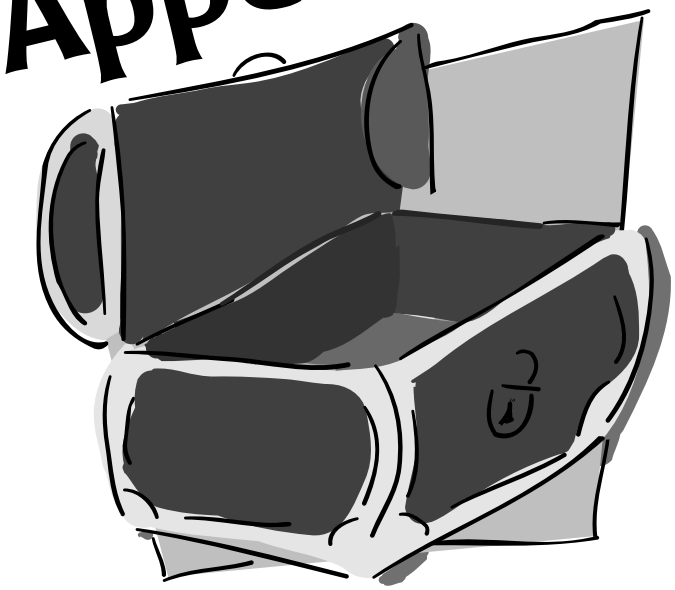
Appendix



Site Definition Sheet

Clouds 1-Measurement Data Sheet

Clouds 7-Measurement Data Sheet

Integrated 1-Day Data Sheet

Integrated 7-Day Data Sheet

Aerosols Data Sheet

Water Vapor Data Sheet

Digital Max/Min Thermometer Calibration and Reset Data Sheet

Digital Multi-Day Max/Min Data Sheet

Surface Temperature Data Sheet

Ozone Data Sheet

Weather Station Calibration Data Sheet

Observing Cloud Type

Glossary

Atmosphere Investigation

Site Definition Sheet

School Name: _____Class or Group Name:_____

Name(s) of student(s) filling in Site Definition Sheet: _____

_____

Date: _____ Check one: ❒ New Site ❒ Metadata Update

Site name (give your site a unique name):_____

Location: Latitude: _____° ❒ N or ❒ S Longitude: _____° ❒ E or ❒ W

Elevation: ___ meters

Source of Location Data (check one): ❒ GPS ❒ Other _____

Obstacles (Check one): ❒ No obstacles ❒ Obstacles (describe below)

(Obstacles are trees, buildings, etc. that appear above 14° elevation when viewed from the site.)

Description:_____

_____

_____

Buildings within 10 meters of your instrument shelter (Check one): ❒ No buildings ❒ Buildings (describe below)

Description:_____

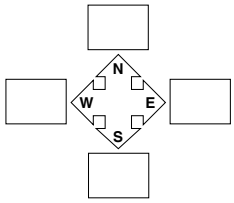
_____

_____

_____

_____

Photo Number and Orientation



Other Site Data:

Steepest Slope: _____ Compass Angle (facing up slope): _____

Height of the top of the rain gauge: _____ cm

Height of the sensor or bulb of your max/min thermometer: _____cm

Height of the clip in your ozone measurement station: _____cm

Surface Cover under instrument shelter (Check one): ❒ Pavement ❒ Bare ground

❒ Short grass (< 10 cm) ❒ Long grass (> 10 cm) ❒ Sand ❒ Roof (describe below)

❒ Other (describe below)

Description:_____

_____

Overall comments on the site (metadata):_____

_____

_____

_____

Atmosphere Investigation

Clouds 1-Measurement Data Sheet

School Name: _____

Observer names: _____

_____

Date: Year_____ Month_____ Day_____ Study Site: ATM-_____

Local Time (hour:min):_____ Universal Time (hour:min):_____

Cloud Type

High (in the sky):
(Check all types seen)


❑ Cirrus


❑ Cirrocumulus


❑ Cirrostratus

Middle (of the sky):
(Check all types seen)


❑ Altostratus


❑ Altocumulus

Low (in the sky):
(Check all types seen)


❑ Stratus


❑ Stratocumulus


❑ Cumulus

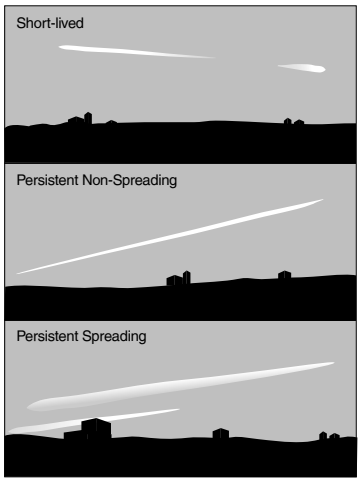
Rain or Snow Producing Clouds:
(Check all types seen)


❑ Nimbostratus


❑ Cumulonimbus

School Name _____ Study Site: ATM-_____

Contrail Type (Record the number of each type observed)



Short-lived Contrails

How many do you see? _____

Persistent Non-Spreading Contrails

How many do you see? _____

Persistent Spreading Contrails

How many do you see? _____

Three-quarters or More of the Sky is Visible:

Cloud Cover (Check One)

No Clouds

❑ 0%-No Clouds

Clear

❑ <10% Clouds

Isolated

❑ 10-25% Clouds

Scattered

❑ 25-50% Clouds

Broken

❑ 50-90% Clouds

Overcast

❑ >90%

Contrail Cover (Check one)

❑ No Contrails (0%) ❑ 0-10% ❑ 10-25% ❑ 25-50% ❑ >50%

View of more than one-quarter or more of the sky is blocked: Obscured ❑ Check here

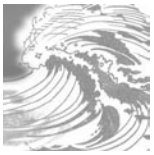
Why is the view of the sky blocked? (Check all that apply)

❑ Blowing Snow

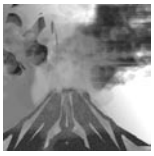
❑ Heavy Snow

❑ Heavy Rain

❑ Fog



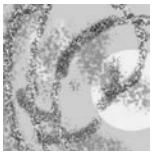
❑ Spray



❑ Volcanic Ash

❑ Smoke

❑ Dust



❑ Sand

❑ Haze

Comments:_____

Atmosphere Investigation

Clouds 7-Measurement Data Sheet

School Name _____ Study Site: ATM-_____

Day of the week							
Date							
Local time (hour:min)							
Universal time (hour:min)							
Observer names							

Cloud Type *(Check all types seen)*

Cirrus	❒	❒	❒	❒	❒	❒	❒
Cirrocumulus	❒	❒	❒	❒	❒	❒	❒
Cirrostratus	❒	❒	❒	❒	❒	❒	❒
Altostratus	❒	❒	❒	❒	❒	❒	❒
Altocumulus	❒	❒	❒	❒	❒	❒	❒
Cumulus	❒	❒	❒	❒	❒	❒	❒
Nimbostratus	❒	❒	❒	❒	❒	❒	❒
Stratus	❒	❒	❒	❒	❒	❒	❒
Stratocumulus	❒	❒	❒	❒	❒	❒	❒
Cumulonimbus	❒	❒	❒	❒	❒	❒	❒

Contrail Type *(Record the number of each type observed)*

Short-lived							
Persistent Non-Spreading							
Persistent Spreading							

Cloud Cover *(Check one- if sky not obscured)*

No clouds (0%)	❒	❒	❒	❒	❒	❒	❒
Clear (0% - 10%)	❒	❒	❒	❒	❒	❒	❒
Isolated (10% - 25%)	❒	❒	❒	❒	❒	❒	❒
Scattered (25% - 50%)	❒	❒	❒	❒	❒	❒	❒
Broken (50% - 90%)	❒	❒	❒	❒	❒	❒	❒
Overcast (90% - 100%)	❒	❒	❒	❒	❒	❒	❒
Sky obscured	❒	❒	❒	❒	❒	❒	❒

School Name _____ Study Site: ATM-_____

Contrail Cover *(Check one- if sky not obscured)*

None	❒	❒	❒	❒	❒	❒	❒
0-10%	❒	❒	❒	❒	❒	❒	❒
10-25%	❒	❒	❒	❒	❒	❒	❒
25-50%	❒	❒	❒	❒	❒	❒	❒
>50%	❒	❒	❒	❒	❒	❒	❒

