Highlights on mantle deformation beneath the Western Alps with seismic anisotropy using CIFALPS2 data

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Abstract. There are still open questions about the deep structure beneath the Western Alps. Seismic velocity tomographies show the European slab subducting beneath the Adria plate, but all these images did not clarify completely the possible presence of tears, slab windows, or detachments. Seismic anisotropy, considered as an indicator of mantle deformation and studied using data recorded by dense networks, allows a better understanding of mantle flows in terms of location and orientation at depth. Using the large amount of shear wave splitting and splitting intensity measurements available in the Western Alps, collected through the CIFALPS2 temporary seismic network, together with already available data, some new patterns can be highlighted and gaps left by previous studies can be filled. Instead of the typical seismic anisotropy pattern parallel to the entire arc of the Western Alps, this study supports the presence of a differential contribution along the belt, only partly related to the European slab steepening. A nearly NS anisotropy pattern beneath the external Western Alps, a direction that cuts the morphological features of the belt, is clearly found with the new CIFALPS2 measurements. It is however confirmed that the asthenospheric flow from Central France towards~~about the possible presence of tears, slab windows or detachments. Seismic anisotropy, addressed as an indicator of mantle deformation and studied using data recorded by dense networks, may shed some light about the location and orientation of mantle flow at depth. Using the large amount of shear wave splitting and splitting intensity measurements available in the Western Alps, collected through the CIFALPS2 temporary seismic network, together with already available data, highlight some new patterns, filling the gaps left by previous studies. Instead of the typical seismic anisotropy pattern parallel to the entire arc of the Western Alps, this study supports the presence of a differential contribution along the belt, only partly related to the European slab retreat. A nearly NS anisotropy pattern beneath the external Alps, direction that cuts the morphological features of the belt, is clearly~~

found with the new CIFALPS2 measurements. It is however confirmed that the asthenospheric flow from Central France toward the Tyrrhenian Sea, is turning around the southern tip of the European slab.

1 Introduction

Seismic anisotropy has become a convincing study tool, mainly in the areas where recent and past geodynamic evolution have left their marks in the mantle deformation and its patterns (e.g. Long and Silver, 2009; Long, 2013 for a complete review). Several methods exist to measure seismic anisotropy. Depending on the used seismic phase, signal, and frequency, it is possible to measure seismic anisotropy at different depths and relate it to different parts of the Earth's structure, last but not least with seismic anisotropy tomography (e.g. Zhao et al., 2023). Local seismicity and surface waves are used to measure crustal seismic anisotropy, usually attributed to fractures or/and the state of stress of crustal depths (i.e. Crampin and Peacock, 2008; Okaya et al., 2018). Using seismic signals that travel deeper, it is possible to sample the deformation at lithospheric-asthenospheric depths. For instance, Pn phases record the seismic anisotropy immediately below the Moho in the lithospheric mantle (i.e. Diaz et al., 2013). On the other hand, using core phases (SKS, SKKS, etc) that record information on the receiver branch of their path, we can sampl~~areas where recent and past geodynamic evolution have left their marks in the mantle deformation and its patterns (e.g. Long and Silver, 2009; Long, 2013 for a complete review). Several methods exist to measure seismic anisotropy. Depending on the used seismic phase, the kind of signal and frequency, it is possible to measure seismic anisotropy at different depths and relate it to different parts of the Earth's structure, last but not least with seismic anisotropy tomography (e.g. Zhao et al., 2023). Local seismicity and surface waves are used to measure crustal seismic anisotropy, usually attributed to fractures or/and the state of stress of crustal depths (i.e. Crampin and Peacock, 2008; Okaya et al., 2018). Using seismic signals that travel deeper, it is possible to sample the deformation at the lithospheric-asthenospheric depths. For instance, Pn phases record the seismic anisotropy immediately below the Moho in the lithospheric mantle (i.e. Diaz et al., 2013). On the other hand, using core phases (SKS, SKKS, etc) that record information on the receiver branch of their path, we can sample th~~e seismic anisotropy that is thought to be mainly concentrated in the upper mantle.

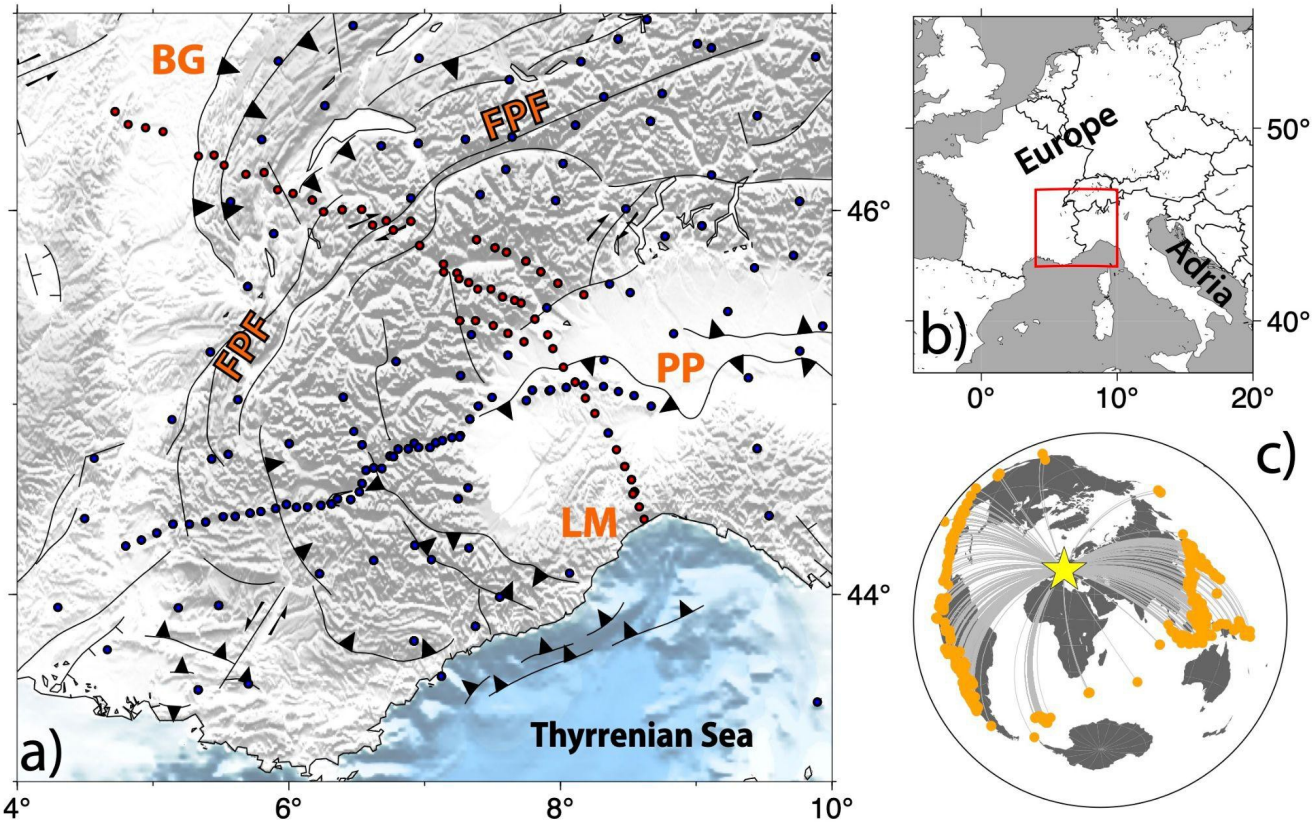

Figure 1 - a) Map of the study region, focusing on the Western Alps. In red are indicated the CIFALPS2 stations, while in blue are permanent and previous temporary stations (i.e. CIFALPS and AlpArray). FPF = Frontal Pennine Fault, BG = Bresse Graben, PP = Po Plain, LM = Ligurian Mountains; b) the red square is the study area reported in a); c) map of all seismic events used in this study, with the star centered in the study region.

The azimuth of the fast velocity direction and the delay time, the two parameters that commonly result from shear wave splitting analysis of core phases, are interpreted respectively as the direction assumed by olivine crystals, the principal mineral component of the upper mantle when mantle undergoes deformation, and the amount of anisotropy crossed by a seismic ray. ~~Azimuth of the fast velocity direction and delay time, the two parameters that commonly result from shear wave splitting analysis of core phases, are interpreted respectively as the direction assumed by olivine crystals, the principal mineral component of the upper mantle, when mantle undergoes deformation, and the amount of anisotropy crossed by a seismic ray.~~

In the Alps these kinds of measurements improved immensely with recent temporary experiments such as AlpArray (Hetényi et al., 2018) or CIFALPS and CIFALPS2 in the western sector of the chain (Zhao et al., 2015; 2016: 2018), which complemented the permanent seismic networks operating in the region.

The European Alps originated in the late Cretaceous from the oblique subduction of the Alpine Tethys under the Adria microplate. The subduction evolved in a continental collision during the late Cenozoic (e.g., Handy et al., 2010, 2013 and references therein). In the Western Alps, the tectonic lineament that worked as the suture accommodating the shortening between the two plates is the Frontal Penninc Fault (FPF, Fig. 1). Even though the geological history of this belt is one of the best studied and well known in the world, the geodynamic evolution of the European slab, in terms of position and possible presence of slab break off, is still poorly understood~~Figure 1 - a) Map of the study region, focusing on the Western Alps. In red are indicated the CIFALPS2 stations, while in blue are permanent and previous temporary stations (i.e. CIFALPS and AlpArray). FPF = Frontal Pennine Fault; b) the red square is the study area reported in a); c) map of all seismic events used in this study, with the star centered in the study region~~.

All travel time tomographic studies identified at mantle depth the presence of seismic velocity heterogeneities interpreted as the European slab subducting beneath the Adria plate (e.g. Piromallo and Morelli, 2003; Lippitsch et al., 2003; Kissling et al., 2006; Giacomuzzi et al., 2011; Paffrath et al., 2021; Rappisi et al., 2022). However, the existence of possible slab detachments, windows or tears is debated, for instance beneath the Western Alps (e.g., Zhao et al., 2016). The first CIFALPS experiment (see Malusà et al., 2021 and references therein) clarified several points, starting from the first seismic evidence of subducted European continental lithosphere beneath the Adria lithosphere (Zhao et al., 2015), to a tomographic model with a continuous slab beneath this region (Zhao et al., 2016). In addition, recent seismic anisotropy analyses of the Western to the Central Alps shed additional light on potential discontinuities of the slabs, thanks to the possible mapping of mantle flows that would occur through them (Petrescu et al., 2020; Salimbeni et al., 2018).

The additional contribution of CIFALPS2, a temporary experiment deployed for 14 months from 2018 to 2019 (Zhao et al., 2018), on mantle seismic anisotropy mapping and interpretation, was expected to fill a gap in the northwestern part of the Alpine arc (red dots in Figure 1). Receiver function and ambient-noise tomography studies have underlined the north-south differences in the lithospheric structure along the belt strike (Paul et al., 2022). Therefore, there is a need for measuring additional seismic anisotropy in the mantle from CIFALPS2 data and to compare them to previous results.

~~In the Alps these kinds of measurements had a large improvement with recent temporary experiments such as AlpArray (Hetényi et al., 2018) or CIFALPS and CIFALPS2 in the western sector of the chain (Zhao et al., 2015; 2016; 2018), that complemented the permanent seismic networks operating in the region. The main interest in the Alps is related to the still open questions concerning the deep structure and geodynamic evolution of this orogenic belt.~~

~~All travel time tomographic studies identified the presence at mantle depth of seismic velocity heterogeneities interpreted as the European slab subducting beneath the Adria plate (e.g. Piromallo and Morelli, 2003; Lippitsch et al., 2003; Kissling et al., 2006; Giacomuzzi et al., 2011; Paffrath et al., 2021; Rappisi et al., 2022). However, the existence of possible slab detachments, windows or tears is still debated, for instance beneath the Western Alps (e.g., Zhao et al., 2016). The first CIFALPS experiment (see Malusà et al., 2021 and references therein) clarified several points, starting from the first seismic evidence of subducted European continental lithosphere beneath the Adria lithosphere (Zhao et al., 2015) to a tomographic model with a continuous slab beneath this region (Zhao et al., 2016). In addition, recent seismic anisotropy analyses of the Western to the Central Alps shed additional light on potential discontinuities of the slabs, thanks to the possible mapping of mantle flows that would occur through them (Petrescu et al., 2020; Salimbeni et al., 2018).~~

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In this study, we present the results of the analysis of data recorded by CIFALPS2, ~~-~~describing them in an integrated view with previous shear wave splitting measurements (SWS) to identify new features in the mantle and draw hypotheses on their origin.

2 Data and Methods

Data used for the analysis are the recordings at CIFALPS2 stations (Figure 1; Zhao et al., 2018; doi: 10.15778/RESIF.XT2018) of teleseismic earthquakes with a magnitude M>6.0, that occurred between June 2018 and December 2019 and are located at a distance interval from the network between 88° and 120°, typical to guarantee well isolated SKS phases in the waveforms. 80 to 150 events for each of the 56 temporary stations have been analyz~~located at a distance interval from the network between 88° and 120°, typical to guarantee well isolated SKS phases in the waveforms. 80 to 150 events for each of the 56 temporary stations have been select~~ed (Figure 1).

The entire SWS analysis has been conducted using the code SplitRacer (Reiss and Rümpker, 2017), based on the Silver and Chan (1991) method and thus on the minimization of the energy on the transverse component. Different filters have been applied according to the amount of noise at the various sites. For most of them, located in the Alps or Ligurian mountains, a bandpass filter between 7 and 20 s worked well, while for instance sites in the Po Plain needed different choices, i.e. 5-30 s. The signal to noise ratio (SNR) was also used to avoid noisy waveforms; initially, the threshold was 3, but where the amount of events to be analyzed was scarce we decreased it down to 1.5, again mainly for sites located in or close to the Po Plain. It is worth noticing that SWS analysis recovers fast-velocity directions, assuming a single layer of horizontal anisotropy. Moreover, the depth at which this anisotropy is located is difficult to define, ~~that a single layer is anisotropic, and characterized by horizontal anisotropy. Moreover, the depth at which this anisotropy is located is difficult to define~~ but it is classically assumed that most measured anisotropy is in the upper mantle (Savage, 1999). Thus, it is common to visualize any lateral variation by plotting results at the piercing point of the incident ray at 150 km depth (Figure 2a).

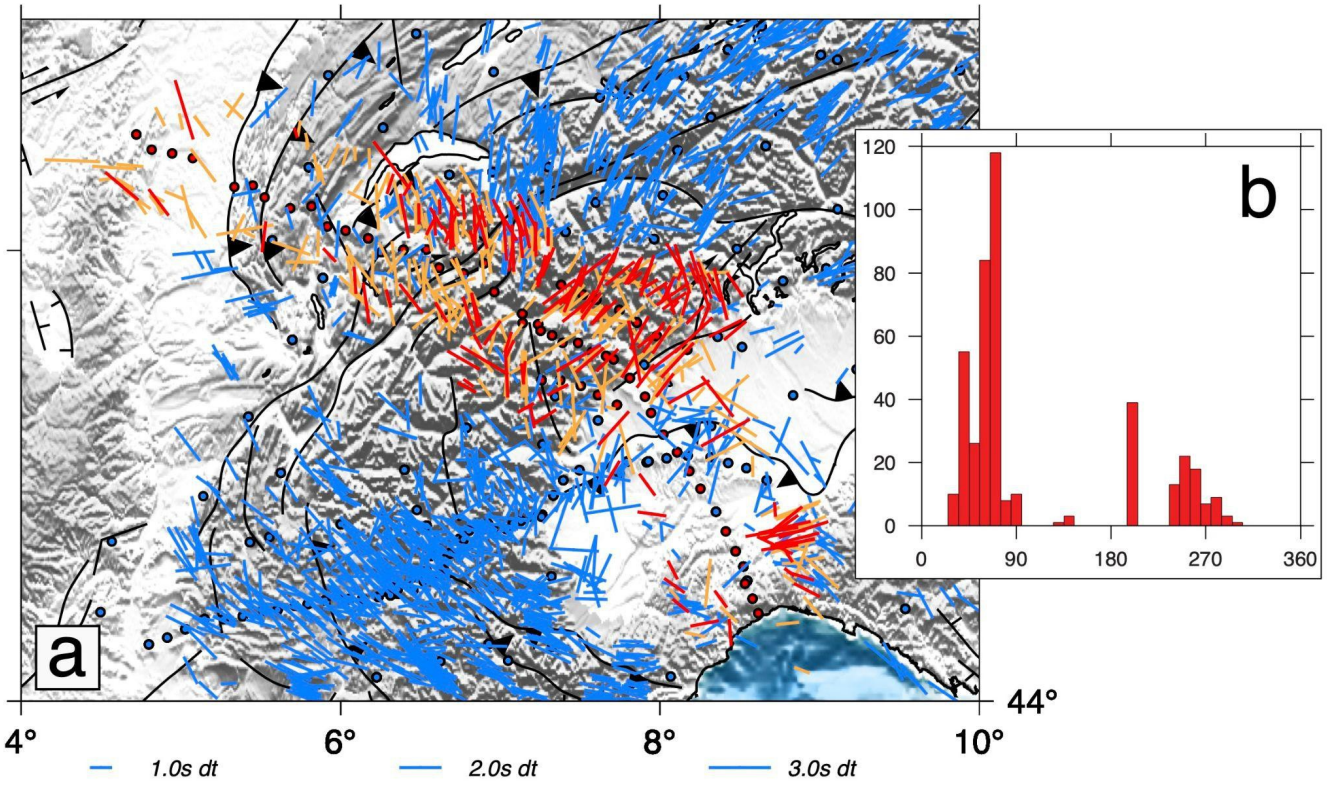

Figure 2 - a) Map of single SWS measurements for the study region, plotted at the location of the piercing point of the ray at 150 km depth. In red and orange are good and fair measurements from CIFALPS2 stations (red circles) respectively. In the background, in light blue, previous SWS measurements and stations; b) histogram of back azimuths of events used in the analysis.

To improve the resolution of the data to be discussed and interpreted, splitting intensity (SI) measurements have been performed on the same CIFALPS2 recordings used for SWS measures (Table

S2 in Supplementary Material). Splitting intensity is measured by projecting the transverse component on the radial component derivative; it is related to the variations of the amplitude of the transverse component with the back azimuth (Chevrot, 2000; Monteiller and Chevrot, 2010). A routine based on Kong et al. (2015) and Confal et al. (2023) was used to calculate splitting intensity values from waveforms with a cut-off of 15 s before and 30 s after the supposed SKS arrival. A dominant period of 12 s is used for the Wiener filtering. To filter out low quality waveforms in this automatic process a cross-correlation coefficient of |0.7| and splitting intensities values and error threshold of |2.0| and 0.5 respectively were used (Baccheschi et al., under revision). With splitting measurements from at least four different 10° bins of back azimuths, the classical evaluation of the anisotropy parameters, i.e. the azimuth of the fast direction phi and the delay time dt, is obtained by fitting a sinusoid to the back azimuthal dependence of splitting intensity values (Chevrot, 2000). In particular, the sinusoid amplitude and phase give dt and phi respectively (see Figure S1 in Supplementary M~~1 in Supplementary Material). Splitting intensity is measured by projecting the transverse component on the radial component derivative; it is related to the variations of the amplitude of the transverse component with the back azimuth (Chevrot, 2000; Monteiller and Chevrot, 2010). A routine based on Kong et al. (2015) and Confal et al. (2023) was used to calculate splitting intensity values from the waveform with a cut-off of 15 s before and 30 s after the supposed SKS arrival. A dominant period of 12 s is used for the Wiener filtering. To filter out low quality waveforms in this automatic process a cross-correlation coefficient of |0.7| and splitting intensities values and error threshold of |2.0| and 0.5 respectively were used (Baccheschi et al., under revision). With splitting measurements from at least four different 10° bins of back azimuths, the classical evaluation of the anisotropy parameters, i.e. the azimuth of the fast direction phi and the delay time dt, is obtained by fitting a sinusoid to the back azimuthal dependence of splitting intensity values (Chevrot, 2000). In particular, the sinusoid amplitude and phase give dt and phi respectively (see Figure S2 in supplementary m~~aterial as an example).

