
2007	6	14	22	49	40	954644848	29.84	N	-95.3	W	-28.1	kA	2	7	18	7440
2007	6	14	22	51	21	517490457	29.82	N	-95.26	W	-29.41	kA	8	31	54	7475
2007	6	14	22	49	28	874591846	29.82	N	-95.28	W	-8.6	kA	5	17	33	7609
2007	6	14	22	24	5	533355156	29.83	N	-95.23	W	-15.93	kA	3	18	39	7862
2007	6	14	22	58	36	841389089	29.8	N	-95.21	W	-23.07	kA	3	24	52	7924
2007	6	14	22	45	55	403434682	29.83	N	-95.26	W	-27.51	kA	15	31	58	7965

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2007	6	14	22	44	37	664114638	29.82	N	-95.23	W	-17.85	kA	9	16	30	8067
2007	6	14	22	13	54	411774020	29.8	N	-95.22	W	-24.85	kA	3	4	11	8077
2007	6	14	22	13	40	375113466	29.81	N	-95.21	W	-30.06	kA	4	10	26	8150
2007	6	14	22	47	32	532490311	29.8	N	-95.21	W	-25.2	kA	2	7	15	8208
2007	6	14	22	58	23	101321529	29.87	N	-95.29	W	-27.69	kA	1	10	25	8260
2007	6	14	22	52	34	231092517	29.84	N	-95.26	W	-23.46	kA	1	10	30	8280
2007	6	14	22	33	55	444523248	29.9	N	-95.28	W	-17.59	kA	2	18	45	8401
2007	6	14	22	28	14	114523982	29.72	N	-95.26	W	-28.86	kA	4	19	41	8427
2007	6	14	22	10	36	734647440	29.81	N	-95.23	W	-22.13	kA	1	8	16	8454
2007	6	14	22	20	26	832831	29.82	N	-95.15	W	-18.52	kA	1	13	27	8568
2007	6	14	22	27	59	132825285	29.82	N	-95.19	W	-33.71	kA	3	7	19	8652
2007	6	14	22	56	54	257490969	29.89	N	-95.26	W	-35.46	kA	1	19	44	8710
2007	6	14	22	45	27	550395044	29.84	N	-95.26	W	-12.95	kA	1	7	16	8738
2007	6	14	22	30	48	670396218	29.83	N	-95.18	W	-14.47	kA	2	6	12	8750
2007	6	14	22	30	22	925776701	29.84	N	-95.22	W	-21.77	kA	10	20	37	8753
2007	6	14	22	57	2	779132588	29.82	N	-95.28	W	-42.96	kA	2	11	25	8931
2007	6	14	22	59	19	717912693	29.77	N	-95.35	W	-13.97	kA	1	21	51	8955
2007	6	14	22	33	24	970113954	29.83	N	-95.21	W	-16.39	kA	1	11	25	8980
2007	6	14	22	15	35	56126623	29.82	N	-95.17	W	-28.3	kA	2	4	10	8985
2007	6	14	22	39	51	623428148	29.77	N	-95.22	W	-8.29	kA	1	6	16	9081
2007	6	14	22	54	17	207825945	29.81	N	-95.32	W	-40.5	kA	10	21	46	9266
2007	6	14	22	9	55	798506904	29.77	N	-95.24	W	-25.83	kA	2	7	21	9281
2007	6	14	22	16	51	735125474	29.8	N	-95.17	W	-20.48	kA	3	6	12	9317
2007	6	14	22	32	22	893163607	29.86	N	-95.27	W	-73.81	kA	1	23	49	9329
2007	6	14	22	54	6	640392693	29.86	N	-95.3	W	-22.66	kA	1	13	27	9406
2007	6	14	22	53	20	267819494	29.84	N	-95.23	W	-38.2	kA	3	32	82	9464
2007	6	14	22	55	46	120006894	29.82	N	-95.25	W	-19.18	kA	1	26	68	9465
2007	6	14	22	34	59	35226396	29.77	N	-95.2	W	-36.65	kA	9	26	42	9519
2007	6	14	22	54	23	2084385	29.81	N	-95.26	W	-34.8	kA	4	11	35	9537
2007	6	14	22	53	46	280443983	29.77	N	-95.3	W	-26.84	kA	4	14	45	9573
2007	6	14	22	9	2	182261720	29.82	N	-95.19	W	-26.88	kA	1	5	11	9726
2007	6	14	22	43	29	837441952	29.79	N	-95.17	W	-61.94	kA	1	23	41	9924
2007	6	14	22	19	31	921390749	29.8	N	-95.09	W	-31.15	kA	2	8	10	9970
2007	6	14	22	39	14	544768681	29.78	N	-95.24	W	-22.55	kA	2	29	66	10101
2007	6	14	22	48	15	671769565	29.78	N	-95.23	W	-44.01	kA	4	24	54	10601
2007	6	14	23	54	8	474324150	29.77	N	-95.34	W	-11.01	kA	2	21	35	4395
2007	6	14	23	10	20	952267593	29.81	N	-95.32	W	-22.35	kA	2	11	29	5115
2007	6	14	23	51	48	371451759	29.82	N	-95.43	W	-14.97	kA	6	27	55	5162
2007	6	14	23	58	36	932499109	29.68	N	-95.43	W	-38.24	kA	8	26	51	5256
2007	6	14	23	58	10	901119886	29.76	N	-95.39	W	-42.99	kA	10	69	115	5275
2007	6	14	23	56	53	108073839	29.98	N	-95.63	W	-12.06	kA	1	4	6	5326
2007	6	14	23	55	30	59015953	29.76	N	-95.39	W	-46.1	kA	6	51	86	5397
2007	6	14	23	56	42	174714317	29.78	N	-95.38	W	-15.47	kA	16	52	100	5404
2007	6	14	23	55	7	735180408	29.74	N	-95.34	W	-68.6	kA	7	49	88	5470
2007	6	14	23	59	58	67672026	29.72	N	-95.43	W	-23.46	kA	5	15	29	5491

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2007	6	14	23	57	21	244534069	30.05	N	-95.65	W	-14.61	kA	4	11	17	5502
2007	6	14	23	59	49	908670374	29.88	N	-95.63	W	-9.53	kA	1	2	2	5579
2007	6	14	23	57	24	33302070	29.82	N	-95.43	W	-38.41	kA	10	50	82	5779
2007	6	14	23	54	32	576348783	29.81	N	-95.44	W	-22.87	kA	9	48	87	5808
2007	6	14	23	56	26	382232080	29.71	N	-95.41	W	-21.52	kA	9	37	80	5932
2007	6	14	23	40	28	417627591	29.74	N	-95.34	W	-46.99	kA	11	31	71	6270
2007	6	14	23	49	27	533596421	29.82	N	-95.5	W	-21.98	kA	6	7	13	6312
2007	6	14	23	44	9	352614974	29.9	N	-95.4	W	-8.38	kA	7	30	77	6382
2007	6	14	23	40	14	639023580	29.66	N	-95.43	W	-12.47	kA	8	27	72	6596
2007	6	14	23	18	55	356330293	29.77	N	-95.38	W	-17.54	kA	13	32	54	6643
2007	6	14	23	52	5	589368484	29.87	N	-95.35	W	-134.03	kA	9	89	171	6645
2007	6	14	23	41	33	472744290	29.8	N	-95.46	W	-27.36	kA	13	34	66	6680
2007	6	14	23	39	26	917785661	29.81	N	-95.43	W	-32.36	kA	1	19	57	6699
2007	6	14	23	46	27	967847135	29.8	N	-95.38	W	-46.71	kA	16	42	90	6722
2007	6	14	23	47	10	630295001	29.79	N	-95.43	W	-24.77	kA	15	35	75	6824
2007	6	14	23	35	42	977007797	29.82	N	-95.35	W	-16.78	kA	5	27	85	6838
2007	6	14	23	36	10	80432283	29.79	N	-95.43	W	-31.19	kA	5	21	59	6843
2007	6	14	23	39	8	179551445	29.8	N	-95.43	W	-17.11	kA	12	30	70	6881
2007	6	14	23	32	13	47296394	29.8	N	-95.42	W	-36.89	kA	9	34	86	6931
2007	6	14	23	41	27	282327970	29.77	N	-95.53	W	-16.67	kA	3	27	68	6932
2007	6	14	23	28	56	692805084	29.78	N	-95.36	W	-21.74	kA	8	29	58	7033
2007	6	14	23	42	41	558840086	29.81	N	-95.45	W	-24.25	kA	5	27	58	7066
2007	6	14	23	38	40	223715415	29.67	N	-95.43	W	-10.79	kA	2	19	49	7111
2007	6	14	23	32	50	540435895	29.8	N	-95.39	W	-33.11	kA	5	21	58	7192
2007	6	14	23	28	46	580380532	29.79	N	-95.33	W	-29.99	kA	10	56	98	7218
2007	6	14	23	39	51	403499319	29.8	N	-95.41	W	-21.42	kA	12	43	92	7249
2007	6	14	23	16	59	388352213	29.79	N	-95.41	W	-25.49	kA	16	51	89	7281
2007	6	14	23	1	18	81653034	29.81	N	-95.36	W	-10.27	kA	1	7	26	7329
2007	6	14	23	16	9	376000664	29.8	N	-95.42	W	-14	kA	6	23	60	7372
2007	6	14	23	44	23	640699726	29.79	N	-95.44	W	-14.02	kA	2	17	35	7375
2007	6	14	23	0	57	41924646	29.82	N	-95.28	W	-43.36	kA	6	16	25	7408
2007	6	14	23	27	26	432907773	29.79	N	-95.4	W	-31.73	kA	4	28	61	7460
2007	6	14	23	41	55	395761793	29.8	N	-95.4	W	-13.56	kA	1	28	45	7538
2007	6	14	23	39	13	230534041	29.76	N	-95.33	W	-26.97	kA	5	32	66	7564
2007	6	14	23	45	14	250822102	29.78	N	-95.48	W	-29.3	kA	3	13	21	7568
2007	6	14	23	28	40	354322546	29.83	N	-95.37	W	-29.12	kA	6	23	68	7608
2007	6	14	23	51	7	772766986	29.81	N	-95.48	W	-24.12	kA	11	44	79	7613
2007	6	14	23	48	39	480413650	29.78	N	-95.37	W	-28.79	kA	9	67	117	7625
2007	6	14	23	30	44	373046645	29.75	N	-95.46	W	-20.68	kA	8	43	104	7664
2007	6	14	23	39	36	220935159	29.81	N	-95.45	W	-33.84	kA	2	32	67	7708
2007	6	14	23	26	24	259335774	29.82	N	-95.39	W	-22.55	kA	4	16	41	7725
2007	6	14	23	43	35	608213283	29.69	N	-95.41	W	-22.38	kA	1	28	73	7731
2007	6	14	23	26	33	432158550	29.8	N	-95.5	W	-7.79	kA	2	32	62	7739
2007	6	14	23	22	57	182180539	29.8	N	-95.4	W	-32.34	kA	7	28	66	7742
2007	6	14	23	41	29	998158977	29.8	N	-95.38	W	-8.27	kA	1	24	60	7783
2007	6	14	23	37	48	546687681	29.79	N	-95.43	W	-22.74	kA	2	11	32	7791

