Difference in earthquake mechanisms between first motion solutions and moment tensor solutions

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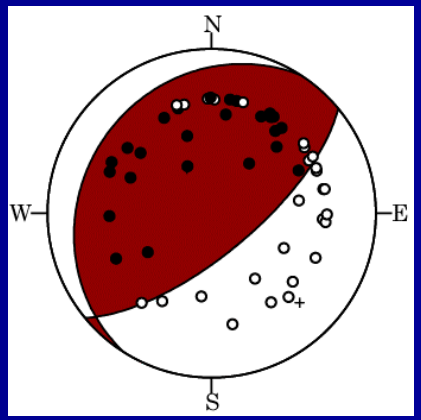
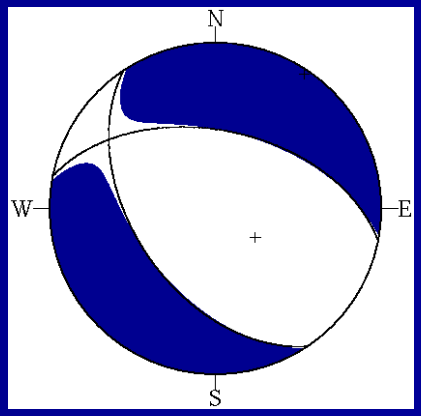
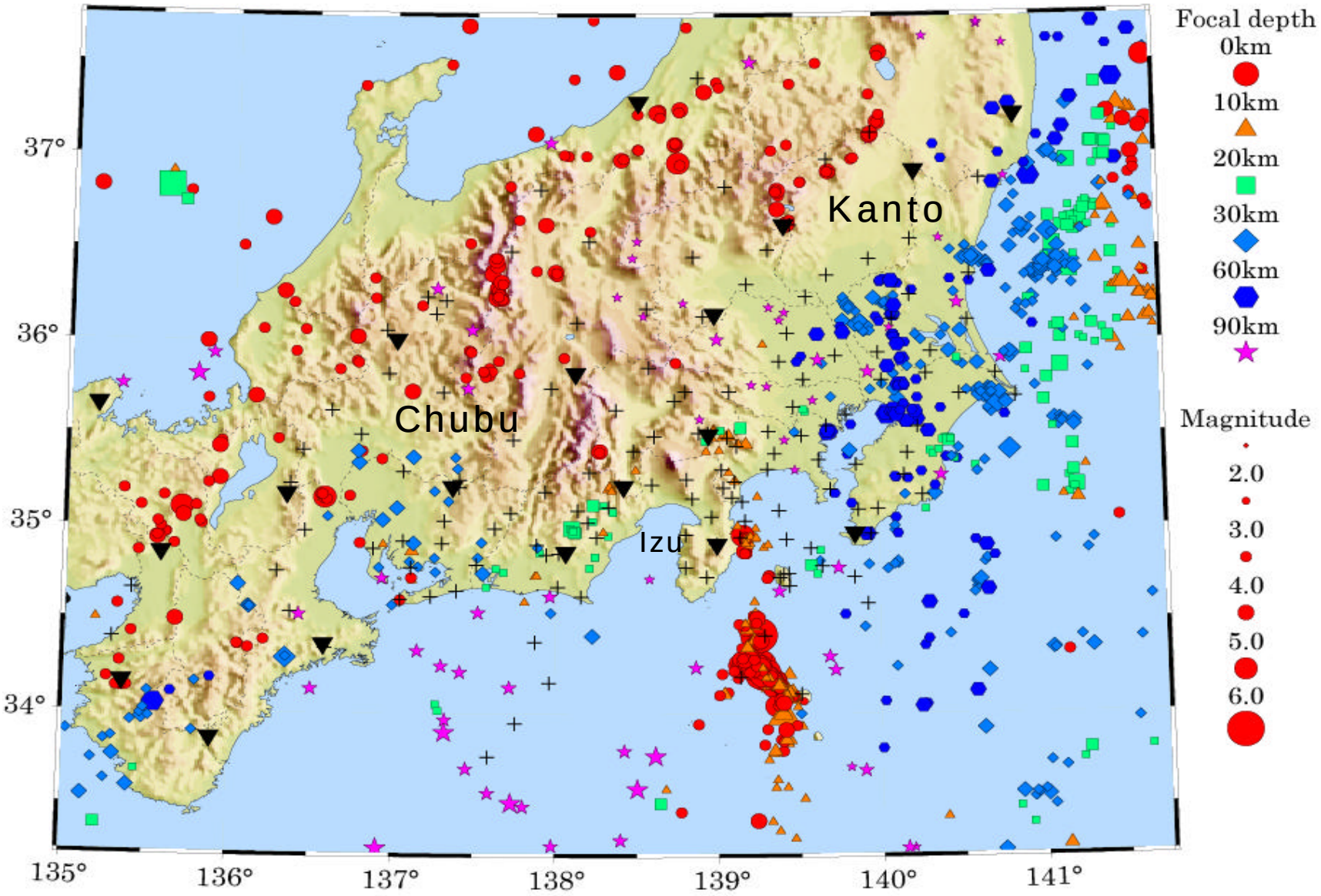
Earthquake Mechanisms

- First motion solution
  - P wave polarity data
  - Initial rupture
  - Applicable to small events (M~1)
  - Non-uniqueness
  - Difficulty in error estimation
- Moment tensor solution
  - Broadband waveform data
  - Averaged rupture
  - Not applicable to small events (M>3~4)
  - Uniquely determined with variance reduction

