

# Ocean Drifter Challenge

**MIT Portugal Marine Robotics Summer 2023**

## **Competition:** Accurately predict drifter location

Working in a team of 4

Design, build and deploy a  
biodegradable\* ocean drifter

Predict and track drifter  
location

\*excluding the electronics

## **Competition:** Accurately predict drifter location

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Design, build and deploy a  
biodegradable\* ocean drifter

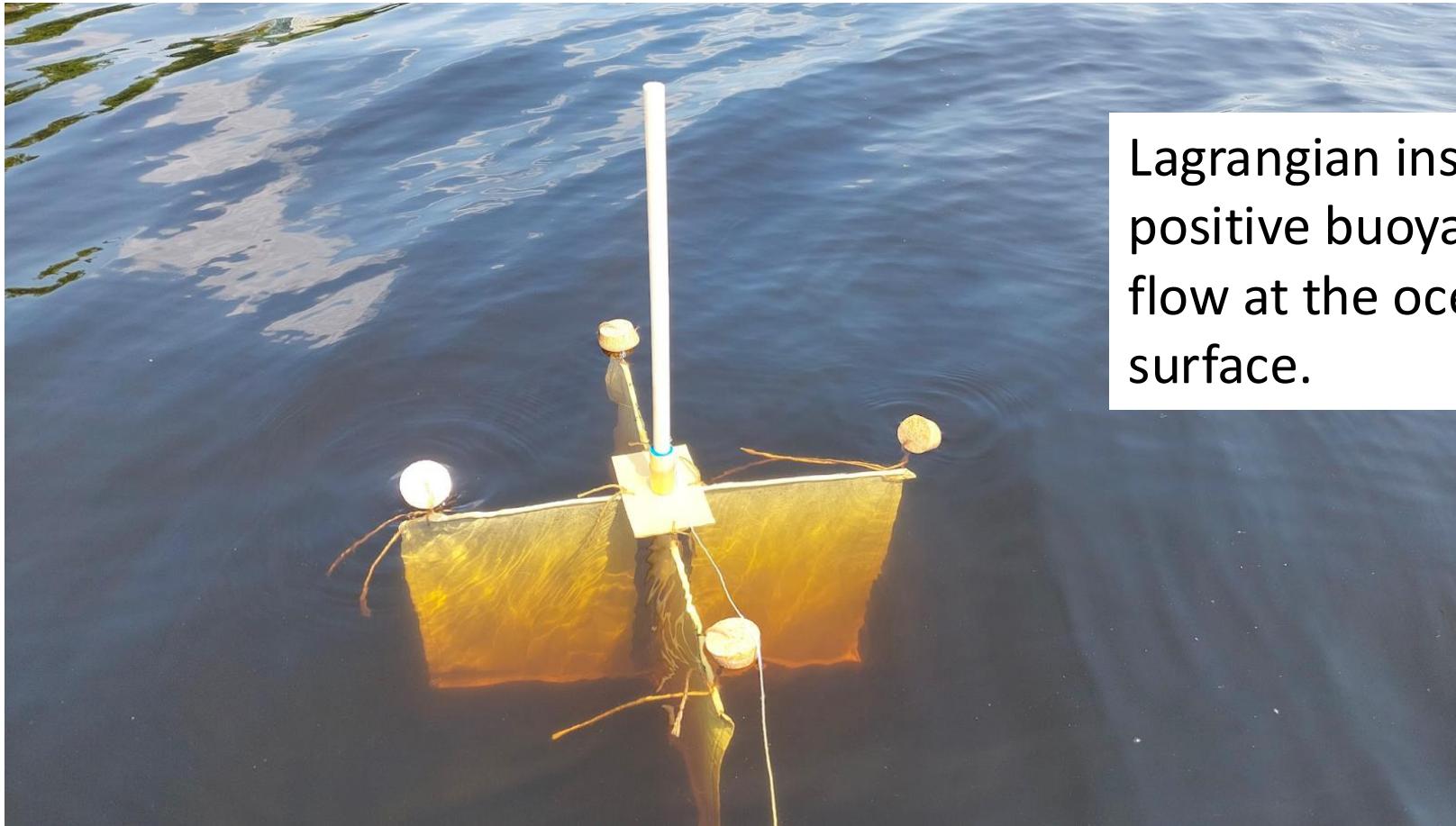
Predict and track drifter  
location

Learning from each other

Share your knowledge and  
skill

## Background - History of drifters

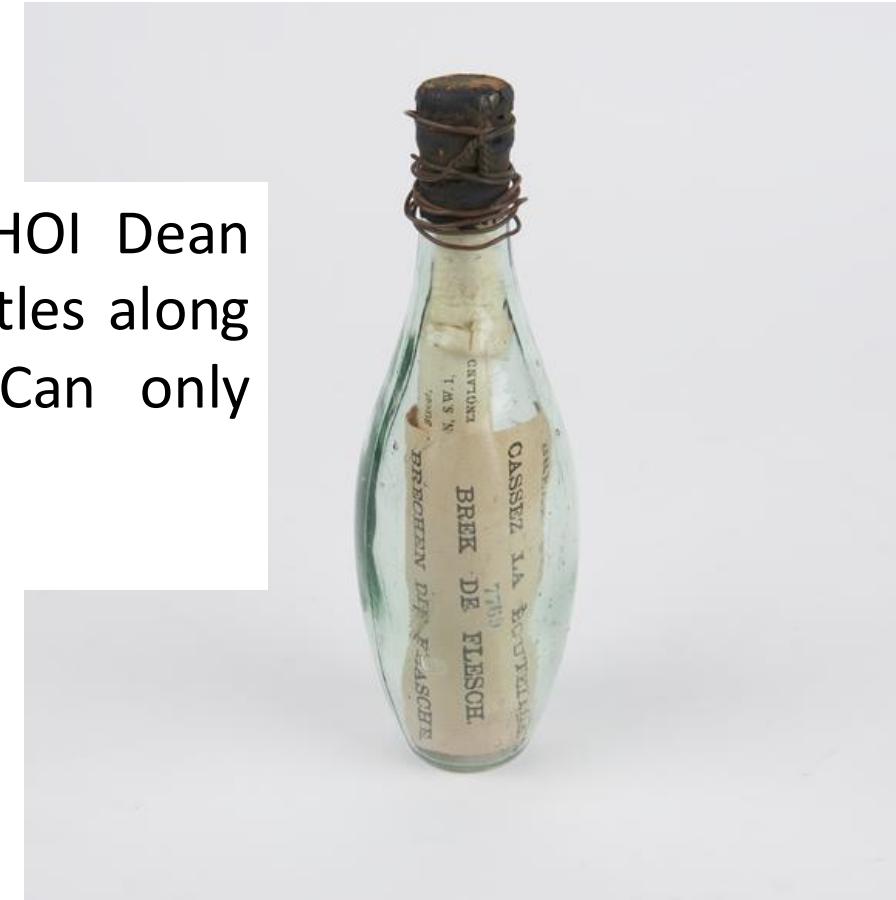
Drifters float and floats sink.



Lagrangian instrument with positive buoyancy, follow the flow at the ocean surface or near surface.

# Background - History of drifters

Message in a drifting bottle. WHOI Dean Bumpus release over 300,000 bottles along US East Coast 1956 to 1972. Can only measure end to end locations.



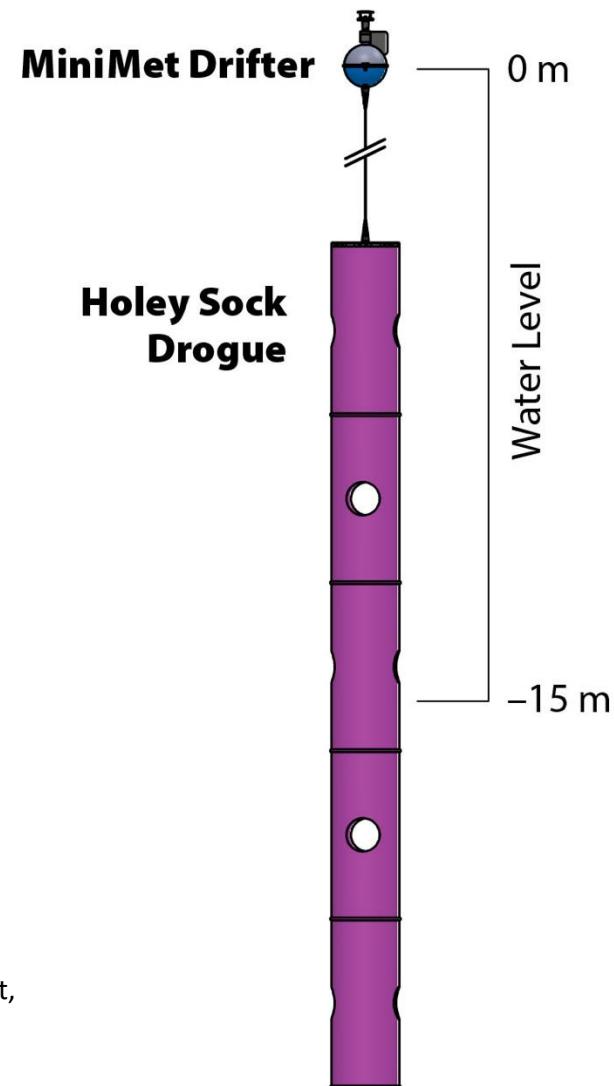
## The first ocean drifter

# Background - History of drifters

Surface Velocity Program (**SVP**) Drifter developed by AOML.

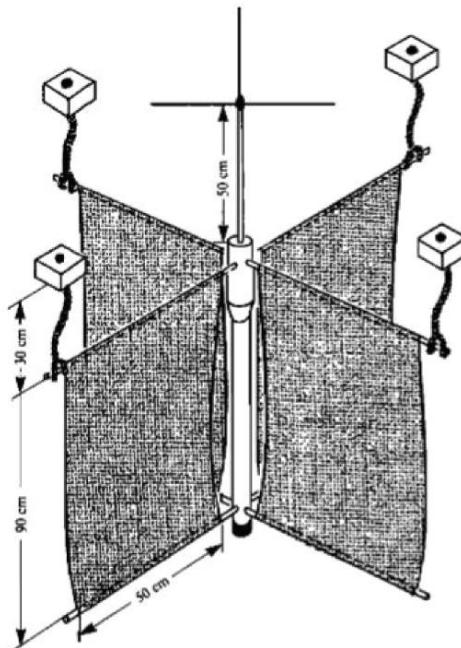


Lumpkin R, Pazos M. 2007. Measuring surface currents with Surface Velocity Program drifters: the instrument, its data, and some recent results. In Lagrangian Analysis and Prediction of Coastal and Ocean Dynamics, ed. A Griffa, AD Kirwan, A Mariano, T O'zgo'kmen, T Rossby, pp. 39–67. Cambridge, UK: Cambridge Univ. Press



# Background - History of drifters

## Costal Ocean Dynamics Experiment surface drifter (**CODE**) Drifter



Davis, R.E. 1985. Drifter observations of coastal surface currents during CODE: The method and descriptive view. *Journal of Geophysical Research* 90(C3):4,741–4,755, <https://doi.org/10.1029/JC090iC03p04741>.

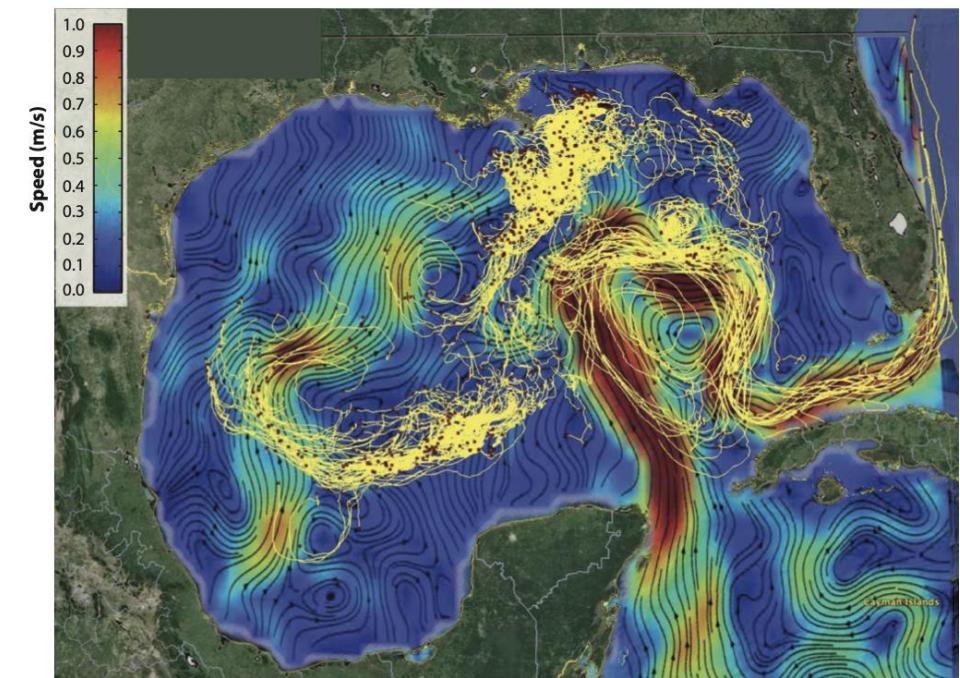
## Robotic Embedded System Laboratory (**RESL**) Drifter



Jnaneshwar Das, Frederic Py, Thom Maughan, Tom O'Reilly, Monique Messié, John Ryan, Kanna Rajan and Gaurav S. Sukhatme. "Simultaneous Tracking and Sampling of Dynamic Oceanographic Features with AUVs and Drifters". In 12th International Symposium on Experimental Robotics, 2010 (ISER 2010), Dec 2010.

# Background - History of drifters

Injection molded biodegradable Lagrangian Submesoscale Experiment (**LASER**) drifter. Trajectories of LASER drifters in the Gulf of Mexico superimposed on surface current.



Novelli, Guillaume, et al. "A biodegradable surface drifter for ocean sampling on a massive scale." *Journal of Atmospheric and Oceanic Technology* 34.11 (2017): 2509-2532.

# Background - History of drifters



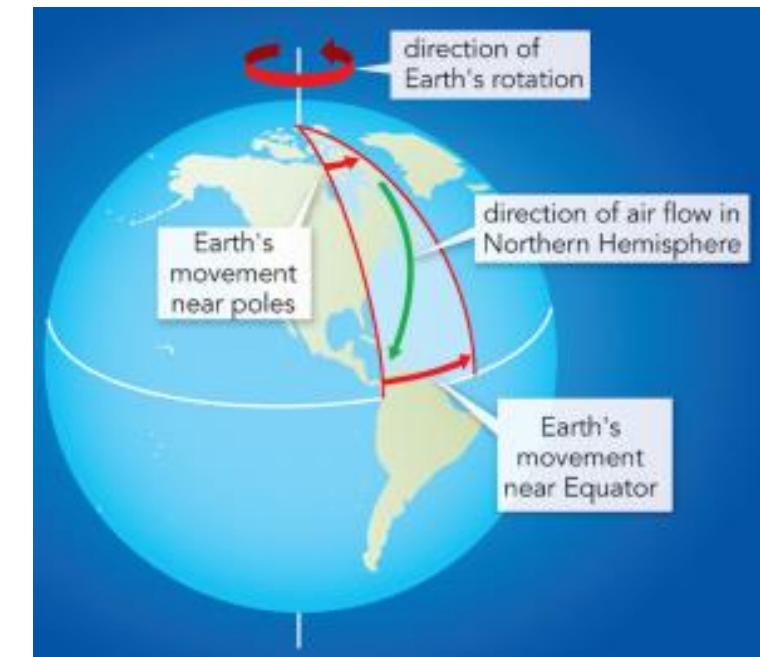
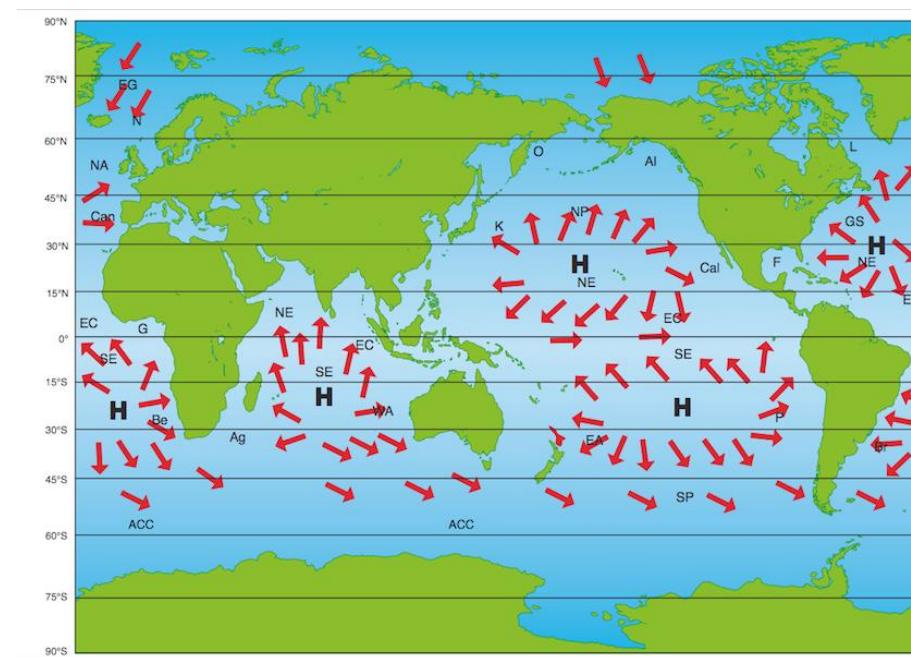
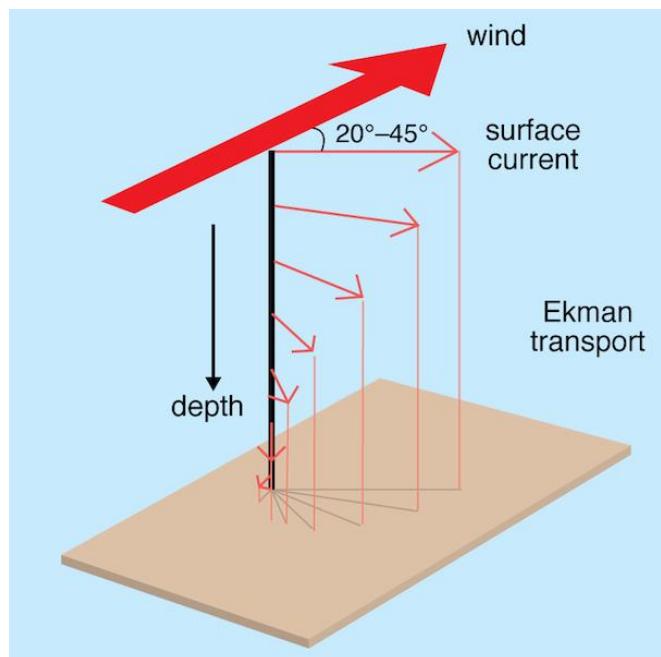
Marine debris drifters designed to simulate pollution and discarded items.



