Example of correction for SWS for DAS event

Prepare inputs and python module imports

In [1]:

```
# Import neccessary modules:
%load_ext autoreload
%autoreload 2
import sys,os
import numpy as np
import matplotlib
import matplotlib.pyplot as plt
%matplotlib notebook
# Import modules for downloading synthetic model data:
import gdown
# Modules from TomSHudson github:
import SeisSrcInv
```

0. Download snythetic model data (generated using fk)

In [2]:

```
# NOT NEEDED CURRENTLY, AS CURRENTLY EXPORT WITH ALL THE DATA

# Download fk synthetic data for example from google drive:
# (~ 200 mb)
# synth_gd_fnames_and_urls = np.loadtxt(os.path.join("inputs", "gdown_lnk_lis
# for i in range(len(synth_gd_fnames_and_urls[:,0])):
#     url = synth_gd_fnames_and_urls[i,1]
#     output = os.path.join("inputs","fk_greens_funcs_and_real_data",synth_gd
#     gdown.download(url, output, quiet=True)
# print("Finished downloading fk synthetic data")
```

1. Run small inversion:

Note that we only run for 1000 samples here, just to show the inversion working.

In [3]:

```
preform_inv = True

# Define paramters for performing actual inversion:
# Don't change parameters unless confident of what they do! See function help
datadir = os.path.join("inputs", "fk_greens_funcs_and_real_data")
nlloc_hyp_fname = os.path.join("inputs", 'loc.Tom__RunNLLoc000.20200114.04014
outdir = os.path.join('outputs', 'FW_data_out')
real_data_fnames = [] # List of real waveform data files within datadir corre
MT_green_func_fnames = [] # List of Green's functions data files (generated u
for i in range(0,960,10):
    real_data_fnames.append('real_data_D'+str(i).zfill(4)+'_das_axis.txt')
    MT_green_func_fnames.append('green_func_array_MT_D'+str(i).zfill(4)+'_das_
single_force_green_func_fnames = [] # List of Green's functions data files (g
data_labels = [] # Format of these labels must be of the form "station_name, 
for i in range(0,960,10):
    data_labels.append(''.join(('D', str(i).zfill(4), ', T')))
inversion_type = 'DC' # Inversion type automatically filled (if single force,
perform_normallised_waveform_inversion = True
num_samples = 1000 # Number of samples to perform Monte Carlo over (typically
comparison_metric = "VR"
# manual_indices_time_shift_MT = [0, 0, 0, 0, 0, 0, 0] # Don't need t specify
# manual_indices_time_shift_SF = [0, 0, 0, 0, 0, 0, 0] # Don't need t specify
auto_shift_for_best_fit = True #True # If True, performs automatic shift for 
cut_phase_start_vals = 600*np.ones(len(MT_green_func_fnames)) #500*np.ones(le
cut_phase_length = 200
num_processors = 10 # Number of processors to run for (default is 1)
```

```
set_pre_time_shift_values_to_zero_switch = False # If True, sets values befor
return_absolute_similarity_values_switch = True # If True, will also save abs
# For other options, see help(SeisSrcInv.inversion.run())
```

In [4]:

```
# Perform inversion:
if preform_inv:
    print("----------------------- Performing source mechanism inversion ----
    # Perform the inversion:
    SeisSrcInv.inversion.run(datadir, outdir, real_data_fnames, MT_green_func_
    print("----------------------- Finsihed performing source mechanism inver
```

