

Curriculum Units by Fellows of the Yale-New Haven Teachers Institute 2015 Volume III: Physics and Chemistry of the Earth's Atmosphere and Climate

How Does A Solar Oven Work?

Curriculum Unit 15.03.05 by Alexandra Novak

Introduction

As I head into my 3 rd year teaching a weather unit to 6 th grade science, I have realized that there are many more aspects to this unit that I have not taught and that if taught, will give students a more in depth understanding of how our sun provides everything essential to life. I have found that students at this level do not have a concept of the universes' sheer never-ending mass, if they know that at all. I have found that most students' concepts of the universe consists of the planets in our Solar System; and while most students know that the sun is a star, they do not have a concept of the utter necessity that humans and the Earth have for the sun's rays and that life as we know it would not otherwise exist.

Therefore, in order to introduce a unit on weather and how it effects the climate in Connecticut, I start way back. The first lesson of this unit explores Earth's position in the Solar System, Milky Way Galaxy, and ultimately the entire universe. The gives the students a concept of how small Earth is, and how amazing it is that it is crawling with life. Earth's position in the Solar System is precisely why the sun is so crucial to our lives. The next lesson delves into the seasons and why they exist. We discuss the Earth's tilt, revolutions, day time and nighttime, the hemispheres, and how all of this is the perfect recipe for seasons. After a discussion of why we have seasons, students will have a more solid understanding of the sun's importance. Seasons are essentially what controls weather in different parts of the world at different times of the year, which is what they students will study next. Students will explore connections between the seasons, weather, and how that effects climate. Within that lesson, students will learn about equinoxes and solstices and the moon's role in Earth's day-to-day routines.

At this point in the unit, the students will begin keeping a daily weather log and exploring questions that challenge them to make connections between climate and weather in Connecticut. Students will learn meteorology terms and use them in their daily weather logs. Students will give miniature weather reports at the beginning of each class and will be expected to use their newly acquired vocabulary.

While continually keeping weather logs (throughout the rest of the unit), students will next create rotating atmospheric layer wheels complete with appropriate illustrations for what usually appears in each layer. With a solid understanding of what generally occurs in each layer, we will move onto the Earth's Cycles: Water, Carbon, and the Greenhouse Effect. The students will be familiar with these as we discussed them during our terrarium unit at the beginning of the school year. We will spend a day learning about the Ice Coring Process using excerpts from, "The Two Mile Time Machine" to gain an understanding of how ice cores provide scientists with information on our atmosphere centuries ago until the present day.

Next we will explore the sun, radiation, and types of wavelengths that reach Earth's surface in preparation for the final project for the unit. Students will participate in activities such as measuring the temperatures of different surfaces in sunlight. We will then explore how to use the sun's energy to harness alternative energy sources and briefly discuss fossil fuel consumption. We get deeper into this in the 4 th unit of my school yearwater resources. Also discussed will be how humans interact both negatively and positively with the Earth and it's environments.

Our unit will culminate with a project. The students will create solar oven using pizza boxes, tin foil, and black paper. Students will explain how the sun was able to heat the s'mores without electricity.

The Cartoon Introduction to Climate Change

This text by Yoram Bauman and illustrated by Grady Klein will serve as a textbook for the unit. It explains in easy language and pictures the climate of Earth, and how human interaction is/is not contributing to a larger climate change. It discusses various cycles on Earth, and how humans may/may not be effecting Earth's changes. Various parts will serve as good introductions to many lessons in this unit. The book's main point which perfectly coincided with this class was that: climate change has always occurred throughout history before and after human and animal interaction with the environment. Climate change will continue to occur as the conditions of our Solar System, sun, galaxy, etc. change, so long as volcanoes erupt, asteroids fall, amongst countless other things that could happen to change Earth's climate. Humans, are not helping the climate and are definitely directly hurting plant and animal species, the world's oceans, our physical Earth, as well as our own health with our wasteful cultures and over-production of plastics, and pollution of the atmosphere responsible for giving us life. Humans can change these patterns, and can take measures to repair our Earth and life on it, which would not have negative effects environmentally. However the facts remain that Al Gore and others' predictions that we would have had a massive global warming by now did not come to fruition, and are not necessarily indicating that a global warming period is coming based solely upon human interactions. Climate change is occurring, but how and when it will occur is completely unknown, and will likely remain so.

