GMT examples:

Plotting the content of the shear-wave splitting data base

Michael Grund
(Email: mgrund_info@gmx.de)

Karlsruhe Institute of Technology (KIT), Geophysical Institute, Karlsruhe, Germany

General information

If you make use of the content described in this manual please give reference to my dissertation in whose framework the presented map was developed:

> **Grund, M. (2019)**, *Exploring geodynamics at different depths with shear wave splitting*, Karlsruhe Institute of Technology (KIT), http://doi.org/10.5445/IR/1000091425.

Contents

1 Plotting the map

In this manual I provide GMT (Generic Mapping Tools, e.g. Wessel et al., 2013) instructions to go from a raw map in a global Robinson projection to a publication-ready figure that displays the individual shear-wave splitting measurements included in the shear-wave splitting data base (Barruol et al., 2009; Wüstefeld et al., 2009).

All content shown in the following is based on the bash-script `GMT_PLOT_splittingDB.gmt` that can be downloaded together with all required files (colormaps etc.) from https://github.com/michaelgrund/GMT-plotting. The content of the splitting data base was downloaded from http://splitting.gm.univ-montp2.fr/DB/. Scientific cyclic colormaps are provided by Fabio Crameri (Crameri, 2018a,b) and were downloaded from http://www.fabiocrameri.ch/cycliccolourmaps.php.

If GMT 5.2.1 (or higher, Wessel et al., 2013) is installed on your (Linux) system you can directly reproduce the whole content shown in this manual by running `GMT_PLOT_splittingDB.gmt` via command line. In the following the individual steps to get the final figure are lined out. Detailed comments on each step are included in the code blocks (gray boxes). Since the final GMT output is stored in a postscript file (`*.ps`), a pdf converter such as `ps2pdf` (see bottom of the last code block) should be installed on your system. Furthermore, to get a figure without white spaces around the plot, I recommend to install `pdfcrop` from Heiko Oberdiek (can be downloaded from https://ctan.org/pkg/pdfcrop?lang=de).

1.1 Basic settings

```
#!/bin/bash

gmtset  MAP_GRID_PEN_PRIMARY 0.3p,dimgrey \
        PROJ_LENGTH_UNIT c \
        MAP_ANNOT_OBLIQUE 30 \
        MAP_ANNOT_OFFSET 0.1i \
        MAP_ANNOT_OFFSET_PRIMARY 5p \
        MAP_ANNOT_OFFSET_SECONDARY 5p \
        COLOR_MODEL rgb \
        FONT_ANNOT_PRIMARY 8p,Helvetica \
        FONT_LABEL 8p \
        MAP_FRAME_WIDTH 2p \
        MAP_FRAME_PEN 1.2p \
        PS_CHAR_ENCODING Standard+ \
  MAP_TICK_LENGTH_PRIMARY 0i

################################################################################################
# GMT (5.2.1) script to plot the content of the shear-wave splitting data base
################################################################################################

# 2019, Michael Grund (KIT Karlsruhe, Geophysical Institute)

# Required files to run this script are included in the download directory.

################################################################################################
# If you use the content of this script or the accompanying files please acknowledge GMT
# and my PhD thesis (DOI: 10.5445/IR/1000091425).
################################################################################################

################################################################################################
# define output file name
outps=PLOT_GMT_splittingDB.ps

# use cyclic colormaps of Fabio Crameri downloaded from:
#
#       http://www.fabiocrameri.ch/cycliccolourmaps.php

cmap2use=vikO.cpt
#cmap2use=corkO.cpt
#cmap2use=brocO.cpt

################################################################################################
# data containing the individual shear-wave splitting results were downloaded from:
#
#       http://splitting.gm.univ-montp2.fr/DB/
#

################################################################################################
```

1.2 Plot continents and map gridlines

```
##########
# Fig. 1 # plot continents
##########

# add continents, only plot objects with areas larger than 10000 km^2 (-A10000)
# add annotations and lat/lon gridlines (-Bx... and -By...), only annotate south axis (-BweSn)
col_cont=217.6/217.6/217.6
pscoast -Rd -JN0/3.5i -Dc -G$col_cont -C$col_cont -K -P -A10000 -Bx90g45 -By30g15 -BweSn > $outps

#############################################################################################
```