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3 Shear wave splitting results

From SWS analysis we obtained more than 400 pairs of splitting parameters (phi and dt) if we consider together good (170) and fair (241) results (Figure 2a, good in red, fair in orange; all results are available at https://osf.io/nqxk4, Pondrelli et al., 2023). The quality assignment is given following the SplitRacer criteria (Reiss and Rümpker, 2017), considering the visibility of the phase, the ellipticity of the initial particle motion and its linearity in the final stage, and the errors associated with phi and dt values. In Figure S2 of the Supplementary Material some measurement examples are shown. In addition, nearly 600 null measurements have been obtained (Figure S3 in Supplementary Material), where a null is considered when no split appears in the signal (i.e. no energy in the transversal component). This is due either to the absence of anisotropy or to the initial polarization being parallel to the fast or slow anisotropic direction. A high percentage of good and fair results were obtained for events with a NE back azimuth, so it should be taken into account that this direction is oversampled (Figure 2b).~~fast polarization direction phi and delay time dt) if we consider together good and fair results (Figure 2a, good in red, fair in orange; all results are available at https://osf.io/nqxk4, Pondrelli et al., 2023). The quality assignment is given following the SplitRacer criteria (Reiss and Rümpker, 2017), considering the visibility of the phase, the ellipticity of the initial particle motion and its linearity in the final stage, and the errors associated with phi and dt values.~~

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This new dataset fills the region between the north-western external Alps and the Ligurian Sea. The anisotropy directions of no-nulls and nulls mostly agree with previous measurements (Figures 2 and 3, Figure S3 in Suppl. Material). Along the part of the transect crossing the Alps (transect AA' in Figure 3), NE-SW direction dominates in the internal part of the belt, between the FPF and the boundary of the Po Plain (see average values, red dots in Figure 3). In the western part of the AA' transect, measurements are more scattered, with a coexistence of NE-SW and NS to NNE-SSW directions. In the outer part of the Alpine belt and in the Bresse Graben, the prevailing directions are NS to NNE-SSW. Anisotropy in this region is weaker, but fast velocity directions remain constant toward the NW end of the transect, confirmed also by null measurements (Fig.S3 in Supplementary Material). These two patterns, one NE-SW parallel to the Alps strike and the other nearly NS, and their location along the transect are well visible in Figure 3, mainly following average values (reddish dots)~~mostly agree with previous measurements (Figures 2 and 3). Along the part of the transect crossing~~

the Alps (transect AB in Figure 3), NE-SW direction dominates in the internal part of the belt, between the Frontal Penninic Fault (FPF) and the western boundary of the Po Plain. In the western part of the transect, measurements are more scattered, with a coexistence of NE-SW and NS to NNE-SSW directions. In the outer part of the Alpine belt and in the Bresse Graben, NW of the FPF, the prevailing directions are NS to NNE-SSW. Anisotropy in this region is weak, but fast velocity directions remain constant toward the NW end of the transect.These two patterns, one NE-SW parallel to the Alps strike and the other nearly NS, and their location along the transect are well visible in Figure 3, mainly following average values of transect AB.

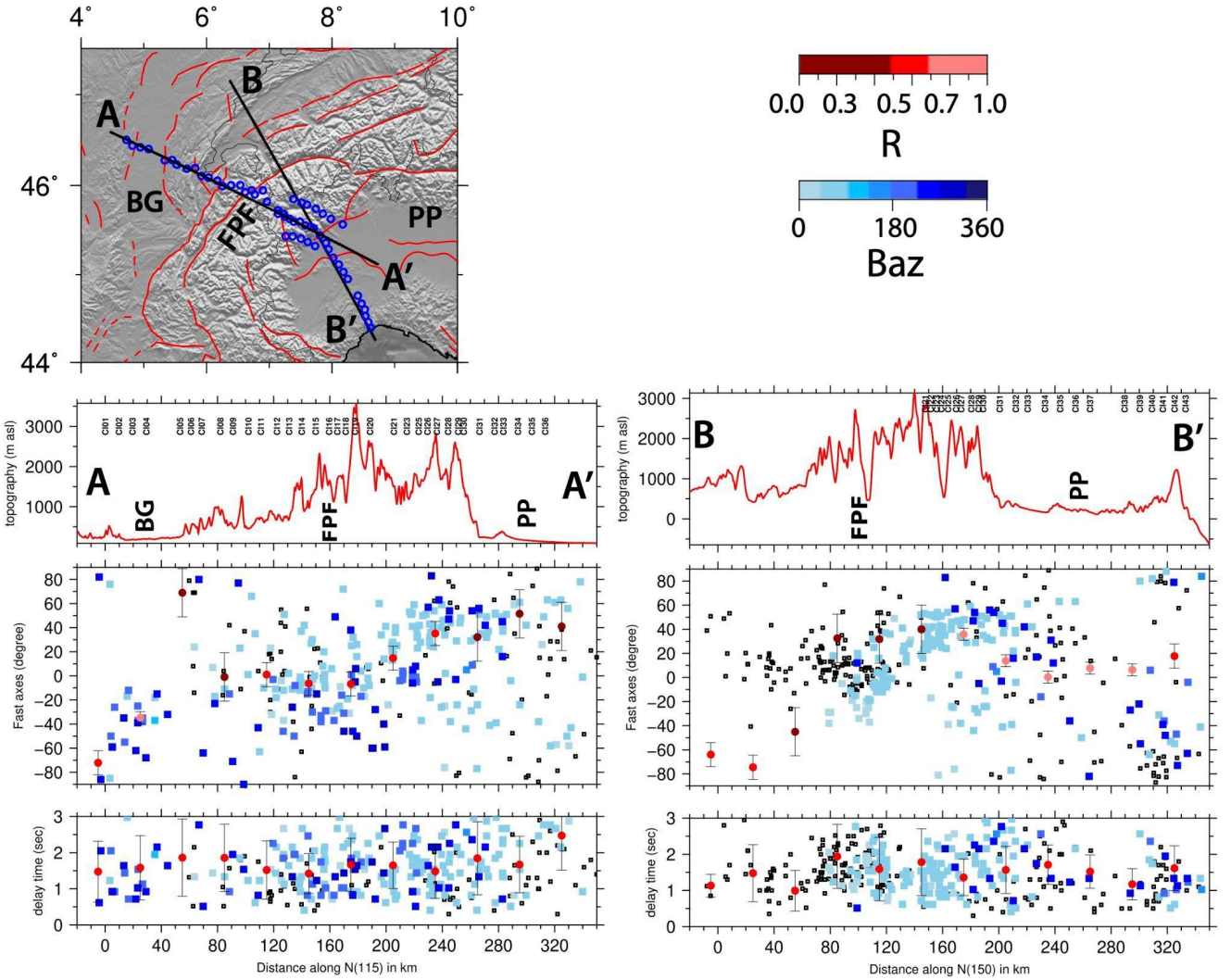

Figure 3 - Distribution of splitting parameters along the two sections of the CIFALPS2 region. For each section topography (upper), fast axes direction (middle) and delay time (lower) distributions along a swath box of 30 km are displayed. In the fast axes and delay time panels, every single measurement is represented by a square; the results of CIFALPS2 are blueish and color coded in agreement with the back azimuth of the events analyzed, while the results of previous works are represented by smaller empty squares. In the fast axes panel, circles represent the average values calculated using a basic circular arithmetic mean inside the swath box with 30-km-step increment; they are coloured in agreement with the spreading distribution around the mean value (R=0 distribution completely scattered, R=1 distribution completely aligned with the mean direction). In the delay time panels, red dots are the average value and its error, calculated with arithmetic mean and standard deviation. FPF = Frontal Penninic Fault; BG = Bresse Graben; PP = Po Plain.

In the Po Plain, measurements appear scattered, similar to previous studies (e.g. Salimbeni et al., 2018; Petrescu et al., 2020; Figures 2 and 3). In the transition between the belt and the plain, the typical NE-

SW Alpine direction prevails. Even if measurements are scarce, this direction appears also in the center of the Po Plain, together with a few NW-SE directions located southeast, close to the Ligurian Alps. However section BB' in Figure 3 shows that anisotropy directions are diverse, resulting in a strong dispersion of average values computed along the section. In the Ligurian part of the transect, several directions are detected, ENE-SSW and NW-SE (Apenninic) on the eastern side with a few weaker (lower dt) NNE-SSW measurements in the western side. ~~Apenninic directions located southeast, close to Ligurian Alps. However section CD in Figure 3 shows that anisotropy directions are diverse, resulting in a strong dispersion of average values computed along the section (dark green symbols, i.e. low R).~~

In general, we do not find any particular pattern in the delay time measurements. Average values computed along the sections (Figure 3) are mostly constant, around 1.5 s with a large range in single measurement values.

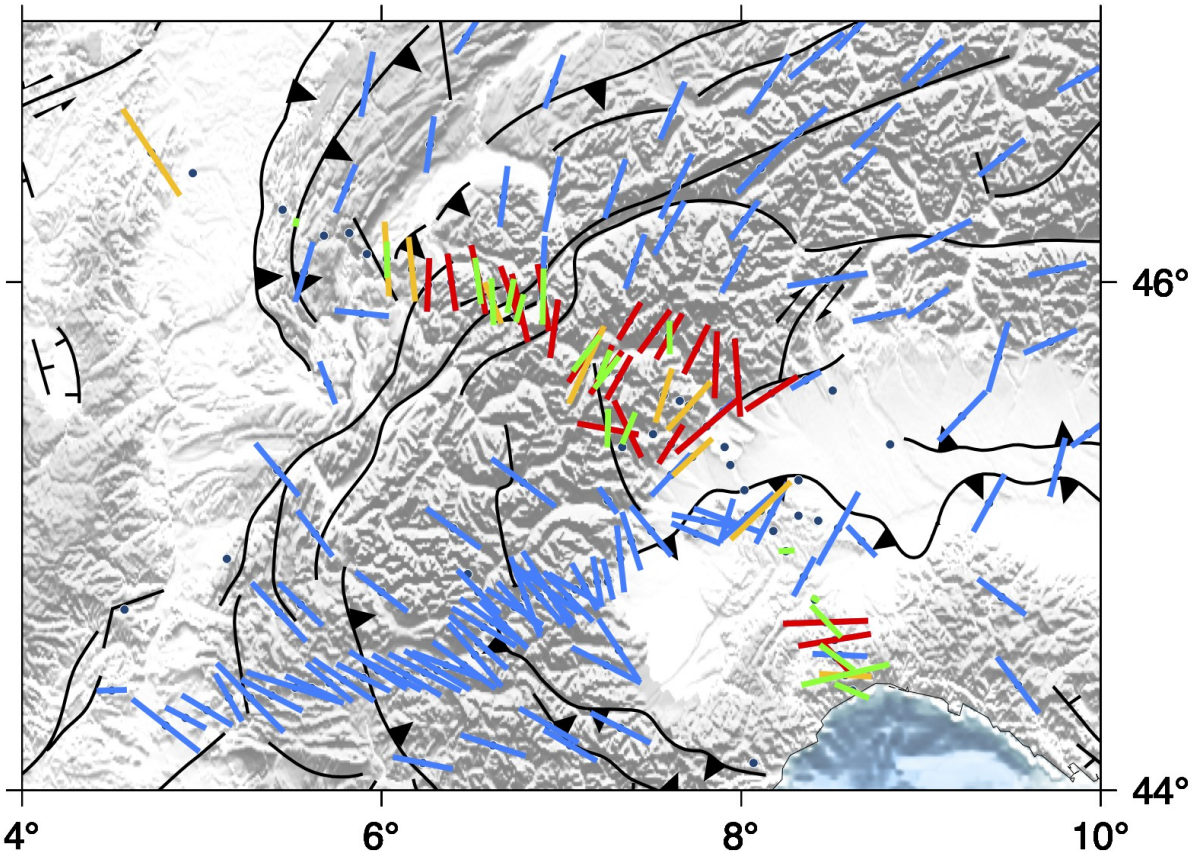

Figure 4 - Maps of average SWS measurements (red, yellow and blue) and anisotropy parameters obtained using SI measurements (green). In red average values for CIFALPS2 stations obtained with more than 3 measurements, in yellow averages obtained with less than 3 values; in light blue, average measurements from previous works. Dots represent stations.

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In Figure 4, average SWS values for each station are mapped together with anisotropy values obtained by splitting intensity (SI) measurements (Table S1 in Supplementary Material). The first observation is that average SWS and SI data are very similar, mainly at sites where the single measurement results are more homogeneous, while differences are present where back azimuthal variations in fast direction are more evident, for instance in the southernmost part of the transect, in the Ligurian Mountains~~Figure 3 - Distribution of splitting parameters along the two sections of the~~

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In general, it is clear that CIFALPS2 results are coherent with the average distribution of the anisotropy from previous measurements. The main Alpine pattern that follows the belt arc, here NE-SW, is represented in most of the averaged values for sites located in the transition between the Po Plain and the FPF. From the FPF to the NW endpoint of the transect, the main direction is close to NS, a direction that does not find an agreement with the orogen trend, still NE-SW.Figure 4, average SWS values for each station are mapped together with anisotropy values obtained by splitting intensity (SI) measurements (Table S2 in Supplementary Material). The first observation is that average SWS and SI data are very similar, mainly at sites where the results are more homogeneous, while differences are present where detections at the east and the west of the transect are more evident, for instance in the southernmost part of the transect, close to the Ligurian Sea. In general, it is clear that CIFALPS2 results are coherent with the average distribution of the anisotropy from previous measurements. The main Alpine pattern that follows the belt arc, here NE-SW, is represented in most of the averaged values for sites in the transition between the Po

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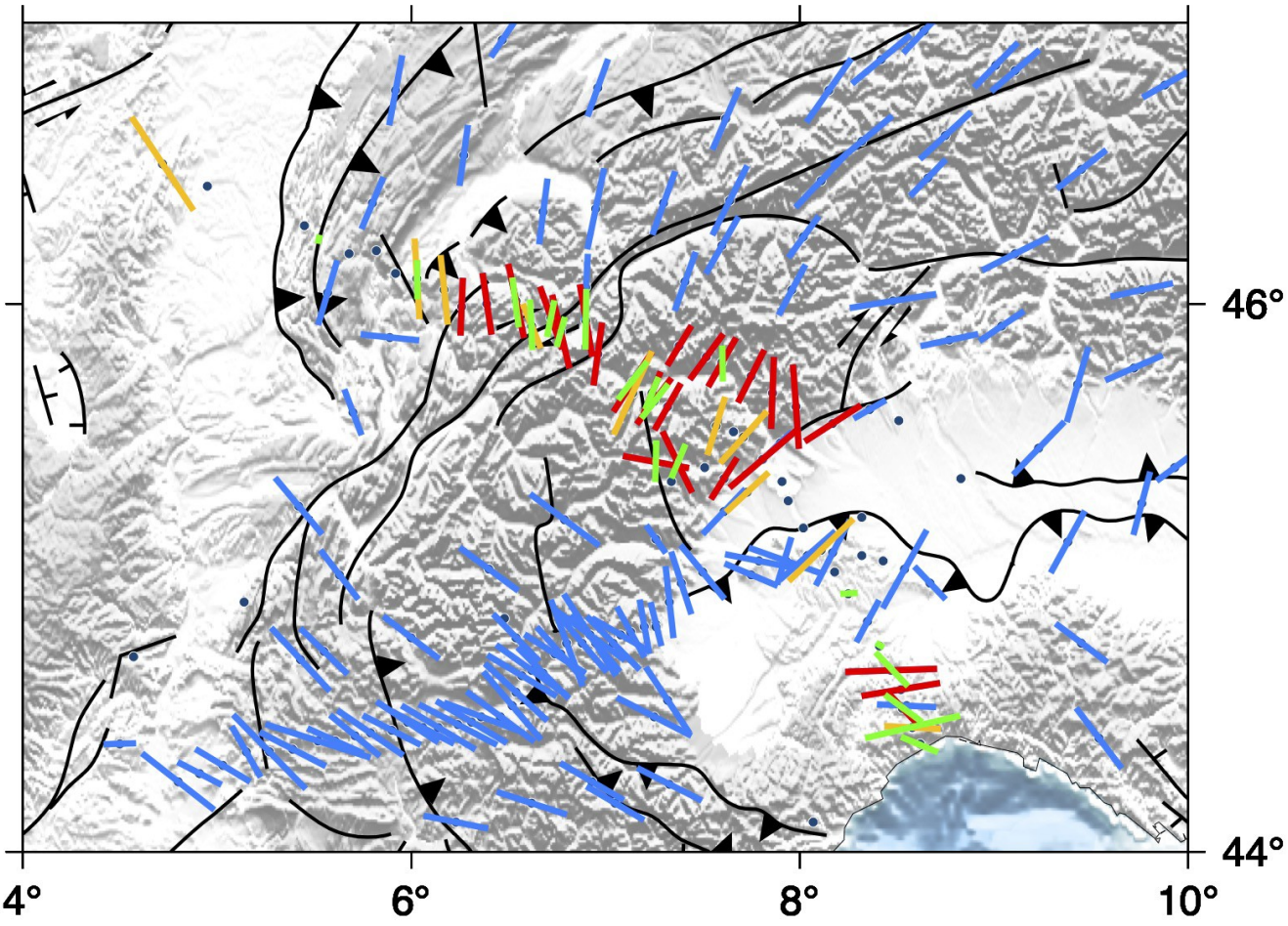
46°
44°
4°
6°
8°
10°

In order to extract as much information as possible, we split the dataset into groups according to the main morphological features: a) External zone to the west of the FPF; b) Internal zone between the FPF and the western boundary of the Po plain, c) the Po Plain, and d) the Ligurian Alps. By plotting a rose diagram for all good and fair measurements obtained for the stations of each group, taking into account the influence of back azimuths, we get an overview of the main features and lateral changes of the anisotropy detected through these SWS measurements.

