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Agriculture MVP

Waziup Weather Station – Assembly Guide

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1. INTRODUCTION

This document describe the development of a Waziup Weather Station using low-cost hardware that together will communicates with Waziup LoRa Gateway. In order to develop this solution, multi-technology sensors were used as part of the IoT sensor node with LoRa network integration.

The challenge was to develop an easy-to-deploy solution capable of acquire data from the surrounding area and then making it available to the Waziup Cloud Platform. This solution uses a several components that are easily bought on the market and can be potentially replaced by equivalent models.

This work was done in the context of Waziup Research Project, which has received funding from the European Union's H2020 Programme for research, technological development and demonstration under grant agreement No 687607.

2. COMPONENTS

The objective is to develop a low-cost and sustainable solution capable of reading real-time data typical of a Weather Station, using different sensors, and capable of communicating via LoRa.

The components chosen was:

- Adafruit Feather M0 with RFM95 LoRa Radio
- Sparkfun Weather Shield
- Weather Meters
- 4,5 dBi 868-900 SMAM-RP Antenna
- uFL SMT Antenna Connector
- RP-SMA to uFL/u.FL/IPX/IPEX RF Adapter Cable
- 2x RJ11 6-Pin Connector
- 36-pin 0.1" Female header - pack of 5
- Adafruit AM2315 Sensor
- 1.5W Solar Panel 81x137
- Lithium-Ion Battery - 3.7v 2200mAh
- Schottky Rectifying Diode

The use of all this material allowed the development of the "LoRa Weather Station" solution that cost less than 200€ and is available on the IoT-Catalogue platform through the following link[1].

In the following Figure 1 are represented the respective materials mentioned above.

[1] https://iot-catalogue.unparallel.pt/unparallel/#iotSolution/59b1797c763cfc066f6d092b

Figure 1 – Components chosen.

The next sections provide a step-by-step tutorial on how to build the LoRa Weather Station in order to collect data and send them to the gateway.

First, it is necessary to assembling the chosen components, and then upload the software. All the information used for this Weather Station is open source and hosted in the Unparallel Innovation GitHub repository[2].

[2] https://github.com/unparallel-innovation/UI_Waziup_Weather_Station

3. ASSEMBLY WEATHER STATION

Before connecting the cables between the components, it is necessary to perform delicate but simple solder task. Is recommended to train a little by following a guide as Adafruit[3].

3.1. Solder Components

3.1.1. Adafruit Feather

The Adafruit Feather M0 comes with fully assembled and tested radio but is necessary solder the female header pins in Feather by following the Adafruit guide[4]. In the following Figure 2 can be seen the Adafruit Feather M0 after solder the female header pins.

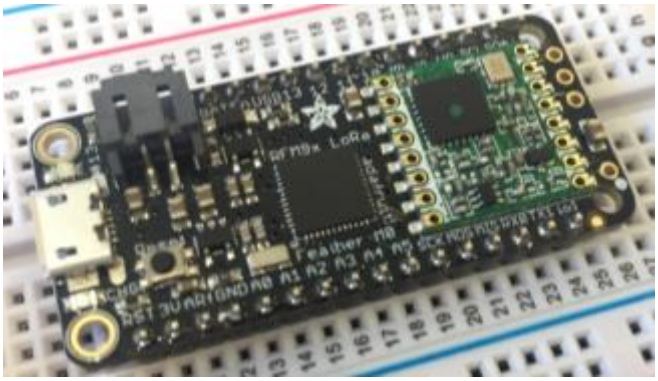

Figure 2 – Female Header pins in Feather.

3.1.2. uFL Antenna Connector in Feather

To use an 865MHz Antenna, it is required to solder the "uFL SMT Antenna Connector" in the Adafruit Feather M0 by following the steps in the Adafruit guide[5].

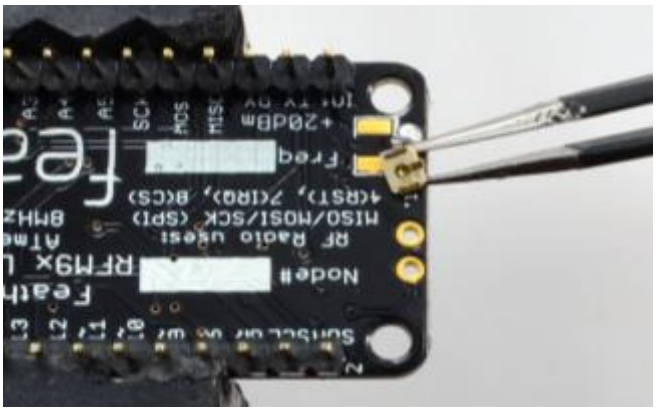

Figure 3 – uFL SMT Antenna Connector in Feather.

[3] https://learn.adafruit.com/adafruit-guide-excellent-soldering

[4] https://learn.adafruit.com/adafruit-feather-m0-radio-with-lora-radio-module/assembly

[5] https://learn.adafruit.com/adafruit-feather-m0-radio-with-lora-radio-module/antenna-options

3.1.3. Sparkfun Weather Shield

The Sparkfun Weather Shield does not come with the female header pins or the RJ11 6-Pin Connector included. As such it is necessary to order these components as well. Start by solder the female header pins in the Weather Sheild by following the suggested steps in the official Sparkfun guide[6].

3.1.4. RJ11 connectors in Weather Shield

To acquire rain and wind data from the Weather Meters sensor kit, it is necessary to solder the two RJ11 connectors in the Sparkfun Weather Shield. The Figure 4 shows the Sparkfun Weather Shield after solder the female header pins and the two RJ11 connectors.

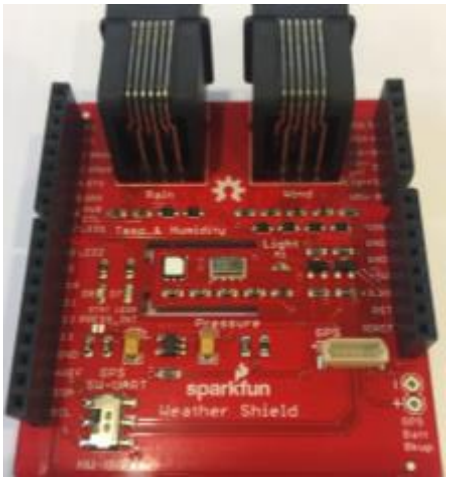

Figure 4 – Female header pins and RJ11 connectors in Weather Shield.

