**Seismic Anisotropy in the Lower Mantle underneath North America from SKS-SKKS splitting Discrepancies**

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                                                          XinXin Xu, 29 April, 2015

**Abstract**

Many studies have shown that the lowermost mantle, the D” layer, is anisotropic in nature. Recent works have shown that the layer could have a significant contribution to the anisotropy signals documented in seismic waves. We isolate the effect of anisotropy from the D” and examined and the geometry of mantle flow underneath Central North America. Using the differential splitting of the SKS and SKKS phases, seismograms from eleven stations along eastern coast of the US were examined. We find that there is shear wave splitting due to anisotropy in the lowermost mantle along the margin of a fast shear anomaly underneath Midwestern US. This is consistent with previous studies, which have also found anisotropy in the D” across the boundary of a fast shear anomaly.

**I. INTRODUCTION**

Seismic anisotropy provides useful constrains on the deformation of the mantle both in the past and present. Shear wave (SKKS and SKS) splitting clearly demonstrates anisotropy of body waves within the Earth’s interior; most often, these phases are used to examine anisotropy in the upper mantle. Most of the lower mantle is isotropic with one exception: the D” layer at the base of the mantle (Meade et al. 1995; Moulik & Ekström 2014). With numerous studies demonstrating anisotropic behavior, the lowermost 250-300km of the mantle is seen as a frontier for further development in terms of understanding the geometry of mantle flow, geochemical heterogeneity, and phase transitions (Long & Becker, 2010). Anisotropy can be detected in seismic waves generated via various earthquake events, with a variety of measurement methods that can be applied to study anisotropy in D”.

Multiple studies have concluded that the lowermost mantle is seismically different from the majority of the lower mantle (Niu and Perez, 2004). The D” layer represents a thermal boundary between the colder slowly convecting mantle above it and the hotter outer core beneath it. Because of its unique position, the D” has features that are not present elsewhere in the mantle. It is common to identify ultra low velocity zones at the base of D” at the CMB (Garnero et al., 1998); these features are also indicative of a complex structure in the D” layer that can be identified via scattered seismic energy (e.g. Hedlin et al., 1997). In addition, D” is also postulated to be where upwelling mantle plumes originate, and the location of where downwelling mantle material stops (e.g. Wysession et al., 1998).

The lower mantle, above the D”, is approximately 75% orthorhombic MgSiO3 perovskite (bridgmanite), 20% cubic (Mg,Fe)O ferropericlase, and 5% CaSiO3 perovskite. (Kesson et al. 1998; Murakami et al. 2005). A portion of the perovskite phases likely changes structurally and chemically in D” to post-perovskite. Post-perovskite is orthorhombic and is likely more seismically anisotropic than perovskite because of its SiO6 layering in the octahedral structure (Guignot et al., 2007; Mao et al., 2010). In addition, the low spin state of the iron in the ferropericlase at the base of the mantle could contribute to the anisotropic signals (Lin & Tsuchiya, 2008). These phase transitions and chemical heterogeneity could be used in constructing parameters to more accurately constrain the anisotropic signal contribution from mineralogy and from mantle flow geometries (Simmons et al. 2009).

Mantle flow underneath the Southern Appalachians, in the southeastern United States, is of particular interest because of its location along a passive margin. Previously, Long et al. (2010) evaluated SKS splitting in this region over a range of back azimuths to constrain the geometry of mantle flow and past deformation in the mantle lithosphere. This previous study highlighted three plausible scenarios proposed for the region. First, Forte et al. (2007) proposed that the cold Farallon slab subducting could be causing downwelling of the mantle flow. This motion would limit viscous flow causing stresses to build up. This explanation would also account for the existence of earthquakes beneath the New Madrid Seismic Zone. Secondly, there could be dehydration of the Farallon slab in the transition zone. Vertical upwelling could occur beneath the Eastern North American margin resulting in surface uplift (van der Lee et al., 2008). This scenario would result in vertical axis of symmetry in the upper mantle anisotropy. With a vertical axis, SKS would lack shear wave splitting signals. Finally, the last model proposes small-scale convection underneath the region at the edges of cratons, which would produce downwelling, and thus a vertical axis of anisotropic symmetry. This convection would be comparable to those beneath the West African cratons and Bermuda (King, 2007).

As a follow up to Long et al. (2010), this study uses the same set of stations to examine lower mantle anisotropy beneath the Eastern and Central US through measurements of SKS-SKKS shear wave spitting discrepancies. SKS and SKKS have similar raypaths in the upper mantle (Niu and Perez, 2004); however, in the lower mantle, they sample different geographical regions (Lynner and Long, 2014). One of the arguments that the splitting of SKS and SKKS phases mainly reflects anisotropy in the upper mantle is that in approximately 95% of cases, SKS and SKKS phases from the same event-station pair exhibit the same splitting behavior (Niu and Perez, 2004). In a minority of cases, the splitting behavior of these phases is different, reflecting a likely contribution from anisotropy in the lower mantle. Previously, Niu and Perez (2004) evaluated global patterns of shear wave splitting for SKS-SKKS pairs measured at long-running seismic stations. They found that while most of the lower mantle is isotropic, the presence of SKS-SKKS splitting discrepancies in a minority of cases suggests that the lower mantle makes a contribution to the observed splitting in localized region. It is this type of discrepant SKS-SKKS measurements that this study seeks to exploit. There have been multiple studies done on the upper mantle anisotropy utilizing SKS splitting; however, relatively few studies have used SK(K)S phases to examine anisotropy in the lowermost mantle. Therefore the study serves two purposes: first, discovering anisotropy in the lowermost mantle via shear wave splitting could illuminate lower mantle flow patterns. Secondly, understanding what contribution lowermost mantle anisotropy makes to the splitting of SK(K)S phases is crucial to interpreting previous studies’ results on anisotropy and understanding the patterns of anisotropy underneath the region.

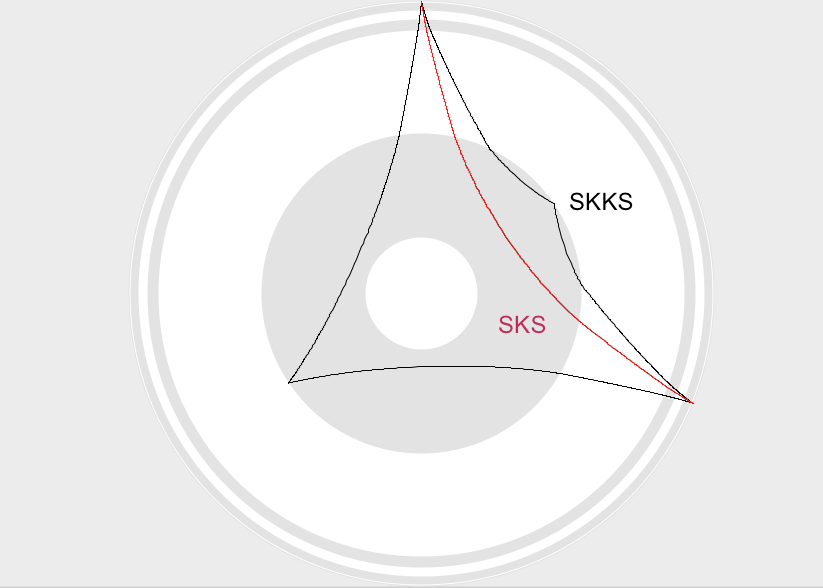
Long et al. (2010) examined SKS patterns at permanent stations in the Southeastern US and found that the splitting patterns at the coast exhibited mostly null signals (or no splitting), which is consistent with the isotropic model of the mantle or a vertical axis of symmetry (splitting would not be demonstrated in the SKS phase). The stations located more inland had mainly NE-SW fast direction, which is consistent with either shear in the asthenosphere, caused by either absolute plate motion (APM) or lithospheric anisotropy. These signals are evidence for a complex anisotropy beneath the region, which could be caused by multiple layers of anisotropy or small-scale lateral heterogeneity. Another possibility that may explain the complex splitting patterns identified by Long et al. (2010) is a contribution to SKS splitting from the lower mantle.

**II. DATA AND METHODS**

Shear wave splitting occurs when a shear wave enters an anisotropic medium (Vinnik et al. 1989; Silver and Chan, 1988). With an initially linear polarization, the wave would split into two orthogonal components. One component would be parallel to the fast direction of the medium therefore causing the two components to propagate at different speeds. The time delay between the two components constrains the geometry of the strength of anisotropy while the fast direction constrains the geometry of anisotropy and thus deformation (Karato et al. 2008). Shear wave splitting is especially useful for interpreting anisotropy as this measurement is unaffected by isotropic wave speed heterogeneity.

A widely used method for analyzing lowermost mantle anisotropy is using phases such as S, ScS and Sdiff. In particular, for S-ScS pairs, the ray paths have similar paths in the upper mantle but differ in the lower mantle at the relevant epicentral distances (Δ= 55o-82o), S does not sample D”, turning before it reaches the lowermost mantle, while ScS (and Sdiff) both do sample the D”. These ScS and Sdiff phases have nearly horizontal wave paths within D”. A limitation of this method therefore, is that an assumption of a vertical transverse isotropy structure (VTI) is often made. Using only phases with a nearly horizontal path through D”, it is impossible to constrain anisotropy with a non-VTI geometry.

In contrast, the use of SKS-SKKS shear wave discrepancies can allow for the consideration of non-VTI anisotropy. SKS is widely used to study upper mantle anisotropy, as the initial polarization at the core-mantle boundary resulting from a P to S conversion is well known, and several lines of evidence suggest that it usually reflects anisotropy in the upper mantle. SKKS has a similar path as SKS in the upper mantle; however, their paths differ in the lower most mantle (Figure 1). The difference in travel path is used to constrain anisotropy in the D” region (e.g. Niu & Perez 2004; Long 2009; Lynner & Long 2014).



**Figure 1**. Ray paths of the SKS and SKKS phases. The two phases exhibit similar paths in the upper mantle and crust; however, their paths differ dramatically in the lowermost mantle. Therefore any discrepancies between the two phases can be attributed to the D” layer.

I examined shear wave splitting of the SKS and SKKS phases recorded at 11 stations that are a part of the US Reference Array located in the southeastern United States (BLA, CBN, CEH, CNNC, GOGA, GWDE, LRAL, MCWV, MYNC, NHSC, and TZTN shown on Figure 2).

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**Figure 2**. Map of the stations with station codes in their geographic location. Part of the United States National Seismic Network (station code: US).

Of the 11 stations in the study, 8 are currently operating (the analysis of data from station GOGA was stopped in 2006 because of multiple misalignment problems). Stations CEH and GWDE ceased operations in 2001; MYNC did so in 2007. We examined at least 10 years of data examined at each station except for those that are no longer running. SKS and SKKS phases were used from events magnitude 5 or greater, with epicentral distances of 108o to 122o, where both phases of SKS and SKKS would overlap and show up on the seismogram (e.g. Astiz et al., 1996). We generally followed the SKS-SKKS preprocessing and measurement procedures of Long (2009) and Lynner and Long (2014).

Utilizing the SplitLab software (Wüstefeld et al., 2008), the seismograms were examined after passing through a filter with corner frequencies of 0.01 and 0.1Hz. In a small number of cases, the corner frequencies were slightly adjusted to obtain the highest signal to noise ratio (usually to the frequency range 0.04 to 0.125Hz). Events with clear SKS and SKKS arrivals, high signal to noise ratios, and clean waveforms were selected for analysis. This occurred in about 0.8% of the records examined. Pairs of discrepant and non-discrepant shear waves were measured in the analysis. Single null measurements and nonnull measurements were not used, as they do not provide unique constraints on anisotropy in D”.

Two simultaneous measurement methods, the rotation correlation method and the transverse component minimization method, were used in order to ensure that the data set is high quality (e.g. Lynner and Long 2014). Splitting measurements were retained only when the 95% confidence region of the two methods agreed with one another. Variation in fast directions was allowed up a difference of 30 degrees and 1.2 seconds in delta t. That standard was not applied to null measurements as previous studies have indicated that the two methods usually disagree for null signals. Linear or nearly linear initial particle motions with high signal to noise ratios were classified as nulls. Complex and noisy waveforms were excluded from this category; nulls were characterized exclusively as linear uncorrected particle motion in the direction of the back azimuths. Signal to noise ratio and measurement errors were quantified formally for all measurements, but each measurement was normally assigned a quality rating following standards set by Long et al. (2010) and previous studies that necessarily has some subjectivity.

**III. RESULTS**

From the 11 stations, we examined approximately 28,000 waveforms total. 215 measurements were taken of clear SKS and SKKS discrepant and non-discrepant pairs. There were 21 discrepant pairs (one null and one non-null in the pair), 15 non-discrepant split pairs, and 179 null-null pairs. At least one measurement pair was identified at every station. Seven of the eleven stations had at least one documented discrepant pair. Most of the discrepant pairs consisted of a split SKS phase and a null SKKS phase. The stations could be feasibly divided into two groups: on near the coast (CBN, CNNC, GWDE, and NHSC), and more inland (BLA, CEH, MYNC, LRAL, MCWV, TZTN, and GOGA). The first group of stations had one discrepant pair and no nonnull nondiscrepant pairs. The rest of the measurements (38 pairs) are null-null pairs. The second group of stations had all the nonnull nondiscrepant pairs (15 pairs), and 20 of the 21 discrepant pairs.

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**Figure 3**. Map of stations (red triangles), discrepant events (blue circles), and null events (white circles) that were used in this study. The black lines represent great circle paths for the various event station pairs. All the discrepant events were located in the southeast Pacific.

Most of the waves were sampling the Midwest region of the US and the Hudson Bay region of Canada at depths of 2700km (which is located in the D” region). 38 seismic events were captured on more than one station. Of those events, four had variation in terms of null and discrepant over the stations. Event 2006.219.22 had a discrepant pair at station BLA and null pairs at stations CBN and LRAL. Event 2009.281.08 had a null pair at station CBN and discrepant pairs at stations LRAL, MCWV, and TZTN. Waveform examples are shown in Figure 4.

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**Figure 4**. Waveform examples for a null (CBN) and a discrepant (BLA) pair from the same event measured at two different stations. The first column and third column shows the SKS and SKKS phase respectively – the blue dashed line represents the radial component, the red line represents the transverse components, and the gray shading represents the time window used in the measurement. The second and fourth column shows the particle motion diagram for the SKS and SKKS phase respectively – the blue dashed line shows the actual particle motion while the red solid line shows the correction for the splitting. Here, only the SKS phase for BLA is split, demonstrating a discrepant pair.

In order to visualize our results in the context of the lower mantle structure, in Figure 5, we show a map of pierce-points for all SKS and SKKS phases at a depth of 2700km, plotted on top of the GyPSuM S wave tomography model also at a depth of 2700km (Simmons et al. 2010). The program TauP (Crotwell et al. 1999) was used to calculate the pierce points with a 1-D velocity earth model. The black lines connect the pierce points of each SKS-SKKS pair. White circles indicate non-discrepant pairs (there is no differentiation between null-null pairs or nonnull-nonnull pairs). Red and orange circles indicate discrepant SKS and SKKS split phases, with the associated splitting parameters plotted on top. The SKS pierce point is always sampling closer to the stations. The map demonstrates that the discrepant pairs primarily sample one region beneath the central US extending roughly from the US-Mexico to the US-Canada border.

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**Figure 5**. *(Left)* All discrepant and non discrepant pairs plotted on top of the GyPSuM tomography model at a depth of 2700km. White dots show the non-discrepant pairs with black lines connecting the SKS and SKKS pierce points. Orange and red dots show the SKS and SKKS phases of the discrepant pairs also with black lines connecting the appropriate pierce points. *(Right)* A zoomed in look at the discrepant region in beneath Central US. The SKS phase demonstrates a northeast-southwest trend while the SKKS phase shows no discernable trend.

Interestingly, the region that has splitting is associated with a fast anomaly underneath North America; however, there are fast anomalies both in the north and south of the splitting region. There is no evidence from this study that there is splitting occurring in those regions.

Without explicit upper mantle corrections, the splitting pairs cannot be directly attributed to anisotropy in the lowermost mantle. The splitting patterns found via SKS splitting in Long et al. (2010) were complicated; there was a significant contribution of anisotropy from the lithosphere and the asthenosphere in the upper mantle. The patterns were could not conclusively constrain the upper mantle anisotropy enough to formulate a coherent correction. However, despite the limitation imposed on the dataset, it is still useful to examine patterns of observed fast directions and delay times for discrepant pairs. For the 15 discrepant pairs in which the SKS is split, the range directions is generally from 11o to 71o (with one exception of -72o) with an average of 42o; the range for delay times is from 0.7 to 2.7 with an average of 1.5 seconds for both the rotation correlation and transverse component minimization methods. For the other 6 discrepant pairs in which the SKKS is split, the range of directions is from -56o to 52o with an average of 11o and the delay times range from 1 to 2.8 with an average of 1.7 seconds. The SKS split phase generally show a more northeast-southwest direction in the northern area of the map and a more north-south direction for the southern area of the map. The SKKS phase is more scattered without a clear general pattern. The upper mantle is pretty anisotropic itself; without clear constraints and understanding of upper mantle anisotropy, corrections would most likely introduce new sources of error to the analysis.

