Visualising your sensor data using Excel

About this sheet

The excel template

- Dashboard
- Sensor info
- Temperature Average
- Temperature Minimum
- Temperature Maximum
- Light
- Water

How to make this template work for your data

- Saving the excel sheet ‘Sensor analysis.xlsx’ and setting up a folder for the .CSV files
- Update the table with your sensor
- Setting your folder path in the excel sheet
- To view your data (refreshing your dataset)
- Adding more data

Dealing with outliers (incorrect data points)

- Example 1 – Single outlier
- Example 2 – Data to be removed

Possible errors

- Running out of memory
- Excel files excessively large

About this sheet

This template will allow you to display the sensor dataset you have downloaded, using the MyData program (Fig. 1), as graphs and see the pivot tables (a summary of data from a more extensive table) used to create them. You will even be able to decide what you want to see on the graphs, and filter the data accordingly through a main dashboard. For example, if you have 5 sensors, you can view the data for all 5, or filter that data to display 2 – allowing you to directly compare the readings.

Your data is stored out with this spread sheet and accessed automatically using the data source setting. You will need to save the excel sheet, and the sensor data on your computer.

Once you have worked through 'HOW TO MAKE THIS TEMPLATE WORK FOR YOUR DATA' you can add future data files by following the step 'To view your data (refreshing your dataset)'.

The limitation of this method is the large amount of data the sensors collect, and you may find that space becomes an issue if you have collected data for several sensors over a long period of time. In these cases, it will be necessary to summarise the data in the .CSV files before loading it into the excel spread sheet, you will have to follow the template for summarised data and run a small program to initially summarise your data and reduce the size of your files. (which shall be explained later).

Now it's time to work through 'HOW TO MAKE THIS TEMPLATE WORK FOR YOUR DATA'. You can add future data files by following the step 'To view your data (refreshing your dataset)'.

	A	B	C	D	E	F	G	H	I
1	Plant Nickname	SensorIdentifier	NickName	serial_number	capture_datetime_utc	fertilizer_level	light	soil_moisture_percent	air_temperature_celsius
2	School field 2	Flower power CDB7	Flower power CDB7	PI040297AD5I209636	18/02/2019 14:54	0	40.54	20.68	15.87
3									
4	School field 2	Flower power CDB7	Flower power CDB7	PI040297AD5I209636	18/02/2019 15:09	0	11.92	21.04	9.96
5									
6	School field 2	Flower power CDB7	Flower power CDB7	PI040297AD5I209636	18/02/2019 15:24	0	7.7	21.04	9.24
7									
8	School field 2	Flower power CDB7	Flower power CDB7	PI040297AD5I209636	18/02/2019 15:39	0	15.16	20.68	10.25
9									
10	School field 2	Flower power CDB7	Flower power CDB7	PI040297AD5I209636	18/02/2019 15:54	0	8.37	21.28	10.08

Figure 1 – example of a .CSV file

The excel template

There are 8 sheets in this Work Book:

Dashboard -

Where all your data are summarised in graphs (Fig. 2)

Using the buttons, you can filter this information to, for example, view a single month of data.

Sensor info

Your input is required here.

Table containing information about your sensors - this is used by power pivot to link the serial number to all the information (meta data) you have about each sensor (Fig. 3).

- **Sensor name** - *this must be filled in*, and will be used as buttons on the dashboard
- **Code** - Flower Power name, not used, just for validation
- **Serial number** - *this must be filled in,* as it links your downloaded data to your sensor name, it MUST be exactly the same as in the downloaded data in the .CSV files. (see the hints at the bottom)
- **Growing space name** - if you have many sensors and multiple growing spaces you can filter by space, for example If I have 15 sensors in 3 farms, I can look at the data for each farm separately.
- **Soil** - not used (yet) – you can change this
- **Plant** - not used (yet) – you can change this

All the following sheets are pivot tables used to summarise the data – it is these summaries which appear on the graphs on the dashboard.

Temperature Average

Calculates daily average temperature (°C).

Temperature Minimum

Calculates daily minimum temperature (°C).

Temperature Maximum

Calculates daily maximum temperature (°C).

Light

Calculates the sum of daily Lumens – a measure of the total amount of visible light (to the human eye) from a light source, in this case, the sun.

Water

Calculates daily average water content (%) (Fig. 4).

