TEACH - LEARN - ACT

PROVIDED BY ***NATIONAL WILDLIFE FEDERATION***
WITH ***CLIMATE CHANGE INITIATIVE*** ***University of Massachusetts Lowell*** AND ***CLIMATE INTERACTIVE***

an inconvenient sequel
TRUTH TO POWER

LEARN LIKE YOUR WORLD DEPENDS ON IT

participant media

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Paramount
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an inconvenient sequel
TRUTH TO POWER

EDUCATIONAL COMPANION • TEACH, LEARN, ACT • MIDDLE-HIGH SCHOOL

PROVIDED BY ***NATIONAL WILDLIFE FEDERATION*** WITH ***MIT Sloan, CLIMATE CHANGE INITIATIVE University of Massachusetts - Lowell*** AND ***CLIMATE INTERACTIVE***

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A decade after *An Inconvenient Truth* brought climate change into the heart of popular culture, comes the riveting and rousing follow-up, *An Inconvenient Sequel: Truth to Power*, that shows just how close we are to a real energy revolution. Vice President Al Gore continues his tireless fight traveling around the world training an army of climate champions and influencing international climate policy.

Cameras follow him behind the scenes – in moments both private and public, funny and poignant – as he pursues the inspirational idea that while the stakes have never been higher, the perils of climate change can be overcome with human ingenuity and passion. As the film's education partner, National Wildlife Federation has teamed up with Participant Media and Paramount Pictures to provide educational resources to help students understand climate change while inspiring them to find ways to bring our nation across the finish line to a viable clean energy economy.

We encourage you to use each of the three guides for a complete learning experience:

WATCH KIT • *TRUTH IN 10 WRITER'S GUIDE* • TEACH, LEARN, ACT

Together they complement the film and deepen understanding of how climate change is altering our planet, how the need for civil discourse and civic participation is critical and how innovative technologies and solutions can lead all of us to a more sustainable future.

For example, before using this guide review the systems thinking strategies in the Watch Kit to better understand current climate change issues locally and around the globe. Understanding how you think and what influences your decisions makes us better students, teachers, artists, leaders, athletes and citizens. The Writer's Guide provides a synopsis of climate change facts and scientific consensus.

Our goal is to help students develop critical thinking skills by leveraging the diverse perspectives and fact-based evidence shared in the film, *An Inconvenient Sequel: Truth to Power*. Students will practice systems thinking as they share their own stories, analyze and reflect on biases, and construct new mental models about climate change solutions locally and globally — supported by scientific facts and evidence from climate change impacts in their own community and across their country.

We hope to engage, educate and empower a world of "Systems Thinkers," who understand scientific principles and can discern truth from misinformation, who want to solve the problems of climate change and take advantage of the opportunities the new green economy affords.

LESSON SUMMARY – PARIS CLIMATE AGREEMENT

A major focal point of the film is the activities leading up to and surrounding the signing of the ground-breaking Paris Climate Agreement of 2015. As the world literally comes together, we see first-hand the dedication of the delegates to solve the climate crisis and reduce human caused greenhouse gas emissions; and then new political challenges emerge in the United States. To provide a scientifically rigorous and engaging activity that captures the complexity and diplomacy of years of negotiations necessary to achieve net zero greenhouse gas emissions, we teamed up with Climate Interactive and Climate Change Initiative, University of Massachusetts. Their World Climate simulation provides students with the opportunity to use computer climate simulation models called C-ROADS and role-play the Paris climate talks. These are the types of tools used to prepare policymakers and participants at the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP 21).

After providing students with an engaging and unique learning opportunity using a collaborative global simulation, students will be informed and empowered to drive real change in their community through place-based problem solving and civic action.

LEARNING OBJECTIVES

STUDENTS WILL:

- Analyze and manipulate data using scientific models.
- Use role play through civic discourse to debate, defend, corroborate and collaborate.
- Modify their mental models of climate change based on new knowledge acquired as the result of the World Climate simulation.
- Develop an action plan using systems thinking that will directly benefit their school and/or community.

TIME NEEDED

- Film Length – 100 minutes
- 1 to 3 class periods or several hours after school and planning by students)
- With various possible extensions (providing out of class time for research

MATERIALS

- Computer
- Internet Access
- Science notebook
- Vocabulary List
- A projector
- A board to write on
- An apple
- Teacher Notes
- Download C-ROADS World Climate
- Briefing Materials for Students
- Student Worksheet: Pre-negotiations
- Website: www.climateinteractive.org/
- Website: *An Inconvenient Sequel: Truth to Power Education* www.inconvenientsequeleducation.org/

World Climate uses C-ROADS climate policy simulator to test the impact that your chosen policies will have on the climate. C-ROADS is used to analyze the actual pledges countries make to the United Nations and is trusted by top decision-makers worldwide. An external scientific review panel reviewed C-ROADS and found that it reproduced results consistent with the Intergovernmental Panel on Climate Change (or IPCC's) findings.

LESSONS: PART I - WORLD CLIMATE

Climate Interactive's World Climate Simulation is a dynamic learning experience, diving into the civic, social and environmental issues that demands strong, yet kind leaders with collaborative spirits and the passion and determination to secure the trajectory of our planet's health for future generations.

As a companion to *An Inconvenient Sequel: Truth to Power* and Vice President Al Gore's slide presentation, Truth in 10, National Wildlife Federation is adapting Climate Interactive's World Climate Simulation to strategically align to the tenets of the movie and slide presentation. Our hope is that *An Inconvenient Sequel: Truth to Power* will inspire you to conduct the full World Climate Simulation and to include the school community. Engaging the school community by building lasting and genuine relationships is one way students can begin driving change, because climate change impacts everyone and everything.

In World Climate, your students will take on the roles of delegates to the United Nations climate negotiations and will be challenged to create an agreement that meets international climate goals according to current scientific understanding.

PREPARATION

Read through the Teachers Notes and review the Briefing Materials for Students prior to planning how you will carry out the role play activity with your students. At least one day before the in-class activity, assign your students to one of three delegations:

1. Developed Nations
2. Developing A Nations
3. Developing B Nations

Give each student a Briefing Statement that corresponds to his or her delegation. If you have more than 30 students and more than one class period, you may want to use the version of World Climate with six delegations.

ASSIGN EACH STUDENT TO:

- Read their Briefing Statement, review Vocabulary and complete the Student Worksheet: Pre-negotiations;
- Write a one-paragraph summary of their country or delegation's position on climate change, including their view on their responsibility to act and what they seek from other countries;
- Make initial decisions on their country or delegation's emissions trajectory for the coming decades; and
- Come to class prepared and dressed to play their roles. (Encourage them to bring props or clothes that enable them to symbolically represent their country or delegation's. Ask them to avoid stereotypes.)

AGENDA FOR IN CLASS ACTIVITY

Suggested Agenda for 1 hour class period

- Introduction: 10 minutes
- First Round of negotiation: 10 minutes
- Entering decisions: 5 minutes
- Debrief Round One: 5 minutes
- Second Round of negotiation: 10 minutes
- Debrief: 10 minutes

Classroom Setup: If possible, rearrange your classroom prior to the activity (or with students help) so that the Developed Nations delegation is at the front of the room; Developing A Nations is near the middle or next to Developed Nations; and Developing B Nations is placed at the back of the room.

Have both Truth in 10 slide presentation and the C-ROADS World Climate program open on the computer projection system.

INTRODUCE THE SIMULATION

This simulation will rely on the same computer model used to analyze real-world pledges to UN climate negotiations, C-ROADS. C-ROADS has been used by former White House Science Advisor, John Holdren, to brief policymakers from the U.S. and elsewhere. It has also been used by >30,000 students and citizens in >70 countries who have participated in the World Climate Simulation.

Note: Research on the learning impacts of World Climate show that the more engaged students are with the simulation, the more science content they learn. We encourage you to model a high level of engagement by also playing a role, such as the UN Secretary General or the Executive Secretary of the UNFCCC. (Put on a blazer, tie, or scarf to signal that you are entering the role-play.) Refer to your students as distinguished delegates and welcome them to an important negotiation. Ask them to feel the full weight of the decisions they make.

Explain that they, as delegates, are tasked with and share a goal of reaching an international agreement to reduce greenhouse gas emissions and limit global warming to well below +2°C above to preindustrial times by 2100; and agree on a deal to share costs of mitigation and adaptation fund to aid most vulnerable nations.

- Give the Truth in 10 slide presentation to review the facts, to highlight recent events and to set the stage for the role-play.
- Explain expected impacts under a "business-as-usual" emissions scenario, or +~4.5°C over preindustrial temperatures, which provides an imperative for action.
- Explain that the delegates have an opportunity to create a better future.

FIRST ROUND OF NEGOTIATIONS

Tell students they have 10 minutes to meet with their delegations, make decisions about their emissions trajectory, and decide on the want/need from other delegations. They should use their individual responses to the **Student Worksheet: Pre-negotitions** as a starting point for group discussion. They will need to come to a group consensus on the decisions they made in the homework, i.e.: emissions peak year, reductions begin year, and annual rate of decline.

Remind them that economists consider a 3.5% rate of decline to be extremely ambitious.

At the end of the 10-minute negotiation period, call for their attention and explain that you are now convening a plenary session. Bring up C-ROADS on the computer projection system and orient the students towards the default graphs: i.e., the graph on the left shows expected "business-as-usual" CO_2 emissions (in gigatons, or billions of tons, of CO_2 per year) from fossil fuels for each of the countries/groups over the course of the 21st century. The graph on the right shows the expected temperature rise over the 21st century as a result of the emissions scenario. Explain that "business-as-usual" assumes no major effort (and no major catastrophes) to reduce emissions from fossil fuels. Then explain that you will now enter their decisions to find out their expected climate outcomes.

- Ask the Developed Nations, Developing A Nations, and Developing B Nations to have at least one delegate stand up and explain their decisions in 1 minute or less.
- At the end of the speeches, thank them and then draw their attention to C- ROADS and the line representing the Developed Nations (i.e., the blue line).
- Tell the students to watch the line as you enter the emissions peak year. Then draw their attention to the temperature line (right graph: purple line), which may now be below the black "business-as-usual" reference scenario.
- Continue entering their remaining decisions about when emissions should begin to decline and at what annual rate.
- Next, repeat above with the Developing A Nations delegation, followed by Developing B Nations.
- After all decisions are entered, note the expected temperature rise by 2100.
- Tell the delegates that they have made progress, but that serious impacts are expected given the decisions they have taken, and then present the appropriate slide. Urge them to do better. Ask them what it will take to achieve their shared goal to limit warming to less than 2°C?

DEBRIEF FIRST ROUND

This is a great moment to explain the accumulation dynamics of CO_2 in the atmosphere.

It is helpful to explain the finite nature of the atmosphere. This can be done quickly with an apple – show the students the apple and ask them, if the Earth were the same size as this apple, where would the top of the atmosphere be? You can move your finger closer to or further away from the apple and ask them to raise their hands when your finger reaches the right distance from the apple's surface. Then, point out that actually, the skin of the apple is about as thick as Earth's atmosphere (~12 km) if Earth were the same size as an apple. In other words, our atmosphere is a relatively small, finite space.

Next, explain that CO_2 follows the law of conservation of mass: if it is released into the atmosphere, it is colorless and odorless, but it does not disappear. Instead, it accumulates in the finite atmosphere.

SECOND ROUND OF NEGOTIATIONS

- Urge students to do better and give tell them they have ten minutes to meet with each other, and other delegations, to make further reductions.
- At the end of the time allotted, call for their attention.
- Ask each group to quickly give new decisions (without speeches), starting with Developed Nations as before. Enter the decisions as they announce them and ask students to watch the graphs in C-ROADS as you populate the fields.

DEBRIEF SECOND ROUND AND CONCLUDE

After all decisions have been entered, if they have still not reached the <2°C rise, invite them to step out of their roles and invite Developing B delegates to find chairs and get comfortable. If you are wearing a scarf or tie to represent your role, you may want to remove that to symbolize your own stepping out of role.

