



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

The interaction of oceanic and atmospheric processes control 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.

**A.1.** 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.

**A.2.** The ocean's absorption of heat moderates the global climate.

**A.5.** Heat exchange between the ocean and the atmosphere drives oceanic and atmospheric circulation and the water cycle.

**A.16.** Seasonal and short-term changes in ocean temperature can affect rainfall and temperatures on land (i.e., weather). Long-term changes in ocean temperature can affect the climate.

**A.3.** The weather along coastlines is generally more moderate than inland regions due to the greater heat capacity of the ocean.

**A.4.** Ocean currents move heat throughout the ocean basins.

**A.6.** Heating of Earth's surface and atmosphere by the sun drives circulation of the upper layers of the ocean.

**A.8.** Heat exchange between the ocean and atmosphere can result in dramatic global and regional weather phenomena, including impacting patterns of rain and drought.

**A.13.** Heat stored in the tropical ocean provides energy for weather, including hurricanes, cyclones, and polar storms.

**A.7.** Differential heating causes vertical convection in the atmosphere, which helps drive horizontal wind patterns. Those winds transfer energy to the ocean through surface wind stress, which drives the upper layer circulation patterns of the ocean.

**A.9.** 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.

**A.14.** Most precipitation that falls on land evaporated from the tropical ocean.

**A.10.** The increase in sea surface temperature increases atmospheric convection, changing patterns of rainfall and drought.

**A.11.** El Niño and La Niña events affect ocean ecological communities.

**A.12.** El Niño and La Niña events can affect terrestrial processes, such as fire frequency, drought, flooding, etc.

See Principle 1: C14 See Principle 1: C1

Principle 6: C

**Global Climate Change**

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

**B.1.** 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.

**B.2.** 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.

**B.6.** The ocean and atmosphere are in a dynamic equilibrium related to carbon fluctuation. Excess carbon input into the atmosphere, including that from human activity, changes this equilibrium.

**B.3.** Carbon dioxide is taken up by phytoplankton through photosynthesis.

**B.4.** Ocean absorption of carbon dioxide may produce carbonic acid, which increases the acidity of the ocean.

**B.5.** An increase in greenhouse gases contributes to excessive warming of the atmosphere.

**B.7.** A primary source of excess carbon dioxide is burning fossil fuels.

**B.8.** Deforestation reduces the amount of photosynthesis, increasing the amount of carbon dioxide in the atmosphere.

**B.11.** Changes in ocean circulation have produced large, abrupt changes in climate during the last 50,000 years.

See Principle 2: B3 See Principle 6: D2

**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.

**B.9.** Changes in climate can cause changes in ocean circulation patterns, which can cause further changes in climate.

**C.1.** Climate change may affect the frequency and intensity of hurricanes and cyclones.

**C.2.** Climate change may alter the frequency and intensity of El Niño and La Niña events.

**C.4.** Increased carbon dioxide in the atmosphere can lead to ocean acidification.

**C.6.** Climate change affects species distribution, productivity, and diversity in the ocean.

**C.8.** As the climate warms, the rate at which glaciers and ice caps melt increases.

**C.3.** 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.

**C.5.** Ocean acidification may alter biological activity, including inhibiting the ability of organisms to form shells, bones and exoskeletons, and may also dissolve these structures.

**C.7.** Climate change is changing ocean temperature, which can result in ecosystem changes, such as coral bleaching and redistributions of commercially valuable species.

**C.9.** 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.

**C.10.** 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.

**C.11.** An increase in melting ice may cause a decrease in regional salinity. This can change ocean circulation.

See Principle 1: C1

See Principle 1: B2

See Principle 5: C35

See Principle 5: C36

See Principle 1: D5