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INSTALLING AND USING A HP1000 HOME WEATHER STATION

By Mark Little

Original Image from University of Delaware

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WHAT IS THE HP1000 WEATHER STATION?

The HP1000 family of weather stations are designed to allow for simple wireless installation and connection to the Internet. They are primarily designed to connect to Internet weather services such as the Weather Bureau's WOW (Weather Observations Website) and the Weather Underground.

The weather station provides a wide range of measurements that relate to personal weather. In additional to the usual measurements, it includes the measurement of solar power levels, as well as UV levels.

Unlike many home weather stations, it provides a system for calibrating the readings from the weather station to provide more accurate readings and to account for the aging of the sensors.

NOTE: There are various software versions for this device, so your station may have other features or displays.

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HP1000 WEATHER STATION CONSTRUCTION

The HP1000 weather station consists of three (3) parts:

(1) The display which contains the computer and the WIFI connection. It also has wireless connections to the other two units. It does not contain any meteorological sensors.

(2) The indoor sensor unit that measures the indoor temperature, humidity and atmospheric pressure. This unit is battery powered without any charging method.

(3) The solar powered outdoor unit measure outside temperature and humidity, rainfall, wind direction and speed as well as solar radiation.

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INSTALLING THE HP1000 WEATHER STATION

- **The MOST important thing that most people installing a home weather station have to accept is that it will not be able to meet the conditions required of a standard Bureau Of Meteorology (BOM) station.** Their weather station will be measuring the microclimate of their backyard, rather than representing the average conditions of the area – and this is OK.

- Once this is accepted, the task is to select a position that is (1) Safe to maintain, (2) Provides the most even air flow, and (3) away from potential man-made sources of heat (or cold).

- For the HP1000, the location of the both the indoor sensor and the outdoor sensor need some consideration to get the best out of the weather station.

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LOCATING THE DISPLAY UNIT

- Although the display unit does not have any sensors, its location must still be carefully selected.

The first requirement is that it must be located near a power point as it is powered by a plug pack to provide a 5V supply, and within a 100 metres of the external and internal units and your WIFI router (subject to house construction). The more common situation where the display unit is placed on a shelf near a free power point, and in a location where most people in the house frequent such as the kitchen or recreation area. On hot, wet or windy days it will probably be looked at quite frequently, so it probably best not put in an area where that would disturb others.

If you are electronically minded and don't mind invalidating the warranty, it can be powered from USB type power supply. To the left is a HP1000 weather station that has been mounted on a houseboat and powered via a DC-DC converter that outputs the required 5V from the boat's 12V domestic battery.

LOCATING THE INTERNAL SENSOR

- The internal sensor measures the internal temperature and humidity. Things that can affect the temperature is placing it under the vents of the air-conditioner (heating and cooling) as it will tend to register the temperature of the vented air rather than a temperature more representative of the air in the rest of the building.

- It is also best to avoid, if possible, mounting the sensor on any walls that are subject to prolonged heating by the sun. In these cases, the wall will heat up and transfer heat to the sensor by conduction. An internal wall is more likely to represent the average internal conditions of the house.

- If the sensor is to be mounted in a kitchen area, consider where the heat from the oven and range hoods exhaust. There may be warm air currents.

- The sensor should also be mounted in an area that most represents the area that is important to the occupants of the house. It is more useful to have a temperature record on an areas that is used frequently, rather than some nook that is never used and not well ventilated.

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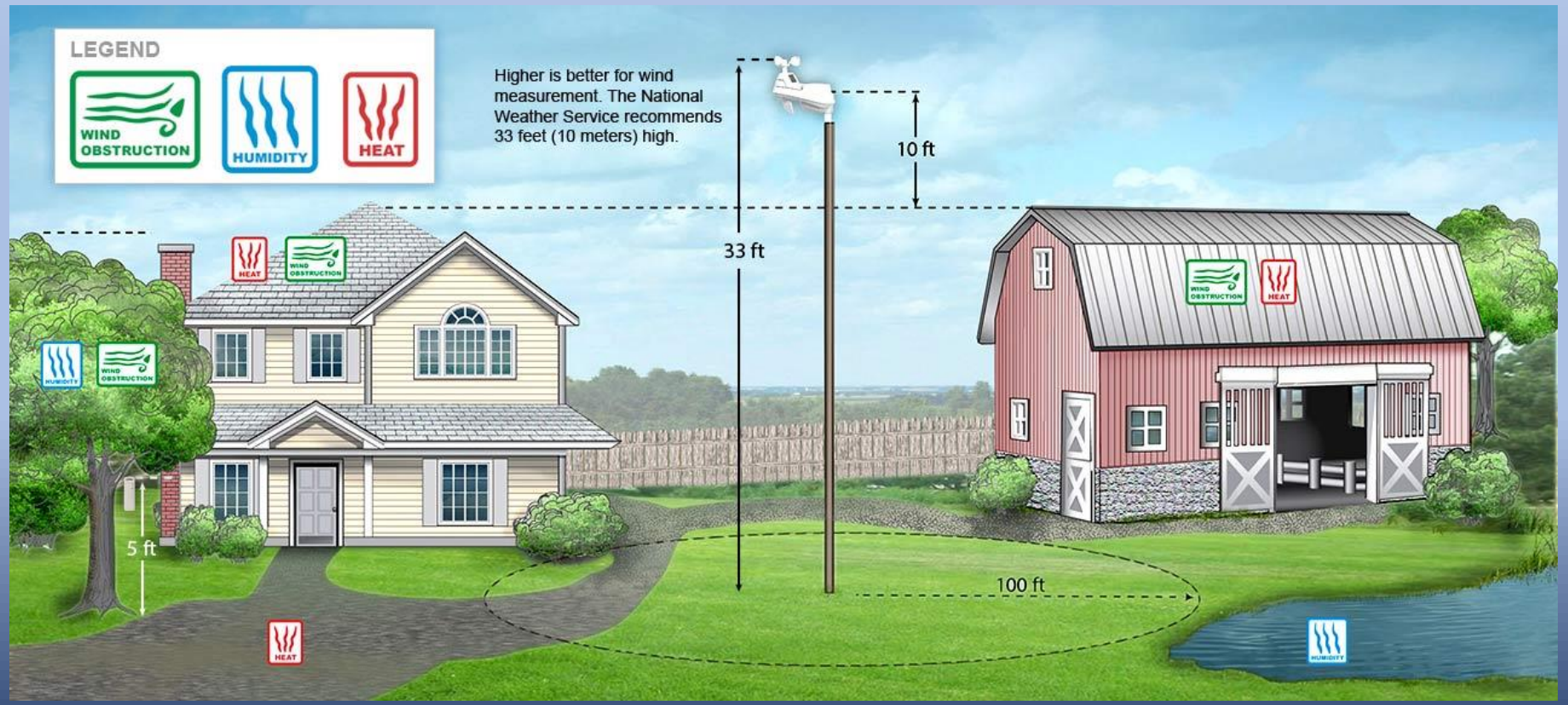
LOCATING THE EXTERNAL SENSOR

THE IDEAL LOCATION



Ideally the weather station is located well away from obstructions that block the wind, man made structures that can operate as heat banks, and large bodies of water than can affect local humidity.

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LOCATING THE EXTERNAL SENSOR

REALITY STRIKES

Most homes cannot meet the ideal environment for a weather station and are limited by the reality of their home and the need to maintain the weather station.

Not only does the weather station need to have as must clear air around it as possible, the outdoor sensor must be mounted so that the solar panel is facing North.

It also needs to be accessible so that if the rain gauge gets clogged by leaves and twigs blown in from surrounding trees, or a bird decides to leave its “calling card” that dries and blocks the drain hole of the rain gauge.

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LOCATING THE EXTERNAL SENSOR

LIFTING THE SENSOR HIGHER

A home weather station can be relatively easily raised using a facia mounted TV antenna pole, although the easiest place to mount it is below the gutter which will probably not lift it above the roof line.

A disadvantage of a long pole is that the sensor will tend to vibrate in the wind. This may affect the amount of rainfall detected, if the sensor uses a tipping bucket or similar rain gauge. Support struts or guy wires can be installed to reduce this effect, but taking down the sensor for maintenance becomes more complicated.

DISCLAIMER: The AMETA strongly recommends that you do not attempt installations if you do not have the right safety equipment, experience and assistance.

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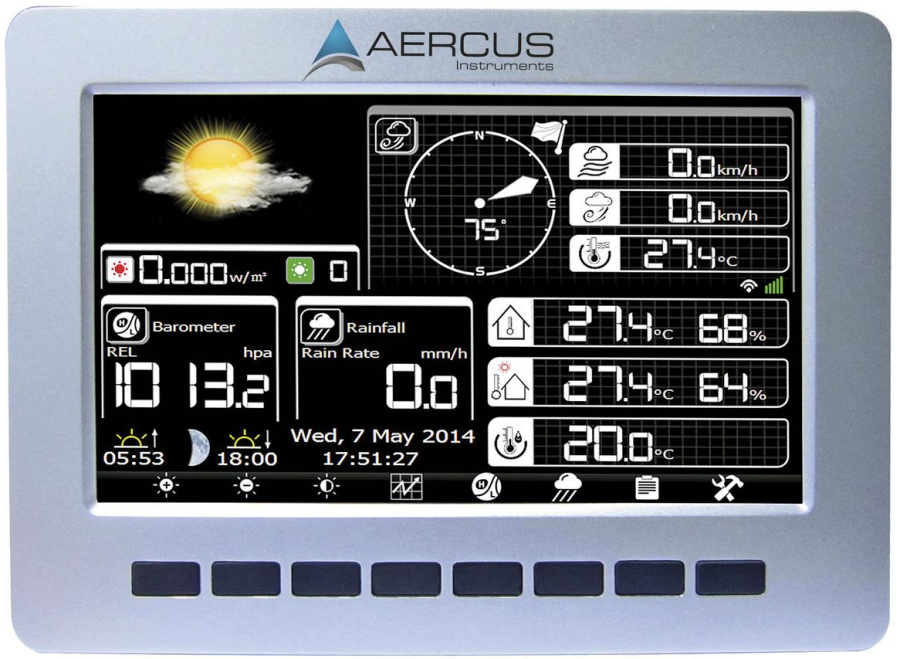
BEFORE INSTALLING THE OUTDOOR SENSOR



After you have selected the location for the outdoor sensor, but before it is installed, you need to calibrate the wind vane. The unit is designed for use in the Northern Hemisphere where the solar panel would face South.

The method is to point the needle to exactly South as marked on the outdoor sensor case. Then press the button below the hammer and spanner symbol. For the next two displays, press the button below the hammer and spanner symbol.

This display will now show the “Correct” Menu.

