WWU
MÜNSTER

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Q coda

Coda amplitude is unrelated to the source-receiver distance.

Variations in the peak amplitudes of the coda are the result of site amplifications.

Coda amplitude decays with increased lapse time (time since event).

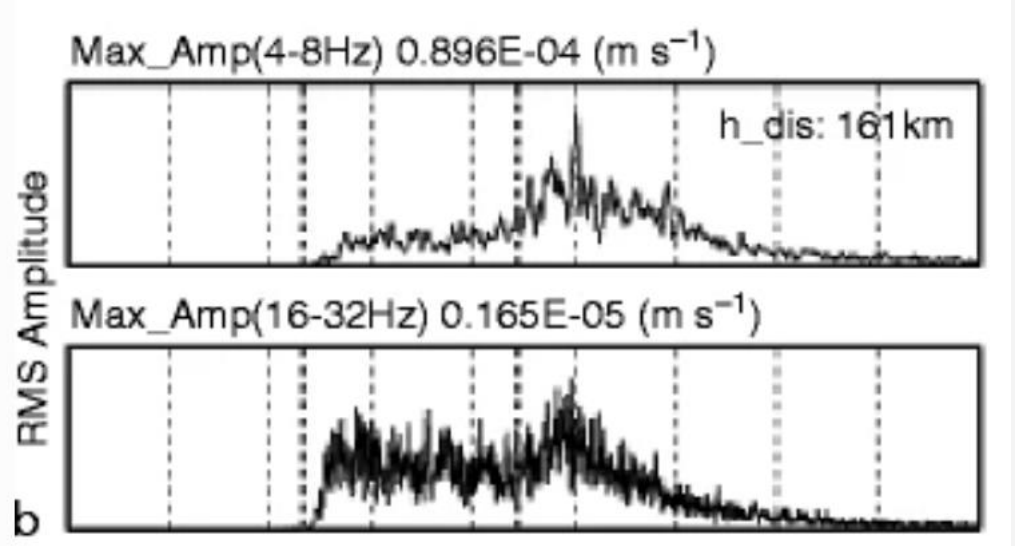
The site amplification factor for the coda wave was found to be the same as direct S waves, suggesting the coda consists primarily of backscattered S waves

Q coda

Peak delay

Delay between the onset of the direct shear wave and the maximum of the amplitude.

Observations are usually focused on the *S* wave train for which pulse broadening is usually much clearer than for *P* waves



Radiative transfer theory

The radiative transfer equation also takes into account the anisotropy of the scattering process, in particular large-angle scattering

(Margerin, 2011)

Q determination: Qopen (Eulenfeld and Wegler, 2016)

1) Caluclate Gij for fixed g0
2) Solve: ln Eobs=ln Emod
   for R, W and b
3) Repeat for range of g0 to find minimized misfit
4) Repeat for different events and frequency ranges.

$$E_{\mathrm{mod}ij} = R_i W G_{ij}(g0) e^{-bt_{ij}}$$

Ri = site amplification factor
W = spectral source energy
Gij(g0) = scattering Green‘s function
- g0 = scattering parameter
e^{btij} = constant damping
- b = absorption constant

(Eulenfeld and Wegler, 2016)

Q determination: Qopen (Eulenfeld and Wegler, 2016)

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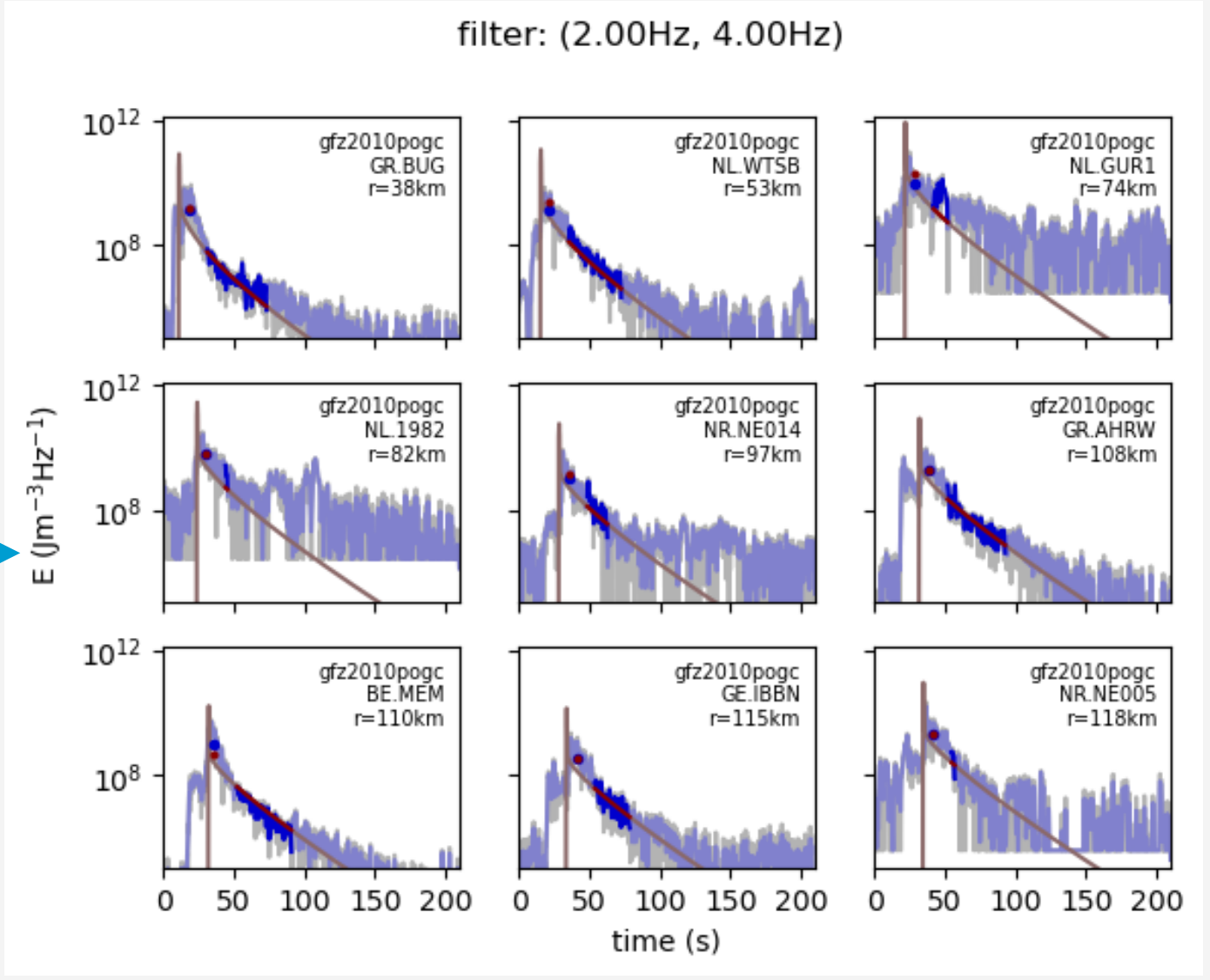