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2007	6	14	23	23	51	687460189	29.73	N	-95.35	W	-40.16	kA	11	24	47	7804
2007	6	14	23	12	46	55497436	29.8	N	-95.36	W	-17.06	kA	1	14	37	7815
2007	6	14	23	21	54	251180385	29.84	N	-95.4	W	-25.22	kA	5	34	74	7823
2007	6	14	23	46	39	21594630	29.8	N	-95.44	W	-20.13	kA	4	17	39	7835
2007	6	14	23	17	16	551377006	29.82	N	-95.38	W	-26.57	kA	6	33	79	7878
2007	6	14	23	37	30	119673138	29.81	N	-95.37	W	-14.1	kA	6	24	66	7899
2007	6	14	23	20	54	632081494	29.79	N	-95.41	W	-32.65	kA	12	39	93	7928
2007	6	14	23	47	22	790981061	29.79	N	-95.39	W	-24.09	kA	8	43	100	7964
2007	6	14	23	51	23	737819883	29.81	N	-95.48	W	-19.98	kA	12	32	61	7990
2007	6	14	23	13	35	180301186	29.78	N	-95.42	W	-17.74	kA	1	30	70	8017
2007	6	14	23	43	4	158885386	29.78	N	-95.45	W	-31.95	kA	14	18	38	8028
2007	6	14	23	42	32	582895474	29.79	N	-95.4	W	-9.88	kA	3	18	30	8047
2007	6	14	23	16	19	631606361	29.8	N	-95.28	W	-23.75	kA	3	48	92	8053
2007	6	14	23	31	55	650455104	29.81	N	-95.44	W	-21.7	kA	1	36	75	8102
2007	6	14	23	27	53	577862695	29.78	N	-95.3	W	-13.75	kA	10	62	145	8133
2007	6	14	23	45	5	442023027	29.81	N	-95.47	W	-22.92	kA	7	34	66	8133
2007	6	14	23	31	18	748314230	29.76	N	-95.34	W	-60.48	kA	10	47	84	8138
2007	6	14	23	29	36	831571618	29.77	N	-95.36	W	-31.75	kA	3	34	85	8148
2007	6	14	23	27	50	719586348	29.8	N	-95.39	W	-12.91	kA	3	19	66	8157
2007	6	14	23	25	15	121334833	29.88	N	-95.4	W	-36.11	kA	3	30	71	8177
2007	6	14	23	27	6	559107065	29.78	N	-95.41	W	-26.49	kA	5	27	55	8219
2007	6	14	23	23	37	337695981	29.82	N	-95.36	W	-46.19	kA	14	58	114	8267
2007	6	14	23	45	48	109201658	29.77	N	-95.35	W	-13.13	kA	2	57	141	8289
2007	6	14	23	50	32	581948711	29.8	N	-95.47	W	-50.43	kA	9	55	120	8295
2007	6	14	23	22	24	641679769	29.77	N	-95.44	W	-27.79	kA	5	23	54	8346
2007	6	14	23	15	11	637275868	29.77	N	-95.34	W	-18.68	kA	2	30	68	8352
2007	6	14	23	30	13	990742669	29.76	N	-95.43	W	-19.74	kA	4	33	66	8383
2007	6	14	23	13	43	947648020	29.79	N	-95.38	W	-13.28	kA	2	31	90	8387
2007	6	14	23	35	58	344379324	29.78	N	-95.38	W	-10.67	kA	6	36	73	8396
2007	6	14	23	31	47	705838456	29.78	N	-95.39	W	-21.98	kA	1	30	80	8408
2007	6	14	23	38	28	963615814	29.8	N	-95.41	W	-22.55	kA	8	31	74	8437
2007	6	14	23	51	19	946152897	29.63	N	-95.43	W	-29.3	kA	1	35	77	8438
2007	6	14	23	7	26	369252376	29.8	N	-95.37	W	-42.4	kA	1	14	44	8441
2007	6	14	23	7	43	771571942	29.76	N	-95.39	W	-19.7	kA	1	22	56	8559
2007	6	14	23	33	43	366646105	29.77	N	-95.35	W	-17.72	kA	6	37	93	8576
2007	6	14	23	36	38	904749382	29.83	N	-95.47	W	-23.22	kA	1	20	52	8662
2007	6	14	23	14	36	250463444	29.81	N	-95.26	W	-7.73	kA	4	24	75	8680
2007	6	14	23	20	42	780788478	29.8	N	-95.4	W	-18.87	kA	2	32	91	8778
2007	6	14	23	31	59	658159901	29.81	N	-95.38	W	-37.3	kA	8	54	126	8789
2007	6	14	23	43	56	148287886	29.79	N	-95.45	W	-20.66	kA	4	19	47	8834
2007	6	14	23	39	20	381018470	29.78	N	-95.34	W	-13.12	kA	2	19	43	8851
2007	6	14	23	47	50	950245525	29.8	N	-95.53	W	-15.45	kA	1	58	135	8874
2007	6	14	23	48	0	288757601	29.8	N	-95.44	W	-12.84	kA	2	34	99	8884
2007	6	14	23	44	59	136952573	29.79	N	-95.4	W	-23.49	kA	2	50	112	8886
2007	6	14	23	33	56	601402143	29.76	N	-95.41	W	-28.84	kA	1	15	35	8890

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2007	6	14	23	24	1	597434048	29.75	N	-95.37	W	-31.17	kA	2	31	66	8893
2007	6	14	23	42	5	230068088	29.77	N	-95.52	W	-27.93	kA	7	22	49	8907
2007	6	14	23	31	9	161597185	29.86	N	-95.35	W	-7.73	kA	4	24	47	8918
2007	6	14	23	39	46	690104666	29.71	N	-95.41	W	-28.92	kA	5	37	104	8921
2007	6	14	23	18	16	617633492	29.81	N	-95.37	W	-19.44	kA	4	15	44	8958
2007	6	14	23	31	15	589086104	29.78	N	-95.39	W	-20.83	kA	1	30	69	8970
2007	6	14	23	58	58	938199119	29.83	N	-95.43	W	-28.14	kA	1	53	118	8973
2007	6	14	23	43	50	228691081	29.94	N	-95.15	W	-35.54	kA	6	63	124	9002
2007	6	14	23	46	7	175589018	29.8	N	-95.45	W	-18.5	kA	3	38	95	9016
2007	6	14	23	28	16	397531755	29.79	N	-95.33	W	-33.6	kA	5	33	64	9022
2007	6	14	23	17	48	753557672	29.8	N	-95.4	W	-21.03	kA	5	14	38	9041
2007	6	14	23	34	57	223773963	29.83	N	-95.33	W	-18.26	kA	1	21	42	9091
2007	6	14	23	29	31	621318809	29.79	N	-95.4	W	-17.7	kA	2	16	42	9094
2007	6	14	23	36	59	57920899	29.77	N	-95.37	W	-9.1	kA	1	18	47	9097
2007	6	14	23	40	1	316926093	29.81	N	-95.44	W	-23.22	kA	10	22	48	9097
2007	6	14	23	27	14	80079747	29.81	N	-95.39	W	-17.26	kA	9	33	84	9122
2007	6	14	23	37	57	765689732	29.8	N	-95.43	W	-27.14	kA	2	16	51	9124
2007	6	14	23	16	18	356392156	29.81	N	-95.33	W	-20.98	kA	1	38	76	9126
2007	6	14	23	10	46	396787397	29.77	N	-95.42	W	-19.39	kA	1	29	77	9170
2007	6	14	23	52	43	99349615	30.01	N	-95.6	W	-10.23	kA	2	7	14	9184
2007	6	14	23	21	43	728830540	29.81	N	-95.33	W	-11.64	kA	1	12	30	9225
2007	6	14	23	52	53	590310207	29.76	N	-95.38	W	-13.3	kA	1	19	45	9225
2007	6	14	23	7	14	208066828	29.8	N	-95.14	W	-6.79	kA	1	30	56	9259
2007	6	14	23	59	51	373592450	29.71	N	-95.33	W	-9.77	kA	2	74	157	9261
2007	6	14	23	9	33	860623119	29.82	N	-95.35	W	-31.65	kA	10	34	79	9276
2007	6	14	23	41	12	181585635	29.77	N	-95.51	W	-11.16	kA	1	14	39	9325
2007	6	14	23	46	14	390837032	29.78	N	-95.43	W	-22.75	kA	6	24	61	9337
2007	6	14	23	37	24	393321763	29.77	N	-95.37	W	-15.52	kA	1	16	34	9357
2007	6	14	23	10	25	696411825	29.81	N	-95.35	W	-21.07	kA	1	40	108	9359
2007	6	14	23	41	43	164169149	29.78	N	-95.48	W	-26.16	kA	1	15	45	9368
2007	6	14	23	0	5	511296760	29.88	N	-95.26	W	-44.05	kA	14	40	79	9387
2007	6	14	23	30	52	681595595	29.81	N	-95.33	W	-7.49	kA	1	27	76	9393
2007	6	14	23	30	36	434484598	29.82	N	-95.41	W	-26.86	kA	1	47	104	9397
2007	6	14	23	5	10	921764177	29.78	N	-95.34	W	-26.36	kA	10	37	84	9409
2007	6	14	23	24	26	268655431	29.84	N	-95.32	W	-9.77	kA	1	13	28	9416
2007	6	14	23	42	45	108178514	29.78	N	-95.44	W	-39.9	kA	2	41	109	9429
2007	6	14	23	46	37	178340273	29.78	N	-95.45	W	-12.39	kA	1	7	18	9457
2007	6	14	23	19	13	164882998	29.77	N	-95.36	W	-13.84	kA	2	17	38	9465
2007	6	14	23	43	15	238205968	29.78	N	-95.35	W	-11.45	kA	1	28	65	9467
2007	6	14	23	20	33	926432456	29.89	N	-95.33	W	-37.7	kA	1	25	60	9504
2007	6	14	23	31	12	722680091	29.76	N	-95.42	W	-20.52	kA	1	32	77	9510
2007	6	14	23	30	37	697035118	29.79	N	-95.44	W	-22.74	kA	2	50	126	9531
2007	6	14	23	53	26	139732395	29.75	N	-95.38	W	-21.63	kA	1	7	15	9537
2007	6	14	23	26	54	982945604	29.79	N	-95.4	W	-38.63	kA	3	36	92	9540
2007	6	14	23	40	34	28346814	29.72	N	-95.42	W	-11.56	kA	4	28	76	9555
2007	6	14	23	19	3	380066508	29.75	N	-95.45	W	-17.13	kA	2	23	47	9572

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2007	6	14	23	41	57	577536240	29.85	N	-95.29	W	-7.73	kA	1	40	90	9578
2007	6	14	23	48	22	650734505	29.82	N	-95.55	W	-18.37	kA	1	42	99	9580
2007	6	14	23	52	22	25614891	29.85	N	-95.5	W	-13.78	kA	1	49	127	9590
2007	6	14	23	17	57	169016633	29.81	N	-95.37	W	-28.23	kA	2	14	33	9597
2007	6	14	23	17	33	995865859	29.77	N	-95.4	W	-12.38	kA	2	58	156	9607
2007	6	14	23	35	33	109795874	29.91	N	-95.38	W	-7.84	kA	1	35	98	9615
2007	6	14	23	36	19	930332020	29.77	N	-95.44	W	-32.43	kA	3	29	78	9646
2007	6	14	23	14	22	533760472	29.84	N	-95.37	W	-23.24	kA	1	32	84	9661
2007	6	14	23	45	57	419684091	29.8	N	-95.46	W	-13.8	kA	1	18	53	9709
2007	6	14	23	29	17	582757978	29.82	N	-95.42	W	-17.35	kA	1	22	65	9743
2007	6	14	23	20	44	91813397	29.85	N	-95.35	W	-7.49	kA	1	40	92	9763
2007	6	14	23	18	44	12155544	29.8	N	-95.4	W	-27.58	kA	4	31	81	9777
2007	6	14	23	25	47	854139136	29.74	N	-95.38	W	-26.55	kA	4	36	81	9782
2007	6	14	23	48	31	372863648	29.79	N	-95.44	W	-15.76	kA	1	23	60	9783
2007	6	14	23	23	56	883701077	29.79	N	-95.38	W	-26.34	kA	1	21	59	9800
2007	6	14	23	54	6	166881834	29.74	N	-95.36	W	-12.47	kA	1	53	121	9833
2007	6	14	23	35	47	260813149	29.78	N	-95.41	W	15.3	kA	1	23	56	9843
2007	6	14	23	50	9	662169295	29.82	N	-95.36	W	-21.77	kA	1	30	69	9844
2007	6	14	23	4	5	473540625	29.84	N	-95.38	W	-10.21	kA	1	16	29	9846
2007	6	14	23	30	5	871942353	29.8	N	-95.38	W	-25.01	kA	1	44	95	9846
2007	6	14	23	50	6	656330497	29.76	N	-95.44	W	-16	kA	1	19	48	9850
2007	6	14	23	35	15	835453252	29.81	N	-95.39	W	-33.15	kA	5	53	135	9923
2007	6	14	23	5	19	778711518	29.82	N	-95.22	W	-18.76	kA	1	21	63	9985
2007	6	14	23	21	35	288072380	29.77	N	-95.38	W	-34.54	kA	1	41	100	9990
2007	6	14	23	27	48	81745577	29.77	N	-95.46	W	-20.89	kA	4	31	63	10001
2007	6	14	23	23	9	761270130	29.76	N	-95.34	W	-35.58	kA	2	26	49	10007
2007	6	14	23	26	27	423265895	29.8	N	-95.21	W	-16.56	kA	1	35	85	10074
2007	6	14	23	22	51	42538006	29.8	N	-95.44	W	-34.19	kA	1	50	99	10084
2007	6	14	23	24	10	693709054	29.8	N	-95.35	W	-24.62	kA	1	18	35	10118
2007	6	14	23	53	11	395700492	29.77	N	-95.4	W	-11.64	kA	1	20	56	10123
2007	6	14	23	21	37	912493376	29.84	N	-95.39	W	-41.83	kA	4	43	119	10143
2007	6	14	23	43	38	655550332	29.82	N	-95.35	W	-15.39	kA	1	46	100	10202
2007	6	14	23	37	44	42517918	29.78	N	-95.4	W	-7.2	kA	1	12	42	10204
2007	6	14	23	5	43	592464230	29.75	N	-95.19	W	-7.62	kA	2	27	84	10264
2007	6	14	23	46	34	718771065	29.79	N	-95.37	W	-16.28	kA	2	33	91	10292
2007	6	14	23	27	34	492507213	29.77	N	-95.4	W	-13.71	kA	1	31	75	10294
2007	6	14	23	47	17	271129980	29.85	N	-95.34	W	-12.88	kA	1	28	61	10323
2007	6	14	23	54	20	419023412	29.76	N	-95.4	W	-13.88	kA	1	12	27	10346
2007	6	14	23	18	49	790204273	29.81	N	-95.38	W	-26.99	kA	1	13	44	10379
2007	6	14	23	34	24	364447169	29.8	N	-95.23	W	-12.47	kA	1	33	70	10431
2007	6	14	23	16	5	991681633	29.81	N	-95.19	W	-12.54	kA	1	42	112	10540
2007	6	14	23	5	38	184047585	29.78	N	-95.34	W	-15.63	kA	1	6	14	10567
2007	6	14	23	6	16	587393294	29.76	N	-95.3	W	-15.65	kA	1	33	77	10570
2007	6	14	23	24	7	383530592	29.82	N	-95.37	W	-32.89	kA	1	27	68	10591
2007	6	14	23	40	50	33716728	29.75	N	-95.3	W	-12.15	kA	1	26	55	10636
2007	6	14	23	35	27	161745299	29.72	N	-95.25	W	-8.05	kA	1	14	36	10726

