INVESTIGATION OF SEISMICITY AND UPLIFT PATTERNS ABOVE THE SOCORRO MAGMA BODY IN CENTRAL NEW MEXICO INCLUDING CHARACTERIZATION OF THE AUGUST 2009 MICROEARTHQUAKE SWARM

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SUMMARY

Anomalously high seismicity and uplift have been observed in the central Rio Grande rift near Socorro, New Mexico since the mid-nineteenth century (Sanford et al, 2002, 2006; Larsen et al., 1986). Seismic observations led to the discovery of the mid-crustal sill-like intrusion called the Socorro magma body (SMB). Temporal and spatial clusters of seismic events are commonly observed above the SMB, often in repeated locations over decadal time scales. Long-term uplift rates up to ~2.5 mm/yr have been reported from repeated leveling surveys as well as from InSAR imaging data (e.g. Fialko and Simons, 2001; Finnegan and Pritchard, 2009). We locate and study seismicity patterns to investigate the relationships between seismicity, vertical deformation, and the evolution of the SMB.

Chapter 1 focuses on exploring the relationship between seismicity and uplift. We located 804 earthquakes from June 2007 through December 2009 occurring in the SMB region (Appendix A). Using waveform-cross-correlation phase adjustment techniques, we relocated 480 of these events that occurred in spatial clusters. We incorporate relocated catalogs going back to September 2004 and find that most, ~67%, of these events occur in areas of uplift as opposed to areas of subsidence or neutral areas. Of 804 events, 431 were part of the 26-day August 2009 seismic swarm. Events for the swarm and the entire catalog show a magnitude distribution similar to those of other continental rift zones.

The August 2009 microearthquake swarm is discussed in more detail in Chapter 2. 431 events occurred between 20 August 2009 and 14 September 2009.

We relocated 374 of these highly similar events that occurred in a concentrated volume, 34.5 km^3, starting on 23 August 2009. We examine the spatial distribution of this concentrated activity and find weak east-west migration. We use focal mechanisms, frequency-magnitude statistics, aftershock decay rates, and frequency-time and moment-time histories to further characterize the swarm. We also compare this swarm in detail to the October 2005 sequence to characterize variability in SMB swarm behavior and characteristics.

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1.1 Abstract

The Socorro magma body (SMB) is a large mid-crustal sill-like intrusion associated with seismicity and vertical deformation in the central Rio Grande rift, New Mexico. Microearthquake swarms with highly similar waveforms are characteristic of the seismicity above the SMB and, coupled with uplift rates of ~2.5 mm/yr, suggest fluid-flow or magma movement associated with the SMB. We present a seismicity catalog for central New Mexico from June 2007 through December 2009 that includes 804 events of M_d 2.5 and lower. More than half of the events during this 31-month period occurred over 26 days during the August 2009 microearthquake swarm. We relocated 480 of the microearthquakes using cross-correlation-based phase repicking methods based on initial spatial clustering. SMB seismicity dating back to September 2004 shows characteristics typical of normal non-volcanic intraplate seismicity. Approximately 67% of earthquakes from September 2004 to December 2009 occurred in areas of uplift, while only 8% occurred in areas of subsidence.

1.2 Introduction

Earthquake swarm sequences are spatially and temporally correlated groups of events most commonly found in volcanic regions but present in many inter- and intraplate regions (e.g. Sykes, 1970; Smith and Sbar, 1974; Brandsdottir et al., 1979, Vilardo et al., 1991). Seismicity in continental rift systems (e.g. Eger rift, Kenya rift, Rio Grande rift) is commonly characterized by earthquake swarms associated with magma bodies at depth (Ibs-von Seht et al., 2008). The migration of hydrothermal, magmatic, or volcanic fluids, the existence of concentrated stresses in a highly fractured, highly heterogeneous subsurface, and/or the succession of many small shear failures are among the suggested mechanisms for swarm generation (e.g. Mogi, 1963; Sykes, 1970; Hill, 1977; Shelly et al., 2009). Several earthquake swarm regions with associated magma bodies also have uplift correlated with high seismicity (e.g. Long Valley caldera, Campi Flegrei, Yellowstone).

Spatial and spatio-temporal clusters of events (Fig. 1.1) have dominated seismicity in the Socorro area of the Rio Grande continental rift extending to the mid-nineteenth century (Reid, 1911; Sanford and Holmes, 1962; Sanford et al., 2002, 2006). About half of all events occur during distinct earthquake swarm sequences, although spatial clustering of events over yearly time scales also exists (Sanford et al., 2002, 2006). The anomalously high seismicity in this part of the Rio Grande rift is associated with the presence of the Socorro Magma Body (SMB). The SMB sits at a mid-crustal depth of ~19-km with an area of >3400 km^2 and a total thickness of <150 m (Balch et al., 1997). The sill-like intrusion was discovered through the observation of reflected seismic phases as early as the 1960s with reflection coefficients in agreement with an underlying low-velocity, molten layer and P-wave reflection variability suggesting a multi-layered intrusion (Sanford and Long, 1965, Rinehart et al., 1979; Brocher, 1981; Ake and Sanford, 1988). Typical hypocenter depths are in the upper 10 km of crust implying a plastic, aseismic zone due to SMB heat and/or fluids up to 9 km above the magma body surface (Brocher, 1981; Rinehart et al, 1981; Sanford et al, 1983). The presence of an additional phase seen repeatedly on local seismograms recorded from intermediate- and deep-focus earthquakes at distances near 90° supports the existence of an active conduit system beneath the SMB (Schlue et al., 1996). Heat flow studies by Reiter (2005) suggest semi-brittle zone model temperatures of ~200 - 300° C for depths from ~6 – 10 km in the central to northern SMB region. The high seismicity and evidence for a root structure suggest the SMB is currently active. Another interesting observation to support ongoing, recent (centuries) magmatic activity is anomalous vertical deformation in the SMB region of the Rio Grande rift.

Repeated leveling surveys from 1909 to 1979 were used to estimate an area of crustal doming no less than 7,000 km^2 with average continuous uplift estimated at ~5 mm/yr (Reilinger and Oliver, 1976; Reilinger et al., 1980). Larsen et al. (1986) also performed leveling surveys in 1911, 1951, and 1980-1981 that measured average uplift of a few millimeters per year. InSAR imaging during 1992 - 1999 suggests a volume-increase rate of 6-8 x 10^{-3} km^3/yr if steady-state elastic inflation were assumed, however the authors shed light on thermodynamic arguments that make this seem unlikely (Fialko and Simons, 2001). The most recent uplift estimates from InSAR data (1992 – 2006) suggest a maximum uplift rate of ~2.5 mm/yr (Finnegan and Pritchard, 2009). Finnegan and Pritchard (2009) also found that 25 – 50 m, at most, of cumulative surface uplift has occurred since the middle Pleistocene with no requirement for long-term uplift and, based on geomorphic evidence and thermal arguments, suggest that uplift is either recent (within centuries) or that long-term uplift and subsidence are essentially equal.

The high seismicity, uplift anomaly, and evidence for the existence of a root structure (Schlue et al., 1996) suggest current inflation of the SMB. In this chapter, we present a relocated catalog of seismicity from June 2007 through December 2009 that includes the very active August 2009 microearthquake swarm. We examine the relationship between seismicity and uplift above the Socorro magma body and compare it to other regions with swarm events and uplift. We also use magnitude statistics and time histories dating back to September 2004 to better understand this complex active system.

1.3 Methods

Data Recording

Data is recorded on 10 short-period (1 Hz) Socorro Seismic Network (SSN) vertical component seismic stations sampling at a rate of 100 Hz (Fig. 1.1). Observations were also recorded on 10 to 25 broadband EarthScope Transportable Array stations (40-Hz sampling rate) deployed in New Mexico in 2008 and 2009. We used this data to better locate 6 events that were part of the August 2009 swarm. These 6 events were also recorded on the Global Seismic Network station ANMO located north of the SMB. We located 804 earthquakes between 01 June 2007 and 31 December 2009. Four hundred and thirty-one of these events occurred as part of the August 2009 swarm sequence. Four hundred and eighty events, more than half the catalog, were relocated using cross-correlation-based seismic phase repicking methods outlined below.

Initial Processing

Events are initially identified via visual inspection of online helicorder records kept by the SSN. We use the SEISMOS earthquake location algorithm specifically developed for the SMB region (Hartse et al., 1992) to estimate location parameters based on analyst-identified arrival times of P and S phases, and S to P (SzP) and S to S (SzS) top-side SMB reflections where observed. We weight the initial arrival times of direct and SMB-reflected phases from at least three stations (Fig. 1.2). We use a generalized least-squares solution and minimized 2-norm travel-time errors and incorporate a region-specific velocity model to estimate source locations (Hartse et al., 1992). The 1-D velocity model includes a low-velocity sill at 19-km depth to better constrain depth estimates when SMB-reflected phases are observed (Hartse et al., 1992). Local duration-based magnitudes (M_d) that are comparable to moment magnitudes are calculated for all events using a local magnitude formula:

$$M_d = 2.79 \log_{10} (\tau_d) - 3.63, \qquad (1.1)$$

where τ_d is the duration of the signal above background noise in seconds (Ake et al., 1983).

Waveform Cross-Correlation Technique

When separate but similar earthquakes occur nearby to each other, seismic waveforms recorded at individual stations will commonly be very similar despite vast differences in waveforms from the same event recorded at different stations

(Shearer et al., 1997). Seismic sequences such as aftershock groups or earthquake swarms generally include large numbers of events in small areas. The similarity of events in these seismic sequences is taken advantage of by matching and/or shifting phase arrival picks for individual events in time based on high correlation coefficients (e.g Shearer, 1997; Rowe et al., 2002). Differential times computed for events on a station-by-station basis provides a consistency of picks that cannot be achieved through analyst-defined picking. These techniques have been applied to a variety of seismic sequences including mainshock-aftershock, reservoir-induced, swarm, and seismic tremor (e.g. Shearer, 1997; Rowe et al., 2002; Shelly et al., 2009). Cross-correlation repicking methods can be used to improve absolute and relative locations of groups of similar events and to resolve structural features (e.g. Shearer, 1997; Rowe et al., 2002; Shelly et al., 2009). Waveform cross-correlation can also be used to identify events in continuous data based on similarity to a master event, greatly reducing analyst workload (Stankova et al., 2008; Shelly et al., 2009) These methods have been applied to spatially clustered events over month- to year-long time periods in the SMB region with success in reducing location uncertainties (Stankova et al., 2008; Morton, 2008).

1.4 Results

In the 31-month period between June 2007 and December 2009, 9 clusters of events were identified based on initial spatial correlation including one group of events that is also temporally clustered (Fig. 1.3). For each of the clusters, all event waveforms for one phase on one station are windowed 5 samples before and 95 samples after the analyst-picked phase arrival. Correlation coefficients are computed for the raw data and events meeting the correlation threshold of 0.55 are then lag-adjusted at the sample level in an iterative process to achieve the highest possible correlation coefficient (Fig. 1.4). We weight the lag adjustments based on individual event correlation coefficients so that the adjustments are refined to the sub-sample level (Fig. 1.4). After the picks are adjusted, we use the location algorithm to relocate the events. Cross-correlation results and information for each cluster are shown in Table 1.1.

1.5 Discussion of Results

Cross-Correlation Results

Epicentral standard deviations decreased as much as 0.3 km, however the vast majority of events had very small improvements close to zero. The average changes in location after cross-correlation ranged from 0.083 – 2.17 km without a clear dependence on initial cluster area or average correlation indicating that 0.55 was an acceptable correlation threshold for pick adjustment. Correlation coefficients for P-picks on station BAR were computed to compare similarity within each of the clusters. The average correlation coefficients ranged from 0.564 to 0.723 for clusters 1 through 8, but was significantly higher, 0.884, for temporal cluster 9 (Fig. 1.3). Correlation coefficients were calculated using a length of 1 s (100 samples).

Cluster 1 includes 11 events occurring between 15 August 2008 and 24 October 2009. These events occurred within an area of ~7 km^2 with a density of 1.57 events/km^2 and average correlation coefficient (for P-picks on station BAR) of

0.564 (Fig. 1.5). Cluster 1 was also active between 5 December 2004 and 29 March 2006 (Morton, 2008) with a similar event density of 1.53 events/ km^2. Only two events from 1968 to 2004 have been recorded in this area (Sanford et al., 2002, 2006). Focal mechanisms computed for events by Morton (2008) show north-south oriented normal fault motions fitting well with faults in the area. The cluster could be related to a southward extension of the Cliff Fault from the north, which would explain repeated seismicity in this area.

Cluster 2 is a group of 22 events from 3 December 2007 to 6 November 2009 with an event density of 0.47 events/km^2 and average correlation coefficient of 0.671 (Fig. 1.6). Eight of these events were part of the August 2009 earthquake swarm, including a M_d 2.3 event on August 20, 2009, the first event of that swarm sequence. Nine events from January 2005 to December 2005 also occurred in the central part of this cluster area with a high event density of 3.55 events/km^2 (Morton, 2008). Eight events from 1968-2004 occurred in this location as well. Despite continued activity on decadal time scales, connections between seismicity and faults in this area remain unclear.

Six events were relocated for Cluster 3 covering a time period from 21 April 2008 to 27 September 2009. The events in this highly faulted area had a density of 0.59 events/km^2 and correlation coefficient of 0.610 (Fig. 1.6). This northwest portion of Cluster 3 was also active with 21 events occurring in 2005, mainly as part of the October 2005 swarm sequence, with a higher event density of 1.92 events/km^2 (Morton, 2008). Focal mechanisms for the 2005 events from Morton (2008) are generally north-northwest striking normal faults that agree nicely with mapped faults in the area (Fig. 1.6). Seismic swarms in May and July 1983 also locate in this general area, indicating active clustering over decadal time scales.

Cluster 4 consists of 16 events from 14 April 2008 to 25 November 2009 with an event density of 0.45 events/km^2 and average correlation of 0.723 (Fig. 1.6). Inside the boundaries of Cluster 4, 12 events occurred between 31 October 2004 and 6 May 2006 with an event density of 1.01 events/km^2 (Morton, 2008). Twelve events from 1968 to 2004 occurred in this region as well. The high seismicity in this area is reasonable considering the greater number of mapped faults here than compared to other areas above the SMB. Mechanisms for events in 2005 were consistent with the area exhibiting normal fault motion on northwest-southeast and north-northwest striking fault planes (Morton, 2008).

Cluster 5 includes 7 events from 19 May 2008 to 9 November 2009 with a correlation coefficient of 0.606 and event density of 0.20 events/km^2 (Fig. 1.6). Similar event densities, 0.27 events/km^2, were found for 12 events from 14 December 2004 to 20 January 2006. These events were found to be consistent with the general northwest-southeast striking faults, although some dextral strike-slip is suggested on a southwest dipping fault plane (Morton, 2008). Five events from 1968-2004 occurred in this area as well (Sanford et al., 2004, 2006).

Cluster 6 is a group of 9 events from 12 January 2008 to 27 August 2009 with an average correlation of 0.687 and event density of 0.62 events/km^2 (Fig. 1.5). Seven additional events occurred between 6 January 2005 and 4 September 2005 with an event density of 1.96 events/km^2 (Morton, 2008). Nineteen events $M_d > 2$ from 1968 to 2004 occurred in this area as well (Sanford et al., 2004, 2006). These events are likely related to the north trending normal fault (Cliff fault, down to left) shown in figure 1.5. This is the most active seismic cluster over decadal time scales and it nearly coincides with the highest central uplift (Fig. 1.7).

Cluster 7 consists of 10 events from 12 March 2009 to 14 September 2009 with event density of 0.24 events/km^2 and mean correlation coefficient of 0.699 (Fig. 1.5). From 21 December 2004 to 31 December 2006, 7 events occurred in this same area with an event density of 1.34 events/km^2 (Morton, 2008). Additionally, 12 events occurred between 1968 and 2004, suggesting that this is another area that has been active in the past (Sanford et al., 2004, 2006).

Cluster 8 includes 25 events from 3 January 2008 to 10 December 2009 with an event density of 0.21 events/km^2 and average correlation of 0.603 (Fig. 1.5). Sixteen of these events occurred during and after the August 2009 swarm, 20 August 2009 to 10 December 2009. There is no history of clustering in this area, suggesting it became active over 2008 and 2009. Roughly north-striking normal faults are likely causes of the seismicity here as well as in most of the SMB region.

Cluster 9 is the only temporally-correlated cluster including 374 concentrated events from 00:00 (UTC) 23 August to 00:00 (UTC) 15 September 2009 (Fig. 1.5). The event density is 12.6 events/km^2, significantly higher than all other clusters. The average correlation coefficient for P-picks on station BAR is 0.884, also significantly higher than the other clusters. This indicates that temporally and tightly clustered groups of events are better correlated than variably timed events in spatial clusters. The August 2009 activity is clearly the largest swarm sequence to occur since 2004 (Fig. 1.8B). The background seismicity in the swarm area was 8 events/year from September 2004 to December 2009 and only 2 events M_d > 2 occurred in this area from 1968 to 2004 (Sanford et al., 2002, 2006). This suggests that the August 2009 swarm represents an area of new activity, possibly due to rapid or spatially dependent evolution of the SMB. It is possible that these events locate on the Veranito fault (Cather et al., 2004), a north-striking, west-dipping normal fault, because projections of the fault surface intersect the events at depth. However, it is unclear what this fault does in the subsurface and the events show some shallowing possibly due to another fault plane at depth.

Seismicity Characteristics

We calculated well-constrained depths for 466 events using SMB top surface reflection arrivals during the location process (Appendix A). Approximately 97% of these 466 events located at depths from 0 – 10 km, typical of the SMB region, with only 14 events locating from 10 - 18 km. Events below 10 km are not common in this area because of a suggested plastic, heated zone up to 9 km above the SMB (Brocher, 1981). No patterns were observed in the waveforms, locations, or timing of these deeper events.

Local duration magnitudes ranged from -1.7 to 2.5 with a mean of M_d 0.3. There were only six events greater than M_d 2.0 during the 31-month period. The *b*-value of an earthquake catalog is the negative slope of the logarithmic frequency-magnitude relation suggested by Gutenberg and Richter (1944). Typical mainshock-aftershock sequences and global catalog estimates exhibit *b*-values near 1, however *b*-values in volcanic and earthquake swarm regions are often much larger than 1

(Gutenberg and Richter, 1944; Hill et al., 2003; Kurz et al., 2004). To get a better estimate of seismicity characteristics, we include data from Morton (2008) and Stankova et al. (2008) to complete the entire relocated catalog of SMB seismicity from September 2004 to December 2009. The *b*-value of the entire catalog of seismicity based on local magnitudes 0 – 2.5 is 1.1, typical of non-volcanic intraplate regions (Fig. 1.8). The *b*-value of the August 2009 earthquake swarm alone is 0.9 (Fig. 1.8). To estimate errors for the *b*-value statistics, we resampled the data 100 times using the bootstrap method, computed 100 *b*-values using the resampled data, and use the standard deviation of those data, which are approximately Gaussian, to estimate errors for the original statistic. The computed first standard deviations are 0.08 for the *b*-value of the entire catalog and 0.09 for the 2009 swarm. These *b*-values suggest that seismicity above the SMB is governed by faulting processes rather than direct magmatic or volcanic interaction with the crust. The lower *b*-value observed for the swarm than for the entire five-year catalog is likely due to the swarm including four of the largest events typically seen in this area ($M_d > 2$).

Another well-studied swarm in the Socorro area occurred over a 32-day period starting in October 2005 (Stankova et al., 2008). This swarm included 85 events with the greatest magnitude reaching M_d 2.4. The cumulative moment release for the October 2005 swarm was an order of magnitude lower than for the August 2009 swarm. The *b*-value of the October 2005 swarm was ~1.3, higher than for the August 2009 swarm and the five-year catalog. Estimates of *b*-values in similar continental rift systems such as the Lake Magadi region of the Kenya rift, a part of the East African rift system, and the NW-Bohemia/Vogtland area in the Eger rift, part of the European Cenozoic rift system as well as in the Rio Grande rift prior to 2004 are ~0.8 (Ibs-von Seht et al., 2008). The similar *b*-value of the August 2009 swarm suggests that SMB seismicity is more characteristic of continental rifting than magmatic and volcanic earthquake swarm regimes.

Seismicity and Uplift

We used InSAR line-of-sight velocity data from Finnegan and Pritchard (2009) to correlate seismicity and vertical deformation above the SMB (Fig. 1.7). Maximum uplift rate estimates are ~2.5 mm/yr for 1992 - 2006 (Finnegan and Pritchard, 2009). We used 132 0.1° X 0.1° bins (Fig. 1.7) to explore the data by assigning each bin to be one of three area categories: uplift (47 bins), subsidence (45 bins), or neutral (40 bins). Bin categories were designated when over 60% of a bin area was of that category. In areas of no data, we interpolated the available rates by eye where three sides were of one category. Data is not available in some areas because of surface water, farming, or atmospheric effects that change too often to be used. We found that 68.2% of earthquakes from September 2004 through December 2009 located in areas of uplift, while only 16.2% occurred in areas of subsidence. Less than 15.6% of events occurred in areas of transition between uplift and subsidence. Using the catalog dating back to 1968, similar percentages were found with 66.6% of events in uplift areas, 18.3% in subsidence areas, and 15.1% in neutral areas.

We also binned the earthquake data by cumulative moment to compare the sizes of events with the uplift areas. Moments were calculated based on local duration magnitudes using this formula:

$$\log_{10}(M_o) = 1.5M_w + 16.1 \qquad (1.2)$$

from Stein and Wysession (2003) where M_0 is moment and M_w is magnitude (Fig. 1.8). About 93% of the cumulative moment since 1962 occurred in areas of uplift while only 4.2% and 2.6% occurred in areas of subsidence and transition, respectively (Fig. 1.9). The entire August 2009 earthquake swarm occurred in an area of uplift, while the swarm of October 2008 occurred in an area of transition between uplift and subsidence (Fig. 1.7). Clusters 2 - 5 occurred in highly faulted areas of neutral and subsiding vertical deformation. All other clusters were in areas of uplift. Differences observed between seismicity from the October 2005 and August 2009 swarms could be related to the difference in location above the SMB and differences in long-term uplift in those areas.

