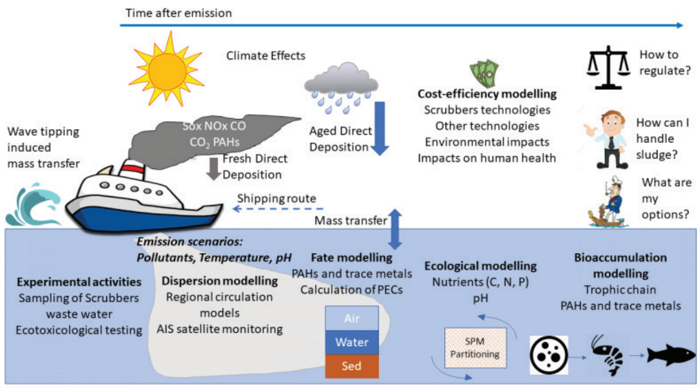
Application Note

Aanderaa, a Xylem brand • XA AN115

High quality current profiles from surface platforms: buoy and bottom installed systems compared

Tracking pollution from ships

The aims of the EU funded EMERGE project are to quantify and evaluate the effects of potential emission reduction solutions for shipping in Europe and to develop effective strategies to reduce the environmental impacts of shipping. The Chalmers University of Technology and The University of Gothenburg are partners in the EMERGE project.



The scope and approach of the EMERGE project.

In a recent field study in the Oresund straight, one of the entrances to the Baltic Sea, multiple instruments were combined to measure and model the underwater dispersion of pollutants from open-loop scrubbers. This is a technique that moves pollutants from engine exhausts to the water. The method was developed to allow ship owners with low environmental engagement to continue to run their ships on dirty, but inexpensive, residual oils.

In contrast to the polluting open-loop scrubber ships passing through this area are the electrical ferries. They are the largest electrical ships globally and charge with renewable electricity at their short, 5-10 min, stops during their 40-50 daily crossings between Sweden and Denmark.

A car carrier crossing the route of an electric ferry between Sweden and Denmark. There is high ship traffic through the Oresund straight, one of the entrances to the Baltic Sea.

Five systems to measure currents running in parallel

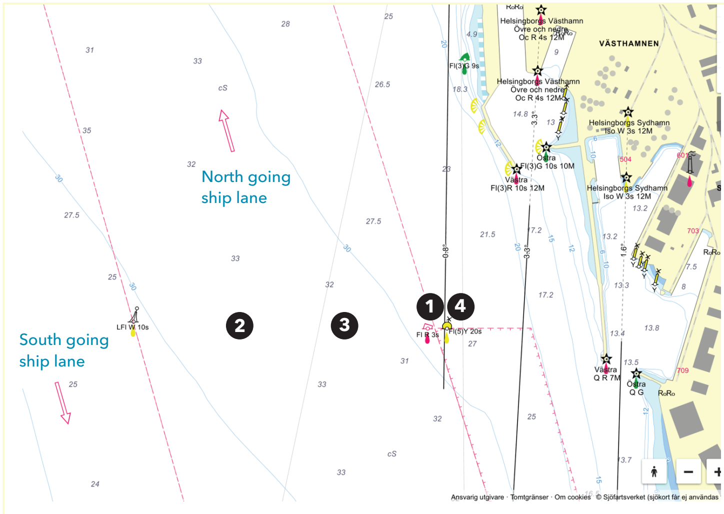
Three ADCPs, one Aanderaa SeaGuardII and two Nortek Signature 500 and 1000, were deployed below the North going ship lane. These instruments collected comparable current information with clear influences from ships passing above them.

The measurement from these instruments was complemented with current information from two permanent systems closer to land, outside the shipping lanes. A real-time reporting navigational aid buoy and a SeaGuard Single Point Current Meter deployed on the bottom to measure long-term changes in the area, years-decades (Figure 1, page 2).

a xylem brand

Challenges to do high-quality current measurements from buoys

To use Acoustic Doppler Current sensors from moving surface platforms like buoys are challenging. Changes in tilt and heading should be compensated for continuously. Magnetic disturbances from metal parts on the buoy can influence the compass, and acoustic reflections against objects below the buoy, e.g. the mooring line/chain, could introduce speed and directional faults. Another challenge is that acoustic sensors that use broadband become noisier if the buoy is "jumping around" in the waves.



The Aanderaa solution

For the Doppler Current Profiling Sensors (DCPS), the user can select broadband or narrowband, depending on the situation. Broadband saves power and gives advantages for e.g., directional wave detection but normally gives lower quality currents from buoys and surface platforms moving in the waves.

For more than 15 years, all our Doppler Current Sensors include an inbuilt 3-axes compass (gives heading) and an accelerometer (gives tilt) for advanced attitude and heading compensations of every single acoustic ping, regardless if it is a single point or an acoustic profiling sensor. For the acoustic profiling sensors, an automatic "Beam repositioning" is done for tilts up to 35 degrees, and the single point sensors can handle 50-degree tilt. To compensate for magnetic influences on buoys, an external compass is placed high up on the buoy. It gives heading information to the current and directional wave sensor(s) instead of their internal compasses. Disturbances from acoustic reflections against objects like the mooring chain are filtered out by the "auto beam function," which automatically removes a disturbed beam and calculates currents from the remaining three beams.

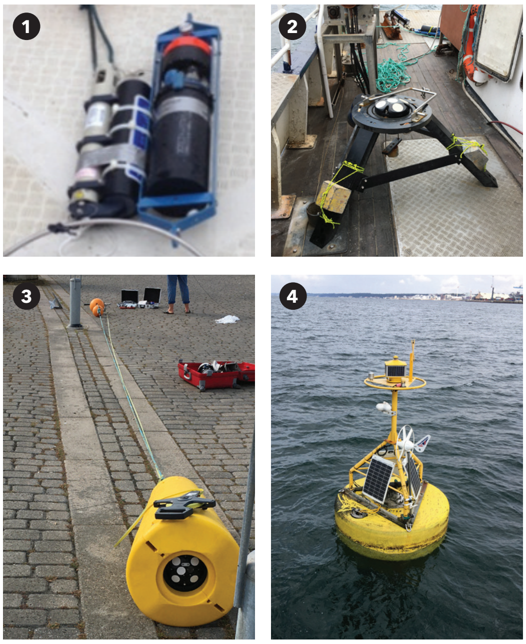


Figure 1
(1) SeaGuard @ bottom, 1 year deployments, 1h interval, CTO$_2$ & Single Point Currents, 150 Z-pulse pings spread.
(2) Signature 500 on bottom
(3) Mooring with SeaGuardII @ bottom & Signature 1000, 15 m above in special float.
(4) Buoy, operational since Jan 2016

"Another unique feature is that the Aanderaa ADCPs can be set-up to collect information from several acoustic columns simultaneously."

Another unique feature is that the Aanderaa ADCPs can be set-up to collect information from several acoustic columns simultaneously. In this fieldwork, the upward-facing SGII was set-up with four columns (Figure 2). For direct comparison with the Signature 500, an instrument referenced column with 0.5 cell size covered the entire water column (orange). Then three surface referenced columns (blue) were collected. One was the surface currents, and one was a column for direct comparison with the buoy measurements, with 1m cell size. The last column was to compare with the Signature 1000 above. The SGII was set up with a cell size of 0.25 m, obtained by overlapping. The surface is detected with the onboard wave/tide/pressure sensor.

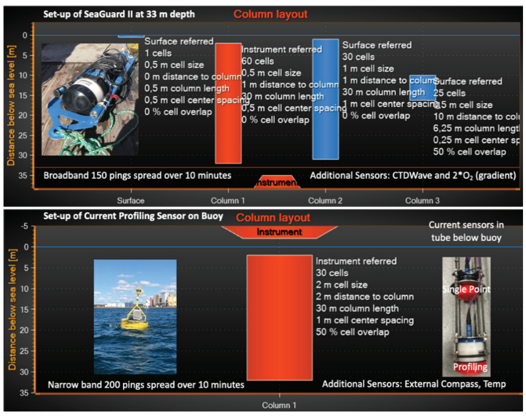


Figure 2: Set up of bottom moored SeaGuardII instrument and Doppler Current Profiling Sensor on buoy.

The processing of the collected data is done "on-the-fly" on-board the sensors, which makes data transmission in real-time and post-deployment analyzing of data with the freely included DataStudio3D software fast and efficient.

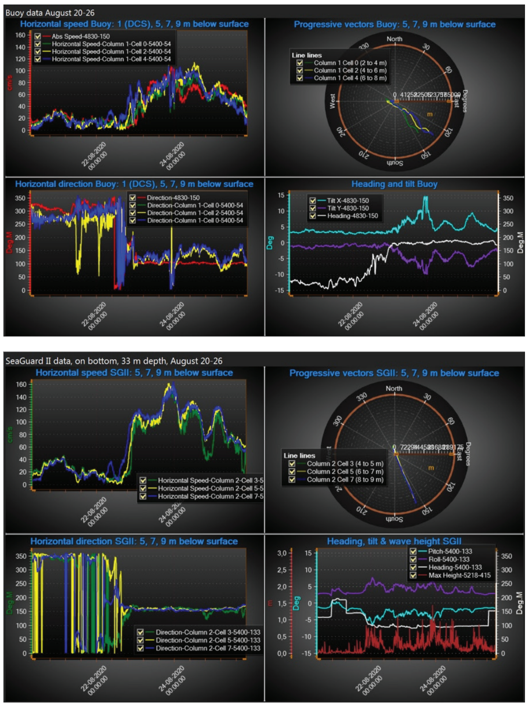


Figure 3: During the first 2.5 days currents agree well in speed, but with about 40-50 deg difference in direction

DOCUMENT XA-AN115-R1-NOR

Buoy profiler versus SeaGuardII on bottom, 400 m away

Since January 2016, the buoy reports currents every 10 min at different depths from 1 to 18 m. Simultaneously more detailed information is stored on-board, including currents to the bottom at 32m, acoustic backscatter, and mixing.

The buoy is located 400m from the SGII, closer to land, where currents are generally weaker. During the first 2.5 days, currents agree well in speed, but with about 40-50 deg difference in direction (Figure 3). On August 22, the currents veer towards the South, and the speed at the SGII becomes stronger than at the buoy. The direction out in the straight is more North-South and closer to land more NW-SE following the main direction of the coastline. The observations correspond well with the natural variation seen on the installation site.

Buoy profiler versus SeaGuard on bottom, 50 m away

"Since January 2016, the buoy reports currents in real-time every 10 min at different depths from 1 to 18 m."

Close to the buoy the Municipality of Helsingborg have installed a SeaGuard instrument to asses decadal changes in currents (single point) oxygen, salinity and temperature about 1 m above bottom. This instrument is serviced and data downloaded from it about once per year. The current scatter plots in figure 4 is a comparison between the single point sensor 1 m above bottom (a) and the last non-contaminated cell, about 4 m above bottom, measured from the surface buoy (b). These measurements were done during 3 months, July-October 2018. The overall patterns of the currents are similar but there is a difference in direction of about 10 deg between the two instruments and when calculating the total traveled distance from progressive vector diagrams the measurements closer to the bottom gave 268 km and the last good cell from the profiler, 2m higher up, gave 278 km.

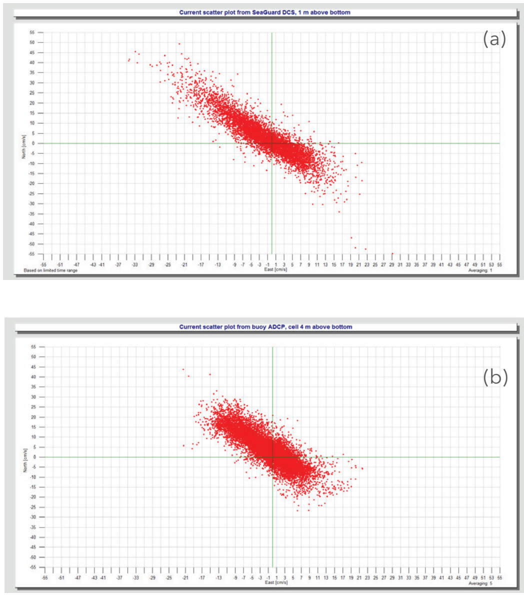


Figure 4: Scatter plots for 3 months of measurements (a) from bottom deployed SeaGuard instruments and (b) from buoy mounted Doppler Current Profiling Sensor.

As the single point current sensor is able to measure closer to the bottom, the currents are similar, but not directly comparable. The single point is able to accurately pick up bottom currents making a good complement to the downward facing profiler.

Aanderaa Data Instruments AS
Sanddalsringen 5b
P.O. Box 103 Midtun
5843 Bergen, Norway

+47 55 60 48 00
aanderaa.info@xyleminc.com
Aanderaa.com

Aanderaa.com