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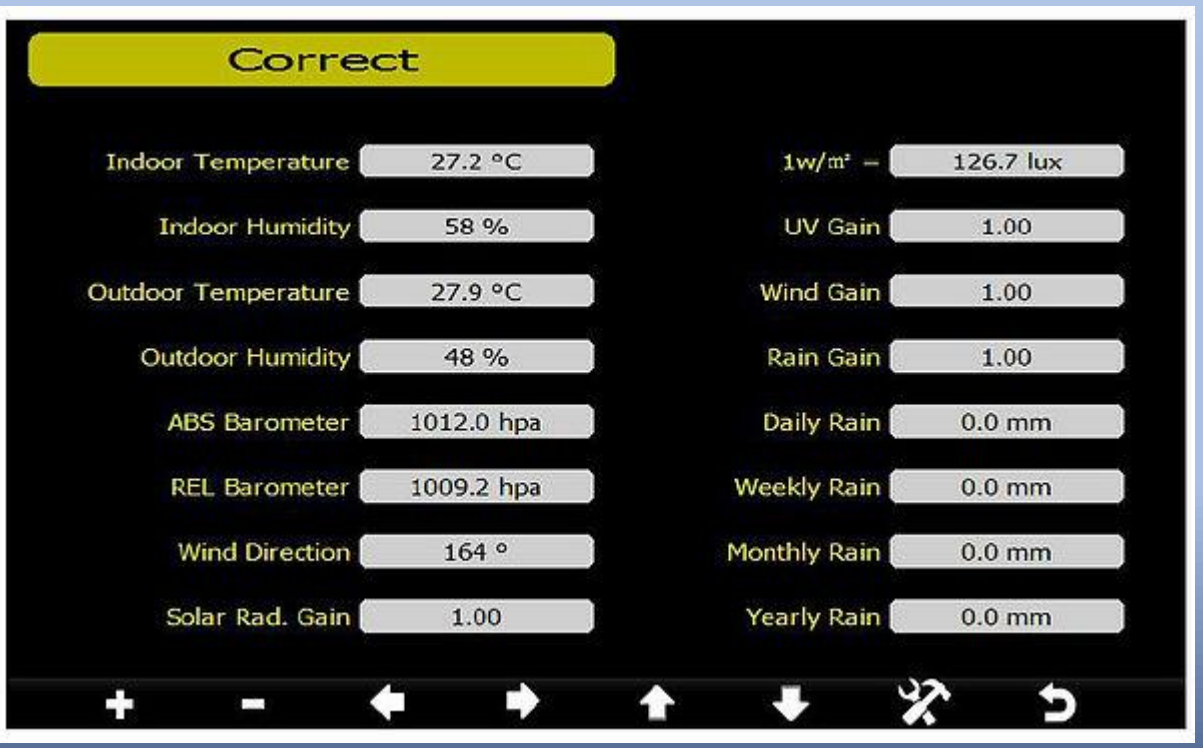
BEFORE INSTALLING THE OUTDOOR SENSOR

NOTE: The *Correct* Menu may also be called the *Calibration* Menu.



Press the Down Button, until the Wind Direction is highlighted, then set to 180° to account for the unit being in the Southern Hemisphere.

Press Return Button to go back to the main display. The wind should now show that the wind vane is pointing North (as it will be when you mount the outdoor sensor with the solar panel facing North). Adjust value if necessary to achieve a North reading.

If after installation you find that you haven't installed the sensor exactly North, the direction can be corrected by adjusting the value you just set before

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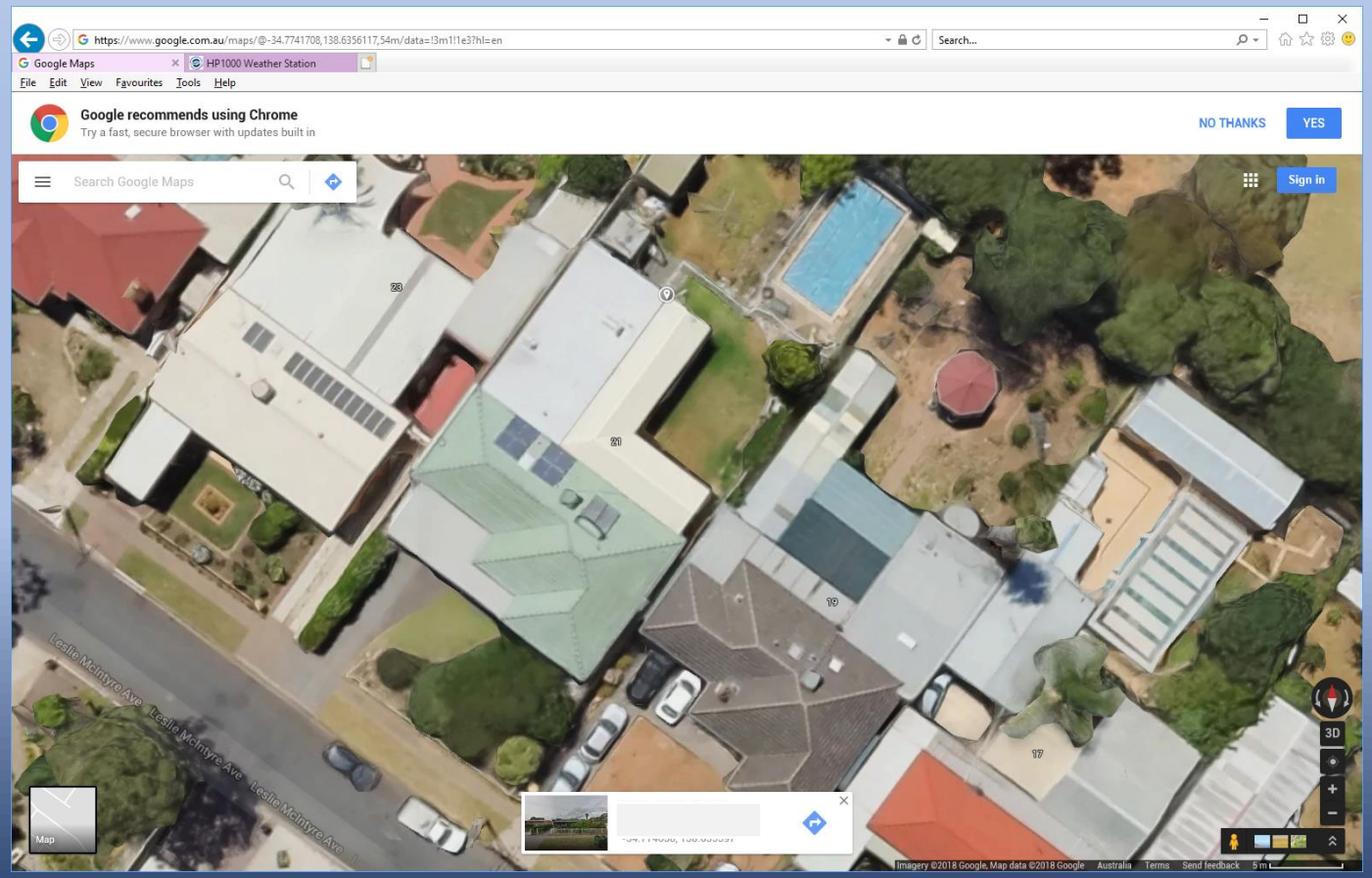
FINDING THE LATITUDE AND LONGITUDE



For the weather station to correctly indicate the correct sunrise and sunset times, it needs to know its latitude and longitude.

Google Maps provides an easy way to determine the latitude and longitude of your weather station. Click location of your outdoor sensor and make a note of the latitude and longitude shown at the bottom of the page.

If you want to wait until after you register your weather station with the Weather Underground, it will provide you with your latitude and longitude obtained in a similar way to Google Maps.

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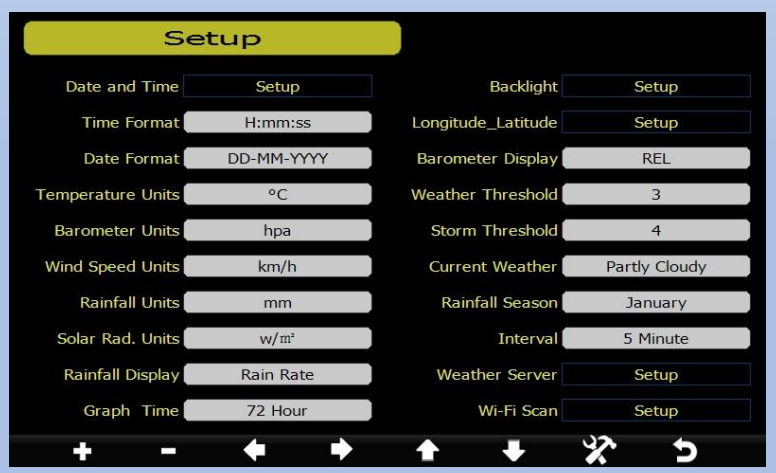
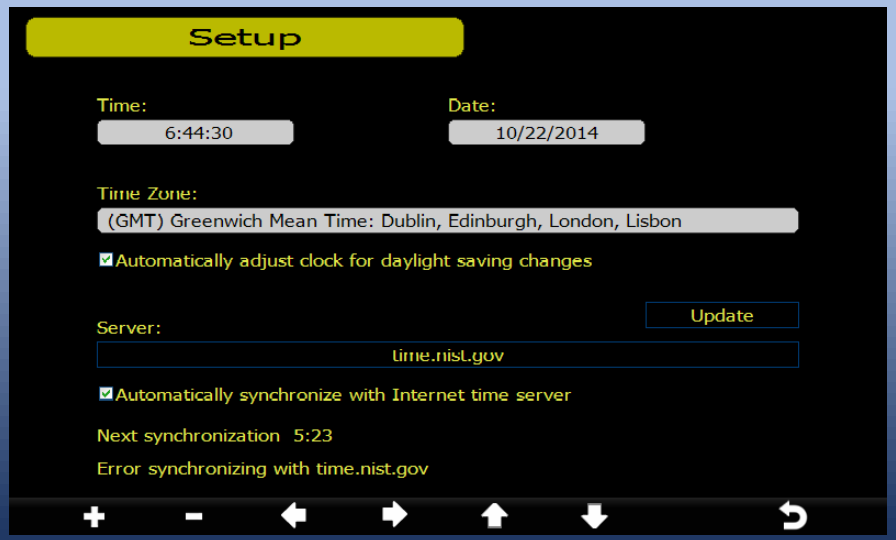
BASIC SETUP





From the Main display, press the spanner and hammer button to get to the Setup menu.

Press the Down button to highlight the Date and Time Setup. Press the plus (+) button to select it.

Use the Down button to select the time. Use the plus (+) and (-) minus numbers to adjust the number up and down. Use the left and right arrows to select the hours minutes and seconds.

Set the time zone to Darwin (GMT + 9hr 30min)

Adjust the date in the same manner as the time.

The time will automatically update when the unit connects to the Internet.

