Natural Resources Canada | Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8226

Regional centroid moment tensor solutions for Eastern Canadian earthquakes: 2016

A.L. Bent

2019

Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8226

Regional centroid moment tensor solutions for Eastern Canadian earthquakes: 2016

A.L. Bent

2019

Permanent link: https://doi.org/10.4095/314592

This publication is available for free download through GEOSCAN (http://geoscan.nrcan.gc.ca/).

Recommended citation
Bent, A.L., 2019. Regional centroid moment tensor solutions for Eastern Canadian earthquakes: 2016; Geological Survey of Canada, Open File 8226, 24 p. https://doi.org/10.4095/314592

Publications in this series have not been edited; they are released as submitted by the author.

Abstract

Regional centroid moment tensor solutions have been determined for five moderate-sized earthquakes in eastern Canada during 2016. Four additional earthquakes were also evaluated but their solutions did not meet the minimum quality standards for acceptance. The moment tensor inversion method is used to determine the focal mechanism, depth and seismic moment of the earthquakes. These parameters, in turn, provide information about the seismotectonic environment in which the earthquakes occur and may help improve seismic hazard estimates. Focal mechanisms determined from first motions for four small earthquakes in New Brunswick are also included. The purpose of this report is not to provide an in-depth analysis of any specific earthquake but to catalog the solutions and data used to obtain them to make them available for future research projects.

Introduction

Earthquake focal mechanisms provide information about the orientation and direction of motion on the fault that generated the earthquake. A suite of focal mechanisms from a particular region can be used to improve the understanding of the seismotectonic environment in which the earthquakes occur. In the past, focal mechanisms were most often determined by the polarity distribution of first motions. This method is time-consuming and requires a large number of clear readings from a wide variety of azimuths, which makes it difficult to obtain unique solutions for smaller earthquakes or those occurring in regions, such as the offshore, where the station density is low and azimuthal coverage poor. The moment tensor inversion, which makes use of a longer portion of the waveform, is a more robust and more objective method to determine focal mechanisms. The moment tensor solutions also provide the hypocentral depth, which has implications for seismic hazard as well as information about regional seismotectonics, and seismic moment (and moment magnitude), which is generally considered the best measure of earthquake size. However, moment tensors use relatively long-period data and they, too, do not always result in good-quality solutions for smaller earthquakes, which do not always have a good signal to noise (S:N) ratio at the frequencies of interest, roughly 0.06-0.03 HZ. Having said that, since roughly 2005-2006 when the regional centroid moment tensor (RCMT) method was implemented in eastern Canada there has been an increase in the percentage of magnitude 4+ earthquakes for which focal mechanisms could be determined. The impact is most notable in the north where it was difficult to obtain focal mechanism solutions based on first motions for all but the few earthquakes large enough to be well-recorded at teleseismic distances. For example, Bent et al (2003) were able to obtain focal mechanisms for only four of fourteen events evaluated in the region extending from the Labrador Sea to northern Baffin Bay-Baffin Island during the period 1994-2000. From 2011 through 2015 twenty-two solutions were obtained via the RCMT inversion method for twenty-seven events evaluated in the same region (Bent, 2015a.b, 2017) and another five out of nine for 2016.

For seismological purposes eastern Canada is roughly defined as east of 100°W longitude. Some judgment calls in whether to treat earthquakes as western or eastern, however, are made in the case of the extreme north where lines of longitude are close together and where the m_N or Nuttli magnitude scale (Nuttli, 1973) used for eastern Canada may be used as the primary or database magnitude for earthquakes west of this line. As a general practice earthquakes falling within the territory of the United States or Greenland are not included although exceptions may be made in the case of any event close to the border that was widely felt in Canada. In some cases the closest seismograph station to the earthquake may be in the United States or Greenland even if the earthquake is in Canada. With respect to offshore earthquakes there are no strict criteria used to determine which earthquakes to study but most earthquakes occurring close enough to Canadian territory to have been recorded by a reasonable number of seismograph stations at distances between 150 and 1500 km will be evaluated.

RCMT solutions for all of Canada through the end of 2010 were summarized by Kao et al. (2012) and Bent (2015a,b, 2017) catalogued eastern solutions for 2011-2015. The current paper catalogs the RCMT solutions for eastern Canada in 2016. Solutions that met the minimum quality criteria, discussed in the RCMT Inversion Method section, were obtained for five out of nine earthquakes evaluated. This report is the fourth in a series of RCMT summaries for eastern Canada intended to be produced on an annual basis although other options for the dissemination of RCMT solutions, such as the creation of an online database are being explored. It should be noted that although this report focuses on eastern Canada, the RCMT method is also routinely applied to earthquakes in western Canada. (for example, Ristau, 2004; Ristau et al., 2007; Kao et al., 2012)

Regional Centroid Moment Tensor Inversion Method

Moment tensor inversion is one method by which earthquake focal mechanisms, or faulting parameters may be determined. It also provides additional source parameters including depth, seismic moment and source time function as well as a measure of any non-double couple component of the source. Note that source time function is generally not well resolved for small and moderate earthquakes because it is small relative to the frequencies modeled. For all earthquakes summarized in this paper a 1.0/1.0/1.0 (sec) time function is assumed. In the case of very large earthquakes, the default value may not be appropriate and a different value may be used. Because the RCMT method is based on fitting a relatively long portion of the recorded waveform and provides a quantitative measure of the fit, the RCMT is advantageous over other methods of focal mechanism determination, such as first motions which are based on a very small portion of the waveform, which can be difficult to accurately determine for small earthquakes or emergent arrivals or arrivals within the noise and which require a larger number of good quality recordings for a unique solution to be determined. In theory, an RCMT solution can be obtained from a single station. However, it is preferable to have more to ensure that the preferred solution is the one that provides the best fit for a range of azimuths and distances.

The RCMT method used to analyze Canadian earthquakes is that of Kao et al (1998). More details about the method may be found in that paper and an in-depth discussion of its implementation in Canada is covered by Kao et al (2012). Both papers also include references which provide supplementary background information on centroid moment tensors. The discussion below is focused on topics specifically related to eastern Canada.

In eastern Canada the RCMT inversion is run for all earthquakes of magnitude 4.0 or greater. Note that the Nuttli M_N magnitude is the most commonly used magnitude scale in eastern Canada but that M_L may be listed as the magnitude for offshore earthquakes for which the Lg wave is either not observed or is strongly attenuated. This minimum threshold is used only for identifying events large enough for the RCMT method to be a viable analysis tool and the selection is based on the value and not the magnitude type.

Moment magnitude, M_W, for eastern Canada is, on average, about 0.5 magnitude units smaller than M_N (Bent, 2011). Good quality solutions cannot always be obtained for the smallest earthquakes because the signal to noise ratio is generally poor at the long periods modeled. The default frequency range is 0.03-0.06 Hz but the inversion code will modify the range if there is sufficient long period energy in the data in other frequency bands, sufficient energy being roughly defined as a signal to noise ratio (S/N) of 2.0 or greater.

Data from three-component broadband (both bh* and hh*) stations are used in the inversion. Standard practice is to use only stations from which data are received in real time by the Geological Survey of Canada (GSC; CNWA, 2017). Data from additional stations may be added if an earthquake is of particular interest and if additional data are likely to improve the quality of the solution. For example, data from Greenland often help constrain the solutions for earthquakes occurring in Baffin Bay. Similarly, data from New England improve coverage for the southeastern offshore regions.

Two velocity models are used- one for southeastern Canada and one for the north. Essentially these are the same model, the only difference being the depth of the Moho discontinuity, which is at 40 km for the south and 35 km for the north. These are referred to as EM40 and EM35 models respectively. With the exception of the modified Moho depth the velocity model is that of Brune and Dorman (1963). The boundary between north and south is at approximately 60°N. If an earthquake occurs close to the boundary the inversion may be run with both models and the best solution selected. At some future point a suite of regional models may be implemented if there is evidence that this would improve the quality of the solutions. The current model is based on shield paths but it should be noted that even for those earthquakes that occur in the Appalachians most of the paths modeled are sufficiently long that there will be a strong shield component. This statement may not be true for all offshore events. The northern model is shown in Table 1. For the southeast the thickness of layer 3 is increased to 24 km. The lowermost layer is a mantle half-space.

