

Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure
and Water Management*

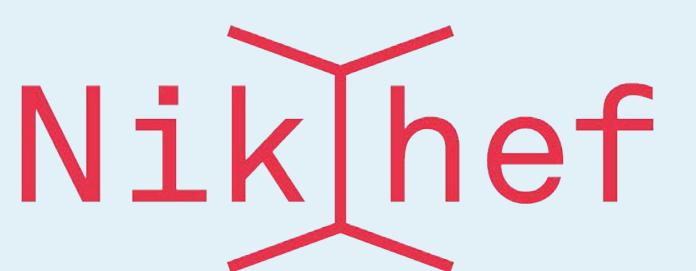
Interreg
Euregio Meuse-Rhine



Noise monitoring in the EMR site



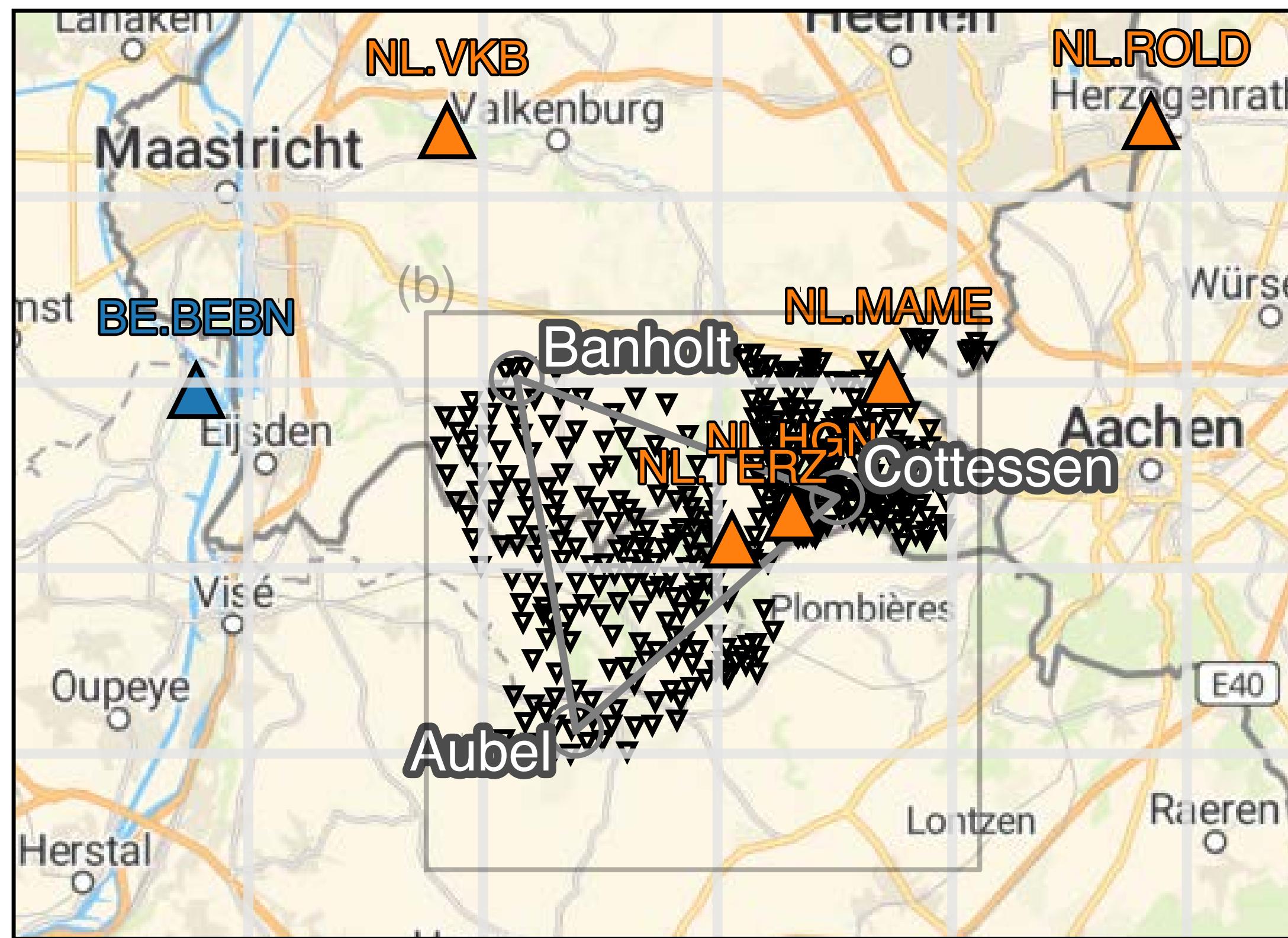
Einstein Telescope
EMR Site & Technology





A rich network of seismic sensors

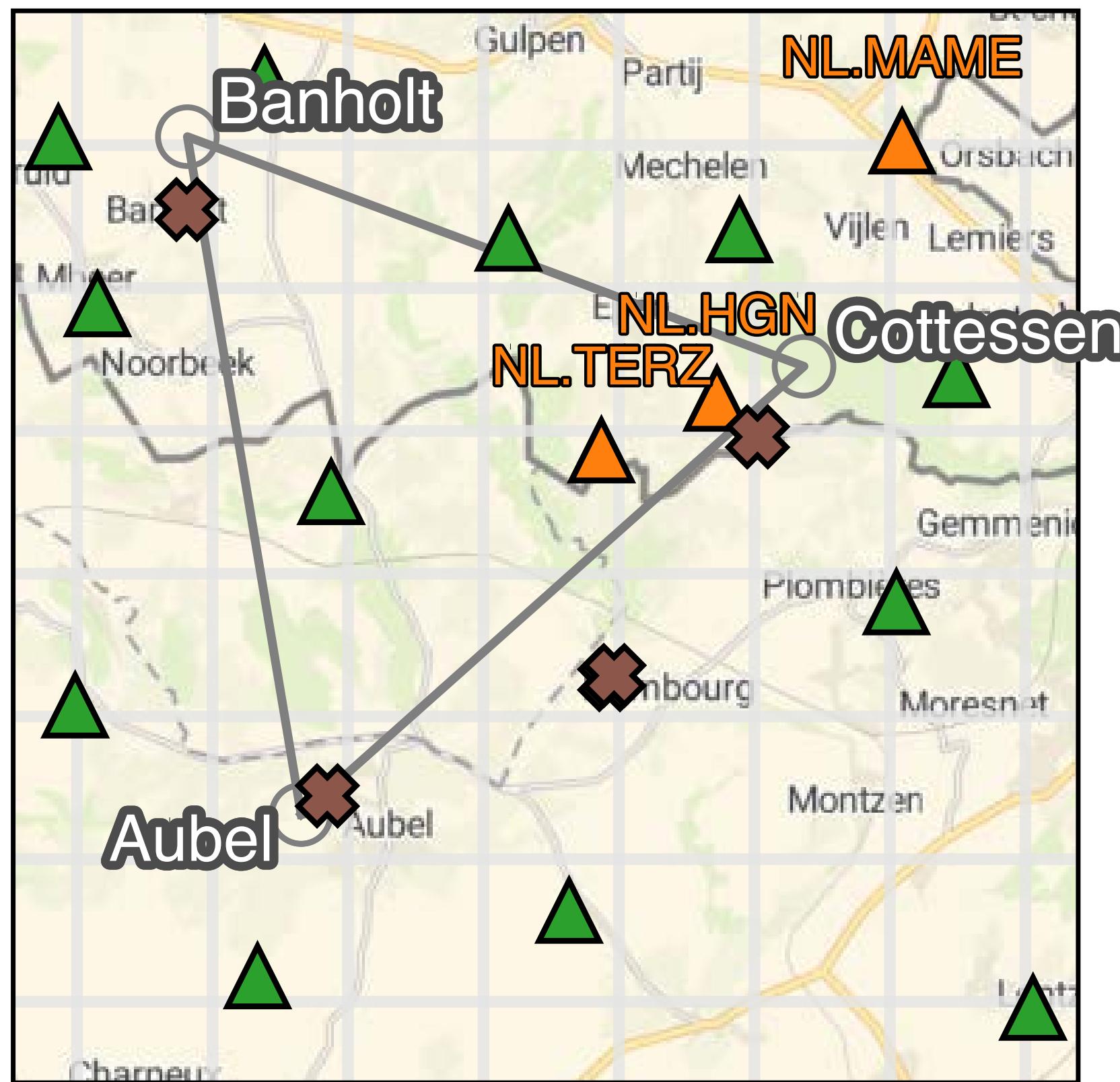
1. Seismic noise characterisation for the optimal location of the ET corner-points.
2. Imaging the subsurface to support geotechnical engineering efforts.
3. Extending the existing seismic network in the region: 15 new broadband seismic stations (surface) & 4 new broadband borehole seismic stations (250 m depth)





A rich network of seismic sensors

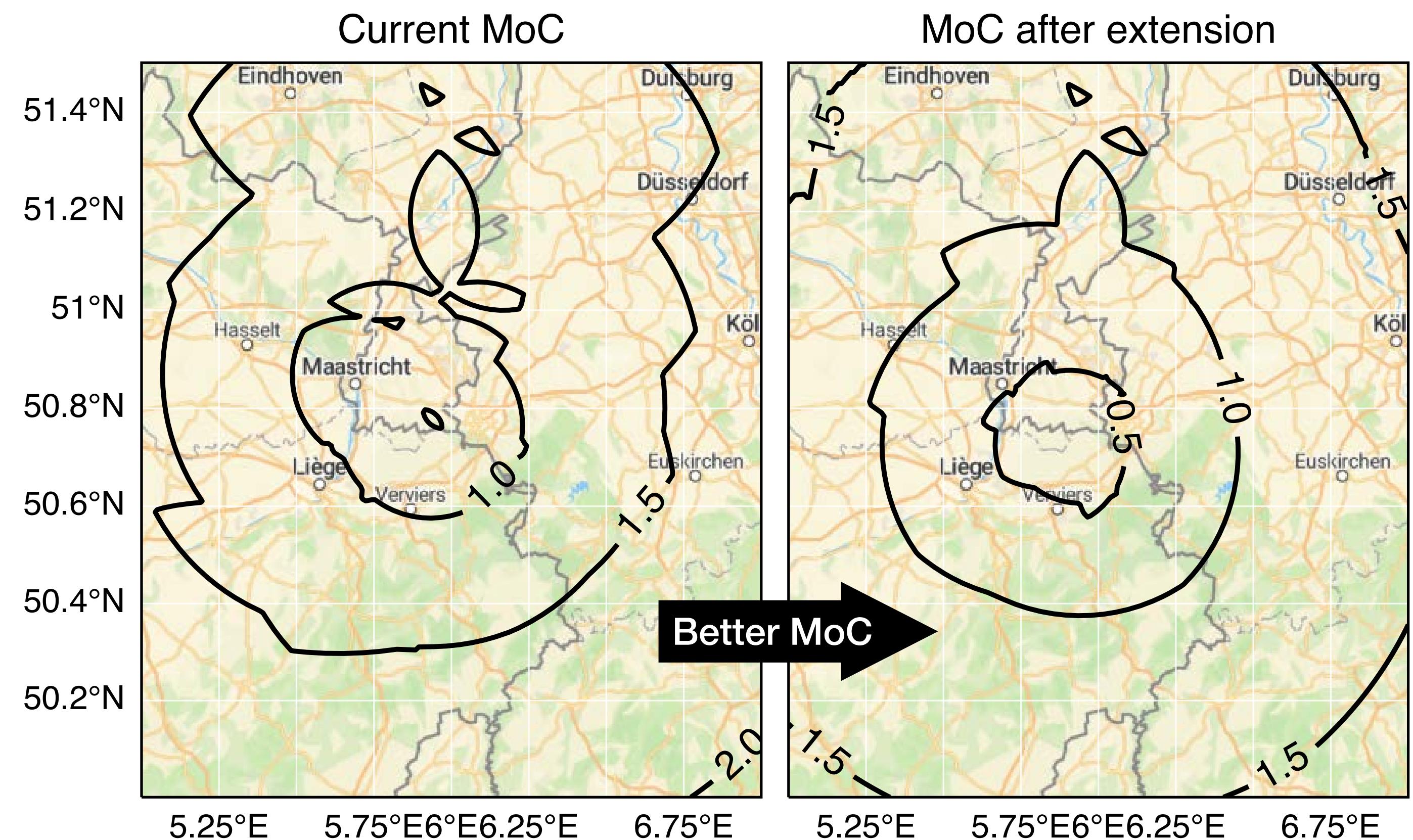
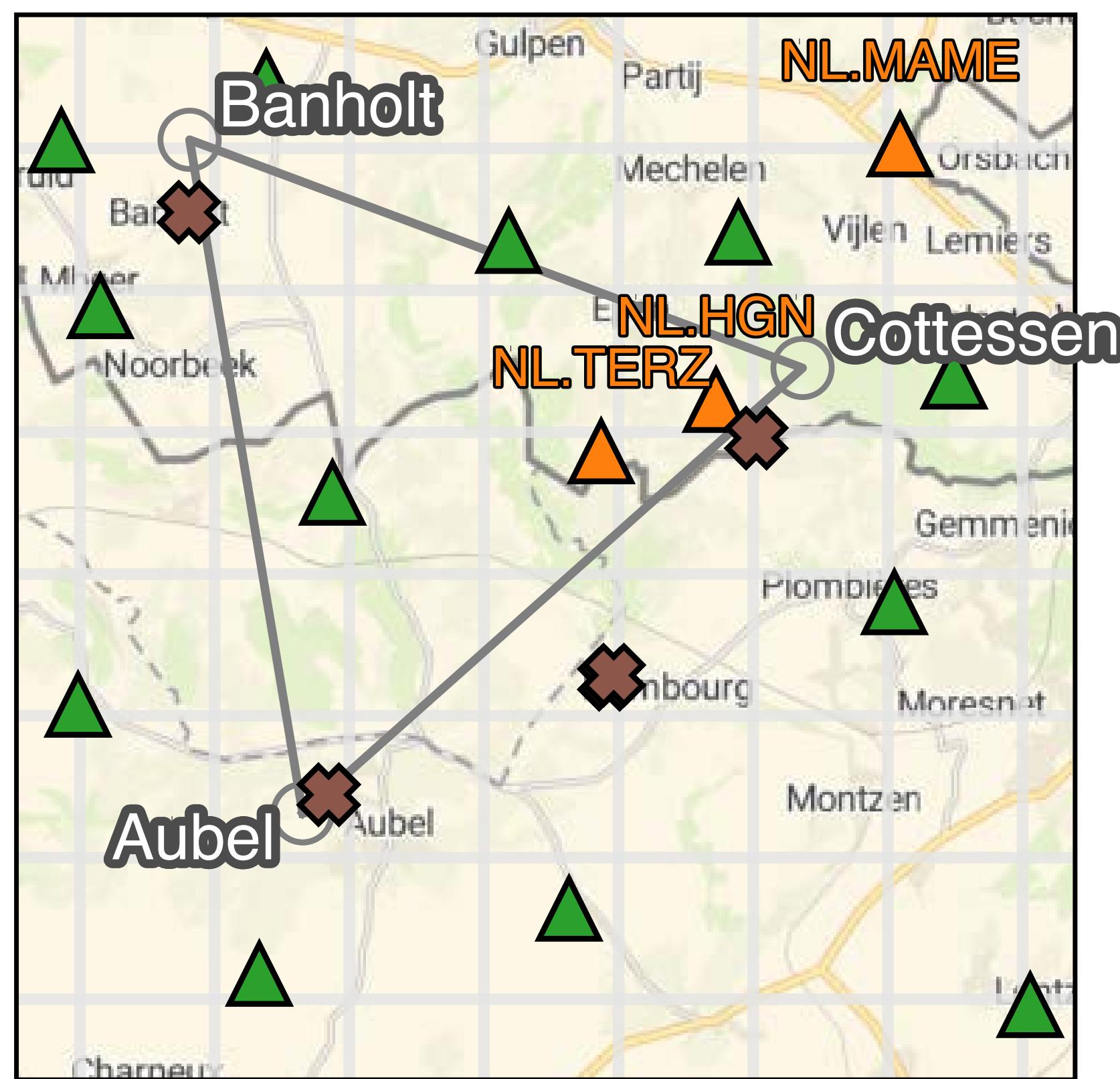
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A rich network of seismic sensors

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2. Imaging the subsurface to support geotechnical engineering efforts.
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ORFEUS FDSN



Orfeus

https://www.fdsn.org/networks/detail/3T_2020/



International Federation of Digital Seismograph Networks



Home / Networks / 3T (2020-2024): Einstein Telescope Seismic Campaigns Sign in

3T (2020-2024): Einstein Telescope Seismic Campaigns

FDSN Network Information

FDSN code	3T (2020-2024)	Network name	Einstein Telescope Seismic Campaigns (ET)
Start year	2020	Operated by	Royal Netherlands Meteorological Institute (KNMI) ROR
End year	2024	Deployment region	-
Description	In the scope of E-TEST (*E*instein *T*elescope *E*uregio Meuse-Rhine *S*ite & *T*echnology), Multiple seismic campaigns are planned. In each campaign, hundreds of sensors are deployed. This includes geophones, seismometers, acoustic instruments, and others.		

