HYPOSAT Version 6.0b

Event solution by HYPOSAT

NORTHERN MOLUCCA SEA, 1996 29 June, converted from pIDC's Reviewed Event Bulletin (REB)

Parameters of initial solution (1 standard deviation):

[Not all backazimuth-observation pairs are used: if one station is more than 170 deg apart from the crossing point, this crossing point is skipped.]
Mean epicenter calculated from 165 backazimuth observation pairs
Mean epicenter lat: 29.475   42.008 [deg]
Mean epicenter lon: 121.592   6.098 [deg]

[type 1: S - P or S1 - P1 observation, type 2: Sg - Pg observation, type 3: Sn - Pn observation, type 4: Sb - Pb observation]
S-P Travel-time difference type 1 with   2 observation(s)
   to=   836008582.7   11.6 [s] Vp/Vs= 1.76 0.04
Mean source time: 836008582.700   11.636 [s]
Mean   vp/vs: 1.758   0.035

Iterations   :   9
Number of defining: 40
Main reference model   : ak135_A
Second reference model : iasp91_A

The new source parameters:
Confidence level of given uncertainties: 68.27 %

Source time : 1996 06 29 00 36 42.467   0.090 [s]
        or   836008602.467   0.090 [s]
        or   1996-181:00.36.42.467   0.090 [s]

Epicenter lat: 1.3946   0.0172 [deg]
Epicenter lon: 126.3036   0.0352 [deg]
Source depth :   0.00   [km] Fixed

Epicenter error ellipse:
Major half axis: 8.03 [km] Minor half axis: 7.93 [km]
Azimuth: 113.1 [deg] Area: 200.11 [km**2]

Flinn-Engdahl Region (266): Northern Molucca Sea

Magnitudes: 4.4 (mb, G-R) 3.6 (Ms, R-P)

[Stat - station name; Delta - epicentral distance in [deg] or [km]; Azi - azimuth from epicenter in [deg]; Phase - phase name from hyposat-in;
  [used] - program chosen phase name (if not identical with Phase); Onset time - hours, minutes & seconds from hyposat in;
  Res - travel time residuum in [s]; Baz - backazimuth (from station to epicenter) in [deg]; Res - Baz residuum in [deg];
  Rayp - ray parameter of onset in [s/deg]; ray parameter residuum in [s/deg]; Used - usage of input data as defining;
  SNR - signal-to-noise ratio; Amplitude - signal amplitude in [nm]; Period - signal period in [s]; MAG - magnitude and magnitude type;
  Q - onset quality as defined by parameter settings in hyposat-parameter; Em-Ang - emergence angle of seismic onset at the source in [deg]]
 Stat Delta   Azi   Phase   [used]   Onset time   Res   Baz   Res   Rayp   Res Used   SNR   Amplitude Period   MAG   Q Em-Ang

WRA   22.623 160.01 P   00 41 44.700 -0.455 331.50   -7.20 11.10   0.48 T S   97.80   4.50 0.300 4.44 mb e 33.64