If Sky Obscured *(Check all that apply)*

Fog	❒	❒	❒	❒	❒	❒	❒
Smoke	❒	❒	❒	❒	❒	❒	❒
Haze	❒	❒	❒	❒	❒	❒	❒
Volcanic ash	❒	❒	❒	❒	❒	❒	❒
Dust	❒	❒	❒	❒	❒	❒	❒
Sand	❒	❒	❒	❒	❒	❒	❒
Spray	❒	❒	❒	❒	❒	❒	❒
Heavy rain	❒	❒	❒	❒	❒	❒	❒
Heavy snow	❒	❒	❒	❒	❒	❒	❒
Blowing snow	❒	❒	❒	❒	❒	❒	❒

Comments:

Atmosphere Investigation

Integrated 1-Day Data Sheet

School Name: _____

Observer names: _____

_____

Date: Year_____ Month_____ Day_____ Study Site: ATM-_____

Local Time (hour:min):_____ Universal Time (hour:min):_____

Cloud Type *(Check all types seen)*

High:	❒ Cirrostratus	❒ Cirrus	❒ Cirrocumulus
Middle:	❒ Altostratus		❒ Altocumulus
Low:	❒ Stratus	❒ Stratocumulus	❒ Cumulus
Rain or Snow-Producing:	❒ Nimbostratus		❒ Cumulonimbus

Contrail Type *(Record the number of each type observed)*

Short-lived_____ Persistent Non-Spreading_____ Persistent Spreading_____

Cloud Cover *(Check one- if sky not obscured)*

❒ No Clouds (0%) ❒ Clear (0% - 10%) ❒ Isolated (10% - 25%) ❒ Scattered (25% - 50%) ❒ Broken (50% - 90%) ❒ Overcast (90% - 100%) ❒ Sky obscured

Contrail Cover *(Check one- if sky not obscured)*

❒ None ❒ 0-10% ❒ 10-25% ❒ 25-50% ❒ >50%

If Sky Obscured *(Check all that apply)*

❒ Fog ❒ Smoke ❒ Haze ❒ Volcanic ash ❒ Dust ❒ Sand ❒ Spray ❒ Heavy rain
❒ Heavy snow ❒ Blowing snow

Barometric Station Pressure

Barometric Pressure (mbar): _____ ❒ Sea Level Pressure ❒ Station Pressure

Local Time (Hour:Min)*_____

Universal Time (Hour:Min)*_____

* If different from other measurements

Relative Humidity

Dry bulb temperature* (°C): _____

(note: Current air temp. and dry bulb temp. should be similar)

Wet bulb temperature* (°C): _____

* Sling Psychrometer only.

Relative Humidity (%): _____

School Name _____ Study Site: ATM-_____

Rainfall

Number of days rain has accumulated: _____

Rainwater in rain gauge (mm)*: _____

**Remember: enter 0.0 when there has been no rainfall.*

Record M for missing if there was rain and you weren't able to take an accurate reading.

Record T for trace if the amount of rainfall is less than 0.5 mm.

Snowfall

Daily: Number of days snow has accumulated on the snowboard: _____

Depth of new snow on the snowboard* (mm):

Sample 1: _____ Sample 2: _____ Sample 3: _____

Snow Pack: Total snow accumulation on the ground (mm):

Sample 1: _____ Sample 2: _____ Sample 3: _____

Rain equivalent of:

1. New snow on the snow board (mm): _____2. Total snowpack on the ground (mm): _____

** Remember: Record 0 when there has been no snowfall.*

Record M for missing if there was snow and you weren't able to take an accurate reading.

Record T for trace amount of snowfall (too small to measure).

Precipitation pH

Measurement method for pH: ❒ paper ❒ meter

pH of the rain or melted snow:

Sample 1:_____ Sample 2:_____ Sample 3:_____ Average: _____

pH of the melted snow pack:

Sample 1:_____ Sample 2:_____ Sample 3:_____ Average: _____

Maximum, Minimum, and Current Temperatures

Current air temperature: (˚C) _____

Maximum daily air temperature: (˚C) _____

Minimum daily air temperature: (˚C) _____

Current soil temperature: (˚C)*_____

Maximum daily soil temperature: (˚C)* _____

Minimum daily soil temperature: (˚C)* _____

*Note: Daily soil temperature measurements apply to those using a digital max/min thermometer with a soil probe.

Comments (Unusual conditions):

_____

_____

Atmosphere Investigation

Integrated 7-Day Data Sheet

School Name _____ Study Site: ATM-_____

Day of the week							
Date							
Local time (hour:min)							
Universal time (hour:min)							
Observer names							

Cloud Type *(Check all types seen)*

Cirrus	❒	❒	❒	❒	❒	❒	❒
Cirrocumulus	❒	❒	❒	❒	❒	❒	❒
Cirrostratus	❒	❒	❒	❒	❒	❒	❒
Altostratus	❒	❒	❒	❒	❒	❒	❒
Altocumulus	❒	❒	❒	❒	❒	❒	❒
Cumulus	❒	❒	❒	❒	❒	❒	❒
Nimbostratus	❒	❒	❒	❒	❒	❒	❒
Stratus	❒	❒	❒	❒	❒	❒	❒
Stratocumulus	❒	❒	❒	❒	❒	❒	❒
Cumulonimbus	❒	❒	❒	❒	❒	❒	❒

Contrail Type *(Record the number of each type observed)*

Short-lived							
Persistent Non-Spreading							
Persistent Spreading							

Cloud Cover *(Check one- if sky not obscured)*

No clouds (0%)	❒	❒	❒	❒	❒	❒	❒
Clear (0% - 10%)	❒	❒	❒	❒	❒	❒	❒
Isolated (10% - 25%)	❒	❒	❒	❒	❒	❒	❒
Scattered (25% - 50%)	❒	❒	❒	❒	❒	❒	❒
Broken (50% - 90%)	❒	❒	❒	❒	❒	❒	❒
Overcast (90% - 100%)	❒	❒	❒	❒	❒	❒	❒
Sky obscured	❒	❒	❒	❒	❒	❒	❒

Contrail Cover *(Check one- if sky not obscured)*

None	❒	❒	❒	❒	❒	❒	❒
0-10%	❒	❒	❒	❒	❒	❒	❒
10-25%	❒	❒	❒	❒	❒	❒	❒
25-50%	❒	❒	❒	❒	❒	❒	❒
>50%	❒	❒	❒	❒	❒	❒	❒

School Name _____ Study Site: ATM-_____

If Sky Obscured (Check all that apply)

Fog	❒	❒	❒	❒	❒	❒	❒
Smoke	❒	❒	❒	❒	❒	❒	❒
Haze	❒	❒	❒	❒	❒	❒	❒
Volcanic ash	❒	❒	❒	❒	❒	❒	❒
Dust	❒	❒	❒	❒	❒	❒	❒
Sand	❒	❒	❒	❒	❒	❒	❒
Spray	❒	❒	❒	❒	❒	❒	❒
Heavy rain	❒	❒	❒	❒	❒	❒	❒
Heavy snow	❒	❒	❒	❒	❒	❒	❒
Blowing snow	❒	❒	❒	❒	❒	❒	❒

Barometric Pressure ❒ *Sea Level Pressure* ❒ *Station Pressure*

Barometric Pressure (mbar)							
Local Time (Hour:Min)*							
Universal Time (Hour:Min)*							

* If different from other measurements

Relative Humidity

Dry bulb temperature (°C) - Sling Psychrometer							
Wet bulb temperature (°C) - Sling Psychrometer							
Relative humidity (%)							

Rainfall

Number of days rain has accumulated							
Rainwater in rain gauge (mm)*							

** Remember: Record 0.0 when there has been no rainfall.*
Record M for missing if there was rain and you weren't able to take an accurate reading.
Record T for trace if the amount of rainfall is less than 0.5 mm.

