



BUILDING CLIMATE UNDERSTANDING: TOOLS AND STRATEGIES



WEB TOOLS



NOAA CLIMATE SERVICES

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



Explore: ClimateWatch Magazine

Data & Services

Climate Science

Education

Search...

Featured Articles



Article One

This is HTML formatted text imported dynamically through XML. You can easlily insert links, email links, change color, font, change font size, and much more!
read more

Browse ClimateWatch Article Archives

Climate Conversations

Browse Video Archives

New ClimateWatch Video series up close conversations with NOAA Scientists



Scientist Name
On climate science and data-based objectivity



Scientist Name
On climate science and data-based objectivity



Scientist Name
On climate science and data-based objectivity

Recent Images

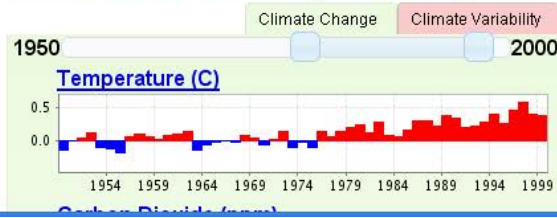
Browse Image Archives

We post pictures all the time, click a thumbnail to view images in gallery



Subscribe to ClimateWatch Media RSS

Global Climate Dashboard (server-side)



CLIMATE WHERE AND WHEN

City, State or Zip

08-19-2009

Lookup

Paleoclimate Data

Climate Timeline Information Tool - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.ngk.noaa.gov/pub/tl/

NOAA Home Page NOAA Webmail Getting Started Latest Headlines

Climate
TimeLine

Data Access | Tutorial | Glossary | About CTL | Site Map

Overview

Today

1 Year

10 Yrs

100 Yrs

1,000 Yrs

10,000 Yrs

100,000 Yrs

Beyond

Search

Go

Done

Exploring Weather & Climate Change Through the Powers of 10

Climate TimeLine Summary

Drag your mouse over the Timeline below for a snapshot of the scientific processes (Climate Science) and events (Climate History) of each period or click on timescale for more

Interannual to Decadal Scale
The oceans, with their great heat capacity and slowly changing properties, give rise to cycles in climate like El Niño and La Niña. Abrupt climatic changes can occur within a ten year period.

Climate Science: Investigating Climatic and Environmental Processes

Climate History: Exploring Climate Events and Human Development

Past Ten Years
ENSO's twin pulses of El Niño warming and La Niña cooling have impacted socio-ecological conditions in many parts of the world.

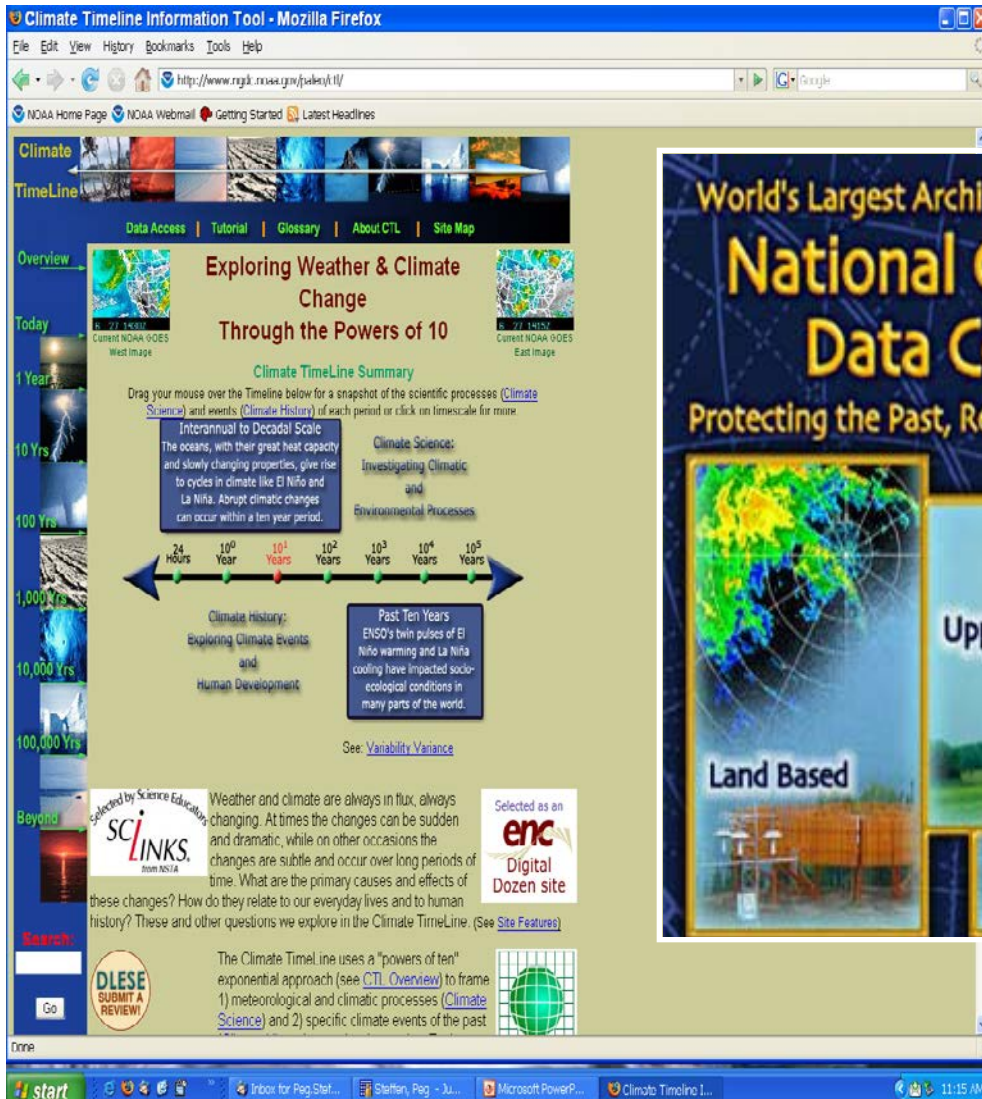
See: [Variability Variance](#)

Selected by Science Education **sciLINKS** from NSTA

Weather and climate are always in flux, always changing. At times the changes can be sudden and dramatic, while on other occasions the changes are subtle and occur over long periods of time. What are the primary causes and effects of these changes? How do they relate to our everyday lives and to human history? These and other questions we explore in the Climate TimeLine. (See [Site Features](#))

Selected as an **enc Digital Dozen** site

The Climate TimeLine uses a "powers of ten" exponential approach (see [CTL Overview](#)) to frame 1) meteorological and climatic processes ([Climate Science](#)) and 2) specific climate events of the past



World's Largest Archive of Climate Data

National Climatic Data Center

Protecting the Past, Revealing the Future

Satellite


Upper Air

Marine

Land Based

Weather/Climate, Events, Information & Assessments

Paleoclimatology



Education.noaa.gov

NOAA Education Resources: Climate Theme Homepage - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.education.noaa.gov/Climate/

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Ocean and Coasts Climate Weather and Atmosphere Marine Life Freshwater Special Topics

NOAA Education Resources: Changing Seasons Collection - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.education.noaa.gov/Climate/Changing_Seasons.html