3.2. Boards Connection

3.2.1. Connect Antenna

Once soldered the “uFL SMT Antenna Connector”, can be connected the 868MHZ Antenna in the Adafruit Feather M0. As such, it is necessary to screw the 868MHZ Antenna into the “RP-SMA to uFL Adapter Cable" to be able to connect to the “uFL SMT Antenna Connector” soldered in Adafruit Feather M0.

Figure 5 – Connect the 868MHz Antenna in Feather.

[6] https://learn.sparkfun.com/tutorials/arduino-shields/installing-headers-assembly

Note that there are also products in the market that have the 868MHZ Antenna and the RP-SMA to uFL Adapter together.

It is necessary that the type of connection between the “uFL SMT Connector Adapter” and the Antenna must have the same type. If it does not happen, although it is possible to screw, will not be possible to make the communication.

Therefore, only "SMA Male" can be connected with "SMA Female" and "RP-SMA Male" with "RP-SMA Female". These different types of connectors are shown in the following Figure 6.

Figure 6 – Different SMA and RP-SMA connectors.

3.2.2. Power the Weather Shield

It is recommended to use a breadboard and cables with different colours when connect the circuits. To power the Weather Shield, use the Feather “3V” pin and make sure to connect in the Weather Shield “3.3V” pin and not in the “+3.3V”. Also connect the Feather “3V” pin in the Weather Shield “+5V” pin.

It is also necessary connect the Feather “GND” pin to the Weather Shield “GND” pin. The following Table 1 and Figure 7 respectively presents and shows the power connection using the breadboard as a bus between the Adafruit Feather M0 and the Sparkfun Weather Shield.

Table 1 – Pin Connection to power the Weather Shield.

Adafruit Feather	Sparkfun Weather Shield
GND	GND
3V	(+5V) and (3.3V)

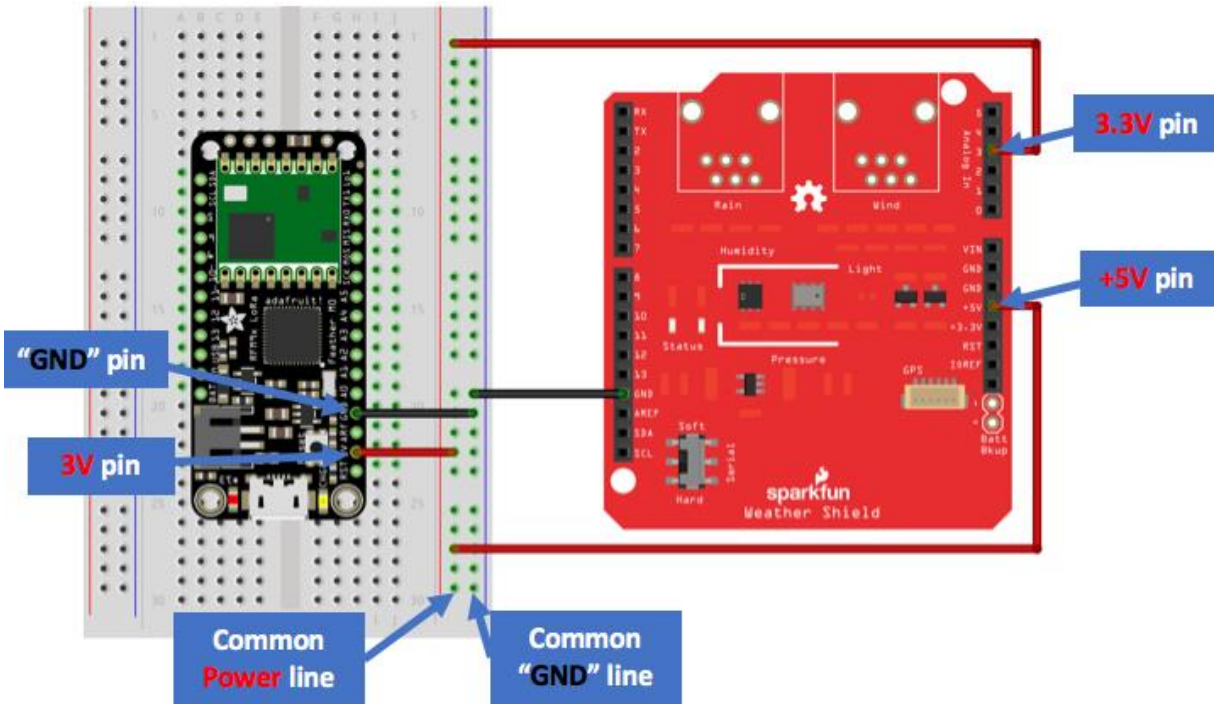

Figure 7 – Weather Shield power connection.

3.2.3. Connect Weather Shield sensors.

The Sparkfun Weather Shield already has built-in sensors that need to be connected to the Adafruit Feather M0. Theses connection are established in the Table 2 and is shown in Figure 8

First it is necessary connect the Feather "SDA" pin to the Weather Shield "SDA (4)" pin and the Feather "SCL" pin to the Weather Shield "SCL (5)" pin.

The Wind Direction connection is shown through the green cable that connect the Feather "A0" pin to the Weather Shield "WDir (0)" pin.

The Rain pin must be connected as shown in figure through the orange cable by connect the Feather "11" pin to the Weather Shield "RAIN" pin.

To the Wind Speed, connect the Feather "12" pin to the Weather Shield "WSpd (3)" as shown through the blue cable.

Table 2 – Weather Shield internal sensors pin connection.