Other earthquake swarm regions with associated vertical deformation include the Long Valley caldera in California and the Campi Flegrei caldera in Italy. Both of these areas also have shallow magma bodies and exhibit similar seismicity characteristics as observed in the SMB region although significant differences in deformation rates suggest overall differences in the processes at each location.

Long Valley caldera is located in the intraplate region of eastern California. The top surface of the magma bodies at Long Valley is estimated from geodetic and gravity data to be at ~6 km depth although intrusions of magmatic fluids have been observed much shallower, ~2 km, since the 1980s (Battaglia et al., 2003; Farrar et al., 1995). Clustered seismicity and earthquake swarms are common at Long Valley caldera. A *b*-value of ~1.3 was calculated for a swarm sequence of greater than 2000 events in November 1997 attributed to successive failures on immature, highly fractured faults (Barton et al., 1999). This swarm sequence was accompanied by concentrated uplift with maximum rates peaking at ~36 cm/yr, much higher than the long-term estimates for the SMB region (Hill et al., 2003).

The Campi Flegrei is a large, active caldera located west of Naples, Italy. The magma body here sits at ~8 km depth (Judenherc and Zollo, 2004). Shallow (1-4 km) swarms of seismicity from 1970-1972 and 1982-1984 were correlated with concentrated vertical deformation reaching several meters in some areas (e.g. Aster and Meyer, 1988, 1989; Castagnolo et al., 2001). Vertical uplift rates up to ~2 mm/day were estimated during the frequent seismicity from 1982-1984. This group of events occurred near the region of highest uplift and exhibited swarm-like character with a *b*-value of 1.35 for events M 0 – 4 (Yokoyama and Nazzaro, 2002; Vilardo et al., 1991).

Deformation rates discussed for the SMB region are long-term estimates. Based on continuous GPS measurements, no concentrated uplift was observed for the October 2005 or August 2009 SMB swarms (Newman, personal comm., 2009). The uplift rates discussed for Long Valley and Campi Flegrei are 1 and 2 orders of magnitude higher than rates estimated for uplift above the SMB, respectively. The lower uplift above the SMB is more steady-state, while the vertical deformation associated with both previously described calderas is highly variable over relatively short time scales. The seismicity rates at Long Valley in November 1997 were also much higher than in the SMB, with over 2000 events in 4 days (Barton et al., 1999). The much higher and highly variable uplift associated with these shallower magma bodies indicates that the SMB is much less active than these volcanic/magmatic regimes. The lower *b*-value for the SMB region than seen in Campi Flegrei and Long Valley also indicates a less active magma chamber.

1.6 Conclusions

We located 804 microearthquakes from June 2007 to December 2009 within the Socorro area of the Rio Grande rift and applied cross-correlation techniques to achieve higher pick consistency and improve the locations of 480 of those events. More than half of the events during this 31-month period occurred over 26 days during the August 2009 microearthquake swarm. We found that 67% of seismicity in the SMB region from September 2004 – December 2009 occurred in areas of long-term uplift. The seismicity exhibits moderate *b*-values consistent with non-volcanic intraplate seismicity and other continental rifting regimes.

Chapter 2: Relocation and Characterization of the August 2009 Microearthquake Swarm above the Socorro Magma Body in the Central Rio Grand Rift

2.1 Abstract

Earthquake swarms occur in many tectonic settings, most commonly in volcanic regions, and are often attributed to magma or fluid movement in the uppermost crust. Swarm sequences lack a clear mainshock and often exhibit magnitude statistics and decay rates different than typical earthquake sequences. Volcanic swarms commonly have *b*-values, an indication of the frequency-magnitude distribution of earthquakes, up to 2.5, although swarms in continental rifts may have *b*-values ~0.8-1, not significantly different than typical mainshock-aftershock sequences. Within portions of the Rio Grande continental rift in the western US, several earthquake swarms have occurred over the last few decades, with variable characteristics. Here we characterize the 2009 swarm in the Socorro Magma Body (SMB) region of the Rio Grande rift. This swarm produced over 431 events with magnitudes of -1.0 to 2.5 over a 26-day period. We relocated 374 events based on cross-correlation techniques, finding the majority of the seismicity occurred within a small volume of 34.5 km^3. Focal mechanisms computed for the largest events are roughly consistent with regional stress patterns. The computed *b*-value of 0.9 is more characteristic of continental rift zones than volcanic swarms, suggesting minimal influence from the SMB on this seismic swarm.

2.2 Introduction

Earthquake swarms occur in both inter- and intraplate regions and differ from typical mainshock-aftershock sequences by lacking a distinctive mainshock or having many foreshocks preceding the largest events (e.g. Sykes, 1970; Hill, 1977). Seismic swarms occur most commonly in volcanic and magmatic regions and often exhibit peculiar earthquake statistics that differ from standard patterns of aftershock decay and frequency-magnitude relationships observed for mainshock-aftershock sequences (e.g. Sykes, 1970; Smith and Sbar, 1974; Brandsdottir et al., 1979). The mechanism behind swarm generation is not well understood, although the migration of hydrothermal or magmatic fluids in/near a volcanic conduit, the existence of concentrated stresses in a highly fractured, highly heterogeneous subsurface, and/or the succession of many small shear failures are among common explanations (e.g. Mogi, 1963; Sykes, 1970; Hill, 1977; Shelly et al., 2009). Earthquake swarms are also common in continental rifts with associated magma intrusions and are attributed to fluctuations of fluids derived from the magma bodies at depth (Ibs-von Seht et al., 2008).

The Socorro magma body (SMB) is a large mid-crustal sill-like intrusion associated with seismicity and vertical deformation in central New Mexico within the Rio Grande rift. Microearthquake swarms with highly similar waveforms are characteristic of the seismicity above the SMB (Sanford et al., 2002; Stankova et al., 2008) and, coupled with uplift rates of ~2.5 mm/yr, suggest fluid-flow or magma movement associated with the SMB (Finnegan and Pritchard, 2009). In this paper, we present precise locations and characteristics of the most recent (2009) swarm activity above the SMB.

The SMB (Fig. 2.1) sits below the central Rio Grande rift where crustal thickness is ~32 km (Wilson et al., 2005). The top surface is at ~19-km depth with an areal extent of >3400 km^2 and a total thickness of <150 m (Balch et al., 1997). Reflected phases observed in seismograms as early as the 1960s led to the discovery of a strong mid-crustal discontinuity with reflection coefficients supporting an underlying low-velocity, molten layer (Sanford and Long, 1965; Rinehart et al., 1979; Brocher, 1981). P-wave reflection variability suggests a multi-layered intrusion (Ake and Sanford, 1988). Seismicity occurs mainly in the upper 10 km of crust implying an aseismic zone due to SMB heat and/or fluids up to 9 km above the top surface (Brocher, 1981; Rinehart et al, 1981; Sanford et al, 1983). Temperatures for depths ~6 – 10 km within the central to northern portions of the SMB are estimated at ~200 - 300° C (Reiter, 2005). The volume increase rate and uplift rate estimated from InSAR data are 6-8 x 10^{-3} km^3/yr and 2.5 mm/yr, respectively, rates that suggest current (a few centuries) inflation of the SMB. Episodic subsidence and inflation has also been suggested based on geomorphic evidence (Fialko and Simons, 2001; Finnegan and Pritchard, 2009). The high seismicity, geomorphic and geodetic evidence, and support for the existence of a root structure (Schlue et al., 1996) indicate that the magma body is presently active. Fluid- or magma-migration associated with the repeating occurrence of earthquake swarms would also support an active magma system.

The most recent earthquake swarm activity began on 20 August 2009 and continued until 14 September 2009 (Fig. 2.1). We use cross-correlation-based seismic phase arrival time adjustments at the sub-sample level to refine the locations of 374 of the swarm events. We present focal mechanisms, correlation results, analysis of frequency-magnitude and frequency-time relationships, as well as a comparison to the October 2005 SMB swarm to further investigate the character of earthquake swarms and the evolution of the SMB.

2.3 Data Recording and Processing

We use data recorded on 10 short-period (1 Hz) Socorro Seismic Network (SSN) vertical component seismic stations sampling at a rate of 100 Hz (Fig. 2.1). Additionally, we used observations recorded on 10 to 25 broadband EarthScope Transportable Array stations (40-Hz sampling rate) deployed in New Mexico in 2009 and the Global Seismographic Network station ANMO, located north of the SMB, for 6 events. We located 431 earthquakes between 20 August 2009 and 14 September 2009 by using arrival times of P and S phases, and S to P (SzP) and S to S (SzS) top-side SMB reflections where observed in the SEISMOS earthquake location algorithm developed for use in the SMB region (Hartse et al., 1992). We weight the initial arrival times of direct and SMB-reflected phases from at least three stations to estimate earthquake locations based on a generalized least-squares solution and minimized 2-norm travel-time errors. We incorporate a region-specific velocity model which includes a low-velocity sill at 19-km depth to better constrain depth estimates when SMB-reflected phases are identifiable (Hartse et al., 1992). Duration magnitudes (M_d) comparable to moment magnitudes are calculated using a local magnitude formula:

$$M_d = 2.79 \log_{10} (\tau_d) - 3.63, \quad (2.1)$$

where τ_d is the duration of the signal above background noise in seconds (Ake et al., 1983).

The first M_d 2.3 event of 20 August 2009 was preceded by 19 days of quiescence and followed by 26 days of increased levels of seismicity that included three additional events greater than M_d 2 on 30 August 2009. The first event occurred ~10 km south of the highly concentrated main swarm activity which included 386 events over 22 days in a 0.1° x 0.1° (~100 km^2) area where background seismicity over the last five years is 8 events/year. Focal mechanism solutions were computed using P-wave polarities for the four largest events (labeled A-D). Mechanisms A and B are well constrained with 23 and 35 observations, respectively, and are consistent with a northeast-striking normal fault. Mechanism C shows northwest-striking normal fault motion and is the least well constrained with only 19 observations. Mechanism D also shows normal faulting with more of a northerly strike and is well constrained with 25 observations.

The Veranito fault is the largest of many smaller, roughly north-striking normal faults with dips from 70° - 80° west in this area. The Veranito fault has a left-lateral slip component and sits ~1.5 km east of the swarm. It is possible that these events locate on the Veranito fault, however little is known about the geometry at depth. The fault surface projected with dips of 70 - 80° W does intersect the earthquake locations at depth, but the events suggest some shallowing of a possible fault plane. All four mechanisms are reasonable for this highly faulted area of the Rio Grande rift. Stankova-Pursley et al. (Characterization of the August 2009 New Mexico earthquake swarm in the central Rio Grande rift, paper presented at Fall Meeting, American Geophysical Union, San Francisco, CA.) computed 5 additional focal mechanisms. Three of these are very similar northeast striking normal faults, while 2 showed northwest striking normal fault mechanisms. Mechanism solutions for swarms in May and July of 1983 and October of 2005 near station WTX indicate more northerly striking normal faults than found for the 2009 swarm although none of these incorporate Earthscope stations to better constrain the fault planes (Ake, 1984; Balch et al., 1994; Stankova et al., 2008), so our computed mechanisms may in fact be more representative for these events.

2.4 Cross-Correlation Earthquake Relocation

Waveform cross-correlation techniques have been widely applied to improve relative locations of groups of similar events, detect similar events in continuous data, and to delineate structural features by improving locations in a variety of seismic sequences including mainshock-aftershock, reservoir-induced, swarm, and seismic tremor (e.g. Shearer, 1997; Rowe et al., 2002; Shelly et al., 2009). Cross-correlation techniques capitalize on the similarity of events in a given data set by computing differential times for well-correlated waveforms on a station-by-station basis (e.g. Shearer, 1997). The similarity of waveforms in a spatially concentrated earthquake swarm is ideal for cross-correlation-based pick adjustment techniques to improve the consistency of arrival time picks and thus refine locations. These methods have been used to improve location uncertainties for spatially clustered events over month- to year-long time periods in the SMB region (Stankova et al., 2008; Morton, 2008).

We relocated a concentrated subset of the main swarm activity from 00:00 (UTC) 23 August to 00:00 (UTC) 15 September 2009, including 374 events, using adjusted arrivals of P and S phases on up to 5 SSN stations as well as some SMB-reflected phases recorded on station LEM (Table 2.1). All event waveforms for one station are windowed around one phase arrival pick (Fig. 2.2) and correlation coefficients are computed for the raw data. The events above the correlation threshold of 0.55 are then lag-adjusted at the sample level in an iterative process to achieve the highest possible correlation. The final adjustment is refined to the sub-sample level by weighing the adjustments based on individual event correlation (Fig. 2.2).

Correlation coefficients varied among phases and stations (Table 2.1). Three stations showed high correlation values with averages greater than 0.85 (Fig. 2.3A), although SzS and SzP reflected phases show significantly lower correlation values. Reflections are usually much noisier than direct phases and thus more difficult to pick, likely contributing to the lower correlation values. The use of these reflected phases, however, allows us to better constrain the depths of events to mainly 4 -6 km, shown in the cross-sections in Figure 2.3. Changes in absolute epicenter locations were as high as 0.42 km with location uncertainties reduced by 0.01 km on average.

2.5 Swarm Characteristics

The first event on 20 August 2009 occurred at 106° 51' 47" W, 34° 4' 12" N, however the majority of the events were centered 10 km north around 106° 51' 18" W, 34° 9' 54" N. The overall seismicity lacks a clear south-to-north migration from 20 August 2009 to the main activity, possibly due to data loss on 22 August 2009, although we do not see evidence of migration in the available data from 20 August through early 22 August. The concentrated seismicity exhibits weak east to west migration (Fig. 2.3). Event depths are typical for SMB seismicity, ranging from 1.1 to 8.9 km. The events occur mainly at 5 – 7 km depth and get shallower 8 – 11 days after the first event indicating vertical progression with time (Fig. 2.3). Events M_d>2 tended to be shallower with an average depth of 4.2 km relative to the depth average of 5.6 km ± 0.8 km for the entire swarm. The flat shape of most of the swarm might indicate the faults in this area becoming listric at these depths. The upward spatiotemporal migration of events could be connected to the diffusion of fluid moving upward from depth as suggested by Hainzl (2004). The volume of concentrated swarm seismicity is estimated at 34.5 km^3.

We examine moment release estimates and aftershock-decay rates to further characterize the swarm (Fig. 2.4). Moment release was calculated using the following equation,

$$\log_{10}(M_o) = 1.5M_w + 16.1 \qquad (2.2)$$

where M_w is the moment magnitude and M_o is the moment. We use local duration magnitudes, which are comparable to moment magnitudes (Ake and Sanford, 1983).

The largest increase in seismic moment, 7.08×10^{12} N-m, occurred at 00:31 (UTC) on 30 August 2009, due to the largest M_d 2.5 event (Fig. 2.1, Mechanism B).

Typical mainshock-aftershock sequences exhibit aftershock decay according to the modified form of Omori's Law (Utsu, 1961):

$$N(t)= \frac{C}{(k + t)^p} \qquad (2.3)$$

C and k are fault dependent parameters (Stein and Wysession, 2003). Using a range of decay rates, represented by the *p* exponent with typical values around 1, we were unable to fit any of the exponential decay curves to our data (Fig. 2.4A). The late progression of energy in this sequence (Fig. 2.4B) also supports that this is a swarm sequence and not a typical mainshock-aftershock sequence.

The *b*-value statistic for an earthquake catalog provides information about the relative number of small to large earthquakes within that catalog, defined by the negative slope of the logarithmic frequency-magnitude relation suggested by Gutenberg and Richter (1944). Typical mainshock-aftershock sequences and global catalog estimates suggest a *b*-value of about 1, however *b*-values in volcanic and earthquake swarm regions are often much larger than 1 (e.g. Gutenberg and Richter, 1944; Hill et al., 2003; Kurz et al., 2004). The *b*-value of the 2009 earthquake swarm based on local magnitudes is 0.9 ($1\sigma = 0.09$) for events M_d 0 - 2.5 (Fig. 2.4C). The *b*-value of the entire catalog of SMB-related seismicity from September 2004 to December 2009 is 1.1 ($1\sigma = 0.08$), higher than the swarm itself. To estimate the standard deviations for the *b*-value statistics, we resampled the data 100 times using the bootstrap method, computed 100 *b*-values using the resampled data, and report the standard deviation of those data, which are approximately Gaussian, to estimate errors for the original statistic. The swarm included four of the largest events occurring in this area, likely contributing to the lower *b*-value observed than for the entire five-year catalog. Both *b*-values are lower than what might be expected for a volcanic or magmatic earthquake swarm region and, in fact, are quite consistent with typical *b*-values of mainshock-aftershock sequences occurring on well-known faults. These *b*-values are similar to those found by Ibs-von Seht et al. (2008) for continental rifts generally and the Rio Grande rift specifically (0.8). This *b*-value is also consistent with the main swarm activity having been dominated by failures on or near the Veranito fault (Fig. 2.3).

2.6 Discussion

Another well-located earthquake swarm occurred in this area in October 2005, approximately 15 km southwest of the August 2009 sequence. The October 2005 swarm included over 1600 detectable and 85 locatable events over a 32-day period that were highly concentrated near 34.06° N, 106.96° W (mean location uncertainty of 0.72 km) and exhibited very similar waveforms with mean P-wave correlation coefficient of 0.90 (Stankova et al., 2008). This swarm occurred in an area of previous swarm activity in May and July 1983 that also provided similar waveforms and focal mechanisms as the 2005 activity.

The *b*-value for the October 2005 swarm is 1.3, higher than in the August 2009 sequence (0.9) probably because of a fewer number of large events in 2005 (Stankova et al., 2008). The higher *b*-value seen in the 2005 swarm suggests a more volcanic or active magmatic origin for swarm activity than seen in 2009, however, maximum moment release in the 2005 swarm is an order of magnitude lower than for the 2009 activity (Fig. 2.4B). The two swarms show very different frequency-time relationships as well (Fig. 2.4D). The 2005 sequence appears to exhibit an aftershock fall-off compared to the late activity in the 2009 swarm, however the 2005 swarm was also poorly fit by standard decay rates (Stankova et al., 2008). The significant differences in the 2005 and 2009 SMB earthquake swarms suggest that swarm-like sequences in this area are quite variable dependent on location above the magma body. The 2009 swarm occurred in an area of long-term uplift with line-of-sight velocity rates of 1.75 mm/yr estimated from InSAR data, while the 2005 swarm occurred in area of transition between uplift and subsidence (Fig. 1.7). There was no unusual vertical deformation above the long-term estimates associated with either of the swarms based on continuous GPS measurements (Newman, personal comm., 2009; Stankova et al., 2008). The differences in seismicity of the two swarms might indicate a diverse stress field dependent on location relative to the highest uplift areas.

Based on a comparison to other earthquake swarm regions, Stankova et al. (2008) suggest that it is the interaction of fluid- or pressure-induced processes related to the inflation of the SMB with extensive, preexisting fault systems linked to the regional tectonics that causes the swarm-like seismicity here over decadal time scales. The upward migration of events seen in the 2009 swarm suggests fluid diffusion as an important role in swarm generation (Hainzl, 2004). The lack of aftershock decay and spatial distribution discussed for the 2009 sequence also support this hypothesis. The lower *b*-value of the 2009 swarm sequence, however, might indicate a more important role of faults in a highly fractured crust than fluid migration associated with magmatic evolution.

2.7 Conclusions

The August 2009 swarm included 431 locatable microearthquakes over a 26-day period. Using waveform cross-correlation techniques to achieve higher pick consistency, we relocated 374 events, finding a concentrated volume (34.5 km^3) of seismicity. We find weak evidence of temporal migration with the swarm. Earthquake statistics, such as Omori-Law decay rates, suggest this sequence was a swarm rather than a typical mainshock-aftershock sequence. The calculated *b*-value of 0.9 is similar to those estimated for other continental rifting areas indicating that this swarm was likely dominated by normal faulting processes rather than a magmatic origin.

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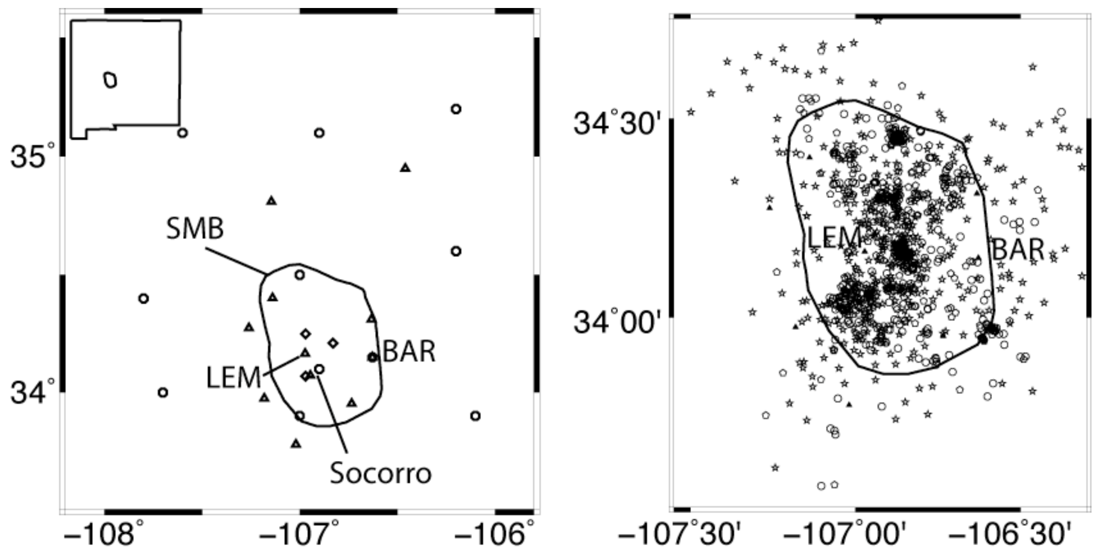

Figure 1.1: Left: Socorro magma body outline shown on New Mexico inset and in general study area with the following seismic networks shown: Socorro Seismic Network (triangles) and EarthScope USArray Transportable Array (triangles). Three GPS stations are also shown (diamonds). Right: SMB seismicity from 1968-Present from catalogs of Sanford et al. 2002 and 2006 (circles), Morton, 2008 and Stankova et al., 2008 (pentagons), and the present study (stars) shown with SMB outline. Stations are shown with same symbol shapes as left figure.

