Expedition 330 - GBM Data Processing

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1 Processing

This document is supposed to give a short overview over the necessary data processing steps for Göttingen Borehole Magnetometer (GBM) data. Further detail can be found in Leven (1997); Steveling et al. (2003); Virgil (2012); Virgil et al. (2011, accepted) and in upcoming publications about Expedition 330. The IODP Log Database contains the raw data files, i.e. all data that has been acquired during northing and the complete down- and uplogs, as well as unoriented files and reoriented files. All data in the unoriented files are corrected for sensor errors, but not for tool rotation and rotation of the Earth. All data in the reoriented files are additionally corrected for tool rotation and rotation of the Earth. The depth scale of the processed files begins at seafloor, the depth scale of the raw data files begins at rig floor.

1.1 General Processing

1.2 Fibre Optic Gyros

- Removal of the temperature dependent drift.
- Correction for the misalignment between R_z and R_y, R_z and R_x
- Interpolation of R_x and R_y to a data frequency of 2 Hz

1.3 Magnetometer

Correction of sensor offsets, scale factors and misalignments:

$$\vec{B}_c = \omega \cdot \sigma(\vec{B}_m - \vec{B}_{off}) \tag{1}$$

with

$$\omega = \begin{pmatrix} 1 & \cos\xi_{xy} & \cos\xi_{xz} \\ 0 & \sin\xi_{xy} & \frac{\cos\xi_{yz} - \cos\xi_{xy}\cos\xi_{xz}}{\sin\xi_{xy}} \\ 0 & 0 & \sqrt{\sin^2\xi_{xz} - (\frac{\cos\xi_{yz} - \cos\xi_{xy}\cos\xi_{xz}}{\sin\xi_{xy}})^2} \end{pmatrix}, \tag{2}$$

and

$$\sigma = \begin{pmatrix} \sigma_x & 0 & 0 \\ 0 & \sigma_y & 0 \\ 0 & 0 & \sigma_z \end{pmatrix} \tag{3}$$

where ω is a matrix containing the misalignment angles ξ_{ij}, σ is a matrix containing the scale factors σ_i and $\vec{B}_{off}$ is a vector containing the offsets.

1.4 Inclinometers

Correction for Offsets. The definition of the inclination angles used here additionally requires a multiplication of N_y with -1. This results in positive N_x and N_y when the tool is inclined in the direction of the respective axis.

1.5 Reorientation

All reorientation algorithms have in common that in each step the effective rotation of the Earth in the reference frame of the tool is calculated and removed from the gyro data. Additionally, a misalignment between the coordinate system of the gyros and the coordinate system of the magnetometers is taken into account.

1.5.1 U1374 - Run 1

Here, a combination of N_x and N_y is used to reorient the tool. For the initial northing, data point 1294 was chosen and the orientation of the tool was determined as 53.7°. An additional drift of -0.00006 °/s was added to each R_z value.

1.5.2 U1374 - Run 2

Again, a combination of N_x and N_y is used to reorient the tool. For the initial northing, data point 2725 was chosen and the orientation of the tool was determined as 51.05°. An additional drift of 0.0002 °/s was added to each R_z value.

1.5.3 U1376

Here we used R_x, R_y and R_z for reorientation. An optimal drift was determined to reduce the difference between the inclination of the tool calculated from the gyros and the inclination as given by N_x and N_y. For the initial northing, data point 3027 was chosen and the orientation of the tool was determined as 227.3500°. An additional drift of 0.00046 °/s was added to each R_x value, of -0.00147 °/s to each R_y value and of 0.00028 °/s to each R_z value.

2 Settings

This section lists all calibration factors as they were used to process and reorient the data for Expedition 330.

Errors in Orthogonality of the Gyros

fogxz -0.19°
fogyz -0.02°

Misalignment between Magnetometer and Gyro

magfogxz 0.165°
magfogyz -0.028°

Calibration Factors for the Magnetometer

Scale Factors:
σ_x: 0.9982
σ_y: 1.0068
σ_z: 0.9940
Offsets:
Off_x: 98.85
Off_y: 316.73
Off_z: 187.48
Errors in Orthogonality:
ξ_{xy}: -0.001352
ξ_{xz}: 0.0001863
ξ_{yz}: 0.000178

Temperature Drift of the Gyros

T_x in °C: 0.0 23 28 32 36 40 43.5 74
$Drift_x$ in °/h: 1.2 1.27 1.32 1.29 1.48 1.33 1.46 1.35
T_y in °C: 0 26 28 30 34 38 40 42 46 50 52 56 60 62 66 74
$Drift_y$ in °/h: -16.6 -1.9 -0.9 -0.2 0.9 1.6 1.7 1.7 1.6 1.1 0.7 0.4 0.3 0.4 0.9 2.4
T_z in °C: 0 20 24 26 28 34 38 44 46 50 52 54 56 58 74
$Drift_z$ in °/h: 3.1 3.1 3.0 2.9 2.7 1.8 1.4 1.3 1.4 1.6 1.8 1.9 1.8 1.7 0.6

Conversion Factors from bit to the respective units

R_x, R_y: 46603.375
R_z: 11650.844

N_x, N_y: 163.830
T_1, T_2: 54.605
B_x, B_y, B_z: 0.16383

The B_z component additionally has to be multiplied by a factor of 1.4, as the range of the component was increased compared to the ranges of B_x and B_y during IODP Expedition 330.

Offsets of the inclinometers in bit

N_x 8447
N_y 8035

References

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