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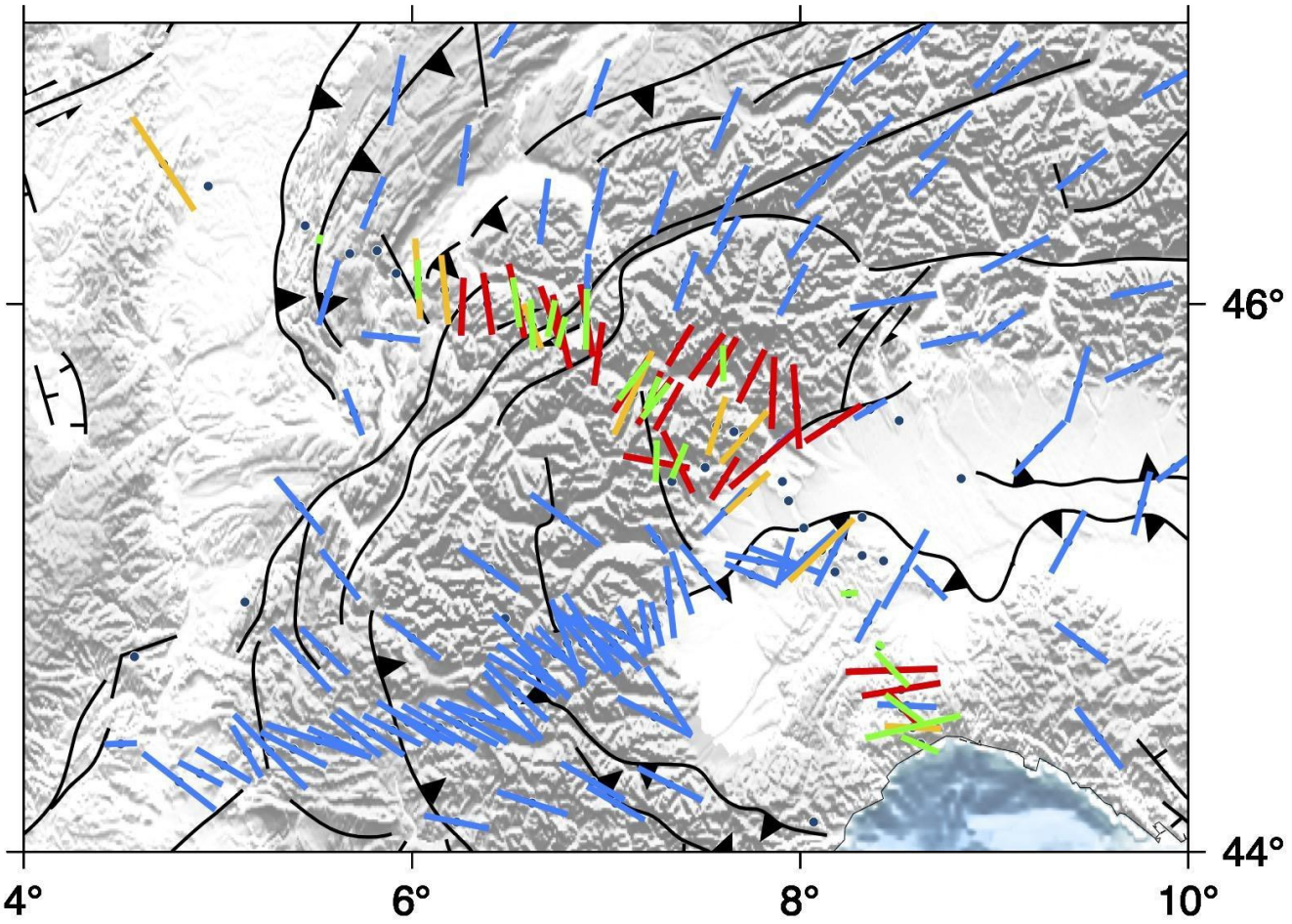
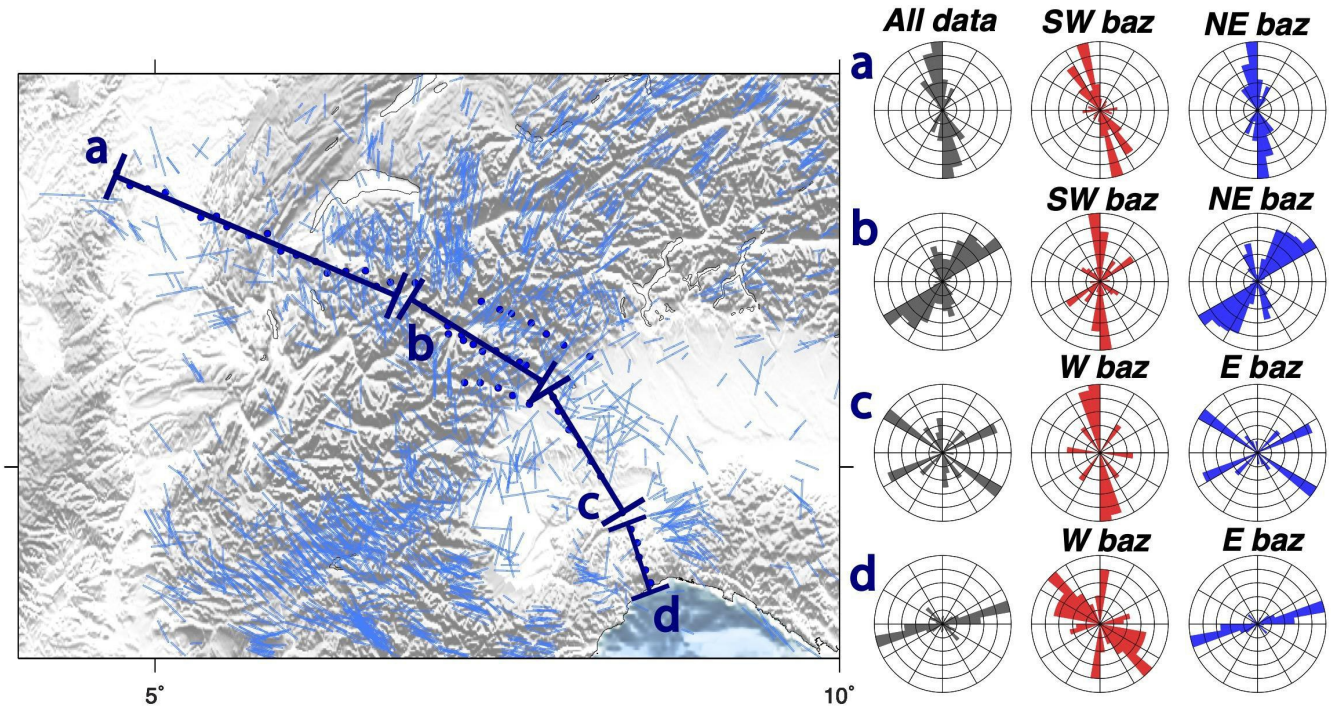


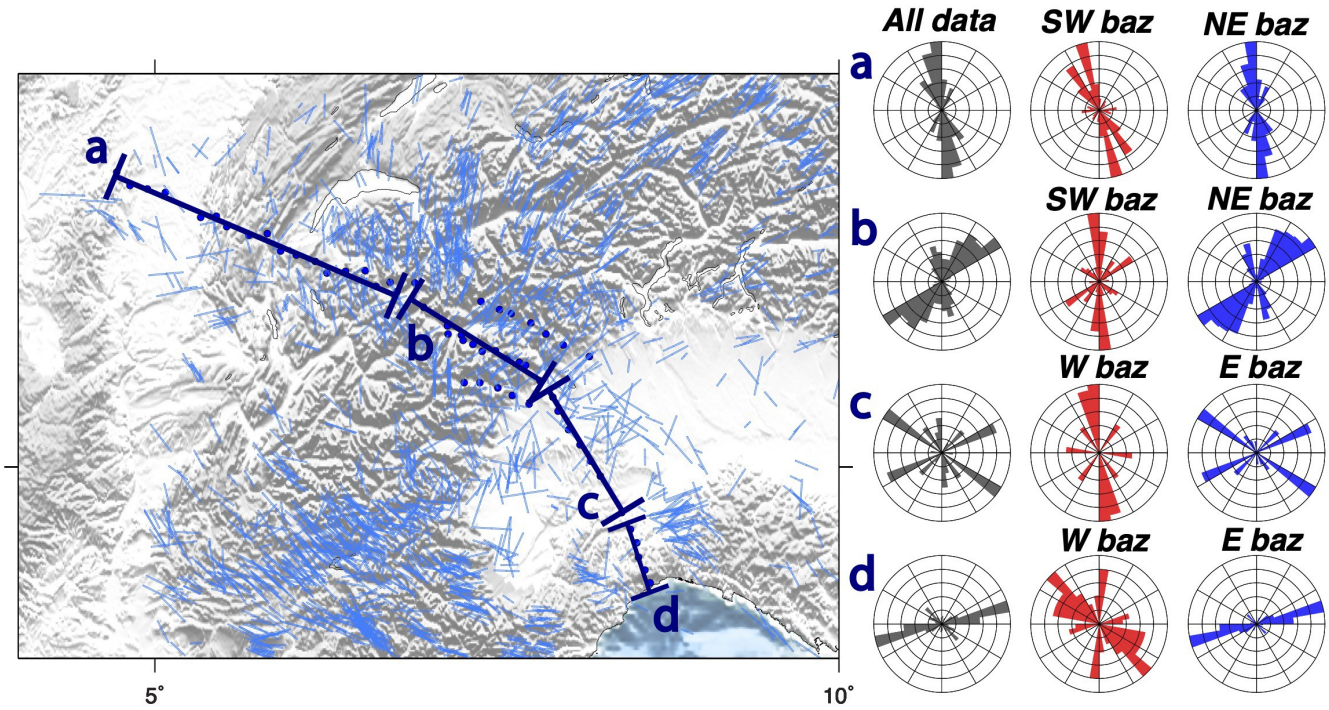
In Figure 5, the rose diagrams show evident differences along the CIFALPS2 transect, somewhere underlined by different patterns with respect to back azimuths. Only in group a), in the External zone, the N-S dominant direction remains, regardless of the amount of measurements or separation into opposite back azimuths (red and blue rose diagrams). For all other groups, there is a clear difference depending on the back azimuth. In group b) the entire dataset shows a main trend in a NE-SW direction, in agreement with the Alps strike in this region; the same direction is observed for events coming from NE (blue rose diagram). On the contrary, measurements obtained from events with a SW back azimuth are dominated by a nearly NS direction, quite similar to that shown by group a). The entire dataset for the Po Plain (c) and the subgroup with east back azimuths show a clear bimodal distribution, with both the Alpine NE-SW and the Apenninic NW-SE typical directions; west back azimuth events show instead N to NNW directions, very similar to those obtained in previous work at the first CIFALPS transect (e.g. Salimbeni et al., 2018) and again similar to group a) and SW back azimuth measurements of group b). In the Ligurian Alps, in the group d), opposite back azimuths show different results. It is worth noticing that in the group d) the ENE-WSW direction is dominant both in the all data plot and in the east back azimuth plot, while the west back azimuth plot shows a wide dispersion with a NW-SE direction prevailing. ~~order to extract as much information as possible, we split the dataset into groups according to the main morphological features: a) External zone to the west of the FPF; b) Internal zone between the FPF and the western boundary of the Po plain, c) the Po Plain part and d) the Ligurian Alps. By plotting a rose diagram for all good and fair measurements obtained for the stations of each group, taking into account the influence of back azimuths, we get an overview of the main features and lateral changes of the anisotropy detected through these SWS measurements.~~

Figure 5 - Normalised rose diagrams produced for groups of stations along the profile, a) External zone with respect to FPF; b) Internal zone with respect to FPF; c) Po Plain; d) the Ligurian Alps. Grey rose diagrams: all data; Red: events with SW (a,b) or W (c,d) back azimuths, blue: events with NE (a,b) or E (c,d) back azimuths.



~~In Figure 5, the rose diagrams show evident differences along the CIFALPS2 transect, somewhere underlined by different patterns with respect to back azimuths. Only in group a), in the External zone, the N-S dominant direction remains independently if all the dataset is used or if measurements are separated with respect to opposite back azimuths (red and blue rose diagrams). For all other groups, there is a clear difference depending on the back azimuth. In the group b) the entire dataset shows a main trend in a NE-SW direction, in agreement with the Alps strike in this region; the same direction is observed for events coming from NE (blue rose diagram). On the contrary, measurements obtained from events with a SW back azimuth are dominated by a nearly NS direction, quite similar to that shown by group a). The entire dataset for the Po Plain (c) and the subgroup with east back azimuths show a clear bimodal distribution, with both the Alpine NE-SW and the Apenninic NW-SE typical directions; west back azimuth events giving instead N to NNW directions, very similar to those obtained in previous work (e.g. Salimbeni et al., 2018) and again similar to group a) and SW back azimuth measurements of group b). In the Ligurian Alps, in the group d), opposite back azimuths show different results. It is worth noticing that the ENE-WSW direction is dominant both in the all data plot and in the E back azimuth plot, while the W back azimuth plot shows a wide dispersion with a NW-SE direction prevailing.~~

~~Figure 5 - Normalised rose diagrams produced for groups of stations along the profile , a) External zone with respect to FPF; b) Internal zone with respect to FPF; c) Po Plain; d) the Ligurian Alps. Grey rose diagrams: all data; Red: events with SW (a,b) or W (c,d) back azimuths, blue: events with NE (a,b) or E (c,d) back azimuths.~~



4 Discussion and hypotheses

CIFALPS2 SWS measurements clearly provide new information since they cover large areas where no seismic station is currently deployed or has been operating in the past. They allow us ~~or has been operating in the past. They allow~~ to fill data gaps and draw conclusions on the seismic anisotropy pattern and mantle deformation beneath the Western Alps.

A large-scale summary, prepared using the average values to avoid the scatter of single SWS measurements, is shown in Figure 6. ENE-WSW fast velocity directions, parallel to the strike of the Alps, are present from the Central to the Western Alps, in the transition between Po Plain and the belt, and terminate where the European slab and the belt are bending (double headed arrows in the inset sketch of Figure 6). At this point anisotropy directions do not strictly follow the chain strike, as they rather cut the main tectonic and morphological features. In the same zone (highlighted by the green circle A, Figure 6) converges a mantle flow that strikes from NE-SW to NS, in a coherent direction that however cuts the arcuate shape of the belt (yellow lines in the northern part of study region, Figure 6); this pattern is different from those described in previous anisotropy studies of the Western Alps (Barruol et al., 2004; Lucente et al., 2006; Barruol et al., 2011; Salimbeni et al., 2018) where anisotropy has always been described as rotating with the belt direction. The discrepancy between the direction of tectonic lines and the nearly NS fast velocity is in agreement with a deep source of the anisotropy, in the mantle. Link and Rumpker (2023) in a recent analysis found that a similar nearly NS pattern would be mostly located in a shallower part of the mantle, and in part also present in a lower layer. They consider it as a shallow asthenospheric contribution. ~~Link and~~

~~Rumpker (2023) in a recent analysis found that this pattern is mostly located in a shallower layer, but being also present in the lower layer and being close to the tectonic sutures, they consider it as a shallow asthenospheric contribution. The NW-SE asthenospheric flow identified from SE France toward the Ligurian Sea, which culminates in a flow around the southern tip of the European slab, is instead in agreement with previous studies. This flow apparently originates beneath Central France, in the Massif Central region (Barruol et al., 2004), and it seems that the NS mantle flow merges with it (left green circle, Figure 6) and then, flowing around the southern tip of the European slab, moves to the Tyrrhenian Sea.~~

On the contrary, the NW-SE asthenospheric flow identified from SE France toward the Ligurian Sea, which culminates in a flow around the southern tip of the European slab, is in agreement with previous studies. This flow apparently originates beneath Central France, in the Massif Central region (Barruol et al., 2004), and it seems that the NS mantle flow merges with it (left green circle, Figure 6) and then, flowing around the southern tip of the European slab, moves to the Tyrrhenian Sea.

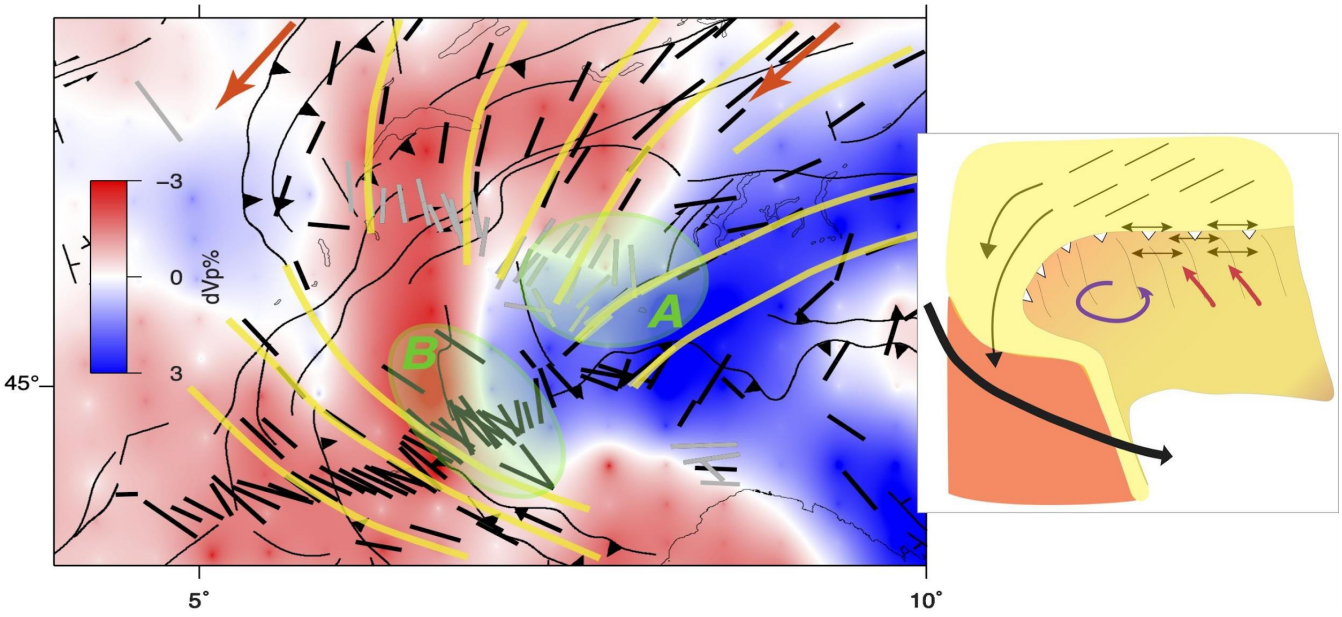
The overlap with the teleseismic travel time tomographic image at 150 km depth by Zhao et al. (2016) indicates that all these fast velocity directions correspond to mantle deformation below the European slab. The mantle close to the slab has a NE-SW seismic anisotropy direction because it is deformed by the slab steepening. This feature is visible only in a narrow stripe, in the transition between Western and Central Alps, probably because in this place the slab steepening was favored by the plate motion direction (e.g. Adria anticlockwise rotation, Figure 6). Moving north, in the outer part of the belt, the anisotropy directions are those of an undeformed mantle, substantially parallel to the APM direction (orange arrows in Figure 6). Moving (south)westward, the deflection from NE-SW to NS may be related to the mantle being squeezed by the retreating European slab and moved toward the south where the retreat process was weakening or probably already ended. Indeed, in the Western Alps, the arcuate shape of the trench and slab, together with the (upper) Adria plate rotating in anticlockwise direction with a rotation pole more or less located in the western Po Plain (e.g. Serpelloni et al., 2016; Le Breton et al., 2017), may have been less favorable to the retreat of the slab. Such differences between the northern and southern Western Alps, in particular in the European Moho geometry, have been also identified by comparing CIFALPS and CIFALPS2 receiver function sections (Paul et al., 2022). The European Moho is strongly dipping down~~deformed by the slab retreat. This feature is visible only in a narrow stripe, in the transition between Western and Central Alps, probably because in this place the slab retreat was favored by the plate motion direction (e.g. Adria anticlockwise rotation, Figure 6). Moving north, in the outer part of the belt, the anisotropy directions are those of an undeformed mantle, substantially parallel to the APM direction (orange arrows in Figure 6). Moving (south)westward, the deflection from NE-SW to NS may be related to the mantle being squeezed by the retreating European slab that moved toward the south where however the retreat process was weakening or probably already ended. Indeed, in the Western Alps, the arcuate shape of the trench and slab, together with the (upper) Adria plate rotating in anticlockwise direction with a rotation pole more or less located in the western Po Plain (e.g. Serpelloni et al., 2016; Le Breton et al., 2017), may have been less favorable to the retreat of the slab, which was less effective with respect to other locations. Such differences between the northern and southern Western Alps, in particular

~~in the European Moho geometry, have been also identified by comparing CIFALPS and CIFALPS2 receiver function sections (Paul et al., 2022). The European Moho is strongly dipping~~ to ~75 km depth along CIFALPS section, while its dip is much weaker in CIFALPS2 section. Moreover, the absence of slab retreat in the Western Alps has been described also by Malusà et al. (2015), studying the mechanisms for exhumation of (U)HP terranes along the Cenozoic Adria-Europe plate boundary.

The mantle flow from beneath the Central Alps converges with the asthenospheric flow coming from SE France where Western Alps subduction, precisely a continental subduction (Malusà et al., 2021; Paul et al., 2022) runs out. In the region, the European slab is almost vertical (Zhao et al., 2016) and is no more affected by slab retreat. Substantially a differential behaviour of slab movement along the chain is at the base of the anisotropy pattern variation from Central to the entire Western Alps.

In the Po Plain, the image is patchy and complex, with very few good quality measurements and some really low values of dt. This does not necessarily mean that the mantle is isotropic, but that anisotropy may be multilayered or fast velocity directions are vertical~~Figure 6 - Top left: Zhao et al. (2016) tomography (dVp in %) - layer at 150 km depth - overlapped with average SWS measurements: results from CIFALPS2 data in light grey and from previous studies in black. Orange arrows on top represent the absolute European plate motion from GSRM v2.1 model (calculated from Plate Motion Calculator | Software | GAGE). Yellow traces simulate average mantle deformation directions and green areas A and B highlight points where directions converge. Bottom right: a sketch of this part of alpine subduction, where, in light yellow is the European plate, the double-headed arrows represent the only anisotropy of the study region related to European slab retreat (whose direction is represented by the red arrows), thin black lines are the anisotropy parallel to the APM, the thick black arrow represents the SE France asthenospheric mantle flow, the purple circular arrow represents the Adria plate rotation~~.