Next, ask what else would need to be done to achieve the goal. Encourage them to look at the emissions graph to see which country/group has the greatest impact. At least one person usually offers to start earlier and reduce more quickly. Ask for emissions decisions from each group until the <2°C rise goal has been reached.

Complete the debrief by asking students to share their insights from the simulation. If you are running out of class time, you may ask students to write a paragraph describing their insights. Provide the following questions to prompt answers:

1. Is it possible to achieve the goal? (Yes – it is technically possible, although some may offer that it is not politically possible, which is an open question.)
2. When does action need to be taken? (Immediately or extremely soon.)
3. What if we wait – will we still be able to reach the goal then? (Only if reductions are steeper and, therefore, more difficult to achieve.)
4. Who needs to act? (Everyone, or all nations.)

Source: Model and data created by Climate Interactive and M.I.T. Sloan, including John Sterman, Ellie Johnston and Lori Siegel.

TEACHERS NOTES: WORLD CLIMATE SIMULATION

Use the instructor resources provided at Climate Interactive for more background and clarification.

Driving Question: How can we as global leaders, collaborate on a global scale to reduce impacts from climate change, while ensuring the cultural integrity and prosperity of our citizens now and for future generations?

As the facilitator, you will be responsible for:

1. Presenting the simulation, welcoming the delegation and facilitating two rounds of negotiations.
2. Facilitating a systems thinking activity looking at how student's mental models may have shifted as the result of their new learning experiences.

PREPARE YOUR CLASSROOM

1. Rearrange your desks/tables so that Developed Nations delegation is at the front of the room; Developing Nations A is near or next to the Developed Nations; and Developing Nations B delegation is placed at the back of the room.
2. Copy and print out Table Cards for each delegation. Students, once assigned, must always sit with their delegation. Proper protocol is important.
3. Have Vice President Al Gore's slide presentation, Truth in 10 up on the screen in the classroom immediately prior to the beginning of the simulation.

PREPARE YOUR STUDENTS

1. Randomly assign students to delegations and provide them with the pre-simulation homework, two days prior to carrying out the role-playing activity. [Homework to include, delegation brief, outline that explains their current mental model on climate change, a list of potential decisions to offer to the delegation for emissions trajectory in the coming decades, instructions for dress.]
2. Present Truth in 10 for the students within the two days prior to the simulation.

SIMULATION

As the facilitator, you take on the role of UN Secretary General of the United Nations Framework Convention Climate Change (UNFCCC). While playing this role, refer to students as 'distinguished' delegates and welcome them to these important negotiations. Request delegates feel the full weight of the decisions they are making not only for their country, but globally, and not just today, but for future generations. Delegates are tasked with reaching an international agreement to limit global warming, to bring balance to the carbon budget, to well below +2°C as compared to preindustrial times by 2100.

TEACHER REFLECTION

Based on the film and student discussions and activities:

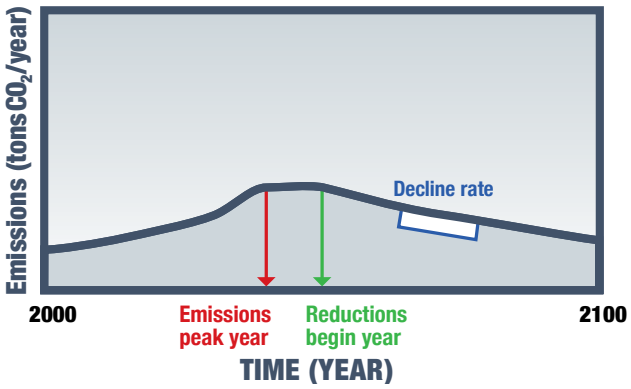
a. How have students' or the groups' views changed?
b. What information had the greatest impact on them?
c. What thinking has remained the same?

STUDENT WORKSHEET: PRE-NEGOTIATIONS

During the ***World Climate*** simulation, you will be taking on the role of a delegate to the United Nations climate change negotiations. Together with all of the other delegates (your classmates), you will be challenged to create an agreement that meets international climate goals, while also representing and interests of the countries you represent.

To prepare for the simulation, your homework assignment is to:

1. Read your Country or Delegation's Briefing Statement carefully (required) and do additional research about the countries in your country/delegation and their position on climate change.
2. Write one paragraph about your country/delegation's position going into the negotiations. In your paragraph, you should consider questions such as:
   - **a.** What actions are the people you represent willing to take to address climate change?
   - **b.** What responsibility do other country/delegations have to act?
   - **c.** How can you best represent your country/delegation's interests?
3. Using the graph below, make initial decisions about the following (you will discuss these decisions with other members of your delegation during the simulation):



   - **a.** Peak emissions year: in what year will your country/delegation's emissions of heat-trapping gases stop increasing?
     Year: _____
   - **b.** Reductions begin year: in what year will your country/delegation begin reducing its emissions of heat-trapping gases? This year must be some time later than your peak emissions year.
     Year: _____
   - **c.** Decline rate: at what annual rate will your country/delegation reduce its emissions? For example, a 1% annual rate of decline would mean that every year after your reductions begin, your country/delegation's emissions would be 1% lower than the previous year. Note that a 3.5% annual rate is considered to be very high by most economists. Annual rate: _____
4. For class on the day(s) of the simulation, bring your written responses to the questions above and a prop or item of clothing that will help you represent your country/delegation.

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PART II: CLIMATE CLASSROOM CONNECTIONS

INTRODUCTION

The following lessons provide students with foundational global warming and climate science in parallel with key concepts and events presented in the film. Following Vice President Gore's journey and documenting the changes taking place in our natural world offers a unique and timely teaching opportunity. The science and evidence of climate change presented provides the foundation for authentic learning experiences through inquiry. Instruction on climate change provides ample opportunities for interdisciplinary teaching and requires an understanding of basic climate science.

Scientific evidence concludes global warming and climate change are happening now. There is overwhelming scientific agreement on human-caused global warming. More than 97% of publishing scientists and a synthesis of peer reviewed studies confirm this scientific fact. Virtually all national and international science academies and societies have issued statements or assessments affirming human's role in recent climate change. This includes the academies of science from 80 countries. No scientific body in the U.S. or internationally formally dissents from this consensus.

This section is designed to help students build their knowledge of climate science and solutions while encouraging students to analyze the relevance of climate change to their daily lives.

KEELING CURVE

LESSON SUMMARY

Introduce your students to the Keeling Curve. Explain that it is a graph which plots the ongoing change in concentration of carbon dioxide in Earth's atmosphere since the 1950's. It is based on continuous measurements taken at the Mauna Loa Observatory in Hawaii and named for the scientist, Charles David Keeling, who started this work. Students will examine CO_2 data from Mauna Loa and Alaska and use this data to explore how seasonal growth and die-off of vegetation in temperate and colder regions influences CO_2 levels. Students will also investigate the long-term trend in CO_2 and how it relates to emissions from fossil fuel burning.

LEARNING OBJECTIVES

STUDENTS WILL:

- Analyze and compare datasets.
- Compute a linear regression of the data.
- Draw conclusions from evidence in the datasets about the rise in CO_2 levels.

TIME NEEDED

- 1 class period or 50 minute block of time

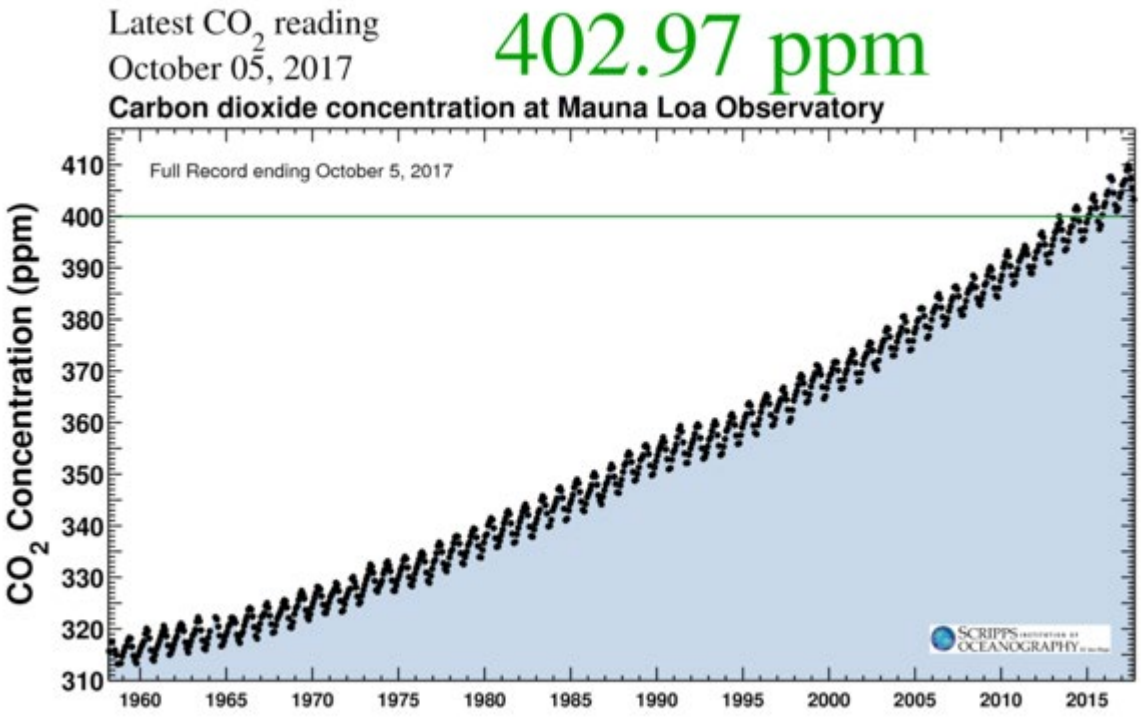
MATERIALS

- Science notebook
- Computer with internet access
- Student Handout: Time series Graphs
- Student Handout: Raw Data

Display the Keeling Curve for the class to view and ask students to make observations. Have a discussion about their observations. Have the students use their context clues to determine what is shown in the graph.

If not discussed yet, bring attention to what the blue space in the graph represents as well as the wiggly line. Students will probably understand the blue space, but may need guidance to unpack what the wiggly line represents. (The blue space shows the concentration of CO_2 over the course of the entire record, starting in the 1950's. The wiggly line shows the Earth "breathing.)

Ask students to determine what they think is meant by Earth's ability to "breath". After writing their responses or discussion, show the green up, green down animation. Be sure to point out that while there are cyclical changes in CO_2, we are still experiencing an extreme uptick in CO_2 concentration since the industrial revolution.



Provide the Student Handout: Time Series Graph of Hawaii and Alaska showing average monthly CO_2 in the troposphere, over a nine-year time span. Have students discuss the similarities and differences and make comparisons to the Keeling Curve map.

Provide students with Student Handout: Raw Data for both Hawaii and Alaska. Students can use this raw data to calculate a linear regression. A linear regression is used to create models that can in turn be used to make predictions.

As current CO_2 levels have already caused problems in communities around the world, ask students to research *climate resilience* and then brain storm a project where students use design thinking to develop a resiliency plan to combat issues that are prevalent in their own community.

