Ocean Drifter Measurements from the Atlantic Ocean, November 2018 to July 2023

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ABSTRACT

McMillan, J., Soontiens, N., Holden, J. and Schillinger, D. 2024. Ocean Drifter Measurements from the Atlantic Ocean, November 2018 to July 2023. Can. Data Rep. Hydrogr. Ocean Sci. 220: vi + 28 p.

As part of the Oceans Protection Plan and Tracer Release Experiment, 220 drifter tracks were recorded in the Atlantic Ocean between November 2018 and July 2023. These tracks were obtained using six different types of commercial drifters. The drifters moved under the influence of ocean currents, wind, and waves, tracking currents near the surface (four types), at 1m depth (one type), and at 15m depth (one type). The tracks totaled over 472 000 km and 15 000 days of data. The drifters reported their position, and occasionally sea surface temperature and pressure, every 5 to 60 minutes in near real-time via GPS satellites. The drifters grounded 40.5% of the time and were recovered 16.4% of the time, typically by beachcombers. In this document, the quality control methods are outlined and basic statistics of the drifter tracks are presented. The variation in lifetime and distance at sea is described by both geographic region and drifter type. The drifter data have been primarily used for model validation and calibration and are now available for download from the Water Properties Group (`https://waterproperties.ca`).

RÉSUMÉ

McMillan, J., Soontiens, N., Holden, J. and Schillinger, D. 2024. Ocean Drifter Measurements from the Atlantic Ocean, November 2018 to July 2023. Can. Data Rep. Hydrogr. Ocean Sci. 220: vi + 28 p.

Dans le cadre du Plan de protection des océans et de l'expérience de dispersion de traceurs (Tracer Release Experiment), un total de 220 trajectoires de bouées dérivantes ont été enregistrées dans l'océan Atlantique entre novembre 2018 et juillet 2023. Ces trajectoires ont été obtenues à l'aide de six différents types de bouées dérivantes commerciales. Les bouées dérivantes se déplaçaient sous l'influence des courants océaniques, du vent et des vagues, et mesuraient les courants près de la surface (quatre types). Un type de bouée mesurait à 1 m de profondeur et un autre à 15 m de profondeur. Au total, il y en avait pour 472 000 km de trajectoire et 15 000 jours de données. Les bouées dérivantes signalaient leur position, et parfois la température et la pression de la surface de la mer, toutes les 5 à 60 minutes en temps quasi réel par l'intermédiaire de satellites GPS. Les bouées dérivantes se sont échouées 40,5% du temps et ont été récupérées 16,4% du temps, généralement par des batteurs de grève. Ce document décrit les méthodes de contrôle de la qualité et présente des statistiques de base sur les trajectoires de bouées dérivantes. La variation de la durée de vie et de la distance en mer est décrite selon la région géographique et selon le type de bouée dérivante. Les données des bouées dérivantes ont été principalement utilisées pour la validation et l'étalonnage du modèle et peuvent maintenant être téléchargées auprès du Groupe des propriétés de l'eau (`https://waterproperties.ca`).

1 Introduction

Ocean drifters have been deployed off the coast of Canada in the Atlantic Ocean as part of several monitoring and science programs. More specifically, as part of the Oceans Protection Plan (OPP) and the Tracer Release Experiment (TReX; Pawlowicz et al. 2021), 208 drifters were deployed between 2018 and 2022. Because the drifters occasionally grounded and were redeployed, these deployments resulted in 220 separate drifter tracks starting between November 2018 and July 2023. In total, the drifter tracks consist of over 472 000 km and 15 000 days of data.

The purpose of the drifter deployments was largely to provide validation and calibration for existing ocean circulation models used for emergency response, ocean and ice predictions, and electronic navigation. The drifters were deployed both individually and in multiples. Some were deployed as part of targeted experiments, whereas others were deployed when ship opportunities were available. This report summarizes all the drifters with no distinctions made between the individual projects or their objectives. The aim of this report is to simply give an overview of the available data so that it can be accessed and analyzed more readily by others.

Six different types of commercial drifters were used; four types tracked surface currents, one type tracked the near-surface currents (top 1 m) and one type tracked the currents at 15 m depth. The drifters all provided position data in near-real time over various intervals ranging from 5 to 60 minutes. Many of the drifters also collected sea surface temperature and barometric pressure measurements. Two of the drifters also collected wave measurements; however, those data are not included in this report. The details of the drifter types are summarized in Section 2.1.

The drifter tracks were processed and quality controlled primarily using the DRIFTEVAL tool (Pawlowicz et al. 2019). The tracks were grouped into five different deployment areas (Figure 6) and basic statistics are summarized in Section 3.

The format of the report and the analysis follow closely from that of Hourston et al. 2021, which summarized 1397 drifter tracks from the Pacific and Arctic Oceans. In this report, we also include some examples of the temperature and pressure data that were collected (Section 4) and highlight some lessons learned (Section 5). A final summary is provided in Section 6.

2 Materials and Methods

2.1 Drifter Types

Six different types of drifters were deployed. They are all commercially available and product specifications can be found in Appendix B and on the manufacturers' websites. Figure 1 shows a picture of each drifter and Table 1 summarizes the drifter deployments per year for each drifter type. The cross-sectional profiles of the drifters with respect to the water surface are shown in Figure 2.

2.1.1 Stokes

The Stokes drifter (Figure 1a, Figure 2a) is a truncated cylinder (i.e. disk) designed to track surface currents. It has a diameter of 24 cm and a height of 4.1 cm. It measures its position and sea surface temperature. The specifications are available in Appendix B.1 and at `https://metocean.com/products/stokes-drifter/`. In total, 23 drifters of this type were deployed (Table 1).

2.1.2 OSKER

The OSKER drifter (Figure 1b, Figure 2b) is also a disk designed to track surface currents. It has an outer diameter of 20 cm at its widest point and a thickness of 5.1 cm. The drifter only measures its

Figure 1: A picture of each of the drifter types from the manufacturer's websites. The drifters are not scaled equally.

Table 1: Drifter types, drag-area ratios, and the number of drifter tracks by year.

Drifter Type	Drag Area Ratio [decimal]	Drag Area Ratio [fraction]	2018	2019	2020	2021	2022	2023	Total
iSVP	0.007	1/151.4	3	15	3	9	7	1	38
CODE/Davis	0.011	1/87.1	12	18	24	18	9	0	81
OSKER	1	1/1	5	22	20	10	16	0	73
Stokes	1	1/1	0	0	0	11	12	0	23
iSphere	1	1/1	0	0	3	0	0	0	3
Spotter	1.075	1/0.9	0	0	0	1	1	0	2
Total			20	55	50	49	45	1	220

position. The specifications are available in Appendix B.2 and at https://xeostech.com/osker. In total, 73 drifters of this type were deployed (Table 1).

2.1.3 CODE/Davis

The CODE/Davis drifter (Figure 1c, Figure 2c) is designed to track near-surface currents. It has a cylindrical hull with a diameter of about 10.2 cm. Below the surface, it has four X-shaped sails that measure approximately 70 cm in height and 50 cm in width. The drifter measures its position and the sea surface temperature. It was originally designed to meet the needs of the Coastal Ocean Dynamics Experiment (CODE) by Dr. Russ Davis. The specifications are available in Appendix B.3 and at: https://metocean.com/products/code-davis-drifter/. In total, 81 drifters of this type were deployed (Table 1).

2.1.4 Spotter

The Spotter drifter (Figure 1d, Figure 2d) is designed to measure surface currents. It has a diameter of 42 cm and a height of 31 cm, about half of which floats above the surface. The drifter measures its position, sea surface temperature, barometric pressure and waves. The specifications are available in Appendix B.4 and at: https://www.sofarocean.com/products/spotter. In total, 2 drifters of this type were deployed (Table 1).

2.1.5 iSphere

The iSphere (Figure 1e, Figure 2e) is a spherical buoy with a diameter of 34 cm that tracks near surface currents. The drifter only measures its position and is commonly used for oil spill response. The specifications are available in Appendix B.5 and at: https://metocean.com/products/isphere/. In total, 3 drifters of this type were deployed (Table 1).

2.1.6 iSVP

The Surface Velocity Program (SVP) drifter (Figure 1f, Figure 2f), or iSVP, is designed to track water currents 15 m below the surface. The iSVP has a spherical surface float with a diameter of 35 cm and a 6.1 m holey sock that is centered on 15 m below the surface. The drifter measures its position, sea surface temperature and barometric pressure (optional). The detailed specifications are available in Appendix B.6 and at https://metocean.com/products/isvp/. In total, 38 drifters of this type were deployed (Table 1).

2.2 Drag Area Ratios

The drag area ratios (DAR), which are a primary measure of a drifter's water following characteristics, are included in Table 1. Drifters with DAR values below 1:40, such as the iSVP and CODE/Davis drifters, are less affected by the wind, and have better water following characteristics (Niiler et al. 1995). Drifters with higher DAR values – particularly those near 1 such as the OSKER, Stokes, iSphere and Spotter – will be affected by direct wind drag. This distinction is important when interpreting the data from these drifters.

The drag area ratio is determined by the profile of the drifter above and below the water surface. It is computed by the following formula:

$$DAR = \frac{\int_{0}^{z_{max}} w(z)C(z)dz}{\int_{z_{min}}^{0} w(z)C(z)dz} \tag{1}$$

where $w(z)$ is the cross-sectional width of the drifter and $C(z)$ is the drag coefficient. The integrals are computed from the deepest point of the drifter (z_{min}) to the water surface ($z = 0$) and from the water surface to the highest point of the drifter (z_{max}). The drag coefficients used for the drifters in this report are indicated in Table 2. The widths were taken from the manufacturers' specification sheets and are plotted as a function of z in Figure 2.

Table 2: Drag coefficients used for the calculation of DAR values.

Geometry	$C(z)$
Sphere	0.47
Cylinder	0.47
Flat Plate	1.15
Holey Drogue	1.40
Tether	1.40

