Seismic Transfer Program (STP) to HYPOINVERSE Guide

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To begin, the user should preferably have STP and HYPOINVERSE installed on their computer.

Hypoinverse:

ftp://ehzftp.wr.usgs.gov/klein/hyp1.40/hyp1.40.tar

STP:

http://service.scedc.caltech.edu/ftp/programs/stp/stp1.6.3.tar

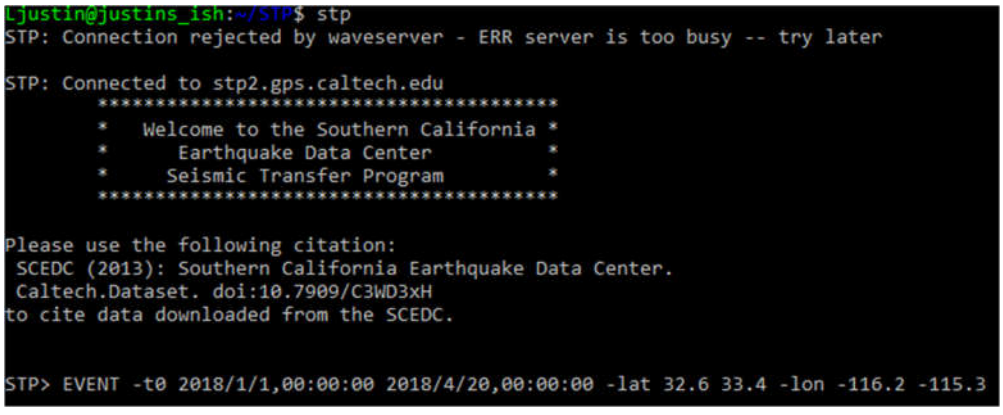
For HYPOINVERSE to work, 5 parameters must be met in the phase file: (1) the remark field ("IP" or "ES") must be occupied, (2) the station in the phase file must be in the station file, (3) the phase file must be in one of the four correct phase file formats, (4) the P arrival time and date must not differ by more than six minutes from the first station, (5) the station site code must not be on the list of stations to ignore (given by the UNK command).

The user should start by downloading the preferred data from STP. This document will focus on the Latitude 32.6 to 33.4 and the Longitude -116.2 to -115.3.

The user must first locate events in a desired region and time. This is achieved by using the EVENT command. To find a specific window of time, EVENT should then be followed by -t0 and a time window. To find a specific latitude and longitude window as well as a time window, EVENT should be followed by –t0 (yyyy/mm/dd hh:mm:ss) –lat (latitudes) –lon (longitudes). If you would like STP to print this to the command line, you can execute the command. If you would like to see this in a file, add the command –f (file name) to the end of EVENT. The command used in this document is as follows:

EVENT –t0 2018/1/1,00:00:00 2018/4/20,00:00:00 –lat 32.6 33.4 –lon -116.2 -115.3 –f April_2018_events.txt

The following command finds events occurring between midnight of January 1, 2018 and midnight of April 20, 2018 in latitude 32.6 to 33.4 and longitude -116.2 -115.3. the output will show the event ID, event type, date, latitude, longitude, depth, magnitude, magnitude type, and quality, respectively.

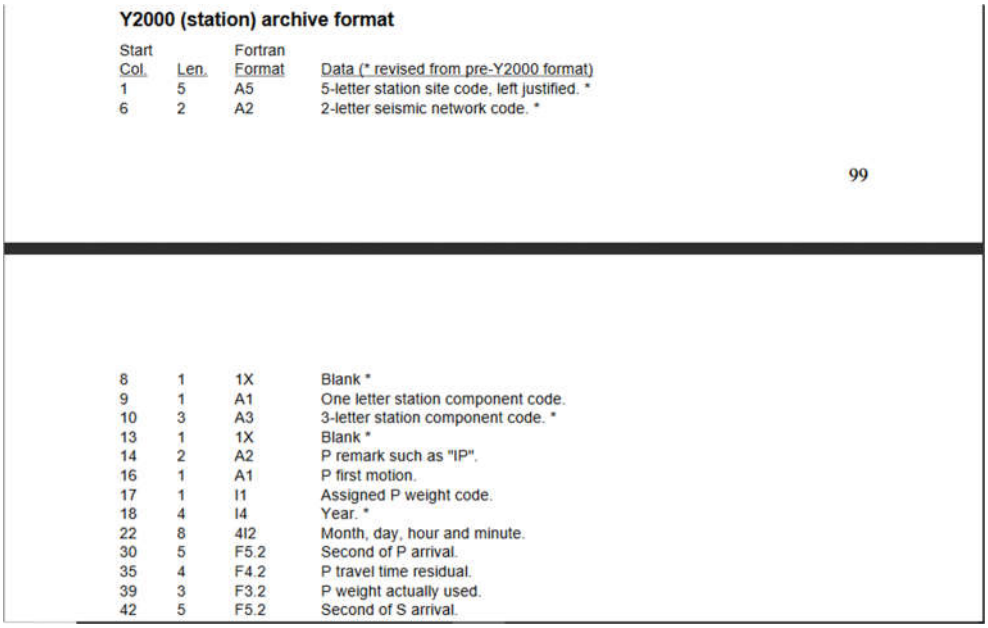


The following command should output a max of 100 events occurring in the appropriate time and coordinate window. The file "April_2018_events.txt" will also have the information output by the command above. Once a suitable event is located, the user can download a phase file from that event. The following command picks a desired event and saves the phase file to a file called "STP_Phase37917415":

PHASE –f STP_Phase37917415 –e 37917415

This will be the file that the user needs to manipulate for HYPOINVERSE to execute.