USEFUL LINKS

Charles Keeling and the Keeling Curve
www.earthobservatory.nasa.gov/IOTD/view.php?id=5620

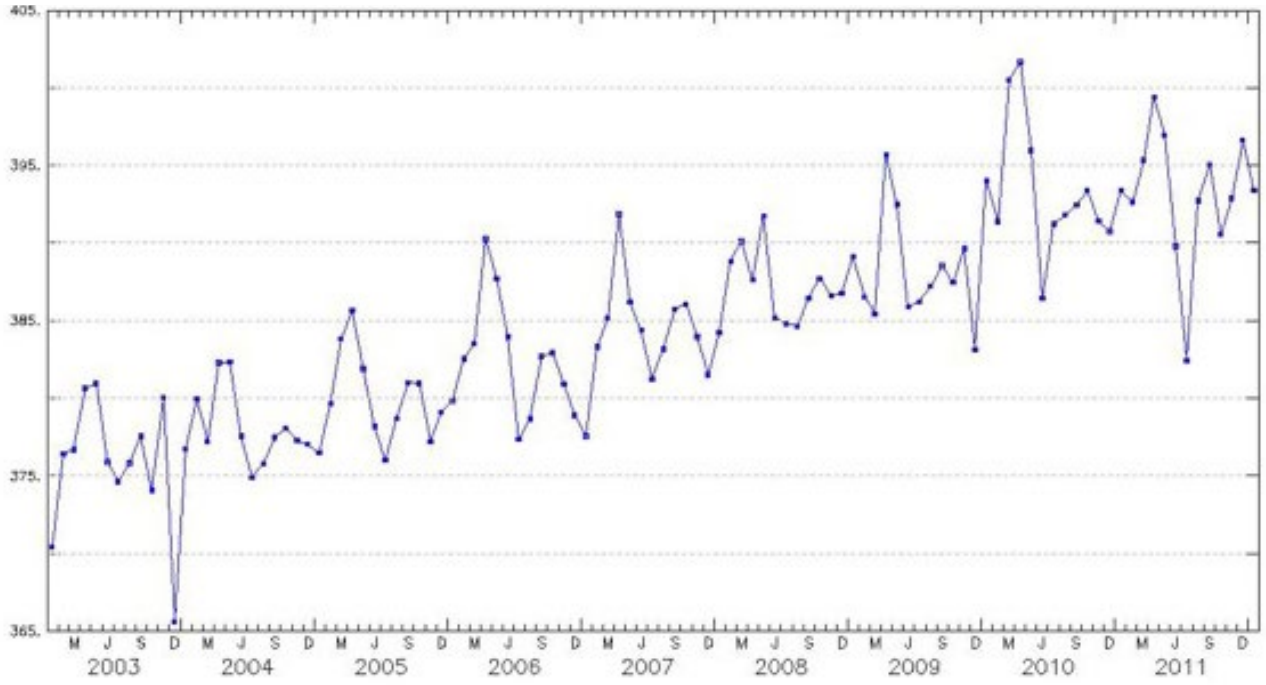
The Mauna Loa Observatory
www.earthobservatory.nasa.gov/IOTD/view.php?id=43182

NASA's Earth Observatory-Carbon Cycle
www.earthobservatory.nasa.gov/Features/CarbonCycle/page1.php

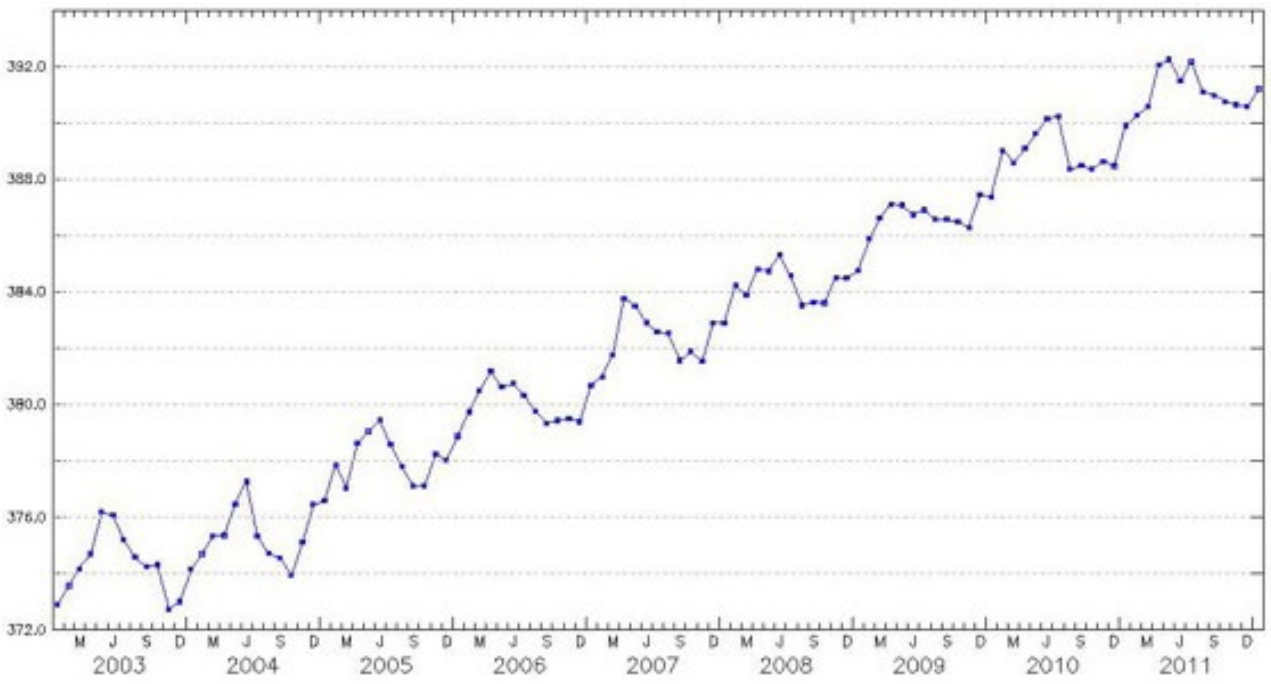
Changing the Global Land Surface: The Carbon Cycle
http://earthobservatory.nasa.gov/Features/LandSurface/landsurface2.php

STUDENT HANDOUT: TIME SERIES GRAPHS

From NASA



ALASKA



HAWAII

STUDENT HANDOUT: RAW DATA

ALASKA

VARIABLE : Monthly Carbon Dioxide in Troposphere (AIRS) (ppmv)
DATA SET : Monthly CO_2 present in free troposphere - mole fraction
FILENAME : AIRS_CO_2_2a.nc
FILEPATH : /usr/local/fer_data/data/

SUBSET : 109 points (TIME)
LONGITUDE : 155W(-155)
LATITUDE : 64N 155W 11

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15-FEB-2003 00 / 6: 376.4353
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15-APR-2003 00 / 8: 380.6300
15-MAY-2003 00 / 9: 380.9584
15-JUN-2003 00 / 10: 375.8938
15-JUL-2003 00 / 11: 374.6334
15-AUG-2003 00 / 12: 375.8104
15-SEP-2003 00 / 13: 377.5467
15-OCT-2003 00 / 14: 374.0693
15-NOV-2003 00 / 15: 380.0177
15-DEC-2003 00 / 16: 365.6154
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15-AUG-2004 00 / 24: 375.7609
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17-APR-2010 00 / 92: 401.6402
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17-JUN-2010 00 / 94: 386.4220
18-JUL-2010 00 / 95: 391.2125
18-AUG-2010 00 / 96: 391.7865
18-SEP-2010 00 / 97: 392.4496
18-OCT-2010 00 / 98: 393.3792
18-NOV-2010 00 / 99: 391.3990
18-DEC-2010 00 / 100: 390.7358
18-JAN-2011 00 / 101: 393.3856
18-FEB-2011 00 / 102: 392.6411
20-MAR-2011 00 / 103: 395.3235
19-APR-2011 00 / 104: 399.4000
17-MAY-2011 00 / 105: 396.9562
17-JUN-2011 00 / 106: 389.7890
17-JUL-2011 00 / 107: 382.4240
17-AUG-2011 00 / 108: 392.7155
17-SEP-2011 00 / 109: 395.0720
17-OCT-2011 00 / 110: 390.5422
17-NOV-2011 00 / 111: 392.8886
17-DEC-2011 00 / 112: 396.6170
17-JAN-2012 00 / 113: 393.3843

STUDENT HANDOUT: RAW DATA

HAWAII

VARIABLE : Monthly Carbon Dioxide in Troposphere (AIRS) (ppmv)
DATA SET : Monthly CO_2 present in free troposphere - mole fraction
FILENAME : AIRS_CO_2_2a.nc
FILEPATH : /usr/local/fer_data/data/

SUBSET : 109 points (TIME)
LONGITUDE : 155W(-155)
LATITUDE : 20N 155W 11

15-JAN-2003 00 / 5: 372.8897	15-NOV-2005 00 / 39: 378.2187	15-SEP-2008 00 / 73: 383.6272	17-JUL-2011 00 / 107: 392.1575
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15-OCT-2003 00 / 14: 374.2972	15-AUG-2006 00 / 48: 379.7600	15-JUN-2009 00 / 82: 386.7289	
15-NOV-2003 00 / 15: 372.7190	15-SEP-2006 00 / 49: 379.3243	15-JUL-2009 00 / 83: 386.9052	
15-DEC-2003 00 / 16: 372.9993	15-OCT-2006 00 / 50: 379.4220	15-AUG-2009 00 / 84: 386.5586	
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15-FEB-2004 00 / 18: 374.6946	15-DEC-2006 00 / 52: 379.3897	15-OCT-2009 00 / 86: 386.4827	
15-MAR-2004 00 / 19: 375.3228	15-JAN-2007 00 / 53: 380.6767	15-NOV-2009 00 / 87: 386.2778	
15-APR-2004 00 / 20: 375.3385	15-FEB-2007 00 / 54: 380.9804	15-DEC-2009 00 / 88: 387.4337	
15-MAY-2004 00 / 21: 376.4558	15-MAR-2007 00 / 55: 381.7544	15-JAN-2010 00 / 89: 387.3593	
15-JUN-2004 00 / 22: 377.2597	15-APR-2007 00 / 56: 383.7555	15-FEB-2010 00 / 90: 389.0169	
15-JUL-2004 00 / 23: 375.3340	15-MAY-2007 00 / 57: 383.4895	17-MAR-2010 00 / 91: 388.5818	
15-AUG-2004 00 / 24: 374.7002	15-JUN-2007 00 / 58: 382.8996	17-APR-2010 00 / 92: 389.0831	
15-SEP-2004 00 / 25: 374.5474	15-JUL-2007 00 / 59: 382.5660	17-MAY-2010 00 / 93: 389.6018	
15-OCT-2004 00 / 26: 373.9273	15-AUG-2007 00 / 60: 382.5318	17-JUN-2010 00 / 94: 390.1446	
15-NOV-2004 00 / 27: 375.0891	15-SEP-2007 00 / 61: 381.5507	18-JUL-2010 00 / 95: 390.2146	
15-DEC-2004 00 / 28: 376.4454	15-OCT-2007 00 / 62: 381.8661	18-AUG-2010 00 / 96: 388.3418	
15-JAN-2005 00 / 29: 376.5788	15-NOV-2007 00 / 63: 381.5222	18-SEP-2010 00 / 97: 388.4791	
15-FEB-2005 00 / 30: 377.8527	15-DEC-2007 00 / 64: 382.8930	18-OCT-2010 00 / 98: 388.3397	
15-MAR-2005 00 / 31: 377.0301	15-JAN-2008 00 / 65: 382.8894	18-NOV-2010 00 / 99: 388.6274	
15-APR-2005 00 / 32: 378.6218	15-FEB-2008 00 / 66: 384.2136	18-DEC-2010 00 / 100: 388.4611	
15-MAY-2005 00 / 33: 379.0384	15-MAR-2008 00 / 67: 383.8749	18-JAN-2011 00 / 101: 389.8978	
15-JUN-2005 00 / 34: 379.4381	15-APR-2008 00 / 68: 384.7963	18-FEB-2011 00 / 102: 390.2631	
15-JUL-2005 00 / 35: 378.5644	15-MAY-2008 00 / 69: 384.7279	20-MAR-2011 00 / 103: 390.5830	
15-AUG-2005 00 / 36: 377.7869	15-JUN-2008 00 / 70: 385.3041	19-APR-2011 00 / 104: 392.0450	
15-SEP-2005 00 / 37: 377.0925	15-JUL-2008 00 / 71: 384.5690	17-MAY-2011 00 / 105: 392.2464	
15-OCT-2005 00 / 38: 377.1080	15-AUG-2008 00 / 72: 383.5121	17-JUN-2011 00 / 106: 391.4822	

ICE-ALBEDO FEEDBACK

LESSON SUMMARY

The Earth has an average albedo, which describes how much sunlight is reflected on average for the whole planet and throughout an entire year. How fast the planet warms in response to adding greenhouse gases to the atmosphere depends in part on climate feedbacks. These natural processes can amplify/hasten the warming - a positive climate feedback - or counteract some warming - a negative climate feedback. How snow and ice respond to warming and the resultant impact on surface albedo is an important positive climate feedback. As the climate warms, snow and ice melt - the earth's surface becomes less reflective-especially if sea ice melts revealing open ocean, which is very dark, more solar energy is absorbed by the Earth's surface rather than being reflected back to space, causing the temperature to increase and the cycle to continue. What could be the causes for current trends and what role do both seasonal and human-caused activity play?

LEARNING OBJECTIVES

STUDENTS WILL:

- Use National Snow and Ice Data Center, NSIDC, data to analyze the connection between snow-ice cover and trends in albedo.
- Predict impacts from continued loss of Earth's reflectivity.
- Develop a solution to bring attention to or design a resilience focused product through a civic engagement, communications or green infrastructure lens.

TIME NEEDED

- 1 class period
- Part 3 will require more time either in class or independently.

MATERIALS

- Science notebook
- Computer with internet access
- Student Handout: Arctic Sea Ice

WHAT YOU DO

PART 1

1. Review surface reflectivity, the darker the surface the more solar radiation is absorbed. Inform students they will be applying that concept to their work today.

2. Have students define sea ice minimum, maximum and extent in their science notebook and sketch a visual to accompany the definition. Students may reference Quick Facts on Arctic Sea Ice

PART 2

1. In pairs or small groups, provide students with two graphics: a) Arctic sea ice extent from 1979 to 2017 as a time series, and b) the other graphic shows a map, Arctic Sea Ice Extent, NSIDC from 1987 to 2017. Have students discuss the similarities and differences between the two maps, and remind them to be thinking about what is happening to Earth's surface in terms of reflectivity over the years. Have a class discussion about their observations, specifically about the relationship between Earth's surface and solar radiation.

2. Share the same data students observed, now as an animation, Arctic September sea ice extent, 1979-2016. Provide students with the term "albedo" and explain through their observations and discussions, they have been looking at changes in albedo at a high level. Albedo is defined as a non-dimensional, unit less quantity that indicates how well a surface reflects solar energy. Albedo (Î±) varies between 0 and 1. Albedo commonly refers to the "whiteness" of a surface, with 0 meaning black and 1 meaning white (NSIDC). Learn more about the thermodynamics of albedo.

PART 3

1. Have students research and identify the important role sea ice plays for Arctic wildlife and communities, such as those off the coasts of Alaska's Beaufort Sea. For example (polar bears need sea ice to hunt.) How does the decline in sea ice impact not only local communities, but communities around the nation? Use the U.S. Arctic Council Chairmanship initiative's blog, Our Arctic Nation as one resource to help students with their research.

2. Encourage students to use design thinking to develop a civic, communications or green infrastructure solution to combat impacts associated with a decline in Arctic sea ice.

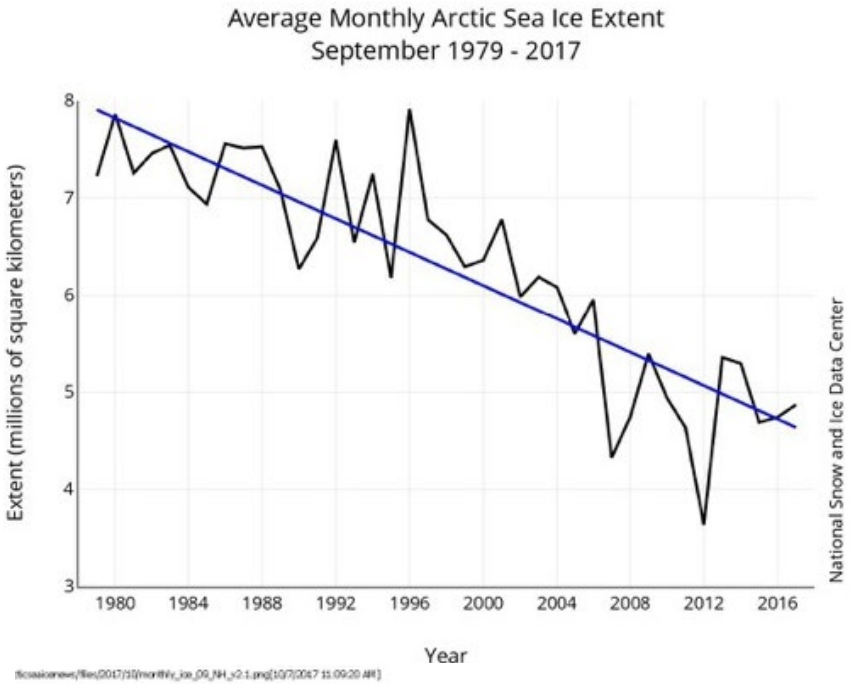
USEFUL LINKS

Energy Budget Explanation
www.mynasadata.larc.nasa.gov/radiation-energy-transfer/

PBS Learning – What is Albedo? and Earth's Albedo and Global Warming
www.kera.pbslearningmedia.org/search/?q=albedo

Reading: NASA's Earth Observatory-The Relationship between Snow Cover and Net Radiation
www.earthobservatory.nasa.gov/GlobalMaps/view.php?d1=MOD10C1_M_SNOW&d2=CERES_NETFLUX_M

STUDENT HANDOUT: SEA ICE EXTENT



Note: These graphics can be seen online as long as students have a 1:1 or 2:1 computer ratio, projected in class or otherwise printed in color.

WEATHER AND CLIMATE

LESSON SUMMARY

Students commonly use weather and climate interchangeably, but while there is a relationship, the two terms are not synonymous. Weather is what we experience on a daily basis. It helps us decide what we should wear for the day or what to bring on a vacation the following week. Weather is a prediction based on a variety of data collected in a variety of ways from ground stations to radars and weather maps are created to help us understand what to expect based on the evidence compiled by meteorologists. Climate on the other hand allows us to see long term patterns in weather data collected over time. Climate can tell us many things from seasonal information and planting zones to increases in global temperatures or carbon dioxide. Students will analyze weather and climate maps to develop a better understanding of each terms unique qualities and develop an understanding of the relationship between weather and climate.

LEARNING OBJECTIVES

1. Analyze weather and climate maps
2. Use secondary resources to help define weather and climate.
3. Create a model showing the relationship between weather and climate.

TIME NEEDED

- 1-2 class periods or (2) 50 minute time blocks

MATERIALS

- Science notebook
- Student Handout: Weather and Climate Maps

WHAT YOU DO

Survey the students by asking for a thumbs up or down response to the following question. “Weather and climate are the same. Thumbs up for true, thumbs down for false”. Record the responses and hold them till later.

Ask students to write down a definition for both weather and climate in their science notebook and hold their responses till later.

Distribute Student Handout: Weather and Climate Maps (either digitally or hard copy) to each pair or small group of students. Ask them to detail in their science notebooks the similarities and differences between each map as well as, the specific information or data that can be concluded from each.

Have a class discussion starting with current definitions for weather and climate and then moving into the unique qualities of both maps. Facilitate the discussion by asking. Which is the weather map and which is the climate map? How do you know? What are their defining characteristics? What's the relationship between them? How do scientists use these maps? How do scientists use these maps to communicate to the public?

Take the survey again asking the same question and record the thumbs up and thumbs down. Has understanding of weather and climate changed? How so?

Ask students to create a model using a method they choose that will communicate:

- The difference between weather and climate.
- The relationship between weather and climate.
- Why understanding weather and climate helps communities understand climate change and increases our scientific literacy.

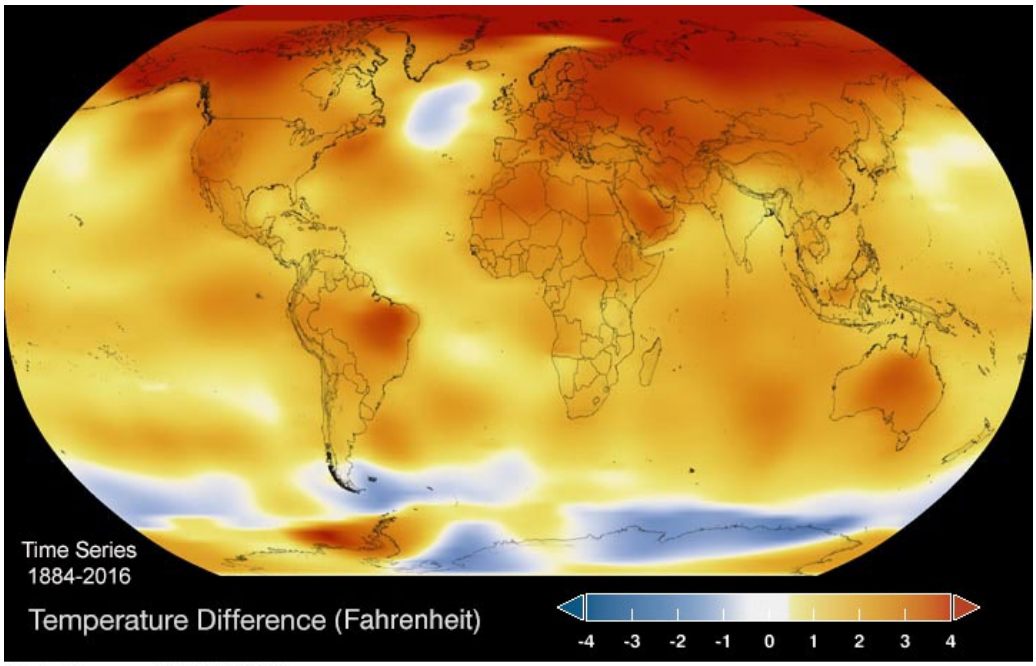
USEFUL LINKS

Climate Wizard
www.climatewizard.org/

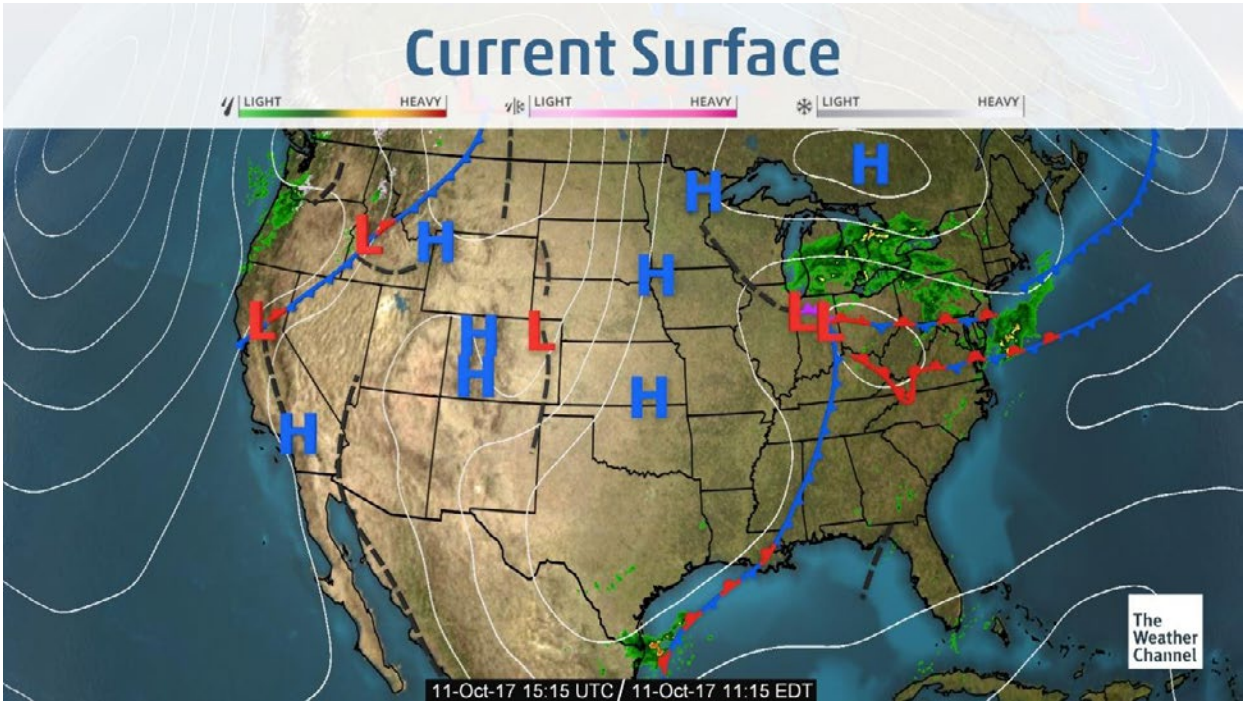
U.S. Satellite Maps
www.weather.com/maps/ussatellitemap

Neil deGrasse Tyson – Weather Versus Climate Change (2 minute video)
www.channel.nationalgeographic.com/cosmos-a-spacetime-odyssey/videos/weather-versus-climate-change/

STUDENT HANDOUT: WEATHER AND CLIMATE MAPS



Data Source: NASA/GISS
Creidt: NASA Scientific Visualization Studio



Note: These graphics can be seen online as long as students have a 1:1 or 2:1 computer ratio, projected in class or otherwise printed in color.