**IV. DISCUSSION**

The back azimuth range for which we have documented discrepant SKS-SKKS splitting is between 209.4 and 310 degrees, with the majority (>75%) of discrepant pairs occurring between the range of 260 and 300 degrees. This is a relatively narrow range of fast polarization directions, which could suggest that the SKS arrivals are generally sampling a continuous piece of anisotropy that is not affecting the SKKS phase. Upper mantle corrections would have been desirable but were not made to the data set.

There could be multiple reasons for the appearance of transverse component energy on the seismograms and cause discrepancies between the SKS-SKKS pairs. One possibility is that the upper mantle could contain a region of anisotropy that could cause splitting if the initial polarizations of the wave pair were different. Anisotropic effects depend on the incoming polarization of the waves (e.g. Long & Silver 2009). However, since the waves are paired and from the same seismic events, the incoming polarizations should be controlled by wave phase conversions at the core-mantle boundary (CMB). This implies that initial polarizations are the same for both phases, and the single region of anisotropy that might be in the upper mantle is not a viable explanation for the discrepancies we observe in small-scale heterogeneity. Second, there could be anisotropic structure in the crust or shallow mantle lithosphere that may affect SKS and SKKS phases differently. This is a possible effect on our dataset; however, the large average delay times we measure for discrepant SKS-SKKS pairs in this study (~1.5 sec) are difficult to explain with an anisotropic source in the crust or shallow mantle lithosphere. The third possible explanation for the discrepancies we observe is lowermost mantle anisotropy, and it is this explanation we favor. Since the majority of the lower mantle is isotropic, and there is a multitude of evidence of an anisotropic D” layer, the differential splitting of the SKS and SKKS phases documented hear are most likely due to anisotropy in the D” layer beneath central North America.

Anisotropy as observed via SKS-SKKS pairs are very much a regional phenomenon (Niu and Perez, 2004). There are two major reasons why discrepant pairs demonstrating anisotropy may be rare occurrences in the SKS-SKKS phases. One potential reason is that D” anisotropy is generally weak. This may be true in some regions, but there is plentiful evidence for locally strong D” anisotropy in many regions (Nowacki et. al., 2011). A second possible explanation is that because SKS and SKKS phases are nearly vertical rays that have a relatively short path in the D” layer, very strong anisotropy is needed to cause observable splitting of these phases. Given these arguments we suggest that the anisotropic structure in the lowermost mantle beneath central North America that we infer from this study must involve locally strong anisotropy.

The anomalous SKS splitting region we document coincides with a fast speed anomaly in the central North America extending to approximately 45N. This result is consistent with previous work on anisotropy near a fast tomographic region. Long and Lynner (2015, in review) found anisotropy associated with a fast region under Central Asia. In addition, Long 2009 made a similar discovery off the West Coast of North America, in which she attributed anisotropy to impingement of the downgoing slab materials on the core-mantle boundary, causing deformation and anisotropy at the edges. Nowacki et al. (2010) also documented anisotropy in and around the region identified here using S-ScS pairs measured at 500 seismic stations located in North and Central America. Specifically, they argued for anisotropy in the lowermost mantle just to the west of the region we identify. Several recent geodynamical modeling studies have shown that it is plausible to get to an impinging slab (e.g. McNamara et al., 2002; Cottoar et al. 2014). The area of anisotropy next to the fast anomaly that we document here could be the manifestation of that deformation.

The results that this study found could potentially provide the basis for reinterpreting some of the conclusions reached in Long et al., 2010. A lower mantle contribution could be the explanation for some of the complex anisotropic patterns identified in that paper. We have documented discrepant SKS-SKKS pairs at seven of the eleven stations examined in Long et al. (2010). These seven stations cover fairly different crustal and upper mantle anisotropy regimes, providing further evidence that the signal is from D”. The fact that we have documented some contribution to SK(K)S splitting from lowermost mantle anisotropy at stations used by Long et al. (2010) suggests that the complicated splitting patterns documented beneath eastern North America (e.g. Long et al.; Wagner et al., 2012) may need to be reevaluated in order to properly characterize upper mantle anisotropy.

**V. FURTHER STUDY**

Though this study produces some interesting preliminary results, it lacks the geographical coverage necessary to produce any definitive hypothesis about anisotropy in the D” underneath central North America. Currently, most of the waveforms sample beneath Central US; without the same coverage more north, in Canada, more south, in Mexico, and more west, beneath the Rocky Mountains, the discrepant pairs by the fast velocity anomaly beneath the Central US cannot be contextualized. Therefore examining stations that lie to the west and south, which will translate to waveforms that sample to the west and south in the lower most mantle, could provide a clearer picture of the anisotropic patterns in the D”. We also hope to utilize a different shear wave splitting pair to help generate more back azimuthal coverage. PKS-SKKS wave pairs start off as different phases beneath the earthquake; however, on the receiver side, they both sample D” as shear waves. As with SKS-SKKS pairs, the two waves will have generally the same path in the upper mantle close to the receiver station. In addition, PKS-SKKS waves would sample different regions of D” than SKS-SKKS pairs (epicentral distances in which the pairs coincide are between approximately 125o-175o compared to 108o-122o for SKS-SKKS; Astiz et al. 1996).

Secondly, this study’s findings seem to generally agree with findings from previous studies on anisotropy in D”at the edges fast anomalies (e.g. Long 2009; Long and Lynner, in review). Further studies of the D” near fast anomalies in other stations could help constrain a global pattern for anisotropy. Finally, our measurements of D” anisotropy could be used to test anisotropic model for D’ beneath North America proposed by Nowacki et al. 2010. If the model can accurately predict SKS-SKKS discrepancies observed in the current data set (and eventually newer data sets from similarly positioned stations), it will help to further constrain the geometry of the lowermost mantle flow beneath North America.

**VI. SUMMARY**

I have presented the reliable SKS-SKKS splitting measurements which provide evidence for D” anisotropy in Central North America. The resultant anisotropy is thought to be from the D” because of the ray path differences in the SKS and SKKS phases. This provides additional constraint on previous studies in terms of upper and lower mantle contribution of anisotropic signals. This study agrees with previous studies on the existence of anisotropy along the boundary of fast shear anomalies; however, because back azimuthal coverage of Canada and Western US was not complete, this study cannot provide definitive evidence for a fast anomaly pattern. Further study utilizing PKS-SKKS pairs that could provide better coverage and mineral physics models together could provide more definitive constrains on the anisotropy found.

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**References**

Astiz, L., Earle, P., and Shearer, P. (1996). Global stacking of broadband seismograms, *Seismol.*

*Res. Lett*., **67**, 8-18

Cottaar, S., Li M., McNamara, A.K., Romanowicz, B., Wenk, H.R., (2014). Synthetic seismic

anisotropy models within a slab impinging on the core–mantle boundary, *Geophys. J. Int.*, **199**, 164-177

Crotwell, H. P., T. J. Owens, and J. Ritsema (1999), The TauP Toolkit: Flexible seismic travel-

time and ray-path utilities, *Seismol. Res. Lett.*, **70**, 154-160.

Forte, A. M., J. X. Mitrovica, R. Moucha, N. A. Simmons, and S. P. Grand (2007), Descent of

the ancient Farallon slab drives localized mantle flow below the New Madrid Seismic Zone, *Geophys. Res. Lett.*, **34**, L04308, doi:10.1029/2006GL027895.

Garnero, E.J., Revenaugh, J., Williams, Q., Lay, T., Kellogg, L., 1998. Ultralow velocity zone at

the core–mantle boundary. In: Gurnis, M., Wysession, M.E., Knittle, E., Buffett, B.A. (Eds.), The Core–Mantle Boundary Region. Geodynamics Series, 28. American Geophysical Union, Washington, D.C., USA, pp. 319–334.

Guignot, N., Andrault, D., Morard, G., Bolfan-Casanova, N., Mezouar, M., (2007).

Thermoelastic properties of post-perovskite phase MgSiO3 determined exper- imentally at core–mantle boundary P-T conditions. *Earth Planet. Sci. Lett*. **256**, 162–168.

Hall, S., Kendall, J.M., van der Baan, M., (2004). Some comments on the effects of lower-mantle

anisotropy on SKS and SKKS phases. *Phys. Earth Planet. Inter*. **146,** 469–481.

Hedlin, M., Shearer, P., Earle, P., 1997. Seismic evidence for small-scale heterogeneity

throughout the Earth’s mantle. *Nature* **387**, 145–150.

Karato S-i., Jung H., Katayama I., Skemer P. (2008) Geodynamic significance of seismic

anisotropy of the upper mantle: New insights from laboratory studies, *Annual Review of Earth and Planetary Science* **36**:59–95

Kesson, S., Gerald, J.F., Shelley, J., 1998. Mineralogy and dynamics of a pyrolite lower mantle.

*Nature* **393**, 252–255.

King, S. D. (2007), Hotspots and edge‐driven convection, *Geology*, **35**, 223–226,

doi:10.1130/G23291A.1.

Lin, J.F., Tsuchiya, T., 2008. Spin transition of iron in the Earth’s lower mantle. *Phys. Earth*

*Planet. Inter.* **170**, 248–259.

Long, Maureen D. (2009), Complex anisotropy in D″ beneath the eastern Pacific from SKS–

SKKS splitting discrepancies, *Earth and Planetary Science Letters*, Volume **283**, Issues 1–4, Pages 181-189, http://dx.doi.org/10.1016/j.epsl.2009.04.019.

Long, Maureen D., Paul G. Silver (2009), Shear Wave Splitting and Mantle Anisotropy:

Measurements, Interpretations, and New Directions, *Surveys in Geophysics*, Volume **30**, Issue 4-5, pp 407-46, http://dx.doi.org/10.1007/s10712-009-9075-1

Long, Maureen D., Thorsten W. Becker (2010), Mantle dynamics and seismic anisotropy, *Earth*

*and Planetary Science Letters*, Volume **297**, Issues 3–4, 1 September 2010, Pages 341-354, ISSN 0012-821X, http://dx.doi.org/10.1016/j.epsl.2010.06.036.

Long, M. D., M. H. Benoit, M. C. Chapman, and S. D. King (2010), Upper mantle anisotropy

and transition zone thickness beneath southeastern North America and implications for mantle dynamics, *Geochem. Geophys. Geosyst*., **11**, Q10012, doi:10.1029/2010GC003247.

Long, Maureen D., Colton Lynner (2015), Seismic anisotropy in the lowermost mantle near the

Perm Anomaly, *in review,* 15 April 2015

Lynner, C., and M. D. Long (2014), Lowermost mantle anisotropy and deformation along the

boundary of the African LLSVP, *Geophys. Res. Lett.*, **41**, 3447–3454, doi:10.1002/2014GL059875

Mao, W.L., Meng, Y., Mao, H., 2010. Elastic anisotropy of ferromagnesian post-

perovskite in Earth’s D′′ layer. *Phys. Earth Planet. Inter*. **180**, 203–208.

McNamara, A.K., van Keken, P.E., Karato, S.-i., 2002. Development of anisotropic structure in

the Earth's lower mantle by solid-state convection. *Nature,* **416**, 310–314.

Meade, C., P. G. Silver, and S. Kaneshima (1995), Laboratory and seismological observations of

lower mantle isotropy, *Geophys. Res. Lett*., **22**, 1293–1296.

Moulik, P., and G. Ekström (2014), An anisotropic shear velocity model of the Earth’s mantle

using normal modes, body waves, surface waves, and long-period waveforms, *Geophys. J. Int*., **199**, 1713-1738.

Murakami, M., Hirose, K., Sata, N., Ohishi, Y., 2005. Post-perovskite phase transition and

mineral chemistry in the pyrolitic lowermost mantle. *Geophys. Res. Lett*. **32**, L03304.

Niu, F., and A. M. Perez (2004), Seismic anisotropy in the lower mantle: A comparison of

waveform splitting of SKS and SKKS, *Geophys. Res. Lett.*, **31**, L24612, doi:10.1029/2004GL021196.

Nowacki, Andy, James Wookey, J-Michael Kendall (2010), Deformation of the lowermost

mantle from seismic anisotropy, *Nature*, Vol. **467**, 28 Oct. 2010, http://doi:10.1038/nature09507

Nowacki, Andy, James Wookey, J-Michael Kendall (2011), New advances in using seismic

anisotropy, mineral physics and geodynamics to understand deformation in the lowermost mantle, *Journal of Geodynamics*, Volume **52**, Issues 3–4, October 2011, Pages 205-228 http://dx.doi.org/10.1016/j.jog.2011.04.003

Ren, Y., Stutzman, E., van der Hilst, R. D. & Besse, J. Understanding seismic heterogeneities in

the lower mantle beneath the Americas from seismic tomography and plate tectonic history. *J. Geophys. Res. Solid Earth* **112**, B01302 (2007).

Silver, P. G., and W. W. Chan, 1988. Implications for continental structure and evolution from

seismic anisotropy, *Nature*, **335**, 34-39, doi:10.1038/335034a0.

Simmons, N.A., Forte, A.M., Grand, S.P., 2009. Joint seismic, geodynamic and mineral physical

constraints on three-dimensional mantle heterogeneity: implications for the relative importance of thermal versus compositional heterogeneity. *Geophys. J. Int*. **177**, 1284–1304.

Simmons, N.A., A. Forte, L. Boschi, and S. Grand (2010), GyPSuM: a joint tomographic model

of mantle density and seismic wave speeds, *J. Geophys. Res*. **115**, B12310, doi:10.1029/2010JB007631.

van der Lee, S., K. Regenauer‐Lieb, and D. A. Yuen (2008), The role of water in connecting past

and future episodes of subduction, *Earth Planet. Sci. Lett*., **273**, 15–27, doi:10.1016/j.epsl.2008.04.041.

Vinnik, L.P., Kind, R., Kosarev, G., Makeyeva, L., 1989. Azimuthal anisotropy in

the lithosphere from observations of long-period S-waves. *Geophys. J. Int.* **99,**

549–559.

Wagner, L. S., Long, M. D., Johnston, M. D.\*\*, Benoit, M. H., 2012. Lithospheric and

asthenospheric contributions to shear-wave splitting observations in the southeastern United States. Earth and Planetary Science Letters, 341-344, 128-138.

Wookey, J., Kendall, J.M., Rumpker, G., 2005a. Lowermost mantle anisotropy beneath the north

Pacific from differential S–ScS splitting. *Geophys. J. Int*. **161**, 829–838.

Wüstefeld, A., G. Bokelmann, G. Barruol, and C. Zaroli (2008), Splitlab: A shear‐wave

splitting environment in Matlab, *Comput. Geosci*., **34**, 515–528, doi:10.1016/j.cageo.2007.08.002.

Wysession, M.E., Lay, T., Revenaugh, J., Williams, Q., Garnero, E.J., Jeanloz, R., Kellogg, L.,

1998. The D” discontinuity and its implications. In: Gurnis, M., Wysession, M.E., Knittle, E., Buffett, B.A. (Eds.), The Core–Mantle Boundary Region. Geo- dynamics Series, 28. American Geophysical Union, Washington, D.C., USA, pp. 273–298.