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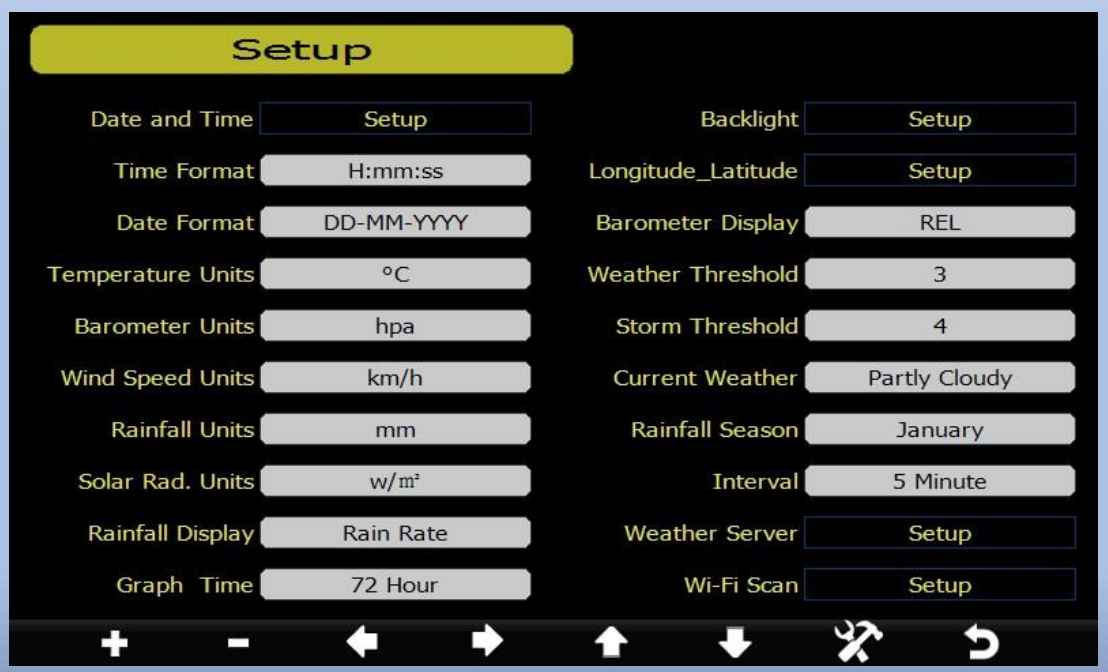
BASIC SETUP (CONTINUED)



After setting up the time, step down to each option and select the desired display units.

For graph time on the main display, I normally select 72 hours as the trends over the last 3 days are shown.

The Backlight option allows the intensity of the display to be set and allows the display to be automatically turn on at a particular time and off at another time, so it is not lighting up the room at night. The display can be controlled from the main display.

The Latitude and longitude that you found from Google Maps will now be used to let the weather station know where it is (for the Sunrise and Sunset calculations).

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BASIC SETUP

The Latitude provided by Google Maps will be something like -34.234234°. The negative sign indicates that the latitude should be set to SOUTH and the absolute number entered.

The longitude will be a positive number which indicates that the longitude is EAST. The absolute number is entered.

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ALTERNATIVE TO WEATHER SERVER

The next few slides will deal with registering the weather station on the Weather Underground site, but even if you do not do this, you can still access the readings from your weather station by inserting a micro-SD memory card into the weather and downloading all of the readings as an Excel Spreadsheet and view recent history on the weather station's graphs. Although this allows for more detailed analysis, it does not have the immediacy of the on-line graphs

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	U	V
No.	Time	Indoor Temperature	Indoor Humi	Outdoor Tempe	Outdoor H	Wind (km/h)	Gust (km/h)	Dew Point (°(	Wind Chil	Wind Directio	ABS Baromet	REL Baromet	Rain Rate (mm/	Daily Rain	Weekly Ra	Monthly R	Yearly Rai	Solar Rad.	UV (uW/c	UVI
1	1/01/2017 0:00	23.2	66	19.4	78	0	0	15.5	19.4	224	1007.9	1012.8	0	0	0	0	0	0	1	0
2	1/01/2017 0:01	23.2	66	19.4	78	1.4	4	15.5	19.4	222	1008	1012.9	0	0	0	0	0	0	1	0
3	1/01/2017 0:02	23.2	66	19.4	78	1.8	4	15.5	19.4	250	1008	1012.9	0	0	0	0	0	0	1	0
4	1/01/2017 0:03	23.2	66	19.4	78	4.3	7.9	15.5	19.4	222	1008	1012.9	0	0	0	0	0	0	1	0
5	1/01/2017 0:04	23.2	66	19.4	78	1.4	4	15.5	19.4	207	1008	1012.9	0	0	0	0	0	0	1	0
6	1/01/2017 0:05	23.2	66	19.4	78	4.3	7.9	15.5	19.4	207	1008	1012.9	0	0	0	0	0	0	0	0
7	1/01/2017 0:06	23.2	66	19.4	78	6.8	7.9	15.5	19.4	236	1007.9	1012.8	0	0	0	0	0	0	1	0
8	1/01/2017 0:07	23.2	66	19.4	77	3.2	4	15.3	19.4	210	1008	1012.9	0	0	0	0	0	0	1	0
9	1/01/2017 0:08	23.2	66	19.4	77	2.9	4	15.3	19.4	209	1008	1012.9	0	0	0	0	0	0	0	0
10	1/01/2017 0:09	23.2	66	19.4	77	0	0	15.3	19.4	222	1008	1012.9	0	0	0	0	0	0	0	0
11	1/01/2017 0:10	23.2	66	19.4	77	0	0	15.3	19.4	205	1008	1012.9	0	0	0	0	0	0	1	0
12	1/01/2017 0:11	23.2	66	19.5	77	0	0	15.4	19.5	214	1008.1	1013	0	0	0	0	0	0	1	0
13	1/01/2017 0:12	23.2	66	19.5	77	0	0	15.4	19.5	187	1008	1012.9	0	0	0	0	0	0	1	0
14	1/01/2017 0:13	23.2	66	19.5	77	0	0	15.4	19.5	199	1008	1012.9	0	0	0	0	0	0	1	0
15	1/01/2017 0:14	23.2	66	19.5	77	0	0	15.4	19.5	218	1008	1012.9	0	0	0	0	0	0	0	0
16	1/01/2017 0:15	23.2	66	19.5	77	0	0	15.4	19.5	194	1008	1012.9	0	0	0	0	0	0	1	0
17	1/01/2017 0:16	23.2	66	19.5	77	2.2	4	15.4	19.5	195	1008.1	1013	0	0	0	0	0	0	0	0
18	1/01/2017 0:17	23.2	66	19.5	77	1.8	4	15.4	19.5	187	1008.1	1013	0	0	0	0	0	0	1	0
19	1/01/2017 0:18	23.2	66	19.5	77	5.4	7.9	15.4	19.5	234	1008.1	1013	0	0	0	0	0	0	1	0
20	1/01/2017 0:19	23.2	66	19.5	77	1.8	4	15.4	19.5	238	1008	1012.9	0	0	0	0	0	0	0	0
21	1/01/2017 0:20	23.2	66	19.5	77	2.2	4	15.4	19.5	200	1008	1012.9	0	0	0	0	0	0	1	0
22	1/01/2017 0:21	23.2	66	19.5	77	0	0	15.4	19.5	235	1008	1012.9	0	0	0	0	0	0	0	0
23	1/01/2017 0:22	23.2	66	19.5	77	0	0	15.4	19.5	208	1008	1012.9	0	0	0	0	0	0	0	0
24	1/01/2017 0:23	23.2	66	19.5	77	0	0	15.4	19.5	195	1008	1012.9	0	0	0	0	0	0	0	0
25	1/01/2017 0:24	23.2	66	19.5	77	3.2	7.9	15.4	19.5	203	1007.9	1012.8	0	0	0	0	0	0	1	0
26	1/01/2017 0:25	23.2	66	19.5	77	0.4	4	15.4	19.5	205	1008	1012.9	0	0	0	0	0	0	1	0

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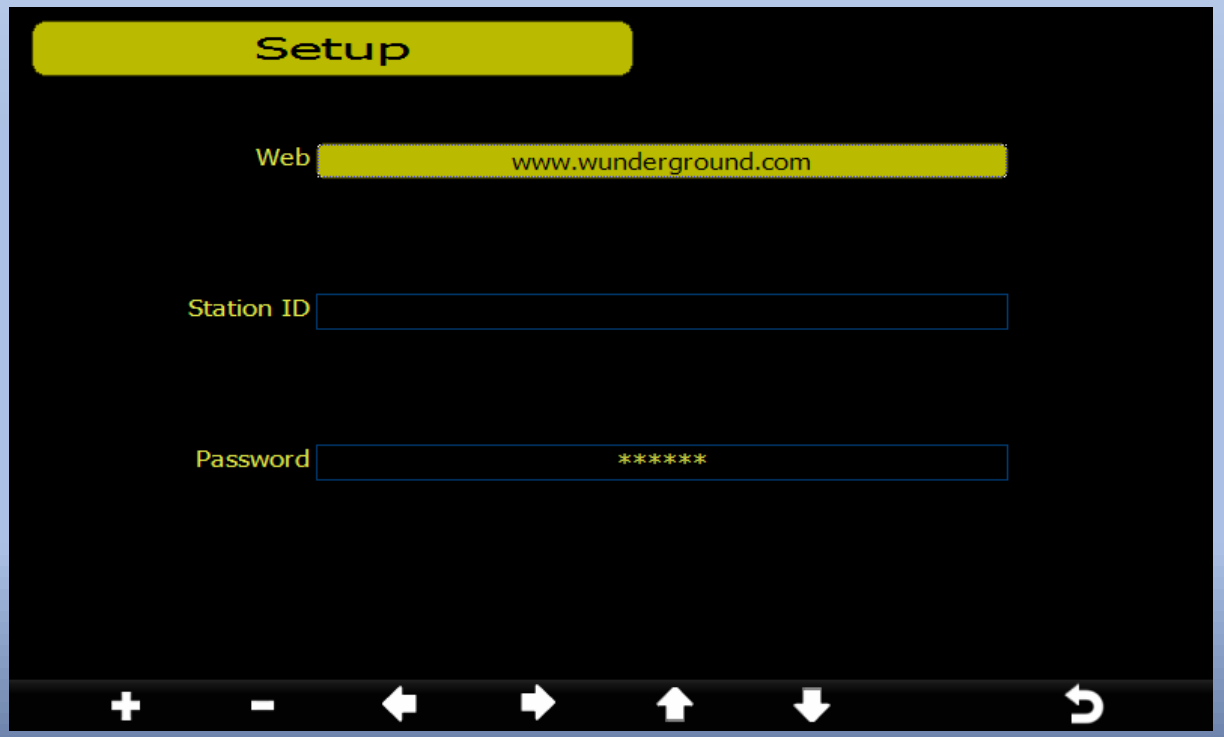
WEATHER SERVER



This menu varies with different versions of the software, with some versions offering more options for sending data to the Internet. This presentation shows the simple version for brevity.

To connect to the Weather Underground, an account on the website must be created to set up a Station ID and a password.

The Station ID is publicly used to identify your station, while the password helps ensure that bogus data is not uploaded to you account.

