Supplementary Material

Title: A Plan for a Long-Term, Automated, Broadband Seismic Monitoring Network on the Global Seafloor

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This is the supplementary material for *A Plan for a Long-Term, Automated, Broadband Seismic Monitoring Network on the Global Seafloor*. Section I shows survey questions and the percentage breakdowns of respondents' answers to each question, described in the main manuscript text. Section II shows additional maps produced for different types of seismic phases, analogous to Figure 5 in the main manuscript.

Section I: Survey questions and answers

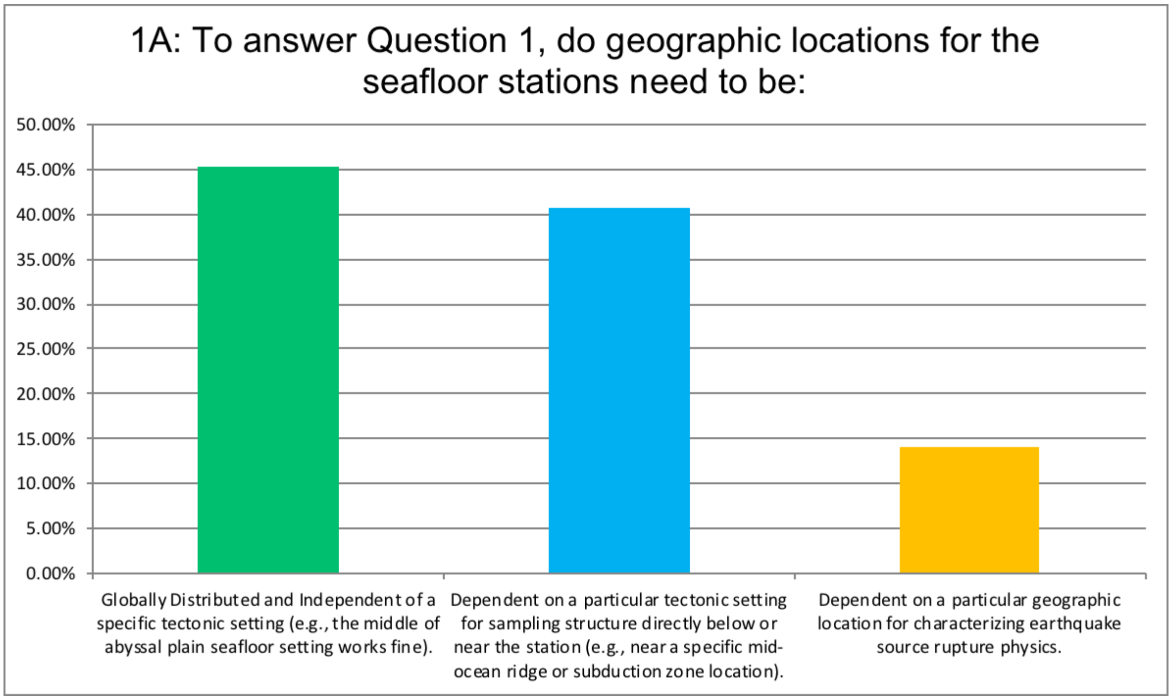
Q1 1: Please describe what you perceive as the most important unanswered question in global seismology where significant advancement could be made with up to five (5) new, long-term seafloor seismometers or small-aperture seafloor arrays.

Answered: 51 Skipped: 4

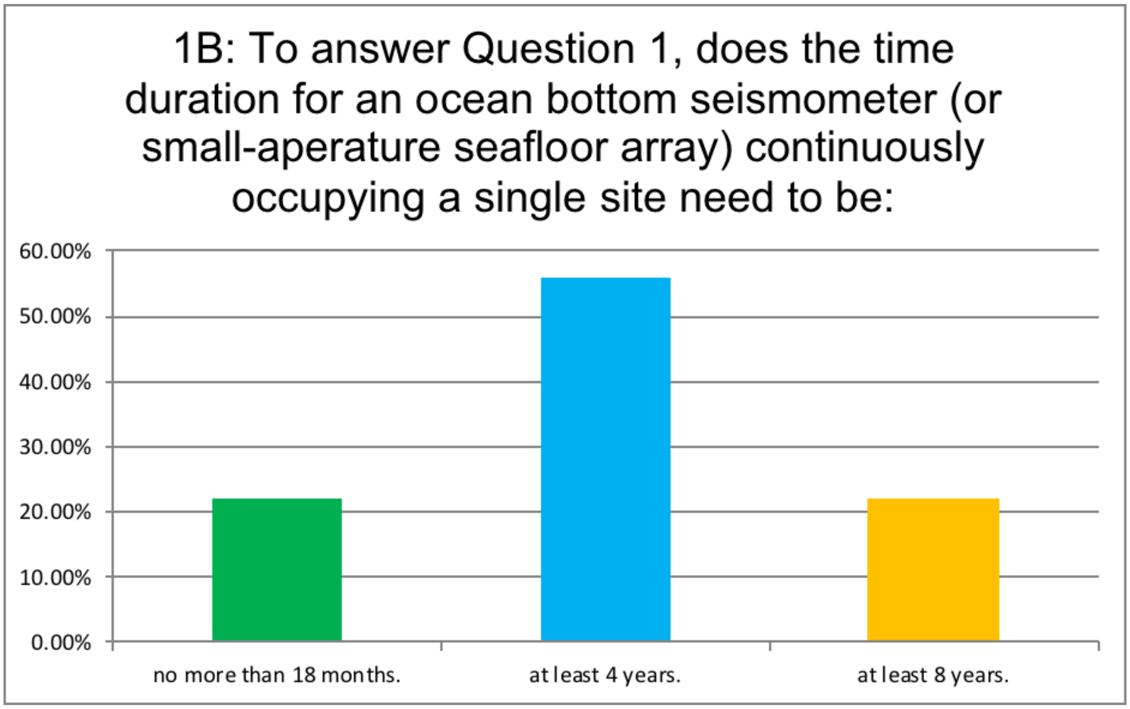
#	RESPONSES	DATE
1	How much serpentinization of the mantle occurs at mid-ocean ridges, and does a serpentinized layer acquired at the ridge crest persist as a low-velocity anisotropic layer, as the plate migrates across an ocean basin? To resolve anisotropic crustal structure well with receiver functions, we need 100+ good body-wave code. Experience with OBS in 2 year deployment on the Hawaii Swell (Leahy et al., 2010) suggests that the deployment should be 5-6 years. Would desire stations to be deployed off the ridge axis in ~30 Ma plate for ridges of waying spreading rates, e.g., East Pacific Rise (fast), Atlantic Ridge (slow), SW Indian Ridge (very slow), Carlsberg Ridge, etc. Leahy, G. M., J. A. Collins, C. J. Wolfe, G. Laske, and S. C. Solomon (2010), Underplating of the Hawaiian Swell: Evidence from teleseismic receiver functions, Geophys. J. Int., 183, 313–329, doi:10.1111/j.1365-246X.2010.04720.x.	4/17/2018 9:46 PM
2	What controls the symmetry/asymmetry of the oceanic lithosphere away from the spreading center?	4/17/2018 9:43 PM
3	what are the time constants of the ocean wave spectrum that couple into the solid Earth?	4/17/2018 9:40 PM
4	where is Earth's hum generated?	4/17/2018 9:38 PM
5	study of deep mantle and core structure	4/17/2018 9:36 PM
6	How does the seismic structure of oceanic lithosphere change with age?	4/17/2018 9:34 PM
7	mid-ocean magnetic sensors	4/17/2018 9:31 PM
8	Study of earthquake sources	4/17/2018 9:29 PM
9	What is the true nature of undersea marine plateaus, e.g., Ontong-Java Plateau, Hess Rise, Shatsky Rise, Kerguelen Plateau, etc? They are thought to be large outpourings of mantle-derived magma, but Korenaga (2011) concluded that Ontong Java could not easily be made with a one-stage partial melt of Earth's mantle. A stage of further igneous or metamorphic reprocessing is required. This means that the velocity layering of Ontong Java is important, e.g., frozen-melt layers or multiple Moho interfaces. Tharimena et al. (2016) claims to detect a mid-lithospheric discontinuity within Ontong Java with SS precursors. At Kerguelen, Pettersen and Maupin (2002) interpret surface-wave polarization anomalies in terms of pervasive anisotropy within this marine plateau. So we need to worry about detecting anisotropy in the oceanic-plateau structure as well. To detect anisotropic layering robustly with receiver functions, we will need at least a 100 good body-wave coda. The experience of Leahy et al (2010) on the Hawaii Swell OBS deployment was that 10-20 good receiver functions could be gleaned from a 2-year deployment. Assuming that improved siting and data analysis can increase this yield to 30-40 events in 2 years, we would want to install the stations 5-6 years. Korenaga, J. (2011), Velocity-depth ambiguity and the seismic structure of large igneous provinces: a case study from the Ontong Java Plateau, Geophys. J. Int., 185, 1022–1036, doi:10.1111/j.1365-246X.2011.04999.x. Leahy, G. M., J. A. Collins, C. J. Wolfe, G. Laske, and S. C. Solomon (2010), Underplating of the Hawaiian Swell: Evidence from teleseismic receiver functions, Geophys. J. Int., 183, 313–329, doi:10.1111/j.1365-246X.2010.04720.x. Pettersen, O., and V. Maupin, (2002), Lithospheric anisotropy on the Kerguelen hotspot track inferred from Rayleigh wave polarisation anomalies, Geophys. J. Int., 149, 225–246, doi:10.1046/j.1365-246X.2002.01646.x. Tharimena, S., C. A. Rychert, and N. Harmon (2016), Seismic imaging of a mid1744 lithospheric discontinuity beneath Ontong Java Plateau, Earth and Planetary 1745 Science Letters, 450, 62-70.	3/22/2018 4:44 PM
10	Long term Seafloor instruments could potentially help to improve distance range and/or azimuthal gaps for studying specific deep mantle/core structure and or core anisotropy while improving the amount of data in the regional distance ranges while completing the azimuthal gap for important/specific events/regions.	3/19/2018 11:56 AM