Appendix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Station | Date | SiteLat | SiteLong | Lat | Long | Depth | Backazi-muth | Distance | Phase | -errPhiSC | PhiSC | +errPhiSC | -errdtSC | dtSC | +errdtSC | Is Null? | AGREE (3=Discrepant, 2=non-dis) |
| BLA | 14-Jun-00 | 37.2113 | -80.42049 | -25.5 | 178.1 | 605 | 255.2 | 113.8 | SKS | -13.1 | -6.8 | -5.1 | 2.2 | 4 | 4 | Yes | 2 |
| BLA | 14-Jun-00 | 37.2113 | -80.42049 | -25.5 | 178.1 | 605 | 255.2 | 113.8 | SKKS | 75.8 | 79.2 | -57.6 | 0.2 | 4 | 4 | Yes | 2 |
| BLA | 15-Aug-00 | 37.2113 | -80.42049 | -31.5 | 179.7 | 358 | 248.7 | 115.6 | SKS | -21.2 | -15.3 | -13.1 | 2.4 | 4 | 4 | Yes | 2 |
| BLA | 15-Aug-00 | 37.2113 | -80.42049 | -31.5 | 179.7 | 358 | 248.7 | 115.6 | SKKS | 71.8 | 74.7 | 77.9 | 3.1 | 4 | 4 | Yes | 2 |
| BLA | 3-Jun-01 | 37.2113 | -80.42049 | -29.7 | -178.6 | 178 | 249.6 | 113.5 | SKS | 69.8 | 75.6 | 83.9 | 1.6 | 4 | 4 | Yes | 2 |
| BLA | 3-Jun-01 | 37.2113 | -80.42049 | -29.7 | -178.6 | 178 | 249.6 | 113.5 | SKKS | -Inf | 77.6 | Inf | 0 | 4 | Inf | Yes | 2 |
| BLA | 15-Jun-01 | 37.2113 | -80.42049 | 18.8 | 147 | 33 | 312.8 | 108.4 | SKS | 47.5 | 50.8 | 55.6 | 2.9 | 4 | 4 | Yes | 2 |
| BLA | 15-Jun-01 | 37.2113 | -80.42049 | 18.8 | 147 | 33 | 312.8 | 108.4 | SKKS | 49.6 | 50.8 | 55.6 | 3.2 | 4 | 4 | Yes | 2 |
| BLA | 8-Dec-01 | 37.2113 | -80.42049 | 28.2 | 129.6 | 33 | 332.3 | 108.7 | SKS | 63.7 | 66.3 | 71.8 | 2.1 | 4 | 4 | Yes | 2 |
| BLA | 8-Dec-01 | 37.2113 | -80.42049 | 28.2 | 129.6 | 33 | 332.3 | 108.7 | SKKS | 65.7 | 66.3 | 69.8 | 3.2 | 4 | 4 | Yes | 2 |
| BLA | 12-Dec-01 | 37.2113 | -80.42049 | -17.2 | 167.7 | 33 | 268.7 | 117.5 | SKS | -90 | -85.3 | -83.9 | 2.9 | 4 | 4 | Yes | 3 |
| BLA | 12-Dec-01 | 37.2113 | -80.42049 | -17.2 | 167.7 | 33 | 268.7 | 117.5 | SKKS | 17.2 | 18.7 | 23.3 | 2.4 | 2.8 | 3.1 | No | 3 |
| BLA | 18-Dec-01 | 37.2113 | -80.42049 | 23.9 | 122.7 | 14 | 336.6 | 115.1 | SKS | -Inf | 76.6 | Inf | 0 | 0.9 | Inf | Yes | 2 |
| BLA | 18-Dec-01 | 37.2113 | -80.42049 | 23.9 | 122.7 | 14 | 336.6 | 115.1 | SKKS | -23.3 | -19.4 | -19.2 | 2.7 | 4 | 4 | Yes | 2 |
| BLA | 26-Apr-02 | 37.2113 | -80.42049 | 13.1 | 144.6 | 86 | 310.9 | 114.3 | SKS | 43.5 | 48.9 | 57.6 | 1.4 | 4 | 4 | Yes | 2 |
| BLA | 26-Apr-02 | 37.2113 | -80.42049 | 13.1 | 144.6 | 86 | 310.9 | 114.3 | SKKS | 47.5 | 48.9 | 51.6 | 2.6 | 3.7 | 4 | Yes | 2 |
| BLA | 10-Jun-02 | 37.2113 | -80.42049 | 11 | 140.7 | 33 | 312.9 | 118.3 | SKS | 49.6 | 50.9 | 55.6 | 3.2 | 4 | 4 | Yes | 2 |
| BLA | 10-Jun-02 | 37.2113 | -80.42049 | 11 | 140.7 | 33 | 312.9 | 118.3 | SKKS | 49.6 | 50.9 | 55.6 | 2.5 | 4 | 4 | Yes | 2 |
| BLA | 30-Jun-02 | 37.2113 | -80.42049 | -22.2 | 179.2 | 620 | 257.6 | 111.1 | SKS | -11.1 | -2.4 | -1 | 2.5 | 4 | 4 | Yes | 2 |
| BLA | 30-Jun-02 | 37.2113 | -80.42049 | -22.2 | 179.2 | 620 | 257.6 | 111.1 | SKKS | -13.1 | -8.4 | -5.1 | 1.2 | 3.5 | 4 | Yes | 2 |
| BLA | 19-Aug-02 | 37.2113 | -80.42049 | -21.7 | -179.5 | 580 | 257.4 | 109.9 | SKS | -11.1 | -2.6 | 1 | 2.1 | 4 | 4 | Yes | 2 |
| BLA | 19-Aug-02 | 37.2113 | -80.42049 | -21.7 | -179.5 | 580 | 257.4 | 109.9 | SKKS | 79.9 | 83.4 | 88 | 3.1 | 4 | 4 | Yes | 2 |
| BLA | 16-May-05 | 37.2113 | -80.42049 | -32.6 | -179.3 | 34 | 247.2 | 115.5 | SKS | -Inf | -18.8 | Inf | 0 | 0.7 | Inf | Yes | 2 |
| BLA | 16-May-05 | 37.2113 | -80.42049 | -32.6 | -179.3 | 34 | 247.2 | 115.5 | SKKS | 69.8 | 71.2 | 73.8 | 3 | 4 | 4 | Yes | 2 |
| BLA | 29-May-05 | 37.2113 | -80.42049 | -30.1 | -178 | 19 | 248.9 | 113.2 | SKS | -Inf | 68.9 | Inf | 0 | 4 | Inf | Yes | 2 |
| BLA | 29-May-05 | 37.2113 | -80.42049 | -30.1 | -178 | 19 | 248.9 | 113.2 | SKKS | -Inf | -19.1 | Inf | 0 | 4 | Inf | Yes | 2 |
| BLA | 11-Jul-05 | 37.2113 | -80.42049 | -27 | -176.3 | 10 | 250.9 | 110.3 | SKS | -19.2 | -15.1 | -7.1 | 0.7 | 3.6 | 4 | Yes | 2 |
| BLA | 11-Jul-05 | 37.2113 | -80.42049 | -27 | -176.3 | 10 | 250.9 | 110.3 | SKKS | -17.2 | -11.1 | -7.1 | 1.8 | 3.7 | 4 | Yes | 2 |
| BLA | 11-Aug-05 | 37.2113 | -80.42049 | -22.7 | 169.5 | 10 | 262.4 | 119 | SKS | -Inf | 84.4 | Inf | 0 | 3.7 | Inf | Yes | 2 |
| BLA | 11-Aug-05 | 37.2113 | -80.42049 | -22.7 | 169.5 | 10 | 262.4 | 119 | SKKS | 83.9 | 86.4 | -15.2 | 0.1 | 2 | 4 | Yes | 2 |
| BLA | 26-Aug-05 | 37.2113 | -80.42049 | 14.4 | 52.4 | 10 | 50 | 111.9 | SKS | 73.8 | -62 | -49.6 | 0.5 | 1 | 2.2 | Yes | 2 |
| BLA | 26-Aug-05 | 37.2113 | -80.42049 | 14.4 | 52.4 | 10 | 50 | 111.9 | SKKS | -Inf | -42 | Inf | 0 | 4 | Inf | Yes | 2 |
| BLA | 5-Dec-05 | 37.2113 | -80.42049 | -6.2 | 29.8 | 22 | 82.6 | 109.8 | SKS | 86 | 86.6 | -37.4 | 0.2 | 3.2 | 4 | Yes | 2 |
| BLA | 5-Dec-05 | 37.2113 | -80.42049 | -6.2 | 29.8 | 22 | 82.6 | 109.8 | SKKS | -Inf | -21.4 | Inf | 0 | 0.6 | Inf | Yes | 2 |
| BLA | 7-Dec-05 | 37.2113 | -80.42049 | -30 | -177.6 | 21 | 248.8 | 112.9 | SKS | -Inf | -15.2 | Inf | 0 | 1.1 | Inf | Yes | 2 |
| BLA | 7-Dec-05 | 37.2113 | -80.42049 | -30 | -177.6 | 21 | 248.8 | 112.9 | SKKS | -Inf | 70.8 | Inf | 0 | 4 | Inf | Yes | 2 |
| BLA | 31-Mar-06 | 37.2113 | -80.42049 | -29.5 | -176.8 | 27 | 248.9 | 112 | SKS | -Inf | -15.1 | Inf | 0 | 1.2 | Inf | Yes | 2 |
| BLA | 31-Mar-06 | 37.2113 | -80.42049 | -29.5 | -176.8 | 27 | 248.9 | 112 | SKKS | -Inf | 66.9 | Inf | 0 | 3 | Inf | Yes | 2 |
| BLA | 16-May-06 | 37.2113 | -80.42049 | -31.6 | -179.3 | 149 | 248.2 | 114.9 | SKS | -Inf | -19.8 | Inf | 0 | 4 | Inf | Yes | 2 |
| BLA | 16-May-06 | 37.2113 | -80.42049 | -31.6 | -179.3 | 149 | 248.2 | 114.9 | SKKS | 71.8 | 72.2 | 73.8 | 2.6 | 3.9 | 4 | Yes | 2 |
| BLA | 7-Aug-06 | 37.2113 | -80.42049 | -15.9 | 167.8 | 150 | 269.9 | 116.8 | SKS | 11.1 | 25.9 | 61.7 | 0.6 | 0.9 | 1.8 | No | 3 |
| BLA | 7-Aug-06 | 37.2113 | -80.42049 | -15.9 | 167.8 | 150 | 269.9 | 116.8 | SKKS | 1 | 5.9 | 79.9 | 0.2 | 2.1 | 4 | Yes | 3 |
| BLA | 3-Oct-06 | 37.2113 | -80.42049 | -19 | 169 | 172 | 266.2 | 117.5 | SKS | -3 | -1.8 | 1 | 1.1 | 4 | 4 | Yes | 2 |
| BLA | 3-Oct-06 | 37.2113 | -80.42049 | -19 | 169 | 172 | 266.2 | 117.5 | SKKS | -1 | 2.2 | 13.1 | 1.1 | 3.4 | 4 | Yes | 2 |
| BLA | 4-Apr-07 | 37.2113 | -80.42049 | -7.8 | 156.5 | 10 | 284.8 | 120.8 | SKS | -90 | -79.2 | -79.9 | 0.9 | 3.9 | 4 | Yes | 2 |
| BLA | 4-Apr-07 | 37.2113 | -80.42049 | -7.8 | 156.5 | 10 | 284.8 | 120.8 | SKKS | 15.2 | 18.8 | 41.5 | 0.4 | 4 | 4 | Yes | 2 |
| BLA | 4-Apr-07 | 37.2113 | -80.42049 | -20.7 | 168.9 | 10 | 264.7 | 118.5 | SKKS | -1 | 74.7 | 83.9 | 0.2 | 1 | 3 | Yes | 2 |
| BLA | 4-Apr-07 | 37.2113 | -80.42049 | -20.7 | 168.9 | 10 | 264.7 | 118.5 | SKS | -3 | 0.7 | 27.3 | 0.4 | 2.6 | 4 | Yes | 2 |
| BLA | 4-Apr-07 | 37.2113 | -80.42049 | -20.2 | 168.8 | 33 | 265.2 | 118.4 | SKS | -Inf | -0.8 | Inf | 0 | 4 | Inf | Yes | 2 |
| BLA | 4-Apr-07 | 37.2113 | -80.42049 | -20.2 | 168.8 | 33 | 265.2 | 118.4 | SKKS | -Inf | 79.2 | Inf | 0 | 1.2 | Inf | Yes | 2 |
| BLA | 17-May-07 | 37.2113 | -80.42049 | -30.6 | -178.2 | 35 | 248.6 | 113.6 | SKKS | -Inf | -85.4 | Inf | 0 | 0.1 | Inf | Yes | 2 |
| BLA | 17-May-07 | 37.2113 | -80.42049 | -30.6 | -178.2 | 35 | 248.6 | 113.6 | SKS | 71.8 | 72.6 | 77.9 | 1.7 | 3.6 | 4 | Yes | 2 |
| BLA | 17-Jul-07 | 37.2113 | -80.42049 | -26.1 | -177.8 | 55 | 252.5 | 111 | SKS | 65.7 | 68.5 | 75.8 | 1.7 | 4 | 4 | Yes | 2 |
| BLA | 17-Jul-07 | 37.2113 | -80.42049 | -26.1 | -177.8 | 55 | 252.5 | 111 | SKKS | -11.1 | 68.5 | 75.8 | 0.2 | 3.2 | 4 | Yes | 2 |
| BLA | 2-Sep-07 | 37.2113 | -80.42049 | -11.6 | 165.8 | 35 | 275 | 115.8 | SKS | 9.1 | 13 | 21.2 | 1.6 | 3.8 | 4 | Yes | 2 |
| BLA | 2-Sep-07 | 37.2113 | -80.42049 | -11.6 | 165.8 | 35 | 275 | 115.8 | SKKS | -90 | -85 | -86 | 2.2 | 4 | 4 | Yes | 2 |
| BLA | 28-Sep-07 | 37.2113 | -80.42049 | 22 | 142.7 | 261 | 318.2 | 108.2 | SKS | 53.6 | 52.2 | 55.6 | 3.3 | 4 | 4 | Yes | 2 |
| BLA | 28-Sep-07 | 37.2113 | -80.42049 | 22 | 142.7 | 261 | 318.2 | 108.2 | SKKS | 51.6 | 52.2 | 63.7 | 0.8 | 4 | 4 | Yes | 2 |
| BLA | 5-Oct-07 | 37.2113 | -80.42049 | -25.1 | 179.4 | 508 | 254.8 | 112.6 | SKS | 77.9 | 80.8 | 86 | 2.6 | 4 | 4 | Yes | 2 |
| BLA | 5-Oct-07 | 37.2113 | -80.42049 | -25.1 | 179.4 | 508 | 254.8 | 112.6 | SKKS | 77.9 | 78.8 | 83.9 | 2.1 | 4 | 4 | Yes | 2 |
| BLA | 13-Oct-07 | 37.2113 | -80.42049 | -21.2 | 169.2 | 40 | 264 | 118.5 | SKS | -5.1 | 0 | 1 | 2.6 | 4 | 4 | Yes | 2 |
| BLA | 13-Oct-07 | 37.2113 | -80.42049 | -21.2 | 169.2 | 40 | 264 | 118.5 | SKKS | -7.1 | -4 | -5.1 | 2.7 | 4 | 4 | Yes | 2 |
| BLA | 31-Oct-07 | 37.2113 | -80.42049 | 18.9 | 145.4 | 207 | 314.1 | 109.2 | SKS | 53.6 | 52.1 | 55.6 | 3.5 | 4 | 4 | Yes | 2 |
| BLA | 31-Oct-07 | 37.2113 | -80.42049 | 18.9 | 145.4 | 207 | 314.1 | 109.2 | SKKS | 45.5 | 50.1 | -49.6 | 0.1 | 2.8 | 4 | Yes | 2 |
| BLA | 27-Nov-07 | 37.2113 | -80.42049 | -10.9 | 162.1 | 16 | 278 | 118.4 | SKS | 13.1 | 68 | -90 | 0.2 | 0.7 | 3.4 | Yes | 2 |
| BLA | 27-Nov-07 | 37.2113 | -80.42049 | -10.9 | 162.1 | 16 | 278 | 118.4 | SKKS | -Inf | -88 | Inf | 0 | 2.6 | Inf | Yes | 2 |
| BLA | 15-Jan-08 | 37.2113 | -80.42049 | -22 | -179.5 | 597 | 257.1 | 110.1 | SKS | -15.2 | -8.9 | 65.7 | 0.2 | 4 | 4 | Yes | 2 |
| BLA | 15-Jan-08 | 37.2113 | -80.42049 | -22 | -179.5 | 597 | 257.1 | 110.1 | SKKS | -Inf | 75.1 | Inf | 0 | 2.4 | Inf | Yes | 2 |
| BLA | 19-Apr-08 | 37.2113 | -80.42049 | -20.3 | 168.8 | 14 | 265.1 | 118.3 | SKS | -92 | -86.9 | -88 | 3.2 | 4 | 4 | Yes | 2 |
| BLA | 19-Apr-08 | 37.2113 | -80.42049 | -20.3 | 168.8 | 14 | 265.1 | 118.3 | SKKS | -3 | 1.1 | 5.1 | 1.8 | 3.4 | 4 | Yes | 2 |
| BLA | 9-May-08 | 37.2113 | -80.42049 | 12.5 | 143.2 | 76 | 311.7 | 115.6 | SKS | -Inf | -44.3 | Inf | 0 | 4 | Inf | Yes | 2 |
