

CLOUDS TELL A STORY

Overview:

Students investigate cloud types with a focus on noctilucent clouds, a rare cloud type scientists think could be a climate-change indicator, then interview Elders about cloud knowledge as a weather predictor.

Objectives:

The student will:

- view visual aids, online multimedia and a classroom demonstration to review basic information about cloud formation and types;
- read and answer questions about a series of science articles that trace scientific knowledge of noctilucent clouds; and
- build a model that represents the conditions necessary to view noctilucent clouds.

Targeted Alaska Grade Level Expectations:

Science

- [7-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [8] SA2.1 The student demonstrates an understanding of the attitudes and approaches to scientific inquiry by recognizing and analyzing differing scientific explanations and models.
- [7] SD3.1 The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by describing the weather using accepted meteorological terms (e.g., pressure systems, fronts, precipitation).

Vocabulary:

- altostratus** – middle clouds, light gray and uniform in appearance, generally covering most of the sky; indicate the likelihood of precipitation
- altocumulus** – middle clouds with puffy, patchy appearance
- cirrus** – a cloud formation made up of feathery white patches, bands, or streamers of ice crystals; cirrus clouds form at upper levels of the atmosphere
- cirrocumulus** – high clouds with puffy, patchy appearance, often with wave-like patterns, the clouds indicate rain, thunder, lightning, and wind, never produce rain or snow
- cirrostratus** – high clouds, light gray or white, often thin with light seen through them; usually covers much of the sky; never produce rain or snow
- cloud** – a visible mass of condensed water droplets or ice particles floating in the atmosphere; clouds take various shapes depending on the conditions under which they form and their height in the atmosphere, ranging from ground level or sea level to several miles above Earth
- condensation** – the change of a gas or vapor to a liquid, either by cooling or by being subject to increased pressure; when water vapor condenses in the atmosphere, it condenses into tiny drops of water, which form clouds
- cumulonimbus** – large clouds with dark bases and tall billowing towers, can have sharp well defined edges or anvil shape at the top, can be accompanied by thunder, usually are seen when there is a storm or storm coming
- cumulus** – a white, fluffy cloud often having a flat base; cumulus clouds form at lower levels of the atmosphere and are generally associated with fair weather, however large cumulus clouds that billow to higher levels can produce rain showers
- ice** – water frozen solid, normally at or below a temperature of 32°
- nimbostratus** – low and middle dark gray clouds with precipitation falling from them
- precipitation** – a form of water, such as rain, snow, or sleet, that condenses from the atmosphere and falls to Earth's surface

LOUDS TELL A STORY

stratus – a low-lying, grayish cloud layer that sometimes produces drizzle; a stratus cloud that is close to the ground or water is called fog

stratocumulus – low clouds with irregular masses, rolling or puffy in appearance, sometimes with space between clouds; often form after a rainstorm

water cycle – the continuous process by which water is distributed throughout Earth and its atmosphere; energy from the sun causes water to evaporate from oceans and other bodies of water and from soil surfaces; plants and animals also add water vapor to the air by transpiration; as it rises into the atmosphere, the water vapor condenses to form clouds; rain and other forms of precipitation return water to Earth, where it flows into bodies of water and into the ground, beginning the cycle over again

water vapor – water in its gaseous state, especially in the atmosphere and at a temperature below the boiling point

Materials:

- Small, clear plastic container w/clear lid (or use clear plastic wrap), big enough for tin can lid to fit inside
- Salt (a pinch)
- Lid from juice concentrate or cut lid from canned good
- Soda bottle lid
- Warm water
- Styrofoam™ ball, approximately 6" (one per group)
- Flashlight, small (one per group)
- Batting (small pinch per group)
- Toothpicks (5 per group)
- Round head sewing pin (1 per group)
- Oil pastels (1 set per group)
- Clay or tacky putty (one lump per group)
- NOAA/NASA Cloud Chart (one per pair)
- VIDEO: "Cloud Game"
- VIDEO: "Noctilucent Cloud Song"
- VISUAL AID: "Clouds"
- VISUAL AID: "Noctilucent Clouds"
- VISUAL AID: "Noctilucent Clouds in Perspective"
- VISUAL AID: "Studying Noctilucent Clouds"
- STUDENT INFORMATION SHEET: "Scientists Learn About Night-Shining Clouds"
- STUDENT INFORMATION SHEET: "Noctilucent Cloud Song Lyrics"
- STUDENT WORKSHEET: "Cloud Review"
- STUDENT WORKSHEET: "Understanding Night-Shining Clouds"
- STUDENT LAB: "Understanding Night-Shining Clouds"
- STUDENT WORKSHEET: "Elder Interview"

Whole Picture:

Alaska Native people have always been careful observers of the weather. Native languages are rich in words describing weather. Knowing how to interpret the weather, including the cloud types, is important cultural knowledge. It affects all aspects of daily and yearly cultural activities, especially subsistence hunting and food gathering.

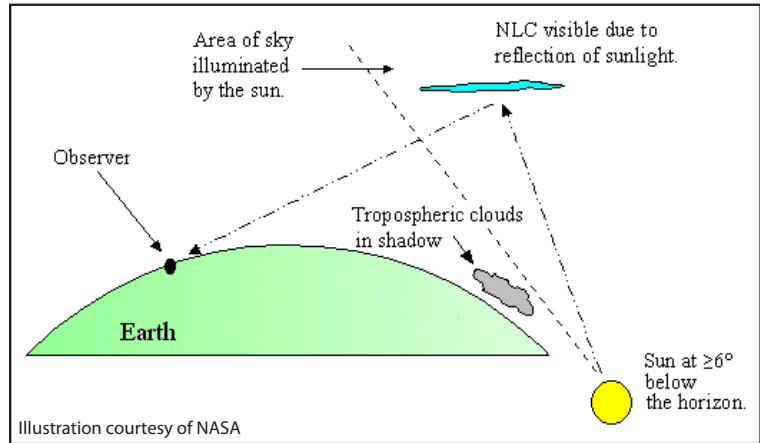
By middle school, students likely have knowledge of how clouds form. In case review is needed:

Clouds are formed when water on Earth evaporates and forms water vapor held in the air. As warm air rises, cooling occurs. The cooler the air, the smaller the amount of water vapor it can hold, therefore some of the water vapor is forced to condense onto tiny particles (dust, pollution, etc.) floating in the atmosphere. A small drop of water forms around each particle. A cloud is a visible mass of such water in the form droplets of water

CLOUDS TELL A STORY

or ice crystals small enough to stay suspended in the atmosphere.

Noctilucent clouds are clouds on the edge of space that are visible in Alaska and similar latitudes in late summer. They occur in the extreme conditions of the cold summer mesosphere. The appearance of the clouds appears to be sensitive to environmental conditions. The sky must be relatively free of tropospheric clouds. The 82-kilometer altitude region must be in sunlight – this condition is fulfilled when sun is less than 16 degrees below the observer’s horizon.



The sky background must be dark enough for the clouds to stand out – this requires that the sun is at least 6 degrees below the horizon.

In the last few decades scientists, such as those with NASA’s AIM (Aeronomy of Ice in the Mesosphere) have learned a lot about how the clouds form. At temperatures around minus 230 degrees Fahrenheit, dust from space that finds its way to the atmosphere provides a resting spot for water vapor to condense and freeze. The clouds form every day and are widespread, though can only be seen under certain environmental conditions. During the northern hemisphere’s summer, the atmosphere is heating up and expanding. At the outside edge of the atmosphere, that actually means that it’s getting colder because it’s pushed farther out into space.

Activity Preparation:

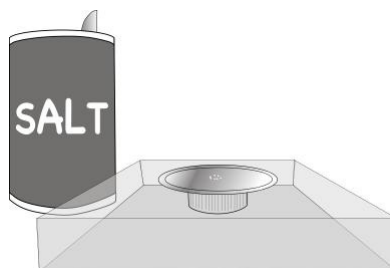
Gather the materials needed for the lesson and review the information and related articles.

Activity Procedure:

1. Gauge student knowledge and review the basics of cloud formation with students as needed. As a motivational activity, perform the following demonstration:
 - a. Fill a soda bottle cap with water and place it on the bottom of the clear container.

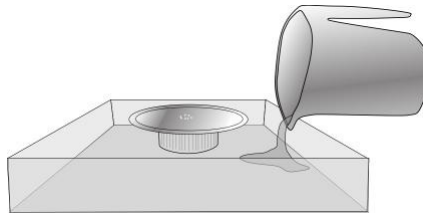


- b. Place a few salt grains onto the metal lid (removed from the can).
 - c. Set on top of the soda bottle cap.

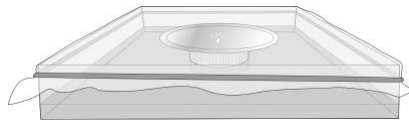


CLOUDS TELL A STORY

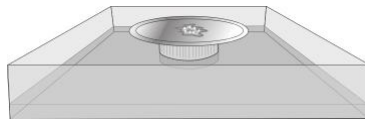
- d. Carefully add warm water to the dish so that the bottom is covered. Do not wet the lid.



- e. Cover the container with a lid or plastic wrap. Make sure it is tightly covered.



- f. Wait 20 minutes. While waiting, continue with the lesson.
g. After 20 minutes, you should see water gathered around the salt. The water evaporated from the bottom of the container, but instead of escaping into the air, it attached itself to the salt, just like it does to dust and other microscopic particles in the air.



2. Show VISUAL AID: "Clouds" and review the three basic cloud types.
3. Hand out STUDENT WORKSHEET: "Cloud Review." Explain students will use the information in the worksheet along with VIDEO: "Cloud Game" to complete the worksheet. If students are having trouble finding answers to the crossword puzzle, allow them to ask peers for assistance. Students should not give peers the answer, but instead show them where to find it.

NOTE: Have you checked the demonstration? Reiterate that dust and other pollutants form the nucleus for water droplets. Ask: What kinds of things are atmospheric pollutants? (exhaust, smoke, volcanic ash, factory pollution, etc.)

4. Write the word "noctilucent" on the board. Ask students if they have heard the word. Remind them of the word "nocturnal". What part of the word is similar? (noct meaning night) What about "lucent" – what does it mean? (Means softly bright or radiant, shining) Write the word "clouds" after noctilucent. "Knowing what you do about the word, what kind of clouds do you think these are?" (night-shining, or night-glowing clouds)
5. Explain students are going to study about noctilucent clouds, which are a very rare kind of cloud found only in Alaska and other areas with similar latitude. Noctilucent clouds can only be seen under very specific circumstances: The sun must be below the horizon but still casting light into the upper atmosphere, the sky must be free of other cloud types (which could obstruct the view) and it must be late summer. Tell students they will hear more about these things in the lesson.
6. Show VISUAL AID: "Noctilucent Clouds." Explain noctilucent clouds are found in an area of the atmosphere much higher than more common clouds. Show VISUAL AID: "Noctilucent Clouds in Perspective." Point out the highest common clouds (associated with weather patterns) are found up to about 10 miles above Earth's surface. Noctilucent clouds are found about 50 miles above the surface. They are not associated with weather, but are thought to be a climate indicator.

CLOUDS TELL A STORY

- Hand out STUDENT INFORMATION SHEET: “Scientists Learn About Night-Shining Clouds” and STUDENT WORKSHEET: “Understanding Night-Shining Clouds.” The reading level in each article included is high school level, so choose a reading strategy best suited for the class. Consider reading aloud to students, one article at a time, then discussing each set of related questions. When you reach the Critical Thinking section, consider doing a Think-Pair-Share activity. Ask students to pair up and talk about the questions. Once they have explored the question, ask them to share their ideas with one other pair then write the answer they think is best on their own worksheet.
- Divide students into small groups. Hand out STUDENT LAB: “Understanding Night-Shining Clouds.” Ask each group to select a member to collect materials listed on the lab sheet. Read through the directions then allow students to explore on their own. Circulate to check for understanding.
- Hand out STUDENT WORKSHEET: “Elder Interview.” Explain students will interview Elders and culture bearers to find out Native language terms for different cloud types and weather associated with such clouds. Assist students in identifying Elders to visit. Students may visit individually or in small groups.
- After Elder visits are complete, ask each student to share what they learned from their Elder interview with the class. Help students identify similarities and differences among information learned from different Elders. Create a class list of Native language terms for clouds and cloud types..

Language Links:

Ask a local Native language speaker to provide the words in the local dialect for the weather phenomenon listed in the chart below. The local dialect for these words may differ from the examples provided. Share the words with students to build fluency in local terms related to weather. Include local words in songs, stories and games when possible.

English	Gwich'in	Denaakk'e	Lower Tanana	Deg Xinag	Your Language
Rain / It's raining	Tsin / ahtsin	Kohn / yotee hødelaatlghaanh	Chonh	Chonh	
Wind / It's windy	Ahtr'aii	Ts'ehy	Eltr'eyh	Xidetr'iyh	
Snow / It's snowing	Zhah	Tseetl	Yeth	Yith	
Clouds / It's cloudy	Zhee k'oh / gwit'eh goo'aii	Kk'ul / yokk'uł hoolaanh	K'wth / k'wth xulanh	Q'uth	
Sun / It's sunny	Drin oozhrii	So / Soleł	Sro	No'oy	
Freeze / It's freezing	Datan	Ggaats	Gats		
Ice	Łuu	Ten	Tenh	Tinh	

Extension Ideas:

- Visit NASA's AIM (Aeronomy of Ice in the Mesosphere) Project website to learn more about the latest discoveries involving noctilucent clouds. (<http://aim.hamptonu.edu/mission/index.html>)
- Consider studying other rare cloud formations and the cause behind them. Look for rare cloud types such as nacreous clouds, mammatus clouds, altocumulus castelanus, mushroom clouds, cirrus Kelvin-Helmholtz, lenticular clouds, roll clouds, shelf clouds, Morning Glory clouds, pileus cloud, and diamond dust. Visit the cloud appreciation society website for tips. (<http://cloudappreciationsociety.org/>)
- Perform the “cloud in a bottle” demonstration. Pour two inches of very hot tap water into a clear, empty 2-liter soda bottle that has the label removed. Place your mouth over the opening and blow into it to ensure

CLOUDS TELL A STORY

the bottle is fully expanded. Immediately seal the bottle tightly. Shake the bottle vigorously for one minute. This will distribute water molecules in the air. Light a match and let it burn for two seconds then drop it into the bottle. Quickly recap the bottle. Lay the bottle on its side with black paper behind it. Press hard on the bottle for ten seconds. The bottle is strong, so don't be afraid to really push hard. Release, observe and repeat until a cloud forms. When the cloud forms, unscrew the cap. You should see the cloud escape from the bottle. If not, give the bottle a light squeeze.

The cloud in a bottle activity simulates the conditions necessary for cloud formation: water vapor in the air, smoke particles for water to collect on, and cooling of the air by lowering the air pressure within the bottle.

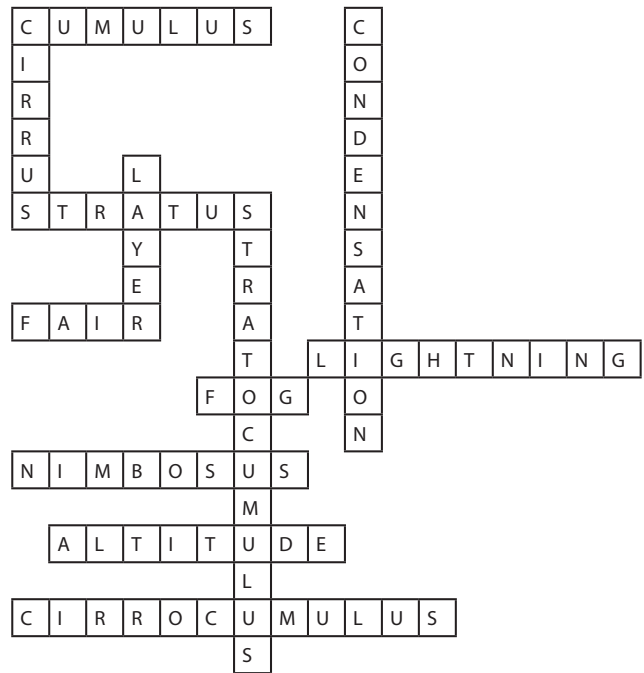
Answers:

STUDENT WORKSHEET: "Cloud Review"

- 1.-3. Answers will vary. Drawing should resemble description and VISUAL AID.
4. See crossword puzzle answers at right.

STUDENT WORKSHEET: "Understanding Night Shining Clouds"

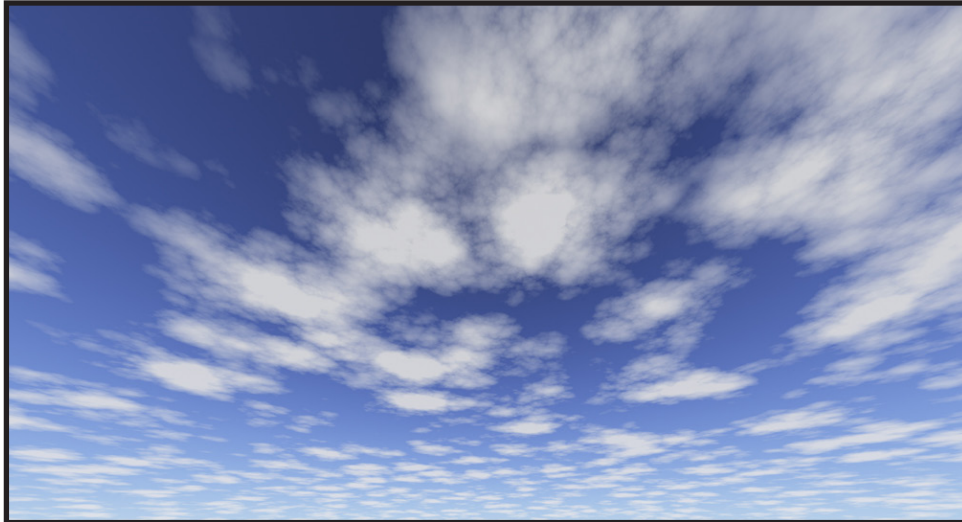
1. 1885
2. No, they thought it was ice-coated dust particles from the dust of meteors.
3. C. 50 Miles
4. B. An electron microscope found that nickel was in the clouds, an element in meteors.
5. A Nike-Cajun rocket
6. No
7. Any one of the following: Why are the clouds only seen in the summer? Why are the displays localized? Why do the clouds behave the way they do?
8. lasers
9. They pop before they reach high enough.
10. C. During the warm summer months.
11. D. All of the above.
12. Yes
13. Answers will vary but student should indicate an understanding of at least one of the following concepts: In the last three decades (1979 – 2007 or current) understanding of the cause of noctilucent clouds has increased. A variety of different scientific instruments have been used to study the clouds so scientists have much more data. The theory that meteor dust helps form the clouds is now widely accepted.
14. Answers will vary but students should indicate that the sighting of noctilucent cloud is a new phenomenon; scientists wonder if the sightings began around the same time that the climate began to warm. Many scientists attribute the recent trend toward a warmer climate to human activity, such as an increase in carbon dioxide in the atmosphere. Carbon dioxide is a greenhouse gas.



STUDENT WORKSHEET: "Elder Interview"

Answers will vary depending on the Elder interviewed.

CLOUDS



Cirrus clouds

Cirrus clouds occur high up in the sky.

These thin, wispy clouds are often stretched out by high winds.



Cumulus clouds

Cumulus clouds are white, puffy clouds that look like floating cotton balls.

When they grow larger and taller, they can develop into thunderstorm clouds.



Stratus clouds

Stratus clouds are thick gray clouds that occur lower and often cover the entire sky.

Light rain or drizzle often falls from these clouds.

NOCTILUCENT CLOUDS

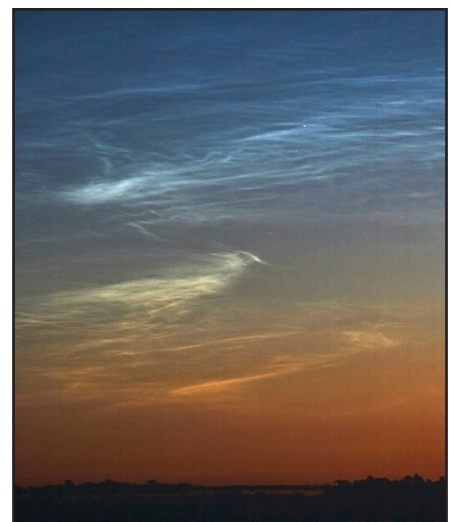
Noctilucent clouds look like their wispy cousin the cirrus, but they occur at a much higher altitude.

Cirrus clouds are found in the troposphere – about 10 miles up (6 to 12 kilometers).

Noctilucent clouds are much higher. They occur in the mesosphere – about 50 miles up (82 kilometers).

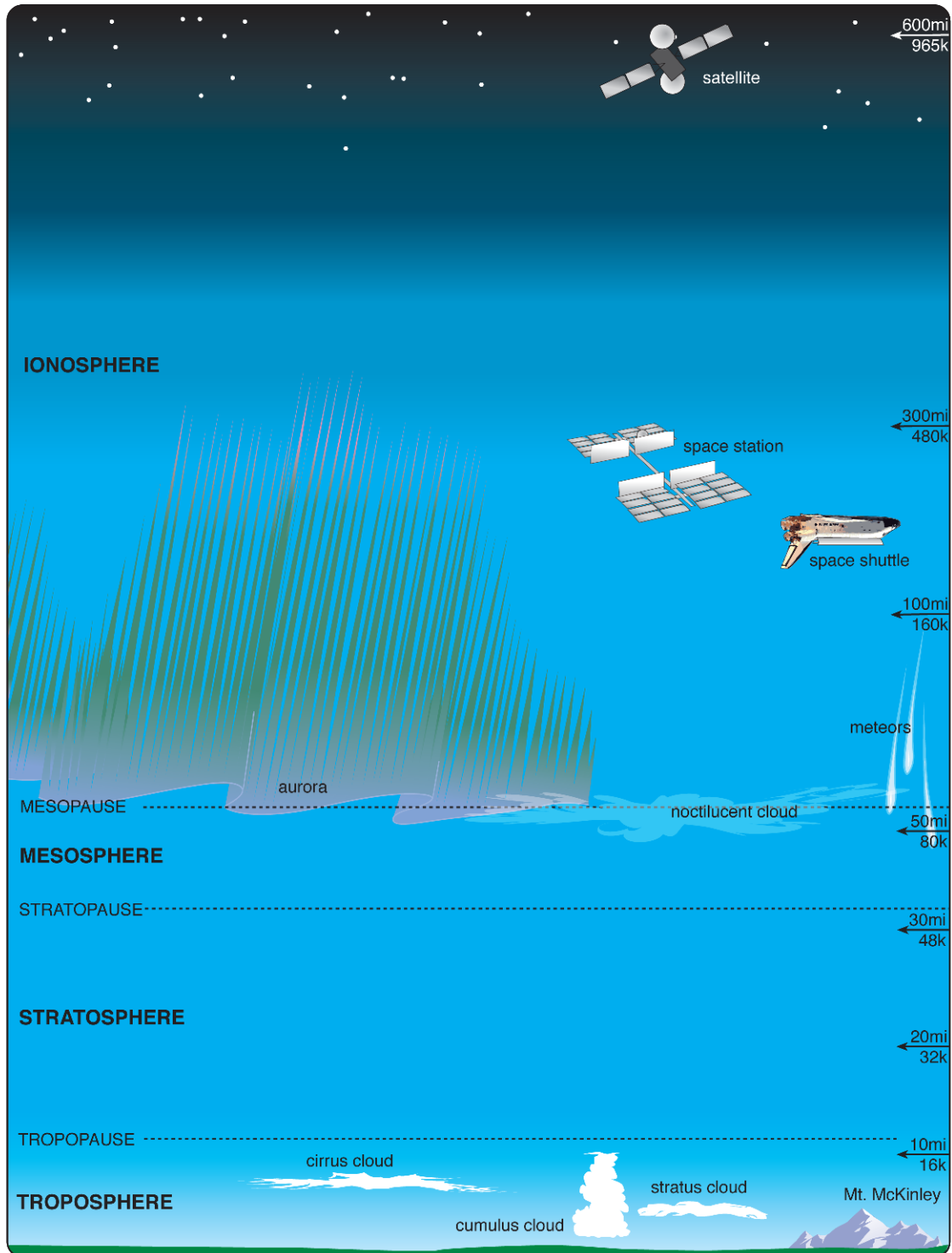
The conditions under which they occur are slightly different than other cloud types too.

- They are only seen in the Arctic.
- They are only seen in late summer.
- They are only seen at dusk or dawn.
- Reported sightings are new to recorded history. The clouds may be a climate change indicator.



Noctilucent cloud photos by Patrick Cobb.

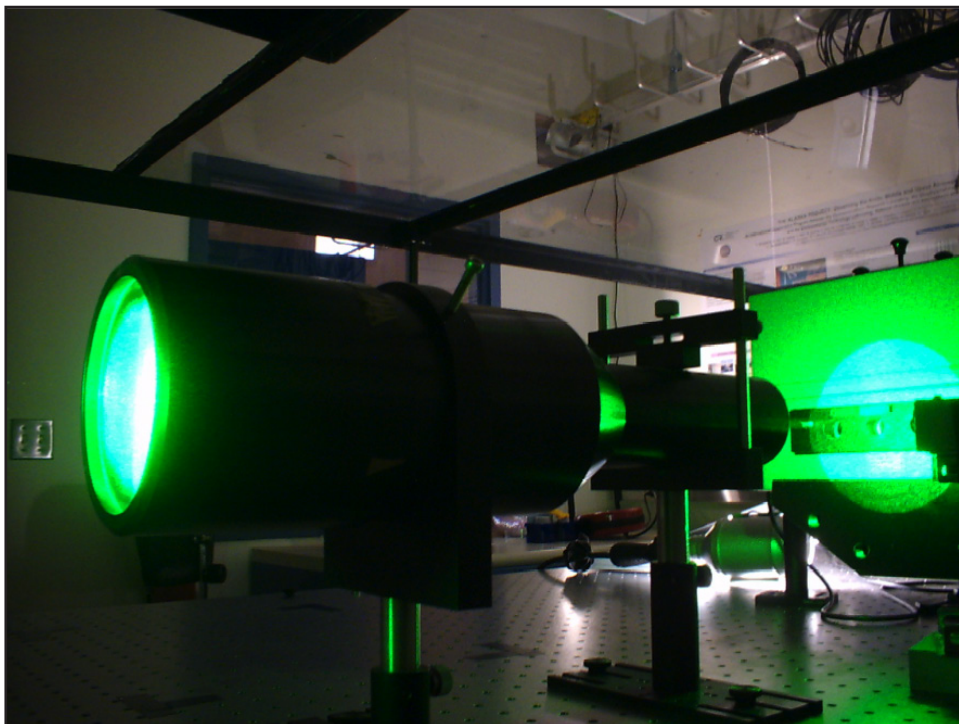
NOCTILUCENT CLOUDS IN PERSPECTIVE



STUDYING NOCTILUCENT CLOUDS



UAF, in partnership with NASA and several other agencies, operates a rocket range that also serves as a clustered observatory for rocket-borne and ground-based studies of the atmosphere. These images, taken at Poker Flat Research Range were provided by the University of Alaska Fairbanks Geophysical Institute.



SCIENTISTS LEARN ABOUT NIGHT-SHINING CLOUDS

NOTE: The following articles, Noctilucent Clouds, Clouds that Glow at Night and Exploring the Heavens with Laser Light, are excerpts from the Alaska Science Forum. The full article for each can be found at the Geophysical Institute website: <http://www.gi.alaska.edu/ScienceForum/>.

Noctilucent Clouds

by T. Neil Davis

September 28, 1979, Article #346

This column is provided as a public service by the Geophysical Institute, University of Alaska Fairbanks, in cooperation with the UAF research community. T. Neil Davis is a seismologist at the institute.

Like blue-white spider webs laced across the twilight sky, noctilucent clouds form a wispy filigree in the heavens. Truly a polar phenomenon, noctilucent clouds are never seen at latitudes below 45°. Thus, in North America, noctilucent clouds are pretty much the property of Alaska and Canada.

Nor are noctilucent clouds an everyday occurrence. In 1885, they were first recognized as something strange in the sky. Since then more than a thousand sightings have been recorded in the world. Several displays occurred over central Alaska in the summer of 1979.

The characteristic that distinguishes noctilucent clouds from all others is their remarkably high altitude, 82 (plus or minus a few) kilometers (about 50 miles). Rarely do normal clouds extend as high as 15 kilometers. Noctilucent clouds are seen only in deep twilight, when the sun is 6° to 16° below the horizon. Then the sky is dark enough for the thin noctilucent clouds to be seen and yet the sun is still in position to reflect enough light from the clouds to make them visible to an observer.

Though noctilucent clouds have been recognized for nearly a century, no one quite knows why they occur. Almost certainly, the clouds consist of ice-coated dust particles, the dust presumably coming from meteors striking the atmosphere. Beyond that, not much is known.

Clouds that Glow at Night

by Larry Gedney

July 30, 1982, Article #556

This article is provided as a public service by the Geophysical Institute, University of Alaska Fairbanks, in cooperation with the UAF research community. Larry Gedney is a seismologist at the Institute.

As we move into August, the opportunity to observe noctilucent clouds is at its best. Many people who have lived in the northern latitudes for years have probably noticed them before without having a proper appreciation for what they really are.

Noctilucent (night-shining) clouds ride in the sky above 99.9 percent of the atmosphere and over 40 miles above the highest clouds associated with weather. At an average altitude of 50 miles (80 km), they actually skirt the lowest fringes of the aurora, and are above the height at which meteors are observed. For reasons which are not well understood, they occur only at higher latitudes and almost exclusively during the summer months.

What are they made of and why are they there? Some rocketborne observations have provided clues. The first of these studies was made in Sweden in 1962. A Nike-Cajun rocket with a payload designed to trap particles of a cloud and return them to earth was fired into a noctilucent display and successfully recovered.

Under an electron microscope, the surfaces on which the particles were captured revealed millions of minute motes of dust as small as 0.05 microns in diameter (a micron is one-thousandth of a millimeter, a millimeter is about half the thickness of pencil lead). Electron bombardment indicated that the particles contained nickel. Nickel is an element quite rare on earth, but common in meteorites.

SCIENTISTS LEARN ABOUT NIGHT-SHINING CLOUDS

The picture which therefore emerges is that noctilucent clouds are meteor dust particles covered with ice. Knowing what they are, however, in no way explains why they behave as they do. It would be expected that meteoritic particles would be evenly distributed in the earth's upper atmosphere. Why, then, are noctilucent displays localized; why do they occur only occasionally; why only during the summer months; and, why only at the higher latitudes? These questions about the rare and beautiful spectacle remain to be answered.

Exploring the Heavens with Laser Light

by Ned Rozell

February 17, 1998, Article #1376

This column is provided as a public service by the Geophysical Institute, University of Alaska Fairbanks, in cooperation with the UAF research community. Ned Rozell is a science writer at the institute.

Imagine a glowing green pencil that reaches so far into the night sky it seems to pierce the Big Dipper. Such is the sight on a hillside above the Chatanika River valley, where scientists at Poker Flat Research Range aim lasers skyward. With lasers, they hope to learn more about the upper tiers of Earth's atmosphere.

Laser light is the primary tool of Richard Collins, a researcher at the Geophysical Institute of the University of Alaska Fairbanks. Unlike a standard light bulb that emits light in all directions, a laser's energy is focused in one direction. Collins is able to send pulses of laser light high enough to reach the part of the atmosphere he studies—the mesosphere, a region from thirty to fifty miles above sea level, just below where the bottom of the aurora forms. The laser also allows Collins to see noctilucent, or "luminous night" clouds.

Collins is funded to study the mesosphere because scientists think this area will cool as Earth's surface warms, and they want to find out why. Because the mesosphere is a tough place to study—balloons carrying sensors pop before they get that high, and satellites can't orbit that low—scientists know little about the region.

The mesosphere is the home of shooting stars, where meteors flame out as they hurdle toward Earth at speeds as fast as 30 miles per second. Meteors, pebble-size fragments left over from the birth of the solar system, glow with the heat of friction as they collide with gas molecules in the mesosphere. When a meteor burns, it leaves a trail of smoke and atoms of metal.

Oddly, temperatures in the mesosphere are coldest when it is warmest on the ground. This leads to the formation of noctilucent clouds above Alaska in August. Because the clouds have only been reported since the 1870s, scientists wonder if perhaps human activity causes or intensifies the clouds, which may be the result of pollution and a fingerprint of global change. Measurements taken throughout the year, through the waxing and waning of the seasons, are important in understanding how the entire atmosphere might evolve over the long haul. Collins gathers information from the mesosphere with an incredibly simple tool—a column of colored light that reaches where more complicated machines fail.

Polar Ice Clouds May Be Climate Change Symptom

ScienceDaily (Aug. 21, 2007) — As the late summer sun sets in the Arctic, bands of wispy, luminescent clouds shine against the deep blue of the northern sky.

To the casual observer, they may simply be a curiosity, dismissed as the waning light of the midnight sun. But to scientists, these noctilucent ice clouds could be an upper-atmospheric symptom of a changing climate.

"The question which everyone in Alaska is dealing with is what are the symptoms of climate change and, as in medicine, how do these symptoms reflect the underlying processes," said Richard Collins, a researcher at the Geophysical Institute at the University of Alaska Fairbanks. "It is believed that [these clouds] are an indicator of climate change."

SCIENTISTS LEARN ABOUT NIGHT-SHINING CLOUDS

Dozens of scientists from several countries will gather at the University of Alaska Fairbanks Aug. 20-23 to discuss the latest findings on noctilucent clouds and other phenomena of the earth's

upper atmosphere during the Eighth International Workshop on Layered Phenomena in the Mesopause Region. Sessions will include information on the latest ground-based and satellite data on the mesopause region, an area of the atmosphere 50 miles above Earth's surface and the site of the coldest atmospheric temperatures.

Noctilucent clouds form under conditions that counter common logic. They only form in the summer, when solar radiation is most intense, Collins said. That solar heating, rather than warming the mesopause, causes cooling, he said. "The mesopause region is colder in summer under perpetual daylight than it is in winter under perpetual darkness."

The reason lies in the movement of air within the atmosphere, Collins said. Solar radiation heats the lower atmosphere, causing a rising cell of air over the summer pole, he said. "As the air rises it cools and that beats out the radiative heating." Those cold temperatures allow the ice clouds to form in the mesopause. The clouds could serve as an indicator of climate change because an increase in carbon dioxide, which causes heating in the lower atmosphere, causes cooling in the upper atmosphere.

Collins said the noctilucent clouds are a relatively new phenomenon. History indicates that humans first recorded their presence in the 19th century, he said. Satellite and ground-based data has been limited, he said, but it appears that the clouds have become more prevalent over time. A new satellite, Aeronomy of Ice in the Mesosphere, or AIM, was launched in April 2007 to observe clouds and their environment in the mesopause, Collins said scientists are looking forward to having more reliable data, which could contribute to a broader understanding of the upper atmosphere, noctilucent clouds and how both fit into the climate system.

University of Alaska Fairbanks (2007, August 21). Polar Ice Clouds May Be Climate Change Symptom. ScienceDaily. Retrieved November 15, 2010, from <http://www.sciencedaily.com/releases/2007/08/070820145343.htm>

NOCTILUCENT CLOUD SONG LYRICS

Noctilucent Cloud Song

Words and Music by Patricia Boyd

©2007 P. Boyd

High oh high way up above the ozone
 High oh high in regions near the poles
 Set against the arctic cold twilight
 Casting off an iridescent light
 Known for only the last century
 We don't know how you have come to be

Noctilucent Cloud

That ghostly shining polar shroud
 We didn't think you'd be allowed
 At latitudes so low (but there you go)

Shining over a darkened sky
 In mesospheric zones so high
 How and why can you be?

You're a cloudy mystery (mystery...)
 For the twenty-first century
 Noctilucent Cloud!

High oh high on wings above the ocean
 On a Pegasus, AIM launches into space
 Measuring the temperature so cold
 Sizing up the cosmic dust so old
 How much water vapor lies within
 Your layer so thin?

Noctilucent Cloud

That ghostly iridescent shroud
 We didn't think you'd be allowed
 At latitudes so low (how can we know?)

Shining over a darkened sky
 In mesospheric zones so high
 How and why can you be?
 Are you tied to our destiny
 Our global climate history
 An atmospheric mystery
 Noctilucent!

Every year you number more and more
 And with time you're brighter than before

Forming in a most unlikely place
 At the edge of space

Noctilucent Cloud

That ghostly iridescent shroud
 We didn't think you'd be allowed
 At latitudes so low (we need to know)

Glowing over the polar sky
 In mesospheric zones so high
 How and why can you be?
 Are you tied to our destiny
 Our global climate history
 You're still a cloudy mystery
 Noctilucent Noctilucent Noctilucent Cloud!

NAME: _____

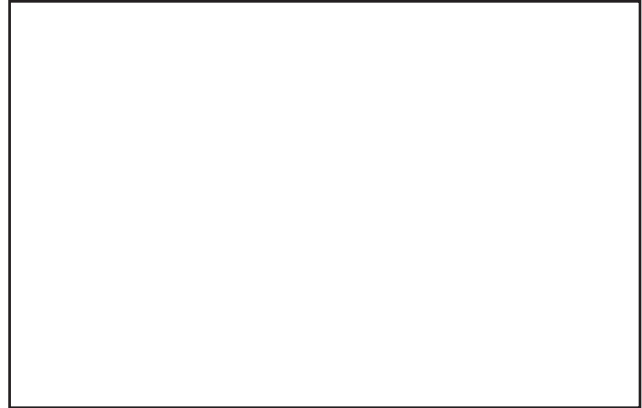
CLOUD REVIEW

Directions: Below you will find descriptions for the three main types of clouds. In the box to the right of each description draw a sketch of what the cloud type looks like.

1. Cirrus

Cirrus clouds are described as thin, wispy strands that appear high in the sky, generally between 20,000 and 40,000 feet (6 to 12 kilometers) but can be higher. High winds blow the clouds into long streamers thin enough for sunlight and moonlight to pass through. Airplanes traveling at such heights leave condensation trails that can turn into cirrus clouds. In Latin cirrus means, "curl of hair."

The presence of cirrus clouds can mean a weather front is approaching.



2. Cumulus

Cumulus clouds are usually puffy, billowing towers of white that can extend for thousands of feet, usually beginning with flat bases ranging from 4,000 to 8,000 feet (1.2 to 2.5 kilometers) in altitude. Such clouds are formed when warm, moist air rises. As it rises, air cools and condensation occurs. The size of a cumulus cloud depends on the force of the upward movement of the air and the amount of moisture in the air. In Latin cumulus means, "heap."

The presence of cumulus clouds usually means fair weather, however when such clouds continue to grow larger and taller, forming cumulonimbus clouds, they can produce heavy rain, lightning, wind, hail and even tornadoes.



3. Stratus

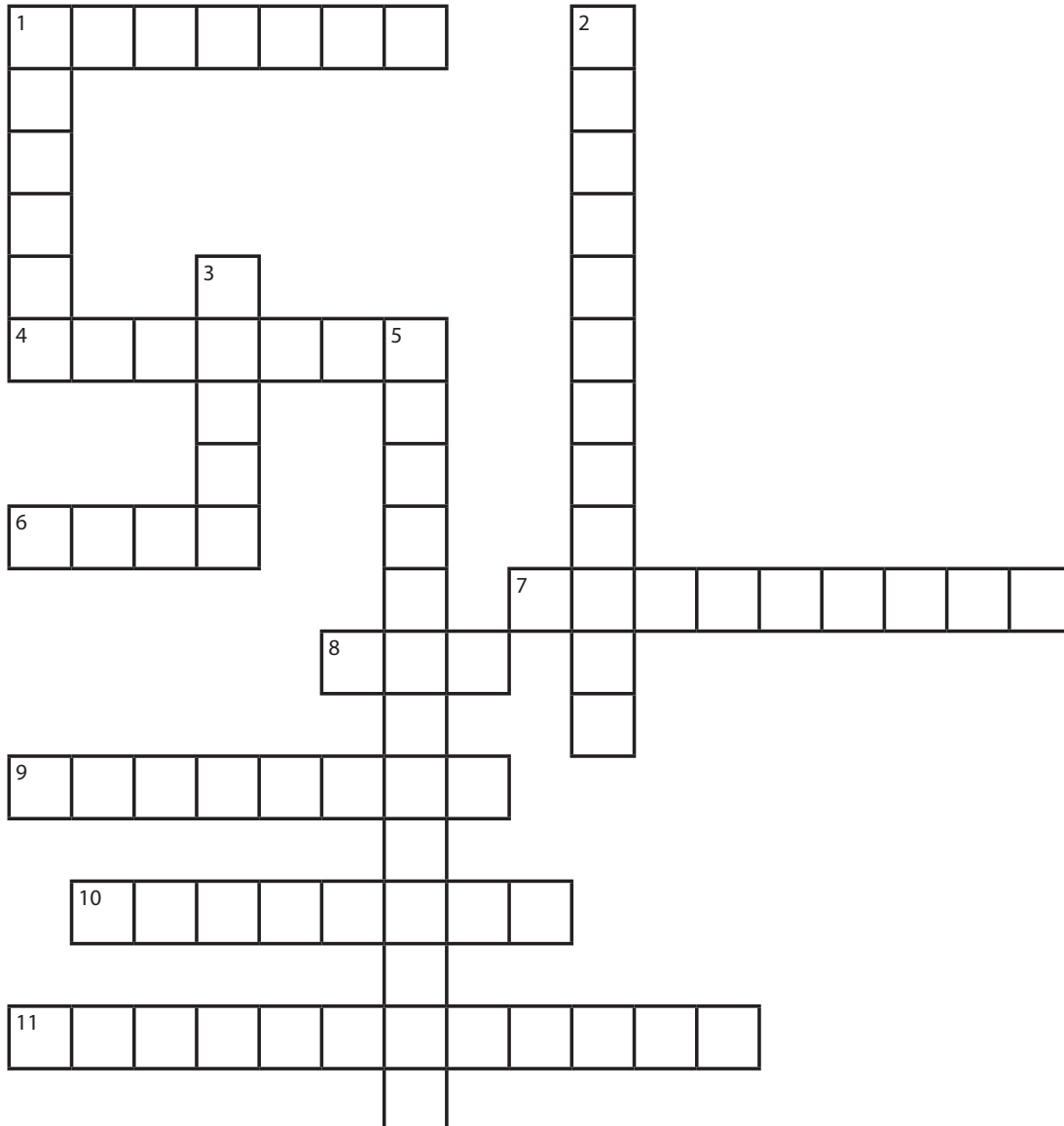
Stratus clouds blanket the sky with white and grey. Such clouds are often formed when a layer of warm, moist air passes over a layer of cool air. As the two layers meet, the warm air cools to the point of condensation, forming a blanket-like cloud. These flat, featureless clouds are low in altitude (usually 2,000 to 7,000 feet) and block out the sun. Stratus clouds can reach all the way to the ground, too. When this happens it is called fog. In Latin stratus means, "layer."

The presence of stratus clouds can mean light mist, drizzle or light snow.



NAME: _____
CLOUD REVIEW

Directions: Complete the following crossword puzzle using information from the previous page and watch the VIDEO FILE: "Cloud Game."


ACROSS

1. Means "heap" in Latin.
4. Presence can mean light drizzle or light snow.
6. Cumulus clouds usually mean this kind of weather.
7. Produced by cumulonimbus.
8. A very low stratus layer.
9. Latin for rainy or stormy.
10. Word meaning how high.
11. Sailors called this 'mackerel sky.'

DOWN

1. Occur at heights of 20,000 to 40,000 feet.
2. Trail left by airplanes.
3. Latin meaning for stratus.
4. A combination of cumulus and stratus.

NAME: _____

UNDERSTANDING NIGHT-SHINING CLOUDS

Directions: Use STUDENT INFORMATION SHEET: "Scientists Learn about Night-Shining Clouds" to answer questions 1 - 14.

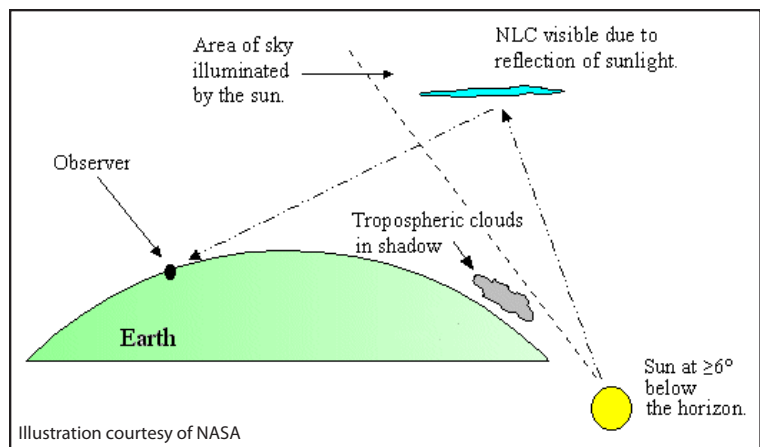
Article One: Noctilucent Clouds by T. Neil Davis, 1979

1. Around what year was the first recorded sighting of noctilucent clouds? _____

2. In 1979, did scientists know what caused the phenomenon? What was their guess?

3. Circle one. About how high above Earth's surface are noctilucent clouds found?

- A. 82 miles
- B. 15 miles
- C. 50 miles
- D. 16 degrees



Article Two: Clouds That Glow at Night by Larry Gedney, 1982

4. Circle the best answer. How can scientists guess that meteors are involved with the presence of noctilucent clouds?

- A. Scientists have watched meteors fly through noctilucent clouds.
- B. An electron microscope found nickel in cloud residue, an element in meteors.
- C. Meteors also glow in the night sky, so they are likely related.

5. What instrument was used to reach and study the clouds? _____

6. In 1982, did scientists know why noctilucent clouds are found only in certain latitudes? _____

7. Write one other thing scientists were wondering in 1982 about noctilucent clouds.

Article Three: Exploring the Heavens with Laser Light by Ned Rozell, 1998

8. What instrument are scientists like Dr. Richard Collins currently using to study noctilucent clouds?

NAME: _____

UNDERSTANDING NIGHT-SHINING CLOUDS

9. Why can't scientists use a weather balloon to study noctilucent clouds? _____

10. Circle one. Temperatures in the mesosphere, where these clouds are found, are coldest when?

- A. During the Ice Age.
- B. During the coldest part of the winter.
- C. During the warm summer months.

Article Four: Polar Clouds May Be Climate Change Symptom by ScienceDaily, 2007

11. Circle one. What are scientists hoping to learn in current studies of the mesosphere?

- A. Is human activity contributing to an increase in noctilucent cloud sightings?
- B. Are noctilucent clouds a climate-change indicator?
- C. Is an increase in the amount of carbon dioxide contributing to more noctilucent clouds?
- D. All of the above.

12. Are scientists still learning about the mesosphere and noctilucent clouds? _____

Critical Thinking

13. How do these four articles show progress in the scientific study of noctilucent clouds?

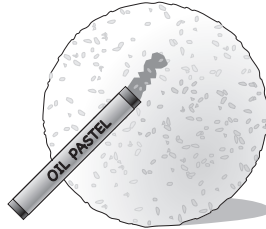
14. Why do scientist think the increase in sightings of noctilucent clouds could be related to human activity?

NAME: _____

UNDERSTANDING NIGHT-SHINING CLOUDS

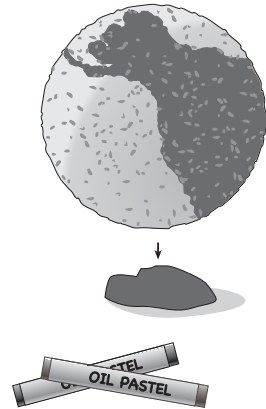
Directions: Using the materials listed, follow the steps below to create noctilucent clouds above Earth.

STEP 1: Using oil pastels, color the Styrofoam™ ball to resemble planet Earth. Sketch in Alaska in the Northern hemisphere.



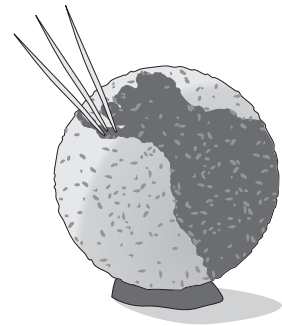
Materials

- Styrofoam™ ball, approximately 6" (one)
- Batting (small pinch)
- Round head sewing pin (one)
- Clay or tacky putty (one small lump)
- Flashlight, small (one)
- Toothpicks (five)
- Oil pastels (one set per group)

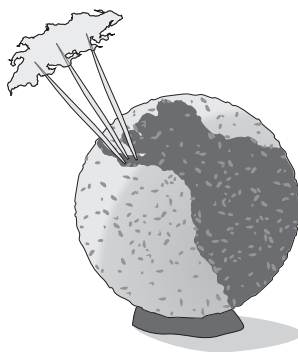


STEP 2: Place a piece of clay or tacky putty about the size of a half-dollar coin on your working surface. Place your foam Earth on the tacky surface and gently press until it stays in place. Make sure Alaska is tilted upward. (*Remember: Earth is tilted on its axis at an angle of about 23.5°.)

STEP 3: Place a round head pin where your community lies in Alaska. Press it until the round head sits at the surface. Place three or four toothpicks around the pin.



STEP 4: Take a small piece of batting material and pull it thin so that it looks like wispy clouds. Gently place the "clouds" over the toothpicks. The toothpicks support the "clouds."



STEP 5: Use your small flashlight to imitate the sun. Light up the clouds but leave Earth's surface, where your community is marked, in the dark.

HINTS:

- Noctilucent clouds are seen at dawn and dusk. Where is the sun in relation to Alaska during those times of day?
- The sun is most directly overhead in the region of the equator. Where is the equator on your model Earth?

NAME: _____
UNDERSTANDING NIGHT-SHINING CLOUDS

STEP 6: In the space below, draw your lab set up. Include the flashlight/sun. Use labels.



STEP 7: Write a sentence or two that explains how the surface of Earth can be dark, but the noctilucent clouds are illuminated by the sun.