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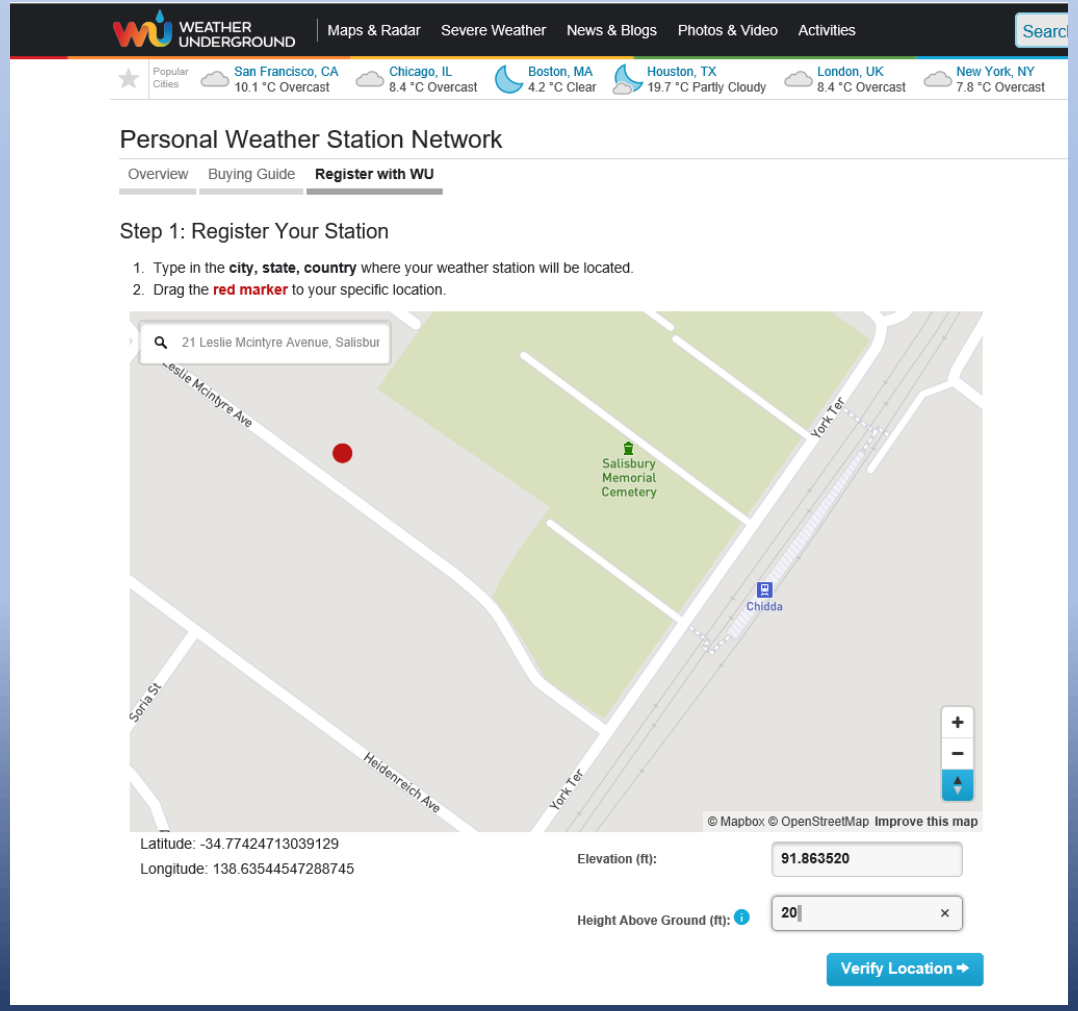
WEATHER UNDERGROUND REGISTRATION



- Registering your weather station with Weather Underground is relatively simple. All you need to know is where your weather station is located and how above the ground you have installed the weather station. The measurements default to feet, so the easiest thing is to pre-convert the height to feet before you start.
- The location of the weather station (usually your home address) will end up being visible to the Internet at large, so you will need to consider whether this is an issue for you.
- Once you are happy with the location and the height, press “Verify Location” button.

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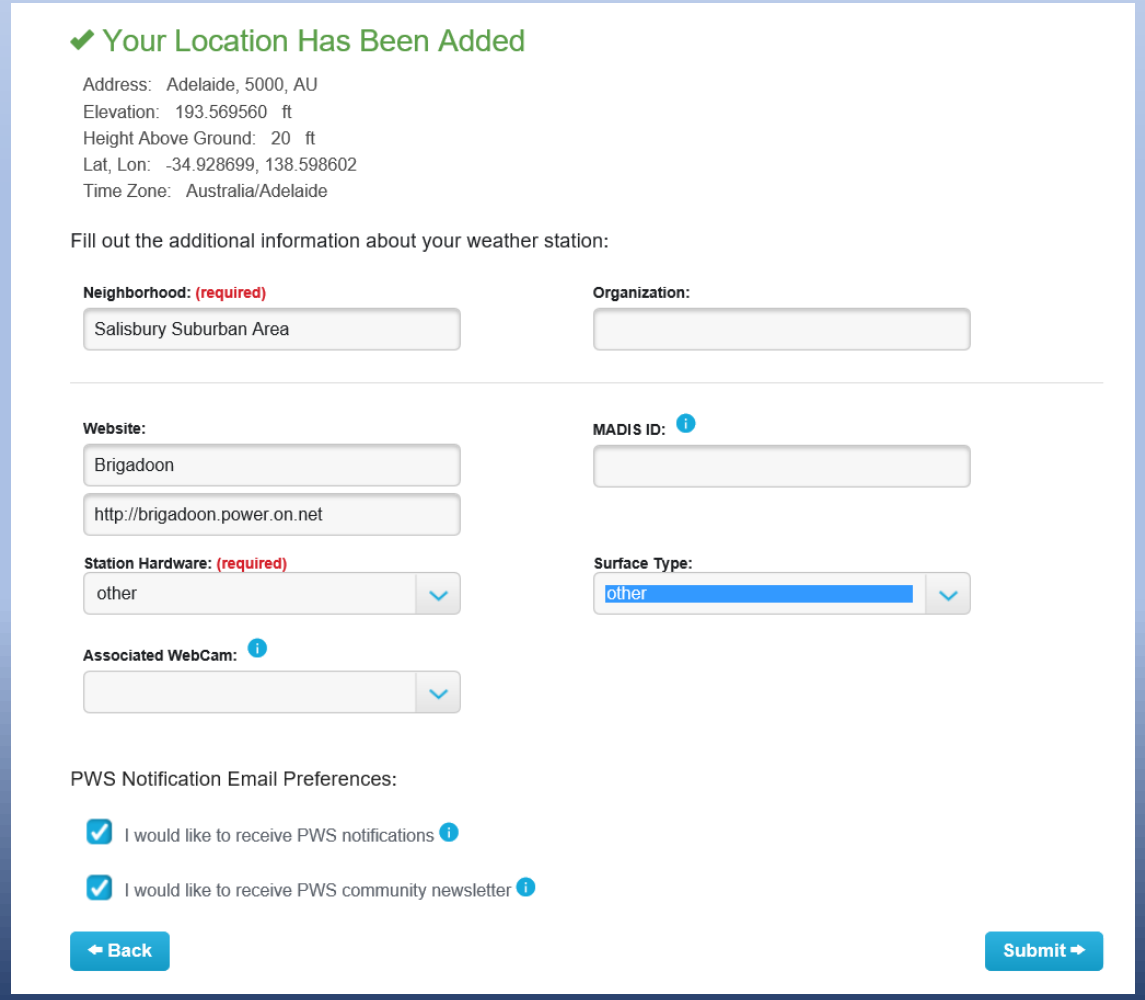
WEATHER UNDERGROUND REGISTRATION



- A bit of information such as the roof type and the weather station type is required before you can submit your application for registration.
- Once you have the registration information, you can put that information into your weather station and it will automatically start uploading your weather data.
- Once the observations have been uploaded for a while, it is time to use your registration information to get onto Weather Underground and view your station.

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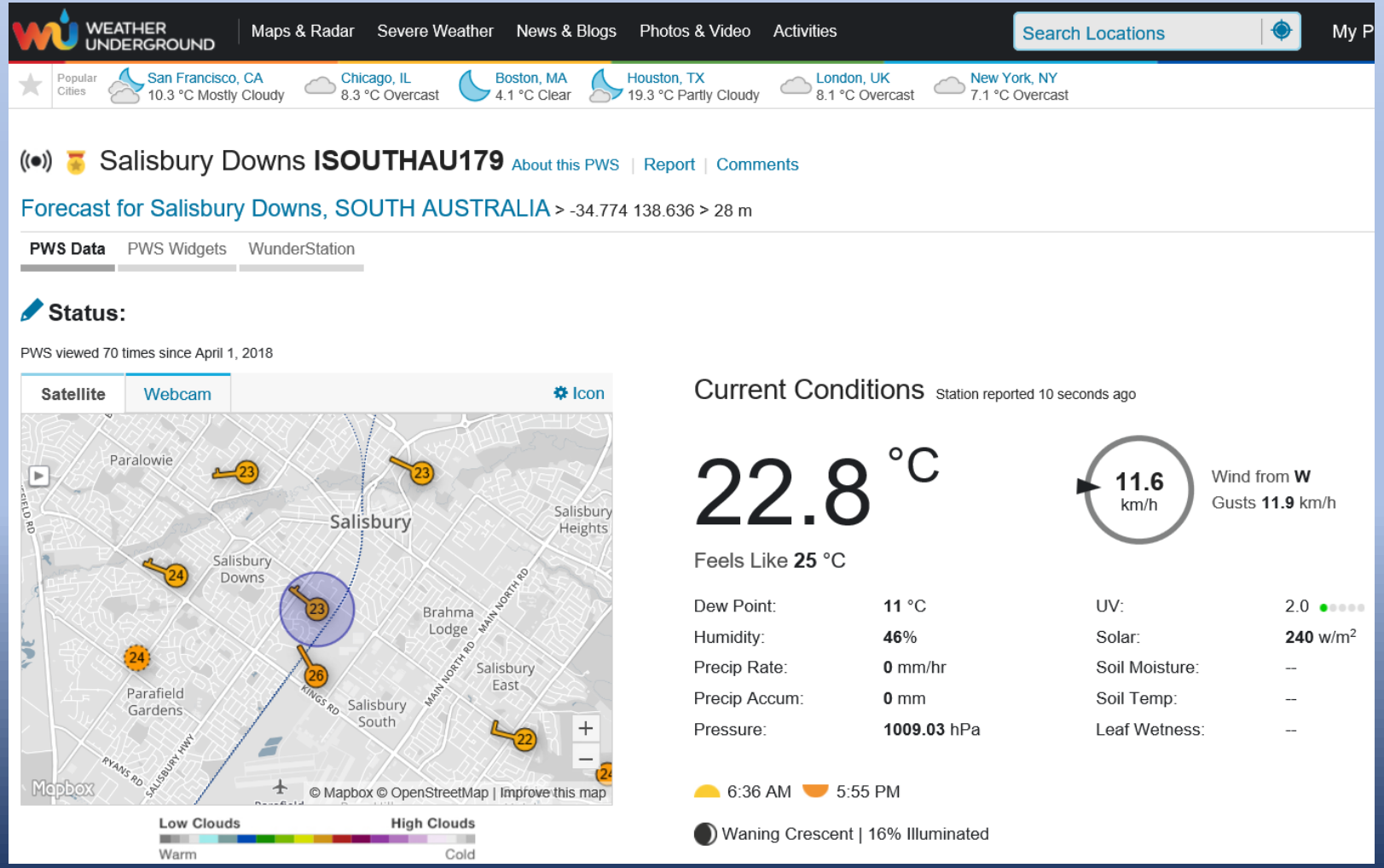
WEATHER UNDERGROUND STATION DISPLAY



There are a few different types of display, so this talk will be restricted to the default page displayed when a particular weather station is selected.

The information about the selected site is displayed, along with a map of the other home weather stations in the area. The information (currently temperature, wind direction and speed) are updated for all stations periodically.

