In-situ monitoring around wrecks and dump sites in the Baltic and North Seas

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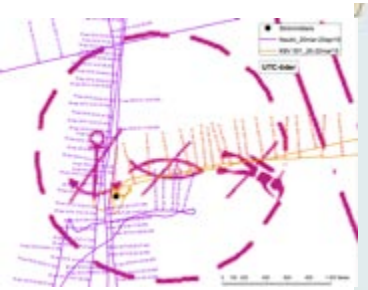
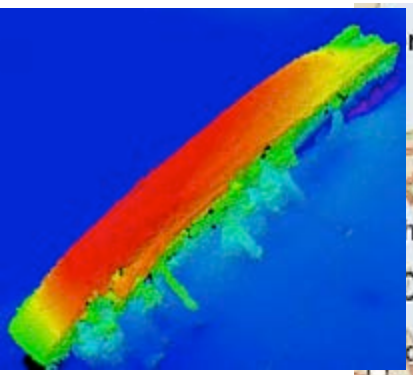
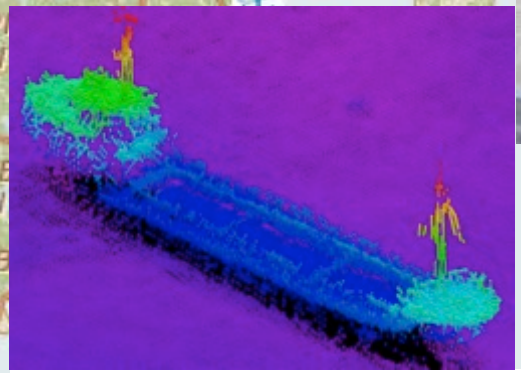
RDCP deployment sites

Maseskaer: Chemical weapon dump
- **Depth 220-240 m; Tot 1 months of data**
- **Frequent bottom trawling in the area**



Skytteren:
- **Wreck, 173 m, sunk 1942, 500 m^3 oil**
- **Depth 74 m; Tot 6 months of data**





Villon:
- **Wreck, 51 m, sunk 1985, 4 m^3 oil**
- **Depth 37 m; Tot 8 months of data**

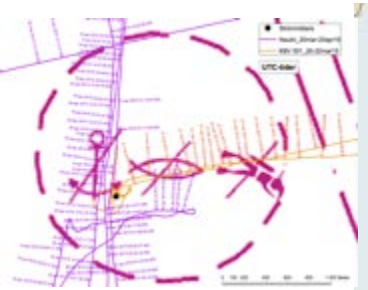
RDCP deployment sites

Parameters measured every 30 min:

- Current profile every m from 3-50 m above bottom
- Temperature 2 m from bottom
- Salinity 2 m from bottom
- Oxygen 2 m from bottom
- Pressure/depth 2 m from bottom
- Turbidity (mineralogenic particles) 2 m from bottom
- Acoustic reflections 3-50 m
- Mixing (stdev currents) 3-50 m

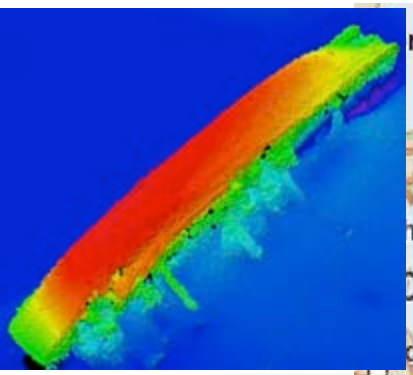
Maseskaer: Chemical weapon dump

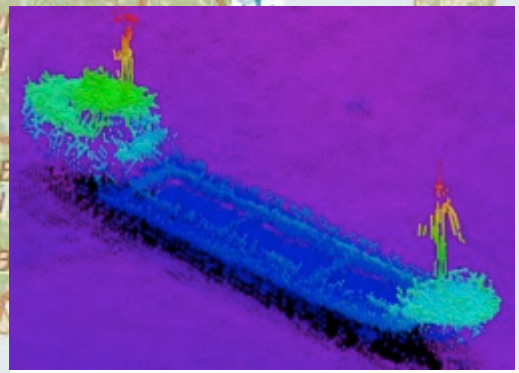
- **Depth 220-240 m; Tot 1 months of data**
- **Frequent bottom trawling in the area**



Skytteren:

- **Wreck, 173 m, sunk 1942, 500 m^3 oil**
- **Depth 70 m; Tot 6 months of data**



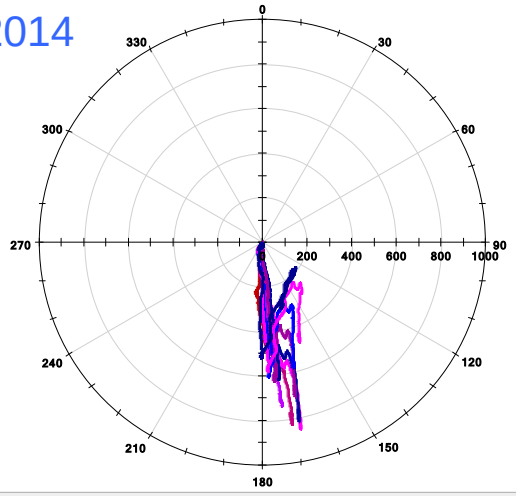


Villon:

- **Wreck, 51 m, sunk 1985, 4 m^3 oil**
- **Depth 37 m; Tot 8 months of data**

Progressive Vector - Column1 - 2.0 to 38.0m - Ref. instrument

Jun-Oct, 2014

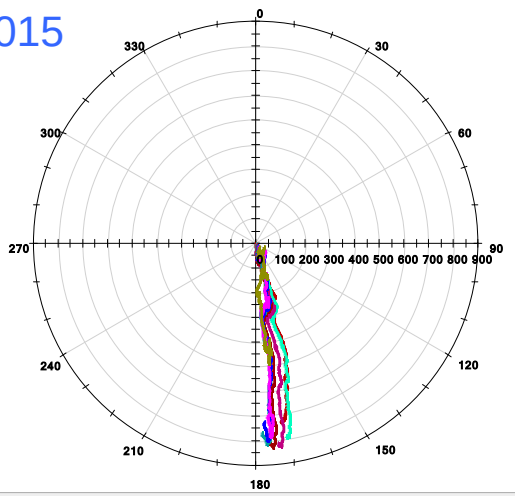


Magnitude: [km]

Cell1: 2.0 to 4.0m
Cell3: 4.0 to 6.0m
Cell6: 7.0 to 9.0m
Cell9: 10.0 to 12.0m
Cell15: 16.0 to 18.0m
Cell18: 19.0 to 21.0m
Cell21: 22.0 to 24.0m
Cell24: 25.0 to 27.0m

Progressive Vector - Column1 - 2.0 to 38.0m - Ref. instrument

Jan-Jun, 2015

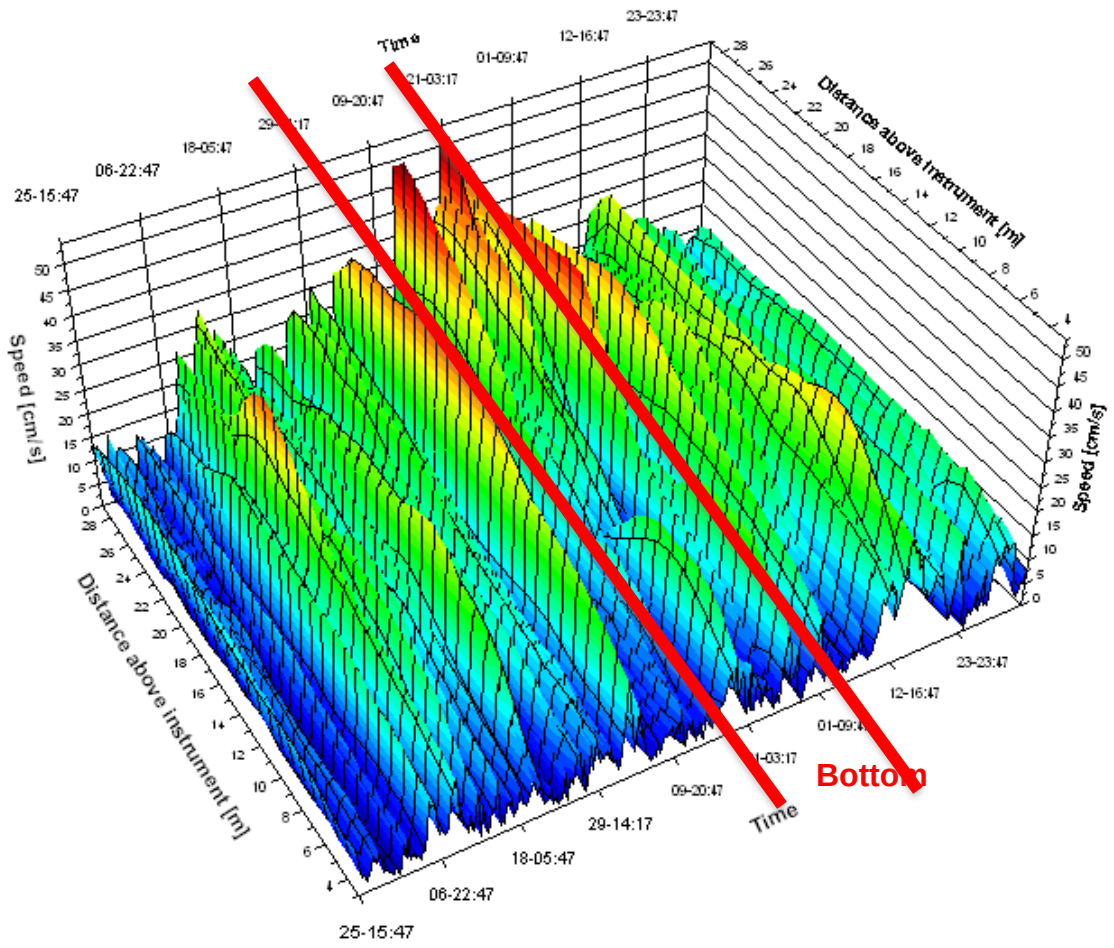


Magnitude: [km]