11	Mapping the structure of plumes from the CMB to the seafloor.	3/19/2018 10:00 AM
12	what does tremor in subduction zone settings signify ?	3/15/2018 6:17 AM
13	Seismic structure below Pacific and Atlantic oceans	3/14/2018 10:51 PM
14	The nature of major hotspots, and their underlying structure. Geochemistry is making new advances in this area, and high pressure science is getting better at interpreting what is going on at depth. But we still lack crucial seismic constraints owing to limited coverage. Deployments around the Hawaiian islands or Iceland, for example, help to reveal shallow mantle structure and support a mantle plume origin but leave deeper questions unanswered such as how deep is the plume rooted, or what detailed structure exists between what is imaged in the CMB region and the shallow mantle? Small arrays could be used to illuminate the deeper structure of plumes from one direction, by placing them on the opposite side of a hotspot from active seismic sources. For example, park a small array further north of Hawaii and use the EQ sources in Tonga-Fiji to reveal deeper structure (especially the shallow lower mantle). Then move it to the SE of Hawaii to illuminate it with Japan-Kamchatka seismic radiation. And so on.	3/14/2018 3:59 PM
15	How to get high fidelity ocean bottom seismic records seems to be the most relevant question (probably not the most important, but necessary).	3/14/2018 12:10 PM
16	What are the dominant length scales of mantle convection, and the relationship of the convection to mantle melting and compositional heterogeneity?	3/14/2018 12:03 PM
17	Potentially improve the resolution of tomographic seismic anomalies, especially in the lower mantle, for regions where ray coverage is poor (e.g. lower hemisphere). SKS splitting measurements and receiver function studies can also be proposed and help identify and/or constrain mantle discontinuities and heterogeneities in the whole mantle.	3/14/2018 9:52 AM
18	CMB Structure & Properties	3/14/2018 9:42 AM
19	enhancing global mantle flow models	3/14/2018 9:42 AM
20	1) Providing accurate locations of subduction earthquakes, most networks are on land and this may make locations skewed and biased. 2) Providing data on regions of the Earth where land-stations do not sample. 3) Oceanic lithospheric & ridge structure 4) Detailed subduction plate geometry and tremor 5) Outer ridge seismicity and its relationship to the earthquake cycle	3/14/2018 8:33 AM
21	How are earthquake cycles at oceanic transform faults controlled by the thermal and compositional structures and far-field stress loading?	3/14/2018 8:22 AM
22	earthquake dynamic near the trench	3/14/2018 7:42 AM
23	I can not answer that, I am not familiar that much of what is the situation like at the moment, regarding the OBS instrumentation.	3/14/2018 7:35 AM
24	There are still many places on Earth that still need to be studied in detail with respect to trench subduction, roll-back, and oblique kinematics. What is the fate of the subducting slab along highly curved arcs? For instance, the Puerto Rico trench, a place highly studied in the 60's and regarded as one of the first laboratories for testing developing marine geophysical equipment back then, have not seen much happening since those early days when Harry Hess visited those areas. Now, after 30 years of seismic catalogs, we are able to define regions of peculiar seismicity that is still intriguing and have not been focused with expensive studies to understand it further. The same thing happens with other parts of the world, for example, The Scotia and Sunda Arcs, having extremeley curved morphological expressions.	3/14/2018 7:31 AM
25	What is the heat flux carried by plumes	3/14/2018 3:06 AM
26	If earthquakes occur in the mantle	3/14/2018 2:22 AM
27	Improving data coverage in the oceans for global tomography (and/or studies of the Earth's interior) where huge gaps currently exist	3/14/2018 2:14 AM
28	LAS structure Subduction system (w/ geodesy) Oceanic LIP	3/13/2018 9:40 PM
29	What is the origin of along-strike variations/segmentations of spreading centers/mid-ocean ridges, which are the places where the new oceanic lithosphere is produced?	3/13/2018 8:47 PM
30	Understanding oceanic counterparts of continental mantle and crustal structures imaged via direct wave observations, receiver function analysis, and seismic tomography.	3/13/2018 8:44 PM
31	Depth-dependent seismogenesis Improvement of parameters of offshore earthquakes	3/13/2018 8:33 PM

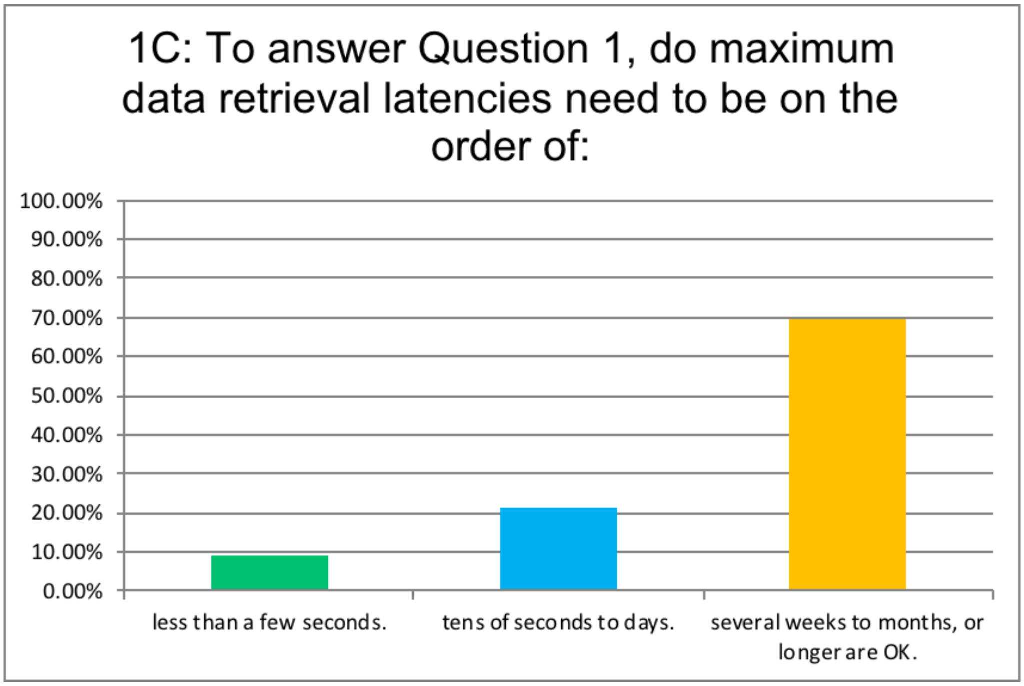
32	on what time scale does Earth's inner core rotation independent from the mantle?	3/12/2018 5:38 PM
33	Deep structure of hot spot plumes.	3/12/2018 4:38 PM
34	seismic wavefom intercept from underground explosion source id an ddmonstrated problem to be solved	3/7/2018 8:26 PM
35	1. Collecting data that is needed for imaging structures in the mid-mantle and lower mantle. 2. Determine the cause of the India Geoid low. 3. Find where the Indian lithosphere is located in the mid- and lower mantle. 4. Mid-mantle reflections (discontinuities) and dynamic processes in the mid-mantle.	3/7/2018 11:14 AM
36	I don't feel comfortable answering this question, there are likely many worthy challenges to address, from understanding subduction zone dynamics and deep earth structure to detailed studies of MOR and/or hotspots.	3/7/2018 3:55 AM
37	elucidation of the lithosphere-asthenosphere system beneath the ocean	3/7/2018 12:23 AM
38	high resolution structure of the oceanic lithosphere asthenosphere structure	3/6/2018 3:14 PM
39	Lithospheric studies	3/6/2018 12:54 PM
40	Data from seafloor seismometers would improve the resolution of both the elastic and anelastic structure of the mantle.	3/6/2018 12:15 PM
41	Improvement of hypocentres for small-magnitude earthquakes (up to M5) located away from continental landmasses.	3/6/2018 11:23 AM
42	Can global models of seismic anisotropy be trusted? The isotropic component of seismic velocity appears broadly consistent between models, but the anisotropic component has not proven reliable.	3/6/2018 11:03 AM
43	What are the dynamics of the oceanic plates? Are they dominated by traction from mantle flows, or ridge push and slab pull?	3/6/2018 10:43 AM
44	Characterizing propagation for land-based events into the seafloor for OBS observation. Array design to optimize SNR in the noisy marine environment.	3/6/2018 10:28 AM
45	A deployment in the Indian Ocean can be useful for investigating structure near the CMB and ICB related to heat transport across these boundaries and and the geodynamo.	3/6/2018 10:12 AM
46	Structure of the lower mantle, informing how the mantle convects	3/6/2018 9:23 AM
47	Dynamics of the Earth's lower mantle.	3/6/2018 8:01 AM
48	pattern and engine of mantle convection	3/6/2018 8:01 AM
49	seismicity of oceanic dorsals	3/6/2018 7:13 AM
50	Better resolution of the deep structure of the Earth	3/6/2018 7:07 AM
51	upper mantle structure	3/6/2018 6:31 AM