Solid Precipitation

Total snowpack on the ground:

Depth sample 1 (mm)							
Depth sample 2 (mm)							
Depth sample 3 (mm)							

School Name _____ Study Site: ATM-_____

Solid Precipitation (continued)

New snow on the snowboard:

Number of days snow has accumulated on the snowboard:							
Depth sample 1 (mm)*							
Depth sample 2 (mm)*							
Depth sample 3 (mm)*							

Rain Equivalent:

Rain equivalent of new snow on the snowboard (mm)							
Rain equivalent of total snow-pack on the ground (mm)							

** Remember: Record 0 when there has been no snowfall.*
Record M for missing if there was snow and you weren't able to take an accurate reading.
Record T for trace amount of snowfall (too small to measure).

Precipitation pH

Measurement method for pH: ❒ paper ❒ meter

pH of the rain or melted snow:

pH sample 1						
pH sample 2						
pH sample 3						
Average						

pH of the melted snowpack:

pH sample 1							
pH sample 2							
pH sample 3							
Average							

Maximum, Minimum, and Current Temperatures

Current air temperature: (°C)							
Maximum daily air temperature: (°C)							
Minimum daily air temperature: (°C)							
Current soil temperature: (°C)*							
Maximum daily soil temperature: (°C)*							
Minimum daily soil temperature: (°C)*							

*Note: Daily soil temperature measurements apply to those using a digital max/min thermometer with a soil probe.

Add Comments on the back of this sheet: (Unusual conditions - date your comments)

Atmosphere Investigation

Aerosols Data Sheet

School Name _____ Study Site: ATM-_____

Date : _____

Observer names:_____

_____

For Satellite overflights on date of measurements:

Satellite/instrument name: _____ Time of overflight (UT): _____ Max elevation angle (deg): ____

Sun Photometer Instrument serial number: _____

Case temperature before taking measurements (multiply voltage reading times 100) _____ ° C

Fill in the second-fifth columns of this table and report your data to GLOBE. GLOBE will provide you with calculated values for AOT, which you then record in the sixth column. If your sun photometer has a rotary switch with a "T" (case temperature) position, fill in 100 times the displayed value before and after your measurements.

Measurement Number[1]	Local Time[2] (hrs:min:sec)	Universal Time[3] (hrs:min:sec)	Maximum Voltage in Sunlight[4] (volts)	Dark Voltage[5] (volts)	AOT[6] (cm)
1 (green)					
1 (red)					
2 (green)					
2 (red)					
3 (green)					
3 (red)					
4 (green)					
4 (red)					
5 (green)					
5 (red)					

[1] At least three sets of measurements are required.

[2] Ideally, time should be reported to the nearest 15 seconds, using an accurately set timepiece.

[3] Be careful when converting local time to UT.

[4] Always report voltages with 3 digits to the right of the decimal point. For example, 1.773 rather than 1.77.

[5] Enter dark voltage in units of volts, not millivolts. For example, 0.003 V rather than 3 mV.

[6] These values are calculated from your data and provided by GLOBE.

Case temperature, after taking case measurements: (multiply voltage reading x 100):_____ °C

School Name _____ Study Site: ATM-_____

Cloud and contrail conditions (If sky not obscured, check the box for each cloud or contrail type you observe and check one box for cloud or contrail cover amount.)

Cloud Type *(Check all types seen)*

Cirrus	❒
Cirrostratus	❒
Cirrocumulus	❒
Altostratus	❒
Altocumulus	❒
Stratus	❒
Stratocumulus	❒
Cumulus	❒
Nimbostratus	❒
Cumulonimbus	❒

Contrail Type *(Record the number of each type observed)*

Short-lived	_____
Persistent Non-Spreading	_____
Persistent Spreading	_____

Cloud Cover *(Check one- if sky not obscured)*

No clouds (0%)	❒
Clear (0% - 10%)	❒
Isolated (10 - 25%)	❒
Scattered (25% - 50%)	❒
Broken (50% - 90%)	❒
Overcast (90% - 100%)	❒
Sky Obscured	❒

Contrail Cover *(Check one- if sky not obscured)*

None	❒
0-10%	❒
10-25%	❒
25-50%	❒
>50%	❒

Sky Conditions

(Check one box in each table, as appropriate.
Sky conditions can be checked only if sky not obscured.)

Sky Color		***Sky Clarity***		***Sky Obscured by***	
Deep blue	❒	Unusually clear	❒	Fog	❒
Blue	❒	Clear	❒	Smoke	❒
Light blue	❒	Somewhat hazy	❒	Haze	❒
Pale blue	❒	Very hazy	❒	Volcanic ash	❒
Milky	❒	Extremely hazy	❒	Dust	❒
				Sand	❒
				Marine Spray	❒
				Strong rain	❒
				Strong snow	❒
				Blowing snow	❒

School Name _____ Study Site: ATM-_____

Current Air Temperature (obtained following GLOBE Protocol):_____ °C

Relative Humidity (obtained following GLOBE Protocol)

Dry bulb temperature* (°C):_____ Wet bulb temperature* (°C):_____

*Sling Psychrometer only. (Note: Current air temperature and dry bulb temperature should be similar.)

Relative Humidity (%): _____

Barometric Pressure: _____ mbar ❒ Sea Level Pressure ❒ Station Pressure

Select data source (check one):

❒ Online or broadcast source

❒ Aneroid barometer

❒ Other barometer

Comments: Describe conditions that could affect your measurements, such as urban smog, smoke from forest fires, blowing sand, or dust from agricultural activities. Also, include air temperature and relative humidity values that were obtained without following GLOBE protocols.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Atmosphere Investigation

Water Vapor Data Sheet

School Name _____ Study Site: ATM-_____

Date on which the measurements were taken: _____

Observer names:_____

For Satellite overflights on date of measurements (optional):

Satellite/instrument name: _____ Time of overflight (UT): _____

Max elevation angle (deg): _____

GLOBE/GIFTS Water Vapor Instrument serial number: _____

Case temperature, before taking measurements: (multiply voltage reading x 100):_____ °C

Fill in the second-fifth columns of this table and report your data to GLOBE. GLOBE will provide you with calculated values for **Precipitable Water**, which you then record in the sixth column.

Measurement Number[1]	Local Time[2] (hrs:min:sec)	Universal Time[3] (hrs:min:sec)	Maximum Sunlight Voltage[4] (volts)	Dark Voltage[5] (volts)	Precipitable Water[6] (cm)
1 (IR1)					
1 (IR2)					
2 (IR1)					
2 (IR2)					
3 (IR1)					
3 (IR2)					
4 (IR1)					
4 (IR2)					
5 (IR1)					
5 (IR2)					

[1] At least three sets of measurements are required.
[2] Ideally, time should be reported to the nearest 15 seconds, using an accurately set timepiece.
[3] Always report voltages with 3 digits to the right of the decimal point. For example, 1.773 rather than 1.77.
[4] Enter dark voltage in units of volts, not millivolts. For example, 0.003 V rather than 3 mV.
[5] These values are provided by the GLOBE database and calculated from your data.

Case temperature, after taking measurements: (multiply voltage reading x 100):_____ °C

School Name _____ Study Site: ATM-_____

Cloud Type *(Check all types seen)*

Cirrus	❒
Cirrostratus	❒
Cirrocumulus	❒
Altostratus	❒
Altocumulus	❒
Stratus	❒
Stratocumulus	❒
Cumulus	❒
Nimbostratus	❒
Cumulonimbus	❒

Contrail Type *(Record the number of each type observed)*

Short-lived	_____
Persistent Non-Spreading	_____
Persistent Spreading	_____

Sky Color

Deep blue	❒
Blue	❒
Light blue	❒
Pale blue	❒
Milky	❒

Sky Obscured *(check the box for each observed phenomenon*

Fog	❒
Smoke	❒
Haze	❒
Volcanic ash	❒
Dust	❒
Sand	❒
Spray	❒
Heavy rain	❒
Heavy snow	❒
Blowing snow	❒

Cloud Cover *(Check one- if sky not obscured)*

No clouds (0%)	❒
Clear (0% - 10%)	❒
Isolated (10 - 25%)	❒
Scattered (25% - 50%)	❒
Broken (50% - 90%)	❒
Overcast (90% - 100%)	❒
Sky Obscured	❒

Contrail Cover *(Check one- if sky not obscured)*

None	❒
0-10%	❒
10-25%	❒
25-50%	❒
>50%	❒

Sky Clarity

Unusually clear	❒
Clear	❒
Somewhat hazy	❒
Very hazy	❒
Extremely hazy	❒

School Name _____ Study Site: ATM-_____
Current Air Temperature (if obtained following GLOBE Protocol)_____ ˚C

Relative Humidity (if obtained following GLOBE Protocol)

Dry bulb temperature* (˚C):_____Wet bulb temperature* (˚C):_____

** Sling Psychrometer only. (Note: Current air temperature and dry bulb temperature should be similar)*

Relative Humidity (%):_____

Barometric Pressure : _____ mbar ❒ Sea Level Pressure ❒ Station Pressure

Select data source (check one):

❒ Online or broadcast source

❒ Aneroid barometer

❒ Other barometer

Comments: Describe conditions that might affect sky clarity, such as urban smog, smoke from forest fires, blowing sand, or dust from agricultural activities. Also, include air temperature and relative humidity values that were obtained without following GLOBE protocols.