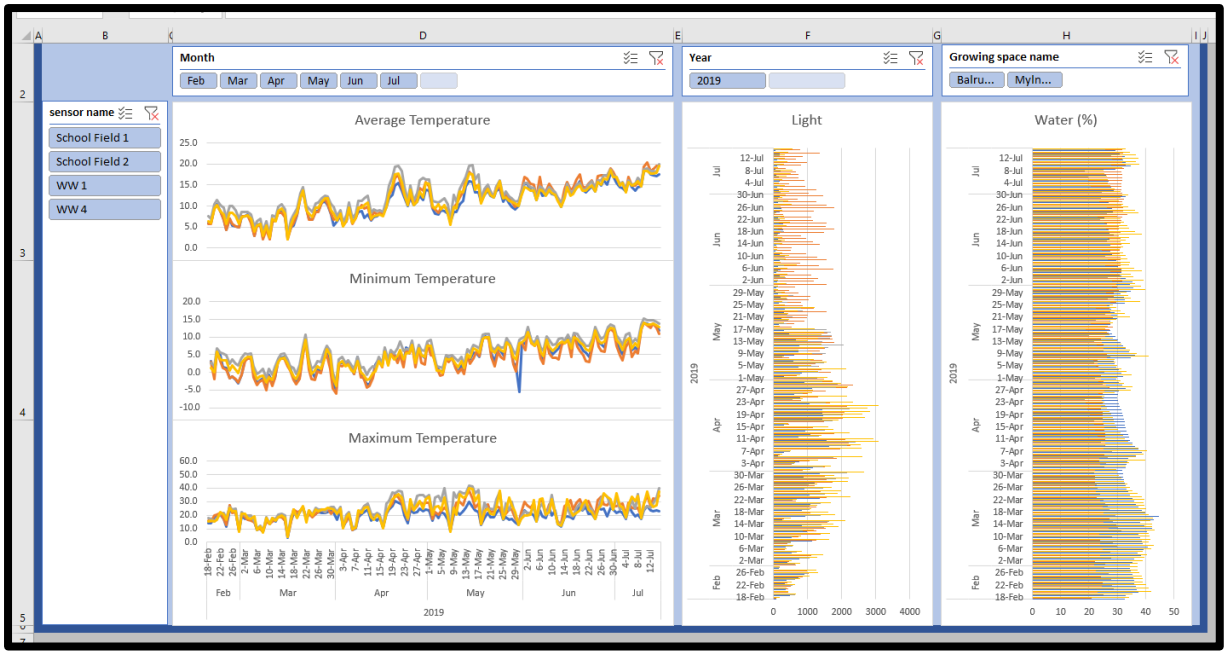


Figure 2 – dashboard

	A	B	C	D	E	F
1	sensor name	code	serial number	Growing space name	soil	plant
2	School Field 1	CDC2	PI040297AD5I209633	MyInfield Farm		Blackcurrant
3	School Field 2	CDB7	PI040297AD5I209636	MyInfield Farm		Blueberry
4	WW 1	E50C	PI040297AD5I205951	Balruddery Farm		winter wheat
5	WW 4	E6C4	PI040297AD5I207435	Balruddery Farm		winter wheat

Figure 3 – sensor table

	A	B	C	D	E	F
1						
2						
3	Average of soil_moisture_percent	Column Labels				
4	Row Labels	Bungalow Field 2	Carslea 2	School Field 1	WW 1	Grand Total
44	23-Mar	33	26	35	24	30
45	24-Mar	33	26	35	24	29
46	25-Mar	32	26	34	23	29
47	26-Mar	32	26	33	23	28
48	27-Mar	31	25	33	23	28
49	28-Mar	31	25	33	22	28
50	29-Mar	30	25	32	22	27
51	30-Mar	29	25	32	22	27
52	31-Mar	29	24	32	22	27
53	**Apr**					
54	1-Apr	29	24	32	22	27
55	2-Apr	30	26	33	26	29
56	3-Apr	30	26	33	26	29
57	4-Apr	32	28	34	28	30
58	5-Apr	32	27	34	27	30
59	6-Apr	35	29	37	27	32
60	7-Apr	36	29	39	28	33
61	8-Apr	35	28	37	27	32
62	9-Apr	34	27	36	25	31
63	10-Apr	33	26	35	24	30
64	11-Apr	33	26	35	23	29
65	12-Apr	32	26	34	23	29
66	13-Apr	32	25	34	22	28
67	14-Apr	31	25	33	22	28
68	15-Apr	30	25	33	22	28
69	16-Apr	30	25	33	22	27
70	17-Apr	30	24	33	22	27

Figure 4 – example Pivot Table of daily average water content (%)

How to make this template work for your data

Saving the excel sheet ‘Sensor analysis.xlsx’ and setting up a folder for the .CSV files

1. Create a folder in your documents. You can call it anything you want, for example “My sensor data”.
2. Save the excel spreadsheet into the folder.
3. In this folder make another folder. Save all the data files (these should be .CSV files), which you have downloaded using the “My Data” program, into this folder. You can find the “My Data” program on the GROW Observatory web pages. **Note – do not save any other files to this folder, it must only contain the .CSV files.**

In this example I have saved my excel sheet in a folder on my D: drive called ‘My sensor data’ (Fig. 5).

In the folder ‘My sensor data’ I have another folder for my data files called ‘my sensor data files’, containing 4 example datasets (Fig. 6).

