JR17005 Underway navigation, sea surface hydrography and meteorology

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This section describes data acquisition and processing during JR17005, summarising navigational, bathymetric, meteorological and sea surface hydrographic data.

Overview of instruments and data streams

The oceanlogger system recorded sea surface properties and most meteorological measurements. Measurements of wind, depth and position were stored in separate (anemometer, EA600 and Seatex GPS) streams. Each data stream was stored as a *.ACO* file with an associated *.TPL* file listing variable names. All data streams that have been extracted and processed are listed in Table 1. The oceanlogger data steam recorded measurements at an average frequency of 0.2 Hz; all other data streams recorded at an average frequency of 1 Hz. Small variations in recording frequency were accounted for during data processing.

Table 1. Data streams processed

Instrument	Parameter	Unit
Oceanlogger	airtemp1	Celsius
	humidity	%RH
	par1	umol/m2/s
	tir1	W/m2
	airtemp2	Celcius
	humidity2	%RH
	par2	umol/m2/s
	tir2	W/m2
	baro1	hPa
	baro2	hPa
	tstemp	Celcius
	conductivity	S/m
	salinity	psu
	sound velocity	m/s
	chlorophyll	mg/l
	flow rate	l/min
	sstemp1	Celsius
	sstemp2	Celsius
	transmittance	0< tr <1
Anemometer	Wind direction	degrees
	Wind speed	m/s
EA600 (EM122)	Depth	m
Seatex	Latitude	degrees
	Longitude	degrees

Data processing

Each data set was processed by filtering noise and erroneous measurements, and then applying per-minute medians to generate smoothed data and smaller file sizes. Measurements taken in days before the first sampling event (13/05/2018) were omitted from the analyses. All processed data were combined into a single *.csv* file. All data processing was conducted using *R*, and all *R* scripts have been made available. The scripts have been written to process the data and generate plots and *.csv* files of cleaned data by simply opening *R* in the appropriate directory and typing 'source('run.R')'.

Navigation and bathymetry

Seatex positional data were thinned by calculating per-minute medians of latitude and longitude using *R* script 'seatex_lat_lon.R'.

EA600 bathymetry data were particularly noisy and contained many obviously spurious measurements of zero, or near-zero, depths. These data were processed by first removing measurements of depths less than 10 m, which were considered spurious. Three separate filters were then applied sequentially to smooth the bathymetry data. Moving medians and moving standard deviations were calculated over 2000 s time intervals, and measurements beyond 1.1 times the standard deviation were omitted. This was repeated with an interval of 300 s, removing measures beyond 1.5 times the standard deviation; and again with interval size 120 s, removing measures beyond 1.5 times the standard deviation. The first of these filters had to be applied separately to each day of data due to RAM limitations. The smoothed data were then thinned by calculating per-minute medians. This cleaning process used *R* script 'EA600_traceplots.R'. The swath navigational system was in use from 5/6/18, and the EM122 echo-sounder interfered with EA600 measurements. Bathymetry measurements were taken from the EM122 whenever both systems were in use.

