EAST PENN SCHOOL DISTRICT

Meteorology
July 14, 2025

Unit 1 - Introduction to the Atmosphere

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.3.9-12.N Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

3.3.9-12.E Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

Transfer

Students will be able to independently use their learning to consider...

- ❑ Why does weather happen?
- ❑ How does the atmosphere affect life on Earth?
- ❑ How do humans affect the atmosphere?

Meaning

UNDERSTANDINGS

Students will understand that...

- ❑ Understanding the past is critical towards our efforts to better predict the future.
- ❑ Climate is what we expect, but weather is what we get.
- ❑ Life on Earth depends on weather and climate.

ESSENTIAL QUESTIONS

Students will keep considering...

- ❑ How does the weather affect me?
- ❑ What connections are there between the changing Earth, evolution of life, and our changing atmosphere?

Acquisition

Students will know...

Disciplinary Core Ideas

- ☐ Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- ☐ The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual coevolution of Earth's surface and the life that exists on it.
- ☐ Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of

Students will be skilled at...

- ☐ Construct an evidence-based argument explaining how the evolution of photosynthetic organisms significantly altered Earth's early atmosphere over time
- ☐ Formulate a scientific argument, using historical evidence, about how major biological events (e.g., mass extinctions affecting biomass, or the spread of land plants) correlated with or potentially contributed to significant shifts in Earth's climate history
- ❑ Creating a vertical profile of the atmosphere
- ❑ Identifying various events on Earth's

	thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. ☐ The geologic record climate shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. ☐ The foundation for Earth's global climate systems is the Electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space. **Other knowledge for dual credit/credit-by-exam:** ❑ Earth's current atmospheric composition and how it has changed greatly since Earth's creation. ❑ Weather affects many aspects of life on Earth. ❑ How the human body changes with changes in the atmosphere. ❑ Properties of air change with changes in elevation. ❑ Weather and climate share the basic elements (temperature, humidity, cloudiness, precipitation, air pressure, winds), but differ in scale. ❑ Ozone's role/function and threats.	timeline that had worldwide climatic effects ❑ Conducting a weather analysis comparing weather forecasters ❑ Recognizing various weather/climate effects on daily life ❑ Distinguishing between weather and climate and name the basic elements of weather and climate

Unit 2 - Cycles

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.3.9-12.L Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

3.3.9-12.K Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

3.3.9-12.H Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Transfer

Students will be able to independently use their learning to consider...

- ☐ Why does weather happen?
- ☐ How does the atmosphere affect life on Earth?
- ☐ How do humans affect the atmosphere?

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ The water cycle is essential to all forms of life on Earth.
- ☐ The carbon cycle is a natural cycle disrupted recently by human activities.

ESSENTIAL QUESTIONS

Students will keep considering...

- ☐ How does water move?
- ☐ How does carbon move?
- ☐ How do cycles and Earth systems affect all forms of life?

Acquisition

Students will know...

Disciplinary Core Ideas:

- ☐ Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- ☐ Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- ☐ The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.
- ☐ The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection,

Students will be skilled at...

- ☐ Constructing a simplified mass balance model of carbon exchange between the atmosphere and the terrestrial biosphere
- ☐ Developing a simple quantitative model illustrating the net exchange of carbon between the atmosphere and the ocean (hydrosphere)
- ☐ Designing and carrying out an investigation to explore how temperature affects the amount of water vapor air can hold
- ☐ Modeling the movement of water and carbon in their respective cycles
- ☐ Calculating dew point temperatures and relative humidity
- ☐ Calculating temperature changes according to dry adiabatic and wet adiabatic lapse rates
- ☐ Plan and conduct a precipitation analysis comparing locations throughout the U.S.

	absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space. **Other knowledge for dual credit/credit-by-exam:** ☐ Evaporation is a cooling process ☐ The different phases of water, why changes happen, and places it can be within the water cycle ☐ Ways that humidity is represented and changes (absolute humidity, relative humidity, and dew point) ☐ When air expands, it cools. The rate at which it cools is dependent upon the air being dry or wet. ☐ Various mechanisms of lifting (orographic lifting, localized convective lifting, convergence, and front wedging create rising air currents) ☐ Locations in the Earth that are reservoirs for carbon and water	☐ Using a psychrometer to investigate dry- and wet-bulb temperatures to calculate relative humidity ☐ Explaining the difference between saturated, supersaturated, and unsaturated air

Unit 3 - Heating & Temperature

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.3.9-12.E Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

3.3.9-12.L Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Transfer

Students will be able to independently use their learning to consider...