| BLA | 9-May-08 | 37.2113 | -80.42049 | 12.5 | 143.2 | 76 | 311.7 | 115.6 | SKKS | 45.5 | 47.7 | 53.6 | 1.4 | 2.7 | 3.7 | Yes | 2 |
| BLA | 13-Jul-08 | 37.2113 | -80.42049 | 21 | 121.1 | 14 | 337.1 | 118.3 | SKS | -21.2 | -16.9 | -15.2 | 3.1 | 4 | 4 | Yes | 2 |
| BLA | 13-Jul-08 | 37.2113 | -80.42049 | 21 | 121.1 | 14 | 337.1 | 118.3 | SKKS | -21.2 | -16.9 | -15.2 | 3.2 | 4 | 4 | Yes | 2 |
| BLA | 1-Aug-08 | 37.2113 | -80.42049 | 32 | 104.7 | 11 | 355.3 | 110.6 | SKS | -7.1 | -2.7 | 83.9 | 0 | 4 | 4 | Yes | 2 |
| BLA | 1-Aug-08 | 37.2113 | -80.42049 | 32 | 104.7 | 11 | 355.3 | 110.6 | SKKS | 86 | 87.3 | -92 | 1.2 | 4 | 4 | Yes | 2 |
| BLA | 17-Aug-09 | 37.2113 | -80.42049 | 23.5 | 123.5 | 20 | 335.7 | 115.2 | SKS | -25.3 | -16.3 | -15.2 | 2.2 | 4 | 4 | Yes | 2 |
| BLA | 17-Aug-09 | 37.2113 | -80.42049 | 23.5 | 123.5 | 20 | 335.7 | 115.2 | SKKS | 65.7 | 75.7 | -57.6 | 0.2 | 4 | 4 | Yes | 2 |
| BLA | 17-Aug-09 | 37.2113 | -80.42049 | 23.4 | 123.5 | 15 | 335.7 | 115.3 | SKS | 67.8 | 71.7 | 77.9 | 2.1 | 4 | 4 | Yes | 2 |
| BLA | 17-Aug-09 | 37.2113 | -80.42049 | 23.4 | 123.5 | 15 | 335.7 | 115.3 | SKKS | -23.3 | -14.3 | -11.1 | 2.7 | 4 | 4 | Yes | 2 |
| BLA | 25-Dec-10 | 37.2113 | -80.42049 | -19.7 | 167.9 | 16 | 266.2 | 118.7 | SKS | -Inf | -1.8 | Inf | 0 | 3.3 | Inf | Yes | 2 |
| BLA | 25-Dec-10 | 37.2113 | -80.42049 | -19.7 | 167.9 | 16 | 266.2 | 118.7 | SKKS | -1 | 2.2 | 39.4 | 0.5 | 2.9 | 4 | Yes | 2 |
| BLA | 18-Apr-11 | 37.2113 | -80.42049 | -34.3 | 179.9 | 86 | 245.8 | 116.9 | SKS | -21.2 | -14.2 | -5.1 | 1 | 2.1 | 3.4 | Yes | 3 |
| BLA | 18-Apr-11 | 37.2113 | -80.42049 | -34.3 | 179.9 | 86 | 245.8 | 116.9 | SKKS | -17.2 | -2.2 | 17.2 | 1.1 | 2.1 | 3.6 | No | 3 |
| BLA | 7-Jul-11 | 37.2113 | -80.42049 | -29 | -176.7 | 10 | 249.3 | 111.7 | SKKS | -Inf | 69.3 | Inf | 0 | 4 | Inf | Yes | 2 |
| BLA | 7-Jul-11 | 37.2113 | -80.42049 | -29 | -176.7 | 10 | 249.3 | 111.7 | SKS | -23.3 | -16.7 | 63.7 | 0.1 | 3.5 | 4 | Yes | 2 |
| BLA | 11-Nov-12 | 37.2113 | -80.42049 | 23 | 95.9 | 14 | 3.9 | 119.7 | SKS | 5.1 | 79.9 | -90 | 0.1 | 0.5 | 2.3 | Yes | 2 |
| BLA | 11-Nov-12 | 37.2113 | -80.42049 | 23 | 95.9 | 14 | 3.9 | 119.7 | SKKS | -Inf | 67.9 | Inf | 0 | 0.2 | Inf | Yes | 2 |
| BLA | 21-Dec-12 | 37.2113 | -80.42049 | -14.3 | 167.3 | 201 | 271.6 | 116.3 | SKS | 13.1 | 55.6 | 83.9 | 0.5 | 1 | 2.4 | No | 3 |
| BLA | 21-Dec-12 | 37.2113 | -80.42049 | -14.3 | 167.3 | 201 | 271.6 | 116.3 | SKKS | -Inf | -88.4 | Inf | 0 | 4 | Inf | Yes | 3 |
| BLA | 7-Feb-13 | 37.2113 | -80.42049 | -11 | 165.7 | 10 | 275.6 | 115.6 | SKS | 11.1 | 15.6 | 21.2 | 1.6 | 2.9 | 4 | Yes | 2 |
| BLA | 7-Feb-13 | 37.2113 | -80.42049 | -11 | 165.7 | 10 | 275.6 | 115.6 | SKKS | 9.1 | 11.6 | 21.2 | 1.2 | 3.2 | 4 | Yes | 2 |
| BLA | 15-Jun-13 | 37.2113 | -80.42049 | -33.9 | 179.4 | 195 | 246.5 | 117 | SKS | -21.2 | -15.5 | -11.1 | 1.2 | 2.4 | 3.9 | Yes | 2 |
| BLA | 15-Jun-13 | 37.2113 | -80.42049 | -33.9 | 179.4 | 195 | 246.5 | 117 | SKKS | 67.8 | 68.5 | 71.8 | 2 | 4 | 4 | Yes | 2 |
| CBN | 30-Sep-03 | 38.2046 | -77.3732 | -30.4 | -177.4 | 10 | 250.2 | 115.6 | SKS | 75.8 | 76.2 | 79.9 | 3.3 | 4 | 4 | Yes | 2 |
| CBN | 30-Sep-03 | 38.2046 | -77.3732 | -30.4 | -177.4 | 10 | 250.2 | 115.6 | SKKS | 73.8 | 76.2 | 81.9 | 2.4 | 4 | 4 | Yes | 2 |
| CBN | 6-Nov-03 | 38.2046 | -77.3732 | -19.3 | 168.9 | 114 | 268.4 | 120.2 | SKS | -Inf | -89.6 | Inf | 0 | 2.6 | Inf | Yes | 3 |
| CBN | 6-Nov-03 | 38.2046 | -77.3732 | -19.3 | 168.9 | 114 | 268.4 | 120.2 | SKKS | -57.6 | -35.6 | -23.3 | 1.4 | 2.1 | 3.1 | No | 3 |
| CBN | 9-Nov-04 | 38.2046 | -77.3732 | -11.2 | 163.7 | 13 | 279.4 | 119.5 | SKS | 11.1 | 15.4 | 19.2 | 1.9 | 4 | 4 | Yes | 2 |
| CBN | 9-Nov-04 | 38.2046 | -77.3732 | -11.2 | 163.7 | 13 | 279.4 | 119.5 | SKKS | -92 | -82.6 | -81.9 | 0.9 | 4 | 4 | Yes | 2 |
| CBN | 12-May-05 | 38.2046 | -77.3732 | -57.4 | -139.2 | 10 | 210.1 | 108.7 | SKS | 41.5 | 40.1 | 43.5 | 3.8 | 4 | 4 | Yes | 2 |
| CBN | 12-May-05 | 38.2046 | -77.3732 | -57.4 | -139.2 | 10 | 210.1 | 108.7 | SKKS | 35.4 | 40.1 | 53.6 | 1.7 | 4 | 4 | Yes | 2 |
| CBN | 2-Feb-06 | 38.2046 | -77.3732 | -17.7 | -178.4 | 596 | 262.3 | 109.3 | SKS | 86 | 88.3 | -86 | 1.2 | 4 | 4 | Yes | 2 |
| CBN | 2-Feb-06 | 38.2046 | -77.3732 | -17.7 | -178.4 | 596 | 262.3 | 109.3 | SKKS | -Inf | -89.7 | Inf | 0 | 1.9 | Inf | Yes | 2 |
| CBN | 16-May-06 | 38.2046 | -77.3732 | -31.6 | -179.3 | 149 | 250.1 | 117.5 | SKS | 71.8 | 76.1 | -73.8 | 0.2 | 4 | 4 | Yes | 2 |
| CBN | 16-May-06 | 38.2046 | -77.3732 | -31.6 | -179.3 | 149 | 250.1 | 117.5 | SKKS | 71.8 | 74.1 | 83.9 | 1 | 4 | 4 | Yes | 2 |
| CBN | 7-Aug-06 | 38.2046 | -77.3732 | -15.9 | 167.8 | 150 | 272.3 | 119.1 | SKS | -90 | -83.7 | -81.9 | 1.4 | 4 | 4 | Yes | 2 |
| CBN | 7-Aug-06 | 38.2046 | -77.3732 | -15.9 | 167.8 | 150 | 272.3 | 119.1 | SKKS | 5.1 | 6.3 | 9.1 | 1.9 | 4 | 4 | Yes | 2 |
| CBN | 15-Aug-06 | 38.2046 | -77.3732 | -21.2 | -176.3 | 156 | 258.1 | 109.7 | SKS | -11.1 | -5.9 | -3 | 2.8 | 4 | 4 | Yes | 2 |
| CBN | 15-Aug-06 | 38.2046 | -77.3732 | -21.2 | -176.3 | 156 | 258.1 | 109.7 | SKKS | -Inf | -89.9 | Inf | 0 | 1.9 | Inf | Yes | 2 |
| CBN | 30-Sep-07 | 38.2046 | -77.3732 | 10.5 | 145.6 | 10 | 311.2 | 116.9 | SKS | -Inf | -58.8 | Inf | 0 | 0.7 | Inf | Yes | 2 |
| CBN | 30-Sep-07 | 38.2046 | -77.3732 | 10.5 | 145.6 | 10 | 311.2 | 116.9 | SKKS | 49.6 | 55.2 | 77.9 | 0.9 | 2 | 3.5 | Yes | 2 |
| CBN | 1-Aug-08 | 38.2046 | -77.3732 | 32 | 104.7 | 11 | 358.1 | 109.7 | SKS | -Inf | 2.1 | Inf | 0 | 1 | Inf | Yes | 2 |
| CBN | 1-Aug-08 | 38.2046 | -77.3732 | 32 | 104.7 | 11 | 358.1 | 109.7 | SKKS | 47.5 | 82.1 | 88 | 0.4 | 2.5 | 4 | Yes | 2 |
| CBN | 7-Nov-08 | 38.2046 | -77.3732 | -14.8 | 168 | 13 | 273.1 | 118.3 | SKS | 5.1 | 69.1 | -92 | 0.1 | 0.4 | 2.6 | Yes | 2 |
| CBN | 7-Nov-08 | 38.2046 | -77.3732 | -14.8 | 168 | 13 | 273.1 | 118.3 | SKKS | 3 | 15.1 | -90 | 0.1 | 1 | 4 | Yes | 2 |
| CBN | 17-Aug-09 | 38.2046 | -77.3732 | 23.5 | 123.5 | 20 | 338.8 | 115.3 | SKS | -Inf | 70.8 | Inf | 0 | 1.8 | Inf | Yes | 2 |
| CBN | 17-Aug-09 | 38.2046 | -77.3732 | 23.5 | 123.5 | 20 | 338.8 | 115.3 | SKKS | 73.8 | -41.2 | -25.3 | 0.2 | 1.1 | 4 | Yes | 2 |
| CBN | 17-Aug-09 | 38.2046 | -77.3732 | 23.4 | 123.5 | 15 | 338.8 | 115.3 | SKS | -21.2 | -17.2 | -19.2 | 3.2 | 4 | 4 | Yes | 2 |
| CBN | 17-Aug-09 | 38.2046 | -77.3732 | 23.4 | 123.5 | 15 | 338.8 | 115.3 | SKKS | 73.8 | -27.2 | -25.3 | 0.1 | 2.3 | 4 | Yes | 2 |
| CBN | 8-Oct-09 | 38.2046 | -77.3732 | -13.3 | 165.9 | 35 | 275.9 | 119.1 | SKS | 79.9 | -86.1 | -88 | 0.6 | 3.8 | 4 | Yes | 2 |
| CBN | 8-Oct-09 | 38.2046 | -77.3732 | -13.3 | 165.9 | 35 | 275.9 | 119.1 | SKKS | -92 | -86.1 | -88 | 2.7 | 4 | 4 | Yes | 2 |
| CBN | 25-Dec-10 | 38.2046 | -77.3732 | -19.7 | 167.9 | 16 | 268.5 | 121.2 | SKS | -7.1 | -3.5 | -5.1 | 2.7 | 4 | 4 | Yes | 2 |
| CBN | 25-Dec-10 | 38.2046 | -77.3732 | -19.7 | 167.9 | 16 | 268.5 | 121.2 | SKKS | -Inf | -3.5 | Inf | 0 | 2.4 | Inf | Yes | 2 |
| CBN | 23-Apr-11 | 38.2046 | -77.3732 | -10.4 | 161.2 | 79 | 281.8 | 121 | SKS | -Inf | -82.2 | Inf | 0 | 3.3 | Inf | Yes | 2 |
| CBN | 23-Apr-11 | 38.2046 | -77.3732 | -10.4 | 161.2 | 79 | 281.8 | 121 | SKKS | -Inf | -82.2 | Inf | 0 | 1.5 | Inf | Yes | 2 |
| CBN | 3-Sep-11 | 38.2046 | -77.3732 | -20.7 | 169.7 | 185 | 266.5 | 120.3 | SKS | -86 | -9.5 | -7.1 | 0.2 | 2 | 4 | Yes | 2 |
| CBN | 3-Sep-11 | 38.2046 | -77.3732 | -20.7 | 169.7 | 185 | 266.5 | 120.3 | SKKS | -Inf | 84.5 | Inf | 0 | 3 | Inf | Yes | 2 |
| CBN | 8-Nov-11 | 38.2046 | -77.3732 | 27.3 | 125.6 | 224 | 338.2 | 111 | SKS | 73.8 | 78.2 | -75.8 | 0.6 | 2 | 3.9 | Yes | 2 |
| CBN | 8-Nov-11 | 38.2046 | -77.3732 | 27.3 | 125.6 | 224 | 338.2 | 111 | SKKS | -Inf | -29.8 | Inf | 0 | 1.4 | Inf | Yes | 2 |
| CBN | 6-Jul-12 | 38.2046 | -77.3732 | -14.7 | 167.3 | 160 | 273.7 | 118.8 | SKS | -Inf | -88.3 | Inf | 0 | 4 | Inf | Yes | 2 |
| CBN | 6-Jul-12 | 38.2046 | -77.3732 | -14.7 | 167.3 | 160 | 273.7 | 118.8 | SKKS | 17.2 | 83.7 | -92 | 0.2 | 1.2 | 2.7 | Yes | 2 |
| CBN | 28-Aug-13 | 38.2046 | -77.3732 | -27.8 | 179.6 | 478 | 254.2 | 116.4 | SKS | -Inf | 80.2 | Inf | 0 | 1.9 | Inf | Yes | 2 |
| CBN | 28-Aug-13 | 38.2046 | -77.3732 | -27.8 | 179.6 | 478 | 254.2 | 116.4 | SKKS | 81.9 | -23.8 | -19.2 | 0.2 | 1.6 | 4 | Yes | 2 |
| CEH | 23-Aug-95 | 35.89084 | -79.09278 | 18.9 | 145.2 | 596 | 314.9 | 111.1 | SKS | -Inf | 48.9 | Inf | 0 | 4 | Inf | Yes | 2 |
| CEH | 23-Aug-95 | 35.89084 | -79.09278 | 18.9 | 145.2 | 596 | 314.9 | 111.1 | SKKS | 47.5 | 48.9 | 51.6 | 3.1 | 4 | 4 | Yes | 2 |
| CNNC | 28-Sep-07 | 35.2393 | -77.8901 | 22 | 142.7 | 261 | 319.7 | 111.1 | SKS | 37.4 | 45.7 | 47.5 | 1 | 3.9 | 4 | Yes | 2 |
| CNNC | 28-Sep-07 | 35.2393 | -77.8901 | 22 | 142.7 | 261 | 319.7 | 111.1 | SKKS | -Inf | -36.3 | Inf | 0 | 3.7 | Inf | Yes | 2 |
| CNNC | 24-Sep-13 | 35.2393 | -77.8901 | 27 | 65.5 | 15 | 34.2 | 108.8 | SKS | 43.5 | 60.2 | -75.8 | 0.7 | 1.2 | 2.9 | Yes | 2 |
| CNNC | 24-Sep-13 | 35.2393 | -77.8901 | 27 | 65.5 | 15 | 34.2 | 108.8 | SKKS | 45.5 | 62.2 | -71.8 | 0.4 | 0.6 | 1.5 | Yes | 2 |
| GOGA | 26-Nov-99 | 33.4112 | -83.4666 | -16.4 | 168.2 | 33 | 265.6 | 114 | SKS | -Inf | 83.6 | Inf | 0 | 1.9 | Inf | Yes | 3 |
| GOGA | 26-Nov-99 | 33.4112 | -83.4666 | -16.4 | 168.2 | 33 | 265.6 | 114 | SKKS | -77.9 | -56.4 | -31.3 | 1 | 1.4 | 2.1 | No | 3 |
| GOGA | 6-May-00 | 33.4112 | -83.4666 | -11.3 | 165.4 | 12 | 271.9 | 113.7 | SKS | 1 | 7.9 | 88 | 0 | 1.2 | 4 | Yes | 2 |
| GOGA | 6-May-00 | 33.4112 | -83.4666 | -11.3 | 165.4 | 12 | 271.9 | 113.7 | SKKS | -90 | -82.1 | -75.8 | 1 | 4 | 4 | Yes | 2 |