Adafruit Feather	Sparkfun Weather Shield
SDA	SDA(4)
SCL (white cable)	SCL(5) (white cable)
A0	WDir (0)
11	RAIN (2)
12	WSpd (3)

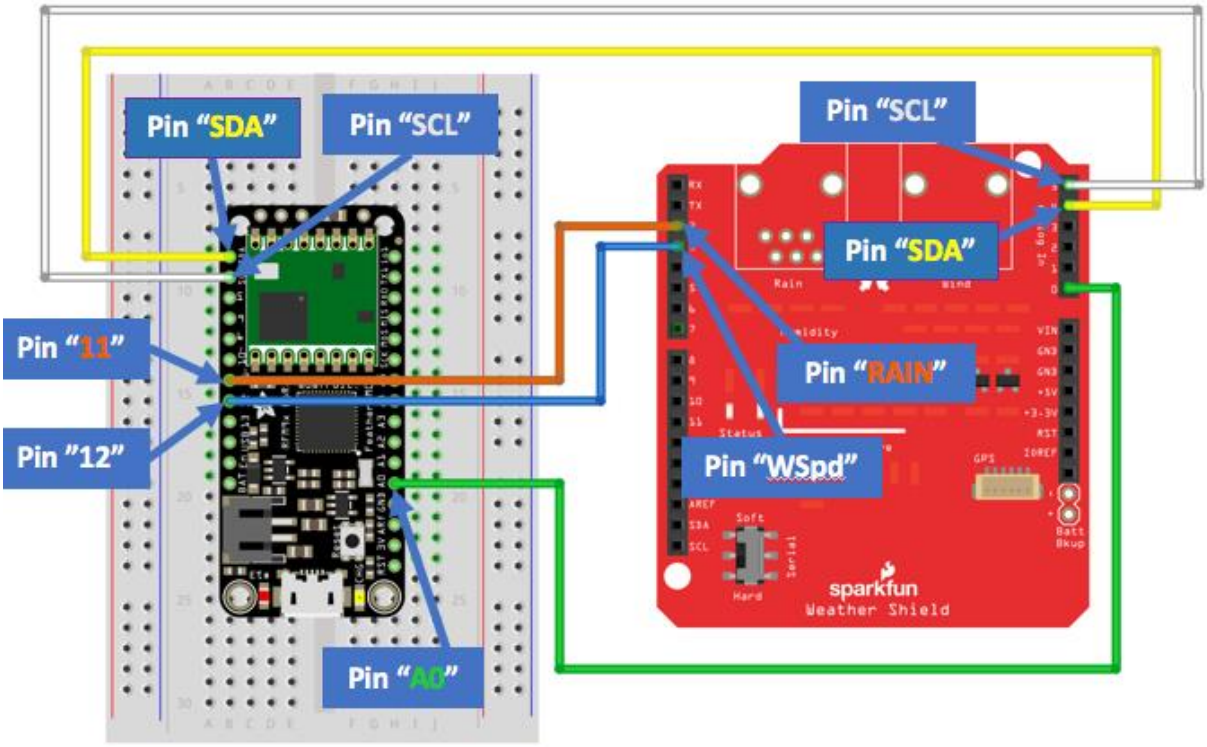

Figure 8 – Weather Shield internal sensors pin connection.

3.2.4. Previous connections validation

This step is only to confirm the connections between the Adafruit Feather M0 and The Sparkfun Weather Shield. The Figure 9 presents the power and internal sensors connections made in the previous steps.

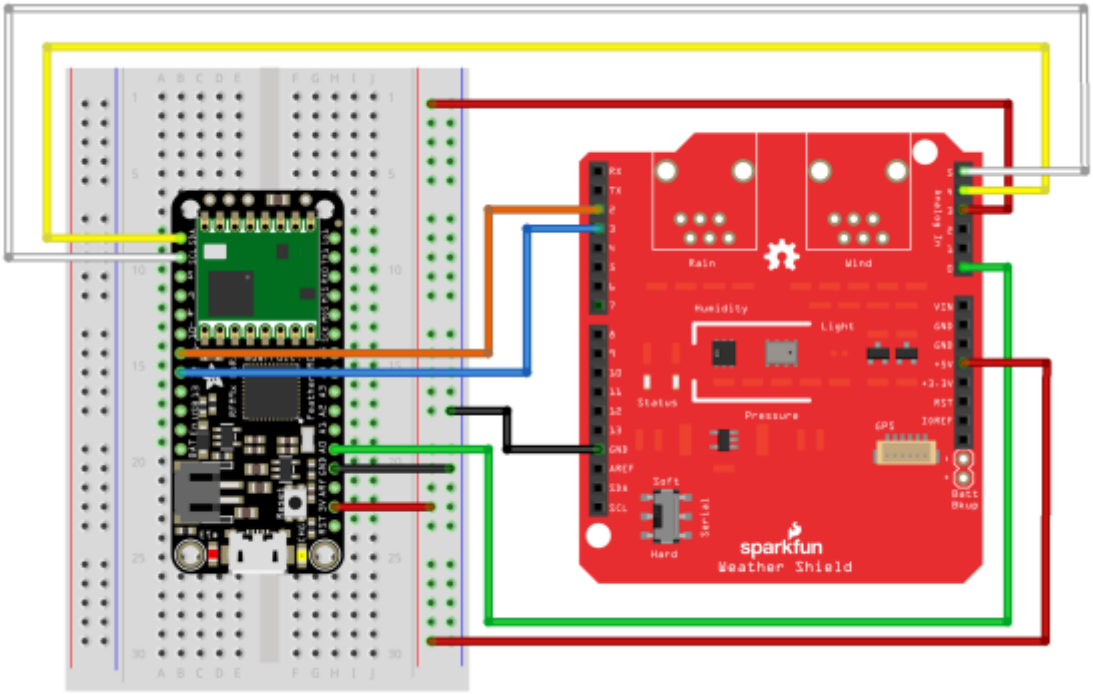

Figure 9 – Power and internal sensors connection between Feather and Weather Shield.

3.3. Components connection.

3.3.1. Connect External sensor.

The Table 3 established the connection between the Adafruit Feather M0, the AM2315 Temperature and Humidity external sensor and the Sparkfun Weather Shield. The following Figure 10 presents the Table 3 established connection.

The Weather Shield has one more set of “SDA” and “SCL" pins (the last two pins on the left side) that can be used to connect the external sensor yellow cable to the Weather Shield “SDA” pin and the external sensor white cable to the Weather Shield “SCL” pin. Also connect the external sensor red cable “VCC” to the common power of the breadboard and the external sensor black cable “GND” to the common "GND" of the breadboard.

Table 3 – Pin Connection between Feather, External sensor and Weather Shield.