Digital Max/Min Thermometer Calibration and Reset

Data Sheet

School Name: _____ Study Site: ATM- _____

Observer Names: _____

_____

Calibration

Thermometer Readings						
Reading Number	**Date** (Year/ Month/Day)	**Local Time** (Hour:Min)	**UT Time** (Hour:Min)	**Calibration thermometer readings (˚C)**	**Digital air sensor readings (˚C)**	**Digital soil sensor readings (˚C)**
1						
2						
3						
4						
5						

Time of Reset

Note: The thermometer should be reset only when it is first setup, after the battery is changed, or if the time of local solar noon drifts to more than one hour from your time of reset.

Date: Year_____ Month _____ Day _____

Local time (Hour:Min) _____ Universal time (Hour:Min) _____

Was the reset due to a battery change?_____

Soil Sensor Error Check

Local time (hour/min) _____ Universal time (hour/min) _____

1. Soil probe thermometer from *Soil Temperature Protocol* readings (˚C):
   a. reading #1(˚C):_____
   b. reading #2(˚C):_____
   c. reading #3(˚C):_____
   d. reading #4(˚C):_____
   e. reading #5(˚C):_____

   total of the 5 readings (˚C):_____

2. Digital soil sensor readings:
   a. reading #1(˚C):_____
   b. reading #2(˚C):_____
   c. reading #3(˚C):_____
   d. reading #4(˚C):_____
   e. reading #5(˚C):_____

   total of the 5 readings(˚C):_____

3. Average of the 5 soil probe thermometer readings(˚C)
   [= the total of the five soil probe thermometer readings/5]:_____

4. Average of the 5 soil sensor readings(˚C)
   [= the total of the five soil sensor readings/5]: _____

5. Soil sensor error (˚C) [= #4 – #3]: _____

6. If the absolute value of the soil sensor error (#5) is greater than or equal to 2˚ C , then dig-out the sensor and recalibrate both the air and soil sensor following the *Digital Multi-Day Max/Min Thermometer Sensor Calibration Field Guide*. If the absolute value of the soil sensor error that you calculate is less than 2˚ C then leave the soil sensor buried and proceed to recalibrate just the air sensor.

Digital Multi-Day Maximum/ Minimum Thermometer

Data Sheet

School Name: _____ Study Site: ATM- _____

Observer Names: _____

_____

Date: Year _____ Month _____ Day _____

Local time (hour:min)_____ Universal time (hour:min) _____

Your *Time of Reset* in universal time (hour:min): _____

Current Temperatures

Air temperature (°C): _____

Current soil temperature (°C): _____

Maximum, Minimum Temperatures

Do not read the thermometer within 5 minutes of your *time of reset.*

	Label on Digital Display Screen					
	D1	D2	D3	D4	D5	D6
Maximum Air Temperature (°C)						
Minimum Air Temperature (°C)						
Maximum Soil Temperature (°C)						
Minimum Soil Temperature (°C)						
If you are reading thermometer AFTER your time of reset, Correspond to 24-hour Period Ending:	Today	Yesterday	Two days ago	Three days ago	Four days ago	Five days ago
If you are reading thermometer BEFORE your time of reset, Correspond to 24-hour Period Ending:	Yesterday	Two days ago	Three days ago	Four days ago	Five days ago	Six days ago

Atmosphere Investigation

Surface Temperature Data Sheet

Check after Data Entered onto Website ☐

School Name _____ Study Site: ATM-_____

Date: _____

Observer names:_____

_____

*Surface Temperature Supplemental Site Definition Data**

** To be filled out the first time taking Surface Temperature Measurements at a particular site, or if one of the values below has changed.*

Homogenous Site Size (Meters) – Check One

❒ = 90 x 90 ❒ = 30 x 30 ❒ < 30 X 30, specify size: ____ X ____

(Land Cover Sample Site)

Cover Type – Check One
(If you are at a Land Cover Sample Site then check only the last box)

- ❒ Short Grass (less than 0.5 m in height)
- ❒ Tall Grass (0.5 m to 2 m in height)
- ❒ Barren Land
- ❒ Shrubs
- ❒ Dwarf Shrubs
- ❒ Concrete
- ❒ Asphalt
- ❒ Other Describe:_____
- ❒ This is a Land Cover Sample Site

Manufacturer and model of IRT instrument used at this site:_____

Cloud Type (Check all types seen)

Cirrus	❒
Cirrostratus	❒
Cirrocumulus	❒
Altostratus	❒
Altocumulus	❒
Stratus	❒
Stratocumulus	❒
Cumulus	❒
Nimbostratus	❒
Cumulonimbus	❒

Contrail Type (Record the number of each type observed)

Short-lived _____
Persistent Non-Spreading _____
Persistent Spreading _____

Cloud Cover (Check one- if sky not obscured)

No clouds (0%)	❒
Clear (0% - 10%)	❒
Isolated (10 - 25%)	❒
Scattered (25% - 50%)	❒
Broken (50% - 90%)	❒
Overcast (90% - 100%)	❒
Sky Obscured	❒

Contrail Cover (Check one- if sky not obscured)

None	❒
0-10%	❒
10-25%	❒
25-50%	❒
>50%	❒

Date:_____ School Name _____Study Site: ATM-_____

If there is NO snow located on the ground anywhere in your Site, then check one.

Site's Overall Surface Condition: ❒ Wet ❒ Dry

Check which **Method Used to Prevent IRT from Experiencing Thermal Shock:**

☐ IRT was wrapped in Thermal Glove, then taken from storage location to study site

☐ IRT was placed outdoors for at least 30 minutes prior to data collection (No Thermal Glove used)

☐ IRT was taken directly from storage location to study site (No Thermal Glove used)

☐ Other method used, please describe: _____

Surface Temperature

Observation Spots	Local Time (hrs:mins)	Universal Time (hrs:mins)	Surface Temperature (example 25.8° C)	Snow Depth (mm)*
1	:	:		
2	:	:		
3	:	:		
4	:	:		
5	:	:		
6	:	:		
7	:	:		
8	:	:		
9	:	:		

*Record Snow Depth according to:

- If there is NO snow at this Observation Spot, then record "0" (zero).
- If there is snow LESS than ten millimeters in depth, then record the letter "T"
- If there is snow GREATER than ten millimeters in depth, then put your ruler or meter stick vertically into the snow at the spot where you just took your surface temperature reading, so that it penetrates all the way to the ground. Read and record the snow depth in millimeters.

