Additional file 1 for "GPS-based slip models of one M_w 7.2 and twenty moderate earthquakes along the Sumatran plate boundary"

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This additional file presents a catalog of GPS-based uniform slip models for one M_w 7.2 and 20 moderate ($5.9 \leq M_w < 7$) events along the Sumatran plate boundary between 2002 and 2013 detected by the SuGAr network.

The figures are contour maps showing the error-weighted variance explained with the preferred model outlined as a black box. Yellow stars, orange triangles, blue diamonds, and red inverted triangles represent the epicenter locations from the ANSS (NCEDC 2016), ISC (International Seismological Center, 2016), ISC-EHB (Engdahl et al. 1998; Weston et al. 2018), and ISC-GEM (Storchak et al. 2013, 2015) teleseismic catalogs, respectively. Focal mechanisms are placed at the gCMT centroid locations (Dziewonski et al. 1981; Ekström et al. 2012). Red circles are the SuGAr stations that had been installed before the event, while white circles are those installed later or decommissioned before the event. Green and red vectors represent the observed vertical and horizontal displacements, while black vectors represent the displacements predicted from our best-fit models. Gray dashed lines delineate the inferred subducted fracture zones underneath Simeulue (Franke et al. 2008) and Batu Islands (Pesicek et al. 2010) based on seismicity. Brown lines indicate slab contours at 20 km, 40 km, and 60 km intervals from Slab1.0 (Hayes et al. 2012).

The tables summarize all the parameters of our final models along with the relevant information from the gCMT and ANSS catalogs and the coseismic offsets obtained from Feng et al. (2015).

References

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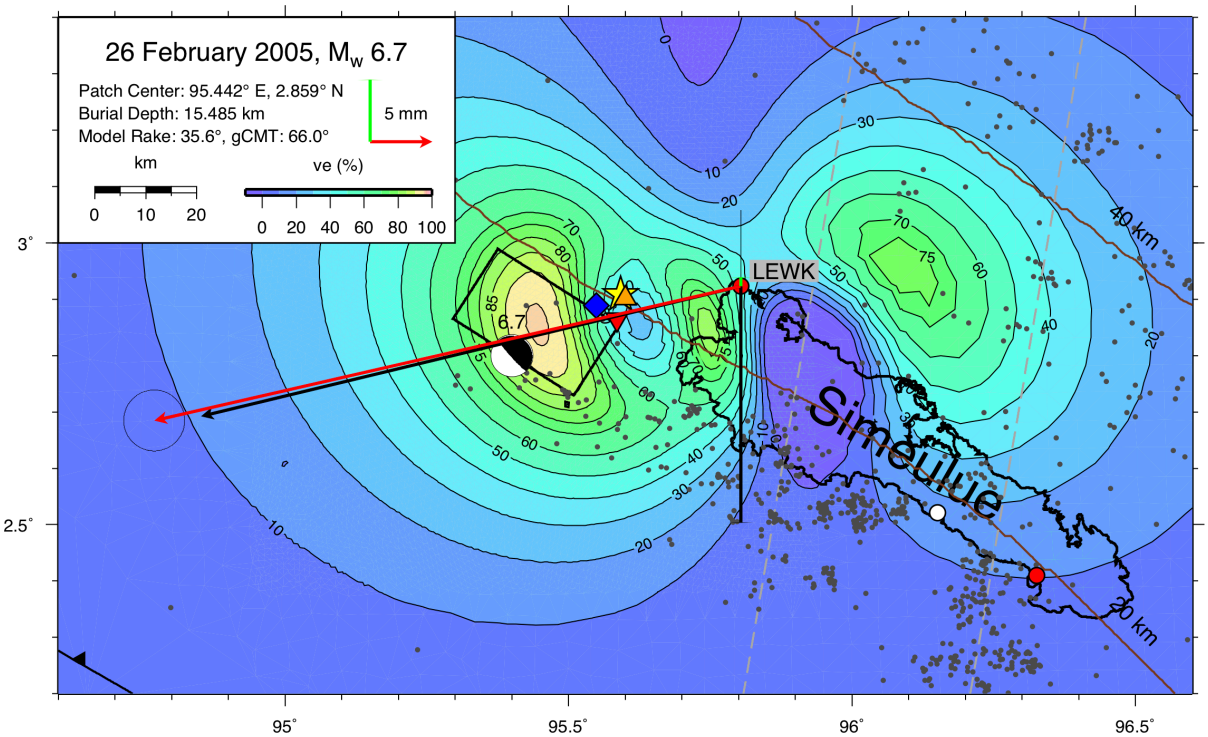
S1. Megathrust Events

S1.1 The 26 February 2005 M_w 6.7 Simeulue Event

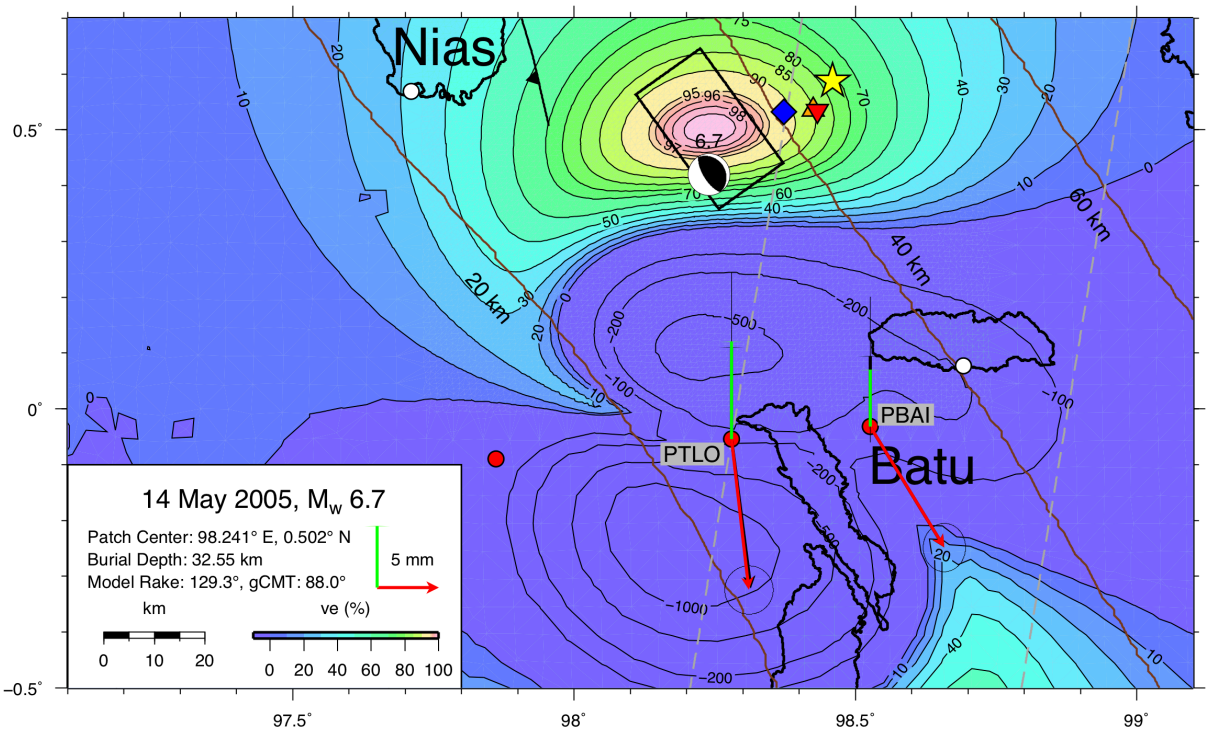


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20050226	6.7	95.442	2.859	95.40	2.80	95.592	2.908	15.5	18.6	12.0	36.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
35.6	66	302.6	294	10.8	6	28.12	468.9	1.0043	95.95%

		Displacement / mm		
		(E)	(N)	(V)
LEWK	(O)	-47.1 ± 1.0	-10.8 ± 1.0	0.7 ± 2.2
	(M)	-43.32	-10.45	-19.00

S1.2 The 14 May 2005 M_w 6.7 Nias-Batu Event

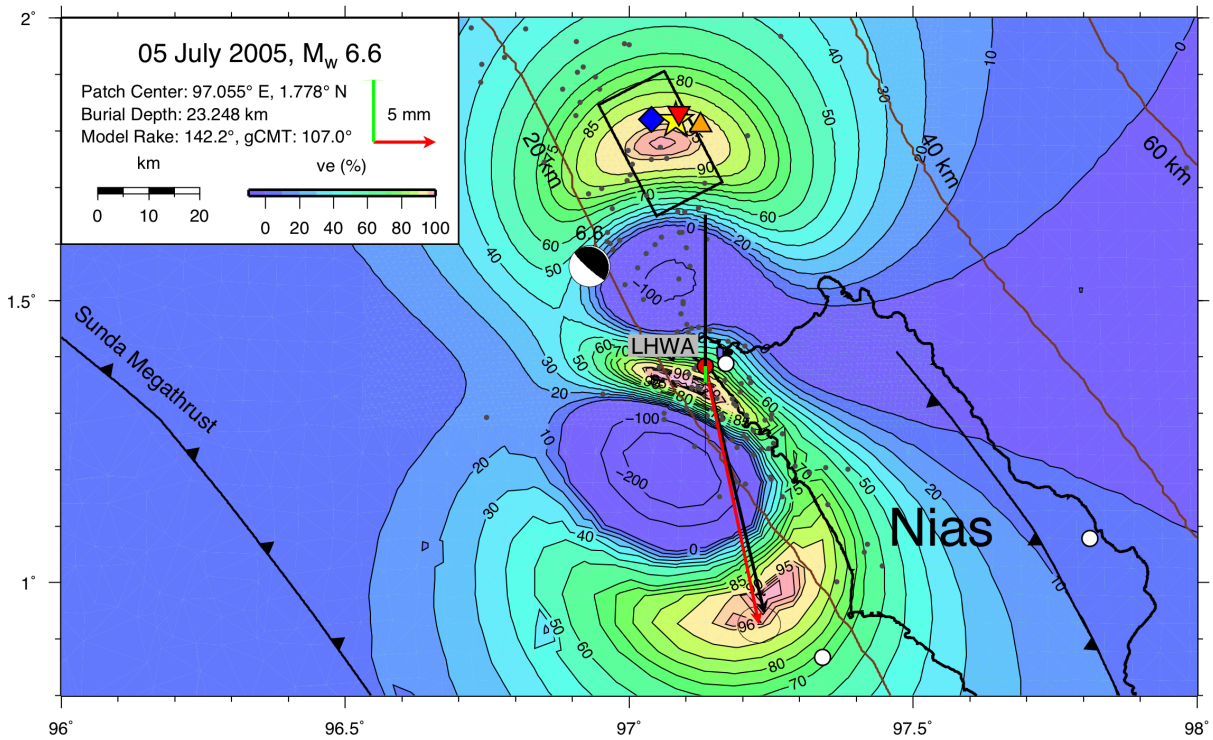


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20050514	6.7	98.241	0.502	98.24	0.42	98.459	0.587	32.6	38.0	39.0	34.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
129.3	88	324.3	326	19.3	22	28.12	468.9	1.0043	99.93%

