CRUISE REPORT

R/V Aranda

Cruise 15/2019

VIMMA/2019

28. August - 6. September 2019

This report is based on preliminary data and is subject to changes.

VIMMA 2019 cruise

28 August – 6 September 2019

Chief Scientist: Laura Tuomi /Finnish Meteorological Institute

1. VIMMA research cruise

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The RV Aranda was on VIMMA 2019 research cruise on 28.8.-6.9. 2019. The study area was the Gulf of Finland. The overall purpose of the measurement campaign was to improve our understanding of stratification, water exchange and sedimentation dynamics in and along large submarine channel in the western part of Gulf of Finland.

The first part of the cruise 28.-30.8. concentrated on measuring the hydrography of the western Gulf of Finland to get an overall estimate of the conditions in the study area. Eight transects were done across the Gulf of Finland including 5-7 CTD stations (Fig 1.) and four transects close to the submarine channel study area with a more dense net of stations. In addition to CTD, shipborn ADCP was used to make measurements at the stations.

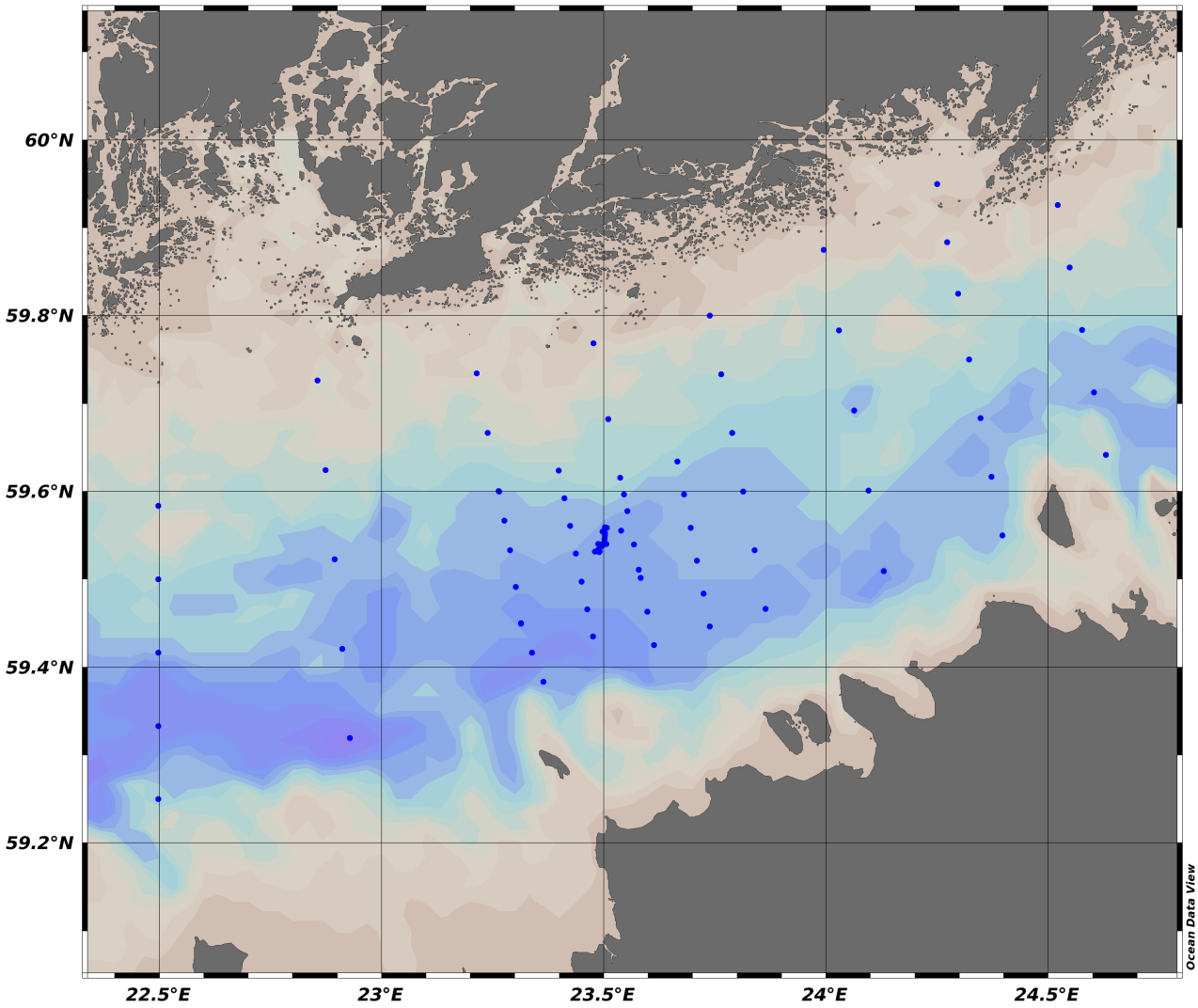

Figure 1. Stations visited during the VIMMA 2019 cruise shown with blue dots.
During the second part of the cruise (1.-5.9.) an integrated hydrophysical, hydrochemical and sediment sampling campaign was carried out over a large submarine channel in the western Gulf of Finland. We visited 15 sites in the