Click on another station will switch the display to that station, and its information will be displayed in detail.

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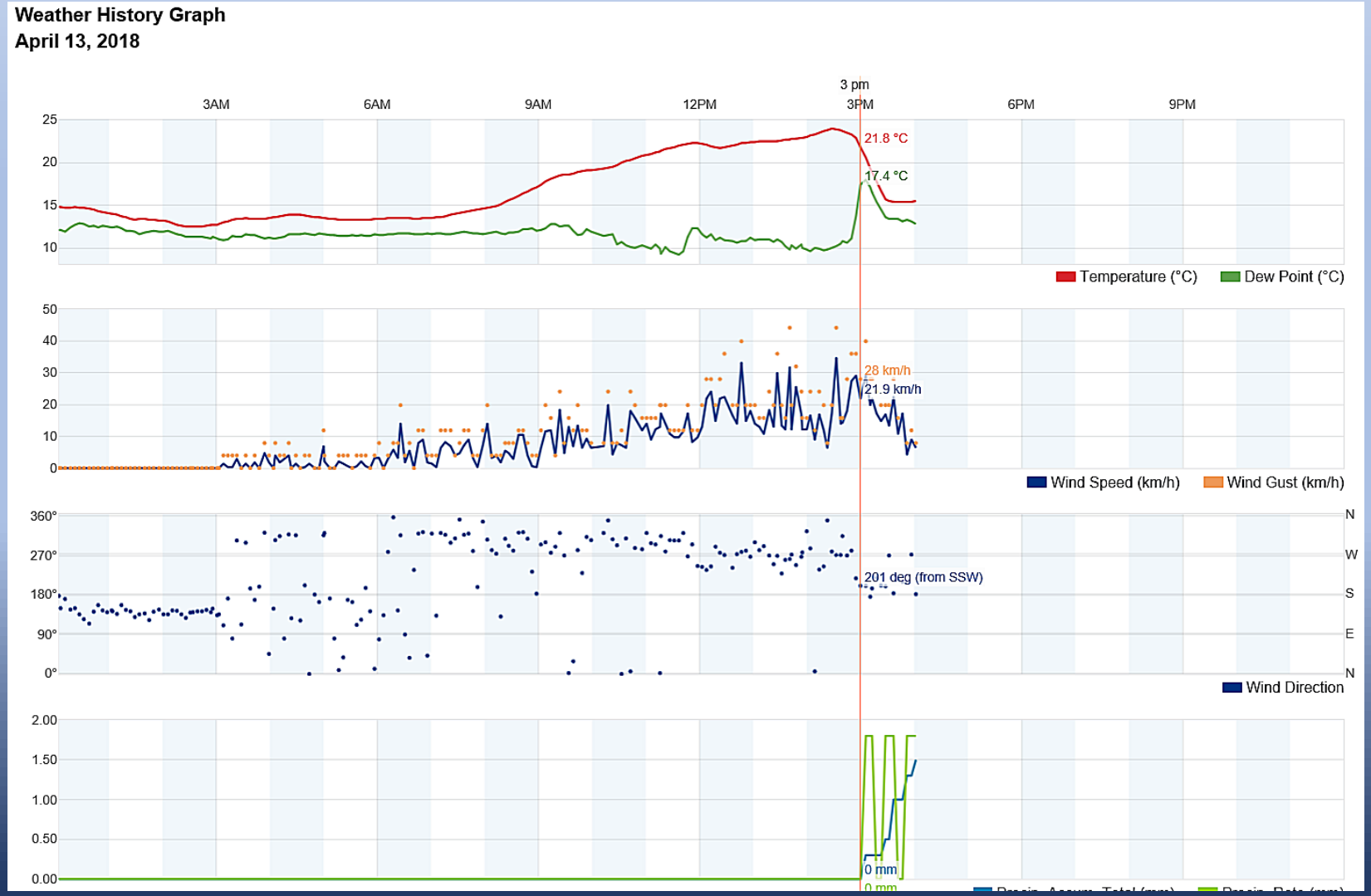
WEATHER UNDERGROUND STATION DISPLAY



This Weather Underground graphs shows the change coming through on Monday 13th April around 15:00 (3pm).

The temperature has a significant fall, and the Dew Point rises, indicating that cooler, moister air in in the area.

The wind swings more to the South and the speed drops off.

Around this time, the rainfall starts.

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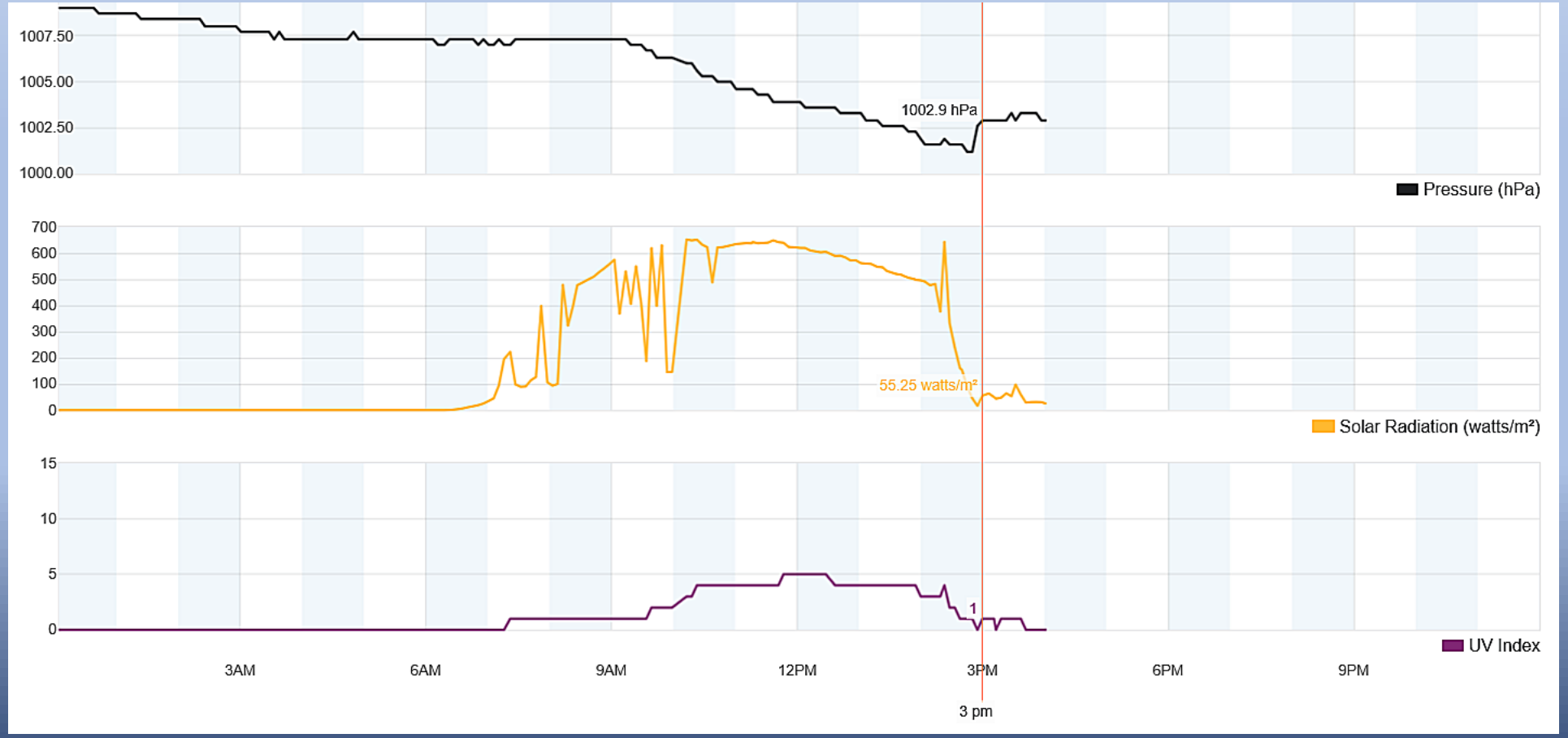
WEATHER UNDERGROUND STATION DISPLAY



Atmospheric Pressure has an abrupt increase at 3pm as the other weather parameters are changing.

The solar radiation falls off significantly as the cloud blocks the Sun. In the period just before the drop in solar radiation, it increases as the reflections from the building cloud increases the radiation.

The UV index falls off.

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LOCAL STATION SKY CAMERA DISPLAY

Images from the sky camera movie of the day show the clouds moving in from the South. It can be seen that the sky can actually get brighter because of the reflections from the cloud, potentially increasing the solar radiation at that time.

At 15:00 (3pm), the sky is completely covered with thick cloud, corresponding with the fall in solar radiation indicated on the graph.

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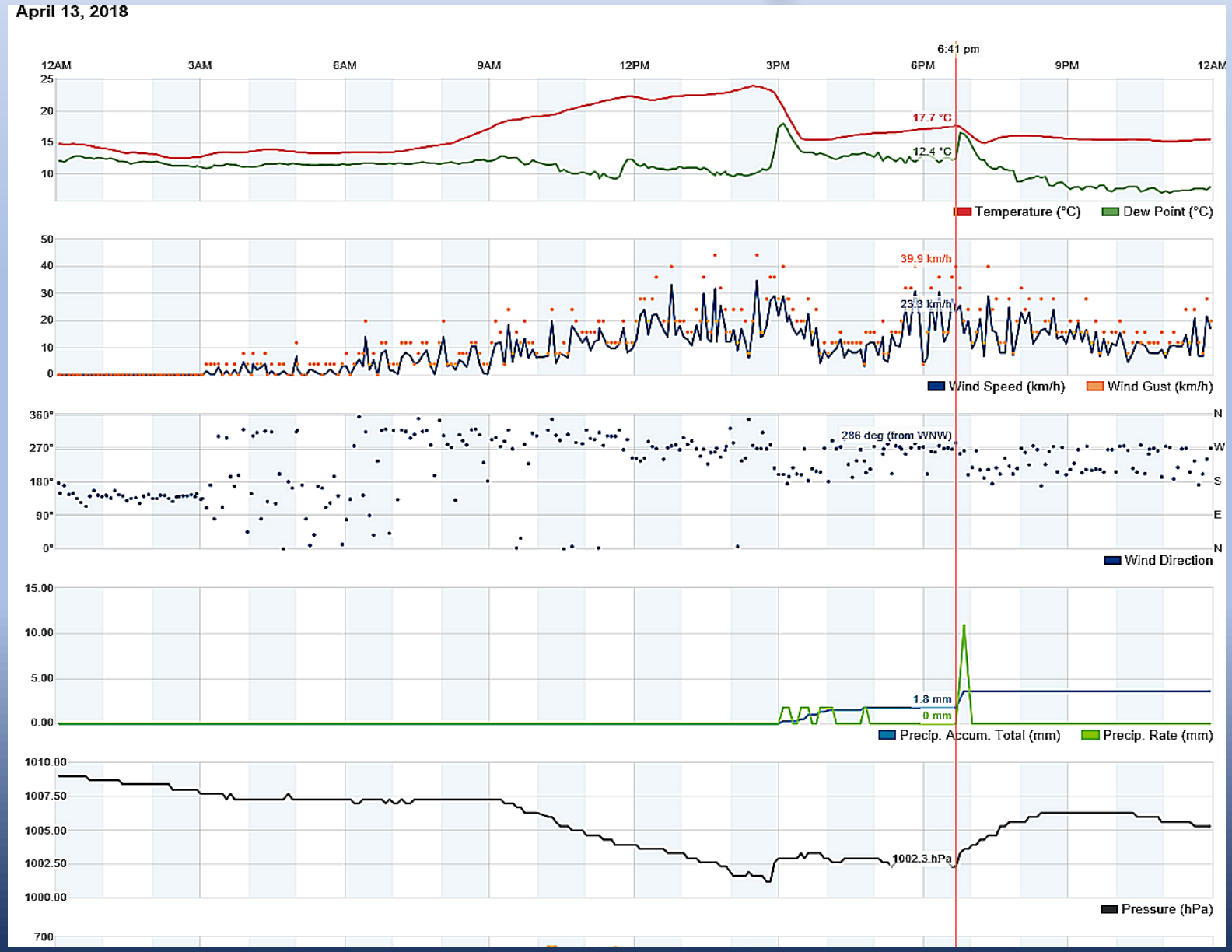
LOCAL STATION SKY CAMERA DISPLAY

Images during the rain event show that rain is being blown from the South and getting under the weather cover and hitting the lens.

