CARITAS Schweiz Suisse Svizzera Svizra

MANUAL

For assembling the low-cost weather station

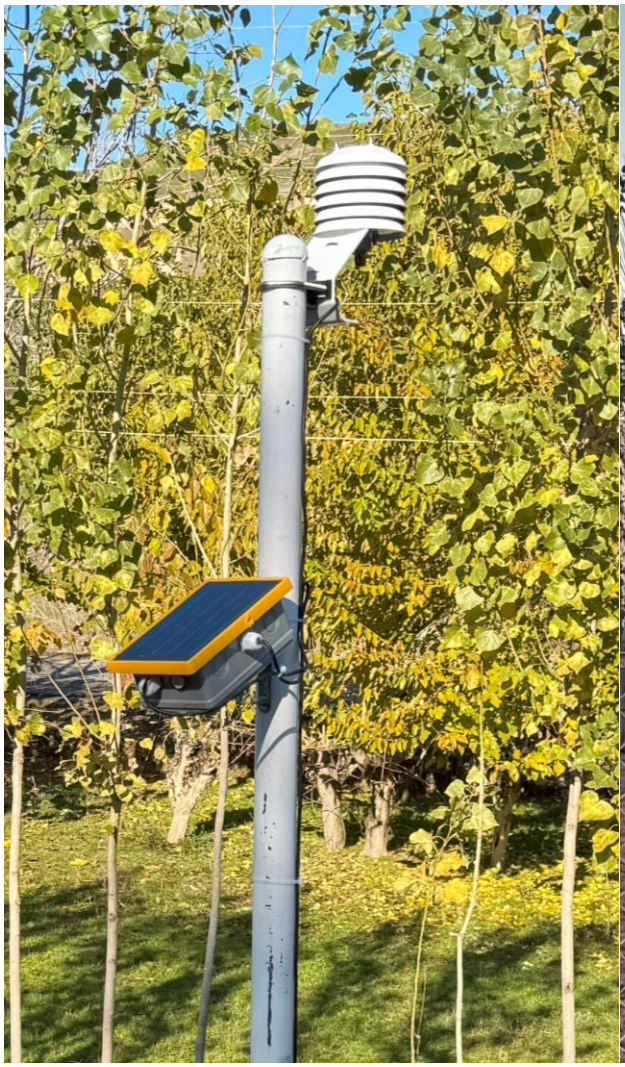
ABSTRACT

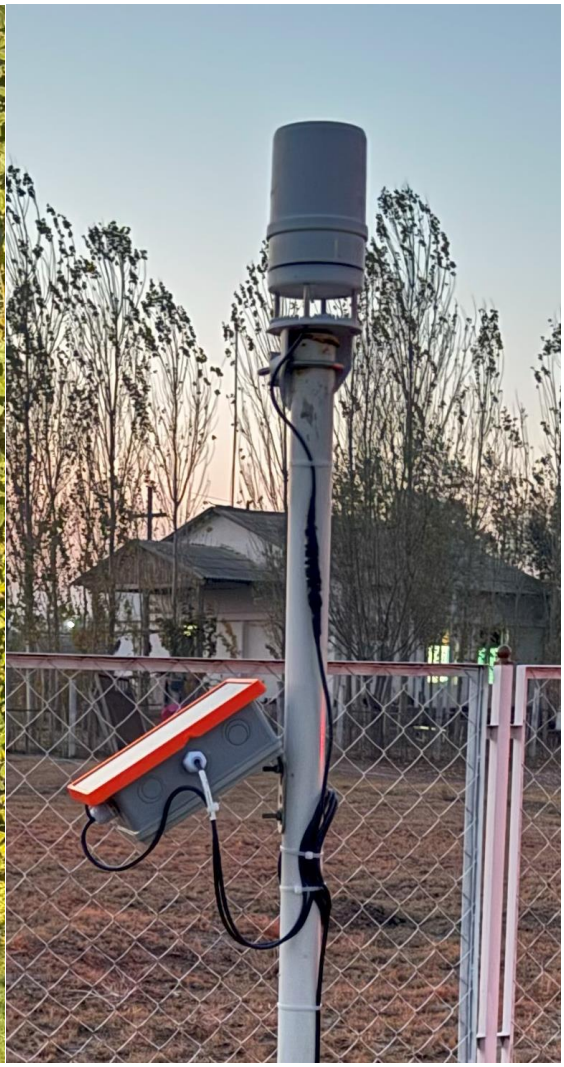
This guide outlines the step-by-step process for assembling a low-cost weather station. The manual includes instructions for mounting, wiring, and configuring the components to ensure accurate data collection and reliable performance in field conditions. This assembly is suitable for environmental monitoring applications in remote or urban settings. Until now we have two types of the stations; the first one is comprehensive one where we are using ClimaVUE50 sensor and it gives 12 parameters like Air temperature, barometric pressure, lightning average distance, lightning strike count, precipitation, relative humidity, solar radiation, tilt, wind direction, and wind speed, the second one where we are using SHT30 sensor is measuring air temperature, air pressure and air humidity. In both types of stations also we are connecting the SHT30 sensor to measure the soil temperature at a depth of 10cm.