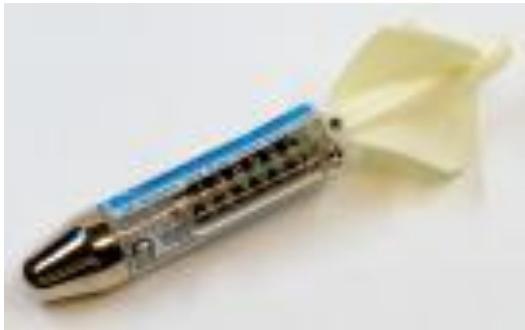
[https://www.aoml.noaa.gov/tracking-marine-debris/?simply\\_static\\_page=8015483](https://www.aoml.noaa.gov/tracking-marine-debris/?simply_static_page=8015483)

# Background - Ocean Surface Current

Surface ocean currents are produced by friction created by wind blowing. Ekman spiral is the motion of water influenced by wind and the Coriolis effect.



# Background - Ocean Surface Current



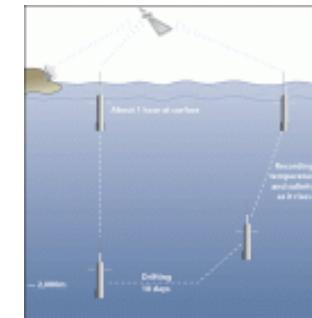
Flow  
meters



Clod Cards



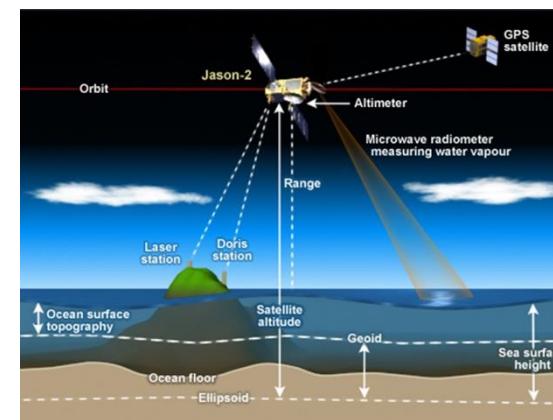
Surface  
drifter



Deep Ocean  
drifter



Acoustic  
Doppler  
Current  
Profiler



Satellite  
Altimeters

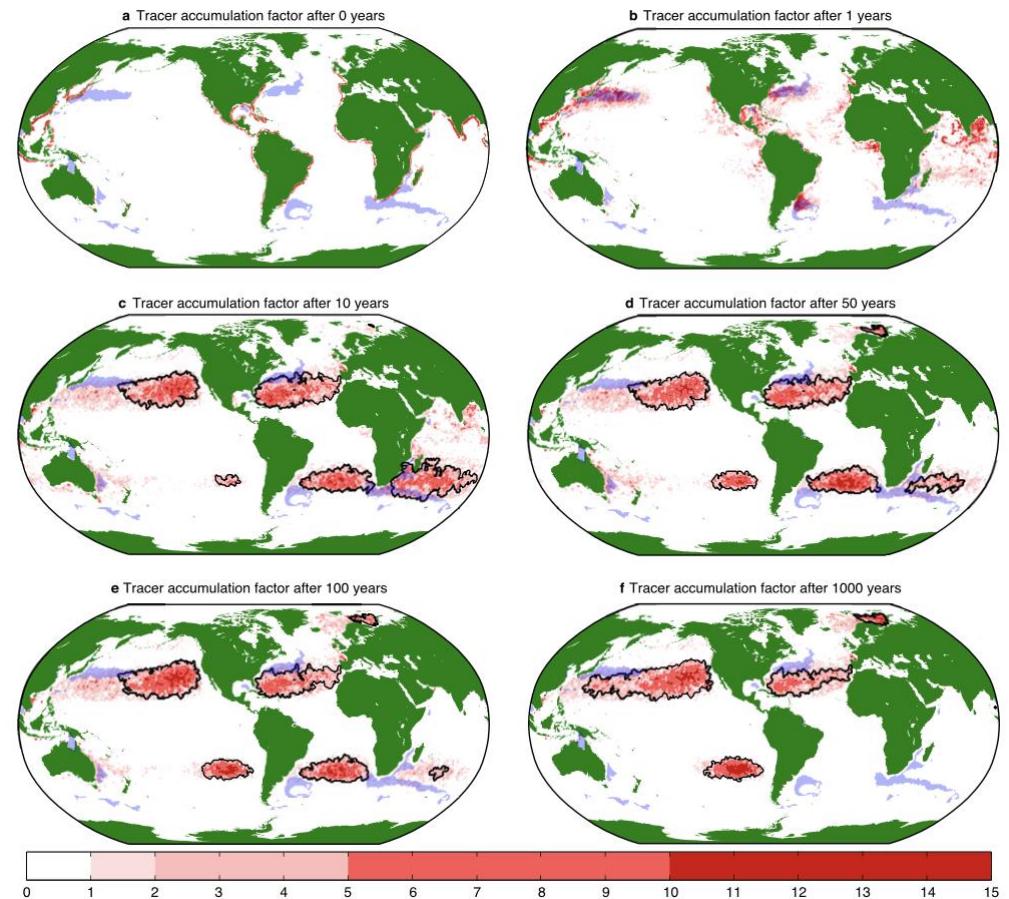
# Background - Applications

CODE drifters released in the Gulf of Mexico explore surface flows after the Deepwater Horizon oil spill.



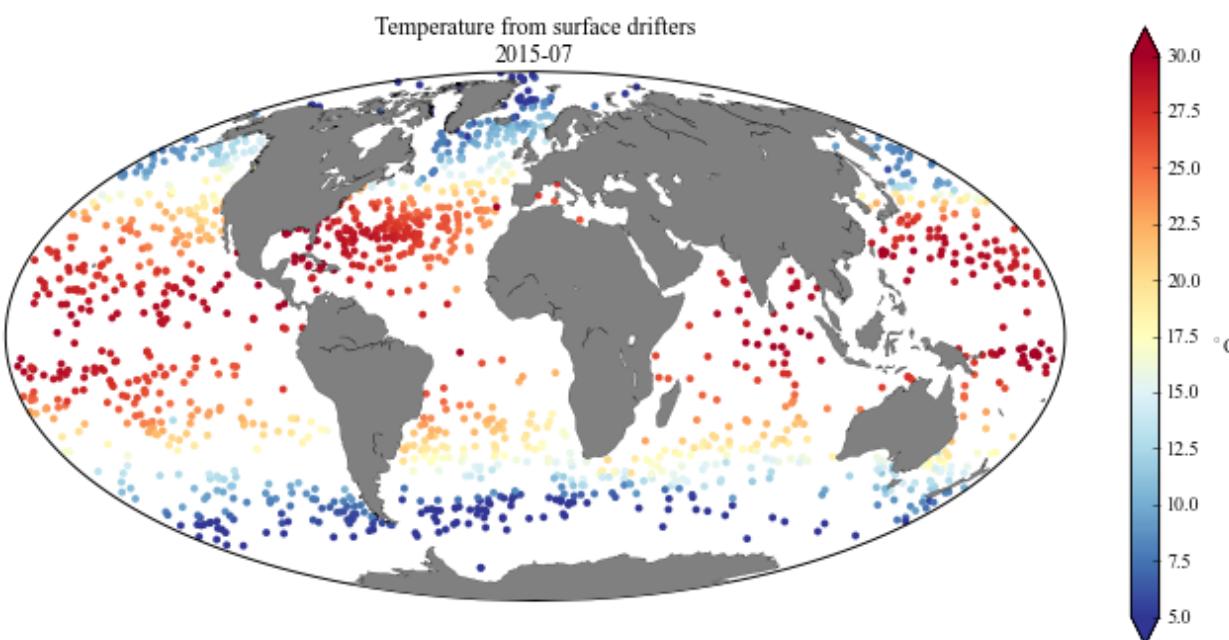
Origin, dynamics and evolution of ocean garbage patches from observed surface drifters

Erik van Sebille<sup>1,3</sup>, Matthew H England<sup>1</sup> and Gary Froyland<sup>2</sup>

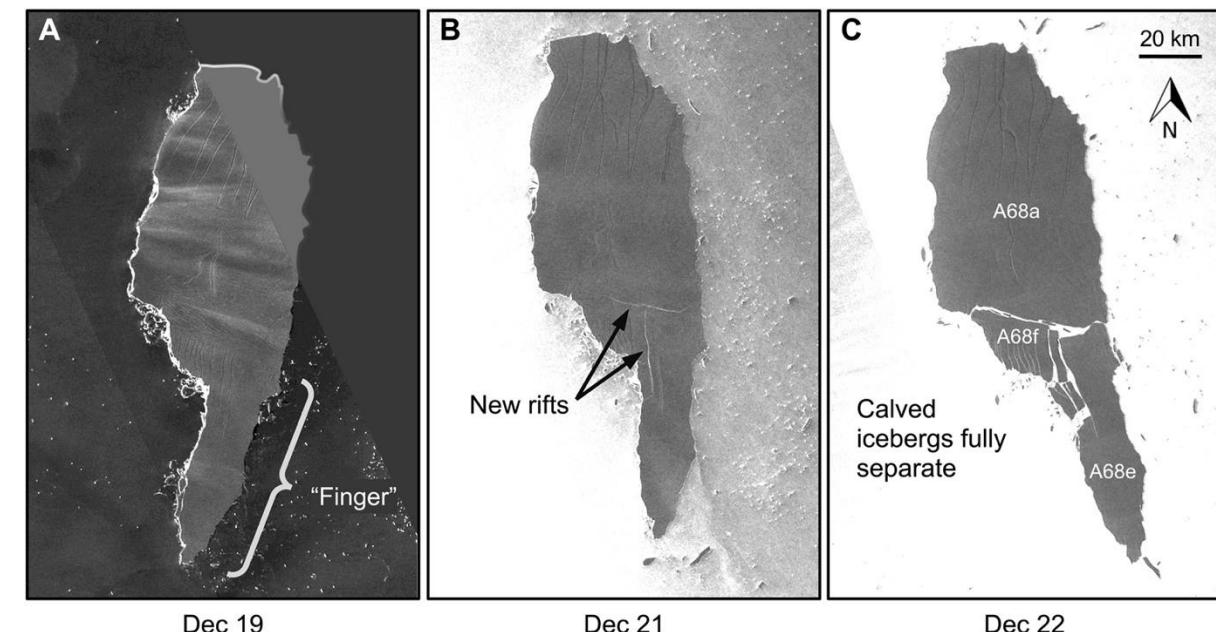


# Background - Applications

Ocean current redistributing heat, nutrients and marine life, ground truth for satellite data.

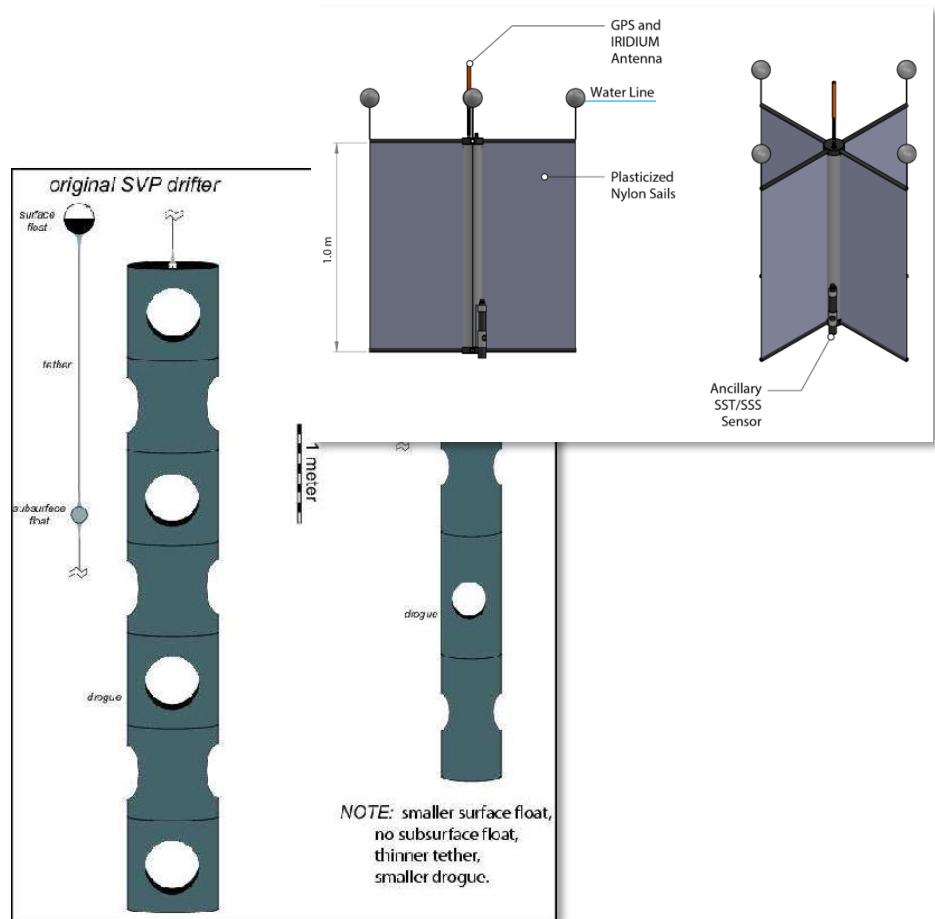


Ocean currents break up a tabular iceberg.

