NASA CERES

Student Cloud Observation On-Line Report Form (REEEPP Version)

A 501 (c)(3) non-profit educational organization
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Community-based Environmental Education for Families and Sustainable Neighborhoods

Login ID: Promwangkhwa Na Fa Village, Thawangpha

Latitude: 19.08 N Longitude: 100.86 E

Date: Year ______ Month _______ Day ___ **Satellite:** ☐ Terra ☐ Aqua

Time Zone: UT +7

(24-hr format) Local Time: Hr _____ Min _____ **Universal Time:** Hour ____ Min _____

CLOUD OBSERVATIONS (Required)

If more than one cloud layer exists, check the boxes to show the clouds are present.

Cloud Height	Cloud Type	Visual Opacity			Cloud Cover
		Transparent	Translucent	Opaque	• Use the Na Fa Cloud Cover Estimator Dome Worksheet to record the student observations and calculations. • Then check the box below
High	☐ Cirrus				
	☐ Cirrocumulus				
	☐ Cirrostratus				
Middle	☐ Altocumulus				☐ Overcast (95-100%)
	☐ Altostratus				
Low	☐ Cumulonimbus				☐ Mostly cloudy (50-95%)
	☐ Cumulus				
	☐ Stratocumulus				☐ Partly cloudy (5-50%)
	☐ Stratus				
	☐ Nimbostratus				☐ Clear (0-5%)
	☐ Fog				

CONTRAILS (This is optional.)

1	Can you see high into the sky?	☐ Yes, go to #2 ☐ No, why?	☐ Sky is overcast ☐ Too many clouds
2	Can you see any contrails?	☐ Yes, go to #3 ☐ No, why?	☐ None present ☐ Sky is overcast ☐ Too many clouds
3	Contrail type & count	☐ Short-lived Count? ☐ Persistent Count? Go to #4	

4	Any natural looking cirrus clouds in sky with the persistent contrails?	☐Yes, type?	☐ Cirrus ☐ Cirrocumulus ☐ Cirrostratus	Go to #5
		☐ No	Make a fist to block out the sun. Can you see a halo?	☐ Yes ☐ No
5	Estimate % sky covered by persistent contrails			

GROUND OBSERVATIONS

Surface Cover (Required)

Yes	No	
☐	☐	Snow / Ice
☐	☐	Standing water
☐	☐	Muddy
☐	☐	Dry Ground
☐	☐	Leaves on trees

Surface Measurements (These are optional.)

Precipitation		☐ mm ☐ in
Temperature		☐ °C ☐ °F
Relative Humidity %	Temperature	☐ °C ☐ °F
	Dry	
	Wet	
	Difference	

Wind		
Speed		☐ kmph ☐ mph
Direction		☐ True ☐ Mag

Barometric Pressure		
	☐ In Hg	Trend
	☐ mm Hg	
	☐ Mb	

Na Fa Elementary School: REEEPP

Cloud Cover Estimator Dome Worksheet

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Date:		Local Time:		
Estimator Dome Frame Cloud Cover Fraction Terms				
0	1 / 2		1	
No Clouds	¼ Covered	½ Covered	¾ Covered	Fully Covered

Team		Observer's Name					
Grade							
Teacher							
Sky Segment							
Number	Name						
1	North (N)						
2	Northeast (NE)						
3	East (E)						
4	Southeast (SE)						
5	South (S)						
6	Southwest (SW)						
7	West (W)						
8	Northwest (NW)						
Observer's Total							

Sum of All Observers		Add all Observer totals together
Averaged team estimated cloud cover		Divide the Sum of All Observers by 6 to get the Average Team Estimated Cloud Cover.
Estimated % Cloud Cover		Divide the Average Team Estimated Cloud Cover by 8 to get the Estimated % Cloud Cover.
Cloud Cover Term	□ Clear (0-5%) □ Partly Cloudy (5-50%)	□ Mostly Cloudy (50-95%) □ Overcast (95-100%)

Atmosphere

Cloud Observation
(For NASA CERES S'COOL Project)

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INTRODUCTION

Clouds are classified on the basis of their height above the ground and their general shape. Fog can be considered clouds that are low to the ground. [**Note**: There are some significant differences how fog and clouds are made. But their physical appearance is similar.]

There are 3 general cloud height groups: ***low*** (ground level to 6,500-7,000 feet), ***middle*** (6,500-7,000 to 20,000 feet) and ***high*** (20,000-40,000+ feet). Some clouds extend vertically across these layers. The vertical development is so significant; these clouds are classified a separately. [**Note**: For S'COOL, these vertically developed clouds are grouped with the low clouds because you just see the bottom of these clouds.

The basic terms for cloud shape include: ***cumulus*** (Latin for "heap") usually found from 300 to 1,525 m / 4,000-5,000 feet (often associated with fair weather); ***cirrus*** (Latin for "curl") found above 6,000 to 12,000 m / 18,000-20,000 feet (often signal an approaching storm); ***stratus*** (Latin for "spreading out" or "layered") found at 600 to 2,200 m / 2,000-7,000 feet (low clouds often signaling bad weather is coming); ***nimbus*** (Latin for "rain") low clouds that bring rain. There are also combination terms that modify the basic terms: ***alto*** (Latin for "high") can be combined to form ***altostratus, altocumulus***, which are middle, clouds with a stratus or cumulus form.

CLOUD IDENTIFICATION PROCEDURE:

Step 1. Go to an open area with a clear view of the sky and Doi Phu Ka.

Step 2. Look at Doi Phu Ka and use the mountain to try to judge the height of the clouds. If a cloud is touching the mountain, it must be a low cloud. Use this cloud as a reference to see if there are other clouds above it (middle or high clouds).