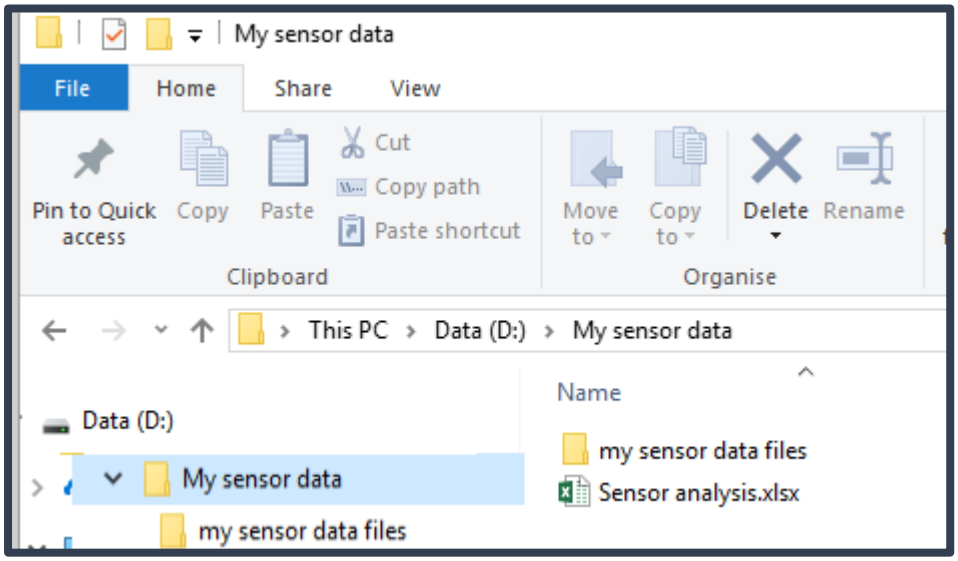


Figure 5 – excel sheet

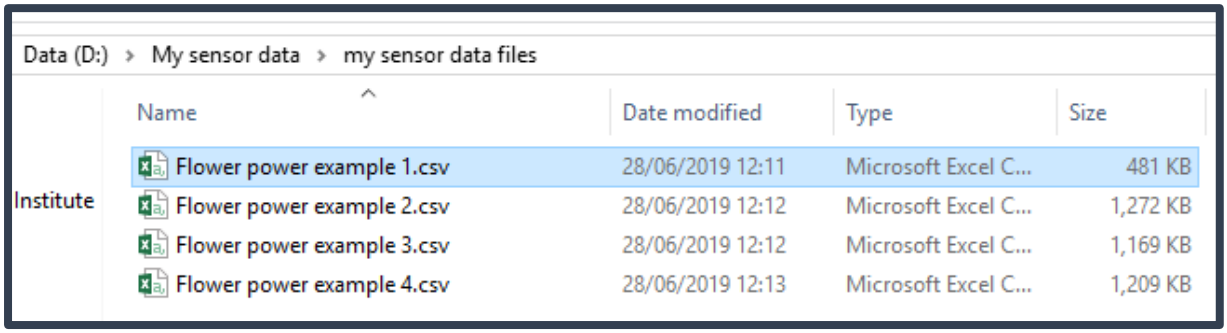


Figure 6 – data storage

Add your sensors!

1. Fill in the table in the sheet called "Sensor info". The first row is the table headers, the second row is the first row of information about your sensors. To add a second sensor to this table input the information into the next row. Excel will automatically recognise this as another row in the table. **Note – the serial numbers must be exactly the same in the sensor table as in the .CSV files.**

Hint - Copying your serial number into the table:

> Your parrot sensor has a serial number which is 18 characters long (PI040297AD5I204958), to copy this into your 'My sensors' sheet you can either type it in (remember it is case sensitive) or copy and paste from your downloaded .CSV files.
>
> To do this:
>
> Open the .CSV (either into a spread sheet, or a text editor), highlight the serial number, right click the highlighted number, click copy, then go to the appropriate cell in the excel table, right click, and then click paste. Each sensor will have a different number, so you will have to open the .CSV data file for each of your flower power sensors to get their associated serial numbers.

Setting up your folder path

1. In your excel 'Sensor analysis.xlsx' spreadsheet, go to the 'Data' tab and open the menu under 'get data' and choose 'Data source settings' (Fig. 7).
    a. The example is currently set to 's:\grow\sensor data jhi
2. Change where YOUR data is saved. Click on "Change Source" and browse to your data folder. Click Okay. Your folder will now be in the 'Data source settings' window. Close this window (Fig. 8).

To view your data (refreshing your dataset)

1. Choose the 'Data' tab, then 'Refresh all' (Fig. 9). This may take a while, depending on how much data you have (Fig. 10).
2. Open the 'Dashboard' sheet where your sensor data should now be displayed.

Adding more data

1. To add more data to your dashboard, or add another sensor. Download the CSV file, save it in the data folder and refresh. If you are adding another sensor remember to add it to your table in "sensor info".