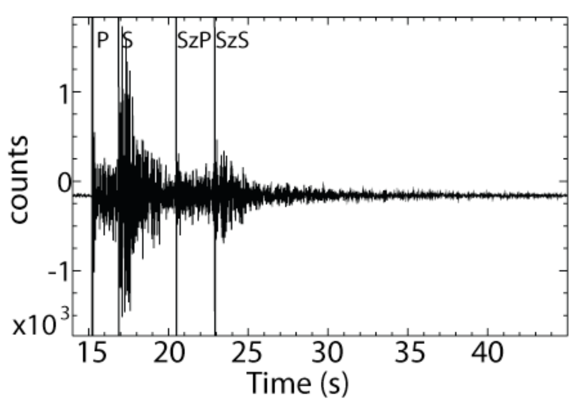

Figure 1.2: Vertical component seismogram recorded on SSN station LEM showing direct and SMB-reflected phase arrivals for a Md 0.67 event on 24 August 2009 08:09:13 (UTC).

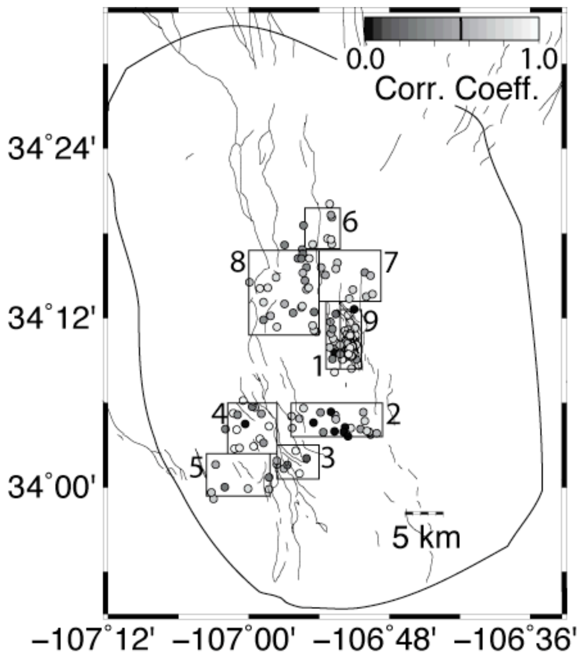

Figure 1.3: Map of all cluster locations and relocated events colored by correlation coefficients for P-picks on station BAR. Line on correlation scale bar represent threshold of 0.55 used. The SMB outline and faults are shown. Cluster 1 and clusters 6 - 9 are shown in more detail in Figure 1.5. Clusters 2 - 5 are shown in Figure 1.6. Faults are from Cather at al. (2004) and Love et al. (2009).

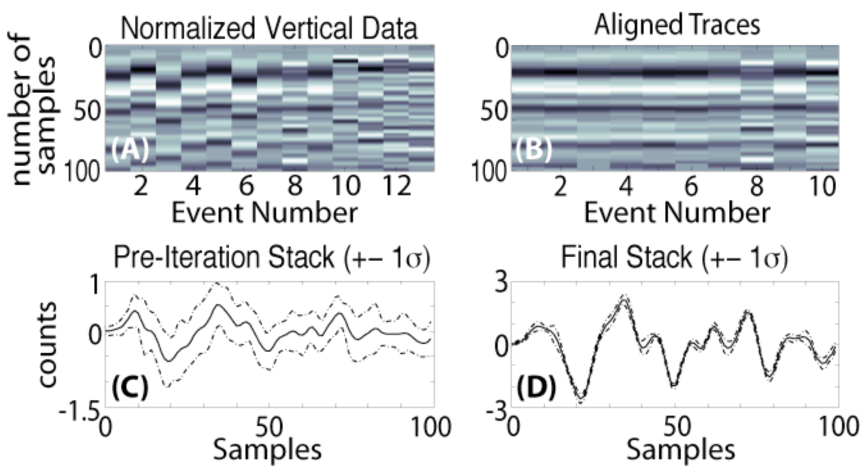

Figure 1.4: (A) 13 waveforms recorded on station BAR starting 3 samples before the initial analyst-defined P-wave arrival. Black and white represent trough and peak amplitudes of -1 and 1, respectively. (B) Initial stack of waveforms shown in A (solid line) with standard deviations shown by dashed lines. (C) 10 pick-adjusted vertical waveforms after 5 iterations using a correlation threshold of 0.55. (D) Stack of final waveforms (solid line) with standard deviations shown (dashed lines). All data in cross correlations were 1 second (100 samples).

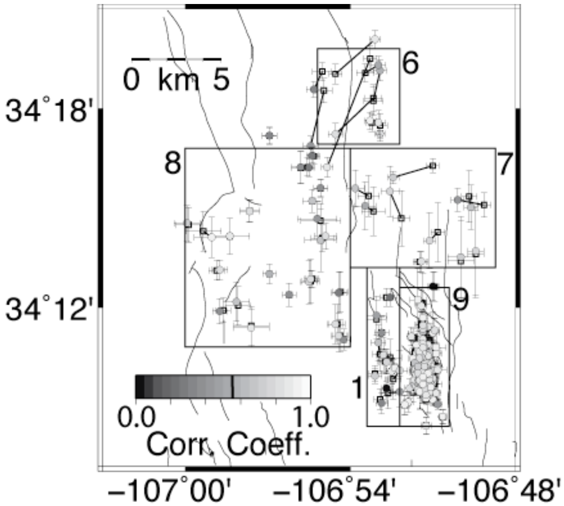

Figure 1.5: Initial (squares) and relocated (circles, colored by correlation coefficients on SSN station BAR, P-pick) earthquake locations for clusters 1, 6, 7, 8, and 9 connected by thick black lines. Location error estimates are shown for events before and after relocation. Faults are also shown. Faults are from Cather at al. (2004) and Love et al. (2009).

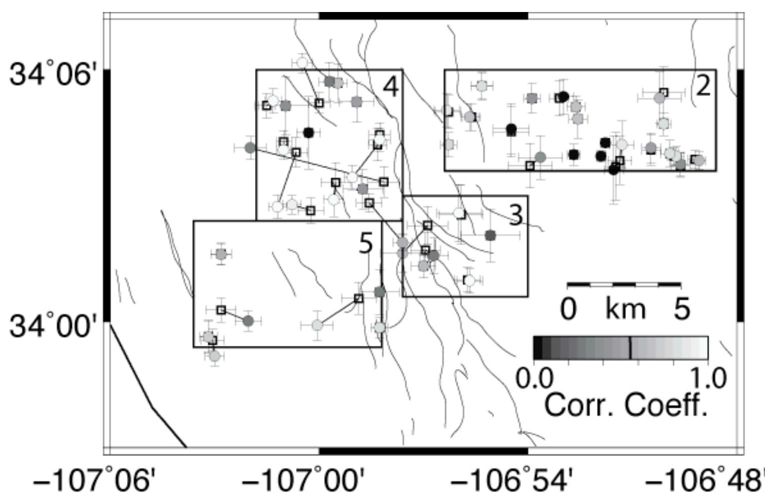

Figure 1.6: Initial (squares) and relocated (circles, colored by correlation coefficients on SSN station BAR, P-pick) earthquake locations for clusters 2-5 connected by thick black lines. Location error estimates are shown for events before and after relocation. Faults are also shown from Cather at al. (2004) and Love et al. (2009).

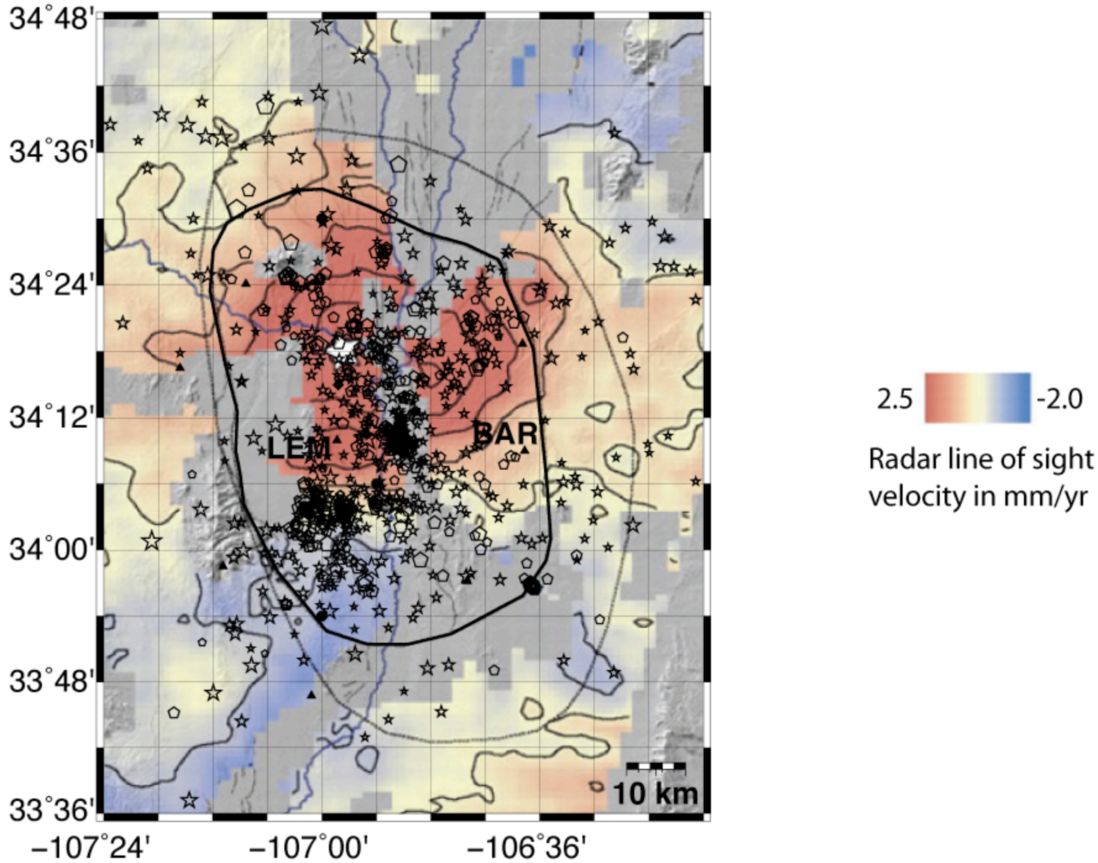

Figure 1.7: Map of SMB seismicity 2004 – 2009 sized by magnitude and overlain on InSAR line-of-sight velocity map modified from Finnegan and Pritchard, 2009. White star represent point of highest uplift of 2.5 mm/yr. Pentagons are data from Morton (2008) and stars are from this study.

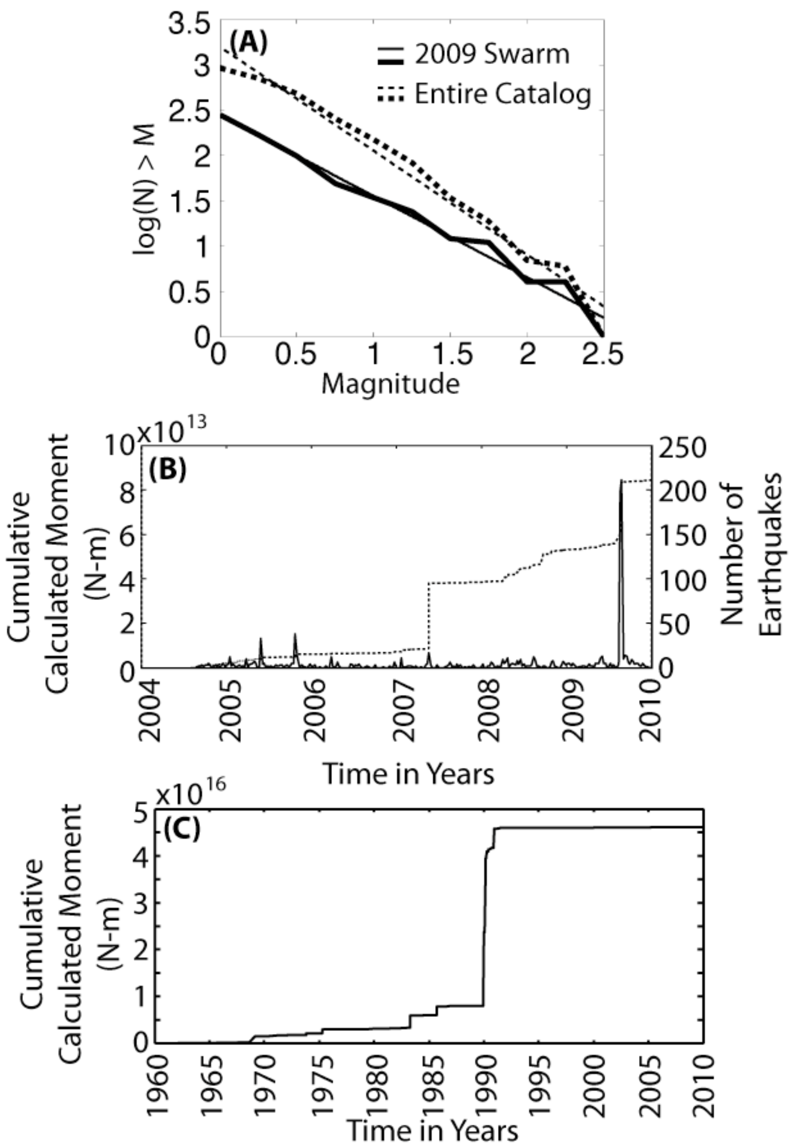

Figure 1.8: (A) Frequency-Magnitude distribution of the entire catalog of seismicity above the SMB from September 2004 to December 2009 (dashed) and the events from 20 August 2009 to 14 September 2009 (solid). Thick lines are cumulative values and thin lines are the best fit linear for M > 0 events used to estimate *b*-values. The cumulative *b*-values for the entire catalog and the swarm are 1.1 and 0.9, respectively. (B) Frequency-time (solid line) and moment-time (dotted line) histories from September 2004 through the end of 2009. (C) Moment-time history from 1968 through 2009. Large jump in 1990 is attributed to four events M > 4.

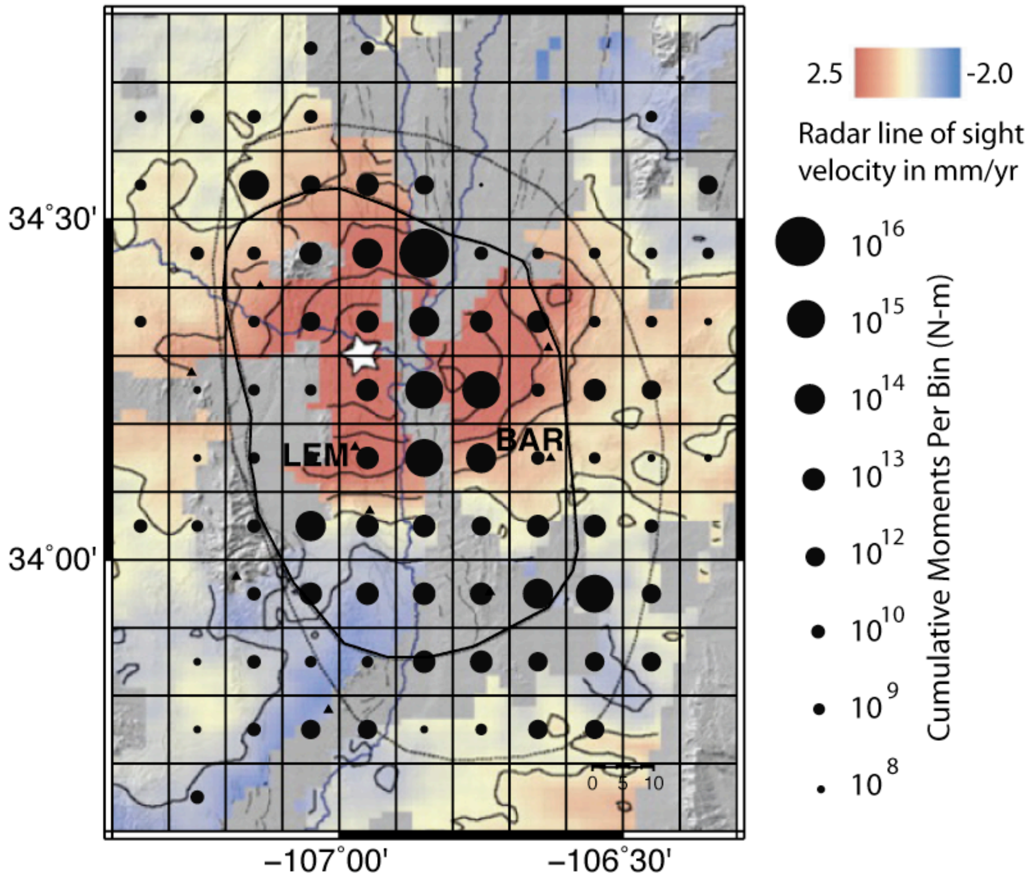

Figure 1.9: Map cumulative moment release per bin for earthquakes from 1968 to 2009 overlain on InSAR line-of-sight velocity map modified from Finnegan and Pritchard, 2009. White star represent point of highest uplift of 2.5 mm/yr. 93% of the moment occurred in areas of uplift. Color scale and moment size scale are shown.

Cluster	Number of Events	Area (sq. km)	Avg. Corr. Coefficient	Avg. Change in Location (km)	Avg. Change in Location Uncertainty (km)
1	11	6.98	0.564	0.286	-0.015
2	22	46.7	0.671	0.124	-0.002
3	6	10.2	0.610	0.387	-0.003
4	16	35.4	0.723	1.070	-0.100
5	7	34.8	0.606	0.608	-0.071
6	9	14.6	0.687	2.170	-0.092
7	10	41.9	0.699	0.859	-0.065
8	25	119	0.603	0.105	0.000
9	374	29.7	0.884	0.083	-0.002

Table 1.1: Cross-correlation results for clusters 1 through 9. Average change in location uncertainty was obtained by the difference between the relocated epicentral standard deviations and the initial epicentral error estimates.

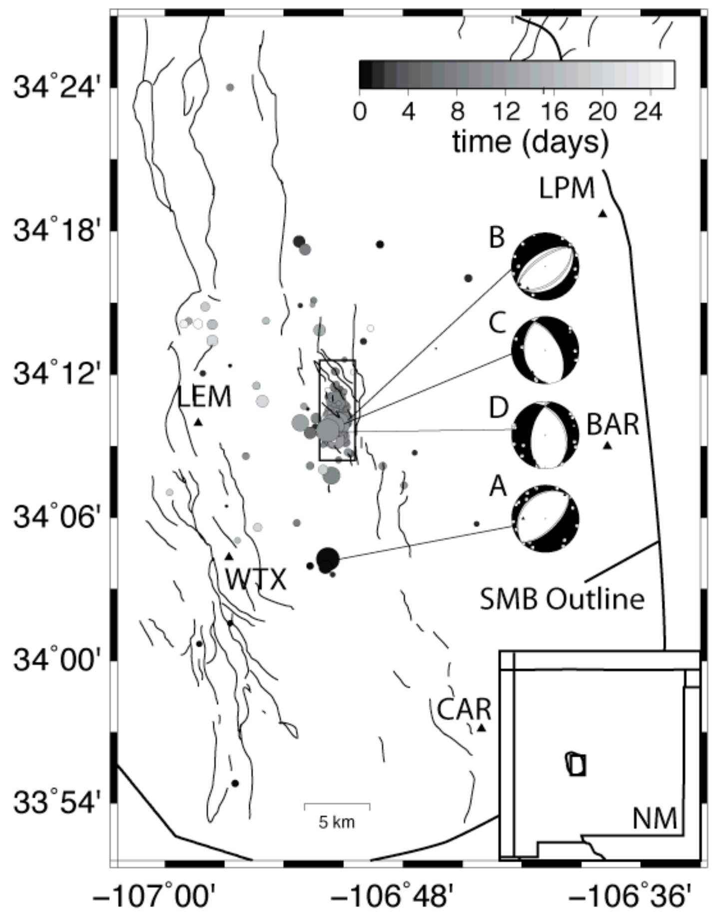

Figure 2.1: The August 2009 swarm area showing locations of earthquakes (circles, sized by magnitude) from 20 August 2009 to 14 September 2009, faults (thin lines), and focal mechanisms for the four largest earthquakes in the swarm. Seismic stations (triangles) are labeled by station name. The study area of central New Mexico and outline of the Socorro Magma Body (SMB) are shown in the inset. (A) Focal mechanism solution for the first earthquake, M 2.29, occurring on 20 August 2009 at 01:57 (UTC) south of the main swarm cluster. Impulsive P-wave polarities are shown, although some emergent observations are not shown. Dilation first motions are triangles and compressional first motions are octogons. Focal mechanisms are also shown for three earthquakes on 30 August 2009: (B) M 2.5, 00:31 (UTC), (C) M 2.34, 06:39 (UTC), (D) M 2.26, 07:09 (UTC). Fault information is from Cather et al. (2004) and Love et al. (2009).