Figure 6 - Left: Zhao et al. (2016) tomography (dVp in %) - layer at 150 km depth - overlapped with average SWS measurements: results from CIFALPS2 data in light grey and from previous studies in black. Orange arrows on top represent the absolute European plate motion from GSRM v2.1 model (calculated from Plate Motion Calculator | Software | GAGE). Yellow traces simulate average mantle deformation directions and green areas A and B highlight points where directions converge. Right: a sketch of this part of alpine subduction, where, in light yellow is the European plate, the double-headed arrows represent the only anisotropy of the study region related to European slab retreat (whose direction is represented by the red arrows), thin black lines are the anisotropy parallel to the APM, the thick black arrow represents the SE France asthenospheric mantle flow, the purple circular arrow represents the Adria plate rotation.



In the Po Plain, the image is patchy and complex, with very few good quality measurements and some really low values of dt. This does not necessarily mean that the mantle is isotropic, but that anisotropy may be multilayered or fast velocity directions vertical. It is worth noting that beneath the Po basin, the European slab is nearly vertical (e.g., Zhao et al. 2016; Paffrath et al., 2021) and the space for the mantle above is really narrow. With such a complex mantle structure, it is not surprising that a unique and significant pattern of anisotropy cannot be identified. In the Ligurian Alps, our measurements show different orientations east and west of the transect with, in general, a prevailing EW direction (Figure 5d), but a minor NNE-SSW set of measurements from the western back azimuths. These results are certainly intriguing but not sufficient to support any new hypothesis.

5 Conclusions

New data collected by the CIFALPS2 project clearly fills the gap that has forced the interpolation between more sparse information in the past. The pattern of seismic anisotropy shown here, is not entirely parallel to the belt, as it is in the Central Alps and in the transition to the Western Alps, up to the point this portion of belt is arcuate. Indeed, in the central part of the study region, a nearly NS pattern coming from central Europe cuts all principal morphologic features of the belt. It converges with the part of the mantle deformed by the retreating slab in the point where the retreat is less favored or ended. The arcuate shape of the belt and of the slab, added to the Adria plate rotation with respect to Eurasia around a pole here particularly close to the boundary, reduce the effectiveness of a slab retreat. The NS mantle flow is then interpreted as the

European mantle moving south to merge with the large asthenospheric flow that from beneath Central France moves toward the Tyrrhenian Sea turning around the southern tip of the European slab.

Data availability

All shear wave splitting measurements from this work have been included and are available in the Italian shear wave splitting collection https://osf.io/nqxk4 (Pondrelli et al., 2023).

Author contribution

PS, SS and CJM made measurements and analyses. PS prepared the manuscript with the contribution of all co-authors. All authors designed the CIFALPS2 experiment~~experiments CIFALPS2~~ and carried it out.

Competing interests

The authors declare that they have no conflict of interest.

Acknowledgements

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525 | **Supplementary Material**

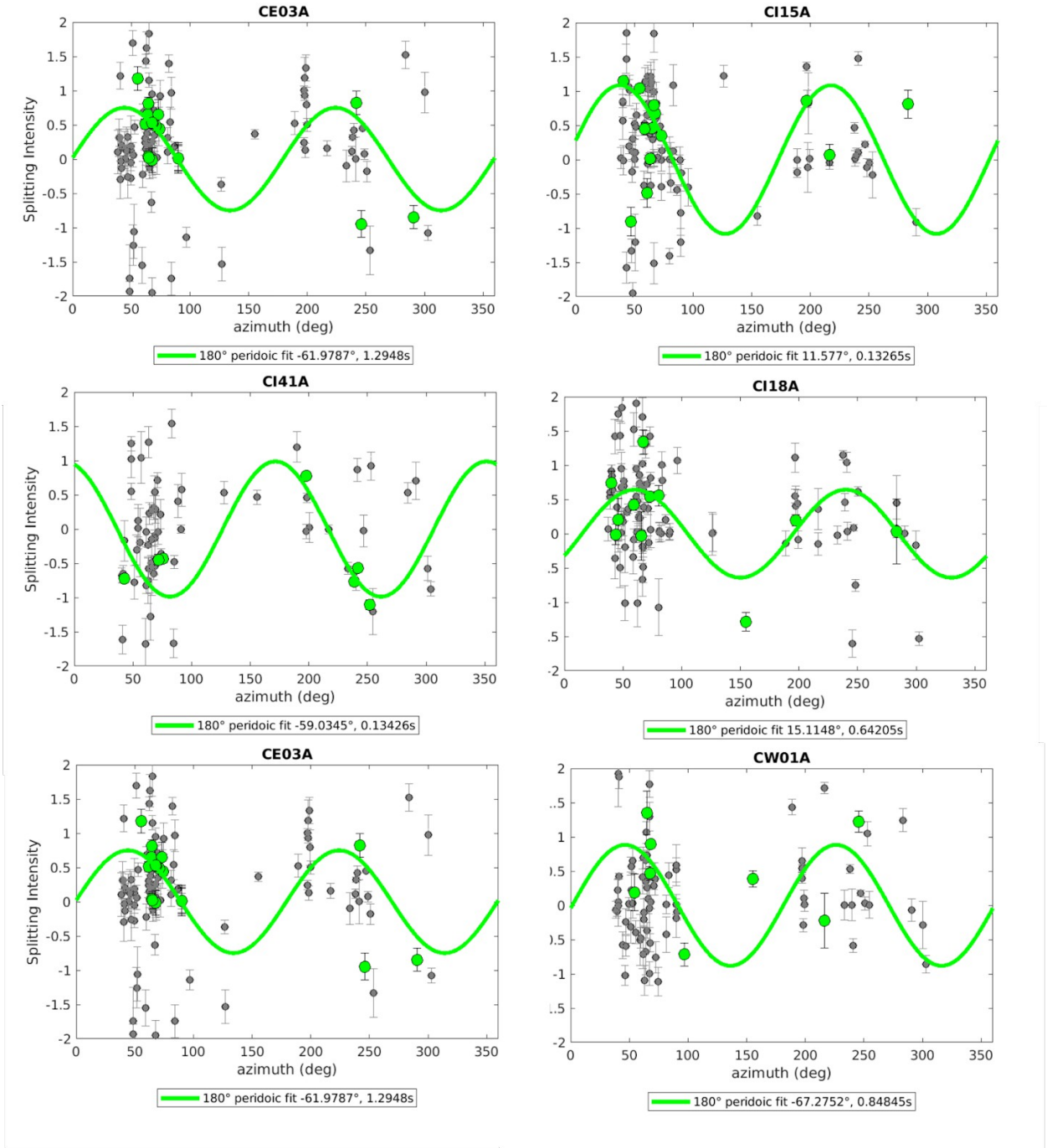
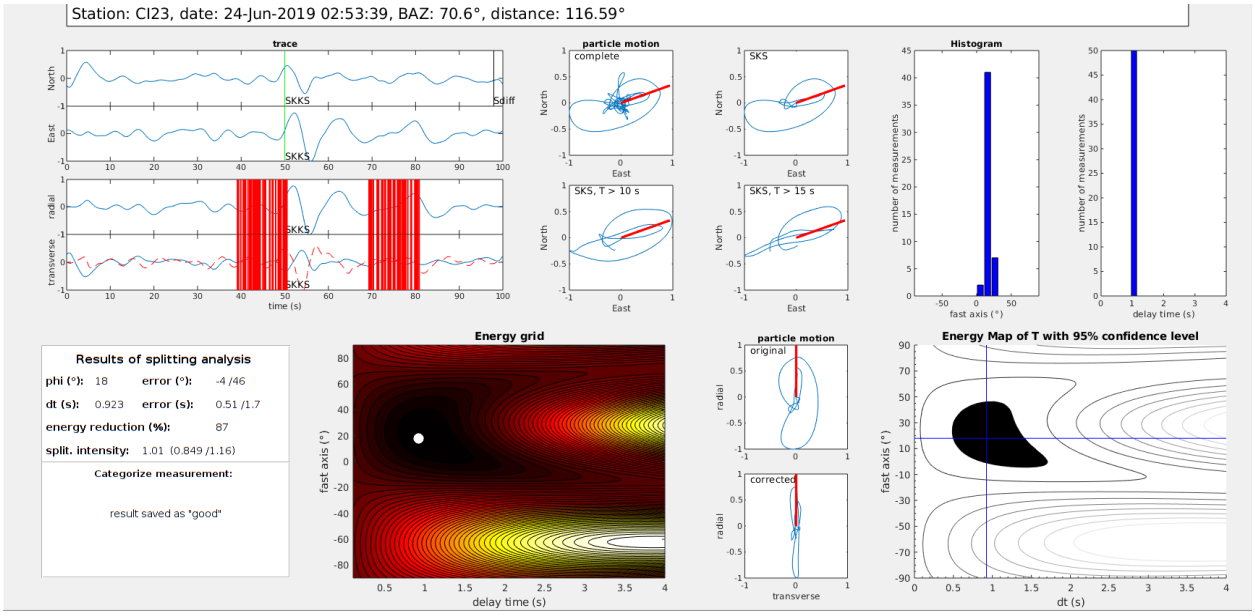


Figure S1 - Splitting intensity measurements for a few example stations. Gray dots: all measurements; green circles: only measurements that fit the criteria and the sinusoidal curve (fast polarization direction and time delay written below).



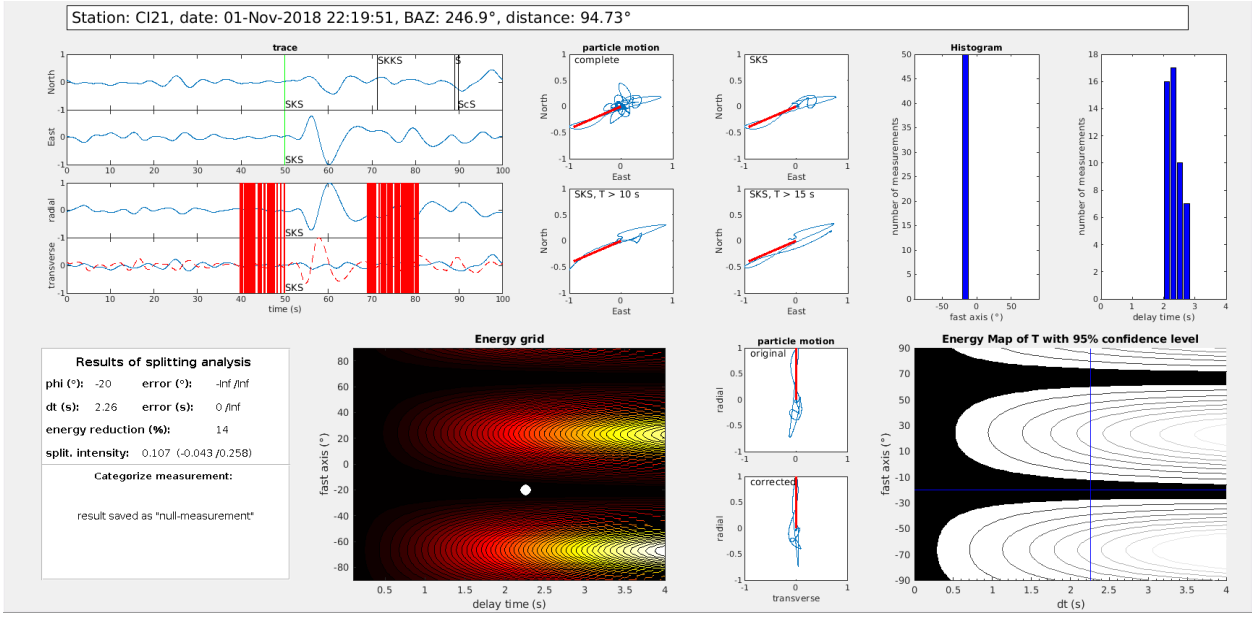


Figure S2 - Examples of measurements. Upper panel: a good shear wave splitting measurement at station CI23. Lower panel: a null measurement at station CI21.

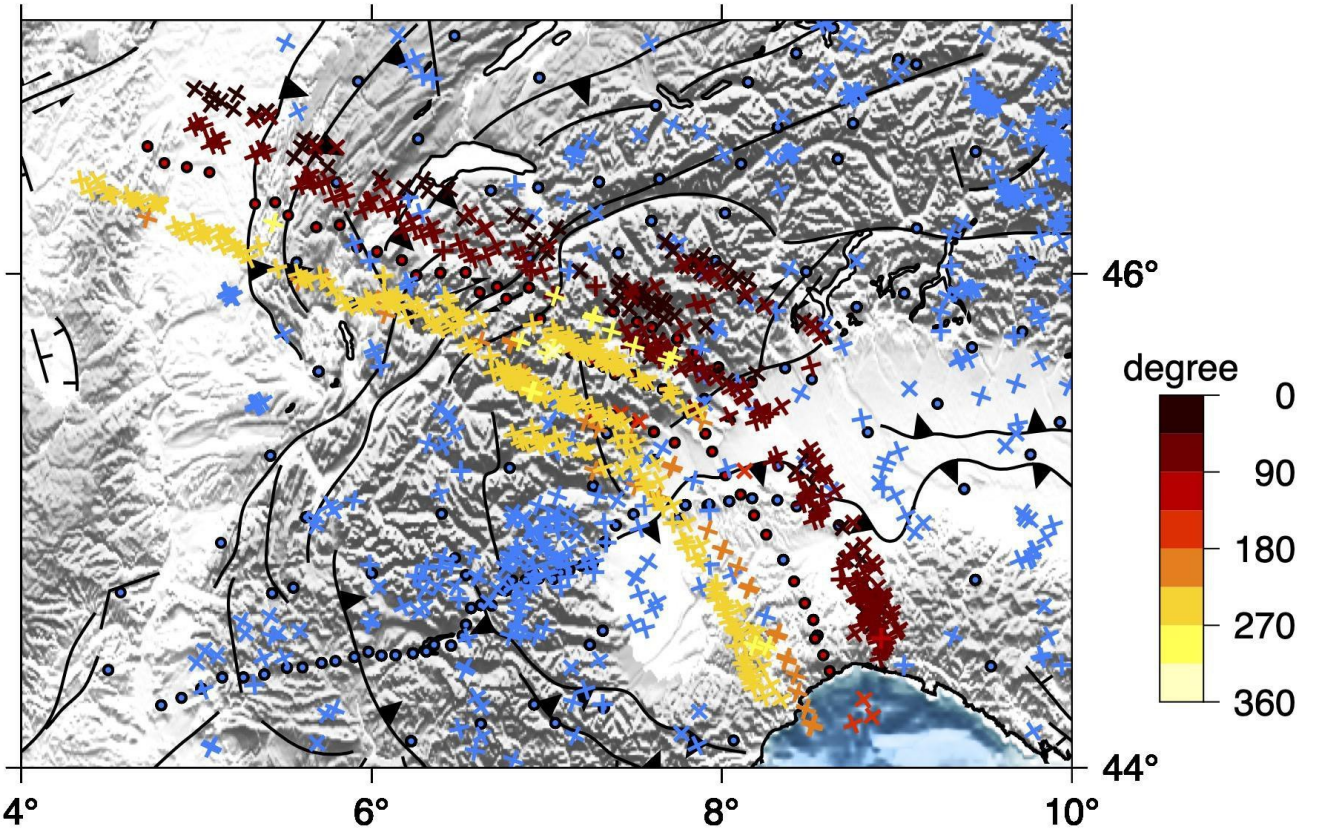


Figure S3 – Map of null measurements plotted at the piercing point of 150 km depth, marked with crosses rotated in the back azimuth direction and coloured following the color scale on the right, depending on the back azimuth; in light blue all previous data.

Table S1 - Good single Splitting Intensity (SI) measurements. Header: Station | Station latitude | Station longitude | Earthquake ID (YYMMDDhhmm) | back-azimuth | SI |SI error

Station	Lat	Lon	EQ ID	BAZ	SI	SI error
CE01	45.85	7.38	1809281002	73.70	0.56	0.04
CE01	45.85	7.38	1812290339	64.00	0.06	0.09
CE01	45.85	7.38	1901061727	66.54	0.65	0.04
CE01	45.85	7.38	1901171506	52.65	0.75	0.26
CE01	45.85	7.38	1901260812	66.06	-0.16	0.18
CE01	45.85	7.38	1903150503	245.84	0.39	0.15
CE01	45.85	7.38	1904121140	72.66	0.44	0.07
CE01	45.85	7.38	1904230537	61.60	0.43	0.06
CE01	45.85	7.38	1905141258	46.67	1.24	0.09
CE01	45.85	7.38	1905311012	64.11	0.31	0.13
CE01	45.85	7.38	1907071508	68.18	0.24	0.23
CE01	45.85	7.38	1907140943	67.84	-0.40	0.38
CE01	45.85	7.38	1909190706	83.83	0.62	0.06
CE01	45.85	7.38	1909211953	69.62	0.01	0.17
CE01	45.85	7.38	1909252346	69.16	0.32	0.17
CE01	45.85	7.38	1910290104	64.96	1.83	0.16
CE01	45.85	7.38	1911141617	67.24	1.11	0.06
CE02	45.81	7.52	1809281025	74.30	1.92	0.28
CE02	45.81	7.52	1901212359	81.62	-0.54	0.23

CE02	45.81	7.52	1902121234	40.73	-0.08	0.28
CE02	45.81	7.52	1904121140	72.78	0.74	0.36
CE02	45.81	7.52	1906240253	70.77	0.85	0.03
CE02	45.81	7.52	1907140539	86.98	0.35	0.35
CE02	45.81	7.52	1907140943	67.97	-0.62	0.27
CE02	45.81	7.52	1908021203	89.90	0.01	0.12
CE02	45.81	7.52	1909190706	83.94	1.09	0.06
CE02	45.81	7.52	1910290104	65.08	1.86	0.18
CE03	45.79	7.60	1809281002	73.89	0.44	0.04
CE03	45.79	7.60	1812290339	64.19	0.65	0.03
CE03	45.79	7.60	1901181640	290.91	-0.85	0.17
CE03	45.79	7.60	1902020927	90.21	0.02	0.18
CE03	45.79	7.60	1902021059	90.19	0.02	0.22
CE03	45.79	7.60	1902021101	89.97	0.02	0.20
CE03	45.79	7.60	1903150503	246.00	-0.95	0.19
CE03	45.79	7.60	1904121140	72.86	0.65	0.23
CE03	45.79	7.60	1904230537	61.78	0.51	0.07
CE03	45.79	7.60	1905062119	55.46	1.18	0.17
CE03	45.79	7.60	1905311012	64.30	0.04	0.08
CE03	45.79	7.60	1906140019	241.68	0.82	0.17
CE03	45.79	7.60	1906240253	70.85	0.49	0.06
CE03	45.79	7.60	1907071508	68.38	0.53	0.04
CE03	45.79	7.60	1909141621	67.50	-0.01	0.18
CE03	45.79	7.60	1909290202	64.64	0.81	0.09
CE03	45.79	7.60	1910161137	65.18	0.02	0.13

CE03	45.79	7.60	1911141617	67.44	0.54	0.06
CE04	45.74	7.75	1809281002	74.01	0.90	0.08
CE04	45.74	7.75	1812290339	64.32	0.49	0.04
CE04	45.74	7.75	1901061727	66.87	1.22	0.13
CE04	45.74	7.75	1904220911	63.38	-0.06	0.13
CE04	45.74	7.75	1904230537	61.90	0.66	0.04
CE04	45.74	7.75	1905311012	64.42	0.62	0.04
CE04	45.74	7.75	1906240253	70.99	0.49	0.03
CE04	45.74	7.75	1907071508	68.51	0.82	0.08
CE04	45.74	7.75	1909190706	84.12	0.48	0.06
CE04	45.74	7.75	1909290202	64.76	1.31	0.12
CE04	45.74	7.75	1910290104	65.27	0.73	0.08
CE04	45.74	7.75	1910310111	65.04	-0.39	0.24
CE04	45.74	7.75	1911052052	189.30	0.79	0.21
CE04	45.74	7.75	1911150117	67.63	1.83	0.26
CE05	45.68	7.86	1810292017	216.72	0.37	0.12
CE05	45.68	7.86	1811040755	65.60	0.10	0.18
CE05	45.68	7.86	1812290339	64.42	0.34	0.05
CE05	45.68	7.86	1902081155	62.14	0.41	0.21
CE05	45.68	7.86	1903240437	67.67	0.50	0.31
CE05	45.68	7.86	1904121140	73.09	1.03	0.06
CE05	45.68	7.86	1904230537	61.99	1.00	0.05
CE05	45.68	7.86	1905311012	64.52	0.77	0.27
CE05	45.68	7.86	1906240253	71.10	0.75	0.04
CE05	45.68	7.86	1907071508	68.61	1.37	0.08

