# Master Track RV Polarstern PS93.2

## Data Processing Report

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1 Introduction

This report describes the processing of raw data acquired by position sensors on board RV Polarstern during expedition PS93.2 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
Vessel name: RV Polarstern
Cruise name: PS93.2
Cruise start: 21.07.2015 Tromsø
Cruise end: 15.08.2015 Tromsø
Cruise duration: 26 days
Master track reference point: Resulting master track is referenced to MINS installation point.

Position sensors

<table>
<thead>
<tr>
<th>Sensor name</th>
<th>Description</th>
<th>Accuracy</th>
<th>Installation point</th>
<th>Installation offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raytheon Anschütz MINS2, short: MINS</td>
<td>Marine inertial navigation system with reference positions from Trimble DGPS</td>
<td>&lt; 60 m CEP50 (with SPS GPS)</td>
<td>Gravimeter room on F-Deck, close to COG</td>
<td>X Positive to bow 0.000 m, Y Positive to starboard 0.000 m, Z Positive upwards 0.000 m</td>
</tr>
<tr>
<td>Trimble Marine SPS461 (1), short: Trimble 1</td>
<td>DGPS-Receiver, correction type DGPS RTCM 2.x, correction source DGPS Base via radio</td>
<td>Horizontal: ± 0.25 m + 1 ppm &amp; Vertical: ± 0.50 m + 1 ppm</td>
<td>Observation deck (starboard)</td>
<td>Offset from master track reference point to sensor installation point X Positive to bow 22.777 m, Y Positive to starboard -5.460 m, Z Positive upwards 21.525 m</td>
</tr>
</tbody>
</table>
Sensor name | Trimble Marine SPS461 (2), short: Trimble 2
---|---
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 | Observation deck (port)
Installation offset | Offset from master track reference point to sensor installation point
| X Positive to bow 16.527 m
| Y Positive to starboard 12.408 m
| Z Positive upwards 21.538 m

**Motion sensor**

Sensor name | Raytheon Anschuetz MINS2, short: MINS
---|---
Description | Marine inertial navigation system with reference positions from Trimble DGPS
Accuracy | ± 0.02° roll, ± 0.02° pitch, ± 0.05° heading
Installation point | Gravimeter room on F-Deck, close to COG

### 4 Processing Report

**Database Extraction**

| Data source | DSHIP database (dship.awi.de)
| Exported values | 2246400
| First dataset | 2015-07-21T00:00:00 UTC
| Last dataset | 2015-08-15T23:59:59 UTC

**Centering & Motion Compensation**

Each position track has been centered to the *MINS installation point* by applying the correspondent motion angles for heading, roll and pitch as well as the installation offsets from chapter 2. The motion data were acquired by Raytheon Anschuetz MINS2.

**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/s² 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 Polarstern (hdl:10013/epic.45909).

Flagging result

<table>
<thead>
<tr>
<th>Sensor</th>
<th>MINS</th>
<th>Trimble 1</th>
<th>Trimble 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>115810</td>
<td>115220</td>
<td>319799</td>
</tr>
<tr>
<td>Speed</td>
<td>1294</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Acceleration</td>
<td>2528</td>
<td>257</td>
<td>313</td>
</tr>
<tr>
<td>Course</td>
<td>743044</td>
<td>745493</td>
<td>810617</td>
</tr>
<tr>
<td>Manually</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Master Track Generation

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

Sensor priority used:
1. Trimble 1
2. MINS
3. Trimble 2

Filters applied: manual, speed, acceleration.

Distribution of position sensor data in master track:

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Data points</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2131200</td>
<td>94.872 %</td>
</tr>
<tr>
<td>MINS</td>
<td>250</td>
<td>0.012 %</td>
</tr>
<tr>
<td>Trimble 1</td>
<td>2130926</td>
<td>99.987 %</td>
</tr>
<tr>
<td>Trimble 2</td>
<td>2</td>
<td>0.000 %</td>
</tr>
<tr>
<td>Interpolated</td>
<td>22</td>
<td>0.001 %</td>
</tr>
<tr>
<td>Gaps</td>
<td>0</td>
<td>0.000 %</td>
</tr>
</tbody>
</table>

Remarks

Data only available until 2015-08-14T15:59:59 UTC.

Score

For each cruise, a score is calculated ranging from 0 (no data) to 100 (only very good data). the score for the cruise PS93.2 is 92.
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:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of generalized points</td>
<td>893 points</td>
</tr>
<tr>
<td>Data reduction</td>
<td>99.9581 %</td>
</tr>
</tbody>
</table>
Result files

Report in XML format:

The XML contains all information of the master track generation in a machine-readable format. In addition a XSD schema file is provided.

Master track text file:

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

<table>
<thead>
<tr>
<th>Column separator</th>
<th>Tabulator “\t”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column 1</td>
<td>Date and time expressed according to ISO 8601</td>
</tr>
<tr>
<td>Column 3</td>
<td>Latitude in decimal format, unit degree</td>
</tr>
<tr>
<td>Column 4</td>
<td>Longitude in decimal format, unit degree</td>
</tr>
<tr>
<td>Column 5 Flag for data source</td>
<td>1 MINS 2 Trimble 1 3 Trimble 2 INTERP Interpolated point GAP Missing data</td>
</tr>
</tbody>
</table>

Text file of the generalized master track:

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

<table>
<thead>
<tr>
<th>Column separator</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Column 1</td>
<td>Date and time expressed according to ISO 8601</td>
</tr>
<tr>
<td>Column 2</td>
<td>Latitude in decimal format, unit degree</td>
</tr>
<tr>
<td>Column 3</td>
<td>Longitude in decimal format, unit degree</td>
</tr>
</tbody>
</table>

Processing Report:

This PDF document.
Cruise map

Figure 2: Map of the generalized master track