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	6	14	23	29	34	810039158	29.76	N	-95.26	W	-15.3	kA	1	30	69	11299
2007	6	14	23	29	19	313501214	29.86	N	-95.26	W	-7.95	kA	1	17	35	12381
2007	6	15	0	55	15	633018841	30.18	N	-95.6	W	-16.21	kA	7	3	5	3228
2007	6	15	0	58	4	627411208	29.78	N	-95.67	W	-9.31	kA	1	1	1	3926
2007	6	15	0	4	56	808479697	29.71	N	-95.39	W	-36.74	kA	5	42	81	4698
2007	6	15	0	2	49	547232843	29.71	N	-95.37	W	-16.35	kA	8	71	141	4885
2007	6	15	0	1	28	773566165	29.77	N	-95.45	W	-12.65	kA	2	28	63	5234
2007	6	15	0	1	57	474659846	29.69	N	-95.4	W	-30.84	kA	11	23	50	5374
2007	6	15	0	8	20	300543524	29.71	N	-95.45	W	-20.57	kA	7	12	20	5383
2007	6	15	0	58	43	189802632	29.88	N	-95.76	W	-15.23	kA	3	4	9	5467
2007	6	15	0	4	44	397140521	29.88	N	-95.64	W	-14.36	kA	2	12	17	5479
2007	6	15	0	6	32	630120863	29.98	N	-95.62	W	-21.33	kA	1	5	7	5543
2007	6	15	0	12	38	961358087	30.01	N	-95.59	W	-23.07	kA	5	17	28	5550
2007	6	15	0	0	35	252928684	29.71	N	-95.37	W	-33.84	kA	8	75	132	5587
2007	6	15	0	7	46	876064704	29.89	N	-95.64	W	-15.61	kA	1	11	14	5682
2007	6	15	0	57	49	891614147	29.97	N	-95.74	W	-64.62	kA	12	17	20	5812
2007	6	15	0	50	25	96373215	29.93	N	-95.76	W	-28.58	kA	4	6	7	6044
2007	6	15	0	7	5	950613184	29.99	N	-95.65	W	-6.14	kA	5	14	22	6134
2007	6	15	0	54	56	141626512	30.19	N	-95.56	W	-17.2	kA	8	17	21	6246
2007	6	15	0	48	19	590820377	29.9	N	-95.63	W	-26.95	kA	14	49	84	6397
2007	6	15	0	6	47	599102568	29.98	N	-95.7	W	-26.1	kA	9	17	21	6689
2007	6	15	0	59	5	439001622	29.87	N	-95.76	W	-19.67	kA	6	7	7	6835
2007	6	15	0	58	17	197368244	29.9	N	-95.56	W	-16.61	kA	3	42	64	6940
2007	6	15	0	29	53	59244358	29.86	N	-95.51	W	-27.01	kA	7	42	76	6972
2007	6	15	0	22	9	200411522	29.94	N	-95.62	W	-29.82	kA	15	37	69	7438
2007	6	15	0	10	23	977545488	30	N	-95.64	W	-28.71	kA	4	22	33	7494
2007	6	15	0	30	40	796239642	29.91	N	-95.64	W	-40.63	kA	12	15	25	7498
2007	6	15	0	49	10	39048945	29.91	N	-95.65	W	-20.54	kA	8	75	122	7499
2007	6	15	0	52	33	250277054	29.91	N	-95.62	W	-11.4	kA	6	58	103	7526
2007	6	15	0	39	48	623479239	29.93	N	-95.46	W	-10.86	kA	1	51	106	7543
2007	6	15	0	16	5	956267864	30.14	N	-95.52	W	-22.02	kA	5	16	22	7546
2007	6	15	0	45	44	599219640	29.9	N	-95.62	W	-34.67	kA	8	27	46	7610
2007	6	15	0	44	0	876099510	29.91	N	-95.65	W	-29.79	kA	14	36	58	7935
2007	6	15	0	15	36	107552081	29.87	N	-95.64	W	-18.74	kA	2	13	20	7989
2007	6	15	0	11	30	515454592	29.92	N	-95.67	W	-18.07	kA	6	22	37	8019
2007	6	15	0	35	29	289808649	29.91	N	-95.57	W	-21.89	kA	4	26	42	8061
2007	6	15	0	13	4	548425285	29.8	N	-95.4	W	-30.95	kA	1	105	278	8153
2007	6	15	0	15	13	693227027	29.91	N	-95.67	W	-11.78	kA	1	16	20	8159
2007	6	15	0	51	33	788735582	30.04	N	-95.59	W	-61.35	kA	6	67	139	8189
2007	6	15	0	14	38	441366126	29.99	N	-95.64	W	-22.27	kA	3	24	49	8261
2007	6	15	0	36	8	16993219	29.92	N	-95.64	W	-21.81	kA	11	41	79	8365
2007	6	15	0	42	19	157571089	29.92	N	-95.64	W	-14.78	kA	1	13	17	8386
2007	6	15	0	2	38	363946820	29.77	N	-95.51	W	-27.07	kA	3	55	114	8671
2007	6	15	0	16	17	572187887	29.85	N	-95.65	W	-17.93	kA	8	23	48	8722
2007	6	15	0	8	16	690626136	29.99	N	-95.62	W	-19.33	kA	3	17	38	8891
2007	6	15	0	44	55	167723210	29.92	N	-95.64	W	-22.44	kA	5	31	59	8924

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	6	15	0	52	14	38573635	30	N	-95.51	W	-39.7	kA	2	89	167	8957
2007	6	15	0	1	18	175331885	29.9	N	-95.41	W	-67.04	kA	2	80	177	9028
2007	6	15	0	50	4	691834677	29.98	N	-95.75	W	-40.22	kA	2	15	23	9032
2007	6	15	0	27	53	212071033	30.1	N	-95.62	W	-17	kA	2	45	89	9036
2007	6	15	0	44	20	627421631	29.9	N	-95.66	W	-26.42	kA	5	25	44	9039
2007	6	15	0	46	59	445911774	29.92	N	-95.64	W	-23.64	kA	16	97	188	9072
2007	6	15	0	24	0	816042769	29.92	N	-95.63	W	-10.51	kA	4	19	29	9096
2007	6	15	0	25	49	85736055	30.13	N	-95.66	W	-19.46	kA	3	94	190	9175
2007	6	15	0	59	8	831615236	29.86	N	-95.54	W	-10.97	kA	4	53	113	9181
2007	6	15	0	55	20	565156358	30.03	N	-95.56	W	-39.96	kA	2	71	172	9331
2007	6	15	0	12	59	720321711	30	N	-95.61	W	-22.55	kA	8	42	108	9350
2007	6	15	0	50	40	248005880	29.89	N	-95.58	W	-17.74	kA	2	21	50	9400
2007	6	15	0	16	43	128149961	29.92	N	-95.67	W	-24.33	kA	5	12	21	9401
2007	6	15	0	15	44	351955026	30.06	N	-95.55	W	-5.53	kA	1	22	38	9418
2007	6	15	0	25	0	43817331	29.92	N	-95.64	W	-37.13	kA	6	52	95	9419
2007	6	15	0	27	15	354608489	29.89	N	-95.66	W	-15.21	kA	14	44	81	9441
2007	6	15	0	56	29	441424941	30.19	N	-95.55	W	-34.23	kA	3	18	29	9448
2007	6	15	0	17	44	332788732	29.94	N	-95.6	W	-10.45	kA	1	20	34	9463
2007	6	15	0	20	9	289704012	29.97	N	-95.6	W	-17.11	kA	4	25	48	9519
2007	6	15	0	57	26	812514024	29.99	N	-95.4	W	-73.87	kA	3	109	240	9583
2007	6	15	0	42	34	221910476	29.89	N	-95.64	W	-23.46	kA	6	20	44	9649
2007	6	15	0	45	5	274044267	29.89	N	-95.64	W	-39.07	kA	7	19	32	9676
2007	6	15	0	56	38	667645311	29.93	N	-95.75	W	-10.49	kA	4	21	48	9735
2007	6	15	0	47	26	356878021	29.88	N	-95.53	W	-19.05	kA	1	20	48	9779
2007	6	15	0	41	29	226789680	29.86	N	-95.41	W	-9.16	kA	2	35	67	9820
2007	6	15	0	20	16	948184483	29.9	N	-95.65	W	-14.06	kA	3	35	74	9845
2007	6	15	0	49	28	646496388	30.04	N	-95.64	W	-22.74	kA	1	55	111	9878
2007	6	15	0	22	36	74151692	29.98	N	-95.58	W	-19.37	kA	13	38	69	9882
2007	6	15	0	43	17	919079375	29.92	N	-95.6	W	-21.59	kA	2	54	137	9916
2007	6	15	0	26	8	83297759	29.9	N	-95.63	W	-13.38	kA	12	39	80	9947
2007	6	15	0	22	57	312333514	29.98	N	-95.65	W	-17.57	kA	2	27	43	10037
2007	6	15	0	27	29	748695005	30.15	N	-95.66	W	-11.21	kA	1	33	67	10068
2007	6	15	0	47	20	989472254	29.88	N	-95.61	W	-13.56	kA	1	14	31	10113
2007	6	15	0	34	2	964982913	29.93	N	-95.66	W	-18.85	kA	4	40	92	10137
2007	6	15	0	14	54	114321428	29.87	N	-95.66	W	-17.83	kA	4	16	35	10141
2007	6	15	0	43	19	849323033	29.91	N	-95.54	W	-8.16	kA	2	29	55	10220
2007	6	15	0	49	46	241698519	29.88	N	-95.58	W	-13.8	kA	1	23	46	10235
2007	6	15	0	57	58	167691883	29.88	N	-95.75	W	20.74	kA	6	35	65	10242
2007	6	15	0	56	24	971491548	29.98	N	-95.7	W	-15.3	kA	1	24	49	10247
2007	6	15	0	53	51	373121444	29.89	N	-95.6	W	-9.21	kA	1	50	147	10254
2007	6	15	0	12	49	770426236	29.96	N	-95.67	W	-11.25	kA	1	16	24	10260
2007	6	15	0	33	53	747201103	29.84	N	-95.53	W	-8.47	kA	1	33	52	10277
2007	6	15	0	28	50	131448913	29.91	N	-95.65	W	-20.44	kA	1	18	41	10280
2007	6	15	0	38	38	266250476	29.86	N	-95.5	W	-7.53	kA	1	43	97	10283
2007	6	15	0	44	7	408115665	29.87	N	-95.54	W	-8.82	kA	1	48	93	10292
2007	6	15	0	45	35	643683272	29.89	N	-95.41	W	-9.99	kA	1	55	117	10346