| GOGA | 14-Jun-00 | 33.4112 | -83.4666 | -25.5 | 178.1 | 604 | 252.2 | 110.4 | SKS | -Inf | 70.2 | Inf | 0 | 4 | Inf | Yes | 2 |
| GOGA | 14-Jun-00 | 33.4112 | -83.4666 | -25.5 | 178.1 | 604 | 252.2 | 110.4 | SKKS | 73.8 | 74.2 | 81.9 | 0.7 | 4 | 4 | Yes | 2 |
| GOGA | 31-Jul-00 | 33.4112 | -83.4666 | -16.7 | 174.5 | 10 | 262.1 | 108.9 | SKS | -Inf | 84.1 | Inf | 0 | 3.9 | Inf | Yes | 2 |
| GOGA | 31-Jul-00 | 33.4112 | -83.4666 | -16.7 | 174.5 | 10 | 262.1 | 108.9 | SKKS | -Inf | 88.1 | Inf | 0 | 0.6 | Inf | Yes | 2 |
| GOGA | 9-Aug-00 | 33.4112 | -83.4666 | -16.8 | 174.3 | 33 | 262.1 | 109.1 | SKS | -Inf | -5.9 | Inf | 0 | 4 | Inf | Yes | 2 |
| GOGA | 9-Aug-00 | 33.4112 | -83.4666 | -16.8 | 174.3 | 33 | 262.1 | 109.1 | SKKS | 86 | -21.9 | -11.1 | 0.1 | 0.9 | 4 | Yes | 2 |
| GOGA | 15-Aug-00 | 33.4112 | -83.4666 | -31.5 | 179.7 | 357 | 245.8 | 111.8 | SKS | 65.7 | 69.8 | -57.6 | 0.1 | 4 | 4 | Yes | 2 |
| GOGA | 15-Aug-00 | 33.4112 | -83.4666 | -31.5 | 179.7 | 357 | 245.8 | 111.8 | SKKS | 67.8 | 67.8 | 69.8 | 2.8 | 4 | 4 | Yes | 2 |
| GOGA | 12-Sep-00 | 33.4112 | -83.4666 | 35.4 | 99.3 | 10 | 357.5 | 111.1 | SKS | -1 | 3.5 | 9.1 | 2.1 | 4 | 4 | Yes | 2 |
| GOGA | 12-Sep-00 | 33.4112 | -83.4666 | 35.4 | 99.3 | 10 | 357.5 | 111.1 | SKKS | 3 | 5.5 | 9.1 | 2.1 | 3.4 | 4 | Yes | 2 |
| GOGA | 9-Jan-01 | 33.4112 | -83.4666 | -14.9 | 167.2 | 103 | 267.6 | 114.2 | SKS | -Inf | -4.4 | Inf | 0 | 4 | Inf | Yes | 2 |
| GOGA | 9-Jan-01 | 33.4112 | -83.4666 | -14.9 | 167.2 | 103 | 267.6 | 114.2 | SKKS | 88 | -86.4 | -71.8 | 0.4 | 4 | 4 | Yes | 2 |
| GOGA | 29-May-01 | 33.4112 | -83.4666 | -7 | 155 | 14 | 282.2 | 120 | SKS | 13.1 | 14.2 | 19.2 | 0.5 | 4 | 4 | Yes | 2 |
| GOGA | 29-May-01 | 33.4112 | -83.4666 | -7 | 155 | 14 | 282.2 | 120 | SKKS | -71.8 | 6.2 | 11.1 | 0.2 | 2.1 | 4 | Yes | 2 |
| GOGA | 3-Jun-01 | 33.4112 | -83.4666 | -29.7 | -178.6 | 178 | 246.8 | 109.7 | SKS | -23.3 | -19.2 | -17.2 | 2.1 | 4 | 4 | Yes | 2 |
| GOGA | 3-Jun-01 | 33.4112 | -83.4666 | -29.7 | -178.6 | 178 | 246.8 | 109.7 | SKKS | -Inf | -21.2 | Inf | 0 | 4 | Inf | Yes | 2 |
| GOGA | 23-Dec-01 | 33.4112 | -83.4666 | -9.6 | 159.5 | 16 | 277 | 117.7 | SKS | 9.1 | 27 | -88 | 0.1 | 0.5 | 3.5 | Yes | 2 |
| GOGA | 23-Dec-01 | 33.4112 | -83.4666 | -9.6 | 159.5 | 16 | 277 | 117.7 | SKKS | -Inf | 11 | Inf | 0 | 4 | Inf | Yes | 2 |
| GOGA | 26-Apr-02 | 33.4112 | -83.4666 | 13.1 | 144.6 | 85 | 307.1 | 114.7 | SKS | -Inf | -44.9 | Inf | 0 | 4 | Inf | Yes | 2 |
| GOGA | 26-Apr-02 | 33.4112 | -83.4666 | 13.1 | 144.6 | 85 | 307.1 | 114.7 | SKKS | 37.4 | 39.1 | -57.6 | 0.1 | 4 | 4 | Yes | 2 |
| GOGA | 10-Jun-02 | 33.4112 | -83.4666 | 11 | 140.7 | 33 | 308.6 | 118.9 | SKS | 45.5 | 44.6 | 47.5 | 3.2 | 4 | 4 | Yes | 2 |
| GOGA | 10-Jun-02 | 33.4112 | -83.4666 | 11 | 140.7 | 33 | 308.6 | 118.9 | SKKS | -51.6 | -47.4 | -45.5 | 2.8 | 4 | 4 | Yes | 2 |
| GOGA | 16-May-05 | 33.4112 | -83.4666 | -32.6 | -179.3 | 34 | 244.4 | 111.6 | SKS | -Inf | -19.6 | Inf | 0 | 4 | Inf | Yes | 2 |
| GOGA | 16-May-05 | 33.4112 | -83.4666 | -32.6 | -179.3 | 34 | 244.4 | 111.6 | SKKS | -Inf | -21.6 | Inf | 0 | 4 | Inf | Yes | 2 |
| GWDE | 28-Apr-01 | 38.8256 | -75.6171 | -18.1 | -176.9 | 352 | 262.4 | 109.9 | SKS | 83.9 | 86.4 | -92 | 2.5 | 4 | 4 | Yes | 2 |
| GWDE | 28-Apr-01 | 38.8256 | -75.6171 | -18.1 | -176.9 | 352 | 262.4 | 109.9 | SKKS | -Inf | -89.6 | Inf | 0 | 3.1 | Inf | Yes | 2 |
| LRAL | 12-Oct-01 | 33.0348 | -86.9978 | 12.7 | 145 | 37 | 303.7 | 112.6 | SKS | 41.5 | 47.7 | 55.6 | 2.2 | 3.7 | 4 | No | 2 |
| LRAL | 12-Oct-01 | 33.0348 | -86.9978 | 12.7 | 145 | 37 | 303.7 | 112.6 | SKKS | 41.5 | 45.7 | 49.6 | 2.5 | 3.4 | 4 | No | 2 |
| LRAL | 27-Nov-01 | 33.0348 | -86.9978 | -33.2 | -178.6 | 10 | 241.9 | 108.5 | SKS | 63.7 | -70.1 | -31.3 | 0.1 | 1.1 | 4 | No | 3 |
| LRAL | 27-Nov-01 | 33.0348 | -86.9978 | -33.2 | -178.6 | 10 | 241.9 | 108.5 | SKKS | -29.3 | -22.1 | 3 | 0.4 | 3.7 | 4 | Yes | 3 |
| LRAL | 8-Dec-01 | 33.0348 | -86.9978 | 28.2 | 129.6 | 33 | 326.1 | 109.6 | SKS | 57.6 | 58.1 | 63.7 | 2 | 4 | 4 | Yes | 2 |
| LRAL | 8-Dec-01 | 33.0348 | -86.9978 | 28.2 | 129.6 | 33 | 326.1 | 109.6 | SKKS | 59.7 | 62.1 | -69.8 | 0.2 | 2.6 | 4 | Yes | 2 |
| LRAL | 18-Dec-01 | 33.0348 | -86.9978 | 23.9 | 122.7 | 14 | 329.6 | 116.4 | SKS | -31.3 | -26.4 | -27.3 | 3.2 | 4 | 4 | Yes | 2 |
| LRAL | 18-Dec-01 | 33.0348 | -86.9978 | 23.9 | 122.7 | 14 | 329.6 | 116.4 | SKKS | -27.3 | -18.4 | 21.2 | 0.4 | 1.4 | 2.7 | Yes | 2 |
| LRAL | 23-Dec-01 | 33.0348 | -86.9978 | -9.6 | 159.5 | 16 | 274.7 | 114.8 | SKS | 25.3 | 32.7 | 47.5 | 1.3 | 1.8 | 2.3 | No | 3 |
| LRAL | 23-Dec-01 | 33.0348 | -86.9978 | -9.6 | 159.5 | 16 | 274.7 | 114.8 | SKKS | 7.1 | 6.7 | 7.1 | 3.2 | 4 | 4 | Yes | 3 |
| LRAL | 2-Jan-02 | 33.0348 | -86.9978 | -17.6 | 167.9 | 21 | 262.7 | 111.9 | SKS | -7.1 | -1.3 | 5.1 | 1.8 | 4 | 4 | Yes | 2 |
| LRAL | 2-Jan-02 | 33.0348 | -86.9978 | -17.6 | 167.9 | 21 | 262.7 | 111.9 | SKKS | -5.1 | -1.3 | 1 | 3.1 | 4 | 4 | Yes | 2 |
| LRAL | 31-Mar-02 | 33.0348 | -86.9978 | 24.3 | 122.2 | 33 | 330.3 | 116.3 | SKS | 61.7 | 64.3 | 67.8 | 2.4 | 4 | 4 | Yes | 2 |
| LRAL | 31-Mar-02 | 33.0348 | -86.9978 | 24.3 | 122.2 | 33 | 330.3 | 116.3 | SKKS | -29.3 | -15.7 | 59.7 | 0 | 0.6 | 2.2 | Yes | 2 |
| LRAL | 25-Nov-03 | 33.0348 | -86.9978 | -5.6 | 150.9 | 35 | 283.8 | 119.8 | SKKS | 19.2 | 27.8 | 35.4 | 2.4 | 4 | 4 | No | 2 |
| LRAL | 25-Nov-03 | 33.0348 | -86.9978 | -5.6 | 150.9 | 35 | 283.8 | 119.8 | SKS | 21.2 | 29.8 | 39.4 | 1.7 | 3 | 4 | No | 2 |
| LRAL | 10-Dec-03 | 33.0348 | -86.9978 | 23 | 121.4 | 10 | 330.4 | 117.7 | SKS | -43.5 | -33.6 | -31.3 | 0.9 | 3.8 | 4 | Yes | 2 |
| LRAL | 10-Dec-03 | 33.0348 | -86.9978 | 23 | 121.4 | 10 | 330.4 | 117.7 | SKKS | -Inf | 64.4 | Inf | 0 | 4 | Inf | Yes | 2 |
| LRAL | 25-Dec-03 | 33.0348 | -86.9978 | -22.2 | 169.5 | 10 | 257.5 | 112.8 | SKS | -1 | 11.5 | 39.4 | 1 | 1.9 | 3.1 | No | 3 |
| LRAL | 25-Dec-03 | 33.0348 | -86.9978 | -22.2 | 169.5 | 10 | 257.5 | 112.8 | SKKS | 3 | 9.5 | 23.3 | 0.6 | 0.8 | 1.1 | Yes | 3 |
| LRAL | 24-May-04 | 33.0348 | -86.9978 | -32.6 | -178.2 | 10 | 242.3 | 108 | SKS | -27.3 | -21.7 | -19.2 | 2.6 | 4 | 4 | Yes | 2 |
| LRAL | 24-May-04 | 33.0348 | -86.9978 | -32.6 | -178.2 | 10 | 242.3 | 108 | SKKS | 65.7 | 66.3 | 69.8 | 2.5 | 4 | 4 | Yes | 2 |
| LRAL | 16-Jul-04 | 33.0348 | -86.9978 | -65.7 | -179.6 | 10 | 208.7 | 120.8 | SKKS | 31.3 | 32.7 | 37.4 | 1.7 | 4 | 4 | Yes | 2 |
| LRAL | 16-Jul-04 | 33.0348 | -86.9978 | -65.7 | -179.6 | 10 | 208.7 | 120.8 | SKS | 35.4 | 38.7 | 45.5 | 2.4 | 4 | 4 | Yes | 2 |
| LRAL | 5-Aug-04 | 33.0348 | -86.9978 | 14 | 146.4 | 46 | 303.6 | 110.7 | SKS | 43.5 | 49.6 | 55.6 | 1.9 | 2.6 | 3.6 | No | 2 |
| LRAL | 5-Aug-04 | 33.0348 | -86.9978 | 14 | 146.4 | 46 | 303.6 | 110.7 | SKKS | 45.5 | 49.6 | 53.6 | 2.8 | 3.6 | 4 | No | 2 |
| LRAL | 4-Sep-04 | 33.0348 | -86.9978 | -21 | 169.3 | 10 | 258.8 | 112.4 | SKS | -1 | 20.8 | 53.6 | 0.7 | 1.7 | 3.5 | No | 3 |
| LRAL | 4-Sep-04 | 33.0348 | -86.9978 | -21 | 169.3 | 10 | 258.8 | 112.4 | SKKS | 83.9 | 86.8 | -92 | 2.4 | 4 | 4 | Yes | 3 |
| LRAL | 8-Oct-04 | 33.0348 | -86.9978 | -10.9 | 162.2 | 36 | 271.9 | 113.4 | SKS | 19.2 | 45.9 | 71.8 | 0.8 | 1.4 | 2.2 | No | 3 |
| LRAL | 8-Oct-04 | 33.0348 | -86.9978 | -10.9 | 162.2 | 36 | 271.9 | 113.4 | SKKS | 7.1 | 7.9 | 9.1 | 3.2 | 4 | 4 | Yes | 3 |
| LRAL | 15-Oct-04 | 33.0348 | -86.9978 | 24.5 | 122.7 | 94 | 329.9 | 115.9 | SKS | -33.4 | -28.1 | -27.3 | 1.8 | 4 | 4 | Yes | 2 |
| LRAL | 15-Oct-04 | 33.0348 | -86.9978 | 24.5 | 122.7 | 94 | 329.9 | 115.9 | SKKS | -Inf | -4.1 | Inf | 0 | 0.5 | Inf | Yes | 2 |
| LRAL | 11-Nov-04 | 33.0348 | -86.9978 | -11.1 | 162.2 | 10 | 271.7 | 113.4 | SKS | 5.1 | 9.7 | 21.2 | 1.4 | 4 | 4 | Yes | 2 |
| LRAL | 11-Nov-04 | 33.0348 | -86.9978 | -11.1 | 162.2 | 10 | 271.7 | 113.4 | SKKS | 1 | 5.7 | 15.2 | 0.8 | 4 | 4 | Yes | 2 |
| LRAL | 8-Feb-05 | 33.0348 | -86.9978 | -14.2 | 167.3 | 206 | 266.1 | 110.8 | SKS | 1 | 4.1 | 13.1 | 1.7 | 3.5 | 4 | Yes | 2 |
| LRAL | 8-Feb-05 | 33.0348 | -86.9978 | -14.2 | 167.3 | 206 | 266.1 | 110.8 | SKKS | -5.1 | -1.9 | -1 | 1.9 | 4 | 4 | Yes | 2 |
| LRAL | 16-May-05 | 33.0348 | -86.9978 | -32.6 | -179.3 | 34 | 242.8 | 108.8 | SKS | 65.7 | 66.8 | 71.8 | 2.5 | 4 | 4 | Yes | 2 |
| LRAL | 16-May-05 | 33.0348 | -86.9978 | -32.6 | -179.3 | 34 | 242.8 | 108.8 | SKKS | 65.7 | 66.8 | 69.8 | 3.1 | 4 | 4 | Yes | 2 |
| LRAL | 15-Oct-05 | 33.0348 | -86.9978 | 25.3 | 123.4 | 183 | 329.8 | 114.9 | SKS | -31.3 | -24.2 | -23.3 | 1.6 | 3.2 | 4 | Yes | 2 |
| LRAL | 15-Oct-05 | 33.0348 | -86.9978 | 25.3 | 123.4 | 183 | 329.8 | 114.9 | SKKS | -31.3 | -24.2 | 7.1 | 0.3 | 2.2 | 4 | Yes | 2 |
| LRAL | 16-May-06 | 33.0348 | -86.9978 | -31.6 | -179.3 | 149 | 243.7 | 108.3 | SKS | -Inf | -22.3 | Inf | 0 | 4 | Inf | Yes | 2 |
| LRAL | 16-May-06 | 33.0348 | -86.9978 | -31.6 | -179.3 | 149 | 243.7 | 108.3 | SKKS | 65.7 | 69.7 | 71.8 | 3.2 | 4 | 4 | Yes | 2 |
| LRAL | 7-Aug-06 | 33.0348 | -86.9978 | -15.9 | 167.8 | 150 | 264.4 | 111.2 | SKS | -3 | 0.4 | 17.2 | 1 | 4 | 4 | Yes | 2 |
| LRAL | 7-Aug-06 | 33.0348 | -86.9978 | -15.9 | 167.8 | 150 | 264.4 | 111.2 | SKKS | -5.1 | -1.6 | 1 | 2.1 | 4 | 4 | Yes | 2 |
| LRAL | 18-Aug-07 | 33.0348 | -86.9978 | -22.2 | 174.7 | 35 | 255.1 | 108.5 | SKS | -17.2 | -8.9 | 47.5 | 0.2 | 3.8 | 4 | Yes | 2 |
| LRAL | 18-Aug-07 | 33.0348 | -86.9978 | -22.2 | 174.7 | 35 | 255.1 | 108.5 | SKKS | -15.2 | -10.9 | -11.1 | 3.1 | 4 | 4 | Yes | 2 |
| LRAL | 13-Jul-08 | 33.0348 | -86.9978 | 21 | 121.1 | 14 | 329.6 | 119.6 | SKS | -Inf | -30.4 | Inf | 0 | 4 | Inf | Yes | 2 |
