
Norwegian National Seismic Network

Revision of
Technical Report No. 30 A



UPDATING THE DATABASE

by

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Based on Technical Report no. 28 - *Station Relocation
Coordinates* by Maren Kjos Veim

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Background:

In 2015, Maren Kjos Veim made an updated list of all station coordinates. These differs up to several hundred meters from the actual station position, as they are based on map readings done many decades ago. For more information, see Technical Report No. 28 - *Revision of Station coordinates*, by Maren Kjos Veim.

Before applying the updated station coordinates on the database, an update (in a test directory) using the old station coordinates was applied on the entire NNSN database. This was necessary in order to check for any changes or errors introduced by changes in the locating routine. The editing and checking is done by Marte L. Strømme, with advice from Jens Havskov and Lars Ottemöller where needed.

Revision/compleating the database update:

All scripts and output can be found here: `/home/seismo/WOR/maren`
In the above mentioned test directory `/maren`, the NNSN database was updated using the `STATION0.HYP` file with the old, original coordinates.

The events are segregated for local and distant events, in the following four time windows: 1980 - 1989, 1990 - 1999, 2000 - 2009, 2010 - present (April 2019).

The script gives the following outputs:

- comp_hyp.out: list with changes of all events
- comp_hyp_change.out: list of events that changed
- comp_hyp_events_changed.out: nordic format
- comp_hyp_events_unchanged.out: nordic format

Definition of event changes that was flagged for manual check:

Before 2000, local events:

Epicentral change more than 20km, depth more than 15km, RMS more than 0.3.

Before 2000, distant events:

Epicentral change more than 10km, depth more than 10km, RMS more than 0.2.

After 2000, local events:

Epicentral change more than 15km, depth more than 10km, RMS more than 0.3.

After 2000, distant events:

Epicentral change more than 10km, depth more than 10km, RMS more than 0.2.

The database update was done after three rounds of revision: in 2015, 2018 and 2019.

1) First attempt, 2015

When Maren Kjos Veim ran the scripts for checking the updated station coordinates in 2015, it was evident that most of the flagged events was changing due to changes in the locate function. Some of the general findings in 2015 was:

1980-1989, local events: (Almost) only Western Norway and Jan Mayen events changes. Mainly concentrated around Florø/Hya/Ask.

The Jan Mayen events looks more or less correct no matter what we do, having low residuals and few, close stations.

Some Svalbard events can jump between two locations easily due to two local minimas east and west of Svalbard, if few stations are used and epicentral distance is large. Depth changes are not unexpected, could they just be fixed to 10km when 31km or above? (most events turn to 31 or 0 km after update).

Many local events were flagged due to depth changing from an OK value to the maximum or minimum "allowed" local depth value of 31 or 0 km.

2) Second attempt, Spring 2018

A more thorough investigation into the database update project was done in 2018. A total of 2264 local and 1030 distant events was analyzed, and conclusion was that more adjustments needed to be done to the locate program.

Amount of flagged events, second revision:

Year	Local	Distant
2010-2017	555	115
2000-2009	638	317
1990-1999	774	349
1980-1989	297	249

Total:	2264	1030

The big changes in teleseismic seemed to be only around Papua New Guinea/Kermadec Islands/South Pacific, where we already know that something odd happens when locating teleseismic events, possibly due to scattering. Fixing these events to correct (PDE/USGS) location gives a good solution and OK RMS, but the locate function does not seem to find the best solution by itself.

Example, Teleseismic event that was OK before and now need to be fixed to PDE (note the jump in RMS):

```
2010 720 1918 25.9 D -5.601 148.621 35.0F BER 12 2.6          5.6bPDE
2010 720 1925 4.5 D 41.948 128.480 35.0F BER 834.0         5.6bPDE
```

Table 1: Example, of Kermadec/Fiji teleseismic event that turns bad after update. Old solution above, new below.