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WRA    22.623 160.01 S               00 45 48.700  -5.776 338.00   -0.70 17.00  -2.31  A       8.10         2.00  0.900         e  36.94
QIS    25.412 149.84 P1      P       00 42 12.800   0.780                            T  D     35.50                                e  28.27
QIS    25.412 149.84 PcP             00 45 44.800   0.186                            T  D                                        e   6.75
ASAR   25.984 163.93 P               00 42 16.900  -0.312 346.30    3.87  7.10  -1.96 TA D     35.10         3.40  0.500 4.24 mb e  28.19
ASAR   25.984 163.93 PcP             00 45 45.200  -0.694 345.10    2.67  2.30   0.00 TASD    11.50         2.20  0.500         e   6.88
ASAR   25.984 163.93 S               00 46 45.300  -3.756 347.60    5.17 20.30   4.48         6.10         3.90  0.800         e  29.48
WARB   27.419 179.34 P               00 42 31.200   1.106 339.40  -19.86  8.20  -0.78   SD     8.20         6.50  0.700 4.51 mb e  27.92
WARB   27.419 179.34 PcP             00 45 49.400   0.218                            T  D                                        e   7.20
MEEK   28.840 194.38 P               00 42 42.700  -0.102                            T       6.80                                e  27.63
CMAR   31.748 304.00 P               00 43  9.000   0.386 109.70   -9.47  7.80  -1.00 T S     4.30         0.60  0.400 3.88 mb e  27.31
[ The following LR onset was not used because its backazimuth residuum became too large. ]
CMAR   31.748 304.00 LR              00 57 48.700  26.323 110.00   -9.17 39.50   0.45                 188.80 19.360 3.88 MS _
FORT   32.039 177.15 P               00 43 11.300   0.348                            T       10.80                               e  27.27
WOOL   32.587 187.38 P               00 43 15.600  -0.198   7.90   -0.71  9.90   1.14 TA      8.80         4.10  0.600 4.54 mb e  27.20
SHK    33.501   9.56 P               00 43 25.400   1.651                                                                       e  27.05
KSAR   35.901   2.15 P               00 43 46.700   2.271 177.30   -5.40 10.10   1.53         7.20         1.70  0.700 4.00 mb e  26.57
KSAR   35.901   2.15 LR              01 04 25.000 260.898 160.00  -22.70 46.00   6.96                 40.10 19.860 3.26 MS _
STKA   36.128 157.63 P               00 43 46.800   0.310 323.20  -10.24  9.00   0.44 T SD    8.30         7.20  0.600 4.67 mb e  26.52
STKA   36.128 157.63 PcP             00 46 12.000  -0.541                            T  D                                        e   8.93
MJAR   36.668  16.15 P               00 43 51.900   0.816 357.10  156.90 18.80  10.27 T                     2.00  0.550 4.09 mb e  26.41
PDY    59.037 351.99 P               00 46 47.000   2.949 111.20  -52.89  6.60  -0.34   S     23.80         4.30  0.450 4.78 mb e  21.22
ZAL    62.474 333.78 P               00 47  9.000   1.430                                                                       e  20.42
ABKT   72.027 309.49 P               00 48  9.500   0.824                            T                                          e  18.23
[ The unknown phase x was associated as P and the corresponding residuals were calculated. ]
NRI    72.531 346.75 x       P       00 48  8.700  -2.189 195.90   56.32  3.90  -2.06        11.20         3.00  0.750 4.50 mb e  18.11
MAW    81.431 200.28 P               00 49  1.100   0.070                            T                                          e  16.05
KVAR   84.428 313.85 P               00 49 17.200  -0.185                            T                                          e  15.33
NPO    87.382  25.36 P               00 49 31.000  -0.385                            T                                          e  14.60
ARCES  92.478 339.77 P               00 49 51.700  -3.475  94.50   15.10  4.10  -0.52   S     10.50         0.80  0.550 4.31 mb e  13.94
SPITS  92.672 348.81 P               00 49 55.900  -0.039 116.60   46.41  3.50  -1.12 T       10.40         3.60  0.900 4.77 mb e  13.93
FINES  93.674 331.72 P               00 50  0.000  -0.785 111.20   30.85  5.90   1.30 T        6.60         0.60  0.550 4.17 mb e  13.89
HFS    99.871 332.03 P               00 50 28.700  -0.197 311.30 -118.21  1.50  -2.95 T        3.70         1.10  0.750 4.58 mb e  13.41
SCHQ  122.925   9.01 PKPdf           00 55 41.200   0.409                            T                                          e   5.74
TXAR  123.344  53.16 PKPdf           00 55 42.700   0.209                            T                                          e   5.74
DBIC  130.601 279.95 PKPdf           00 55 57.100   0.557                            T                                          e   5.68
PLCA  137.969 160.79 PKPdf           00 56  9.100  -0.699 311.90  106.25  6.40   4.56 T        4.40         0.90  0.900         e   5.51
LPAZ  159.475 136.94 PKPdf           00 56 44.700  -0.522                            T                                          e   3.44

Defining travel-time differences:

 Stat  Delta  Phases           Observed   Res

QIS    25.412 PcP - P           212.000  -0.594
ASAR   25.984 PcP - P           208.300  -0.382
WARB   27.419 PcP - P           198.200  -0.889
STKA   36.128 PcP - P           145.200  -0.851

Number of usable stations:   28

[ The azimuth range of the maximum gap without any observations is always given in clockwise direction. ]
Maximum azimuthal gap of defining observations:  53.2 -> 136.9 [deg] =  83.8 [deg]

[ The azimuth range of the maximum possible secondary gap (see Bond r et al., 2004) without any observations is always given in clockwise
  direction. ]
Maximum secondary azimuthal gap of defining observations:  25.4 -> 136.9 [deg] = 111.6 [deg]
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[ RMS is defined as sqrt(sum(res*res)/N), MEAN-ERROR is defined as sqrt(sum(|res|)/N), and MEAN is defined as -(Res/N); all with the listed
  residuals Res and the number of data N. ]
Residuals of defining data          RMS    MEAN-ERROR      MEAN
    25 onset times             :    0.476       0.409      0.000  [s]
     4 backazimuth values      :    2.400       1.985      1.282  [deg]
     7 ray parameters          :    0.586       0.507     -0.244  [s/deg]
     4 travel-time differences :    0.709       0.679     -0.679  [s]