| LRAL | 13-Jul-08 | 33.0348 | -86.9978 | 21 | 121.1 | 14 | 329.6 | 119.6 | SKKS | -Inf | -20.4 | Inf | 0 | 0.6 | Inf | Yes | 2 |
| LRAL | 2-Jun-09 | 33.0348 | -86.9978 | -17.8 | 167.9 | 15 | 262.5 | 111.9 | SKS | -5.1 | 0.5 | 9.1 | 1.2 | 4 | 4 | Yes | 2 |
| LRAL | 2-Jun-09 | 33.0348 | -86.9978 | -17.8 | 167.9 | 15 | 262.5 | 111.9 | SKKS | -9.1 | -3.5 | -1 | 1.6 | 4 | 4 | Yes | 2 |
| LRAL | 10-Aug-09 | 33.0348 | -86.9978 | -11.6 | 166.1 | 35 | 269.2 | 110.4 | SKS | 1 | 7.2 | 19.2 | 1.1 | 3.8 | 4 | Yes | 2 |
| LRAL | 10-Aug-09 | 33.0348 | -86.9978 | -11.6 | 166.1 | 35 | 269.2 | 110.4 | SKKS | 5.1 | 7.2 | 9.1 | 3.4 | 4 | 4 | Yes | 2 |
| LRAL | 17-Aug-09 | 33.0348 | -86.9978 | 23.5 | 123.5 | 20 | 328.7 | 116.4 | SKS | -31.3 | -25.3 | -11.1 | 0.6 | 2.2 | 3.8 | Yes | 2 |
| LRAL | 17-Aug-09 | 33.0348 | -86.9978 | 23.5 | 123.5 | 20 | 328.7 | 116.4 | SKKS | -11.1 | 38.7 | 53.6 | 0.4 | 1 | 2.4 | Yes | 2 |
| LRAL | 26-Feb-10 | 33.0348 | -86.9978 | 25.9 | 128.4 | 25 | 325.8 | 112.1 | SKS | 59.7 | 63.8 | 88 | 0.6 | 2.5 | 4 | Yes | 2 |
| LRAL | 26-Feb-10 | 33.0348 | -86.9978 | 25.9 | 128.4 | 25 | 325.8 | 112.1 | SKKS | -Inf | 57.8 | Inf | 0 | 0.1 | Inf | Yes | 2 |
| LRAL | 4-Mar-10 | 33.0348 | -86.9978 | 22.9 | 120.8 | 21 | 330.9 | 118.1 | SKS | -Inf | -7.1 | Inf | 0 | 0.4 | Inf | Yes | 2 |
| LRAL | 4-Mar-10 | 33.0348 | -86.9978 | 22.9 | 120.8 | 21 | 330.9 | 118.1 | SKKS | -Inf | 58.9 | Inf | 0 | 2.6 | Inf | Yes | 2 |
| LRAL | 17-Jun-10 | 33.0348 | -86.9978 | -33.2 | 179.7 | 170 | 242.6 | 109.8 | SKS | -29.3 | -23.4 | -21.2 | 1.3 | 4 | 4 | Yes | 2 |
| LRAL | 17-Jun-10 | 33.0348 | -86.9978 | -33.2 | 179.7 | 170 | 242.6 | 109.8 | SKKS | -27.3 | -23.4 | -19.2 | 1.2 | 3.5 | 4 | Yes | 2 |
| LRAL | 10-Aug-10 | 33.0348 | -86.9978 | -17.5 | 168.1 | 25 | 262.7 | 111.7 | SKS | -7.1 | -1.3 | 79.9 | 0.1 | 1.3 | 4 | Yes | 2 |
| LRAL | 10-Aug-10 | 33.0348 | -86.9978 | -17.5 | 168.1 | 25 | 262.7 | 111.7 | SKKS | -Inf | -1.3 | Inf | 0 | 4 | Inf | Yes | 2 |
| LRAL | 3-Sep-10 | 33.0348 | -86.9978 | -43.5 | 171.8 | 12 | 234.9 | 119.5 | SKS | -29.3 | 20.9 | 51.6 | 0.2 | 0.5 | 2.1 | Yes | 2 |
| LRAL | 3-Sep-10 | 33.0348 | -86.9978 | -43.5 | 171.8 | 12 | 234.9 | 119.5 | SKKS | -35.4 | -31.1 | -29.3 | 1.9 | 4 | 4 | Yes | 2 |
| LRAL | 25-Dec-10 | 33.0348 | -86.9978 | -19.7 | 167.9 | 16 | 260.7 | 112.9 | SKS | -7.1 | 0.7 | 75.8 | 0.2 | 1.8 | 4 | Yes | 2 |
| LRAL | 25-Dec-10 | 33.0348 | -86.9978 | -19.7 | 167.9 | 16 | 260.7 | 112.9 | SKKS | -7.1 | 12.7 | 79.9 | 0.1 | 0.7 | 4 | Yes | 2 |
| LRAL | 18-Jan-11 | 33.0348 | -86.9978 | 28.8 | 64 | 68 | 27.4 | 112.3 | SKS | 37.4 | 51.4 | 88 | 0.6 | 1 | 1.9 | Yes | 2 |
| LRAL | 18-Jan-11 | 33.0348 | -86.9978 | 28.8 | 64 | 68 | 27.4 | 112.3 | SKKS | 33.4 | 81.4 | -71.8 | 0.2 | 0.7 | 2.6 | Yes | 2 |
| LRAL | 18-Apr-11 | 33.0348 | -86.9978 | -34.3 | 179.9 | 86 | 241.5 | 110.2 | SKS | -27.3 | -22.5 | -23.3 | 2 | 3.5 | 4 | Yes | 2 |
| LRAL | 18-Apr-11 | 33.0348 | -86.9978 | -34.3 | 179.9 | 86 | 241.5 | 110.2 | SKKS | 63.7 | 67.5 | 69.8 | 2.2 | 4 | 4 | Yes | 2 |
| LRAL | 16-Jun-11 | 33.0348 | -86.9978 | -5.9 | 151 | 16 | 283.4 | 119.8 | SKS | 25.3 | 33.4 | 51.6 | 1 | 1.7 | 2.6 | No | 3 |
| LRAL | 16-Jun-11 | 33.0348 | -86.9978 | -5.9 | 151 | 16 | 283.4 | 119.8 | SKKS | 17.2 | 21.4 | 35.4 | 1 | 2.7 | 4 | Yes | 3 |
| LRAL | 21-Jul-13 | 33.0348 | -86.9978 | -41.7 | 174.4 | 14 | 236 | 117.1 | SKS | -33.4 | -30 | -25.3 | 1 | 2.5 | 4 | Yes | 2 |
| LRAL | 21-Jul-13 | 33.0348 | -86.9978 | -41.7 | 174.4 | 14 | 236 | 117.1 | SKKS | -31.3 | -28 | -25.3 | 1.8 | 3.2 | 4 | Yes | 2 |
| LRAL | 16-Aug-13 | 33.0348 | -86.9978 | -41.7 | 174.2 | 8 | 236.1 | 117.3 | SKS | -33.4 | -29.9 | -27.3 | 1.5 | 3.3 | 4 | Yes | 2 |
| LRAL | 16-Aug-13 | 33.0348 | -86.9978 | -41.7 | 174.2 | 8 | 236.1 | 117.3 | SKKS | -31.3 | -27.9 | -25.3 | 2.9 | 4 | 4 | Yes | 2 |
| LRAL | 30-Aug-13 | 33.0348 | -86.9978 | -4.4 | 151.6 | 203 | 284.4 | 118.5 | SKS | 29.3 | 40.4 | 65.7 | 1 | 1.8 | 2.8 | No | 2 |
| LRAL | 30-Aug-13 | 33.0348 | -86.9978 | -4.4 | 151.6 | 203 | 284.4 | 118.5 | SKKS | 25.3 | 30.4 | 41.5 | 1.7 | 2.9 | 4 | No | 2 |
| MCWV | 1-Aug-99 | 39.6581 | -79.8456 | -30.4 | -177.8 | 10 | 249.9 | 114.5 | SKKS | 69.8 | 73.9 | 86 | 0.5 | 3.6 | 4 | Yes | 2 |
| MCWV | 1-Aug-99 | 39.6581 | -79.8456 | -30.4 | -177.8 | 10 | 249.9 | 114.5 | SKS | -21.2 | -14.1 | -15.2 | 2.2 | 4 | 4 | Yes | 2 |
| MCWV | 15-Aug-00 | 39.6581 | -79.8456 | -31.5 | 179.7 | 358 | 250.1 | 116.9 | SKS | 47.5 | 68.1 | 71.8 | 0.1 | 1.2 | 4 | Yes | 2 |
| MCWV | 15-Aug-00 | 39.6581 | -79.8456 | -31.5 | 179.7 | 358 | 250.1 | 116.9 | SKKS | 69.8 | 70.1 | 71.8 | 1.8 | 3.1 | 4 | Yes | 2 |
| MCWV | 16-Nov-00 | 39.6581 | -79.8456 | -4 | 152.2 | 33 | 293.3 | 121.1 | SKS | 61.7 | 79.3 | -90 | 1.1 | 1.5 | 2.1 | No | 3 |
| MCWV | 16-Nov-00 | 39.6581 | -79.8456 | -4 | 152.2 | 33 | 293.3 | 121.1 | SKKS | 31.3 | 35.3 | 39.4 | 3.3 | 4 | 4 | Yes | 3 |
| MCWV | 9-Jan-01 | 39.6581 | -79.8456 | -14.9 | 167.2 | 103 | 272.7 | 117.1 | SKS | 7.1 | 24.7 | 86 | 0.3 | 1.6 | 4 | No | 2 |
| MCWV | 9-Jan-01 | 39.6581 | -79.8456 | -14.9 | 167.2 | 103 | 272.7 | 117.1 | SKKS | 11.1 | 14.7 | 23.3 | 1.8 | 3.1 | 4 | No | 2 |
| MCWV | 3-Jun-01 | 39.6581 | -79.8456 | -29.7 | -178.6 | 178 | 251 | 114.7 | SKS | -9.1 | 63 | 67.8 | 0.2 | 2 | 4 | Yes | 2 |
| MCWV | 3-Jun-01 | 39.6581 | -79.8456 | -29.7 | -178.6 | 178 | 251 | 114.7 | SKKS | -33.4 | -21 | -23.3 | 0.6 | 4 | 4 | Yes | 2 |
| MCWV | 12-Sep-01 | 39.6581 | -79.8456 | -21 | -179.1 | 608 | 259 | 110.1 | SKS | -Inf | 79 | Inf | 0 | 4 | Inf | Yes | 2 |
| MCWV | 12-Sep-01 | 39.6581 | -79.8456 | -21 | -179.1 | 608 | 259 | 110.1 | SKKS | -Inf | -49 | Inf | 0 | 0.2 | Inf | Yes | 2 |
| MCWV | 29-Sep-01 | 39.6581 | -79.8456 | -18.5 | 168.2 | 33 | 268.9 | 118.4 | SKS | 35.4 | 56.9 | 71.8 | 1 | 1.5 | 2.2 | No | 3 |
| MCWV | 29-Sep-01 | 39.6581 | -79.8456 | -18.5 | 168.2 | 33 | 268.9 | 118.4 | SKKS | -Inf | -5.1 | Inf | 0 | 1.2 | Inf | Yes | 3 |
| MCWV | 12-Oct-01 | 39.6581 | -79.8456 | 12.7 | 145 | 37 | 311.6 | 113.1 | SKS | 43.5 | 51.6 | 63.7 | 1.5 | 4 | 4 | Yes | 2 |
| MCWV | 12-Oct-01 | 39.6581 | -79.8456 | 12.7 | 145 | 37 | 311.6 | 113.1 | SKKS | 43.5 | 47.6 | 49.6 | 2.2 | 3.8 | 4 | Yes | 2 |
| MCWV | 18-Dec-01 | 39.6581 | -79.8456 | 23.9 | 122.7 | 14 | 337.6 | 113 | SKS | -25.3 | -16.4 | -13.1 | 2.5 | 4 | 4 | Yes | 2 |
| MCWV | 18-Dec-01 | 39.6581 | -79.8456 | 23.9 | 122.7 | 14 | 337.6 | 113 | SKKS | -23.3 | -18.4 | -19.2 | 2.6 | 4 | 4 | Yes | 2 |
| MCWV | 2-Jan-02 | 39.6581 | -79.8456 | -17.6 | 167.9 | 21 | 269.9 | 118.1 | SKS | 5.1 | 7.9 | 13.1 | 2.4 | 4 | 4 | Yes | 2 |
| MCWV | 2-Jan-02 | 39.6581 | -79.8456 | -17.6 | 167.9 | 21 | 269.9 | 118.1 | SKKS | 1 | 5.9 | 11.1 | 1.4 | 4 | 4 | Yes | 2 |
| MCWV | 31-Mar-02 | 39.6581 | -79.8456 | 24.3 | 122.2 | 33 | 338.2 | 112.8 | SKS | -Inf | -17.8 | Inf | 0 | 2.1 | Inf | Yes | 2 |
| MCWV | 31-Mar-02 | 39.6581 | -79.8456 | 24.3 | 122.2 | 33 | 338.2 | 112.8 | SKKS | 73.8 | 74.2 | 77.9 | 3.4 | 4 | 4 | Yes | 2 |
| MCWV | 26-Apr-02 | 39.6581 | -79.8456 | 13.1 | 144.6 | 86 | 312.2 | 113 | SKS | 49.6 | 50.2 | 55.6 | 2.4 | 4 | 4 | Yes | 2 |
| MCWV | 26-Apr-02 | 39.6581 | -79.8456 | 13.1 | 144.6 | 86 | 312.2 | 113 | SKKS | -49.6 | -45.8 | -45.5 | 3 | 4 | 4 | Yes | 2 |
| MCWV | 17-Jun-02 | 39.6581 | -79.8456 | -12.6 | 166.4 | 33 | 275.3 | 116.2 | SKS | 9.1 | 41.3 | 86 | 0.2 | 0.9 | 4 | No | 2 |
| MCWV | 17-Jun-02 | 39.6581 | -79.8456 | -12.6 | 166.4 | 33 | 275.3 | 116.2 | SKKS | 7.1 | 19.3 | 83.9 | 0.4 | 2.7 | 4 | No | 2 |
| MCWV | 30-Jun-02 | 39.6581 | -79.8456 | -22.2 | 179.2 | 620 | 258.9 | 112.1 | SKS | -Inf | -9.1 | Inf | 0 | 3.7 | Inf | Yes | 2 |
| MCWV | 30-Jun-02 | 39.6581 | -79.8456 | -22.2 | 179.2 | 620 | 258.9 | 112.1 | SKKS | -17.2 | -13.1 | -13.1 | 1.6 | 4 | 4 | Yes | 2 |
| MCWV | 20-Jan-03 | 39.6581 | -79.8456 | -10.5 | 160.8 | 33 | 281.1 | 119.2 | SKS | 29.3 | 33.1 | 37.4 | 2.9 | 3.4 | 4 | No | 2 |
| MCWV | 20-Jan-03 | 39.6581 | -79.8456 | -10.5 | 160.8 | 33 | 281.1 | 119.2 | SKKS | 25.3 | 29.1 | 35.4 | 2.5 | 3.1 | 3.8 | No | 2 |
| MCWV | 4-May-03 | 39.6581 | -79.8456 | -30.5 | -178.2 | 62 | 250 | 114.9 | SKS | -21.2 | -16 | -13.1 | 1 | 3.1 | 4 | Yes | 2 |
| MCWV | 4-May-03 | 39.6581 | -79.8456 | -30.5 | -178.2 | 62 | 250 | 114.9 | SKKS | -Inf | -88 | Inf | 0 | 0.5 | Inf | Yes | 2 |
| MCWV | 27-Jul-03 | 39.6581 | -79.8456 | -21.1 | -176.6 | 213 | 257.4 | 108.3 | SKS | -13.1 | -6.6 | 5.1 | 0.6 | 1.9 | 3.6 | Yes | 2 |
| MCWV | 27-Jul-03 | 39.6581 | -79.8456 | -21.1 | -176.6 | 213 | 257.4 | 108.3 | SKKS | 67.8 | 73.4 | 77.9 | 0.7 | 2.7 | 4 | Yes | 2 |
| MCWV | 30-Sep-03 | 39.6581 | -79.8456 | -30.4 | -177.4 | 10 | 249.6 | 114.2 | SKS | -21.2 | 49.6 | 67.8 | 0.1 | 0.6 | 4 | Yes | 2 |
| MCWV | 30-Sep-03 | 39.6581 | -79.8456 | -30.4 | -177.4 | 10 | 249.6 | 114.2 | SKKS | -Inf | -24.4 | Inf | 0 | 2.4 | Inf | Yes | 2 |
| MCWV | 19-May-04 | 39.6581 | -79.8456 | 22.7 | 121.5 | 20 | 338.3 | 114.6 | SKS | -21.2 | -15.7 | -11.1 | 1 | 2.9 | 4 | Yes | 2 |
| MCWV | 19-May-04 | 39.6581 | -79.8456 | 22.7 | 121.5 | 20 | 338.3 | 114.6 | SKKS | 71.8 | 76.3 | -41.5 | 0.4 | 2.3 | 4 | Yes | 2 |
| MCWV | 15-Oct-04 | 39.6581 | -79.8456 | 24.5 | 122.7 | 94 | 337.8 | 112.5 | SKS | -Inf | 73.8 | Inf | 0 | 4 | Inf | Yes | 2 |
| MCWV | 15-Oct-04 | 39.6581 | -79.8456 | 24.5 | 122.7 | 94 | 337.8 | 112.5 | SKKS | -Inf | -18.2 | Inf | 0 | 4 | Inf | Yes | 2 |
| MCWV | 11-Nov-04 | 39.6581 | -79.8456 | -11.1 | 162.2 | 10 | 279.5 | 118.5 | SKS | 17.2 | 21.5 | 25.3 | 2.5 | 3.5 | 4 | No | 2 |
| MCWV | 11-Nov-04 | 39.6581 | -79.8456 | -11.1 | 162.2 | 10 | 279.5 | 118.5 | SKKS | 13.1 | 21.5 | 65.7 | 0.7 | 2.7 | 4 | No | 2 |