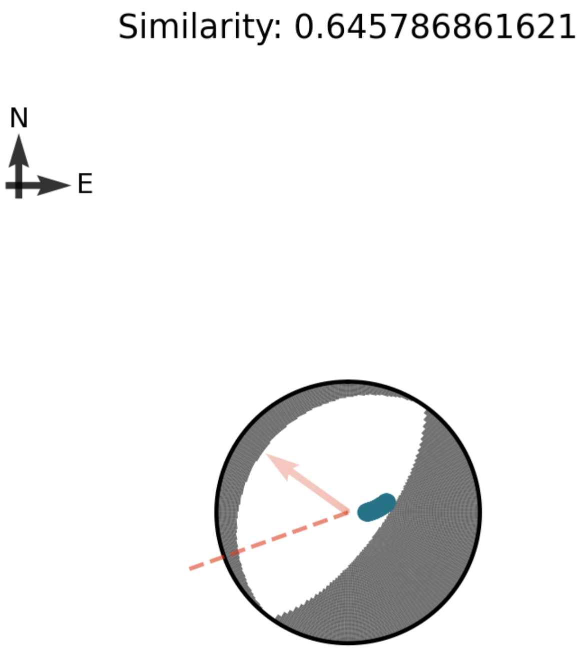
```
----------------------- Performing source mechanism inversion ----------------
-------
/Users/eart0504/Documents/python/github_repositories/SeisSrcInv/SeisSrcInv/inv
ersion.py:276: FutureWarning: `rcond` parameter will change to the default of
machine precision times ``max(M, N)`` where M and N are the input matrix dimen
sions.
To use the future default and silence this warning we advise to pass `rcond=No
ne`, to keep using the old, explicitly pass `rcond=-1`.
  M, res, rank, sing_values_G = np.linalg.lstsq(G,D) # Equivilent to M = G\D;
for G not square. If G is square, use linalg.solve(G,D)
Saving FW inversion to file: outputs/FW_data_out/least_squares_result/20200114
040142400428_FW_DC.pkl
Saving FW inversion to file: outputs/FW_data_out/least_squares_result/20200114
040142400428_FW_DC.wfs
Processing for process:Processing for process: 0 1 Processing for process:for
Processing for process: 2for 100   3 100Processing for process:for samples.
 4for samples. 100
for Processing for process:  100  samples.1005samples.
Processing for process:
 samples. for
6  for Processing for process:100   100samples.7
 Processing for process: samples.for
8 100  for samples. Processing for process:
100  samples.9
 for  100 samples.
Processor number: 0Processor number:  - Processed for1  0- Processed forProces
sor number:   samples out of0Processor number:2   Processor number: 1003sample
s out of - Processed for   - Processed for4samples 100 0
 - Processed for 0samples samples out of
0samples out ofProcessor number:    100100samples out ofProcessor number:5
samplessamples1006- Processed for

   samples- Processed forProcessor number:0
  07samples out of  Processor number: samples out of - Processed for100  8100
0   samplessamples- Processed for
samples out of
  0 100samples out of  samples100
 Processor number:samples
9 - Processed for 0 samples out of 100 samples
Finished processing process: 1 for  100Finished processing process: samples.
2 for  100 samples.
Finished processing process: 7 Finished processing process:for   5100  for  sa
mples.
Finished processing process:100  4samples.
Finished processing process:for   3100 Finished processing process: for  sampl
es. 8
100  for samples.
Finished processing process:100  6samples. for
 100Finished processing process:  samples.9
 for  100 samples.
Finished processing process: 0 for  100 samples.
Saving FW inversion to file: outputs/FW_data_out/20200114040142400428_FW_DC.pk
l
Saving FW inversion to file: outputs/FW_data_out/20200114040142400428_FW_DC.wf
s
Finished
```

```
----------------------- Finsihed performing source mechanism inversion -------
----------------
```

In [5]:

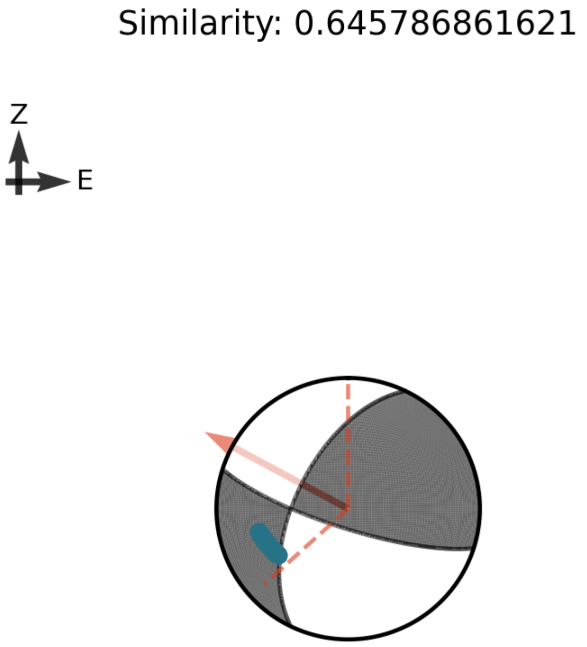
```
# Plot results:
# Define plotting parameters:
inversion_output_data_dir = outdir
plot_outdir = os.path.join('outputs','FW_data_out','plots')
event_uid = "20200114040142400428"
plot_wfs_on_focal_mech_switch= False
plot_uncertainty_switch = True
# DAS specific plotting parameters:
plot_das_wfs_switch=True
fs_das=1000.
SeisSrcInv.plot.run(inversion_type, event_uid, inversion_output_data_dir, plo
```

```
Plotting data for inversion
Processing data for: outputs/FW_data_out/20200114040142400428_FW_DC.pkl
Sampled 1000 out of 1000 events
```



```
(Skipping current nodal plane solution as can't plot.)
```

```
/Users/eart0504/opt/anaconda3/lib/python3.7/site-packages/numpy/core/_asarray.
py:136: VisibleDeprecationWarning: Creating an ndarray from ragged nested sequ
ences (which is a list-or-tuple of lists-or-tuples-or ndarrays with different
lengths or shapes) is deprecated. If you meant to do this, you must specify 'd
type=object' when creating the ndarray
  return array(a, dtype, copy=False, order=order, subok=True)
```



```
/Users/eart0504/opt/anaconda3/lib/python3.7/site-packages/numpy/core/_asarray.
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  return array(a, dtype, copy=False, order=order, subok=True)
```