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Ocean and Coasts Climate Weather and Atmosphere Marine Life Freshwater Special Topics

Home >> Climate >> Changing Seasons

Changing Seasons

Resources

- Multimedia
 - Fur Seal Migrations Video
- Lessons and Activities
 - Shadows Measuring Lab (ES, MS)
 - The Mystery of the Missing Hummingbirds (ES)
 - Graphing Seasonal Climate Patterns (MS)
 - Modeling the Reasons for Seasonal Change (MS, HS)
 - Observing Phenology
 - Seasonal Changes: Green-Up and Green-Down (MS, HS)
 - Seasons and Phenology Activities (ES, MS, HS)
- Real World Data
 - Localized Seasonal Climate Data
 - Interactive Map of Vegetation Changes
 - Sunrise Sunset Calculator
 - Severe Storm Data
 - Climatology Maps
 - Frost/Freeze Dates
 - Interactive Sea Ice Maps
- Background Information
 - Why Do We Have Seasons?
 - The Annual Cycle

Featured Climate Collections

CHANGING SEASONS CLIMATE CHANGE IMPACTS

Chaninging Seasons

This collection provides educational resources that can help students learn about the impacts of the seasons. The majority of the resources are related to environmental impacts of the seasons. These resources include those that are related to ecosystems and organisms.

Quick Links

- Multimedia**
 - Fur Seal Migrations Video
- Activities & Lessons**
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- Background Information**
 - Why Do We Have Seasons?
 - The Annual Cycle

Sources: NOAA Climate Program Office and the NOAA Climate Portal

Done

NOAA Education Resources: Climate Theme Homepage - Mozilla Firefox

File Edit View History Bookmarks Tools Help

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Ocean and Coasts Climate Weather and Atmosphere Marine Life Freshwater Special Topics

Climate

Climate is the long-term prevailing pattern of temperature and other weather variables at a given location, described such as means and extremes. The climate includes conditions of the atmosphere and ocean, and is often described in terms of frequency, and duration of severe and non-severe weather. Earth's history, indications of climate change have been found in fossils and ice core samples. Climate change can result in drought and extensive glaciation at one extreme and climate data show that our planet's global surface temperature linked to the dramatic increase in greenhouse gases in the past two centuries. Understanding the resulting impacts of a changing climate are important as actions that influence climate.

The collections under this theme are developed to improve access to scientific information, which can inform actions that influence climate.

Sources: NOAA Climate Program Office and the NOAA Climate Portal

Done

NOAA Education Resources: Changing Seasons Collection - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.education.noaa.gov/Climate/Changing_Seasons.html

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Sources: NOAA Climate Program Office and the NOAA Climate Portal

Done

Cleanet.org

CLEAN
CLIMATE LITERACY & ENERGY AWARENESS NETWORK

Welcome to the Climate Literacy and Energy Awareness Network. Explore our reviewed collection of educational resources. Learn how you can build your students' understanding of the core ideas in climate and energy science.

Teaching Climate Literacy and Energy Awareness

How do we develop climate literacy and energy awareness in our students? A set of essential principles frame the key science and teaching strategies. Learn more about these principles and how they can inform your teaching.

Browse the Reviewed Educational Resources

This hand-picked collection of teaching activities includes materials for middle and high school students as well as undergraduate classrooms. Learn [how we select materials](#) that are both scientifically sound and pedagogically effective.

Join the CLEAN Community

Meet your colleagues, join discussions, comment on educational resources, become a CLEAN reviewer, join the CLEAN announcement email list, or join the active Climate Literacy Network.

Featured Signs of Studying

In this hands-on activity, students learn dendrochronology (the study of understand ecological conditions in the past) and come up with possible climatic conditions that may have influenced tree growth in their region. [Discuss](#)

About this Project

The CLEAN project, a part of the Digital Library, provides a review of resources coupled with the tool online community to share and learn about climate and energy science.

Call for Teaching Materials

Know of an excellent activity that illustrates the principles of climate literacy? Please let us know.

Paleoclimates and Pollen
CLIMATE LITERACY & ENERGY AWARENESS NETWORK

Paleoclimates and Pollen
http://www.ucar.edu/learn/1_2_2_10t.htm
S. Henderson, S. Holman, L. Mortensen (eds. modified), UCAR

Teaching Climate & Energy
Educational Resources
Community
About CLEAN

In this activity, students examine pictures of pollen grains representing several species that show the structural differences that scientists use for identification. Students analyze model soil samples with material mixed in to represent pollen grains. They then determine the type and amount of 'pollen' in the samples and, using information provided to them, determine the type of vegetation and age of their samples. Finally, they make some conclusions about the likely climate at the time the pollen was shed.

Activity takes one to two 45 minute class periods. Materials that are needed are tweezers, pie pans, confetti/paper dots and soil.

Learn more about Teaching Climate Literacy and Energy Awareness

Notes From Our Reviewers

The CLEAN collection is hand-picked and rigorously reviewed for scientific accuracy and classroom effectiveness. Read what our review team had to say about this resource below or learn more about how [CLEAN reviews teaching materials](#).

[Teaching Tips](#) | [Science](#) | [Pedagogy](#) | [Technical Details](#)

Teaching Tips

- Questions like "Why does climate change over time?" need to be addressed after stimulating the students with this activity.
- Educators should show an image of a real soil core so students can differentiate between the model and reality.
- Educators should note that all soil layers do not have unique pollen, and that pollen is not often well preserved in sediments.
- Educators need to be explicit about what is modeled and what is real; e.g. potting soil is very different than a real soil sample from a lake from a certain time period.
- Educator should include a discussion on the difficulty of deciding on boundaries between sedimentation layers and touch on dating techniques of these layers. In the activity, dates are given but no explanation is provided.
- Keys to types of pollen and climate are found in tables and student answer sheets.

Topics

Proxy Data
See more on this topic.

Grade Level

Middle (6-8)
See more at this grade level.

High School (9-12)
See more at this grade level.

Climate Literacy

About Teaching Climate Literacy
► [4d](#) (see details)
About Teaching Principle 4
Other materials addressing 4d

Benchmarks for Science Literacy

Learn more about the Benchmarks
► [4B/HG**](#) (see details)
Other materials addressing

Coming Soon: Interactive Earth



http://csc.noaa.gov/psc/dataviewer



http://csc.noaa.gov/psc/dataviewer/

Google

The Hive Chesapeake ... Login Page Deltek Time ...nse - Login Watershed Profiles Digital Arc...R Documents Eyes on the ...uality Data Chesapeake ...tem (CBIBS) Centralized ...ment Office

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
GLOBAL SCIENCE INVESTIGATOR

NOAA PACIFIC SERVICES CENTER

HAZARDS OCEANS CLIMATE HELP

PLEASE SELECT AN EVENT DATA SET FROM THE MENUS TO THE RIGHT. MANIPULATE THE GLOBE BY CLICKING AND DRAGGING ON THE GLOBAL VIEWER BELOW. CLICK ON THE DIFFERENT TABS IN THE DATA BOX FOR ADDITIONAL RESOURCES AND INFORMATION.

