

RV Langseth Data Reduction Summary

MGL2104

Cascadia Cruises MCS Survey

Leg 2

June 1st, 2021 – July 10th, 2021

V1.0, 2022-03-17

Lamont-Doherty Earth Observatory, Columbia University

Date	Julian Date	Time	Port
2021-06-01	152	0000 UTC	Newport, Oregon
2021-07-10	191	0000 UTC	Seattle, Washington

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Table of Contents

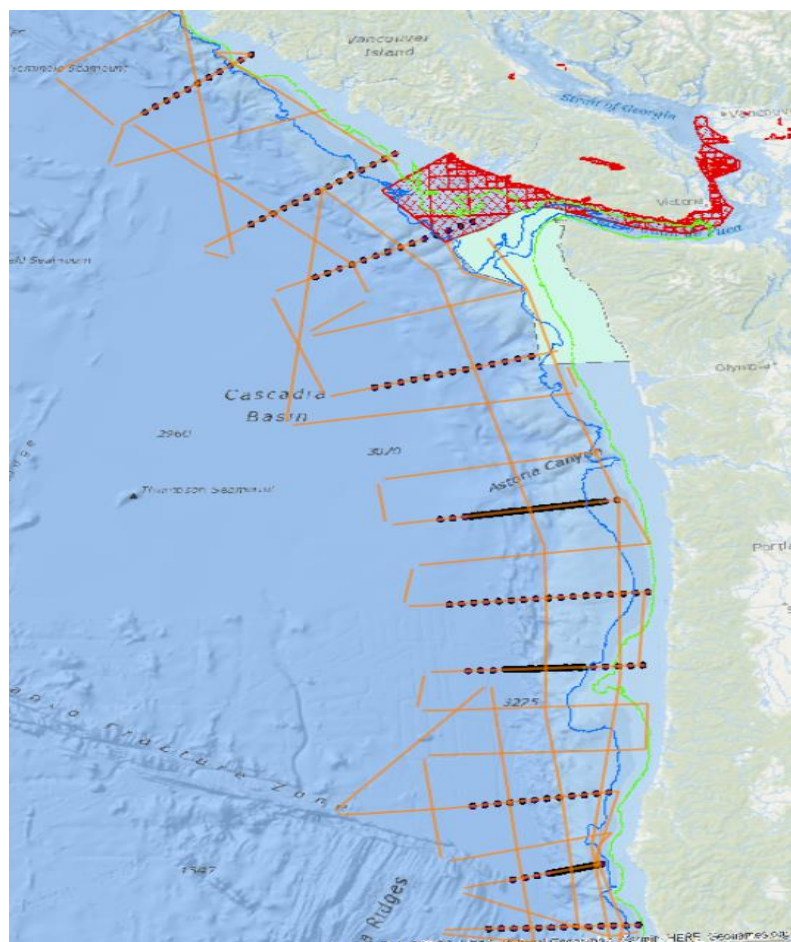
Table of Contents	4
I. Background and Scientific Objectives	4
II. Personnel	6
III. Instrumentation Summary	8
IV. Data Strings	9
V. Acquisition Parameter Table(s)	14
VI. RV Langseth Gravity Tie Information	18
VII. Archive Contents	18
VIII. Data Formats	19

I. Background and Scientific Objectives

The proposed study on the R/V Langseth (this SSP) consists of two Legs, one that would deploy 60 OBS and one that would use 2-D seismic surveying and OBSs and OBNs to investigate the Cascadia Subduction Zone and provide data necessary to illuminate the depth, geometry, and physical properties of the seismogenic portion and updip extent of the megathrust zone between the subducting Juan de Fuca plate and the overlying accretionary wedge/North American plate providing essential constraints for earthquake and tsunami hazard assessment in this heavily populated region of the Pacific Northwest. The portion of the megathrust targeted for this survey is the source region for great earthquakes that occurred at Cascadia in pre-historical times, comparable in size to the Tohoku M9 earthquake in 2011; an earthquake of similar size is possible at Cascadia within the next century. The proposed surveys would occur within ~42–51°N, ~124–130°W; representative survey tracklines are shown in Figure 1. As described further in this document, however, some deviation in actual track lines, including order of survey operations, could be necessary for reasons such as science drivers, poor data quality, inclement weather, or mechanical issues with the research vessel and/or equipment. Thus, the tracklines could occur anywhere within the coordinates noted above. The surveys are proposed to occur within the EEZs of the U.S. and Canada, as well as in U.S. state waters and Canadian Territorial Waters, ranging in depth 60–4400 m.

Leg 2 is scheduled for a total of 44 days with 4 total days of mob and demob and 40 days of seismic operations.

Leg 2 will depart Newport on June 1 and return to Seattle, WA on July 10th.



II. Personnel

#	Name	Position	Nationality + Passport #	DOB	Date Embark	Place Embark
1	Crum, Breckenridge C.	Master			15-May-21	Newport, OR
2	Osiadacz, Alexander E.	Chief Mate			18-May-21	Newport, OR
3	Caldwell, Neil J.	2nd Mate			1-May-21	Seattle, WA
4	McPherson, Gregory S.	2nd Mate			8-May-21	Seattle, WA
5	Redito, Ricardo M.	Bosun			15-May-21	Newport, OR
6	Robison, William J.	AB			15-May-21	Newport, OR
7	Otwell, Michael S	AB			18-May-21	Newport, OR
8	Rimando, Inocencio B.	AB			8-May-21	Seattle, WA
9	Crumady, Davin L.	OS			18-May-21	Newport, OR
10	Rillera De Guzman, Marcialleo	OS			8-May-21	Seattle, WA
11	Levine, Isaac D.	Ch Engr			15-May-21	Newport, OR
12	Quinlan, Michael P.	1st A/E			18-May-21	Newport, OR
13	Ivins, Dean T.	2nd A/E			18-May-21	Newport, OR
14	Baxter-Harwell, Winston G.	3rd A/E			18-May-21	Newport, OR
15	Florendo, Rodolfo A.	Oiler			23-Feb-21	Newport, OR
16	Hammond, Robert D.	Oiler			5-Feb-21	Newport, OR
17	Petchnaitip, Srawut	Oiler			15-May-21	Newport, OR
18	Kidder, Juanita R.	Steward			15-May-21	Newport, OR
19	Rios, Ricardo	Cook			8-May-21	Seattle, WA
20	Shaver, Shaun	Tech			15-May-21	Newport, OR
21	Spoto, Thomas	Tech			18-May-21	Newport, OR
22	Agee, Brian	Tech			15-May-21	Newport, OR
23	Thompson, Alan	Tech			15-May-21	Newport, OR
24	Bahlau, Cody	Tech			29-May-21	Newport, OR
25	Guerin, Gilles	Tech			29-May-21	Newport, OR
26	Greenberg, Jacob	Tech			29-May-21	Newport, OR
27	Coufal, Michael	Tech			29-May-21	Newport, OR
28	Hatten, Ray	Tech			29-May-21	Newport, OR
29	Walker, Mark	Tech			29-May-21	Newport, OR
30	Carbotte, Suzanne	Science			31-May-21	Newport, OR
31	Han, Shuoshuo	Science			31-May-21	Newport, OR
32	Boddupalli, Bhargav	Science			31-May-21	Newport, OR
33	Jian, Hanchao	Science			31-May-21	Newport, OR
34	Beeson, Jeffrey	Science			31-May-21	Newport, OR
35	Wright, Vanshan	Science			31-May-21	Newport, OR
36	Lee, Michelle	Science			31-May-21	Newport, OR
37	Lucas, Madeleine	Science			31-May-21	Newport, OR
38	Boston, Brian	Science			31-May-21	Newport, OR

39	Moser, Liam	Science			31-May-21	Newport, OR
40	Debuque, Amanda	PSO			31-May-21	Newport, OR
41	Frey, Cassandra	PSO			31-May-21	Newport, OR
42	De La Rosa, Leonardo	PSO			31-May-21	Newport, OR
43	Rodriguez, Felipe	PSO			31-May-21	Newport, OR
44	Brunett, Edgar	PSO			31-May-21	Newport, OR

III. Instrumentation Summary

All science instruments aboard the Langseth are listed below with data formats in section VI. Summary notes on operation during this cruise are listed below.

Instrument Data Files

Instrument	Description	Data Set	Data Outputs	Files	Interval
EM122	Kongsberg EM122 Multibeam Sonar	Full	Center beam data	MGL-bath02.*	variable
KNUDSEN	Knudsen Engineering 3260 Sub-bottom Profiler	Full	KEA, KEB, SEG-Y	See below	variable
DS80	Furuno DS80 Doppler Speedlog	Full	serial logs	MGL-slog01.*	1s
XBT/XCTD	Sippican MK21 XBT/XCTD Launcher	Not used	raw output to file	See below	n/a
TSG	SeaBird SBE45 Thermosalinograph	Full	raw serial logs	MGL-tsgraw.*	1s
CNAV	C&C Tech. CNAV 2000 DGPS Receiver	Full	serial logs	MGL-cnav.*	1s
CNAV3050	C&C Tech. CNAV 3050 DGPS Receiver	Full	raw serial logs	MGL-cnav3050all.*	1s
MAG01	GeoMetrics 882 Magnetometer	Not used	serial logs	MGL-mag01.*	1s
BGM	Bell Aerospace BGM-3 Gravimeter	Full	serial logs	MGL-vc01.*	1s
GYRO	Simrad GC80 Gyrocompass/AD100	Full	serial logs	MGL-gy01.*	1s
POSMV	POSMV Integrated Nav	Full	serial logs	MGL-posmv*	1s
SEAPATH	Kongsberg SeaPath Integrated Nav System	Full	serial logs	MGL-seapath.*	1s
MICROSV	Applied Microsystems Sound Velocity USS Unit	Full	serial logs	MGL-svuss01.*	1s
ADCP	RDI OS75 Current Profiler	Full	serial logs	MGL-adcp.*	N/A
Vaisala	Vaisala WXT-520 Ultrasonic Weather Station	Full	serial logs	MGL-vaisala1.*	1s
Vaisala	Vaisala WXT-520 Ultrasonic Weather Station	Full	serial logs	MGL-vaisala2.*	1s

All timestamps in this report are presented using UTC time and day of year in order to avoid confusion with local time changes.

IV. Data Strings

EM-122 Multibeam

EM122 swath data is saved to the cruise archive under MGL2104/raw/multibeam. Center beam depth is recorded separately to serial log. A daily built in self test (BIST) is done on the EM122 at which time logging of data is secured. Data gaps are approximately 8-12 minutes in duration, and every effort is made to schedule them during turns or areas where coverage already exists. See MGL2104/docs/elog for times and durations of tests.

File id: bath02

Logging interval: variable with water depth

bath02 data format:

```
bath02      2008:192:00:00:12.6663  $KIDPT,2938.25,0.0,12000.0*4a
bath02      2008:192:00:00:30.3301  $KIDPT,2954.08,0.0,12000.0*4f
```

Knudsen Engineering 3260 Sub-bottom Profiler

The Knudsen 3260 is a chirp echosounder/sub-bottom profiler.

File id: n/a

Logging interval: Variable with water depth

The Knudsen 3260 is a chirp echosounder/sub-bottom profiler. It was operated only in permitted areas for the length of the cruise. Data written in proprietary KEB, KEA, and SEG Y format. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

DS80 Speedlog

The Furuno DS-80 is a Doppler speed log. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: slog01

Logging interval: 1 second

slog01 data format:

```
slog01      2008:231:00:00:00.1906  $VDVBW,009.68,000.09,A,009.68,000.09,V*46
slog01      2008:231:00:00:00.1908  $VDVLW,0005960.30,N,0005960.30,N*5F
```

CNAV2000

The C-NAV is a global satellite-based differential receiver. This was used as a secondary GPS system on the ship. This system was operational during the cruise. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: cnav

Logging interval: 1 second

cnav data format:

```
cnav 2008:231:00:00:00.6936
$GPGGA,000000.00,1434.94372,N,10444.85748,W,2,8,1.1,15.52,M,-20.60,M,9.0108*65
cnav 2008:231:00:00:00.7137 $GPVTG,006.5,T,,M,9.64,N,17.85,K*53
```

CNAV3050

The C-NAV 3050 is a global satellite-based differential receiver. This is the best individual receiver currently on the ship. This system was operational during the cruise. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: cnav3050all

Logging interval: 1 second

cnav3050 data format:

```
cnav3050all 2020:284:00:00:00.9338
$GNGGA,000000.00,5408.8791,N,16627.4934,W,2,18,0.7,36.5,M,0.0,M,6.0,0678*4C
cnav3050all 2020:284:00:00:00.9916
$PNCTGGA,000000.00,5408.879124,N,16627.493375,W,2,18,0.7,36.484,M,0.000,M,6.0
,0436*4A
cnav3050all 2020:284:00:00:00.9917
$GNGLL,5408.879124,N,16627.493375,W,000000.00,A,D*63
cnav3050all 2020:284:00:00:01.0520 $GNVTG,355.3,T,,M,9.03,N,16.72,K,P*3A
cnav3050all 2020:284:00:00:01.0521 $GNZDA,000000.00,10,10,2020,00,00*78
cnav3050all 2020:284:00:00:01.1085
$GNGSA,A,3,01,03,04,06,09,17,19,22,25,31,,,1.5,0.7,1.3,1*32
cnav3050all 2020:284:00:00:01.1086
$GNGSA,A,3,65,66,67,74,75,81,82,88,,,,,1.5,0.7,1.3,2*33
```

GC80 Gyrocompass

The GC80 gyrocompass is installed on the bridge and used for ship and seismic navigation. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: gy01

Logging interval: 1 second

gy01 data format:

```
gy01 2008:231:00:00:00.4110 $PTKM,HEALM,0000,0,G1*09
gy01 2008:231:00:00:00.6395 $HEHDT,005.8,T*22
gy01 2008:231:00:00:00.6396 $HEROT,-005.25,A*34
gy01 2008:231:00:00:01.6394 $HEHDT,005.7,T*2D
gy01 2008:231:00:00:01.6395 $HEROT,-004.53,A*34
```

POSMV 320

The POS/MV is a receiver that uses CNAV input in addition to its own antennae, an inertial sensor and optional RTG, WTC, or WAAS corrections and a Kalman filter to produce a smooth navigation output

and very accurate heading. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: posmv

Logging interval: 1 second

posmv data format:

```
posmv 2008:231:00:00:00.0885
      $INGGA,235959.842,1434.95002,N,10444.85734,W,2,,1.1,12.71,M,,9.0,0108*2E
posmv 2008:231:00:00:00.0889 $INHDT,15.0,T*11
posmv 2008:231:00:00:00.2047 $INVTG,7.0,T,,M,9.7,N,17.9,K*46
posmv 2008:231:00:00:00.3208 $INGST,235959.842,,0.9,0.9,0.0,0.9,0.9,2.5*51
posmv 2008:231:00:00:00.4411 $PASHR,235959.842,15.05,T,-
0.58,0.48,0.15,0.069,0.069,0.045,2,0*05
posmv 2008:231:00:00:00.4412 $INZDA,235959.0000,17,08,2008,,*73
```

SeaPath 330

The Kongsberg Seapath is an inertial navigation system. Operational for the duration of the cruise. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: seapath

Logging interval: 1 second

seapath data format:

```
seapath 2020:283:00:00:00.4225
      $INGGA,000000.18,5354.327837,N,16631.306673,W,2,08,1.0,9.98,M,9.48,M,2.0,0291
*7F
seapath 2020:283:00:00:00.6563
      $INGLL,5354.327837,N,16631.306673,W,000000.18,A,D*6E
seapath 2020:283:00:00:00.6564 $INVTG,307.97,T,299.43,M,0.0,N,0.0,K,D*39
seapath 2020:283:00:00:00.6565 $INHDT,232.73,T*12
seapath 2020:283:00:00:00.6566 $PSXN,20,0,0,0,0*3B
seapath 2020:283:00:00:00.7294 $PSXN,23,0.03,0.83,232.73,0.01*36
```

Geometrics 882 Magnetometer - Not in use on MGL2104

The Geometrics 882 magnetometer is towed behind the ship. Raw serial output is logged using LDS. Deployment is dependent upon seismic operations. Data collected only when Magnetometer is deployed. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

Logging interval: 1 second

File id: mag01

mag01 data sample:

```
mag01 2015:329:00:00:01.2776 $ 45499.940,0881,0691
mag01 2015:329:00:00:01.3735 $ 45500.167,0879,0691
mag01 2015:329:00:00:01.4695 $ 45499.940,0874,0691
```

SBE-45 Thermosalinograph

The Seabird TSG output is logged by LDS to the “tsgraw” set. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: tsgraw

Logging interval: 1 second

tsgraw data sample:

```
tsgraw      2015:337:00:01:15.3000  t1= 18.9500, c1= 5.17155, s= 39.1095,  
sv=1522.706, t2= 18.7851  
tsgraw      2015:337:00:01:25.3004  t1= 18.9526, c1= 5.17196, s= 39.1105,  
sv=1522.715, t2= 18.7878  
tsgraw      2015:337:00:01:35.3018  t1= 18.9539, c1= 5.17219, s= 39.1113,  
sv=1522.720, t2= 18.7892
```

BGM-3 Gravimeter

The Bell Aerospace BGM-3 Gravimeter operated normally during the length of this cruise. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: vc01

Logging interval: 1 second

vc01 data format:

```
vc01  2011:130:00:00:08.2866  01:024436  00  
vc01  2011:130:00:00:09.2926  01:024548  00
```

AML Oceanographic – Micro-X SV-Xchange sensor Unit

Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: svuss01

Logging interval: 1 second

svuss01 data format:

```
svuss01      2015:338:00:00:15.1382      1521.897  
svuss01      2015:338:00:00:16.1282      1521.900
```

Mk21 XBT System - Not in use on MGL2104

Files: *.RDF,*.EDF

No XBT drops were made during the cruise. Refer to the MGL2104 Expendable Drops.xls spreadsheet in the docs/operations directory of the cruise archive for more information.

Vaisala Meteorological Ultrasonic Integrated Weather

The weather station is used to log wind speed, direction, air temperature, relative humidity, precipitation, dew point, and barometric pressure. The unit was functioning during the cruise. Reference MGL2104/docs/elog for information on any data gaps or degraded operation.

File id: vaisala1

Logging interval: 1 second

vaisala data format:

```
vaisala      2015:346:00:00:00.0038 $WIMWV,129,R,15.7,N,A*04
vaisala      2015:346:00:00:00.9930 $WIXDR,A,125,D,0,A,129,D,1,A,134,D,2,S,15.3,N
,0,S,15.7,N,1,S,16.5,N,2,C,14.2,C,0,C,14.4,C,1,H,52.9,P,0,P,1018.3,H,0,V,0.00,M,0,Z
,0,s,0,R,0.0,M,0,V,0.0,M,1,Z,0,s,1,R,0.0,M,1,R,66.5,M,2,R,0.0,M,3*6D
```

File id: vaisala2

Logging interval: 1 second

vaisala data format:

```
vaisala      2015:346:00:00:00.0038 $WIMWV,129,R,15.7,N,A*04
vaisala      2015:346:00:00:00.9930 $WIXDR,A,125,D,0,A,129,D,1,A,134,D,2,S,15.3,N
,0,S,15.7,N,1,S,16.5,N,2,C,14.2,C,0,C,14.4,C,1,H,52.9,P,0,P,1018.3,H,0,V,0.00,M,0,Z
,0,s,0,R,0.0,M,0,V,0.0,M,1,Z,0,s,1,R,0.0,M,1,R,66.5,M,2,R,0.0,M,3*6D
```

Offsets

All antenna and in-water offset drawings are in the file *MGL2104_Offsets_MCS_Line.xls* and *MGL2104_Offsets_Source_Only*.

Spectra

Spectra was used for all timing and navigation during the cruise. Spectra generated UKOOA P294 and P190 files for the MCS line acquired.

SeisPos

SeisPos is used for post processing of Spectra UKOOA P294 files to produce UKOOA P190 files with improved positioning.

V. Acquisition Parameter Table(s)

Acquisition Parameter Table 1	
FieldActivityID	MGL2104
Acquisition_sequence(s)	Seq 1 - 11
ReceiverType	MCS/OBS
SourceType	Airgun
Acquisition System Name	Sercel Seal 408
Acquisition System Type	MCS
Seismic_Nav_System	C-Nav 3050 primary
Survey_datum	WGS84
Navigation Reference Point (primary GPS antenna)	Fore/Aft+29.5 m, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 330 calculated center of gravity) waterline
Antenna(NRP)_to_source	230 m
Source_to_Near_Channel	190 m
Number_of_channels_recorded	1200
Number_of_cables	1
Number_of_channels_each_cable	1200
Channel_length	12.5 m
Cable_length	15 k
Cable_spacing	Applicable to multi-streamer MCS only
Near_Channel_Number	1
Cable_depth	12
Number_sources	1
Sub-arrays_per_source	2 – refer to logs for sub-arrays in use
Flipflop_shooting (dual source alternating)	False
Source_separation	Applicable to flipflop (dual source alternating) only
Sub-array_separation	6.0 m
Source_volume	6600 cubic inches
Source_pressure	2000 psi nominal
Source_make,model	Bolt 1500LL & 1900LL
Source_element_number	36 + 4 spare
Source_depth	12 m
Shot_control	Distance
Shot_Interval	37.5 m
Sample_interval	2 ms
Record_length	15 s
Compass_birds	45
Recording_delay	False
Active_tail_buoy	Yes
Multiple_ships	False

Acquisition Parameter Table 2	
FieldActivityID	MGL2104
Acquisition_sequence(s)	Seq 12-34, and 42-50.
ReceiverType	MCS/OBS
SourceType	Airgun
Acquisition System Name	Sercel Seal 408
Acquisition System Type	MCS
Seismic_Nav_System	C-Nav 3050 primary
Survey_datum	WGS84
Navigation Reference Point (primary GPS antenna)	Fore/Aft+29.5 m, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 330 calculated center of gravity) waterline
Antenna(NRP)_to_source	230 m
Source_to_Near_Channel	190
Number_of_channels_recorded	960
Number_of_cables	1
Number_of_channels_each_cable	960
Channel_length	12.5 m
Cable_length	12 k
Cable_spacing	Applicable to multi-streamer MCS only
Near_Channel_Number	1
Cable_depth	12
Number_sources	1
Sub-arrays_per_source	4 (except where noted in \processed\obsip*_source.xls files)
Flipflop_shooting (dual source alternating)	False
Source_separation	Applicable to flipflop (dual source alternating) only
Sub-array_separation	12 m
Source_volume	6600 cubic inches (except where noted \processed\obsip*_source.xls)
Source_pressure	2000 psi nominal
Source_make,model	Bolt 1500LL & 1900LL
Source_element_number	36 + 4 spare
Source_depth	12 m
Shot_control	Distance
Shot_Interval	37.5 m
Sample_interval	2 ms
Record_length	15 s
Compass_birds	45
Recording_delay	False
Active_tail_buoy	False
Multiple_ships	False

Acquisition Parameter Table 3

FieldActivityID	MGL2104
Acquisition_sequence(s)	Seq 35
ReceiverType	MCS/OBS
SourceType	Airgun
Acquisition System Name	Sercel Seal 408
Acquisition System Type	MCS
Seismic_Nav_System	C-Nav 3050 primary
Survey_datum	WGS84
Navigation Reference Point (primary GPS antenna)	Fore/Aft+29.5 m, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 330 calculated center of gravity) waterline
Antenna(NRP)_to_source	230 m
Source_to_Near_Channel	190
Number_of_channels_recorded	960
Number_of_cables	1
Number_of_channels_each_cable	960
Channel_length	12.5 m
Cable_length	12 k
Cable_spacing	Applicable to multi-streamer MCS only
Near_Channel_Number	1
Cable_depth	13 m
Number_sources	1
Sub-arrays_per_source	3
Flipflop_shooting (dual source alternating)	False
Source_separation	Applicable to flipflop (dual source alternating) only
Sub-array_separation	6.0 m
Source_volume	4950 cubic inches
Source_pressure	2000 psi nominal
Source_make,model	Bolt 1500LL & 1900LL
Source_element_number	27 + 3 spare
Source_depth	12 m
Shot_control	Distance
Shot_Interval	37.5 m
Sample_interval	2 ms
Record_length	14 s
Compass_birds	45
Recording_delay	False
Active_tail_buoy	False
Multiple_ships	False

Acquisition Parameter Table 4

FieldActivityID	MGL2104
Acquisition_sequence(s)	Seq 36-41
ReceiverType	MCS/OBS
SourceType	Airgun
Acquisition System Name	Sercel Seal 408
Acquisition System Type	MCS
Seismic_Nav_System	C-Nav 3050 primary
Survey_datum	WGS84
Navigation Reference Point (primary GPS antenna)	Fore/Aft+29.5 m, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 330 calculated center of gravity) waterline
Antenna(NRP)_to_source	230 m
Source_to_Near_Channel	190
Number_of_channels_recorded	960
Number_of_cables	1
Number_of_channels_each_cable	960
Channel_length	12.5 m
Cable_length	12 k
Cable_spacing	Applicable to multi-streamer MCS only
Near_Channel_Number	1
Cable_depth	13
Number_sources	1
Sub-arrays_per_source	4
Flipflop_shooting (dual source alternating)	False
Source_separation	Applicable to flipflop (dual source alternating) only
Sub-array_separation	6.0 m
Source_volume	6600 cubic inches
Source_pressure	2000 psi nominal
Source_make,model	Bolt 1500LL & 1900LL
Source_element_number	36 + 4 spare
Source_depth	12 m
Shot_control	Distance
Shot_Interval	37.5 m
Sample_interval	2 ms
Record_length	15 s
Compass_birds	45
Recording_delay	False
Active_tail_buoy	False
Multiple_ships	False

VI. RV Langseth Gravity Tie Information

Please refer to the documents located under MGL2104/docs/gravity_tie for detailed records.

VII. Archive Contents

Key files are bolded.

MGL2104/docs	Cruise documents and logs
MGL2104/docs/elog	Cruise elog
MGL2104/docs/gravity_tie	Gravity Tie information
MGL2104/docs/map	Cruise maps, track map
MGL2104/docs/offsets	Vessel/sensor offsets
MGL2104/docs/operations/	Operations documents
MGL2104/docs/operations/Daily_Reports	Cruise Daily Reports from Chief Science Officer
MGL2104/docs/operations/NavLogs	Seismic navigation logs (spectra)
MGL2104/docs/operations/ObsLogs	Seismic acquisition logs (gun controller)
MGL2104/docs/operations/MGL2104_B15_line_log_multi_channel_seismics.xls	Master line log table
MGL2104/docs/permits	Clearance Documents
MGL2104/docs/waypoints	Waypoint files
MGL2104/docs/personnel	Personnel rosters, org chart, bunk and phone lists
MGL2104/docs/reports/MGL2104_DataReport_v1.0.doc	This file
MGL2104/docs/offsets/MGL2104_Offsets_MCS.xls	Vessel/sensor offsets
MGL2104/processed	Processed data
MGL2104/processed/reflex (3D data-sets only, not applicable to OBS and 2D)	Spectra reflex files
MGL2104/processed/obsip	Shot log files & Source vol
MGL2104/processed/seispos	Sprint UKOOA P190s
MGL2104/processed/svp	Sound velocity profiles
MGL2104/raw	Raw data
MGL2104/raw/adcp	Raw ADCP data
MGL2104/raw/knudsen	Raw Knudsen sub-bottom profiler data
MGL2104/raw/MarkeyWinch	DESH-5 Winch Tension / Payout data files
MGL2104/raw/multibeam	Raw EM122 data
MGL2104/raw/serial	Underway serial data: gps, tsg, weather, etc.
MGL2104/raw/spectra/P1	Spectra underway p190
MGL2104/raw/spectra/P2	Raw seismic navigation, p294
MGL2104/raw/XBT	Raw XBT data

VIII. Data Formats

Gravimeter data

The gravimeter serial data is output in the following format:

01:025610 01

01:xxxxxx ff

Item	Definition	Units
01	output frequency	Hz
xxxxxx	raw counts	n/a
ff	sensor status	n/a

CNAV GPS receiver data

CNAV outputs data in NMEA 0183 compatible format. Currently* the following sentence types are enabled:

\$GPVTG-GPS Velocity, Track made good and Ground speed data (computed by the CNAV GPS receiver).

\$GPGGA-Global Positioning System Fix data (computed by the CNAV GPS receiver).

*Note: there are other sentence types available from CNAV. Please consult the software manual for more options.

\$GPVTG, xxx.x, T, M, m.mm, N, n.nn, K*hh

\$GPVTG Sentence Fields

Item	Definition	Units
xxx.x	Course over ground (COG)	Degrees from True North
T	Indicates course relative to True North	n/a
M	COG	Degrees from Magnetic North
m.mm	Speed over ground (SOG)	Nautical miles per hour (knots)
N	Indicates that the speed over ground is in knots	n/a
n.nn	SOG	km/h
K	Indicates that the SOG is in km/h	n/a
*hh	Checksum (hexadecimal representation)	n/a

\$GPGGA,hhmmss.ss, dddm.mmmmm, a, dddm.mmmmm, a, x, xx, x.x, xx.xx, M, xx.xx, M, x.x, xyy*hh

\$GPGGA Sentence Fields

Item	Definition	Units
hhmmss.ss	UTC time of position	Hours/Minutes/Seconds.decimal.

ddmm.mmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude N = North S = South	n/a
ddmm.mmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude E = East W = West	n/a
x	GPS Quality indicator 0 = fix not valid 1 = GPS Autonomous fix 2 = GcGPS Corrected Fix	n/a
xx	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision (HDOP)	n/a
xx.xx	C-NAV GPS receiver antenna altitude reference to Mean Sea Level (MSL)	n/a
M	Altitude units--M indicates meters	n/a
xx.xx	WGS-84 Geoidal separation distance from MSL based on the NIMA/NASA EGM96 15- minute (Earth Gravity Model)	Meters
M	Geosoidal separation units--M indicates meters	n/a
x.x	Age of GcGPS corrections used in solution fix	n/a
xyy	C-NAV GPS receiver reference identification	x is downlink satellite communication beam in use yy is the GPS correction signal mode/type being used
*hh	Checksum (hexadecimal representation) followed by CRLF terminator pair	n/a

CNAV 3050 GPS receiver data

CNAV 3050 outputs data in NMEA 0183 compatible format. Currently* the following sentence types are enabled:

\$GPVTG-GPS Velocity, Track made good and Ground speed data (computed by the CNAV GPS receiver).

\$GPGGA-Global Positioning System Fix data (computed by the CNAV GPS receiver).

*Note: there are other sentence types available from CNAV. Please consult the software manual for more options.

\$GPVTG, xxx.x, T,, M, m.mm, N, n.nn, K*hh

\$GPVTG Sentence Fields

Item	Definition	Units
xxx.x	Course over ground (COG)	Degrees from True North
T	Indicates course relative to True North	n/a
M	COG	Degrees from Magnetic North
m.mm	Speed over ground (SOG)	Nautical miles per hour (knots)
N	Indicates that the speed over ground is in knots	n/a
n.nn	SOG	km/h
K	Indicates that the SOG is in km/h	n/a
*hh	Checksum (hexadecimal representation)	n/a

\$GPGGA,hhmmss.ss, ddmm.mmmmm, a, ddmm.mmmmm, a, x, xx, x.x, xx.xx, M, xx.xx, M, x.x, xyy*hh

\$GPGGA Sentence Fields

Item	Definition	Units
hhmmss.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude N = North S = South	n/a
ddmm.mmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude E = East W = West	n/a
x	GPS Quality indicator 0 = fix not valid 1 = GPS Autonomous fix 2 = GcGPS Corrected Fix	n/a
xx	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision (HDOP)	n/a
xx.xx	C-NAV GPS receiver antenna altitude reference to Mean Sea Level (MSL)	n/a
M	Altitude units--M indicates meters	n/a
xx.xx	WGS-84 Geoidal separation distance from MSL based on the NIMA/NASA EGM96 15-minute (Earth Gravity Model)	Meters
M	Geosoidal separation units--M indicates meters	n/a
x.x	Age of GcGPS corrections used in solution fix	n/a
xyy	C-NAV GPS receiver reference identification	x is downlink satellite communication beam in use yy is the GPS correction signal mode/type being used
*hh	Checksum (hexadecimal representation) followed by CRLF terminator pair	n/a

EM122 Center Beam Depth

This page describes the EM122 centerbeam depth serial output, used for real-time depth display. For full multibeam data, please see the [multibeam](#) page.

The EM122 outputs serial data in the following formats:

KIDPT - Depth below transducer

\$KIDBT,x.x,x.x,x.x,*hh

SDDBT sentence format

Item	Definition	Units
x.x	Water depth	feet
x.x	Water depth	meters
x.x	Water depth	fathoms
*hh	Checksum	n/a

Gyroscope data

The gyroscope serial data is output in the following sentence formats:

PTKM,HEALM -- Unspecified

HEHDT -- Heading - True

HEROT -- Rate Of Turn

\$PCICM,HEALM,xxxx,x,xx*hh

ALM sentence format

Item	Definition	Units
xxxx	unspecified	n/a
x	unspecified	n/a
*hh	unspecified	n/a

\$HEHDT,xxx.x,T*hh

HDT sentence format

Item	Definition	Units
xxx.x	Heading true	degrees
T	T = true	n/a
*hh	Checksum	n/a

\$HEROT,-xxx.x,A*hh

HEROT sentence format

Item	Definition	Units
xxxx.x	Rate of turn	Degrees per minute, Note: "-" means bow turns to port
A	A = data valid	n/a
*hh	Checksum	n/a

Geometrics 882 Magnetometer Data

The magnetometer serial data is output in the following format:

\$ 53863.927,0652

\$ xxxxx.xxx,vvvv

Item	Definition	Units
xxxxx.xxx	Magnetic field intensity	nT
vvvv	Reserved for future use	n/a

OBSIP Shotlog Format

Each OBSIP shotlog contains a header followed by shot records:

#obsipshotfile v1.0

```
#shotnumber date time sourceLat sourceLon shipLat shipLon waterDepth sciTag
0001280 2009-08-27 05:08:49.807873 48.495334 -129.201444 48.494097 -129.203017 2530.6
MGL0910_05
0001279 2009-08-27 05:12:33.961869 48.491860 -129.204474 48.490060 -129.205425 2526.4
MGL0910_05
0001278 2009-08-27 05:16:36.302883 48.488608 -129.206115 48.486807 -129.206944 2530.3
MGL0910_05
0001277 2009-08-27 05:19:51.053880 48.485157 -129.209212 48.483406 -129.209755 2526.1
MGL0910_05
0001276 2009-08-27 05:24:01.863875 48.480813 -129.212118 48.479293 -129.213152 2516.1
MGL0910_05
```

Shot records are in the following format:

```
0001276 2009-08-27 05:24:01.863875 48.480813 -129.212118 48.479293 -129.213152 2516.1
MGL0910_05
```

```
sssssss yyyy-mm-dd hh:mm:ss.ssssss xx.xxxxxx yy.yyyyyy vv.vvvvvv www.wwwwww dddd.d
llllllllllllll
```

OBSIP record format

Item	Definition	Units
sssssss	shot number	n/a
yyyy-mm-dd	date	ISO8601 format
hh:mm:ss.ssssss	time	ISO8601 format
xx.xxxxxx	source lat	degrees, WGS84
yy.yyyyyy	source lon	degrees, WGS84
vv.vvvvvv	vessel lat	degrees, WGS84
ww.wwwwww	vessel lon	degrees, WGS84
dddd.d	depth	meters
llllllllllllll	linename	n/a

POS/MV Position and Orientation System for Marine Vessels

POS/MV outputs data using the NMEA 0183 format at rates of up to fifty sentences per second. The following seven different sentence formats are available.

1. \$INGGA-Global System Position Fix Data
2. \$INHDT-Heading - True data
3. \$INVTG-Course over ground and Ground speed data
4. \$INGST-GPS pseudorange noise statistics
6. \$PRDID-Attitude data
7. \$INZDA-Time and date

\$INGGA, hhmmss.sss, llll.llll, a, yyyy.yyyyy, b, t, nn, v.v, x.x, M,,,c.c,rrrr*hh

\$INGGA-Global System Position Fix Data

Item	Definition	Value	Units
\$INGGA	Header	\$INGGA	
hhmmss.sss	UTC time of position	n/a	Hours/Minutes/Seconds.decimal. Two fixed digits of hours. Two fixed digits of minutes. Two fixed digits of seconds. Three digits for decimal fractions of a second.
llll.llll	Latitude	-90 to +90	Degrees/Minutes.decimal. Two fixed digits of degrees Two fixed digits of minutes Five digits for decimal minutes.
a	N (north) or S (south)	N or S	
yyyyy.yyyyy	Longitude	-180 to +180	Degrees/Minutes.decimal. Three fixed digits of degrees. Two fixed digits of minutes. Five digits for decimal minutes.
b	E (east) or W (west)	E or W	
t	GPS Quality Indicator	0 = Fix not available or invalid 1 = CIA standard GPS; fix valid. 2 = DGS mode; fix valid. 3 = PPP mode; fix valid. 4 = RTK fixed 5 = RTK float 6 = free inertial	
nn	Number of satellites used in fix	0 to 32	
v.v	Horizontal dilution of precision		
x.x	Altitude of the IMU above or below the mean sea level. A negative value indicates below sea level.	n/a	Metres

M	Units of measure = metres	M	
Null	Null		
Null	Null		
c.c	Age of differential corrections in records since last RTCM-104 message.	0 to 99.9	Seconds
rrr	DGPS reference station identity	0000 to 1023	
*hh	Checksum	00 - FF	
/CR/LF	Carriage return and line feed	/CR/LF	

Note that, in the case of the HDOP, IMU altitude and age of differential connections, POS/MV adds leading digits as required (i.e. if the value exceeds 9.9). Also, note that commas separate all items, including null fields. The information is valid at the location of the vessel frame.

\$INHDT, x.x, T*hh

\$INHDT-Heading - True data

Item	Definition	Value	Units
\$INHDT	Header	\$INHDT	
x.x	True vessel heading in the vessel frame	0 to 359.99	degrees
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

\$INVTG, x.x, T,, M, n.n, N, k.k, K*hh

\$INVTG-Course over ground and Ground speed data

Item	Definition	Value	Units
%INVTG	Header	\$INVTG	
x.x	True vessel track in the vessel frame	0 to 359.99	degrees
T	True	T	
null	Not supported	null	
M		M	
n.n	Speed in the vessel frame	n/a	Knots
N	Knots	N	
k.k	Kilometres	K	
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

Note that, in the case of the track and the speed fields, POS/MV adds the leading digits as required (i.e. if the value exceeds 9.9). Also, note that commas separate all items in the including null fields.

\$INGST, hhmmss,sss,,smjr.smjr,smnr.smnr, o.o, l.l, y.y, a.a *hh

\$INGST-GPS pseudorange noise statistics

Item	Definition	Value	Units
\$INGST	Header	\$INGST	
hhmmss.sss	UTC time of position	n/a	Hours/Minutes/Seconds.decimal. 2 fixed digits of hours. 2 fixed digits of minutes. 2 fixed digits of seconds. Three digits for decimal fractions of a second.
null	Not supported	null	
smjr.smjr	Standard Deviation of semi-major axis of error ellipse	n/a	Metres
smnr.smnr	Standard deviation of semi-minor axis of error ellipse	n/a	Metres
o.o	Orientaion of semi-major axis ellipse	0 to 359.9	Degrees from true north
l.l	Standard deviation of latitude	n/a	Metres
y.y	Standard deviation of longitude	n/a	Metres
a.a	Standard deviation of Altitude	n/a	Metres
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

Note that, in the case of all fields POS/MV adds leading digits as required (i.e. if the value exceeds 9.9).

Also, note that commas separate all items, including null fields. The information is valid at the location of the vessel frame.

Note that commas separate all items

Two attitude data strings are available. The strings are identical except for the definition of roll and pitch angles. One string uses Tate-Bryant angles and the other uses TSS angles. Use the POS/MV Controller program to set the required angle convention.

\$PRDID, PPP.PP, RRR.RR, xxx.xx*hh

\$PRDID-Attitude data

Item	Definition	Value	Units
\$PRDID	Header	\$PRDID	
PPP.PP	Pitch	-90.00 to +90.00	Degrees
RRR.RR	Roll	-90.00 to +90.00	Degrees
xxx.xx	Sensor heading	0 to 359.99	Degrees
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

Note that commas separate all items

Two attitude data strings are available. The strings are identical except for the definition of roll and pitch angles. One string uses Tate-Bryant angles and the other uses TSS angles. Use the POS/MV Controller program to set the required angle convention.

\$INZDA, hhmmss.ss, DD, MM, YYYY,, *hh

\$INZDA-Time and date

Item	Definition	Value	Units
\$INZDA	Header	\$INZDA	

hhmmss.sss	UTC time	n/a	Hours/Minutes/Seconds.decimal. 2 fixed digits of hours 2 fixed digits of minutes 2 fixed digits of seconds Three digits for decimal fractions of a second
DD	Day of month	01 to 31	
MM	Month of year	01 to 12	
YYYY	Year		
Null	Null		
Null	Null		
*hh	Checksum	n/a	/CR/LF

SEAPATH 330 Inertial Navigation System

SEAPATH outputs data in NMEA format using the following sentence formats:

1. \$INGGA-Global System Position Fix Data
2. \$INHDT-Heading - True data
3. \$INVTG-Course over ground and Ground speed data
4. \$INZDA-Time and date

\$INGGA, hhmmss.sss, llll.llll, a, yyyy.yyyy, b, t, nn, v.v, x.x, M,,c.c,rrrr*hh

\$INGGA-Global System Position Fix Data

Item	Definition	Value	Units
\$INGGA	Header	\$INGGA	
hhmmss.sss	UTC time of position	n/a	Hours/Minutes/Seconds.decimal. Two fixed digits of hours. Two fixed digits of minutes. Two fixed digits of seconds. Three digits for decimal fractions of a second.
llll.llll	Latitude	-90 to +90	Degrees Minutes.decimal. Two fixed digits of degrees Two fixed digits of minutes Five digits for decimal minutes.
a	N (north) or S (south)	N or S	
yyyyy.yyyyy	Longitude	-180 to +180	Degrees/Minutes.decimal. Three fixed digits of degrees. Two fixed digits of minutes. Five digits for decimal minutes.
b	E (east) or W (west)	E or W	
t	GPS Quality Indicator	0 = Fix not available or invalid 1 = CIA standard GPS; fix valid. 2 = DGS mode; fix valid. 3 = PPP mode; fix valid. 4 = RTK fixed 5 = RTK float 6 = free inertial	
nn	Number of satellites used in	0 to 32	

	fix		
V.V	Horizontal dilution of precision		
X.X	Altitude of the IMU above or below the mean sea level. A negative value indicates below sea level.	n/a	Metres
M	Units of measure = metres	M	
Null	Null		
Null	Null		
C.C	Age of differential corrections in records since last RTCM-104 message.	0 to 99.9	Seconds
rrr	DGPS reference station identity	0000 to 1023	
*hh	Checksum		
/CR/LF	Carriage return and line feed	/CR/LF	

\$INHDT, x.x, T*hh

\$INHDT-Heading - True data

Item	Definition	Value	Units
\$INHDT	Header	\$INHDT	
x.x	True vessel heading in the vessel frame	0 to 359.99	degrees
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

\$INVTG, x.x, T,, M, n.n, N, k.k, K*hh

\$INVTG-Course over ground and Ground speed data

Item	Definition	Value	Units
\$INVTG	Header	\$INVTG	
x.x	True vessel track in the vessel frame	0 to 359.99	degrees
T	True	T	
null	Not supported	null	
M		M	
n.n	Speed in the vessel frame	n/a	Knots
N	Knots	N	
k.k	Kilometres	K	
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

\$INZDA, hhmmss.ss, DD, MM, YYYY,, *hh

\$INZDA-Time and date

Item	Definition	Value	Units
\$INZDA	Header	\$INZDA	
hhmmss.sss	UTC time	n/a	Hours/Minutes/Seconds.decimal. 2 fixed digits of hours

		2 fixed digits of minutes 2 fixed digits of seconds Three digits for decimal fractions of a second
DD	Day of month	01 to 31
MM	Month of year	01 to 12
YYYY	Year	
Null	Null	
Null	Null	
*hh	Checksum	n/a
/CR/LF	Carriage return and line feed	/CR/LF

Speed log data

Speed log data is formatted in the following sentences:

VHW - Water speed and heading

VBW - Dual Ground/Water Speed

\$VHW,x.x,T,x.x,M,x.x,N,x.x,K*hh

VHW sentence fields

Item	definition	units
x.x	degrees true	?
T	T=true	n/a
x.x	degrees Magnetic	?
M	M = Magnetic	n/a
x.x	Speed of vessel relative to water	Knots/hour
N	N = Nots	n/a
x.x	Speed of vessel relative to water	Km/hour
K	K = Kilometers	n/a
*hh	Checksum	n/a

\$VBW,x.x,x.x,A,x.x,x.x,A*hh

VBW sentence fields

Item	Definition	Units
x.x	Longitudinal water speed, "-" means astern	?
x.x	Transverse water speed, "-" means port	?
A	A = Data Valid	n/a
x.x	Longitudinal ground speed, "-" means astern	?
x.x	Transverse ground speed, "-" means port	?
A	A = data valid, V = data invalid	n/a
*hh	Checksum	n/a

AML Oceanographic Micro-X XChange Sound Velocity Probe Data

The sound velocity probe serial data is output in the following format:

1479.35

xxxx.xx

Item	Definition	Units
------	------------	-------

xxxx.xx	Sound Velocity	m/s
---------	----------------	-----

Seabird SBE38 Thermometer Probe Data

The sound velocity probe serial data is output in the following format:

8.2221

xx.xxxx

Item	Definition	Units
xx.xxxx	Temperature	Celcius

Vaisala Ultrasonic Meteorological Station Data

The meteorological data from the Viasala integrated ultrasonic weather station is output in the following sentence format:

\$WIMWV,105,R,3.8,N,A*32

\$WIMWV,x.x,R,y.y,N,A*32

Item	Definition	Units
x.x	Wind direction value: Wind direction is given in relation to the devices north-south axis.	Degrees
R	Wind direction unit (R = relative)	n/a
y.y	Wind speed value	Knots
N	Wind speed unit (knots)	n/a
A	Data status: A = valid, V = Invalid	n/a

\$WIXDR,A,105,D,0,A,105,D,1,A,105,D,2,S,3.7,N,0,S,3.8,N,1,S,3.9,N,2,C,27.2,C,0,C,28.4,C,1,H,70.5,P,0,P,1013.5,H,0,V,0.00,M,0,Z,0,s,0,R,0.0,M,0,V,0.0,M,1,Z,0,s,1,R,0.0,M,1,R,1.7,M,2,R,0.0,M,3*6D

\$WIXDR,A,xxx,D,0,A,xxx,D,1,A,xxx,D,2,S,x.x,N,0,S,x.x,N,1,S,x.x,N,2,C,xx.x,C,0,C,xx.x,C,1,H,xx.x,P,0,P,xxxx.x,H,0,V,x.xx,M,0,Z,0,s,0,R,x.x,M,0,V,x.x,M,1,Z,0,s,1,R,x.x,M,1,R,x.x,M,2,R,x.x,M,3*6D

Item	Definition	Units
A	Transducer id 0 type (Wind Direction)	n/a
xxx	Transducer id 0 data (min wind direction)	Degrees
D	Transducer id 0 units (degrees, min wind direction)	n/a
0	Transducer id for min wind direction	n/a
A	Transducer id 1 type (wind direction)	n/a
xxx	Transducer id 1 data (average wind direction)	Degrees
D	Transducer id 1 units (degrees, average wind direction)	n/a
1	Transducer id for average wind direction	n/a
A	Transducer id 2 type (wind direction)	n/a

xxx	Transducer id 2 data (max wind direction)	Degrees
D	Transducer id 2 units (degrees, max wind direction)	n/a
2	Transducer id for max wind direction	n/a
S	Transducer id 0 type (wind speed)	n/a
x.x	Transducer id 0 data (min wind speed)	Knots
N	Transducer id 0 units (Knots, min wind speed)	n/a
0	Transducer id for min wind speed	n/a
S	Transducer id 1 type (wind speed)	n/a
x.x	Transducer id 1 data (average wind speed)	Knots
N	Transducer id 1 units (Knots, average wind speed)	n/a
1	Transducer id for average wind speed	n/a
S	Transducer id 2 type (wind speed)	n/a
x.x	Transducer id 2 data (max wind speed)	Knots
N	Transducer id 2 units (Knots, max wind)	n/a
2	Transducer id for max wind speed	n/a

C	Transducer id 0 type (Temperature)	n/a
xx.x	Transducer id 0 data (Temperature)	Celcius
C	Transducer id 0 units (C, Temperature)	n/a
0	Transducer id for Temperature	n/a
C	Transducer id 1 type (temperature)	n/a
xx.x	Transducer id 1 data (Tp internal temperature)	Celcius
C	Transducer id 1 units (C, Tp internal temperature)	n/a
1	Transducer id for Tp internal temperature	n/a
H	Transducer id 0 type (Humidity)	n/a
xx.x	Transducer id 0 data (Humidity)	% Reletive Humidity
P	Transducer id 0 units (% , Humidity)	n/a
0	Transducer id for Humidity	n/a
P	Transducer id 0 type (Pressure)	n/a
xxxx.x	Transducer id 0 data (Pressure)	hPA
H	Transducer id 0 units (hPa, Pressure)	n/a
0	Transducer id for Pressure	n/a

V	Transducer id 0 type (Accumulated rainfall)	n/a
x.xx	Transducer id 0 data (Accumulated rainfall)	millimeters

I	Transducer id 0 units (mm, Accumulated rainfall)	n/a
0	Transducer id for Accumulated rainfall	n/a
Z	Transducer id 0 type (Rain duration)	n/a
xx	Transducer id 0 data (Rain duration)	seconds
s	Transducer id 0 units (s, Rain duration)	n/a
0	Transducer id for Rain duration	n/a
R	Transducer id 0 type (Rain intensity)	n/a
x.x	Transducer id 0 data (Rain intensity)	mm/hr
M	Transducer id 0 units (mm/h, Rain intensity)	n/a
0	Transducer id for Rain intensity	n/a
V	Transducer id 1 type (Hail accumulation)	n/a
x.x	Transducer id 1 data (Hail accumulation)	hits/cm2
M	Transducer id 1 units (hits/cm2, Hail accumulation)	n/a
1	Transducer id for Hail accumulation	n/a
Z	Transducer id 1 type (Hail duration)	n/a
x	Transducer id 1 data (Hail duration)	seconds
s	Transducer id 1 units (s, Hail duration)	n/a
1	Transducer id for Hail duration	n/a
R	Transducer id 1 type (Hail intensity)	n/a
x.x	Transducer id 1 data (Hail intensity)	hits/cm2h
M	Transducer id 1 units (hits/cm2h, Hail intensity)	n/a
1	Transducer id for Hail intensity	n/a
R	Transducer id 1 type (Rain peak intensity)	n/a
x.x	Transducer id 1 data (Rain peak intensity)	mm/h
M	Transducer id 1 units (mm/h, Rain peak intensity)	n/a
2	Transducer id for Rain peak intensity	n/a
R	Transducer id 1 type (Hail peak intensity)	n/a
x.x	Transducer id 1 data (Hail peak intensity)	hits/cm2
M	Transducer id 1 units (hits/cm2, Hail peak intensity)	n/a