Reverse Drift Analysis of the Path of the *Chicken Pox*'s Life Raft During September 18-25, 2016

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INTRODUCTION

This report documents the ocean currents, surface waves, and wind conditions observed during the 7-day period September 18-25, 2016 in shelf break region approximately 100 nautical miles (nm) south of Martha's Vineyard Island, MA where Nathan Carman in a drifting life raft was recovered at 1320 (all times in this report are local, EDST time) on September 25, 2016 by the freighter *ORIENT LUCKY*. The objective of this report was to estimate the path of the drifting life raft for 7 days prior to Carman being recovered using a reverse drift analysis. The reverse drift analysis calculates the combined forces of wind, waves, and ocean currents on the life raft over the 7-day period using real-time, high-quality observations from a Woods Hole Oceanographic Institution instrumented surface mooring located 23.4 nautical miles (nm) NNW from the *ORIENT LUCKY's* position on September 25, 2016 at 1320. The reverse drift analysis concludes the life raft moved on average **toward** W by N (282° True) at a mean speed of 0.23 kt for the assumed 7 days prior to being recovered. The reverse drift estimated position of where the life raft and Nathan Carman would have started if Carman's vessel had sunk on September 18, 2016 was 39° 29.98' N, 69° 45.02' W.

In addition, independent, collaborating data from 1) satellite sea surface temperature, 2) OSCAR (Ocean Surface Current Analysis Real-time) derived ocean currents, and 3) paths of two satellite-tracked surface drifting buoys that passed near Block Canyon during September 2016 are provided to directly support this reverse drift analysis.

It is my opinion, to a reasonable degree of certainty as a physical oceanographer, that assuming the *Chicken Pox* sank on September 18, 2016, the reverse drift analysis in this report indicates the *Chicken Pox* sank approximately 39 nautical miles east by south (102° True) from where the life raft was found adrift on September 25, 2018 by the *ORIENT LUCKY* and not at Block Canyon 42 nm northwest of the *ORIENT LUCKY* position.

This report is organized as follows - a brief background of the known facts is summarized, followed by a methodology discussion of moored meteorological and oceanographic data collected by the Woods Hole Oceanographic Institution near the drifting life raft. Then an analysis of 1) life raft reverse drift to the *ORIENT LUCKY* recovery location, and 2) life raft forward drift from the reported Block Canyon sinking location are given. Next a review of the USCG SAR flight paths is given. Then a section discusses additional supporting observations of westward life raft drift from satellite sea surface temperature data, ocean models, and satellite-tracked drifting buoys, followed by conclusions and Appendices. All wind and current data used in this reverse drift analysis report is included in Appendices 11-12.

BACKGROUND

The 31-foot center-console recreational vessel *Chicken Pox* departed Ram's Head Marina in Rhode Island September 17, 2016 around 2300 with a mother and son onboard planning to fish near Block Island overnight and to return the next morning. The vessel was reported missing on September 18, 2016. One survivor, the son Nathan Carman aged 22, was sighted drifting alone at sea in a life raft (Figure 1) by the freighter *ORIENT LUCKY* seven (7) days later at about 1240 on September 25, 2016 approximately 100 nm south of Martha's Vineyard, and Carman was picked up at 1320.

Figure 1*. Carman at sea in the drifting 4-man life raft on 9/25/2016 just before pickup by ORIENT LUCKY.*

Also see Appendix 1 for a copy of the email sent on September 25, 2016 to the USCG by the Master of the *ORIENT LUCKY* with subject "*ORIENT LUCKY*//1 person rescue at sea", Appendix 2 for *ORIENT LUCKY* Automatic Identification System (AIS) position data on September 25, 2016 obtained from www.vesselfinder.com, and Appendix 3 for a copy of the *ORIENT LUCKY* ship's log on 9/25/2016, Navigation Chart on September 25, 2016, and Certification of Navigation Chart September 25, 2016.

During an Examination Under Oath of Nathan Carman on December 16, 2016, Farrell & Smith LLP (pages 161-163), **Carman stated "I could estimate that it (the vessel *Chicken Pox*) sank …. halfway between the X and the asterisk"**. During the deposition Carman made X and * marks in Block Canyon near the 140 fathom depth contour on NOAA Chart 12300 showing the estimated sinking location halfway between his X and * marks (see Figure 2). Carman stated under oath "we started somewhere in the vicinity of the X trolling north" and the asterisk represents "the direction in which we were trolling", and "the boat sank after we started trolling north".

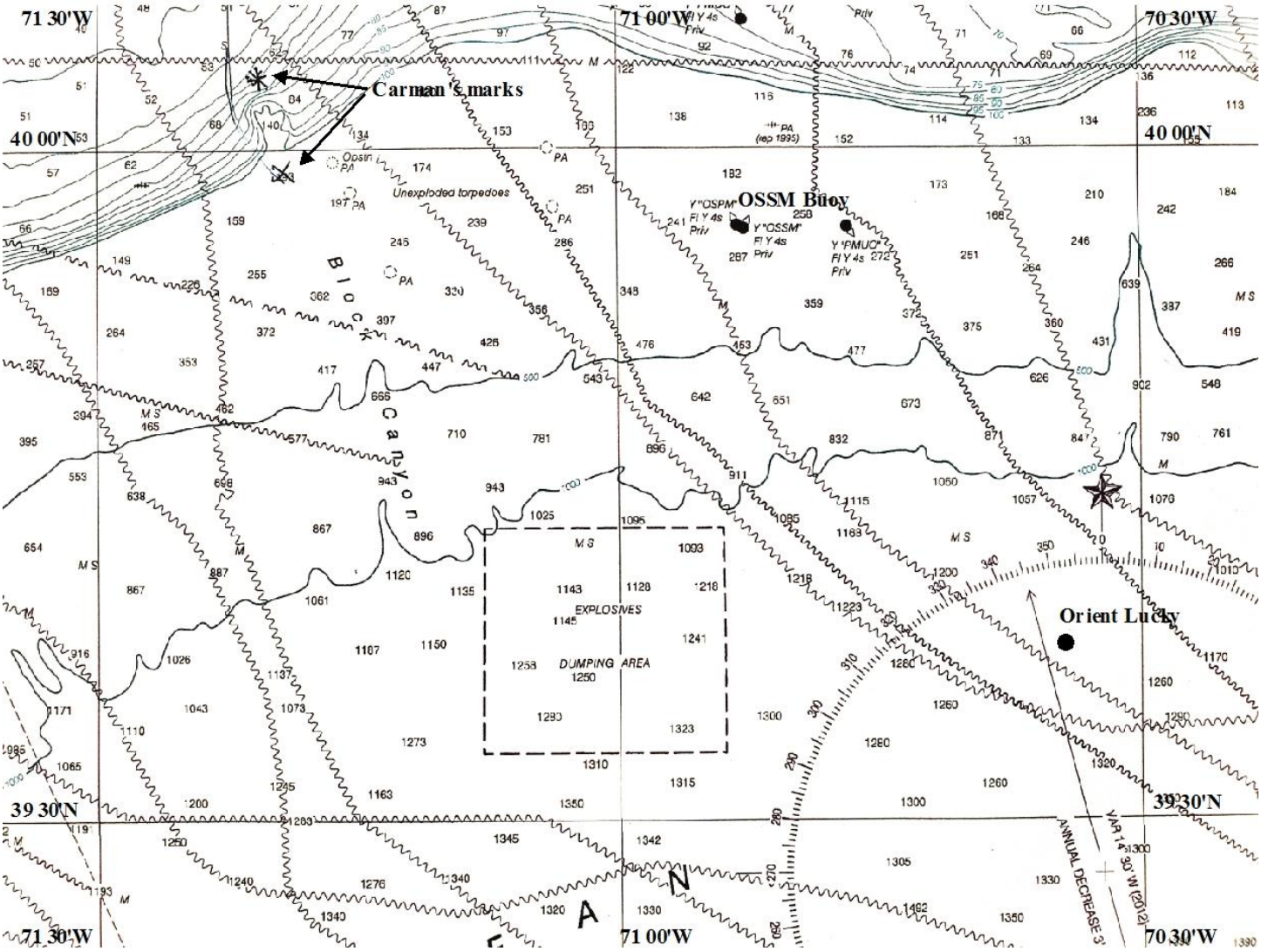

Figure 2*. Selected area of NOAA Chart 12300 showing Block Canyon and Carman's marks estimating the sinking location halfway between his X and * marks near the 140 fathom depth contour. Also shown are the location of the ORIENT LUCKY when the Carman was recovered on September 25, 2016, and the location of an instrumented Woods hole Oceanographic Institution Offshore Surface Mooring Buoy (OSSM) where oceanographic data was collected to estimate the life raft's reverse drift path during September 18-25, 2016. Depths on Chart 12300 are in fathoms. For scale the distance between Carman's X and * marks is 4.4 nm and the distance between the Lucky Orient position and a mark halfway between Carman's marks is 42.8 nm.*

The general area including Block Canyon and Carman's marks in Figure 2 is often referred to as the shelf break. The shelf break is the submerged offshore edge of the relatively shallow continental shelf with depths less than 100 fathoms (~200 m), where the seafloor transitions to the deeper continental slope. The shelf break is characterized by markedly increased slope gradients toward the deep ocean bottom.

It is important to note that the reported deployment of the life raft at Block Canyon on September 18, 2016 and the location eastward where the life raft and Carman were found by the freighter *ORIENT LUCKY* on September 25, 2016 are **not consistent with the historical winds and mean westward currents** for this region shown in Figure 3 (Chen, K., and R. He, 2015, Flagg et. al., 2006).

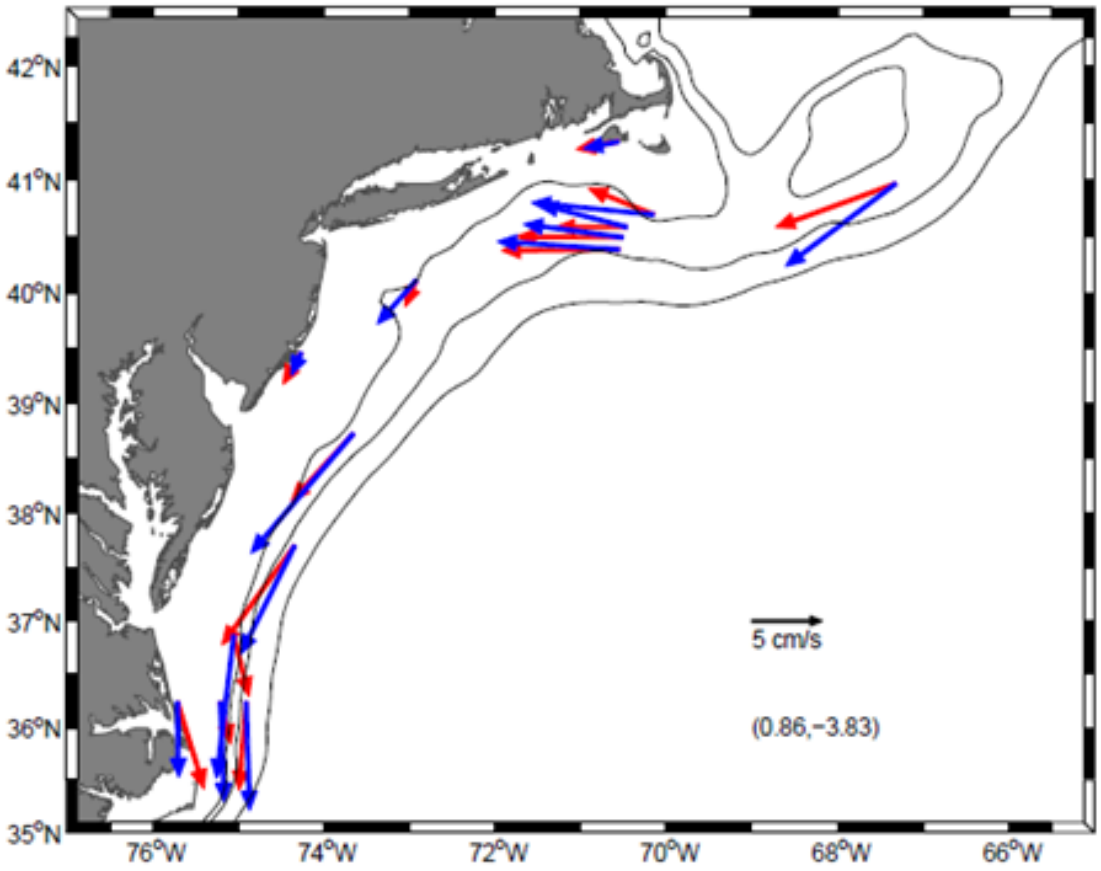

Figure 3*. The comparison between observed (red) and model-simulated (blue) 2004-2013 mean along-shelf, depth-averaged currents. 5 cm/s ~ 0.1 kt. From Chen, K., and R. He, 2015.*

The mean westward flowing currents observed and modelled near Block Canyon in Figure 3 are a robust character of the near-surface currents in the shelf break region south of Massachusetts, Rhode Island, Nantucket Shoals and Georges Bank. However, there are times when the mean westward current in this region can weaken and flow offshore or even flow eastward at times. This occurs when meanders of the Gulf Stream or Gulf Stream rings (meanders that detach from the Gulf Stream) are observed in the shelf break region (Figure 4). These rings and meanders in the shelf break region are anomalous, infrequent events that enclose warm north Atlantic Ocean water and are easily detectable with satellite images due to the higher surface temperature inside the meanders compared to the surrounding colder shelf water.

Figure 4 shows satellite sea surface temperature data combined with near-surface drifter velocities showing both warm- and cold-core rings near the Gulf Stream (Limeburner and Beardsley, 1997). The red arrows are near-surface drifter mean velocities within 0.5° squares for the five-day period centered on June 13, 1997, the time of the sea surface temperature image. Observed warm-core rings always circulate clockwise.

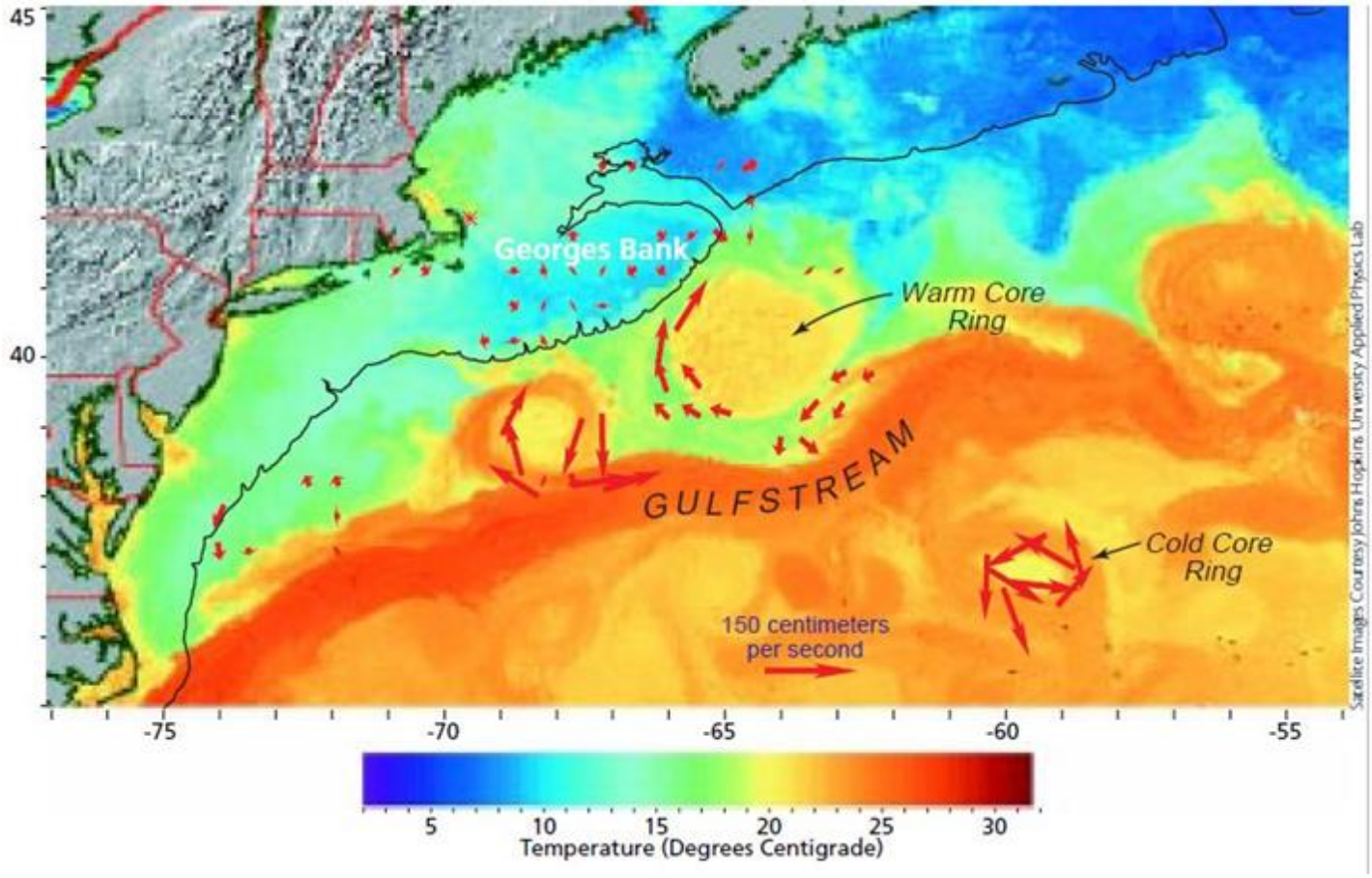

Figure 4*. Satellite sea-surface temperature data on June 13, 1997 combined with five-day averaged near-surface drifter velocities showing a Gulf Stream meander, and warm- and cold-core rings near the Gulf Stream. 150 cm/sec ~ 3 kt. (Limeburner and Beardsley, 1997). Depth contour shown is 200m (=109 fathoms).*

However, satellite sea-surface temperature imagery on September 18, 2016 (see Appendix 5) shows **no Gulf Stream meanders nor warm core rings were present near Block Canyon nor the *ORIENT LUCKY* position**.

This report estimates the actual drifting path of the life raft and Nathan Carman over 7 days from the reported time of the *Chicken Pox* sinking to the known time and position when the *ORIENT LUCKY* found them. The reverse drift analysis used real-time, local observed surface currents and wind observations, and satellite derived surface currents to calculate the life raft's path backwards in time. The results of this analysis indicate the *Chicken Pox* sank, using Carman's reported time of 1200 on September 18, 2016, approximately 39 nautical miles east by south (102° True) from where the lone survivor was picked up by the *ORIENT LUCKY* and not at Block Canyon 42 nautical miles northwest of the *ORIENT LUCKY* position.

METHODOLOGY

Forces on Floating Debris

An object floating on the sea surface moves horizontally under the combined forces of the wind, surface waves, tidal current, and other low frequency currents. The wind alone will move a floating object downwind at ~1% to 5% of the wind speed depending on whether the floating object has more cross-sectional area above the water surface (sail area) or below the water surface (keel area). For instance, the *Argo Merchant* oil spill in 1976 over Nantucket Shoals moved under the influence of the wind in a downwind direction at 3% the wind speed. Floating debris such as the cork life jackets from the *S/V Portland* disaster in 1898 drifted downwind under the influence of the wind at 4% the wind speed since they had more sail area above the water surface than keel area below. Bodies from the Air France 447 plane crash in June 2009 initially drifted just below the sea surface at about 2% the wind speed (Chen et. al., 2012).

By combining the wind effects on floating debris, the surface waves effects, the tidal currents, and the background ocean current I can estimate the actual drift path of a floating object in time. Knowledge of the wind and ocean currents can also be used to estimate the reverse drift track backwards in time from where the drifting life raft was recovered and this reverse drift analysis will give a good estimate of where the floating life raft originally came from. In general, regional winds were not strong and waves were not breaking over September 18-25, 2016 and wind wave heights were less than 3 ft. except for the last 48 hours when surface waves were 3-6 ft. (see Appendix 4). Waves were travelling toward the northwest September 18-25 and their effect on surface current is called the Stokes Drift (Stokes, 1847). The Stokes Drift on the life raft's track in this report was minimal (estimated less than 0.5 nm/day), and thus not included in this report.

Another possible influence on the path of the drifting life raft was the nearby Gulf Stream, Gulf Stream rings and meanders that could entrain the life raft into unique coherent current structures, for example shown in Figure 4 for 1997. However, Appendix 5 shows sea surface temperature for the region on September 18, 2016 and no warm (> 24°C) Gulf Stream, rings nor meanders were near the life raft at that time.

Woods Hole Oceanographic Institution Moored Data

Fortunately, during September 2016 there were National Science Foundation funded Ocean Observatories Initiative (OOI) instrumented moorings in the shelf break region (see the small yellow rectangle south of Martha's Vineyard in Figure 5) located near the September 25, 2016 *ORIENT LUCKY* position. The New England shelf break south of Rhode Island and Cape Cod is where offshore depths change from 100 fathoms to 1000 fathoms in about 20 nautical miles and this region is historically well known to have a mean westward near-surface current of 0.1 m/s (0.2 kt) (Flagg et. al., 2006). This westward historical jet is conveniently labelled "shelf break jet" in Figure 5. The OOI Pioneer Array moorings were deployed and maintained by the Woods Hole Oceanographic Intuition.

All OOI data used in this report was obtained from the internet OOI Data Portal http://oceanobservatories.org/data-portal/ and anyone with an internet connection can create a login on OOINet and access the OOI data used in this report. A short video https://youtu.be/D26iLlg-a5I presents a quick overview of the data portal, including how to browse the list of OOI sites, the Data Stream catalog, how to create a quick plot of data, and more. All the raw quality controlled data used in this life raft reverse drift analysis report was originally in NETCDF format. NETCDF is a set of software libraries and self-describing,

machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data. NETCDF files are complex and special programs are needed to read this data. For the calculations and figures in this life raft reverse drift analysis report I use MATLAB that combines a desktop environment tuned for iterative analysis and design processes with a programming language that expresses matrix and array mathematics directly. Appendix 16 documents explicit access to the OOI data used in this report.

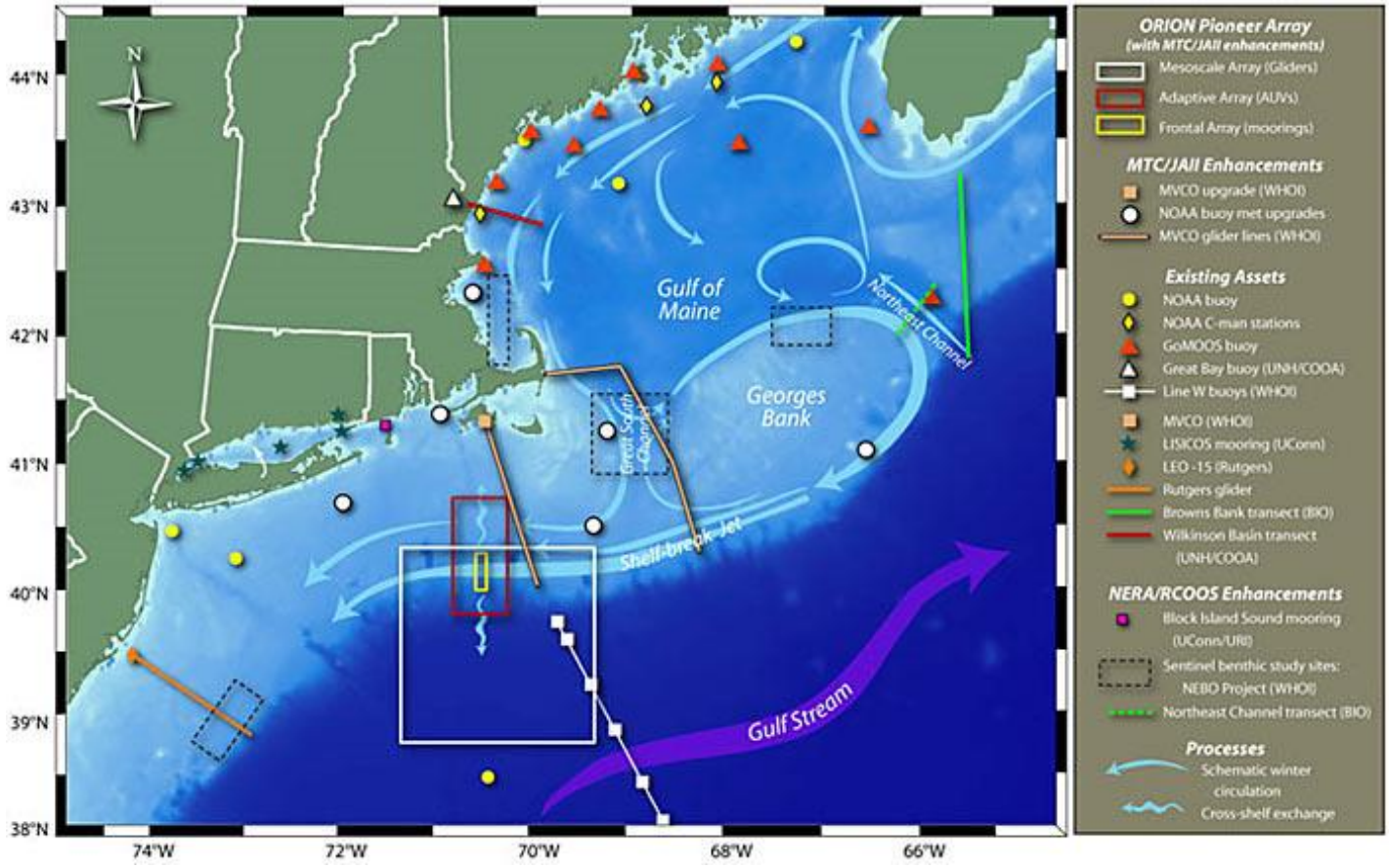

Figure 5*. Instrumented oceanographic moorings in the Northeast US during 2016 and the US Ocean Observatories Initiative Pioneer Array of real time oceanographic observations (red, white, and yellow rectangles). Of special interest is the Frontal Array moorings (in the small yellow rectangle above south of Martha's Vineyard Island). Note, the historical mean shelf break westward currents labelled above as the "Shelf Break Jet". (Illustration by Jack Cook, Woods Hole Oceanographic Institution Graphic Services)*

Buoy Wind Observations

A complete suite of meteorological instruments and a duplicate meteorological instrument package were mounted on the OOI Pioneer Array Off Shore Surface Mooring (OSSM) buoy during the period 2014 to present (see Figure 6 for a typical surface buoy setup). These surface buoy instruments measured high-quality meteorological parameters continuously and recorded raw data (see Appendix 12 for a list of the hourly averaged met data used in this report). The 1-hour averaging effectively removes any buoy heaving and pitching motions and smooths the wind gusts in the wind data. Other quality control actions were taken to insure good quality data. The OSSM surface buoy was located 23.4 nm from the September 25, 2016 *ORIENT LUCKY* recovery position and also located between Block Canyon and the *ORIENT LUCKY* (Figure 2).

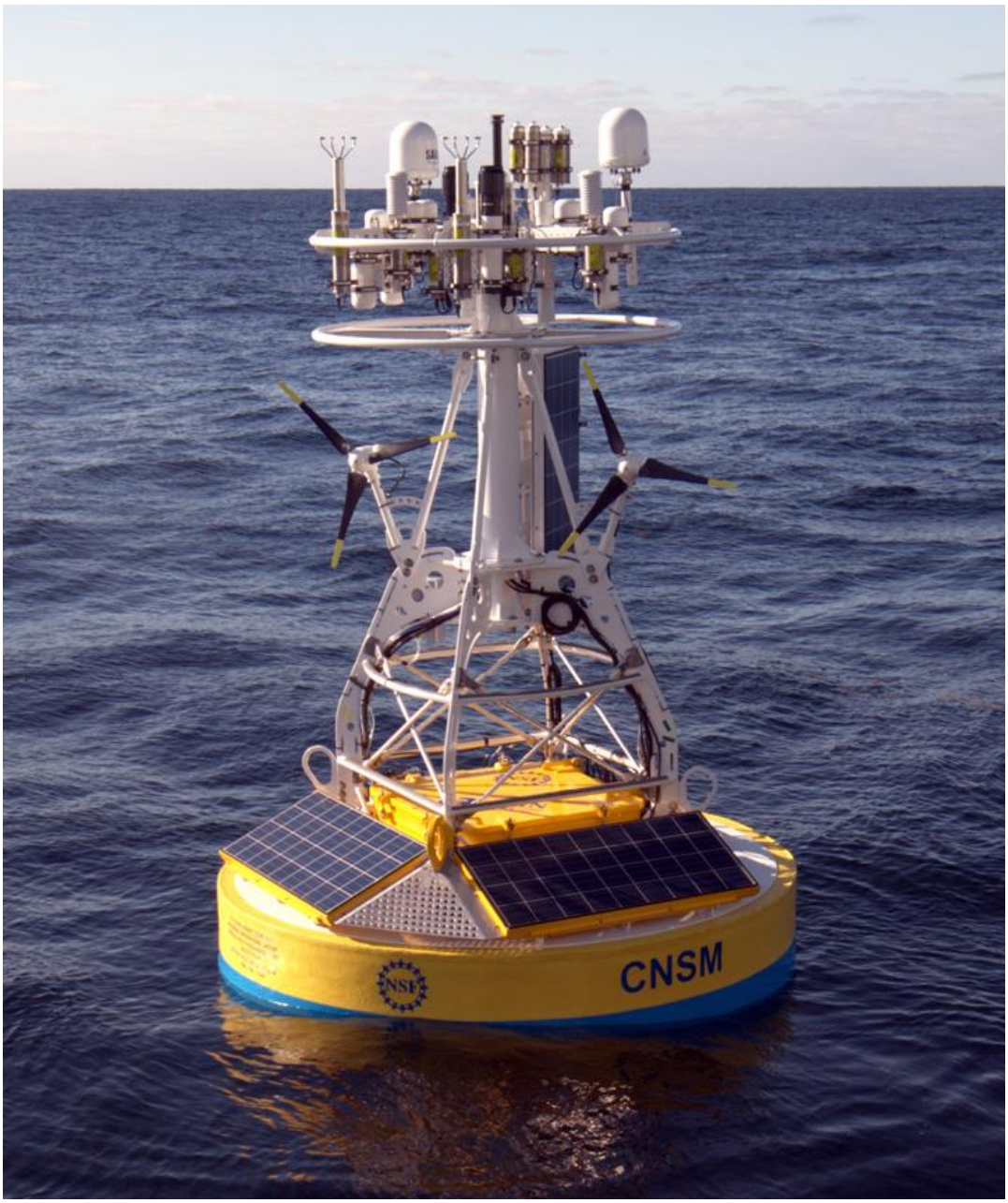

Figure 6*. Typical Woods Hole Oceanographic Institution OOI surface buoy with dual meteorological sensor packages. Note the 2 propeller sensors and 2 acoustic sensors (top) for measuring wind speed and direction.*

One-hour averaged wind data from the OOI Pioneer Array Off Shore Surface Mooring (OSSM) best represents the wind forcing and these data were used for all calculations in this report and are shown in Figure 7 and the data are listed in a table in Appendix 12. The OSSM surface buoy was located 23.4 nautical miles from the *ORIENT LUCKY* position at 1320 on September 25, 2016. The wind and wave conditions leading up to the assumed time of the *Chicken Pox* sinking, September 18, 2016 at 0600 to 1200, were as follows - wind less than 10 kt from the southwest, and significant waves 3.3 ft. high with 9 second periods coming from the southeast.

The wind observations in Figure 7 are generally moderate with average wind speed ~10 kt from the southwest for the 7-day period except for strong 16 kt winds from the east on 9/22/16, stronger 17 kt winds

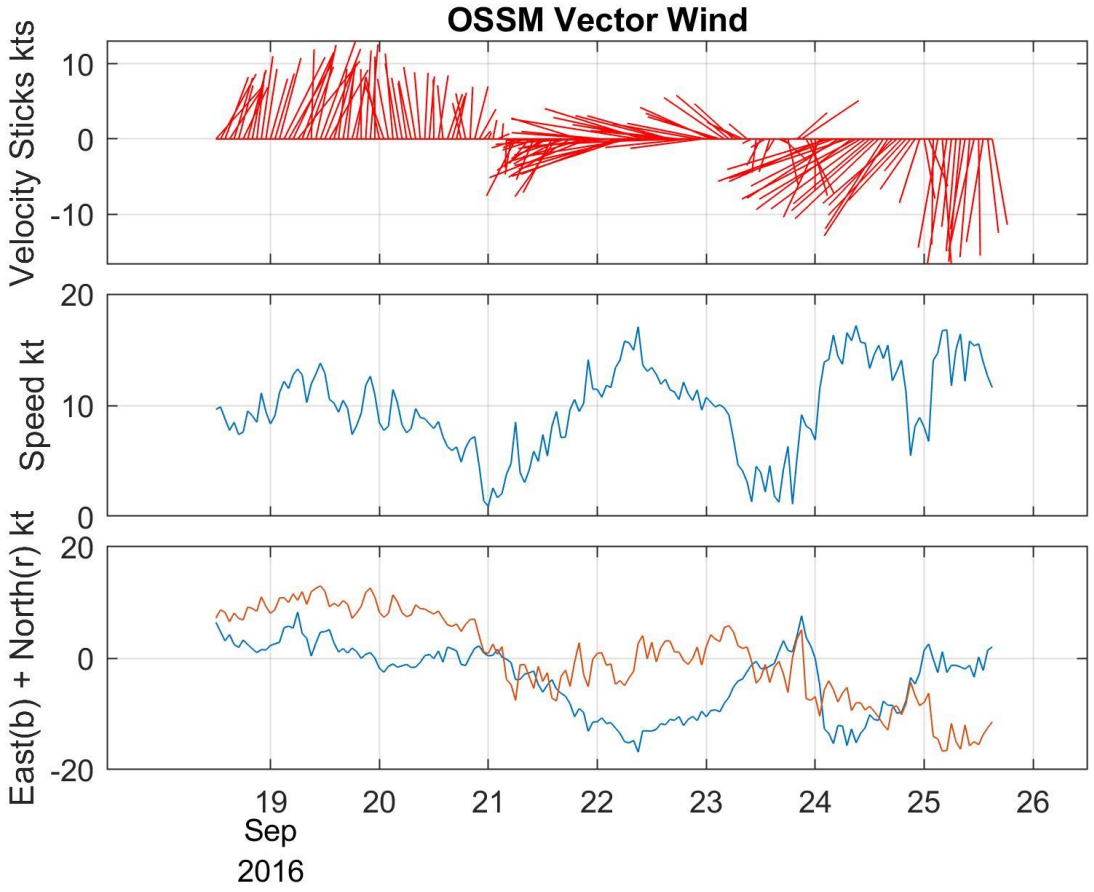

Figure 7*. Hourly wind data from the OSSM buoy September 18-25, 2016. Top panel is a vector stick plot showing the direction the wind is blowing towards from the 0 horizontal line, middle panel is a plot of the wind speed in kt, and lower panel the eastward (positive blue) and westward (negative blue) wind component and the northward (positive red) and southward (negative red) in kt. All times are local. Data listed in in Appendix 12.*

from the northeast on 9/24/16, and 17 kt winds from the north on 9/25/2016. The net effect of the north/south component of the wind was minimal over the 7 days (the north component of the wind approximately balanced the south component), but the on average the negative east/west component of the wind indicated a mean wind toward the west during September 18-25, 2016. Note winds are conventionally described as the direction the winds come from, but the plotted winds in this report are vector winds and direction is the direction the wind is going towards.

Buoy Near-Surface Current Observations

Near-surface ocean current data from the OSSM mooring is shown in Figure 8. A Nortek AquaDopp current meter was located at a near-surface depth 7 m (23 ft.) and measured currents continuously and recorded raw east and north current components. The raw data was hourly averaged and these hourly currents are plotted in Figure 8 and the data are listed in a table in Appendix 11. The data shows a combination of tidal currents, wind driven currents, and other low frequency currents including a mean westward along-isobath flow. Note for the eastward and northward component currents (and winds), the convention is positive. Southward and

westward currents (and winds) are negative. The lower panel in Figure 8 shows the eastward (blue) component of the current is generally negative on average indicting a mean westward flow.

The current at the sea surface is very similar to the current at the 7m instrument depth since there was a surface mixed layer approximately 10 m deep. This is because the surface wind stress is easily mixed vertically in the surface mixed layer by turbulence. Also surface waves were generally not breaking over the 7-day period.

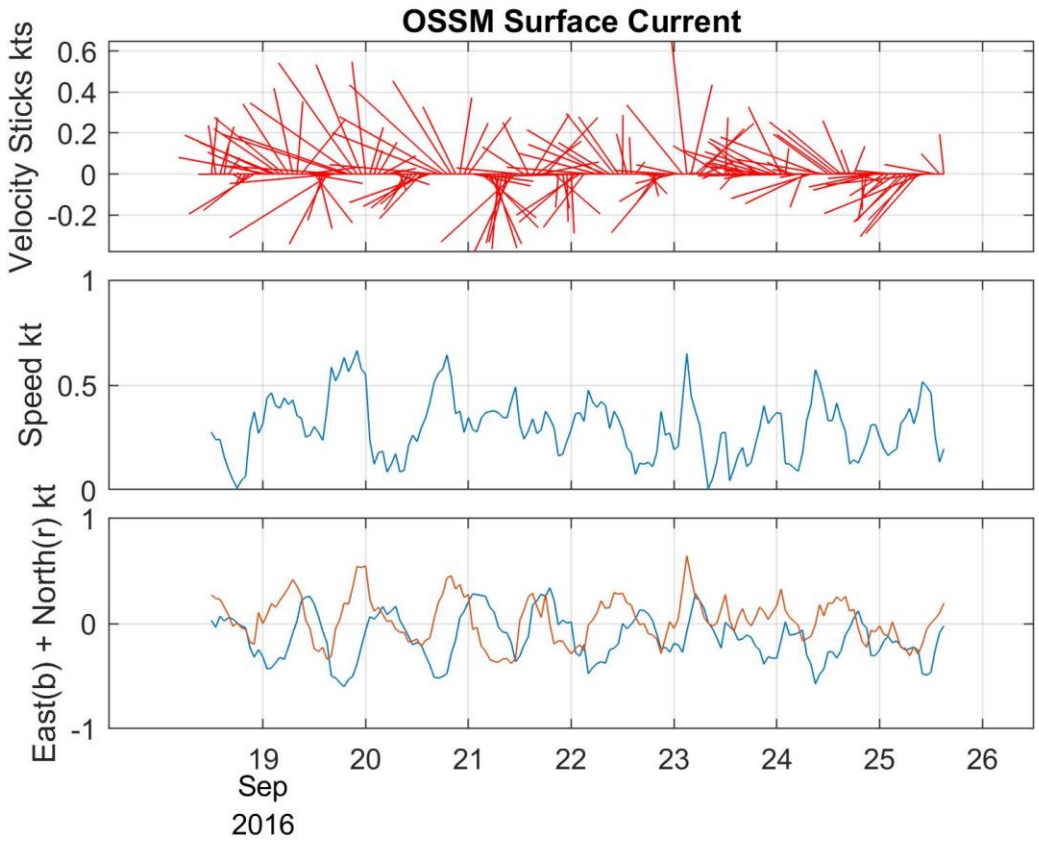

Figure 8. *Hourly near-surface current data from the OSSM buoy September 18-25, 2016. Top panel is a vector stick plot showing the direction the current is flowing towards, middle panel is a plot of the current speed in kt, and lower panel the eastward (blue) and northward (red) current components in kt. All times are local.*

ANALYSES

Reverse Drift of the life raft to the *ORIENT LUCKY* during September 18-25, 2016

The drift of the *Chicken Pox* life raft was calculated by combining the wind and current forcing from the OSSM mooring observations during the period from 9/18/16 at 1200 to 9/25/16 at 1300. The OSSM moored wind and ocean current observations were measured continuously and only 1-hour averaged data were used in the analysis. This 1-hour averaging smoothed the data by removing high frequency variability such as oscillatory surface wave motions or short small-scale wind gusts. The wind and current speeds were measured in meter/sec and converted to knots for my calculations.

Wind drift (leeway) on an occupied Revere 4-man life raft (required by USCG, Appendix 6) has been observed in the peer-reviewed scientific literature to be **2.0% of the wind speed for a deep-ballasted drogued**

life raft and **3.5% for a deep ballasted life raft with no drogue** (Allen et. al., 1999, Breivik et. al., 2011, Appendix 7). For the reverse drift estimate in this report I used 2.5% of the wind speed for the hourly windage displacement since Carman testified under oath that he deployed the drogue (sea anchor) during 6 of the 7 days adrift.

The combined (added together) hourly current and wind vector data then represented a displacement in nautical miles for each hour. The hourly displacement vectors were added (in a head to tail sense) to calculate a displacement over the seven-day period of drifting life raft. Simply stated, this is similar to actually plotting on a paper chart a start position, then plotting from the start position the next hour's vector drift distance and direction, and then recording the new latitude and longitude, and repeating this operation for each hour. Rather than plot on a paper chart I use a computer to perform this vector operation. I can estimate the life raft drift path backwards in time from the ORIENT LUCKY position (Figure 9), or forward in time from the reported sinking location in Block Canyon (Figure 10).

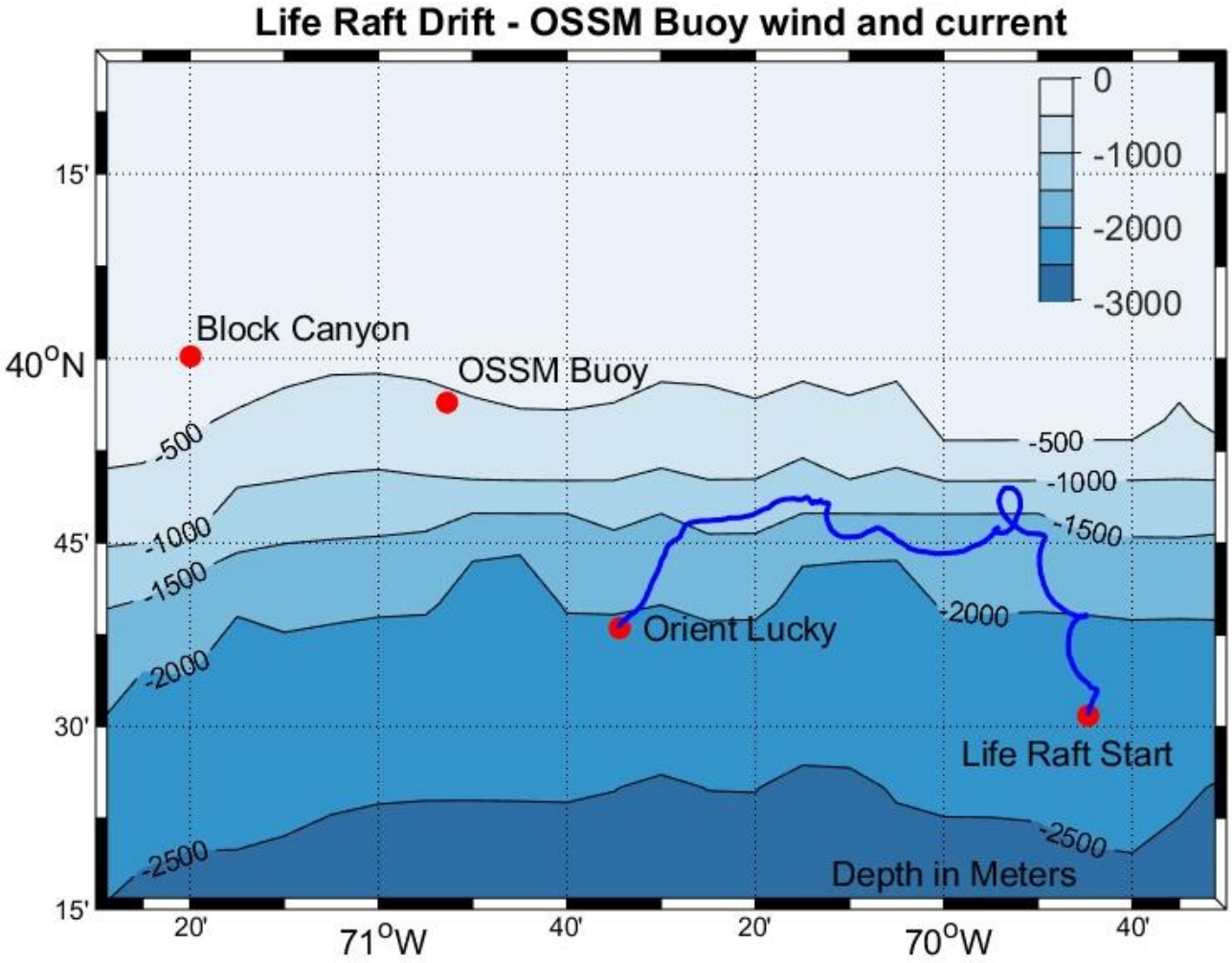

Figure 9. *Reverse drift estimate of the life raft path (solid blue line from "Life Raft Start" to the "ORIENT LUCKY" September 18-25, 2016 using observations of wind and current at the OSSM mooring. Depths are shown in meters. The locations of the OSSM wind and current data buoy and the September 25, 2016 ORIENT LUCKY position are also shown. The estimated path assumes the drift began at 1200 on September 18, 2016.*

The total displacement of the drifting life raft due to wind and current was 39 nm toward 282 True (approximately W by N) over the 7-day period with a mean speed of 0.23 kt (Figure 9).

Forward Drift of the life raft from Block Canyon September 18-25, 2016

The track of the life raft can also be estimated forward in time from the reported sinking location at Block Canyon on September 18, 2016 at 1200. Drift path estimates are given for both the life raft with the drogue deployed (blue lines, 2.0% of wind speed leeway), and without the drogue deployed (cyan lines 3.5% leeway) in Figure 10. Carman stated under oath he deployed the life raft drogue (a sea anchor) on 6 of the 7 days he was adrift. Both the drogued sea anchor 2% wind leeway drift rate and the non-drogued sea anchor 3.5% wind leeway rate were used **to estimate the error (+/-** 4 nm longitudinally**)** in the calculation due to the deployment of the life raft sea anchor for 6 of 7 days (Figure 10, Appendix 6 & 7, and Carman's testimony under oath).

The **forward drift analysis beginning at Block Canyon** indicates the life raft would be located at 1320 on September 25 at the western end of the 2 tracks on left in Figure 10 since the currents flow westward in this region. The previous (Figure 9) westward **reverse drift analysis ending at the *ORIENT LUCKY*** is also plotted in Figure 10 below by the 2 tracks on the right. The difference between the reported Block Canyon drift track (left) and the known *ORIENT LUCKY* end position reverse drift track (right) is 78 nm. This 78 nm difference is too large an error for the 7-day drift estimates in this report and this fact provides evidence in my opinion that the reported Block Canyon sinking location is not consistent with the known evidence and is suspect.

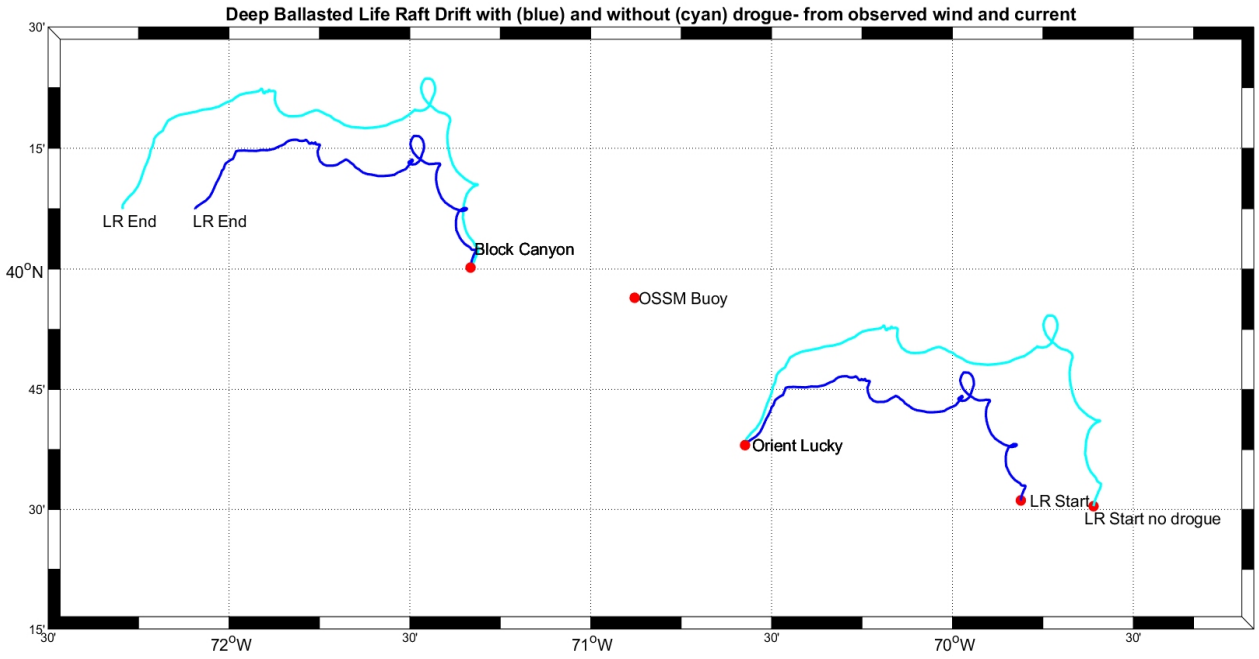

Figure 10. *Estimated life raft drift paths September 18-25,2016 using real-time wind and current observations at buoy OSSM. On right the reverse drift estimate of the life raft path to the ORIENT LUCKY. On left the forward drift estimate for the life raft path from the reported sinking location at Block Canyon. Drift path estimates are given for the life raft with the drogue deployed, a blue line (2.0% wind speed leeway), and without the drogue deployed, a cyan line (3.5% leeway). Carman stated under oath he deployed the life raft drogue on 6 of the 7 days he was adrift.*

USCG Search and Rescue (SAR) Flight Paths and Other Vessels

The USCG Search and Rescue (SAR) flight paths during September 18-25, 2016 are shown in Figure 11. The USCG initially only had knowledge that the *Chicken Pox* planned to fish near Block Island and not at Block Canyon where the vessel later reportedly sank. Extensive SAR operations were focused near Block Island and one Bravo flight path September 19, 2016 extended to Block Canyon. If the life raft was deployed September 18, 2016 near Block Canyon (solid yellow line drift track in Figure 11), then the SAR aircraft search of area Bravo (also Appendix 8) should have seen the life raft near Block Canyon on September 19, 2016. The USCG search area Bravo flight paths 9/19/2016 1200-1600 (local time) near Block Island and out to Block Canyon are shown in red (Figure 11). Additionally, there were numerous vessels navigating in the general area of both Block Canyon and where ORIENT LUCKY recovered Mr. Carman during the week he was adrift. (See Appendixes 13 & 14) There was even one vessel in Block Canyon on September 18, 20167. (See Appendix 15).

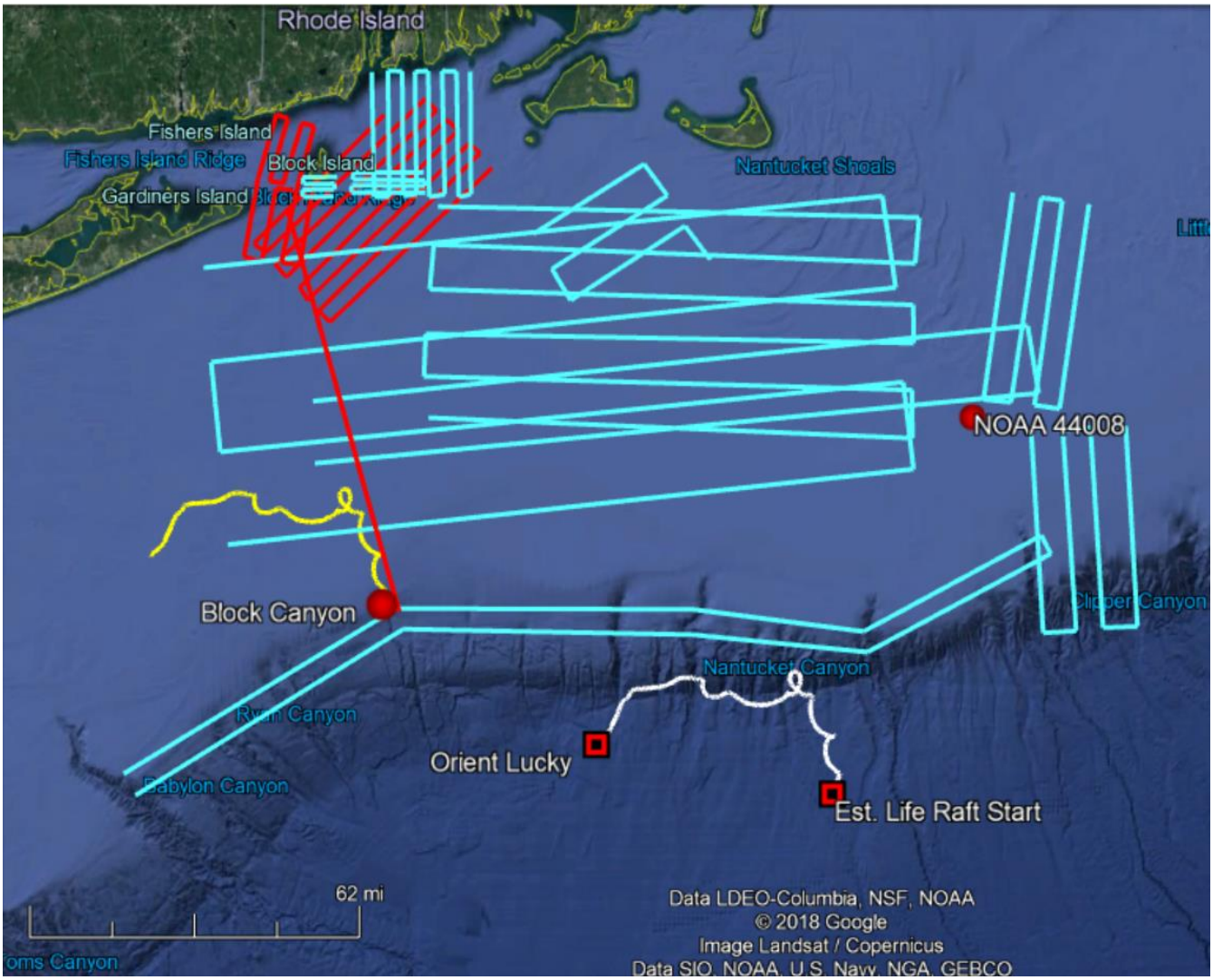

Figure 11. *USCG SAR flight patterns (red and cyan) during September 18-25, 2016. The* ***solid white line is the reverse drift estimated path of the life raft*** *to the ORIENT LUCKY. If the Chicken Pox sank near Block Canyon at an assumed time of 1200 on September 18, 2016 then* ***a forward drift analysis of the life raft from Block Canyon would indicate it would be located at 1320 on September 25 at the western end of the solid yellow colored line (track)*** *since the currents flow generally westward in this region.*

SUPPORTING OBSEVATIONS OF WESTWARD LIFE RAFT DRIFT

OSCAR (Ocean Surface Current Analysis Real-time) derived ocean currents

An independent estimate of the near-surface currents is shown in Figure 12 by National Aeronautics and Space Administration (NASA) modelled OSCAR (Ocean Surface Current Analysis Real-time) derived ocean currents. https://www.esr.org/research/oscar/oscar-surface-currents/. OSCAR contains near-surface ocean current estimates derived using momentum equations. The horizontal velocity is directly estimated from sea surface height, surface vector wind and sea surface temperature. These data were collected from the various satellites and in situ instruments. Data are given on a 1/4 degree grid with a 5 day resolution. Figure 12 shows the OSCAR (colored) surface current arrows on September 19, 2016 overlaid.

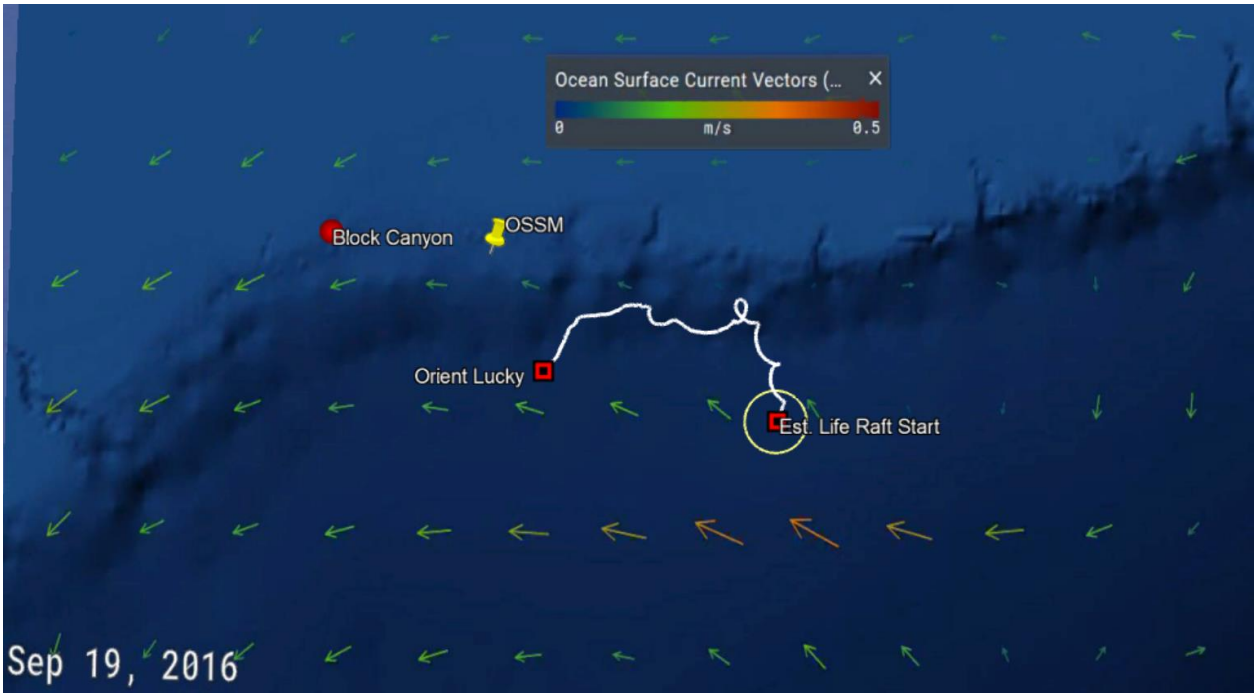

Figure 12. *Reverse drift path (solid white line) of the life raft September 18-25, 2017 to the location where the Lucky Orient recovered the life raft. OSSM observed wind drift of 2.5% and currents were used in this analysis. Satellite-derived surface currents from the OSCAR dataset averaged within ¼° (~15 nautical mile) latitude/longitude boxes on September 19, 2016 are overlaid colored arrows. The OSCAR surface current color bar scale in m/s is shown above (1 m/s = 2 kt). A 5 nautical mile error estimate is drawn around the estimated life raft start position.*

The results of this present analysis suggest the *Chicken Pox* sank approximately 40 nm east by south from where the life raft was picked up by the *Lucky Orient* assuming a sinking on September 18, 2016 at 1200. The Block Canyon location was ~42 nm from the *Lucky Orient* position.

NOAA Northeast Fisheries Science Center satellite-tracked surface drifters

A NOAA Northeast Fisheries Science Center (NEFSC) satellite-tracked Irina surface drifter 165420705 (Figure 13) was deployed 6/19/2016 near Gloucester, MA by Gloucester High School students and passed within 2 nautical miles (nm) of Block Canyon https://www.nefsc.noaa.gov/drifter/ on 9/1/2016, 17 days before the *Chicken Pox* presumed sinking on 9/18/2016 (Figures 14, thin white line). A second surface drifter 165420691 (thin cyan line in Figure 14) was deployed by the Truro MA Central School and was located near the OOI Pioneer Array Off Shore Surface Mooring (OSSM) position on 9/14/2016, 4 days before the *Chicken Pox* reported sinking.

Figure 13*. An Irina satellite-tracked surface drifter. The lower canvass drogued component is below the sea surface.*

These two surface drifters were not directly affected by the wind since there was little direct wind drag and leeway due to the minimal sail area above the water line (Figure 13) and thus Irina surface drifters do not perfectly compare to the track of a 4-man deep ballast life raft with windage. However, the winds generally were not strong September 18-25, 2016. These two drifter tracks (Figure 14) moved westward on average during August-September 2016 and independently confirm the westward historical character of the surface currents in the shelf break region south of Martha's Vineyard during September, 2016.

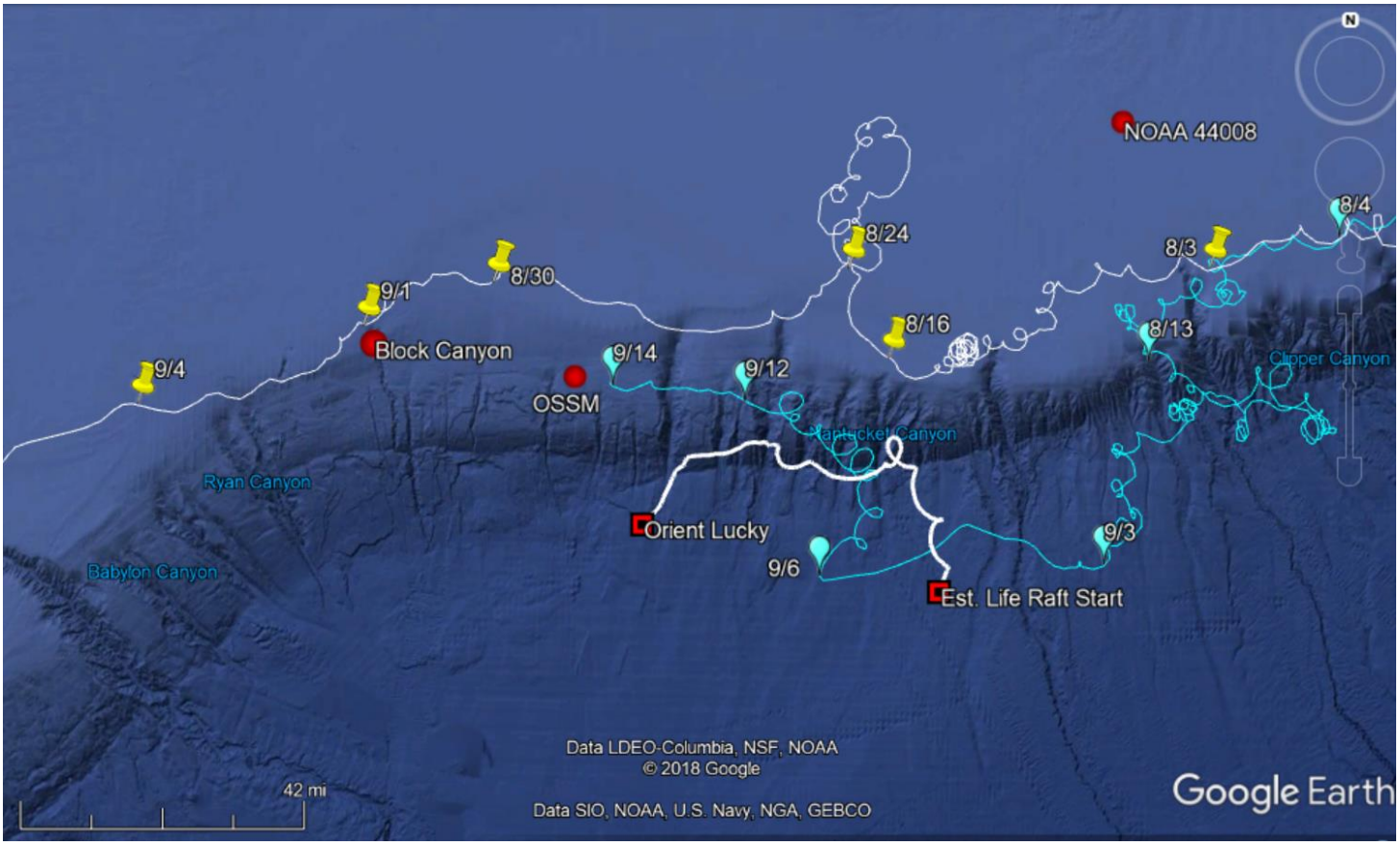

Figure 14*. Two NOAA Northeast Fisheries Science Center satellite-tracked* ***surface drifters moved westward during August-September, 2016 - shown by thin white and thin cyan lines****. One drifter (thin white line) moved steadily westward and passed within 2 nm of Block Canyon on 9/1/2016. The second drifter (thin cyan line) was located near the OSSM mooring on 9/14/2016. The westward* ***reverse drift analysis track of the life raft to the ORIENT LUCKY on 9/25/2016 is shown by a thicker white line.*** *Drifter location dates during 2016 are shown along each drifter track. Also shown are the locations of Block canyon, the OSSM buoy, and the ORIENT LUCKY.*

The intermittent loops along the drifter tracks in Figure 14 are called inertial oscillations and these common wave-like motions can be trapped to the shelf break and they propagate westward**.** Inertial waves are primarily due to the earth's rotation and have wave periods (the time to go around the drifter loop) dependent on latitude, approximately 18.8 hours for the drifter latitude of 39° 30' N. The loops are small with 3-6 nm diameters. These are 18.8 hr **inertial waves and are not Gulf Stream rings** that have a typical diameter of 60 nm.

Appendix 9 gives a link to an animation of all NOAA NEFSC Irina surface drifters over Georges Bank during August-September 2016, but does include the region to 71° W to 63° W.

Appendix 17 documents explicit access to the NOAA Irina drifter data.

CONCLUSIONS

The use of real time meteorological data and independent oceanographic surface current data near Block Canyon were used to accurately estimate a westward track of the drifting life raft and sole survivor for an assumed 7 days during September 18-25, 2017. The reverse drift analysis in this report indicated the *Chicken Pox* sank approximately 39 nautical miles approximately southeast of where the life raft was found adrift on September 25, 2016 by the *ORIENT LUCKY* and not at Block Canyon 42 nm NW of the *ORIENT LUCKY* position.

I will use the inserts, tables, and appendices herein as exhibits as necessary at trial.

As a physical oceanographer it is my professional assessment with a reasonable degree of certainty that Mr. Carman's testimony stating his boat sank near the 140-fathom curve in Block Canyon on September 18, 2016 is in not consistent with my analysis and Carman being picked up on September 25, 2016 at the *ORIENT LUCKY*'s position at 1300.

This report is the best expression of my findings and opinions, and I reserve the right to amend or extend this report upon receipt of additional information.

The photos, figures, and references in this report depict my trial exhibits. My opinions are stated to a reasonable degree of professional certainty as a Physical Oceanographer.

Richard Limeburner April 19, 2019

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USCG Search and Rescue Report, From Marcus G. Gherardi, CDR, 9/20/2016, Vessel CHICKEN POX-SRU info and search area and tracks.

Carman Examination Under Oath regarding sink location/time and his life raft (particularly pages 161-166 and 176); and Ex. 9 P00383.

Defender website item # 453620 and # 550824 life raft specs. https://www.defender.com/category.jsp?id=2290102&path=-1|135|2290100

Carman Deposition, regarding sinking location/time, life raft, and *ORIENT LUCKY* pickup (particularly pages 11-12, 57-59, 245-248,259-268,282-301); and Exs. 9, 30, and 34; and

ABC 20/20 episode for video of the life raft at the *ORIENT LUCKY* pick up: https://abc.go.com/shows/2020/episode-guide/2017-02/03-020317-Lost-at-Sea

Ocean Observatories Initiative Data Porthole https://ooinet.oceanobservatories.org/

ORIENT LUCKY Deck Log Book, Admiralty Chart 2860 with applicable entries from September 18-25, 2016

Facts and Data Considered – Testimony and Documentary Evidence

Carman Examination Under Oath, December 16, 2016; Farrell & Smith LLP; Salem, Massachusetts;

Carman Deposition, January 22, 2018; Farrell & Smith LLP; Salem, Massachusetts.

Carman Deposition, July 17, 2018; Salem, MA; the sinking location/time, life raft, *ORIENT LUCKY* pick up.

USCG Case report 1045605 opened 19SEP2016; SAR OVERDUE /31 CENTER CONSOLE/Block IS

APPENDICES

Appendix 1. Email message from the Captain of the *ORIENT LUCKY* to the USCG on 9/25/2016.

Orient Lucky Rescue Email 1

From: ORIENT LUCKY [orientlucky@amosconnect.com]
Sent: Sunday, September 25, 2016 3:34 PM
To: D01-SMB-D1CMDCenter
Cc: ????; ????; 1607 sub-owner3; 1607 sub-owner2; ?????;
1607 USA Agent
Subject: [Non-DoD Source] Orient Lucky//Rescue 1 person from Sea
Attachments: DSC_5653.jpg; DSC_5706.jpg; DSC_5718.jpg; DSC_5788.jpg; DSC_5817.jpg

Dear Miss/Sirs

Goodday

Pls see the photo of Survival according you required by phone.

[redacted]

MASTER OF MV.ORIENT LUCKY
[redacted]
FOR AND ON BEHALF OF REGISTERED OWNERS,
AS AGENT ONLY
INMARSAT TEL:00870 773238317
E-MAIL:orientlucky@amosconnect.com

Dear Miss/Sirs

Orient Lucky Rescur 1 person from Sea at position(39-38.05N 070-34.40W)

The Person Name: [redacted] He is from wakefield, RI USA. He said that he and his mother,[redacted] is fishing before overboard. He already fall into water 1 week. His health looks like normal. I, master of Orient Lucky, arrange food, water and care for him.

Orient Lucky now is drifting at currrent Position for changing Ballast Water.
Orient Lucky ETA Boston PM 27th/Sep.

No doctor on board. I will pay more attention to the survival. If his condition become worth, I will contact to you.

[redacted]

MASTER OF MV.ORIENT LUCKY
[redacted]
FOR AND ON BEHALF OF REGISTERED OWNERS,
AS AGENT ONLY
INMARSAT TEL:00870 773238317
E-MAIL:orientlucky@amosconnect.com

Appendix 2. *ORIENT LUCKY* Automatic Identification System (AIS) position data obtained from www.vesselfinder.com

Copy of email to Richard Limeburner from Dan McQuin, Vesselfinder.com

Dear Richard,

We have checked the AIS data availability for the requested vessel *ORIENT LUCKY* within the specified time range from 12:00 UTC to 23:59 UTC on 25 Sep, 2016.

We have 7 position records at 5-minute time resolution. We usually charge our customers for the data but due to the low amount of the data in the report, in the table below, I am providing you the positions free of charge.

DATE TIME (UTC)	MMSI	LATITUDE	LONGITUDE		COURSE	SPEED	HEADING	
IMO	NAME	CALLSIGN	AISTYPE	A	B	C	D	DRAUGHT
DESTINATION	ETA							
2016-09-25 12:33:44	352521000	40.40736	-70.72535		89.4	11.3	85	9436111
	ORIENT LUCKY	3FRF6	70	170	30	10	22	8	BOSTON	09-27 00:00
2016-09-25 12:39:45	352521000	40.40792	-70.70289		90.4	11.1	85	9436111
	ORIENT LUCKY	3FRF6	70	170	30	10	22	8	BOSTON	09-27 00:00
2016-09-25 12:57:45	352521000	40.39128	-70.6144		115.1	11.7	115	9436111
	ORIENT LUCKY	3FRF6	70	170	30	10	22	8	BOSTON	09-27 00:00
2016-09-25 13:00:45	352521000	40.39128	-70.6144		115.1	11.7	115	9436111
	ORIENT LUCKY	3FRF6	70	170	30	10	22	8	BOSTON	09-27 00:00
2016-09-25 15:54:52	352521000	39.79531	-70.56664		181.1	12.4	180	9436111
	ORIENT LUCKY	3FRF6	70	170	30	10	22	8	BOSTON	09-27 00:00
2016-09-25 15:58:10	352521000	39.79531	-70.56664		181.1	12.4	180	9436111
	ORIENT LUCKY	3FRF6	70	170	30	10	22	8	BOSTON	09-27 00:00
2016-09-25 16:01:11	352521000	39.79531	-70.56664		181.1	12.4	180	9436111
	ORIENT LUCKY	3FRF6	70	170	30	10	22	8	BOSTON	09-27 00:00

Data included in the vessel movements report is:

DATE / TIME - time stamp of last received position record (in UTC)

MMSI number - Maritime Mobile Service Identity

LATITUDE - geographical latitude AIS format (WGS84)

LONGITUDE - geographical longitude AIS format(WGS84)

COURSE - course over ground (in degrees)

SPEED - speed over ground (in knots)

HEADING - heading of the vessel's hull (in degrees). 511 indicates there is no heading data.

IMO number - IMO ship identification number

NAME - vessel's name

CALLSIGN -vessel's call sign

AIS TYPE -vessel's type according to AIS specification (more info at Table 11. Codes for Ship Type).

A - distance between AIS receiver and bow of the vessel (in meters)

B - distance between AIS receiver and stern of the vessel (i.e. Ship Length = A + B)

C - distance between AIS receiver and port side of the vessel (in meters)

D - distance between AIS receiver and starboard of the vessel (i.e. Ship Width = C + D)

DRAUGHT - vessel's draught at the time of the position record

DESTINATION - destination port the vessel is sailing to (as manually entered by the Master)

ETA - estimated time of arrival (as manually entered by the Master)

If there is anything else I can assist you with, please let me know.

Best regards,

Dan McQuin

Email: info@vesselfinder.com

Web: www.vesselfinder.com

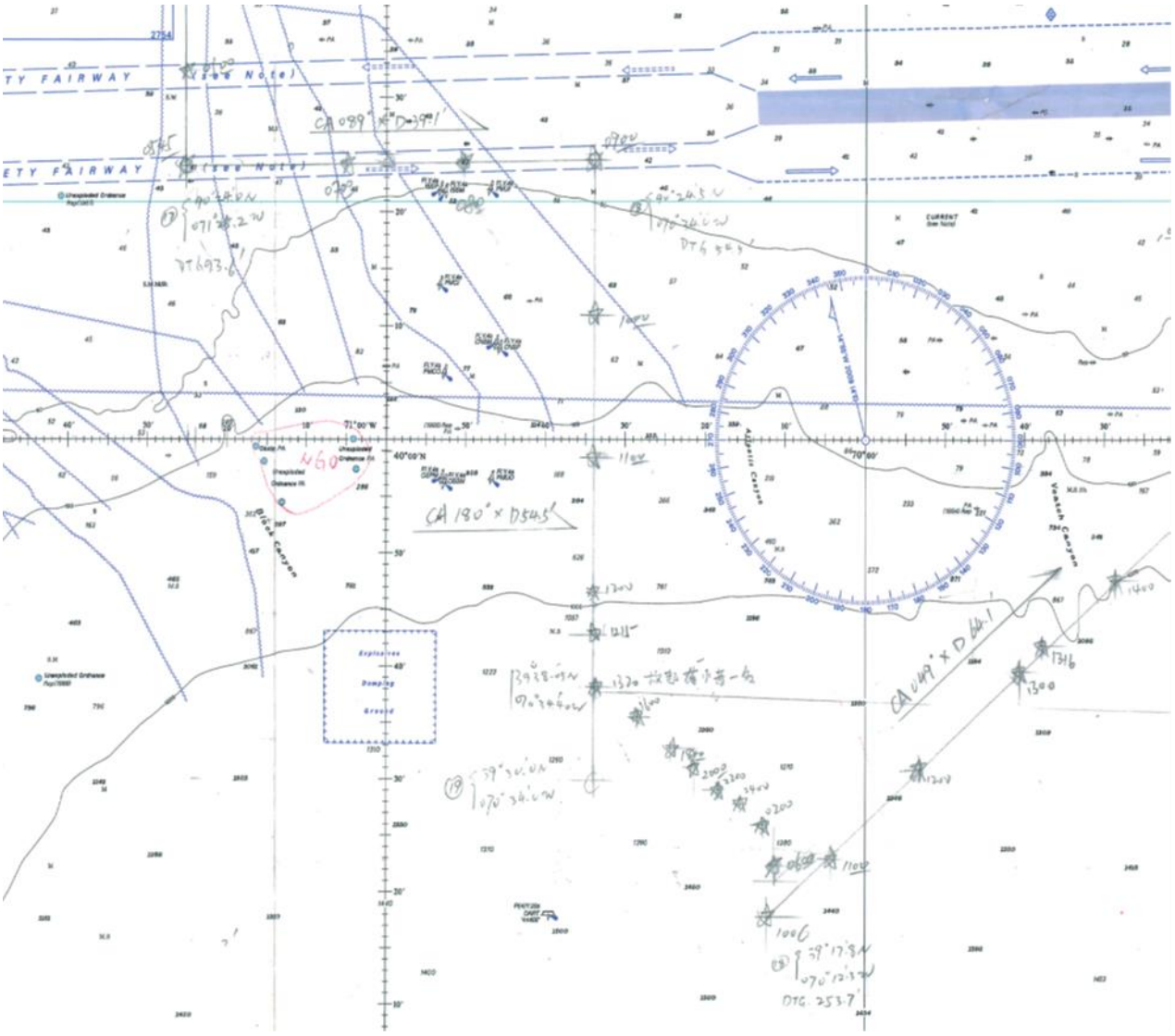
Note: The *ORIENT LUCKY* was on a southerly course when the drifting life raft was found. The freighter was assumed to be going offshore to “change ballast water” (*ORIENT LUCKY* Captain, see Appendix 1) prior to going to Boston.

Appendix 3. *ORIENT LUCKY* Log on 9/25/2016

航次 自 PROVIDENCE 迄 BOSTON 停泊港名

记 事 栏	重大事项记录栏
NVG-21 检查表内容交接清楚. λ071°21.1W [illegible] 1608 [illegible] λ071°22.9W SOSP [illegible] 204° 0051 GPS φ41°23.1N λ071°25.6W A/C To 180° λ071°25.6W [illegible] λ071°25.2W [illegible]	1240 Find a chrysoidine Life raft and Sound MOB alarm. Manoeuvre and rescue the survival:
NVG-21 检查表内容交接清楚 071°25.2W A/C TO 089° 手操舵与自动舵转换正常 检查助航设备正常 λ070°50.1W 晴 [illegible] 中浪 安全防火巡视全船正常	1320 pick up the survival and give fresh water and food and care. The survial: Nathan Carman
NVG-21 检查表内容交接清楚. λ070°34.0W A/C TO 180° 手操舵与自动舵转换正常 λ070°34.0W. 安全防火巡视正常. 检查助航设备正常 λ070°34.0W 半晴天 清风中浪.	Set out: Wakefield, RI USA He said that his boat sunk at Block canyon. USA a week ago. He and his mum go fishing before peril of the sea.
NVG-21 检查表内容交接清楚. 070°34.2W EOSP [illegible] 1235 [illegible] CFR33.1625 [illegible] [illegible] 070°34.05W [illegible] 1名. 1330 GPS φ39°37.36N λ070°33.40W [illegible] λ070°23.73W [illegible]	I arrange sharp look at all around but find nothing. Capt. [illegible]
NVG-21 检查表内容交接清楚 [illegible]	周 检 1. [illegible] 检查 救生. 消防设 [illegible]

Appendix 3 cont. *ORIENT LUCKY* Navigation Cart September 25, 2016



Appendix 3 cont. *ORIENT LUCKY* Navigation Cart September 25, 2016 Certification

UNITED STATES DISTRICT COURT
DISTRICT OF RHODE ISLAND

NATIONAL LIABILITY & FIRE INSURANCE CO.	:	
	:	
and	:	
	:	
BOAT OWNERS ASSOCIATION OF THE UNITED STATES	:	**Civil Action No: 17-0038-S-PAS**
	:	
	:	**In Admiralty**
Plaintiffs,	:	
	:	
v.	:	
	:	
NATHAN CARMAN	:	
	:	
Defendant.	:	

ORIENT LUCKY CHART CERTIFICATION

I, Wu YoNgWu, Master of the Motor Vessel ORIENT LUCKY certify that the attached document is a true copy AND ORIGINAL of the M/V ORIENT LUCKY's nautical chart used on September 25, 2016, and that I am the custodian of this chart. Nautical charts are used to record the navigation activities of the ship, and to safely navigate. The officers on watch or the captain plot positions on the nautical chart as the vessel reaches said positions. Nautical charts are maintained in the ordinary course of the ship's business. Recording events on the nautical chart, including the rescue of Nathan Carman and the position of his rescue, was a regular practice of using the nautical chart.

I declare that this certification is truthful and realize that I would be subject to a criminal penalty in the Republic of Indonesia where I am signing this certification (as ORIENT LUCKY is currently berthed here in the Port of Dumai) if the certification were not truthful.

I declare that this certificate is truthful and realize that I would be subject to a criminal penalty in the Republic of Panama, the flag of ORIENT LUCKY, if the certification were not truthful.

I declare that this certificate is truthful and realize that I would be subject to a criminal penalty in the People's Republic of China, as this is my nationality, if the certification were not truthful.

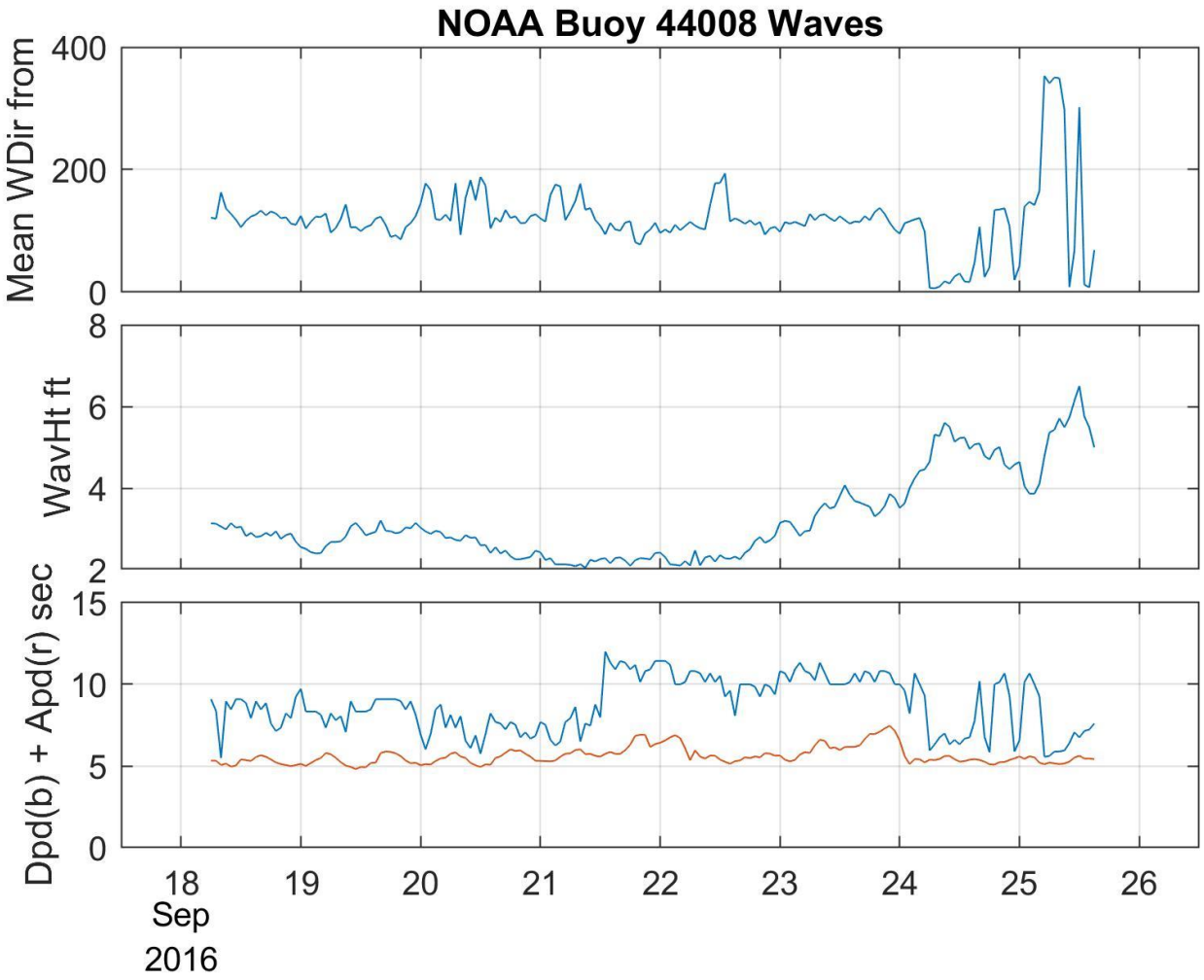
I verify and declare under the pain and penalty of perjury of the laws of the United States of America pursuant to 28 U.S.C. § 1746 that the foregoing is true and correct.

Signature

2018.05.12
Date

Appendix 4. Wave data from NOAA Buoy 44008 (historically Nantucket Lightship) for September 18-26, 2016.

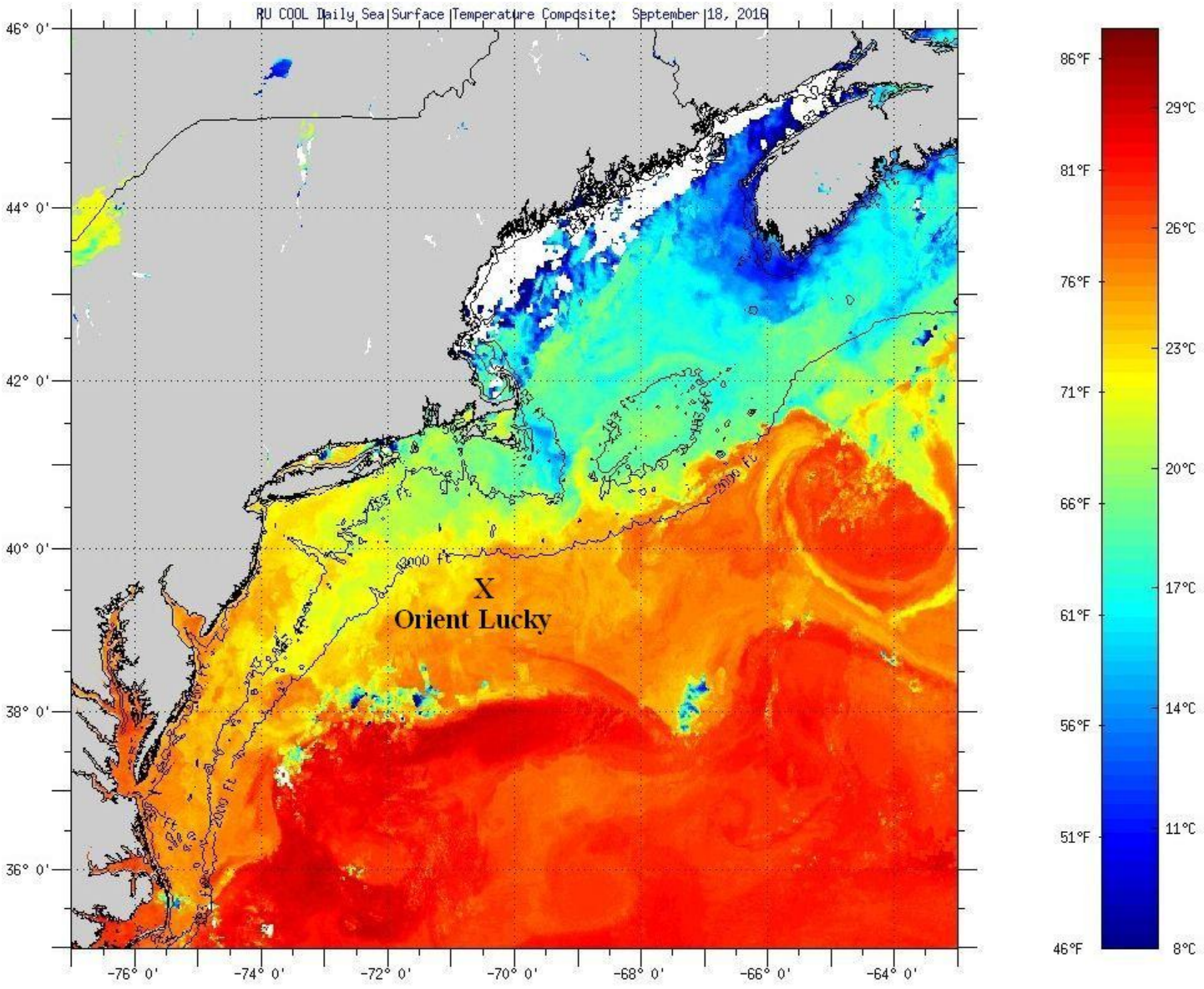
NOAA Buoy 44008 was located 81 nm NE of the *ORIENT LUCKY* position on September 25, 2017. Top panel – mean wave direction (degrees true) from where the waves came. Middle panel – significant wave height (average of the 1/3 highest waves). Lower panel dominant wave period (blue) and average wave period (red). Time in this Figure is EDST starting September 18, 2016 at 0600.



Appendix 5. Satellite sea surface temperature °C on 9/18/16.

The solid black square indicates the approximate location of the *ORIENT LUCKY* on 9/25/2016. Note, there were no Gulf Stream rings near the shelf break south of Martha's Vineyard at this time. Image Source

https://marine.rutgers.edu/cool/sat_data/?product=sst&region=bigbight&nothumbs=0



Appendix 6. Revere Offshore Elite Liferaft 4-Person / Canister

Capacity: 4 People, Application: Offshore, Pack Type: Canister (No Cradle)

Warranty: 12-Year Limited Warranty Valid with 3-Year Service Intervals*

Full-Featured Lightweight Offshore Raft with Oversized Tubes, Inflatable Floor

Revere Survival **Offshore Elite™ Liferaft**

Features:

- (2) large, multi-chambered buoyancy tubes up to 11.25" in diameter
- Automatically inflated canopy with zippered windows and reflective strips
- Inflatable floor
- Stowage pockets
- Extra-large ballast pockets improve stability in rough sea conditions
- Heavy-duty self-inflating boarding ramp
- Flashing strobe
- Vacuum-packed for protection against the environment and to minimize service costs
- **Self-deployed sea anchor**
- Floating rescue ring and 75 ft. (23 m) line
- Equipment included:
    - (3) USCG / SOLAS approved red hand flares
    - (2) parachute signal rockets
    - Signal mirror
    - Repair kit
    - Seasick tablets
    - Rescue whistle
    - Water-tight flashlight with spare batteries
    - Floating knife
    - Fishing kit
    - Food rations and drinking water
    - (2) sponges
    - Bailer
    - First aid kit
    - Scissors
    - Owner's manual

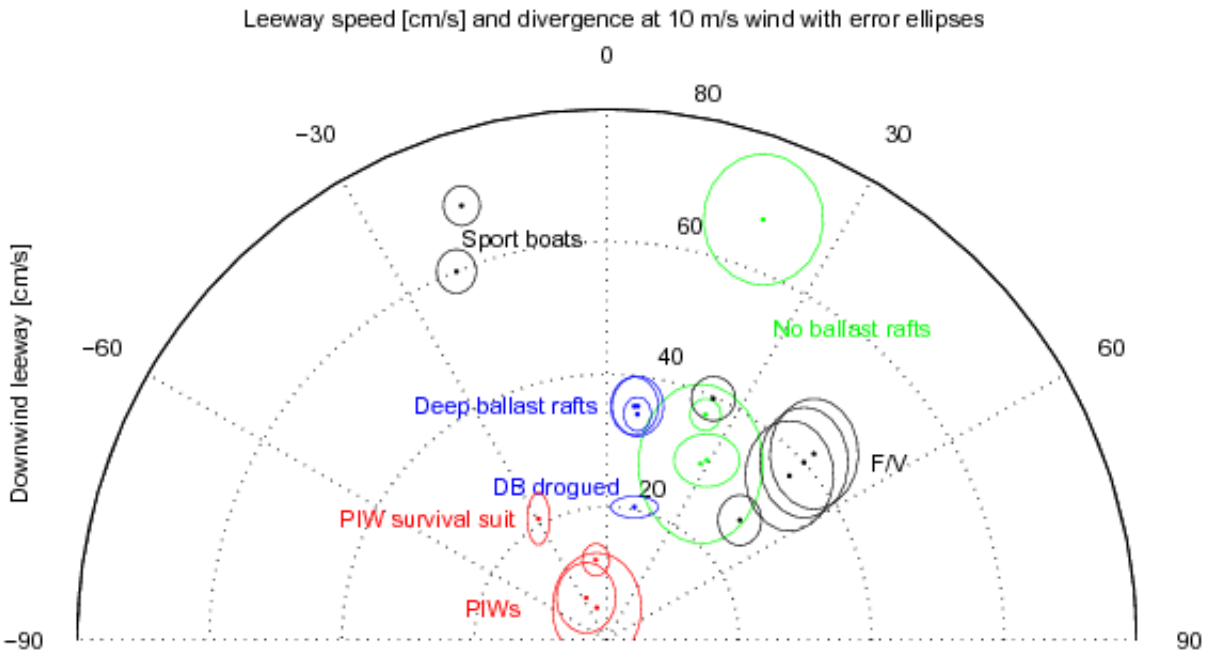
- *12-Year limited warranty valid with:
    - Required 3-year service intervals
    - Service performed by Revere Supply Company-certified service stations
    - Proper installation and use in accordance with Revere Owner's Manual
    - Warranty registration

Specifications:

- Revere Survival Model No. 45-OE4C
- Application / Intended Use: Offshore
- Max. Capacity: 4 people
- Floor Space per Person: 4 sq. ft.
- Raft Color: Red / yellow
- Pack Type: Canister (cradle not included)
    - Packed Dimensions: 22" W x 31.5" L x 12.5" D
    - Weight: 71 lbs

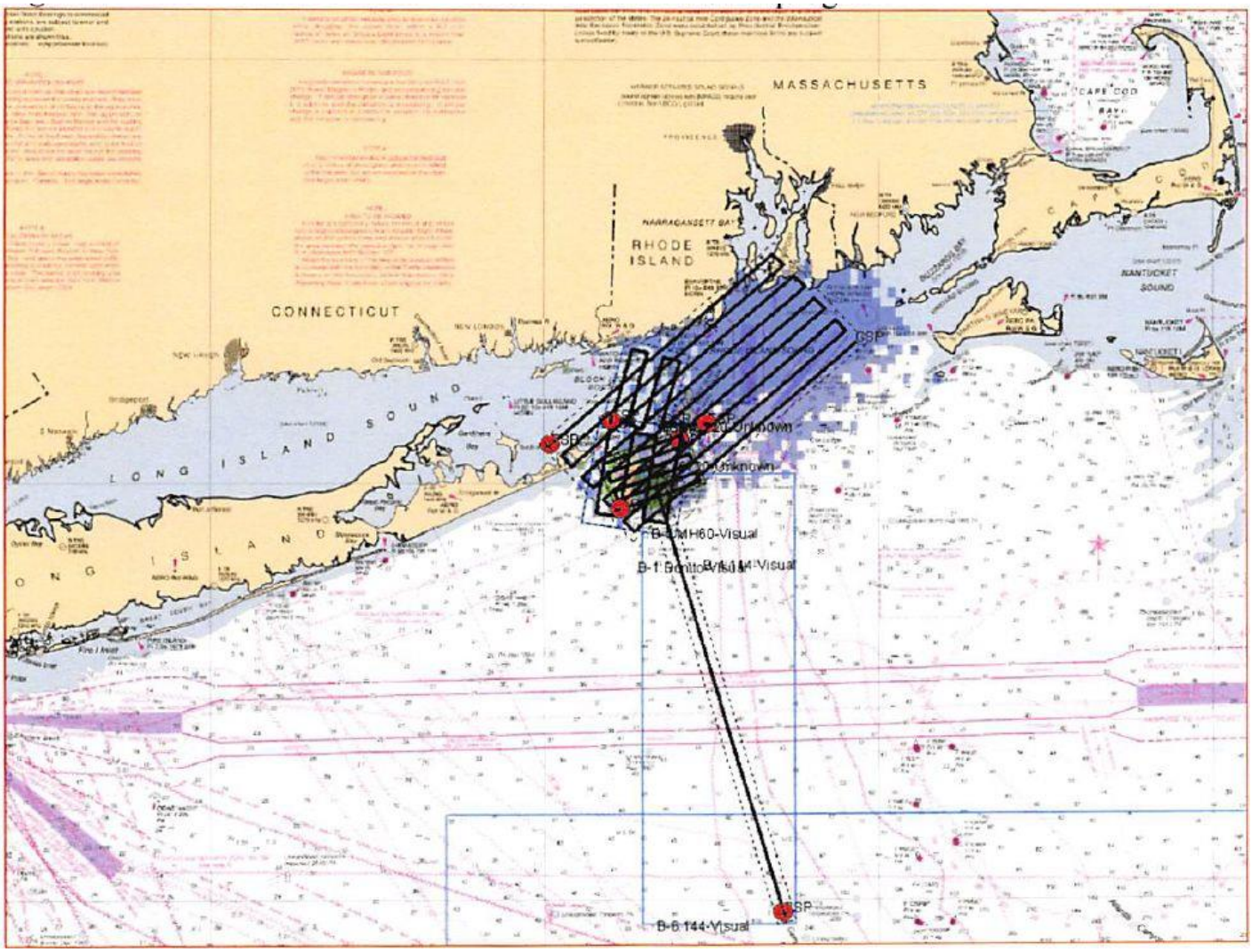
Reference: Defender website item # 453620 and # 550824 life raft specs.
https://www.defender.com/category.jsp?id=2290102&path=-1|135|2290100

Appendix 7. Four-person maritime life raft leeway for deep ballasted life rafts (blue) with and without drogues.

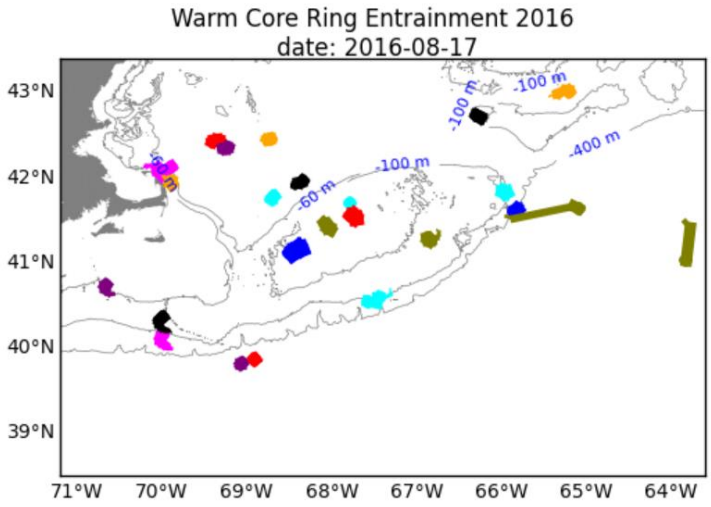


Reference. Breivika, Øyvind, A. Allen, C. Maisondieu and J. Roth, 2011. Wind-induced drift of objects at sea: The leeway field method. *Applied Ocean Research*. Volume 33, Issue 2, Pages 100-109. http://dx.doi.org/10.1016/j.apor.2011.01.005

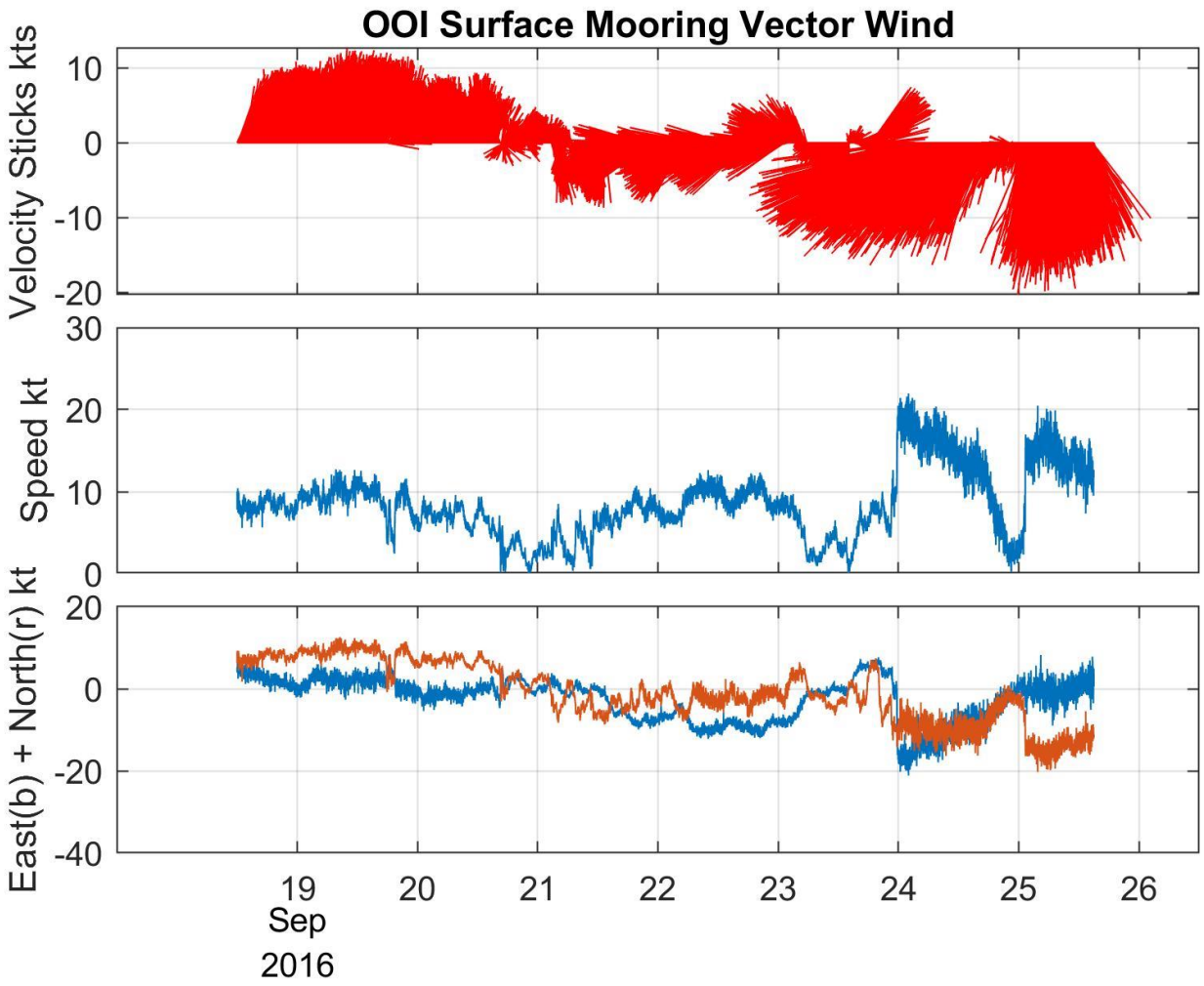
Appendix 8. USCG Search area bravo 9/19/2016 1200-1600 out to Block Canyon.



Appendix 9. Surface Irina drifter animation.
https://www.nefsc.noaa.gov/drifter/anim/drifter_WCR_2016.gif



Appendix 10. Same as Figure 6 but the raw OOI meteorological data are plotted instead of the hourly averaged data shown in Figure 6.



Appendix 11. Near-surface Current data hourly - Woods Hole Oceanographic Institution OSSM Buoy

Local Time EDST

Year	Mon	Day	Hr	Eastward	Northward
				kt	kt
2016	9	18	12	0.03	0.27
2016	9	18	13	-0.04	0.24
2016	9	18	14	0.07	0.23
2016	9	18	15	0.02	0.16
2016	9	18	16	0.06	0.08
2016	9	18	17	0.04	-0.03
2016	9	18	18	0.01	0.01
2016	9	18	19	-0.02	-0.04
2016	9	18	20	-0.04	-0.05
2016	9	18	21	-0.23	-0.18
2016	9	18	22	-0.32	-0.20
2016	9	18	23	-0.25	0.11
2016	9	19	0	-0.32	-0
2016	9	19	1	-0.43	0.08
2016	9	19	2	-0.42	0.19
2016	9	19	3	-0.37	0.15
2016	9	19	4	-0.32	0.22
2016	9	19	5	-0.34	0.28
2016	9	19	6	-0.22	0.34
2016	9	19	7	-0.09	0.42
2016	9	19	8	0.03	0.35
2016	9	19	9	0.22	0.27
2016	9	19	10	0.25	0.03
2016	9	19	11	0.26	-0.05
2016	9	19	12	0.19	-0.24

2016	**9**	**19**	**13**	**0.07**	**-0.27**
2016	**9**	**19**	**14**	**-0.07**	**-0.23**
2016	**9**	**19**	**15**	**-0.18**	**-0.34**
2016	**9**	**19**	**16**	**-0.50**	**-0.31**
2016	**9**	**19**	**17**	**-0.52**	**-0.05**
2016	**9**	**19**	**18**	**-0.56**	**0.04**
2016	**9**	**19**	**19**	**-0.60**	**0.20**
2016	**9**	**19**	**20**	**-0.53**	**0.18**
2016	**9**	**19**	**21**	**-0.50**	**0.35**
2016	**9**	**19**	**22**	**-0.38**	**0.54**
2016	**9**	**19**	**23**	**-0.22**	**0.53**
2016	**9**	**20**	**0**	**-0.07**	**0.55**
2016	**9**	**20**	**1**	**0.07**	**0.23**
2016	**9**	**20**	**2**	**0.04**	**0.12**
2016	**9**	**20**	**3**	**0.09**	**0.16**
2016	**9**	**20**	**4**	**0.16**	**0.09**
2016	**9**	**20**	**5**	**0.08**	**0.02**
2016	**9**	**20**	**6**	**0.12**	**0.03**
2016	**9**	**20**	**7**	**0.17**	**-0.05**
2016	**9**	**20**	**8**	**0.03**	**-0.08**
2016	**9**	**20**	**9**	**-0.04**	**-0.08**
2016	**9**	**20**	**10**	**-0.12**	**-0.17**
2016	**9**	**20**	**11**	**-0.20**	**-0.17**
2016	**9**	**20**	**12**	**-0.18**	**-0.15**
2016	**9**	**20**	**13**	**-0.20**	**-0.22**
2016	**9**	**20**	**14**	**-0.30**	**-0.16**
2016	**9**	**20**	**15**	**-0.39**	**-0.14**
2016	**9**	**20**	**16**	**-0.51**	**0.05**
2016	**9**	**20**	**17**	**-0.52**	**0.20**
2016	**9**	**20**	**18**	**-0.50**	**0.28**

2016	**9**	**20**	**19**	**-0.48**	**0.43**
2016	**9**	**20**	**20**	**-0.29**	**0.45**
2016	**9**	**20**	**21**	**-0.16**	**0.33**
2016	**9**	**20**	**22**	**0.06**	**0.37**
2016	**9**	**20**	**23**	**0.12**	**0.25**
2016	**9**	**21**	**0**	**0.21**	**0.28**
2016	**9**	**21**	**1**	**0.28**	**-0.06**
2016	**9**	**21**	**2**	**0.28**	**-0.04**
2016	**9**	**21**	**3**	**0.27**	**-0.21**
2016	**9**	**21**	**4**	**0.26**	**-0.26**
2016	**9**	**21**	**5**	**0.15**	**-0.34**
2016	**9**	**21**	**6**	**0.11**	**-0.36**
2016	**9**	**21**	**7**	**-0.03**	**-0.37**
2016	**9**	**21**	**8**	**-0.08**	**-0.34**
2016	**9**	**21**	**9**	**-0.09**	**-0.33**
2016	**9**	**21**	**10**	**-0.18**	**-0.38**
2016	**9**	**21**	**11**	**-0.36**	**-0.33**
2016	**9**	**21**	**12**	**-0.31**	**0.03**
2016	**9**	**21**	**13**	**-0.20**	**0.13**
2016	**9**	**21**	**14**	**-0.12**	**0.25**
2016	**9**	**21**	**15**	**0.18**	**0.29**
2016	**9**	**21**	**16**	**0.22**	**0.16**
2016	**9**	**21**	**17**	**0.28**	**0.06**
2016	**9**	**21**	**18**	**0.26**	**0.28**
2016	**9**	**21**	**19**	**0.34**	**0**
2016	**9**	**21**	**20**	**0.22**	**-0.20**
2016	**9**	**21**	**21**	**-0.01**	**-0.16**
2016	**9**	**21**	**22**	**0.03**	**-0.17**
2016	**9**	**21**	**23**	**0.01**	**-0.23**
2016	**9**	**22**	**0**	**0.01**	**-0.29**

2016	**9**	**22**	**1**	**-0.28**	**-0.24**
2016	**9**	**22**	**2**	**-0.31**	**-0.20**
2016	**9**	**22**	**3**	**-0.20**	**-0.26**
2016	**9**	**22**	**4**	**-0.48**	**-0.01**
2016	**9**	**22**	**5**	**-0.42**	**0.03**
2016	**9**	**22**	**6**	**-0.38**	**0.10**
2016	**9**	**22**	**7**	**-0.36**	**0.22**
2016	**9**	**22**	**8**	**-0.38**	**0.14**
2016	**9**	**22**	**9**	**-0.25**	**0.15**
2016	**9**	**22**	**10**	**-0.23**	**0.30**
2016	**9**	**22**	**11**	**-0.19**	**0.28**
2016	**9**	**22**	**12**	**0**	**0.29**
2016	**9**	**22**	**13**	**-0.05**	**0.20**
2016	**9**	**22**	**14**	**-0.01**	**0.18**
2016	**9**	**22**	**15**	**0.05**	**0.06**
2016	**9**	**22**	**16**	**0.13**	**-0.01**
2016	**9**	**22**	**17**	**0.12**	**0**
2016	**9**	**22**	**18**	**0.09**	**-0.10**
2016	**9**	**22**	**19**	**0.03**	**-0.11**
2016	**9**	**22**	**20**	**-0.10**	**-0.15**
2016	**9**	**22**	**21**	**-0.24**	**-0.29**
2016	**9**	**22**	**22**	**-0.22**	**-0.13**
2016	**9**	**22**	**23**	**-0.27**	**0.02**
2016	**9**	**23**	**0**	**-0.19**	**-0.05**
2016	**9**	**23**	**1**	**-0.20**	**0.05**
2016	**9**	**23**	**2**	**-0.27**	**0.34**
2016	**9**	**23**	**3**	**-0.07**	**0.65**
2016	**9**	**23**	**4**	**0.10**	**0.44**
2016	**9**	**23**	**5**	**0.28**	**0.25**
2016	**9**	**23**	**6**	**0.22**	**0.22**

2016	**9**	**23**	**7**	**0.15**	**0.06**
2016	**9**	**23**	**8**	**0.01**	**0**
2016	**9**	**23**	**9**	**-0.05**	**-0.02**
2016	**9**	**23**	**10**	**-0.14**	**0**
2016	**9**	**23**	**11**	**-0.23**	**0.14**
2016	**9**	**23**	**12**	**0.01**	**0.28**
2016	**9**	**23**	**13**	**-0.03**	**0.03**
2016	**9**	**23**	**14**	**-0.07**	**-0.08**
2016	**9**	**23**	**15**	**-0.16**	**0.06**
2016	**9**	**23**	**16**	**-0.14**	**0.14**
2016	**9**	**23**	**17**	**-0.11**	**0.03**
2016	**9**	**23**	**18**	**-0.13**	**-0.02**
2016	**9**	**23**	**19**	**-0.21**	**0.05**
2016	**9**	**23**	**20**	**-0.25**	**0.16**
2016	**9**	**23**	**21**	**-0.39**	**0.11**
2016	**9**	**23**	**22**	**-0.31**	**0.04**
2016	**9**	**23**	**23**	**-0.33**	**0.11**
2016	**9**	**24**	**0**	**-0.33**	**0.17**
2016	**9**	**24**	**1**	**-0.16**	**0.33**
2016	**9**	**24**	**2**	**0.02**	**0.13**
2016	**9**	**24**	**3**	**-0.11**	**0.06**
2016	**9**	**24**	**4**	**-0.10**	**0.02**
2016	**9**	**24**	**5**	**-0.09**	**-0.02**
2016	**9**	**24**	**6**	**-0.06**	**-0.16**
2016	**9**	**24**	**7**	**-0.30**	**-0.14**
2016	**9**	**24**	**8**	**-0.39**	**-0.12**
2016	**9**	**24**	**9**	**-0.57**	**-0.01**
2016	**9**	**24**	**10**	**-0.48**	**0.18**
2016	**9**	**24**	**11**	**-0.43**	**0.07**
2016	**9**	**24**	**12**	**-0.27**	**0.19**

2016	**9**	**24**	**13**	**-0.27**	**0.19**
2016	**9**	**24**	**14**	**-0.33**	**0.25**
2016	**9**	**24**	**15**	**-0.26**	**0.21**
2016	**9**	**24**	**16**	**-0.11**	**0.26**
2016	**9**	**24**	**17**	**-0.04**	**0.12**
2016	**9**	**24**	**18**	**0.05**	**0.14**
2016	**9**	**24**	**19**	**0.12**	**-0.04**
2016	**9**	**24**	**20**	**-0**	**-0.18**
2016	**9**	**24**	**21**	**-0.04**	**-0.23**
2016	**9**	**24**	**22**	**-0.30**	**-0.06**
2016	**9**	**24**	**23**	**-0.30**	**-0.08**
2016	**9**	**25**	**0**	**-0.25**	**-0.02**
2016	**9**	**25**	**1**	**-0.17**	**-0.11**
2016	**9**	**25**	**2**	**-0.12**	**-0.11**
2016	**9**	**25**	**3**	**-0.18**	**0.02**
2016	**9**	**25**	**4**	**-0.16**	**-0.11**
2016	**9**	**25**	**5**	**-0.22**	**-0.23**
2016	**9**	**25**	**6**	**-0.25**	**-0.24**
2016	**9**	**25**	**7**	**-0.24**	**-0.31**
2016	**9**	**25**	**8**	**-0.22**	**-0.22**
2016	**9**	**25**	**9**	**-0.26**	**-0.29**
2016	**9**	**25**	**10**	**-0.48**	**-0.19**
2016	**9**	**25**	**11**	**-0.49**	**-0.05**
2016	**9**	**25**	**12**	**-0.46**	**0**
2016	**9**	**25**	**13**	**-0.25**	**0.05**
2016	**9**	**25**	**14**	**-0.09**	**0.10**
2016	**9**	**25**	**15**	**-0.02**	**0.19**

Appendix 12. Wind Data hourly - Woods Hole Oceanographic Institution OSSM Buoy

Local Time EDST

Year	Mon	Day	Hr	Eastward	Northward
Local	EDST			kt	kt
2016	9	18	12	6.40	7.21
2016	9	18	13	4.75	8.66
2016	9	18	14	3.10	8.23
2016	9	18	15	4.23	6.52
2016	9	18	16	2.47	8.13
2016	9	18	17	1.92	7.14
2016	9	18	18	3.26	6.88
2016	9	18	19	2.45	9.19
2016	9	18	20	1.69	8.92
2016	9	18	21	1	8.43
2016	9	18	22	1.54	11.02
2016	9	18	23	1.46	9.32
2016	9	19	0	2.28	8.03
2016	9	19	1	2.57	8.72
2016	9	19	2	2.85	10.79
2016	9	19	3	5.45	10.88
2016	9	19	4	5.75	9.98
2016	9	19	5	5.40	11.54
2016	9	19	6	8.29	10.38
2016	9	19	7	4.43	11.95
2016	9	19	8	3.55	9.63
2016	9	19	9	0.37	11.94
2016	9	19	10	2.69	12.52
2016	9	19	11	4.67	12.99

2016	**9**	**19**	**12**	**4.76**	**11.99**
2016	**9**	**19**	**13**	**5.14**	**9.21**
2016	**9**	**19**	**14**	**2.73**	**9.86**
2016	**9**	**19**	**15**	**1.11**	**9.33**
2016	**9**	**19**	**16**	**1.72**	**10.33**
2016	**9**	**19**	**17**	**0.92**	**9.69**
2016	**9**	**19**	**18**	**1.81**	**7.16**
2016	**9**	**19**	**19**	**1.18**	**8.12**
2016	**9**	**19**	**20**	**-0.05**	**9.30**
2016	**9**	**19**	**21**	**0.70**	**11.79**
2016	**9**	**19**	**22**	**1.01**	**12.60**
2016	**9**	**19**	**23**	**0.01**	**10.99**
2016	**9**	**20**	**0**	**-1.80**	**8.26**
2016	**9**	**20**	**1**	**-2.53**	**7.34**
2016	**9**	**20**	**2**	**-1.46**	**8.02**
2016	**9**	**20**	**3**	**-1.03**	**11.39**
2016	**9**	**20**	**4**	**-1.64**	**10.07**
2016	**9**	**20**	**5**	**-1.38**	**8.13**
2016	**9**	**20**	**6**	**-1.11**	**7.47**
2016	**9**	**20**	**7**	**-1.67**	**7.76**
2016	**9**	**20**	**8**	**-1.60**	**9.59**
2016	**9**	**20**	**9**	**-0.76**	**8.90**
2016	**9**	**20**	**10**	**0.43**	**8.81**
2016	**9**	**20**	**11**	**0.67**	**8.32**
2016	**9**	**20**	**12**	**-0.08**	**7.93**
2016	**9**	**20**	**13**	**1.30**	**8.47**
2016	**9**	**20**	**14**	**-0.71**	**7.15**
2016	**9**	**20**	**15**	**1.99**	**5.98**
2016	**9**	**20**	**16**	**1.70**	**5.71**
2016	**9**	**20**	**17**	**1.30**	**6.15**

2016	**9**	**20**	**18**	**-1.13**	**4.79**
2016	**9**	**20**	**19**	**-1.30**	**6.08**
2016	**9**	**20**	**20**	**0.34**	**6.95**
2016	**9**	**20**	**21**	**1.77**	**7**
2016	**9**	**20**	**22**	**2.21**	**3.96**
2016	**9**	**20**	**23**	**0.92**	**1.08**
2016	**9**	**21**	**0**	**0.42**	**0.85**
2016	**9**	**21**	**1**	**0.51**	**2.55**
2016	**9**	**21**	**2**	**1.59**	**0.69**
2016	**9**	**21**	**3**	**0.18**	**2.08**
2016	**9**	**21**	**4**	**-0.19**	**-3.83**
2016	**9**	**21**	**5**	**-0.78**	**-4.73**
2016	**9**	**21**	**6**	**-3.87**	**-7.58**
2016	**9**	**21**	**7**	**-3.79**	**-1.18**
2016	**9**	**21**	**8**	**-2.87**	**-1.14**
2016	**9**	**21**	**9**	**-2.63**	**-3.27**
2016	**9**	**21**	**10**	**-2.32**	**-5.43**
2016	**9**	**21**	**11**	**-4.76**	**-1.46**
2016	**9**	**21**	**12**	**-6.10**	**-4.19**
2016	**9**	**21**	**13**	**-4.80**	**-2.61**
2016	**9**	**21**	**14**	**-3.84**	**-7.15**
2016	**9**	**21**	**15**	**-5.53**	**-7.69**
2016	**9**	**21**	**16**	**-6.30**	**-3.31**
2016	**9**	**21**	**17**	**-6.84**	**-2.15**
2016	**9**	**21**	**18**	**-8.18**	**-5.09**
2016	**9**	**21**	**19**	**-10.52**	**-0.72**
2016	**9**	**21**	**20**	**-9.04**	**2.79**
2016	**9**	**21**	**21**	**-9.76**	**-2.96**
2016	**9**	**21**	**22**	**-13.15**	**-5.15**
2016	**9**	**21**	**23**	**-11.48**	**-0.19**

2016	**9**	**22**	**0**	**-11.42**	**0.84**
2016	**9**	**22**	**1**	**-10.70**	**0.99**
2016	**9**	**22**	**2**	**-11.74**	**-1.27**
2016	**9**	**22**	**3**	**-11.57**	**-1.04**
2016	**9**	**22**	**4**	**-12.55**	**-4.70**
2016	**9**	**22**	**5**	**-13.48**	**-4.02**
2016	**9**	**22**	**6**	**-14.98**	**-4.95**
2016	**9**	**22**	**7**	**-15.23**	**-3.53**
2016	**9**	**22**	**8**	**-14.77**	**-2.37**
2016	**9**	**22**	**9**	**-16.87**	**2.66**
2016	**9**	**22**	**10**	**-13.03**	**4.05**
2016	**9**	**22**	**11**	**-13.06**	**-0.15**
2016	**9**	**22**	**12**	**-13.10**	**2.87**
2016	**9**	**22**	**13**	**-12.77**	**-0.68**
2016	**9**	**22**	**14**	**-11.76**	**1.91**
2016	**9**	**22**	**15**	**-11.97**	**3.09**
2016	**9**	**22**	**16**	**-11**	**3.08**
2016	**9**	**22**	**17**	**-11.16**	**1.12**
2016	**9**	**22**	**18**	**-10.48**	**1.09**
2016	**9**	**22**	**19**	**-12.11**	**-0.40**
2016	**9**	**22**	**20**	**-11.01**	**-1.13**
2016	**9**	**22**	**21**	**-10.45**	**-0.04**
2016	**9**	**22**	**22**	**-11.23**	**2.02**
2016	**9**	**22**	**23**	**-9.51**	**-1.25**
2016	**9**	**23**	**0**	**-10.53**	**2.09**
2016	**9**	**23**	**1**	**-9.41**	**4.20**
2016	**9**	**23**	**2**	**-9.26**	**3.42**
2016	**9**	**23**	**3**	**-9.63**	**2.96**
2016	**9**	**23**	**4**	**-8.06**	**5.52**
2016	**9**	**23**	**5**	**-7.02**	**5.84**

2016	**9**	**23**	**6**	**-5.19**	**4.69**
2016	**9**	**23**	**7**	**-4.10**	**2.23**
2016	**9**	**23**	**8**	**-3.74**	**1.75**
2016	**9**	**23**	**9**	**-2.41**	**2.02**
2016	**9**	**23**	**10**	**-1.21**	**-0.59**
2016	**9**	**23**	**11**	**-0.58**	**-4.51**
2016	**9**	**23**	**12**	**-1.86**	**-3.53**
2016	**9**	**23**	**13**	**-1.93**	**-1.12**
2016	**9**	**23**	**14**	**-1.41**	**-4.39**
2016	**9**	**23**	**15**	**-0.96**	**-1.62**
2016	**9**	**23**	**16**	**1.20**	**-0.54**
2016	**9**	**23**	**17**	**3.15**	**-2.87**
2016	**9**	**23**	**18**	**1.37**	**-6.19**
2016	**9**	**23**	**19**	**1.13**	**0.10**
2016	**9**	**23**	**20**	**4.01**	**3.50**
2016	**9**	**23**	**21**	**7.62**	**5.12**
2016	**9**	**23**	**22**	**3.72**	**-7.27**
2016	**9**	**23**	**23**	**2.23**	**-7.55**
2016	**9**	**24**	**0**	**-0.03**	**-6.90**
2016	**9**	**24**	**1**	**-4.83**	**-10.42**
2016	**9**	**24**	**2**	**-12.68**	**-5.67**
2016	**9**	**24**	**3**	**-13.54**	**-4.06**
2016	**9**	**24**	**4**	**-15.34**	**-5.63**
2016	**9**	**24**	**5**	**-12.08**	**-7.88**
2016	**9**	**24**	**6**	**-12.18**	**-6.27**
2016	**9**	**24**	**7**	**-15.71**	**-5.24**
2016	**9**	**24**	**8**	**-12.69**	**-9.41**
2016	**9**	**24**	**9**	**-15.20**	**-8.01**
2016	**9**	**24**	**10**	**-13.48**	**-8.01**
2016	**9**	**24**	**11**	**-12.53**	**-9.31**

2016	**9**	**24**	**12**	**-10.15**	**-8.62**
2016	**9**	**24**	**13**	**-11.02**	**-9.55**
2016	**9**	**24**	**14**	**-11.15**	**-10.63**
2016	**9**	**24**	**15**	**-7.70**	**-11.95**
2016	**9**	**24**	**16**	**-8.46**	**-12.90**
2016	**9**	**24**	**17**	**-8.45**	**-8.83**
2016	**9**	**24**	**18**	**-9.88**	**-8.58**
2016	**9**	**24**	**19**	**-9.75**	**-10.16**
2016	**9**	**24**	**20**	**-7.65**	**-8.18**
2016	**9**	**24**	**21**	**-3.47**	**-4.26**
2016	**9**	**24**	**22**	**-4.64**	**-6.70**
2016	**9**	**24**	**23**	**-2.69**	**-8.52**
2016	**9**	**25**	**0**	**1.42**	**-7.93**
2016	**9**	**25**	**1**	**2.55**	**-6.28**
2016	**9**	**25**	**2**	**-0.19**	**-14.06**
2016	**9**	**25**	**3**	**-2.60**	**-14.47**
2016	**9**	**25**	**4**	**1.19**	**-16.69**
2016	**9**	**25**	**5**	**-2.58**	**-16.59**
2016	**9**	**25**	**6**	**-1.28**	**-11.70**
2016	**9**	**25**	**7**	**-1.29**	**-14.95**
2016	**9**	**25**	**8**	**-1.57**	**-16.36**
2016	**9**	**25**	**9**	**-1.95**	**-12.01**
2016	**9**	**25**	**10**	**-1.27**	**-15.74**
2016	**9**	**25**	**11**	**-3.40**	**-14.97**
2016	**9**	**25**	**12**	**0.21**	**-15.54**
2016	**9**	**25**	**13**	**-2.23**	**-13.73**
2016	**9**	**25**	**14**	**1.43**	**-12.51**
2016	**9**	**25**	**15**	**2.01**	**-11.43**

Appendix 13. AIS hourly positions from September 18-25, 2016, shown in Local Time. (Note actual data is in Microsoft Excel format)

Automatic Identification System (AIS) position data obtained from www.vesselfinder.com for relevant area from September 18-25, 2016

Subject: Re: Vesselfinder.com new historical data request from Richard Limeburner <rlimeburner@whoi.edu>
Date: Fri, 22 Feb 2019 14:42:35 +0200
From: Vessel Finder <info@vesselfinder.com>
To: Richard Limeburner <rlimeburner@whoi.edu>

Hi Richard,

We have received confirmation about your payment and I have attached the ordered data. Thank you very much.

You can access the voyage analyser service based on the purchased data at this link.

Data included in the vessel movements report is:

- DATE / TIME - time stamp of each position record (in UTC)
- MMSI number of the vessel
- LATITUDE - coordinates (WGS84)
- LONGITUDE - coordinates (WGS84)
- COURSE - course over ground (in degrees)
- SPEED - speed over ground (in knots)
- HEADING - heading of the vessel's hull (in degrees). 511 means that there is no heading data.
- IMO number of the vessel
- NAME of the vessel
- CALLSIGN - vessel's call sign
- AIS TYPE - vessel's type according to AIS specification (reference Ship Type Codes section at http://www.bosunsmate.org/ais/message5.php)
- A - distance between AIS receiver and bow
- B - distance between AIS receiver and stern (i.e. Ship Lenght = A + B)
- C - distance to port
- D - distance to starboard (i.e. Ship Width = C + D)
- DRAUGHT - vessel's draught at the time of the position record
- DESTINATION - destination port (as entered by the Master)
- ETA - estimated time of arrival (as entered by the Master)

Please confirm safe receipt.

Best regards,
Alexander Tonev

Email: info@vesselfinder.com
Web: www.vesselfinder.com

VesselFinder Ltd.

On Fri, Feb 22, 2019 at 9:51 AM Vessel Finder <info@vesselfinder.com> wrote:
Dear Richard,

Thank you very much for your response.

We have rechecked the data availability for the newly requested area (see the attached image for verification) and we can offer you:

- **5,793 position records** at **1-hour time resolution** for **283 MMSI numbers** within the time range **from 00:00 UTC on 18 Sep, 2016 to 04:00 UTC on 26 Sep, 2016.** The cost of the report is **320 EUR.**

Should you decide to proceed with the purchase, I have generated an online invoice for 320 EUR which can be paid via credit/debit card or a PayPal account. You just need to follow this link and fill the form. If you pay from a company account, registered in the European Union, make sure to enter your company VAT number in order to omit additional VAT charges.

I will send you the data as soon as we have it processed and you complete the payment process.

Best regards,
Alexander Tonev

Email: info@vesselfinder.com
Web: www.vesselfinder.com

VesselFinder Ltd.

On Thu, Feb 21, 2019 at 7:27 PM Richard Limeburner <rlimeburner@whoi.edu> wrote:

Alexander,

I want to modify the search area to be slightly larger.

The period is still 9/18/2016 @ 0000 UTC until 9/26/2016 0400 UTC

For the area: Lat 39°N to 40°30'N,

and new Long 069°W to 072 30°W.

Simple xls data and 1 hour frequency should be good.

The cost will be a little higher than your quote due to my slightly enlarged search area.

How can I best give you my credit card info to pay now? Telephone you?

I am requesting here a faster delivery if possible.

Thanx again,

Richard Limeburner

On 2/21/2019 2:12 AM, Vessel Finder wrote:
Dear Richard,

Thank you very much for your Historical AIS data request.

REQUESTED DATA:
Area: see the attached image for verification
Time range: **from 18 Sep, 2016 to 26 Sep, 2016**

AVAILABLE DATA:
Number of positions: **1,607** (see sample of the report in the attachment; here is the description of all data fields)
Number of vessels: **185 MMSI numbers**
Data resolution: **1-hour** (available at 5-minute or other resolution)

DELIVERED DATA:

- A report in XLS/CSV format with all data fields described here
- Access to the Voyage Analyser service, so you can explore the vessel movements. Here is a Demo of the Voyage Analyser.

DATA PRICING:

1-hour resolution: **180 EUR**
5-minute resolution: **360 EUR**

DELIVERY TIME: 2 business days

PAYMENT METHODS: bank transfer; credit card or PayPal

You can read more general information about our historical AIS data archives here.

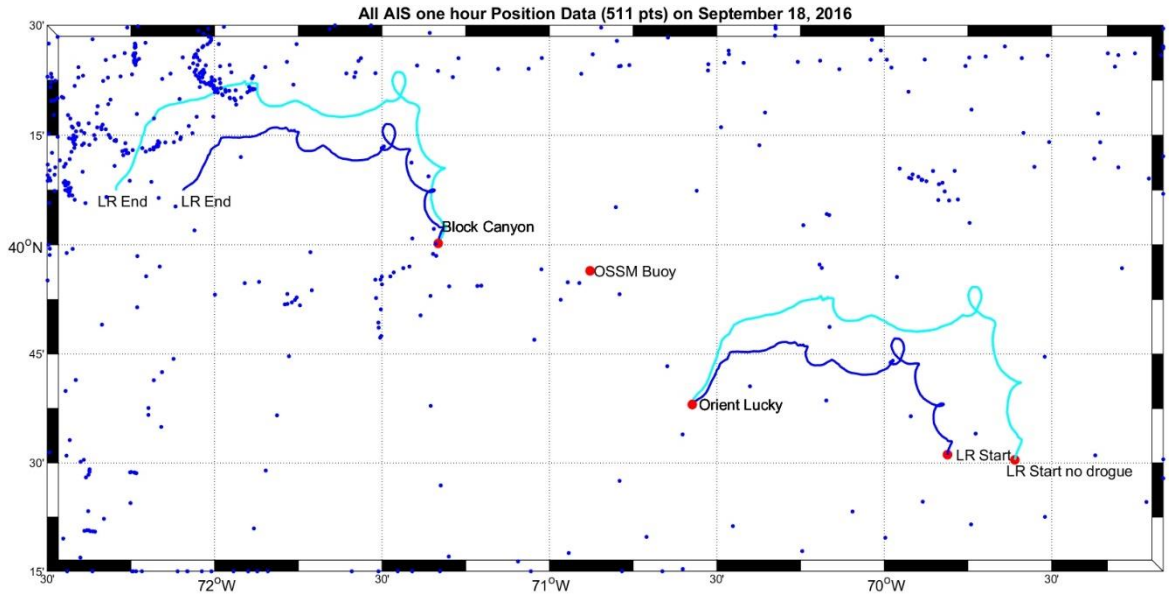
If you need more information, please let me know. I would be glad to assist you.

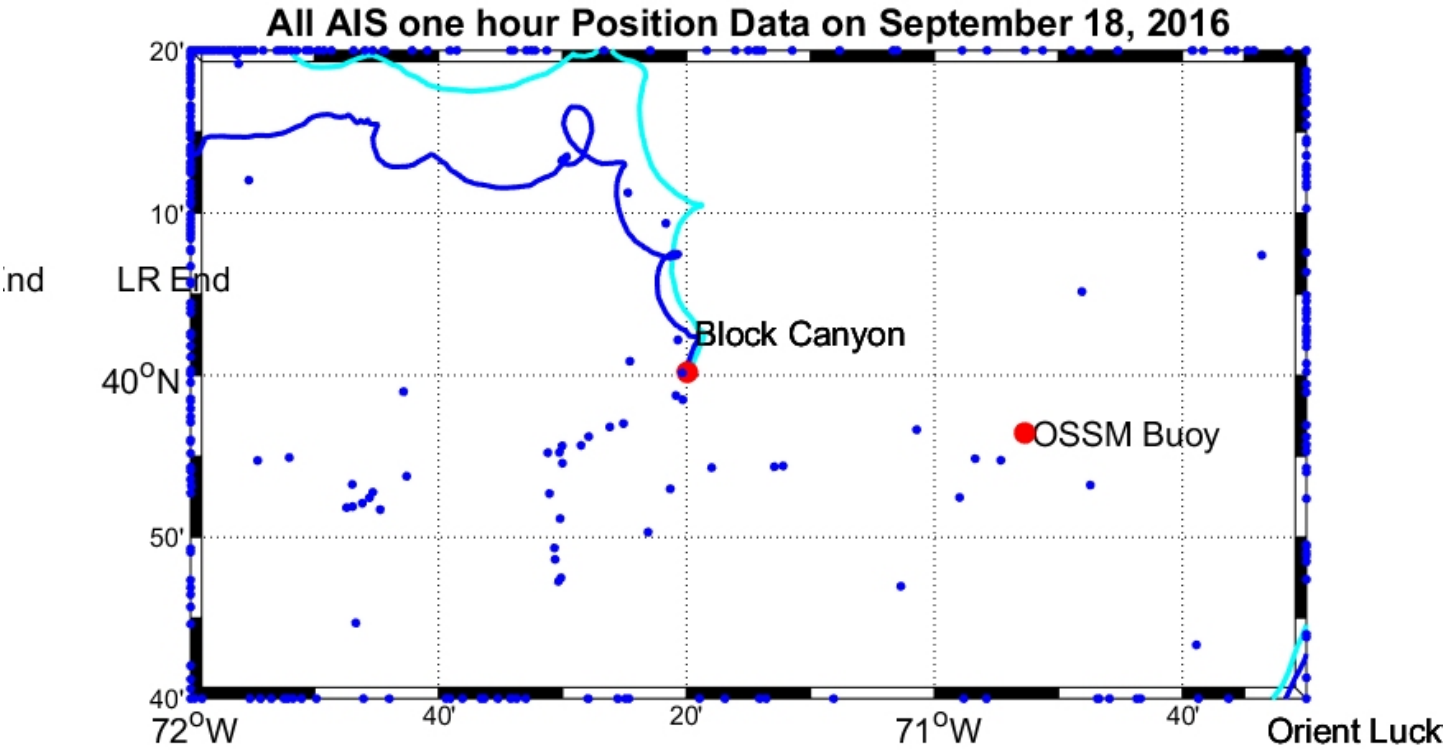
Best regards,
Alexander Tonev

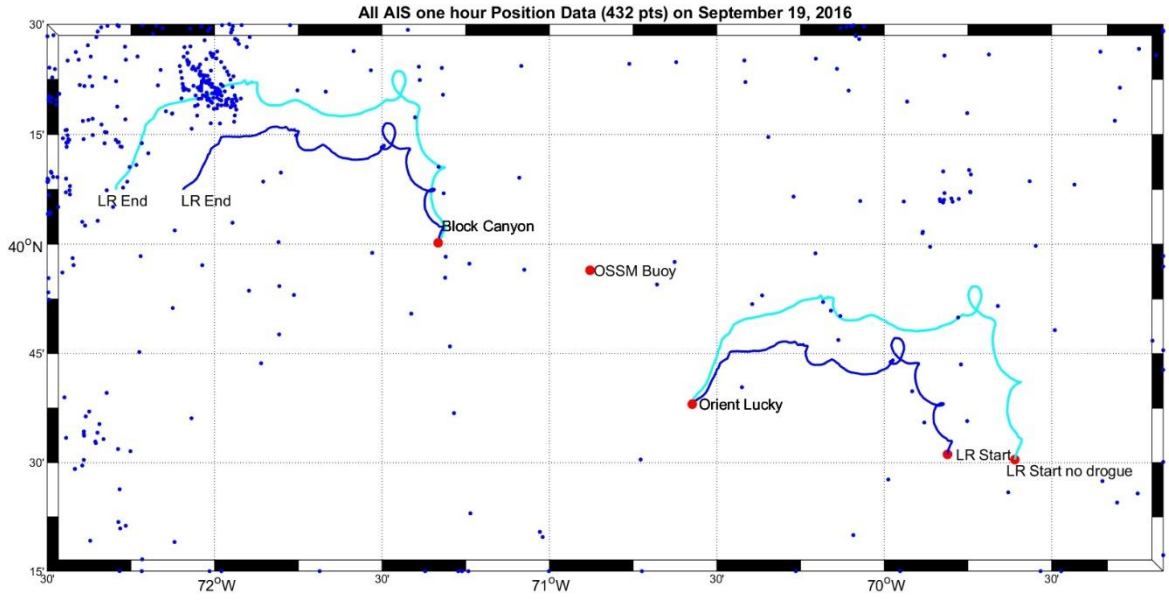
Email: info@vesselfinder.com
Web: www.vesselfinder.com

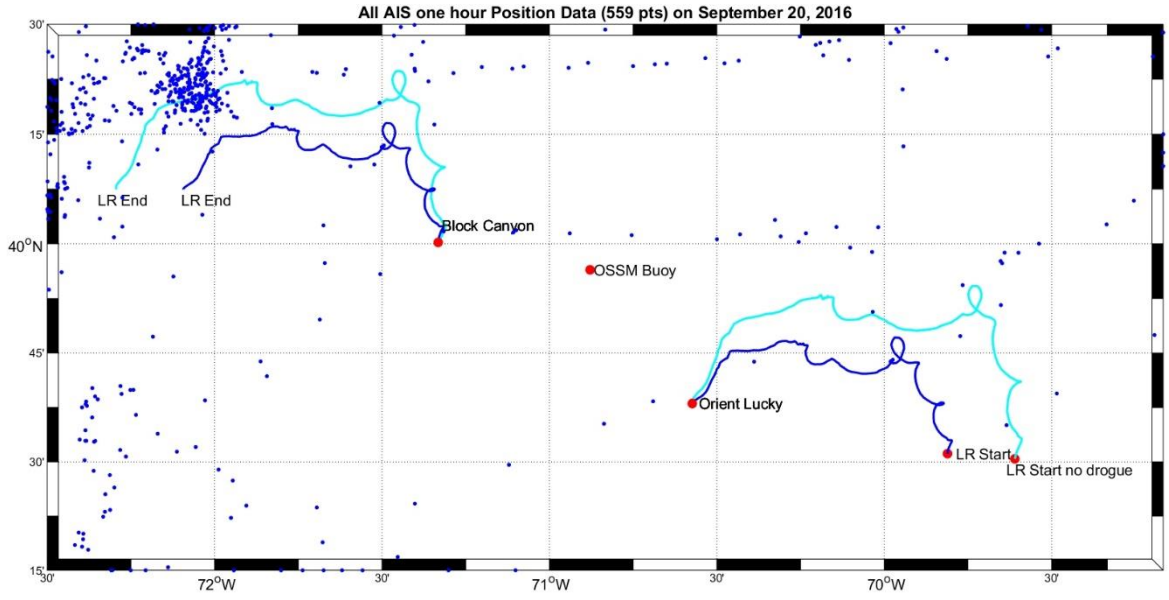
VesselFinder Ltd

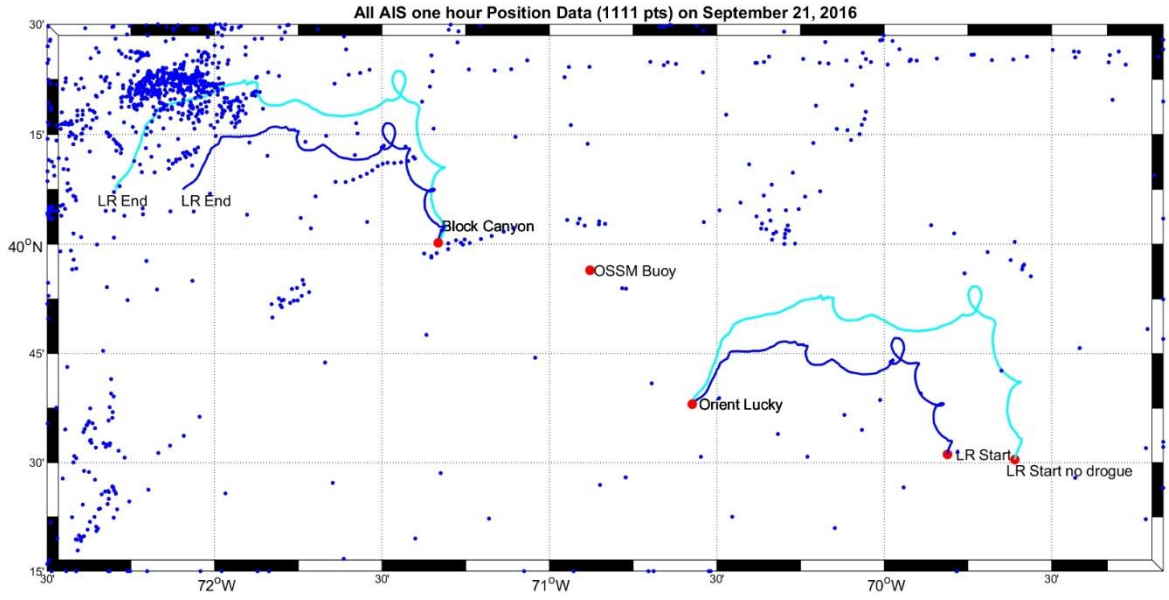
Appendix 14. **AIS hourly positions from September 18-25, 2016, shown in Local Time.**

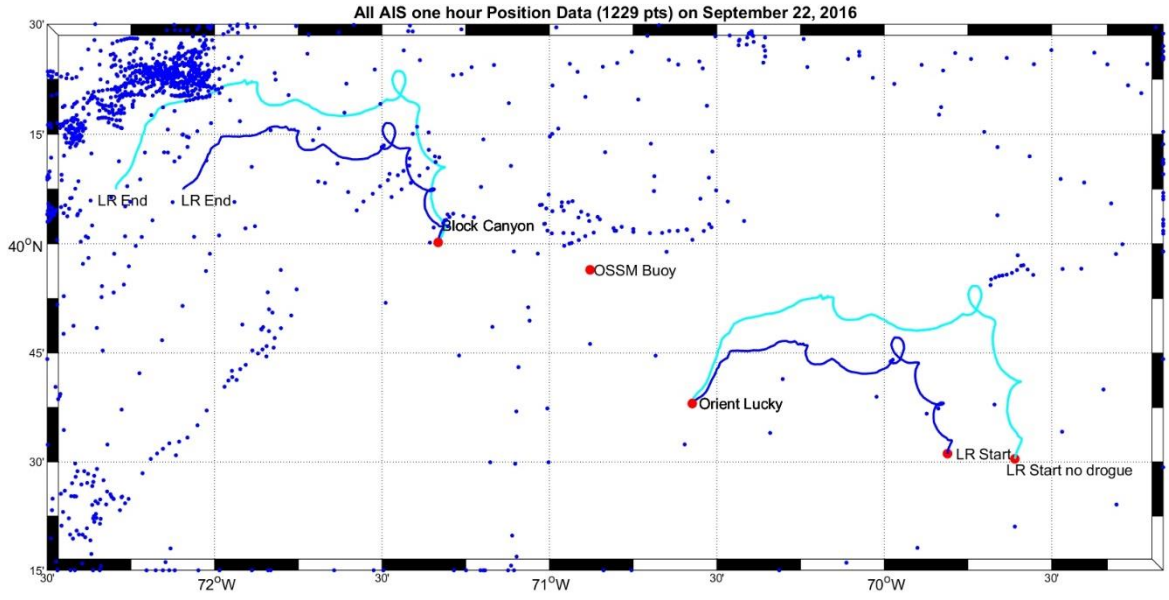


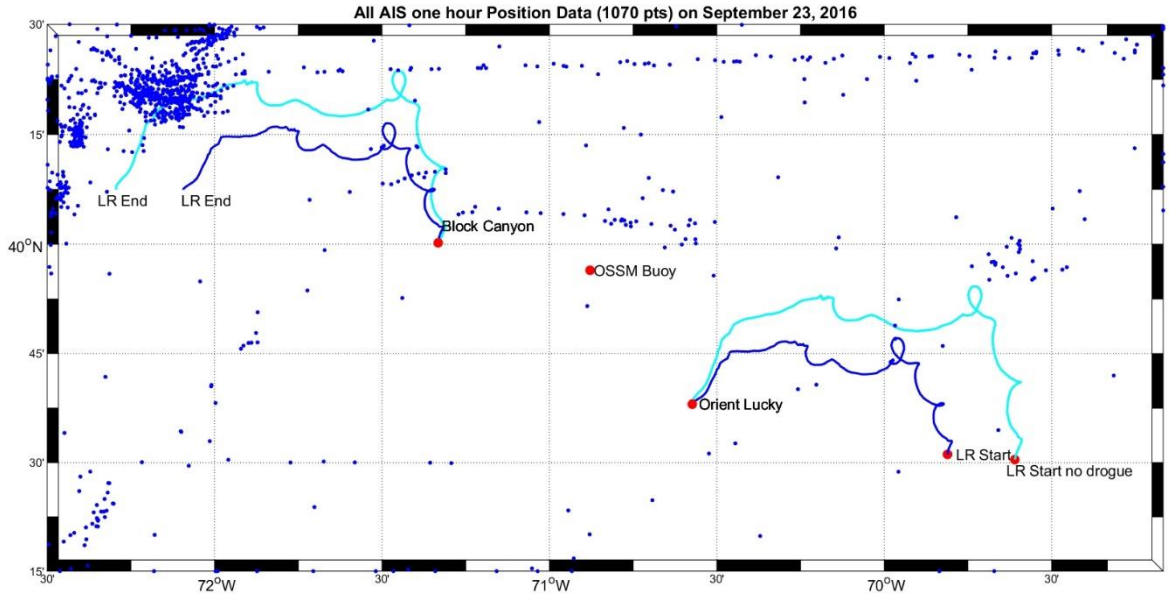


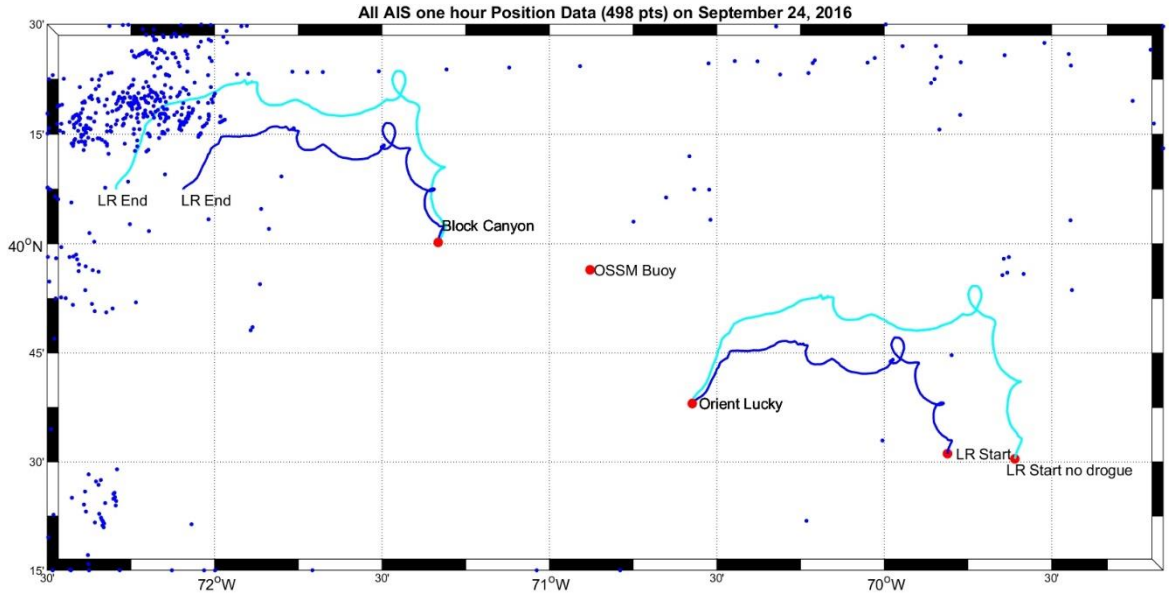

All AIS one hour Position Data (432 pts) on September 19, 2016
LR End
LR End
Block Canyon
OSSM Buoy
Orient Lucky
LR Start
LR Start no drogue
40°N
72°W
71°W
70°W

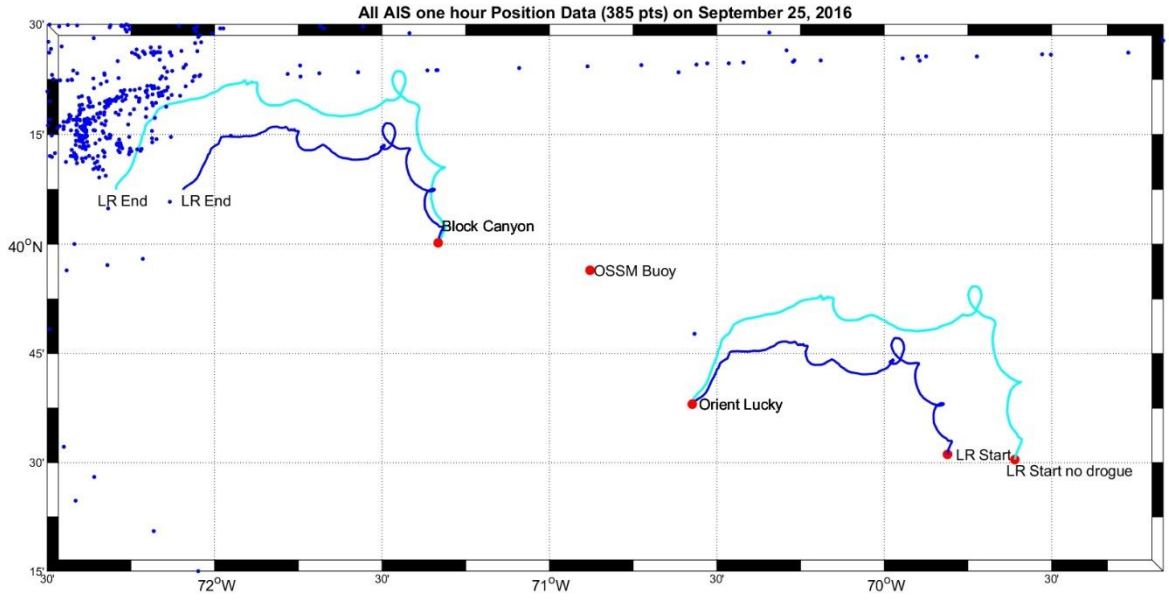

All AIS one hour Position Data (559 pts) on September 20, 2016
LR End
LR End
Block Canyon
OSSM Buoy
Orient Lucky
LR Start
LR Start no drogue
40°N
72°W
71°W
70°W


All AIS one hour Position Data (1111 pts) on September 21, 2016
LR End
LR End
Block Canyon
OSSM Buoy
Orient Lucky
LR Start
LR Start no drogue
40°N
72°W
71°W
70°W


All AIS one hour Position Data (1229 pts) on September 22, 2016
LR End
LR End
Block Canyon
OSSM Buoy
Orient Lucky
LR Start
LR Start no drogue
40°N
72°W
71°W
70°W

