MOMENT TENSOR CODE FOR THE ANTELOPE ENVIRONMENTAL MONITORING SYSTEM

Reyes, J.C. <reyes@ucsd.edu>[1], van den Hazel,G.J.[2], Newman, R.L.[1] and Vernon, F.L.[1]

1) Array Network Facility, Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA 92093-0225

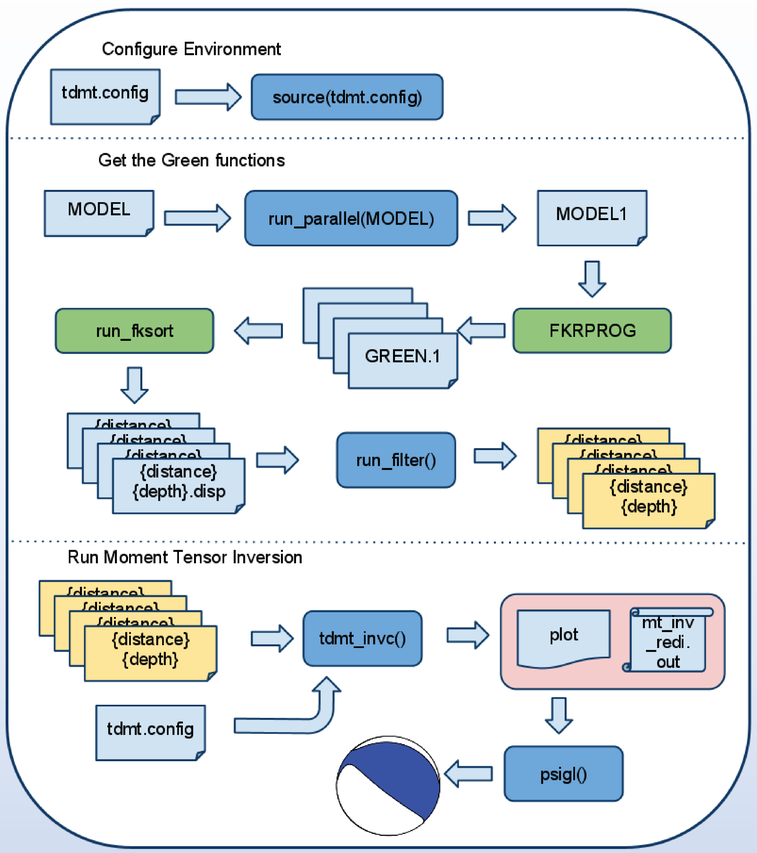
2) Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands

Introduction

The seismic moment tensor inversion software package written by Dreger (2003) and updated by Minson & Dreger (2008) has been rewritten for inclusion into the open-source contributed code repository for the Boulder Real Time Technology (BRTT) Antelope Environmental Monitoring System. The new code-base was written natively in the Python language and utilizes both the Python interface to Antelope (Lindquist et al., 2008) for computation and the ObsPy library (Beyreuther et al., 2010) for graphical representation. The new moment tensor code uses the Center for Seismic Studies (CSS) 3.0 schema, and can be added to any real time earthquake monitoring system that uses the schema for post-event creation of moment tensor solutions. Converting the original code-base (Dreger, 2003; Minson & Dreger, 2008) from a combination of configuration scripts, Numerical Recipes for C, Seismic Analysis Code (SAC), the Fortran FKRPROG package (Saikia, 1994), and the various intermediary files in ASCII and binary formats greatly simplifies the installation and deployment of the software for use in Antelope Environmental Monitoring systems. All configuration files have been converted and condensed into a format familiar to users of the BRTT software suite.

Previous Method

Moment Tensor (MT)computation using the mtpackagev 1.1 package developed by Douglas Dreger of the Berkeley Seismological Laboratory, and the Green's functions computation using the FKRPROG software developed by Chandan Saikia of URS.