		Displacement / mm		
		(E)	(N)	(V)
PTLO	(O)	6.0 ± 0.7	-9.8 ± 0.8	4.6 ± 2.4
	(M)	5.98	-9.78	5.73
PBAI	(O)	1.4 ± 0.8	-12.0 ± 0.8	7.9 ± 2.3
	(M)	1.56	-12.08	7.44

S1.3 The 05 July 2005 M_w 6.6 Nias Event

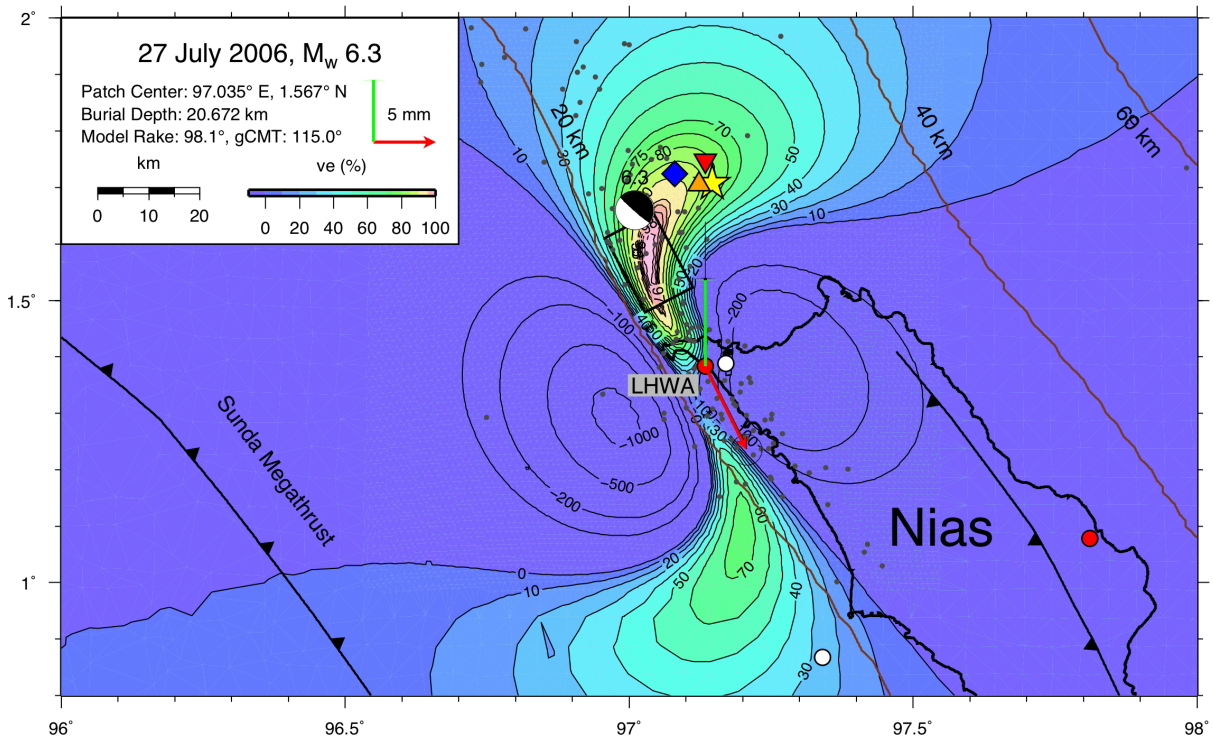


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20050705	6.6	97.055	1.778	96.93	1.56	97.082	1.819	23.2	27.0	16.0	21.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
142.2	107	332.6	329	14.5	8	24.66	369.8	0.9013	97.24

		Displacement / mm		
		(E)	(N)	(V)
LHWA	(O)	4.3 ± 0.7	-20.7 ± 0.6	-1.3 ± 2.4
	(M)	4.75	-19.84	12.15

S1.4 The 27 July 2006 M_w 6.3 Nias Event

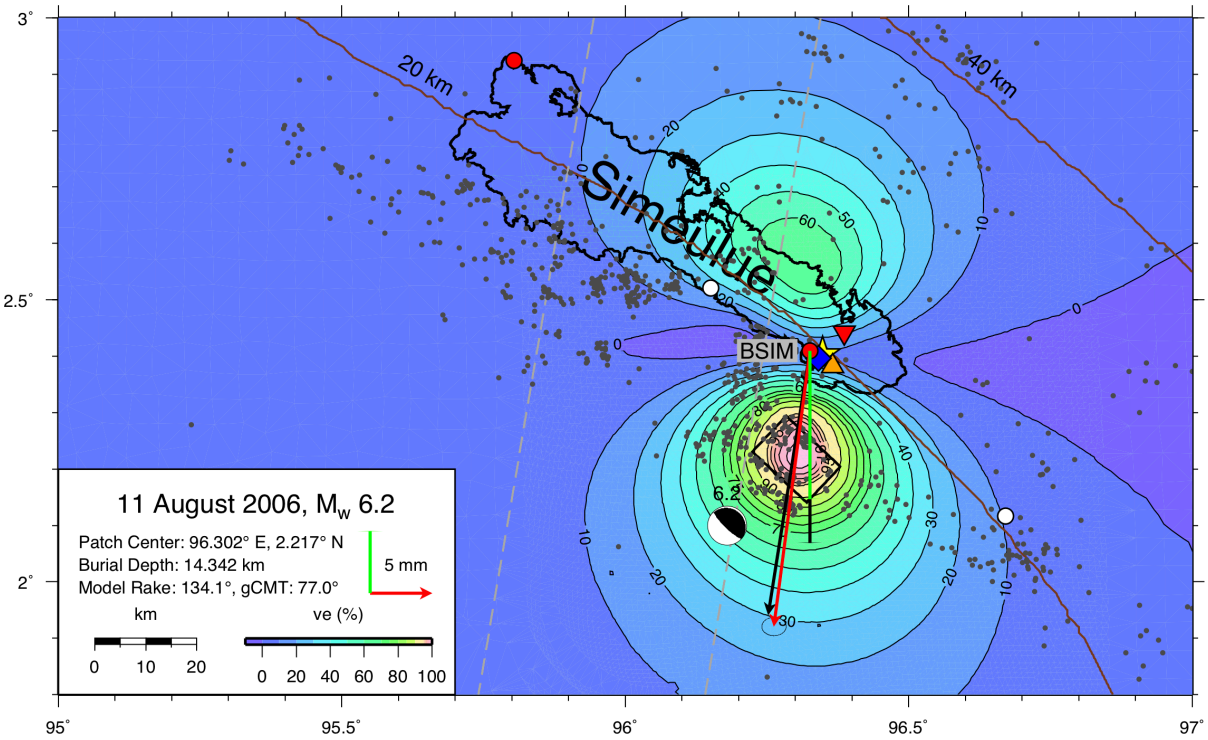


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20060727	6.3	97.035	1.567	97.01	1.66	97.146	1.707	20.7	23.2	15.0	20.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
98.1	115	332.1	336	13.4	5	16.63	181.6	0.6515	99.99%

		Displacement / mm		
		(E)	(N)	(V)
LHWA	(O)	3.3 ± 0.5	-6.7 ± 0.5	6.9 ± 1.9
	(M)	3.34	-6.67	7.06