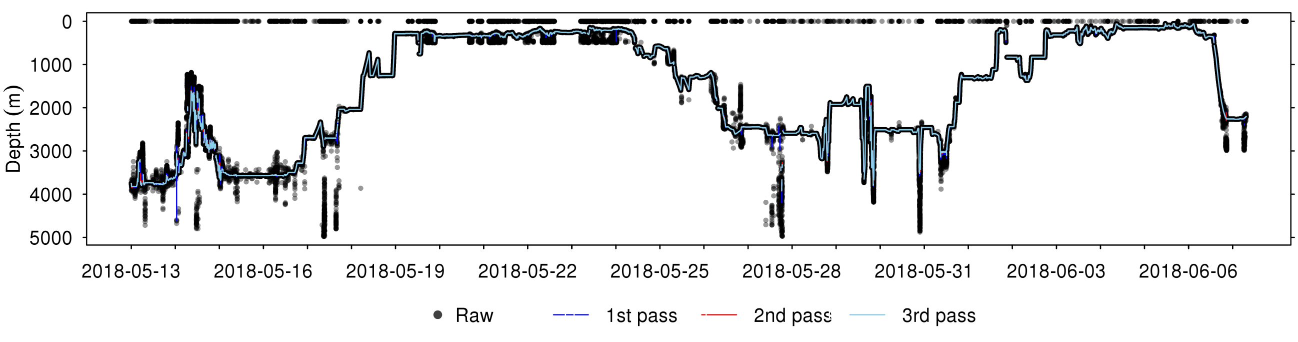

Fig. 1. Raw and filtered EA600 echo-sounder data.

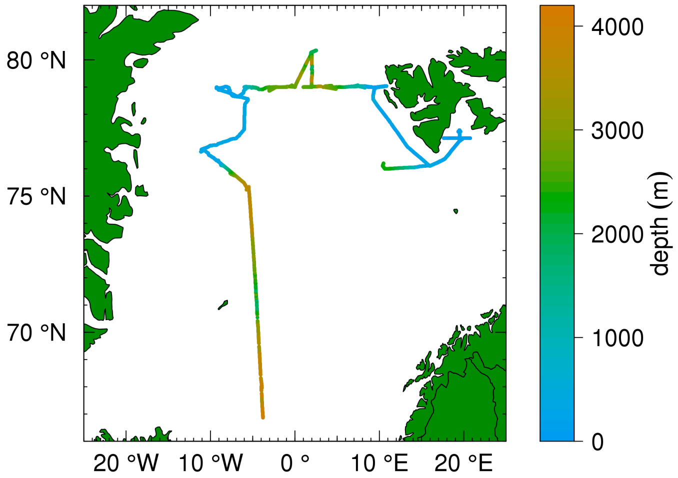

Fig. 2. The JRC17005 cruise track coloured to indicate depth measured by the EA600.

Oceanlogger data

Oceanlogger data consisted of both meteorological and sea surface measurements. The sea surface measurements were collected via the ship's underway system which, due to blockages, only provided data in regions with relatively little sea ice. Only sea surface measurements recorded when the flow rate through the underway was between 0.4 and 0.7 l/min were retained (this range was deemed appropriate after inspection of an underway flow rate histogram). Sea surface measurements 20 minutes prior to, and 20 minutes after, periods of underway inactivity were also omitted as they often appeared spurious. Beyond this stage of cleaning, both the sea surface and meteorological data were treated identically.

The data were smoothed by applying two filters. First, moving medians and moving standard deviations were calculated over time intervals of 600 s, and measurements beyond 1.5 times the standard deviation were omitted. The second filter repeated the process with an interval size of 300 s, again removing points beyond 1.5 times the standard deviation. The smoothed oceanlogger data were then thinned by calculating per-minute medians. This cleaning process used *R* script 'oceanlogger_traceplots.R'. (Approximately 50 minutes of oceanlogger data were lost during 1/6/18.)