Citation Information

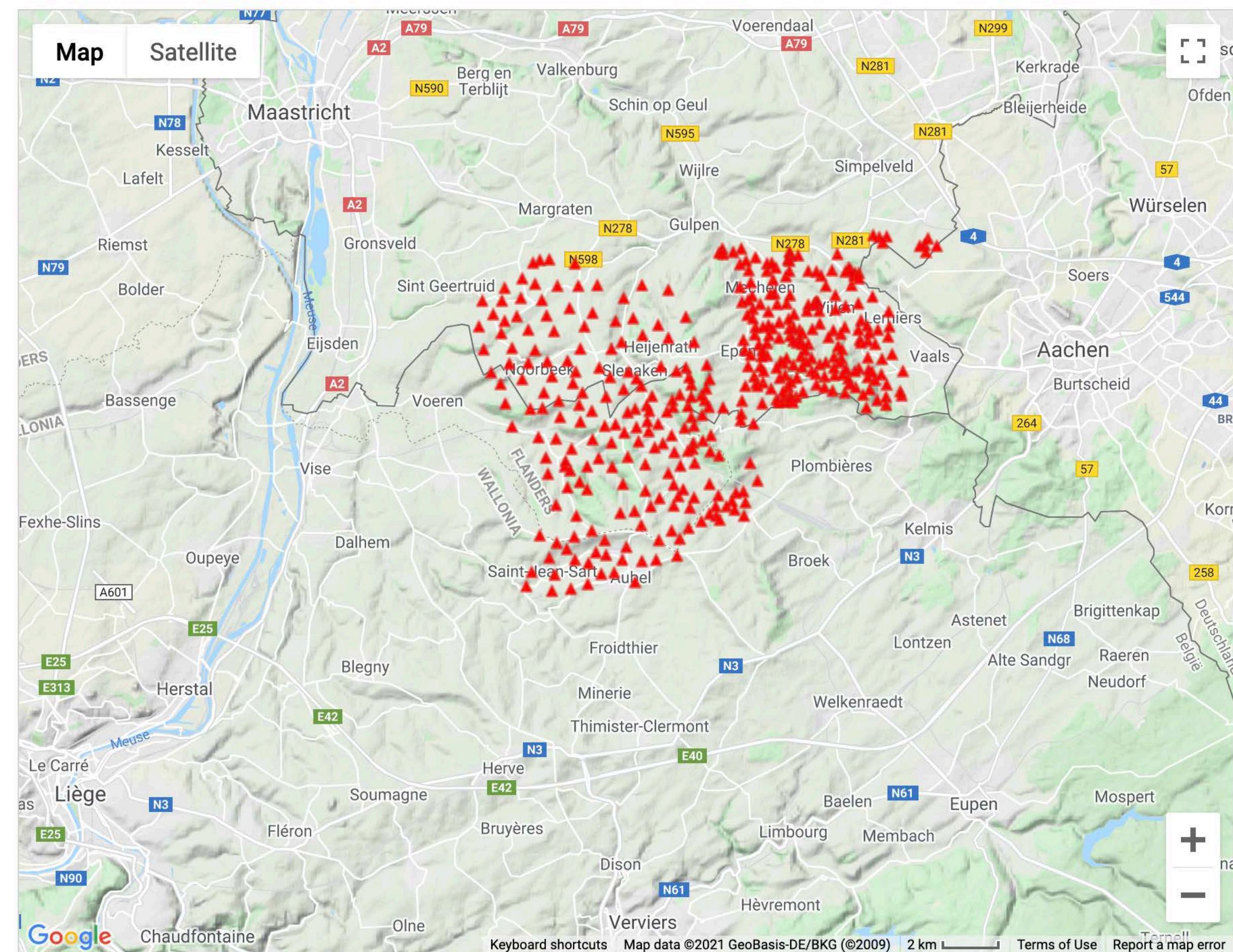
Digital Object Identifier (DOI)	https://doi.org/10.7914/SN/3T_2020
Citation	Shahar Shani-Kadmiel, Frank Linde, Láslo Evers, & Bjorn Vink. (2020). Einstein Telescope Seismic Campaigns [Data set]. Royal Netherlands Meteorological Institute (KNMI). https://doi.org/10.7914/SN/3T_2020 For more: DataCite (JSON XML BibTeX)

Data Access

Data Availability	Data available from: The ORFEUS Data Center (ORFEUS) : http://www.orfeus-eu.org/fdsnwsl/dataservice/1/
	FDSN Web Services provide a common data access API for seismic data.
	Availability based on irisws-fedcatalog service. Full fedcatalog information for this network
Additional Notes	Through KNMI/ORFEUS/EIDA

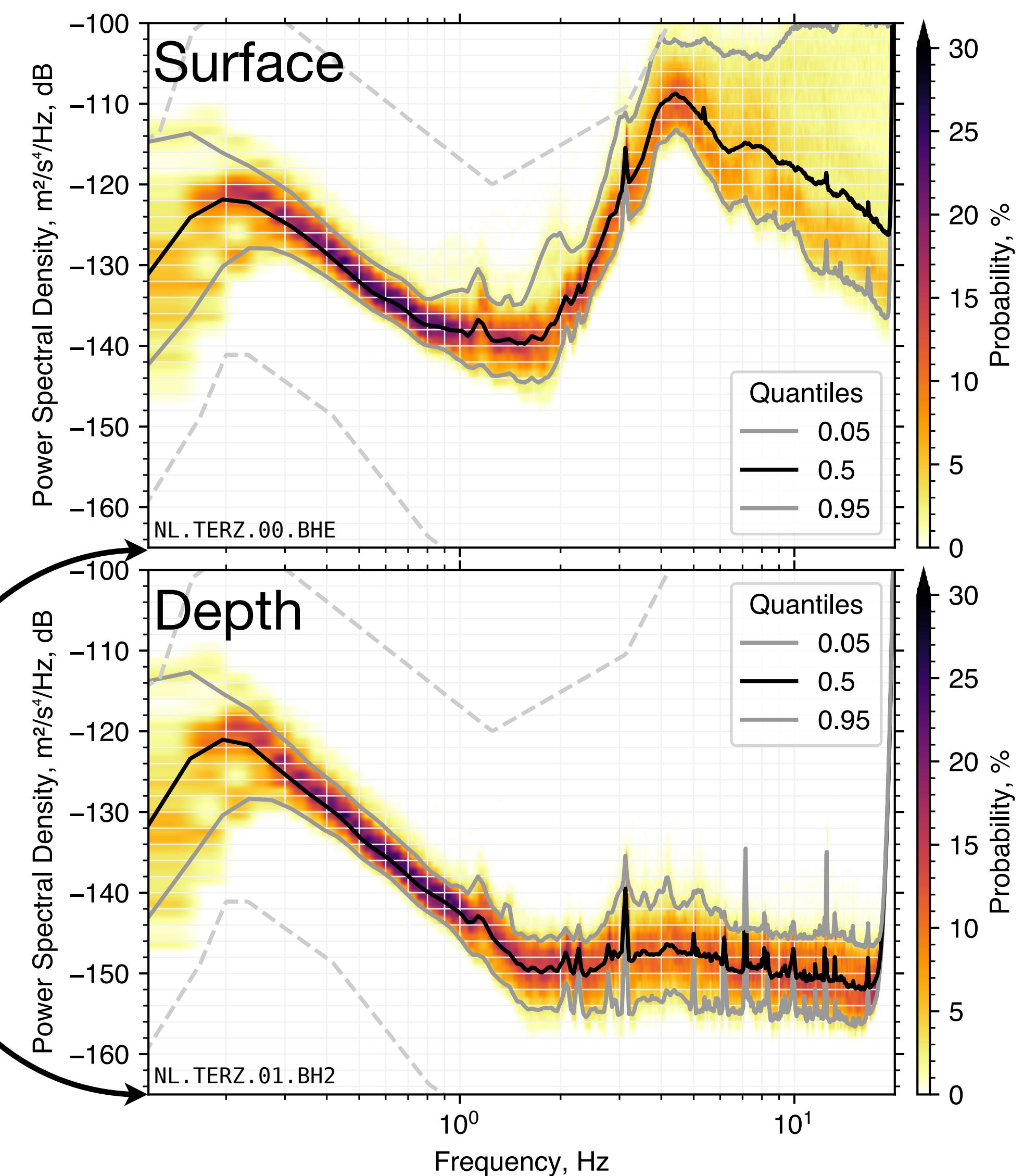
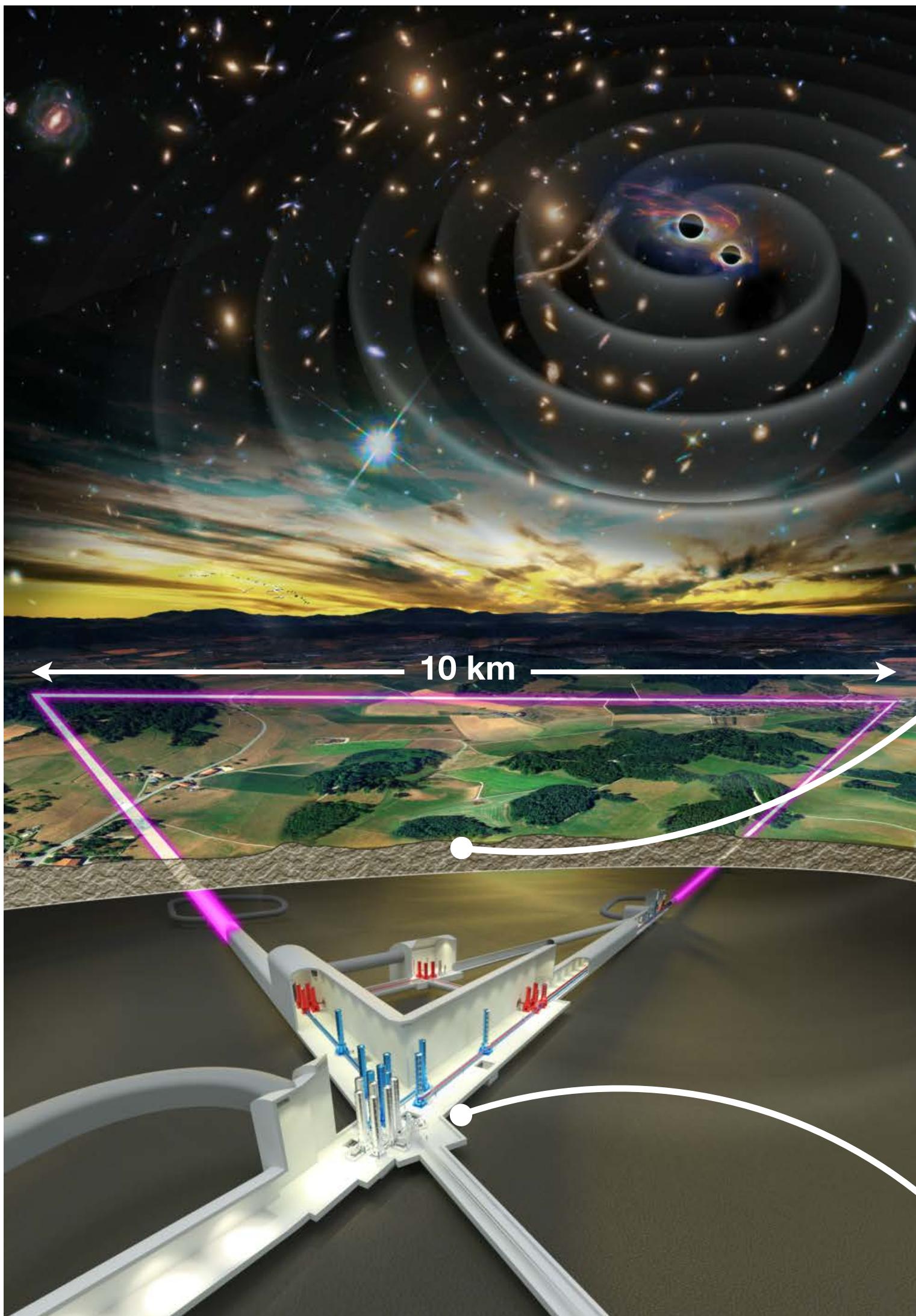
- More than 400 stations deployed and retrieved
- Campaign Data available on ORFEUS FDSN

Stations in this Network





Why should ET be in the subsurface?





**Scan for NL.TERZ
Live Waveforms**



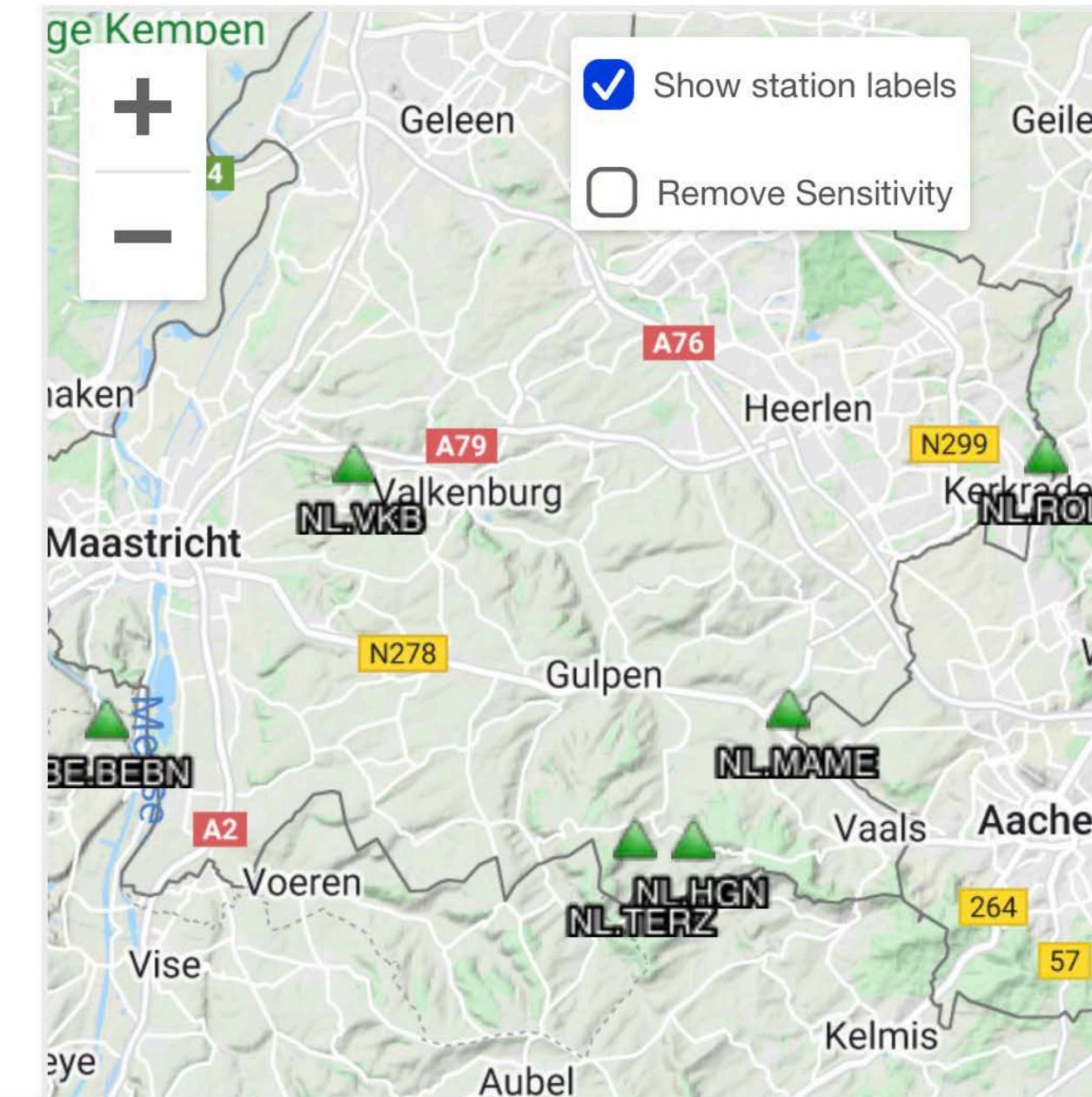
Orfeus



Live Waveform Seedlink

WebSocket

This map shows stations archived by the ORFEUS Data Center and realtime data from Seedlink that is being archived. Select a station to subscribe to and receive data for its highest available sampling rate. It may take some moments for the first record to arrive. Stale connections are timed out after 60 seconds.

