Master Track RV Polarstern ARK-XVII/2
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 Polarstern during expedition ARK-XVII/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	ARK-XVII/2
Cruise start	31.07.2001 Tromsø
Cruise end	07.10.2001 Bremerhaven
Cruise duration	69 days
Master track reference point:	Resulting master track is referenced to *MINS installation point*.

Position sensors

Sensor name	**Raytheon Anschuetz MINS2**, short: MINS
Description	Marine inertial navigation system with reference positions from Trimble DGPS
Accuracy	< 60 m CEP50 (with SPS GPS)
Installation point	Gravimeter room on F-Deck, 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 (1)**, short: Trimble 1
Description	DGPS-Receiver, correction type DGPS RTCM 2.x, correction source DGPS Base via radio
Accuracy	Horizontal: $\pm$ 0.25 m + 1 ppm & Vertical: $\pm$ 0.50 m + 1 ppm
Installation point	Observation deck (starboard)
Installation offset	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

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: $\pm$ 0.25 m + 1 ppm & Vertical: $\pm$ 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	$\pm$ 0.02$°$ roll, $\pm$ 0.02$°$ pitch, $\pm$ 0.05$°$ heading
Installation point	Gravimeter room on F-Deck, close to COG

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Database Extraction

Data source	DSHIP database (dship.awi.de)
Exported values	5961600
First dataset	2001-07-31T00:00:00 UTC
Last dataset	2001-10-07T23:59:59 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/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 Polarstern (hdl:10013/epic.45909).

Flagging result

	MINS		Trimble 1		Trimble 2	
Missing	55730	0.935%	11759	0.197%	11732	0.197%
Speed	63770	1.070%	36068	0.605%	35057	0.588%
Acceleration	1133870	19.020%	63340	1.062%	78027	1.309%
Course	2106232	35.330%	753191	12.634%	877078	14.712%
Manually	306896	5.148%	1069	0.018%	1241	0.021%

Master Track Generation

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

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

Filters applied: manual, speed, acceleration, course.

Distribution of position sensor data in master track:

Sensor	Data points	Percentage
Total	5961599	100.000 %
MINS	279313	4.685 %
Trimble 1	5167502	86.680 %
Trimble 2	368518	6.182 %
Interpolated	135399	2.271 %
Gaps	10867	0.182 %

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 ARK-XVII/2 is 98.

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	18019 points
Data reduction	99.6977 %

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.

Column separator	Tabulator "\t"	
Column 1	Date and time expressed according to ISO 8601	
Column 3	Latitude in decimal format, unit degree	
Column 4	Longitude in decimal format, unit degree	
Column 5	Flag for data source	
	1	MINS
	2	Trimble 1
	3	Trimble 2
	INTERP	Interpolated point
	GAP	Missing data

Text file of the generalized master track:

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

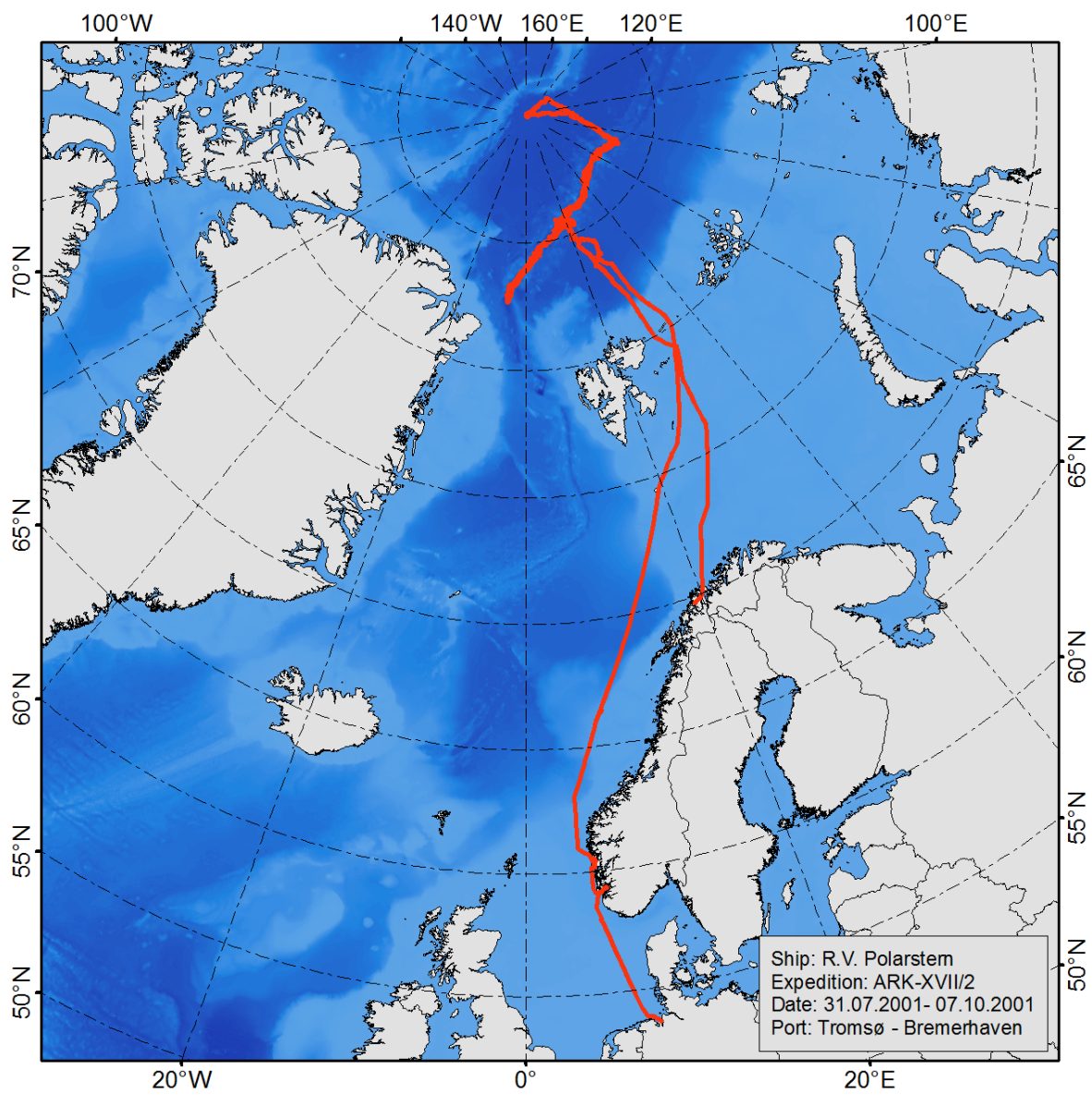| Column separator	Tabulator "\t"
Column 1	Date and time expressed according to ISO 8601
Column 2	Latitude in decimal format, unit degree
Column 3	Longitude in decimal format, unit degree

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This PDF document.

Cruise map

Figure 2: Map of the generalized master track