GLOBAL VIEWER Earth Topography and Bathymetry

Rotate

Reset

Play

Narrative More Info FAQ References Standards

This dataset shows the intricate topography and bathymetry of the Earth. The Himalayas in Asia, are home to Mount Everest, the tallest point on Earth at 29,035 feet. The longest mountain range in the world, the global mid-oceanic ridge system, can be found on the ocean floors and runs for approximately 37,000 miles.

Please select a data set from the HAZARDS, OCEANS, and CLIMATE icons above. Manipulate the globe by clicking and dragging it. Click on the tabs (Narrative, More Info, FAQ, References, and Standards) for additional information and resources.

Look/play with the globe to see if you can answer the question posed in the Narrative section.

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Carbon Tracker 2004

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA PACIFIC SERVICES CENTER

GLOBAL SCIENCE INVESTIGATOR

PLEASE SELECT AN EVENT DATA SET FROM THE MENUS TO THE RIGHT. MANIPULATE THE GLOBE BY CLICKING AND DRAGGING ON THE GLOBAL VIEWER BELOW. CLICK ON THE DIFFERENT TABS IN THE DATA BOX FOR ADDITIONAL RESOURCES AND INFORMATION.

HAZARDS

OCEANS

CLIMATE

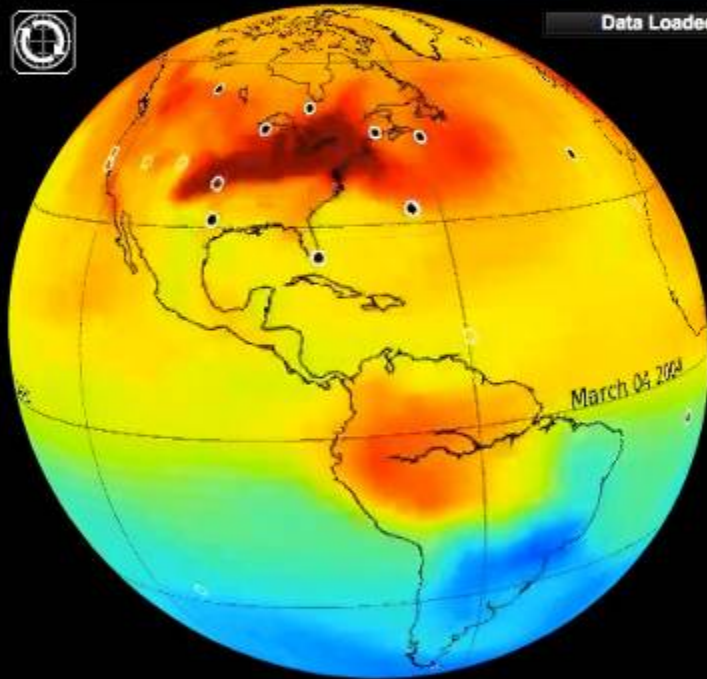
HELP



GLOBAL VIEWER

CarbonTracker 2004

Data Loaded



CARBON DIOXIDE CONCENTRATIONS

LOW 365 375 385 HIGH
PARTS PER MILLION

January April July September December

2004

Narrative

More Info

FAQ

References

Standards

This is an animation of the daily distribution of carbon dioxide (CO₂) in the atmosphere in 2004. The colors represent different CO₂ concentrations. The black and white dots show where NOAA Earth Systems Research Lab and its collaborators collect samples of air, to analyze the contents for CO₂ and other gases.

CO₂ tracking equipment can distinguish between changes in the natural carbon cycle and those occurring in human-produced fossil fuel emissions. This accurate information helps NOAA scientists project future climate change.

Where are there major sources of carbon dioxide? How does the carbon dioxide distribution change with the seasons?

ABOUT US

PRIVACY POLICY

Contact Us

Slider

2004
Data

Sea Level Rise

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA PACIFIC SERVICES CENTER

GLOBAL SCIENCE INVESTIGATOR

PLEASE SELECT AN EVENT DATA SET FROM THE MENUS TO THE RIGHT. MANIPULATE THE GLOBE BY CLICKING AND DRAGGING ON THE GLOBAL VIEWER BELOW. CLICK ON THE DIFFERENT TABS IN THE DATA BOX FOR ADDITIONAL RESOURCES AND INFORMATION.

HAZARDS

OCEANS

CLIMATE

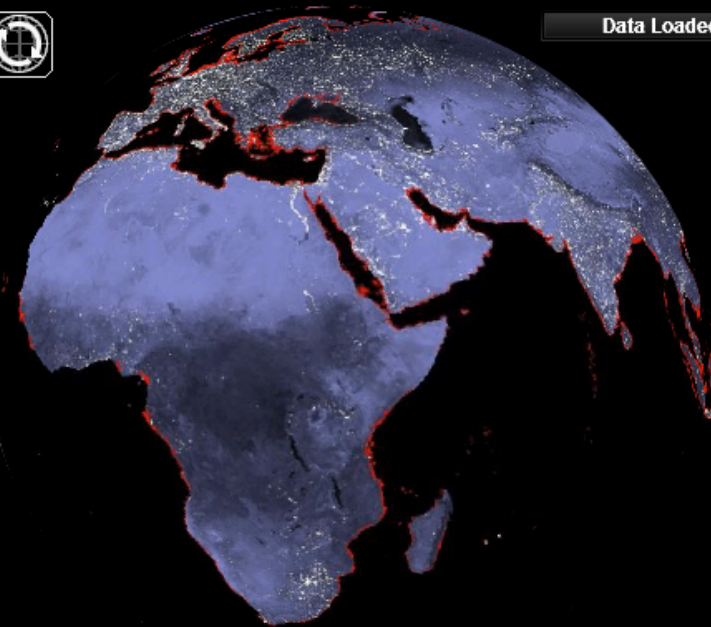
HELP



GLOBAL VIEWER

Sea Level Rise

Data Loaded



GLOBAL IMPACT OF 1 METER IN SEA LEVEL RISE

Narrative

More Info

FAQ

References

Standards

This model demonstrates what the Earth would look like if sea levels were to rise by 1 meter (3 feet). Red areas indicate land that would be underwater. The white dots are lights at night as seen from space.

Sea level rise in coastal areas can result in frequent flooding during severe storms, seawater mixing into freshwater sources, accelerated coastal erosion, and inland migration of beaches.

NOAA's Center for Sponsored Coastal Ocean Research monitors climate change to help coastal managers and planners better prepare for changes in coastal ecosystems caused by sea level rise.

Have you been to any of the areas that might be impacted by a 1 meter (3 foot) rise in sea level?

Stand where you would expect the greatest impact of sea level rise? Type potential impacts in the chat box.

Coral Reefs and Ocean Acidification

GLOBAL SCIENCE INVESTIGATOR

PLEASE SELECT AN EVENT DATA SET FROM THE MENUS TO THE RIGHT. MANIPULATE THE GLOBE BY CLICKING AND DRAGGING ON THE GLOBAL VIEWER BELOW. CLICK ON THE DIFFERENT TABS IN THE DATA BOX FOR ADDITIONAL RESOURCES AND INFORMATION.

