Weather Station Set Up 101

Weather Instrument Location Advice

Home Weather Stations are both rewarding and informative and weather station setup is fun and easy. However, to obtain accurate weather information, weather instrument location should be carefully considered since their placement is directly related to the weather measurements being taken.

Setting up Weather Sensors

A Weather Station Installation Overview

Setting up home weather stations is fun, relatively easy, and when completed, rewarding and informative as well. To obtain the most reliable and accurate weather information, it's important to give some thoughtful consideration as to where the various components are located. Though some compromise may be required, following these general guidelines should enable you to place your weather sensors in locations that will result in accurate and useful readings.

Ideally, weather sensors should be sited out in the open and away from objects that may affect measurement accuracy. Depending on your situation, features such as landscaping and/or building structures can significantly impact the location where your sensors can be sited. Of course cable length (cabled weather stations) or transmitter range (wireless weather stations) will also limit the locations available for placing weather sensors.

A major factor affecting placement of wireless weather sensors is their transmission range, the maximum distance between the console receiver and remote transmitting sensor. Manufacturers base this rating upon “open air”; meaning a line of sight path with no obstructions (walls, etc.) between components. **Of course the signal will have to penetrate building materials in most installations, so to estimate the maximum “effective”; range between those components the rule of thumb is 1/3 to 1/2 of the open air rating. As an example, if a system has an open air transmission range of 330 feet, the estimated maximum effective range is 110 to 150 feet between outdoor sensor and indoor console.**

The optimum placement for each type of sensor is different. Thermometers and hygrometers should be installed from four to six feet above the ground in a shaded location (not under trees!). If the thermometer hygrometer is placed on a building, select a location below the eaves on a north facing wall, which will provide shade and some shelter from rain. Rain gauges should be sited out in the open and relatively close to the ground (two feet above is optimal), then leveled. This placement makes it convenient to clean the rain gauge should it become obstructed by debris. Anemometers should be sited in a location where the wind flows

freely (such as roof mount) and oriented to true north as instructed by the manufacturer. **The standard height of an anemometer is 10 meters (33 feet) above ground.** Given the difference in siting recommendations between anemometers and rain gauges, mounting them together should be avoided.

The indoor console should be located where it's convenient to see and use it. Barometers are typically housed in the console and some consideration should be given to that barometer when determining console placement. Linking to a computer or other equipment will likely narrow those options. For the installation of wireless weather stations, it's a good idea to put it near an outside wall and as close as possible to the remote sensors. Remember that radio signal strength will be reduced by each layer of building material the signals must penetrate.

Be extremely careful when installing your weather stations components and follow all procedures recommended by the manufacturer. Use caution and common sense, Safety First! When installing a mast for anemometers, keep in mind the danger of falling or coming into contact with power lines. Be aware too that any elevated metal pole can act like a lightning rod so be sure to ground it properly. Failure to do so could prove to be deadly.

Rain Gage

Siting a Rain Sensor

Simply put, rain gages are used to record the cumulative precipitation at a given location for a given time. There are a variety of factors that can affect rain gage measurements. Buildings, landscaping and trees, and even the wind can impact the amount of precipitation reaching the rain detector. Proper placement is critical to ensure that rain sensor readings are an accurate representation of the actual rain measurement rates and amounts that have fallen.

The ideal site for a rain gage is in an open area that is protected from the wind in all directions, such as in a large inner court yard, an unlikely possibility for most owners of weather stations. Therefore, rain gages should be sited in an open area away from the external factors mentioned above. A good guideline to follow as a minimum distance from these objects is twice their height. This may be difficult in some situations, so the best compromise is to stay as far away as possible from the objects and ideally no closer than half their height. Wireless rain gauges are often the best choice for difficult installation locations.

Rain gages should also be sited relatively close to the ground but not so close that precipitation falling next to the rain detector splashes into it. The minimum guideline is no lower than two feet. However, the issue with height isn't limited to the rain gage being too close to the ground. The rain sensor can also be sited too high. This was demonstrated over two centuries ago (1769) when a rain gage was placed atop a 30 foot tall house and it received only 80% of the amount that ground-based rains gauge measured. Another rain sensor was placed

on top of a 150 foot church tower and it only received 50% of the ground level rain detector measurement! It wasn't until the late 1800s that researchers learned why. Wind was the culprit! What then is the best rain gage height? Actually the minimum guideline of two feet is best and no higher than six feet.

Finally, to ensure optimal performance, rain gages must be mounted on a vibration-free level surface. Use a bubble level to make sure that the surface is indeed level. This is critical to the accuracy of the most common type of rain detector sensor, the tipping bucket rain gauge which degrades significantly if installed on a non-level plane.

Thermometer Hygrometer

Siting an Outdoor Thermometer & Hygrometer

Taking accurate temperature and humidity measurements is not as easy as you may think. Factors associated with solar radiation and other sources of heating and cooling can cause erroneous readings if your thermometer and/or digital hygrometers are not sited properly.

Temperature humidity sensors, often combined into one instrument on home weather stations (thermometer hygrometer), should not be sited in direct sunlight unless they are adequately protected by a solar radiation shield or placed inside a ventilated weather measurement tools housing. If that is not an option, the thermometer hygrometer sensors should be installed in a shaded location (such as the north side of a structure) and protected from rainfall (under the eaves but not too close to the roof is a compromise).

Ideally thermometer hygrometer weather sensors should be located in an open area and on level terrain - preferably above trimmed grass, which will allow for ventilation and air mixing between the sensor and ground. Avoid soil/dirt, natural groundcover, and rough or rocky terrain unless representative of your area. Steep slopes should be avoided also, as water and/or air flow induced by gravity could produce non-representative data. The standard height above ground for a thermometer hygrometer is five feet (1.5 meters).

If at all possible, keep the thermometer hygrometer away local sources of heating and cooling, and from nearby obstructions by a distance of at least four times their height. Be at least 100 feet (30 meters) from large areas of concrete and/or asphalt. Avoid sites where water or snow collects. DO NOT install the sensors under the shade of trees or vegetation.

Anemometer

Installing Wind Speed Sensor

The goal of installing a wind speed meter (anemometer) is to position it in a location where the wind flows freely and is not influenced by nearby objects. The World Meteorological

Organization has set the **international standard height for wind measurement devices at 10 meters (33 feet) above ground**, with no obstructions at or above this level. Attaining this height can not only be difficult but expensive as well. For most home weather stations installations, striking a compromise is likely the best alternative.

So what are your alternatives? Part of the answer to that is how accurate you want your measurements to be? Wind observations taken at 7 meters (23 feet) are accurate enough for the National Weather Service to accept. For a rooftop installation, the minimum height to avoid anomalous winds caused by the roof itself is 3 meters (10 feet) above the most exposed part. Accuracy of the wind speed indicator is not just a matter of height. Local obstructions like nearby mature trees, houses and buildings all have the potential of impacting anemometer readings. Unfortunately this is the reality of taking wind measurements and the choice of how to deal with it is ultimately yours.

Other requirements for the proper installation of an anemometer include mounting the mast absolutely vertical and orienting the wind direction indicator to true north for accurate wind direction readings. The mast can easily be leveled using a carpenter's bubble level, but orientation to true north is a bit more problematic. The best way to locate magnetic north is by using a magnetic compass and correct to true north by the magnetic declination for your area. Visit the National Geophysical Data Center (NGDC) page that will calculate it for your location. Do not use a GPS to make the determination, the magnetic compass is a more accurate tool to determine true north. If you need to brush up on magnetic declination, visit Wikipedia.

Before erecting a tower or mast for your anemometer, check for possible height restrictions set by local ordinances and homeowner's association covenants. It would be unfortunate to have to take it down after installation. When selecting your mounting system, take into consideration that you will occasionally need to access the anemometer for preventive maintenance and possible component replacement. If the mast is roof mounted, position the supporting structure in an area that won't jeopardize roof construction. High winds and icy precipitation can place significant stress on the mast assembly so make sure the installation is sturdy. Be aware also that any elevated metal pole can act as a lightning rod, so be sure to ground it properly. Failure to do so could be deadly.

Be extremely careful when installing the anemometer and follow all procedures recommended by the manufacturer. Use caution and common sense, Safety First! Consider asking a friend to help out; it will make the job safer and easier. Always keep in mind the danger of falling or coming into contact with power lines. Likewise, make absolutely certain that your mast will not come into contact with power lines if it falls. And never work on your wind speed meter during slippery conditions or in strong winds.

Barometer

Air Pressure Sensor Installation

In order to obtain accurate barometric pressure measurements, a barometer needs to be both stable and calibrated against a known reference atmospheric pressure source, i.e. one that is professionally maintained. Without calibration, air pressure measurements from home weather stations have little value other than in identifying pressure trends.

Most weather stations house their barometric pressure sensor within the weather station display console. Therefore, placement of the weather station console receiver is an important consideration since the physical environment of the console will influence air pressure measurement readings. If possible, install the console at an indoor location where the temperature is as constant as practical, i.e. not affected by home heating, drafts, or the sun.

Station elevation, or the height of your location above sea level, is also a factor influencing barometric pressure measurements. Since all barometric pressure measurements are referenced to sea level pressure, the effect of the higher elevation needs to be removed so that readings are comparable, whether they're taken on top of a mountain or at the seashore. The National Weather Service (NWS) defines this standard as: “A pressure value obtained by the theoretical reduction of barometric pressure to sea level. Where the Earth's surface is above sea level, it is assumed that the atmosphere extends to sea level below the station and that the properties of that hypothetical atmosphere are related to conditions observed at the station.”

As mentioned above, the barometer needs to be calibrated against a professionally maintained, known reference pressure source. This can generally be done with ease on most home weather stations, ensuring consistent performance. The NWS tests their pressure gauges annually using calibrated instruments from the National Pressure Standards Laboratory. Taking the altitude of your instrument into account, calibrating your barometer using the air pressure measurement of the nearest NWS automated weather station is highly recommended. To find the nearest ASOS station to you, visit NOAA's Weather Service and enter your zip code.

Please be aware that most manufacturers provide an altitude rating for the barometer in their weather stations. Many are limited to operating at 6,000 feet or below and using the station above the maximum rated altitude will likely result in erroneous barometer pressure readings. If your weather station is going to be installed above 6,000 feet elevation be sure to check the altitude rating before making your purchase.

Digital Weather Station Console

Setting Up the Indoor Weather Station Console

After completing the installation and activation of your weather station sensors, the indoor console of your digital weather station will need to be set up as instructed by the manufacturer. For basic home weather stations, user input may be as simple as entering your station's time zone and the current time/date (unless your weather station has a radio controlled clock). Complete weather stations will likely also require the geographical coordinates and elevation of the station to be entered into the digital weather station console. Finding out how to determine these parameters is the focus of this article.

Accurately documenting a weather station position on Earth is as important as placing the weather station instruments in the most favorable locations, especially if you intend to share your weather data. Geographical coordinates (latitude and longitude) are used as a way of identifying your station's horizontal position. These coordinates are used not only to calculate the correct sunrise and sunset times, but also to tell the station how to interpret the weather data being collected to provide a better forecast specific to your location. Elevation is a way of identifying your station vertically. This is important because barometer data must be provided with reference to sea level (standardized) so that readings are comparable, whether they're taken on a mountainside or by the ocean.

Determining your position - Latitude measures distance north or south of the equator. North latitude is positive and south latitude negative if the “N” or “S” hemisphere is not designated. Longitude measures distance east or west of the Prime Meridian, an imaginary line running north and south through Greenwich, England. Degrees east longitude is positive and degrees west longitude is negative if not designated with “E” or “W” hemisphere. The target is to be within 100 feet (30 meters) of your true position. Depending on the unit, the information is typically entered into the digital weather station console as either DEG: MM:SS or decimal degrees.

Solar Powered Weather Stations

Solar Power Systems for Weather Sensors

Remote sensors used in wireless weather stations are powered by one of two sources of energy; batteries or solar power systems. Remote sensor and batteries will eventually be depleted and must be replaced on a regular basis. Unfortunately data can be lost during those times. Many wireless weather stations have to be completely reset when replacing sensor batteries, which typically means you will have to remove the batteries from the indoor console as well (always power up the weather sensors first before turning on the indoor console). A solar powered weather station has the advantage of being able to provide energy for long

periods of time. The downside is that over time, solar power systems collector panels degrade and will eventually have to be replaced. Overall, solar power systems are the most dependable source of power for remote sensors.

Typically, solar powered weather stations are made up of several components. The solar panels power the sensors during the hours of daylight and at the same time recharge an attached battery pack, which is then used for sensor power after the sun goes down. In some professional weather stations, such as the Davis Vantage Pro2, the solar panels charge up a capacitor that then discharges during nighttime providing power to the sensors. This system also relies on a lithium battery pack for backup power should the capacitive discharge component be depleted. Rechargeable lithium batteries are also highly recommended for use as opposed to rechargeable alkaline batteries. Lithium batteries last longer and are much less susceptible to failure in cold temperatures.

After following the weather station set up guidelines elsewhere on this site, there may be times during the day (early in the morning and late in the afternoon) when nearby buildings and landscaping throw the area your solar powered weather station sensors are placed into shadow. You may also live in a location that is prone to a significant number of cloudy days or long periods of darkness such as Alaska. Should any of these scenarios be the case, before you purchase your solar powered weather station it would be prudent to investigate the effectiveness of the solar energy system in being able to power the sensors during those conditions. This would definitely be an issue to discuss with a technical support representative.

Sensor Maintenance

Information on Weather Instruments Maintenance

To ensure that your home weather station sensors are transmitting accurate weather measurements, they must be properly maintained. Preventive sensor maintenance is an important aspect of that effort and each sensor should be physically examined on a regular basis, helping to head off future problems and protect your investment. Be sure to review and follow your weather station manufacturer's cleaning and maintenance recommendations. For example, do not assume that all moving parts need lubrication, find out for sure!

The following are general guidelines for the maintenance of weather sensors:

Temperature & Humidity Sensors - Remove any dirt and debris that has accumulated on the thermometer hygrometer solar radiation shield. During the winter, be sure to remove snow and ice as that will affect temperature and humidity readings.

Anemometers (wind sensor or wind gauge) - Annually inspect your anemometer, then clean and lubricate (if required) the bearings. Also verify the orientation of the wind vane to ensure accurate directional wind measurement readings. Throughout the rest of the year, make sure the anemometer rotates freely by observing it during light wind conditions. If it doesn't

appear to be turning freely, stops abruptly or makes a grinding sound, a closer examination is in order as it is likely the anemometer needs cleaning. They can also be symptoms of bad bearings, so if the problem remains after cleaning, consult the manufacturer. Anemometers can sometimes ice up during winter weather events and you should take great care if you decide to remove it. Plastic is usually very brittle at low temps and can break relatively easy. As an option, you could wait until it melts away naturally or bring the sensor inside.

Rain Gages (rain sensor) - Avoid inaccurate rainfall readings by checking the rain collector (funnel) often for obstructions (dirt and debris). Birds have also been known to nest in them. Remove the rain collector and check underneath it as well, but do so cautiously as wasps, spiders, and other insects can set up housekeeping inside the base. Dust and debris can also affect the operation of a tipping bucket rain gauge. Clean the buckets and collector funnel gently using water and a mild liquid detergent, rinsing thoroughly.

Solar Radiation & Ultraviolet Light Sensors - Keeping the lens/cover free of dust, dirt, and debris is critical to ensuring accurate readings from these solar sensors. Examine agricultural weather station sensors on a weekly basis.

Sensor Power Sources - If you have a solar powered weather station, make sure the solar panels are kept clean. If powered by batteries, follow the manufacturer's recommendations concerning battery replacement. You may find it worthwhile to change out the batteries a bit more frequently than recommended to ensure that reliable communication is maintained between console and sensors. If your sensors use rechargeable batteries, follow the manufacturer's recommendations regarding replacement.

Consider using lithium batteries during winter if temperatures are expected to remain below freezing for an extended period of time. Lithium batteries have superior cold temperature performance compared to alkaline batteries and will function at extremely low temperatures. They are available at most stores selling electronics or cameras. Alkaline batteries will lose power in cold temperatures and will freeze somewhere around -4°F (-20°C) and stop working. This will not harm your temperature sensor and when the temperature goes back above freezing, the batteries will thaw and start working again.

A note on remote sensors with liquid crystal displays: Even though a remote sensor with lithium batteries should operate down to about -40°F (-40°C), the display will probably fade out at about 0°F (-17.8°C). This is normal behavior for LCDs, and the display will reappear when the temperature warms back up.

Sensor Re-calibration - Sensor readings may begin to drift over time (several years) and require re-calibration. If you suspect that this is happening, first compare your readings with those of a nearby calibrated station (NWS office or airport weather station). If this check confirms that your sensor needs re-calibration, consult your owner's manual and/or contacts the manufacturer for instructions.