Examples of changes that occur often in local events:

Western norway, two local minimas (HYA/ASK):

```
change epicentre,depth,rms: 24.4 0.0 0.0
2000 4 8 1631 36.2 L 60.940 3.967 0.0 BER 5 0.7 0.2CBER
2000 4 8 1631 41.6 L 60.972 5.007 16.7 BER 5 1.7 0.2CBER
change epicentre,depth,rms: 56.2 16.7 1.0
2000 413 1812 47.6 L 77.906 4.198 0.0 BER 2 0.5 4.2NBER 2.0CBER 2.7LNAO
```

Svalbard area, two local minimas:

```
change epicentre,depth,rms: 97.1 0.0 0.5
2004 413 1812 47.6 L 77.906 4.198 0.0 BER 2 0.5 4.2NBER 2.0CBER 2.7LNAO
2004 413 1812 47.6 L 77.906 4.198 0.0 BER 2 0.5 4.2NBER 2.0CBER 2.7LNAO
change epicentre,depth,rms: 423.4 15.0 0.2
2004 415 0032 37.6JL 71.088 -7.868 17.5 BER 3 0.0 1.4CBER
```

Svalbard event that is probably correct after:

```
change epicentre,depth,rms: 23.2 3.6 -0.3
2004 5 4 0015 50.8 L 85.165 13.634 0.0 BER 5 0.6 3.0LBER
2004 5 4 0015 51.4 L 85.075 19.207 0.0 BER 5 0.0 3.0LBER
change epicentre,depth,rms: 53.5 0.0 -0.6
2004 5 5 0025 24.6 L 70.245 7.000 0.0 BER 3 0.4 2.0LBER 1.0CBER 2.5LNAO
```

High RMS is fixed after update:

```
2000 5 6 1348 56.3 D 12.704 165.749 12.0F BER 529.1 5.8sBER 6.0bBER 6.0bPDE
2000 5 6 1344 14.3 D -11.441 167.741 12.0F BER 4 0.4 5.9sBER 6.0bPDE
change epicentre,depth,rms: 999.0 0.0 -28.7
2000 516 1431 5.3 D 20.007 127.165205 05 BER 3 0.0 4.0LBER
```

High RMS is introduced after update:

```
change epicentre,depth,rms: 696.6 14.9 -0.1
2000 616 0809 20.7 D 60.252 -33.927120.0F BER 4 1.9 4.2sBER 4.7bBER 6.2bPDE
2000 616 0809 33.6 D 60.006 -34.144120.0F BER 413.5 4.7bBER 6.2bPDE
change epicentre,depth,rms: 29.8 0.0 11.6
```

Table 2: Typical changes for local events. Old solution above, new below.

3) Third attempt, November 2018

Since the attempt last spring, Lars has fixed the hyp script.

A new list of changes after update/hyp using the old STATION0.HYP file has been made (WOR/maren/utenrelokalisering/, using s-files and the script run_comphyp.exp), to check that nothing strange happens after hyp.

Some strange things did happen.

- Main bulk of changes are in Jan Mayen area. Could this be due to changes done in the J-model at some point?
- Other suspicious change affects events located with 2 stations and azimuth. All of them had a OK location (ridge, "known" areas, same location as Norsar and PDE) before, and got a very unlikely solution after, with higher RMS.
- PN is causing trouble. Example in table 3 shows event where location disappears if updated (OK when removing the N's).

1985	111	829	48.6	L	59.618	3.096	0.00	*BER	4	1.7	1.2	CBER	1
GAP=307		4.21	126.5		317.0227.6	0.3884E+05	-0.7029E+05	-0.2809E+05E					
Flagged not to be relocated before database update. mls 2018 B3													
ACTION:UPD 15-08-09 10:31 OP:lo STATUS: ID:19850111082948 L I													
STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO AIN AR TRES W DIS CAZ7													
ASK	SZ	EPN			830	11.00	59			50	-1.8810152.0	50	
ASK	SZ	ISN	830	31.00					50	0.16010152.0	50		
SUE	SZ	EPN			830	20.30	40			50	3.2910185.0	29	
SUE	SZ	ESN			830	37.60				50	-0.43010185.0	29	
ODD	SZ	EPN			830	17.90	60			50	-1.5510204.0	78	
ODD	SZ	ISN	830	43.50					50	1.2310204.0	78		
FOO	SZ	ESN			830	50.20				50	-0.83010245.0	25	

Table 3: PN causing problems.

- Mo i Rana events (probably many of them from the quarry Rana Gruber) has a tendency to jump to the south (table 4). Old location is probably correct for all these events.

2004 1113 1602 51.6 L 67.813 15.019 0.0 BER 3 0.8 1.0LBER 1.2CBER
2004 1113 1602 49.6 L 67.942 12.969 93.7 BER 3 0.4 1.1LBER 1.3CBER
2004 1117 0048 59.0 L 67.803 15.073 0.0 BER 3 0.6 1.7CBER
2004 1117 0048 57.6 L 67.933 13.389 95.6 BER 3 0.3 1.7CBER
2008 918 1348 54.1 LP 66.069 14.886 0.0F BER 3 0.8 1.3LBER 1.0CBER
2008 918 1348 54.6 LP 66.454 15.057 0.0F BER 3 0.4 1.2LBER 1.0CBER

Table 4: Rana area events turning bad after update. Old solution above, new below.