[ The weighted RMS is here defined as sqrt(sum(res*res)/N) with the listed residuals Res and the data weights w used for the inversion
  (i.e., here the standard deviations of the data from hyposat-in) as used at the ISC. ]
Weighted RMS of onset times (ISC type):    0.476 [s]

[ The weighted misfit is here defined for the L1-norm as sum(Res/w)/N and for the L2-norm as sqrt(sum((Res/w)*(Res/w))/N) with N the number
  of data. Input data also means data not used to locate the event. In this case, all backazimuth and ray parameter observations defined as
  usable by the switches in hyposat-in were also included. ]
Weighted misfit of input data         L1      L2
    33 onset times             :    2.815    4.080
    20 backazimuth values      :    1.351    2.281
    17 ray parameters          :    1.474    2.734
     4 travel-time differences :    1.600    1.672
    74 misfit over all         :    2.046    3.271

[ The following line is a repetition of the most important inversion results ]
T0                        LAT      LON       Z     VPVS   DLAT     DLON      DZ       DT0    DVPVS DEF    RMS
1996-06-29 00 36 42.467    1.395  126.304    0.00   1.76   0.0172   0.0352  Fixed     0.090   0.04   40    0.476

[ However, we have still a fixed depth. Let us now try to fit the data better with another depth (see DEPTH FLAG is set to b! ]
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Iterations        :    4
Number of defining:   48
Main reference model    : ak135_A
Second reference model  : iasp91_A

The new source parameters:

Confidence level of given uncertainties:  68.27 %

Source time  : 1996 06 29 00 36 49.514     0.492 [s]
        or               836008609.514     0.492 [s]
        or       1996-181:00.36.49.514     0.492 [s]


Epicenter lat:                  1.3237    0.0145 [deg]
Epicenter lon:                126.2875    0.0347 [deg]
Source depth :                 47.15      4.37   [km]

[ The mean travel-time residuum was not zero. The source time is therefore corrected for this bias. ]
Source time corrected for mean travel-time residual (  -0.035)

Source time  : 1996 06 29 00 36 49.480     0.492 [s]
        or               836008609.480     0.492 [s]
        or       1996-181:00.36.49.480     0.492 [s]

[ Note the now much smaller error ellipse. ]
Epicenter error ellipse:
Major half axis:     5.16 [km]  Minor half axis:     3.10 [km]
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Azimuth: 71.5 [deg] Area: 50.27 [km**2]

Flinn-Engdahl Region (266): Northern Molucca Sea

Magnitudes: 4.4 (mb, G-R) 3.6 (Ms, R-P)