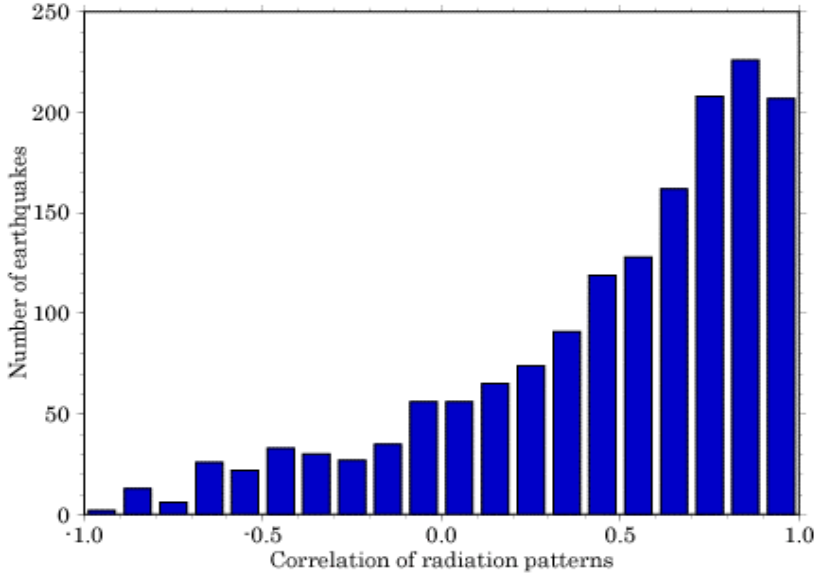


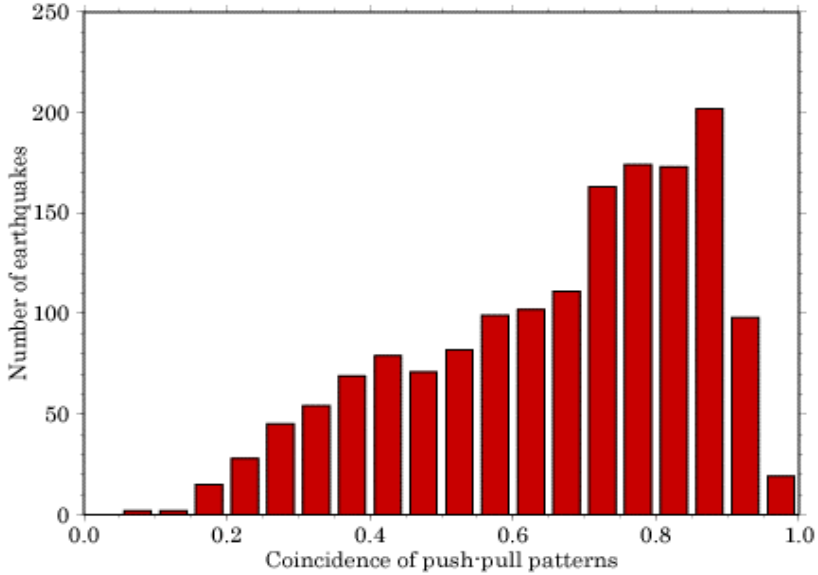


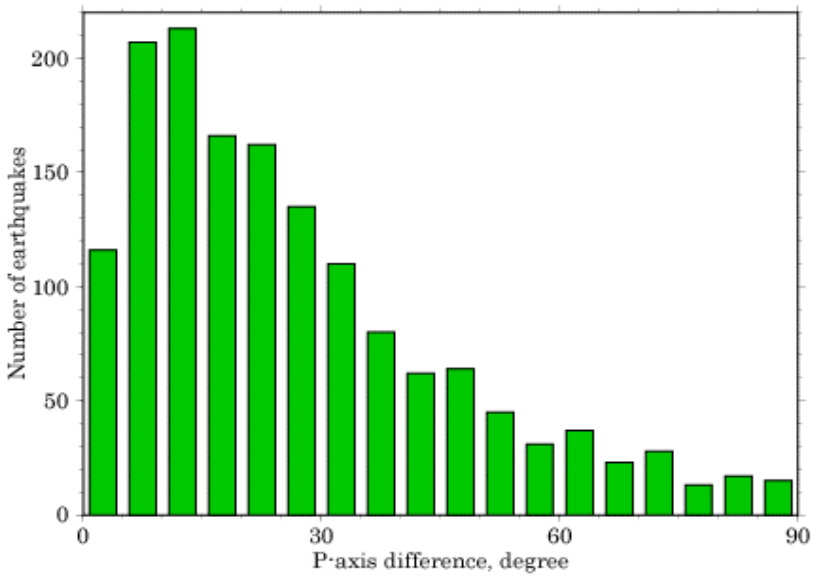
Distribution of hypocenters and stations

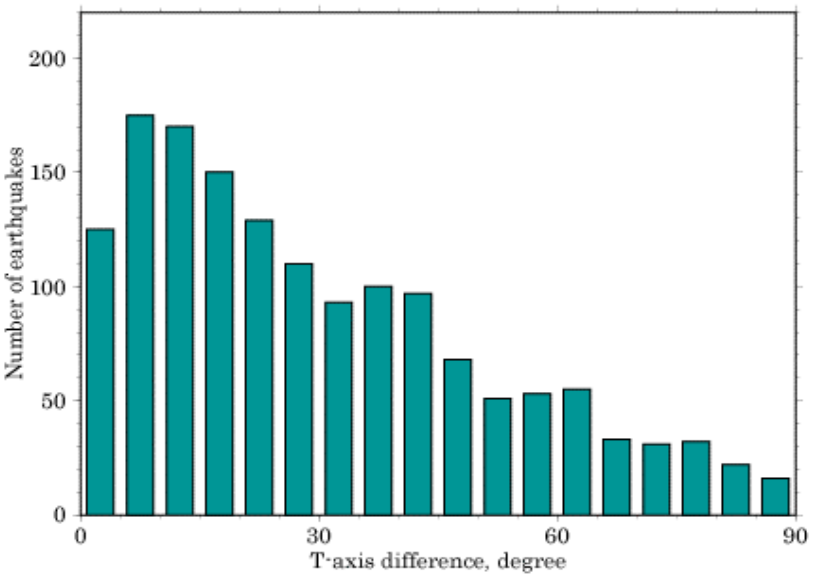


Difference between first motion and moment tensor solutions

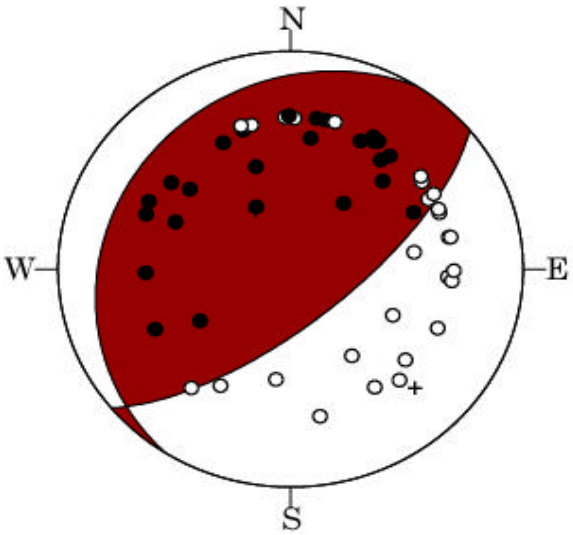


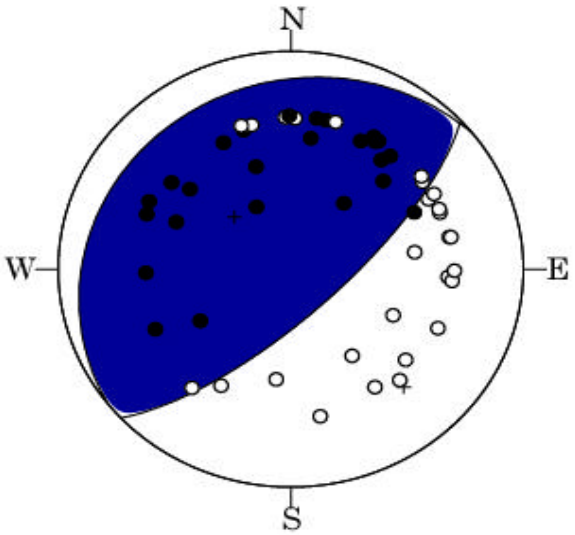






2001/02/18 16:17:23.72 36.0975N 139.9040E 47.4km Mj3.8 Mw4.2





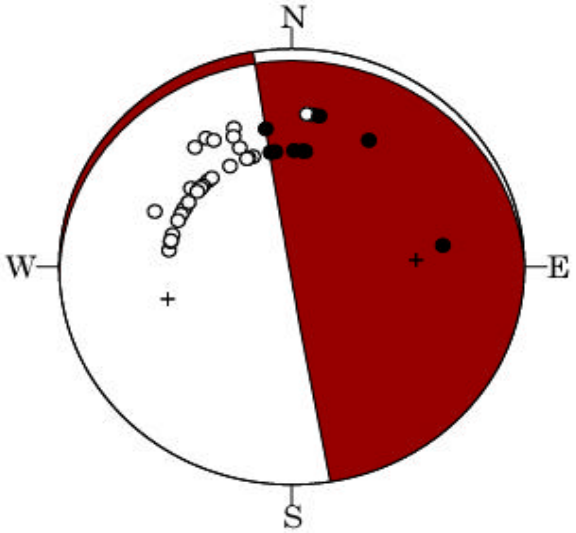
Earthquake with similar solutions

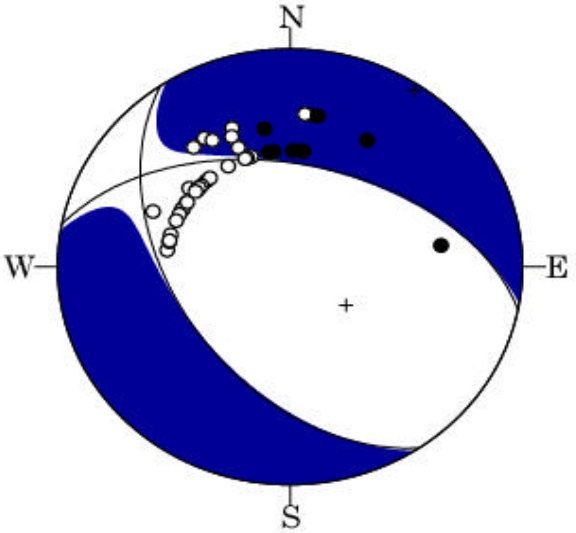
Correlation Coefficient: 0.99
Pattern mismatch: 3.55%
Variance reduction: 94.32%