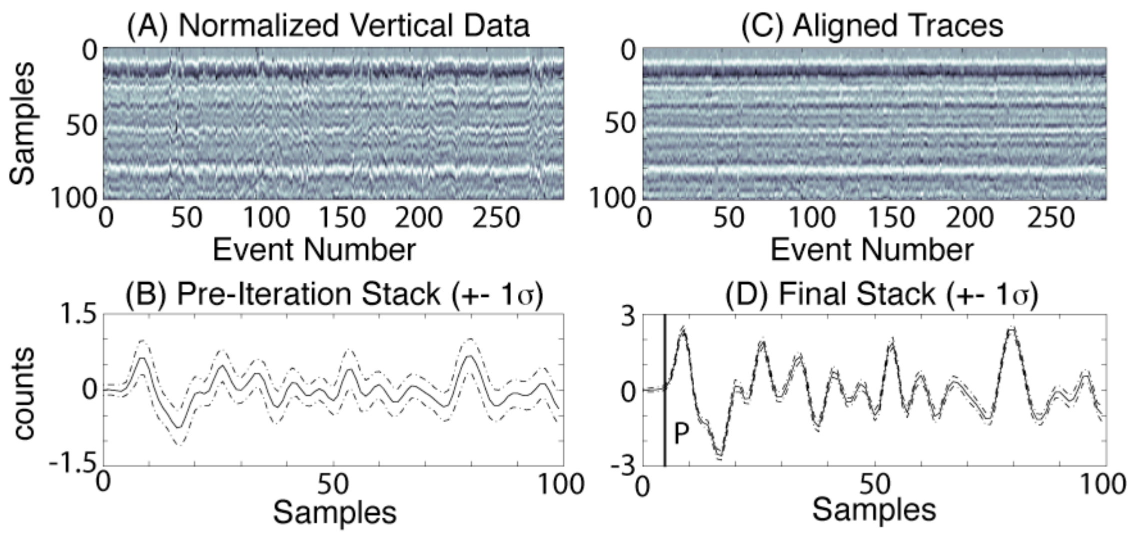

Figure 2.2: (A) An example of 298 waveforms recorded on station BAR starting 5 samples (0.05 seconds) before the initial analyst-defined P-wave arrival. Black and white represent trough and peak amplitudes of -1 and 1, respectively. (B) Initial stack of waveforms shown in A (solid line) with standard deviations shown by dashed lines. (C) 294 pick-adjusted vertical waveforms after 5 iterations using a correlation threshold of 0.55. (D) Stack of final waveforms (solid line) with standard deviations shown (dashed lines) and arrival of P-wave labeled.

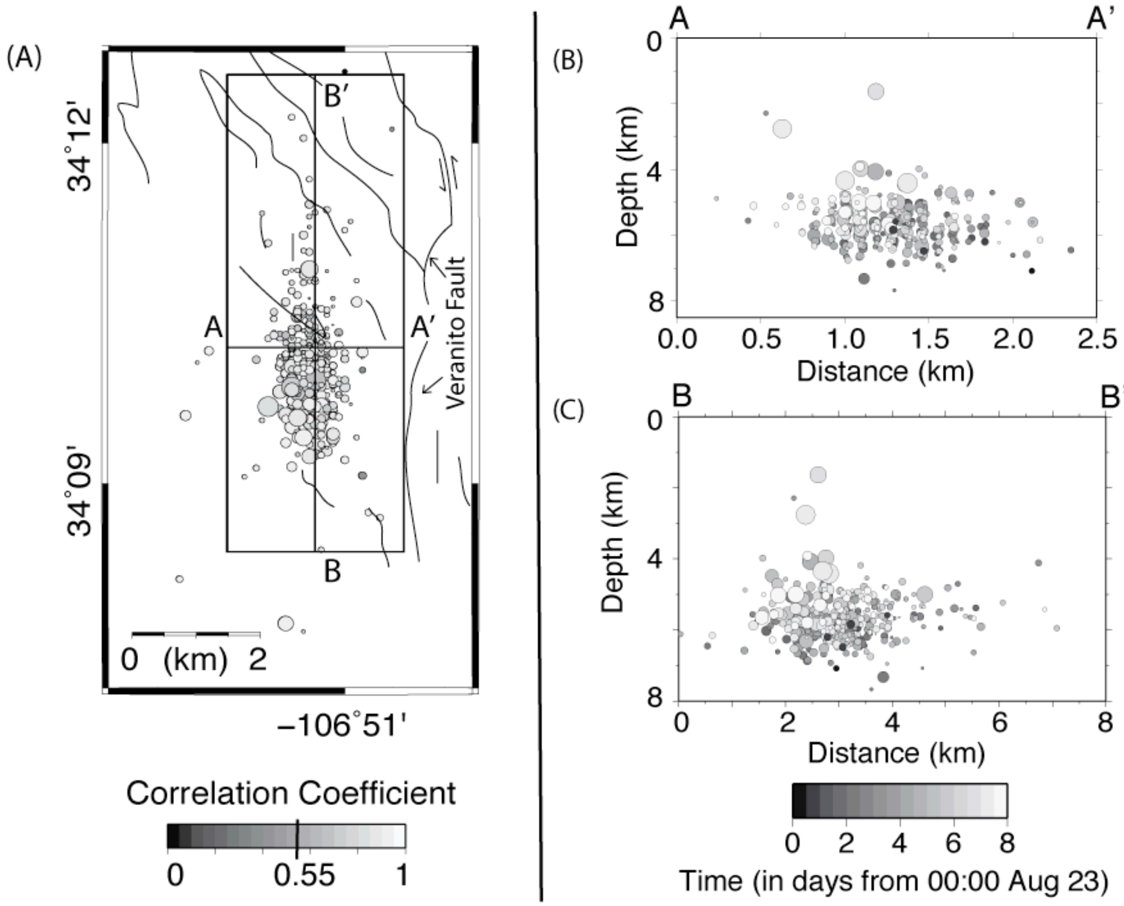

Figure 2.3: (A) 374 relocated events are shown as circles sized by magnitude and colored by maximum correlation coefficient on station BAR. A threshold of 0.55 was used during relocation. The boxed area shows events projected onto the cross-section lines A-A' and B-B'. (B) East-west cross-section of swarm events sized by magnitude and colored by time from 00:00 (UTC) on 23 August 2009 through 00:00 on 31 August 2009. 13 additional events occurred between 31 August 2009 and 14 September 2009 (White). (C) North-south cross-section of the swarm (size and color same as B). Larger and shallower events occur later in the swarm. Fault information is from Love et al. (2009) and Cather et al. (2004).

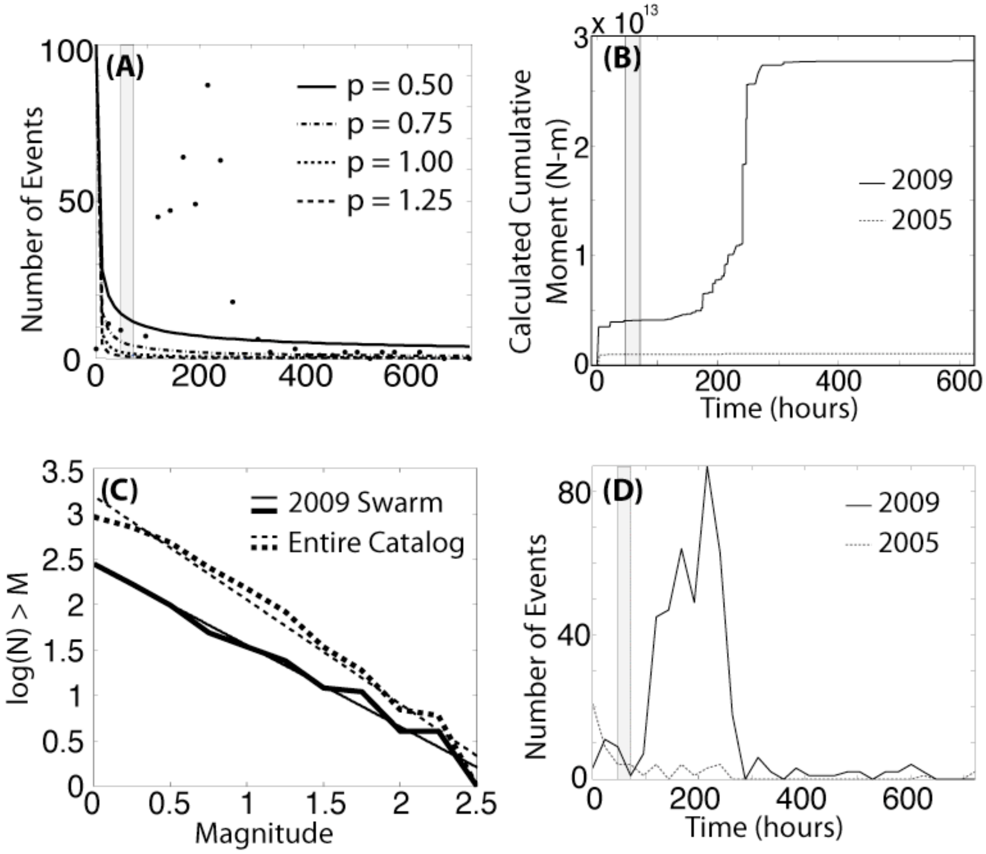

Figure 2.4: (A) Frequency-time plot for the August 2009 swarm, showing poor fit to standard Omori-Law aftershock decay parameters (0.5 (solid), 0.75 (dashed dot), 1.0 (dot), and 1.25 (dashed)). The time begins on 00:00 20 August 2009 and includes events for the 26-day duration of the swarm. Gray blocks in A, B, and D represent the loss of data on 22 August 2009. (B) Moment release in N-m for the October 2005 (dashed) and August 2009 (solid) swarms. 0 hour begins at the 1st event of each swarm and includes the entire swarm activity (32-day period for October 2005 and 26-day period for August 2009). (C) Frequency-magnitude relationship for the entire catalog of seismicity above the SMB from September 2004 to December 2009 (dashed) and the events from 20 August 2009 to 14 September 2009 (solid). Thick lines are cumulative values and thin lines are the best linear fit for M > 0 events used to estimate b values. Cumulative b-values for the entire catalog and the swarm are 1.1 and 0.9, respectively. (D) Histogram of earthquakes for both the October 2005 (dashed) and August 2009 swarms (solid). Time scale is the same as B.

Station	Phase	Arrivals In	Arrivals Out	Correlation Coefficient
BAR	P	374	369	0.884
	S	370	363	0.897
LEM	P	371	287	0.639
	S	352	203	0.551
	SzP	115	63	0.488
	SzS	326	232	0.543
WTX	P	339	335	0.745
	S	230	101	0.861
CAR	P	317	227	0.562
	S	283	191	0.723
LPM	P	253	247	0.861

Table 2.1: Cross-correlation results by station and phase arrival. "Arrivals In" reflects number of events used for each specific stations and phase. "Arrivals Out" reflects the number of events that were actually adjusted based on a correlation threshold of 0.55. All cross correlation lengths were 1 second (100 samples).

Appendix A: Complete Relocated Earthquake Catalog June 2007 to December 2009.

The columns are abbreviated as follows: IND = index number, C = cluster number for relocated events, YYYY = Year, MM = month, DD = day, hh = hour, mm = minute, SEC = origin time in seconds, LON = longitude, STD = 1st standard deviation, LAT = latitude, DEP = depth, MAG = local duration magnitude, and RMS = root mean square error.

IND	C	YYYY	MM	DD	hh	mm	SEC	LON	STD	LAT	STD	DEP	MAG	RMS
1	-	2007	06	01	03	11	53.99	-107.1780	0.51	34.1350	0.47	1.20	-0.20	1.23
2	-	2007	06	01	03	13	12.06	-107.1790	1.21	34.1652	1.58	5.00	-0.11	1.52
3	-	2007	06	28	22	33	10.35	-107.0040	1.16	33.9167	1.28	5.00	-1.68	1.90
4	-	2007	06	28	22	33	10.35	-107.0040	1.16	33.9167	1.28	5.00	-1.68	1.90
5	-	2007	06	28	22	34	35.60	-106.9840	1.13	33.9540	1.36	3.75	-0.52	1.96
6	-	2007	06	28	22	35	25.48	-106.8400	1.31	34.0428	1.48	5.00	-0.79	3.81
7	-	2007	08	02	17	08	17.54	-107.0870	1.68	34.0328	1.19	5.47	-0.35	0.71
8	-	2007	08	11	01	38	25.20	-106.9220	0.63	33.9662	0.96	9.42	-0.01	1.42
9	-	2007	08	11	01	44	22.41	-106.9330	0.58	34.0298	0.71	1.27	0.20	1.94
10	-	2007	08	18	08	08	37.07	-106.8310	0.47	34.1648	0.65	5.00	0.87	1.29
11	-	2007	08	19	19	16	27.96	-106.7200	0.54	34.1545	0.93	5.00	0.01	1.47
12	-	2007	08	21	00	55	12.68	-107.1030	0.60	34.3628	0.74	7.57	0.08	2.10
13	-	2007	08	23	06	30	52.24	-106.7570	0.64	34.2535	0.89	5.00	0.38	0.34
14	-	2007	08	23	13	23	43.43	-106.5350	1.39	34.1112	0.69	5.00	0.31	1.82
15	-	2007	08	23	16	40	28.58	-107.0320	0.72	34.3102	0.80	5.44	0.00	0.60
16	-	2007	08	24	01	32	7.40	-106.6800	0.91	34.3378	0.65	12.49	0.83	0.96
17	-	2007	08	24	21	34	53.63	-107.0010	1.08	34.0490	0.95	5.00	0.30	1.69
18	-	2007	08	25	05	01	23.67	-107.2600	1.53	34.2980	1.52	6.64	0.07	5.81
19	-	2007	08	29	22	17	21.77	-106.7290	0.96	34.3228	0.70	5.00	0.00	1.36
20	-	2007	09	06	06	35	12.31	-106.8580	0.76	34.0755	0.67	3.03	-0.06	0.16
21	-	2007	09	07	12	05	40.03	-106.9090	0.56	33.9730	0.54	5.00	0.00	1.98
22	-	2007	09	22	13	27	28.79	-107.1100	1.58	34.1502	1.26	5.04	-0.62	0.88
23	-	2007	09	22	18	38	29.87	-107.1480	0.78	34.0415	0.51	5.00	0.56	2.63
24	-	2007	09	24	00	10	49.09	-106.7380	0.48	34.2867	0.67	5.00	0.22	1.97
25	-	2007	09	24	13	04	39.43	-106.9720	0.48	34.2653	0.56	5.00	0.00	1.40
26	-	2007	10	01	23	54	11.89	-106.4940	1.41	34.0878	0.55	5.00	0.54	1.21
27	-	2007	10	04	05	16	6.23	-106.7820	0.76	34.4225	1.16	5.00	0.55	1.97
28	-	2007	10	05	14	40	13.01	-106.8910	0.95	33.9832	1.36	5.61	0.66	0.65
29	-	2007	10	06	12	29	12.92	-106.9170	0.65	34.1753	0.61	11.14	-0.54	1.41
30	-	2007	10	14	12	17	16.13	-106.3990	1.94	34.1470	1.00	5.00	-0.14	1.23
31	-	2007	10	29	08	27	16.46	-106.6760	1.12	34.3235	1.25	5.23	-0.13	1.32
32	-	2007	11	13	19	40	7.92	-107.2470	1.22	34.6410	0.58	5.00	1.27	3.85
33	-	2007	11	18	06	27	54.11	-105.7750	2.46	33.5593	2.29	5.00	1.50	1.07
34	2	2007	12	03	00	36	12.67	-106.8980	0.44	34.0887	0.65	3.53	0.14	1.02
35	-	2007	12	03	12	28	11.93	-106.7000	0.49	34.3077	0.65	5.00	0.42	1.41
36	-	2007	12	04	04	42	11.35	-107.1560	0.91	33.8880	1.08	5.00	1.02	0.78
37	-	2007	12	08	14	32	12.49	-107.0330	0.65	33.8332	1.00	5.00	0.65	2.07
38	8	2008	01	03	16	02	9.21	-106.9790	0.50	34.1980	0.70	8.85	0.53	1.66
39	6	2008	01	12	02	24	6.98	-106.8820	0.46	34.3190	0.59	3.33	0.66	2.06
40	2	2008	01	13	08	40	19.42	-106.9280	0.47	34.0812	0.59	5.00	0.30	1.05

41	-	2008	01	15	22	20	9.34	-106.7450	0.56	34.2433	0.50	5.00	0.52	0.99
42	-	2008	01	16	03	03	5.79	-107.2400	1.35	34.4482	1.43	7.96	0.26	0.94
43	-	2008	01	31	12	12	13.53	-106.9340	1.63	34.3600	1.92	5.00	0.65	2.17
44	-	2008	02	07	01	07	3.36	-106.8230	0.70	33.9118	0.68	5.00	0.70	1.62
45	-	2008	02	09	02	32	1.51	-106.8530	1.33	34.1533	0.92	5.00	0.20	1.28
46	-	2008	02	14	09	22	7.95	-106.6980	0.70	34.3383	1.06	5.00	0.38	1.87
47	-	2008	02	14	14	13	6.11	-106.5520	2.18	34.3762	2.36	5.00	0.37	0.99
48	-	2008	02	14	17	23	13.38	-106.6840	0.68	34.2983	0.73	5.00	0.22	1.92
49	-	2008	02	14	17	42	15.55	-106.8140	0.58	34.3158	1.05	5.00	0.51	1.58
50	-	2008	02	14	21	43	7.28	-106.5790	0.72	34.2897	0.54	5.00	0.96	1.30
51	-	2008	02	15	10	55	12.31	-106.7590	0.72	34.4042	0.72	5.00	1.04	2.25
52	-	2008	02	17	13	54	9.21	-106.7680	0.54	34.2803	0.56	5.00	0.74	1.71
53	-	2008	02	22	05	12	16.27	-106.6590	1.23	34.3580	1.25	5.00	0.48	0.73
54	-	2008	02	22	11	25	6.57	-106.4930	1.32	34.3448	1.08	5.00	0.47	0.82
55	-	2008	02	22	13	19	7.42	-106.6910	0.99	34.4272	1.58	5.00	0.35	2.12
56	-	2008	02	28	00	39	16.16	-106.5700	1.06	34.3730	0.70	5.00	0.77	1.34
57	-	2008	02	28	01	55	28.22	-106.6620	0.61	34.2467	0.49	5.00	0.60	1.00
58	-	2008	03	04	10	22	9.11	-106.7820	0.42	34.1227	0.50	5.00	0.80	1.69
59	-	2008	03	15	05	45	9.79	-106.5610	1.30	34.0718	0.70	5.00	0.17	1.51
60	8	2008	03	15	11	42	8.99	-106.9230	0.39	34.2763	0.44	5.00	0.65	1.64
61	-	2008	03	19	12	31	9.08	-107.1570	0.77	34.3327	0.58	5.00	0.61	2.38
62	-	2008	03	28	13	28	4.08	-107.1080	0.66	33.9377	0.61	8.54	0.43	1.61
63	8	2008	04	02	17	59	27.24	-106.9370	0.47	34.2063	0.64	5.00	0.96	1.22
64	-	2008	04	02	20	58	34.12	-107.1600	0.93	34.0403	0.76	5.00	1.06	1.29
65	2	2008	04	05	20	55	30.26	-106.8550	0.64	34.0703	1.03	5.00	0.11	1.89
66	-	2008	04	05	23	53	21.14	-107.2760	11.74	32.9063	6.42	5.00	1.04	2.23
67	-	2008	04	06	01	31	17.15	-107.2300	1.97	34.4147	0.83	5.00	-0.56	1.82
68	-	2008	04	06	01	36	21.05	-106.8490	0.90	33.7858	1.41	5.00	0.05	0.95
69	-	2008	04	06	02	04	29.70	-106.9410	0.42	33.9820	0.52	5.00	0.43	0.96
70	-	2008	04	07	18	47	4.45	-107.1760	8.38	32.2963	2.51	5.00	1.45	1.19
71	-	2008	04	07	20	35	37.06	-107.1010	0.36	34.0297	0.47	5.00	1.23	1.22
72	-	2008	04	14	17	28	4.81	-107.3220	6.39	32.3440	2.39	5.00	1.68	2.35
73	4	2008	04	14	18	59	27.46	-107.0220	0.43	34.0877	0.53	5.00	1.05	1.78
74	-	2008	04	16	09	05	18.56	-105.8740	0.70	33.6638	0.89	5.00	1.85	1.84
75	-	2008	04	16	15	58	20.82	-108.4980	10.52	33.0460	14.28	5.00	1.39	1.44
76	-	2008	04	16	16	11	21.43	-107.1810	1.85	34.8742	1.60	5.00	1.01	1.28
77	-	2008	04	21	15	02	29.29	-107.0670	1.27	34.3495	1.23	5.00	0.75	1.11
78	-	2008	04	21	18	29	23.54	-106.8250	1.61	34.2038	0.94	5.00	1.06	1.00
79	3	2008	04	21	21	28	29.43	-106.9280	0.69	34.0163	0.54	5.00	1.50	1.30
80	-	2008	04	22	17	59	31.82	-107.0850	0.56	34.1903	0.76	5.00	1.46	2.25
81	2	2008	04	22	20	59	27.22	-106.8770	0.48	34.0853	0.49	8.79	1.25	1.16
82	-	2008	04	23	14	36	25.65	-106.8750	0.83	34.3868	0.83	6.05	1.03	1.15
83	2	2008	04	24	16	56	31.55	-106.8940	1.18	34.0653	0.96	6.70	0.63	0.34
84	-	2008	04	25	13	10	23.81	-106.8980	2.87	34.3555	1.92	5.00	-0.84	0.27
85	-	2008	04	26	10	26	31.12	-106.5600	2.64	34.1320	0.94	5.00	-0.62	0.36
86	-	2008	04	29	07	54	30.82	-106.4600	1.15	34.1398	0.48	5.00	0.14	1.59
87	-	2008	04	29	09	52	28.19	-106.5020	2.05	34.0450	0.91	5.00	0.23	0.71
88	-	2008	04	29	17	50	32.72	-106.6300	1.89	34.0990	0.63	5.00	0.26	1.23
89	2	2008	04	29	18	20	8.08	-106.8370	1.14	34.0888	1.13	5.00	-0.97	0.56

90	3	2008	04	29	18	57	32.34	-106.9180	1.59	34.0343	1.16	5.00	0.16	1.53
91	8	2008	04	29	21	00	31.88	-106.9040	0.49	34.1838	0.59	5.00	1.68	1.49
92	-	2008	04	30	03	43	34.63	-106.7120	0.47	34.1590	0.44	5.00	0.40	0.54
93	3	2008	04	30	17	59	26.00	-106.9330	1.17	34.0432	1.27	5.00	1.27	1.05
94	-	2008	05	13	01	50	27.70	-106.8330	0.45	33.8967	0.68	5.00	0.36	2.63
95	-	2008	05	13	01	50	1.41	-107.0460	1.93	34.0530	2.52	11.44	-0.63	1.41
96	4	2008	05	13	17	57	25.34	-106.9710	0.55	34.0723	0.52	5.00	0.65	1.41
97	-	2008	05	15	04	35	37.37	-106.6680	0.74	34.4220	0.81	5.00	0.01	4.01
98	-	2008	05	15	04	42	22.72	-106.5170	2.00	34.3317	1.26	5.00	-0.63	2.17
99	4	2008	05	19	19	59	28.43	-106.9840	0.43	34.0573	0.53	5.00	0.84	2.48
100	-	2008	05	19	20	14	19.82	-106.7820	1.76	34.8783	2.18	5.00	0.30	2.61
101	5	2008	05	19	21	14	47.12	-107.0500	0.50	33.9863	0.43	5.00	-0.22	1.10
102	-	2008	05	22	17	12	29.41	-106.7950	0.41	34.3615	0.59	5.00	0.31	1.59
103	-	2008	05	23	09	08	33.71	-107.1210	1.44	34.3295	0.83	5.00	-0.71	2.11
104	-	2008	05	24	01	16	28.66	-107.1060	0.75	33.9945	0.60	5.00	0.41	3.36
105	-	2008	05	27	16	49	36.39	-106.9400	1.06	33.8795	1.21	5.00	-0.26	1.51
106	-	2008	05	28	20	31	56.31	-107.3400	2.81	33.3750	4.53	5.00	-0.20	8.20
107	5	2008	06	03	20	59	28.78	-107.0010	0.86	33.9985	0.65	5.00	1.15	1.46
108	-	2008	06	04	17	43	29.53	-107.0500	0.75	33.8720	0.54	5.00	0.02	2.06
109	-	2008	06	06	15	38	33.44	-106.8780	1.08	33.7432	1.56	5.00	0.30	5.70
110	-	2008	06	06	19	22	19.10	-107.2360	0.91	34.4998	0.42	5.00	0.49	3.88
111	-	2008	06	06	20	06	16.88	-107.1830	0.98	34.6222	0.47	5.00	1.78	3.15
112	-	2008	06	09	18	30	25.14	-107.1250	0.93	34.1685	0.92	10.08	1.13	0.98
113	-	2008	06	09	21	27	34.45	-106.9840	0.81	34.1103	0.59	5.00	1.19	1.96
114	4	2008	06	10	17	58	26.80	-107.0200	0.47	34.0457	0.52	5.00	1.16	1.38
115	-	2008	06	11	09	45	16.47	-107.0000	1.17	34.7910	0.98	5.00	1.89	3.64
116	-	2008	06	11	16	03	24.96	-107.1440	1.47	33.9993	0.79	5.00	1.34	3.15
117	-	2008	06	12	18	43	22.63	-107.2940	1.00	34.6573	0.54	5.00	1.08	4.06
118	-	2008	06	13	14	08	33.01	-107.0570	0.52	34.4368	1.08	5.00	-0.06	1.27
119	-	2008	06	14	19	03	42.25	-107.1990	0.72	33.7830	0.64	5.00	1.32	2.69
120	4	2008	06	16	17	59	53.78	-106.9930	0.53	34.0485	0.75	5.00	1.39	1.29
121	-	2008	06	19	20	04	24.71	-106.9390	0.71	33.8420	0.79	5.00	1.22	2.27
122	2	2008	06	20	03	22	8.62	-106.8270	0.49	34.0625	0.52	5.00	0.52	2.69
123	-	2008	06	20	20	25	36.87	-107.0810	0.62	33.9848	0.79	5.00	1.27	0.96
124	-	2008	06	24	16	15	22.88	-107.2430	4.28	33.6195	2.36	5.00	1.28	2.90
125	-	2008	06	24	16	27	10.65	-107.0050	1.29	34.6885	0.45	5.00	1.37	3.81
126	-	2008	06	24	21	48	34.31	-107.0070	1.41	34.4353	2.32	5.00	0.13	1.67
127	-	2008	06	25	17	02	36.14	-107.1290	2.62	33.8253	2.17	5.00	1.21	1.26
128	-	2008	06	25	18	30	11.69	-107.2090	1.52	34.4145	2.06	5.00	1.27	2.39
129	8	2008	06	25	23	03	23.37	-106.9180	0.46	34.2600	0.48	5.00	0.72	1.83
130	-	2008	06	26	20	01	18.59	-107.0970	1.60	34.6207	0.97	5.00	1.03	3.51
131	-	2008	07	01	16	35	32.74	-107.0320	0.61	34.2955	0.55	5.00	1.00	2.08
132	-	2008	07	04	18	09	4.34	-106.3140	1.65	34.1038	1.21	5.00	0.19	1.20
133	-	2008	07	04	20	20	14.60	-107.1300	0.99	33.8513	0.84	5.00	0.13	1.91
134	-	2008	07	06	09	56	11.59	-106.4750	1.58	34.0038	0.90	5.00	0.09	1.07
135	-	2008	07	09	03	15	9.45	-106.9060	1.15	34.3870	1.69	5.00	-0.13	0.59
136	-	2008	07	09	19	31	13.82	-106.5230	2.02	34.2918	1.13	5.00	0.00	0.52
137	-	2008	07	21	02	24	4.86	-106.7390	0.66	34.2057	0.56	5.00	0.27	2.09
138	-	2008	07	22	13	02	4.97	-106.7350	0.73	34.1468	0.69	5.00	0.67	1.14

139	-	2008	07	27	00	35	58.92	-105.9620	1.56	34.1222	2.07	5.00	-0.20	2.82
140	-	2008	07	27	00	37	5.96	-106.3650	1.81	34.1732	1.30	5.00	0.07	0.94
141	-	2008	07	31	06	37	8.07	-106.8890	0.51	34.1313	0.55	5.00	1.08	3.25
142	-	2008	08	04	04	04	37.43	-107.3120	1.51	34.0133	0.83	5.00	1.82	3.25
143	-	2008	08	07	18	31	28.31	-107.0200	0.58	34.1427	0.83	5.00	1.31	2.70
144	-	2008	08	09	17	10	18.11	-106.9850	0.47	33.9070	0.43	5.00	1.23	1.73
145	-	2008	08	11	14	35	19.57	-106.4580	1.11	34.8372	1.02	5.00	0.71	2.38
146	-	2008	08	14	06	38	57.27	-106.4780	1.66	34.9020	1.44	5.00	0.96	2.61
147	1	2008	08	15	04	12	28.63	-106.8760	0.47	34.2050	0.51	9.79	-0.06	1.28
148	-	2008	08	15	18	28	8.74	-107.0430	0.83	34.6757	0.50	5.00	-0.07	3.67
149	-	2008	08	15	22	41	8.77	-107.0300	1.02	34.3978	1.49	5.00	0.03	1.02
150	-	2008	08	16	00	30	38.57	-109.6130	4.91	33.8433	13.89	5.00	1.53	3.11
151	-	2008	08	16	18	22	23.32	-106.8830	1.39	34.4528	1.34	0.80	-0.48	1.79
152	-	2008	08	17	18	05	35.17	-106.7360	0.85	34.4985	1.23	5.00	0.75	1.68
153	-	2008	08	18	00	26	13.47	-107.1620	2.66	33.9885	1.29	5.00	0.83	0.39
154	-	2008	08	18	20	47	47.54	-107.4980	1.12	34.5157	0.63	5.00	0.70	4.13
155	-	2008	08	19	05	27	11.68	-106.7670	0.78	33.8263	0.90	14.60	0.74	1.16
156	-	2008	08	20	01	32	13.97	-107.1470	0.81	33.7400	1.01	5.00	0.79	2.68
157	-	2008	08	20	09	18	53.54	-106.7060	0.71	34.4077	0.85	5.00	0.49	1.33
158	-	2008	08	22	02	19	3.08	-106.7810	0.83	33.7553	1.06	5.00	0.61	1.82
159	-	2008	08	23	10	14	48.59	-106.8060	0.78	33.8210	0.95	5.00	1.06	2.18
160	6	2008	08	23	16	30	38.69	-106.9090	0.48	34.2870	0.61	5.00	-0.27	1.55
161	-	2008	08	23	18	54	11.01	-106.8140	0.85	34.3565	1.22	5.00	0.31	1.08
162	-	2008	08	24	06	06	15.51	-106.7490	0.58	34.3902	0.69	5.00	0.96	1.49
163	-	2008	08	25	13	21	28.20	-107.0950	0.57	33.8983	0.61	5.00	0.92	4.16
164	-	2008	08	26	10	48	48.64	-107.0580	0.60	34.3627	0.58	5.00	0.29	1.12
165	-	2008	08	26	17	43	10.17	-107.1800	1.77	34.4140	1.24	14.83	0.41	1.11
166	-	2008	08	27	20	22	39.58	-106.9540	1.30	34.5435	2.71	5.00	1.29	1.34
167	-	2008	09	03	19	49	5.26	-106.9890	0.46	34.5068	0.56	5.00	0.95	4.65
168	-	2008	09	08	21	00	35.40	-106.9390	0.29	34.0932	0.38	5.00	1.02	1.82
169	4	2008	09	10	17	05	32.49	-107.0130	0.49	34.0465	0.41	5.00	0.73	1.86
170	-	2008	09	16	19	50	35.67	-106.6790	0.68	34.2815	0.66	5.00	0.55	2.85
171	-	2008	09	29	15	32	36.51	-106.9170	0.64	34.1693	0.67	5.00	2.37	3.74
172	-	2008	09	30	15	56	36.00	-106.7460	0.52	34.0625	0.53	5.00	0.59	2.50
173	4	2008	10	02	20	27	34.94	-107.0080	0.53	34.1027	0.42	8.29	0.85	1.89
174	-	2008	10	04	08	43	26.25	-107.2220	0.74	34.0605	0.50	5.00	1.09	3.41
175	-	2008	10	23	20	02	33.32	-107.3370	1.39	34.6183	0.69	5.00	0.17	5.12
176	-	2008	10	30	15	23	1.18	-106.4780	1.95	33.5148	2.27	5.00	0.71	2.71
177	-	2008	11	02	13	57	25.00	-106.1260	1.34	33.5978	1.84	5.00	2.00	9.53
178	-	2008	11	03	17	17	33.32	-107.0980	1.12	34.6843	0.66	5.00	0.38	4.97
179	-	2008	11	03	22	50	11.34	-106.5540	3.01	34.4785	2.58	5.00	0.36	1.86
180	-	2008	11	04	22	45	31.27	-106.6780	1.64	34.3588	1.08	5.00	0.31	2.98
181	-	2008	11	06	07	08	16.90	-106.4340	1.86	34.2968	1.33	5.00	0.39	1.96
182	-	2008	11	07	18	21	10.17	-107.3880	1.13	34.6417	0.63	5.00	0.78	4.62
183	-	2008	11	09	03	17	8.58	-107.0450	0.65	34.5427	1.10	5.00	0.37	2.95
184	-	2008	11	10	17	52	54.92	-107.0180	0.59	34.3275	0.63	5.00	1.00	2.65
185	-	2008	11	10	23	07	15.54	-106.4630	3.48	34.6287	2.22	5.00	0.62	1.61
186	-	2008	11	11	18	26	15.64	-107.6380	1.25	34.9800	1.21	5.00	0.85	5.40
187	-	2008	11	12	12	20	27.90	-107.0920	0.81	33.9965	0.51	5.00	0.56	1.96

188	4	2008	11	12	15	40	26.17	-106.9600	0.50	34.0315	0.37	5.00	0.22	1.89
189	-	2008	11	13	23	25	36.46	-106.2980	1.86	34.2857	1.46	5.00	0.41	2.07
190	-	2008	11	18	22	19	34.59	-106.8150	1.16	34.3850	1.70	5.00	0.62	2.91
191	2	2008	11	24	04	08	27.36	-106.8180	0.37	34.0640	0.39	5.00	0.75	1.47
192	-	2008	12	02	12	44	36.70	-106.9830	0.75	34.4597	0.69	5.00	1.27	3.69
193	-	2008	12	03	22	07	3.41	-106.8330	1.32	34.4478	1.41	5.00	0.66	1.91
194	-	2008	12	04	17	33	39.24	-107.1590	1.01	33.8725	0.67	5.00	1.03	2.47
195	-	2008	12	06	11	13	6.50	-107.3650	1.61	34.3430	0.88	5.00	0.78	4.23
196	-	2008	12	11	22	31	6.69	-106.3240	2.28	34.4205	1.91	5.00	0.53	0.51
197	-	2008	12	15	22	00	30.83	-106.8910	1.41	34.4318	1.52	5.00	0.60	2.68
198	-	2008	12	19	19	26	12.81	-106.3540	2.74	34.4277	3.88	5.00	0.51	0.07
199	1	2008	12	20	23	26	19.63	-106.8780	0.51	34.1725	0.68	5.00	0.25	2.37
200	-	2008	12	24	09	23	16.07	-106.9370	2.16	33.9418	3.11	5.00	1.00	1.94
201	6	2008	12	25	08	02	27.00	-106.8830	0.50	34.3218	0.48	5.00	1.47	1.10
202	8	2008	12	29	00	21	13.25	-106.9230	0.64	34.2535	0.65	5.00	0.22	2.56
203	-	2008	12	31	14	46	2.19	-107.1160	1.13	34.5048	1.50	5.00	-0.17	2.09
204	-	2008	12	31	15	31	13.48	-106.8980	1.16	34.4663	0.80	5.00	0.13	4.47
205	-	2009	01	02	00	02	14.31	-107.0050	0.50	33.9737	0.84	3.36	0.41	1.36
206	-	2009	01	05	14	13	11.27	-106.7460	0.60	34.5138	1.16	5.00	-0.27	2.21
207	-	2009	01	08	18	13	5.11	-106.9740	0.61	34.3225	0.78	5.00	0.01	2.73
208	-	2009	01	08	22	29	12.70	-106.4430	3.80	34.4857	2.63	5.00	0.45	0.19
209	-	2009	01	09	16	43	12.59	-106.9780	1.94	33.9437	1.74	5.00	-0.38	1.20
210	-	2009	01	09	23	18	7.86	-106.3940	3.90	34.4962	2.46	5.00	0.25	0.98
211	-	2009	01	10	03	38	16.66	-106.8370	0.49	33.9978	0.54	5.00	0.22	1.48
212	-	2009	01	13	19	58	9.09	-107.1430	1.86	34.6103	0.53	5.00	0.09	3.95
213	-	2009	01	15	22	26	17.80	-106.8030	0.98	34.3008	1.03	5.00	0.83	2.30
214	-	2009	01	16	21	44	10.91	-106.4280	1.49	34.2730	0.91	5.00	0.50	2.34
215	5	2009	01	17	13	40	16.40	-107.0340	0.70	34.0003	0.44	5.00	0.01	2.48
216	-	2009	01	18	22	34	5.70	-106.9310	1.04	34.7445	0.79	5.00	1.28	4.37
217	-	2009	01	19	23	48	13.39	-106.3790	1.44	34.4292	1.31	5.00	0.75	2.59
218	-	2009	01	23	04	50	6.24	-107.1470	2.33	34.2555	1.64	7.23	-0.18	0.45
219	-	2009	01	29	11	50	7.56	-106.7180	1.15	34.1925	1.44	9.12	-0.33	0.39
220	-	2009	01	29	22	39	8.17	-107.3200	10.95	34.5755	1.90	5.00	0.65	9.37
221	-	2009	01	30	21	13	26.64	-107.4370	1.55	34.5627	1.46	5.00	0.18	11.81
222	-	2009	02	03	21	33	8.59	-106.4720	2.23	34.4638	1.35	5.00	0.40	0.09
223	-	2009	02	04	22	10	4.22	-106.6000	1.73	34.3913	1.08	15.99	0.84	2.84
224	4	2009	02	04	23	03	7.45	-107.0170	0.38	34.0682	0.41	5.00	0.98	1.41
225	-	2009	02	05	22	07	14.77	-106.8470	1.02	34.4118	1.46	5.00	0.84	1.84
226	-	2009	02	07	12	25	4.37	-106.7960	3.74	33.9623	2.47	4.06	0.29	0.53
227	-	2009	02	08	01	04	6.59	-106.9990	1.35	33.9430	0.41	5.00	0.31	0.09
228	-	2009	02	13	09	40	11.37	-107.0790	1.38	34.0327	0.79	10.13	-0.04	0.17
229	-	2009	02	15	17	41	5.23	-106.9910	0.50	33.9445	0.46	5.00	0.24	0.23
230	-	2009	03	03	01	42	5.90	-106.7270	1.74	33.9645	1.11	14.49	0.56	0.14
231	-	2009	03	10	20	05	2.62	-107.0460	1.03	34.5937	0.65	5.00	1.32	3.86
232	7	2009	03	12	08	38	11.73	-106.8740	0.38	34.2653	0.35	5.00	1.05	1.78
233	-	2009	03	12	10	15	5.06	-106.9540	0.56	34.3318	0.54	5.00	1.41	2.41
234	-	2009	03	18	21	36	38.87	-106.3710	2.15	34.4733	2.19	5.00	0.84	1.24
235	-	2009	03	25	11	35	8.92	-107.1470	1.21	34.2547	0.75	5.00	0.78	1.00
236	-	2009	03	26	20	33	6.06	-106.2810	1.83	34.4647	2.22	5.00	1.13	2.66

237	-	2009	04	07	20	50	15.29	-106.8480	2.74	34.4743	3.26	5.00	1.01	0.54
238	6	2009	04	14	02	13	6.84	-106.9220	0.50	34.3095	0.43	5.00	1.51	1.65
239	-	2009	04	15	04	41	9.07	-107.0370	0.70	34.3238	0.59	5.00	0.56	2.03
240	-	2009	04	15	07	55	14.20	-106.8910	0.98	34.1257	2.65	4.60	0.72	0.66
241	7	2009	04	15	08	02	11.18	-106.8350	0.45	34.2540	0.65	5.00	0.65	2.04
242	-	2009	04	18	20	17	10.18	-106.8010	0.56	34.3873	0.91	5.00	1.00	1.51
243	-	2009	04	22	11	05	12.56	-106.7440	1.01	34.4325	1.38	5.00	0.80	1.02
244	-	2009	04	24	05	07	19.89	-107.0270	1.45	34.2872	2.25	5.00	0.38	1.79
245	-	2009	04	25	22	38	5.49	-107.0960	1.33	34.4293	1.15	5.00	0.64	2.20
246	-	2009	05	08	20	43	0.67	-106.6570	1.91	34.4507	2.14	6.43	0.70	0.71
247	-	2009	05	09	02	35	2.33	-106.6340	1.13	34.0178	0.66	8.11	0.58	0.69
248	-	2009	05	10	06	46	7.60	-106.6150	3.28	34.0085	1.61	12.11	0.56	0.28
249	-	2009	05	11	22	15	14.36	-106.8010	1.73	34.5570	1.65	5.00	0.67	1.26
250	-	2009	05	12	21	01	8.43	-106.5820	1.17	34.4885	1.81	5.00	0.82	3.81
251	-	2009	05	15	23	07	12.29	-106.7030	0.57	34.1767	0.52	5.00	0.40	1.25
252	6	2009	05	16	15	34	4.24	-106.8850	0.36	34.3347	0.49	5.00	0.66	1.37
253	-	2009	05	17	04	46	9.98	-106.6620	0.95	34.4465	1.55	5.00	0.16	0.98
254	6	2009	05	20	03	30	8.12	-106.9140	0.38	34.2705	0.56	5.00	0.62	2.39
255	-	2009	05	22	16	10	5.63	-107.2130	1.23	34.6240	0.56	5.00	1.26	2.54
256	-	2009	05	24	17	37	9.36	-106.4480	0.98	33.4150	0.96	5.00	1.60	1.78
257	8	2009	05	25	09	36	9.97	-106.9490	0.50	34.2863	0.47	5.00	1.00	1.71
258	8	2009	05	26	06	48	10.78	-106.9300	0.63	34.2705	0.90	5.00	0.67	0.69
259	-	2009	05	26	14	34	12.57	-107.0020	0.89	34.1627	1.11	5.56	0.37	0.50
260	-	2009	05	27	23	12	11.74	-106.5570	2.39	34.1027	0.81	5.00	0.66	0.22
261	-	2009	05	29	20	51	1.17	-106.7450	0.44	34.2932	0.71	5.00	0.80	1.60
262	6	2009	05	29	22	27	3.97	-106.9240	0.51	34.2812	0.53	5.00	0.51	2.51
263	-	2009	05	31	20	27	7.03	-107.0340	0.50	33.9347	0.43	5.00	0.64	0.77
264	-	2009	06	02	18	42	12.54	-106.2990	2.82	34.5317	2.32	5.00	0.74	0.20
265	-	2009	06	03	11	45	13.93	-106.8020	0.49	34.0062	0.59	5.00	0.57	1.28
266	-	2009	06	03	18	03	13.97	-106.8330	0.67	34.0292	0.66	5.00	0.46	0.20
267	2	2009	06	03	21	08	12.58	-106.8290	0.40	34.0658	0.40	5.00	0.70	1.31
268	-	2009	06	04	00	19	9.13	-106.8670	0.46	33.9572	0.49	5.00	0.67	0.73
269	2	2009	06	04	06	08	4.83	-106.9380	0.43	34.0703	0.53	5.00	0.60	1.61
270	-	2009	06	04	20	52	16.19	-106.8940	0.54	34.1043	0.60	5.00	0.46	1.86
271	-	2009	06	05	07	22	59.56	-106.0910	1.62	34.4298	1.53	5.00	1.16	1.08
272	-	2009	06	05	09	42	7.82	-106.0100	1.01	34.3832	0.84	5.00	1.38	2.33
273	-	2009	06	05	15	10	7.28	-106.7650	0.40	34.0452	0.42	5.00	0.79	1.26
274	2	2009	06	05	19	48	12.19	-106.8410	0.50	34.0690	0.66	5.32	0.24	0.75
275	3	2009	06	05	19	50	47.55	-106.9500	0.65	34.0222	0.52	5.00	-0.17	1.74
276	-	2009	06	06	13	33	33.85	-106.0610	2.13	34.3292	1.94	5.00	0.97	2.47
277	-	2009	06	06	22	36	4.94	-106.5900	1.32	34.1963	0.62	5.00	-0.39	1.03
278	-	2009	06	07	13	59	14.85	-106.7900	0.70	33.9277	0.64	6.79	0.52	0.59
279	-	2009	06	07	14	04	6.27	-106.8470	0.42	33.9883	0.50	5.00	0.63	0.95
280	-	2009	06	09	16	39	16.22	-106.8940	0.39	33.9075	0.82	5.00	0.90	1.64
281	-	2009	06	10	02	00	7.73	-107.0190	0.59	34.2653	0.63	5.00	0.40	0.71
282	-	2009	06	11	07	22	6.96	-107.0380	0.63	33.9690	0.39	5.00	0.76	0.92
283	4	2009	06	11	17	53	8.27	-107.0330	0.84	34.0690	0.50	5.00	0.43	1.47
284	-	2009	06	11	19	03	1.49	-106.2990	2.32	34.2897	1.65	5.00	0.59	0.92
285	-	2009	06	11	19	25	10.32	-106.0900	2.47	33.4070	1.56	5.00	1.30	1.30

286	-	2009	06	12	00	27	15.26	-106.8510	0.47	34.0172	0.60	5.00	0.48	1.32
287	-	2009	06	14	16	00	11.01	-106.9170	0.48	33.9363	0.54	5.00	1.00	1.86
288	-	2009	06	22	03	34	12.10	-106.4640	1.63	33.8137	1.10	5.00	0.68	1.66
289	-	2009	06	22	04	51	8.21	-106.9640	0.39	33.9642	0.37	5.00	0.68	1.71
290	-	2009	06	22	04	57	9.53	-106.9650	0.42	34.0047	0.45	5.00	0.84	2.08
291	4	2009	06	22	05	07	16.11	-107.0110	0.42	34.1760	0.66	5.00	0.61	1.87
292	-	2009	06	23	18	06	7.23	-106.6730	0.65	33.9550	0.47	5.00	0.65	1.36
293	5	2009	07	08	21	05	14.97	-107.0530	0.45	33.9940	0.72	6.79	0.06	1.63
294	-	2009	07	10	20	27	18.02	-106.9450	7.44	34.5880	2.42	5.00	0.89	3.55
295	-	2009	07	11	21	53	10.62	-107.0680	0.99	33.9212	1.02	5.00	0.58	1.42
296	8	2009	07	14	12	39	10.61	-106.9250	0.37	34.2703	0.50	5.00	0.49	0.99
297	-	2009	07	15	09	12	1.57	-106.9110	0.41	33.9437	0.35	5.00	0.33	1.25
298	-	2009	07	15	12	12	21.16	-107.4130	3.12	35.3438	1.34	5.00	1.63	1.29
299	-	2009	07	23	20	57	41.49	-106.3140	1.71	34.3782	1.52	5.00	0.47	0.78
300	-	2009	07	23	20	58	2.18	-106.5970	2.02	34.3987	1.85	5.00	0.80	1.58
301	-	2009	07	28	15	57	12.23	-107.0070	0.43	34.4007	0.76	5.00	0.78	0.96
302	4	2009	07	31	20	32	17.29	-107.0050	0.63	34.0750	1.59	5.00	1.05	1.41
303	2	2009	08	20	01	57	24.86	-106.8630	0.19	34.0710	0.18	5.21	2.29	0.30
304	2	2009	08	20	02	13	33.31	-106.8780	0.34	34.0663	0.46	7.15	0.01	0.84
305	2	2009	08	20	03	14	33.27	-106.8650	0.24	34.0657	0.25	5.00	0.93	1.66
306	-	2009	08	20	19	10	26.01	-107.2200	1.24	34.6760	1.13	5.00	0.49	1.10
307	-	2009	08	20	19	28	7.89	-106.8190	1.34	34.2908	1.56	5.00	0.11	0.57
308	3	2009	08	20	19	55	46.17	-106.9450	0.77	34.0263	0.78	5.00	-0.13	0.54
309	-	2009	08	20	20	13	24.51	-106.9410	0.98	33.9140	1.00	5.00	0.02	1.06
310	-	2009	08	20	21	06	19.89	-106.9480	0.84	34.1080	0.81	5.00	-0.56	0.40
311	8	2009	08	20	22	06	24.39	-106.9250	0.57	34.2128	1.23	5.00	-0.49	0.48
312	5	2009	08	20	22	12	37.69	-106.9710	1.05	34.0118	1.00	5.00	-0.13	0.87
313	1	2009	08	20	22	16	17.67	-106.8800	0.48	34.1760	0.98	5.00	-0.51	0.29
314	2	2009	08	21	05	40	14.43	-106.8590	0.52	34.0603	1.49	5.00	-0.20	0.15
315	-	2009	08	21	07	20	25.89	-106.7720	0.46	34.2183	2.08	5.00	-0.77	0.76
316	1	2009	08	21	12	36	16.64	-106.8700	0.52	34.1682	1.14	5.00	-0.27	0.19
317	-	2009	08	21	16	35	24.23	-106.7450	0.62	34.2673	1.31	5.00	0.10	1.20
318	-	2009	08	21	16	58	43.34	-106.7900	0.56	34.1453	0.95	5.00	-0.20	0.30
319	-	2009	08	21	17	01	57.63	-106.7380	0.45	34.0957	0.71	5.00	-0.28	0.69
320	7	2009	08	21	19	37	15.52	-106.8910	0.72	34.2510	1.33	5.00	-0.30	0.52
321	-	2009	08	21	19	42	30.31	-106.4290	1.74	34.0370	1.05	5.00	1.24	0.28
322	8	2009	08	21	20	00	53.61	-106.9690	0.88	34.2027	1.09	5.00	-0.18	0.58
323	7	2009	08	21	20	16	26.69	-106.8330	0.88	34.2253	2.26	5.00	-0.05	0.63
324	6	2009	08	21	23	35	17.03	-106.8880	0.37	34.2938	0.49	5.00	0.68	0.44
325	9	2009	08	23	02	58	38.05	-106.8470	0.35	34.1667	0.52	7.08	0.00	0.21
326	9	2009	08	23	17	28	19.33	-106.8540	0.31	34.1677	0.41	6.48	0.30	0.25
327	9	2009	08	23	17	55	24.49	-106.8560	0.30	34.1690	0.35	5.84	0.40	0.26
328	9	2009	08	23	18	23	23.28	-106.8560	0.35	34.1752	0.79	5.58	0.02	0.07
329	9	2009	08	23	18	55	38.72	-106.8500	0.29	34.1652	0.48	6.20	0.23	0.33
330	9	2009	08	24	01	17	44.09	-106.8530	0.32	34.1703	0.68	5.95	0.22	0.06
331	9	2009	08	24	01	53	54.97	-106.8510	0.36	34.1722	0.68	6.08	0.29	0.09
332	9	2009	08	24	08	09	13.26	-106.8550	0.23	34.1652	0.29	5.04	0.67	0.71
333	9	2009	08	24	14	16	39.95	-106.8540	0.33	34.1667	0.71	5.87	0.20	0.04
334	9	2009	08	24	14	28	47.20	-106.8530	0.33	34.1655	1.06	6.06	0.03	0.10

335	9	2009	08	24	14	35	58.77	-106.8560	0.28	34.1707	0.42	6.27	0.32	0.13
336	9	2009	08	24	15	39	53.18	-106.8590	0.24	34.1610	0.32	6.24	0.56	0.39
337	9	2009	08	24	15	46	59.40	-106.8540	0.36	34.1685	1.86	5.78	-0.43	0.05
338	9	2009	08	24	15	53	0.47	-106.8540	0.24	34.1582	0.28	6.26	0.45	0.63
339	9	2009	08	24	18	13	37.71	-106.8580	0.23	34.1647	0.26	5.97	0.92	0.40
340	9	2009	08	24	19	39	26.35	-106.8530	0.22	34.1548	0.23	6.02	0.72	0.46
341	9	2009	08	24	20	15	32.04	-106.8550	0.32	34.1697	0.85	5.93	0.36	0.10
342	9	2009	08	24	22	09	6.69	-106.8570	0.32	34.1842	0.68	5.95	-0.17	0.14
343	9	2009	08	24	23	11	58.39	-106.8550	0.32	34.1797	0.61	5.57	0.06	0.20
344	9	2009	08	24	23	32	15.51	-106.8530	0.33	34.1902	0.73	5.38	0.10	0.24
345	9	2009	08	25	00	27	35.15	-106.8580	0.23	34.1650	0.30	6.09	0.71	0.46
346	9	2009	08	25	00	54	32.12	-106.8560	0.28	34.1747	0.36	6.17	0.24	0.15
347	9	2009	08	25	01	03	56.67	-106.8560	0.22	34.1617	0.26	6.86	0.43	0.51
348	9	2009	08	25	01	42	16.71	-106.8590	0.28	34.1722	0.37	5.83	0.27	0.32
349	9	2009	08	25	02	19	48.95	-106.8550	0.32	34.1667	0.67	5.72	-0.11	0.33
350	-	2009	08	25	02	37	27.64	-106.8550	0.23	34.1633	0.30	6.32	0.57	0.38
351	9	2009	08	25	02	45	0.54	-106.8440	0.26	34.1450	0.39	6.45	0.08	0.48
352	9	2009	08	25	02	47	7.62	-106.8590	0.27	34.1702	0.40	5.47	0.09	0.26
353	9	2009	08	25	02	48	27.61	-106.8530	0.30	34.1630	0.56	6.24	-0.19	0.24
354	9	2009	08	25	02	56	29.85	-106.8550	0.23	34.1595	0.27	5.98	0.55	0.48
355	9	2009	08	25	03	17	43.06	-106.8550	0.23	34.1608	0.29	5.57	0.74	0.38
356	9	2009	08	25	03	26	58.93	-106.8510	0.49	34.1718	1.14	6.04	-0.72	0.06
357	9	2009	08	25	03	38	15.12	-106.8540	0.28	34.1655	0.39	5.68	0.35	0.23
358	9	2009	08	25	03	50	34.63	-106.8560	0.38	34.1725	1.07	7.67	-0.39	0.38
359	9	2009	08	25	04	33	42.36	-106.8540	0.31	34.1722	0.62	5.94	-0.06	0.31
360	9	2009	08	25	06	10	57.80	-106.8540	0.22	34.1590	0.24	5.07	1.06	0.41
361	9	2009	08	25	06	40	56.22	-106.8560	0.25	34.1672	0.33	5.61	0.78	0.29
362	9	2009	08	25	06	55	33.24	-106.8580	0.25	34.1745	0.30	7.32	0.93	0.49
363	9	2009	08	25	07	01	31.99	-106.8520	0.29	34.1605	0.43	5.98	0.53	0.38
364	9	2009	08	25	07	59	54.05	-106.8540	0.25	34.1610	0.32	5.26	0.41	0.55
365	9	2009	08	25	08	06	35.89	-106.8500	0.25	34.1535	0.33	5.74	0.24	0.47
366	9	2009	08	25	08	21	29.93	-106.8500	0.27	34.1692	0.35	5.68	0.12	0.16
367	9	2009	08	25	08	27	51.37	-106.8570	0.24	34.1670	0.30	6.10	0.47	0.47
368	9	2009	08	25	08	42	1.48	-106.8500	0.25	34.1625	0.31	5.83	0.31	0.43
369	9	2009	08	25	08	61	30.73	-106.8610	0.26	34.1717	0.37	6.19	0.29	0.28
370	9	2009	08	25	09	05	17.18	-106.8530	0.30	34.1600	0.48	6.34	0.41	0.25
371	-	2009	08	25	09	11	17.70	-106.8500	0.43	34.1692	1.04	5.00	0.45	0.07
372	9	2009	08	25	09	37	46.92	-106.8520	0.25	34.1610	0.31	6.71	0.40	0.18
373	9	2009	08	25	09	44	45.03	-106.8530	0.47	34.1715	1.14	6.44	-0.27	0.09
374	9	2009	08	25	10	00	45.07	-106.8480	0.31	34.1568	0.51	6.61	-0.13	0.18
375	9	2009	08	25	10	27	56.49	-106.8530	0.35	34.1620	0.59	6.56	-0.06	0.15
376	9	2009	08	25	11	17	13.30	-106.8570	0.22	34.1685	0.27	5.60	0.10	0.22
377	-	2009	08	25	11	22	13.31	-106.8550	0.33	34.1712	0.61	5.94	0.22	0.09
378	9	2009	08	25	12	13	8.43	-106.8540	0.30	34.1660	0.50	5.62	-0.28	0.07
379	9	2009	08	25	12	33	59.60	-106.8500	0.40	34.1872	1.13	4.70	-0.06	0.15
380	9	2009	08	25	12	58	15.45	-106.8570	0.22	34.1602	0.24	5.61	1.00	0.37
381	9	2009	08	25	13	04	2.20	-106.8520	0.23	34.1647	0.26	5.85	0.49	0.33
382	9	2009	08	25	13	05	2.17	-106.8530	0.39	34.1688	0.57	5.99	0.40	0.23
383	9	2009	08	25	13	08	47.84	-106.8520	0.44	34.1760	0.89	6.21	-0.46	0.10

384	9	2009	08	25	12	20	44.15	-106.8560	0.31	34.1670	0.60	6.12	-0.19	0.10
385	9	2009	08	25	15	27	29.79	-106.8560	0.23	34.1633	0.25	6.12	0.71	0.44
386	9	2009	08	25	16	26	48.16	-106.8580	0.23	34.1708	0.25	6.39	0.61	0.33
387	9	2009	08	25	17	02	41.64	-106.8570	0.32	34.1807	0.66	5.62	0.38	0.07
388	9	2009	08	25	17	06	16.63	-106.8570	0.49	34.1283	0.79	5.37	-0.41	0.33
389	9	2009	08	25	18	30	35.42	-106.8570	0.32	34.1795	0.57	5.66	0.05	0.19
390	9	2009	08	25	18	51	22.17	-106.8560	0.24	34.1610	0.35	6.28	0.28	0.26
391	9	2009	08	25	19	01	10.02	-106.8560	0.22	34.1563	0.24	5.72	0.66	0.40
392	9	2009	08	25	19	04	20.39	-106.8590	0.33	34.1643	0.41	5.01	0.68	0.32
393	1	2009	08	25	19	07	36.04	-106.8780	0.33	34.1592	0.38	5.13	0.71	0.17
394	9	2009	08	25	19	16	17.34	-106.8550	0.34	34.1760	0.82	5.24	-0.20	0.03
395	9	2009	08	25	19	42	54.84	-106.8650	0.32	34.1523	0.55	5.56	-0.02	0.45
396	9	2009	08	25	19	53	32.95	-106.8530	0.27	34.1728	0.42	5.74	-0.38	0.20
397	9	2009	08	25	20	07	27.79	-106.8580	0.35	34.1668	0.67	5.86	-0.35	0.12
398	9	2009	08	25	20	12	43.80	-106.8580	0.32	34.1693	0.62	5.78	-0.13	0.17
399	9	2009	08	25	20	14	43.58	-106.8530	0.45	34.1812	0.92	7.07	-0.45	0.87
400	9	2009	08	25	20	33	13.95	-106.8540	0.22	34.1572	0.27	5.53	0.31	0.40
401	9	2009	08	25	21	19	29.76	-106.8580	0.21	34.1602	0.22	5.66	1.13	0.45
402	9	2009	08	25	21	50	14.66	-106.8550	0.32	34.1707	0.63	6.51	-0.43	0.13
403	9	2009	08	25	22	12	15.19	-106.8540	0.30	34.1623	0.54	6.26	0.01	0.11
404	9	2009	08	26	00	27	16.31	-106.8550	0.31	34.1653	0.66	5.97	-0.24	0.16
405	9	2009	08	26	00	51	24.22	-106.8530	0.29	34.1657	0.47	6.92	0.01	0.13
406	9	2009	08	26	00	58	31.92	-106.8540	0.24	34.1650	0.30	5.66	0.61	0.33
407	9	2009	08	26	01	11	26.58	-106.8560	0.27	34.1670	0.35	5.34	0.21	0.38
408	9	2009	08	26	03	11	17.02	-106.8570	0.29	34.1747	0.52	4.78	-0.26	0.33
409	9	2009	08	26	03	23	31.44	-106.8560	0.31	34.1665	0.54	5.69	-0.25	0.15
410	9	2009	08	26	03	35	30.39	-106.8570	0.24	34.1650	0.31	5.77	0.31	0.36
411	9	2009	08	26	04	11	37.46	-106.8540	0.25	34.1653	0.30	5.13	0.60	0.31
412	9	2009	08	26	04	26	30.17	-106.8570	0.30	34.1613	0.49	6.35	-0.14	0.80
413	9	2009	08	26	04	41	41.96	-106.8570	0.58	34.1865	1.27	5.39	0.36	1.39
414	9	2009	08	26	05	02	40.31	-106.8540	0.26	34.1555	0.32	5.88	0.06	0.42
415	9	2009	08	26	05	34	16.88	-106.8570	0.35	34.2007	0.85	4.11	0.12	0.26
416	9	2009	08	26	06	16	39.71	-106.8560	0.33	34.1673	0.89	5.19	-0.11	0.23
417	9	2009	08	26	07	37	52.23	-106.8530	0.33	34.1553	0.94	5.94	-0.48	0.21
418	9	2009	08	26	07	38	53.86	-106.8640	0.33	34.1593	0.53	2.29	-0.18	0.71
419	9	2009	08	26	07	46	55.27	-106.8510	0.25	34.1630	0.28	6.19	0.14	0.30
420	9	2009	08	26	08	00	9.54	-106.8550	0.30	34.1675	0.40	5.19	0.05	0.23
421	9	2009	08	26	08	38	7.80	-106.8540	0.29	34.1645	0.36	6.68	0.13	0.17
422	9	2009	08	26	09	41	19.99	-106.8600	0.31	34.1763	0.59	5.67	-0.30	0.32
423	9	2009	08	26	09	51	39.38	-106.8520	0.30	34.1615	0.33	5.62	0.26	0.37
424	9	2009	08	26	11	06	18.01	-106.8530	0.26	34.1645	0.32	4.71	0.34	0.37
425	9	2009	08	26	12	00	42.94	-106.8540	0.27	34.1600	0.32	5.16	1.34	0.35
426	9	2009	08	26	12	37	42.18	-106.8590	0.27	34.1682	0.33	6.65	0.14	0.30
427	7	2009	08	26	14	59	22.74	-106.8520	0.40	34.2335	1.56	4.68	-0.52	0.36
428	9	2009	08	26	50	80	36.01	-106.8540	0.27	34.1660	0.36	6.11	-0.14	0.27
429	9	2009	08	26	15	11	23.83	-106.8550	0.42	34.1672	0.75	5.64	-0.15	0.11
430	9	2009	08	26	15	14	4.22	-106.8520	0.22	34.1600	0.27	5.59	0.34	0.52
431	9	2009	08	26	15	52	17.42	-106.8580	0.22	34.1617	0.24	5.07	0.89	0.45
432	9	2009	08	26	16	06	5.06	-106.8560	0.35	34.1608	0.98	5.58	-0.06	0.14

433	9	2009	08	26	16	15	22.01	-106.8560	0.22	34.1733	0.26	5.20	0.30	0.41
434	9	2009	08	26	16	18	41.66	-106.8550	0.33	34.1730	0.90	5.35	0.00	0.23
435	9	2009	08	26	16	35	34.49	-106.8530	0.49	34.1617	1.10	6.21	-0.39	0.42
436	9	2009	08	26	17	12	55.54	-106.8550	0.26	34.1618	0.37	6.85	0.18	0.14
437	9	2009	08	26	17	49	55.53	-106.8610	0.32	34.1610	0.51	5.72	0.23	0.35
438	9	2009	08	26	18	14	49.10	-106.8600	0.28	34.1768	0.40	5.11	0.03	0.19
439	9	2009	08	26	19	24	15.36	-106.8580	0.24	34.1618	0.27	6.02	1.31	0.34
440	9	2009	08	26	19	41	57.85	-106.8610	0.29	34.1683	0.36	5.84	-0.04	0.15
441	9	2009	08	26	19	43	57.72	-106.8560	0.41	34.1840	0.89	5.50	0.18	0.11
442	9	2009	08	26	20	24	36.94	-106.8750	0.36	34.1678	0.70	6.35	-0.43	0.44
443	9	2009	08	26	21	04	5.19	-106.8550	0.24	34.1677	0.30	5.75	0.29	0.16
444	9	2009	08	26	21	11	5.18	-106.8510	0.39	34.1703	0.63	5.80	0.37	0.25
445	9	2009	08	27	00	43	57.21	-106.8600	0.30	34.1642	0.47	5.94	-0.08	0.25
446	9	2009	08	27	00	49	15.30	-106.8520	0.30	34.1648	0.53	6.22	-0.35	0.09
447	6	2009	08	27	02	18	12.75	-106.8830	0.49	34.2928	0.67	5.00	-0.26	0.17
448	9	2009	08	27	02	29	10.49	-106.8470	0.25	34.1512	0.27	6.58	0.29	0.37
449	9	2009	08	27	02	48	11.34	-106.8550	0.32	34.1723	0.66	6.13	-0.31	0.19
450	9	2009	08	27	03	10	34.91	-106.8590	0.23	34.1602	0.30	6.48	0.55	0.26
451	-	2009	08	27	03	16	34.42	-106.8580	0.46	34.1685	0.71	6.09	-0.03	0.09
452	9	2009	08	27	04	05	48.77	-106.8550	0.32	34.1635	0.56	6.08	-0.14	0.13
453	9	2009	08	27	04	36	14.66	-106.8600	0.22	34.1602	0.25	6.11	1.25	0.36
454	9	2009	08	27	04	39	3.95	-106.8480	0.37	34.1767	0.62	5.00	0.72	0.20
455	9	2009	08	27	04	40	5.94	-106.8610	0.22	34.1635	0.25	6.00	1.30	0.34
456	9	2009	08	27	04	43	13.59	-106.8570	0.33	34.1692	0.71	6.10	-0.08	0.03
457	-	2009	08	27	04	46	21.97	-106.8580	0.34	34.1840	0.96	5.23	-0.44	0.22
458	2	2009	08	27	04	48	13.96	-106.8830	0.52	34.0893	0.79	4.21	0.00	1.04
459	9	2009	08	27	06	01	49.38	-106.8540	0.21	34.1630	0.24	5.93	0.57	0.28
460	9	2009	08	27	06	02	49.50	-106.8510	0.38	34.1650	0.49	4.74	0.57	0.14
461	9	2009	08	27	06	03	28.89	-106.8580	0.22	34.1632	0.23	5.48	1.32	0.31
462	9	2009	08	27	06	10	41.30	-106.8520	0.23	34.1560	0.26	5.51	0.20	0.46
463	9	2009	08	27	06	24	29.28	-106.8550	0.32	34.1898	0.64	6.63	-0.06	0.33
464	9	2009	08	27	06	51	45.85	-106.8540	0.19	34.1673	0.19	8.92	1.97	0.54
465	9	2009	08	27	07	02	43.25	-106.8560	0.32	34.1877	0.77	5.41	-0.43	0.19
466	9	2009	08	27	07	08	37.98	-106.8580	0.26	34.1638	0.36	5.51	0.18	0.16
467	9	2009	08	27	07	09	37.94	-106.8580	0.37	34.1728	0.67	5.20	0.22	0.10
468	9	2009	08	27	07	13	53.88	-106.8580	0.33	34.1813	0.92	5.91	-0.27	0.17
469	9	2009	08	27	07	18	31.44	-106.8560	0.34	34.1892	0.76	5.64	-0.13	0.17
470	9	2009	08	27	07	17	53.00	-106.8610	0.30	34.1675	0.40	5.31	-0.11	0.27
471	9	2009	08	27	07	24	25.06	-106.8550	0.28	34.1690	0.42	5.38	-0.02	0.15
472	9	2009	08	27	07	26	25.00	-106.8560	0.31	34.1718	0.62	5.98	0.12	0.09
473	9	2009	08	27	08	02	14.02	-106.8520	0.24	34.1647	0.29	6.14	0.36	0.42
474	9	2009	08	27	08	07	1.79	-106.8550	0.27	34.1697	0.37	6.28	0.36	0.13
475	9	2009	08	27	08	13	6.28	-106.8600	0.27	34.1767	0.37	6.32	0.38	0.19
476	9	2009	08	27	08	31	27.61	-106.8520	0.61	34.1650	1.26	6.13	-0.35	0.05
477	9	2009	08	27	08	52	29.98	-106.8590	0.26	34.1615	0.32	5.53	0.07	0.52
478	-	2009	08	27	08	53	29.87	-106.8540	0.37	34.1713	0.67	6.00	0.53	0.06
479	9	2009	08	27	08	55	14.04	-106.8520	0.32	34.1733	1.16	6.12	-0.72	0.09
480	9	2009	08	27	09	41	57.82	-106.8500	0.34	34.2105	0.80	5.06	-0.20	0.47
481	9	2009	08	27	10	20	29.11	-106.8580	0.22	34.1600	0.25	5.52	0.45	0.62

482	9	2009	08	27	10	20	29.11	-106.8580	0.22	34.1600	0.25	5.52	0.45	0.62
483	9	2009	08	27	10	21	59.25	-106.8550	0.42	34.1697	0.67	5.14	0.54	0.18
484	9	2009	08	27	10	31	25.42	-106.8580	0.34	34.1747	0.61	6.30	0.08	0.17
485	9	2009	08	27	11	04	56.67	-106.8540	0.33	34.1678	0.91	6.06	-0.35	0.17
486	9	2009	08	27	11	38	21.86	-106.8590	0.33	34.1697	0.51	6.68	-0.01	0.29
487	-	2009	08	27	11	39	21.95	-106.8490	0.33	34.1795	1.04	5.07	0.00	0.29
488	9	2009	08	27	11	44	28.31	-106.8580	0.24	34.1600	0.29	6.66	0.25	0.33
489	9	2009	08	27	12	19	36.49	-106.8530	0.33	34.1618	1.06	6.04	-0.13	0.11
490	9	2009	08	27	12	34	50.64	-106.8610	0.23	34.1672	0.26	6.18	0.42	0.33
491	9	2009	08	27	13	58	3.45	-106.8540	0.34	34.1757	1.29	5.35	0.12	0.03
492	9	2009	08	27	14	27	40.88	-106.8580	0.24	34.1627	0.29	6.63	0.45	0.27
493	9	2009	08	27	14	46	16.45	-106.8540	0.36	34.1403	0.48	6.12	-0.07	0.56
494	9	2009	08	27	15	10	30.70	-106.8560	0.26	34.1722	0.35	5.88	0.38	0.51
495	9	2009	08	27	15	11	30.60	-106.8560	0.43	34.1910	0.69	5.91	0.36	0.12
496	9	2009	08	27	15	15	9.02	-106.8540	0.41	34.1695	0.86	5.00	-0.17	0.15
497	9	2009	08	27	16	15	36.57	-106.8560	0.34	34.1738	0.69	5.42	-0.16	0.03
498	9	2009	08	27	16	60	3.78	-106.8590	0.31	34.1783	0.65	5.13	-0.15	0.05
499	9	2009	08	27	17	22	56.95	-106.8520	0.45	34.1772	0.95	5.00	-0.35	0.11
500	9	2009	08	27	17	31	50.42	-106.8600	0.22	34.1673	0.28	5.53	0.81	0.38
501	9	2009	08	27	17	38	20.68	-106.8630	0.31	34.1853	0.52	4.81	0.21	0.17
502	9	2009	08	27	17	56	5.39	-106.8540	0.33	34.1677	0.56	5.88	0.58	0.18
503	9	2009	08	27	18	16	55.43	-106.8540	0.23	34.1702	0.27	6.45	0.41	0.22
504	9	2009	08	27	18	18	55.47	-106.8500	0.37	34.1642	0.58	5.94	0.73	0.06
505	9	2009	08	27	91	80	19.95	-106.8580	0.32	34.1757	0.50	5.66	0.13	0.10
506	9	2009	08	27	20	13	23.13	-106.8590	0.31	34.1795	0.67	5.71	-0.17	0.13
507	9	2009	08	27	20	29	28.22	-106.8540	0.23	34.1675	0.27	6.41	0.50	0.34
508	9	2009	08	27	20	33	15.66	-106.8520	0.41	34.1692	0.68	5.80	0.32	0.07
509	9	2009	08	27	24	70	44.08	-106.8580	0.32	34.1752	0.64	5.95	0.38	0.20
510	9	2009	08	27	23	03	15.85	-106.8570	0.19	34.1622	0.20	4.07	1.86	0.67
511	9	2009	08	28	01	00	26.72	-106.8470	0.24	34.1693	0.28	5.60	0.80	0.30
512	-	2009	08	28	01	05	8.73	-106.8530	0.37	34.1683	0.54	4.15	0.71	0.23
513	9	2009	08	28	02	37	14.06	-106.8590	0.28	34.1675	0.35	6.33	0.35	0.21
514	-	2009	08	28	02	42	47.73	-106.8510	0.35	34.1728	0.81	6.29	-0.62	0.16
515	9	2009	08	28	03	04	12.72	-106.8560	0.23	34.1665	0.27	6.16	0.46	0.10
516	9	2009	08	28	03	33	15.67	-106.8550	0.21	34.1557	0.23	4.48	1.25	0.32
517	9	2009	08	28	03	52	35.87	-106.8540	0.23	34.1615	0.26	6.32	1.43	0.32
518	9	2009	08	28	04	00	34.47	-106.8550	0.22	34.1645	0.25	6.52	0.69	0.23
519	9	2009	08	28	04	05	59.03	-106.8530	0.30	34.1718	0.62	4.54	-0.20	0.16
520	9	2009	08	28	04	11	30.81	-106.8590	0.32	34.1697	0.72	5.94	-0.20	0.30
521	9	2009	08	28	04	19	52.28	-106.8520	0.28	34.1673	0.38	4.90	0.24	0.18
522	9	2009	08	28	04	20	52.32	-106.8500	0.33	34.1683	0.74	5.46	0.29	0.10
523	9	2009	08	28	04	55	11.94	-106.8550	0.28	34.1660	0.39	6.01	0.01	0.16
524	9	2009	08	28	05	17	35.21	-106.8560	0.35	34.1722	0.82	5.00	-0.35	0.04
525	9	2009	08	28	06	25	51.10	-106.8590	0.30	34.1700	0.42	5.81	0.22	0.12
526	9	2009	08	28	06	54	58.16	-106.8540	0.27	34.1692	0.36	6.17	0.02	0.17
527	9	2009	08	28	07	12	10.44	-106.8580	0.28	34.1683	0.39	6.37	-0.22	0.09
528	9	2009	08	28	08	10	39.71	-106.8580	0.27	34.1692	0.32	6.25	0.03	0.10
529	9	2009	08	28	08	35	50.13	-106.8530	0.34	34.1688	0.81	5.91	-0.20	0.09
530	9	2009	08	28	08	52	48.72	-106.8530	0.27	34.1748	0.38	5.70	-0.14	0.09

531	9	2009	08	28	08	56	47.88	-106.8530	0.44	34.1752	0.85	6.95	-0.37	0.08
532	9	2009	08	28	08	59	9.65	-106.8580	0.22	34.1597	0.24	6.06	0.90	0.48
533	9	2009	08	28	09	17	3.99	-106.8520	0.30	34.1600	0.52	4.71	0.19	0.12
534	9	2009	08	28	09	18	31.21	-106.8470	0.61	34.1685	1.19	5.60	-0.58	0.12
535	9	2009	08	28	09	45	1.11	-106.8550	0.22	34.1543	0.23	5.49	0.71	0.50
536	9	2009	08	28	09	49	59.29	-106.8570	0.29	34.1760	0.46	6.41	0.00	0.13
537	9	2009	08	28	09	54	10.97	-106.8610	0.27	34.1715	0.38	5.66	0.29	0.26
538	9	2009	08	28	13	11	45.31	-106.8570	0.28	34.1663	0.39	5.71	0.00	0.10
539	9	2009	08	28	13	26	3.47	-106.8480	0.65	34.1798	0.92	5.00	-0.27	0.12
540	9	2009	08	28	13	42	34.05	-106.8570	0.26	34.1680	0.31	5.81	0.02	0.29
541	9	2009	08	28	13	45	16.81	-106.8570	0.23	34.1618	0.25	5.79	1.14	0.25
542	9	2009	08	28	14	08	22.61	-106.8600	0.17	34.1295	0.17	4.93	1.49	2.91
543	9	2009	08	28	14	17	18.00	-106.8580	0.28	34.1675	0.43	5.94	0.41	0.15
544	9	2009	08	28	14	30	34.54	-106.8780	0.26	34.1360	0.33	6.38	0.07	0.82
545	9	2009	08	28	15	00	14.49	-106.8540	0.42	34.1693	0.98	5.11	-0.72	0.06
546	9	2009	08	28	15	03	44.68	-106.8540	0.37	34.1707	0.67	4.18	0.00	0.06
547	9	2009	08	28	15	11	7.44	-106.8610	0.34	34.1687	0.67	5.77	-0.29	0.11
548	9	2009	08	28	15	12	7.51	-106.8580	0.44	34.1580	1.02	4.57	-0.20	0.12
549	9	2009	08	28	16	07	50.70	-106.8570	0.31	34.1665	0.55	6.24	-0.12	0.12
550	9	2009	08	28	16	08	50.64	-106.8530	0.41	34.1755	1.08	5.81	-0.02	0.09
551	9	2009	08	28	16	28	53.22	-106.8620	0.29	34.1742	0.36	5.89	0.03	0.22
552	9	2009	08	28	16	29	53.21	-106.8560	0.34	34.1947	0.63	5.23	-0.06	0.18
553	9	2009	08	28	16	34	35.64	-106.8560	0.41	34.1735	0.79	5.60	-0.26	0.07
554	9	2009	08	28	16	55	43.00	-106.8560	0.34	34.1703	0.80	5.01	-0.27	0.11
555	9	2009	08	28	17	03	45.72	-106.8530	0.24	34.1670	0.29	6.21	0.25	0.31
556	9	2009	08	28	17	13	43.69	-106.8600	0.21	34.1662	0.24	5.54	0.51	0.48
557	9	2009	08	28	17	24	42.37	-106.8670	0.32	34.1510	0.54	4.88	-0.23	0.49
558	9	2009	08	28	17	33	29.59	-106.8590	0.34	34.1627	0.75	5.48	-0.62	0.39
559	9	2009	08	28	17	39	25.03	-106.8590	0.25	34.1680	0.35	5.90	0.23	0.33
560	-	2009	08	28	17	41	22.92	-106.8550	0.46	34.1627	0.79	5.00	-0.40	0.06
561	-	2009	08	28	17	43	8.93	-106.8550	0.38	34.1875	0.82	5.46	-0.16	0.17
562	9	2009	08	28	17	44	53.00	-106.8590	0.21	34.1672	0.26	5.28	1.49	0.40
563	9	2009	08	28	17	50	34.69	-106.8590	0.30	34.1783	0.47	6.30	0.06	0.22
564	9	2009	08	28	17	56	27.23	-106.8600	0.30	34.1810	0.50	5.32	-0.04	0.18
565	9	2009	08	28	18	06	20.33	-106.8570	0.30	34.1725	0.54	5.72	-0.35	0.17
566	9	2009	08	28	18	28	36.48	-106.8560	0.34	34.1772	0.82	5.64	-0.64	0.13
567	9	2009	08	28	18	33	48.25	-106.8580	0.30	34.1743	0.55	5.60	0.19	0.17
568	9	2009	08	28	18	34	48.18	-106.8550	0.44	34.1800	1.17	5.66	-0.14	0.08
569	9	2009	08	28	18	37	27.85	-106.8560	0.21	34.1588	0.25	5.88	0.90	0.38
570	9	2009	08	28	18	55	33.43	-106.8560	0.54	34.1815	0.57	5.00	1.83	1.05
571	9	2009	08	28	19	01	34.48	-106.8600	0.27	34.1687	0.39	6.13	0.01	0.33
572	9	2009	08	28	19	04	4.16	-106.8590	0.53	34.2038	1.73	5.95	0.00	0.14
573	9	2009	08	28	19	14	2.64	-106.8520	0.18	34.1567	0.24	4.71	1.02	0.49
574	9	2009	08	28	19	21	44.19	-106.8580	0.27	34.1702	0.39	6.33	0.22	0.18
575	9	2009	08	28	19	33	20.31	-106.8590	0.36	34.1718	0.58	5.43	-0.13	0.09
576	9	2009	08	28	19	52	49.37	-106.8590	0.21	34.1622	0.26	4.78	0.57	0.55
577	9	2009	08	28	19	58	31.57	-106.8540	0.27	34.1717	0.39	6.61	-0.04	0.14
578	9	2009	08	28	20	06	18.10	-106.9450	0.57	34.4003	0.53	1.14	0.05	2.12
579	9	2009	08	28	20	26	35.62	-106.8570	0.39	34.1750	1.29	5.19	-0.20	0.04

580	9	2009	08	28	20	46	44.98	-106.8550	0.28	34.1685	0.36	5.63	-0.09	0.17
581	9	2009	08	28	20	55	35.23	-106.8560	0.27	34.1675	0.34	6.16	0.23	0.15
582	9	2009	08	28	21	09	21.12	-106.8530	0.32	34.1605	0.71	5.86	-0.12	0.20
583	7	2009	08	28	21	14	31.21	-106.8760	0.59	34.2583	1.41	3.93	-0.06	1.35
584	9	2009	08	28	21	22	36.93	-106.8590	0.29	34.1725	0.41	5.97	-0.24	0.18
585	9	2009	08	28	21	40	5.52	-106.8550	0.21	34.1613	0.24	5.44	0.95	0.17
586	9	2009	08	28	21	55	46.13	-106.8730	0.23	34.1695	0.26	5.79	0.42	1.08
587	9	2009	08	28	22	16	31.70	-106.8590	0.26	34.1712	0.32	4.78	0.27	0.16
588	9	2009	08	28	22	21	3.11	-106.8580	0.56	34.1680	0.81	6.17	0.12	0.05
589	9	2009	08	28	22	47	31.44	-106.8540	0.22	34.1542	0.23	3.98	0.10	0.45
590	9	2009	08	28	22	51	41.50	-106.8580	0.25	34.1648	0.35	6.30	0.07	0.27
591	9	2009	08	28	22	59	25.73	-106.8560	0.30	34.1653	0.49	6.05	-0.37	0.10
592	2	2009	08	28	23	08	30.68	-106.9080	0.95	34.0765	1.11	7.05	-0.24	0.42
593	9	2009	08	28	23	10	46.28	-106.8580	0.43	34.1777	0.73	4.64	0.20	0.20
594	9	2009	08	28	23	15	57.16	-106.8570	0.22	34.1610	0.23	5.13	1.20	0.22
595	9	2009	08	28	23	27	12.98	-106.8580	0.27	34.1625	0.37	5.43	-0.08	0.16
596	9	2009	08	28	23	48	43.08	-106.8560	0.27	34.1642	0.34	4.83	0.32	0.14
597	9	2009	08	28	23	54	48.84	-106.8590	0.22	34.1583	0.23	5.53	1.20	0.79
598	9	2009	08	29	00	22	5.48	-106.8580	0.23	34.1648	0.23	3.97	1.79	0.26
599	9	2009	08	29	00	25	2.65	-106.8520	0.21	34.1573	0.22	5.58	1.01	0.34
600	9	2009	08	29	00	50	22.51	-106.8550	0.24	34.1672	0.33	5.93	0.75	0.38
601	9	2009	08	29	00	59	17.05	-106.8540	0.24	34.1643	0.33	5.33	0.60	0.27
602	9	2009	08	29	01	03	12.65	-106.8540	0.30	34.1682	0.49	5.43	0.00	0.11
603	9	2009	08	29	01	10	21.41	-106.8540	0.25	34.1595	0.32	6.53	0.44	0.35
604	9	2009	08	29	01	19	46.35	-106.8570	0.24	34.1632	0.27	5.82	0.30	0.15
605	9	2009	08	29	01	23	41.86	-106.8530	0.24	34.1610	0.25	5.82	0.32	0.16
606	9	2009	08	29	01	31	18.51	-106.8560	0.33	34.1705	0.81	5.60	-0.43	0.07
607	9	2009	08	29	01	34	33.81	-106.8550	0.22	34.1588	0.22	5.84	0.62	0.25
608	9	2009	08	29	01	42	45.27	-106.8580	0.30	34.1678	0.54	5.77	-0.06	0.10
609	9	2009	08	29	01	53	9.37	-106.8550	0.26	34.1647	0.35	5.45	0.06	0.15
610	9	2009	08	29	01	58	20.77	-106.8510	0.24	34.1598	0.28	5.48	0.21	0.42
611	9	2009	08	29	02	10	16.30	-106.8540	0.24	34.1677	0.30	5.49	0.29	0.10
612	9	2009	08	29	02	19	35.72	-106.8600	0.26	34.1690	0.33	5.27	0.14	0.15
613	9	2009	08	29	02	44	31.80	-106.8590	0.28	34.1728	0.39	5.75	0.05	0.16
614	9	2009	08	29	02	59	47.78	-106.8590	0.30	34.1690	0.51	6.40	-0.22	0.12
615	9	2009	08	29	03	38	54.86	-106.8580	0.23	34.1638	0.26	5.86	0.41	0.31
616	9	2009	08	29	04	03	34.99	-106.8590	0.31	34.1723	0.52	6.75	0.17	0.19
617	9	2009	08	29	04	21	46.16	-106.8580	0.24	34.1628	0.36	5.69	-0.13	0.12
618	9	2009	08	29	04	29	40.22	-106.8570	0.33	34.1687	1.20	5.00	-0.35	0.07
619	9	2009	08	29	05	21	48.50	-106.8490	0.34	34.1885	0.67	5.61	-0.27	0.46
620	9	2009	08	29	05	43	42.36	-106.8580	0.31	34.1743	0.44	5.35	0.10	0.21
621	9	2009	08	29	06	45	53.81	-106.8570	0.28	34.1677	0.35	5.62	0.09	0.13
622	9	2009	08	29	07	08	18.88	-106.8560	0.65	34.1707	1.29	5.00	-0.72	0.05
623	9	2009	08	29	07	17	49.06	-106.8610	0.26	34.1720	0.31	5.22	-0.04	0.18
624	9	2009	08	29	08	56	47.11	-106.8540	0.21	34.1558	0.27	5.25	0.16	0.46
625	9	2009	08	29	09	19	38.92	-106.8520	0.40	34.1637	0.72	5.00	-0.43	0.09
626	9	2009	08	29	14	10	19.22	-106.8570	0.22	34.1635	0.21	1.63	1.86	0.26
627	9	2009	08	29	14	22	17.51	-106.8560	0.33	34.1797	0.63	5.36	-0.27	0.07
628	9	2009	08	29	16	22	16.00	-106.8590	0.26	34.1668	0.42	5.95	0.06	0.25

629	9	2009	08	29	16	54	13.81	-106.8550	0.32	34.1712	0.69	5.63	-0.48	0.10
630	9	2009	08	29	17	17	23.81	-106.8550	0.28	34.1703	0.39	6.13	-0.18	0.15
631	9	2009	08	29	17	28	37.23	-106.8520	0.30	34.1663	0.50	6.38	-0.12	0.14
632	9	2009	08	29	17	34	47.55	-106.8560	0.21	34.1633	0.24	5.05	0.50	0.20
633	9	2009	08	29	18	29	25.94	-106.8590	0.25	34.1702	0.32	4.92	0.19	0.16
634	9	2009	08	29	19	21	49.38	-106.8580	0.21	34.1632	0.22	5.84	1.30	0.30
635	9	2009	08	29	20	01	2.21	-106.8520	0.29	34.1673	0.39	5.42	0.15	0.64
636	9	2009	08	29	20	40	47.01	-106.8580	0.28	34.1632	0.34	5.51	0.00	0.15
637	9	2009	08	29	21	42	55.25	-106.8530	0.30	34.1668	0.56	6.48	0.06	0.17
638	9	2009	08	29	22	45	49.48	-106.8560	0.23	34.1612	0.27	5.49	0.68	0.13
639	9	2009	08	29	23	31	3.89	-106.8560	0.25	34.1650	0.30	6.09	0.47	0.19
640	9	2009	08	29	23	43	10.77	-106.8580	0.26	34.1575	0.34	5.81	0.16	0.24
641	9	2009	08	29	23	48	27.98	-106.9320	0.40	34.1428	0.46	5.66	0.00	0.21
642	-	2009	08	30	00	18	25.73	-106.8590	0.22	34.1552	0.26	5.88	1.35	0.28
643	9	2009	08	30	00	23	28.42	-106.8570	0.23	34.1602	0.27	5.74	0.59	0.24
644	9	2009	08	30	00	31	1.11	-106.8550	0.18	34.1653	0.19	4.41	2.50	0.26
645	9	2009	08	30	00	38	7.13	-106.8590	0.21	34.1655	0.28	5.99	0.75	0.22
646	9	2009	08	30	00	44	26.66	-106.8570	0.27	34.1707	0.39	5.69	0.11	0.19
647	9	2009	08	30	00	50	30.03	-106.8520	0.22	34.1652	0.28	5.75	0.60	0.32
648	9	2009	08	30	00	54	47.79	-106.8540	0.32	34.1677	0.61	6.02	-0.27	0.06
649	9	2009	08	30	01	08	46.12	-106.8560	0.27	34.1728	0.34	5.02	0.26	0.07
650	9	2009	08	30	01	18	19.11	-106.8560	0.22	34.1595	0.28	6.21	0.45	0.38
651	9	2009	08	30	01	23	27.31	-106.8590	0.24	34.1640	0.28	5.87	0.71	0.28
652	9	2009	08	30	01	52	43.89	-106.8620	0.26	34.1752	0.31	5.92	0.17	0.24
653	9	2009	08	30	02	13	42.00	-106.8530	0.24	34.1660	0.27	6.04	0.00	0.21
654	9	2009	08	30	02	22	46.25	-106.8550	0.30	34.1723	0.45	6.06	-0.16	0.20
655	9	2009	08	30	02	47	44.19	-106.8560	0.33	34.1750	0.56	5.25	-0.20	0.18
656	9	2009	08	30	03	36	29.17	-106.8580	0.21	34.1685	0.25	5.00	0.47	0.15
657	9	2009	08	30	04	10	28.77	-106.8590	0.21	34.1653	0.25	4.87	0.74	0.28
658	-	2009	08	30	04	47	53.70	-106.8720	0.33	34.1583	0.70	4.58	-0.52	0.29
659	9	2009	08	30	04	55	38.67	-106.8560	0.32	34.1733	0.52	5.98	0.22	0.11
660	9	2009	08	30	05	15	2.64	-106.8590	0.28	34.1645	0.37	4.75	0.13	0.14
661	9	2009	08	30	05	21	45.35	-106.8580	0.21	34.1597	0.23	5.40	1.00	0.31
662	9	2009	08	30	05	31	56.79	-106.8560	0.33	34.1668	0.78	5.75	-0.15	0.08
663	9	2009	08	30	05	50	51.82	-106.8570	0.30	34.1662	0.53	5.61	0.16	0.10
664	9	2009	08	30	06	11	25.60	-106.8590	0.23	34.1525	0.28	5.87	0.60	0.35
665	9	2009	08	30	06	17	33.62	-106.8560	0.23	34.1667	0.28	6.41	0.41	0.34
666	9	2009	08	30	06	39	48.54	-106.8590	0.25	34.1642	0.25	4.34	2.34	0.14
667	9	2009	08	30	06	50	53.00	-106.8620	0.31	34.1717	0.53	4.82	-0.24	0.12
668	9	2009	08	30	07	01	26.67	-106.8540	0.25	34.1585	0.29	5.97	0.34	0.43
669	9	2009	08	30	07	09	44.63	-106.8630	0.26	34.1613	0.26	2.76	2.26	0.42
670	9	2009	08	30	07	26	21.44	-106.8570	0.22	34.1597	0.25	5.74	0.46	0.46
671	9	2009	08	30	07	51	36.13	-106.8610	0.25	34.1653	0.31	6.33	-0.01	0.38
672	9	2009	08	30	08	19	49.14	-106.8620	0.31	34.1722	0.63	5.00	-0.27	0.13
673	9	2009	08	30	08	40	41.92	-106.8560	0.27	34.1645	0.33	6.19	-0.11	0.30
674	9	2009	08	30	09	00	44.02	-106.8510	0.31	34.1647	0.62	4.88	-0.08	0.12
675	9	2009	08	30	09	08	54.17	-106.8580	0.23	34.1568	0.26	5.53	0.86	0.32
676	-	2009	08	30	09	13	12.41	-106.8170	0.30	34.1360	0.55	5.00	0.12	1.74
677	9	2009	08	30	09	31	20.23	-106.8460	0.30	34.1458	0.40	6.15	0.09	1.11

678	9	2009	08	30	09	49	7.58	-106.8540	0.32	34.1708	0.78	5.85	-0.27	0.12
679	9	2009	08	30	09	56	15.63	-106.8580	0.28	34.1640	0.38	5.76	-0.13	0.18
680	9	2009	08	30	10	12	50.67	-106.8560	0.27	34.1687	0.36	5.78	-0.16	0.19
681	9	2009	08	30	10	18	48.68	-106.8540	0.27	34.1668	0.35	5.93	-0.11	0.16
682	9	2009	08	30	10	22	27.11	-106.8580	0.25	34.1668	0.30	5.31	0.26	0.14
683	9	2009	08	30	10	46	23.78	-106.8550	0.31	34.1648	0.60	5.77	-0.45	0.19
684	9	2009	08	30	10	53	20.74	-106.8600	0.27	34.1707	0.33	5.05	0.00	0.21
685	9	2009	08	30	11	10	52.56	-106.8530	0.33	34.1673	0.78	4.87	-0.35	0.14
686	9	2009	08	30	11	28	17.38	-106.8590	0.33	34.1813	0.76	5.35	-0.40	0.09
687	9	2009	08	30	11	51	10.81	-106.8610	0.22	34.1677	0.27	4.97	0.17	0.30
688	9	2009	08	30	11	56	36.45	-106.8570	0.32	34.1693	0.72	4.90	-0.37	0.14
689	9	2009	08	30	12	03	51.18	-106.8560	0.26	34.1558	0.41	6.28	0.16	0.30
690	9	2009	08	30	12	33	18.62	-106.8590	0.22	34.1642	0.29	5.77	0.23	0.43
691	-	2009	08	30	12	49	1.06	-106.7990	0.27	34.1227	0.30	8.23	0.05	6.37
692	9	2009	08	30	13	05	38.51	-106.8630	0.27	34.1713	0.34	5.13	0.06	0.27
693	9	2009	08	30	13	12	40.81	-106.8570	0.27	34.1670	0.33	5.78	0.00	0.10
694	9	2009	08	30	14	49	31.09	-106.8590	0.34	34.1713	0.93	5.48	-0.52	0.09
695	9	2009	08	30	15	06	2.08	-106.8580	0.26	34.1728	0.36	5.58	0.14	0.13
696	9	2009	08	30	16	05	37.73	-106.8560	0.30	34.1687	0.55	6.44	-0.47	0.11
697	9	2009	08	30	16	15	0.13	-106.8600	0.24	34.1595	0.29	5.89	0.34	0.22
698	9	2009	08	30	16	21	43.11	-106.8560	0.34	34.1750	1.04	4.80	-0.20	0.05
699	9	2009	08	30	16	59	34.69	-106.8600	0.22	34.1560	0.25	5.56	0.59	0.24
700	9	2009	08	30	17	54	11.36	-106.8570	0.28	34.1655	0.42	5.94	-0.24	0.16
701	9	2009	08	30	18	01	51.64	-106.8580	0.21	34.1617	0.23	3.91	0.58	0.17
702	9	2009	08	30	19	02	39.08	-106.8620	0.24	34.1718	0.30	5.12	0.39	0.28
703	9	2009	08	30	21	42	28.38	-106.8570	0.22	34.1648	0.32	5.03	0.48	0.16
704	9	2009	08	31	02	07	24.01	-106.8580	0.23	34.1597	0.23	5.00	1.92	0.52
705	9	2009	08	31	07	07	31.55	-106.8570	0.22	34.1568	0.22	5.02	1.78	0.42
706	9	2009	08	31	09	39	43.00	-106.8560	0.22	34.1540	0.23	5.64	1.43	0.27
707	7	2009	09	01	16	00	6.64	-106.8970	0.60	34.2598	1.03	5.18	-0.29	1.17
708	1	2009	09	01	20	38	9.18	-106.8850	0.45	34.1655	0.43	5.00	1.33	0.63
709	9	2009	09	01	20	38	38.33	-106.8590	0.24	34.1638	0.29	5.30	1.29	0.13
710	1	2009	09	01	20	45	34.32	-106.8830	0.50	34.1822	1.00	6.02	-0.04	0.67
711	8	2009	09	01	20	55	10.24	-106.9610	0.66	34.2483	0.63	5.43	0.04	1.78
712	9	2009	09	02	04	17	45.38	-106.8600	0.27	34.1718	0.40	4.90	0.30	0.10
713	7	2009	09	03	00	01	11.98	-106.8570	0.45	34.2230	0.56	5.00	0.67	0.96
714	9	2009	09	03	00	01	39.24	-106.8560	0.21	34.1617	0.22	5.79	1.15	0.28
715	8	2009	09	05	02	01	34.56	-106.9070	0.49	34.1857	0.91	6.45	0.10	1.16
716	8	2009	09	05	02	03	19.48	-106.9420	0.93	34.3007	2.56	3.83	0.03	1.20
717	2	2009	09	05	11	16	31.94	-106.9390	0.68	34.0840	0.74	5.00	-0.12	1.55
718	8	2009	09	05	12	09	11.49	-106.9490	0.45	34.2168	0.54	2.77	0.47	2.14
719	-	2009	09	07	09	08	42.20	-106.9660	1.01	34.2473	1.24	7.39	0.27	1.13
720	-	2009	09	08	06	54	27.04	-106.8670	0.40	34.1335	0.78	6.51	0.38	0.68
721	4	2009	09	08	20	56	23.52	-107.0160	1.64	34.0857	1.28	5.00	-0.06	0.46
722	2	2009	09	09	04	25	34.32	-106.9220	0.58	34.0935	0.59	1.29	0.16	1.28
723	8	2009	09	09	13	01	7.02	-106.9600	1.19	34.1897	1.06	5.00	0.72	2.47
724	8	2009	09	09	22	58	28.91	-106.9150	0.76	34.2358	0.74	6.29	0.62	2.13
725	9	2009	09	12	06	60	16.91	-106.8580	0.82	34.1543	1.16	5.00	-0.20	0.61
726	9	2009	09	12	07	49	14.76	-106.8580	0.29	34.1692	0.44	5.34	0.09	0.22

727	8	2009	09	13	09	43	30.13	-106.9840	1.17	34.2352	1.11	5.90	0.19	1.01
728	9	2009	09	13	10	41	53.80	-106.8490	0.32	34.1617	0.59	6.22	-0.53	0.09
729	9	2009	09	13	13	29	36.27	-106.8420	0.41	34.2020	0.88	5.42	-0.20	0.45
730	7	2009	09	14	03	30	29.16	-106.8240	0.54	34.2283	2.48	5.15	-0.03	0.67
731	9	2009	09	14	03	30	56.78	-106.8540	0.26	34.1645	0.33	6.04	-0.10	0.20
732	9	2009	09	14	10	00	49.55	-106.8650	0.27	34.1682	0.34	5.10	0.24	0.30
733	9	2009	09	14	17	00	47.37	-106.8640	0.33	34.1897	0.64	5.68	-0.15	0.32
734	8	2009	09	14	23	02	27.92	-106.9730	1.32	34.2358	1.00	7.62	0.34	1.17
735	-	2009	09	15	03	37	2.95	-107.6070	1.31	34.4070	0.73	5.00	0.92	0.92
736	-	2009	09	17	17	21	22.56	-106.9320	1.05	34.2997	1.39	8.88	0.58	2.04
737	4	2009	09	17	21	48	50.00	-107.0310	1.07	34.1068	0.78	4.80	0.20	2.09
738	8	2009	09	18	00	53	5.93	-106.9200	1.32	34.2445	0.97	5.00	0.12	5.06
739	-	2009	09	18	15	09	34.27	-106.9680	0.92	34.2892	0.69	5.00	0.38	1.00
740	-	2009	09	19	01	11	50.97	-106.7240	0.63	34.3360	1.55	5.00	0.10	1.42
741	-	2009	09	19	08	13	10.29	-106.6100	1.31	34.3272	1.04	6.29	0.29	0.35
742	-	2009	09	19	09	42	56.42	-106.8110	0.45	34.2017	3.09	5.00	0.17	0.20
743	-	2009	09	19	11	54	57.37	-107.0000	0.57	34.1273	0.77	11.35	0.23	1.20
744	5	2009	09	19	13	10	27.66	-106.9710	0.47	33.9977	0.46	5.00	0.34	1.59
745	-	2009	09	19	21	23	16.37	-106.7990	0.34	34.0995	0.55	5.00	0.48	0.89
746	-	2009	09	19	22	32	50.65	-106.8590	0.53	34.2057	0.70	4.69	0.76	0.61
747	-	2009	09	21	19	34	37.40	-106.7740	0.45	34.2353	0.85	2.98	0.53	0.47
748	-	2009	09	21	19	35	50.25	-106.7640	0.55	34.2460	1.24	3.03	0.00	0.37
749	8	2009	09	22	04	21	45.40	-106.9090	0.54	34.1915	1.11	8.24	-0.13	0.64
750	-	2009	09	23	06	15	32.97	-106.8280	0.44	34.1640	0.87	2.24	0.47	0.48
751	-	2009	09	25	05	00	24.25	-106.9010	0.48	34.1363	0.80	6.32	-0.20	0.24
752	-	2009	09	27	12	15	27.13	-106.7650	0.55	34.2723	1.23	5.00	0.23	0.84
753	-	2009	09	27	19	18	51.78	-106.8010	0.43	34.1822	1.09	4.30	0.47	0.49
754	3	2009	09	27	23	10	48.72	-106.9600	1.17	34.0272	0.83	3.05	-0.04	0.55
755	-	2009	09	30	09	31	11.33	-107.0250	0.99	34.1603	1.45	5.00	0.21	1.45
756	2	2009	09	30	16	23	37.12	-106.8320	0.47	34.0668	0.57	5.00	0.08	2.26
757	-	2009	10	01	07	48	35.79	-106.7760	1.00	34.2642	1.58	7.27	0.07	1.60
758	-	2009	10	03	19	35	35.63	-106.8480	0.43	34.1768	1.03	5.64	0.11	1.27
759	-	2009	10	06	16	07	32.09	-106.5180	2.03	34.0173	1.04	5.00	0.15	1.02
760	-	2009	10	07	02	43	3.36	-107.0440	0.57	34.3965	0.52	5.00	0.51	2.03
761	-	2009	10	08	07	33	36.82	-107.0440	0.74	34.1795	0.66	5.00	0.02	1.13
762	-	2009	10	09	03	53	36.94	-106.7010	0.69	34.3922	1.18	5.00	0.83	1.17
763	-	2009	10	09	15	55	27.25	-106.6860	1.50	34.0810	0.75	5.00	0.39	1.54
764	-	2009	10	10	02	57	6.41	-106.4020	1.47	34.1603	0.81	5.00	-0.06	1.27
765	8	2009	10	10	04	03	29.24	-106.9070	0.49	34.2073	1.14	6.17	0.11	0.31
766	-	2009	10	10	19	08	54.38	-106.8160	0.46	34.1098	0.75	3.54	-0.03	0.48
767	2	2009	10	11	09	49	21.01	-106.8350	0.38	34.0785	0.52	5.00	0.59	2.10
768	1	2009	10	12	18	15	16.71	-106.8810	0.48	34.1872	0.91	5.00	0.19	2.18
769	8	2009	10	13	11	30	19.49	-106.9240	0.41	34.2142	0.46	5.81	0.74	0.93
770	-	2009	10	15	12	47	22.77	-106.6600	0.70	34.0670	0.48	5.00	0.51	1.38
771	-	2009	10	18	00	52	30.02	-106.1210	1.96	33.9140	0.93	5.00	0.32	7.93
772	1	2009	10	18	14	16	12.04	-106.8700	0.50	34.1575	0.88	4.72	0.54	0.84
773	-	2009	10	18	23	12	46.23	-106.6760	2.26	34.0493	0.99	5.00	0.27	1.58
774	1	2009	10	19	04	27	48.36	-106.8810	0.41	34.1518	0.58	7.72	0.16	1.22
775	8	2009	10	20	00	49	40.09	-106.9790	0.53	34.2188	0.53	6.48	0.47	1.99

776	-	2009	10	22	06	26	44.76	-106.8350	0.34	34.1432	0.40	5.00	0.46	2.21
777	-	2009	10	22	08	45	18.11	-106.8140	0.38	34.1642	0.74	5.00	0.07	0.22
778	-	2009	10	23	13	39	19.41	-106.5950	1.07	34.0178	0.59	5.00	0.36	1.70
779	-	2009	10	23	23	32	34.21	-106.9080	0.54	34.0732	0.66	3.00	0.06	0.46
780	1	2009	10	24	05	00	26.50	-106.8840	0.64	34.1958	1.07	7.64	0.47	1.49
781	-	2009	10	24	22	28	14.46	-106.8320	0.44	34.2962	1.22	6.49	-0.31	2.38
782	4	2009	10	31	08	46	19.58	-106.9820	0.92	34.0522	0.86	4.28	-0.35	0.53
783	-	2009	11	01	22	29	46.63	-106.8110	0.38	34.1338	0.64	5.00	-0.07	0.18
784	-	2009	11	02	11	22	40.02	-106.8780	0.41	33.8823	0.47	5.00	0.17	1.64
785	-	2009	11	02	17	13	23.38	-107.1710	0.66	34.2775	0.66	5.00	-0.06	1.71
786	-	2009	11	06	01	12	32.26	-106.9480	0.53	34.2922	0.56	5.35	-0.24	0.37
787	2	2009	11	06	18	44	44.66	-106.8760	0.48	34.0805	0.85	7.91	0.19	0.13
788	-	2009	11	06	20	05	2.81	-106.7800	0.49	34.3113	0.69	5.00	-0.28	0.63
789	-	2009	11	07	22	58	31.84	-107.0030	0.73	34.2873	0.82	5.00	0.45	1.47
790	5	2009	11	09	21	38	24.23	-107.0470	0.54	34.0268	0.47	2.89	0.41	1.29
791	-	2009	11	11	17	50	26.30	-106.9980	0.47	34.4950	0.53	5.00	0.50	0.49
792	-	2009	11	15	16	58	20.05	-106.5560	1.47	33.8330	1.01	5.00	0.53	0.89
793	-	2009	11	18	12	20	27.82	-107.0010	0.39	33.9598	0.47	5.00	0.06	0.59
794	-	2009	11	22	14	00	25.97	-107.1690	0.63	33.8862	0.60	5.00	0.77	1.04
795	4	2009	11	25	19	48	53.01	-106.9950	0.56	34.0953	0.85	7.85	0.32	0.62
796	-	2009	11	27	22	22	26.37	-106.5330	1.68	34.0985	1.06	15.97	0.78	1.04
797	-	2009	11	28	18	13	18.85	-107.1950	1.44	35.2113	1.01	5.00	1.59	1.42
798	-	2009	12	01	17	02	52.68	-106.8250	0.53	34.1892	0.88	5.00	-0.31	1.15
799	-	2009	12	02	01	23	19.88	-107.0100	0.47	34.1842	0.67	1.81	-0.08	1.37
800	-	2009	12	04	02	00	48.05	-106.5320	1.14	33.9847	0.67	5.00	0.08	1.06
801	-	2009	12	08	03	56	44.84	-106.9730	0.41	34.4535	0.80	5.00	0.81	1.51
802	8	2009	12	10	02	08	36.72	-106.9990	0.87	34.2423	0.98	17.29	0.62	2.12
803	-	2009	12	11	14	07	34.38	-106.7350	0.66	33.9602	0.66	18.01	1.06	0.96
804	-	2009	12	18	04	48	25.23	-106.8210	0.43	34.1308	0.55	2.77	0.61	1.44