CE05	45.68	7.86	1909290202	64.86	1.55	0.14
CE05	45.68	7.86	1910310111	65.14	1.42	0.09
CE05	45.68	7.86	1911141617	67.68	0.28	0.15
CE06	45.63	7.98	1812290339	64.54	0.58	0.08
CE06	45.63	7.98	1901171506	53.37	1.42	0.22
CE06	45.63	7.98	1903010850	251.39	1.21	0.10
CE06	45.63	7.98	1904062155	74.88	-0.16	0.07
CE06	45.63	7.98	1904121140	73.20	0.68	0.06
CE06	45.63	7.98	1904230537	62.10	0.66	0.08
CE06	45.63	7.98	1906240253	71.23	1.27	0.03
CE06	45.63	7.98	1907011659	64.54	1.01	0.20
CE06	45.63	7.98	1907071508	68.73	1.48	0.05
CE06	45.63	7.98	1907081852	68.65	0.96	0.09
CE06	45.63	7.98	1907140943	68.41	1.43	0.37
CE06	45.63	7.98	1907141026	68.08	-1.18	0.07
CE06	45.63	7.98	1911141617	67.79	1.26	0.05
CE07	45.57	8.17	1809281002	74.38	0.77	0.11
CE07	45.57	8.17	1812110226	198.19	-0.23	0.06
CE07	45.57	8.17	1812290339	64.70	0.95	0.08
CE07	45.57	8.17	1904050956	41.09	0.61	0.26
CE07	45.57	8.17	1904230537	62.25	0.35	0.07
CE07	45.57	8.17	1906040439	41.36	-0.27	0.10
CE07	45.57	8.17	1907011659	64.70	0.20	0.44
CE07	45.57	8.17	1907071508	68.91	0.78	0.09
CE07	45.57	8.17	1907141026	68.25	1.83	0.13

CI01	46.50	4.72	1809281014	71.35	-1.19	0.12
CI01	46.50	4.72	1901221901	153.32	0.65	0.11
CI01	46.50	4.72	1902020927	88.08	0.90	0.14
CI02	46.44	4.82	1809181157	40.67	0.00	0.09
CI02	46.44	4.82	1809281014	71.45	-1.35	0.08
CI02	46.44	4.82	1810260905	37.16	1.27	0.46
CI02	46.44	4.82	1812011327	69.30	0.00	0.05
CI02	46.44	4.82	1812192137	47.80	0.46	0.12
CI02	46.44	4.82	1901221901	153.39	1.11	0.09
CI03	46.42	4.95	1809281002	71.64	0.28	0.04
CI03	46.42	4.95	1809281014	71.55	-1.57	0.22
CI03	46.42	4.95	1809281025	72.11	-1.37	0.18
CI03	46.42	4.95	1904091753	196.05	1.38	0.07
CI03	46.42	4.95	1904220911	61.24	-0.06	0.12
CI04	46.40	5.07	1901221901	153.56	-0.52	0.16
CI04	46.40	5.07	1902121234	38.50	1.47	0.24
CI05	46.28	5.33	1809281025	72.46	1.21	0.16
CI05	46.28	5.33	1903240437	65.43	0.03	0.12
CI05	46.28	5.33	1908272355	196.24	0.27	0.08
CI05	46.28	5.33	1910290242	63.18	-0.02	0.11
CI05	46.28	5.33	1911231211	60.00	0.24	0.13
CI06	46.28	5.45	1901212359	79.84	0.40	0.08
CI06	46.28	5.45	1906040439	39.28	0.34	0.05
CI06	46.28	5.45	1907141026	65.75	-0.92	0.42
CI06	46.28	5.45	1911042153	238.70	0.03	0.15

CI07	46.23	5.52	1810020016	79.26	-0.42	0.17
CI07	46.23	5.52	1810292326	282.59	-0.02	0.20
CI07	46.23	5.52	1812160942	57.14	0.55	0.10
CI07	46.23	5.52	1901181640	289.41	0.00	0.04
CI07	46.23	5.52	1901200132	240.02	0.03	0.33
CI07	46.23	5.52	1901212359	79.92	0.01	0.18
CI07	46.23	5.52	1901220510	80.09	0.01	0.18
CI07	46.23	5.52	1901221901	153.87	0.00	0.06
CI07	46.23	5.52	1901260812	64.23	0.03	0.34
CI07	46.23	5.52	1901301531	282.22	0.01	0.06
CI07	46.23	5.52	1902020927	88.69	0.01	0.13
CI07	46.23	5.52	1902021059	88.67	0.01	0.13
CI07	46.23	5.52	1902021101	88.44	0.01	0.13
CI07	46.23	5.52	1902081155	60.18	0.04	0.43
CI07	46.23	5.52	1904062155	72.64	0.20	0.05
CI07	46.23	5.52	1907141026	65.84	-0.70	0.24
CI07	46.23	5.52	1911042153	238.74	1.88	0.45
CI08	46.18	5.68	1810260905	38.00	0.47	0.08
CI08	46.18	5.68	1811011930	196.58	1.32	0.12
CI08	46.18	5.68	1901220510	80.24	-0.66	0.08
CI08	46.18	5.68	1901260351	42.14	0.83	0.30
CI08	46.18	5.68	1907141026	65.99	-0.54	0.29
CI08	46.18	5.68	1909290202	62.99	1.21	0.32
CI08	46.18	5.68	1911161019	65.86	0.26	0.19
CI09	46.19	5.82	1809230552	42.15	-0.47	0.19

CI09	46.19	5.82	1812011327	70.27	-0.60	0.10
CI09	46.19	5.82	1901220510	80.34	-0.85	0.08
CI09	46.19	5.82	1903060013	60.97	0.69	0.13
CI09	46.19	5.82	1904051614	198.90	-0.01	0.12
CI09	46.19	5.82	1911141845	66.04	-1.48	0.33
CI10	46.11	5.92	1809281002	72.50	0.17	0.04
CI10	46.11	5.92	1812110226	197.10	1.31	0.07
CI10	46.11	5.92	1812280303	61.53	0.21	0.15
CI10	46.11	5.92	1901200132	240.25	0.02	0.25
CI10	46.11	5.92	1909190732	82.63	-0.44	0.04
CI11	46.09	6.03	1809181157	42.41	0.02	0.10
CI11	46.09	6.03	1810292326	282.94	0.24	0.31
CI11	46.09	6.03	1811011930	196.75	0.75	0.30
CI11	46.09	6.03	1812110226	197.16	1.04	0.09
CI11	46.09	6.03	1901212359	80.37	0.09	0.07
CI11	46.09	6.03	1902021059	89.05	-0.90	0.19
CI11	46.09	6.03	1905162252	282.79	0.54	0.17
CI11	46.09	6.03	1906040439	39.73	0.68	0.24
CI11	46.09	6.03	1907071508	67.01	0.69	0.03
CI12	46.05	6.17	1812110226	197.23	1.06	0.11
CI12	46.05	6.17	1812290339	62.97	0.03	0.04
CI12	46.05	6.17	1901260351	42.81	0.93	0.17
CI12	46.05	6.17	1905162252	282.89	1.74	0.33
CI12	46.05	6.17	1906040439	39.84	0.67	0.07
CI12	46.05	6.17	1906240253	69.53	0.50	0.05

CI12	46.05	6.17	1907071508	67.13	0.70	0.03
CI12	46.05	6.17	1910290104	63.96	0.44	0.06
CI12	46.05	6.17	1910310111	63.72	1.00	0.13
CI13	45.99	6.26	1809281014	72.70	1.80	0.17
CI13	45.99	6.26	1810102200	46.90	-0.34	0.24
CI13	45.99	6.26	1812290339	63.06	0.01	0.09
CI13	45.99	6.26	1901260351	42.95	0.80	0.10
CI13	45.99	6.26	1906040439	39.90	1.02	0.08
CI14	46.00	6.39	1809281025	73.37	1.72	0.49
CI14	46.00	6.39	1811040755	64.40	0.89	0.18
CI14	46.00	6.39	1901061727	65.69	1.04	0.11
CI14	46.00	6.39	1901221901	154.45	-0.78	0.08
CI14	46.00	6.39	1904051614	199.19	-0.05	0.21
CI14	46.00	6.39	1904221449	198.79	0.10	0.17
CI14	46.00	6.39	1911141845	66.57	-0.04	0.20
CI15	46.01	6.54	1809281002	73.01	0.35	0.03
CI15	46.01	6.54	1810102200	47.20	-0.91	0.21
CI15	46.01	6.54	1810290654	216.44	0.07	0.15
CI15	46.01	6.54	1812290339	63.28	0.02	0.08
CI15	46.01	6.54	1901260812	65.24	0.46	0.12
CI15	46.01	6.54	1902081155	61.04	-0.48	0.21
CI15	46.01	6.54	1905062119	54.23	1.04	0.07
CI15	46.01	6.54	1905162252	283.15	0.81	0.20
CI15	46.01	6.54	1906191724	58.74	0.45	0.09
CI15	46.01	6.54	1906281551	40.68	1.15	0.03

CI15	46.01	6.54	1907071508	67.44	0.68	0.06
CI15	46.01	6.54	1908272355	196.79	0.85	0.03
CI15	46.01	6.54	1911141617	66.51	0.80	0.04
CI16	45.92	6.62	1809281002	73.09	0.62	0.04
CI16	45.92	6.62	1809281025	73.57	-0.49	0.16
CI16	45.92	6.62	1812190137	253.14	-0.03	0.25
CI16	45.92	6.62	1901221901	154.61	-0.01	0.06
CI16	45.92	6.62	1901260812	65.35	0.03	0.32
CI16	45.92	6.62	1901301531	282.96	0.01	0.06
CI16	45.92	6.62	1902020927	89.50	0.01	0.13
CI16	45.92	6.62	1902021059	89.48	0.01	0.13
CI16	45.92	6.62	1902021101	89.26	0.01	0.13
CI16	45.92	6.62	1902081155	61.11	0.05	0.40
CI16	45.92	6.62	1903081506	61.23	1.55	0.19
CI16	45.92	6.62	1904230537	60.99	1.01	0.05
CI16	45.92	6.62	1905062119	54.37	0.99	0.07
CI16	45.92	6.62	1905141258	45.78	0.87	0.19
CI16	45.92	6.62	1906040439	40.18	0.97	0.07
CI16	45.92	6.62	1906191724	58.85	1.38	0.11
CI16	45.92	6.62	1906240253	69.96	0.59	0.06
CI16	45.92	6.62	1906281551	40.76	1.33	0.05
CI16	45.92	6.62	1907071508	67.54	0.87	0.04
CI16	45.92	6.62	1907140910	66.78	1.30	0.11
CI16	45.92	6.62	1907141026	66.86	1.09	0.21
CI16	45.92	6.62	1908272355	196.83	1.32	0.05

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CI16	45.92	6.62	1910290844	44.71	-0.28	0.10
CI17	45.95	6.72	1809281002	73.16	0.45	0.07
CI17	45.95	6.72	1810020016	80.31	1.45	0.23
CI17	45.95	6.72	1810101844	82.37	-0.09	0.11
CI17	45.95	6.72	1812290339	63.44	0.03	0.14
CI17	45.95	6.72	1901181640	290.27	-0.68	0.13
CI17	45.95	6.72	1901200132	240.73	0.38	0.11
CI17	45.95	6.72	1901221901	154.67	-0.92	0.10
CI17	45.95	6.72	1901301531	283.04	0.80	0.11
CI17	45.95	6.72	1902121234	40.02	0.45	0.26
CI17	45.95	6.72	1903041006	53.47	1.24	0.44
CI17	45.95	6.72	1903081506	61.30	0.65	0.09
CI17	45.95	6.72	1904091753	196.91	0.41	0.10
CI17	45.95	6.72	1906040439	40.25	0.73	0.07
CI17	45.95	6.72	1906281551	40.85	0.82	0.03
CI17	45.95	6.72	1907071508	67.61	0.70	0.03
CI17	45.95	6.72	1909190706	83.31	0.84	0.05
CI17	45.95	6.72	1910161137	64.44	0.37	0.08
CI18	45.90	6.77	1809281002	73.22	0.54	0.07
CI18	45.90	6.77	1810012359	80.36	0.55	0.15
CI18	45.90	6.77	1812110226	197.51	0.19	0.08
CI18	45.90	6.77	1901221901	154.71	-1.29	0.14
CI18	45.90	6.77	1901260351	43.62	-0.01	0.15
CI18	45.90	6.77	1901260812	65.50	-0.03	0.35
CI18	45.90	6.77	1901301531	283.07	0.03	0.47

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CI18	45.90	6.77	1902121234	40.07	0.74	0.17
CI18	45.90	6.77	1902171435	46.02	0.20	0.31
CI18	45.90	6.77	1906191724	59.00	0.42	0.09
CI18	45.90	6.77	1907140910	66.91	1.34	0.18
CI19	45.94	6.90	1812192137	50.38	-0.86	0.19
CI19	45.94	6.90	1903010850	250.64	0.52	0.05
CI19	45.94	6.90	1904051614	199.46	1.10	0.08
CI19	45.94	6.90	1904062155	73.88	1.87	0.14
CI19	45.94	6.90	1904091753	197.00	0.26	0.20
CI19	45.94	6.90	1904121140	72.25	0.77	0.06
CI19	45.94	6.90	1906040439	40.39	1.24	0.13
CI19	45.94	6.90	1906191724	59.10	1.39	0.08
CI19	45.94	6.90	1907071508	67.76	0.94	0.04
CI19	45.94	6.90	1908272355	196.96	0.72	0.04
CI19	45.94	6.90	1909291557	237.91	0.79	0.07
CI19	45.94	6.90	1911141617	66.82	1.58	0.05
CI21	45.72	7.14	1809280659	73.71	0.41	0.34
CI21	45.72	7.14	1809281002	73.55	1.08	0.10
CI21	45.72	7.14	1809281014	73.46	1.54	0.09
CI21	45.72	7.14	1810141241	126.72	0.04	0.17
CI21	45.72	7.14	1812290339	63.84	0.84	0.08
CI21	45.72	7.14	1901181640	290.55	0.07	0.38
CI21	45.72	7.14	1901212359	81.37	0.15	0.23
CI21	45.72	7.14	1901220510	81.54	0.26	0.19
CI21	45.72	7.14	1901260351	44.17	0.94	0.26

CI21	45.72	7.14	1906240253	70.49	0.97	0.04
CI21	45.72	7.14	1907071508	68.03	1.11	0.05
CI21	45.72	7.14	1907140539	86.75	1.16	0.12
CI21	45.72	7.14	1909141621	67.14	-0.09	0.16
CI21	45.72	7.14	1909190732	83.64	1.50	0.26
CI21	45.72	7.14	1911150117	67.15	-1.21	0.14
CI22	45.68	7.14	1809281002	73.56	0.80	0.07
CI22	45.68	7.14	1809281014	73.47	1.94	0.20
CI22	45.68	7.14	1905162252	283.51	-0.04	0.16
CI22	45.68	7.14	1907011659	63.88	1.96	0.14
CI22	45.68	7.14	1907071508	68.04	0.97	0.09
CI22	45.68	7.14	1907140539	86.77	0.92	0.16
CI23	45.68	7.24	1809281002	73.64	1.07	0.07
CI23	45.68	7.24	1810020016	80.83	-0.37	0.17
CI23	45.68	7.24	1810141241	126.79	-1.21	0.16
CI23	45.68	7.24	1812160942	59.06	-0.01	0.06
CI23	45.68	7.24	1812161426	96.66	-0.02	0.25
CI23	45.68	7.24	1812290339	63.93	0.39	0.06
CI23	45.68	7.24	1901061727	66.48	0.46	0.10
CI23	45.68	7.24	1901181640	290.62	-0.91	0.21
CI23	45.68	7.24	1903060013	62.22	0.48	0.08
CI23	45.68	7.24	1904051614	199.61	0.04	0.14
CI23	45.68	7.24	1904230537	61.52	0.86	0.06
CI23	45.68	7.24	1905030725	39.67	1.39	0.16
CI23	45.68	7.24	1905311012	64.03	0.60	0.07

CI23	45.68	7.24	1906240253	70.60	0.95	0.04
CI23	45.68	7.24	1907071508	68.12	0.90	0.05
CI23	45.68	7.24	1910290104	64.89	0.79	0.08
CI23	45.68	7.24	1911141617	67.18	1.19	0.13
CI24	45.65	7.25	1809281002	73.66	1.07	0.09
CI24	45.65	7.25	1812290339	63.95	0.31	0.05
CI24	45.65	7.25	1902021101	89.73	-0.33	0.24
CI24	45.65	7.25	1904062155	74.29	0.19	0.09
CI24	45.65	7.25	1904230537	61.53	0.86	0.05
CI24	45.65	7.25	1905062119	55.19	0.07	0.30
CI24	45.65	7.25	1906240253	70.62	1.03	0.05
CI24	45.65	7.25	1907071508	68.14	0.90	0.05
CI24	45.65	7.25	1910142223	90.32	1.03	0.06
CI24	45.65	7.25	1910290104	64.90	0.92	0.06
CI24	45.65	7.25	1911052052	189.03	-0.24	0.25
CI24	45.65	7.25	1911231211	61.89	0.55	0.07
CI25	45.63	7.32	1809281002	73.72	0.97	0.07
CI25	45.63	7.32	1809281025	74.20	0.64	0.14
CI25	45.63	7.32	1812290339	64.01	0.44	0.04
CI25	45.63	7.32	1901220510	81.72	0.98	0.08
CI25	45.63	7.32	1902121234	40.60	-0.19	0.13
CI25	45.63	7.32	1903041006	54.27	-0.55	0.14
CI25	45.63	7.32	1904230537	61.59	0.57	0.05
CI25	45.63	7.32	1905311012	64.11	-1.80	0.38
CI25	45.63	7.32	1906240253	70.69	1.04	0.06

CI25	45.63	7.32	1907071508	68.21	0.91	0.10
CI25	45.63	7.32	1907141026	67.54	-0.92	0.19
CI25	45.63	7.32	1910290104	64.96	1.17	0.13
CI25	45.63	7.32	1911141617	67.27	0.27	0.08
CI26	45.60	7.39	1901220510	81.78	1.15	0.21
CI26	45.60	7.39	1903101248	51.72	0.71	0.28
CI26	45.60	7.39	1907071508	68.27	1.17	0.08
CI26	45.60	7.39	1907141026	67.61	1.75	0.45
CI27	45.60	7.49	1810020016	81.05	0.39	0.48
CI28	45.56	7.57	1904230537	61.79	0.45	0.11
CI28	45.56	7.57	1907140943	68.10	1.42	0.38
CI29	45.54	7.66	1905311012	64.41	0.44	0.24
CI29	45.54	7.66	1906240253	71.01	1.09	0.15
CI29	45.54	7.66	1907071508	68.51	0.79	0.39
CI29	45.54	7.66	1905311012	64.41	0.44	0.24
CI29	45.54	7.66	1906240253	71.01	1.09	0.15
CI29	45.54	7.66	1907071508	68.51	0.79	0.39
CI30	45.52	7.71	1812192137	51.51	-1.19	0.25
CI30	45.52	7.71	1902121234	40.95	-1.45	0.16
CI30	45.52	7.71	1907071508	68.55	1.23	0.11
CI30	45.52	7.71	1909141621	67.68	0.49	0.29
CI31	45.44	7.81	1903010850	251.27	0.58	0.05
CI31	45.44	7.81	1904220911	63.45	0.23	0.11
CI31	45.44	7.81	1906040439	41.09	-0.65	0.15
CI31	45.44	7.81	1910161137	65.42	0.49	0.08