Moving average: 1

Cell1: 2.0 to 4.0m
Cell5: 6.0 to 8.0m
Cell9: 10.0 to 12.0m
Cell13: 14.0 to 16.0m
Cell17: 18.0 to 20.0m
Cell21: 22.0 to 24.0m
Cell24: 25.0 to 27.0m
Cell28: 29.0 to 31.0m

Horizontal currents



Current speed [cm/s]

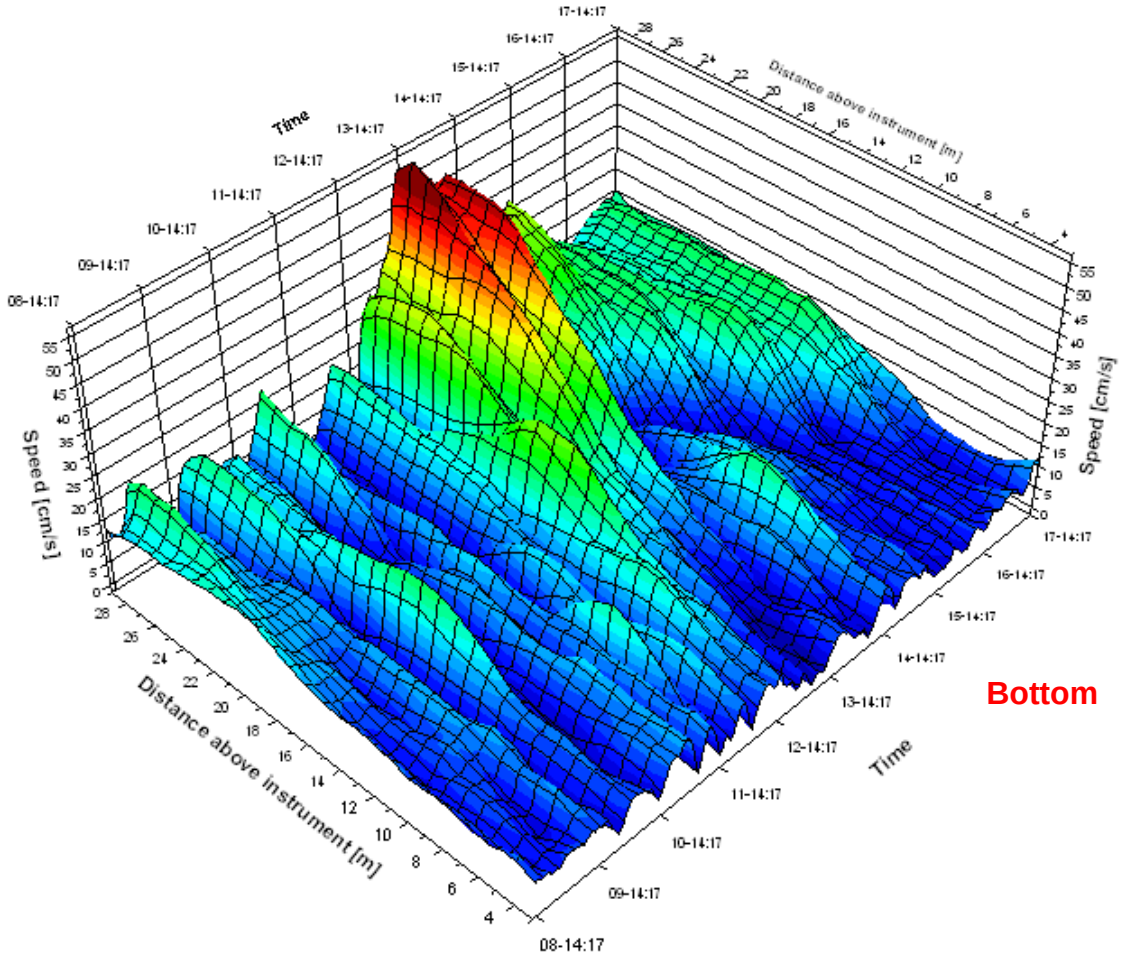
50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0

Time range: 2014.06.25 - 15:47 to 2014.10.05 - 08:17

Decimation: 16
Moving average: 9

<u>Comments</u>: Highest currents around 50, lower currents in the bottom 18 m, shading from wreck?

Horizontal currents, detail



Time range: 2014.08.08 - 14:17 to 2014.08.17 - 15:17

Decimation: 2
Moving average: 9

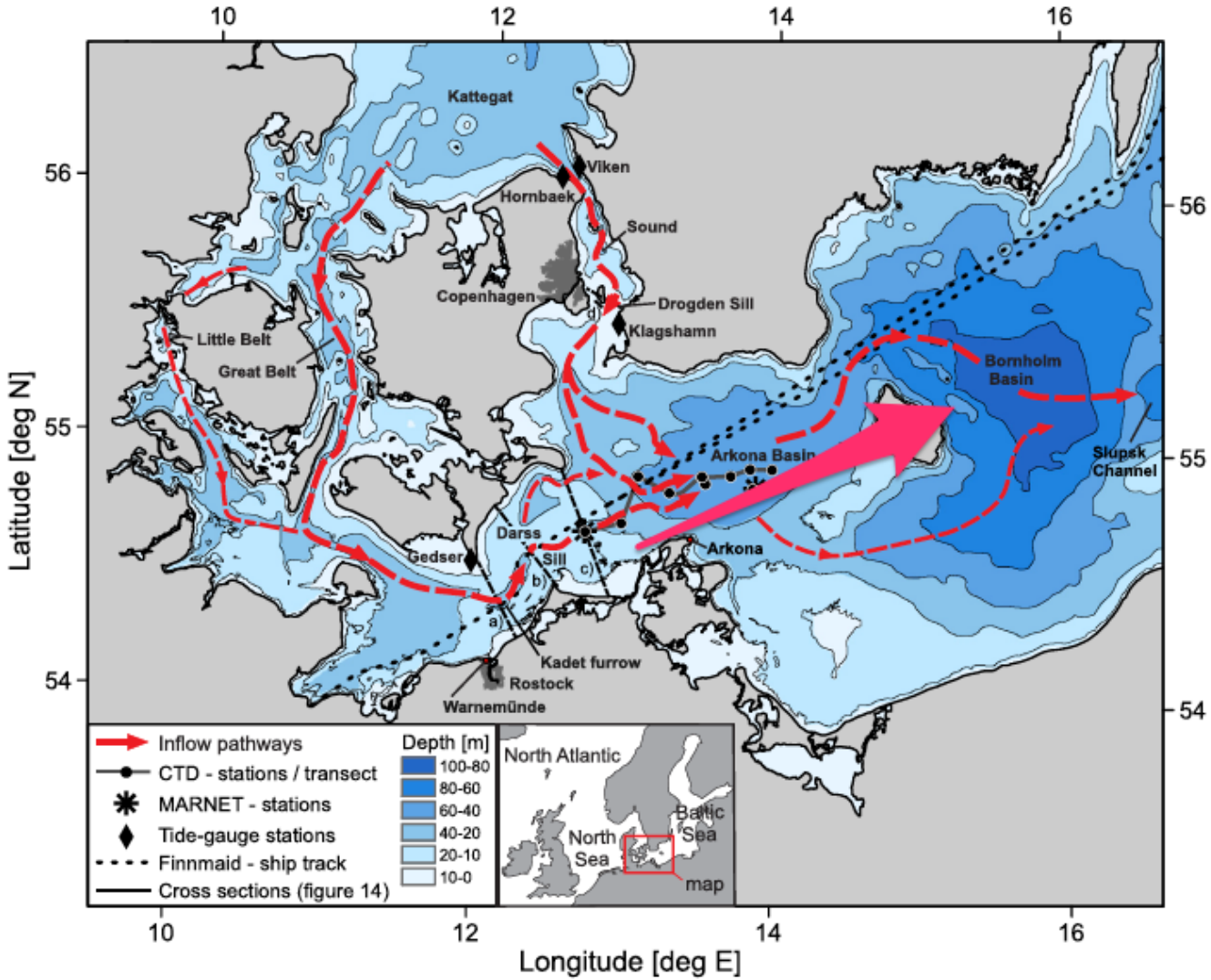
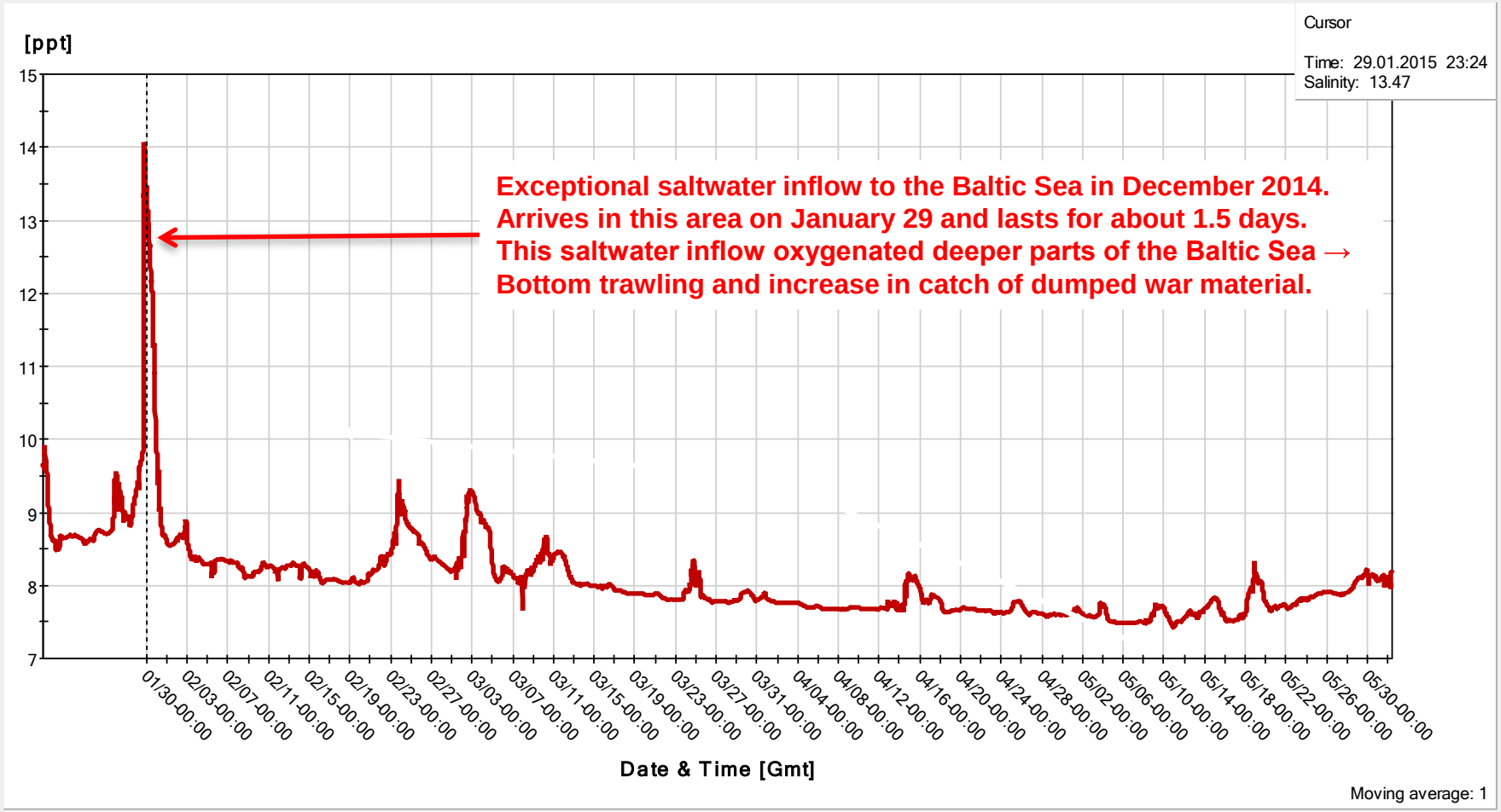


Fig. 1. Bathymetric map of the southwestern Baltic Sea with positions of the measurement sites. The pathways of inflowing highly saline water are indicated by dashed bold arrows. The black dashed lines depict the location of across channel sections of Fig. 14. The entire area is covered by the applied high resolution numerical model.

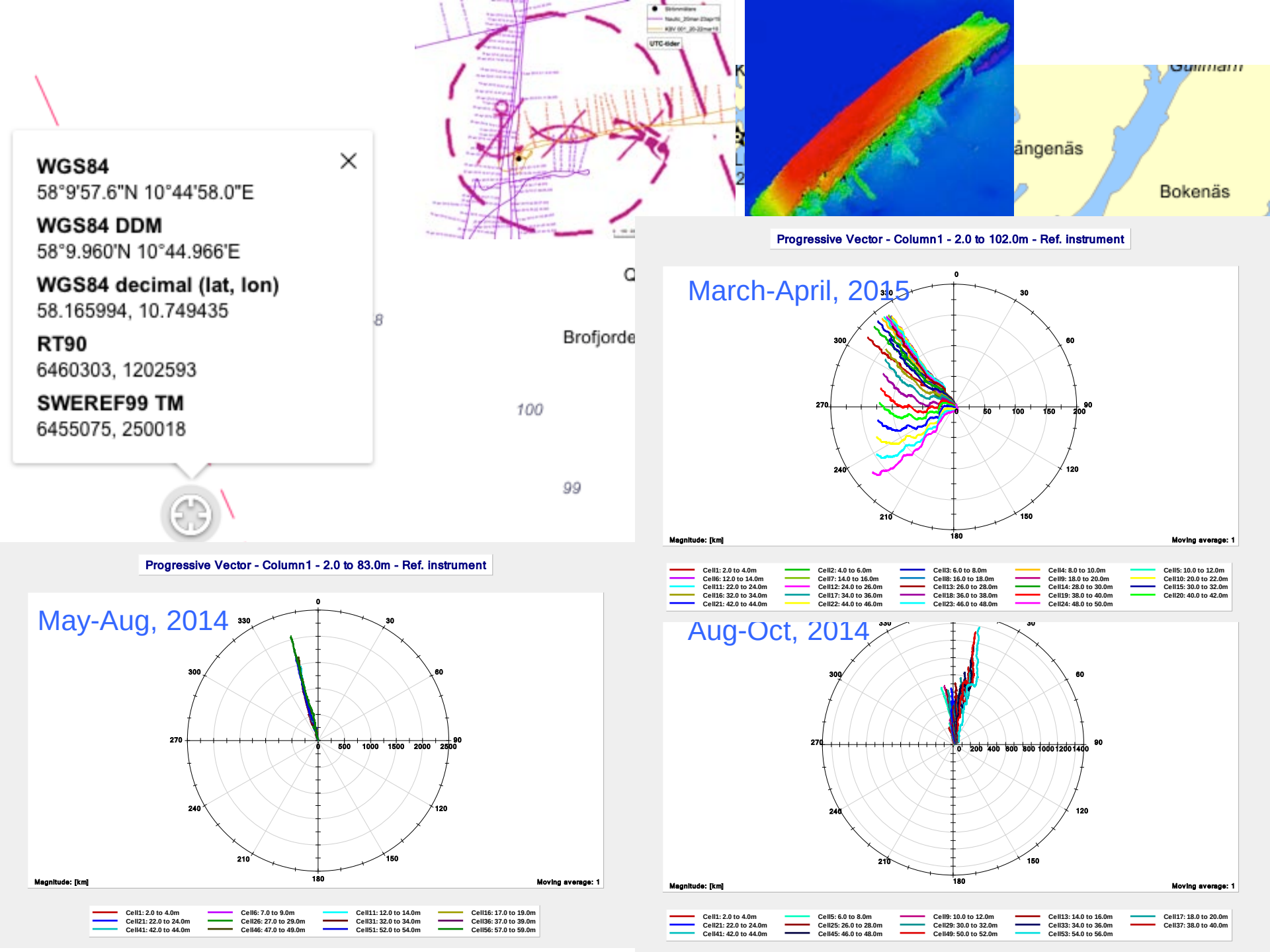
Exceptional saltwater inflow to the Baltic Sea in December 2014. This saltwater inflow oxygenated deeper parts of the Baltic Sea → Bottom trawling and increase in catch of dumped war material.

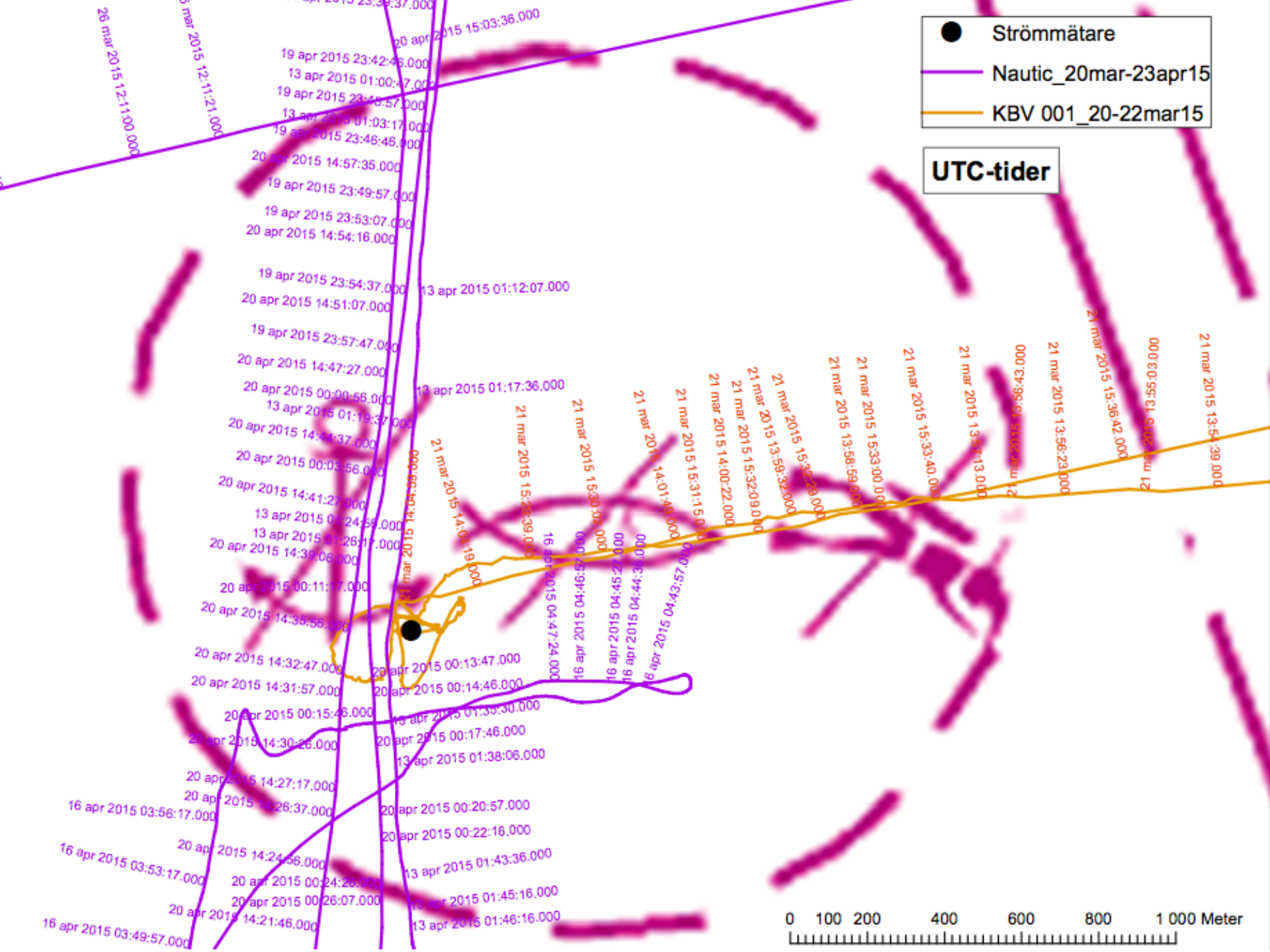
From Mohrholz et al. (2015) *"In the list of the MBIs since 1880, the 2014 inflow is the third strongest event together with theMBI in 1913".*

Salinity

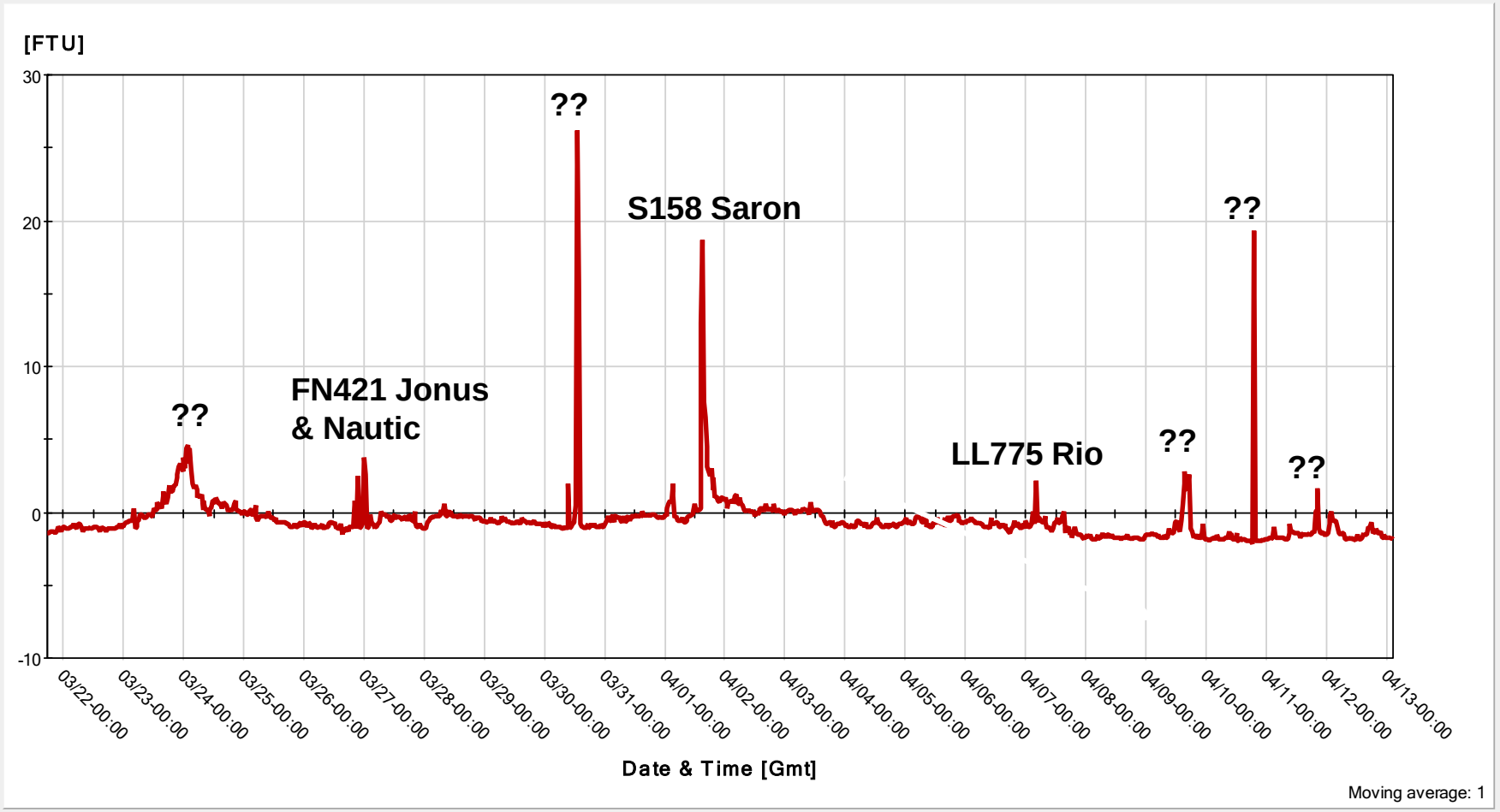


<u>Comments</u>: Salinity 7.5-10 except for exceptional high peak (14 psu) on January 19. Related to exceptional salt water inflow in December 2014.

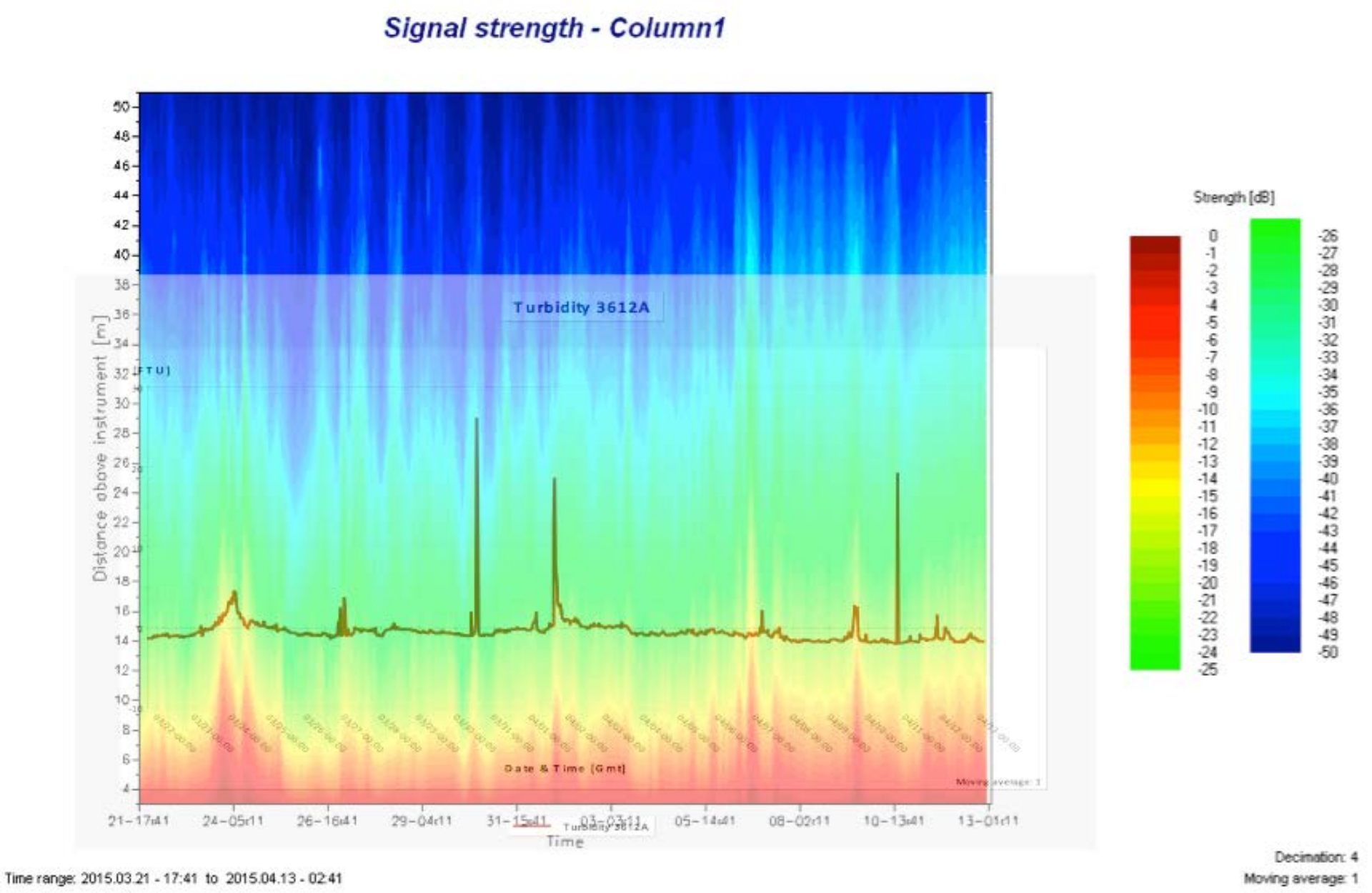

WGS84
58°9'57.6"N 10°44'58.0"E
WGS84 DDM
58°9.960'N 10°44.966'E
WGS84 decimal (lat, lon)
58.165994, 10.749435
RT90
6460303, 1202593
SWEREF99 TM
6455075, 250018
Brofjorde
100
99
ångenäs
Bokenäs
Progressive Vector - Column1 - 2.0 to 102.0m - Ref. instrument
March-April, 2015
Magnitude: [km]
Moving average: 1
Cell1: 2.0 to 4.0m
Cell2: 4.0 to 6.0m
Cell3: 6.0 to 8.0m
Cell4: 8.0 to 10.0m
Cell5: 10.0 to 12.0m
Cell6: 12.0 to 14.0m
Cell7: 14.0 to 16.0m
Cell8: 16.0 to 18.0m
Cell9: 18.0 to 20.0m
Cell10: 20.0 to 22.0m
Cell11: 22.0 to 24.0m
Cell12: 24.0 to 26.0m
Cell13: 26.0 to 28.0m
Cell14: 28.0 to 30.0m
Cell15: 30.0 to 32.0m
Cell16: 32.0 to 34.0m
Cell17: 34.0 to 36.0m
Cell18: 36.0 to 38.0m
Cell19: 38.0 to 40.0m
Cell20: 40.0 to 42.0m
Cell21: 42.0 to 44.0m
Cell22: 44.0 to 46.0m
Cell23: 46.0 to 48.0m
Cell24: 48.0 to 50.0m
Progressive Vector - Column1 - 2.0 to 83.0m - Ref. instrument
May-Aug, 2014
Magnitude: [km]
Moving average: 1
Cell1: 2.0 to 4.0m
Cell6: 7.0 to 9.0m
Cell11: 12.0 to 14.0m
Cell16: 17.0 to 19.0m
Cell21: 22.0 to 24.0m
Cell26: 27.0 to 29.0m
Cell31: 32.0 to 34.0m
Cell36: 37.0 to 39.0m
Cell41: 42.0 to 44.0m
Cell46: 47.0 to 49.0m
Cell51: 52.0 to 54.0m
Cell56: 57.0 to 59.0m
Aug-Oct, 2014
Magnitude: [km]
Moving average: 1
Cell1: 2.0 to 4.0m
Cell5: 6.0 to 8.0m
Cell9: 10.0 to 12.0m
Cell13: 14.0 to 16.0m
Cell17: 18.0 to 20.0m
Cell21: 22.0 to 24.0m
Cell25: 26.0 to 28.0m
Cell29: 30.0 to 32.0m
Cell33: 34.0 to 36.0m
Cell37: 38.0 to 40.0m
Cell41: 42.0 to 44.0m
Cell45: 46.0 to 48.0m
Cell49: 50.0 to 52.0m
Cell53: 54.0 to 56.0m


Strömmätare
Nautic_20mar-23apr15
KBV 001_20-22mar15
UTC-tider
0 100 200 400 600 800 1 000 Meter

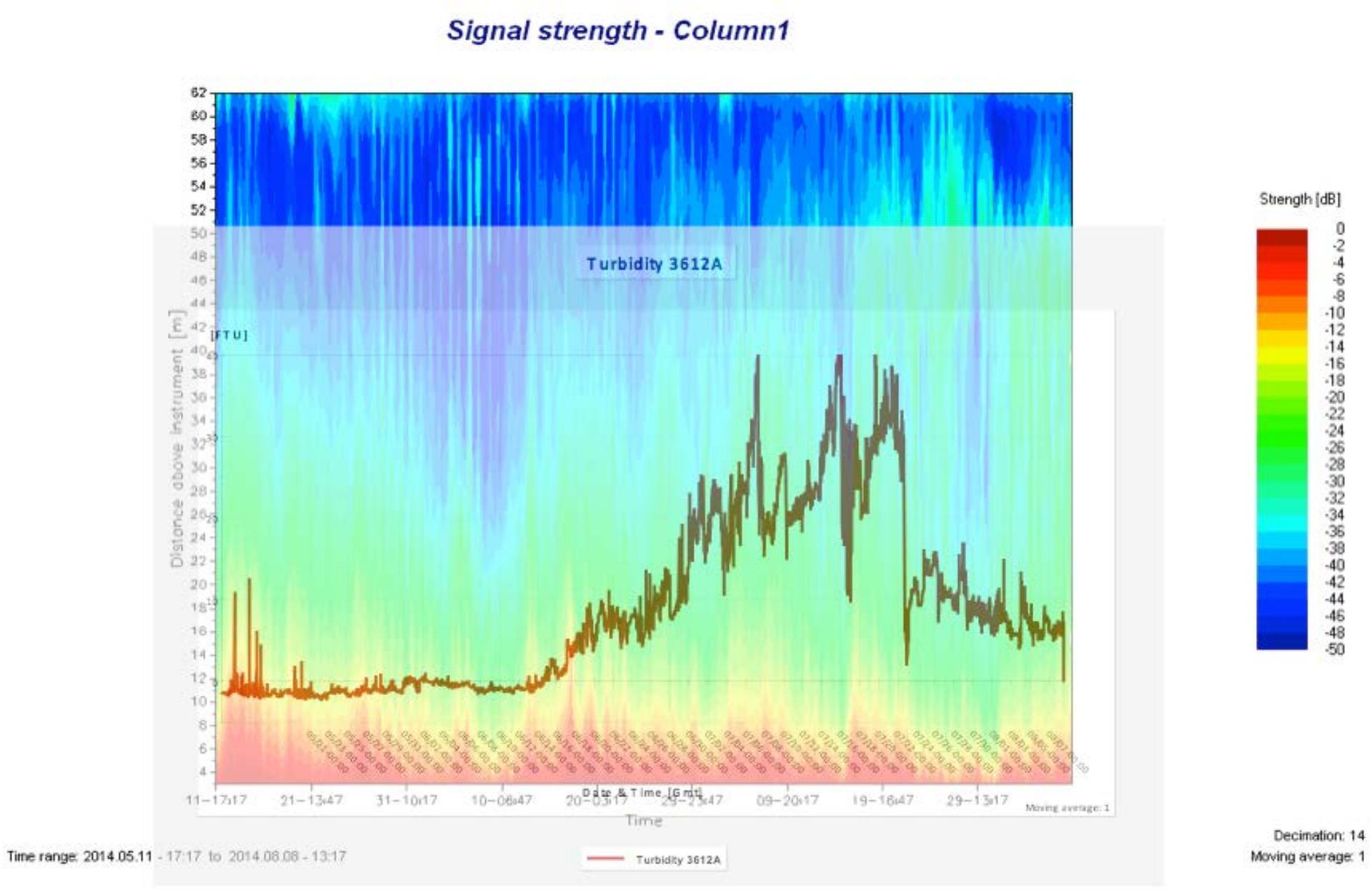
Turbidity 3612A



<u>Comments</u>: Short Turbidity peaks related to bottom trawling in the area. Not all trawling vessels are caught on AIS.

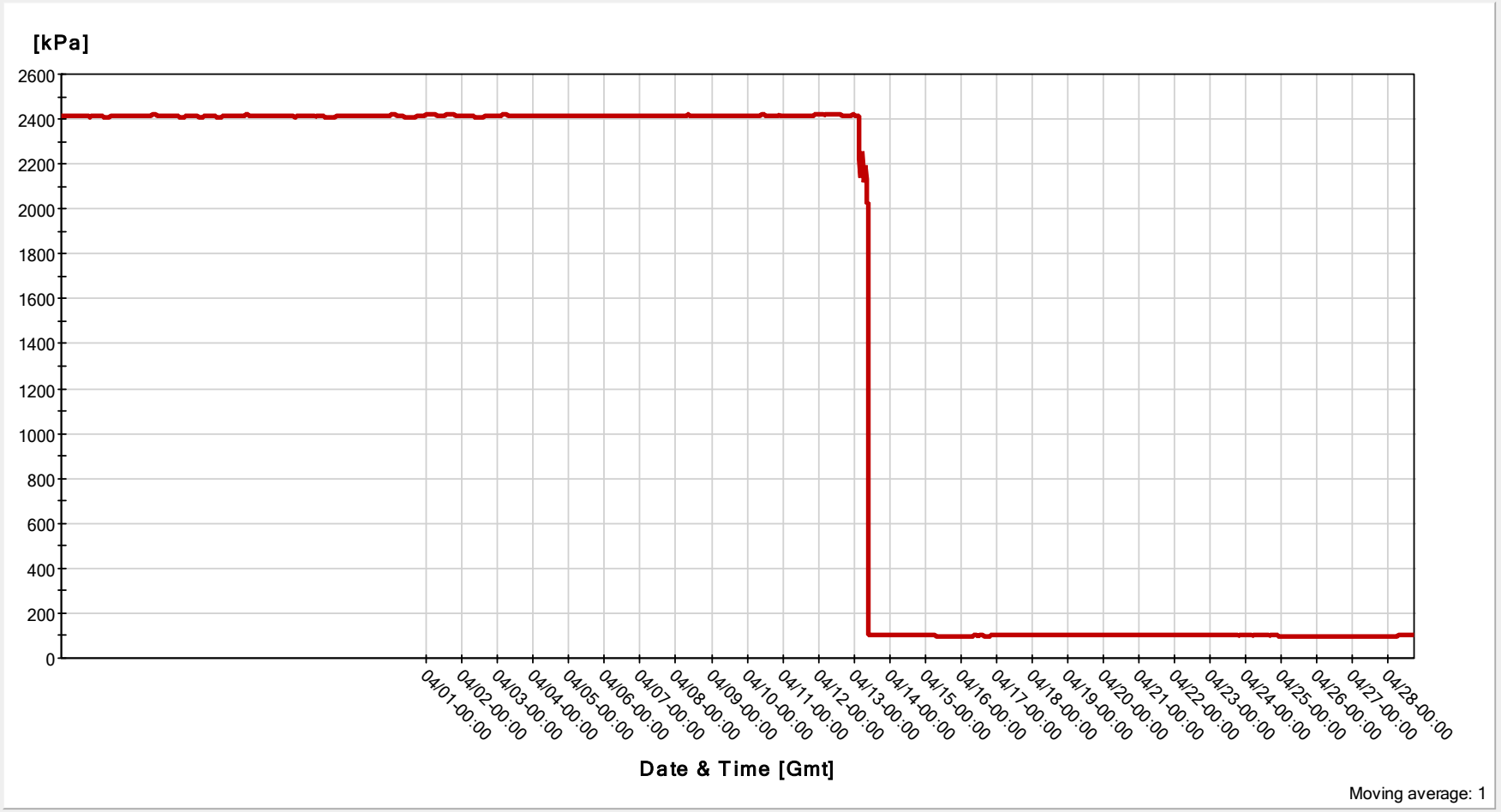


<u>Comments</u>: Signal strength (acoustic reflections) gradual increase, could be related to spring bloom arrival to the sea floor. Longer periods of higher in signal strength often reflected also in turbidity.



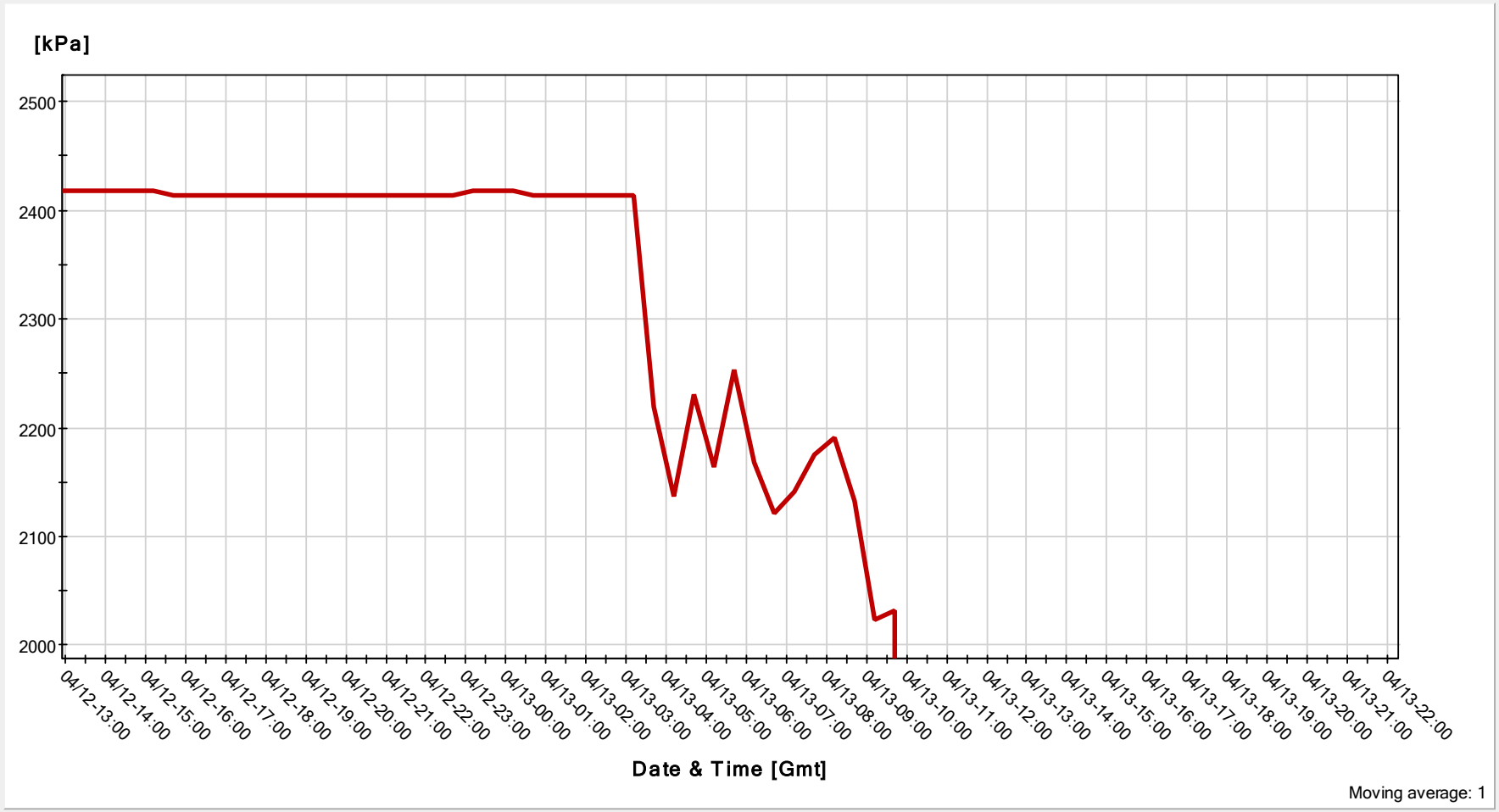
<u>Comments</u>: Skytteren, increase in both signal strength and Turbidity from June – end of July. Large turbidity increase is normally not seen during spring-bloom.

Pressure 4017B



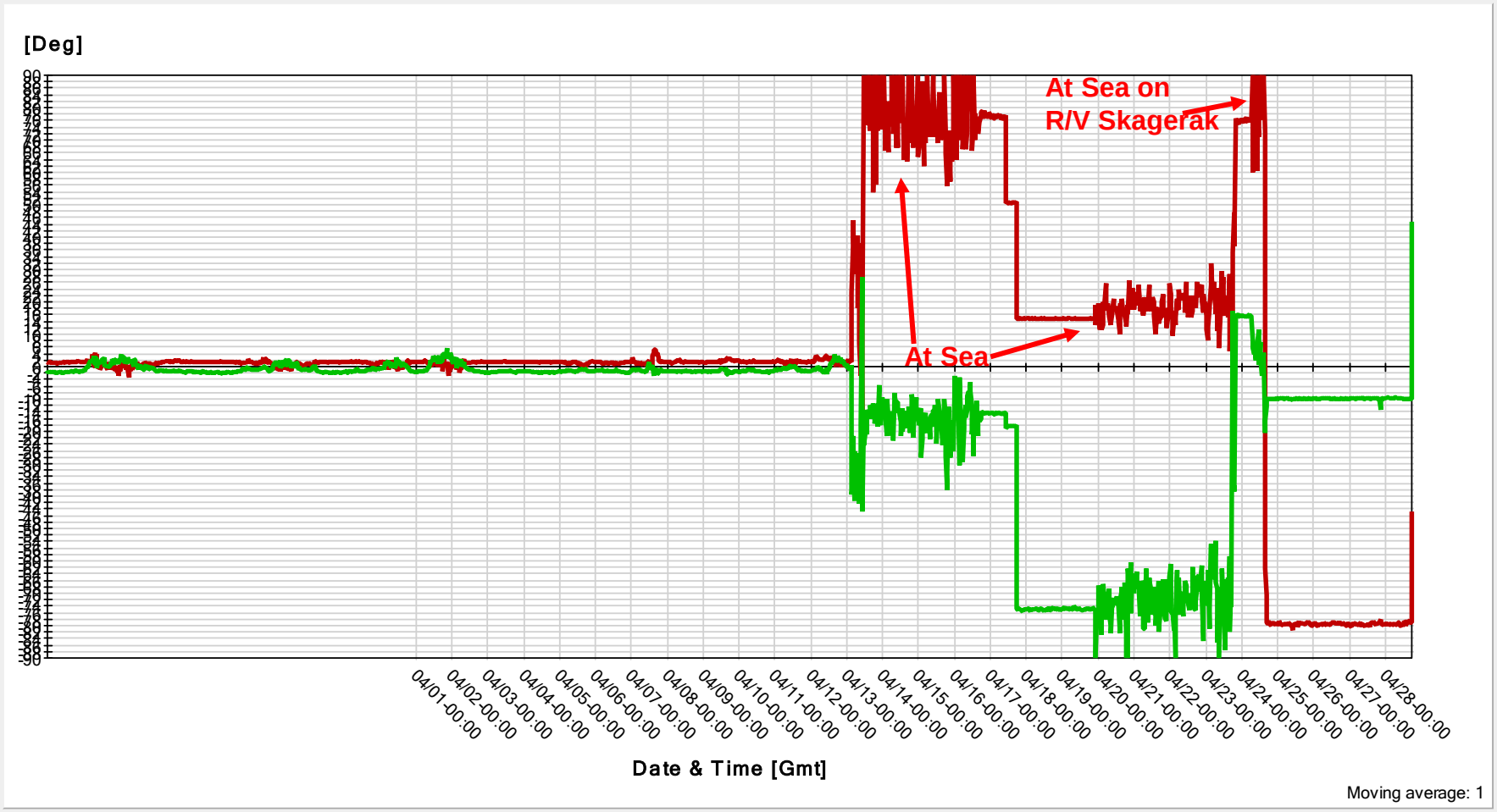
Pressure 4017B

Pressure 4017B



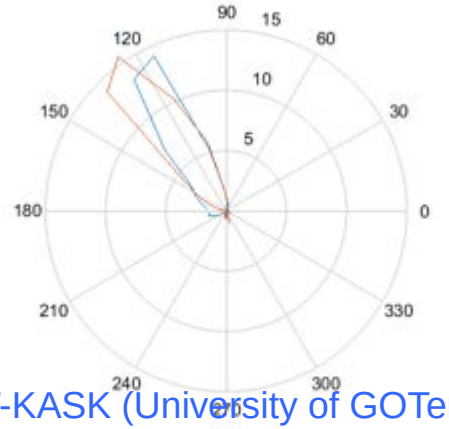
<u>Comments</u>: The instrument was in the trawl for about 6 h before it was recovered.

Pitch & Roll



<u>Comments</u>: Periods at Sea and in harbor can be distinguished.

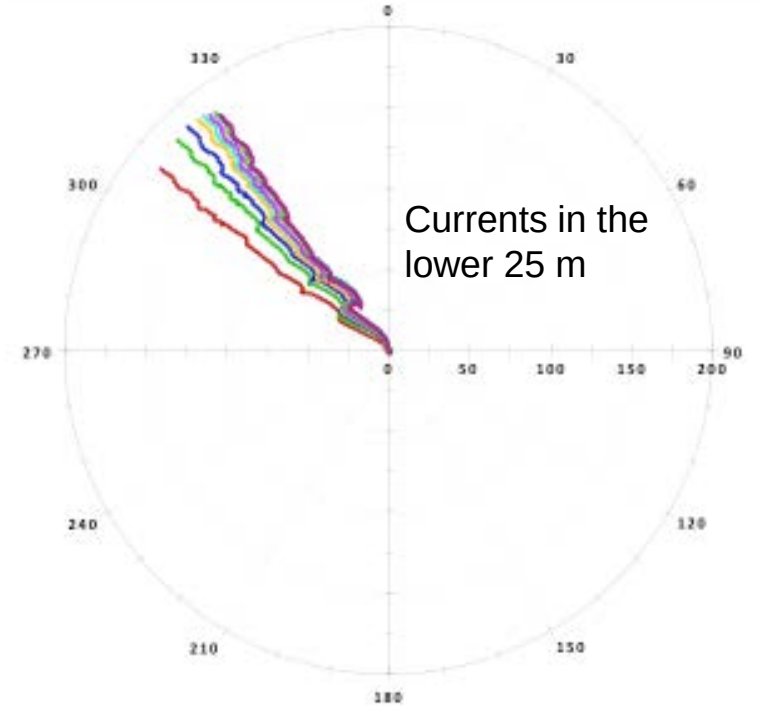
SGU
Sveriges geologiska undersökning
Geological Survey of Sweden



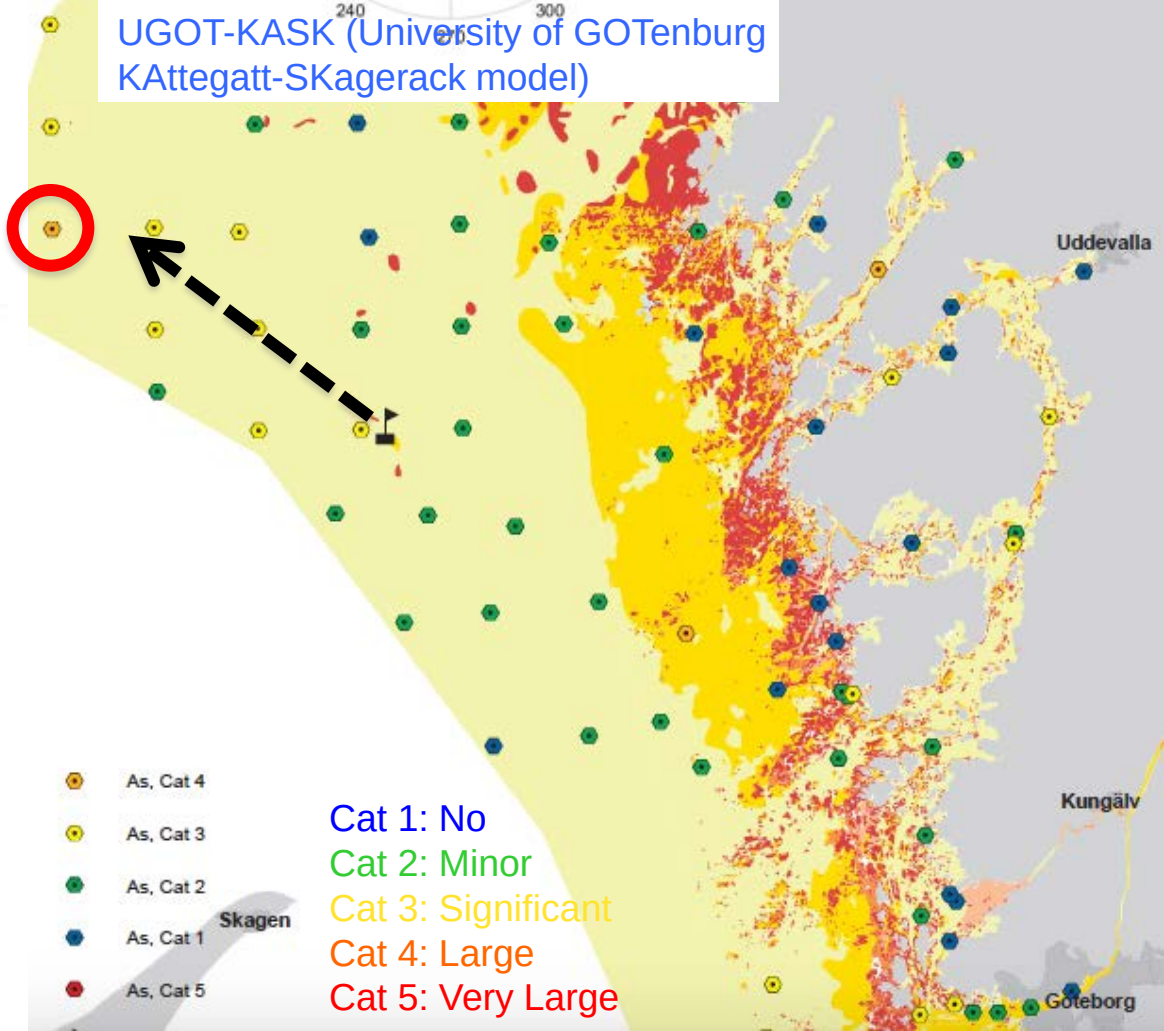
Meteorologisk institutt

UGOT-KASK (University of GOTenburg KAttegatt-SKagerack model)

Highest Arsenic value on the W Coast



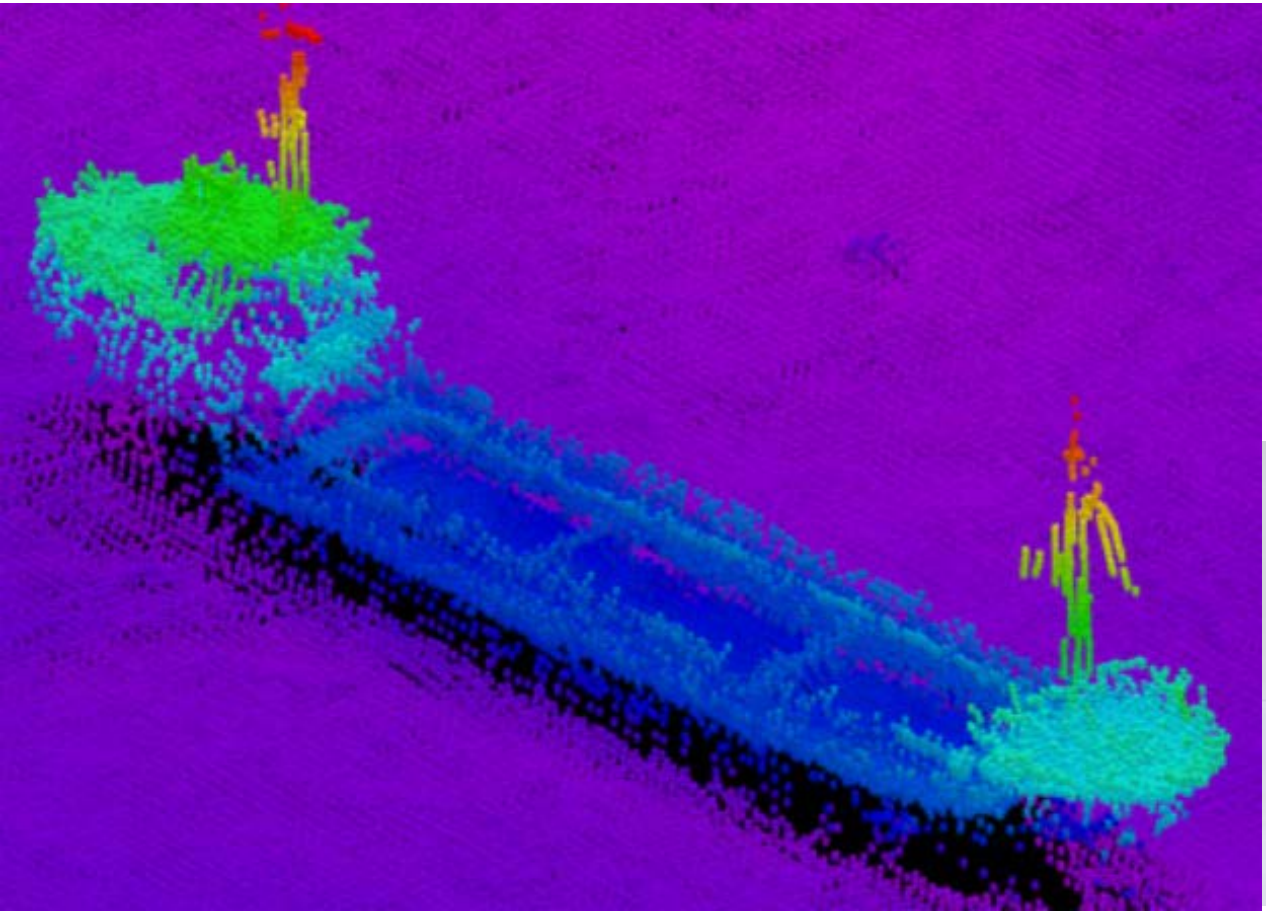
Currents in the lower 25 m



Cat 1: No
Cat 2: Minor
Cat 3: Significant
Cat 4: Large
Cat 5: Very Large

Compact Lander for automatic leak detection placed downstream, in the turbulence, of wreck with tethered alarm buoy with data transmission