Breadboard	Sparkfun Weather Shield	AM2315 sensor
GND	-	Black cable
3V	-	Red cable
-	SDA(4)	Yellow cable
-	SCL(5)	White cable

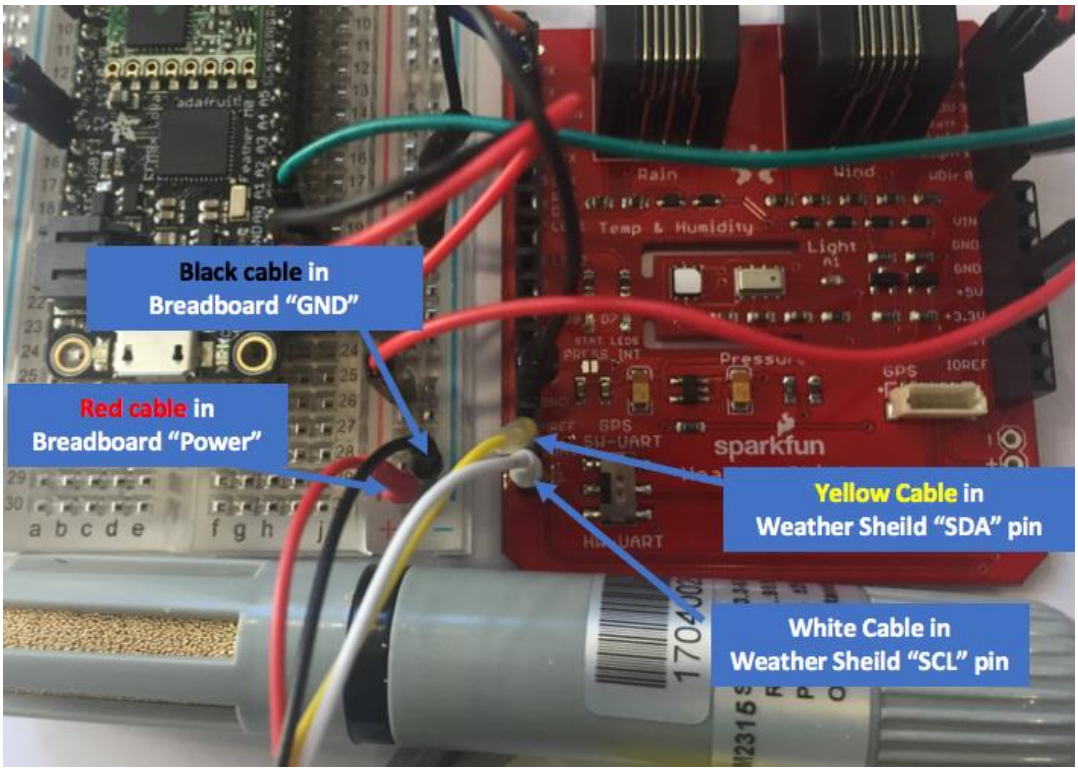

Figure 10 – Pin Connection between Feather, External sensor and Weather Shield.

3.3.2. Connect Weather Meters

If the Step 3.1.4 was concluded it is possible to connect in the Rain and Wind sensors from the Weather Meters. It is necessary to pay attention and connect the Weather Meters RJ11 cables in the respective places as shown in the Figure 11.

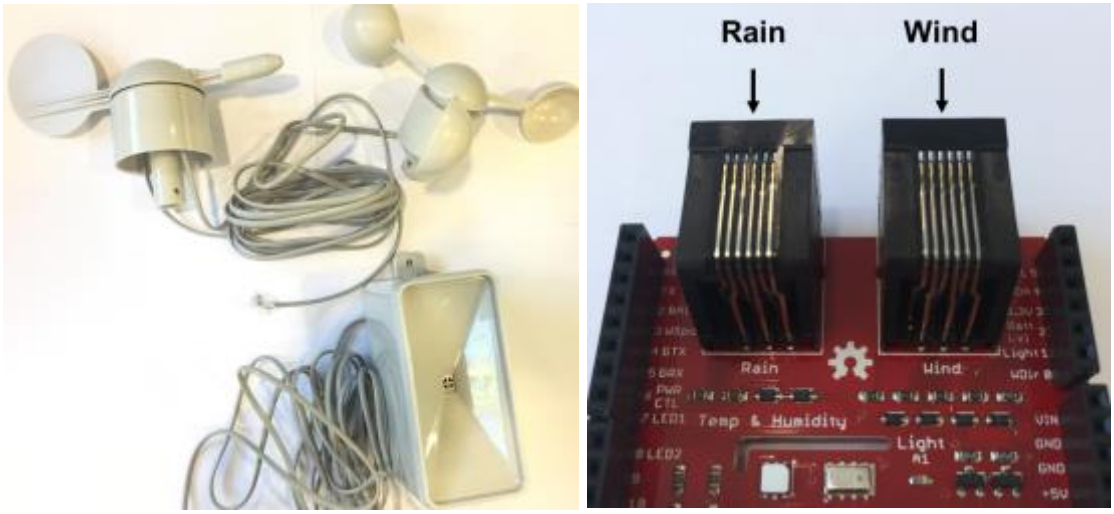

Figure 11 – Weather Meters and respective Rain and Wind connections.

3.3.3. Connect the Battery

Use cables to connect the battery in the Adafruit Feather M0. Connect the battery red cable in the Feather “BAT” pin and the battery black cable in the common breadboard “GND”" as shown in the following Figure 12.

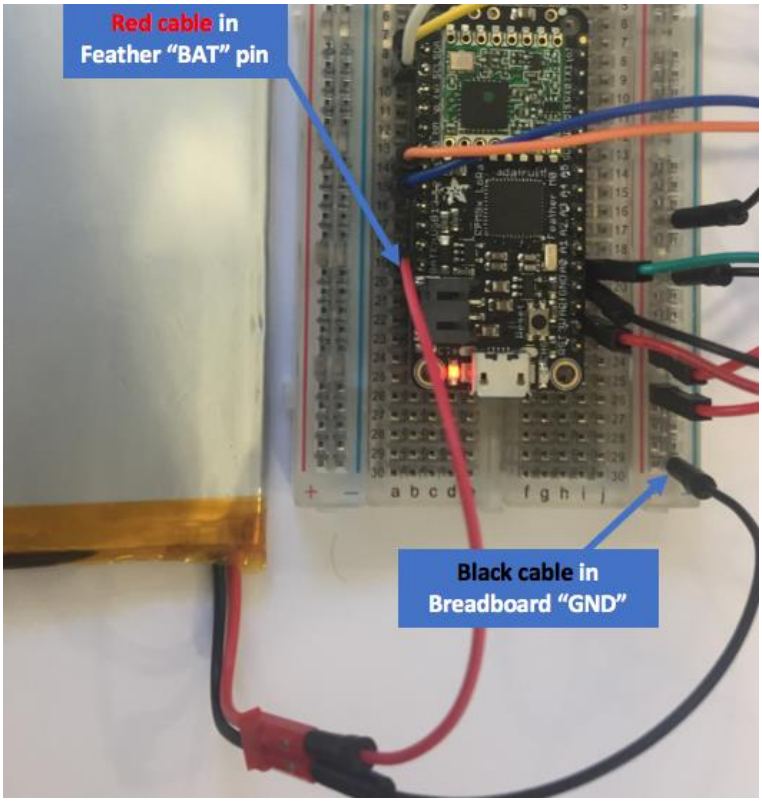

Figure 12 – Connect the Battery in the Feather.

3.3.4. Connect the Solar Panel

The Adafruit Feather M0 comes with an integrated charging circuit which allows to charge the battery using an external power source. To use a Solar Panel to charge the battery it is also necessary to use a Schottky Diode that allows that the current to go in the right direction and not to the Solar Panel.

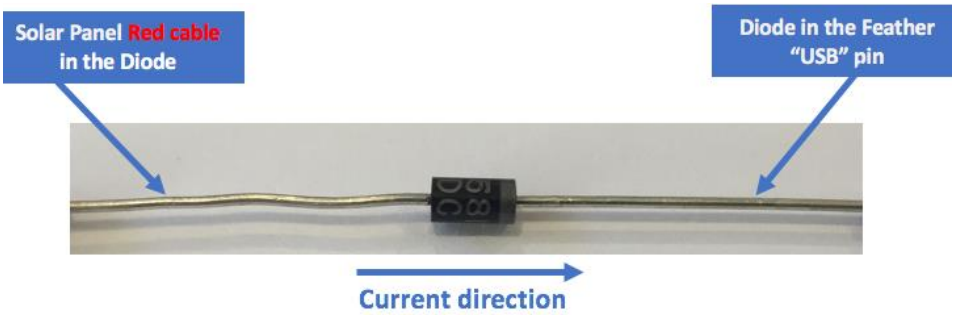

Figure 13 – Correct Diode connection.

As represented in the Figure 14 connect the Solar Panel red cable to the Schottky diode and from the diode to the Feather "USB" pin using the breadboard as a bus. Also connect the Solar Panel black cable "GND" to the common breadboard "GND".

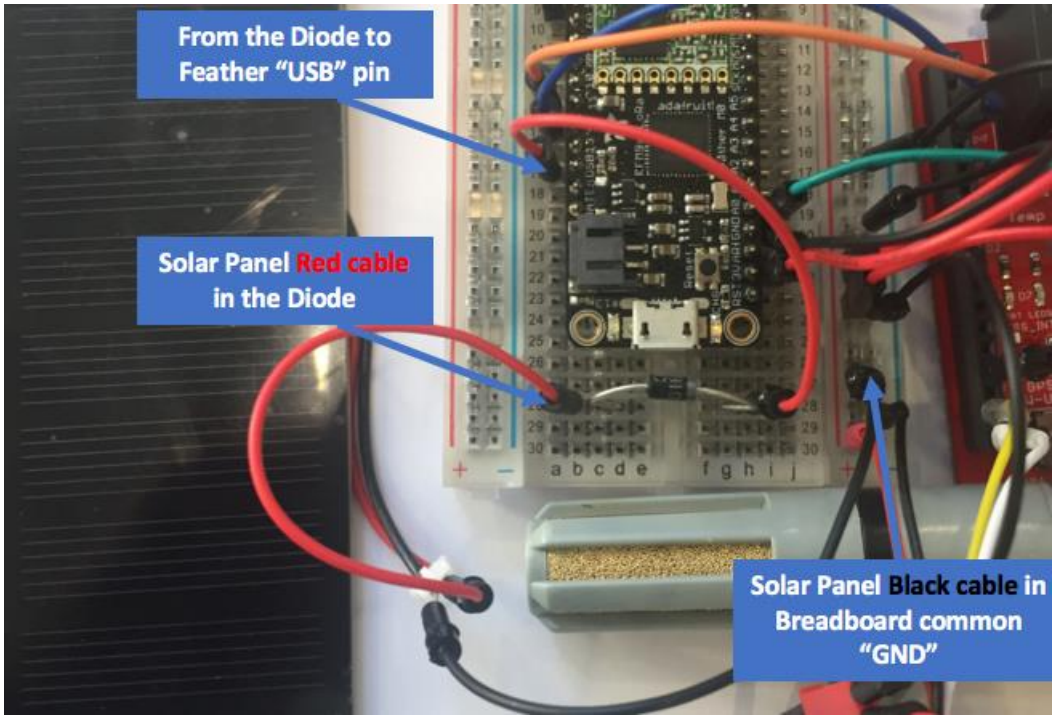

Figure 14 – Solar Panel connection.

4. UPLOAD SOFTWARE

4.1. Download & Install Arduino IDE

First, it is necessary to download the Arduino IDE 1.6.6 or later. Go to the Arduino website[7], select “Software” and choose the compatible version with the operating system that is being.

Once the download is complete, the Arduino IDE can be installed by following the suggested steps in the official operating system installation guide[8].

4.2. Add Adafruit Boards to Arduino IDE

After completed the previous steps it is necessary go to “Arduino”, “Preferences” and include the link for Adafruit boards in the "Additional Boards Manager URLs" as shown in the Figure 15.

