

Lg-Wave Cross Correlation Applied to Detection and Location of Events in High-Seismicity Regions of Mainland East Asia

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Stephen Heck², Paul G. Richards¹, Christopher Young²

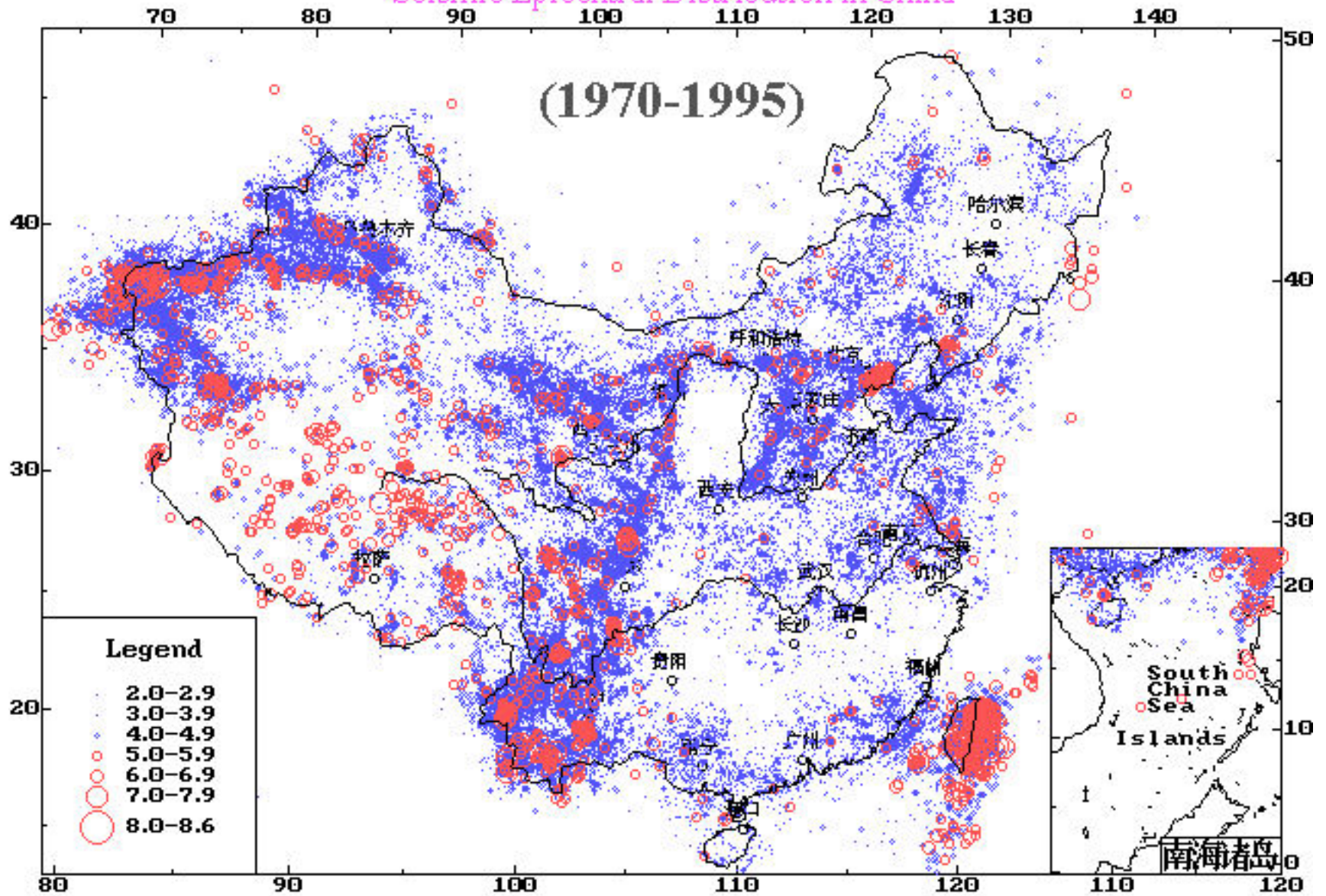
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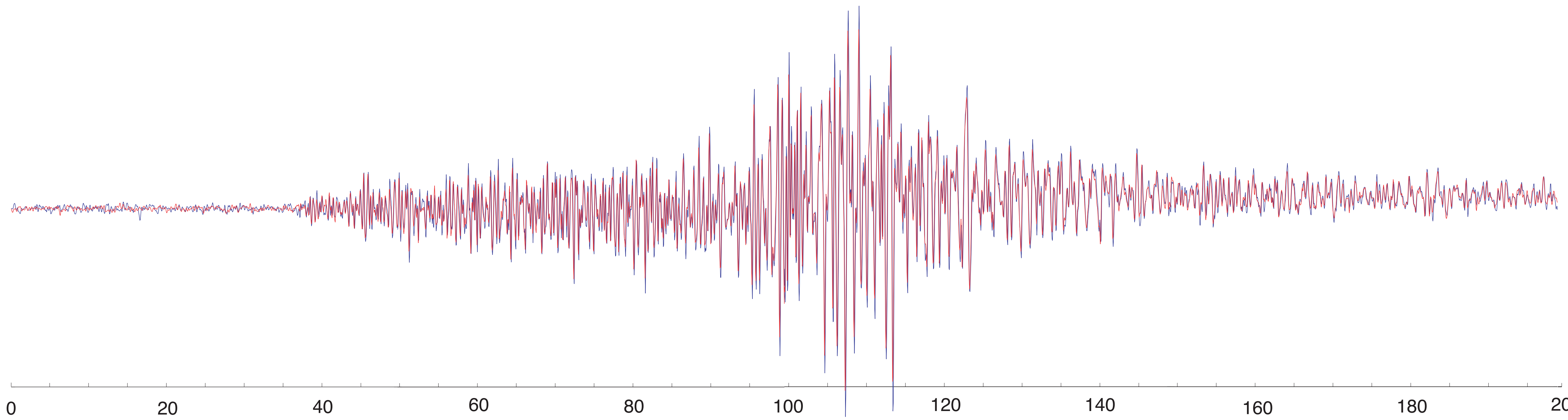
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“Precision Seismology”