Step 3. After you know the height of the cloud (e.g. low, middle or high), look at the general shape of a cloud. Try to recognize its basic shape: lumpy (***cumulus***), thin and flat (***stratus***), or thin, wispy and curly (***cirrus***). [**Note:** Look at a wall chart or look for examples of cloud photos on the Internet such as NASA CERES S'COOL website or http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/cld/cldtyp/home.rxml.]

[**Note:** Keep good observation records. Some types of clouds will often appear before a storm arrives. This can be a very useful weather prediction method.

CLOUDS					
Code	**Name**	**Description**	**Altitude**		**Class**
			m	**ft**	
Ci	Cirrus	Delicate, wispy, curly; streaky, stringy; slow moving; doesn't block the sun; mares tails—large ice crystals extending down	12,000 to 6,000	40,000 to 20,000	High (ice)
Cc	Cirrocumulus	Thin sheets or closely packed small puffs without shadows; "mackerel" sky			
Cs	Cirrostratus	Whitish veil, usually fibrous; makes halo around the sun or moon.			
Ac	Altocumulus	Layer of separate cloud masses; fit closely in geometric pattern; blue sky visible between masses; white or gray on shaded side; associated with bad weather.	6,000 to 2,000	20,000 to 6,500	Middle
As	Altostratus	Extensive, eve, gray layer over entire sky; gray, smooth bottom; sun is a bright spot; associated with bad weather.			
Sc	Stratocumulus	Distinct gray masses (long rolls, right angles to the wind and cloud motion) with patches of open sky, flat tops; often associated with fair or clearing weather; but snow flurries or rain are possible from individual cloud masses.	2,000 to Groun d	6,500 to Ground	Low
St	Stratus	Dense, dark gray layer; uniform base			
Ns	Nimbostratus	Dense, dark gray layer with precipitation (rain or snow); thick enough to block the sun			
Cb	Cumulonimbus	White, anvil shaped top; very dark base; vertical dimension greater than horizontal; heavy rainfall, thunder, lightning, gusty winds, hail possible; strong updrafts	12,000 to 300	40,000 to 1,000	Vertically developed
Cu	Cumulus	White, wooly mass, flat base, lumpy top; gray or dark on shaded side or bottom; small clouds associated with fair weather. (Often starts as a Low Cloud but can grow taller.)	1,525 to 300	5,000 to 1,000	

FOG		
Code	**Name**	**Description**
Fr	Radiation Fog	Often associated with a temperature inversion; bottom layer of air (closest to ground) cools below the dew point.
Fa	Advection Fog	Warm, moist air moves over a cold surface (snow, ice, or cool ocean current) and cools below the dew point.
Fo	Orographic Fog	Warm, moist air is forced upslope and is cooled below the dew point.
Fe	Evaporation Fog "Steam Fog" "Sea Smoke"	Evaporations adds water vapor to air that is already cool and near saturation (high relative humidity); cool air passing over warm water increases the relative humidity so that evaporation adds the needed water vapor to attain saturation.
Note: Fog is sometimes called "clouds close to the ground." Sometimes it is considered precipitation (as is the case with this observation form).		

VISUAL OPACITY

This describes the amount of light coming through the cloud. This is somewhat related to cloud thickness (the vertical dimension of the cloud), but other factors also affect cloud opacity (e.g. number of cloud layers, water droplet size, ice crystal size, etc.). The 3 terms used in the study are: Transparent, Translucent, and Opaque.

When multiple cloud layers are present, get this information for each cloud layer.

Transparent	Clear glass or plastic	Thin clouds that let light pass easily. Sometimes you can even see blue sky through the cloud.
Translucent	Frosted glass or milky white plastic	Clouds of medium-thickness that you can see some sunlight coming through them, but you cannot any blue sky.
Opaque	Thick paper	Thick clouds that do not let direct light to pass through, but some light can diffuse through them. These thick clouds often look gray.

The Visual Opacity Guide

Use the Visual Opacity Guide to show students the function differences between the terms “Transparent”, “Translucent”, and “Opaque” to describe the visual opacity of a cloud.

Transparent	**Translucent**	**Opaque**
You can see clearly through the transparent window of the visual opacity guide.	Light comes through the translucent window of the visual opacity guide, but you cannot see clearly through it.	No light comes through the opaque part of the visual opacity guide and you cannot see through the opaque portion of the guide.

CLOUD COVER

Take the cloud cover measurements at the same place and time you do the cloud identification and visual opacity observations.

Look directly overhead. Divide the sky into 8 triangles. This is called the celestial dome.

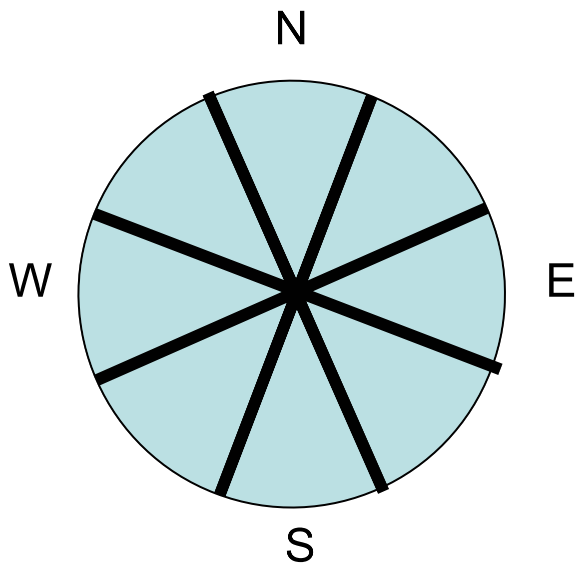
Step 1. Estimate the part of each triangle covered by clouds of any thickness (translucent or not), rounded to the nearest one-half of a triangle.