HAZARDS

OCEANS

CLIMATE

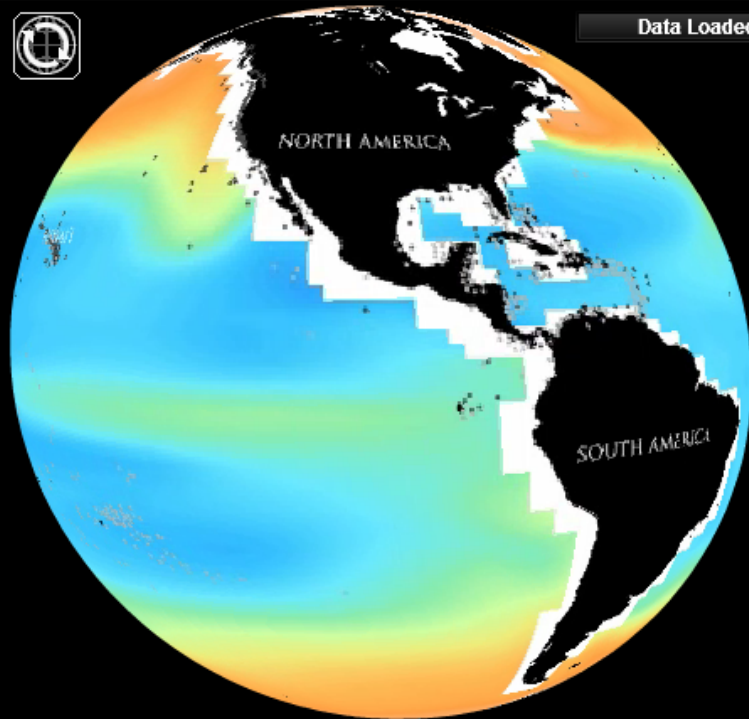
HELP



GLOBAL VIEWER

Coral Reefs and Ocean Acidification

Data Loaded



ARAGONITE SATURATION LEVELS

VERY LOW 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 OPTIMAL

1895 1920 1945 1970 1995 2020 2045 2070 2094

Year

Narrative

More Info

FAQ

References

Standards

This animation shows computer model simulations of the ocean's carbonate chemistry from January 1895 through July 2094. Dark gray dots show cold-water coral reefs. Medium gray dots show warm-water coral reefs. Ocean acidification describes the process of ocean water becoming corrosive and harmful to corals.

The colors show aragonite saturation levels, which represent the amount of material available for corals and shellfish to build their skeletons and shells. The blue areas are the most favorable conditions for corals and shellfish. Green and yellow areas have fewer present. In areas that are orange or gray, they may be rare, injured, or gone. White indicates no data.

Which areas (shown in gray) are predicted to have the least favorable conditions for coral and shellfish?

Stand where you would expect high ocean acidification by 2100? Type potential impacts in the chat box.

NASA's Global Climate Change Website

<http://climate.nasa.gov>

NASA's one-stop shop for news, current data,

Continuously updated
Key Indicators of
climate change

Interactives

Images of
Change

Climate Reel:
videos and
animations

Tips n' Tricks
for Teachers

The screenshot shows the NASA Global Climate Change website. At the top, it features the NASA logo and the text "National Aeronautics and Space Administration". Below this is the main heading "GLOBAL CLIMATE CHANGE" with the subtitle "NASA's Eyes on the Earth". A navigation bar includes "VITAL SIGNS OF THE PLANET" and "Experience Earth satellites in 3D".

Key indicators are listed in a table:

ARCTIC SEA ICE MINIMUM	CARBON DIOXIDE	SEA LEVEL	GLOBAL TEMPERATURE	LAND ICE
↓ 11.5% per decade	↑ 391 parts per million	↑ 52 mm since 1993	↑ 1.9 °F avg. temp. since 1880	↓ 24 (Greenland) cubic miles per year

A central video player shows a scene with penguins and the text "Is Antarctica melting? Latest data show net loss since 2002".

On the left sidebar, several menu items are circled in red: "Key Indicators", "Interactives", "IMAGES OF CHANGE", "CLIMATE REEL", and "FOR EDUCATORS".

On the right sidebar, a "NEW STUFF" section contains a "EYES ON THE EARTH 3D" link, also circled in red. Other links include "SEA LEVEL VIEWER", "CLIMATE TIME MACHINE", and "GLOBAL ICE VIEWER".

At the bottom, there are sections for "NEWS AND FEATURES" (with articles like "Unchained goddess" and "Another sign of global warming") and "COMMUNICATIONS FROM THE FIELD" (with a "my big fat planet" blog).

Near real time
satellite data
in 3D

Interactive Visualizations

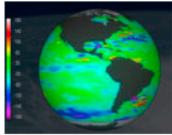
<http://climate.nasa.gov/interactives/>



Climate Time Machine

Go backward and forward in time with this interactive visualization that illustrates how the Earth's climate has changed in recent history.

[Click here to launch](#)



Sea Level Viewer

Explore the world of ocean topography from space with this 3D interactive viewer.

[Click here to launch](#)



Global Ice Viewer

Explore the sentinels of climate change with this 3D interactive global ice viewer.

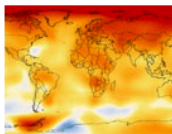
[Click here to launch](#)



Quizzes

Explore and test your knowledge with these interactive quizzes.

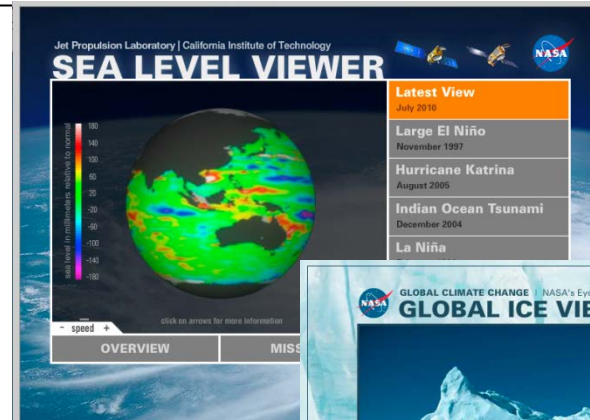
[Click here to view](#)



How Hot is the Earth?

Take a look at the latest worldwide temperature trends and what they mean.

[Click here to launch](#)



- Create immersive experience
- Help viewers visualize complicated scientific concepts
- Students have fun and forget they are being educated

