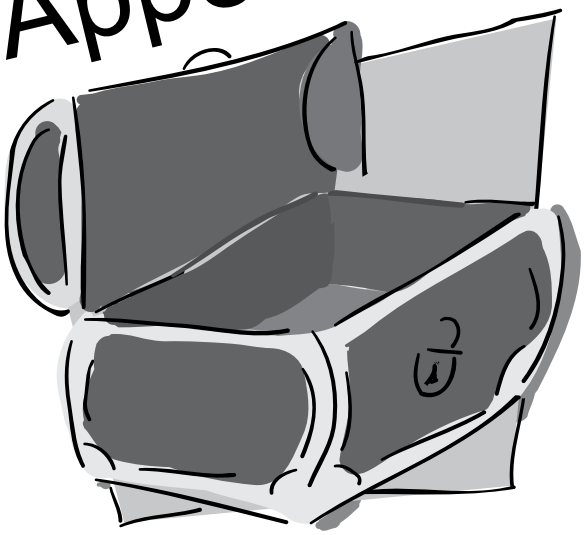
Appendix



DEACTIVATED PROTOCOL: The GLOBE Atmosphere Protocol - Surface Ozone has been deactivated as of September 2023. To learn more about the Deactivation Process, please visit the Globe.gov website.

Site Definition Sheet

*** Required Field**

School Name: _____ Site Name:_____

Choose a unique name based on location, e.g. "Grassy area - Front of School"

Names of students completing Site Definition Sheet: _____

Date: Year_____ Month_____ Day____ Check one: ❑ New Site ❑ Metadata Update

***Coordinates:** Latitude: _____˚ ❑ N or ❑ S Longitude: _____˚ ❑ E or ❑ W

Elevation: _____ meters

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

Comments: _____

_____

Site Type (select all that apply based on intended measurements, then complete the necessary fields below): ❑ Atmosphere ❑ Surface Temperature ❑ Hydrosphere
❑ Biosphere Land Cover ❑ Biosphere Greening ❑ Biosphere Phenological Gardens
❑ Biosphere Lilacs ❑ Soil (Pedosphere) Characteristics
❑ Soil (Pedosphere) Moisture and Temperature ❑ Soil (Pedosphere) Frost Tube

Cover type (Select one): ❑ Short grass (< 0.5m) ❑ Tall grass (> 0.5m) ❑ Barren land
❑ Sand ❑ Closed Forest (Trees interlocking) ❑ Woodland (Trees not interlocking)
❑ Shrubs ❑ Dwarf Shrubs ❑ Flowering Plants ❑ Wetland ❑ Cultivated Agricultural
❑ Cultivated Recreational ❑ Open Water ❑ Bare Rock ❑ Urban Residential
❑ Urban Commercial ❑ Asphalt ❑ Concrete ❑ Other ❑ Land Cover site

If you selected Closed Forest or Woodland, indicate the ground cover (Select one)**:**
❑ Leaf Litter ❑ Moss ❑ Peat

Atmosphere

List any 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 instrument shelter (Check one):
❑ No buildings ❑ Buildings (describe below)

Description:_____

_____

Other Site Data:

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

Rain Gauge Height [ ] cm Ozone Clip Height [ ] cm Thermometer Height [ ] cm

****Thermometer Type*** (Check one):
❑ Other, Soil or Air
❑ Liquid-filled, Current Temperature Only
❑ Digital Single-Day Min/Max
❑ Digital Multi-Day Min/Max
❑ Reset Digital Multi-Day Min/Max Thermometer

Note: reset is required before data collection and entry, when batteries are changed or every 6 months

*** Required Field**

School Name: _____Study Site: _____ Date: _____

Date: Year____ Month____ Day___ Universal Time (hour:min): _____

Was this reset due to a battery change? ❑ Yes ❑ No

❑ Earth Networks Station (Automated Station ID _____)
❑ Davis Instrument (Davis Thermometer Type _____)
❑ Data Logger (HOBO)
❑ Rainwise
❑ WeatherHawk
❑ No Thermometer

Surface Cover Description 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): _____
_____

Surface Temperature

Homogeneous site size (Select one): ❑ 90m x 90m ❑ 30m x 30m
❑ Smaller than 30 x 30m (specify size: __ m x __ m)

Type of IRT Instrument: ❑ Raytech ST20 ❑ Other (specify instrument manufacturer and model) _____)

Overall comments on the site (metadata): _____
_____

Hydrosphere

***Name of Body of Water:** _____ (the name commonly used on maps; if the body of water does not have a common name, provide a description of the water body it comes from or flows into or both.)

***Water Body Type** (Select one): ❑ Unknown ❑ Saltwater ❑ Freshwater ❑ Brackish

Water Body Source (Select one):

❑ Pond (Area of standing water ___ km^2; Average Depth of Standing Water ___ m)
❑ Lake (Area of standing water ___ km^2; Average Depth of Standing Water ___ m)
❑ Reservoir (Area of standing water ___ km^2; Average Depth of Standing Water ___ m)
❑ Bay (Area of standing water ___ km^2; Average Depth of Standing Water ___ m)
❑ Ditch (Area of standing water ___ km^2; Average Depth of Standing Water ___ m)
❑ Ocean
❑ Estuary (Area of standing water ___ km^2; Average Depth of Standing Water ___ m)
❑ Stream (Width of Moving water ___ m)
❑ River (Width of Moving water ___ m)
❑ Marsh/Swamp
❑ Agriculture

*** Required Field**

School Name: _____Study Site: _____ Date: _____

❑ Puddles, animal and vehicle tracks

❑ Other (Width of Moving water ___ m; Area of standing water ___ km^2;
Average Depth of Standing Water __ m)

Water Sample Location: ❑ Outlet ❑ Bank ❑ Bridge ❑ Boat ❑ Inlet ❑ Pier

Can you see the bottom? ❑ Yes ❑ No

Channel/Bank Material: ❑ Soil ❑ Rock ❑ Concrete ❑ Vegetated Bank

Bedrock: ❑ Granite ❑ Limestone ❑ Volcanics ❑ Mixed Sediments ❑ Unknown

Freshwater Habitats Present: ❑ Rocky Substrate ❑ Vegetated Banks ❑ Mud Substrate
❑ Sand Substrate ❑ Submersed Vegetation ❑ Logs

Saltwater Habitats Present: ❑ Rocky Shore ❑ Sandy Shore ❑ Mud Flats/Estuary

Overall comments on the site (metadata): _____
_____

Biosphere

Land Cover

MUC Description: Level 1: _____ Level 2: _____
Level 3: _____ Level 4: _____

***MUC Code:** _____ **Note:** *Use the MUC Guide to determine the greatest level possible within the MUC system*

Overall comments on the site (metadata): _____
_____

Greening

Are there multiple dominant species? ❑ Yes ❑ No

Primary Plant

Is this plant in the understory? ❑ Yes ❑ No

Vegetation Type (Select one): ❑ Grass Genus: _____
❑ Tree Genus: _____ Species: _____
❑ Shrub Genus: _____ Species: _____

Label: _____

Secondary Plant

Is this plant in the understory? ❑ Yes ❑ No

Vegetation Type (Select one): ❑ Grass Genus: _____
❑ Tree Genus: _____ Species: _____
❑ Shrub Genus: _____ Species: _____

Label: _____

Tertiary Plant

Is this plant in the understory? ❑ Yes ❑ No

*** Required Field**

School Name: _____Study Site: _____ Date: _____

Vegetation Type (Select one): ❑ Grass Genus: _____
❑ Tree Genus: _____ Species: _____
❑ Shrub Genus: _____ Species: _____

Label: _____

If additional plants will be monitored record the information on another sheet or in your Science Log.

Overall comments on the site (metadata): _____
_____

Phenological Gardens

Soil Texture (Select one): ❑ Unknown ❑ Sandy Clay ❑ Sandy Clay Loam ❑ Sandy Loam ❑ Silty Clay ❑ Silty Clay Loam ❑ Silt Loam ❑ Loamy Sand ❑ Sand ❑ Silt ❑ Clay ❑ Clay Loam ❑ Loam ❑ Organic

Soil pH: _____; **pH Method**: ❑ pH Maper ❑ pH Meter

Shrub Name	Date Planted
Witch Hazel 'Jelena'	
Witch Hazel 'Genuine'	
Lilac	
Mock-Orange	

Shrub Name	Date Planted
Forsythia	
Heather 'Allegro'	
Heather 'Long White'	
Snowdrops	

Cloned and Common Lilac

Lilac Shrub Name	Cloned or Common	Date Planted/Died	Height (cm)

Soil (Pedosphere)

Soil Characteristics

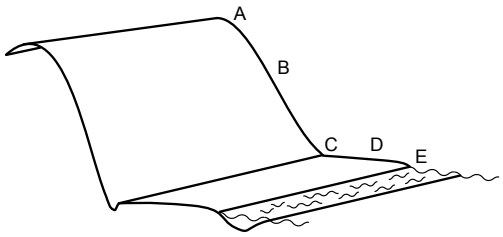
Slope angle (North, Northeast, etc.): _____

Method (select one): ❑ Soil Pit ❑ Auger Hole ❑ Near Surface ❑ Excavation ❑ Road Cut ❑ Erosion Cut

Land Use (Select one): ❑ Urban ❑ Agricultural ❑ Recreation ❑ Wilderness ❑ Other _____

Landscape Position (Select one):

❑ A. Summit
❑ B. Slope
❑ C. Depression
❑ D. Large Flat Area
❑ E. Stream Bank



School Name: _____ Study Site: _____ Date: _____

*** Required Field**

Soil Horizon Definitions

Horizon Number	**Date** (YYYY, MM, DD)	***Top Depth** (cm)	***Bottom Depth** (cm)	**Moisture Estimate** (Select one: Unknown, Dry, Moist, Wet)	**Structure Estimate** (Select one: Unknown, Granular, Blocky, Platy, Prismatic, Columnar, Single Grained, Massive)	**Main color** (code from soil color book)	**Secondary Color** (code from soil color book)	**Consistence Estimate** (Select one: Extremely Firm, Firm, Friable, Loose, Unknown)	**Texture Field Estimate** (Select one: Unknown, Sandy Clay, Sandy Clay Loam, Sandy Loam, Silty Clay, Silty Clay Loam, Silt Loam, Loamy Sand, Sand, Silt, Clay, Clay Loam, Loam, Organic)	**Root Quantity Estimate** (Select one: Unknown, None, Few, Many)	**Rock Quantity Estimate** (Select one: Unknown, None, Few, Many)	**Carbonates** (Select one: Unknown, None, Slight, Strong)

Note: The Top Depth of any horizon must be the same depth or lower than the Bottom Depth of the horizon above it; it cannot be higher that the bottom depth above it.

Comments on the site (metadata): _____ _____

*** Required Field**

School Name: _____Study Site: _____ Date: _____

Parent Material (Select one): ❑ Bedrock ❑ Organic Material ❑ Construction Material ❑ Marine Deposits ❑ Lake Deposits ❑ Stream Deposits (Alluvium) ❑ Wind Deposits (Loess) ❑ Glacial Deposits (Glacial Till) ❑ Volcanic Deposits ❑ Loose Materials on Slope (Colluvium) ❑ Don't Know ❑ Other _____

Distance from Major Features: _____

Soil Moisture and Temperature

Surface State (Select one): ❑ Natural ❑ Plowed ❑ Graded ❑ Backfill ❑ Compacted ❑ Other _____

Canopy Cover (Select one): ❑ Open ❑ Some Trees (within 30m) ❑ Canopy Overhead

Overall comments on the site (metadata): _____

_____

Frost Tube:

We recommend you also complete the atmosphere and surface temperature sections.

Date installed: _____

Height above ground (cm): _____ Depth below ground (cm): _____ Total length (cm): ____

Water body within 100m of site: ❑ No ❑Yes (complete below)

Water body type (Select one): ❑ Unknown ❑ Saltwater ❑ Freshwater ❑ Brackish

Direction to closest point of water: ❑ N ❑ NE ❑ E ❑ SE ❑ S ❑ SW ❑ W ❑ NW

Landscape Position (Choose one, see above in **Soil Characteristics**)

Overall comments on the site (metadata): _____

_____

Site Photos

(record the appropriate photo number for easy identification during data entry)

North	South	East	West
Photo number _____	Photo number _____	Photo number _____	Photo number _____

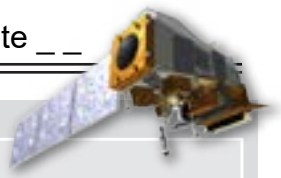
Overall comments on the site (metadata): _____

_____

School/Observer Name:_____ Study Site:_____

Date (ex. 2017 01 13): Year: _ _ _ _ Month: _ _ Day: _ _

Time (ex. 24 Hour Clock: 14 26): Local: Hour _ _ Minute _ _ Universal: Hour _ _ Minute _ _



1. What is in Your Sky?

Total Cloud/Contrail Cover:

- ○ Sky is Obscured →
  - ○ Fog
  - ○ Heavy Rain
  - ○ Heavy Snow
  - ○ Blowing Snow
  - ○ Sand
  - ○ Spray
  - ○ Smoke
  - ○ Dust
  - ○ Haze
  - ○ Volcanic Ash

  Go to box 6
- ○ None (Go to box 2)
- ○ Few(<10%)
- ○ Isolated (10-25%)
- ○ Scattered (25-50%)
- ○ Broken (50-90%)
- ○ Overcast (90-100%)

*If you can observe sky color or visibility, complete box 2

2. Sky Color and Visibility

Color (Look Up): ○ Cannot Observe ○ Deep Blue ○ Blue ○ Light Blue ○ Pale Blue ○ Milky

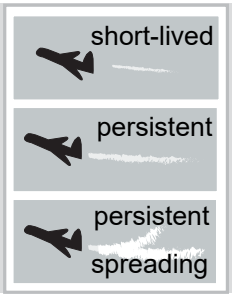
Visibility (Look Across): ○ Cannot Observe ○ Unusually Clear ○ Clear ○ Somewhat Hazy ○ Very Hazy ○ Extremely Hazy

3. High Level Clouds

○ No High Level Clouds Observed (Go to box 4)

Cloud Type:

- ○ Contrails (number of): → #
- ○ Cirrus #
- ○ Cirrocumulus #
- ○ Cirrostratus #



Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

4. Mid Level Clouds

○ No Mid Level Clouds Observed (Go to box 5)

Cloud Type:

- ○ Altostratus
- ○ Altocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

5. Low Level Clouds

○ No Low Level Clouds Observed (Go to box 6)

Cloud Type:

- ○ Fog
- ○ Nimbostratus
- ○ Cumulonimbus
- ○ Stratus
- ○ Cumulus
- ○ Stratocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

6. Surface Conditions

Mandatory:

	Yes	No		Yes	No
Snow/Ice	○	○	Dry Ground	○	○
Standing Water	○	○	Leaves on Trees	○	○
Muddy	○	○	Raining/Snowing	○	○

Optional:
You may submit any or all

Temperature: ___°C
Barometric Pressure: ___mb
Relative Humidity: ___%

Comments:

Atmosphere Investigation

Integrated 1-Day Data Sheet

* Required Field

School Name: _____ Study Site: _____

Observer names: _____

Date: Year_____ Month_____ Day____ Universal Time (hour:min): _____

Air Temperature

Current Temperature (°C): ____

Maximum Temperature (°C): ____ (record only when collected at Local Solar Noon)

Minimum Temperature (°C): ____ (record only when collected at Local Solar Noon)

Comments: _____

_____

Barometric Pressure

(Check one): ❑ Sea Level Pressure ❑ Station Pressure

Pressure (mb): ____

Comments: _____

_____

Relative Humidity

(Select instrument used):

❑ Sling Psychrometer	❑ Digital Hygrometer
Dry bulb temperature (˚C): _____	Ambient air temperature (˚C): _____
Wet bulb temperature (˚C): _____	Relative Humidity (%): _____

Comments: _____

_____

Precipitation (record only when collected at Local Solar Noon)

Days of accumulation: ____

Rainfall select one: ❑ Measurable ❑ Trace ❑ Missing
(if measurable is selected, complete the following fields)
Accumulation (mm): ____

Rain pH Measured With (select one): ❑ pH Paper ❑ pH Meter

pH of Rain: ____ (pH measurements only allowed when liquid amount is 3.5 mm or more)

Comments: _____

_____

* Required Field

Study Site: _____ Date: _____ Time (UT): _____

New Snowfall

Sample 1	Sample 2	Sample 3
Select one: ❑ Measurable ❑ Trace ❑ Missing	Select one: ❑ Measurable ❑ Trace ❑ Missing	Select one: ❑ Measurable ❑ Trace ❑ Missing
If measurable, record amount (mm): ____	If measurable, record amount (mm): ____	If measurable, record amount (mm): ____

Rain Equivalent of New Snow

Select one: ❑ Measurable ❑ Trace ❑ Missing
If measurable, record amount (mm): ____

Snowfall pH Measured with (select one): ❑ pH Paper ❑ pH Meter

pH of New Snowfall: ____ (pH measurements only allowed when liquid amount is 3.5 mm or more)

Comments: _____

_____

Snowpack

Sample 1	Sample 2	Sample 3
Select one: ❑ Measurable ❑ Trace ❑ Missing	Select one: ❑ Measurable ❑ Trace ❑ Missing	Select one: ❑ Measurable ❑ Trace ❑ Missing
If measurable, record amount (mm): ____	If measurable, record amount (mm): ____	If measurable, record amount (mm): ____

Rain Equivalent of Snowpack

Select one: ❑ Measurable ❑ Trace ❑ Missing
If measurable, record amount (mm): ____

Snowpack pH Measured with (select one): ❑ pH Paper ❑ pH Meter

Snowpack pH: ____ (pH measurements only allowed when liquid amount is 3.5 mm or more)

Comments: _____

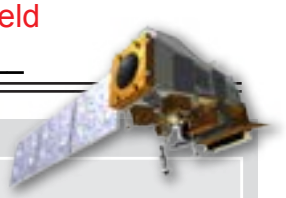
_____

Sky Conditions (next page):

DEACTIVATED PROTOCOL: The GLOBE Atmosphere Protocol - Surface Ozone has been deactivated as of September 2023. To learn more about the Deactivation Process, please visit the Globe.gov website.

* Required Field

Study Site: _____ Date: _____ Time (UT): _____



1. What is in Your Sky?

Total Cloud/Contrail Cover:

- ○ Sky is Obscured →
- ○ None (Go to box 2)
- ○ Few(<10%)
- ○ Isolated (10-25%)
- ○ Scattered (25-50%)
- ○ Broken (50-90%)
- ○ Overcast (90-100%)

- ○ Fog
- ○ Heavy Rain
- ○ Heavy Snow
- ○ Blowing Snow
- ○ Sand
- ○ Spray
- ○ Smoke
- ○ Dust
- ○ Haze
- ○ Volcanic Ash

Go to box 6

*If you can observe sky color or visibility, complete box 2

2. Sky Color and Visibility

Color (Look Up): ○ Cannot Observe ○ Deep Blue ○ Blue ○ Light Blue ○ Pale Blue ○ Milky

Visibility (Look Across): ○ Cannot Observe ○ Unusually Clear ○ Clear ○ Somewhat Hazy ○ Very Hazy ○ Extremely Hazy

3. High Level Clouds

○ No High Level Clouds Observed (Go to box 4)

Cloud Type:

- ○ Contrails (number of): → #
- ○ Cirrus #
- ○ Cirrocumulus #
- ○ Cirrostratus #

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

4. Mid Level Clouds

○ No Mid Level Clouds Observed (Go to box 5)

Cloud Type:

- ○ Altostratus
- ○ Altocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

5. Low Level Clouds

○ No Low Level Clouds Observed (Go to box 6)

Cloud Type:

- ○ Fog
- ○ Nimbostratus
- ○ Cumulonimbus
- ○ Stratus
- ○ Cumulus
- ○ Stratocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

6. Surface Conditions

Mandatory:

	Yes	No		Yes	No
Snow/Ice	○	○	Dry Ground	○	○
Standing Water	○	○	Leaves on Trees	○	○
Muddy	○	○	Raining/Snowing	○	○

Optional:
You may submit any or all

Temperature: ___°C
Barometric Pressure: ___mb
Relative Humidity: ___%

Comments:

Atmosphere Investigation

Aerosols Data Sheet

* Required Field

School Name: _____ Study Site: _____

Observer names: _____

Date: Year_____ Month _____ Day _____ Universal Time (hour:min): _____

***Sun Photometer Instrument Type** (Check One):

❑ Measures Voltage Only or ❑ Displays AOT (Model) _____

❑ Serial Number: _____ ❑ Serial Number: _____

***If known, Satellite overflights on date of measurements:**

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

If Your Photometer Only Measures Voltages:

Case Temperatures

Before taking measurements (multiply voltage reading by 100) (°C) ____
After taking measurements (multiply voltage by 100) (°C) ____

[1] At least 3 sets of measurements are required.
[2] Always report voltages with 3 digits to the right of the decimal point (e.g., 1.733 rather than 1.77).

Measurement Number [1]	**Universal Time** (hour:minute:second)	**Maximum Voltage in Sunlight** [2] (volts)	**Dark Voltage** [2] (volts)
1 (green)			
1 (red)			
2 (green)			
2 (red)			
3 (green)			
3 (red)			
4 (green)			
4 (red)			
5 (green)			
5 (red)			

* Required Field

Study Site: _____ Date: _____ Time (UT): _____

If Your Photometer Displays AOT:

[1] At least 3 sets of multiple wavelengths are required.
[2] At least two different channel wavelengths must have been used among the 3 to 5 measurements.

Trial 1 [1]

*UT (hour:minute:second) : _____	Channel Wavelength [2] (nanometers)	AOT reading
1		
2		
3		

Trial 2 [1]

*UT (hour:minute:second) : _____	Channel Wavelength [2] (nanometers)	AOT reading
1		
2		
3		

Trial 3 [1]

*UT (hour:minute:second) : _____	Channel Wavelength [2] (nanometers)	AOT reading
1		
2		
3		

Trial 4 [1]

*UT (hour:minute:second) : _____	Channel Wavelength [2] (nanometers)	AOT reading
1		
2		
3		

Trial 5 [1]

*UT (hour:minute:second) : _____	Channel Wavelength [2] (nanometers)	AOT reading
1		
2		
3		

Comments: _____
_____

Atmosphere Investigation

Water Vapor Data Sheet

* Required Field

School Name: _____ Study Site: _____

Observer names: _____

Date: Year_____ Month _____ Day _____ Universal Time (hour:min): _____

***Sun Photometer Instrument Type** (Check One):

❑ Measures Voltage Only (Serial Number): _____

***If known, Satellite overflights on date of measurements:**

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

Case Temperatures

Before taking measurements (multiply voltage reading by 100) (°C) ____
After taking measurements (multiply voltage by 100) (°C) ____

[1] At least 3 sets of measurements (including IR1 and IR2) are required.
[2] Always report voltages with 3 digits to the right of the decimal point (e.g., 1.733 rather than 1.77).

Measurement Number [1]	**Universal Time** (hour:minute:second)	**Maximum Voltage in Sunlight** [2] (volts)	**Dark Voltage** [2] (volts)
1 (IR1)			
1 (IR2)			
2 (IR1)			
2 (IR2)			
3 (IR1)			
3 (IR2)			
4 (IR1)			
4 (IR2)			
5 (IR1)			
5 (IR2)			

Comments: _____

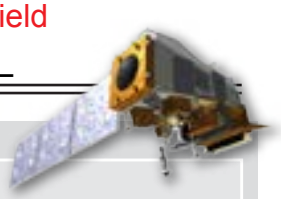
_____

Sky Conditions (next page):

DEACTIVATED PROTOCOL: The GLOBE Atmosphere Protocol - Surface Ozone has been deactivated as of September 2023. To learn more about the Deactivation Process, please visit the Globe.gov website.

* Required Field

Study Site: _____ Date: _____ Time (UT): _____



1. What is in Your Sky?

Total Cloud/Contrail Cover:

- ○ Sky is Obscured →
  - ○ Fog
  - ○ Heavy Rain
  - ○ Heavy Snow
  - ○ Blowing Snow
  - ○ Sand
  - ○ Spray
  - ○ Smoke
  - ○ Dust
  - ○ Haze
  - ○ Volcanic Ash

  Go to box 6
- ○ None (Go to box 2)
- ○ Few(<10%)
- ○ Isolated (10-25%)
- ○ Scattered (25-50%)
- ○ Broken (50-90%)
- ○ Overcast (90-100%)

*If you can observe sky color or visibility, complete box 2

2. Sky Color and Visibility

Color (Look Up): ○ Cannot Observe ○ Deep Blue ○ Blue ○ Light Blue ○ Pale Blue ○ Milky

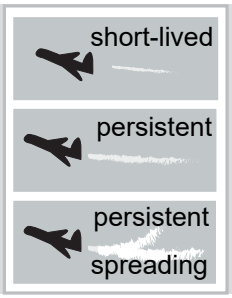
Visibility (Look Across): ○ Cannot Observe ○ Unusually Clear ○ Clear ○ Somewhat Hazy ○ Very Hazy ○ Extremely Hazy

3. High Level Clouds

○ No High Level Clouds Observed (Go to box 4)

Cloud Type:

- ○ Contrails (number of): → #
- ○ Cirrus #
- ○ Cirrocumulus #
- ○ Cirrostratus #



Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

4. Mid Level Clouds

○ No Mid Level Clouds Observed (Go to box 5)

Cloud Type:

- ○ Altostratus
- ○ Altocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

5. Low Level Clouds

○ No Low Level Clouds Observed (Go to box 6)

Cloud Type:

- ○ Fog
- ○ Nimbostratus
- ○ Cumulonimbus
- ○ Stratus
- ○ Cumulus
- ○ Stratocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

6. Surface Conditions

Mandatory:

	Yes	No		Yes	No
Snow/Ice	○	○	Dry Ground	○	○
Standing Water	○	○	Leaves on Trees	○	○
Muddy	○	○	Raining/Snowing	○	○

Optional:

You may submit any or all

Temperature: ___°C

Barometric Pressure: ___mb

Relative Humidity: ___%

* Required Field

Study Site: _____ Date: _____ Time (UT): _____

Comments: _____

_____

Air Temperature

Current Temperature (˚C): ____

Comments: _____

_____

Relative Humidity

(Select instrument used):

❑ Sling Psychrometer	❑ Digital Hygrometer
Dry bulb temperature (˚C): _____ Wet bulb temperature (˚C): _____	Ambient air temperature (˚C): _____ Relative Humidity (%): _____

Comments: _____

_____

***Barometric Pressure**

(Check one): ❑ Sea Level Pressure ❑ Station Pressure

Pressure (mb): ____

Comments: _____

_____

Digital Multi-Day Minimum/ Maximum Thermometer

Data Sheet

School Name: _____ Study Site: _____

Observer names: _____

Date: Year_____ Month _____ Day _____ Universal Time (hour:min): _____

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

Note: If Min/Max Air and Soil Temperatures are being collected after your *Time of Reset* (e.g., if your *Time of Reset* is 12:00 and you are reading the thermometer at 12:15) then the date of D1 will be the same as the date you read your thermometer.

If Min/Max Air and Soil Temperatures are being collected before your *Time of Reset* (e.g., if your *Time of Reset* is 12:00 and you are reading the thermometer at 11:50) then the date of D1 will be the same as the date prior to when you read your thermometer.

Multi-Day Min/Max Air Temperature

Label on Thermometer Display	Corresponding Date	Minimum Temperature (°C)	Maximum Temperature (°C)
D1			
D2			
D3			
D4			
D5			
D6			

Multi-Day Min/Max Soil Temperature

Label on Thermometer Display	Corresponding Date	Minimum Temperature (°C)	Maximum Temperature (°C)
D1			
D2			
D3			
D4			
D5			
D6			

Study Site: _____ Date: _____ Time (UT): _____

Current Air Temperature

_____ (˚C)

Current Soil Temperature

_____ (˚C)

Comments: _____

_____

Atmosphere Investigation

Surface Temperature Data Sheet

* Required Field

School Name: _____ Study Site: _____

Observer names: _____

Date: Year_____ Month _____ Day _____ Universal Time (hour:min): _____

***Surface Temperature**

Site's Overall Surface Condition (Select One): ❑ Wet ❑ Dry ❑ Snow

Sample	Temperature Measurement (°C)	Snow Depth (mm) (*if snow selected above)
1		❑ zero ❑ Trace (<10 mm) ❑ Measureable (>10mm) ____ mm
2		❑ zero ❑ Trace (<10 mm) ❑ Measureable (>10mm) ____ mm
3		❑ zero ❑ Trace (<10 mm) ❑ Measureable (>10mm) ____ mm
4		❑ zero ❑ Trace (<10 mm) ❑ Measureable (>10mm) ____ mm
5		❑ zero ❑ Trace (<10 mm) ❑ Measureable (>10mm) ____ mm
6		❑ zero ❑ Trace (<10 mm) ❑ Measureable (>10mm) ____ mm
7		❑ zero ❑ Trace (<10 mm) ❑ Measureable (>10mm) ____ mm
8		❑ zero ❑ Trace (<10 mm) ❑ Measureable (>10mm) ____ mm
9		❑ zero ❑ Trace (<10 mm) ❑ Measureable (>10mm) ____ mm

Comments: _____

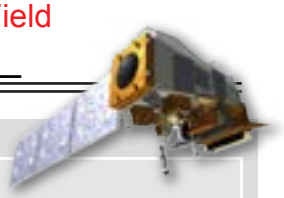
_____

***Sky Conditions (next page):**

DEACTIVATED PROTOCOL: The GLOBE Atmosphere Protocol - Surface Ozone has been deactivated as of September 2023. To learn more about the Deactivation Process, please visit the Globe.gov website.

* Required Field

Study Site: _____ Date: _____ Time (UT): _____



1. What is in Your Sky?

Total Cloud/Contrail Cover:

- ○ Sky is Obscured →
- ○ None (Go to box 2)
- ○ Few(<10%)
- ○ Isolated (10-25%)
- ○ Scattered (25-50%)
- ○ Broken (50-90%)
- ○ Overcast (90-100%)

- ○ Fog
- ○ Heavy Rain
- ○ Heavy Snow
- ○ Blowing Snow
- ○ Sand
- ○ Spray
- ○ Smoke
- ○ Dust
- ○ Haze
- ○ Volcanic Ash

Go to box 6

*If you can observe sky color or visibility, complete box 2

2. Sky Color and Visibility

Color (Look Up): ○ Cannot Observe ○ Deep Blue ○ Blue ○ Light Blue ○ Pale Blue ○ Milky

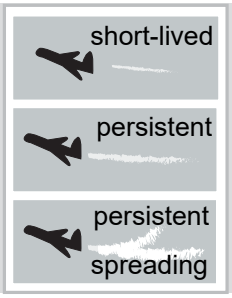
Visibility (Look Across): ○ Cannot Observe ○ Unusually Clear ○ Clear ○ Somewhat Hazy ○ Very Hazy ○ Extremely Hazy

3. High Level Clouds

○ No High Level Clouds Observed (Go to box 4)

Cloud Type:

- ○ Contrails (number of): → #
- ○ Cirrus #
- ○ Cirrocumulus #
- ○ Cirrostratus #



Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

4. Mid Level Clouds

○ No Mid Level Clouds Observed (Go to box 5)

Cloud Type:

- ○ Altostratus
- ○ Altocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

5. Low Level Clouds

○ No Low Level Clouds Observed (Go to box 6)

Cloud Type:

- ○ Fog
- ○ Nimbostratus
- ○ Cumulonimbus
- ○ Stratus
- ○ Cumulus
- ○ Stratocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

6. Surface Conditions

Mandatory:

	Yes	No		Yes	No
Snow/Ice	○	○	Dry Ground	○	○
Standing Water	○	○	Leaves on Trees	○	○
Muddy	○	○	Raining/Snowing	○	○

Optional:
You may submit any or all

Temperature: ___°C
Barometric Pressure: ___mb
Relative Humidity: ___%

Comments: _____

Atmosphere Investigation

Surface Ozone Data Sheet

* Required Field

School Name: _____ Study Site: _____

Observer names: _____

Ozone Strip Exposed at:

Date: Year_____ Month _____ Day _____ Universal Time (hour:min): _____

Ozone Strip Measured at:

Date: Year_____ Month _____ Day _____ Universal Time (hour:min): _____

***Surface Ozone** _____ (ppb)

Comments: _____

_____

***Data (When Ozone Strip was Exposed)**

***Air Temperature (°C): _____**

Relative Humidity

(Select instrument used):

❑ Sling Psychrometer	❑ Digital Hygrometer
Dry bulb temperature (˚C): _____ Wet bulb temperature (˚C): _____	Ambient air temperature (˚C): _____ Relative Humidity (%): _____

Comments: _____

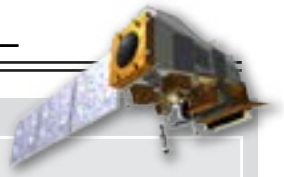
_____

***Sky Conditions (next page):**

DEACTIVATED PROTOCOL: The GLOBE Atmosphere Protocol - Surface Ozone has been deactivated as of September 2023. To learn more about the Deactivation Process, please visit the Globe.gov website.

* Required Field

Study Site: _____ Date: _____ Time (UT): _____



1. What is in Your Sky?

Total Cloud/Contrail Cover:

- ○ Sky is Obscured →
- ○ None (Go to box 2)
- ○ Few(<10%)
- ○ Isolated (10-25%)
- ○ Scattered (25-50%)
- ○ Broken (50-90%)
- ○ Overcast (90-100%)

- ○ Fog
- ○ Heavy Rain
- ○ Heavy Snow
- ○ Blowing Snow
- ○ Sand
- ○ Spray
- ○ Smoke
- ○ Dust
- ○ Haze
- ○ Volcanic Ash

Go to box 6

*If you can observe sky color or visibility, complete box 2

2. Sky Color and Visibility

Color (Look Up): ○ Cannot Observe ○ Deep Blue ○ Blue ○ Light Blue ○ Pale Blue ○ Milky

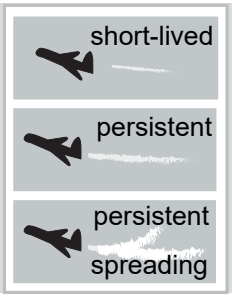
Visibility (Look Across): ○ Cannot Observe ○ Unusually Clear ○ Clear ○ Somewhat Hazy ○ Very Hazy ○ Extremely Hazy

3. High Level Clouds

○ No High Level Clouds Observed (Go to box 4)

Cloud Type:

- ○ Contrails (number of): → #
- ○ Cirrus #
- ○ Cirrocumulus #
- ○ Cirrostratus #



Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

4. Mid Level Clouds

○ No Mid Level Clouds Observed (Go to box 5)

Cloud Type:

- ○ Altostratus
- ○ Altocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

5. Low Level Clouds

○ No Low Level Clouds Observed (Go to box 6)

Cloud Type:

- ○ Fog
- ○ Nimbostratus
- ○ Cumulonimbus
- ○ Stratus
- ○ Cumulus
- ○ Stratocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

6. Surface Conditions

Mandatory:

	Yes	No		Yes	No
Snow/Ice	○	○	Dry Ground	○	○
Standing Water	○	○	Leaves on Trees	○	○
Muddy	○	○	Raining/Snowing	○	○

Optional:
You may submit any or all

Temperature: ___°C
Barometric Pressure: ___mb
Relative Humidity: ___%

* Required Field

Study Site: _____ Date: _____ Time (UT): _____

Comments: _____

_____

***Wind**

*Instrument (Check one): ❑ GLOBE Instrument ❑ Automated Instrument

0 to10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

*Direction (Check One):

North

Northwest ❑ ❑ ❑ Northeast

West ❑ ❑ East

Southwest ❑ ❑ ❑ Southeast

South

Comments: _____

_____

***Data (When Ozone Strip was Measured)**

***Air Temperature (°C): _____**

Relative Humidity

(Select instrument used):

❑ Sling Psychrometer	❑ Digital Hygrometer
Dry bulb temperature (˚C): _____	Ambient air temperature (˚C): _____
Wet bulb temperature (˚C): _____	Relative Humidity (%): _____

Comments: _____

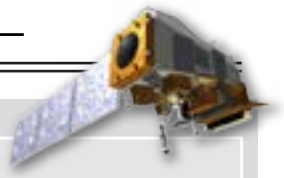
_____

***Sky Conditions (next page):**

DEACTIVATED PROTOCOL: The GLOBE Atmosphere Protocol - Surface Ozone has been deactivated as of September 2023. To learn more about the Deactivation Process, please visit the Globe.gov website.

* Required Field

Study Site: _____ Date: _____ Time (UT): _____



1. What is in Your Sky?

Total Cloud/Contrail Cover:

- ○ Sky is Obscured
- ○ None (Go to box 2)
- ○ Few(<10%)
- ○ Isolated (10-25%)
- ○ Scattered (25-50%)
- ○ Broken (50-90%)
- ○ Overcast (90-100%)

- ○ Fog
- ○ Heavy Rain
- ○ Heavy Snow
- ○ Blowing Snow
- ○ Sand
- ○ Spray
- ○ Smoke
- ○ Dust
- ○ Haze
- ○ Volcanic Ash

Go to box 6

*If you can observe sky color or visibility, complete box 2

2. Sky Color and Visibility

Color (Look Up): ○ Cannot Observe ○ Deep Blue ○ Blue ○ Light Blue ○ Pale Blue ○ Milky

Visibility (Look Across): ○ Cannot Observe ○ Unusually Clear ○ Clear ○ Somewhat Hazy ○ Very Hazy ○ Extremely Hazy

3. High Level Clouds

○ No High Level Clouds Observed (Go to box 4)

Cloud Type:

- ○ Contrails (number of): #
- ○ Cirrus #
- ○ Cirrocumulus #
- ○ Cirrostratus #

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

4. Mid Level Clouds

○ No Mid Level Clouds Observed (Go to box 5)

Cloud Type:

- ○ Altostratus
- ○ Altocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

5. Low Level Clouds

○ No Low Level Clouds Observed (Go to box 6)

Cloud Type:

- ○ Fog
- ○ Nimbostratus
- ○ Cumulonimbus
- ○ Stratus
- ○ Cumulus
- ○ Stratocumulus

Cloud Cover:

- ○ Few (<10%)
- ○ Isolated (10%-25%)
- ○ Scattered (25%-50%)
- ○ Broken (50%-90%)
- ○ Overcast (>90%)

Visual Opacity:

- ○ Opaque
- ○ Translucent
- ○ Transparent

6. Surface Conditions

Mandatory:

	Yes	No		Yes	No
Snow/Ice	○	○	Dry Ground	○	○
Standing Water	○	○	Leaves on Trees	○	○
Muddy	○	○	Raining/Snowing	○	○

Optional:

You may submit any or all

Temperature: ___°C

Barometric Pressure: ___mb

Relative Humidity: ___%

* Required Field

Study Site: _____ Date: _____ Time (UT): _____

Comments: _____

_____

***Wind**

*Instrument (Check one): ❑ GLOBE Instrument ❑ Automated Instrument

0 to10% ❑ 10 to 25% ❑ 25 to 50% ❑ >50%

*Direction (Check One):

North

Northwest ❑ ❑ ❑ Northeast

West ❑ ❑ East

Southwest ❑ ❑ ❑ Southeast

South

Comments: _____

_____

Observing Cloud Type

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

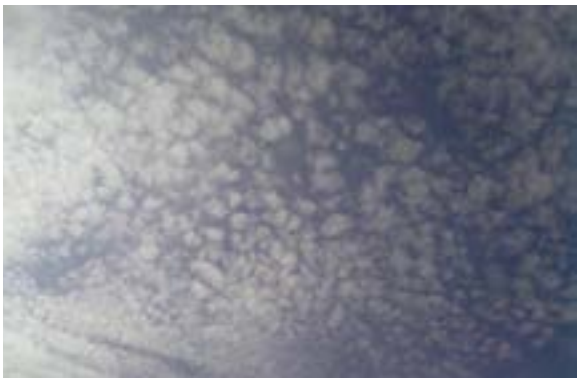
CIRRO or high clouds
ALTO or middle clouds
CUMULUS or white puffy clouds
STRATUS or layered clouds
NIMBUS or clouds from which precipitation is falling

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.

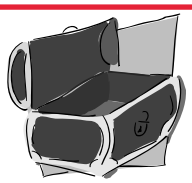
Cumulus

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*.