2000/08/08 15:42:51.50 34.1845N 139.2967E 15.0km Mj3.5 Mw3.8

Earthquake with different solutions

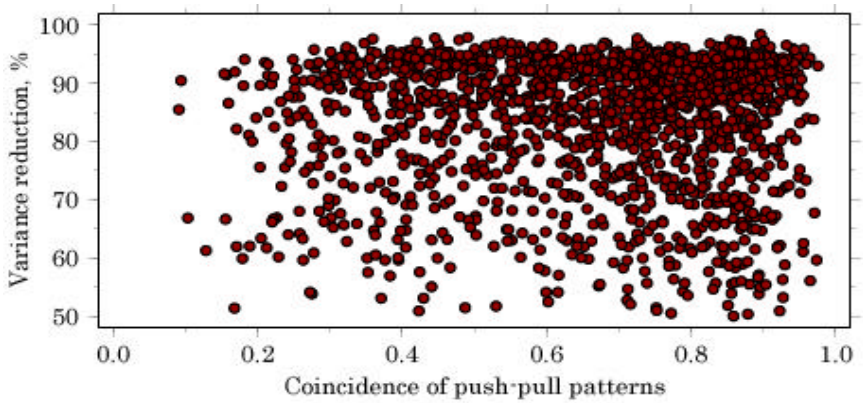
Correlation Coefficient: -0.25
Pattern mismatch: 55.53%
Variance reduction: 90.09%