Later in the movie, the rain/wind falls off and the water clears from the lens.



A few hours later, another rain event came through, pretty much following the same sequence of events.

The noticeable temperature and dew point changes; as well as the noticeable change in atmospheric pressure trend.

Even though it is dark, the infra-red image from the Sky Camera confirms that it is raining during the period that rainfall is indicated by the weather station.

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INSTALLING AND USING A SKY CAMERA

Original Image from University of Delaware

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CHARACTERISTICS OF HOME SKY CAMERAS

Sun Blocker on All-Sky Camera

- Home Sky cameras can be used to:

(1) Current cloud cover remote from the location.
(2) Create Time Lapse movies of the cloud cover.

- Meteorological sky cameras use a “fish-eye” lens to get a “whole of sky” picture. However, the brightness of the Sun means that it has to be blocked from the camera as it swamp the image and possible damage the camera sensor.

- Home sky cameras often overcome the need to track the Sun to block it out by observing only a part of the sky away from the Sun at all times of the year.

- Many home Sky Cameras in the city can be used to detect large changes to low clouds during the night, because low clouds will reflect the street lights. By carefully examining a sequences of images, cloud presence and movement can be detected under suitable conditions.

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PROCESSING NIGHT IMAGES

By applying a bit of signal processing to the night images, the light reflected from the low clouds can be seen. While this looks like it could just be noise, if the images are combined back together as a movie and run, it is easier to see that they are clouds moving across the sky. From this (sometimes), it can be determined roughly which direction the clouds are travelling.

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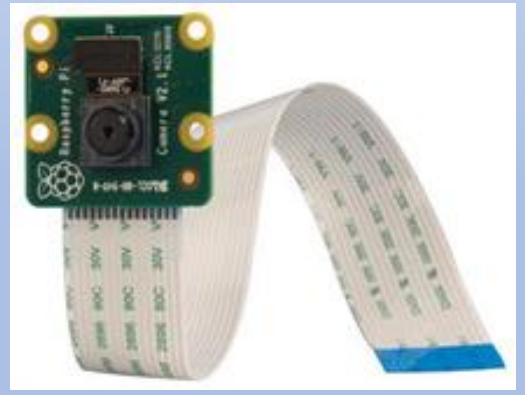
TYPES OF SKY CAMERA

IP Camera

USB Camera



Raspberry Pi Camera

There are essentially three main type of camera that is used in home weather stations. The first is an IP camera (connects to the weather system via an Ethernet Cable or a WiFi link). The second type are devices that plug directly into an I/O port (such as USB) on a computer. The third type is on that plugs into an Input/Output (I/O) port on the computer.

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SELECTING A HOME SKY CAMERA

The first think to decide is whether you want to build the sky camera yourself, or do you want an out of the box solution?

If the answer is “Out of the Box”, then you can rule out the Raspberry Pi camera. If you want to “build your own”, the Raspberry Pi camera is a good starting point. There are plenty of websites that say where to buy thing like the glass dome to protect the camera, etc.

If you want out of the box, and the camera will be located relatively close to the computer that will be controlling it, then the USB Camera may be a good choice. The length of the USB cable needed between the camera and the computer can be a problem.

If the camera will be located a long way from the computer, then the IP Camera is likely to be the best bet as they usually have the option of using a WiFi connection from the camera to the home network. Even of that is not possible, Ethernet cable is capable of being used over longer distances than USB, but they normally need to be connected to a hub of some kind.

Last, but obviously not least, is how much can you afford. There are a wide range of cameras, so shop about for value.

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HOW DO I CONTROL THE CAMERA?

Many people have Windows computers and will want to run their sky camera from that computer. The following (free for personal use) software packages may be useful to them – but no guarantees.

ISPYCONNECT

Primarily Surveillance oriented, but free software and lots of information available about cameras. This is the only Windows based software I have used and it seems ok. I found it to be an excellent source of information about cameras.

YAWCAM

- Yet Another Webcam Software -

Yawcam is short for *Yet Another WebCAM software.* More precisely Yawcam is a webcam software for Windows written in Java. The main ideas for Yawcam are to keep it simple and easy to use but to include all the usual features

This software will control your SLR style camera remotely from your Windows PC via USB. Trigger image capture via release button on the camera or remotely from your computer. Handhold the camera, shoot, and have the resulting images displayed on the computer monitor

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HOW DO I CONTROL THE CAMERA?

People who want to run a Linux computer, or want to use a cheap computer, such as a Raspberry Pi to control a sky camera can also find a number of free programs available on the Internet.

Interesting, one of the programs that is found if you do a search, is Mark's SkyCamera software. This software can be used with all three sorts of camera and is running on his website. The sky images shown earlier came from his computer using this software.

Is it better than any other sky camera program? No, Most likely not.

However, it has one big advantage and that is that Mark is available to help if members are trying to put together a web camera on a Linux computer or a Raspberry Pi.

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PURPLE AIR AIR QUALITY MONITORING SYSTEM

Original Image from University of Delaware

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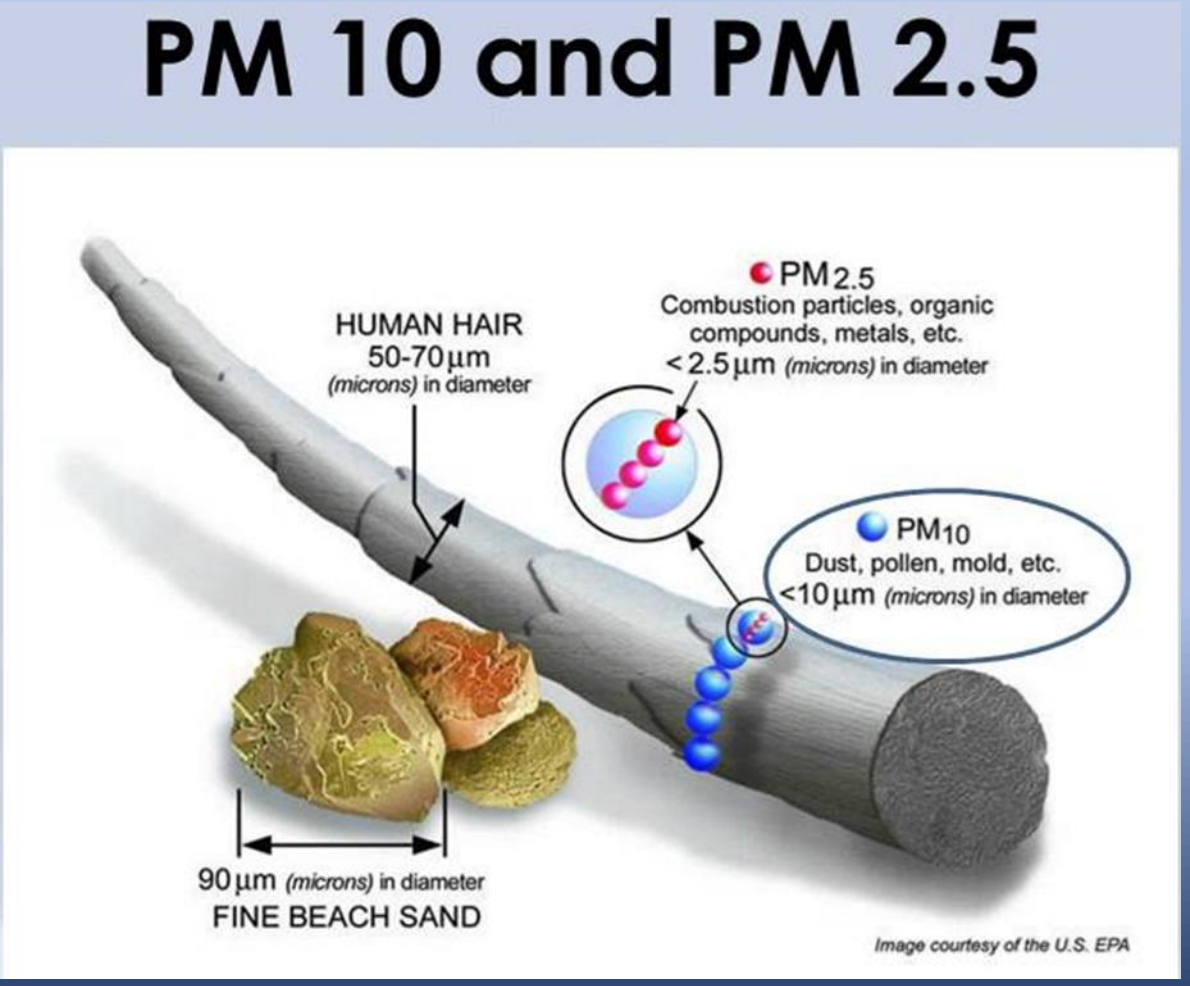
PARTICLES IN THE ATMOSPHERE



According to World Health Organization (WHO), adverse health effects due to atmospheric pollutants are mainly due to particulate matter, especially small particles - less than 10 microns in diameter, PM10. Atmospheric particles generally occur in two distinct modes: the fine (<2.5 µm) mode and the coarse (2.5 - 10.0 µm) mode.

Fine particles have an aerodynamic diameter less than 2.5 µm (PM2.5) and differ from coarse particles in origin and chemistry. These particles are generally man-made.

Coarse particles are mainly formed by mechanical forces such as crushing, grinding, and abrasion of materials of geological origin. Pollen and spores are also included in the coarse particle range.