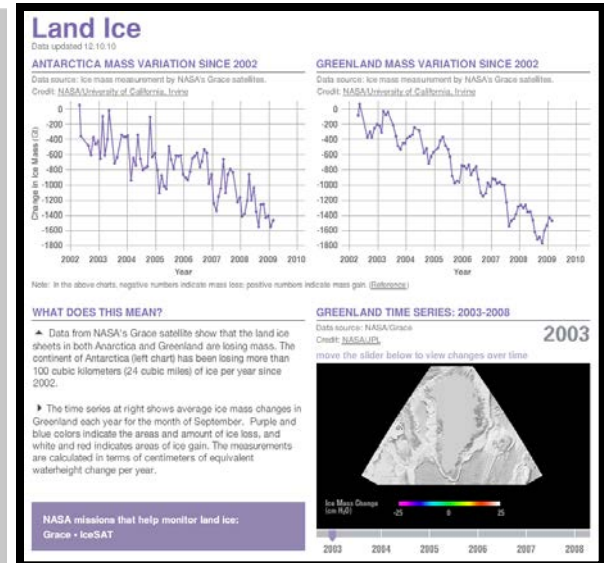
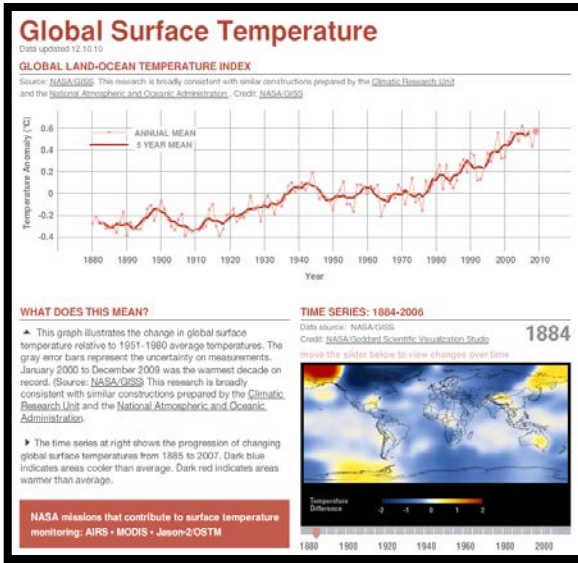
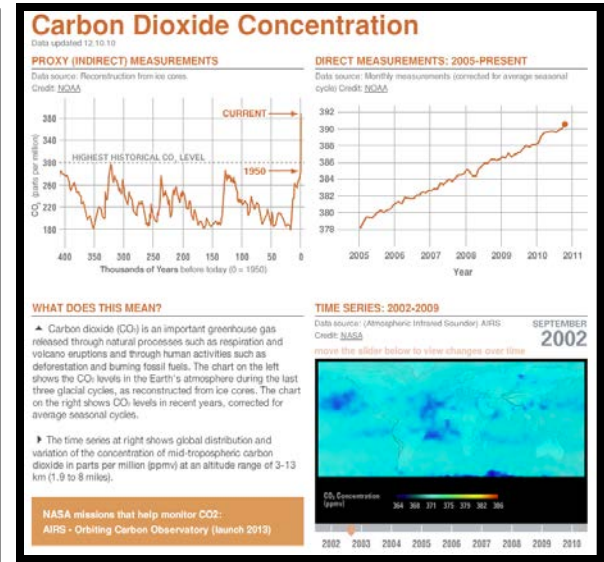
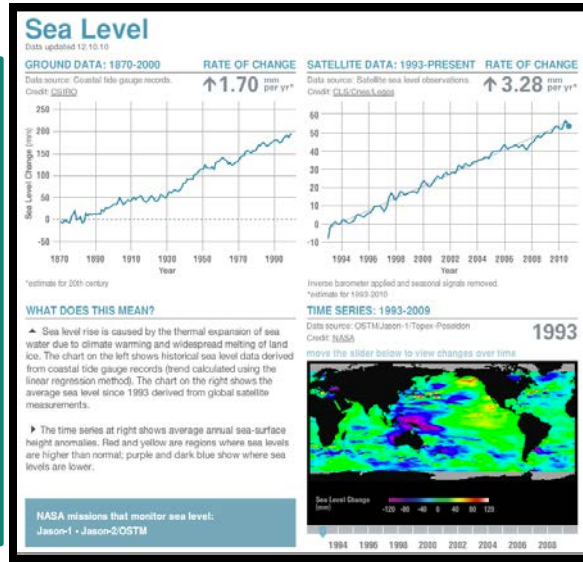
Key Indicators

<http://climate.nasa.gov/keyIndicators/>

Vital signs of the planet:

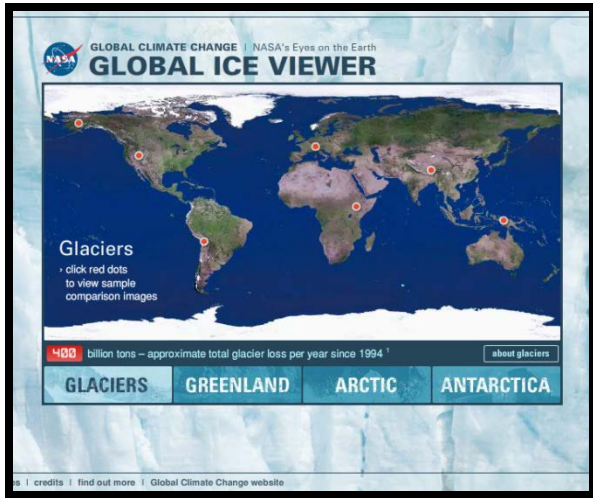
5 Key indicators

- Scroll over from mainpage
- Current satellite datapoints
- Interactive slider bars