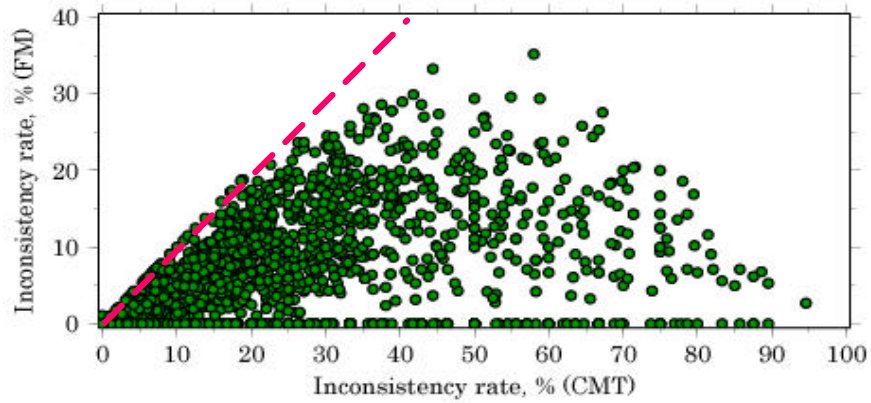


Effect on difference in mechanism solutions

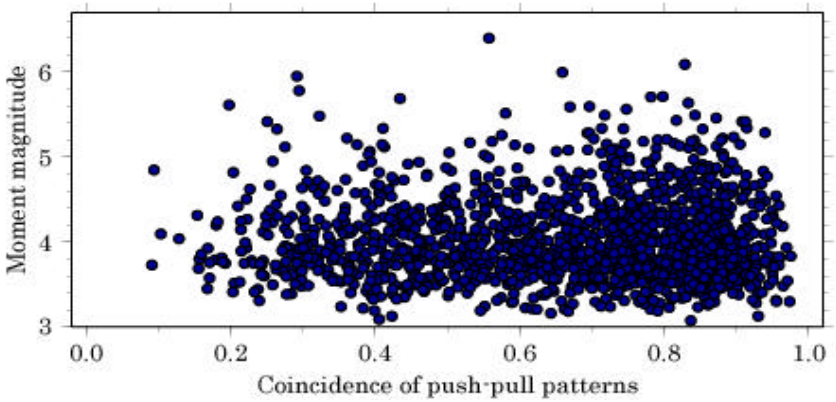
Quality of MT



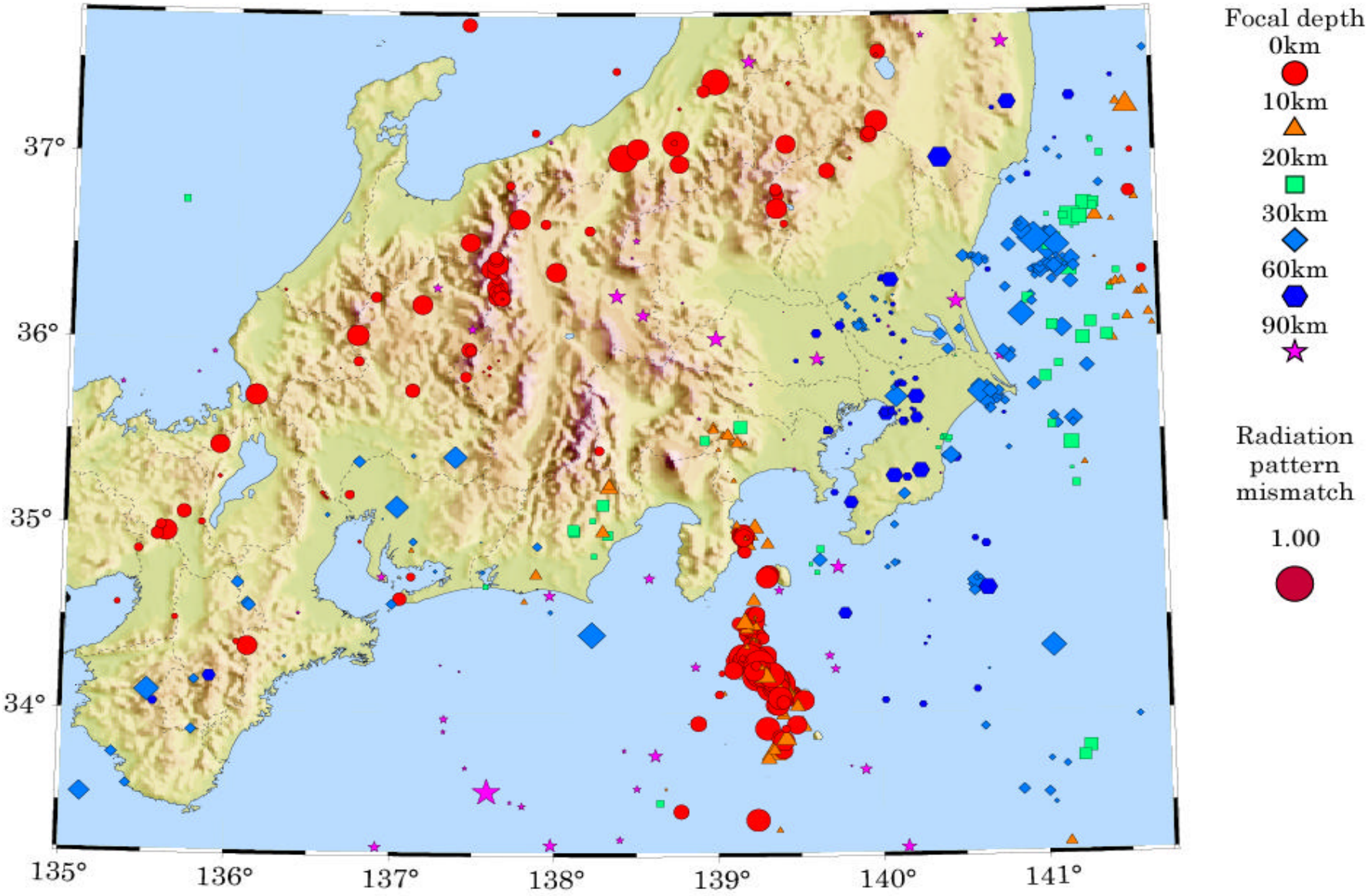
Non-uniqueness of FM



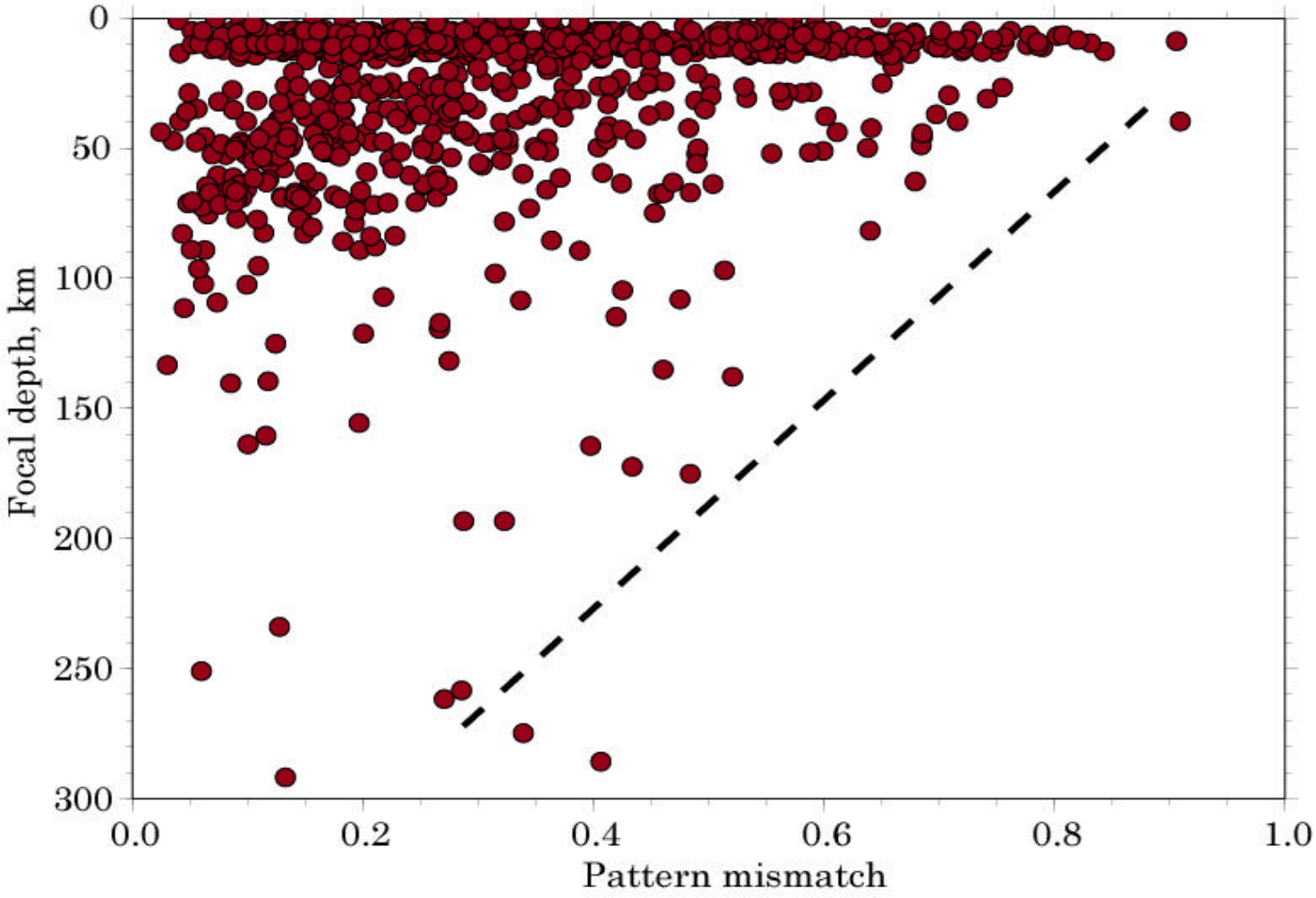
Earthquake size



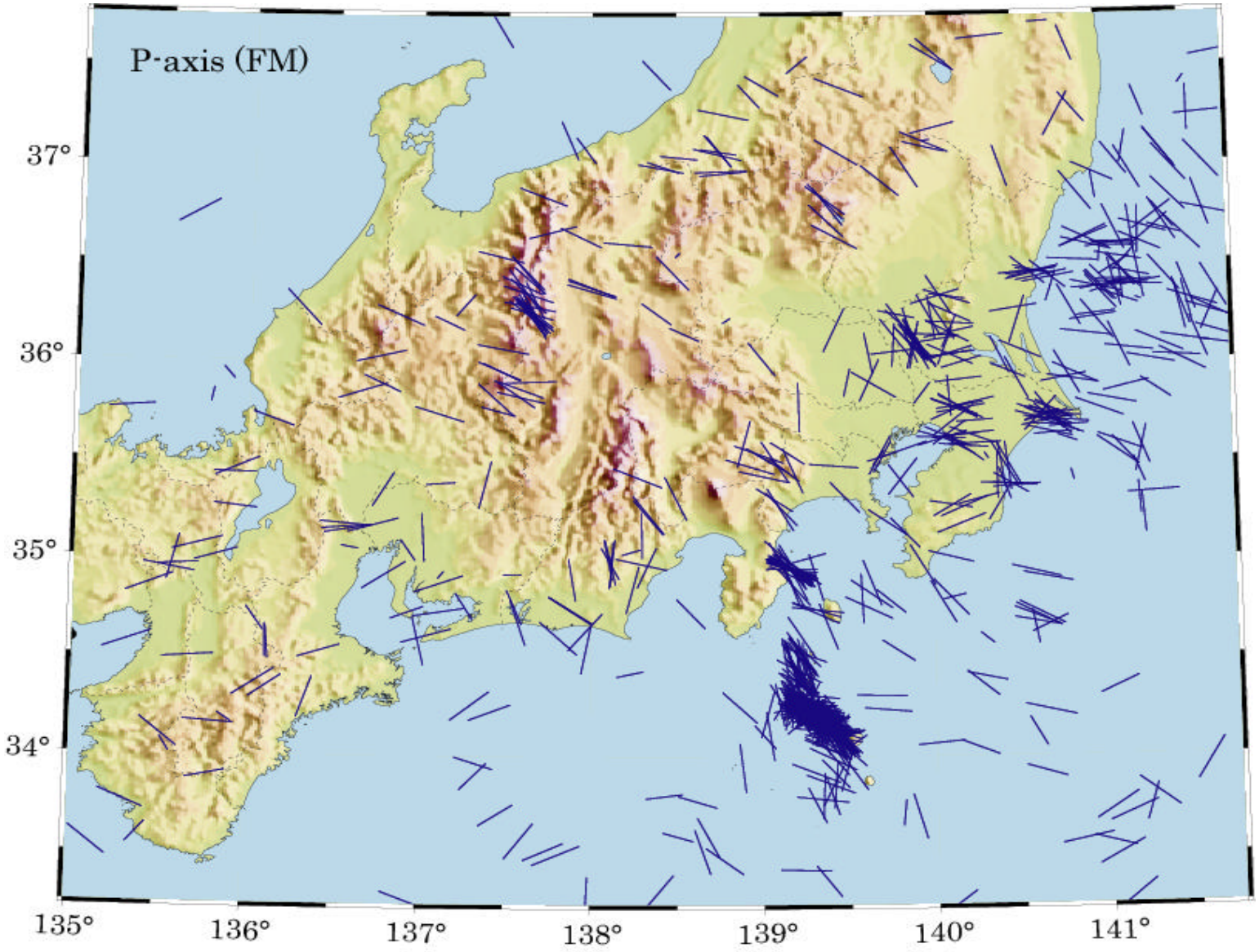
Distribution of earthquakes with different solutions



