Supplementary Materials:

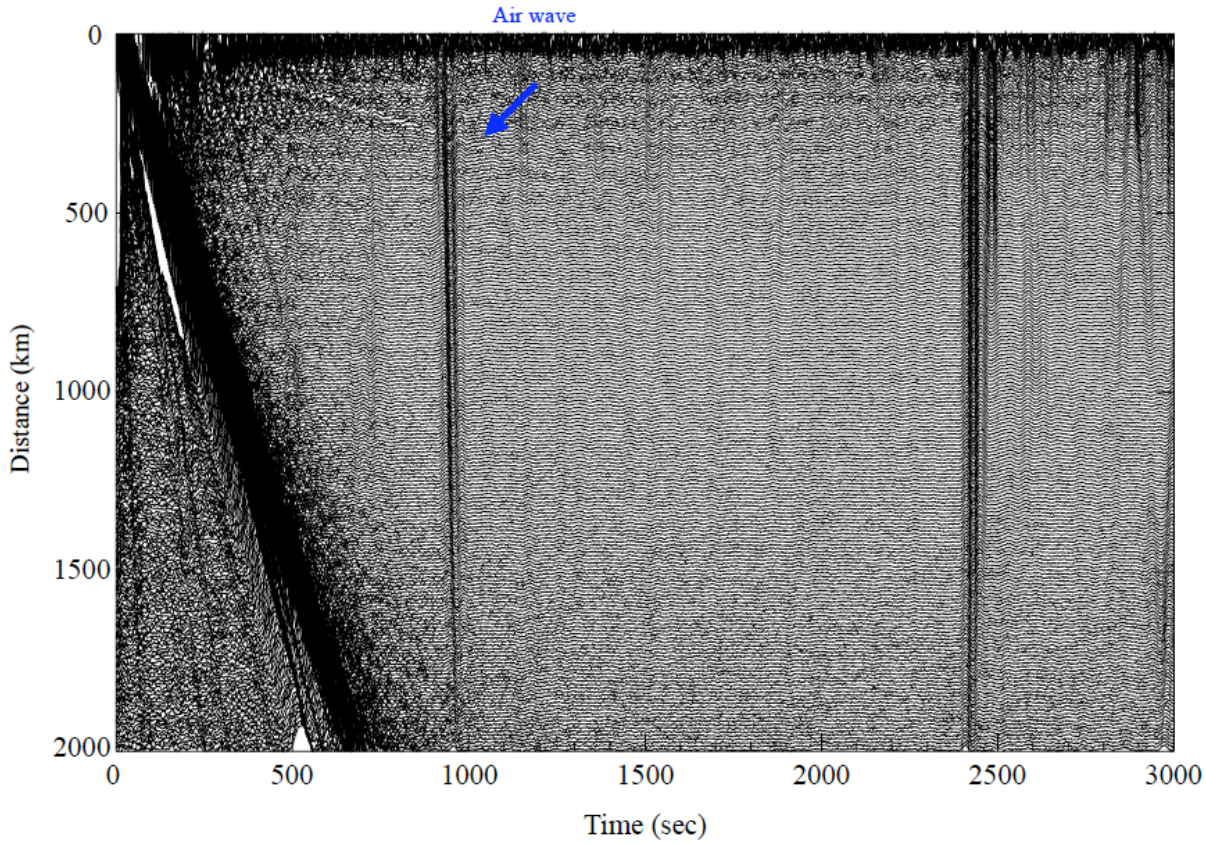
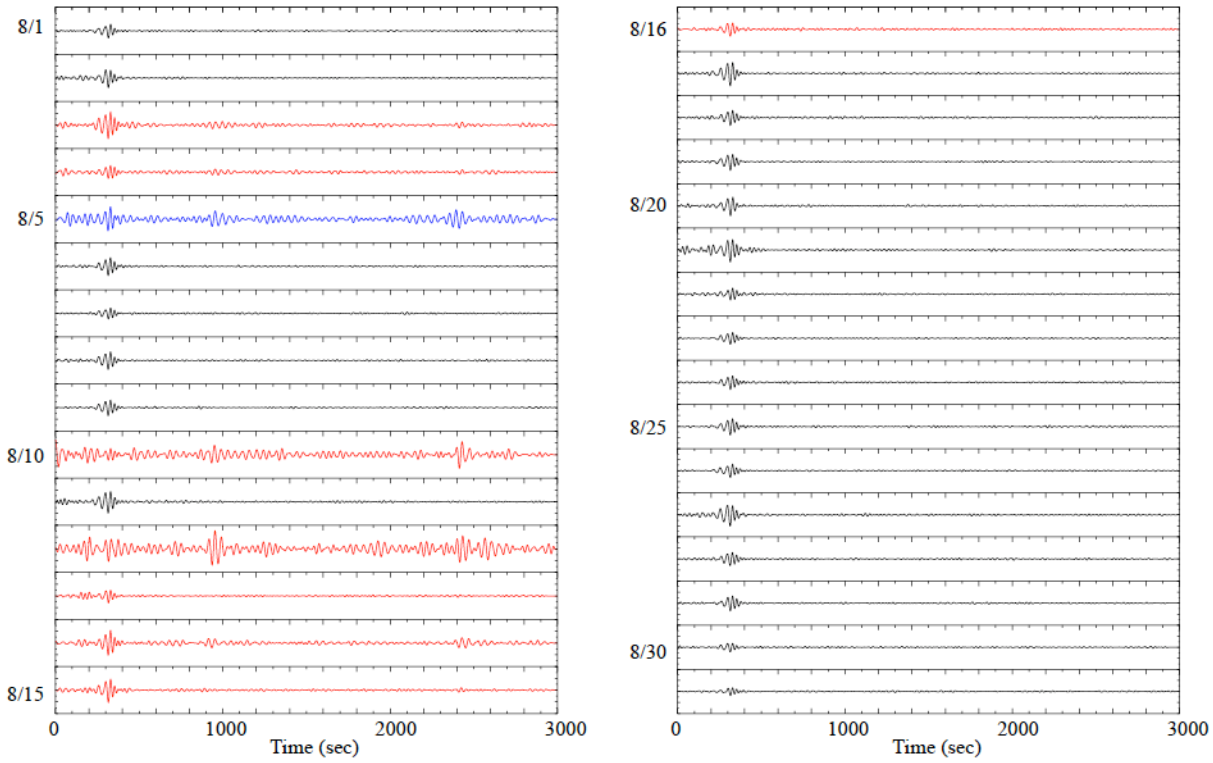


