

Statistical Modeling and Characterization of Induced Seismicity within the Western Canada Sedimentary Basin

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Introduction

This supporting information provides analogous figures to those found in the regional analysis portion of the main article and some additional context to the cluster analyses. In particular, Figures S1-4 show the event maps for each cluster analyzed in section 5. Figures S5-8 give the regional NND analyses results at higher cutoff magnitudes, which confirm the existence of three earthquake subpopulations and a transformation in earthquake distribution between 1975-2009 and 2010-2018. Finally, Figures S9-12 give the structural representations and statistical parameters of the event families identified in section 5.3.

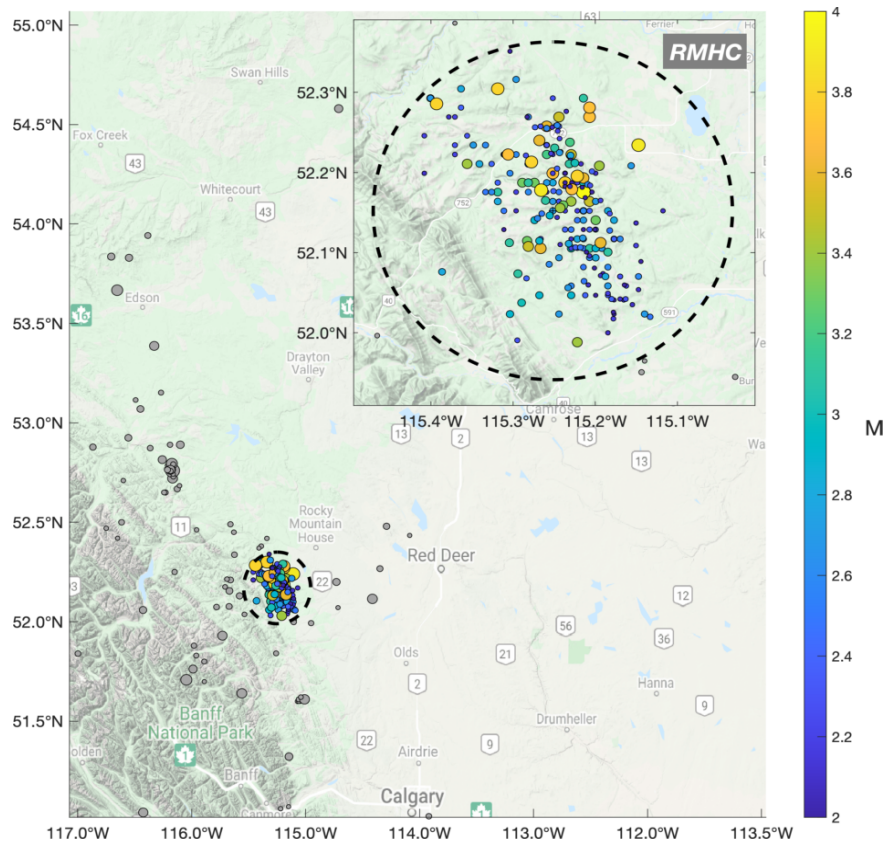


Figure S1. Map of the Rocky Mountain House cluster (RMHC) study area between 1975-2000. Dashed circle represents a 20 km radius from the coordinates [115.24°W, 52.17°N]. Markers are seismic events. Coloured markers are the data points used for analysis.

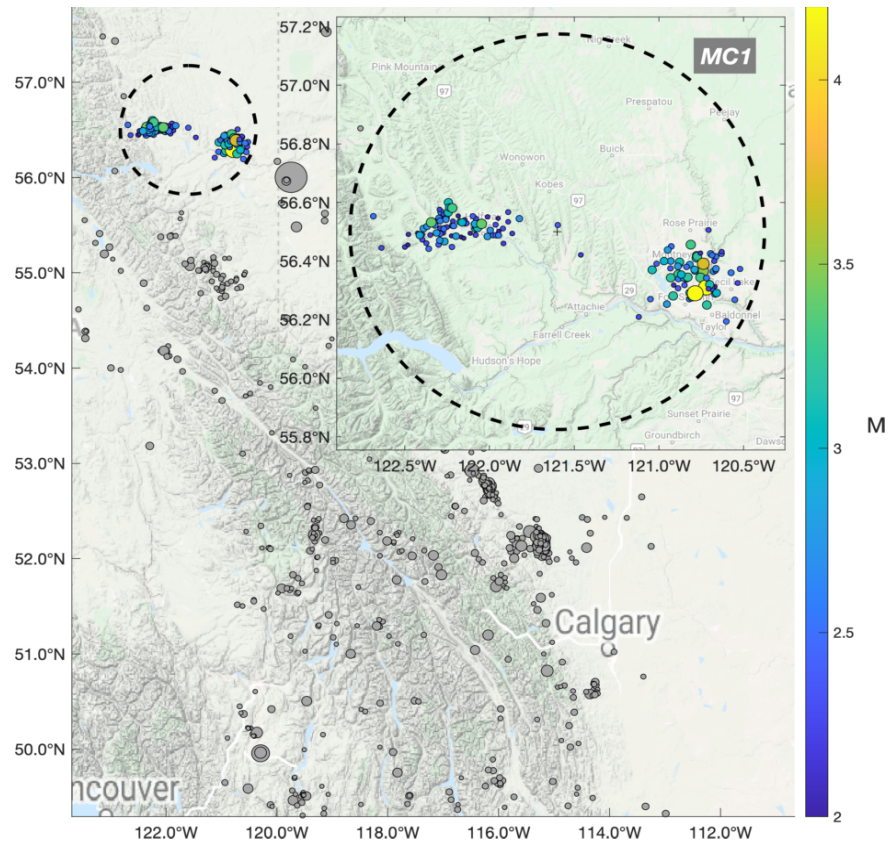


Figure S2. Map of the Montney cluster 1 (MC1) study area between 1984-2009. Dashed circle represents a 75 km radius from the coordinates [121.6°W, 56.5°N]. Markers are seismic events. Coloured markers are the data points used for analysis.