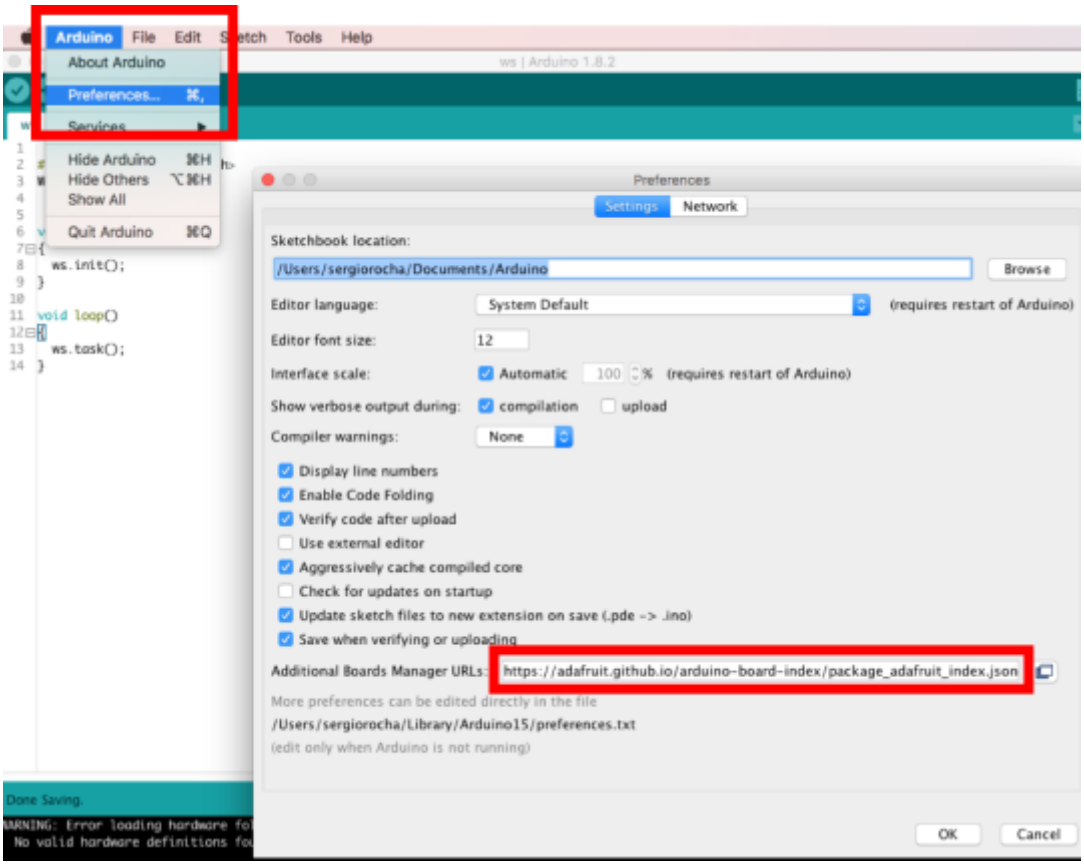

Figure 15 – Add Adafruit Boards to Arduino IDE.

To get the link for the Adafruit boards and conclude this task it is recommended to follow the steps in the official Adafruit guide[9].

[7] https://www.arduino.cc/en/Main/Software

[8] https://www.arduino.cc/en/Guide/HomePage

[9] https://learn.adafruit.com/adafruit-feather-m0-radio-with-lora-radio-module/setup

4.3. Install Adafruit Boards in Arduino IDE.

Once added the Adafruit Boards in the Arduino IDE, it is necessary go to “Tools”, “Board” and access the “Board Manager” to install the required Adafruit Board. To install correctly the Adafruit boards it is recommended to follow the steps in the official Adafruit guide for the Adafruit Feather M0[10] board.

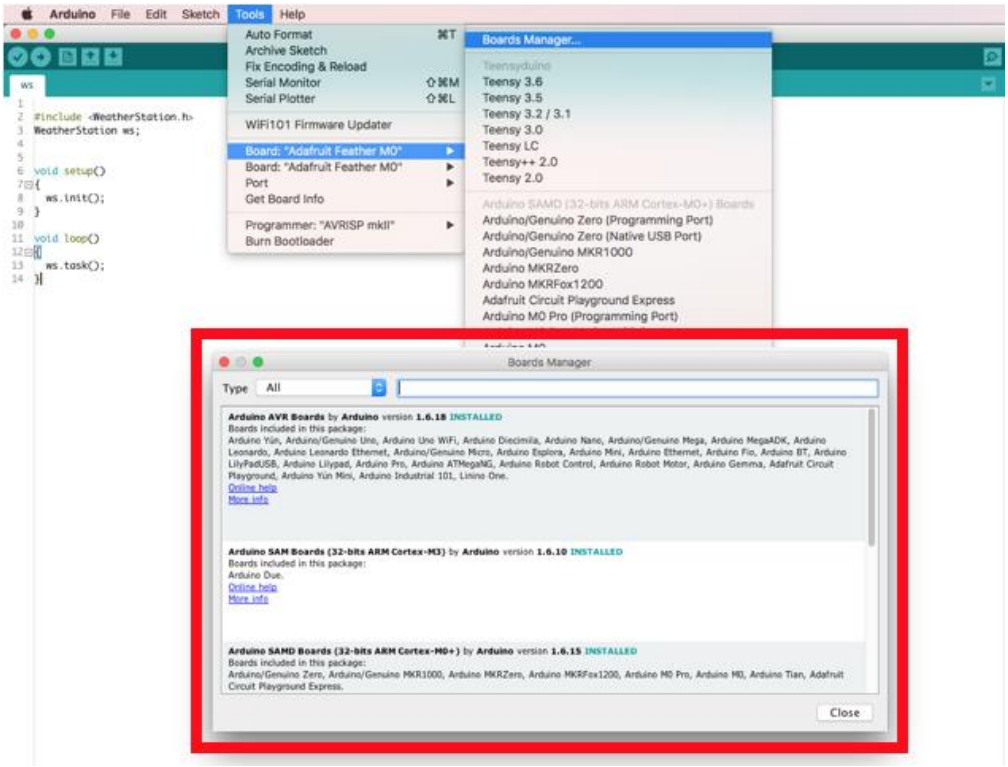

Figure 16 – Install Adafruit Boards in Arduino IDE.

4.4. Download Weather Station library.

It is necessary to acquire the Weather Station library presents in the Unparallel Innovation Github[11] that includes all necessary control functions and a set of other resources that allow the correct operation of the LoRa Weather Station. To do that click on “Clone or download” green button located in the right side from GitHub website and choose “Download Zip” option to download the “UI_Waziup_Weather_Station-master.zip” file.

4.5. Install Weather Station library in Arduino IDE

Once completed the previous step is necessary include the downloaded “UI_Waziup_Weather_Station.zip” file in the Arduino IDE. To do that go to “Sketch”, “Include Library” and click in the “Add .ZIP Library” option. Will appear a window where need to be added the zip file.

[10] https://learn.adafruit.com/adafruit-feather-m0-radio-with-lora-radio-module/using-with-arduino-ide

[11] https://github.com/unparallel-innovation/UI_Waziup_Weather_Station

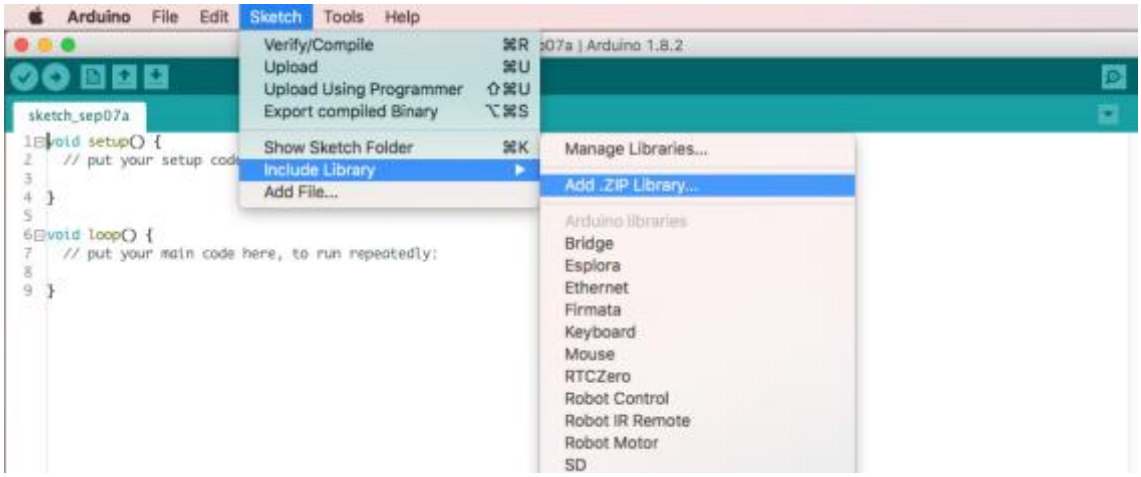

Figure 17 – Install Weather Station library by the "Add. ZIP Library".

4.6. Open Weather Station example code.

After conclude with success the previous step it is possible to open the Weather Station example code. To do that go to “File”, “Examples”, “UI_Waziup_Weather_Station” and click in the “LoRaWeatherStation”.

This code, is the latest firmware tested from the LoRa Weather Station and include all the Weather Station configurations.

4.7. Choose Board and USB Port in Arduino IDE

After connect the micro-USB cable from the computer to the Feather, it is necessary choose the correct Adafruit Feather Board and the USB port in the Arduino IDE. To do that go to “Tools”, “Board” and click in the “Adafruit Feather M0” and go to Tools”, “Port” and click in the “Adafruit Feather M0” too.

Figure 18 – Define the USB port.

4.8. Upload the Weather Station software

The Weather Station already has some configuration parameters defined by default such as the period time in minutes between messages and the ThingSpeak identification channel that can be changed.

To upload the software in the Adafruit Feather M0 just need to click in the “Upload” button presented in the upper left side of the following Figure 19.

After concluding the upload with success, a message will appear in the lower left side. To open the Arduino Serial Monitor and visualize the LoRa Weather Station workflow click in upper right side button.

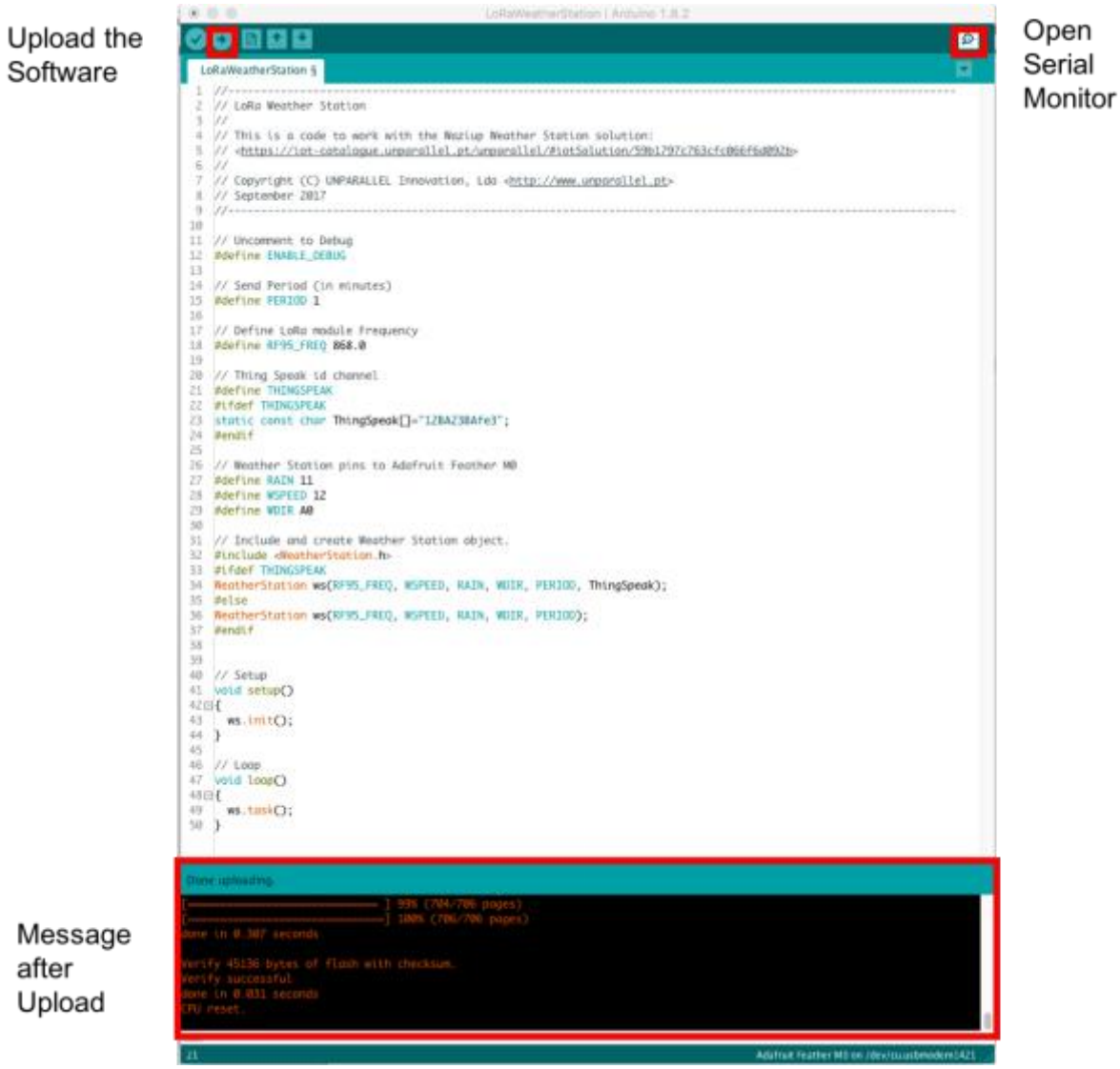

Figure 19 – Upload the software.

5. DEPLOYMENT WEATHER STATION

5.1. Assembly Weather Station in a Box

Once the previous steps have been completed, it will be necessary to place the assembly Weather Station inside a box to place easily in the desired location. The following Figure 20 show, as an example, the Weather Station in a box that not need to be the same. Pay attention to the material that the box is made. To place the Weather Station in locations under rain, it is convenient to use a waterproof box.

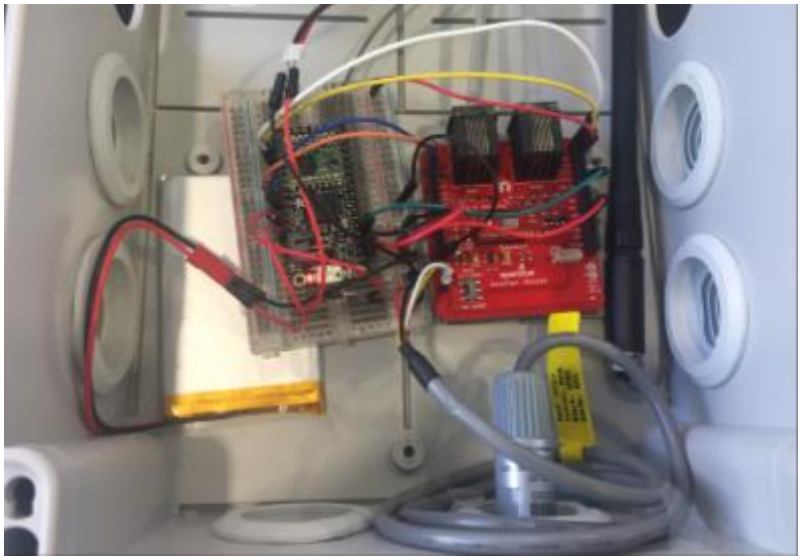

Figure 20 – Place Weather Station in a box.

Place the components with some organization because will be easier in the future to change one component or access the microprocessor to re-upload the software. To place the components, use a contact material such as hot glue to ensures that the hardware is in the correct places and no cable connection is lost if, for some reason, a strong oscillation occurs in the box.

5.2. External Sensor outside the box

Make sure that the temperature and humidity external sensor is slightly out of the box, as shown in the box of Figure 21, and preferably in a shadow location without sun.

Figure 21 – Place external sensor outside the box.

5.3. Assembly Weather Meters sensors

The Weather Meters come with material components, to allow their assembly in an auxiliary structure. These materials together allow to build a structure to easily place the sensors (rain, wind speed and wind direction).

Once assembled this structure can be placed in the desired location. To mount it is recommended to perform the suggested steps in the guide provided by SparkFun[12].

5.4. Solar Panel outside the box

It is necessary to place the Solar Panel outside the box in a place where it is possible to guarantee the conditions of implementation. To realize and ensure a correct Solar Panel implementation it is recommended to consult the "Solar Panel Deployment" document that is available in folder “documents” in the Unparallel Innovation GitHub repository[13]

The hole created for the external sensor can be used to route the Solar Panel cables as well as the RJ11 Rain and Wind sensor cables.

Completed these steps the LoRa Weather Station shown in the Figure 22 is ready to receive the measurements and send the information to the LoRa gateway.

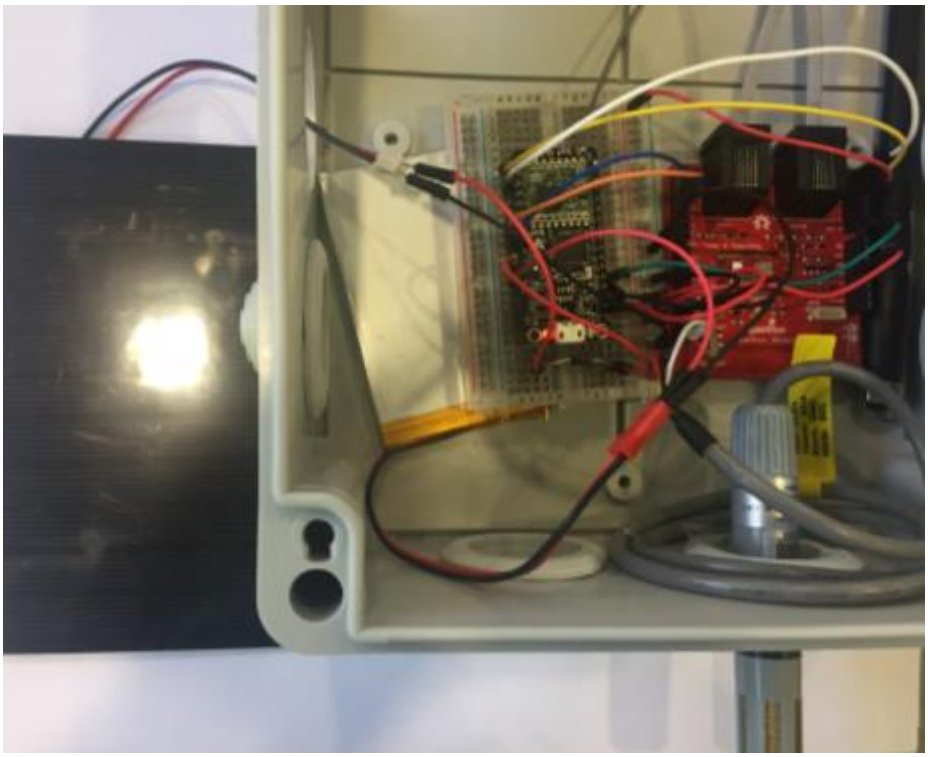

Figure 22 – LoRa Weather Station prototype.

[12] https://learn.sparkfun.com/tutorials/weather-meter-hookup-guide

[13] https://github.com/unparallel-innovation/UI_Waziup_Weather_Station

ACKNOWLEDGEMENT

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