Comments:

_____

_____

_____

_____

Atmosphere Investigation

Ozone Data Sheet

School Name _____ Study Site: ATM-_____

Day of the week							
Date							
Observer names							

Ozone Strip Exposed

Local time (hour:min)							
Universal time (hour:min)							
Wind direction (N, NE, E, SE, S, SW, W, NW)							
Use values reported on Atmosphere Data Entry for clouds, contrails, current temperature, and relative humidity (Check the box)							
Current temperature (°C)							
Dry bulb temperature (°C) - Sling Psychrometer							
Wet bulb temperature (°C) - Sling Psychrometer							
Relative humidity (%)							

Ozone Strip Read

Local time (hour:min)							
Universal time (hour:min)							
Ozone concentration* (parts per billion)							
Wind direction (N, NE, E, SE, S, SW, W, NW)							
Current temperature (°C)							
Dry bulb temperature (°C) - Sling Psychrometer							
Wet bulb temperature (°C) - Sling Psychrometer							
Relative humidity (%)							

**Remember: enter M if the chemical strip gets damaged by snow or rain, or the response of the chemical is marbled.*

Comments: _____

_____

_____

_____

School Name _____ Study Site: ATM-_____

Ozone Strip Exposed Cloud Data

Day of the week							
Date							

Take cloud data from ❒ ❒ ❒ ❒ ❒ ❒ ❒
Atmosphere Data Work Sheet

Cloud Type (Check all types seen)

Cirrus	❒	❒	❒	❒	❒	❒	❒
Cirrocumulus	❒	❒	❒	❒	❒	❒	❒
Cirrostratus	❒	❒	❒	❒	❒	❒	❒
Altostratus	❒	❒	❒	❒	❒	❒	❒
Altocumulus	❒	❒	❒	❒	❒	❒	❒
Cumulus	❒	❒	❒	❒	❒	❒	❒
Nimbostratus	❒	❒	❒	❒	❒	❒	❒
Stratus	❒	❒	❒	❒	❒	❒	❒
Stratocumulus	❒	❒	❒	❒	❒	❒	❒
Cumulonimbus	❒	❒	❒	❒	❒	❒	❒

Contrail Type (Record the number of each type observed)

Short-lived							
Persistent Non-Spreading							
Persistent Spreading							

Cloud Cover (Check one- if sky not obscured)

No clouds (0%)	❒	❒	❒	❒	❒	❒	❒
Clear (0% - 10%)	❒	❒	❒	❒	❒	❒	❒
Isolated (10% - 25%)	❒	❒	❒	❒	❒	❒	❒
Scattered (25% - 50%)	❒	❒	❒	❒	❒	❒	❒
Broken (50% - 90%)	❒	❒	❒	❒	❒	❒	❒
Overcast (90% - 100%)	❒	❒	❒	❒	❒	❒	❒
Sky obscured	❒	❒	❒	❒	❒	❒	❒

Contrail Cover (Check one- if sky not obscured)

None	❒	❒	❒	❒	❒	❒	❒
0-10%	❒	❒	❒	❒	❒	❒	❒
10-25%	❒	❒	❒	❒	❒	❒	❒
25-50%	❒	❒	❒	❒	❒	❒	❒
>50%	❒	❒	❒	❒	❒	❒	❒

School Name _____ Study Site: ATM-_____

If Sky Obscured *(Check all that apply)*

Fog	❒	❒	❒	❒	❒	❒	❒
Smoke	❒	❒	❒	❒	❒	❒	❒
Haze	❒	❒	❒	❒	❒	❒	❒
Volcanic ash	❒	❒	❒	❒	❒	❒	❒
Dust	❒	❒	❒	❒	❒	❒	❒
Sand	❒	❒	❒	❒	❒	❒	❒
Spray	❒	❒	❒	❒	❒	❒	❒
Heavy rain	❒	❒	❒	❒	❒	❒	❒
Heavy snow	❒	❒	❒	❒	❒	❒	❒
Blowing snow	❒	❒	❒	❒	❒	❒	❒

Ozone Strip Read Cloud Data

Day of the week							
Date							

Cloud Type *(Check all types seen)*

Cirrus	❒	❒	❒	❒	❒	❒	❒
Cirrocumulus	❒	❒	❒	❒	❒	❒	❒
Cirrostratus	❒	❒	❒	❒	❒	❒	❒
Altostratus	❒	❒	❒	❒	❒	❒	❒
Altocumulus	❒	❒	❒	❒	❒	❒	❒
Cumulus	❒	❒	❒	❒	❒	❒	❒
Nimbostratus	❒	❒	❒	❒	❒	❒	❒
Stratus	❒	❒	❒	❒	❒	❒	❒
Stratocumulus	❒	❒	❒	❒	❒	❒	❒
Cumulonimbus	❒	❒	❒	❒	❒	❒	❒

Contrail Type *(Record the number of each type observed)*

Short-lived							
Persistent Non-Spreading							
Persistent Spreading							

School Name _____ Study Site: ATM-_____

Cloud Cover *(Check one- if sky not obscured)*

No clouds (0%)	❒	❒	❒	❒	❒	❒	❒
Clear (0% - 10%)	❒	❒	❒	❒	❒	❒	❒
Isolated (10% - 25%)	❒	❒	❒	❒	❒	❒	❒
Scattered (25% - 50%)	❒	❒	❒	❒	❒	❒	❒
Broken (50% - 90%)	❒	❒	❒	❒	❒	❒	❒
Overcast (90% - 100%)	❒	❒	❒	❒	❒	❒	❒
Sky obscured	❒	❒	❒	❒	❒	❒	❒

Contrail Cover *(Check one- if sky not obscured)*

None	❒	❒	❒	❒	❒	❒	❒
0-10%	❒	❒	❒	❒	❒	❒	❒
10-25%	❒	❒	❒	❒	❒	❒	❒
25-50%	❒	❒	❒	❒	❒	❒	❒
>50%	❒	❒	❒	❒	❒	❒	❒

If Sky Obscured *(Check all that apply)*

Fog	❒	❒	❒	❒	❒	❒	❒
Smoke	❒	❒	❒	❒	❒	❒	❒
Haze	❒	❒	❒	❒	❒	❒	❒
Volcanic ash	❒	❒	❒	❒	❒	❒	❒
Dust	❒	❒	❒	❒	❒	❒	❒
Sand	❒	❒	❒	❒	❒	❒	❒
Spray	❒	❒	❒	❒	❒	❒	❒
Heavy rain	❒	❒	❒	❒	❒	❒	❒
Heavy snow	❒	❒	❒	❒	❒	❒	❒
Blowing snow	❒	❒	❒	❒	❒	❒	❒

Atmosphere Investigation

Weather Station Calibration Data Sheet

School Name _____ Study Site: ATM-_____

Air Temperature Sensor Recalibration

Reading Number	Date (year/month/day)	Local time (hour:min)	Universal time (hour:min)	Calibration Thermometer Reading (°C)	Digital Temperature Sensor (°C)
1					
2					
3					
4					
5					

Rain Gauge Recalibration

Reading Number	Date (year/month/day)	Local time (hour:min)	Universal time (hour:min)	Rain Gauge Reading* (mm)	Digital Tipping Bucket Total Reading (mm)
1					
2					
3					
4					
5					

* must be greater than 20 mm for recalibration

Observing Cloud Type

There are five descriptive terms for the various types of clouds:

CIRRO or high clouds
ALTO or middle clouds
CUMULUS or white puffy clouds
STRATUS or layered clouds
NIMBUS or clouds from which precipitation is falling

The following ten types of clouds, named using the above terms, are to be used when reporting the cloud type for your area:

High Clouds

Cirrus

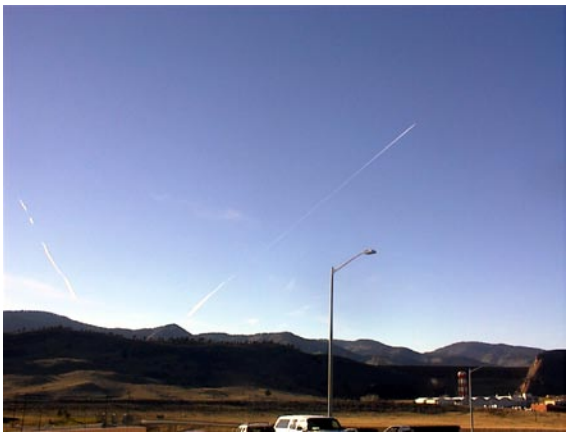
These clouds look like white delicate feathers. They are generally white wispy forms. They contain ice crystals.

Cirrocumulus

These clouds are thin white layers with a texture giving them the look of patches of cotton or ripples without shadows. They contain primarily ice crystals and perhaps some very cold water droplets.

