Rural Training Center-Thailand: Technical Paper
ศูนย์ฝึกอบรมชนบท-ประเทศไทย: ทางเทคนิคกระดาษ

Ban Na Fa G.R.O.W. Station

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www.neighborhoodlink.com/org/rtcth E-mail: rtc2k5@gmail.com

Community-based environmental education for the self-sufficiency and sustainability of small rural family farms
ชุมชนตามสิ่งแวดล้อมศึกษาเพื่อการพึ่งตัวเองและยั่งยืนชนบทขนาดเล็กครอบครัวฟาร์ม

You may post questions / comments about this paper to the Discussion area of our website

We created the Getting Real On-farm Weather program using manual methods to suit the conditions of impoverished rural Thailand.

Small rural family farms can benefit from gathering local weather data on their farm. The data serves many useful purposes:

- Monitor local climate change
- Rainfall data can be used to plan effective rainwater harvesting
- Rainfall data can help plan soil erosion management on the farm
- Evapotranspiration data helps water conservation planning.
- Weather data helps evaluate possible alternative energy potential (esp. for solar and wind power).

The Ambient Weather WS-1000 Start-up screen

The integrated sensor array measures wind direction / speed, rainfall, outside temperature, outside humidity, incoming solar radiation. The data are sent wirelessly at 915 MHz to the main Display Console. From there, the data can be sent via the Internet to various data sharing websites.

We have been searching for a weather station system for many years. It would serve as a reference datum for the manual observations. The Davis Vantage Pro 2 meets nearly all the items on our wish list. But the price was out of reach. Compromise is not always an easy path. So after more than 6 years of seeking alternatives, we settled on the Ambient Weather WS-1000 Wifi Observer weather station which was about 10% the cost of the Davis system. The WS-1000 doesn't measure all the parameters of the Davis system. For example, it won't measure soil or water conditions, and other agricultural variables. That was the compromise for the substantial cost savings.

The Display Console displays wind speed, wind direction, maximum wind gust, maximum and minimum temperatures, relative humidity, barometric pressure, dew point temperature, wind chill, rainfall, and incoming solar radiation. It can store a year of observations. The Display Console can show the data in tabular or graphic form.

A separate Indoor sensor measures temperature, relative humidity, and barometric pressure. These are transmitted wirelessly to the Display Console.

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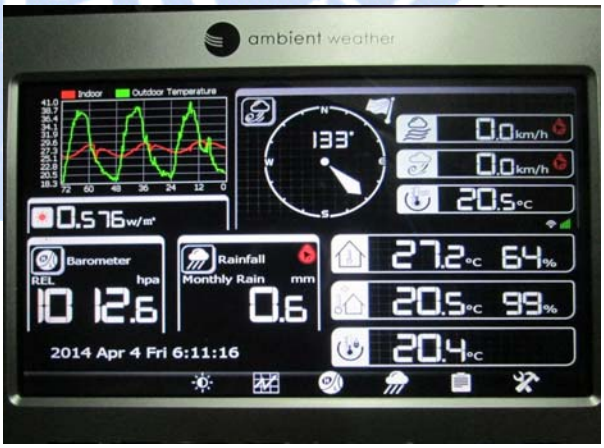
Summary of WS-1000 Sensors & Data Format

Ambient WS-1000 wireless digital sensor array		RTC-TH Analog Back-up Instrument	
1	Wind vane (for wind direction)	Flag or wind streamer	
2	Wind speed	Flag & Modified Beaufort Wind Scale	
3	Solar collector	-----	
4	Outdoor Thermometer	Thermometer	Max-Min Thermometer
5	Outdoor Hygrometer	Hygrometer	
6	Solar Radiation Sensor	-----	
7	Rain collector	PVC rain collector	
Indoor Thermo-Hygrometer-Barometer Transmitter		**Analog Back-up Instrument**	
7	Indoor Thermometer	Thermometer	3 Instrument analog weather station
8	Indoor Hygrometer	Hygrometer	
9	Barometer	Aneroid barometer	

Ambient WS-1000 Data Output / Format			
Col	Parameter	Measurement Units Selected	
1	Sequence Number	(data point number)	We chose to use these measurement units so our data formats would more readily conform to the Thai Meteorological Department weather records
2	Time	YYYY-MM-DD, hh:mm	
3	Indoor Temperature	°C	
4	Indoor Humidity	%	
5	Outdoor Temperature	°C	
6	Outdoor Humidity	%	
7	Dew Point	°C	
8	Wind Chill	°C	
9	Wind	km/ph	
10	Gust	km/ph	
11	Wind Direction	° azimuth	
12	ABS Barometer	hpa	
13	Rel Barometer	hpa	
14	Rain Rate	mm/h	
15	Daily Rain	mm	
16	Weekly Rain	mm	
17	Monthly Rain	mm	
18	Yearly Rain	mm	
19	Solar Radiation	Lux	

As you can see, one key advantage of having a digital weather station is the automatic data logging. It saves countless hours of manual record keeping. This gives us more time to do field work. We can use the recorded data to validate or adjust manually collected weather data from our farm.