Contents

Overview

When fully assembled, the weather station comprises two main components: a radiation shield that houses the sensor or ClimaVUE 50 sensor, where on sensor you can see the letter ‘N’ (should be directed to the north) and an enclosure containing the microcontroller and battery, with a solar panel mounted on its lid. The accompanying photo shows a section of the test setup in the field.





Ingredients

- Board Koala
- Sensors: SHT30 with cable (1 metre or 3 metres) or ClimaVUE 50
- 18650 batteries 2pcs
- Solar panel 5-6V/4W
- Box for board
- Screws & nuts M10 2pcs 80mm and 2pcs 20mm for mounting
- Metal angle or similar for mounting the box
- Radiation shield (Campbell Scientific, model RAD06)

- jumper connector mother type
- If needed, a 2-wire cable for connecting the solar panel
- Double-sided adhesive tape, glue
- Cable glands 2pcs
- Gore vent/pressure equalising valve, e.g.
- LTE antenna

Full technical specification and pictures for ingredients are given in the adjoint Excel.

Preparing the Arduino IDE

First, install the IDE for Arduino (tested at version 2.3.6) and the additions for ESP32, as described here:

Installing ESP32 for Arduino

For the Koala board that we use, in **Tools > Board,** I set the board to 'ESP32 Wrover Kit (all versions)'

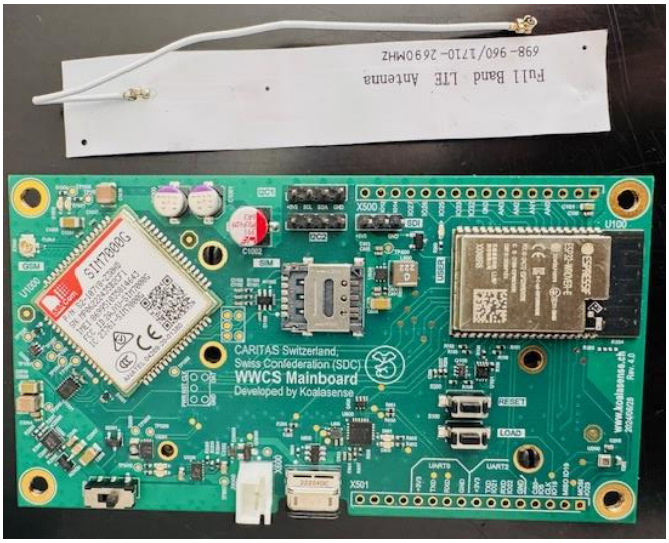
Then we need to install the following libraries (tested with the versions shown below):

profiles:
default:
fqbn: esp32:esp32:esp32wrover
platforms:
platform: esp32:esp32 (3.0.2)
platform_index_url: https://espressif.github.io/arduino-esp32/package_esp32_index.json
libraries:

- ✓ Adafruit BME280 Library (2.2.4)
- ✓ Adafruit BMP3XX Library (2.1.6)
- ✓ Adafruit BusIO (1.17.1)
- ✓ Adafruit Unified Sensor (1.1.15)
- ✓ ArduinoJson (7.4.1)
- ✓ arduino-sht (1.2.6)
- ✓ ArduinoHttpClient (0.6.1)
- ✓ ESP32Time (2.0.6)
- ✓ GovoroxSSLClient (1.3.2)
- ✓ LTC2942 (1.2.2)
- ✓ StreamDebugger (1.0.1)
- ✓ Time (1.6.1)
- ✓ TinyGSM (0.12.0)
- ✓ SDI-12 (2.1.4)

Testing the board and networking

This is the board and the white LTE antenna for the cell phone network



The first step is to test whether the board works and can connect to the internet. For this, insert a SIM card and connect the antenna to the GSM connector (as in the picture).

