

## Obtaining ISC Data for *mloc*

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The multiple event relocation program *mloc* recognizes only one format for files carrying arrival time data: MLOC Native Format or MNF. The current version of MNF is v1.3; it is fully defined in a separate document. *mloc* can still read and process data files in MNF v1.1 and v1.2. No data center provides data in MNF format so it will be necessary for users of *mloc* to convert from other formats into MNF. This document describes the procedure for obtaining data from the ISC website and converting it into MNF v1.3 format for use in *mloc*. The source codes of the utility programs used in this process are provided with the *mloc* distribution and may serve as templates for conversion programs for other formats. Please contact me if you need help with a conversion program for some commonly-encountered format, as I may already have written one.

### Searching the ISC Bulletin

1. Navigate to:  
<<http://www.isc.ac.uk/iscbulletin/search/bulletin/>>  
or the mirror site at  
<<http://isc-mirror.iris.washington.edu/iscbulletin/search/bulletin/>>
2. Select the desired database. The “Reviewed ISC Bulletin” is of higher quality but is usually about 2 years behind real time. The “ISC Bulletin” will provide data for events that are quite recent, within the last day or so, but the quality of the data and the hypocenters is, well, unreviewed.
3. Select “ISF Bulletin” as output format. The data file that you will obtain is not actually in ISF format, but rather in a version of IMS format. I have not investigated why this is the case.
4. Choose search region, time period, and optional search parameters to narrow your search. Most of these options make no difference for *mloc*, but selecting “Include events without defining phases” is not going to be helpful as far as relocation goes. It may be helpful to specify a modest value (say, 20) for “Min defining phases” to weed out events with only a few readings. You will be able to do a selection with minimum number of readings at a later stage of the conversion process, so I recommend keeping this value fairly small in the web search, to avoid losing good events. I have the impression that setting a minimum number of defining phases only works properly for the Reviewed ISC Bulletin, but I have not confirmed this.
5. Choose output options. Select “Prime hypocenters”, “phases” and “magnitudes”. Deselect the other check boxes.
6. Click the “Search Bulletin” button. After a short delay (maybe a longer delay if you are using the home ISC server), a window will pop up and start filling up with data. It may

take a while for all the data to transfer. At the end you will see a STOP line and some other output.

7. Select everything in the output window and paste it into a new text document, named in some reasonable fashion after the nature of the search you have done.

You now have a data file in what I refer to as “ISC” format (but it is only one of several formats the ISC can serve), that needs to be converted into MNF format. Make a new directory for this file with an appropriate name.

## Conversion to an MNF Bulletin

The next step in the conversion process is to turn the ISC-format text file, which may be thought of as a seismic bulletin, into a bulletin in MNF format. See the MNF documentation for discussion of the bulletin concept and how it is handled in MNF. The program *isc\_ims2mnf* (actually, just the Fortran source code *isc\_ims2mnf.f90*) is provided for this purpose. So you will need to compile the program:

1. Place the file *isc\_ims2mnf.f90* and the include file *isc\_ims2mnf.inc* into a convenient folder and compile with whatever basic command your Fortran compiler uses, for example: `f90 isc_ims2mnf.f90 -o isc_ims2mnf`
2. Then copy the executable *isc\_ims2mnf* into the folder containing the ISC data file.

Before running the conversion code, it is useful to do a little editing on the ISC data file. If you don’t, you’ll need to do a little editing on the MNF file afterwards. The editing of the ISC data file consists of:

1. At the top, delete all lines above the line “DATA\_TYPE BULLETIN IMS1.0:short”.
2. At the end, delete all lines below the line “STOP”
3. Delete one blank line above the line “STOP”, such that there is only a single blank line between the last phase line and the “STOP” line.

I have provided a sample of an ISC data file in two forms, “*isc\_test1.txt*” which is copied straight from the ISC website and “*isc\_test2.txt*” which is the same file edited as recommended above.

Here is the terminal session in which I ran *isc\_ims2mnf* on both data files:

```
$ cd /Users/eab/Desktop/untitled\ folder/test
$ ./isc_ims2mnf
Enter input filename:
isc_test1.txt
Bulletin output?:
y
Bulletin comment:
test1
EOF reached after    6 events
$ ./isc_ims2mnf
Enter input filename:
```

```

isc_test2.txt
Bulletin output?:
y
Bulletin comment:
test2
EOF reached after    6 events
$ ls -all
total 768
drwxr-xr-x  8 eab  staff   272 Nov 29 22:43 .
drwxr-xr-x  7 eab  staff   238 Nov 29 22:38 ..
-rw-r--r--@ 1 eab  staff  6148 Nov 29 22:42 .DS_Store
-rwxr-xr-x  1 eab  staff 210924 Nov 19 18:46 isc_ims2mnf
-rw-r--r--@ 1 eab  staff  43138 Nov 29 22:37 isc_test1.txt
-rw-r--r--  1 eab  staff  40016 Nov 29 22:42 isc_test1.txt.mnf
-rw-r--r--@ 1 eab  staff  41768 Nov 29 22:41 isc_test2.txt
-rw-r--r--  1 eab  staff  38552 Nov 29 22:43 isc_test2.txt.mnf
$

```

There are now two MNF-formatted files, derived from the two versions (original and edited) of the ISC data file. By comparing the two files you will easily see the consequences of not editing the input file, and you can decide for yourself whether you'd rather edit the input ISC data file or clean up the MNF bulletin file afterwards. Further processing will be done with `isc_test2.txt.mnf`.