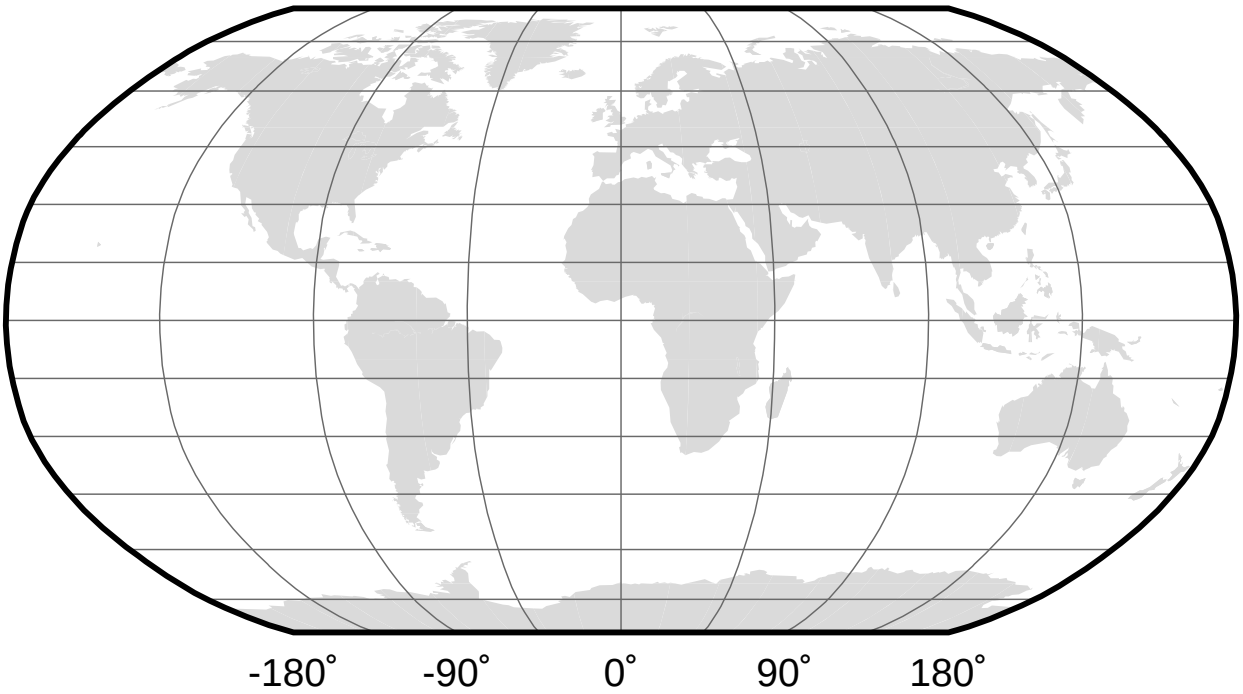

Figure 1: Plot the continents in light gray. Add also annotations, gridlines and a map frame.

1.3 Plot individual splitting measurements

```
##########
# Fig. 2 # plot splits
##########

# generate colormap based on the input given above
makecpt -C$cmap2use -T0/360/1 -M -Z > FASTcol.cpt

# color of bar edges
bar_edgecol=black

# process the splitting data and plot it as bars (-SJ), color-coded by the fast axis direction
# between 0 and 360 degrees and scaled by the delay time ($6*250), bar width is 70
awk 'BEGIN {FS="|"}{"NR > 1"}{if ($3*$3>0 && $6>0 && tolower($5) != "null" ) \
    print $4, $3, $5, $5, ($6*250), 70}' splittingDB.txt | psxy -R -J -SJ \
            -W0.01p,$bar_edgecol -CFASTcol.cpt -K -O >> $outps

#############################################################################################
```