Edit the “koala04_climavue_50_sht30_bmp390” to have matching APN, user, passwd, PIN for the SIM if required.

Connect the board via USB-C to the computer. Open **Tools > Serial Monitor.** Upload the “koala04_climavue_50_sht30_bmp390” sketch and check what you get in the serial monitor. It should look similar to the output to the right.

Note that initializing modem can fail at first start up (ignore it; should work next time) and that connecting to network can take a while at first start-up.

```
Powering on modem...
... init modem successful ...
My APN now is: Babilon
Setting network modes... Waiting for
network... Network connected
Connecting to: Babilon... OK
Signal quality: 31.000000
Connected to wwcs.tj

Trying post request -> {"sign":"ccc4001d
05480ea3b2b9b2118d511d796875b86087a923c0d
a33c6c023af30ff","timestamp":"1970-01-01
00:00:03","ta":-999.99,"rh":-
999.99,"p":907.585,"ts10cm":-
999.99,"logger_ta":27.25025,"U_Battery1":
4.095766,"Temp_Battery1":37.55163,"Charge
_Battery1":2019.144,"U_Solar":0,"loggerID
":"70:b8:f6:02:ad:14","git_version":"Flas
hGIT","signalStrength":31}

Post request successful.
```

Preparing the box

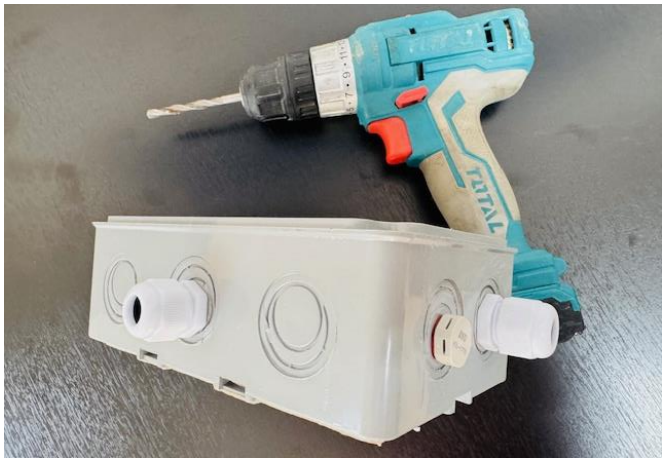
This setup can be different, but one possible design is described below. Any sufficiently large and waterproof plastic box will do. The pictures show this box. I have also tried this smaller one. Suggestions are welcome!

Remove the lid of the box, place the metal angle on the outer face of the lid, and mark the two holes of the metal angle. The angle must be aligned with the top edge of the lid. Drill holes for the M10 bolts 2pcs (that is, I use screws of this diameter).

Screw the angle to the lid.
Bend the metal angle to approximately. 45 degrees, making sure that the half which goes onto the box lid remains straight.
Use two screws with nuts to attach it to the lid. Also, the cable for the ground should be mounted inside the lid as on the picture.

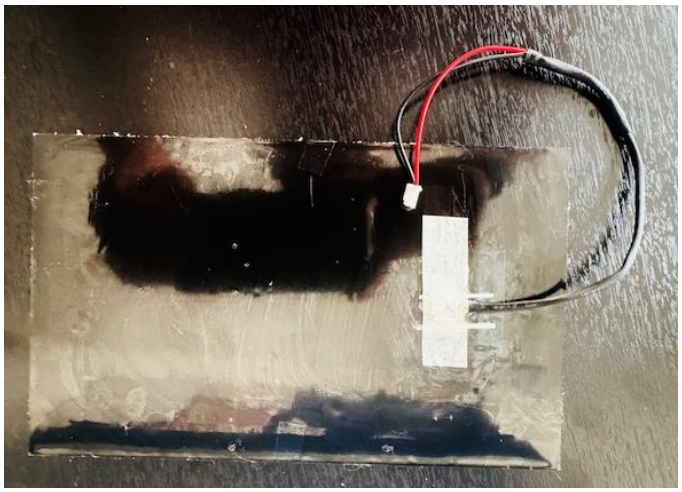
Drill 3 holes into one side of the box of matching diameters for the pressure-equalizing valve and the two cable glands.