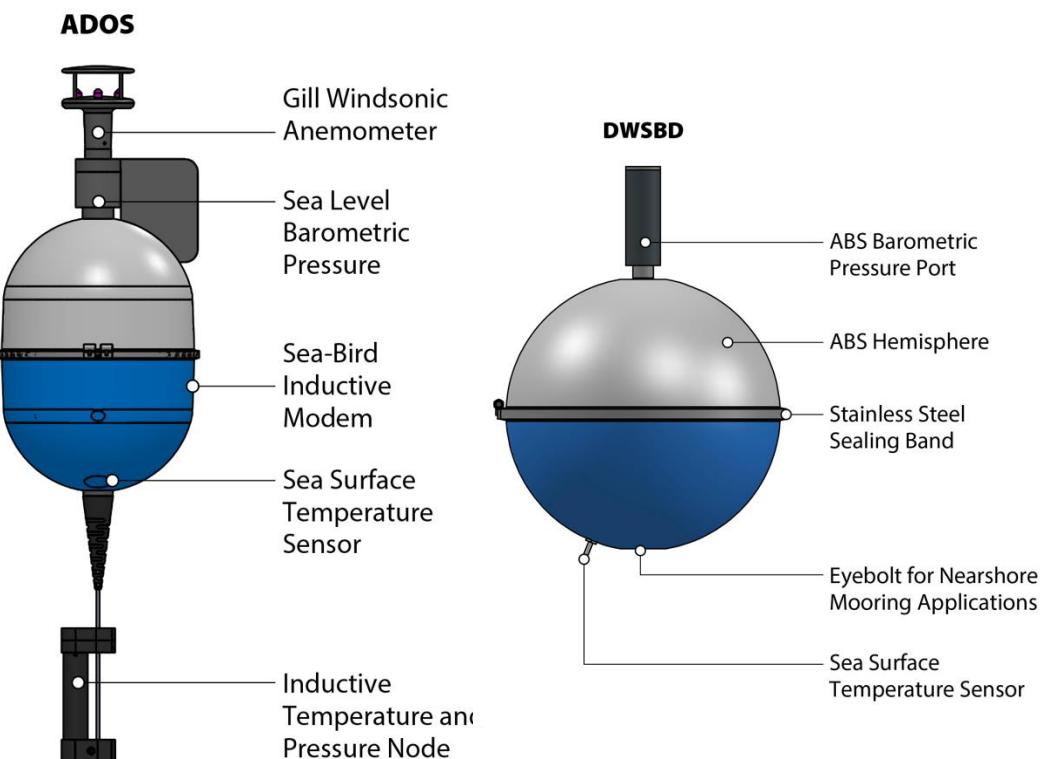


# Drifter Design Consideration

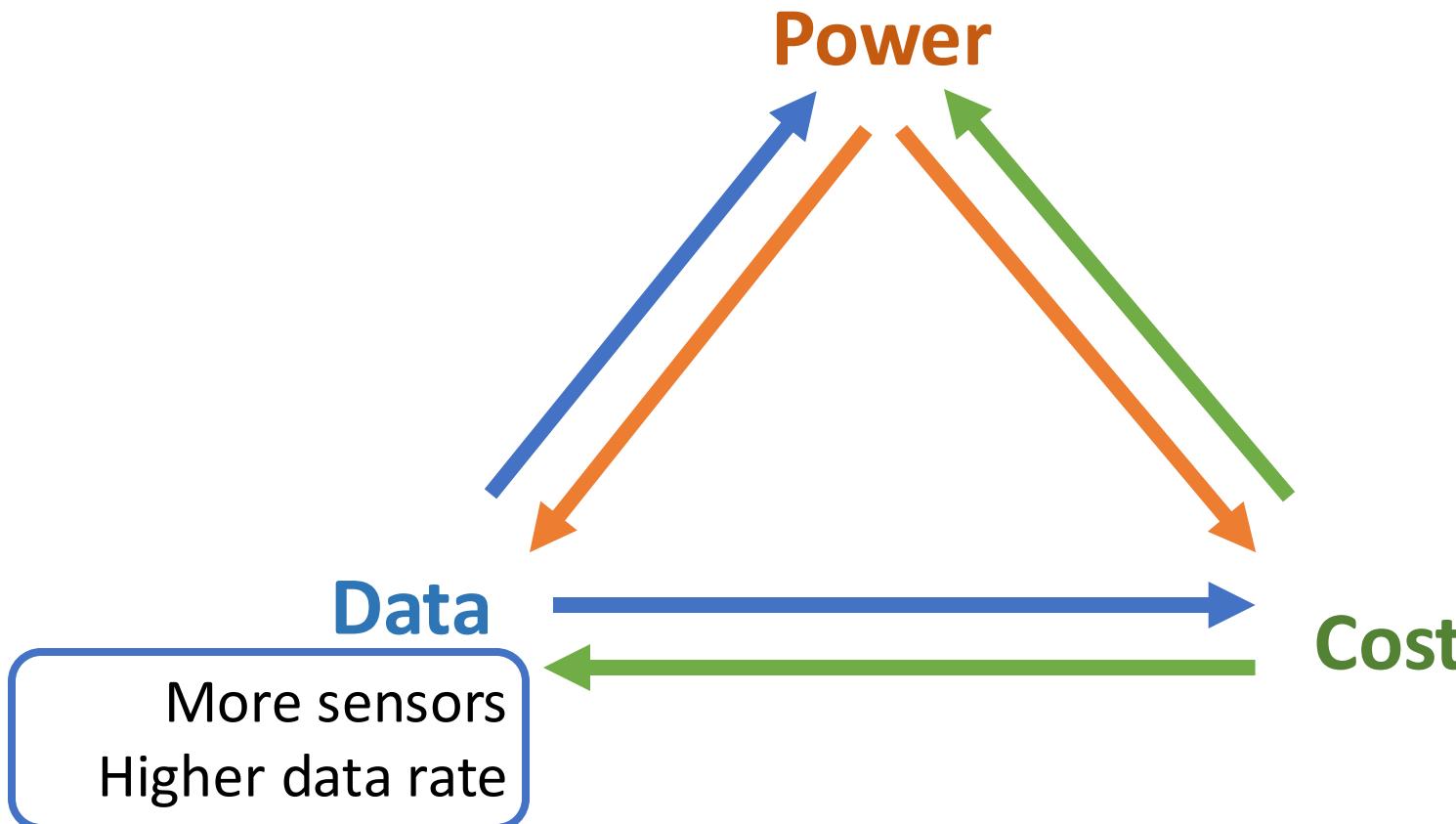
## With drogue



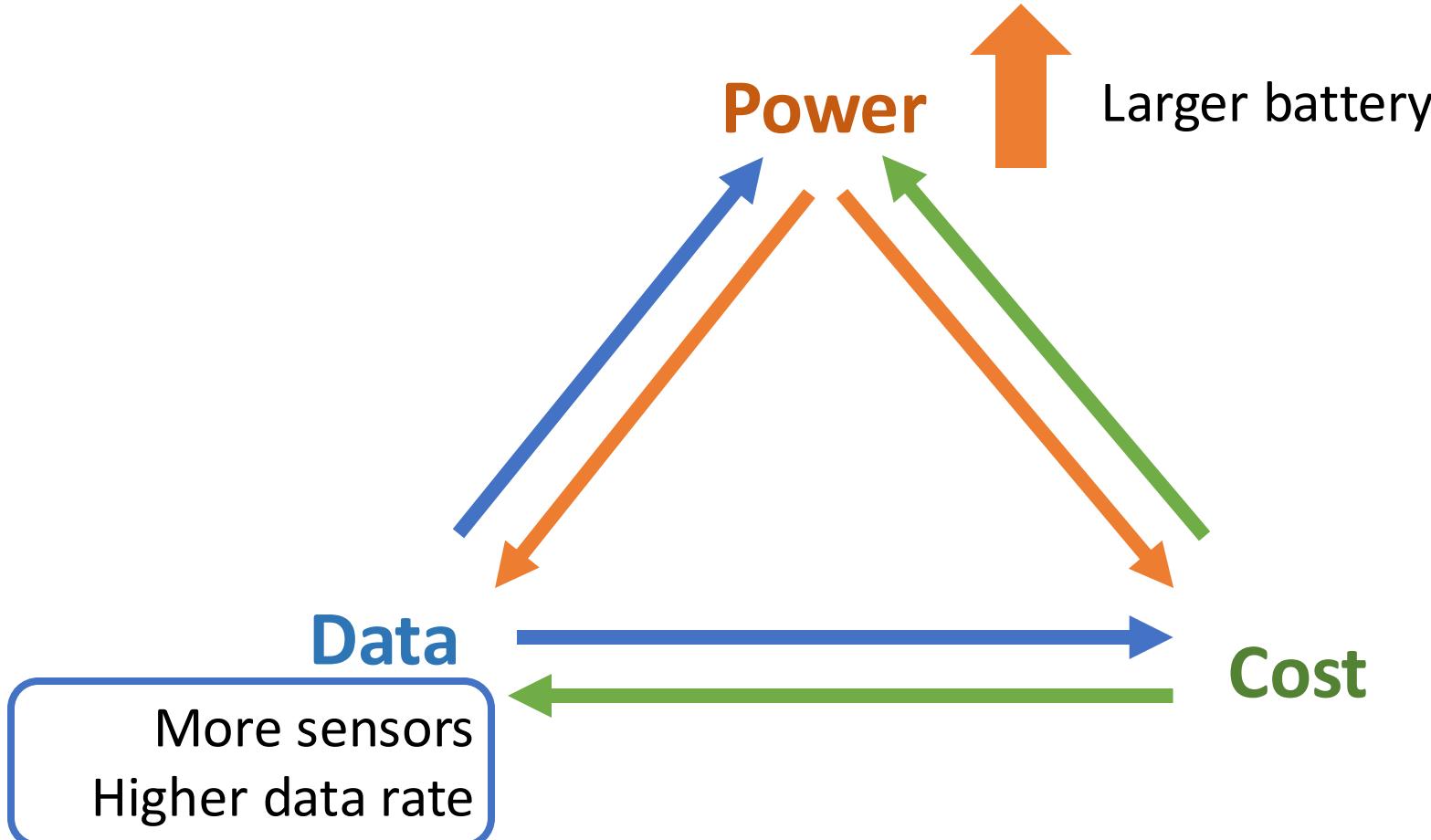
## Without drogue



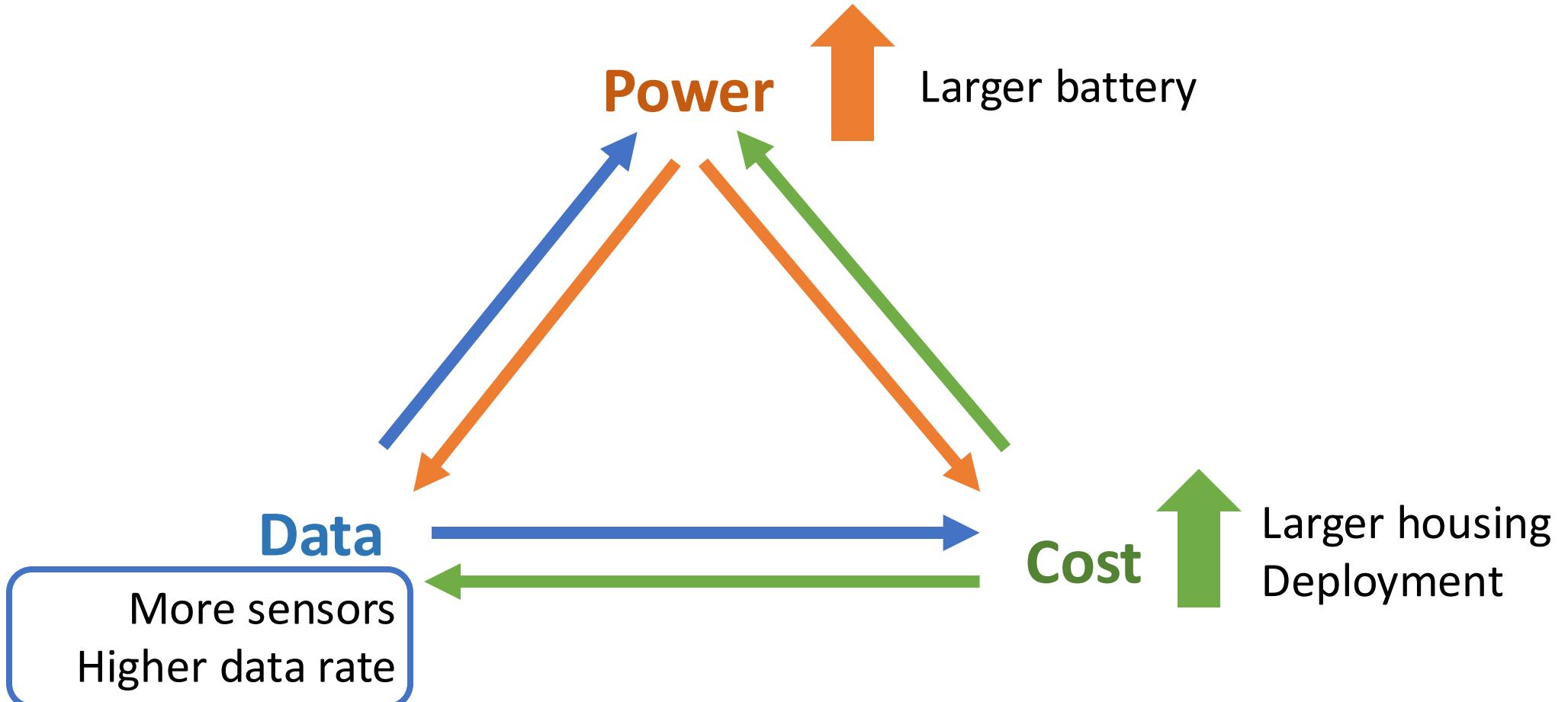
# Drifter Design Consideration



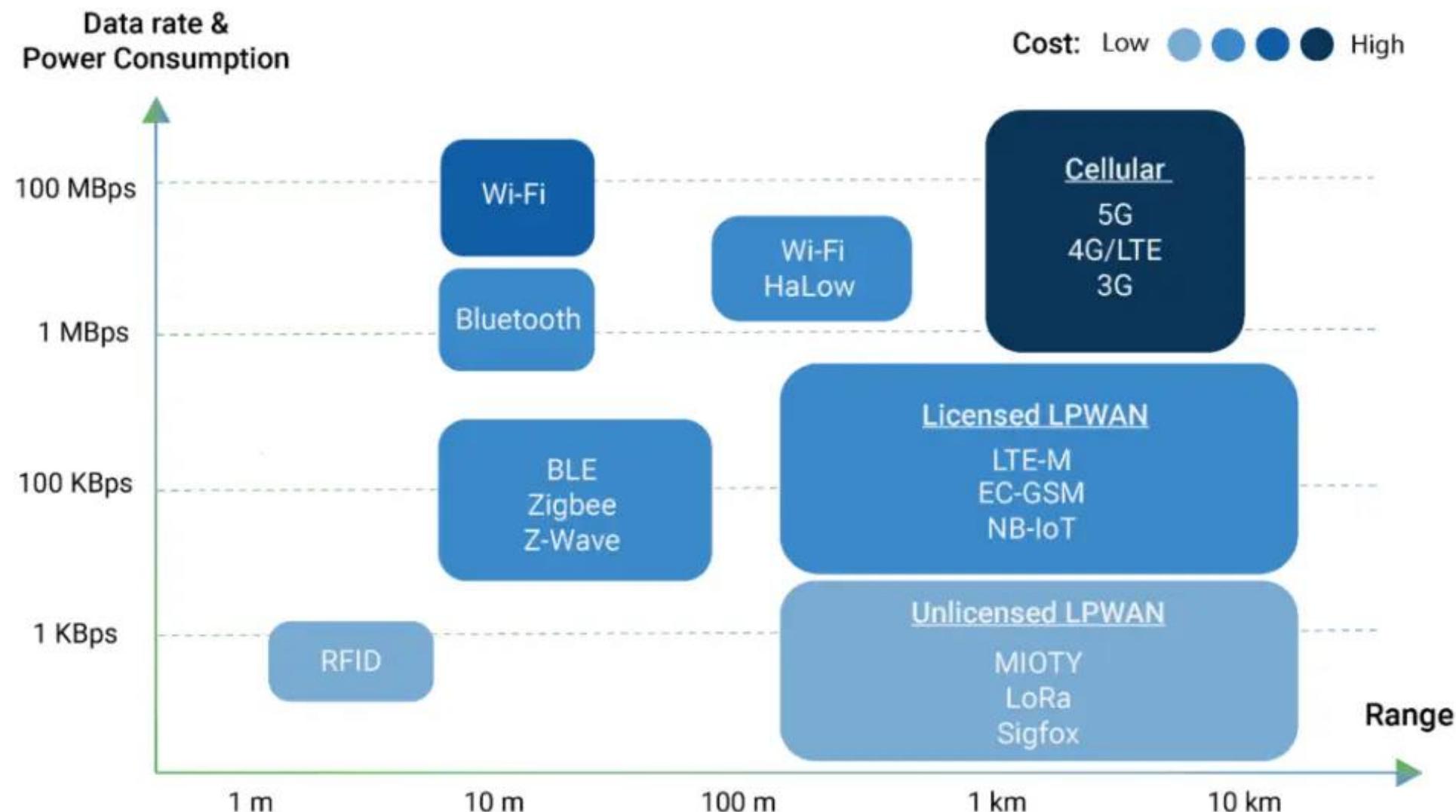
# Drifter Design Consideration



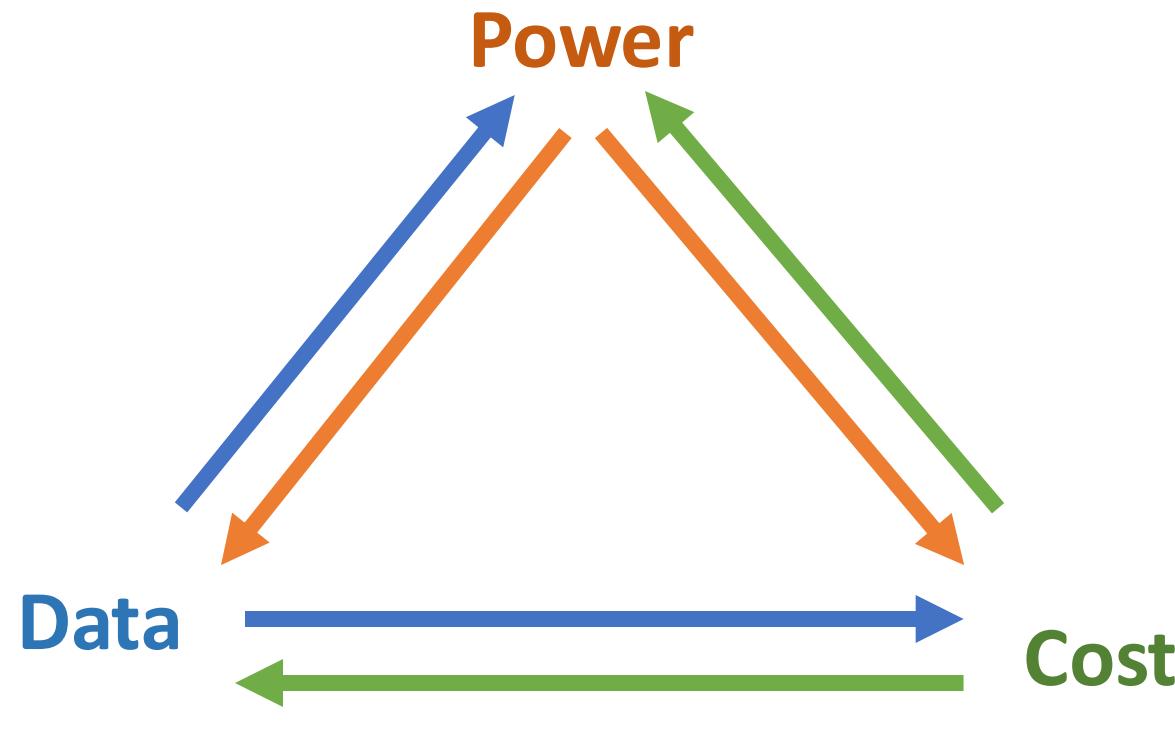
# Drifter Design Consideration



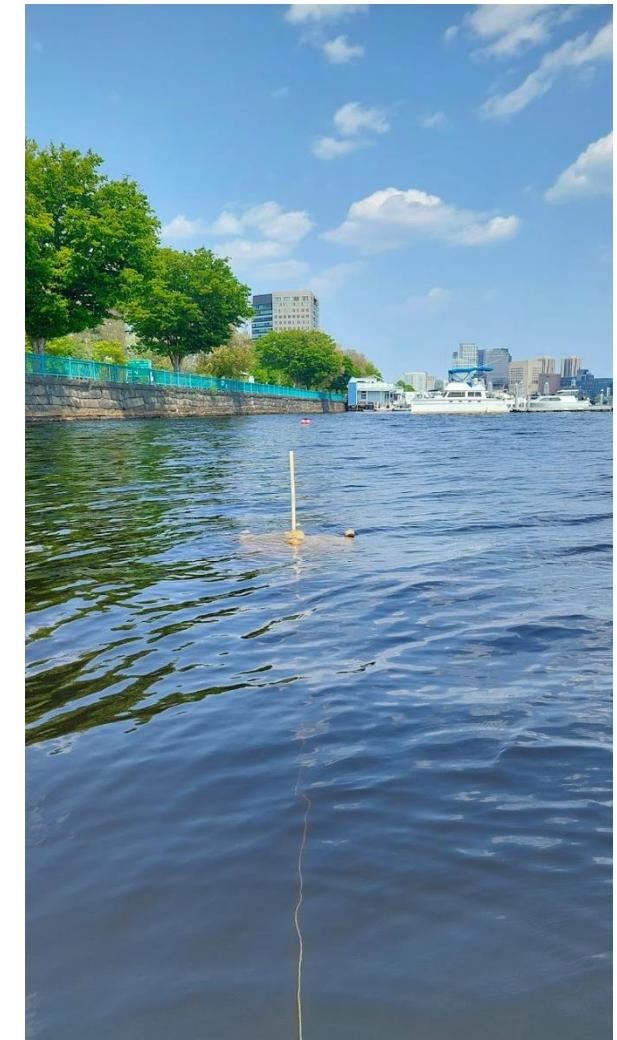
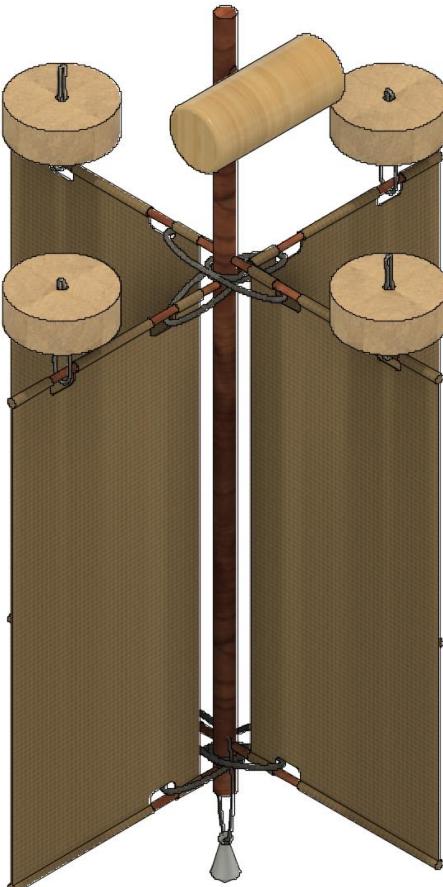
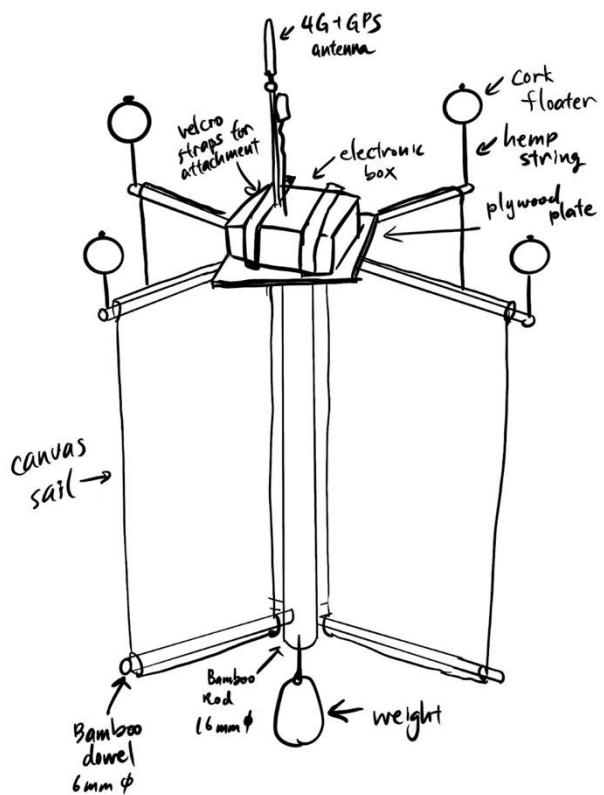
# Drifter Design Consideration - Communication