CI32	45.36	7.91	1810102113	50.39	-0.81	0.23
CI32	45.36	7.91	1905311012	64.64	0.74	0.20
CI32	45.36	7.91	1907011659	64.53	-1.09	0.26
CI32	45.36	7.91	1910290104	65.48	0.46	0.14
CI33	45.29	7.94	1812161426	97.32	-0.93	0.12
CI33	45.29	7.94	1901200132	241.36	0.65	0.14
CI33	45.29	7.94	1902021101	90.25	1.85	0.19
CI33	45.29	7.94	1902081155	62.28	0.27	0.09
CI33	45.29	7.94	1906281551	41.99	-1.47	0.07
CI33	45.29	7.94	1907141026	68.17	0.08	0.40
CI34	45.19	8.02	1810102045	50.26	1.44	0.13
CI34	45.19	8.02	1901301531	283.79	0.19	0.18
CI34	45.19	8.02	1906040439	41.26	-0.86	0.13
CI35	45.11	8.11	1811040755	65.91	-0.89	0.11
CI35	45.11	8.11	1911021808	199.25	-0.63	0.14
CI36	45.03	8.18	1810020016	81.81	-1.17	0.24
CI36	45.03	8.18	1901220510	82.60	-0.71	0.07
CI36	45.03	8.18	1902020927	90.67	-0.09	0.23
CI36	45.03	8.18	1904230537	62.34	0.38	0.07
CI36	45.03	8.18	1905311012	64.94	0.82	0.12
CI37	44.95	8.25	1812161426	97.69	-1.46	0.41
CI37	44.95	8.25	1902121234	41.51	0.00	0.13
CI37	44.95	8.25	1903150503	246.43	-0.63	0.14
CI37	44.95	8.25	1905311012	65.01	0.37	0.18
CI37	44.95	8.25	1907150821	52.80	-0.92	0.11

CI37	44.95	8.25	1909141621	68.34	0.77	0.30
CI37	44.95	8.25	1910161137	65.87	0.04	0.09
CI38	44.76	8.41	1810290654	216.76	0.00	0.02
CI38	44.76	8.41	1810292017	216.62	0.00	0.02
CI38	44.76	8.41	1810292326	284.31	-0.02	0.16
CI38	44.76	8.41	1903010850	251.66	-0.51	0.05
CI38	44.76	8.41	1904230537	62.56	0.04	0.11
CI38	44.76	8.41	1905311012	65.18	-1.31	0.20
CI38	44.76	8.41	1906250601	127.59	0.01	0.06
CI38	44.76	8.41	1906281551	42.47	-0.01	0.09
CI38	44.76	8.41	1907011659	65.02	-0.02	0.24
CI38	44.76	8.41	1907071508	69.35	-0.02	0.24
CI38	44.76	8.41	1907081852	69.27	-0.02	0.23
CI38	44.76	8.41	1907122042	63.50	-0.02	0.18
CI38	44.76	8.41	1907140910	68.66	-0.02	0.23
CI38	44.76	8.41	1907140943	69.06	-0.02	0.23
CI38	44.76	8.41	1907141026	68.73	-0.02	0.23
CI38	44.76	8.41	1907150821	53.09	-0.01	0.12
CI38	44.76	8.41	1910290104	66.01	-0.06	0.37
CI38	44.76	8.41	1910290242	65.95	-0.03	0.37
CI38	44.76	8.41	1910310111	65.77	-0.02	0.36
CI38	44.76	8.41	1911021808	199.38	0.00	0.04
CI38	44.76	8.41	1911042153	240.19	-0.02	0.21
CI38	44.76	8.41	1911052052	189.62	0.00	0.03
CI38	44.76	8.41	1911141845	68.58	-0.03	0.42

CI38	44.76	8.41	1911142112	68.46	-0.38	0.41
CI38	44.76	8.41	1911150117	68.46	-0.03	0.43
CI38	44.76	8.41	1911161019	68.50	-0.02	0.42
CI38	44.76	8.41	1911231211	63.20	-0.03	0.31
CI38	44.76	8.41	1912030846	249.30	-0.03	0.34
CI39	44.67	8.47	1810290654	216.75	-1.12	0.15
CI39	44.67	8.47	1810292326	284.33	1.74	0.24
CI39	44.67	8.47	1902020927	90.90	0.09	0.30
CI39	44.67	8.47	1907140943	69.14	1.87	0.44
CI39	44.67	8.47	1908272355	197.59	0.92	0.03
CI39	44.67	8.47	1911231211	63.28	-0.20	0.15
CI40	44.60	8.52	1902020927	90.94	-1.97	0.25
CI40	44.60	8.52	1904221449	199.78	0.30	0.38
CI40	44.60	8.52	1906191724	61.22	-0.75	0.07
CI40	44.60	8.52	1907140539	88.35	-0.78	0.23
CI40	44.60	8.52	1909141621	68.68	0.27	0.22
CI41	44.53	8.53	1903010850	251.73	-1.10	0.07
CI41	44.53	8.53	1904062155	75.78	-0.43	0.06
CI41	44.53	8.53	1906140019	241.98	-0.57	0.04
CI41	44.53	8.53	1906240253	72.19	-0.45	0.08
CI41	44.53	8.53	1906281551	42.61	-0.73	0.04
CI41	44.53	8.53	1908272355	197.60	0.78	0.02
CI41	44.53	8.53	1909291557	238.46	-0.77	0.04
CI42	44.46	8.58	1901220510	83.12	1.14	0.23
CI42	44.46	8.58	1901221901	155.96	0.87	0.05

CI42	44.46	8.58	1903150503	246.65	-1.35	0.20
CI42	44.46	8.58	1906240253	72.26	-0.60	0.10
CI42	44.46	8.58	1909291557	238.47	-1.21	0.07
CI42	44.46	8.58	1911142112	68.69	-0.49	0.05
CI43	44.40	8.62	1811011930	197.91	-0.01	0.12
CI43	44.40	8.62	1811040755	66.44	0.03	0.27
CI43	44.40	8.62	1901221901	155.98	0.95	0.07
CI43	44.40	8.62	1902171435	48.88	-0.70	0.10
CI43	44.40	8.62	1903010850	251.79	-0.70	0.09
CI43	44.40	8.62	1906240253	72.32	-0.32	0.06
CI43	44.40	8.62	1908011828	238.95	-0.88	0.07
CI43	44.40	8.62	1909190706	85.08	-1.42	0.09
CI43	44.40	8.62	1909291557	238.47	-1.08	0.08
CW01	45.43	7.26	1810292017	216.40	-0.22	0.40
CW01	45.43	7.26	1811040755	65.19	1.35	0.32
CW01	45.43	7.26	1812161426	96.79	-0.72	0.17
CW01	45.43	7.26	1901221901	155.05	0.39	0.12
CW01	45.43	7.26	1903041006	54.32	0.19	0.27
CW01	45.43	7.26	1903150503	245.75	1.23	0.15
CW01	45.43	7.26	1907071508	68.22	0.89	0.05
CW01	45.43	7.26	1907141026	67.56	0.47	0.10
CW02	45.43	7.37	1810290654	216.58	1.77	0.12
CW02	45.43	7.37	1810292017	216.45	-0.22	0.10
CW02	45.43	7.37	1901181640	290.69	-1.46	0.48
CW02	45.43	7.37	1902121234	40.67	-0.78	0.12

CW02	45.43	7.37	1906250601	126.80	-1.91	0.19
CW02	45.43	7.37	1907071508	68.31	1.07	0.09
CW02	45.43	7.37	1908142135	302.99	-0.04	0.36
CW02	45.43	7.37	1909141621	67.44	0.04	0.19
CW03	45.41	7.51	1901061727	66.77	1.73	0.20
CW03	45.41	7.51	1904230537	61.76	0.59	0.08
CW03	45.41	7.51	1907071508	68.42	0.86	0.10
CW03	45.41	7.51	1910290104	65.16	-0.58	0.20
CW04	45.37	7.61	1810292326	283.91	-1.01	0.31
CW04	45.37	7.61	1903060013	62.58	0.44	0.09
CW04	45.37	7.61	1907071508	68.52	1.08	0.09
CW05	45.32	7.73	1901260812	66.63	0.87	0.11
CW05	45.32	7.73	1910290104	65.35	-0.71	0.09
CW05	45.32	7.73	1911052052	189.28	1.43	0.38

Supplementary Material

Figure S1 – Map of null measurements plotted at the piercing point of 150 km depth, marked with crosses, rotated in the back azimuth direction; in red from CIFALPS2 stations, in light blue all previous data.

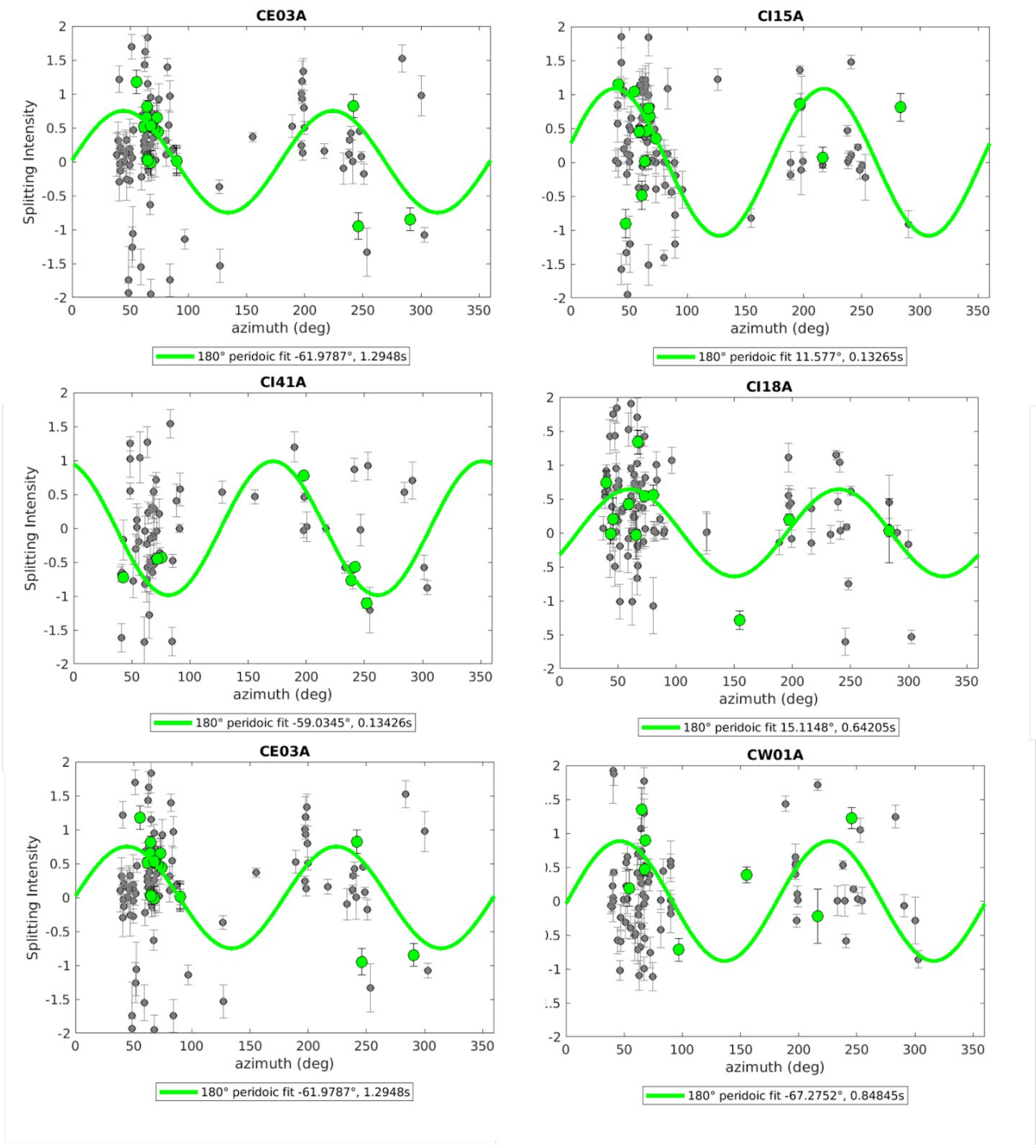

Figure S2 – Splitting intensity measurements for a few example stations. Grey dots: all measurements; green circles: only measurements that fit the criteria and the sinusoidal curve (fast polarisation direction and time delay written below).

Table S2 - Splitting parameters for stations with good SI measurements from at least four different back-azimuthal bin directions. Header: Station | Station latitude (Lat) | Station longitude (Lon) | FPD | FPDerr | TD | TDerr | RMS | Number of Measurements (#)~~1 - Single Splitting Intensity (SI) measurements~~

Station	Lat	Lon	FPD	FPDerr	TD	TDerr	RMS	#
CE03	45.79	7.60	-0.78	2.35	0.75	0.06	12.64	18
CI07	46.23	5.52	11.58	6.57	0.13	0.04	8.05	17
CI11	46.09	6.03	-0.33	1.56	0.83	0.05	13.30	9
CI15	46.01	6.54	-7.45	0.57	1.08	0.02	18.86	13
CI16	45.92	6.62	-2.58	0.66	1.09	0.02	27.78	23
CI17	45.95	6.72	11.48	0.96	0.79	0.02	17.21	17
CI18	45.90	6.77	15.11	2.53	0.64	0.06	8.29	11
CI19	45.94	6.90	0.98	0.61	1.32	0.03	20.85	12
CI21	45.72	7.14	37.08	2.27	1.04	0.07	18.74	15
CI23	45.68	7.24	22.22	1.97	0.74	0.05	20.34	17
CI24	45.65	7.25	37.75	1.59	0.93	0.05	14.58	12
CI37	44.95	8.25	87.15	12.30	0.32	0.09	9.52	7
CI38	44.76	8.41	-59.03	3.69	0.13	0.02	10.61	28
CI39	44.67	8.47	-43.54	2.80	1.01	0.07	16.59	6
CI41	44.53	8.53	-53.46	0.62	0.99	0.02	19.35	7
CI42	44.46	8.58	76.64	1.76	2.18	0.13	5.75	6
CI43	44.40	8.62	-67.28	1.86	0.85	0.06	12.82	9
CW01	45.43	7.26	1.35	3.98	0.88	0.13	12.19	8
CW02	45.43	7.37	22.80	2.92	0.78	0.08	19.64	8

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CE01A	45.850	7.3820	-0.26	119.90	19.5	73.7	7.74	0.5633	0.0405	1809281002
CE01A	45.850	7.3820	-5.86	126.89	83.2	64.0	7.74	0.0601	0.0928	1812290339
CE01A	45.850	7.3820	-2.27	126.85	66.8	66.5	7.38	0.6501	0.0388	1901061727
CE01A	45.850	7.3820	-3.47	146.07	10.2	52.6	5.52	0.7454	0.2563	1901171506
CE01A	45.850	7.3820	-5.52	133.85	9.8	66.0	6.14	0.1614	0.1787	1901260812
CE01A	45.850	7.3820	-1.81	122.63	19.5	72.6	7.34	0.4412	0.0684	1904121140
CE01A	45.850	7.3820	-11.71	125.30	84.8	61.5	8.53	0.4253	0.0563	1904230537
CE01A	45.850	7.3820	-4.10	152.61	19.5	46.6	5.11	1.2355	0.0936	1905141258
CE01A	45.850	7.3820	-6.26	126.61	98.0	64.1	7.80	0.3064	0.1287	1905311012
CE01A	45.850	7.3820	-0.49	126.18	19.5	68.1	7.27	0.2399	0.2292	1907071508
CE01A	45.850	7.3820	-3.44	128.44	19.5	69.1	6.72	0.3207	0.1676	1909252346
CE01A	45.850	7.3820	-6.80	125.20	19.5	64.9	8.00	1.8302	0.1558	1910290104
CE01A	45.850	7.3820	-1.56	126.39	59.0	67.2	7.35	1.1091	0.0626	1911141617
CE02A	45.809	7.5183	-1.06	119.96	10.0	74.3	7.67	1.9190	0.2833	1809281025
CE02A	45.809	7.5183	-10.34	119.05	19.5	81.6	6.89	0.5372	0.2347	1901212359
CE02A	45.809	7.5183	-1.81	122.63	19.5	72.7	7.35	0.7407	0.3568	1904121140
CE02A	45.809	7.5183	-6.38	129.17	226.4	70.7	6.38	0.8537	0.0250	1906240253
CE02A	45.809	7.5183	-18.05	120.33	9.8	86.9	6.15	0.3457	0.3510	1907140539
CE02A	45.809	7.5183	-7.31	104.81	19.5	89.9	8.50	0.0089	0.1153	1908021203
CE02A	45.809	7.5183	-6.80	125.20	19.5	65.0	8.01	1.8607	0.1805	1910290104
CE03A	45.786	7.6024	-0.26	119.90	19.5	73.8	7.75	0.4436	0.0433	1809281002
CE03A	45.786	7.6024	-5.86	126.89	83.2	64.1	7.75	0.6473	0.0336	1812290339
CE03A	45.786	7.6024	-2.72	100.20	19.5	90.2	9.54	0.0166	0.1762	1902020927

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CE03A	45.786	7.6024	-2.78	100.26	19.5	90.1	9.53	0.0174	0.2243	1902021059
CE03A	45.786	7.6024	-1.81	122.63	19.5	72.8	7.36	0.6455	0.2272	1904121140
CE03A	45.786	7.6024	-11.71	125.30	84.8	61.7	8.55	0.5141	0.0685	1904230537
CE03A	45.786	7.6024	-6.94	146.46	139.5	55.4	5.20	1.1786	0.1737	1905062119
CE03A	45.786	7.6024	-6.26	126.61	98.0	64.2	7.82	0.0370	0.0817	1905311012
CE03A	45.786	7.6024	-30.00	-72.11	9.8	241.6	7.90	0.8227	0.1711	1906140019
CE03A	45.786	7.6024	-6.38	129.17	226.4	70.8	6.39	0.4875	0.0605	1906240253
CE03A	45.786	7.6024	-0.49	126.18	19.5	68.3	7.29	0.5261	0.0354	1907071508
CE03A	45.786	7.6024	-0.92	128.60	9.8	67.4	6.95	0.0136	0.1784	1909141621
CE03A	45.786	7.6024	-5.69	126.66	91.0	64.6	7.75	0.8130	0.0916	1909290202
CE03A	45.786	7.6024	-6.80	125.15	19.5	65.1	8.02	0.0234	0.1278	1910161137
CE03A	45.786	7.6024	-1.56	126.39	59.0	67.4	7.36	0.5351	0.0624	1911141617
CE04A	45.740	7.7453	-0.26	119.90	19.5	74.0	7.76	0.9002	0.0797	1809281002
CE04A	45.740	7.7453	-5.86	126.89	83.2	64.3	7.76	0.4851	0.0445	1812290339
CE04A	45.740	7.7453	-2.27	126.85	66.8	66.8	7.41	1.2227	0.1311	1901061727
CE04A	45.740	7.7453	-11.71	125.30	84.8	61.8	8.56	0.6598	0.0393	1904230537
CE04A	45.740	7.7453	-6.26	126.61	98.0	64.4	7.83	0.6234	0.0394	1905311012
CE04A	45.740	7.7453	-6.38	129.17	226.4	70.9	6.39	0.4874	0.0283	1906240253
CE04A	45.740	7.7453	-0.49	126.18	19.5	68.5	7.30	0.8205	0.0843	1907071508
CE04A	45.740	7.7453	-5.69	126.66	91.0	64.7	7.76	1.3103	0.1227	1909290202
CE04A	45.740	7.7453	-6.80	125.20	19.5	65.2	8.03	0.7340	0.0793	1910290104
CE04A	45.740	7.7453	-6.94	125.31	19.9	65.0	8.03	0.3912	0.2440	1910310111
CE05A	45.685	7.8551	-57.49	-66.29	33.6	216.7	5.99	0.3681	0.1224	1810292017