This is what it becomes.

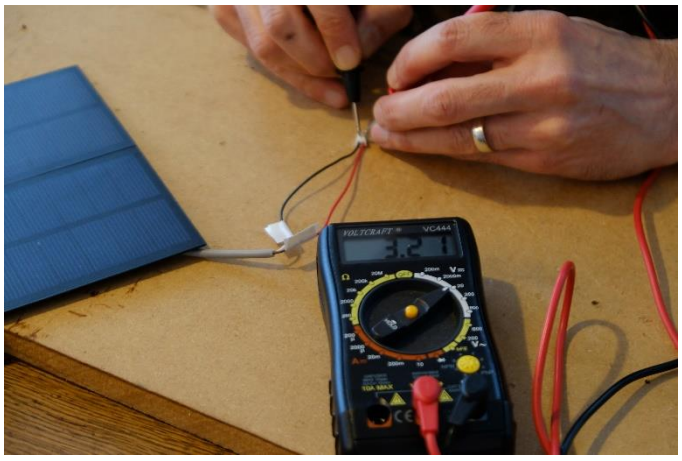


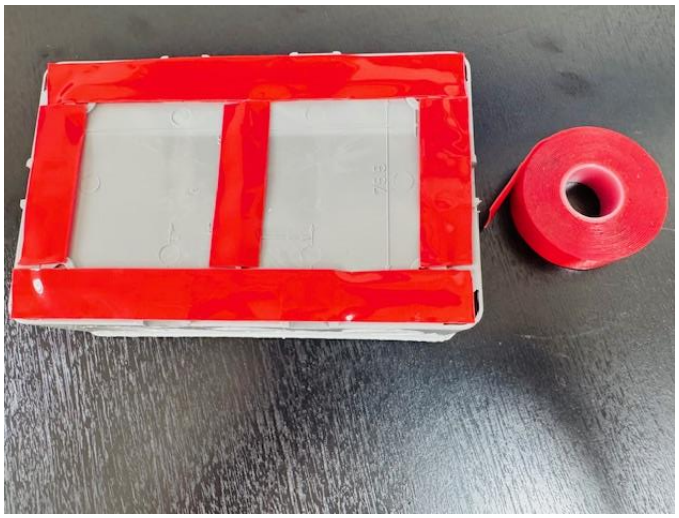
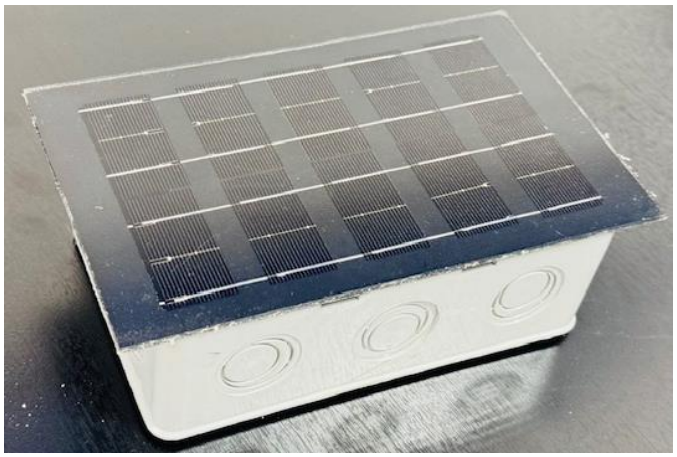
Solar panel preparation

We need 5W at 5-6V.
We should test the panels before proceeding further, using a multimeter.
Solder the red-black connector cable to the solar panel so that red goes to + and black to -.



Test whether everything works.