Step 2. Repeat the process for each of the 8 triangles.

Step 3. Add to get the sum of all the triangles.

Step 4. Divide the result by 8 to get the average estimated cloud cover.

Step 5. Report the correct S'COOL term for the Cloud Cover in the table below.



The Na Fa Cloud Cover Estimator Dome

The playground merry-go round was fitted with a bamboo frame dome overhead. The bamboo dome divides the sky into 8 parts: North (N), Northeast (NE), East (E), Southeast (SE), South (S), Southwest (SW), West (W), and Northwest (NW). Six students can make observations at the same time. This produces an averaged estimate of cloud cover based on six separate observations. Report the Cloud Cover using the following Cloud Cover terms.

Oktas	Term	Percent	Notes
8 oktas	Overcast:	95 – 100%	There may be some breaks in the clouds (up to 1/2 okta).
5–7 oktas.	Mostly Cloudy (Broken clouds)	50 – 95%	If you see more clouds than you do blue sky, then the cloud cover is broken
1–4 oktas.	Partly Cloudy (Scattered Clouds)	5 – 50%	The total sky cover is one-half or less, but not zero. If you see more clear blue sky than clouds, or if the amounts are about equal, then the cloud cover is considered to be scattered
Zero oktas	Clear:	0 – 5%	Since a "clear" sky can include some clouds (as long as it's less than 1/2 okta), it is possible to report cloud type even when you report a clear sky!
	When the sky is "clear", make a fist and hold it up to block the sun and look for a halo around it. Be careful not to look directly at the sun. It can damage your eyes. Look around your fist and watch for a halo that indicates a very thin cirrus cloud is present.		

Note: Everyone in the class should make an estimate, and then average all the answers. This helps prevent bias of a single observer. Good science uses many observations.

Using the Na Fa Cloud Cover Dome-Estimator

Step 1. The Cloud Cover Dome-Estimator must be centered over the merry-go round in an open area with a clear view of the sky in all oktas. The four cardinal directions (North, East, South, and West) must each be centered on a separate okta.

Step 2. Six students enter the Dome-Estimator and take a separate seat facing the center of the merry-go round.

Step 3. Each student looks directly across from their seated position to see a portion of the sky in a triangular frame of the dome. They estimate the portion of sky in the frame as being 0 (clear sky, no clouds), ½, or 1 (fully covered) by clouds of any kind. They record their estimates in their notebook.

Step 4. All observations will be put on the chalkboard. All students will compute the average cloud cover for the 6 sets of observations. Once the average is calculated, it will be divided by 8 to get the estimated % cloud cover for the observation period.

Step 5. Record all of the data on the Cloud Cover Estimator Dome Worksheet.

CONTRAILS

[Note: For REEEPP, reporting Contrails is considered optional.]

There is growing concern about the effects of high altitude jet exhausts in the atmosphere. In some cases, persistent contrails triggered cirrus cloud formation that expanded to cover the sky. When you see contrails, complete the section of the data form dealing with contrails. In Item #4, when no high clouds appear, make a fist and hold it up to block the sun and look for a halo around it. NEVER LOOK DIRECTLY AT THE SUN! A halo indicates the presence of very thin cirrus cloud.

The following passage is from the NASA S'COOL website: "Contrails are human-induced clouds that only form at very high altitudes (usually above 8 km) where the air is extremely cold (less than -40°C). If the air is very dry, they do not form behind the plane. If the air is somewhat moist, a contrail will form immediately behind the aircraft and make a bright white line that lasts for a short while. Persistent contrails form immediately behind the airplane in very moist air. These long-lived contrails will usually grow wider and fuzzier as time passes. Sometimes they will actually take on the characteristics of a natural cirrus cloud and no longer look like contrails after only a half hour or so. Persistent contrails can exist long after the airplane that made them has left the area. They can last for a few minutes or longer than a day. However, because they form at high altitudes where the winds are usually very strong, they will move away from the area where they were born. Often, when we look up into the sky, we will see old persistent contrails that formed far away but moved overhead because of the wind."

When contrails are present, complete the relevant portions of the form in the Contrails section.

<table>
<tr><th colspan="9">CONTRAILS</th></tr>
<tr><td>1</td><td>See high into the sky?</td><td>☐ Yes, go to #2
☐ No, why?</td><td>☐ Sky is overcast
☐ Too many clouds</td><td rowspan="2">4</td><td rowspan="2">Any natural looking cirrus clouds in sky with the persistent contrails?</td><td>☐Yes, type?</td><td>☐ Cirrus
☐ Cirrocumulus
☐ Cirrostratus</td><td>Go to #5</td></tr>
<tr><td>2</td><td>See any contrails?</td><td>☐ Yes, go to #3
☐ No, why?</td><td>☐ None present
☐ Sky is overcast
☐ Too many clouds</td><td>☐ No</td><td>Can you see a halo?</td><td>☐ Yes
☐ No</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Contrail type & count</td><td>☐ Short-lived</td><td>Count?</td><td rowspan="2">5</td><td rowspan="2" colspan="3">Estimate % sky covered by persistent contrails</td><td rowspan="2"></td></tr>
<tr><td>☐ Persistent</td><td>Count? Go to #4</td></tr>
</table>

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S'COOL
OPTIONAL SURFACE MEASUREMENTS

INTRODUCTION

This paper provides instructions on how to gather additional surface measurements to supplement the required S'COOL surface observations. If you do not have the proper instruments to take the measurements, check to see if these data are given in a local radio or TV weather report or if you can get these from a nearby airport or government weather observation station.

