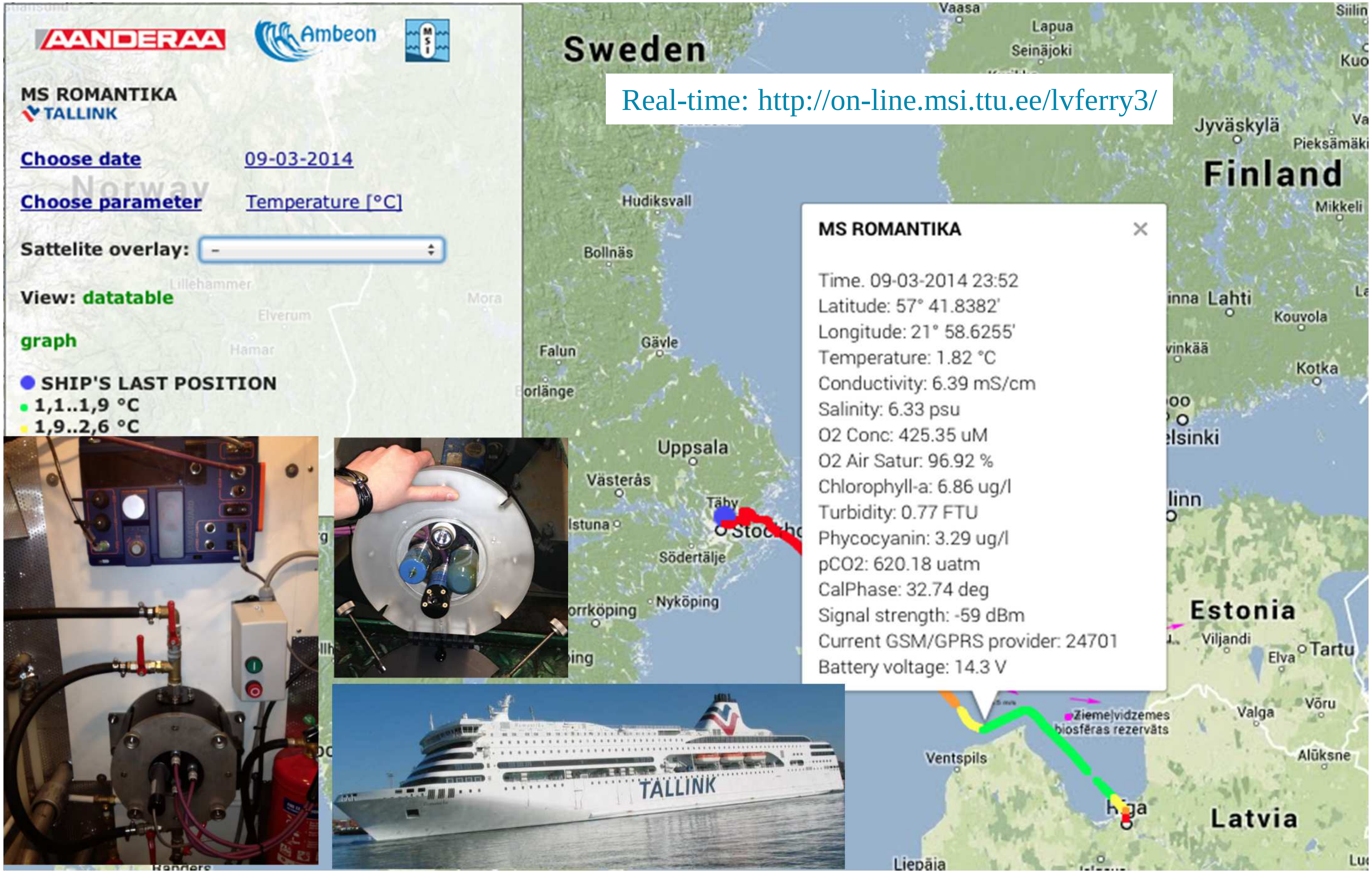
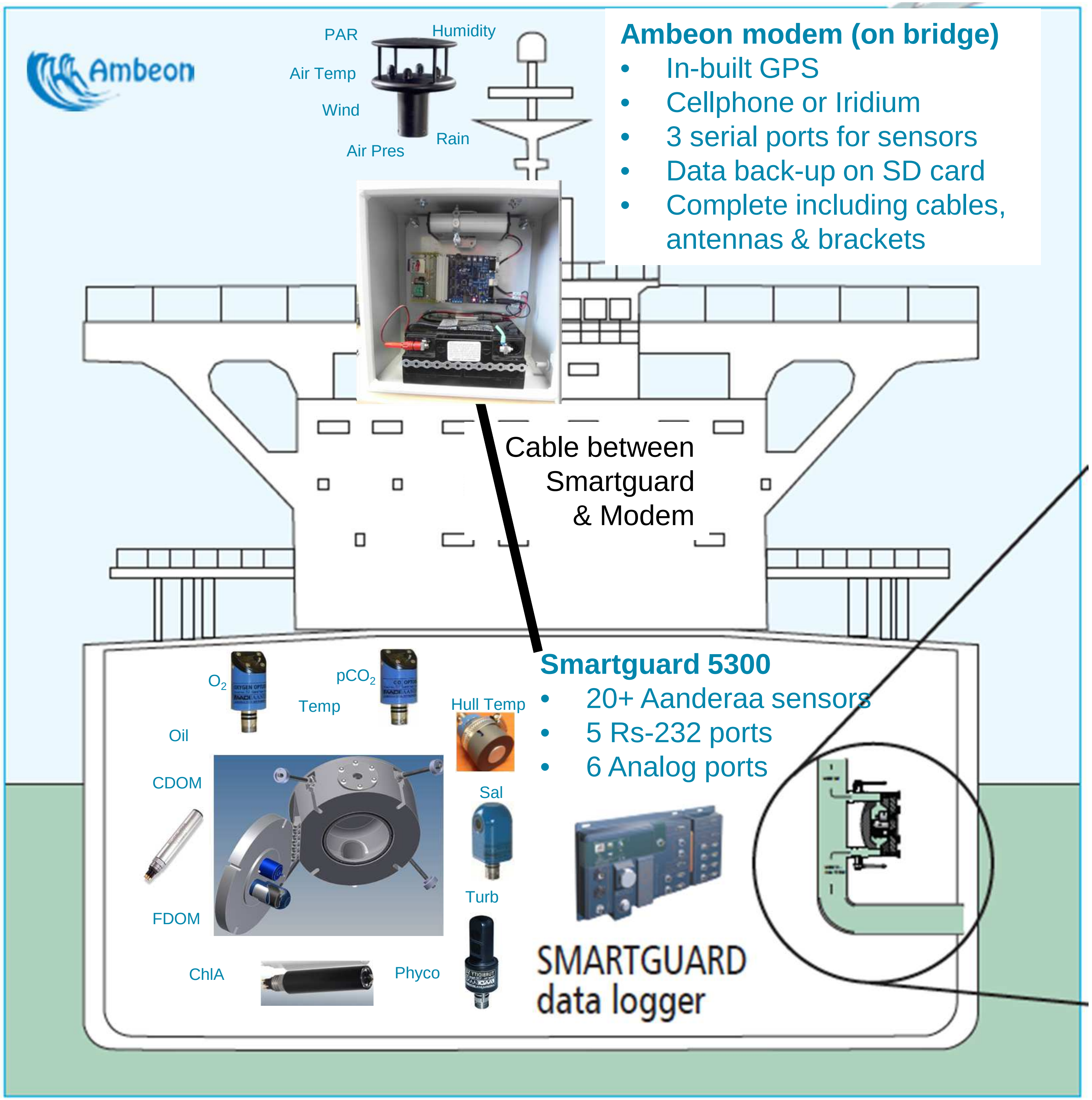
Experiences from 1 min on-line monitoring of Temp, Sal, O_2, pCO_2, ChlA, Turb, Phyco of surface waters with compact SOOGuard systems

Anders Tengberg[12], Daria Atamanchuk (University of Gothenburg[1], Sweden),
Jostein Hovdenes (Aanderaa[2], Bergen, Norway) & Tarmo Koutts (TUT, Tallinn, Estonia),

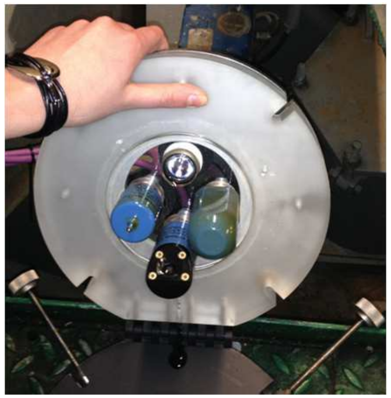


Installation

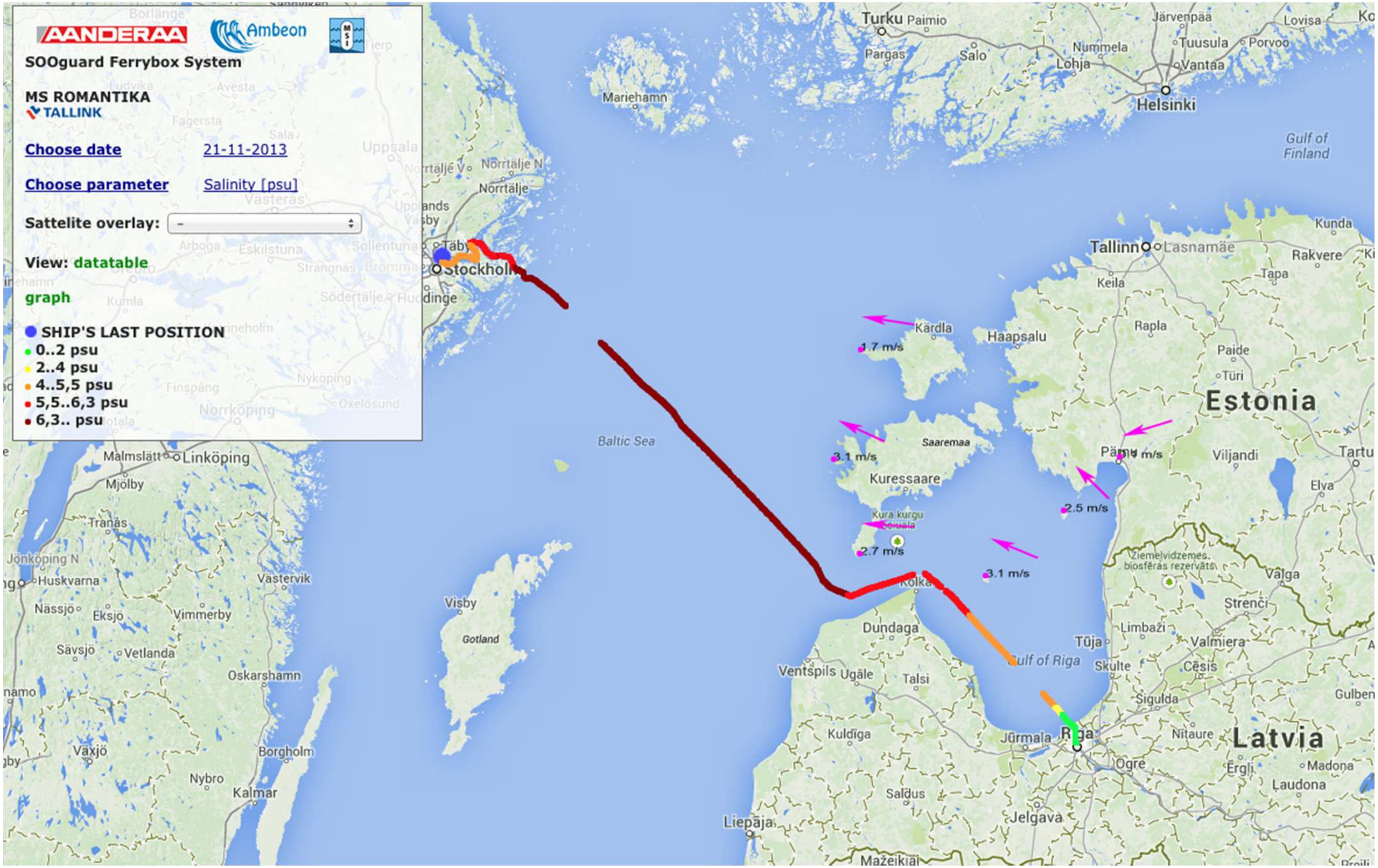


SOOGuard Chamber

- Compact 30*30*20 cm
- Easy to install, brackets included
- Add extra chamber & sensors for more parameters
- 10 bar rated
- Easy to service, takes less than 10 s to open

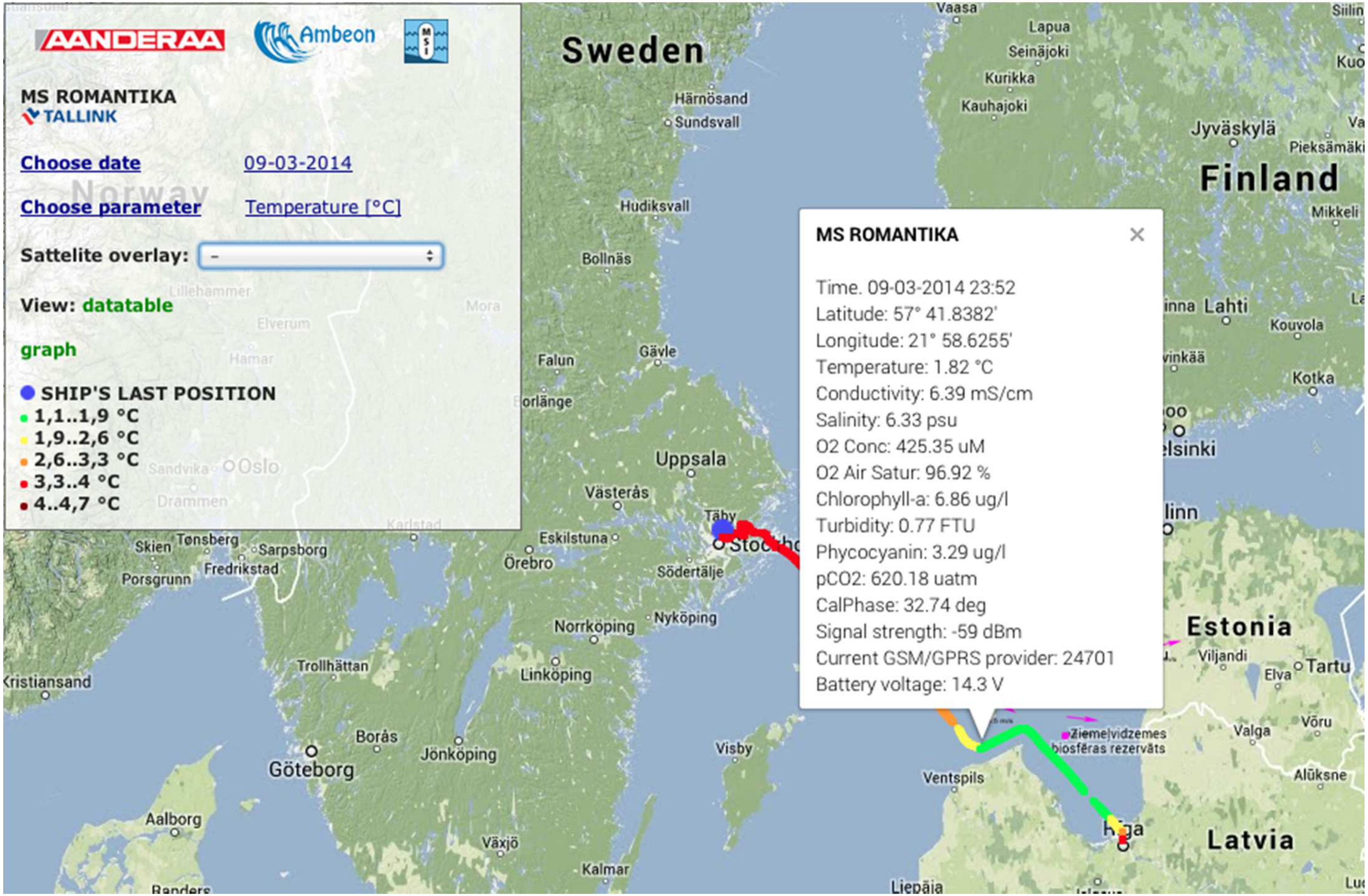


Software and presentation: Color coded data, real time & all historical



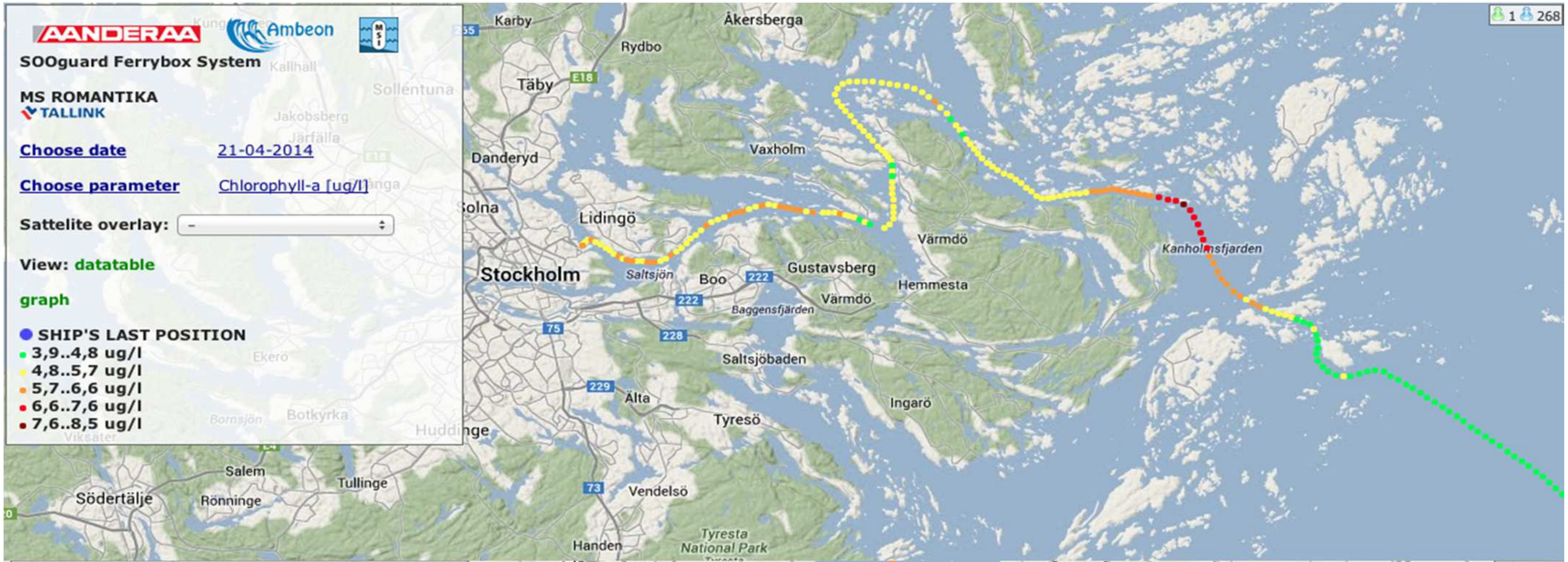
Real-time: http://on-line.msi.ttu.ee/lvferry3/

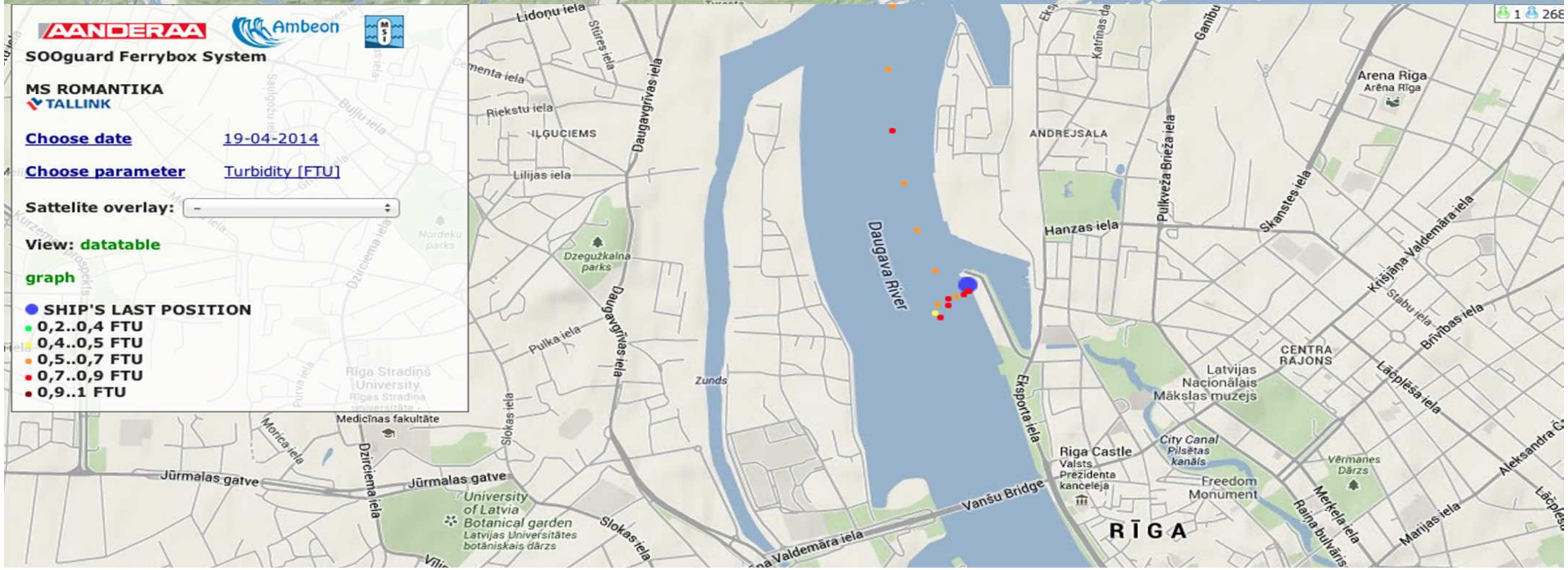
Software and presentation: Hold cursor over track and get 1 minute values



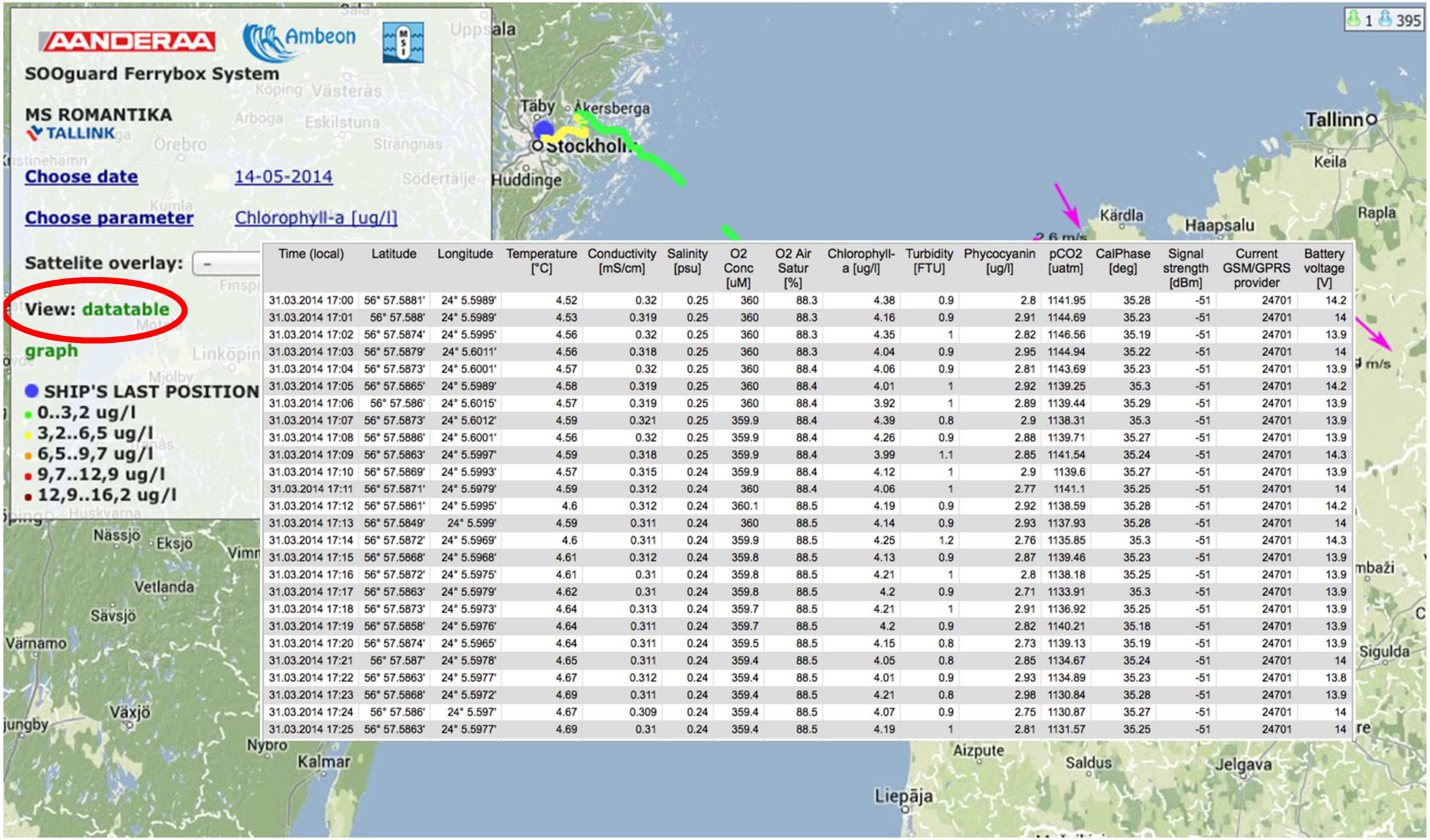
Real-time: http://on-line.msi.ttu.ee/lvferry3/

Software and presentation: Zoom in on map and look at detailed (1-min) values





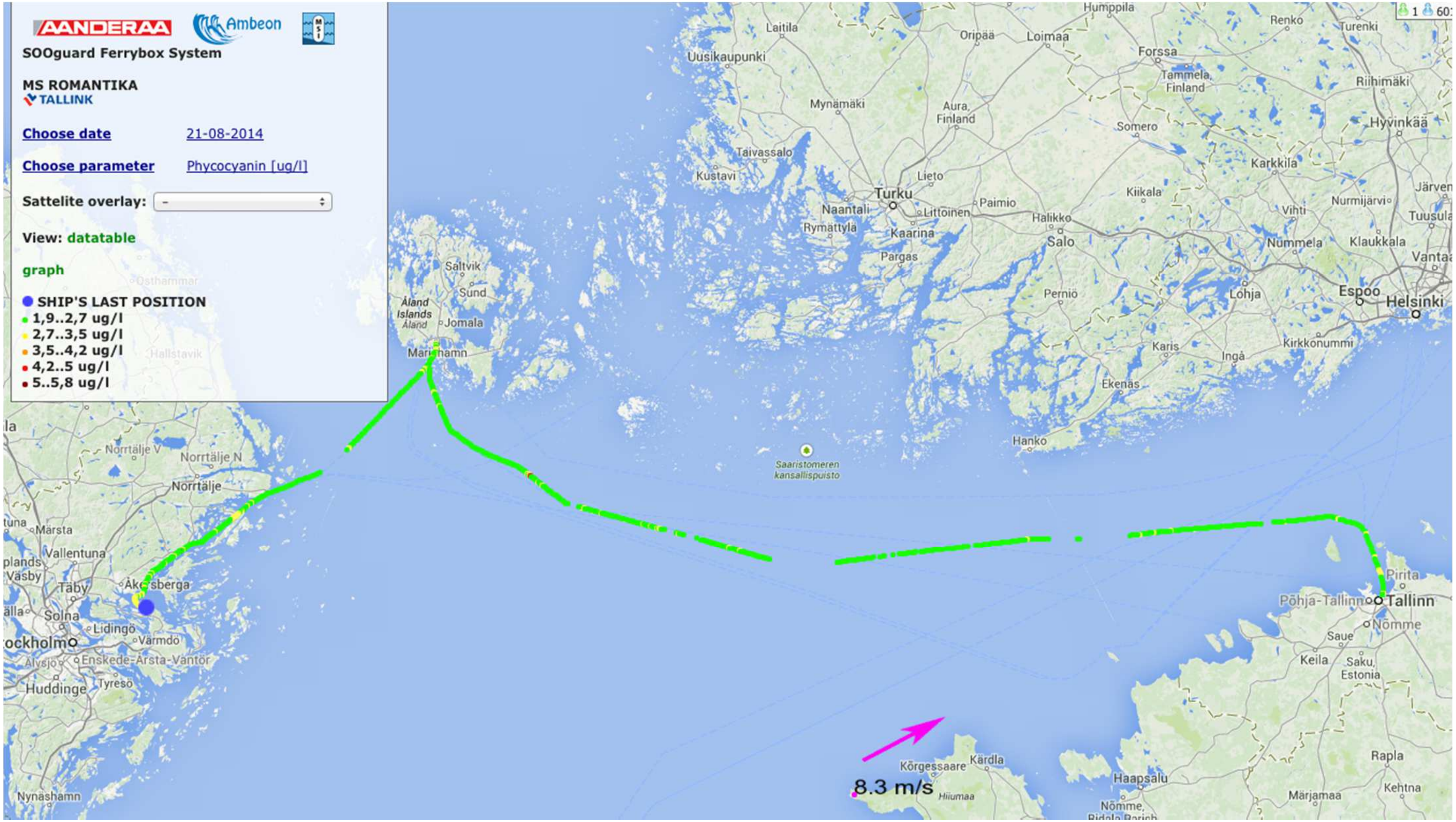
Software and presentation: Data-table & download data from any day



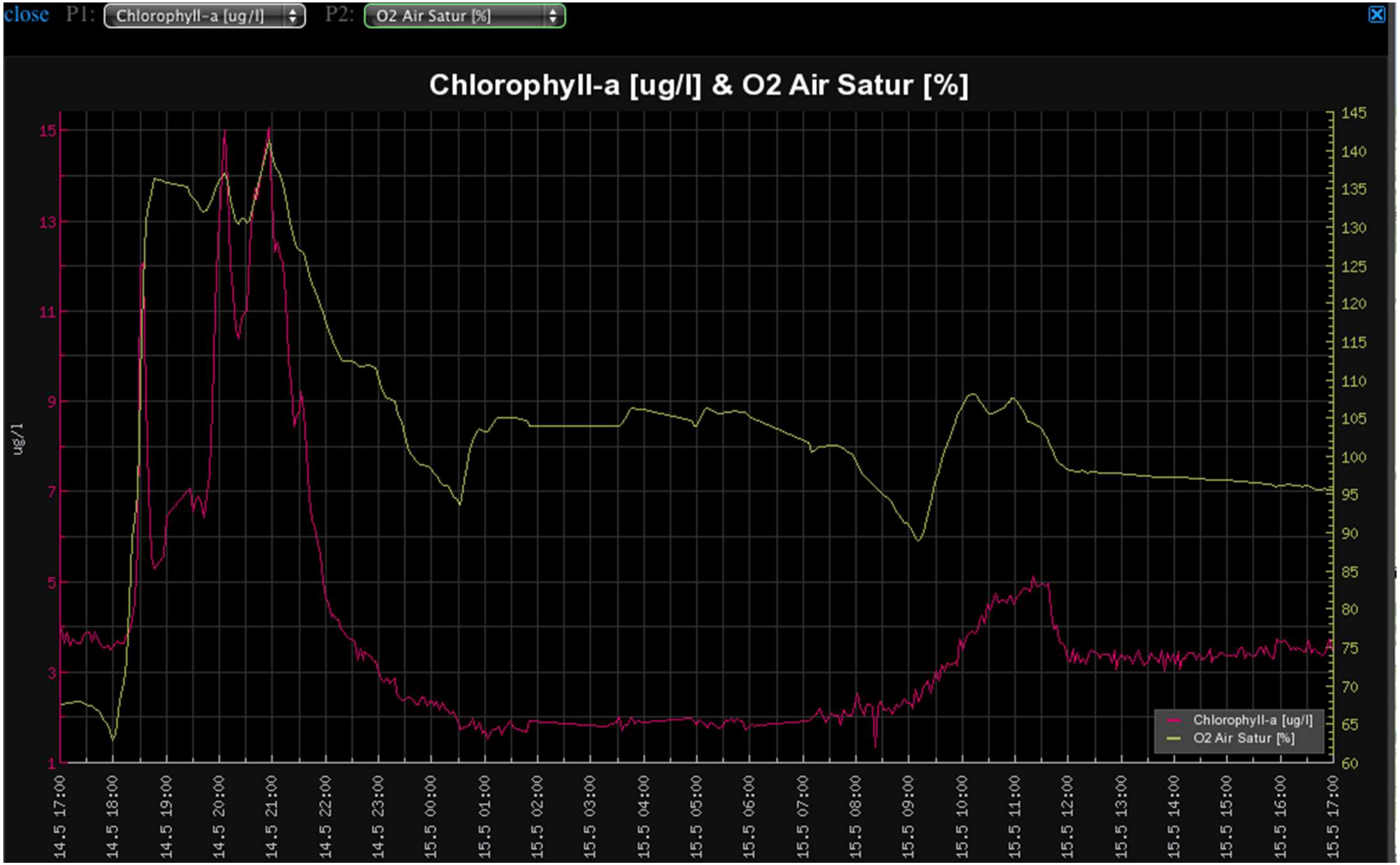
Time (local)	Latitude	Longitude	Temperature [°C]	Conductivity [mS/cm]	Salinity [psu]	O2 Conc [uM]	O2 Air Satur [%]	Chlorophyll-a [ug/l]	Turbidity [FTU]	Phycocyanin [ug/l]	pCO2 [uatm]	CalPhase [deg]	Signal strength [dBm]	Current GSM/GPRS provider	Battery voltage [V]
31.03.2014 17:00	56° 57.5881'	24° 5.5989'	4.52	0.32	0.25	360	88.3	4.38	0.9	2.8	1141.95	35.28	-51	24701	14.2
31.03.2014 17:01	56° 57.588'	24° 5.5989'	4.53	0.319	0.25	360	88.3	4.16	0.9	2.91	1144.69	35.23	-51	24701	14
31.03.2014 17:02	56° 57.5874'	24° 5.5995'	4.56	0.32	0.25	360	88.3	4.35	1	2.82	1146.56	35.19	-51	24701	13.9
31.03.2014 17:03	56° 57.5879'	24° 5.6011'	4.56	0.318	0.25	360	88.3	4.04	0.9	2.95	1144.94	35.22	-51	24701	14
31.03.2014 17:04	56° 57.5873'	24° 5.6001'	4.57	0.32	0.25	360	88.4	4.06	0.9	2.81	1143.69	35.23	-51	24701	13.9
31.03.2014 17:05	56° 57.5865'	24° 5.5989'	4.58	0.319	0.25	360	88.4	4.01	1	2.92	1139.25	35.3	-51	24701	14.2
31.03.2014 17:06	56° 57.586'	24° 5.6015'	4.57	0.319	0.25	360	88.4	3.92	1	2.89	1139.44	35.29	-51	24701	13.9
31.03.2014 17:07	56° 57.5873'	24° 5.6012'	4.59	0.321	0.25	359.9	88.4	4.39	0.8	2.9	1138.31	35.3	-51	24701	13.9
31.03.2014 17:08	56° 57.5886'	24° 5.6001'	4.56	0.32	0.25	359.9	88.4	4.26	0.9	2.88	1139.71	35.27	-51	24701	13.9
31.03.2014 17:09	56° 57.5863'	24° 5.5997'	4.59	0.318	0.25	359.9	88.4	3.99	1.1	2.85	1141.54	35.24	-51	24701	14.3
31.03.2014 17:10	56° 57.5869'	24° 5.5993'	4.57	0.315	0.24	359.9	88.4	4.12	1	2.9	1139.6	35.27	-51	24701	13.9
31.03.2014 17:11	56° 57.5871'	24° 5.5979'	4.59	0.312	0.24	360	88.4	4.06	1	2.77	1141.1	35.25	-51	24701	14
31.03.2014 17:12	56° 57.5861'	24° 5.5995'	4.6	0.312	0.24	360.1	88.5	4.19	0.9	2.92	1138.59	35.28	-51	24701	14.2
31.03.2014 17:13	56° 57.5849'	24° 5.599'	4.59	0.311	0.24	360	88.5	4.14	0.9	2.93	1137.93	35.28	-51	24701	14
31.03.2014 17:14	56° 57.5872'	24° 5.5969'	4.6	0.311	0.24	359.9	88.5	4.25	1.2	2.76	1135.85	35.3	-51	24701	14.3
31.03.2014 17:15	56° 57.5868'	24° 5.5968'	4.61	0.312	0.24	359.8	88.5	4.13	0.9	2.87	1139.46	35.23	-51	24701	13.9
31.03.2014 17:16	56° 57.5872'	24° 5.5975'	4.61	0.31	0.24	359.8	88.5	4.21	1	2.8	1138.18	35.25	-51	24701	13.9
31.03.2014 17:17	56° 57.5863'	24° 5.5979'	4.62	0.31	0.24	359.8	88.5	4.2	0.9	2.71	1133.91	35.3	-51	24701	13.9
31.03.2014 17:18	56° 57.5873'	24° 5.5973'	4.64	0.313	0.24	359.7	88.5	4.21	1	2.91	1136.92	35.25	-51	24701	13.9
31.03.2014 17:19	56° 57.5858'	24° 5.5976'	4.64	0.311	0.24	359.7	88.5	4.2	0.9	2.82	1140.21	35.18	-51	24701	13.9
31.03.2014 17:20	56° 57.5874'	24° 5.5965'	4.64	0.311	0.24	359.5	88.5	4.15	0.8	2.73	1139.13	35.19	-51	24701	13.9
31.03.2014 17:21	56° 57.587'	24° 5.5978'	4.65	0.311	0.24	359.4	88.5	4.05	0.8	2.85	1134.67	35.24	-51	24701	14
31.03.2014 17:22	56° 57.5863'	24° 5.5977'	4.67	0.312	0.24	359.4	88.5	4.01	0.9	2.93	1134.89	35.23	-51	24701	13.8
31.03.2014 17:23	56° 57.5868'	24° 5.5972'	4.69	0.311	0.24	359.4	88.5	4.21	0.8	2.98	1130.84	35.28	-51	24701	13.9
31.03.2014 17:24	56° 57.586'	24° 5.597'	4.67	0.309	0.24	359.4	88.5	4.07	0.9	2.75	1130.87	35.27	-51	24701	14
31.03.2014 17:25	56° 57.5863'	24° 5.5977'	4.69	0.31	0.24	359.4	88.5	4.19	1	2.81	1131.57	35.25	-51	24701	14

Real-time: http://on-line.msi.ttu.ee/lvferry3/

Software and presentation: Automatic adatptation to new routes

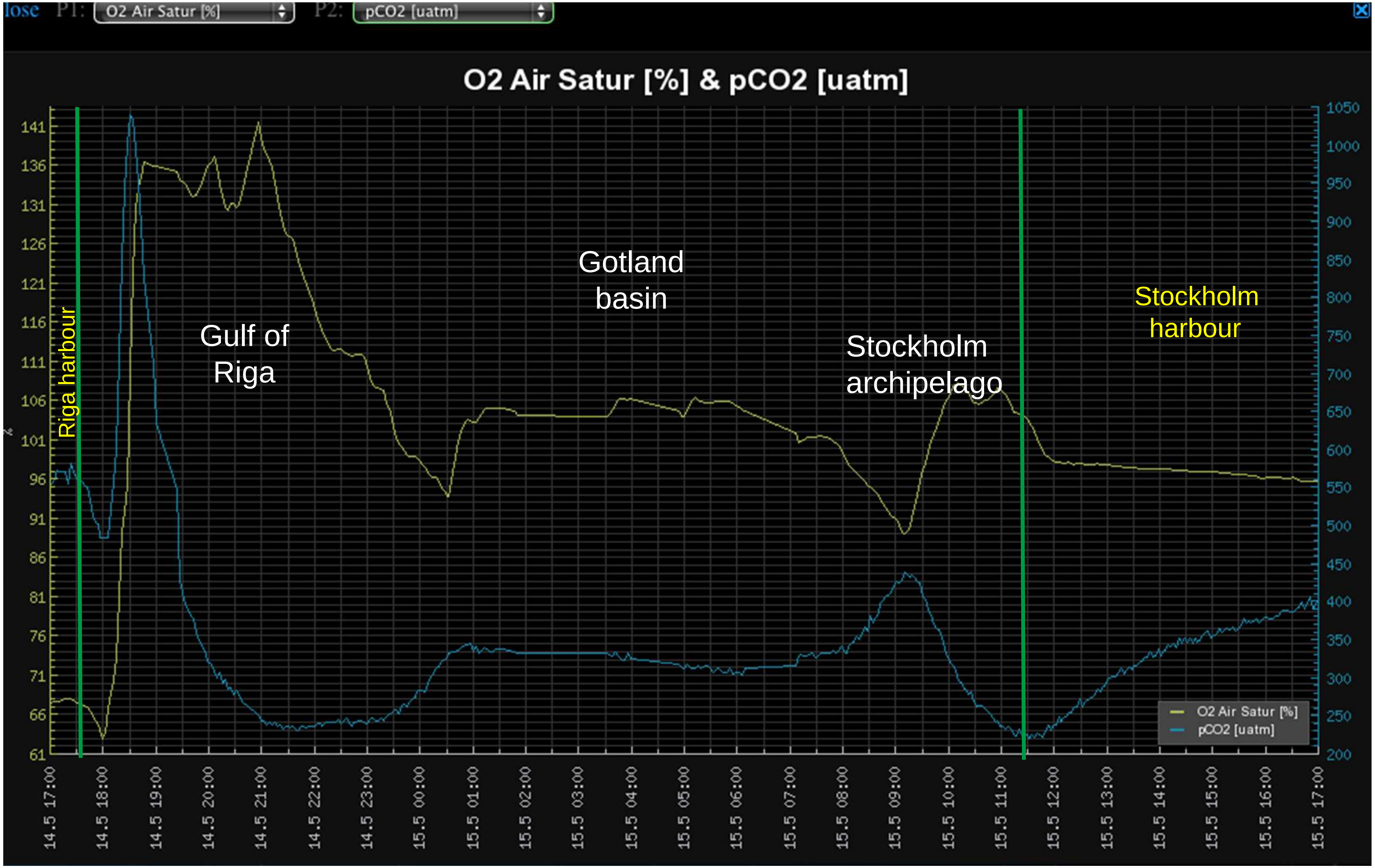


Software and presentation: On-line comparative graphs Property vs. Property



Real-time: http://on-line.msi.ttu.ee/lvferry3/

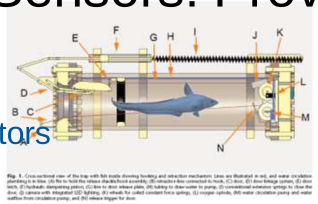
Route Riga-Stockholm



Sensors: Proven off the shelf technology, high accuracy long-term stable

Oxygen Optodes

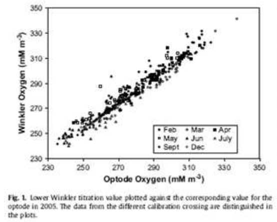
Examples of Scientific Papers



Incubators

Drazen et al (2005), Almroth et al (2012), Wikner et al (2013)

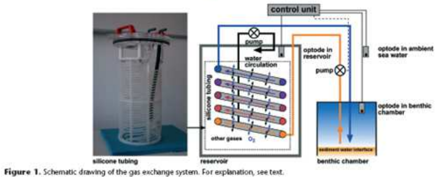
Tengberg et al (2006)



Ferry boxes

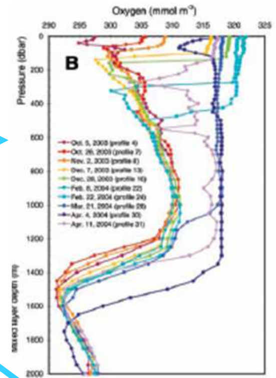
Hydes et al (2009)

Gas Exchange Chamber



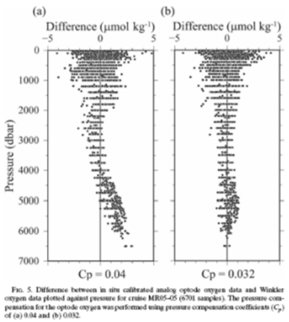
Sommer et al (2008)

Argo floats



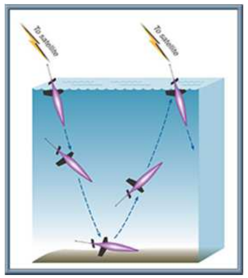
Körtzinger et al (2004, Nature)
Johnson et al (2010, Nature)
Fiedler et al (2013)
Takeshita et al (2013)

Cabled CTD



Uchida et al (2008)

Sea Gliders

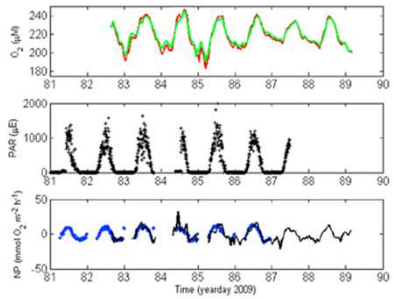


Nicholson et al (2008)

Boys

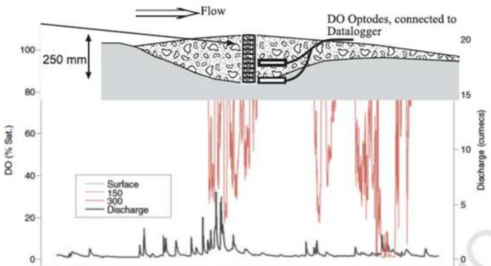
Jannash et al (2008), Bushinsky and Emerson (2013)

Gradients



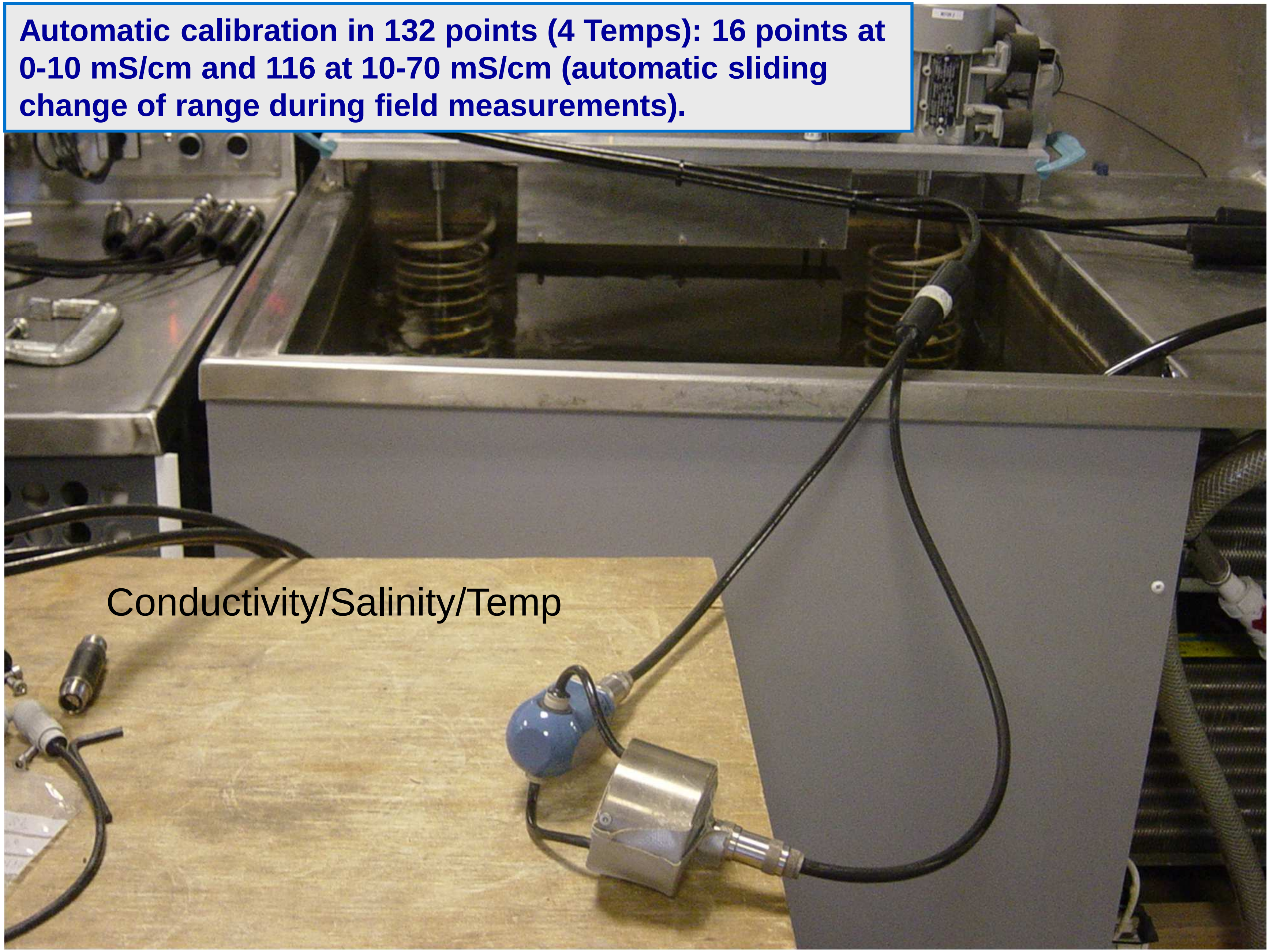
McGillis et al (2011), Champenois and Borges (2012)

Rivers/Hydrology/Hyporheic



Birkel et al (2013), Malcolm et al (2006, 2008, 2010), Soulsby et al (2008)

Sensors: Proven off the shelf technology, high accuracy long-term stable



Sensors: Proven off the shelf technology, high accuracy long-term stable

TriLux Fluorometer (for Chlorophyll, Phycoerythrin, Phycocyanin & Turbidity monitoring)

| Print |

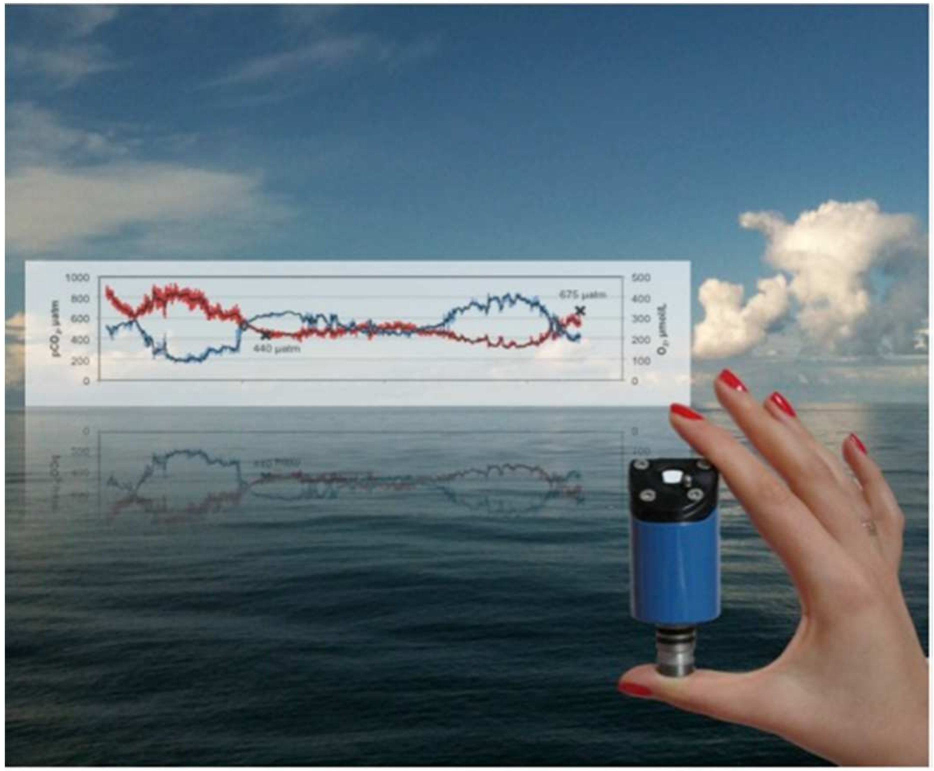
The innovative TriLux range of digital, in-situ, multi-wavelength fluorometers provides the user with increased functionality when compared to other fluorometers. Over 200 fluorometers are now in the field with users reporting excellent datasets. Applications include in-situ chlorophyll *a* & algae class studies, environmental monitoring, dye tracing, particulate studies, cell culture monitoring and process control.

Combinations available:

- Chlorophyll *a*, Phycoerythrin, Phycocyanin fluorometer
- Chlorophyll *a*, Turbidity, Phycoerythrin fluorometer
- Chlorophyll *a*, Turbidity, Phycocyanin fluorometer

Sensors: Integration and testing of new compact technology (e.g. pCO_2 and pH optodes)

Development and use of an optical pCO_2 sensor in marine studies



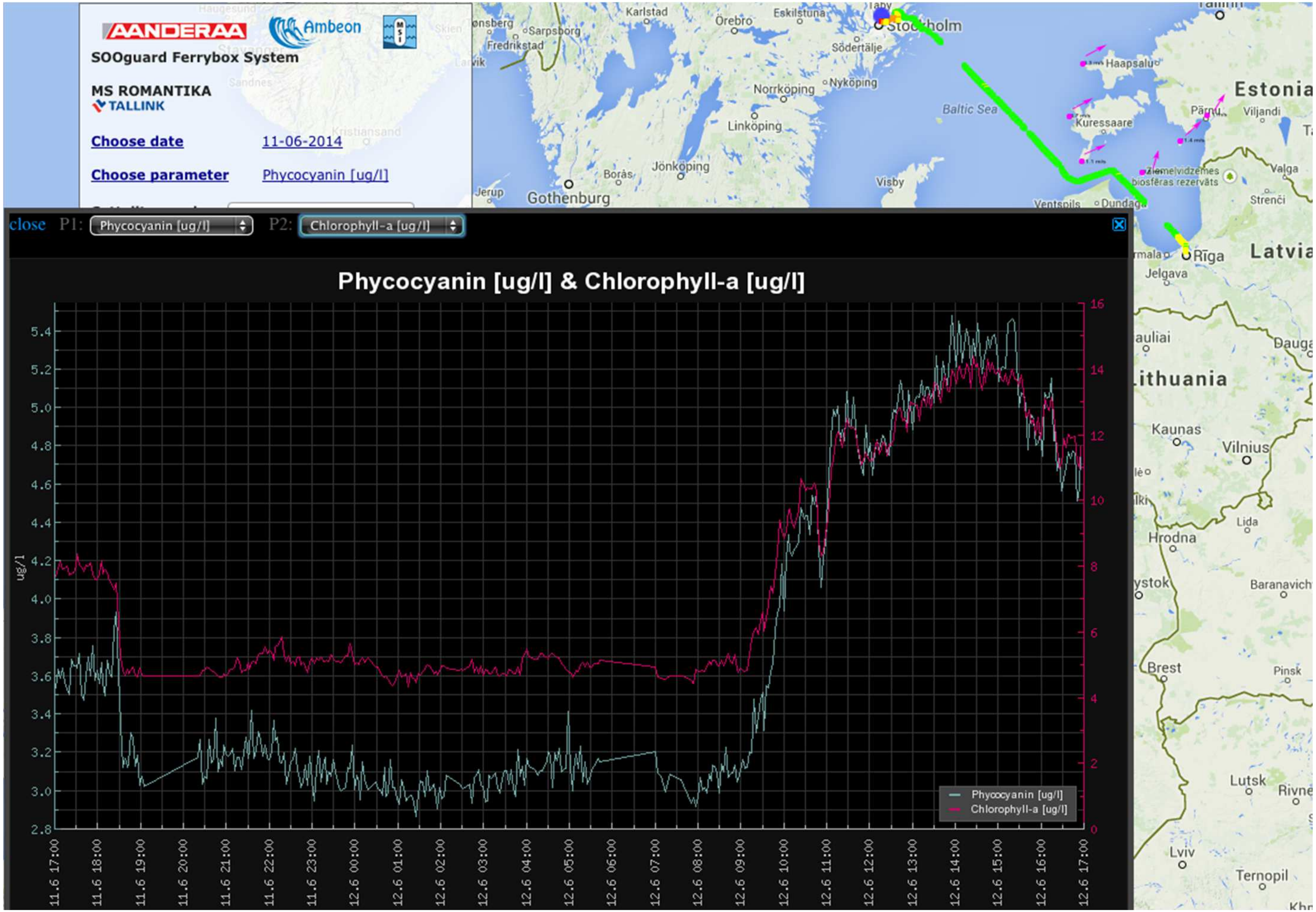
PhD thesis presentation

Dariia Atamanchuk

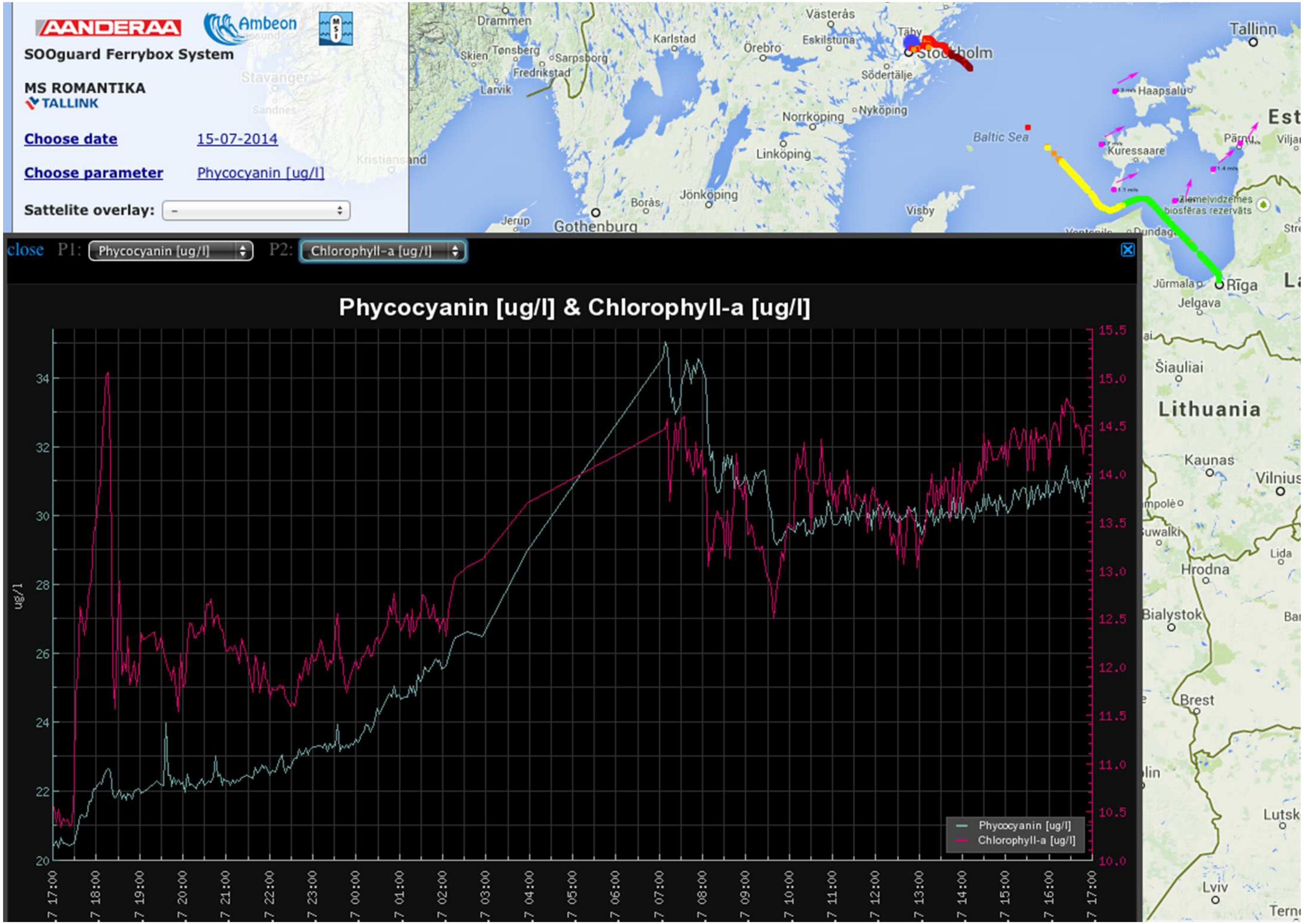
Department of Chemistry and Molecular Biology,
Marine Chemistry
Faculty of Natural Sciences
University of Gothenburg
Gothenburg, Sweden

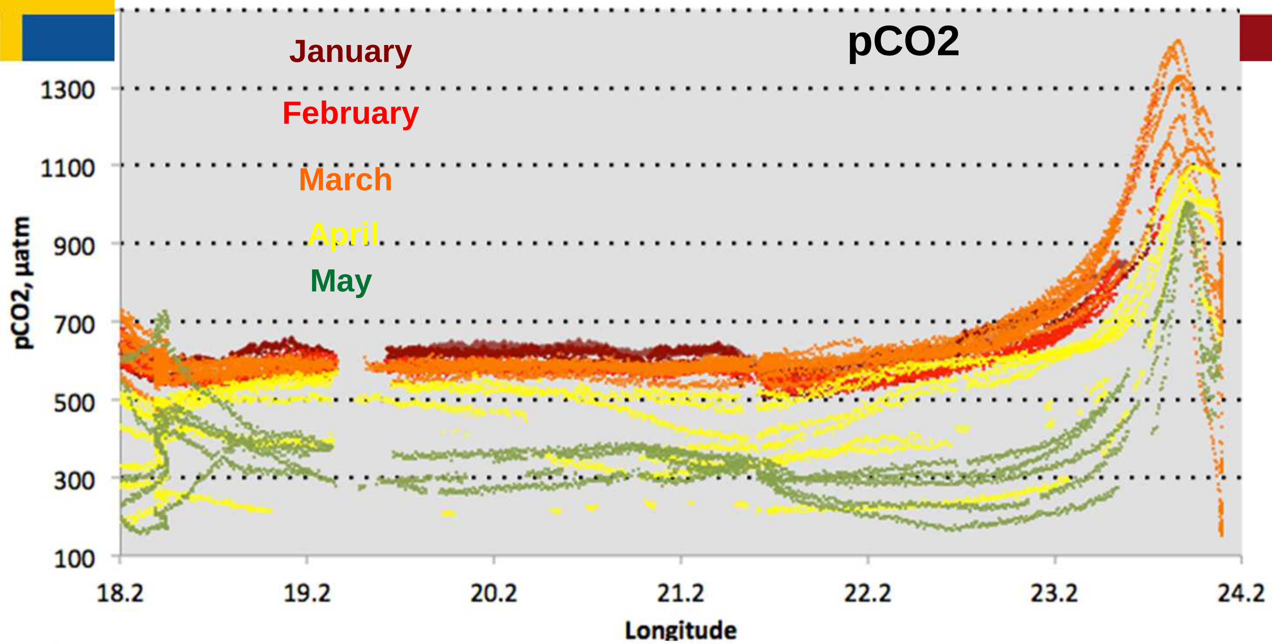
25 October 2013

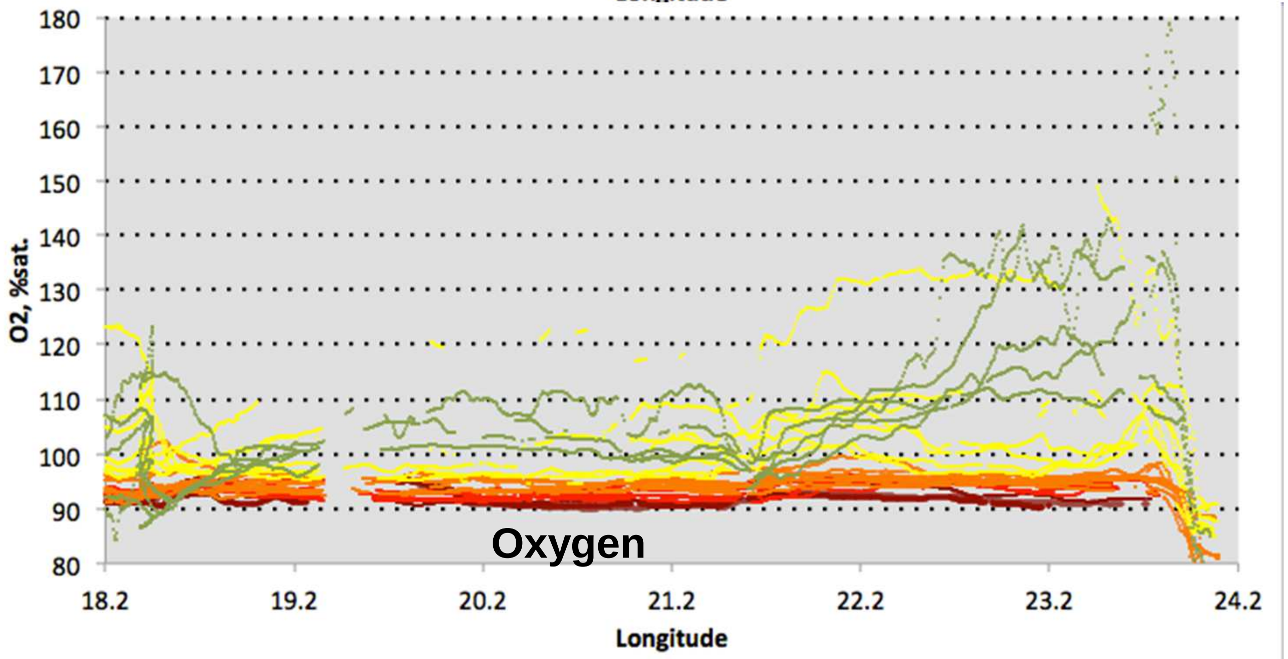
Some results



Some results







Observational period Jan-May 2014

- **one-directional transect every second day**
- **1 min sampling interval (900-950 measurements per transect)**

Functioning

- 14 months continuous operation running at 1 min interval, about 600 000 measurements (CO_2 optode about 300 000). No sensor drift except CO_2 during last weeks, dry out? acid wash?
- Cleaning once in two weeks in winter and 1-3 times per week in summer, Trilux most sensitive.
- About 95 % data return, 4 % of time no/low flow and fouling, 1 % SD card problem
- Reference samples taken manually at a couple of occasions

F7

Future improvements/updates

- Turn off pump while in harbor
- Automatic antifouling: Chlorination, UW light, wiper
- More reference samples and/or instruments along route
- Flow measurements
- Oil spill detection
- pCO_2 and pH optodes combined, possible expansion with second chamber
- Gap filling software

Other use of SooGuard systems

R.V. Callista
Where it all happens...

- Land based aquaculture and well boats
- Monitoring from small platforms/boats
- Ballast water monitoring
- SooGuard in operation for more than 2 years on

R.V. Callista (NOC & University of Southampton),
no issues with fouling, pump turned off in harbor, air in system

Slide 17

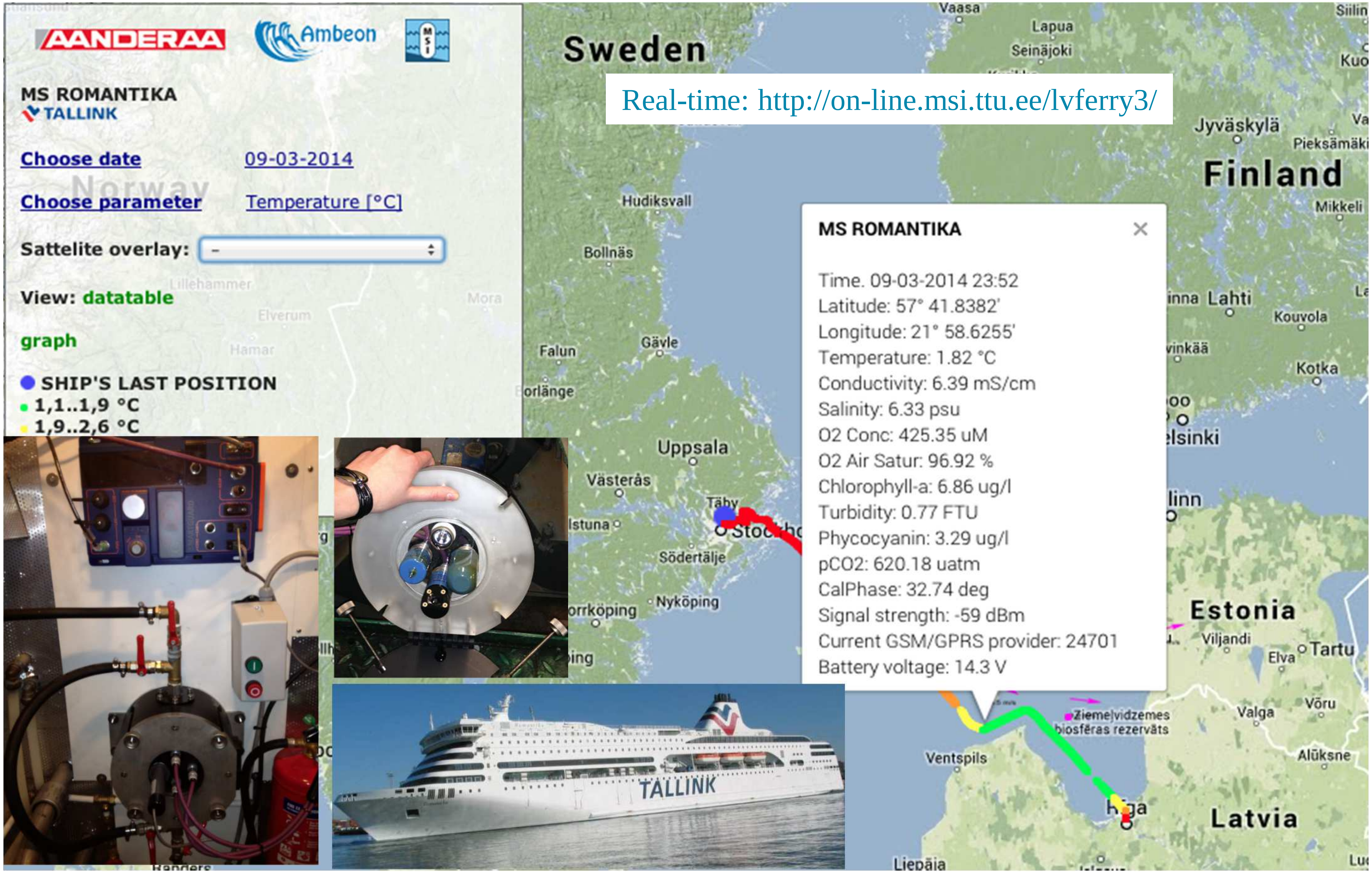
F7

BENTHIC OXYGEN DYNAMICS: COMPARING NEW IN-SITU TECHNOLOGY AND METHODS WITH "CLASSICAL" MEASUREMENTS

Oxygen is of primary importance to the marine environment. Recent publications indicate that, in terms of oxygen, the marine environment is much more dynamic than previously thought. Continuous in-situ measurements are needed and so are new methods to estimate oxygen consumption/production at the sediment water interface. During recent field work in the Baltic Sea we utilized a new type of fast responding long-term stable optical oxygen sensors (optodes) and advanced current meters to compare recent (eddy correlation) and new (gradient measurements) methods to estimate benthic oxygen consumption with more classical measurements including chamber lander incubations and oxygen consumption calculated from planar optode images. Advantages and inconveniences of the different methods will be discussed as well as the potential of the different methods to carry out long term (years) monitoring of oxygen consumption/production at interfaces.

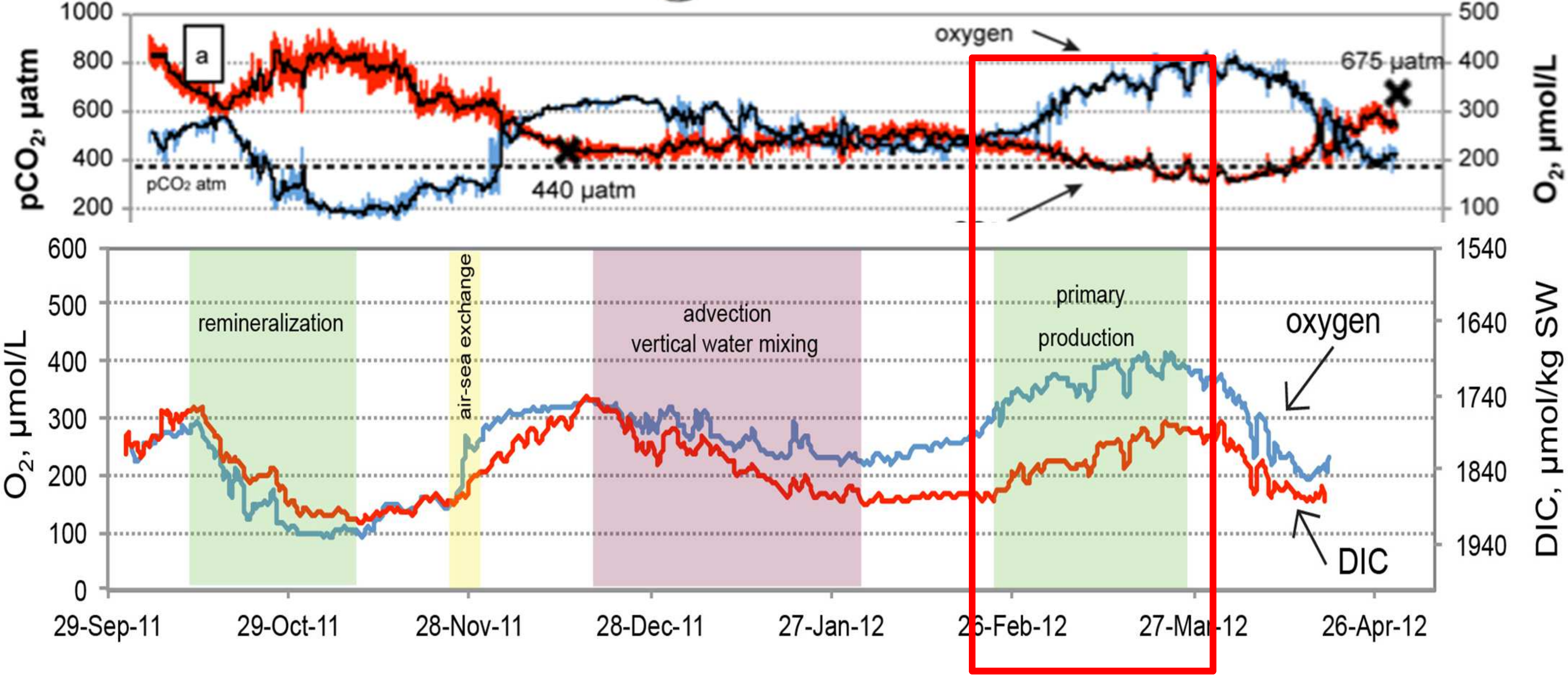
Författare; 25/01/2009

Thank You!


Real-time: http://on-line.msi.ttu.ee/lvferry3/
AANDERAA
Ambeon
MS ROMANTIKA
TALLINK
Choose date
09-03-2014
Choose parameter
Temperature [°C]
Sattelite overlay:
View: datatable
graph
SHIP'S LAST POSITION
1,1..1,9 °C
1,9..2,6 °C
MS ROMANTIKA
Time. 09-03-2014 23:52
Latitude: 57° 41.8382'
Longitude: 21° 58.6255'
Temperature: 1.82 °C
Conductivity: 6.39 mS/cm
Salinity: 6.33 psu
O2 Conc: 425.35 uM
O2 Air Satur: 96.92 %
Chlorophyll-a: 6.86 ug/l
Turbidity: 0.77 FTU
Phycocyanin: 3.29 ug/l
pCO2: 620.18 uatm
CalPhase: 32.74 deg
Signal strength: -59 dBm
Current GSM/GPRS provider: 24701
Battery voltage: 14.3 V
Sweden
Finland
Estonia
Latvia
Hudiksvall
Bollnäs
Gävle
Falun
Uppsala
Västerås
Täby
Södertälje
Nyköping
Vaasa
Lapua
Seinäjoki
Jyväskylä
Pieksämäki
Mikkeli
Lahti
Kouvola
Kotka
Viljandi
Tartu
Elva
Valga
Võru
Alūksne
Ventspils
Liepāja
TALLINK

pCO_2 optode and O_2 optode at the depth of 12.6 m

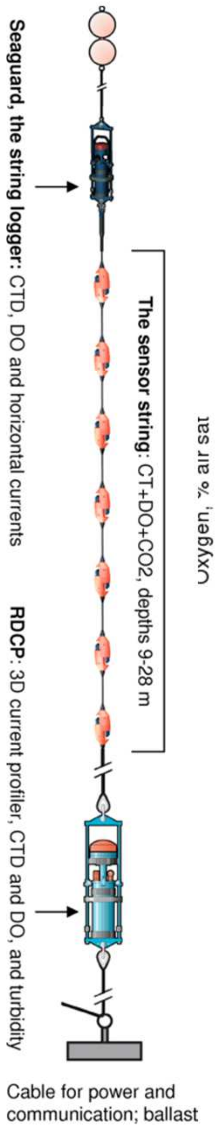
Salinity derived Alkalinity

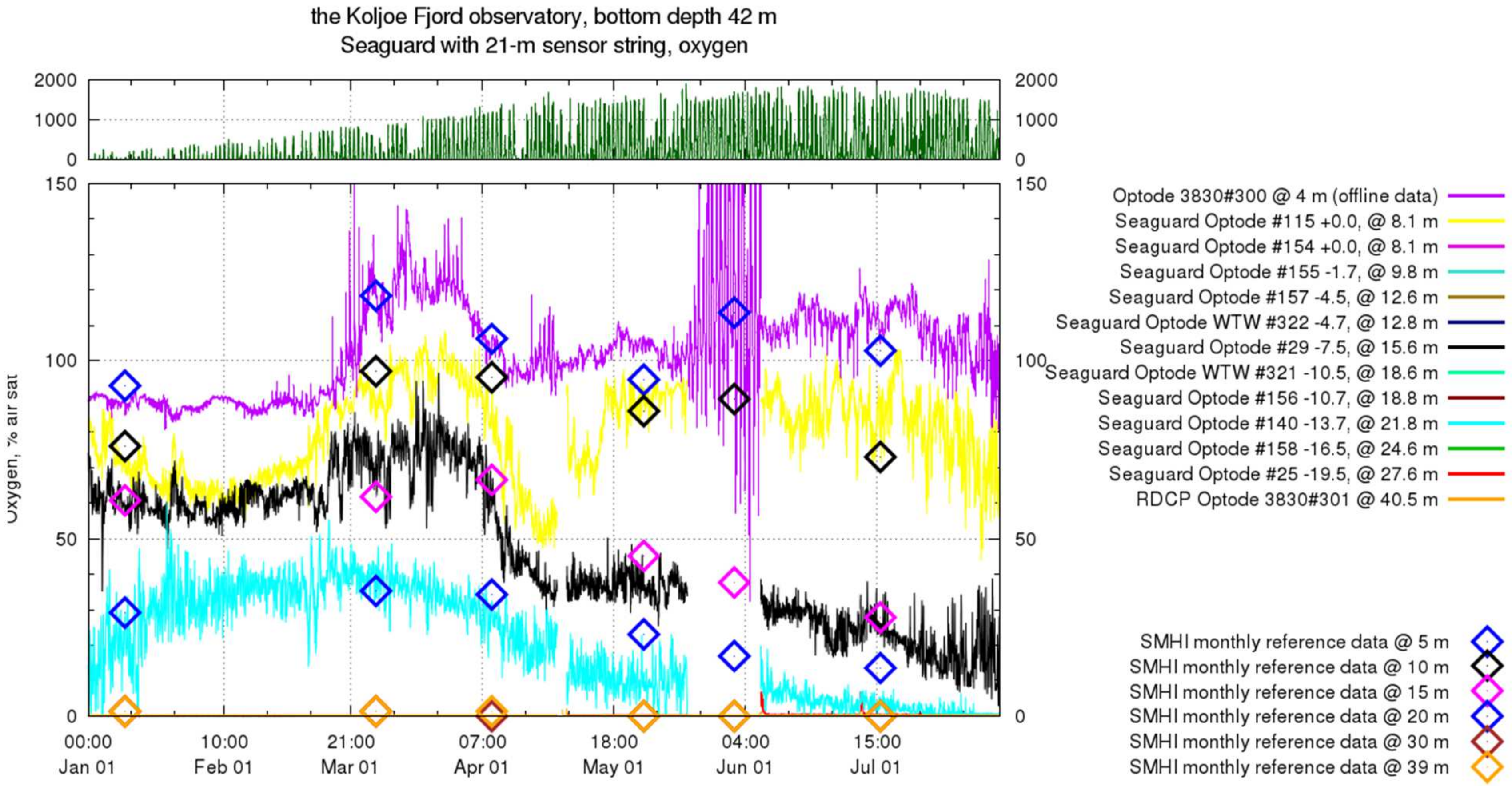


Net primary production (NPP) rates during spring bloom

- In 2012: 1.79 g C m-2
- In 2013: 2.10 g C m-2

Koljoefjord observatory: O_2 recordings, with monthly reference data from SMHI





- Monthly sampling not enough
- Reference data needed for high quality sensor data
- Are plastic (PVC) bottles suitable for sampling at low O2?