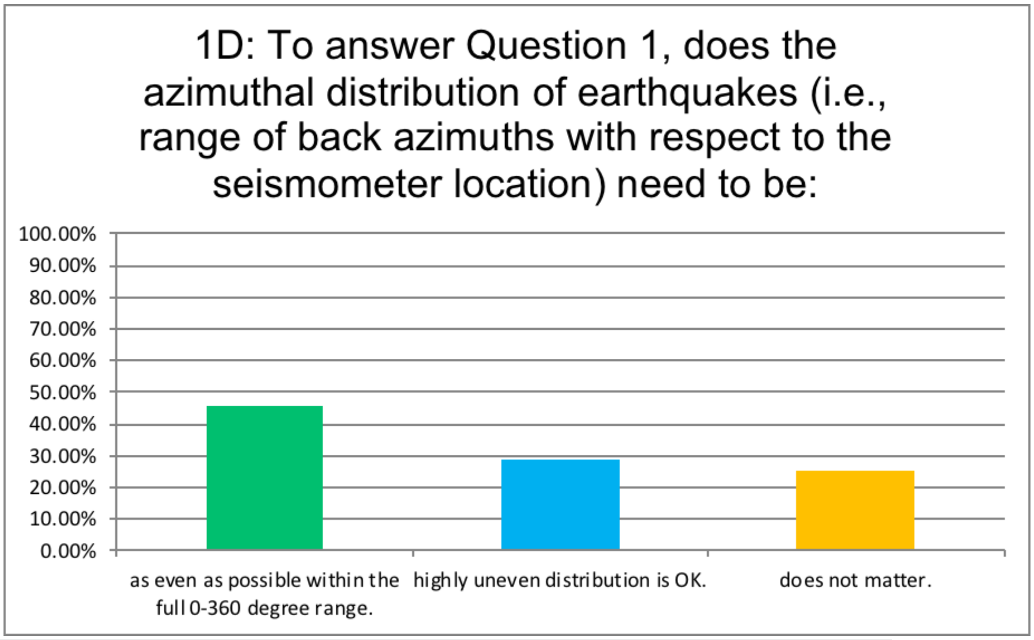
ANSWER CHOICES	RESPONSES	
globally distributed and independent of a specific tectonic setting (e.g., the middle of abyssal plain seafloor setting works fine).	45.31%	29
dependent on a particular tectonic setting for sampling structure directly below or near the station (e.g., near a specific mid-ocean ridge or subduction zone location).	40.62%	26
dependent on a particular geographic location for characterizing earthquake source rupture physics.	14.07%	9
Total Respondents: 55; Total Responses: 64		



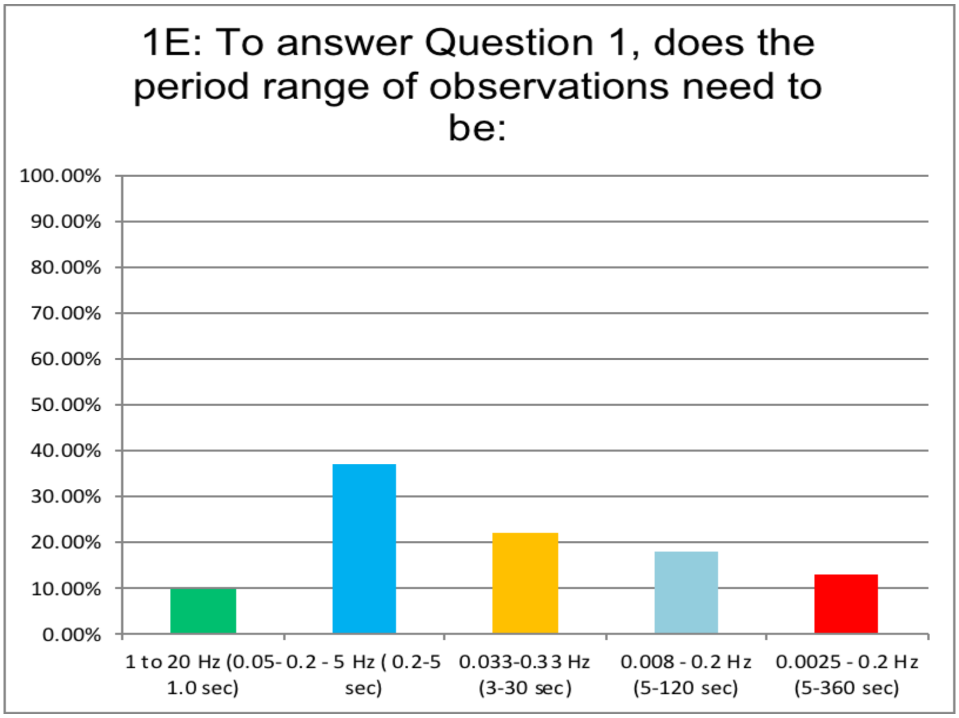
ANSWER CHOICES	RESPONSES	
no more than 18 months.	22.03%	13
at least 4 years.	55.93%	33
at least 8 years.	22.03%	13
Total Respondents: 55; Total Responses: 59		



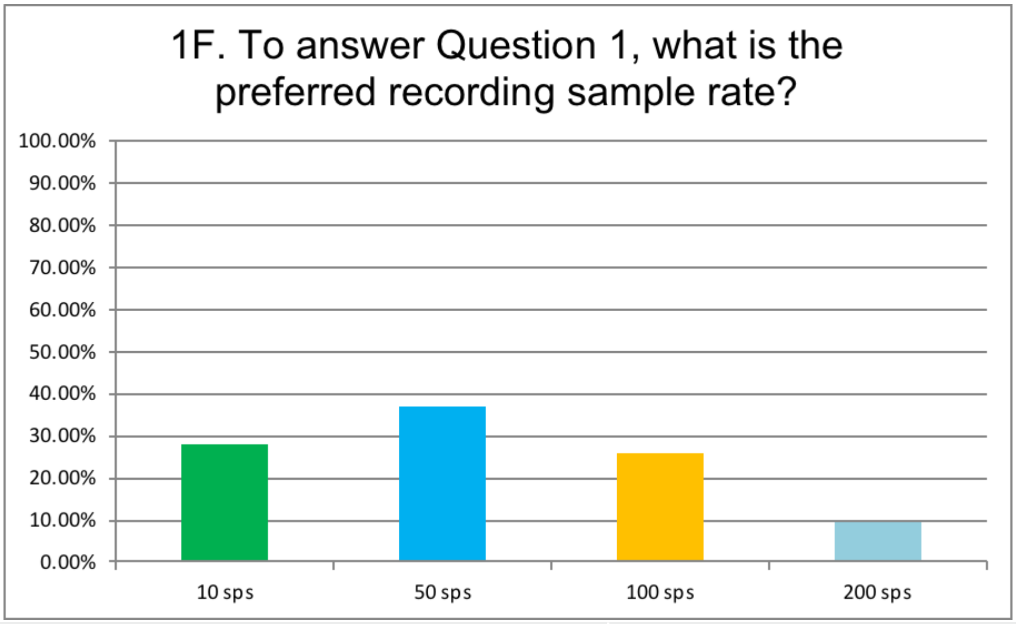
ANSWER CHOICES	RESPONSES	
less than a few seconds.	8.93%	5
tens of seconds to days.	21.43%	12
several weeks to months, or longer are OK.	69.64%	39
Total Respondents: 55; Total Responses: 56		



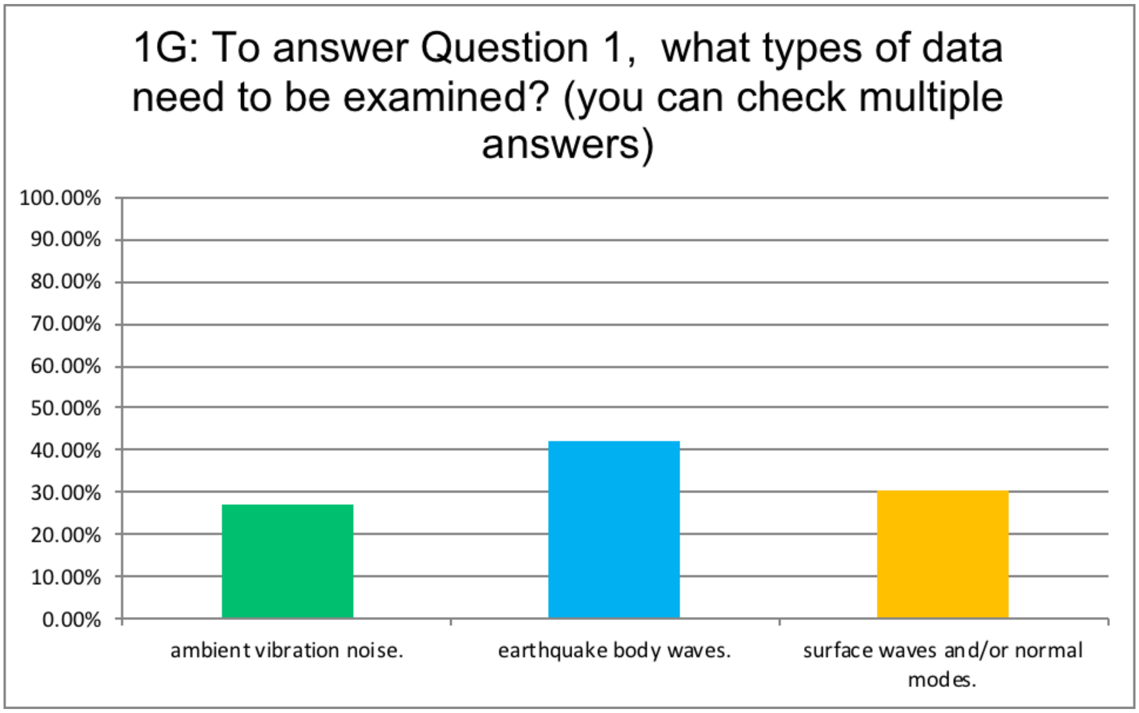
ANSWER CHOICES	RESPONSES	
as even as possible within the full 0-360 degree range.	45.76%	27
highly uneven distribution is OK.	28.81%	17
does not matter.	25.42%	15
Total Respondents: 55; Total Responses: 59		