channel and along the margins of the channel, covering on area of ca. 2 km^2. The sites were selected on the basis of multibeam and sub-bottom profiler pre-site surveys, previously run onboard the r/v Geomari of the Geological Survey of Finland (GTK). The water column measurements were carried out using both shipborn CTD sonde , FMI's Slocum Glider Uivelo and an instrumented bottom lander, recording O_2, H_2S, pH, turbidity and suspension grain-size distribution, along with the usual salinity and temperature. In addition, currents were measured from the whole water column both with moored ADCP and shipborn ADCP.

At the end of the cruise on 6.9. a sediment sample was collected with a piston corer at station A11 (59°47.15' 025°37.58'E).

During the cruise also maintenance was done for FMI's buoys and moorings.

The list of stations visited in the VIMMA 2019 research cruise can be found in Appendix 1.

2. Observations

2.1 CTD measurements

Measurements were done with R/V Aranda CTD along transects in the Gulf of Finland. The aim of these measurement was to define the overall hydrographic conditions in the Gulf of Finland before the intensive measurement campaing at submarine channel, which was the main study area of this research cruise. The CTD measurements showed that the temperature in the surface layer varied between 15 – 21 °C (Fig. 2) . The colder water mass was on the Finnish coast of the Gulf of Finland and the warmer water at Estonian coast. The large differences in the SST and thermocline depth were due to an upwelling event, which can be seen in temperature sections across the Gulf of Finland (Fig. 3). The salinity in the surface layer varied between 5-6.5 g/kg. The halocline depth was between 60-80m at the deeper parts of the Gulf of Finland and the bottom salinities were up to 11 g/kg. The bottom layer below the halocline was anoxic. The anoxic bottom layer was found on at least one station in each transect (Fig. 4).