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	6	15	0	21	16	643638982	30.12	N	-95.69	W	-15.6	kA	1	25	55	10382
2007	6	15	0	50	44	235945530	29.9	N	-95.44	W	-6.92	kA	2	41	98	10397
2007	6	15	0	40	29	375164232	29.92	N	-95.57	W	-13.25	kA	1	26	57	10416
2007	6	15	0	47	16	818086132	29.89	N	-95.65	W	-23.83	kA	2	49	112	10438
2007	6	15	0	45	3	498268380	29.92	N	-95.57	W	-7.92	kA	1	30	54	10580
2007	6	15	0	30	45	951377023	29.9	N	-95.58	W	-8.23	kA	1	35	66	10610
2007	6	15	0	59	34	461208839	29.91	N	-95.74	W	-21.44	kA	10	24	39	10617
2007	6	15	0	47	18	591491285	29.94	N	-95.76	W	-14.67	kA	3	48	100	10673
2007	6	15	0	17	17	209400290	29.91	N	-95.69	W	-20.22	kA	1	20	40	10674
2007	6	15	0	29	58	944097535	29.9	N	-95.59	W	-9.58	kA	1	22	55	10678
2007	6	15	0	50	19	549719068	29.87	N	-95.54	W	-16.13	kA	1	27	60	10824
2007	6	15	0	34	42	770815005	29.93	N	-95.62	W	-12.47	kA	1	45	104	10833
2007	6	15	0	49	20	89161106	29.94	N	-95.73	W	-15.98	kA	1	20	36	10875
2007	6	15	0	36	41	299237699	29.9	N	-95.61	W	-8.4	kA	1	18	37	10941
2007	6	15	0	21	59	71518086	30.1	N	-95.71	W	-15.47	kA	1	22	39	11113
2007	6	15	0	25	50	852329742	29.85	N	-95.68	W	-11.43	kA	1	24	42	11121
2007	6	15	0	54	3	907779674	29.97	N	-95.67	W	-5.62	kA	1	36	66	11426
2007	6	15	0	35	36	450105514	29.9	N	-95.63	W	-9.93	kA	1	24	57	11584
2007	6	15	0	55	34	117228345	29.94	N	-95.73	W	-14.43	kA	1	11	23	11795
2007	6	15	0	54	51	23238303	29.91	N	-95.76	W	-14.19	kA	1	3	7	12699
2007	6	15	1	30	9	710459188	29.83	N	-95.52	W	-25.23	kA	1	4	9	3963
2007	6	15	1	46	8	199715948	29.86	N	-95.5	W	-39.28	kA	3	26	48	4279
2007	6	15	1	42	6	262469850	29.85	N	-95.49	W	-31.06	kA	4	15	31	4314
2007	6	15	1	29	3	828493140	29.83	N	-95.51	W	-34.5	kA	8	28	60	5032
2007	6	15	1	23	24	223202646	29.81	N	-95.54	W	-64.75	kA	2	46	98	5287
2007	6	15	1	1	7	764335485	29.93	N	-95.75	W	-33.32	kA	3	10	11	5357
2007	6	15	1	12	7	116436572	29.81	N	-95.61	W	-18.02	kA	2	2	4	5408
2007	6	15	1	44	26	181569319	30.26	N	-95.05	W	-15.91	kA	4	2	2	6188
2007	6	15	1	48	10	919864010	29.89	N	-95.76	W	-46.69	kA	10	49	79	6205
2007	6	15	1	32	45	794385324	30.29	N	-95.07	W	-7.51	kA	4	1	1	6677
2007	6	15	1	36	2	333557653	30.29	N	-95.03	W	-44.46	kA	6	1	2	6729
2007	6	15	1	17	42	264149385	30.25	N	-95.51	W	-15.26	kA	2	4	4	6763
2007	6	15	1	1	57	250595147	30.21	N	-95.67	W	-9.93	kA	1	9	11	7012
2007	6	15	1	58	12	545041363	29.82	N	-95.53	W	-14.89	kA	1	137	235	7622
2007	6	15	1	49	25	514795994	29.86	N	-95.5	W	-10.56	kA	1	108	257	8010
2007	6	15	1	46	58	533625836	29.84	N	-95.59	W	-82.53	kA	2	109	253	8197
2007	6	15	1	52	8	870888234	29.9	N	-95.59	W	-7.64	kA	1	77	166	8452
2007	6	15	1	5	34	995142294	29.94	N	-95.69	W	-13.32	kA	5	53	86	8560
2007	6	15	1	19	7	393163807	29.95	N	-95.68	W	29.86	kA	1	19	42	8777
2007	6	15	1	9	17	125111373	29.85	N	-95.77	W	-18.41	kA	1	64	118	8841
2007	6	15	1	10	13	945310639	29.88	N	-95.76	W	-15.52	kA	10	23	42	8890
2007	6	15	1	41	25	579535084	29.86	N	-95.48	W	-23.86	kA	1	107	247	9212
2007	6	15	1	11	38	956859484	29.85	N	-95.59	W	-10.01	kA	1	80	155	9253
2007	6	15	1	22	53	994549510	30.28	N	-95.02	W	-14.91	kA	1	10	15	9336
2007	6	15	1	21	25	480130734	30.29	N	-95.5	W	-20.68	kA	1	14	26	9540
2007	6	15	1	21	35	215100161	30.02	N	-95.64	W	-63.16	kA	5	59	114	9588

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	6	15	1	10	36	239605108	29.9	N	-95.72	W	-11.77	kA	4	141	264	9664
2007	6	15	1	16	58	70866336	29.77	N	-95.55	W	-24.33	kA	1	28	68	9715
2007	6	15	1	29	8	594047487	29.85	N	-95.55	W	-12.64	kA	1	43	86	9757
2007	6	15	1	19	52	601734775	29.91	N	-95.71	W	-18.09	kA	1	81	155	9880
2007	6	15	1	20	45	704031336	29.85	N	-95.7	W	23.98	kA	2	26	64	10034
2007	6	15	1	36	57	466371143	29.86	N	-95.5	W	-7.46	kA	1	34	81	10038
2007	6	15	1	12	5	255991906	29.86	N	-95.77	W	-14.19	kA	8	22	35	10122
2007	6	15	1	7	53	632434072	29.91	N	-95.73	W	-6.38	kA	1	15	25	10131
2007	6	15	1	25	55	225747610	29.85	N	-95.57	W	-16.84	kA	1	17	51	10214
2007	6	15	1	2	55	103783683	29.95	N	-95.73	W	-21.64	kA	1	11	22	10269
2007	6	15	1	23	47	766073492	29.84	N	-95.54	W	-6.7	kA	1	15	38	10313
2007	6	15	1	42	43	951132195	30.29	N	-95.07	W	-5.66	kA	2	14	24	10448
2007	6	15	1	0	8	621859785	29.85	N	-95.68	W	-10.45	kA	1	40	94	10592
2007	6	15	1	1	15	989562981	29.93	N	-95.71	W	-8.75	kA	1	16	35	10656
2007	6	15	1	19	12	404973208	29.81	N	-95.51	W	-13.97	kA	1	12	33	10744
2007	6	15	1	4	28	31341500	29.88	N	-95.75	W	-8.99	kA	3	19	35	11400
2007	6	15	1	4	59	117009644	29.93	N	-95.7	W	-9.6	kA	1	10	23	11425
2007	6	15	1	2	41	182117954	29.93	N	-95.62	W	-5.9	kA	1	12	25	11809
2007	6	15	2	49	31	83965428	29.69	N	-95.65	W	-38.24	kA	5	11	17	4177
2007	6	15	2	14	53	218122589	29.77	N	-95.63	W	-22.51	kA	3	27	39	4314
2007	6	15	2	6	49	457913596	29.81	N	-95.66	W	-51.32	kA	6	13	21	5187
2007	6	15	2	13	41	391907687	30.19	N	-94.9	W	-50.76	kA	4	1	1	6426
2007	6	15	2	16	47	34364879	30.14	N	-94.77	W	-63.9	kA	3	1	1	6569
2007	6	15	2	31	17	67899098	30.25	N	-94.78	W	-11.34	kA	1	1	1	7039
2007	6	15	2	13	33	97965648	30.22	N	-95.07	W	-10.01	kA	1	4	4	7469
2007	6	15	2	50	14	414836378	29.67	N	-95.72	W	-16.84	kA	6	9	12	7593
2007	6	15	2	45	12	216793299	30.08	N	-94.88	W	-13.13	kA	2	6	9	7620
2007	6	15	2	25	47	346791847	30.17	N	-94.83	W	-53.22	kA	5	1	1	7917
2007	6	15	2	0	24	779788918	29.84	N	-95.71	W	-56.91	kA	1	91	199	7918
2007	6	15	2	58	39	536479879	29.7	N	-95.73	W	-18.02	kA	1	19	32	8501
2007	6	15	2	0	48	876891605	29.8	N	-95.64	W	-22.26	kA	1	43	73	8611
2007	6	15	2	40	4	992299139	30.14	N	-94.86	W	-4.44	kA	1	5	5	8781
2007	6	15	2	7	6	429825486	29.75	N	-95.69	W	-13.54	kA	1	92	180	9053
2007	6	15	2	41	27	543931496	30.17	N	-94.78	W	-11.82	kA	5	15	29	9925
2007	6	15	2	49	24	585621369	30.17	N	-94.88	W	-29.49	kA	3	7	9	10600
2007	6	15	2	56	31	228428633	30.12	N	-94.82	W	-10.6	kA	3	3	3	10629
2007	6	15	2	0	6	289458397	29.81	N	-95.64	W	-7.14	kA	1	13	30	10834
2007	6	15	2	52	3	686318291	30.15	N	-94.83	W	-23.01	kA	2	12	18	11065
2007	6	15	2	58	18	264909992	30.14	N	-94.86	W	-21.68	kA	4	4	4	13439
2007	6	15	3	5	48	215914135	30.14	N	-94.78	W	-43.23	kA	6	1	1	6843
2007	6	15	3	8	0	830713501	29.73	N	-95.73	W	-19.05	kA	1	37	59	7926
2007	6	15	3	4	49	363395588	30.16	N	-94.82	W	-20.5	kA	5	1	1	8000
2007	6	15	3	40	42	287571383	30.03	N	-94.77	W	-27.01	kA	1	11	17	10477
2007	6	15	3	12	31	349509139	30.19	N	-94.79	W	-69.93	kA	4	9	18	11353
2007	6	15	3	15	16	879266975	30.15	N	-94.78	W	-22.26	kA	1	7	12	11681
2007	7	13	22	13	44	430538180	29.9257	N	-95.51	W	-30.32	kA	3	5	8	4215

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
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2007	7	13	22	26	9	660387484	29.7829	N	-94.9241	W	-26.2	kA	4	3	4	6265
2007	7	13	22	51	32	412465900	29.8973	N	-94.9992	W	-22.03	kA	5	8	10	6435
2007	7	13	22	22	46	147155465	29.7695	N	-94.9347	W	-19.46	kA	6	2	3	6460
2007	7	13	22	55	41	458689965	29.9353	N	-94.9963	W	-25.38	kA	6	4	4	6531
2007	7	13	22	8	8	995481941	29.7619	N	-94.9086	W	-22.13	kA	2	1	2	6532
2007	7	13	22	45	32	604438948	29.9291	N	-95.048	W	-111.81	kA	3	5	8	6669
2007	7	13	22	44	18	104607892	29.7893	N	-94.9131	W	-34.89	kA	4	7	9	6868
2007	7	13	22	39	57	663570149	29.7914	N	-94.9898	W	-23.16	kA	10	6	9	6891
2007	7	13	22	48	25	367606532	29.7695	N	-94.9176	W	17.96	kA	4	4	6	7143
2007	7	13	22	45	26	655874405	29.7839	N	-94.9248	W	-28.25	kA	3	3	4	7216
2007	7	13	22	22	28	419589090	29.7923	N	-94.911	W	-15.69	kA	2	4	5	7296
2007	7	13	22	44	59	582183875	29.7852	N	-94.9288	W	-27.56	kA	3	4	4	7402
2007	7	13	22	31	29	133848470	29.7808	N	-94.8869	W	-47.01	kA	10	4	7	7541
2007	7	13	22	30	6	436955292	29.7768	N	-94.9006	W	-33.84	kA	4	6	9	7573
2007	7	13	22	38	33	395557890	29.7915	N	-94.9174	W	-29.4	kA	6	7	10	7686
2007	7	13	22	55	7	665428432	29.9294	N	-94.9779	W	-30.52	kA	6	5	7	7711
2007	7	13	22	33	25	369653047	29.7931	N	-94.9324	W	-29.53	kA	6	3	5	7734
2007	7	13	22	45	51	910296722	29.801	N	-94.9227	W	-24.92	kA	1	4	4	7749
2007	7	13	22	29	57	554382495	29.7685	N	-94.9728	W	-54.02	kA	1	7	15	7894
2007	7	13	22	36	37	821167644	29.7923	N	-94.9186	W	-32.47	kA	1	2	3	7924
2007	7	13	22	46	58	792547249	29.9397	N	-95.0915	W	-59.74	kA	2	9	17	7961
2007	7	13	22	29	3	459728858	29.7645	N	-94.9885	W	-40.2	kA	1	11	23	8136
2007	7	13	22	40	51	383124488	29.7958	N	-94.9172	W	-10.03	kA	5	9	14	8315
2007	7	13	22	24	56	384347816	29.73	N	-94.9634	W	-31.32	kA	4	13	28	8343
2007	7	13	22	26	24	544774131	29.7882	N	-94.9434	W	-60.12	kA	3	4	6	8671
2007	7	13	22	32	14	853310386	29.7279	N	-94.976	W	-29.54	kA	1	13	23	8764
2007	7	13	22	20	0	512873793	29.7759	N	-94.899	W	-11.56	kA	1	7	12	9086
2007	7	13	22	29	22	494383669	29.8578	N	-94.9871	W	-44.95	kA	1	17	41	9105
2007	7	13	22	23	47	288396334	29.7983	N	-94.9195	W	-21.31	kA	4	5	8	9178
2007	7	13	22	58	14	558470269	29.9463	N	-94.9797	W	-9.82	kA	5	12	23	9535
2007	7	13	22	59	48	355370940	29.9859	N	-95.0246	W	-19.28	kA	3	8	11	9574
2007	7	13	22	21	54	160123299	29.7959	N	-94.9552	W	-10.38	kA	3	2	4	9629
2007	7	13	22	24	29	366970085	29.7999	N	-94.9535	W	-21.09	kA	2	5	14	9821
2007	7	13	22	17	43	643386631	29.9172	N	-95.5234	W	-9.64	kA	1	8	16	9848
2007	7	13	22	25	13	362346957	29.7729	N	-94.8959	W	-15.17	kA	1	4	8	10002
2007	7	13	22	21	26	531568898	29.801	N	-94.9132	W	-13.8	kA	1	7	16	10026
2007	7	13	22	28	20	988632415	29.7768	N	-94.9076	W	-62.86	kA	2	4	7	10060
2007	7	13	22	50	3	143324476	29.991	N	-95.0476	W	-34.59	kA	1	19	38	10078
2007	7	13	22	23	34	357438097	29.783	N	-94.9308	W	-13.65	kA	1	4	10	10180
2007	7	13	22	31	6	464361109	29.7654	N	-94.9267	W	-42.57	kA	1	4	6	10400
2007	7	13	22	29	31	836717176	29.7733	N	-94.9006	W	-17.41	kA	2	4	5	10498
2007	7	13	22	53	58	496863311	29.78	N	-94.8997	W	-19.74	kA	2	7	12	10861
2007	7	13	22	34	4	146623479	29.7957	N	-94.9142	W	-20.83	kA	1	3	6	11078
2007	7	13	22	59	28	108080121	29.9354	N	-95.0065	W	-31.56	kA	7	4	5	11538
2007	7	13	22	51	56	631954460	29.7457	N	-94.8941	W	-7.9	kA	1	6	17	11707

