

Master Track RV Heincke HE535

Data Processing Report

Contents

| | |
|----------------------------|----------|
| 1 Introduction | 1 |
| 2 Workflow | 1 |
| 3 Sensor Layout | 2 |
| 4 Processing Report | 3 |

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|---------------------|----------|------------------|---------------|
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1 Introduction

This report describes the processing of raw data acquired by position sensors on board RV Heincke during expedition HE535 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.

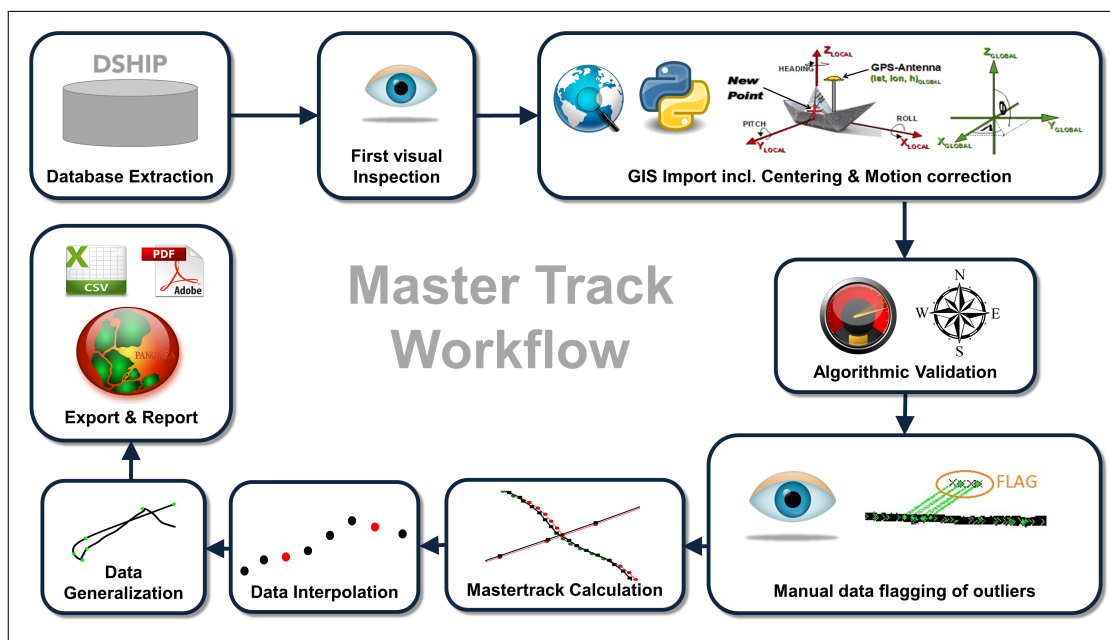


Figure 1: Workflow of master track data processing

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 | HE535 |
| Cruise start | 2019-06-30 Bremerhaven |
| Cruise end | 2019-07-05 Bremerhaven |
| Cruise duration | 5 days |
| Master track reference point: | Resulting master track is referenced to <i>PHINS installation point</i> . |

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 X Positive to bow 0.000 m Y Positive to starboard 0.000 m 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 X Positive to bow 13.648 m Y Positive to starboard 2.976 m 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 X Positive to bow 12.985 m Y Positive to starboard 2.958 m 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 | ± 0.01 roll, ± 0.01 pitch, ± 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 | 457201 |
| First dataset | 2019-06-30T07:00:00 UTC |
| Last dataset | 2019-07-05T14:00:00 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 | 0 | 0.000% | 0 | 0.000% | 0 | 0.000% |
| Acceleration | 123 | 0.027% | 27 | 0.006% | 9 | 0.002% |
| Course | 87150 | 19.062% | 75989 | 16.620% | 322100 | 70.450% |
| 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 | 457201 | 100.000 % |
| PHINS | 457078 | 99.973 % |
| Trimble | 123 | 0.027 % |
| SAAB | 0 | 0.000 % |
| Interpolated | 0 | 0.000 % |
| Gaps | 0 | 0.000 % |

Remarks

None.

Score

For each cruise, a score is calculated ranging from 0 (no data) to 100 (only very good data). The score for the cruise HE535 is 97.