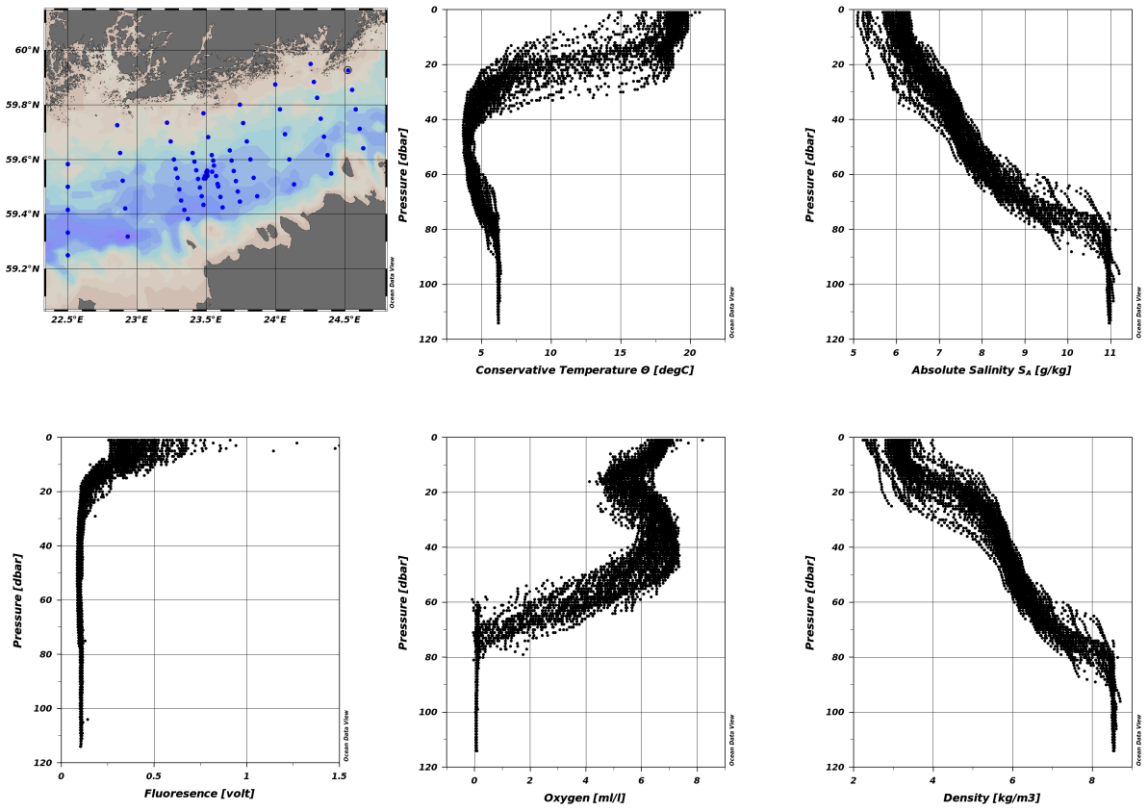

Figure 2. CTD profiles from the Gulf of Finland.

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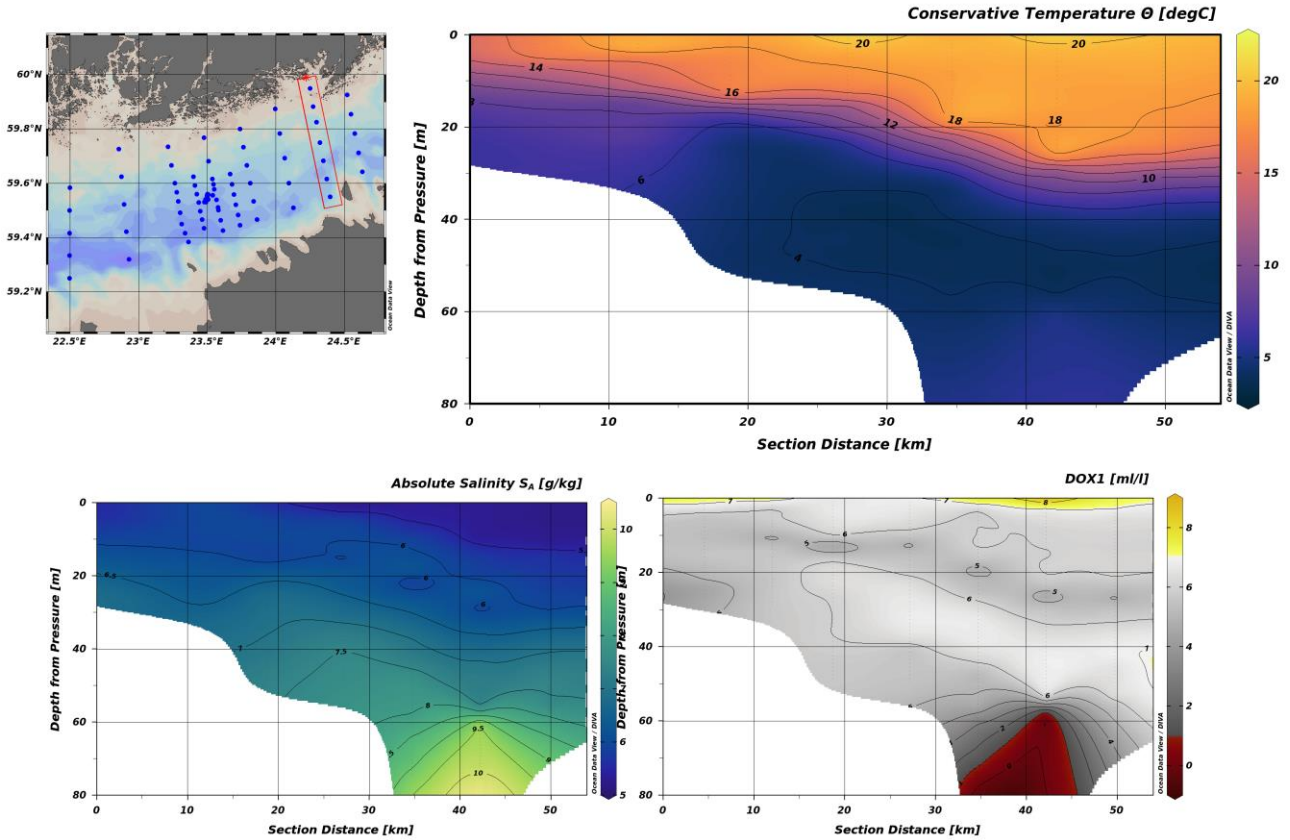

Figure 3. Temperature, salinity and oxygen measured with RV Aranda CTD along section across the Gulf of Finland.

2.2 ADCP measurements

Shipborn ADCP was used to collect data at CTD stations and along transects. The data quality is quite poor due to the shortness of the station visits and to the sensitivity of the ADCP to disturbancies caused for example by ship engine/propellers and ship movement. Only at the submarine channel during the longer station visits and relatively calm weather the disturbances and errors in the data are smaller and some usefull data was collected.

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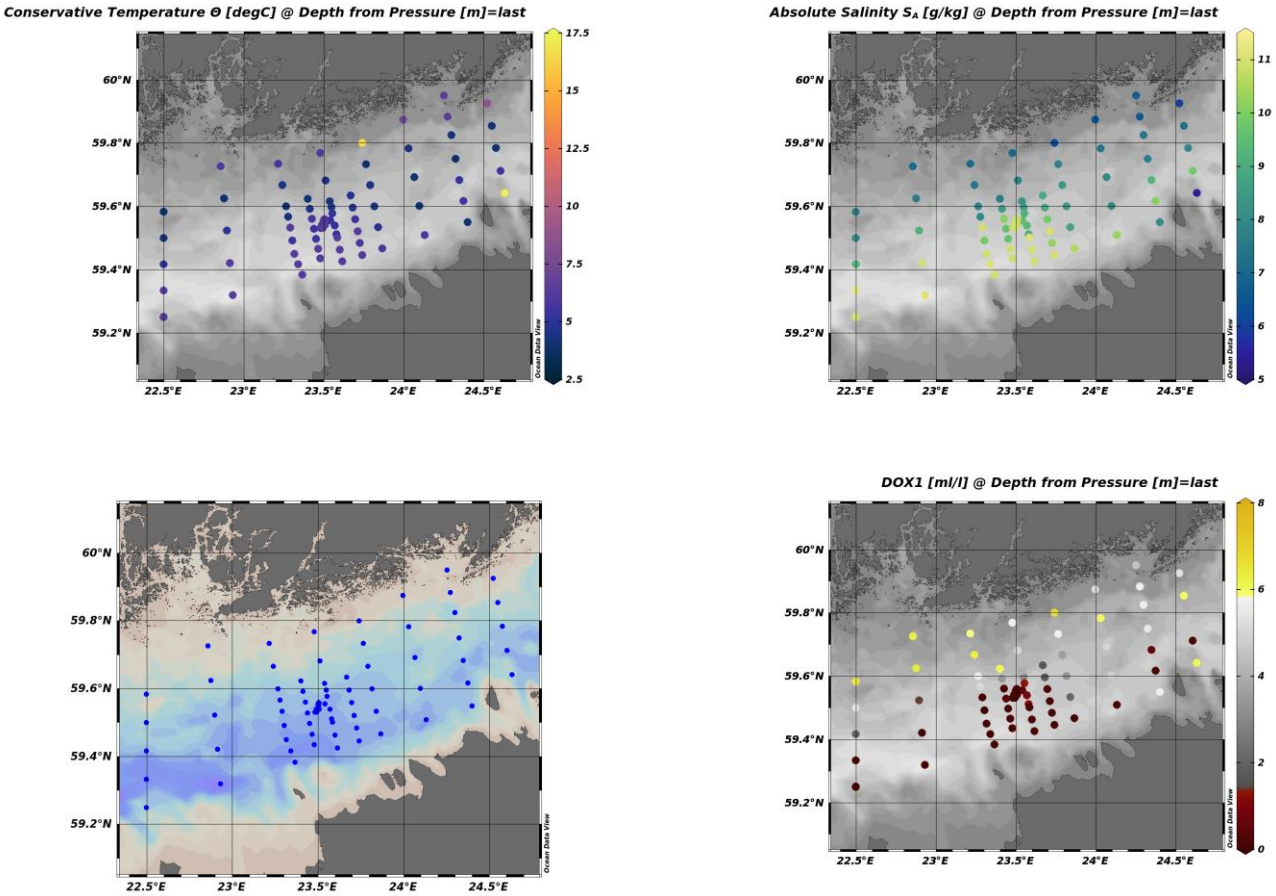

Figure 4. Temperature, salinity and oxygen at the lowest CTD depth (typically 5 m above the bottom).

2.3 Echo sounding

Hydroacoustic data was recorded using Meridata MDCS sub bottom profiling system and drop-keel-mounted 12-22 kHz chirp transducer. Most of the collected data is of good quality and vertical penetration to the seafloor up to ca. 30 metres depending on location. The data was collected along the cruise route from Helsinki and back.

2.4 CTD, ADCP and Glider measurements at submarine channel

For five days, the research campaign concentrated conducting measurements at the submarine channel in the western Gulf of Finland. Measurements were done at 15 sites selected on basis of earlier measurements. In addition to this, FMI's ADCP and two Aanderaa current profilers were measuring in the area since April 2019. Measurements were carried out with shipborn CTD (Fig. 5), ADCP and echo sounding devices. Water column measurements were carried out using also an instrumented bottom lander, recording O_2, H_2S, pH, turbidity and suspension grain-size distribution, along with the usual salinity and temperature. In addition, sediment samples were collected with Gemax corer

and piston corer. For few days, water column measurements were also made with FMI's Slocum Glider Uivelo, which was set to a virtual mooring sampling across the submarine channel.

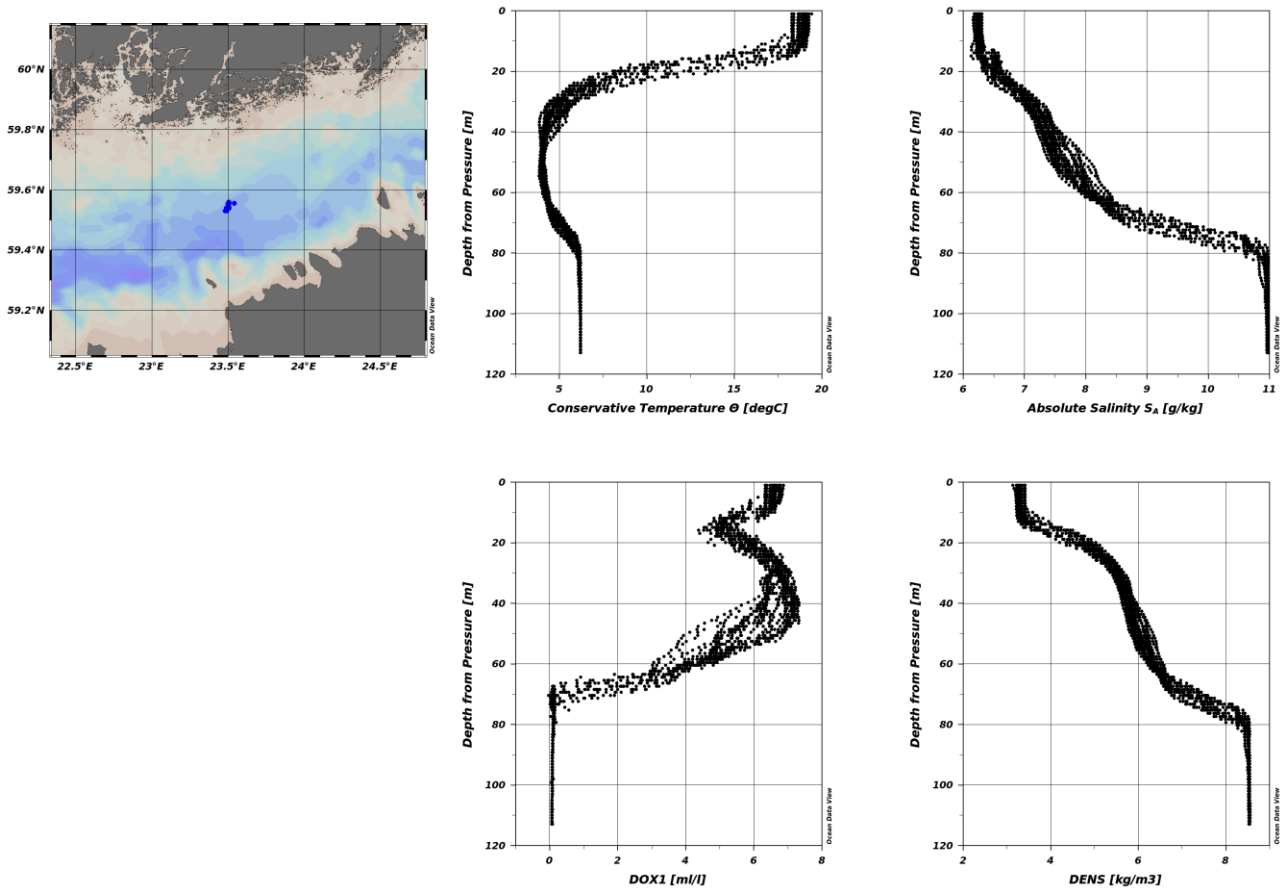

Figure 5. CTD profiles at the stations in the submarine channel.

In situ measurements of hydrogen sulfide

A multi-channel sensor (Analysenmeßtechnik GmbH – Sea and Sun Technology GmbH, Germany) attached to a bottom lander rigging (SYKE) was used to record stratification and temporal variability of H_2S concentration and pH Additionally measurements of turbidity and suspension grain-size distribution, along with the usual salinity and temperature were carried out with the same setup.

A a significant redoxcline occurred at 71–78 m depth, slightly above the level of surrounding seafloor at ca. 83 m. At the redoxcline, O_2 concentration drops to near-zero values, whereas H_2S concentration rapidly increases, followed by a gentle increase and homogenization toward the channel floor at 100–120 m depth. The redoxcline depth, anoxic bottom-layer thickness and H_2S

concentration varied during the five-day measurement campaign. Changes in the water column were reflected in changes of H_2S upper boundary location (average change -1.67 m per day, i.e. rising), upper boundary pH (+ 0.03 per day), H_2S layer thickness (+1.8 m per day), seafloor level [H_2S] (-0.04 mg per litre per day), seafloor level temperature (-0.01 °C per day) and seafloor level pH (-0.02 per day) at the deepest Jontka location over 3.36 days. The results underline the constant variability of physical and chemical composition of seawater even in small time scales.

2.5 Sediment coring

Altogether 14 sediment cores were collected from the submarine channel area, using a short twin-barrel gravity corer Gemax. The coring stations and core ID's according to GTK's indexing system are presented in Table X. In addition, 3 long cores were collected using the GTK's long piston corer.

Table 1. Collected sediment cores.

Station	Core ID	Date and time (UTC)	Notes
VIMMA0	MGGN-2019-10	2019-09-01T14:10	
VIMMA1	MGGN-2019-11	2019-09-01T17:30	
FULL1	MGGN-2019-12	2019-09-01T20:05	
FULL2	MGGN-2019-13	2019-09-02T14:05	
FULL4	MGGN-2019-14	2019-09-02T17:45	The same site as MGML-2019-1
FULL4	MGML-2019-1	2019-09-02T18:45	The same site as MGGN-2019-14
FULL4B	MGGN-2019-15	2019-09-03T12:55	The same site as MGML-2019-2
FULL4B	MGML-2019-2	2019-09-03T14:30	The same site as MGGN-2019-15
VIMMA3B	MGGN-2019-16	2019-09-03T15:05	
VIMMA5	MGGN-2019-17	2019-09-03T17:30	
VIMMA5B	MGGN-2019-18	2019-09-04T10:10	
VIMMA4B	MGGN-2019-19	2019-09-04T12:30	
VIMMA6	MGGN-2019-20	2019-09-04T15:30	
VIMMA_GAS	MGGN-2019-21	2019-09-04T16:45	
FULL3	MGGN-2019-22	2019-09-05T16:15	
A11	MGML-2019-3	2019-09-09T11:30	The same site as MGGN-2019-23
A11	MGGN-2019-23	2019-09-06T11:55	The same site as MGML-2019-3

3. Participants

Scientific crew	Organistation	Contact details for data	Dataset
Laura Tuomi	Finnish Meteorological Institute (FMI)	firstname.lastname@fmi.fi	CTD, ADCP and Glider data
Harri Kankaanpää	Finnish Environment Institute (SYKE)	firstname.lastname@ymparisto.fi	Echo sounding data; H_2S and pH data
Joonas Virtasalo	Geological Survey of Finland (GTK)	firstname.lastname@gtk.fi	Sediment data
Kimmo Tikka	FMI		
Hedi Kanarik	FMI		
Elisa Lindgren	FMI		
Tuomo Roine	FMI		
Pekka Kosloff	FMI		
Okko Outinen	SYKE		
Jyrki Hämäläinen	GTK		
Satu Huurtomaa	GTK		

Appendix 1: List of stations visited during VIMMA 2019 cruise

IDX	Station	Latitude	Longitude	Depth	Date and time (UTC)
495	SLPNHP0	59°55.56'N	024°31.27'E	14	2019-08-28T10:02
496	SL_13_8	59°51.30'N	024°32.90'E	44	2019-08-28T10:53
497	SLX4	59°47.04'N	024°34.53'E	57	2019-08-28T11:52
498	SL_13_7	59°42.78'N	024°36.15'E	82	2019-08-28T12:46
499	SLHPPN45	59°38.52'N	024°37.78'E	47	2019-08-28T13:43
500	SLPN5	59°33.01'N	024°23.81'E	65	2019-08-28T15:03
501	SLPN4	59°37.01'N	024°22.31'E	84	2019-08-28T15:51
502	SLPN3	59°41.01'N	024°20.81'E	79	2019-08-28T16:33
503	SLPN2	59°45.01'N	024°19.31'E	46	2019-08-28T17:17
504	SLPN1	59°49.51'N	024°17.81'E	54	2019-08-28T18:03
505	SLPN0	59°53.01'N	024°16.31'E	30	2019-08-28T18:46
506	SLPN_1	59°57.00'N	024°15.01'E	33	2019-08-28T19:51
507	SLPNJP1	59°52.48'N	023°59.67'E	11	2019-08-28T21:12
508	SL_13_10	59°47.01'N	024°01.73'E	52	2019-08-28T22:05
509	SLX5	59°41.54'N	024°03.81'E	71	2019-08-28T23:02
510	SL_13_9	59°36.06'N	024°05.74'E	62	2019-08-28T23:55
511	SLJPPN5	59°30.58'N	024°07.76'E	89	2019-08-29T00:48
512	SLJP5	59°28.01'N	023°51.81'E	88	2019-08-29T02:02
513	SLJP4	59°32.01'N	023°50.31'E	83	2019-08-29T02:53
514	SLJP3	59°36.01'N	023°48.81'E	72	2019-08-29T03:47
515	SLJP2	59°40.01'N	023°47.31'E	70	2019-08-29T04:46
516	SLJP1B	59°44.01'N	023°45.81'E	45	2019-08-29T05:42
517	SLJP1A	59°48.01'N	023°44.31'E	45	2019-08-29T06:34
518	SLLOJP1	59°46.08'N	023°28.52'E	16	2019-08-29T07:49
519	SL_13_12	59°40.94'N	023°30.62'E	53	2019-08-29T08:47
520	SLX6	59°35.81'N	023°32.74'E	71	2019-08-29T09:41
521	SL_13_11	59°30.67'N	023°34.71'E	85	2019-08-29T10:36
522	SLJPLO5	59°25.53'N	023°36.78'E	90	2019-08-29T11:24
523	SLLO5	59°23.01'N	023°21.81'E	106	2019-08-29T12:33
524	SLLO4	59°27.01'N	023°18.81'E	98	2019-08-29T13:25
525	SLLO3	59°32.01'N	023°17.31'E	82	2019-08-29T14:14
526	SLLO2	59°36.01'N	023°15.81'E	68	2019-08-29T15:16
527	SLLO1	59°40.01'N	023°14.31'E	48	2019-08-29T16:00
528	SLLO_1	59°44.01'N	023°12.81'E	77	2019-08-29T16:55
529	SLBLO1	59°43.57'N	022°51.30'E	28	2019-08-29T18:38
530	SL_13_14	59°37.47'N	022°52.44'E	47	2019-08-29T19:33
531	SLX7	59°31.38'N	022°53.64'E	78	2019-08-29T20:30
532	SL_13_13	59°25.27'N	022°54.66'E	85	2019-08-29T21:25
533	SLBTLO6	59°19.17'N	022°55.69'E	120	2019-08-29T22:20
534	SLBT7	59°15.00'N	022°29.81'E	98	2019-08-29T23:59
535	UTÖ P	59°45.42'N	021°22.09'E	-9	2019-08-30T05:13
536	SLBT3	59°35.01'N	022°29.81'E	49	2019-08-30T12:47
537	SLBT4	59°30.00'N	022°29.81'E	55	2019-08-30T14:25
538	SLBT5	59°25.01'N	022°29.81'E	84	2019-08-30T15:16
539	SLBT6	59°20.00'N	022°29.81'E	102	2019-08-30T16:08
540	SLBT7	59°15.00'N	022°29.81'E	98	2019-08-30T17:05
541	SLVIMMA1	59°25.01'N	023°20.31'E	100	2019-08-30T20:11
542	SLLO4	59°27.01'N	023°18.81'E	98	2019-08-30T21:00
543	SLVIMMA2	59°29.51'N	023°18.06'E	88	2019-08-30T21:45
544	SLLO3	59°32.01'N	023°17.31'E	82	2019-08-30T22:27

545	SLVIMMA3	59°34.01'N	023°16.56'E	74	2019-08-30T23:06
546	SLLO2	59°36.01'N	023°15.81'E	68	2019-08-30T23:41
547	SLVIMMAC5	59°37.44'N	023°23.87'E	53	2019-08-31T00:30
548	SLVIMMAC6	59°35.55'N	023°24.65'E	69	2019-08-31T01:06
549	SLVIMMAC7	59°33.65'N	023°25.42'E	75	2019-08-31T01:48
550	JONTKA	59°31.87'N	023°29.38'E	121	2019-08-31T02:49
551	SLVIMMAC8	59°31.76'N	023°26.20'E	89	2019-08-31T03:51
552	SLVIMMAC9	59°29.87'N	023°26.98'E	89	2019-08-31T04:31
553	SLVIMMAC10	59°27.98'N	023°27.75'E	93	2019-08-31T05:14
554	SLVIMMAC11	59°26.09'N	023°28.53'E	96	2019-08-31T05:55
555	SLVIMMAD9	59°27.81'N	023°35.87'E	90	2019-08-31T06:50
556	SLVIMMAD8	59°30.10'N	023°34.95'E	85	2019-08-31T07:27
557	SLVIMMAD7	59°32.38'N	023°34.04'E	84	2019-08-31T08:03
558	SLVIMMAD6	59°34.66'N	023°33.12'E	80	2019-08-31T08:38
559	SLVIMMAD5	59°36.95'N	023°32.20'E	62	2019-08-31T09:12
560	SLVIMMAE5	59°38.04'N	023°39.92'E	63	2019-08-31T10:05
561	SLVIMMAE6	59°35.79'N	023°40.80'E	80	2019-08-31T10:40
562	SLVIMMAE7	59°33.54'N	023°41.67'E	75	2019-08-31T11:19
563	SLVIMMAE8	59°31.28'N	023°42.55'E	80	2019-08-31T11:57
564	SLVIMMAE9	59°29.03'N	023°43.42'E	83	2019-08-31T12:33
565	SLVIMMAE10	59°26.78'N	023°44.29'E	84	2019-08-31T13:08
566	JONTKA	59°31.87'N	023°29.38'E	121	2019-09-01T05:55
567	JONTKA	59°31.87'N	023°29.38'E	121	2019-09-01T06:42
568	VIMMA0	59°31.87'N	023°29.35'E	89	2019-09-01T10:02
569	VIMMA1	59°33.17'N	023°30.12'E	83	2019-09-01T11:57
570	FULL1	59°33.33'N	023°32.30'E	85	2019-09-01T14:40
571	JONTKA	59°31.87'N	023°29.38'E	121	2019-09-02T06:15
572	FULL2	59°32.02'N	023°29.20'E	84	2019-09-02T09:46
573	VIMMA3	59°32.31'N	023°29.77'E	84	2019-09-02T11:56
574	FULL4	59°32.34'N	023°29.64'E	-9	2019-09-02T13:32
575	VIMMA5	59°32.38'N	023°29.45'E	84	2019-09-02T18:01
576	VIMMA_ADCP2	59°33.52'N	023°30.36'E	92	2019-09-02T18:40
577	VIMMA_ADCP7	59°33.27'N	023°29.83'E	87	2019-09-02T19:40
578	VIMMA1	59°33.17'N	023°30.12'E	83	2019-09-02T20:55
579	JONTKA1	59°32.93'N	023°30.14'E	110	2019-09-02T22:02
580	FULL4B	59°32.43'N	023°30.09'E	85	2019-09-03T08:41
581	VIMMA3B	59°32.43'N	023°29.89'E	84	2019-09-03T12:32
582	VIMMA5	59°32.38'N	023°29.45'E	84	2019-09-03T14:21
583	JONTKA	59°31.87'N	023°29.38'E	121	2019-09-03T16:17
584	VIMMA3	59°32.31'N	023°29.77'E	84	2019-09-03T18:13
585	VIMMA3	59°32.31'N	023°29.77'E	84	2019-09-04T04:03
586	VIMMA5B	59°32.43'N	023°30.33'E	85	2019-09-04T05:01
587	VIMMA4B	59°32.43'N	023°30.22'E	85	2019-09-04T07:53
588	VIMMA6	59°32.43'N	023°29.25'E	84	2019-09-04T10:39
589	VIMMA_GAS	59°31.90'N	023°28.78'E	87	2019-09-04T13:13
590	JONTKA	59°31.87'N	023°29.38'E	121	2019-09-04T16:52
591	VIMMA2	59°32.74'N	023°30.04'E	85	2019-09-05T05:32
592	FULL3	59°33.58'N	023°30.14'E	83	2019-09-05T11:04
593	JONTKA	59°31.87'N	023°29.38'E	121	2019-09-05T15:40
594	A11	59°47.15'N	025°37.58'E	93	2019-09-05T15:40

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