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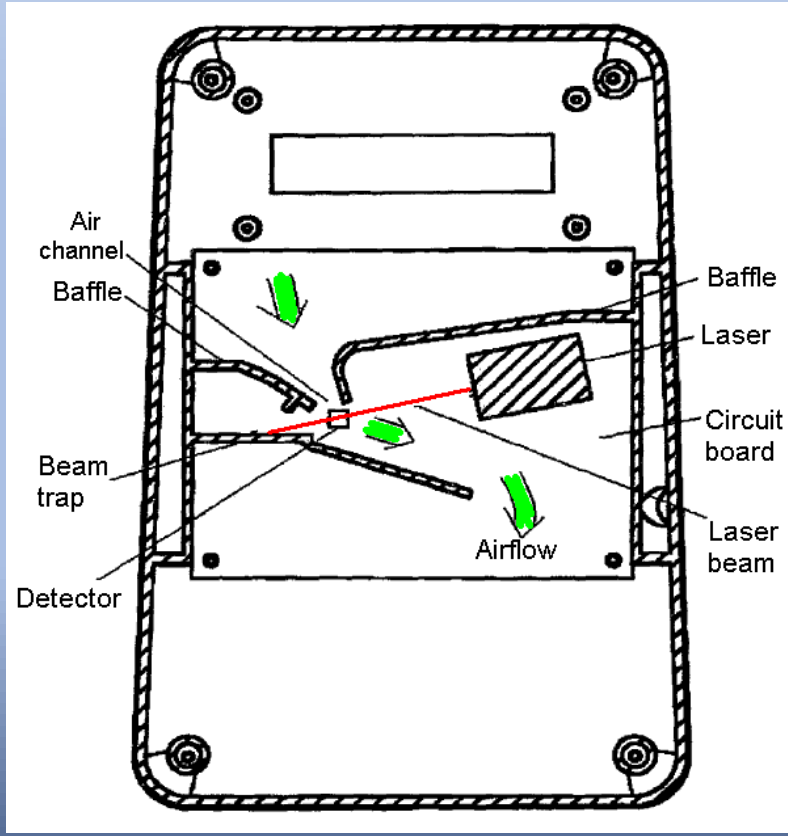
MEASURING ATMOSPHERIC PARTICLES



Dylos air quality monitor

Although this is not a Purple Air device, the image to the left shows the basic principle that is involved.

Air is sucked from the atmosphere into a measurement chamber (possibly through a filter to control the size of the particles that can enter). The air passes through the beam of a laser.

Particles passing through the laser beam will scatter light.

A detector can either be inline with the laser beam and detect a reduction in light level due to scattering, or offset from the beam and detect particles by detecting scattered light. Both schemes can be used simultaneously to improve accuracy. Water turbidity monitors use similar schemes.

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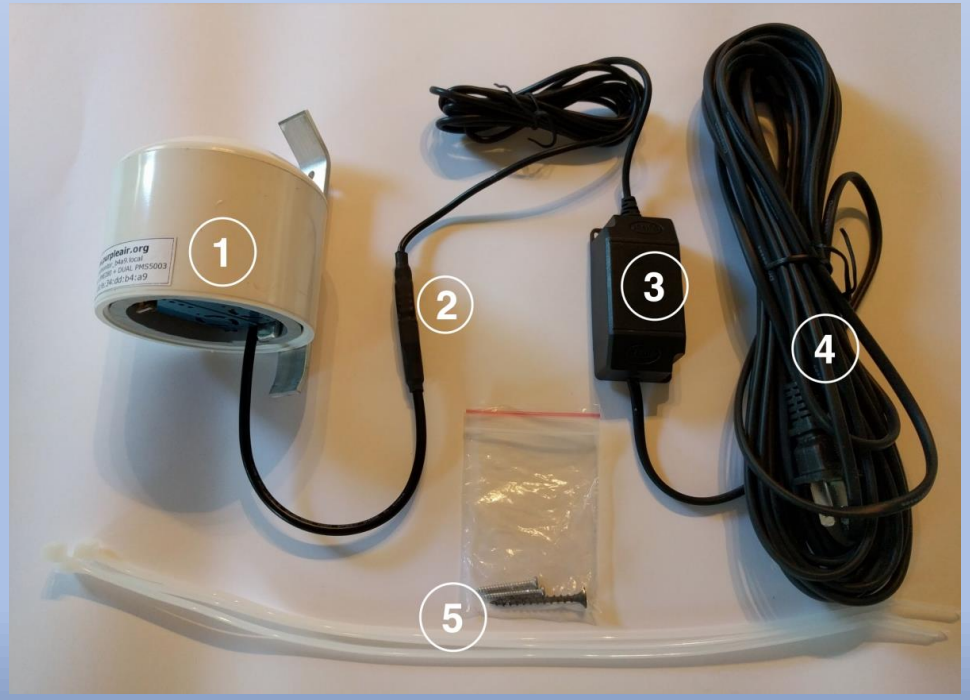
PURPLE AIR DUAL LASER AIR QUALITY SENSOR



PurpleAir sensors use a fan to draw air past a laser, causing reflections from any particles in the air. These reflections are used to count particles in six sizes between 0.3µm and 10µm diameter.

Using one second particle counts, estimated total mass for PM1.0, PM2.5 and PM10 is averaged by the PurpleAir Internet of Things (IOT) control board.

Readings are then uploaded to the cloud every 80 seconds or so where they are stored for download and display on the PurpleAir map.

The device also measures Pressure, Temperature and Humidity.

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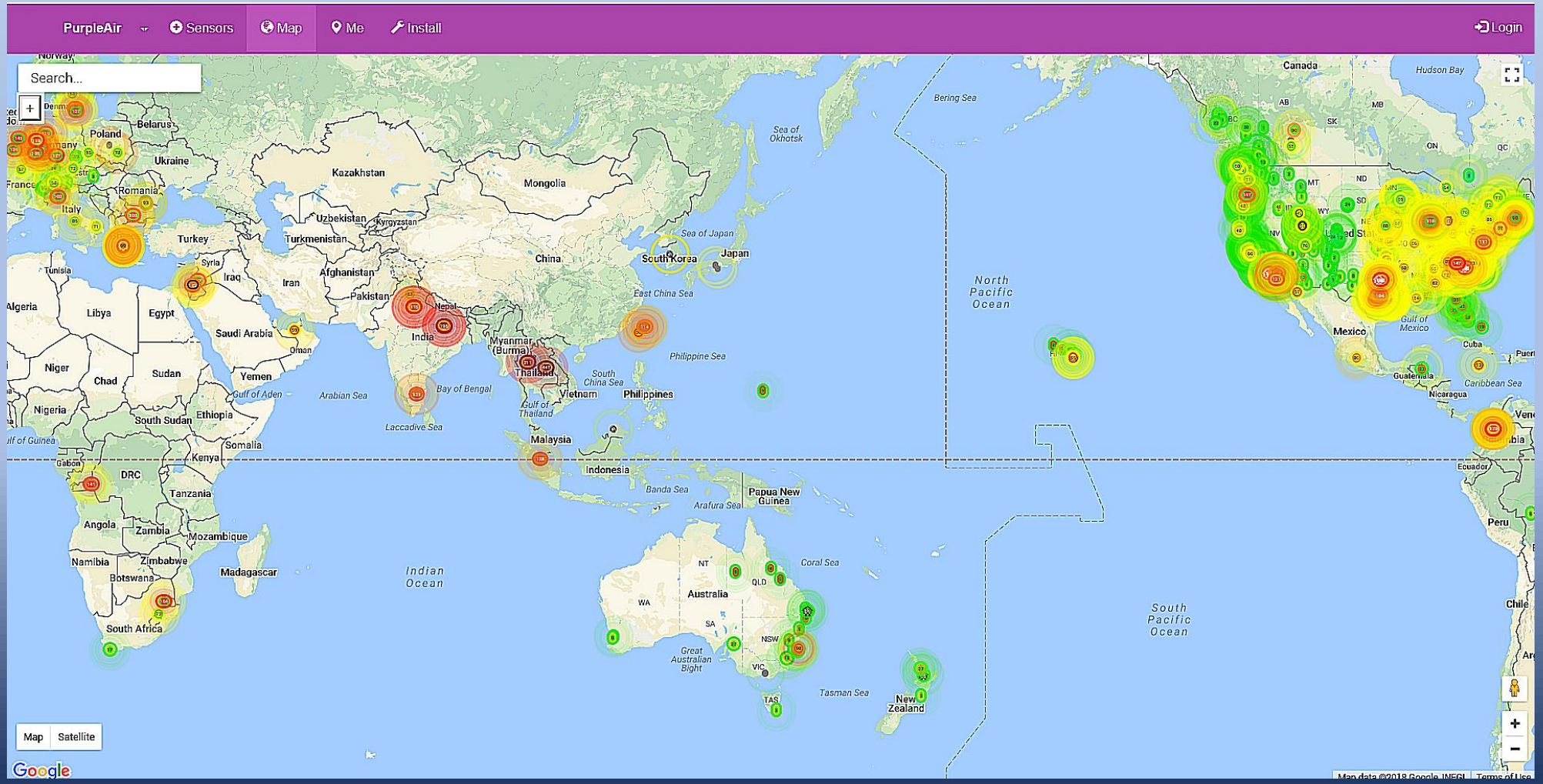
PURPLE AIR MAP



Where there are plenty of air quality monitors, Purple Air appears to the one of few, if not the only site that maps the readings.

Unlike the weather station sites, this site is limited to Purple Air sensors.

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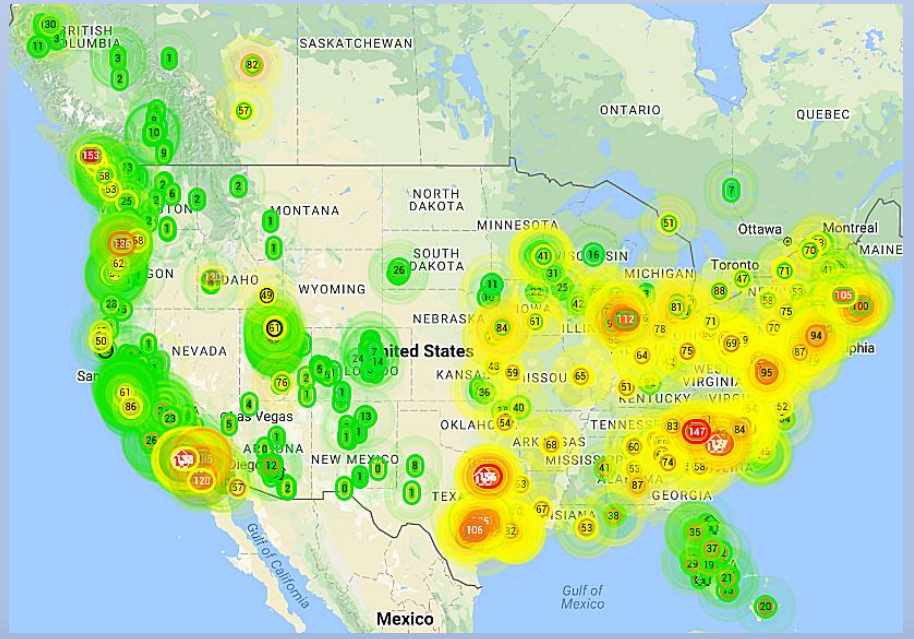
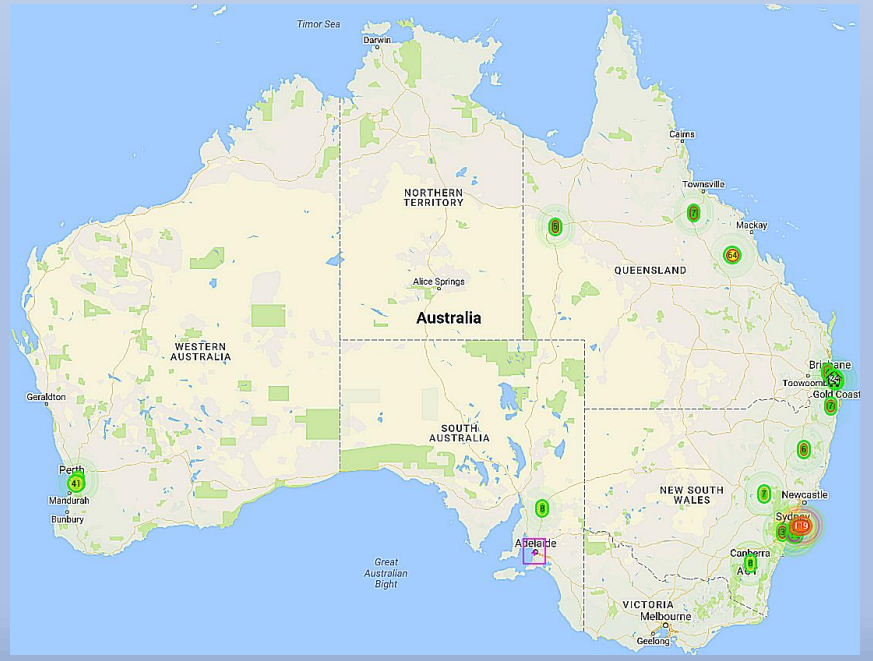
PURPLE AIR MAP