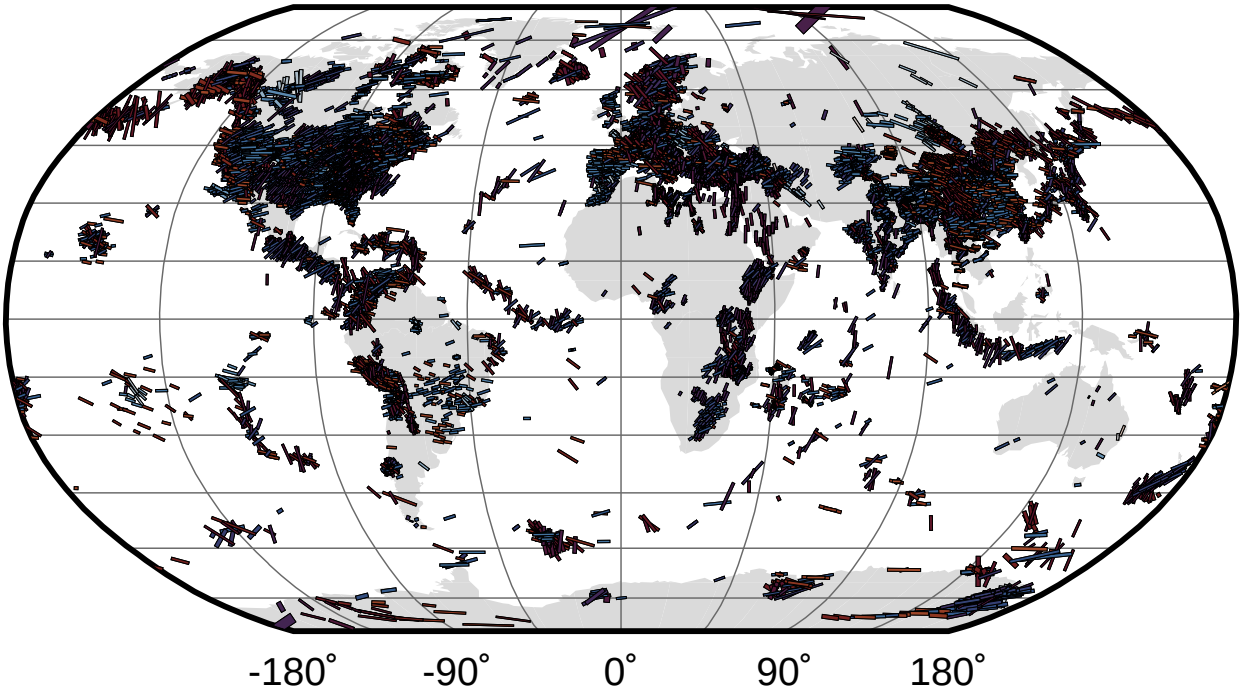

Figure 2: Plot the individual splitting measurements of the shear-wave splitting data base (Barruol et al., 2009; Wüstefeld et al., 2009), color-coded by the fast axis direction between 0° and 360° and scaled by the delay time.

1.4 Plot the colorbar

```
##########
# Fig. 3 # plot the colorbar
##########

# adjust some settings for plotting the scale
gmtset MAP_ANNOT_OFFSET 0.14i
gmtset MAP_TICK_LENGTH_PRIMARY -0.1i
gmtset MAP_FRAME_PEN 1p

# plot the bar with annotation, location and size of the bar is defined via -Dx, +h gives
# a horizontal bar
psscale -CFASTcol.cpt -Dx1.3/5.2+w2.5i/0.1i+ml+h -Bxa45+l"Fast axis direction" \
    -O -K >> $outps

##########
ps2pdf $outps $outps.pdf
pdfcrop $outps.pdf $outps.pdf
```