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2007	7	13	22	42	13	446081120	29.7669	N	-94.8934	W	-7.9	kA	1	12	27	11952
2007	7	13	22	42	57	929951030	29.7714	N	-94.9125	W	-7.34	kA	1	10	18	11954
2007	7	13	22	27	59	482997130	29.7755	N	-94.9178	W	24.9	kA	1	6	11	12309
2007	7	13	22	25	59	379504443	29.768	N	-94.9079	W	-6.79	kA	1	4	9	12311
2007	7	13	22	56	59	593452494	29.8868	N	-94.9456	W	-8.01	kA	1	13	27	12638
2007	7	13	22	59	45	544173833	29.9469	N	-94.982	W	-16.22	kA	1	3	10	12729
2007	7	13	22	32	29	230253749	29.756	N	-94.8979	W	-7.97	kA	1	1	4	12753
2007	7	13	22	59	2	834269883	29.9332	N	-95.0028	W	-18.57	kA	1	5	7	12788
2007	7	13	22	27	49	650081251	29.7743	N	-94.928	W	-14.54	kA	1	4	7	13179
2007	7	13	22	32	7	210019326	29.7468	N	-94.8888	W	-8.9	kA	1	4	5	13877
2007	7	13	22	31	37	161480795	29.7453	N	-94.894	W	-7.2	kA	1	4	6	14690
2007	7	13	23	22	5	558488225	29.9066	N	-95.0626	W	-15.48	kA	2	3	5	2742
2007	7	13	23	19	23	450568305	29.9018	N	-95.1249	W	-39.87	kA	3	2	3	4398
2007	7	13	23	19	6	183797146	29.9145	N	-95.1462	W	-33.45	kA	2	1	1	5016
2007	7	13	23	24	23	1310345	29.9184	N	-95.1811	W	-45.99	kA	5	8	12	5146
2007	7	13	23	16	3	205092939	29.9294	N	-95.1872	W	-13.41	kA	2	3	5	5363
2007	7	13	23	22	9	633017510	29.8734	N	-94.9347	W	-45.08	kA	9	5	6	5565
2007	7	13	23	27	45	5943946	29.9171	N	-94.9879	W	-38.85	kA	2	1	2	5633
2007	7	13	23	51	44	958366188	29.8282	N	-94.7736	W	-59.4	kA	2	1	1	5649
2007	7	13	23	17	1	754902056	29.9254	N	-95.1729	W	-26.73	kA	2	2	4	5695
2007	7	13	23	45	48	452107358	29.8291	N	-94.7835	W	-70.93	kA	3	4	6	5749
2007	7	13	23	54	38	717922517	29.8951	N	-94.9817	W	-173.09	kA	3	9	12	5826
2007	7	13	23	32	51	926706657	29.9099	N	-95.1146	W	-10.42	kA	1	8	12	5832
2007	7	13	23	50	29	21887209	29.8071	N	-94.7884	W	-46.36	kA	3	2	3	5941
2007	7	13	23	23	14	878893078	29.8384	N	-94.9696	W	-45.34	kA	4	3	3	5978
2007	7	13	23	55	48	705035585	29.8022	N	-94.7782	W	-86.99	kA	1	10	15	5989
2007	7	13	23	44	19	857798774	29.9076	N	-95.0659	W	-68.89	kA	6	6	10	6013
2007	7	13	23	52	20	220883433	29.8019	N	-94.7766	W	-26.18	kA	4	2	2	6058
2007	7	13	23	36	44	677533746	29.8665	N	-95.053	W	-55	kA	4	6	12	6264
2007	7	13	23	26	23	71464771	29.9019	N	-95.1243	W	-13.34	kA	4	6	9	6328
2007	7	13	23	37	24	514294701	29.9219	N	-95.0984	W	-18.85	kA	6	6	11	6433
2007	7	13	23	3	11	385984629	29.9493	N	-94.9778	W	-52.41	kA	11	5	5	6458
2007	7	13	23	7	1	575279496	29.9837	N	-94.967	W	-41.35	kA	6	6	7	6467
2007	7	13	23	7	18	855713321	29.943	N	-94.9547	W	-34.89	kA	5	3	4	6472
2007	7	13	23	14	37	316296532	29.8752	N	-94.9722	W	-16.95	kA	11	15	20	6489
2007	7	13	23	9	35	132432651	29.9621	N	-94.9428	W	-32.3	kA	13	7	8	6554
2007	7	13	23	43	4	276801028	29.8241	N	-94.7803	W	-52.54	kA	6	5	5	6569
2007	7	13	23	15	6	456114108	29.8631	N	-94.9549	W	-35.04	kA	4	3	3	6626
2007	7	13	23	36	20	935293632	29.8082	N	-94.8767	W	-19.28	kA	3	2	3	6707
2007	7	13	23	26	16	533997063	29.9279	N	-95.0276	W	-36.09	kA	3	4	5	6723
2007	7	13	23	10	8	838030680	30.0087	N	-94.9605	W	-38.54	kA	9	7	8	6763
2007	7	13	23	2	15	200126934	29.8962	N	-94.9917	W	-7.42	kA	5	3	5	6867
2007	7	13	23	21	20	656777318	29.8418	N	-94.9647	W	-64.94	kA	10	10	12	6917
2007	7	13	23	59	21	133361397	29.8105	N	-94.7782	W	-62.22	kA	1	1	1	6942
2007	7	13	23	7	44	346604407	29.994	N	-94.9745	W	-41.96	kA	6	3	4	6952

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2007	7	13	23	2	3	237248245	29.9459	N	-94.9811	W	-79.55	kA	2	11	18	7078
2007	7	13	23	3	34	436026625	29.9519	N	-95.0144	W	-46.8	kA	4	8	9	7080
2007	7	13	23	1	36	852417040	29.9467	N	-94.9904	W	-15.72	kA	6	7	13	7170
2007	7	13	23	58	7	663408516	29.8188	N	-94.8301	W	-27.95	kA	9	7	8	7172
2007	7	13	23	10	23	189255853	29.9682	N	-94.9368	W	-30.67	kA	9	10	15	7431
2007	7	13	23	12	22	529360608	29.9281	N	-94.9331	W	-13.75	kA	1	5	5	7600
2007	7	13	23	51	22	312516020	29.8055	N	-94.7924	W	-83.31	kA	11	3	5	7659
2007	7	13	23	4	53	588492996	29.9399	N	-94.9945	W	-14.17	kA	8	8	11	7726
2007	7	13	23	16	24	647535570	29.9166	N	-95.1602	W	-31.62	kA	1	2	4	7846
2007	7	13	23	21	15	10019502	29.9041	N	-95.2141	W	-16.63	kA	1	9	21	8205
2007	7	13	23	4	37	372311663	30.0467	N	-94.9386	W	-45.7	kA	7	16	20	8419
2007	7	13	23	25	46	230141360	29.8413	N	-95.2369	W	-56.79	kA	2	15	42	8573
2007	7	13	23	0	39	361488230	29.9438	N	-95.0013	W	-51.37	kA	12	11	18	8923
2007	7	13	23	22	52	973589845	29.902	N	-95.2159	W	-54.57	kA	1	13	34	9016
2007	7	13	23	12	8	245543839	30.0047	N	-95.0692	W	-52.47	kA	1	14	23	9601
2007	7	13	23	11	25	620448216	29.8434	N	-95.0162	W	-19.39	kA	7	8	16	9937
2007	7	13	23	31	46	118215505	29.8744	N	-95.0886	W	-17.28	kA	5	14	26	10077
2007	7	13	23	27	17	752270045	29.9057	N	-95.1347	W	-11.06	kA	1	9	19	10547
2007	7	13	23	46	34	459278222	29.8217	N	-94.8061	W	-25.64	kA	1	5	8	10639
2007	7	13	23	52	13	585931747	29.973	N	-94.8382	W	-94.41	kA	3	36	62	10708
2007	7	13	23	11	18	124611470	29.8477	N	-95.0029	W	-7.79	kA	1	3	9	10811
2007	7	13	23	19	47	994146399	29.9278	N	-95.1429	W	-14.1	kA	1	3	9	10828
2007	7	13	23	6	58	859731897	29.9368	N	-94.9297	W	16.17	kA	1	10	21	10863
2007	7	13	23	29	18	173104723	29.8278	N	-94.7762	W	-15.5	kA	1	10	20	10923
2007	7	13	23	33	46	203036059	29.893	N	-95.0295	W	-31.34	kA	7	9	14	10960
2007	7	13	23	11	0	501621960	29.8413	N	-94.9399	W	-10.36	kA	1	12	28	10963
2007	7	13	23	5	19	834218760	29.9498	N	-94.9671	W	-28.77	kA	7	25	56	10984
2007	7	13	23	10	28	289898131	29.8224	N	-94.9396	W	-39.29	kA	1	14	26	11033
2007	7	13	23	0	54	790132697	29.9454	N	-94.9898	W	-63.57	kA	4	9	18	11235
2007	7	13	23	34	57	7426740	29.9172	N	-95.0735	W	-7.64	kA	1	13	23	11340
2007	7	13	23	10	2	480928490	29.8793	N	-94.9946	W	-8.64	kA	1	10	23	11349
2007	7	13	23	48	3	497958026	29.8141	N	-94.7978	W	-18.89	kA	1	4	7	11493
2007	7	13	23	1	18	422865467	29.9599	N	-95.0032	W	-57.89	kA	9	13	26	11699
2007	7	13	23	46	50	528900649	29.7912	N	-94.7848	W	-8.36	kA	1	7	18	11712
2007	7	13	23	4	22	501298923	29.9398	N	-94.9494	W	-10.32	kA	1	11	22	11728
2007	7	13	23	35	5	921909675	29.9877	N	-95.1734	W	-7.94	kA	1	8	19	11762
2007	7	13	23	5	34	660976429	29.9653	N	-94.959	W	-29.45	kA	4	9	18	11916
2007	7	13	23	12	18	422893002	29.8419	N	-94.9521	W	-14.12	kA	1	6	23	11997
2007	7	13	23	4	44	713855263	29.9059	N	-94.9784	W	-16.3	kA	1	12	21	12054
2007	7	13	23	33	10	572137334	29.8157	N	-94.8745	W	-9.53	kA	1	3	8	12089
2007	7	13	23	2	12	7303437	29.888	N	-94.9706	W	-32	kA	1	5	6	12375
2007	7	13	23	51	5	989886398	29.8008	N	-94.7835	W	-20.92	kA	1	4	7	12381
2007	7	13	23	17	51	807723789	29.8502	N	-94.9481	W	-18.07	kA	1	22	53	12391
2007	7	13	23	23	31	378421033	29.9203	N	-95.1744	W	-12.23	kA	1	6	16	12400
2007	7	13	23	1	34	198186159	29.9387	N	-94.9797	W	-11.43	kA	1	4	11	12490