Q determination: Qopen (Eulenfeld and Wegler, 2016)

1) Caluclate Gij for fixed g0
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   for R, W and b
3) Repeat for range of g0 to find minimized misfit
4) Repeat for different events and frequency ranges.

$$Q_{sc}^{-1} = \frac{g0v0}{2\pi f}$$

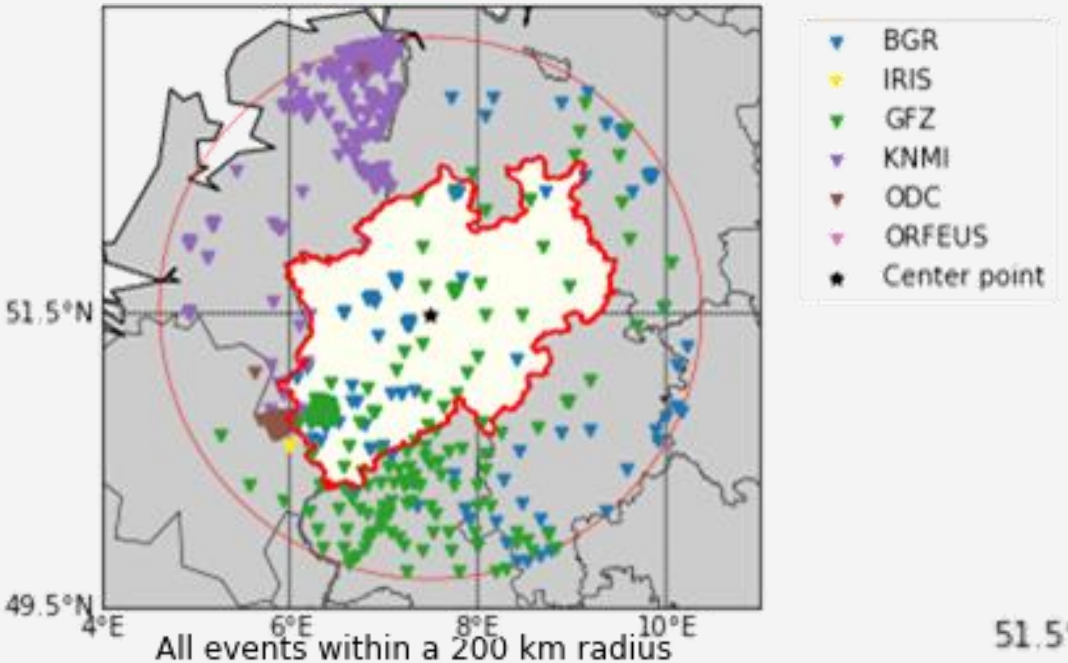
$$Q_{i}^{-1} = \frac{b}{2\pi f}$$

g0 = scattering parameter
b = absorption constant
v0 = velocity
f = frequency

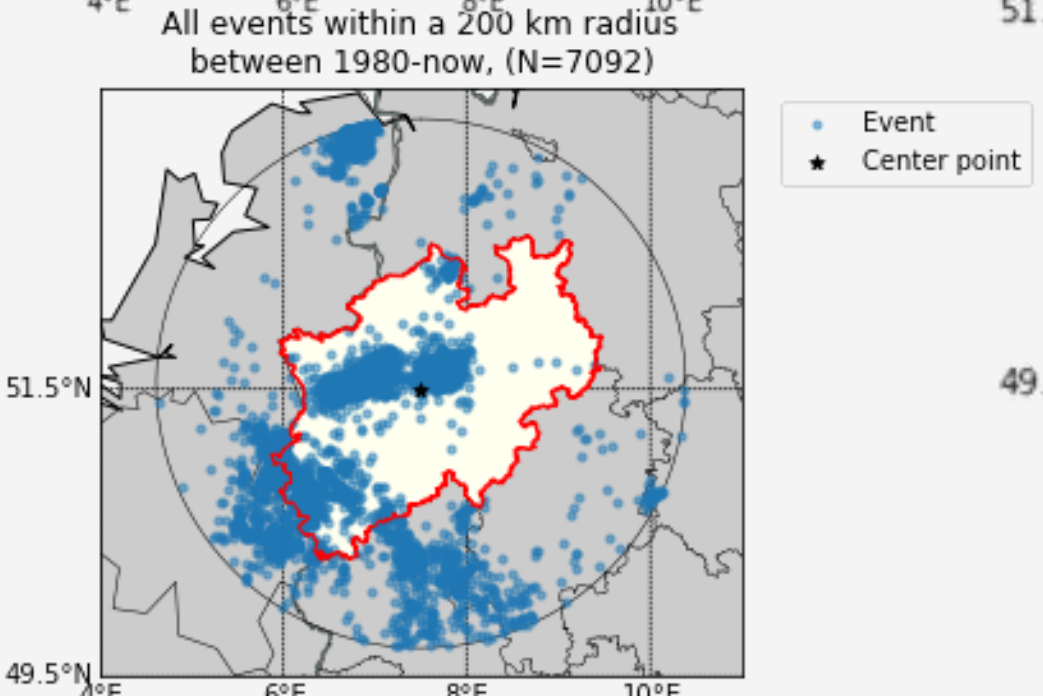
(Eulenfeld and Wegler, 2016)