Table 1
Velocity Model for Northeastern Canada

Layer	Thickness (km)	Vp (km/s)	Vs (km/s)	Density (g/cm^3)
1	6	5.64	3.47	2.70
2	10	6.15	3.64	2.80
3	19	6.60	3.85	2.85
4	-	8.10	4.72	3.30

Solutions are rated using the quality classification table in Kao et al. (2001). The classification consists of a character value from A through F based on the average misfit and a numerical value from 1 through 4 based on the compensated linear vector dipole (CLVD) component. Solutions must have a minimum quality of C4 to be accepted. Any user of these solutions should bear in mind that the quality classification is strictly based on the fit of the solutions to the data modeled and does not consider the number of components modeled. Solutions based on small numbers of modeled waveforms, roughly defined as three or fewer stations, should be used with some caution even if the fit is reasonably good.

Regional Centroid Moment Tensor Solutions for Eastern Canada

Nine earthquakes were evaluated (Figure 1 and Tables 2 and 3). Solutions of quality C4 or better were obtained for all events in Table 2. The events in Table 3 are those for which the solution quality was not acceptable. While the details of why a solution is not acceptable may vary from event to event, a rule of thumb is that the average misfit was in the D-F range and did not show an appreciable improvement for any combination of stations tested even if the data set was reduced to only the few best stations. A misfit value is not included in Table 3 because it is not necessarily representative of the best possible solution but would merely indicate the quality of the best solution obtained prior to deciding that further work on the event would be unlikely to produce a solution that met the quality criteria. For reference, the boundary between C (acceptable) and D (not acceptable) is for an average misfit of 0.7.

Table 2
Earthquakes Evaluated: Solutions Obtained

Date	Time (UT)	Lat (°N)	Lon (°W)	Mag (M_W)	Location/Region	Quality
2016-07-22	09:02:49	72.7208	74.8617	3.9	104 km E of Pond Inlet, NU	C1
2016-08-26	17:54:51	71.6491	69.8903	4.4	140 km N of Clyde River, NU	B2
2016-08-27	10:47:58	71.9613	75.1341	3.8	127 km SE of Pond Inlet, NU	C3
2016-10-20	17:49:45	62.1762	61.6214	4.0	Labrador Sea	C2
2016-12-02	15:22:59	60.0703	59.4049	4.1	Labrador Sea	C4

Table 3
Events Evaluated: No Acceptable Solution Obtained

Date	Time (UT)	Lat (°N)	Lon (°W)	Mag	Location/Region	Quality
2016-02-09	07:37:12	74.0578	72.1428	4.6 (M_L)	Baffin Bay	NA
2016-06-23	03:33:59	59.9829	56.0067	4.3 (M_L)	Labrador Sea	NA
2016-07-17	23:50:32	64.0522	86.7996	4.1(M_N)	Boothia-Ungava Seismic Zone	NA
2016-10-30	07:33:59	66.0921	85.6917	4.0 (M_N)	55 km SE of Repulse Bay, NU	NA

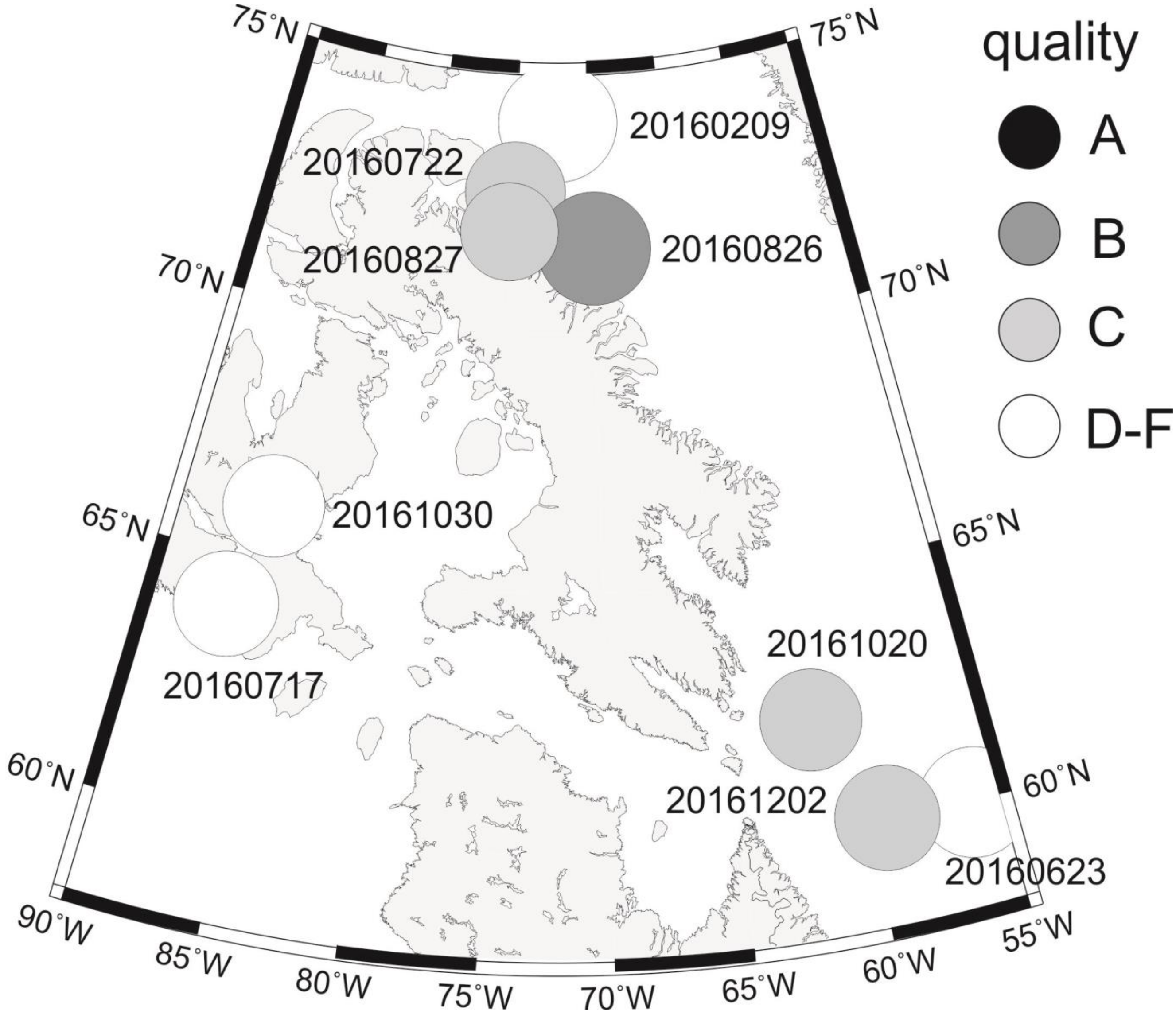

Figure 1: Locations and quality of solutions for all earthquakes evaluated in this study. Symbol size is scaled to M_W if a solution of A-C quality was obtained and to the magnitude type listed in Table 3 otherwise.

The solutions for the earthquakes listed in Table 2 are presented below (Figures 2a-2e) in chronological order without additional comments. Each solution is presented as a figure with the format discussed in the next few paragraphs. The solution is summarized in the upper left corner. The origin times and epicenters are taken from the Canadian National Earthquake Database (CNED, 2017). All other parameters are derived from the RCMT inversion. Only the best fitting double couple solution is summarized on the figure. The complete moment tensor solutions may be found in the Appendix.

The map in each plot shows the best fitting focal mechanism (lower hemisphere projection) from the inversion. The solid lines show the best fitting double couple solution and the shaded and white regions show the full moment tensor solution with the shaded regions representing compressional regions and white dilations. The P- and T-axes are indicated by gray and white dots, respectively.

