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QUICK-START MANUAL
for
HYPOELLIPSE

A Computer Program for Determining
Local Earthquake Hypocentral Parameters,
Magnitude, and First-Motion Pattern
(Y2K Compliant Version)

1999 Version 1.0

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The full HYPOELLIPSE manual (Lahr, 1999) has grown too large, too complicated, and too user unfriendly! This is an attempt to write concise instructions that will allow someone to quickly start locating earthquakes. Further refinements and modifications to the input control files can then be made incrementally when and if they prove necessary for a given application.

These instructions are aimed at running on a PC platform, but the same general approach would also work on a UNIX platform. In order to run HYPOELLIPSE you will need to create a few ASCII files to specify the crustal velocity model, the program option selections, the station locations, the observed arrival times, and the station response characteristics (needed only for magnitude determinations). The test data set provides an example of each of these files:

| FILE NAME | CONTENTS |
|--------------|--|
| akutan.pha | Observed arrival times, amplitudes, and periods |
| akutan.sta | Station parameters, including latitude, longitude, and elevation (m). |
| crustal.prm | Velocity model specifications. |
| headopts.prm | Program control parameters for network processing. |
| headopts.vol | Program control parameters adjusted for a volcanic network. |
| caldata.prm | Station calibration parameters. |
| hypo.in | This file answers the interactive questions that HYPOELLIPSE asks when the program is first run. It specifies the name of the input file (hypo.ctl) and the names of the output files. |
| hypo.ctl | This file is read by HYPOELLIPSE and lists the names of the previous files. |

To make a quick run to see if the program is working on your computer, follow these steps:

- 1) cd to the directory with the test run files.
- 2) Move the files hypoel.*, which were generated when I ran the test data to a different directory.
- 3) Give the command:
hypoel < hypo.in
- 4) Compare the files generated on your computer with those that you moved in step 2 to make sure the answers are the same.

Below are described the contents and format of the files that you will have to create to run your own data.

akutan.pha (Of course this file could be renamed.)

For each earthquake to be processed, this file contains one set of records. In each set there is one "arrival-time" record for each seismic station with the arrival times of P and S, the maximum amplitude and the period for magnitude determination, and a code (0 through 4) that indicates the precision of the arrival times. The final record of each set is a blank. As many earthquakes as desired can be included in one file.

| Item | Col. Nos. | Format |
|--|-----------|--------|
| Station name | 1 - 4 | A4 |
| Alphanumeric symbol describing P-phase arrival (for example, I or E) | 5 | A1 |
| Phase descriptor | 6 | A1 |
| P - P-arrival read on vertical component N - P-arrival read on North-South component E - P-arrival read on East-West component If N or E is used, then neither the coda duration nor the maximum amplitude will be used and the first motion direction will not be plotted. The extended 5-character station name is formed from the station name in columns 1-4 (shifted to the right) plus the phase descriptor. If the phase descriptor is not n or e, then z is assumed. This extended name must agree with the extended name in the station list (see 2.2.5.2). | | |
| First motion direction of P-arrival | 7 | A1 |
| c, C, u, or U Compression d, D Dilatation + Poor compression - Poor dilatation Z Nodal, and not clearly up or down N Noisy . or Blank Not readable | | |
| P-phase weight code based on estimated standard deviation (SD) | 8 | F1.0 |
| 0 or blank Full weight SD <= 0.07s 1 Partial weight SD <= 0.35s 2 Partial weight SD <= 0.70s 3 Partial weight SD <= 1.40s 4, 5, 6, 7, 8 No weight | | |
| 2-digit year, month, day, hour, minute | 10 - 19 | I10 |
| Seconds of P arrival. If left blank, the assigned weight code will be set to 8 both during this run and on the ARCHIVE ARRIVAL TIME record. | 20 - 24 | F5.2 |
| Seconds of S arrival | 32 - 36 | F5.2 |
| S remark | 37 - 39 | A3 |
| S phase weight code | 40 | F1.0 |
| Maximum peak-to-peak amplitude. Values from .001 to 9,999 are entered as positive. | 44 - 47 | F4.0 |
| *Maximum peak-to-peak amplitude. Values from .001 to 9,999 are entered as positive. Negative entries are multiplied by -10,000 to allow for values of 10,000 to 9,990,000. | 44 - 47 | F4.0 |

| Item | Col. Nos. | Format |
|--|-----------|--------|
| Period of maximum amplitude in hundredths of sec. If left blank, 0.1 will be used. | 48 - 50 | F3.2 |
| Time correction in seconds | 66 - 70 | F5.2 |
| F-P time interval, in sec, for FMAG calculation. In USGS practice, one measures the time between the first P-arrival and the point where the peak-to-peak amplitude of the signal drops below 1 cm on a Geotech Develocorder film viewer (X 20 magnification). If the F-P is less than 1.25 times the S-P time, then FMAG is not calculated. | 71 - 75 | F5.0 |

akutan.sta (Of course this file could be renamed, too.)

This file specifies the station coordinates. Each station is specified by two records, a "primary" and a "time-dependent" record.

Format for PRIMARY STATION PARAMETER records:

| Item | Col. Nos. | Format |
|--|-----------|--------|
| Station Name | 1 - 4 | A4 |
| Latitude (Degrees) | 5 - 6 | I2 |
| N or blank for North, S for South | 7 | A1 |
| Latitude (Minutes) | 8 - 12 | F5.3 |
| Longitude (Degrees) | 14 - 16 | I3 |
| W or blank for West, E for East | 17 | A1 |
| Longitude (Minutes) | 18 - 22 | F5.3 |
| Elevation above sea level (Meters) | 24 - 27 | I4 |
| z, n, or e for vertical, north-south or east-west component. If blank, z is assumed. | 80 | A1 |

Format for TIME-DEPENDENT STATION PARAMETER records:

| | | |
|---|---------|----|
| Station name | 1 - 4 | A4 |
| * | 5 | A1 |
| Primary system response code: Use 18 | 10 - 11 | I2 |

The pair of entries for one stations might look like this:

ak154 08.15 165 46.20 12

ak1* 18

crustal.prm contains the velocity model to be used.

The crustal model is defined by a set of records beginning with the word VELOCITY and including three real numbers in free format starting after column number 18.

Format: VELOCITY real, real, real

The sample file crustal.prm includes two velocity models. The test data and parameters are set up to always use the first of the two models, which consists of flat layers with constant velocity. The second model is included to illustrate how to specify a linear increase over a half space. The parameters in headopts.vol for this test run specify that the top of the velocity model is located 3 km above sea level ($E_o = \text{Test}(8)$). Earthquake depths are still computed with respect to sea level, so negative depths, up to -3 km are allowed. Station elevations on the station records must be specified in meters above sea level. Specification of E_o allows for the correct location of earthquakes within a region of great topographic relief, such as within a volcano; travel times and take-off angles are computed correctly, even to stations that are at a lower elevation than the hypocenter.

a) Constant velocity in each layer.

The three real variables to be specified are P-phase velocity (km/sec), depth to top of layer (km) with respect to E_o , and V_p/V_s ratio. The first record of each model must have a depth of 0.0 km specified. The model may consist of from 1 to 11 layers over a half space. Embedded low velocity zones are allowed. For example, a 5 km thick layer with velocity of 5.2 km/s and a V_p/V_s ratio of 1.78 over a 7.0 km/s half space with V_p/V_s ratio of 1.78 would be specified by the following two records:

| | | | |
|----------|-----|-----|------|
| VELOCITY | 5.2 | 0.0 | 1.78 |
| VELOCITY | 7.0 | 5.0 | 1.78 |

b) Linear increase in velocity over a half space.

For this model the velocity increases linearly from V_o at the surface (E_o) by K km/s per km until the half space is reached at a depth of D km. Velocity within the halfspace is V_h km/s. To use this type of model, the VELOCITY records are defined as follows:

| | | | |
|----------|-------|-----|-----------|
| VELOCITY | V_o | 0.0 | V_p/V_s |
| VELOCITY | K | 1.0 | V_p/V_s |
| VELOCITY | D | 2.0 | V_p/V_s |
| VELOCITY | V_h | 3.0 | V_p/V_s |
| VELOCITY | 200. | 4.0 | V_p/V_s |

headopts.prm and **headopts.vol** set many of the parameters that control the way HYPOELLIPSE locates earthquakes. In most earthquake computer programs many of these values would be hard wired within the program code. This has the advantage that the program is easier to use and the disadvantage that the user might have to recompile the program to make some types of changes.

HYPOELLIPSE gives the user a lot of control over the program, but this has the disadvantage that the number of options is very great and it is difficult to understand what all of the parameters do. There are also some combinations of parameter changes that will cause the program to malfunction. Indeed, many combinations have probably never been tried! My suggestion is to move slowly in making changes. Some things are rather obvious and are well documented in the full manual and in the sample files provided here, while the effect of other parameter changes might need to be determined by trial and error.

I would be happy to help with the setup parameters if you are having difficulty with the program.

headopts.prm includes the parameters that are use for locating events that range in depth from the surface to 200 km depth with the regional network in Alaska. After this file is read, the file headopts.vol is read which resets some of the parameters to the values used for processing shallow earthquakes with a dense network around a volcano. Depending on your network and the depth range of the local seismicity, you may not want to use the headopts.vol file.

caldata.prm specifies the seismic amplitude response and is used for magnitude calculations. This file contains up to 100 records with the following information: station name, source code, begin yrmody, end yrmody, number of pairs - n, period(1), system magnification(i), period(n), system magnification(n). The pairs must be given in order of increasing period. The format is fixed for the station name and source code, but free for the remainder of the record.

| Item | Format |
|--|-------------------------|
| Station Name | A4 (columns 1-3 or 1-4) |
| One blank character | |
| Source code letter | A1 (column 5 or 6) |
| One blank character | |
| Begin year month day of cal. | Free format integer |
| Ending year month day of cal. | Free format integer |
| Npairs - number of pairs | Free format integer |
| Period seconds | Free format real |
| Magnification - counts/mm ground displacement | Free format real |

HYPOELLIPSE is designed to read the parameter values that will control the program and to then read one set of earthquake phase arrival times for each earthquake to be located. Although all of these input items could be placed in one file, it is more convenient to break them up into more than one file. As HYPOELLIPSE reads from the "master" input file (in this example named hypoctl and listed below) it can be directed by "jump" records to read from other files as well. Note that comments begin with an exclamation mark (!) and are ignored by HYPOELLIPSE.

The following is a listing of the sample input control file:

```
! headopts.prm and headopts.vol contain the setup parameters
! for running HYPOELLIPSE.
jump headopts.prm
jump headopts.vol
!
! crustal.prm specifies the velocity model. The first
! model, which is the one that will be used, shows how to set
! up a linear increase over a halfspace. The second model
! illustrates a multilayer velocity model.
jump crustal.prm
!
! caldata.prm contains the calibration parameters for the
! Akutan stations.
uofacal option caldata.prm
!
! Constants noprint = 1 will cause documentation of the
! parameter values, crustal model, station locations, etc
! to be added to the output (.out) file. Note that if the
! same parameter value is specified more than once, the last
! setting will be the one used (in this case the value will
! be set to 1).
constants noprint 0
constants noprint 1
!
! Printer option 1 adds a blow by blow description of
! every iteration step and is useful for debugging purposes.
! Reverse the order of the following records to turn this
! option on.
printer option 1
printer option 0
!
begin station list +1 19960101
jump akutan.sta
arrival times next
jump akutan.pha
```

Y2K Modifications

In order to allow events from after 1999, just a few changes were made to HYPOELLIPSE. The summary record was modified. It used to begin with the year, such as 98, but not begins with the century and year, such as 1998. All of the other fields are pushed to the right by two columns. New summary records generated by HYPOELLIPSE will always include the century. Old data sets for which the century is not included may still be run, however, because reset test variable (55) specifies the default century in case it is not specified on the summary record. Reset test (55) also sets the century in case there is no summary record preceding the arrival time records.

References:

Lahr, J.C., 1999, HYPOELLIPSE: A computer program for determining local earthquake hypocentral parameters, magnitude, and first motion pattern, (Y2K compliant version) *U.S. Geological Survey Open-File Report 99-23*, 112 p.

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