Table 5 shows additional examples of changes that occur often. Note the increase in RMS:

1984 910 1304 22.4 L 59.363 6.762 13.7 BER 7 1.1 1.3CBER
1984 910 1304 24.9 L 61.654 5.684 21.0 BER 7 3.1 1.3CBER
change epicentre,depth,rms: 261.1 7.3 2.0
1984 920 1752 40.4 LE 59.402 6.907 0.0F BER 8 1.3 1.6CBER
1984 920 1752 42.4 LE 61.606 5.830 0.0F BER 8 3.2 1.6CBER
change epicentre,depth,rms: 251.7 0.0 1.9
1984 10 7 0718 55.2 L 62.032 3.951 20.6 BER 9 1.8 2.6CBER
1984 10 7 0718 45.4 L 58.520 4.675 13.4 BER 9 3.7 2.6CBER

Table 5: More examples. Old solution above, new below.

As for other changed events, only very few from 2000 until 2017 has no evident correct solution (either before or after). Also:

- PDE/USGS/EMSC is not included in BER event files before approx. june 1994.
- Last digit in first header line (1) is missing in first line in some (but not all) events (D and L), 1990 and a few years ahead.

Selected examples of non-systematic errors (that has all been fixed) is presented in table 6.

1986 2 1 1847 57.2 L 57.688 7.301 15.0 BER 3 1.6 1.5LBER 1.6CBER
1986 2 1 1847 59.5 L 60.464 2.467 31.0 BER 3 3.1 1.5LBER 1.6CBER
change epicentre,depth,rms: 413.4 16.0 1.5
OLD: 418 1204 56.1 L 74.619 27.635 15.0 BER 3 1.6 2.8CBER
1986 418 1204 54.0 L 74.825 10.885 15.0 BER 3 0.8 5.2NBER 2.8CBER

OLD: 6 1 0556 48.9 L 66.384 36.549 0.0 BER 3 1.3 3.3LBER 2.5CBER
 1986 6 1 0556 48.8 L 72.401 -2.550 15.0 BER 3 2.6 5.1NBER 2.5CBER

 2003 420 2131 5.0 L 62.295 10.531 15.0F BER 3 1.6 1.7LBER 2.0CBER
 2003 420 2131 5.2 L 57.247 11.778 15.0F BER 3 1.3 1.7LBER 2.0CBER
 change epicentre,depth,rms: 564.9 0.0 -0.3

 2003 812 1329 51.2 LP 58.124 7.185 0.0F BER 3 1.6 1.1LBER 1.6CBER
 2003 812 1329 47.4 LP 60.272 2.877 0.0F BER 3 1.5 1.2LBER 1.6CBER
 change epicentre,depth,rms: 341.8 0.0 -0.1

 OLD: 120 0441 11.6 L 61.122 3.796 15.0 BER 3 0.0 0.1CBER
 1995 120 0441 11.6 L 61.419 5.337 21.6 BER 3 0.1 0.1CBER

 1991 630 2257 25.6 D 73.399 6.564 15.0 BER 3 0.3
 1991 630 2258 32.5 D 71.303 -7.189 15.0 BER 3 0.0

 2001 310 1120 36.4 D 34.632 33.749 15.0 BER 3 0.8 4.3sBER 4.8BPDE
 2001 310 1128 44.6 D 61.041 11.242 0.1 BER 367.9 4.8BPDE

 1983 411 1541 30.9 D 72.001 -24.750 15.0 BER 313.9
 1983 411 1540 46.4 D 71.181 -38.679 15.0 BER 314.5
 change epicentre,depth,rms: 495.4 0.0 0.6

Table 6: Selected examples of some flagged events. Old solution above, new below.

4) Fourth attempt, March - April 2019:

Jens Havskov has modified the locate function in seisan with grid search option. Most of the reoccurring issues (for example Mo i Rana confirmed explosions jumping southeast) have been corrected in the latest version. Most of the errors occurring for local events are locations with two local minimums, For almost all these events, a grid search did not correct them, but fixing the depth to the standard 10km (oceanic crust) or 15km (continental crust) depth seems to always achieve the best location.

