SWAC Core Concept

Anthropogenic influences on the earth-atmosphere-ocean system

VT Standard

S9-12:49 (DOK 3)

Students demonstrate their understanding of Processes and Change within Natural Resources by …

· Choosing a Vermont ecosystem and tracing its **succession** before and after a damaging event, showing how the ecosystem has been restored through the maintenance of atmosphere quality, generation of soils, control of the water cycle, disposal of wastes and recycling of nutrients (e.g., flooding, former mining sites, glacial impact, deforestation, recovery of rivers from sewage/ chemical dumping, burning of fossil fuels).

AND

· Explaining a natural chemical cycle that has been disrupted by human activity and predict what the long term effect will be on organisms (e.g., acid precipitation, global warming, ozone depletion, pollution of water by phosphates, mercury, PCBs,etc.).

7.13 Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:7.13.ccc. Describe, model, and explain the principles of the interdependence of all systems that support life (e.g., flow of energy, ecosystems, life cycles, cooperation and competition, human population impacts on the world ecological system), and apply them to local, regional, and global systems;

7.14 Students demonstrate understanding of the human body heredity, body systems, and individual development and understand the impact of the environment on the human body. This is evident when students: 7.14.ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;

Potential Application

Satellites

- Eutrophication of water bodies by agricultural processes
    - False Color Composite using NIR band
- Acid Rain harming Vegetation
    - NIR band
- Recolonization of Abandoned farms in Pripryat, Chernobyl, Ukraine
- Flooding and damming of rivers (interpretation)

Weather

- Acid Rain
- Cloud Seeding
- Air Pollution/Release and spreading
    - Case Study Japan

Climate

- Link anthropogenic emissions data to changes in Global Climate Change Proxies
    - Ice Cores
    - Tree Rings
    - Boreholes
        - Swiss Alps Example
    - Coral Health
    - Pollen

SWAC Core Concept

The atmosphere is made up of vertical layers, each of which are important to life here on Earth

VT Standard

S9-12:48 (DOK 2)

Students demonstrate their understanding of Processes and Change over Time within Earth Systems by…

· Explaining the uniqueness of the earth's characteristics (e.g., solar intensity, gravity related to size of earth, makeup ofatmosphere).

AND

· Explaining how water as a molecule is also unique in its ability to retain heat, compared to land and air on earth.

AND

· Diagramming and explaining local and large scale wind systems (e.g., land and sea breezes and global wind patterns, Coriolis effect)

7.12 Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students: 7.12.aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements; 7.12.ccc understand the concept of gas density;

7.13 Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:7.13.ccc. Describe, model, and explain the principles of the interdependence of all systems that support life (e.g., flow of energy, ecosystems, life cycles, cooperation and competition, human population impacts on the world ecological system), and apply them to local, regional, and global systems;

Potential Application

Satellites

- “Haze” and atmospheric implications in Satellite and Aerial Imagery
- Ozone Measurements from Satellites
- Failure of NASA Glory Program
- Aerosol Measurements from Space-borne and Terrestrial Sensors
- Oblique photos from Space Shuttle showing Earth’s curvature with Atmosphere

Weather

- “Good” vs. “Bad” Ozone
- Cloud Type Identification
- Atmospheric Pressure Changes
- Inversion layers (pictures from Air Pollution illustrate)
- Lapse rates and parcel rising
- Discussion of Weather Balloons and data from SWAC Launches
- CricketSWAC

Climate

- Changes in “Ozone Hole” over time
- Ice core record of Atmospheric Content over past 420,000 years (Vostok Core)
- Climate Change Proxies
- Permafrost Melt and implications of Methane Releases
- Differentiation of Greenhouse Gases

SWAC Core Concept

Climate controls: elevation, topography (landscape), precipitation, proximity to water, latitude, ocean currents, and vegetation

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AND

· Explaining how water as a molecule is also unique in its ability to retain heat, compared to land and air on earth.

AND

· Diagramming and explaining local and large scale wind systems (e.g., land and sea breezes and global wind patterns, Coriolis effect)

AND

· Predicting weather for a particular location, using weather map data (barometric pressure, frontal systems, isobars, isotherms, mountain effects, lake/ocean effects, ocean currents, temperature/humidity) and examining world weather maps and identifying the most likely locations where extreme weather might occur (e.g., blizzards thunderstorms, hurricanes, tornadoes).

7.15 Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students: 7.15.ccc. Identify, model, explain, and analyze the interrelated parts and connections between earth systems (e.g., sun, radioactive decay, and gravitational energy; weather and climate);

ES 1.4 Global climate is determined by energy transfer from the sun at and near the earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the earth's rotation, and static conditions such as the position of mountain ranges and oceans.

Potential Application

Satellites

- Shuttle Radar Topology Mission (SRTM) digital elevation models
- Interpret Imagery
    - Wet vs. Dry side of mountain - vegetation lush or not?
    - Snow
        - Aspect
        - Elevation
        - Shading
    - Vegetation Differences
        - Conifer vs. Deciduous
        - Dry vs. lush
- Desert areas in context of Latitude and Insolation

Weather

- Inter-Tropical Convergence Zone and wind convergence
- Circulation Cells as explained by Insolation
- Weather Characteristics of different geographies
- Lake Effect Snow
- Cloud Seeding
- Aerosol Formation
- Acid Rain Formation
- Global Ocean Circulation
    - Northern California Beaches Cold, England Warm

Climate

- Koeppen Climate Map
- Bergeron Air Mass Map

SWAC Core Concept

Radiant energy (EMR) is converted to other forms and transferred to other parts of the earth-atmosphere-ocean system

VT Standard

S9-12:48 (DOK 2)

Students demonstrate their understanding of Processes and Change over Time within Earth Systems by…

· Explaining the uniqueness of the earth's characteristics (e.g., solar intensity,gravity related to size of earth, makeup of atmosphere).

AND

· Explaining how water as a molecule is also unique in its ability to retain heat, compared to land and air on earth.

7.12 Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students: 7.12.eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties (diffraction); 7.12.fff discuss electromagnetic waves (e.g. radio waves, x-rays).

PS 5.1 The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However it can never be destroyed. As these transfers occur, the matter involved becomes steadily less ordered.

PS 6.2 Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation, visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of EM waves is carried in packets whose magnitude is inversely proportional to the wavelength.

ES 1.1 The earth systems have internal and external sources of energy, both of which create heat. The sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from the earth's original formation.

ES 1.3 Heating of earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

Potential Application

Satellites

- Interpretation of Satellite Imagery in context of EMR
- Parallel interpretation of meteo sat content with terrestrial datasets
- Time series animations of Satellite data to study atmospheric system
- Discuss EMR in context of Satellite bands/bandwith

Weather

- Heat Islands
- UV Radiation Frisbee exercise
- Understanding pressure systems in the context of Convective Cells

Climate

- Thermohaline Circulation and ramifications of belt changes
- Convective Cells on Earth (see animations)
- Positive Feedback loops in global climate change
- Albedo

SWAC Core Concept

Forces in the earth-land-ocean system, pressure differences, gravity, Coriolis effect

VT Standard

S9-12:48 (DOK 2)

Students demonstrate their understanding of Processes and Change over Time within Earth Systems by…

· Explaining the uniqueness of the earth's characteristics (e.g., solar intensity, gravity related to size of earth, makeup of atmosphere).

AND

· Diagramming and explaining local and large scale wind systems (e.g., land and sea breezes and global wind patterns, Coriolis effect).

7.11 Students analyze and understand living and non-living systems (e.g., biological, chemical, electrical, mechanical, optical) as collections of interrelated parts and interconnected systems. This is evident when students: 7.11.aaa. Demonstrate understanding that analysis of systems is important to define and control inputs and outputs; and

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7.15 Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

7.15.ccc. Identify, model, explain, and analyze the interrelated parts and connections between earth systems (e.g., sun, radioactive decay, and gravitational energy; weather and climate);

ES 1.3 Heating of earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

Potential Application

Satellites

- Gravity Map of Earth
- Solar Radiation Map
- Heat Islands/Sinks from Satellite Data
- Ocean circulation based on surface temp derived from Satellites

Weather

- Discussion of Circulation cells (Hadley, Ferrel, Polar, etc.)
- Coriolis effect and cyclonic system development
- Parcel Rising model and Heat Islands
- Implications of warm bodies of water (i.e. Gulf of Mexico and Severe weather in the US)

Climate

- Ocean Circulation from Gulf of Mexico keeps UK warm
- Volcanic Injection Global Cooling
- Positive feedback loops in Global Climate Change
- Ice core record of Atmospheric Content over past 420,000 years (Vostok Core)

SWAC Core Concept

Hydrological cycle or water cycle - there is no new water on the planet

VT Standard

S9-12:9 (DOK 2)
Students demonstrate their understanding of the Properties of Matter by…

· Distinguishing one substance from another through examination of physical properties (such as density**,** melting point, **conductivity**), chemical properties (such as **pH, reactivity**—with O2 or acid or water), and nuclear properties (such as changes in **atomic mass, isotopes** and **half-life**).

· Explaining the states of a substance in terms of the particulate nature of matter and the forces of interaction between particles.

S9-12:12 (DOK 3)
Students demonstrate their understanding of the States of Matter by…

· Investigating and explaining the interactions between atoms or molecules within a system (e.g., **hydrogen bonding**, van der Waals forces, fluorescent light, stars).

S9-12:14 (DOK 3)
Students demonstrate their understanding of Physical Change by…

· Experimenting, graphing, and explaining the effect of heat energy on the phase changes of water from a solid state to a liquid state to a gaseous state, comparing that data to other substances, and using evidence to draw conclusions based upon these data.

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· Explaining the uniqueness of the earth's characteristics (e.g., solar intensity, gravity related to size of earth, makeup ofatmosphere).

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AND

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PS 2.5 Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is nearly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently or each other and are mostly far apart.

Potential Application

Satellites

- Glacial Mass Monitoring and Energy Budget
    - Time series of Satellite, Aerial, Ground imagery
    - Use of Interferometry in change detection
    - Use of photogrammetry in change detection
- Permafrost formation and Melt - Earth surface changes
    - Siberia Exercise
    - Swiss Alps Examples
- Ocean Surface Temps reveal addition of melted fresh water in Arctic "capping" warmer salt water arriving along Eastern coast of North America
- Hydrological Change Detection (Satellite Image Interpretation)
    - More or Fewer Lakes?
    - Vegetation healthier or more stressed?

Weather

- Lake Effect Snow
- Water Resources in Arid Regions
- Snow Ablation and Sublimation in Vermont
- Precipitation timing (heavy rains periodically or spread out?)

Climate

- Positive Feedback Loops in the Arctic
- Implications of warm bodies of water on severe weather
    - Supercell and Tornado development in United States in context of warmer Gulf of Mexico

SWAC Core Concept

Electromagnetic Energy (EMR) from the Sun drives atmospheric processes on Earth

VT Standard

S9-12:48 (DOK 2)

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ES 1.3 Heating of earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

Potential Application

Satellites

- Radiation/Insolation Maps of Earth from Space
- Theory of Image Sensors
    - Capturing different wavelengths of energy
- Satellite Time Series of Cloud Development (Visible/IR)
- Various sensors capture data in different ranges/spectrums
- Airport “Full Body Scan” sensing

Weather

- Heat Islands
- Cloud Development (parcel model)
- Lapse Rates
- UV Radiation Frisbee exercise
- Understanding pressure systems in the context of Convective Cells

Climate

- Thermohaline Circulation and ramifications of belt changes
- Convective Cells on Earth (see animations)
- Positive Feedback loops in global climate change
    - Arctic Sea Ice
    - Permafrost Melt

SWAC Core Concept

The unequal heating of water or air leads to a thermal gradient and energy transfer

VT Standard

S9-12:9 (DOK 2)

Students demonstrate their understanding of the Properties of Matter by…

· Distinguishing one substance from another through examination of physical properties (such as density**,** melting point, **conductivity**), chemical properties (such as **pH, reactivity**—with O2 or acid or water), and nuclear properties (such as changes in **atomic**
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Potential Application

Satellites

- Thermal Satellite Data showing heat retention in water bodies during fall/spring as compared to land surfaces

- Gravity Map of Earth
- Solar Radiation Map
- Heat Islands/Sinks from Satellite Data

Weather

- Large/Small Scale Wind Patterns
- Lake Effect snow
- Fog formation

Climate

- Fresh/Salt water mixing from ice melt in the Arctic - implications for ocean circulation/climate change
- Implications of warm bodies of water (i.e. Gulf of Mexico and Severe weather in the US)
- Ice core record of Atmospheric Content over past 420,000 years (Vostok Core)

SWAC Core Concept

Weather differs from climate in terms of the time scale of interest, methods used for analysis, prediction vs. trends/patterns

VT Standard

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· Predicting weather for a particular location, using weather map data (barometric pressure, frontal systems, isobars, isotherms, mountain effects, lake/ocean effects, ocean currents, temperature/humidity) and examining world weather maps and identifying the most likely locations where extreme weather might occur (e.g., blizzards thunderstorms, hurricanes, tornadoes).

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Potential Application

Satellites

- GOES and POES Satellites and Purposes
- Interpretation and Exploitation of various Satellite Products
    - IR Temp
    - Water Vapor
    - Visible
- Do we have enough Satellite Data to make inferences about Climate?
- Land Surface Interpretation
    - Landsat dates back to 1970s
    - Climate Changes as seen in Landsat
        - Vegetation differences
        - Hydrological and Cryospheric differences

Weather

- Compare daily weather with historical data
- highlight extreme weather instances that are outside the climatic “norms” for an area

Climate

- Climate Maps
    - Koeppen Climate Zone map
    - Bergeron Air Mass map