## Searching an MNF Bulletin and Extracting Files

The next step is to extract data files for selected events from a bulletin formatted in MNF. *mloc* requires the input data to be presented as individual files. In fact you could have extracted individual data files in the previous step, while converting the ISC-format data file to MNF, by answering 'n' to the question "Bulletin output?". This could be a useful shortcut in the case where the ISC-formatted data file contained only a few events and you knew that you wanted them all. In most cases I find it easier to do a broader search in the ISC bulletin and then use a separate process to search that data set and extract certain events for relocation. The program used for this is called *mnf\_search*, and the source code for this program (`mnf_search.f90`) is provided in the *mloc* distribution.

Like *isc\_ims2mnf*, *mnf\_search* is compiled using a plain vanilla compiler command: "`f90 mnf_search.f90 -o mnf_search`", where you'll need to substitute the executable name for your own Fortran compiler. Then move a copy of the executable into the directory where you've stored `isc_test2.txt.mnf`. Here is a terminal session to illustrate how *mnf\_search* works:

```

$ cd /Users/eab/Desktop/mloc\ distribution/Utilities/isc_test
$ ./mnf_search
Enter input filename:
isc_test2.txt.mnf
Create mloc command file?
y
Enter command file basename:
test2

```

Use lat-lon limits?

n

6 events read

6 events pass the search criteria

6 events that pass the search criteria and have 10 or more phase readings

6 events that pass the search criteria and have 20 or more phase readings

4 events that pass the search criteria and have 30 or more phase readings

4 events that pass the search criteria and have 40 or more phase readings

4 events that pass the search criteria and have 50 or more phase readings

1 events that pass the search criteria and have 60 or more phase readings

1 events that pass the search criteria and have 70 or more phase readings

1 events that pass the search criteria and have 80 or more phase readings

0 events that pass the search criteria and have 90 or more phase readings

0 events that pass the search criteria and have 100 or more phase readings

Minimum number of phase arrivals:

30

Event number selection: beginning and end numbers:

1 6

EOF reached after 6 events

4 events selected

\$ ls -al

total 1256

drwxr-xr-x 14 eab staff 476 Nov 30 16:46 .

drwxr-xr-x 7 eab staff 238 Nov 30 10:35 ..

-rw-r--r--@ 1 eab staff 6148 Nov 29 22:42 .DS\_Store

-rw-r--r-- 1 eab staff 7329 Nov 30 16:46 20110531.0113.25.mnf

-rw-r--r-- 1 eab staff 10989 Nov 30 16:46 20110531.0541.20.mnf

-rw-r--r-- 1 eab staff 6963 Nov 30 16:46 20110531.0646.19.mnf

-rw-r--r-- 1 eab staff 6475 Nov 30 16:46 20110531.1345.22.mnf

-rwxr-xr-x 1 eab staff 210924 Nov 19 18:46 isc\_ims2mnf

-rw-r--r--@ 1 eab staff 43138 Nov 29 22:37 isc\_test1.txt

-rw-r--r-- 1 eab staff 40016 Nov 29 22:42 isc\_test1.txt.mnf

-rw-r--r--@ 1 eab staff 41768 Nov 29 22:41 isc\_test2.txt

-rw-r--r-- 1 eab staff 38552 Nov 29 22:43 isc\_test2.txt.mnf

-rwxr-xr-x 1 eab staff 205692 Nov 19 19:00 mnf\_search

-rw-r--r-- 1 eab staff 212 Nov 30 16:46 test2.cfil

\$

After launching *mnf\_search* and specifying the input file, you need to decide if you want the program to create a command file for you or not. *mnf\_search* cannot create the complete command file, but it creates the event definition section (memb-even-inpu) that is so tedious to write by hand, so usually you will want to take advantage of this offer.

The search options available in *mnf\_search* are rather limited (so far). The options are:

- Search a rectangular region (lat-long bounds)
- Search by minimum number of phase readings
- Search by event number range

The search by minimum number of phase readings is a useful way to pare down the number of events in a cluster to a number that is comfortable for *mloc* (i.e., 200 or less). It usually makes

sense to start with the events that have the most phase readings. You can go back later and pull out events with fewer readings if you like. You can enter any value for the minimum number of phase\_readings (not just multiples of 10).

## **Duplicate Readings**

One problem that has arisen in recent years with the ISC is that they receive many duplicate phase readings because of the multiple distribution channels that exist for many seismograph stations. The duplicates are not always perfect; sometimes they vary slightly in arrival time or have different levels of precision which make it very difficult to be sure if they should be treated as separate samples or as duplicates. The ISC is so far incapable of managing this problem, so it falls to you and your programs to decide what to do. *mloc* contains some logic to detect duplicates and flag them, but it is not perfect. As far as *mnf\_search* is concerned, duplicates count towards the number of phase readings so you will find that some of the events that you thought had plenty of readings actually are much less well recorded.

## **Searching by Event Number**

The option for searching by event number is useful when searching through a very large bulletin, containing thousands of events for a region of interest. This often happens in mainshock aftershock sequences when a temporary network is installed that records small aftershocks that would normally be missed by the permanent network. In that case you may decide to break the analysis down to a set of subclusters based on chronological order. In other words, you might limit a search to the first 200 events (events 1-200) for one cluster, then a second cluster would be produced by searching only events 201-400 and so on. If you use lat-long bounds and minimum number of phase readings as search options it will be difficult to predict how many events you'll get from each search, but a bit of experimentation should make it possible to guide the process effectively.

In the example case above I did not use any latitude-longitude bounds for the search and there were only 6 events in the bulletin so it made no sense to use event number selection. The only search option was for the minimum number of phase readings (30 or more), which selected 4 of the 6 events in the bulletin. The individual event files (and *test2.cfil*) can now be moved or copied into a new directory for the relocation of this cluster. Before running *mloc*, you'll have to edit *test2.cfil* to add the other commands needed for your particular analysis.