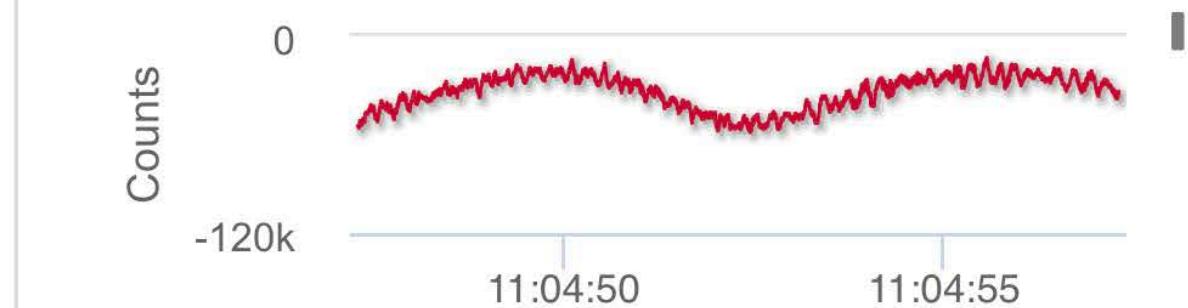


NL.TERZ Terziet

Report Acquisition Problem for NL.TERZ

Click on a station to subscribe to its realtime stream.

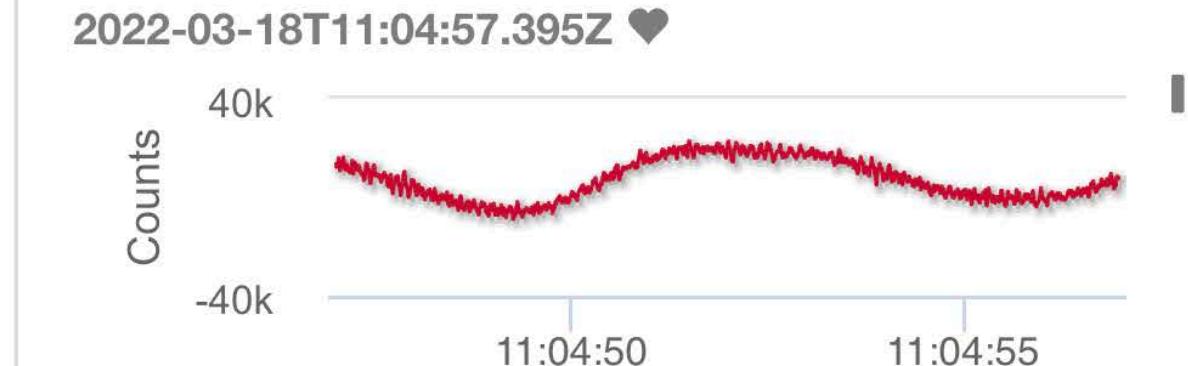
NL.TERZ.00.HHE with 0.43s latency - last heartbeat at 2022-03-18T11:04:57.703Z



NL.TERZ.00.HHN with 0.40s latency - last heartbeat at 2022-03-18T11:04:58.008Z



NL.TERZ.00.HHZ with 0.42s latency - last heartbeat at 2022-03-18T11:04:57.395Z





Orfeus



NL.TERZ Terziet



or NL.TERZ

its realtime

last heartbeat at

1:04:55

last heartbeat at

04:55

last heartbeat at

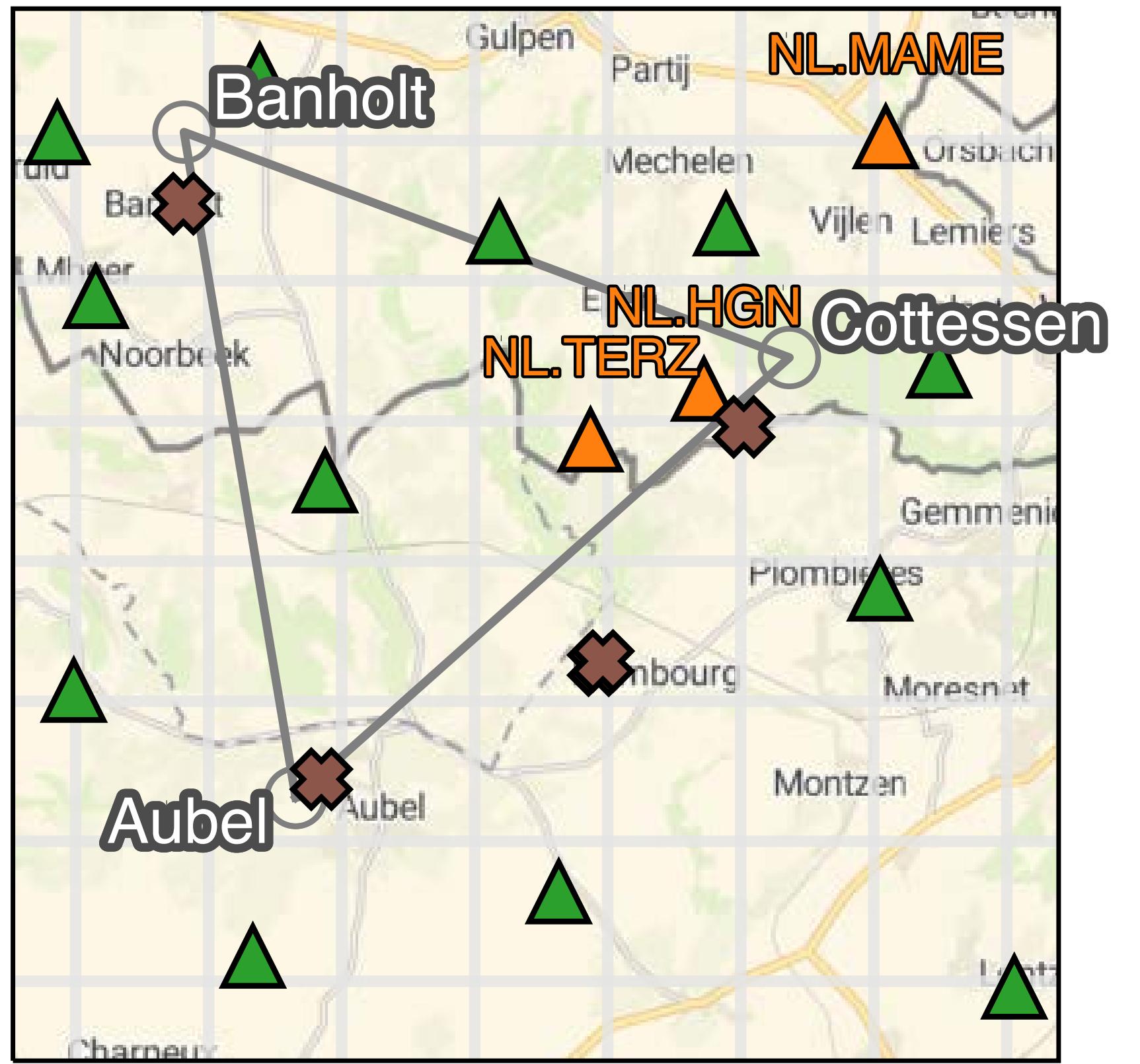
11:04:55

Scal
Live



Cottessen drilling and installation

- Drilling reached 250 m depth.
- Casing and cementing of the Cottessen borehole did not go as planned...
 - Glass fibre snapped after ~30 m
 - Casing leaked cement at ~170 m depth



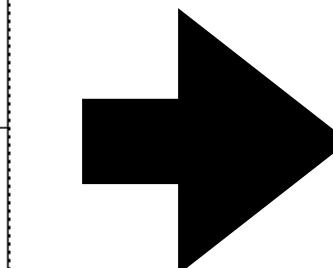
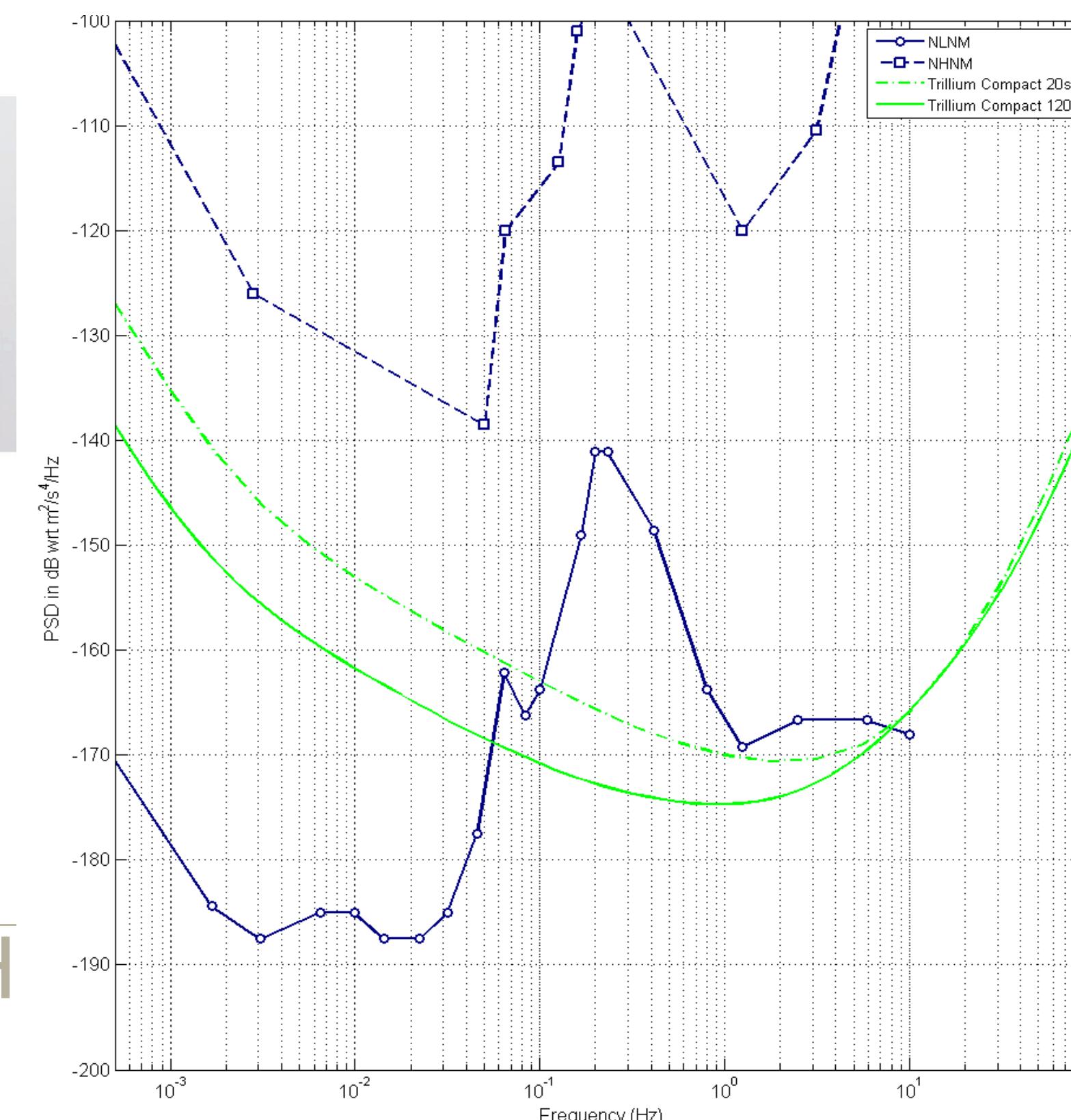


Cottessen drilling and installation

- Drilling reached 250 m depth.
- Casing and cementing of the Cottessen borehole did not go as planned...
 - After drilling inside the casing to clear cement, usable diameter was less than 97 mm
 - Glass fibre had to be cemented inside the casing