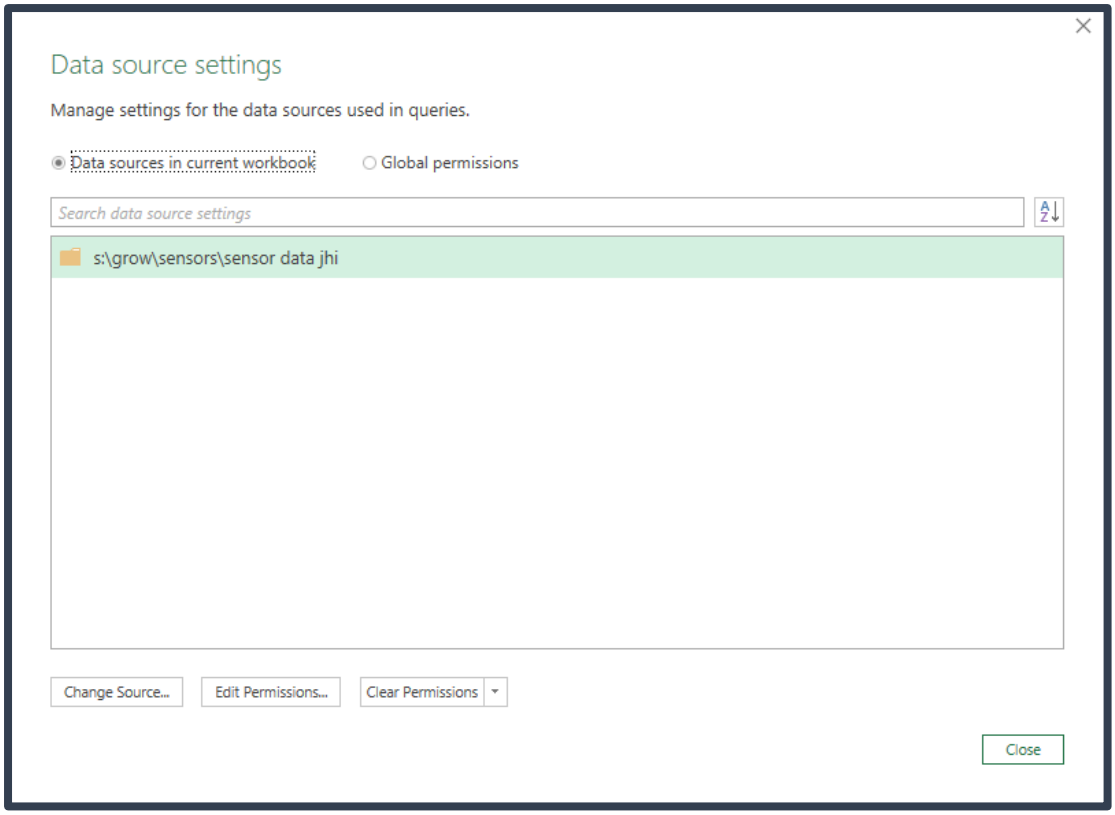


Figure 7 – data source setting window

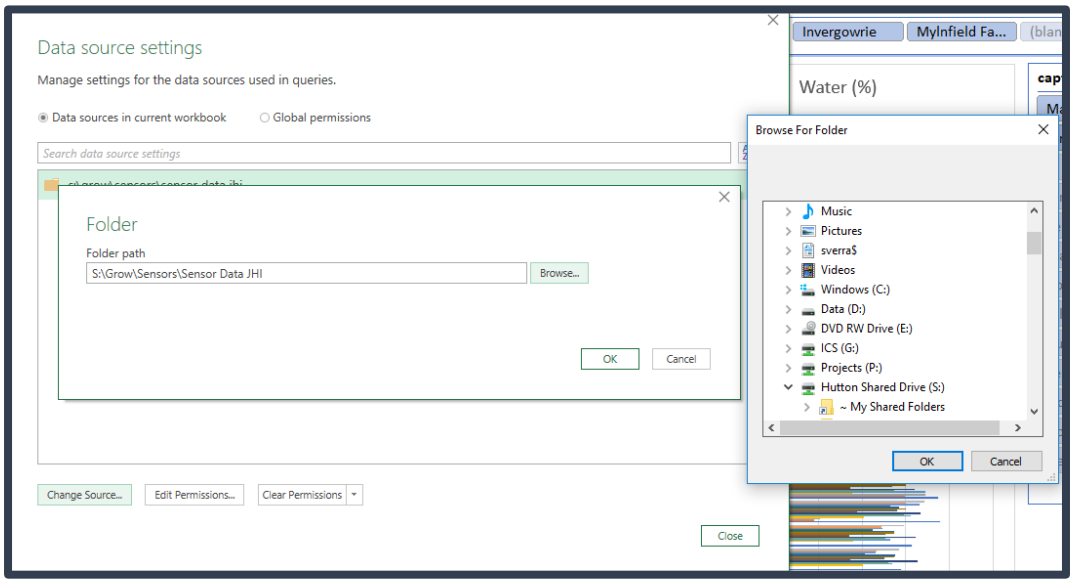


Figure 8 – browsing to your data folder

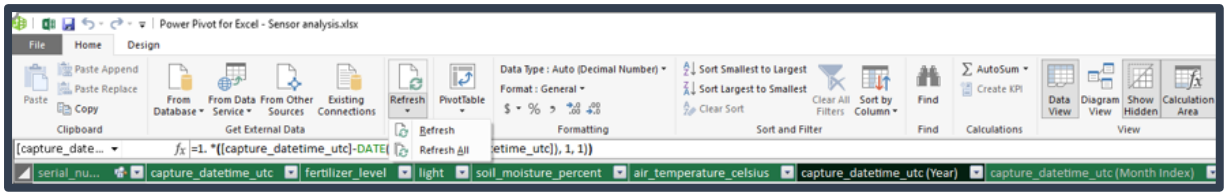


Figure 9 – refresh

Dealing with outliers (incorrect data points)

Sometimes your Parrot Sensor may record incorrect values. You can amend this by identifying which value or values are incorrect, and either deleting, or replacing them, depending on the situation. In all cases it's a good idea to keep the original data, and rename the edited version, for example, change the edited version of "Flower power GROW-01-Jun-2019.CSV", to "Flower power GROW-01-Jun-2019-EDIT.CSV".

