AREA 3

THE EARTH'S ENERGY BUDGETS

AREA TIME EMPHASIS	TOPIC	TITLE	TIME
38 DAYS	V	Energy in Earth Processes	7 days
	VI	Insolation and the Earth's Surface	5 days
	VII	Energy Exchanges in the Atmosphere	16 days
	VIII	Moisture and Energy Budgets and Environmental Change	10 days

What Is the Role of Energy in Earth Processes?

Time Emphasis: 7 days

TOPIC ABSTRACT

Major Behavioral Objectives

At the completion of this topic, the student should be able to:

A. Identify and analyze processes of energy transfer.
B. Describe energy transformations that have been observed in the environment.
C. Analyze environmental processes, and draw inferences about the conservation of energy.

Approach

This topic introduces the basic concepts of thermal and electromagnetic energy essential to understanding the earth processes investigated in subsequent topics. Application of the basic concepts will be expanded in greater detail during subsequent topics.

The depth of treatment of topic V, including the selection of student activities, should utilize the prior experiences and knowledge of the students.

* * * * * *

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A. Electromagnetic energy and energy transfer		
A-1 Electromagnetic energy	***A-1 What are the properties of electromagnetic energy?*** **V-A-1**	
A-1.1 Properties	A-1.11 All objects not at a temperature of absolute zero radiate electromagnetic energy.	CCO-11, 12
	A-1.12 Electromagnetic energy has transverse wave properties.	PIO-2, 3, 5; CCO-1, 7,
	A-1.13 Electromagnetic energy can be refracted, reflected, scattered, and absorbed.	PIO-2, 3; CCO-1, 7, 9, 11
	A-1.14 A good absorber of electromagnetic energy is a good radiator of electromagnetic energy.	CCO-7, 11, 12
A-1.2 Solar energy	A-1.21 The sun is the major source of energy for the earth.	CCO-3, 12
	A-1.22 The solar electromagnetic spectrum includes a wide range of wavelengths. The maximum intensity occurs in the visible region.	PIO-2, 3, 5; CCO-7, 11, 12
A-1.3 Earth energy	A-1.31 The natural decay of radioactive matter is a secondary source of energy for earth processes.	A-1.31 Relate to topic XIII. CCO-11, 12

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A-2 Energy transfer	**A-2 How can energy be transferred?** V-A-2	
A-2.1 Conduction	A-2.11 Conduction of thermal energy occurs as an interaction of matter at the molecular or atomic level.	CCO-11, 12
A-2.2 Convection	A-2.21 Density differences influence the transfer of energy in fluids.	A-2.21 Relate to topic VII. PIO-3, 5; CCO-1, 4, 5, 6, 11
	A-2.22 In a fluid, convection cells develop which transfer energy.	A-2.22 Relate to topic VII and topic XII. PIO-2, 3, 5; CCO-1, 4, 5, 6, 7, 8, 9, 11, 12
A-2.3 Radiation	A-2.31 Electromagnetic energy requires no medium for transfer.	CCO-11, 12
B. Energy transformation		
B-1 Transformation in earth processes	**B-1 What are some energy transformations that can be observed in earth processes?** V-B-1	
B-1.1 Latent heat	B-1.11 Changes of phase are contingent upon the loss or gain of energy	PIO-3, 5; CCO-1, 2, 4, 11, 12
	B-1.12 As energy is added to matter, causing a change of phase while the temperature remains constant, this energy is transformed into potential energy.	PIO-3, 5; CCO-1, 2, 4, 11, 12
	B-1.13 A significantly greater amount of energy is required to change a given mass of water from liquid to vapor than is required to change ice to liquid.	B-1.13 Relate to topic VII and topic VIII. PIO-1, 2, 3, 5; CCO-1, 2, 11
B-1.2 Movement of matter	B-1.21 The movement of matter toward or away from the earth's center of mass results in an energy transformation from kinetic to potential or vice versa.	B-1.21 Relate to topics,IX, X, and XIV. CCO-1, 2, 12
B-1.3 Wavelength absorption and radiation	B-1.31 The characteristics of the surface of a material determine the quantity and type of electromagnetic energy absorbed.	PIO-2, 3, 5; CCO-1, 6, 7, 11, 12
	B-1.32 Absorbed short wavelengths of electromagnetic energy can be subsequently radiated as long wavelengths.	PIO-3, 5; CCO-1, 2, 7, 10
B-1.4 Friction	B-1.41 Energy is transformed at interfaces where friction occurs.	B-1.41 Relate to topic IX. PIO-3, 5; CCO-1, 2, 7, 10
C. Energy relationships in earth processes		
C-1 Conservation of energy	**C-1 What inferences can be drawn about the total energy within a closed system?** V-C-1	
C-1.1 Closed system	C-1.11 Energy flows from sources to sinks.	PIO-2, 3, 5; CCO-1, 2, 4, 7, 9, 11, 12
	C-1.12 The amount of energy lost by a source equals the amount of energy gained by a sink.	PIO-2, 3, 5; CCO-1, 2, 4

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
	C-1.13 The amount of energy needed to produce an equal temperature change in equal masses of different materials varies with the materials.	C-1.13 Relate to topic VIII. PIO-2, 3, 5; CCO-1, 6, 7, 11
	C-1.14 Water has the highest specific heat capacity among naturally occurring materials.	C-1.14 Relate to topic VIII. PIO-2, 3, 5; CCO-1, 2, 7, 11
	C-1.15 Heat lost (or gained) is proportional to the product of the mass and the temperature change.	PIO-1, 2, 3, 5; CCO-1 11,11
	C-1.16 The heat lost (or gained) in a phase change is equal to the product of the mass times the change in potential energy per unit mass.	C-1.16 Relate to topic VII. PIO-2, 3, 5; CCO-1, 2, 7, 11

What Happens to Solar Energy That Reaches the Earth?

Time Emphasis: 5 days

TOPIC ABSTRACT

Major Behavioral Objectives

At the completion of this topic, the student should be able to:
A. Analyze factors which influence the amount of insolation reaching the earth's surface.
B. Measure the effect of factors which influence the amount of terrestrial radiation.

Approach

In this topic the student has the opportunity to investigate the absorption, reflection, radiation, and energy conversions involved in the earth-sun energy system.

In topic VII the radiative budget becomes the basis for the investigation of weather.

* * * * * *

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A. Insolation at the earth's surface		
A-1 Insolation factors	**A-1 What are some factors which affect insolation?**	**VI-A-1**
A-1.1 Angle	A-1.11 The intensity of insolation per unit area increases as the angle of insolation approaches perpendicular. (Screen)	PIO-2, 3, 5; CCO-1, 11
	A-1.12 The intensity of insolation per unit area decreases with an increase in latitude.	PIO-3, 5; CCO-1
	A-1.13 The angle of insolation at any location varies with the time of day.	PIO-3, 5; CCO-1
A-1.2 Duration	A-1.21 The temperature at a given location varies directly with the duration of insolation.	PIO-3, 5; CCO-1, 3, 6
	A-1.22 The duration of insolation varies with latitude and season.	PIO-3, 5; CCO-1, 5
	A-1.23 Maximum insolation in northern mid-latitudes occurs about June 21.	PIO-3, 5; CCO-1, 5
	A-1.24 Maximum surface temperature occurs sometime after the maximum duration of insolation.	PIO-3, 5; CCO-1, 3
A-1.3 Absorption	A-1.31 The atmosphere is largely transparent to visible radiation, but it selectively absorbs quantities of ultraviolet and infrared radiation.	A-1.31 Relate to topic VII. PIO-3; CCO-2, 6
	A-1.32 Land surface temperatures change more rapidly than water surface temperatures.	PIO-3; CCO-1, 3, 6

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A-1.4 Reflection	A-1.41 Clouds may reflect approximately 25 percent of the incident insolation.	PIO-3; CCO-6
	A-1.42 The reflectivity of the earth depends upon the angle of insolation.	PIO-3; CCO-6
	A-1.43 Ice and snow reflect almost all of the incident insolation.	PIO-3; CCO-6
A-1.5 Scattering	A-1.51 Aerosols (such as water droplets and dust) in the atmosphere cause a random reflection of insolation.	PIO-3; CCO-6
	A-1.52 The amount of insolation reaching the earth's surface decreases as the amount of random reflection increases.	PIO-3; CCO-6
A-1.6 Energy conversion	A-1.61 Some insolation is converted into potential energy by evaporation of water and melting of ice.	PIO-3; CCO-1, 2, 6
B. Terrestrial radiation		
B-1 Radiation factors	***B-1 What are some factors which affect terrestrial radiation?*** **VI-B-1**	
B-1.1 Material radiation	B-1.11 The maximum intensity of outgoing radiation from the earth's surface is in the infrared region of the electromagnetic spectrum.	PIO-3, 5; CCO-3, 6
B-1.2 Gases	B-1.21 Water vapor and carbon dioxide are good absorbers of infrared radiation.	PIO-3, 5; CCO-1, 6
B-1.3 Balance	B-1.31 Long-term measurements (thousands of years) of worldwide surface temperatures indicate that the earth *is not* in radiative balance.	PIO-3, 5; CCO-8
	B-1.32 Intermediate term measurement (decades) of worldwide surface temperatures indicates that the earth *is* in radiative balance.	PIO-3, 5; CCO-8
	B-1.33 Annual measurement of worldwide surface temperatures indicates that the earth *is not* in radiative balance.	PIO-3, 5; CCO-4

What Causes the Weather?

Time Emphasis: 16 days

TOPIC ABSTRACT

Major Behavioral Objectives

At the completion of this topic, the student should be able to:

A. Compare locally observed atmospheric variables, and derive interrelationships.
B. Determine characteristics of airmasses from synoptic weather data.
C. Describe energy exchanges in atmospheric processes.

Approach

It is assumed that the student has observed, measured, and recorded local atmospheric variables in a weather watch-type investigation prior to this topic. The data collection which may have been started earlier in topic I or topic II can be used in this topic for analysis.

An analytical approach should be used in this topic. Students should be encouraged to hypothesize relationships based on the evidence *they* have collected.

The prediction of atmospheric changes is an activity which can stimulate the interest of all students.

The moisture-energy relationships in the water cycle should be carefully considered in this topic. The latent heat factor that was introduced in topic V should be reinforced at this point.

* * * * * *

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A. Atmospheric variables		
A-1 Local atmospheric variables	**A-1** *What are some relationships between atmosphere variables that can be observed locally?*	**VII-A-1**
A-1.1 Probability of occurrence	A-1.11 Relationships between atmospheric variables can be expressed as the probability of occurrence.	A-1.11 The use of probabilities is desirable to establish an understanding of the complex and dynamic relationships that exist between the variables. PIO-3, 5; CCO-10, 11
A-1.2 Temperature variations	A-1.21 Temperature is greatly affected by the amount and duration of insolation.	A-1.21 Relate to topic VI. PIO-2, 5; CCO-11, 12
A-1.3 Pressure variations	A-1.31 Air pressure changes are closely associated with temperature changes.	PIO-2, 5; CCO-11, 12

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A-1.4 Moisture variations	A-1.41 Variations in the dew point temperature are indicators of changes in atmospheric moisture.	PIO-2, 5; CCO-4, 6, 11
	A-1.42 The probability of precipitation increases as the difference between dew point temperature and air temperature decreases.	PIO-5; CCO-11
A-1.5 Air movement	A-1.51 Wind speeds are directly related to pressure field gradients.	PIO-5; CCO-11
A-1.6 Atmospheric transparency	A-1.61 Atmospheric transparency varies inversely with the amount of input of materials produced by natural processes and the activities of man.	PIO-2, 5; CCO-6, 8, 11
	A-1.62 The atmosphere tends to clean itself periodically through natural processes such as cloud formation and precipitation.	A-1.62 This understanding can be related to a pollution part of a continuing weather watch. PIO-4, 5, 6, 8, 10
A-1.7 Other variables	A-1.71 Other weather variables seem to be associated in a more complex manner than simply a direct or inverse relationship.	A-1.71 Visibility depends on temperature, humidity, pollution, etc. PIO-2, 5; CCO-10, 11
B. Synoptic weather data		
B-1 Synoptic analysis	**B-1** *What airmass characteristics can be determined from synoptic observations?*	**VII-B-1**
B-1.1 Airmass characteristics	B-1.11 Airmasses are identified on the basis of pressure, moisture, and temperature characteristics.	PIO-2, 3, 5; CCO-7, 10, 11
	B-1.12 Within an airmass, at any given altitude, the air temperature field and the humidity field are nearly uniform.	PIO-2, 3, 5; CCO-7, 11
	B-1.13 In a low pressure airmass (cyclone) circulation is counterclockwise and toward the center in the northern hemisphere.	PIO-3, 5; CCO-11, 12
	B-1.14 In a high pressure airmass (anticyclone), circulation is clockwise and away from the center in the northern hemisphere.	PIO-3, 5; CCO-11, 12
	B-1.15 Precipitation is most probable near the interface (frontal surface) between airmasses of different temperatures.	PIO-2, 3, 5; CCO-4, 6, 8, 11, 12
	B-1.16 Atmospheric conditions are usually unstable in the vicinity of the interfaces.	PIO-2, 3, 5; CCO-4, 6, 8, 11, 12
B-1.2 Airmass source regions	B-1.21 Airmasses have definite characteristics which depend upon the geographic region of origin.	PIO-5
B-1.3 Airmass tracks	B-1.31 Airmass tracks and rates of movement can be determined and usually predicted.	PIO-1, 2, 5; CCO-8, 11, 12

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
C. Atmospheric energy exchanges		
C-1 Input of moisture and energy	**C-1 *How does the atmosphere acquire moisture and energy?***	**VII-C-1**
C-1.1 Evaporation and transpiration	C-1.11 Moisture enters the air by means of transpiration and by evaporation.	PIO-2, 5; CCO-1, 4, 9, 11
	C-1.12 The ocean is the primary source of moisture for the atmosphere.	CCO-1, 6
	C-1.13 Energy is required to cause evaporation and transpiration.	PIO-1, 2, 5; CCO-1, 4, 9, 11
	C-1.14 Evaporation and transpiration constitute an energy input to the atmosphere in the form of more energetic water molecules.	C-1.14 Refer to topic V and topic VI. CCO-1, 4, 5, 6, 9, 11, 12
C-1.2 Vapor pressure	C-1.21 The vapor pressure (moisture content) of the air increases at the air-water interface.	PIO-2, 5; CCO-1, 4, 8, 9, 11
	C-1.22 The rate of evaporation decreases as the vapor pressure of the air at the interface increases.	PIO-2, 5; CCO-1, 4
	C-1.23 The rate of evaporation at a given location depends on surface area, the energy available, and the moisture content of the atmosphere.	C-1.23 Relate to topic VI. PIO-5; CCO-1, 4, 6, 8, 9, 11, 12
C-1.3 Saturation vapor pressure	C-1.31 A state of dynamic equilibrium exists when saturation vapor pressure is reached.	PIO-2, 5; CCO-1, 4, 9, 11, 12
	C-1.32 Saturation vapor pressure varies directly with air temperature.	PIO-5; CCO-1, 4, 9, 11, 12
C-1.4 Other input energy	C-1.41 The atmosphere acquires energy by radiation and conduction from the earth's surface, and radiation from the sun.	C-1.41 Relate to topic V and topic VI. PIO-3, 5; CCO-1, 3, 11, 12
	C-1.42 The rate of energy input is related to variables such as moisture and carbon dioxide content.	CCO-1, 4, 6, 8, 11, 12
	C-1.43 The atmosphere acquires energy by mechanical means such as frictional drag.	CCO-1, 4, 6, 9, 11, 12
C-2 Moisture and energy transfer	**C-2 *How are moisture and energy transferred in the atmosphere?***	**VII-C-2**
C-2.1 Density differences	C-2.11 The density of air decreases with increased moisture content.	PIO-2, 5; CCO-6, 9, 11, 12
	C-2.12 The density of air decreases with increased air temperature.	PIO-2, 5; CCO-6, 9, 11, 12
	C-2.13 Convection cells are caused by density differences and the effect of the gravity field.	C-2.13 This concept can be related to convection in the atmosphere, ocean, and mantle. PIO-5; CCO-1, 5, 6, 9, 12
	C-2.14 Atmospheric convection is affected by variations in insolation.	C-2.14 Refer to topic V and topic IV. PIO-5; CCO-1, 3, 4, 5, 6, 11, 12
	C-2.15 The movement of air is from regions of divergence to regions of convergence.	PIO-5; CCO-1, 4, 5, 9, 11

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
C-2.2 Wind speed and direction	C-2.21 Air moves from high pressure to low pressure.	PIO-5; CCO-1, 4, 6, 8, 9, 11
	C-2.22 Wind direction is modified by the earth's rotation.	PIO-5; CCO-1, 4
	C-2.23 Wind speed is directly related to the pressure field gradient.	PIO-5; CCO-1, 4
C-2.3 Adiabatic changes	C-2.31 Rising or descending air changes temperature by an adiabatic process.	PIO-5; CCO-1, 4, 5, 9, 11
C-3 Release of moisture and energy within the atmosphere	***C-3 How are moisture and energy released within the atmosphere?***	**VII-C-3**
C-3.1 Condensation and sublimation	C-3.11 Condensation can occur when air is saturated and a condensation surface is available.	PIO-2, 5; CCO-1, 8, 9, 11
	C-3.12 When water vapor condenses, a significant amount of heat energy is released.	C-3.12 Refer to topic V. PIO-2, 5; CCO-1, 8, 9, 11
	C-3.13 At temperatures below 0°C., water vapor changes directly to ice.	CCO-1, 8, 9, 11
C-3.2 Cloud formation	C-3.21 Clouds are formed from condensed moisture or from ice crystals.	PIO-5; CCO-1, 6, 7, 8, 9, 11, 12
C-4 Release of moisture and energy from the atmosphere	***C-4 How are moisture and energy released from the atmosphere?***	**VII-C-4**
C-4.1 Precipitation	C-4.11 Precipitation results when condensation droplets form that are large enough to fall.	PIO-5; CCO-1, 4, 6, 7, 8, 9, 11, 12
C-4.2 Wind-water interaction	C-4.21 Surface ocean currents are an effect of a transfer of energy from the atmosphere by winds.	C-4.21 The erosion aspect of winds is treated in topic IX. PIO-3, 5; CCO-1, 6, 11, 12

TOPIC VIII - MOISTURE AND ENERGY BUDGETS
AND ENVIRONMENT CHANGE

What Happens to Water and Energy Released From the Atmosphere?

Time Emphasis: 11 days

TOPIC ABSTRACT

Major Behavioral Objectives

At the completion of this topic, the student should be able to:

A. Measure and describe the nature and movement of water in and on various earth materials.
B. Analyze and relate aspects of the water budget to the environment.
C. Determine, from his analysis of the factors which affect climate, the climate patterns for a continental land mass.

Approach

This topic is essentially a transition from the water cycle and energy budgets, treated earlier, to the rock cycle processes, which will be treated later. Relationships between water movement and aspects of water pollution should be reinforced within this topic.

An analytical approach to climates should be used. The means of identification of climate regions should evolve from water budget analysis. The point should be stressed that climate zones are the results of the combined effect of the environmental factors identified in earlier topics.

* * * * * *

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A. Earth's water		
A-1 Ground water	**A-1 How does water move into the earth?**	**VIII-A-1**
A-1.1 Infiltration	A-1.11 Precipitation may infiltrate the earth's surface, run off, or evaporate.	CCO-5
	A-1.12 Infiltration can occur if the surface is permeable and unsaturated.	PIO-1, 2, 3, 4, 5
A-1.2 Permeability	A-1.21 The permeability of loose material increases with increased particle size.	PIO-1, 2, 3, 4, 5; CCO-11
	A-1.22 Water that has infiltrated loose material continues downward to the saturated zone or water table.	CCO-4
A-1.3 Porosity	A-1.31 The porosity of loose material is largely dependent upon shape, packing, and the mixture of sizes of the particles.	PIO-1, 2, 3, 4, 5; CCO-11
A-1.4 Capillarity	A-1.41 Capillarity in loose materials increases with decreased particle size.	PIO-1, 2, 3, 4, 5; CCO-11

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A-2 Surface water	**A-2** *How does water move on the surface of the earth?*	**VIII-A-2**
A-2.1 Runoff	A-2.11 Surface runoff can occur when rainfall exceeds the permeability rate, when the pore space is filled, or when the slope of the surface is too great to allow infiltration to occur.	A-2.11 Relate to topic IX. PIO-3; CCO-2, 4
A-3 Pollution of the earth's water	**A-3** *What is man's effect on the earth's water?*	**VIII-A-3**
A-3.1 Sources of pollutants	A-3.11 Pollutants are often added to the hydrosphere through the activities of individuals, communities, and industrial processes.	A-3.11 Analyze local conditions. Local conditions that may be considered include pollution of the oceans, rivers, and the ground water supply. Relate to topic VII, A-1.6; CCO-6, 8, 9
A-3.2 Types of pollutants	A-3.21 Hydrospheric pollutants include dissolved and suspended materials such as organic and inorganic wastes, thermal energy effluent from industrial processes, radioactive substances, and the abnormal concentration of various organisms.	A-3.21 Relate to local area. CCO-8, 9
	A-3.22 The excessive heating of water, or the increased activity of aerobic bacteria, can cause a loss of dissolved oxygen from the water. This may lead to an increase in the concentration of anaerobic bacteria, a biologic pollutant.	CCO-8, 9
A-3.3 Concentration of pollutants	A-3.31 The concentration of water pollutants in rivers increases in the vicinity of population centers.	A-3.31 Relate to stream discharge. CCO-6
	A-3.32 Lake pollution tends to vary with the population density near the lake.	CCO-6
	A-3.33 Ground water pollution within a community tends to vary directly with the population density.	CCO-6
A-3.4 Long-range effects	A-3.41 The uncontrolled increase of pollution in the hydrosphere may eventually render the sources of water unfit for human use.	CCO-6, 8
	A-3.42 The purification of water for human use is complex and costly.	CCO-6
B. The local water budget		
B-1 Water budget variables	**B-1** *How is the water budget influenced by the environment?*	**VIII-B-1**
B-1.1 Precipitation (P)	B-1.11 The moisture source for the local water budget is precipitation (P).	PIO-3, 5

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
B-1.2 Potential evapotranspiration (E_p)	B-1.21 The potential evapotranspiration (E_p) of an area is directly proportional to the energy available or the amount of evaporation surface.	CCO-3, 4, 8
B-1.3 Moisture storage	B-1.31 A specific maximum quantity of moisture can be stored in a soil under optimum conditions.	PIO-2; CCO-9, 10
B-1.4 Moisture utilization	B-1.41 Available moisture is taken from soil storage if precipitation is less than potential evapotranspiration ($P<E_p$).	CCO-1, 3
B-1.5 Moisture deficit	B-1.51 Moisture deficit exists when soil moisture is depleted and P is less than E_p.	CCO-3, 5, 9
B-1.6 Moisture recharge	B-1.61 Soil moisture is recharged when precipitation exceeds potential evapotranspiration, $P>E_p$.	CCO-3, 5, 9
B-1.7 Moisture surplus	B-1.71 Surplus moisture exists when soil moisture storage is maximum and precipitation is greater than potential evapotranspiration.	CCO-3, 5, 9
B-2 Streams	***B-2 How is the local water budget related to stream discharge?***	**VIII-B-2**
B-2.1 Stream discharge and the water budget	B-2.11 Stream discharge is a measure of the loss of available surface water through runoff.	B-2.11 Stream characteristics relative to erosion are treated in topic IX. PIO-5; CCO-6
	B-2.12 The stream discharge during a dry season is related to ground water depletion.	PIO-5; CCO-6
B-3 Climates and the local water budget	***B-3 How is the local water budget related to climate?***	**VIII-B-3**
B-3.1 Climatic regions	B-3.11 Climatic regions can be distinguished quantitatively by factors such as P/E_p or $P - E_p$.	CCO-7
C. Climate pattern factors		
C-1 Factors	***C-1 What factors affect climate patterns?***	**VIII-C-1**
C-1.1 Latitude	C-1.11 Latitude is a factor which influences temperature patterns.	C-1.11 Relate to topic VI. CCO-3, 5
C-1.2 Elevation	C-1.21 The elevation (height above sea level) influences temperature and moisture patterns.	CCO-6

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
C-1.3 Large bodies of water and ocean currents	C-1.31 Large bodies of water modify the latitudinal climate patterns of their shoreline areas.	C-1.31 Relate to topic VI and topic VII. CCO-1, 4
	C-1.32 Ocean currents modify the coastal climate patterns.	CCO-1, 4
C-1.4 Mountain barriers	C-1.41 Mountains, acting as barriers to circulation, modify the latitudinal climate pattern.	CCO-1, 4
C-1.5 Wind belts	C-1.51 Moisture and temperature patterns are affected by planetary wind and pressure belts.	C-1.51 Relate to topic VI. CCO-4, 5
C-1.6 Storm tracks	C-1.61 Low pressure systems,which affect temperature and moisture patterns, seem to follow statistically predictable paths.	CCO-4, 5