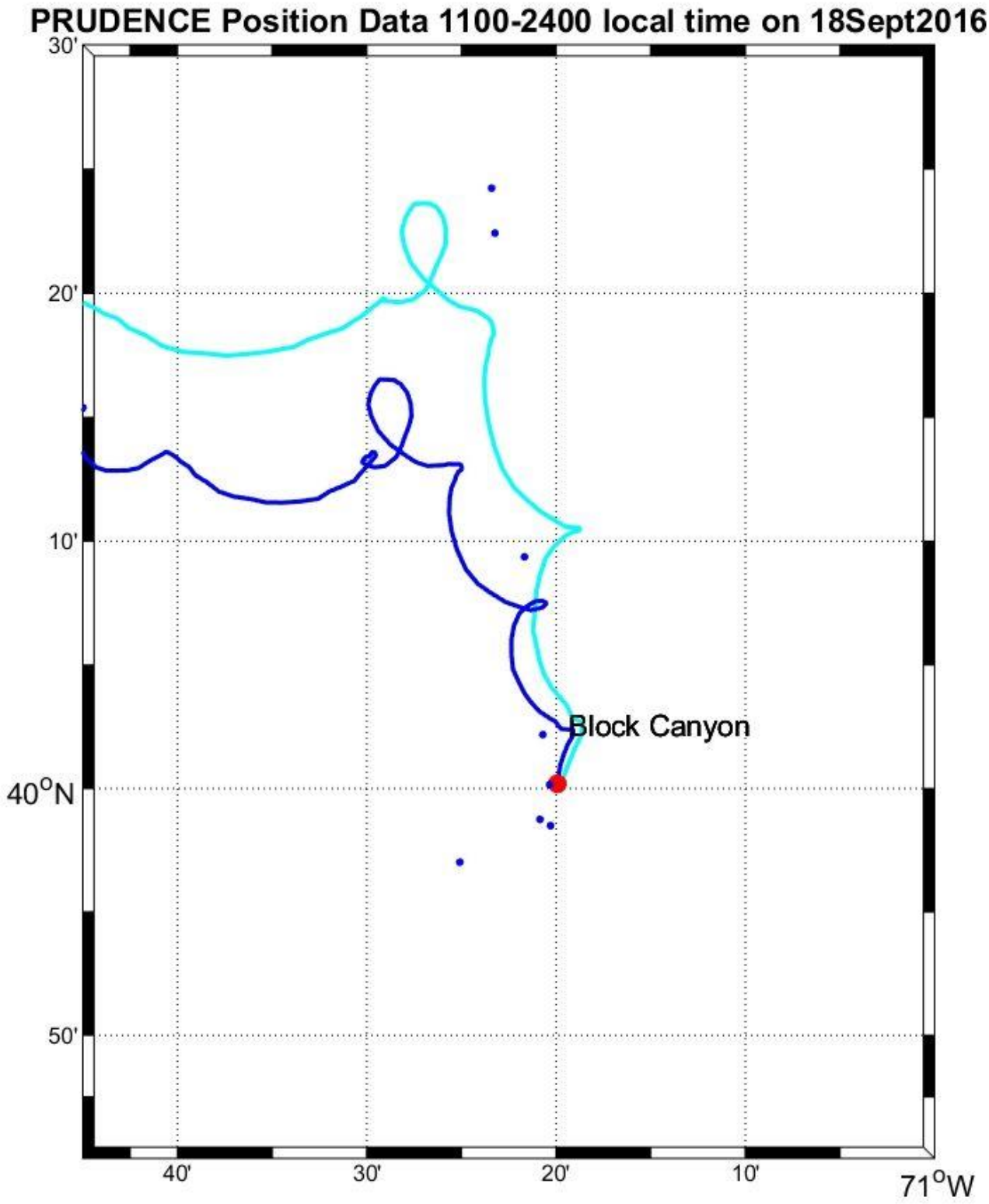

All AIS one hour Position Data (1070 pts) on September 23, 2016
LR End
LR End
Block Canyon
OSSM Buoy
Orient Lucky
LR Start
LR Start no drogue
40°N
72°W
71°W
70°W


All AIS one hour Position Data (498 pts) on September 24, 2016
LR End
LR End
Block Canyon
OSSM Buoy
Orient Lucky
LR Start
LR Start no drogue
40°N
72°W
71°W
70°W


All AIS one hour Position Data (385 pts) on September 25, 2016
LR End
LR End
Block Canyon
OSSM Buoy
Orient Lucky
LR Start
LR Start no drogue
40°N
72°W
71°W
70°W

Appendix 15. Vessel Prudence AIS hourly positions from September 18, 2016

DATE TIME (UTC)	MMSI	LATITUDE	LONGITUDE	COURSE	SPEED	HEADING
IMO NAME	CALLSIGN	AISTYPE	A B C D	DRAUGHT		
DESTINATION	ETA					
9/18/2016 15:35	367573470	39.950316	-71.418033	264 6	511 0	PRUDENCE
WDG8046	30 8	16 4	3 0			
9/18/2016 18:32	367573470	39.979164	-71.347423	199.6 5.5	511 0	PRUDENCE
WDG8046	30 8	16 4	3 0			
9/18/2016 19:36	367573470	39.974933	-71.338183	195 5.9	511 0	PRUDENCE
WDG8046	30 8	16 4	3 0			
9/18/2016 21:11	367573470	40.002544	-71.338933	195.8 1.5	511 0	PRUDENCE
WDG8046	30 8	16 4	3 0			
9/18/2016 22:02	367573470	40.036322	-71.344993	352.1 7.7	511 0	PRUDENCE
WDG8046	30 8	16 4	3 0			
9/18/2016 23:00	367573470	40.156133	-71.361123	352.1 6.8	511 0	PRUDENCE
WDG8046	30 8	16 4	3 0			
9/19/2016 0:47	367573470	40.373773	-71.387113	357.8 7.6	511 0	PRUDENCE
WDG8046	30 8	16 4	3 0			
9/19/2016 1:02	367573470	40.403923	-71.390063	355.5 7.4	511 0	PRUDENCE
WDG8046	30 8	16 4	3 0			


PRUDENCE Position Data 1100-2400 local time on 18Sept2016
30'
20'
10'
40°N
50'
Block Canyon
40'
30'
20'
10'
71°W

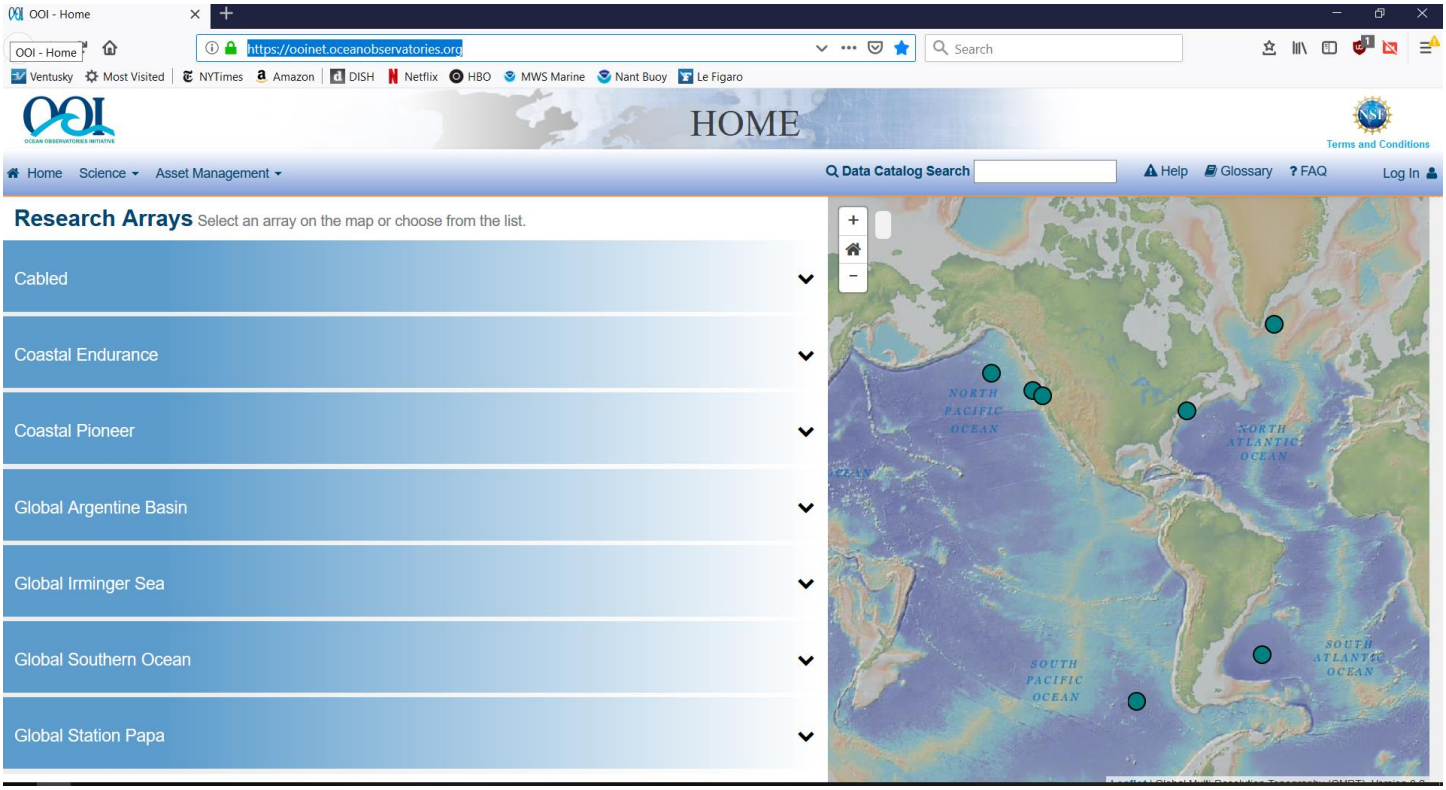
Appendix 16 – OOI Data access

The OOI CI (Computer Interface) provides a common operating infrastructure, the OOI system software (OOI Net), to connect and enable the coordination of operations of the OOI marine components (Global, Coastal, and Cabled Arrays) with the scientific and educational pursuits of oceanographic research communities. OOI Net permits 24/7 connectivity to bring sustained ocean observing data to a user any time, any place. **Anyone with an internet connection can create a login on OOINet and access OOI data.** See https://oceanobservatories.org/data/

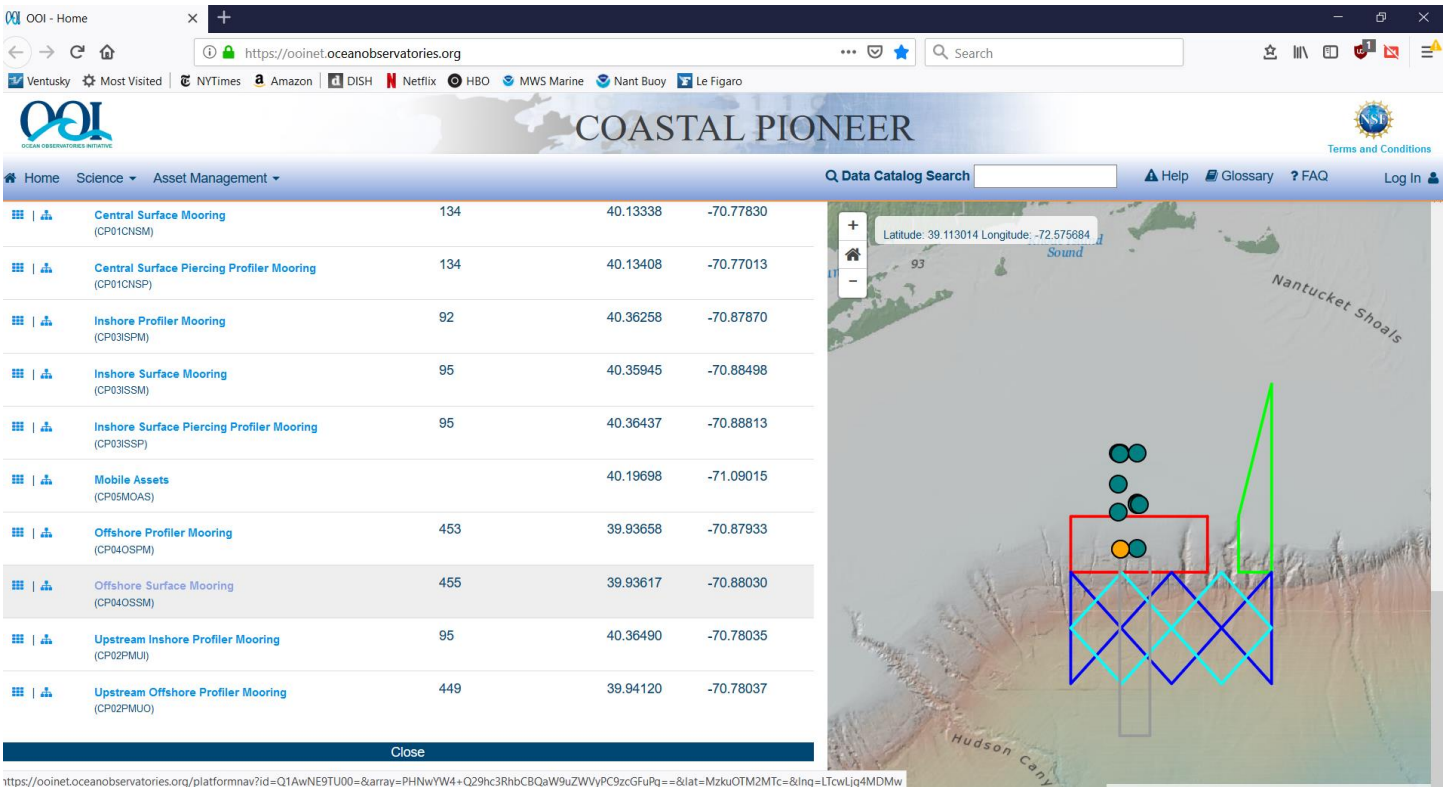
A username and password are free and required to download the data.

How to Obtain OOI Source Data used in this report

1. Go to the OOI home https://ooinet.oceanobservatories.org/ and login with your username and password



2. Choose the Coastal Pioneer Research Array (3rd from top)



Now scroll down on left side to the Offshore Surface Mooring and

3. Click the grid of 3x3 dots on left side to access data from the Offshore Surface Mooring line.

Note on the above web page the depth in meters and position as decimal degrees latitude and longitude. Note the mooring location shown at right by a solid orange filled circle.

All OOI data used in this report came from

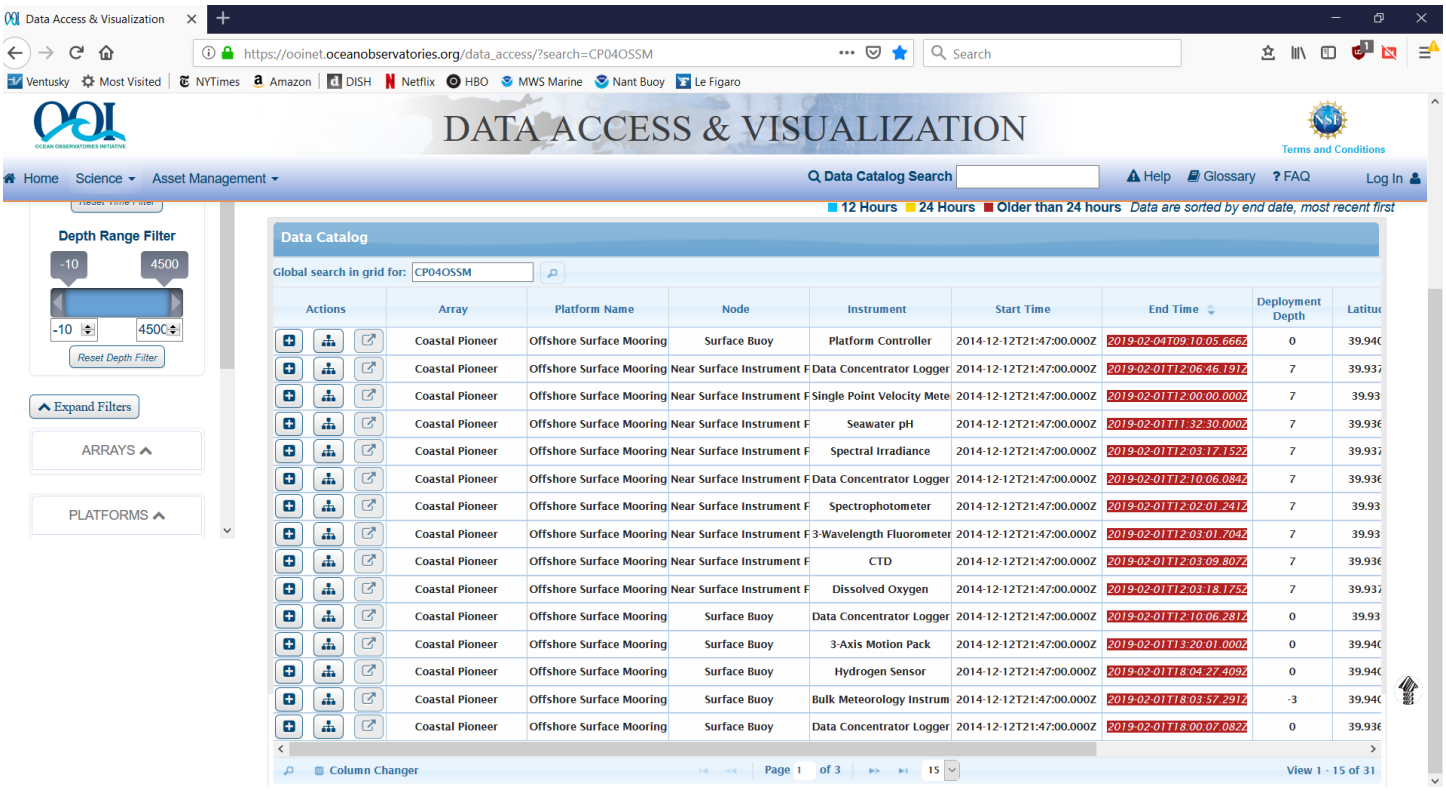
Offshore Surface Mooring Depth 455m 39.93617 Lat -70.88030 Lon

(CP04OSSM)

More specifically the data set from recovered host

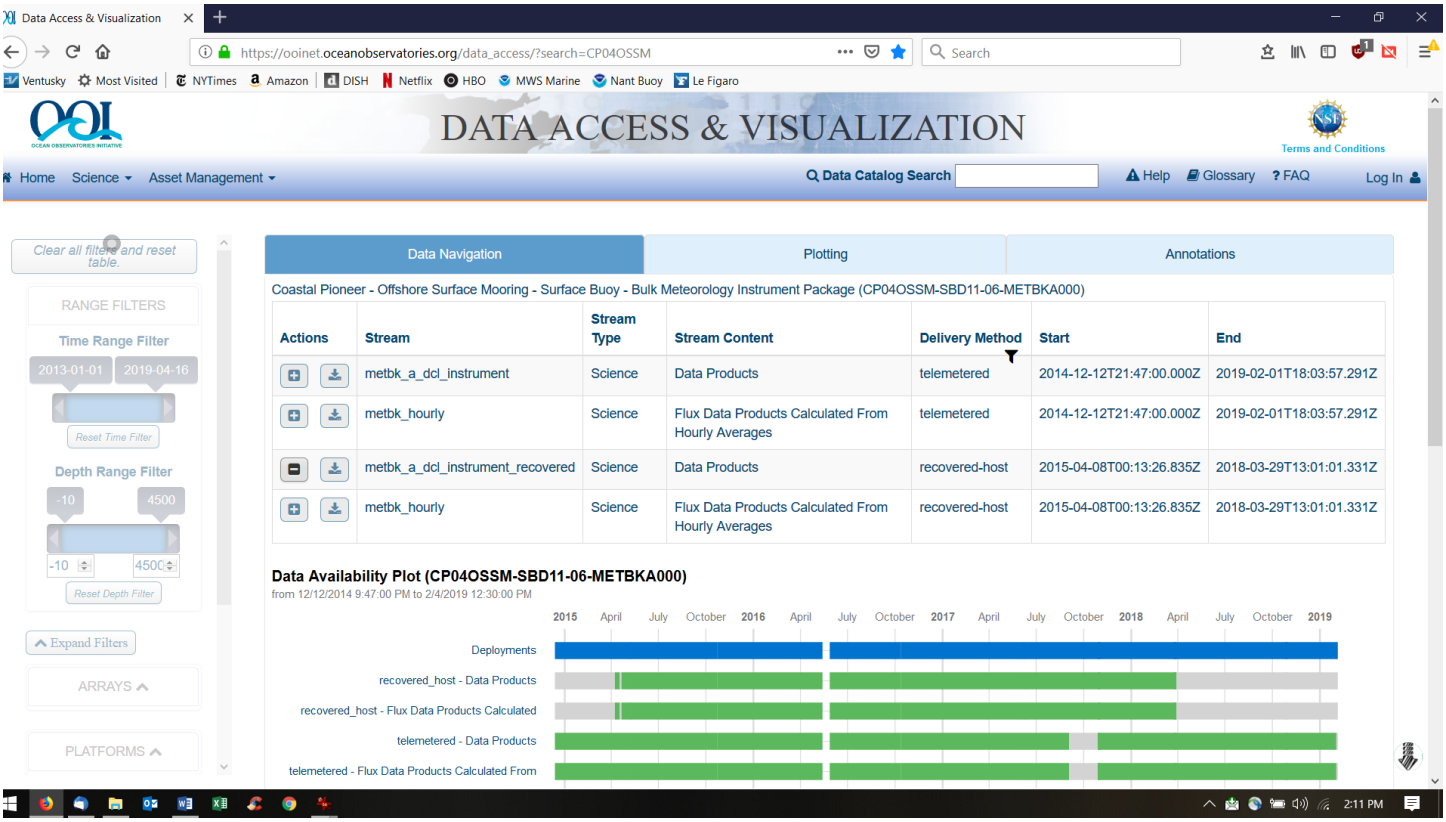
Coastal Pioneer - Offshore Surface Mooring - Surface Buoy - Bulk Meteorology Instrument Package

The next screen may offer a tour of the data, skip the tour and scroll down to the bottom.

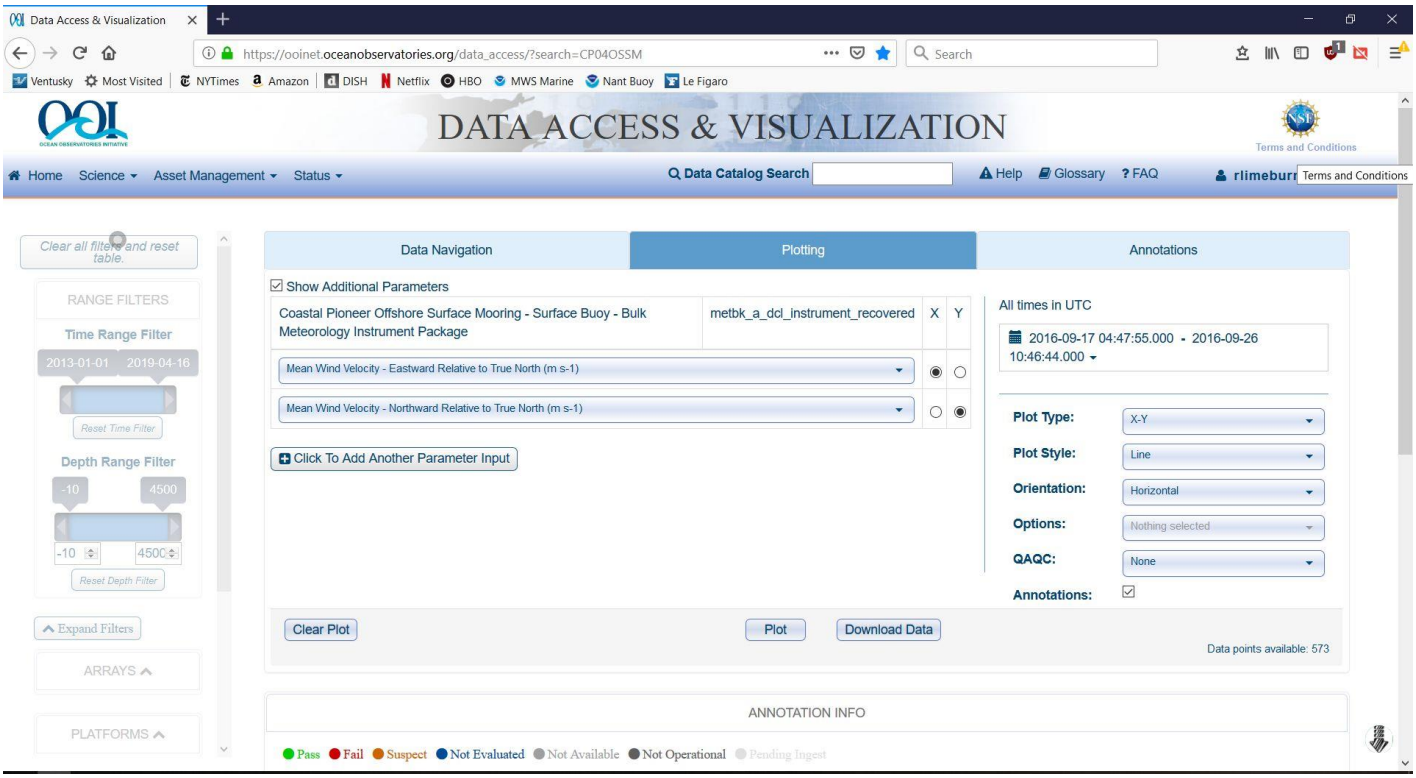


Scroll down to bottom.

4. Choose the 2nd from bottom, Coastal Pioneer, Offshore surface mooring, Node = Surface Mooring, Platform controller = Bulk Meteorology Instrument by clicking the + on the left of this line.