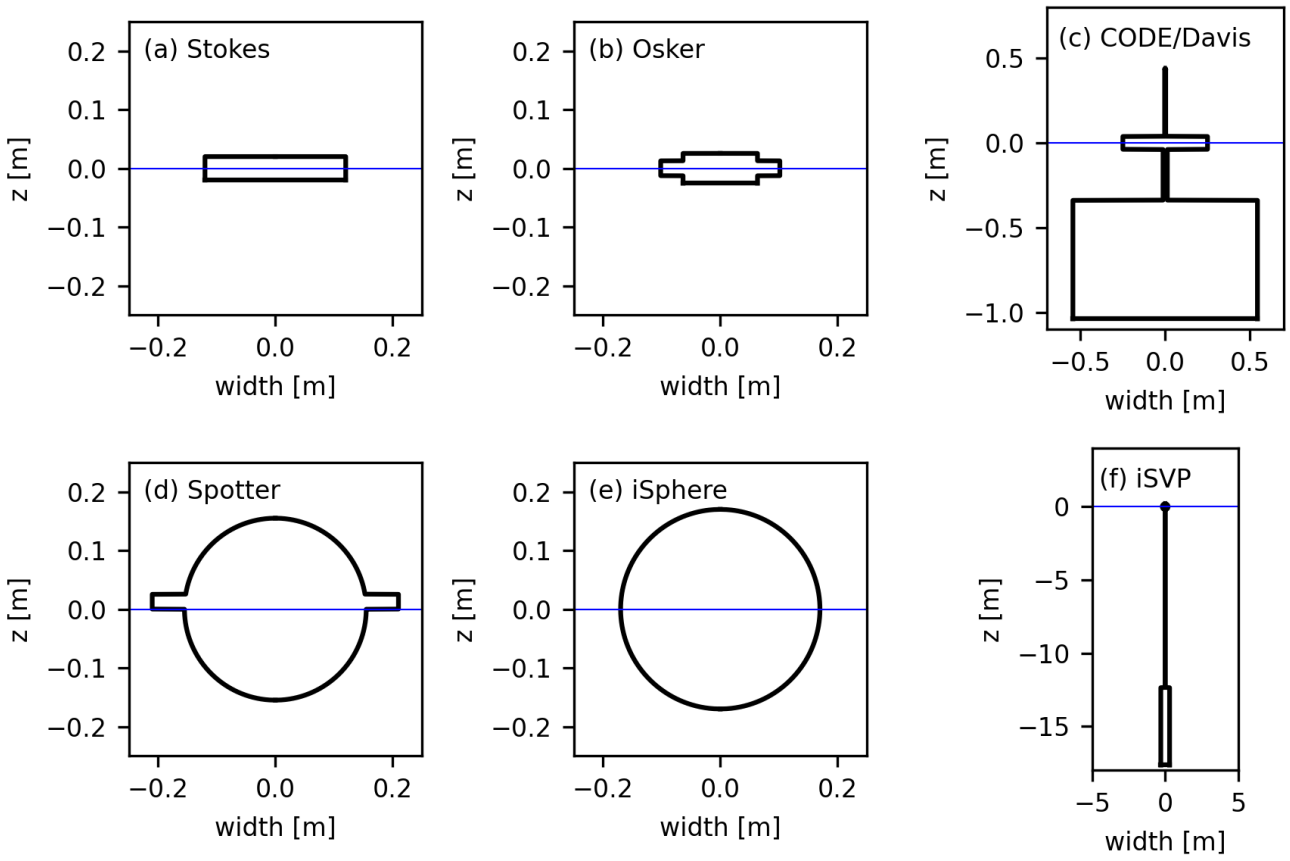

Figure 2: The cross-sectional profile of each drifter type with respect to the water surface (blue line). The axes scales for the near-surface drifters (a, b, d, e) are the same whereas the CODE/Davis (c) and iSVP (f) are plotted on different scales.

2.3 Data Processing

The drifter tracks were processed through the series of steps outlined in Figure 3. There are four main quality control steps:

(i) Apply flags

(ii) Initial quality control

(iii) Run DRIFTEVAL

(iv) Final quality control

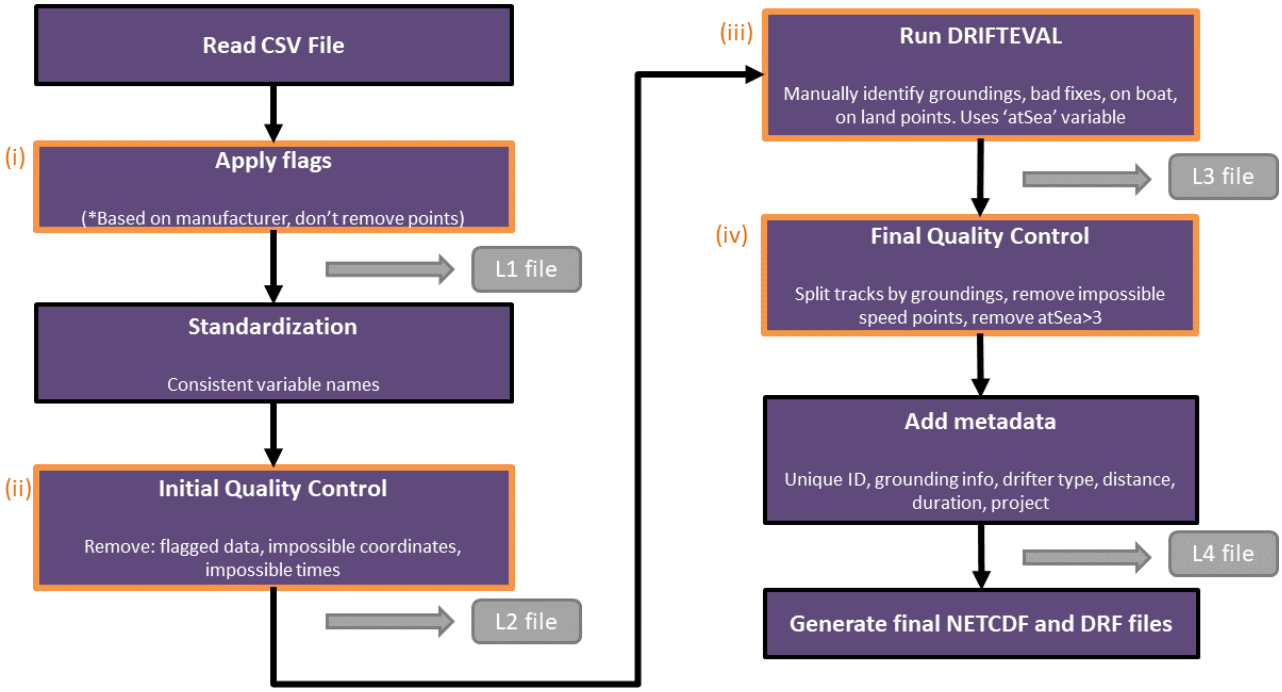

Figure 3: Schematic of the steps taken to process the drifter data. The main quality control steps are outlined in orange. The gray boxes indicate intermediate MAT files (L1 to L4) that were saved at various stages of the processing.

The application of flags to invalid data points (step i) is specific to the manufacturer, and not commonly documented in manuals. It was after personal communication with MetOcean (Stokes, iSVP, Code/Davis, iSphere drifters) and Sofar (Spotter drifters) that flags were applied when:

- The "fixValid" data field was "False" for Stokes drifters.
- The "TTFF" (i.e. time to first fix) or "fixTime" data field was greater than or equal to 254 seconds for any MetOcean drifter. According to the manufacturer, when the drifter can not obtain a reliable GPS fix in 254 seconds, the buoy transmits its previous position. This results in repeated coordinates with different timestamps.
- The wave data were completely missing for Spotter drifters. According to the manufacturer, these data rows were recorded when the drifter was awaking from a sleep mode and the position data had not yet been updated. This issue was observed for a drifter operating in a custom configuration of the "Waves:Spectrum" mode.

At this step in the processing, the data were simply flagged and not removed.

For the initial quality control (step ii), flagged data, impossible times (i.e. past and future) and impossible coordinates were removed from the track data. Repeated rows of identical data were also removed.

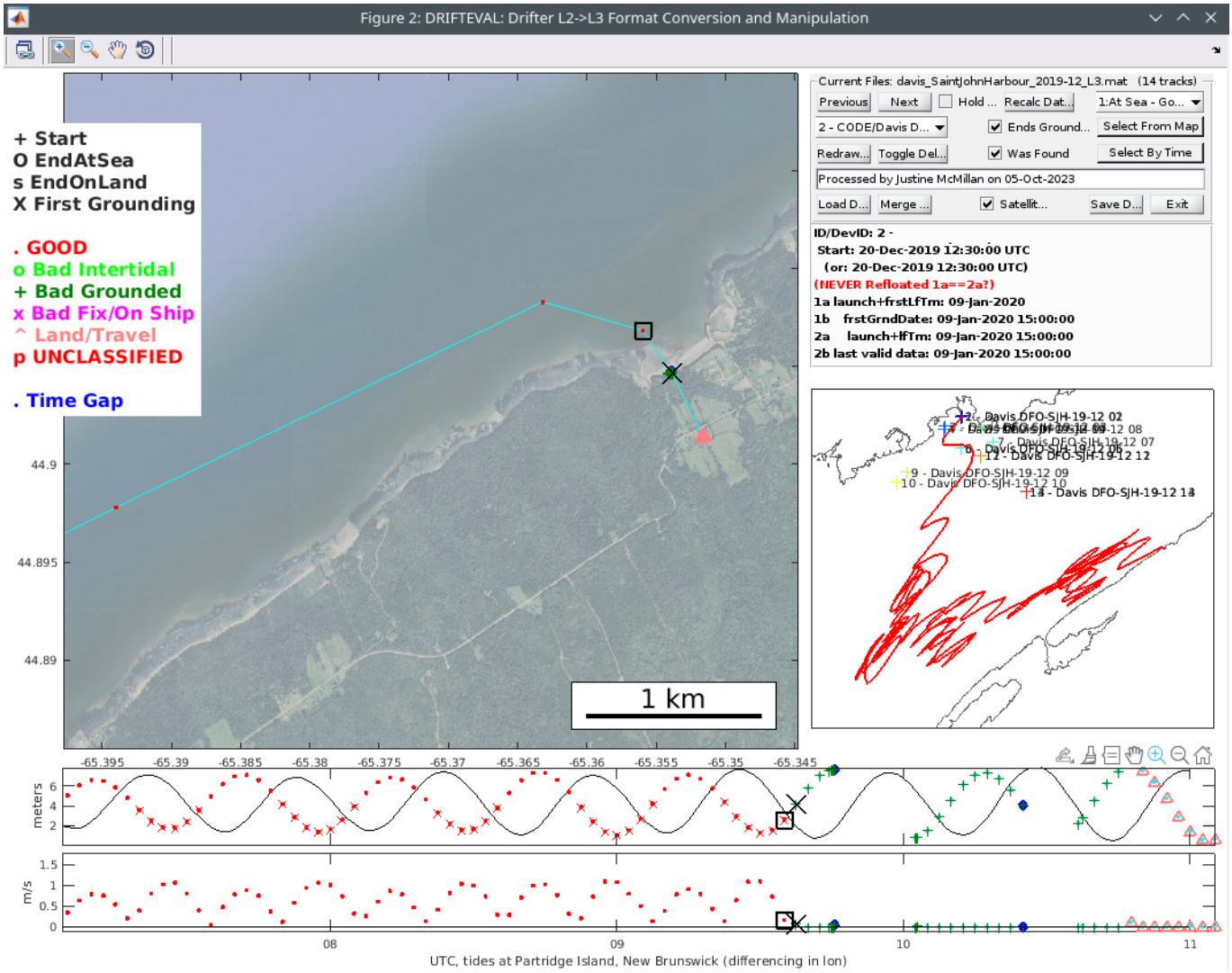

Figure 4: Screenshot of the DRIFTEVAL interactive computer code showing one drifter track in the Bay of Fundy. In the top left plot, the drifter track is overlaid on the satellite image. The map is zoomed in on the end of the track where the drifter becomes "grounded" (Category 3, green squares, black X) and is then taken on land (Category 5, pink triangles). The red points are when the drifter was freely floating "at sea" (i.e. Category 1). The time series at the bottom of the figure show the elevation at a nearby location and the computed speed based on the change in drifter position. The time limits are zoomed out in comparison to what is seen in the satellite map. The interactive user interface is shown in the top right of the figure and the entire drifter track is shown in red on the middle right panel with the starting positions of the other drifters marked by the coloured + symbols.

The drifter tracks were then processed manually (step iii) using the MATLAB-based interactive computer code DRIFTEVAL developed by R. Pawlowicz at the University of British Columbia. For each drifter, the code displays (1) the drifter tracks overlaid on coastlines and satellite imagery, (2) time series of the tidal height from a nearby location and (3) time series of the computed drifter speed (Figure 4). The user interface allows for the selection of points on either the spatial map or the time series, and then points can be classified into five "atSea" categories (Pawlowicz et al. 2019). Category 1 includes all points in which the drifter was moving freely at sea ("valid"). Categories 2 and 3 are used to identify interactions of the drifters with land, whereas categories 4 and 5 identify points that are "bad" or "invalid". More specifically:

- Category 2 is used when the drifter is judged to be mostly floating, but trapped (e.g. within an intertidal zone, near fish farms, in a tidal pool or against cliffs). These data points are typically identified when the drifter speed decreases rapidly, but is not zero. The satellite position, combined with knowledge of the drifter type, can also provide confirmation of a drifter that is likely trapped, e.g. if an iSVP drifter is in a shallow area and moving slowly, it is likely that the drogue is dragging on the bottom.