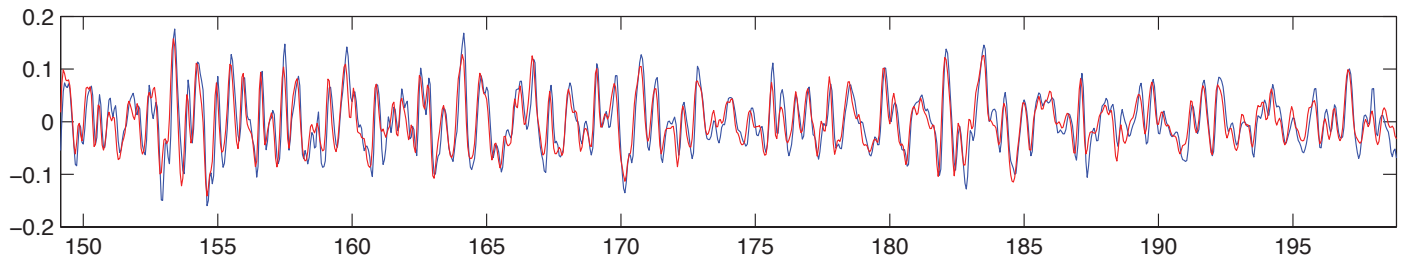
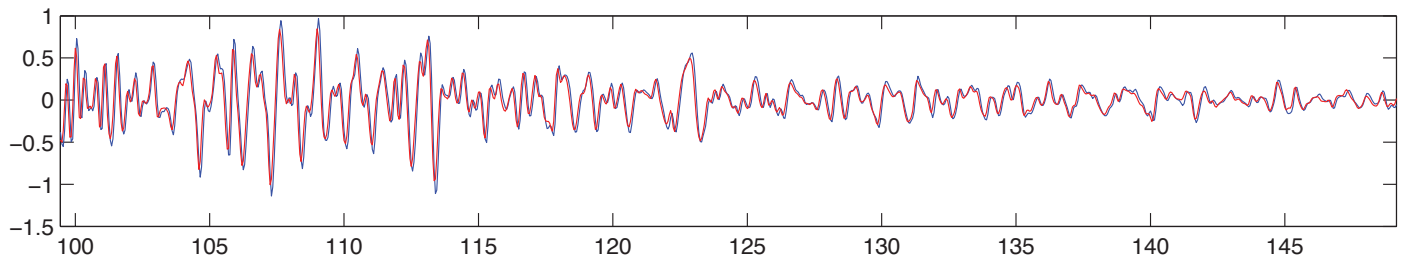
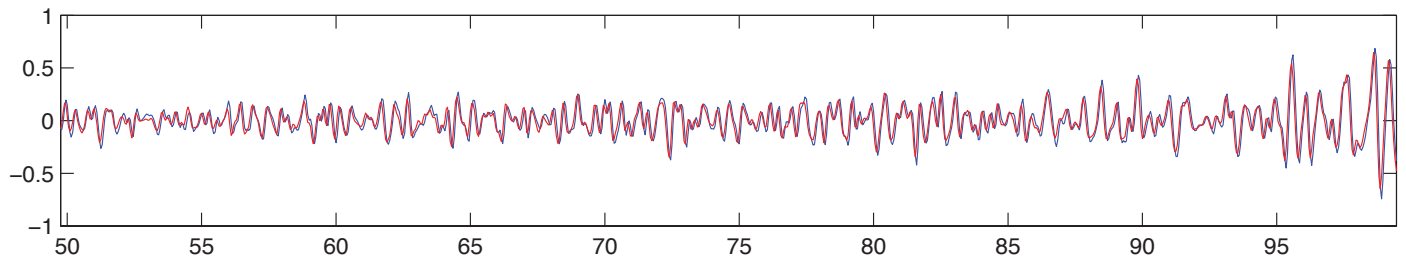
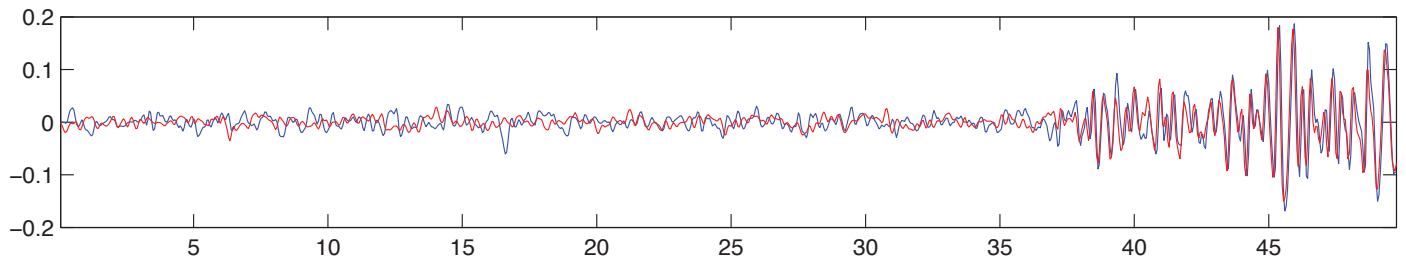
中国地震震中分布图