To the right of the map the average misfit is plotted as a function of depth. The best fitting focal mechanism for each depth is plotted and the size of the symbol is scaled to the moment magnitude for that particular solution. Lack of variation in symbol size, as is most often the case, indicates that the calculated seismic moment is not heavily dependent on depth. A flat misfit plot indicates that the depth is not well constrained (for example, 20151118, Figure 2g in Bent, 2017) whereas a sharp dip in the misfit function is an indication of a well-constrained depth (for example, 20161020, Figure 2d of this paper). In most cases the focal mechanism is relatively independent of depth but there are solutions for which this is not the case. If the best fitting mechanism has a significantly lower misfit than one indicating a different style and/or orientation of faulting it is likely correct (for example, 20161020, Figure 2d of this paper). If two significantly different mechanisms have similar misfits (for example, 20141003, Figure 2f in Bent, 2015) then both mechanisms need to be considered as viable options or additional techniques applied to the data to determine which solution is better.

In the bottom section, the waveforms are shown with the solid lines representing the data and the dashed lines the synthetic seismograms. For each station the waveforms from left to right are the vertical, radial and tangential components respectively. The misfit is indicated below the waveforms. The horizontal (time) and vertical (amplitude) scales are indicated to the right. The waveforms for each station are scaled to the largest amplitude at that station. Components not plotted were not used in the inversion. The most common reason for rejecting a component is a poor signal to noise ratio at the periods modeled. There could be other reasons, however, such as lack of data from one component. Note that the RCMT inversion program allows for more complicated weighting schemes but practice is to use either 1.0 (full weight) or 0.0 (not used). This provides a stable comparative base among RCMT catalog solutions over the years. There were other weighting schemes proposed in RCMT studies in other regions, such as given higher weighting for stations with good S/N or lower weight for a group of stations in the same area. Given the station distribution in eastern and northern Canada there have been no obvious benefits derived from using other weighting schemes. The text to the left of each set of waveforms provides information about the station. The first line is the station code and velocity model used. The second line indicates the azimuth of the station with respect to the epicenter. The third line gives the epicentral distance, the fourth the frequency range modeled and the fifth the average misfit for the station.

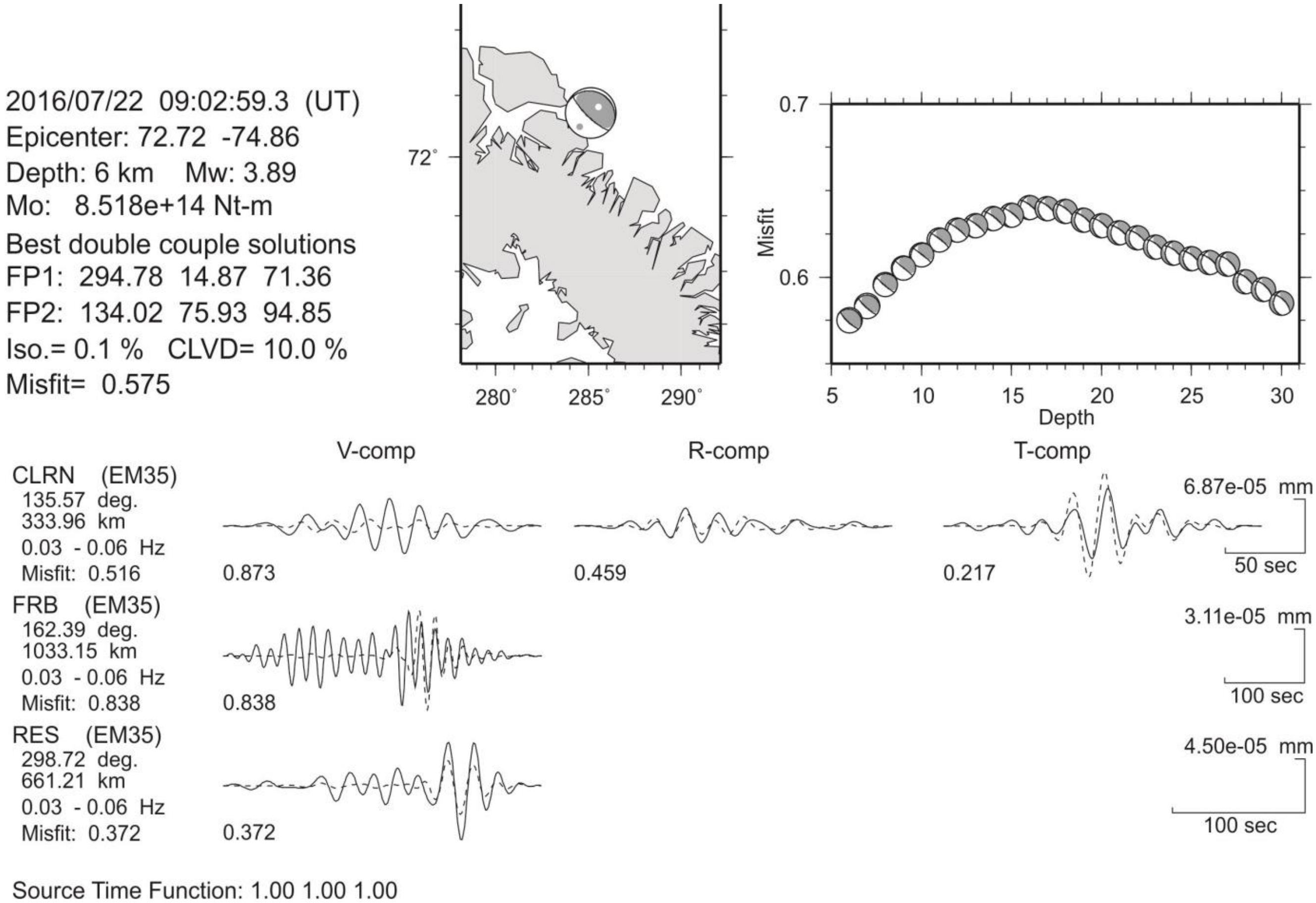

Figure 2a: RCMT solution for event 2016-07-22. See text for explanation of figure.