- Category 3 is used when the drifter is "grounded" or mostly grounded, that is when it is largely or fully touching a solid boundary. These data points typically have a speed near zero, and show no significant change in the satellite position (green squares in Figure 4).

- Category 4 is used when the drifter is at sea, but it is either on a ship or there is a bad fix. These data points are usually identified when the drifter position is suddenly far away and then returns.

- Category 5 is used when the drifter is being transported on land. These points are usually obvious from the drifter's position in the satellite image (pink triangles in Figure 4).

For all drifters, the last recorded valid point is flagged as being either "grounded/on land" or "died at sea". Note that in Pawlowicz et al. 2019 and Hourston et al. 2021 categories 4 and 5 were combined into one category to identify the invalid points.

For the final quality control (step iv), positions that were marked as Category 4 and 5 were removed. The resulting drifter tracks were split whenever the drifter had grounded, but was then either redeployed or refloated (e.g. by a high tide). This resulted in 220 drifter tracks from 208 deployed drifters. Then, as a final check, the drifter speeds were computed and points were removed if the atSea category was equal to one and the speed was deemed impossible (i.e. speeds equal to zero, greater than $5\,\mathrm{m\,s^{-1}}$, or three times greater than a local mean of about 12 hours). Based on a GPS accuracy of ± 1 to 100 m (specification for Stokes drifters) and one hour sampling, drifter speeds are believed to be accurate to within $4\,\mathrm{cm\,s^{-1}}$.

Metadata was then added to the quality controlled drifter track data and the files were saved as both NETCDF and DRF files. The DRF files were created for upload to the Water Properties Group (https://waterproperties.ca). All the drifter tracks are shown by year in Figure 5.

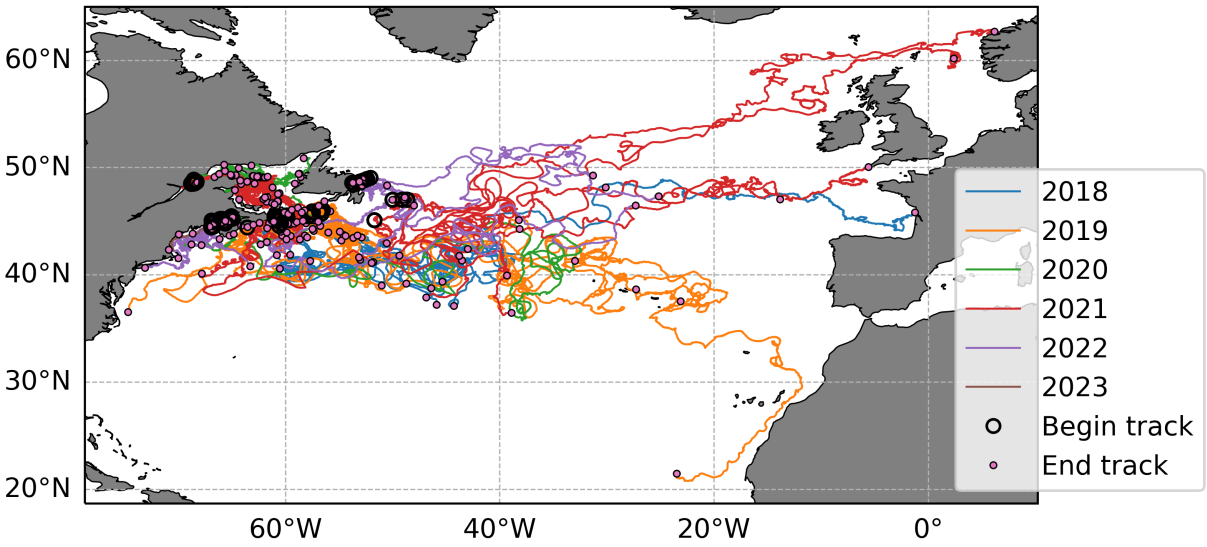

Figure 5: Tracks of all drifters deployed between 2018 and 2023. Colour of tracks indicate the deployment year. Open circles represent where each track began, pink circles represent where each track ended.

2.4 Deployment Regions

The drifters deployed in the Atlantic Ocean have been grouped into five regions (Figure 6, Table 3). The regions were chosen based on where drifters had been deployed, and also on the dynamical differences between the circulation patterns. For example, in the Bay of Fundy, the tides provide the dominant forcing, whereas in the Gulf of St. Lawrence, the estuarine circulation is much more significant.

Table 3: Drifter tracks for each region and type.

Region	CODE/Davis	OSKER	Spotter	Stokes	iSVP	iSphere	Total
Bay of Fundy	22	11	0	2	10	0	45
Gulf of St. Lawrence	25	26	0	5	5	3	64
Laurentian Channel	4	10	0	0	2	0	16
Newfoundland Shelf	1	9	2	16	6	0	34
Scotian Shelf	29	17	0	0	15	0	61
Total	81	73	2	23	38	3	220

3 Drifter statistics

The processed drifter data were used to compute statistics that allow the tracks to be compared between deployment region, drifter type and end location (at sea or on land).

For each track, the following metrics were calculated:

- Lifetime at sea: the total length of time that a drifter was at sea
- Distance at sea: the total distance travelled by a drifter while at sea

These "at sea" metrics only include valid at sea data points (i.e. Category 1 as defined in Section 2.3). Hourston et al. 2021 also included metrics for distance and lifetime "deployed" which include periods where the drifter was grounded or in an intertidal zone. The "deployed" metrics were not included in this report because they do not differ significantly from the at sea metrics.

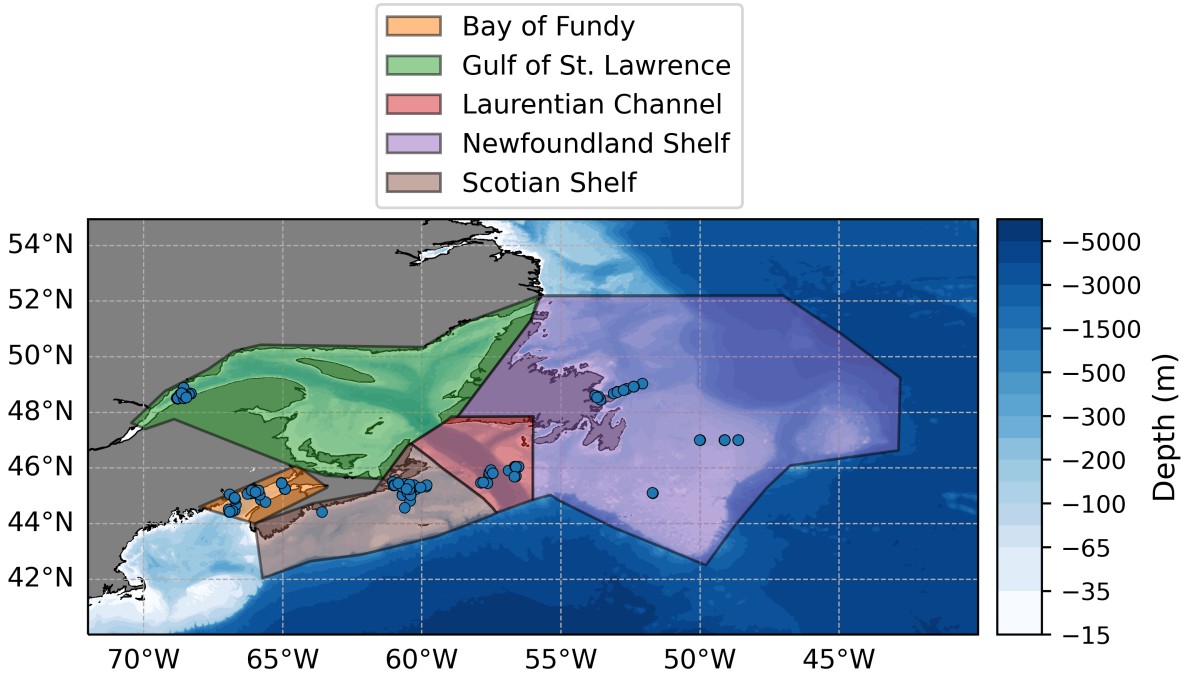

Figure 6: Definition of the deployment regions discussed in this report. Blue circles represent the deployment location of each drifter.

The statistics for the distance and lifetime at sea are compared graphically in Figures 7 and 8 for the deployment regions, end location and drifter type. Tabulated values and some discussion follow in Sections 3.1 to 3.3.

For each region and drifter type, the grounding and recovery rates are also compared in Sections 3.1 and 3.2, where:

- Grounding rate: percentage of drifters ending on land while they are activated
- Recovery rate: percentage of drifters found on land, or picked up by a vessel at sea

3.1 Drifter statistics by region

The 220 tracks were dispersed among the five deployment regions that were defined in Section 2.4. The totals per region are summarized in Table 1. The largest number of drifter tracks were in the Gulf of St. Lawrence (64) and the Scotian Shelf (61). The fewest number were in the Laurentian Channel (16).

The 220 drifter tracks had an average lifetime at sea of 71 days with a median of 34 days (Table 4). The lifetime is highly variable with a minumum of 0.1 days, a maximum of 872 days and a standard deviation of 123 days. The drifters travelled an average distance of 2147 km with a median of 1045 km (Table 5). The shortest drifter track was 0.6 km, whereas the longest was 25 878 km. The longest drifter track occurred in the Bay of Fundy from a drifter that repeatedly transited a 30 km path between Isle Haute and Cape d'Or for over eight months. The drifter track with the longest duration was released on the Scotian Shelf and travelled across the Atlantic.

The grounding and recovery rates are summarized in Table 6. In total, 89 of the 220 drifters (40.5%) grounded while activated. The number of drifters that were recovered was 36 (16.4%). The groundings and recoveries were the highest in the Bay of Fundy and Gulf of St. Lawrence, which is not surprising, because these deployments were done fairly close to shore.