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CE05A	45.685	7.8551	5.86	126.89	83.2	64.4	7.77	0.3449	0.0544	1812290339
CE05A	45.685	7.8551	9.78	126.60	19.5	62.1	8.24	0.4057	0.2107	1902081155
CE05A	45.685	7.8551	1.65	126.44	65.2	67.6	7.39	0.5038	0.3057	1903240437
CE05A	45.685	7.8551	1.81	122.63	19.5	73.0	7.38	1.0346	0.0606	1904121140
CE05A	45.685	7.8551	11.71	125.30	84.8	61.9	8.56	1.0035	0.0526	1904230537
CE05A	45.685	7.8551	6.26	126.61	98.0	64.5	7.84	0.7699	0.2665	1905311012
CE05A	45.685	7.8551	6.38	129.17	226.4	71.1	6.40	0.7452	0.0435	1906240253
CE05A	45.685	7.8551	0.49	126.18	19.5	68.6	7.30	1.3720	0.0813	1907071508
CE05A	45.685	7.8551	5.69	126.66	91.0	64.8	7.77	1.5481	0.1440	1909290202
CE05A	45.685	7.8551	6.94	125.31	19.9	65.1	8.04	1.4171	0.0876	1910310111
CE05A	45.685	7.8551	1.56	126.39	59.0	67.6	7.38	0.2845	0.1529	1911141617
CE06A	45.627	7.9818	5.86	126.89	83.2	64.5	7.78	0.5776	0.0807	1812290339
CE06A	45.627	7.9818	3.47	146.07	10.2	53.3	5.54	1.4210	0.2191	1901171506
CE06A	45.627	7.9818	14.62	70.10	258.6	251.3	9.71	1.2115	0.1033	1903010850
CE06A	45.627	7.9818	6.85	125.03	549.6	74.8	6.62	0.1637	0.0712	1904062155
CE06A	45.627	7.9818	1.81	122.63	19.5	73.2	7.39	0.6756	0.0601	1904121140
CE06A	45.627	7.9818	11.71	125.30	84.8	62.0	8.57	0.6584	0.0794	1904230537
CE06A	45.627	7.9818	6.38	129.17	226.4	71.2	6.41	1.2692	0.0288	1906240253
CE06A	45.627	7.9818	0.49	126.18	19.5	68.7	7.31	1.4828	0.0455	1907071508
CE06A	45.627	7.9818	1.56	126.39	59.0	67.7	7.39	1.2550	0.0529	1911141617
CE07A	45.567	8.1720	0.26	119.90	19.5	74.3	7.80	0.7674	0.1094	1809281002
CE07A	45.567	8.1720	58.42	26.33	164.8	198.1	7.42	0.2332	0.0613	1812110226
CE07A	45.567	8.1720	5.86	126.89	83.2	64.7	7.79	0.9517	0.0782	1812290339

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CE07A	45.567	8.1720	11.71	125.30	84.8	62.2	8.58	0.3496	0.0663	1904230537
CE07A	45.567	8.1720	29.00	139.37	434.8	41.3	9.47	0.2703	0.1049	1906040439
CE07A	45.567	8.1720	0.49	126.18	19.5	68.9	7.33	0.7826	0.0851	1907071508
CI01A	46.504	4.7212	0.00	119.76	10.0	71.3	7.57	1.1948	0.1183	1809281014
CI01A	46.504	4.7212	42.87	42.28	19.5	153.3	9.28	0.6481	0.1108	1901221901
CI01A	46.504	4.7212	2.72	100.20	19.5	88.0	9.22	0.8975	0.1411	1902020927
CI02A	46.439	4.8174	0.00	119.76	10.0	71.4	7.58	1.3547	0.0757	1809281014
CI02A	46.439	4.8174	17.29	147.87	10.2	37.1	7.42	1.2665	0.4633	1810260905
CI02A	46.439	4.8174	7.43	128.75	159.0	69.2	6.16	0.0045	0.0479	1812011327
CI02A	46.439	4.8174	6.04	149.90	19.5	47.8	4.99	0.4637	0.1208	1812192137
CI02A	46.439	4.8174	42.87	42.28	19.5	153.3	9.29	1.1079	0.0936	1901221901
CI03A	46.421	4.9455	0.26	119.90	19.5	71.6	7.54	0.2770	0.0378	1809281002
CI03A	46.421	4.9455	0.00	119.76	10.0	71.5	7.59	1.5665	0.2224	1809281014
CI03A	46.421	4.9455	1.06	119.96	10.0	72.1	7.47	1.3681	0.1830	1809281025
CI04A	46.402	5.0743	42.87	42.28	19.5	153.5	9.31	0.5223	0.1560	1901221901
CI05A	46.277	5.3345	1.06	119.96	10.0	72.4	7.49	1.2095	0.1553	1809281025
CI05A	46.277	5.3345	1.65	126.44	65.2	65.4	7.21	0.0324	0.1228	1903240437
CI05A	46.277	5.3345	60.03	26.63	124.2	196.2	7.22	0.2716	0.0822	1908272355
CI05A	46.277	5.3345	6.87	125.24	34.8	63.1	7.86	0.0161	0.1148	1910290242
CI05A	46.277	5.3345	1.64	132.86	9.8	60.0	6.74	0.2371	0.1292	1911231211
CI06A	46.282	5.4496	10.34	119.05	19.5	79.8	6.72	0.3987	0.0763	1901212359
CI06A	46.282	5.4496	29.00	139.37	434.8	39.2	9.36	0.3377	0.0487	1906040439
CI06A	46.282	5.4496	31.80	71.45	55.9	238.7	7.92	0.0303	0.1514	1911042153

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI07A	46.231	-5.5241	-10.46	120.17	10.0	79.2	6.62	-0.4238	0.1723	1810020016
CI07A	46.231	-5.5241	-30.11	-71.58	61.3	240.0	8.07	-0.0305	0.3285	1901200132
CI07A	46.231	-5.5241	-10.34	119.05	19.5	79.9	6.73	-0.0121	0.1786	1901212359
CI07A	46.231	-5.5241	-10.37	119.05	19.5	80.0	6.73	-0.0144	0.1773	1901220510
CI07A	46.231	-5.5241	-42.87	-42.28	19.5	153.8	9.36	-0.0046	0.0551	1901221901
CI07A	46.231	-5.5241	-5.52	133.85	9.8	64.2	6.03	-0.0272	0.3418	1901260812
CI07A	46.231	-5.5241	-2.72	100.20	19.5	88.6	9.30	-0.0113	0.1311	1902020927
CI07A	46.231	-5.5241	-2.78	100.26	19.5	88.6	9.29	-0.0097	0.1310	1902021059
CI07A	46.231	-5.5241	-9.78	126.60	19.5	60.1	8.08	-0.0419	0.4250	1902081155
CI07A	46.231	-5.5241	-6.85	125.03	549.6	72.6	6.46	-0.1952	0.0530	1904062155
CI07A	46.231	-5.5241	-31.80	-71.45	55.9	238.7	7.91	-1.8757	0.4471	1911042153
CI08A	46.185	-5.6842	-17.29	147.87	10.2	37.9	7.44	-0.4694	0.0833	1810260905
CI08A	46.185	-5.6842	-10.37	119.05	19.5	80.2	6.74	-0.6585	0.0788	1901220510
CI08A	46.185	-5.6842	-7.00	156.40	384.4	42.1	4.58	-0.8294	0.3038	1901260351
CI08A	46.185	-5.6842	-5.69	126.66	91.0	62.9	7.62	-1.2057	0.3176	1909290202
CI09A	46.193	-5.8187	-12.22	146.24	10.0	42.1	6.97	-0.4719	0.1859	1809230552
CI09A	46.193	-5.8187	-7.43	128.75	159.0	70.2	6.22	-0.6023	0.1002	1812011327
CI09A	46.193	-5.8187	-10.37	119.05	19.5	80.3	6.75	-0.8538	0.0843	1901220510
CI09A	46.193	-5.8187	-8.52	127.04	15.6	60.9	7.92	-0.6865	0.1300	1903060013
CI09A	46.193	-5.8187	-55.76	-27.85	74.2	198.9	7.71	-0.0111	0.1160	1904051614
CI10A	46.105	-5.9172	-0.26	119.90	19.5	72.4	7.62	-0.1711	0.0390	1809281002
CI10A	46.105	-5.9172	-58.42	-26.33	164.8	197.1	7.42	-1.3135	0.0682	1812110226
CI10A	46.105	-5.9172	-30.11	-71.58	61.3	240.2	8.05	-0.0236	0.2471	1901200132

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI11A	46.087	-6.0314	-58.42	-26.33	164.8	197.1	7.42	-1.0427	0.0921	1812110226
CI11A	46.087	-6.0314	-10.34	119.05	-19.5	80.3	6.76	-0.0942	0.0732	1901212359
CI11A	46.087	-6.0314	-2.78	100.26	-19.5	89.0	9.35	-0.8960	0.1927	1902021059
CI11A	46.087	-6.0314	-29.00	139.37	434.8	39.7	9.38	-0.6820	0.2361	1906040439
CI11A	46.087	-6.0314	-0.49	126.18	-19.5	67.0	7.17	-0.6936	0.0319	1907071508
CI12A	46.053	-6.1727	-58.42	-26.33	164.8	197.2	7.42	-1.0550	0.1108	1812110226
CI12A	46.053	-6.1727	-5.86	126.89	-83.2	62.9	7.65	-0.0273	0.0413	1812290339
CI12A	46.053	-6.1727	-7.00	156.40	384.4	42.8	4.59	-0.9258	0.1733	1901260351
CI12A	46.053	-6.1727	-29.00	139.37	434.8	39.8	9.38	-0.6696	0.0703	1906040439
CI12A	46.053	-6.1727	-6.38	129.17	226.4	69.5	6.29	-0.5003	0.0529	1906240253
CI12A	46.053	-6.1727	-0.49	126.18	-19.5	67.1	7.18	-0.7010	0.0255	1907071508
CI12A	46.053	-6.1727	-6.80	125.20	-19.5	63.9	7.91	-0.4365	0.0629	1910290104
CI12A	46.053	-6.1727	-6.94	125.31	-19.9	63.7	7.92	-0.9995	0.1303	1910310111
CI13A	45.994	-6.2554	-0.00	119.76	-10.0	72.6	7.69	-1.8037	0.1709	1809281014
CI13A	45.994	-6.2554	-4.94	151.71	139.8	46.8	5.02	-0.3421	0.2386	1810102200
CI13A	45.994	-6.2554	-5.86	126.89	-83.2	63.0	7.66	-0.0133	0.0877	1812290339
CI13A	45.994	-6.2554	-7.00	156.40	384.4	42.9	4.59	-0.7991	0.0959	1901260351
CI13A	45.994	-6.2554	-29.00	139.37	434.8	39.9	9.38	-1.0184	0.0821	1906040439
CI14A	46.004	-6.3926	-1.06	119.96	-10.0	73.3	7.57	-1.7214	0.4915	1809281025
CI14A	46.004	-6.3926	-2.27	126.85	-66.8	65.6	7.31	-1.0425	0.1084	1901061727
CI14A	46.004	-6.3926	-42.87	-42.28	19.5	154.4	9.44	-0.7778	0.0786	1901221901
CI14A	46.004	-6.3926	-55.76	-27.85	74.2	199.1	7.72	-0.0462	0.2071	1904051614
CI15A	46.005	-6.5370	-0.26	119.90	-19.5	73.0	7.67	-0.3478	0.0340	1809281002

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI15A	46.005	-6.5370	-4.94	151.71	139.8	47.2	5.03	-0.9066	0.2099	1810102200
CI15A	46.005	-6.5370	-57.30	-66.37	63.3	216.4	6.03	-0.0711	0.1547	1810290654
CI15A	46.005	-6.5370	-5.86	126.89	-83.2	63.2	7.68	-0.0152	0.0767	1812290339
CI15A	46.005	-6.5370	-5.52	133.85	-9.8	65.2	6.08	-0.4599	0.1246	1901260812
CI15A	46.005	-6.5370	-9.78	126.60	-19.5	61.0	8.15	-0.4844	0.2110	1902081155
CI15A	46.005	-6.5370	-6.94	146.46	139.5	54.2	5.15	-1.0375	0.0683	1905062119
CI15A	46.005	-6.5370	-2.16	138.50	-19.5	58.7	6.06	-0.4506	0.0900	1906191724
CI15A	46.005	-6.5370	-19.79	144.47	409.8	40.6	7.87	-1.1455	0.0290	1906281551
CI15A	46.005	-6.5370	-0.49	126.18	-19.5	67.4	7.21	-0.6778	0.0558	1907071508
CI15A	46.005	-6.5370	-60.03	-26.63	124.2	196.7	7.23	-0.8547	0.0277	1908272355
CI15A	46.005	-6.5370	-1.56	126.39	-59.0	66.5	7.29	-0.7970	0.0410	1911141617
CI16A	45.925	-6.6170	-0.26	119.90	-19.5	73.0	7.67	-0.6229	0.0386	1809281002
CI16A	45.925	-6.6170	-1.06	119.96	-10.0	73.5	7.59	-0.4874	0.1644	1809281025
CI16A	45.925	-6.6170	-35.87 -	101.03	18	253.1	5.33	-0.0334	0.2491	1812190137
CI16A	45.925	-6.6170	-42.87	-42.28	19.5	154.6	9.46	-0.0054	0.0569	1901221901
CI16A	45.925	-6.6170	-5.52	133.85	-9.8	65.3	6.09	-0.0277	0.3249	1901260812
CI16A	45.925	-6.6170	-2.72	100.20	-19.5	89.5	9.43	-0.0097	0.1283	1902020927
CI16A	45.925	-6.6170	-2.78	100.26	-19.5	89.4	9.42	-0.0110	0.1277	1902021059
CI16A	45.925	-6.6170	-9.78	126.60	-19.5	61.1	8.15	-0.0456	0.4047	1902081155
CI16A	45.925	-6.6170	-10.35	126.12	-62.1	61.2	8.24	-1.5484	0.1891	1903081506
CI16A	45.925	-6.6170	-11.71	125.30	-84.8	60.9	8.47	-1.0051	0.0516	1904230537
CI16A	45.925	-6.6170	-6.94	146.46	139.5	54.3	5.15	-0.9850	0.0723	1905062119
CI16A	45.925	-6.6170	-4.10	152.61	-19.5	45.7	5.08	-0.8694	0.1868	1905141258

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI16A	45.925	-6.6170	-29.00	139.37	434.8	40.1	9.40	-0.9680	0.0709	1906040439
CI16A	45.925	-6.6170	-2.16	138.50	-19.5	58.8	6.06	-1.3793	0.1107	1906191724
CI16A	45.925	-6.6170	-6.38	129.17	226.4	69.9	6.32	-0.5927	0.0624	1906240253
CI16A	45.925	-6.6170	-19.79	144.47	409.8	40.7	7.87	-1.3315	0.0520	1906281551
CI16A	45.925	-6.6170	-0.49	126.18	-19.5	67.5	7.21	-0.8738	0.0392	1907071508
CI16A	45.925	-6.6170	-0.64	128.02	-9.8	66.7	6.95	-1.3038	0.1065	1907140910
CI16A	45.925	-6.6170	-60.03	-26.63	124.2	196.8	7.23	-1.3241	0.0545	1908272355
CI17A	45.947	-6.7180	-0.26	119.90	-19.5	73.1	7.69	-0.4495	0.0705	1809281002
CI17A	45.947	-6.7180	-10.46	120.17	-10.0	80.3	6.72	-1.4507	0.2269	1810020016
CI17A	45.947	-6.7180	-7.45	114.43	-19.5	82.3	7.48	-0.0878	0.1087	1810101844
CI17A	45.947	-6.7180	-5.86	126.89	-83.2	63.4	7.69	-0.0272	0.1362	1812290339
CI17A	45.947	-6.7180	-30.11	-71.58	61.3	240.7	7.99	-0.3770	0.1061	1901200132
CI17A	45.947	-6.7180	-42.87	-42.28	19.5	154.6	9.46	-0.9240	0.1025	1901221901
CI17A	45.947	-6.7180	-10.35	126.12	-62.1	61.3	8.25	-0.6499	0.0917	1903081506
CI17A	45.947	-6.7180	-29.00	139.37	434.8	40.2	9.41	-0.7326	0.0746	1906040439
CI17A	45.947	-6.7180	-19.79	144.47	409.8	40.8	7.88	-0.8229	0.0342	1906281551
CI17A	45.947	-6.7180	-0.49	126.18	-19.5	67.6	7.22	-0.6969	0.0281	1907071508
CI17A	45.947	-6.7180	-6.80	125.15	-19.5	64.4	7.95	-0.3724	0.0796	1910161137
CI18A	45.900	-6.7699	-0.26	119.90	-19.5	73.2	7.69	-0.5447	0.0679	1809281002
CI18A	45.900	-6.7699	-10.51	120.24	-19.5	80.3	6.71	-0.5548	0.1480	1810012359
CI18A	45.900	-6.7699	-58.42	-26.33	164.8	197.5	7.42	-0.1933	0.0836	1812110226
CI18A	45.900	-6.7699	-42.87	-42.28	19.5	154.7	9.47	-1.2876	0.1389	1901221901
CI18A	45.900	-6.7699	-7.00	156.40	384.4	43.6	4.61	-0.0103	0.1471	1901260351

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI18A	45.900	-6.7699	-5.52	133.85	9.8	65.5	6.10	-0.0302	0.3543	1901260812
CI18A	45.900	-6.7699	-3.35	152.23	358.6	46.0	5.13	-0.2036	0.3078	1902171435
CI18A	45.900	-6.7699	-2.16	138.50	19.5	59.0	6.07	-0.4230	0.0856	1906191724
CI18A	45.900	-6.7699	-0.64	128.02	9.8	66.9	6.97	-1.3366	0.1783	1907140910
CI19A	45.945	-6.8987	-6.04	149.90	19.5	50.3	5.07	-0.8620	0.1875	1812192137
CI19A	45.945	-6.8987	-14.62	-70.10	258.6	250.6	9.81	-0.5240	0.0502	1903010850
CI19A	45.945	-6.8987	-55.76	-27.85	74.2	199.4	7.71	-1.1017	0.0813	1904051614
CI19A	45.945	-6.8987	-6.85	125.03	549.6	73.8	6.55	-1.8740	0.1424	1904062155
CI19A	45.945	-6.8987	-1.81	122.63	19.5	72.2	7.31	-0.7696	0.0560	1904121140
CI19A	45.945	-6.8987	29.00	139.37	434.8	40.3	9.42	-1.2433	0.1255	1906040439
CI19A	45.945	-6.8987	-2.16	138.50	19.5	59.0	6.08	-1.3913	0.0837	1906191724
CI19A	45.945	-6.8987	-0.49	126.18	19.5	67.7	7.24	-0.9356	0.0420	1907071508
CI19A	45.945	-6.8987	-60.03	-26.63	124.2	196.9	7.22	-0.7249	0.0415	1908272355
CI19A	45.945	-6.8987	-35.41	-73.17	13.1	237.9	7.35	-0.7925	0.0687	1909291557
CI19A	45.945	-6.8987	-1.56	126.39	59.0	66.8	7.32	-1.5790	0.0520	1911141617
CI21A	45.724	-7.1389	-0.26	119.90	19.5	73.5	7.71	-1.0832	0.0989	1809281002
CI21A	45.724	-7.1389	-0.00	119.76	10.0	73.4	7.75	-1.5397	0.0906	1809281014
CI21A	45.724	-7.1389	-5.86	126.89	83.2	63.8	7.72	-0.8406	0.0842	1812290339
CI21A	45.724	-7.1389	-10.34	119.05	19.5	81.3	6.85	-0.1473	0.2306	1901212359
CI21A	45.724	-7.1389	-10.37	119.05	19.5	81.5	6.85	-0.2566	0.1864	1901220510
CI21A	45.724	-7.1389	-7.00	156.40	384.4	44.1	4.62	-0.9413	0.2628	1901260351
CI21A	45.724	-7.1389	-6.38	129.17	226.4	70.4	6.35	-0.9671	0.0372	1906240253
CI21A	45.724	-7.1389	-0.49	126.18	19.5	68.0	7.25	-1.1114	0.0520	1907071508

