R/V Marcus G. Langseth Data Reduction Summary

MGL2307 – Cape Fear Coring

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Norfolk, VA to Morehead city, NC

Lamont-Doherty Earth Observatory, Columbia University

Sailing dates:

Date	Day of Year	Time	Port
2023-06-04	155	11:30 UTC	Morehead City, North Carolina
2023-06-10	161	23:00 UTC	Port Canaveral, Florida

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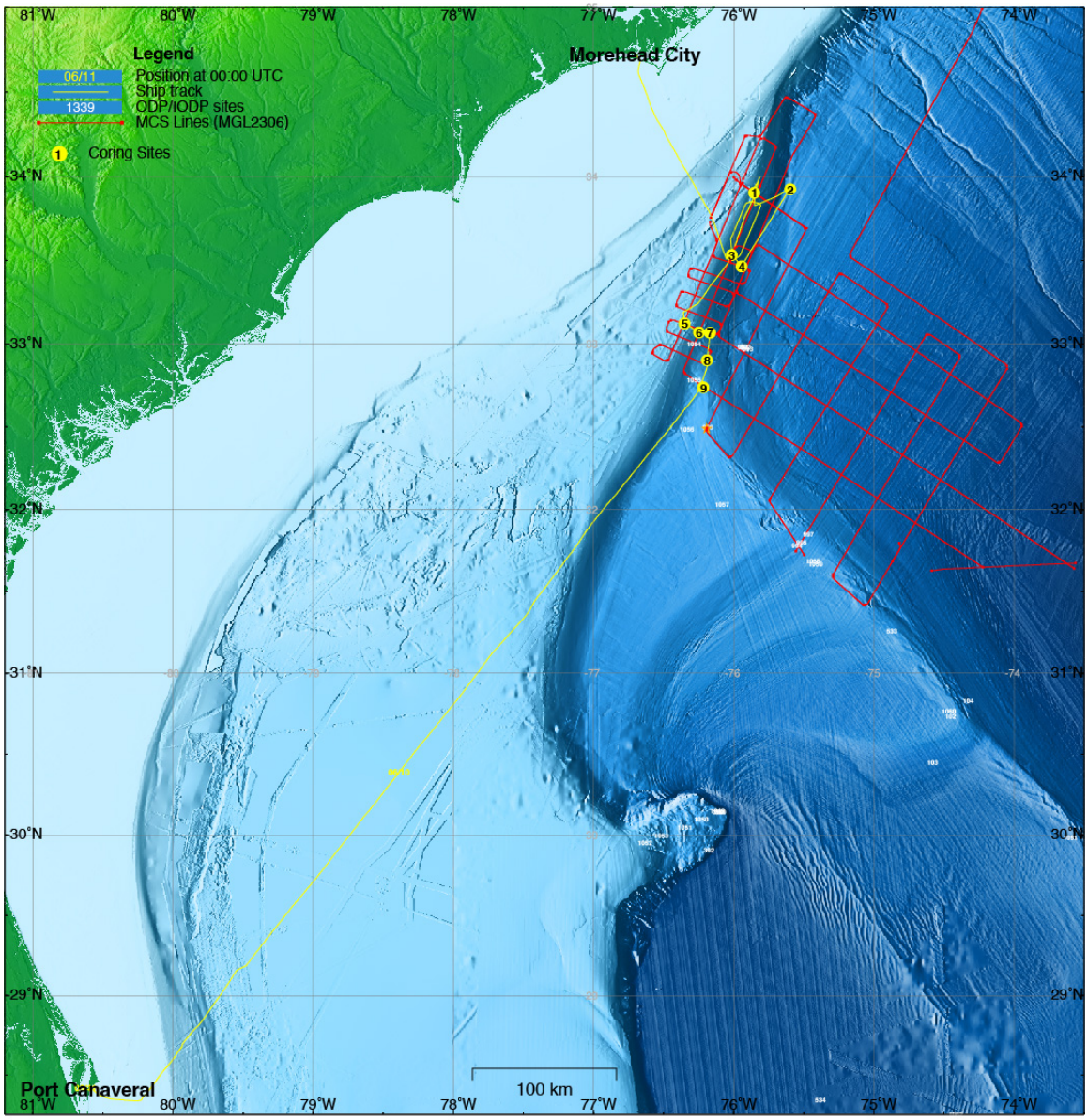
Background and Scientific Objectives

Following the collection of a 2D, high-resolution multi-channel seismic (MCS) dataset, to core and make heat flow measurements at 9 sites in and around the Cape Fear Slide and Cape Lookout landslide complexes offshore North Carolina. This cruise will enable us to better estimate the size, trend and overall volume and internal characteristics of the most recent and large, buried landslide deposits and to provide new critical constraints on the rock properties in and around the Cape Fear Slide complex in order to better understand their triggering mechanisms.



Nine piston cores will be collected above locations where strong BSRs have been imaged and/or near the locations of seafloor gas seeps. Coring operation will start by collecting a gravity core at coring sites followed by piston coring operations. Thermal data will be collected with outrigger temperature probes mounted to the outside of a piston core barrel. The core data will allow us to document sediment physical properties and pore fluids.