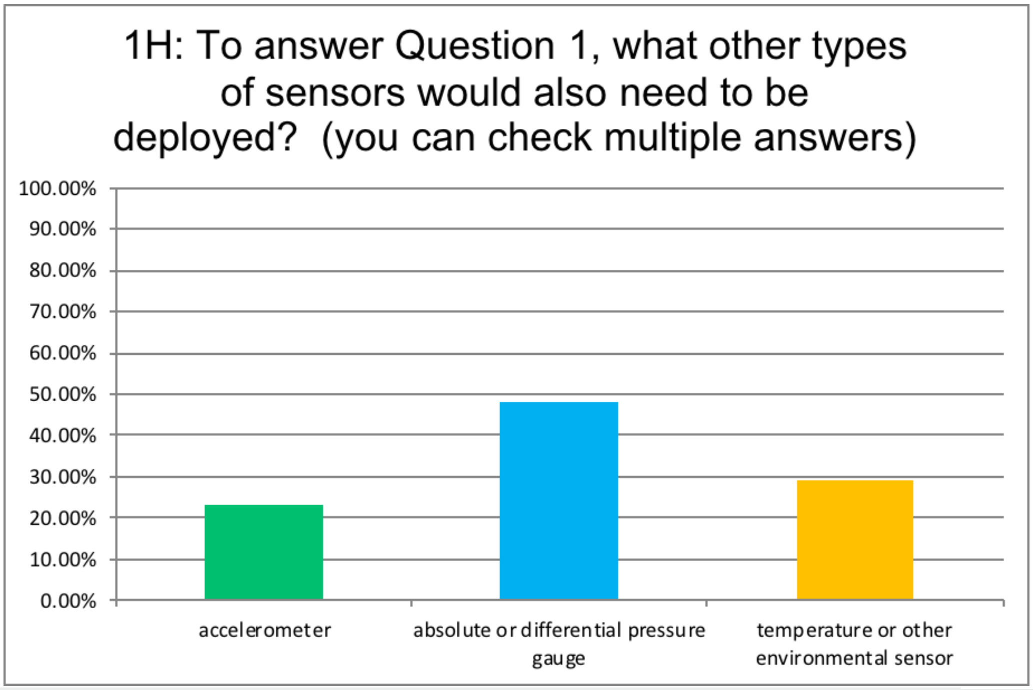
ANSWER CHOICES	RESPONSES	
1 to 20 Hz (0.05-1.0 sec)	10.00%	10
0.2 - 5 Hz (0.2-5 sec)	37.00%	37
0.033-0.33 Hz (3-30 sec)	22.00%	22
0.008 - 0.2 Hz (5-120 sec)	18.00%	18
0.0025 - 0.2 Hz (5-360 sec)	13.00%	13
Total Respondents: 55; Total Responses: 100		



ANSWER CHOICES	RESPONSES	
10 sps	27.78%	15
50 sps	37.04%	20
100 sps	25.93%	14
200 sps	9.26%	5
Total Respondents: 54: Total Responses: 54		54



ANSWER CHOICES	RESPONSES	
ambient vibration noise.	27.12%	32
earthquake body waves.	42.37%	50
surface waves and/or normal modes.	30.51%	36
Total Respondents: 54; Total Responses: 118		



ANSWER CHOICES	RESPONSES	
accelerometer	23.19%	16
absolute or differential pressure gauge	47.83%	33
temperature or other environmental sensor	28.99%	20
Total Respondents: 42; Total Responses: 69		

Section II

This section shows additional maps produced for different types of seismic phases, analogous to Figure 5 from the main manuscript text.

List of figure captions

Figure S1. Maps showing expected Receiver Function ('Rfn') phase arrival detection rates as a function of geographic location. The locations where more Rfn arrivals could be detected is shown in pink, and fewer Rfn signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S2. Maps showing expected Sp receiver function phase arrival detection rates as a function of geographic location. The locations where more Sp arrivals could be detected is shown in pink, and fewer Sp signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S3. Maps showing expected mantle transition zone ('MTZ') phase arrival detection rates as a function of geographic location. The locations where more MTZ arrivals could be detected is shown in pink, and fewer MTZ signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S4. Maps showing expected PP phase arrival detection rates as a function of geographic location. The locations where more PP arrivals could be detected is shown in pink, and fewer PP signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S5. Maps showing expected SS arrival detection rates as a function of geographic location. The locations where more SS arrivals could be detected is shown in pink, and fewer SS signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S6. Maps showing expected Ultra Low Velocity Zone ('ULVZ') phase arrival detection rates as a function of geographic location. The locations where more ULVZ arrivals could be detected is shown in pink, and fewer ULVZ signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S7. Maps showing expected ScP phase arrival detection rates as a function of geographic location. The locations where more ScP arrivals could be detected is shown in pink, and fewer ScP signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations. Same as Figure 5 in the main manuscript and shown again here for completion.

Figure S8. Maps showing expected ScS phase arrival detection rates as a function of geographic location. The locations where more ScS arrivals could be detected is shown in pink, and fewer ScS signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

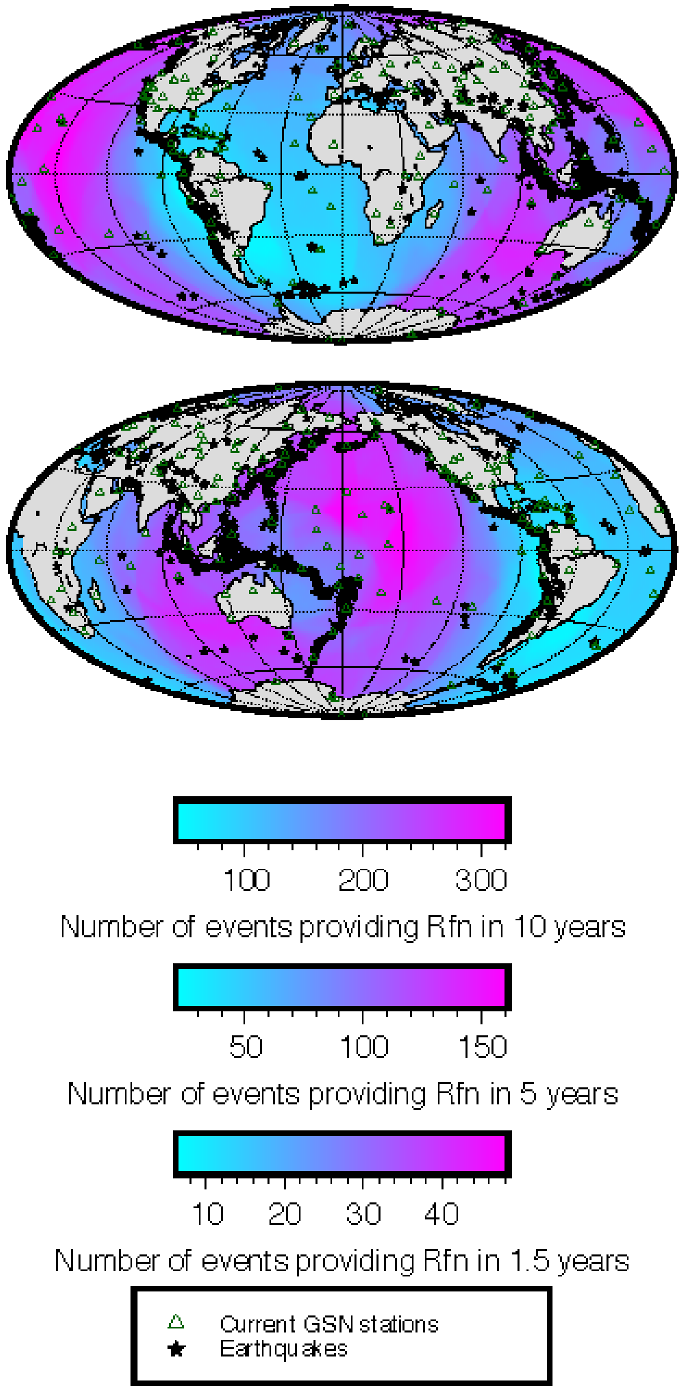
Figure S9. Maps showing expected Sdiff (diffracted S) phase arrival detection rates as a function of geographic location. The locations where more Sdiff arrivals could be detected is shown in pink, and fewer Sdiff signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S10. Maps showing expected SmKS phase arrival detection rates as a function of geographic location. The locations where more SmKS arrivals could be detected is shown in pink, and fewer SmKS signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S11. Maps showing expected SPdKS phase arrival detection rates as a function of geographic location. The locations where more SPdKS arrivals could be detected is shown in pink, and fewer SPdKS signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S12. Maps showing expected PKPbc-PKIKP detection rates as a function of geographic location. The locations where more PKPbc-PKIKP arrivals could be detected is shown in pink, and fewer PKPbc-PKIKP signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

Figure S13. Maps showing expected PKiKP-PKIKP detection rates as a function of geographic location. The locations where more PKiKP-PKIKP arrivals could be detected is shown in pink, and fewer PKiKP-PKIKP signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.