S1.5 The 11 August 2006 M_w 6.2 Simeulue Event

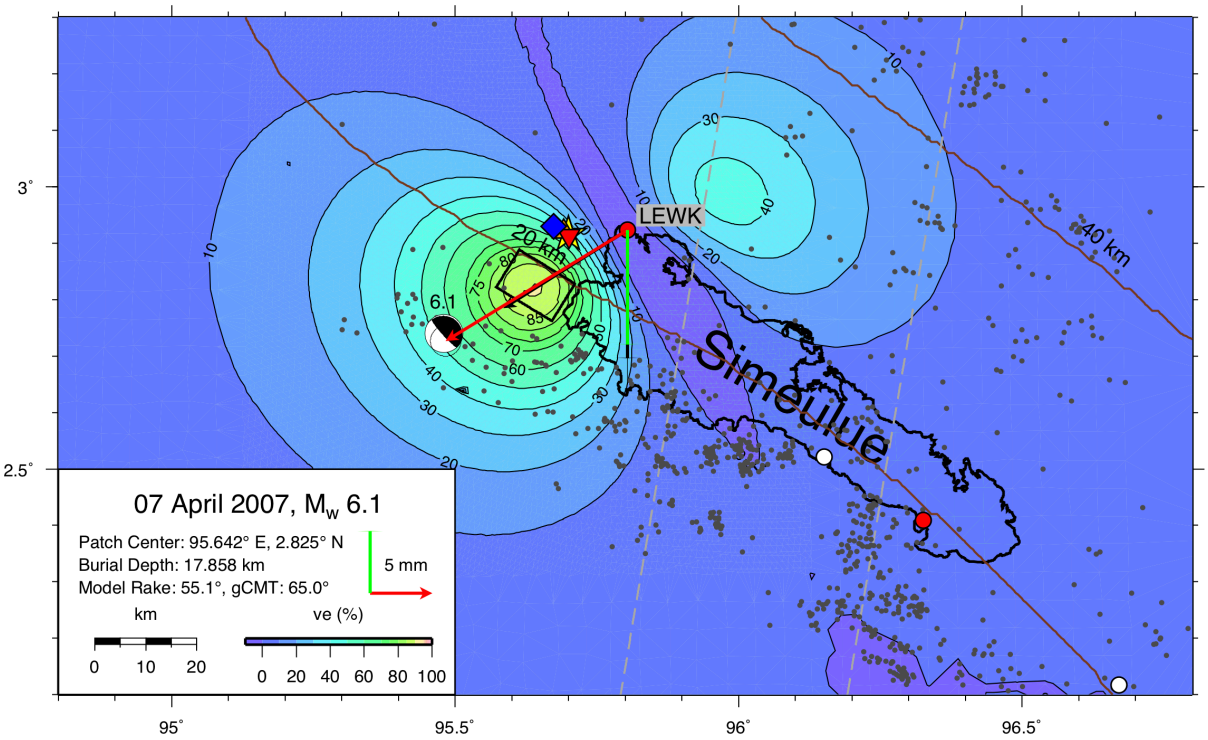


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20060811	6.2	96.302	2.217	96.18	2.10	96.348	2.406	14.3	16.2	20.6	22.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
134.1	77	313.2	301	11.0	12	14.59	143.2	0.5846	99.63

		Displacement / mm		
		(E)	(N)	(V)
BSIM	(O)	-2.9 ± 0.4	-22.1 ± 0.3	-11.9 ± 1.1
	(M)	-3.36	-21.20	-15.41

S1.6 The 07 April 2007 M_w 6.1 Simeulue Event

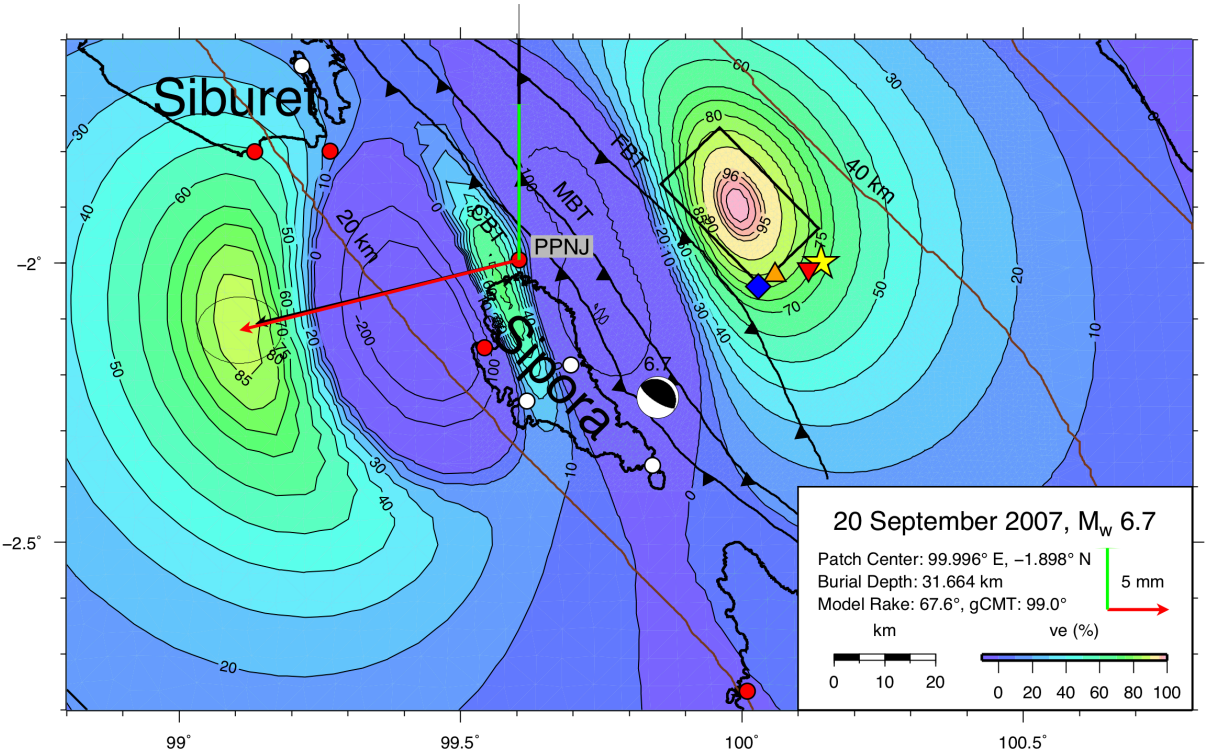


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20070407	6.1	95.642	2.825	95.48	2.74	95.700	2.916	17.9	19.8	12.0	30.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
55.1	65	301.5	293	12.3	8	12.79	113.0	0.5247	90.59

		Displacement / mm		
		(E)	(N)	(V)
LEWK	(O)	-14.6 ± 0.5	-8.9 ± 0.5	-9.2 ± 1.3
	(M)	-9.96	-6.27	-10.29

S1.7 The 20 September 2007 M_w 6.7 Sipora Event

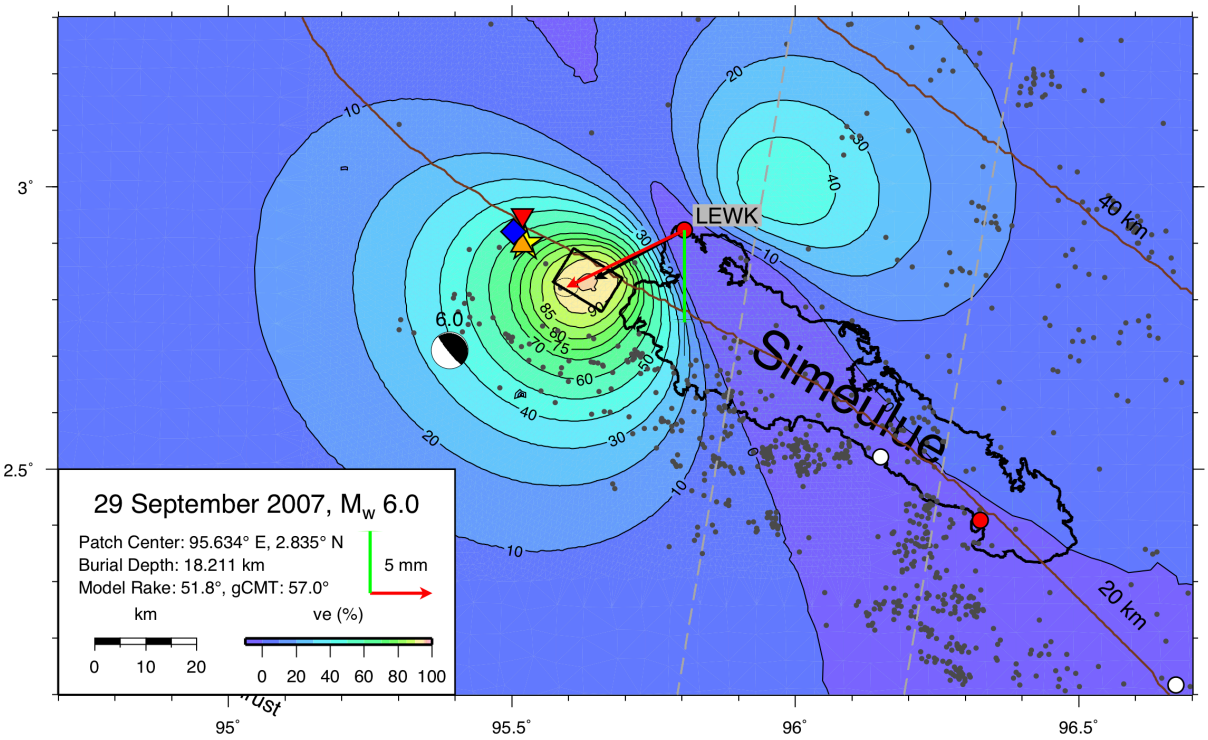


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20070920	6.7	99.996	-1.989	99.85	-2.24	100.141	-1.999	31.7	35.7	32.3	30.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
67.6	99	315.8	313	13.9	19	28.12	468.9	1.0043	98.81

		Displacement / mm		
		(E)	(N)	(V)
PPNJ	(O)	-22.6 ± 1.4	-5.7 ± 1.1	12.6 ± 3.3
	(M)	-21.36	-5.20	17.94