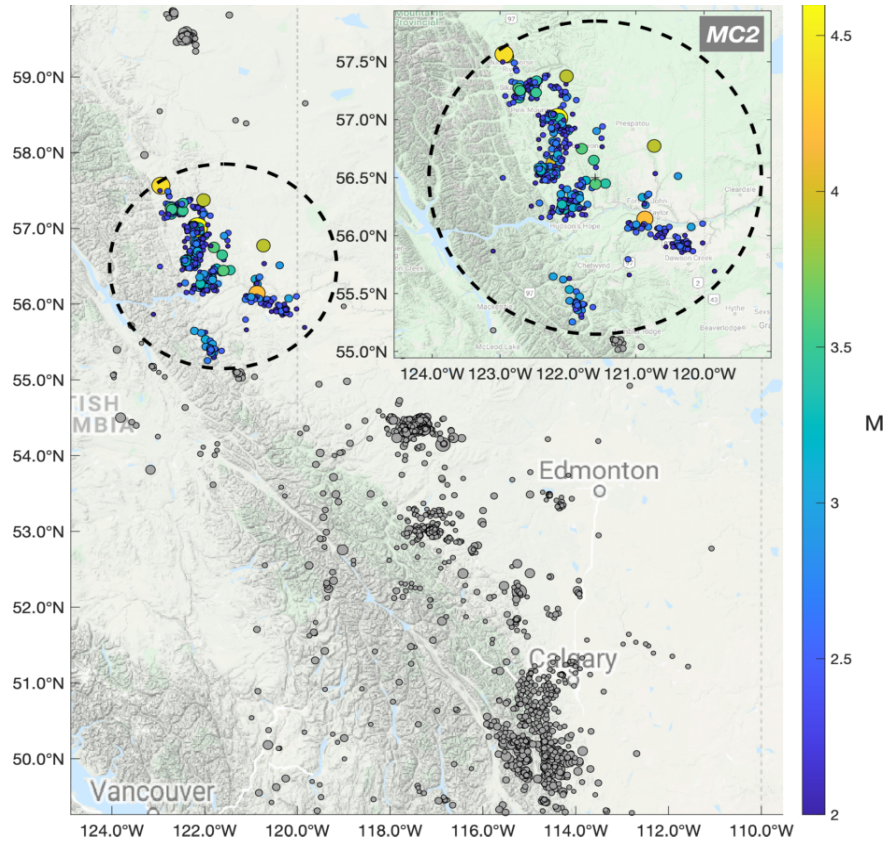


Figure S3. Map of the Montney cluster 2 (MC2) study area between 2010 and 2018. Dashed circle represents a 150 km radius from the coordinates [121.6°W, 56.5°N]. Markers are seismic events. Coloured markers are the data points used for analysis.

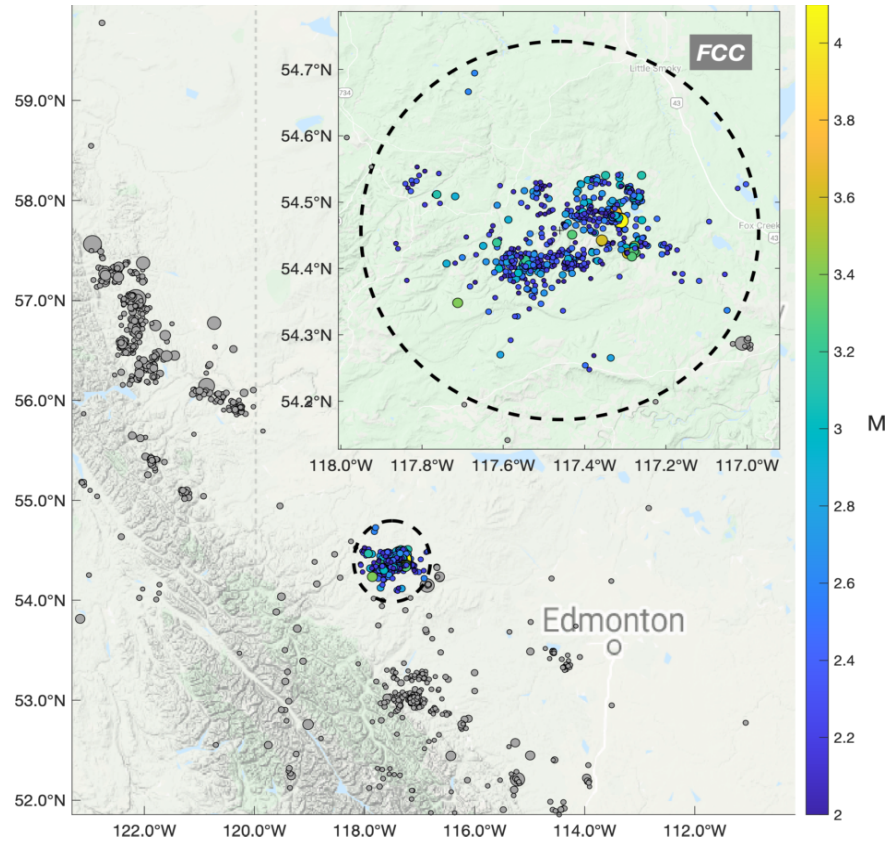


Figure S4. Map of the Fox Creek cluster (FCC) study area between 2013 and January 2020. Dashed circle represents a 45 km radius from the coordinates [117.4°W, 54.4°N]. Markers are seismic events. Coloured markers are the data points used for analysis.

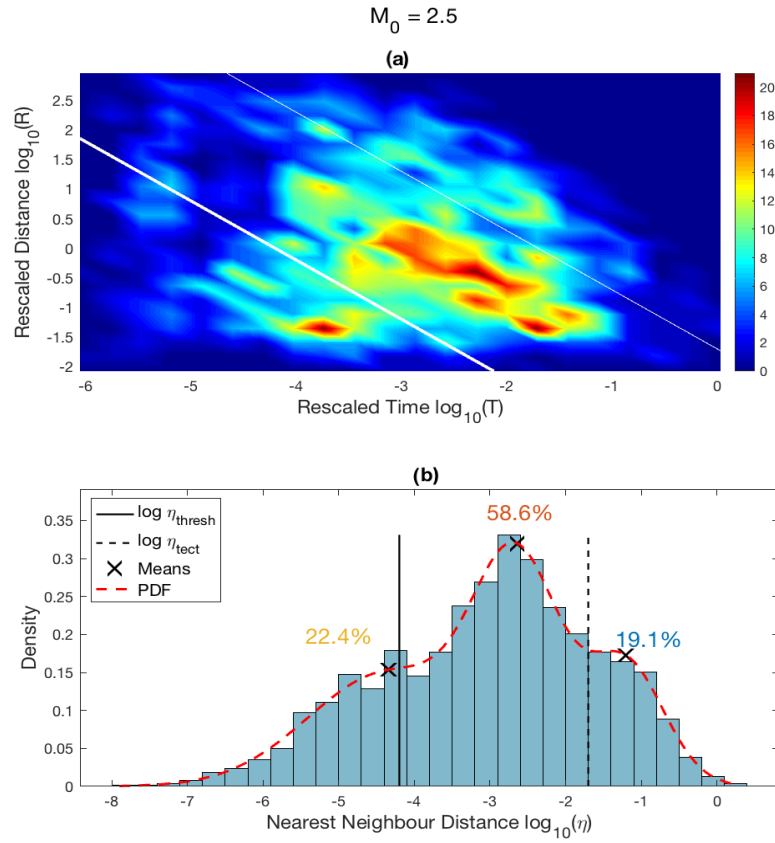


Figure S5. Nearest neighbor distance distribution of the regional CASC dataset from 1975-2018, using a cutoff magnitude of $M_0 = 2.5$ (analogous to Figure 2). Percentages in subplot (b) reflect the modal mixing proportions.

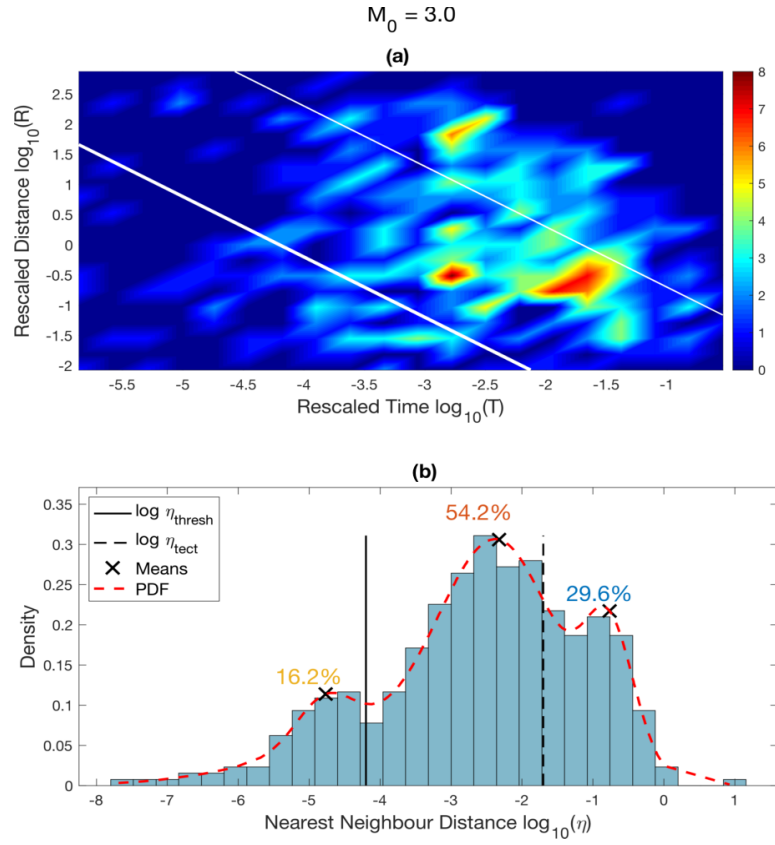


Figure S6. Nearest neighbor distance distribution of the regional WCSB catalogue from 1975-2018, using a cutoff magnitude of $M_0 = 3.0$ (analogous to Figure 2). Percentages in subplot (b) reflect the modal mixing proportions.

$$M_0 = 2.5$$

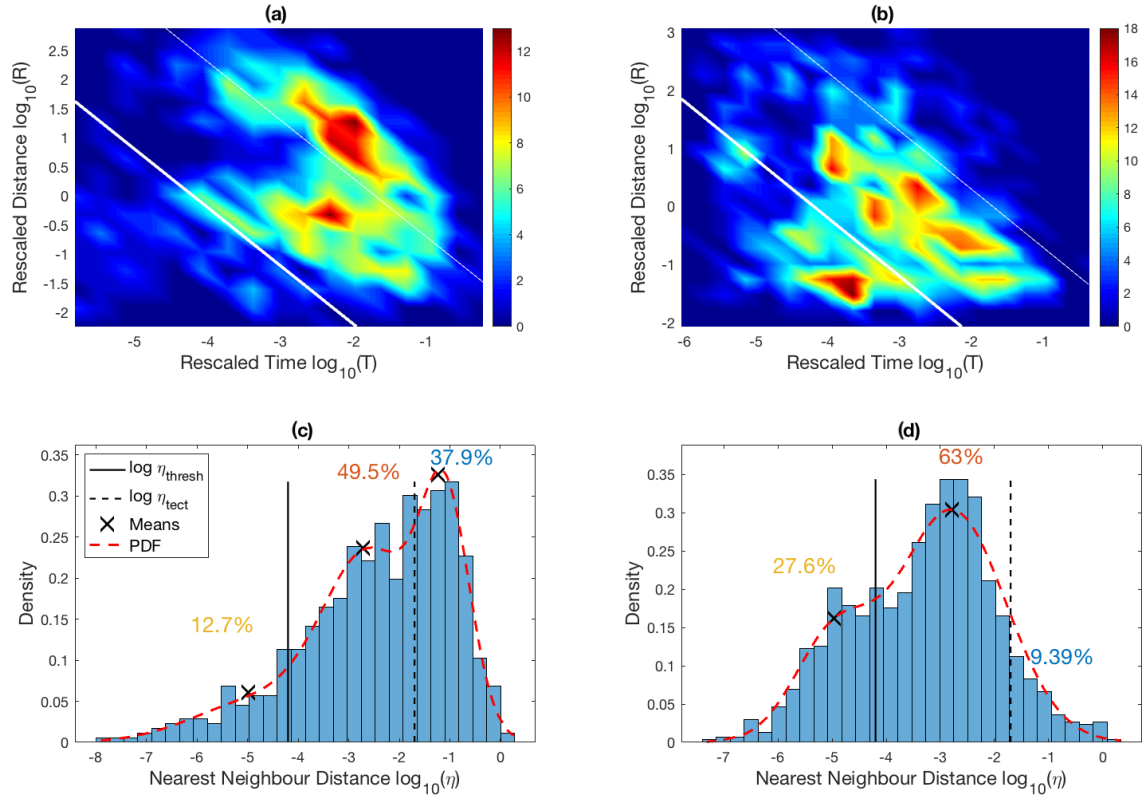


Figure S7. Comparison of NND distributions of the regional WCSB catalogue across time using a cutoff magnitude of $M_0 = 2.5$ (analogous to Figure 5). (a, c) 1975-2009. (b, d) 2010-2018. Percentages in subplots (c, d) reflect the modal mixing proportions.

$M_0 = 3.0$

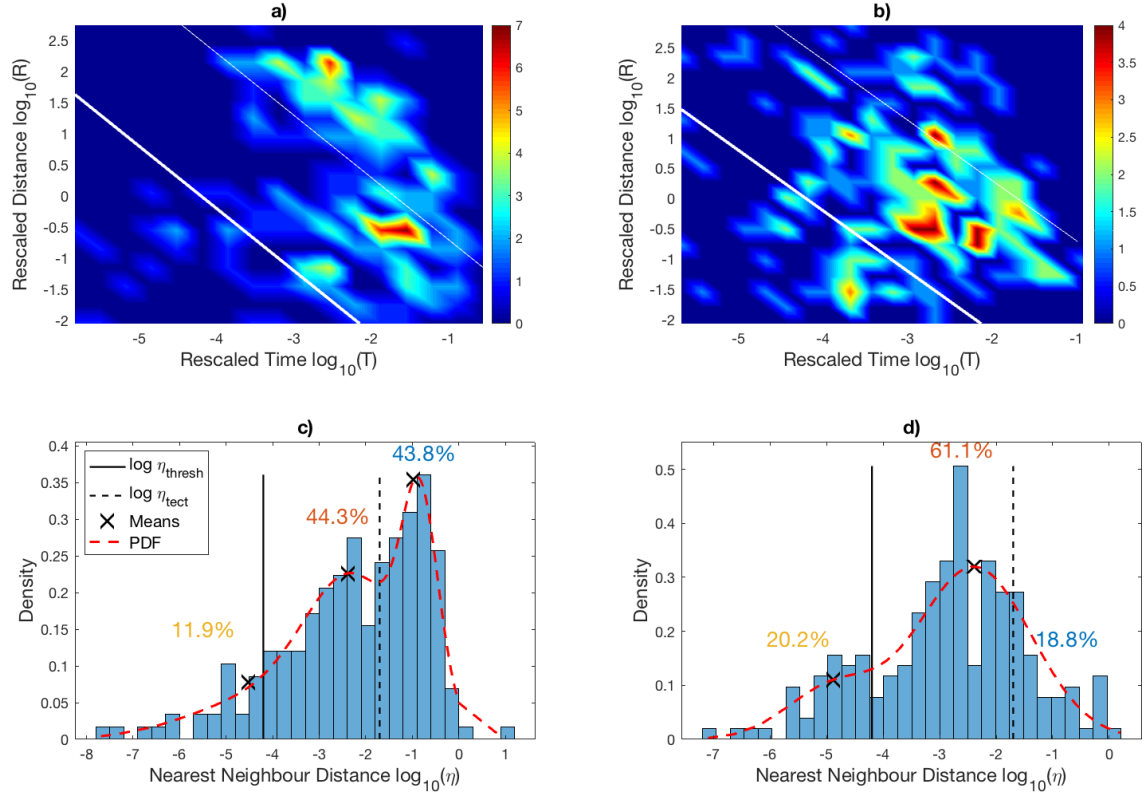


Figure S8. Comparison of NND distributions of the regional WCSB catalogue across time using a cutoff magnitude of $M_0 = 3.0$ (analogous to Figure 5) (a, c) 1975-2009. (b, d) 2010-2018. Percentages in subplots (c, d) reflect the modal mixing proportions.

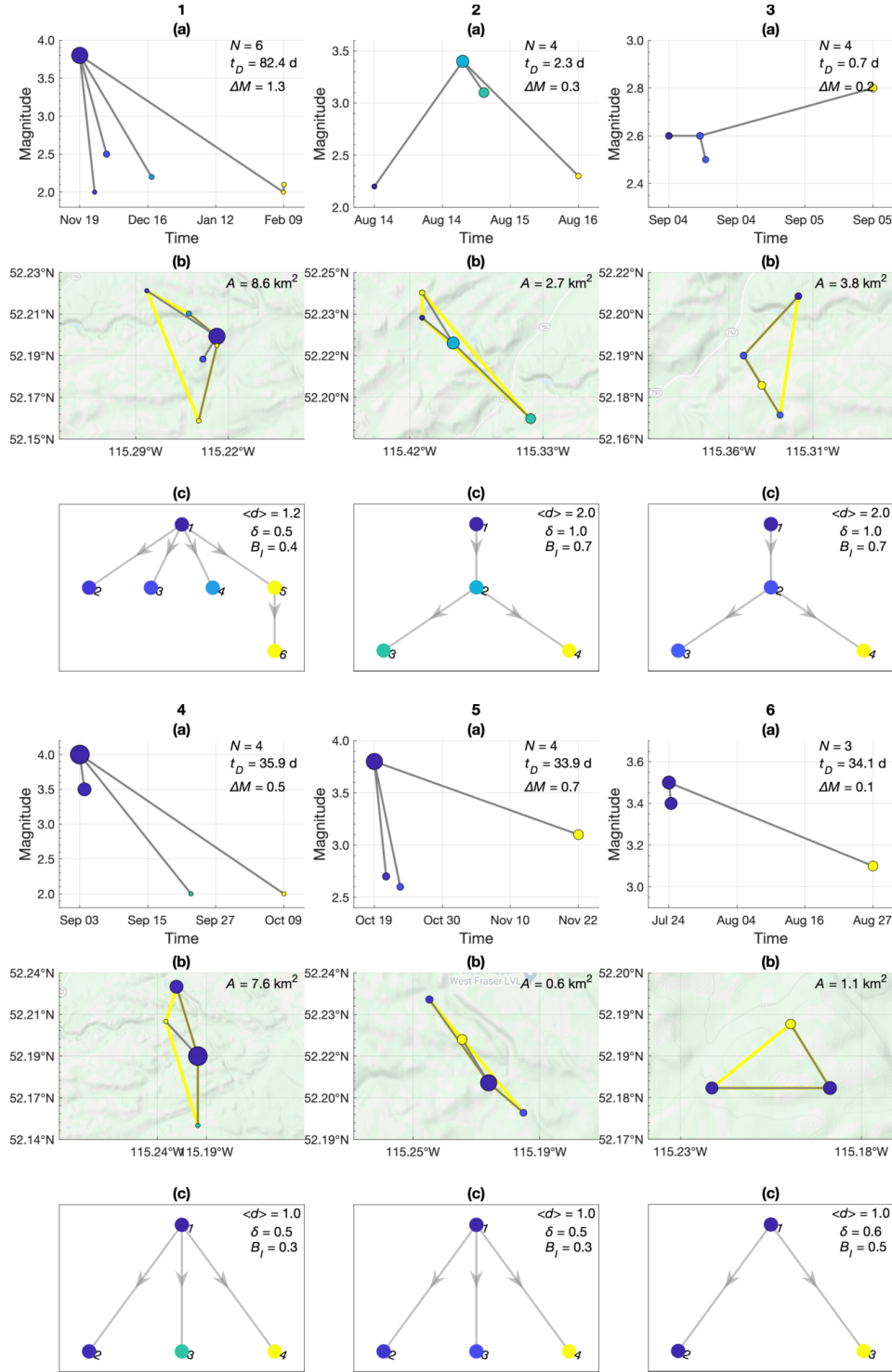


Figure S9. Event Family Structures in the Rocky Mountain House cluster (RMHC). a) Moment magnitude vs. time in days. b) Spatial map; yellow border outlines the hull area occupied by the sequence. c) Directed tree graph in dimensionless space. Data points are coloured chronologically from darkest to lightest.

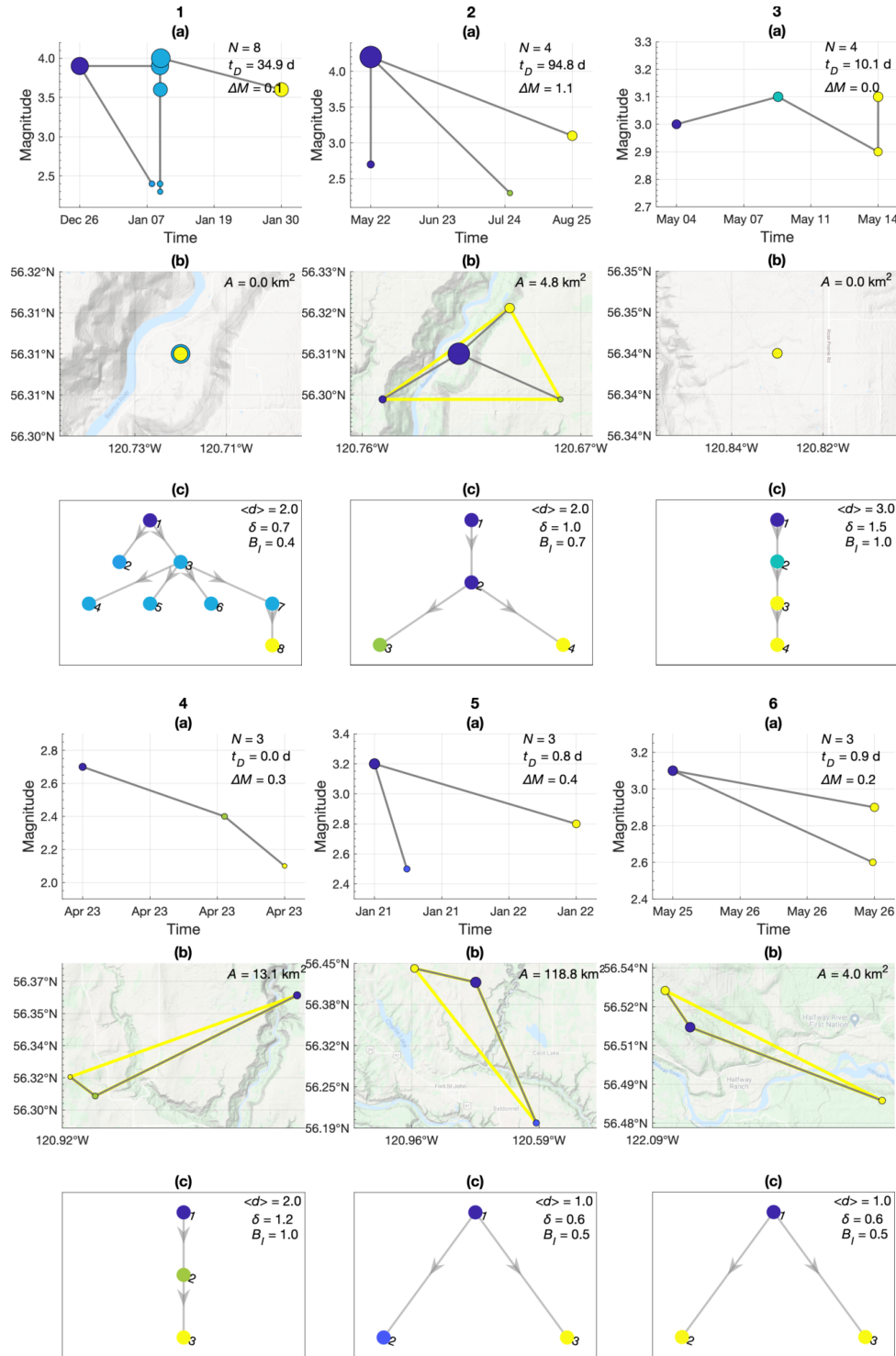
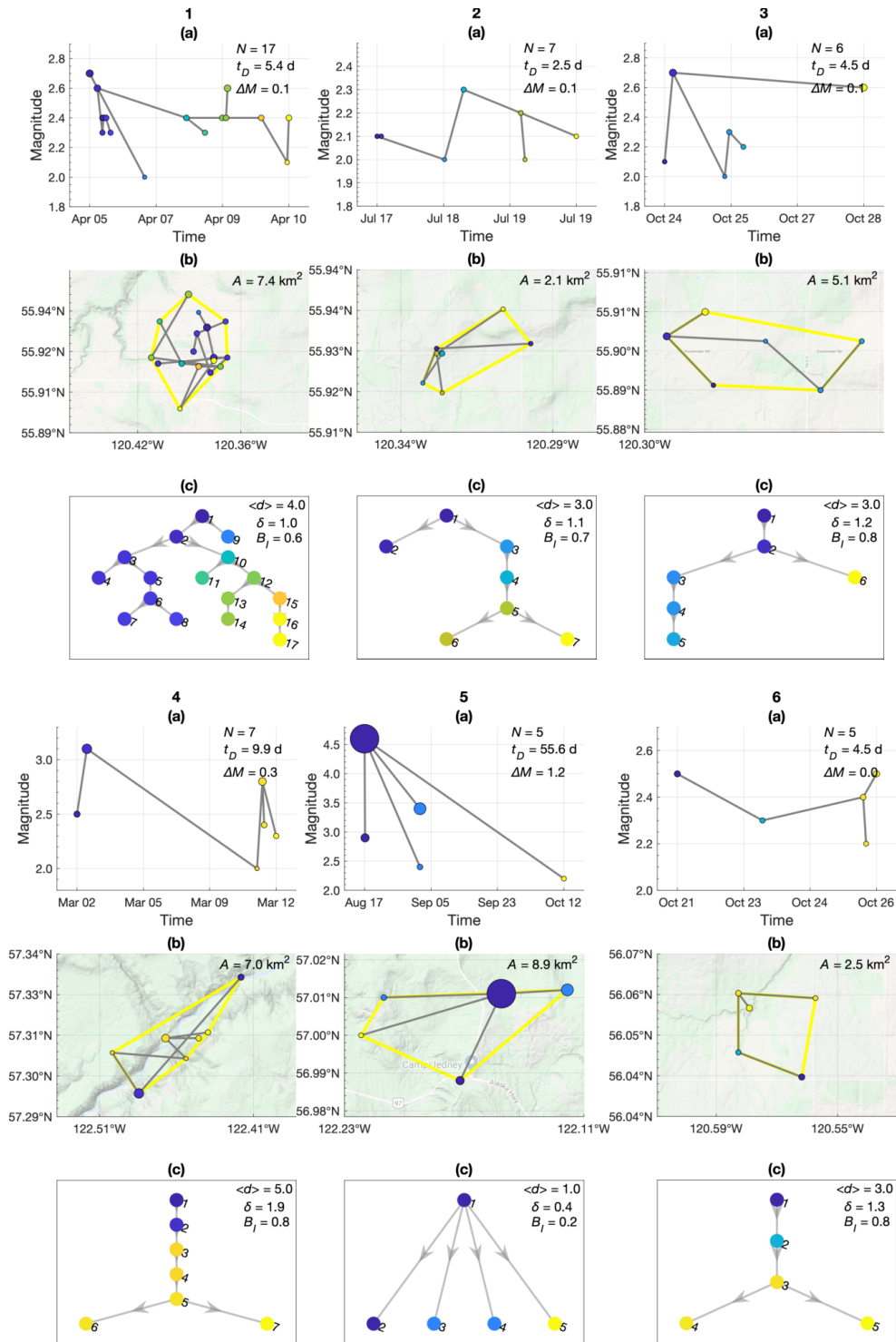


