Lamont-Doherty Earth Observatory
Office of Marine Affairs
61 Route 9W
Palisades, NY 10964

R/V Maurice Ewing

Transit Data Reduction Summary

EW0003 - Suva, Fiji - Puntarenas, Costa Rica

March 2, 2000 - March 26, 2000

Port Dates

Date	Julian	Time	Port
3/2/2000	062	2110	Depart Suva
3/28/2000	086	1520	Arrive Puntarenas, Costa Rica

Contents

Cruise Members

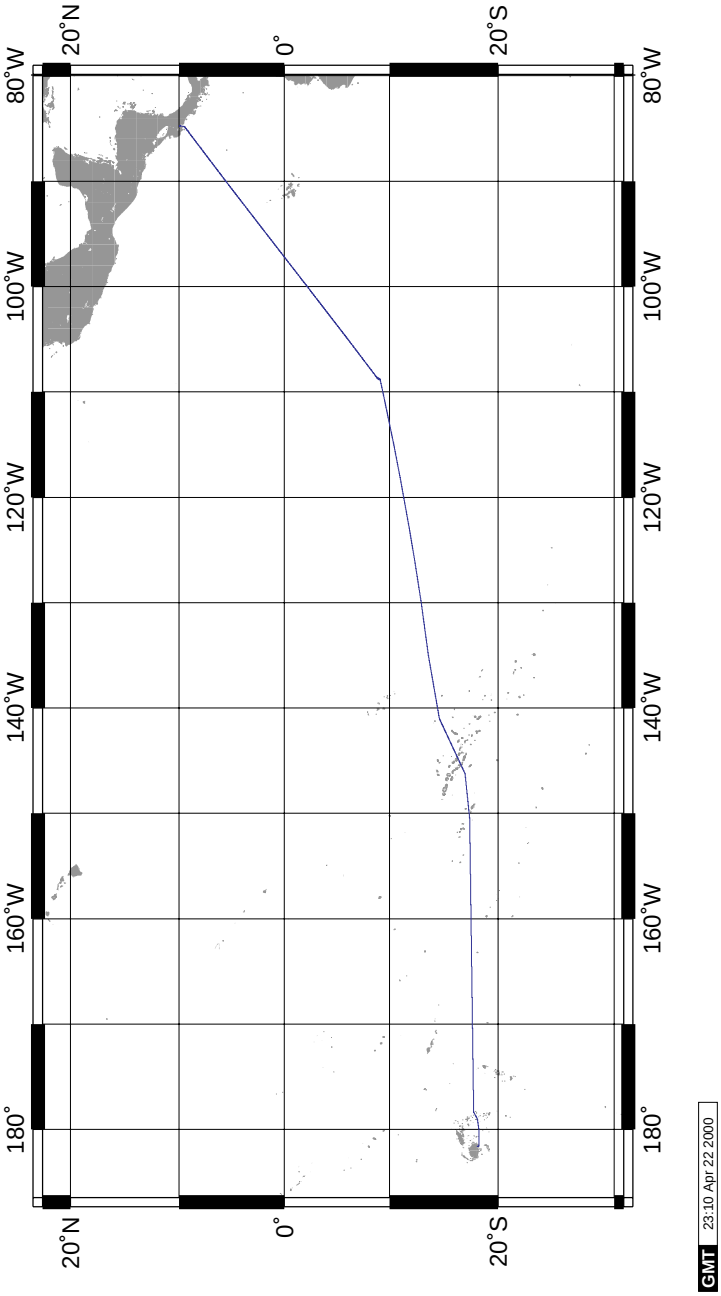
Ship Staff

Name	Position	Email
Mark Landow	Master	captain@ewing.ldeo.columbia.edu
Albert Karlyn	Chief Engineer	engine@ewing.ldeo.columbia.edu

Science Party

Track Map

EW-0003 Suva, Fiji - Puntarenas, CR



Cruise Notes

Data Acquisition Notes

This cruise was not attended by a data processor, so this report is based on the processing of the data after the cruise. This report and processing were performed by Jeff Turmelle [*jefft@ldeo.columbia.edu*]

It appears there are some anomalies in the Hydrosweep data . Specifically at day 063, starting approximately 2100, there is a vertical drop about 1,000 meters in one minute. There is also a gap of about 2 hours on day 067 between 1800 and 2000, and about one hour on day 075 between 1900 and 2000.

