DriftAlong

User Manual

By *Coastal Measures* LLC

Introduction

DriftAlong is a small passive marine drifter designed for use in coastal environments including bays, estuaries, inlets and low-energy nearshore regions. A Raspberry Pi is at the core of the acquisition electronics and is powered by an easily rechargeable lithium ion battery. A small touch screen displays the DriftAlong GUI through which Users may start and end collections. During collections, a GPS receiver delivers position data and quality measures that are written to a CSV file by the DriftAlong software. On models including a remote connection, an external cellular module and antenna allows users to remotely request DriftAlong's position which is sent to an online Dashboard or as a google maps link to the Users phone as an SMS (text) message.

Contents

Quick Start Guide

1. Make sure all colored plugs **except green** are inserted in their corresponding ports.

2. Turn on the unit by plugging the **green** micro-usb power cord into the **green** port on the **Electronics Module (EM)**.

3. Wait for the **EM** to boot up (<1 minute) and the desktop to display.

4. Use the included stylus or your finger to double click the "**DriftAlong**" icon (yellow buoy) that starts the DriftAlong GUI.

5. Click the green "**START RECORDING**" button to begin recording. Monitor the status bar for GPS information and instructions.

NOTE: Values are written to a file only when a GPS signal is available (Green status bar). If the status bar shows yellow, try moving to a place with clear overhead views.

6. Insert the **EM** into the **External Casing (EC)** and re-seal the casing.

7. When finished collecting data, remove from the EC and hit the red "**STOP RECORDING**" button.

8. Files are saved locally on the **EM** at:

   ~/Desktop/Output/

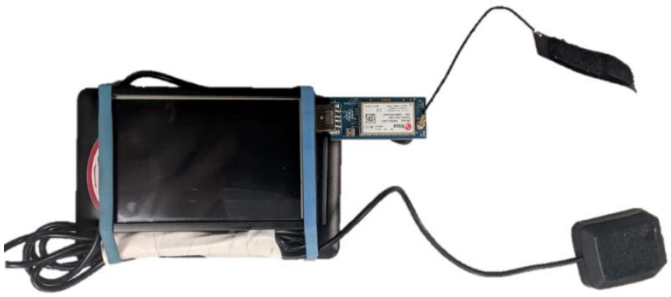
*Note: Files may be transferred from DriftAlong to your computer either remotely over WiFi or manually be using a USB storage device. See '***Retrieving Files from the DriftAlong***' for more information.*

9. Close the DriftAlong GUI and power down the **EM** by clicking the raspberry icon in the upper left and scrolling down to and clicking, "shut down." When the screen goes blank, remove the **green** power cord from the **EM** to preserve power.

Components

A DriftAway is composed of **two** parts:
1) an Electronic Module (EM) that performs all data collection processes and
2) an External Casing (EC) that provides a waterproof shell for marine deployments.

Electronics Module (EM)



Raspberry Pi

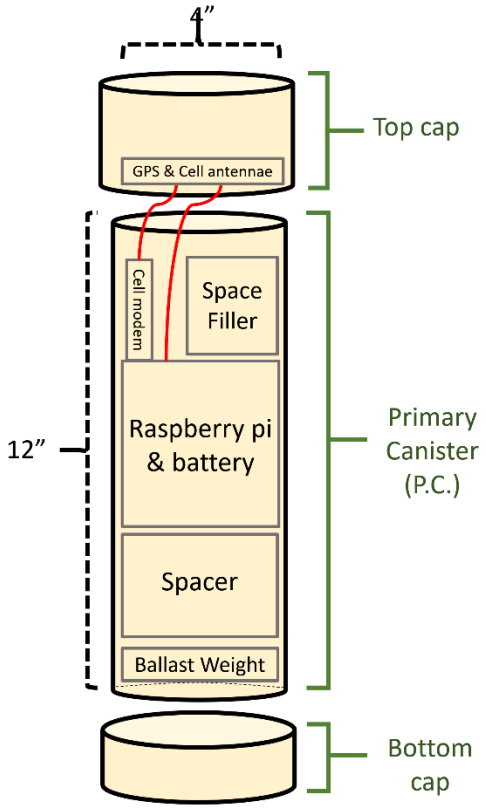
16,750mAh rechargeable lithium ion battery pack

GPS Receiver Antenna

Cellular Module -modem (left) and antenna (right)

LCD touch screen

External Casing (EC)



External Casing Schematic

The Primary Canister of the **EC** is composed of a polyvinyl chloride (PVC) pipe. The Canister is permanently sealed on one end by a PVC Bottom Cap. A ballast weight (lead beads) sits upon Bottom Cap. Above the ballast weight sits a spacer sectioned off by rubber mats. The **EM** sits atop the spacer and the GPS antenna (and optional cellular antenna) stick to the bottom of an internal plastic cap. A rubber Top Cap seals the unit and is held in place by a hose clamp. From end to end, the **EC** is about 14” with a diameter of just over 4”.

User Manual (FULL)

Electronics Module Configuration

1. Check that all components (listed in the components section – pages 4-5) are present.
   NOTE: The Raspberry Pi is within the black **EM***, underneath the LCD screen.*

2. Without separating the **battery** from the rest of the **EM**, charge the **battery** pack via a microUSB plug. You may use the included power cord (**green**) or any other charge capable micro-USB cord. Blue lights across the battery will indicate charge level. Charge up to 8 hours until all four blue lights on the **battery** remain permanently lit (not-blinking).

3. If not already, insert the **green** USB plug into the **green** USB port on the **battery**. Do NOT plug the other end into the **EM** yet!

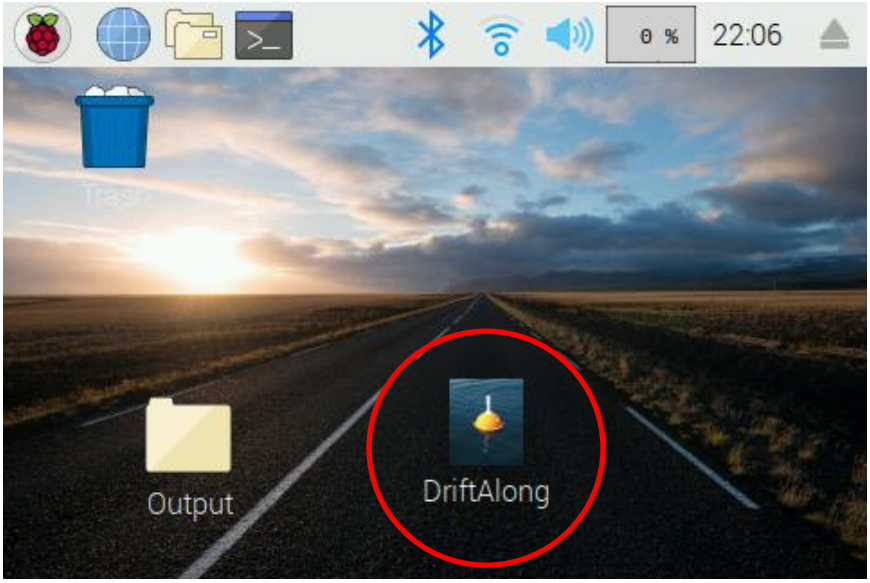
4. Make sure the **blue** USB plug (GPS antenna) is plugged into the **blue** USB port on the **EM**.

