Fit for 55 – en utmaning eller möjlighet för Preem

Åsa Håkansson, Preem AB

Luftvårdsförbundet
i Göteborgsregionen

Fartygsutsläppsmätning med drönare och andra avancerade sensorer

Johan Mellqvist

GeoScience and Remote Sensing
Space, Earth and Environment
Chalmers University of Technology

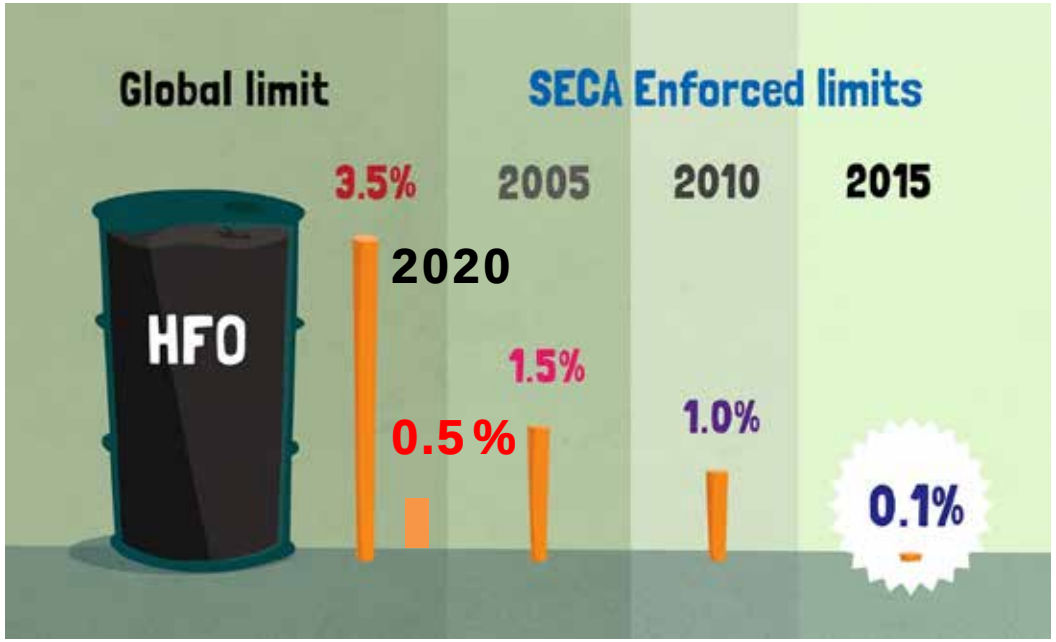
CHALMERS

Environmental Control Areas

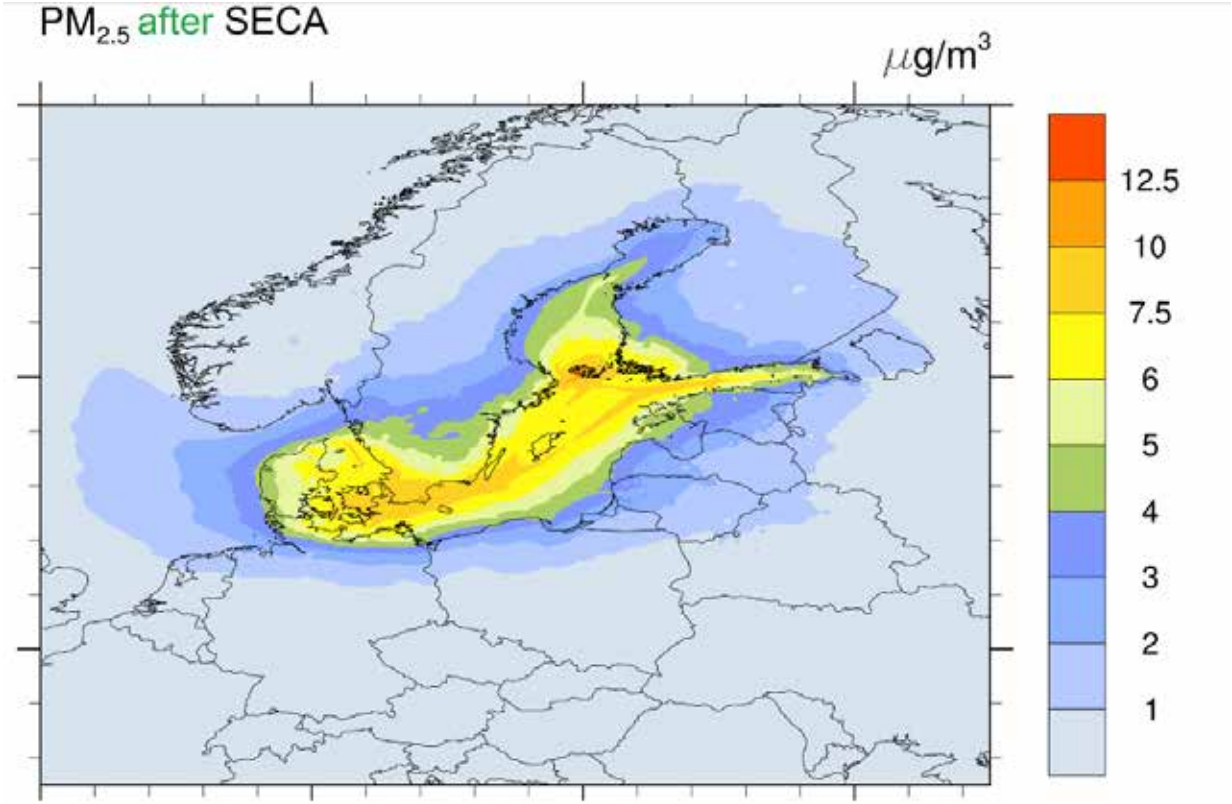
Pollution from shipping causes significant health impacts

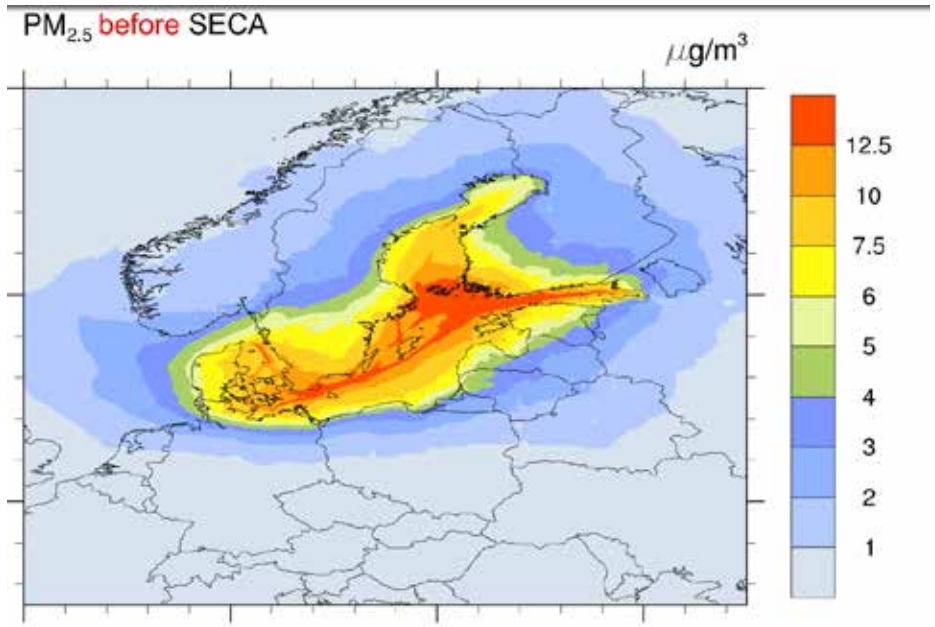
Special environmental zones have been established by IMO requiring the usage of lower fuel sulfur content (0.1 %) (SECA) and NOx abatement in new ships (NECA).

From 2020 it is required to operate with fuel sulfur content <0.5% worldwide and since 2021, new built ships have to reduce NO_x by 90% in special areas



Envisum, Jan Eiof Jonsson)





Port state control of fuel sulfur content (FSC)

- According to European sulfur directive 10% of ships should be inspected every year
- 40% of the inspected should be checked with fuel sampling.
  - (2017, sampling showed ~5% non compliance within FSC 0.1-0.2%.)
- Fuel sampling error <0.02% ppm
- **If remote sensing or handheld XRF is used sampling can be reduced by 50%**
- Scrubber ships usually have to monitor their SO2/CO2 emission and report exceedances, (depends on type approval.)

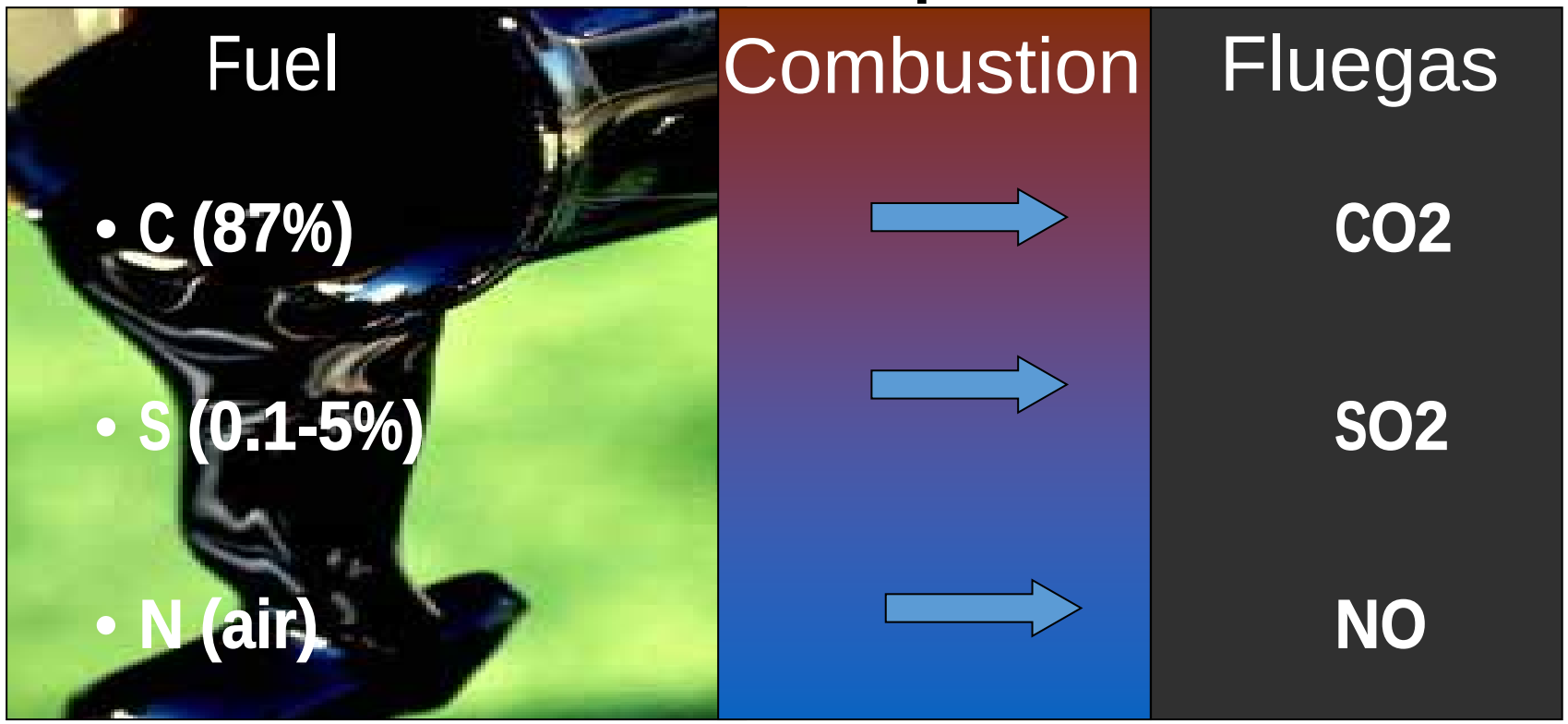
Some countries enforce sulfur rules by fees (Sweden, Belgium 150kEuros), others legal prosecution (Denmark) (upto 50 kEuros). Some countries detains ships. In the US they have a fee system based on economic benefit and gravity.

Emissions from Shipping- Chalmers

- Chalmers has developed and applied automatic systems for sulfur and NOx compliance control for usage from fixed stations, ship platforms, airplanes and drones . Also particle emissions are measured. *This system is backbone for all monitoring in Europe today.*
- Operational Compliance measurements for Danish EPA, Swedish Transport agency. We also built a system for the Belgian pollution control (MUMM) . Aprox 30000 ships measured.
- Research work within several EU projects: Innoship, Envisum, CompMon. In Scipper (H2020) we study emissions of NOx and particles and compliance rates on Mediterranen sea and work with quality assurance. We will study emissions in different types of operation and quantify impact on health on

Sniffer measurements of ships

Combustion of ship fuel :



SO2 / CO2 är proportionell mot svavelbränslehalten

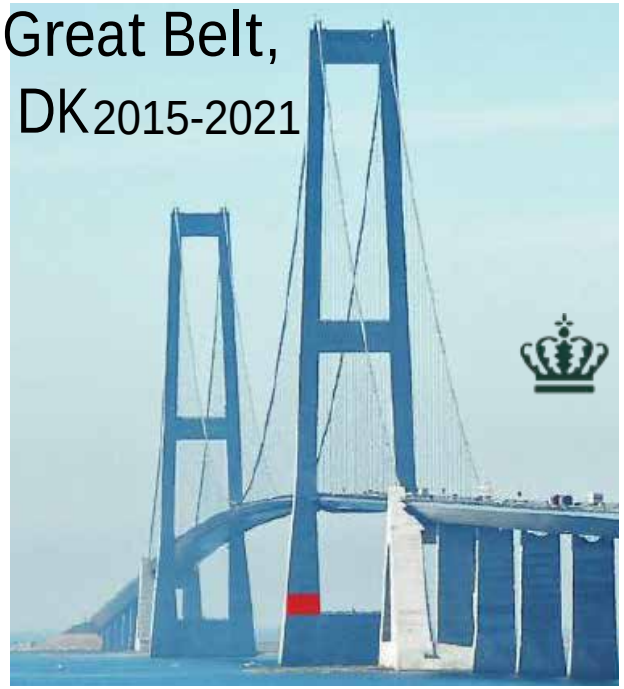
NOx / CO2 är propertionell mot utsläpp NOx per kg bränsle

Sites

Pebbarholmen
DK 2019-2021

TRANSPORT STYRELSEN

Öresund bridge, SE
2017-2018



Great Belt,
DK 2015-2021

Ministry of Environment of Denmark
Environmental Protection Agency

Göteborg, Älvsborg SE 2008-2020, not continous

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Mobile platforms used by Chalmers

Denmark. Commercial aircraft equipped with Chalmers medium sniffer sensor

Drone: SkyEye Micro, 1 kg payload, 30 min durability.Sensors: Minisniffer, optical and bag-sampling. Scipper & 4 campaigns 2021 in Nat project

Measurement vessels
For campaigns or
coast guard (St Petersburg, Gdansk/Gdynia, Rdam)

Belgium, Royal Belgian Institute uses Chalmers medium sniffer and NOx sensor

High end (SO2 3s 200 ppt) 1 s t_{10}-t_{90}

Mid level (SO2 3s 3 ppb) 30 s t_{10}-t_{90}
Cross interference NO, 1.5%

Low level (3s 10 ppb) 30 s t_{10}-t_{90}
Cross interference NO2 -100%

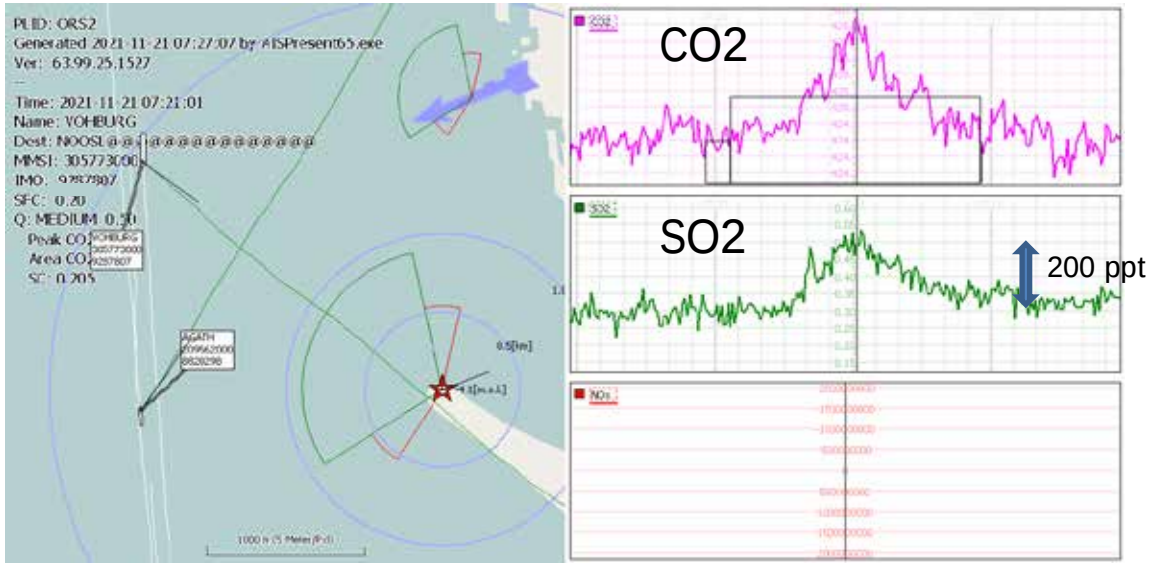
Laser spectrometer,

Fluorescence, Chemiluminiscene, NDIR, CRDS

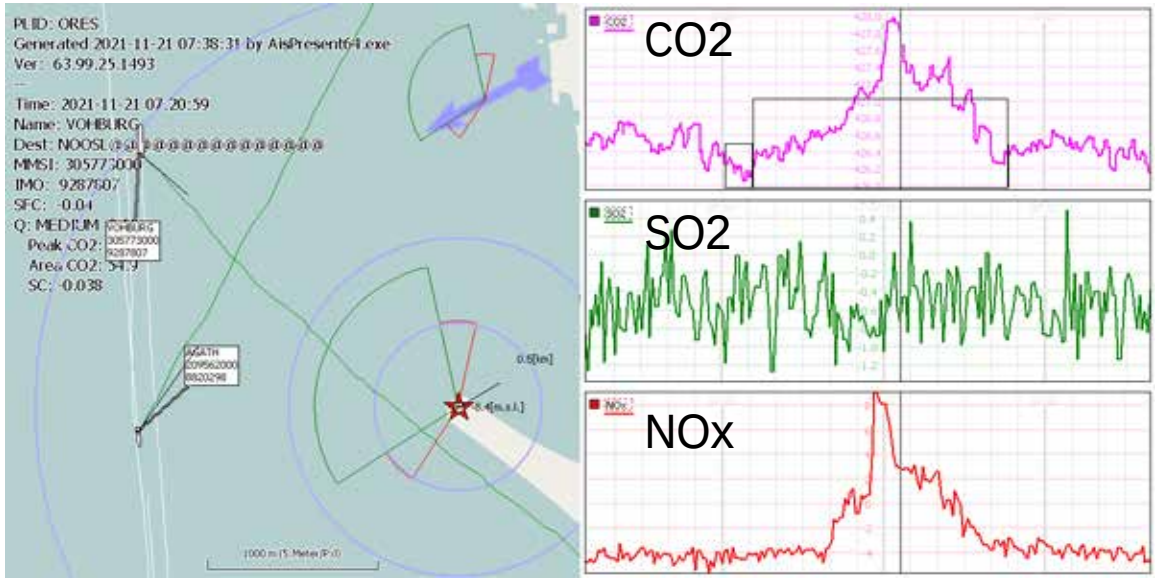
ECC, PID, NDIR, Light scattering,

Comparison of ultrasensitive laser system with standard sniffer instrument when measuring same ship at Pebbarholmen, Öresund (2.5 km distance to ship)

Hi end (Laser system)

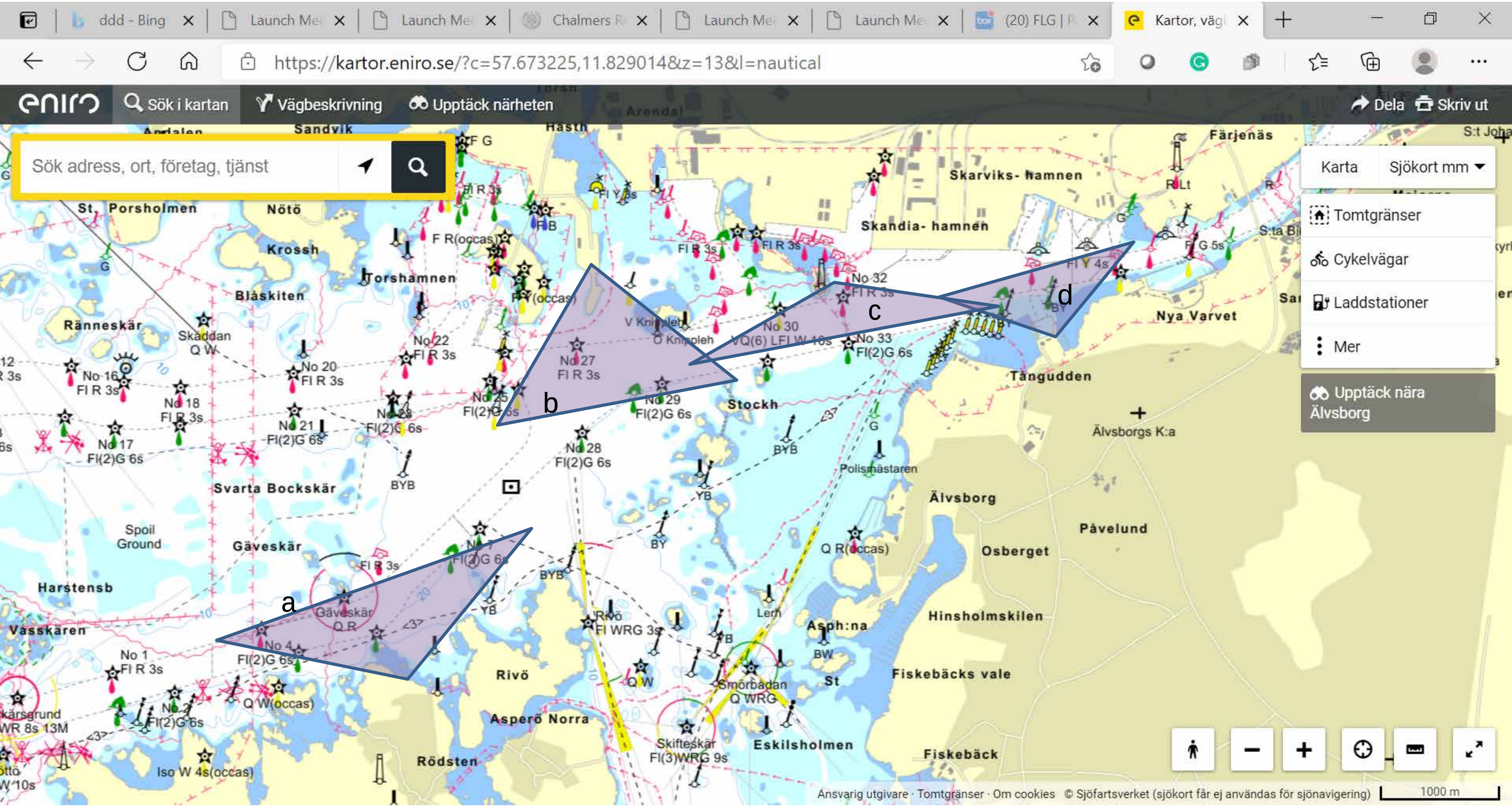


Mid level (Standard system)

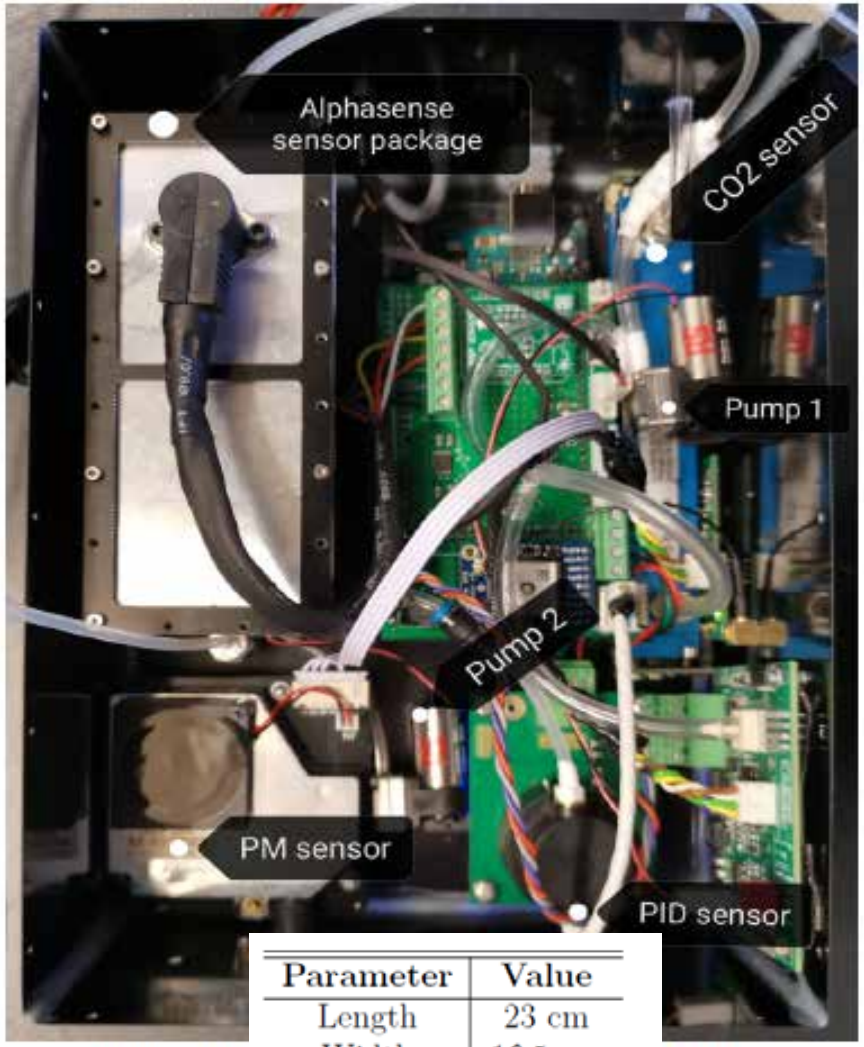


Drönarprojekt Göteborgs hamn

- *Projekt:* Kontroll av rökgasutsläpp från fartyg med drönare, 2020-04595, Vinnova
- Målsättning: Utveckling av drönarsensorer för rökgasmätning av fartyg
- *Drönare:* Skyeye Micro Sky, 4 kg, 80 cm diameter, hasitghet 20 m/s (vind <10 m/s)
- *Sniffersensorer:* Elektrokemiska och optiska, ca 1,3 kg, vindmätare
- Optisk sensor. UV/synlig spektrometer, uppåt och framåttittande
- Max avstånd ca 2 km från pilot.
- Flygning görs ca 50 m från relingen, under 1 minut åt gången , med 3 upprepningar

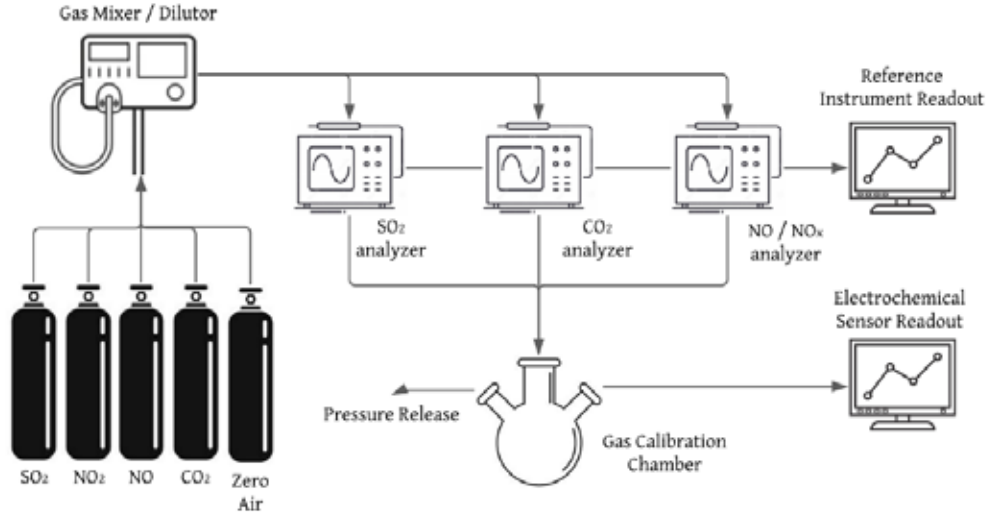


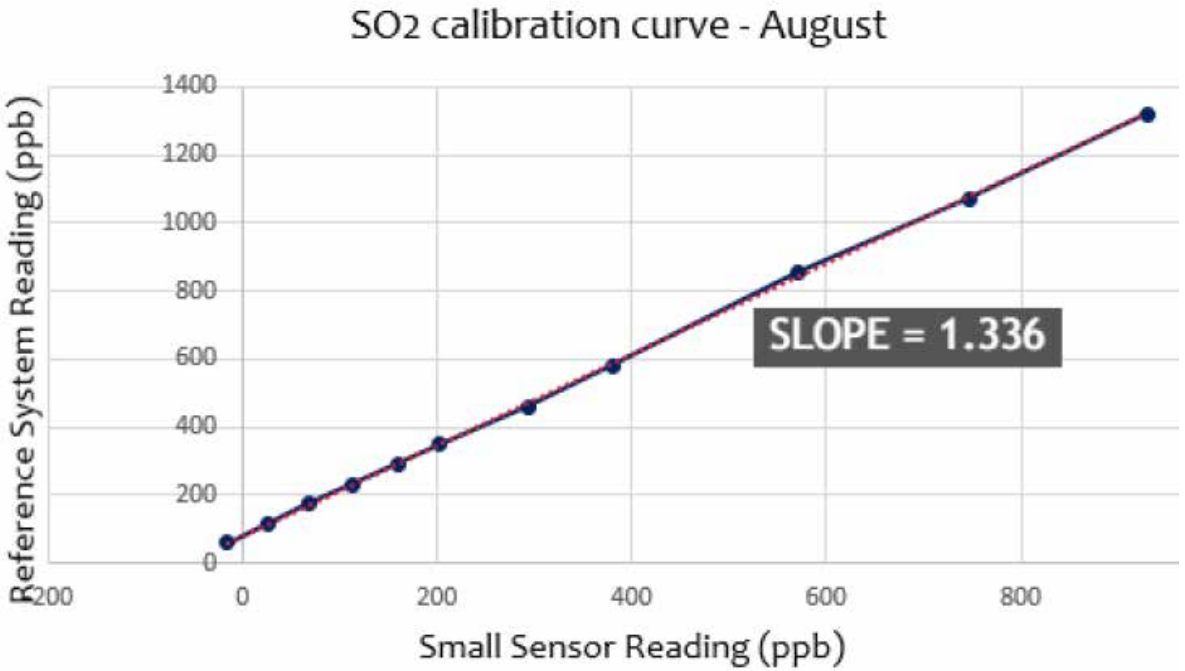
https://kartor.eniro.se/?c=57.673225,11.829014&z=13&l=nautical
eniro
Sök i kartan
Vägbeskrivning
Upptäck närheten
Dela
Skriv ut
Sök adress, ort, företag, tjänst
Karta
Sjökort mm
Tomtgränser
Cykelvägar
Laddstationer
Mer
Upptäck nära Älvsborg
a
b
c
d
St. Porsholmen
Nötö
Krossh
Torshamnen
Blåskiten
Ränneskär
Skäddan
Svarta Bockskär
Spoil Ground
Gäveskär
Harstensb
Vasskären
Rivö
Asperö Norra
Rödsten
Eskilsholmen
Skifteskär
Smörbadan
Fiskebäcks vale
Fiskebäck
Hinsholmskilen
Osberget
Påvelund
Älvsborg
Polismästaren
Älvsborgs K:a
Tångudden
Nya Varvet
Skarviks- hamnen
Skandia- hamnen
Färjenäs
Sandvik
Stockh
Ansvarig utgivare · Tomtgränser · Om cookies © Sjöfartsverket (sjökort får ej användas för sjönavigering)
1000 m



Parameter	Value
Length	23 cm
Width	16.5 cm
Height	8.5 cm
Weight	1.275 kg

Calibration of small sensors. Here is shown the SO2 ECC sensor respons to SO2 and cross sensitivity to NO2





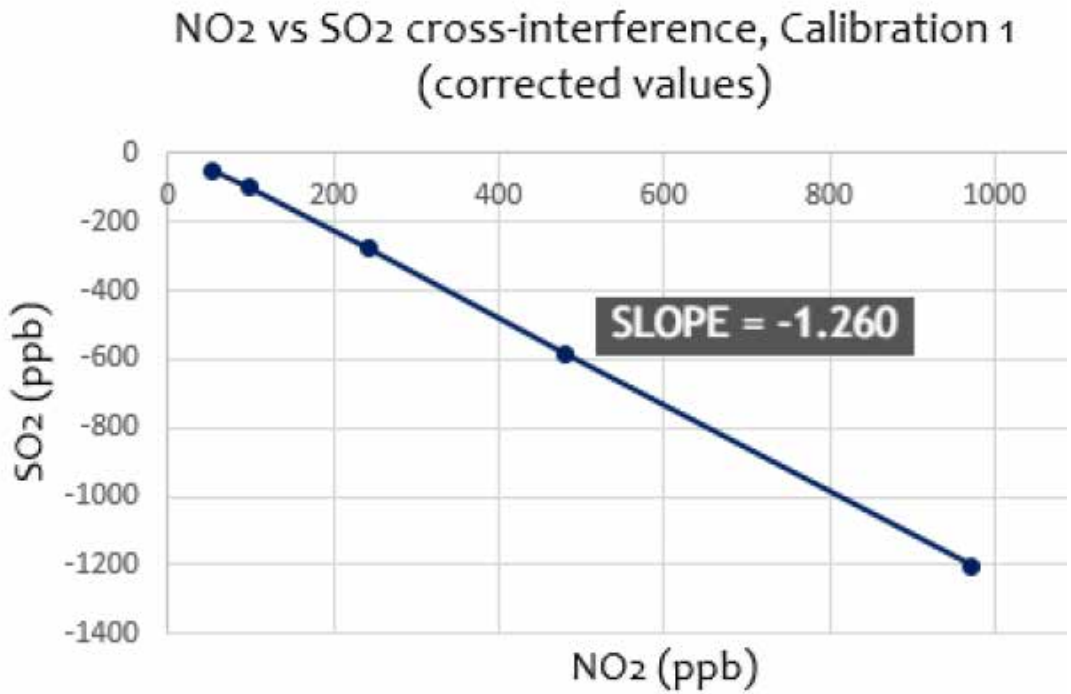


Foto från Chalmers drönare vid mätning av rökgasutsläpp från Stena Germanica. Parallella mätningar ombord gjordes i Scipper projektet. Mätningar görs ca 50 m från fartygets reling, genom att köra in i plymen 60 s sedan ut i ren luft 60 s; detta repeteras 3 ggr.

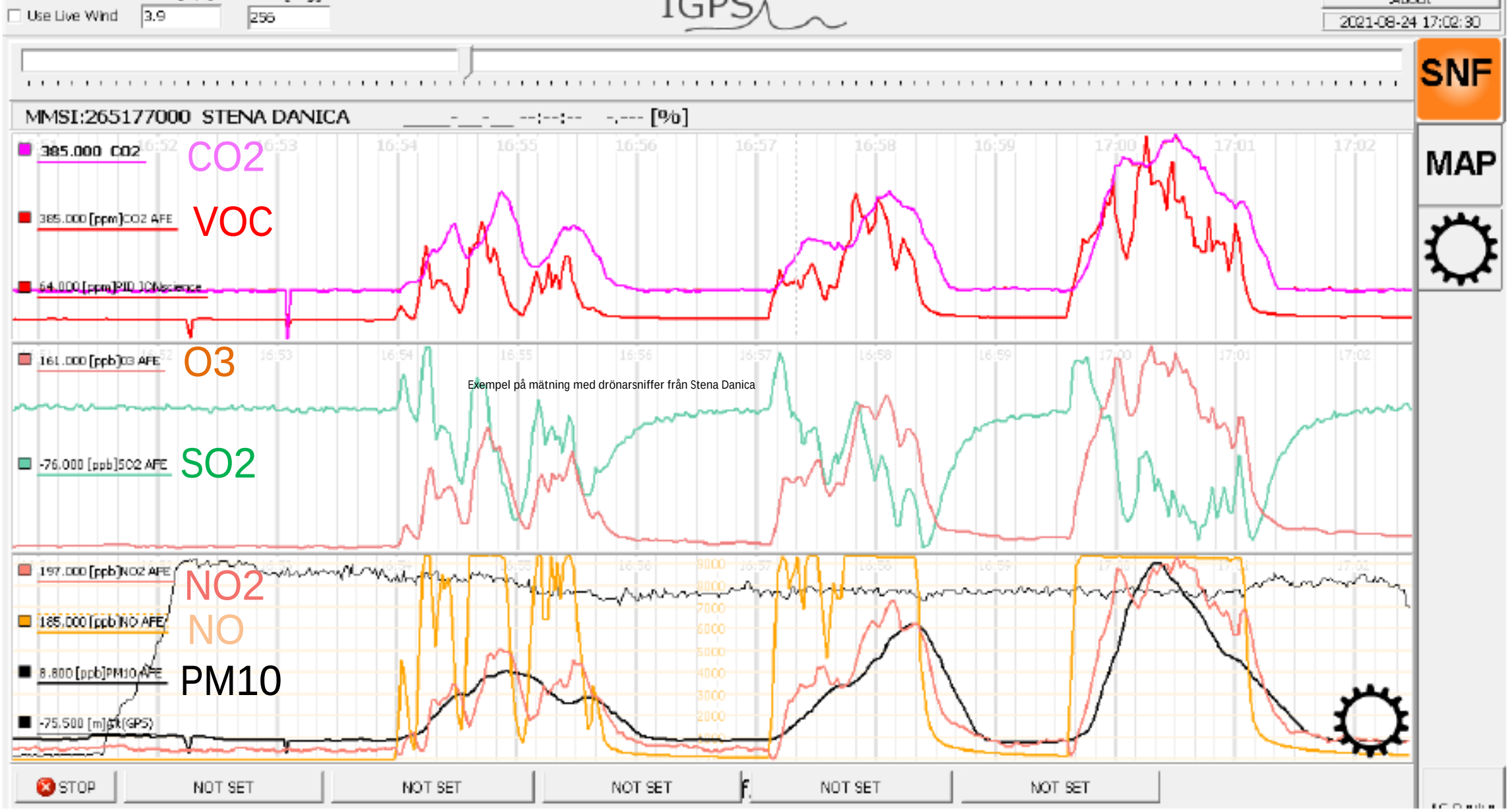

Use Live Wind
3.9
256
2021-08-24 17:02:30
SNF
MAP
MMSI:265177000 STENA DANICA
385.000 CO2
CO2
385.000 [ppm]CO2 AFE
VOC
64.000 [ppm]PID JCNscience
161.000 [ppb]O3 AFE
O3
Exempel på mätning med drönarsniffer från Stena Danica
-76.000 [ppb]SO2 AFE
SO2
197.000 [ppb]NO2 AFE
NO2
185.000 [ppb]NO AFE
NO
8.800 [ppb]PM10 AFE
PM10
-75.500 [m]alt(GPS)
STOP
NOT SET
NOT SET
NOT SET
NOT SET
NOT SET

Table 7.1: FSC results for 8 different types of ships for every plume transect. The uncertainty is calculated only for the baseline standard deviation.

			FSC [%] ± Baseline Standard Deviation		
No.	**Ship Type**	**Speed**	**Plume 1**	**Plume 2**	**Plume 3**
1	Tanker	8.5 kn	0.0988 ±11.045	0.1053 ±11.927	-
2	Tanker	10.1 kn	0.1446 ± 10.789	0.1383 ±9.505	0.1492 ± 13.871
3	Passenger	8.4 kn	0.1120 ±13.466	0.1919 ±12.424	0.1607 ±15.405
4	Cargo	19.5 kn	0.0329 ±8.752	0.0527 ±8.251	0.0327 ±6.490
5	Oil Tanker	12.7 kn	0.0455 ±17.902	0.0498 ±15.409	0.0490 ±15.084
6	Passenger	8.8 kn	0.1631 ±8.808	0.1784 ±7.278	0.1559 ±8.067
7	Cargo	8 kn	0.1261 ± 10.683	0.1011 ± 11.111	0.1393 ± 11.680
8	Passenger	8.7 kn	0.1718 ±18.658	0.2181 ±12.021	0.1586 ±10.041

Table 7.2: NO_x [g / kg fuel] results for same ships in Table 7.1 for every plume transect. The uncertainty is calculated only for the baseline standard deviation.

			NO_x [g / kg fuel] ± Baseline Standard Deviation		
No.	**Ship Type**	**Speed**	**Plume 1**	**Plume 2**	**Plume 3**
1	Tanker	8.5 kn	37.238 ±15.377	36.926 ±38.151	-
2	Tanker	10.1 kn	34.150 ±6.014	34.717 ±6.854	38.221 ±6.854
3	Passenger	8.4 kn	15.577 ±18.269	60.921 ±21.499	46.380 ±24.365
4	Cargo	19.5 kn	41.162 ±8.341	47.838 ±7.418	43.029 ±15.009
5	Oil Tanker	12.7 kn	3.097 ±8.239	3.416 ±3.971	7.160 ±4.247
6	Passenger	8.8 kn	70.054 ±10.773	91.313 ±8.562	48.287 ±8.480
7	Cargo	8 kn	87.997 ±9.222	90.978 ±10.488	74.568 ±8.534
8	Passenger	8.7 kn	66.873 ±4.852	39.429 ±4.523	28.467 ±14.564

Sammanfattning

- Drönarmätningen fungerar bra i lugnare väder <7 m/s med god reproducibilitet mellan flera mätningar.
- Ca 100 fartyg har mätts från Risholmen; utvärdering pågår och jämförelse mot ombordmätning.
- Mätningar visar god reproducibilitet men svavelresultat verkar något höga och vidare kvalitetsarbete krävs.
- Fartygsensorpaketet har också installeras i vattentätt låda med solceller för autonomdrift från fasta mätstationer
- Ett nytt Vinnova projekt genomförs 2022 med drönarmätning av metan med lasersensor i utsläppsplymer från fartyg, deponier, reningsverk och raffinaderier. Flera av dessa mätplatser är i Göteborg.