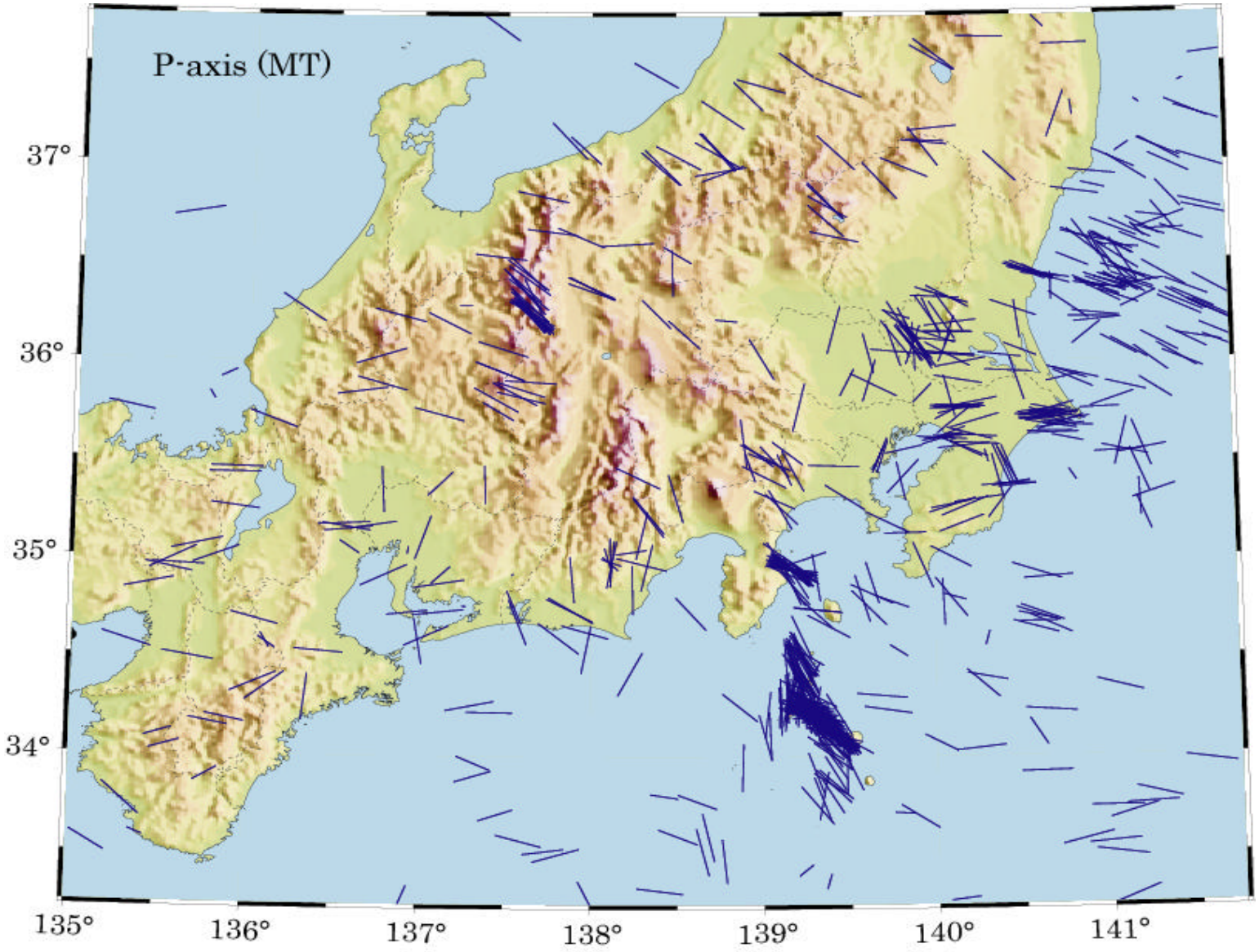
Focal depth and difference in solutions



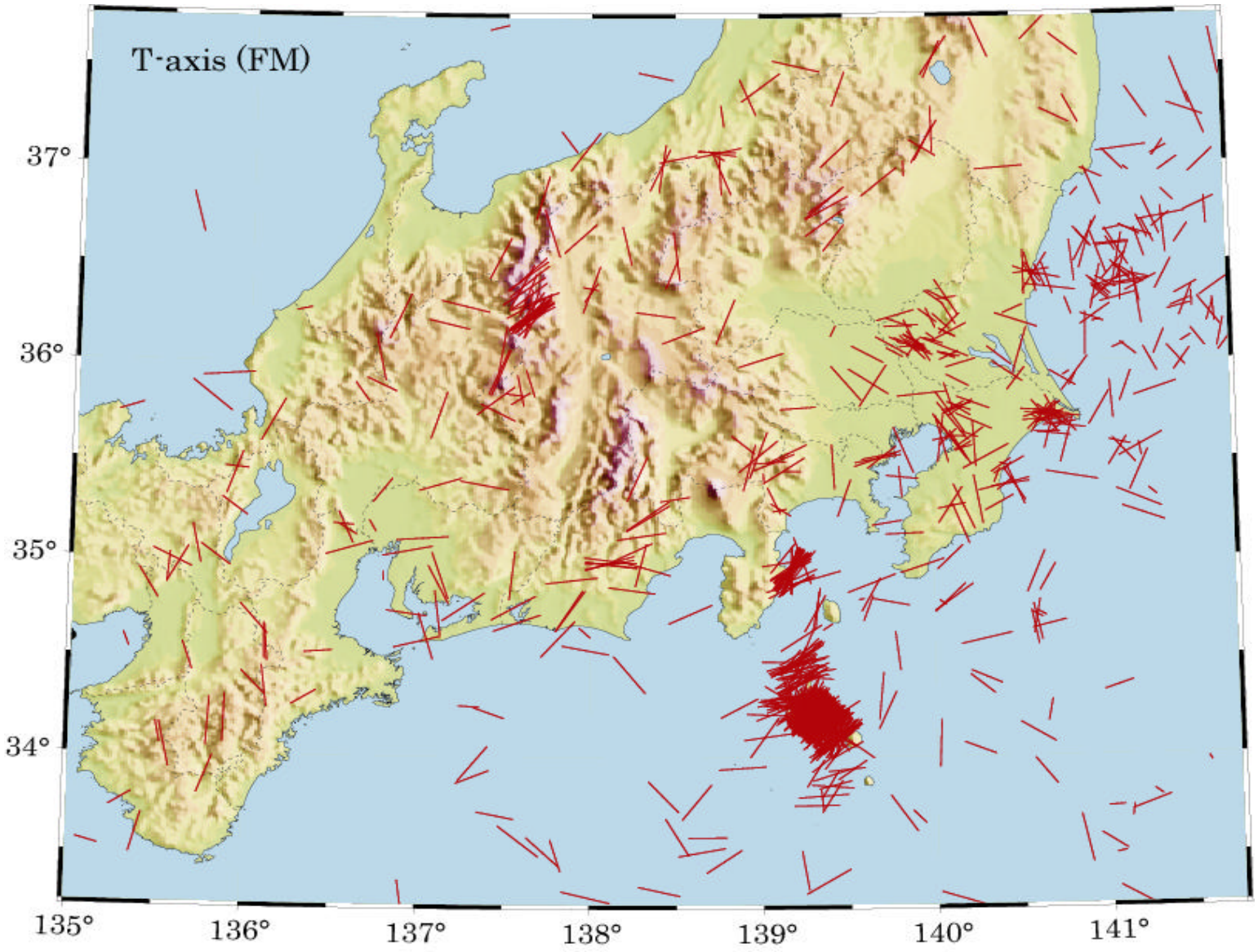
Distribution of P-axes of first motion solutions