Stat	Delta	Azi	Phase	[used]	Onset time	Res	Baz	Res	Rayp	Res	Used	SNR	Amplitude	Period	MAG	Q	Em-Ang
WRA	22.562	159.91	P		00 41 44.700	-1.177	331.50	-7.09	11.10	0.52	SD	97.80	4.50	0.300	4.36 mb	e	50.23
WRA	22.562	159.91	S		00 45 48.700	-1.901	338.00	-0.59	17.00	0.65	TASD	8.10	2.00	0.900		e	41.40
QIS	25.359	149.74	P1	P	00 42 12.800	0.379					T D	35.50				e	41.16
QIS	25.359	149.74	PcP		00 45 44.800	0.505					T D					e	9.38
ASAR	25.921	163.86	P		00 42 16.900	-0.612	346.30	3.95	7.10	-1.95	TA D	35.10	3.40	0.500	4.19 mb	e	41.02
ASAR	25.921	163.86	PcP		00 45 45.200	-0.351	345.10	2.75	2.30	0.00	TASD	11.50	2.20	0.500		e	9.56
ASAR	25.921	163.86	S		00 46 45.300	0.613	347.60	5.25	20.30	4.50	T D	6.10	3.90	0.800		e	39.72
WARB	27.349	179.30	P		00 42 31.200	0.887	339.40	-19.83	8.20	-0.76	T SD	8.20	6.50	0.700	4.41 mb	e	40.54
WARB	27.349	179.30	PcP		00 45 49.400	0.578					T D					e	10.00
MEEK	28.768	194.38	P		00 42 42.700	-0.287					T	6.80				e	40.12
CMAR	31.774	304.11	P		00 43 9.000	-0.645	109.70	-9.60	7.80	-0.99	T S	4.30	0.60	0.400	3.78 mb	e	39.59
CMAR	31.774	304.11	LR		00 57 48.700	18.291	110.00	-9.30	39.50	0.45			188.80	19.360	3.88 MS	_	
FORT	31.969	177.12	P		00 43 11.300	0.160					T	10.80				e	39.55
WOOL	32.515	187.37	P		00 43 15.600	-0.360	7.90	-0.70	9.90	1.14	TA	8.80	4.10	0.600	4.47 mb	e	39.42
SHK	33.573	9.56	P		00 43 25.400	0.245					T					e	39.12
KSAR	35.972	2.16	P		00 43 46.700	0.923	177.30	-5.42	10.10	1.55	T	7.20	1.70	0.700	4.03 mb	e	38.35
KSAR	35.972	2.16	LR		01 04 25.000	251.114	160.00	-22.72	46.00	6.96			40.10	19.860	3.26 MS	_	
STKA	36.069	157.57	P		00 43 46.800	0.075	323.20	-10.17	9.00	0.45	T SD	8.30	7.20	0.600	4.72 mb	e	38.31
STKA	36.069	157.57	PcP		00 46 12.000	-0.213					T D					e	12.44
MJAR	36.740	16.15	P		00 43 51.900	-0.526	357.10	156.90	18.80	10.29	T		2.00	0.550	4.17 mb	e	38.09
[This P onset has now a larger residuum than in the first run and is therefore no longer defining for the solution.]																	
PDY	59.104	352.00	P		00 46 47.000	2.110	111.20	-52.92	6.60	-0.32	S	23.80	4.30	0.450	4.79 mb	e	30.09
ZAL	62.530	333.80	P		00 47 9.000	0.730					T					e	28.90
ABKT	72.059	309.51	P		00 48 9.500	0.424					T					e	25.68
NRI	72.595	346.76	x	P	00 48 8.700	-2.773	195.90	56.29	3.90	-2.04		11.20	3.00	0.750	4.36 mb	e	25.49
MAW	81.359	200.28	P		00 49 1.100	0.350					T					e	22.54
KVAR	84.465	313.86	P		00 49 17.200	-0.440					T					e	21.46
NPO	87.452	25.36	P		00 49 31.000	-0.759					T					e	20.35
ARCES	92.539	339.77	P		00 49 51.700	-3.764	94.50	15.06	4.10	-0.52	S	10.50	0.80	0.550	4.29 mb	e	19.52
SPITS	92.738	348.81	P		00 49 55.900	-0.352	116.60	46.38	3.50	-1.11	T	10.40	3.60	0.900	4.74 mb	e	19.51
FINES	93.729	331.71	P		00 50 0.000	-1.042	111.20	30.80	5.90	1.30		6.60	0.60	0.550	4.19 mb	e	19.44
HFS	99.925	332.02	P		00 50 28.700	-0.428	311.30	-118.26	1.50	-2.95	T	3.70	1.10	0.750	4.57 mb	e	18.77
SCHQ	122.997	9.01	PKPdf		00 55 41.200	0.490					T					e	7.98
TXAR	123.399	53.19	PKPdf		00 55 42.700	0.322					T					e	7.97
DBIC	130.597	279.89	PKPdf		00 55 57.100	0.784					T					e	7.88
PLCA	137.908	160.83	PKPdf		00 56 9.100	-0.364	311.90	106.30	6.40	4.56	T	4.40	0.90	0.900		e	7.65
LPAZ	159.435	137.10	PKPdf		00 56 44.700	-0.227					T					e	4.78

Defining travel-time differences:

Stat	Delta	Phases	Observed	Res
WRA	22.562	S - P	244.000	-0.724
QIS	25.359	PcP - P	212.000	0.126
ASAR	25.921	PcP - P	208.300	0.262
ASAR	25.921	S - P	268.400	1.226
ASAR	25.921	S - PcP	60.100	0.964
WARB	27.349	PcP - P	198.200	-0.309

STKA   36.069 PcP - P   145.200 -0.288

Number of usable stations: 28

[Here we get the number of all iterations e.g., also including an earlier solution for fixed depth.]
Total number of iterations: 22

Maximum azimuthal gap of defining observations: 53.2 -> 137.1 [deg] = 83.9 [deg]

Maximum secondary azimuthal gap of defining observations: 25.4 -> 137.1 [deg] = 111.7 [deg]

Residuals of defining data		RMS	MEAN-ERROR	MEAN	
29 onset times	:	0.615	0.515	0.000	[s]
4 backazimuth values	:	2.447	1.996	1.351	[deg]
8 ray parameters	:	0.593	0.526	-0.120	[s/deg]
7 travel-time differences	:	0.678	0.557	0.179	[s]

Weighted RMS of onset times (ISC type):   0.694 [s]

Weighted misfit of input data		L1	L2
33 onset times	:	2.199	3.128
20 backazimuth values	:	1.351	2.282
17 ray parameters	:	1.429	2.726
7 travel-time differences	:	0.952	1.071
77 misfit over all	:	1.695	2.700

T0	LAT	LON	Z	VPVS	DLAT	DLON	DZ	DT0	DVPVS	DEF	RMS
1996-06-29 00 36 49.480	1.324	126.288	47.15	1.76	0.0145	0.0347	4.37	0.492	0.04	48	0.615