5. IF you are using a unit with a **cellular module**, make sure its USB plug (**yellow**) is plugged into the **yellow** USB port on the **EM**.

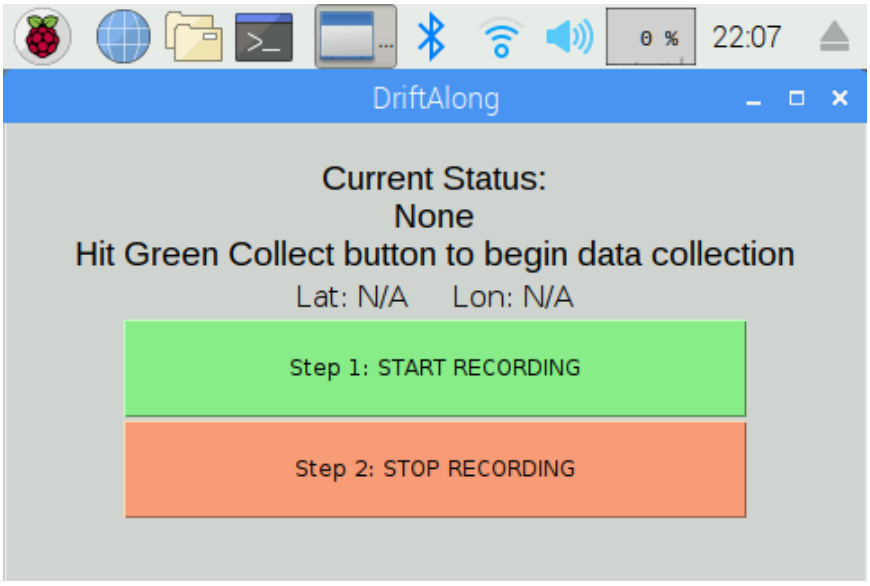
6. Plug the **green** microUSB plug into the **green** micoUSB port on the **EM**. At this point, the screen on the **EM** should power on and display a booting sequence. This should take less than one minute, after which a desktop will be displayed.

Using the DriftAlong Software

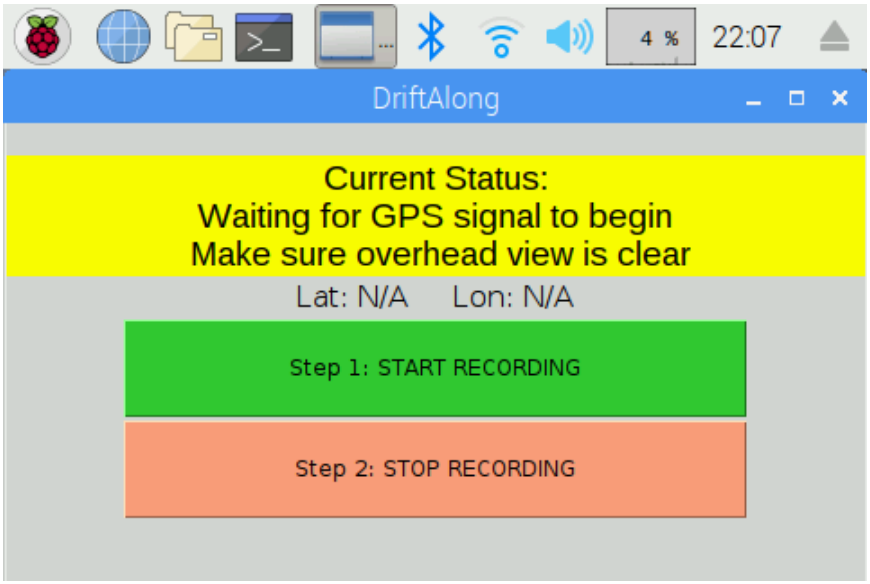
1. Double click on the DriftAlong icon on the desktop (circled here in red). The touch screen is capacitive (pressure sensitive), so the included stylus or the non-marking end of a pen may make interacting with the screen easier.



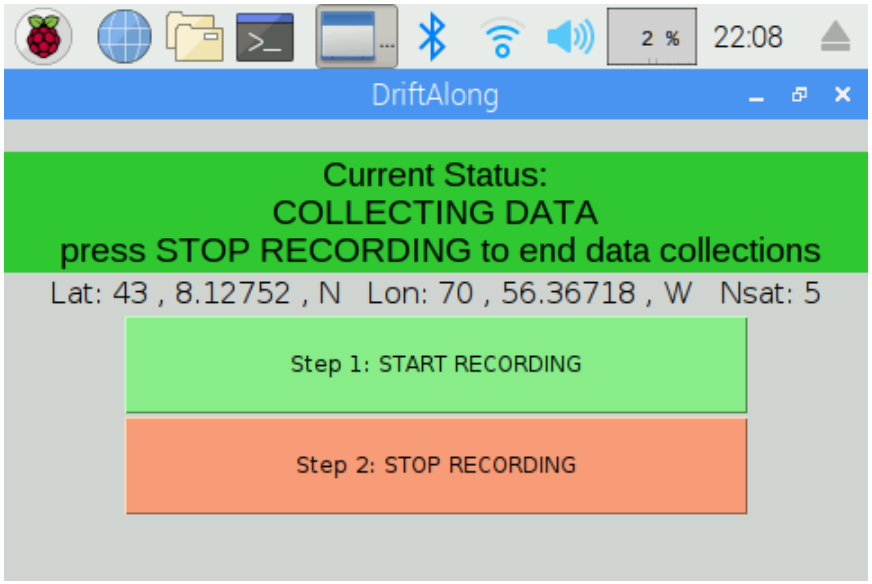
2. The DriftAlong GUI should start up and show the current status (None) as well as a green button to start a collection and a red button to stop a collection.