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 | 161 points |
| Data reduction | 99.9648 % |

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 | |
| | 1 | PHINS |
| | 2 | Trimble |
| | 3 | SAAB |
| | INTERP | Interpolated point |
| | 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

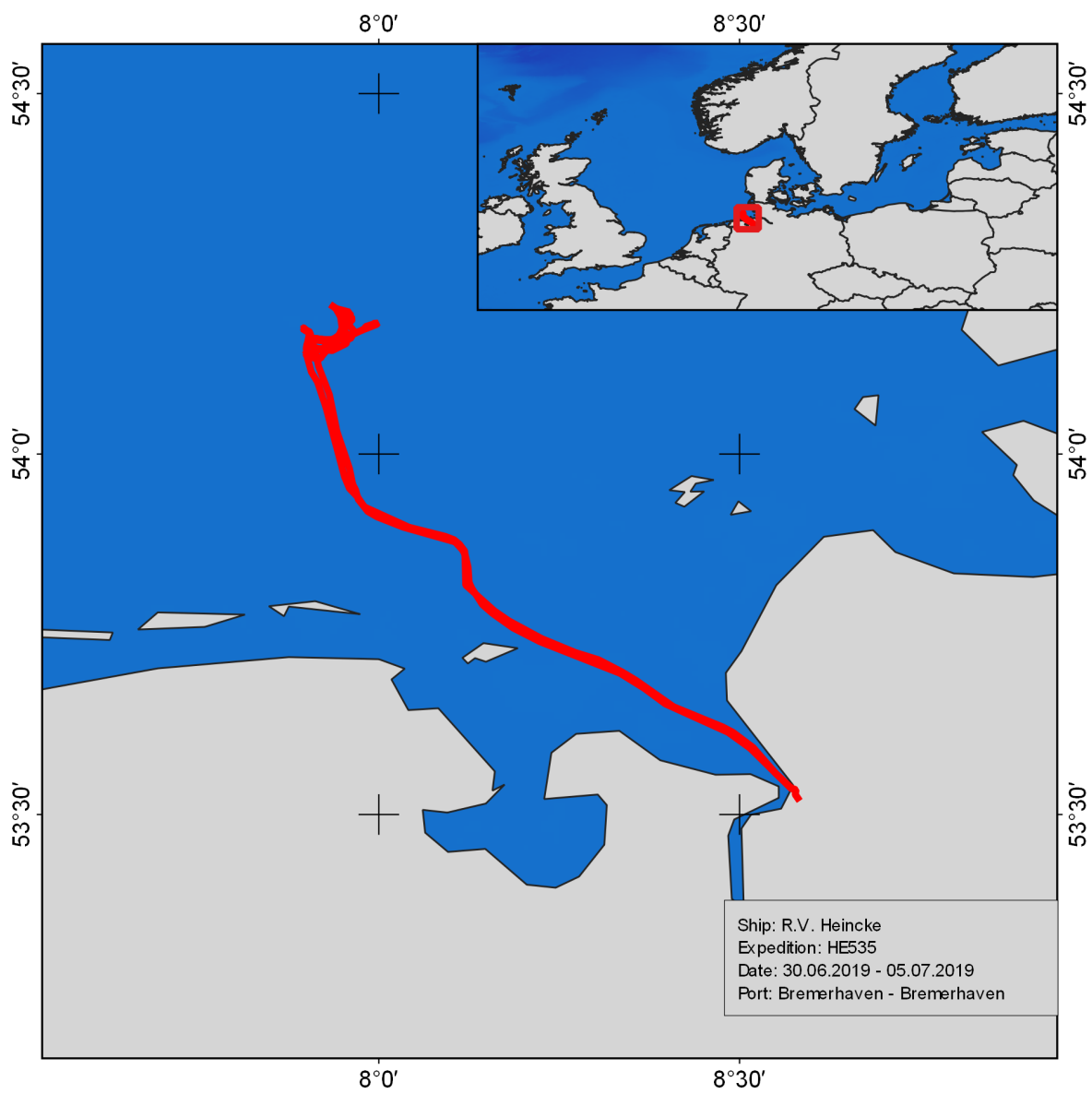


Figure 2: Map of the generalized master track