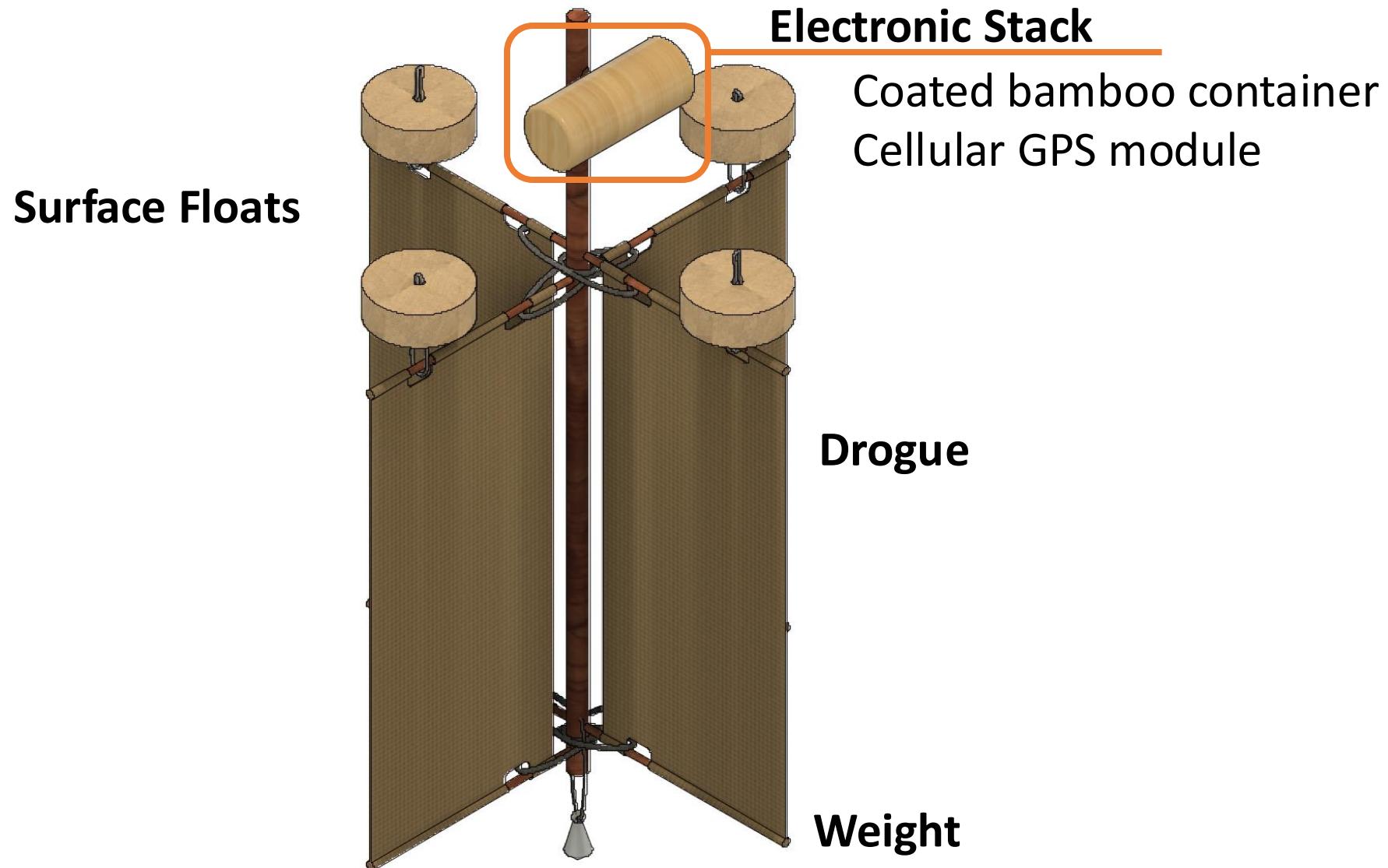
# Drifter Design Consideration



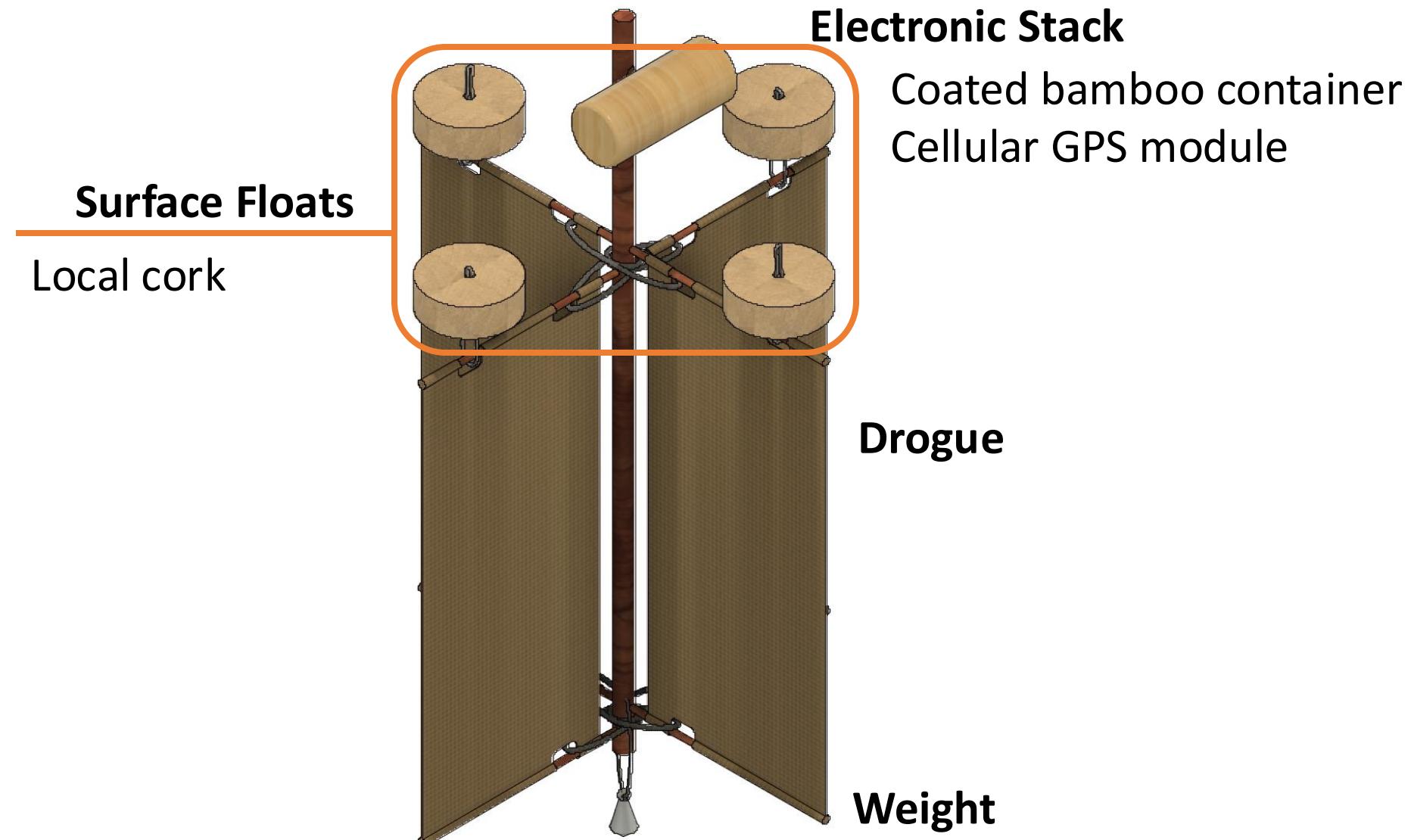
# Example Drifter



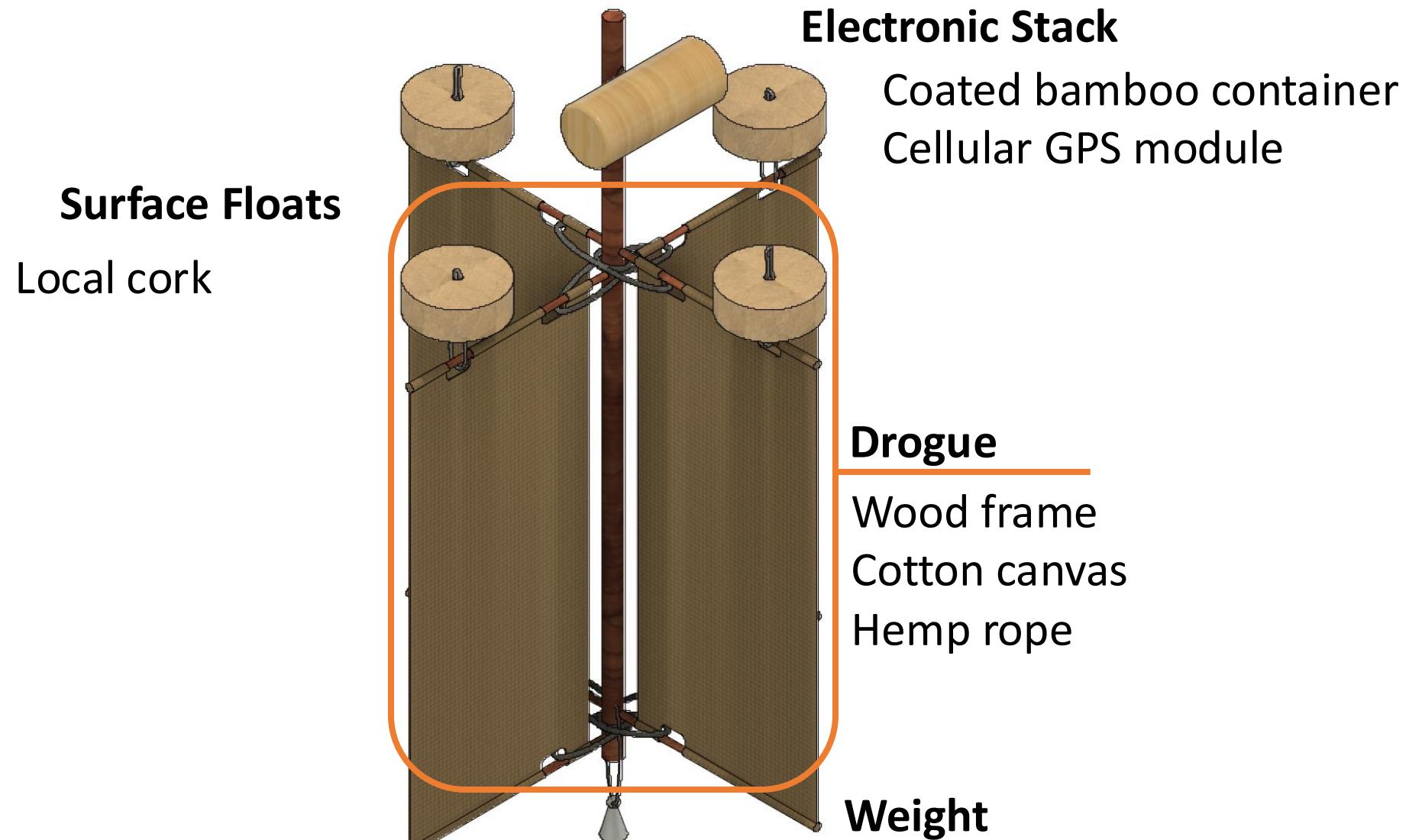
# Example Drifter - Frame Construction



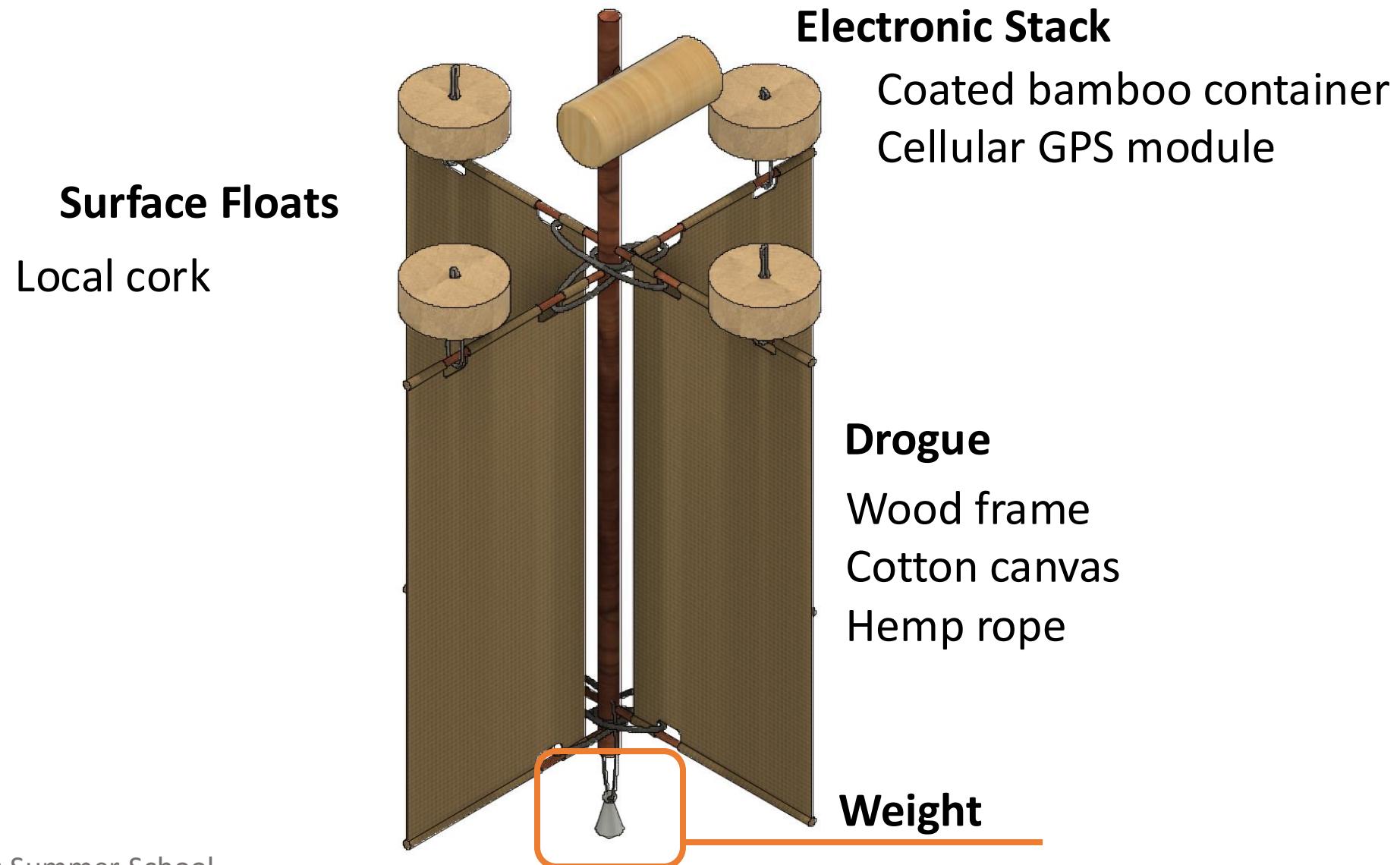
# Example Drifter - Frame Construction



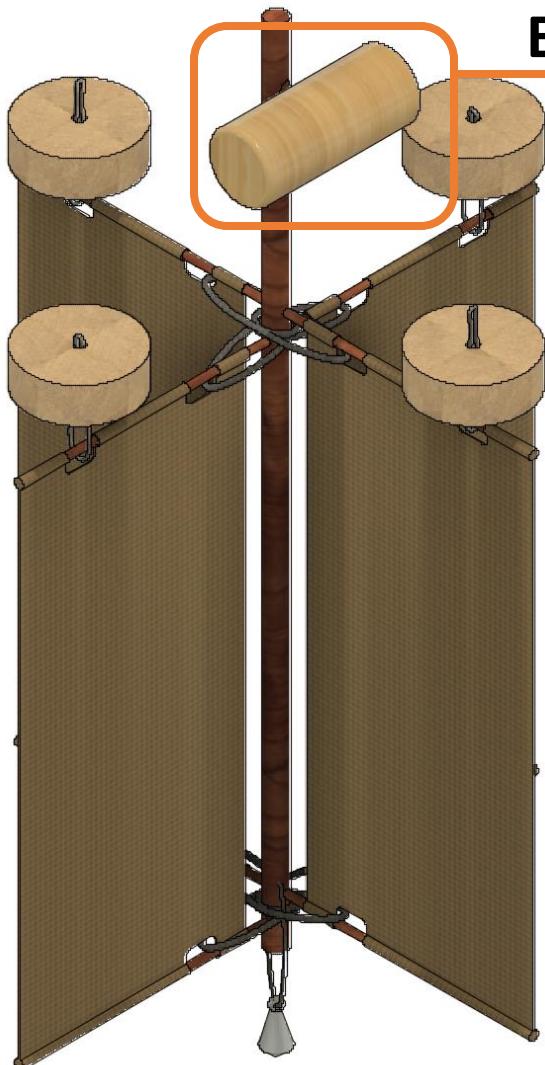
# Example Drifter - Frame Construction



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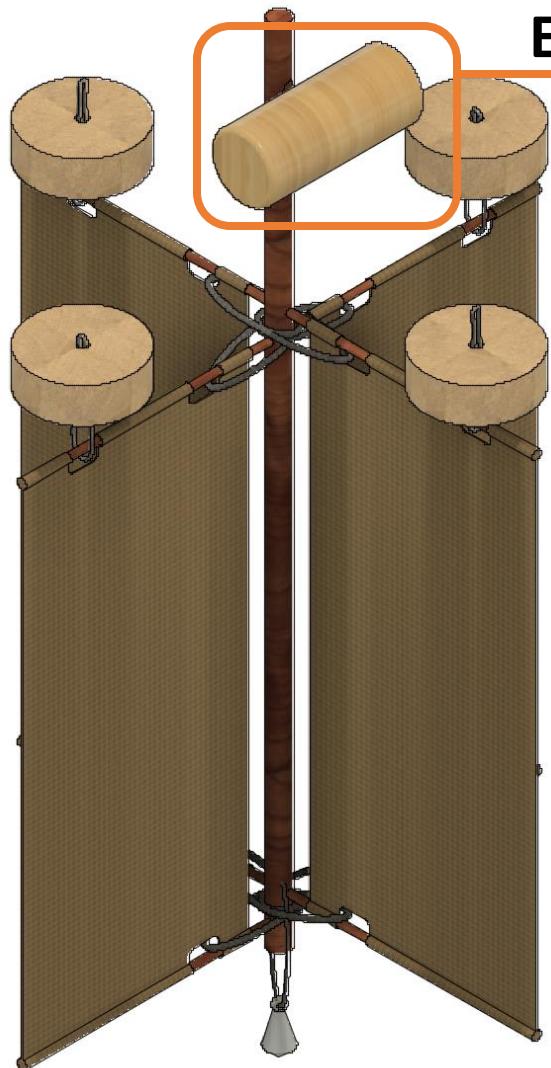


**Electronic Stack**

Bamboo container is waterproof with multiple coats of shellac, a lacquer coating made from beetle.