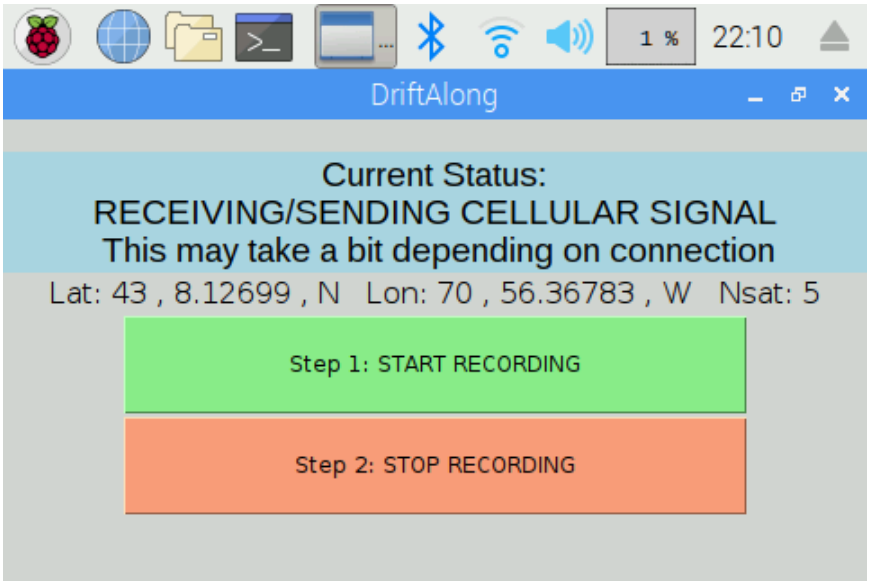
3. Push the START RECORDING button to start recording positions to a file. If the GPS antenna is not able to receive a signal from GPS satellites, the status will turn yellow and report this. Make sure there is a clear view to the sky above the antenna, preferably away from trees and buildings.



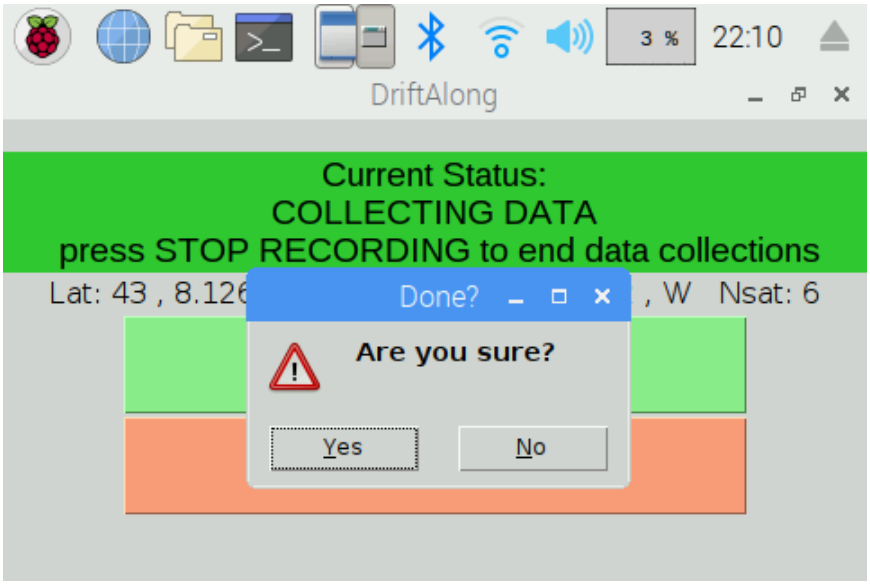
4. Once the unit obtains a GPS signal, the status will turn green and the Latitude and Longitude will begin to update in the status window, along with the number of satellites currently being used to obtain that position. If the unit loses its GPS signal, the status window will again switch to yellow and temporarily stop recording positions until it again has a GPS signal.

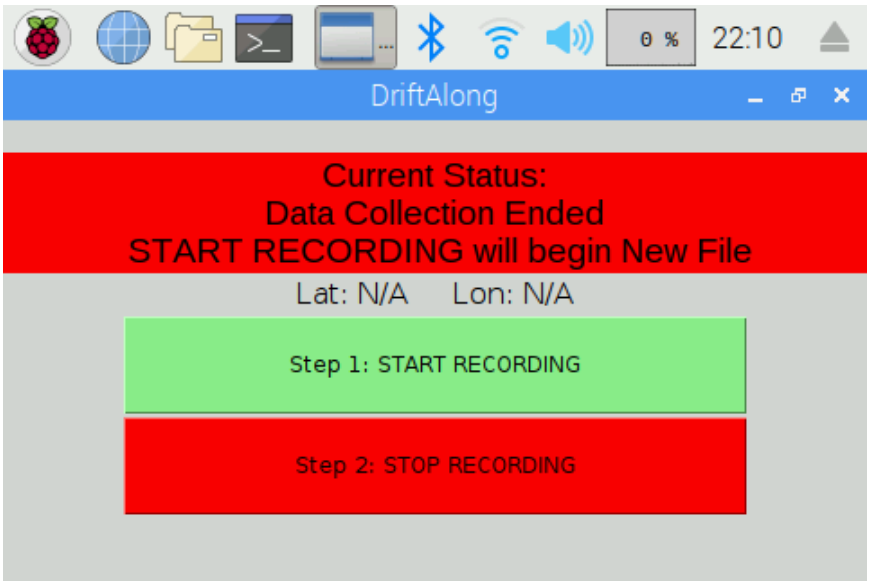


5. IF using a **cellular module**, the status window will turn light blue and indicate when the unit is receiving and sending a message (details on this process to follow in section "**Using your Cellular Module**"). The unit stops recording positions for this time, generally only a few seconds.

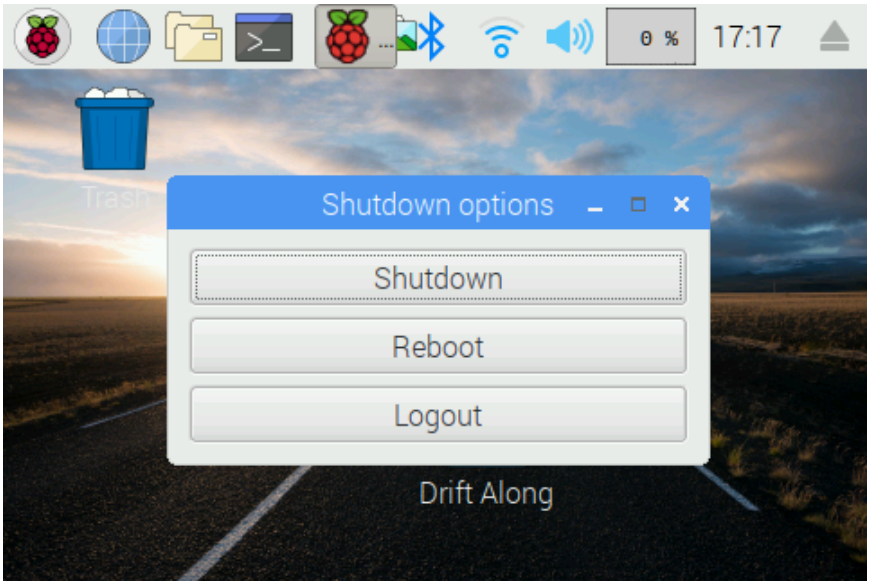


6. Once the desired collection is complete, push the STOP RECORDING button to end the file. You will be prompted with an "Are you sure?" so that you don't accidently end a file. If you are, hit yes and the file will be closed, and the status window will turn red. A new file can be started by again hitting the green START RECORDING button.