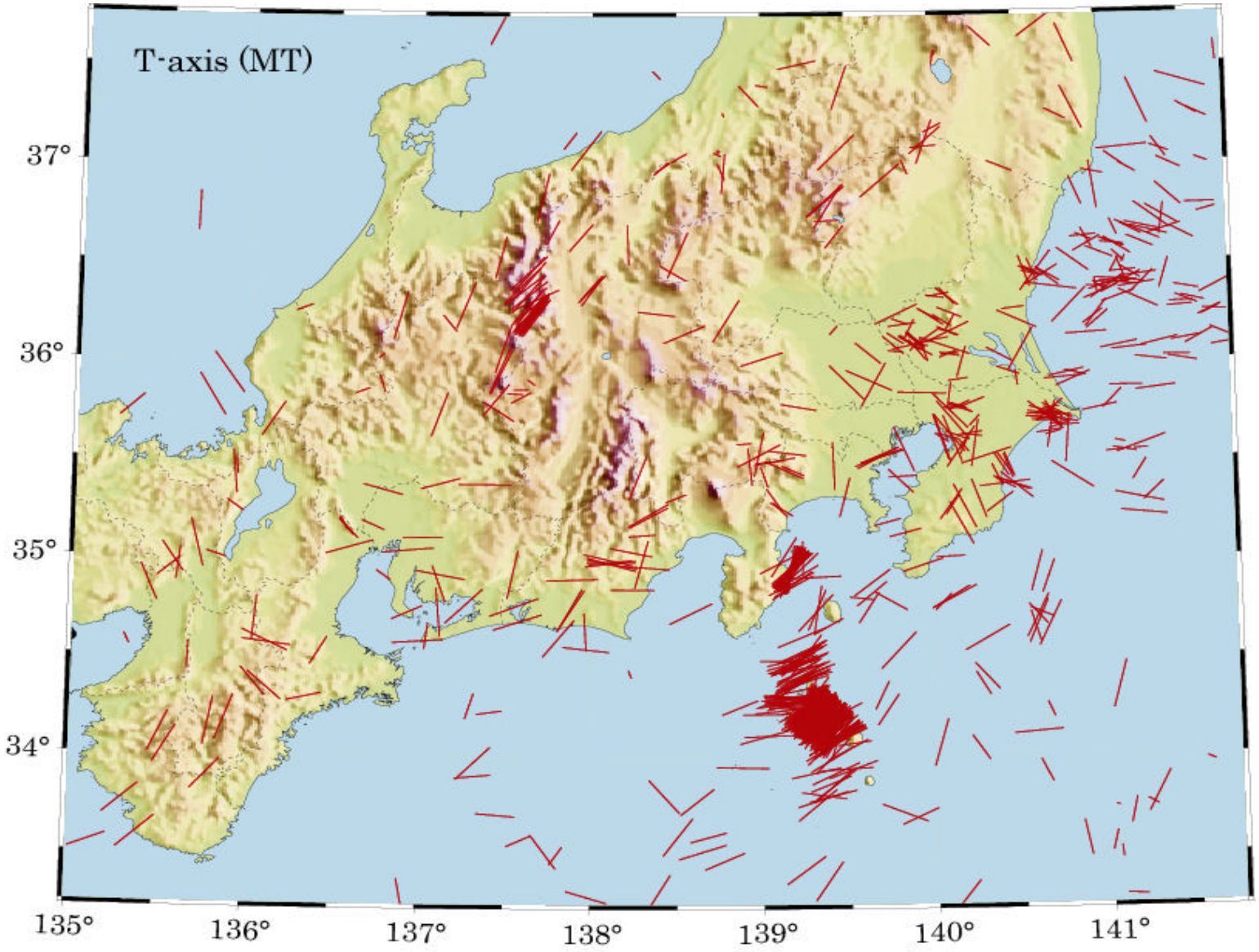
Distribution of P-axes of moment tensor solutions



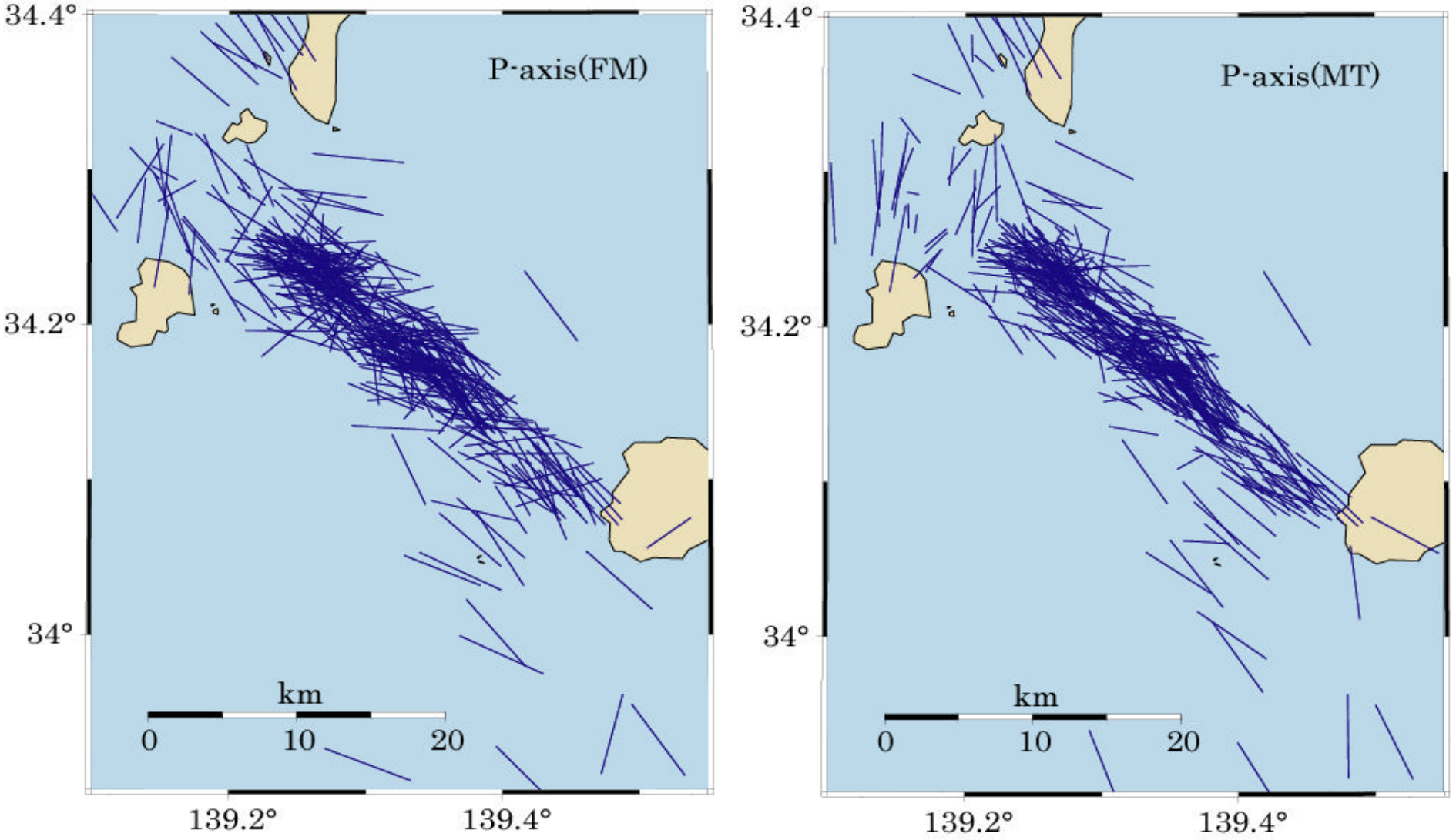
Distribution of T-axes of first motion solutions



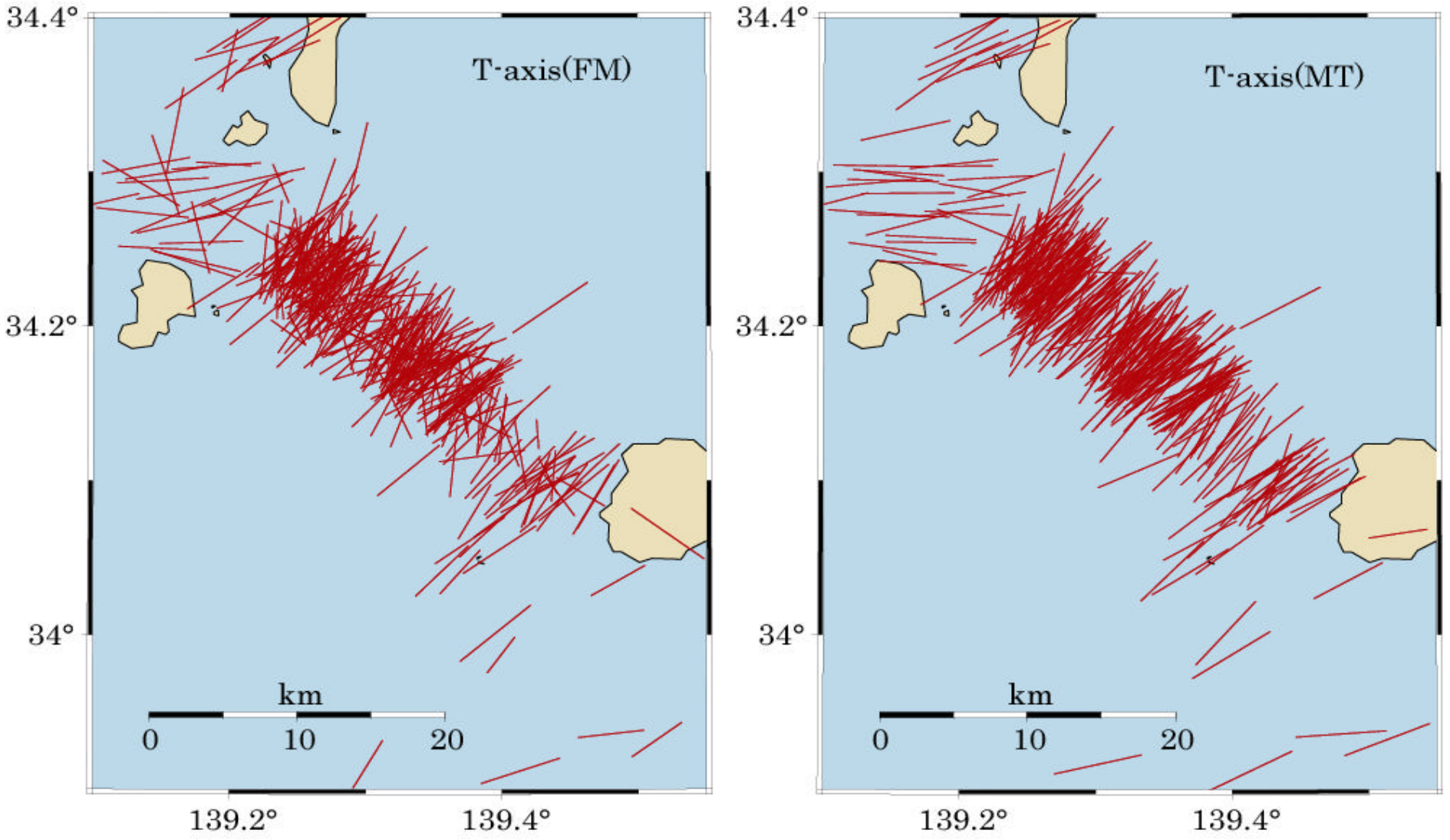
Distribution of T-axes of moment tensor solutions