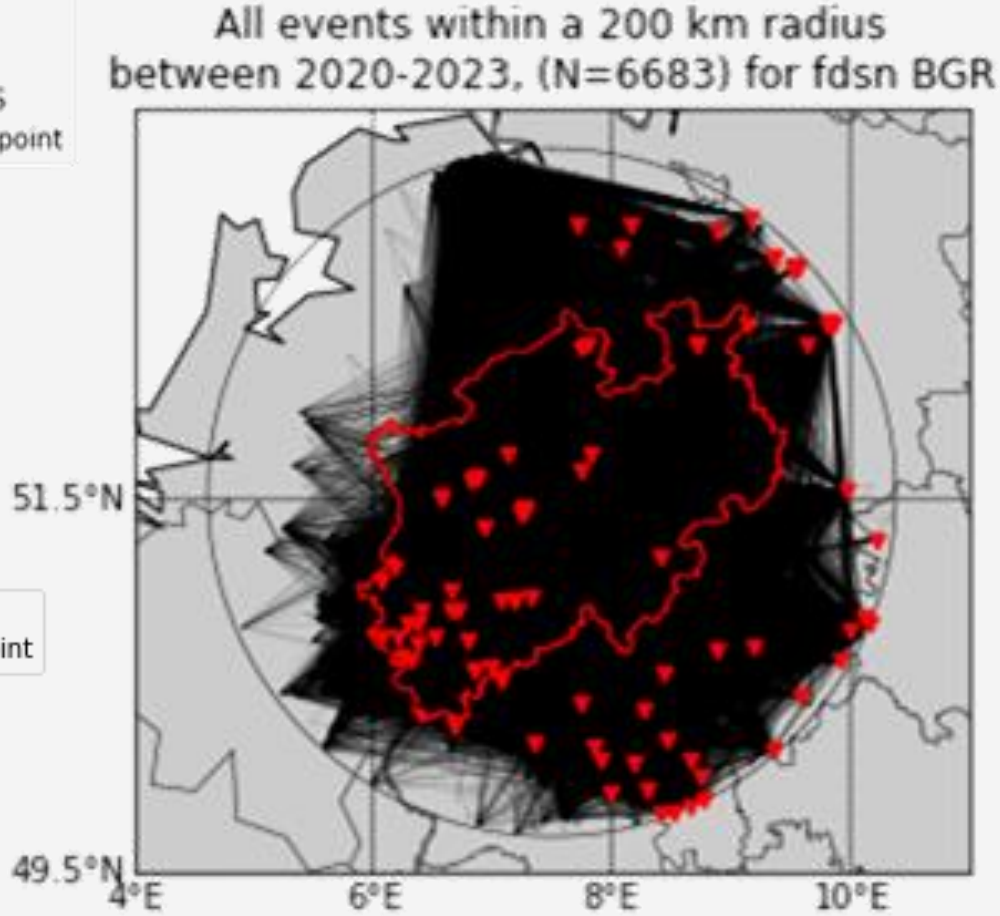
Flashback

Stations



Events

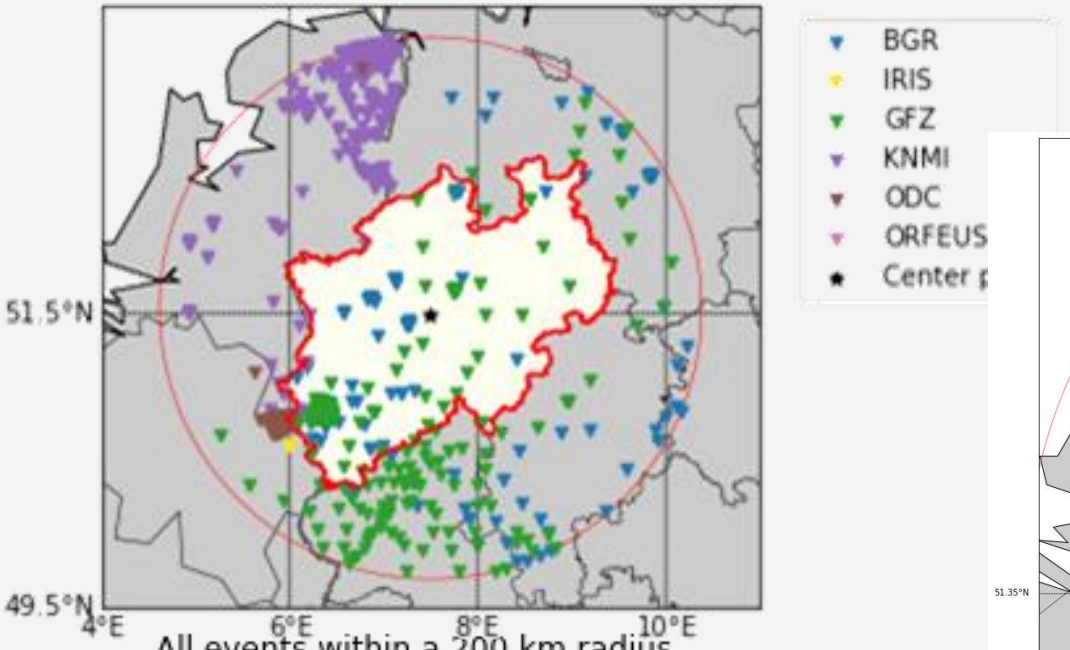




Paths

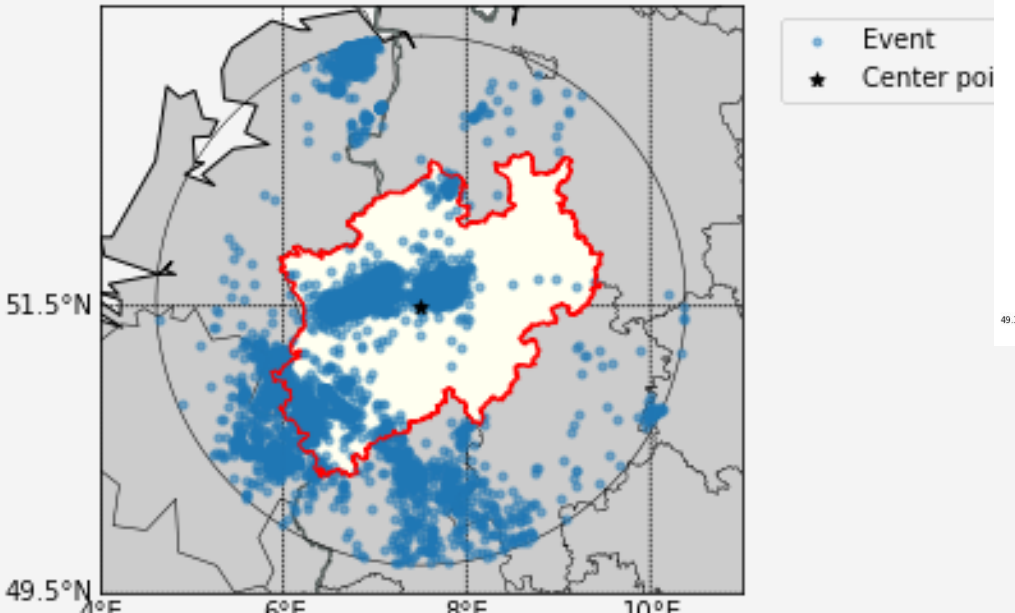
Flashback

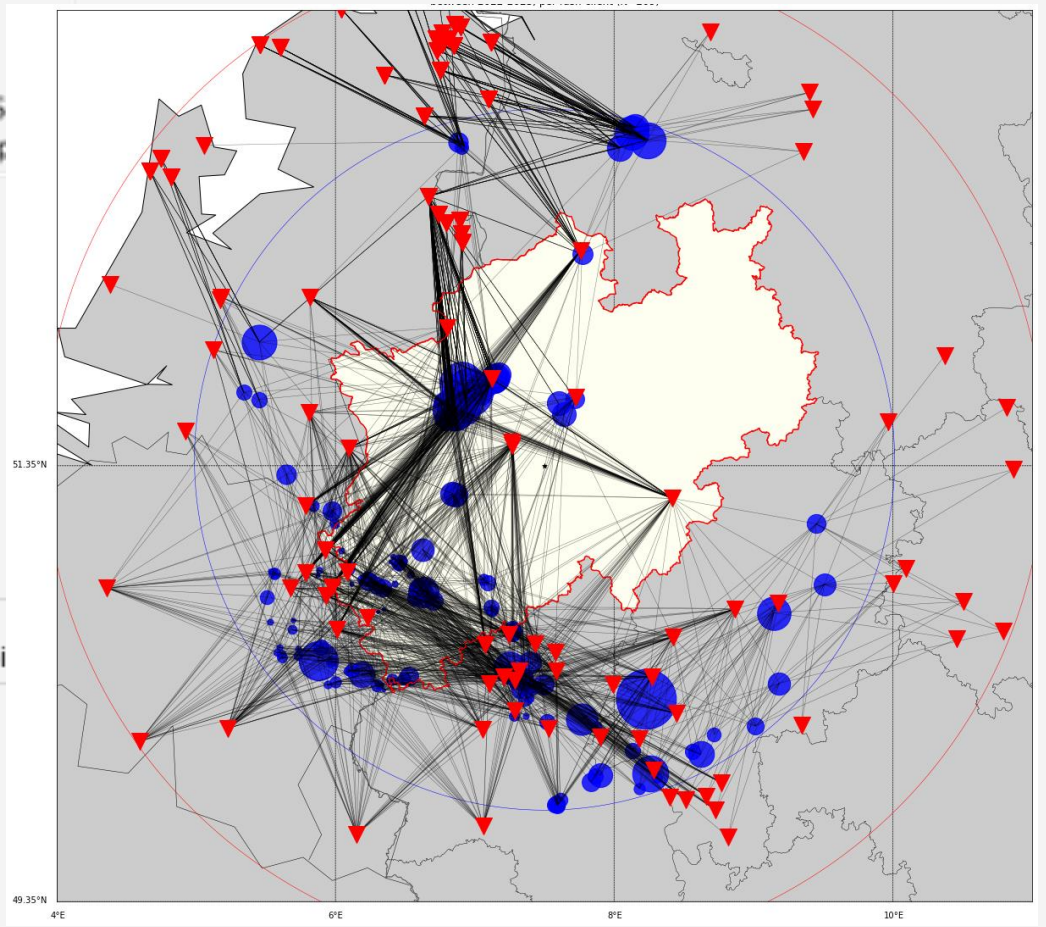
Stations



All events within a 200 km radius between 1980-now, (N=7092)