The topics are presented in order of their sequential appearance on the ESSI NASA CERES S'COOL Report Form. Additional lessons are included that involve other routine weather observations / measurements as well as basic weather forecasting. It is not required to do any or all of these supplementary lessons. However, they are included as a means of providing additional training for those who are interested in doing more weather related studies.

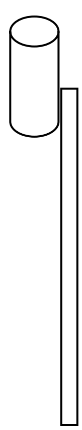
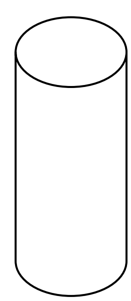
PRECIPITATION

Precipitation is any form of liquid or solid water falling from a cloud. The names and meanings of the common types of precipitation are given in the table below. They are listed in order of the most common in Thailand to the least common.

Name		Form	Definition
Common	Rain	Liquid	Drops of water falling from a cloud that reaches the ground. Rain can also start as snow falling from a cloud, melts in the air to form drops of water that reach the ground. Droplets (small drops of water) and small droplets are called drizzle. Very small droplets can be called mist.
Uncommon	Freezing Rain	Liquid	Drops of water falling from a cloud that freeze when reaching the ground.
	Sleet	Solid	Drops of water falling from a cloud that freezes in the air and bounces when it hits the ground. Some people also use this term to describe a mixture of rain and snow, rain and hail, and sometimes snowflakes that melt in the air before reaching the ground. This is less common than freezing rain.
	Snow	Solid	Snowflakes are small, lacey flat flakes of ice crystals (solid water) falling from a cloud. If the snowflakes are large and fluffy when they reach the ground, it indicates the air high up is fairly still and calm.
	Hail	Solid	Hailstones are solid ball of ice that fall from a cloud and strike the ground. They are hard and can hurt if they hit you.

Making a Rain Gauge: You need rain gauge to take this measurement. You can make a simple rain gauge using an empty bottle. The open top should be round. You need to place the rain gauge in an open area away from a building, tower, pole, overhead power or telephone lines, or tree. Find the tallest object in the area of your rain gauge. Place the rain gauge at a distance equal to least 4 times the height of the object. [Note: If you need to measure / estimate the height of the object, see Appendix A at the end of this paper.]

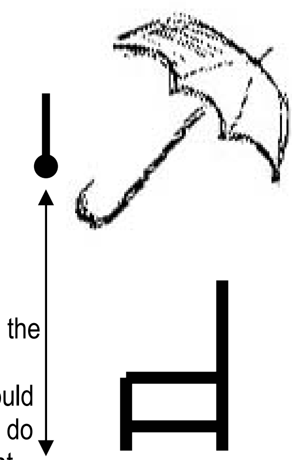
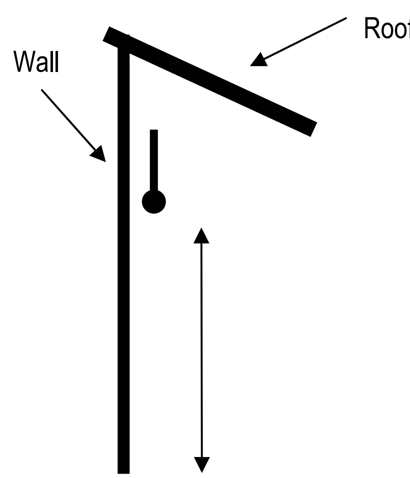
- **Ground Level:** Make sure it will not fall over or get blown over by the wind. The height of the open top of the collector bottle should be at least 50 cm / 20 in above the ground to keep water from the surface splashing into the rain gauge.
- **Pole Mounted:** The open top of the collector bottle should be above the top of the pole so raindrops hitting the pole don't splash into the collector bottle. Even pole-mounted rain gauges should be fairly close to ground level. [**Note**: Be sure the pole and rain gauge are perpendicular to the ground. Before you set up the rain gauge, carefully measure the diameter of the opening of the collector bottle, and calculate the area of the opening. You will need this measurement to calculate the total precipitation.]
    - Measure the diameter of the collector bottle opening in cm
    - Divide the diameter by 2 to get the radius
    - Multiple the radius in cm by pi (3.14159) to get the area in sq cm of the collector bottle opening.
    - Record and save the area of the collector bottle opening.
    - Accurately measure the total volume (in milliliters) of the collector bottle.
    - Multiply the total number of milliliters by 0.001 to report the total number of millimeters of rainfall.

Pole Mounted Rain Gauge	Ground Level Rain Gauge
The rain gauge should be located in an open, level area.	
Be sure you can easily remove the remove the rain gauge from the pole so you can empty the water to do the measurement. The top of the rain gauge should be taller than the top of the pole to avoid raindrops splashing from the pole into the rain gauge. 	Water splashing from a hard surface may get into the rain gauge. Make sure the top of the rain gauge is 50 cm / 20 inches above the ground. 
If the rain gauge is located in a very windy area, you need to protect it with an "alter-type" shield that is not closer than 2 x the height of the fence. For example, if the shelter fence is 0.6 m tall, it should not be closer than 1.2 m from the rain gauge. (See Appendix _B_ for information about making an "alter-type" shield.)	

TEMPERATURE

Air temperatures should be measured at a level site, in the shade AND 1.5 m / 4.9 ft above the ground. [**Note:** At Na Fa Elementary School, use the Dry Bulb Thermometer on the hygrometer to measure the air temperature. You can use the Air temperature measurement in the Relative Humidity section of the ESSI S'COOL Report Form. This can save you some time.]

- **Level Site:** Avoid taking temperature measurements on hillsides or in low-lying areas. Hillsides could be windy, and cooler. In low-lying areas, the air is NOT circulating freely and may warmer.
- **Shade:** All air temperatures should be taken in the shade not in direct sunlight.
- **Above the Ground:** It is important to take the temperature 1.5 m / 4.9 ft above the ground to reduce the effect of heat coming from the ground.