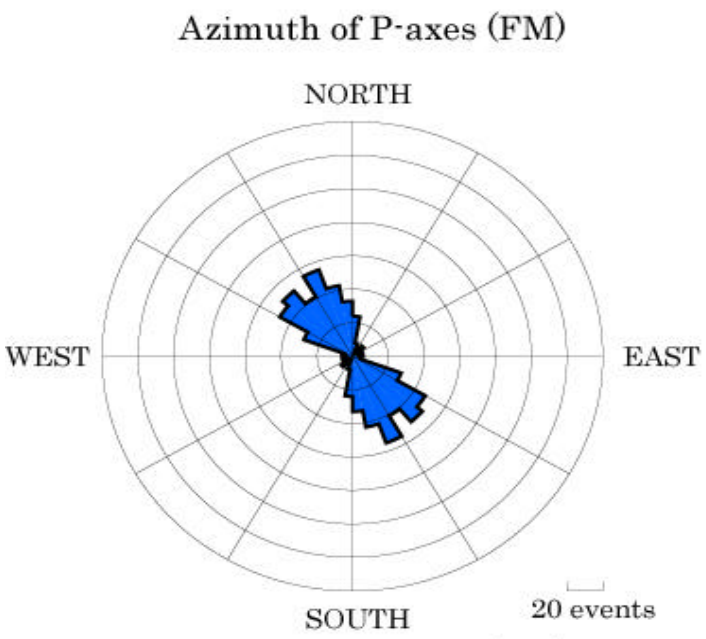


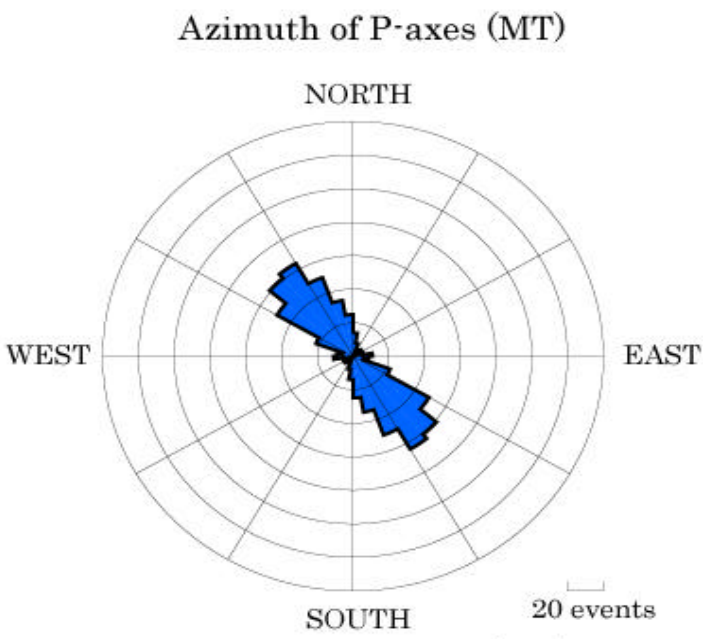
Distribution of P-axes in Kozu-Miyake region

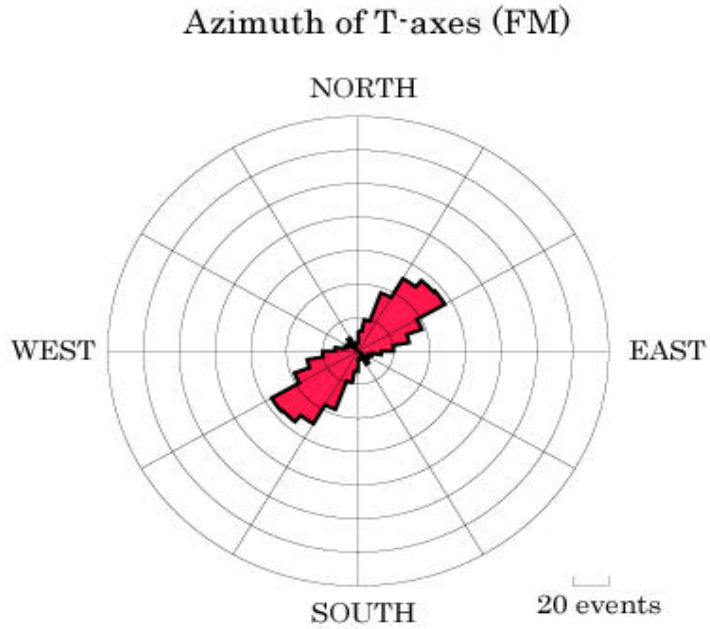


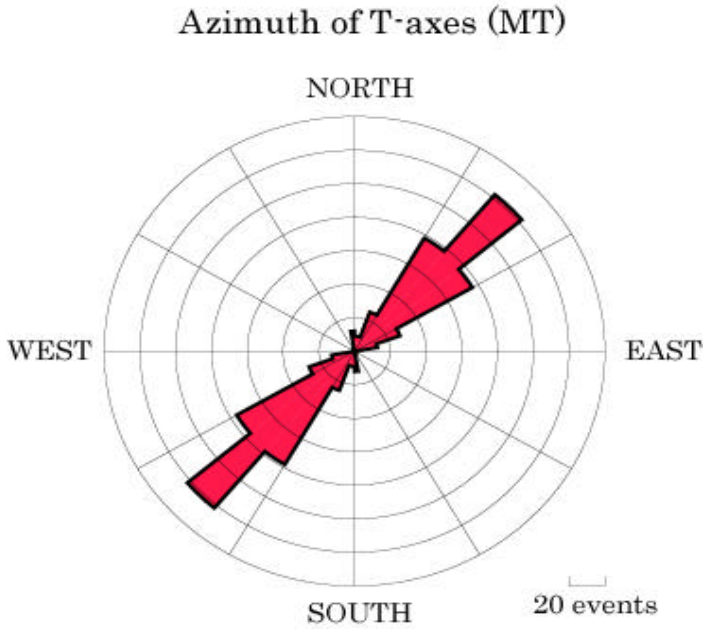
Distribution of T-axes in Kozu-Miyake region