Events





Paths

Qopen

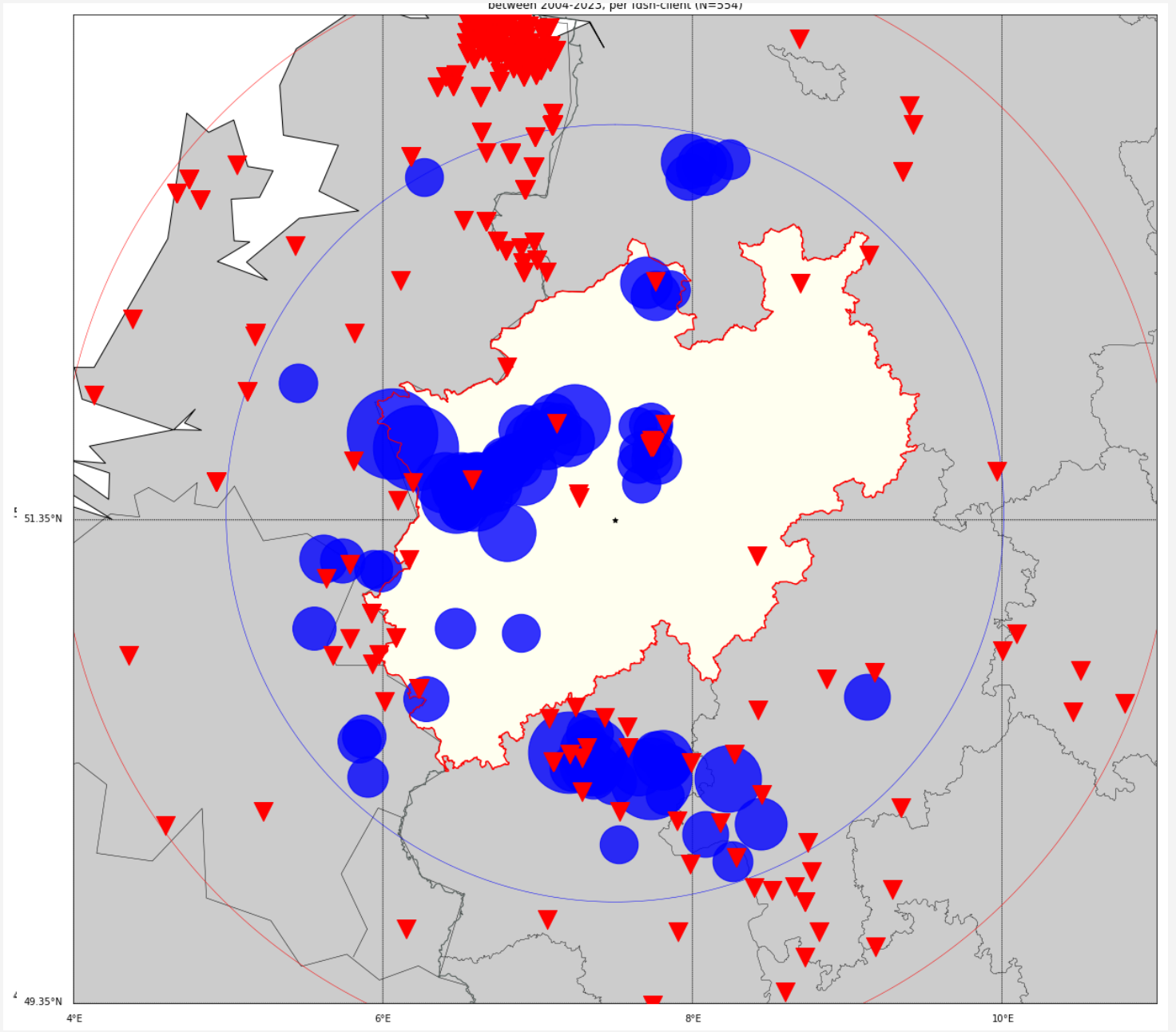
Nr events = 62

2004-now

> 3.0 M

< 175 km radius EV

< 125 km radius src-rec



Qopen

Nr events = ~~62~~ 9

~~2004-now~~ 2014-2016

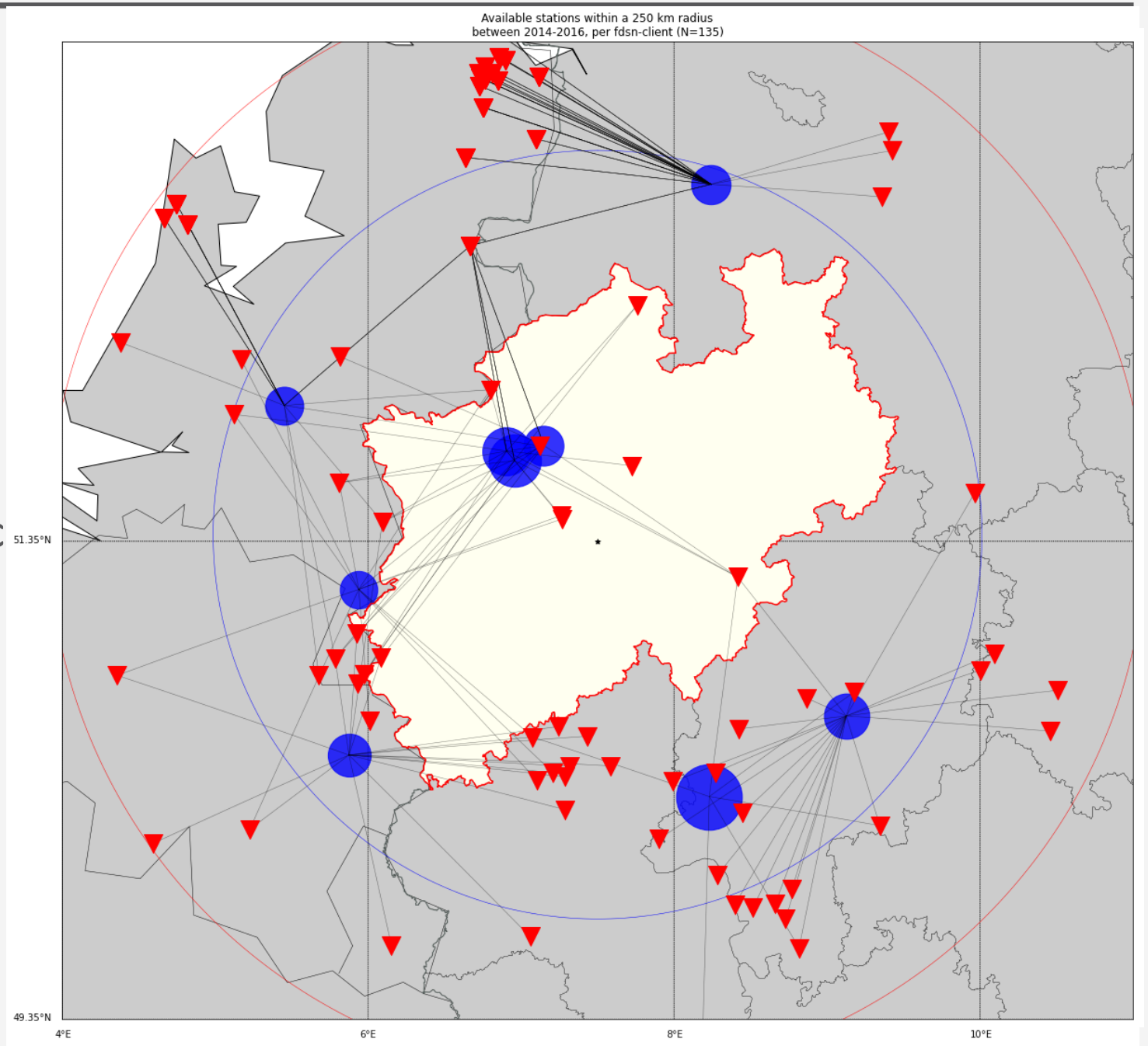
> 3.0 M

< 175 km radius EV

< 125 km radius src-rec

Detrend, remove response,

bandpass filter 0.1-50Hz



Qopen

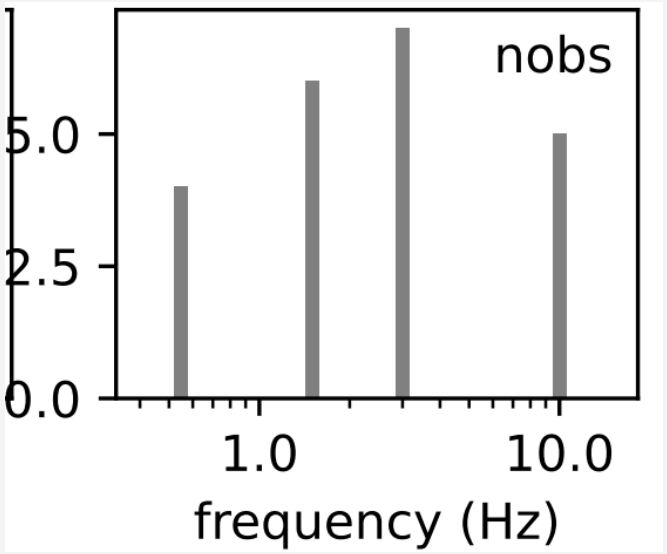
Nr events = 9

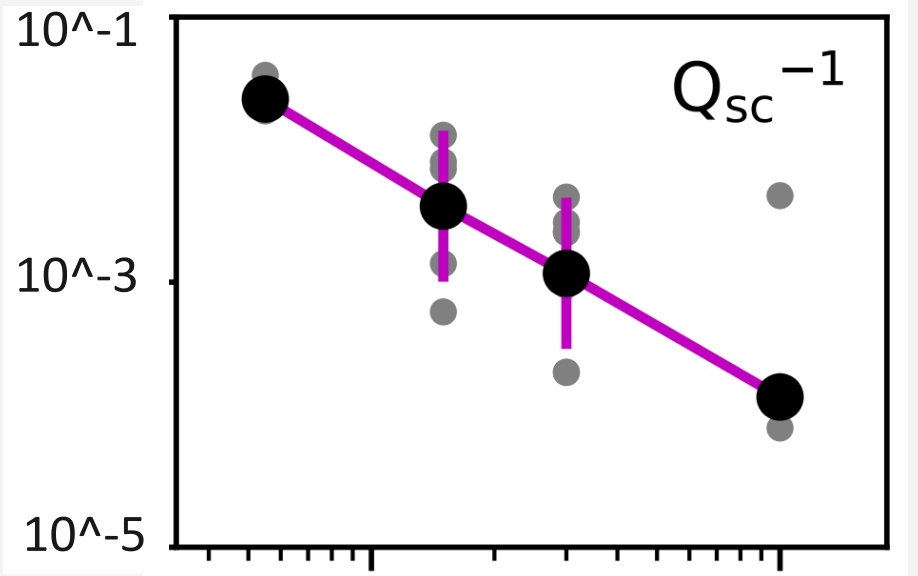
2014-2016

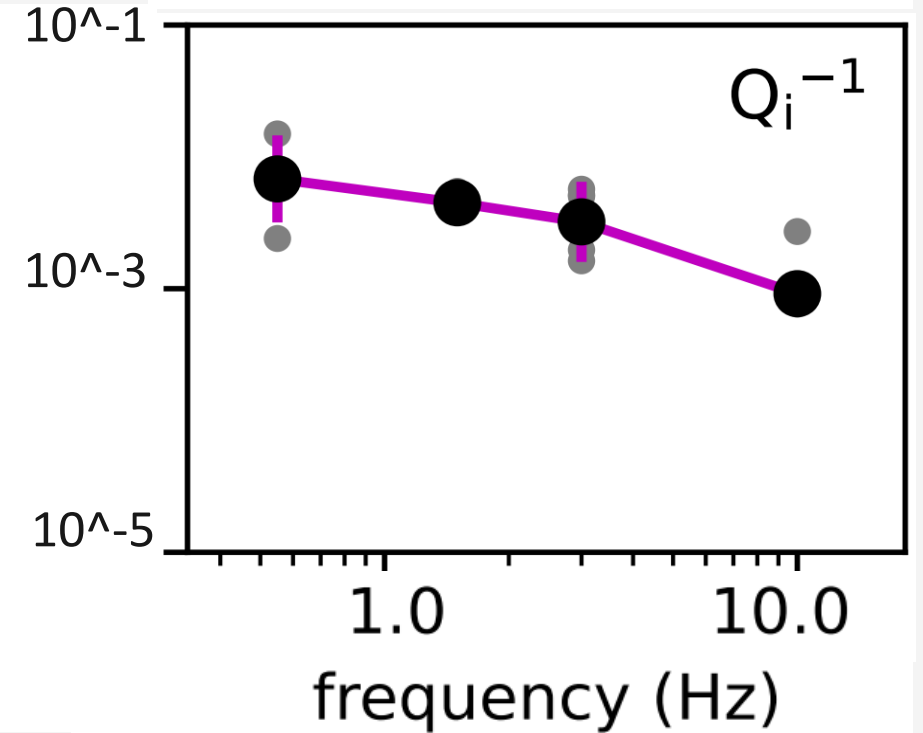
> 3.0 M

< 175 km radius EV

< 125 km radius src-rec







Qopen

Nr events = 62

2004-now

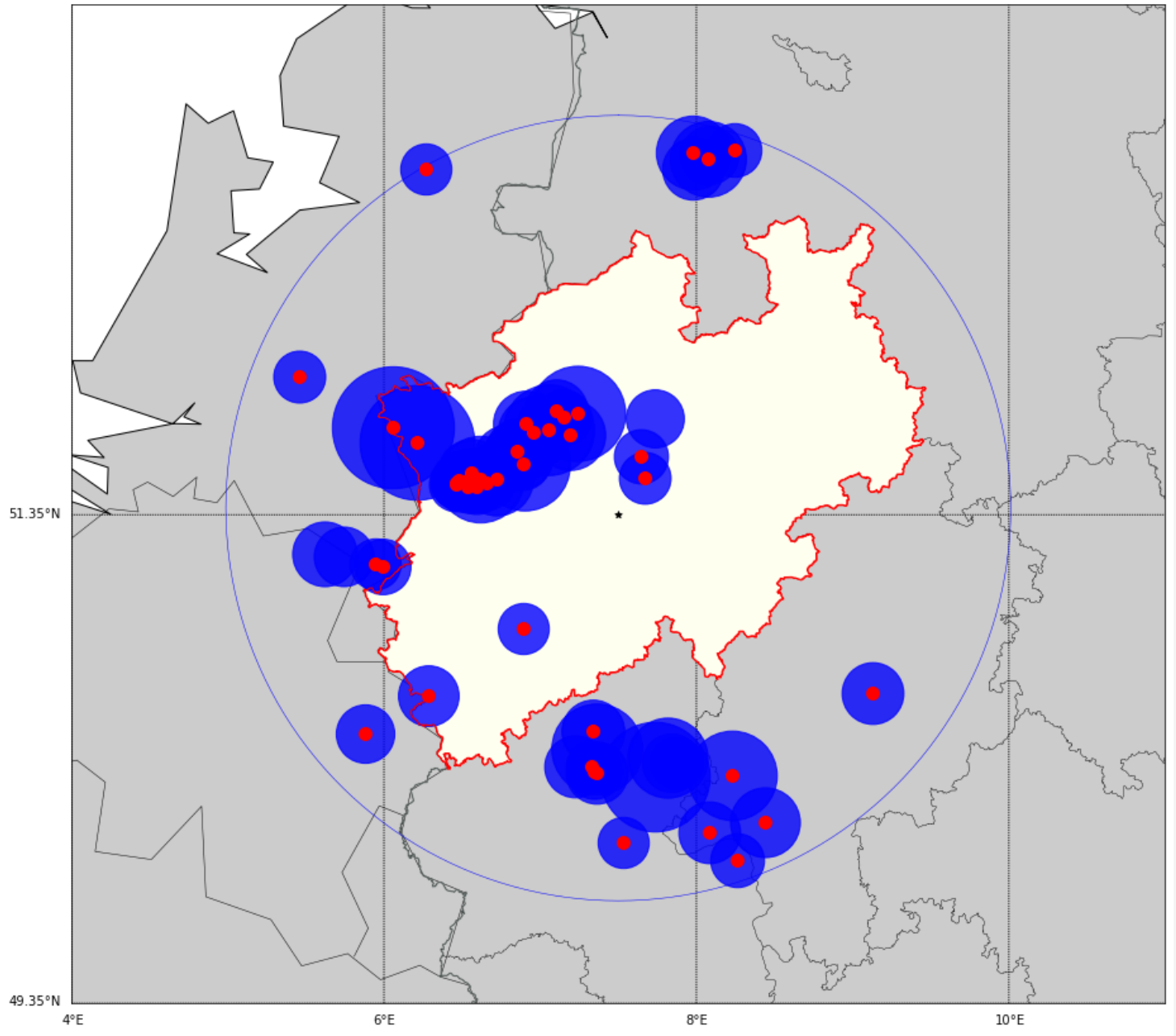
> 3.0 M

< 175 km radius EV

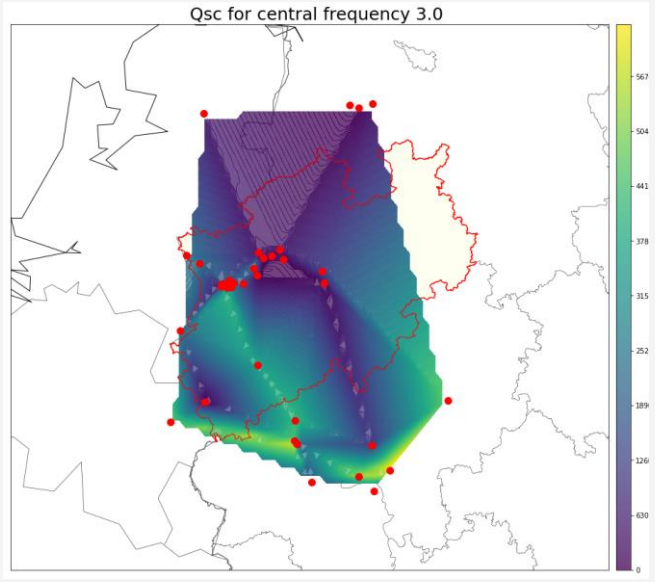
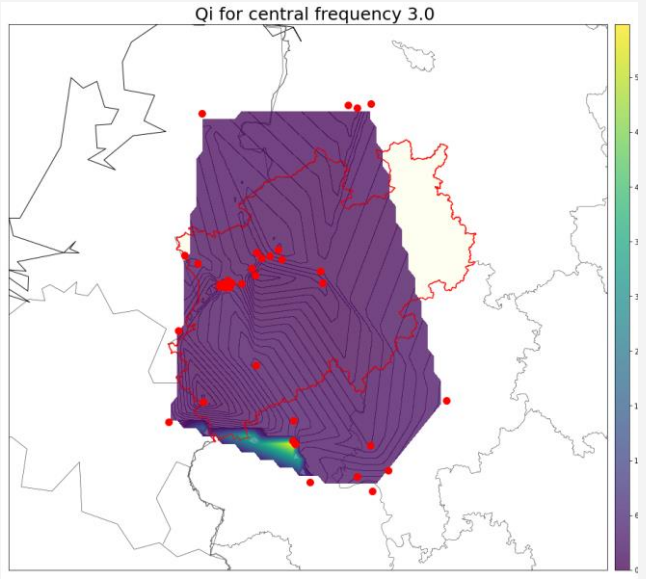
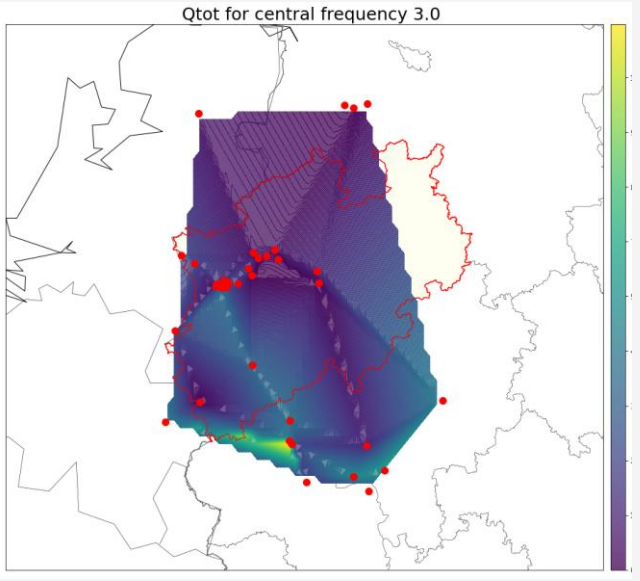
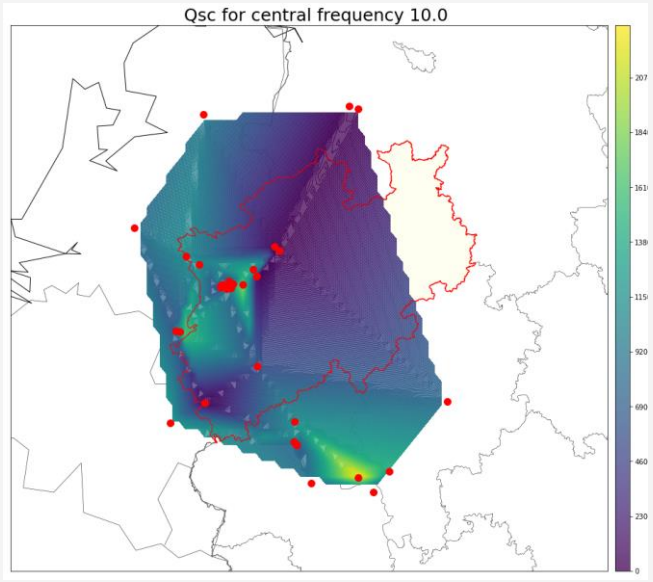
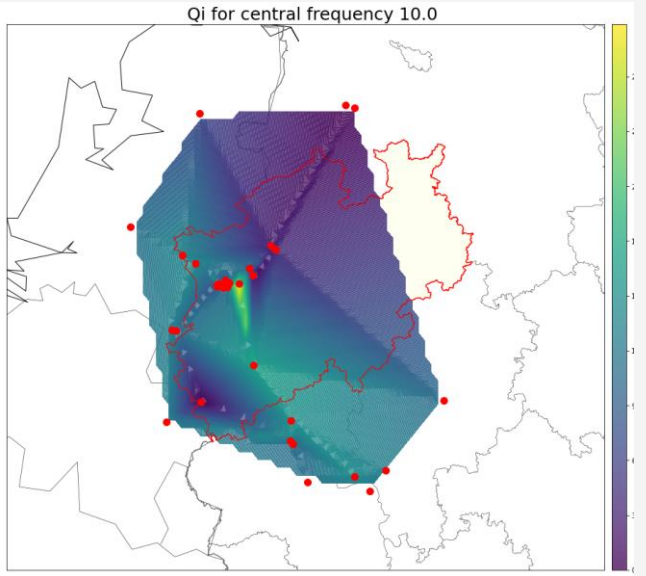
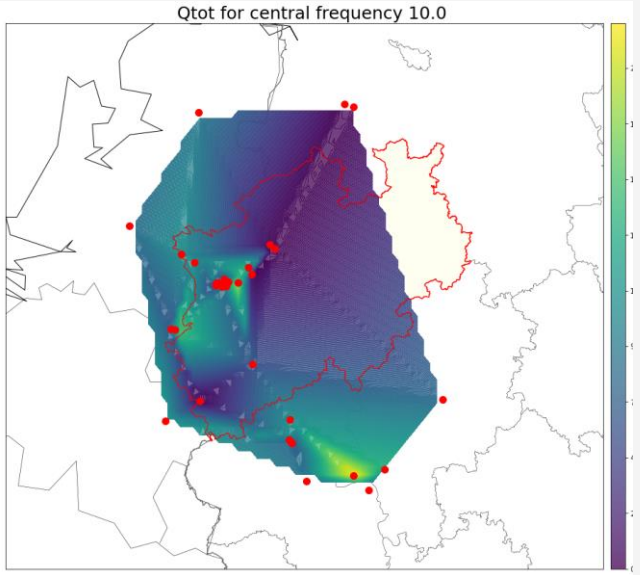
< 125 km radius src-rec

Detrend, remove response, bandpass filter 0.1-50Hz

Events used = 46



Regionalization

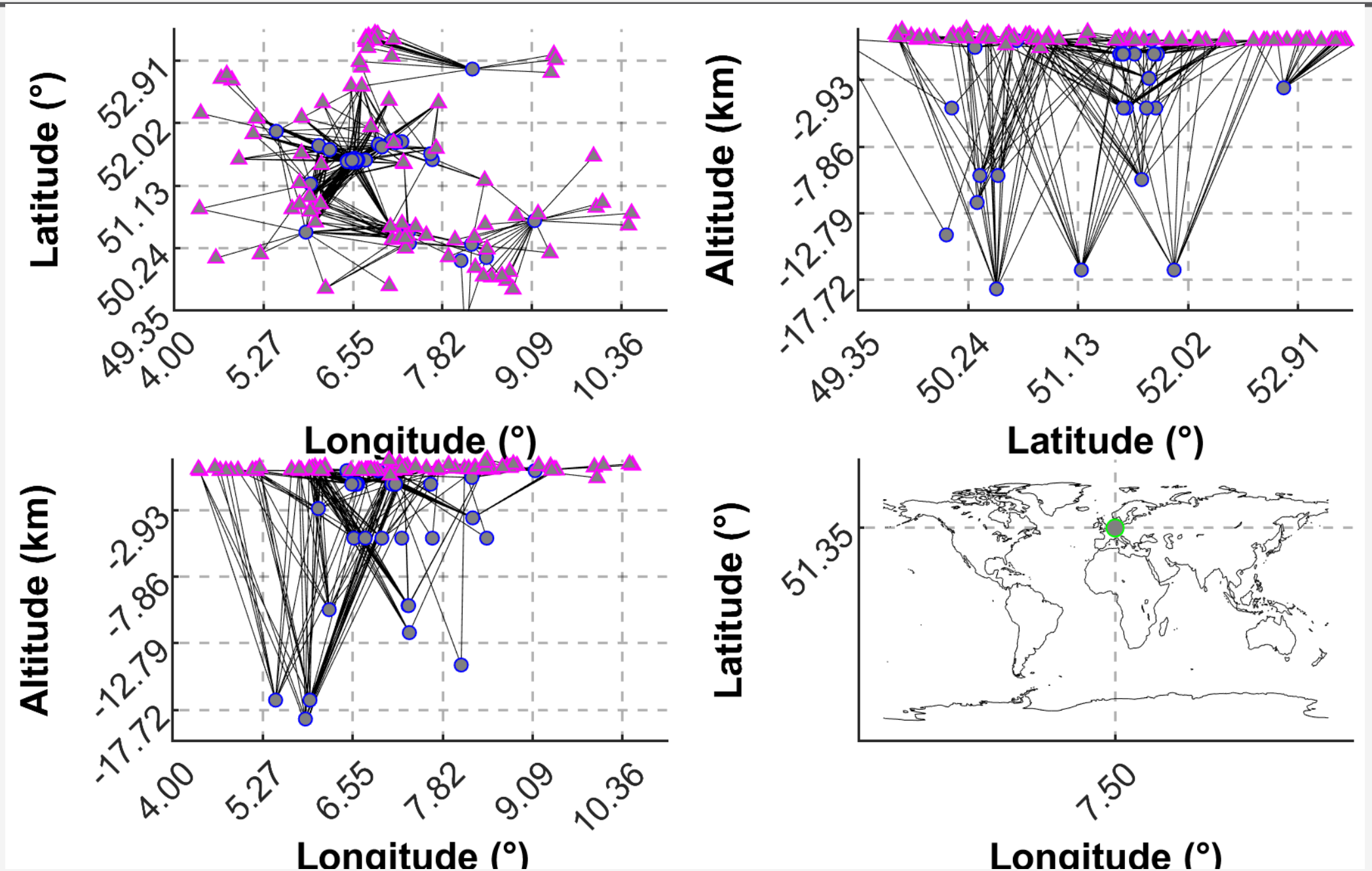
Fc	Qsc^-1	Qi^-1	Qsc^-1 + Qi^-1
3 Hz N= 344			
10 Hz N= 260			

Q determination: MurAT (De Siena, 2014)

Coda normalisation

Removes source function and instrument response from direct wave measurements. Depending on chosen window, source radiation pattern is negligble (2 s).

Regionalization and robustness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52.02
51.13
50.24
49.35
4.00
5.27
6.55
7.82
9.09
10.36
Longitude (°)
Altitude (km)
-2.93
-7.86
-12.79
-17.72
49.35
50.24
51.13
52.02
52.91
Latitude (°)
Altitude (km)
-2.93
-7.86
-12.79
-17.72
4.00
5.27
6.55
7.82
9.09
10.36
Longitude (°)
Latitude (°)
51.35
7.50
Longitude (°)

References

De Siena, L., Thomas, C., & Aster, R. (2014). Multi-scale reasonable attenuation tomography analysis (MuRAT): An imaging algorithm designed for volcanic regions. *Journal of Volcanology and Geothermal Research*, *277*, 22-35.

Eulenfeld, T., & Wegler, U. (2016). Measurement of intrinsic and scattering attenuation of shear waves in two sedimentary basins and comparison to crystalline sites in Germany. *Geophysical Journal International*, *205*(2), 744-757.

Margerin, L. (2011). Seismic Waves, Scattering. In: Gupta, H.K. (eds) Encyclopedia of Solid Earth Geophysics. Encyclopedia of Earth Sciences Series. Springer, Dordrecht. https://doi.org/10.1007/978-90-481-8702-7_54