Hand-held Thermometer	Permanently Mounted Thermometer
The site should be level (not on a hillside, not in a low area) and open area (not sheltered from the wind). Air must be freely circulating around the thermometer. Be sure to indicate if you are use °Celsius or °Fahrenheit.]	
Hold the thermometer in the shade a few minutes before recording the temperature.  1.5 m / 4.9 ft above the ground Short students should stand on a chair to do this measurement	Be sure the thermometer is fully shaded all year long.  Mount the thermometer is l.5 m / 4.9 ft above the ground.

If the thermometer is permanently mounted outdoors, it must be place so it is always in the shade. Use a north-facing wall. Na Fa Village is located about 19° N latitude. Be sure it shades the thermometer from May 15 to July 31 when the sun is North of Na Fa. For the rest of the year, the sun will be to the south of the school. So if the thermometer is mounted on a north-facing wall, it will be in the shade for most of the year. The thermometer should not be influenced by artificial conditions such as concrete or a dark paved surface, heat radiating from buildings, heating / cooling exhausts, etc. Avoid placing thermometers above house roofs or near windows, doors or roof eaves. Vegetation near a thermometer should be cut to 25.4 cm / 10 inch height or less.

RELATIVE HUMIDITY

Relative humidity is the measurement of how much water vapor is in the air compared to how much water vapor could be in the air, if the air were saturated (full of water vapor). It is reported as a percentage.

A hygrometer is used to measure relative humidity. It has two thermometers. One thermometer looks like a normal thermometer. This is called the “dry bulb” thermometer. The second thermometer has a piece of cloth tied to the bulb end that is kept wet. This is called the “wet bulb” thermometer.

- Check the appropriate box for the temperature units you are using for this set of measurements (°Celsius or °Fahrenheit).
- Read and record the Dry Bulb Temperature and d the Wet Bulb Temperature.
- Subtract the Wet Bulb temperature from the Dry Bulb temperature. Record the result in the “Difference” box.
- Use the Dry Bulb Temperature and the Difference and refer to the Relative Humidity Table to determine the relative humidity. Record the Relative Humidity in the appropriate box.

Dry bulb thermometer

Wet bulb thermometer

Water bottle

Location:	Date:
Recorded by:	Time:

Step 1. Read and record the wet bulb temperature in row B.
Step 2. Read the record the dry bulb temperature in row A.
Step 3. Subtract the wet bulb temperature (B) from the dry bulb temperature (A); write the result in row C.
Step 4. Use the reference table to find the relative humidity. Record the result in row D.

	Measurement	Hygrometer
A		Dry Bulb Temperature
B		Wet Bulb Temperature
C		Dry - Wet Bulb Temperature
D		% Relative Humidity

% Relative Humidity Table

Step 1: Find the Air Temperature in the left column. For example, 31°C. Follow that row going across the table.
Step 2. Subtract the wet bulb temperature from the dry bulb temperature. For example, 3°C. Follow that column going down until it crosses the row for 30°C.
Step 3. Read and record the relative humidity number in the table. For example, 86%.

Air Temp (°C)	Wet Bulb Depression (Difference between Dry Bulb-Wet Bulb Temperature)													
	0.5	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**7.5**	**10.0**	**12.5**	**15.0**
40.0	97	94	91	88	85	82	79	77	74	72	59	48	38	29
37.5	97	94	91	87	85	82	79	76	73	70	58	46	36	26
35.0	97	93	90	87	84	81	78	75	72	69	56	44	33	23
32.5	97	93	90	86	83	80	77	74	71	68	54	42	30	20
30.0	96	93	89	86	82	79	76	73	70	67	52	39	27	16
27.5	96	92	89	85	82	78	75	71	68	65	50	36	23	12
25.0	96	92	88	84	81	77	73	70	66	63	47	32	19	7
22.5	96	92	87	83	80	76	72	68	64	61	44	28	14	1
20.0	95	91	87	82	78	74	70	66	62	58	40	24	8	--
17.5	95	90	86	81	77	72	68	64	60	55	36	18	2	--
15.0	95	90	85	80	75	70	66	61	57	52	31	12	--	--
12.5	94	88	84	78	73	68	63	58	53	48	25	4	--	--
10.0	94	88	82	76	71	65	60	54	49	44	19	--	--	--
7.5	93	87	80	74	68	62	56	50	44	38	11	--	--	--
5.0	93	86	78	71	65	58	51	45	38	32	1	--	--	--
2.5	92	84	76	68	61	53	46	38	31	24	--	--	--	--
0.0	91	82	73	65	56	47	39	31	23	15	--	--	--	--
-2.5	90	80	70	60	50	41	31	22	12	3	--	--	--	--
-5.0	88	77	66	54	43	32	21	11	0	--	--	--	--	--
-7.5	87	73	60	48	35	22	10	--	--	--	--	--	--	--
-10.0	85	69	54	39	24	10	--	--	--	--	--	--	--	--

BAROMETRIC PRESSURE

[**Note**: For REEEPP, contact the Thawangpha government weather station for the barometric pressure reported in millibars (mb).]

Simply stated, the barometric pressure is the weight of the column of air over the weather station measured using a barometer. The barometer should be mounted in a weatherproof location. The barometer should be kept away from pressure changes caused by compression (closing doors), vibrations, rapid temperature changes, direct sunlight, and wind (open doors / windows, heating or cooling vents). All of these can cause artificially low barometer readings.

Barometers can use different measurement scales (e.g. In Hg = inches of mercury; mm Hg = millimeters of mercury; Mb = millibars) depending on the instrument available. To change from one type of barometric pressure unit to another, use the conversion table in Appendix C.