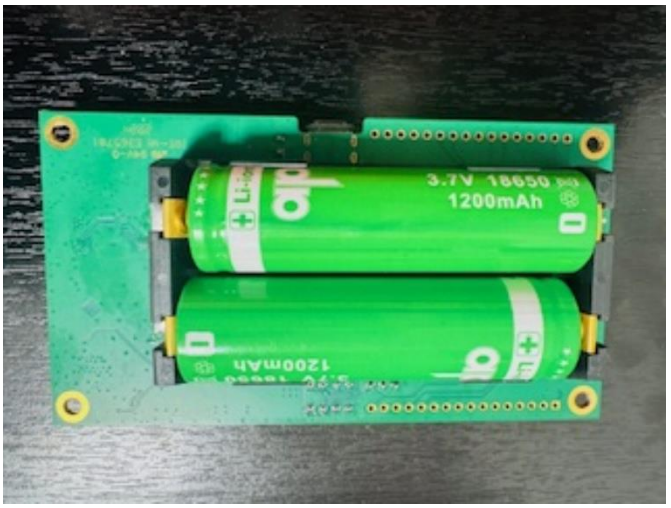


Put double adhesive tape on the bottom of the box.	
Put the solar panel on the thus prepared box, aligning with the top edge of the box and centring vertically.	
Preparing the platform inside the box for setting up the board. Gluing in the standoff screw for mounting the board. I was using the plastic one; you can also use the metal one.	

Preparing the board

Inserting the battery: Do it carefully, so as not to damage the plastic.
The position of the battery should be correct, + should go to the + and – should go to -

Just to be informed that the batteries a sitting opposite each other, as in the picture. You can charge the battery by connecting the board to the USB-C port.



Once the battery is in, you can plug the LTE antenna into the GSM plug on the board. Also, you can put the SIM card into the board as on the picture.

Preparing the box and connecting the sensors

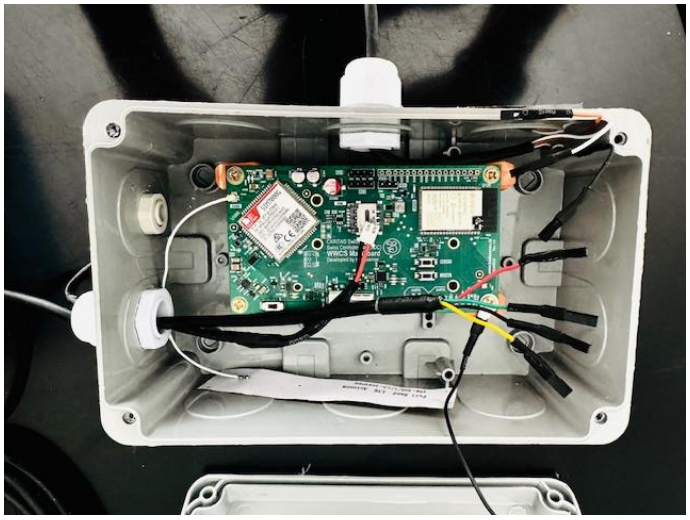
As we now use two sensors (and likely even more in future), we don't solder the sensors directly to the board. Instead, we solder jumper connectors to the sensors and connect sensors directly to the board as described below.

First, we are mounting the board inside the box. In one of the corners of the board we must also screwing the ground cable which was on the box lid as on the picture.

Then we should cut the original connectors from the sensors SHT 30 or ClimaVUE 50.

After cutting the original connectors, we should solder the jumper connectors (mother) on both sensors, SHT30, as on the picture.
For the ClimaVUE 50 sensor, we have to solder the black and transparent cables together and then solder Arduino connectors.
In total, for the SHT 30, we have 4 connectors, and for ClimaVUE 50, we have only 3 connectors, as on the pictures.

Then, VERY IMPORTANT, put the cables from the solar and the SHT30 or ClimaVUE 50 sensors through the cable glands.
From below part of the box, the solar panel cable and the SHT 30 sensor for the soil temperature are going through, and from the side of the box, ClimaVUE 50 or SHT 30 for measuring the air parameters.



Now it is time to connect all components to the board.
First, we connect the solar panel cable to the board. The positive "+" cable should always be the red cable and should sit on the board exactly like in the picture.

Next, we are connecting the SHT 30 sensor for the soil temperature and the ClimaVUE 50 sensor for measuring other air parameters.

