Critical Analysis of Climate Change Sources

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Introduction

Global warming is a myth created by attention seeking scientists. Data that does not support global warming theories is destroyed or manipulated to protect funding for the scientists or for political reasons. Antarctic sea ice is actually increasing instead of decreasing as global warming scientists would have the public believe. The science is at best mixed on the evidence for global warming, so until we know more there is no reason to act on it. These are some of the claims that global warming skeptics make. Or is there something to their claims? What is the truth? Where can you go to find information you can trust on a topic that has become so politicized? What makes a good source?

This unit is designed to be used with high school students in IB Biology III. This unit could also be used with AP Biology classes or with Environmental Science classes. I teach in an urban high school with a very diverse population, almost half of whom are on free and reduced lunch. The activities in this unit on climate change and rising sea levels are designed to address the Common Core Reading Standards 6 and 8 for Literacy in Science in which students are to analyze the author's purpose in a scientific text and evaluate how well the evidence in the text supports the author's claims about a scientific question. Students who meet the Common Core Standards should be able to read complex text and determine what the author is saying, why they are saying it, and determine what support the author has for what they are saying. Students will be able to evaluate the reliability of the evidence and the veracity of the claims made in the text. They will have to develop a clear understanding of a problem from a variety of sources, even when those sources may present conflicting information. [1]

To meet the requirements of Writing Standards 1 and 8 for Literacy in Science, students must write argumentative essays in which they defend their position on a topic based on the evidence from the sources they have gathered and evaluated for their usefulness in answering the research question.[2]

This is not an easy thing to do, even for teachers. Rarely do we take the time to do more than a cursory evaluation of the sources we use for information. We tend to accept as given, that global warming is happening, but have we ever really looked at the actual data that the predictions are coming from? How can we defend the science if we don't understand, or haven't even looked at the scientific data behind the predictions? We have all seen *Inconvenient Truth*, but what do we tell students when they read on various websites that the data in that video is erroneously presented, if not outright lied about?

In this unit, I will present examples from a variety of sources on global warming—both pro and con—and identify examples suitable for the reading level and background knowledge of Biology I and IB Biology III students. I want to teach them how to evaluate sources for use in argumentative essays by showing them examples of good and bad sources, using climate change as a focus. I will have students use a rubric to help them quickly evaluate sources, practicing with climate change websites. Students will then focus on one aspect of climate change—sea level rise—and why North Carolina lawmakers attempted to exclude sea level calculations from being used by any agencies doing long term coastal planning. They were skewered by the press and late night talk show hosts. What were they thinking and who were they listening to that convinced them this was a good idea? Students will re-enact this scenario by role playing scientists, lawmakers, and special interest groups and present evidence to support the point of view of the group they are representing.

Summary of climate change

Causes of Climate Change

Our planet stays at a comfortable temperature for living things because of the greenhouse effect created by our atmosphere. Just as light that enters an actual glass greenhouse is trapped and heats up the air in the greenhouse, the light energy from the sun hits the earth and is absorbed and reemitted back from the surface as infrared energy which is absorbed by "greenhouse" gases in our atmosphere—carbon dioxide, water vapor, and methane. In addition to these gases, pollutants such as sulfur dioxide, nitrogen oxides, chlorofluorocarbons, and ozone can also absorb heat energy.[3] Like a blanket around our planet, this has the effect of keeping us warm. Too many greenhouse gases can be like too many blankets, trapping too much heat in—and we can't throw the extra blankets off.

Climate change is the result of both natural and anthropogenic (manmade) factors that affect the level of greenhouse gases over time. Prior to the industrial revolution, climate change was the result of natural forces. The consensus of a majority of scientists that has developed over the last twenty years is that human activities have accelerated the rate of climate change since the mid-1700s with the increasing use of fossil fuels.[4] The drivers of this change include: **greenhouse gas concentrations**, **atmospheric aerosols,** the **amount of solar radiation**, and **land surface properties**.[5] If these four things change, they can affect the amount of global warming and thus the earth's climate. Each of these is evaluated by the Intergovernmental Panel on Climate Change (IPCC) in terms of radiative forcing—how much a factor influences climate change in units of watts per square meter, or Wm^{-2}. Positive forcing indicates factors that warm the surface of the earth and negative forcing indicate a cooling effect on the earth's surface, in comparison to pre-industrial conditions.[6] Figure 1 below provides a graphic representation of the contributions of the various influences.