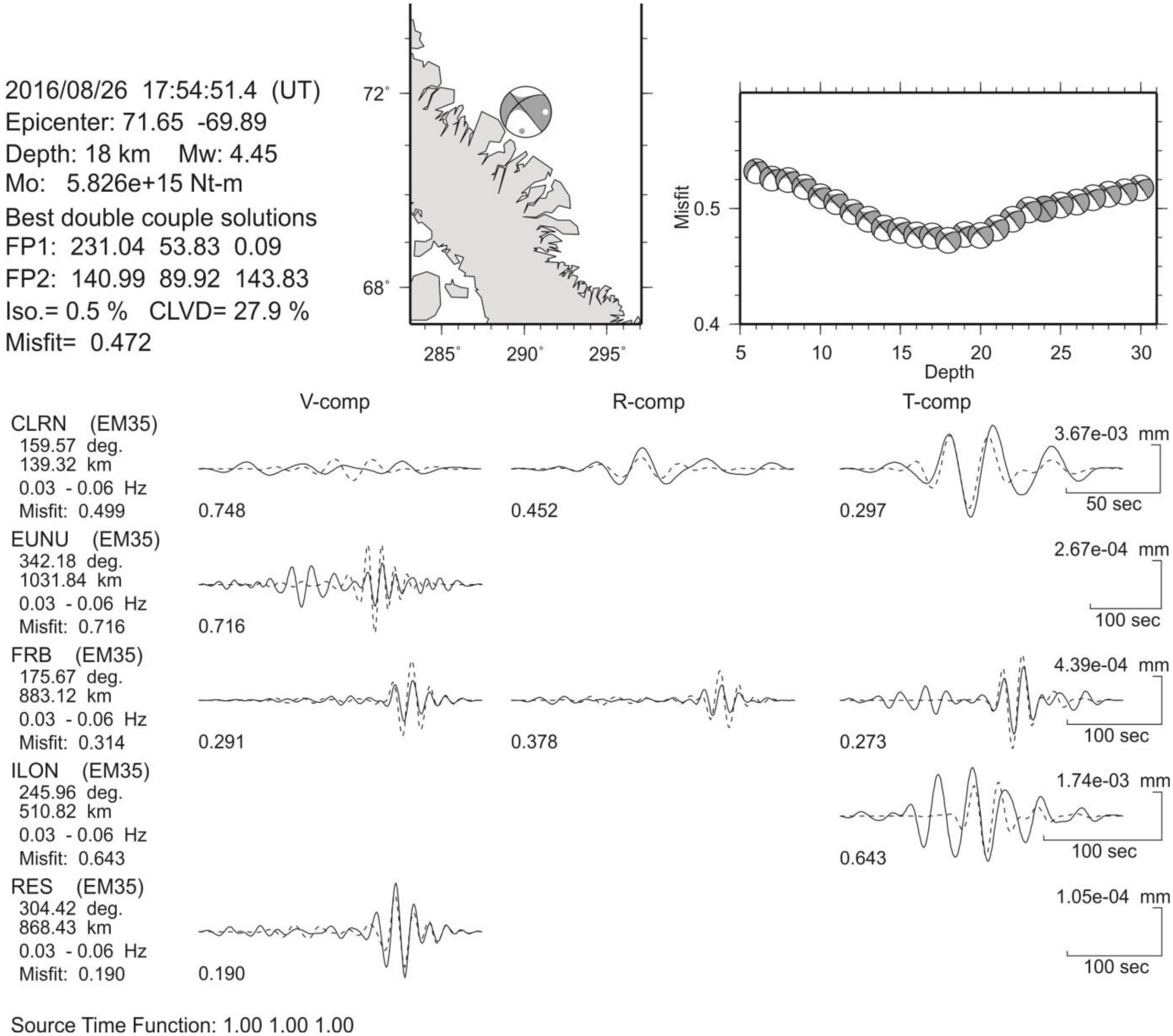

Figure 2b RCMT solution for event 2016-08-26. See text for explanation of figure.

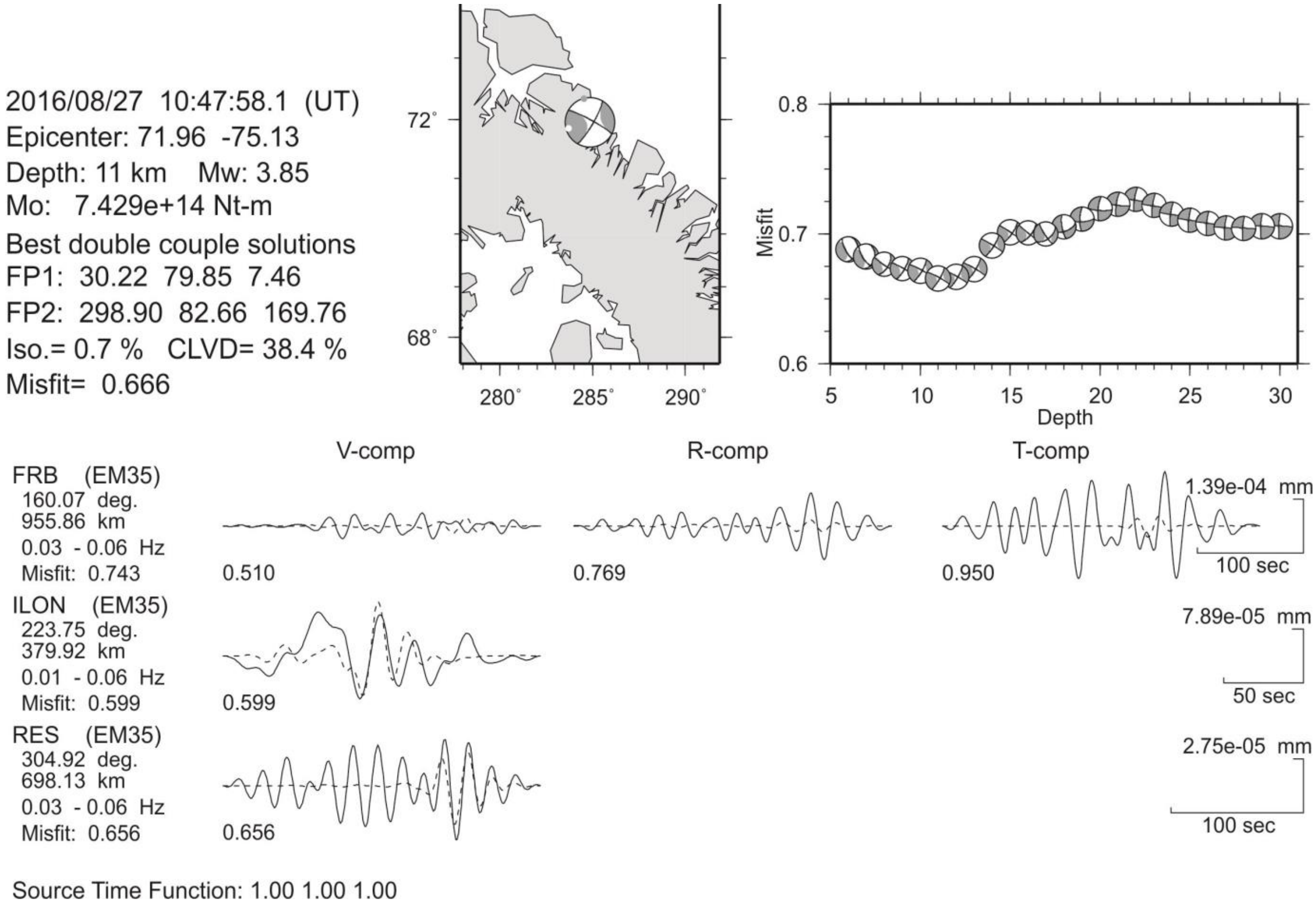

Figure 2c RCMT solution for event 2016-08-27. See text for explanation of figure.