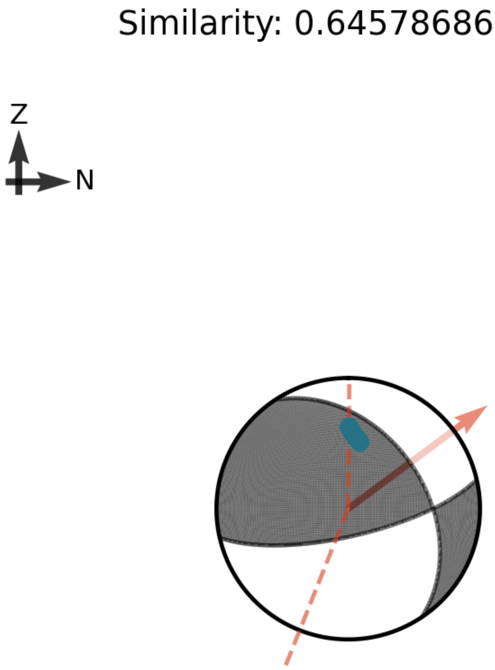

```
/Users/eart0504/opt/anaconda3/lib/python3.7/site-packages/numpy/core/_asarray.
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ences (which is a list-or-tuple of lists-or-tuples-or ndarrays with different
lengths or shapes) is deprecated. If you meant to do this, you must specify 'd
type=object' when creating the ndarray
  return array(a, dtype, copy=False, order=order, subok=True)
['D0000, T', 'D0010, T', 'D0020, T', 'D0030, T', 'D0040, T', 'D0050, T', 'D006
0, T', 'D0070, T', 'D0080, T', 'D0090, T', 'D0100, T', 'D0110, T', 'D0120, T',
'D0130, T', 'D0140, T', 'D0150, T', 'D0160, T', 'D0170, T', 'D0180, T', 'D019
0, T', 'D0200, T', 'D0210, T', 'D0220, T', 'D0230, T', 'D0240, T', 'D0250, T',
'D0260, T', 'D0270, T', 'D0280, T', 'D0290, T', 'D0300, T', 'D0310, T', 'D032
0, T', 'D0330, T', 'D0340, T', 'D0350, T', 'D0360, T', 'D0370, T', 'D0380, T',
'D0390, T', 'D0400, T', 'D0410, T', 'D0420, T', 'D0430, T', 'D0440, T', 'D045
0, T', 'D0460, T', 'D0470, T', 'D0480, T', 'D0490, T', 'D0500, T', 'D0510, T',
'D0520, T', 'D0530, T', 'D0540, T', 'D0550, T', 'D0560, T', 'D0570, T', 'D058
0, T', 'D0590, T', 'D0600, T', 'D0610, T', 'D0620, T', 'D0630, T', 'D0640, T',
'D0650, T', 'D0660, T', 'D0670, T', 'D0680, T', 'D0690, T', 'D0700, T', 'D071
0, T', 'D0720, T', 'D0730, T', 'D0740, T', 'D0750, T', 'D0760, T', 'D0770, T',
'D0780, T', 'D0790, T', 'D0800, T', 'D0810, T', 'D0820, T', 'D0830, T', 'D084
0, T', 'D0850, T', 'D0860, T', 'D0870, T', 'D0880, T', 'D0890, T', 'D0900, T',
'D0910, T', 'D0920, T', 'D0930, T', 'D0940, T', 'D0950, T']
```