7. Once finished using DriftAlong, shut down the **EM** by pressing the raspberry icon in the upper left, navigating to the bottom of the menu and pressing "shutdown". Hit "Shutdown" in the popup menu. Once the **EM** has finished shutting down (the screen will go blank white), unplug the **green** micro USB from the **EM** to preserve battery power.



Cellular Connection

DriftAlongs equipped with a cellular module may be remotely queried for their position if cellular service is available. Communication occurs through a third-party called Hologram that developed the cellular module and provides an easy online dashboard through which to monitor DriftAlong.

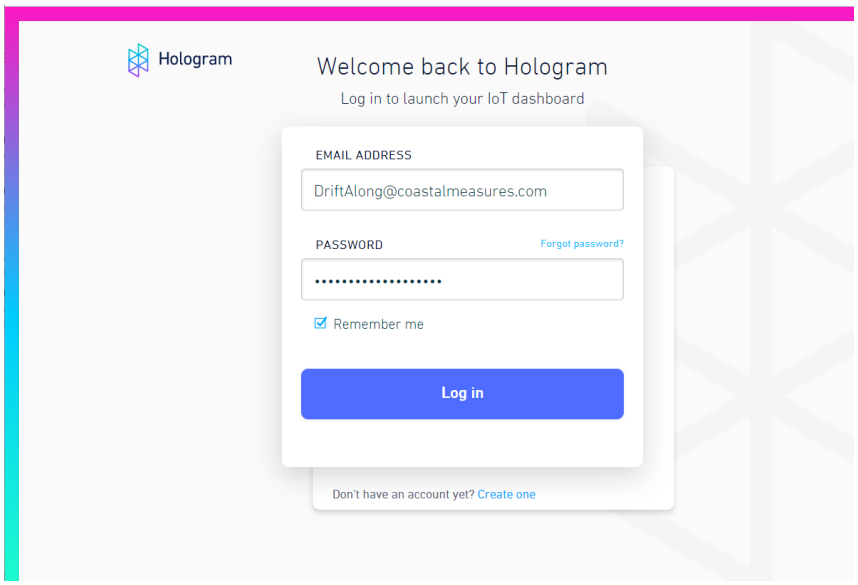
If you have not yet set up an account with Hologram, you may do so through their webpage:

hologram.io

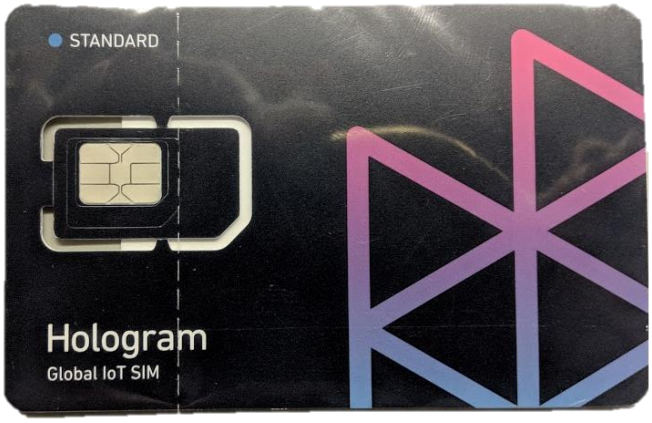
1. In the upper right hand corner, click “Dashboard”

2. If you have not created an account, click on “Create One”

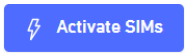
3. Once you have created an account, sign in with your email address and password



4. Once logged into the hologram Dashboard, you will need to activate the SIM card for your cellular module (included).

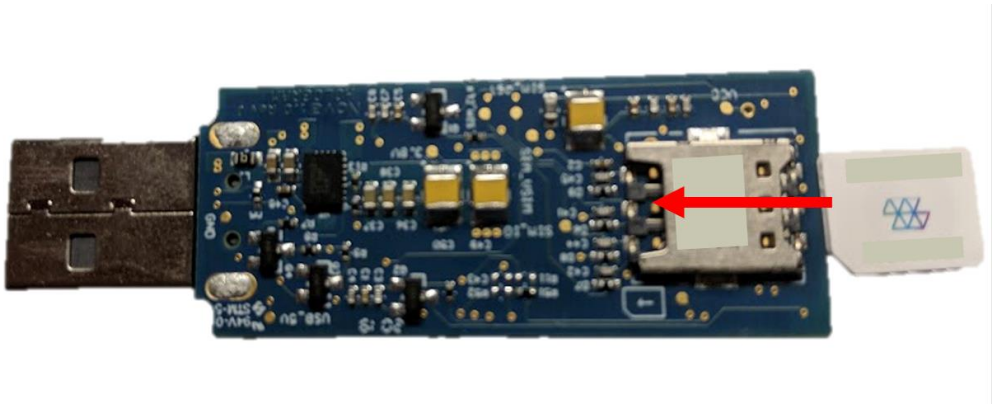


5. Pop the SIM card out of the larger card. There are three size options included: Mini, micro and nano. Break off the pieces until you are left with the smallest possible SIM card configuration (nano).

6. On The Hologram Dashboard, click the 

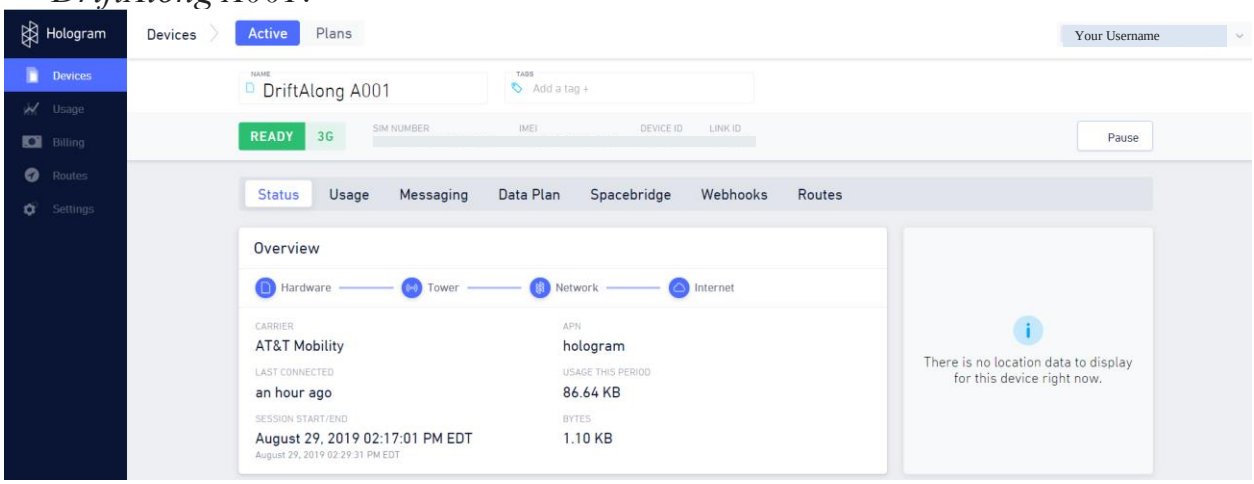
button and follow the onscreen instructions to activate your SIM.