Fig. S1. Same as Fig. 2b but using 10-km distance bins. An air wave propagating near the sound speed (~320 m/s) is observed.



Year	M	D	hr/mm/ss	lat	lon	depth	Mw	Region
2010	8	3	12/08/26	1.24	126.21	41.0	6.3	NORTHERN MOLUCCA SEA
2010	8	4	07/15/34	-5.50	146.81	225.6	6.5	EASTERN NEW GUINEA REG.,
2010	8	4	12/58/24	51.42	-178.65	27.0	6.4	ANDREANOF ISLANDS, ALEUT
2010	8	4	22/01/43	-5.75	150.76	44.0	6.9	NEW BRITAIN REGION, P.N.
2010	8	10	05/23/45	-17.54	168.07	25.0	7.3	VANUATU ISLANDS
2010	8	12	11/54/15	-1.27	-77.31	206.7	7.1	ECUADOR
2010	8	13	21/19/33	12.48	141.48	10.0	6.9	SOUTH OF MARIANA ISLANDS
2010	8	14	07/30/16	12.35	141.49	10.0	6.3	SOUTH OF MARIANA ISLANDS
2010	8	15	15/09/29	-5.69	148.34	174.7	6.3	NEW BRITAIN REGION, P.N.
2010	8	16	03/30/53	-17.76	65.65	9.8	6.3	MAURITIUS - REUNION REGI

Fig. S2. Daily stacked cross-correlations for the month of August 2010. For each day, all available cross-correlations with distances between 1000 and 1050 km are stacked and bandpassed between 20 and 50-sec period. Days with earthquakes larger than 6.3 Mw in the CMT catalog are highlighted in red, and earthquake information is listed. Note the correlation between days with high core-phase amplitudes and large earthquakes. The high core-phase amplitudes on 8/5 (highlighted in blue) are likely due to the Mw 6.9 earthquake near the island of New Britain in Papua New Guinea late on 8/4. The 2-hour time difference between the earthquake and the onset of the 8/5 time series used in the cross-correlation suggests that the observed core phases originate from long-lasting body-wave coda excited by the earthquake.