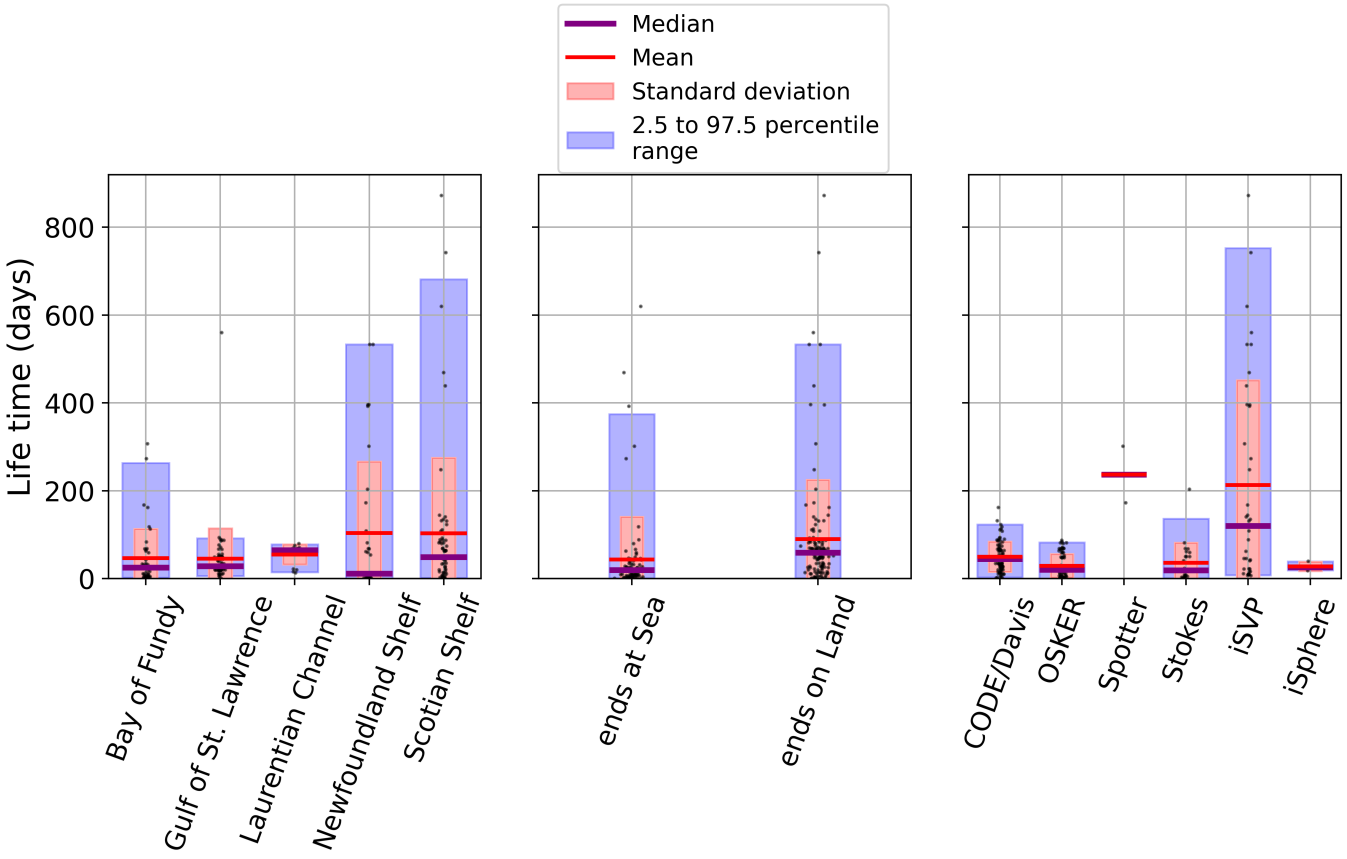

Figure 7: Lifetime at sea statistics by deployment region, end location, and drifter type. Median shown by purple line, mean by red line. Red area is the mean plus or minus 1 standard deviation. Blue area is the 2.5 to 97.5 percentile range. Small black dots represent data points.

Table 4: Lifetime at sea (days) by region

Region	N	Mean	Median	Std. Dev	Min.	Max	Sum
Bay of Fundy	45	46.1	25.0	66.7	0.5	307.0	2076.5
Gulf of St. Lawrence	64	44.9	28.2	69.4	0.7	560.3	2872.3
Laurentian Channel	16	54.8	64.7	22.8	13.2	79.5	876.7
Newfoundland Shelf	34	103.4	11.2	162.7	0.1	533.4	3515.0
Scotian Shelf	61	102.8	49.0	172.0	0.8	872.2	6270.1
All	220	71.0	33.7	123.3	0.1	872.2	15610.6

Table 5: Distance at sea (km) by region

Region	N	Mean	Median	Std. Dev	Min.	Max	Sum
Bay of Fundy	45	2237.1	1005.5	4305.4	25.1	25877.9	100668.9
Gulf of St. Lawrence	64	1349.9	934.1	1933.8	8.6	15943.7	86395.2
Laurentian Channel	16	1428.2	1649.0	626.2	283.0	2390.7	22851.8
Newfoundland Shelf	34	2656.0	197.4	3927.9	0.6	12607.3	90304.2
Scotian Shelf	61	2820.9	1096.4	4714.2	5.5	21341.4	172075.6
All	220	2146.8	1044.9	3692.2	0.6	25877.9	472295.6

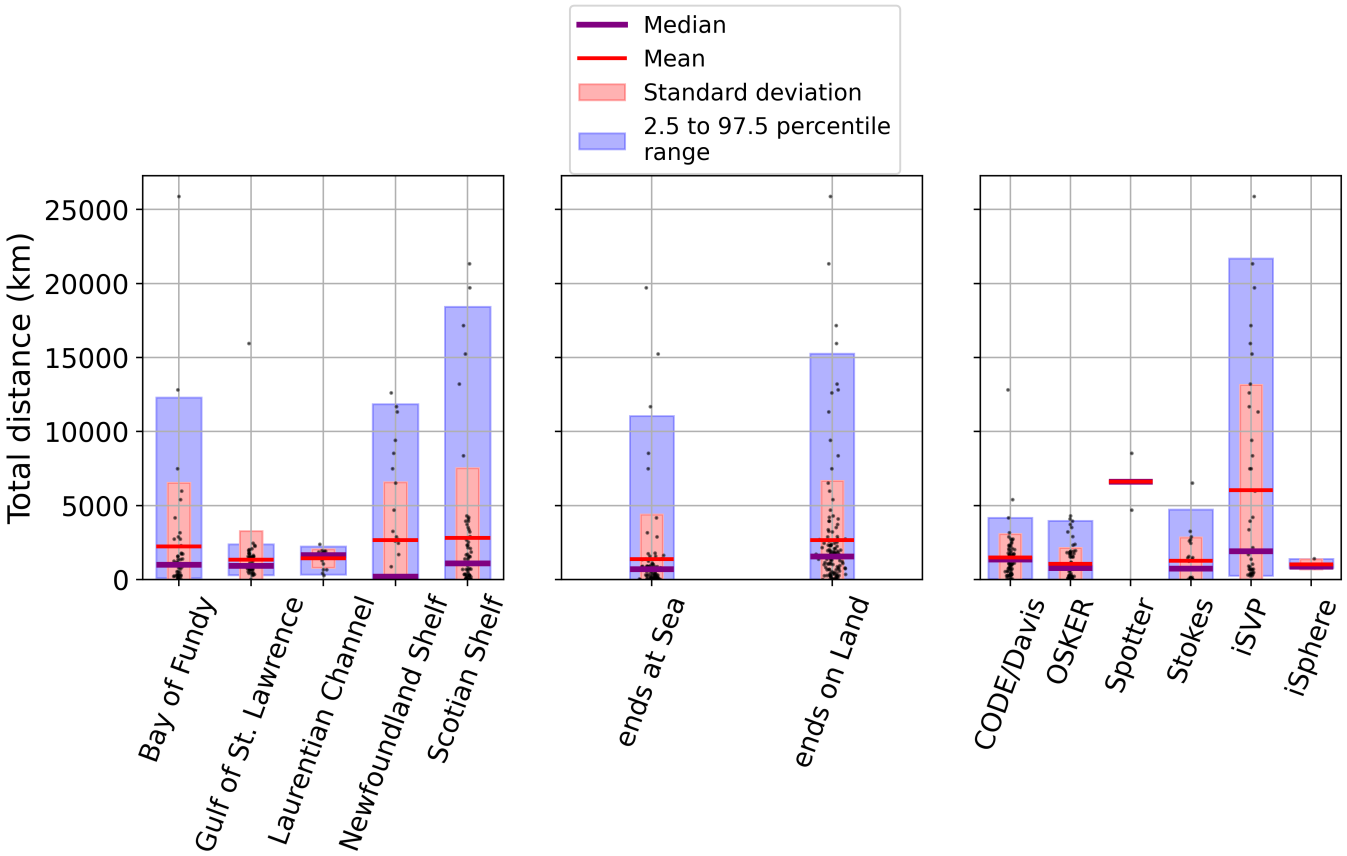

Figure 8: Total distance statistics by deployment region, end location, and drifter type. Median shown by purple line, mean by red line. Red area is the mean plus or minus 1 standard deviation. Blue area is the 2.5 to 97.5 percentile range. Small black dots represent data points.

Table 6: Groundings and recoveries by region

Region	Number Tracks	Groundings	Recoveries
Bay of Fundy	45	25 (55.6%)	11 (24.4%)
Gulf of St. Lawrence	64	37 (57.8%)	11 (17.2%)
Laurentian Channel	16	1 (6.2%)	0 (0.0%)
Newfoundland Shelf	34	12 (35.3%)	6 (17.6%)
Scotian Shelf	61	14 (23.0%)	8 (13.1%)
Total	220	89 (40.5%)	36 (16.4%)

3.1.1 Bay of Fundy

In total, 45 drifter tracks are available in the Bay of Fundy (Figure 9). The majority of the drifters were deployed near Saint John, which is one of the ports of focus for the OPP program. Most of the drifters remained in the Bay of Fundy, however, four iSVPs and six CODE/Davis drifters traveled through the Gulf of Maine.

There are 22 tracks from CODE/Davis drifters, 11 from OSKER, 10 from iSVP and two from Stokes (Table 3). Twenty-five of the drifters grounded and 11 of the drifters were recovered (Table 6). These grounding and recovery rates are higher than the overall rate for all 220 drifters. Most of the drifters grounded on the New Brunswick and Nova Scotia coasts of the Bay of Fundy.

The average distance travelled by the drifters was 2237 km. It is significantly greater than the median of 1006 km (Table 5) because there were two drifters that travelled more than 10 000 km (Figure 8). The average lifetime of the drifters was 46 days, whereas the median was 25 days (Table 4). The longest lifetime was 307 days, whereas the shortest was just 0.5 days.

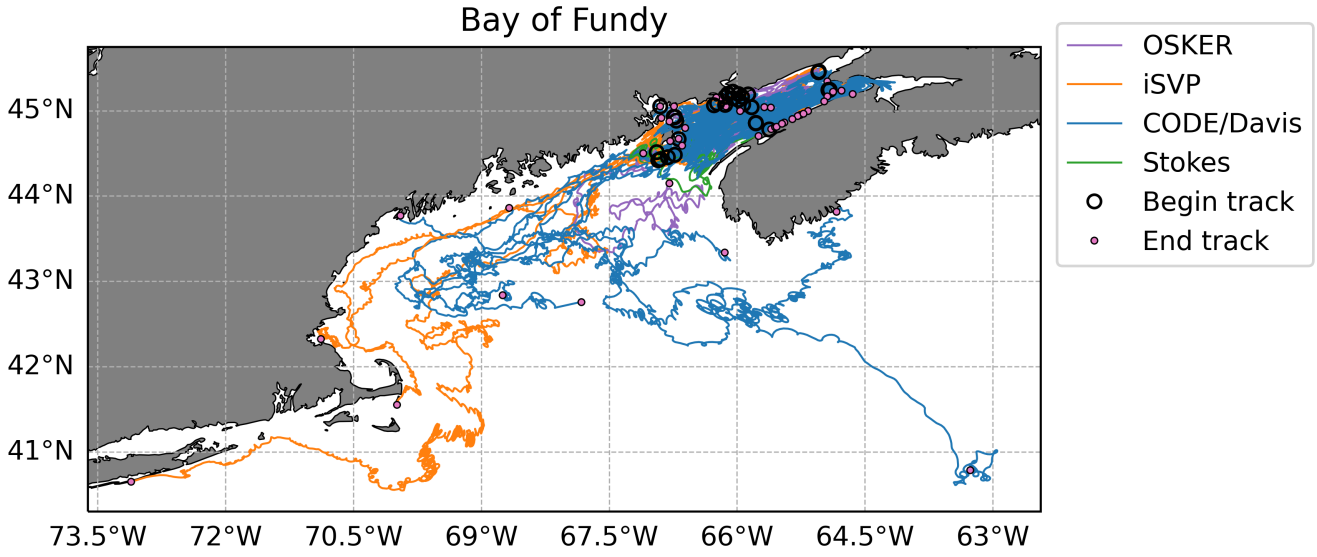

Figure 9: Tracks of all drifters deployed in the Bay of Fundy region. Colour of tracks indicate the drifter type. Open circles represent where each track began, pink circles represent where each track ended.

3.1.2 Gulf of St. Lawrence

In total, 64 drifter tracks are available in the Gulf of St. Lawrence. These drifters were all deployed near Rimouski, Quebec as part of two deployments of the TReX project (September 2020 and September 2021). The drifters were DFO's contribution to a larger campaign where approximately 300 drifters were deployed to study surface dispersion in the area (e.g. Pawlowicz et al. 2021).

The majority of the tracks were from OSKER (26) and CODE/Davis (25) drifters (Table 3). There were also 5 Stokes, 5 iSVP and 3 iSphere tracks. Most of the drifters remained in the Gulf of St. Lawrence, with a few reaching the Scotian Shelf and one iSVP travelling part way across the Atlantic Ocean (Figure 10).

The median lifetime and distance of the drifters was 28.2 days and 934.1 km, respectively (Table 4 and Table 5). The corresponding average values of 44.9 days and 1350 km, were significantly higher because one of the iSVP drifters travelled more than 15 900 km in 560 days. The grounding rate of 57.8% was the highest of all the deployment areas (Table 6) with 20 of the 37 groundings occurring on Anticosti Island. The recovery rate was 17.2% (Table 6).

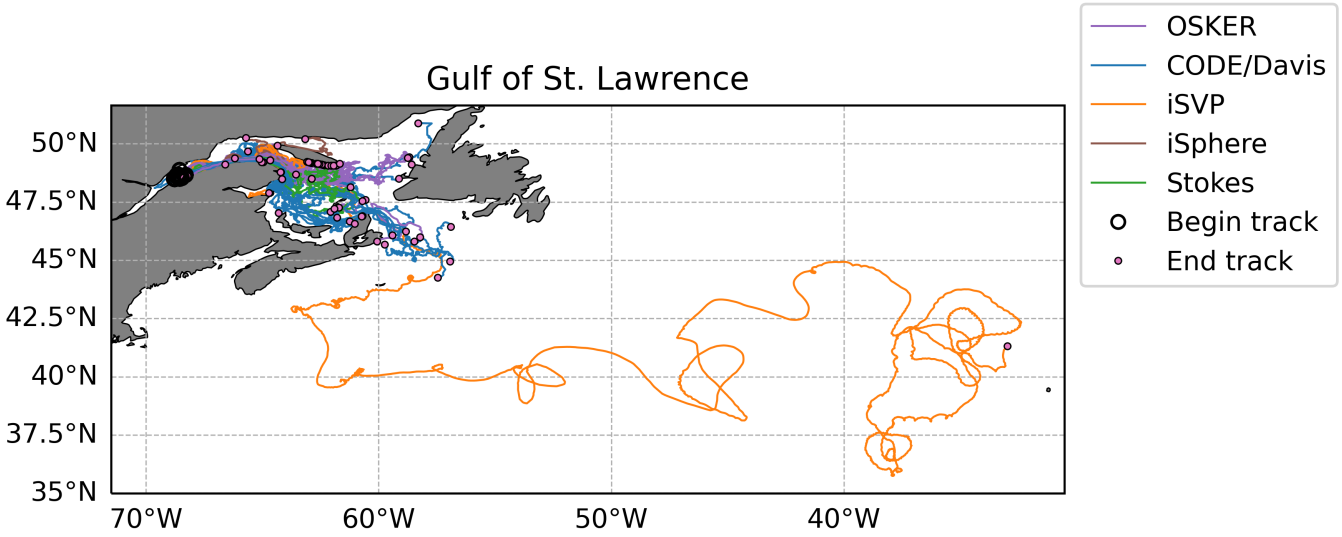

Figure 10: Tracks of all drifters deployed in the Gulf of St. Lawrence region. Colour of tracks indicate the drifter type. Open circles represent where each track began, pink circles represent where each track ended.

3.1.3 Laurentian Channel

Sixteen drifters were deployed in the Laurentian Channel in 2019 (Figure 6). Ten of the drifters were OSKERS, 4 were CODE/Davis and 2 were iSVP (Table 3). Only one of the drifters grounded and it was not recovered (Table 6). Most of the drifters traveled southeast from the deployment location (Figure 11).

The drifters deployed in the Laurentian Channel had mean and median lifetimes of 55 and 65 days, respectively (Table 4). The mean and median distances were 1428 and 1649 km, respectively (Table 5). The standard deviations in lifetime of 23 days and distance of 626 days were the lowest of all the regions, influenced by the smaller number of drifter tracks, but also the low number of groundings. The drifters had the longest minimum duration of all the regions at 13.2 days and the longest minimum distance at 283 km. The maximum values of 79.5 days and 2391 km were also the shortest duration and distances in comparison with other regions.

3.1.4 Newfoundland Shelf

Thirty four drifter tracks began on the Newfoundland Shelf (Table 3). There are 16 tracks from Stokes drifters, 9 from OSKERs, 6 from iSVP, 2 from Spotters and 1 from CODE/Davis (Table 3). The deployments were all completed in 2021 and 2022. Three of the drifters deployed in 2021 crossed the Atlantic (Figure 12), two of which grounded and were recovered. On the other hand, six of the drifters deployed in 2022 grounded on the Bonavista peninsula shortly after deployment. Four of these drifters eventually refloated after several tidal cycles, leading to multiple short tracks per drifter.

The quick grounding of several drifters led to significantly smaller median values than mean values for the metrics. The median lifetime and distance at sea were 11.2 days and 197 km, respectively (Table 4 and Table 5). On the other hand, the mean values were 103 days and 2656 km, respectively. The minimum values of 0.1 days and 0.6 km were the lowest of all the drifter tracks included in the report. The grounding rate of 35.3% was slightly lower than the overall rate (Table 6).

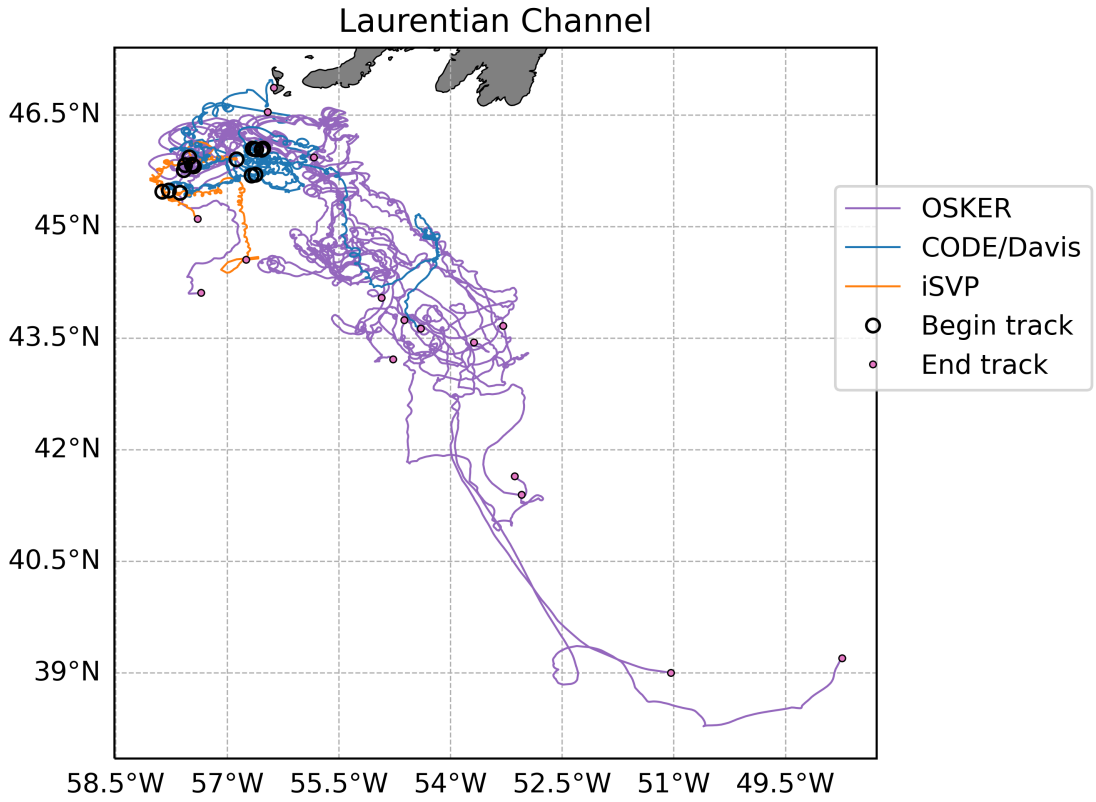

Figure 11: Tracks of all drifters deployed in the Laurentian Channel region. Colour of tracks indicate the drifter type. Open circles represent where each track began, pink circles represent where each track ended.

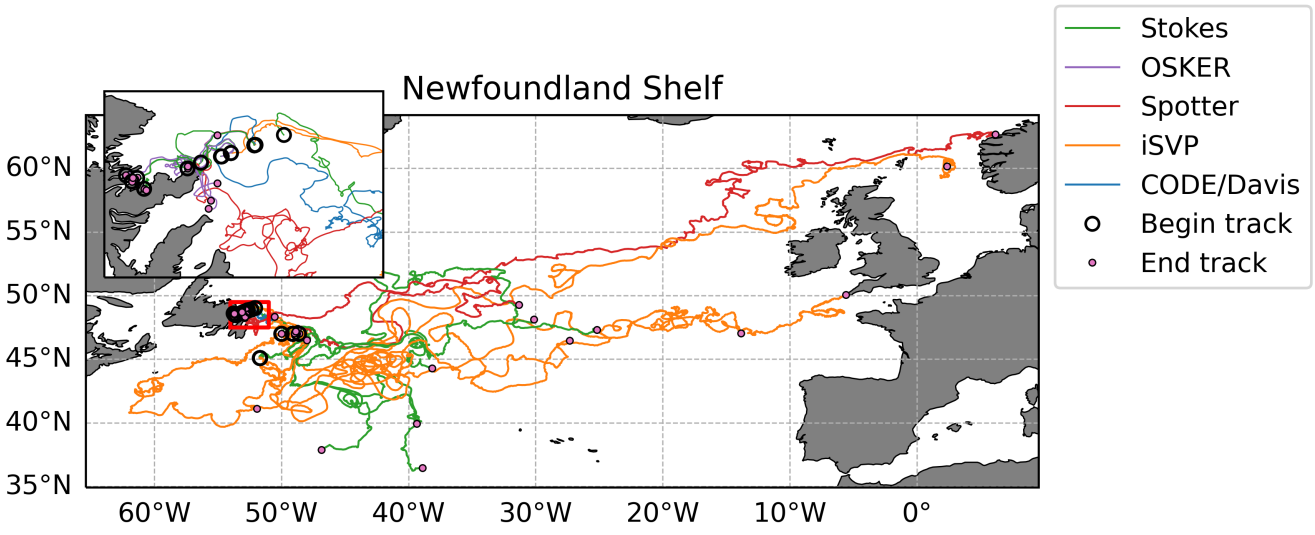

Figure 12: Tracks of all drifters deployed in the Newfoundland Shelf region. Colour of tracks indicate the drifter type. Open circles represent where each track began, pink circles represent where each track ended. The red rectangle represents the zoomed-in area shown in the inset.

3.1.5 Scotian Shelf

Sixty-one drifter tracks began on the Scotian Shelf. Twenty-nine tracks are from CODE/Davis drifters, 17 from OSKERs and 15 from iSVPs (Table 3). Most of the drifters were deployed within Chedabucto Bay or on Canso Bank (Figure 13). The drifters deployed within the harbour tended to ground quickly, whereas those deployed on the bank often travelled long distances, two crossing the Atlantic Ocean.

The drifter tracks had the longest mean distance (2821 km) of all the regions (Table 5). The mean lifetime was 103 days (Table 4). The median values were significantly lower with a lifetime of 58.5 days and a distance of 1096 km. The maximum lifetime of 872 days and maximum distance of 21 341 km were the longest of all the drifter tracks. The grounding and recovery rates of 23% and 13% were lower than the overall values (Table 6).