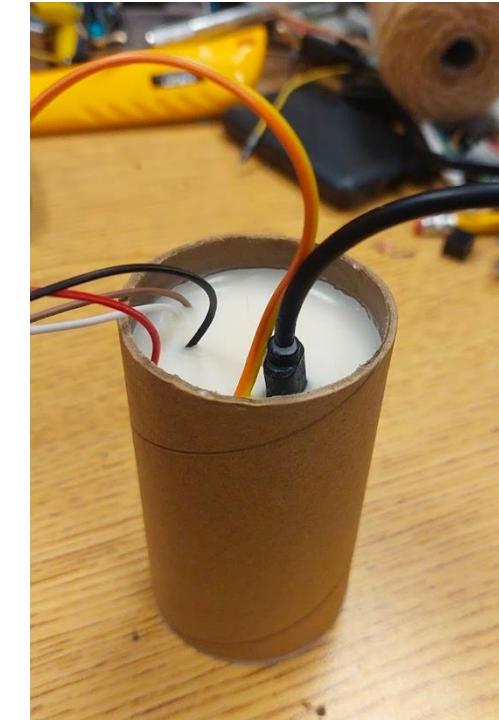


# Example Drifter - Frame Construction

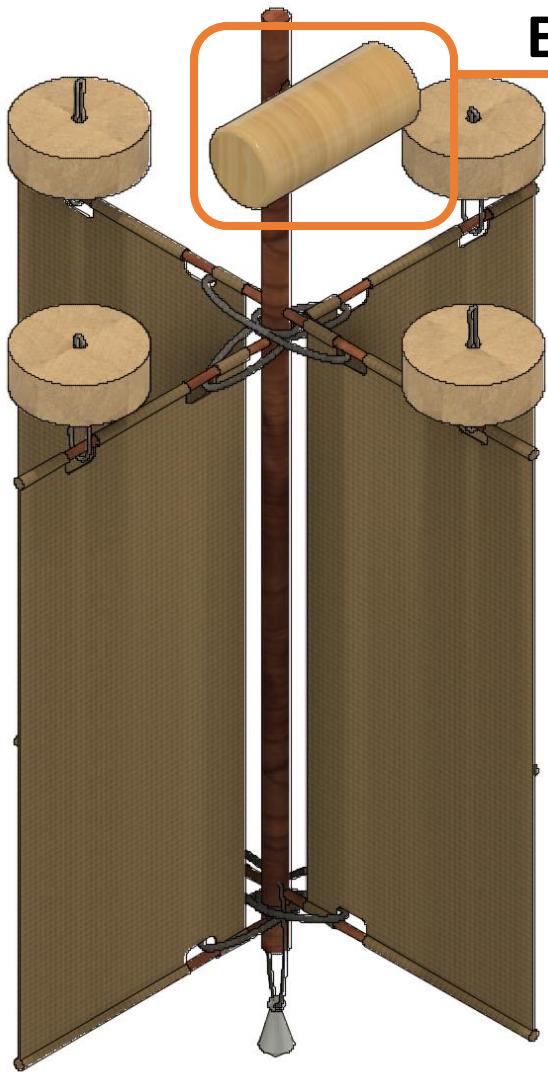


**Electronic Stack**

The waterproof shellac coating was tested by submerging coated container in water for 48 hours. Electronic can also be potted with coconut wax for additional protection.

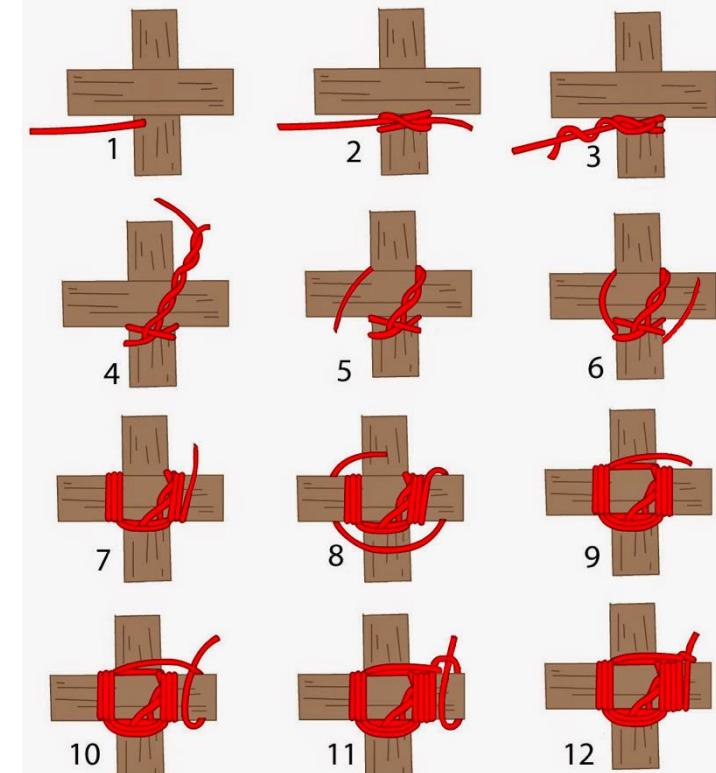


# Example Drifter - Frame Construction

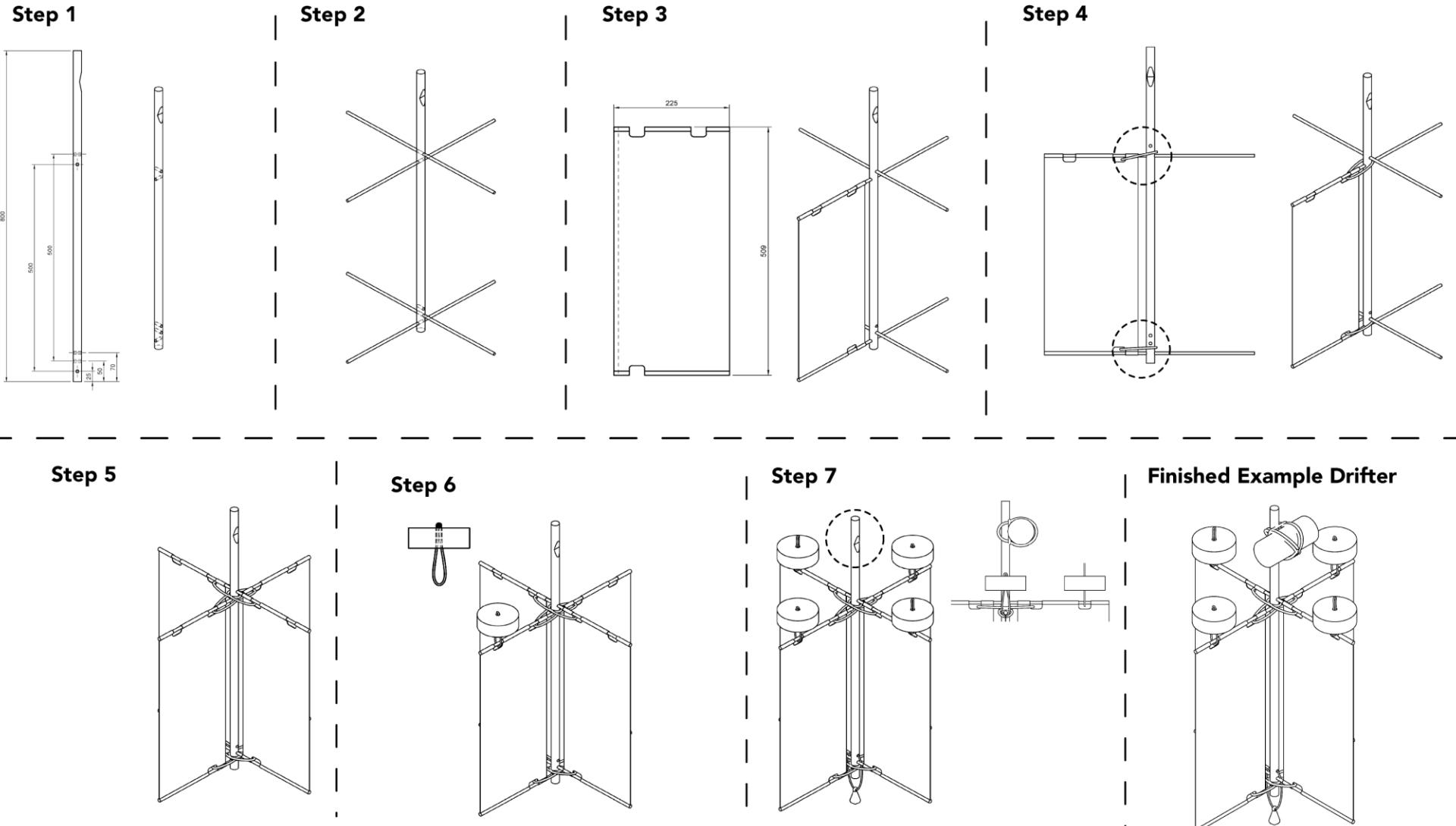


## Electronic Stack

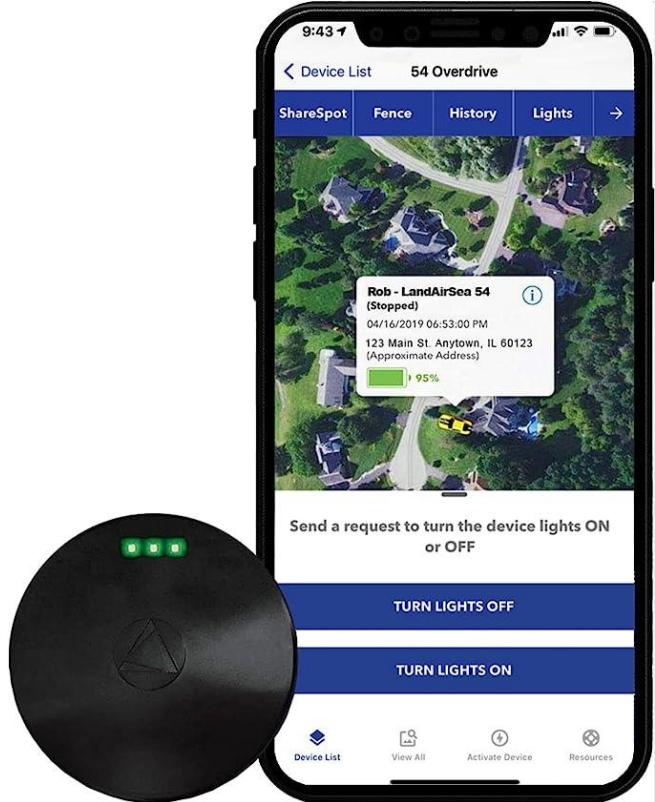
Hemp rope square lashing to fasten the electronic container to the vertical frame. Soak the hemp rope in water for 20mins before tying.



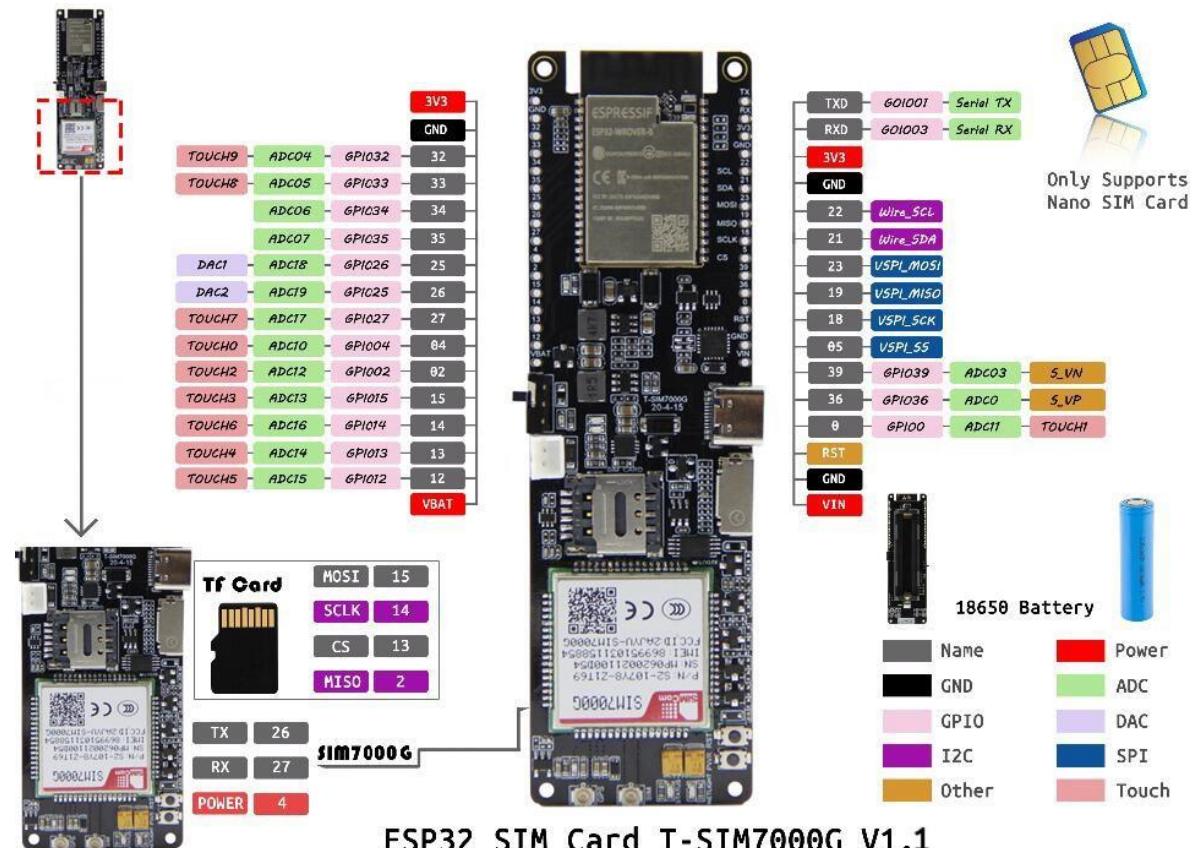
# Example Drifter - Frame Construction



# Example Drifter - Electronic stack

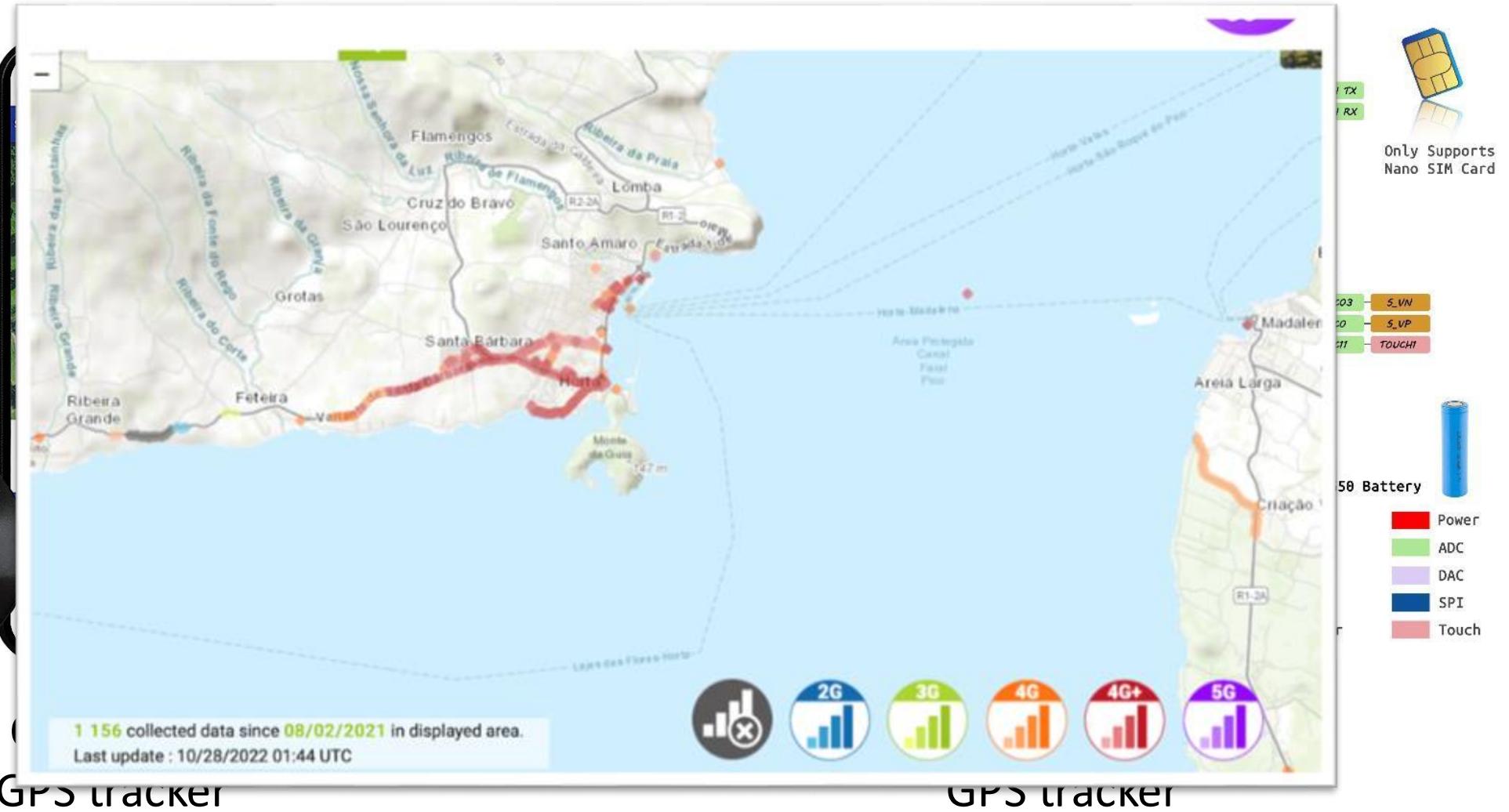


Option 1: Commercial Cellular  
GPS tracker



Option 2: Custom Cellular  
GPS tracker

# Example Drifter - Electronic stack

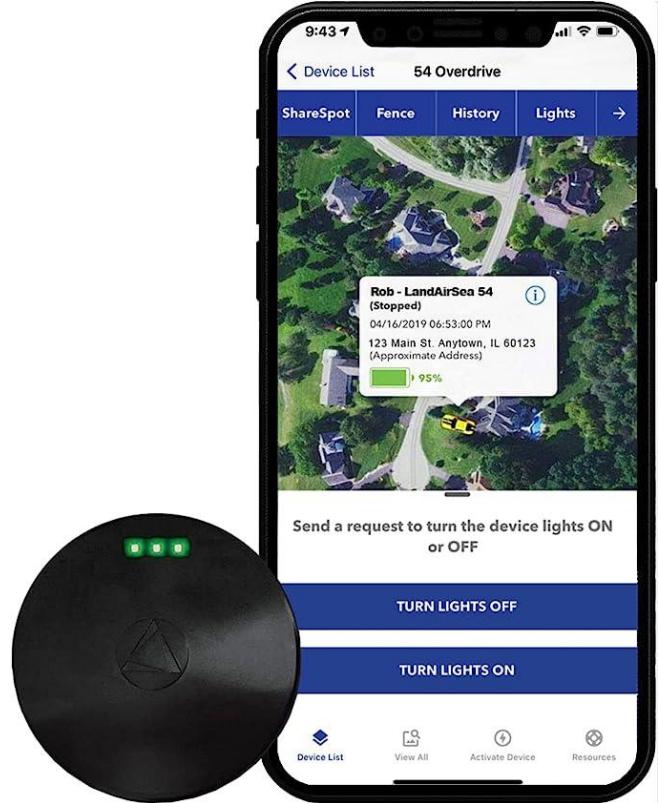


Option 1:

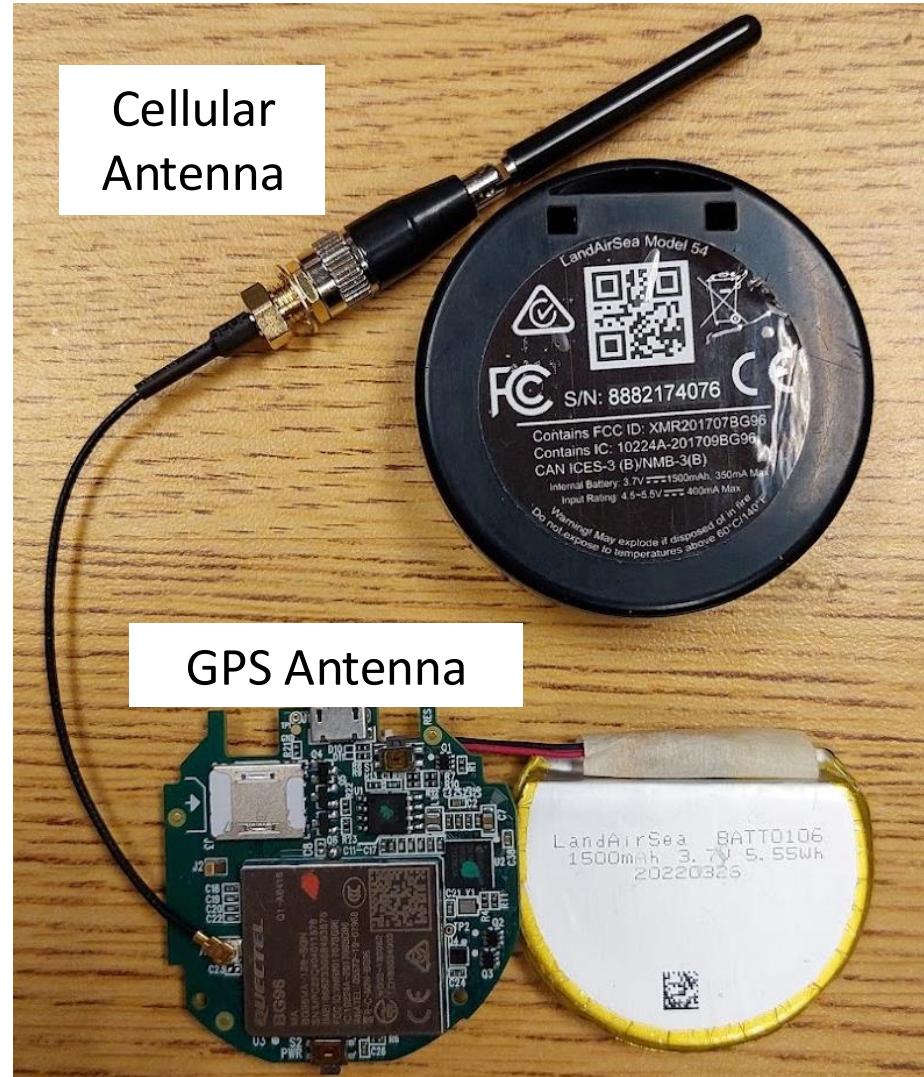
GPS tracker

GPS tracker

# Example Drifter - Electronic stack



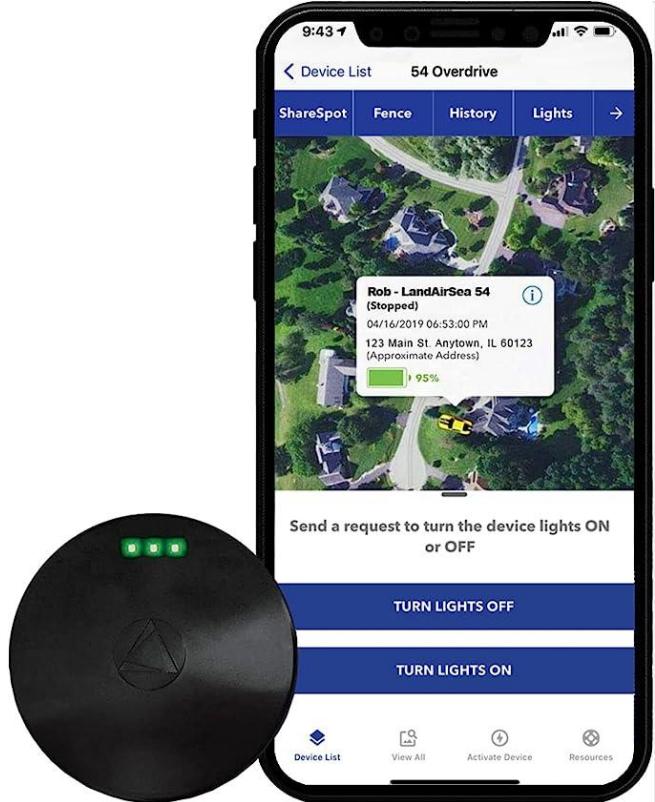
Option 1: Commercial Cellular GPS tracker



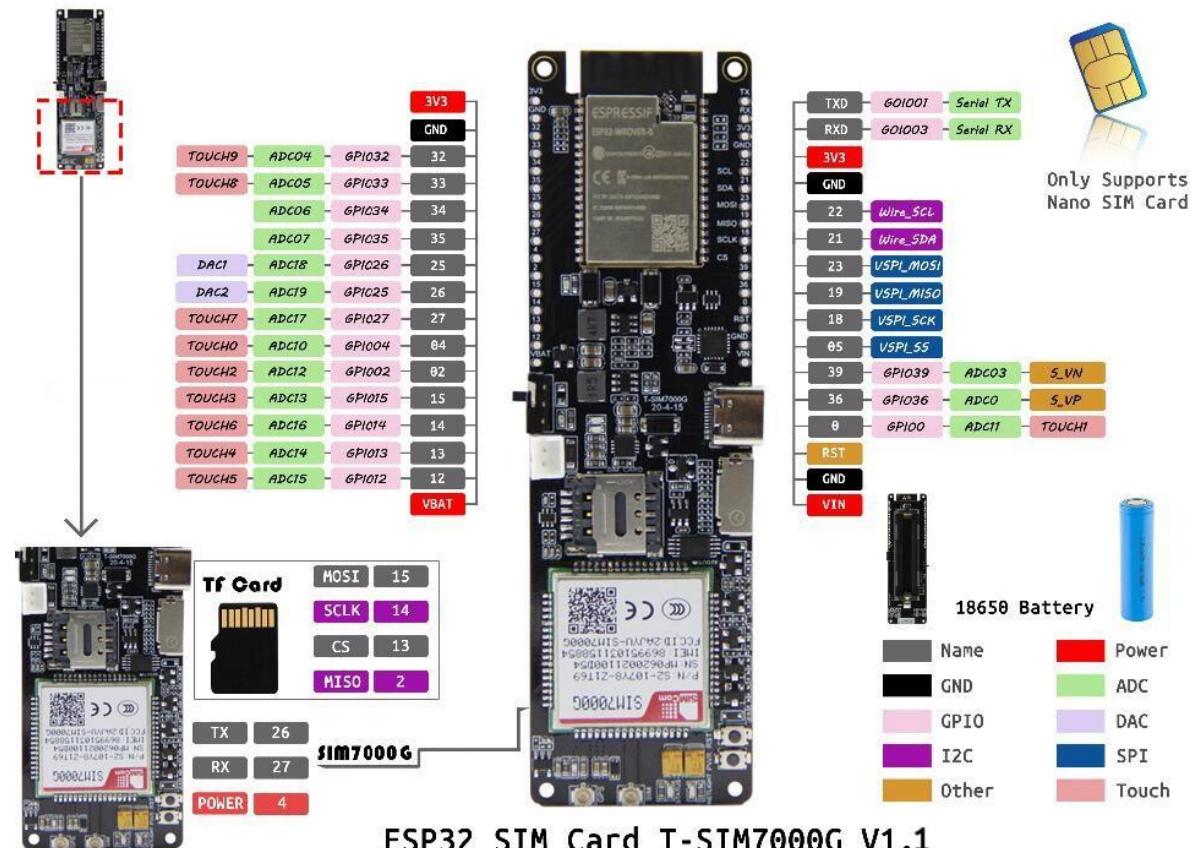
Cellular Antenna

GPS Antenna

# Example Drifter - Electronic stack

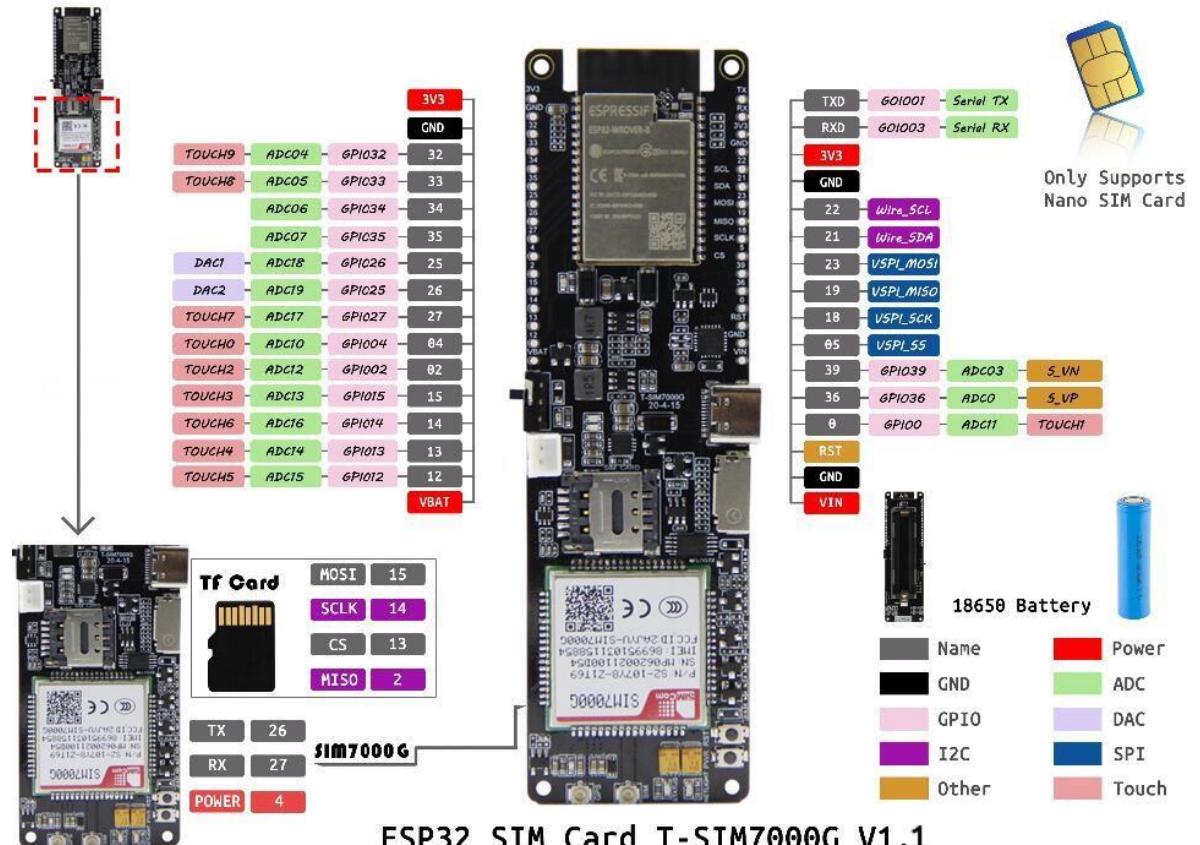
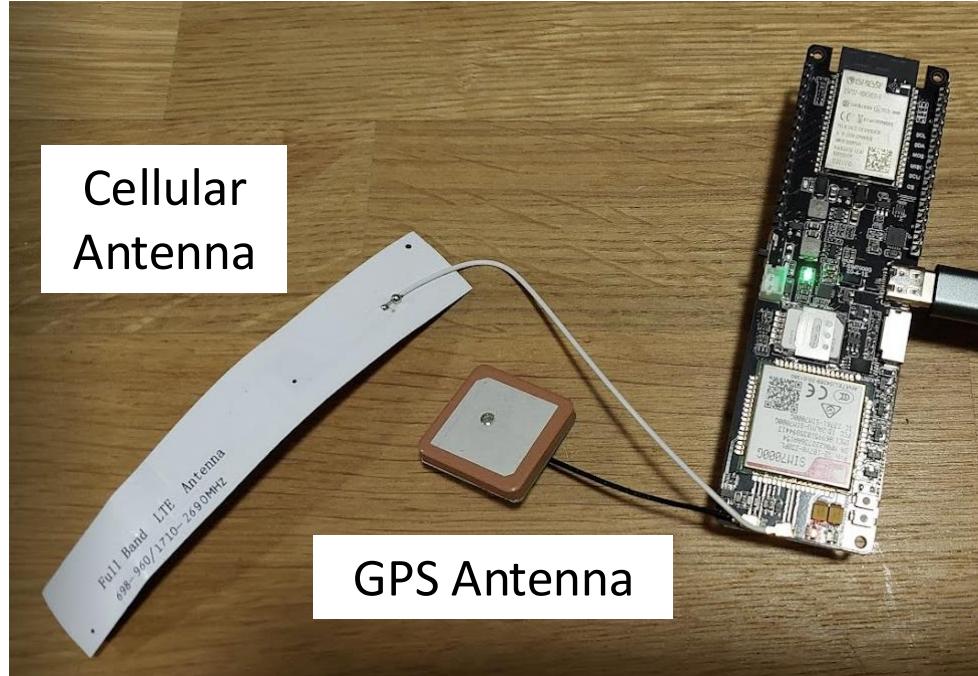


Option 1: Commercial Cellular  
GPS tracker



Option 2: Custom Cellular  
GPS tracker

# Example Drifter - Electronic stack



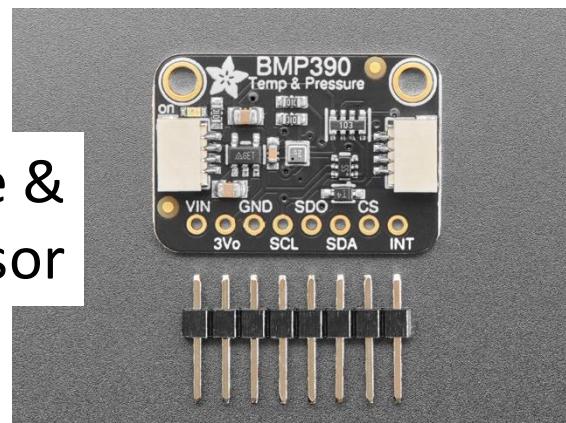
## Option 2: Custom Cellular GPS tracker

# Example Drifter - Electronic stack

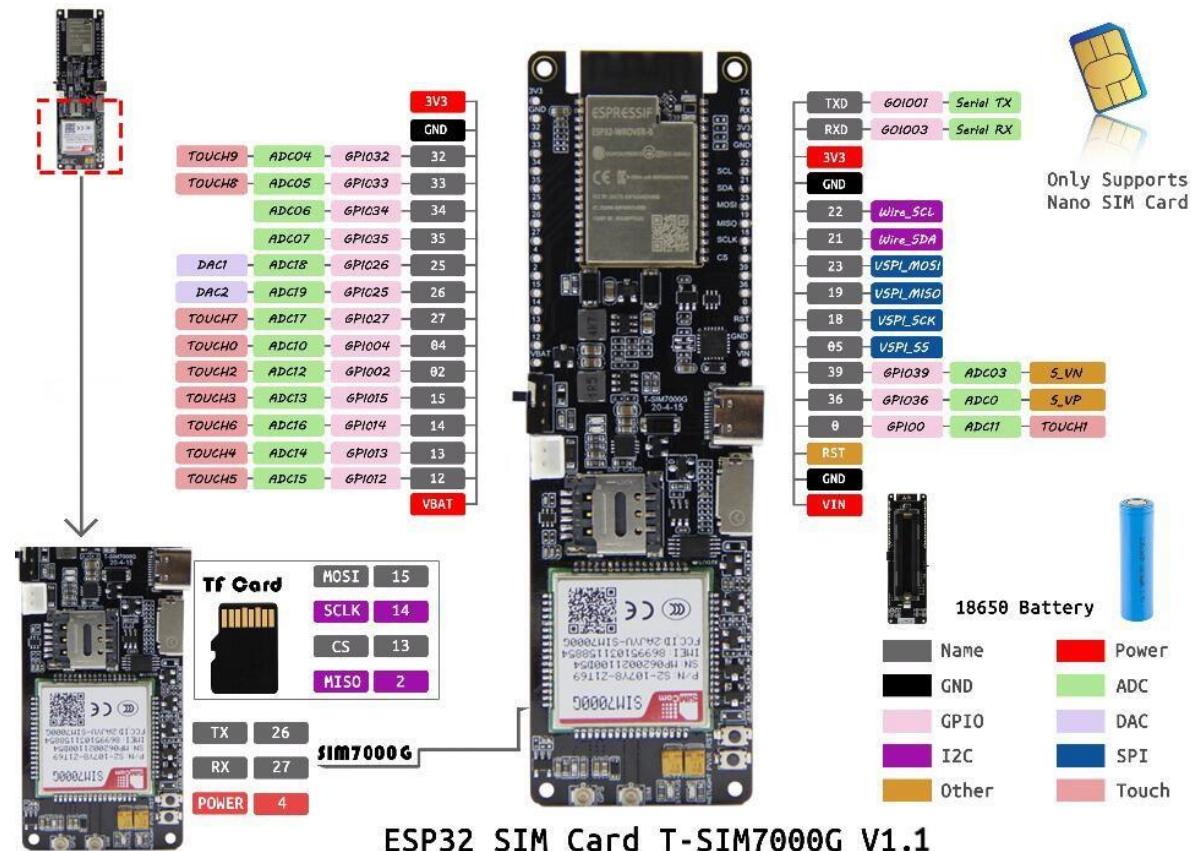
Waterproof  
temperature prob



Temperature &  
Pressure Sensor



ESP32 microcontroller + SIM7000G Modem



Option 2: Custom Cellular  
GPS tracker

# Example Drifter - Electronic stack

LTE-M network



Custom data dashboard

Blynk

OceanDrifter1 online

Charlene My organization - 4469NE

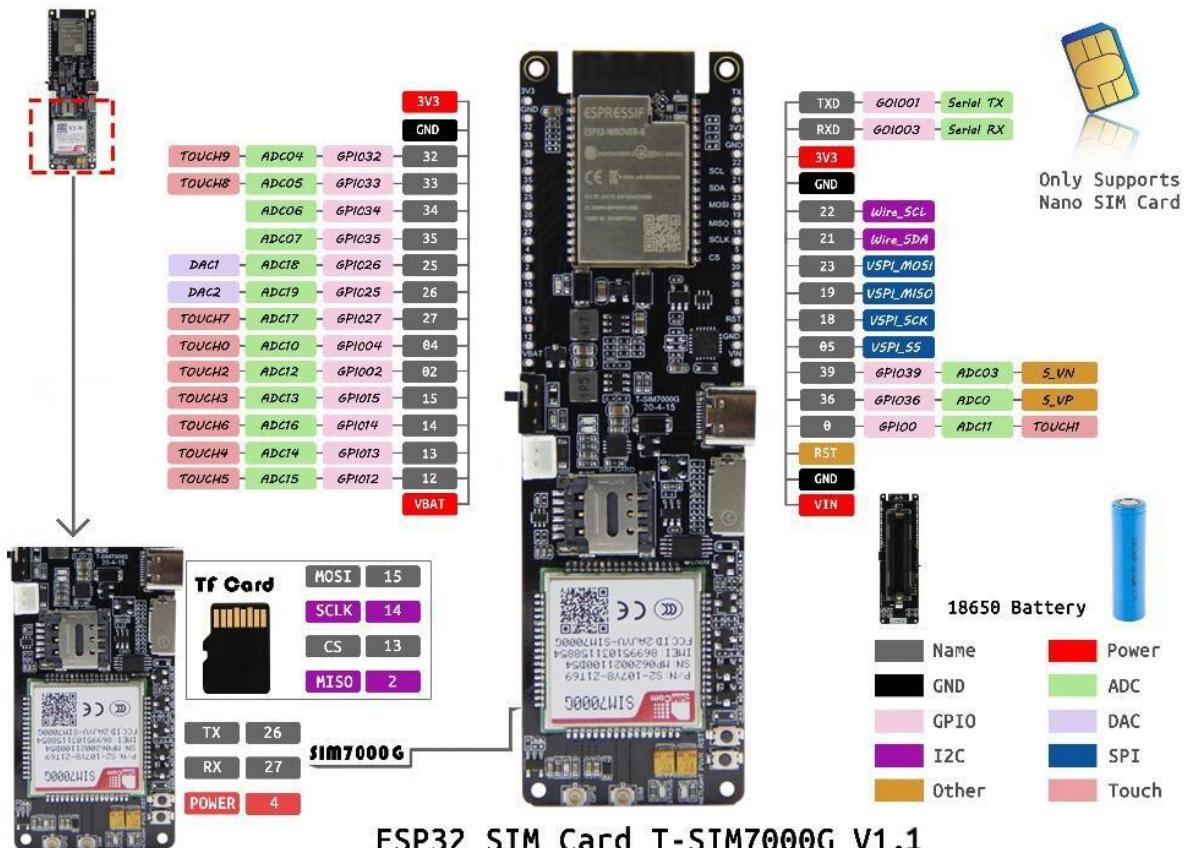
Dashboard Timeline Device Info Metadata Actions Log Datastreams

Latest Last Hour 6 Hours 1 Day 1 Week 1 Month 3 Months 6 Months 1 Year

Battery Level

GPS raw value  
1.0,...,0,...,7,...,34,,

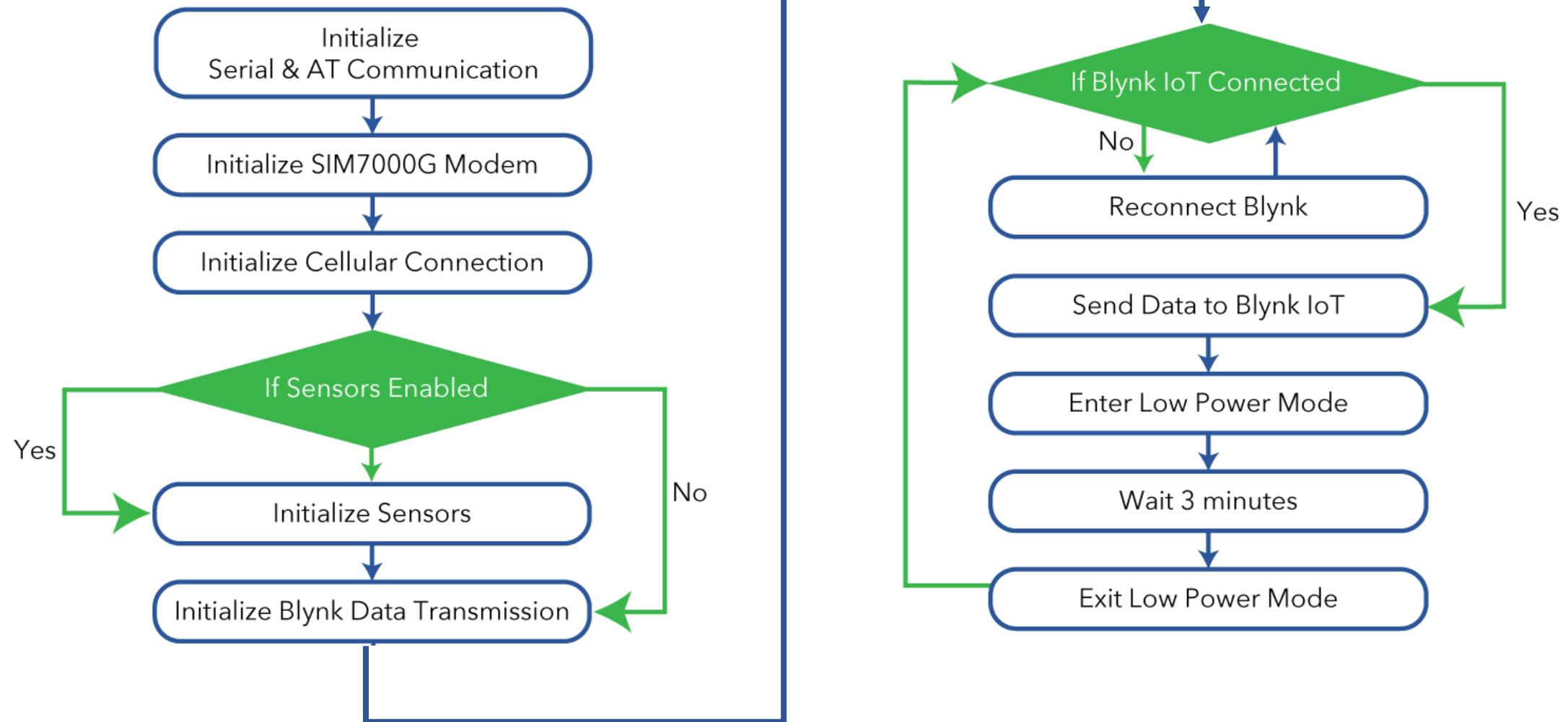
ESP32 microcontroller + SIM7000G Modem



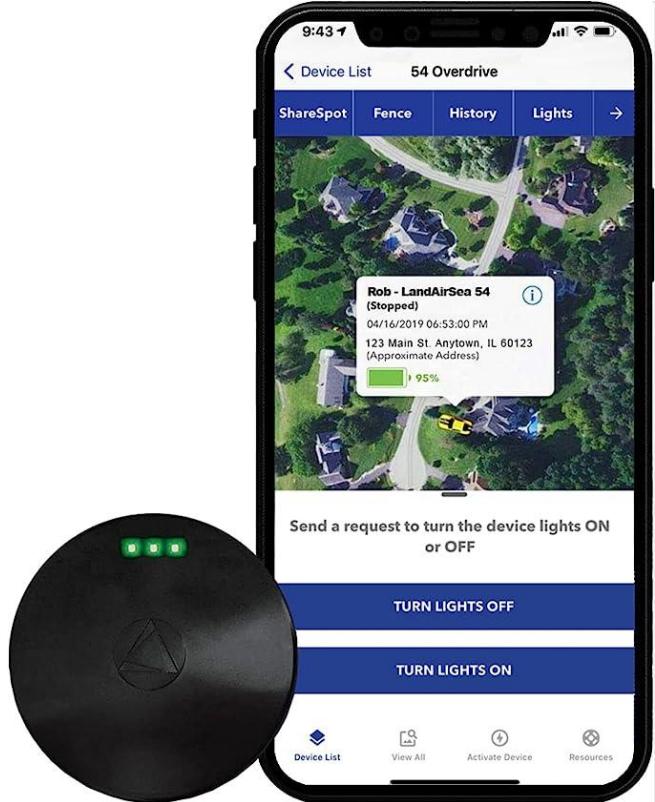
ESP32 SIM Card T-SIM7000G V1.1

Option 2: Custom Cellular GPS tracker

# Example Drifter - Electronic stack

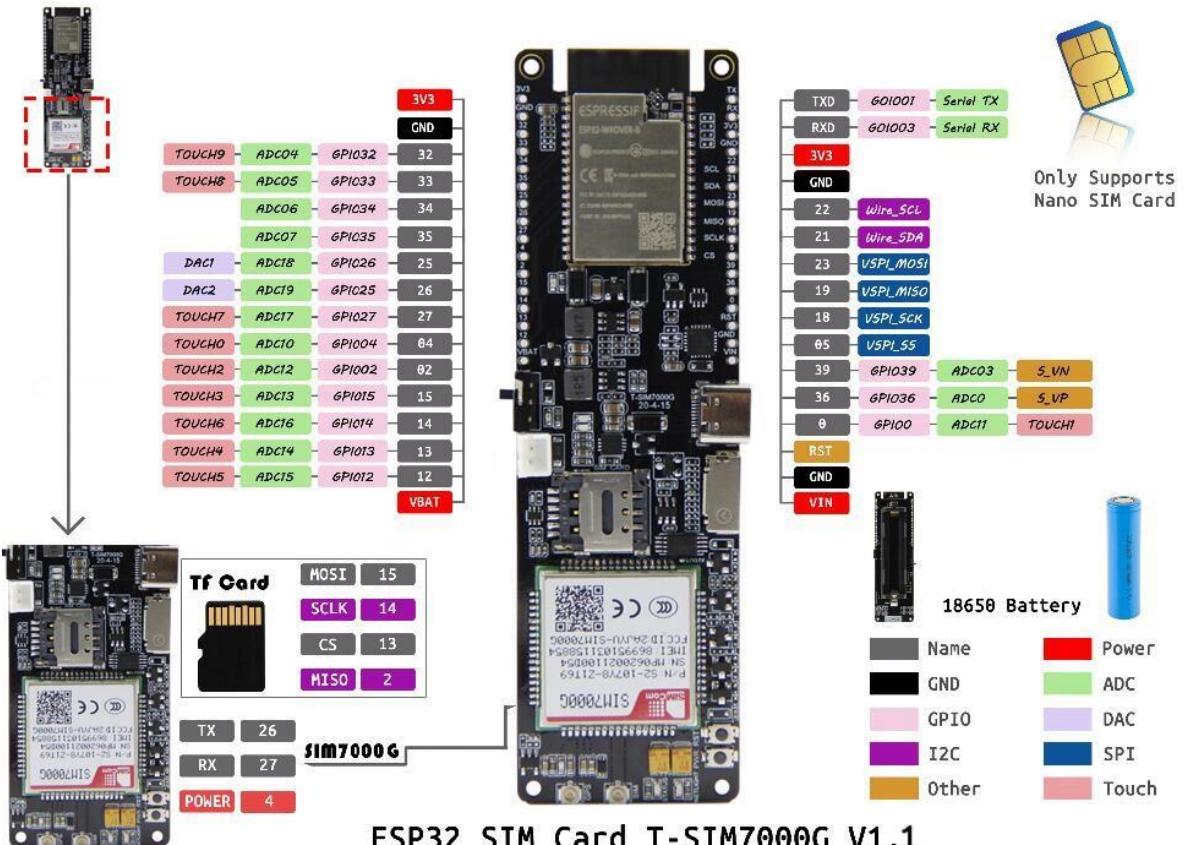


## Example Drifter - Electronic stack



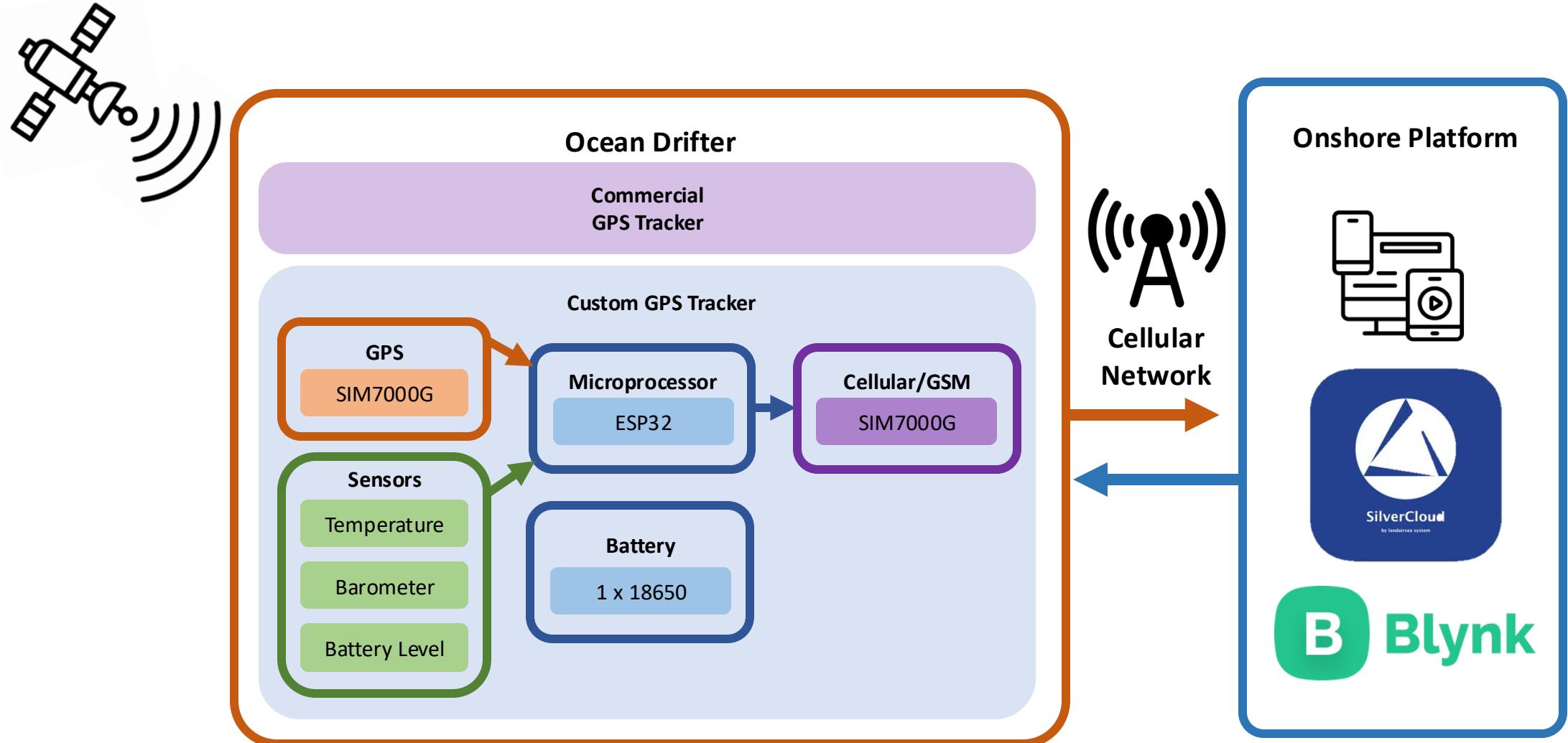
# Option 1: Commercial Cellular GPS tracker

Both!

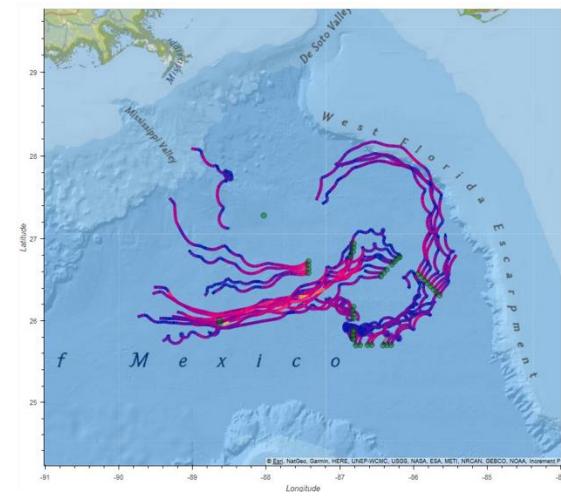
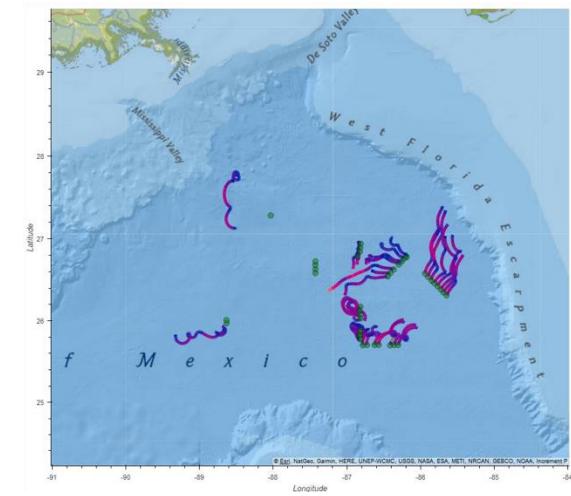
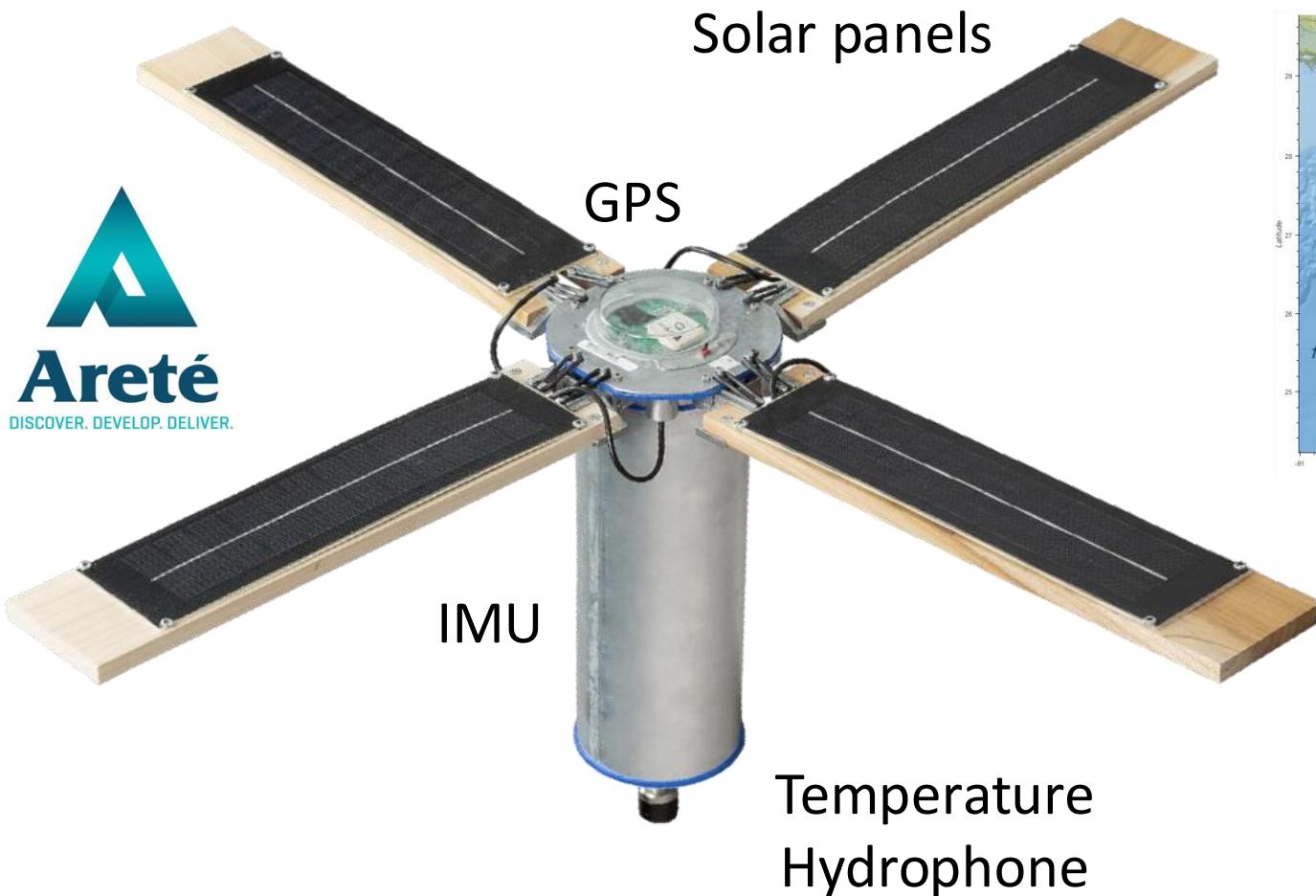


## Option 2: Custom Cellular GPS tracker

# Example Drifter - Electronic stack

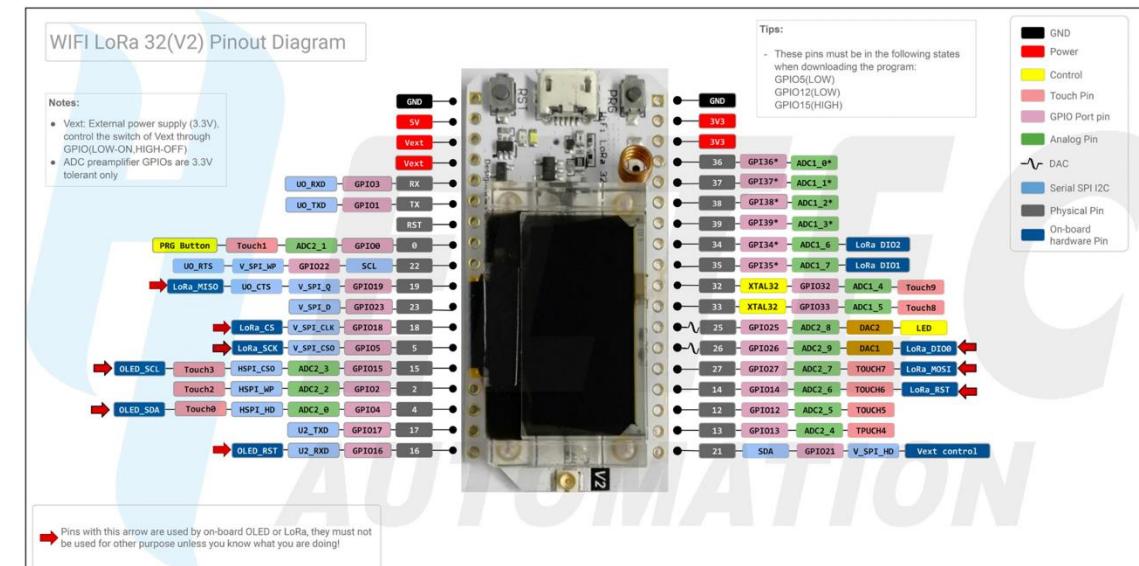
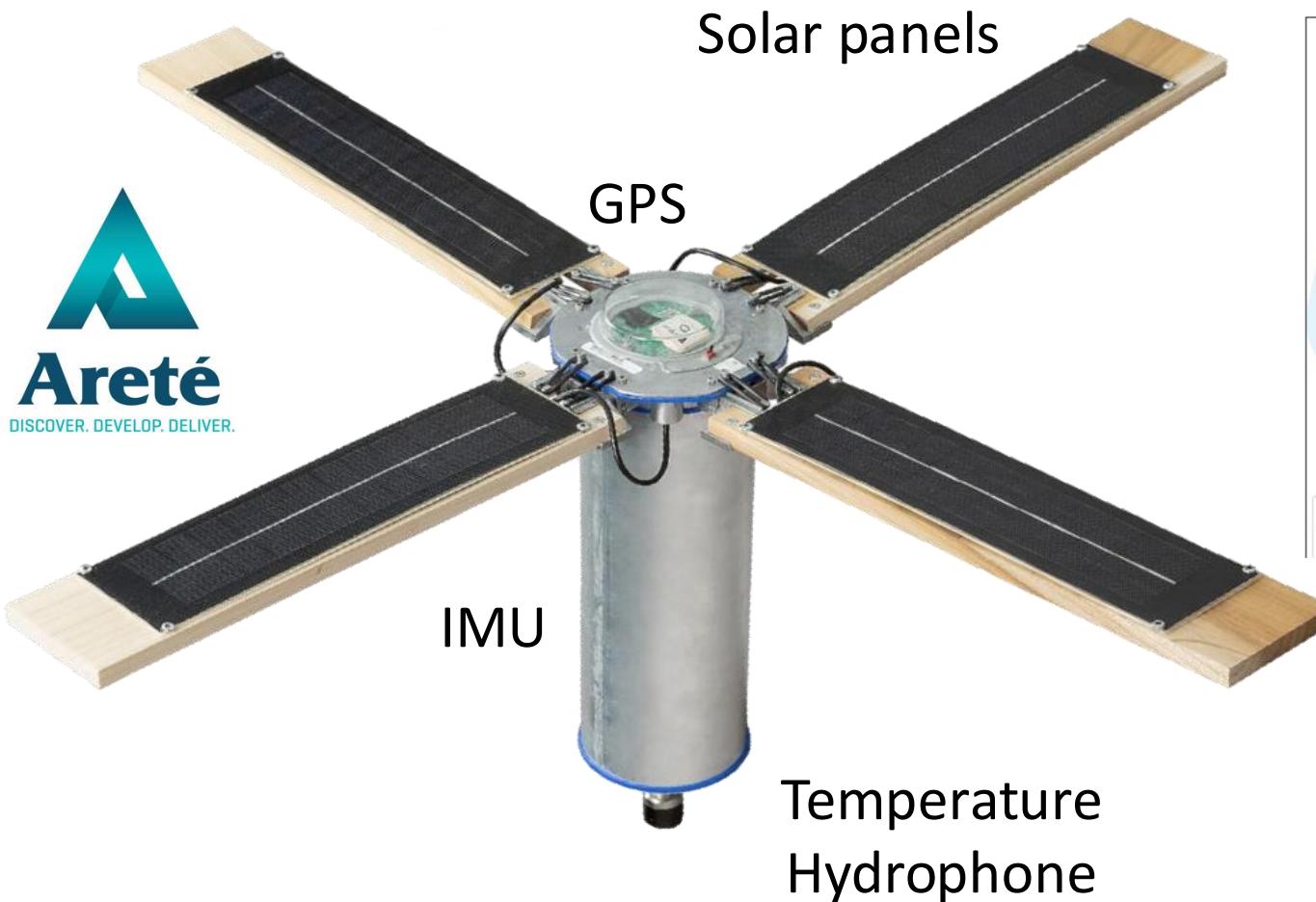


# Commercial Drifter - STRIDR



Trajectories of a 50 STRIDR deployment in the Gulf of Mexico, Sept. 2019. Trajectories are color-coded by velocity.

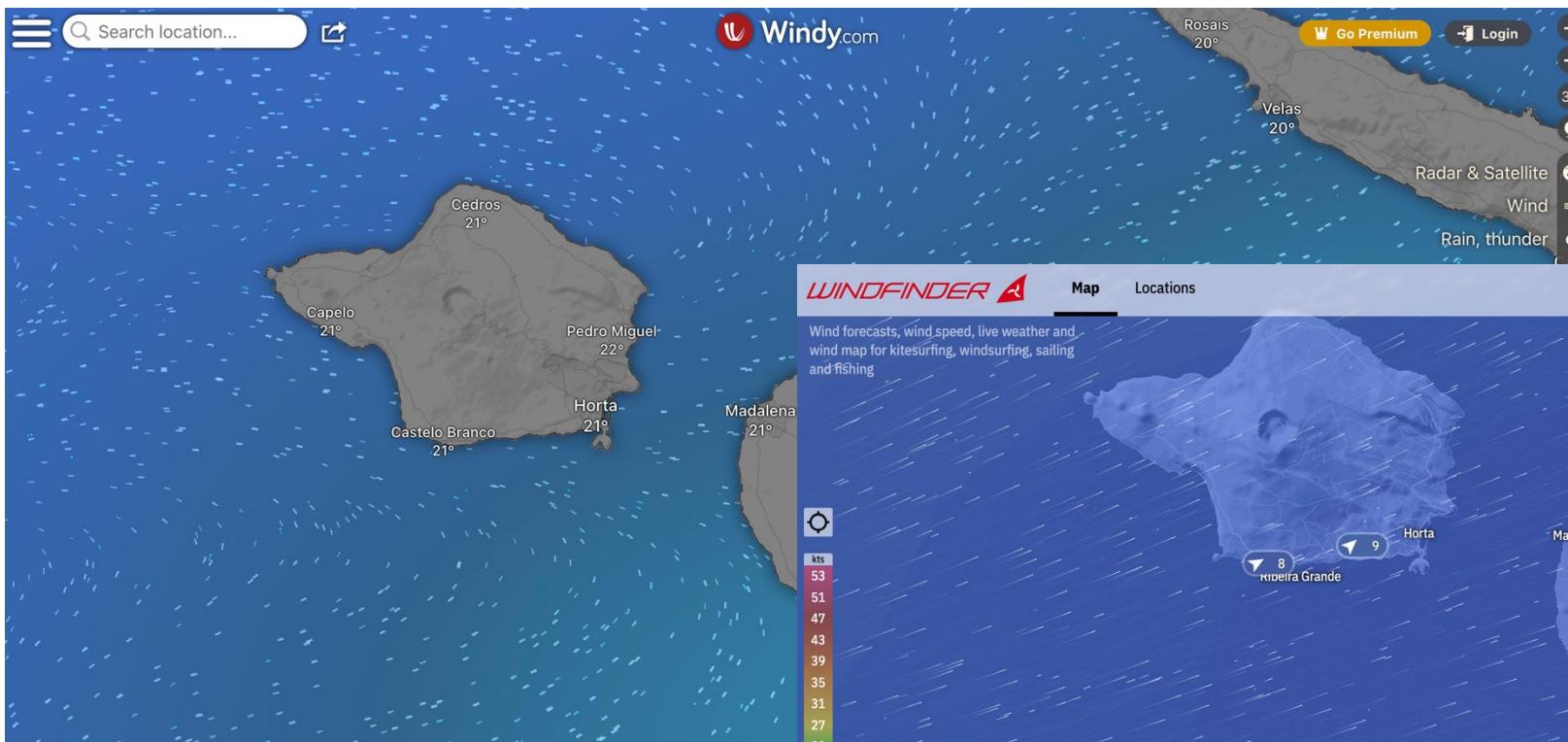
# Commercial Drifter - STRIDR



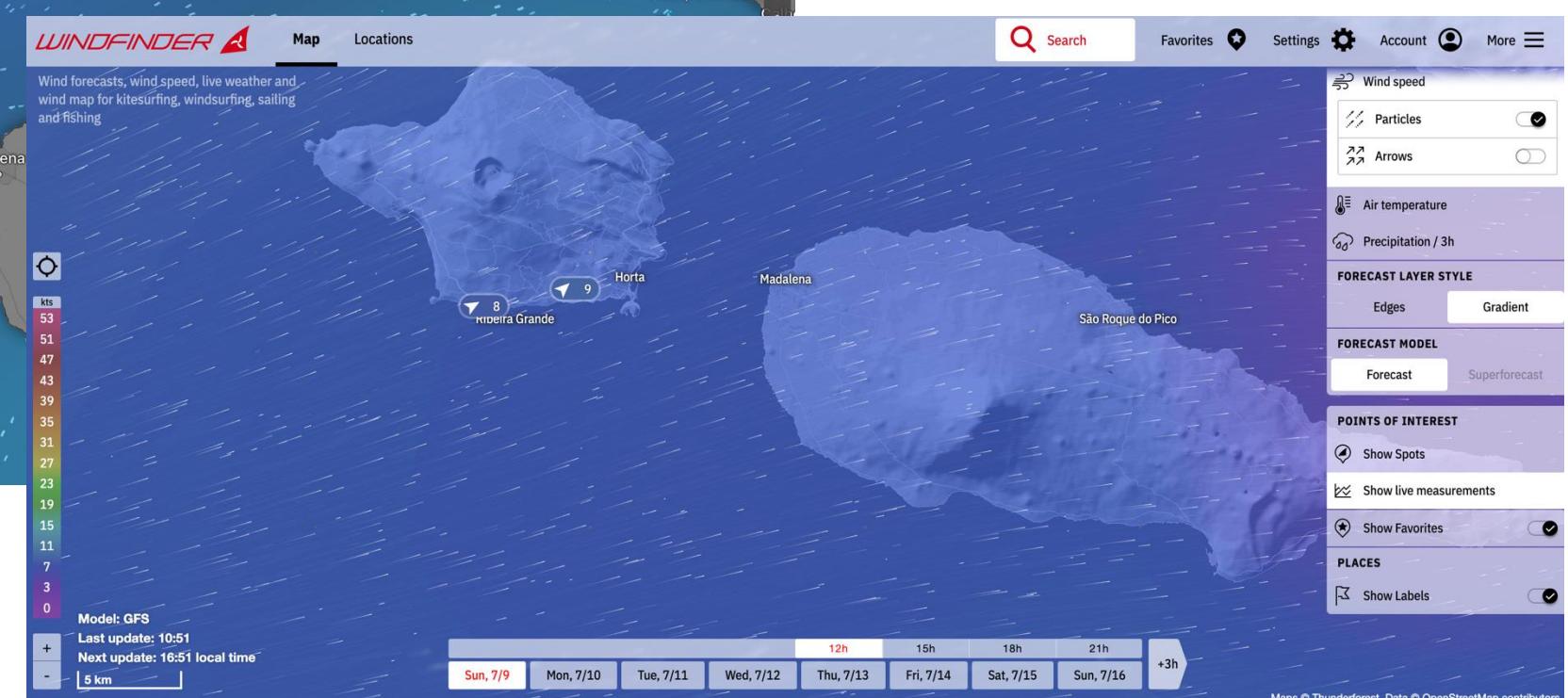
Need to add LoRaWAN communication Radio

# Drifter Tracking - Prediction

Windy.com



Windfinder.com



# Drifter Tracking - Resource

<https://www.buoyweather.com/map/azores>

<https://en.allmetsat.com/marine-weather/azores.php>

<https://search.earthdata.nasa.gov/search?fs10=ocean%20currents&fsm0=ocean%20circulation&fst0=oceans&lat=4.830891180153927&long=28.08984375&zoom=3>

<https://map.openseamap.org/>

<https://satellitemaps.nesdis.noaa.gov/arcgis/apps/webappviewer3d/index.html?id=ced40646adeb41f1ad60786a23f03edf>

<https://earth.nullschool.net/#current/ocean/surface/currents/orthographic=-26.79,38.40,4951>

<https://www.arcgis.com/home/webmap/viewer.html?webmap=72c523c47ae241f0821f21773eb20709#!>

<https://www.star.nesdis.noaa.gov/GOES/sector.php?sat=G16&sector=na>

[https://www.aoml.noaa.gov/phod/gdp/interactive/drifter\\_array.html](https://www.aoml.noaa.gov/phod/gdp/interactive/drifter_array.html)

[https://ocean.weather.gov/Atl\\_tab.php](https://ocean.weather.gov/Atl_tab.php)

<https://svs.gsfc.nasa.gov/3912>

<https://www.accuweather.com/en/pt/national/wind-flow>

# Drifter Tracking