7. Once activated, insert your SIM card into your cellular module with the active side (reflective) facing the cellular module and the side marked with the Hologram logo facing away. Push the SIM in until it goes no further. Do NOT apply excessive force if the SIM does not immediately slide in, but instead check to make sure it is oriented correctly.



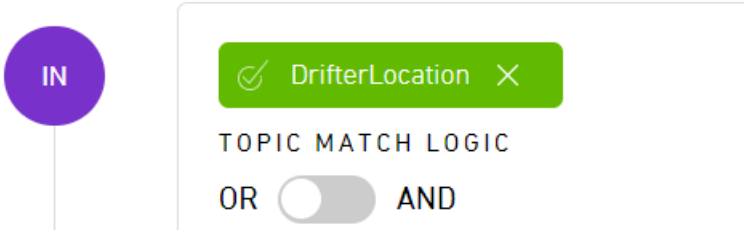
8. Insert your cellular module into your Primary Unit in the upper right USB receptacle (it does not need to be this receptacle, but it is the preferred configuration).

9. Return to the Hologram Dashboard and follow the instructions to set up your device, preferably changing its name to your DriftAlong's name, *ie DriftAlong A001*.

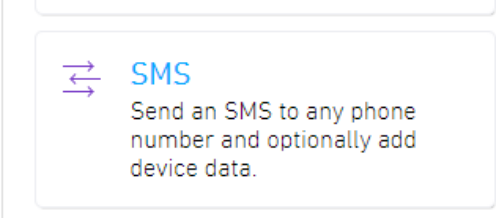


10. If you would like to receive position updates via SMS (text message), click on your newly setup device. Click on "Routes," then "Add Route."

11. Under Topics, add "DrifterLocation" with no spaces as shown.



12. In the "Out" section, click SMS..



13. Add a phone number where indicated with a plus sign (+) and your country code preceding your full phone number. Leave the Message area blank. Click “Update Route.”

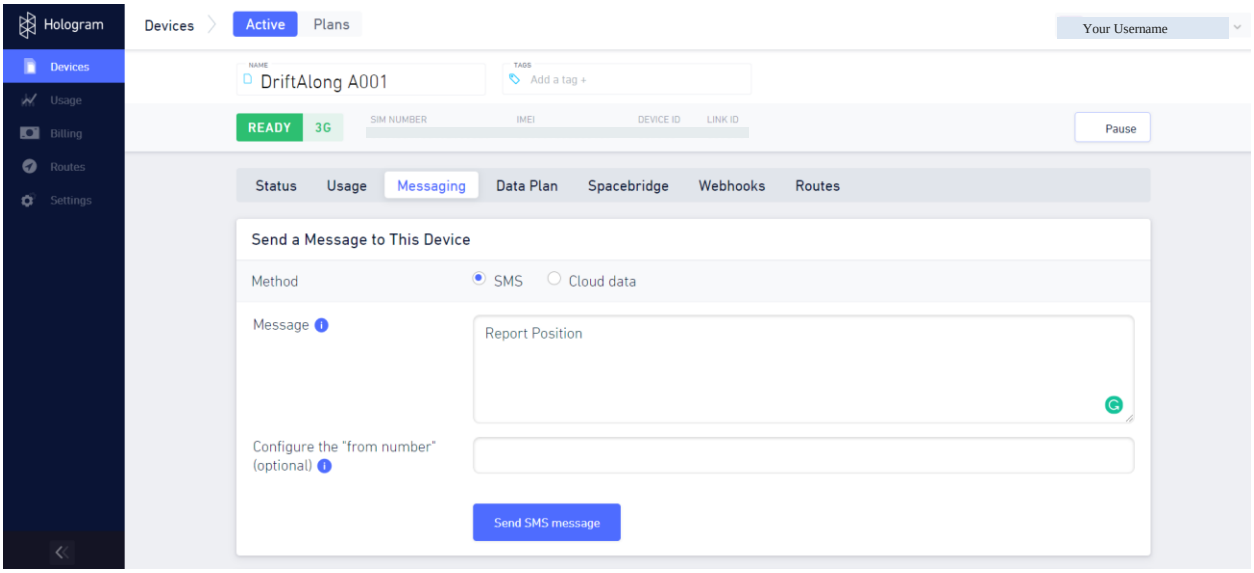
14. Start your DriftAlong as indicated in the sections “Electronics Module Configuration” and “Using the DriftAlong Software.”

15. If your cellular module is working, a small blue light on the cellular modem will either blink slowly to indicate a 2-g connection or rapidly to indicate a 3-g connection.

16. Start a Collection.

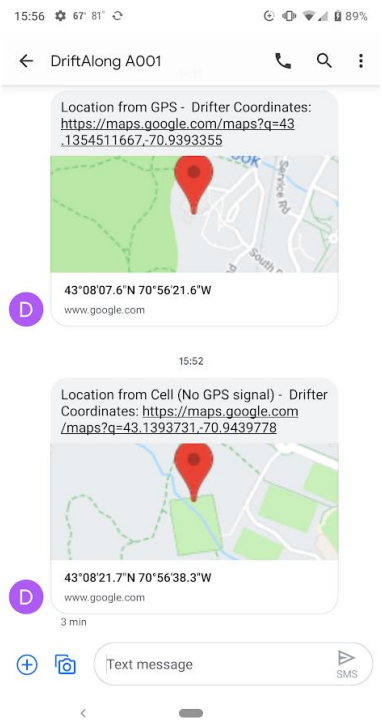
17. Return to the Hologram Dashboard. Click on the device you intend to communicate with. Click on “messaging” and within the Message box, enter “Report Position.” Click, “Send SMS message”

    Note: Currently, any message will direct DriftAlong to report its position, but it is good practice to use this message as future software updates may allow for DriftAlong to provide different information depending on the message received:



18. If you set up the route correctly, you should receive a text message within a minute on the phone number you indicated. If DriftAlong has a GPS connection, it will include a link to Google Maps with the location of your

DriftAlong. In the unlikely case your DriftAlong does not have a GPS connection but does have a cell connection, you will receive a Google Maps link with the location of the cellular tower currently closest to your DriftAlong. Either way, the source will be indicated in the text message.