Seismic Epicentral Distribution in China





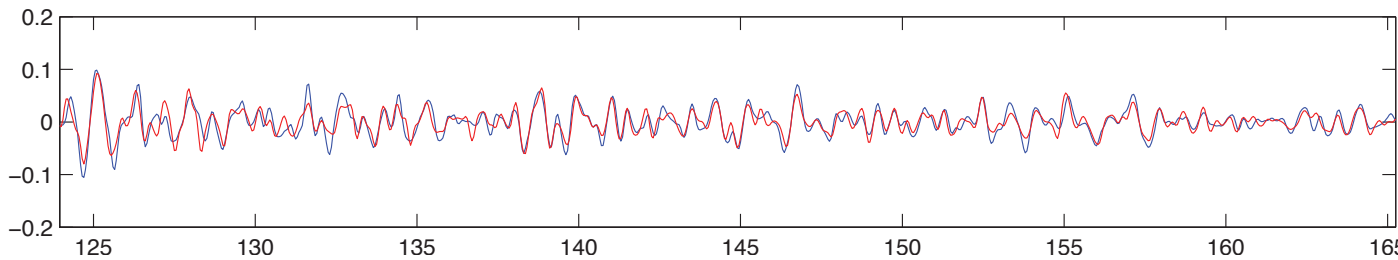
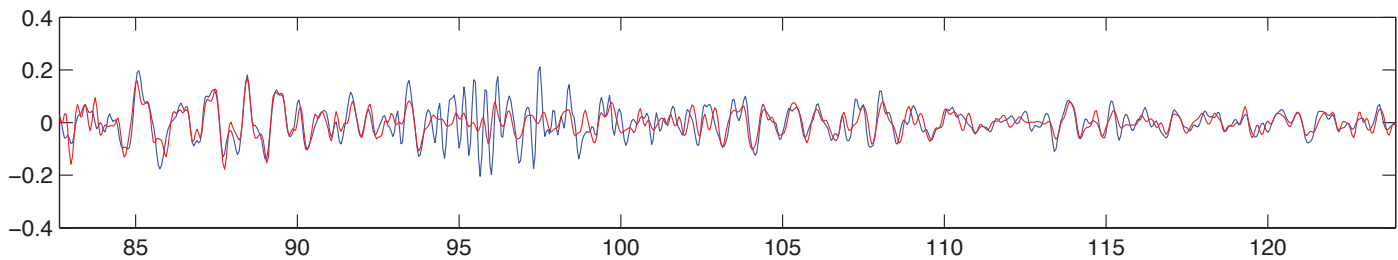
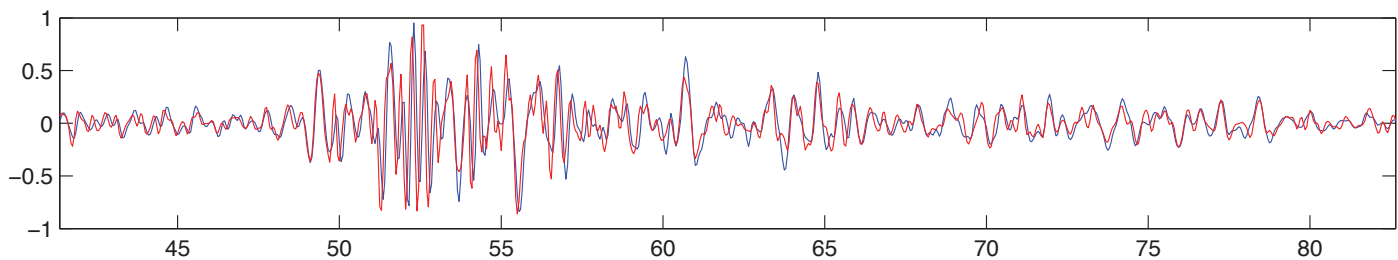
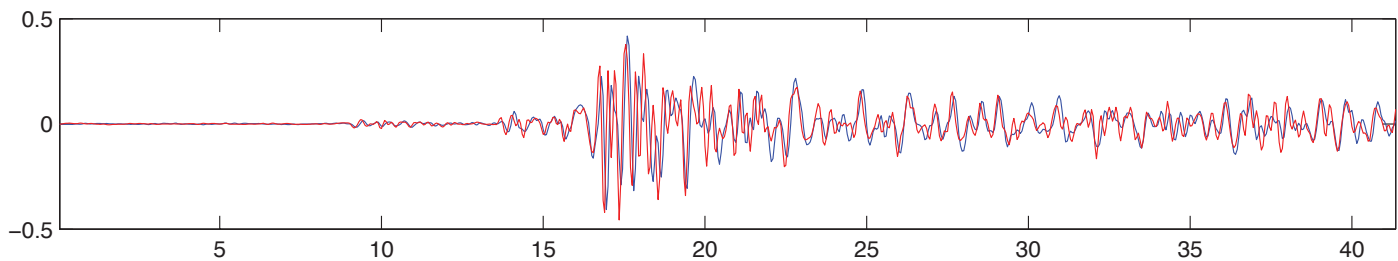
CC = 0.993



seconds

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ABCE distance 142 km



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seconds

	ABCE	ISC
Median (km)	16	16
Mean (km)	23	22
Max (km)	142	234
Number of doublet pairs	2178	671
Number of observations	6326	2297
Number of events	2379	1168

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“Repeating Events” as Estimator of Location Precision: The China National Seismograph
Network

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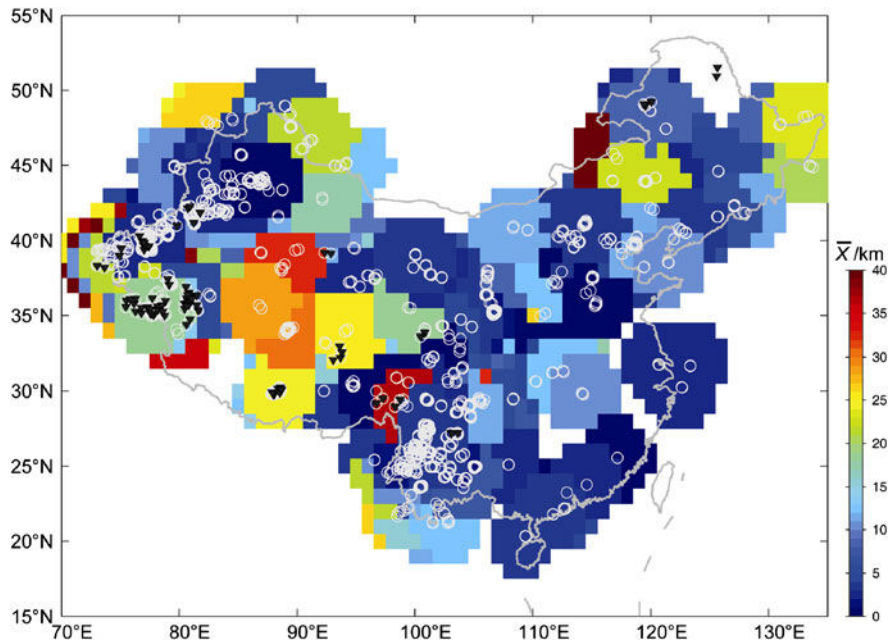
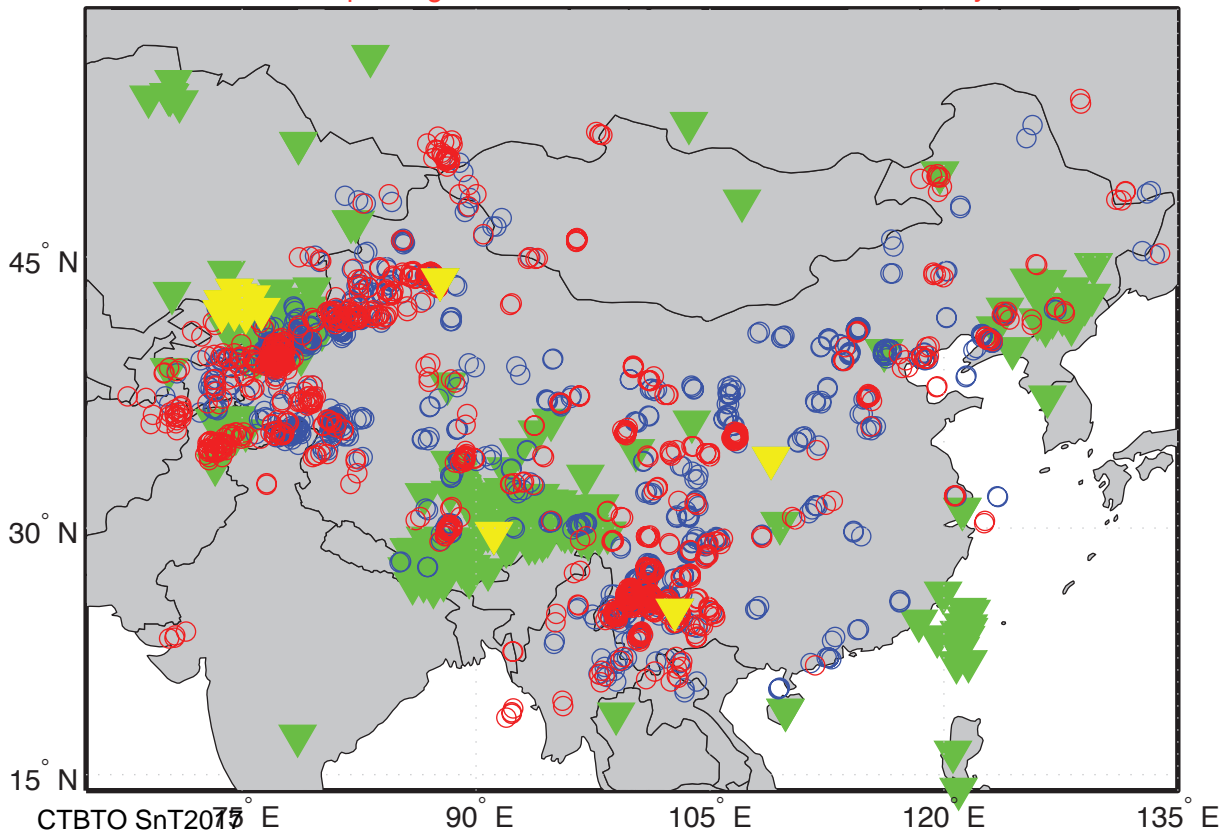


Figure 4

Spatial distribution of the network-measured apparent distance X between the “repeating events”. *White circles* indicate the “repeating pairs” used in the analysis. Pairs with apparent distance larger than 40 km are marked by *black reverse triangles*. For all the pairs, only the later event is plotted

2379 repeating events in and near China: where are they?



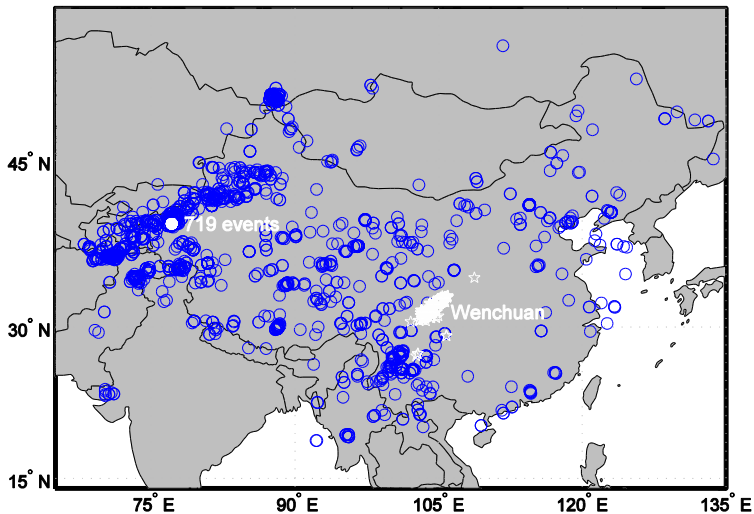


Figure 1

Figure 1. Final locations for 5,623 events well-distributed throughout China—3,689 for all of China from 1985 to 2005 and 1,934 for the Wenchuan area from May to August of 2008.

Location of Wenchuan events are given by white stars and 719 event cluster is given by white dot.
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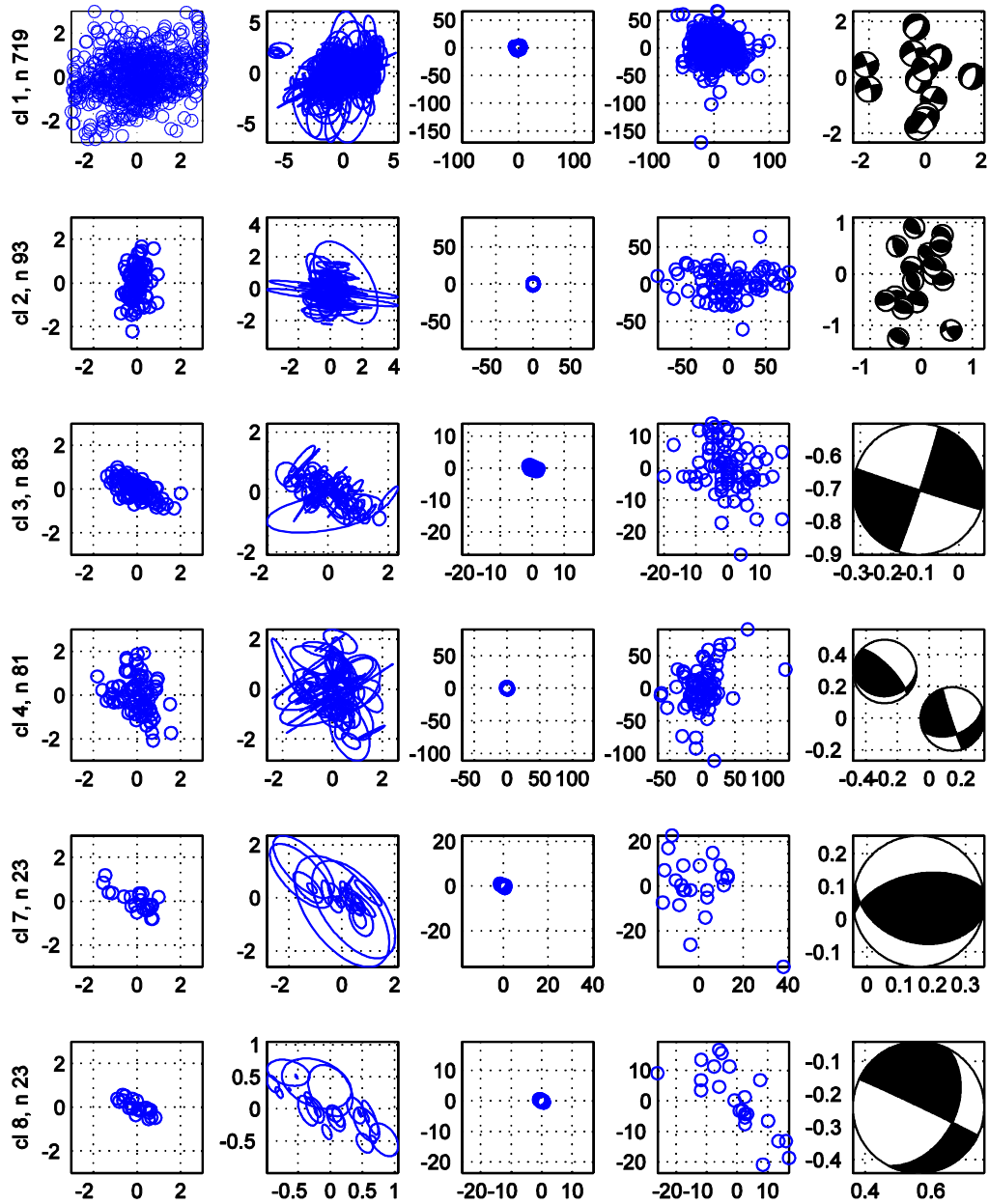


Figure 4. First column of subplots shows final locations of epicenters for selected clusters with cluster index (cl) and number of events (n). Second column of subplots shows corresponding error ellipses. Third column shows same relocated data as in first column but on the scale of the same axes as in the fourth column which is the locations of the ABCE. Fifth column has moment tensor solutions for matching events in the cluster. All axes are in km and map view.