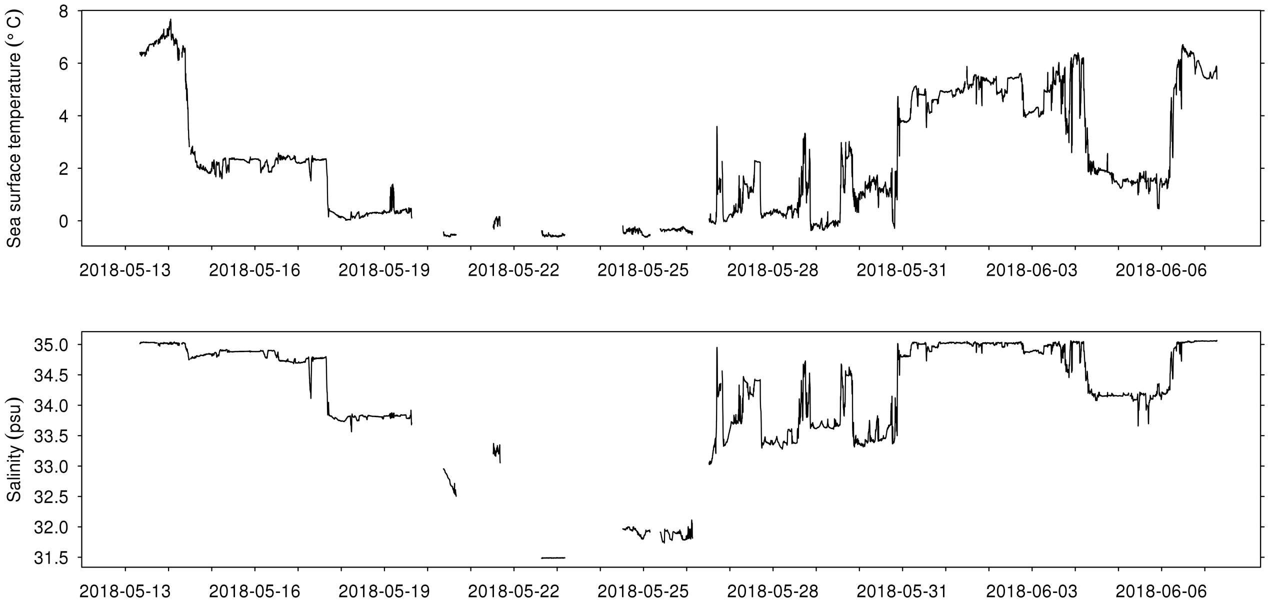

Fig. 3. Processed sea surface temperature and salinity oceanlogger measurements. Gaps in the data correspond to periods of underway inactivity, usually caused by sea ice.

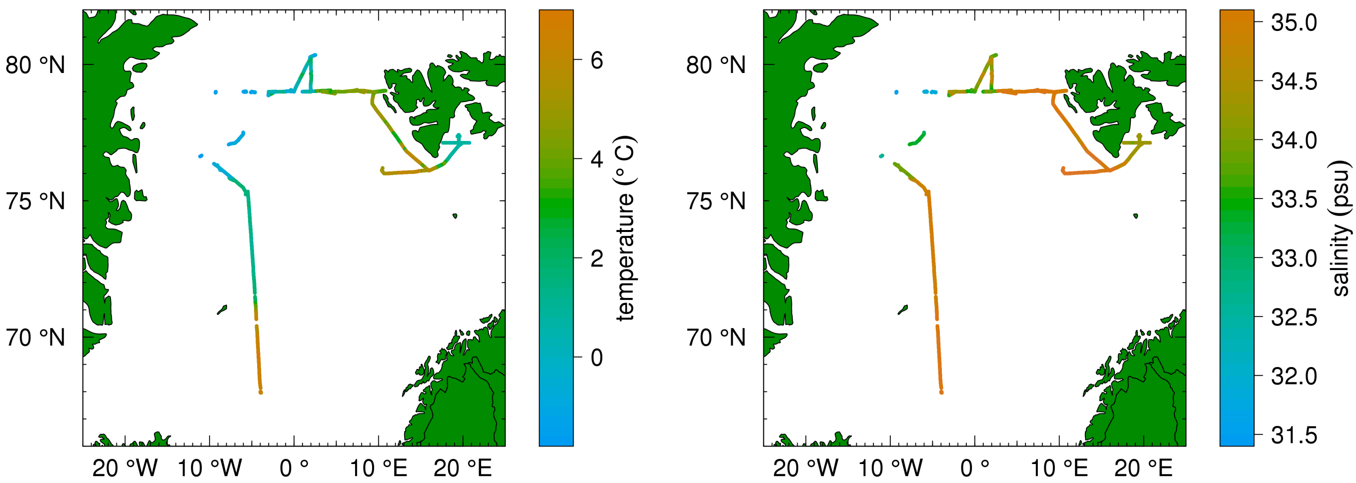

Fig. 4. Sea temperature and salinity measurements varying over the JR17005 cruise course.