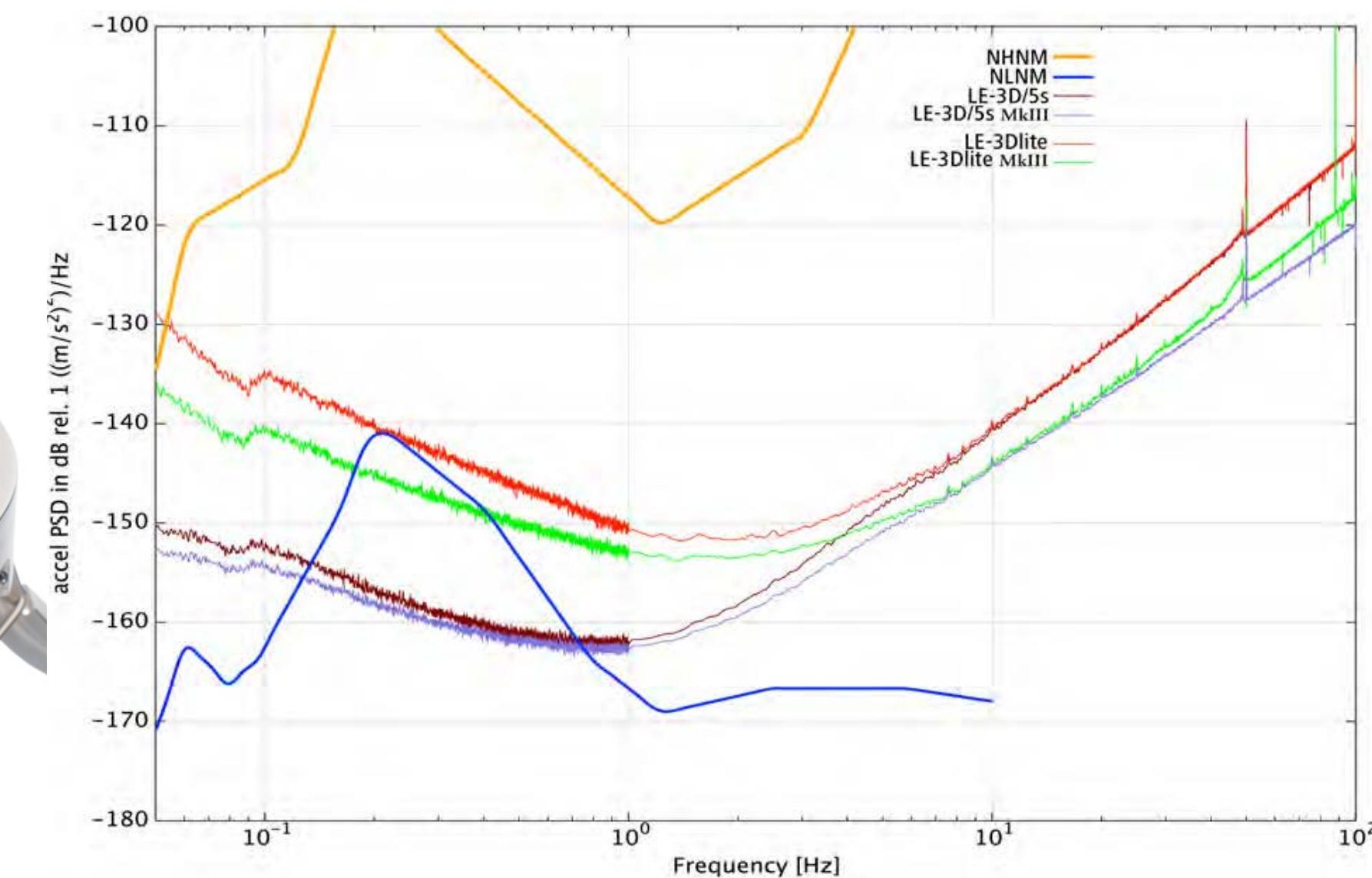


Trillium
CompactPH



lennartz
electronic

LE-3D/BH(s) MkIII





Cottessen drilling and installation

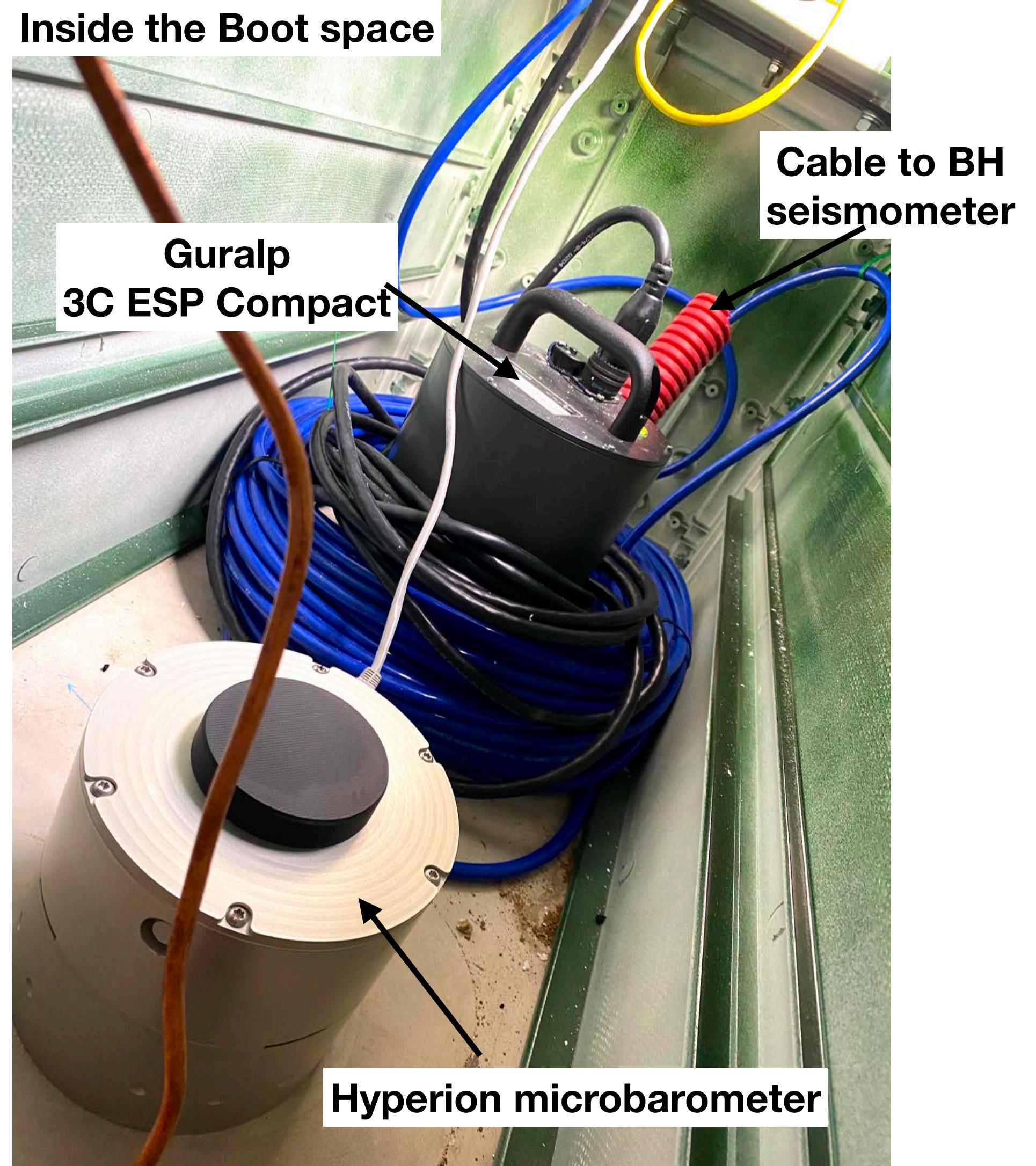
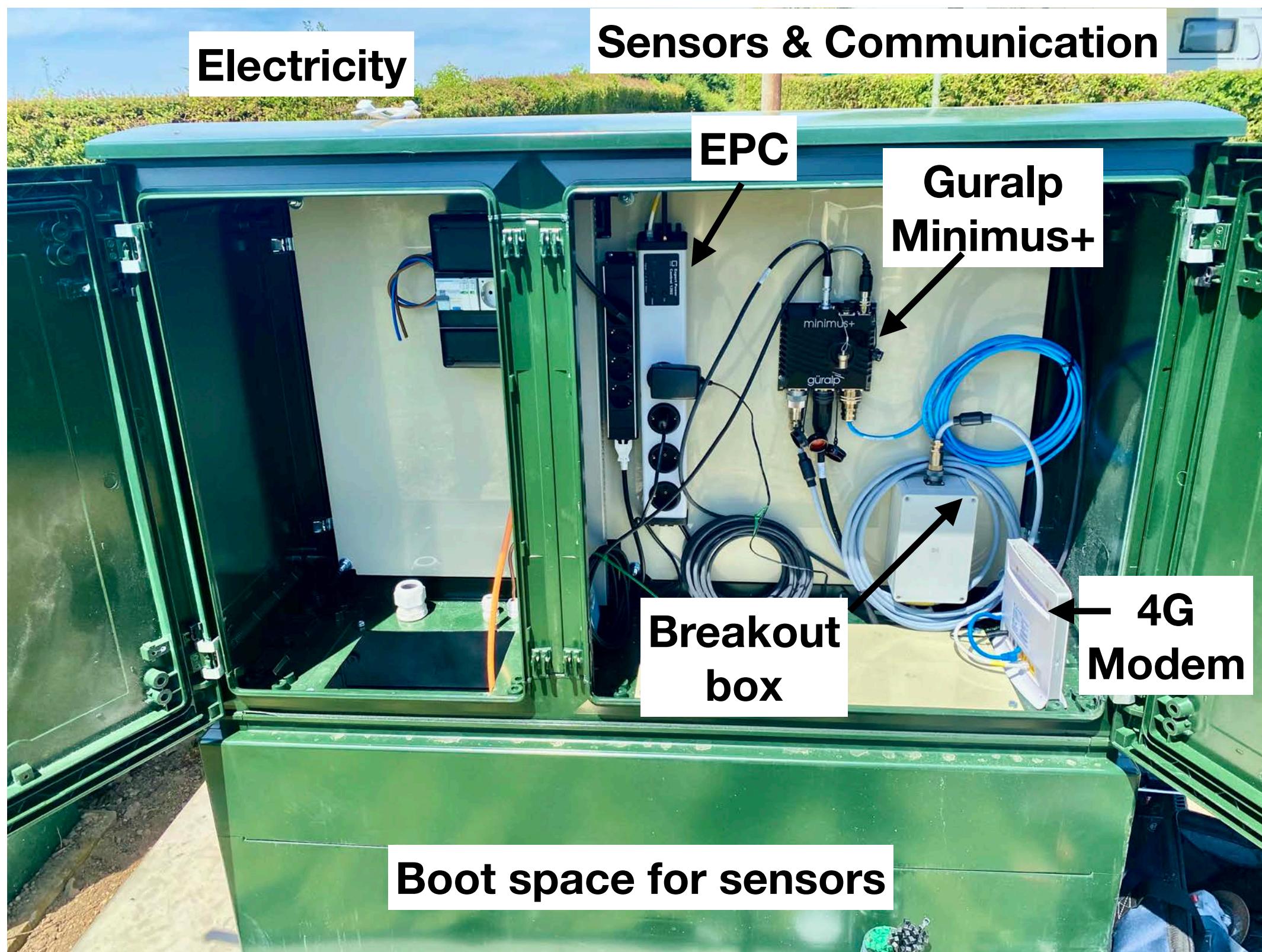
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Cottessen drilling and installation

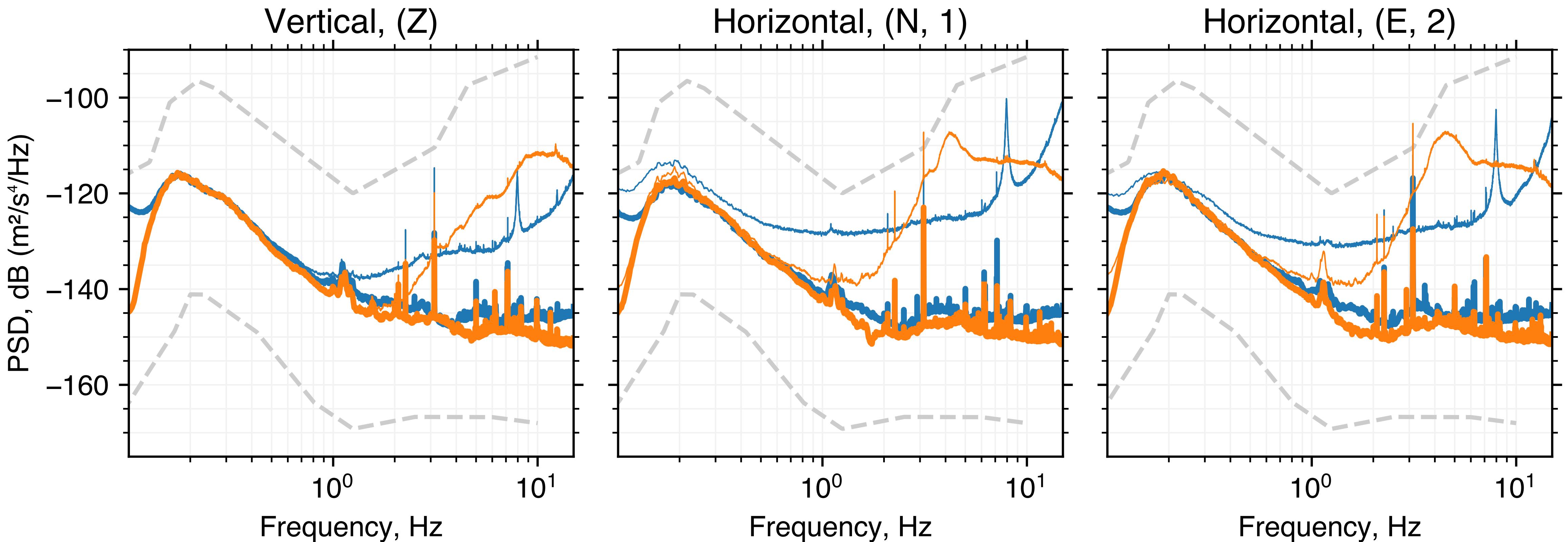
- Surface installation





Cottessen & Terziet PSD comparison

2022-12-13 00:30:00 -> 2023-01-22 14:00:00

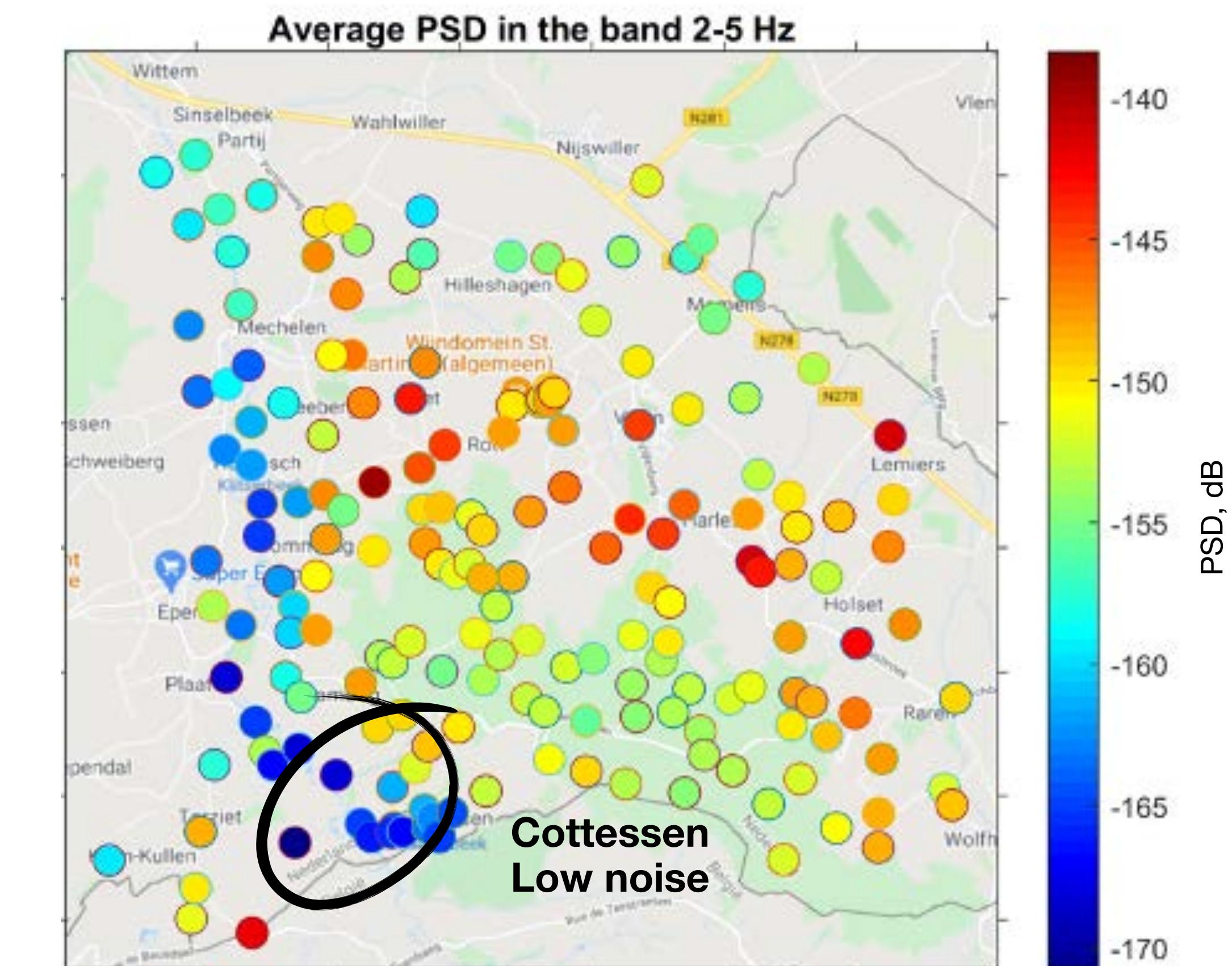
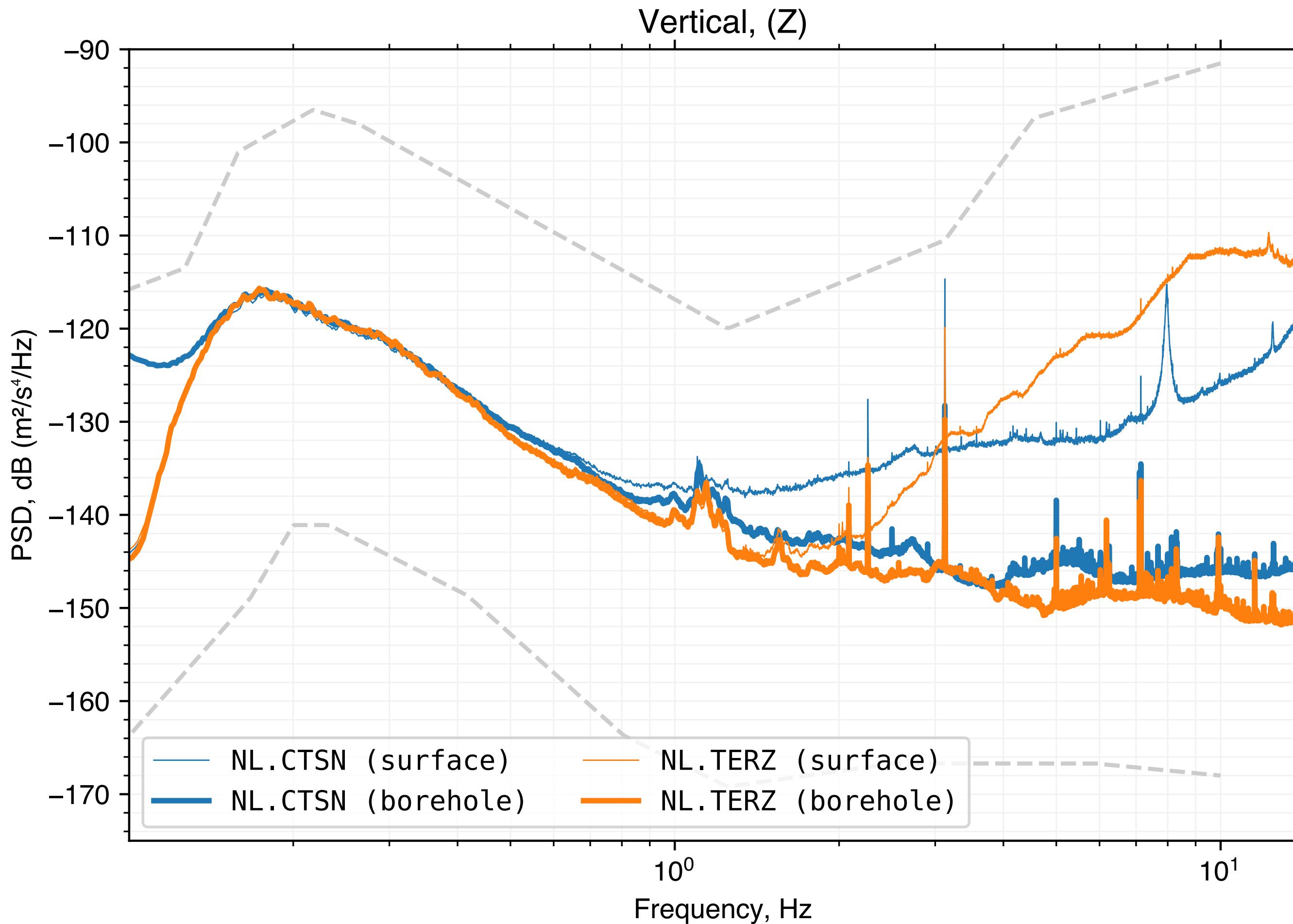


— NL.CTSN (surface) — NL.CTSN (borehole) — NL.TERZ (surface) — NL.TERZ (borehole)



Cottessen & Terziet comparison

2022-12-13 00:30:00 -> 2023-01-22 14:00:00

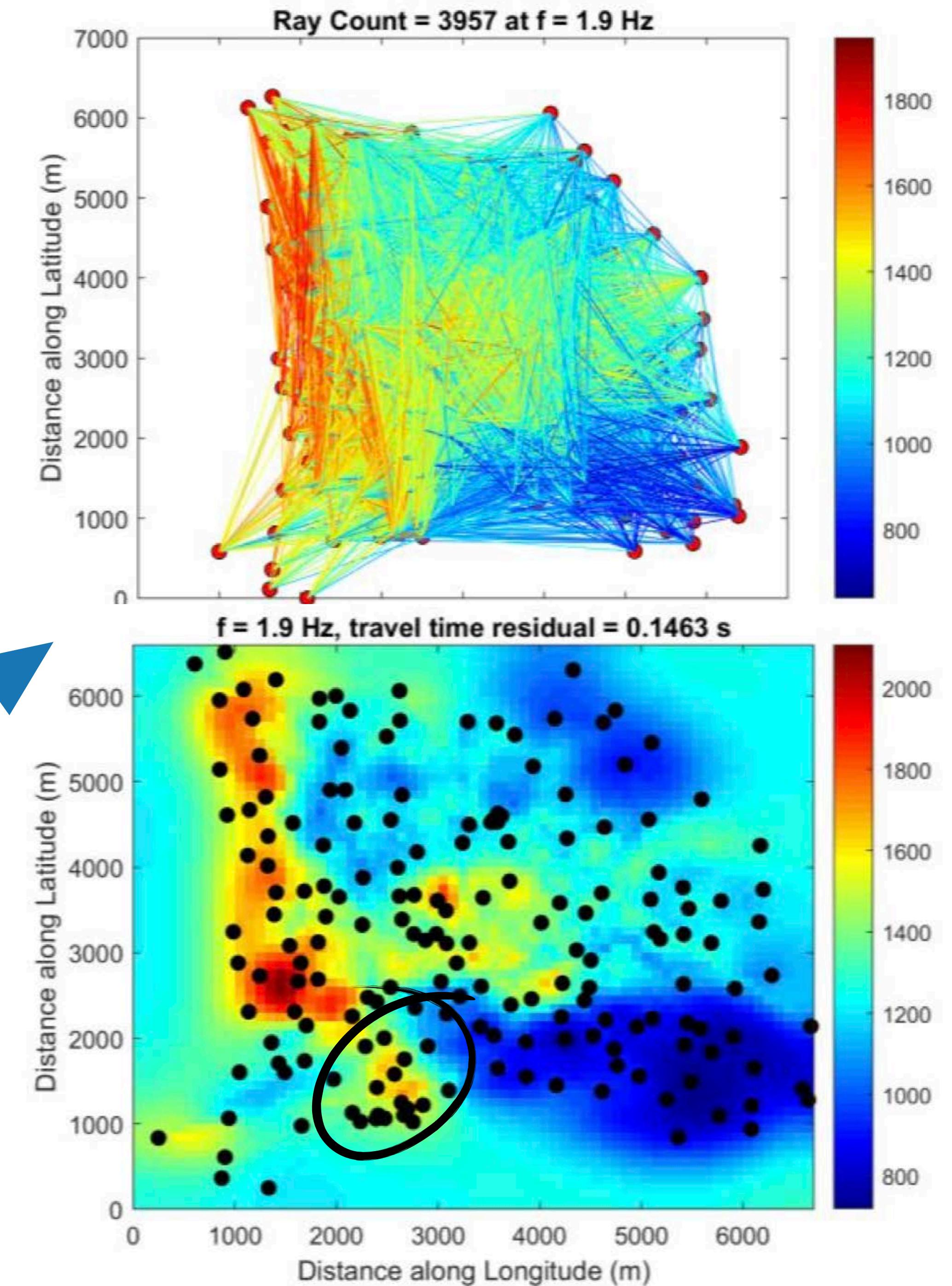
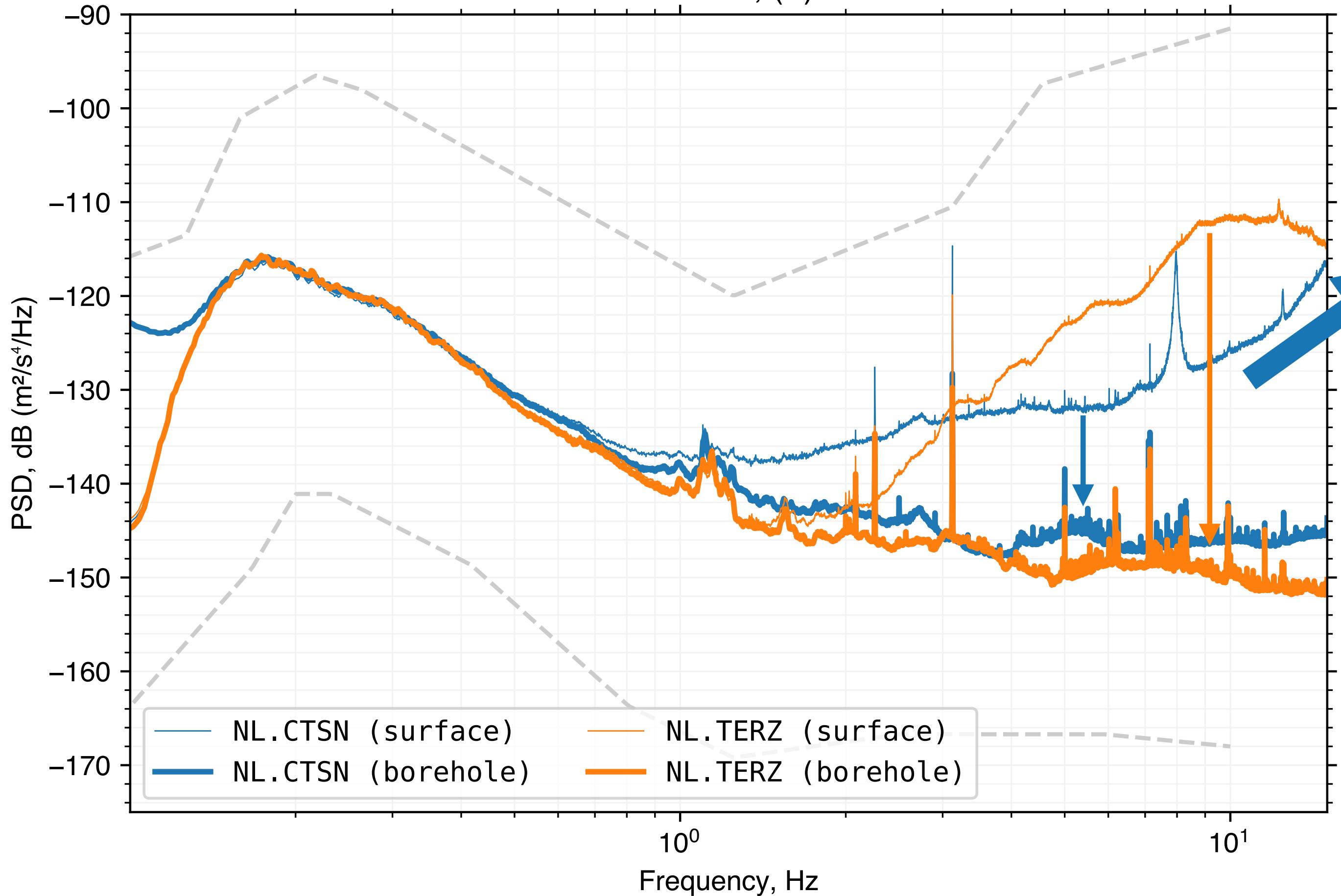




Cottessen & Terziet comparison

2022-12-13 00:30:00 -> 2023-01-22 14:00:00

Vertical, (Z)

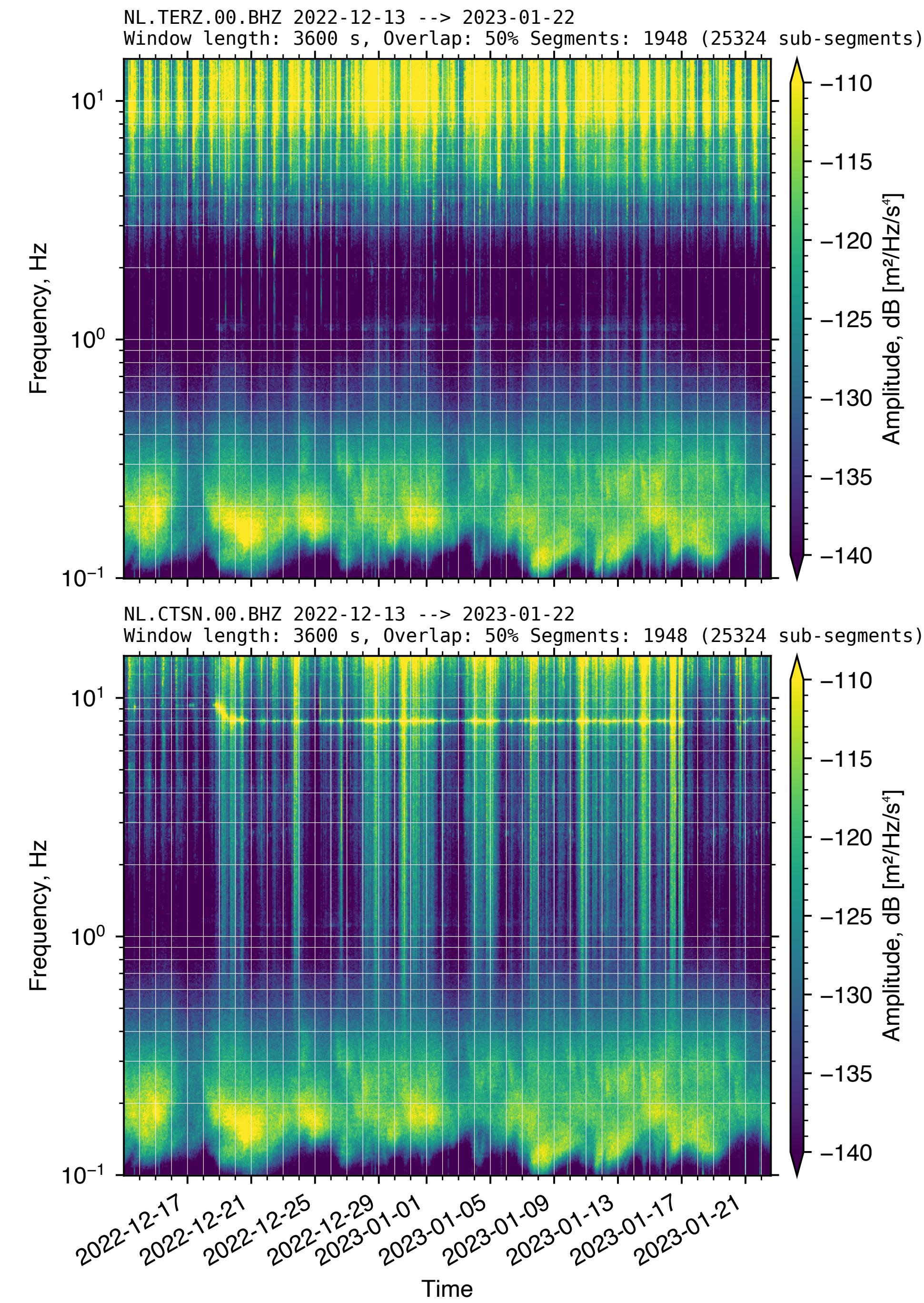
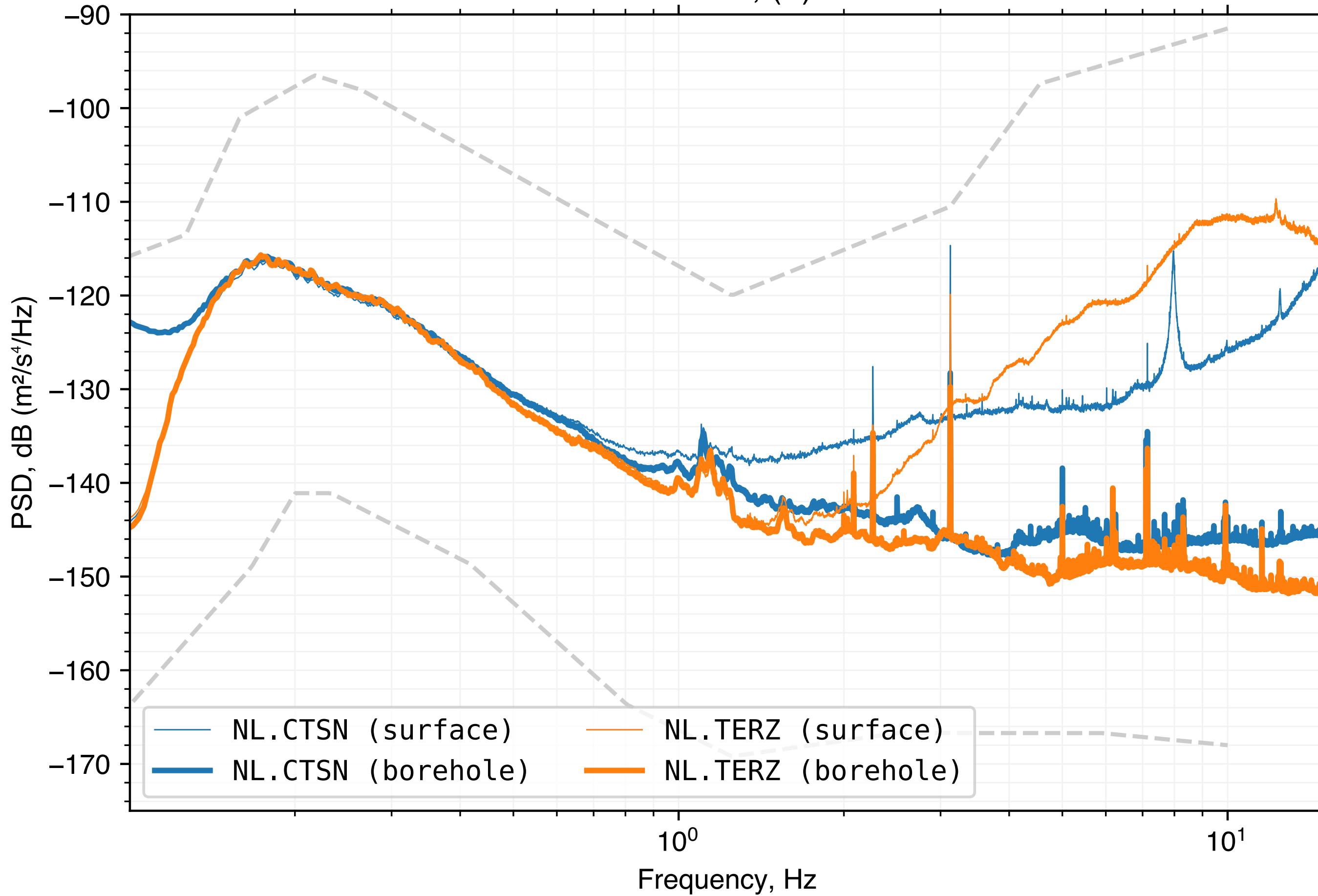




Cottessen & Terziet comparison

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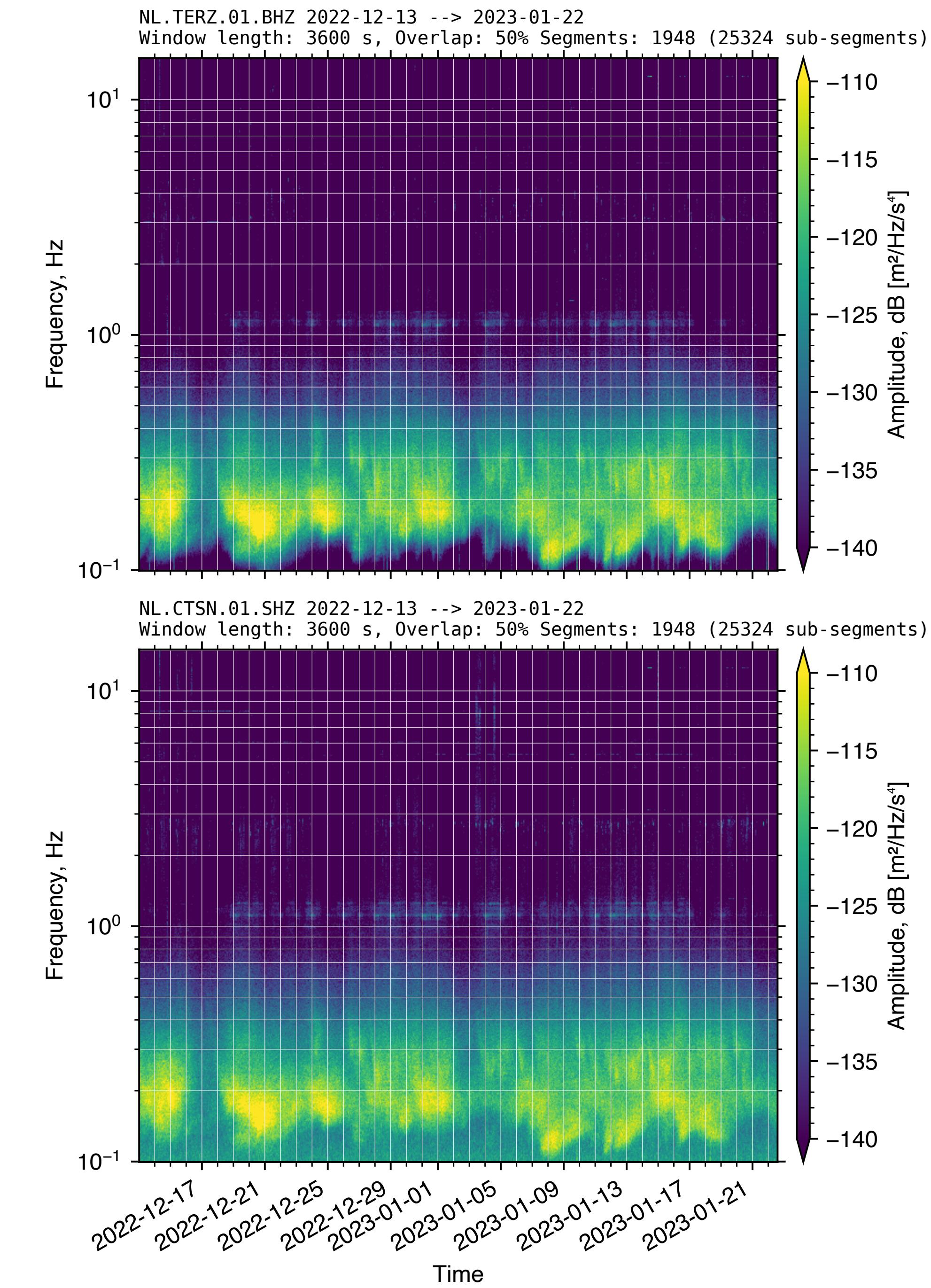
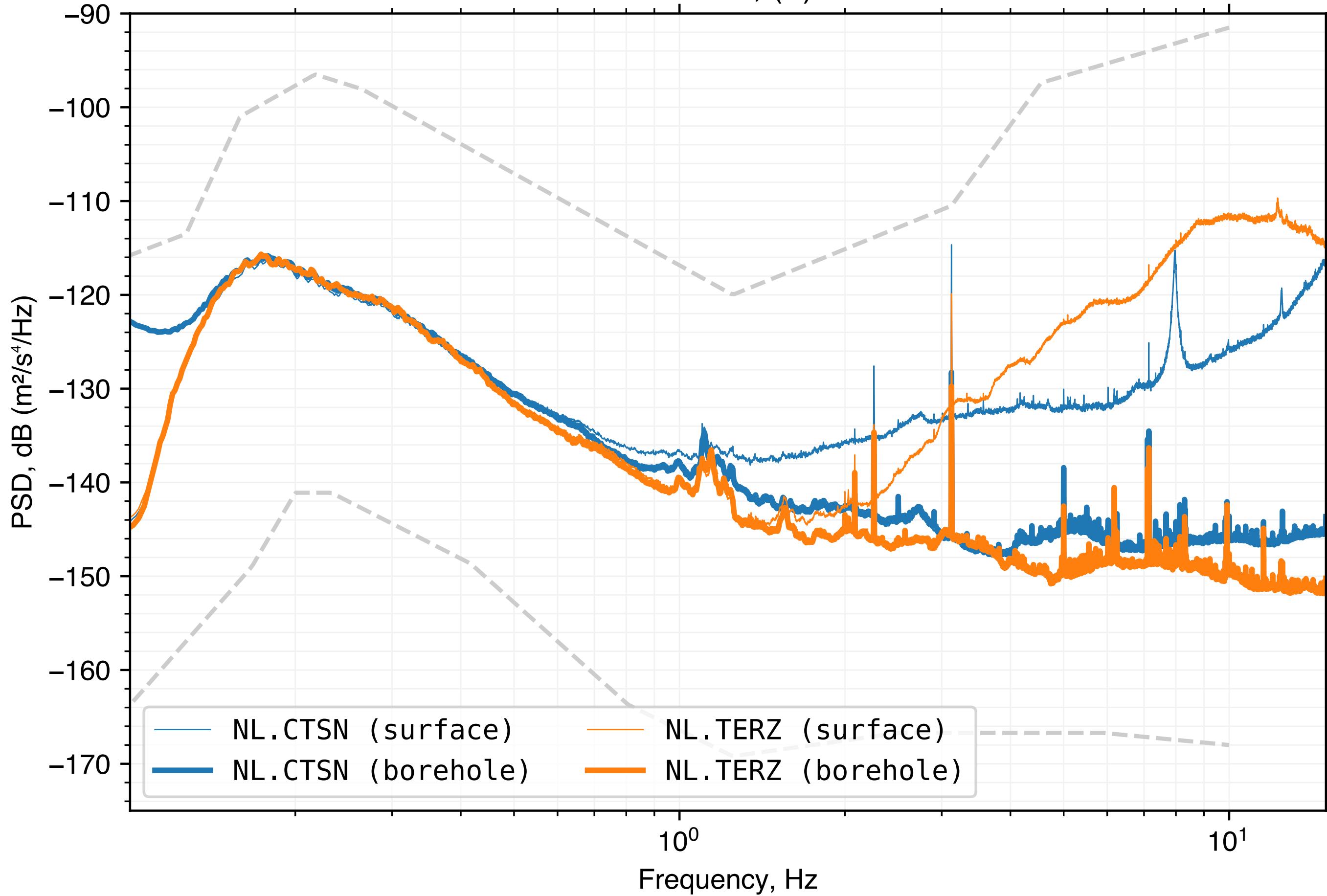
Vertical, (Z)





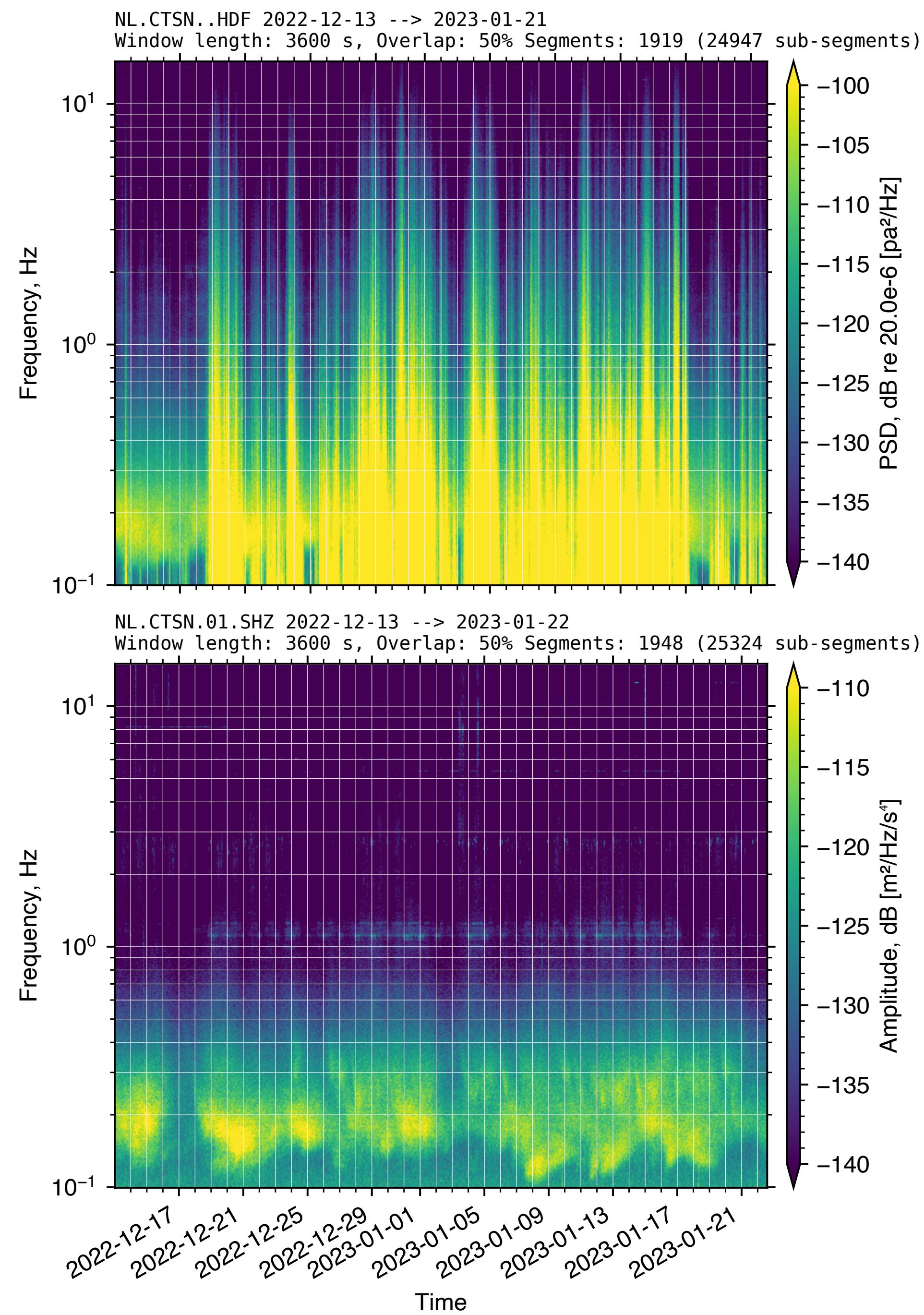
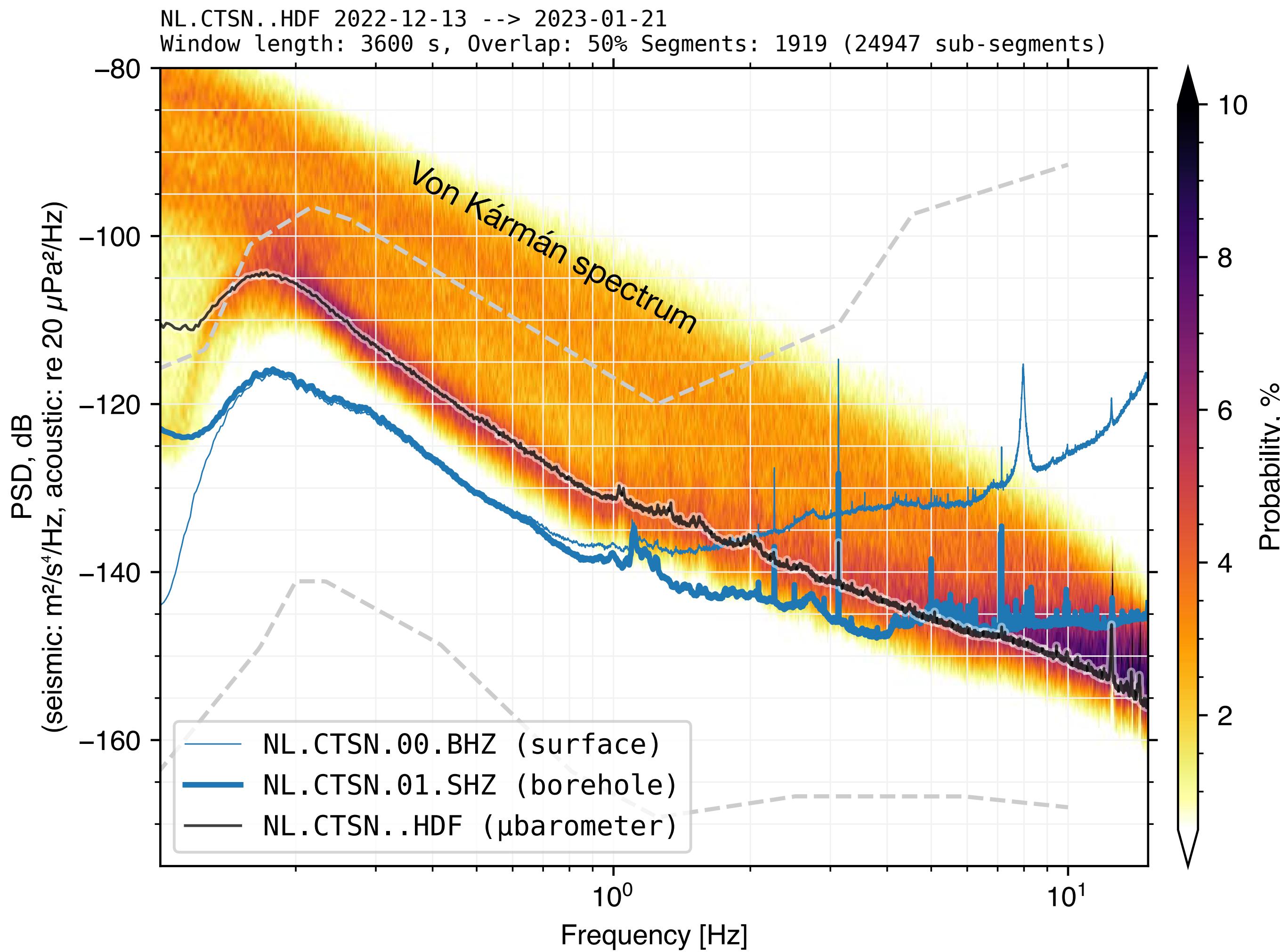
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Vertical, (Z)

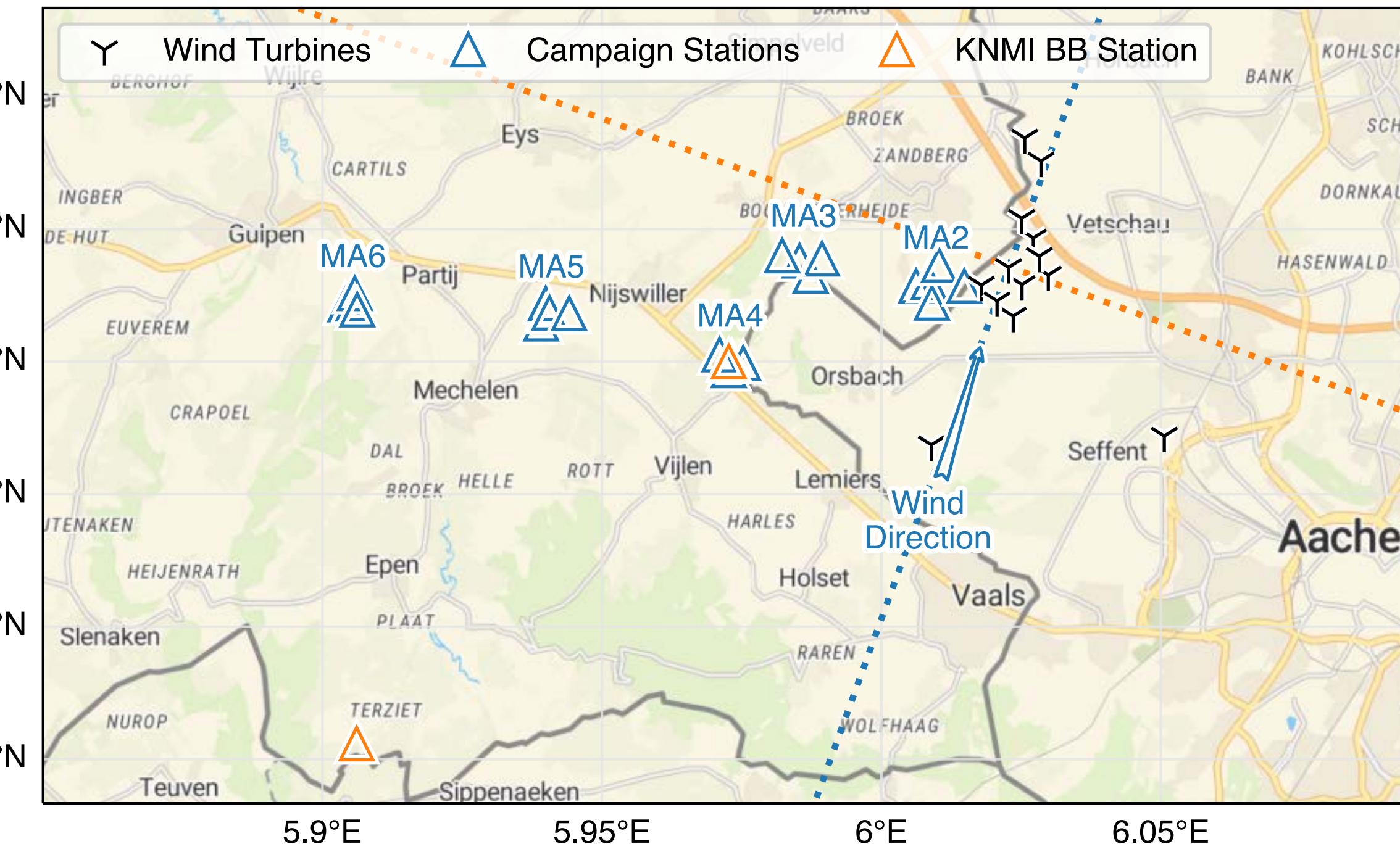




Cottessen & Terziet comparison



Where is the noise coming from?



Horizontal comp.

- 1.1 spike consistent
- Decreases with distance

7 Hz peak is most likely related to the fundamental resonant mode in the steel casing:

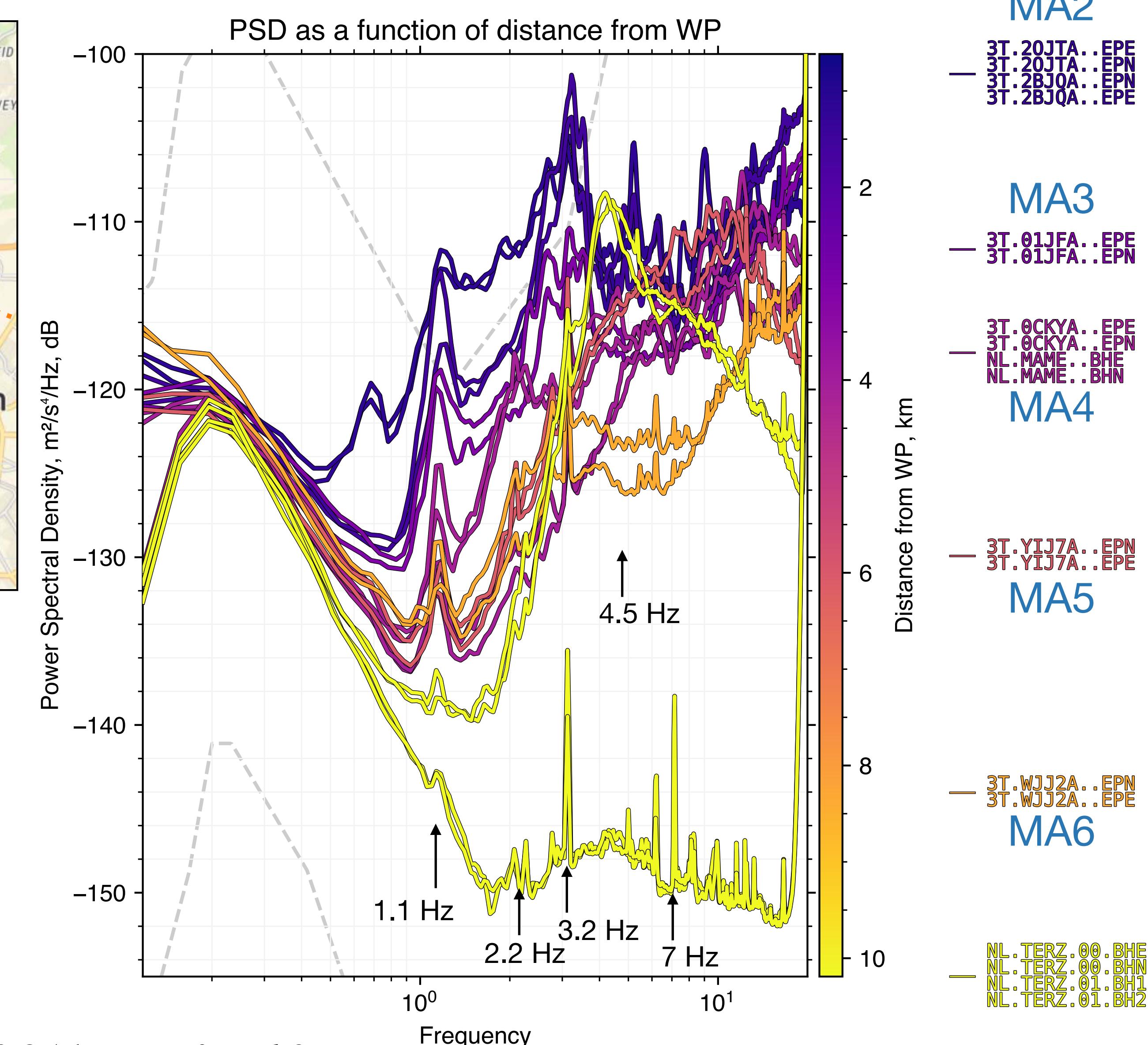
$$f_0 = V/(4h)$$

$$V_p = 6 \text{ km/s}, h = 0.25 \text{ km}, \Rightarrow f_0 = 6 \text{ Hz}$$

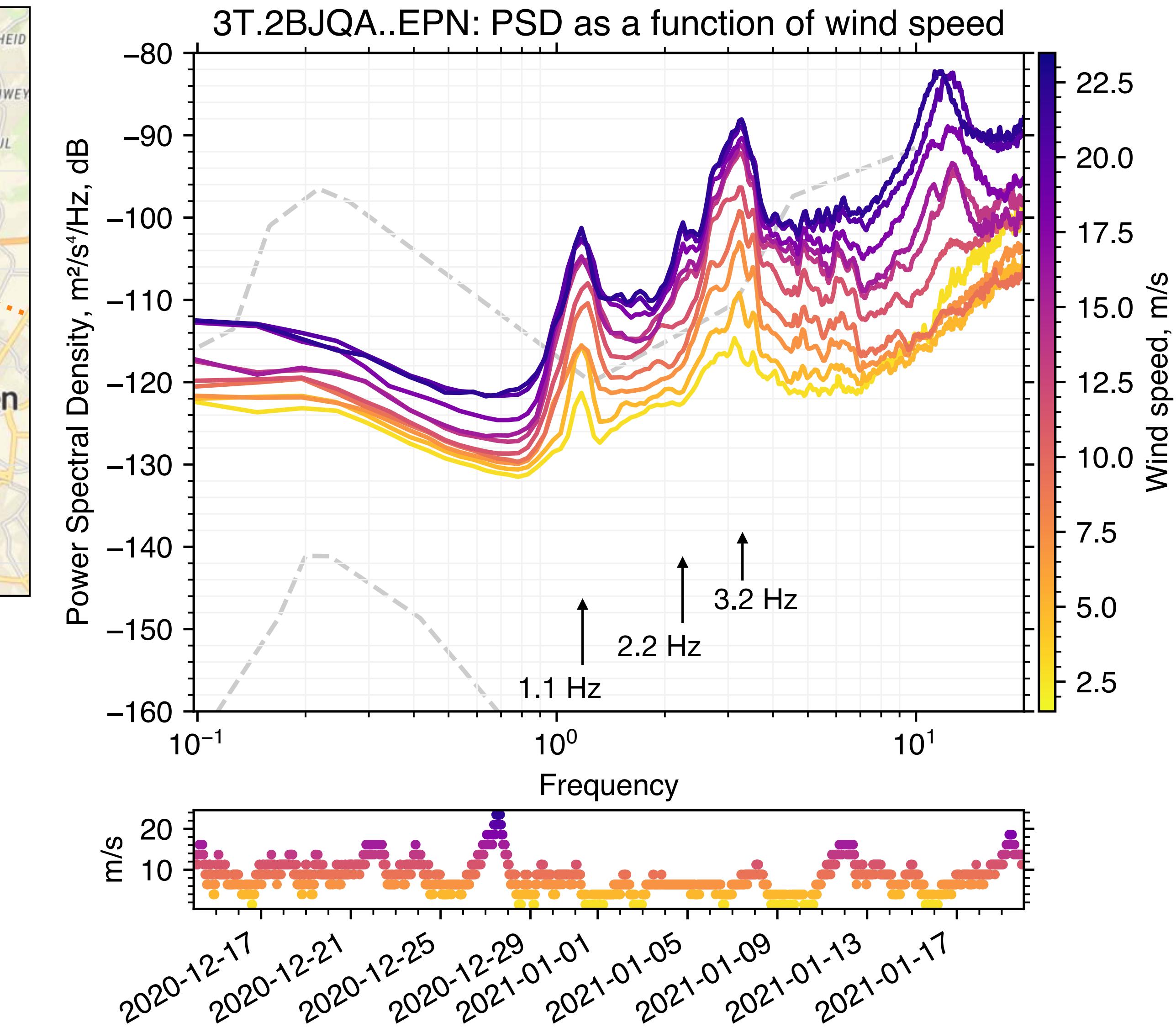
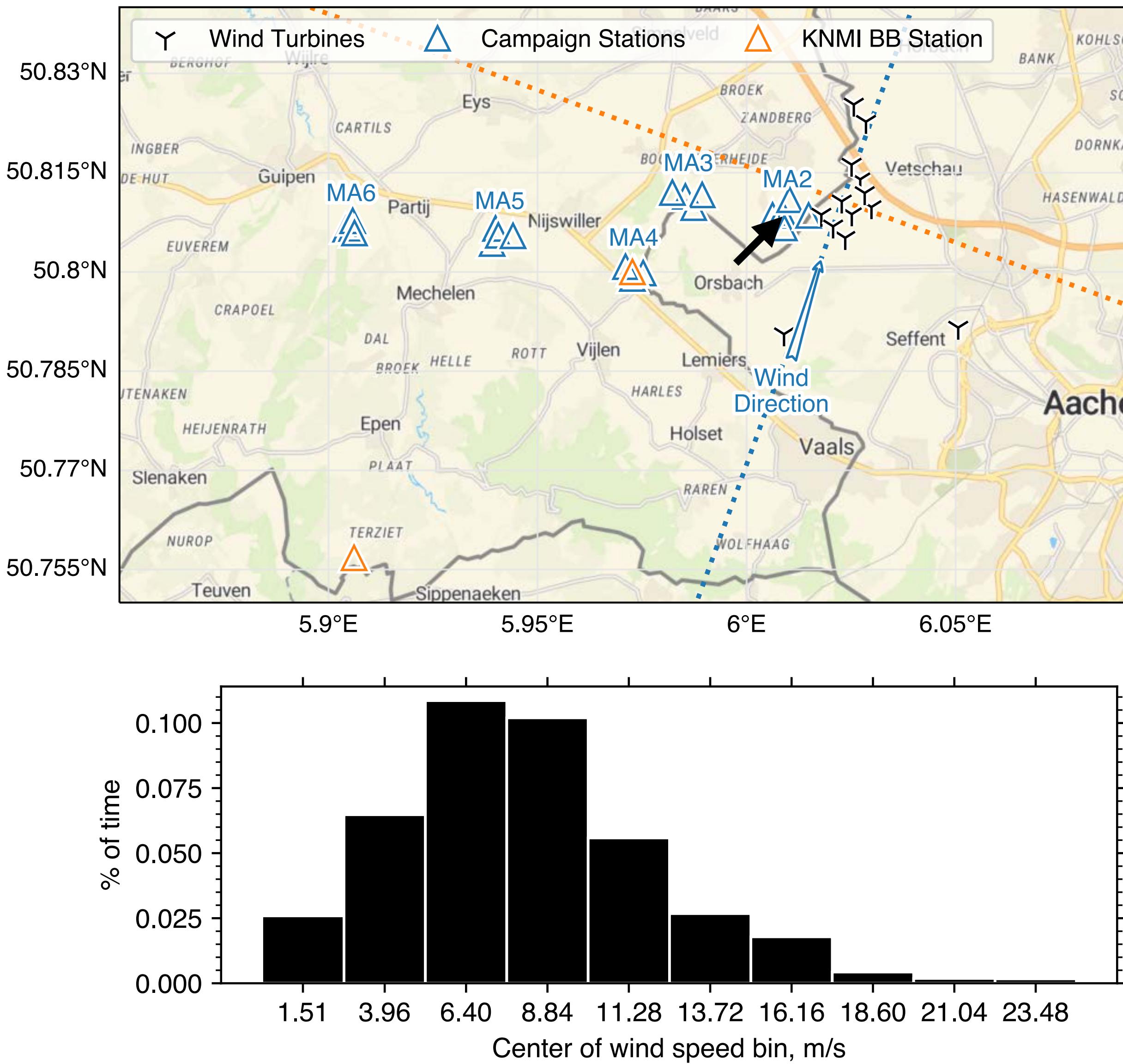
or

$$f_0 = V/(2h)$$

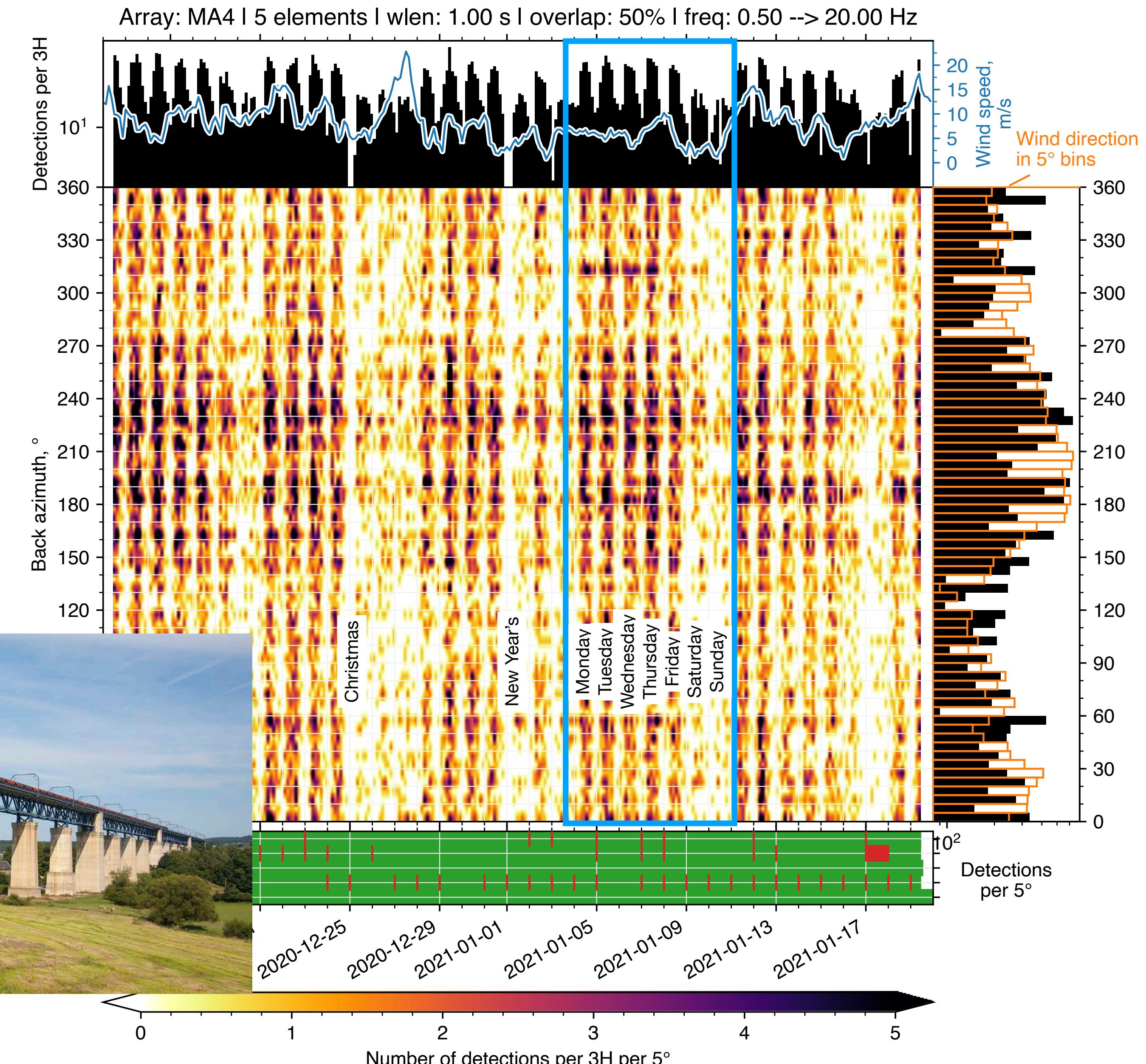
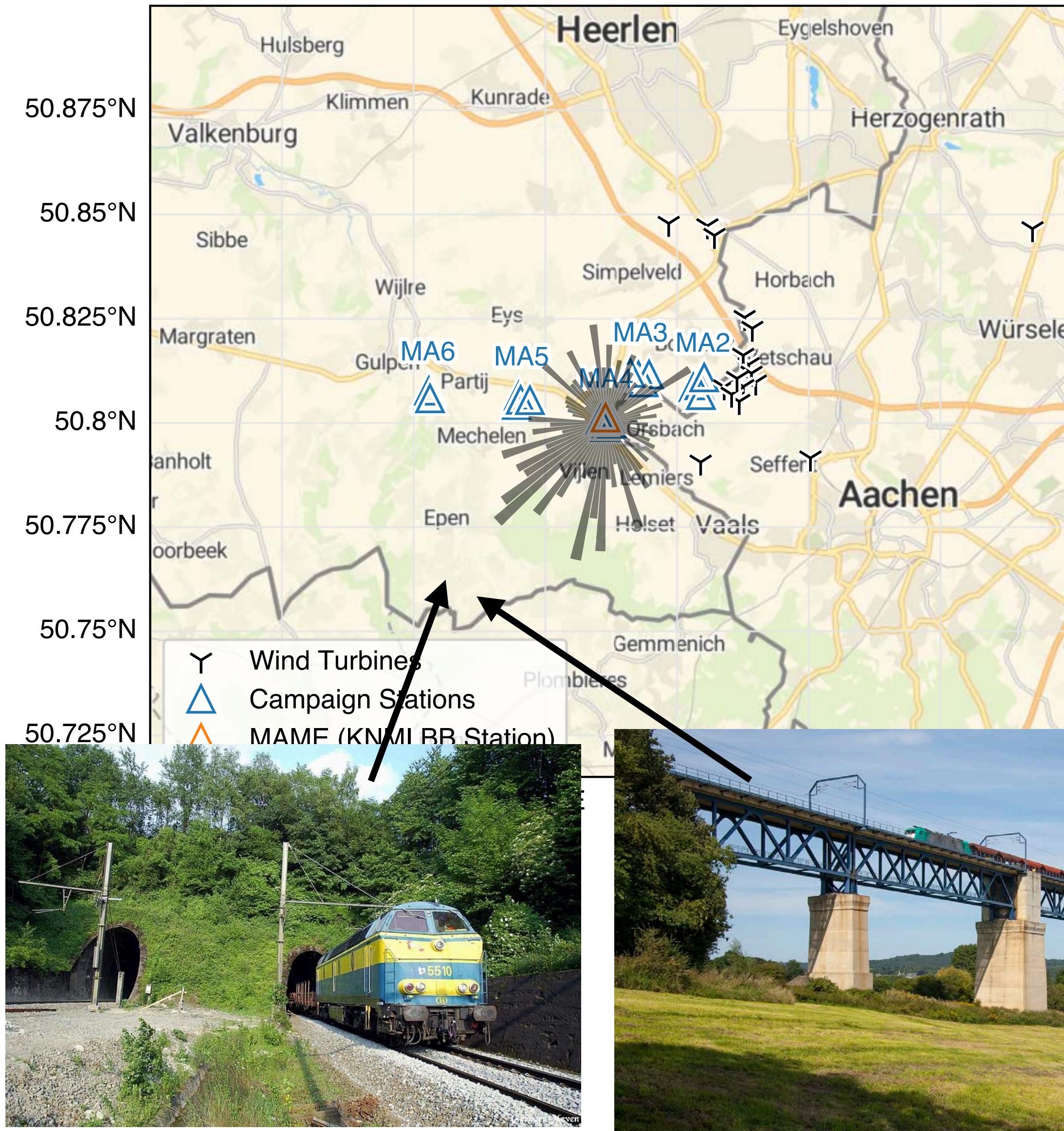
$$V_s = 3.45 \text{ km/s}, h = 0.25 \text{ km}, \Rightarrow f_0 = 6.9 \text{ Hz}$$



Where is the noise coming from?

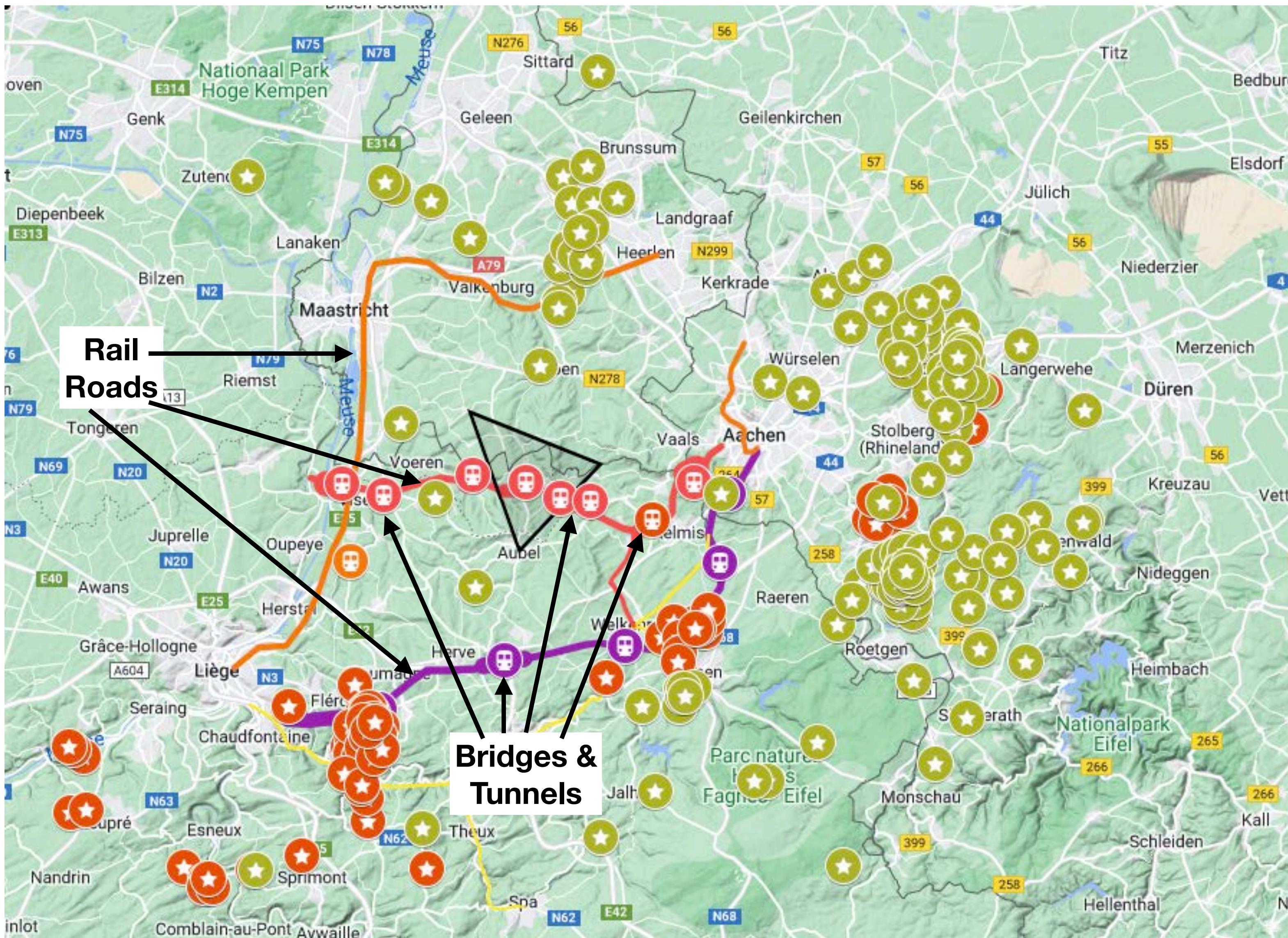


Source identification



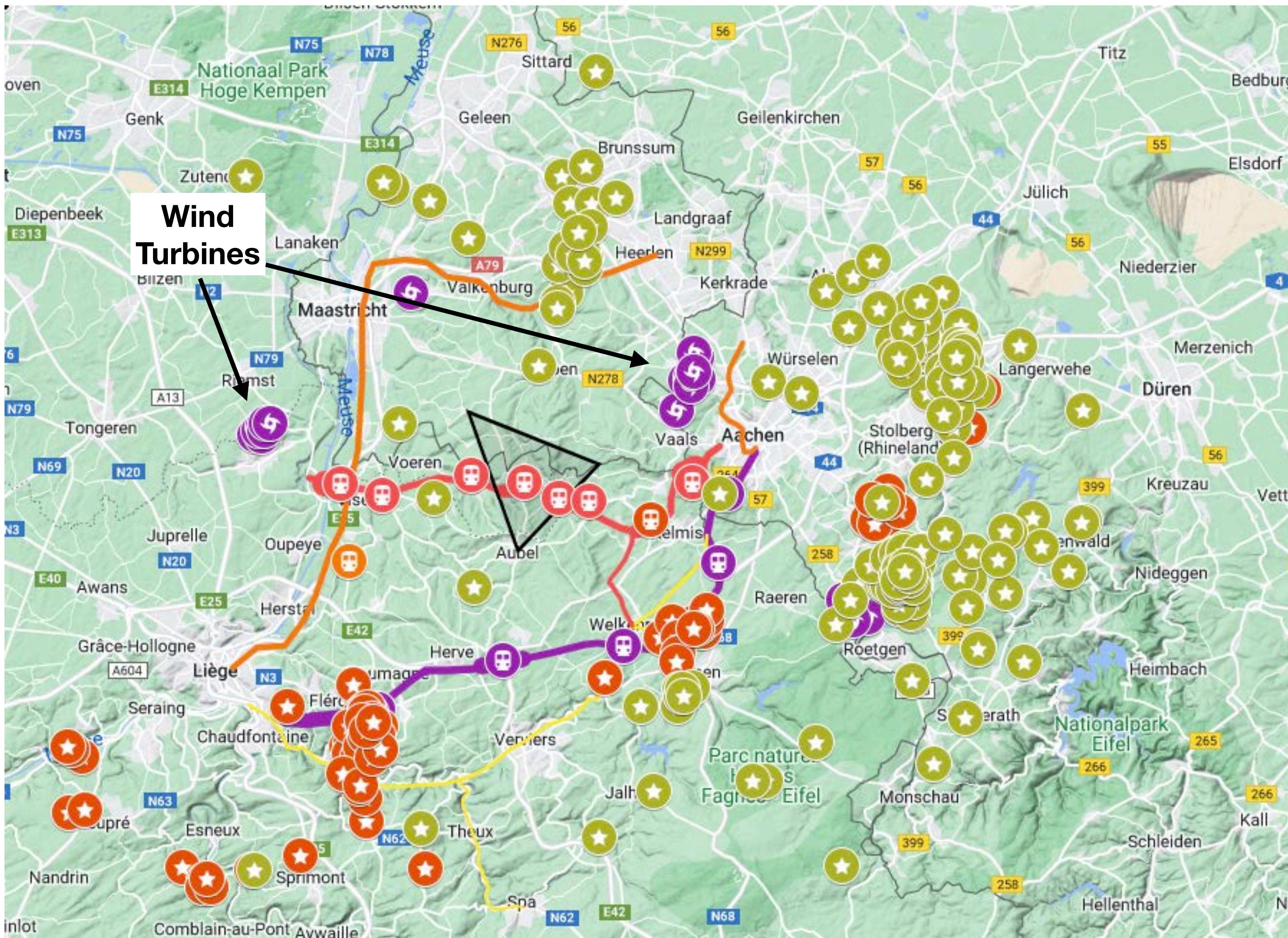


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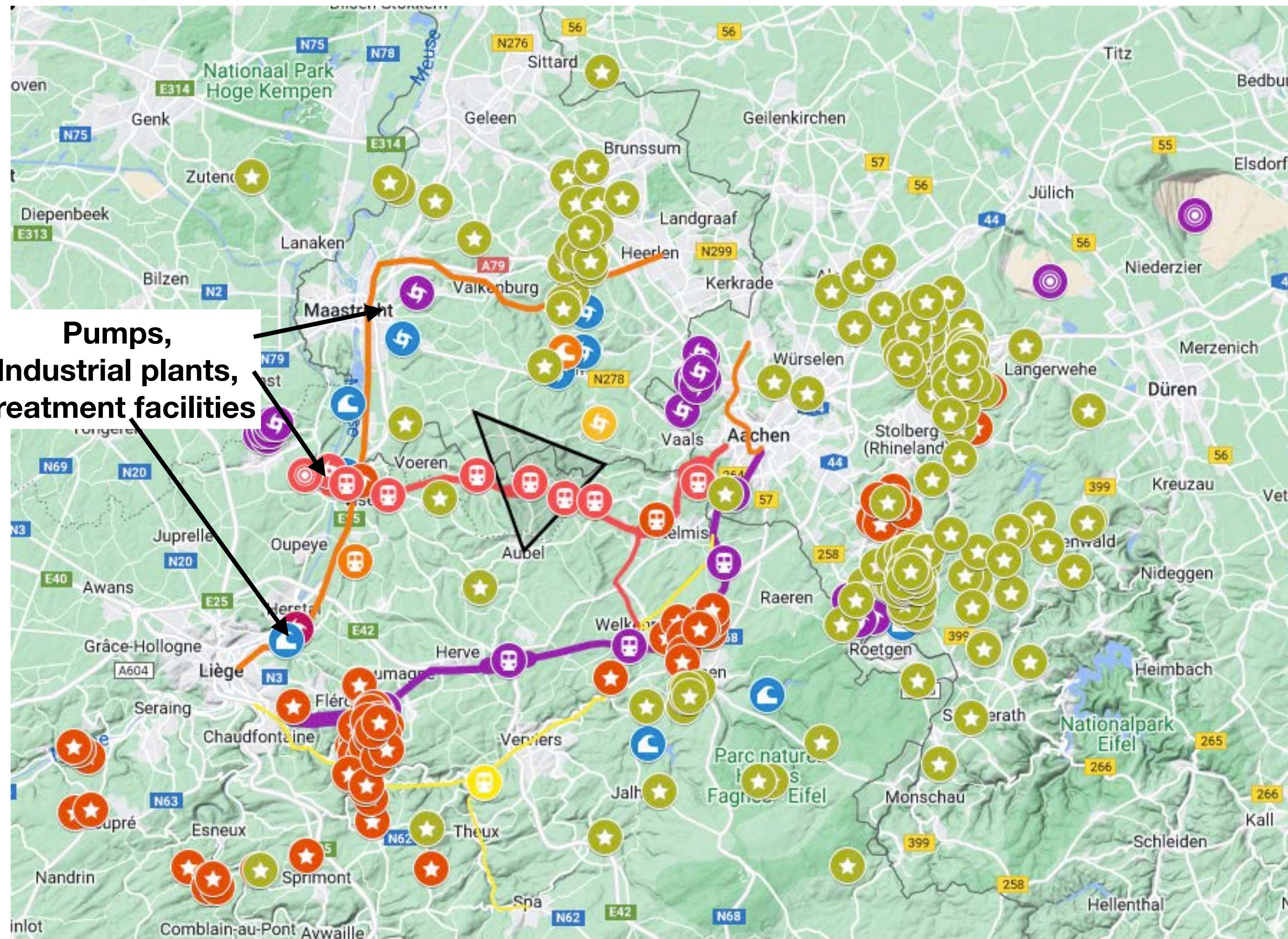


Where is the noise coming from?





Where is the noise coming from?





Future ambitions and concluding remarks

Future ambitions:

- Deploy nodes next to suspected sources of noise to serve as pilot signal.
- Cross-correlate pilot signals with surface and borehole sensors.

Concluding remarks:

- Thin soil cover means “quite” surface conditions bet less attenuation at depth.
- Noise sources on the surface couple better to the subsurface. That means more noise at depth.