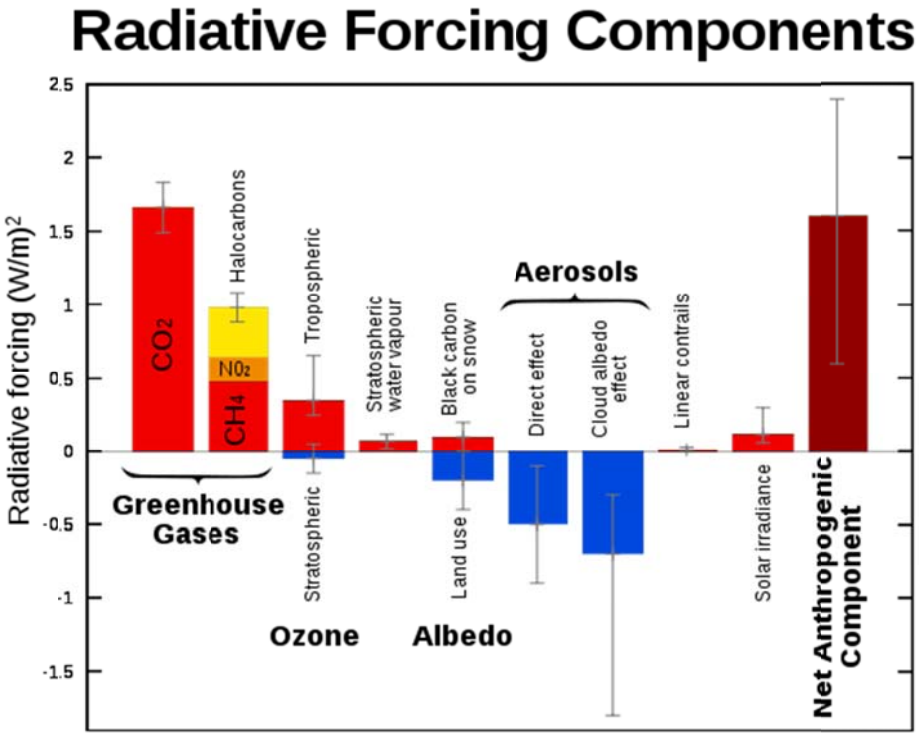

Figure 1.Radiative Forcing Components--Leland McInnes at the English language Wikipedia[7]

Greenhouse gases include carbon dioxide, methane, and nitrous oxide. Carbon dioxide levels are increasing as a result of burning fossil fuels for electricity production, transportation, and to power industrial processes.[8] Changes in land use also contribute to changes in carbon dioxide levels. Deforestation leads to increases in carbon dioxide levels since trees remove and sequester carbon dioxide from the atmosphere.

Along with natural sources of methane, there are increasing emissions of methane from anthropogenic sources including natural gas production, coal mining, livestock digestion, decomposition in landfills, wastewater treatment and rice paddies.[9] Nitrous oxide in the atmosphere has increased, mainly due to the use of fertilizers in agriculture.[10] The combined radiative forcing of these greenhouse gases is approximately +2.30 Wm^{-2} and has been increasing since the industrial revolution.[11]

Aerosols are solid or liquid particles suspended in the atmosphere. The majority of aerosols are natural, from volcanoes, forest fires, and dust storms. Anthropogenic sources include organic carbon, black carbon, nitrates, and sulphates from burning fossil fuels, and dust produced from land denuded of vegetation.[12] Many of these particles, and the clouds they seed, reflect light and so have a negative radiative forcing, and a cooling effect. However, depending on the reflective properties of the aerosols, some, especially darker particles, may actually absorb light.[13]