| MCWV | 16-Jan-05 | 39.6581 | -79.8456 | 10.9 | 140.8 | 25 | 314.1 | 116.9 | SKS | 49.6 | 56.1 | 88 | 0.8 | 3.2 | 4 | Yes | 2 |
| MCWV | 16-Jan-05 | 39.6581 | -79.8456 | 10.9 | 140.8 | 25 | 314.1 | 116.9 | SKKS | -45.5 | -41.9 | -37.4 | 1.2 | 4 | 4 | Yes | 2 |
| MCWV | 12-May-05 | 39.6581 | -79.8456 | -57.4 | -139.2 | 10 | 209.4 | 109 | SKS | 41.5 | 69.4 | -73.8 | 0.4 | 0.8 | 1.8 | No | 2 |
| MCWV | 12-May-05 | 39.6581 | -79.8456 | -57.4 | -139.2 | 10 | 209.4 | 109 | SKKS | 43.5 | 63.4 | -81.9 | 0.6 | 1.1 | 2.2 | No | 2 |
| MCWV | 16-May-05 | 39.6581 | -79.8456 | -32.6 | -179.3 | 34 | 248.6 | 116.8 | SKS | 67.8 | 68.6 | 69.8 | 1.4 | 4 | 4 | Yes | 2 |
| MCWV | 16-May-05 | 39.6581 | -79.8456 | -32.6 | -179.3 | 34 | 248.6 | 116.8 | SKKS | 86 | -27.4 | -25.3 | 0.3 | 3.7 | 4 | Yes | 2 |
| MCWV | 26-Aug-05 | 39.6581 | -79.8456 | 14.4 | 52.4 | 10 | 49.8 | 110 | SKS | 59.7 | -48.2 | -45.5 | 0.2 | 1.1 | 2.8 | Yes | 2 |
| MCWV | 26-Aug-05 | 39.6581 | -79.8456 | 14.4 | 52.4 | 10 | 49.8 | 110 | SKKS | 49.6 | 51.8 | 55.6 | 1.8 | 4 | 4 | Yes | 2 |
| MCWV | 22-Feb-06 | 39.6581 | -79.8456 | -21.2 | 33.3 | 10 | 93 | 120.9 | SKS | 7.1 | 9 | 13.1 | 3.4 | 4 | 4 | Yes | 2 |
| MCWV | 22-Feb-06 | 39.6581 | -79.8456 | -21.2 | 33.3 | 10 | 93 | 120.9 | SKKS | 5.1 | 7 | 11.1 | 2.4 | 4 | 4 | Yes | 2 |
| MCWV | 31-Mar-06 | 39.6581 | -79.8456 | -29.5 | -176.8 | 27 | 250.2 | 113.2 | SKS | -Inf | -15.8 | Inf | 0 | 2.9 | Inf | Yes | 2 |
| MCWV | 31-Mar-06 | 39.6581 | -79.8456 | -29.5 | -176.8 | 27 | 250.2 | 113.2 | SKKS | -19.2 | -13.8 | -9.1 | 2.3 | 4 | 4 | Yes | 2 |
| MCWV | 16-May-06 | 39.6581 | -79.8456 | -31.6 | -179.3 | 149 | 249.5 | 116.2 | SKS | -Inf | 73.5 | Inf | 0 | 0.9 | Inf | Yes | 2 |
| MCWV | 16-May-06 | 39.6581 | -79.8456 | -31.6 | -179.3 | 149 | 249.5 | 116.2 | SKKS | -Inf | -22.5 | Inf | 0 | 4 | Inf | Yes | 2 |
| MCWV | 7-Aug-06 | 39.6581 | -79.8456 | -15.9 | 167.8 | 150 | 271.5 | 117.2 | SKS | 9.1 | 17.5 | 43.5 | 0.8 | 1.8 | 3 | No | 2 |
| MCWV | 7-Aug-06 | 39.6581 | -79.8456 | -15.9 | 167.8 | 150 | 271.5 | 117.2 | SKKS | 7.1 | 15.5 | 49.6 | 0.7 | 1.8 | 3.3 | No | 2 |
| MCWV | 27-Jul-07 | 39.6581 | -79.8456 | -21.4 | 170.9 | 35 | 264.4 | 118 | SKS | -Inf | 0.4 | Inf | 0 | 1.1 | Inf | Yes | 2 |
| MCWV | 27-Jul-07 | 39.6581 | -79.8456 | -21.4 | 170.9 | 35 | 264.4 | 118 | SKKS | -Inf | 86.4 | Inf | 0 | 2.5 | Inf | Yes | 2 |
| MCWV | 16-Oct-07 | 39.6581 | -79.8456 | -25.5 | 179.5 | 477 | 255.8 | 113.8 | SKS | 73.8 | 75.8 | 75.8 | 3.6 | 4 | 4 | Yes | 2 |
| MCWV | 16-Oct-07 | 39.6581 | -79.8456 | -25.5 | 179.5 | 477 | 255.8 | 113.8 | SKKS | -Inf | 73.8 | Inf | 0 | 2.8 | Inf | Yes | 2 |
| MCWV | 9-May-08 | 39.6581 | -79.8456 | 12.5 | 143.2 | 76 | 313 | 114.3 | SKS | 47.5 | 53 | 59.7 | 2.2 | 4 | 4 | Yes | 2 |
| MCWV | 9-May-08 | 39.6581 | -79.8456 | 12.5 | 143.2 | 76 | 313 | 114.3 | SKKS | 47.5 | 49 | 53.6 | 2 | 3.7 | 4 | Yes | 2 |
| MCWV | 29-Sep-08 | 39.6581 | -79.8456 | -29.8 | -177.7 | 36 | 250.4 | 114.1 | SKS | -19.2 | -15.6 | -3 | 0.5 | 3.2 | 4 | Yes | 2 |
| MCWV | 29-Sep-08 | 39.6581 | -79.8456 | -29.8 | -177.7 | 36 | 250.4 | 114.1 | SKKS | -31.3 | -21.6 | -23.3 | 0.6 | 3.1 | 4 | Yes | 2 |
| MCWV | 17-Aug-09 | 39.6581 | -79.8456 | 23.5 | 123.5 | 20 | 336.7 | 113.2 | SKS | -Inf | 70.7 | Inf | 0 | 4 | Inf | Yes | 2 |
| MCWV | 17-Aug-09 | 39.6581 | -79.8456 | 23.5 | 123.5 | 20 | 336.7 | 113.2 | SKKS | -23.3 | -19.3 | -19.2 | 1.8 | 3.7 | 4 | Yes | 2 |
| MCWV | 8-Oct-09 | 39.6581 | -79.8456 | -13.3 | 165.9 | 35 | 275 | 117 | SKS | 9.1 | 11 | 15.2 | 2.2 | 4 | 4 | Yes | 3 |
| MCWV | 8-Oct-09 | 39.6581 | -79.8456 | -13.3 | 165.9 | 35 | 275 | 117 | SKKS | 7.1 | 61 | -90 | 0.2 | 1.1 | 4 | No | 3 |
| MCWV | 25-Dec-10 | 39.6581 | -79.8456 | -19.7 | 167.9 | 16 | 267.9 | 119.3 | SKS | 1 | 13.9 | 81.9 | 0.2 | 0.5 | 2 | Yes | 2 |
| MCWV | 25-Dec-10 | 39.6581 | -79.8456 | -19.7 | 167.9 | 16 | 267.9 | 119.3 | SKKS | -3 | -0.1 | -1 | 1.5 | 3.7 | 4 | Yes | 2 |
| MCWV | 20-Aug-11 | 39.6581 | -79.8456 | -18.4 | 168.1 | 32 | 269 | 118.4 | SKS | 61.7 | 83 | 88 | 0.7 | 3.4 | 4 | Yes | 2 |
| MCWV | 20-Aug-11 | 39.6581 | -79.8456 | -18.4 | 168.1 | 32 | 269 | 118.4 | SKKS | -Inf | 87 | Inf | 0 | 4 | Inf | Yes | 2 |
| MCWV | 11-Oct-13 | 39.6581 | -79.8456 | -30.7 | -178.5 | 151 | 250 | 115.1 | SKS | -Inf | 6 | Inf | 0 | 0.2 | Inf | Yes | 2 |
| MCWV | 11-Oct-13 | 39.6581 | -79.8456 | -30.7 | -178.5 | 151 | 250 | 115.1 | SKKS | 71.8 | -34 | -23.3 | 0.1 | 0.9 | 4 | Yes | 2 |
| MYNC | 1-Sep-06 | 35.0739 | -84.1279 | -6.8 | 155.5 | 54 | 282.7 | 118.6 | SKS | 31.3 | 42.7 | 61.7 | 1.2 | 1.7 | 2.4 | No | 3 |
| MYNC | 1-Sep-06 | 35.0739 | -84.1279 | -6.8 | 155.5 | 54 | 282.7 | 118.6 | SKKS | 17.2 | 82.7 | -83.9 | 0.2 | 1.2 | 3.9 | Yes | 3 |
| NHSC | 31-Mar-02 | 33.1067 | -80.1778 | 24.3 | 122.2 | 32 | 336.7 | 118.8 | SKS | -21.2 | -13.3 | 23.3 | 0.6 | 2.1 | 4 | Yes | 2 |
| NHSC | 31-Mar-02 | 33.1067 | -80.1778 | 24.3 | 122.2 | 32 | 336.7 | 118.8 | SKKS | -21.2 | -17.3 | -15.2 | 2.7 | 4 | 4 | Yes | 2 |
| NHSC | 22-Feb-06 | 33.1067 | -80.1778 | -21.3 | 33.6 | 11 | 96.7 | 120.9 | SKS | -83.9 | -81.3 | -83.9 | 2.8 | 4 | 4 | Yes | 2 |
| NHSC | 22-Feb-06 | 33.1067 | -80.1778 | -21.3 | 33.6 | 11 | 96.7 | 120.9 | SKKS | -Inf | 8.7 | Inf | 0 | 4 | Inf | Yes | 2 |
| NHSC | 31-Mar-06 | 33.1067 | -80.1778 | -29.6 | -176.8 | 17 | 247.4 | 110.7 | SKS | -Inf | -20.6 | Inf | 0 | 4 | Inf | Yes | 2 |
| NHSC | 31-Mar-06 | 33.1067 | -80.1778 | -29.6 | -176.8 | 17 | 247.4 | 110.7 | SKKS | 71.8 | 75.4 | 79.9 | 2.4 | 4 | 4 | Yes | 2 |
| NHSC | 16-May-06 | 33.1067 | -80.1778 | -31.8 | -179.3 | 151 | 246.4 | 113.6 | SKS | -25.3 | -17.6 | 19.2 | 0.3 | 4 | 4 | Yes | 2 |
| NHSC | 16-May-06 | 33.1067 | -80.1778 | -31.8 | -179.3 | 151 | 246.4 | 113.6 | SKKS | -21.2 | -15.6 | -11.1 | 2.2 | 4 | 4 | Yes | 2 |
| NHSC | 28-Sep-07 | 33.1067 | -80.1778 | 22 | 142.7 | 272 | 317.4 | 111.4 | SKS | -43.5 | -36.6 | -37.4 | 2.8 | 4 | 4 | Yes | 2 |
| NHSC | 28-Sep-07 | 33.1067 | -80.1778 | 22 | 142.7 | 272 | 317.4 | 111.4 | SKKS | 49.6 | 53.4 | 55.6 | 2.2 | 4 | 4 | Yes | 2 |
| NHSC | 31-Oct-07 | 33.1067 | -80.1778 | 18.9 | 145.4 | 207 | 313.1 | 112.2 | SKS | -Inf | 51.1 | Inf | 0 | 4 | Inf | Yes | 2 |
| NHSC | 31-Oct-07 | 33.1067 | -80.1778 | 18.9 | 145.4 | 207 | 313.1 | 112.2 | SKKS | 49.6 | 53.1 | 55.6 | 3.2 | 4 | 4 | Yes | 2 |
| NHSC | 12-Mar-08 | 33.1067 | -80.1778 | -16.6 | 167.3 | 13 | 267.5 | 117.6 | SKS | -1 | 3.5 | 41.5 | 0.3 | 2.4 | 4 | Yes | 2 |
| NHSC | 12-Mar-08 | 33.1067 | -80.1778 | -16.6 | 167.3 | 13 | 267.5 | 117.6 | SKKS | 25.3 | 81.5 | 86 | 0.3 | 3.7 | 4 | Yes | 2 |
| NHSC | 29-Sep-08 | 33.1067 | -80.1778 | -29.8 | -177.7 | 36 | 247.7 | 111.5 | SKS | -23.3 | -16.3 | 53.6 | 0.2 | 4 | 4 | Yes | 2 |
| NHSC | 29-Sep-08 | 33.1067 | -80.1778 | -29.8 | -177.7 | 36 | 247.7 | 111.5 | SKKS | -23.3 | -18.3 | -19.2 | 2.4 | 4 | 4 | Yes | 2 |
| NHSC | 5-Oct-08 | 33.1067 | -80.1778 | -30.2 | -177.2 | 10 | 247 | 111.3 | SKS | -23.3 | -19 | -19.2 | 1.5 | 2.9 | 4 | Yes | 2 |
| NHSC | 5-Oct-08 | 33.1067 | -80.1778 | -30.2 | -177.2 | 10 | 247 | 111.3 | SKKS | 71.8 | 73 | 77.9 | 2.9 | 4 | 4 | Yes | 2 |
| NHSC | 10-Jul-10 | 33.1067 | -80.1778 | 11.1 | 146 | 13 | 307 | 117.6 | SKS | -51.6 | -47 | -45.5 | 3.2 | 4 | 4 | Yes | 2 |
| NHSC | 10-Jul-10 | 33.1067 | -80.1778 | 11.1 | 146 | 13 | 307 | 117.6 | SKKS | 43.5 | 45 | 49.6 | 3.2 | 4 | 4 | Yes | 2 |
| NHSC | 30-Nov-10 | 33.1067 | -80.1778 | 28.4 | 139.2 | 486 | 324.1 | 108.1 | SKS | -33.4 | -27.9 | -21.2 | 1.6 | 3.7 | 4 | Yes | 2 |
| NHSC | 30-Nov-10 | 33.1067 | -80.1778 | 28.4 | 139.2 | 486 | 324.1 | 108.1 | SKKS | -35.4 | -27.9 | -25.3 | 2.4 | 4 | 4 | Yes | 2 |
| NHSC | 18-Jan-11 | 33.1067 | -80.1778 | 28.8 | 64 | 68 | 33 | 109.4 | SKS | -Inf | -53 | Inf | 0 | 4 | Inf | Yes | 2 |
| NHSC | 18-Jan-11 | 33.1067 | -80.1778 | 28.8 | 64 | 68 | 33 | 109.4 | SKKS | 35.4 | 39 | 43.5 | 2.1 | 4 | 4 | Yes | 2 |
| NHSC | 21-Jun-11 | 33.1067 | -80.1778 | -11.5 | 165.6 | 14 | 273.4 | 116.5 | SKS | -Inf | 11.4 | Inf | 0 | 1.6 | Inf | Yes | 2 |
| NHSC | 21-Jun-11 | 33.1067 | -80.1778 | -11.5 | 165.6 | 14 | 273.4 | 116.5 | SKKS | -Inf | 7.4 | Inf | 0 | 2.6 | Inf | Yes | 2 |
| NHSC | 16-Apr-13 | 33.1067 | -80.1778 | 28.1 | 62.1 | 82 | 34.9 | 109.1 | SKS | -Inf | 40.9 | Inf | 0 | 4 | Inf | Yes | 2 |
| NHSC | 16-Apr-13 | 33.1067 | -80.1778 | 28.1 | 62.1 | 82 | 34.9 | 109.1 | SKKS | -Inf | -51.1 | Inf | 0 | 4 | Inf | Yes | 2 |
| NHSC | 14-May-13 | 33.1067 | -80.1778 | 18.7 | 145.3 | 602 | 313.1 | 112.4 | SKS | 45.5 | 47.1 | 51.6 | 2 | 4 | 4 | Yes | 2 |
| NHSC | 14-May-13 | 33.1067 | -80.1778 | 18.7 | 145.3 | 602 | 313.1 | 112.4 | SKKS | -Inf | -50.9 | Inf | 0 | 1.9 | Inf | Yes | 2 |
| NHSC | 21-Jul-13 | 33.1067 | -80.1778 | -41.7 | 174.4 | 14 | 238 | 122 | SKS | -31.3 | -26 | -23.3 | 3.1 | 4 | 4 | Yes | 2 |
| NHSC | 21-Jul-13 | 33.1067 | -80.1778 | -41.7 | 174.4 | 14 | 238 | 122 | SKKS | 61.7 | 64 | 67.8 | 2.2 | 4 | 4 | Yes | 2 |
| TZTN | 16-May-05 | 36.5439 | -83.549 | -32.6 | -179.3 | 34 | 245.5 | 112.9 | SKS | -25.3 | -18.5 | -17.2 | 1.6 | 4 | 4 | Yes | 2 |
| TZTN | 16-May-05 | 36.5439 | -83.549 | -32.6 | -179.3 | 34 | 245.5 | 112.9 | SKKS | 67.8 | 69.5 | 71.8 | 2 | 4 | 4 | Yes | 2 |
| TZTN | 16-May-06 | 36.5439 | -83.549 | -31.8 | -179.3 | 151 | 246.2 | 112.5 | SKS | 53.6 | 60.2 | 65.7 | 1.6 | 4 | 4 | Yes | 2 |
| TZTN | 16-May-06 | 36.5439 | -83.549 | -31.8 | -179.3 | 151 | 246.2 | 112.5 | SKKS | 53.6 | 60.2 | 67.8 | 1.4 | 4 | 4 | Yes | 2 |
| TZTN | 2-Jun-07 | 36.5439 | -83.549 | 23 | 101 | 5 | 355.1 | 120.3 | SKS | -7.1 | -0.9 | 81.9 | 0.1 | 1.8 | 4 | Yes | 2 |
