

Teacher's Guide For

Measuring the Earth's Temperature

For grade 7 - College

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Executive Producer
William V. Ambrose

Teacher's Guide by
Ron Meyer

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145 West 45th St., Suite 1115
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1-800-526-4663
24-Hour Fax 212-768-9282
<http://www.ambrosevideo.com>

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LINKS TO CURRICULUM STANDARDS

The design for this program includes the following curriculum correlations: National Science Education Standards, Content Standard B - Properties and changes of properties in matter, motions and forces, transfer of energy; Content Standard D – Structure of the Earth system, Earth's history, Earth in the solar system and the McRel K-12 Science Standards and Benchmarks, Level III (Grades 6-8) and Level IV (Grades 9-12).

MATERIALS IN THE PROGRAM

Teacher's Guide -This Teacher's Guide has been prepared to aid the teacher in utilizing materials contained within this program. In addition to this introductory material, the guide contains the following:

- Suggested Instructional Notes
- Student Learning Goals
- Test Questions on Blackline Master Quiz 1A for duplication and handout to students

INSTRUCTIONAL NOTES

It is suggested that you preview the program and read the related Student Goals and Teacher Points. By doing so, you will become familiar with the materials and be better prepared to adapt the program to the needs of your class. You will probably find it best to follow the program's chapters in the order in which they are presented in this Teacher's Guide, but this is not necessary. The program can be divided into chapters accessed through the DVD's Menu Screen under Chapter Selects. It is also suggested that the program presentation take place before the entire class and under your direction. As you review the instructional program outlined in the Teacher's Guide, you may find it necessary to make some changes, deletions, or additions to fit the specific needs of your students. After viewing the programs you may wish to copy the Test Questions on Blackline Master Quiz 1A, and distribute to your class to measure their comprehension of the events.

INTRODUCTION AND SUMMARY OF PROGRAM

Measuring the Earth's Temperature presents in a clear way the scientific study of the data of the Earth's temperature is collected and correlated to create an overall temperature of the Earth. The Earth's temperature is measured in the six to ten mile thick bottom layer of the atmosphere called the troposphere. Meteorologists use a unique combination of data gathered by satellite, weather balloon and surface stations to compile the temperature of the Earth from every corner of the globe. *Measuring the Earth's Temperature* examines the key concepts, means and principles in measuring the temperature of our unique planet. It also examines how this data is compiled at super weather stations around the globe and is used to measure the Earth's temperature and temperature changes over time. In addition, the program discusses the role of temperature data plays in creating climate change models.

Below is a list of the program and its chapters. Using this program, teachers can create a lesson plan to cover the specific concepts and themes mentioned.

Measuring the Earth's Temperature

- The Earth's Atmosphere
- History of Temperature Data Collection
- How the Earth's Temperature is Measured
- Super Weather Stations
- Graphing the Earth's Temperature over Time
- Regional Temperature Differences
- The Role of Temperature Data in Climate Change Models

SUMMARY OF PROGRAM

Measuring the Earth's Temperature

This program *Measuring the Earth's Temperature* presents a unique look at how the Earth's temperature is measured and correlated and then how the data are used to create climate change models.

Chapter one shows the layered structure of the Earth's atmosphere is made up of the troposphere, stratosphere, mesosphere and thermosphere.

The history of how scientists have collected meteorological data is discussed in chapter two.

Chapter three shows how meteorologists, using data gathered from satellites, surface stations, radar, and aircraft observations, create weather models to make forecasts.

The vital role of NOAA's super weather stations in collecting highly accurate temperature data is discussed in chapter four.

Chapter five examines how scientists have measured and interpreted temperature and temperature changes over the past 100 years, not only for the United States, but also for the entire world.

The vast differences in the regional temperatures - from the poles, to the mid-latitudes to the tropics - and their warming over the past 100 years is looked at in chapter six.

Chapter seven discusses how the role of temperature changes has affected the creation and use of climate models for modern scientists and meteorologists.

Chapter 1 Measuring the Earth's Temperature: The Earth's Atmosphere

Student Goals - In this *Measuring the Earth's Temperature* chapter the students will learn:

- The Earth's atmosphere is in a delicate dynamic balance that is absolutely critical for all life on the planet
- People live in the lower densest part of the atmosphere called the troposphere
 - The troposphere extends above the Earth's surface five miles at the poles and nine miles at the equator
 - All weather takes place in the troposphere
- The next layer is the stratosphere
 - It is home to a band of powerful winds known as the jet stream
 - It is also home to the ozone layer, which protects life on the planet from lethal, ultraviolet radiation from the sun
- The mesosphere starts where the stratosphere ends, extending from 31 to 55 miles
- Above the mesosphere is the largest section of the atmosphere: the thermosphere, where the Northern lights, or the aurora borealis, occur

Chapter 2 Measuring the Earth's Temperature: History of Temperature Data Collection

Student Goals - In this *Measuring the Earth's Temperature* chapter the students will learn:

- Climate study started around 130 years ago when scientists around the world started keeping records - measuring precipitation and temperature over the course of days, months and years
 - Meteorologists started erecting weather stations designed to record precipitation amounts and measure temperature variations at a particular place
 - Using the data collected over time, climatologists put together a pattern to represent the climate at each of these weather stations
- Weather data gathering began in 1873 and the first weather balloon launch was 1892
 - The invention of the *radiosonde* in 1930 made weather data gathering from balloons even easier
 - In 1960 the first weather satellite, TIROS was launched from Cape Canaveral
 - Today 187 nations and territories participate in gathering information in many ways, including land-based observation stations, radar systems, weather balloons, airplanes, ships, and satellites

Chapter 3 Measuring the Earth's Temperature: How the Earth's Temperature is Measured

Student Goals - In this *Measuring the Earth's Temperature* chapter the students will learn:

- Weather information is gathered in three ways today - satellite, weather balloons and surface weather stations
- How satellites, weather balloons and surface stations gather their data
- Meteorologists measure temperature, precipitation, cloud cover, relative humidity, barometric pressure, and wind speed and direction
 - Using computers, all of this data from all the sources can be plotted on a map
 - As a result, a picture of the weather across a region can then be displayed on a computer screen
- Using atmospheric observations to make a computer forecast of the weather is an interplay between atmospheric observations and the computer model
 - Scientists look at the atmosphere with satellites, surface stations, radar, and aircraft observations
 - To forecast with a computer, scientists need the best possible, most accurate description of the current state of the atmosphere
- The goal for meteorologists is to produce long and short-term weather forecasts But the data collected from all those meteorological observations has a second purpose to measure the planet's regional and worldwide temperatures and look for changes in temperature patterns
- Three centers specialize in doing just that
 - NASA's Goddard Institute for Space Studies in New York City
 - Meteorology Office in Devonshire, England
 - NOAA National Climatic Data Center in Asheville, North Carolina

Chapter 4 Measuring the Earth's Temperature: Super Weather Stations

Student Goals - In this *Measuring the Earth's Temperature* chapter the students will learn:

- Meteorologists have always strived to produce ever better long and short-term weather forecasts using data from conventional weather stations
- In 2005 NOAA began building a network of super weather stations
 - The goal was to get continuously, highly accurate temperatures
 - The super weather stations became known as the climate reference network
- How a U.S. Climate Reference Network Station works
 - These super weather stations connect to satellites to send their temperature data immediately to the National Climate Data Center
 - The data produced by the super weather station is needed to measure the Earth's temperature
 - There are 114 of these super weather stations that have produced a national temperature record of high quality

Chapter 5 Measuring the Earth's Temperature: Graphing the Earth's Temperature over Time

Student Goals - In this *Measuring the Earth's Temperature* chapter the students will learn:

- The data from these weather stations helps forecasting but it has a second purpose
 - Combined with the more typical weather stations' information, the data is used by scientists to measure the planet's regional and worldwide temperatures
 - These scientists also look for changes in temperature patterns
- Three centers specialize in doing this data interpretation
 - NASA's Goddard Institute for Space Studies in New York City
 - The Meteorology Office in Devonshire, England
 - The NOAA National Climatic Data Center in Asheville, North Carolina
- Each data collection arrives at a slightly different number for the temperature of the Earth's lower atmosphere
- How the three different centers process the temperature data is important
- They also use satellite data that can create subtle differences in recorded temperature data around the globe
- How scientists use the data collected to measure the Earth's temperature
 - Meteorologists can give a temperature for each of the past 100 years
 - During the first decade of the 21st century, it was around 58°
- Temperature data comes from all around the country and the world
- Meteorologists graph temperature changes over the years by plotting a particular year's temperature difference from the average of many years
 - This difference is called an anomaly
 - The average temperature of the planet for the 20th century was about 57 degrees
 - In 2005 the average temperature was 58.1
 - The difference of 1.1 is an example of an anomaly
- Scientists compare temperature trends from the three specialized data centers by a single number
 - This single number expresses the difference from each data center's home 100 year average temperature
 - The three data centers process the data differently but they are all telling the same story – since 1880 there has been a rise in the global temperature
 - The warmest decade has been the one ending in 2009
- In his 2007 movie, *an Inconvenient Truth*, Al Gore introduced the public to the hockey stick analogy for Earth's accelerating upwards temperature change
- A close examination of the hockey stick data for the last 130 years
- Scientists can accurately measure the Earth's temperature and graph how it changes over time
 - It is a change over time that shows a steady rise during the last 100 plus years

Chapter 6 Measuring the Earth's Temperature: Regional Temperature Differences

Student Goals - In this *Measuring the Earth's Temperature* chapter the students will learn:

- The Earth's lower atmosphere is not warming uniformly
- How the Earth's different areas have warmed over the past 130 years
- Mid-latitudes are warming faster than the overall trend
 - Winters are shorter, first frosts are coming later, and last frosts are coming sooner
 - Mountain glaciers have all but disappeared in the 21st century
- The poles are warming even faster and they show a very sensitive response to global warming
 - Sea ice is disappearing, the permafrost is melting, and continental glaciers are retreating
 - While the warming in the Arctic is dramatic, the Arctic is a small part of the planet
- The tropics, on the other hand are large band around the center of the planet
 - They are so huge, they dominate the planet
 - As a result, the tropics control how fast the Earth's atmosphere warms or cools

Chapter 7 Measuring the Earth's Temperature: The Role of Temperature Data in Climate Change Models

Student Goals - In this *Measuring the Earth's Temperature* chapter the students will learn:

- The rise in the Earth's temperature raises many questions
 - Has man's activity been responsible for this upward trend in temperature
 - What will the impact be of a continued temperature rise
 - What will be the impact on extreme weather
 - What will the impact be on sea level
 - How will it affect climates and ecosystems
- We do have a reliable and accurate system in place to monitor the Earth's ever changing temperature
- All the data is publicly accessible and can be used by anybody

ANSWERS TO BLACKLINE MASTER QUIZ 1A

1 – c; 2 – b; 3 – c; 4 – d; 5 – b; 6 – c; 7 – a; 8 – c; 9 – a; 10 – b; 11 – d; 12 – a