

NASA Earth Science Education to understand our atmosphere: Observing aerosols and clouds.

American Meteorological Society

94th Annual Meeting

Teacher Workshop and Share-a-thon

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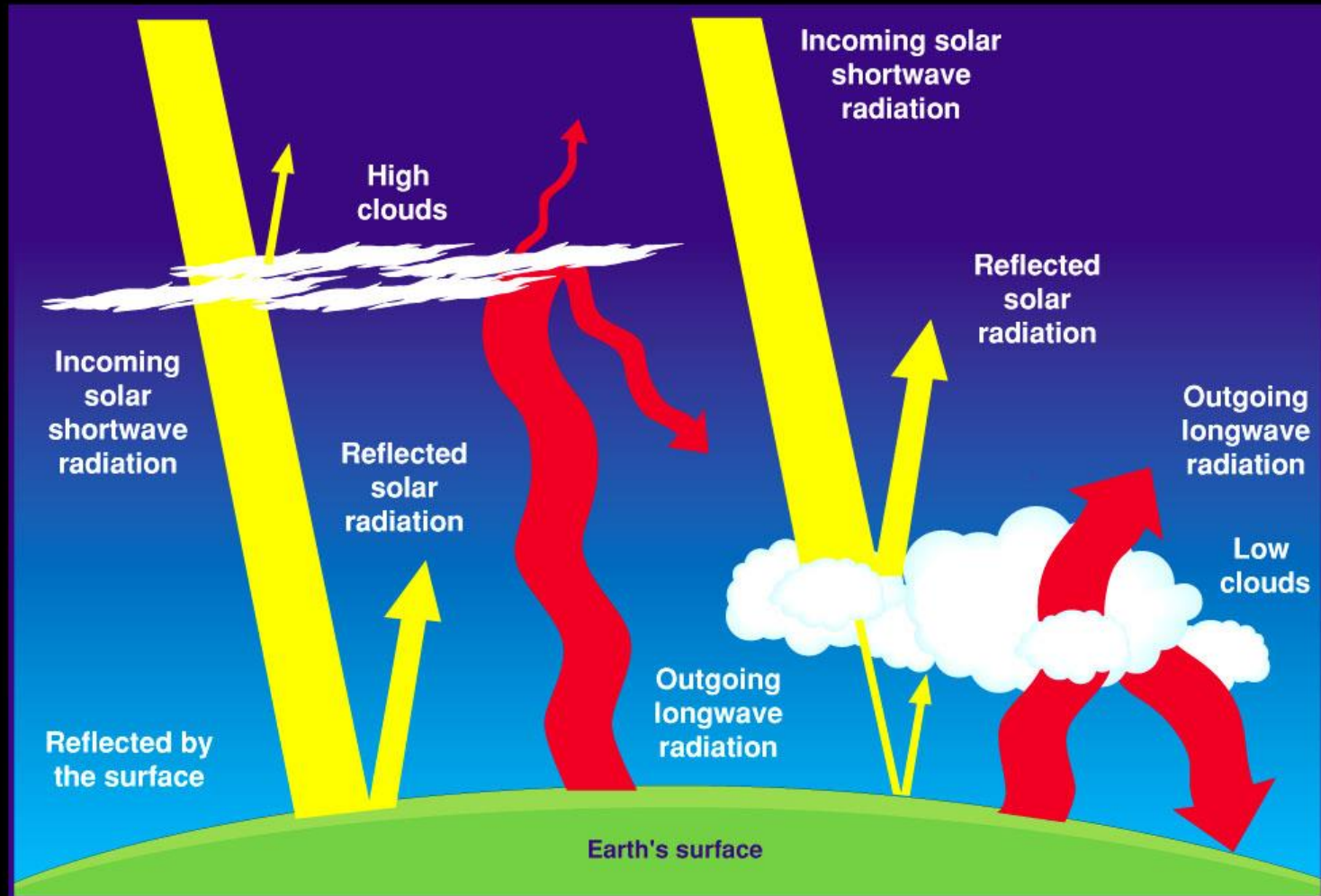
Bell Ringer...

Group 1: How do clouds effect climate?

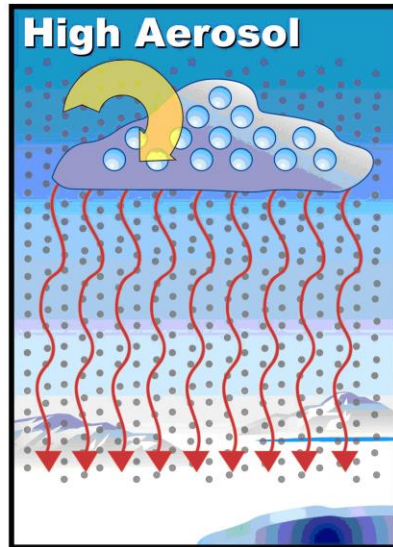
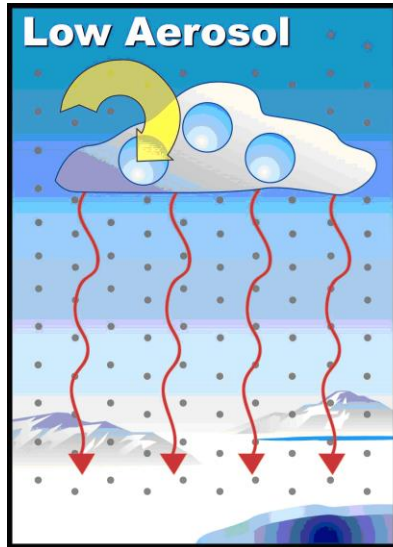
Group 2: How do aerosols concentrations effect climate?

Group 1: How do cloud effect the Earth's climate?

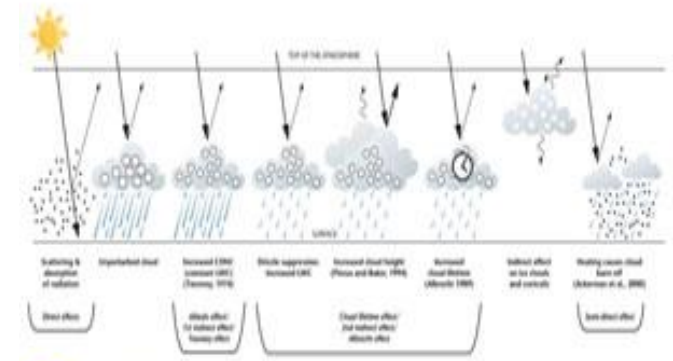
Cloud Effects On Earth's Radiation



Group 2: How do aerosols concentrations effect the Earth's climate?

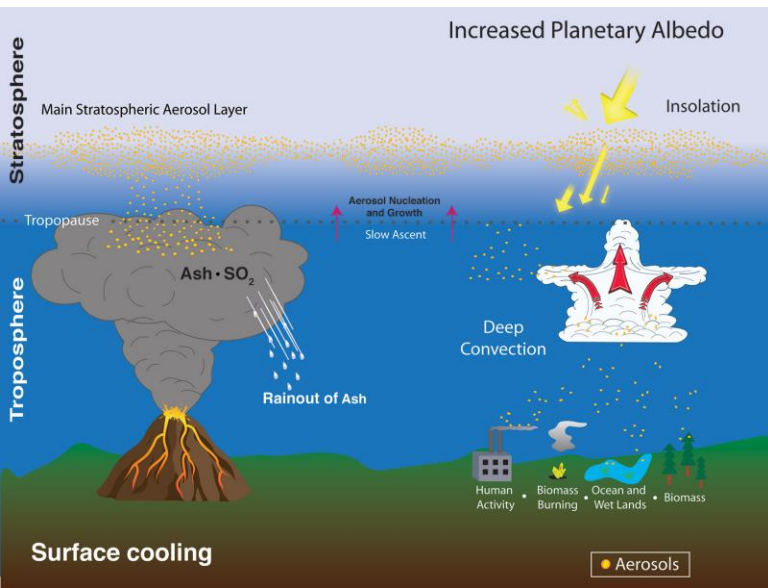
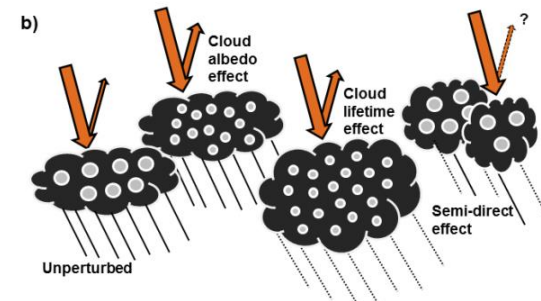
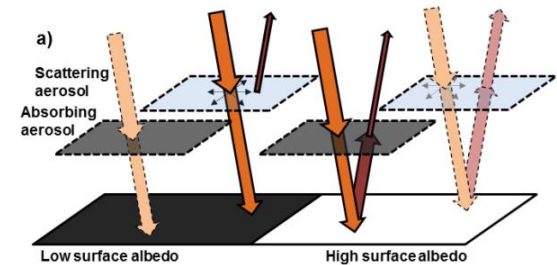