Gravity data was inexplicably lost from day 075, starting around 1900. No Tie was performed in Fiji, so the previous tie is the one that is used here.

Gravity Tie Data:

- DC Shift: 4.16
- Drift/Day: .001
- Tie Date: 3/28/2000

Logging Notes

The following devices were logged during this cruise:

- Kinemetrics True Time GPS UTC receiver
- Furuno CI-30 doppler speed log with Sperry MK-27 gyro
- Trimble Tasman GPS Y-Code receiver
- Trimble NT200D GPS Differential receiver
- Bell BGM-3 Gravimeter
- Krupp Atlas Hydrosweep DS Swath bathymetry
- RM Young 26700 weather station

Data Instruments

Time Reference

The Kinemetrics Truetime UTC clock is logged at 60 second intervals. CPU time is synchronized every 60 seconds to this clock. Since the log files weren't included on the tape from the ship, these will need to be included on tape EW0003. There is no processing for these files, and are usually only used during the cruise to insure that the CPUs are maintaining time synchronization with UTC.

Speed and Heading

The Furuno CI-30 dual axis speed log and Sperry MK-27 are logged at 3 second intervals.

Date	Comment
062/0100	Furuno logging started
088/1812	Furuno logging stopped

GPS Receivers

gp1 = Trimble Tasman Y-Code
gp2 = Trimble NT200D

Both GPS receivers were logged at 10 second intervals. Navigation os processed and reduced to 60 second intervals which is then applied to the magnetics, gravity, bathymetry, shot data and any other acquired data. All data for this cruise was processed with the Tasman (gp1). Only outages > 10 minutes are accounted for here.

Date	Comment
062/0100	GPS Logging starts
088/1812	GPS Logging ends

Gravimeter

The Bell BGM-3 Gravimeter is logged at 1-second intervals.
DC Shift: 4.16 **Drift per Day:** 0.001 **Gravity Tie Date:** March 28,03:20

Date	Comment
062/0230	Gravity logging begins
075/1840	Gravity logging ends

Magnetometer

The Geometrics G-886 Marine Magnetometer was not logged.

Date	Comment

Hydrosweep Bathymetry

The Krupp Atlas Hydrosweep-DS full swath data is logged for each ping, and the centerbeam data is extracted and processed separately. The hydrosweep operates at varying intervals based on water depth.

The full swath data can be read and processed using the MB-System software which can be downloaded from the web site: **http://www.ldeo.columbia.edu/MB-System**
MB-System 4.6.10 is necessary to process data after Jan 1, 2000.

Date	Comment
062/2220	HS logging starts
067/1800 - 067/2000	HS interruption
075/1830 - 075/1940	HS interruption
086/2130	HS logging ends

Sea Temperature

Sea Temperature was not logged.

Date	Comment

Weather Station

The R.M. Young Precision Meteorological Instruments; 26700 series is used to log a variety of weather conditions at 1-minute intervals.

Date	Comment
062/0100	Logging starts
059/1811	Logging ends

PreCruise Gravity Tie

EW 9914 Christchurch, NZ Gravity Tie

Pier/Ship	Latitude	Longitude
	43 36.4S	172 43.2 E

Reference	Latitude	Longitude
	43 31.77 S	172 37.18 E

Using Reference point from March 1992, and again in February 1996:

Marker ***1962*** on walkway across from RR tracks.

	Id	Julian	Date	Mistie	Drift/Day	DC Shift
Pre Cruise	EW9912	336	12/2/99	3.87	0.04	2.28
Post Cruise	EW9914	363	12/29/99	4.16	0.011	3.87
Total Days			27.00	0.29		

Time	Entry	Value	
	CDeck Level BELOW Pier	1.50	meters
	Pier 1 L&R Value	4095.00	L&R
	Reference L&R Value	4064.90	L&R
	Pier 2 L&R Value	4095.00	L&R
7/1/70 0:00	Reference Gravity	980508.06	mGals
	Gravity Meter Value (BGM Reading)	980546.30	mGals
	Potsdam Corrected	0	1 if corrected

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

Difference in meters between Gravity Meter and Pier: 7.00 meters

Height Cor = Pier Height* × FAA Constant

Pier Height*	FAA	Constant			
7.00	0.31			2.17	mGals/min

Difference in mGals between Pier and Gravity Meter

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

Pier (avg)	Reference	1.06 L&R/mGal		Delta L&R	
4095.00	4064.90	1.06		31.91	mGals

Gravity in mGals at Pierside

Reference + Delta mGals [+ Potsdam] = Pier Gravity

Reference	Delta mGals	[+ Potsdam]		Pier Gravity	
980508.06	31.91	0.00		980539.97	mgals

Gravity in mGals at Meter

Pier Gravity+ Height Correction = Gravity@meter

Pier Gravity	Height Correction			Gravity@meter	
980539.97	2.17			980542.14	mGals

Current Mistie

BGM Reading- Calculated Gravity = Current Mistie

BGM Reading	Calculated Gravity			Current Mistie	
980546.30	980542.14			4.16	mGals

Post-Cruise Gravity Tie

EW -2003

Pier/Ship	Latitude	Longitude
	9 58.4N	84 49.9W

Tied at dock in Puntarenas, about 100 meters from the base station

Reference	Latitude	Longitude
	9 58.4N	84 49.9W

At the end of the dock by the 4 canons is a tiny gravity marker in the corner closes to the water.

ACIC 4551-1

	Id	Julian	Date	Mistie	Drift/Day	DC Shift
Pre Cruise	EW9914	363	12/29/99	4.16	0.01	3.87
Post Cruise	EW2003	88	3/28/00	4.21	0.001	4.16
Total Days			90.00	0.05		

Time	Entry	Value	
03:20 CST	CDeck Level BELOW Pier	1.00	meters
	Pier 1 L&R Value	1912.30	L&R
	Reference L&R Value	1912.30	L&R
	Pier 2 L&R Value	1912.30	L&R
	Reference Gravity	978230.87	mGals
	Gravity Meter Value (BGM Reading)	978237.10	mGals
	Potsdam Corrected	0	1 if corrected

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

Difference in meters between Gravity Meter and Pier: 6.50 meters

Height Cor =	Pier Height*	FAA Constant			
	6.50	0.31			2.02 mGals/min

Difference in mGals between Pier and Gravity Meter

Pier (avg) -	Reference *	1.06 L&R/mGal		Delta L&R
1912.30	1912.30	1.06		0.00 mGals

Gravity in mGals at Pierside

Reference +	Delta mGals [+ Potsdam]			Pier Gravity
978230.87	0.00	0.00		978230.87 mgals

Gravity in mGals at Meter

Pier Gravity+	Height Correction			Gravity@meter
978230.87	2.02			978232.89 mGals

Current Mistie

BGM Reading-	Calculated Gravity			Current Mistie
978237.10	978232.89			4.21 mGals

Data Processing

GPS Processing

Navigation data is post-processed in order to accurately determine the position and remove GPS accuracy errors. We perform slightly different processing depending on the type of receiver.

1. Check data for mutant records and non-sequential times.
2. If we have speed and/or DOP information, remove records that have excessive speed or too high of a DOP[1]
3. Convert from NMEA or proprietary format to a standard format
4. 2000+009:00:28:50.091 N 42 14.1536 W 063 25.5897 P-trimble
5. If we are processing known differential data, remove non-differential fixes from the file.
6. Interpolate and reduce data. Fixes are reduced to 30 second fixes and any minor gaps (< 3 minutes) are linearly interpolated.
7. Smooth data using a 9 point running average algorithm and further reduce data to 60 second fixes.
8. Perform dead reckoning using the smoothed Furuno speed and heading to fill in major gaps (> 3 minutes) and to insure the accuracy of the GPS data

Furuno Processing

Furuno speed and heading is processed by smoothing the data using a vector summing algorithm. Data is reduced and output at 60 second intervals by taking the smoothed values and calculating the mean value for the 30 seconds before and after the whole minute.

Hydrosweep Processing

Center Beam Processing

1. Remove all survey and calibration records from the raw data and all 0 level depths
2. Reduce data to one minute intervals on 00 seconds of the minute by computing the median values from the raw values that lie between +-30 seconds of 00 seconds of the minute.
3. Merge the data with the processed navigation to end up with one minute hydrosweep centerbeam fixes with navigation.

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1. Dilution of Precision, a term used to measure the accuracy of the fix based on the number of Satellites the GPS receiver is tracking, and the position of the satellites.

Full Swath Processing

Hydrosweep swath data is processed using the MB-System software, and consists primarily of hand-editing the beam data. Source code and documentation for MB-System may be found at the Web site: **http://www.ldeo.columbia.edu/MB-System**.

The full swath data was not processed for this cruise.

Gravity Processing

bias = 852645.3;Dec 5, 1997
scale = 5.0940744July 9, 1992
*mGals = raw_gravity_count * scale + bias;*

Logging

- Raw gravity is logged to disk (roughly 1 sample/second) and broadcast to the network.
- A real-time gravity process reads the sampled data and applies a 6 minute gaussian filter to the raw sample to provide a running display of the current gravity. This value is used in the gravity ties to determine the local gravity. (Gravity Meter Value (BGM Reading))

Reduction

1. Raw gravity is filtered using a 6 minute gaussian filter and mGals are output. The raw mGals are represented by
   `mGals = gravitycount * scale + bias;`
2. A second filter is then applied; an 8 minute Gaussian filter using the GMT system:
   `filter1D -G480 -R -E`
3. The filtered output is then reduced to 1 minute intervals by using the mean values of all data +/- 30 seconds from the 00 second mark of the minute to output:
   `98+254:00:07:00.000 980422.37`
   `98+254:00:08:00.000 980422.38`
4. The data is merged with the navigation. See Processed File Formats.
   At this point eotvos corrections are determined by merging the daily navigation and raw gravity files and calculating the Eotvos correction as:
   `Eotvos correction = 7.5038 * vel_east * cos(lat) + .004154 * vel*vel`
5. The velocities used in the Eotvos calculation are smoothed to reduce the jitter in the corrected gravity and FAA values. The smoothing is done using a 9 point running average.

Gravity Tie

It is usual practice to have a gravity "tie" to a gravity reference base station during the port stay. A portable gravity meter, e.g. the Lacoste Model G #70, is used to make 1) a pier-side reading; 2) a reading at the base station; 3) an additional pier-side reading. The pier-side gravity value, adjusted in value to correspond to the height of the BGM gravity meter, is compared to the real-time BGM Gravity Reading discussed previously.

The practice is not to adjust the BGM-3 so that its reading agrees with the pier-side gravity value, but to establish a "dc shift", which represents a constant correction to be applied to all gravity values on the next cruise.

For example, suppose the pier-side value equaled 980274.7 mGal and the BGM reading was 980279.9, the dc shift would be 5.2 mGal. In other words, the BGM is 5.2 mGal high. This value is subtracted from observed values of gravity following the cruise as a constant correction. The "drift" of the Bell gravity meter is determined from the two in-port gravity station ties. In the pre-cruise tie the BGM might have been found to be 5.3 mGal high and during the post-cruise tie it is 8.4 mGal high. The drift during the cruise is therefore equal to 3.2 mGal (8.4 - 5.2). The amount of drift per day is then calculated and gravity data is processed with the drift values corrected for the length of the cruise.

Thus, for daily reduction at sea the drift correction option cannot be used. However, the drift rate of the Bell gravimeter is very low, usually much less than 0.1 mGals/day; thus useful analysis of the FAA values while at sea is possible

A corrected gravity value is computed as:

```
corrected_grv = raw_grv + eotvos_corr - drift - dc_shift
```

The theoretical gravity value is based upon different models for the earth's shape.

```
1930 = 1930 International Gravity Formula
1967 = 1967 Geodetic Reference System Formula
1980 = 1980 Gravity Formula
```

The FAA is computed as:

```
faa = corrected_grv - theoretical_grv
```

Raw Compass Block — cb1.d*jjj*

CPU Time Stamp	Line	Shot	GPS1 Position
2000+009:00:01:29.572	LAU1	021144	S 19 26.4331 W 176 16.3491

GPS2 Position	Tailbuoy Position	Compass Positions/Compass# ...
S 19 26.4393 W 176 16.3198	S 19 25.2864 W 176 19.7897	107.0 C01 97.8 C03

No processing is performed on compass block data since the compasses are directly related to the GPS position at the given time.

Raw Furuno Log — fu.d*jjj*

CPU Time Stamp	Track	Speed	Heading	Gyro
2000+009:00:01:53.091	-	4.4	140.5	148.3

Hydrosweep Center Beam merged w/ Navigation — hb.n*jjj*

CPU Time Stamp	Latitude	Longitude	Depth
2000+009:09:55:00.000	N 13 6.6206	W 59 39.3908	134.9

Hydrosweep is median filtered at 1 minute intervals, then merged with navigation at 1 minute intervals.

Merged Data — m.*jjj*

CPU Time Stamp	Latitude	Longitude	GPS	Set	Drift	Depth
2000+009:14:08:00.000	N 13 54.3859	W 59 43.5175	gp1	0.0	0.0	732.9

Magnetic Total Intensity	Gravity Anomaly	FAA	GRV	EOTVOS	Drift	Shift
0.0	0.0	31.3	978370.7	-3.9	0.0	4.5

The gravity drift and shift are values that have been added to the raw gravity logged to make up for drift in the meter that has been lost in accordance with a gravity check at each port stop

Navigation File n.*jjj*

CPU Time Stamp	Latitude	Longitude	Used	Set	Drift
2000+009:00:03:00.000	N 13 6.2214	W 59 37.9399	gp1	0.0	0.0

The raw navigation is interpolated to 30 second intervals. Then smoothed with a 9 point windowing average. The smoothed GPS points are them Fixed at 1 minute intervals. Dead reckoning is then performed across the gaps to insure proper GPS positioning.

Time Shot File ts.n*jjj*

CPU Time Stamp	Shot #	Latitude	Longitude	Line Name
2000+009:00:15:00.000	00295	N 16 11.8600	W 59 48.0157	strike1

Gravity File merged with navigation vt.n*jjj*

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

CPU Time Stamp	Latitude	Longitude	Model[1]	FAA	Raw
2000+009:00:15:00.000	N 16 11.8600	W 59 48.0157	1980	-175.9	978253.6

Eotvos Smooth	Drift Total	DC Shift	Raw Velocity North	Raw Velocity East	Smooth Velocity North	Smooth Velocity East
9.7	0.0	4.5	-4.350	1.282	-4.333	1.329

1. The theoretical gravity value is based upon different models for the earth's shape: 1930 is the 1930 Intl. Gravity Gormula; 1967 is the 1967 Geodetic Referency System Formula, and 1980 is the 1980 Intl. Gravity Formula.

Raw Weather File Format — wx.d*jjj*

CPU Time Stamp	wsi1	wss1	wsm1	wsx1	wdc1	wds1
2000+009:00:00:00.244	9.3	5.4	13.2	21.1	27.1	26.1

wdm1	wsi2	wss2	wsm2	wsx2	wdc2	wds2	wdm2	tcur	tavg
6	0	0	0	0	0	0	0	26.7	26.7

min	tmax	rh	rhn	rhx	baro
26.5	27.0	66	58	68	10

wsi1 = wind speed, instantaneous, bird #1
wss1 = wind speed, 60 second average, bird #1
wsm1 = wind speed, 60 minute average, bird #1
wsx2 = wind speed, current 60 minute maximum, bird #1
wdc1 = wind direction, current, bird #1
wds1 = wind direction, 60 second average, bird #1
wdm1 = wind direction, 60 second st deviation, bird #1
~~wsi2 = wind speed, instantaneous, bird #2~~
~~wss2 = wind speed, 60 second average, bird #2~~
~~wsm2 = wind speed, 60 minute average, bird #2~~
~~wsx2 = wind speed, current 60 minute maximum, bird #2~~
~~wdc2 = wind direction, current, bird #2~~
tcur = temperature, current
tavg = temperature, current 60 minute average
tmin = temperature, current 60 minute minimum
tmax = temperature, current 60 minute maximum
rh = relative humidity
rhn = relative humidity, current 60 minute minimum
rhx = relative humidity, current 60 minute maximum
baro = barometric pressure

Bird2 is deactivated, so all strikeout items are not valid.

Tape Contents

- *EW0003.pdf*
  cruise report (Adobe Acrobat PDF file)
- *ew0003.cdf*
  final processed data tied to navigation (NetCDF files) for LDEO MG&G database
- *ew0003.cdf_nav*
  final processed navigation (NetCDF files) for LDEO MG&G database
- *docs/*
  FileFormats for all the files included on tape.
- *hs/*
  Hydrosweep swath and centerbeam bathymetry (raw)
- *processed/*
  final processed data tied to navigation (day files) plus trackplots, scripts, summary files
- *raw/*
  original logged data (day files)
- *reduction/*
  intermediate processed data (day files)