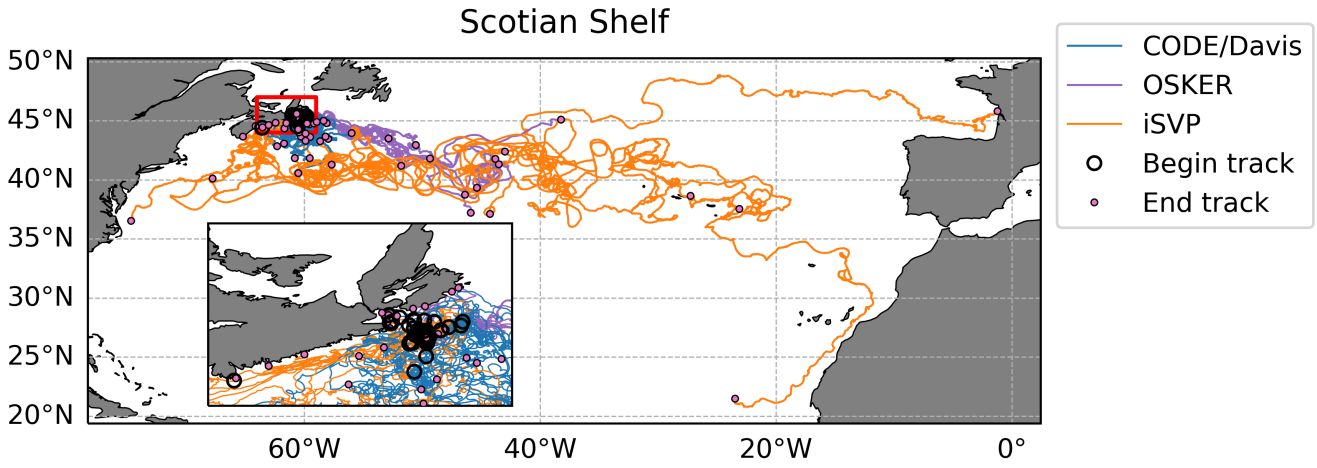

Figure 13: Tracks of all drifters deployed in the Scotian Shelf region. Colour of tracks indicate the drifter type. Open circles represent where each track began, pink circles represent where each track ended. The red rectangle represents the zoomed-in area shown in the inset.

3.2 Drifter Statistics by Type

The distributions of the lifetime at sea and distance at sea metrics are tabulated by drifter type in Tables 7 and 9. They are also presented graphically in Figures 7 and 8.

The iSVP drifters had the longest maximum lifetimes at sea (Table 7). The longest lifetime was 872 days, which is over 1.5 times the 18 month (547 day) operating life stated by the manufacturer. Four of the iSVP drifters exceed this operating life and two others lasted 533 days (Figure 7). However, the mean and median lifetime were significantly lower at 213 and 120 days, respectively, because several of the drifters grounded before their batteries died. The Spotter drifters also had long lifetimes, both exceeding 172 days, however, there were only two deployed so it is not possible to quantify the variability.

The OSKER and Stokes drifters had the shortest lifetimes with median values of 19.9 and 18.8 days, respectively. The three iSphere drifters also had short lifetimes with a median of 25.8 days and a maximum of 39.4 days. These drifters all had high grounding rates – 100% for the iSphere, 52.2% for the Stokes and 47.9% for the OSKER.

If the statistics are computed for the drifters that died at sea without grounding (Table 8), then the lifetime statistics can be compared to the manufacturer's expectations. For one hour sampling, the expected lifetimes are 90-365 days for CODE/Davis, 95 days for Osker, 120 days for Stokes, and 547 days for iSVP. The mean and median values in Table 8 are all below these estimates likely due to several factors: (1) the drifters were often stored for many months prior to deployment, (2) the drifters were

often set to sample in 5-10 minute intervals for the first couple days of their deployment and then one-hour sampling thereafter, and (3) several of the drifters stopped reporting quickly yielding very short lifetimes. It should be noted that for all drifter types, the maximum lifetime exceeds, or comes very close to, the manufacturer's estimates.

The patterns in the distances at sea are very similar to the lifetimes. The longest maximum track length was 25 878 km from an iSVP. The OSKER, Stokes and iSphere drifters traveled shorter distances because of their limited lifetimes.

The CODE/Davis drifters grounded the least often of all the drifters with a grounding rate of 25.9%. The iSVP drifters ranked second with a rate of 44.7% followed by the OSKERs at 47.9%. The Spotter, Stokes and iSphere drifters grounded more than 50% of the time. The grounding rates are likely more affected by the deployment location and its proximity to shore as opposed to the drifter type.

Table 7: Lifetime at sea (days) by drifter type

Type	N	Mean	Median	Std. Dev	Min.	Max	Sum
CODE/Davis	81	49.8	44.8	34.6	0.7	161.8	4032.3
OSKER	73	28.8	19.9	26.9	0.1	87.5	2101.4
Spotter	2	237.1	237.1	90.7	172.9	301.2	474.1
Stokes	23	35.6	18.8	45.7	0.2	203.8	819.3
iSVP	38	213.2	119.9	238.3	7.2	872.2	8099.9
iSphere	3	27.9	25.8	10.6	18.4	39.4	83.6

Table 8: Lifetime at sea by drifter type for drifters that died at sea on their initial track (i.e. never grounded).

Type	N	Mean	Median	Std. Dev	Min.	Max	Sum
CODE/Davis	60	54.1	48.5	35.6	1.0	161.8	3243.7
OSKER	37	43.2	49.0	29.9	0.1	87.5	1598.8
Spotter	1	172.9	172.9	nan	172.9	172.9	172.9
Stokes	10	69.6	60.6	51.5	3.2	203.8	695.9
iSVP	19	307.0	248.3	254.0	15.8	872.2	5833.1
iSphere	0	nan	nan	nan	nan	nan	0.0

Table 9: Distance at sea (km) by drifter type

Type	N	Mean	Median	Std. Dev	Min.	Max	Sum
CODE/Davis	81	1483.4	1363.4	1593.1	5.5	12826.7	120156.7
OSKER	73	1060.8	773.6	1087.8	0.6	4301.2	77440.1
Spotter	2	6617.0	6617.0	2719.3	4694.2	8539.8	13234.0
Stokes	23	1270.5	748.0	1587.8	3.7	6515.4	29220.7
iSVP	38	6030.4	1923.2	7124.1	260.9	25877.9	229156.7
iSphere	3	1029.1	874.5	342.1	791.7	1421.3	3087.4

3.3 Drifter statistics by End Location

On average, drifters ending on land had longer lifetimes and travelled further than those ending at sea (Figures 7 and 8). This result is surprising and is opposite of that of Hourston et al. 2021. It is likely driven by the fact that several of the drifters that ended at sea died shortly after deployment, particularly in the Newfoundland deployments where storms occurred within the first few weeks of deployment. In

Table 10: Groundings and recoveries by drifter type.

Type	Number Tracks	Groundings	Recoveries
CODE/Davis	81	21 (25.9%)	10 (12.3%)
OSKER	73	35 (47.9%)	10 (13.7%)
Spotter	2	1 (50.0%)	2 (100.0%)
Stokes	23	12 (52.2%)	1 (4.3%)
iSVP	38	17 (44.7%)	13 (34.2%)
iSphere	3	3 (100.0%)	0 (0.0%)
Total	220	89 (40.5%)	36 (16.4%)

addition, several of the drifters that ended on land did so after crossing the Atlantic, contributing to the long duration and distance measurements.

4 Temperature and pressure measurements

Temperature sensors are included by default on Stokes, CODE/Davis, iSVP and Spotter drifters, so 144 of the 220 tracks also had measurements of the sea surface temperature (Figure 14). Because these drifters were deployed at different times, it is impossible to interpret instantaneous patterns in the dataset, but individual tracks may be useful in focused studies.

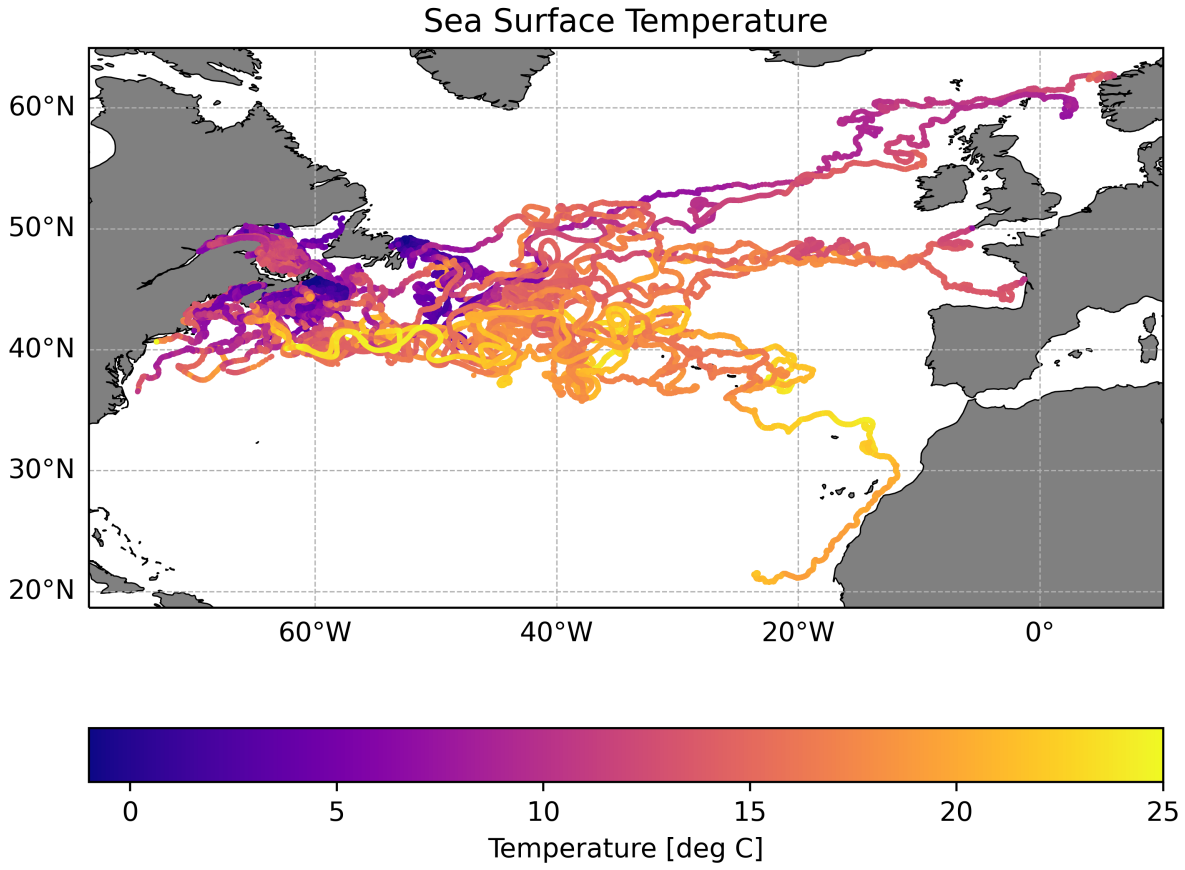

Figure 14: Sea surface temperature from drifters with a temperature sensor.

A barometer is an optional sensor on iSVP drifters. Fourteen of the 38 iSVP tracks included measurements of barometric pressure (Figure 15). Because the drifter data is sent to the Global

Telecommunication System (GTS), these pressure measurements were available to be assimilated in weather forecasts in near real time.