Cirrostratus

These clouds are a thin, almost transparent, whitish layer made up of ice crystals. They may totally or partly cover the sky and can create a halo appearance around the sun.



Contrails

Short-lived Contrail

Note the short line of cloud above the lightpole. The airplane is barely visible in this photo but is at the front of the contrail

Persistent Contrails

These are very distinct contrails, and show a range from persistent non-spreading on the right to persistent spreading on the left. The most likely explanation for this photo is that all three airplanes followed about the same path, but that the winds high in the atmosphere are blowing from right to left, moving the older contrails to the left. The spreading of the left-most contrail indicates there is a fair amount of water vapor in the upper atmosphere.

Persistent, Spreading Contrails

This photo shows persistent, spreading contrails in an area of high air traffic. As above, it is likely that the planes are mostly following a similar path, but the contrails are being spread out by the wind. Note that all the contrails in this photo appear as wide or wider than those above, indicating that the presence of abundant water vapor in the atmosphere is allowing the contrails to spread. Also note the cloud near the middle of the photo, which looks like a regular cirrus cloud, but whose position makes it likely that this cloud actually originated from a contrail.

Middle Clouds

Altostratus

These clouds form a bluish or grayish veil that totally or partially covers the sky. The light of the sun can be seen through them but there is no halo effect.

Altocumulus

These clouds look like waves of the sea with white and gray coloring and shadows. They contain mostly water droplets and perhaps some ice crystals.

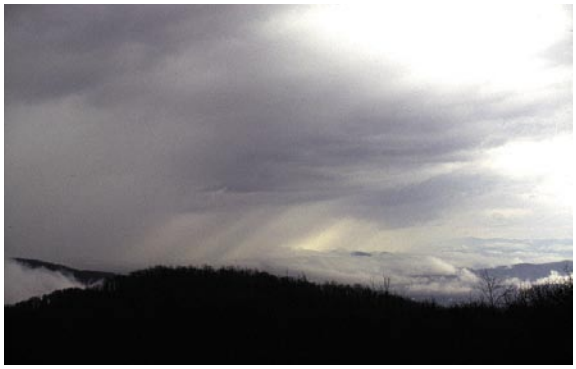
Low Clouds

Stratus

These clouds are gray and lie very close to the surface of the Earth. They usually look like a sheet layer but sometimes are found in patches. They rarely produce precipitation.

Stratocumulus

These clouds are a gray or whitish color. The bases of these clouds tend to be more round than flat. They can be formed from old stratus clouds or from cumulus clouds that are spreading out. Their tops also tend to be mostly flat.



Nimbostratus

This is a very dark and gray-colored cloud layer that blots out the light of the sun. It is massive and has a continuous fall of precipitation.

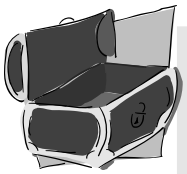
Cumulus

These clouds have a flat base and a dense, mound-shaped top that resembles a large cauliflower. Where the sun hits these clouds they are a brilliant white. The base tends to be a darker gray. They generally do not produce precipitation.

Cumulonimbus

These are large, heavy, and dense clouds. They have a generally flat, dark surface with very tall and large tops like the shape of a massive mountain or anvil. These clouds are often associated with lightning, thunder and sometimes hail. They may also produce tornados.

Glossary



Absolute Zero
The theoretical temperature at which matter has the least energy; the limit of how cold matter can get. If substances could be cooled to absolute zero they would not emit any electromagnetic radiation.

Absorption
Radiation retained by an object and converted to other forms of energy

Acid Rain
Rain having a pH lower than 5.6, the pH of water in equilibrium with the current concentration of carbon dioxide in the air

Aerosols
Liquid or solid particles suspended in the atmosphere. Their sizes generally have linear dimensions in the range of 100-1000 nanometers (nm).

Air Mass
A large volume of air (often covering thousands of square kilometers) with temperature and humidity characteristics that vary little horizontally

Albedo
The percentage of incoming radiation (usually visible light) reflected back to space from a planet or object, its surface, or its cloud layers

Altimeter
A barometer, normalized to standard pressure, temperature and density, used to measure altitude by measuring atmospheric pressure. Altitude is determined by assuming all changes in pressure are due to a change in height relative to sea level. Altimeters are adapted to work over wide ranges of height above sea level and used in GLOBE to measure barometric pressure at elevations above 500 meters.

Ambient Air
Air that is moving freely and not part of a specific perturbation to the surrounding atmosphere (e.g., not part of an exhaust plume, not smoke from a fire, not a dust cloud blown off a field)

Atmospheric Greenhouse Effect
Warming of a planet by the atmospheric absorption and re-emission of infrared radiation emitted from the surface of the planet by various gases in the atmosphere (i.e., *greenhouse gases*)

Barometer
An instrument used to measure atmospheric pressure

Biological Diversity (biodiversity)
The variety of life in all its forms, levels and combinations that coexist in an ecosystem. At different scales this includes ecosystem diversity, species diversity, and genetic diversity. The degree of biodiversity is often used as an indicator of the health of the environment.

Blowing Dust
Dust (soil particles smaller than sand) suspended in the air that reduces visibility, or obscures part or all of the sky

Blowing Sand
Sand suspended in the air that reduces visibility, or obscures part or all of the sky

Blowing Snow
Snow from the ground that the wind blows into the air that reduces visibility, or obscures part or all of the sky

Carbon Monoxide
Chemical compound of one oxygen atom and one carbon atom primarily produced as product of incomplete combustion (chemical symbol: CO)

Ceiling
The height of the base of the cloud layer that covers more than 50% of the sky

Ceilometer
An instrument used to determine the height of the cloud base, which helps to indicates cloud type

Celsius Scale
A temperature scale invented in 1742 by Swedish astronomer Anders Celsius. This scale defines the melting point of water ice as 0° C, and the boiling point of water as 100° C. Because of the 100-degree interval between these two points, this scale is sometimes called the "*centigrade scale*".

Chemical Test Strip
A piece of paper treated with special chemicals that show a color change when exposed to ozone

Cirriform
A cloud type formed of ice crystals at high altitudes (greater than 6 km above sea level)

Climate
Weather at a locality averaged over some time period, plus extremes in weather behavior during a time period

Cloud Cover
The percent of the sky covered by clouds

Compounds
Chemicals made of atoms from two or more elements

Concentration
The number of molecules of a specific gas in a unit volume relative to the sum of all the molecules in that volume, often reported as parts per million (ppm) or parts per billion (ppb)

Condensation
The change of phase of a substance from a vapor to a liquid. The process of condensation releases energy; this energy is known as latent heat

Conduction
The transfer of heat through collisions of the individual constituents of a substance (e.g., molecules, atoms) without the systematic movement of groups of these constituents. For example, if one end of a metal rod is heated, the heat will be conducted the length of the rod so that the other end will also increase in temperature. Conduction can occur in solids, liquids, or gases (but is generally most efficient in solids).

Convection
The transfer of heat by mass flow, that is, large scale motion within a liquid or a gas of groups of constituents (e.g. molecules, atoms) that are relatively warmer or cooler than their surroundings. In the atmosphere convection mostly refers to vertical motions brought about by warm air rising and cooler air sinking.

Cumuliform
A cloud type that is heaped, puffy, banded, or otherwise is characterized by rounded features particularly on the top and sides

Density (D)
The ratio of the mass (M) of a substance to its volume (V) (D = M/V)

Deposition
The process by which water vapor turns directly into ice on a surface without passing through the liquid phase

Dew Point Temperature
The temperature at which the water vapor begins to condense in air cooled at constant pressure. Dew Point Temperature is a measure of the amount of water vapor in air.