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2007	7	13	23	3	26	528265086	29.9289	N	-94.9973	W	-28.88	kA	1	7	16	12494
2007	7	13	23	0	16	374203537	29.9461	N	-94.9733	W	-12.1	kA	1	7	17	12636
2007	7	13	23	13	4	799484483	29.858	N	-94.9354	W	33.76	kA	1	19	38	12756
2007	7	13	23	5	44	602365789	29.9315	N	-94.9524	W	-11.78	kA	2	9	21	12804
2007	7	13	23	2	40	484302248	29.969	N	-94.9805	W	-51.12	kA	2	9	15	12819
2007	7	13	23	1	44	552120589	29.9875	N	-94.967	W	-25.94	kA	2	6	11	12865
2007	7	13	23	7	38	292412986	29.8899	N	-94.9574	W	-18.19	kA	1	15	29	12915
2007	7	13	23	1	27	871394907	29.9405	N	-94.9822	W	-7.1	kA	1	5	16	13491
2007	7	13	23	2	33	434207552	29.943	N	-94.9507	W	-13.69	kA	1	6	13	13847
2007	7	13	23	2	8	204421668	29.9395	N	-94.9953	W	-7.68	kA	1	3	4	14322
2007	7	13	23	4	31	612979171	29.9383	N	-94.9717	W	-9.18	kA	1	2	2	15413
2007	7	14	0	4	44	327825349	29.8059	N	-94.7968	W	-47.86	kA	9	1	1	4788
2007	7	14	0	8	45	314550805	29.7957	N	-94.7725	W	-29.64	kA	3	2	2	7254
2007	7	14	0	6	44	844602998	29.8294	N	-94.783	W	-17.3	kA	4	2	2	7457
2007	7	14	0	7	28	32212242	29.8142	N	-94.7983	W	-48.25	kA	10	2	2	8172
2007	7	14	0	12	4	997848654	29.8305	N	-94.7737	W	-26.18	kA	1	10	11	8459
2007	7	22	12	45	41	258069043	30.0675	N	-95.2661	W	-14.61	kA	1	6	11	7516
2007	7	22	12	49	38	105922478	30.2007	N	-95.3306	W	-12.75	kA	1	9	13	8146
2007	7	22	12	32	2	10002961	30.239	N	-95.3259	W	-16.41	kA	1	13	15	8865
2007	7	22	13	12	40	406108353	30.0379	N	-95.3849	W	-12.3	kA	7	8	12	6189
2007	7	22	13	15	33	214089017	30.0333	N	-95.3829	W	-20.96	kA	5	14	31	7484
2007	7	22	13	24	0	873226944	29.982	N	-95.3288	W	-104.38	kA	2	29	62	8136
2007	7	22	13	18	32	486055205	30.0572	N	-95.3762	W	-9.68	kA	1	24	51	8227
2007	7	22	13	57	49	889053789	29.9851	N	-95.5755	W	-13.97	kA	1	27	59	8653
2007	7	22	13	16	54	564580149	30.0249	N	-95.3567	W	-113.09	kA	3	24	43	9003
2007	7	22	13	57	13	21916577	29.8343	N	-95.4898	W	-23.96	kA	1	9	22	9597
2007	7	22	13	58	32	845521505	29.832	N	-95.5	W	-15.89	kA	1	8	15	10269
2007	7	22	13	5	30	795802298	30.0619	N	-95.3601	W	-7.51	kA	1	5	9	11630
2007	7	22	14	13	51	119773082	29.7964	N	-95.5212	W	-10.56	kA	2	7	18	4394
2007	7	22	14	22	27	587386240	29.7464	N	-95.5526	W	-23.4	kA	3	8	20	4497
2007	7	22	14	19	1	857866136	29.7404	N	-95.5378	W	-28.14	kA	1	7	15	5158
2007	7	22	14	24	5	449967374	29.7461	N	-95.5354	W	-94.76	kA	2	5	9	5417
2007	7	22	14	6	56	540293240	29.8112	N	-95.5007	W	20.68	kA	4	26	55	5551
2007	7	22	14	31	0	329657544	29.7995	N	-95.587	W	-14.17	kA	1	42	103	6008
2007	7	22	14	22	5	814064530	29.8402	N	-95.5478	W	-7.25	kA	1	44	108	6414
2007	7	22	14	32	18	42887339	29.7254	N	-95.5389	W	-24.59	kA	1	39	104	6421
2007	7	22	14	35	30	621660329	29.7944	N	-95.5788	W	-17.35	kA	1	47	103	6687
2007	7	22	14	39	40	252281383	29.6894	N	-95.5581	W	-16.22	kA	1	36	91	7066
2007	7	22	14	13	19	476701866	29.862	N	-95.4253	W	-6.62	kA	1	23	58	7395
2007	7	22	14	20	37	93617360	29.7608	N	-95.5415	W	-13.99	kA	1	49	134	7559
2007	7	22	14	37	42	216349386	29.704	N	-95.5624	W	-7.79	kA	1	25	73	7566
2007	7	22	14	19	28	1025393	29.7555	N	-95.5319	W	-13.26	kA	1	37	104	7640
2007	7	22	14	17	17	836265540	29.7497	N	-95.5314	W	-17.82	kA	1	16	57	8368
2007	7	22	15	31	52	169631722	30.2934	N	-95.6591	W	-8.42	kA	1	21	29	8322
2007	7	22	15	30	25	565070453	30.2879	N	-95.7041	W	18.7	kA	3	15	25	9897
2007	7	22	15	14	36	881548115	30.2922	N	-95.6619	W	-34.39	kA	1	17	23	10603

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2007	7	23	0	46	11	632305051	30.0182	N	-95.2517	W	-14.1	kA	3	1	2	5651
2007	7	23	0	5	14	296247742	30.0217	N	-95.0996	W	-28.88	kA	1	1	1	6345
2007	7	23	0	39	49	787326436	30.0164	N	-95.196	W	-33.28	kA	1	12	22	7670
2007	7	23	0	40	18	693476573	30.0414	N	-95.1811	W	-49.19	kA	1	12	25	7721
2007	7	23	0	35	0	972169948	30.1639	N	-95.3163	W	-12.1	kA	1	7	9	7776
2007	7	23	0	38	53	805420059	30.0679	N	-95.1539	W	-30.23	kA	1	13	23	8031
2007	7	23	0	34	27	286806426	30.0032	N	-95.2168	W	-21.13	kA	2	4	9	8070
2007	7	23	0	53	10	707223641	30.0269	N	-95.2535	W	-14.02	kA	6	10	18	8220
2007	7	23	0	41	2	725109465	30.0185	N	-95.2594	W	-46.77	kA	7	3	5	8256
2007	7	23	0	43	39	57433786	30.0102	N	-95.2028	W	-44.79	kA	1	10	17	8701
2007	7	23	0	45	51	549897753	29.9624	N	-95.2154	W	-46.56	kA	2	10	20	8862
2007	7	23	0	44	37	948351989	30.0631	N	-95.2916	W	-14.56	kA	1	10	21	8895
2007	7	23	0	50	9	383919094	29.9731	N	-95.1929	W	-28.93	kA	1	7	17	8910
2007	7	23	0	45	3	569499354	30.0298	N	-95.2092	W	-17.48	kA	1	8	21	9148
2007	7	23	0	47	3	513641550	30.0098	N	-95.2727	W	-11.6	kA	1	5	8	9452
2007	7	23	0	49	31	365649368	29.9803	N	-95.2236	W	-18.24	kA	5	13	28	9498
2007	7	23	0	45	53	666846943	30.0509	N	-95.3047	W	-15.41	kA	1	4	9	11075
2007	7	23	0	50	56	945708616	30.0024	N	-95.2509	W	-4.98	kA	2	7	11	11595
2007	7	23	1	22	15	206195159	29.5985	N	-95.2586	W	-30.15	kA	1	3	4	5982
2007	7	23	1	58	49	69942035	29.5335	N	-95.3295	W	-13.6	kA	2	13	20	6363
2007	7	23	1	53	44	127089188	29.5313	N	-95.2671	W	-36	kA	8	20	34	7437
2007	7	23	1	59	36	970072136	29.5123	N	-95.1752	W	-27.49	kA	11	23	36	8129
2007	7	23	1	41	57	627432705	29.5446	N	-95.2974	W	-33.98	kA	5	11	20	8271
2007	7	23	1	55	16	518784123	29.6013	N	-95.4	W	-72.37	kA	6	41	80	8779
2007	7	23	1	21	51	570350340	29.6096	N	-95.2393	W	-34.84	kA	1	12	23	9042
2007	7	23	1	46	16	676568921	29.4501	N	-95.2481	W	-53.84	kA	4	36	63	9411
2007	7	23	1	52	36	854913177	29.5212	N	-95.2973	W	-32.38	kA	6	19	37	9554
2007	7	23	1	54	0	317190946	29.5452	N	-95.2794	W	-11.86	kA	2	12	22	10419
2007	7	23	1	54	15	507983334	29.5439	N	-95.2825	W	-7.36	kA	1	15	36	10594
2007	7	23	1	58	0	565841927	29.5038	N	-95.1721	W	-27.44	kA	6	14	27	10614
2007	7	23	1	53	36	917427309	29.5454	N	-95.1735	W	-18.07	kA	1	37	78	10816
2007	7	23	1	59	47	704957336	29.4636	N	-95.3817	W	-7.21	kA	2	29	64	10935
2007	7	23	1	54	46	663680805	29.5082	N	-95.2965	W	25.27	kA	1	30	65	11206
2007	7	23	1	55	34	477187799	29.5601	N	-95.2912	W	-8.38	kA	1	19	42	11720
2007	7	23	2	7	16	181147888	29.4589	N	-95.2077	W	-31.32	kA	6	24	26	7551
2007	7	23	2	1	18	785014219	29.529	N	-95.3806	W	-19.72	kA	5	28	50	7657
2007	7	23	2	41	8	55926546	29.3324	N	-95.1021	W	-24.88	kA	5	7	9	7785
2007	7	23	2	23	34	421702977	29.4268	N	-95.1844	W	-36.11	kA	7	22	31	7825
2007	7	23	2	31	57	311946692	29.3605	N	-95.0789	W	-32.73	kA	9	12	18	8307
2007	7	23	2	28	34	668177087	29.4584	N	-95.221	W	-59.07	kA	3	34	63	8621
2007	7	23	2	17	11	444960461	29.5247	N	-95.4145	W	-47.3	kA	8	65	122	9151
2007	7	23	2	6	57	495590772	29.5548	N	-95.429	W	-35.78	kA	10	33	70	9318
2007	7	23	2	3	40	473297764	29.5284	N	-95.2306	W	-18.68	kA	6	33	70	9351
2007	7	23	2	11	30	937849643	29.5319	N	-95.4006	W	-24.86	kA	6	59	101	9366
2007	7	23	2	13	22	268722150	29.4697	N	-95.1807	W	-43.77	kA	13	25	45	9916
2007	7	23	2	18	0	361537251	29.4296	N	-95.243	W	-15.06	kA	8	47	88	9938