Here is the order for the setup with the ClimaVUE50:

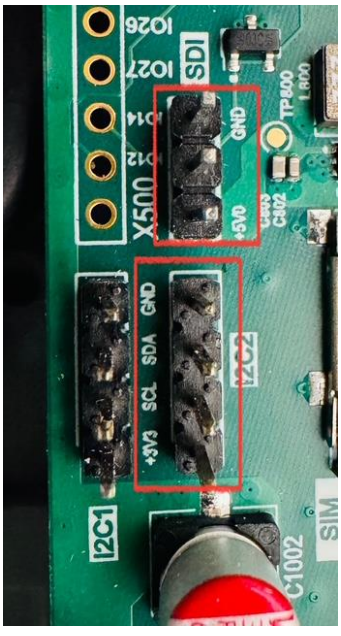
ClimaVUE 50
Black – GND (SDI)
White – middle pin (SDI)
Brown – +5V0 (SDI)

SHT 30 for soil
Black – GND (I2C2)
Green – SDA (I2C2)
Yellow – SCL (I2C2)
Red – +3V3 (I2C2)

ClimaVUE 50

SHT 30 soil

ClimaVUE 50



This one is the second option for the stations, which we are using for the soil temperature and the air parameters, the SHT30 sensors.

Here is the setup for two SHT30 sensors, one for soil, one for air:

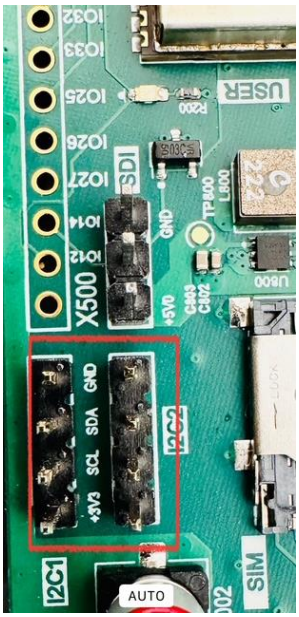
SHT 30 soil
Black – GND (I2C2)
Green – SDA (I2C2)
Yellow – SCL (I2C2)
Red – +3V3 (I2C2)

SHT 30 sensor for measuring air parameters going inside the radiation shield RAD06
Black – GND (I2C1)
Green - SDA (I2C1)
Yellow – SCL (I2C1)
Red – +3V3 (I2C1)

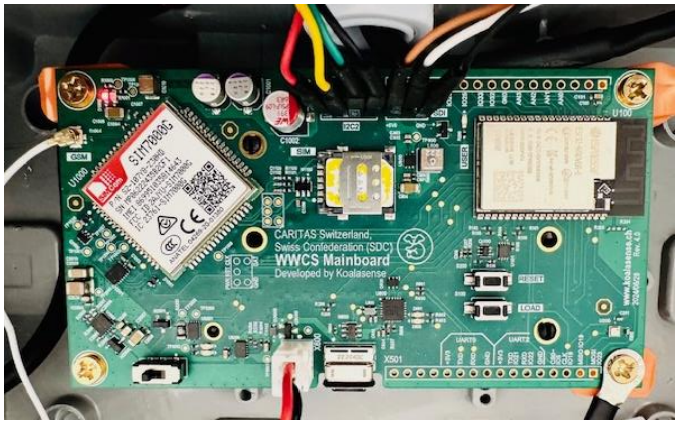
SHT 30 soil

SHT 30 air

SHT 30



Finally, in the picture, you can see a fully assembled machine with all components connected.
Connect everything. Make sure that especially the cables from the sensor have a tight fit.
Make sure that the power switch remains accessible and is switched on.



One very important point during uploading the sketch, when the sketch compilation is done on the serial monitor of the Arduino IDE, “connecting....” will appear, you should immediately press and hold for 10 seconds the LOAD button on the board as on the picture.

Make sure that the power switch remains accessible.

All together

If all went well so far, it's time to adapt the koala04_climavue_50_sht30_bmp390.ino sketch. Make sure that your GPRS network and server parameters are correct. Ready? Then

1. Upload the sketch to the board and connect the Serial monitor from the Arduino IDE. The first line shows the MAC address of the board. This is used as the unique identifier. Save it and write it down.
2. Test that it submits plausible data to the server before going any further. If you submit to the 'wwcs.tj ' the domain in Tajikistan, you can check your station by opening wwcs.tj/map by logging in (using login and password). The limit parameter specifies the number of 10-minute time steps to display.

Note*: if you are using the ClimaVUE 50 sensor, you should change the code on line* 27 `const bool CLIMAVUE50 = true;` *if you are using SHT 30 then it should be* `= false;` *It is also a good practice to create a database where you will write the station's ID, MAC address, location or name of the station and SIM number.*

Close the lid. Now we have a fully made weather station ready to be installed on the identified site.

Assembly at a pole outdoors: Use a bolt, screws M10 8-10 cm and clamps for fastening cable to the pole as on the picture.

The solar panel should face south.