I. Personnel

Science Party

Participant	Affiliation	Position
Hugh Daigle	UTIG	PI
Céline Jo Grall	Université de La Rochelle	PI
Anne Bécel	LDEO	PI
James Gibson	LDEO	Scientist
Ali Mohamed	UTIG	Student
Mason Farnsworth	UTIG	Student
Nathan Miller	USGS	Scientist
Bill Danforth	USGS	Scientist
Dave Foster	USGS	Scientist
Wayne Baldwin	USGS	Scientist
Louis Marin Bodiguel Dupuis	Université de La Rochelle	Student
Emma Le Gall	Université de La Rochelle	Student
Yael Kiro	Weizmann Institute Of Science	Scientist
Elie Viel	Weizmann Institute Of Science	Student
Eden Markovitz	Weizmann Institute Of Science	Student
Carlos Figueora-Diaz	UTIG	Student
Anthony D'Aoust	OSU	Coring Tech.
Drew Cole	OSU	Coring Tech.
Benjamin Freiberg	OSU	Coring Tech.
Katherine Sterling	OSU	Coring Tech.
Daniel Wildrick	OSU	Coring Tech.

Shipboard technical staff

Participant	Group/Affiliation	Position
Todd Jensvold	LDEO	Chief Science Officer
Gilles Guérin	LDEO	Marine Technician
Riley Lopez	LDEO	Marine Technician
Brian Agee	LDEO	Source Mechanic
Jared Gursslin	MATE program	Marine Technician
Claire Mayorga	MATE program	Marine Technician

Ship Crew

Participant	Position
Crum, Breckenridge C.	Master
Wolford, David H.	Chief Mate
Loziere, Francis C.	2nd Mate
White, Joselyn N.	3rd Mate
Cereno, George G.	Bosun
Hammond, Robert D.	AB
Robison, William J.	AB
Sandoval, Felix E.	AB
Rillera De Guzman, Marcial	OS

Participant	Position
Butler, Gerald O.	Chief Engineer
Slonaker, Michael L.	1st A/E
Rodriguez, Vincente L.	2nd A/E
Boro, Tristan M.	3rd A/E
Florendo, Rodolfo A.	Oiler
Dawson, Maurice Q.	Oiler
Walsh, Joseph B.	Oiler
McLean Fuller, Hervin	Steward
Rios, Ricardo	Cook

II. Instrumentation Summary

All science instruments aboard the Langseth that were used and generated data during the cruise are listed below. File names and samples are in section IV, and details of serial formats in section VII.

Instrument	Description	Data Set	Data Outputs	Files	Sampling rate
ADCP	Teledyne Ocean Surveyor 75 Doppler Current Profiler	Full	various	See below	variable
BGM	Bell Aerospace BGM-3 Gravimeter	Full	serial log	MGL-vc01.*	1s
CNAV	C&C Technology C-Nav2000 DGPS	Full	serial log	MGL-cnav.*	1s
CNAV3050	Oceaneering C-Nav3050 DGPS	Full	serial log	MGL-cnav3050all.*	1s
DS80	Furuno DS-80 Doppler Speed log	Full	serial log	MGL-slog01.*	3s
EM122	Kongsberg EM122 Multibeam Sonar	Full	various	See below	variable
GYRO	Simrad GC80 Gyrocompass	Full	serial log	MGL-gy01.*	0.1s
KNUDSEN	Knudsen 3260 Sub-bottom Profiler	Full	kea, keb, segy	See below	variable
MICROSV	AML Oceanographic Micro-X SV Xchange velocity probe	Full	serial log	MGL-svuss01.*	1s
POSMV	Applanix POS-MV Inertial Navigation System	Full	serial log	MGL-posmv*	0.5s
SEAPATH	Kongsberg Seapath 330+ Inertial Navigation System	Full	serial log	MGL-seapath.*	1s
TSG	SeaBird SBE45 MicroTSG Thermosalinograph	Full	serial log	MGL-tsgraw.*	10s
Vaisala1,2	Vaisala WXT-520 Weather Stations	Full	serial log	MGL-vaisala1,2.*	2s

III. Data Files and Data Strings

The outputs of all the science instruments listed in the previous section are described below, in the same alphabetical order for instrument names as the previous table.
For all serial data, the files are named MGL-*inst*.y*YYYY*d*jjj*, after the code or ID of the instrument (*inst*), the year (*YYYY*) and the julian day (*jjj*) when they are recorded, with a new file created every day. Each data sentence is preceded by its ID and a UTC time stamp, added by the Lamont Data System (LDS). The description of the sentence formats is in section VII.
See **docs/elog/MGL2307_r2relog.csv** for information on any data gaps or degraded operation.

ADCP: Teledyne Doppler Current Profiler

ADCP data were collected during the entire cruise, starting shortly after leaving port.
Data are delivered as a replication of its acquisition directory structure, including raw and processed data, reports, figures and binary data in clearly labeled folders.

BGM: Bell Aerospace BGM-3 Gravimeter

The Bell Aerospace BGM-3 Gravimeter operated normally during the length of this cruise.

Serial file id: vc01
Logging interval: 1 second
vc01 data sample:

```
vc01   2023:160:00:00:00.0051 04:025563 00
```

CNAV: C-Nav2000 DGPS

The C-Nav2000 is a global satellite-based differential receiver. It was used as a secondary GPS system on the ship and was operational during the entire cruise.

Serial file id: cnav
Logging interval: 1 second
cnav data sample:

```
cnav   2023:160:00:00:00.2488 $GPDTM,999,,,,,,,999*4A
cnav   2023:160:00:00:00.2491 $GPGGA,000000.00,3253.5851,N,07610.8263,W,2,17,0.6,16.3,M,-43.1,M,6.0,0446*4D
cnav   2023:160:00:00:00.3187 $GPVTG,47.9,T,,M,0.33,N,0.60,K,P*20
```

CNAV3050: C-Nav3050 DGPS

The C-Nav3050 is a global satellite-based differential receiver. This is the best individual receiver currently on the ship, used as the reference for the seismic navigation system, and it was operational during the entire cruise.

Serial file id: cnav3050all
Logging interval: 1 second
cnav3050all data sample:

```
cnav3050all  2023:160:00:00:00.0791 $GNDTM,999,,,,,,,999*54
cnav3050all  2023:160:00:00:00.0793 $PNCTDTM,ITR,,,,,,,ITR*54
cnav3050all  2023:160:00:00:00.1382 $GNGGA,000000.00,3253.5686,N,07610.8270,W,2,17,0.7,-22.8,M,0.0,M,6.0,0446*6E
cnav3050all  2023:160:00:00:00.1383 $PNCTGGA,000000.00,3253.568568,N,07610.826952,W,2,17,0.7,-
22.751,M,0.000,M,6.0,0536*61
cnav3050all  2023:160:00:00:00.1958 $GNGLL,3253.568568,N,07610.826952,W,000000.00,A,D*65
cnav3050all  2023:160:00:00:00.1959 $GNVTG,21.9,T,,M,0.54,N,1.01,K,P*39
cnav3050all  2023:160:00:00:00.2561 $GNZDA,000000.00,09,06,2023,00,00*74
cnav3050all  2023:160:00:00:00.2561 $GNGSA,A,3,05,10,13,15,18,23,24,27,29,32,,,1.1,0.6,0.9,1*3D
```

DS80: Furuno DS-80 Doppler Speed log

The Furuno DS-80 is a Doppler speed log. It was in operation for the duration of the cruise.

Serial file id: slog01
Logging interval: 3 seconds
slog01 data sample:

```
slog01  2023:160:00:00:01.8695  $VDVLW,150254.86,N,406.53,N*62
slog01  2023:160:00:00:02.0233  $VDVBW,1.0,,A,,,V*69
```

EM122: Kongsberg EM122 Multibeam Sonar

The EM122 multibeam sonar was operated throughout the cruise.
EM122 swath data is saved to the cruise archive under **raw/multibeam**. Data in Kongsberg raw formats (*.all, *.wcd, *.asvp, *.abs) are replicated in the original directory structure, named by time stamps and sorted by day of acquisition. Center beam depth is recorded separately to serial log. See **docs/elog/MGL2307_r2relog.csv** for times and durations of tests.

Serial file id: bath02
Logging interval: variable with water depth
bath02 data sample:

```
bath02 2023:160:00:00:04.6488 $KIDPT,1876.10,6.91,12000.0*74
```

GYRO: Simrad GC80 Gyrocompass

The GC80 gyrocompass is installed on the bridge and used for ship and seismic navigation. It was in operation for the duration of the cruise.

Serial file id: gy01
Logging interval: 0.1s
gy01 data sample:

```
gy01   2023:160:00:00:00.3516 $HEROT,-016.55,A*31
gy01   2023:160:00:00:00.4514 $HEHDT,179.5,T*25
gy01   2023:160:00:00:00.6508 $PTKM,HEALM,0000,0,G1*09
```

KNUDSEN: Knudsen Engineering 3260 Sub-bottom Profiler

The Knudsen 3260 is a chirp echosounder/sub-bottom profiler. Its 3.5kHz channel was in operation for the length of the cruise. Data are written in proprietary KEB, KEA, and SEGY format.

Serial file id: n/a

MICROSV: AML Oceanographic Micro-X SV Xchange velocity probe

The AML Micro SV probe operated normally during the length of this cruise, while the uncontaminated sea water pump was active. It was started once in open sea and stopped shortly before getting into port.

Serial file id: svuss01
Logging interval: 1 second
svuss01 data sample:

```
svuss01   2023:160:00:00:00.1158  1539.658
```

POSMV: POS-MV Inertial Navigation System

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. It was used for the entire cruise.

Serial file id: posmv
Logging interval: 0.5-1 second, depending on sentence
posmv data sample:

```
posmv  2023:160:00:00:00.0633 $INZDA,000000.0036,09,06,2023,,*7F
posmv  2023:160:00:00:00.2681 $PASHR,000000.131,177.50,T,0.97,2.15,0.86,0.020,0.020,0.013,2,0*11
posmv  2023:160:00:00:00.2682 $PRDID,2.15,0.97,177.50*75
posmv  2023:160:00:00:00.3893 $INGST,000000.131,,0.4,0.3,31.3,0.4,0.4,0.5*69
posmv  2023:160:00:00:00.3894 $INGGA,000000.131,3253.56172,N,07610.82798,W,2,19,0.8,-1.65,M,,,7,0134*2F
posmv  2023:160:00:00:00.4435 $INHDT,177.5,T*21
posmv  2023:160:00:00:00.4436 $INVTG,27.8,T,,M,0.2,N,0.5,K,D*22
```

SEAPATH: Kongsberg SeaPath 330 Inertial Navigation System

The Kongsberg Seapath is an inertial navigation system. It was operational for the duration of the cruise.

Serial file id: seapath
Logging interval: 1 second
seapath data sample:

```
seapath   2023:160:00:00:00.0528 $INGLL,3253.568027,N,07610.826670,W,235959.57,A,D*69
seapath   2023:160:00:00:00.0531 $INVTG,61.79,T,,M,0.3,N,0.6,K,D*14
seapath   2023:160:00:00:00.0531 $INHDT,177.75,T*16
seapath   2023:160:00:00:00.0533 $PSXN,20,0,0,0,0*3B
seapath   2023:160:00:00:00.1235 $PSXN,23,1.35,2.15,177.75,-0.19*1F
seapath   2023:160:00:00:00.8184 $INGGA,000000.57,3253.568087,N,07610.826585,W,2,09,1.0,-5.70,M,-37.67,M,0.0,0001*48
```

TSG: SBE-45 Thermosalinograph

The Seabird TSG operated normally during the length of the cruise, while the uncontaminated sea water pump was active, started once in open sea and stopped shortly before getting into port.

Serial file id: tsgraw
Logging interval: 10 seconds
tsgraw data sample:

```
tsgraw 2023:160:00:00:05.4377 t1= 27.0379, c1= 5.64671, s= 35.8990, sv=1539.764, t2= 26.8765
```

Vaisala1,2: Vaisala Meteorological Ultrasonic Integrated Weather Stations

The two weather stations are used to log wind speed, direction, air temperature, relative humidity, precipitation, dew point, and barometric pressure. Both are located on top of the tower. The units were operational for the duration of the cruise.

Serial file id: vaisala1 and vaisala2
Logging interval: 1 second (vaisala2) and 2 seconds (vaisala1)
vaisala data sample:

```
vaisala1. 2023:160:00:00:00.9064 $WIXDR,A,135,D,0,A,141,D,1,A,144,D,2,S,13.4,N,0,S,14.5,N,1,S,15.9,N,2,C,24.5,C,0,C,
24.9,C,1,H,71.1,P,0,P,1003.9,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,225.6,M,2,R,0.0,M,3*5D
vaisala1  2023:160:00:00:01.6335 $WIMWV,141,R,14.8,N,A*04
```

IV. Gravity Tie Information

One gravity tie was performed in Port Canaveral, Florida, at the end of the cruise. See the documents located under **docs/gravity tie** for detailed records.

V. Cruise Data Archive Contents

docs	**Cruise documents and logs**
docs/elog	Cruise elog files
docs/elog/MGL2307_r2relog.csv	Cruise elog report
docs/gravity tie	Gravity ties
docs/map	Cruise maps
docs/offsets	Vessel/sensor offsets
docs/permits	Clearance documents
docs/reports	Associated reports
docs/reports/MGL2307_DataReport.doc	This file
docs/weather	Daily weather reports
docs/waypoints	Waypoint and planning files
Docs/winch_DAQ	Winch depth data recorded while coring
raw	**Raw data**
raw/adcp	Raw ADCP data
raw/knudsen	Raw Knudsen sub-bottom profiler data
raw/multibeam	Raw EM122 multibeam data
raw/serial	Underway serial data
raw/MGL2307_serial_data_10s.csv	Serial data filtered and sampled every 10s
raw/MGL2307_serial_data_1min.csv	Serial data filtered and sampled every minute

VI. Serial Data Formats

Unless specified otherwise, all serial data sentences are in NMEA 0183 compatible format.
On each line, the data sentences generated by the instrument follows the instrument ID and time stamp added by the Lamont Data Logger (LDS) system.
In the following format descriptions, unless specified otherwise, x.x stands for floating point values, n for integer, and a for character. When fixed, the number of characters and precision are indicated (e.g. x.xx = two decimal point precision; nnnn = 4 integers).
In all sentences with a mode indicator associated with the checksum in the last word, if nothing else is specified, the options are: A: Autonomous mode; D: Differential mode; E: Estimated (dead reckoning) mode; M: Manual Input mode; S: Simulator mode; N: Data not valid.

MGL-bath02.*

The EM122 center beam depth is output to files *MGL-bath02.yYYYYdjjj* using the following format :

$KIDPT,x.x,x.x,x.x*hh		
Item	**Definition**	**Units / Options**
x.x	Water depth	m
x.x	Offset from transducer	m; positive means from transducer to water line
x.x	Maximum range scale in use	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-cnav.*

The C-Nav2000 GPS outputs data to files MGL-cnav.y*YYYY*d*jjj*. The following sentence types were recorded:

- $GPDTM: Datum reference information
- $GPGGA: Global Positioning System Time, position and fix related data.
- $GPVTG: Track made good and Ground speed data.

$GPDTM sentence

$GPDTM,a,a,mm.mmmm,a,mm.mmmm,a,0,aaa*hh		
Item	**Definition**	**Units / Options**
a	Local datum code	n/a
a	Local datum subcode	n/a
mm.mmmm	Latitude offset	minutes
a	Latitude offset mark (N: +; S: -)	n/a
mm.mmmm	Longitude offset	minutes
a	Longitude offset mark (E: +; W: -)	n/a
0	Altitude offset (always 0)	m
aaa	Datum code	n/a
*hh	Checksum	n/a (hexadecimal)

$GPGGA sentence

$GPGGA,hhmmss.ss,ddmm.mmmm,a,dddmm.mmmm,a,x,nn,x.x,x.x,M,x.x,M,x.x,nnnn*hh		
Item	**Definition**	**Units / Options**
hhmmss.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude: N = North; S = South	n/a
dddmm.mmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude: E = East; W = West	n/a
x	GPS Quality indicator	0: not valid; 1: Auto fix; 2: Corrected fix
nn	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision (HDOP)	n/a
x.x	Antenna altitude from Mean Sea Level (MSL)	m
M	Altitude units--M indicates meters	n/a
x.x	Geoidal separation distance from MSL	m
M	Geoidal separation units--M indicates meters	n/a
x.x	Age of corrections used in solution fix	s
nnnn	Differential GPS reference station ID	n/a
*hh	Checksum	n/a (hexadecimal)

$GPVTG sentence

$GPVTG,x.x,T,mmm.m,M,x.x,N,x.x,K,a*hh		
Item	**Definition**	**Units / Options**
x.x	Course over ground (COG)	Degrees from True North
T	Indicates course relative to True North	n/a
x.x	COG relative to magnetic north	Degrees from Magnetic North
M	Indicates course relative to magnetic north	n/a
x.x	Speed over ground (SOG)	Nautical miles per hour (knots)
N	Indicates that SOG is in knots	n/a
x.x	SOG	km/h
K	Indicates that SOG is in km/h	n/a
a	Mode Indicator	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-cnav3050all.*

C-Nav3050 GPS receiver outputs data to files MGL-cnav3050all.y*YYYY*d*jjj*, named after the year *YYYY* and the julian day *jjj*. The following sentence types were recorded:

- $GNDTM: Datum reference information
- $GNGGA: Global Positioning System Time, position and fix related data
- $GNGLL: Position data: position fix, time of position fix, and status
- $GNGSA: GPS Dilution of Precision (DOP) and active satellites
- $GNVTG: Track made good and Ground speed data
- $GNZDA: UTC day, month, and year, and local time zone offset
- $PNCTDTM: C-Nav proprietary Datum reference information
- $PNCTGGA: C-Nav proprietary GPS Time, position and fix related data

$GNDTM sentence

$GNDTM,aaa,a,mm.mmmm,a,mm.mmmm,a,0,aaa*hh		
Item	**Definition**	**Units / Options**
aaa	Local datum code	n/a
a	Local datum subcode	n/a
mm.mmmm	Latitude offset	minutes
a	Direction of Latitude	N: North; S: South
mm.mmmm	Longitude offset	minutes
a	Direction of Longitude	E: East; W: West
0	Altitude offset	m (always 0)
aaa	Datum code	n/a
*hh	Checksum	n/a (hexadecimal)

$GNGGA sentence

$GNGGA,hhmmss.ss,ddmm.mmmm,a,dddmm.mmmm,a,x,n,x.x,x.x,M,x.x,M,x.x,a*hh		
Item	**Definition**	**Units / Options**
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
x	GPS Quality indicator	0: not valid; 1: Auto fix; 2: Corrected fix
n	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision	n/a
x.x	Antenna altitude from Mean Sea Level (MSL)	m
M	Altitude units--M indicates meters	n/a
x.x	Geoidal separation distance from MSL	m
M	Geoidal separation units	n/a (M indicates meters)
x.x	Age of corrections used in solution fix	s
nnnn	Differential GPS reference station ID	n/a
*hh	Checksum	n/a (hexadecimal)

$GNGLL sentence

$GNGLL,ddmm.mmmmmm,a,dddmm.mmmmmm,a,hhmmss.ss,a,a*hh		
Item	**Definition**	**Units / options**
ddmm.mmmmmm	Latitude	Degree, decimal minute
a	Latitude direction	N: North; S: South
dddmm.mmmmm	Longitude	Degree, decimal minute
a	Longitude direction	E: East; W: West
hhmmss.ss	UTC time	Hour/minute/Sec.dec
a	Status indicator	A: valid; V: not valid
a	Mode Indicator	n/a
*hh	Mode*Checksum data	n/a (hexadecimal)

$GNGSA sentence

$GNGSA,A,3,nn,nn,nn,nn,nn,nn,nn,nn,nn,nn,nn,x.x,x.x,x.x,1*3D		
Item	**Definition**	**Units / options**
a	Mode	M: Manual; A: Automatic
n	Solution	1: N/A; 2: 2D; 3: 3D
nn	ID (PRN) of satellites used	Up to 12 values
x.x	Position (3D) of Dilution of Precision (PDOP)	N/A
x.x	Horizontal Dilution of Precision (HDOP)	N/A
x.x	Vertical Dilution of Precision (VDOP)	N/A
n	System ID	1 = GPS
*hh	Checksum	n/a (hexadecimal)

$GNVTG sentence

$GNVTG,xxx.x,T,xxx.x,M,x.xx,N,x.xx,K,a*hh		
Item	**Definition**	**Units / Options**
ttt.t	Course over ground (COG)	Degrees from True North
T	Indicates course relative to True North	n/a
mmm.m	COG relative to magnetic north	Degrees from Magnetic North
M	Indicates course relative to magnetic north	n/a
x.xx	Speed over ground (SOG)	Nautical miles per hour (knots)
N	Indicates that SOG is in knots	n/a
x.xx	SOG	km/h
K	Indicates that the SOG is in km/h	n/a
a	Mode Indicator	n/a
*hh	Checksum	n/a (hexadecimal)

$GNZDA sentence

$GNZDA,hhmmss.sss,dd,mm,yyyy,hh,mm*hh		
Item	**Definition**	**Units / options**
hhmmss.sss	UTC time	Hour/minute/Sec.dec
dd	Day	01-31
mm	Month	01-12

yyyy	Year	
hh	Local time zone offset from GMT, hours	00-13
mm	Local time zone offset from GMT, minutes	00-59
*hh	Checksum	n/a (hexadecimal)

$PNCTGGA sentence

`$PNCTGGA,hhmmss.ss,ddmm.mmmmmm,a,dddmm.mmmmmm,a,n,n,x.x,x.x,M,x.x,M,x.x,iijj*hh`

Item	Definition	Units / Options
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
n	GPS Quality indicator	0: not valid; 1: GPS SPS fix; 2: DGPS SPS fix
n	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision	n/a
x.x	Antenna altitude from Mean Sea Level (MSL)	m
M	Antenna Altitude units	n/a (M indicates meters)
x.x	Geoidal separation distance from MSL	m
M	Geoidal separation units	n/a (M indicates meters)
x.x	Age of corrections used in solution fix	s
iijj	Differential GPS reference ID	ii:satellite beam; jj: correction type
*hh	Checksum	n/a (hexadecimal)

$PNCTDTM sentence

`$PNCTDTM,aaa,,,,,,,aaa*54`

Item	Definition	Units / Options
aaa	Local datum code	n/a
a	Local datum subcode	n/a
mm.mmmm	Latitude offset	minutes
a	Latitude direction	N: North; S: South
mm.mmmm	Longitude offset	minutes
a	Direction of Longitude	E: East; W: West
0	Altitude offset from reference	m
aaa	Reference Datum code	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-gy01.*

The Simrad GC80 Dual Gyro Compass output to files *MGL-gy01.yYYYYdjjj*. The following sentence types were recorded:

- HEHDT: True Heading
- HEROT: Rate Of Turn
- PTKM: Alarm

$HEHDT Sentence

$HEHDT,x.x,T*hh		
Item	**Definition**	**Units / Options**
x.x	Heading	Degrees
T	T = Preceding value is True heading	n/a
*hh	Checksum	n/a (hexadecimal)

$HEROT Sentence

$HEROT,x.x,T*hh		
Item	**Definition**	**Units / Options**
x.x	Rate of turn	Degrees per minute; "-" = bow turns to port
a	Status	n/a; A: Valid data
*hh	Checksum	n/a (hexadecimal)

$PTKM Sentence

$PTKM,aaaa,nnnn,n,a*hh		
Item	**Definition**	**Units / Options**
HEALM	Almanac code	n/a
nnnn	unspecified	n/a
n	unspecified	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-posmv.*

Data from the POS/MV inertial navigation system are recorded in files *MGL-posmv.yYYYYdjjj*. The following sentences were recorded. Two attitude data strings are available.

- $INGGA: Global Positioning System Time, position and fix related data
- $INGST: GPS Pseudorange Noise Statistics
- $INHDT: True Heading
- $INVTG: Course over Ground and Ground speed Data
- $INZDA: GPS Time and Date
- $PASHR: Proprietary Attitude data
- $PRDID: Proprietary Attitude data

$INGGA sentence

$INGGA,hhmmss.sss,ddmm.mmmm,a,dddmm.mmmm,a,n,n,x.x,x.x,M,,,n,nnnn*hh		
Item	**Definition**	**Units / Options**
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
n	GPS Quality indicator	0: not valid; 1: Auto fix; 2: DGS fix; 3: PPS fix
n	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision	n/a
x.x	Altitude of IMU from Mean Sea Level (MSL)	M; "-" indicates below seal level
M	Altitude units--M indicates meters	n/a
Null		
Null		
n	Age of corrections used in solution fix	s
nnnn	Differential GPS reference station ID	0000 to 1023
*hh	Checksum	n/a (hexadecimal)

$INGST sentence

$INGST,hhmmss.sss,,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh		
Item	**Definition**	**Units / Options**
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
Null	Null	
x.x	Std deviation of semi-major axis of error ellipse	m
x.x	Std deviation of semi-minor axis of error ellipse	m
x.x	Orientation of semi-major axis of error ellipse	Degrees from true north
x.x	Std deviation of latitude	m
x.x	Std deviation of longitude	m
x.x	Std deviation of altitude	m
*hh	Checksum	n/a (hexadecimal)

$INHDT sentence

$INHDT,x.x,T*hh		
Item	**Definition**	**Units / Options**
x.x	Vessel heading	Degrees
T	T = Preceding value is True heading	n/a
*hh	Checksum	n/a (hexadecimal)

$INVTG sentence

$INVTG,x.x,T,,M,x.x,N,x.x,K,*a*hh		
Item	**Definition**	**Units / Options**
x.x	True vessel track in the vessel frame	Degrees
T	T = Preceding value is True heading	n/a
Null		
M		M: Magnetic
x.x	Speed in the vessel frame	Knots
N	Preceding value is in Knots	N: Knots
x.x	Speed in the vessel frame	km/h
K	Preceding value is in km/h	K: km/h
a	Mode indicator	n/a
*hh	Checksum	n/a (hexadecimal)

$INZDA sentence

$INZDA,hhmmss.sss,dd,mm,yyyy,,*hh		
Item	**Definition**	**Units / options**
hhmmss.sss	UTC time	Hour/minute/Sec.dec
dd	Day	01-31
mm	Month	01-12
yyyy	Year	
Null		
Null		
*hh	Checksum	n/a (hexadecimal)

$PASHR sentence

$PASHR,hhmmss.sss,x.xx,T,x.xx,x.xx,x.xx,x.xxx,x.xxx,x.xxx,n,n*3B		
Item	**Definition**	**Units / options**
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
x.xx	True Vessel Heading	Degrees
T	T = Preceding value is True heading	n/a
x.xx	Roll	Degrees
x.xx	Pitch	Degrees
x.xx	Heave	m
x.xxx	Roll Accuracy	Degrees
x.xxx	Pitch Accuracy	Degrees
x.xxx	Heading Accuracy	Degrees

n	Flag: Accuracy Heading	0: no aiding; 1: GNSS; 2:GNSS & GAMS
n	Flag: IMU	0: IMU out; 1: IMU satisfactory
*hh	Checksum	n/a (hexadecimal)

$PRDID sentence

$PRDID,x.x,x.x,x.x*hh		
Item	**Definition**	**Units / options**
x.x	Pitch	Degrees
x.x	Month	Degrees
x.x	Sensor Heading	Degrees
*hh	Checksum	n/a (hexadecimal)

MGL-seapath.*

The Seapath 330 Inertial Navigation System outputs data to the MGL-seapath.yYYYYdjjj files. The following sentences were recorded:

- $INGGA: Global Positioning System Time, position and fix related data
- $INGLL: Geographic Position - Latitude/Longitude
- $INHDT: True Heading
- $INVTG: Course over Ground and Ground speed Data
- $PSXN,20: Proprietary QC data
- $PSXN,23: Proprietary Attitude

$INGGA sentence

`$INGGA,hhmmss.sss,ddmm.mmmm,a,dddmm.mmmm,a,n,n,x.x,x.x,M,x.x,M,n,nnnn*hh`

Item	Definition	Units / Options
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
n	GPS Quality indicator	0: not valid; 1: Auto fix; 2: DGS fix; 3: PPS fix
n	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision	n/a
x.x	Altitude of IMU from Mean Sea Level (MSL)	meters; "-" indicates below seal level
M	Altitude units	n/a (M indicates meters)
x.x	Geoidal separation distance from MSL	m
M	Geoidal separation units	n/a (M indicates meters)
x.x	Age of corrections used in solution fix	s
nnnn	Differential GPS reference station ID	0000 to 1023
*hh	Checksum	n/a (hexadecimal)

$INGLL sentence

`$INGLL,ddmm.mmmm,a,dddmm.mmmm,a,hhmmss.ss,a,a*hh`

Item	Definition	Units / Options
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
a	Status	A: valid; V: not valid
a	Mode	A: GPS; D: DGPS; E : dead reckoning; N:invalid
*hh	Checksum	n/a (hexadecimal)

$INHDT sentence

$INHDT,x.x,T*hh		
Item	**Definition**	**Units / Options**
x.x	True vessel heading	Degrees
T	T = Preceding value is True heading	n/a
*hh	Checksum	n/a (hexadecimal)

$INVTG sentence

$INVTG,x.x,T,,M,x.x,N,x.x,K,*a*hh		
Item	**Definition**	**Units / Options**
x.x	True vessel track in the vessel frame	Degrees
T	T = Preceding value is True heading	n/a
Null		
M		M: Magnetic
x.x	Speed in the vessel frame	Knots
N	Preceding value is in Knots	N: Knots
x.x	Speed in the vessel frame	Km/h
K	Preceding value is in km/h	K: km/h
a	Mode indicator	n/a
*hh	Checksum	n/a (hexadecimal)

$PSXN,20 sentence

$PSXN,20,n,n,n,n*hh		
Item	**Definition**	**Units / Options**
20	Sentence ID	20: following words are quality indicators
n	Horizontal position and velocity quality	0: Normal; 1: reduced quality; 2:invalid
n	Height and vertical velocity quality	0: Normal; 1: reduced quality; 2:invalid
n	Heading quality	0: Normal; 1: reduced quality; 2:invalid
n	Roll and pitch quality	0: Normal; 1: reduced quality; 2:invalid
*hh	Checksum	n/a (hexadecimal)

$PSXN,23 sentence

$PSXN,23,x.x,x.x,x.x,x.x*hh		
Item	**Definition**	**Units / Options**
23	Sentence ID	23: following words are attitude data
x.x	Roll	Degrees
x.x	Pitch	Degrees
x.x	Heading	Degrees
x.x	Heave	m
*hh	Checksum	n/a (hexadecimal)

MGL-slog01.*

The Furuno DS-80 Doppler speed log outputs data to files MGL-slog01.y*YYYY*d*jjj*, named after the year YYYY and the julian day jjj. The following sentence types were recorded:

- $VDVBW: Dual Ground/Water Speed
- $VDVLW: Distance Traveled through Water

$VDVBW sentence

$VDVBW,x.x,x.x,a,x.x,x.x,a*hh		
Item	**Definition**	**Units / Options**
x.x	Longitudinal water speed	Knots; - means astern
x.x	Transverse water speed	Knots; - means port
a	Status	A: valid; V: not valid
x.x	Longitudinal ground speed	Knots; - means astern
x.x	Transverse ground speed	Knots; - means port
a	Status	A: valid; V: not valid
*hh	Checksum	n/a (hexadecimal)

$VDVLW sentence

$VDVLW,x.x,N,x.x,N*hh		
Item	**Definition**	**Units / Options**
x.x	Total cumulative water distance	Nautical miles
N	Indicates distance travelled in nautical miles	n/a
x.x	Water distance since last reset	Knots; - means astern
N	Indicates distance travelled in nautical miles	Knots; - means port
*hh	Checksum	n/a (hexadecimal)

MGL-svuss01.*

The AML Oceanographic Micro-X SV Xchange velocity probe outputs serial data to files *MGL-svuss01.yYYYdjjj* in the following format, which doesn't follow the NMEA standard.

xxxx.xxx		
Item	**Definition**	**Units / Options**
xxxx.xxx	Sound velocity	m/s

MGL-tsgraw.*

The SeaBird SBE45 MicroTSG Thermosalinograph outputs serial data to files *MGL-tsgraw.yYYYYdjjj* in the following format, which doesn't follow the NMEA standard. Each data item is listed by its code and its value separated by "=".

t1= xx.xxxx, c1= x.xxxxx, s= xx.xxxx, sv=xxxx.xxx, t2= xx.xxxx		
Item	**Definition**	**Units / options**
t1	Temperature	°C
c1	conductivity	S/m (Siemens/meter)
s	salinity	ppt
sv	Sound velocity	m/s
t2	Remote Temperature	°C

MGL-vaisala1.*, MGL-vaisala2.*

The meteorological data from the Vaisala integrated ultrasonic weather stations is output to files *MGL-vaisala1.yYYYdjjj* and *MGL-vaisala2.yYYYYdjjj*. The following sentences were recorded:

- $WIMWV: wind speed and angle
- $WIXDR: all transducers data

$WIMWV sentence

$WIMWV,n,a,x.x,a,a*hh		
Item	**Definition**	**Units / Options**
n	Wind direction, referenced to instrument axis	Degrees
a	Reference	R: relative; T: Theoretical
x.x	Wind speed	Defined by next word
a	Wind Speed Unit	N: knots; K: km/h; M: m/s
a	Status	A: valid; V: not valid
*hh	Checksum	n/a (hexadecimal)

$WIXDR sentence

$WIXDR,A,n,D,0,A,n,D,1,A,n,D,2,S,x.x,N,0,S,x.x,N,1,S,x.x,N,2,C,x.x,C,0,C,x.x,C,1,H,x.x,P,0,P,x.x,H,0,V,x.xx,M,0,Z,n,S,0,R,x.x,M,0,V,x.x,M,1,Z,n,S,1,R,x.x,M,1,R,x.x,M,2,R,x.x,M,3*hh		
Item	**Definition**	**Units / Options**
A	Transducer id 0 type	A: Wind direction
n	Transducer id 0 data (minimum wind direction)	Degrees
D	Transducer id 0 Unit	D: Degrees
0	Transducer id for minimum wind direction	n/a
A	Transducer id 1 type	A: Wind direction
n	Transducer id 1 data (average wind direction)	Degrees
D	Transducer id 1 Unit	D: Degrees
1	Transducer id for average wind direction	n/a

A	Transducer id 2 type	A: Wind direction
n	Transducer id 2 data (maximum wind direction)	Degrees
D	Transducer id 2 Unit	D: Degrees
2	Transducer id for average wind direction	n/a
S	Transducer id 0 type	S: Wind speed
x.x	Transducer id 0 data (minimum wind speed)	Knots
N	Transducer id 0 Unit	N: knots
0	Transducer id for minimum wind speed	n/a
S	Transducer id 1 type	S: Wind speed
x.x	Transducer id 1 data (average wind speed)	Knots
N	Transducer id 1 Unit	N: knots
1	Transducer id for average wind speed	n/a
S	Transducer id 2 type	S: Wind speed
x.x	Transducer id 2 data (maximum wind speed)	Knots
N	Transducer id 2 Unit	N: knots
2	Transducer id for maximum wind speed	n/a
C	Transducer id 0 type	C: Temperature
x.x	Transducer id 0 data (Temperature)	°C
C	Transducer id 0 Unit	C: °C
0	Transducer id for temperature	n/a
C	Transducer id 1 type	C: Temperature
x.x	Transducer id 1 data (Internal Temperature)	°C
C	Transducer id 1 Unit	C: °C
1	Transducer id for internal temperature	n/a
H	Transducer id 0 type	H: Humidity
x.x	Transducer id 0 data (humidity)	%
P	Transducer id 0 Unit	P: %
0	Transducer id for humidity	n/a
P	Transducer id 0 type	P: Pressure
x.x	Transducer id 0 data (pressure)	hPa
H	Transducer id 0 Unit	H: hPa
0	Transducer id for pressure	n/a
V	Transducer id 0 type	V: Accumulated rainfall
x.xx	Transducer id 0 data (Accumulated rainfall)	mm
M	Transducer id 0 Unit	M: mm
0	Transducer id for accumulated rainfall	n/a
Z	Transducer id 0 type	Z: Rain duration
n	Transducer id 0 data (rain duration)	seconds
S	Transducer id 0 Unit	S: seconds
0	Transducer id for rain duration	n/a
R	Transducer id 0 type	R: Rain intensity
x.x	Transducer id 0 data (rain intensity)	mm/h
M	Transducer id 0 Unit	M: mm/h

0	Transducer id for rain intensity	n/a
V	Transducer id 1 type	V: hail accumulation
x.x	Transducer id 1 data (hail accumulation)	hits/cm^2
M	Transducer id 1 Unit	M: hits/cm^2
1	Transducer id for hail accumulation	n/a
Z	Transducer id 1 type	Z: hail duration
n	Transducer id 1 data (hail duration)	seconds
S	Transducer id 1 Unit	M: seconds
1	Transducer id for hail duration	n/a
R	Transducer id 1 type	R: hail intensity
x.x	Transducer id 1 data (hail intensity)	seconds
M	Transducer id 1 Unit	M: hits/cm^{2}h
1	Transducer id for hail intensity	n/a
R	Transducer id 2 type	R: rain peak intensity
x.x	Transducer id 2 data (rain peak intensity)	mm/h
M	Transducer id 2 Unit	M: mm/h
2	Transducer id for rain peak intensity	n/a
R	Transducer id 3 type	R: hail peak intensity
x.x	Transducer id 3 data (hail peak intensity)	hits/cm^{2}h
M	Transducer id 3 Unit	M: hits/cm^{2}h
3	Transducer id for hail peak intensity	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-vc01.*

The gravimeter serial data is output to files MGL-vc01.y*YYYY*d*jjj* in the following format, which doesn't follow the NMEA standard.

04:nnnnnn a		
Item	**Definition**	**Units**
04	output frequency	0.25Hz (4 = 4 × clock periods = 1Hz)
nnnnnn	raw counts	n/a
a	sensor status	n/a

VII. Operation and Log files Description

docs/operations/Daily_Reports contains the daily production report compiled by the CSO.

docs/operations/Science_Support_Plan contains all of the revisions of the plan which details the intended survey activity.