# Master Track RV Heincke HE523

## Data Processing Report

## Contents




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|---|---|---|---|

# 1 Introduction

This report describes the processing of raw data acquired by position sensors on board RV Heincke during expedition HE523 to receive a validated master track which is used as reference of further expedition data.

# 2 Workflow

The different steps of processing and validation are visualized in figure 1. Unvalidated data of up to three sensors and ship-motion data are extracted from the DAVIS SHIP data base (https://dship.awi.de) in a 1-second interval. They are converted to ESRI point shapefiles and imported to ArcGIS. A visual screening is performed to evaluate data quality and remove outliers manually. The position data from each position sensor are centered to the destined master track origin by applying ship-motion data (angles of roll, pitch and heading) and lever arms. For all three resulting position tracks, a quality check is performed using a ship's speed filter and an acceleration filter. Filtered positions are flagged. In addition, a manual check is performed to flag obvious outliers. Those position tracks are combined to a single master track depending on a sensor priority list (by accuracy, reliability) and availability / applied exclusion of automatically or manually flagged of data. Missing data up to a time span of 60 seconds are linearly interpolated. To reduce the amount of points for overview maps the master track is generalized by using the Ramer-Douglas-Peucker algorithm. This algorithm returns only the most significant points from the track. Full master track and generalized master track are written to text files and imported to PANGAEA (http://www.pangaea.de) for publication.

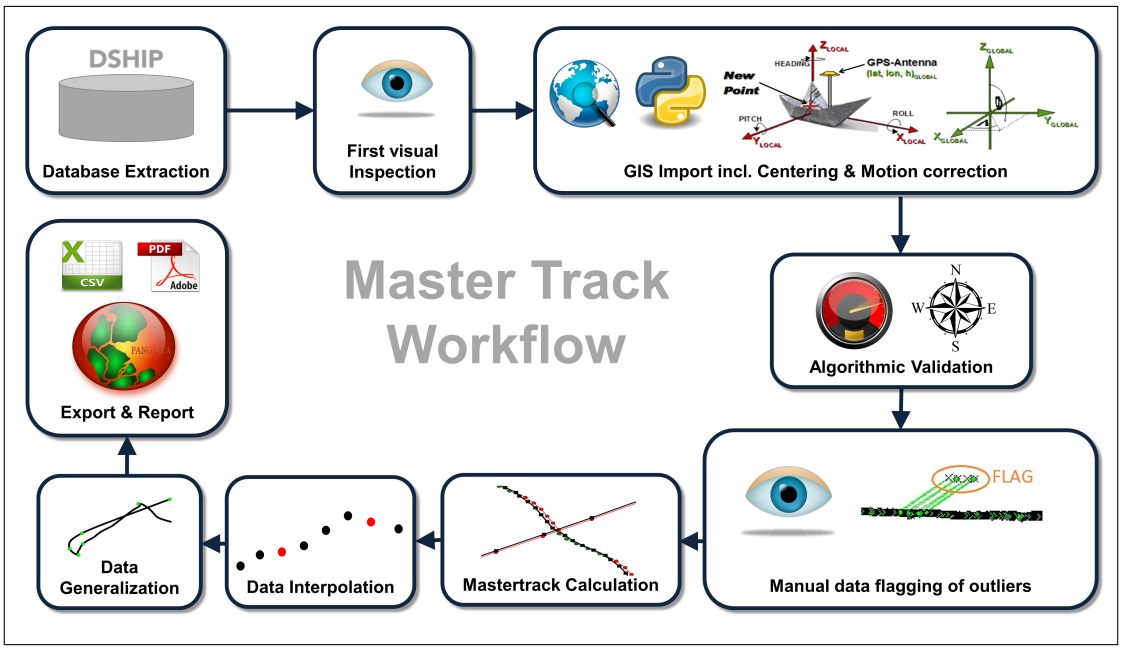


Figure 1: Workflow of master track data processing

# 3 Sensor Layout

This chapter describes the position sensors mounted during this cruise.