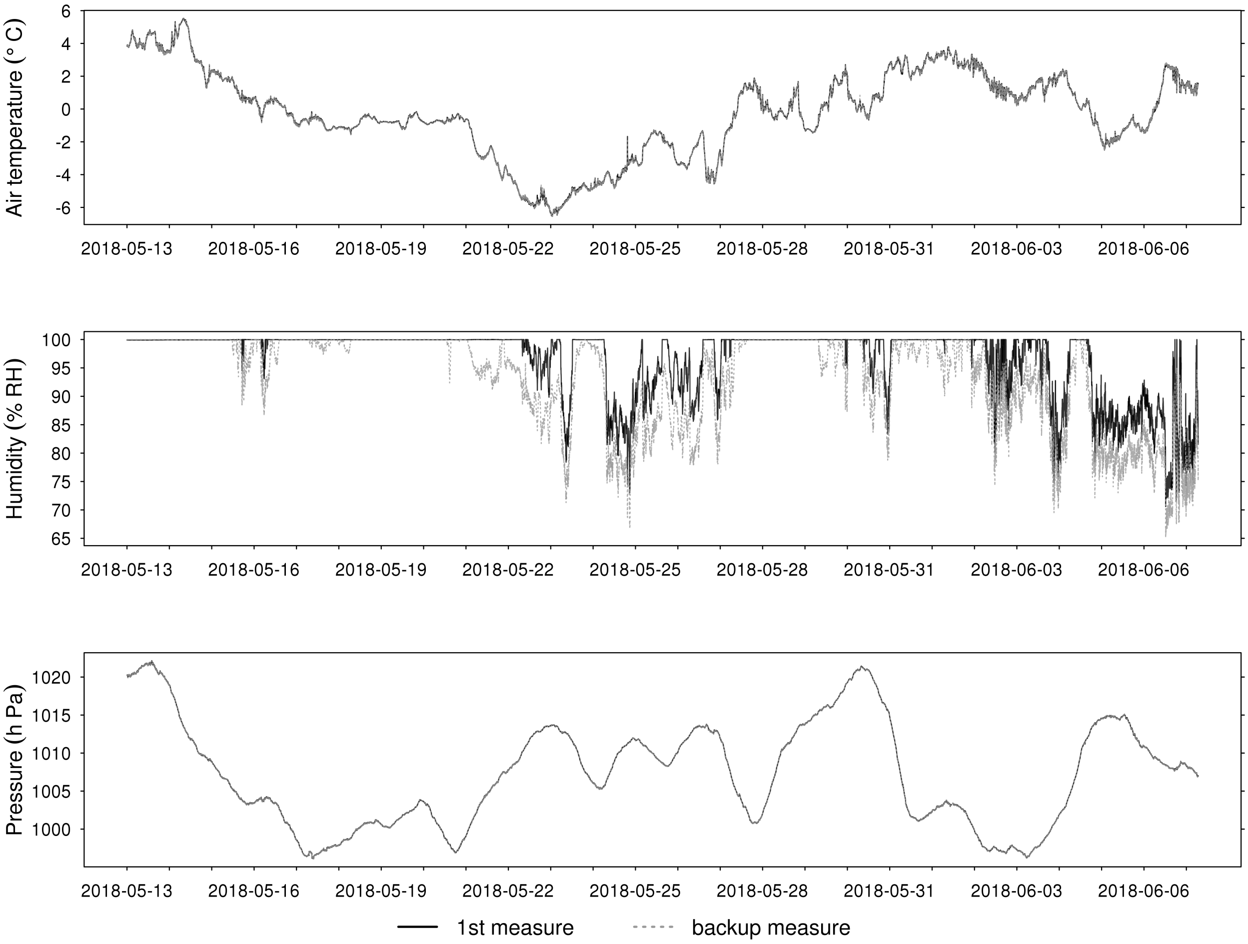

Fig. 5. Processed air temperature, humidity and air pressure measurements.

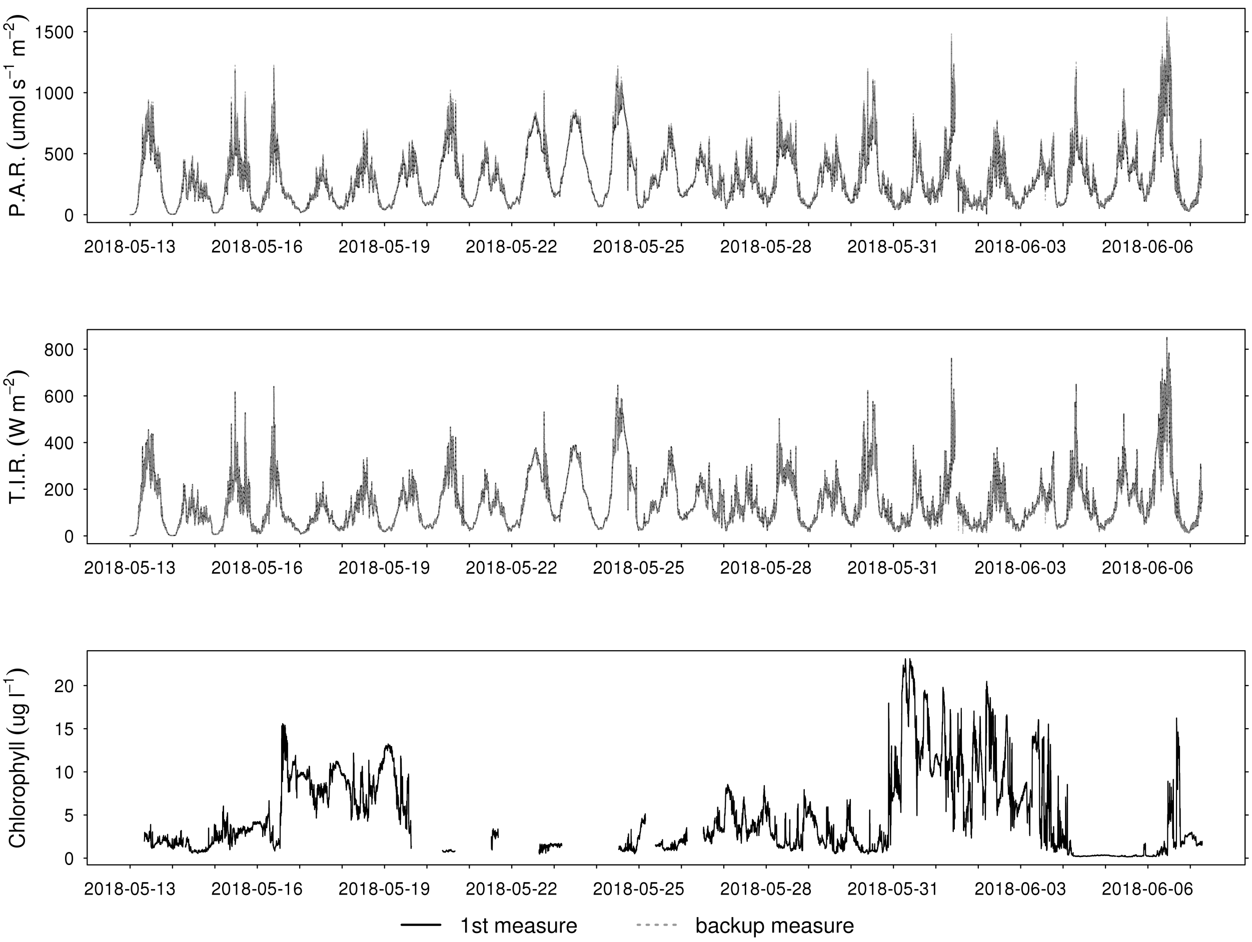

Fig. 6. Processed P.A.R., T.I.R and chlorophyll concentration measurements.

Anemometer data

Anemometer data were smoothed by calculating moving medians and moving standard deviations over 120 s time intervals, then omitting measurements beyond 1.5 times the standard deviation. The data were then thinned by calculating per-minute medians. This process was applied to wind speed and wind direction measurements using *R* script 'anemometer_traceplots.R'

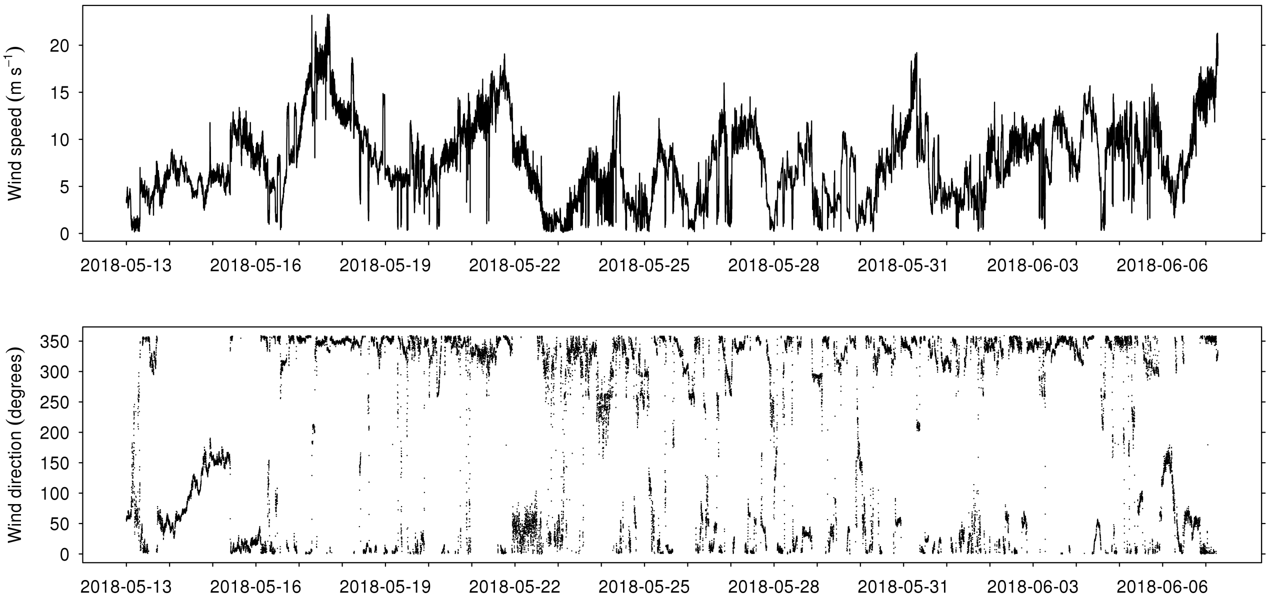

Fig. 7. Processed wind speed and wind direction measurements.

Salinity Calibration

The underway salinity was calibrated using 37 samples taken from the underway system and analysed on a Guildline Autosal and a further 16 salinity samples taken from niskin bottles fired within the top 10 m of the water column.