HYPOINVERSE has several formats. This document will focus on converting STP to the Archive format (the command is COP 3). HYPOINVERSE produced a user guide denoting what each column and line means for each format.



Y2000 (station) archive format

Start Col.	Len.	Fortran Format	Data (* revised from pre-Y2000 format)
1	5	A5	5-letter station site code, left justified. *
6	2	A2	2-letter seismic network code. *

99

8	1	1X	Blank *
9	1	A1	One letter station component code.
10	3	A3	3-letter station component code. *
13	1	1X	Blank *
14	2	A2	P remark such as "IP".
16	1	A1	P first motion.
17	1	I1	Assigned P weight code.
18	4	I4	Year. *
22	8	4I2	Month, day, hour and minute.
30	5	F5.2	Second of P arrival.
35	4	F4.2	P travel time residual.
39	3	F3.2	P weight actually used.
42	5	F5.2	Second of S arrival.

The above image is an example of one of the many formats available. STP also has a user guide for the meaning of each column and line in the phase file.

The output for each event begins with a line containing event location information. Each subsequent line lists the phase picks for one channel with the following fields: network, station, channel, two-digit location code, latitude, longitude, elevation, phase, first-motion, signal onset quality, pick quality, epicentral distance, and time after origin time. An example of phase output is:

```
10167485 le 2006/02/01,06:39:26.210    36.0207    -117.7710    1.91   0.95   l 1.0
CI     WCS EHZ --   36.0270   -117.7676   1135.0 P d. i   1.0     0.77    0.337
CI     WCS EHZ --   36.0270   -117.7676   1135.0 P d. w   1.0     0.77    0.370
CI    JRC2 HHZ --   35.9825   -117.8089   1469.0 P c. i   1.0     5.44    1.072
[...]
```

These were interpreted and input into an excel file labeled “Persaud Project file”.

When creating a script for converting STP files into HYPOINVERSE phase files, the user must be aware that the phase file starts with a one-line header, followed by the phases on the proceeding lines, followed by a terminating line on the last line.

The user must also be aware that a station file is necessary for HYPOINVERSE to execute. The STP station file can be found within the “Persaud Project” folder labeled “scedc_ws_station”. The format is as follows:

From SCEDC station database

05/07/2018 21:24:33

```
NET STA   CHA LOC STANAME                          LAT      LON         ELEV ONDATE     OFFDATE     EDEPTH REALTIME

CE  00022 HNE  -- Winterhaven - Sheriff Substati  32.73900 -114.63570    40 1999/12/01 3000/01/01       0
CE  00022 HNN  -- Winterhaven - Sheriff Substati  32.73900 -114.63570    40 1999/12/01 3000/01/01       0
CE  00022 HNZ  -- Winterhaven - Sheriff Substati  32.73900 -114.63570    40 1999/12/01 3000/01/01       0
CE  01711 HNZ  -- El Centro - Imperial & Ross     32.77970 -115.56750    -7 2002/12/10 3000/01/01       0
CE  01794 HNE  -- El Centro - Meloland Geotechni  32.77380 -115.44860    -4 2007/02/06 3000/01/01       0
```

The user should be aware that there are a few things that need to be changed in STP before you can convert to HYPOINVERSE.

- The latitude and longitude must be in degrees as well as in minutes.
    - Latitude degrees has two possible integers (i.e. ##) while Longitude degrees has three possible integers (i.e. ###)
    - Latitude minutes and Longitude minutes has four possible integers (i.e. ####)
- Each phase should have an individual arrival time
    - This can be achieved by adding "time after origin" time to the time given in the event file
- STP may need to convert the capital letters in "signal onset quality" and "P first motion" to lowercase letters.
- Hypoinverse does not use negative numbers for latitude and longitude, instead S and W will replace the negative
- I was not able to find an appropriate column for "pick weight" so there may be a bit of error in locating an earthquake
- The date and time will not have ':' or '/' in HYPOINVERSE

For the reference of the user:

HYPOINVERSE Station file format name: The HYPOINVERSE station data format #2

HYPOINVERSE Phase file format name: Archive

HYPOINVERSE header format name: Y2000 hypoinvere summary format

HYPOINVERSE terminator format name: Hypoinverse Terminator format

STP user guide: http://scedc.caltech.edu/research-tools/stp/STP_Manual_v1.01.pdf

HYPOINVERSE user guide: https://pubs.usgs.gov/of/2002/0171/pdf/of02-171.pdf