Principle 3: The ocean is a major influence on weather and climate.

The interaction of oceanic and atmospheric processes controls weather and climate by dominating Earth's energy system.

Weather and Climate — A

Global climate and weather are determined by energy transfer from the sun. Energy transfer from the sun is influenced by the ocean, the topography of the land, by processes such as cloud cover and Earth's rotation, and other factors.

A1

The ocean absorbs most of the solar radiation reaching Earth. Differential heating of Earth results in circulation patterns in the atmosphere and ocean that globally distribute the heat.

A2

The ocean's absorption of heat moderates the global climate.

A3

The weather along coastlines is generally more moderate than inland regions due to the greater heat capacity of the ocean.

A4

Ocean currents move heat throughout the ocean basins.

A4

Ocean currents move heat throughout the ocean basins.

A5

Heat exchange between the ocean and the atmosphere drives oceanic and atmospheric circulation and the water cycle.

A6

Heating of Earth's surface and atmosphere by the sun drives circulation of the upper layers of the ocean.

A7

Differential heating causes vertical convection in the atmosphere, which helps drive horizontal wind patterns. Those wind patterns transfer energy to the ocean through surface wind stress, which drives the upper layer circulation patterns in the ocean.

A8

Heat exchange between the ocean and atmosphere can result in dramatic global and regional weather phenomena, including impacting patterns of rain and drought.

A9

El Niño Southern Oscillation (ENSO) and La Niña events are significant examples of global ocean/atmosphere phenomena, and cause important changes in global weather patterns because they alter the sea surface temperature patterns in the Pacific.

A10

The increase in sea surface temperature increases atmospheric convection, changing patterns of rainfall and drought.

A11

El Niño and La Niña events affect ocean ecological communities.

A12

El Niño and La Niña events can affect terrestrial processes, such as fire frequency, drought, flooding, etc.

A13

Heat stored in the tropical ocean provides energy for weather, including hurricanes, cyclones, and polar storms.

A14

Most precipitation that falls on land evaporated from the tropical ocean

A16

Seasonal and short-term changes in ocean temperature can affect rainfall and temperature on land (i.e., the weather). Long-term changes in ocean temperature can affect the climate.

Global Climate Change — B

Changes in the ocean/atmosphere system can result in changes to the climate.

B1

Carbon-containing gases (e.g., carbon dioxide and methane) are exchanged between the ocean and the atmosphere. These gases are called greenhouse gases. The exchange of carbon is part of the carbon cycle.

B2

Greenhouse gases in the atmosphere create a greenhouse effect by trapping longwave radiation and preventing it from leaving Earth, thus contributing to the warming of the atmosphere. The ocean removes and stores atmospheric carbon dioxide through biological and chemical activity that mediates the global greenhouse effect.

B3

Carbon dioxide is taken up by phytoplankton through photosynthesis.

B4

Ocean absorption of carbon dioxide may produce carbonic acid, which increases the acidity of the ocean.

B5

An increase in greenhouse gases contributes to excessive warming of the atmosphere.

B6

The ocean and atmosphere are in dynamic equilibrium related to carbon fluctuation. Excess carbon input into the atmosphere, including that from human activity, changes this equilibrium.

B4

Ocean absorption of carbon dioxide may produce carbonic acid, which increases the acidity of the ocean.

B5

An increase in greenhouse gases contributes to excessive warming of the atmosphere.

B7

A primary source of excess carbon dioxide is burning fossil fuels.

B8

Deforestation reduces the amount of photosynthesis, increasing the amount of carbon dioxide in the atmosphere.

B9

Changes in climate can cause changes in ocean circulation patterns, which can cause further changes in climate.

B10

Feedback loops can amplify the effects of a change in one component of the climate system, influencing the equilibrium of the entire Earth system. These complex interactions may result in climate change that is more rapid and on a larger scale than projected by current climate models.

B11

Changes in ocean circulation have produced large, abrupt changes in climate during the last 50,000 years.

Consequences of Global Climate Change — C

Changes to weather and climate, which result from changes to the ocean/atmosphere system, have physical, chemical, biological, economic, and social consequences.

C1

Climate change may alter the frequency and intensity of hurricanes and cyclones.

C2

Climate change may alter the frequency and intensity of El Niño and La Niña events.

C3

More frequent and/or intense El Niño and La Niña events may have worldwide economic impacts, e.g., collapse of fisheries, decreased agricultural production, etc.

C4

Increased carbon dioxide in the atmosphere can lead to ocean acidification.

C5

Ocean acidification may alter biological activity, including inhibiting the ability of organisms to form shells, bones and exoskeletons, and may also dissolve these structures.

C6

Climate change affects species distribution, productivity, and diversity in the ocean.

C7

Climate change is changing ocean temperature, which can result in ecosystem changes, such as coral bleaching and redistributions of commercially valuable species.

C8

As the climate warms, the rate at which glaciers and ice caps melt increases.

C9

As glaciers and ice caps melt, sea level rises. Rising sea level can inundate coastal regions and low-lying islands, destroying habitats and submerging ecosystems and human communities.

C10

Ice reflects a large amount of heat from the sun back into the atmosphere. When ice melts, less heat is reflected back into the atmosphere, further warming the land and causing more ice to melt.

C11

An increase in melting ice may cause a decrease in regional salinity. This can change ocean circulation.