S1.8 The 29 September 2007 M_w 6.0 Simeulue Event

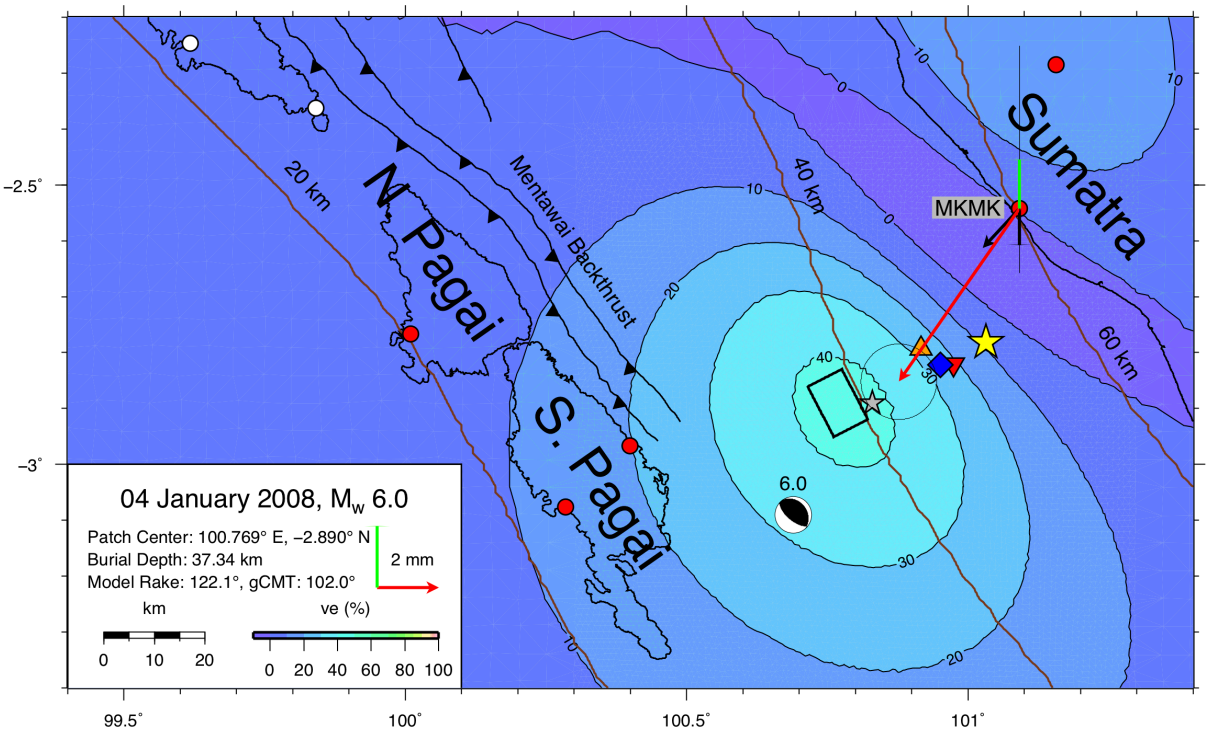


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20070929	6.0	95.634	2.835	95.39	2.71	95.523	2.900	18.2	19.9	15.0	35.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
51.8	57	301.5	288	12.5	8	11.22	89.1	0.4709	95.62

		Displacement / mm		
		(E)	(N)	(V)
LEWK	(O)	-9.5 ± 0.4	-4.6 ± 0.3	-7.4 ± 1.1
	(M)	-7.23	-3.94	-7.20

S1.9 The 04 January 2008 M_w 6.0 South Pagai Event

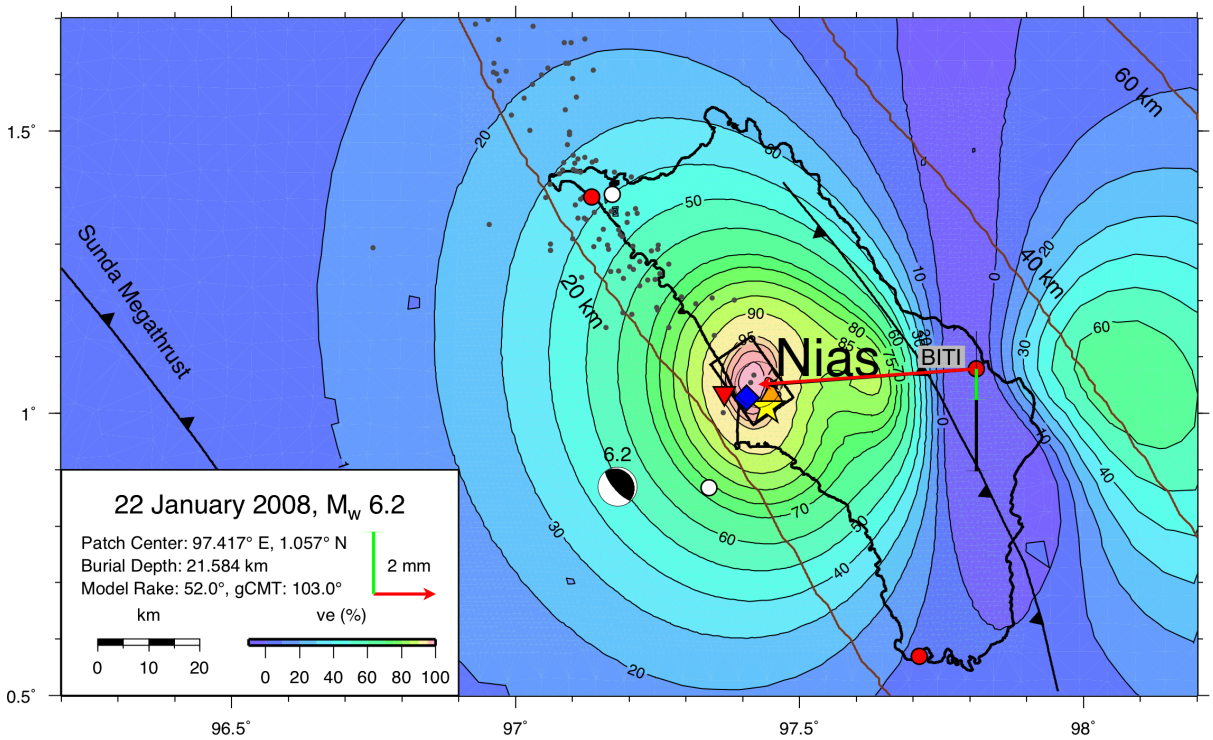


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20080104	6.0	100.769	-2.890	100.69	-3.09	101.032	-2.782	37.3	39.8	46.1	35.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
122.1	102	332.7	323	17.9	27	11.22	89.1	0.4709	42.76

		Displacement / mm		
		(E)	(N)	(V)
MKMK	(O)	-3.9 ± 0.5	-5.6 ± 0.5	1.6 ± 1.5
	(M)	-1.19	-1.28	-1.19

S1.10 The 22 January 2008 M_w 6.2 Nias Event

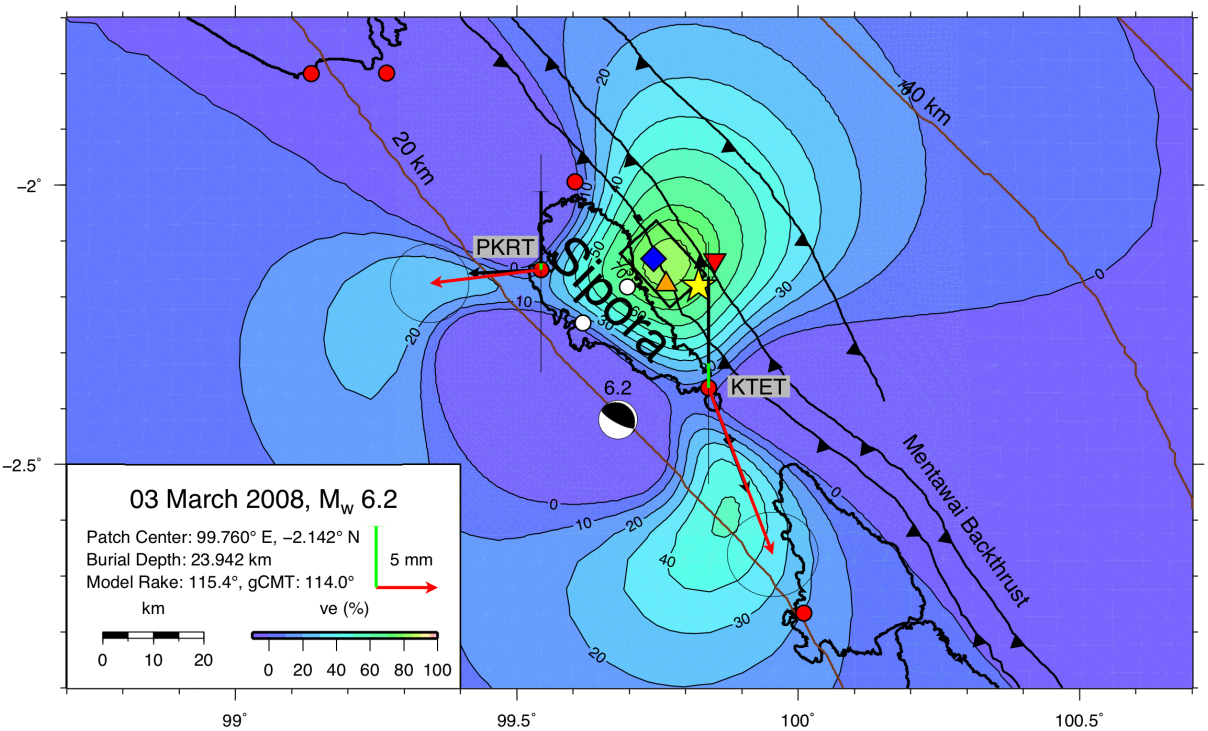


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20080122	6.2	97.417	1.057	97.18	0.87	97.442	1.011	21.6	23.8	23.0	20.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
52.0	103	325.2	332	13.3	17	14.59	143.2	0.5846	98.69

		Displacement / mm		
		(E)	(N)	(V)
BITI	(O)	-7.0 ± 0.3	-0.5 ± 0.3	-1.0 ± 0.9
	(M)	-6.73	-0.51	-3.28

S1.11 The 03 March 2008 M_w 6.2 Sipora Event

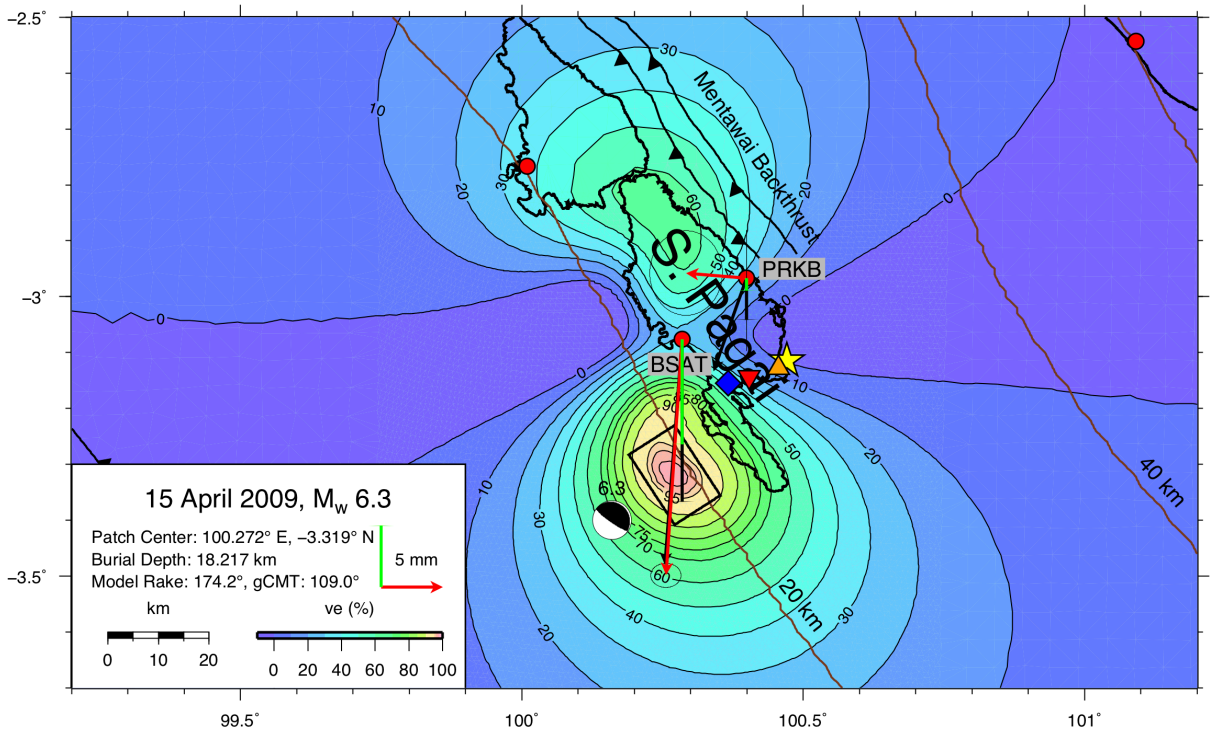


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20080303	6.2	99.760	-2.142	99.68	-2.42	99.823	-2.18	23.9	25.8	23.0	25.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
115.4	114	317.6	323	11.0	17	14.59	143.2	0.5846	83.30

		Displacement / mm		
		(E)	(N)	(V)
KTET	(O)	5.2 ± 1.5	-13.5 ± 1.4	2.0 ± 4.0
	(M)	3.23	-8.58	9.01
PKRT	(O)	-9.0 ± 1.3	-1.1 ± 1.3	0.5 ± 3.6
	(M)	-5.92	-0.31	6.33

S1.12 The 15 April 2009 M_w 6.3 South Pagai Event

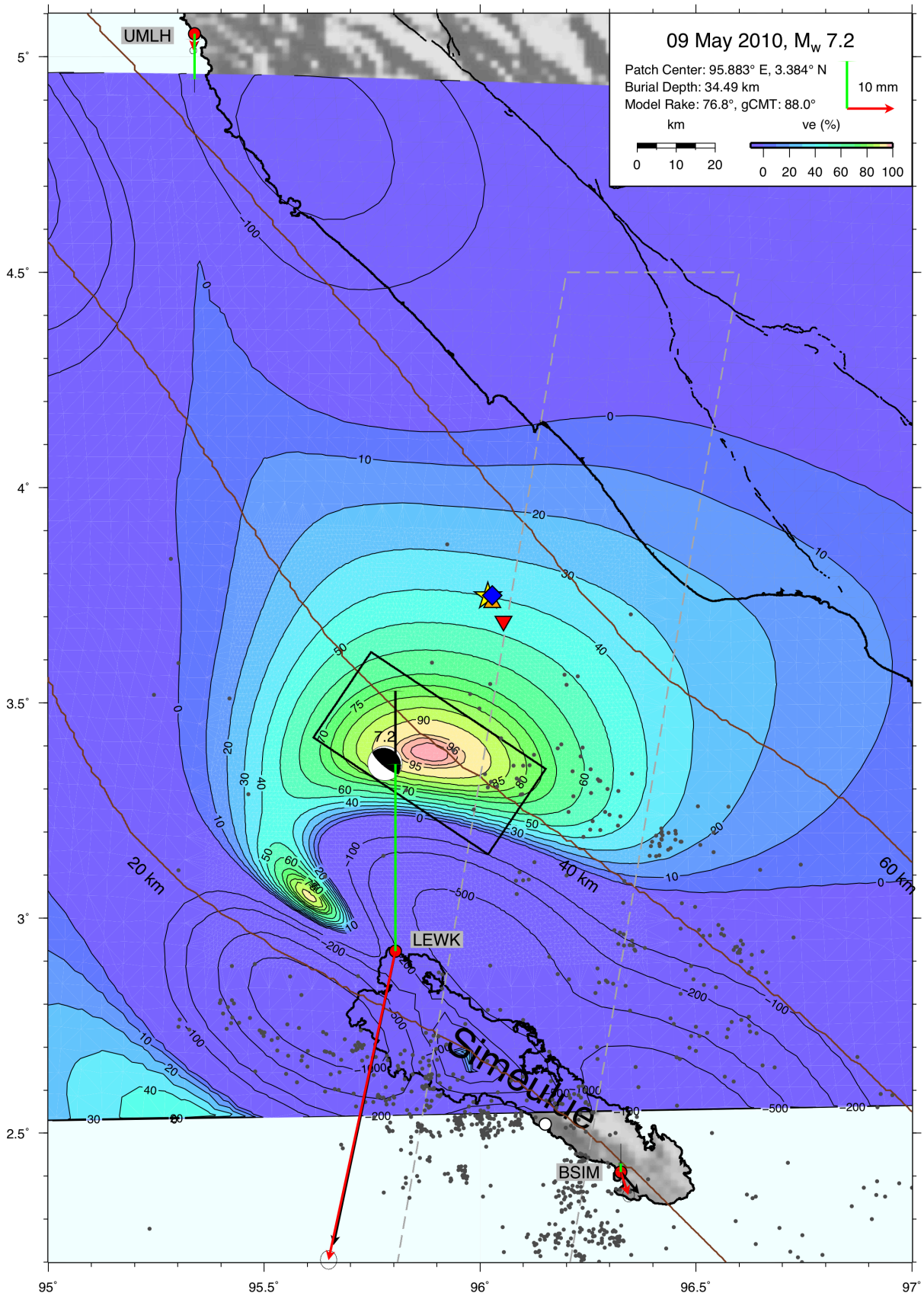


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20090415	6.3	100.272	-3.319	100.16	-3.40	100.471	-3.115	18.2	20.3	15.0	22.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
174.2	109	327.1	324	11.2	10	16.63	181.6	0.6515	97.76

		Displacement / mm		
		(E)	(N)	(V)
BSAT	(O)	-1.3 ± 0.5	-19.1 ± 0.4	-8.5 ± 1.4
	(M)	-1.39	-18.27	-13.17
PRKB	(O)	-4.9 ± 1.2	0.4 ± 1.4	-1.0 ± 2.0
	(M)	-2.66	-7.53	-3.37

S1.13 The 9 May 2010 M_w 7.2 Simeulue Event

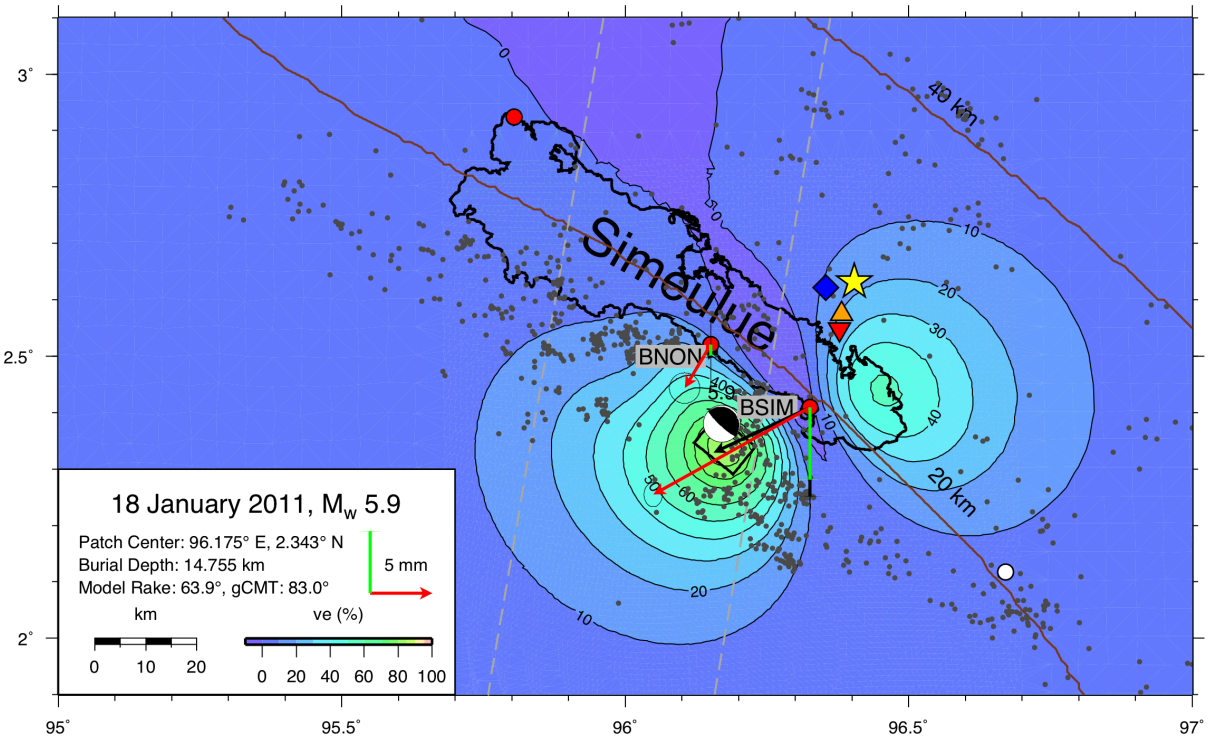


Date	M_w	Location / º						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20100509	7.2	95.883	3.384	95.78	3.36	96.018	3.748	34.5	44.1	37.2	38.0

Rake / º		Strike / º		Dip / º		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
76.8	88	303.9	308	19.8	15	54.20	1534.6	1.7254	97.81

		Displacement / mm		
		(E)	(N)	(V)
BSIM	(O)	1.6 ± 0.5	-4.8 ± 0.6	1.8 ± 1.7
	(M)	3.88	-4.60	4.2
LEWK	(O)	-14.1 ± 0.7	-65.0 ± 0.8	39.4 ± 1.8
	(M)	-13.07	-61.89	54.80
UMLH	(O)	-0.3 ± 0.3	-3.5 ± 0.3	-9.6 ± 1.1
	(M)	-0.3	-3.43	-1.21

S1.14 The 18 January 2011 M_w 5.9 Simeulue Event

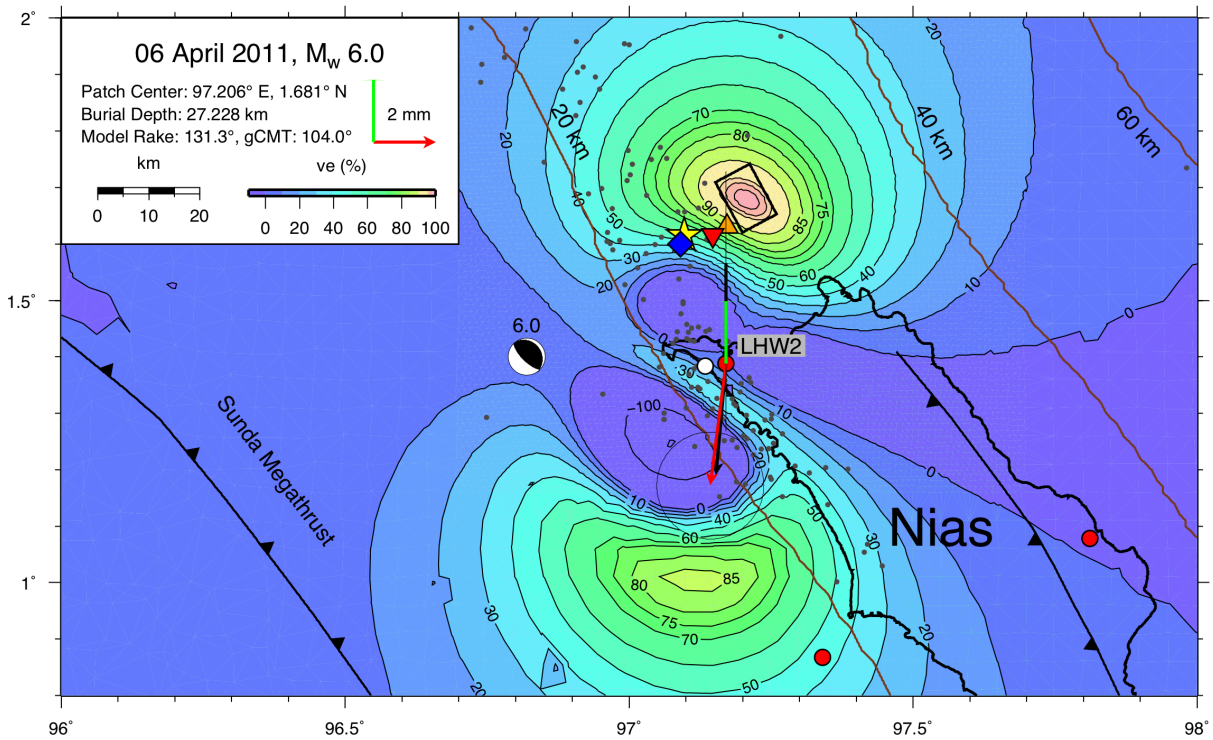


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20110118	5.9	96.175	2.343	96.17	2.38	96.404	2.632	14.8	16.2	15.0	21.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
63.9	83	308.8	306	11.5	9	9.84	70.3	0.4226	82.89

		Displacement / mm		
		(E)	(N)	(V)
BNON	(O)	-2.1 ± 0.5	-3.5 ± 0.5	-0.9 ± 1.2
	(M)	-0.17	-1.20	-1.06
BSIM	(O)	-12.6 ± 0.3	-7.0 ± 0.4	-5.8 ± 1.3
	(M)	-7.75	-3.63	-7.15

S1.15 The 06 April 2011 M_w 6.0 Nias Event

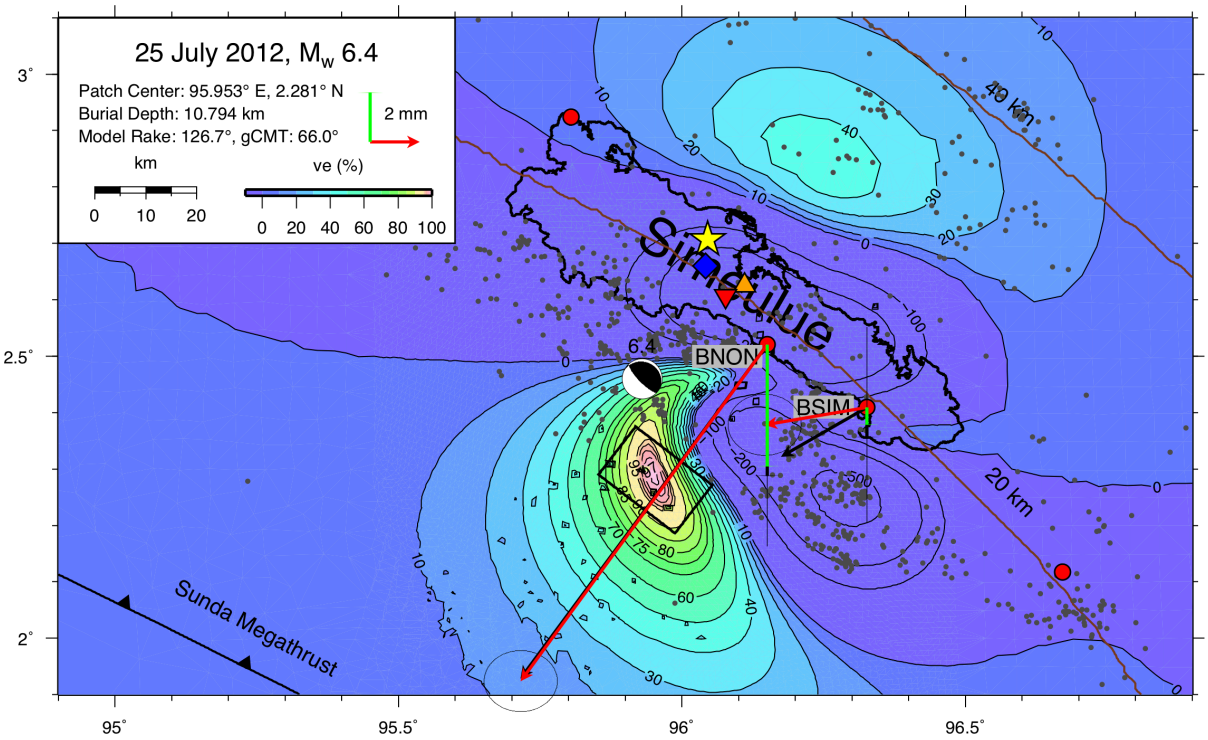


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20110406	6.0	97.206	1.681	96.82	1.40	97.097	1.615	27.2	29.5	24.4	25.3

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
131.3	104	331.9	329	16.4	21	11.22	89.1	0.4709	97.64

		Displacement / mm		
		(E)	(N)	(V)
LHW2	(O)	-0.5 ± 0.7	-3.9 ± 0.7	2.0 ± 1.7
	(M)	-0.32	-3.58	3.22

S1.16 The 25 July 2012 M_w 6.4 Simeulue Event



Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20120725	6.4	95.953	2.281	95.93	2.46	96.045	2.707	10.8	12.5	20.0	22.0

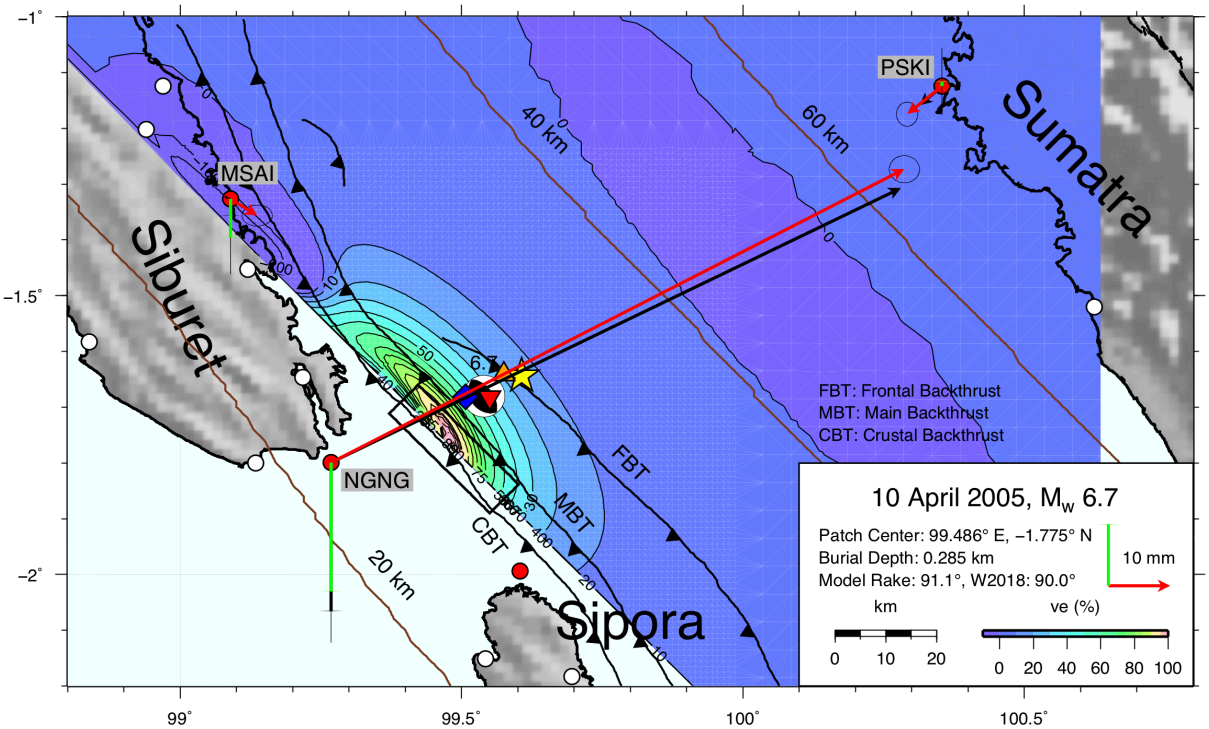
Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
126.7	66	307.6	291	8.2	16	18.97	230.1	0.7259	99.26

		Displacement / mm		
		(E)	(N)	(V)
BNON	(O)	-9.9 ± 0.6	-13.5 ± 0.5	-4.9 ± 1.3
	(M)	-9.91	-13.40	-5.27
BSIM	(O)	-4.1 ± 0.6	-0.7 ± 0.5	-0.7 ± 1.6
	(M)	-3.45	-1.98	-1.21

Our preferred model for the 25 July 2012 M_w 6.4 Simeulue event lies just to the south of the seismic band of aftershocks studied by Tilmann et al. [2010]. We can see that although our model is able to closely fit the displacement recorded by BNON, we are unable to accurately model the horizontal displacement of BSIM. Furthermore, our model lies some distance to the south from the epicentres given by the teleseismic catalogs. This is in contrast to our other preferred models in the region, which usually lie in between the gCMT solution and the solutions for the other teleseismic catalogs.

S2. Non-Megathrust Thrust Events

S2.1 The 10 April 2005 M_w 6.7 Mentawai Backstop Event

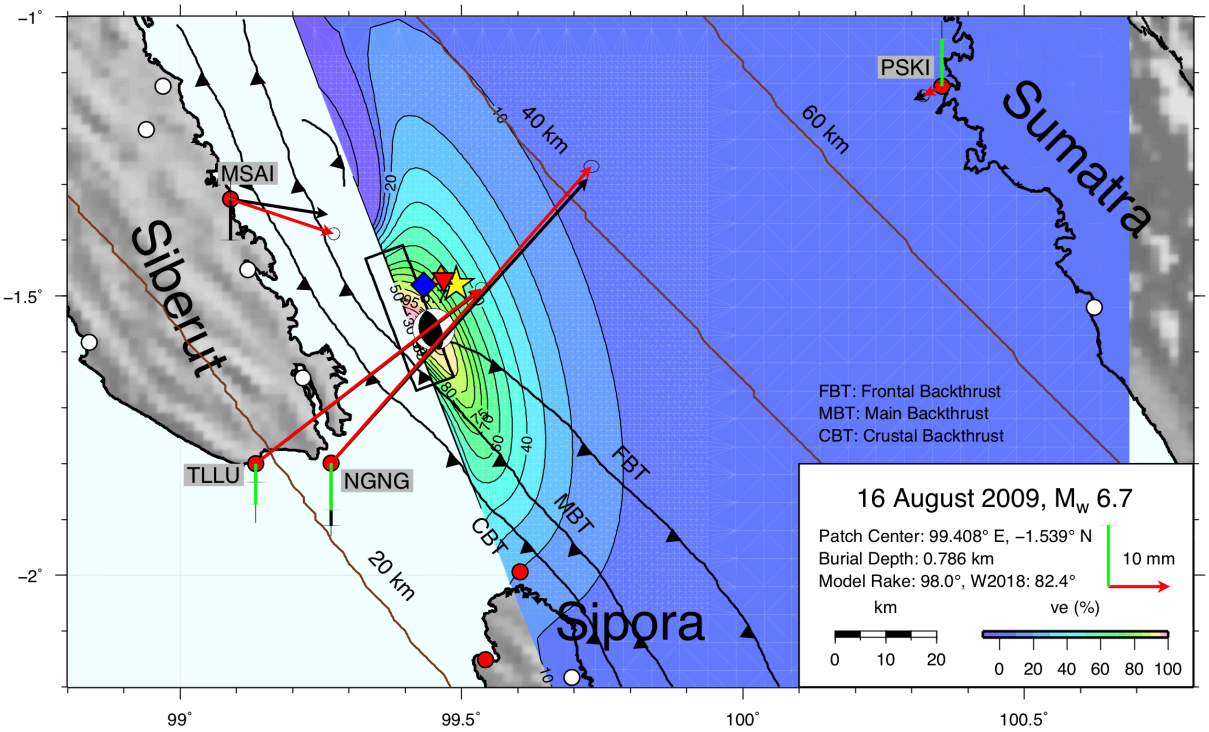


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20050410	6.7	99.486	-1.775	99.54	-1.68	99.607	-1.644	0.3	14.9	12.0	19.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	W2018	Model	W2018	Model	W2018	Len / km	Area / km^2		
91.1	91	323	323	56	56	28.12	468.9	1.0043	99.36

		Displacement / mm		
		(E)	(N)	(V)
MSAI	(O)	4.3 ± 1.0	-2.7 ± 0.7	-6.3 ± 2.4
	(M)	-1.08	0.40	-2.75
NGNG	(O)	92.7 ± 1.0	47.6 ± 0.9	-20.9 ± 3.4
	(M)	92.17	44.53	-24.10
PSKI	(O)	-5.6 ± 0.7	-4.5 ± 0.8	0.8 ± 2.2
	(M)	-3.63	-3.11	0.61

S2.2 The 16 August 2009 M_w 6.7 Mentawai Backstop Event



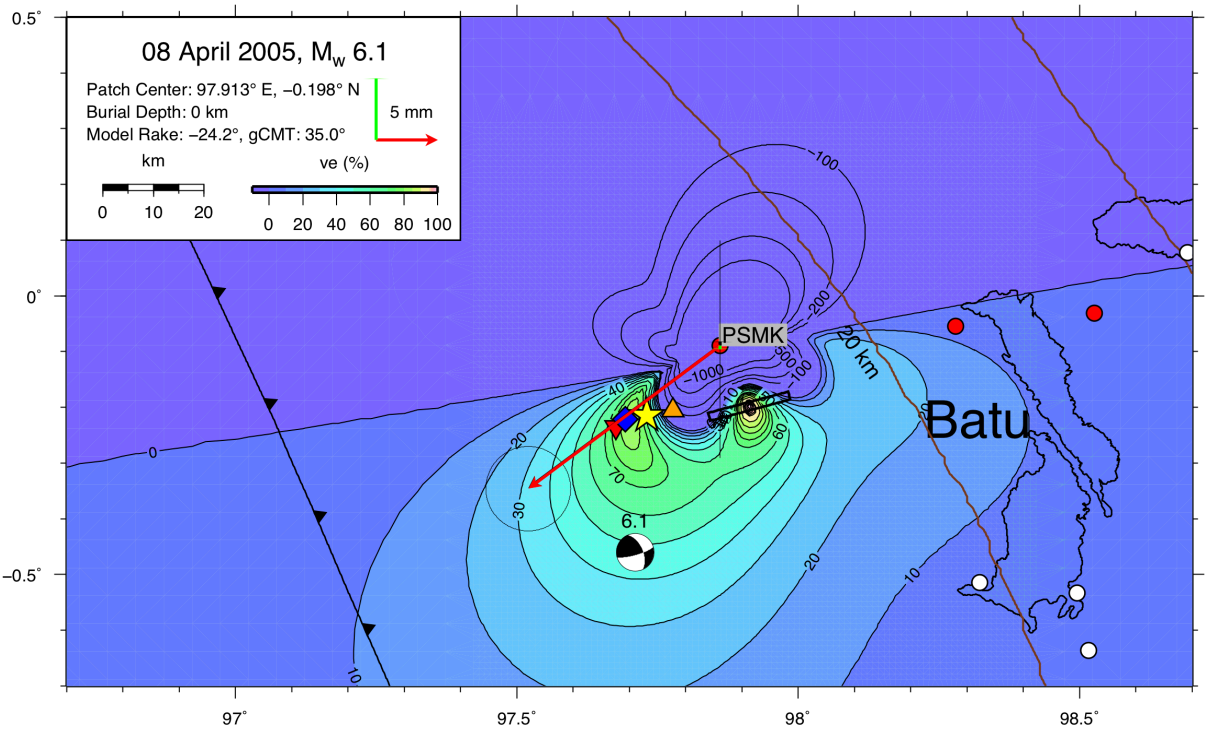
Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20090816	6.7	99.408	-1.539	99.45	-1.56	99.490	-1.479	0.8	15.5	12.0	20.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	W2018	Model	W2018	Model	W2018	Len / km	Area / km^2		
98.0	82.4	339.1	339.1	61.9	61.9	28.12	468.9	1.0043	99.50

		Displacement / mm		
		(E)	(N)	(V)
MSAI	(O)	16.7 ± 0.4	-5.6 ± 0.4	0.1 ± 1.3
	(M)	15.82	-2.50	-6.67
NGNG	(O)	42.1 ± 0.5	48.1 ± 0.4	-7.6 ± 1.7
	(M)	41.55	46.13	-10.17
PSKI	(O)	-3.0 ± 0.4	-1.5 ± 0.4	7.7 ± 1.2
	(M)	4.67	-2.27	0.66
TLLU	(O)	36.5 ± 0.4	28.4 ± 0.4	-6.6 ± 1.2
	(M)	36.55	28.23	-3.05

S3. Strike-Slip Events

S3.1 The 08 April 2005 M_w 6.1 Batu Event



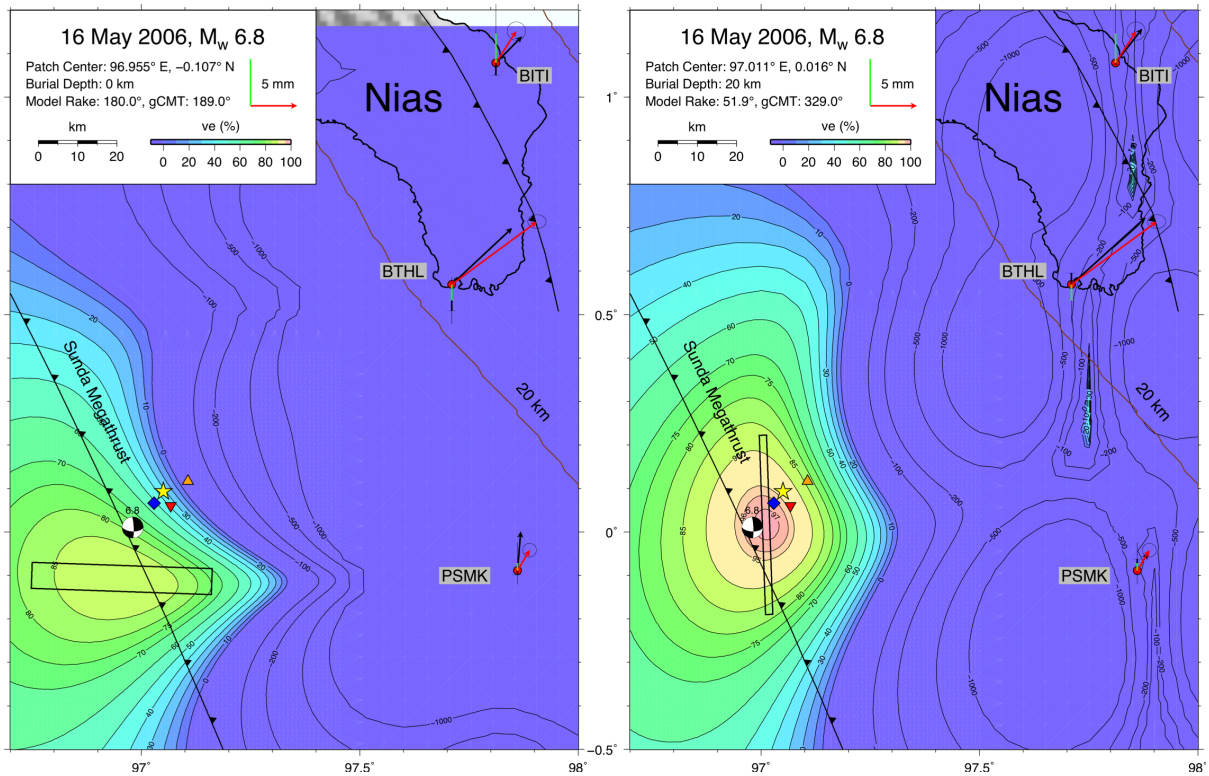
Date	M_w	Location / º						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20050408	6.1	97.913	-0.198	97.71	-0.46	97.731	-0.215	0.0	7.6	12.0	20.9

Rake / º		Strike / º		Dip / º		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
-24.2	35	75	75	78	78	16.37	127.9	0.4633	99.98%

		Displacement / mm		
		(E)	(N)	(V)
PSMK	(O)	-15.5 ± 1.4	-11.6 ± 1.4	0.3 ± 3.6
	(M)	-15.32	-11.35	-1.09

Though the model for the other fault plane is able to marginally fit the data better, the rake of the final model for the second fault plane is very close to 90º, which fits a thrust mechanism rather than a strike-slip mechanism like the current fault plane, and therefore we take this particular fault plane to be the best-fit model.

S3.2 The 16 May 2006 M_w 6.8 Sunda Trench Event

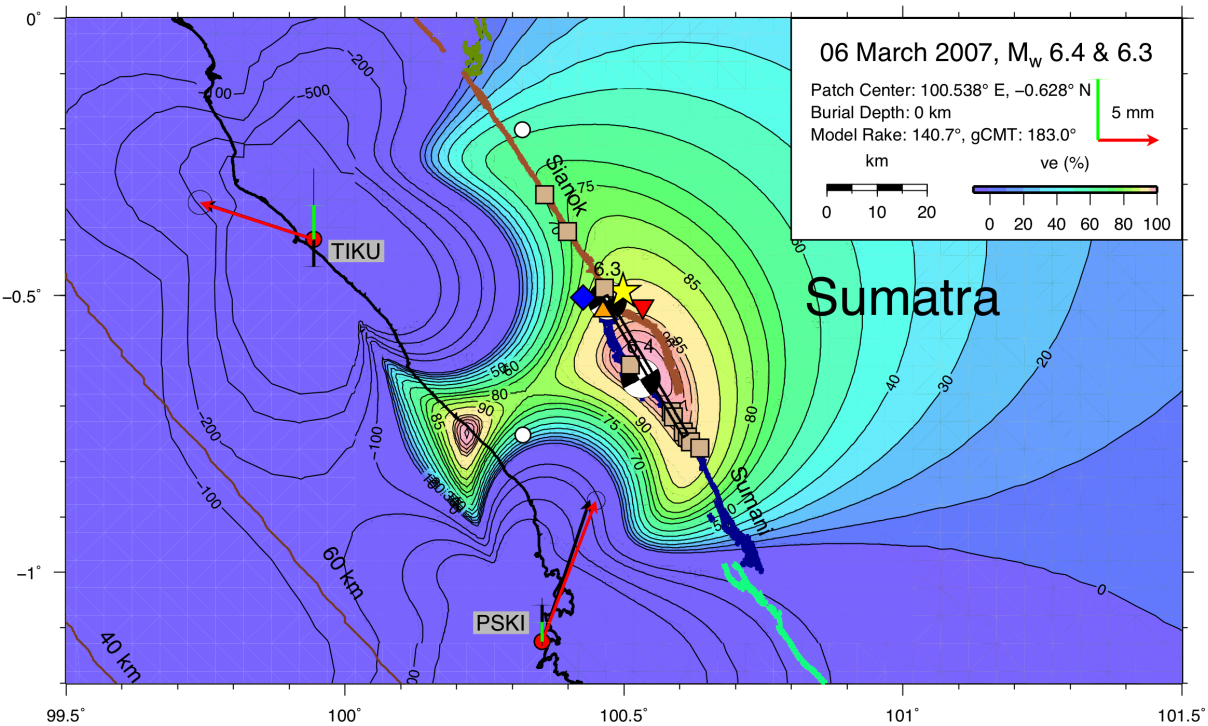


Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20060516	6.8	97.011	0.016	96.98	0.01	97.050	0.093	20.0	33.2	13.5	12.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
51.9	329	358	358	82	82	45.92	610.9	1.0886	97.46

		Displacement / mm		
		(E)	(N)	(V)
BITI	(O)	2.2 ± 0.4	3.4 ± 0.4	3.1 ± 1.3
	(M)	2.84	3.65	-0.20
BTHL	(O)	9.1 ± 0.4	6.7 ± 0.3	-1.7 ± 1.0
	(M)	7.92	7.15	1.23
PSMK	(O)	1.3 ± 0.3	2.2 ± 0.3	0.8 ± 0.9
	(M)	1.14	1.88	1.23

S3.3 The 06 March 2007 M_w 6.4 and 6.3 Sumatran Fault Earthquake Doublet



This earthquake was modelled as a single event of magnitude M_w 6.56, in order to simulate an equivalent amount of energy released by the doublet.

Date	M_w	Location / °						Depth / km			
		Model		gCMT		ANSS		Model		gCMT	ANSS
		Lon	Lat	Lon	Lat	Lon	Lat	z_1	z_2		
20070306	6.4	100.538	-0.628	100.53	-0.65	100.498	-0.493	0	11.0	20.9	19.0
	6.3			100.47	-0.51	100.530	-0.488			21.9	11.0

Rake / °		Strike / °		Dip / °		Patch Dimensions		Slip / m	*ve* / %
Model	gCMT	Model	gCMT	Model	gCMT	Len / km	Area / km^2		
140.7	183	150	150	84	84	32.24	357.4	0.8122	98.95
	179		149		80				

		Displacement / mm		
		(E)	(N)	(V)
PSKI	(O)	4.4 ± 0.3	11.5 ± 0.3	1.6 ± 0.8
	(M)	3.92	11.61	3.02
TIKU	(O)	-9.3 ± 0.4	3.0 ± 0.4	2.8 ± 1.2
	(M)	-9.06	2.95	-2.26