MIRAI **MR09-04** **Gravity**

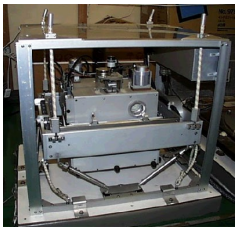
Last Modified: 2024/2/28

For Using Data	
Data Policy	JAMSTEC
Principal Investigator	Data Management Office
Use Constraints	See Terms and Conditions about constrain of use.
Data Citation	See Terms and Conditions about data citation.

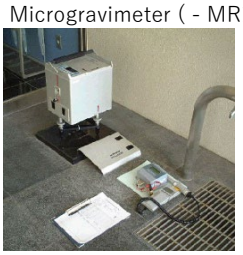
Quality DMO-Processed

Instrument

Shipboard gravimeter



Microgravimeter (- MR11-05 Leg2)



Overview

The data provided here are quality-controlled absolute gravity data and free-air anomalies. The absolute gravity data are a combination of relative gravity data measured by the shipboard gravity meter and the absolute gravity data of the ports in departure and arrival. Drift corrections and the Eoetvoes corrections were done before converting into absolute gravity. As a quality control, low reliability data were removed (see Quality control of data for the judging criteria). The absolute gravity values of the ports are referenced to those of the Japan Gravity Standardization Net of the Geographical Survey Institute of Japan.

Measurement System

1) Shipboard gravity meter

The system consists of two main assemblies; the gyro-stabilized platform including the gravity sensor and the data handling & control system.

Manufacturer :	LaCoste & Romberg
Type :	S-116
Measurement range :	12,000 mGal
Accuracy :	1.0 mGal
Drift rate :	< 3.0 mGal/month
Location :	Gravity meter room
Reference :	"Model S Air-Sea Dynamic Gravity Meter System II" INSTRUCTION MANUAL LaCoste and Romberg Gravity Meters, Inc. 2004

2) Portable gravity meter

The portable gravity meter consists of two modules; the data acquisition/control module and the gravity sensor module. The gravity sensor is enclosed in a thermostatically controlled vacuum chamber. The portable gravity meter is used to calculate the absolute gravity of the port with reference to the gravity station of the Japan Gravity Standardization Net of the Geographical Survey Institute of Japan.

Manufacturer :	SCINTREX
Model :	CG-3M
Measurement range :	7,000 mGal
Standard deviation :	0.005 mGal
Drift rate :	< 0.02 mGal/day
Reference :	“CG-3M AUTOGRAV AUTOMATED GRAVITY METER OPERATOR MANUAL”, 'SCINTREX

Absolute gravity in Ports

Date (UTC)	2009/10/25 2:34	2009/12/12 5:25
Port	SEKINEHAMA	SEKINEHAMA
Absolute gravity (mGal)	980371.95	980371.93
Sea level (cm)	256	239

Draft shipboard (cm)	628	630
Absolute gravity at sensor position (mGal)	980372.96	980372.89
Reading of shipboard gravity meter (mGal)	12642	12641.5

Altitude conversion formula

Ag = Pg + β * HS/100 + (HD - HSG)/100 * (β - 4π*k*ρw)

Ag : The absolute gravity at the shipboard sensor position (mGal)

Pg : The absolute gravity of the portable gravity meter (mGal)

HSG : Height of the shipboard gravity meter from the ship bottom (530 cm : R/V MIRAI)

HS : Sea level (cm)

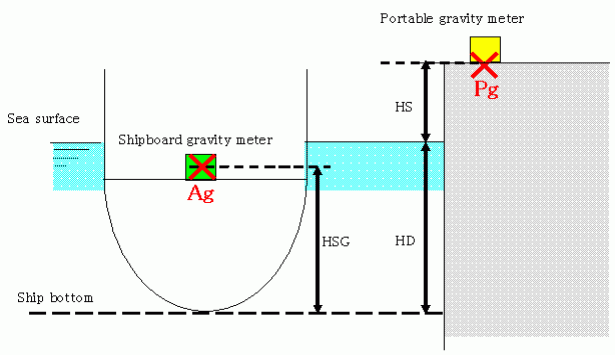
HD : Draft (cm)

β : Free-air gradient 0.3086 (mGal/m)

k : Gravitational constant

ρw : Density of sea water

4π*k*ρw = 0.0864



Data processing

According to the filter process of the gravity meter system, the gravity data has a time lag of 120 seconds between the measurement and its output. After adjustment of this lag time, the following corrections and calculations were performed.

1) Drift correction

D = ((Vge-Vgs)-(Age-Ags))/(Te-Ts)

D : Drift value (mGal/day)

Vgs : The shipboard gravity at the start of the cruise (mGal)

Vge : The shipboard gravity at the end of the cruise (mGal)

Ags : The absolute gravity at the shipboard sensor position at the start of the cruise (mGal)

Age : The absolute gravity at the shipboard sensor position at the end of the cruise (mGal)

Ts : The start time of the cruise (day)

Te : The end time of the cruise (day)

2) Eoetvoes correction

E = 7.503*S*cos(ϕ)*sin(α)+0.004154*S^2

E : Eoetvoes correction (mGal)

S : Ground speed of the ship (knot)

ϕ : Latitude

α : Course of the ship (measured clockwise from the north)

Reference : Blakely,R.J., Potential theory in gravity & magnetic applications, Cambridge University Press, New York,441pp,1995

* The navigation data such as S, ϕ and α are the 4-min average values. Before average processing, following data were removed from each dataset. If the number of data used for a 4-min average calculation did not include more than 50% of good data, the processed average value was considered as a missing value.

・Time error (inversion of time, continuation of same timestamps)

・Ship speed exceeding 20 knot

・Course of the ship except 0-360 degree

3) Calculation of the absolute gravity

G = Ags+(Vg-Vgs)-D*(T-Ts)+E-H*(β-4π*k*ρw)

G : The absolute gravity at sea surface (mGal)

Ags : The absolute gravity at the shipboard sensor position at the start of the cruise (mGal)
Vgs : The shipboard gravity at the start of the cruise (mGal)
Vg : The shipboard gravity at the measurement time (mGal)
D : Drift value (mGal/day)
Ts : The start time of the cruise (day)
T : The measurement time (day)
E : Eoetvoes correction (mGal)
H : Height from sea surface of the shipboard sensor position (m)
β : Free-air gradient 0.3086 (mGal/m)
k : Gravitational constant
ρ w : Density of sea water
4π *k* ρ w = 0.0864

4) Calculation of the Free-air anomaly

Gf = G - γ + δ

Gf : The Free-air anomaly (mGal)
G : Absolute gravity at sea surface (mGal)
γ : Normal gravity (mGal)
* The normal gravity formula of the Geodetic Reference System 1980

γ = 978032.67715(1+0.0052790414sin^2 ϕ +0.0000232718sin^4 ϕ +0.0000001262sin^6 ϕ +0.0000000007*sin^8 ϕ)

δ : Atmospheric correction at sea surface
δ = 0.87-0.0000965*0 (mGal)

5) Output of the data

Time (UTC)
Latitude (degree)
Longitude (degree)
Processed absolute gravity at sea surface (mGal)
Free-air anomaly (mGal)

Quality control of data

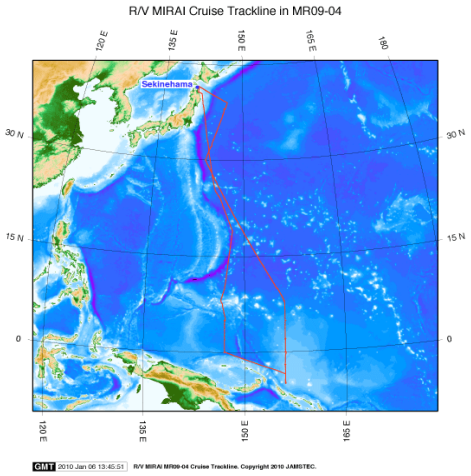
Following criteria were used for removal of low reliability data:

・Abrupt free-air anomaly change exceeding 10 mGal/km
・Change in Eoetvoes correction exceeding 3 mGal/min
・Ground speed of the ship below 3 knot

Note

1) File naming rule : Cruise ID_corr.grv
2) Data interval : ten seconds
3) Geodetic system : WGS84
4) If you would like the raw data set, please contact DMO at "dmo@jamstec.go.jp".
5) It was appeared that errors in a part of gravity data obtained by using R/V Mirai, associated with converting into absolute gravity. Inappropriate processing was also performed on this cruise, the data has been reprocessed using the correct absolute gravity value for the port and replaced in March 2024.

Related Information



MR09-04

Ship Name:	MIRAI
Period:	2009/11/03 - 2009/12/12
Chief Scientist:	Yuji Kashino (JAMSTEC)
Project Name:	[Tropical Ocean Climate Study (TOCS),Station KEO]
Proposal:	Tropical Ocean Climate Study

Lidar observations of optical characteristics and vertical distribution of aerosols and clouds

Anatomy of the ocean-atmosphere interface in mid-latitudes

Variability of Salinity and Temperature in the North Western Pacific (Argo program)

Archive of surface meteorological data

Tectonic evolution of the Pacific Plate

Standardising the marine geophysics data and its application to the ocean floor geodynamics studies

Distribution and ecology of oceanic Halobates inhabiting tropical area around equator and their responding system to several environmental factors

Development of drifting buoy system with in situ sea surface pCO2 sensor

Observational Research on the Kuroshio Transport and Sea Surface Flux

Study on long term and vertical measurement by in-situ pH/pCO2 sensor

On-board continuous air-sea eddy flux measurement

Water sampling for making isotope distribution map over the Ocean

Influence of abnormal bases from bacteria in marine eco-system

Format Description for Gravity Corrected

No.	Column	Content	Format	Unit	Remarks
1	1 - 8	Date	i4,i2,i2		YYYYMMDD (UTC)
2	10 - 15	Time	i2,i2,i2		hhmmss (UTC)
3	17 -25	Latitude	f9.5	degree	No sign for the northern hemisphere. Negative for the southern hemisphere.
4	27 -36	Longitude	f10.5	degree	No sign for eastern hemisphere. Negative for the western hemisphere.
5	38 -45	Absolute gravity	f8.1	mGal	
6	48 -53	Free-air anomaly	f6.1	mGal	