Diffuse Insolation
Solar radiation that reaches Earth's surface by being scattered or reflected by components of Earth's atmosphere (such as gases, clouds and aerosols)

Direct Insolation
Solar radiation that reaches Earth's surface by passing directly through the atmosphere without interacting with the components of Earth's atmosphere

Diurnal Cycle
Refers to the 24 hours of the day, and sometimes the changes that occur over that 24-hour time period

Drizzle
Slow falling liquid precipitation made up of droplets with diameters between 0.2 and 0.5 mm. Drizzle reduces visibility more than light rain because of the large numbers of very small drops

Dry Bulb Temperature
The temperature on one of two thermometers on a sling psychrometer; this temperature corresponds to the bulb which does not contain the water saturated wick

Ecosystem
A community of different species interacting with one another and with the chemical and physical factors making up their surroundings

El Niño
El Niño refers to a prolonged significant warming of surface waters in the central and eastern tropical Pacific Ocean and generally to the phenomena that accompany this warming.

Electromagnetic (EM) Radiation
Energy waves produced by oscillating or accelerating electric charges. EM waves have both electric and magnetic components. Unlike conduction and convection, EM waves do not need media like solids, liquids, or gases in order to transfer energy. Electromagnetic radiation can be arranged in a spectrum from very energetic short wavelengths (gamma rays, x-rays), to less energetic, very long wavelengths (microwaves and radio waves). Visible light is a small part of the electromagnetic spectrum that human eyes can see.

Elevation Angle
The angular distance between the horizon and an object in the sky, such as the sun. The *zenith angle* is 90° minus the elevation angle.

Evaporation
The phase change of a substance from a liquid to a gas

Evapotranspiration
The transfer and transformation of liquid water from soil to air by the combined processes of evaporation and transpiration by vegetation

Fahrenheit Scale
A temperature scale invented by the 18th century German physicist Daniel Gabriel Fahrenheit. This scale defines the melting point of water ice as 32° F and the boiling point of water as 212° F. The United States is the only major country in the world still commonly using the Fahrenheit scale.

Fog
A cloud in contact with Earth's surface

Force (F)
a push or pull

Freezing
The process of water changing phase from liquid to solid (ice)

Freezing Rain and Freezing Drizzle
Supercooled water drops that freeze when they come in contact with cold surfaces

Front
The narrow transition region between two distinct air masses. A front is a region of changing wind direction, changing surface air pressure, and often results in the development of clouds and precipitation.

Frost
The deposition of ice from water vapor in the atmosphere directly onto surfaces such as grass or windows

Geostationary
An object in orbit around Earth that stays above a certain location on the planet; the object is generally located directly above the Equator at a fixed longitude.

Greenhouse Gas
Any gas that causes heat to be retained in the atmosphere and thereby causes the average temperature of the atmosphere to increase. Greenhouse gases are strong absorbers of infrared radiation. Examples of significant greenhouse gases are water vapor, carbon dioxide, nitrous oxide, methane, and chlorofluorocarbons.

Gravity
The force of attraction among all matter (e.g., gravity pulls each of us toward Earth's center)

Greenwich Mean Time (GMT)
The same reference time as Universal Time (UT); the time at 0 degrees longitude (the prime meridian) that passes through Greenwich, England

Hail (also known as Hailstones)
Precipitation in the form of irregular balls of ice ranging in size from about 2 mm to 13 cm in diameter. The largest hailstones can only form in the most violent thunderstorms that have extremely strong updrafts (upward moving air).

Halo
The optical phenomenon caused when sunlight or moonlight is refracted through ice crystals, splitting the visible beam into its distinct colors. This occurs only with cirrostratus or thick cirrus clouds.

Haze
The reduction of visibility by aerosols in the atmosphere. Haze may cause the sky to appear milky white to yellowish, reddish, or brown, depending on whether the aerosol is wet or dry and depending on the size and nature of the particles which scatter the light.

Heat
The total energy of motion of all of the atoms and molecules that make up a substance

Heavy Rain
Rain falling at such a great rate (greater than 7.5 mm/hr) that it reduces visibility and obscures the view of the sky

Heavy Snow
Falling snow that reduces visibility to less than 400 meters and obscures the view of the sky

Hydrocarbons
Compounds composed primarily of carbon and hydrogen atoms. Gaseous hydrocarbons occur in the atmosphere, (e.g., the compounds in natural gas, chemical species given off naturally by plants, and compounds that result from by-products of the combustion process).

Hydrologic Cycle
The continuous flow of water through the Earth system. The hydrologic cycle is composed of reservoirs of water (such as ice caps, oceans, atmospheric humidity, and aquifers) and fluxes or flows of water (such as evaporation, precipitation, river flow, and iceberg calving).

Hygrometer
An instrument used to measure the relative humidity of air

Ice Pellets
Same as sleet

Infrared radiation
Light (electromagnetic radiation) with wavelengths ranging from just longer than visible light (0.7 micrometers) to just shorter than microwaves or radio waves (1000 micrometers). The amount of light thermally emitted by Earth's surface and lower atmosphere peaks at wavelengths near 10 micrometers, and light in this portion of the infrared wavelength range is often referred to as thermal infrared.

In situ
In place. Most of the atmospheric measurements in GLOBE, such as temperature and ozone, are taken *in situ*; however, many of these quantities can also be measured *remotely* through the use of special satellites.

Insolation
Incoming solar radiation

Interplanetary Medium
The space between the planets that contains electromagnetic radiation, electric and magnetic fields, ionized gas, neutral atoms, and microscopic dust particles. The characteristics of interplanetary space are primarily influenced by the sun and not by individual planets.

Inverse Relationship
When two variables are related to each other in an opposite way; for example, as one increases, the other decreases (e.g. $x = 1/y$)

Isobars
Lines on a map connecting points of equal pressure

Isotherms
Lines on a map connecting points of equal temperature

Kelvin Scale
A temperature scale named for British physicist William Thomson Kelvin who proposed it in 1848. One Kelvin degree is equivalent to one Celsius degree. However, zero on the Kelvin scale is defined to be the temperature at which molecular energy is a minimum, also

called "absolute zero". The convention when writing temperatures in the Kelvin scale is to just use the letter K, omitting the degree symbol. Zero on the Kelvin scale corresponds to approximately –273° C.

La Niña
A period of anomalous cooling of sea-surface temperatures in the central and eastern tropical Pacific Ocean

Latent heat
The heat used or released when water changes phase between solid, liquid, and gas

Melting
The process of a substance changing phase from solid to liquid

Mesosphere
The third layer of the atmosphere above Earth's surface, generally found between altitudes of 50 km and 80 85 km and characterized by temperature decreasing with altitude

Millibar
A unit of barometric pressure equivalent to one one-thousandth of a bar and equivalent to a hectopascal

Mixing Ratio
A scientific term often used synonymously with concentration. One example is the mass of water vapor in a sample of air divided by the total mass of air in the sample

Nitrogen Oxides
The family of compounds comprised of one or more nitrogen atoms and one or more oxygen atoms. Nitric oxide (NO) and Nitrogen dioxide (NO_2) are both primarily products of combustion whereas nitrous oxide (N_2O) is a primarily product of microbial activity in soils.

Optical thickness (also optical depth)
A measure of how much particles (aerosols) and gas molecules (air) impede the transmission of light through a gas at a specific wavelength. At an optical depth of one, the incoming light is attenuated to 1/e in intensity.

Ozone
A highly reactive gas composed of 3 oxygen atoms that exists in varying amounts in the troposphere and stratosphere. Ozone is found naturally in the atmosphere as a result of breaking apart oxygen molecules (O_2) into two oxygen atoms that combine with molecules of oxygen to form ozone (O_3).

Ozone Layer
The layer of the atmosphere in the stratosphere and lower mesosphere that absorbs most incoming ultraviolet radiation

Ozone Optical Scanner
An instrument used in GLOBE's ozone protocol that measures the color change on the chemical test strips and interprets this change as an ozone concentration in units of ppb

Pascal
The unit of pressure equivalent to 1 Newton/meter-squared. 100 pascals equals one hectopascal which is a standard pressure unit used in GLOBE

pH Scale
The system used to specify the range of acidity or alkalinity of substances. On this scale, a substance with a pH of 7 is neutral. Substances with pH less than 7 are acidic; substances with pH greater than 7 are alkaline (or basic).

Phase Change
The change in a substance from one phase to another. Substances (elements and compounds) generally exist in one of three phases solid, liquid, and gas; For example, water vapor (gas) condensing into water (liquid). Substances undergoing phase changes take up or give off heat without changing temperature. (See Latent Heat)

Photolysis
The break-up of an atmospheric compound by light. For example, when ozone (O_3) is formed in the atmosphere, it can be split into atomic oxygen (O) and molecular oxygen (O_2) by ultraviolet sunlight.