### Cruise details according to Cruise Report https://www.pangaea.de/expeditions/

| | |
|---|---|
| Vessel name | RV Heincke |
| Cruise name | HE523 |
| Cruise start | 2019-02-14 Bremerhaven |
| Cruise end | 2019-02-15 Bremerhaven |
| Cruise duration | 1 days |
| Master track reference point: | Resulting master track is referenced to *PHINS installation point*. |

### Position sensors

| | |
|---|---|
| Sensor name | **IXSEA PHINS III**, short: PHINS |
| Description | Inertial navigation system with reference positions from Trimble DGPS |
| Accuracy | ± 0.5-3.0 m |
| Installation point | Electrician's workshop, close to COG |
| Installation offset | Offset from master track reference point to sensor installation point<br>X Positive to bow 0.000 m<br>Y Positive to starboard 0.000 m<br>Z Positive upwards 0.000 m |

| | |
|---|---|
| Sensor name | **Trimble Marine SPS461**, short: Trimble |
| Description | DGPS-Receiver, correction type DGPS RTCM 2.x, correction source DGPS Base via radio |
| Accuracy | Horizontal: ± 0.25 m + 1 ppm & Vertical: ± 0.50 m + 1 ppm |
| Installation point | Observational Deck, fore rail |
| Installation offset | Offset from master track reference point to sensor installation point<br>X Positive to bow 13.648 m<br>Y Positive to starboard 2.976 m<br>Z Positive upwards 11.406 m |

| | |
|---|---|
| Sensor name | **SAAB R5 SUPREME NAV**, short: SAAB |
| Description | DGPS-Receiver, SBAS-correction with RTCM-104 input |
| Accuracy | GPS: ± 3.0 m; DGPS (2D RMS): ± 1.0 m |
| Installation point | Observational Deck, fore rail |
| Installation offset | Offset from master track reference point to sensor installation point<br>X Positive to bow 12.985 m<br>Y Positive to starboard 2.958 m<br>Z Positive upwards 11.328 m |

### Motion sensor

| | |
|---|---|
| Sensor name | **IXSEA PHINS III**, short: PHINS |
| Description | Inertial navigation system with reference positions from Trimble DGPS |
| Accuracy | $\pm$ 0.01 roll, $\pm$ 0.01 pitch, $\pm$ 0.05 heading (deg) |
| Installation point | Electrician's workshop, close to COG |

## 4 Processing Report

### Database Extraction

| | |
|---|---|
| Data source | DSHIP database (dship.awi.de) |
| Exported values | 104401 |
| First dataset | 2019-02-14T08:00:00 UTC |
| Last dataset | 2019-02-15T13:00:00 UTC |

### Centering & Motion Compensation

Each position track has been centered to the *PHINS installation point* by applying the correspondent motion angles for heading, roll and pitch as well as the installation offsets from chapter 3. The motion data were acquired by IXSEA PHINS III.

### Automatic Validation

The following thresholds were applied for the automatic flagging of the position data:

| | |
|---|---|
| Speed | Maximum 20 kn between two datapoints. |
| Acceleration | Maximum 1 m/s$^2$ between two datapoints. |
| Change of course | Maximum 5° between two datapoints. |

### Manual Validation

Obvious outliers were removed manually. For details see Processing Logbook of RV Heincke (hdl:10013/epic.45841) .

### Flagging result

| | PHINS | | Trimble | | SAAB | |
|---|---|---|---|---|---|---|
| Missing | 0 | 0.000% | 0 | 0.000% | 0 | 0.000% |
| Speed | 2 | 0.002% | 2 | 0.002% | 2 | 0.002% |
| Acceleration | 48 | 0.046% | 16 | 0.015% | 16 | 0.015% |
| Course | 27739 | 26.570% | 8395 | 8.041% | 8395 | 8.041% |
| Manually | 0 | 0.000% | 0 | 0.000% | 0 | 0.000% |

## Master Track Generation

The master track is derived from the position sensors' data selected by priority.

Sensor priority used:
1. PHINS
2. Trimble
3. SAAB

Filters applied: manual, speed, acceleration.

Distribution of position sensor data in master track:

| Sensor | Data points | Percentage |
|---|---|---|
| Total | 104401 | 100.000 % |
| PHINS | 85658 | 82.047 % |
| Trimble | 18732 | 17.942 % |
| SAAB | 0 | 0.000 % |
| Interpolated | 11 | 0.011 % |
| Gaps | 0 | 0.000 % |

## Remarks

Until ca. 13:00 on 14.02.2019 the NMEA distribution on RV Heincke was out of order and therefore PHINS operation was not supported.

## Score

For each cruise, a score is calculated ranging from 0 (no data) to 100 (only very good data). the score for the cruise HE523 is 99.

## Generalization

The master track is generalized to receive a reduced set of the most significant positions of the track using the Ramer-Douglas-Peucker algorithm and allow a maximum tolerated distance between points and generalized line of 4 arcseconds.