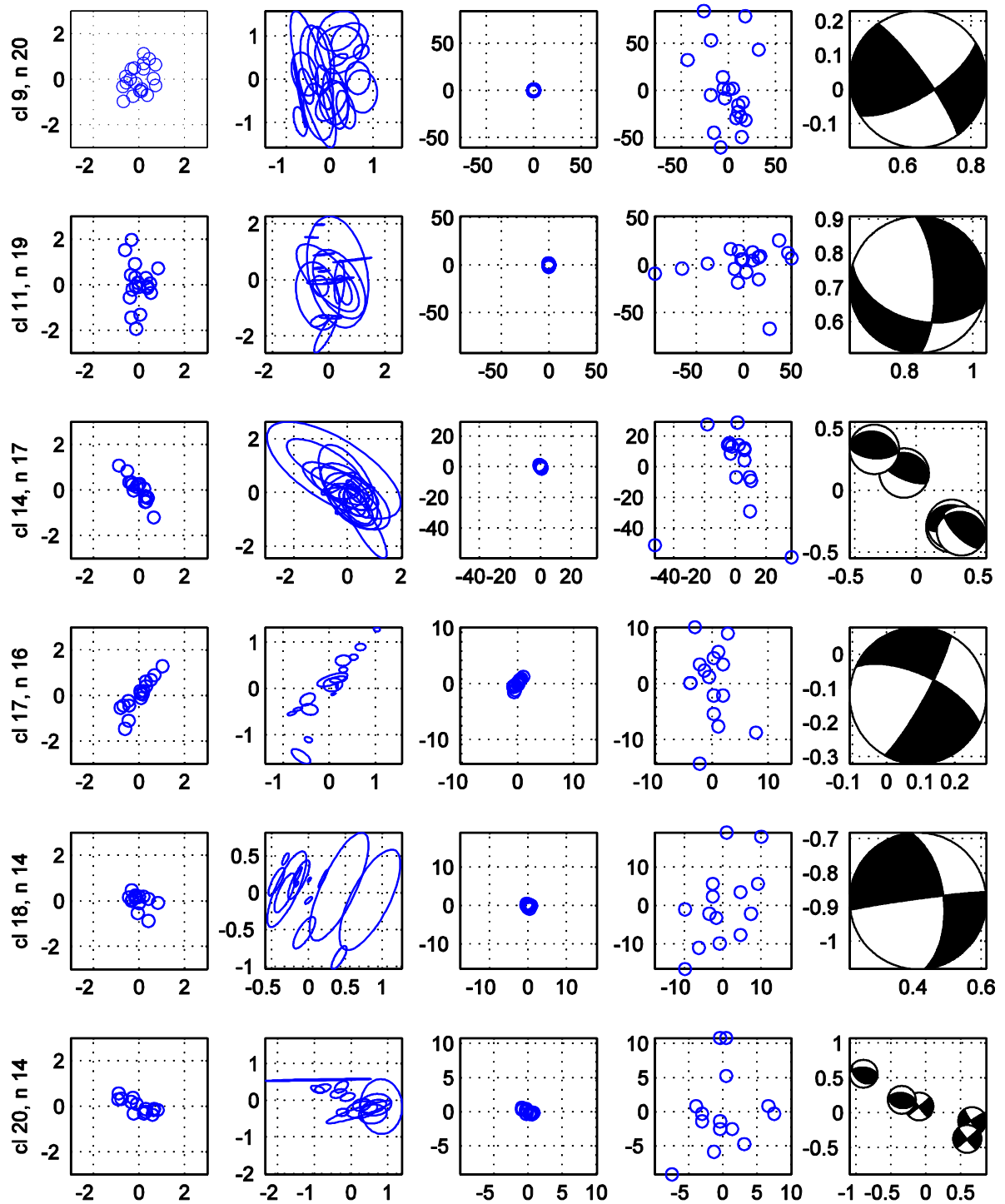


Figure 5. Same as Figure 4 but for six more clusters.