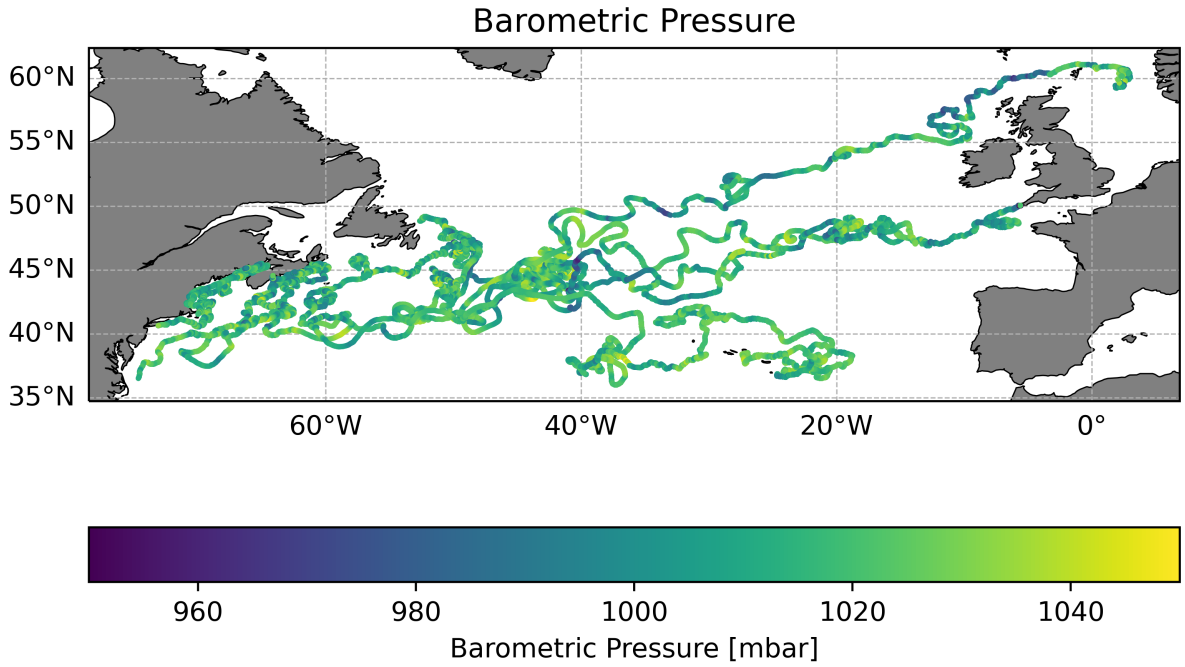

Figure 15: Barometric pressure from drifters with a barometer.

5 Lessons learned

Quality Control Initially, quality control of the data was simplistic – impossible times and coordinates were removed and then the DRIFTEVAL tool was used to categorize the remaining data. This approach created tracks that looked reasonable, but an analysis of the drifter speeds yielded numerous unrealistic values (i.e identically zero, or very high values). Discussions with the manufacturers then led to the flagging of the data summarized in Section 2.3. The flagging resulted in more than 30% of the data being removed from 9 of the drifter tracks and more than 10% of the data in 35 of the tracks. For one of the iSVP deployments, 75% of the data was flagged because the time to first fix value was 254 seconds. After implementing the flagging, and then running DRIFTEVAL, a final quality control step of removing unrealistic speeds was implemented. For these data, this final check of the speeds typically removed less than 1% of the data.

Environmental conditions Drifters were exposed to a variety of environmental conditions during their deployment lifetime. For example, drifters in the Laurentian Channel deployment were subject to the passage of Hurricane Dorian in early September 2019. Similarly, drifters deployed on the Grand Banks, east of Newfoundland, in early December 2021 experienced harsh environmental conditions during the passage of a large storm with significant wave heights of nearly 10 m. Many drifters fared well during these extreme conditions, however, some experienced temporary interruptions in data transmission and some did not report any data after the passage of the storms.

Deployment configurations and schedule Where possible, attempts were made to deploy drifters in groups or pairs with the same starting location and time. Initially, these deployment groups followed the same path, however, over time, many of the groups separated. The separation rates depended on local circulation patterns and environmental conditions. Drifters in coastal and

near-shore regions either grounded or left the domain of interest rapidly, hence, a deployment schedule which targeted regular, recurring deployments was selected. As a result, fewer drifters were available for targeted process-driven studies but this schedule optimized data availability for model evaluation. Given the chaotic nature of drifter behaviour, grouped deployments with a large sample size should be considered for both process-driven studies and comprehensive model evaluation. Yet, single drifter deployments, as often used in operational and response settings, can also provide valuable insights regarding the accuracy of model surface currents during these specific events.

Recoveries and engagement Contact information left on each drifter made it possible for those that were recovered to be reported to the owner. In general, the people who reported recovered drifters were provided with a short explanation of the device's purpose, deployment time and location, data collected, and instructions on how to safely dispose of the device. In some special cases where contact information was not available on the device, the finder contacted the drifter manufacturer who assisted in making a connection with the owner. Some finders were very keen to learn more about the drifter program and kept the recovered device as a memento. Although efforts were made to ensure responsible and sustainable disposal of the recovered devices, future procurement options should consider biodegradable devices such as the CARTHE drifter (`https://www.pacificgyre.com/carthe-drifter.aspx`).

6 Summary

This report describes 220 drifter tracks in the Atlantic Ocean between November 2018 and July 2023. Six different types of commercially available drifters were used. Eighty-nine of the drifters grounded (40.5%) and 36 (16.4%) were recovered.

The lifetime and distance at sea of the drifter tracks varied by deployment region and drifter type. A drifter in the Bay of Fundy travelled the furthest at 25 878 km and a drifter deployed on the Scotian Shelf lasted the longest at 872 days. The shortest drifter track of 0.1 km and 0.6 days occurred on the Newfoundland Shelf, where the drifter had previously grounded, and then been refloated by a high tide. In general, the drifters intended to measure surface currents (Stokes, OSKER, iSphere) had a shorter lifetime (< 29 days) than those intended to measure subsurface currents (CODE/Davis, iSVP). The exception was the Spotter drifter which measures surface currents, but survived a minimum of 173 days. For drifters that did not ground, the median lifetimes were all less than the expected lifetimes based on the manufacturers estimates, possibly because the drifters had been on the shelf for a year or more prior to deployment or the drifters were configured to sample more quickly than the default configuration for the first 24-48 hours of their deployment.

Overall, the drifter deployments were successful, resulting in over 472 000 km and 15 600 days of data. The limitations of the data set are primarily that several drifters grounded quickly when deployed close to shore, and drifters often stopped reporting after large storms. The data have been used successfully for model validation; however, given the chaotic nature of drifter behaviour it is recommended that future deployments for validation purposes include larger groups of drifters deployed at the same time. Single, or small group, drifter deployments can be used during operational and response events to help provide insight on the instantaneous accuracy of the model's surface currents.

7 Acknowledgements

The authors would like to thank all who helped deploy the drifters, as well as the many individuals who found and reported a grounded drifter.

We would also like to thank the officers and the crew of the vessels used for the deployments: *CCG Perley*, *HMCS Ville de Quebec*, *CCGS Cygnus*, *R/V Atlantis*, *DMK*, *Polar Prince* and the *R/V Coriolis*.

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Pawlowicz, Rich, Cedric Chavanne, Dany Dumont, Roy Hourston, Douglas Schillinger, and Nancy Soontiens. 2021. *TReX Surface Dye Release Phase 1 Drifter Dataset*. Raw drifter data (L1 datasets) from a variety of interfaces have been collected and merged into a uniform format (L2 dataset) which is then quality-controlled, with classifications added for all locations dividing them into "Valid" (freely floating at sea), "trapped", "grounded" and "bad". The final L3 dataset is provided here in both the form of a MATLAB binary data structure, and archival ASCII-format files. DOI: http://dx.doi.org/10.14288/1.0398295. URL: https://open.library.ubc.ca/collections/researchdata/items/1.0398295.

Pawlowicz, Rich, Charles Hannah, and Andy Rosenberger. 2019. Lagrangian observations of estuarine residence times, dispersion, and trapping in the Salish Sea. Estuarine, Coastal and Shelf Science **225**(March), 106246. ISSN: 02727714. DOI: 10.1016/j.ecss.2019.106246.

A Recovered Drifter Locations

Table 11 lists the locations where 36 of the drifters were recovered. Twenty-six grounded on the coastline and ten were retrieved by a vessel at sea. In some cases, the drifter was assumed to be recovered based solely on the drifter track (i.e. brought to a wharf, or brought onshore to a residence) and was never actually recovered. Others were found by residents on beaches and reported to DFO, occasionally well after the drifters stopped transmitting.

Table 11: List of recovered drifters and their locations.

	Date	Drifter ID	Latitude	Longitude	Land/Sea	Location
1	2019-05-29	SVP DFO-CB-19-02-M2088	44.4590	-63.5489	Sea	Sambro, NS
2	2019-06-06	SVP DFO-CB-19-02-E	43.9417	-59.8904	Land	Sable Island, NS
3	2019-07-10	SVP DFO-CB-19-02-F	44.6639	-63.0089	Land	Jeddore Rock, NS
4	2019-11-05	Davis DFO-CB-2019-11 02	45.3758	-61.0572	Sea	Canso, NS
5	2020-01-03	SVP DFO-SJH-2019-12 03	45.1532	-66.2453	Sea	Musquash Harbour, NB
6	2020-01-10	Davis DFO-SJH-19-12 02	44.9046	-65.3539	Land	Hampton Beach, NS
7	2020-01-14	SVP DFO-CB-2019-11 02	44.5539	-64.1335	Land	East River, NS
8	2020-02-05	Davis DFO-SJH-19-12 04	44.8499	-65.4746	Land	Youngs Cove, NS
9	2020-02-19	SVP Canso-4	45.8322	-1.2475	Land	Olonne sur Mer, France
10	2020-02-22	Davis DFO-SJH-19-12 01	45.1977	-64.6436	Land	Halls Harbour, NS
11	2020-03-27	SVP DFO-CB-2019-11 03	36.5131	-74.6684	Sea	Ocean City, Maryland, USA
12	2020-03-29	Davis DFO-SJH-19-12 12	45.1689	-64.9434	Sea	Morden, NS
13	2021-02-11	SVP DFO-CB-19-02-M2088	38.6544	-27.2784	Land	Azores, Portugal
14	2021-09-08	Davis DFO-TRX-21-09 10	48.5505	-68.3830	Land	Luceville, QC
15	2021-10-09	Davis DFO-TRX-21-09 12	47.0308	-64.3106	Sea	Skinners Pond, PEI
16	2021-10-22	Davis DFO-TRX-21-09 10	48.6174	-68.2203	Land	Saint Flavie, QC
17	2021-10-26	Davis DFO-TRX-21-09 04	47.2238	-61.9113	Land	Magdalen Islands, QC
18	2021-10-27	Osker 1118	47.3824	-61.8843	Land	Magdalen Islands, QC
19	2021-11-04	SVP DFO-TRX-2021-09 03	48.7926	-64.2258	Land	Forillon National Park, QC
20	2021-11-08	Osker 1117	47.3824	-61.8843	Land	Magdalen Islands, QC
21	2021-11-10	Osker 1124	45.8076	-60.0810	Land	Gabarus, NS
22	2021-12-26	Osker 1116	45.7716	60.2012	Land	Belfry Beach, NS
23	2022-03-29	Osker 1121	48.6948	-58.9288	Land	Winterhouse, NL
24	2022-05-24	stokes_DFONL_Spring2022_01	48.4395	-53.5490	Land	Summerville, NL
25	2022-06-16	davis_DFONL_Spring2022_01	48.3386	-50.5386	Sea	St. John's, NL
26	2022-10-08	Osker OPP_SIO_SOO 1215	44.9402	-65.2892	Land	Port Lorne, NS
27	2022-10-10	SPOT-1017	62.6656	6.1672	Land	Haramsøya, Norway
28	2022-11-13	SVP DFO-SIO-22-09 04	44.6470	-66.7854	Sea	Gran Manan NB
29	2022-12-13	Osker 1119	52.8583	-9.4447	Land	Clare Co. Ireland
30	2022-12-19	SVP DFO-SIO-22-09 03	41.5563	-69.9896	Land	Chatam, MA, USA
31	2023-02-20	Osker 1319	53.5384	-9.8875	Land	Galway Co. Ireland
32	2023-06-24	SVP DFO-SIO-22-09 01	40.6544	-73.1071	Land	Long Island, NY
33	2023-07-04	Osker OPP_SIO_SOO 883	45.0240	-66.8320	Land	Bliss Island, NB
34	2023-07-25	SVP DFO-SIO-22-09 02	43.8623	-68.6775	Sea	Vinalhaven, Maine, USA
35	2023-09-17	Osker 1010	49.2136	-63.0135	Land	Anticosti Island, QC
36	2023-10-17	SPOT-1759	52.3011	3.9160	Sea	North Sea, Netherlands

B Drifter Specifications

The following subsections include screenshots of the drifter specifications. Product data sheets were downloaded on Feb 20, 2024.

