NAME

dislosing, dislomul, dislogrid, disloresp – displacements, tilts, and strains from a dislocation source

DESCRIPTION

These four programs are designed to allow (relatively) convenient computation of deformations produced by a dislocation source (the usual model for fault slip). The source is specified as one or more rectangular dislocation patches in an elastic halfspace. There is constant slip on each patch, and the top edge of the patch is parallel to the surface. The equations for the displacements and their gradients (strains and tilts) for this case were given by Okada (1985); these programs are basically a packaging of these routines to allow the user to specify patch locations, places of observation, and directions of deformation in geographic coordinates.

The way in which fault slip and observation type is specified is the same for all programs (see below); there are different routines to allow for different cases that tend to arise in practice. `Dislosing` is for the case where you want to find the effects at a single location, and allows the most interactive input. `Dislomul` is for the case where you want to find the effects at multiple locations (say, a number of GPS points). `Dislogrid` provides the effect on a regular latitude-longitude grid, suitable for subsequent contouring. `Disloresp` provides what is needed for an inversion, namely a table of the response over the different parts of the fault plane, for various observations at different places.

FAULT SPECIFICATION: INTERACTIVE

If only one patch (fault plane) is to be specified, the information may be given interactively, through the following set of questions:

Specify fault location by center of plane (c), top edge (t), or outcrop (o) This provides a choice of what the coordinate of the middle of the fault (next question) refers to, if the fault is not perfectly vertical (if it is, the answer does not matter). The coordinate will always be halfway between the two ends of the fault.

North latitude and East longitude of fault. Geographical location, with West longitude being negative. Note that all computations assume a halfspace; the relative locations of the fault and place of observation are found by using the geodesic distanced and azimuth.

Fault strike and dip. The strike is given as degrees clockwise from North. Following the usual convention, the dip is measured in degrees clockwise from the surface to the right of the fault, viewed along strike; so, for example, a strike of -90° and dip of 45° would correspond to a fault striking West and dipping down to the North.

Specify fault depth by center of plane (c), or of top edge (t)

Depth (km) of fault. These two questions specify the depth of the top of the patch, while allowing the depth to be given to the middle if more convenient.

Rake of slip (−180 for right-lateral strike-slip, 370 normal). A rake of 0° corresponds to left-lateral motion, and of 90° to thrust. The special case of rake 370° means that slip is normal (outwards) to the fault plane (inwards slip may be specified by changing the sign of the slip in a later question).

Specify fault slip (s) or moment (m)?. The amount of motion on the patch may be given by specifying the size of the patch and amount of slip, or the moment. In the first case, the questions are: *Fault dimensions (length [along-strike] by width down-dip], km)* and *Slip (m)*; once these are given the moment is displayed. Alternatively, if the specification is done by giving the moment, the fault dimensions are asked for (needed to completely specify the patch), and the next question is *Moment (n-m, or <0 for dyne-cm)*. Conversion between moment and slip assumes a shear modulus of 3.3×10^{10} Pa (0.33 Mbar). The rest of the computation needs only the Poisson's ratio of the material, which is taken to be 0.25.

FAULT SPECIFICATION: FILE-BASED

If fault segments are read in from a file, the information is read in one segment per line. If there are too many segments the program prints an error message and stops. The information on each line is free-format, and consists of the following:

North latitude and East longitude of segment ends. These are the coordinates of the two ends of the dislocation. The fault strike is assumed to be from the first coordinates to the second (this matters if the dip is non-vertical).

Location flag. This tells what the coordinates refer to, the choices being

c the coordinates of the center of the fault plane.

t the coordinates of the top edge.

o the coordinates of the surface trace.

which are of course all the same for a vertical fault plane.

Depth flag. This is **c** to specify the fault depth by the center of the fault plane, or **t** to specify it by the depth of the top edge.

Depth, in km, positive down.

Width, in km (this is measured along the plane as it dips). The length is found from the end coordinates.

Dip, in degrees; Following the usual convention, the dip is measured in degrees clockwise from the surface to the right of the fault, viewed along strike.

Slip, in meters.

Rake, in degrees: −180° for right-lateral strike-slip, 90°, and (as a special case) 370° for slip normal (outwards) to the fault plane.

OBSERVATION TYPES

All the programs allow the same types of deformation to be output (or, in the case of `disloresp`, to be used as the observation type for which fault response is computed. The types are

z Vertical displacement, in mm.

*nnn***d** Horizontal displacement, in mm, at azimuth *nnn*. The azimuth must be given in degrees clockwise from North. A value of 666 means maximum displacement (in absolute value).

*nnn***l** Extensional strain, in nanostrain, extension positive, at azimuth *nnn*. The azimuth must be given in degrees clockwise from North. A value of 666 means maximum extension (in absolute value).

v Volume strain, in nanostrain, extension positive, for Poisson's ratio 0.25, assuming a free-surface condition.

*nnn***s** Shear (tensor) strain, in nanostrain, at azimuth *nnn*. The azimuth must be given in degrees clockwise from North.

*nnn***t** Tilt at azimuth *nnn*, in nanoradians. Positive tilt is means increasingly downward displacement in the azimuth specified. The azimuth must be given in degrees clockwise from North. A value of 666 gives the maximum tilt (in absolute value).

b Local rotation about a vertical axis, in nanoradians, clockwise positive.

r RMS extension, in nanostrain: this is the RMS of extension measured over three azimuths 120° apart.

x Exit, or loop.

In `dislogrid`, the output may either be as values, or as log of values; the latter can be useful for contouring.

DISLOSING

This program first asks for the location of a single place of observation; then the fault information (either from a file or from the terminal) and finally for the observation type. It is possible to loop over different types of observations.

DISLOMUL

This program first asks for a file giving the locations of multiple places of observations (called "monuments" in recognition of the usual geodetic applications). This file should give the north latitude in columns 7—14, and the east longitude in columns 15—25, but is otherwise free-format. The program then asks for the fault information (either from a file or from the terminal) then for the observation type, and finally for the name of an output file. The input location information will be written out with the deformation prepended to each line. It is possible to loop over different types of observations, with different output files for each one.

DISLOGRID

This program writes out values on an array of points, evenly spaced in latitude and longitude; the same number of points are taken in both. The program first asks for the range in latitude, then longitude; then for the fault information (either from a file or from the terminal) then for the observation type, then the number of points on a side, and finally for the name of an output file. If the number of points on a side is M, and the range of latitudes is (say) from θ_S to θ_N, the latitudes at which the response is found will be θ_N, $\theta_N - \delta\theta$, $\theta_N - 2\delta\theta$, ..., θ_S, where $\delta\theta = (\theta_N - \theta_S)/M$. The results are output from North to South, and for each latitude from West to East, as in row-first order for a matrix. (The message about contouring refers to a program, contour, used at IGPP)>

DISLORESP

This program assumes a fault model with many segments, and a limited number of observations (currently, no more than 30), which may be at different locations. The program first asks for observation locations and types, with looping allowed. Once this information has been input, the fault information is requested, either from the terminal (for a single segment) or from a file. The output (to an ASCII file) gives, for each segment, the latitude and longitude of the center of the segment, the depth, and all the responses for the different data types.

AUTHORS

D. C. Agnew, H. Johnson, Y. Okada

REFERENCE

Y. Okada (1985). Surface deformation due to shear and tensile faults in a half-space, *Bull. Seis. Soc. Am.*, **75**, 1135-1154.