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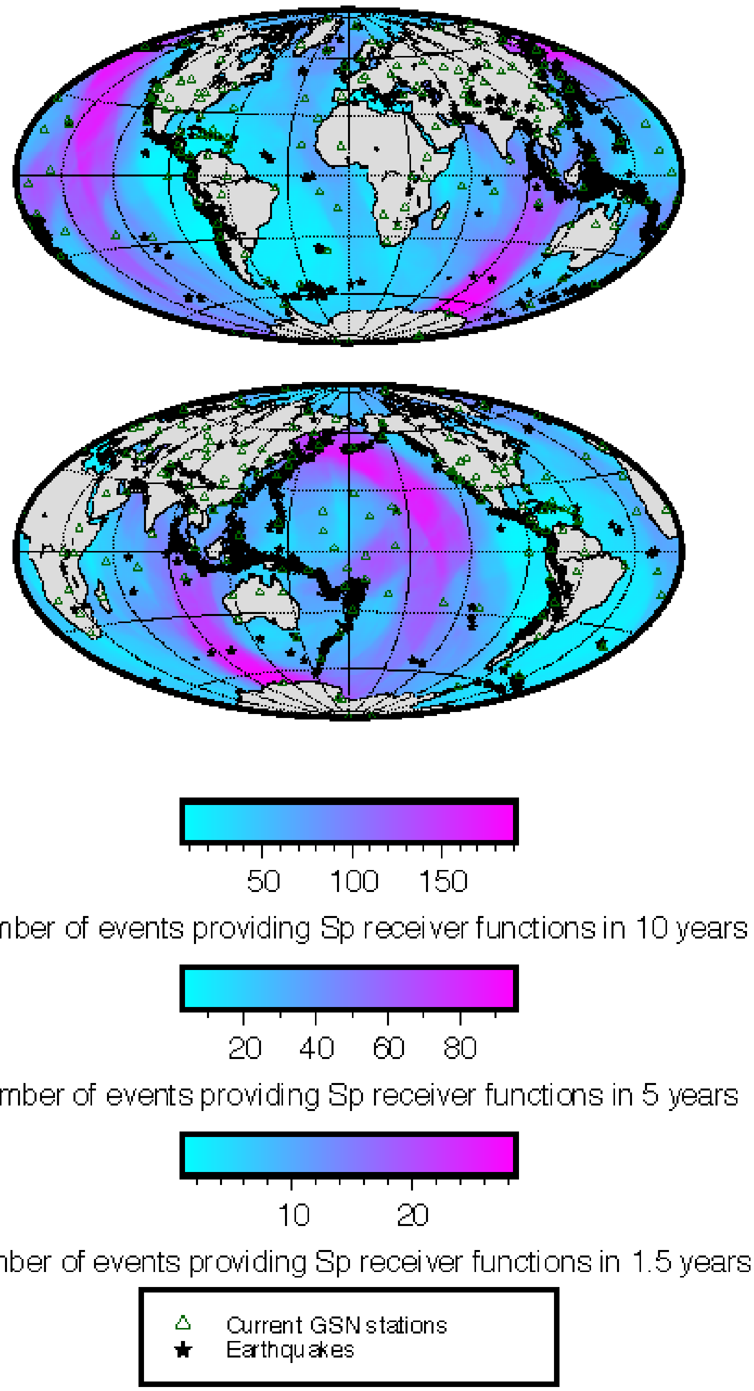

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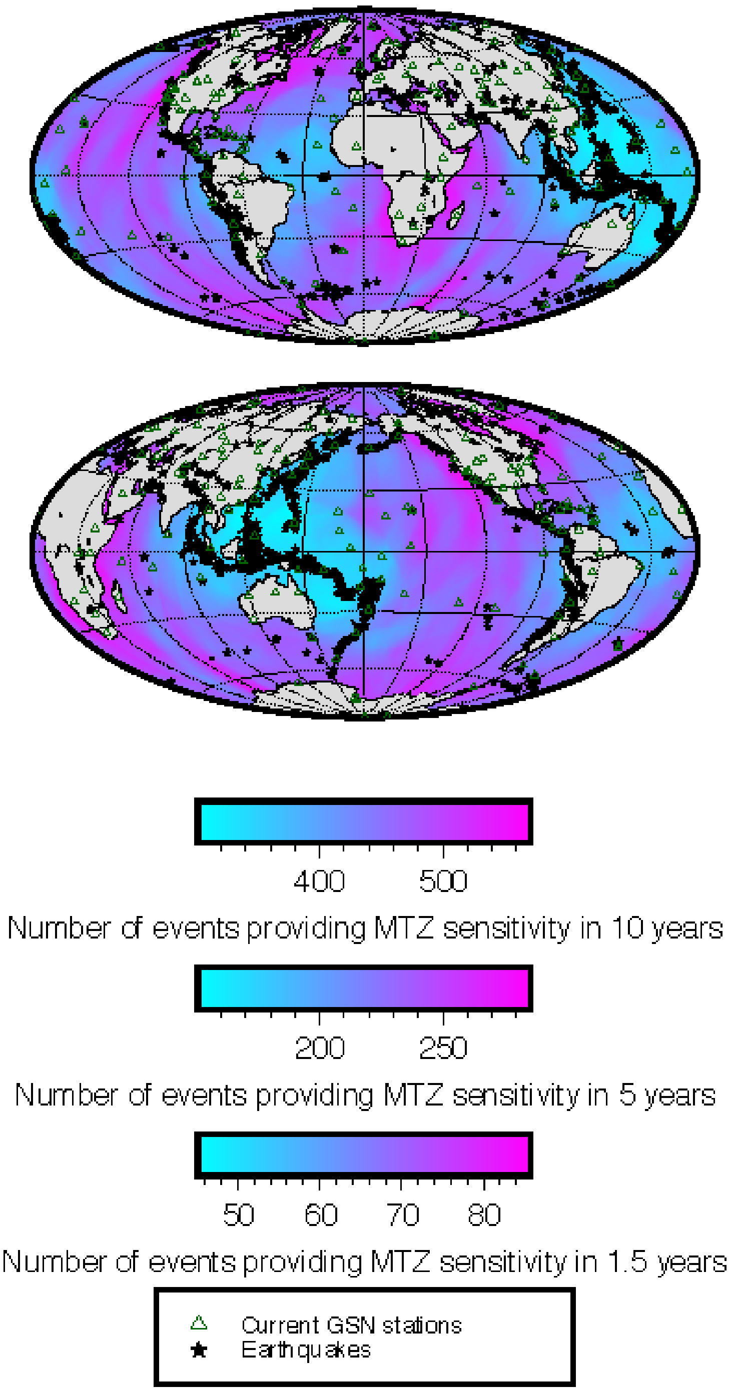

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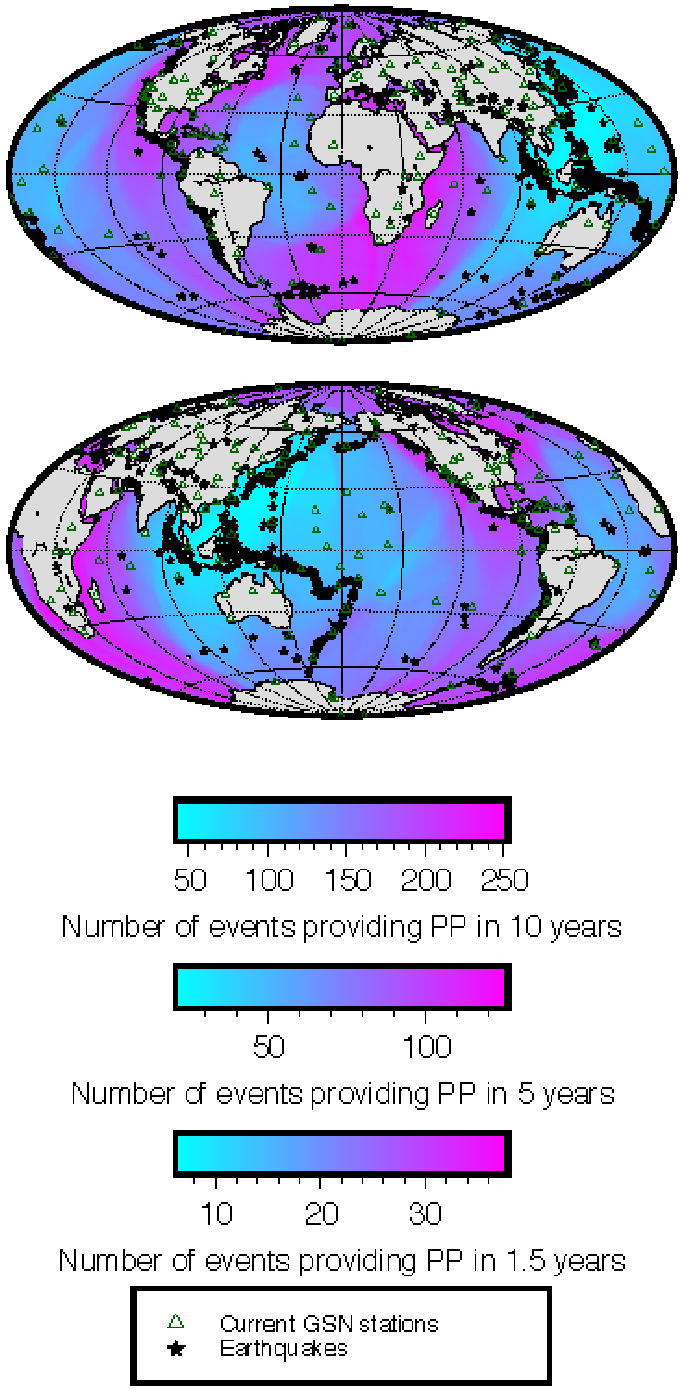