Figure S10. Event Family Structures in the Montney cluster 1 (MC1). a) Moment magnitude vs. time in days. b) Spatial map; yellow border outlines the hull area occupied by the sequence. c) Directed tree graph in dimensionless space. Data points are coloured chronologically from darkest to lightest.



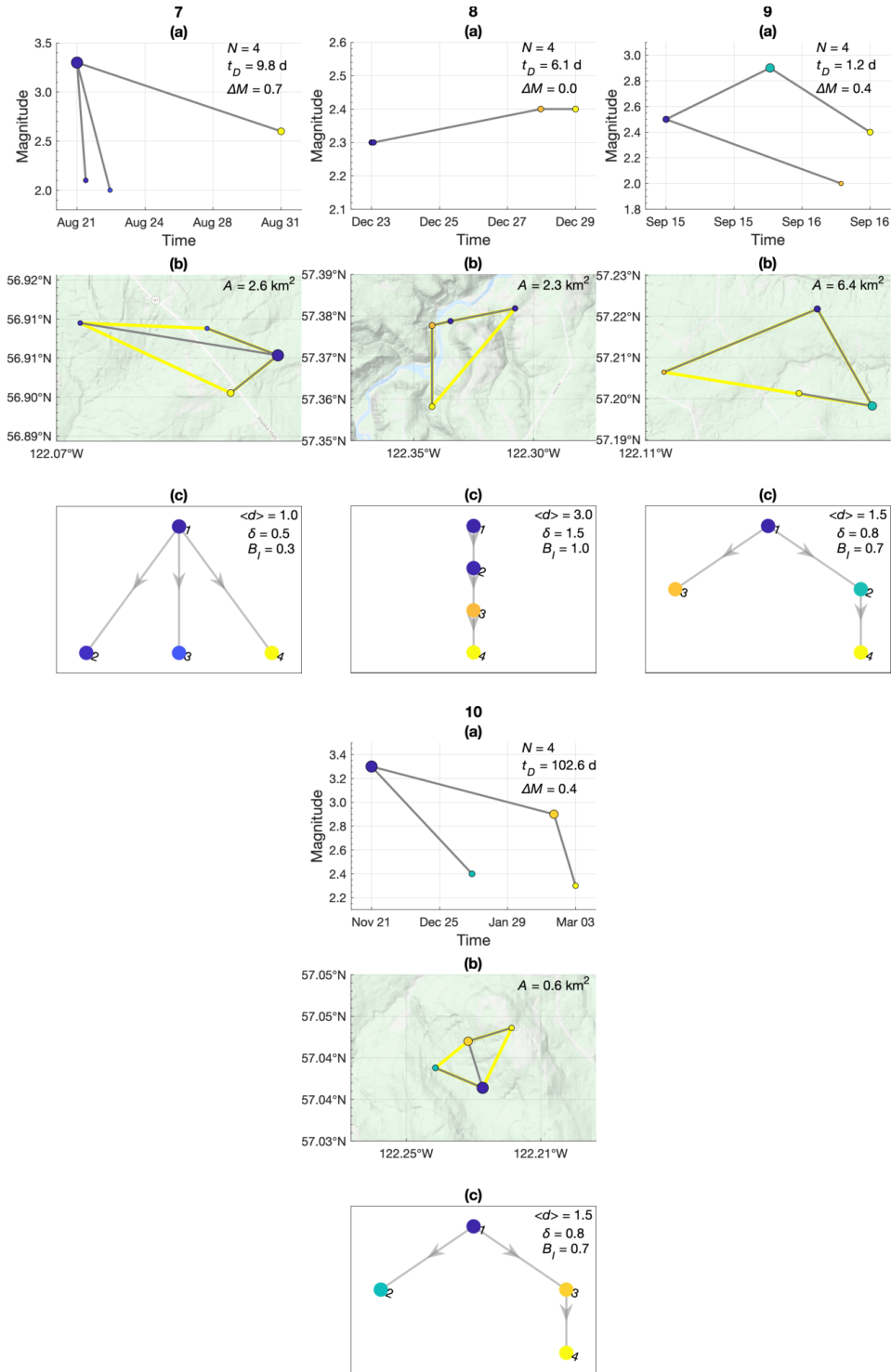
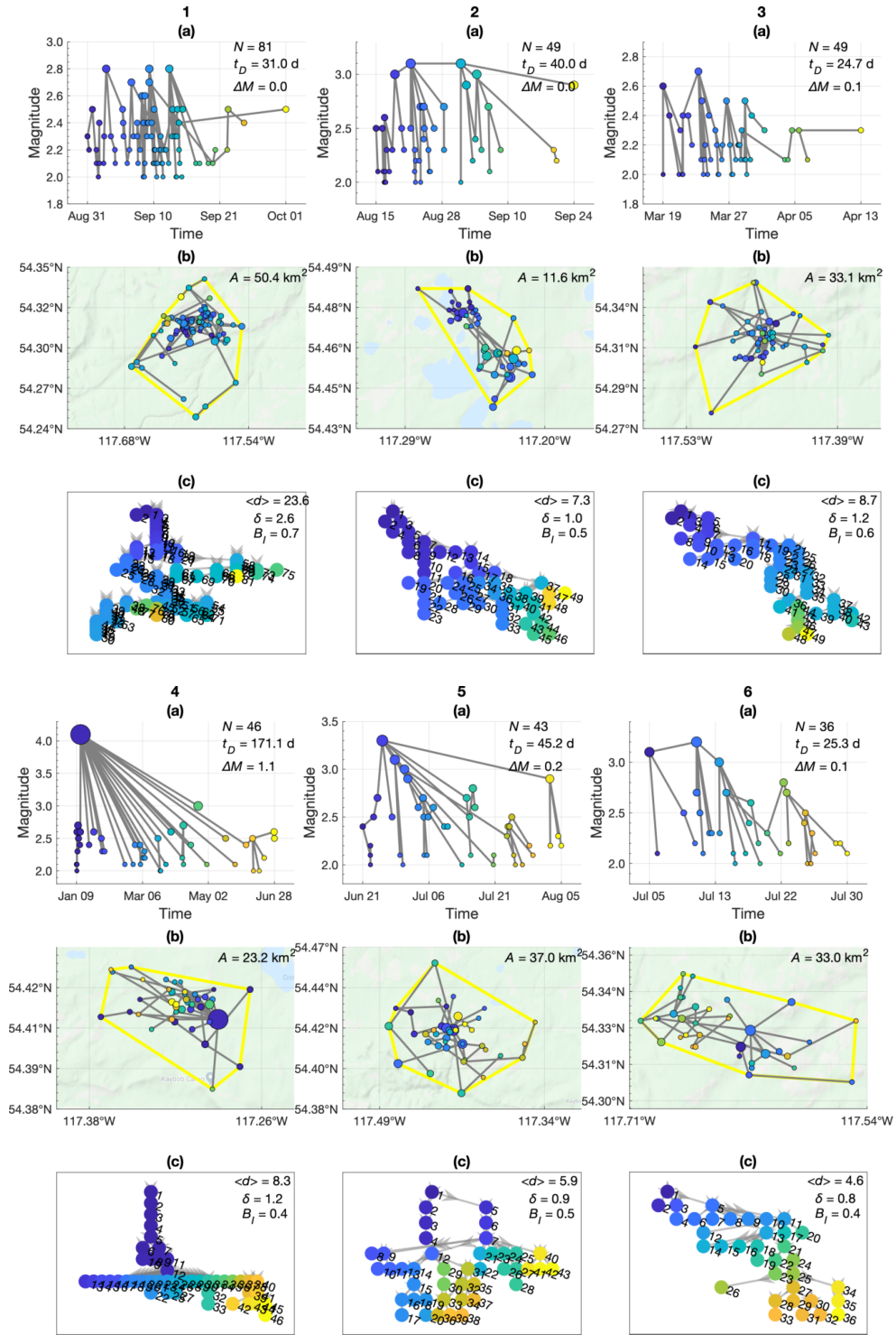
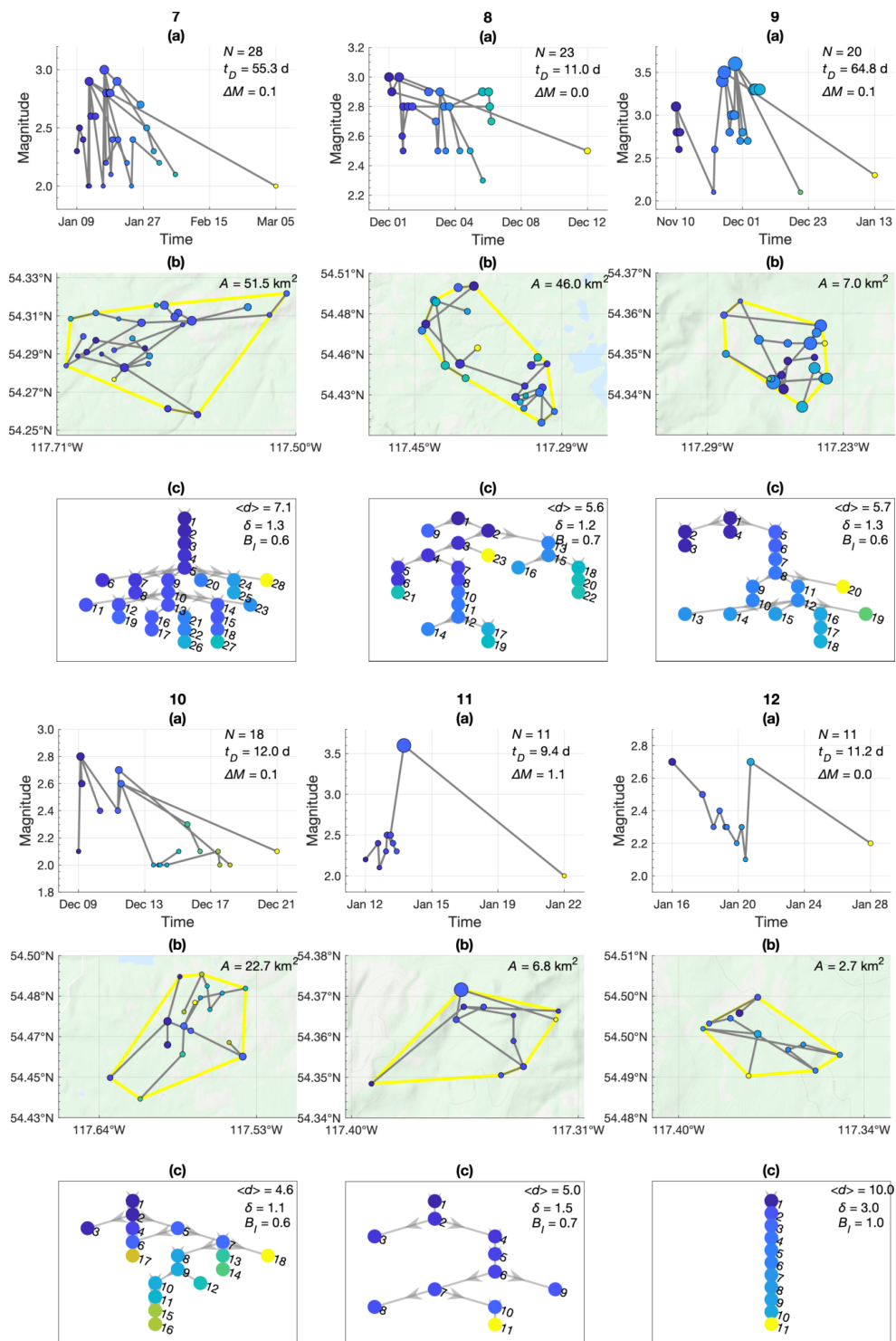