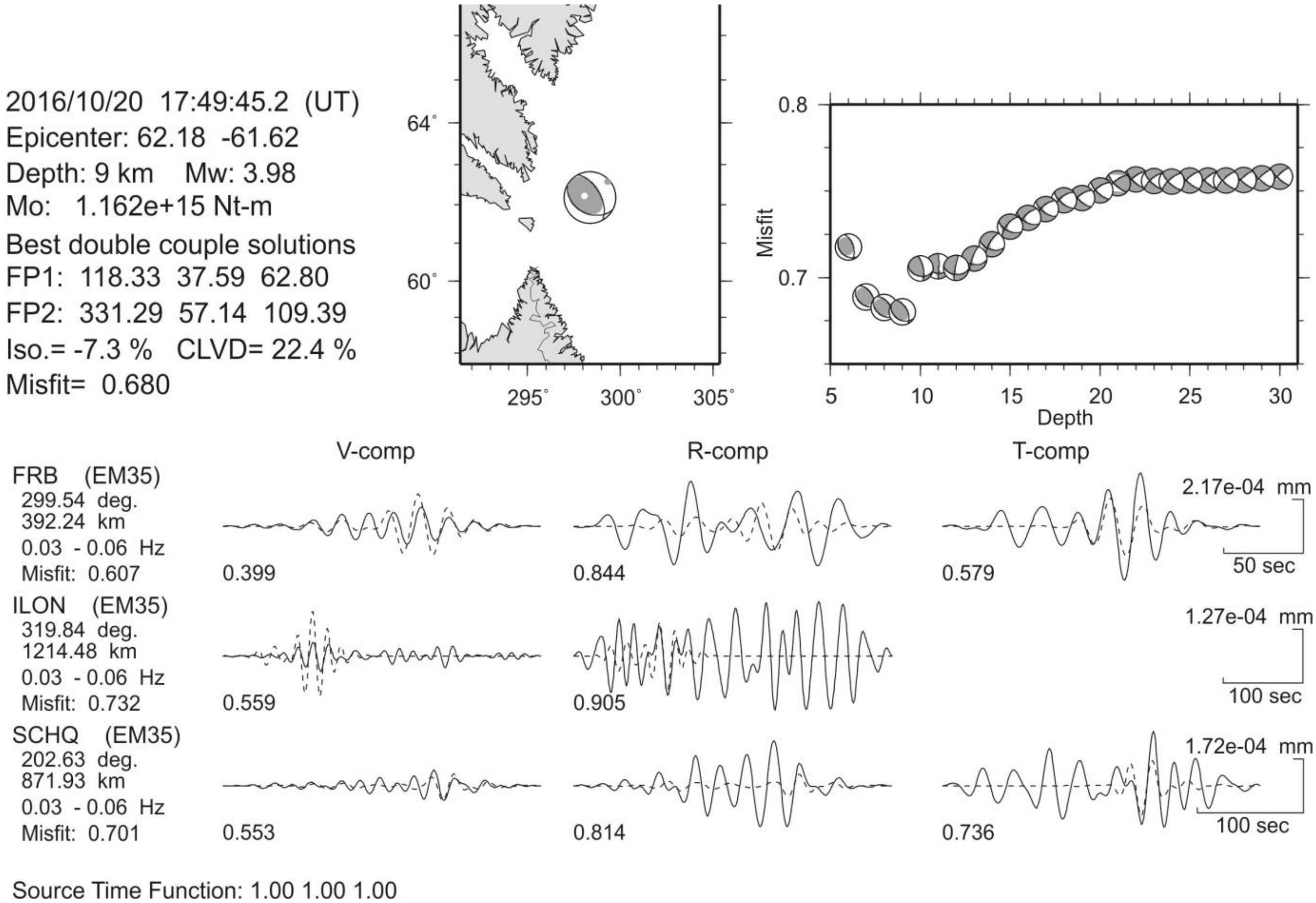

Figure 2d RCMT solution for event 2016-10-20. See text for explanation of figure.

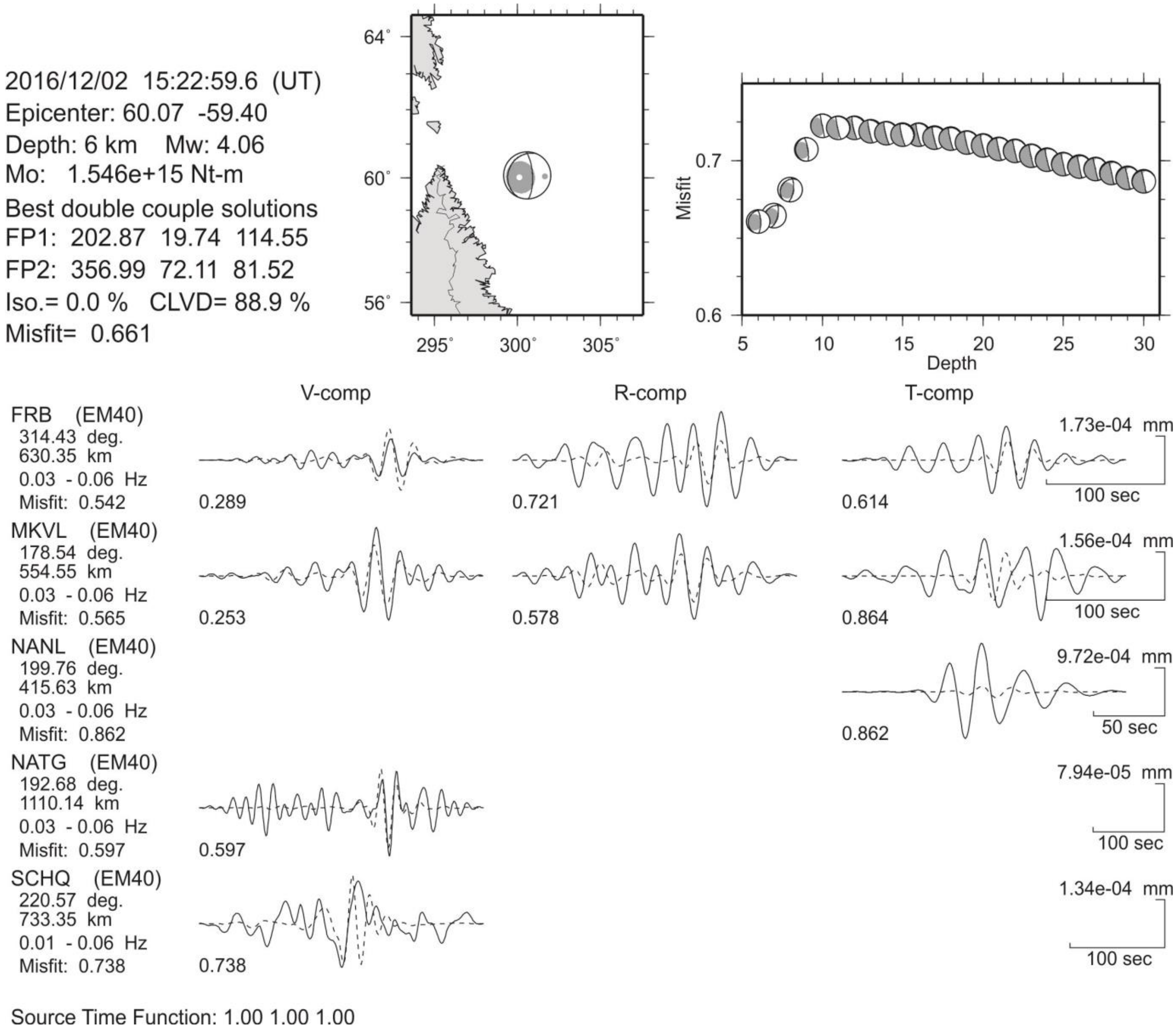

Figure 2e RCMT solution for event 2016-12-02. See text for explanation of figure.

Related Studies

The earthquakes summarized in the previous sections were relatively small and remote and thus were not part of any in-depth research projects as far as I have been able to ascertain. There were, however, a few earthquakes in New Brunswick too small (i.e. too high frequency) for use with the RCMT method but for which focal mechanism solutions were obtained using first motion polarities and the grid search algorithm of Snoke et al. (1984). They are briefly discussed below.

On 2 February 2016 a magnitude (M_N) 3.6 earthquake occurred 30 km southeast of Saint Andrews, NB. First motion data recorded in eastern Canada and New England were used to derive a focal mechanism indicative of oblique thrust faulting in response to northeast-southwest compression (Figure 3).

During February 2016 earthquake swarm activity in McAdam NB resumed. The area had experienced swarm activity in 2012 but had been seismically quiet since. First motion focal mechanism solutions were obtained for three of the February 2016 events using polarities from Canadian and New England seismograph stations although some are better constrained than others. The focal mechanisms are briefly summarized below and shown in Figure 3. A more in-depth discussion of the McAdam swarm may be found in Bent et al. (2017).

An M_N 2.6 event that occurred on 5 February 2016 has a well-constrained, predominantly thrust focal mechanism on a roughly NW-SE striking plane, and is similar in general characteristics although not in fine detail to the composite mechanism determined for the 2012 swarm. A poorly constrained focal mechanism was determined for an M_N 2.7 event on 8 February 2016. Its stress axes are consistent with NE-SW compression and it is predominantly a thrust faulting event but a range of fault orientations fit the data. One possible mechanism is comparable to the two previously described (shown in Figure 3) but there are other equally good solutions with fault planes striking NNE-SSW or near E-W (see Bent et al., 2017). The third focal mechanism is for the largest event of the swarm, an M_N 3.3 event that occurred on 9 February 2016. Based on the clear, impulsive first motions the solution is also a predominantly thrust faulting event but on a fault striking near N-S (Figure 3) in response to compression in the W to WNW octant, somewhat different from the regional stress field. If, however, the emergent polarities are also considered, a wider range of focal mechanisms would fit the data, many of which have P axes more consistent with the regional NE-SW compression. These solutions are also predominantly thrust faulting but with a wider range of possible fault orientations (see Bent et al., 2017 for more detail).