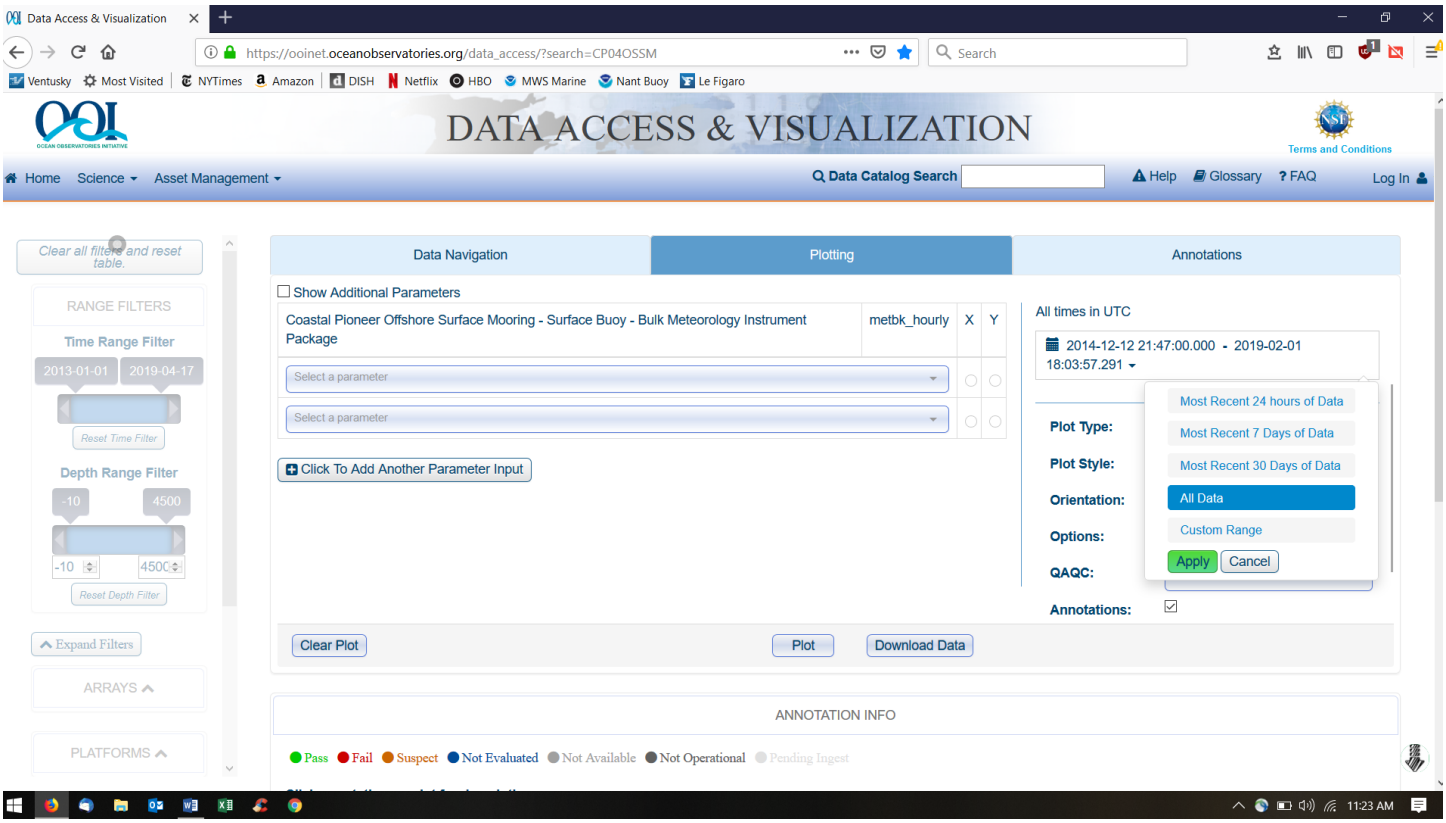
5. Choose the 3rd Stream from the top by clicking the + on left under Actions, Stream = metbk_a_dcl_instrument_recovered, Stream type= science, stream content Data Products, delivery method = recovered-host



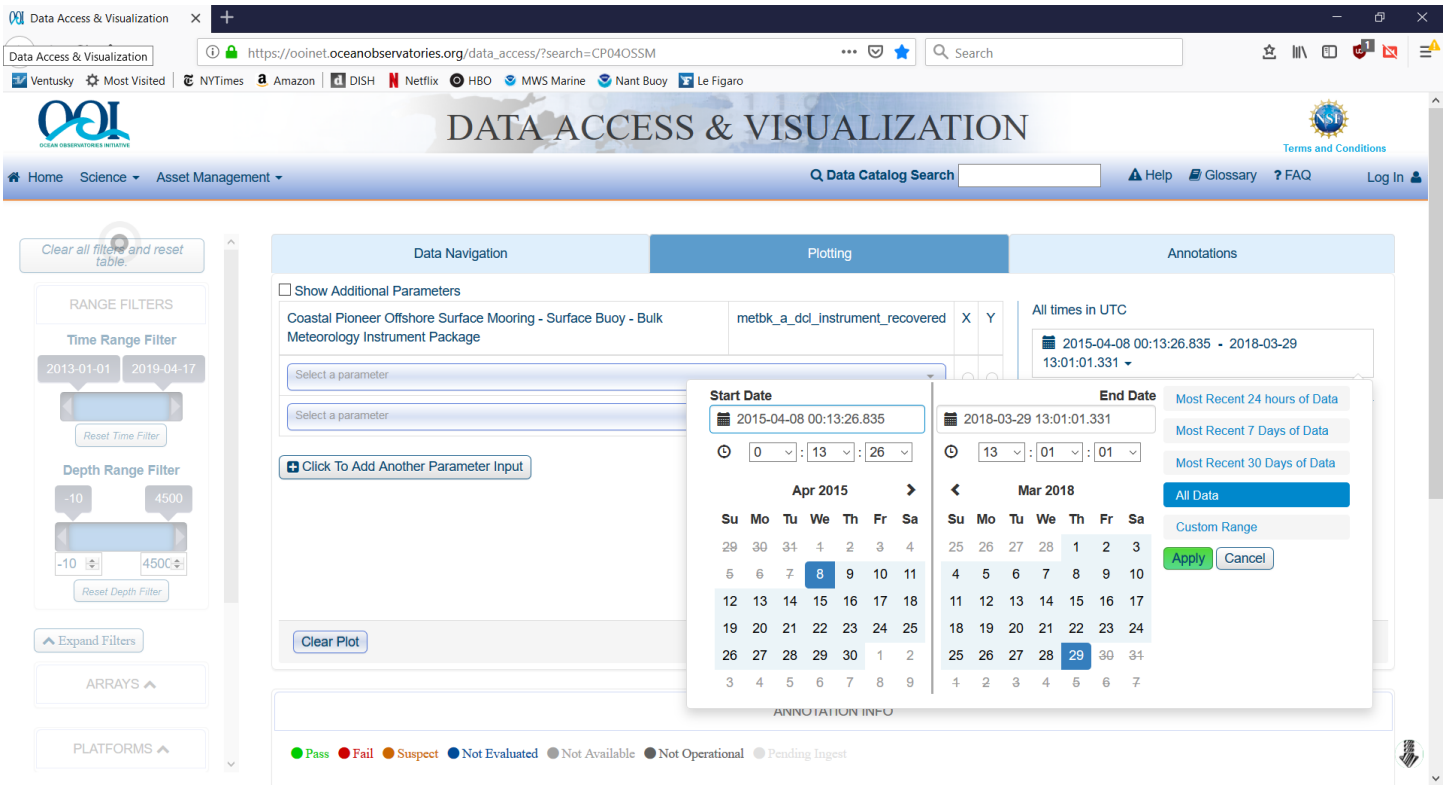
6. Choose Plotting near the top of the page

Now is the time to choose a custom start and stop time so you do not download a huge data set.

7. Open the time box in the upper right below the words “All times are in UTC” by clicking the solid triangle at the end of the start and stop times,



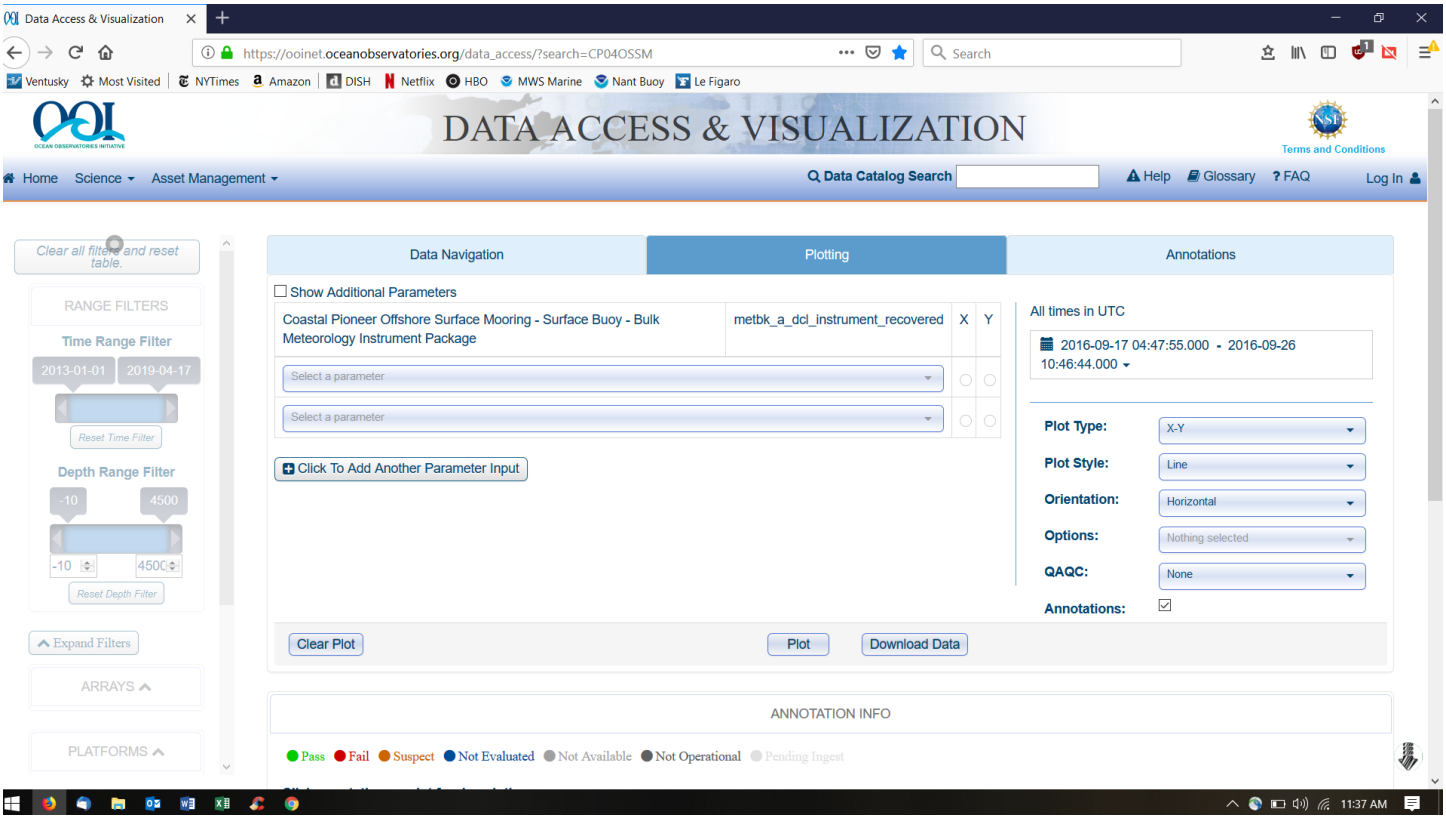
8. Choose a custom range of time to limit the size of the data set



Under start date in the left box choose September 17, 2016 at 04 hours, 47 min, 55 sec

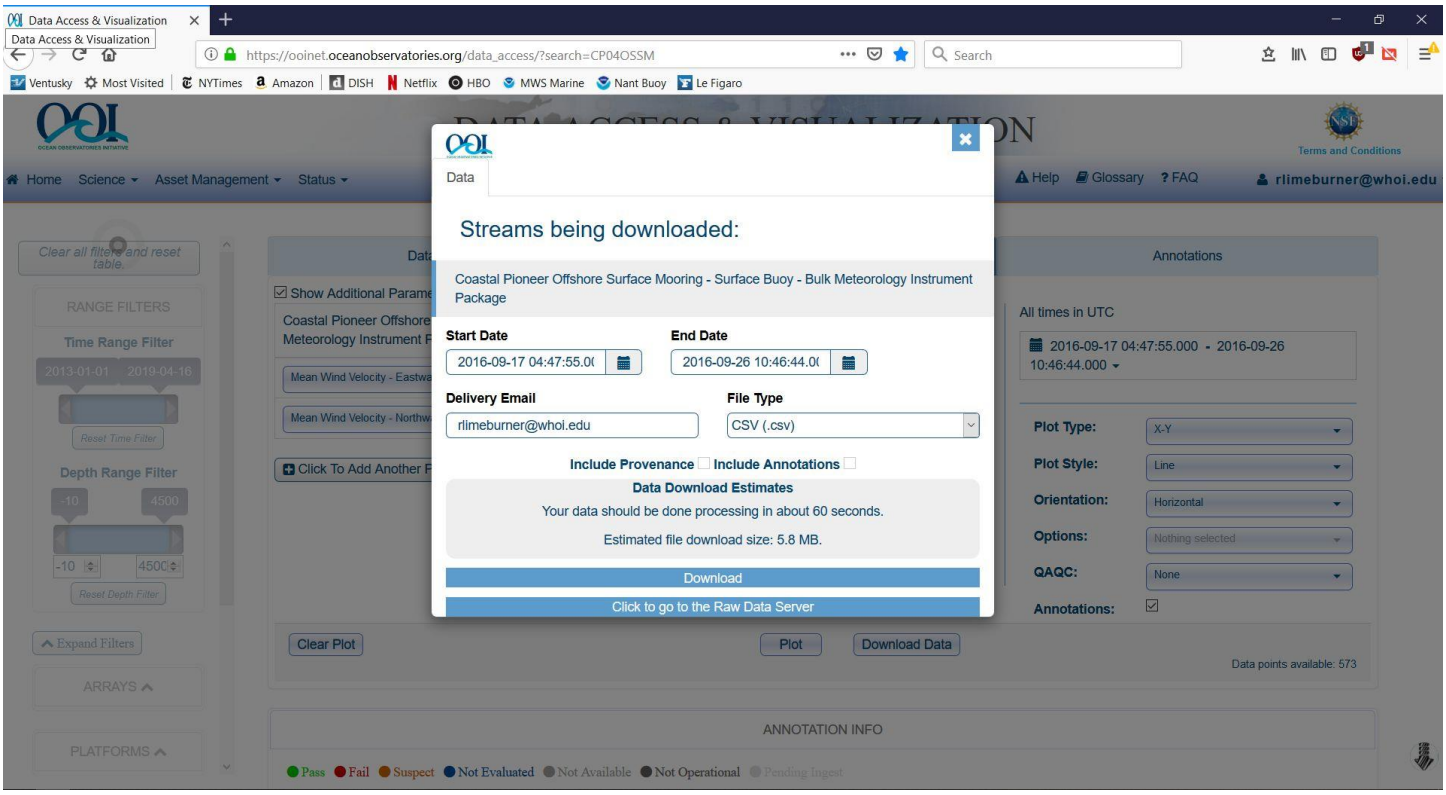
Under stop date in the right box choose September 26, 2016 at 10 hours, 46 min, 44 sec

9. Click the apply button in green.



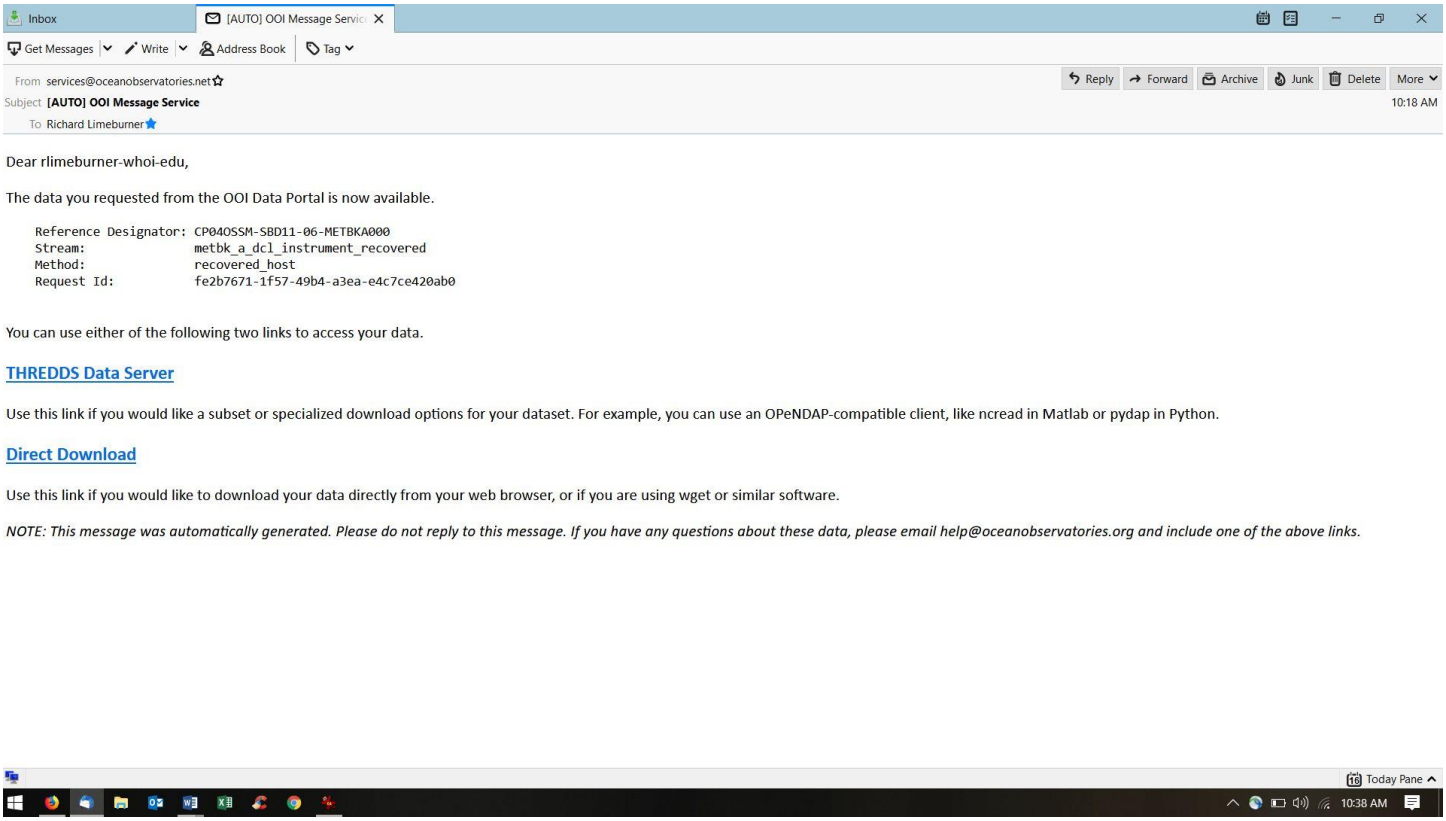
10. Choose under file type CSV.

Note: I downloaded file type *.nc (NetCDF) format because it is binary, more compact data. If you are not familiar with NetCDF then choose CSV (comma separated variable) format that will open up in an MS Excel spreadsheet.



11. Choose download data

A message will state an email will be sent to you in 5-10 minutes with instructions on how to download the data file



Inbox [AUTO] OOI Message Servic

Get Messages | Write | Address Book | Tag

From services@oceanobservatories.net

Subject [AUTO] OOI Message Service

To Richard Limeburner

Reply | Forward | Archive | Junk | Delete | More

10:18 AM

Dear rlimeburner-whoi-edu,

The data you requested from the OOI Data Portal is now available.

```
Reference Designator: CP04OSSM-SBD11-06-METBKA000
Stream:               metbk_a_dcl_instrument_recovered
Method:               recovered_host
Request Id:           fe2b7671-1f57-49b4-a3ea-e4c7ce420ab0
```

You can use either of the following two links to access your data.

THREDDS Data Server

Use this link if you would like a subset or specialized download options for your dataset. For example, you can use an OPeNDAP-compatible client, like ncread in Matlab or pydap in Python.

Direct Download

Use this link if you would like to download your data directly from your web browser, or if you are using wget or similar software.

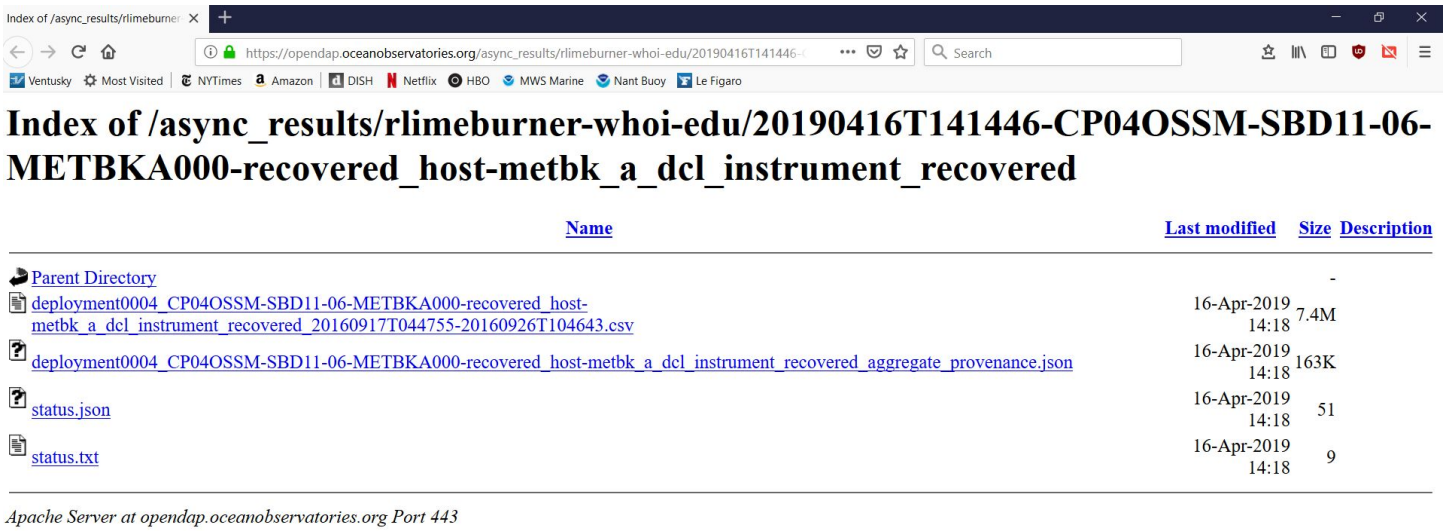
NOTE: This message was automatically generated. Please do not reply to this message. If you have any questions about these data, please email help@oceanobservatories.org and include one of the above links.

Today Pane

10:38 AM

This is the email I was sent.

12. Choose Direct Download and you will received the following link



Index of /async_results/rlimeburner

https://opendap.oceanobservatories.org/async_results/rlimeburner-whoi-edu/20190416T141446-

Search

Ventusky | Most Visited | NYTimes | Amazon | DISH | Netflix | HBO | MWS Marine | Nant Buoy | Le Figaro

Index of /async_results/rlimeburner-whoi-edu/20190416T141446-CP04OSSM-SBD11-06-METBKA000-recovered_host-metbk_a_dcl_instrument_recovered

Name	Last modified	Size	Description
Parent Directory		-	
deployment0004_CP04OSSM-SBD11-06-METBKA000-recovered_host-metbk_a_dcl_instrument_recovered_20160917T044755-20160926T104643.csv	16-Apr-2019 14:18	7.4M	
deployment0004_CP04OSSM-SBD11-06-METBKA000-recovered_host-metbk_a_dcl_instrument_recovered_aggregate_provenance.json	16-Apr-2019 14:18	163K	
status.json	16-Apr-2019 14:18	51	
status.txt	16-Apr-2019 14:18	9	

Apache Server at opendap.oceanobservatories.org Port 443

13. The data can be downloaded by double clicking the 1st file at the top.

If this is too complicated a process to follow, it is possible anyone can access this same raw data file from

https://opendap.oceanobservatories.org/async_results/rlimeburner-whoi-edu/20190416T141446-CP04OSSM-SBD11-06-METBKA000-recovered_host-metbk_a_dcl_instrument_recovered/

I plotted and downloaded the raw data in NetCdf format (*.nc) and the downloaded data file I received from OOI was named (one string of characters):

deployment0004_CP04OSSM-SBD11-06-METBKA000-recovered_host-metbk_a_dcl_instrument_recovered_20160917T044755.753000-20160926T104643.338000.nc

The *.cvs (comma separated variables) asci file (will open in MS Excel file) is named

deployment0004_CP04OSSM-SBD11-06-METBKA000-recovered_host-metbk_a_dcl_instrument_recovered_20160917T044755.753000-20160926T104643.cvs

With the following formats: time is UTC seconds since January 1, 1900; speeds are m/sec; wind and current direction is the direction going towards; directions are relative to true north.

The data used in this report was a subset of the above 2 files. Time was converted to local time (EDST), speeds were converted to kts, the time span was truncated to September 18 at 1200 until September 25 at 1500. Hourly averged data were computed and used for this report.

This name has a lot of information including the:

start time in UTC 20160917T044755.753000 (September 17, 2016 hr 04 min 47 sec 55.753)

stop time in UTC 20160926T104643.338000

This is the source file for all OOI wind and surface current data used in this report.

Note: to download this data file anyone will need to register and login with a free username and password.

The one hour averaged data I created from this dataset is listed in Appendixes 11 and 12.

Appendix 17 – NOAA NEFSC Source of Data uses in this report

All the NOAA Irina surface drifter data for 2016 found on:

https://www.nefsc.noaa.gov/drifter/drift_noaamd_2016_1.csv

To save: right click mouse, choose select all, copy, and paste in an editor and save.

This large data set includes 45,455 lines of drifter data times and positions.

A subset of this large data set is contains data from Irina drifter IDs 165420705 and 165420691 that I used in this report.

For data from Drifter ID 165420705 go to line numbers 28758 thru 31446.

For data from Drifter ID 165420691 go to line numbers 38191 thru 39527.