Figure S11. Event Family Structures in the Montney cluster 2 (MC2). a) Moment magnitude vs. time in days. b) Spatial map; yellow border outlines the hull area occupied by the sequence. c) Directed tree graph in dimensionless space. Data points are coloured chronologically from darkest to lightest.





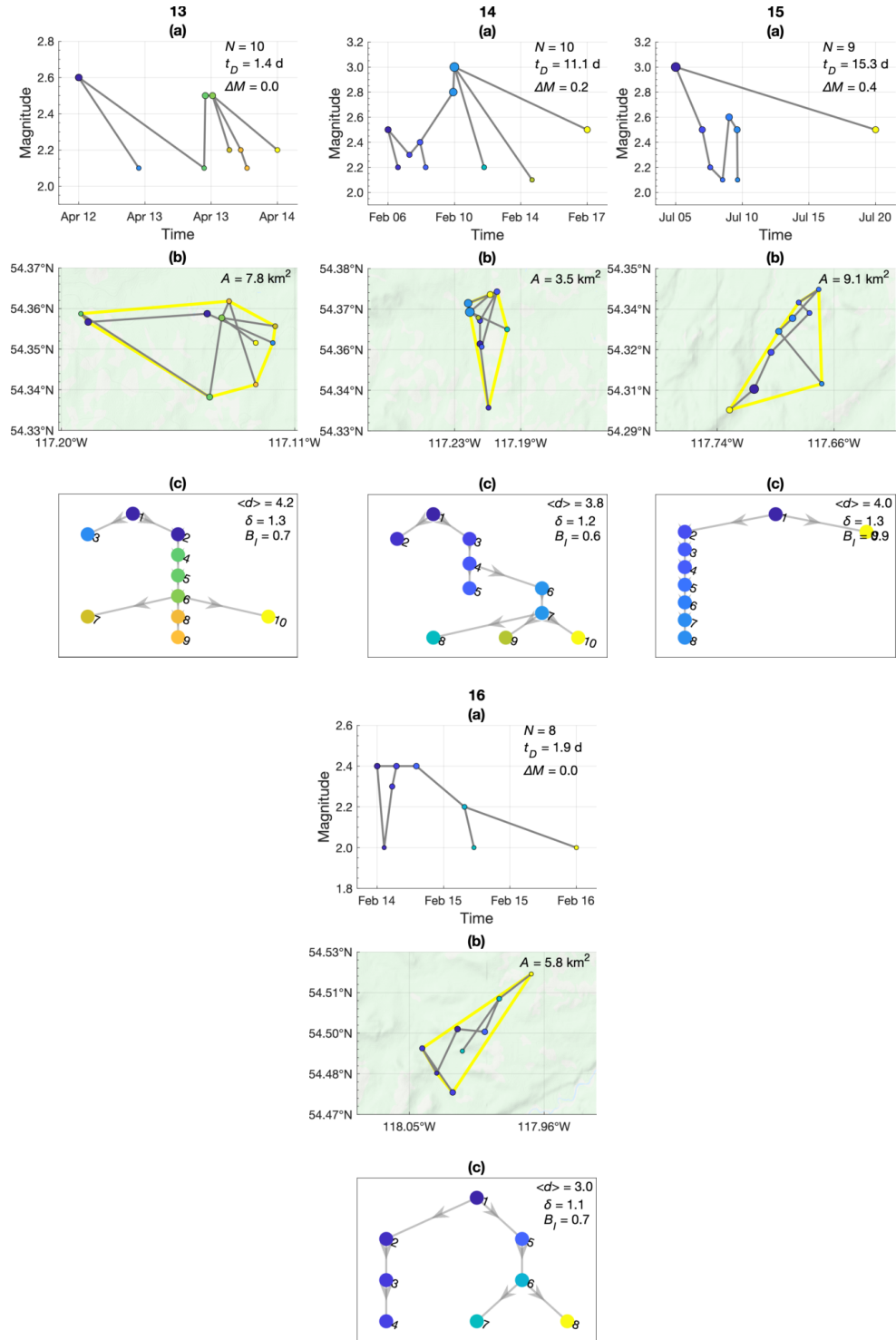


Figure S12. Event Family Structures in the Fox Creek cluster (FCC). a) Moment magnitude vs. time in days. b) Spatial map; yellow border outlines the hull area occupied by the sequence. c) Directed tree graph in dimensionless space. Data points are coloured chronologically from darkest to lightest.