Solar radiation is the amount of solar energy that reaches the Earth's atmosphere. About 1368 Watts m^{-2} reaches earth's outer atmosphere. The earth absorbs about 70% of the total solar irradiance and the rest is reflected back into space.[14] Solar energy is absorbed by land, water, and the atmosphere. About 1% of the energy is absorbed by the stratospheric ozone layer as ultraviolet radiation. Gases, water vapor, clouds and darker aerosols in the lower atmosphere absorb 20 to 24% of the energy and the land and water absorbs the rest.[15] Solar irradiance—the amount of solar energy reaching the Earth--can vary with solar activity. Sunspot activity follows an eleven year cycle, varying the amount of irradiance that the earth receives. In addition, there are longer activity cycles that can affect irradiance.[16] In the 2001 report of the IPCC, it was estimated that increased solar activity made up almost half of the 0.6 degrees of global warming over the last 100 years.[17] However, new studies estimate that only about 0.15^{o}C of that increase is due to increases in solar activity.[18] The 2007 IPCC report estimated a radiative forcing of 0.12 Wm^{-2} for solar irradiance.[19] New technology may help generate more accurate measurements of solar radiation in the future. In the meantime, rising global temperatures cannot be attributed to increased solar activity when temperatures at higher atmospheric levels are actually decreasing. If solar activity was causing the changes, then these levels should have increasing temperatures as well. Instead the warming is occurring at the lower levels of the atmosphere where greenhouse gases are present.[20]

The last factor to be considered is land surface properties. One of the characteristics of land surface is albedo—how much of the sun's radiation it reflects back. This can be affected by anthropogenic sources such as deforestation, urbanization, agriculture, irrigation and other forms of land use change. Forested areas have a lower albedo than grasslands; with deforestation, albedo increases. Albedo is also affected by changes in snow or ice cover, which are seasonal. Areas of snow or ice have a high albedo, so the melting of glaciers and ice caps reduce the overall amount of solar radiation reflected back. Increases in albedo, result in increases in global temperatures.[21]

Impacts of Climate Change

Average global temperatures are rising and are expected to continue to rise due to the increase in greenhouse gases. Even a slight rise in temperature can have an effect on the environment, and when the rise happens over a relatively short time period, there can be big consequences. In the one hundred years from the early 1900's to 2005:

- Global surface temperatures rose 0.74^{o}C, and lower atmosphere temperatures saw a similar increase. Atmospheric water vapor content has increased since the 1980s as would be expected as temperatures rise.[22]
- Global ocean temperatures have been increasing, down to a depth of at least 3000meters, showing that the oceans are absorbing at least 80% of the heat being added by global warming.[23]

- Precipitation patterns have changed with some parts of the world receiving more precipitation, while others are receiving less. Droughts are more intense, last for longer periods of time and cover more area. Intense precipitation events are more frequent. The number and duration of cold spells are decreasing, while the number and intensity of heat waves are increasing.[24]
- The area covered by glaciers and snow is decreasing as rising temperatures cause melting. Arctic temperatures are increasing and arctic sea ice is shrinking, at even higher rates in the summer. The area of permafrost that stays frozen year-round is decreasing.[25]
- Sea levels have risen 0.17 meters in the last 100 years, with rates of rise increasing in the last ten years or so. Ice loss from the ice shelves of Greenland and Antarctica have contributed to this rise. Increasing ocean temperatures cause thermal expansion of the water and add to the rise in sea level.[26]

These effects are only predicted to increase in intensity as levels of greenhouse gases increase, and global temperatures continue to rise.

NC Sea level rise legislation story

In March of 2010, The NC Coastal Resources Commission's Science Panel on Coastal Hazards published the North Carolina Sea-Level Rise Assessment Report. The report was a review of the published literature on how sea-level rise is measured, how sea-level varies along the NC coast, predictions about future sea-level rise and the confidence levels and margins of error for those predictions. [27] It referenced the IPCC report of 2007 which conservatively estimated global sea-level rise of 0.18-0.59 meters by 2100. Other studies the panel looked at predicted higher sea-levels—up to 1.4 meters by 2100. Because of variation in sea-level rise around the globe, the panel looked at studies that were specific to North Carolina. Three studies were based on geological evidence of sea-level changes, and one was based on tide gauges along the NC coast. The panel compared tide gauge data to the most recent geological evidence and found consistency between the two. Their conclusion was that sea levels have changed and are likely to change in the future.[28]

Using the sea-level information from one of the recording gauges as a basis for predicted sea-levels, the panel presented three possible scenarios based on the current research—a rise of 0.38 meters, 1 meter and 1.4 meters by 2100. They recommended that the predicted rise of 1 meter be used for planning purposes.[29]

A one meter rise in sea level would significantly impact a large area of the North Carolina coastline, as well as its economy. It is not surprising that people were upset by these predictions. In anticipation of the fallout of these predictions, Republican Representative Patricia McElraft, of the North Carolina House of Representatives, and state Senator David Rouser, introduced a bill in April of 2011to allow beachfront homes over 5000 square feet to be rebuilt or repaired, in exemption of the setback rules

established by the Coastal Area Management Act. Under the previous setback rules, homes, hotels, or other buildings greater than 5000 square feet would have to be relocated a distance of 60 times the erosional rate for the area, or no less than 120 feet behind the first line of vegetation on the dunes, if they are being repaired or rebuilt after a storm. If the property is not large enough to accommodate this, then the structure cannot be rebuilt.[30] The purpose of the setback rules is to reduce damage to areas of environmental concern such as shorelines and estuaries, and to reduce loss of lives when storms occur. Many landowners along the coast felt that these requirements would significantly impact the value of their property and affect their livelihoods if they were unable to rebuild. So House Bill 819 was introduced to grandfather in those structures over 5000 square feet already present on the shoreline, making them exempt from the setback rules.[31]

As the bill moved through the House, it became something quite different. By the fourth draft, the bill included a section on sea-level policy restrictions and sea-level rise calculations. No rules, policies, or planning guidelines based on sea-level rise predictions could be adopted by any county or local governing bodies. Sea-level rise was to be calculated by the Coastal Resources Commission and Division of Coastal Management using historical data.

"Historic rates of sea-level rise may be extrapolated to estimate future rates of rise but shall not include scenarios of accelerated rates of sea-level rise unless such rates are from statistically significant, peer-reviewed data and are consistent with historic trends."[32]

What this meant was that the CRC could not use the information that predicted acceleration in sea level rise. What had happened? Why were the state legislators ignoring the science? What happened was a group called NC-20.

NC-20 is a non-profit civic group, funded by the people, governments and businesses of twenty coastal counties. They put together a campaign to convince state legislators that the CRC report was flawed and biased. On their website, they make a case that the Science Panel was biased and ignored scientific evidence that went against their pre-conceived ideas that sea-levels were rising. Apparently they were very convincing. When Bill 819 passed the state Senate, it became news world-wide: North Carolina was trying to legislate away climate change! An early version of the bill stated, "Rates of sea-level rise may be extrapolated linearly (from historical data) to estimate future rates of rise but shall not include scenarios of accelerated rates of sea-level rise."[33] The revised version of the bill took out the part about only using linear estimates--perhaps due to the international embarrassment. The final bill required the CRC Science Panel to conduct another review of sea-level studies by March of 2015 that included all peer-reviewed papers whether they predicted no change, acceleration, or deceleration in sea-levels. In the meantime, no estimates of accelerating sea-level rise could be used for planning purposes or policy making until July 2016. North Carolina would not accept the fact that

sea-level was going to rise until more studies were done. NC-20 had gained a reprieve for its members.