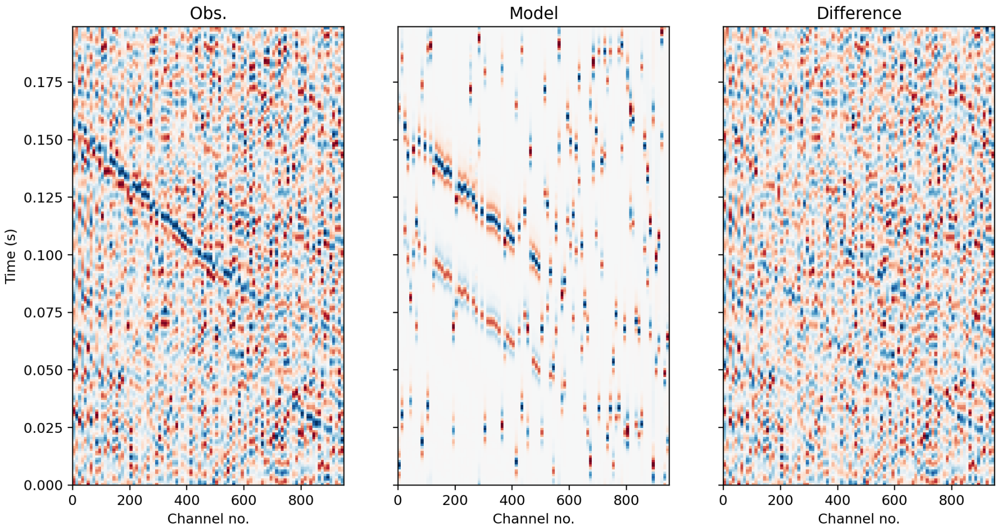

```
/Users/eart0504/Documents/python/github_repositories/SeisSrcInv/SeisSrcInv/plo
t.py:1465: MatplotlibDeprecationWarning: shading='flat' when X and Y have the
same dimensions as C is deprecated since 3.3.  Either specify the corners of t
he quadrilaterals with X and Y, or pass shading='auto', 'nearest' or 'gourau
d', or set rcParams['pcolor.shading'].  This will become an error two minor re
leases later.
  axes[0].pcolormesh(X, T, real_wfs, cmap='RdBu', vmin=-max_amp, vmax=max_amp)
/Users/eart0504/Documents/python/github_repositories/SeisSrcInv/SeisSrcInv/plo
t.py:1466: MatplotlibDeprecationWarning: shading='flat' when X and Y have the
same dimensions as C is deprecated since 3.3.  Either specify the corners of t
he quadrilaterals with X and Y, or pass shading='auto', 'nearest' or 'gourau
d', or set rcParams['pcolor.shading'].  This will become an error two minor re
leases later.
  axes[1].pcolormesh(X, T, synth_wfs, cmap='RdBu', vmin=-max_amp, vmax=max_am
p)
/Users/eart0504/Documents/python/github_repositories/SeisSrcInv/SeisSrcInv/plo
t.py:1467: MatplotlibDeprecationWarning: shading='flat' when X and Y have the
same dimensions as C is deprecated since 3.3.  Either specify the corners of t
he quadrilaterals with X and Y, or pass shading='auto', 'nearest' or 'gourau
d', or set rcParams['pcolor.shading'].  This will become an error two minor re
leases later.
  axes[2].pcolormesh(X, T, real_wfs - synth_wfs, cmap='RdBu', vmin=-max_amp, v
max=max_amp)
Full MT (max prob.):
[[  1.65402938e+11  -2.29348697e+11   3.05859336e+11]
 [ -2.29348697e+11   3.18016267e+11  -4.24106373e+11]
 [  3.05859336e+11  -4.24106373e+11  -4.83419205e+11]]
(For plotting radiation pattern)
Finished processing unconstrained inversion data for: outputs/FW_data_out/2020
0114040142400428_FW_DC.pkl
Finished
```

In [ ]: