Failure modes

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« Every float has a story to tell »

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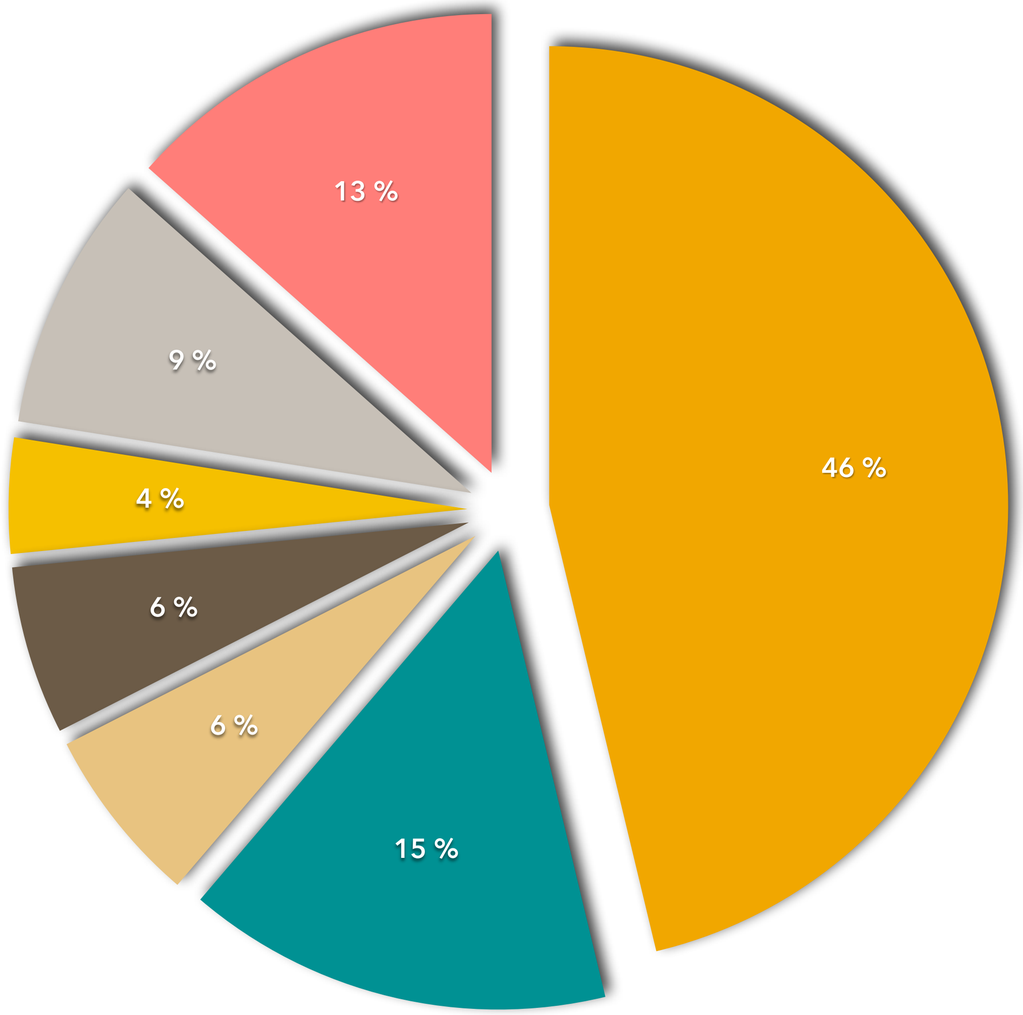
Failure rates



- Natural battery
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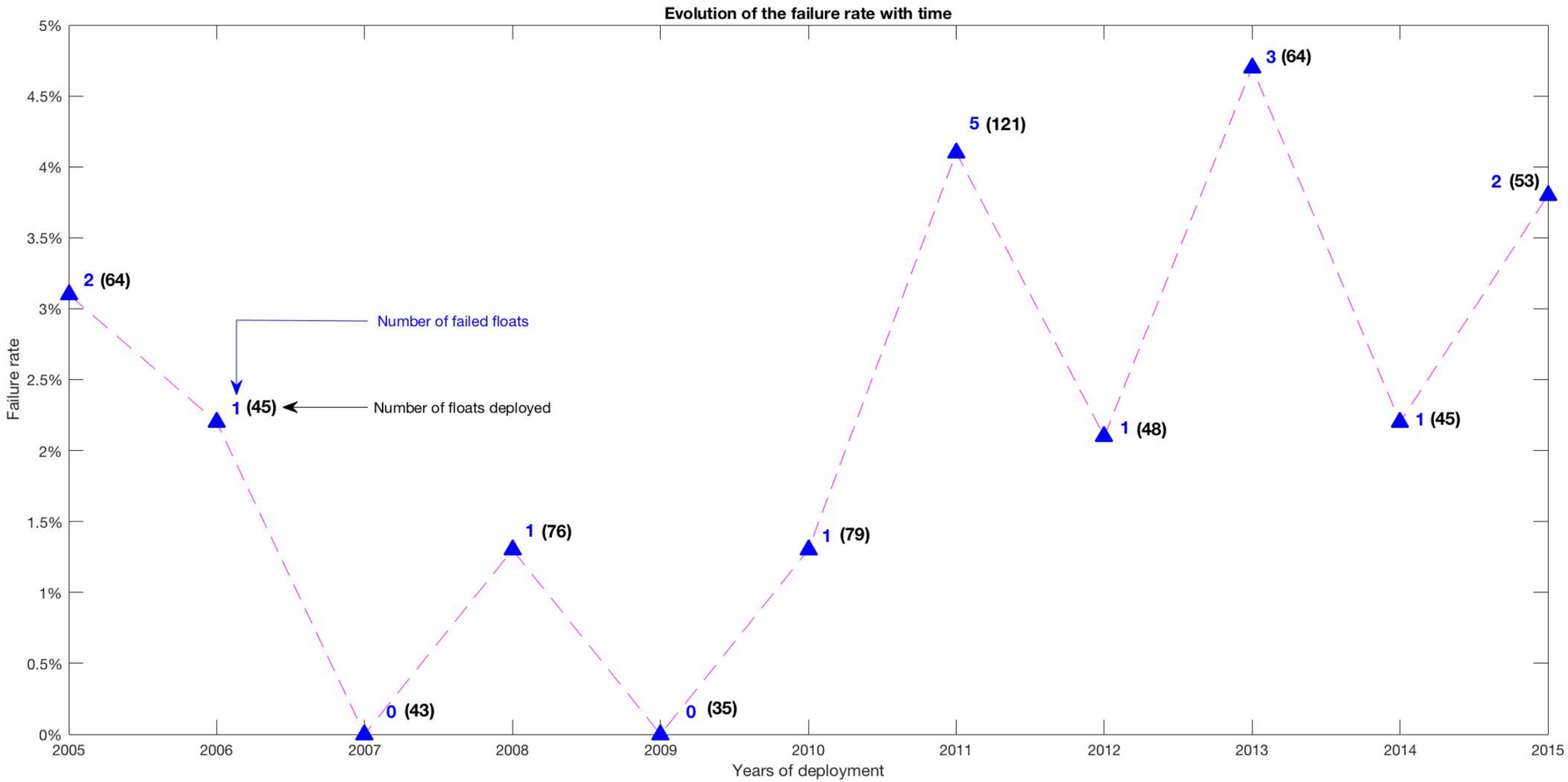
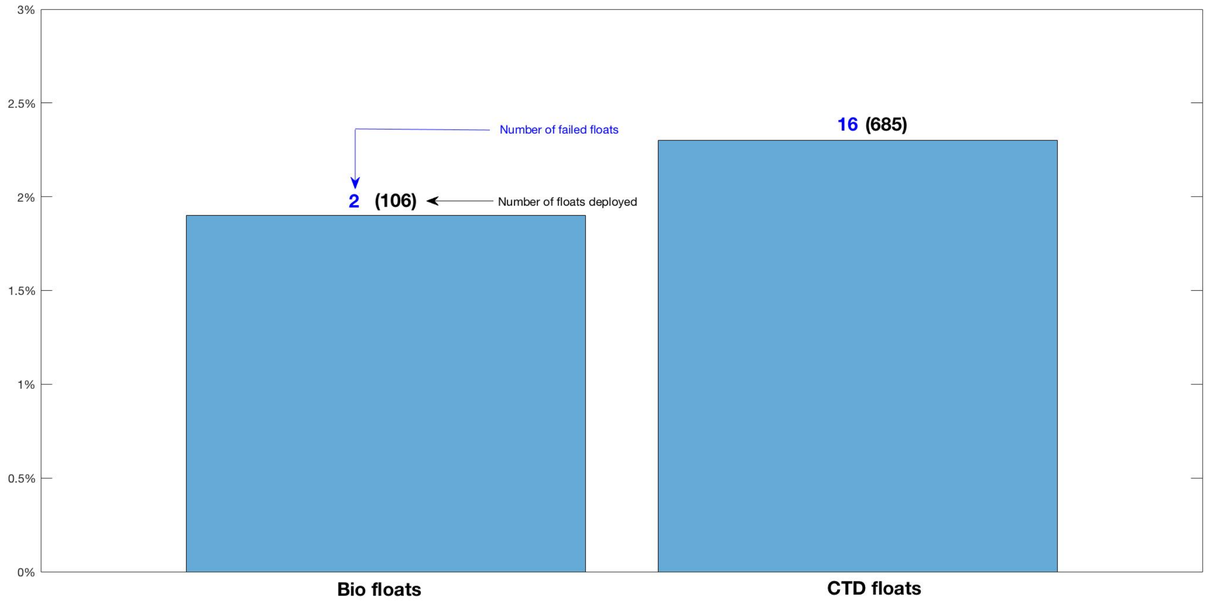
Situation for the Australian floats

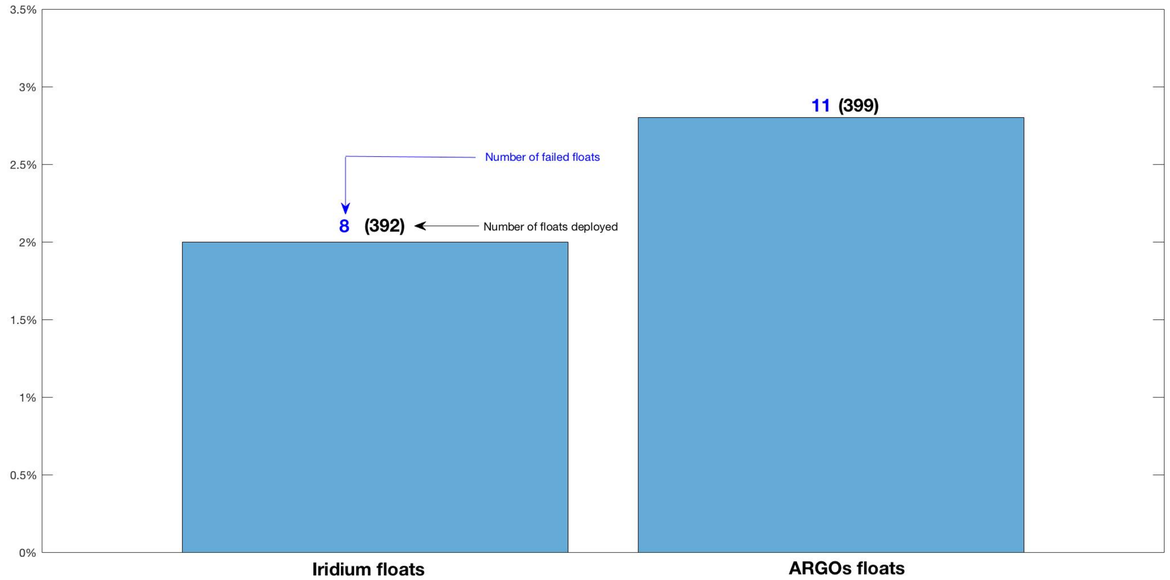
Evolution of failure rates



Situation for the Australian floats

Comparison of failure rates





The failure rate depends on the type of float launched at sea.

Typical evolution

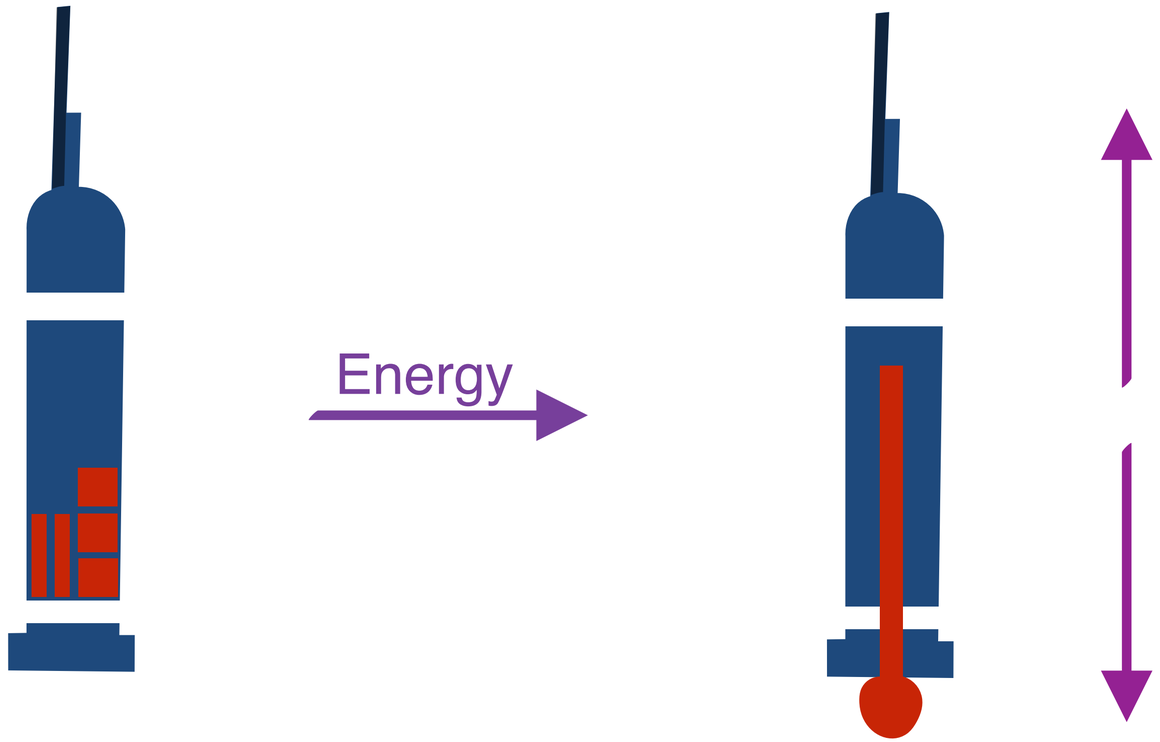
Typical evolution of a float

How an ARGO float works ?

Battery pack

Typical evolution of a float

How an ARGO float works ?

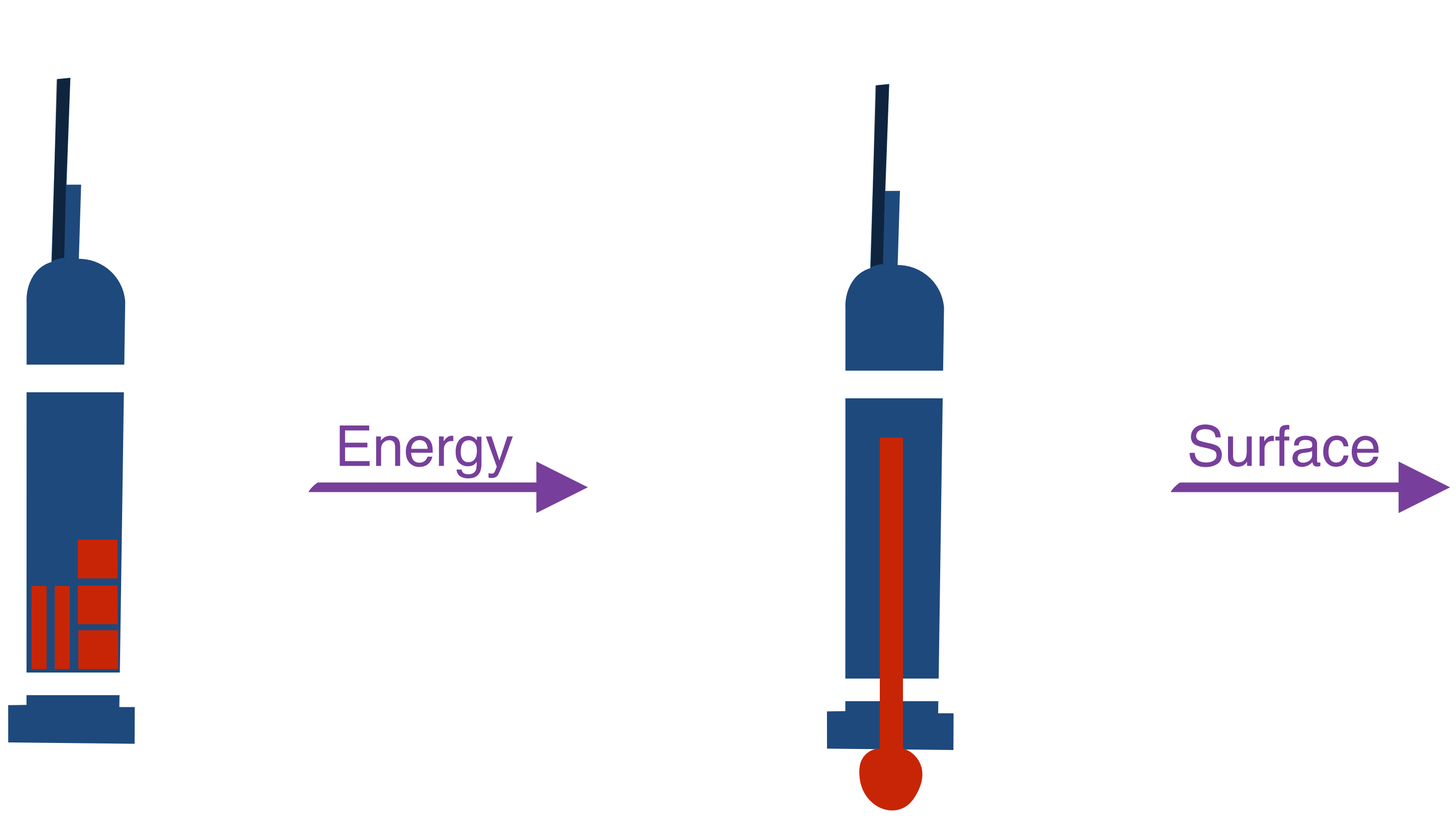


Battery pack

Movement of the piston position

Typical evolution of a float

How an ARGO float works ?



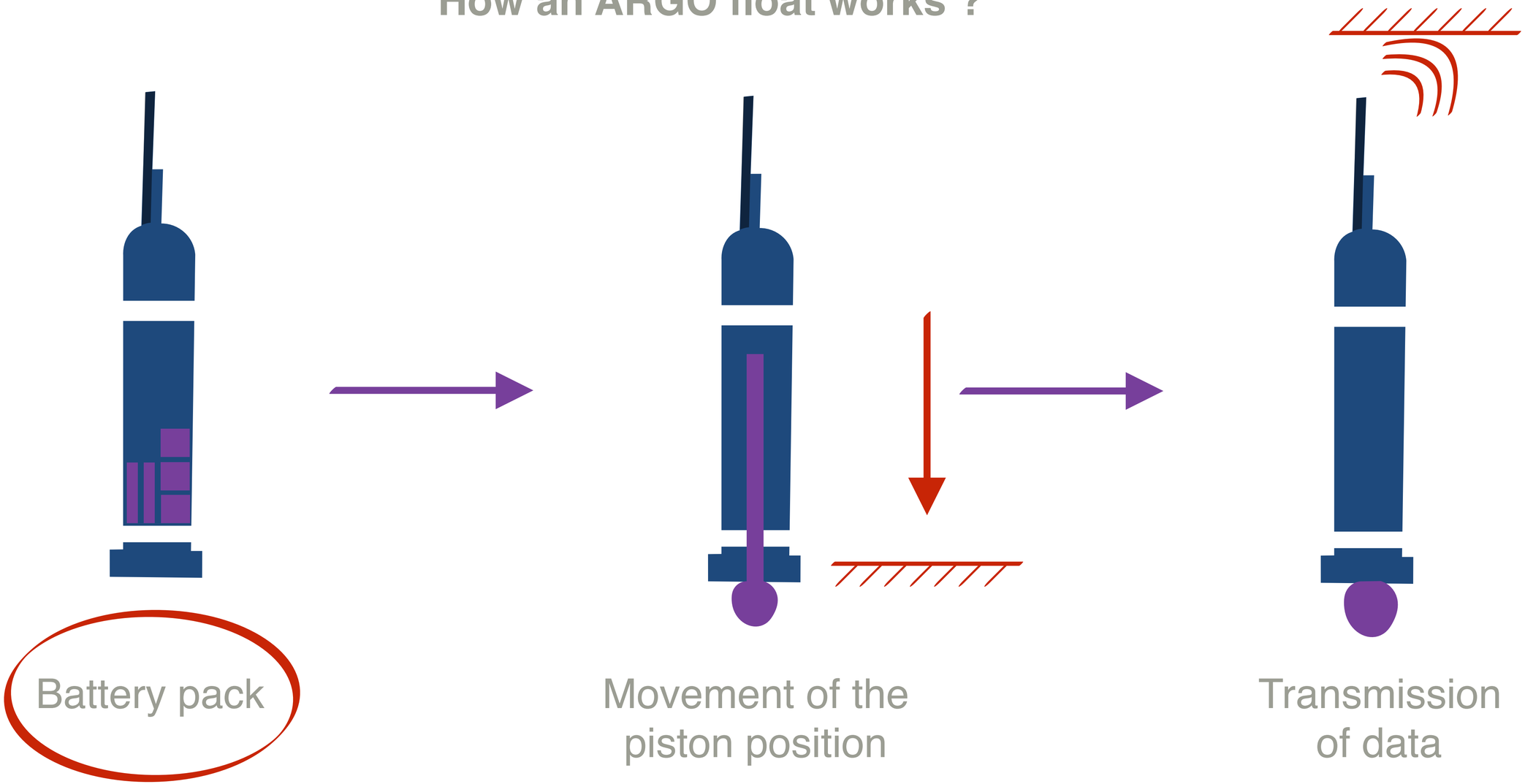
Battery pack

Movement of the piston position

Transmission of data

Typical evolution of a float

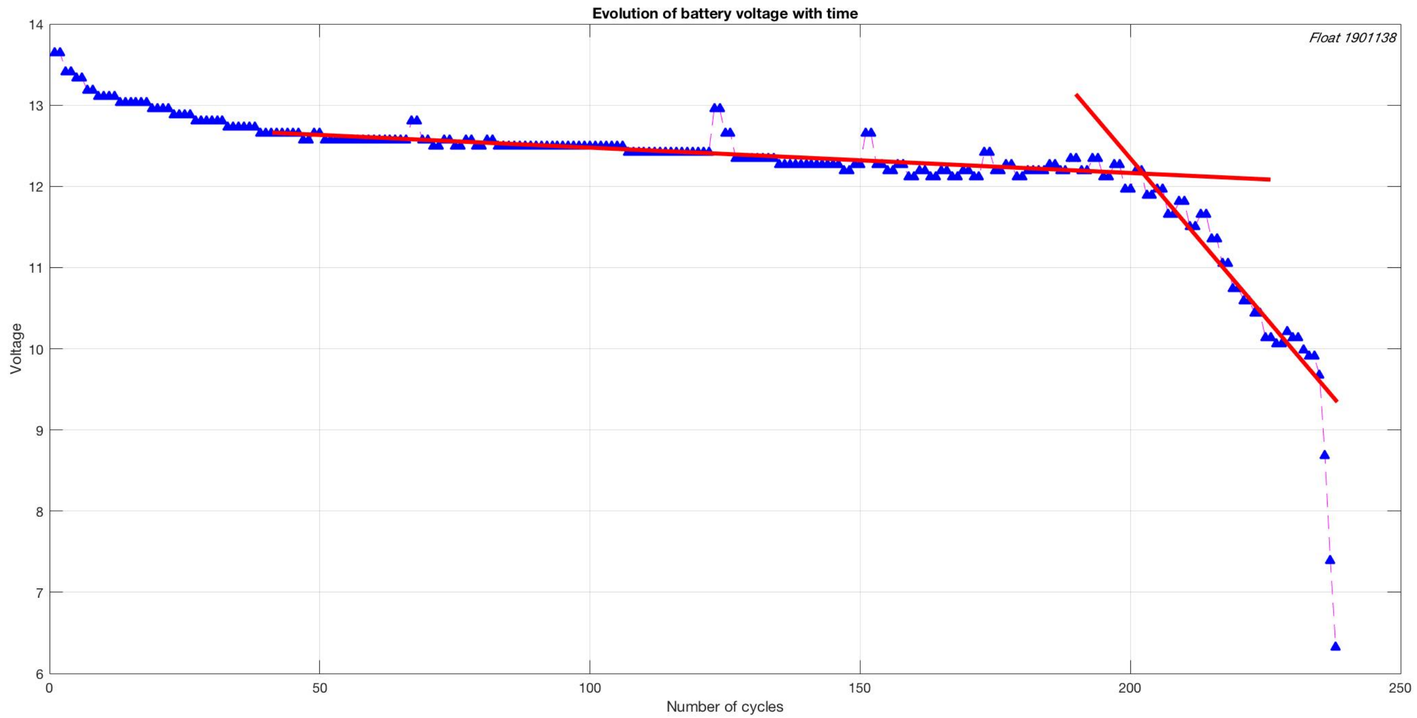
How an ARGO float works ?



Typical evolution of a float

Battery power distribution

Because the battery is the only source of power, if the voltage starts being critical, the float will not be able to survive for a long time.



Step 1: slight decrease of the voltage.

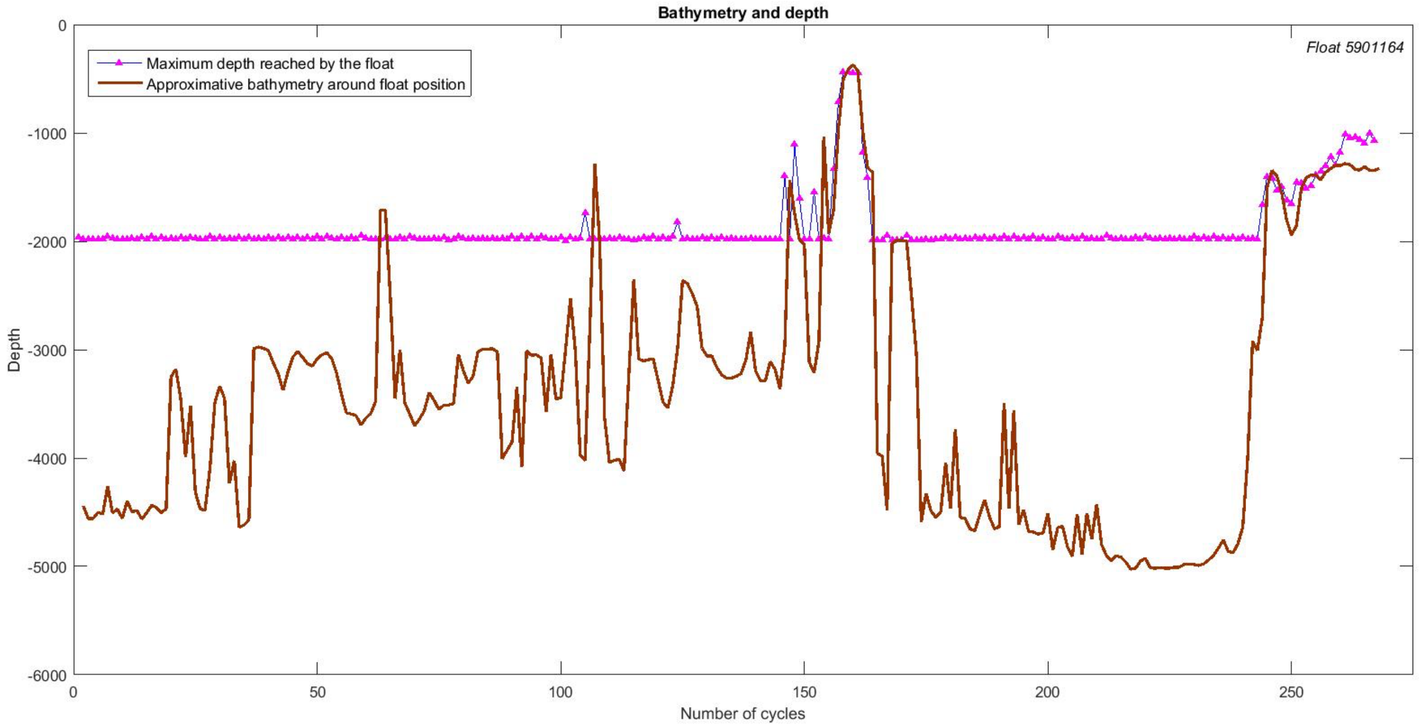
Step 2: significant loss of voltage.

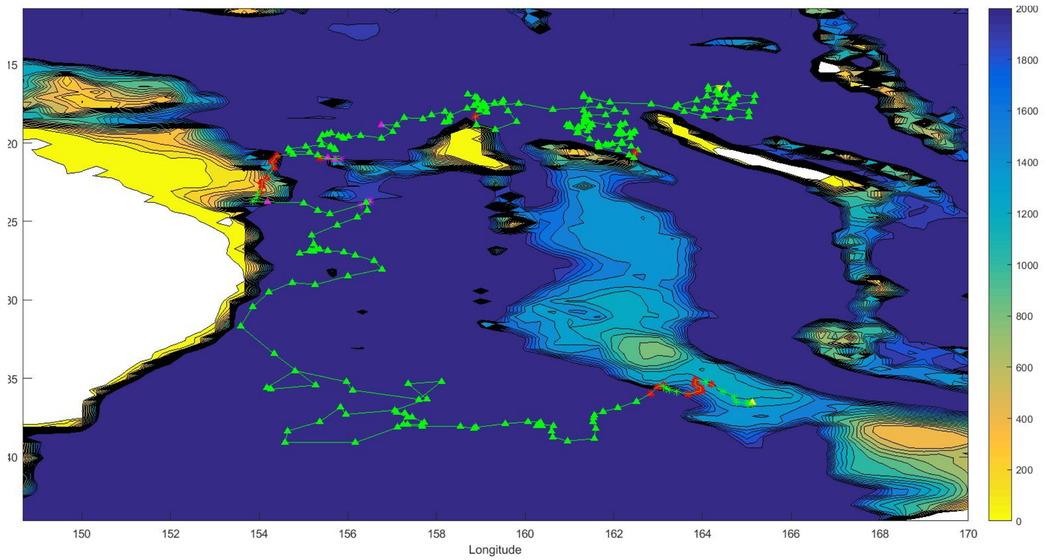
When the evolution starts being non-linear, the clock is ticking.

Typical evolution of a float

Bathymetry trouble

To characterize this problem, there is no other way than mapping the position of the float, and having a quick look to its environment.

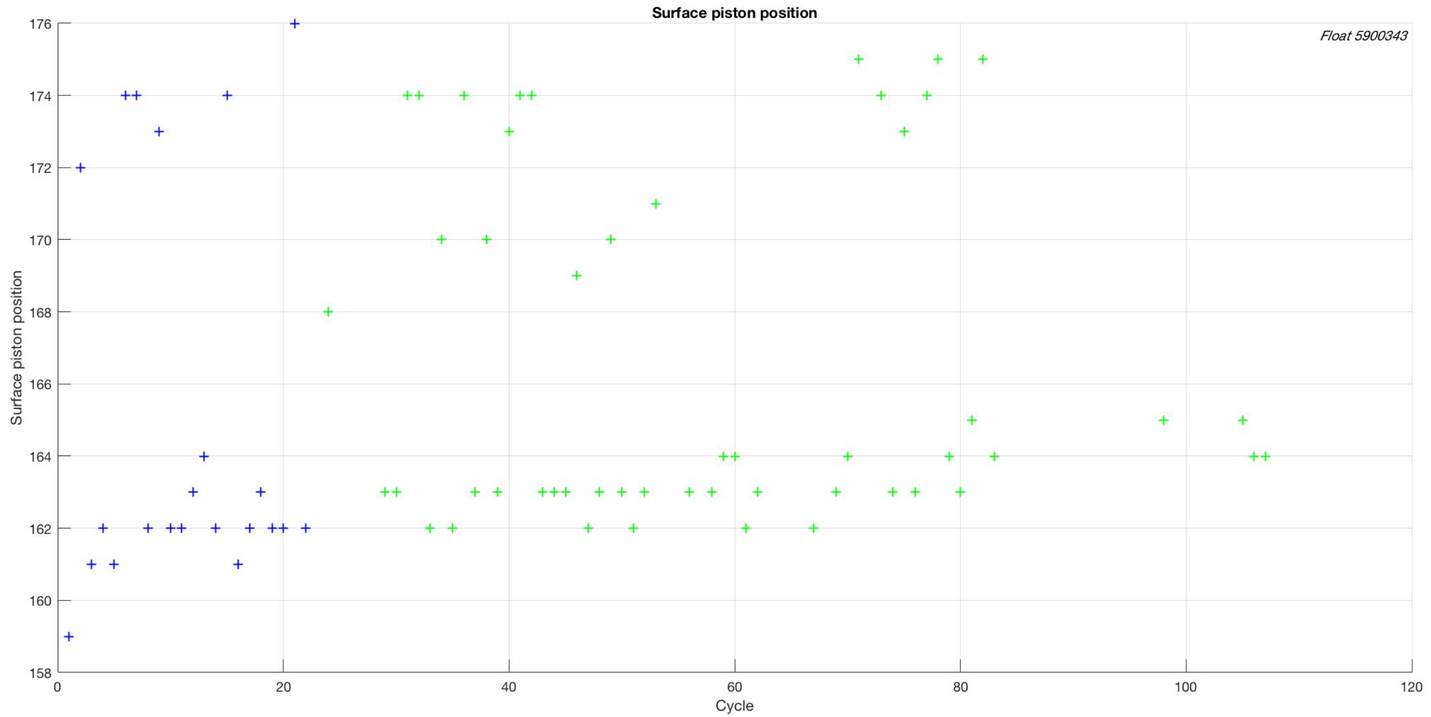


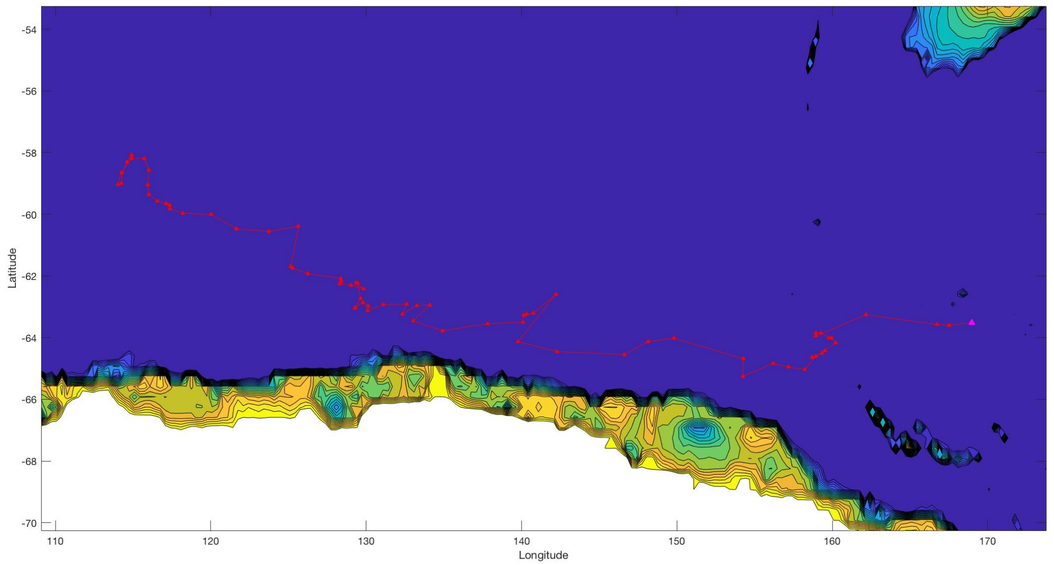


Typical evolution of a float

Ice trouble

In order to characterize this trouble, the surface piston position can be plotted with incorporating an ice detection flag.



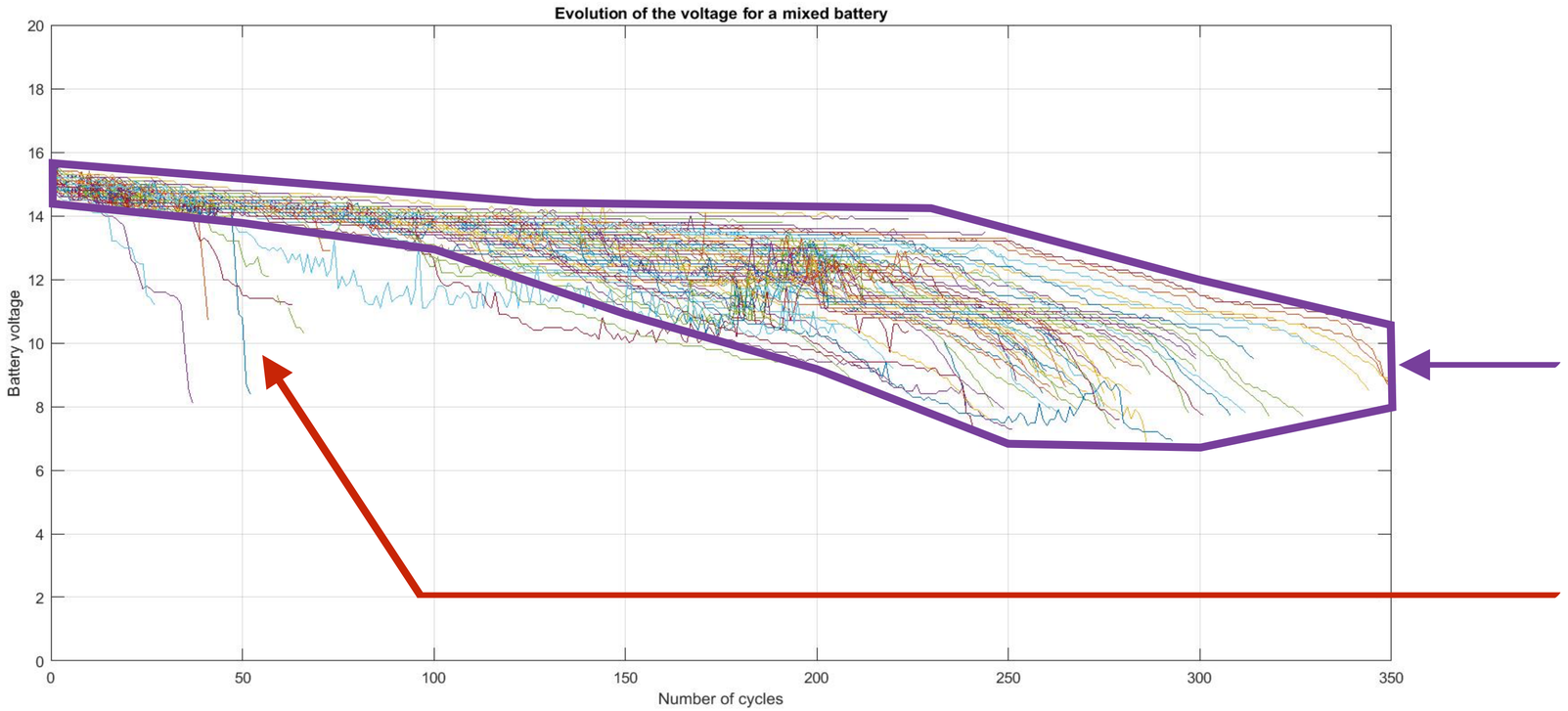


Detection of failures

Detection of failures

Battery failures

By plotting the battery voltage in function of the number of cycles for each type of battery, it is possible to emphasize a failure due to a manufacturing defect.



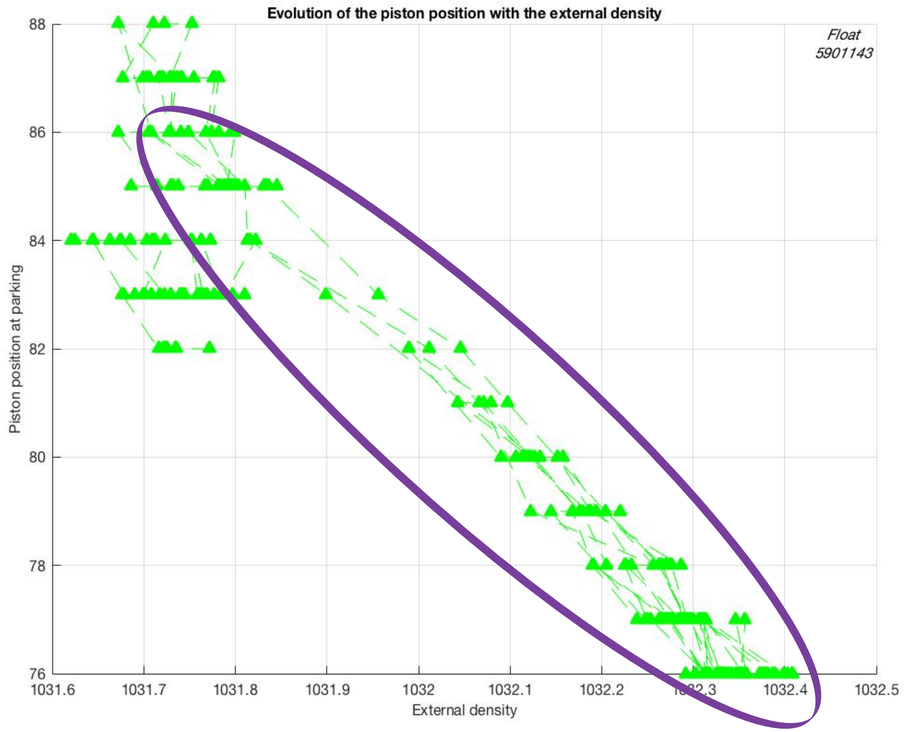
Main path followed by the float batteries.

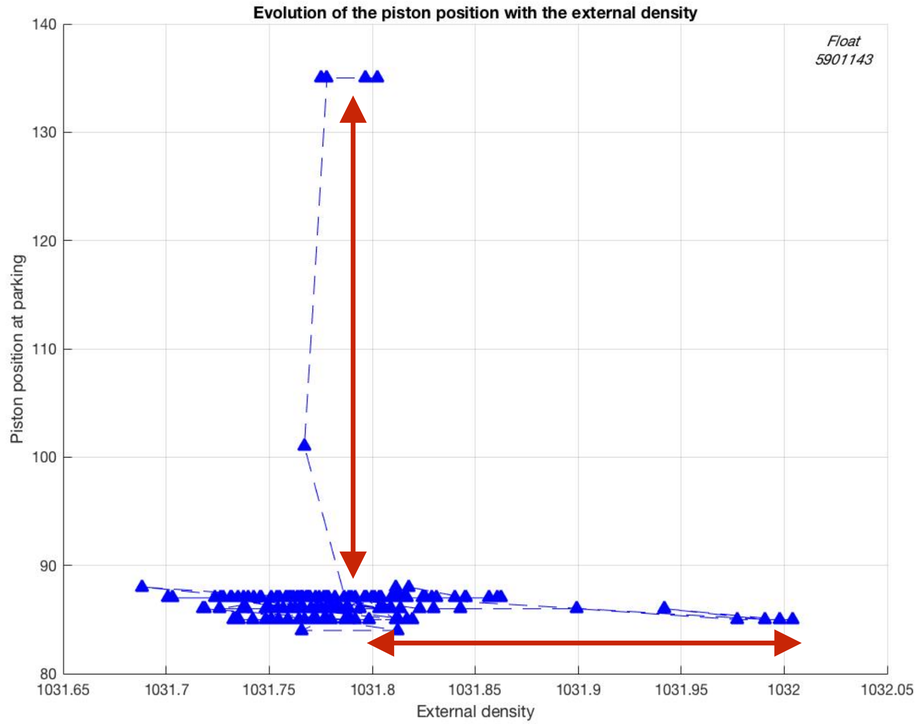
Detection and characterization of failures.

Detection of failures

Piston position trouble

A key element of a float is its piston because it permits to create the movement by controlling the buoyancy though the oil bladder. How to detect a problem of piston positioning ?

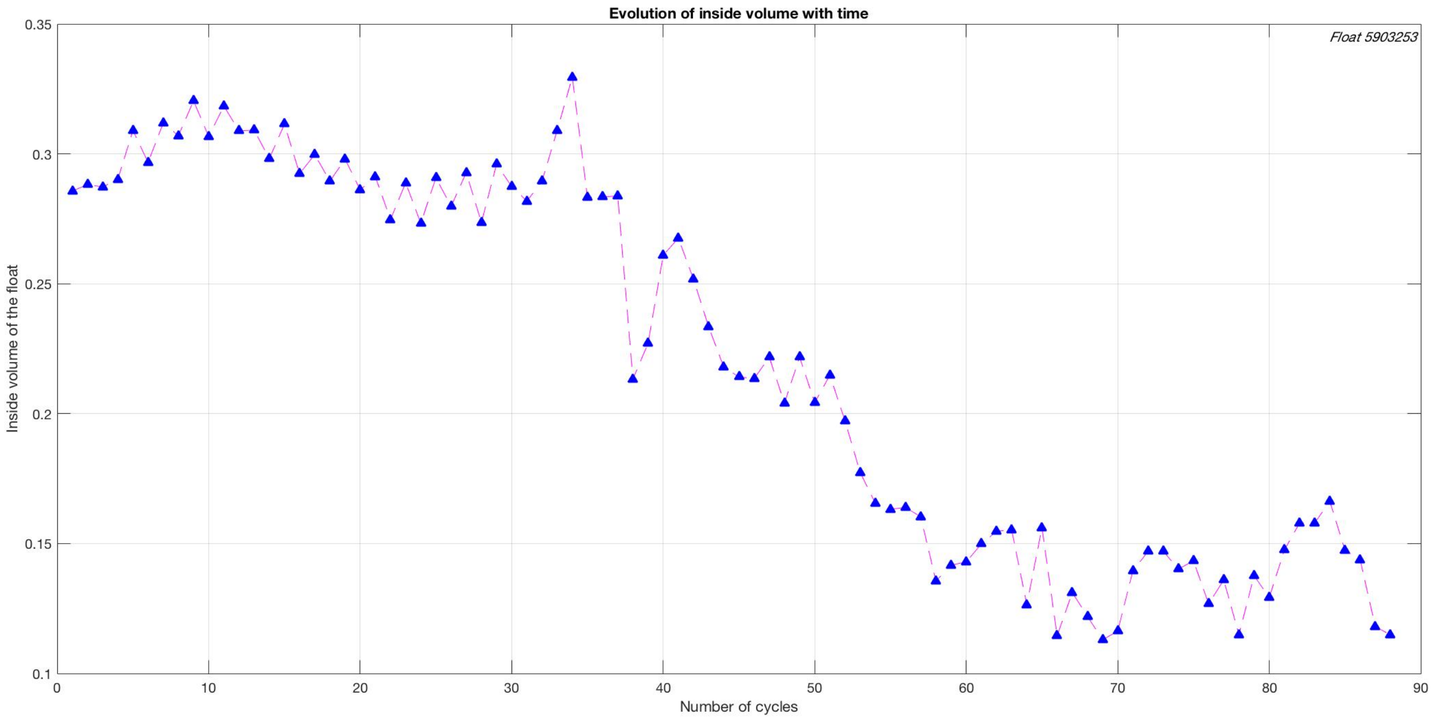




Detection of failures

Leaking issue

A lack of tightness will entail an accumulation of water inside of the float, then its weight will increase and its propulsion system will be in trouble.



$$P_i \cdot V_i = n \cdot R \cdot T_i$$

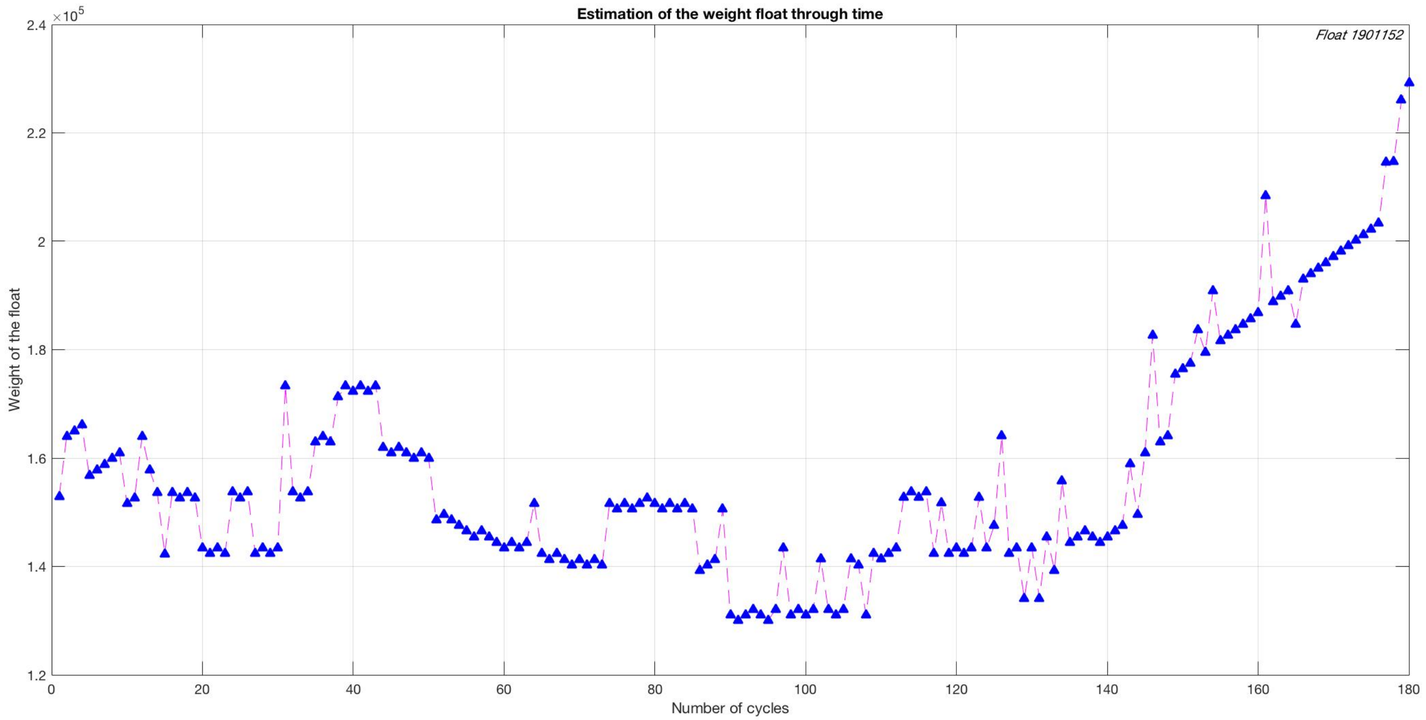
P_i: through the internal vacuum.

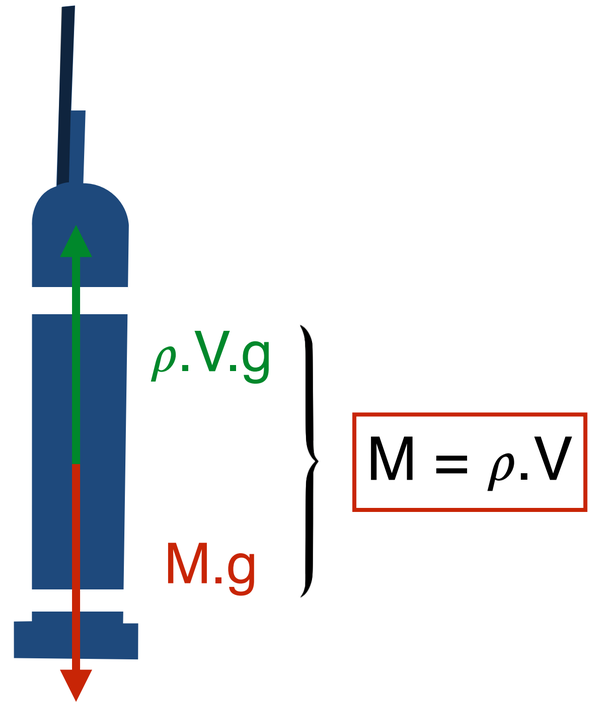
T_i: through the CTD sensor.

Detection of failures

Change of weight issue

At parking, the piston position is calibrated in order to equalize the buoyancy of the float to its weight: the Archimedes force permit to compensate the weight.

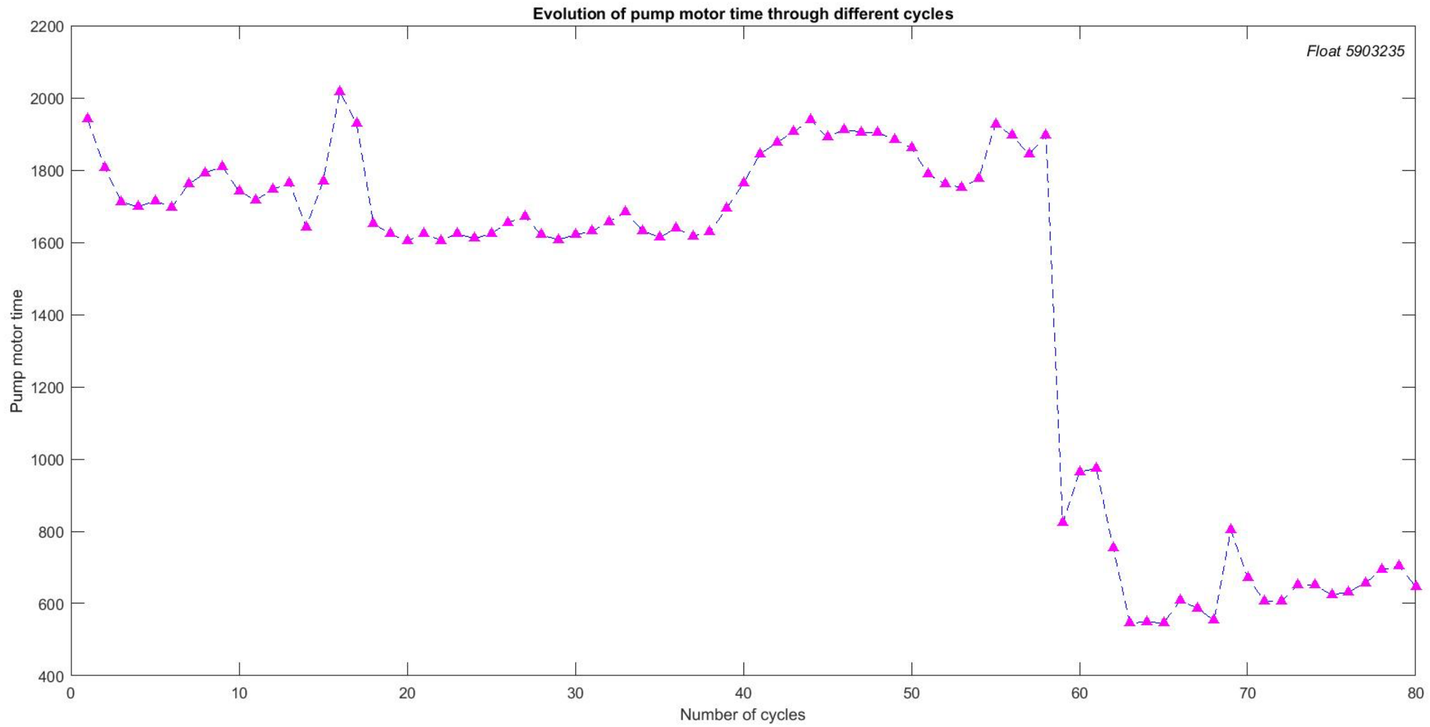




Detection of failures

Pump motor issue

The role of the pump motor is crucial because it permits to link the source of power (the battery) to the control of the movement (piston position).



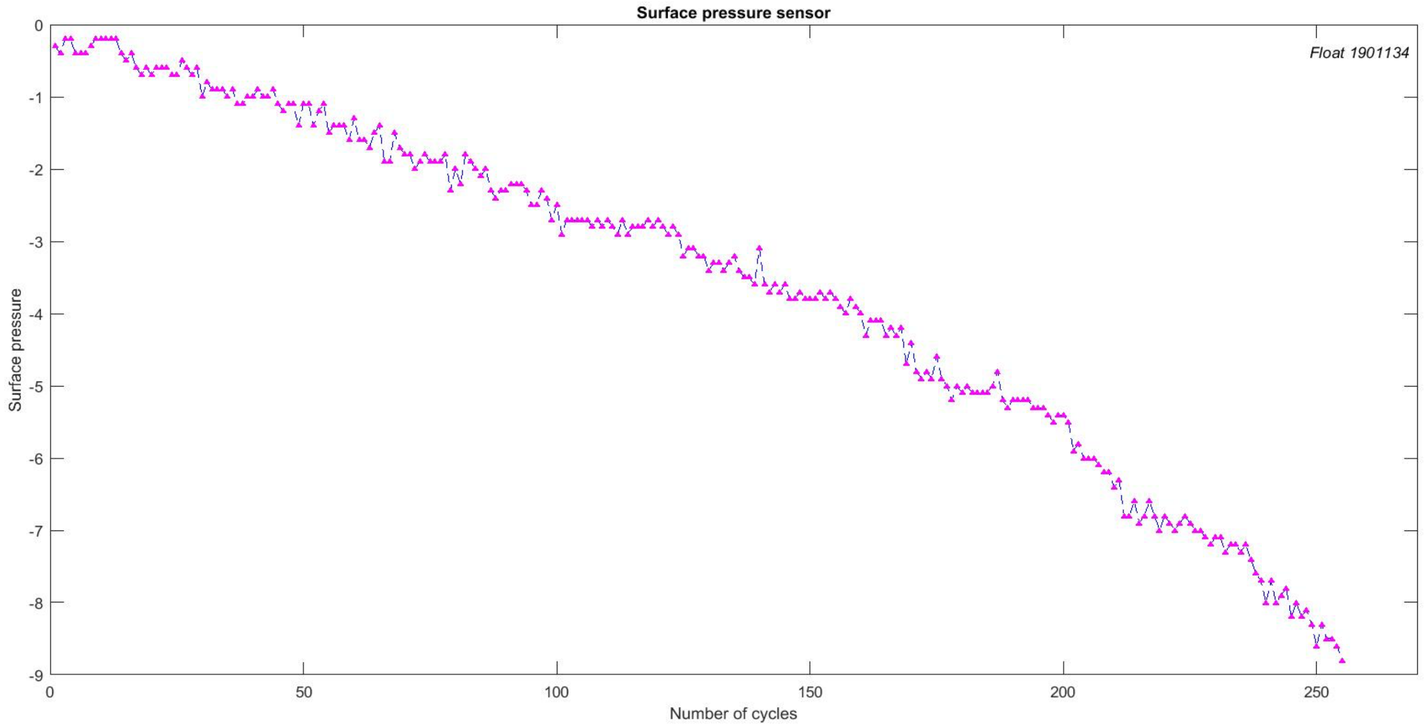
The tricky part is to understand if the failure of the pump motor is the consequence of another problem or if it is the reason of the failure.

Detection of failures

Pressure sensor issue

The controller of the buoyancy depends directly on the precision of the pressure determination.

Then, if there is an error of measurements the float won't be able to survive long.

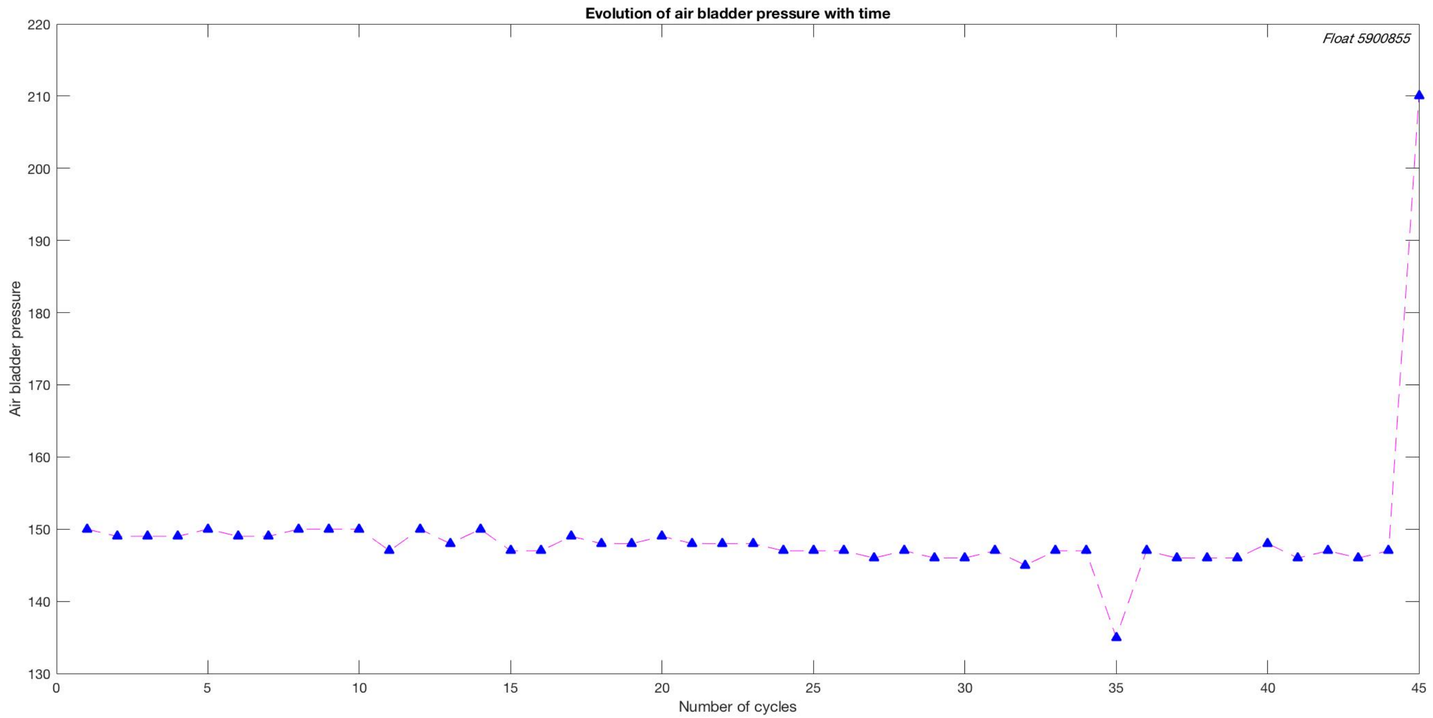


The slight decrease is due to a micro leak of the pressure sensor.

Detection of failures

Air bladder issue

The air bladder permits at the float to reach the surface. If the pressure is not high enough, the increase of the buoyancy won't be enough.

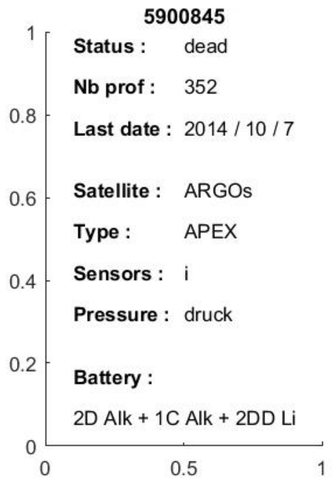


In that case, the float won't be able to transmit its data and will appear as not reporting.

Implementation

Implementation

Presentation of the program



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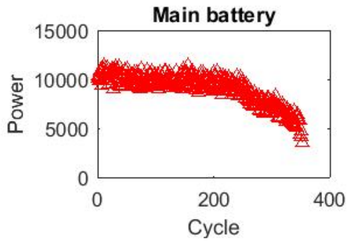

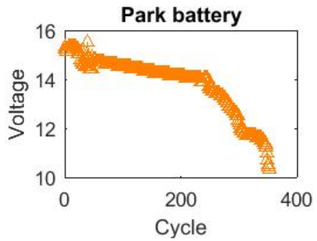

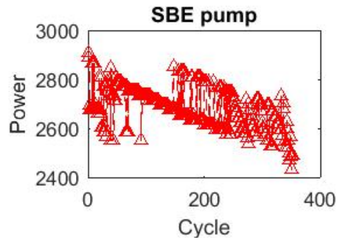

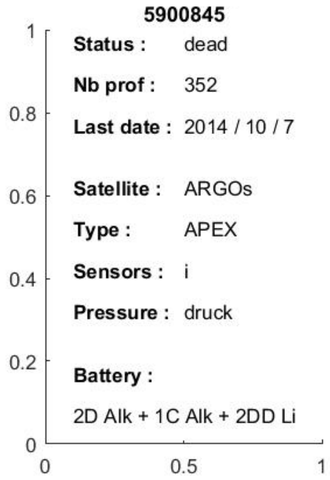

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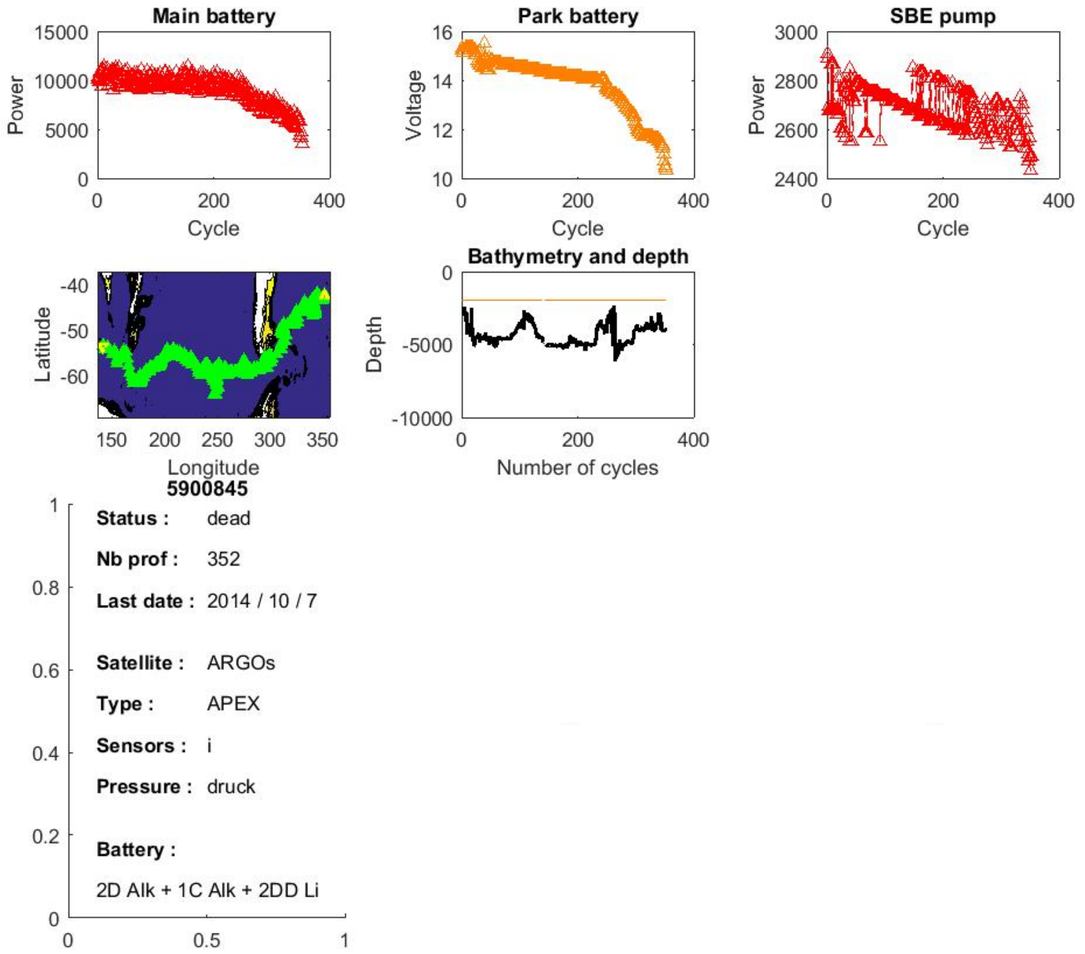

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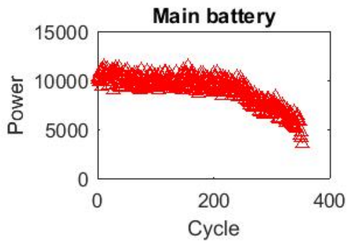

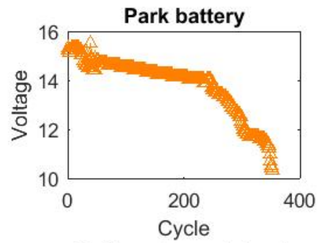

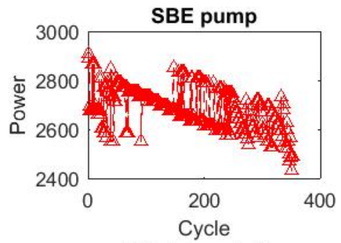

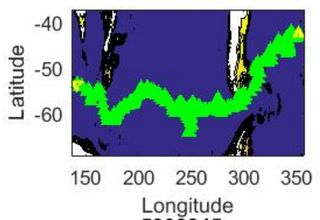

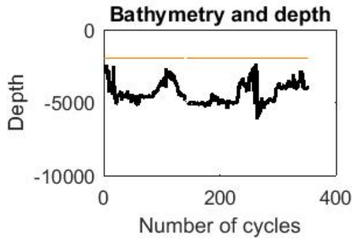

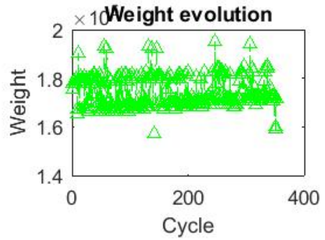

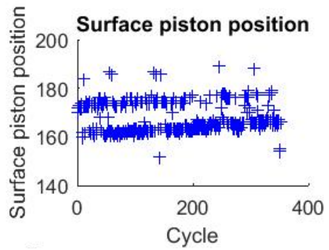

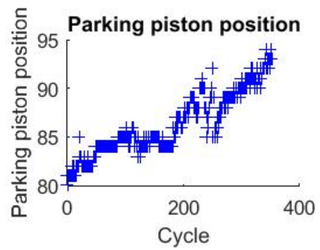

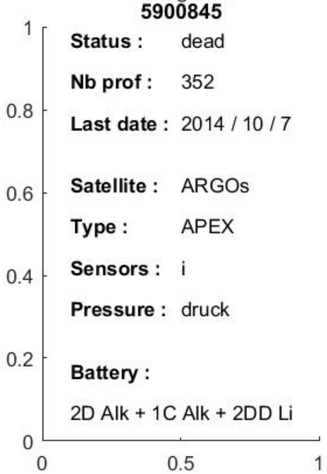

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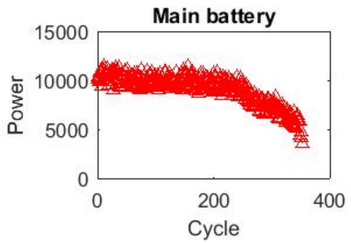

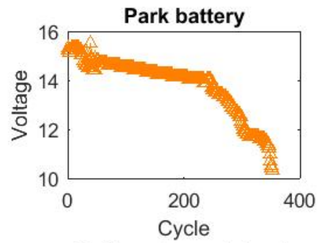

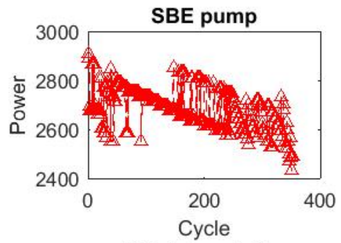

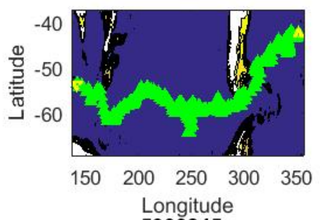

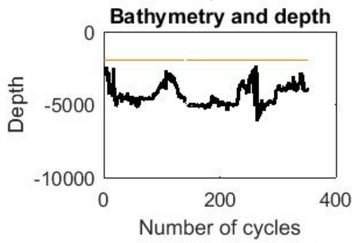

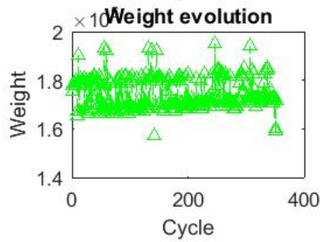

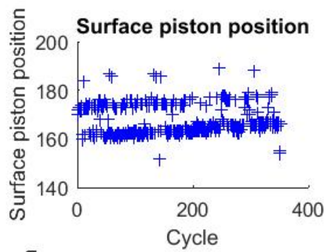

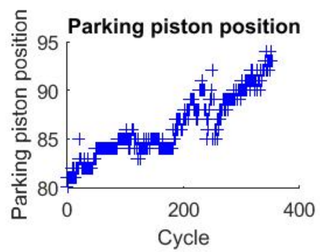

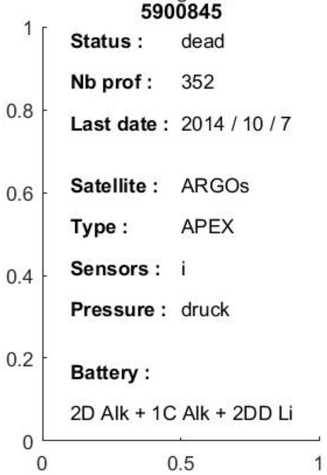

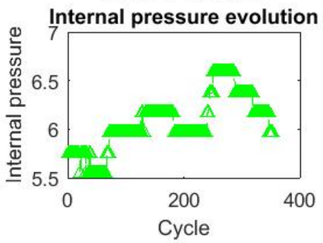

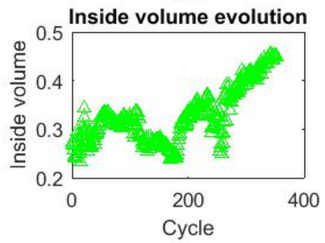

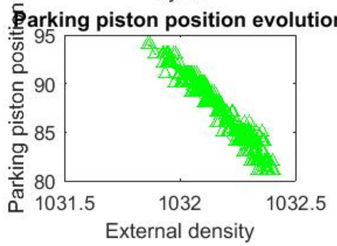

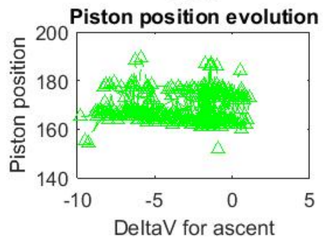

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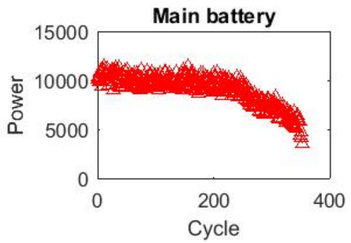
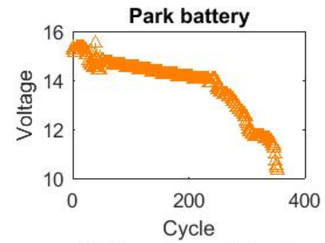
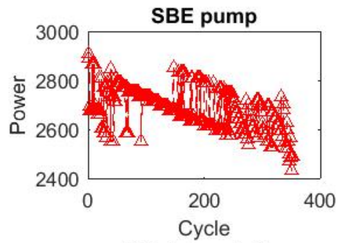
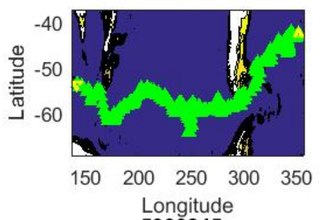
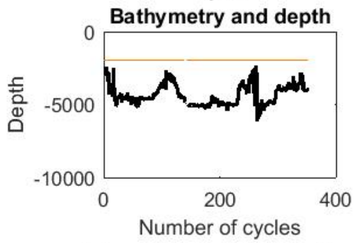
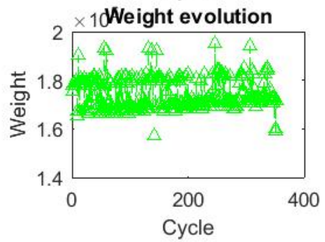


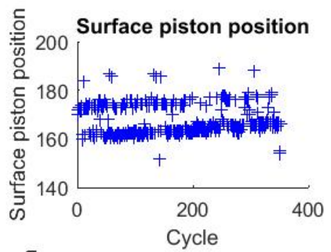


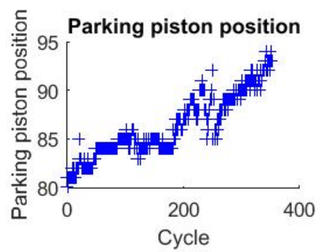


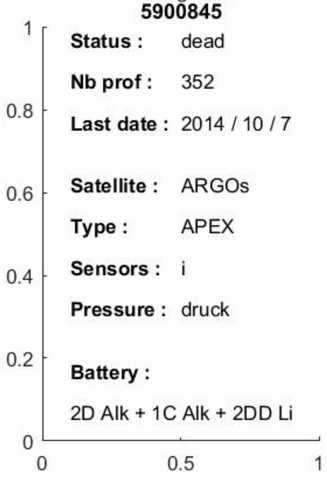


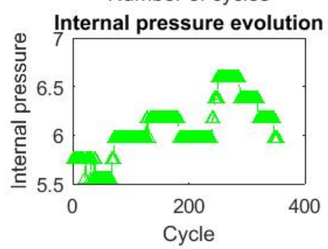


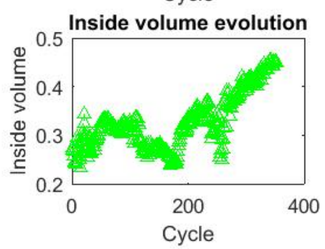


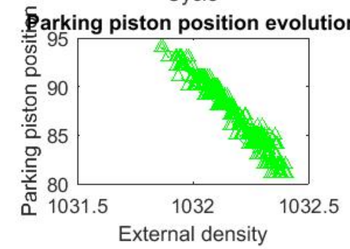


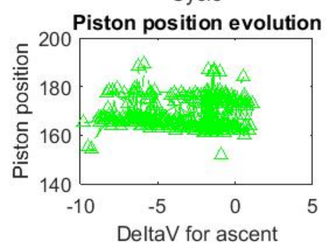


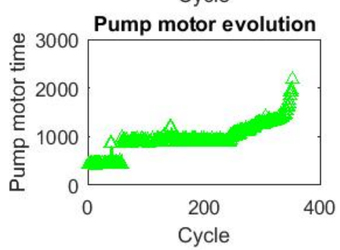


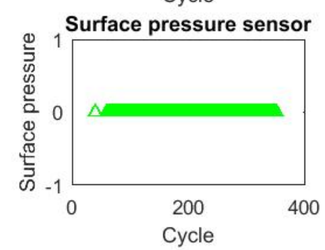


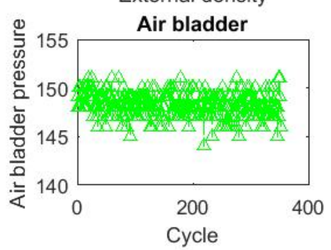






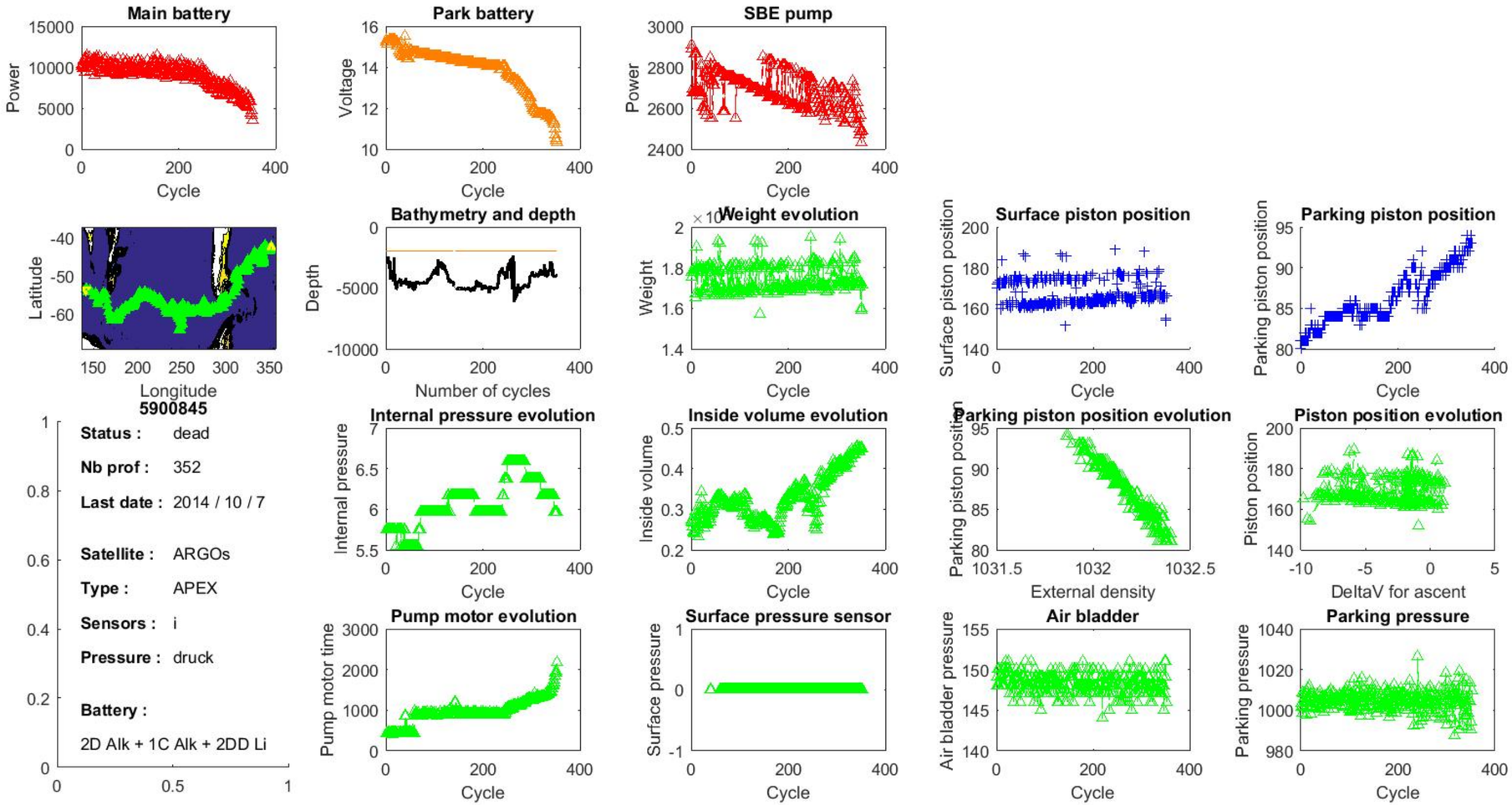






Implementation

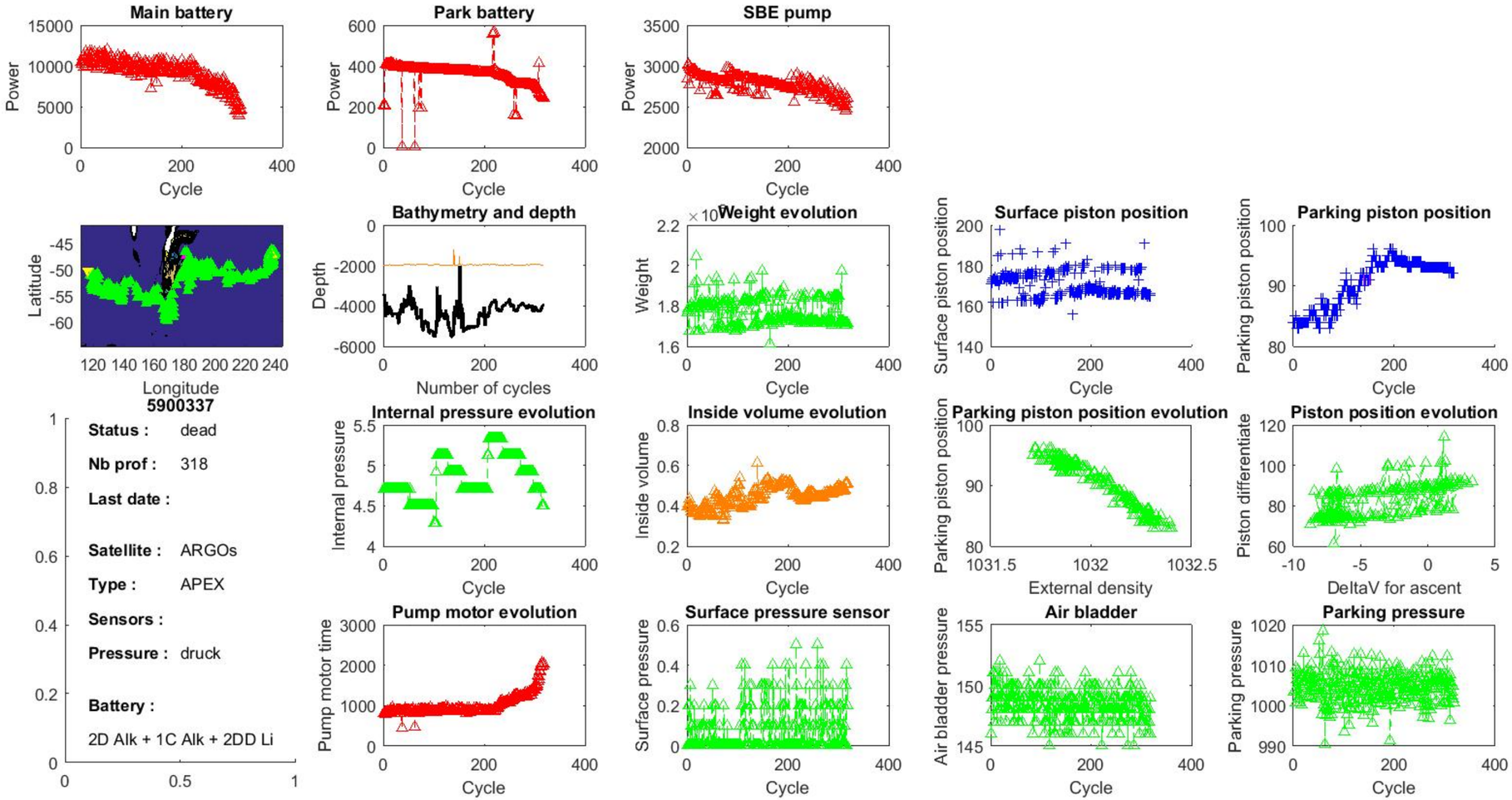
Presentation of the program



Iconical exemples

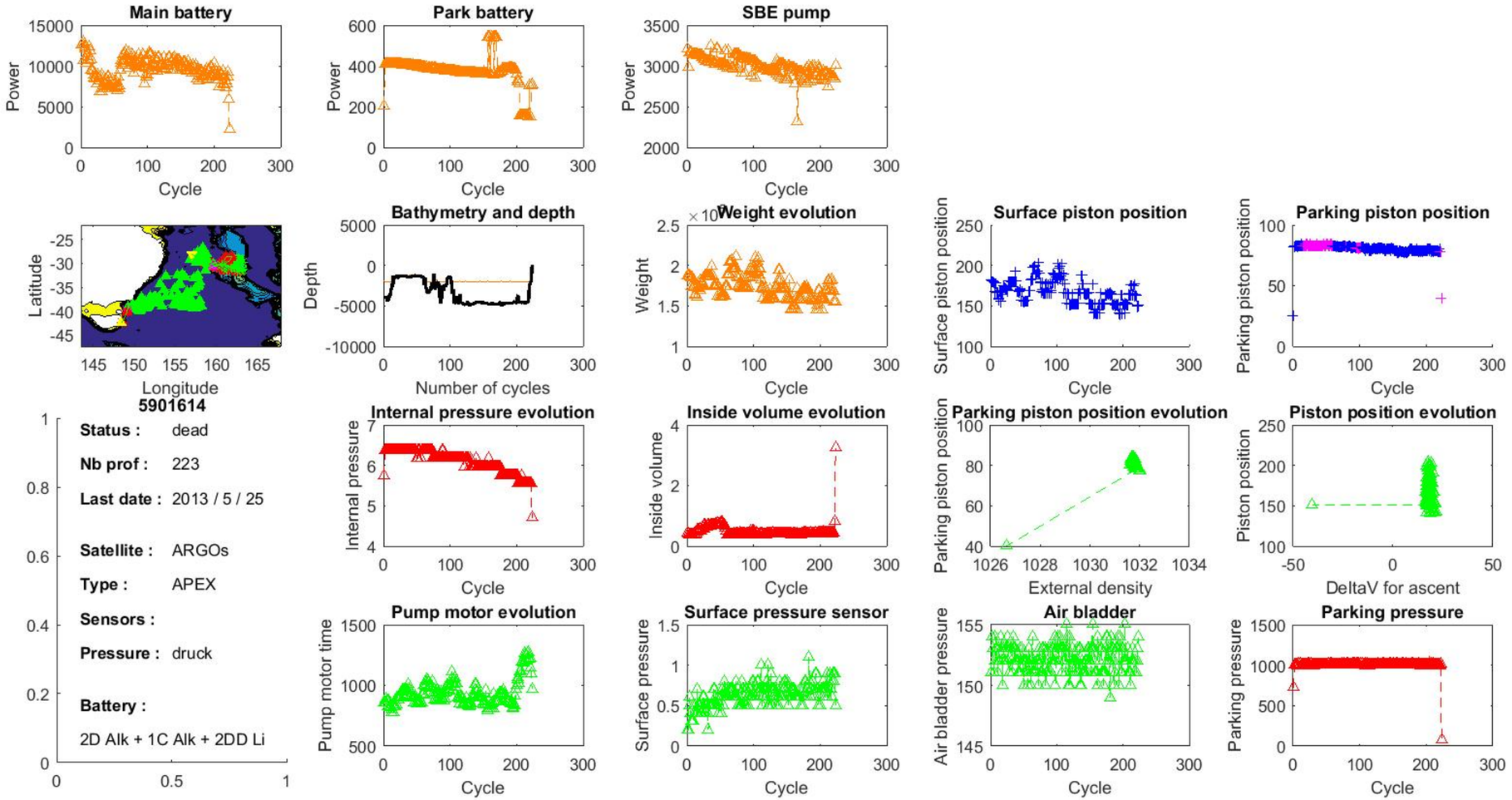
Implementation

Natural death



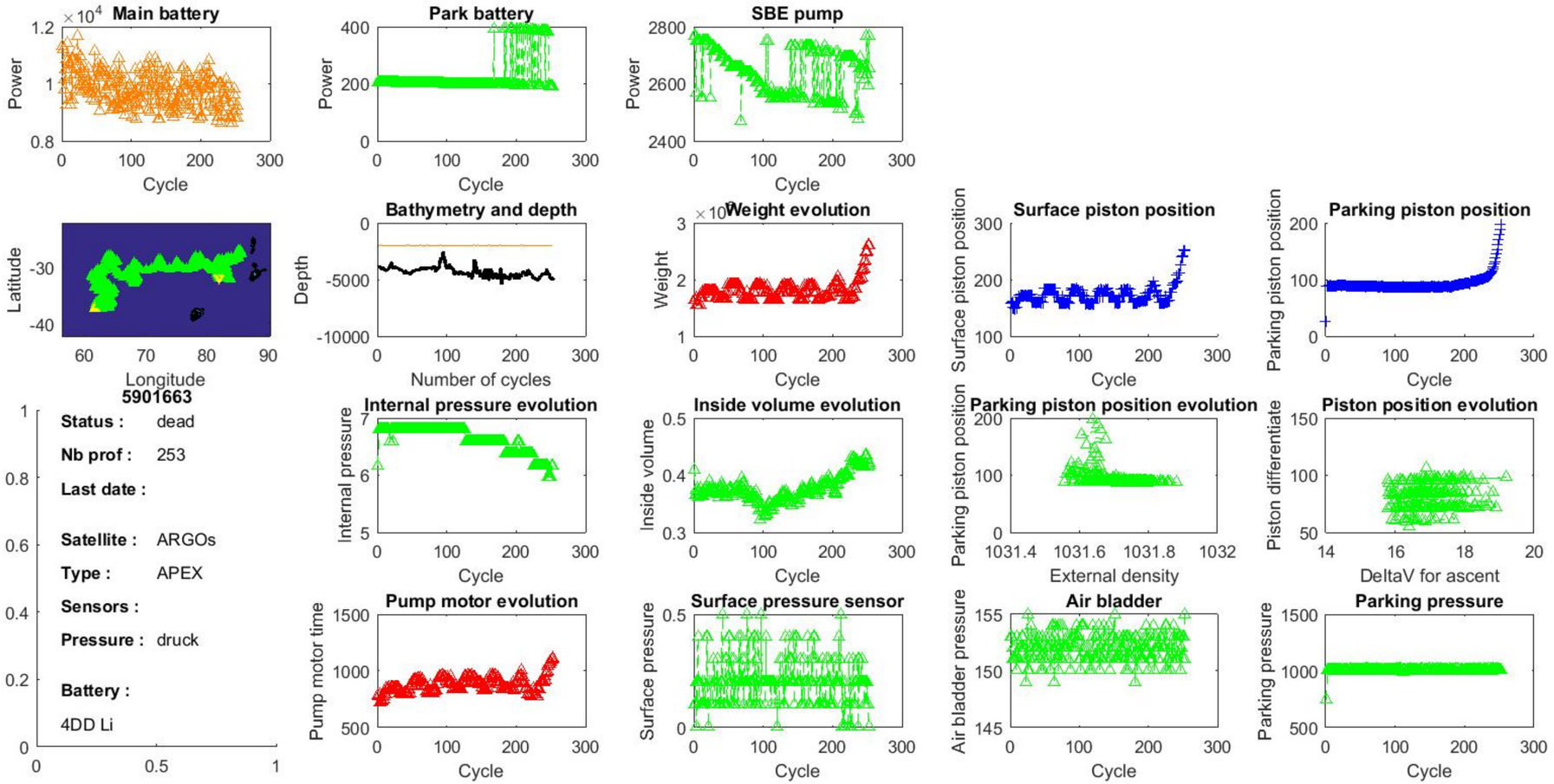
Implementation

Bathymetry



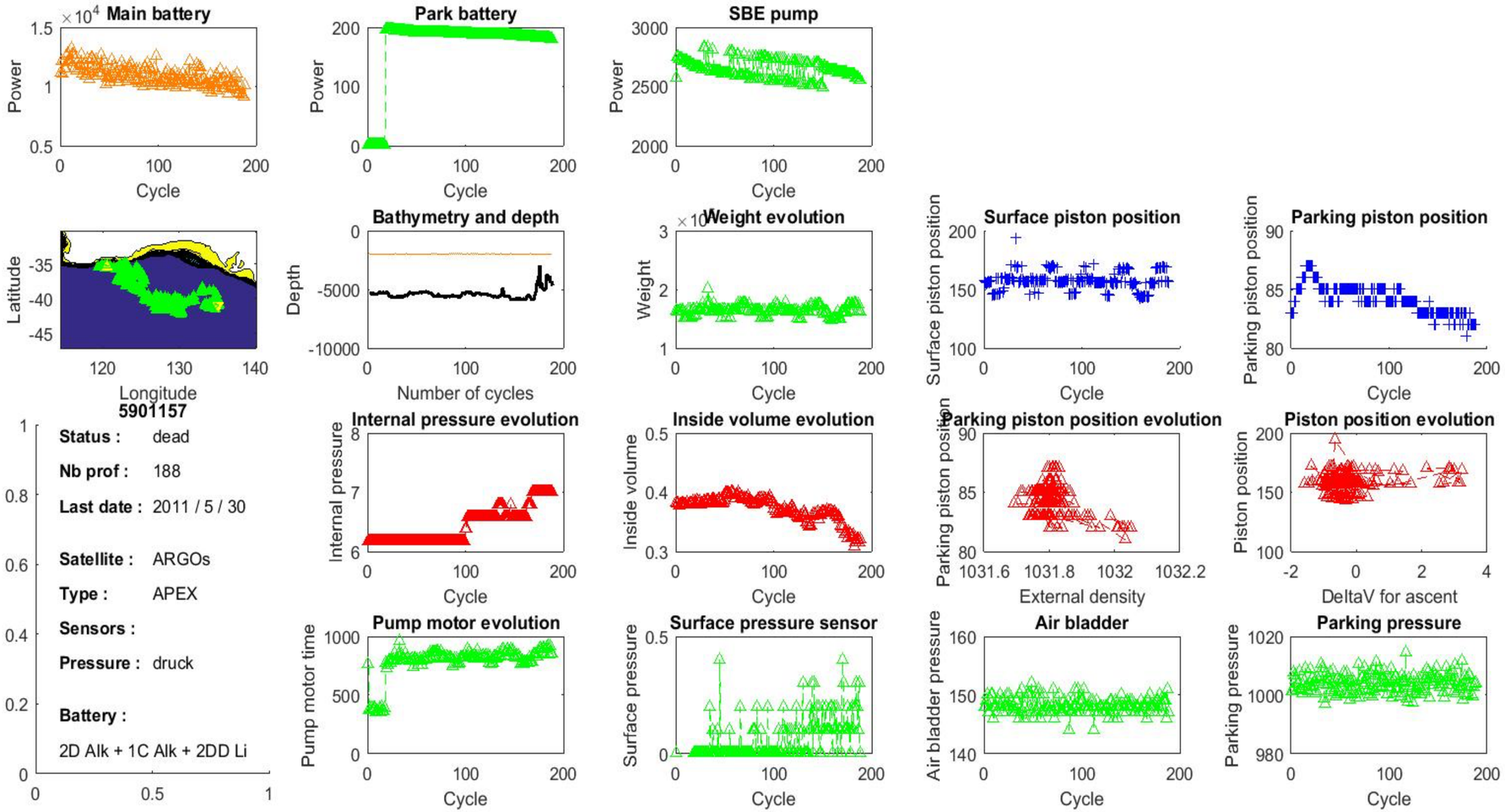
Implementation

Weight change



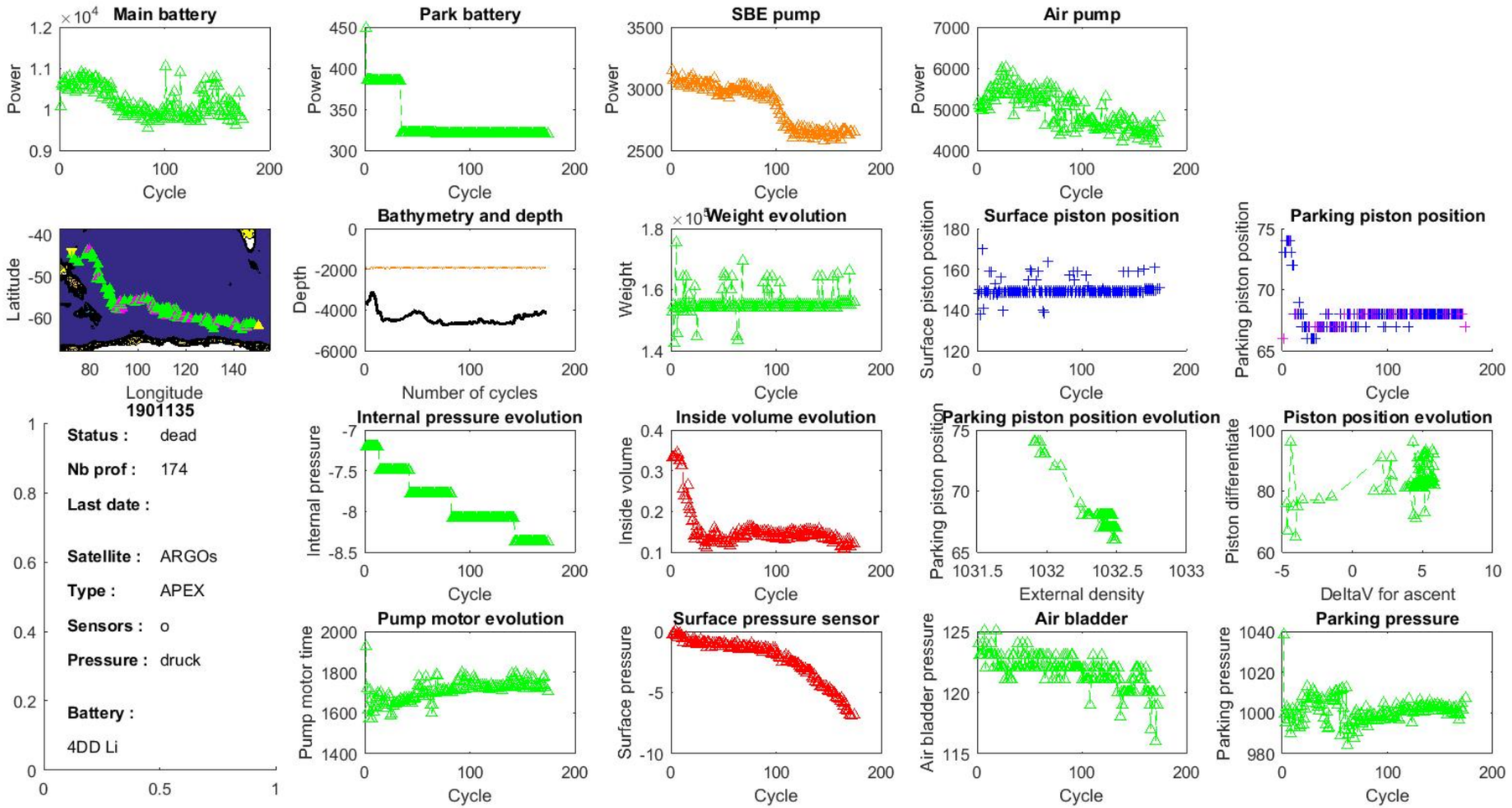
Implementation

Leak



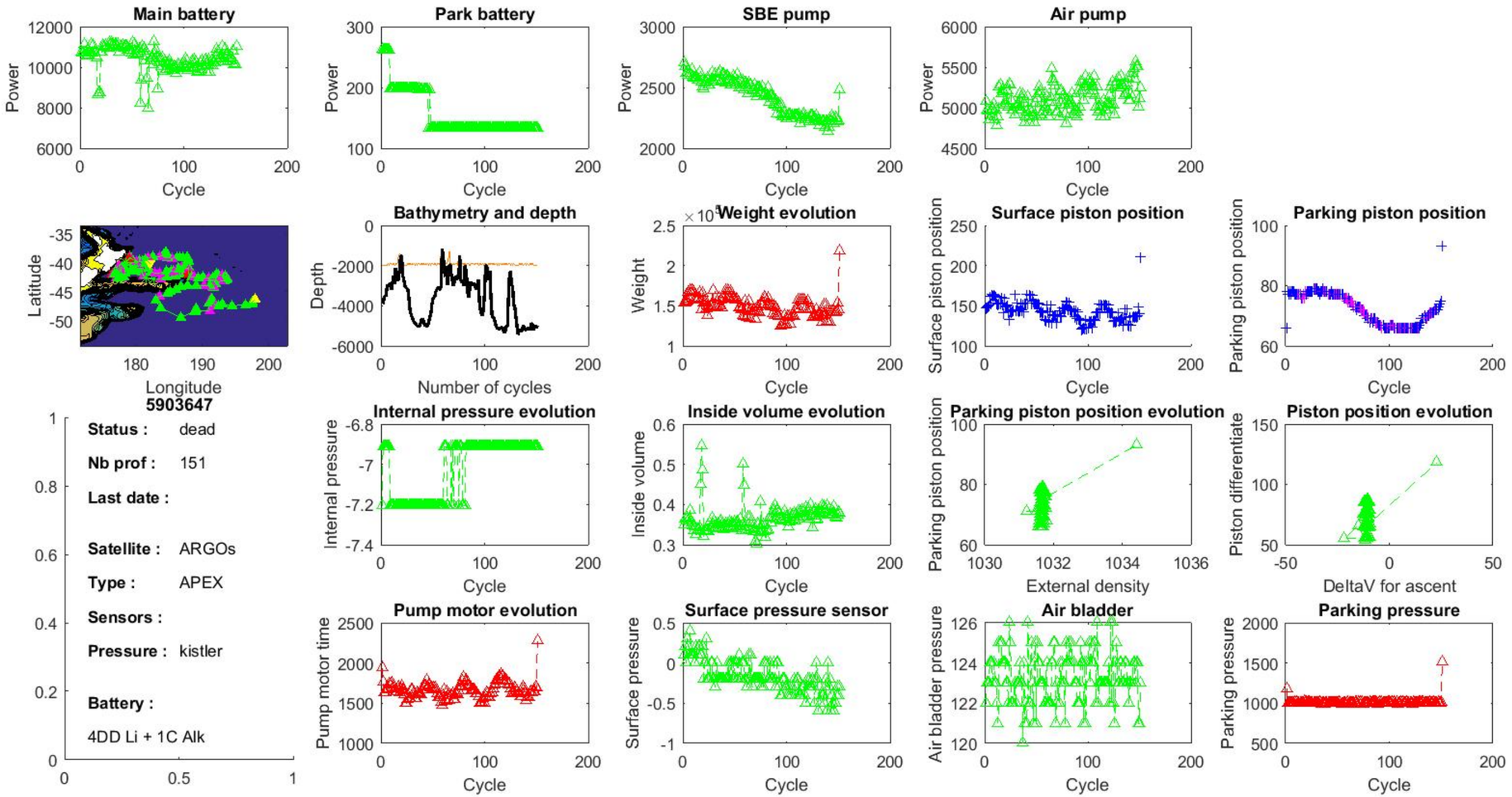
Implementation

Pressure sensor



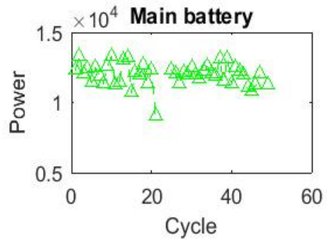
Implementation

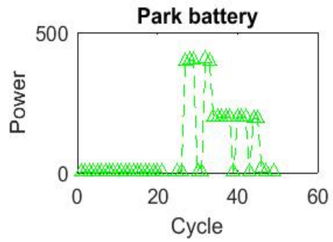
Pump motor

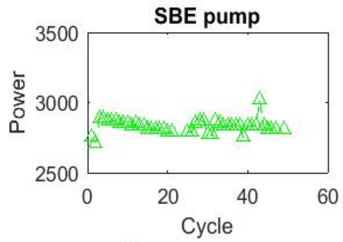


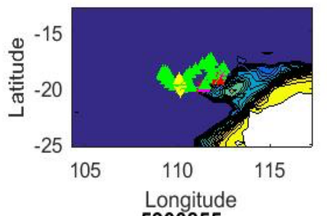
Implementation

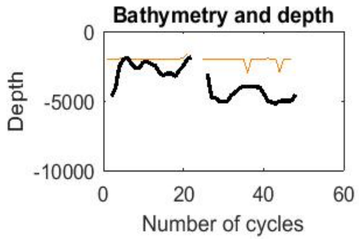
Air bladder

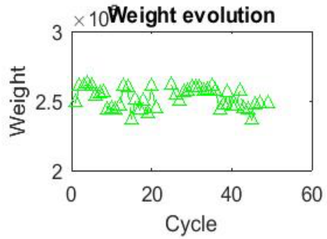


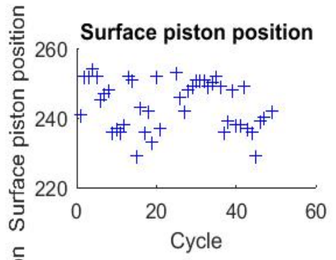


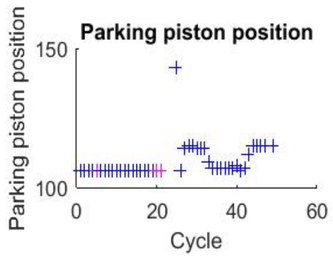


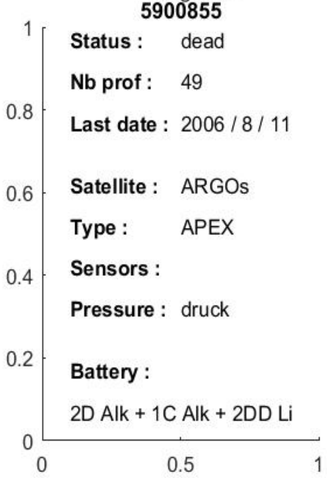


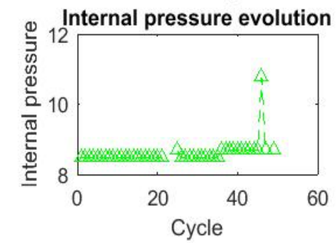


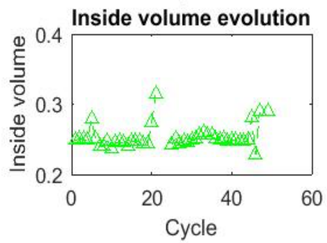


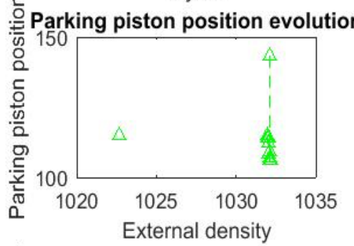


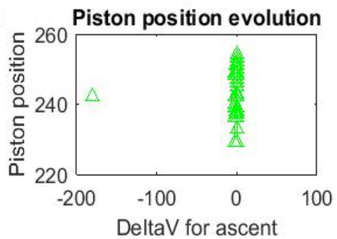


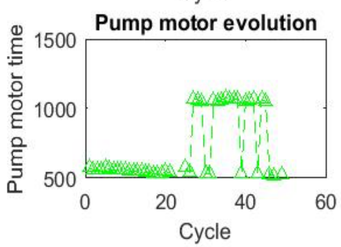


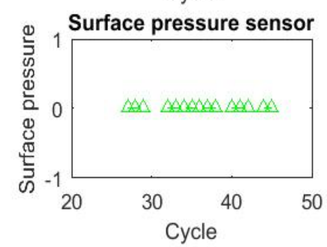


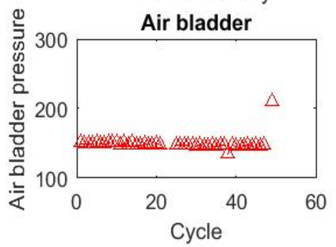


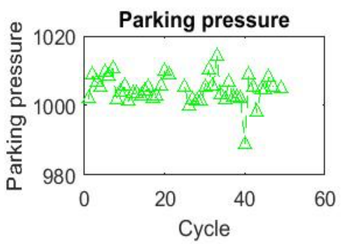












Conclusion

Conclusion

Through all of this examples, it is now possible to get an idea on the life status of a float. The implementation permits to have a quick understanding of the parameters that are critical.

Thanks a lot for your attention.