Lamont-Doherty Earth Observatory of Columbia University

EW9802 DATA REDUCTION CRUISE SUMMARY

February 15, 1998 - March 12, 1998

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Lamont-Doherty of Columbia University

Science Party: N/A

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Navigation Processing

The following pages describe the GPS and shot processing pipeline used to create all the navigation based files: shot, hydrosweep centerbeam, magnetic, gravity, as well as the MCS navigation data.

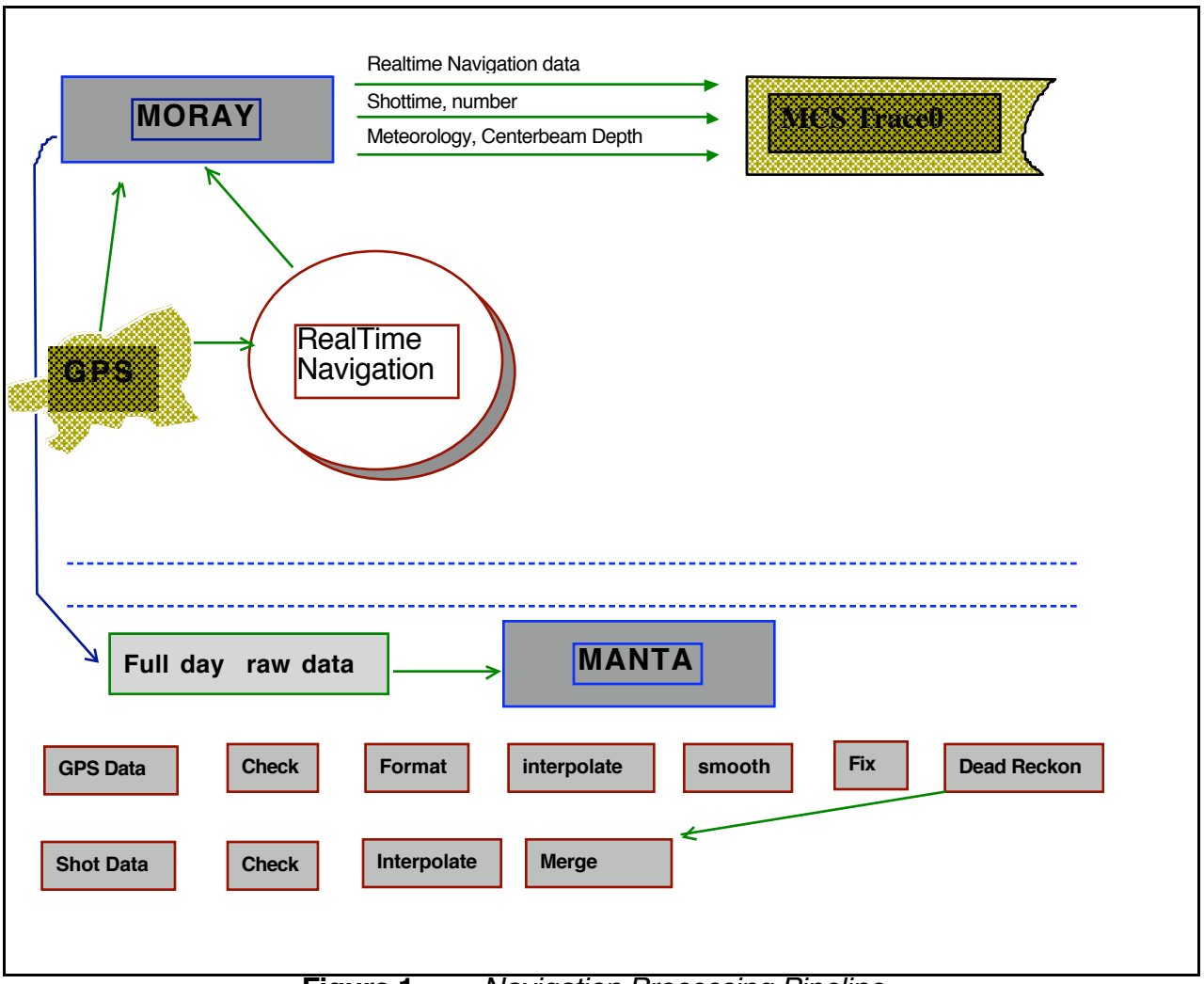

Figure 1. *Navigation Processing Pipeline*

Navigation Pipeline [refer to figure 1]