<http://www.bnl.gov/newsroom/news.php?a=1413>



Met Office

<http://www.metoffice.gov.uk/research/areas/chemistry-ecosystems/aerosols>



<http://www.nasa.gov/topic/s/earth/features/stratospheric-aerosols.html>

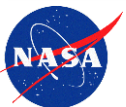
<http://www.nature.com/scitable/knowledge/library/aerosols-and-their-relation-to-global-climate-102215345>

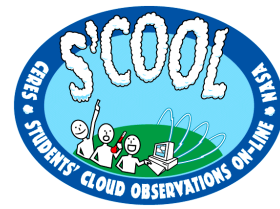


S'COOL is...

The CERES S'COOL Project is a 16 year running and *involves students and the citizen science community in real science*, by making and reporting ground truth observations of clouds *to assist NASA in the validation of the CERES satellite instruments*.

The multilingual S'COOL website boasts over 80 classroom lesson plans, an interactive reporting system and helpful materials and resources for observing clouds. The S'COOL Project has a broad range of users in 84 countries around the world and has collected over 120,000 ground observations.





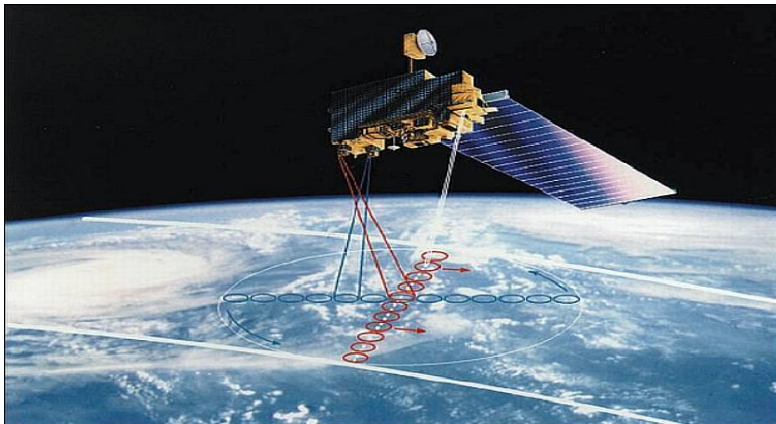
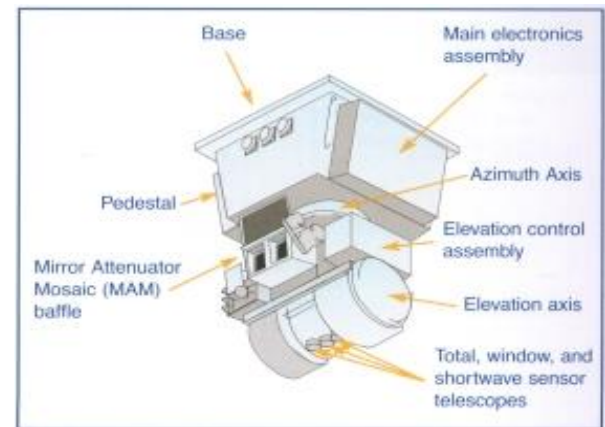
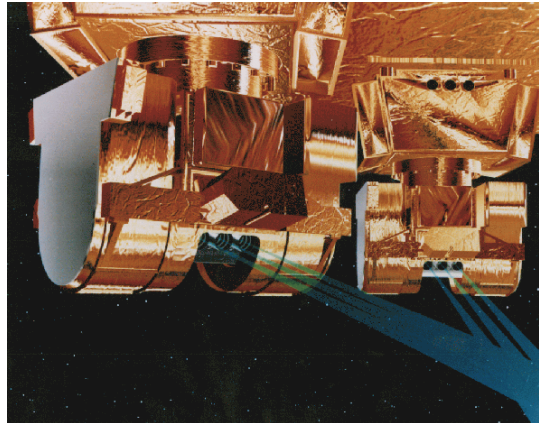
Why is it important that we study clouds?



- Temperature
- Weather
- Climate
- Plants
- Animals
- Agriculture
- Humans

Global Cloud cover is 50-70%

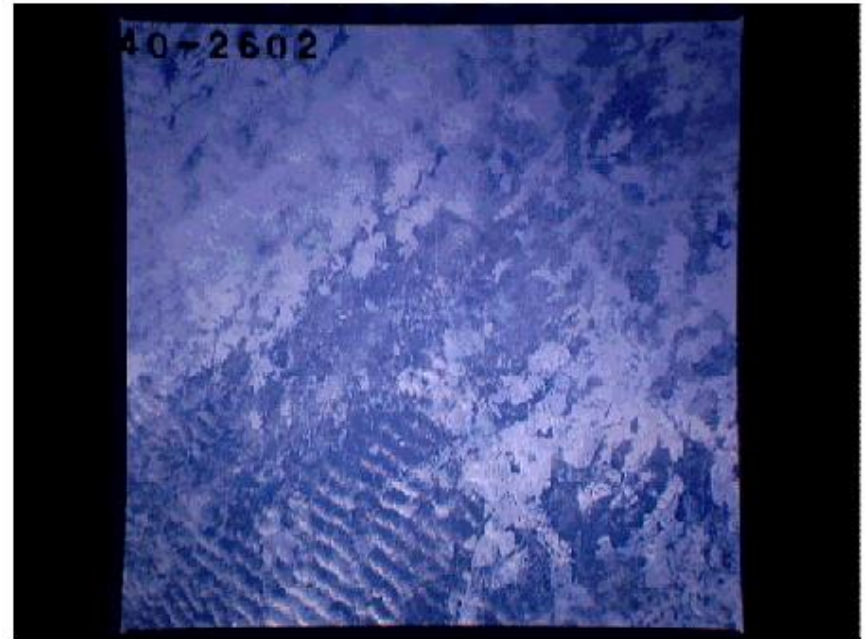
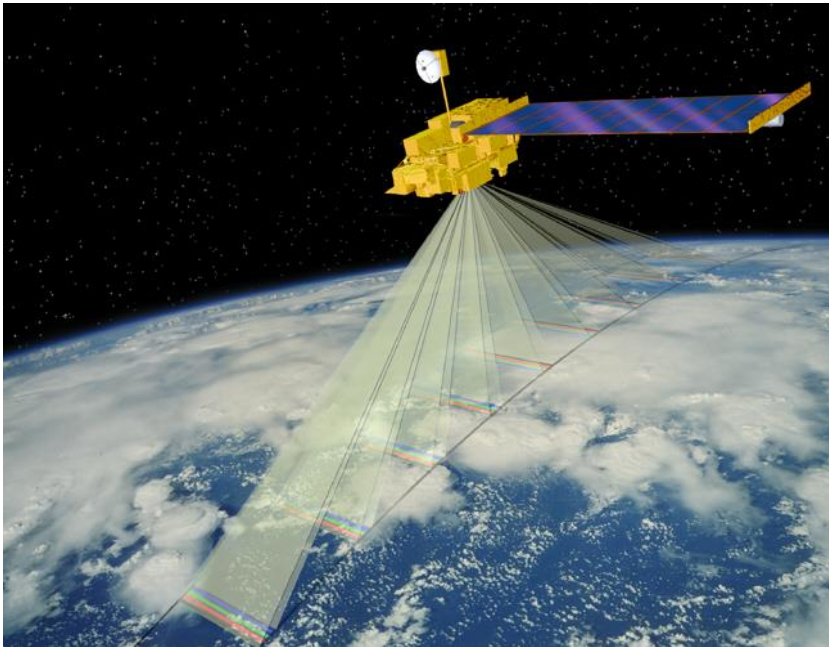
How do we (NASA) measure the Earth's radiation Budget?

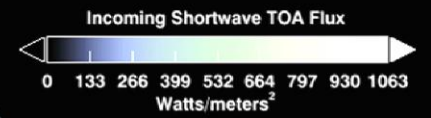
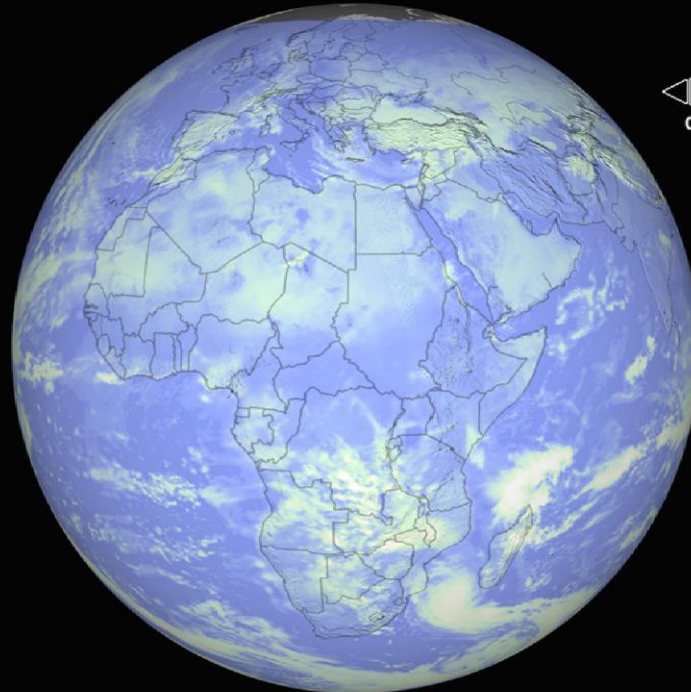
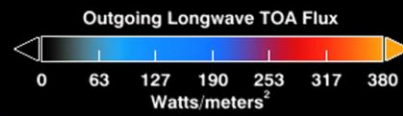
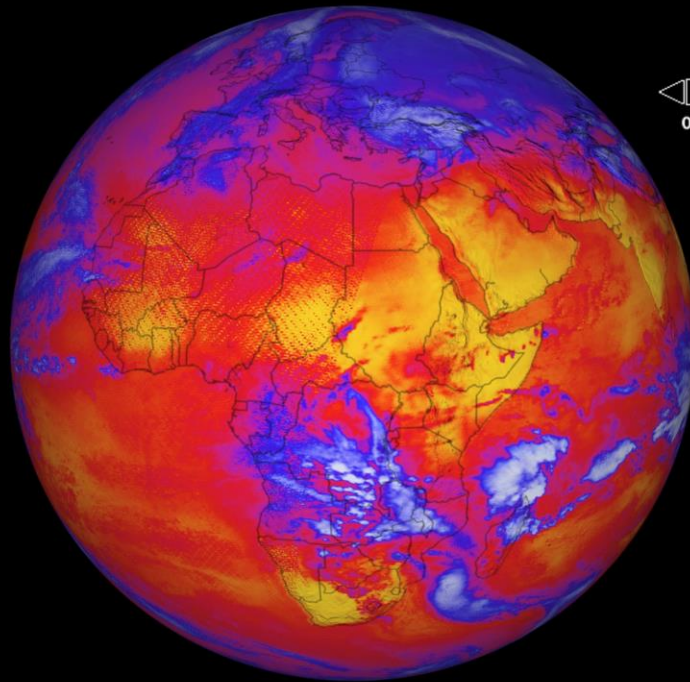


The CERES instruments are remote sensors that measure the solar reflected and Earth emitted radiation.

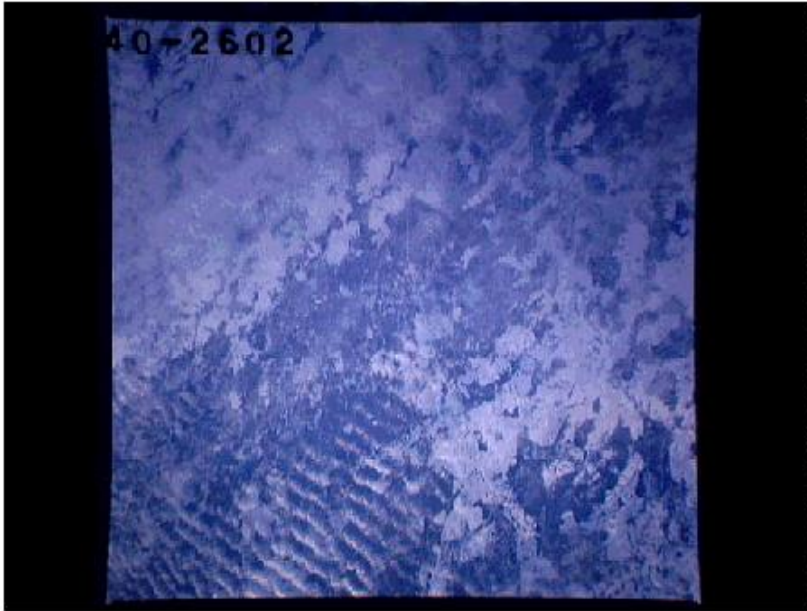
Remote Sensing

Remote sensing has been defined as "a technique used to gather information about an object or an area without actually touching it". Our eyes, ears, and skin, as well as more sophisticated instruments, all aid us in remote sensing.





Why does NASA need help from Observers?



Satellite view of the clouds



Student Observation

The students also saw mountains with snow and ice



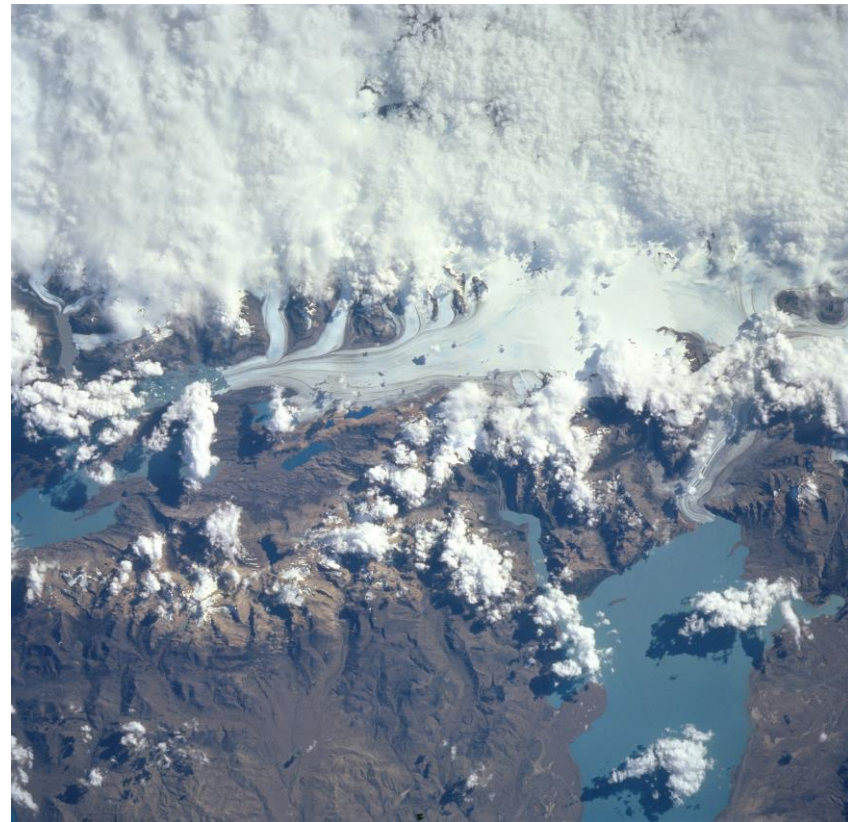
Clouds Looking Up



Clouds Looking Down



25% Cloud Cover



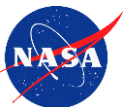
70 % Cloud Cover



Importance of Studying Clouds

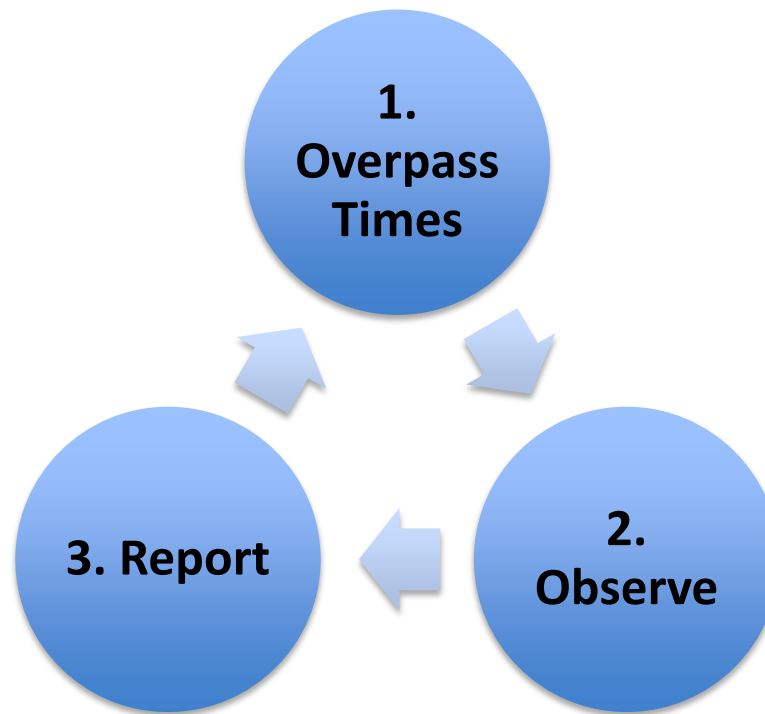
Clouds are an important part of our atmosphere, and scientists are studying how they affect our weather and climate. S'COOL observations provide one more piece of the puzzle.

[<http://science-edu.larc.nasa.gov/SCOOL/FindOutMore-whyback.html>](http://science-edu.larc.nasa.gov/SCOOL/FindOutMore-whyback.html)



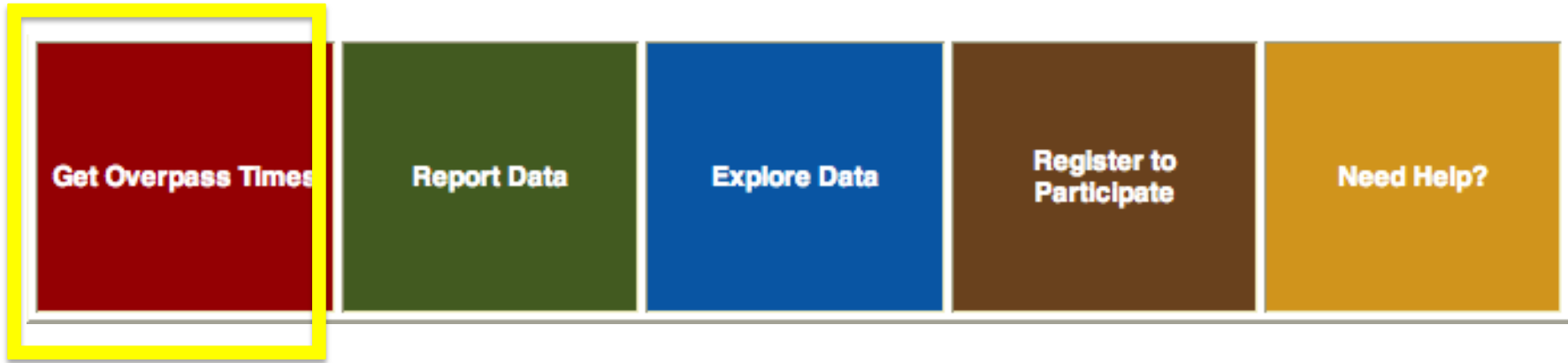
3 Easy Steps

Being a S'COOL Observer is easy!



Explore: See your data over time and what other classes around the world are seeing!

Request Satellite Overpass Times



Login:

Password:

Satellite:

- ☐ Daylight Saving Time in Effect for Period Selected.
- ☐ Do you want Nighttime Overpass Schedules?

Observation Period:

Note: We suggest that your start date must be greater than today's date. Please try not to calculate the overpasses for more than 1 - 2 months ahead of time. There are changes in the orbit that might not be reflected correctly any further in the future.

Starting Date:

Ending Date:

Observe and Report Clouds

Students' Cloud Observations On-Line
REPORT FORM

Observer Information: Rover Nickname/Login ID: _____ Email: _____
 Date (ex. 2011 09 20): Year ____ Month ____ Day ____ Satellite: _____
 Local Time (24 Hour Clock: ex. 14 26): Hour ____ Minute ____ Universal Time: Hour ____ Minute ____

Make A S'COOL Observation!

① **Total Cloud Cover:** ☐ No Clouds ☐ Clear (<10%) ☐ Isolated (10%-25%) ☐ Scattered (25%-50%) ☐ Broken (50%-90%) ☐ Overcast (>90%)
Sky Visibility: ☐ Unusually Clear ☐ Clear ☐ Somewhat Hazy ☐ Very Hazy ☐ Extremely Hazy
Sky Color: ☐ Deep Blue ☐ Blue ☐ Light Blue ☐ Pale Blue ☐ Milky

Number of Short Lived _____ Number of Persistent _____ Number of Persistent Spreading _____

② **What do you see? High Level Clouds**

Cloud Type: ☐ Cirrus ☐ Cirrocumulus ☐ Altostratus	Cloud Cover: ☐ Clear (<10%) ☐ Isolated (10%-25%) ☐ Scattered (25%-50%) ☐ Broken (50%-90%) ☐ Overcast (>90%)	Visual Opacity: ☐ Opaque ☐ Translucent ☐ Transparent
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③ **What do you see? Mid Level Clouds**

Cloud Type: ☐ Altostratus ☐ Alto cumulus	Cloud Cover: ☐ Clear (<10%) ☐ Isolated (10%-25%) ☐ Scattered (25%-50%) ☐ Broken (50%-90%) ☐ Overcast (>90%)	Visual Opacity: ☐ Opaque ☐ Translucent ☐ Transparent
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④ **What do you see? Low Level Clouds**

Cloud Type: ☐ Fog ☐ Nimbostratus ☐ Cumulonimbus ☐ Stratocumulus ☐ Cumulus ☐ Stratocumulus	Cloud Cover: ☐ Clear (<10%) ☐ Isolated (10%-25%) ☐ Scattered (25%-50%) ☐ Broken (50%-90%) ☐ Overcast (>90%)	Visual Opacity: ☐ Opaque ☐ Translucent ☐ Transparent
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⑤ **What do you observe? Ground Measurements**

Surface Cover: (Mandatory) Yes No ☐ Snow/Ice ☐ Standing Water ☐ Muddy ☐ Dry ground ☐ Leaves on Trees ☐ Raining/Snowing	Surface Measurements: (Optional - you may submit any or none) Temperature: ____ °C or ____ °F Barometric Pressure: (Select One) ____ ohPa ____ psi ____ inches Hg ____ omb ____ atm ____ torr (mm Hg) Relative Humidity: ____ %
--	---

Comments: _____

Date of Ground Observation:	2013 v January v Day v
Satellite:	Select Satellite v
Time of Ground Observation:	Local Time: Hour v Minute v Universal Time: Hour v Minute v
Useful Resources: Cloud Observation Observing Cloud Type Contrails Visual Opacity Surface Cover Sky Color	
- If No Clouds in section 1 - Total Cloud Cover select "No Clouds (0%)" then skip down to section 5 - Surface Observation. - If clouds are present, fill in the sections levels below where clouds were observed. - If more than one cloud type per level, record in the Comments section located at the bottom of this form.	
1 Total Cloud Cover: (required) Sky Visibility: (optional) Sky Color: (optional)	Total Cloud Cover v Sky Visibility v Sky Color v
2 ☐ High Level Clouds: Complete only if clouds observed at this level.	Persistent Non-spreading Contrails Select One v Persistent Spreading Contrails Select One v Short-Lived Contrails Select One v
	Cloud Type: Select One v Cloud Cover: Select One v Visual Opacity: Select One v
3 ☐ Mid Level Clouds: Complete only if clouds observed at this level.	Cloud Type: Select One v Cloud Cover: Select One v Visual Opacity: Select One v
4 ☐ Low Level Clouds: Complete only if clouds observed at this level.	Cloud Type: Select One v Cloud Cover: Select One v Visual Opacity: Select One v

What's New on the Report Form?

Students' Cloud Observations On-Line
REPORT FORM

Observer Information: Rover Nickname/Login ID: _____ Email: _____
 Date (ex. 2011 09 20): Year ____ Month ____ Day ____ Satellite: _____
 Local Time (24 Hour Clock: ex. 14 26): Hour ____ Minute ____ Universal Time: Hour ____ Minute ____

Make A S'COOL Observation!

① Total Cloud Cover: ☐ No Clouds ☐ Clear (<10%) ☐ Isolated (10-25%) ☐ Scattered (25-50%) ☐ Broken (50-90%) ☐ Overcast (90-100%)
 Sky Visibility: ☐ Unusually Clear ☐ Clear ☐ Somewhat Hazy ☐ Very Hazy ☐ Extremely Hazy
 Sky Color: ☐ Deep Blue ☐ Blue ☐ Light Blue ☐ Pale Blue ☐ Milky

Number of Short Lived _____ Number of Persistent _____ Number of Persistent Spreading _____

②

What do you see? High Level Clouds

☐ Cirrus	☐ Clear (<10%)	☐ Opaque
☐ Cirrocumulus	☐ Isolated (10%-25%)	☐ Translucent
☐ Cirrostratus	☐ Scattered (25%-50%)	☐ Transparent
	☐ Broken (50%-90%)	
	☐ Overcast (>90%)	

③

What do you see? Mid Level Clouds

Cloud Type:	Cloud Cover:	Visual Opacity:
☐ Altostratus	☐ Clear (<10%)	☐ Opaque
☐ Altocumulus	☐ Isolated (10%-25%)	☐ Translucent
	☐ Scattered (25%-50%)	☐ Transparent
	☐ Broken (50%-90%)	
	☐ Overcast (>90%)	

④

What do you see? Low Level Clouds

Cloud Type:	Cloud Cover:	Visual Opacity:
☐ Fog	☐ Clear (<10%)	☐ Opaque
☐ Nimbostratus	☐ Isolated (10%-25%)	☐ Translucent
☐ Cumulonimbus	☐ Scattered (25%-50%)	☐ Transparent
☐ Stratus	☐ Broken (50%-90%)	
☐ Cumulus	☐ Overcast (>90%)	
☐ Stratocumulus		

⑤

What do you observe? Ground Measurements

Surface Cover: (Mandatory)	Surface Measurements:
Yes No	(Optional – you may submit any or all)
☐ ☐ Snow/Ice	Temperature: ____ °C or °F
☐ ☐ Standing Water	Barometric Pressure: (Select One)
☐ ☐ Muddy	____ hPa ____ psi ____ inches Hg
☐ ☐ Dry ground	____ omb ____ atm ____ torr (mm Hg)
☐ ☐ Leaves on Trees	Relative Humidity: ____%
☐ ☐ Raining/Snowing	

Comments: _____

New Observations include:

- Sky Conditions
- 3 Contrail Categories

Explore Data

Escuela	Latitud	Longitud	Ciudad	Estado	País
Colegio San Jose Hermanas Franciscanas Misioneras	4.612400	-74.092500	Bogota D.C	Outside U.S.-Canada	Colombia

Observación de Tierra: 99536				Satélite Terra				
Fecha: 2011-07-14		Hora Local: 10:12	Hora Universal: 15:12	Fecha: 2011-07-14		Universal Time: 15:17:00		
Opacidad	Cubierta de Nube	Tipo	Visualización		Altitude (km)	Opacity	Cloud Cover	Phase Temp(K)
					6.72	Opaco 12.72	Parte Nublado (5% to 50%) 15.93	hielo 258.77
					4.91	Opaco 19.7	Casi Todo Nublado (50% to 95%) 77.95	mixed 269.85
Translucente	Todo (95% to 100%)	Estratocumulo						
Estelas Persistente: 0 Estelas Pasajera: 0								
Observaciones Superficiales Nieve/Hielo: Agua Estancada: Fangoso: Tierra Seca: Hojas en Árboles: ¿Está lloviendo o nevando:		Vertical Profiles Along the MODIS Centerline Cloudsat Quick Look Cloudsat Tutorial CALIPSO Expedited Browse Image CALIPSO Tutorial						
Comments: No comments provided by participant.								

Why is it important?

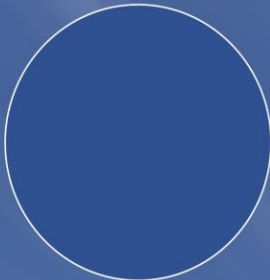
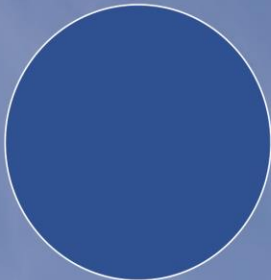
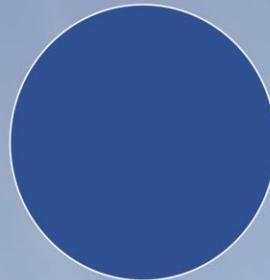
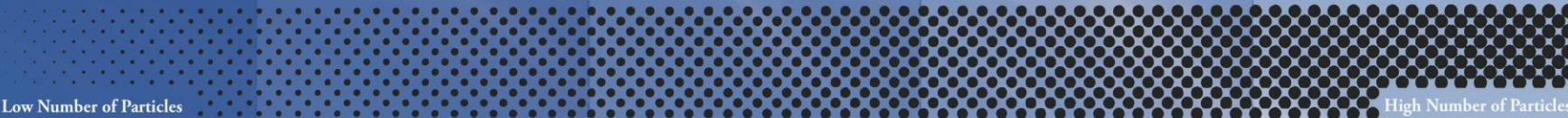
- Cloud affect the earth's weather and climate.
- You are our eyes on the ground!
- Everyone plays a part and everyone can do their part to understand and help our world!



SKY CONDITIONS

The amount of aerosols in the atmosphere affects our sky conditions. Most aerosols are too small to see but we can observe their impacts by observing and categorizing sky color and visibility. Observing these parameters helps us to understand how aerosols reflect, refract, and absorb energy entering and leaving the Earth's atmosphere.

*Each circle represents the conditions of an unusually clear, deep blue sky. The addition of drops of milk into the water represents an increasing amount of aerosols in the atmosphere.

					
	Clear H ₂ O, No Drop of Milk	~ .5 Drops of Milk	~1 Drop of Milk	~2 Drops of Milk	4 Drops of Milk
Sky Color	Deep Blue	Blue	Light Blue	Pale Blue	Milky
Aerosols					
	Low Number of Particles				High Number of Particles
Visibility	Unusually Clear	Clear	Somewhat Hazy	Very Hazy	Extremely Hazy

Helpful tips for observing sky conditions:

- When observing sky condition, look for something out of the ordinary. Different locations can have different common observations (commonly clear or commonly hazy).
- To get a good starting point for sky condition observations in your area, wait for a cold front or a storm to pass through. A cold front or a storm tends to "wash" the aerosols out of the atmosphere which will provide the clearest sky conditions for your area. It also helps to take a picture, as this will be a good comparison for later sky condition observations.



Sky Conditions Activity

Activity Introduction:

In this activity, students discover the importance of sky observations to better understand the effects of aerosols on our atmosphere.

Audience: K-8

Resource Type: Activity or Demonstration

Learning Time: 15- 30 minutes

Instructional Strategies: Hands-on-learning; Inquiry Based Learning

Learning Objectives:

Student will:

- Learn that by observing sky color and visibility; one can see the impact of aerosols on the atmosphere.
- Learn that clouds and aerosols in Earth's atmosphere can be measured with observations through light/lasers/lidar.

Materials:

- S'COOL Sky Conditions Poster
- Clear Plastic Cups (suggested: 4" Tall with a 2" diameter base)
- Water
- Milk or Liquid Coffee Creamer
- Stirring Utensil
- Activity Procedure printout

Vocabulary:

Aerosol: Small liquid or solid particles dispersed in the atmosphere (man-made or naturally occurring). Large quantities are often regarded as pollutants in the form of haze and smoke. A low amount of aerosols in the atmosphere relates to unusually clear visibility and a deep blue-sky color. Visibility is extremely hazy and the sky color is milky when there are a lot of aerosols present in the atmosphere. (NASA Aerosol Fact Sheet-<http://www.nasa.gov/centers/langley/news/factsheets/Aerosols.html>)

Visibility: The classification of the clarity with which objects can be viewed through the intervening atmosphere is divided into 5 categories: Unusually Clear, Clear, Somewhat Hazy, Very Hazy, and Extremely Hazy.

Sky Color: The classification of the color of the sky into one of the following 5 categories: Deep Blue, Blue, Light Blue, Pale Blue, and Milky. Near the horizon it is typically lighter due to the presence of aerosols. The darkest part of sky can often be seen about half way between the horizon and directly overhead, in the "anti-sun" direction - that is, when you look at the sky with your shadow in front of you. When observing Sky Color you should classify the darkest (bluest) color of the sky (S'COOL Sky Color Chart-<http://scool.larc.nasa.gov/skycolor.html>)

Engagement: *What can cause good or bad visibility in the atmosphere? Why?*

Background:

The sunlight that enters our atmosphere is composed of all the colors in the rainbow. When it hits the atmosphere, air molecules (water vapor, oxygen, nitrogen, CO₂, and other trace gases) scatter the light; the color blue is scattered most effectively.

The light is also scattered and/or absorbed by particles dispersed in the atmosphere called aerosols. An aerosol can be liquid or solid: mists and droplets, or tiny particles or material, such as ash. Aerosols can be anthropogenic (man-made) or naturally occurring.

The amount of aerosols in the atmosphere affects our sky conditions. Most aerosols are too small to see but we can observe their impacts by observing and categorizing sky color and visibility. A low amount of aerosols in the atmosphere relates to unusually clear visibility and a deep blue sky color. Visibility is extremely hazy and the sky color is milky when there are a lot of aerosols present in the atmosphere.

Observing these parameters helps us to understand our sky condition and make an educated guess about the amount of aerosols in our atmosphere.

NASA's CALIPSO satellite relies on remote sensing measurements from a laser and its reflected light, called a lidar, to gather information about clouds, aerosols, and their effects on our atmosphere.

Sky Conditions Activity Procedure

Set up:

1. Place a plastic cup on each of the five blue circles on the poster.
2. Fill each cup with 1.5-2" of water.
3. Starting with the second circle from the left, add increasing drops of milk to the cups as you move to the right on the poster. Add milk drops as instructed on the poster in black text under each circle.
4. Using a stirring utensil, mix milk well to achieve an even consistency.

(*NOTE: You should have an increase of milky water as you move from left to right on the poster starting with clear water.)

*Additional Set Up Information:

1. It may help to use the first cup (clear water) and the last cup (milky water) to make the cups in between. For example:
 - a. For the Light Blue/ Somewhat Hazy cup use a half and half mixture of the Deep Blue/Unusually Clear and Milky/Extremely Hazy cups.
 - b. For the Blue/Clear cup use a half and half mixture of the Deep Blue/Unusually Clear and Light Blue/ Somewhat Hazy cups.
 - c. For the Pale Blue/Very Hazy cup use a half and half mixture of the Light Blue/ Somewhat Hazy and Milky/Extremely Hazy cups.
2. Only fill cup to 1.5-2", to decrease the chance of accidental spills and clean up.

Exploration: *Have students observe and compare the "sky color" and "visibility" through each cup.*

1. To best observe the sky color parameter, view cup from the top. Look straight down into the cup to view the new color of the blue circle under the cup.
2. To best view visibility parameter, view cup from the top as well as the side. Look through the cup/liquid and compare the different cups side by side.

Questions:

1. What does the water and drops of milk stand for in each cup? (Water = Atmosphere, Milk = Aerosols)
2. In this activity, how does the increase of milk affect the water color and visibility? The cup of water represents our atmosphere. (Milky cup = Low/Hazy Visibility, Clear cup = high/clear visibility and blue sky)
3. What are some examples of these conditions in real life?(High amount of aerosols = pollution or smoke, Low amount of aerosols = clear day or after a storm/rain to wash the aerosols out of the air)

Explanation:

The amount of aerosols in the atmosphere affects our sky conditions. Most aerosols are too small to see but their impact can be observed by categorizing sky color and visibility. Observing these parameters helps participants understand how aerosols scatter and absorb energy entering and leaving the Earth's Atmosphere.

Elaboration:

- S'COOL CALIPSO Activity: CALIPSO Profile of the Atmosphere (http://scool.larc.nasa.gov/lesson_plans/4_CALIPSO_Profile_of_the_Atmosphere.pdf)
- S'COOL Project, Report Form (<http://science-edu.larc.nasa.gov/SCool/pdf/forme-ol.pdf>)
- MY NASA DATA Lesson: Sky Color for Kids (<http://mynasadata.larc.nasa.gov/804-2/sky-color-for-kids/>)
- MY NASA DATA Lesson: What is Your Sky Color (<http://mynasadata.larc.nasa.gov/what-color-is-your-sky/>)

Evaluation:

Student understanding and completion of this activity can be used to formatively assess the topics of this activity (the affect of aerosols in the atmosphere, measured by sky color and visibility).

Sky Conditions Activity URL:

http://science-edu.larc.nasa.gov/SCool/pdf/Sky_Conditions_ActivityVer1.pdf

Students' Cloud Observations On-Line:

<http://scool.larc.nasa.gov/>





Science Content: What are Aerosols?

- Solid or liquid particles suspended in the air

Sources:

- Natural: volcanoes, sea spray, dust, smoke, wind erosion, water droplets, ice particles, pollen
- Human: plowing, surface mining, combustion



© National Center for Atmospheric Research





Science Content: Effects of Aerosols



Photo taken by Carlye Calvin

© University Corporation for Atmospheric Research

- Too small to be seen individually (100's – 1000's nm)
- They scatter visible sunlight:
 - The sky looks dirty or hazy
 - Creates brilliant orange and red skies at sunrise and sunset
 - Creates a large aureole around the sun or full moon
 - Some act as nuclei formation of cloud drops or ice crystals





Science Content: Aerosols and Light Absorption

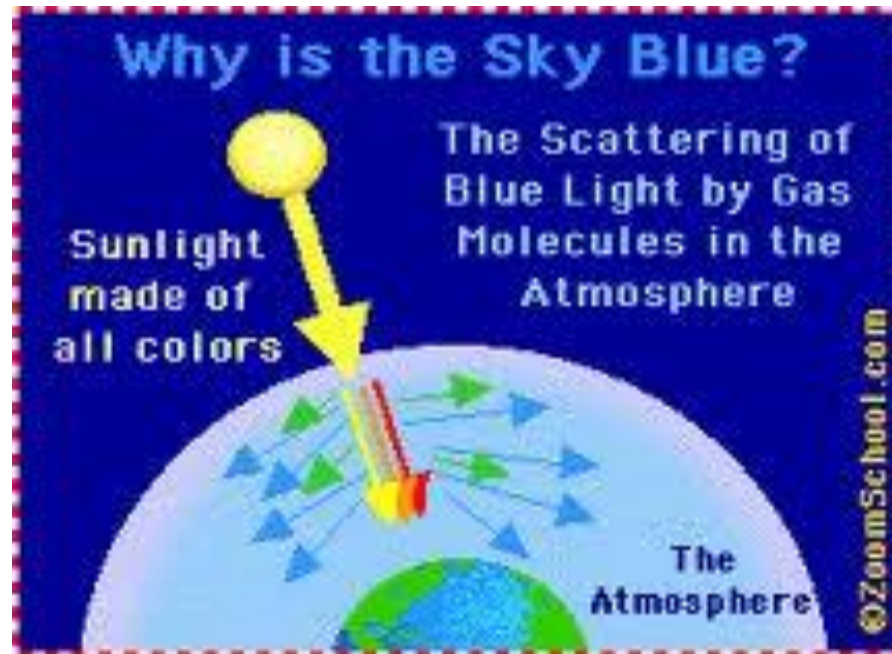
- Sunlight includes a range of wavelengths
- Aerosols and gases absorb and scatter light best at wavelengths that match their size
- Both gases and aerosols absorb and scatter sunlight
- If we know (1) atmospheric pressure, and (2) the elevation angle of the sun, we know the amount of gas between us and the sun
- In the absence of clouds, any light absorption not caused by atmospheric gas is from aerosols





Atmosphere Investigation

Aerosols Protocol



- The atmosphere consists primarily of molecules of oxygen and nitrogen. Sunlight bounces off these molecules, a process called scattering. Light with shorter wavelengths, at the blue end of the visible light spectrum, is scattered more efficiently than longer wavelengths.





Effects of Aerosols

- Aerosols are too small to be individually visible, but you can often see their combined effect when the sky is hazy or looks dirty. Brilliant orange skies at sunrise and sunset may also be indicators that aerosols are present.





Sky Conditions

Visibility Categories

Unusually clear

Clear

Somewhat hazy

Very hazy

Extremely hazy

Sky Color Categories

Deep blue

Blue

Light blue

Pale blue

Milky



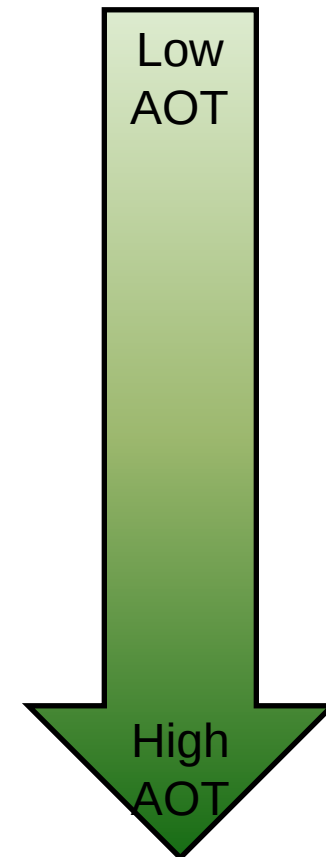


Guide to Sky Colors

These colors are intended as an approximate guide to the interpretation of the sky color choices on the data entry form. The appearance of colors on computer monitors varies quite a bit depending on the quality and adjustment of your monitor.

deep blue (bleu foncé)
blue (bleu soutenu)
light blue (bleu clair)
pale blue (bleu pale)
milky (laiteux)

Aerosol Amount
Aerosol Optical Thickness (AOT)





Sky Color

- Observing Color
 - Observe darkest part of sky
 - generally half way between horizon and directly overhead
 - Anti-sun direction
 - shadow in front of you



Photo by Mason Resnick

<http://www.adorama.com/alc/article/8351>





Other Colors

- In some places, especially in and near urban areas, the sky can have a **brownish** or **yellowish** tint due to air pollution
 - primarily particulates and NO₂



Photo by Joseph Eid/AFP/Getty Images

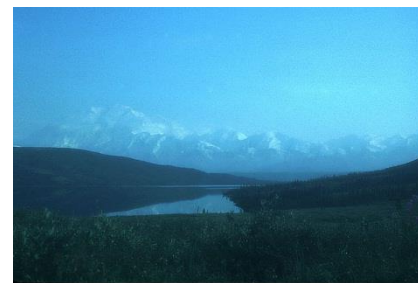
<http://www.guardian.co.uk/environment/2010/sep/10/eu-emissions-trading-savings>





Visibility

- *Visibility* - Clarity with which objects can be viewed through the intervening atmosphere.



Denali National Park, National Park Service Air Quality Office
<http://www.shodor.org/metweb/session8/gallery.html>

Unusually
Clear

Clear

Somewhat
Hazy

Very
Hazy

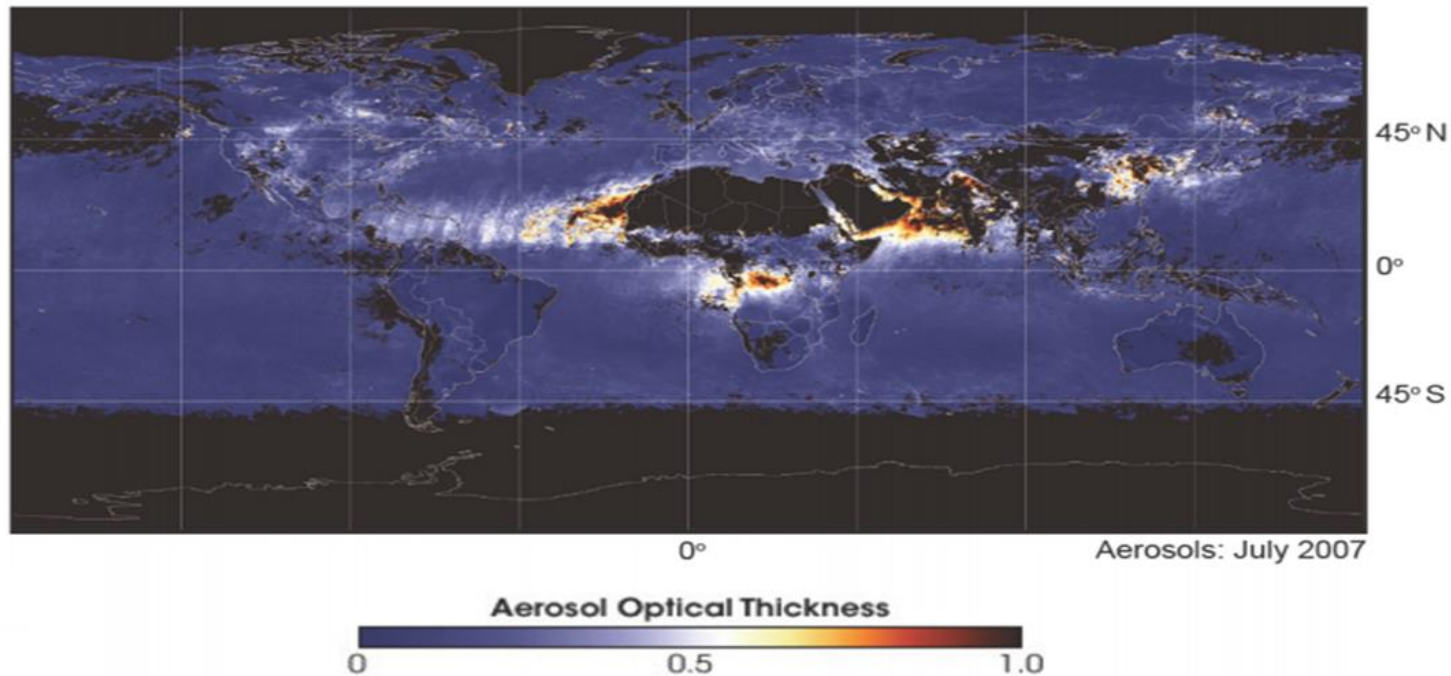
Extremely
Hazy





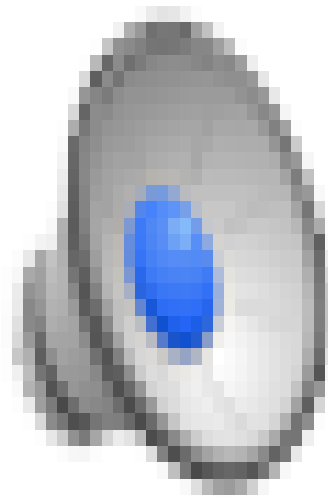
Values of Aerosol Optical Thickness (AOT)

- Clear Sky, visible light – AOT ~ 0.1
- Very Clear Sky, green light – AOT ~ 0.05 or less
- Very Hazy Skies – AOT ~ 0.5 or greater





Aerosol Animation





Percent Transmission

- Percentage of light that is transmitted through the atmosphere
 - percent transmission = $100 \times e^{-a}$ (where a is optical thickness at a particular wavelength)
- This is percentage of light at a particular wavelength that would be transmitted through the atmosphere if the sun were directly overhead.
 - For an optical thickness of 0.10, the percent transmission is about 90.5%.

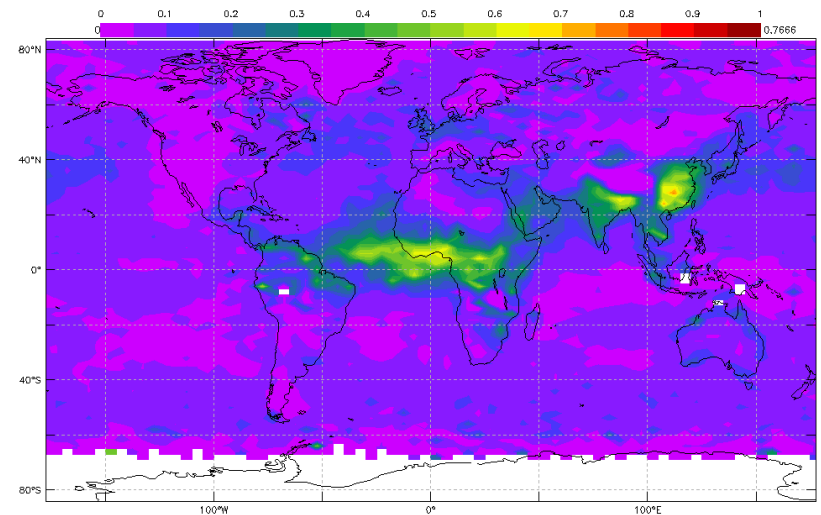
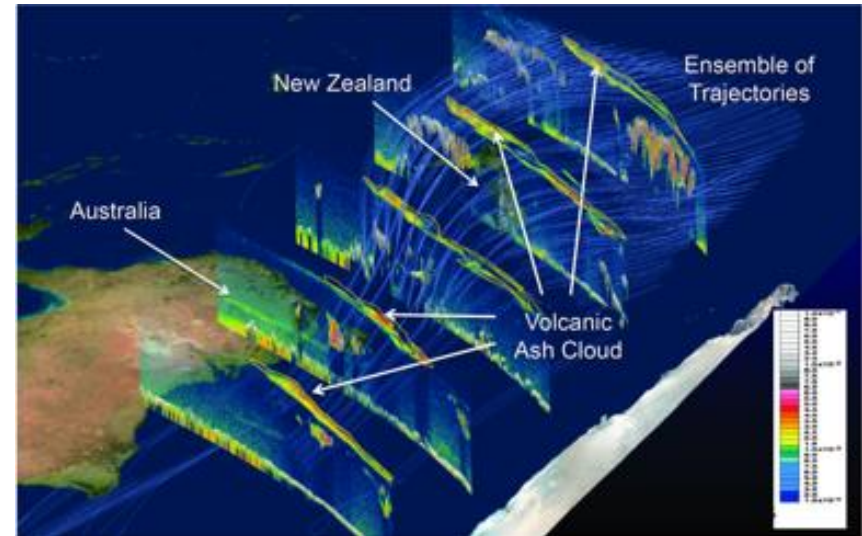
Optical Thickness	Percent Transmission
0.10	90.5%
0.20	81.9%
0.30	74.1%
0.40	67.0%
0.50	60.7%
0.60	54.9%
0.75	47.2%
1.00	36.8%
1.25	28.7%
1.50	22.3%
2.00	13.5%
2.50	8.2%
3.00	5.0%
3.50	3.0%
4.00	1.8%
5.00	0.7%



Seasonal Patterns of Aerosols on MY NASA DATA

In this activity, students will become familiar with aerosols and use the MY NASA DATA Live Access Server (LAS) to create maps to analyze seasonal patterns of aerosols. Through this inquiry activity, students take on the role of NASA researcher and must create a short presentation for their team on the seasonal patterns of aerosols. Teachers may need to discuss the importance of creating images representative of the different seasons and may also wish to talk about how the more images (months of data) compared, the more clear seasonal patterns will become.

Depending on the length of a class period and the background understanding of the students regarding the use of the MY NASA DATA Live Access Server it might be necessary to decrease or increase the class periods necessary to complete this lesson.



Additional Resources/Lessons

- Seasonal Patterns of Aerosols on MY NASA Data
 - http://mynasadata.larc.nasa.gov/lesson-plans/?page_id=474?&passid=132
- Observing Sky Conditions on GLOBE
 - <http://www.globe.gov/documents/348614/353086/atla-hazyskies.pdf>
- Calculating Relative Air Mass
 - <http://www.globe.gov/documents/348614/353086/airmass.pdf>
- Sky Color for Kids on MY NASA DATA
 - <http://mynasadata.larc.nasa.gov/804-2/sky-color-for-kids/>

NASA Earth Science Education to understand our atmosphere: Observing aerosols and clouds.

- What are your take-a-ways?
 - Clouds
 - Aerosols
- How will you implement the presented information/activities in your classroom?

NASA Earth Science Education to understand our atmosphere: Observing aerosols and clouds.

- Take-a-ways
 - Clouds and aerosols are an important part of our atmosphere and effect or our weather and climate.
 - Observations take practice
 - Clouds and aerosols can be observed by:
 - Satellites/NASA instrumentation: CALIPSO, SAGE, AQUA, Terra, NPP
 - Ground Observations: AERONET, Citizen Scientists, Public
- How will you implement the presented information/activities in your classroom?
 - NASA Resources
 - S'COOL Registration
 - MY NASA DATA lesson plans/ activities
 - Earth Observatory
 - GLOBE Resources
 - Data collection/observation Protocols
 - Instrumentation