The new MN-magnitude scale mess up some magnitudes in the 1980`s. This was fixed by Lars, he changed hyp so that mn is not computed if period is more than 2 seconds.

All events that has been edited due to change after relocation (without and with station changes) have a comment line describing the edits and reason for it, as well as operator initials and year of the change.

Source:

Location by grid search: <http://seis.geus.net/software/seisan/node78.html>

Reset test parameters # 118-121: <http://seis.geus.net/software/seisan/node82.html>

Backup: In REA/NNSN, text file named

Backup_1980-1999_before_database_update_in_2019.out and

Backup_2000-2019_before_database_update_in_2019.out

Bulletin checks

Some events could not be solved in other ways than to check the original bulletins stored in the Realfagbygget attic.

Would coda be calculated if this was likely explosion? Yes. No clue of correct location in s-file. Stations used: TRO, NC2, NC4.

1985 422 2031 45.5 L 69.316 17.320 15.0 BER 3 3.8 2.7LBER 2.3CBER

1985 422 2031 56.4 L 69.145 9.504 15.0 BER 3 2.2 2.6LBER 2.4CBER

Answer: Checked original location in bulletin, it was in Södankyyä, Finland, 67N 26E, fixed event to this location.

7 Jun 1989 01:50 7 L 65.364 30.800 11.3 12.8 BER

Is KTK2 wrong? Gives location on the ridge.

Yes, KTK2 is wrong. The original bulletin has no location published for this event. Kept good Jan Mayen area relocation by weighting out KTK2 and keeping the remaining 5 stations.

1992 213 0226 38.2 L 71.435 12.346 15.0 BER 2 0.6 1

GAP=285 10.01 712.6 999.9999.9 -0.2749E+07 0.1870E+09 -0.1406E+08E

OLDACT:UPD 07-03-14 15:59 OP:jh STATUS: ID:19920213022636 L 3

635 NEAR NORTH COAST OF GREENLAND 3

Answer: bulletin had location 82N 22W, fixed event to this original location computed by Jens in '92. Solution gave large RMS then and now (6.2).

Table 7: Events that required bulletin check.

Selected examples of improved location

Many events improved the localisation after database update. Table 8 shows a few examples of this, including before and after locate routine fixes in 2018/2019:

2002 5 6 2351 44.0 L 57.515 7.582 21.7 BER 2 0.3 1.9CBER - original

2002 5 6 2351 39.4 L 59.197 5.270292.1 BER 2 0.3 1.9CBER - solution 2018

2002 5 6 2351 44.0 L 57.515 7.582 21.7 BER 2 0.3 1.9CBER - updated version of locate

1994 822 0746 18.9 L 62.724 3.819 28.7 BER 3 0.0 1.8CBER - original

1994 822 0746 18.9 L 62.726 3.813 47.4 BER 3 0.0 1.8CBER - solution 2018

1994 822 0746 18.9 L 62.726 3.813 31.0 BER 3 0.0 1.8CBER - updated version of locate

OLD: 728 1118 9.0 L 63.670 23.949 15.0 BER 5 4.8

1988 728 1118 9.6 L 65.864 29.036 12.2 BER 5 0.5

LQ i Kuusamo, Finland. HEL har 65.937 28.903

OLD: 9 5 1544 46.3 L 67.060 10.526 0.0 BER 3 0.8 1.9CBER
 1989 9 5 1544 46.6 L 66.725 15.278 0.0 BER 3 1.0 1.9CBER

1998 718 1655 4.0 D 74.560 76.162 33.0F BER 4 0.0 4.5sBER 4.4bBER 5.2BNAO
 1998 718 1641 26.8 D -11.061 178.654 33.0F BER 3 1.6 5.7sBER 5.2BNAO
 change epicentre,depth,rms: 999.0 0.0 1.6 (PDE: -18.369 168.173).