Azimuth of P-axes (FM)
NORTH
WEST
EAST
SOUTH
20 events

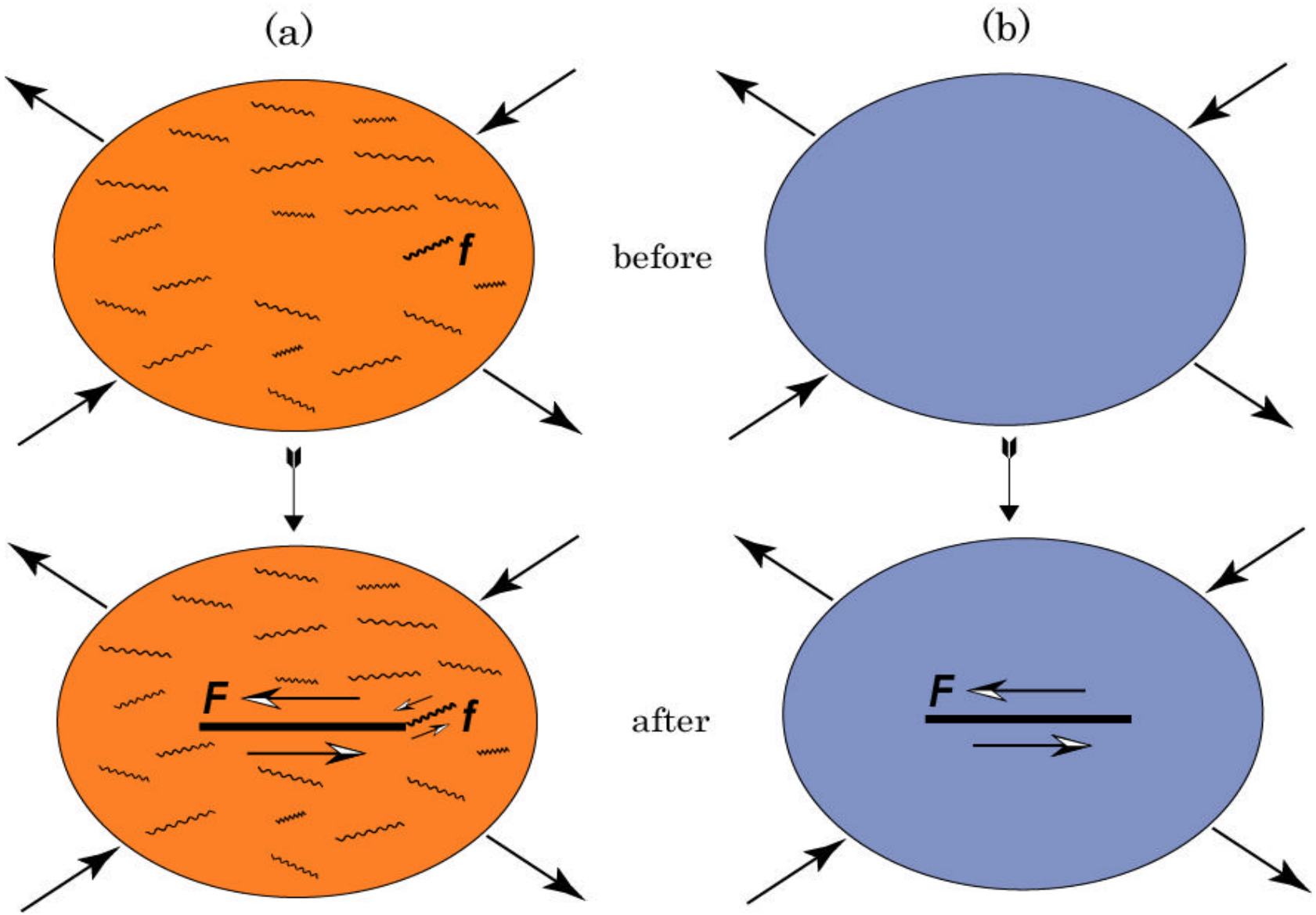

Azimuth of P-axes (MT)
NORTH
WEST
EAST
SOUTH
20 events


Azimuth of T-axes (FM)
NORTH
WEST
EAST
SOUTH
20 events


Azimuth of T-axes (MT)
NORTH
WEST
EAST
SOUTH
20 events

Different solutions

Similar solutions

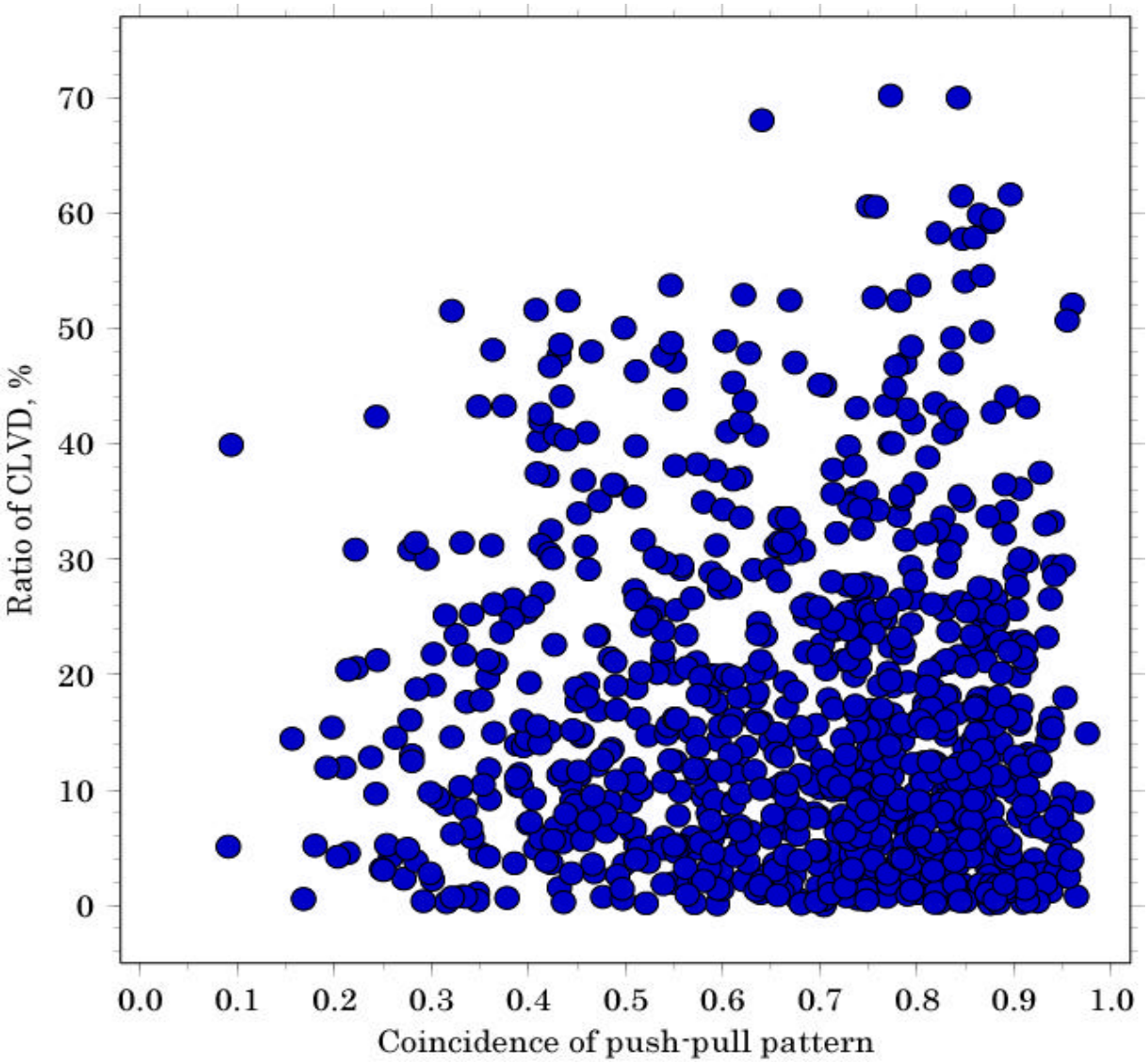


Inhomogeneous

Homogeneous

Summary

- Agreement of the first motion solution and the moment tensor solution is good as a whole.
- There are considerable number of earthquakes with large difference in mechanism solutions.
- Difference does not originate from uncertainty of the solutions but represents real difference in source process.
- Difference is large in the volcanic region from Miyake to Niijima islands but is small for deeper earthquakes.
- P- or T- axis orientation is more scattered for the first motion solutions as compared with themoment tensor solutions.
- Moment tensor approach is more appropriate to analysis of local seismotectonics or seismogenic structure.
- A model to explain difference in mechanism solutions is proposed.


Ratio of CLVD, %
70
60
50
40
30
20
10
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Coincidence of push-pull pattern