- Current profile, Acoustic reflections, Mixing
- Temperature, Salinity, Oxygen, Waves/Pressure/Depth, Turbidity
- Light/Crude oil at 3 levels above sea floor
- Acoustic data download and release
- Tethered alarm buoy with data transmission
- Autonomy 1-2 years



Real-time: http://on-line.msi.ttu.ee/eeferry/?param=air_sat

M/S ROMANTIKA SooGuard monitoring system

TALLINK

Choose date 12-10-2015

Choose parameter O2 Air Satur [%]

Satellite overlay (demo): -

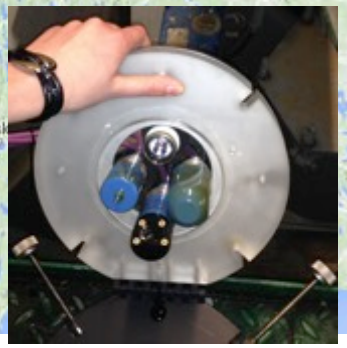
View: datatable

graph

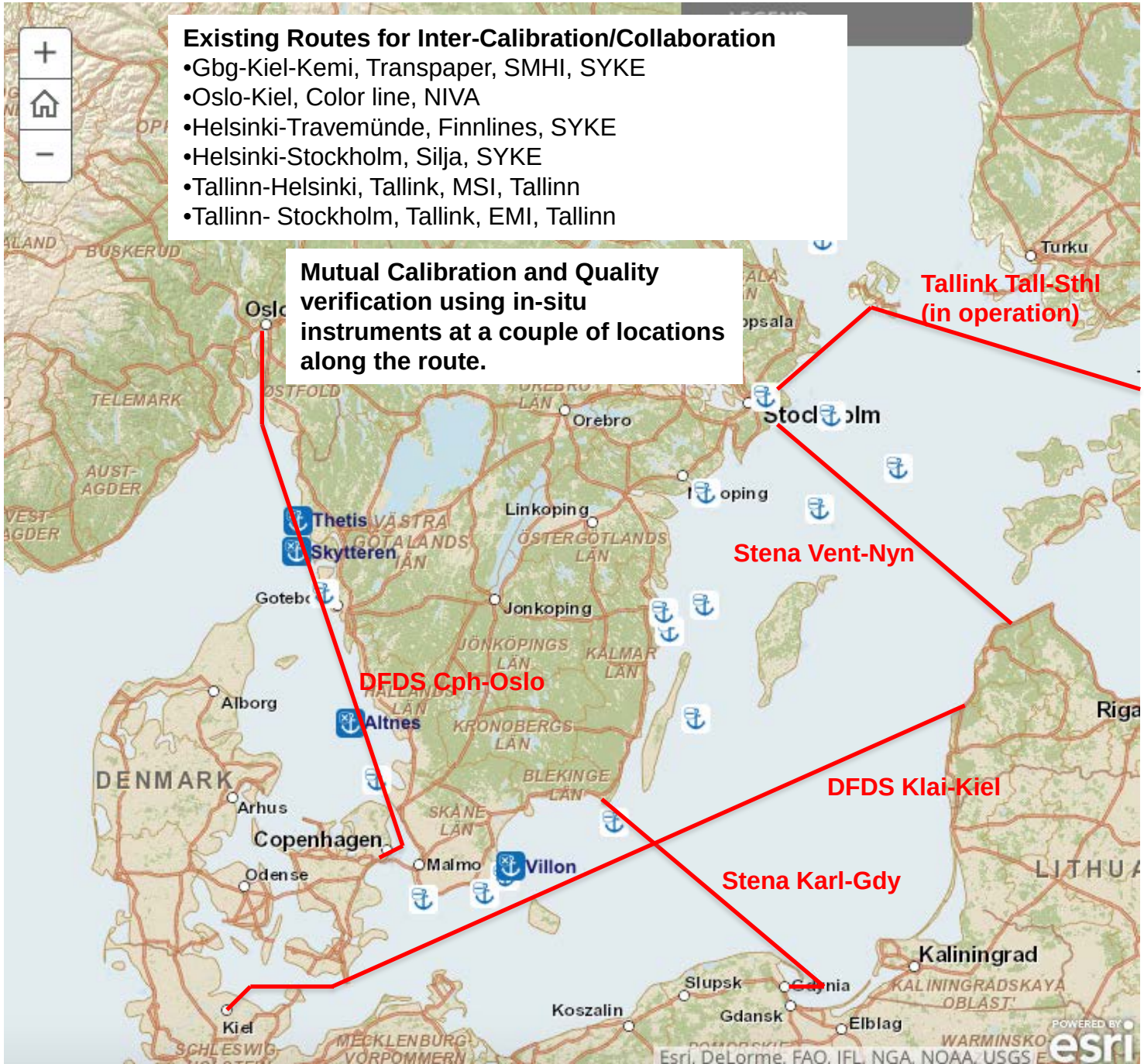
SHIP'S LAST POSITION
64,3..69,3 %
69,3..74,3 %
74,3..79,2 %
79,2..84,2 %
84,2..89,2 %

MS ROMANTIKA

Time. 12-10-2015 08:00
Latitude: 59° 31.3179'
Longitude: 23° 52.0210'
Temperature: 13.37 °C
Conductivity: 8.24 mS/cm
Salinity: 5.98 psu
O2 Conc: 276.96 uM
O2 Air Satur: 84.57 %
Chlorophyll-a: 0.0 ug/l
Turbidity: 0.0 FTU
Phycocyanin: 0.0 ug/l
PAH conc: 0.0 ug/l
PAH data quality: 0
O2 conc: 276.963 uM
CO2 conc: -0.18 ppm
H2O: 13.58 ppt
Signal strength: -61.0 dBm
Current GSM/GPRS provider: 24801
Battery voltage: 15.1 V



Suitable Ferry Routes for Dump Site, Wreck Leak and Oil Spill Detection

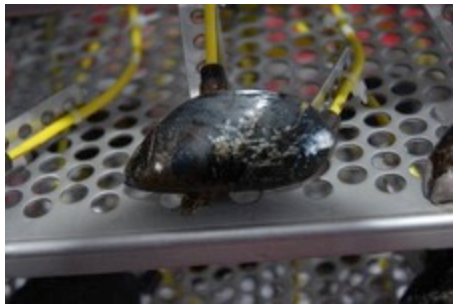


Sail buoy


Offshore Sensing AS


O_2
pCO_2
Temp
Hull Temp
Oil
CDOM
Sal
Turb
FDOM
ChlA
Phyco

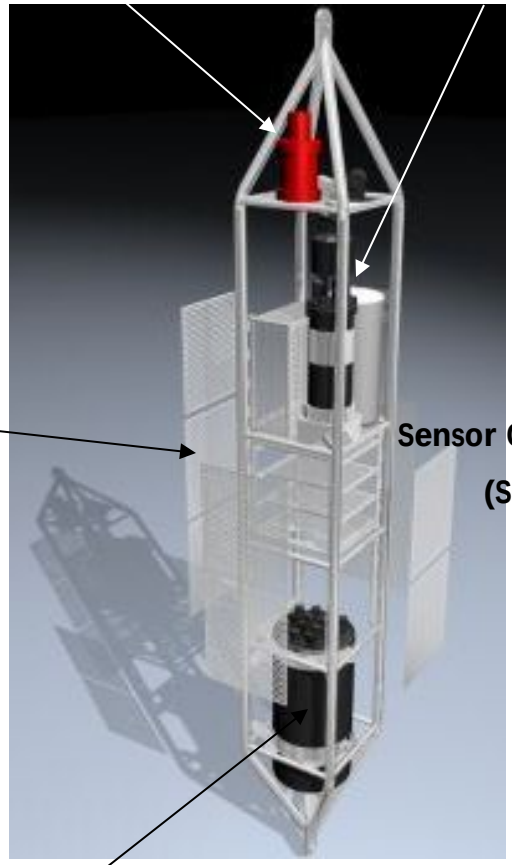
Combining Biosensors with ”traditional measurements”



Biological sensors (instrumented organisms)

Acustic modem / cable communication

Physical & Chemical sensors



Sensor Cage Unit (SCU)

Control & battery canister

http://www.biotaguard.no

Biotaguard project

- Real-Time environmental monitoring
  - Stress level of mussels used to detect presence of oil components in water
  - Seaguard instrument measures environmental parameters
  - Multivariate statistical methods on-line provide power analytical tool

Pictures: Biota Guard AS

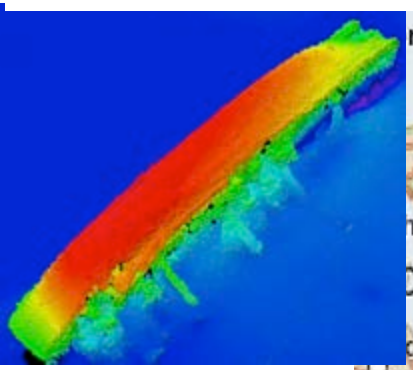
Tack/Than You!

Maseskaer: Chemical weapon dump

- **Depth 220-240 m; Tot 1 months of data**
- **Frequent bottom trawling in the area**

Conclusions

- Marine coastal environments are very variable
- In-situ monitoring + quality control + modeling ➔ 3 essential components of understanding aquatic environments including wreck and dump sites
- Combined measurements crucial to understand processes
- Compact ferry box for monitoring/sniffing in surface waters
- Combined biosensors (mussels) and instruments efficient for oil spill detection
- Compact technology for automatic warning systems exists



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