2001 630 1147 41.2 D 28.192 -53.492 35.0F BER 3 0.4 4.7sBER 5.0BPDE
 2001 630 1147 40.8 D 26.948 70.692 35.0F BER 2 0.4 4.7sBER 5.0BPDE
 change epicentre,depth,rms: 999.0 0.0 0.0 (PDE has 30.983 69.773 35.0)

Higher residuals, but location is closer to the 3 previous, saved locations:
 1989 9 5 1544 48.6 LM 66.734 15.427 15.0 BER 3 1.1 2.3CBER 2.2LBER 3
 1989 9 5 1544 46.0 LP 66.721 15.512 0.1 BER 3 0.8 2.3CBER 3
 1989 9 5 1544 48.5 L 66.800 13.621 0.1F KOL 3 0.1 2.3CBER 2.2CNOR 2.0LNOR1

PDE has -0.266 125.094:
 1996 812 1700 36.5 D -7.213 -55.464 42.0F BER 4 0.0 5.6bBER 5.7BPDE
 1996 812 1700 36.2 D 1.515 124.735 42.0F BER 2 0.1 5.6bBER 5.7BPDE
 change epicentre,depth,rms: 999.0 0.0 0.1

1999 817 0445 26.5 D 70.365 11.484 10.0F BER 8 9.9 3.4LBER 4.6BPDE
 1999 817 0444 27.4 D 67.629 35.738 10.0F BER 8 0.6 4.0LBER 4.6BPDE
 Pde has 67.863 34.379.

1999 821 0003 14.5 D -20.121 82.560 15.0 BER 6 7.8 5.9bBER 4.5BPDE
 1999 821 0009 18.1 D 37.380 69.553158.0 BER 6 0.2 4.9bBER 4.5BPDE
 Pde has 36.516 70.595.

1996 4 1 2157 28.7 L 66.917 21.289 12.8 BER 2 1.7 1.7LBER 2.3CBER
 1996 4 1 2157 34.6 L 67.332 20.234 13.5 BER 2 1.4 1.6LBER 2.3CBER

Table 8: Examples of improved location. Old solution above, new below.

Teleseismic, 1980 - 1989:

Same as before for the teleseismic changes. Table 9 shows selected examples.

Original location more correct (USGS has it at 85.642°N 87.328°E):
 1982 611 1141 59.7 D 85.910 74.158 15.0 BER 3 0.0
 1982 611 1143 43.1 D 77.592 21.633 15.0 BER 3 0.0
 change epicentre,depth,rms: 999.0 0.0 0.0

Old location correct, new is wrong: (USGS has 26.535°S 70.563°W, MW7.4):

OLD: 10 4 1851 51.2 D -31.588 -74.121 15.0 BER 3 1.9
1983 10 4 1904 29.4 D 68.142 12.890 15.0 BER 3 0.0

1997 7 9 2328 14.9 LP 67.743 19.801 0.0F BER 3 1.1 1.7LBER 2.3CBER
1997 7 9 2328 26.9 LP 66.791 9.944 0.0F BER 3 3.0 2.0LBER 2.4CBER
(it is many of these between approx. 1995 and a few years onwards)

Table 10: More examples. Old solution above, new below.

Depth issues:

Some examples on depth issues is shown in table 11.

Fixed depth (to PDE, 33km) gives correct location and low RMS:
2001 310 1120 36.4 D 34.632 33.749 15.0 BER 3 0.8 4.3sBER 4.8BPDE
2001 310 1128 44.6 D 61.039 11.246 0.1 BER 367.9 4.8BPDE
change epicentre,depth,rms: 999.0 14.9 67.1

2000 1 9 0706 38.3 L 66.107 15.737 15.0F BER 3 2.0 1.3LBER 2.1CBER
2000 1 9 0706 36.0 L 66.725 13.951 15.0F BER 3 1.6 1.4LBER 2.1CBER
change epicentre,depth,rms: 104.9 0.0 -0.4

1986 821 0123 12.1 D -58.036 -69.162 15.0 BER 410.6
1986 821 0127 36.9 D -28.900 -80.395 15.0 BER 4 9.9

No location in bulletin, not on USGS, PDE. Weighted out two stations to avoid wrong location.

Bad before and bad now. Does not match two USGS reported events around this time. I weighed down 1 out of 3 stations (RNF) to avoid a location:

1987 818 0216 40.3 D 81.144 -80.025 15.0 BER 317.3
1987 818 0221 8.8 D 67.761 12.013 15.0 BER 3 8.2

Table 11: More examples. Old solution above, new below.

Distant events 2010 - 2019:

No major changes, just a few (approx. 20 events 2010-2015) around Kermadec changing location, fixed to PDE.

Throughout the database, Fiji/Kermadec Islands-area events are better located before than now. One example shown in table 12.

```

1987 9 7 1157 38.9 D -23.232 142.258 2.8 BER 9 4.5
1987 9 7 1201 51.3 D -16.012 128.610 15.0 BER 8 3.6
change epicentre,depth,rms: 999.0 12.2 -0.9
USGS solution is: 31.089°S 177.968°W

```

Table 12: Kermadec example. Old solution above, new below.