Results:

| | |
|---|---|
| Number of generalized points | 103 points |
| Data reduction | 99.9013 % |

## Result files

Master track text file:

The format is a plain text (tab-delimited values) file with one data row in 1 second interval.

| | |
|---|---|
| Column separator | Tabulator "\t" |
| Column 1 | Date and time expressed according to ISO 8601 |
| Column 2 | Latitude in decimal format, unit degree |
| Column 3 | Longitude in decimal format, unit degree |
| Column 4 | Flag for data source<br>1 PHINS<br>2 Trimble<br>3 SAAB<br>INTERP Interpolated point<br>GAP Missing data |

Text file of the generalized master track:

The format is a plain text (tab-delimited values) file.

| | |
|---|---|
| Column separator | Tabulator "\t" |
| Column 1 | Date and time expressed according to ISO 8601 |
| Column 2 | Latitude in decimal format, unit degree |
| Column 3 | Longitude in decimal format, unit degree |

Processing Report:

This PDF document.

## Cruise map

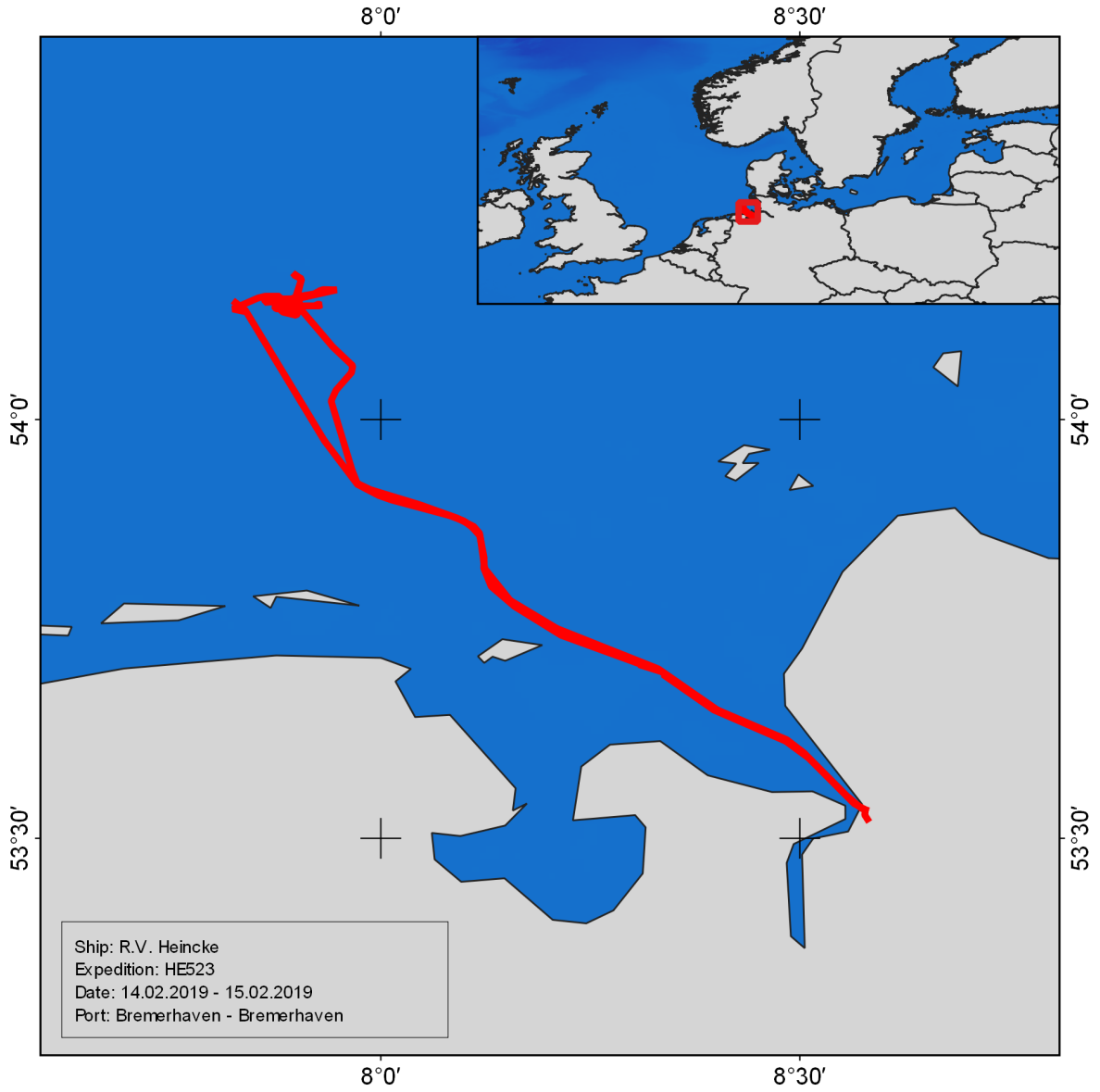


Figure 2: Map of the generalized master track