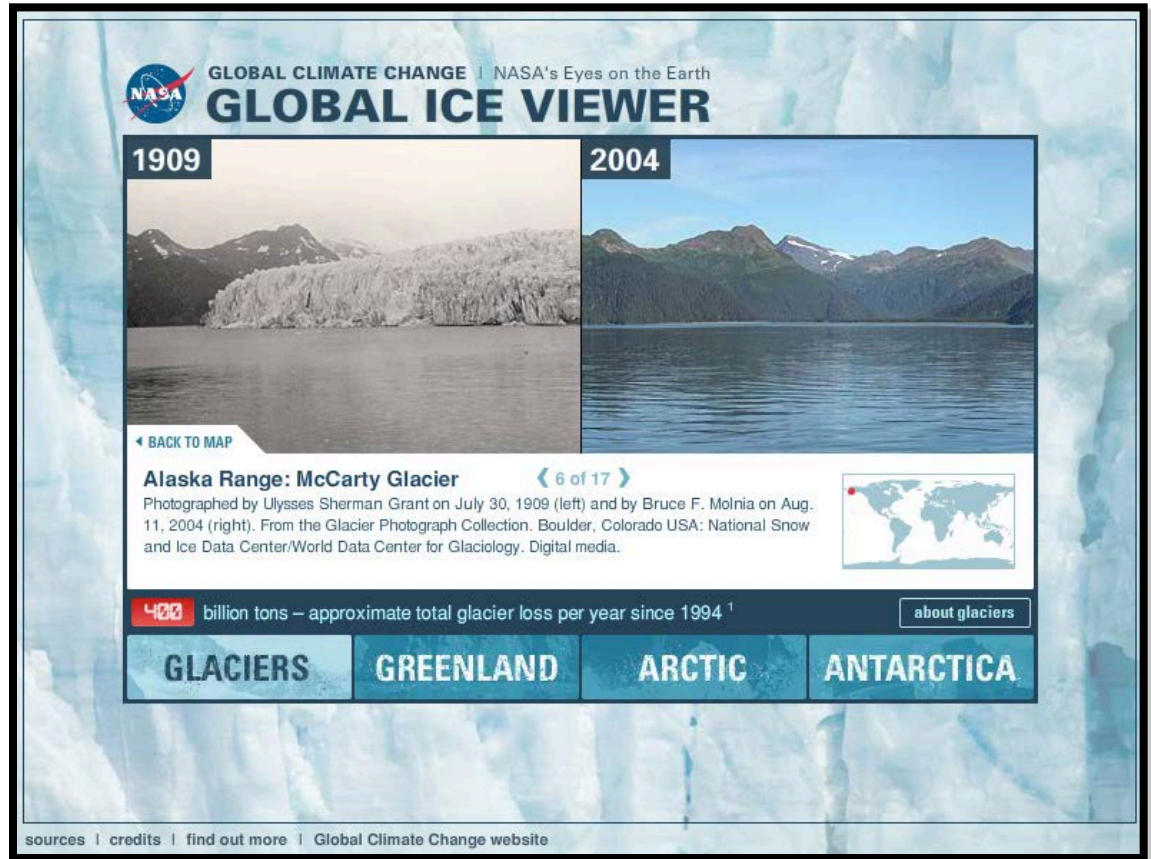


Global Ice Viewer

<http://climate.nasa.gov/GlobalIceViewer/index.cfm>



Before and after glacier pairs at seven locations around the world



McCarty Glacier 1909 and 2004



ACTIVITIES THAT USE DATA

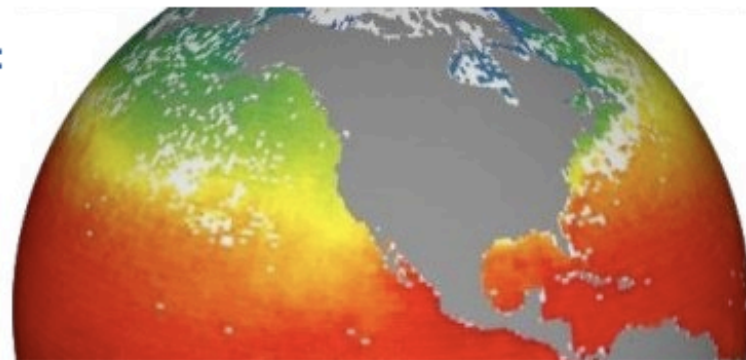
Data in the classroom.org

Data in the Classroom

[About](#)[NODE Project](#)[Downloads](#)[A+](#)[A-](#)[R](#)

Investigate Earth processes using real data:

- [El Niño](#)
- [Sea Level](#)
- [Water Quality](#) In development



● Sign up

Step
1

Teachers, if you are interested in helping us test the new curriculum modules for this project, please take a moment to [register and sign up](#).

● Use the curriculum

Step
2

Once you've registered, feel free to try any of the curriculum modules shown above. The [El Niño](#) and [Sea Level](#) modules are available now.

● Tell us what you think

Step
3

After using the curriculum, be sure to fill out an [evaluation survey](#). You can earn continuing education credits through the University of

Wisconsin.

Online Curriculum for Grades 6-12

DataintheClassroom.org

Activity Levels:

1. **Entry** – look for patterns and relationships
2. **Adoption** – use data graphs
3. **Adaptation** – recreate climate change models
4. **Interactivity** – use data to support or disprove a simple hypothesis
5. **Invention** – design an investigation using real data

Data in the Classroom

Understanding Ocean Acidification

Level 1

Level 2

Level 3

Level 4

Level 5

Get Data

Carbonate Simulation

Teachers

Survey

Problems? [Contact us](#)

Ocean Acidification

▶ Carbonate Simulation (BETA version)

Elapsed time: 0

y e a r s

0 10 20 30 40 50 60 70 80 90 100

Time years

Δ Water Temp. °C

Δ Atmos. CO₂ ppm

[About this simulation](#)
[View IPCC projection \(A1B\)](#)

Calcification

CO₂

Atmos. CO₂

CO₂ + H₂O ⇌ H₂CO₃ ⇌ H⁺ + HCO₃⁻ ⇌ 2H⁺ + CO₃²⁻

Ocean CO₂
Carbonic acid
Bicarbonate ion
Carbonate ion





noaa ocean service education

[Edu Home](#)

[Students](#)

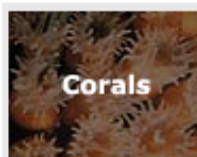
[Teachers](#)

[For Fun](#)

[NOS Home](#)

[Education HOME](#) / [Teachers: PD](#)

Professional Development



Corals



Estuaries



Ocean's
Role



Climate



Problem
Based
Learning

Teachers need accurate information and resources to integrate ocean, coastal, and climate science into local and state curricula. These resources provide a variety of lesson plans, background information, resource links, tutorials, archived professional development seminars, media galleries, and interactive tools that can be used in a variety of ways in grades 5-12. Many of the resources provided here were created in partnership with the National Science Teachers Association. Teachers can access resources in additional topics at the NSTA Learning Center site, <http://learningcenter.nsta.org>.

[\(top\)](#)

Recently added:

- [Coral Reefs](#)
- [Estuaries](#)
- [Climate Resources](#)
- [Problem Based Learning](#)

Partnership with
NSTA

[Details](#)



NOAA's National Ocean Service: Education: Professional Develo...

File Edit View History Bookmarks Tools Help

http://oceanservice.noaa.gov/education/pd/ocean

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION


noaa ocean service education

Edu Home Students Teachers For Fun NOS Home

Education HOME / Teachers: PD

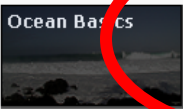
The Ocean's Role in Weather and Climate

The ocean covers more than 70 percent of the Earth's surface. The ocean plays a major role in regulating the weather and climate of the planet. These materials will help you understand the factors that impact the Earth's weather and climate, and how changes in temperature or air circulation are part of complex, long-term cycles. Understanding the influence of ocean conditions on the Earth's climate and monitoring changes in ocean conditions are key to predicting climate change.




Classroom Resources

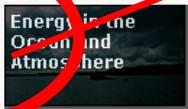
Ocean Basics



Weather and Climate Basics



Energy in the Ocean and Atmosphere



This professional development section provides an understanding of the complex interactions between the ocean, weather, and climate. These resources present information on the water cycle, including real-time and animated data of surface and deep ocean currents. Activities and lesson plans explain the causes of ocean currents, and the interaction of ocean density, atmospheric winds, and Earth's rotation. Real-time weather and climate data show how meteorologists record and forecast the weather. Satellite and radar imagery provide a visual understanding of convection in the ocean, the atmosphere and their interrelatedness.

Teacher Tutorials

The tutorials, cooperatively developed by NOAA scientists and National Science Teachers Association (NSTA) pedagogic experts, are designed to help teachers understand ocean, climate and weather connections based on the science literacy goals in the National Standards. Each tutorial focuses on a key content idea, contains interactive simulations and embedded questions.

Global Climate Patterns Global Precipitation and Energy

Interactives


- Carbon Dioxide Emissions
- Climate Zones
- Create a Hurricane
- El Niño
- Evaporation in a Pot
- Hurricane Path
- Ocean and Wind Currents
- Ocean Circulation
- Land and Sea Breeze
- Specific Heat
- Water Cycle

Galleries

- NOAA Photo Library
- Ocean Explorer
- National Marine Sanctuaries

NSTA Partnership

Details



NOAA's National Ocean Service: Education: Professional Develo...

File Edit View History Bookmarks Tools Help

http://oceanservice.noaa.gov/education/pd/ocean

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION


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Education HOME / Teachers: PD - Ocean & Climate

Weather and Climate Basics

What is the difference between weather and climate? Weather is the air temperature, cloud cover, precipitation, wind, moisture content, and air pressure at any particular time in any particular place. Weather reflects the prevailing conditions of the air masses overlying the land and seas over the entire globe. Climate is the overall picture of weather during periods of seasons or years. Historical records (including geological and recorded history) show us how the climate of the Earth has changed throughout its history.



Earth's Energy Source

Links for Teachers | Links for Students

The Earth's main energy source is the sun. The sun causes convection within the atmosphere, which in turn affects weather and climate. Find resources here to help students use real-time data to learn about the relationship between the sun, weather, and climate.

Convection in the Atmosphere

Links for Teachers | Links for Students

The heating of the Earth's surface and atmosphere by the sun drives convection within the atmosphere and ocean, producing winds and ocean currents. Find resources here to help you better understand how convection impacts weather and climate, including some hands-on activities, lesson plans, real-time data and images.

Atmospheric Pressure and Winds

Links for Teachers | Links for Students

The heating of the Earth's surface and atmosphere by the sun drives convection within the atmosphere and ocean. This convection produces winds and ocean currents. The greater the pressure differences between a low-pressure area and a high-pressure area, the stronger the winds.

Weather Patterns

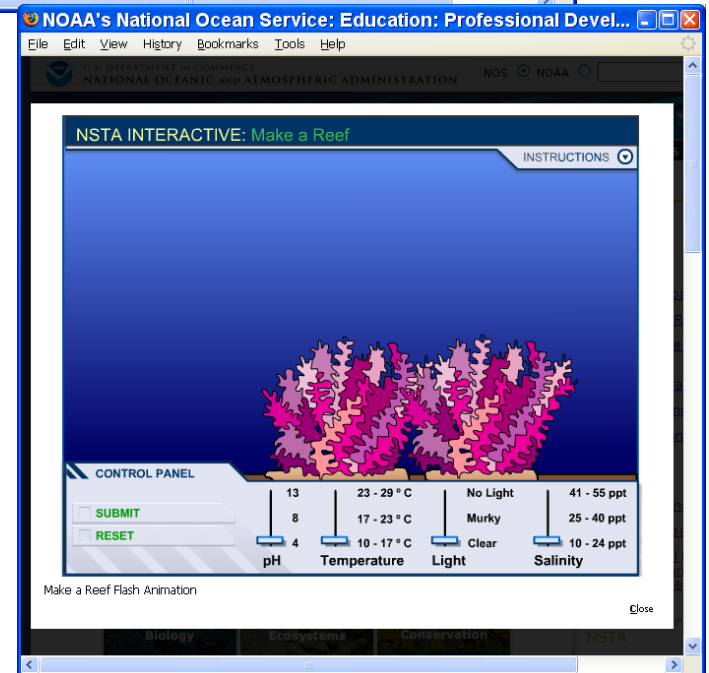
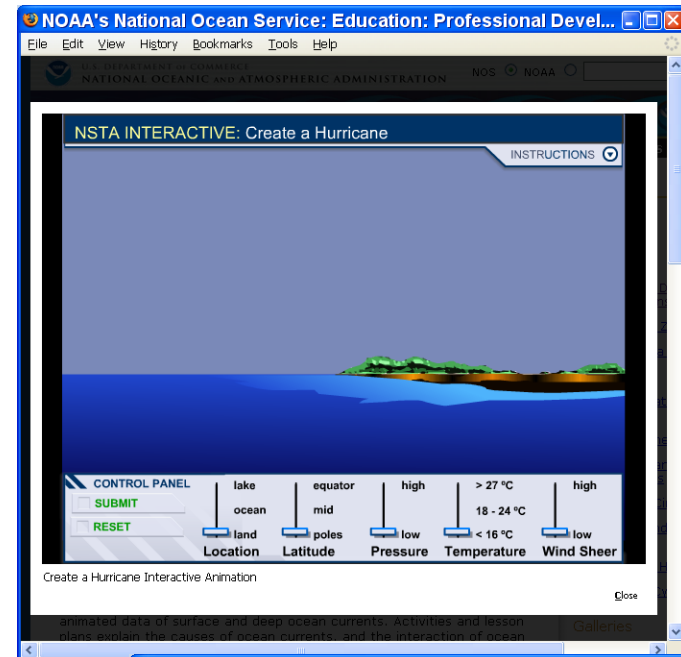
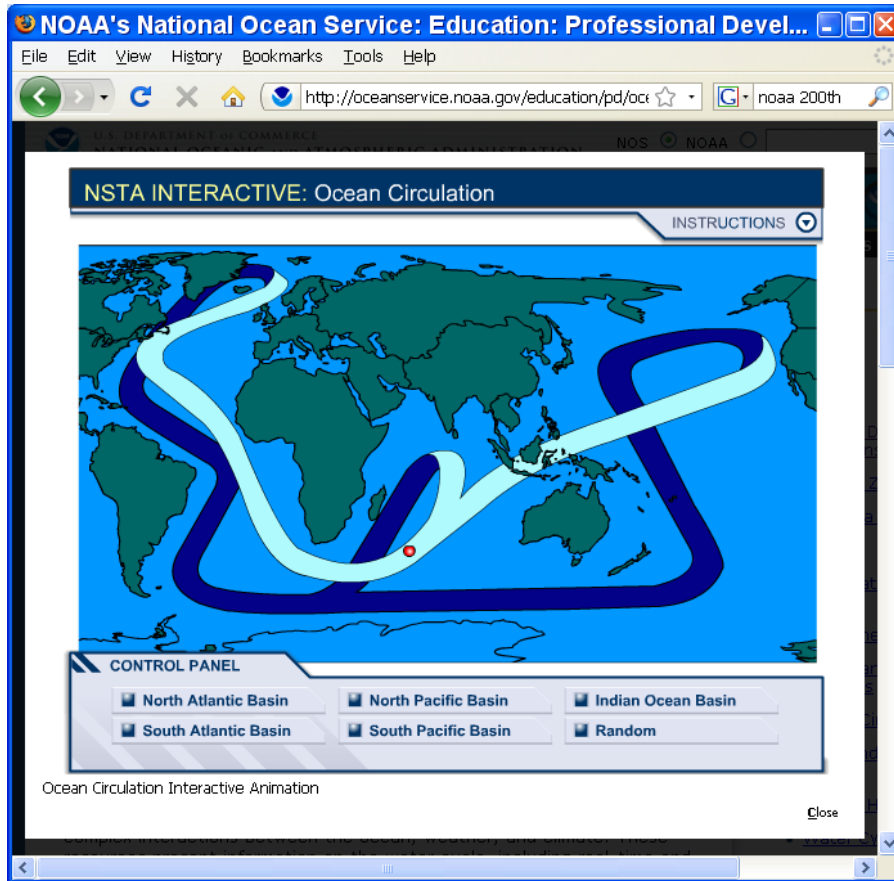
Links for Teachers | Links for Students

The Earth's Energy Budget

- Lesson Plan
- Case Study
- Sample of Student Work (1.9 Mb)

Interactive simulations*

- Coral reef
- Climate
- Ocean Circulation



Developed in partnership with the National Science Teachers Association.