The USA currently has the highest density of monitors, even if India and South East Asian appears to consistently have the highest readings. Australia currently have very low coverage and density. This is probably the sensor is still relatively new and poor air quality is not currently a great concern. The unit current cost approximately between AUD$305 to $350 depending on the model.

It was hoped that a unit would be running before this presentation, but unfortunately, the order appears to have gone astray.

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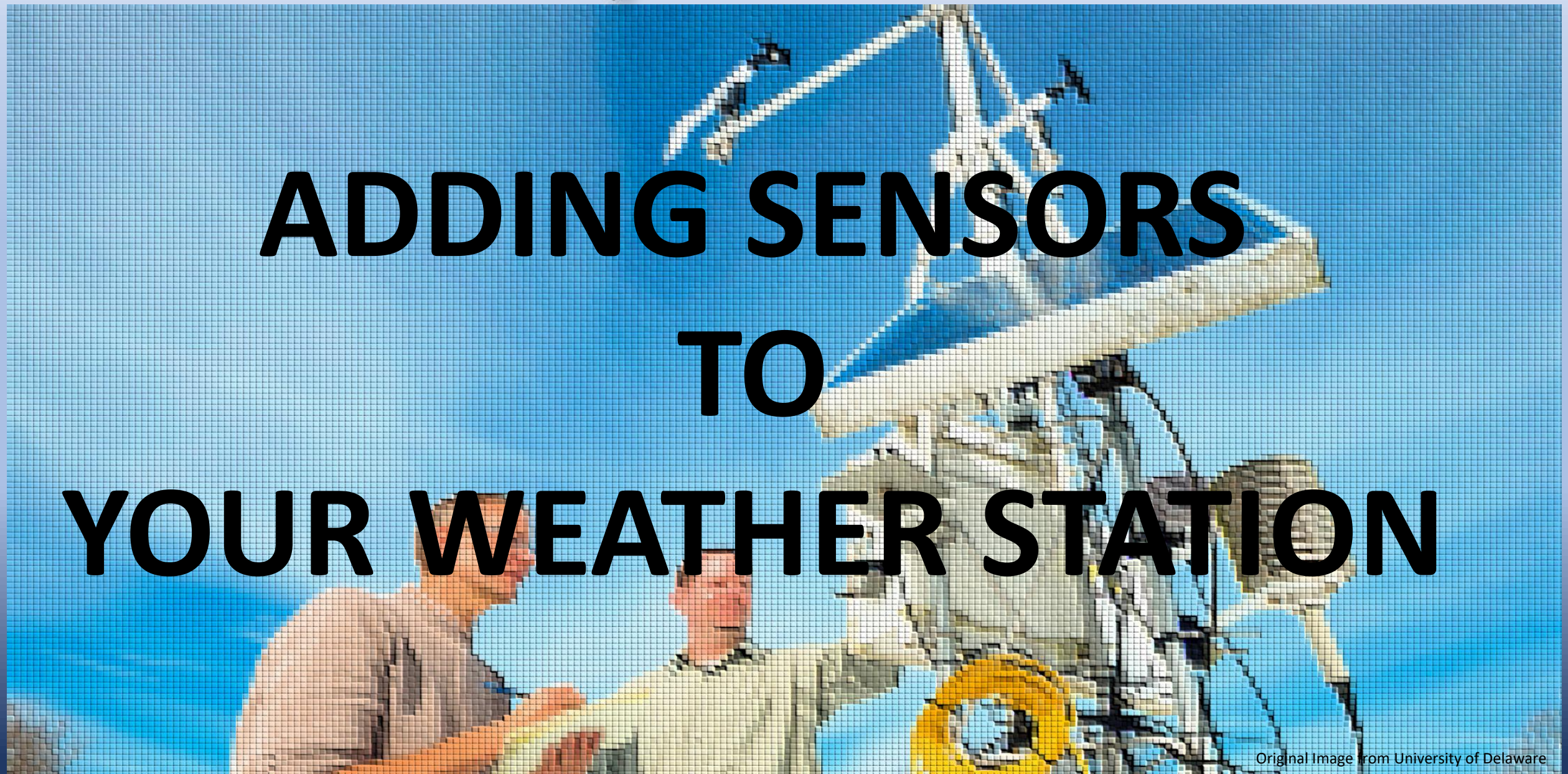
ADDING SENSORS TO YOUR WEATHER STATION



Original Image from University of Delaware

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ADDING SENSORS TO YOUR WEATHER STATION

While it is possible to add expand your weather station with commercial devices such as the Purple Air monitor, modern technology provides an opportunity for home observers to add other sensors to their station at a relatively budget price, if they are prepared to “do it yourself”, as shown with a Sky Camera using the Raspberry Pi computer and the related camera devices.

Since this is a huge area, the following slides just give a taste of what can be done. Presentations on specific projects will be presented at a later time.

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A SMALL SELECTION OF AVAILABLE SENSORS

Although probably not that high on the priorities of most people in Adelaide, this sensor detects lightning and estimates the distance from the sensor.

Gas Sensors are available to measure the concentrations of various chemicals such as Carbon Monoxide, Methane, Ethane (and even Alcohol)

Leaf wetness detector that can be used to detect water that would form on leaves from condensation or rainfall.

Waterproof temperature sensors that can be used to measure air, water or ground temperatures.

Automate monitoring of your swimming pool's pH, or measure the pH of water in streams with this sensor.

Not quite good enough to measure the cloud base, but a LIDAR (a light-based Radar) that can measure 40 metres is still pretty cool.

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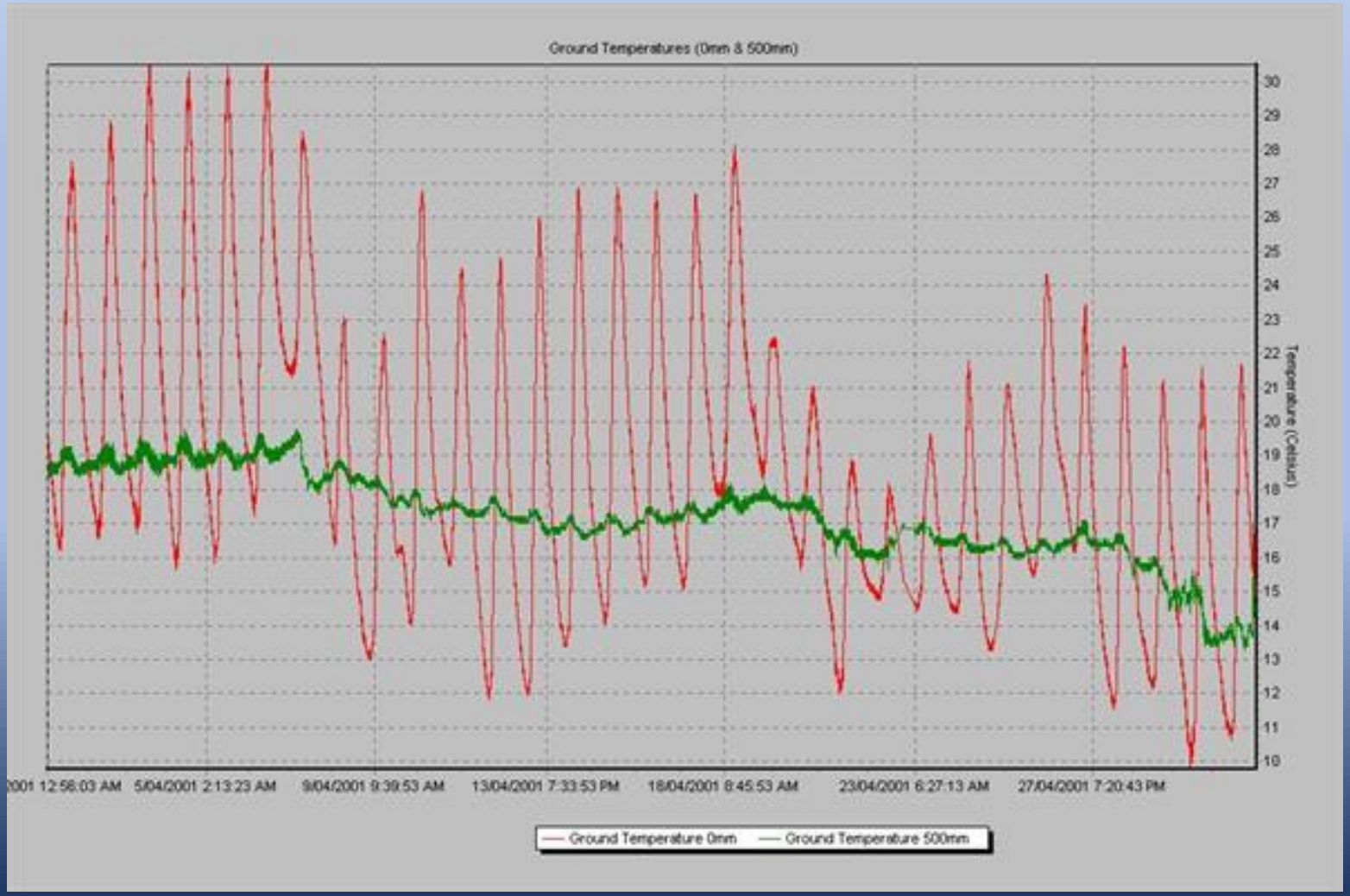
MONITORING GROUND TEMPERATURE



Looking at the previous examples, you might have thought “Yeah, But it is really practical to do at home?”

Here is an example of adding additional sensors to your weather station from quite some time ago (2001) – measuring ground temperature at ground level and 500mm.

This was achieved with a couple of sensors and a length of plastic pipe sunk into the ground.

Calibration can be a problem, but that is a story for another day.

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THANK YOU FOR YOUR ATTENTION
AND
I HOPE YOU HAVE FOUND IT INFORMATIVE