Local events 2010 - 2019

Not many changes in the last decade, probably due to more available stations. However, some examples of the changes that *does* occur several times in this decade is listed in Table 13.

```

2010 1115 0239 54.5 L 77.092 19.577 16.4 BER 3 0.2 1.3LBER 2.0CBER
2010 1115 0240 2.5 L 77.431 13.827 0.0 BER 3 2.4 1.1LBER 2.0CBER

2011 2 4 0442 58.9 L 67.499 34.500 26.3 BER 4 0.5 2.5CBER
2011 2 4 0442 58.7 L 67.870 34.180236.0 BER 4 0.1 2.5CBER

2011 913 2336 59.5 LP 67.843 20.386 0.0F BER 7 0.2 1.5LBER
2011 913 2336 47.7 LP 70.494 18.662 0.0F BER 7 4.3 1.6LBER

2012 319 1830 5.5 LP 67.826 21.446 0.0F BER 3 0.3
2012 319 1828 57.6 LP 63.042 17.939 0.0F BER 3 0.1

2014 7 4 0502 6.0 LQ 77.276 9.162 10.0F BER 3 0.7 1.2LBER
2014 7 4 0502 8.2 LQ 79.825 19.050 10.0F BER 3 1.6 1.2LBER

2016 7 2 1128 10.2 LP 67.389 30.831 0.0F BER 5 0.4 1.5LBER
2016 7 2 1128 13.5 LP 71.603 21.531 0.0F BER 5 4.2 1.3LBER

```

A few of these, various locations, but mainly LP's in Kiruna/Marmberget. They were good, turned worse, and was fixed with the last locate routine update. No editing needed.

```

2010 1127 1757 13.8JL 70.978 -8.386 1.1 BER 3 0.0 1.3LBER 2.1CBER
2010 1127 1757 13.8JL BER 2.1CBER

```

Some loose their location if few picks. There was a new rule in 2018(?) not allowing location using P on 2 stations and E, I, IAML, on the third station.

Table 13: More examples. Old solution above, new below.

Pre-written commands describing the most used corrections:

- Flagged not to be relocated before database update. mls 2019
- PN, SN changed to P, S for better location before database update. mls 2019

One typical example, happening for some events located with 1, 2 or 3 stations, mainly Norsar events: 2003 1 6 1041 46.0 L 79.042 4.554 0.0 BER 2 1.1 2.5LNAO 2003 1 6 1042 10.7 L 78.469 13.526 15.0 BER 2 0.5 2.5LNAO

Table 14: Example of event with the PN/SN pre-written command. Old solution above, new below.

- Event fixed to PDE* before database update due to big shift in location. Mls 2019
**: Can also be fixed to USGS, NAO if applicable.*
- Depth unfixed to keep original and probable, low RMS location. mls 2019
**Due to grid location, see above*
- Depth fixed to XX km in order to keep original and low RMS location. mls 2019
**10 km for oceanic crust, 15 km for continental crust.*
- JL changed to L before database update in order to keep location. mls 2019

Used on some (maybe 10-15) events in 2001-2003 (plus one in aug 2004, one in oct 2005). These events had a location, and lost it after updating using original JL model. Removing the J for these events caused only minimal change in location (less than a few km), all had OK RMS and the depth was changed (typically from standard 3 km to approx. 15km).

DATABASE UPDATE - SUMMED UP:

Main causes for problems are the following:

Pn/Sn: Messes up the solution. For these events, the n is removed and a comment line about what and why is added in the s-file.

Locations using one or two stations without azimuth are no longer producing a solution.

JL - small changes in the model? Many events has non-drastrical changes, and it is difficult to determine if before or after is more correct. When medium to large uncertainty about the new loaction, the original event is kept and flagged not to be relocated before the database update.

Kermadec Island/Fiji-area teleseismic events. These were ok, but turned bad at some time many years ago. They are OK when fixed to USGS/PDE location.

Depth and grid search (two local minimas). Only a problem 1980-2000, and it has to do with depth (2D model).

Mn magnitude was calculated for old events instead of Ms. Lars fixed this issue by setting a limitation of 2sec period for the amplitude readings.

Update of database 1980-1999 is done 9/4 2019, at 12:45, by mls.

Update of database 2000-2009 is done 12/4 2019, at 13:00, by mls.

Update of database 2010-2019 is done 23/4 2019, by mls.