Other Notes:

- The position message may also be viewed in the Hologram Dashboard by clicking “All activity” at the bottom of the desktop site.
- Your included SIM card is on the Pilot Plan that provides 1MB of data per month at no additional charge. This is approximately 1500 messages, not including messages send to DriftAlong via the Dashboard interface.
- You will need to add a credit card to your Hologram account in case you exceed your free data plan, at which point you are charged $0.60 per MB.
- Once you have set up your Hologram account, multiple devices may be added and communicated with through that single account.

Marine Deployments

The External Casing provides a watertight and properly weighted canister for DriftAlong to be deployed to marine environments. Carefully follow these instructions to increase the likelihood of a successful deployment.

1. Open the **EC** by loosening the hoseclamp over the rubber top cap.

2. Remove the Rubber top cap. Place to the side and avoid dirt or dust that may compromise the seal.

3. Pull off the internal cap (white), using a plyers on the tab if necessary.

4. Start a collect (section **Using the DriftAlong Software**) and insert the **EM** as shown.

5. Make sure the internal whitecap is covered along its internal edge by plumbers' tape.

6. Carefully attach the GPS antenna and (if included) cellular antenna to the corresponding Velcro points on the bottom of the internal cap as you place the cap on top.

7. If you suspect there may be dust along the inside of the rubber cap, wipe thoroughly with KIM wipes. Add O-ring grease carefully along the 2 built-in O-Rings on the rubber cap, spreading thinly and evenly.

8. Replace the rubber cap on the Casing and firmly (but not overly forcefully) tighten the hoseclamp in place.

Retrieving Files from the DriftAlong

While it is possible to use a manual drive to transfer data from a DriftAlong to another computer, remote methods are much preferred owing to USB permission issues often existing between different operating systems.

Remote Transfer Instructions:
Secure Copy (scp) is a network protocol that allows files to be transferred directly from a remote host (such as your **EM**) to your local host (such as your computer).

If you are using a *WINDOWS* operating system, you must first install a program called **Putty** (available for free at https://www.putty.org). From here, the procedure is very similar for Mac, linux and windows computers.

1. If the DriftAlong GUI is open on your **EM**, close it by clicking the "x" in the top right corner.

2. Connect your Primary Unit to the WiFi network your computer is on by clicking the "" logo in the top information bar. If necessary, follows the prompts to enter the network's passcode.

3. Once connected to the same WiFi network as your computer, open a terminal window by clicking the black terminal icon () in the top information bar. Resize as necessary to fit the terminal window within the screen.

4. In the terminal, type "ifconfig" and hit enter.

5. The Primary Unit will report network information. Find the lines that reads, "inet" followed by a number which is the **EM**'s IP address.

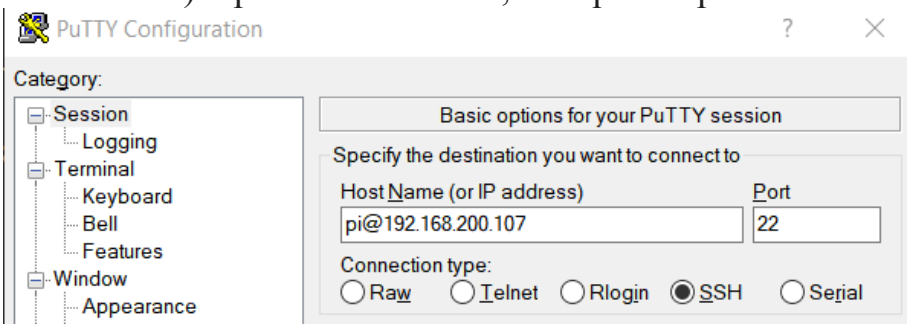
```
inet 192.168.200.107
```

Note: This is likely to remain the same when using the same network for follow up transfers.

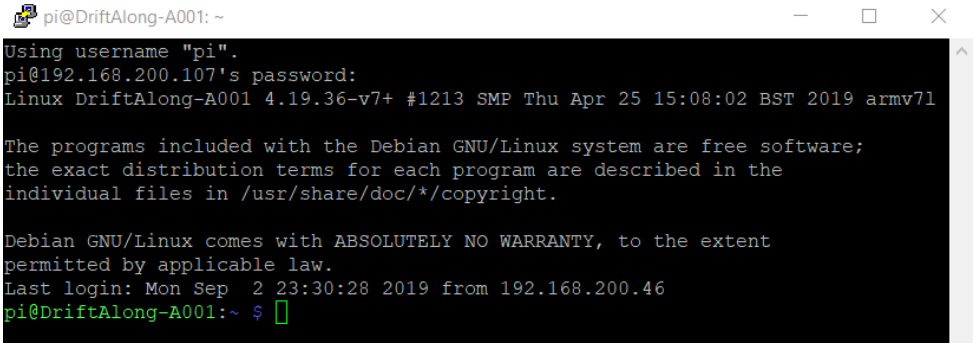
6. Before copying files, you may sign directly into your DriftAlong to see which files are there. This can be done from a *MAC* or *LINUX* using **ssh** (secure shell) protocol with the **EM**'s information:

   Username: **pi**
   IP address: **obtained from 'ifconfig'** (step 5)
   Password: **CoastalMeasures**

If you are using a *WINDOWS* computer, open the **Putty** program you installed and enter **pi@** followed by the IP address of your **EM** in the Host Name (or IP address) input area as shown, then press open



Enter the password (CoastalMeasures) and you will see a shell just like what would be reached using ssh.



7. From here, you may navigate to the output located at the directory '*/home/pi/Desktop/Output/'* using basic linux shell commands. See Appendix A or check out https://maker.pro/linux/tutorial/basic-linux-commands-for-beginners

8. To copy these files to your local computer, return to your computer's shell or command prompt. Type scp (or pscp for windows), a space, the address of the files you want from the remote host (the **EM**) and the location you want them to be transferred to on your computer. Then enter your **EM**'s password.

```
 UserName@Computer:~$ scp pi@192.168.200.107:/home/pi/Desktop/Output/* .
pi@192.168.200.107's password:
DriftAlong_A001_20190830_125207.csv                    100%   14KB  14.3KB/s   00:00
DriftAlong_A001_20190830_125512.csv                    100%  792     0.8KB/s   00:00
DriftAlong_A001_20190831_152506.csv                    100%  716KB 716.1KB/s   00:00
DriftAlong_A001_20190831_175420.csv                    100% 4134     4.0KB/s   00:01
DriftAlong_A001_20190831_222456.csv                    100% 8074     7.9KB/s   00:00
```

In this example, the "*" indicates that all units at this location will be transferred, and the "." at the very end means they will be transferred to your current directory.