[**Note:** Official weather stations report their position in terms of latitude, longitude and altitude. The altitude is actually the field elevation of the station above mean sea level, plus the height of the barometer above the ground. This is required in order to reduce the barometric pressure observations / measurements of all weather stations to sea level pressure.]

WIND SPEED

Wind speed can be estimated by visual observation of familiar objects around you or by direct measurement. To visually estimate the wind velocity, use the Beaufort Scale of Wind Effects.

BEAUFORT SCALE OF WIND EFFECTS				
Speed (mph)	**Speed (kph)**	**Force #**	**Effects on Land**	**Official Term**
<1	<1.5	0	Calm; smoke rises vertically.	Calm
1-3	1.5-6	1	Smoke indicates wind but not wind vane.	Light Air
4-7	6-12	2	Wind felt on face, leaves rustle; wind vane moves	Light Breeze
8-12	12-20	3	Leaves, small twigs move; light flags fully extended.	Gentle Breeze
13-18	21-29	4	Wind blows dust and loose papers; small branches move.	Moderate Breeze
19-24	30-39	5	Small trees w/ leaves sway; crested wavelets appear on lakes/ponds.	Fresh Breeze
25-31	40-50	6	Large branches move; phone wires whistle; umbrellas hard to use.	Strong Breeze
32-38	51-61	7	Whole trees sway; hard to walk in the wind.	Near Gale
39-46	62-74	8	Twigs break off trees; cars veer on roads.	Gale
47-54	75-87	9	Slight damage to buildings (roof shingles blow off).	Strong Gale
55-63	88-101	10	Trees uprooted; considerable damage to buildings.	Storm
64-72	102-114	11	Widespread damage caused.	Violent Storm
>73	>115	12	Widespread damage caused.	Hurricane
mph: Miles per hour. **kph:** Kilometers per hour. **Force #:** A relative numbering scale used by sailors. **Official Terms** from the World Meteorological Organization (WMO).				

MEASURING WIND SPEED:

The Dwyer Wind Gauge is a portable and reliable tool to measure wind speed in the field. This is a hand held instrument. As the wind blows, the white indicator ball in the tube moves up with high wind speeds, and drops down with low wind speeds. Because the wind does not blow at a constant velocity, you have to subjectively judge when to read and record the position of the indicator ball. With practice, you gain proficiency using the device. If you take several readings, carefully noting the maximum and the minimum wind speeds during the measurement interval, you can mathematically calculate the average wind speed. The Dwyer wind speed indicator has 2 wind speed ranges (Low, 2 – 10 mph; High, 6 - 66 mph).

To Use the Dwyer Wind Speed Indicator:

Step 1. Find a clear open area away from trees, buildings and other structures that might block or amplify the wind.

Step 2. Stand facing into the wind. Hold the Dwyer wind meter perpendicular to the ground with your arm fully extended.

Step 3. Hold the instrument in your hand with the wind speed scales facing you. Be sure the white indicator ball moves freely. Stretch your arm out in front of you and hold the instrument above your head.

Step 4. Watch the tiny white ball in the Dwyer wind meter. If the ball stays within the Low speed scale (2-10 mph, to the left of the white ball), read the wind velocity based on the position of the white indicator ball. If the ball goes all the way to the top of the Low speed scale, place a fingertip over the red plastic pipe at the top of the wind gauge. Then read the position of the white indicator ball using the High-speed scale (6 – 66 mph, to the right of the white ball).

Step 5. Repeat Steps 2 & 3 until you have taken at least 3 measurements. Watch for the maximum and minimum wind speeds. Use the table below to record your data. Watch the indicator ball and read off the corresponding wind velocity in mph. If it goes up to 10 mph, you need to change to the High-speed scale. To do this, hold a fingertip over the red pipe at the top of the instrument. Watch the white ball and read off the corresponding wind velocity in mph.

1. Low speed scale in miles per hour (mph)

2. Cover this opening with your finger if wind is stronger than 10 mph

3. High speed scale in mph

4. White indicator ball. Read the wind speed in mph where you see the white ball.

Dwyer Wind Speed Indicator

Step 6. Calculate the average wind speed. Add the three measurements together. Divide the sum by 3 to get the average wind speed. Use the reference table to convert mph to kph.

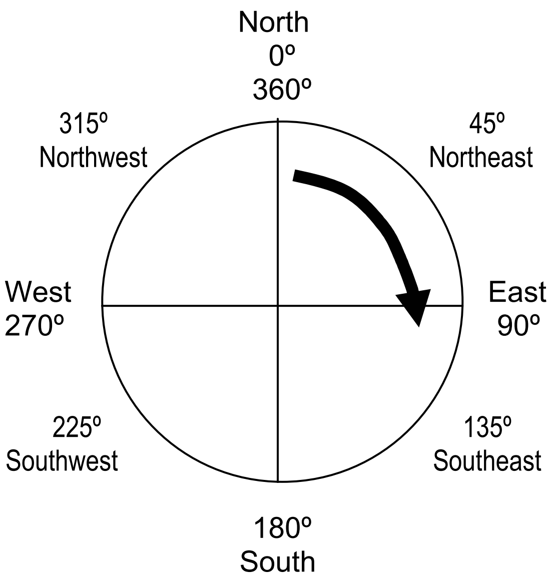
Miles per hour to Kilometers per hour Conversion Table					
mph	**kph**	**mph**	**kph**	**mph**	**kph**
1	1.61	6	9.66	20	32.19
2	3.22	7	11.27	30	48.28
3	4.83	8	12.87	40	64.37
4	6.44	9	14.48	50	80.47
5	8.05	10	16.09	60	96.56

<table>
<tr><td colspan="6">Wind Speed Data Log Form</td></tr>
<tr><td colspan="4">Location</td><td>Date</td><td>Time</td></tr>
<tr><td colspan="3">Recorded by</td><td colspan="3">Wind Direction ☐ True ☐ Magnetic</td></tr>
<tr><td>Observation</td><td>Max Speed</td><td>Min Speed</td><td>Ave Speed</td><td colspan="2" rowspan="6">Use this area for your calculations</td></tr>
<tr><td>#1</td><td></td><td></td><td></td></tr>
<tr><td>#2</td><td></td><td></td><td></td></tr>
<tr><td>#2</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Total of Averages</td><td></td></tr>
<tr><td colspan="3">Average of Averages</td><td></td></tr>
</table>

[**Note:** A weather station anemometer is a more technical wind speed measuring tool. An official anemometer would be mounted on a tower that is 9 – 11 m / 30-33 feet above the ground.]

WIND DIRECTION

Winds are named based on the direction from which they come. Thus, a North wind is coming from the North and blows toward the South. Weather reports are oriented toward True North, not magnetic north. There are plans to construct an outdoor worktable that permanently indicates the True cardinal directions. A wind vane (wind directional indicator) will be erected so students can easily observe and record the wind direction.

Measuring Wind Direction with a Magnetic Compass	
 	**To Measure Wind Direction:** Imagine you are standing in the middle of the circle in the picture on the left. Step 1. Stand facing the wind (looking into the direction from which the wind is blowing). Step 2. Aim the magnetic compass directly into the wind, but keep the compass level so the needle swings freely. Step 3. Read off the azimuth angle in degrees ranging from 0º (starting at North) going clockwise around the circle. Step 4. Change the azimuth number into the name of the direction using the table below. Ultra precision is not needed. The general direction is good enough.

Measuring Wind Direction with a Wind Tell-Tale:

Step 1. Find a clear open area away from trees, buildings and other structures that might block or amplify the wind.	
Step 2. Set up the wind direction meter on a flat surface. Step back and let the wind blow freely over the instrument.	

Step 3. Look at the tell tail as the wind blows. Slowly turn the instrument so the tell tail is lined up directly behind the compass. **Step 4.** Read the letter for the compass direction at the red indicator line on the magnetic compass. (In the photo, the wind is coming from the SW---southwest. Remember, winds are named for the direction FROM which they come.) If you haven't already done so, you will need to correct the magnetic compass direction to True North: A common magnetic compass points toward Magnetic North. The magnetic declination for Na Fa Village is about 0° 41' W. This changes by 0° 4' to the West each year.	 
Note: Many magnetic compasses for common use may not be precisely scaled to show angular degrees (azimuth) less than 2°. With the declination correction for Na Fa Village less than 1°, you won't really see much of a difference.	

Making a Wind Tell "Tail": You can make a simple wind tell tail to measure the wind direction.

Materials: A piece wood 30 cm x 30 cm; a wire or wooden rod 20 cm long, a piece of yarn 15 cm long, a magnetic compass. (The dimensions are variable depending on the size you want instrument you want.)

Procedures:

Step 1. Lay the wood flat on a tabletop. Drill a small hole in the center and mount the rod perpendicular to the wood base.	**Step 2.** Attach the compass to one edge of the wooden board. The center of the compass should make a straight line with the rod at the center of the board.	**Step 3.** Make the tell tail by typing the thread to the top of the rod so it can hang freely for it full length. Tie a piece of light plastic bag (the tail) to the loose end of the thread.
		

APPENDIX A:

Biosphere-Flora

Sight Ruler Method to Estimate Tree Height

A 501 (c)(3) non-profit educational organization

Po Box 8042, Van Nuys, CA 91409-8042 Phone: (818) 343-2363
www.earthsystemsscience.org E-mail: earthsystemsscience@yahoo.com

Community-based Environmental Education for Families and Sustainable Neighborhoods

1.0 INTRODUCTION: In many cases, it is not practical to climb a tree to measure its height.

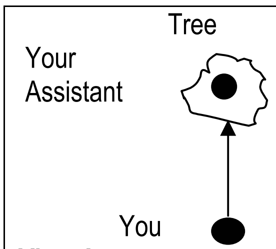
2.0 Materials: Long measuring tape, ruler, field notebook.

3.0 Procedure:

Step 1. Have your assistant stand next to the trunk of the tree you are measuring. See View A (in the diagram on the next page).

Step 2. Fully extend your arm, hold the ruler perpendicular to the ground. . Close one eye and sight along your arm to the treetop. Read the height of the tree in inches on the ruler.

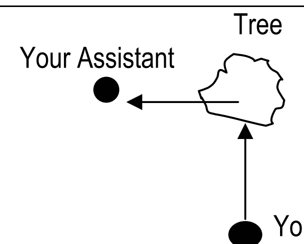
Step 3. Turn the ruler parallel to the ground. Have your assistant walk out from the tree the distance on the sight ruler equal to the height of the tree (in inches). See View B in the diagram. The estimated tree height is the actual distance from your assistant to the tree. Use the long measuring tape to determine the distance from your assistant to the tree.