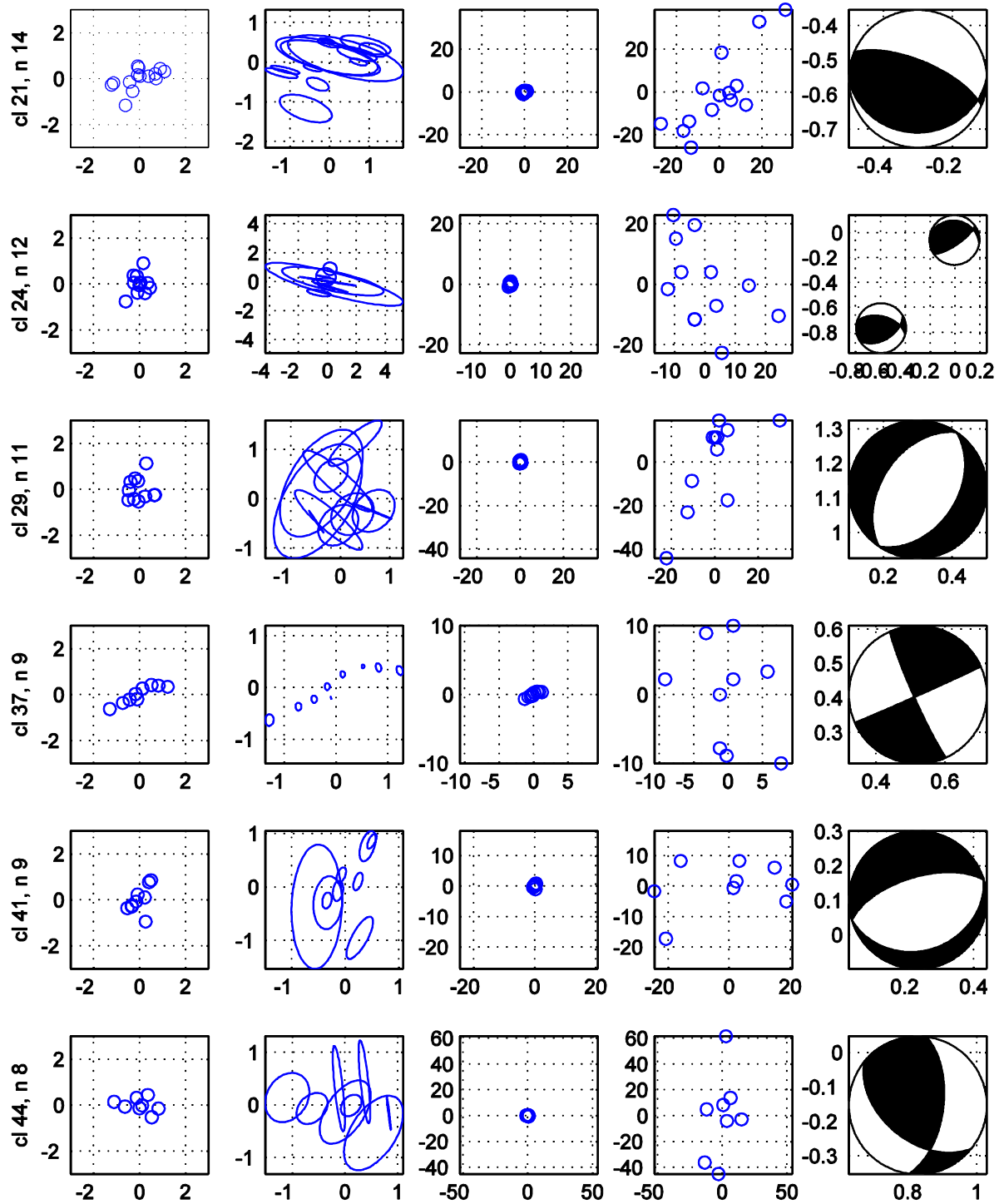


Figure 6. Same as Figure 4 but for six more clusters.

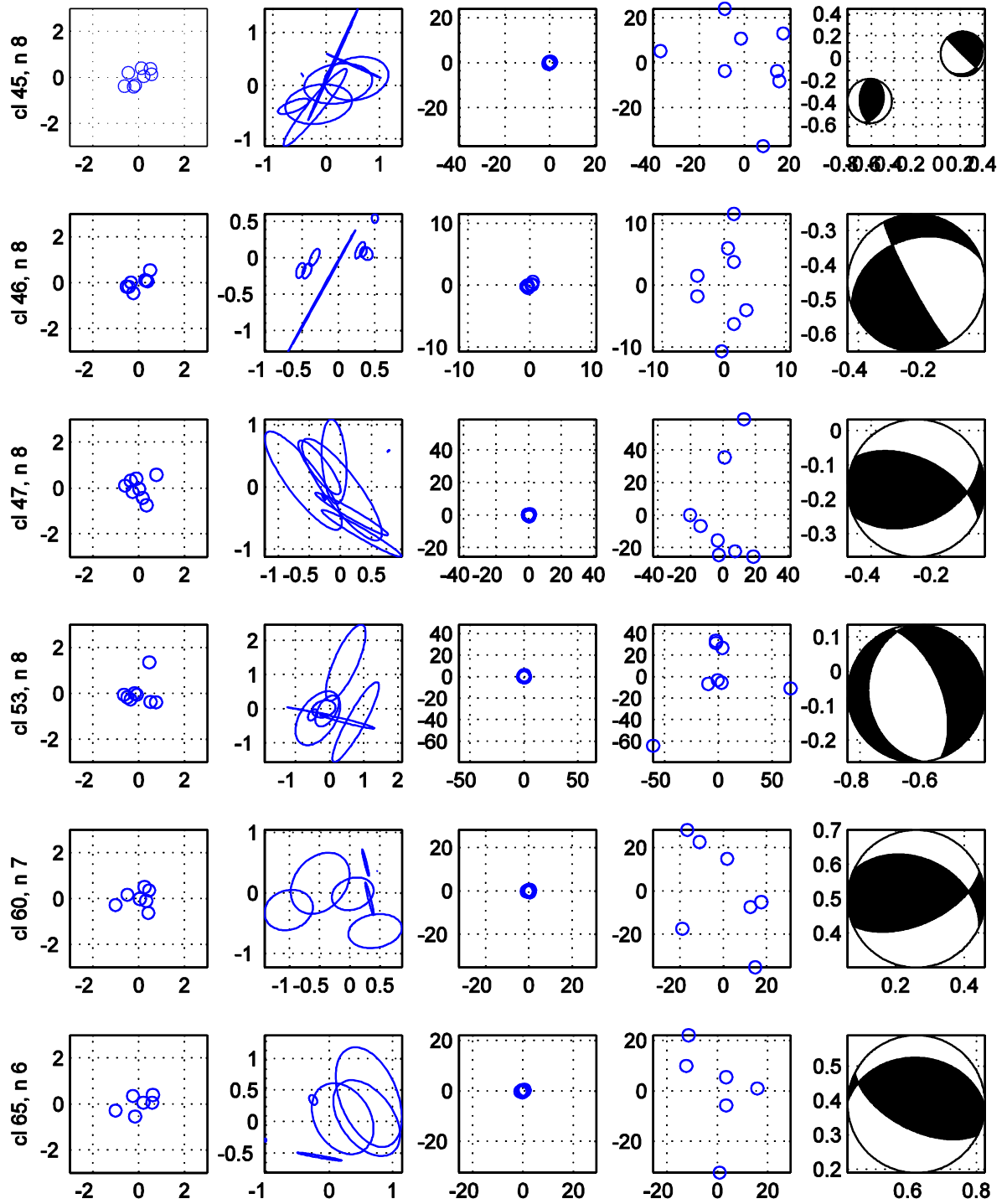


Figure 7. Same as Figure 4 but for six more clusters.

A short summary of results:

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- Our final locations explain travel-time residuals (that is, the difference between observed and calculated times) which are 89 times better than those for the catalog locations (0.042 s versus 3.730 s).
- The average of semi-major axes for the 3689 relocated events, is 420 meters.