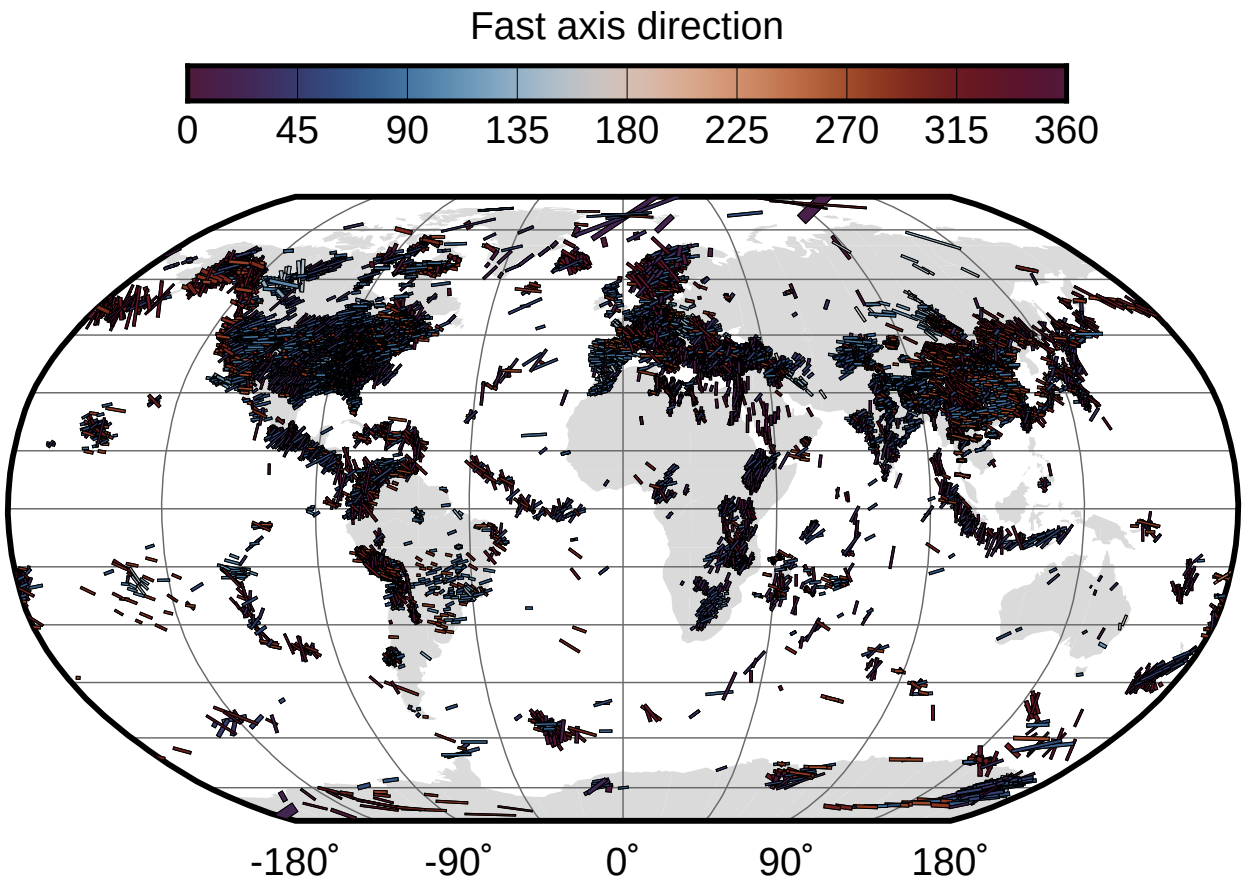

Figure 3: Plot the colorbar with annotations.

2 Using other colormaps

As mentioned in the beginning of this manual, of course you can also use other colormaps to plot the data. In principle each colormap available in (or converted to) GMT's cpt format can be used here. Fig. 4 displays three examples (including the one shown above) that can be easily reproduced by changing the `cmap2use` parameter (see first code box, default is `vik0.cpt`). The corresponding cyclic colormap files for these three examples (`vik0.cpt`, `cork0.cpt` and `broc0.cpt`) are already included in the download package. However, they can be also downloaded from Fabio Crameri's webpage (Crameri, 2018a,b).