- ☐ Why does weather happen?
- ☐ How does the atmosphere affect life on Earth?
- ☐ How do humans affect the atmosphere?

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ Energy transfers from the sun and aspects of Earth's surface determine climate and local temperatures.

ESSENTIAL QUESTIONS

Students will keep considering...

- ☐ Why/how do seasons and temperatures change?
- ☐ What would the world be like without heat transfers?

Acquisition

Students will know...

Disciplinary Core Ideas

- ☐ Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes.
- ☐ The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space.
- ☐ The foundation for Earth's global climate systems is the Electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into

Students will be skilled at...

- ☐ Utilizing a simple energy balance model to illustrate how changes in factors like atmospheric composition (e.g., greenhouse gases) or surface reflectivity (albedo from ice/snow cover) affect Earth's average temperature
- ☐ Employing a conceptual or graphical model to represent how cyclical changes in Earth's orbit and axial tilt (Milankovitch cycles) alter the seasonal and latitudinal distribution of incoming solar radiation
- ☐ Modeling changes in incoming light to surface temperature changes
- ☐ Identifying the 3 types of heat transfer based on solid/gas/liquid
- ☐ Correlating approximate hours of daylight for various locations on Earth to sun angle
- ☐ Determining the sun's direct rays, noon sun angle, and solar intensity
- ☐ Converting temperature from Fahrenheit to Celsius
- ☐ Calculating temperature changes with

	space. **Other knowledge for dual credit/credit-by-exam:** ☐ Resulting changes from the changing angle of incoming light ☐ Differences and importance of latent and sensible heat ☐ Solar budget, including the albedo of surface and atmospheric materials ☐ Characteristics of the materials absorbing the energy such as color, texture, transparency, state of matter, and specific heat. ☐ A location's climate is influenced by latitude, proximity to water, ocean currents, prevailing winds, vegetative cover, elevation, and mountain ranges.	changes in elevation ☐ Identify seasons for different parts of the Earth based on Earth-Sun models ☐ Predicting temperature changes throughout the day for different surface/material types ☐ Modeling ocean currents and identifying temperature impacts on coastal/inland locations ☐ Modeling and predicting temperature changes with changes in altitude

Unit 4 - Climate Change

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.3.9-12.M Use a computational representation to illustrate the relationships among Earth's systems and how those relationships are being modified due to human activity.

3.3.9-12.H Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

3.3.9-12.L Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

3.3.9-12.S Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

Transfer

Students will be able to independently use their learning to consider...

- ☐ Why does weather happen?
- ☐ How does the atmosphere affect life on Earth?
- ☐ How do humans affect the atmosphere?

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ Climate is regulated by complex interactions among different factors in various Earth systems.

ESSENTIAL QUESTIONS

Students will keep considering...

- ☐ What effect do I have on the climate?
- ☐ What effect does the climate have on us?
- ☐ Why is the climate changing?

Acquisition

Students will know...

Disciplinary Core Ideas:

- ☐ Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- ☐ Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- ☐ Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of humangenerated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary) Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.

Students will be skilled at...

- ☐ Utilizing computational climate models to simulate the impact of increased atmospheric carbon dioxide concentrations on global temperatures.
- ☐ Analyzing data output from computational simulations that illustrate the flow of energy and matter (like carbon) between the atmosphere, ocean, and biosphere and how this cycling is affected by human activities
- ☐ Employing computational tools to visualize and compare projected regional climate changes (e.g., temperature, precipitation patterns) under different scenarios of future human greenhouse gas emissions
- ☐ Calculating their own carbon footprint
- ☐ Differentiating and calculating the differences between natural and

	☐ Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. **Other knowledge for dual credit/credit-by-exam:** ☐ The Greenhouse Effect is a natural phenomena that makes Earth habitable, but also linked to global warming. ☐ Oxygen isotope ratios in ice core data tell us about past climates ☐ More than half of the carbon released by humans is absorbed by new plant matter or dissolved in the oceans. 45% remains in the atmosphere for decades. ☐ Earth has experienced natural changes in the climate and human-induced changes ☐ Positive-feedback mechanisms reinforce the initial change (melting of sea ice equals decreasing albedo) and negative-feedback mechanisms counteract the initial effect (more clouds blot out more radiation, which leads to cooling) ☐ In the future, Earth's surface temperature is likely to continue to rise. Sea levels are predicted to rise. Populations are likely to rise. Sea ice cover and permafrost will likely decrease.	anthropogenic carbon ☐ Discussing hypotheses that relate to natural causes of climate change ☐ Analyzing ice core data and climatic changes ☐ Contrasting positive- and negative-feedback mechanisms ☐ Identifying their own views on climate change and being able to consider natural and human causes

Unit 5 - Clouds, Precipitation, & Fog

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.3.9-12.K Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Transfer

Students will be able to independently use their learning to consider...

- ☐ Why does weather happen?
- ☐ How does the atmosphere affect life on Earth?
- ☐ How do humans affect the atmosphere?

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ Water's ability to move is essential to life.
- ☐ There is more to the sky than what is seen by the eye.

ESSENTIAL QUESTIONS

Students will keep considering...

- ☐ What would the world be like without condensation and/or precipitation?
- ☐ Why do we see what we see in the sky?

Acquisition

Students will know...

Disciplinary Core Ideas:

- ☐ The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

Other knowledge for dual credit/credit-by-exam:

- ☐ Precipitation and condensation are results of various conditions and can be seen on a skew-t log-p diagram
- ☐ Form and height are the basis for naming clouds
- ☐ The relationships between physical geography and precipitation/condensation

Students will be skilled at...

- ☐ Construct an evidence-based argument about how biological processes, such as evapotranspiration from plants, contribute to the water vapor content in the atmosphere, thereby influencing cloud formation and precipitation patterns in a region
- ☐ Communicate scientific ideas in the form of a weather prediction using available evidence in the form of observational and quantitative weather data
- ☐ Identifying clouds, the reasons for different cloud types, and associated weather effects
- ☐ Describe the conditions necessary for all types of precipitation and condensation
- ☐ Using a prediction chart to know what various clouds mean for forecasting
- ☐ Creating a forecast after analyzing and interpreting a skew-T log-P diagram

	☐ A rain gauge is the standard instrument used to measure rainfall ☐ Each cloud is associated with certain predictable weather	☐ Designing and building a rain gauge to accurately measure rainfall ☐ Identifying various types of precipitation and condensation based on physical observations and patterns ☐ Modeling various types of condensation and different surface types

Unit 6 - Air Pressure & Winds

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.3.9-12.R Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

3.3.9-12.H Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

3.3.9-12.M Use a computational representation to illustrate the relationships among Earth's systems and how those relationships are being modified due to human activity.

Transfer

Students will be able to independently use their learning to consider...

- ☐ Why does weather happen?
- ☐ How does the atmosphere affect life on Earth?
- ☐ How do humans affect the atmosphere?

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ Unequal heating of Earth sets the atmosphere into motion.

ESSENTIAL QUESTIONS

Students will keep considering...

- ☐ How does air move locally and globally?
- ☐ How can humans use wind to improve life?
- ☐ What is the influence of wind?

Acquisition

Students will know...

Disciplinary Core Ideas:

- ☐ The foundation for Earth's global climate systems is the Electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space.

Other knowledge for dual credit/credit-by-exam:

- ☐ Wind is the horizontal movement of air from differences in air pressure and is also controlled by friction and the Coriolis Effect
- ☐ Air pressure is a force exerted by the weight of the air above
- ☐ High pressure and low pressure have varying associated weather and ways in which the air moves
- ☐ Air pressure affects the human body and performance in many types of objects
- ☐ El Nino (ocean warming in the Eastern Pacific and

Students will be skilled at...

- ☐ Employ a simple computational simulation to demonstrate how altered sea surface temperatures (potentially influenced by human-driven climate change) affect the stability and pressure of the overlying atmosphere, illustrating how this interaction between the hydrosphere and atmosphere can modify localized winds, such as sea breezes
- ☐ Create a model to illustrate Earth's absorption and distribution of energy, and describe how these changes can modify atmospheric stability and global air pressure patterns, consequently altering large-scale wind systems
- ☐ Identifying the changes in air pressure at various altitudes
- ☐ Analyzing/coding information from a station model

	associated with strong eastward-moving equatorial currents) and La Nina (colder surface temperatures in the Eastern Pacific and associated with strong westward-moving equatorial currents)	☐ Recognizing rising/sinking air masses based on areas of high and low pressure ☐ Interpreting isobars on weather maps and associated wind speeds and direction ☐ Identifying local winds and the way they are formed and why they work ☐ Recognizing atmospheric pressure effects on the human body and objects

Unit 7 - Air Masses & Weather Patterns

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.3.9-12.E Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

3.3.9-12.M Analyze geoscience data and the results from global climate change models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

3.3.9-12.L Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

3.3.9-12.P Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Transfer

Students will be able to independently use their learning to consider...

- ☐ Why does weather happen?
- ☐ How does the atmosphere affect life on Earth?
- ☐ How do humans affect the atmosphere?

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ Observable weather at the surface is a result of atmospheric events we cannot see with the eye

ESSENTIAL QUESTIONS

Students will keep considering...

- ☐ Why does the weather change?
- ☐ Where do air masses originate and travel to?
- ☐ How do we see weather patterns and project their path?

Acquisition

Students will know...

Disciplinary Core Ideas:

- ☐ The foundation for Earth's global climate systems is the Electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space.
- ☐ Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of humangenerated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary)
- ☐ Through computer simulations and other studies, important discoveries are still

Students will be skilled at...

- ☐ Create a model to illustrate how the movement of air masses causes resulting regional weather patterns
- ☐ Identifying air masses and fronts based on different types of data (temperature, dew points, etc...) and associated weather
- ☐ Forecasting weather based on weather patterns and fronts
- ☐ Reading, interpreting, and using weather models to create a prediction

	being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. **Other knowledge for dual credit/credit-by-exam:** ☐ Different weather maps show us air masses and fronts ☐ Day-to-day weather depends on the temperature, stability, and moisture content of an air mass affecting our region ☐ Classification of an air mass depends on latitude and moisture content, which determines observable weather ☐ Fronts are boundary surfaces that separate air masses (warm, cold, stationary, occluded) ☐ The different types of fronts all bring different observable weather	

Unit 8 - Severe Storms

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.3.9-12.M Use a computational representation to illustrate the relationship among Earth systems and how these relationships are being modified due to human activity.

3.3.9-12.H Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

3.3.9-12.L Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Transfer

Students will be able to independently use their learning to consider...

- ❑ Why does weather happen?
- ❑ How does the atmosphere affect life on Earth?
- ❑ How do humans affect the atmosphere?

Meaning

UNDERSTANDINGS

Students will understand that...

- ❑ Humans have made severe storms more severe
- ❑ Some storms are more predictable than others

ESSENTIAL QUESTIONS

Students will keep considering...

- ❑ Why do storms occur?
- ❑ How will humans deal with storms in the future?

Acquisition

Students will know...

Disciplinary Core Ideas:

- ☐ The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space.
- ☐ Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

Other knowledge for dual credit/credit-by-exam:

- ❑ There are multiple types of thunderstorms including air-mass thunderstorms, severe thunderstorms, and supercells.
- ❑ Conditions necessary to sustain thunderstorm, tornado, and hurricane development
- ❑ Loss of property, personal injury, and loss of life can be reduced by effective emergency procedures.
- ❑ The formation and structure of different storms and what conditions fuel their growth
- ❑ Hurricanes are associated with storm surge, torrential rains, and flooding

Students will be skilled at...

- ☐ Use computational model output showing the impact of changes in sea surface temperature on the overlying atmosphere to make an evidence-based claim that a specific change on the ocean surface (such as warming due to altered ocean currents or climate change impacts) creates a positive feedback mechanism that increases the energy and moisture flux into the atmosphere, thereby intensifying tropical cyclones (hurricanes)
- ☐ Analyze geoscience data from computational models simulating different land-use scenarios (e.g., urban vs. rural, deforested vs. forested) to make the claim that changes in surface characteristics alter the transfer of energy and moisture into the atmosphere, creating feedback loops that influence atmospheric instability and convective potential, thereby affecting the likelihood or intensity of severe thunderstorms in a region

- ❑ Identifying storms (hurricanes, nor'easters,

	❑ Global warming will likely enhance the conditions that promote storm development	etc...) and other weather conditions using satellite imagery ❑ Using atmospheric observations of the sky to recognize different stages of thunderstorm development ❑ Using weather maps and models to forecast incoming storms ❑ Building a structure to withstand hurricane-speed winds ❑ Recognizing land-use strategies and the effects of those decisions with regards to future storms ❑ Calculating the pressure gradient of a hurricane