

85.12 FOCMEC: FOCa MEChanism Determinations

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1. Summary of Background and Purpose

The FOCMEC package is in the subfolder for Chapter 85.12 on the attached Handbook CD. The package contains programs for determining and displaying double-couple earthquake focal mechanisms. Input data are polarities (P , SV , SH) and/or amplitude ratios (SV/P , SH/P , SV/SH). The main program, Focmec, performs an efficient, systematic search of the focal sphere and reports acceptable solutions based on selection criteria for the number of polarity errors and errors in amplitude ratios. The search of the focal sphere is uniform in angle, with selectable step size and bounds. The selection criteria for both polarities and amplitudes allow correction or weightings for near-nodal solutions. Applications have been made to finding best-constrained fault-plane solutions for suites of earthquakes recorded at local to regional distances, analyzing large earthquakes observed at teleseismic distances, and using recorded polarities and relative amplitudes to produce waveform synthetics.

Input data can include up to a total of 500 polarities and amplitude ratios—the maximum number of input data is a compile-time option. The program Focmec produces two output files: a complete summary of information about all acceptable solutions, and a shorter summary file with one line for each acceptable solution that can be used as an input to other programs for display or further analysis. Another program in the package, Focplt, produces focal-sphere plots based on the Focmec input data (polarities, ratios) alone or superimposed on solutions (fault planes, compression and tension axes, SV and SH nodal surfaces). Other auxiliary programs include one to create input files for Focmec, a program that converts from among various ways of presenting a double-couple solution, a program that calculates

the radiation factors for an input mechanism, and programs for displaying and printing plot files.

Instructions are included for compiling and running the programs, and there are two data sets with scripts and documentation for running the programs.

2. Hardware and Software Requirements

Executables (and built libraries) are provided for two Sun Microsystems operating systems: Sunos 4.1.4 and Solaris 2.x. Programs and subroutines are coded in Fortran 77. The FORTRAN coding is “standard” with few Sun Fortran enhancements—the coding has been changed very little from that used in earlier versions that ran on PDP 11/34, VAX/VMS, and IBM/CMS platforms. The code has been compiled and linked with only a few modifications (mostly in the I/O) on PC and other UNIX platforms. Scripts for running the program are in UNIX csh format and are heavily commented. The plotting package, as written, requires the SAC Fortran library, but higher-level calls follow the CALCOMP convention so should be easily adapted to other plotting packages.

3. The FOCMEC Home Page

The FOCMEC home page is at <http://www.geol.vt.edu/outreach/vsolfocmec/>. Included are instructions on obtaining the latest versions of the package, including executables. Executables for current versions of all programs are included for Sun Solaris 2.8, for current versions of all executables except the plotting program Focplt on a PC (Windows 98 or later), and for all programs

as of June 2000 on Sunos 4.1.x. An Update History page on the Web site itemizes the chronology of major changes in the package.

Relevant References

- Aki, K., and P. G. Richards (1980). *Quantitative Seismology: Theory and Methods*. W. H. Freeman, San Francisco. Pages 105–109 contain a comprehensive discussion of the theory behind the determination of a seismic moment tensor and the double-couple solution.
- Dreger, D. S., H. Tkalčić, and M. Johnston (2000). Dilational processes accompanying earthquakes in the Long Valley Caldera. *Science* **288**, 122–125. This study includes a review of the methodology for inverting full waveforms to get all six components of the moment tensor, and it includes a description and application of the statistical methods used to estimate the probability of non-double-couple solutions from a full-waveform dataset for an event. See also Chapter 85.11 in this Handbook.
- Dziewonski, A. M., T. A. Chou, and J. H. Woodhouse (1981). Determination of earthquake source parameters from waveform data for studies of regional and global seismicity. *J. Geophys. Res.* **86**, 2825–2852. This paper describes the method used in full-waveform inversion for large ($M \geq 5.5$) earthquakes to produce the Centroid Moment Tensor (CMT) solution published for all large earthquakes.
- Herrmann, R. B. (1975). A student's guide for the use of *P* and *S* wave data for focal mechanism determination. *Earthquake Notes* **46**, 29–39. Covers much the same territory as Aki and Richards, but at a less advanced level. Included are equations for the conversions among different representations of a double-couple focal mechanism.
- Snoke, J. A. (1989). Earthquake mechanisms. In: *The Encyclopedia of Solid Earth Geophysics* (D. E. James, Ed.), pp. 239–245. Van Nostrand Reinhold, New York. A primer on double-couple focal mechanisms.
- Stein, S., and E. Klosko (2002). Earthquake Mechanisms and Plate Tectonics. Chapter 7 of this Handbook. This chapter shows how earthquake mechanisms can be used to constrain earthquake slip vectors and the stresses in various tectonic settings.