Polar-Orbiting Satellite
An artificial satellite (spacecraft that orbits Earth) passing near or over the poles. This term usually refers to satellites in near-polar orbits that are designed so that their orbital plane maintains a constant angle (on average) with the line between the sun and Earth. These are called sun-synchronous satellites.

Pollutant
A trace gas or aerosol that contaminates the air

ppb
Parts per billion, a unit of measure of atmospheric trace gas concentration or mixing ratio; sometimes denoted ppbv (parts per billion by volume), which is how trace gas mixing ratios are normally defined.

Precipitable Water Vapor
The depth of a planet-wide layer of liquid water that would be formed if all the water vapor in a column of atmosphere were condensed onto Earth's surface. On average, the atmosphere contains about 2 centimeters of precipitable water vapor.

Precipitation
Water in solid or liquid form that falls to Earth's surface from the atmosphere

Precursor
A chemical necessary to reactions that form other compounds (e.g., nitric oxide is a precursor of ozone in the near-surface atmosphere)

Pressure
Force per unit area; for the atmosphere, it may be thought of as the weight of the column of air above a given area.

Radiation
See "*Electromagnetic Radiation*".

Rayleigh scattering
Scattering of sunlight by molecules in the atmosphere, named after the 19th century British physicist John William Strutt, the third Baron Rayleigh.

Reactive Chemicals
Chemicals that will undergo chemical reactions in the atmosphere

Reflection
The process by which radiation incident upon an object is directed at some fixed angle away from that object

Relative Air Mass
The ratio of the amount of atmosphere between an observer and the sun relative to the amount of atmosphere directly overhead. Relative air mass is directly related to solar elevation angle.

Relative Humidity
A measure of the amount of water vapor in a sample of air compared to the amount contained in an air sample at the same pressure and temperature saturated with water vapor

Satellite
An object in orbit around a larger celestial body

Scattering
The process by which radiation interacting with a substance is deflected in all directions

Sea Level Pressure
Atmospheric pressure adjusted to the value that would be measured if the measurement location were at sea level

Sea Spray
Aerosols blown off the surface of a salt water body under windy conditions, which may produce obstructions to visibility

Seasonal Cycle
A periodic change in a variable that occurs in tandem with Earth's seasons

Sensible Heat
The heat associated with a change in temperature of a substance as distinct from the heat associated with a phase change

Shower
A type of precipitation event that is typically of short duration, or occurs with frequent changes of intensity

Sleet
Precipitation that at some point is in liquid form, but freezes before reaching the ground

Sling Psychrometer
A device consisting of two thermometers, one of which has a dry bulb and the other of which has a bulb that is kept wet. The difference between the wet and dry bulb temperatures is used to calculate relative humidity.

Smog
Air that contains a sufficient combination of aerosols from water and combustion to be visible. Aerosols in smog may be produced indirectly by reactions among the gases present in combustion exhaust. Smog originated as a term combining the words smoke and fog and may reduce visibility in a similar way.

Smoke
Air containing sufficient aerosols produced by combustion to be visible, which may reduce visibility or obstruct views of the sky

Solar Noon
The time at which the sun is at its highest point in the sky (zenith) during a day

Specific Heat
The amount of heat required to raise the temperature of 1 gram of a substance by 1° C

Squall
An intense or violent shower accompanied by strong, gusty winds

Station Pressure
The true atmospheric pressure, uncorrected to standard conditions at sea level. Weather reports generally give barometric pressure corrected to sea level, not station pressure.

Stratiform
A cloud comprised of a single or multiple horizontal layers; there is very little discernible structure to clouds of this type.

Stratosphere
The second layer of the atmosphere above Earth's surface, generally characterized by temperature increasing with altitude. The stratosphere begins at altitudes ranging from about 8 km in the polar regions to 1618 km in the tropics and extends to altitudes of about 50 km where there is a local maximum in atmospheric temperature. The stratosphere contains most of the ozone found in the atmosphere.

Sublimation
The transition of a substance directly from the solid phase to the gas phase

Sun Photometer
An instrument that measures the intensity of sunlight transmitted through the atmosphere within a narrow wavelength range

Supercooled Water
Water with a temperature that is below its freezing point but still in liquid form

Temperature
A measure of the *average* energy of motion of all the atoms and molecules that make up a substance

Temperature Inversion
An increase in temperature with height in the troposphere, usually associated with a very stable air mass. Normally, temperature in the troposphere increases with height. When and where temperature increases with height, vertical mixing of the atmosphere is greatly decreased. This leads to the trapping of aerosols and trace gases from the surface being contained in the air near the surface. It also causes the atmosphere to be stratified in horizontal layers in the stratosphere, hence the name of this atmospheric layer.

Thermosphere
The fourth layer of the atmosphere above Earth's surface. In the thermosphere, temperature increases greatly, ion concentrations become significant, and the dynamics of the atmosphere is virtually independent of the forces and phenomena associated with Earth's surface and lower atmosphere. Most of the ionosphere is contained within the thermosphere and above the

thermosphere is interplanetary space.

Thunderstorm
A cumulonimbus cloud or family of cumulonimbus clouds that produce lightning, and therefore, thunder. Thunderstorms are not always accompanied by precipitation reaching the ground.

Trace Gas
Gases present in the atmosphere in very small quantities, always less than one-tenth of one percent

Transpiration
The process by which water vapor escapes into the atmosphere through open stomata on plant leaf surfaces

Tropical Cyclone
A low pressure system found in tropical latitudes which may develop into a tropical storm, hurricane, and other similarly intense storm

Troposphere
The lowest layer of the atmosphere where almost all weather occurs. The troposphere contains about 80% of the atmosphere's mass and is characterized by temperatures that normally decrease with altitude. The boundary of the troposphere and the stratosphere depends on latitude and season. It ranges from as low as 8 km over the poles to as high as 16-18 km in the tropics.

Ultraviolet
A part of the electromagnetic spectrum that is more energetic, and of shorter wavelengths than visible light; usually defined as radiation with wavelengths of 0.1 - 0.38 micrometers.

Universal Time (UT)
The time at 0 degrees longitude (the prime meridian); UT is the currently preferred term for this reference time, which is the same as GMT.

Visibility
The distance over which an observer can see and clearly identify an object

Visible Radiation
Light with wavelengths between about 0.38 and 0.7 micrometers that may be seen by humans. The sun emits its peak amount of energy in the visible portion of the electromagnetic spectrum.

Volcanic Ash
Small particles of minerals, rock and glass fragments ejected from volcanic eruptions. As aerosols they may reduce visibility or obscure a view of the sky. These particles often produce spectacular light scattering effects including colorful sunsets.

Water Cycle
See Hydrologic Cycle.

Water Vapor
The colorless, odorless, invisible, gaseous form of water in the atmosphere

Wavelength (of light)
A property of light that is inversely proportional to its frequency and describes the distance from one wave peak to the following wave peak. Visible light lies in the wavelength range from about 0.38 micrometers (violet) to 0.7 micrometers (red). The peak sensitivity of the human eye is to light at a wavelength of about 0.5 micrometers (green), near the response wavelength of the green channel of the GLOBE sun photometer.

Weather
The state of the atmosphere at a particular place and time. Weather includes variables such as temperature, barometric pressure, wind, cloudiness, precipitation, and relative humidity.

Wet Bulb Depression
The difference between the dry bulb and wet bulb temperature readings on a sling psychrometer

Wet Bulb Temperature
The temperature taken on a sling psychrometer from the thermometer with its bulb covered in a wet wick, after slinging or whirling the psychrometer for

the prescribed amount of time

Wet Deposition

The depositing of gases or aerosols from the atmosphere on to Earth's surface through their incorporation in precipitation (rain drops, snowflakes, etc.). Sometimes the terms 'rain out' or 'wash out' are used in place of wet deposition.

Zenith Angle

The angular distance between an object in the sky, such as the sun, and an object directly overhead. Zenith angle is 90° minus the *elevation angle*