SourceSpec Demo

Import modules

Import obspy and sourcespec

In [1]:
```
import obspy
```

In [2]:
```
import sourcespec2
from sourcespec2.source_spec import (ssp_run, ssp_output)
from sourcespec2.ssp_event import SSPEvent
from sourcespec2.ssp_pick import SSPPick
from sourcespec2.spectrum import AttributeDict
```

Import ROB-specific modules

In [3]:
```
import eqcatalog
import robspy
```

Read event, phase picks, waveform data and station inventory

Read earthquake from database and construct SSPEvent

In [4]:
```
id_earth = 21840
[eq] = eqcatalog.rob.query_local_eq_catalog_by_id(id_earth)
```

In [5]:
```
lon_dict = AttributeDict(value=eq.lon, units='deg')
lat_dict = AttributeDict(value=eq.lat, units='deg')
depth_dict = AttributeDict(value=eq.depth, units='km')
hypo_dict = AttributeDict(longitude=lon_dict, latitude=lat_dict, depth=depth_dic
mag_dict = AttributeDict(value=eq.ML, mag_type='ML')
event_dict = AttributeDict(event_id=eq.ID, name=eq.name, hypocenter=hypo_dict, m
event = SSPEvent()
event.from_event_dict(event_dict)
print(event)
```

```
Event ID: 21840
Name: VOEREN (BE)
Hypocenter:
  Longitude: 5.7793°, Latitude: 50.7467°, Depth: 19.8 km, Origin time: 2024-06-14
T18:45:47.660000Z
Magnitude: ML 1.6
```

Read waveform data and phase picks for selected event

In [6]:
```
sg_dict, pp_dict = robspy.rob.read_waveforms_and_picks(eq.ID, skip_stations_with
                                                       pre_p_time=30, min_total_
```

```
<EQ #21840 | 2024-06-14 18:45:47.660000 | VOEREN (BE) | 5.779 50.747 19.8 km | ML
=1.6 | ke>
Warning: duplicate S pick for BNS.KLL
Warning: duplicate S pick for DBN.HGN
Warning: duplicate S pick for DBN.VKB
Warning: duplicate S pick for DBN.TERZ
Determining available stations...
Reading seismograms...
3 Trace(s) in Stream:
BE.CLA..HHE | 2024-06-14T18:45:26.767000Z - 2024-06-14T18:46:18.887000Z | 100.0 H
z, 5213 samples
BE.CLA..HHN | 2024-06-14T18:45:26.767000Z - 2024-06-14T18:46:18.887000Z | 100.0 H
z, 5213 samples
BE.CLA..HHZ | 2024-06-14T18:45:26.767000Z - 2024-06-14T18:46:18.887000Z | 100.0 H
z, 5213 samples
3 Trace(s) in Stream:
BE.DOU..HHE | 2024-06-14T18:45:35.780000Z - 2024-06-14T18:46:52.010000Z | 100.0 H
z, 7624 samples
BE.DOU..HHN | 2024-06-14T18:45:35.780000Z - 2024-06-14T18:46:52.010000Z | 100.0 H
z, 7624 samples
BE.DOU..HHZ | 2024-06-14T18:45:35.780000Z - 2024-06-14T18:46:52.010000Z | 100.0 H
z, 7624 samples
3 Trace(s) in Stream:
BE.DSLB..HHE | 2024-06-14T18:45:30.440000Z - 2024-06-14T18:46:31.835000Z | 200.0
Hz, 12280 samples
BE.DSLB..HHN | 2024-06-14T18:45:30.440000Z - 2024-06-14T18:46:31.835000Z | 200.0
Hz, 12280 samples
BE.DSLB..HHZ | 2024-06-14T18:45:30.440000Z - 2024-06-14T18:46:31.835000Z | 200.0
Hz, 12280 samples
3 Trace(s) in Stream:
BE.BEBN..HHE | 2024-06-14T18:45:21.230000Z - 2024-06-14T18:46:00.150000Z | 100.0
Hz, 3893 samples
BE.BEBN..HHN | 2024-06-14T18:45:21.230000Z - 2024-06-14T18:46:00.150000Z | 100.0
Hz, 3893 samples
BE.BEBN..HHZ | 2024-06-14T18:45:21.230000Z - 2024-06-14T18:46:00.150000Z | 100.0
Hz, 3893 samples
3 Trace(s) in Stream:
BE.GES..HHE | 2024-06-14T18:45:28.918000Z - 2024-06-14T18:46:25.168000Z | 100.0 H
z, 5626 samples
BE.GES..HHN | 2024-06-14T18:45:28.918000Z - 2024-06-14T18:46:25.168000Z | 100.0 H
z, 5626 samples
BE.GES..HHZ | 2024-06-14T18:45:28.918000Z - 2024-06-14T18:46:25.168000Z | 100.0 H
z, 5626 samples
3 Trace(s) in Stream:
BE.GRAP..HHE | 2024-06-14T18:45:35.310000Z - 2024-06-14T18:46:49.160000Z | 100.0
Hz, 7386 samples
BE.GRAP..HHN | 2024-06-14T18:45:35.310000Z - 2024-06-14T18:46:49.160000Z | 100.0
Hz, 7386 samples
BE.GRAP..HHZ | 2024-06-14T18:45:35.310000Z - 2024-06-14T18:46:49.160000Z | 100.0
Hz, 7386 samples
3 Trace(s) in Stream:
BE.HOU..HHE | 2024-06-14T18:45:26.330000Z - 2024-06-14T18:46:16.660000Z | 100.0 H
z, 5034 samples
BE.HOU..HHN | 2024-06-14T18:45:26.330000Z - 2024-06-14T18:46:16.660000Z | 100.0 H
z, 5034 samples
BE.HOU..HHZ | 2024-06-14T18:45:26.330000Z - 2024-06-14T18:46:16.660000Z | 100.0 H
z, 5034 samples
3 Trace(s) in Stream:
BE.KLB..HHE | 2024-06-14T18:45:30.870000Z - 2024-06-14T18:46:31.775000Z | 200.0 H
z, 12182 samples
```

```
BE.KLB..HHN | 2024-06-14T18:45:30.870000Z - 2024-06-14T18:46:31.775000Z | 200.0 H
z, 12182 samples
BE.KLB..HHZ | 2024-06-14T18:45:30.870000Z - 2024-06-14T18:46:31.775000Z | 200.0 H
z, 12182 samples
3 Trace(s) in Stream:
BE.LCH..HHE | 2024-06-14T18:45:22.190000Z - 2024-06-14T18:46:02.620000Z | 100.0 H
z, 4044 samples
BE.LCH..HHN | 2024-06-14T18:45:22.190000Z - 2024-06-14T18:46:02.620000Z | 100.0 H
z, 4044 samples
BE.LCH..HHZ | 2024-06-14T18:45:22.190000Z - 2024-06-14T18:46:02.620000Z | 100.0 H
z, 4044 samples
3 Trace(s) in Stream:
BE.LCHA..HNE | 2024-06-14T18:45:22.190000Z - 2024-06-14T18:46:03.120000Z | 200.0
Hz, 8187 samples
BE.LCHA..HNN | 2024-06-14T18:45:22.190000Z - 2024-06-14T18:46:03.120000Z | 200.0
Hz, 8187 samples
BE.LCHA..HNZ | 2024-06-14T18:45:22.190000Z - 2024-06-14T18:46:03.120000Z | 200.0
Hz, 8187 samples
3 Trace(s) in Stream:
BE.MEMA..HNE | 2024-06-14T18:45:22.550000Z - 2024-06-14T18:46:04.885000Z | 200.0
Hz, 8468 samples
BE.MEMA..HNN | 2024-06-14T18:45:22.550000Z - 2024-06-14T18:46:04.885000Z | 200.0
Hz, 8468 samples
BE.MEMA..HNZ | 2024-06-14T18:45:22.550000Z - 2024-06-14T18:46:04.885000Z | 200.0
Hz, 8468 samples
3 Trace(s) in Stream:
BE.MEM..HHE | 2024-06-14T18:45:22.520000Z - 2024-06-14T18:46:04.870000Z | 100.0 H
z, 4236 samples
BE.MEM..HHN | 2024-06-14T18:45:22.520000Z - 2024-06-14T18:46:04.870000Z | 100.0 H
z, 4236 samples
BE.MEM..HHZ | 2024-06-14T18:45:22.520000Z - 2024-06-14T18:46:04.870000Z | 100.0 H
z, 4236 samples
3 Trace(s) in Stream:
BE.MRD..HHE | 2024-06-14T18:45:32.300000Z - 2024-06-14T18:46:38.800000Z | 100.0 H
z, 6651 samples
BE.MRD..HHN | 2024-06-14T18:45:32.300000Z - 2024-06-14T18:46:38.800000Z | 100.0 H
z, 6651 samples
BE.MRD..HHZ | 2024-06-14T18:45:32.300000Z - 2024-06-14T18:46:38.800000Z | 100.0 H
z, 6651 samples
3 Trace(s) in Stream:
BE.MRG..HHE | 2024-06-14T18:45:24.141000Z - 2024-06-14T18:46:10.171000Z | 100.0 H
z, 4604 samples
BE.MRG..HHN | 2024-06-14T18:45:24.141000Z - 2024-06-14T18:46:10.171000Z | 100.0 H
z, 4604 samples
BE.MRG..HHZ | 2024-06-14T18:45:24.141000Z - 2024-06-14T18:46:10.171000Z | 100.0 H
z, 4604 samples
3 Trace(s) in Stream:
BE.OPTB..HHE | 2024-06-14T18:45:25.588000Z - 2024-06-14T18:46:13.268000Z | 100.0
Hz, 4769 samples
BE.OPTB..HHN | 2024-06-14T18:45:25.588000Z - 2024-06-14T18:46:13.268000Z | 100.0
Hz, 4769 samples
BE.OPTB..HHZ | 2024-06-14T18:45:25.588000Z - 2024-06-14T18:46:13.268000Z | 100.0
Hz, 4769 samples
3 Trace(s) in Stream:
BE.RCHB..HHE | 2024-06-14T18:45:30.590000Z - 2024-06-14T18:46:32.690000Z | 100.0
Hz, 6211 samples
BE.RCHB..HHN | 2024-06-14T18:45:30.590000Z - 2024-06-14T18:46:32.690000Z | 100.0
Hz, 6211 samples
BE.RCHB..HHZ | 2024-06-14T18:45:30.590000Z - 2024-06-14T18:46:32.690000Z | 100.0
Hz, 6211 samples
```

```
3 Trace(s) in Stream:
BE.RQR..HHE | 2024-06-14T18:45:35.580000Z - 2024-06-14T18:46:50.830000Z | 100.0 H
z, 7526 samples
BE.RQR..HHN | 2024-06-14T18:45:35.580000Z - 2024-06-14T18:46:50.830000Z | 100.0 H
z, 7526 samples
BE.RQR..HHZ | 2024-06-14T18:45:35.580000Z - 2024-06-14T18:46:50.830000Z | 100.0 H
z, 7526 samples
3 Trace(s) in Stream:
BE.SKQ..HHE | 2024-06-14T18:45:37.220000Z - 2024-06-14T18:46:55.800000Z | 100.0 H
z, 7859 samples
BE.SKQ..HHN | 2024-06-14T18:45:37.220000Z - 2024-06-14T18:46:55.800000Z | 100.0 H
z, 7859 samples
BE.SKQ..HHZ | 2024-06-14T18:45:37.220000Z - 2024-06-14T18:46:55.800000Z | 100.0 H
z, 7859 samples
3 Trace(s) in Stream:
BE.SNF..HHE | 2024-06-14T18:45:35.640000Z - 2024-06-14T18:46:50.610000Z | 100.0 H
z, 7498 samples
BE.SNF..HHN | 2024-06-14T18:45:35.640000Z - 2024-06-14T18:46:50.610000Z | 100.0 H
z, 7498 samples
BE.SNF..HHZ | 2024-06-14T18:45:35.640000Z - 2024-06-14T18:46:50.610000Z | 100.0 H
z, 7498 samples
3 Trace(s) in Stream:
BE.STI..HHE | 2024-06-14T18:45:23.063000Z - 2024-06-14T18:46:06.043000Z | 100.0 H
z, 4299 samples
BE.STI..HHN | 2024-06-14T18:45:23.063000Z - 2024-06-14T18:46:06.043000Z | 100.0 H
z, 4299 samples
BE.STI..HHZ | 2024-06-14T18:45:23.063000Z - 2024-06-14T18:46:06.043000Z | 100.0 H
z, 4299 samples
3 Trace(s) in Stream:
BE.STIA..HNE | 2024-06-14T18:45:23.100000Z - 2024-06-14T18:46:05.910000Z | 200.0
Hz, 8563 samples
BE.STIA..HNN | 2024-06-14T18:45:23.100000Z - 2024-06-14T18:46:05.910000Z | 200.0
Hz, 8563 samples
BE.STIA..HNZ | 2024-06-14T18:45:23.100000Z - 2024-06-14T18:46:05.910000Z | 200.0
Hz, 8563 samples
3 Trace(s) in Stream:
BE.STNB..HNE | 2024-06-14T18:45:22.770000Z - 2024-06-14T18:46:04.875000Z | 200.0
Hz, 8422 samples
BE.STNB..HNN | 2024-06-14T18:45:22.770000Z - 2024-06-14T18:46:04.875000Z | 200.0
Hz, 8422 samples
BE.STNB..HNZ | 2024-06-14T18:45:22.770000Z - 2024-06-14T18:46:04.875000Z | 200.0
Hz, 8422 samples
3 Trace(s) in Stream:
BE.THEA..HNE | 2024-06-14T18:45:23.630000Z - 2024-06-14T18:46:08.095000Z | 200.0
Hz, 8894 samples
BE.THEA..HNN | 2024-06-14T18:45:23.630000Z - 2024-06-14T18:46:08.095000Z | 200.0
Hz, 8894 samples
BE.THEA..HNZ | 2024-06-14T18:45:23.630000Z - 2024-06-14T18:46:08.095000Z | 200.0
Hz, 8894 samples
3 Trace(s) in Stream:
BE.TNL..HHE | 2024-06-14T18:45:23.641000Z - 2024-06-14T18:46:08.831000Z | 100.0 H
z, 4520 samples
BE.TNL..HHN | 2024-06-14T18:45:23.641000Z - 2024-06-14T18:46:08.831000Z | 100.0 H
z, 4520 samples
BE.TNL..HHZ | 2024-06-14T18:45:23.641000Z - 2024-06-14T18:46:08.831000Z | 100.0 H
z, 4520 samples
3 Trace(s) in Stream:
BE.VIA..HHE | 2024-06-14T18:45:33.830000Z - 2024-06-14T18:46:42.155000Z | 200.0 H
z, 13666 samples
BE.VIA..HHN | 2024-06-14T18:45:33.830000Z - 2024-06-14T18:46:42.155000Z | 200.0 H
```

```
z, 13666 samples
BE.VIA..HHZ | 2024-06-14T18:45:33.830000Z - 2024-06-14T18:46:42.155000Z | 200.0 H
z, 13666 samples
```

Construct obspy Stream

In [7]:
```
st = obspy.Stream()
for sg in sg_dict.values():
    st.extend([comp._trace for comp in sg.components])
```

Construct obspy Inventory

In [8]:
```
# TODO: allow None/empty inventory if config.correct_instrumental_response is Fa
inventory = obspy.Inventory()
for sg in sg_dict.values():
    inventory += sg.get_or_construct_inventory()
print(inventory)
```

```
Inventory created at 2024-07-11T14:11:55.528843Z
        Created by: ObsPy 1.2.2
                    https://www.obspy.org
        Sending institution: ObsPy 1.2.2,ObsPy's obspy.io.xseed version 1.2.2
        Contains:
                Networks (25):
                        BE (25x)
                Stations (25):
                        BE.BEBN (Eben-Emael, Belgium)
                        BE.CLA (Clavier, Belgium)
                        BE.DOU (Dourbes, Belgium)
                        BE.DSLB (Dessel borehole, Belgium)
                        BE.GES (Gesves, Belgium)
                        BE.GRAP (Grapfontaine, Neufchateau, Belgium)
                        BE.HOU (Houvegnez, Belgium)
                        BE.KLB (Kalborn, Luxembourg)
                        BE.LCH (La Chartreuse, Bressoux, Belgium)
                        BE.LCHA (La Chartreuse, Bressoux, Belgium)
                        BE.MEM (Membach, Belgium)
                        BE.MEMA (Membach, Belgium)
                        BE.MRD (Maredsous, Belgium)
                        BE.MRG (Mont Rigi, Belgium)
                        BE.OPTB (Opitter borehole, Belgium)
                        BE.RCHB (Rochefort, Belgium)
                        BE.RQR (Ronquieres, Belgium)
                        BE.SKQ (Steenkerque, Belgium)
                        BE.SNF (Seneffe, Belgium)
                        BE.STI (Sart Tilman, Liege, Belgium)
                        BE.STIA (Sart Tilman, Liege, Belgium)
                        BE.STNB (Saint-Nicolas, Belgium)
                        BE.THEA (Theux, Belgium)
                        BE.TNL (Ternell, Belgium)
                        BE.VIA (Vianden, Luxembourg)
                Channels (75):
                        BE.BEBN..HHZ, BE.BEBN..HHN, BE.BEBN..HHE, BE.CLA..HHZ, B
E.CLA..HHN
                        BE.CLA..HHE, BE.DOU..HHZ, BE.DOU..HHN, BE.DOU..HHE, BE.DS
LB..HHZ
                        BE.DSLB..HHN, BE.DSLB..HHE, BE.GES..HHZ, BE.GES..HHN, B
E.GES..HHE
                        BE.GRAP..HHZ, BE.GRAP..HHN, BE.GRAP..HHE, BE.HOU..HHZ,
                        BE.HOU..HHN, BE.HOU..HHE, BE.KLB..HHZ, BE.KLB..HHN, BE.KL
B..HHE,
                        BE.LCH..HHZ, BE.LCH..HHN, BE.LCH..HHE, BE.LCHA..HNZ, BE.L
CHA..HNN,
                        BE.LCHA..HNE, BE.MEM..HHZ, BE.MEM..HHN, BE.MEM..HHE, BE.M
EMA..HNZ,
                        BE.MEMA..HNN, BE.MEMA..HNE, BE.MRD..HHZ, BE.MRD..HHN, BE.
MRD..HHE,
                        BE.MRG..HHZ, BE.MRG..HHN, BE.MRG..HHE, BE.OPTB..HHZ, BE.O
PTB..HHN,
                        BE.OPTB..HHE, BE.RCHB..HHZ, BE.RCHB..HHN, BE.RCHB..HHE, B
E.RQR..HHZ
                        BE.RQR..HHN, BE.RQR..HHE, BE.SKQ..HHZ, BE.SKQ..HHN, BE.SK
Q..HHE,
                        BE.SNF..HHZ, BE.SNF..HHN, BE.SNF..HHE, BE.STI..HHZ, BE.ST
I..HHN,
                        BE.STI..HHE, BE.STIA..HNZ, BE.STIA..HNN, BE.STIA..HNE, B
E.STNB..HNZ
                        BE.STNB..HNN, BE.STNB..HNE, BE.THEA..HNZ, BE.THEA..HNN,
```

```
                            BE.THEA..HNE, BE.TNL..HHZ, BE.TNL..HHN, BE.TNL..HHE, BE.V
IA..HHZ,
                            BE.VIA..HHN, BE.VIA..HHE
```

Construct list of SSPPick objects

In [9]:
```
picks = []
for nw_stat_code, station_picks in pp_dict.items():
    for _pick in station_picks.values():
        pick = SSPPick()
        pick.station = _pick.station_code
        pick.flag = _pick.onset
        pick.phase = _pick.phase_name
        pick.polarity = _pick.first_motion
        pick.quality = {True: 1, False: 3}[_pick.manual]
        pick.time = _pick.datetime
        picks.append(pick)
```

Configure sourcespec

Load default configuration

In [10]:
```
from sourcespec2.config import config
```

Override configuration settings

In [11]:
```
config.author_name = 'Kris Vanneste'
config.author_email = 'kris.vanneste@oma.be'
config.agency_full_name = 'Royal Observatory of Belgium'
config.agency_short_name = 'ROB'

config.epi_dist_ranges = [5, 200]
#config.correct_instrument_response = True
config.p_arrival_tolerance = 1.5
config.s_arrival_tolerance = 1.5
config.variable_win_length_factor = 0.5
config.wave_type = 'S'
config.clipping_detection_algorithm = None
config.vp_source = [5.5]
config.vs_source = [3.2]
config.rho_source = [2500]
config.rp_from_focal_mechanism = False

config.plot_show = True
config.plot_save = False
```

Append command-line arguments to config

In [12]:
```
options = AttributeDict()
options.sampleconf = False
options.updateconf = None
options.samplesspevent = False
options.updatedb = False
options.config_file = None
options.qml_file = None
options.hypo_file = None
options.pick_file = None
```

```
options.evname = eq.name
options.evid = str(eq.ID)
options.station = None
options.station_metadata = None
options.no_response = False
options.run_id = None
options.run_id_subdir = None
options.outdir = None
options.trace_path = ''
config.options = options
```

Hack for missing or wrongly specified config attributes

In [13]:
```
config.TRACEID_MAP = None
config.Er_freq_range = [None, None]
```

Run sourcespec

In [14]:
```
result = ssp_run(st, inventory, event, picks)
```

```
BE.CLA..HHE: noise window ends after P-window start
BE.CLA..HHN: noise window ends after P-window start
BE.CLA..HHZ: noise window ends after P-window start
BE.DOU..HHE: noise window ends after P-window start
BE.DOU..HHN: noise window ends after P-window start
BE.DOU..HHZ: noise window ends after P-window start
BE.DSLB..HHE: noise window ends after P-window start
BE.DSLB..HHN: noise window ends after P-window start
BE.DSLB..HHZ: noise window ends after P-window start
BE.GES..HHE: noise window ends after P-window start
BE.GES..HHN: noise window ends after P-window start
BE.GES..HHZ: noise window ends after P-window start
BE.GRAP..HHE: noise window ends after P-window start
BE.GRAP..HHN: noise window ends after P-window start
BE.GRAP..HHZ: noise window ends after P-window start
BE.HOU..HHE: noise window ends after P-window start
BE.HOU..HHN: noise window ends after P-window start
BE.HOU..HHZ: noise window ends after P-window start
BE.KLB..HHE: noise window ends after P-window start
BE.KLB..HHN: noise window ends after P-window start
BE.KLB..HHZ: noise window ends after P-window start
BE.MRD..HHE: noise window ends after P-window start
BE.MRD..HHN: noise window ends after P-window start
BE.MRD..HHZ: noise window ends after P-window start
BE.MRG..HHE: noise window ends after P-window start
BE.MRG..HHN: noise window ends after P-window start
BE.MRG..HHZ: noise window ends after P-window start
BE.OPTB..HHE: noise window ends after P-window start
BE.OPTB..HHN: noise window ends after P-window start
BE.OPTB..HHZ: noise window ends after P-window start
BE.RCHB..HHE: noise window ends after P-window start
BE.RCHB..HHN: noise window ends after P-window start
BE.RCHB..HHZ: noise window ends after P-window start
BE.RQR..HHE: noise window ends after P-window start
BE.RQR..HHN: noise window ends after P-window start
BE.RQR..HHZ: noise window ends after P-window start
BE.SKQ..HHE: noise window ends after P-window start
BE.SKQ..HHN: noise window ends after P-window start
BE.SKQ..HHZ: noise window ends after P-window start
BE.SNF..HHE: noise window ends after P-window start
BE.SNF..HHN: noise window ends after P-window start
BE.SNF..HHZ: noise window ends after P-window start
BE.THEA..HNE: noise window ends after P-window start
BE.THEA..HNN: noise window ends after P-window start
BE.THEA..HNZ: noise window ends after P-window start
BE.TNL..HHE: noise window ends after P-window start
BE.TNL..HHN: noise window ends after P-window start
BE.TNL..HHZ: noise window ends after P-window start
BE.VIA..HHE: noise window ends after P-window start
BE.VIA..HHN: noise window ends after P-window start
BE.VIA..HHZ: noise window ends after P-window start
BE.CLA..HH: truncating signal window to noise length!
BE.CLA..HH: truncating signal window to noise length!
BE.CLA..HH: truncating signal window to noise length!
BE.DOU..HH: truncating signal window to noise length!
BE.DOU..HH: truncating signal window to noise length!
BE.DOU..HH: truncating signal window to noise length!
BE.DSLB..HH: truncating signal window to noise length!
BE.DSLB..HH: truncating signal window to noise length!
BE.DSLB..HH: truncating signal window to noise length!
```

```
BE.GES..HH: truncating signal window to noise length!
BE.GES..HH: truncating signal window to noise length!
BE.GES..HH: truncating signal window to noise length!
BE.GRAP..HH: truncating signal window to noise length!
BE.GRAP..HH: truncating signal window to noise length!
BE.GRAP..HH: truncating signal window to noise length!
BE.HOU..HH: truncating signal window to noise length!
BE.HOU..HH: truncating signal window to noise length!
BE.HOU..HH: truncating signal window to noise length!
BE.KLB..HH: truncating signal window to noise length!
BE.KLB..HH: truncating signal window to noise length!
BE.KLB..HH: truncating signal window to noise length!
BE.MRD..HH: truncating signal window to noise length!
BE.MRD..HH: truncating signal window to noise length!
BE.MRD..HH: truncating signal window to noise length!
BE.MRG..HH: truncating signal window to noise length!
BE.MRG..HH: truncating signal window to noise length!
BE.MRG..HH: truncating signal window to noise length!
BE.OPTB..HH: truncating signal window to noise length!
BE.OPTB..HH: truncating signal window to noise length!
BE.OPTB..HH: truncating signal window to noise length!
BE.RCHB..HH: truncating signal window to noise length!
BE.RCHB..HH: truncating signal window to noise length!
BE.RCHB..HH: truncating signal window to noise length!
BE.RQR..HH: truncating signal window to noise length!
BE.RQR..HH: truncating signal window to noise length!
BE.RQR..HH: truncating signal window to noise length!
BE.SKQ..HH: truncating signal window to noise length!
BE.SKQ..HH: truncating signal window to noise length!
BE.SKQ..HH: truncating signal window to noise length!
BE.SNF..HH: truncating signal window to noise length!
BE.SNF..HH: truncating signal window to noise length!
BE.SNF..HH: truncating signal window to noise length!
BE.THEA..HN: truncating signal window to noise length!
BE.THEA..HN: truncating signal window to noise length!
BE.THEA..HN: truncating signal window to noise length!
BE.TNL..HH: truncating signal window to noise length!
BE.TNL..HH: truncating signal window to noise length!
BE.TNL..HH: truncating signal window to noise length!
BE.VIA..HH: truncating signal window to noise length!
BE.VIA..HH: truncating signal window to noise length!
BE.VIA..HH: truncating signal window to noise length!
BE.CLA..HHH broadb: optimal fc within 0.1% of fc_max: 23.839 ~= 23.839: ignoring
inversion results
BE.SKQ..HHH broadb: optimal fc within 0.1% of fc_max: 26.139 ~= 26.139: ignoring
inversion results
```

Unpack and print result

In [15]:
```
(proc_st, spec_st, specnoise_st, weight_st, sspec_output) = result
```

In [16]:
```
sspec_output.mean_values()
```

Out[16]:

```
{'Mw': 1.8003854705126805,
 'Mo': 595933611490.81055,
 'fc': 9.7462389743198745,
 't_star': 0.011030813402790249,
 'radius': 115.67527665512435,
 'ssd': 0.14492969533081676,
 'Qo': 2941.2484316291907,
 'Er': 905375.2252872329,
 'sigma_a': 0.03522159257486604}
```


In [17]:
```
sspec_output.reference_summary_parameters()
```

```
Out[17]:  {'Mw': SummaryStatistics([('_stat_type', 'weighted_mean'),
                                    ('value', 1.7771196921811931),
                                    ('uncertainty', 0.14985438291776121),
                                    ('lower_uncertainty', None),
                                    ('upper_uncertainty', None),
                                    ('confidence_level', 68.269999999999996),
                                    ('lower_percentage', None),
                                    ('mid_percentage', None),
                                    ('upper_percentage', None),
                                    ('nobs', 22),
                                    ('message', None),
                                    ('_format_spec', '{:.2f}')]),
           'Mo': SummaryStatistics([('_stat_type', 'weighted_mean'),
                                    ('value', 545467251748.65137),
                                    ('uncertainty', None),
                                    ('lower_uncertainty', 192738798315.27362),
                                    ('upper_uncertainty', 298055633445.59351),
                                    ('confidence_level', 68.269999999999996),
                                    ('lower_percentage', None),
                                    ('mid_percentage', None),
                                    ('upper_percentage', None),
                                    ('nobs', 21),
                                    ('message', None),
                                    ('_format_spec', '{:.3e}')]),
           'fc': SummaryStatistics([('_stat_type', 'weighted_mean'),
                                    ('value', 6.8054383679930393),
                                    ('uncertainty', None),
                                    ('lower_uncertainty', 2.1178793806870777),
                                    ('upper_uncertainty', 3.07475546124118),
                                    ('confidence_level', 68.269999999999996),
                                    ('lower_percentage', None),
                                    ('mid_percentage', None),
                                    ('upper_percentage', None),
                                    ('nobs', 23),
                                    ('message', None),
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           't_star': SummaryStatistics([('_stat_type', 'weighted_mean'),
                                    ('value', 0.0065147841529086623),
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                                    ('upper_uncertainty', None),
                                    ('confidence_level', 68.269999999999996),
                                    ('lower_percentage', None),
                                    ('mid_percentage', None),
                                    ('upper_percentage', None),
                                    ('nobs', 23),
                                    ('message', None),
                                    ('_format_spec', '{:.3f}')]),
           'radius': SummaryStatistics([('_stat_type', 'weighted_mean'),
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                                    ('uncertainty', None),
                                    ('lower_uncertainty', 37.999820145044964),
                                    ('upper_uncertainty', 49.750206199233304),
                                    ('confidence_level', 68.269999999999996),
                                    ('lower_percentage', None),
                                    ('mid_percentage', None),
                                    ('upper_percentage', None),
                                    ('nobs', 22),
                                    ('message', None),
                                    ('_format_spec', '{:.3f}')]),
```

```
'ssd': SummaryStatistics([('_stat_type', 'weighted_mean'),
                  ('value', 0.059770119648575863),
                  ('uncertainty', None),
                  ('lower_uncertainty', 0.039861511540370015),
                  ('upper_uncertainty', 0.11967322382316531),
                  ('confidence_level', 68.269999999999996),
                  ('lower_percentage', None),
                  ('mid_percentage', None),
                  ('upper_percentage', None),
                  ('nobs', 22),
                  ('message', None),
                  ('_format_spec', '{:.3e}')]),
'Qo': SummaryStatistics([('_stat_type', 'weighted_mean'),
                  ('value', 515.69079091107437),
                  ('uncertainty', 436.60660022748897),
                  ('lower_uncertainty', None),
                  ('upper_uncertainty', None),
                  ('confidence_level', 68.269999999999996),
                  ('lower_percentage', None),
                  ('mid_percentage', None),
                  ('upper_percentage', None),
                  ('nobs', 21),
                  ('message', None),
                  ('_format_spec', '{:.1f}')]),
'Er': SummaryStatistics([('_stat_type', 'weighted_mean'),
                  ('value', 905375.2252872329),
                  ('uncertainty', None),
                  ('lower_uncertainty', 729189.96015510475),
                  ('upper_uncertainty', 3747138.1273429082),
                  ('confidence_level', 68.269999999999996),
                  ('lower_percentage', None),
                  ('mid_percentage', None),
                  ('upper_percentage', None),
                  ('nobs', 22),
                  ('message', None),
                  ('_format_spec', '{:.3e}')]),
'sigma_a': SummaryStatistics([('_stat_type', 'weighted_mean'),
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                  ('uncertainty', None),
                  ('lower_uncertainty', 0.027202502455193123),
                  ('upper_uncertainty', 0.11063514295933675),
                  ('confidence_level', 68.269999999999996),
                  ('lower_percentage', None),
                  ('mid_percentage', None),
                  ('upper_percentage', None),
                  ('nobs', 22),
                  ('message', None),
                  ('_format_spec', '{:.3e}')])}
```