1. Logger
   Moray is the main logging system and is responsible for logging all the real-time data as well as controlling the intervals in which it is logged. This is also the system which controls the firing of the guns. In order to determine the time to fire, as well as the precise location the guns were fired, it relies on the *Real-time Navigation Process.*

2. Real-time Navigation Process
   This process uses the navigation from the selected GPS to provide a means of removing some of the randomness of the selective availability GPS by determining our current speed based on two points taken *filter_length* minutes apart. If available, the same information for the tailbuoy is reported. Simultaneously, the meteorological information and centerbeam data is collected. The output from this process (for both ship and tailbuoy) is:

   - The last lat/lon position (directly from the GPS) and the time (in seconds) of the last fix
   - ship speed in the east direction, ship speed in the west direction
   - Furuno speed and heading
   - Meteorological data

3. Using this data, ***MORAY*** determines the shot position based on the shot time and the time of the last GPS position fix. All this data is then passed on to the MCS system for Trace Zero data.

4. For non-real-time processing, raw gps data is transferred to Manta and processed. Navigation data is processed, then merged with all location specific information: hydrosweep center beam, shot-time, magnetic, and gravity. However, not all data is accumulated on every cruise.

5. GPS Processing

   - Check Data for mutant records and inconsistent times
   - Format the data into a standard format

     NMEA: Time Lat/Longps string

     Magnavox: Time PMVXG proprietary NMEA string

   - Interpolate the data where GPS coverage has been lost for any amount of time 3 minutes or less. In the case where differential coverage is in effect, throw away all values that are not differentially corrected before interpolation. Average the fixes into 30 second intervals:

   97+297:00:08:00.000 N 10 19.2790 W 104 25.4930

   97+297:00:08:30.000 N 10 19.4500 W 104 25.4380

   - Smooth the values with a 9 point running average algorithm. Output remains fixed at 30 second intervals
   - Fix the values to 1 minute intervals
   - Perform dead reckoning based on the furuno for any gaps in the data. At this point, if there are any gaps, they will be gaps greater than 3 minutes.

   97+295:03:49:00.000 N 8 59.9698 W 104 9.7289 gp2 56.0 0.1

   97+295:03:50:00.000 N 8 59.9459 W 104 9.7394 dr 1.8 0.3

   - Decimate the data to 20 minute fixes, then re-fix at 1 minute intervals using dead reckoning. This is done to smooth out the peaks due to selective availability. This is the final navigation.

6. Shot Data

   - Check the raw navblock file for mutant records and inconsistent times.
   - Interpolate between any missing shots using a simple interpolation algorithm, not correcting for latitude. Interpolated shots are marked with a "-" in the time header field.
   - Merge the shot times with the final navigation prepared in the *Step 5*. The distance traveled between the two fixes is determined, allowing us to calculate the point where the shot was fired based on the time:

     ```
     lat = final_nav[i].lat + (final_nav[i+1].lat - final_nav[i].lat) * (navblock_sec / (final_nav[i+1].tot_secs - final_nav[i].tot_secs));

     lon = final_nav[i].lon + (final_nav[i+1].lon - final_nav[i].lon) * (navblock_sec / (final_nav[i+1].tot_secs -
     final_nav[i].tot_secs));
     ```

Data Collected During Cruise

All times are specified in GMT.

Data Files

The data delivered to the research consists of the following subdirectories:

File/Directory Name	Description
processed	Processed data
hs	Processed and raw hydrosweep

The processed directory consists of the following files for each day of data:

n. - 1 minute navigation from the "x." file and "fu.s" file

```
yy+ddd:hh:mm:ss.mmm N 12 12.1234 E 123 12.1234   gp1 123.1 12.1
yr day  time                lat              lon              id    set   drift
```

id strings: "gp1" = GPS Trmble NT200D
"gp 2"=GPS Trimble NT200D
"gp3" = GPS Magnavox MX4200D Receiver #1
"dr" = Dead Reckoned position

vt.n - merged BGM-3 gravity with final nav.

```
yy+ddd:hh:mm:ss.mmm N 16  0.4273 W  73 20.3055  1980   -4.1
yr   day  time              lat              lon              theog  FAA

978416.9   27.6   9.9   13.2    -2.7   3.9     -2.8   3.8
 raw_grav eotvos drift   dc       raw_vel      smooth_vel
                         shift     N     E        N    E
```

hb.n - interpolated center beam merged with navigation

```
yy+ddd:hh:mm:ss:mmm N 12 12.1234 E 123.1234  2222.0
yr day  time              lat              lon           depth (meters)
```

m. - merged bathy, maggie, gravity with final nav.

```
yy+ddd:hh:mm:ss.mmm N 14  9.0555 W  67  2.3969   gp3 276.9  0.2
yr   day  time              lat         lon            id     set    drift

5034.9    37401.8    17.2          -1.6     978349.0   13.1      9.1    13.2
depth     mag tot    mag           grv.     raw_grv    eotvos    tot    dc
          intensity  anomaly faa                                drift  shift
```

Instruments

True Time Clock

Instrument Kinemetric/TrueTime Division Model GPS-DC GPS Synchronized Clock
Logging 1 minute intervals
Science Data None

The True Time clock is used to adjust the CPU clock of the logging computer. The logging computer captures the continuous time records from the clock and provides these as a service to the rest of the network via a UDP broadcast. This enables the computers on the network to adjust their CPU times to UTC time.

Day	Time	Comments
046	1800	Data logging/processing begins
053	2030 - 2130	Power Failure (black out)
063	1500 - 1730	Power down Experiment
063	2120	Acquisition is off while in Panama
064	2300	Acquisition is on
071	1000	Acquisition is Off

Speed and Heading

Instrument Furuno CI-30 2-axis Doppler speed log, Sperry MK-27 gyro
Logging 3 second intervals
Processing The raw Furuno data is processed by taking the mean of all values within the even minute range and outputting the speed and heading on the even minute. All values taken during the 30 seconds before and after the even minute are used to calculate the median.

Science Data: None

Day	Time	Comments
046	1800	Data logging/processing begins
053	2030 - 2130	Power Failure (black out)
063	1500 - 1730	Power down Experiment
063	2120	Acquisition is off while in Panama
064	2300	Acquisition is on
071	1000	Acquisition is Off

GPS SATELLITE FIXES:

Instruments gp1: GPS Trimble NT200D
gp2: GPS Trimble NT200D
gp3: Magnavox MX-4200 Global Positioning System

Logging 10 second intervals on all receivers

Checking

gp3: Minimum number of SATs: 3
Dilution of precision maximum: north = 4.0, east = 4.0
Speed maximum: 20.0

Reject fixes with high drifts in navigation

Processing **See Navigation Processing Pipeline**

Science Data *n.*

Day	Time	Comments
046	1800	Data logging/processing begins
053	2030 - 2130	Power Failure (black out)
063	1500 - 1730	Power down Experiment
063	2120	Acquisition is off while in Panama
064	2300	Acquisition is on
071	1000	Acquisition is Off

BATHYMETRY:

Instrument Krupp Atlas Hydrosweep Center Beam

Logging Each Hydrosweep Ping is logged, and center beam data is extracted and logged separately.

Processing Raw data is checked to process only good centerbeam records that were acquired in *survey* mode.
This data is then processed to produce a median value for each even minute. The median is the median of all records 30 seconds before and after the even minute.

Final Data The median is merged with the one-minute navigation fixes to provide the final centerbeam data.

Notes During the cruise, hydrosweep data was occasionally turned off while coring. The following chart shows all breaks greater than 5 minutes.

Science Data: *hb.n*

Day	Time	Comments
046	1800	Data logging/processing begins
053	2030 - 2130	Power Failure (black out)
054	1930 - 2340	Repairs on HS
063	1500 - 1730	Power down Experiment
063	2120	Acquisition is off while in Panama
064	2300	Acquisition is on
071	1000	Acquisition is Off

SEA TEMPERATURE:

Instrument Omega DP10 Series
Logging 1 minute intervals
Checking none
Smoothing none
Science Data none

Day	Time	Comments
046	1800	Data logging/processing begins
053	2030 - 2130	Power Failure (black out)
063	1500 - 1730	Power down Experiment
063	2120	Acquisition is off while in Panama
064	2300	Acquisition is on
071	1000	Acquisition is Off

WEATHER STATION:

Instrument R.M./. Young Precision Meteorological Instruments 26700 Series
Logging 1 minute interval
Final Data raw.
Notes Bird 2 is no longer used
Science Data none

Day	Time	Comments
046	1800	Data logging/processing begins
053	2030 - 2130	Power Failure (black out)
063	1500 - 1730	Power down Experiment
063	2120	Acquisition is off while in Panama
064	2300	Acquisition is on
071	1000	Acquisition is Off

BGM-3 GRAVITY:

Instrument Bell Aerospace BGM-3 marine gravity meter
Logging 1 second intervals

Science Data *vt.n (Observed, Eotvos, Free Air Anomaly value at 00 seconds of each minute)*
m.n (merged bathy, maggie, gravity with final nav.)

Merge with navigation calculate Eotvos correction and Free Air Anomaly.
Checking Visual check of plot of data to determine satisfactory Eotvos corrections, reject spikes of data at turns.
Velocity smoothing 5 point running average throughout the cruise.
Processing

Since current BGM-3 output has double counts every few minutes the following scheme has been implemented until the hardware and interface code has been fixed:

1. Run a 1 minute Gaussian filter through the data. This will narrow the output spikes and make them stand out better. Output interval has been hard-wired to every 15 seconds.
2. Pass the output through filter1d (see gmtsystem) using -FG480 (an 8 minute Gaussian filter with robust option, i.e., ignore "outlier" points (i.e. the spikes).

Calculations

eotvos_corr = 7.5038 * vel_east * cos(lat) + .004154 * vel*vel
corrected_grv = raw_grv + eotvos_corr - drift - dc_shift
faa = corrected_grv - theoretical_grv

1980 theoretical gravity formula

Y_0 = 978.0327 x (1 + .0053024 x sin(□) x sin(□) - .0000058 x sin(2 x □) x sin(2 x □))

Day	Time	Comments
046	1800	Data logging/processing begins
053	2030 - 2130	Power Failure (black out)
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063	2120	Acquisition is off while in Panama
064	2300	Acquisition is on
071	1000	Acquisition is Off

EW-9802 Bridgetown, Barbados, West Indies *OFFICIAL*

Pier/Ship	Latitude	Longitude	Reference	Latitude	Longitude
				13 06.4 N	59 37.9 W

Bollard 23, same as pier reference

Bollard 34. 3rd Bollard from north end of breakwa at the deep water harbor.

	Id	Date	Drift	Drift/Day	Total Drift
Pre Cruise	EW9801	2/13/98	1.70	0.01	1.56
Post Cruise	EW9801	3/12/98	1.87	0.07	3.43
Total Days		27.00			

Time	Entry	Value	
11:21	CDeck Level BELOW Pier	0.33	meters
11:21	Pier 1 L&R Value	1969.80	L&R
11:33	Reference L&R Value	1970.40	L&R
11:38	Pier 2 L&R Value	1969.83	L&R
Jan-04	Reference Gravity	978294.44	mGals
16:48	Gravity Meter Value (BGM Reading)	978297.50	mGals
	Potsdam Corrected	0	1 if corrected

*Gravity meter is **5.5** meters below CDeck*

Difference in meters between Gravity Meter and Pier: 5.83 meters

Height Cor = Pier Height * FAA Constant

5.83 * 0.31 = 1.81 mGals/min

Difference in mGals between Pier and Gravity Meter

Delta L&R = Pier (avg) - Reference * 1.06 L&R/mGal

1969.82 - 1970.40 * 1.06 = -0.62 mGals

Pier Gravity = Reference + Delta mGals [+ Potsdam]

978294.44 + -0.62 + 0.00 = 978293.82 mgals

Gravity @meter = Pier Gravity+Height Correction

978293.82 + 1.81 = 978295.63 mGals

Current Mistie = BGM Reading - Calculated Gravity

978297.50 - 978295.63 = 1.87 mGals