SEA-LEVEL RISE

SUMMARY

Sea level rise is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers and the expansion of sea water as it warms. This fact is compounded by impacts from hurricanes leading to wide spread destruction and hitting our most vulnerable communities the hardest. Students will use NOAA's Sea Level Rise digital coastal viewer to explore sea level rise and social vulnerability.

LESSON OBJECTIVES

STUDENTS WILL:

- Define vulnerability and climate resilience.
- Explore and identify the most vulnerable communities to be impacted by sea level rise.
- Research climate resiliency plans and collect input and support from the community.
- Use design and systems thinking to translate research and understanding of sea level rise into resiliency-based solutions for their community or nearest coastal location.

TIME NEEDED

- 3-4 class periods or ~3 hours

MATERIALS

- Science notebook
- Computer with internet access
- Student Handout: V Model of Engineering Design
- Student Handout: Sea Level Rise

WHAT YOU DO

- Have a discussion about the paragraph below and share the before and after images of Hurricanes Harvey, Irma and Maria.
- In *An Inconvenient Sequel: Truth to Power*, Al Gore spends time in downtown Miami where nuisance flooding is common place and is causing problems for communities and the municipality. We are also reminded how sea level rise and storm surge, fueled by climate change, increased the devastating impacts of Superstorm Sandy.

INSERT DYNAMIC SLIDES OF FLOODING IN MIAMI AND MANHATTAN.

But in the recent past, the U.S has been hit by incredibly powerful and devastating hurricanes Harvey, Irma and Maria. While the U.S. has always experienced severe storms, the increases in sea surface temperatures and global air temperatures in conjunction with increases in sea-level rise due to land and sea ice melt are having serious consequences for coastal communities around the nation.

- Hurricane Harvey practically stopped over southeast Texas dropping 51.88 inches of rain in Parts of Houston Texas.
- Hurricane Irma hit the Leeward Islands. The strongest storm ever recorded.
- Hurricane Maria dropped over 20 inches of rain on Puerto Rico. As a result the entire island's communication's infrastructure was knocked out. 1.53 million people were left without access to drinking water.

Students will begin to investigate the relationship between sea level rise and social vulnerability. Students will use the Digital Coastal Viewer to define vulnerability and contemplate specific social vulnerability variables including gender, race, wealth, age, disabilities, employability and access to health insurance. As students use the viewer to identify coastal areas at greatest risk from sea level rise, they need to understand the viewer does not take into account impacts from severe weather, such as hurricanes, and therefore should be mindful of the added impacts storm surge and flooding rains will have on communities as they make their observations, draw conclusions and develop resiliency plans.

1. Launch the Digital Coastal Viewer.
2. Have students define "vulnerability". Refer to Student Handout: Sea Level Rise, Figure 1. Use the letter "i" icon on your screen to assist with defining the term.
3. Insert an address of interest, either the school address or search our current Eco-Schools USA, for a coastal school that may be vulnerable to the impacts associated with sea level rise. See Student Handout: Sea Level Rise, Figure 2.
4. Next use the MHHW toggle, see Student Handout: Sea Level Rise, Figure 1, to show how community vulnerability is impacted as sea levels rise.

MHHW is defined as the elevation of the highest predicted astronomical tide expected to occur at a specific tide station. Have students make written observations in their science notebook as to how vulnerability changes as sea level rise reaches 1 foot to 6 feet. Students should conclude their observations with the relationship between sea level rise and impacts to communities. Remind students to keep the social vulnerability variables, referenced above, in mind.

Have student pairs share their results within small groups, then move on to a larger whole class discussion about their conclusions. What new questions do students have? Are they inspired or motivated to take action? Have small groups use research "resiliency" and "resiliency plans and then use design thinking (which focuses on building something better and incorporates the use of empathy interviews to understand the feelings and motives of the groups or communities being designed for), to develop models, outreach programs, or any innovative resources with the potential to positively impact communities by combating sea level rise.

USEFUL LINKS

Before and After Photos: Harvey's devastating floods are clearly visible from space
www.mashable.com/2017/08/31/satellite-before-after-photos-harvey-flood-texas/#XfWUWvFyTPq2

Before and After Photos: Hurricane Irma aerial images show extreme destruction along Florida Coast
www.accuweather.com/en/weather-news/before-and-after-hurricane-irma-aerial-images-show-extreme-destruction-along-florida-coast/70002720

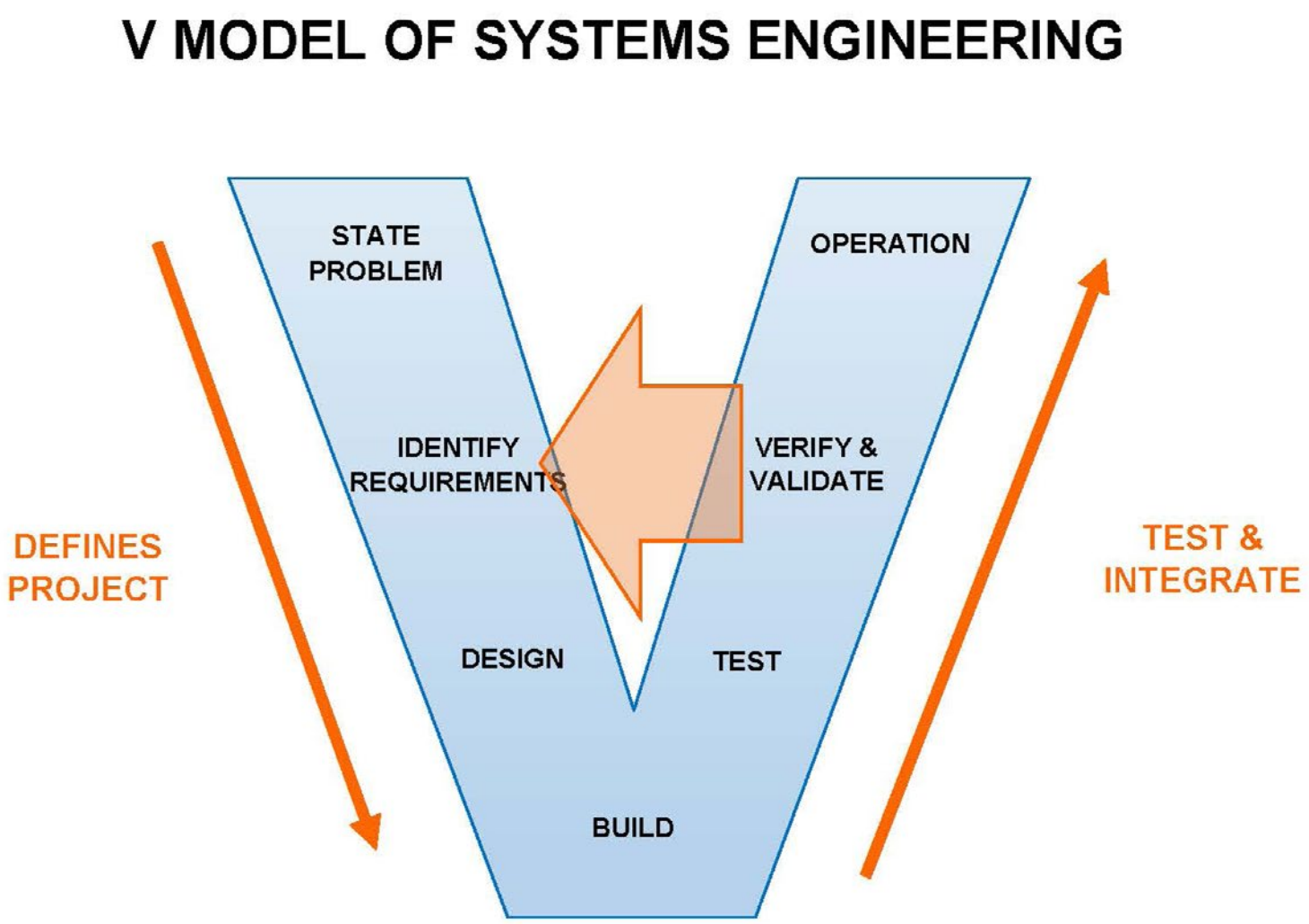
Before and After Photos: September 2017: Hurricane Maria
NASA- Rising Seas-Frontiers of Climate Science
www.nasa.gov/goddard/risingseas

NASA-Vital Signs of the Planet, Sea Level Rise
www.climate.nasa.gov/vital-signs/sea-level/

NOAA-Blue Carbon, Green Infrastructure, Biodiversity and Human Health: Science to support coastal conservation and resilience
www.youtube/JOTmGVfYdxw?t=5m25s

Business Insider, How Miami has prepared for sea level rise and monstrous hurricanes like Irma
www.businessinsider.com/miami-hurricane-irma-sea-level-rise-preparation-2017-9

STUDENT HANDOUT: V MODEL OF ENGINEERING DESIGN



STUDENT HANDOUT: SEA LEVEL RISE

From NOAA

Figure 1

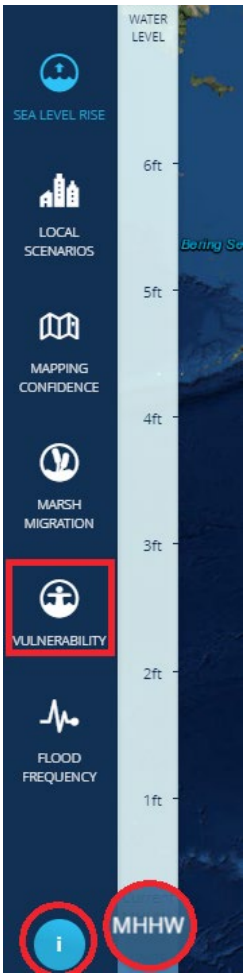
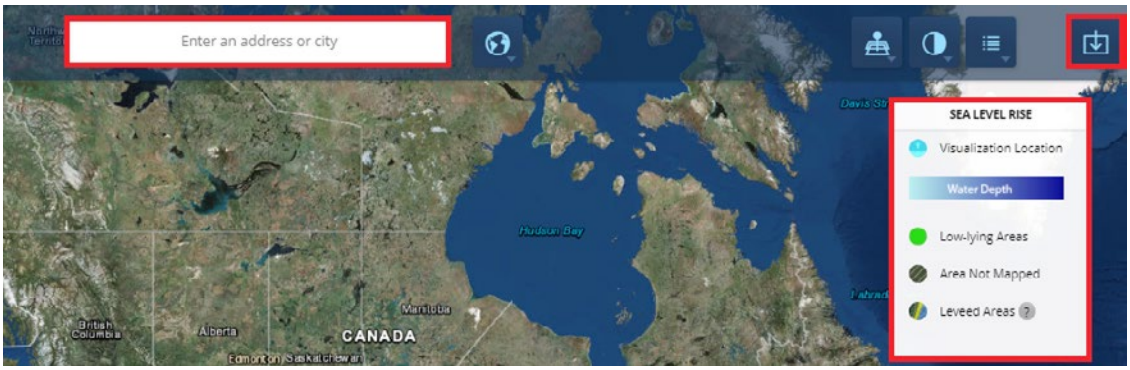


Figure 2



EXTREME WEATHER EVENTS

LESSON SUMMARY

Scientist project global warming will bring more uncertainty, potentially causing both more extremely dry periods and more heavy rainfall events. These extreme events will exacerbate the problems we face with water management, agriculture, human health and consequently the economy. Students will analyze national and state drought maps and investigate how these conditions impact communities around the country.

LEARNING OBJECTIVES

STUDENTS WILL:

- Analyze drought maps and examine impacts on state resources.
- Investigate drought's impact on communities through personal narratives.
- Develop a solution to implement during times of extreme drought or to build resilience to drought conditions through civic engagement, communications or green infrastructure.

TIME NEEDED

- 1 class period or 50 minute block of time

MATERIALS

- Science notebook
- Computer with internet access
- Student Handout: U.S. Drought Monitor

WHAT YOU DO

PART 1

On the projection system, share the Student Handout U.S. Drought Monitor's map for October 5, 2017. Have a class discussion about the data provided and conclusions that can be drawn. To analyze your own state follow this link, and from the drop down menu, "Area Type", choose state and continue to narrow your results.

Now supply student pairs or small groups, the two week comparison map from Student Handout: U.S. Drought Monitor. Ask students to make comparisons between the two weeks and organize their observations in there science notebook. Also ask them to discuss the implications drought may have on the environment, communities and the economy. What evidence do they have to support their mental model?

PART 2

Discuss with students the various images from the film of extreme weather events such as drought in Syria and "rain bombs" in Arizona. You may also have students watch the following three clips from season 1 of *Years of Living Dangerously*. Encourage them to listen carefully and to take notes. After each clip allow students to debrief within a small group before taking the discussion to the whole class. Target questions around drought's impact on the environment, society and the economy.

- Climate Wars: Egypt, 4:01
- Climate Wars: Yemen, 2:11
- Pray for Rain, 3:01

PART 3

Using design thinking and the process of engineering design, develop a solution that can help communities or countries deal with increasing negative impacts from extremes in temperature and precipitation patterns.

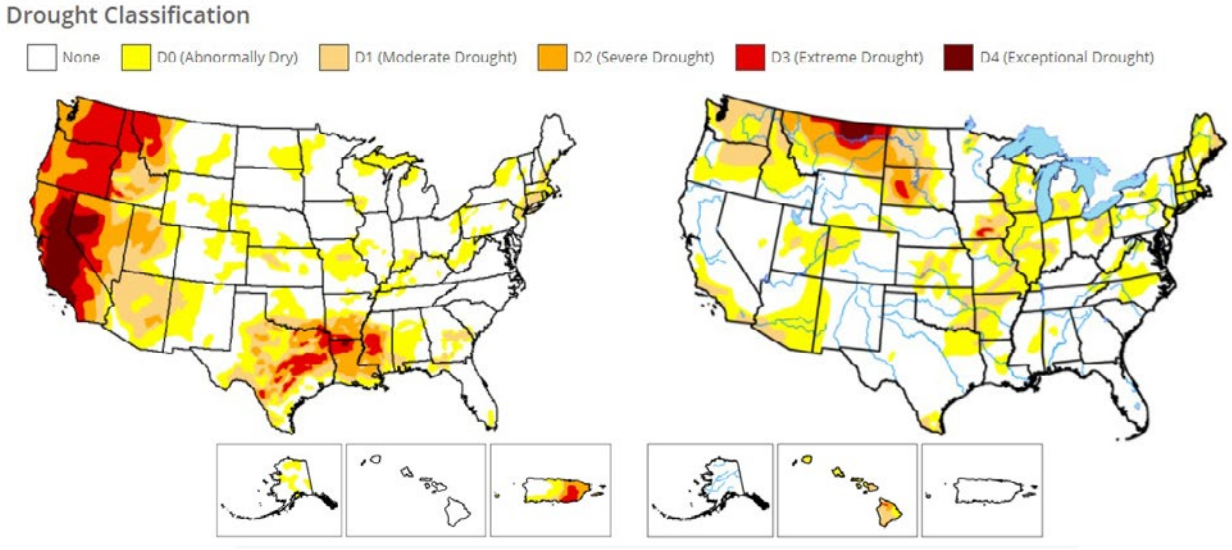
USEFUL LINKS

Thirty-Five Years of Dry Spells
www.nature.com/nature/journal/v501/n7468_supp/interactive3/drought-map.html

Drought and Health
www.cdc.gov/nceh/drought/

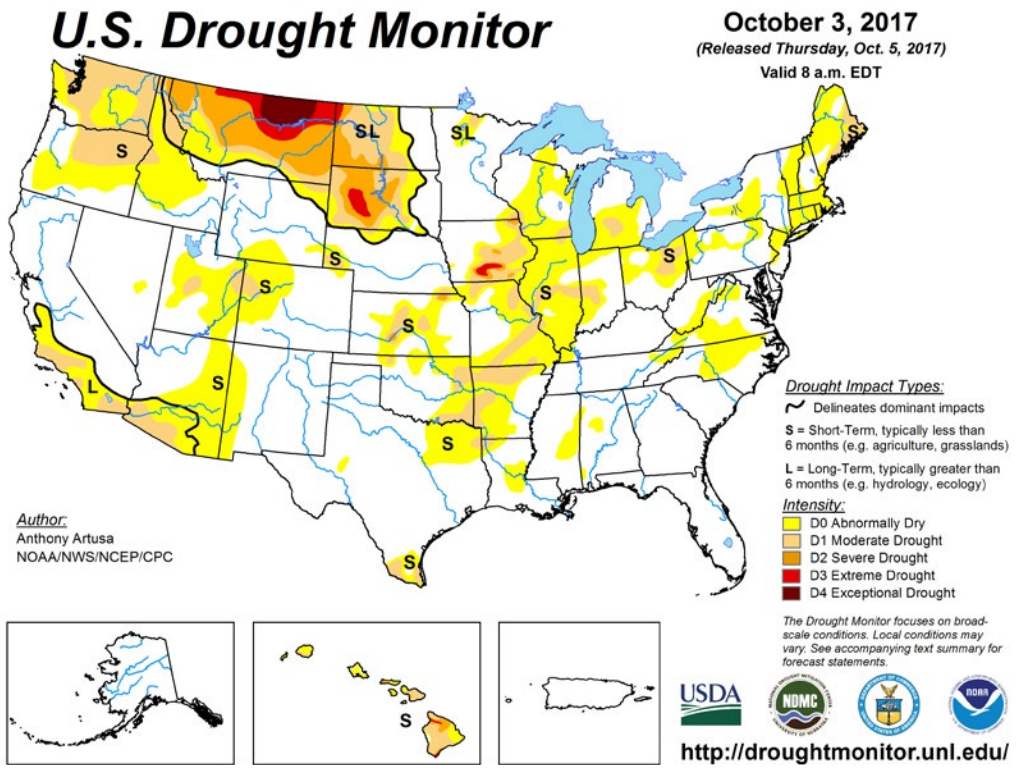
Current Data and Information on Climate Change
www.climate.nasa.gov

STUDENT HANDOUT: U.S. DROUGHT MONITOR



Statistics Comparison

Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4	DSCI
2015-10-06	53.08	46.92	26.42	17.96	10.06	2.56	104
2017-10-03	67.37	32.63	12.12	3.98	1.17	0.42	50



INVESTIGATING SOLAR AND WIND ENERGY

SUMMARY

Renewable energy sources, such as solar and wind, are harnessed through innovative technologies to help reduce carbon dioxide emissions that cause climate change. Students will analyze solar and wind data to determine if solar and/or wind energy technologies makes sense in their part of the nation and then determine the schools potential return on investment for integrating or transitioning to renewable energy as a part of the school's energy portfolio.

LESSON OBJECTIVES

STUDENTS WILL:

1. Access and analyze solar and wind data to estimate energy potential using the school's latitude and longitude.
2. Use design thinking to identify where solar and/or wind energy could be used to help members of the community.
3. Develop a feasibility report that will determine the viability of integrating or transitioning to solar and/or wind at school or that will determine the viability of your community needs-based renewable energy design. A feasibility report also includes a determination of the legal, technical and economic viability of an idea using evidence to justify your goals.

TIME NEEDED

- 2-3 class periods or 2 ½ hours, based on 50 minute class periods

MATERIALS

- Science notebook
- Computer with internet access
- Phone and/or other ways to conduct interviews or make inquiries.
- Student Handout: Solar and Wind Legend

WHAT YOU DO

1. Have a discussion about renewable energy use in the United States, both commercial and residential. What are student's current mental models around renewable energy use?
2. What are the potential impacts to a school or school district in using solar and/or wind energy? Think about the environmental, community and economic impacts. Think back to *An Inconvenient Sequel: Truth to Power* and to the World Climate simulation. Why were some countries pushing back on renewable energy?

3. Investigate wind and solar potential at your school. Use the "Layers/Legends" to click on "solar" under "views". Next use the "Find address" button to put in the zip code for the community in which the school resides. Record your solar potential in kWh/m2/Day Solar Resources. Now choose "remove all layers" and click on "wind" under "views". Typically the mapping system also shows wind plants. Unclick "wind plants" in the Layers/Legends" so you have a better view of the wind potential in your zip code. If needed find your address. Record your wind potential. Use the Student Handout: Solar and Wind Legend to determine if continued research is warranted.

4. If your school and surrounding community appear to be candidates for solar and/or wind have teams of students determine who from the community could help them develop a feasibility project, such as district energy managers, municipality utilities, solar and wind businesses, etc. Also encourage students to develop a model showcasing innovative ways in which solar and wind can be installed, utilized as real-world learning opportunities for students at the school and as a community engagement resource.

USEFUL LINKS

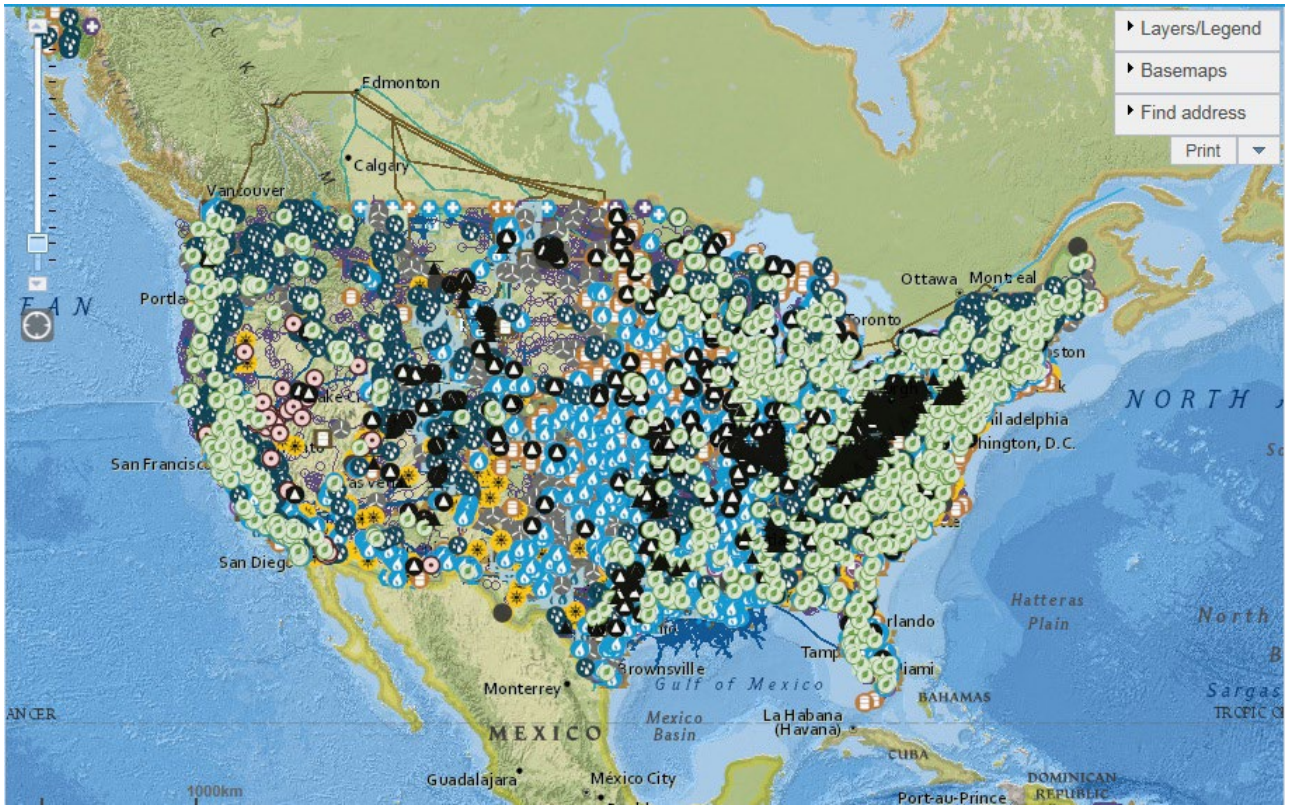
How clouds affect radiation
www.earthobservatory.nasa.gov/Features/Clouds/

Wind and Altitude
www.classzone.com/books/earth_science/terc/content/investigations/es1702/es1702page09.cfm

National Renewable Energy Laboratory, NREL
www.nrel.gov/gis/data.html

The Star School, Schooling Off the Grid
www.starschool.org/solar-wind-power/

STUDENT HANDOUT: SOLAR AND WIND LEGEND



Solar Resources
- 0 - 2.5 kWh/m2/Day Solar Resources
- 2.5 - 3.0
- 3.0 -3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- 6.0 - 6.5
- 6.5 - 7.0

On Shore 50 Meter Tower Wind Potential
- 7 Superb On Shore Wind Potential
- 6 Outstanding
- 5 Excellent
- 4 Good
- 3 Fair
- 2 Marginal
- 1 Poor

LEGEND FOR SOLAR AND WIND POTENTIAL
SOURCE: EIA.GOV

PART III: ACT LIKE YOUR WORLD DEPENDS ON IT

INTRODUCTION

Through the World Climate simulation and participating in any of the activities created in conjunction with the film, students experience the scale and urgency of climate change mitigation with their classmates, offering an opportunity for rich discussion and for students to support each other as they consider what to do next. Ask students how they may use the knowledge they have gained to address climate change in whatever way they choose – from learning more about the issues to screening the film with family and other students, reducing their own carbon footprint, getting involved in institutional or local sustainability efforts, getting involved in public policy or exploring careers in the new green economy.

LESSON SUMMARY

After watching *An Inconvenient Sequel: Truth to Power* and the Truth in 10 slideshow and after participating in the role-play or in conjunction with any of the activities in the Watch Kit and the Writer's Guide, students will use the knowledge they have gained to address climate change in their personal lives, their school and there community. For example, through the World Climate simulation, students have experienced the scale and urgency of climate change mitigation with their classmates, offering an opportunity for rich discussion and for students to support each other as they consider actions to take.

Student action projects are the most effective method by which students can apply the knowledge they have learned in the classroom and retain this information for the long term. Action projects engage students in solving problems in their communities and schools and help them master curriculum content by making meaningful connections between what they are learning and the world at large. Action projects can also help students develop a range of skills. In addition, projects help students realize that their actions matter, helping to develop their ability to influence others and sense that they can make a difference.

Action projects are designed to impact both the recipients (community members, ecosystems health, etc.) and the students. This transformation is accomplished by combining opportunities that link the project with self-reflection and the acquisition of skills, values and knowledge.

Recent studies indicate that students are more receptive to learning when their surroundings and activities complement and reinforce the subject matter. For example, if students are taught the principles of recycling and waste reduction and there are no efforts being made to reduce waste in the school, it is unlikely that the lessons taught will have a significant effect. However, in many cases when recycling is taught in conjunction with an existing waste reduction program, or if students start reusing paper or implement other sustainable practices, they will better understand resource management and change their behavior at school and at home.

Action projects can include fairly simple individual behaviors as well as more comprehensive school-wide events and community activities. The scale of the project does not always determine its merit. For action projects to be significant for all involved, they need to be well-researched, outcome-oriented, planned, communicated, well-promoted and evaluated.

The following are examples of individual and group projects for students who are empowered to drive real change in their community through place-based problem solving and civic action. (Periodically check the website for case studies on student-led climate solution projects.

"This movement is in the tradition of every great movement that has advanced humankind."

— Vice President Al Gore

LEARNING OBJECTIVES

STUDENTS WILL:

- Analyze data using tools, technologies, or models, in order to make scientific claims or determine solutions.
- Design, evaluate, or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, and other criteria.
- Increase engagement and content knowledge at the heart of sustainability, through instruction strategies that are place- and problem-based and integrate the tenets of design thinking.
- Communicate scientific or technical ideas in multiple formats.

TIME NEEDED

- 2 to 4 class periods or several hours after school (providing out of class time for research and planning by students)
- Various possible extensions for semester and year-long projects

MATERIALS

- Varies with each project

WHAT'S YOUR PLAN

After watching *An Inconvenient Sequel: Truth to Power* and learning how human activity has caused global warming, people express feelings of wanting to do something to reduce the threats of climate change. Students should be encouraged to think critically about their carbon footprint and how their daily activities and choices directly and indirectly contribute to global warming.

There are several ways to facilitate how your students analyze their carbon footprint. Each student could keep a journal to document their impact or you build a list as part of a class discussion. Students could calculate their carbon footprint using a worksheet or an online calculator. (There are several online www.ei.lehigh.edu/learners/cc/carboncalc.html.

Start a discussion about the ways students may reduce their carbon footprint or offset the amount of carbon emissions by doing things differently.

On the board draw four columns, label the first column *Activity* and label the remaining columns *One, Two* and *Three*. Have students list an activity that emits carbon and then share the carbon dioxide-reducing new technology or strategy they find. As a group, have the students rate each item for how well it reduces carbon dioxide emissions, 1 = excellent, 2 = good and 3 = not very good. Give the example of the amount of carbon reduced by replacing one incandescent light bulb with CFL or LED and compare that option with natural light in the day, timers on lights and solar or wind power. Discuss the ways we can lower or offset carbon emissions from the chart. Are there any controversies over how to rank carbon-reducing technologies and strategies? Are some strategies and technologies more viable than others?

This should help students realize the range of options they have in everyday life to reduce carbon output, and that the most important lesson is to think critically and be able to evaluate carbon-producing activities and corresponding solutions. Using the systems thinking approaches in the Watch Kit ask students how their findings expanded their view of climate change. Conclude with discussing how individuals, a family, a class, a school and their wider community can have a big impact. Discuss the hopeful themes of taking action now and at scale to address climate change.

TAKE A STAND

Journalism is the activity of gathering, assessing, creating and presenting news and information. Journalists are committed observers whose work is to find and present "the facts" and also the "truth about the facts." -American Press Institute

The following are projects that encourage students to use their voice and hone effective writing and communication skills:

Start a **letter writing campaign** to corporations or to local and national government officials about the need to address climate change.

Create a **blog or newsletter** for your school to highlight things that could be changed, garner support for new energy-saving initiatives and celebrate successes.

Organize a **school or community fair** with speakers, activities and demonstrations of new green technologies.

Share you stories and **write letters to the editor** for your local newspaper.

Enter Young Reporters for the Environment (YRE contest).

YRE is a global competition that aims to empower young people to take a stand on environmental issues they feel strongly about and to give them a platform to articulate these issues through the media of writing, photography and videography. The ultimate goal of young reporters is to highlight environmental injustices, provide a solution and ways the community can be a part of the solution, and get there story out there via digital and social media channels.

- Investigate a local environmental problem or issue
- Research potential solutions that can be thoroughly explained, argued and justified
- Report the issue and solutions through a journalistic media targeting a local audience
- Disseminate work with a local audience via digital periodicals, radio, television, social media, exhibition, film show, etc.

GREEN YOUR SCHOOL

Schools vary in size, age and design all around the world. Whatever type of school, there are a myriad of ways students can study and innovate change to reduce greenhouse gases and the overall environmental impact of their school. By examining energy and water usage, waste, supplies and purchasing, green spaces, food, transportation and proposing solutions to reduce greenhouse gases they will practice hands-on-learning and gain durable climate literacy.

The world's largest green schools program is Eco-Schools. It is in over 60 countries and provides an existing network to support your efforts. In the U.S., Eco-Schools is run by the National Wildlife Federation. Eco-Schools USA focuses on greening existing school buildings, school grounds, curricula, and the student experience. In addition to direct environmental benefits, the program helps to dramatically improve student skills in Science, Technology, Engineering and Math (STEM). It is also a proven framework for promoting youth leadership and community service. Eco-Schools is a holistic program, striving to make environmental awareness and action an intrinsic part of the life and culture of a school and community. Eco-Schools takes learning beyond the classroom walls promoting the use of the school building and grounds as learning laboratories in which to imagine, create, develop and innovate for sustainability.

Eco-Schools is a program of the Foundation for Environmental Education (FEE). Eco-Schools worldwide as members of FEE are partners of the United Nationals Education, Scientific and Cultural Organization (UNESCO) and UNESCO's Global Action Program on Education for Sustainable Development, UNESCO GAP. As members of FEE, the program is aligned to the UN's Sustainable Development Goals (SDGs), goals that call for action by all countries, poor, rich and middle-income to promote prosperity while protecting the planet.

ECO-SCHOOLS IS COMPRISED OF TWO MAIN COMPONENTS:

1. THE PATHWAYS TO SUSTAINABILITY

Students self-select pathways to address issues of sustainability at school and in the larger community. In the United States, green teams can choose from any one or more of our twelve pathways as they work through the 7-Step Framework to create a more sustainable school community.

BIODIVERSITY	CLIMATE CHANGE	CONSUMPTION AND WASTE
ENERGY	HEALTHY LIVING	HEALTHY SCHOOLS
LEARNING ABOUT FORESTS (LEAF)	SCHOOLYARD HABITATS®	SUSTAINABLE FOOD
TRANSPORTATION	WATER	WATERSHEDS, OCEANS AND WETLANDS (WOW)

The Eco-Schools program helps orient students to a more sustainable future and careers. The program is based on a simplified version of the ISO 14001 environmental management process framework. Schools form school-wide teams, conduct audits, and develop action plans. This exposes them to "green" career paths, and facilitates their transition to higher education, the workplace, and adult life. As schools implement their plans, progress is measured helps them reach specific school-wide award levels – Bronze, Silver and Green Flag.

2. THE 7-STEP FRAMEWORK

A series of carefully engineered measures to help schools maximize the success of their Eco-Schools ambitions. The method involves a wide diversity of individuals from the school community – with students playing a primary role in the process.

INTRODUCTION

The Eco-Schools USA Seven Step Framework is designed to be a flexible process and one that any school can implement. You are encouraged within the Framework to implement each of the Seven Steps in a way that suits your school and situation best. The following provides an overview of each step using climate change as the environmental focus area.

Our is to ensure young people are empowered to be the change for sustainability our world needs by engaging them in authentic, action-oriented and socially responsible learning.

FRAMEWORK OBJECTIVES

STUDENTS WILL

- Increase the engagement and content knowledge about topics at the heart of sustainability, through instruction strategies that are place- and problem-based and integrate the tenets of design thinking.
- Be inclusive of the entire school community, within the school walls and into the larger community.
- Improve the school environment and change the culture of the school, becoming increasingly more sustainable and resilient.
- Improve attitudes through actions and activities that cultivate a sense of responsibility and a sustainable mindset on a daily basis.

STEP 1 - ESTABLISH AN ACTION TEAM

The action team is the driving force behind Eco-Schools USA. To combat the threats posed by climate change it's best to assemble a committed team that represents diverse knowledge and skills. Ideally, your action team should represent the whole school community – including people beyond the school walls, such as facilities staff, professors, municipality staff such as those from the water department, city planner's office or environmental protection office, as well as members of the school board and representatives of local businesses.

1. Learn more about the importance of creating an Eco-Action Team.
2. Complete the Student Worksheet: Eco-Action Team Plan.

STEP 2 - CONDUCT AN ENVIRONMENTAL AUDIT

HOW-TO CONDUCT AN ENVIRONMENTAL AUDIT

1. Role Play Activity

    - Using role play is a fun, collaborative learning tool. Instead of laying out the rules your students will follow, have them act out how they should and should not act when conducting environmental audits in a classroom, common area, such as a courtyard or cafeteria, or in the school's offices. The class can then work together to determine "best practice" for conducting audits.
    - Split the class in half. Team A's assignment is to demonstrate how not to conduct an audit at the school and Team B's assignment is to demonstrate how an audit should be conducted at school. Provide each team 5 minutes to devise a plan.
    - At the conclusion of the 5 minutes, ask Team A to role play first while Team B watches from the front of the room and then reverse roles.
    - After both teams have presented, have a class discussion to determine the "best practice" guidelines for conducting an audit.

2. Use the Eco-School USA's School-Based Carbon Calculator to conduct your audit.

What is a Carbon Footprint? "Carbon footprint" is an expression that describes how much carbon dioxide a person (or entity such as a school) releases over time. Assessing your school's carbon footprint is a way to measure the impact your school's activities and behaviors have on the environment. The more energy, paper, and other supplies your school uses, the bigger your school's footprint or impact.

What is a Carbon Calculator? A carbon calculator measures the amount of carbon dioxide, CO2, we contribute to greenhouse gas emissions. The carbon calculator is used to assess climate change because it is a heat-trapping gas that stays in the atmosphere anywhere from decades to thousands of years and over time increases global temperatures.

The Excel worksheet allows students to enter data from the school's climate change audit, calculate carbon emissions both before and after taking action and provide visual tools in the form of charts and graphs to be utilized during classroom instruction and to illustrate classroom and/or school success.

Schools can also use the calculator to challenge other grades or schools in the district to a "Cool School Challenge". The challenge engages students and teachers in practical strategies to reduce CO_2 and other greenhouse gas emissions school-wide by improving energy efficiency, reducing consumption, increasing recycling and changing transportation behaviors.

STEP 3 - DEVELOP AN ACTION PLAN

From the conclusions drawn from conducting the climate change audit, the action team will develop a plan to address issues leading to a reduction in the school's overall carbon footprint. The action plan will include goals, resource expertise, task responsibilities, timeline, and a budget.

Use the Student Worksheet: Eco Action Plan or develop your own template to construct the pathway forward.

STEP 4 - MONITOR AND EVALUATE

To ensure the action team is on the path to reducing their carbon footprint it is critical to monitor and evaluate the team's progress toward each goal. Monitoring and evaluation are intrinsic elements of the action plan and should become routine.

Ask students the following and take an average of their responses. "On a scale of 1-10, use your fingers to show how important you think it is for things to be monitored and evaluated?" Ask students to explain their survey response in their science notebook.

Next ask students to write in their science notebook a "textbook" definition for the words monitor and evaluate. Remind them to not include examples in their definition. (This requires higher level thinking and may be difficult for some students, but will get at how well they understand the terms.)

Next ask students to provide a real example (applied to their own lives) where monitoring and evaluation come into play. Have students discuss their definitions and examples with someone near them.

Have a class discussion, share your own example of the role monitoring and evaluation play in your own work. More importantly, discuss how monitoring and evaluation are intrinsic to meeting carbon reduction goals.

Now ask students again: "On a scale of 1-10, use your fingers to show how important you think it is for things to be monitored and evaluated?" Has their responses changed? What are potential reasons for a shift in thinking?

STEP 5 - CONNECT TO THE CURRICULUM

The overall goal behind Eco-Schools USA is to change the culture of the school, where sustainability is the lens in which all learning takes place. Climate change concepts being taught in the classroom should influence how your school environment operates. Using the school building and grounds as a learning laboratory provides students with authentic, place- and problem-based learning experiences that can have positive impacts on schools carbon footprint and within the greater community.

See Part II: Climate Classroom Connections.

STEP 6 - ENGAGE AND BUILD COMMUNITY

Climate change impacts everyone regardless of race, gender, ethnicity or economic status. Communities are made up of diverse populations with diverse perspectives. Students are well positioned to use their community's diversity as the strength needed in which to build relationships for a stronger, more sustainable community. When students consistently and authentically work to include community members from all walks of life they gain access to dynamic networks, whose end goals are the same; making their place in this world healthier and happier.

Use this blast from the past, Sesame Street's, Who Are the People in Your Neighborhood?" This will get students reminiscing about their childhood and thinking about how the people they know in their neighborhood or community has changed as they have gotten older.

Ask students to define, "community" in their science notebook. Encourage them to think about DSRP when constructing their definition.

Next have students team up in small groups. Everyone share their definition and then as a small group come up with a list of people in the community, obvious and not, who could be instrumental in helping to change the culture of the school and improve community sustainability.

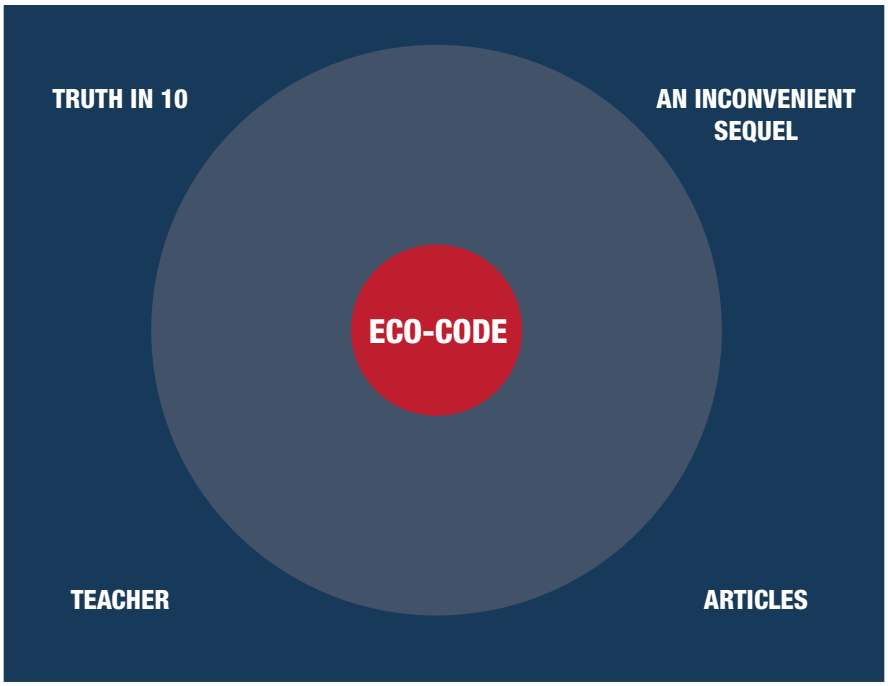
Bring all groups together to make a master list that can be used as a way to engage, include and build community.

STEP 7 - CREATE AN ECO-CODE

The Eco-Code is the school's mission statement and should demonstrate, in a positive, clear and imaginative way, the whole school's commitment to improving their carbon footprint and the overall environmental performance of the school.

Ask students to create a circle map® in their science notebook. The inner circle should read "eco-code". The outer circle will include the descriptors or phrases that come to mind when they think of sustainability at the school. The outer box will include the student's frame of reference; the influences on their current mental model of sustainability.

(create an example like this)



Next have students gather in small groups to develop a circle map that represents the thinking of the group. Each group will then present to the entire class.

As a class, facilitate a discussion and create one thinking map that can be used to develop the school's Eco-Code. This map could be used as part of contest, a way to involve the whole student body in the creation of the final Eco-Code, which could be poem, art installation, a traditional mission statement or any number of products. It's most important the code is student driven and represents the true commitment and passion of the student body, staff, families and community.

Once the Eco-Code is in final form, display it in common areas for all to see.

STUDENT WORKSHEET: ECO-ACTION TEAM PLAN

School Year: _____

Use this sheet to organize your Eco-Action Team (Green Team). Fill in names, roles/tasks, and contact information for each person. **POTENTIAL ROLES:** communications, committee/pathway leaders, auditors, fundraisers, historian/photographers, secretary/evidence of sustainability, progress monitors, volunteer coordinator, publicity, etc. What's most important is that the team and roles work for the school community.

STUDENTS drive National Wildlife Federation's Eco-School's USA program. It is their commitment to "go green", to conserving resources for healthy habitats and sustainable wildlife populations that make the biggest impact. Students should make up the largest component to your Eco-Action Team. The members listed below will add strength and integrity to the work the students are accomplishing.

EDUCATORS	ROLES	CONTACT INFO
1.		
2.		
3.		

ADMINISTRATORS	ROLES	CONTACT INFO
1.		
2.		
3.		

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CUSTODIAL STAFF	ROLES	CONTACT INFO
1.		
2.		
3.		

MAINTENANCE - FACILITIES STAFF	ROLES	CONTACT INFO
1.		
2.		
3.		

PARENTS	ROLES	CONTACT INFO
1.		
2.		
3.		

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LOCAL BUSINESSES/ ORGANIZATIONS	ROLES	CONTACT INFO
1.		
2.		
3.		

RESOURCE EXPERTS/SPECIALISTS	ROLES	CONTACT INFO
1.		
2.		
3.		

REMINDER: Receiving an award from NWF's Eco-Schools USA program requires teams to meet a set of criteria. One of those criteria relate to your Eco-Action Team/Green Team. To receive the Bronze award your Eco-Action Team must be comprised of students and teachers. To receive the Silver your team must be comprised of students, teachers, and community members and to receive the Green Flag the team must include teachers, community members, and school staff, with students making up at least 50% of the team.

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PART IV: AGENTS OF CHANGE - TOWARD A GREEN FUTURE

Finally, whether you completed all of the lessons in this guide or the others, when you conclude your unit on climate change ask your students if they are inspired by the Im. Did it make them think about their future? How did the lesson or project they participated in highlight how they have the power to make a difference ?

All over the planet, an explosion of creativity is resulting in the development of carbon neutral systems and activities to reverse global warming and solve the climate crisis. Sustainability approaches are being pioneered and implements in energy, transportation, agriculture, construction, finance, manufacturing, communication, education, tourism, fashion and the arts. The new green economy has unlimited opportunities. We continue to have an urgent need for the best-known environmental careers–like physicists, chemists, foresters, wildlife biologists and park rangers. These are fantastic career options, but there are so many more.

Our world needs green employees and entrepreneurs in all fields–government, sales and marketing, accounting, information management, human resources, construction and manufacturing, facilities and operations, product design, finance, public relations, risk management-everything! Progressive business leaders are accepting responsibility for assuring ecological health for the planet and social justice for all people. The same transformation is happening in hospitals, schools, universities, government agencies, the military and nonprofit groups.

This is truly a challenging and hopeful time for this generation to take an active role in shaping not only their career path, but to play a role in shaping a sustainable future for everyone.

To meet some of the scientist on the forefront of climate change and more green careers go to www.climateclassroom.org/agents-of-change/.

USEFUL LINKS:

The GLOBE Program, www.globe.gov/

A Partner Program of the United Nations Framework Convention on Climate Change, www.youthclimatereport.org/

UNEP/UNESCO Youth Xchange, www.youthxchange.net/main/lookingahead.asp