Example 1 – Single outlier

In this example I have chosen to replace the value with the average of the 2 readings either side, because it is just one single incorrect value. In the Minimum temperature graph, there is a value much lower that all the other sensor readings (Fig. 10) shows the original data, and Fig. 11 shows the altered data.

By using the mouse to "hover over" the data point, I can see that for the sensor "School Field 1", the value is -5.4 on May 30th, very different to the other measurements. In this example, using the measurements either side, I can see that the temperature is increasing. Therefore, I can assume that using the average of the values before and after is valid. In Fig. 12a, b and c you can see the steps taken to alter the data.

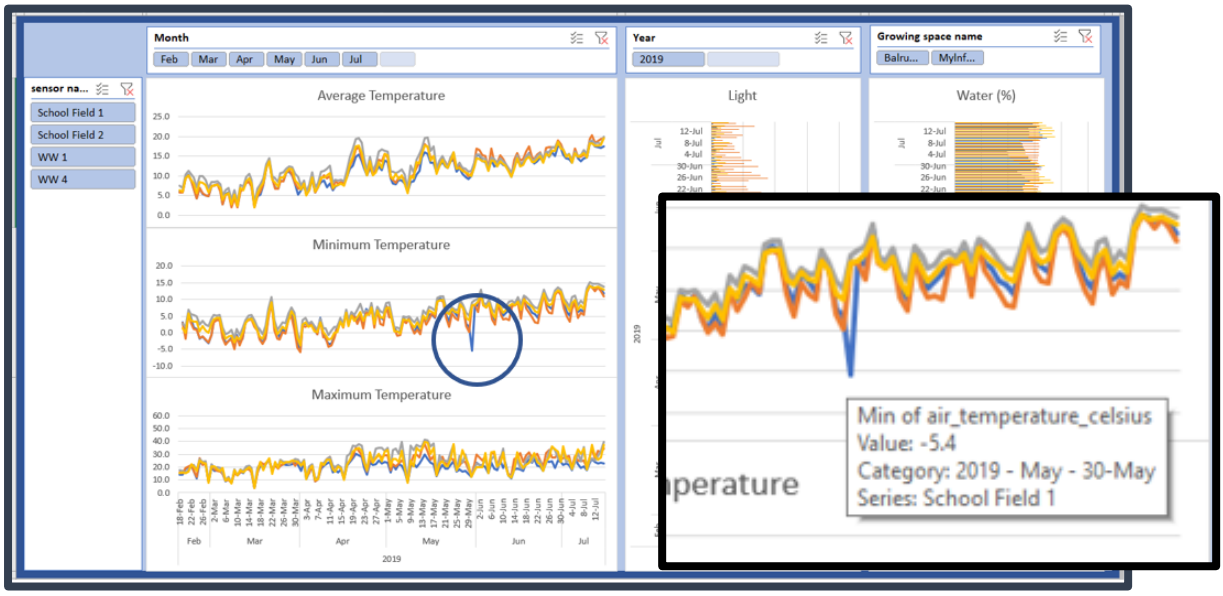


Figure 10 – identify outlier

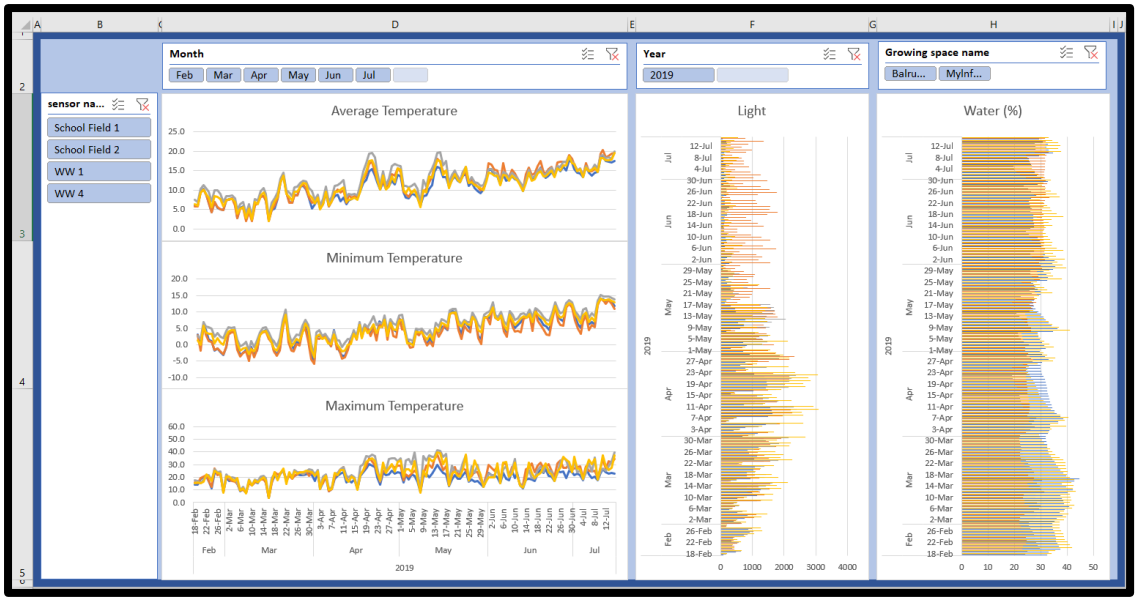


Figure 11 – outlier removed

30/05/2019 07:15	3.86	1.14	33.91	10.25
30/05/2019 07:30	3.86	0.89	33.84	10.31
30/05/2019 07:45	3.86	0.92	34.07	10.55
30/05/2019 08:00	3.86	0.73	34.19	10.61
30/05/2019 08:15	3.86	1.18	34.32	10.84
30/05/2019 08:30	3.86	1.7	34.58	-5.41
30/05/2019 08:45	3.86	2.06	34.94	11.65
30/05/2019 09:00	3.86	2.05	35.05	11.59
30/05/2019 09:15	3.86	2.43	35.05	11.94
30/05/2019 09:30	3.86	2.57	35.37	11.65

Figure 12a – finding the outlier

30/05/2019 07:45	3.86	0.92	34.07	10.55
30/05/2019 08:00	3.86	0.73	34.19	10.61
30/05/2019 08:15	3.86	1.18	34.32	10.84
30/05/2019 08:30	3.86	1.7	34.58	=average(I19342,I19346)
30/05/2019 08:45	3.86	2.06	34.94	11.65
30/05/2019 09:00	3.86	2.05	35.05	11.59
30/05/2019 09:15	3.86	2.43	35.05	11.94

Figure 12b – calculating the average

30/05/2019 07:30	3.86	0.89	33.84	10.31
30/05/2019 07:45	3.86	0.92	34.07	10.55
30/05/2019 08:00	3.86	0.73	34.19	10.61
30/05/2019 08:15	3.86	1.18	34.32	10.84
30/05/2019 08:30	3.86	1.7	34.58	11.245
30/05/2019 08:45	3.86	2.06	34.94	11.65
30/05/2019 09:00	3.86	2.05	35.05	11.59
30/05/2019 09:15	3.86	2.43	35.05	11.94

Figure 12c – replacement value

Example 2 – Data to be removed

In this example (Fig. 13), the total light readings for one of the sensors is higher than the others from 5th May to the 26th May. In this case I have opened the CSV file and plotted this region along with a few days each side to evaluate the issue. The data shows excessively high values have been recorded, and overnight have not returned to the usual value of 0.1. In this case I have replaced the values with 0.1 for the entire period.