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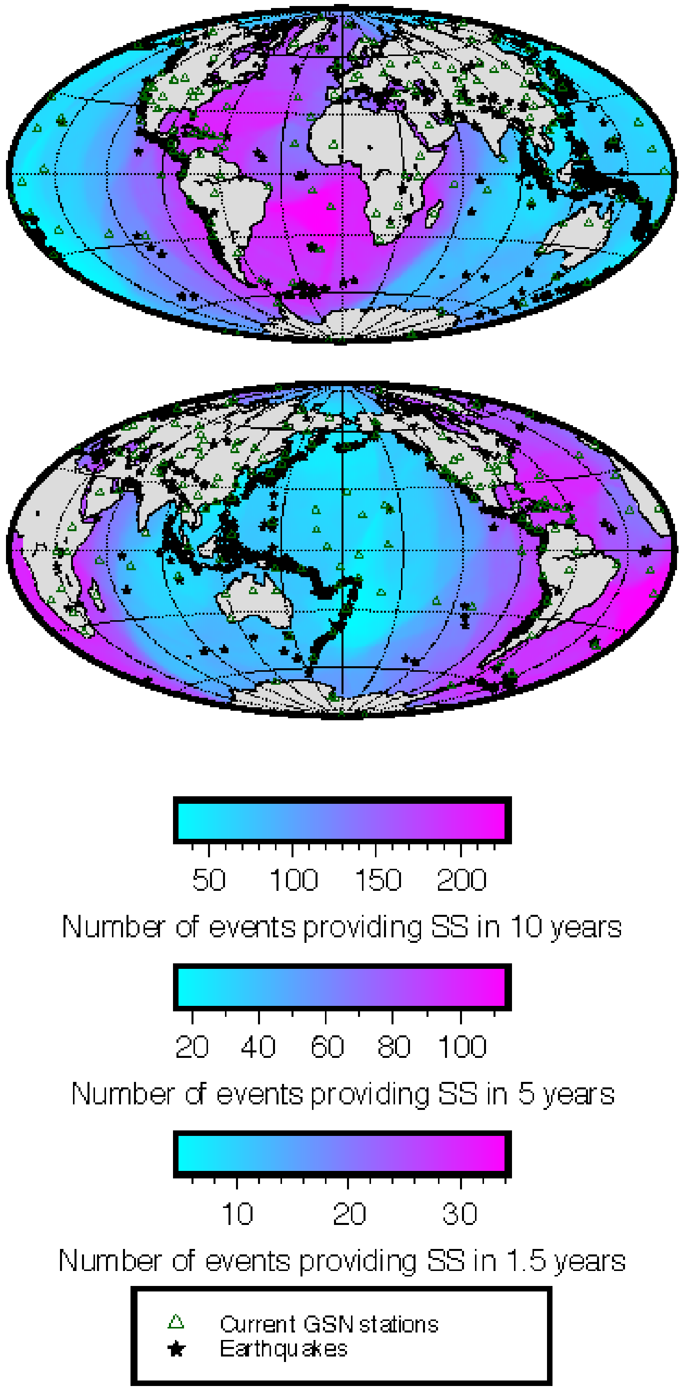

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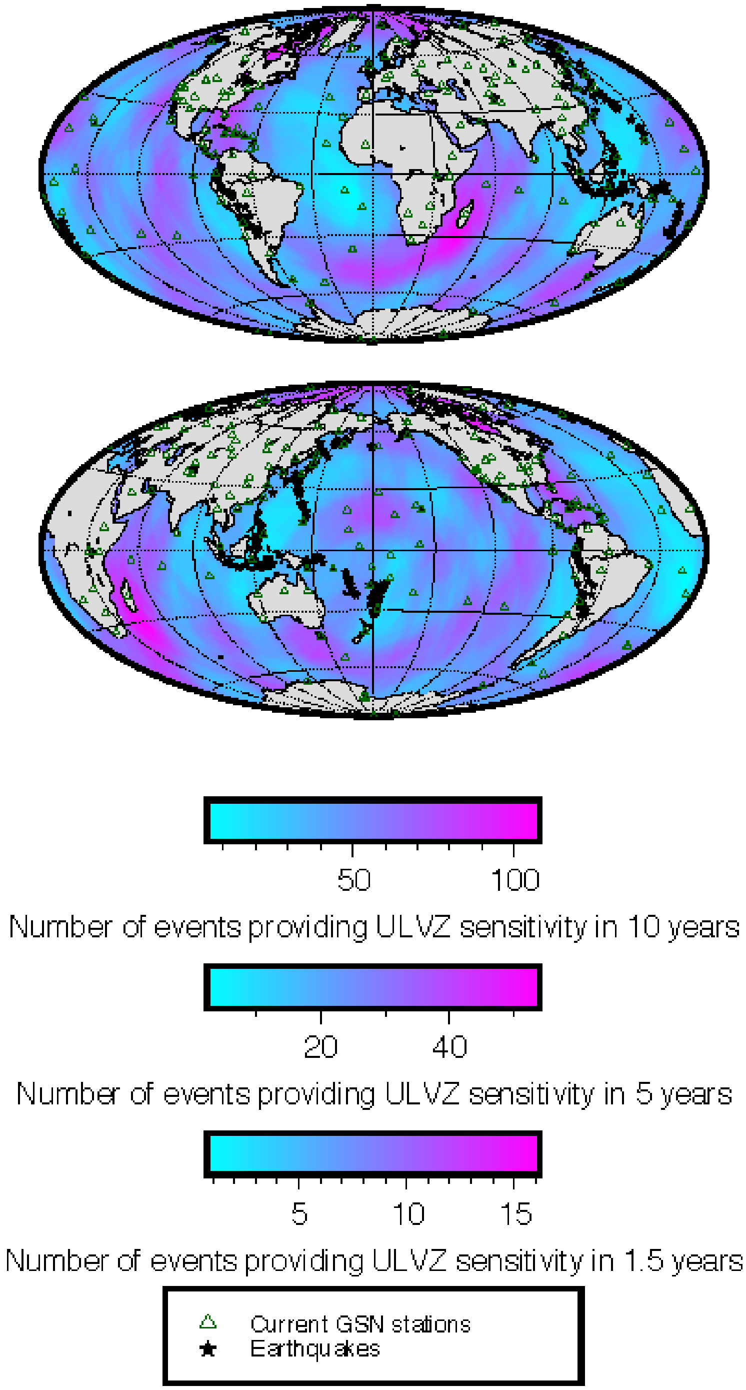

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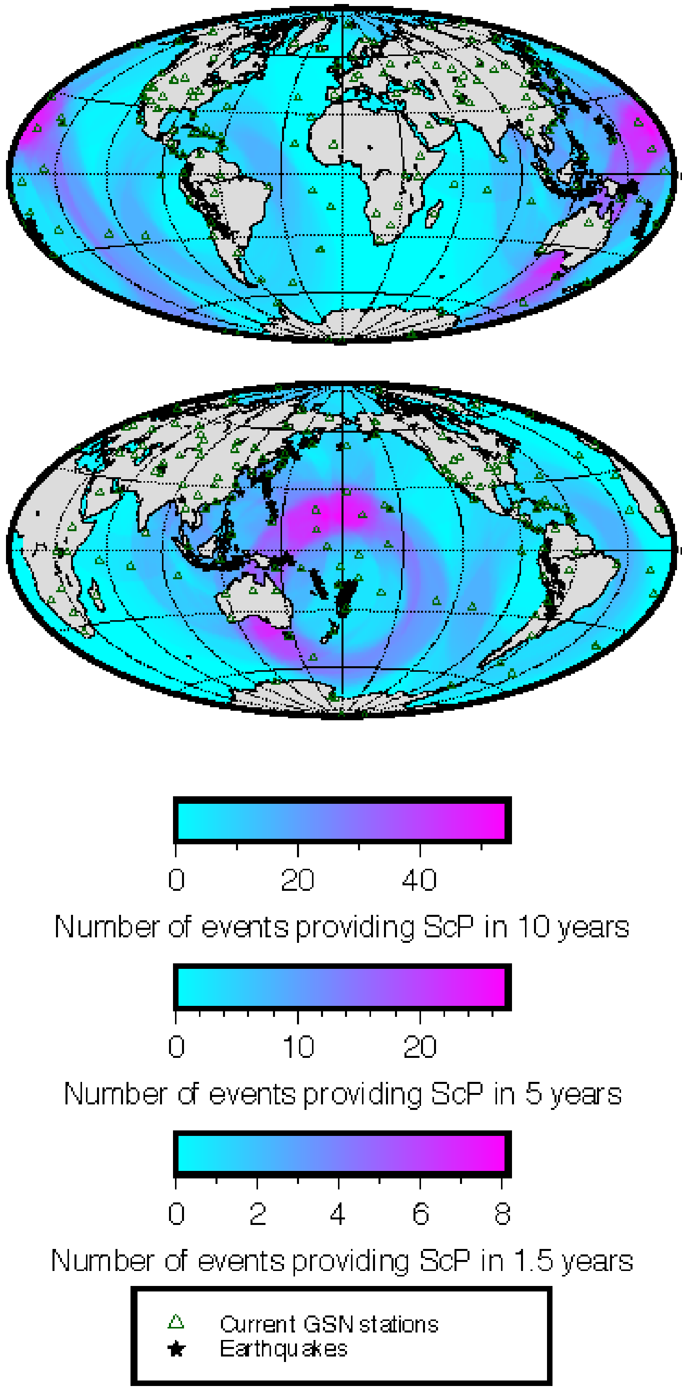

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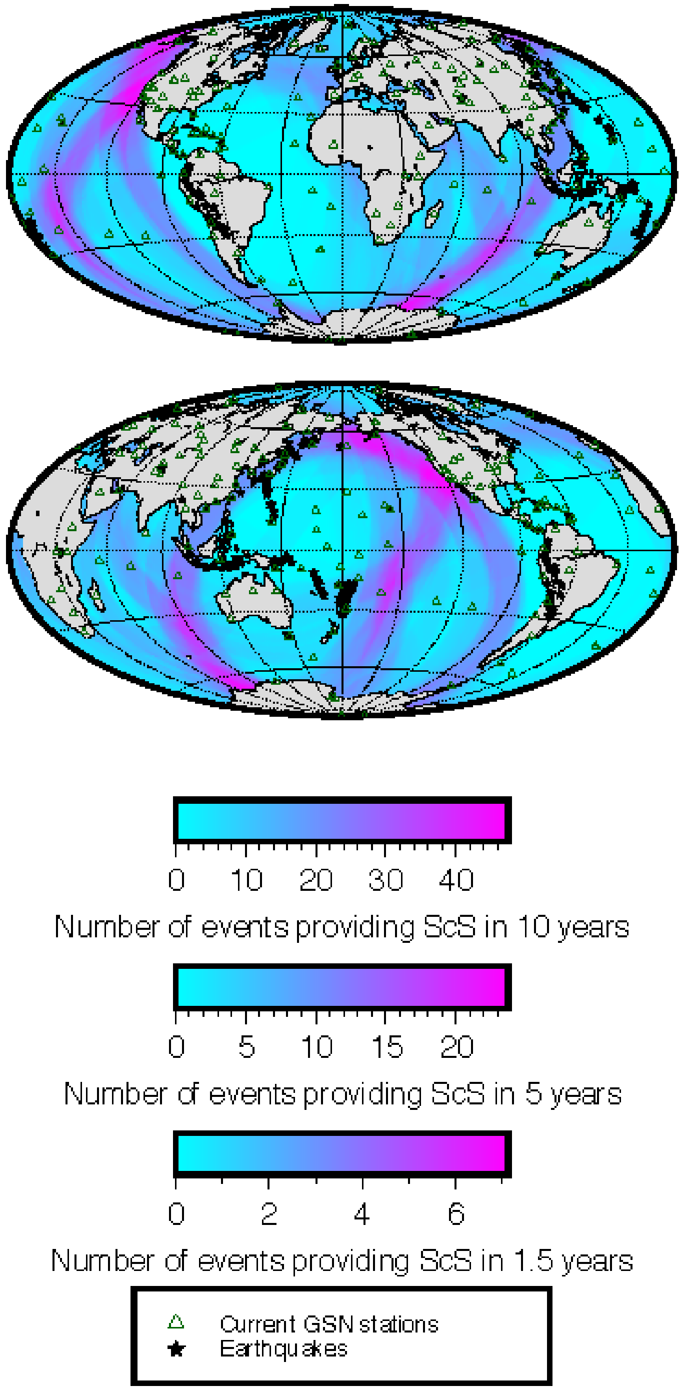

Figure S8. Maps showing expected ScS detection rates as a function of geographic location. The locations where more ScS arrivals could be detected is shown in pink, and fewer ScS signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

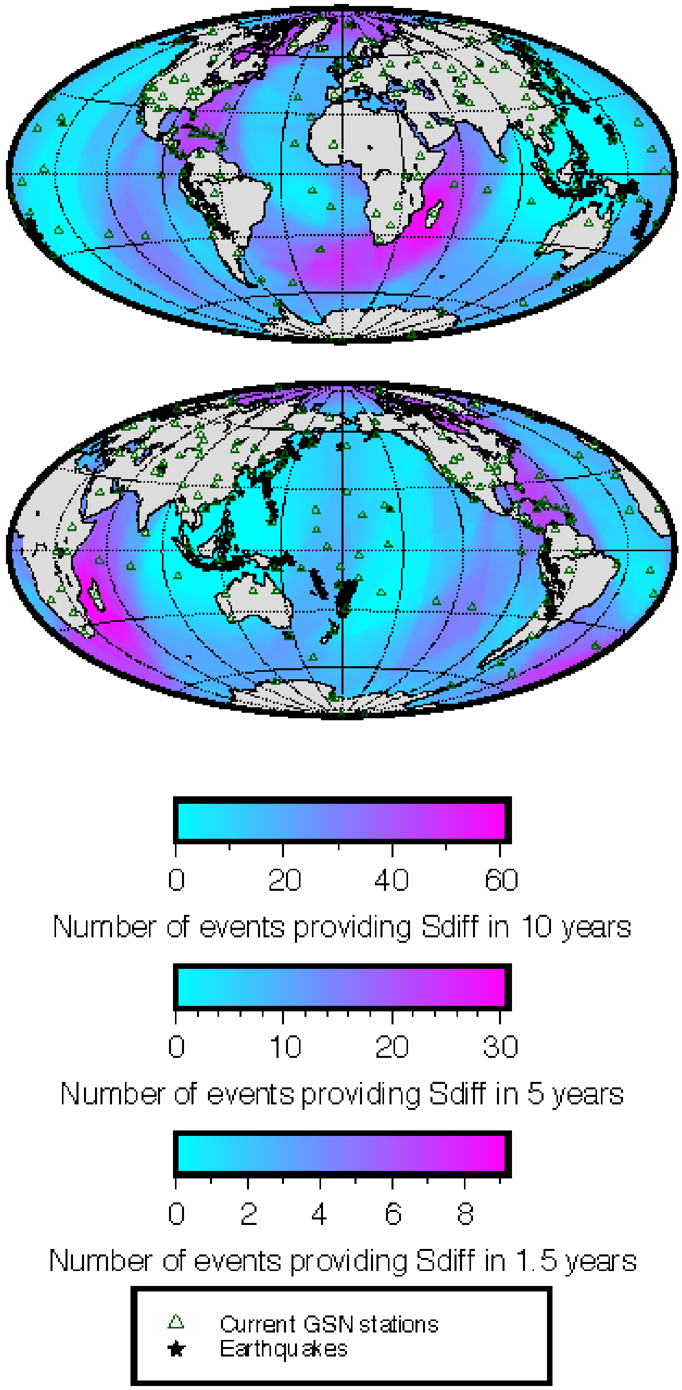

Figure S9. Maps showing expected Sdiff (diffracted S) phase arrival detection rates as a function of geographic location. The locations where more Sdiff arrivals could be detected is shown in pink, and fewer Sdiff signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

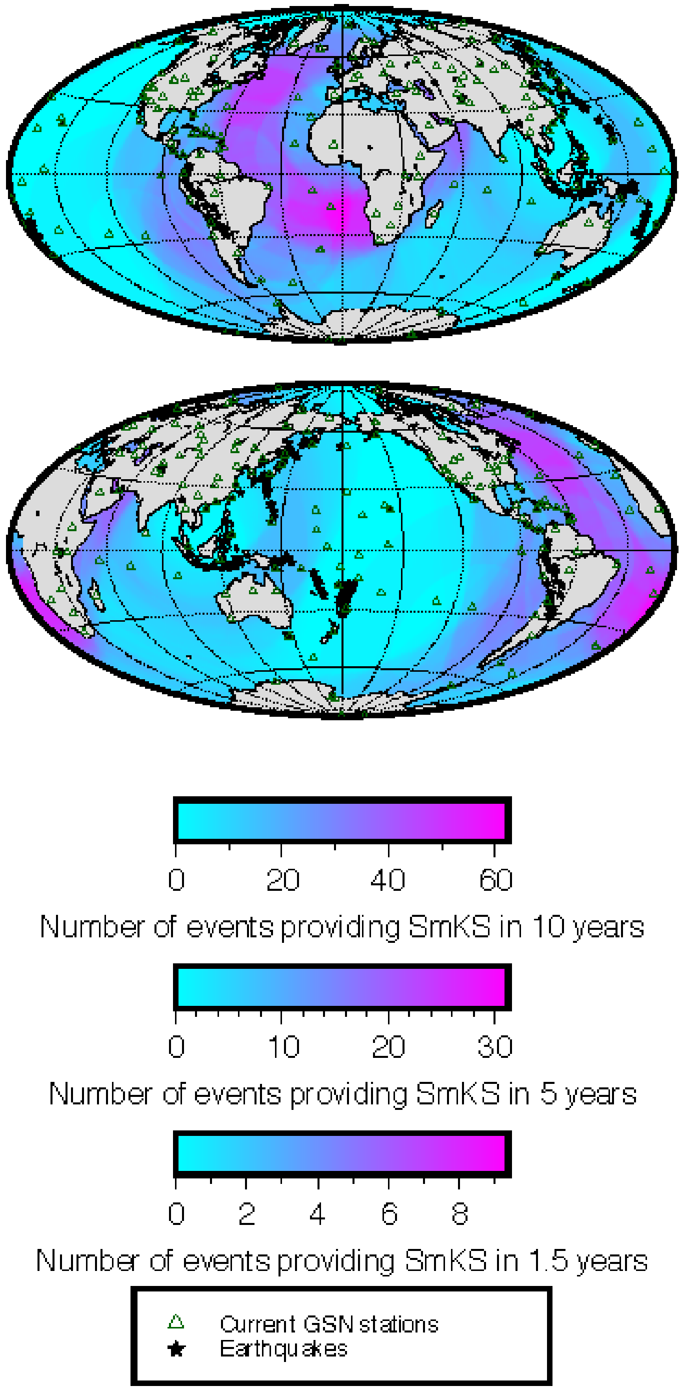

Figure S10. Maps showing expected SmKS phase arrival detection rates as a function of geographic location. The locations where more SmKS arrivals could be detected is shown in pink, and fewer SmKS signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