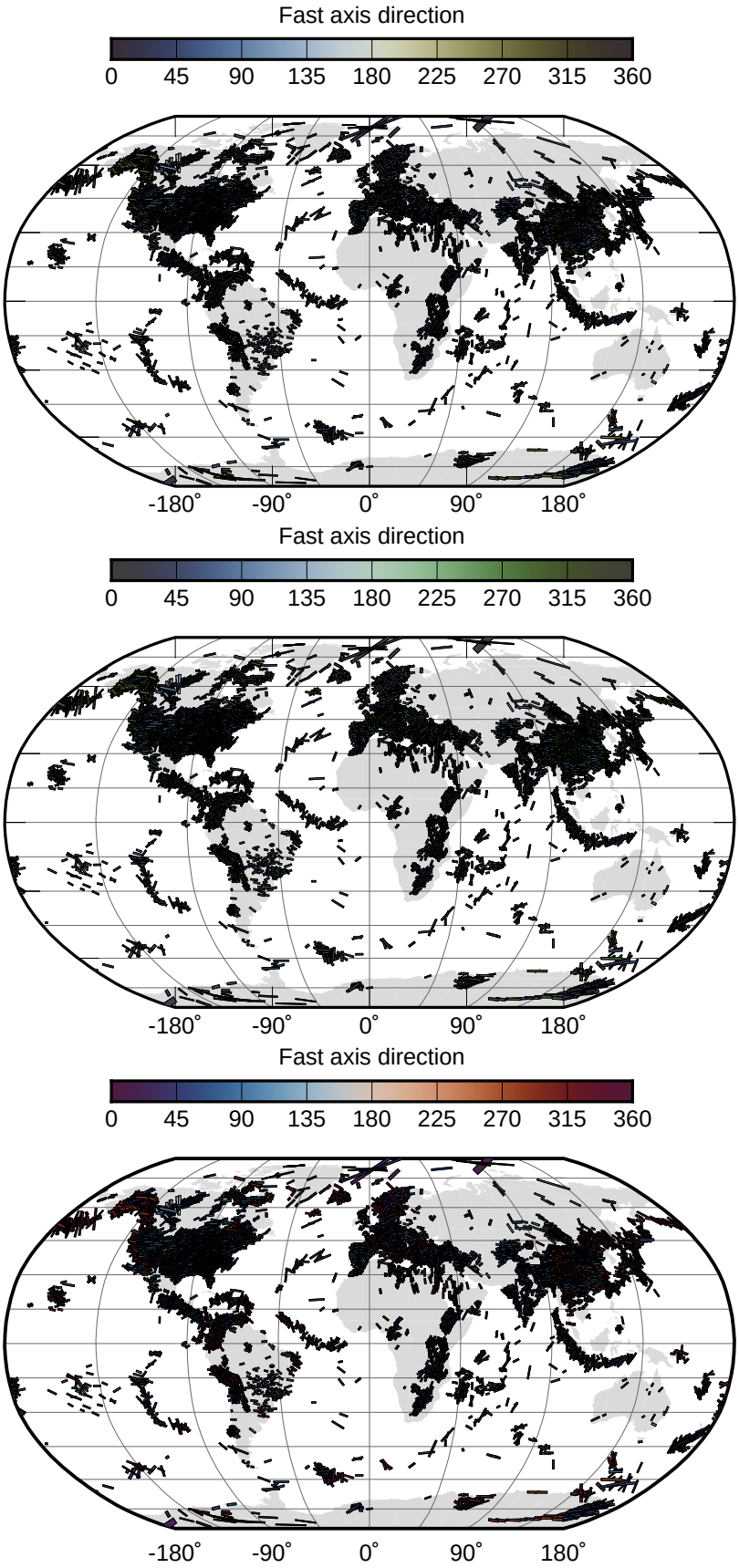

Figure 4: Using the cyclic colormaps (`brocO.cpt`, `corkO.cpt` and `vikO.cpt`) of Fabio Crameri (Crameri, 2018a,b) to plot the shear-wave splitting data.

References

Barruol, G., Wüestefeld, A., & Bokelmann, G., 2009. SKS-Splitting-database, Université de Montpellier, Laboratoire Géosciences, https://doi.org/10.18715/sks_splitting_database.

Crameri, F., 2018a. Scientific colour-maps, http://doi.org/10.5281/zenodo.1243862.

Crameri, F., 2018b. Geodynamic diagnostics, scientific visualisation and StagLab 3.0, *Geosci. Model Dev.*, **11**, 2541–2562, doi:10.5194/gmd–11–2541–2018.

Wessel, P., Smith, W. H. F., Scharroo, R., Luis, J., & Wobbe, F., 2013. Generic Mapping Tools: Improved version released, *Eos Trans. AGU*, **94(45)**, 409–420.

Wüstefeld, A., Bokelmann, G. H. R., Barruol, G., & Montagner, J.-P., 2009. Identifying global seismic anisotropy patterns by correlating shear-wave splitting and surface waves data, *Phys. Earth Planet. Int.*, **176**, 198–212.