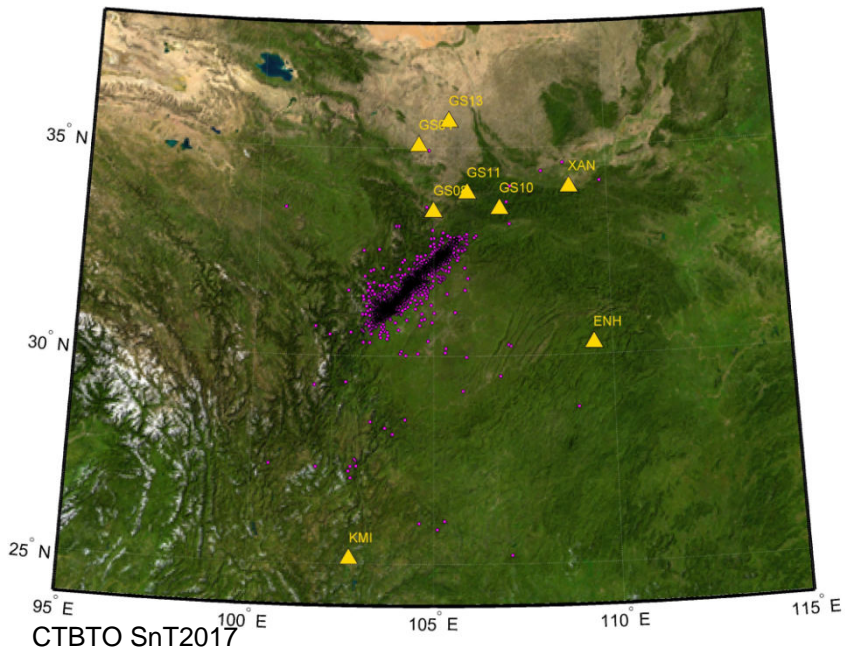
As an example of improved event detection,
using waveforms, let's look at

aftershocks of the Wenchuan earthquake of May 2008

published in BSSA August 2016

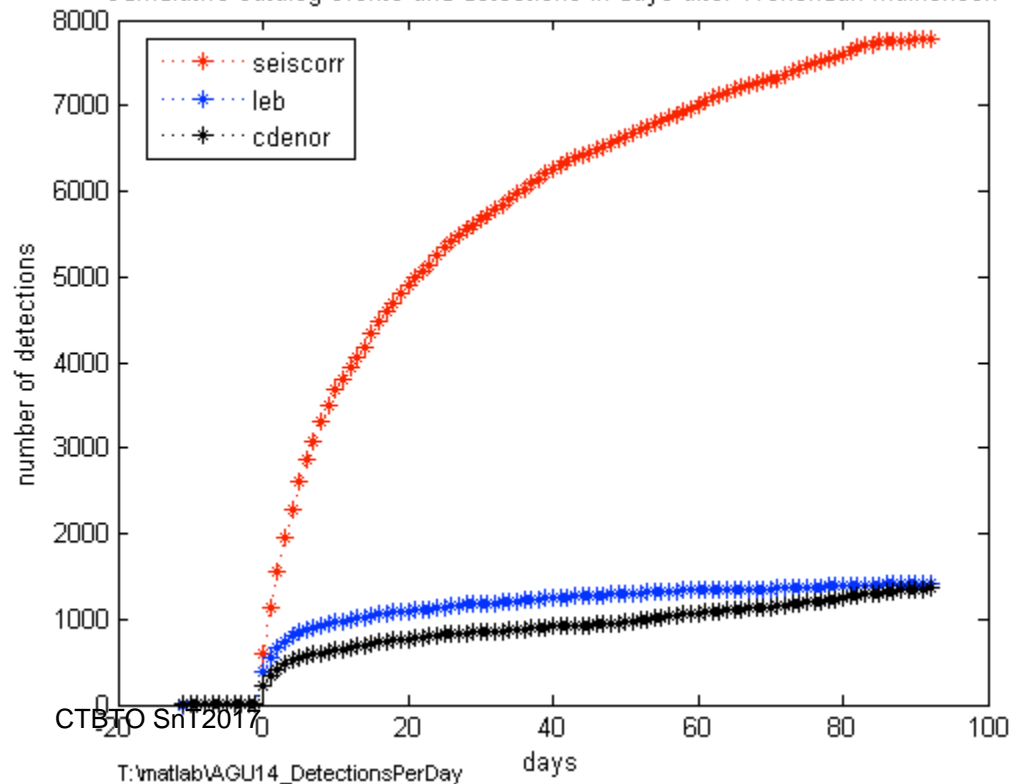
(work done in collaboration
between Lamont/Columbia University
and Sandia National Laboratories:
Heck, Richards, Schaff
Slinkard, Young):

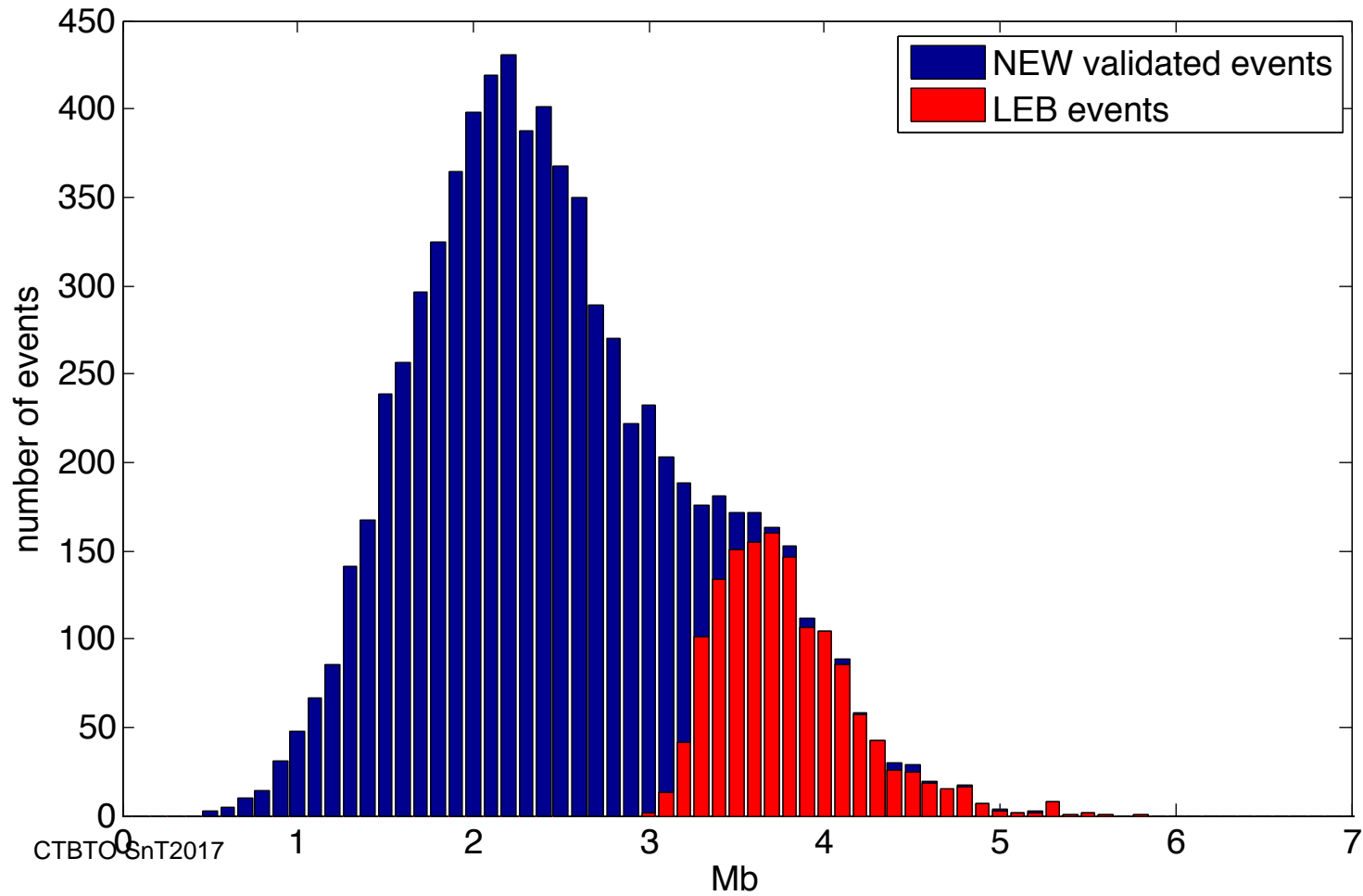
LEB catalog, 2008/05/01-2008/08/12, 1426 origins



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Cumulative catalog events and detections in days after Wenchuan mainshock





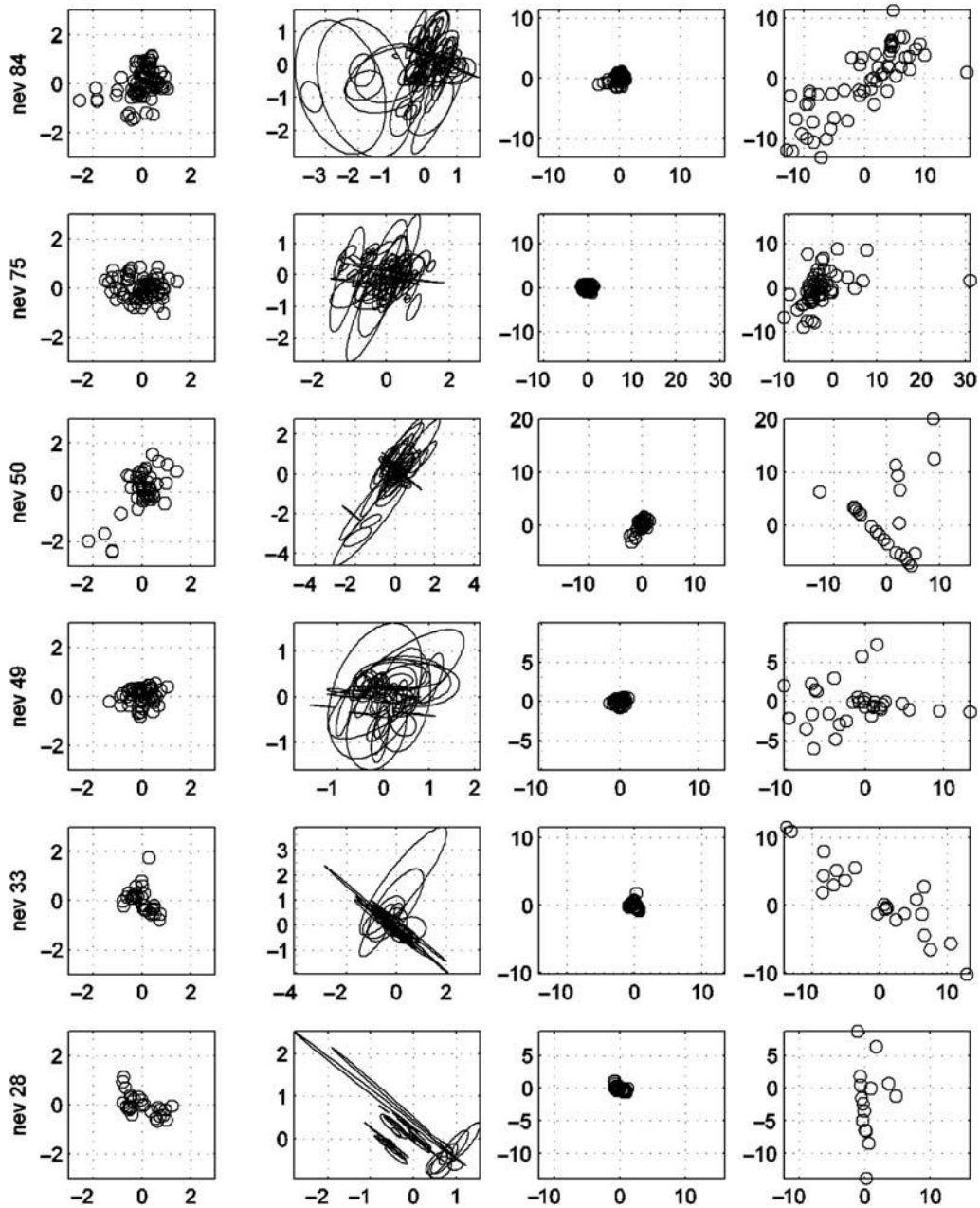


Figure 8. First column of subplots shows final locations of epicenters for selected clusters of new events. The number of events (nev) is listed to the left of the subplots. Second column shows corresponding 95% confidence error ellipses. Third column shows the same relocated data as in the first column but on the scale of the same axes as in the fourth column, which is the location of the detecting templates in the LEB. All axes are in kilometers and map view.

To apply **modern methods of event location**, we would want to take the steps of

- (1) identifying seismic events likely to be well-recorded, using either a regional bulletin or the LEB of the International Data Centre (CTBTO);
- (2) pulling out waveforms to serve as templates (our work to date has identified a few tens of seconds of the *Lg*-wave as being particularly suitable);
- (3) cross-correlating the template for each channel against the continuous archive for that channel, and noting detections (CC values greater than a value identified via a pre-determined false alarm rate as discussed in a December 2014 paper in the BSSA by Slinkard and others);
- (4) validating such detections (typically, using an association approach as discussed in our BSSA paper); and then, after a review of the quality of the detections, to
- (5) measure the relative arrival times (via cross-correlation) of pairs of events that were not far apart from each other and recorded at common stations; and (at last) to
- (6) relocate as many events as possible using double-difference methods.

“Precision Seismology”

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A New Telescope

“Precision Seismology” — A New Telescope

many contributors

who should
supply results ?