This book perfectly summarizes the Yale class in an easy to read, understand, and engage with graphic text. It is age appropriate for the 11 and 12 year olds that I teach Earth science too. Specific pages and excerpts summarize directly concepts I want my students to glean from this unit. Many are used as "hooks" or lesson introductions- the equip the students with background knowledge and incite questions in them that will ensure engagement in each lesson.

How does climate affect weather?

This question is the first and foremost of the unit. The unit required of me to teach my students 3 rd quarter in New Haven as well as per my school's magnet theme asks students to explain how climate in Connecticut effects the seasonal weather patterns, and furthermore connecting back to our 1 st unit on Connecticut ecosystems, how does this weather effect the wildlife and ecosystems of Connecticut. Asking the students how weather effects climate grasps as the basis of my unit, and asks students not only to discuss these patterns in Connecticut, but also *how* and *why* climates exist, so that the answers about patterns in Connecticut come more easily to the students based upon the knowledge acquired in this unit. I will be using this question to frame the entire unit around a comprehensive understanding of climate and weather.

How does Earth's location in the Solar System allow for life?

The basis for an understanding of climate is understanding where climate originates. Why do climates exist? Why are they different in different parts of the world, at different times of year? Why is Connecticut's climate different from other places at the same latitude? These are all questions that can be answered within the concept of understanding our Sun. Not only understanding our Sun, but understanding that our Sun in among millions of others- each star in the sky in another solar system like ours. But then, why is Earth the only planet with life? Exploring our position in relation to the Sun helps the students to understand the amazing and perfect recipe our distance is for creating life, and how fragile that life is. Everything works in a perfect balance, and (later discussed) humans are rocking that balance ever so slightly. Understanding Earth's position in the atmosphere, on it's own axis, and its movements around space are the very reasons for seasons, which of course dictate global climates. This question gives the students the background they need for understanding the importance of the Sun.

How does the Sun warm our atmosphere?

Delving deeper into the Sun being the reason for weather, this question will help students to explore the layers of our atmosphere, and what occurs in each layer. The cycles that allow Earth to function occur closest to the Earth's surface based upon the air in the atmosphere. Humans are filling that perfectly balanced atmosphere with unnatural amounts of Carbon Dioxide and other gases deadly in large amounts. With an appropriate amount of Carbon Dioxide, the atmosphere remains an appropriate temperature for life by the Sun's rays warming it. Therefore excessive amounts can cause a spike in temperature. This also effects climate. In order for students to understand climate and how it effects weather, they need to understand what climate change is as well, and they need to have a solid understanding of the theories and arguments circulating through the media and scientific world. Therefore it is crucial to discuss human interaction with the environment. Neglecting to address climate change would be neglecting to give my students a comprehensive understanding of global and local climate. Therefore understanding how the sun warms the air is crucial to understanding *how* humans can tip that scale.

How can we use renewable resources for energy?

Furthermore, I feel that in order to give my students a complete education of climate, it is crucial to include what alternative energy is, how we can use it, and how it would fix many of the human-caused disasters on

our planet that effect cycles like the Greenhouse effect, Carbon Cycle amongst others, and how alternative energy can help to halt that misuse of Earth's resources. It is crucial for students to understand the cost of burning fossil fuels, and how those costs-monetary, environmental and political-can be offset with alternative energy sources using the Sun and wind which occur naturally and without charge. I have experienced a sense of overwhelmment amongst my students when discussing what human's have done, so I too try and offset some of that. I feel it is important for students to learn about small things they can do on a daily basis to help out the environment. And that the more they know, they more they can spread the word about creating a healthier planet.

Common Core Science Standards

6.3.a. Local and regional weather are affected by the amount of solar energy the area receives and proximity to a large body of water.

This standard is addressed in the second Essential Question, How does the Sun warm our atmosphere? While learning about the position of the Earth relative to the Sun and Earth's movements, the students will have a deeper understanding of how solar energy heats certain parts of Connecticut, especially New Haven next to the Long Island Sound.

6.3.1. Earth is surrounded by layers of gases (atmosphere) that influence the environmental conditions on its surface. Earth's atmosphere (air) is a mixture of different amounts of gases (mainly nitrogen and oxygen, along with small amounts of carbon dioxide, water vapor and other gases).

This standard is directly addressed in the lessons discussing the layers of the Earth's atmosphere and what occurs in each layer. The students will create atmosphere wheel models to use as a reference throughout the unit. The students will gain an understanding of the air through the lessons on the Greenhouse Effect and Carbon Cycle.

6.3.2. Weather on Earth is caused by the daily changes in the temperature, pressure and amount of moisture in the lower atmosphere.

In discussing the layers of the atmosphere, we discuss what occurs in each layer. We discuss what weather is through the exploration of air pressure and humidity, and how these amongst daily temperature determine the weather of a certain area. The students will be keeping track of weather patterns and will be documenting the pressure, temperature and humidity each day and study patterns.

6.3. 3. Climate is the long-term conditions experienced by different regions on earth, and is influenced by the amount of solar energy penetrating the atmosphere to reach Earth's surface.

Throughout this unit the Sun's importance to Earth is discussed and explored trough various activities. The seasons occur due to the Earth's axis and daily rotation creating night and day. Every place on Earth in a certain distance from the Sun causing some areas to be warmer, and others cooler generally.

6.3. 8. Solar energy is absorbed by different surfaces on the earth and radiated back to warm the atmosphere. Land absorbs solar energy at a faster rate, and releases it at a faster rate, than water. Air temperature above the land or water depends on the amount of solar radiation absorbed.

This standard describes the Greenhouse Effect. One entire lesson of this unit is dedicated to the Greenhouse Effect, but it's implications and effects are discussed throughout the unit. We also explore how rising Carbon Dioxide rates contribute to the Greenhouse Effect, and how this is why the planet Venus is so hot despite being so far from the Sun.

6.3. 12. Water on Earth evaporates into the atmosphere (humidity) driven by energy from the sun. Higher temperature causes more evaporation. Clouds form when warm, moist air evaporates, rises and cools, causing its molecules to condense onto tiny dust particles suspended in the air. Different cloud formations are associated with different weather.

When exploring the water cycle and Connecticut weather, this standard is addressed. We discuss the different cloud types and their implications for weather. The students already have background knowledge on this topic as it was extensively discussed during our ecosystems unit when they were making terrariums and could physically see the effects of evaporation, condensation and precipitation. The students will come away from this unit with a solid understanding of how clouds form.

6.3. 15. Connecticut weather is influenced by its closeness to the Atlantic Ocean and Long Island Sound. Water temperature causes coastal temperatures to be cooler in summer and warmer in winter than temperatures inland.

Since my unit required by New Haven asks how CT climate effects its weather, this standard is essentially addressed throughout this entire unit. In our lesson dedicated to CT weather, students will come away with a knowledge of how the ocean effects the weather of Connecticut in comparison to other inland places in CT and of the same latitude.

6.3.16. Connecticut often has rapidly changing weather because three patterns of moving air interact here: cold, dry air from the north, warm, moist air from the Atlantic Ocean coastline, and air moving across the US from west to east.

In the lesson dedicated to CT weather we explore the reasons for the different climates and ecosystems in CT alone. For such a small state, we have very diverse weather patterns and environmental conditions resulting in many types of ecosystems as well.

Lessons

Lesson 1 - Our Solar System

Question : Where is Earth's location in space?

Activity : The students will use magazines to cut out images and create a collage showing the positions of the planets in our Solar System.

Vocabulary : universe, galaxy, Solar System, star, planet

Technology : At the beginning of the class, I will show first 10 minutes of "Cosmos" Episode 1. This episode generalizes Earth's age in relation to the universe and explains theories behind Earth's formation. It provides a visual anchor for students as they grapple with the universe as a place and context for Earth's existence.

Description : The unit will begin with a brief explanation of Earth's location in the universe. This will include our Solar System as well as our location in our galaxy and so on. Students will learn why it is called a "solar system" and what it means for the Earth to be part of it. It is important for students to understand the scale of this so that they can understand Earth's role in juncture with the sun and in space. This will give a big picture image to students before delving into the seasons.

Lesson 2 - Seasons

Question : Why does Earth have seasons?

Activity : I will demonstrate day and night as well as the year, using a globe and a flashlight. This will help students gain a spatial understanding of Earth's movements around the sun and about it's own axis.

"The Cartoon Introduction to Climate Change": "A Brief History of Planet Earth," p. 15

Vocabulary : tilt, gravity, hemisphere, orbit, equator, poles

Technology : http://www.cleanvideosearch.com/media/action/yt/watch?v=z8aBZZnv6y8 This short video clip shows Earth's planets and the rates at which they move.

http://www.cleanvideosearch.com/media/action/yt/watch?v=9n04SEzuvXo

This video shows how Earth rotates and revolves around the Sun. These videos will provide a visual example for them to reference throughout the lesson.

Description : Students will next delve into the Earth's tilt and how and why it effects the hemispheres differently at different times in the year. Students will draw the equator and label the hemispheres and poles onto a small Styrofoam sphere. Students will work with a partner. One will user a flashlight and act as the "sun" while the other student moves in Earth's orbit. Students will document their observations. I will briefly discuss how the moon effects our climate as well.

Lesson 3 - Climate

Question : What does climate effect weather?

Activity : Students will create a Venn Diagram specifically outlining the similarities and differences between what weather and climate. Students will then explain how weather affects climate.

Standards : 6.3.3. Climate is the long-term conditions experienced by different regions on earth, and is influenced by the amount of solar energy penetrating the atmosphere to reach Earth's surface.

"The Cartoon Introduction to Climate Change" : "Climate Science," p. 63

Vocabulary : weather, climate, seasons, equinox, solstice, wind

Description : Students will discover the similarities and differences between weather and climate and how

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seasons affect both. Students will also learn about equinoxes and solstices. Students will discuss typical weather patterns in CT and explore how climate determines those changes. Understanding that climate and weather analyze different things is crucial to their understanding of CT weather.

Lesson 4 - CT Weather

Question : How does Connecticut's climate affect our normal weather patterns?

Activity : Students will begin a daily weather log that they will keep up as we move through the unit. Each day after the students log the daily weather, a few students will take turns giving a small "weather report" using the vocabulary they learn in this lesson.

Standards : 6.3.a. Local and regional weather are affected by the amount of solar energy the area receives and proximity to a large body of water.

6.3.2. Weather on Earth is caused by the daily changes in the temperature, pressure and amount of moisture in the lower atmosphere.

6.3.15. Connecticut weather is influenced by its closeness to the Atlantic Ocean and Long Island Sound. Water temperature causes coastal temperatures to be cooler in summer and warmer in winter than temperatures inland. 16. Connecticut often has rapidly changing weather because three patterns of moving air interact here: cold, dry air from the north, warm, moist air from the Atlantic Ocean coastline, and air moving across the US from west to east.

Vocabulary : meteorologist, weather report, temperature, air pressure, barometer, dew point, humidity, pollen count, visibility, wind chill

Technology : Students will watch a few examples of News8 Weather reports and take notes on the voice, fluency, dress, enthusiasm, and delivery of the weather reports.

Description : Students will learn about the weather patterns in CT and phrases used to describe local weather. Students will learn about how meteorologists deliver the weather forecast and why it is important to daily life. Students will report on the daily weather after keeping their logs for the duration of the unit.

Lesson 5 - Earth's Atmosphere

Questions : What makes up our atmosphere?

Activity : Students will construct a movable model of the layers of the atmosphere and draw what usually occurs in each layer. For example, they may draw a satellite in the exosphere.

Standards : 6.3.1 Earth is surrounded by layers of gases (atmosphere) that influence the environmental conditions on its surface. Earth's atmosphere (air) is a mixture of different amounts of gases (mainly nitrogen and oxygen, along with small amounts of carbon dioxide, water vapor and other gases).

6.3.2. Weather on Earth is caused by the daily changes in the temperature, pressure and amount of moisture in the lower atmosphere.

"The Cartoon Introduction to Climate Change": "Carbon Dioxide," p. 40

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Vocabulary : atmosphere, troposphere, stratosphere, mesosphere, thermosphere, exosphere, carbon dioxide, water vapor, moisture, nitrogen, oxygen, ozone

Description : Students will gain an understanding of the layers of Earth's atmosphere, what gases and temperatures make it up, and what goes on in each layer through a series of short videos. The students will create an atmospheric layer wheel out of card stock and label what gases make up each layer and draw what occurs in each layer. In order to fully understand the Greenhouse Effect, students need to understand which elements exist in the atmosphere and also the Ozone Layer's role in protecting us. I will briefly discuss the hole in the Ozone layer and the banning of CFCs and those effects.

Lesson 6 - The Water Cycle

Question : How does the Water Cycle work?

Activity : Students will create a labeled diagram of the water cycle to keep in their notebooks as a point of reference.

Standards: 6.3. 12. Water on Earth evaporates into the atmosphere (humidity) driven by energy from the sun. Higher temperature causes more evaporation. Clouds form when warm, moist air evaporates, rises and cools, causing its molecules to condense onto tiny dust particles suspended in the air. Different cloud formations are associated with different weather.

"The Cartoon Introduction to Climate Change" : "Water," p. 89

Vocabulary : evaporation, condensation, precipitation, clouds, water vapor, solid, liquid, gas, temperature

Description : In order for students to understand the scope and importance of Earth's atmosphere, they need to have a basic understanding of the gaseous cycles that are constantly occurring. At the beginning of the year, the students learned about the Water Cycle through the creation of terrariums, so this is a review for them. However it also explains how a lot of weather occurs, and helps to tie the year's units together in a cohesive manner.

Lesson 7 - The Carbon Cycle

Question : How does the Carbon Cycle work?

Activity : Students will create a labeled diagram of the water cycle to keep in their notebooks as a point of reference.

"The Cartoon Introduction to Climate Change": "Carbon Dioxide," p. 39

Vocabulary : carbon dioxide, photosynthesis, waste, respiration, fossil fuels, emissions, uptake, decay, methane, organic

Description : In order for students to understand the scope and importance of Earth's atmosphere, they need to have a basic understanding of the gaseous cycles that are constantly occurring. The Carbon Cycle explains how carbon, the most common greenhouse gas, moves in our atmosphere. We will also discuss how humans are adding carbon dioxide to the air in large quantities and how this can affect worldwide weather. Many scientists believe this is a large component to climate change.

Lesson 8 - Radiation

Question : What does the sun emit?

Activity : Students will take part in an activity in which they use different materials and surfaces to measure the temperature and discuss how and why different materials may be different temperatures.

Vocabulary : electromagnetic spectrum, infrared, radio waves, wavelength, visible light, ultraviolet, x-ray, gamma ray, microwave, radiation

Description : Students will watch a video about the electromagnetic spectrum (BrainPop ®) to give them a base for their background knowledge. We will pause the video and take notes at specific parts in a graphic organizer provided by the BrainPop website. Students will use this information to make inferences on how and why different surfaces heat up at different rates and to different temperatures. The materials they will be setting up in sunlight and monitoring will be black paper, aluminum foil, white paper, blue paper, a plastic plate, and a wooden Popsicle stick. The students will use surface thermometers to measure the temperatures after about 10 minutes.

Lesson 9 - The Greenhouse Effect

Question : How does the sun warm the Earth?

Activity : Students will plant mustard seeds in 2 small cups in a group. One cup will have another clear plastic cup over the top with holes poked, and the other will not. Students will water the plants and take the temperature of the plant inside the cup and outside the cup daily to discuss show how one plant is essentially in a greenhouse.

Vocabulary : greenhouse gases, greenhouse, atmosphere, temperature

Description : As a review of the terrarium projects in the beginning of the year, the students will gain an entirely new understanding of how the sun heats the Earth's atmosphere, and will be able to draw connections between the plant in the cup and the Earth's atmosphere- and how both act as "greenhouses" protecting the temperatures. We will discuss why this would be important for life on Earth. We will also discuss which gases stay within the atmosphere and which bounce back out. We will briefly discuss rising CO2 levels, but will delve further into that in the lesson, "Human Interactions with the Environment."

Lesson 10 - Climate Study Through Ice Coring

Question : How do ice cores help to tell scientists about world climate?

Activity : Analysis of an "ice core": Students will receive a picture diagram of an ice core and using their new knowledge on what traits of layers indicate about climate in the past, the students will analyze what past weather/climate patterns may have been.

"The Cartoon Introduction to Climate Change": "A Brief History of Planet Earth," p. 15, "The Ice Ages," p.27-29, 48-50

Vocabulary : glacier, ice core, Antarctica, layers

Description : Students will learn about ice core research through a series of excerpts from Richard B. Alley's "The Two Mile Time Machine". Students will gain an understanding of glaciers versus ice sheets, glacial behavior, what ice coring is and what it tells us, and then analyze pictures of ice core layers to predict climactic behavior from past years. Ice coring has provided scientists with concrete evidence of the climate in Earth's recent and distant past. The layers tell us about precipitation patterns and climactic behavior by the thickness and makeup of layers of ice much like the layers of a tree tell us about rainfall and climactic conditions within the years that make up a tree's life.

Lesson 11 - Alternative Energy Sources

Question : How can we create power without fossil fuels?

Activity : Students will create paper windmills in order to see how much power can be generated using natural power. Students will create several different types and compare and contrast which was most powerful. Students will also be forced to think about models that would be able to generate power with minimal wind.

Technology : Before the lesson, I will show an excerpt from "Cosmos" Episode 7, explaining the creation of Solar Power and what it was initially used for, and why it disappeared as a concept for many years.

The Cartoon Introduction to Climate Change: "Techno-Fix," p. 145, "Uncertainty," p. 121

Vocabulary : solar power, wind power, turbine, water power, dam, windmill, fossil fuels, carbon dioxide

Description : Students will learn about alternative energy sources such as wind, water, and solar power. We will discuss fossil fuels, and how they are harmful and non-renewable. Students will gain an understanding as to why fossil fuels are not ideal as a power source forever. Students will be able to understand how harnessing natural energy sources can be beneficial and environmentally friendly. We will also look at the downsides to some of these sources for energy (such as wind turbines effecting bird populations.)

Lesson 12 - Human Interactions with the Environment

Question : How can humans help to correct some of the mistakes we have made when caring for our environment?

Activity : Students will create environmental awareness posters for the school. Students will use their knowledge of alternative energy sources to raise awareness around the school on the topic.

"The Cartoon Introduction to Climate Change" : "Tragedy of the Commons," p. 135, "Beyond Fossil Fuels," p. 171

Vocabulary : awareness, alternative energy

Description : Students will learn about the burning of fossil fuels, the rising CO2 levels, pollution, and other ways that humans are harming the environment. Students will read excerpts from various print sources discussing alternative energy. Students will create posters to hang around the school calling upon people to make changes in their daily lives to help the environment.

Lesson 13 - Solar Ovens

Question : How does the sun power a home-made oven?

Activity : Students will create solar ovens using pizza boxes, black paper, and tin foil.

Standards : 6.3.a. Local and regional weather are affected by the amount of solar energy the area receives and proximity to a large body of water.

6.3. 8. Solar energy is absorbed by different surfaces on the earth and radiated back to warm the atmosphere. Land absorbs solar energy at a faster rate, and releases it at a faster rate, than water. Air temperature above the land or water depends on the amount of solar radiation absorbed.

Vocabulary : solar power, radiation, conductor, absorption, convection, conduction

Description : Students will explain conduction and convection by making and cooking in a solar oven. Students will see solar energy at work and explain what is happening. This will take several days.

Lesson 14 - Community Outreach

Question : Why it is important to inform the public of environmentally friendly information?

Activity : Students will create brochures explaining the climate of Connecticut at different times in the year, environmental issues in Connecticut, and tips for helping the environment that people can do every day, ie. Reusable bags as opposed to single use plastic bags.

Vocabulary : community, environmentally-friendly, outreach, public information

Description : After discussing human interaction with the environment, and after creating the solar ovens, the students will be armed with new knowledge on how to lighten their "carbon footprint." I have found that many students become passionate about helping the environment after this unit and often want to do more for the public. In this lesson, students will be pairing down what they learned in this unit into a brochure that we will copy and distribute throughout New Haven in the free newspaper bins around the city. The intention of the brochure is to show they students that they can make a difference even through doing something small like this. It helps to engage them in what they learned and take it far beyond the classroom.

Resources

Books

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Grady Klein & Yoram Bauman Ph.D , The Cartoon Introduction Guide to Climate Change (Washington D.C.: Long Island Press, 2014).

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Martin J. Gutnik, The Challenge of Clean Air (New York, NY: Enslow Publishing, 1990).

Jane Walker, Man Made Disasters: The Ozone Hole (Bel Air, CA: Gloucester Press, 1993).

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Video

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Monroe, Mark. Chasing Ice . Documentary. Balog, James. 2012. Submarine Deluxe. 2012. Film.

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