Alternative for Windows

On windows, WinSCP may also be used to transfer files using a GUI and is perhaps the easiest way to keep track of files between your computer and the **EM**. WinSCP is available for free here:

https://winscp.net/eng/index.php

Data Files

The DriftAlong data files are generated automatically when the "start collection" button is pressed on the DriftAlong GUI and the first GPS signal is received. The files are named according to this convention:

DriftAlong_L###_YYYYMMDD_HHMMSS.csv

Where: -*L###* is the preassigned name of the drifter and L is a letter and # are numbers

And the remaining values indicate the time the file is started:
- *YYYY* is the year
- *MM* is the month
- *DD* is the day
- *HH* is the hour
- *MM* is the minute
- *SS* is the second

The data files are "comma separated value" files which may easily be read by many programs including Microsoft excel, notebook, wordpad, etc.

The format of files includes 1 header row indicating which each column is:

```
Day,Month,Year (-2000),hour,minute,second,Lat Deg,Lat Min,Lat Hem,Lon Deg,Lon Min,Lon Hem,Altitude,N Satellites,HDOP,VDOP,PDOP
```

Where:

Day is the GPS day
Month is the GPS month
Year is the GPS year minus 2000. (ie: 2019 would be 19)
Hour is the GPS hour
Minute is the GPS minute
Second is the GPS second
Lat Deg is the degree of latitude
Lat Min is the minutes of latitude
Lat Hem is the hemisphere (ie N or S)
Lon Deg is the degree of longitude
Lon Min is the minute of longitude
Lon Hem is the hemisphere (ie E or W)

Altitude is the altitude relative to the Geoid
N satellites is the number of satellites used for each location
HDOP is the horizontal dilution of precision
VDOP is the vertical dilution of precision
PDOP is the combined dilution of precision

Data files may be quickly read into the Matlab environment using the code: "ProcessDriftAlongCSV.mat" This code may be found online at CoastalMeasures.com or on your **EM** in the directory:

/home/pi/DriftAlong/matlab

Directions on how to use these programs are included in the beginning of the programs. Data will be stored in a structure with the name of your DriftAlong:

```
Name                Size              Bytes  Class     Attributes

DriftAlong_A001     1x1              875120  struct
```

Appendix A

Basic Linux terminal interaction

When interacting with a computer running a version of Linux through the terminal (like the Primary Unit of the DriftAlong), there are just a few commands necessary to navigate:

pwd – Stands for "Print working Directory" and prints your working (or current) directory to the screen.

```
UserName@Computer:~/DrifterExamples$ pwd
/home/jlhumbe/DrifterExamples
UserName@Computer:~/DrifterExamples$
```

ls – Stands for "list" and lists the contents of the current directory you are in.

```
UserName@Computer:~/DrifterExamples$ ls
IamAtestFile01.txt  IamAtestFile02.txt
UserName@Computer:~/DrifterExamples$
```

cd – Stands for "change directory" and requires an argument. If you are in the directory "DriterExamples" and want to change to the sub directory, "DriftData", for example, it would look like:

```
UserName@Computer:~/DrifterExamples$ ls
DrifterData  IamAtestFile01.txt  IamAtestFile02.txt
UserName@Computer:~/DrifterExamples$ cd DrifterData/
UserName@Computer:~/DrifterExamples/DrifterData$
```

If you wanted to move back up a directory to "DrifterExamples" you use '..' to indicate moving up a level. This may be used multiple times individually or together to move up multiple layers:

```
UserName@Computer :~/DrifterExamples/DrifterData$ cd DriftAlongSubDir01/
UserName@Computer :~/DrifterExamples/DrifterData/DriftAlongSubDir01$ mkdir DriftAlongSubDir02
UserName@Computer :~/DrifterExamples/DrifterData/DriftAlongSubDir01$ cd ..
UserName@Computer :~/DrifterExamples/DrifterData$ cd ..
UserName@Computer :~/DrifterExamples$ cd DrifterData/DriftAlongSubDir01/DriftAlongSubDir02/
UserName@Computer :~/DrifterExamples/DrifterData/DriftAlongSubDir01/DriftAlongSubDir02$ cd ../../..
UserName@Computer :~/DrifterExamples$
```

Appendix B

Product Quality Measures

As a GPS signal receiver, the quality of data produced by DriftAlong depends primarily on the number and satellites available and the directness through which those signals are received. In general, DriftAlong will perform best when it has a clear and uninterrupted view of the sky which is generally the case over water. Trees and buildings nearby may block or reflect satellite signals that leads to a reduction in available satellites and potentially 'multi-path' artifacts that decrease the accuracy and precision of DriftAlong data.

DriftAlong was field tested in an open and exposed field for 3 hours relative to a known benchmark position. Field tests were conducted both with the IU exposed and with the IU inside the EU as it would be during a deployment. As can be seen in Figures *** and ***, the precision and accuracy of DriftAlong is reduced when using the EU. This is expected and can be attributed to the distortion of satellite signals through the EU cap.

In the he field test with the GPS receiver exposed, DriftAlong acquired positions over 3-hours with a standard deviation of 22.4cm relative to its own mean position and 27.8cm relative to the known position. The RMSE of the signal was 51.2cm.

In the field test with the IU inside the EU, as it would be in a marine deployment, the standard deviation increased to 40.4cm relative to its own mean position and 61.0cm relative to the known position. The RMSE increased to 140.5 relative to the known position. These increases are associated with the DriftAlong cap and while there appears to be a relative constant offset in this field test, the offset would be likely to change during a mobile deployment and so may not easily be accounted for.