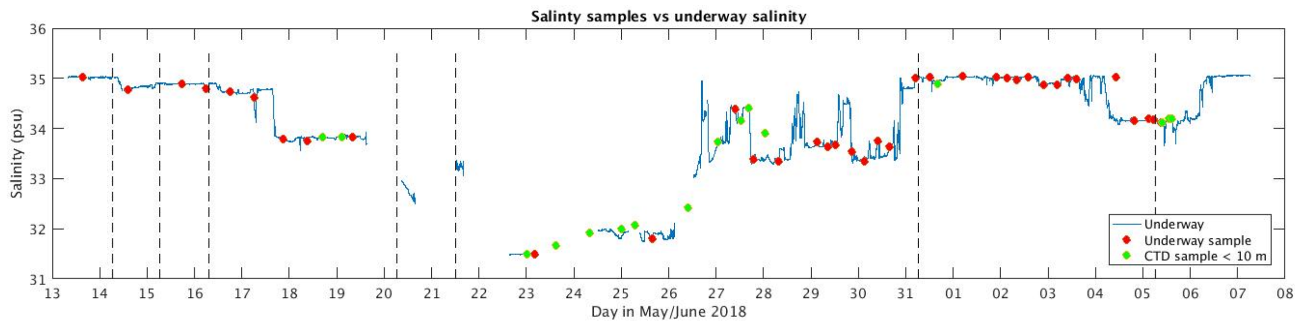

Fig. 8. Underway salinity data with discrete bottle sampling events from the underway outflow in red and niskin bottle samples taken above 10 m in green. Vertical dashed lines mark times when the system was cleaned by an engineer.

Readings from the underway sensor at the times of bottle samples were extracted and the offsets calculated. Offsets greater than 0.1 were immediately removed. The mean offset was 0.0074 psu (std of 0.0082). Offsets more than 1.5 standard deviations above and below the mean were then removed (red values in Figure 9). Of the remaining pairs (green in Figure 9) a significant (pval = 6 e^{-4}) trend over time was found (blue line in Figure 9). The following regression was subsequently used to calculate the offset required to correct the underway salinity time series.

offset = -0.054 + (daynumber x $4.04e^{-4}$)

After applying this time varying offset the mean offset was reduced to 0.0012 psu.

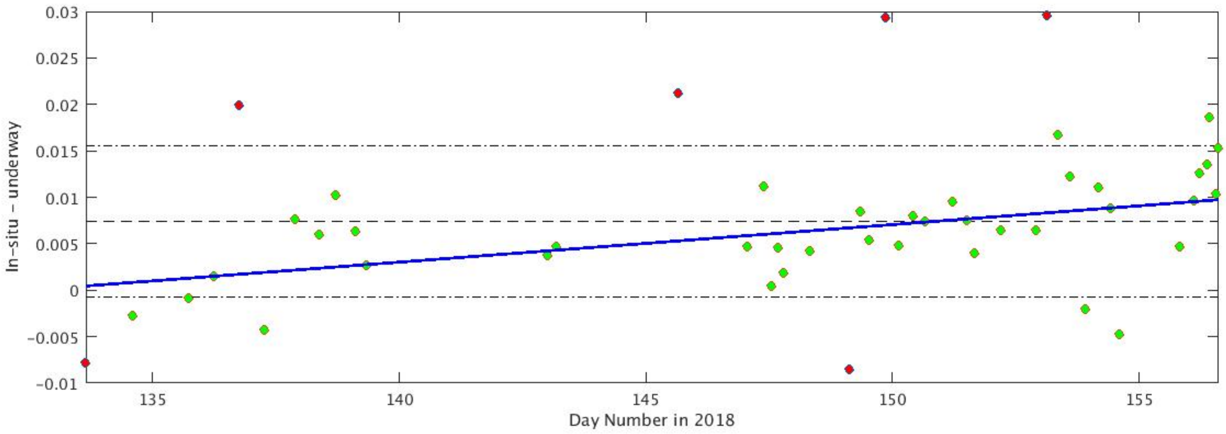

Fig. 9. In-situ salinity samples minus underway reading. Positive values indicate that the underway sensor was reading too low. Linear regression (in blue) was fitted to all offset pairs that were within 1.5 standard deviations of the mean.