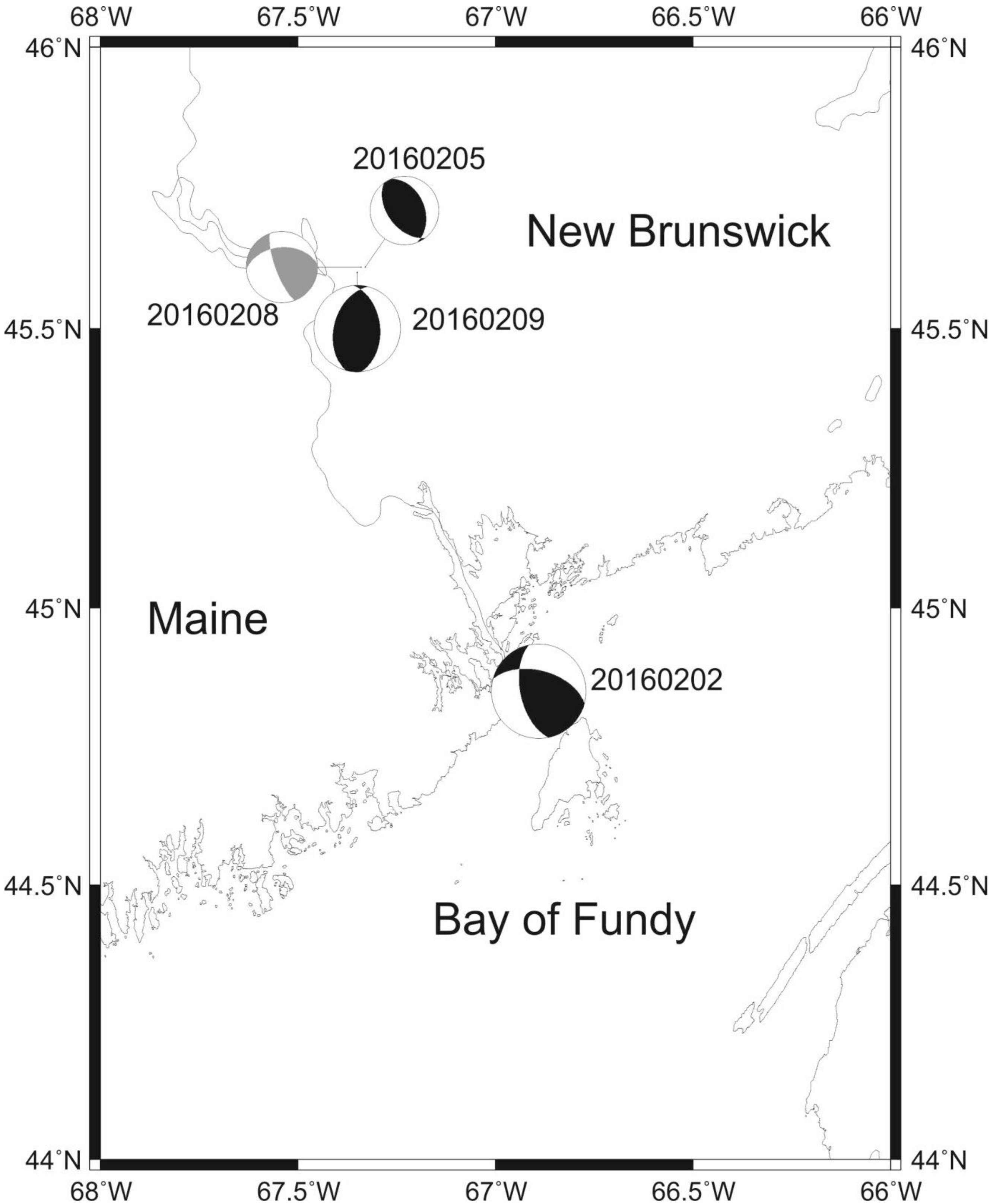

Figure 3: First motion focal mechanisms (lower hemisphere projection) for four earthquakes in New Brunswick. See text for discussion, particularly for 20160208, the event shaded in gray.

Summary

Regional moment tensor solutions have been determined for five moderate earthquakes occurring in northeastern Canada during 2015. Four other events were evaluated but good quality solutions were not obtained. First motion focal mechanisms for four earthquakes occurring in New Brunswick were determined. The moment tensor solutions include focal mechanisms, depths and moment magnitudes which provide input into further studies regarding seismic hazard, regional seismotectonics or stress field. These results are particularly valuable in regions, such as the north and offshore, where there have been considerable difficulties in obtaining these parameters through other methods. This paper is the fourth in what is intended to be a series of annual updates. In addition, other methods for disseminating the solutions are being explored, such as an online database.

Acknowledgments

I thank Taimi Mulder for her review of the manuscript. Nawa Dahal, Weston Observatory, supplied the polarities from seismograph stations operating in New England for the New Brunswick events discussed in the "Related Studies" section.

References

Bent, A. L. (2011). Moment magnitude (M_W) conversion relations for use in hazard assessment in eastern Canada, *Seismological Research Letters*, **82**, 984-990, doi:10.1785/gssrl.83.3.984.

Bent, A. L. (2015a). Regional Centroid Moment Tensor Solutions for Eastern Canadian Earthquakes: 2011-2013, *Geological Survey of Canada Open File 7726*, 71 p.

Bent, A. L. (2015b). Regional Centroid Moment Tensor Solutions for Eastern Canadian Earthquakes: 2014, *Geological Survey of Canada Open File 7834*, 35 pp., doi:10.4095/296822.

Bent, A. L. (2016). Moment Magnitude (M_W) Conversion Relations for Use in Hazard Assessment in Offshore Eastern Canada, *Geological Survey of Canada Open File 8027*, 12 p., doi:10.4095/297965.

Bent, A. L. (2017). Regional Centroid Moment Tensor Solutions for Eastern Canadian Earthquakes: 2015, *Geological Survey of Canada Open File 8050*, 26 pp., doi:10.4095/299816.

Bent, A. L., J. Drysdale and H. K. C. Perry (2003). Focal mechanisms for Eastern Canadian Earthquakes; 1994-2000, *Seismological Research Letters*, **74**, 452-468.

Bent, A. L., S. Halchuk, V. Peci, K. Butler, K. B. S. Burke, J. Adams, N. Dahal and S. Hayek (2017). The McAdam, New Brunswick Earthquake Swarms of 2012 and 2015-16: Extremely Shallow, Natural Events, *Seismological Research Letters*, **88**, 1586-1600, https://doi.org/10.1785/0220170071.

Brune, J. and J. Dorman (1963). Seismic waves and earth structure in the Canadian shield, *Bulletin of the Seismological Society of America*, **53**, 167-210.

Canadian National Earthquake Database (CNED, 2019). On-line database, http://www.earthquakescanada.nrcan.gc.ca/stndon/NEDB-BNDS/bulletin-en.php (last accessed 2 April 2019).

Canadian National Waveform Archive (CNWA, 2019). On-line database, http://www.earthquakescanada.nrcan.gc.ca/stndon/wf_index-en.php (last accessed 2 April 2019).

Kao, H., P.-R. Juan, K.-F. Ma, B.-S. Huang and C.-C. Liu (1998). Moment-tensor inversion for offshore earthquakes east of Taiwan and their implications to regional collision, *Geophysical Research Letters*, **25**, 3619-3622.

Kao, H., Y.-H. Liu and P.-R. Juan (2001). Source parameters of regional earthquakes in Taiwan: January-December 1997, *Terrestrial, Atmospheric and Oceanic Sciences*, **12**, 431-439.

Kao, H., S.-J. Shan, A. Bent, C. Woodgold, G. Rogers, J. F. Cassidy and J. Ristau (2012). Regional Centroid-Moment-Tensor Analysis for Earthquakes in Canada and Adjacent Regions: An Update, *Seismological Research Letters*, **83**, 505-515, doi:10.1785/gssrl.83.3.505.

Nuttli, O. (1973). Seismic wave attenuation and magnitude relations for eastern North America, *Journal of Geophysical Research*, **78**, 876-885.

Ristau, J. P. (2004). Seismotectonics of western Canada from regional moment tensor inversion, *Ph.D. Thesis*, University of Victoria, Victoria BC, Canada.

Ristau, J., G. Rogers and J. F. Cassidy (2007). Stress in western Canada from regional moment tensor analysis, *Canadian Journal of Earth Sciences*, **44**, 127-148, doi:110.1139/E1106-1057.

Snoke, J. A., J. W. Munsey, A. G. Teague and G. A. Bollinger (1984). A program for focal mechanism determination by combined use of polarity and SV-P amplitude data, *Earthquake Notes*, **55**, 15.

Appendix
Complete Moment Tensor Solution for Earthquakes in Table 2

For each event listed in Table 2 the full moment tensor from the RCMT inversion is given. The format is described below (written communication from Kao, 2005). The earthquakes are identified by date of occurrence. In the case of two events on the same day, the origin time (hh:mm) is added for clarification.