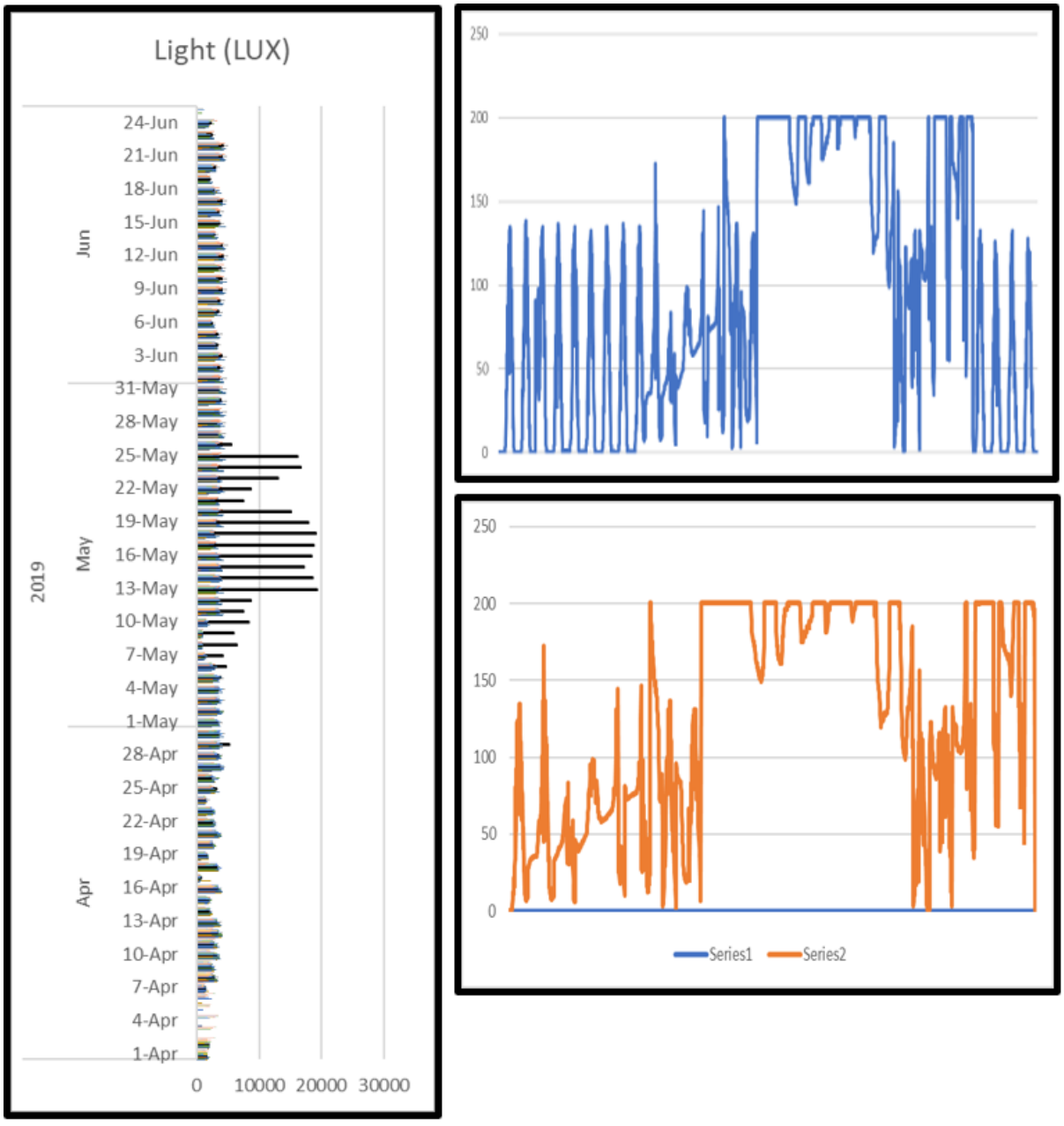


Figure 13 – Removing incorrect data

Possible error messages

Running out of memory

Your Parrot sensor collects data every 15 minutes, resulting in 96 rows of information every day. This very quickly results in large files (6 months of data from 1 sensor gives a 1.8MB file). Excel has size limitations and depending on the version you are using this may make this template run slowly, or not load your data.

You may receive and error message as in Figure 14.

If this happens you can try saving the file and close any other programs you have running. Then reopening the file and try to refresh again.

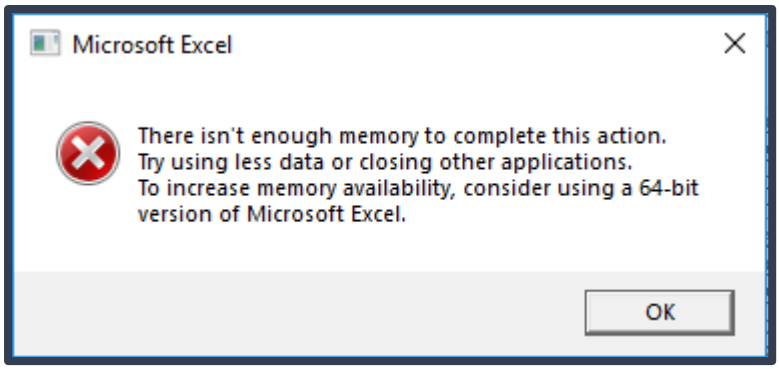


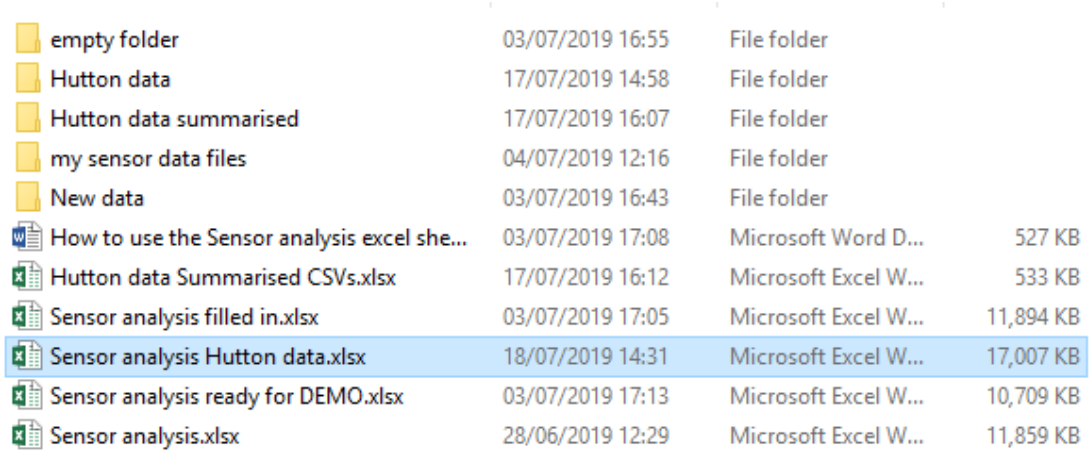
Figure 14 – possible error message

Excel files excessively large

Unexplained excessively large files can be produced which are not related to the size of your data.

In this example I have opened a 17MB (Fig. 15) excel sheet which has been populated with 15 sensors using the instructions above. By doing the following steps the file size has been reduced from 17MB to 6.7MB (Fig. 19).

1. Open the “Light” sheet.
2. The data displayed is the sum of each day (Fig. 16) for all my sensors. By clicking on the “+” beside the first date “15-Feb” this now shows all the values for that day (Fig. 17).
3. Click save. Checking the size of the file, it has now reduced to 14MB (Fig. 18).
4. Click on the “-“ beside the “15-Feb” so your data returns to the sum of values for that day and repeat this for all 5 pivot tables.



