**Oakland Schools Science Scope**

**Grade 7**

**Unit 4 – The Hydrosphere and Global Change**



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**The Hydrosphere and Global Change**

**About Our Scope Unit/Lesson Template**

This template is designed to serve several teaching and learning principles considered as staples of state of the art science instruction. Here are the key principles in summary:

* It’s critical to **elicit prior knowledge** as a unit or lesson begins
* **Key questions** should drive student explorations and investigations
* **Activity Before Concept** – Student inquiry-based explorations which give personal experience with phenomena and ideas should precede a presentation of science ideas.
* **Evidence is the heart of the scientific enterprise.** Students generate evidence and analyze patterns in data that help to construct scientific explanations around key questions.
* **Concept Before Vocabulary** – attaching science vocabulary to concepts developed by student investigations yields more success than beginning a unit or lesson with a list of science vocabulary.
* **Talk, argument** **and writing** are central to scientific practice and are among the most important activities that develops understanding.
* **Application** of the ideas provides review, extends understanding and reveals relevance of important ideas.
* **Assessment** of knowledge, skill and reasoning should involve students throughout the learning process and be well aligned to the main objectives and activities of the unit.

The Scope Science template is designed to put these principles into practice through the design of the ***SCOPE LEARNING CYCLE FOR SCIENCE***. Each unit has at least one cycle. The components are listed below:

|  |  |
| --- | --- |
| The Key Question for the Unit | Each unit has one open-ended Focus Question that relates to all the content and skills of the unit. The Key Question is presented at the opening of the unit and revisited at the unit’s conclusion. |
| Engage and Elicit | Each unit begins with an activity designed to elicit and reveal student understanding and skill prior to instruction. Teachers are to probe students for detailed and specific information while maintaining a non-evaluative stance. They also can record and manage student understanding which may change as instruction proceeds. |
| Explore | A sequence of activities provides opportunities to explore phenomena and relationships related to the Key Question of the unit. They will develop their ideas about the topic of the unit and the Key Question as they proceed through the Explore and Investigate stage of the learning cycle.  Each of the activities may have its own Key Question or central task that will be more focused than the unit question. The heart of these activities will be scientific investigations of various sorts. The results, data and patterns will be the topic of classroom discourse and/or student writing. A key goal of the teacher is to reference the Key Question of the unit, the Explore and Elicit of the students, and to build a consensus especially on the results of the investigations. |
| Explain | Each unit has at least one activity in the Explain portion of the unit when students reconcile ideas with the consensus ideas of science. Teachers ensure that students have had ample opportunity to fully express their ideas and then to make sure accurate and comprehensible representations of the scientific explanations are presented. A teacher lecture, reading of science text or video would be appropriate ways to convey the consensus ideas of science. Relevant vocabulary, formal definitions and explanations are provided. It’s critical that the activity and supporting assessments develop a consensus around the Key Questions and concepts central to the unit. |
| Elaborate | Each unit cycle has at least one activity or project where students discover the power of scientific ideas. Knowledge and skill in science are put to use in a variety of types of applications. They can be used to understand other scientific concepts or in societal applications of technology, engineering or problem solving. Some units may have a modest Elaboration stage where students explore the application of ideas by studying a research project over the course of a day or two. Other units may have more robust projects that take a few weeks. |
| Evaluation | While assessment of student learning occurs throughout the unit as formative assessment, each unit will have a summative assessment. Summative assessments are posted in a separate document. |

**Grade 7**

**Unit 4**

**The Hydrosphere and Global Change**

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**Unit 4 – The Hydrosphere and Global Change**

**Introduction**

This unit attends to the Michigan Grade Level Content Expectations as they are gathered in Unit 4 of the Michigan Department of Education Science Companion Document. Topically, the unit addresses concepts within the disciplines of earth systems science, global climate, meteorology, the water cycle and environmental science. Yes, that is vast. But the Oakland Schools Science Scope has established a good deal of coherence by organizing the unit into three cycles:

Cycle 1: Energy in the Earth Systems

Cycle 2: Meteorology

Cycle 3: The Global Water Crisis

The resources and opportunities to address these topics are of such abundance and quality that the unit has the tremendous potential to be a highly relevant, real world and investigation rich experience for students. As teachers look for ways to have students use real world data, apply interactive technology to real world questions and foster meaningful tasks for reading, writing, argumentation and mathematics and framed by the Common Core Curriculum Standards, the issues here provide abundant opportunity. The main limitation is the class time available given other content demands.

*On the Common Core State Standards for English Language Arts and Literacy in Science*

All science teachers will find the Common Core State Standards of ELA a tremendous asset for reaching learning objectives in science education. Reading, writing, argumentation and discourse are central proficiencies necessary for success in science. All teachers should become fluent with the document and will likely find it validating.

[**http://www.corestandards.org/assets/CCSSI\_ELA%20Standards.pdf**](http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf)

These standards are best reached with science instruction that connects content to real world problems and experiments, complimented with scientific writing, challenging questions, processes for classroom discussion and debate and use of scientific text. The link below describes a number of effective reading strategies for science instruction:

[**Reading Strategies in Support of Science Proficiency**](http://oaklandk12.rubiconatlas.org/links/Science_7/Reading%20Strategies%20in%20Support%20of%20Science%20Proficiency.docx)

It is recommended that teachers require students to use an interactive science notebook to support learning in this unit. Here are some features and policies to consider:

* Use a bound notebook – cut and paste some other materials into it.
* The right facing page is for teacher content, the left is for student reflection.
* Leave four pages for a table of contents.
* Leave the notebooks in the room.

**Learning Cycle One: Energy in the Earth Systems**

**Introduction**:

This cycle opens the unit with an exploration of the central driver of Earth’s weather and climate: energy from the sun. Concepts related to types of energy, energy transference (movement) and transformation (changing forms, e.g., radiant to thermal) should be part of the conversation throughout the unit. It also sets the stage for the study of weather and climate, as well as the use of the Earth Systems Science paradigm. This perspective is now a mainstream foundation among scientists who study global change. Scientists use the concept to account for the movement of matter and energy through the hydrosphere, biosphere, geosphere and atmosphere.

Human energy needs rely on our understanding of earth systems. To connect the academic concepts of Earth in the earth system to practical needs and societal challenges, this unit includes activities where students weigh the opportunities to harness energy for human demands.

**Learning Objectives**

1. Explain how the tilt of the Earth’s axis impacts the amount of solar energy that reaches the Earth at various latitudes.
2. Explain how thermal energy is moved and transformed in specific climatic/weather situations.
3. Describe the Earth’s global atmospheric and oceanic circulation.
4. Relate air and ocean movement as depicted on maps and schematics to descriptions in text.
5. Interpret graphs of seasonal patterns.

**Key Question: How does energy from the sun drive global climate? Engage and Elicit**

**Activity 1 – The GLOBE Earth System Poster Learning Activities 1 - 5**

**Purpose**

To elicit student understanding of Earth systems concepts from a global perspective. These activities would be good to return to at the end of the unit to allow students to have a more informed and detailed analysis.

**Activity Description**

In small collaborative groups, students analyze sets of global maps that show color contoured data sets (temperature, precipitation, insolation, biological, cloud fraction). The activity is very well scripted and organized. It goes well beyond the first five activities suggested here, which can help extend these topics in additional analyses and projects. This is a product of The GLOBE Project which hosts online all the required maps and activity guides. Students will analyze these maps again in Activity 9, which is in the Explain stage of the 5-E learning cycle.

**Focus Question**

How does energy move within and across Earth Systems?

**Duration**

Two class sessions

**Materials**

* Teacher Guide and the 36 global maps, printed two per sheet in color

<http://www.globe.gov/teaching-and-learning/materials/earth-system-science-posters>

Atlas URL:

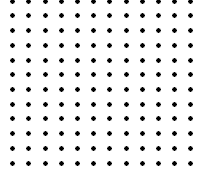
<http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Earth_System_Poster_07_Activities.pdf>

**Teacher Preparation**

1. Download, print, and read the activity guide for teacher use. This is online at GLOBE and uploaded as a resource in Atlas-Rubicon.
2. Download and color print the 36 maps that are part of this activity. One set allows for teams of four in a class of 24. With larger classes, have teams of three who use two sets of images. Each parameter will have more two groups.
3. Make teacher note cards with leading questions to help facilitate the whole group discussion. Be sure to probe for ideas about energy transformation (changing) and transference (moving), since these ideas are central to Cycle 1.
4. Prepare to display the GLOBE maps from the website onto the class screen with a projector. This allows all students to see the details while they are being presented by groups of students.

**Classroom Procedure**

1. Refer to Activity Guide for activity and teacher materials description for the class. The teacher materials are well described.
2. Students will require support as they begin to describe patterns in the data. Some maps (e.g., insolation, aerosols) will require the teacher to define these. Some units will be unfamiliar to students. It’s not necessary for them to completely understanding the units in order to notice variations over space.
3. While students analyze the map, make sure their comments reflect a balance between observation and inference.
4. During group presentations, other students will want to make connections to their map. Allow a couple of these comments, but keep them limited so each team can have the floor with ample time.
5. Close the activity by having student record their “initial ideas about earth systems in their interactive notebook.
6. During group presentations other students will want to make connections to their map. Allow a couple of these comments, but keep them limited so each team can have the floor with ample time.
7. Conclude by summarizing student ideas on Earth’s interacting systems. Provide a brief explanation of the GLOBE project (<http://globe.gov>) and let students know that after a number activities they will have a chance to reconsider these maps.

**Explore**

**Activity 2 – The Energy Dot Model**

**Purpose**

To produce and analyze quantitative evidence on the global distribution of solar energy as it varies by latitude and season.

**Activity Description**

Students manipulate a physical model (a globe, an overhead projector which shines black dots on the globe) to produce and collect data on the amount of solar energy that strikes the earth. To enhance their comprehension of how energy is distributed across earth’s surface, they begin with the “Angle of the Sun” worksheet. The main activity was created by teacher David Leclerc of Southfield school district. It is organized in a packet that can be downloaded from Atlas.

**Focus Question**

How does solar energy striking the earth vary by latitude and season?

**Duration**

Two class periods.

**Materials**

* Angel of the Sun Worksheet

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Angle%20of%20Sunlight%20Lab.doc>

* Energy Dot Model Activity Guide

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Energy%20Dot%20Model%20Activity.doc>

* Completed sample of tables and charts (for teacher use)

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Energy%20Dot%20Data%20and%20Charts.xlsx>

* Student handout
* 4-6 standard globes,
* 4-6 overhead projectors
* 4-6 Energy Dot Transparencies
* Graph paper, rulers, colored pencils

**Teacher Preparation**

1. Read over the Angle of Sunlight lab.
2. For each team of four students, one globe and one overhead projector will be needed. Plan ahead to try to gather/borrow these resources. If this is infeasible and only one model can be set up, a plan to engage the whole class will have to be designed.
3. Print a transparency of energy dots for each station.
4. Print and copy the written materials.

**Classroom Procedure**

1. Begin with the “Angle of the Sun” worksheet.
2. Follow the procedures in the activity packet which follows on the next page.
3. During the set-up, involve the students in a deliberation on the experimental design. Their analysis relies on data shared by other student teams. Challenge them to consider how holding variables constant is critical to produce strong data.
4. Make sure there is a good deal of whole class analysis on the data.
5. Use the opportunity to:
   * emphasize the role of modeling in science,
   * ensure students understand they are using this model to generate evidence.

**Explore**

**Activity 3 – Heat Capacity: How Much Heat Will it Hold?**

**Purpose**

To determine how temperature changes from varying heat capacity of different materials.

**Activity Description**

This activity is from Teach Engineering (K-12). Students relate thermal energy to heat capacity by comparing the heat capacities of different materials and graphing the change in temperature over time for a specific material. Students learn why heat capacity is an important property of thermal energy that engineers use in many applications and is critical for understanding processes in weather and climate.

**Focus Question**

How do materials absorb and release heat differently?

**Duration**

Two class sessions

**Materials**

* Activity guide at Teach Engineering website: <http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.org/collection/cub_/activities/cub_energy2/cub_energy2_lesson06_activity2.xml>
* See materials list provided by the activity guide
* Student worksheet:

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/How%20Much%20Heat%20will%20it%20Hold.doc>

**Teacher Preparation**

1. Review the materials in the Teach Engineering activity guide and gather sets of lab teams.
2. Plan the demonstrations by filling the water balloon and collect the other items:
   * Two balloons – one filled with water, the other with air
   * Lighter
   * Wooden board
   * Cast iron frying pan
3. Anticipate the following unit, which uses the idea of heat capacity in the study of weather and climate.
4. Print and copy the student worksheet.

**Classroom Procedure**

1. See activity guide for details and note that here are two interesting demonstrations that will provide interesting discrepant events that will amaze students.
2. Show students two balloons--one filled with air and one with water. Ask them to predict what will happen if one is held to the candle flame. Hold both to the flame, one at a time. Air balloon will pop, water balloon will not pop. Water absorbs heat so quickly that the heat from the candle is taken away from the surface of the balloon and the flame does not damage it. See it done: <http://www.youtube.com/watch?v=hyPLusD-tyM>
3. Show students a wooden cutting board and an iron frying pan. If students put their hands on each at the same time they will find the frying pan feels cooler. It absorbs and releases heat more readily than wood and therefore absorbs heat from a person’s hand quickly, making it feel cool. Ask which will melt an ice cube faster. From the experience of touching the objects, many students will say the frying pan will melt the ice faster. However, the opposite is true because the frying pan surrenders heat more quickly and so doesn’t melt ice as fast as the cutting board.

**Explore**

**Activity 4 – Heat Transfer and the Effects of Solar Radiation**

**on Land and Sea**

**Purpose**

To measure and analyze how heat capacity controls the temperature of soil versus water.

**Activity Description**

After some discussion around video simulations that show examples of heat transfer, students work with buckets of soil and water and measure the temperature of each over the course of a day. An activity, “Effects of Solar Radiation on Land and Sea,” is one of many downloadable lesson plans hosted by the U.S. Department of Energy’s Climate Research Facility.

**Focus Question**

How do materials with different heat capacity absorb and hold heat differently?

**Duration**

One class period

**Materials**

* Activity from U.S. Department of Energy

<http://education.arm.gov/teacher-lounge/lessons/solar-effects>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Heat%20Transfer-Effects%20of%20Solar%20Radiation%20on%20Land%20and%20Sea.docx>

* Student worksheet:

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Solar%20Radiation%20on%20Land-Sea.doc>

* Online simulators will help class discussions after the activities
  + <http://www.teachersdomain.org/asset/lsps07_int_heattransfer/>
  + <http://www.classzone.com/books/earth_science/terc/content/visualizations/es1903/es1903page01.cfm>
  + [http://cosee.umaine.edu/programs/courses/Umaine491/](http://cosee.umaine.edu/programs/courses/UMaine491/)

(view the video for Activity 4.3)

**Teacher Preparation**

1. Gather required materials for investigation.
2. Preview and practice accessing online simulations/video that are to be used in class discussion.
3. Print and copy student worksheet.

**Classroom Procedure**

1. Begin a classroom discussion by showing the animation from Class Zone that shows the sea breeze and land breeze. Ask students to make a sketch and a short explanation of the types of heat transfer in the picture.
2. Prompt a ‘turn and talk’ so pairs (and only pairs) share their thinking.
3. Elicit some student explanations and supplement them with the other simulation from the Teacher Domain website.
4. Use the procedures from the Department of Energy activity to prepare and organize the investigation.

**Explore**

**Activity 5 – What the Data Says Near Chesapeake Bay**

**Purpose**

To investigate the effect of the heat capacity of land versus the ocean on regional temperature.

**Activity Description**

This is an important activity which will help students transfer through application the physics of thermal energy to the earth systems. It is hosted by a project called BRIDGE, funded by SeaGrant and COSEE. They call it “Heat Capacity: Can’t Take the Heat.” It provides links to real world temperature data near Chesapeake Bay and makes clear the real world impact of heat capacity, specific heat, and thermal buffering of the oceans. The activities has students create an analyze temperature data from 4 different locations in the region. It is supplemented here with a ‘text in the middle’ reading activity.

*As described on their website:*

Why does coffee take so long to cool down? Why is ocean water sometimes at its warmest when the average daily air temperature starts to drop? How can buoys help us explore these questions? In this hands-on introduction to heat capacity by the Bridge and COSEE-NOW, students explore the concept of heat capacity and its effects on our daily lives. Students use ocean observing system data to investigate why water acts as a thermal buffer and the practical applications this has.

**Focus Question**

Why is ocean water sometimes the warmest when the average daily air temperature starts to drop? How can buoys help us explore these questions?

**Duration**

Two class periods.

**Materials**

* BRIDGE materials

<http://www2.vims.edu/bridge/DATA.cfm?Bridge_Location=archive0909.html>

<http://www.marine-ed.org/bridge/>

* Atlas URL’s: (4 items below)
* Revised Student Worksheet

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Temperatures%20near%20Chesapeake%20Bay.doc>

* BRIDGE Student Worksheet:

<http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/StudentWorksheet-Chesapeak.pdf>

Figures 1-3: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Figures1-3-Chesapeak.pdf>

Completed Graph: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/CompletedGraph-Chesapeak.pdf>

* Heat Capacity Reading Task (Text in the Middle)

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Heat%20Capacity%20Text%20in%20the%20Middle.doc>

**Teacher Preparation**

1. Review the procedures and materials at the BRIDGE website.
2. Practice accessing the online buoy data
3. Print and copy the materials.

**Classroom Procedure**

1. Follow the procedure as described by the Bridge website. The student worksheet provided here is an adaptation so it includes more questions.
2. It will be critical to ensure students can apply the idea of heat capacity to land and water. Use the text in the middle activity to help students pull these ideas together and debrief their conclusions as a whole class discussion.

**Explore**

**Activity 6 – Wind Driven Ocean Currents**

**Purpose**

To connect solar energy to global winds and ocean currents.

**Activity Description**

“Wind Driven Ocean Currents” is an activity provided on a NOAA CD and NASA website. It starts with a physical model of students blowing colored water in a pan with a straw to simulate ocean winds. Global surface winds are explained in a general way, and maps compare those to ocean surface currents

**Focus Question**

How do global wind patterns influence global ocean circulation?

**Duration**

One class session

**Materials**

* Student instructions: “Wind Driven Ocean Currents”

<http://sealevel.jpl.nasa.gov/files/archive/activities/ts2siac1.pdf>

Atlas URL:

<http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NASA-Wind%20driven%20ocean%20currents.pdf>

* Student worksheet:

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Wind%20Driven%20Currents.docx>

* Other activities from JPL:

<http://sealevel.jpl.nasa.gov/files/archive/activities.html>

**Teacher Preparation**

1. Review the procedures and materials at the NASA website.
2. Print copy the student materials.

**Classroom Procedure**

1. Review and follow the instructions at the NASA website.

**Explore**

**Activity 7 – Around the World with Ocean Currents**



**Purpose**

To predict how ocean currents would float a student around the world, starting from his/her watershed.

**Activity Description**

There are two simple activities to choose from. The first was created by Nate Childers and Monica Harvey of Rochester School District. It asks students to study and use ocean currents to predict where they would travel in a float trip. A description of the activity can be downloaded from Atlas. The description mentions the waterways of Rochester, Michigan, which users can change to their own.

The second activity is the well-known Nike Shoe investigation where a container ship spilled thousands of Nike Shoes into the ocean, providing scientists new data on ocean currents. It is presented as an alternative.

**Focus Question**

How would ocean currents transport us if we were to drift around the world?

**Duration**:

One class session

**Materials**

* Global maps, activity handout, colored pencils
* Atlas URL (Around the World):
* <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Around%20the%20World%20with%20Ocean%20Currents.doc>
* Atlas URL (Nike Shoe): <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Nike%20Shoe%20Investigation.pdf>

**Teacher Preparation**

1. Review the procedures and materials at the NASA website.
2. Print the student materials.

**Classroom Procedure**

1. Review and follows the instructions at the NASA website.
2. Follow as described by activity handout, but provide opportunity for students to compare and debate their solutions with one another.

**Explain**

**Activity 8 – A Focused Read and Interactive Lecture on Atmospheric Circulation and Global Currents**

**Purpose**

To solidify the content of Cycle 1 and address the Key Question by discussing global wind and current patterns.

**Activity Description**

The Key Question of this cycle is: “How can everyday global patterns of climate be explained in terms of energy?” Using text, teacher lecture, and class discussion, students assume the role of a Scientific Illustrator (a real world role). They must enhance a piece of text by sketching and adding graphics to the article. There are three version that vary be degree of challenge

**Focus Question**

How can everyday global patterns of climate be explained in terms of energy?

**Duration**

Two class sessions.

**Materials**

* Three versions of text for different tasks:

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Sun%20as%20the%20Driver%20of%20Global%20Winds-Blank%20Figures.docx>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Sun%20as%20the%20Driver%20of%20Global%20Winds-Label%20a%20Figure.docx>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Sun%20as%20the%20Driver%20of%20Global%20Winds-With%20Sample%20Figures.docx>

* FYI: Origin of text: Page 4-7 of Climate and Currents document (<http://www.msc.ucla.edu/oceanglobe/pdf/climatecurents/currentsentire.pdf>)

(or similar content from district science text book)

Atlas URL:

<http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Climate%20Curriculum-Global%20Winds-Currents.pdf>

* Sample images that may provide ideas:

<http://www.srh.noaa.gov/jetstream/global/circ.htm> <http://www.srh.noaa.gov/jetstream/global/jet.htm>

* Two blank global maps (one for atmosphere, one for current)
* Projected images of global wind directions in three dimensions and global currents. See samples: ATLAS URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Images%20of%20Global%20Winds.docx>
* Colored pencils, scissors and glue stick

**Teacher Preparation**

1. Determine which of the three versions you will provide for students. These can serve a need to differentiate the task.
2. Be prepared to present color graphics through computer projection.

.

**Classroom Procedure**

1. Provide text to each student and explain that scientific illustration is a career.
2. Each student should begin this task on their own.
3. Support students as they get started, especially for the version that is very open ended. It may be necessary to model the task as they begin. Some students cut, paste and enhance existing images to serve as the illustrations.
4. When students complete their illustrations group them into teams and provide a new blank copy. Now they are to collaborate. Have them share their illustrations with one another and create a single master copy that reflects the best thinking of the group.
5. Discuss the role of energy in global winds, which would include the kinetic energy of Earth’s spin (causing the Coriolis effect), convection, and radiant energy from the sun.

|  |  |
| --- | --- |
| atmo_circulation_3 | Atmosphereic Circulation1 |

**Explain**

**Activity 9 – Reconsidering GLOBE Earth Systems Poster**

**Purpose**

To analyze and explain how interconnected Earth systems reflect the fact that the Sun drives global climate.

**Activity Description**

Students reexamine the global maps from Activity 1 and create a poster that is examined by their colleagues in a gallery walk.

**Focus Question**

What correlations can we recognize between the climatic variables shown in the global maps?

**Duration**:

Two class session

**Materials**

* Global maps from the Globe Earth System Poster

<http://www.globe.gov/teaching-and-learning/materials/earth-system-science-posters>

* Student project description:

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Energy%20on%20Earth%20-%20Globe%20Extension.docx>

* Poster materials

**Teacher Preparation**

1. Gather poster making materials.
2. Print and copy the student project description.

**Classroom Procedure**

1. Explain the project and have students deliberate and begin to make their poster.
2. Discuss their conclusions and plans as they proceed and provide feedback to elevate the sophistication of their product.
3. Host the gallery walk. Control the flow of traffic with a timer. Have student leave comments on Post It notes as they visit each poster.

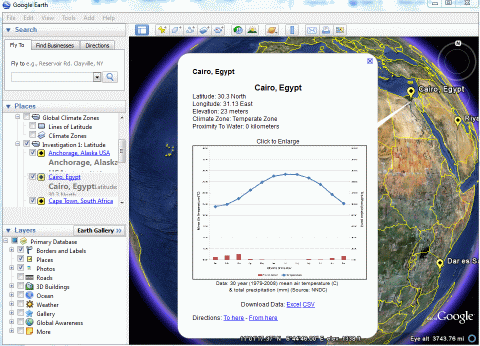
**Elaborate**

It is critical that students explore the connections between the science concept they have been studying, and the real world issues they will be challenged by in the coming decades. This cycle lends itself wonderfully to the currently prominent issues surrounding the world’s demand for energy. Possibilities are numerous for real world design projects or problem solving endeavors. Teachers could take project possibilities in many directions, such as designing alternative energy systems for their schools, or addressing long-term strategic plans related to energy with a project centered on Michigan’s Sustainable Energy Future.

In SCoPE, we include three activities. The first involves the creation and analysis of climatographs. We also are drawing from two of the numerous high-quality activities and projects from the National Energy Education Development project (NEED: <http://www.need.org/Curriculum-Guides-Subject>). If teachers have time, these activities could set up additional, more student-directed projects.

**Elaborate**

**Activity 10 – Influences and Patterns of Regional Climate**



**Purpose**

To build and analyze climatographs of several classic regional patterns.

**Activity Description**

This is a classic activity that can convey the influences of regional climates by graphing average temperature or precipitation data. Students are assigned topics to investigate and describe. They form expert groups to reinforce their understanding. Then a member is randomly chosen to present to the class. That said, there are a number of approaches to this classic analysis. Consider these:

* Traditional approach: preselected data sets are provided to students. They graph them answer observational or analytical questions
* Upgraded Traditional Approach: Students are given a topic (e.g. how elevation influences average monthly temperature). They determine the best 3 or 4 cities to compare by controlling other variables (latitude, marine influence, mountains). The describe patterns in data for selected cities. Teacher provides a menu of datasets to select from. [DESCRIBED BELOW]
* Technically Enhanced Upgraded Traditional Approach: Same as above, but they use software with global weather data (e.g., ISMCS) [DESCRIBED BELOW].
* GLOBE’s astoundingly innovative use of Google Earth with a \*.KML file that hosts datasets, teacher guide and student worksheets.
* GLOBE also has an activity where students make climatographs of their local climate, a major uptick on the relevance scale.

**Focus Question**

What factors influence regional climate?

**Duration**

2 class sessions

**Materials (depending on chosen approach)**

* Student Handout for upgraded traditional approach - Regional Climate Data.doc

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Building%20Climatographs%20with%20Global%20Weather%20Data.doc>

* Dataset for upgraded traditional approach - Regional Climate Data.xls

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Regional%20Climatic%20Data.xls>

* Graph paper
* Colored pencils
* ISMCS Software: (not needed if using dataset provided above)

**International Station Meteorological Climate Summary (ISMCS) Ver 4.0-CD-ROM: http://ols.nndc.noaa.gov/plolstore/plsql/olstore.prodspecific?prodnum=C00268-CDR-A0001 (search for ISMCS)** The CD-ROM features an extensive global dataset of climatic data from all over the world, back to the middle of the twentieth century. The format of the data is PC-only, and the interface is dated, but this selection of climate and weather data is hard to come by. For only $17, a school can network the data for an infinite number of explorations.

* ISMCS.doc (instructions on use)
* Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/ISMCS.DOC>
* GLOBE Activities:

Google Earth: http://globe.gov/scrc/pilots/data

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Unit%204/GLOBE-Exploring%20Climate%20Influences-Google%20Earth.pdf>

Atlas URL: (\*.kml – right mouse, save target as..)

<http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/GLOBEClimateInfluenceActivity.kml>

Atlas URL: (Local Climograph) <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/GLOBE-Climatograph-Local.pdf>

**Teacher Preparation**

1. If using the upgraded traditional approach, print and copy the datasheets and student instructions.
2. If using ISMCS software, acquire and install on PC computers.
3. If using the GLOBE Activity, go their website, download Google Earth, the \*.kml file and the “Viewing Long Term Data” users guide for the activity.

**Classroom Procedures (Upgraded Traditional Approach)**

1. Assign students one of the influences:

* Temperature vs. Latitude
* Temperature vs. Elevation
* The marine influence on local temperature
* Effects of mountains on rainfall
* The lake effect
* Prevailing winds and rainfall on coastal regions
* Effects of boundary currents on local temperature (cold vs. warm boundary currents)
* Rainfall vs. Latitude in the tropics (more advanced--optional)

1. Distribute the “Influences on Regional Climate.” This document provides a general explanation of the influence.
2. Distribute the spreadsheet file “Regional Climate Data.” This provides temperature and precipitation data from 27 cities. Each lists elevation, longitude and latitude.
3. Describe the task: Choose and graph climatic data from the cities that best convey the assigned influence.
4. Teachers should anticipate the struggle students will have controlling for variables. For example, to depict the influence of latitude on average temperature, students should seek two cities that have significantly different latitude, similar elevation, and similar proximity to the marine influence. Support students’ thinking with probing questions that help them consider controlling variables.
5. After graphs are made, group students who worked on similar topics to share their product and construct an explanation for the class. If Google Earth is available, they can navigate to the cities they choose to present the nature of vegetation in the region.
6. Using ‘numbered heads,’ choose a member of the expert group to describe the influence to others.

**Classroom Procedures (Technology Enhanced Upgraded Traditional Approach)**

1. Same as above, but instead of providing datasets to choose from, provide computer access to the ISMCS software. Student still must choose stations to compare in a way that negates the influence of variables other than the one they are trying to investigate.

**Classroom Procedures (GLOBE Activities)**

1. GLOBE provides well written teacher guides. Follow these.

**Elaborate**

**Activity 10 – Energy Flows (provided by NEED Project)**

**Purpose**

To propose a plan for a sustainable energy future for Michigan.

**Activity Description**

Students extend their understanding of energy transference to human energy systems. In this phenomenal NEED Project activity (USDOE), students learn about the forms of energy, how energy is converted from one form to another, and how energy flows through systems.

**Focus Question**

When considering human energy needs, what is critical to understand about how energy flows within a system?

**Duration**

One class session

**Materials**

* Energy Flows Lesson Packet

http://www.need.org/needpdf/Energy%20Flows.pdf

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NEEDS-Energy%20Flows.pdf>

**Teacher Preparation**

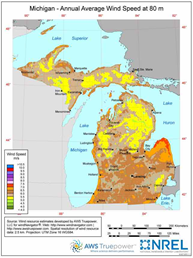
1. Become familiar with the six steps in the NEEDS activity.
2. Create the cards and packets needed for student use.
3. Generate questions in preparation for facilitating the class discourse.

**Classroom Procedure**

1. Review and follows the six steps explained in the instructions at the NEEDS website.

**Elaborate**

**Activity 11 – The Great Energy Debate**



**Purpose**

To understand the advantages and disadvantages of various energy solutions and that decisions involve tradeoffs.

**Activity Description**

This is another NEED Project activity. Students evaluate the advantages and disadvantages of the major energy sources in an innovative debate format. In “The Great Energy Debate,” student teams learn about all of the energy sources, and then are assigned to represent the different energy sources. Working cooperatively, students develop arguments on the merits of their source over the others.

**Focus Question**

What makes solutions to our energy needs most appealing?

**Duration**

Two class sessions

**Materials**

* Explanation of the game (in NEED document)
* Student materials (in NEED document)
* <http://www.need.org/needpdf/Great%20Energy%20Debate%20Game.pdf>
* Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NEEDS-Great%20Energy%20Debate%20Game.pdf>

**Teacher Preparation**

1. Become familiar with the six steps in the NEED activity.
2. Create the cards and packets needed for student use.
3. Generate questions in preparation for facilitating the class discourse.



**Classroom Procedure**

1. Follow the detailed procedures provided in the NEED packet.
2. After the debate, share the following facts to protect students from becoming fatalistic about the formidable issues related to energy:

**Facts**

On October 6, 2008, Public Act 295 was signed into law. This Act, known as the Clean, Renewable and Efficient Energy Act, established a Renewable Energy Standard for the State of Michigan. The Renewable Energy Standard requires Michigan electric providers to achieve a retail supply portfolio that includes at least ten percent renewable energy by 2015. The Michigan Renewables Energy Program (MREP) was established by the legislature, and implemented by the Public Service Commission, to promote the use of renewable energy in the state.

From a report dated January 4, 2011: Michigan's two largest electric utilities Consumers Energy Company and The Detroit Edison Company--report the following:

* Consumers Energy has contracted for 396 MW of renewable energy: 8 MW already in commercial operation and 388 MW more in commercial operation by the end of 2012.
* Detroit Edison has contracted for 252 MW of renewable energy: 44 MW already in commercial operation and 208 MW more in commercial operation by the end of 2011.
* Detroit Edison and Consumers Energy have contracted for a combined total of 648 MW of renewable energy: 598 MW of wind energy, 45 MW of biomass energy, 4 MW of solar PV energy, and 1 MW of hydroelectric energy.

**Evaluation: Cycle Quiz**

**Learning** **Cycle Two: Meteorology**

**Introduction**

Meteorology is a vast field that relies on a good understanding of physical science concepts. It is also easily accessible to students, offering them many opportunities to do real world science with a wide array of tools. Every student lives within the daily weather, and the availability of real time data, satellite, and ground-based imagery and forecasting claims is voluminous. There are also extensive, free, online instructional resources from agencies like NASA, NOAA and the National Weather Service, and other bodies such as universities and school districts. This learning cycle treats Michigan’s Grade Level Content Expectations in a comprehensive fashion, while also serving as an introduction to the topic.

**Knowledge**

1. To understand the composition and structure of the atmosphere.
2. To understand weather fronts (warm, cold, occluded).
3. To understand the measures? that inform weather forecasting.

**Skills**

1. To be able to use gas laws to explain common weather patterns and cloud formation.
2. To generate evidence related to gases and the atmosphere and construct arguments founded on evidence.

**Key Question: What atmospheric factors are necessary to measure and monitor in order to make weather predictions?**

**Engage and Elicit**

**Activity 1 – Our Concept of Earth’s Atmosphere**

**Purpose**

To elicit student ideas about Earth’s atmosphere.

**Activity Description**

Students draw and annotate a scientific profile of Earth’s atmosphere based on their own thinking and knowledge. Teacher prompts ask them to describe their notion of atmospheric composition and structure with references to practical aspects such as weather, air travel, environmental concerns and topography. In Activity 3 they are presented with some content about the atmosphere with which they can improve their understanding of the atmosphere.

**Focus Question**

What do we understand about Earth’s atmosphere?

**Duration**

One class period.

**Materials**

* Student Guide:

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Atmosphere%20Profile.docx>

* Student Guide with Notes for Teachers:

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Atmosphere%20Profile%20-%20activity%20and%20teacher%20notes.docx>

* Graph paper
* Standard pencils and erasers
* Colored pencils
* Ruler with centimeter scale

**Teacher Preparation**

1. Gather student materials.
2. Develop and write down some teacher questions that can be used to elicit student thinking about the concepts of this cycle.

**Classroom Procedure**

* 1. Provide each student with their own graph paper and the other drawing materials.
  2. Post the student task on a screen or board.

***Student Task:***

*Step 1: Independently sketch a scientific profile of Earth’s atmosphere. Some components to include:*

* *A vertical scale*
* *Labels on components of the atmosphere*
* *Some way of depicting and describing the gases that make up the atmosphere*
* *Things that are in the atmosphere: physical, biological, human*

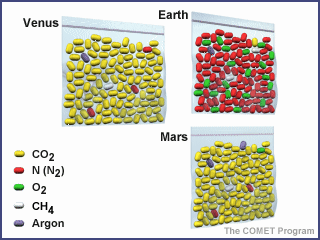
*Step 2: When prompted, join a table group of 3 or 4 (assigned by your teacher). Share your concepts with each other. Teach each other ideas that each of you bring to the conversation.*

*Step 3: Create another annotated profile, this one being a composite of the ideas that each member contributed.*

*Step 4: Participate in a whole group conversation by presenting your ideas.*

* 1. Walk the room to ensure students are setting up their profile properly. Some students may not understand the profile (or cross sectional) perspective. Encourage more details to those who seem to stall.
  2. Look over student work as they produce it to see what notions specific students have. These insights will be useful for probing their thinking in the whole group discussion.
  3. Be prepared for the comment that they don’t know anything about the atmosphere. Reply that although they may not feel confident in their scientific understanding of the atmosphere, they surely have some way of thinking about it and that’s what is important to show and discuss.
  4. Lead them through the other steps and record their picture of the atmosphere. In the whole class discussion, probe for details on these concepts:
     + Composition of the atmosphere
     + Sense of scale of the atmosphere
     + Knowledge of layers of the atmosphere
     + Nature and location of clouds, the ozone layer, where planes fly, how high mountains reach.
     + Understanding of the greenhouse effect
     + Difference between climate and weather
     + How we study the atmosphere
     + Features of weather (clouds types, fronts)
     + Ask: why are airplanes pressurized? Why do fighter pilots wear oxygen masks?
  5. Post some of the depictions in the room. Later, some revisions may become evident to the students. It will be valuable for them to recognize this.

**Explore**



**Activity 2 – The Goldilocks Principle: A Model of Atmospheric Gases**

**Purpose**

To reveal the composition of Earth’s atmosphere in comparison to sister planets Venus and Mars.

**Activity Description**

This activity is provided by the University Corporation for Atmospheric Research (UCAR) It introduces students to the atmospheric differences between the three "sister" planets in a graphic and hands-on way. Students build simple models of the atmospheres, which enable them to notice stark differences. Students will use this understanding later as they begin to appreciate the scope and importance of the greenhouse effect on Earth.

**Focus Question**

How has Earth’s atmosphere benefited life as we know it on our planet?

**Duration**

One class period.

**Materials**

* Details are provided by the UCAR webpage.

<http://www.ucar.edu/learn/1_1_2_1t.htm#materials>

Atlas URL:

<http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/The%20Goldilocks%20Principle.docx>

* Student worksheet

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/The%20Goldilocks%20Principle.docx>

**Teacher Preparation**

1. Review and follow the instructions at the UCAR website.
2. Gather and organize all materials for the models students will use.
3. Follow steps as described by activity handout, but provide opportunity for students to compare and debate their solutions with one another.

**Classroom Procedure**

1. Details are provided by the UCAR webpage which is presented in student worksheet.
2. Prompt students to use the method “Taking to the Text” when reviewing background information.
3. Be sure to emphasize the role of models in science and how the models in this activity help us understand concepts. Also point out where the models may misrepresent the nature of planetary atmospheres.
4. Proceed as described by the student handout and UCAR website.

**Explore**

**Activity 3 – The Nature of Air**

**Purpose**

To demonstrate and describe important phenomena related to gases.

**Activity Description**

Using the ‘expert groups’ collaborative process, small student teams each are given instructions for a simple demonstration of important and interesting properties of gases. Several are suggested below, but teachers may use interesting demonstrations they are aware of as replacement or in addition to those suggested.

Given the amount of time it takes for all students to demonstrate their activity, it is recommended that at least two teams of students do the same activity. It also is efficient to hold a ‘gallery walk’ where one half of the class set up and host their demonstrations as the other half visit those students as ‘museum goers.’

Another approach is to set up four stations for student teams to visit. At each station they manipulate a simple demonstration and try to identify a rule about the behavior of air. Some materials for this activity are listed below in the Material section.

**Focus Question**

How do varying conditions affect the way gases behaves?

**Duration**

Two class sessions

**Materials**

* Physical materials determined by teacher-chosen demonstrations
* Other sources of activities, e.g.:
  + U.S. Department of Energy Climate Research Facility: <http://education.arm.gov/teacher-lounge/lessons/alpha-lessons>
  + BOOK: *Invitations to Science Inquiry* (2nd edition) by the late Tik Liem. This book contains hundreds of activities, each written up on single pages. They include a sketch, procedures and a clearly written explanation.
  + BOOK: *Project Earth Science – Meteorology*, National Science Teacher Association Press (NSTA Press). Numerous weather-related investigations with clear instructions and explanations. The book also includes some clearly written background essays.
* Posters or tri-panel displays for student presentations.
* Four station Behavior of Air approach
  + Student Guide:

<http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/The%20Behavior%20of%20Air.docx>

* + Card for Plunger Activity: <http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Plunger%20Activity.docx>
  + Card for Pressing a Double Membrane:

<http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/Pressing%20a%20Double%20Membrane.docx>

* + Card for the Sticking Cup of Water:

<http://oaklandk12.rubiconatlas.org/links/Science_7/Fluid%20Earth%207th%20Grade%20Science/The%20Sticking%20Cup%20of%20Water.docx>

* + Card for Air by Candlelight:

http://oaklandk12.rubiconatlas.org/links/Science\_7/Fluid%20Earth%207th%20Grade%20Science/Air%20By%20Candlelight.docx

**Teacher Preparation**

Gather materials based on the chosen activities.

**Classroom Procedure**

1. Determine the properties of gases (or gas laws) you want students to explore and understand. Several important concepts are listed here, and suggested activities are provided below:
   * Air exerts pressure
   * Atmosphere is a mixture (several activities)
   * Charles’ Law –temperature is proportional to volume, accounting for the density of an air mass
   * Boyle’s Law –volume is inversely proportional to pressure
   * Water is an invisible gas in air, but can condense and remain aloft as fog
   * Water has a great heat capacity compared to air
   * Carbon dioxide traps heat in the atmosphere
2. Determine what brief and simple demonstrations students can do. Some demonstrations are suggested below, but many excellent activities are available in books and on websites. Consider obtaining the books suggested in Materials list above.
   * BOOK: “Invitations to Science Inquiry (2nd edition) by the late Tik Liem. This has 100’s of activities, each of which is written up on single pages. They include a sketch, procedures and a clearly written explanation.
   * BOOK: Project Erath Science – Meteorology, National Science Teacher Association Press (NSTA Press). Numerous weather related investigations with clear instructions and explanations. This also includes some clearly written background essays.
3. Divide the class into two, and then into teams of three (four or five for each half). Assign activities so there are two teams doing each activity. They can work together, but during the gallery walk they will either be a presenter or a museum goer.
4. Provide clear and simple instructions and all necessary materials. Provide one day for the teams to master their demonstrations.
5. IMPORTANT: Coach each group on connections to weather phenomenon, especially how:

* Humidity depends on temperature
* How condensation causes rain and fog
* How expanding air is less dense and rises
* How air pressure decreases at altitude (or aloft if speaking of the atmosphere)

1. Guide them to integrate such ideas into their explanations.
2. Set up the room for a gallery walk. This is an event where students visit a number of demonstrations which are explained by other student teams. The demonstrations must be spread around the room so students can move freely and safely.
3. Hold the gallery walks twice, switching presenters so all students can view all presentations.
4. Debrief the gallery walk as a whole class. Emphasize the “Take Away Idea” of each demonstration and relate it to the water cycle, weather and climate, and energy in the earth systems.
5. During the whole class discussion, students should describe the demonstration and the take-away idea in their interactive notebooks.

*Here are a number of simple demonstrations worth considering:*

**Team 1: Expanding Air**

**Materials**: three candles, three clear cups or jars, one tray, water

**Procedures**: Place the candles on the tray in three groups. There should be a single candle, a pair and a trio. Adhere the candles by lighting them and melting some wax as a base. Flood the tray with water so the candles are slightly submerged. With all candles lit, cover the single, the pair, and the trio each with a cup. Notice that when the candles go out (the trio being first) the water is pushed up into the cups to a degree proportional to the number of candles.

**Explanation**: The trio produced the most heat and expanded the air around it to the greatest degree. Therefore, the jar contained fewer air molecules, thereby producing the lowest amount of air pressure. This demonstrates Charles’ Law.

**Team 2: Air Pressure versus Gravity**

**Materials**: a cup, an index card, and water

**Procedures**: Fill the cup with water to nearly but not completely full. Put the index card on top of the cup, ensuring that it covers the cup’s lip. Holding the index card firmly on the cup, quickly invert it and let go of the card. A small amount of water may leak out but soon the card will remain on the cup and mysteriously hold the water in the cup.

**Explanation**: The small amount of water that drips out causes the gas inside the cup to expand slightly, lowering the pressure. The outside pressure is greater to the degree that the force of gravity is less than the upward force of air pressure. This demonstrates that the air has pressure as well as Boyle’s Law. Another way to demonstrate air pressure/Boyle’s Law is with two test tubes, one slightly smaller than the other. With water in the larger test tube, push the smaller tube into the larger. As water drips out, the smaller tube will be pushed into the larger tube even when inverted.

**Team 3: Air has ~20 Percent Oxygen**

**Materials**: Two test tubes, iron filings, one ring stand with two test tube holders, one beaker with water, one grease pencil that can mark glass.

**Procedures**: This activity takes several days, so it must be set up ahead of time. Put a small amount of iron filings on the bottom of one of the test tubes (the other is a control). Secure both with the ring stand, inverted so their lips are slightly under water when hung over the beaker. Over the course of several days, water will be drawn into the test tube with the iron filings. Mark the height of the water daily. When the water level does not change for two days, it is time to measure and calculate. Dismantle the apparatus and fill the test tube up to the last mark. Transfer this water into a graduated cylinder and record as “the amount of oxygen.” Also measure the full capacity of the test tube. Record this as the “total volume of the test tube.” Divide the “amount of oxygen” by the “total volume” to obtain the proportion of oxygen of the air in the test tube. Multiply by 100 to obtain the percentage of oxygen.

**Explanation**: The iron was oxidized by atmospheric oxygen. When the iron? was removed from the gas, the air pressure is reduced, allowing outside air to push water up into the test tube. Because oxygen makes up ~20 percent of the atmosphere, the rise of water is proportional to that amount.

**Team 4: The Magnitude of Air Pressure**

**Materials**: Sheets of newspaper, one meter or yard stick (preferably a thin, inexpensive one of the type given as promotions by hardware stores).

**Procedures**: Spread the paper on a large table and flatten it out by pressing with a hand. Lift the paper, place the yard stick on the table, and cover it with the paper. Configure the paper so half of the hard stick extends out from under the paper and off of the table. As before, flatten the paper and attempt to press out all air from underneath the paper. If using a thin, expendable yard stick, the surprising act is to quickly strike the stick to break it off. It is surprising that the paper can hold the stick down. If using a standard meter stick, one can press down to find that the paper slightly arches up and resists due to air pressure. How much weight holds down the paper? Calculate the area of the paper in square inches and multiply that number by 14.7 pounds per square inch.

**Explanation**: Standard air pressure at sea level is roughly 14.7 pounds per square inch (=~101 kilopascals (metric) or ~1 bar). Over the area of a newspaper (~682.5 square inches), that 9555 pounds of weight holds? down the paper. Help students realize that air molecules are subjected to gravity, and there is a pile of them extending to the top of the atmosphere. Probe this topic by asking students how this experiment would work at high elevation, or on another planet such as Mars or Venus.

**Team 5: Pressing a Double Membrane**

**Materials:** one medium-sized jar, one small jar that can fit into the larger one, one large balloon (serves as a flexible membrane) , two rubber bands.

**Procedures:** Cut the balloon into a section that can fit over the small jar. Stretch the balloon over the small jar and wrap it tight with one of the rubber bands. Place it in the larger jar, and cover it with another section of balloon, secured tightly with the other rubber band. Now, press the membrane of the larger balloon, and notice that the membrane over the smaller jar also dimples in.

**Explanation:** The air pressure in the larger jar increases when the membrane is pressed and overcomes the air pressure in the smaller jar.

**Team 6: Cloud in a Jar**

**Materials:** one plastic 2-liter bottle with a lid, one match, and small amount of water.

**Procedures:** This activity may take a few attempts to set up correctly. Place a few drops of water in the bottom of the bottle and swirl around to moisten all sides. Drop a lit match into the bottom of the bottle and quickly seal it. Slightly squeeze the bottle. If the proportions are correct, water in the air of the bottle will show slight precipitation in the form of fog. If it does work, squeeze somewhat harder or reset the contents with more smoke. What will squeezing do?

**Explanation:** Air is a mixture and usually contains water as a gas. The degree of water is measured as humidity. When the air is saturated, water precipitates to form small liquid droplets that can remain suspended in the air. The amount of water that air can hold as a gas depends on temperature and pressure. When air temperature drops or pressure increases, the air can hold less water so precipitation occurs. The water in the bottle is necessary to create a miniature atmosphere with a high humidity. The smoke provides the nuclei on which the water vapor can condense. As the bottle is released, the volume of the air inside the bottle suddenly increases, and the temperature decreases. As the humidity is very high, the air contains the maximum capacity of water vapor. The slightest drop in temperature, therefore, is enough to cause the water vapor to condense and produce a mist or fog.

**Explore**

**Activity 4 – Greenhouse Gas in a Jar**

**Purpose**

To produce carbon dioxide and measure its heat trapping capacity as a model of the greenhouse effect.

**Activity Description**

This activity is one of seven excellent online activities provided by the Smithsonian Institute. Students create a greenhouse gas, carbon dioxide, through a simple chemical reaction between baking soda and vinegar. Students measure the effect of the gas on air temperature, and relate their findings to the greenhouse effect in our atmosphere.

**Focus Question**

How influential is carbon dioxide at trapping thermal energy?

**Duration**:

Two class sessions

**Materials**

* Described by Smithsonian document, but teacher should devise a way to support the thermometers, such as modeling clay, or a small beaker
* Smithsonian URL: <http://forces.si.edu/Atmosphere/pdf/Atmo-Activity-7.pdf>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Smithsonian%20Atmoshere-Activity-7.pdf>

* Student Guide:

<http://oaklandk12.rubiconatlas.org/links/Science_7/7th%20-%20Fluid%20Earth%20Systems%20and%20Human%20Impact/Greenhouse%20Gas%20in%20a%20Jar.docx>

* Student Guide with key:

<http://oaklandk12.rubiconatlas.org/links/Science_7/7th%20-%20Fluid%20Earth%20Systems%20and%20Human%20Impact/Greenhouse%20Gas%20in%20a%20Jar-%20key.docx>

**Teacher Preparation**

1. Review the instructions at the Smithsonian web site.
2. Revise the language of the instructions so they address students rather than teachers.
3. If desired, extract the images, graphs, and text from the pdf and paste into a word processor for student use.
4. Consider using modeling clay or a small beaker to support the thermometer.

**Classroom Procedure**

1. Follow as described by activity handout.
2. Provide opportunity for students to compare and debate their solutions with one another.

**Explore**

**Activity 5 – Structure of the Atmosphere**

**Purpose**: To develop and understanding of the layers of the atmosphere

**Activity Description**

This activity is also one of seven excellent online activities provided by the Smithsonian Institute, with some content supplemented by an EPA website. Students use the accepted dimensions of the layers of the atmosphere to build a scale model for the classroom.

**Focus Question**

What is the accepted model for layers of the atmosphere?

**Duration**

Two class periods.

**Materials**

* Activity: Smithsonian URL: <http://forces.si.edu/Atmosphere/pdf/Atmo-Activity-1.pdf>
* Long poster paper, such as those on roles common in art departments
* Content: NWS URL: <http://www.srh.noaa.gov/jetstream//atmos/atmos_intro.htm>
* Content: <http://www.srh.noaa.gov/jetstream//atmos/layers.htm>
* Atlas URL: (merges both NWS articles) <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NWS-The%20Atmosphere+Layers.docx>

**Teacher Preparation**

1. Review the instructions at the Smithsonian website.
2. Revise the language of the instructions so they address students rather than teachers.
3. Extract some background content from the NOAA and NWS websites, or provide classroom textbooks.

**Classroom Procedure**

1. Provide students the Smithsonian text that describes the layers of the atmosphere.
2. Follow the procedures in the activity so all students individually create a profile.
3. Using a large paper role, provide a full length atmosphere for each class that reaches from the floor to the ceiling.
4. As a class, transfer the basic structure onto the roll and form teams to annotate the aspects of each layer. Consider these components to image and annotate:
   * Temperature of each layer
   * Pressure of each layer
   * Gases of the atmosphere in general
   * Elements of weather/types of clouds
   * Ozone in lower stratosphere
   * Ozone in the lower troposphere
   * Aerosols
   * Air travel
5. Refrain from posting layers until all classes are completed. When the layers are ready, post them on a single day so that each class can make comparisons after the atmospheres are completed.

**Explore**

**Activity 6 – Stratospheric Ozone and Ultraviolet Light**

**Purpose**

To measure the effects of ultraviolet light and consider the best ways to be protected from its effect.

**Activity Description**

This is a critical activity. When it comes to opportunities to use scientific knowledge in one’s personal choices, nothing tops how we choose to interact with the sun. Unfortunately, safety is not always on our students minds when common (but arbitrary) standards of beauty tell them they should be as tan as possible. The general public lacks essential knowledge on this issue. Students need to be clear on the difference between stratospheric ozone and ozone that makes up smog. They need to understand that incidences of skin cancer have doubled in the past 35 years. They need to understand how sunscreens may or may not protect against dangerous UV-A rays.

The activity contains three parts. Using another of the Smithsonian activities, the first part provides an experiment to measure the impact UV light has on a yeast culture. The second part, also based on a Smithsonian activity, allows students to measure natural UV light using photosensitive Frisbees. Part 2 lends itself wonderfully to student modifications of the experiment. Part 3 asks students to determine the best choice commercial sunscreen using the Environmental Working Group website (called Deep Skin – Sunscreen).

Part 1: Effects of UV light on living things-- Smithsonian #6

Part 2: UV and Frisbee – Smithsonian # 8

Part 3: Choosing the best sunscreen – The Environmental Working Group

**Focus Question**

How can we be best protected from the sun’s ultraviolet light.

**Duration**

Three class periods (with some out of class work time).

**Materials**:

* Part 1: UV lamp, live yeast, petri disc, camera, possibly a goggle cabinet
* Smithsonian URL: <http://forces.si.edu/Atmosphere/pdf/Atmo-Activity-6.pdf>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Smithsonian%20Atmoshere-Activity-6.pdf>

* Part 2: UV-sensitive Frisbee, various materials necessary for student-designed experiment
* Smithsonian URL: <http://forces.si.edu/Atmosphere/pdf/Atmo-Activity-7.pdf>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Smithsonian%20Atmoshere-Activity-7.pdf>

* Other options: UV sensitive paper or light meter
* Part 3: Sunscreen section of the Environmental Working Group website (<http://breakingnews.ewg.org/2011sunscreen>)

**Teacher Preparation**

1. Part 1: The material list is provided but requires some decisions on the live yeast life form and the UV light.

* A good choice of live yeast life form can be found at a grocery store. Science supply companies sell packages of clear sealed petri dishes with prepared nutrient agar.
* There are safety concerns with the kinds of UV light that will work for this experiment. Consider using a goggle sterilizer cabinet that is typical in science classrooms. These cabinets have the safety feature of turning off when the door is open. Any use of other UV lamps should employ safety protocol such that students are not exposed to the light. The light should be shielded and focused on the sample only.

1. Part 2: The materials list is provided here and it includes a link to SunWise for the UV sensitive Frisbee. However, another source is Educational Material Center of Central Michigan University:

* <http://www.sunwiseschoolsupplies.com/store/product_info.php/cPath/22/products_id/30>
* <http://www.emc.cmich.edu/sunsafety/SSFRMM.htm>
* As explained in Classroom Procedure, an important modification is to have students create their own experiments. Therefore, the materials they test will determine the needs. They may choose to test different types of clothing, tents, sun shades or umbrellas, sunglasses, or sunscreens.

1. Part 3: This activity require/.es no materials other than paper to describe students’ analysis and report their conclusions.
   * Prepare some arguments to helps students reason about risk. Some critical points to consider:
     + Risk = exposure + severity of consequence + probability of consequence
     + In decision making, known risks (skin cancer) should trump theoretical risks (nano-particles may be dangerous).
     + Claims of dangers vary in their level? of confidence (note ratings listed? on the EWG chemicals)

**Classroom Procedure**

1. Part 1: The Classroom Procedure is described in the Smithsonian’s materials.
   * Part 2: Provide students with Smithsonian’s activity (#8 UV and Frisbees). After students understand the experiment, require them to invent and design their own experiment in student teams of three. Suggest some possible variables, but allow them to formulate researchable questions and the methods that would construct a fair test. Some considerations: Because the instructions are quite general, have student teams of 3 propose a more specific experiment.

Help students conceive of experiments by making a suggestion. Possibilities include c Comparing types of sunscreen (mineral: Zn, Ti – nanomineral, chemical, holistic, varying SPF), compare clothing fabrics, including fabrics that claim to shield UV rays, evaluate tenting material or tinted glass.

* + Consider using the following protocol to develop experimental design:
    - Each student individually designs a proposal
    - Teams of three share and discuss proposals, then vote on which to propose.
    - Students list and present all proposals to the teacher for approval, with the student-chosen idea indicated.
    - Teacher approves, rejects, or revises proposals
    - Students gather materials to be tested outside of class time, unless teacher provides such materials.
  + Do **not** follow the suggestion to test an ant farm due to ethical concerns.
* Provide a source on background on sunscreens and sun protection (<http://breakingnews.ewg.org/2011sunscreen/>).
* Just as it is for professional scientists, such designs are refined through trial and error, so make time for multiple trials and revisions so the class has confidence in the data.
* Determine an opportunity to share student results with outside audiences.

1. Part 3: Using the Environmental Working Group’s website on sunscreen, have students research, evaluate, and recommend the best sunscreen given the current understanding of risks and benefits of sunscreen use (<http://breakingnews.ewg.org/2011sunscreen/>).

**Explore**

**Activity 7 – SAM II Investigations (OPTIONAL)**

**Purpose**

To analyze weather phenomena using real world datasets.

**Activity Description**

These activities have been developed by Beverly Meier (a teacher) with the support of NOAA and the American Metrological Society. These are great, data-rich activities that utilize representations that are as powerful as they are unusual. The tasks are authentic and analytical. If some of the activities appear to be overly complicated, please note that reviews describe their success with middle school students. If class time is lacking, some of these could be used as homework.

*These activities are recommended for this unit:*

**Activity 1: Anatomy of Clouds**

(Note: A beautiful pdf document called “**The Story Clouds Tell**” provides strong background content on clouds and could be used to supplement this activity:

**Activity 4: Forecasting Tornados**

**Activity 5: El Nino and La Nina**

**Activity 6: The Greenhouse Effect**

**Focus Question**

How can various representations of data aid scientific analysis?

**Duration**

One class period for each activity.

**Materials**

* Main Page for SAM II (Student Activities in Meteorology) <http://www.esrl.noaa.gov/gsd/outreach/education/samii/SAM_II_Intro.html>
* Table of Contents for SAM II activities:<http://www.esrl.noaa.gov/gsd/outreach/education/samii/SAM_II_Contents.html>
* List of each activity. **Note:** When an activity is clicked, the web browser presents the activity as a webpage, but a nicely formatted PDF file is linked from the bottom of the page.
* Answer Key for all SAM II activities: <http://www.esrl.noaa.gov/gsd/outreach/education/samii/SAMII_AnswerKey.html>
* Activity 1: Anatomy of Clouds

<ftp://ftp.ucar.edu/communications/Clouds:Stories/Stories_Clouds.pdf>)

* Atlas URL: (activity 1) <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/SAMII_Act1.pdf>
* Atlas URL: (story clouds tell) <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/The%20Stories%20Clouds%20Tell.pdf>
* Activity 4: Forecasting Tornados

Atlas URL: (activity 4) <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/SAMII_Act4.pdf>

* Activity 5: El Nino and La Nina

Atlas URL: (activity 5) <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/SAMII_Act5.pdf>

* **Activity 6: The Greenhouse Effect**

Atlas URL: (activity 6) <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/SAMII_Act6.pdf>

**Teacher Preparation**

1. Review and follows the instructions at the Smithsonian website.

**Classroom Procedure**

1. The details of these activities are explicitly provided by the SAM II material.

**Explore**

**Activity 8 – Measurements of the Atmosphere (OPTIONAL)**

**Purpose**

To collect interesting weather data in the atmosphere.

**Activity Description**

Using an ‘expert group’ collaborative structure, student teams will conduct some basic experiments and collect data that they will explain to others. These are real world investigations in which students collect and interpret weather-related data. The investigations provide an excellent real world data gathering experience that will help student understand how evidence is produced in meteorology. However, if class time is limited, the investigations could be promoted as special out-of-class projects.

The measurements students will use include:

* Relative humidity using a student-made psychrometer
* Barometric pressure using a student-made barometer
* Aerosols using student-made collection device
* Tropospheric ozone using student-created Schoenbein Paper.

**Focus Question**

How do scientists make measurements in the atmosphere?

**Duration**

Three class periods.

**Materials**

* Good activities are provided here. Also find well-presented activities in the NSTA Press book *Project Earth Science – Meteorology*
* Tri-panel displays or posters
* “Relative Humidity” – activity from the University of Fairbanks.

<http://www.arcticclimatemodeling.com/lessons/acmp/acmp_58_Precipitation_MeasuringHumidity.pdf>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Measuring%20Relative%20Humidity.pdf>

* Barometric pressure –NWS Weather lessons

[http://www.srh.noaa.gov/jetstream//atmos/ll\_pressure.htm](http://www.srh.noaa.gov/jetstream/atmos/ll_pressure.htm) and <http://www.srh.noaa.gov/jetstream//atmos/ll_pressure2.htm>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NWS%20Measuring%20Barometric%20Pressure.docx>

* Aerosols – Smithsonian 5

<http://forces.si.edu/Atmosphere/pdf/Atmo-Activity-5.pdf>

URL from GLOBE: (on page 22, find a careful write-up on aerosols, as well as a set of global maps of aerosol levels throughout a year): <http://classic.globe.gov/fsl/pdf/Earth_System_Poster_07_Activities.pdf>

Images here: <http://classic.globe.gov/page?earth_system>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Earth_System_Poster_07_Activities.pdf>

* Tropospheric Ozone – Smithsonian # 6 / Support from Mapping NO2 from Ozone using Google Earth (Earth Exploration Toolbook)

URL (Smithsonian): <http://forces.si.edu/Atmosphere/pdf/Atmo-Activity-6.pdf>

URL: <http://serc.carleton.edu/eet/aura/index.html> (Earth Exploration Toolbook)

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Smithsonian%20Atmoshere-Activity-6.pdf>

**Teacher Preparation**

Each experiment has a well-described set of instructions at the sites listed. The task of gathering and organizing materials will be sizeable. The materials needed will depend on the investigations chosen.

**Classroom Procedure**

1. Divide the class into teams of three or four and assign experiments for each group. Two or three groups may be doing the same experiment.
2. Provide instructions and materials to each group and explain their task.

***Student Task:***

* *Read over the background material of your topic.*
* *Study and implement the instructions for gathering data.*
* *Conduct the study and gather data.*
* *Create a brief report and presentation plan that can be shared with other students. Include images and a summary of the topic, descriptions, and sketches of your tools, data (table or graph,) and an interpretation*
* *Be prepared to explain your results to the class.*

1. Support students’ efforts by clarifying instructions and methods.
2. Provide time for their data to be collected. Since the aerosol and ozone measurements will take more time, proceed with the next activity and schedule presentations for a time after the data is in.
3. Have teams who are doing the same investigation come together to design a poster or tri-panel presentation, where their instruments, datasets, and back ground information can be displayed and explained.
4. Dedicate a space in the room for each of the four investigations and host a single presentation on each topic.

**Explore**

**Activity 9 – Weather Prediction**

**Purpose**

To use real world surface measurements to predict weather conditions.

**Activity Description**

This activity from the National Weather Service (NWS) will help students understand how weather maps are created and how fronts are predicted. The National Weather Service’s online weather course called “Jet Stream” has a well-described process in which students determine the location of cold and warm fronts on a map plotted with weather observations.

**Focus Question**

How do meteorologists use data on air pressure, temperature, and humidity to predict weather?

**Duration**

Two class periods (four with use of the GOES activity).

**Materials**

* Maps for surface conditions: surface pressure, temperature, dew point temperature, pressure change
* Completed plot maps
* Student instructions <http://www.srh.noaa.gov/jetstream/synoptic/ll_analyze.htm> (for required explanation in general, the 4 roles and map printing)

Atlas URL: (needs uploading)

* Norwegian Cyclone Model to students based on description at website below:

<http://www.srh.noaa.gov/jetstream/synoptic/cyclone.htm>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NWS%20Norwegian%20Cyclone%20Model.docx>

* Explanation of types of clouds associated with fronts.

<http://www.srh.noaa.gov/jetstream/synoptic/airmass.htm>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NWS%20Air%20Masses.docx>

* <http://serc.carleton.edu/eet/goes/index.html> (for building animated image set of GOES (satellite) images for storm prediction)
* <http://www.srh.noaa.gov/jetstream/matrix.htm> (matrix of NWS topics and activities)

**Teacher Preparation**

1. Print student general instructions from the main page in addition to the instructions for each of the 4 roles. Click into each role and print out the specific instructions for that role.
2. Print maps: surface pressure, temperature, dewpoint temperature, pressure change, and the Complete Plot maps. Each of the maps can be printed with instructions or you can print the larger versions of the basic maps and provide the students with the instructions in the classroom.
3. Be sure to explore the Norwegian Cyclone Model, which is similar to the Middle Latitude Cyclone common in the contiguous United States.

**Classroom Procedure**

1. Present the Norwegian Cyclone Model to students based on description at website below: <http://www.srh.noaa.gov/jetstream/synoptic/cyclone.htm>
2. Explain the types of clouds associated with fronts.

<http://www.srh.noaa.gov/jetstream/synoptic/airmass.htm>

1. Provide the student instructions through computer projection or as print outs. Also, provide the blank maps and as they proceed. Make references to the images of what the maps should look like.
2. Provide support as necessary, as map interpretation may require some guidance through one-on-one or whole group support.
3. As an extension to this activity, consider using the well-described activity on the use of GOES satellite images to have students track storm development using a free image processing software (Image/J). This activity is one of dozens provided by the Earth Exploration Toolbook. This activity can range from a teacher-directed presentation to students downloading and managing images for the analysis: <http://serc.carleton.edu/eet/goes/index.html>

**Explain**

**Activity 10 – Exploring Weather Patterns**

**Purpose**

To reinforce and secure student understanding of topics in this cycle as they relate to climate and weather systems.

**Activity Description**

This activity gathers several ‘investigations’ provided on Exploring Earth, which is an interactive, data rich earth science website based on a commercial textbook, but enlivened by the non-profit science and math organization TERC and funded by the National Science Foundation. This activity leads step by step through the tools used to forecast weather. The second recommended activity focuses on a common continental weather pattern called a Middle Latitude Cyclone. This phenomenon will demonstrate the dynamics of warm, cold and occluded fronts. During their passage, data is presented on dynamic maps as accessible tags that are displayed in a pop-up window.

**Focus Question**

How can we use online tools to predict weather?

**Duration**

One class session

**Materials**

* Worksheet made up of the question sets found on the website.
* The Exploring Earth website: <http://www.classzone.com/books/earth_science/terc/navigation/home.cfm>

**Teacher Preparation**

1. As an EXPLAIN activity, teachers should be clear on the concepts they want to make sure students completely understand.
2. Teachers can print out pages, lead a class through this content with a computer projector, or ideally secure a computer lab or laptop cart for students. It may also be helpful to gather the questions of the activities into a separate document, or as prompts for class conversation.

**Classroom Procedure**

1. Provide students with a document that lists key questions from the Earth Exploration investigations as well as space for sketches and explanations.

* Using a computer projector and the website, guide students through the Exploring Earth investigations. The Exploring Earth website: <http://www.classzone.com/books/earth_science/terc/navigation/home.cfm>
* From the “Select a Chapter” button, navigate to Unit 5, Chapters’ 19 and 20. Use the following investigations:

1. How does the Jet Stream Change Through the Year? <http://www.classzone.com/books/earth_science/terc/content/investigations/es1906/es1906page01.cfm?chapter_no=19>
2. How Does a Mid-Latitude Low Develop into a Storm System? (this investigation about the Middle Latitude Cyclone – a good activity for students to visualize cold and warm fronts).

<http://www.classzone.com/books/earth_science/terc/content/investigations/es2003/es2003page01.cfm?chapter_no=investigation>

1. How Well Can You Predict Tomorrow's Weather?

<http://www.classzone.com/books/earth_science/terc/content/investigations/es2013/es2013page01.cfm?chapter_no=20>

1. Weather symbols explained by NOAA:

<http://www.hpc.ncep.noaa.gov/html/stationplot.shtml>

1. Prompt small teams and pairs to discuss the ideas and questions of the investigation.
2. Use “numbered heads” as a way to hold all students accountable. In numbered heads, each team numbers their members (say 1-4). When a question is asked, the whole teams discuss the ideas, but the teacher pulls a number out of a bowl to determine which participant will answer the question.

**Elaborate**

**Activity 11 – Is the Incidence of Severe Weather Increasing?**

**Purpose**

To apply student understanding to a current question of interest related to global climate change, through research of severe weather.

**Activity Description**

Teams of students are assigned a severe weather phenomenon to research and discuss in a jigsaw format. Teachers can expect this activity to serve in several ways. It will:

* Help students understand the dynamics of interesting types of severe weather.
* Engage students in an important challenging question (about trends of global climate change.
* Highlight the difference between weather and climate. Scientists agree that any single event or one rough hurricane season cannot be attributed to climate change. Long-term trends need to be recognized in order to claim such patterns are part of global climate change. A good analogy to distinguish between weather and climate is that:

|  |  |
| --- | --- |
| **You wear your clothes based on the weather** | **You buy your clothes based on the climate** |
|  | Description: 0692815947_clothesRack |

**Focus Question**

Is severe weather increasing around the globe?

**Duration**

Three class periods.

**Materials**

* Textbooks or websites that explain severe weather
* Websites that discuss current weather events in the context of global climate change

**Teacher Preparation**

1. Provide students with websites or other materials that describe these weather phenomena.
2. Prepare to help students understand the perspectives of various sources of information. Contrast those of science agencies with interest groups trying to promote a certain perspective. Remind students that in science it’s the evidence, not one’s bias, which influences our opinions. In other words, using the Claim-Evidence-Reasoning lens would help us accept claims from those who may also have a political/social/economic agenda if their evidence is credible

**Classroom Procedure**

1. Divide the class into expert groups who will research these topics:
   * Hurricanes
   * Severe storms
   * Tornados
   * Blizzards
   * Heat waves
   * El Nino – La Nina
2. Each person should research and record explanations on these questions:
   * What conditions cause the weather pattern to form?
   * What are the details of the development of the weather pattern? Provide specifics on temperature, pressure, fronts, moisture, vertical movement or other central elements of the weather pattern.
   * What regions are most affected by the weather patterns?
   * What has been the nature of the frequency in recent times? In other words, are these events increasing in frequency?
3. All students should bring their records with them to a meeting of the expert group. Group size should be no bigger than four students, so it will be necessary to have more than one of some of the groups. In the expert meetings:
   * Students will share reports to fill in expert knowledge. Students should improve their report by adding to or correcting their notes and sketches.
   * Students do not have to agree on the last question regarding frequency. However, all claims must be supported with evidence and reasoning.
   * Each student will produce a single page summary of their expert view for the two or three other students who will hear from them in the next part of the activity.
4. New groups will now form with at least one person from each expert group. Each expert will share their summary explanation to the others and orally explain the phenomena and their evidence supported view regarding frequency of storms.

**Evaluate – Cycle Quiz**

**Learning** **Cycle Three – The Global Water Crisis**

**Introduction** More than many science topics, the study of water lends itself to projects for which students can be personally involved in the design and implementation of real world scientific research in their local watersheds. As new national standards revise and clarify our aims in science education around proficiency in the ways and thinking of science, this topic presents itself as a phenomenal learning opportunity. All schools and all students reside in watersheds that are, for the most part, natural drainage basins with active streams and critical ground water. All watersheds are impacted by the history of human land use decisions.

In addition, a global water crisis exists today, and its severity will only increase throughout the lives of today’s students. Issues of energy and climate are intricately tied to water resource challenges, which everywhere link local, regional, and global trends and patterns.

An abundance of instructional resources and support exist for such projects as field-based water quality analysis of local streams, as well as resources to support the analysis of personal and community water use. Many schools exist in regions with active watershed-based organizations, some of whom have programs to involve schools in field-based water quality analysis. In this cycle, we strongly recommend to teachers that they become involved with such watershed groups, especially if they support student water quality analysis. While our activity sequence is designed to develop content knowledge on water-related topics, we strongly recommend to teachers that they go further in their exploration of some of the resources we will be pointing to. In doing so, it will be easy to find ways to make this topic locally based and personally relevant to students and their communities.

The main topics of this cycle include:

* The water cycle
* Surface and ground water
* The main elements of the water crisis: water quality and water quantity

**Organizations that Support Schools in Water Quality Studies in the Detroit Metropolitan Area:**

* **Clinton River Watershed Council**

<http://www.crwc.org/>

* **Rouge River Project**

<http://www.rougeriver.com/>

* **Huron River Watershed Council** (this group has no school outreach program, but does offer good opportunities for community engagement in research)

<http://www.hrwc.org/>

* **Leslie Science and Nature Center** (helpful for any school, especially those in the Huron River watershed)

<http://www.lesliesnc.org/>

**Learning Objectives**

1. Students understand the general dynamics and components of the water cycle.
2. Students understand how humans interact with and depend on water.
3. Students grasp the breadth of the ongoing global water crisis.
4. Students understand key parameters of water quality (dissolved oxygen, fecal coliform bacteria, temperature, turbidity).
5. Students can analyze the interactions between elements of the water cycle.
6. Students can draw conclusions from water quality data related to land use.
7. Students can manipulate and interpret numeric and spatial datasets.

**Key Question:** **How do humans interact with and depend upon the hydrosphere?**

**Engage and Elicit**

**Activity 1 – What is the Water Cycle?**

**Purpose**

To reveal the degree to which students understand the concept and components of the water cycle and a watershed.

**Activity Description**

Students build a physical model of a watershed and create rain using a watering can. They describe the processes and components of their model. Teachers facilitate by posing questions that allow students to reveal their thinking. Then teachers present students with a US Geological Survey (USGS) water cycle diagram. There are three versions: one with labels, one without labels, and one with letters. Teachers ask students to individually describe the purpose of the schematic and to match letters to the labels.

There are many ways to create physical models of a watershed. We are using the guide created by Rutger’s Institute of Marine and Coastal Sciences. We are borrowing their ideas about materials and general procedures, but the intent of our questioning will be different.

**Focus Question**

What natural processes related to the water cycle can we simulate with a physical model of a watershed?

**Duration**

Two class sessions

**Materials**

* Rutgers’s Build a Watershed Activity: <http://new.coolclassroom.org/files/adventures/1/Activity_Watershed.pdf>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Building%20Climatographs%20with%20Global%20Weather%20Data.doc>

* The materials listed within the Rutgers’s activity
* USGS Water Cycle schematic: (for private teacher use – will be used by students in Activity 9)

<http://ga.water.usgs.gov/edu/watercyclehi.html>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20Water%20Cycles%20-with%20labels.gif>

* URL: USGS Water Cycle schematic without labels or letters: <http://ga.water.usgs.gov/edu/watercycleprintnotext.html>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20Water%20Cycles%20-%20no%20letters%20of%20labels.gif>

* USGS Water Cycle schematic with letters but no labels: <http://ga.water.usgs.gov/edu/watercycleguess.html>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20Water%20Cycle-no%20labels.gif>

**Teacher Preparation**

1. Gather materials for watershed model.
2. Print sets of watershed schematics.
3. Organize questions that can be used to probe student thinking.

**Classroom Procedure**

**Part 1: Building and using the watershed model**

1. Use the guide below to get started with the set up
2. After the student teams have set up their watershed, ask them to predict how the water will flow, and then to test their predictions.
3. Require that teams record their results in sketches and written descriptions.
4. Ask teams to present their findings while noting the differences between the various models.
5. Probe for student understanding of watersheds without using too much science vocabulary. Make some notes on their thinking.
   * Do they recognize the role of the drainage divide?
   * Can they describe that all water exits the basin in the same location?
   * Can they relate their model to real landscapes?

**Part 2: Relating their model to the water cycle**

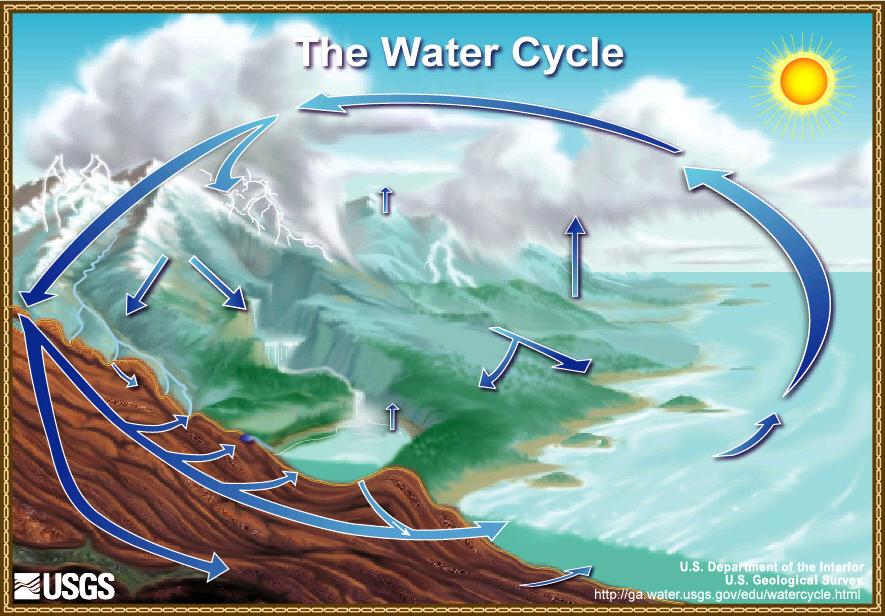
1. Provide each student the version of the USGS Water Cycle schematic without labels.

* USGS Water Cycle schematic: (for private teacher use)

<http://ga.water.usgs.gov/edu/watercyclehi.html>

* USGS Water Cycle schematic without labels or letters: <http://ga.water.usgs.gov/edu/watercycleprintnotext.html>

1. Ask students to individually list the letters and to the best of their abilities label the components.
2. Have students rejoin their teams and compare results. In a whole group discussion, ask each team to report on what they knew individually versus as a whole team.
3. Prompt students to enter their thoughts into their interactive notebook. With the title “My Understanding of the Water Cycle,” ask students to describe their thinking as they began this activity and how it changed according to the task and conversation.



**Explore**

**Activity 2 – Properties of Water (OPTIONAL)**

**Purpose**

To review a brief catalog of important properties of water.

**Activity Description**

This activity addresses fundamental concepts about water as a unique form of matter. If water as a unique form is addressed in other parts of the district curriculum, teachers may skip this activity, but students gain a lot from these types of surprising hands-on investigations. If class time is limited, some of these could be used in quick demonstrations, or simple hands-on bell work.

Using the “expert groups” collaborative process, teachers give small student teams instructions for a simple demonstration of an important and interesting property of water. Several are suggested here, but teachers may use interesting demonstrations they are aware of as replacement or in addition to those suggested.

Given the amount of time it takes for all students to demonstrate their activity, it is recommended that at least two teams of students do the same activity. It also is efficient to hold a ‘gallery walk’ where one half of the class set up and host their demonstrations as the other half visit those students as “museum goers.”

**Focus Question**

What makes water unique?

**Duration**

Three class periods.

**Materials**

* Physical materials determined by teacher-chosen demonstrations
* Other sources of activities, e.g.:
  + BOOK: *Invitations to Science Inquiry* (2nd edition) by the late Tik Liem. This has hundreds of activities, each of which is written up on single pages. They include a sketch, procedures, and a clearly written explanation
* Posters or tri-panel displays for student presentations

**Teacher Preparation**

Gather materials based on the chosen activities.

**Classroom Procedure**

1. Decide which properties of water will be emphasized. Many interesting phenomena occur because of the water molecule’s high degree of polarity. Some possibilities include:
   1. boiling/melting point, boiling and condensation
   2. surface tension
   3. universal solvent
   4. high specific heat/vaporization (i.e. heat capacity)
2. Determine what brief and simple demonstrations students can do. Some are suggested below, but many sources of activities exist. . It is still possible to purchase *Invitations to Science Inquiry* (2nd edition) by the late Tik Liem (see reference above). This has 100’s of activities, each of which is written up on single pages. They include a sketch procedures and a clearly written explanation. Be warned, not all activities are safe for students.
3. Divide the class into two, and then into teams of three (four or five for each half). Assign activities so there are two teams doing each activity. They can work together, but during the gallery walk they will either be a presenter or a museum goer.
4. Provide clear and simple instructions and all necessary materials. Provide one day for the teams to master their demonstrations.
5. Set up the room for a gallery walk. This is an event where students visit a number of demonstrations which are explained by other student teams. The demonstrations must be spread around the room so students can move freely and safely.
6. Hold the gallery walk twice, switching presenters so all students can view all presentations.
7. Debrief the gallery walk as a whole class. Emphasize the “Take Away Idea” of each demonstration and relate it to the water cycle, weather and climate, and energy in the earth systems.
8. During the whole class discussion, students should describe the demonstration and the take away idea in their interactive notebooks.

*Here are a number of simple demonstrations worth considering:*

**Team 1: Surface Tension: Pile it On**

**Materials**: one **dry** penny, one eye dropper, water.

**Procedure**: Make sure the penny is dry. Begin by estimating the number of drops of water that can be piled on the penny before it spills over. Gently place drops of water on the penny until the water spills over. **Explanation**: It is surprising how much water a penny can hold. The polarity of the water molecule causes the drops to attract one another and form beads. Polarity is also responsible for capillary action, which allows water to ascend into the vascular networks of plants.  
**Team 2: Surface Tension: The Floating Paper Clip**

**Materials**: paper clip, container with water, ice.

**Procedure**: Using a steady hand, try to get the paper clip to rest on the surface of the water in such a way that it will not sink.   A variation is to use a flat, plastic bread bag tie and float it on the water. A single drop of liquid soap added to the open side will cut the surface tension and cause the tie to scoot away like a boat.

**Explanation**: The polarity of water causes molecules to attract and adhere to one another. They form a network that takes a certain amount of force to break and penetrate.

**Team 3: Polarity: Water as a Solvent**

**Materials**: Graduated cylinder, 40 mL of alcohol, three beakers, nine test tubes, test-tube rack, 40 mL of water, 40 mL of vegetable oil, sugar, salt, and margarine.

**Procedure**:

1. Number your test tubes (TT) 1-9.

2. Pour 10 mL of water into TT marked 1-3.

3. Pour 10 mL of alcohol into TT marked 4-6.

4. Pour 10 mL of vegetable oil into TT marked 7-9.

5. Place a cap full of sugar in TT 1, 4, and 7.

6. Place a cap full of salt in 2, 5, and 8.

7. Place a small piece of margarine in TT 3, 6, and 9.

8. Cover each TT with your thumb and shake. How well does each solvent dissolve the solute?

9. Observe and record the results.

10. Wash the TT with soap & water and reorganize the station so that it is ready for the next class.

**Explanation**: Because of its high polarity, water is called the universal solvent. A solvent is a substance that dissolves, or breaks apart, another substance (known as a solute). A general rule that determines whether a substance will dissolve in a solvent depends upon its polarity. Polar solvents dissolve polar solutes and nonpolar solvents dissolve nonpolar solutes. In this activity, you will compare the ability of water, alcohol, and vegetable oil to dissolve certain solids.**Caution:** Rubbing alcohol is flammable, an eye irritant, and has fumes.

**Team 4: Polarity: Modeling with Magnets**

**Materials**: Bar magnets or some type of fun magnetic toy like Buckyballs.

**Procedure**: Connect the magnets in a way that simulates the water molecule. Determine creative ways to demonstrate how the properties of surface tension, being a solvent, immiscibility with oil, and expansion when solid is a result of water’s strong polarity.

**Explanation**: The magnets are an analogy of the water molecule which is polar. It has a positive and negative end. Many of the important properties of water (surface tension, solvent, expansion when solid) are due to water’s polarity. Move the magnets around each other. Notice the orientation they are in when they are attracted to each other. Notice what happens when you put two magnets with the same ends together. 

**Team 5: Compare Heat Capacity of Air to Water**

**Materials**: Two balloons, one filled with air, the other with water, and a match or lighter.

**Procedure**: With both balloons filled, hold the lighter to each in turn. The air-filled balloon will immediately pop, but the water-filled balloon will not.

**Explanation**: This video explains heat capacity well and connects it to the oceans’ role in global climate change: <http://www.youtube.com/watch?v=hyPLusD-tyM>. The high heat capacity of water results in the energy from the fire being absorbed by the water, while air cannot absorb and hold nearly as much, therefore causing it to burn through the balloon.

**Explore**

**Activity 3 – The Water Cycle Game**

**Purpose**

To develop an understanding of the components and processes of the water cycle.

**Activity Description**

This activity is role-playing game provided by the National Oceanographic and Atmospheric Administration (NOAA). They provide instructions for the game, color templates of game cubes (which are paper dice), and station labels (which are color photos of elements of a watershed).

Here is a description from NOAA:

Ever wonder where the water you're drinking came from? Where were those water molecules last? With the roll of the dice, you can simulate the journey water molecules may take as they travel within the water cycle.

Water is constantly in motion. Sometimes quickly, like in a fast-flowing river, but sometimes it moves quite slowly, as in underground aquifers. Appreciating the complexity of how water moves around, on a watershed scale, helps us understand how either dissolved contaminants, or those attached to particles, are transported throughout a watershed.

Through role-playing as a molecule of water in this game, you can gain a better understanding for the true complexity of the movement of water. Stations are set up for each of nine different compartments of the water cycle. On each turn, a roll of the dice at each station tells you where to move next. Colored trackers record each person's unique journey through the water cycle to compare to others' journeys later on. You will identify the states of water, and when water changes states as it moves through its cycle. You will also learn where pollutants can enter the water cycle, be transported around, or be left behind.

**Focus Question**

What is meant by the concept of a ‘cycle’ in nature? How is the water cycle like other cycles? (The rock cycle? the carbon cycle?)

**Duration**

One class period.

**Materials**

* [Water Cycle Game, Instructions](http://response.restoration.noaa.gov/book_shelf/1064_Watercycle_instructions.pdf) from NOAA

<http://response.restoration.noaa.gov/book_shelf/1064_Watercycle_instructions.pdf>

Atlas URL:

http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NOAA%20-%20Watercycle%20Game%20Instructions.pdf

* [Water Cycle Game - Game cubes](http://response.restoration.noaa.gov/book_shelf/1066_Game_cubes.zip)

<http://response.restoration.noaa.gov/book_shelf/1066_Game_cubes.zip>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NOAA%20WaterCycleGame_cubes.zip>

* [Water Cycle Game - Station labels](http://response.restoration.noaa.gov/book_shelf/1067_Station_labels.zip)

<http://response.restoration.noaa.gov/book_shelf/1067_Station_labels.zip>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/NOAA%20WaterCycleGame_labels.zip>

**Teacher Preparation**

1. Review and follow the instructions for the Water Cycle Game.
2. Prepare instructions for students.
3. Print station labels.
4. Print and assemble game cubes.

**Classroom Procedure**

1. Use procedures as described by the NOAA activity guide.

**Explore**

**Activity 4 – Exploring Water Use with USGS Activity Center**

**Purpose**

To explore our own relationship with water resources as we learn how water is used by others in the United States.

**Activity Description**

In a whole/small group discussion format, the teacher uses the USGS Activity Center to direct questions out to small teams of students. The Activity Center has online tools in the categories of Questionnaires, Opinion Surveys and Challenge Questions.

**Focus Question**

How do our views on water impact our behavior?

**Duration**

One class period.

**Materials**:

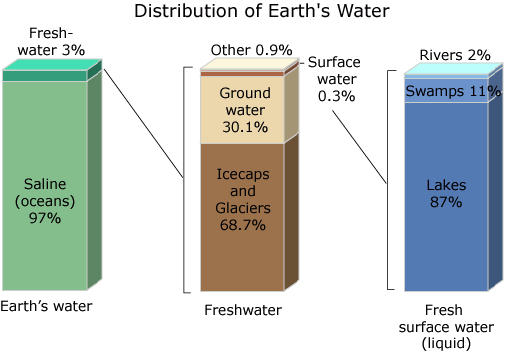
* The USGS Water Science for Schools, Activity Center (<http://ga.water.usgs.gov/edu/msac.html>)
* Computer projector and Internet connection

**Teacher Preparation**

Practice accessing and navigating the webpage.

**Classroom Procedure**

1. Use a computer projector and the website to guide a whole class discussion.
2. Prompt students to record important notions and surprising findings from the activity in their interactive science notebook.

**Explore**

**Activity 5 – Global Water Distribution**

**Purpose**

To understand how proportionally small fresh water is on Earth.

**Activity Description**

Students are presented with the bar chart of the distribution of Earth’s water and a table of percentages. Then they make a 2 pie graph by hand that shows the proportions of water in various locations.

**Focus Question**

What is important to understand about the distribution of water on “The Water Planet”?

**Duration**:

One class period.

**Materials**

* USGS Water Cycle Summary <http://ga.water.usgs.gov/edu/watercyclesummary.html>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20Water%20Cycle%20Summary.docx>

* USGS – What is Ground Water

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20What%20is%20Ground%20Water.pdf>

**Teacher Preparation**

1. Extract graphics, the data table and text from the website, and organize into a word processing document for student use.

**Classroom Procedure**

* 1. Have students do a ‘focused read’ on the section of the USGS Water Cycle Summary (<http://ga.water.usgs.gov/edu/watercyclesummary.html>) Atlas URL on Global Water Distribution: .
  2. Present the bar chart schematic to the whole class and gather impressions.
  3. Provide each student with the Estimate of Global Water Distribution table.
  4. Have each student make two pie graphs. One should group the various elements into these categories: salt water, ice, ground water and surface water. The other pie graph will divide all of the fresh water.
  5. When the charts are created, have students write a compelling narrative about the impression the distribution has made on their thinking about water resources.

**Explore**

**Activity 6 – Understanding the Global Water Crisis**

**Purpose**

To create a larger frame of reference to understand the global water crisis.

**Activity Description**

The National Geographic Magazine published a special issue called “Water is Life” on water in April, 2011. An elaborate web presence is provided to support the project. While the issue is complicated, the crisis comes down to two simple aspects: water quality and water quantity.

In this activity, a whole class discussion centers around the resources that the National Geographic Society has hosted on their website. The steps below direct the teacher to explore and use the website in order to help students understand the vastness and impact of the crisis.

**Focus Question**

What is the nature of the global water crisis?

**Duration**

Two class periods.

**Materials:**

* The various National Geographic websites? from their “Water is Life” website. (listed in Classroom Procedures section below)
* A projected Internet computer
* Computer lab

**Teacher Preparation**:

Practice accessing and navigating the webpage.

**Classroom Procedures**:

* 1. Start with the “Freshwater 101 Quiz:”

<http://environment.nationalgeographic.com/environment/freshwater/freshwater-101-quiz/>

* 1. Visit the home page of the special issue: <http://ngm.nationalgeographic.com/2010/04/table-of-contents/>
  2. Go to the Freshwater crisis link presented on the page above:

<http://environment.nationalgeographic.com/environment/freshwater>

* 1. The “About Freshwater Initiative” has a compelling video and a number of important links below the section titled “New to Freshwater Initiative”

<http://environment.nationalgeographic.com/environment/freshwater/about-freshwater-initiative/>

* 1. Use the interactive map at “Where is Earth’s Fresh Water” link:

<http://ngm.nationalgeographic.com/2010/04/water/water-animation>

* 1. View the topics under “Freshwater 101.”

<http://environment.nationalgeographic.com/environment/freshwater/freshwater-101/>

* 1. View and interact with the “The Hidden Use of Water” page, which reveals how much water is embedded in the use of a variety of important products.

<http://environment.nationalgeographic.com/environment/freshwater/embedded-water/>

* 1. The website contains many other videos and articles. After the whole group presentation, allow students to use part of a class session to explore the website, giving them the following task (contest):
  + In pairs, explore the National Geographic website in the area of the water.
  + Find something very new and interesting that you believe should be shared with the class.
  + Make a proposal to your teacher and if accepted, your suggestion will be presented and discussed by the class.
  1. Have students write up and submit a brief proposal.
  2. Choose two to four proposals that warrant class discussion to help round out the implications of the global water crisis.

**Explore**

**Activity 7 – Issues in Ground Water**

**Purpose**

To develop an awareness of the importance of ground water and provide examples of current environmental challenges.

Atlas URL:

**Activity Description**

Student teams are assigned one of four articles related to ground water issues. Teachers can use any appropriate article but four topics are listed below. Teams become expert groups and will organize and present the issues in a jigsaw format or informal presentations from expert groups.

**Focus Question**

What solutions should be pursued in response to ground water quality and quantity challenges?

**Materials**

* USGS publication: “What is Ground Water” <http://pubs.usgs.gov/of/1993/ofr93-643/pdf/ofr93-643.pdf>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20What%20is%20Ground%20Water.pdf>

* Detroit Free Press article on waste water from fruit processors

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Freep%20Article-Groundwater%20Contamination.doc>

* Resources on hydraulic fracturing (a.k.a. fracking) for natural gas:

<http://www.michiganradio.org/post/companies-buy-drilling-rights-michigan-part-1>

<http://www.michiganradio.org/post/new-gas-drilling-raises-pollution-concerns-part-2>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Michigan%20Public%20Radio-Natural%20Gas.docx>

* State of Michigan’s Department of Environmental Quality: <http://www.michigan.gov/documents/deq/Hydrofrac-2010-08-13_331787_7.pdf>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Michigan%20DEQ-Hydrofrac-2010-08-13_331787_7.pdf>

# Tip of the Mitt Watershed Council: “Natural Gas Drilling & Water/An Overview of Hydraulic Fracturing for Natural Gas in Northern Michigan”:

<http://www.watershedcouncil.org/learn/hydraulic-fracturing/>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Tip%20of%20Mitt-Natural%20Gas%20Drilling.docx>

* USGS publication on Arsenic, Nitrate, and Chloride in Groundwater, Oakland County, Michigan: <http://walrus.wr.usgs.gov/infobank/programs/html/factsheets/pdfs/2004_3120.pdf>

Atlas URL:

[http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS-Arsenic,%20Nitrate,%20and%20Chloride%20in%20Groundwater,%20Oakland%20County,%20Michigan%20Publicaton.pdf](http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS-Arsenic,%20Nitrate,%20and%20Chloride%20in%20Groundwater,%20Oakland%20County,%20Michigan%20Publicaton.pdf%20)

* USGS publication on the High Plains Aquifer: <http://pubs.usgs.gov/fs/2007/3029/pdf/FS20073029.pdf>

Atlas URL: [http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20on%20High%20Plains%20Aquifer.pdf](http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20on%20High%20Plains%20Aquifer.pdf%20)

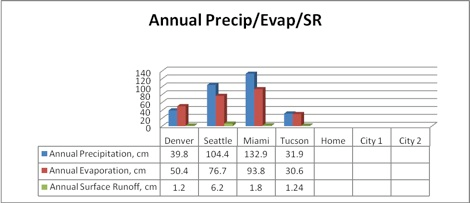
**Teacher Preparation**:

1. Print and copy all articles for student use.
2. Read through the articles and become familiar with the issues.
3. Look up the technique “talking to the text” to help with reading comprehension.

**Classroom Procedure**

1. Provide the USGS Publication “What is Ground Water.”
2. Divide the class into four groups and assign a ground water topic. The group that reads about hydraulic fracturing could be larger since there are three resources (and Michigan Radio’s is lengthy). Reading could be homework.
3. Review some basics of “text structure” in scientific publications, such as how the documents are organized, and the role of graphics.
4. Model the process of talking to the text. Have students practice and provide feedback soon after reading, using a student model (preferably projected). Good components include:
   * Personal paraphrasing of the content
   * Questions about the topic
   * Question about things not understood
   * Sketches
   * Related ideas that come to mind
5. When students finish fully reading their materials, have the groups come together and share their marginal notes and discuss the topic.
6. Using a jigsaw process, or whole group numbered heads, have the experts teach others in the class about the issue they learned about.

**Explore**

**Activity 8 – Water Availability**

**Purpose**

To analyze and understand regional differences in the way precipitation relates to evaporation and runoff.

**Activity Description**

This activity is one of 40-some Earth Exploration Toolbook modules. The modules are designed to teach teachers how to use data in various analytical ways. They are all built to be easily used by students.

This module uses an online geographic information system (GIS) tool with which students explore data from four cities. They create data tables and graphs to address their hypothesis of how precipitation relates to evaporation and runoff.

**Overview description from the Earth Exploration Toolbook:**

Users study the relationship between precipitation, evaporation, and surface runoff data, collected and aggregated by the North American Regional Reanalysis project. Using FieldScope, an online GIS created at the National Geographic Society, they explore data layers, create a map table for comparison, and analyze geographic patterns. A full set of curriculum materials for students has also been created for FieldScope by Northwestern University and The GLOBE Organization. These materials will be available online in the future.

**Duration**

Two class periods.

**Materials**

* Earth Exploration Toolbook

<http://serc.carleton.edu/eet/index.html>

<http://serc.carleton.edu/eet/wateravailability/index.html>

* Graph paper or a spreadsheet program (e.g., Excel)

**Teacher Preparation**

1. Print and copy a class set for teams of students.

* **Note**: It is helpful to print out the detailed instructions on the Earth Exploration Toolbook website for this module. Notice that there are links that say “show me more.” When these are clicked on, more details are revealed. Use discretion as to which ones are opened.

1. Practice doing the activity ahead of time using the instructions provided by the Earth Exploration Toolbook.

**Classroom Procedure**

1. Begin this activity by showing the Power Point “The Trouble with Bottled Water.” Set it to advance while student settle into cla]
2. ss. While the body of this message is fairly well founded, one could ask how we
3. Present the scenario to students and have students using the overview page and the case study. This can be a pre-read.
4. Use the Instructional Strategies provided in the teacher pages:
   1. Before the students begin this investigation, ask them to develop a working hypothesis describing the relationship between total annual precipitation and total annual evaporation. Will areas with high precipitation have high evaporation rates? Will areas with low precipitation, such as the hot, arid west, also have high total annual evaporation? Write the various hypotheses down on the class white board so that students can refer back to them as they work through the GIS analysis.
   2. As part of this investigation, students fill out a table of annual precipitation, evaporation and surface runoff for four pre-selected cities, as well as three of their choice. One extension of this activity is to graph the data using Excel or other graphing/charting program. The chart can help students visualize the relationships of these different variables across the county. One important relationship for them to observe is how little surface runoff occurs compared to evaporation.
   3. An Excel spreadsheet has been created for this purpose. Click here to download: [Water\_Availability.xls](http://serc.carleton.edu/files/eet/wateravailability/water_availability.xls.xls) (Excel 40kB Sep22 09) After downloading and opening, click on the *Investigation III* tab at the bottom of the sheet to open the appropriate table and chart. Blank cells are in the table to add the students selected cities. Below is an example of the data from the four pre-selected cities in the Investigation.
   4. Another option is to have students create the chart of graph paper.
5. Follow the detailed step-by-step procedures provided.
6. Have students provide a write-up that evaluates their hypothesis and describes the results of their investigations.

**Explain**

**Activity 9 – Comprehending the Water Cycle**

**Purpose**

To better consolidate student understanding of concepts related to the water cycle.

**Activity Description**

Here, the teacher will pull together the content and focus questions of this cycle. In an interactive lesson/activity format, students tackle a set of activities while teacher facilitation directly secures student understanding.

Students begin by trying to apply their knowledge to a matching challenge using the USGS Water Cycle. The teacher can lead them to a better understanding using a USGS website called “Follow a Drop Through the Water Cycle.”

**Focus Question**

How do humans interact with and depend upon the hydrospherExplore

**Duration**

Three class sessions

**Materials**

* Power Point: The Problem with Bottled Water

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Problem%20with%20Bottled%20Water.pps>

* “Follow a Drop Through the Water Cycle” <http://ga.water.usgs.gov/edu/followadrip.html>
* USGS water cycle summary: <http://ga.water.usgs.gov/edu/watercyclesummary.html>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20Water%20Cycle%20Summary.docx>

* USGS Water Cycle schematic:

<http://ga.water.usgs.gov/edu/watercyclehi.html>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20Water%20Cycles%20-with%20labels.gif>

* URL: USGS Water Cycle schematic without labels or letters: <http://ga.water.usgs.gov/edu/watercycleprintnotext.html>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20Water%20Cycles%20-%20no%20letters%20of%20labels.gif>

* USGS Water Cycle schematic with letters but no labels: <http://ga.water.usgs.gov/edu/watercycleguess.html>

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/USGS%20Water%20Cycle-no%20labels.gif>

**Teacher Preparation**

1. Print and copy the Water Cycle Schematics for student use.
2. Prepare to display the Water Cycle Schematics from a projector.
3. Schedule a computer lab if possible.
4. Print and copy materials if computer access is lacking.

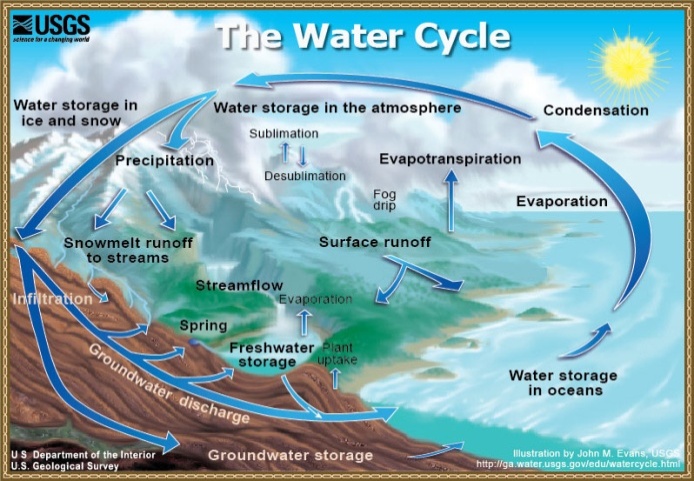
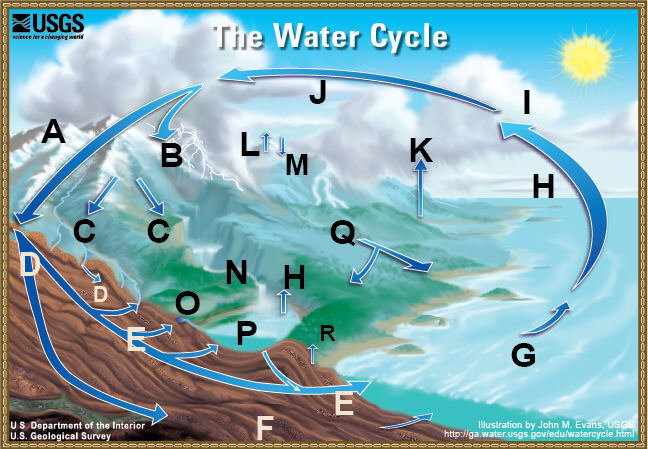
**Classroom Procedure**

1. Provide students with the USGS Water Cycle labeled with letters and the list of 16 watershed components. Have students match the labels to the schematic to the best of their ability. Be sure they understand their ability will not be graded.
2. Provide students with USGS Water Cycle schematics that are fully labeled with the 16 terms and ask them to write a description of what they need to better understand.
3. Provide students with access to the USGS Water Cycle website or a print-out of the summary document.

USGS Water Cycle Summary: <http://ga.water.usgs.gov/edu/watercyclesummary.html>

1. Each of the 16 elements has its own webpage. Teachers can present these in turn for the class discussion, or equip student teams with computers with assigned topics to study and convey to the class. Therefore, it will either be necessary to provide Internet access, print-outs or whole class displays of the details within.
2. A supporting page is the “Follow a Drop Through the Water Cycle” page, where teacher can review these ideas while addressing how humans interact with the water cycle.

USGS link: <http://ga.water.usgs.gov/edu/followadrip.html>)



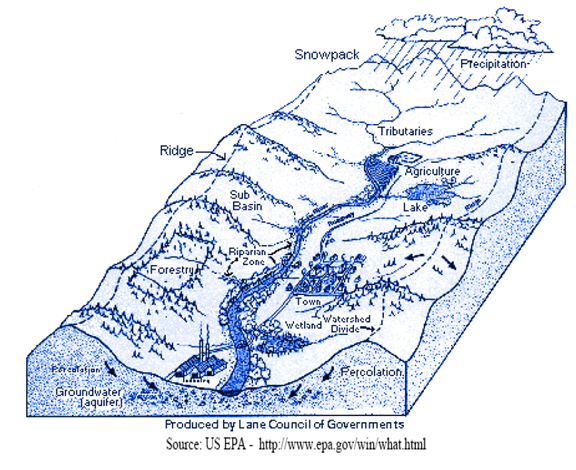
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| --- | --- | --- |
| [    ]  Condensation  [    ]  Evaporation  [    ]  Evapotranspiration  [    ]  Freshwater storage  [    ]  Groundwater discharge  [    ]  Groundwater storage | [    ]  Infiltration  [    ]  Precipitation  [    ]  Snowmelt runoff to streams  [    ]  Spring  [    ] Stream flow  [    ]  Sublimation | [    ]  Surface runoff  [    ]  Water storage in the atmosphere  [    ]  Water storage in ice and snow  [    ]  Water storage in oceans  [    ]  Desublimation  [    ]  Plant uptake |

**Elaborate**

**Introduction**

The topic of this cycle will be relevant and pressing to humanity for the rest of time. It is important that our curriculum requires students to apply this core knowledge and science proficiencies to real world problems. The best opportunity here is to equip students with the tools and time to conduct water quality studies in the field. Coupled with the field experience, it’s imperative that they analyze and interpret their data, or those gathered from other sources. Activity 10 will serve as a stepping stone to such projects and can be used to help students understand connection between land use and water quality as measured by physical characteristics.

**Activity 10 – Water Quality Analysis**



**Purpose**

To develop an understanding of key water quality parameters, and how land use decisions impact water quality.

**Activity Description**

There are several excellent options for pursuing these ideas. Included below is a project with a set of activities that can be followed to develop student understanding of the land use issues and water quality data. It is designed in a 5-E type cycle with which teachers can elicit student understanding using a schematic map of a watershed, develop their understanding of water quality data, and finally interpret data in light of the implied land use of the schematic. This activity is best if teachers only have three class periods to dedicate to this activity. This activity is posted as downloadable packet in Atlas.

Another resource is hosted by NASA’s “Exploring the Environment Modules.” “The Bear Creek Water Quality Module” has a more detailed landscape with multiple stream branches and much more data. It also sets up a problem-based situation concerning a fish kill. They post areas where chemical, physical and biological water quality parameters are explained. Their datasets are posted in online tables and in a very usable downloadable Excel spreadsheet. It includes populations of macroinvertabrates. This would be a stronger, more complex activity, but would require more organization of teams and 10 class periods.

Another high quality program is SEPUP’s “Trouble in Fruitvale” module that focuses on a ground water pollution issue. It presents a well-designed, activity rich, problem-based scenario around a fictitious town of Fruitvale that is struggling with a ground water pollution issue. Used in full, it would take 15 days to do the project. This is provided by the vendor SEPUP and therefore must be purchased.

**Focus Question**

How does land use impact water quality?

**Duration**

Three class periods for “Interpreting Water Quality Data” packet, or 10 days for use of NASA’s “Bear Creek Module,” 15 to 20 days for complete “Trouble in Fruitvale.”

**Materials**

* “Interpreting Water Quality Data”

Atlas URL: <http://oaklandk12.rubiconatlas.org/links/Science7/Unit%204/Interpreting%20Water%20Quality%20Data.doc>

* Alternatively: “NASA’s Bear Creek Module”

<http://www.cotf.edu/ete/modules/waterq3/WQmain.html>

* “Groundwater Contamination: Trouble in Fruitvale”

<http://www.sepuplhs.org/middle/modules/groundwater/overview.html>

**Teacher Preparation**

1. Determine which approach to use (Interpreting Water Quality, Bear Creek or Trouble in Fruitvale.)
2. Become familiar with the water quality parameters and the meaning of such data. The NASA site is more comprehensive because it describes physical, chemical and biological parameters. Interpreting water quality does well with chemical parameters.
3. If using Interpreting Water Quality, be sure students know to determine the percent saturation of dissolved oxygen. Doing so reveals that low water quality is most likely the result of organic waste from agricultural practices.

**Classroom Procedure**

1. If using “Interpreting Water Quality Data,” follow procedures in the packet (or below).
2. If using NASA’s Bear Creek Module, follow the scenario established by the project. Divide the class into teams who will study different datasets, and set up a panel discussion to analyze the data as a class.

**Evaluation: Cycle Quiz**