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI21A	45.724	-7.1389	-18.05	120.33	9.8	86.7	6.12	-1.1557	0.1200	1907140539
CI21A	45.724	-7.1389	-0.92	128.60	9.8	67.1	6.92	-0.0895	0.1605	1909141621
CI22A	45.684	-7.1415	-0.26	119.90	19.5	73.5	7.71	-0.7957	0.0723	1809281002
CI22A	45.684	-7.1415	-0.00	119.76	10.0	73.4	7.75	-1.9444	0.1960	1809281014
CI22A	45.684	-7.1415	-0.49	126.18	19.5	68.0	7.24	-0.9683	0.0948	1907071508
CI22A	45.684	-7.1415	-18.05	120.33	9.8	86.7	6.12	-0.9249	0.1636	1907140539
CI23A	45.678	-7.2388	-0.26	119.90	19.5	73.6	7.72	-1.0696	0.0717	1809281002
CI23A	45.678	-7.2388	-10.46	120.17	10.0	80.8	6.75	-0.3726	0.1663	1810020016
CI23A	45.678	-7.2388	-23.04	112.66	10.2	96.6	6.36	-0.0229	0.2452	1812161426
CI23A	45.678	-7.2388	-5.86	126.89	83.2	63.9	7.72	-0.3909	0.0632	1812290339
CI23A	45.678	-7.2388	-2.27	126.85	66.8	66.4	7.36	-0.4645	0.0964	1901061727
CI23A	45.678	-7.2388	-8.52	127.04	15.6	62.2	8.01	-0.4764	0.0846	1903060013
CI23A	45.678	-7.2388	-55.76	-27.85	74.2	199.6	7.73	-0.0351	0.1391	1904051614
CI23A	45.678	-7.2388	-11.71	125.30	84.8	61.5	8.51	-0.8582	0.0591	1904230537
CI23A	45.678	-7.2388	-6.91	160.18	19.5	39.6	4.49	-1.3872	0.1619	1905030725
CI23A	45.678	-7.2388	-6.26	126.61	98.0	64.0	7.78	-0.5985	0.0725	1905311012
CI23A	45.678	-7.2388	-6.38	129.17	226.4	70.5	6.36	-0.9549	0.0367	1906240253
CI23A	45.678	-7.2388	-0.49	126.18	19.5	68.1	7.25	-0.8975	0.0462	1907071508
CI23A	45.678	-7.2388	-6.80	125.20	19.5	64.8	7.98	-0.7865	0.0844	1910290104
CI23A	45.678	-7.2388	-1.56	126.39	59.0	67.1	7.33	-1.1949	0.1322	1911141617
CI24A	45.650	-7.2530	-0.26	119.90	19.5	73.6	7.72	-1.0694	0.0929	1809281002
CI24A	45.650	-7.2530	-5.86	126.89	83.2	63.9	7.72	-0.3099	0.0539	1812290339
CI24A	45.650	-7.2530	-6.85	125.03	549.6	74.2	6.57	-0.1893	0.0861	1904062155

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI24A	45.650	-7.2530	-11.71	125.30	-84.8	61.5	8.50	-0.8582	0.0459	1904230537
CI24A	45.650	-7.2530	-6.94	146.46	139.5	55.1	5.17	-0.0734	0.2975	1905062119
CI24A	45.650	-7.2530	-6.38	129.17	226.4	70.6	6.36	-1.0258	0.0482	1906240253
CI24A	45.650	-7.2530	-0.49	126.18	-19.5	68.1	7.25	-0.9026	0.0457	1907071508
CI24A	45.650	-7.2530	-4.44	101.28	-19.5	90.3	9.18	-1.0278	0.0605	1910142223
CI24A	45.650	-7.2530	-6.80	125.20	-19.5	64.9	7.98	-0.9197	0.0646	1910290104
CI24A	45.650	-7.2530	-1.64	132.86	-9.8	61.8	6.84	-0.5526	0.0733	1911231211
CI25A	45.629	-7.3243	-0.26	119.90	-19.5	73.7	7.73	-0.9740	0.0663	1809281002
CI25A	45.629	-7.3243	-1.06	119.96	-10.0	74.2	7.64	-0.6391	0.1449	1809281025
CI25A	45.629	-7.3243	-5.86	126.89	-83.2	64.0	7.72	-0.4368	0.0366	1812290339
CI25A	45.629	-7.3243	-10.37	119.05	-19.5	81.7	6.86	-0.9757	0.0780	1901220510
CI25A	45.629	-7.3243	-11.71	125.30	-84.8	61.5	8.51	-0.5712	0.0546	1904230537
CI25A	45.629	-7.3243	-6.26	126.61	-98.0	64.1	7.78	-1.7950	0.3814	1905311012
CI25A	45.629	-7.3243	-6.38	129.17	226.4	70.6	6.36	-1.0434	0.0566	1906240253
CI25A	45.629	-7.3243	-0.49	126.18	-19.5	68.2	7.26	-0.9086	0.0999	1907071508
CI25A	45.629	-7.3243	-6.80	125.20	-19.5	64.9	7.98	-1.1708	0.1304	1910290104
CI25A	45.629	-7.3243	-1.56	126.39	-59.0	67.2	7.34	-0.2650	0.0838	1911141617
CI26A	45.596	-7.3907	-10.37	119.05	-19.5	81.7	6.87	-1.1453	0.2121	1901220510
CI26A	45.596	-7.3907	-10.09	152.09	-10.2	51.7	4.62	-0.7148	0.2772	1903101248
CI26A	45.596	-7.3907	-0.49	126.18	-19.5	68.2	7.26	-1.1745	0.0782	1907071508
CI27A	45.596	-7.4880	-10.46	120.17	-10.0	81.0	6.77	-0.3866	0.4755	1810020016
CI28A	45.556	-7.5737	-11.71	125.30	-84.8	61.7	8.53	-0.4497	0.1141	1904230537
CI29A	45.538	-7.6631	-6.26	126.61	-98.0	64.4	7.81	-0.4439	0.2432	1905311012

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI29A	45.538	-7.6631	-6.38	129.17	226.4	71.0	6.38	-1.0928	0.1515	1906240253
CI29A	45.538	-7.6631	-0.49	126.18	19.5	68.5	7.28	-0.7900	0.3852	1907071508
CI29A	45.538	-7.6631	-6.26	126.61	98.0	64.4	7.81	-0.4439	0.2432	1905311012
CI29A	45.538	-7.6631	-6.38	129.17	226.4	71.0	6.38	-1.0928	0.1515	1906240253
CI29A	45.538	-7.6631	-0.49	126.18	19.5	68.5	7.28	-0.7900	0.3852	1907071508
CI30A	45.524	-7.7104	-6.04	149.90	19.5	51.5	5.08	-1.1889	0.2453	1812192137
CI30A	45.524	-7.7104	-0.49	126.18	19.5	68.5	7.28	-1.2315	0.1096	1907071508
CI30A	45.524	-7.7104	-0.92	128.60	9.8	67.6	6.95	-0.4890	0.2897	1909141621
CI31A	45.441	-7.8122	-14.62	-70.10	258.6	251.2	9.74	-0.5816	0.0492	1903010850
CI31A	45.441	-7.8122	-29.00	139.37	434.8	41.0	9.43	-0.6504	0.1497	1906040439
CI31A	45.441	-7.8122	-6.80	125.15	19.5	65.4	8.02	-0.4940	0.0762	1910161137
CI32A	45.359	-7.9062	-6.26	126.61	98.0	64.6	7.82	-0.7431	0.1956	1905311012
CI32A	45.359	-7.9062	-6.80	125.20	19.5	65.4	8.02	-0.4591	0.1371	1910290104
CI33A	45.288	-7.9447	-23.04	112.66	10.2	97.3	6.42	-0.9293	0.1217	1812161426
CI33A	45.288	-7.9447	-30.11	-71.58	61.3	241.3	7.93	-0.6535	0.1378	1901200132
CI33A	45.288	-7.9447	-9.78	126.60	19.5	62.2	8.22	-0.2719	0.0948	1902081155
CI33A	45.288	-7.9447	-19.79	144.47	409.8	41.9	7.89	-1.4684	0.0720	1906281551
CI34A	45.191	-8.0221	-29.00	139.37	434.8	41.2	9.42	-0.8557	0.1315	1906040439
CI36A	45.031	-8.1833	-10.46	120.17	10.0	81.8	6.82	-1.1712	0.2383	1810020016
CI36A	45.031	-8.1833	-10.37	119.05	19.5	82.6	6.93	-0.7112	0.0744	1901220510
CI36A	45.031	-8.1833	-2.72	100.20	19.5	90.6	9.62	-0.0929	0.2266	1902020927
CI36A	45.031	-8.1833	-11.71	125.30	84.8	62.3	8.55	-0.3814	0.0714	1904230537
CI36A	45.031	-8.1833	-6.26	126.61	98.0	64.9	7.83	-0.8216	0.1222	1905311012

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI37A	44.952	-8.2530	-23.04	112.66	10.2	97.6	6.45	-1.4554	0.4135	1812161426
CI37A	44.952	-8.2530	-6.26	126.61	98.0	65.0	7.83	-0.3742	0.1807	1905311012
CI37A	44.952	-8.2530	-5.97	149.59	77.3	52.8	5.10	-0.9196	0.1089	1907150821
CI37A	44.952	-8.2530	-0.92	128.60	9.8	68.3	6.97	-0.7664	0.2996	1909141621
CI37A	44.952	-8.2530	-6.80	125.15	19.5	65.8	8.03	-0.0407	0.0936	1910161137
CI38A	44.762	-8.4124	-57.30	-66.37	63.3	216.7	6.05	-0.0020	0.0200	1810290654
CI38A	44.762	-8.4124	-57.49	-66.29	33.6	216.6	6.04	-0.0013	0.0212	1810292017
CI38A	44.762	-8.4124	-14.62	-70.10	258.6	251.6	9.71	-0.5057	0.0510	1903010850
CI38A	44.762	-8.4124	-11.71	125.30	84.8	62.5	8.55	-0.0356	0.1141	1904230537
CI38A	44.762	-8.4124	-6.26	126.61	98.0	65.1	7.83	-1.3133	0.1998	1905311012
CI38A	44.762	-8.4124	-19.79	144.47	409.8	42.4	7.87	-0.0079	0.0850	1906281551
CI38A	44.762	-8.4124	-0.49	126.18	19.5	69.3	7.31	-0.0235	0.2395	1907071508
CI38A	44.762	-8.4124	-0.64	128.02	9.8	68.6	7.05	-0.0216	0.2307	1907140910
CI38A	44.762	-8.4124	-5.97	149.59	77.3	53.0	5.09	-0.0113	0.1240	1907150821
CI38A	44.762	-8.4124	-6.80	125.20	19.5	66.0	8.03	-0.0554	0.3688	1910290104
CI38A	44.762	-8.4124	-6.87	125.24	34.8	65.9	8.03	-0.0287	0.3667	1910290242
CI38A	44.762	-8.4124	-6.94	125.31	19.9	65.7	8.03	-0.0234	0.3639	1910310111
CI38A	44.762	-8.4124	-31.80	-71.45	55.9	240.1	7.77	-0.0203	0.2100	1911042153
CI38A	44.762	-8.4124	-1.64	132.86	9.8	63.1	6.88	-0.0321	0.3138	1911231211
CI38A	44.762	-8.4124	-18.35	-70.45	9.8	249.3	9.30	-0.0295	0.3405	1912030846
CI39A	44.674	-8.4731	-57.30	-66.37	63.3	216.7	6.05	-1.1151	0.1490	1810290654
CI39A	44.674	-8.4731	-2.72	100.20	19.5	90.8	9.66	-0.0927	0.2980	1902020927
CI39A	44.674	-8.4731	-60.03	-26.63	124.2	197.5	7.34	-0.9247	0.0259	1908272355

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CI39A	44.674	-8.4731	-1.64	132.86	-9.8	63.2	6.88	-0.1997	0.1510	1911231211
CI40A	44.605	-8.5230	-2.72	100.20	-19.5	90.9	9.66	-1.9685	0.2516	1902020927
CI40A	44.605	-8.5230	-2.16	138.50	-19.5	61.2	6.12	-0.7546	0.0745	1906191724
CI40A	44.605	-8.5230	-18.05	120.33	-9.8	88.3	6.22	-0.7765	0.2318	1907140539
CI40A	44.605	-8.5230	-0.92	128.60	-9.8	68.6	6.97	-0.2667	0.2197	1909141621
CI41A	44.530	-8.5343	-14.62	-70.10	258.6	251.7	9.71	-1.1041	0.0740	1903010850
CI41A	44.530	-8.5343	-6.85	125.03	549.6	75.7	6.64	-0.4293	0.0606	1904062155
CI41A	44.530	-8.5343	-30.00	-72.11	9.8	241.9	7.90	-0.5665	0.0411	1906140019
CI41A	44.530	-8.5343	-6.38	129.17	226.4	72.1	6.41	-0.4470	0.0766	1906240253
CI41A	44.530	-8.5343	-19.79	144.47	409.8	42.6	7.85	-0.7258	0.0398	1906281551
CI41A	44.530	-8.5343	-60.03	-26.63	124.2	197.6	7.35	-0.7816	0.0243	1908272355
CI41A	44.530	-8.5343	-35.41	-73.17	13.1	238.4	7.33	-0.7712	0.0424	1909291557
CI42A	44.462	-8.5805	-10.37	119.05	-19.5	83.1	6.95	-1.1350	0.2285	1901220510
CI42A	44.462	-8.5805	-42.87	-42.28	19.5	155.9	9.78	-0.8690	0.0501	1901221901
CI42A	44.462	-8.5805	-6.38	129.17	226.4	72.2	6.41	-0.6015	0.0986	1906240253
CI42A	44.462	-8.5805	-35.41	-73.17	13.1	238.4	7.33	-1.2119	0.0655	1909291557
CI43A	44.397	-8.6165	-42.87	-42.28	19.5	155.9	9.80	-0.9450	0.0675	1901221901
CI43A	44.397	-8.6165	-3.35	152.23	358.6	48.8	5.12	-0.6969	0.0964	1902171435
CI43A	44.397	-8.6165	-14.62	-70.10	258.6	251.7	9.70	-0.6959	0.0911	1903010850
CI43A	44.397	-8.6165	-6.38	129.17	226.4	72.3	6.41	-0.3171	0.0641	1906240253
CI43A	44.397	-8.6165	-34.17	-72.38	19.7	238.9	7.50	-0.8792	0.0723	1908011828
CI43A	44.397	-8.6165	-35.41	-73.17	13.1	238.4	7.33	-1.0847	0.0803	1909291557
CW01A	45.433	-7.2591	-57.49	-66.29	33.6	216.4	6.04	-0.2244	0.4004	1810292017

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CW01A	45.433	-7.2591	-23.04	112.66	10.2	96.7	6.37	-0.7174	0.1679	1812161426
CW01A	45.433	-7.2591	-42.87	-42.28	19.5	155.0	9.57	-0.3877	0.1196	1901221901
CW01A	45.433	-7.2591	-0.49	126.18	-19.5	68.2	7.24	-0.8938	0.0544	1907071508
CW02A	45.433	-7.3747	-57.30	-66.37	63.3	216.5	6.04	-1.7705	0.1204	1810290654
CW02A	45.433	-7.3747	-57.49	-66.29	33.6	216.4	6.03	-0.2153	0.0996	1810292017
CW02A	45.433	-7.3747	-0.49	126.18	-19.5	68.3	7.25	-1.0730	0.0886	1907071508
CW02A	45.433	-7.3747	-0.92	128.60	-9.8	67.4	6.93	-0.0417	0.1917	1909141621
CW03A	45.407	-7.5053	-2.27	126.85	-66.8	66.7	7.37	-1.7258	0.1987	1901061727
CW03A	45.407	-7.5053	-11.71	125.30	-84.8	61.7	8.51	-0.5868	0.0836	1904230537
CW03A	45.407	-7.5053	-0.49	126.18	-19.5	68.4	7.26	-0.8621	0.1016	1907071508
CW03A	45.407	-7.5053	-6.80	125.20	-19.5	65.1	7.99	-0.5815	0.2034	1910290104
CW04A	45.367	-7.6128	-8.52	127.04	-15.6	62.5	8.02	-0.4399	0.0883	1903060013
CW04A	45.367	-7.6128	-0.49	126.18	-19.5	68.5	7.27	-1.0816	0.0850	1907071508
CW05A	45.324	-7.7318	-5.52	133.85	-9.8	66.6	6.14	-0.8727	0.1121	1901260812
CW05A	45.324	-7.7318	-6.80	125.20	-19.5	65.3	8.00	-0.7146	0.0854	1910290104
CT03A	44.324	-5.0275	-46.33	-35.07	33	159.7	9.43	-1.0060	0.0652	1307220701
CT04A	44.371	-5.1477	-46.33	-35.07	33	159.7	9.42	-1.4409	0.0996	1307220701
CT05A	44.370	-5.2677	-46.33	-35.07	33	159.8	9.43	-1.4937	0.0686	1307220701
CT06A	44.382	-5.3872	-3.23	100.59	-23.5	88.7	9.18	-0.8362	0.1189	1307060505
CT08A	44.412	-5.6051	-18.79	145.27	598.0	39.9	7.44	-0.6962	0.0466	1305140032
CT09A	44.429	-5.7144	-46.33	-35.07	33	160.1	9.44	-1.6600	0.0938	1307220701
CT10A	44.437	-5.7940	-46.33	-35.07	33	160.2	9.44	-1.9193	0.0602	1307220701
CT11A	44.454	-5.9026	-10.03	107.18	-11.1	89.3	7.83	-0.9164	0.0895	1306131647

STA	STA LAT	STA LON	EV LAT	EV LON	DEP	BAZ	INC	SI	SIerr	EQ_ID (yy,mm,dd,hh,mm)
CT11A	44.454	5.9026	-5.43	-81.99	5	264.6	9.80	-1.6904	0.0501	1308120949
CT12A	44.475	5.9826	-46.33	-35.07	33	160.3	9.44	-1.8337	0.0526	1307220701
CT13A	44.460	6.0559	-46.33	-35.07	33	160.3	9.45	-1.9759	0.0929	1307220701
CT20A	44.585	6.5389	-46.33	-35.07	33	160.6	9.45	-1.3514	0.0864	1307220701
CT21A	44.654	6.5686	-3.23	100.59	23.5	89.5	9.31	-0.3706	0.1366	1307060505
CT21A	44.654	6.5686	-46.33	-35.07	33	160.7	9.44	-1.1207	0.0477	1307220701

Table S2 - Anisotropy parameters obtained from SI measurements

STA	ST LAT	ST LON	FPD	Time Delay (s)	FPDerr	TDerr
CE03A	45.786	7.6024	-0.78	0.74992	-11.2	0,639
CI07A	46.231	5.5241	-11.58	0.13265	-14.3	0,203
CI11A	46.087	6.0314	-0.32	0.83092	-12.8	1,75
CI15A	46.005	6.5370	-7.45	1.08421	-7.0	1,101
CI16A	45.925	6.6170	-2.58	1.09206	-2.1	1,304
CI17A	45.947	6.7180	-11.48	0.79153	-12.3	0,709
CI18A	45.900	6.7699	-15.11	0.64205	-21.3	1,154
CI19A	45.945	6.8987	-0.99	1.32372	-4.1	1,079
CI21A	45.724	7.1389	-37.08	1.03633	-36.2	0,871
CI23A	45.678	7.2388	-22.22	0.73735	-22.8	1,026
CI24A	45.650	7.2530	-37.75	0.92882	-32.4	0,781
CI38A	44.762	8.4124	-59.03	0.13426	-45.1	0,187
CI39A	44.674	8.4731	-43.54	1.00657	-79.8	1,005
CI41A	44.530	8.5343	-53.46	0.98773	-66.8	0,707
CI42A	44.462	8.5805	-76.64	2.17814	-79.3	1,755

STA	ST LAT	ST LON	FPD	Time Delay (s)	FPDerr	TDerr
CI43A	44.397	8.6165	-67.27	0.84845	-63.6	0,865
CW01A	45.433	7.2591	-1.35	0.88253	-5.7	1,428
CW02A	45.433	7.3747	-22.80	0.77871	-35.3	1,92