Cruise report Hvaler trench, June 2016
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1 Introduction and cruise overview

The present report is prepared for the Norwegian Directorate of Fisheries. It follows the permission (reference 16/5538) to conduct a scientific cruise in Norwegian waters with R/V Skagerak.

The report covers measurements taken in Norwegian waters, see table 1. The measurements were part of a nine day cruise conducted between June 5 and June 13 in 2016, targeting both Swedish and Norwegian waters. Figure 1 shows the area and the cruise tracks of interest for the present report. Measurements included CTD profiling, Laser In-Situ Scattering and Transmissometry (LISST) profiling for particle size distribution analysis, and water sampling with filtration of water samples.

Table 1: Summary of measurements.

Weekday	Date	Julian Day	Stations	Water samples
Tuesday	2016-06-07	159	7	7
Wednedsay	2016-06-08	160	11	7
Saturday	2016-06-11	163	12	0

2 CTD operations

The aims of the CTD profiling were a) to map the water masses and possible exchange routes for Skagerrak water entering the Koster trench and b) to map turbidity.

Profiling was made in transects in the Hvaler area. The CTD was a SBE 9plus with auxiliary sensors for turbidity, fluorescence, transmission and dissolved oxygen, see figure 2. Niskin bottles of 10 L capacity were mounted on the CTD frame.

Preliminary results of CTD profiling is presented in figures 4 – 8. Processed data files are supplied as digital attachments to this report, see table 4.

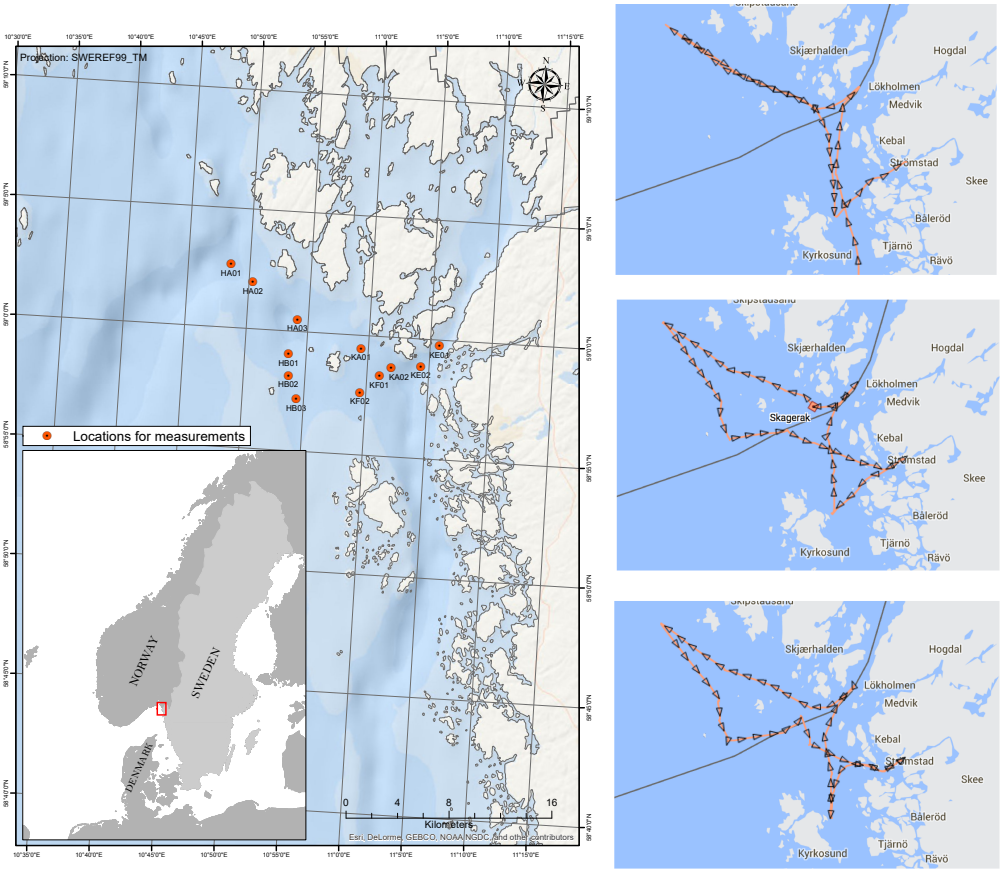

Figure 1: Hvaler and Koster area with stations situated in Norwegian waters indicated (left). Cruise tracks from June 7 (top right), June 8 (middle right) and June 11 (bottom right).

On June 11 there is a malfunction of the electronically controlled pump of the CTD. The malfunction results in spikes in salinity and density, visible in figures 7 and 8, while the effect on temperature is significantly less. The effect is most severe on the measurements of dissolved oxygen, see attached data files. The pump does not influence the turbidity sensor.

3 LISST operations

The aim of the LISST profiling was to map particle size distributions and suspended volumes of particulate matter.

The LISST was mounted horizontally on the lower part of the rosette and oriented so that water could flow freely through the optical endcap, see figure 2. The instrument was a LISST-100X, particle size analyzer type C, by Sequoia Scientific, size ranges from

Figure 2: Rosette frame with main CTD (olive green, mounted horizontally lowest in the frame), auxiliary CTD (white plastic, mounted vertically), Niskin bottles (gray plastic, mounted vertically), LISST (black cylinder, mounted horizontally above main CTD).

2.5-500 μm. The LISST is restricted to operate in depths up to 300 m. Consequently, there are no LISST measurements from station HA01 (see figure 1).

Processed data files are supplied as digital attachments to this report, see table 4. Note that the data in the LISST files have not been put into depth bins. Due to a poorly functioning depth sensor in the LISST, the depth has been interpolated from the CTD depth recordings, using the time stamps of the two instruments. The interpolated depth values have been added to the LISST files as an extra column. The LISST files do not have any header lines describing the parameters, see instead tables 2 and 3.

4 Water sampling and filtration

The aim of the water sampling and filtration was to investigate the total suspended mass. An additional objective was to determine whether the proportion of organic content in the suspended matter correlates with the difference in turbidity that was observed in the down versus up part of casts on a previous cruise.

Water was sampled from bottom and intermediate water. The filtration procedure followed the recommendations in *Bestämning av suspenderat material och glödgningsrest* (SMHI Oceanografiska Laboratoriet i Göteborg). The filtration rig is shown in figure 3.

Figure 3: Filtration rig in R/V Skagerak lab.

Filters used were Whatman® glass fiber filters grade GF/F pore size 0.7 μm, $\oslash$ 47 mm.

The sampling and filtering protocol is supplied as digital attachment Filtrationprotocol201606Hvaler.xlsx.

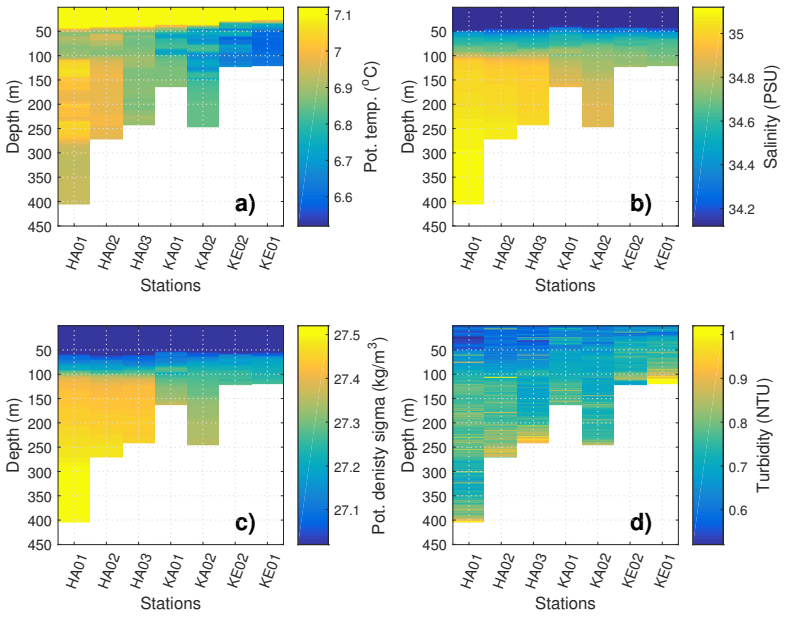

Figure 4: Hvaler main trench transect during June 7 (see figure 1) a) potential temperature, b) salinity, c) potential density sigma and d) turbidity. Note that the colour scales do not resolve the stratification in the surface layer.

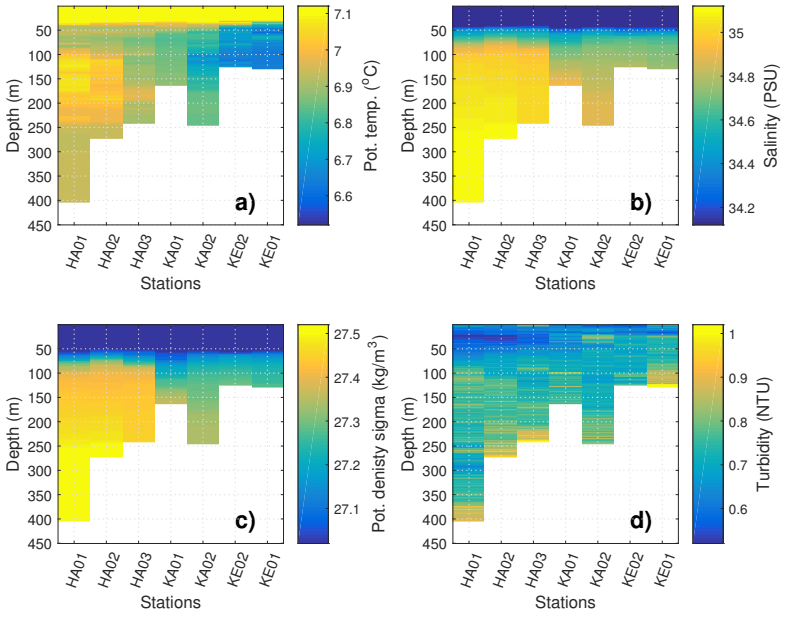

Figure 5: Same as figure 4 but for June 8.

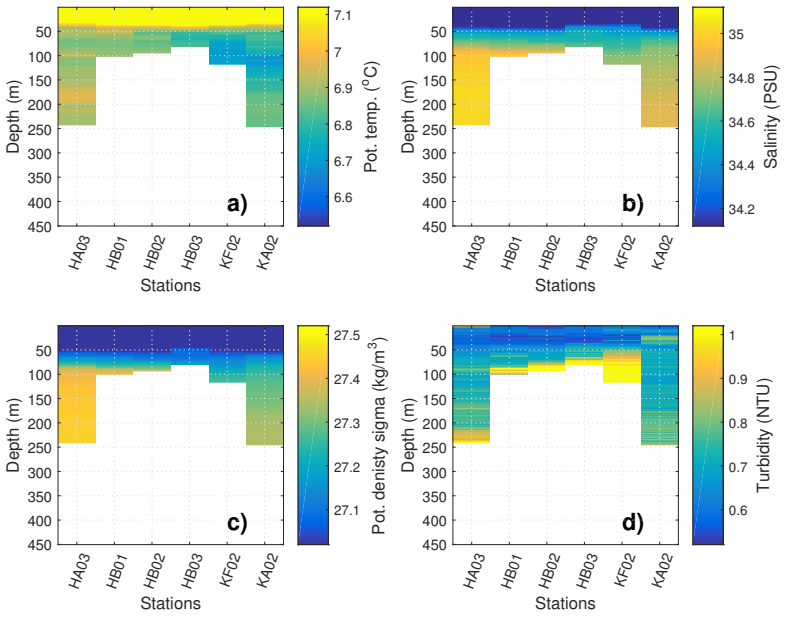

Figure 6: Same as figure 4 but for stations to the south of the Hvaler main trench on June 8, see figure 1. Adjacent stations HA03 and KA02 in the main trench are included for comparison.

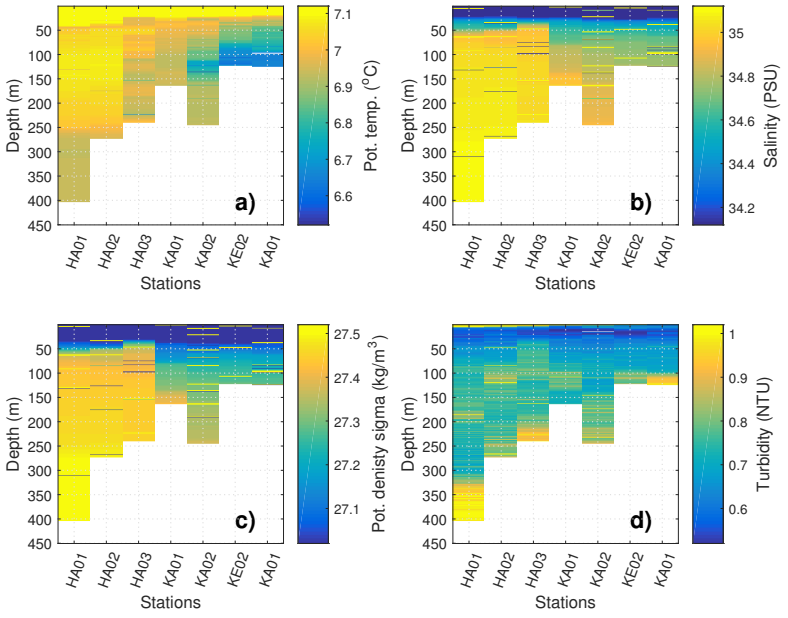

Figure 7: Same as figure 4 but for June 11.

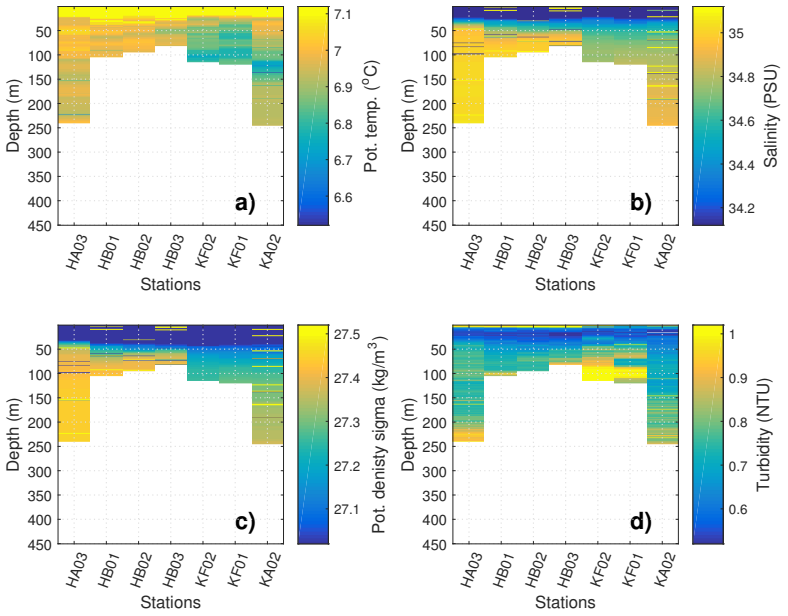

Figure 8: Same as figure 6 but for June 11.

Table 2: The parameter columns in the LISST files.

Column	Parameter	Unit
1 – 32	Suspended volume, see table 3	μL/L
33	Laser transmission Sensor	mW
34	Battery voltage in calibrated units	V
35	External Auxiliary input 1 in calibrated units	mW
36	Laser Reference sensor in calibrated units	mW
37	Pressure in calibrated units	m
38	Temperature in calibrated units	^{o}C
39	(Day*100 + Hour) at which data taken	
40	(Minutes*100 + Seconds) at which data taken	
41	Computed optical transmission over path	
42	Beam-attenuation	m^{-1}
43	Interpolated depth	m

Table 3: The particle size classes of LISST-100X type C. The lower and upper limits and the medians are in μm.

Size bin	Lower	Upper	Median
1	2.50	2.95	2.72
2	2.95	3.48	3.20
3	3.48	4.11	3.78
4	4.11	4.85	4.46
5	4.85	5.72	5.27
6	5.72	6.75	6.21
7	6.75	7.97	7.33
8	7.97	9.40	8.65
9	9.40	11.1	10.2
10	11.1	13.1	12.1
11	13.1	15.4	14.2
12	15.4	18.2	16.8
13	18.2	21.5	19.8
14	21.5	25.4	23.4
15	25.4	30.0	27.6
16	30.0	35.4	32.5
17	35.4	41.7	38.4
18	41.7	49.2	45.3
19	49.2	58.1	53.5
20	58.1	68.6	63.1
21	68.6	80.9	74.5
22	80.9	95.5	87.9
23	95.5	113	122
24	113	133	122
25	133	157	144
26	157	185	170
27	185	218	201
28	218	258	237
29	258	304	280
30	304	359	331
31	359	424	390
32	424	500	460

Table 4: Attached processed data files. CTD files and LISST files from each profile have identical names, except that CTD files start with C and LISST files start with L. Note that there are no LISST files for station HA01.

Station	Julian day, time	CTD/LISST file
KE02	159, 09.18	C/L20161590918.asc
KE01	159, 09.41	C/L20161590941.asc
KA02	159, 10.09	C/L20161591009.asc
KA01	159, 10.39	C/L20161591039.asc
HA03	159, 11.12	C/L20161591112.asc
HA02	159, 11.47	C/L20161591147.asc
HA01	159, 12.17	C20161591217.asc
KE02	160, 09.45	C/L20161600945.asc
KE01	160, 10.11	C/L20161601011.asc
KA02	160, 10.50	C/L20161601050.asc
KA01	160, 11.22	C/L20161601122.asc
HA03	160, 11.56	C/L20161601156.asc
HA02	160, 12.31	C/L20161601231.asc
HA01	160, 13.02	C20161601302.asc
HB01	160, 14.01	C/L20161601401.asc
HB02	160, 14.20	C/L20161601420.asc
HB03	160, 14.37	C/L20161601437.asc
KF02	160, 15.06	C/L20161601506.asc
KE02	163, 09.39	C/L20161630939.asc
KE01	163, 09.57	C/L20161630957.asc
KA02	163, 10.31	C/L20161631031.asc
KA01	163, 10.59	C/L20161631059.asc
HA03	163, 11.34	C/L20161631134.asc
HA02	163, 12.08	C/L20161631208.asc
HA01	163, 12.38	C20161631238.asc
HB01	163, 13.36	C/L20161631336.asc
HB02	163, 13.52	C/L20161631352.asc
HB03	163, 14.09	C/L20161631409.asc
KF02	163, 14.33	C/L20161631433.asc
KF01	163, 14.52	C/L20161631452.asc