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2007	7	23	2	24	42	840945037	29.4152	N	-95.1951	W	-10.23	kA	1	17	33	9952
2007	7	23	2	2	3	586589030	29.5135	N	-95.221	W	-29.34	kA	6	28	56	10028
2007	7	23	2	45	13	965632797	29.3413	N	-95.2215	W	-33.04	kA	2	60	105	10077
2007	7	23	2	8	46	325593908	29.4675	N	-95.1804	W	-52.71	kA	16	51	89	10117
2007	7	23	2	1	20	901560454	29.5224	N	-95.3297	W	-10.56	kA	1	22	44	10127
2007	7	23	2	3	12	22119616	29.5128	N	-95.2971	W	-13.86	kA	1	38	77	10292
2007	7	23	2	15	16	610884158	29.4986	N	-95.1345	W	-37.92	kA	1	19	36	10338
2007	7	23	2	42	31	477303647	29.3212	N	-95.0821	W	-41.98	kA	12	14	20	10387
2007	7	23	2	16	29	154104845	29.3758	N	-95.1042	W	-50.17	kA	4	36	56	10448
2007	7	23	2	10	11	446334342	29.4415	N	-95.1917	W	-16.84	kA	1	32	70	10481
2007	7	23	2	5	5	394980746	29.5093	N	-95.2124	W	-50.62	kA	4	41	84	10548
2007	7	23	2	36	4	195069097	29.3576	N	-95.061	W	-24.9	kA	6	9	16	10550
2007	7	23	2	33	51	128189463	29.3766	N	-95.054	W	-26.42	kA	2	9	18	10579
2007	7	23	2	8	55	295847949	29.4784	N	-95.1986	W	-14.5	kA	2	21	40	10608
2007	7	23	2	6	35	505556315	29.3854	N	-95.4017	W	23.2	kA	1	47	92	10762
2007	7	23	2	19	19	630966050	29.4076	N	-95.1937	W	15.32	kA	1	21	37	10771
2007	7	23	2	18	59	384562197	29.3762	N	-95.2902	W	-11.3	kA	1	16	31	10944
2007	7	23	2	7	5	517612314	29.5107	N	-95.166	W	-17.69	kA	3	50	101	10973
2007	7	23	2	16	54	137036841	29.4055	N	-95.2231	W	-14	kA	2	37	68	10994
2007	7	23	2	17	25	76901196	29.3698	N	-95.1208	W	-49.99	kA	3	63	137	11056
2007	7	23	2	41	43	862560976	29.339	N	-95.0915	W	-42.14	kA	6	5	8	11058
2007	7	23	2	38	54	215286132	29.3686	N	-95.0815	W	-29.8	kA	3	10	16	11080
2007	7	23	2	10	55	542245152	29.4726	N	-95.3112	W	-6.59	kA	1	31	54	11082
2007	7	23	2	35	35	131326894	29.3302	N	-95.007	W	-34.72	kA	4	15	23	11083
2007	7	23	2	40	9	791678710	29.3562	N	-95.0974	W	-40.11	kA	6	7	15	11090
2007	7	23	2	18	29	892196227	29.4259	N	-95.186	W	-29.21	kA	6	18	39	11094
2007	7	23	2	38	2	992774406	29.3535	N	-95.0851	W	-25.38	kA	3	18	27	11196
2007	7	23	2	15	53	997660618	29.3756	N	-95.2726	W	19.05	kA	1	49	101	11200
2007	7	23	2	15	51	832672815	29.4181	N	-95.2246	W	-7.88	kA	1	21	35	11208
2007	7	23	2	43	53	1495112	29.3044	N	-95.0928	W	-33.71	kA	11	9	12	11222
2007	7	23	2	41	35	211307320	29.3492	N	-94.9644	W	-31.52	kA	4	14	16	11224
2007	7	23	2	21	31	269128825	29.3733	N	-95.334	W	-8.12	kA	1	32	52	11245
2007	7	23	2	12	50	241159397	29.461	N	-95.1828	W	-46.99	kA	12	51	87	11260
2007	7	23	2	34	37	774212588	29.3567	N	-95.047	W	-45.27	kA	7	6	11	11260
2007	7	23	2	38	34	344992883	29.3533	N	-95.1663	W	-20.98	kA	2	5	8	11286
2007	7	23	2	33	35	107383257	29.3593	N	-95.0359	W	-28.64	kA	9	5	8	11338
2007	7	23	2	5	38	570539191	29.4962	N	-95.2366	W	-51.21	kA	10	39	84	11346
2007	7	23	2	40	40	861294333	29.3311	N	-95.0607	W	-36.76	kA	2	31	58	11376
2007	7	23	2	35	24	591650233	29.368	N	-95.0486	W	-17.89	kA	5	5	9	11426
2007	7	23	2	2	47	10963205	29.5035	N	-95.2366	W	-26.51	kA	6	25	46	11487
2007	7	23	2	35	58	5844295	29.3764	N	-95.1278	W	-25.4	kA	7	8	10	11522
2007	7	23	2	41	47	522724461	29.3353	N	-95.0901	W	-12.3	kA	1	8	13	11537
2007	7	23	2	3	4	487105911	29.4355	N	-95.2478	W	-13.5	kA	1	31	64	11560
2007	7	23	2	13	34	262850044	29.4695	N	-95.1835	W	-20.13	kA	5	19	43	11569
2007	7	23	2	37	2	528276902	29.3567	N	-95.0948	W	-40	kA	5	11	17	11575
2007	7	23	2	37	17	599109590	29.3453	N	-95.0603	W	-24.97	kA	5	11	21	11624

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2007	7	23	2	20	0	762797435	29.3573	N	-95.2578	W	-9.32	kA	1	25	54	11648
2007	7	23	2	18	43	156160794	29.4546	N	-95.1322	W	-33	kA	11	17	25	11654
2007	7	23	2	38	37	966513285	29.3472	N	-95.1123	W	-28.71	kA	3	11	15	11667
2007	7	23	2	44	51	777777216	29.3262	N	-95.0892	W	-51.08	kA	6	9	15	11668
2007	7	23	2	17	57	450956788	29.4249	N	-95.1756	W	-9.82	kA	1	25	42	11674
2007	7	23	2	39	9	817266748	29.3474	N	-95.0816	W	-32.06	kA	3	6	7	11755
2007	7	23	2	17	48	870612633	29.3988	N	-95.2387	W	-9.88	kA	1	20	40	11793
2007	7	23	2	45	38	985456689	29.3313	N	-95.0843	W	-45.36	kA	5	26	38	11810
2007	7	23	2	14	37	807879303	29.4359	N	-95.3683	W	-15.93	kA	1	35	75	11825
2007	7	23	2	31	48	286925248	29.329	N	-95.0302	W	-12.49	kA	1	7	13	11825
2007	7	23	2	18	6	438429491	29.4475	N	-95.1845	W	-23.05	kA	5	21	40	11899
2007	7	23	2	38	28	490397062	29.3374	N	-95.0616	W	-34.04	kA	2	10	12	11942
2007	7	23	2	10	30	619115575	29.4475	N	-95.1952	W	-13.21	kA	1	24	41	12005
2007	7	23	2	36	29	529161799	29.3489	N	-95.1212	W	-15.82	kA	1	7	14	12006
2007	7	23	2	19	33	802965501	29.429	N	-95.1785	W	-32.97	kA	5	14	29	12040
2007	7	23	2	25	29	680869219	29.4117	N	-95.1787	W	-10.93	kA	1	7	18	12094
2007	7	23	2	54	17	168666749	29.3063	N	-95.0798	W	-34.08	kA	3	17	29	12150
2007	7	23	2	39	36	653813007	29.3366	N	-95.0667	W	-57.61	kA	6	11	16	12184
2007	7	23	2	23	8	452201164	29.3669	N	-95.2137	W	-12.47	kA	1	7	12	12194
2007	7	23	2	6	4	71586720	29.4967	N	-95.1852	W	-32.95	kA	9	15	29	12224
2007	7	23	2	18	47	313741865	29.3885	N	-95.2263	W	-14.71	kA	1	24	39	12249
2007	7	23	2	44	27	926541973	29.3276	N	-95.0839	W	-27.4	kA	8	20	30	12401
2007	7	23	2	18	15	458115335	29.3565	N	-95.2942	W	-7.95	kA	1	22	39	12423
2007	7	23	2	39	26	124949458	29.3576	N	-95.1005	W	-27.32	kA	4	7	14	12431
2007	7	23	2	34	57	421902668	29.3468	N	-95.0862	W	-9.47	kA	1	8	14	12531
2007	7	23	2	40	32	727047645	29.3113	N	-95.1057	W	-16.96	kA	1	6	9	12553
2007	7	23	2	40	25	680412099	29.3346	N	-95.0715	W	-19.26	kA	2	12	23	12618
2007	7	23	2	40	1	518084966	29.3265	N	-95.0681	W	-26.1	kA	4	13	22	12896
2007	7	23	2	54	8	957001135	29.38	N	-95.062	W	-6.14	kA	1	18	29	12940
2007	7	23	2	37	37	78836189	29.3569	N	-95.1061	W	-49.36	kA	2	5	5	12944
2007	7	23	2	49	59	577480077	29.3005	N	-95.0448	W	-20.81	kA	4	19	39	12987
2007	7	23	2	47	12	871921595	29.3025	N	-95.0909	W	-29.73	kA	9	29	51	13029
2007	7	23	2	46	51	841139536	29.306	N	-95.1837	W	-11.23	kA	1	28	46	13044
2007	7	23	2	48	31	362902562	29.3079	N	-95.0776	W	-37.24	kA	4	22	38	13224
2007	7	23	2	41	24	473630159	29.3509	N	-95.0896	W	-33.04	kA	3	9	18	13228
2007	7	23	2	21	10	570519396	29.3554	N	-95.2452	W	-23.33	kA	1	13	26	13255
2007	7	23	2	44	41	846729560	29.3247	N	-95.0726	W	-35.8	kA	6	14	27	13272
2007	7	23	2	43	39	33414223	29.324	N	-95.0693	W	-28.47	kA	6	13	14	13290
2007	7	23	2	42	48	797728316	29.3434	N	-95.1358	W	-7.2	kA	1	11	17	13336
2007	7	23	2	48	59	428490945	29.3138	N	-95.1314	W	-12.47	kA	2	17	23	13384
2007	7	23	2	34	6	281200614	29.3727	N	-95.0421	W	-43.47	kA	2	7	12	13417
2007	7	23	2	44	13	14366646	29.3103	N	-95.0881	W	-34.5	kA	1	12	18	13441
2007	7	23	2	43	44	284012582	29.3001	N	-95.1587	W	-7.79	kA	1	12	18	13512
2007	7	23	2	46	31	585426355	29.3306	N	-95.2553	W	-6.14	kA	1	24	41	13563
2007	7	23	2	44	20	401911820	29.341	N	-95.0998	W	-48.91	kA	1016	21	13593	
2007	7	23	2	36	18	507740012	29.3439	N	-95.1063	W	-35.41	kA	8	3	6	13648

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	7	23	2	43	58	85278939	29.3194	N	-95.0694	W	-23.68	kA	3	19	32	13654
2007	7	23	2	35	0	727009833	29.3547	N	-95.0499	W	-19.98	kA	2	4	6	13694
2007	7	23	2	46	23	10737446	29.3324	N	-95.1522	W	-9.8	kA	1	21	32	13717
2007	7	23	2	37	57	858454471	29.336	N	-95.089	W	-7.71	kA	1	13	19	13793
2007	7	23	2	37	50	291910731	29.3224	N	-95.0852	W	65.29	kA	1	7	11	13806
2007	7	23	2	42	46	996912690	29.3571	N	-95.1566	W	23.42	kA	1	10	17	14103
2007	7	23	2	38	48	805877461	29.3185	N	-95.1146	W	-19.94	kA	1	5	8	14129
2007	7	23	2	50	30	455308701	29.3232	N	-95.112	W	-10.43	kA	1	16	25	14319
2007	7	23	3	7	43	429303731	29.4814	N	-95.6391	W	-10.08	kA	3	3	5	5356
2007	7	23	3	35	36	522010689	29.3093	N	-95.7607	W	-24.05	kA	3	4	6	6196
2007	7	23	3	33	41	594870761	29.3236	N	-95.7659	W	-33.36	kA	5	3	3	7033
2007	7	23	3	39	51	745164288	29.3183	N	-95.6734	W	-16.8	kA	1	9	17	8649
2007	7	23	3	39	4	626157521	29.4026	N	-95.7215	W	-36.78	kA	1	22	38	9862
2007	7	29	15	52	50	629675495	29.4311	N	-94.9207	W	-30.38	kA	1	2	3	7539
2007	7	29	15	54	21	570673298	29.4592	N	-94.9744	W	-43.81	kA	2	5	6	9706
2007	7	29	15	48	56	695955657	29.4104	N	-94.9188	W	-12.64	kA	1	3	4	10693
2007	7	29	16	14	36	439161152	29.5244	N	-94.9258	W	-92.76	kA	4	2	2	1739
2007	7	29	16	11	29	567020167	29.5314	N	-94.9254	W	-92.09	kA	3	4	4	4429
2007	7	29	16	53	21	947044519	29.6328	N	-94.9817	W	-42.61	kA	2	2	3	5642
2007	7	29	16	43	32	838076707	29.628	N	-94.9777	W	-63.07	kA	2	4	5	6879
2007	7	29	16	4	11	64944319	29.4519	N	-94.8844	W	-70.89	kA	3	1	1	8986
2007	7	29	16	48	49	994108904	29.6303	N	-94.993	W	-10.79	kA	1	11	32	9457
2007	7	29	16	33	32	680486333	29.3469	N	-94.8552	W	-22.07	kA	2	4	4	9472
2007	7	29	16	33	40	429198989	29.5202	N	-94.8741	W	-64.44	kA	3	23	46	10476
2007	7	29	16	3	11	34914973	29.5054	N	-94.9702	W	-6.62	kA	1	9	17	10604
2007	7	29	16	16	42	601519283	29.4964	N	-94.8712	W	49.28	kA	1	12	28	10948
2007	7	29	16	46	36	447257235	29.6423	N	-95.0047	W	17.17	kA	1	6	12	11201
2007	7	29	16	6	12	918849501	29.5233	N	-94.9477	W	-18.02	kA	1	3	7	11425
2007	7	29	16	18	17	94576975	29.5369	N	-94.9045	W	17.39	kA	1	5	8	12484
2007	7	29	16	5	32	130071663	29.5154	N	-94.9571	W	-10.03	kA	3	5	9	13238
2007	7	29	17	40	48	310042378	29.8482	N	-95.1695	W	-9.84	kA	1	2	2	3427
2007	7	29	17	58	36	62707231	29.8674	N	-95.209	W	28.75	kA	2	5	6	4902
2007	7	29	17	22	3	62087138	29.8145	N	-94.8614	W	-10.14	kA	6	1	2	4967
2007	7	29	17	2	10	624756092	29.7304	N	-95.115	W	-18.76	kA	3	3	10	5799
2007	7	29	17	5	25	105326381	29.7436	N	-94.9814	W	-5.14	kA	5	2	2	6001
2007	7	29	17	41	45	725364130	29.8596	N	-95.1863	W	-13.89	kA	1	3	6	6126
2007	7	29	17	52	23	694946385	29.8629	N	-95.2216	W	-16.54	kA	1	3	5	6208
2007	7	29	17	42	34	902009771	29.8848	N	-95.2146	W	-11.67	kA	1	1	3	6480
2007	7	29	17	25	5	811244976	29.8042	N	-94.8783	W	-42.85	kA	4	3	3	6813
2007	7	29	17	26	4	54547478	29.7979	N	-94.871	W	-21.81	kA	3	1	1	7623
2007	7	29	17	46	59	607282455	29.8665	N	-95.1774	W	-9.36	kA	2	3	8	7707
2007	7	29	17	43	35	344745704	29.8326	N	-95.1243	W	-18.85	kA	1	5	12	7881
2007	7	29	17	28	22	746968590	29.8122	N	-94.8487	W	-24.66	kA	3	5	6	8205
2007	7	29	17	42	13	597663453	29.8474	N	-94.8355	W	-24.2	kA	1	9	11	8640
2007	7	29	17	32	26	379774590	29.8315	N	-94.8275	W	-44.42	kA	3	5	8	8651
2007	7	29	17	9	24	686158769	29.7405	N	-95.1045	W	-11.41	kA	1	6	19	8926