Our Display Console during normal operations

A quick review of existing weather stations in Nan shows a paucity of available stations. In mountainous terrain, weather can vary from place to place over short distances. Having a weather station only 8 km away can still have very different weather conditions.

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The WS-1000 mast on the West end of the carport

The location of the RTC-TH GROW station is another big compromise. Our first choice was the farm. However, there is no Internet service there. We wanted to share the weather data as a public service. The global concern for climate change research means more data is needed especially from rural areas with a paucity of weather stations.

Co-locating the weather station at our amateur radio station in Ban Na Fa also made it easier to integrate it with our Mobile Emergency Weather Station (MEWS) program and Emergency Communications (EmComm). However, this location is far from the ideal siting parameters of the World Meteorological Organization (WMO). The mast location does not conform to the WMO wind obstacle stand-off guidelines. It is commonly acknowledge meeting the wind siting parameter is the most difficult to meet even for official weather stations. All the trees at the south edge of the carport roof will be trimmed and kept at the height of 3 m (even with the roof).

Wind obstacles are a major station siting challenge

The table below summarizes our actual weather station site relative to the suggested guidelines.

Weather Station Siting Criteria	
Suggested	Actual
Easy access for quarterly maintenance of rain collector solar radiation sensor and solar PV panel.	The carport sheet metal roof requires a ladder climb of 3 m.
WMO suggests wind sensors be 10m AGL; roof mounted sensors should be 3 m above roof peak.	WS-1000 sensor array is ~ 6.4 m AGL. The peak of the house roof is 8 m away and ~ 11 m AGL.
Outdoor Thermometer: Put the thermometer in the shade. Stand-off by 1.6 m above the roof to avoid radiant heat transfer from buildings and structures.	1.6 m tall mast on carport roof. Thermometer mounted in shelter unit of sensor array.
Wireless Range: Max 330 ft in an open field (no obstacles—buildings, trees, vehicles, high voltage lines). For average conditions, ~100 ft may be maximum. May not penetrate metal buildings.	Horizontal distance from the outdoor sensor array to the control / display console in the 2nd floor office is about 18 m.
Humidity: Put the sensor in the shade	Outdoor hygrometer mounted in shelter unit of sensor array.
Wind Direction: Sensor array must be aligned to North.	Oriented to North and verified by GPS and magnetic compass. Declination adjustment for Ban Na Fa is less than 0.5° azimuth.
Wind Speed: stand-off distance = 4X height of nearest tall obstruction	Sensor array height = 6.4 m AGL. Bamboo grove across the street is ~11 m tall, and ~ 23.85 m from the WS-1000 outdoor sensor array.
Rain Collector: stand-off distance = 4X height of nearest tall obstruction	
Note: The RTC-TH plans for an annual routine system calibration (exact date to be determined).	

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Photo summary of the RTC-TH G.R.O.W. Weather Station at Ban Na Fa

The Ban Na Fa Getting Real On-farm Weather (GROW) weather station also supports the Mobile Emergency Weather Station (MEWS) program (which is a part of our Emergency Communications (EmComm) effort. It also supports our community-based education activities for the self-sufficiency and sustainability of small rural family farms.

The closest Thai government weather station is ~8 km away in Tha Wang Pha. We needed local weather data to support activities at our demonstration farm. The Ambient WS-1000 wireless digital weather station is at the heart of the GROW station's instrumentation. Due to the conditions in rural Thailand, we also back- up the WS-1000 with more traditional analog weather equipment. We also have a complete Basic MEWS kit (which is a minimalist emergency weather observing kit) readily available for emergencies.

TP Link TD854W wireless N ADSL2+ modem router

Station Ground Rod

Station Ground Bus Panel

Lightning Detector

Max-Min Thermometer

Analog Weather Station

Rain Gauge

Basic MEWS kit

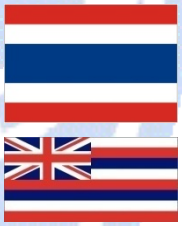
UPS (Uninterrepted Power Supply

Power strip surge protector

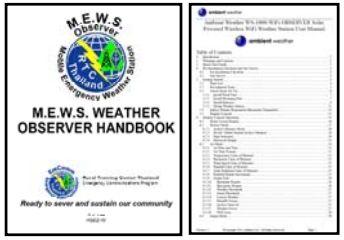
Hygrometer

Sling Psychrometer

Kestrel 4500



Flag



References & Manuals

Ambient WS-1000 Wx Station

Ambient WS-1000 console

The data collected by the Ambient WS-1000 is digitally archived and also transmitted real-time via the Internet to the wunderground community (www.wunderground.com) and listed by the personal weather station ID of INANCHOM2. We transmit our weather data real-time to the wundergound folks who host an internet site making the data available internationally free for non-commercial use. In exchange, they archive all the data we send them. We plan to archive the data locally as well. But in this day and age, it certainly never hurts to have the data backed up elsewhere. We consider this to be part of our public service and as contributing to the solution of studying and documenting climate change. We prefer to be part of the solution and not part of the problem.

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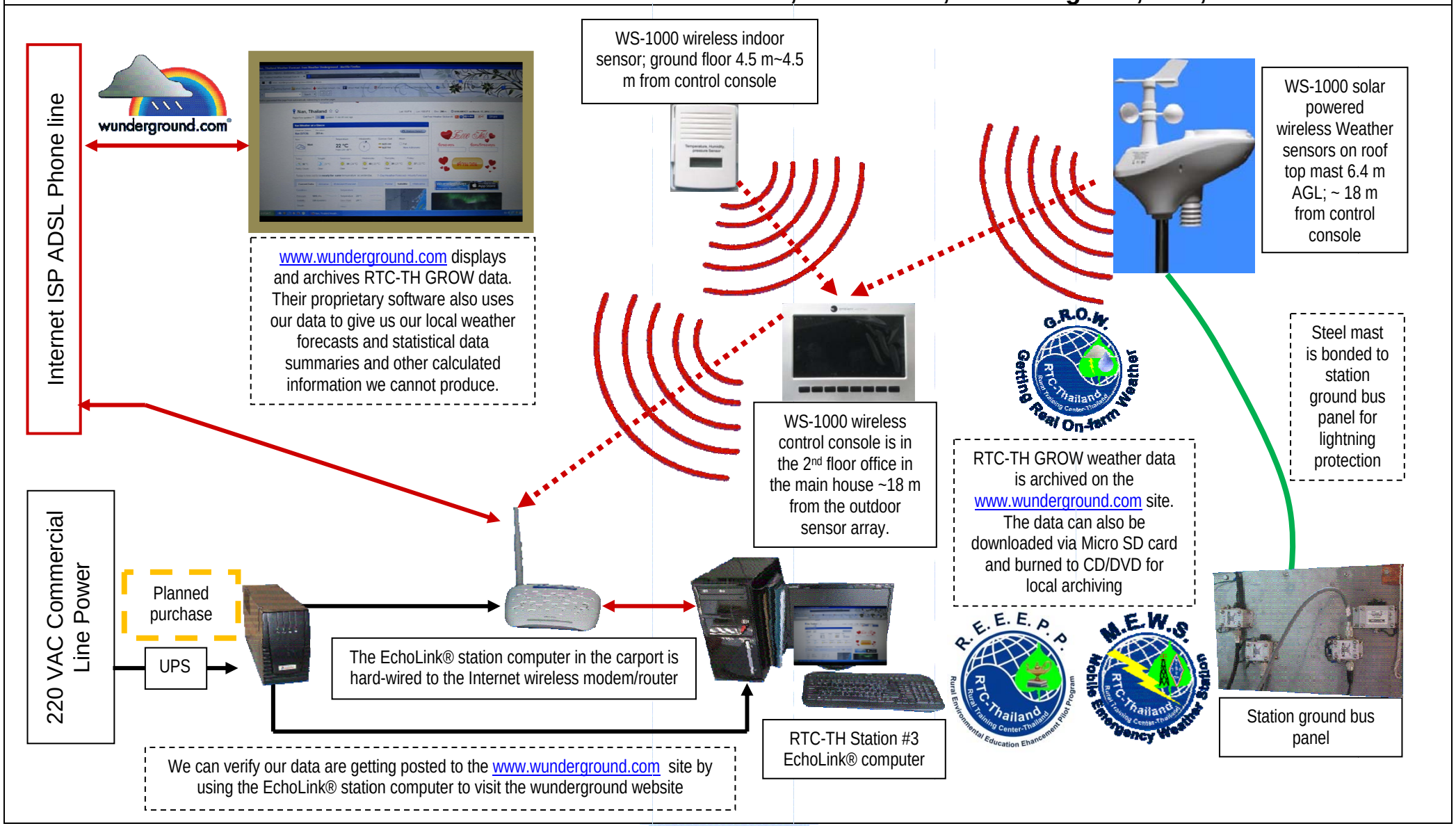
RTC-TH G.R.O.W. Base Weather Station in Ban Na Fa, Chom Phra, Tha Wang Pha, Nan, Thailand



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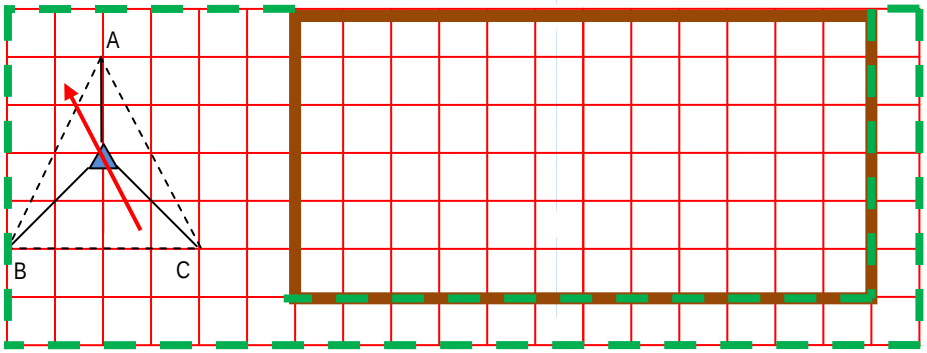
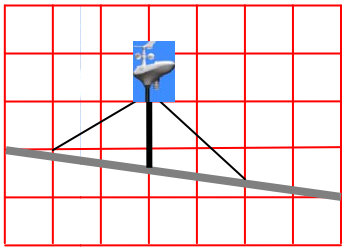
WS-1000 Maintenance

Freq	Action		Notes
3 Months	Clean rain collector		Follow User Manual Sec. 9 pp. 41-42
	Clean solar radiation sensor		Follow User Manual Sec. 9 pp. 42
	Clean solar PV panel		Clean with soft damp cloth
	General inspection of wind sensors		All parts should move freely
1 year	Calibration [Post notice on PWS page]	Thermometer	See User Manual Sec. 6.5 p. 33
		Hygrometer	See User Manual Sec. 6.5 p. 33
		Barometer	See User Manual Sec. 6.5 pp. 33-34
		Wind Speed	See User Manual Sec. 6.5 pp. 33-34
		Wind Direction	See User Manual Sec. 6.5 p. 33, 34
	User manual update		[website]
	Firmware update		[website]
	Monitor Battery Status	Outdoor sensor array	See Display Console: Item #15 (See User Manual, Sec. 6.1 p. 16, Fig 14
		Indoor sensor	
2-3 years	Outdoor sensor array		See User Manual Sec. 5.3.1 pp. 9-10
	Indoor sensor		See User Manual Sec. 5.4 p. 13-14.
Check ___ periodically for updates.			

RTC-TH G.R.O.W. / M.E.W.S. Weather Station Layout

Red lines = 1m X 1m roof framing.
Brown line = secured carport enclosure
Green line = roof overhang
Red arrow = True North





Roof heights:
North side = 4 m; South = 3 m

Roof pitch ~ 15°

Mast height = 1.6 m above roof

The WS-1000 wifi sensor array weighs 1.0 kg, wind profile ~ 0.0393548 sq m.

The mast weighs 2.3 kg; 1.6 m tall; wind profile ~ 0.688 sq m; pivot bolt is stainless steel, 0.125 mm diameter, 7 cm long, 2 flat washers, nylon / stainless steel lock nut, hexagonal head 11 mm.

Base plate weighs 2.8-3.0 kg, wind profile ~0.024 sq m. Secured by 4 steel bolts 7.5 cm long; 1 roofing lag screw, 2 wood screws

Wx Mast guys (measured on roof); 550 parachute cord

A. 3.05 m + 0.3 m = 3.35 m w/ wrap
B. 3.2 m + 0.3m = 3.5 m w/ wrap
C. 3.0 m +0.3 m = 3.3 m w/ wrap

The following pages show the details of the weather mast installation. This is more of a station record and not a "how to" paper. Every weather station installation is unique. The nature of our carport construction is somewhat unique as well. Hardware fittings are not always so readily available. We had to improvise, adapt, and complete the project.

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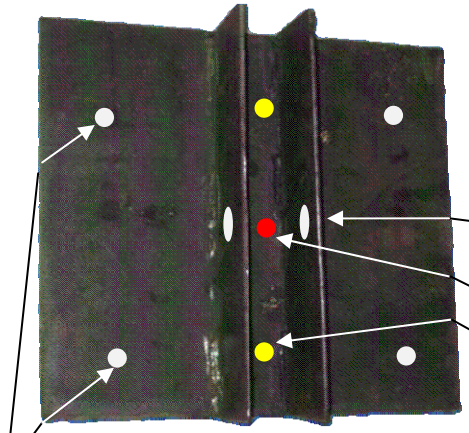
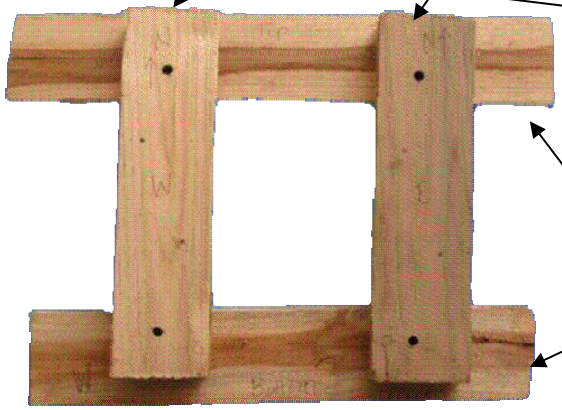
Roof Mounting / Mast Bracket





2 U-bolts (6 cm diam, 13 cm long) from WS-1000 Kit: uses 13 mm wrench; added 4 sets of flat washers and lock washers

Steel mast, 45 mm diameter, 1.6 m tall.

1 mast hinge pin bolt 0.125 mm diameter, 2 flat washers, locking nylon / stainless steel nut, 11 mm wrench

Central base plate fittings:
1 original roofing screw at center of plate;
2 screws 0.625 cm diameter, 4 inches long upslope / down slope from center

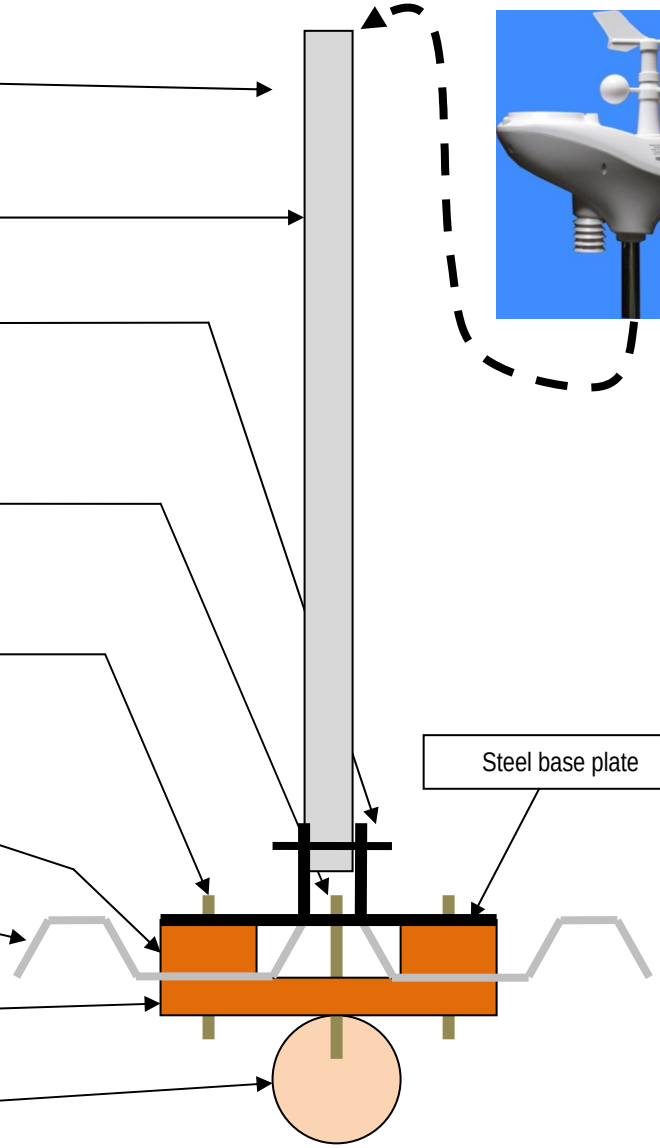
4 lateral base plate bolts, 1.25 cm diameter, 75 mm long, 12 mm; added 4 sets of flat washers and lock washers

2 roof top teak wood shims on both sides of the base plate parallel to the sheet metal roof ridge.

Sheet metal roofing

2 under roof wood backer blocks at right angles to the teak log rafter and parallel to the sheet metal support runners.

Teak log rafter



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Roof Mast Base Plate

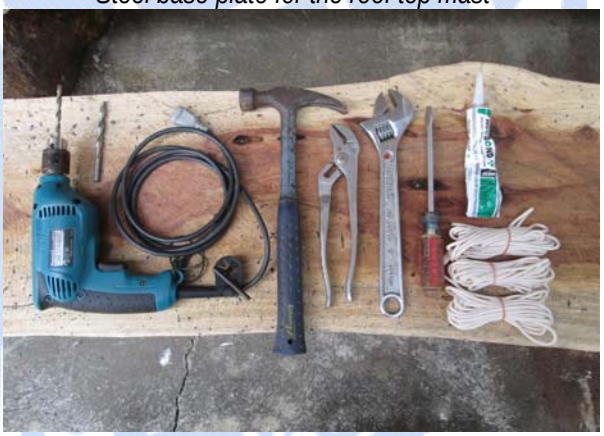
Teak wood shims on top of roof

Teak backer blocks used under the roof

Layout of roof top shims and back blocks

Steel base plate for the roof top mast

Base plate, bolts, shims, and backing blocks



Basic tools for installing the roof top mast

Mast base plate installed on carport roof

Silicon sealing a roofing lag screw

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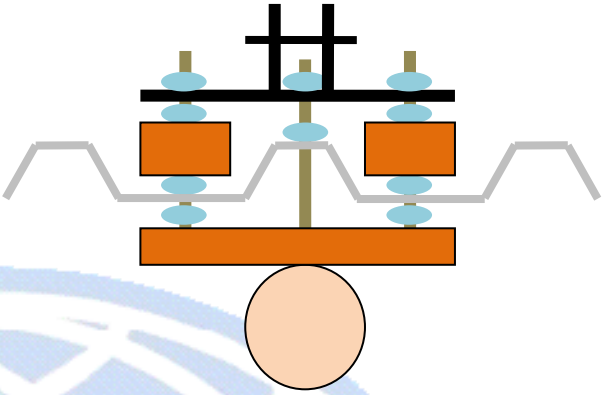
Sealing All Through-roof Holes

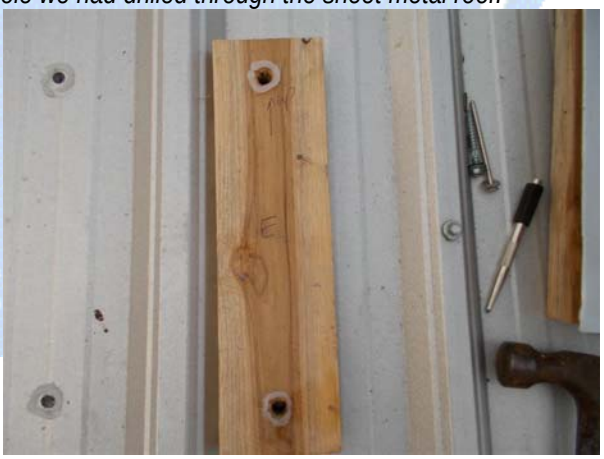


Drilling holes in the roof invites leaks. But there was no way around drilling holes to install the roof top mast base plate. We may have gone overboard with liberally applying silicon sealer around all the bolts and screws for the mounting. The diagram on the rights shows the multiple silicon sealing (blue ovals in the diagram) layers we applied to prevent rainwater from leaking through the roof. We combined the philosophies of "an ounce of prevention is worth a pound of cure" with "pay to do the job right the first time to avoid paying more to do the job right to repair a poorly done job the first time."

As the mounting bolts and screws are tightened, the rings of silicon sealer are compressed and spread to surround the hole in multiple layers above and below the sheet metal roofing. [**Note:** A few days later, a thunderstorm dropped heavy rain after midnight. The next morning revealed no leaks around the roof top mast mount.

A bead ring of silicon sealer is put around each hole we had drilled through the sheet metal roof.

A similar ring of silicon sealer on the wood shim



The wood shim goes over the holes in the roof.

Doing this work solo required careful planning and making numerous checklists in order to avoid unnecessary trips up and down the ladder. Even though it is safe to walk on metal roofing, keeping it to a minimum prevents possible roof damage. Mr. Murphy appeared and caused a few more trips up and down the ladder.

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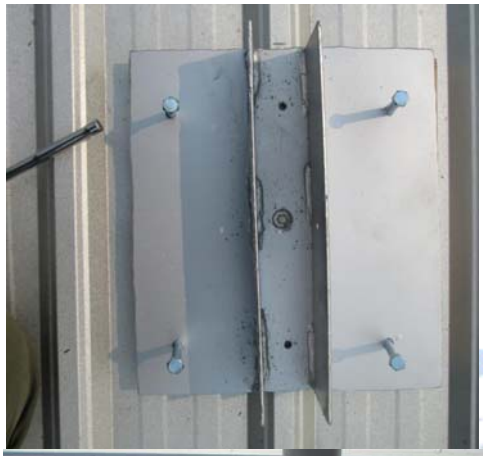
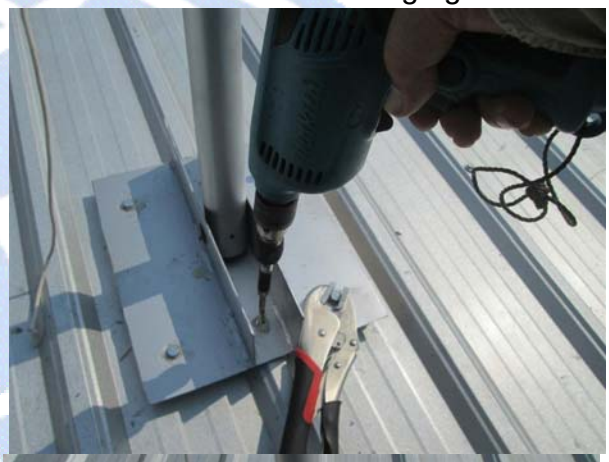


The mast base plate is secured by 4 bolts through the steel base plate, on-roof wood shims, through the steel sheet metal roof, and through the wood under roof cross braces (at right angles to the on-roof wood spacers. There are 3 screws in the center trough through the roof and into a teak beam; the roofing lag screw is at the center with 2 wood screws on either side of the center.

The main function of the base plate is to give the mast a firm attachment to the roof and to spread the weight of the mast over a larger area. It also prevents the mast from damaging the roof.



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We used basic math to estimate the length of the guy lines needed. Then did on site direct measurements to confirm them. We used our PVC thimbles to attach the guy lines to the upper U-bolt hardware of the WS-1000 sensor array unit. We expect the nylon 550 parachute cord will stretch over time. The initial tension will be periodically monitored and adjusted using the turnbuckles. Safety wire ties prevent the turnbuckles from loosening due to vibration.

A plastic wire tie secures the guy line at the thimble

Silicon sealer applied to the guy anchor

We slipped a flat washer over the anchor

The flat washer makes a more secure water seal

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We use a piece of plastic tubing as a chaffing guard

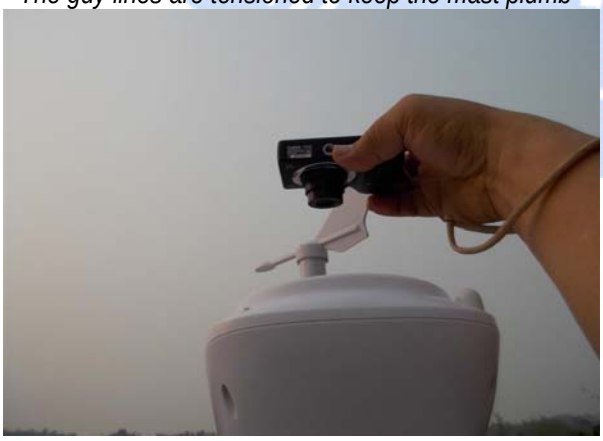
This should help to prolong the life of the nylon guy line

Nylon guy line and turnbuckle ready for installation

Checking the vertical alignment of the mast

The guy lines are tensioned to keep the mast plumb

Turnbuckles are wire safety tied to lock them in place



Final check of the WS-1000 bubble level

The bubble is centered; we are good to go.

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Mast "Lock Blocks"

After setting the mast and guys to keep things vertical, we decided to take one more step to protect the weather station. We installed "lock blocks" to prevent the mast from tipping over along its pivotal axis.

The "lock blocks" are pieces of teak wood held in place with locking pins. The blocks are placed upslope and down-slope of the mast. A 3/16" diameter hole) is drilled through the vertical upright fins of the base plate and the wood block for the locking pin. The locking pin is a 3 mm diameter steel rod, 69 mm long. Once both blocks and pins are in place, the pins are tied together to prevent them from slipping out.

Should any or all of the guys fail, the lock blocks prevent the mast from tipping down. The unit may not be vertically plumb. Rain fall measurements may be inaccurate if the system is not vertically plumb. But we hope the WS-1000 won't be damaged.

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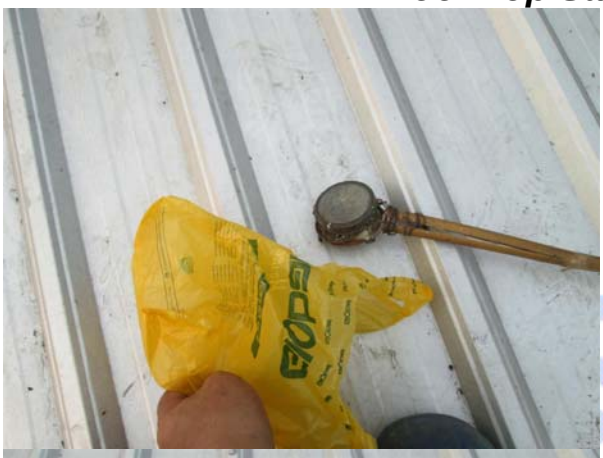
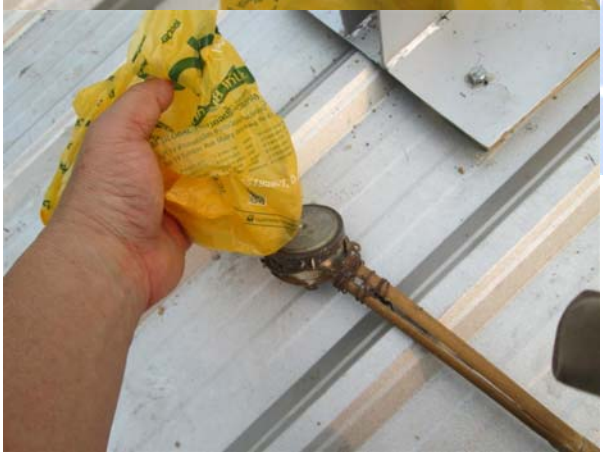
Roof Top Safety Clean-up



Drilling holes through metal on the roof created metal shavings that pose a safety hazard. So we used a magnet and a plastic bag to “sweep” up the metal slivers and shavings. We put a plastic bag over the magnet. Then used the magnet to pick up any loose metal debris. At the end of sweeping, we carefully turned the bag inside out to contain the metal particles for safe and easy removal and disposal from our roof top cleanup effort.



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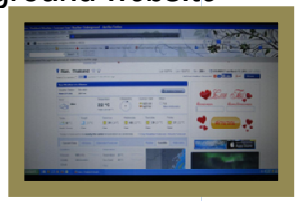
Uses of RTC-TH G.R.O.W. Weather Station Data

Weather is a continuous daily phenomenon affecting all of us throughout our lives. No matter where you go on Earth, weather will affect your daily life both directly and indirectly. For our sustainable agriculture efforts in rural northern Thailand, weather shapes the core foundation of our activities in soil and water management. No farm, large or small, can ignore weather's influence. GROW developed out of the need to have weather data specific to our farm. The closest government weather station is 8 km away. Weather is not uniform over an area. And in mountain areas, weather can vary greatly over a short distance. Collecting weather data on your farm helps you develop a rainwater harvesting plan, monitor soil erosion, manage farm water resources, and gain insight to climate change impacts (among other things).

RTC-TH GROW Weather Station

Getting Real On-farm Weather lessons help local farmers to make weather observations on their farms to help manage water resources, plan rain water harvesting, manage soil erosion. GROW weather station data helps calibrate farmer's GROW field equipment.

wunderground website



RTC-TH GROW weather data are uplinked to the wunderground website through the PWS (Personal Weather Station) program. This makes our weather data available to the world for use by weather / climate researchers and people who are weather enthusiasts, travelers, or anyone with an interest in our local area. We use the PWS program as an RTC-TH public service activity. It is our way to be a part of the solution in studying climate change.

RTC-TH MEWS

The Mobile Emergency Weather Station is part of the RTC-TH Emergency Communication (EmComm) using amateur radio to report local weather data to disaster relief authorities. Amateur radio operators can increase their value in an emergency. GROW weather station data helps calibrate MEWS field equipment. MEWS equipment provide a manual back-up for the GROW station when it cannot function.

RTC-TH REEEPP

The Rural Environmental Education Enhancement Pilot Project create weather observation lessons for Ban Na Fa Elementary School students to learn about weather and apply their school lessons in math and science in the real world. GROW weather station data helps calibrate REEEPP weather equipment. Students can also learn and carry home GROW lessons for the family farm.

Ban Na Fa, Nan Province is in the SW Monsoon Region

Nan Province has 3 distinct seasons. The resulting vegetation is a mixed drought deciduous / evergreen forest heavily impacted by human activity.

Summer or Pre-Monsoon Season (mid-Feb – mid-May) Hot – Dry Season Transition between monsoons. Warmer weather, especially in Northern Thailand. April is the hottest month. Prevailing winds tend to be Southerly.	Rainy or SW Monsoon (mid-May – mid-Oct) Warm – Wet Season Most of Thailand: wettest time of year Cloudy most of the time except some days in Jun	Winter or NE Monsoon (mid-Oct – mid-Feb) Cool – Dry Season Northern Thailand: cold (Dec – Jan) Less cloud cover Nov-Mar.
	Thunderstorms (max in May) due to convection (afternoon & evening) and confluence of warm / cool air masses (other times)	Tropical cyclones (more often Depressions) enter from W. North Pacific / South China Sea from May-Nov. (max in Sep) bringing rainfall and high winds.

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