Miscellaneous notes for *Tape and Tape* (2012a):
"A geometric setting for moment tensors"

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Walter Tape and Carl Tape

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This file can be found at:
`http://code.google.com/p/compearth/source/browse/trunk/momenttensor/plot/TapeTape2012_supp.pdf`

Browse a few related files in the `momenttensor` directory (see "Source" tab, then "Browse") of
`http://code.google.com/p/compearth/`

1 Computing source type coordinates on the fundamental lune

Here we present a guide for converting moment tensors to source types on the fundamental lune, then plotting. All equation references are for *Tape and Tape* (2012a).

1. Start with a moment tensor represented as a 3×3 symmetric matrix in some orthonormal basis (it does not matter which one). Compute the eigenvalues.

2. Sort the eigenvalues as $\lambda_1 \geq \lambda_2 \geq \lambda_3$. Then compute the (γ, β, ρ) coordinates with Eq. 21:

$$\begin{aligned} \tan\gamma &= \frac{-\lambda_1 + 2\lambda_2 - \lambda_3}{\sqrt{3}(\lambda_1 - \lambda_3)} \\ \cos\beta &= \frac{\lambda_1 + \lambda_2 + \lambda_3}{\sqrt{3}\|\mathbf{\Lambda}\|} \\ \rho &= \|\mathbf{\Lambda}\| \end{aligned}$$

   (Here ρ is not needed, but it represents the seismic moment: $M_0 = \rho/\sqrt{2}$.)

If you are starting with eigenvalues, rather than the moment tensor, then start with step 2.

1.1 Plotting in Mathematica

All 3D plots in *Tape and Tape* (2012a) were generated using Mathematica, which is commercial software. A Mathematica code to get started is available here:
`http://code.google.com/p/compearth/source/browse/trunk/momenttensor/plot/mma/Lune.nb`

1.2 Plotting in GMT

Generic Mapping Tools (GMT: *Wessel and Smith* (1991)) is open-source software. It provides numerous options for global projections. One example, the equal-area Hammer projection, is shown in Figure **??**. The key command in GMT is `-JH0/3i -R-30/30/-90/90`; this specifies the projection and also the region of the fundamental lune (γ-δ coordinates). A script to generate these plots, `lune.pl`, is available here:

`http://code.google.com/p/compearth/source/browse/trunk/momenttensor/plot/gmt/`

This requires several text files as well. (The easiest thing is to check out the whole directory `momenttensor`; see link to `compearth` project at the top.)

The 2D plotting option was intentionally not included in *Tape and Tape* (2012a) for two reasons: (1) the projection distracts from the key point that the lune is part of the sphere; (2) the projection, while equal-area, distorts areas that are undistorted on the sphere. Nevertheless, a comparison between Figures **??** and **??** shows that the 2D version might be preferred for representing points that span the full lune. In either case, we note that the 2D lune is preferred over the T-k source-type plots (*Hudson et al.*, 1989; *Tape and Tape*, 2012b).

References

Hudson, J. A., R. G. Pearce, and R. M. Rogers (1989), Source time plot for inversion of the moment tensor, *J. Geophys. Res.*, *94*(B1), 765–774.

Tape, W., and C. Tape (2012a), A geometric setting for moment tensors, *Geophys. J. Int.* (in press).

Tape, W., and C. Tape (2012b), A geometric comparison of source-type plots for moment tensors, *Geophys. J. Int.* (in press).

Wessel, P., and W. H. F. Smith (1991), Free software helps map and display data, *Eos Trans. Am. Geophys. Un.*, *72*(41), 441 ff.