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	7	29	17	35	4	813243667	29.8591	N	-94.8376	W	-34.39	kA	1	5	9	8986
2007	7	29	17	29	18	816542796	29.7649	N	-94.8339	W	-53.78	kA	1	11	20	9097
2007	7	29	17	34	9	472000492	29.8665	N	-94.7904	W	-32.25	kA	1	6	12	9234
2007	7	29	17	36	25	438346303	29.8466	N	-94.7825	W	-27.08	kA	1	9	12	9247
2007	7	29	17	29	59	652163440	29.7453	N	-94.8177	W	-36.96	kA	1	8	15	9644
2007	7	29	17	18	15	257871582	29.7351	N	-94.8177	W	-92.81	kA	1	6	9	9880
2007	7	29	17	33	15	200384495	29.7916	N	-94.8476	W	-20.29	kA	1	5	10	9880
2007	7	29	17	27	37	91879359	29.8082	N	-94.8657	W	-15.02	kA	1	2	3	11465
2007	7	29	17	12	50	576777586	29.7323	N	-94.9055	W	-21.33	kA	1	6	11	11721
2007	7	29	18	45	26	595285738	29.7817	N	-95.4771	W	-18.3	kA	3	9	25	3973
2007	7	29	18	33	34	228616189	29.8097	N	-95.4918	W	-18.5	kA	2	4	15	4319
2007	7	29	18	52	5	541981075	29.8357	N	-95.4503	W	-13.82	kA	6	11	25	4812
2007	7	29	18	7	47	706706882	29.8976	N	-95.1694	W	-5.79	kA	1	7	10	5451
2007	7	29	18	2	6	440410109	29.8672	N	-95.2033	W	-19.55	kA	5	7	17	5949
2007	7	29	18	22	19	489975465	29.9256	N	-95.1144	W	-29.06	kA	2	3	4	6106
2007	7	29	18	54	27	617147272	29.9375	N	-95.5245	W	-9.29	kA	1	10	21	6225
2007	7	29	18	23	46	353507655	29.9179	N	-95.1306	W	-22.74	kA	2	1	1	6262
2007	7	29	18	39	15	722655003	29.8705	N	-95.5345	W	-12.27	kA	3	5	9	6370
2007	7	29	18	49	7	909935320	30.1769	N	-94.8488	W	-15.82	kA	3	1	1	6443
2007	7	29	18	53	59	866373901	29.845	N	-95.4252	W	-28.34	kA	10	14	31	6499
2007	7	29	18	41	56	969861085	30.1509	N	-94.8635	W	-9.66	kA	2	1	1	7186
2007	7	29	18	59	7	591567238	29.3813	N	-95.6252	W	-35.67	kA	1	5	9	7355
2007	7	29	18	57	53	340828081	29.3784	N	-95.5841	W	-21.09	kA	2	2	2	7458
2007	7	29	18	40	11	203316629	29.8251	N	-95.4303	W	-56.24	kA	1	11	32	7943
2007	7	29	18	56	39	25153037	29.3589	N	-95.5911	W	-22.07	kA	2	3	4	8246
2007	7	29	18	18	11	728844059	29.9734	N	-95.1279	W	-11.71	kA	5	12	21	8464
2007	7	29	18	46	10	792257558	30.1644	N	-94.8314	W	-22.87	kA	3	3	4	8527
2007	7	29	18	35	29	811140904	29.886	N	-95.5252	W	-49.69	kA	1	15	33	8671
2007	7	29	18	42	40	889211019	30.127	N	-94.8424	W	-43.51	kA	4	6	8	8748
2007	7	29	18	49	38	30310376	29.7933	N	-95.3948	W	-56.09	kA	1	18	56	8816
2007	7	29	18	51	30	319057244	30.0003	N	-95.5464	W	-20.76	kA	1	12	23	9014
2007	7	29	18	10	24	58356056	29.989	N	-95.1459	W	-35.24	kA	2	12	21	9103
2007	7	29	18	47	17	11309675	30.1329	N	-94.8119	W	-70.61	kA	1	9	14	9320
2007	7	29	18	32	42	613259746	29.8042	N	-95.4935	W	-12.1	kA	1	7	18	9641
2007	7	29	18	50	43	29153209	29.8655	N	-95.4505	W	-7.44	kA	2	9	26	10076
2007	7	29	18	27	14	54676439	30.1082	N	-94.9367	W	-10.32	kA	1	4	7	10167
2007	7	29	18	30	9	589125219	30.0912	N	-94.8945	W	-11.3	kA	1	8	14	10338
2007	7	29	18	53	37	40271743	30.1548	N	-94.7875	W	-38.31	kA	3	2	3	10524
2007	7	29	18	59	14	23722596	30.025	N	-95.5349	W	-54.83	kA	6	18	31	10632
2007	7	29	18	20	30	498225801	29.917	N	-95.1146	W	-16.93	kA	2	7	13	10789
2007	7	29	18	42	47	354025195	29.8152	N	-95.5119	W	-10.16	kA	1	7	19	10839
2007	7	29	18	37	3	965124417	29.8743	N	-95.4842	W	-9.47	kA	1	5	14	11017
2007	7	29	18	56	37	793657909	29.9784	N	-95.619	W	-7.29	kA	2	14	35	11431
2007	7	29	18	47	12	636263728	29.8481	N	-95.5272	W	-7.44	kA	1	11	30	11681
2007	7	29	19	35	3	271946393	29.3279	N	-95.2622	W	-11.6	kA	1	1	1	2253
2007	7	29	19	14	29	84417035	29.6275	N	-95.5191	W	-22.51	kA	3	4	9	4526

YEAR	MO	DY	HR	MN	SE	NANO	LAT		LON		PK CUR		MULT	H	V	AVG HGT
2007	7	29	19	54	33	186437114	29.6607	N	-95.4406	W	-63.86	kA	2	13	34	5292
2007	7	29	19	48	13	177733062	29.6504	N	-95.4792	W	-20.02	kA	3	9	16	5349
2007	7	29	19	27	52	372669984	29.5749	N	-95.535	W	-29.67	kA	9	4	13	5378
2007	7	29	19	35	14	468615362	29.612	N	-95.5441	W	-25.96	kA	7	6	21	5520
2007	7	29	19	37	42	225253299	29.3201	N	-95.3043	W	-35.56	kA	6	4	6	5523
2007	7	29	19	43	32	146239555	29.6456	N	-95.4835	W	-20.66	kA	5	10	32	5529
2007	7	29	19	51	1	195511326	29.6529	N	-95.43	W	-28.32	kA	10	9	39	5534
2007	7	29	19	49	21	780731203	29.6633	N	-95.4688	W	-25.83	kA	5	12	32	5612
2007	7	29	19	17	38	533165033	30.0342	N	-95.4069	W	-15.72	kA	3	7	12	5831
2007	7	29	19	21	44	287752986	29.5555	N	-95.5347	W	-21.27	kA	3	2	9	5835
2007	7	29	19	8	56	965934310	29.6111	N	-95.5349	W	-24.36	kA	2	4	8	5889
2007	7	29	19	6	39	995981285	29.9437	N	-95.5132	W	-50.69	kA	5	10	11	5894
2007	7	29	19	45	34	364404292	29.653	N	-95.4777	W	-38.59	kA	8	10	22	5945
2007	7	29	19	36	28	977549693	29.6115	N	-95.5625	W	-81.97	kA	7	11	19	6192
2007	7	29	19	53	5	451355336	29.6533	N	-95.4234	W	32.13	kA	5	16	34	6221
2007	7	29	19	20	2	857549829	29.5318	N	-95.5431	W	-27.82	kA	3	3	5	6345
2007	7	29	19	26	12	846925421	29.5592	N	-95.5395	W	-27.77	kA	3	7	13	6579
2007	7	29	19	18	32	498052242	29.5486	N	-95.5459	W	26.58	kA	3	3	4	6583
2007	7	29	19	4	3	897587637	29.939	N	-95.5116	W	16.91	kA	5	7	14	7072
2007	7	29	19	56	7	103782683	29.6856	N	-95.3839	W	-35.41	kA	1	10	35	8056
2007	7	29	19	6	23	96606808	29.3266	N	-95.5714	W	-41.98	kA	2	8	13	8113
2007	7	29	19	12	42	610110049	29.5587	N	-95.5422	W	-23.88	kA	2	9	26	8270
2007	7	29	19	15	36	336966676	29.5628	N	-95.5327	W	-21.16	kA	1	8	15	8491
2007	7	29	19	19	2	500929128	29.644	N	-95.5312	W	-16.58	kA	1	3	4	9516
2007	7	29	19	31	20	59941526	29.6136	N	-95.5789	W	-52.58	kA	2	10	35	9615
2007	7	29	19	1	5	345041918	30.0117	N	-95.4891	W	-50.43	kA	1	12	30	9902
2007	7	29	19	43	13	86741199	29.6389	N	-95.4835	W	-15.69	kA	1	9	23	10440
2007	7	29	19	1	1	786152988	29.8565	N	-95.4773	W	-13.8	kA	1	17	36	10830
2007	7	29	19	46	40	927828117	29.652	N	-95.4852	W	-21.07	kA	1	10	26	10832
2007	7	29	19	32	54	865848735	29.5777	N	-95.5732	W	-5.98	kA	1	16	37	10972
2007	7	29	19	34	51	96941534	29.606	N	-95.5342	W	-13.41	kA	1	12	30	11182
2007	7	29	19	52	3	485989479	29.6519	N	-95.4096	W	-13.1	kA	1	4	10	12179

APPENDIX C.

LDAR SITE LOCATIONS

Number (From 5.1)	System Number	Name
1	3	Impact Weather (Hobby Airport)
2	6	San Jacinto College North
3	7	North Harris County Community College
4	9	Cy-Fair ISD
5	2	Barker Dam (US ACE)
6	4	Sugarland Airport
7	10	Houston Southwest Airport (Arcola)
8	8	Alvin ISD
9	2	Johnson Space Center
10	11	Houston Raceway (Baytown)
11	5	May Community Center
12	12	Williams Airport (Porter)

VITA

Joseph William Jurecka received his Bachelor of Science degree in Electronics Engineering Technology with a specialty in telecommunications from Texas A&M University in College Station in 1994. Upon graduation, he enjoyed a career at Nortel Networks in Richardson, TX in a variety of roles ranging from field installation to network planning to product management in the Wireless Networks division. Mr. Jurecka wished to change careers and elected to return to Texas A&M University to pursue a Master of Science degree. He entered the Atmospheric Sciences program at Texas A&M University in June 2006 and received his Master of Science degree in August 2008. His research interests include operational meteorology with special emphasis on lightning, radar, and mesoscale convection.

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