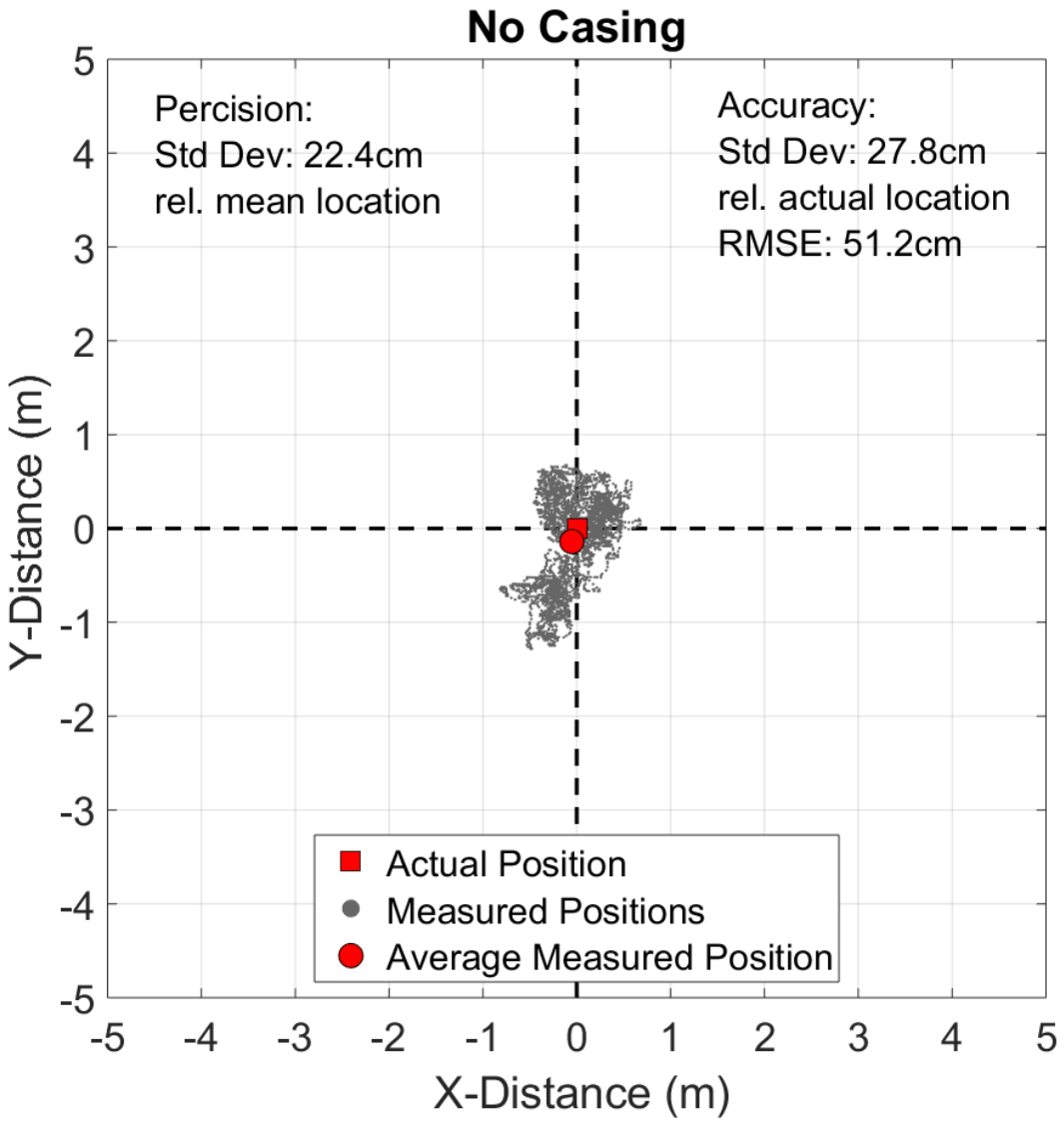


Figure 1: Results from a 3-hour field test with the GPS receiver exposed. Individual position measurements (gray) and the averaged measured position (red circle) are shown relative to the known position (red square). The standard deviation is 22.4cm relative to the mean position and 27.8 relative to the known position.

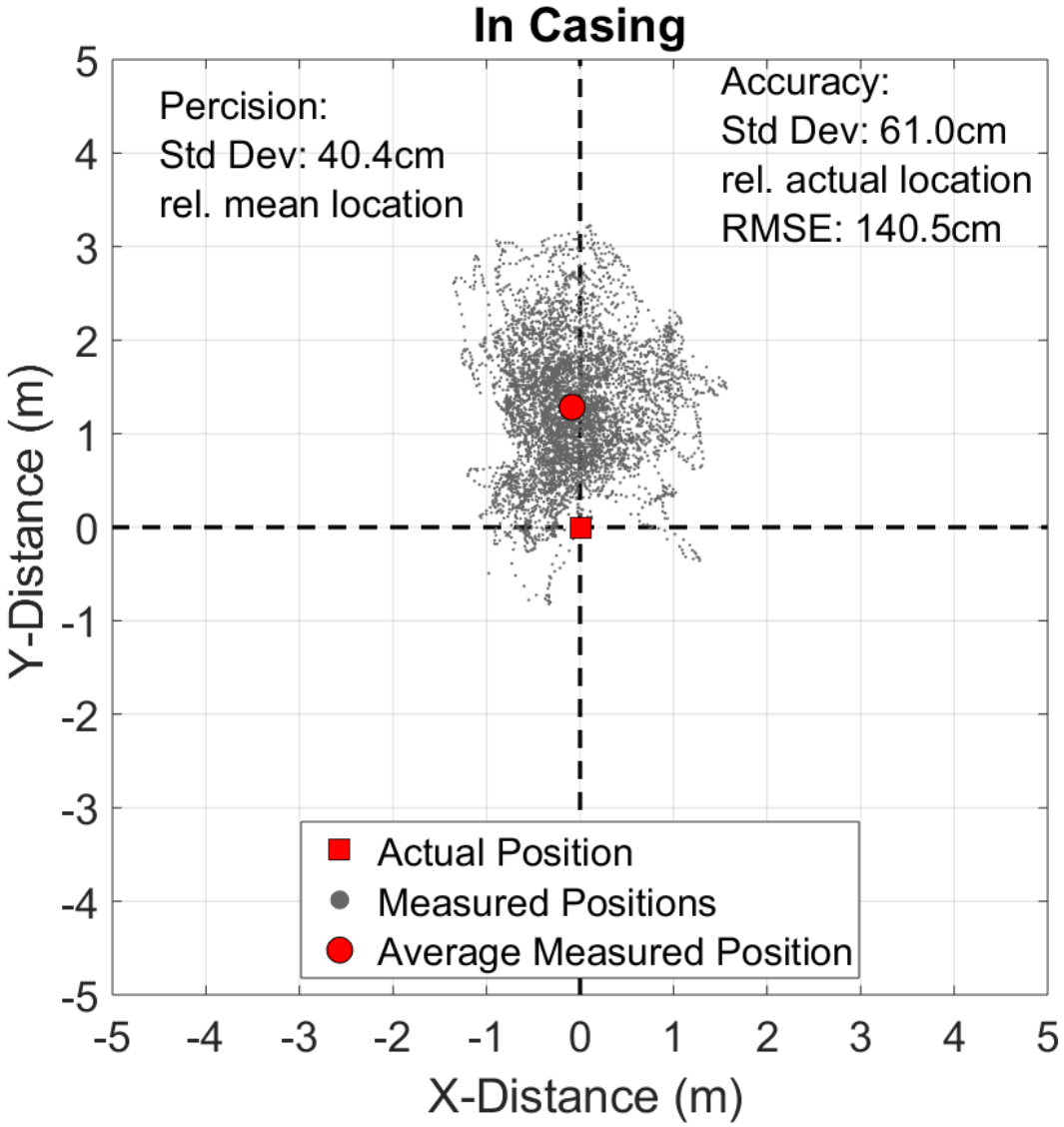


Figure 2: Results from a 3-hour field test with the GPS receiver within the Casing. Individual position measurements (gray) and the averaged measured position (red circle) are shown relative to the known position (red square). The standard deviation is 40.4cm relative to the mean position and 61.0 relative to the known position.

NOTES: