Figure S1. Focal mechanism of the outer-rise earthquake determined by fitting 178 teleseismic waveforms at a frequency range of 0.3-2 Hz. Although this earthquake occurred soon after the Mw9.0 mainshock and the waveforms were contaminated by the mainshock coda, many stations have cross correlations (CC) larger than 70%. Red crosses represent each station on the focal sphere. The mechanism is an oblique normal faulting.

Figure S2. Observed-synthetic cross-correlation coefficients of the 2008 master earthquake for long-period P wave (0.02-0.1 Hz, A), long-period SH wave (0.02-0.1 Hz, B), and short-period P wave (0.8-2.0 Hz, C). The waveforms fit well with most CCs larger than 80%.

Figure S3. Travel-time delays (A) and amplitude amplification factor (B) for the 2008 master earthquake at teleseismic distances using the refined location. Negative and positive delays mean faster and slower arrivals, respectively.

Figure S4. Stacks of 8 short-period array. For European arrays (NOA, HFS, GRF, and BURAR), the depth phases are nodal. Their water phases can not be identified. The water phase for Australia (WRA and ASAR) and North America (NVAR and TXAR) are labeled as blue arrows.

Figure S5. Some example waveform fits for the mainshock, see Fig. 4 for more details.

Figure S6. Inversion of the focal mechanism for the beginning of the mainshock using different subsets of the data. We randomly pick 50 stations and invert the mechanism 200 times. The histogram of dipping angle and focal mechanisms are shown in A and B, respectively. White and black dots represent compressional and extensional axes, respectively. The blue and red dots are compressional and extensional axes of our best mechanism indicated by blue lines.

Figure S7. Travel-time delays of the mainshock using NEIC location. Differential travel times between the master earthquake and the mainshock at each station, shown in Figure 4B can be obtained using delays in Figure S3(A). The differential travel times can be used to calculate their relative locations.
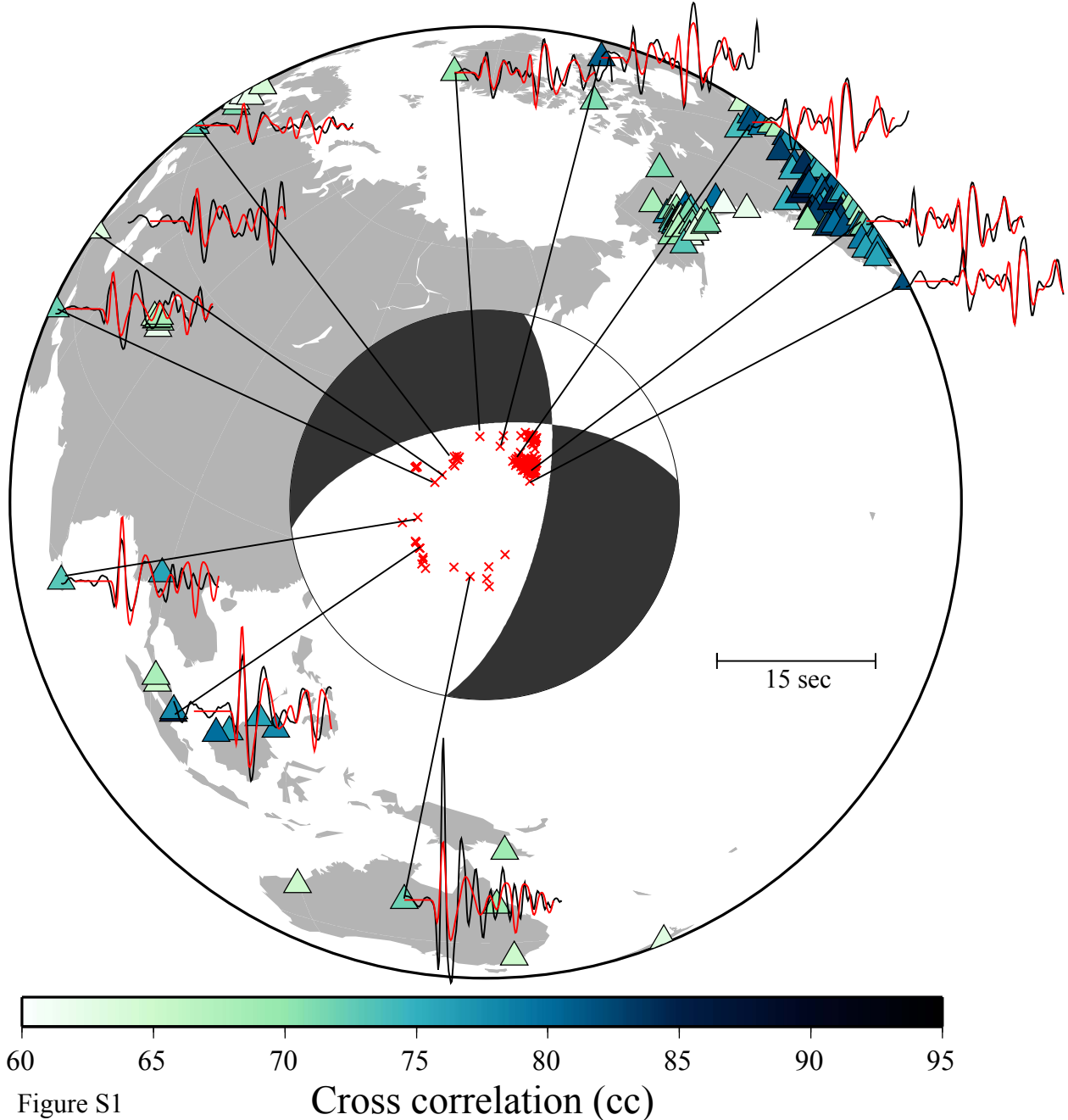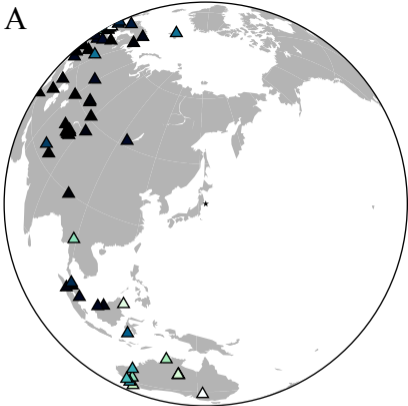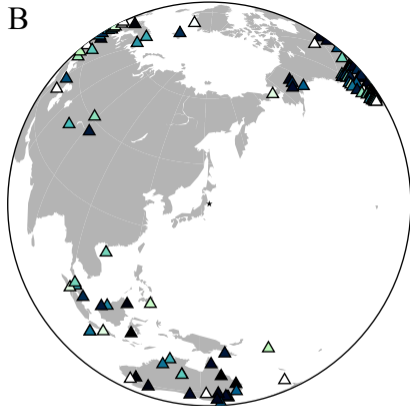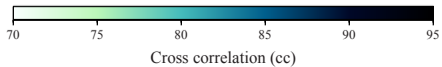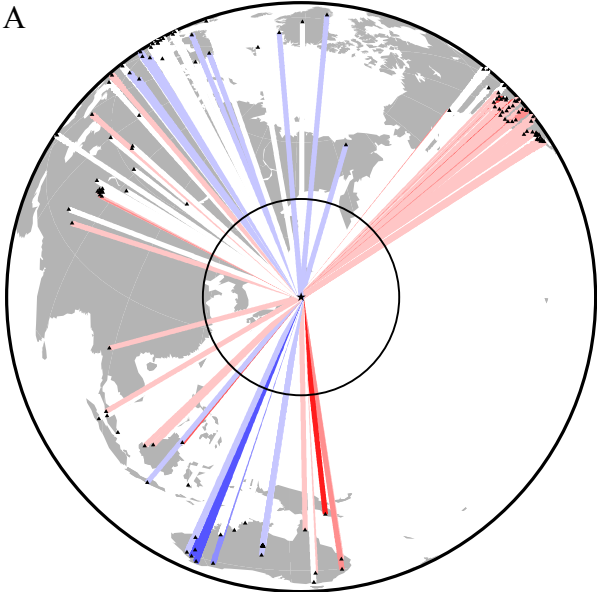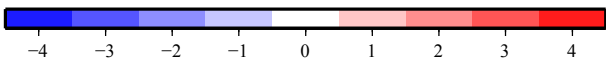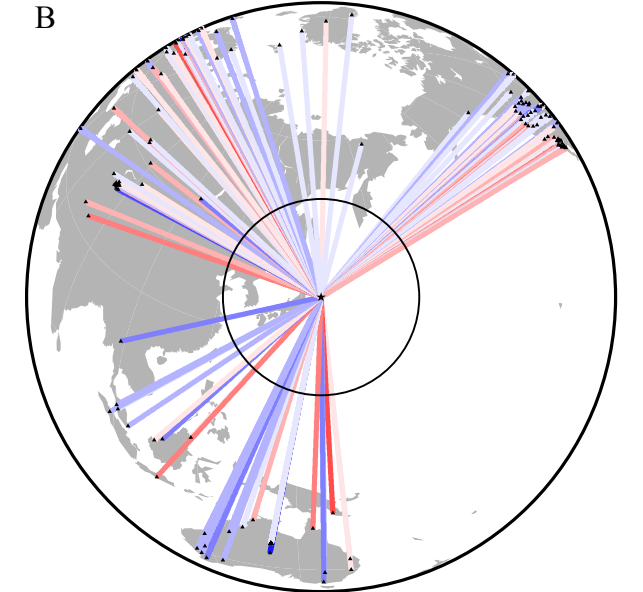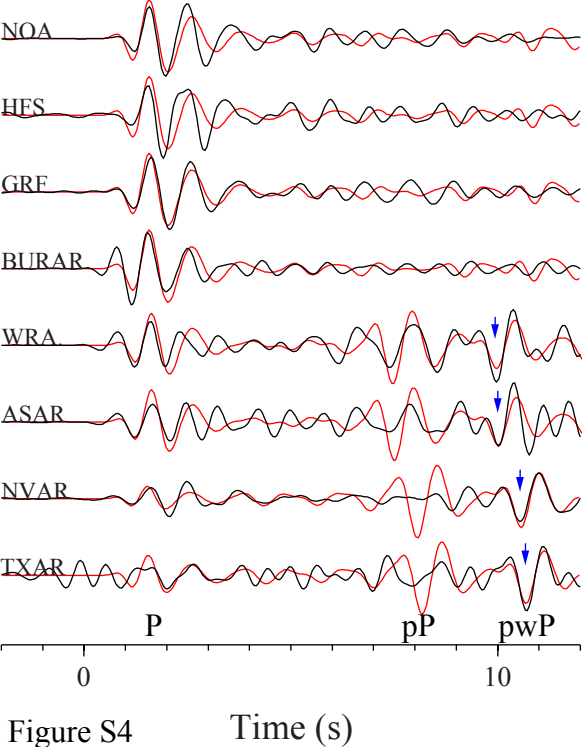
Figure S1

Figure S2
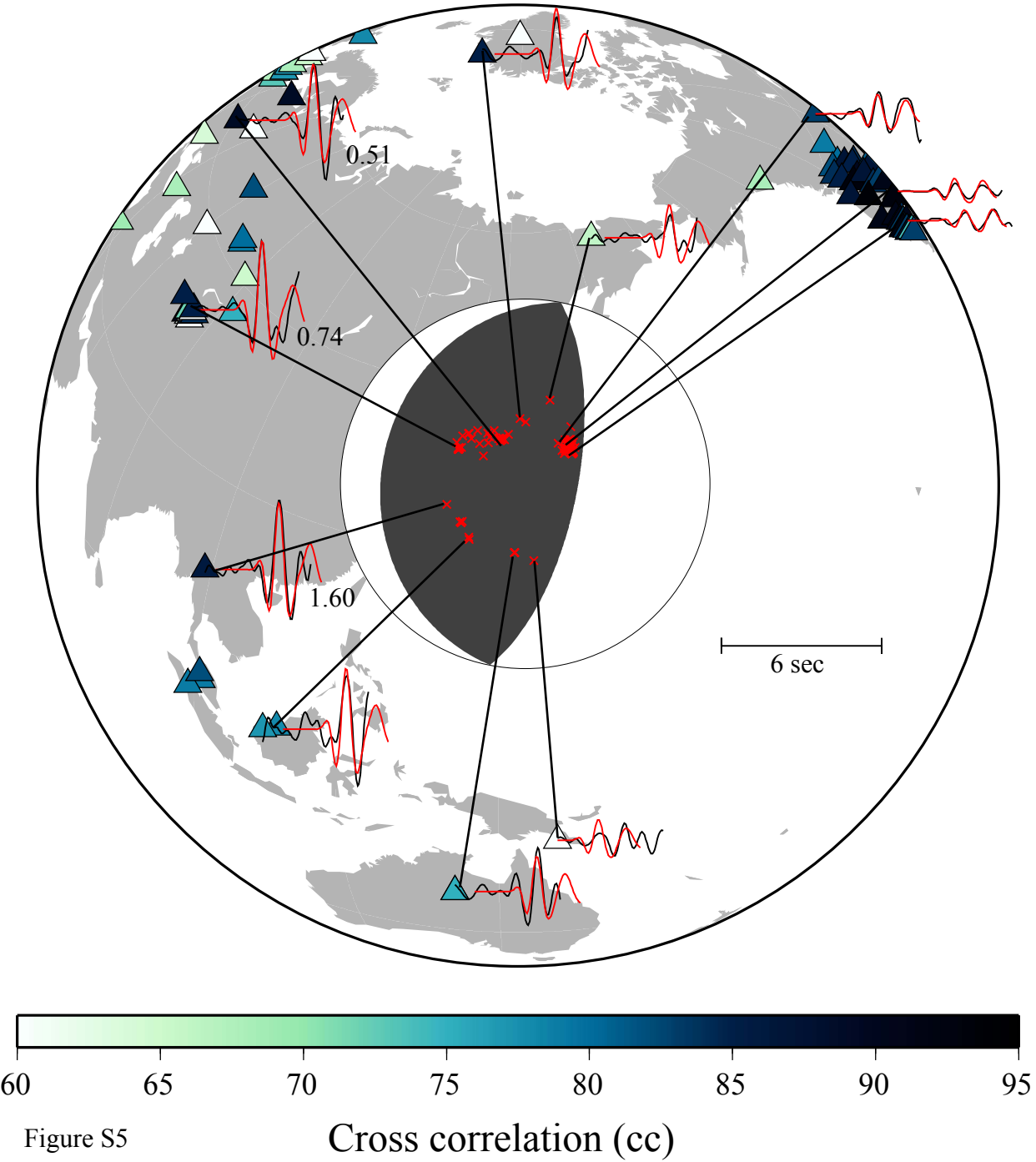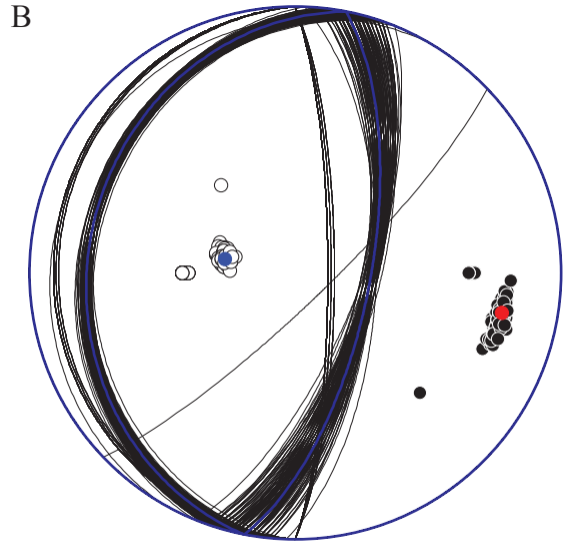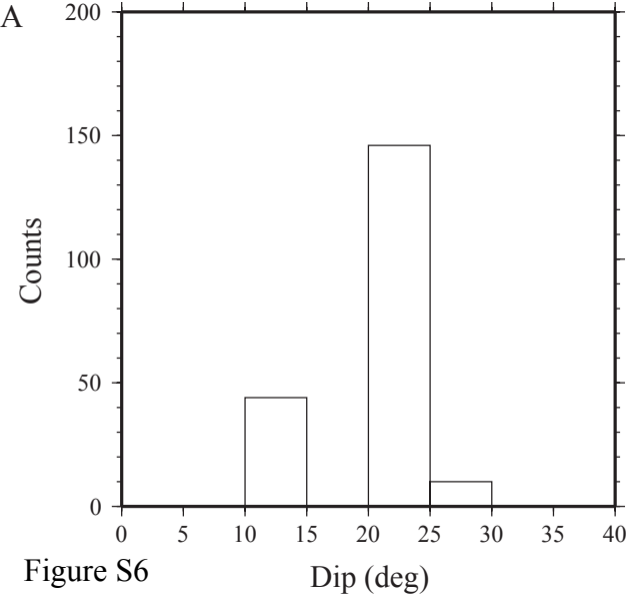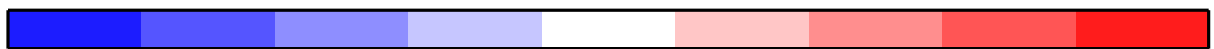
Cross correlation (cc)

A
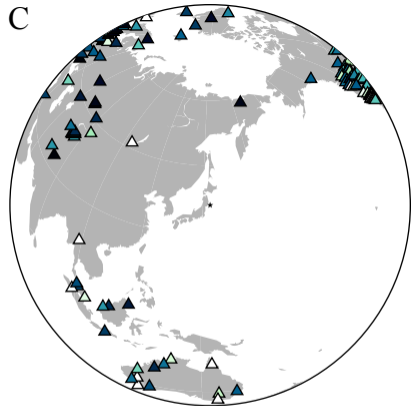
B

Figure S3   Travel time residual (s)

log(AAF)

NOA

HES

GRF

BURAR

WRA

ASAR

NVAR

TXAR

P   pP   pwP

0   10

Figure S4   Time (s)

Figure S5

Cross correlation (cc)

60 65 70 75 80 85 90 95

6 sec

Figure S6

Figure S7

Travel time residual (s)