Plan

Rewrite of Doug Dreger's Time-Domain Moment Tensor INVerse Code using Antelope's Python Interface:

- All components are rewritten in Python
- New frequency-wavenumber integration module
- Remove intermediate data formats
- Remove wrapper scripts
- New Datascope schemas for MT results
- Consolidate configuration in .pf file

Required Python packages

Instruction for installation and configuration of code and required packages can be found at: http://eqinfo.ucsd.edu/~rnewman/howtos/antelope_contrib/moment_tensor/#addmods

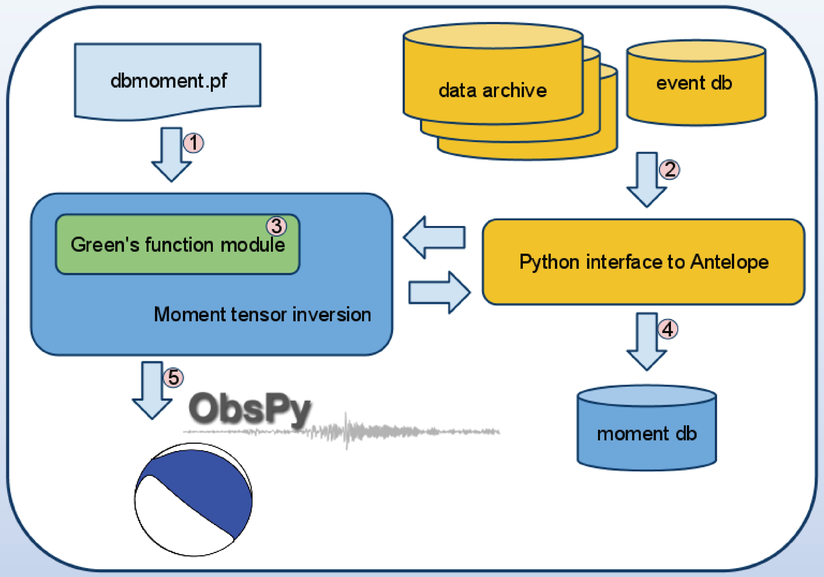
- Numpy - package needed for scientific computing with Python.
- Matplotlib - Python 2D plotting library which produces figures in a variety of formats.
- ObsPy - Open source Python toolbox for seismology.

New Method

The single process approach attempts to simplify the implementation, maintenance and usage of the moment tensor code. Every piece of the code is rewritten in Python and follows Antelope conventions.

1) Configure all variables from single parameter file.
2) Get all event data from specified database or from ORB in a realtime system.
3) Produce Green's functions in memory with module written in Python.
4) Save all products for the Moment tensor analysis in the database.
5) Use ObsPy to produce the required images for our new solution.

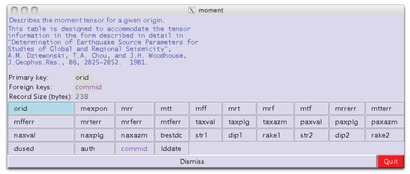
Archived solutions from local or remote repositories can be submitted to the script to generate new images. Focal mechanism solutions could complement event catalogs by expanding or replicating implemented distribution systems. It is possible to have a catalog of regional earth models available within the Antelope contributed code for the focal analysis of earthquake data from other catalogs or from remote sources.

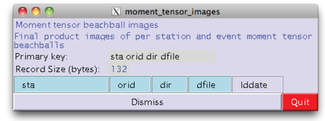


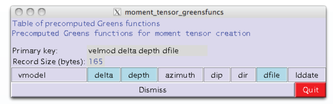
Moment tensor inversion process

1) Get origins and stations from Datascope tables.
2) Filtering and rotation from E-N-Z into R-T-Z.
3) Building of Data Matrix.
4) Get pre-calculated Green's functions from Datascope schema based on distance and azimuth.
5) Construct Green's Matrix
6) Calculate MT using both datasets.
7) Invert the MT and, from the eigen values/vectors, calculate the MT solution
8) Update Datascope with results.

Antelope schemas







Future development

- Frequency-Wavenumber integration module is not stable and requires some debugging.
- Expand code to decimate higher sampled data.
- Compare solutions against Dreger's solutions.

Download

You can download the code used in this presentation from the online Git repository hosted by Github. http://github.com/antelopeusersgroup/antelope_contrib

References

Beyreuther, M., Barsch, R., Krischer, L., Megies, T., Behr, Y. and Wassermann, J. (2010) ObsPy: A Python Toolbox for Seismology, Seismic Research Letters, 81(3), 530-533.

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Lindquist, K.G., Clemesha, A., Newman, R.L. and Vernon, F.L. (2008) The Python Interface to Antelope and Applications. Eos Trans. AGU 89(53), Fall Meet. Suppl., Abstract G43A-0671

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