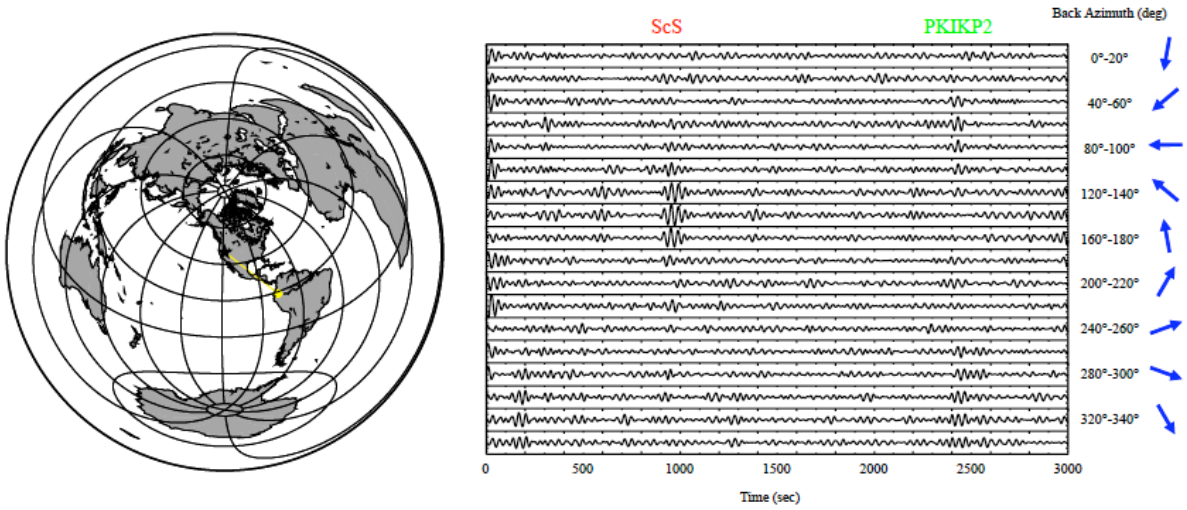


Fig S3. Stacked cross-correlations from August 12 for different back-azimuth directions. The location and the great circle path of the Ecuador earthquake on August 12 are shown at left (yellow circle and line). For each 20° back-azimuth bin, all available cross-correlations with distances between 1000 and 1050 km are stacked and bandpassed between 20 and 50-sec period. Note that we separate the positive and negative components of cross-correlations here such that the stacked cross-correlations reflect the energy coming from the different back-azimuth directions. The strong ScS phases observed between back azimuths of 120° and 180° suggest that the observed phases are due to ScS reverberations directly from the Ecuador earthquake. While strong $PKIKP^2$ amplitudes for back azimuths between 300° and 360° may be due to direct phases emitted by the earthquake, the observed $PKIKP^2$ phases for back azimuths between 40° and 140° are likely due to scattering and the wide Fresnel zone of the phase.

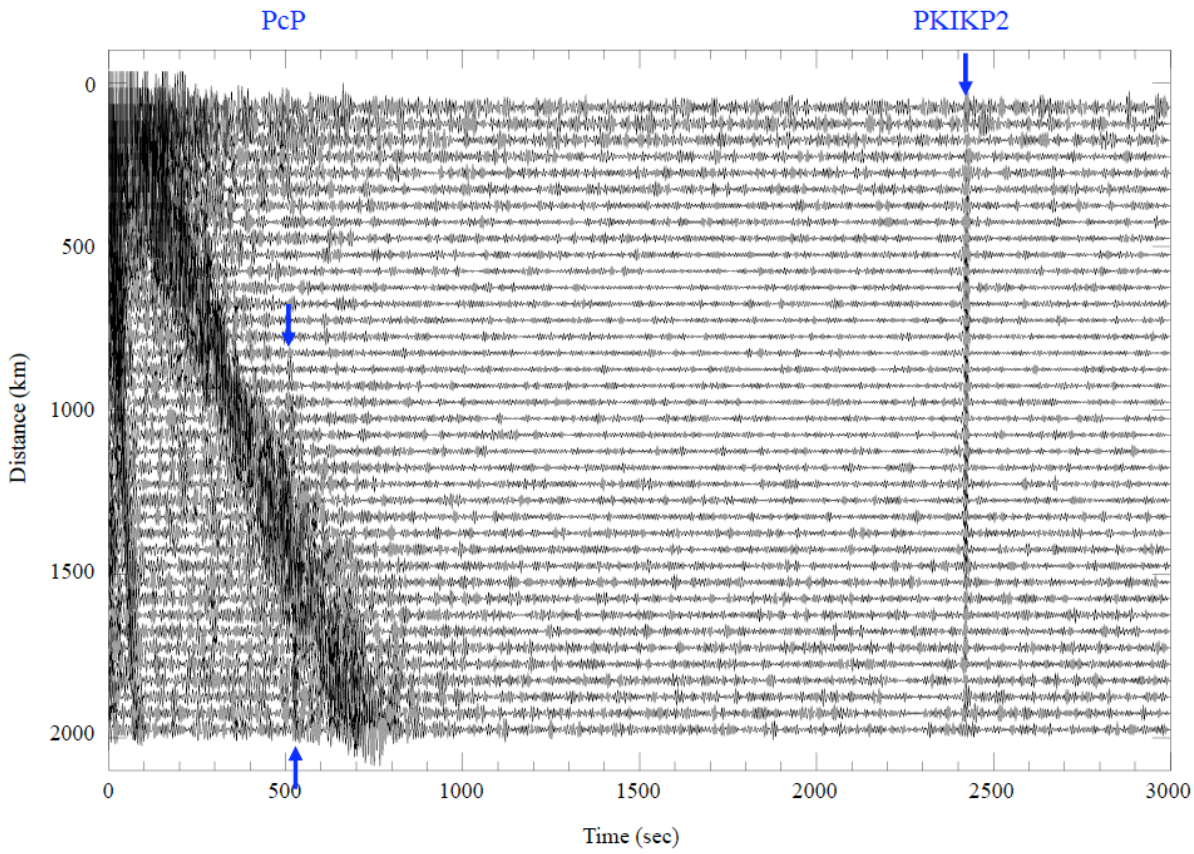


Fig. S4. Same as Fig. 2b but bandpassed between 5 and 10-sec period. Both PcP and PKIKP^2 can be observed.