Line 1-25: depth, E_nosh, E_sh, Mxx, Myy, Mzz, Mxy, Mxz, Myz
    (E_nosh: average misfit without any shift of synthetic seismograms)
    (E_sh: average misfit with shift of synthetic seismograms)
< repeat for each depth >
Line 26: station(i), ishift(i), E(i), Ez(i), Er(i), Et(i)
    (station: station name)
    (ishift: number of shifted points,
        original position + ishift = final position)
    (E: average misfit for this station at the best-fitting depth)
    (Ez: Z-comp misfit for this station at the best-fitting depth)
    (Er: R-comp misfit for this station at the best-fitting depth)
    (Et: T-comp misfit for this station at the best-fitting depth)
< repeat for each station >

Author's note: the misfit for each component is given for all stations used regardless of whether the component was used in the inversion; the average misfit, both for each station and overall, is calculated only from the components that were used.

2016-07-22

6	0.6460	0.5752	-28.40961	-13.57884	42.20048	-16.50088	52.18634	53.60411
7	0.6481	0.5832	-24.37565	-6.45600	30.26473	-4.07441	45.91545	46.80142
8	0.6549	0.5956	-19.85719	0.13329	18.83657	5.36271	41.02993	41.46561
9	0.6554	0.6054	-14.40342	7.13889	6.24617	12.68327	37.17767	37.20381
10	0.6556	0.6129	-11.73741	10.77167	-0.04074	16.40036	34.31669	33.89624
11	0.6541	0.6214	-8.95706	14.29872	-6.27138	18.71075	31.79243	31.01970
12	0.6528	0.6271	-7.87080	16.03635	-9.03087	20.03001	29.92334	28.77257
13	0.6508	0.6296	-6.44799	17.93233	-12.23858	20.63053	28.07409	26.64573
14	0.6494	0.6337	-6.04767	18.89133	-13.54519	21.12522	26.74328	24.98166
15	0.6472	0.6358	-5.07706	19.44159	-14.94327	20.50948	24.50176	22.58242
16	0.6481	0.6401	-3.18488	20.95256	-18.26136	21.84749	25.69254	23.29395
17	0.6452	0.6394	-3.09014	21.51725	-18.87226	21.96006	25.02908	22.31336
18	0.6419	0.6379	-3.05074	22.01075	-19.36268	21.94399	24.44735	21.41973
19	0.6375	0.6330	-2.47249	21.95981	-19.77624	21.39938	22.79293	19.71109
20	0.6340	0.6296	-2.50508	22.32207	-20.07129	21.24245	22.35694	18.98922
21	0.6307	0.6256	-2.45455	23.17656	-20.87498	22.06719	21.34979	17.88403
22	0.6276	0.6227	-2.52018	23.51159	-21.11491	21.83987	21.00520	17.27590
23	0.6229	0.6172	-2.21248	23.88403	-21.70997	21.87895	20.45330	16.97016
24	0.6186	0.6137	-2.09981	23.66258	-21.57022	21.12630	19.33709	15.95007
25	0.6149	0.6106	-2.10110	24.28424	-22.16582	20.96075	18.85560	15.49568
26	0.6126	0.6083	-1.67659	24.04873	-22.29035	20.16630	17.37927	14.27634
27	0.6114	0.6075	-1.82056	24.46090	-22.54797	19.38129	16.97400	13.79490
28	0.6028	0.5973	-1.85015	29.29249	-27.27400	22.08189	19.07492	15.40850
29	0.5981	0.5929	-2.54060	30.23712	-27.51890	21.78092	18.52830	14.65011
30	0.5906	0.5849	-2.31511	30.50566	-27.97708	20.46106	17.69802	13.81107

clrn	1	0.516408	0.873224	0.459278	0.216721
frb	0	0.837677	0.837677	0.956519	0.979819
res	-2	0.371652	0.371652	0.978167	0.991599

2016-08-26

6	0.5727	0.5320	-81.69873	290.69965	-181.55179	-79.82435	179.06087	115.19986
7	0.5691	0.5258	-97.52347	267.54454	-125.81351	-88.32586	164.21102	117.31523
8	0.5695	0.5244	-181.95776	272.55337	-20.24965	-121.19833	197.03774	148.75052
9	0.5484	0.5184	-202.84261	173.60476	80.73893	-93.52716	151.60415	121.06435
10	0.5333	0.5106	-243.07199	165.76717	118.68961	-86.58735	146.58363	119.71772
11	0.5287	0.5054	-264.16510	177.36623	117.48896	-78.90062	143.14104	121.90172
12	0.5275	0.4971	-292.66122	205.41398	111.67246	-78.47806	150.47155	134.12637
13	0.5308	0.4906	-336.43067	250.33106	107.36076	-83.86834	165.47115	149.34905
14	0.5468	0.4828	-524.15267	415.00632	134.32440	-126.15821	255.20848	234.97257
15	0.5650	0.4808	-506.90259	419.37445	106.96702	-119.36568	242.33902	221.11871
16	0.5799	0.4770	-491.23660	418.34902	87.80452	-118.49427	269.85610	235.15553
17	0.6067	0.4764	-482.96789	428.70193	66.27025	-118.17653	264.29140	227.89511
18	0.6427	0.4723	-469.45942	433.59893	45.47891	-119.38698	262.20190	226.27734
19	0.6617	0.4773	-443.84852	422.83432	28.89427	-116.39621	249.97672	213.22604
20	0.6620	0.4768	-434.04050	420.98654	19.79299	-118.73251	249.52901	213.10110
21	0.6641	0.4829	-424.80389	420.45453	10.17254	-121.37535	250.12893	214.62415
22	0.6654	0.4904	-418.69301	418.46430	5.36807	-124.05085	251.01468	216.58180
23	0.6665	0.4987	-412.78796	413.64217	3.55030	-131.08033	251.04611	215.35796
24	0.6688	0.4996	-411.56019	414.47175	0.98288	-134.02778	253.13780	219.82639
25	0.6712	0.5028	-421.25151	431.56167	-6.66878	-135.85893	255.07882	225.38941
26	0.6743	0.5052	-425.19632	436.72597	-8.32266	-138.71073	257.85348	231.43413
27	0.6765	0.5093	-433.86894	448.75361	-11.98278	-141.33564	260.28373	234.86680
28	0.6792	0.5121	-441.16281	459.54460	-15.76295	-144.47765	263.85554	242.24342
29	0.6823	0.5144	-454.96181	474.14468	-16.95736	-146.86847	267.18503	250.97472
30	0.6846	0.5178	-470.94134	493.39121	-20.68382	-149.83326	271.57109	261.44594

clrn	-1	0.498567	0.747508	0.451641	0.296554
eunu	1	0.716298	0.716298	0.985866	0.991831
frb	-1	0.314138	0.291318	0.377755	0.273340
ilon	-3	0.642904	1.000000	0.935323	0.642904
res	5	0.189732	0.189732	0.922186	1.000000

