Lesson Planning Tool for Climate Change

Title of Lesson: Convection Cycles

Grade Level: 6-8
Subject: Earth Science and Technology and Engineering

Source(s) of the lesson adapted from:
Activator- https://www.ucar.edu/learn/1_1_2_7t.htm
Activities- Colorado University- Convection Cycle Box Building (grade 6) and Convection in the Ocean (grade 7, 8) http://sciencediscovery.colorado.edu/wp-content/uploads/2012/02/Convection-Connection.pdf

Essential Question(s): What happens when hot air rises in the troposphere over oceans? Western hemisphere? Eastern Hemisphere?

Massachusetts Curriculum Frameworks Science Standards:
6 ETS 2-2 Given a design task, select appropriate materials based on specific properties needed in the construction of a solution.
7 PS 3-6 Use a model to explain how thermal energy is transferred out of hotter regions or objects and into colder ones by convection, conduction, and radiation.
8 ESS 2-6 Describe how interactions involving the ocean affect weather and climate on a regional scale, including the influence of the ocean temperature as mediated by energy input from the Sun and energy loss due to evaporation or redistribution via ocean currents.

Content Objectives	Practice Objectives	Language Objectives
Describe how the ocean affects weather and climate on a regional scale.	1. Ask questions	I can discuss how oceans and weather affect climate.
Use a model to explain how thermal energy is transferred; heat moves in predictable ways.	2. Modeling	I can explain how the transfer of thermal energy contributes to extreme weather events.
Design and create a convection box model.		

Important Vocabulary:
Tier 1 sun, energy, current, weather, climate, ocean **Tier 2** fluid, convection, conduction, radiation, atmosphere, **Tier 3** density, troposphere, hurricane, cyclone, typhoon, prototype
Advanced Feedback loops

Materials Needed:
Activator- Grade 6- cardboard, candle, beaker, vinegar, baking soda
Grade 7- two jars, water, food coloring, card

Grade 7- Convection in the Ocean- Blue ice cubes (made ahead of time with blue food coloring), One clear, colorless plastic container (about shoebox size), Red food coloring warmed Note: To warm put container of food coloring in a cup of hot - not boiling - water. Blue and red colored pencils, Index cards

Grade 6- Convection Box Building- Cardboard box about the size of a 10-gallon aquarium (Note: A 10-gallon aquarium can be used. If it is, then you just need a piece of cardboard that snugly fits on the top.) Two glass lamp chimneys (clear plastic bottles such as Gatorade® bottles also work) Pencil Scissors or sharp knife for cutting cardboard Wide transparent tape (package tape works well) Transparent plastic wrap, Matches Incense to produce smoke, Tongs, One cup of steaming hot water

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Other Resources: (websites, videos, books, etc.)
http://climatekids.nasa.gov/ocean/

Background Information for Teacher:
The transfer of energy in and out of the atmosphere is weather (day to day) and climate (average).The unequal heating of land and ocean causes different temperature and densities in the ocean and atmosphere. Gravitational force allows for the rise and fall of the different densities, creating a circulation of a convection current, which produces wind and ocean currents. It is recommended that this unit be done after Investigation 5 *Convection* in the Weather and Water unit.

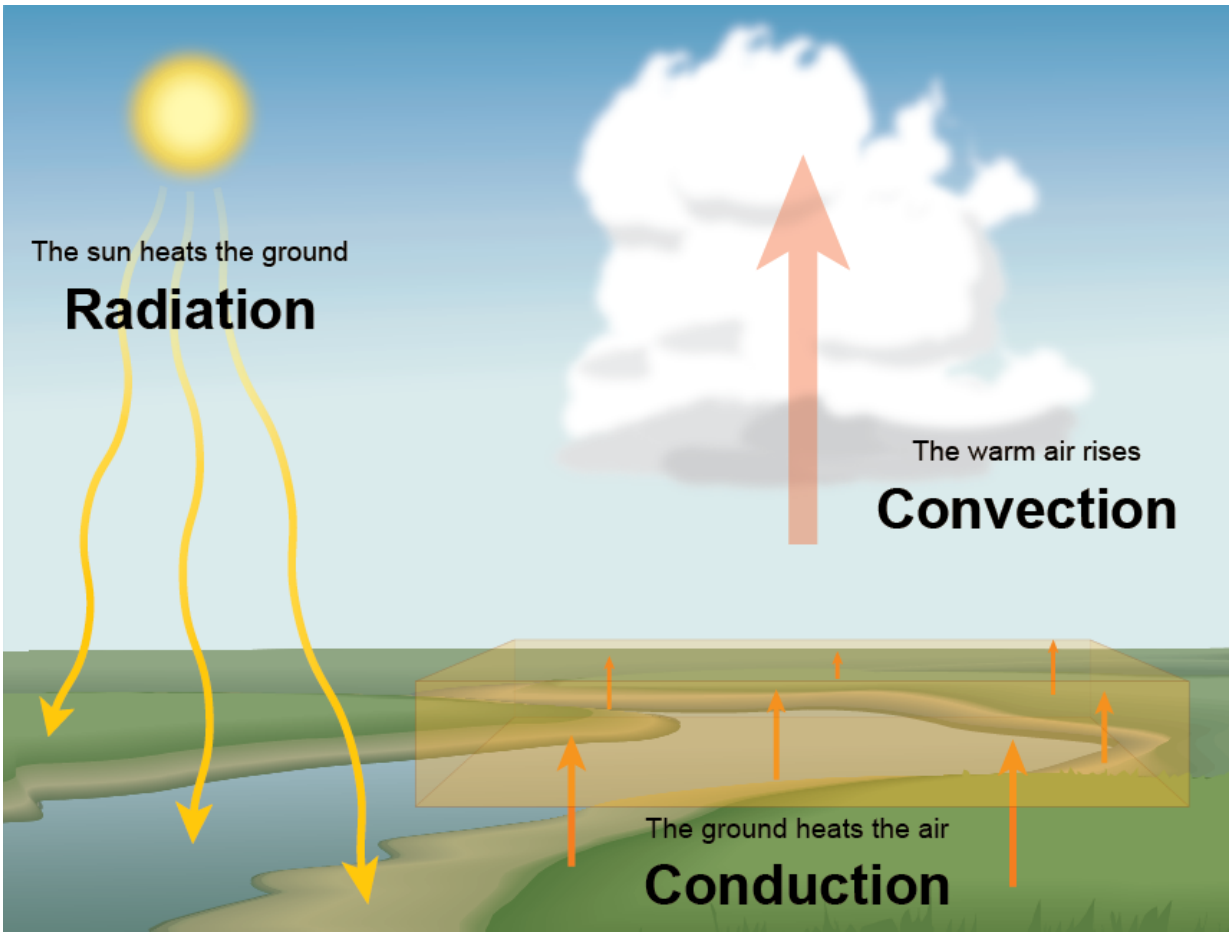
Background Information the Student Needs to Access the Lesson:
Students should know the three heat transfers and be able to identify when each occurs. More in particular, emphasis should be on density of temperature differences when describing convection. They should also have understanding of how heat is transferred into the atmosphere and where most weather occurs- the troposphere in the atmosphere.

Lesson Structure

	Convection Cycle Box Building (grade 6)	**Convection in the Ocean (grade 7,8)**
Lesson Launch (Do Now)	**Engineering Design Process Steps**- cut out and allow students to put it in order	**Gallery Walk**- Identify various heat transfer (posted around the room) or **Label a diagram** of heat transfer to the atmosphere
Background Instruction (pre-activity)	**Air is a Fluid Activator Audiovisual and Reading-** http://www.teachhub.com/how-hurricanes-are-formed-video-lesson-	**Colorful Convection Current Activator-** https://www.stevespanglerscience.com/lab/experiments/colorful-

	kids	convection-currents/ **Reading**- Ck12.org Hurricanes- http://www.ck12.org/earth-science/Hurricanes/
Activity	**Convection Box Building Activity** **Identify Need:** Create a convection current in a box **Research:** Convection Apparatus **Design:** Draw a sketch with materials provided **Build Prototype** **Test and Evaluate:** Does it work?	**Convection Cycle in the Ocean Activity** Extension- Cloud Lab interactive
Discussion/ Debrief	**Praise, Question, Suggest** from Expeditionary Learning- 1) List strengths and weaknesses of design 2) What changes or improvements had to be made? 3) Compare design to other groups. Differences? Similarities? https://www.engageny.org/sites/default/files/resource/attachments/appendix_protocols_and_resources.pdf	**Whiteboards:** Students have small white boards at their desks or tables and write their ideas/thinking/ answers down and hold up their boards for teacher and/or peer scanning; Plain paper can be used if whiteboards not available Fill in the blank or questions taken from- **Analyze and Interpret Data**
Formative Assessment	**Convection Cycle Box Prototype Rubric-** https://www.nasa.gov/pdf/324206main_Design_Packet_II.pdf	**Fist-to-Five**: To show degree of agreement, readiness for tasks, or comfort with a learning target/concept, students can quickly show their thinking by holding up (or placing a hand near the opposite shoulder) a fist for 0/Disagree or 1-5 fingers for higher levels of confidence or agreement. 1) I can use a model to explain how thermal energy is transferred; heat moves in predictable ways. 2) I can describe how the ocean affects weather and climate on a regional scale.

Notes:

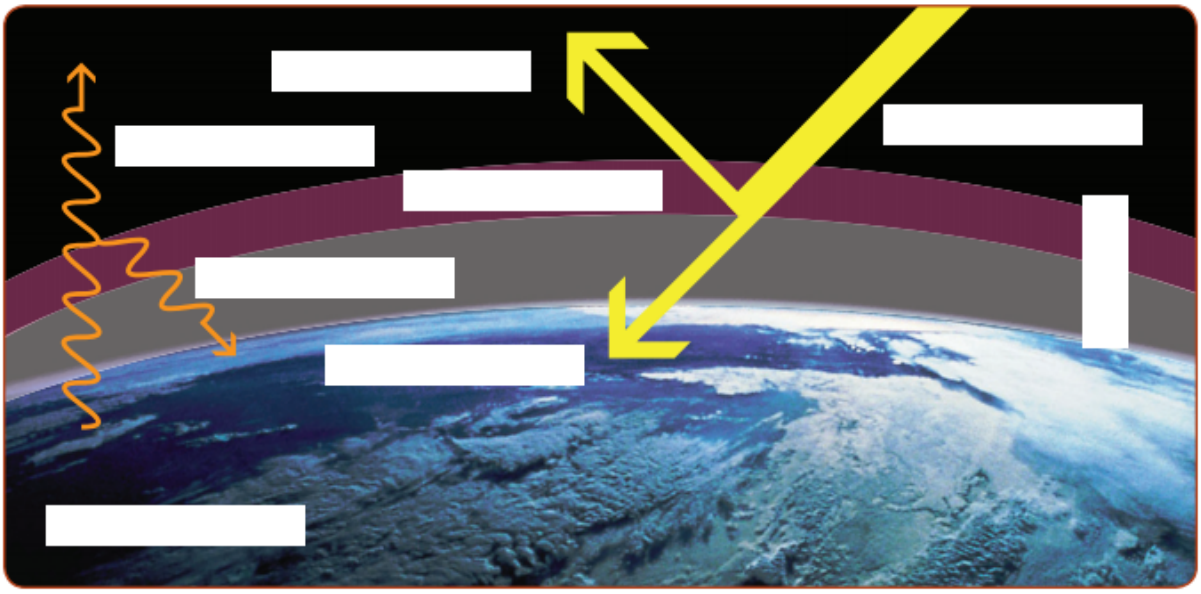


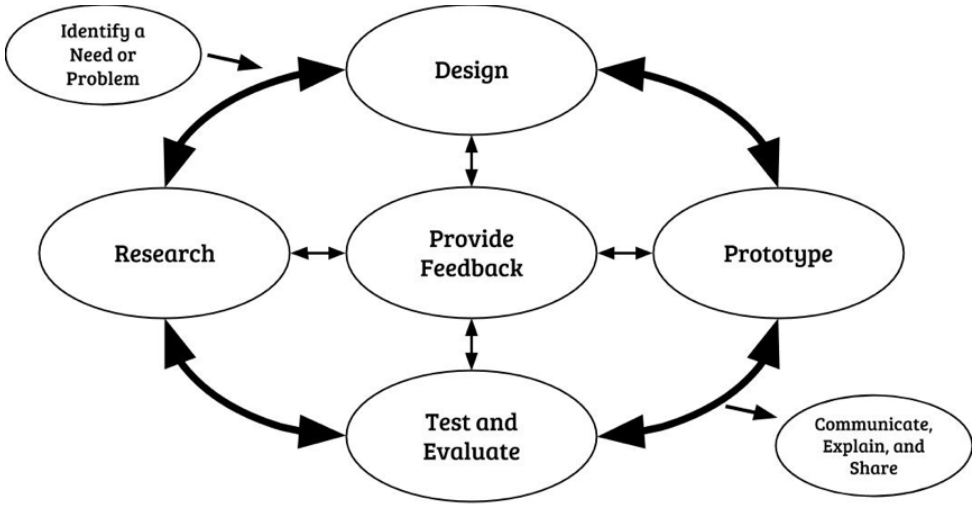
Taken from: https://www.ucar.edu/learn/1_1_2_7t.htm

DO NOW- Fill in the blank of Energy in the Atmosphere-

incoming solar radiation Earth atmosphere absorbed energy reflected energy

infrared radiation absorbed infrared radiation emitted





Engineering Design Process- Cut out and have students arrange

Taken from MA Curriculum Frameworks, 2016

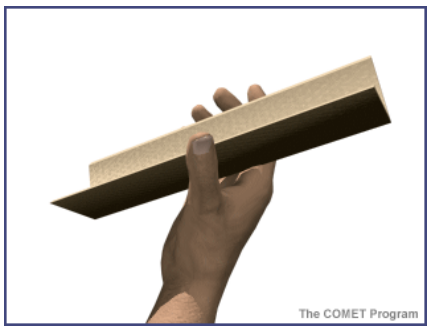
Rubric Category	Score
Brainstorm to Identify the Problem and Constraints • The problem is identified and explained in detail. • All criteria and constraints are listed and clarified. • Possible solutions are listed from the brainstorming session. • The work others have done to solve the problem is included.	
Generate Ideas, Possibilities, and Design Choice • Two or three ideas are selected from brainstormed list. • Detailed sketches are created for the selected ideas. • Sketches are labeled with dimensions and materials for each component. • One design is selected to construct with reasons for the choice.	
Build the Model or Prototype • Detailed list of materials is included. • Detailed procedures are included and followed. • Materials are handled and stored appropriately. • Safety rules are followed.	
Test the Model and Evaluate • Hypothesis following an "if.., then..." format is developed for the design. • Strengths of the design are listed. • Weaknesses of the design or compromises of the design are listed. • Results are accurately recorded. • Data tables are complete and well organized. • The chosen design effectively addresses the identified problem.	
Refine the Design • Modifications to improve the design are based on test results. • Modifications to the design are documented. • Additional trials are conducted. • Reflections show great insight and understanding of process and goals of project.	
Share the Design • Presentation is well-organized. • Presentation covers all areas of the design process. • Presentation is clearly communicated (verbally or visually) with appropriate data, sketches, graphs or pictures. • Presentation includes contributions from all team members.	
TOTAL (out of 24 pts possible)	

4 (Excellent) = All criteria (procedures, steps, and details) are met or followed with rare mistakes.
3 (Good) = Most criteria are met with only a few mistakes.
2 (Fair) = Many criteria are not met and/or there are many mistakes.
1 (Poor) = Most criteria are not met.
0 (No effort) = No effort to meet criteria.

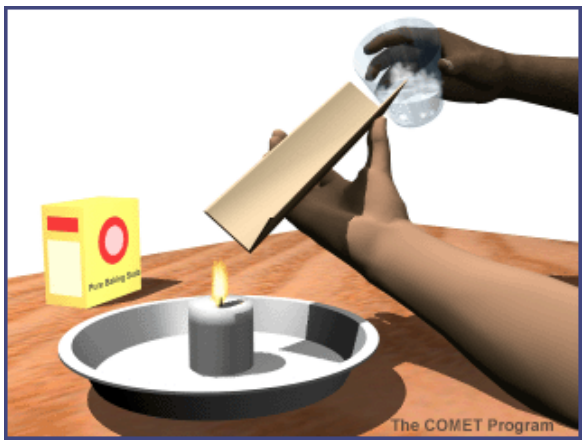
Engineering Design Process Rubric-
https://www.nasa.gov/pdf/324206main_Design_Packet_II.pdf

Air is a fluid activator- https://www.ucar.edu/learn/1_1_2_7t.htm

1. Discuss the physical properties of a fluid with students. Be sure to include the idea that fluids can be poured. Ask students if they think air is a fluid. Ask how it could be demonstrated.



2. Fold the poster board or cardboard lengthwise.
3. Place the candle on a plate and light the candle.
4. Put about a tablespoon of baking soda in the glass jar or beaker.
5. Pour about 1/4 cup of vinegar in the jar or beaker. (The vinegar and baking soda will react immediately filling the jar with carbon dioxide gas.)
6. When the fizzing subsides, hold the poster board "funnel" at an angle so that one end is near the candle flame and the other end is slightly higher.
7. "Pour" the gas in the beaker or jar down the funnel. The flame will go out in a second or two. (Only pour gas)



Observations and Questions

1. What happens when the vinegar and baking soda are mixed? (The mixture froths and bubbles, producing carbon dioxide.)
2. Explain how the flame was extinguished. (There was no more oxygen available for the flame, so it went out. Pure carbon dioxide is denser than air, so it flows like a liquid from the jar or beaker along the funnel. Carbon dioxide is used in fire extinguishers because it is effective at smothering flames.)

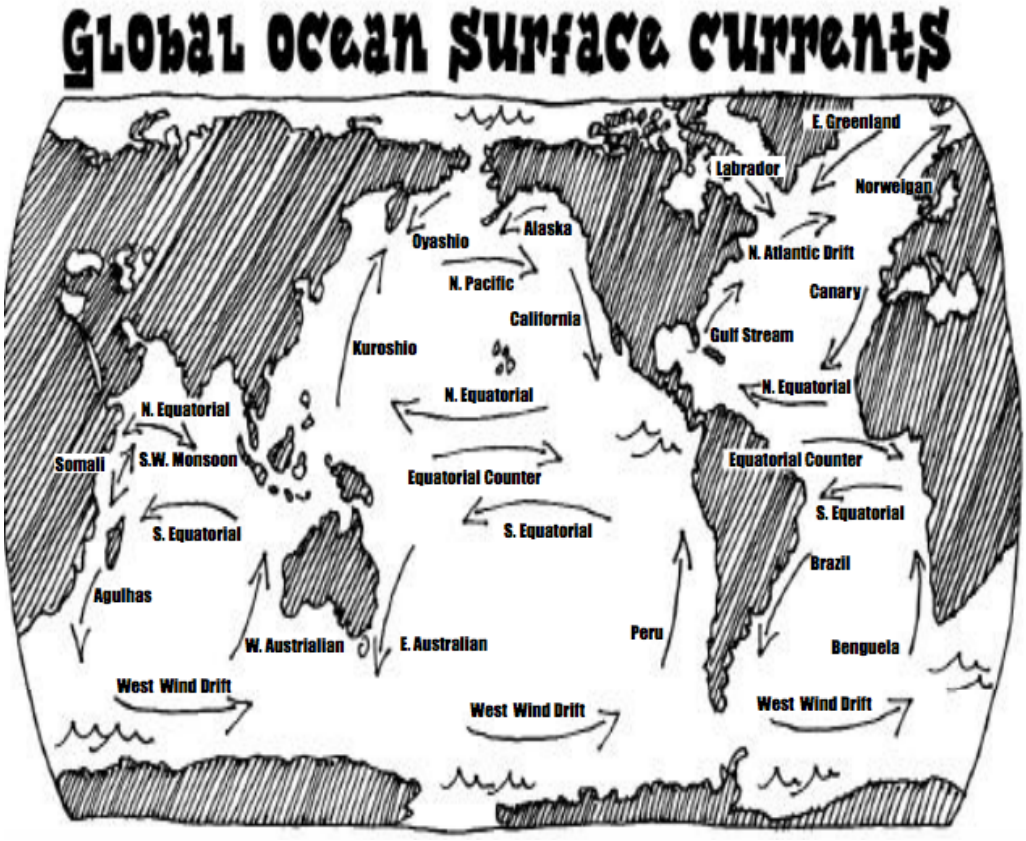
Convection in the Ocean Activity (http://sciencediscovery.colorado.edu/wp-content/uploads/2012/02/Convection-Connection.pdf**)**

Purpose: To observe how changes in _____ cause _____ currents.

Materials: Blue ice cubes (made ahead of time with blue food coloring) One clear, colorless plastic container (about shoebox size) Red food coloring warmed Note: To warm put container of food coloring in a cup of hot - not boiling - water. Blue and red colored pencils Index cards

Procedure:
1. Fill the container two-thirds full of room temperature water. Make sure the water is completely still before proceeding.
2. Place a blue ice cube at one end of the plastic container.
3. Add two drops of the warmed red food coloring at the other end of the container.
5. Observe, and use the blue and red pencils to illustrate, on the index card, what you see happening .

Anaylze Data:
Convection is seen as the _____ water sinks, and the _____ water rises, or stays higher. These currents occurs because



Interpret Data: Color the arrows with red or blue to show ocean currents-

Ocean currents act much like a conveyer belt, transporting warm water and precipitation from the equator toward the poles and cold water from the poles back to the tropics. Thus, currents regulate global climate, helping to counteract the uneven distribution of solar radiation reaching Earth's surface. Without currents, regional temperatures would be more extreme—super hot at the equator and frigid toward the poles—and much less of Earth's land would be habitable (http://oceanexplorer.noaa.gov/facts/climate.html).

What would happen if the ocean did not circulate the solar radiation absorbed from the sun?