| TZTN | 2-Jun-07 | 36.5439 | -83.549 | 23 | 101 | 5 | 355.1 | 120.3 | SKKS | -5.1 | -0.9 | -1 | 2 | 4 | 4 | Yes | 2 |
| TZTN | 17-Jul-07 | 36.5439 | -83.549 | -26.1 | -177.8 | 54 | 250.6 | 108.4 | SKS | -19.2 | -15.4 | -15.2 | 2.8 | 4 | 4 | Yes | 2 |
| TZTN | 17-Jul-07 | 36.5439 | -83.549 | -26.1 | -177.8 | 54 | 250.6 | 108.4 | SKKS | -15.2 | -9.4 | -3 | 1.4 | 2.6 | 4 | Yes | 2 |
| TZTN | 9-Jan-08 | 36.5439 | -83.549 | 32.3 | 85.2 | 10 | 10.2 | 110.4 | SKS | 35.4 | 88.2 | -86 | 0.3 | 1 | 2.4 | Yes | 2 |
| TZTN | 9-Jan-08 | 36.5439 | -83.549 | 32.3 | 85.2 | 10 | 10.2 | 110.4 | SKKS | 21.2 | 80.2 | -88 | 0.3 | 0.9 | 2.3 | Yes | 2 |
| TZTN | 12-Mar-08 | 36.5439 | -83.549 | -16.6 | 167.3 | 13 | 267.3 | 115 | SKS | 25.3 | 37.3 | 51.6 | 1.7 | 2.2 | 2.8 | No | 3 |
| TZTN | 12-Mar-08 | 36.5439 | -83.549 | -16.6 | 167.3 | 13 | 267.3 | 115 | SKKS | 19.2 | 61.3 | 79.9 | 0.7 | 1.3 | 2.9 | Yes | 3 |
| TZTN | 9-May-08 | 36.5439 | -83.549 | 12.5 | 143.2 | 76 | 308.8 | 114.1 | SKS | 43.5 | 52.8 | 65.7 | 1.9 | 4 | 4 | Yes | 2 |
| TZTN | 9-May-08 | 36.5439 | -83.549 | 12.5 | 143.2 | 76 | 308.8 | 114.1 | SKKS | 47.5 | 52.8 | 59.7 | 2.9 | 4 | 4 | Yes | 2 |
| TZTN | 25-May-08 | 36.5439 | -83.549 | 32.6 | 105.4 | 18 | 351.9 | 110.4 | SKS | -Inf | -4.1 | Inf | 0 | 1.1 | Inf | Yes | 2 |
| TZTN | 25-May-08 | 36.5439 | -83.549 | 32.6 | 105.4 | 18 | 351.9 | 110.4 | SKKS | -9.1 | -4.1 | -3 | 2.1 | 4 | 4 | Yes | 2 |
| TZTN | 3-Jun-08 | 36.5439 | -83.549 | -10.5 | 161.3 | 84 | 276.6 | 116.4 | SKS | 29.3 | 38.6 | 49.6 | 1.9 | 2.7 | 3.6 | No | 3 |
| TZTN | 3-Jun-08 | 36.5439 | -83.549 | -10.5 | 161.3 | 84 | 276.6 | 116.4 | SKKS | -83.9 | -75.4 | -59.7 | 0.7 | 3 | 4 | Yes | 3 |
| TZTN | 16-May-09 | 36.5439 | -83.549 | -31.6 | -178.8 | 43 | 246.2 | 112 | SKS | -25.3 | -19.8 | 69.8 | 0.1 | 4 | 4 | Yes | 2 |
| TZTN | 16-May-09 | 36.5439 | -83.549 | -31.6 | -178.8 | 43 | 246.2 | 112 | SKKS | -Inf | -21.8 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 23-Jun-09 | 36.5439 | -83.549 | -5.2 | 153.7 | 65 | 286.5 | 119.1 | SKS | 33.4 | 40.5 | 55.6 | 1.2 | 1.7 | 2.5 | No | 2 |
| TZTN | 23-Jun-09 | 36.5439 | -83.549 | -5.2 | 153.7 | 65 | 286.5 | 119.1 | SKKS | 29.3 | 30.5 | 33.4 | 2.7 | 3.2 | 4 | No | 2 |
| TZTN | 17-Aug-09 | 36.5439 | -83.549 | 23.5 | 123.5 | 20 | 332.7 | 114.8 | SKS | 65.7 | 64.7 | 67.8 | 2.9 | 4 | 4 | Yes | 2 |
| TZTN | 17-Aug-09 | 36.5439 | -83.549 | 23.5 | 123.5 | 20 | 332.7 | 114.8 | SKKS | -Inf | 66.7 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 8-Oct-09 | 36.5439 | -83.549 | -13.3 | 165.9 | 35 | 271.2 | 114.3 | SKS | 13.1 | 25.2 | 47.5 | 1.1 | 1.8 | 2.9 | No | 3 |
| TZTN | 8-Oct-09 | 36.5439 | -83.549 | -13.3 | 165.9 | 35 | 271.2 | 114.3 | SKKS | 3 | 7.2 | 37.4 | 0.5 | 2.9 | 4 | Yes | 3 |
| TZTN | 26-Feb-10 | 36.5439 | -83.549 | 25.9 | 128.4 | 25 | 329.4 | 110.6 | SKS | -Inf | -42.6 | Inf | 0 | 0.7 | Inf | Yes | 2 |
| TZTN | 26-Feb-10 | 36.5439 | -83.549 | 25.9 | 128.4 | 25 | 329.4 | 110.6 | SKKS | -Inf | 61.4 | Inf | 0 | 2.7 | Inf | Yes | 2 |
| TZTN | 20-Mar-10 | 36.5439 | -83.549 | -3.4 | 152.2 | 414 | 289.2 | 119.1 | SKS | 39.4 | 45.2 | 55.6 | 1.7 | 2.2 | 2.7 | No | 2 |
| TZTN | 20-Mar-10 | 36.5439 | -83.549 | -3.4 | 152.2 | 414 | 289.2 | 119.1 | SKKS | 37.4 | 51.2 | 73.8 | 1 | 1.4 | 2.1 | No | 2 |
| TZTN | 26-Apr-10 | 36.5439 | -83.549 | 22.2 | 123.6 | 22 | 332 | 115.9 | SKS | -Inf | 60 | Inf | 0 | 3.5 | Inf | Yes | 2 |
| TZTN | 26-Apr-10 | 36.5439 | -83.549 | 22.2 | 123.6 | 22 | 332 | 115.9 | SKKS | -Inf | 68 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 27-May-10 | 36.5439 | -83.549 | -14.5 | 167 | 35 | 269.5 | 114.1 | SKS | -Inf | -82.5 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 27-May-10 | 36.5439 | -83.549 | -14.5 | 167 | 35 | 269.5 | 114.1 | SKKS | 1 | 7.5 | 15.2 | 1.2 | 4 | 4 | Yes | 2 |
| TZTN | 17-Jun-10 | 36.5439 | -83.549 | -33.2 | 179.7 | 170 | 245.4 | 113.9 | SKS | -25.3 | -18.6 | -13.1 | 1.1 | 4 | 4 | Yes | 2 |
| TZTN | 17-Jun-10 | 36.5439 | -83.549 | -33.2 | 179.7 | 170 | 245.4 | 113.9 | SKKS | -Inf | -20.6 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 30-Jun-10 | 36.5439 | -83.549 | -23.3 | 179.1 | 581 | 254.8 | 109.3 | SKS | -13.1 | -7.2 | -3 | 1.8 | 4 | 4 | Yes | 2 |
| TZTN | 30-Jun-10 | 36.5439 | -83.549 | -23.3 | 179.1 | 581 | 254.8 | 109.3 | SKKS | 71.8 | 76.8 | 79.9 | 0.7 | 4 | 4 | Yes | 2 |
| TZTN | 18-Aug-10 | 36.5439 | -83.549 | 12.2 | 141.5 | 10 | 310 | 115.4 | SKS | 47.5 | 54 | 86 | 0.7 | 2.1 | 4 | No | 2 |
| TZTN | 18-Aug-10 | 36.5439 | -83.549 | 12.2 | 141.5 | 10 | 310 | 115.4 | SKKS | 51.6 | 62 | -86 | 1 | 2.1 | 4 | No | 2 |
| TZTN | 23-Apr-11 | 36.5439 | -83.549 | -10.4 | 161.2 | 79 | 276.7 | 116.4 | SKS | 25.3 | 38.7 | 63.7 | 0.9 | 1.3 | 2.1 | No | 3 |
| TZTN | 23-Apr-11 | 36.5439 | -83.549 | -10.4 | 161.2 | 79 | 276.7 | 116.4 | SKKS | -Inf | 14.7 | Inf | 0 | 0.6 | Inf | Yes | 3 |
| TZTN | 15-May-11 | 36.5439 | -83.549 | -6.1 | 154.4 | 40 | 285.2 | 119.1 | SKS | 27.3 | 33.2 | 43.5 | 1.7 | 2.5 | 3.4 | No | 2 |
| TZTN | 15-May-11 | 36.5439 | -83.549 | -6.1 | 154.4 | 40 | 285.2 | 119.1 | SKKS | 23.3 | 31.2 | 49.6 | 1.2 | 2.4 | 3.9 | No | 2 |
| TZTN | 16-Jun-11 | 36.5439 | -83.549 | -5.9 | 151 | 16 | 287.8 | 121.6 | SKS | 33.4 | 37.8 | 43.5 | 1.7 | 2.1 | 2.8 | No | 2 |
| TZTN | 16-Jun-11 | 36.5439 | -83.549 | -5.9 | 151 | 16 | 287.8 | 121.6 | SKKS | 25.3 | 31.8 | 53.6 | 1 | 2.2 | 3.6 | No | 2 |
| TZTN | 9-Jul-11 | 36.5439 | -83.549 | -29.4 | -177.1 | 19 | 247.4 | 109.6 | SKS | -23.3 | -18.6 | -17.2 | 1.8 | 4 | 4 | Yes | 2 |
| TZTN | 9-Jul-11 | 36.5439 | -83.549 | -29.4 | -177.1 | 19 | 247.4 | 109.6 | SKKS | -25.3 | -18.6 | -15.2 | 1.1 | 4 | 4 | Yes | 2 |
| TZTN | 9-Jul-11 | 36.5439 | -83.549 | -29.4 | -177 | 15 | 247.3 | 109.6 | SKS | -23.3 | -18.7 | -15.2 | 1.1 | 4 | 4 | Yes | 2 |
| TZTN | 9-Jul-11 | 36.5439 | -83.549 | -29.4 | -177 | 15 | 247.3 | 109.6 | SKKS | -Inf | -18.7 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 5-Aug-11 | 36.5439 | -83.549 | -30 | -176.7 | 10 | 246.7 | 109.6 | SKS | -Inf | -21.3 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 5-Aug-11 | 36.5439 | -83.549 | -30 | -176.7 | 10 | 246.7 | 109.6 | SKKS | -23.3 | -17.3 | 29.3 | 0.3 | 3.5 | 4 | Yes | 2 |
| TZTN | 22-Aug-11 | 36.5439 | -83.549 | -29 | -176.7 | 10 | 247.5 | 109.1 | SKS | -25.3 | -18.5 | 47.5 | 0.2 | 3.6 | 4 | Yes | 2 |
| TZTN | 22-Aug-11 | 36.5439 | -83.549 | -29 | -176.7 | 10 | 247.5 | 109.1 | SKKS | 69.8 | 71.5 | 73.8 | 1.7 | 3.2 | 4 | Yes | 2 |
| TZTN | 3-Sep-11 | 36.5439 | -83.549 | -20.7 | 169.7 | 185 | 262.2 | 115.3 | SKS | -Inf | -5.8 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 3-Sep-11 | 36.5439 | -83.549 | -20.7 | 169.7 | 185 | 262.2 | 115.3 | SKKS | -Inf | 84.2 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 14-Mar-12 | 36.5439 | -83.549 | -5.6 | 151 | 28 | 288.1 | 121.4 | SKS | 23.3 | 28.1 | 33.4 | 3 | 4 | 4 | No | 2 |
| TZTN | 14-Mar-12 | 36.5439 | -83.549 | -5.6 | 151 | 28 | 288.1 | 121.4 | SKKS | 31.3 | 52.1 | 86 | 1 | 2 | 3.6 | No | 2 |
| TZTN | 17-Apr-12 | 36.5439 | -83.549 | -59 | -16.6 | 12 | 149.6 | 110.4 | SKS | -33.4 | -26.4 | -27.3 | 2.7 | 4 | 4 | Yes | 2 |
| TZTN | 17-Apr-12 | 36.5439 | -83.549 | -59 | -16.6 | 12 | 149.6 | 110.4 | SKKS | -69.8 | -32.4 | -29.3 | 0.2 | 1.8 | 4 | Yes | 2 |
| TZTN | 11-Sep-12 | 36.5439 | -83.549 | 11.8 | 143.2 | 8 | 308.3 | 114.6 | SKS | -Inf | 36.3 | Inf | 0 | 4 | Inf | Yes | 2 |
| TZTN | 11-Sep-12 | 36.5439 | -83.549 | 11.8 | 143.2 | 8 | 308.3 | 114.6 | SKKS | -63.7 | -57.7 | -55.6 | 1.6 | 4 | 4 | Yes | 2 |
| TZTN | 15-Jun-13 | 36.5439 | -83.549 | -33.9 | 179.4 | 195 | 244.9 | 114.4 | SKS | -23.3 | -19.1 | -19.2 | 2.3 | 3.5 | 4 | Yes | 2 |
| TZTN | 15-Jun-13 | 36.5439 | -83.549 | -33.9 | 179.4 | 195 | 244.9 | 114.4 | SKKS | -25.3 | -21.1 | -19.2 | 2.8 | 4 | 4 | Yes | 2 |
| TZTN | 21-Jul-13 | 36.5439 | -83.549 | -41.7 | 174.4 | 14 | 238.8 | 121.4 | SKS | -31.3 | -27.2 | -25.3 | 2.7 | 4 | 4 | Yes | 2 |
| TZTN | 21-Jul-13 | 36.5439 | -83.549 | -41.7 | 174.4 | 14 | 238.8 | 121.4 | SKKS | 63.7 | 64.8 | 67.8 | 2.8 | 3.9 | 4 | Yes | 2 |
| TZTN | 30-Sep-13 | 36.5439 | -83.549 | -30.9 | -178.3 | 42 | 246.6 | 111.3 | SKS | -23.3 | -19.4 | -17.2 | 1.2 | 3.5 | 4 | Yes | 2 |
| TZTN | 30-Sep-13 | 36.5439 | -83.549 | -30.9 | -178.3 | 42 | 246.6 | 111.3 | SKKS | 65.7 | 68.6 | 73.8 | 1.6 | 4 | 4 | Yes | 2 |
| TZTN | 11-Oct-13 | 36.5439 | -83.549 | -30.7 | -178.5 | 151 | 246.9 | 111.3 | SKS | -23.3 | -17.1 | -15.2 | 2.2 | 4 | 4 | Yes | 2 |
| TZTN | 11-Oct-13 | 36.5439 | -83.549 | -30.7 | -178.5 | 151 | 246.9 | 111.3 | SKKS | -Inf | -19.1 | Inf | 0 | 4 | Inf | Yes | 2 |

The data table below shows all the measurements taken in the study. The first column shows the station code of the site. The second column shows the date and year of the event. The third and fourth columns show the site latitude and longitude respectively. The fourth and fifth column show the event latitude and longitude respectively. The sixth column shows the depth of the earthquake in kilometers. The seventh column shows the back azimuth of the event in degrees. The eighth column shows the epicentral distance in degrees. The ninth column shows if the measurement was in the SKS phase or the SKKS phase. The tenth, eleventh, and twelfth columns show the error range and median measurement in degrees of the directions. The next three columns show the error range and median measurement of the delay times in seconds. The second to last column shows if the measurement is null or not. The final column shows if the pair of measurements (SKS-SKKS) is discrepant or not