empty folder	03/07/2019 16:55	File folder	
Hutton data	17/07/2019 14:58	File folder	
Hutton data summarised	17/07/2019 16:07	File folder	
my sensor data files	04/07/2019 12:16	File folder	
New data	03/07/2019 16:43	File folder	
How to use the Sensor analysis excel she...	03/07/2019 17:08	Microsoft Word D...	527 KB
Hutton data Summarised CSVs.xlsx	17/07/2019 16:12	Microsoft Excel W...	533 KB
Sensor analysis filled in.xlsx	03/07/2019 17:05	Microsoft Excel W...	11,894 KB
Sensor analysis Hutton data.xlsx	18/07/2019 14:31	Microsoft Excel W...	17,007 KB
Sensor analysis ready for DEMO.xlsx	03/07/2019 17:13	Microsoft Excel W...	10,709 KB
Sensor analysis.xlsx	28/06/2019 12:29	Microsoft Excel W...	11,859 KB

Figure 15 – 17MB file

Sum of light	Column Labels			
Row Labels	Balruddery West	Bungalow Field 1	Bungalow Field 2	B
2019				
Feb				
15-Feb		3	3	
16-Feb		476	528	
17-Feb		329	365	
18-Feb	107	541	393	
19-Feb	310	574	443	
20-Feb	226	376	301	
21-Feb	243	426	347	
22-Feb	362	534	433	
23-Feb	276	421	358	

Figure 16 – Pivot table with daily values

Sum of light	Column Labels			
Row Labels	Balruddery West	Bungalow Field 1	Bungalow Field 2	B
2019				
Feb				
15-Feb				
15/02/2019 17:20			0	
15/02/2019 17:31		0		
15/02/2019 17:35			0	
15/02/2019 17:46		0		
15/02/2019 17:50			0	
15/02/2019 18:01		0		
15/02/2019 18:05			0	
15/02/2019 18:16		0		
15/02/2019 18:20			0	
15/02/2019 18:31		0		
15/02/2019 18:35			0	
15/02/2019 18:46		0		
15/02/2019 18:50			0	
15/02/2019 19:01		0		

Figure 17 – Pivot table with individual readings

empty folder	03/07/2019 16:55	File folder	
Hutton data	17/07/2019 14:58	File folder	
Hutton data summarised	17/07/2019 16:07	File folder	
my sensor data files	04/07/2019 12:16	File folder	
New data	03/07/2019 16:43	File folder	
How to use the Sensor analysis excel she...	03/07/2019 17:08	Microsoft Word D...	527 KB
Hutton data Summarised CSVs.xlsx	17/07/2019 16:12	Microsoft Excel W...	533 KB
Sensor analysis filled in.xlsx	03/07/2019 17:05	Microsoft Excel W...	11,894 KB
Sensor analysis Hutton data.xlsx	15/08/2019 16:02	Microsoft Excel W...	14,950 KB
Sensor analysis ready for DEMO.xlsx	03/07/2019 17:13	Microsoft Excel W...	10,709 KB
Sensor analysis.xlsx	28/06/2019 12:29	Microsoft Excel W...	11,859 KB

Figure 18 – File size after first save

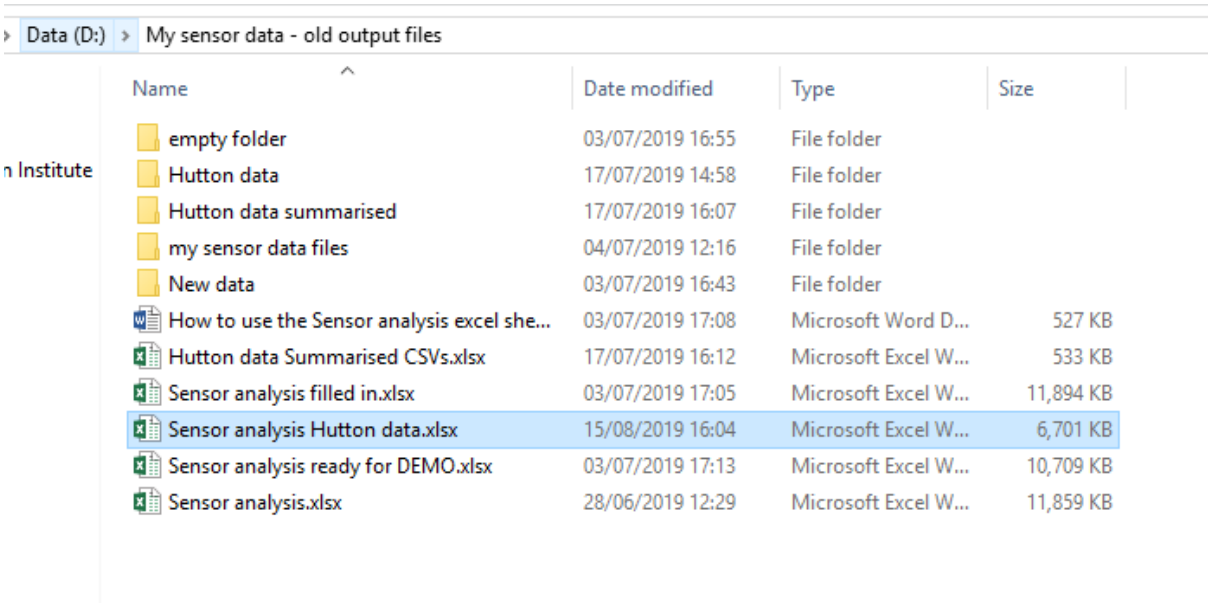


Figure 19 – File size after repeating the process on all 5 Pivot tables