Interactions Between the Atmosphere & Hydrosphere

Weather & Climate
~occur every 3-7 years
~can last weeks or years!
~cooler/wetter conditions in SE US
~dry weather in southern Africa, Southeast Asia, Indonesia, Australia
~warm weather in Alaska, Canada & northern US

Fig. 6 Normally, the trade winds and strong equatorial currents flow toward the west. At the same time, an intense Peruvian current causes upwelling of cold water along the west coast of South America.
The Earth’s Life-Support System Has Four Major Components (The 4 “Spheres”)

- Atmosphere: The Air
- Hydrosphere: The Water
- Geosphere (Lithosphere): The Land/Rock
- Biosphere: The Life
Water Cycles Review

- Natural renewal of water quality: three major processes
  - Evaporation – fueled by the sun
  - Precipitation – fueled by gravity
  - Transpiration – fueled by the sun

- Alteration of the hydrologic cycle by humans
  - Withdrawal of large amounts of freshwater at rates faster than nature can replace it
  - Clearing vegetation
  - Increased flooding when wetlands are drained
Hydrologic Cycle Including Harmful Impacts of Human Activities
Science Focus: Water’s Unique Properties

- Properties of water due to hydrogen bonds between water molecules:
  - Exists as a liquid over a large range of temperature
  - Changes temperature slowly
  - High boiling point: 100°C
  - Adhesion and cohesion
  - Expands as it freezes
  - Solvent
  - Filters out harmful UV
Layers of the Atmosphere

- **Atmosphere**
  - Membrane of air around the planet

- **Troposphere**
  - Weather occurs here

- **Stratosphere**
  - Lower portion contains ozone to filter out most of the sun’s harmful UV radiation

- **Mesosphere**
  - Where meteors burn up

- **Thermosphere (Ionosphere)**
  - Where the aurora borealis occurs
What Happens to Solar Energy Reaching the Earth?

- Solar energy flowing through the biosphere warms the atmosphere, evaporates and recycles water, generates winds and supports plant growth.
Solar radiation

UV radiation

Most absorbed by ozone

Visible light

Absorbed by the earth

Lower Stratosphere (ozone layer)

Reflected by atmosphere

Troposphere

Heat radiated by atmosphere as heat

Radiated by the earth

Heat

Greenhouse effect

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Greenhouse Gases Warm the Lower Atmosphere

- Greenhouse gases
  - H₂O
  - CO₂
  - CH₄
  - N₂O
  - Nitrogen and Oxygen (99% of atmosphere are NOT greenhouse gases)

- Greenhouse effect = GOOD!!

- Human-enhanced global warming “global climate change” (BAD)
STOP
Questions for you!!
Write down your responses!

1. What is weather?
2. Name some characteristics of weather.
3. What is climate?
4. What causes the seasons?
5. What causes wind?
6. What causes ocean currents?
7. How can mountains, lakes, or oceans affect the local climate of an area?
Get with a partner and check yourself!

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1. What is weather?

- Weather is a local area’s short term conditions (we’re talking hours or days at a time).
2. Name some characteristics of weather.

- Temperature
- Precipitation
- Humidity
- Wind speed & direction
- Cloud cover
- Pressure
- Other physical conditions of the lower atmosphere (TROPOSPHERE)
3. What is climate?

- Climate is an area's general pattern of atmospheric weather conditions measured over long periods of time (decades to thousands of years)
  - Two most important factors are:
    - Temperature & Precipitation

  “Climate is what we expect, weather is what we get”
  – Mark Twain
Natural Capital: Generalized Map of the Earth’s Current Climate Zones
What causes the seasons?

- Seasons are caused by the variation in the intensity of solar radiation due to the tilt of the earth.
  - In summer we (Northern Hemisphere) are tilted toward the sun
  - In winter we are tilted away
Animation: Seasonal variation


https://www.youtube.com/watch?v=WLRA87TKXLM
5. What causes wind?

- A combination of two major factors
  1. Uneven heating of the earth’s surface by the sun
  2. Rotation of the earth on its axis
     - The equator spins FASTER than the poles so heated air masses are deflected to the west or east this causes the major prevailing winds, which cause most surface winds.
     - Observe Coriolis effect
       
       [http://www.classzone.com/books/earth_science/terc/content/visualizations/es1904/es1904page01.cfm](http://www.classzone.com/books/earth_science/terc/content/visualizations/es1904/es1904page01.cfm)
Global Air Circulation

- Air cools and descends at lower latitudes:
  - Westerlies
  - Cold deserts

- Warm air rises and moves toward the poles:
  - Northeast trades
  - Hot deserts
  - Forests

- Air cools and descends at lower latitudes:
  - Southeast trades
  - Hot deserts
  - Forests

The highest solar energy input is at the equator.
6. What causes ocean currents?

- The currents are driven by:
  - Prevailing winds
  - The earth’s rotation
  - Redistribution of heat from the sun

https://www.youtube.com/watch?v=I-N_7cgwHmQ
Connected Deep and Shallow Ocean Currents

- Warm, less salty, shallow current
- Cold, salty, deep current
Does the Coriolis effect really make toilets flush “backward in Australia”

- If they did, it would be because of the Coriolis effect – but toilets are far too small and flush too quickly to be influenced by this force.

- Really… it depends on the shape of the bowl (angles of water entry and exit)

  - MYTH – BUSTED!
7. How can mountains, lakes, or oceans affect the local climate of an area?

- **Surface features affect local climate**
  - **Mountains**
    - Windward: rainy (Seattle)
    - Leeward: dry (Death Valley)
      - Rain Shadow Effect
  - **Lakes**
    - Snow
      - Lake Effect Snow
        - https://www.youtube.com/watch?v=6YjuEl0RplA
  - **Oceans**
    - Sea Breezes & Moderate climates
  - Even cities can create a “microclimate”
Rain Shadow Effect

Prevailing winds pick up moisture from an ocean. On the windward side of a mountain range, air rises, cools, and releases moisture. On the leeward side of the mountain range, air descends, warms, and releases little moisture.

http://www.mrphome.net/mrp/rainshadow.swf
Animation: Coastal breezes

https://www.youtube.com/watch?v=gM0d3fGew-0
Interaction Between Climate (Atmosphere & Hydrosphere) & The Biosphere

Chapter 7: How does Climate Effect Terrestrial Biodiversity
Core Case Study: Connections between Wind, Climate, and Biomes

- *Everything we do affects some other part of the biosphere!!*

- **Wind**
  - Indirect form of solar energy

- **Circulates**
  - Heat
  - Moisture
  - Plant nutrients
  - Soil particles
  - Long-lived air pollutants
Dust Blown from West Africa to the Amazonian Rain Forests
There is a link between air circulation, ocean currents, and biomes

**REVIEW**

- **Air circulation** in the lower atmosphere due to:
  - Uneven heating of the earth’s surface by the sun
  - Rotation of the earth on its axis
  - Properties of air, water, and land

- **Currents**
  - Prevailing winds
  - Earth’s rotation
  - Redistribution of heat from the sun
Energy Transfer by Convection in the Atmosphere

Heat released radiates to space

Cool, dry air

Falls, is compressed, warms

Warm, dry air

Rises, expands, cools

Hot, wet air

Flows toward low pressure, picks up moisture and heat

Moist surface warmed by sun

HIGH PRESSURE

LOW PRESSURE

Condensation and precipitation
Global Air Circulation, Ocean Currents, and Biomes

- Polar cap
- Arctic tundra
- 60°: Evergreen coniferous forest, Temperate deciduous forest and grassland
- 30°: Tropical deciduous forest
- Equator: Tropical rain forest
- 30°: Tropical deciduous forest
- 60°: Temperate deciduous forest and grassland

Moist air rises, cools, and releases moisture as rain.
Global Air Circulation

Air cools and descends at lower latitudes.

Warm air rises and moves toward the poles.

Air cools and descends at lower latitudes.

The highest solar energy input is at the equator.
Interaction of Convection Cells, Prevailing Winds and Ocean Currents
Animation: Air circulation

https://smartsite.ucdavis.edu/access/content/user/00002950/bis10v/media/ch31/global_circ_v2.html
Active Figure: Climate and ocean currents map

http://www.kevinflint.org/ppt/chap5/Animations/climate_currents_v2.html