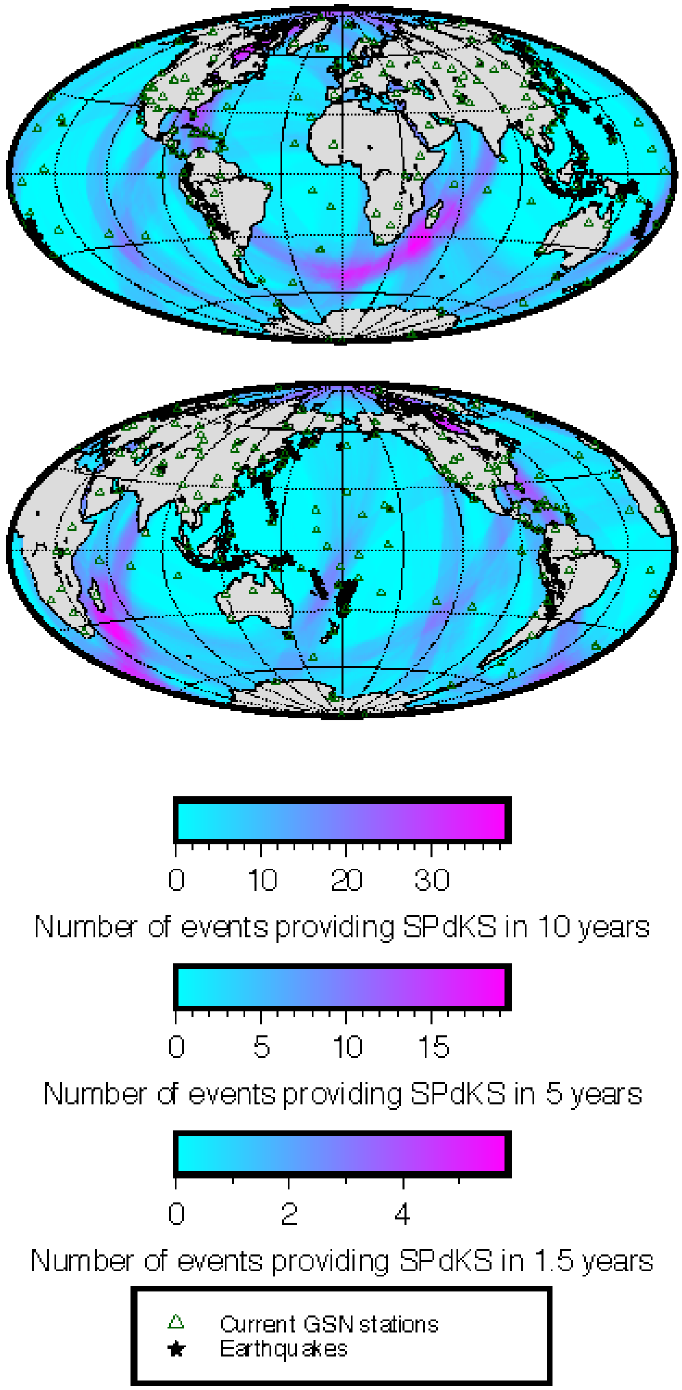

Figure S11. Maps showing expected SPdKS phase arrival detection rates as a function of geographic location. The locations where more SPdKS arrivals could be detected is shown in pink, and fewer SPdKS signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

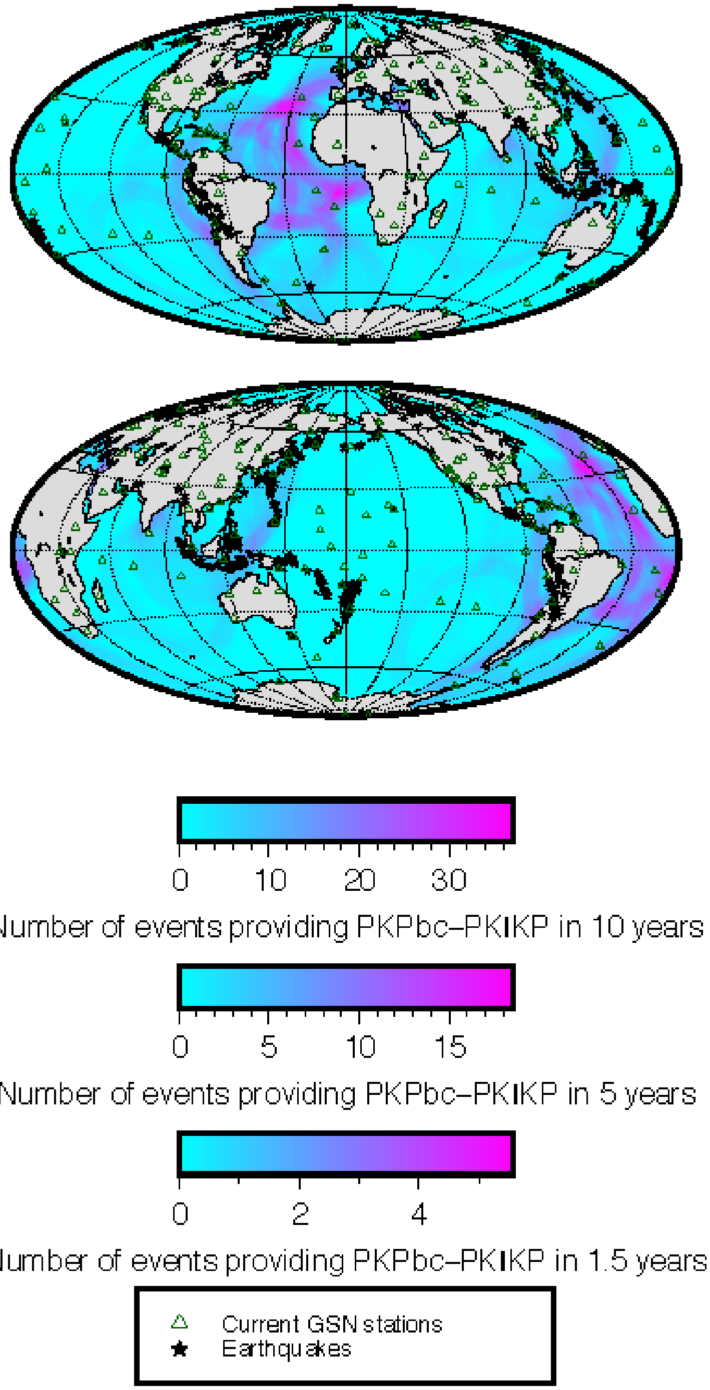

Figure S12. Maps showing expected PKPbc-PKIKP detection rates as a function of geographic location. The locations where more PKPbc-PKIKP arrivals could be detected is shown in pink, and fewer PKPbc-PKIKP signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.

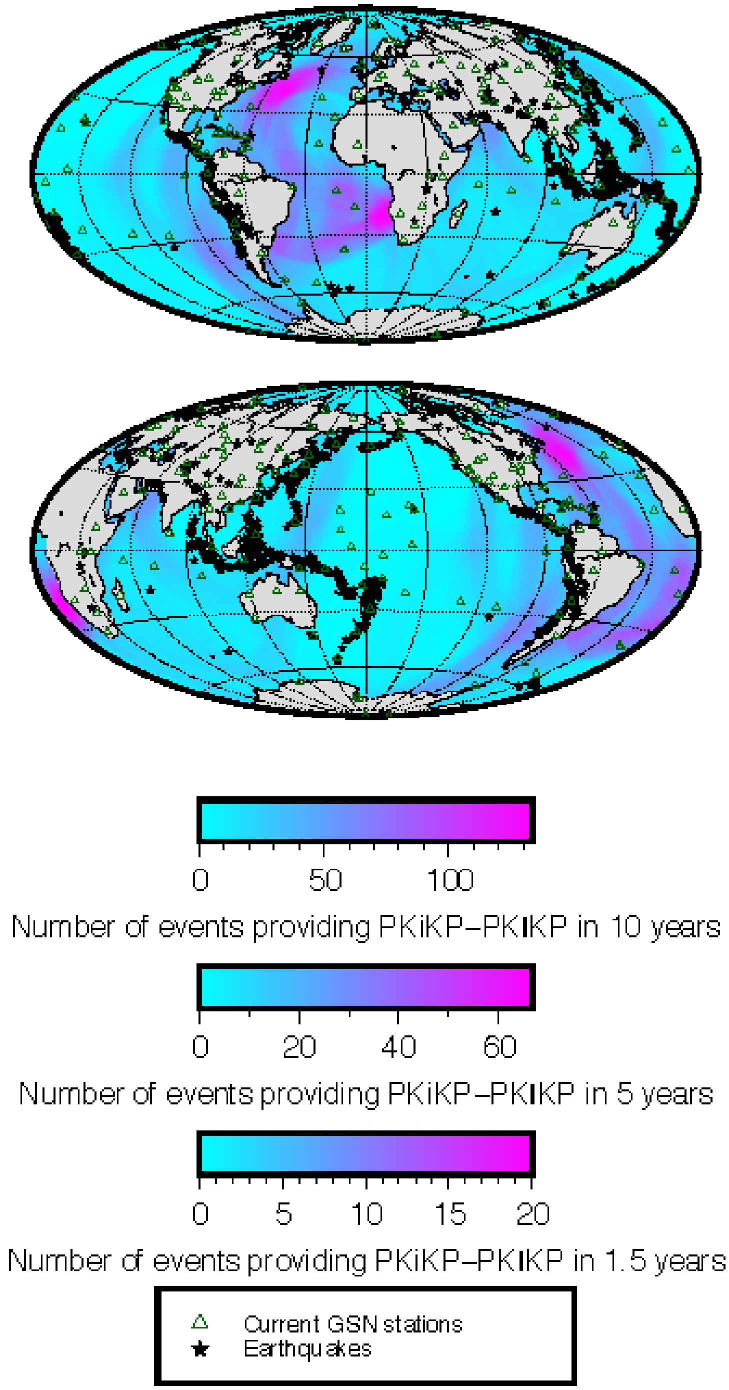

Figure S13. Maps showing expected PKiKP-PKIKP detection rates as a function of geographic location. The locations where more PKiKP-PKIKP arrivals could be detected is shown in pink, and fewer PKiKP-PKIKP signals detected is shown in blue. The three color scales correspond to three different OBS deployment durations with color indicating how many phases we would expect to record at each possible station location on the seafloor. Top: Africa-centered. Bottom: Pacific-centered. Stars: earthquakes within specified time duration with **M** > 6.5. Triangles: GSN station locations.