Climate Discovery Teacher's Guide

National Center for Atmospheric Research



CLIMATE DISCOVERY TEACHER'S GUIDE
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Trees: Recorders of Climate Change

Unit: Little Ice Age
Lesson: 5

Materials & Preparation

Time:

- Preparation: 20 minutes
- Teaching: Part A: 20 min, Part B: 30-40 min

Materials for the Teacher:

- Overhead projector
- Overhead transparency of tree rings (page 5)

Materials for the Class:

- Copies of simulated tree cores (page 6-7)

Materials for Individual Students:

- Student Page
- Tree "cookie"
- Magnifying glass (optional)
- Metric ruler (mm)
- Pencil

National Science Standards

- Science as Inquiry: Content Standard A
- Earth and Space Science: Content Standard D
- History and Nature of Science: Content Standard G

Colorado Science Standards

- Science: 1, 4.2b, 6d

Learning Goals

Students will

- Identify seasonal and annual growth in a cross section of a tree.
- Understand that thickness of a tree ring is affected by environmental conditions.
- Understand that evidence of past climates is recorded in series of tree rings.
- Learn to interpret past climate conditions from tree ring thickness.
- Collect and analyze tree ring data, testing a hypothesis and drawing conclusions.

What Students Do in this Lesson

Students are introduced to tree rings by examining a cross section of a tree, also known as a "tree cookie." They discover how tree age can be determined by studying the rings and how ring thickness can be used to deduce times of optimal growing conditions. Next they investigate simulated tree rings applying the scientific method to explore how climatic conditions varied during the Little Ice Age.

Key Concepts

- During each growing season (spring and summer), trees produce new wood in a ring on the outside of the tree trunk located just inside the bark.
- Wood made during the first part of the growing season is light in color and wood made late in the growing season is dark in color.
- A series of concentric rings form during consecutive years of growth. Age is determined by counting the number of rings, oldest to youngest, from the center to the bark.
- A single tree ring is an indicator of growing conditions over a single growing season. A thicker ring may indicate a longer growing season or more water availability depending on the environment and tree species.
- A set of many consecutive tree rings provides information on climate trends during a tree's lifetime.

The Question:

Has the climate changed over the last 600 years?



PROFESSIONAL DEVELOPMENT

Climate Change in Wisconsin and the Great Lakes Region

CIMSS EPO manager, Margaret Mooney, collaborated with NOAA's National Weather Service on a climate stewards project in May 2011.

Mooney invited local storm spotters to a webinar on climate change, climate mitigation and mobile devices to monitor weather and climate.

Nineteen storm spotters participated and eleven provided feedback via a follow-up survey. **A third of the respondents indicated that they took action to minimize their carbon footprint, a large majority (90%) indicated their likelihood to take action in the near future!**

The webinar is available for viewing at <http://vimeo.com/23571211>.



NSTA Learning Center

The screenshot shows the NSTA Learning Center website. At the top, there are navigation links: "Back to NSTA.org", "Contact Us", "Help", and "Feedback". The main header features the NSTA Learning Center logo and a photograph of three people. Below the header is a navigation menu with options: "Home", "My Account", "Subjects", "Learning Resources & Opportunities", "Professional Development Tools", and "Education Administrator".

The main content area is divided into several sections:

- Welcome to Your Professional Development:** A text block explaining the center's purpose, mentioning over 3,300 resources and tools like "My Library" and "My Transcript". It includes a small image of a woman smiling.
- Explore Learning Opportunities:** A section with a search bar and a "Go" button. Below it are three columns: "By Subject" (Earth & Space Science, Life Science, Physical Science), "By Grade Level" (Elementary, Middle School, High School, College), and "By State Standards" (with a dropdown menu for "Choose a state").
- Do-It-Yourself Learning:** A section with a computer icon and text: "Learn at your own pace online with these 1-2 or 6-10 hour interactive activities."
- Live Online Seminars & Classes:** A section with a person icon and text: "Learn online from certified instructors with your colleagues. 1-2 hour seminars, week and month long courses are available. Earn state..."

On the right side of the page, there are several widgets:

- Login:** A button that says "[Click Here to Log In Now]".
- RSS and Share:** Buttons for RSS and social media sharing (Facebook, Twitter, etc.).
- Most Popular Science Objects:** A list of four items: 1. Energy: Different Kinds of Energy, 2. Plate Tectonics: Layered Earth, 3. Energy: Thermal Energy, Heat, and Temperature, 4. Universe: The Sun as a Star.
- Multimedia Overview:** A section with a "View Overview of the NSTA Learning Center" button and a "Learn More" button. It includes a small image of a group of people and the text "Flash Player Required".
- Free Learning Resources:** A section with a "Solar System: A Look at the..." link.

- Educators are provided with a subscription to all materials in the NSTA library

- Library has been built with funding from agencies

- Allows educators to maintain a professional development portfolio

- Individual collections of resources can be customized for the needs of the educator

NSTA Web Seminars

Title	Featured Scientist(s)
“Climate Change, Here and Now: Western Regional Climate Impacts”	Katharine Hayhoe Texas Tech University
“Climate Change, Here and Now: Eastern Regional Climate Impacts”	Tim Owen NOAA NCDC
“Monitoring the Impacts of Climate Change on Corals”	Mark Eakin NOAA Coral Reef Watch
“Higher Than a Sea-Bird’s Eye View: Coral Reef Remote Sensing Using Satellites	Margaret Mooney Steve Ackerman CIMSS, U.W, Madison
“Impact of Climate Change on West Coast Marine Mammals”	Siri Hakala, NMFS
“Impact of Climate Change on East Coast Fisheries”	NMFS TBD
“Climate Change and Ocean Acidification”	CRCP TBD
“Climate Change and Sea Level Rise”	William Sweet NOS CO-OPS
“Climate Change and Coastal Communities”	Chris Bowser and NERRS Climate Education Working Group



Climate Stewards Project - Overview

- Nation-wide program led by NOAA Ed. Community
- Formal and informal educators, citizen scientists
- Distribution of climate science data, professional development, place-based field opportunities and teaching tools
- Implement of action plans for local environmental stewardship projects

Stewardship in Action!

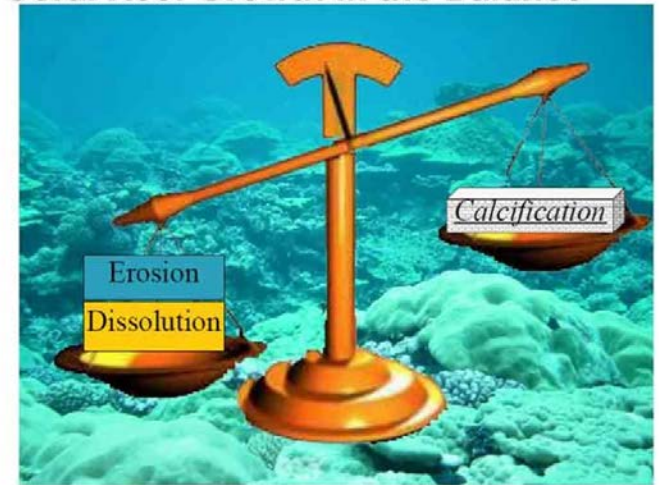


Half-day Symposia at Education Conferences

e.g. Climate Change Impacts on Western Coasts, the Ocean and Atmosphere



Coral Reef Growth in the Balance



A 20% reduction in calcification rate could push many coral reefs into net loss