B.1 Stokes

TECHNICAL SPECIFICATIONS

MECHANICAL SPECIFICATIONS	
Outer Diameter	24 cm
Height	4.1 cm
Weight	905 g

POWER CONSUMPTION	
Shelf Life	5-year shelf life (before battery replacement required)
Deployment Life	Typical +4 months (1-hour sample interval and 2-hour reporting interval)
Battery	10 AA batteries (comes installed and replaceable)

INTERFACES	
Bluetooth	BLE 5.0
Satellite	Iridium SBD
GNSS	+/- 1-100 meter accuracy. Cold start kix < 60s

INTERNAL SENSORS	
Temperature Sensor	0.25°C Accuracy (-5°C to 40°C)

ENVIRONMENTAL	
Operating Temperature	-18°C to +55°C
Storage Temperature	-40°C to +50°C
Ingress	IP68
Test Approvals	IEC 60945 Section 8.5 (Thermal Shock), SAE J1455 Thermal Cycling, SAE J1455 Section 4.9.3 (Low Pressure), SAE J1455 Temperature Cycling

REGULATORY APPROVALS
IC (ISED)
EC
FCC

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B.2 OSKER

ROBY | OSKER

TECHNICAL SPECIFICATIONS*

ROBY

Functionality	
Base Function	2-way Iridium communication
Serial Programmable Functions	GPS location & transmission of data
Electrical	
Battery Supply	18 AA Batteries (lithium or alkaline)
Operational Lifetime	Approximately 2 years at 3 hour intervals
Communication	
Iridium	9603 Modem
Antenna	Dual RHCP Iridium patch antennas & independent dual GPS antennas
Local	Bluetooth Low Energy (BTLE)
Mechanical	
Dimensions	2.25″ diameter x 8.25″ length 8″ diameter collar
Weight (with collar)	1131 g
Material	Delrin & urethane foam
Environmental	
Operating Temperature	-20°C to +60°C
Depth Rating	Surface use only
Compatible With	
XeosOnline™ Console	Web based control & tracking
BTLE Android App	Diagnostic and commands

OSKER

Functionality	
Base Function	2-way Iridium communication Single use
Programmable Intervals	GPS location & transmission of data Watch Circle diameter
Electrical	
Battery Supply	Integrated
Operational Lifetime	181 days at 3 hour intervals
Communications	
Iridium	9603 modem
Antenna	Dual RHCP Iridium patch antennas & independent dual GPS antennas
Local	Bluetooth Low Energy (BTLE)
Mechanical	
Dimensions	5″ diameter x 2.0″ Foam 8″ diameter
Weight	517 g
Material	ABS & urethane foam
Environmental	
Operating Temperature	-20°C to +60°C
Depth Rating	Surface use only
Compatible With	
XeosOnline™ Console	Web based control & tracking
BTLE Android App	Diagnostic and commands

*Specifications subject to change without notice.

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Xeos Technologies Inc

Data Telemetry Specialists

B.3 CODE/Davis

TECHNICAL SPECIFICATIONS

PHYSICAL

- Prior to Deployment:

Packaged Length: 1016 mm (40 inches)
Diameter: 203.2 mm (8 inches)
Weight: 10.8 kg (23.5 lbs)

- Deployed Surface Unit:

Hull Diameter: 102 mm (4 inches)
Total Height: 1400 mm (55.1 inches)
Total Cross-section Width: 1090 mm 43 inches)
Drogue Vane: 50 mm (19.6 in.) X 70 mm (27.0 in.)
Length Of Exposed Mast: 400 mm (16.0 inches)
Float Size: 133 mm (5.25 in.) wide, 216 mm (8.5 in.) long
Mass in Air: 8 kg (17.5 lbs)

CONSTRUCTION

Hull Material	Marine-grade aluminum
Flotation	Four, quarter-cylinder polystyrene floats

OPERATION CONDITIONS

Air Temperature	-20°C to +35°C (-4°F to +95°F)
Water Temperature	-2°C to 35°C (-28°F to 95°F)
Water Type	Fresh or Salt
Significant Wave Height	8 m (26 ft)
Wind Speed	20 m/s (40 knots)
Wind Gusts	30 m/s (60 knots)
External Humidity	100%
Sunlight	Direct exposure
Operating Life	3-12 months depending on sampling

SURVIVAL CONDITIONS

Air Temperature	-30°C to 35°C (-22°F to 95°F)
Water Temperature	-2°C to 35°C (-28°F to 95°F)
Significant Wave Height	12 m (40 ft)
Wind Speed	35 m/s (70 knots)
Shelf Life	24 months with storage conditions at ~21° C

ELECTRONICS

- Option 1:
  Iridium Transceiver: 9602 SBD
  Antenna: Low profile dual band, Iridium/GPS
- Option 2:
  Argos PTT: MetOcean Model MAT 906
- Power Supply: 10 alkaline-manganese dioxide AA cells

SENSORS

Sea Surface Temperature	US sensor ±.05°C thermistor
Battery Voltage	Precision resistive divider
GPS Receiver	Jupiter F2

DEPLOYMENT

Deployment Options	Vessel

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Spotter Technical Specifications

SOFAR

Specs

External dimensions [w X h]	42 cm x 31 cm (16.4 in x 12.2 in)
Weight	7.45 kg (16 lbs, 7 oz)
Connectivity	Iridium SBD (satellite)
Primary power source	Solar powered, 5x 2 Watt, 6 Volt solar panels
Battery	Lithium-ion, capacity 11,200 mAh, 3.7v (rechargeable)

Motion Sensing

Motion data format	Easting, northing, elevation, latitude, longitude
Wave frequency range	0.03-1 Hz (30s to 1s)
Wave direction resolution	0 - 360 degrees (full circle)
Sampling rate	2.5 Hz (Nyquist at 1.25Hz)
Wave displacement accuracy	Approximately +/- 2cm accuracy depends on field of view, weather conditions, and GPS system status
Calibration	Not needed, ever

Additional Onboard Sensors

Sea surface temperature (SST)	-5°C to 50°C range, ±0.1°C absolute accuracy, ±0.02°C resolution
Barometer	Range: 700...1100mbar, Accuracy: +/-0.5 mbar at 25°C

Data Storage

On-board (SD card)	Records time series of 3D displacement data, ships with 16GB (256GB max capacity), FAT16 or FAT32 Format required
Cloud storage (online dashboard)	Online account includes: Real-time and historical data outputs, Spotter configurations, alerts, maps and 2-way communication

Data Outputs

* Can derive from SD card data.

	Standard mode	Spectrum mode	On device
Significant wave height	x	x	x*
Peak period	x	x	x*
Mean period	x	x	x*
Peak direction	x	x	x*
Mean direction	x	x	x*
Peak directional spread	x	x	x*
Mean directional spread	x	x	x*
Variance density spectrum		x	x
Directional moments (a1, b1, a2, b2)		x	x
3D displacement time series @ 2.5 Hz (x,y,z)			x
Sea surface temperature	*Not available with Smart Mooring units.*		
Wind speed	x	x	
Wind direction	x	x	x*
Drift speed			x*
Drift direction			x*
Geographical coordinates (lat, lon)	x	x	x*

Misc. specs

System monitoring	Battery power status
Advised mooring depth	Any depth
Visibility LED	1 flash every 2.5 sec, at least 1 mile visibility under normal conditions.
Firmware upgrade	Standard micro-USB (cable included)
Usability	Magnetic on/off switch, run/idle mode, user LED's and integrated grab handles.

B.5 iSphere

TECHNICAL SPECIFICATIONS

BUOY DIMENSIONS
- Surface Unit Diameter: 13.40 inches (340 mm)
- Mass (in air): 13.15 kg (29 lbs.)

BUOY CONSTRUCTION
- Surface Unit: Injection molded high impact ABS

OPERATION
- Operational Temperature: -2° C to 35° C
- Relative humidity: 0 to 100% marine environment
- Sea state: SS5
- Operating life: Up to 18 months
- Storage life: Up to 36 months
- Storage temperature: -40°C to +40°C (-4F to 131F)
- Time reference: UTC

STORAGE
- Storage life: Up to 36 months
- Storage temperature: -40°C to +40°C (-40°F to 104°F)

SURVIVAL
- Temperature: -2°C to +60°C (35.6°F to 140°F)
- Sea state: SS7
- Deployment free fall height: 10m (33 ft) into water

ELECTRONICS
- MetOcean's GEN II Controller
- Navman Jupiter F2 Global Positioning System module
- Iridium 9602 Short Burst Data transceiver

DATA COLLECTION
- As per the Drifting Buoy Cooperative Panel DBCP-2 format (standard), can be customized depending upon customer requirement (optional)

DATA TRANSMISSION
- Bidirectional communication ability allows the end user to select on demand Iridium transmission interval to suit operational requirement.
- Transmissions can be set up at predetermined schedule intervals and/or poll the unit for immediate results.

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B.6 iSVP

SVP Iridium Drifter

TECHNICAL SPECIFICATIONS

BUOY DIMENSIONS
- Surface Unit Diameter: 15.50 inches (39.5 cm)
- Mass (in air): 40 lbs. (18.1 kg)

BUOY CONSTRUCTION
- Surface Unit: Injection molded high impact ABS
- Tether: Plastic coated stainless steel cable
- Drogue: No rip nylon

DROGUE
- Length: 210 inches (5.3m)
- Diameter: 24.00 inches (60 cm)
- Style: Holey sock

TETHER
- Length (to center of drogue): 590.5 inches (15m)

OPERATION
- Air temperature: -20C to 50C (-4F to 122F)
- Water temperature: -2C to +45C (28F to 113F)
- Relative humidity: 0 to 100% marine environment
- Barometric pressure (optional): 800 to 1060 mbar
- Sea state: SS5
- Operating life: Up to 18 months*
- Storage life: Up to 24 months
- Storage temperature: -20C to +55C (-4F to 131F)
- Time reference: UTC and Julian hour

STORAGE
- Storage temperature: -20C to +55C (-4F to 131F)
- Storage life: Up to 24 months

SURVIVAL
- Temperature: -40C to +70C (-40F to 158F)
- Sea state: SS6
- Deployment free fall height: 33 ft (10m) into water

ELECTRONICS
- MetOcean's Global Platform Transceiver Controller TM
- Navman Jupiter 32 Global Positioning System module
- Iridium 9602N Short Burst Data transceiver
- Strain gauge drogue presence system

DATA COLLECTION
- As per the Drifting Buoy Cooperative Panel DBCP-2 format (standard)
- Can be customized depending upon customer requirement (optional)

DATA TRANSMISSION
- Bidirectional communication ability allows the end user to select on demand Iridium transmission interval to suit operational requirement.
- Transmissions can be set up at predetermined schedule intervals and/or poll the unit for immediate results. Data latency is less than 60 seconds from start of transmission

* Operational life is dependent upon sensor suite, transmission interval and storage conditions.

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