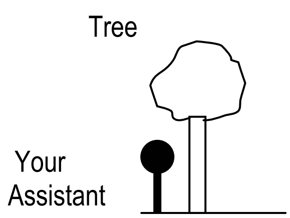
View A

Proper Conditions for this method:

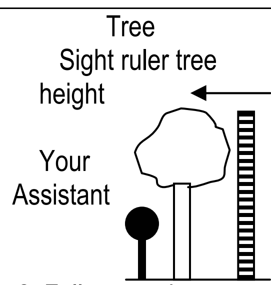
- You must be able to stand next to the object to be measured.
- The ground must be fairly level.
- There must be open space so you can see the object from a distance



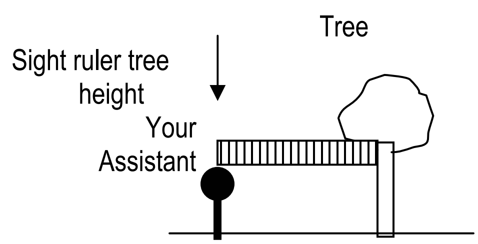
View B



Step 1. Have your assistant stand next to the trunk of the tree you are measuring. See View A.



Step 2. Fully extend your arm, hold the ruler perpendicular to the ground. . Close one eye and sight along your arm to the treetop. Note the height of the tree.



Step 3. Turn the ruler parallel to the ground. Have your assistant walk out from the tree the distance on the sight ruler equal to the height of the tree. See View B. The estimated tree height is the distance from your assistant to the tree.

APPENDIX B:
Alter-Type Rain Gauge Wind Screen

Rain Gauge with Alter-Type Wind Screen

The Alter-Type Wind Screen prevents strong updrafts near a rain gauge from than can deflect additional raindrops into a rain gauge, thus distorting the collected rainfall total. The screen also generates turbulent air motions over the gauge orifice to break up streamlines (strong horizontal air flow) and thus improve the catch of the rain gauge. Use of a windscreen is recommended with all precipitation gauges located in windy areas.

The screen consists of 32 free-swinging galvanized metal leaves, evenly spaced around a 122 cm / 48 in. diameter. Each leaf is fabricated from 22-gauge sheet metal, 40.6 cm / 16 in. long, 7.6 cm / 3 in. wide at the top and 5 cm / 2 in. wide at the bottom. One of the quadrants swings out to permit easy access to the rain gauge. The legs are 61 cm / 48 in tall legs (2' and 3') are available due to variations in gauge height.

To make the rain gauge station more permanent, consider attaching it to a concrete base.

APPENDIX C: BAROMETRIC PRESSURE CONVERSION TABLE

Abbreviations: in = inches of mercury @ 0°C; mm = millimeters of mercury @ 0°C; mB = millibars; kP = kilopascals							
in	mm	mB	kP	in	mm	mB	kP
28.44	722.376	963	96.34146	29.74	755.396	1007	100.74526
28.47	723.138	964	96.44309	29.77	756.158	1008	100.84688
28.50	723.900	965	96.54472	29.80	756.920	1009	100.94851
28.53	724.662	966	96.64634	29.83	757.682	1010	101.05014
28.56	725.424	967	96.74797	29.86	758.444	1011	101.15176
28.59	726.186	968	96.84959	29.89	759.206	1012	101.25339
28.62	726.948	969	96.95122	29.92	759.968	1013	101.35501
28.65	727.710	970	97.05285	29.94	760.476	1014	101.42276
28.68	728.472	971	97.15447	29.97	761.238	1015	101.52439
28.70	728.980	972	97.22222	30.00	762.000	1016	101.62602
28.73	729.742	973	97.32385	30.03	762.762	1017	101.72764
28.76	730.504	974	97.42547	30.06	763.524	1018	101.82927
28.79	731.266	975	97.52710	30.09	764.286	1019	101.93089
28.82	732.028	976	97.62873	30.12	765.048	1020	102.03252
29.85	758.190	977	101.11789	30.15	765.810	1021	102.13415
28.88	733.552	978	97.83198	30.18	766.572	1022	102.23577
28.91	734.314	979	97.93360	30.21	767.334	1023	102.33740
28.94	735.076	980	98.03523	30.24	768.096	1024	102.43902
28.97	735.838	981	98.13686	20.27	514.858	1025	68.66531
29.00	736.600	982	98.23848	30.30	769.620	1026	102.64228
29.03	737.362	983	98.34011	30.33	770.382	1027	102.74390
29.06	738.124	984	98.44173	30.36	771.144	1028	102.84553
29.09	738.886	985	98.54336	30.39	771.906	1029	102.94715
29.12	739.648	986	98.64499	30.42	772.668	1030	103.04878
29.15	740.410	987	98.74661	30.45	773.430	1031	103.15041
29.18	741.172	988	98.84824	30.48	774.192	1032	103.25203
29.21	741.934	989	98.94986	30.51	774.954	1033	103.35366
29.24	742.696	990	99.05149	30.54	775.716	1034	103.45528
29.27	743.458	991	99.15312	30.56	776.224	1035	103.52304
29.30	744.220	992	99.25474	30.59	776.986	1036	103.62466
29.32	744.728	993	99.32249	30.62	777.748	1037	103.72629
29.35	745.490	994	99.42412	30.65	778.510	1038	103.82791
29.28	743.712	995	99.18699	30.68	779.272	1039	103.92954
29.41	747.014	996	99.62737	30.71	780.034	1040	104.03117
29.44	747.776	997	99.72900	30.74	780.796	1041	104.13279
29.47	748.538	998	99.83062	30.77	781.558	1042	104.23442
29.50	749.300	999	99.93225	30.80	782.320	1043	104.33604
29.53	750.062	1000	100.03388	30.83	783.082	1044	104.43767
29.56	750.824	1001	100.13550	30.86	783.844	1045	104.53930
29.59	751.586	1002	100.23713	30.89	784.606	1046	104.64092
29.62	752.348	1003	100.33875	30.92	785.368	1047	104.74255
29.65	753.110	1004	100.44038	30.95	786.130	1048	104.84417
29.68	753.872	1005	100.54201	30.98	786.892	1049	104.94580
29.71	754.634	1006	100.64363	31.01	787.654	1050	105.04743