2016-08-27

6	0.7616	0.6882	-34.52605	61.47472	-27.89040	29.81690	-18.56078	-51.93902
7	0.7744	0.6824	-37.29528	73.86094	-36.77083	34.49712	-16.98664	-45.38969
8	0.7789	0.6767	-26.81587	50.61348	-22.86986	23.77096	-8.99548	-24.06704
9	0.7952	0.6731	-36.45290	57.37795	-19.09748	28.56686	-8.40447	-22.74198
10	0.8047	0.6717	-48.57882	64.93759	-14.27275	34.42579	-7.98285	-21.73105
11	0.8055	0.6658	-54.52670	66.82795	-10.55440	36.48833	-7.10551	-19.03698
12	0.8246	0.6667	-66.14383	78.45724	-10.74110	42.45931	-7.68356	-19.68441
13	0.8498	0.6728	-67.14841	79.55367	-11.16290	40.87262	-7.87493	-18.66753
14	0.8649	0.6909	-65.05663	78.41519	-12.32209	35.86167	-8.85982	-18.53209
15	0.8811	0.7010	-54.37613	68.61191	-13.38506	24.25734	-9.84429	-18.06333
16	0.8905	0.7008	-46.36358	60.76074	-13.66162	12.11528	-11.64435	-19.86421
17	0.9046	0.6999	-30.15528	42.68023	-11.74144	-9.21040	-12.93941	-19.57612
18	0.9102	0.7053	-11.06124	20.08664	-8.21373	-29.25402	-12.60401	-17.19979
19	0.9098	0.7113	2.48199	3.21184	-4.80805	-44.71253	-12.41241	-14.82561
20	0.8892	0.7192	10.38477	-7.56612	-1.91949	-52.54418	-11.52227	-11.89191
21	0.8781	0.7228	16.00545	-14.85261	-0.26977	-57.73490	-10.65498	-10.18083
22	0.8610	0.7264	16.37138	-16.74766	1.22845	-56.95019	-9.85197	-7.93789
23	0.8542	0.7218	16.11193	-17.44746	2.17811	-58.40801	-9.50494	-6.18188
24	0.8499	0.7151	15.47126	-17.55412	2.93736	-61.30383	-9.55169	-4.75048
25	0.8436	0.7106	13.66573	-16.24835	3.40604	-61.43998	-9.26045	-3.22187
26	0.8388	0.7081	11.51472	-14.46169	3.73304	-61.24546	-8.96837	-1.81400
27	0.8372	0.7045	9.62815	-12.85702	4.00477	-63.57305	-8.95191	-0.73035
28	0.8336	0.7043	7.24351	-10.71343	4.21274	-63.35779	-8.66402	0.47232
29	0.8327	0.7057	5.21768	-9.08739	4.60697	-66.19464	-8.75577	1.60836
30	0.8296	0.7058	5.01966	-8.87031	4.52006	-66.72156	-8.20648	2.08536

frb	-1	0.742870	0.509954	0.768789	0.949868
ilon	-5	0.598594	0.598594	0.934961	0.940470
res	-3	0.656026	0.656026	0.963092	1.000000

2016-10-20

6	0.8276	0.7175	-78.21659	-87.41063	166.21936	-29.28069	18.85442	-82.40095
7	0.8224	0.6887	-101.29530	-101.09272	196.39191	-41.65732	6.07653	-61.89984
8	0.8541	0.6826	-87.62660	-82.83247	154.36728	-41.72080	3.18031	-48.41842
9	0.8606	0.6801	-62.86932	-58.50238	95.68839	-49.72153	0.97522	-52.62039
10	0.8818	0.7053	-26.51379	-29.63484	30.95112	-48.81464	-0.76297	-50.96760
11	0.8840	0.7064	-4.99603	-17.59693	0.07352	-48.73173	-2.74874	-49.67918
12	0.8732	0.7055	11.21568	-15.59352	-15.27572	-44.19236	-3.31593	-48.08051
13	0.8643	0.7110	24.89348	-19.83362	-22.41491	-37.44629	-3.66055	-46.77800
14	0.8564	0.7193	37.67722	-27.44064	-25.84994	-29.26273	-3.88068	-45.68389
15	0.8506	0.7294	48.04518	-35.19445	-26.73346	-20.35238	-3.85270	-43.37282
16	0.8432	0.7344	55.16918	-38.33803	-28.56254	-14.51059	-1.76866	-47.95615
17	0.8416	0.7396	66.43713	-50.09517	-27.21122	-4.57760	-3.32795	-45.12534
18	0.8373	0.7446	72.26876	-55.60343	-26.46745	0.53173	-3.05003	-42.59194
19	0.8331	0.7458	80.01273	-62.13894	-26.97690	6.35048	-2.03880	-41.58011
20	0.8318	0.7503	84.47306	-66.67996	-26.48993	7.15382	-1.75173	-40.77645
21	0.8298	0.7545	94.32008	-75.48628	-27.76521	7.38300	-1.58842	-42.78150
22	0.8234	0.7566	75.78973	-61.40368	-21.05672	4.92783	-1.00682	-32.50982
23	0.8205	0.7558	78.48956	-64.29465	-20.64914	3.82237	-0.78628	-31.89703
24	0.8176	0.7555	81.26845	-67.24508	-20.28092	2.55184	-0.58258	-31.25520
25	0.8172	0.7562	83.72887	-69.67363	-20.13475	0.86195	-0.85232	-30.90329
26	0.8142	0.7562	86.99709	-72.97540	-19.91640	-0.49896	-0.66911	-30.21351
27	0.8119	0.7561	91.13515	-76.53774	-20.23425	-0.07442	0.18799	-29.49800
28	0.8094	0.7565	95.08797	-80.41353	-20.23075	-1.36720	0.35395	-28.72835
29	0.8071	0.7573	99.52693	-84.52841	-20.47047	-2.69160	0.56671	-27.96447
30	0.8051	0.7583	104.73123	-89.08584	-20.82793	-3.76822	0.71886	-27.11033

frb 4 0.607419 0.398777 0.844417 0.579065
ilon -6 0.731983 0.559130 0.904835 1.000000
schq 4 0.700970 0.552967 0.813604 0.736338

2016-12-02

6	0.6783	0.6608	-75.00858	-42.29785	117.44255	15.92390	-28.62222	-110.57265
7	0.6843	0.6646	-135.09141	-82.40327	203.00007	23.11206	-37.80956	-151.24445
8	0.7019	0.6813	-142.04727	-78.17015	179.54521	20.66745	-36.01210	-152.75475
9	0.7425	0.7074	-97.55094	-30.42771	75.26404	18.06083	-34.80190	-149.21430
10	0.7690	0.7227	-52.19827	7.86547	-4.33067	16.44321	-32.70457	-146.30993
11	0.7690	0.7213	-26.91988	24.33042	-37.54026	16.18477	-32.16544	-143.44149
12	0.7680	0.7213	-12.58445	30.76262	-51.39492	15.97521	-30.98013	-140.67334
13	0.7618	0.7190	-5.91296	30.05671	-52.26576	15.80925	-30.67924	-137.99589
14	0.7557	0.7179	-1.76766	27.51636	-50.16700	15.71207	-30.83295	-136.23119
15	0.7534	0.7168	1.72558	25.07073	-48.93857	15.46330	-30.32183	-133.79425
16	0.7524	0.7169	4.78681	21.80733	-45.85891	15.26054	-34.78867	-152.94903
17	0.7501	0.7148	7.71754	18.38043	-43.05315	14.94365	-34.19109	-152.74072
18	0.7473	0.7142	9.04003	13.68562	-37.88835	14.42092	-34.13130	-152.94961
19	0.7452	0.7119	10.41003	12.01128	-36.28070	13.59790	-33.73266	-153.64532
20	0.7428	0.7099	11.67315	7.40116	-32.42950	12.75249	-32.41916	-149.91752
21	0.7386	0.7077	10.60820	4.49146	-28.54901	14.06459	-32.54175	-152.00131
22	0.7364	0.7064	12.18361	0.23380	-26.07872	13.63699	-32.30083	-153.59145
23	0.7329	0.7033	12.56072	-4.28982	-21.44707	12.55982	-31.46919	-150.77108
24	0.7301	0.7007	15.46708	-8.00454	-20.39621	12.44460	-31.34428	-152.54085
25	0.7270	0.6979	16.51954	-12.44589	-16.66062	11.77498	-31.52075	-154.71642
26	0.7261	0.6961	18.69986	-16.49042	-14.35276	11.36662	-31.20480	-156.38212
27	0.7245	0.6947	19.25730	-17.38722	-12.89982	9.96473	-30.05419	-153.52640
28	0.7219	0.6920	20.71554	-21.63563	-9.31291	9.32210	-30.22670	-155.58538
29	0.7197	0.6888	21.55775	-23.41625	-7.42873	11.15028	-29.98169	-158.32848
30	0.7174	0.6866	23.36530	-27.81623	-3.76698	10.59969	-30.12329	-160.20695

frb	0	0.541596	0.289086	0.721281	0.614420
mkvl	-2	0.565099	0.253210	0.578114	0.863973
nanl	-4	0.862226	0.961275	0.980374	0.862226
natg	0	0.597013	0.597013	0.966387	0.981643
schq	1	0.737918	0.737918	0.994098	0.996698