Perhaps to avoid such unpleasant news in the future, the recently elected Republican majority in the North Carolina legislature has proposed changing the composition of the NC Coastal Resources Commission. Gone would be the requirement that there be representatives of commercial and recreational fishing, conservation, agriculture, forestry, and marine ecology. Instead, the number of land developers and coastal business owners would be increased, along with 2 members with marine engineering experience. The governor and the Senate would have the power to add at-large members to the Commission, with the potential for stacking the deck even more in favor of coastal business and developer interests.[34]

Climate Change Information Sources

One of the most reliable resources for climate change information, and the one that is referenced most often by other sources, is the Intergovernmental Panel on Climate Change (IPCC). It was established in 1988 by the United Nations Environment Programme and the World Meteorological Organization. The IPCC is run by over 2000 scientists selected by the 154 member countries. Their job is to summarize the research findings of scientists all over the world, none of whom are employed by the IPCC.[35] The IPCC breaks the job up into three working groups and a special task force on greenhouse gas inventories. Working Group 1 focuses on research done by scientists on the physical processes that affect climate systems and that might cause climate change. Working Group II reviews the studies being done on the effects of climate change and the positive and negative impacts on both human society and the natural environment. Working Group III investigates the scientific work being done on methods for reducing greenhouse gases and ways that we can alleviate the effects of climate change.[36] The Task force on Greenhouse Gas Inventories provides countries with a summary of the most current methods for estimating the amount of human-caused greenhouse gas emissions from various sources.[37] Each group evaluates and summarizes the scientific studies that have been published in peer-reviewed publications pertaining to their focus. Non-peer reviewed work may be included if it undergoes and passes review by the IPCC scientists.[38]

Assessment reports are published periodically after an extensive and multi-level review process involving scientists, experts in the field, as well as representatives from the member countries. Only after consensus about the content of the assessments is reached, are the reports published. The IPCC itself does no research and is funded only by the member countries. The reports do not suggest what direction member countries should take when developing policies about climate change, it simply provides the information needed, in as unbiased a way as possible, for them to make those decisions.

Other sites that seem to be trustworthy are government sites, NASA, and major universities. Even these sources will have some kind of agenda based on the focus of that agency or university, but can usually be trusted to have good information. Several of these sites are listed on the Teacher and Student Resource page.

Even respectable publications may be suspect however. Maxwell and Jules Boykoff assert in their paper, “Balance as bias:global warming and the US prestige press”, that in the name of balanced reporting, the mainstream, or “prestige”, press has given too much coverage to minority opinions on global warming compared with the overwhelming consensus among scientists that global warming is happening and that humans are the main contributors to the problem. This has led to the misconception of many in the general public that there is more controversy over global warming in the scientific community than there actually is. Oil companies and other industries who are threatened by the findings on climate change may have even supported the inclusion of global warming skeptics’ viewpoints in the media, in order to influence public opinion and provide politicians an excuse to stall US actions to reduce our carbon footprint.[39]

The Skeptics

In addition to the extreme review process that the IPCC does, there are other peer reviews being done of the IPCC assessments and the research papers they are based on. These reviews come from blogsites such as Watts Up With That, The Air Vent, Climate Audit and Climate Etc. The tone of these sites is sometimes less than objective, perhaps because they feel they are up against Goliath when taking on the opinions of the IPCC. No doubt some of their criticisms are valid, but along with the serious articles pointing out potential flaws in a research paper, is a lot of ranting and personal expression of opinion without any support for the position taken. The best of these sites do some service as a post-publishing peer review. For example, an article on warming of the Antarctic ice sheet in the January 2009 issue of the journal Nature was found to have significant errors by bloggers on some of the sites mentioned above, and a correction had to be printed. This would probably have happened in the usual peer review process, but it happened more quickly and in a more antagonistic way because of the blog sites. I would not recommend these sites to students as sources for research, not because they go against mainstream scientific opinion, but because students may have difficulty determining the level of expertise the writers have in a particular area. The authors of publications in major scientific journals will have been vetted by those publications.

The Sites to Look Out For

There are many websites that at first glance can seem to have very flashy credentials and would have you believe that there is a liberal conspiracy and a political agenda for the creation of the global warming myth and they can prove it. However, closer examination of these sources reveals the flimsiness of their arguments and their credentials. Take, for example the following website: http://www.petitionproject.org/index.php. This is the

Global Warming Petition Project—a petition that claims there is no convincing evidence that humans are contributing to climate change, and that in fact there may be benefits to global warming. It first appeared just after the Kyoto Protocol was established in 1997 to reduce greenhouse gas emissions in industrialized countries. The petition, and accompanying article written by Arthur Robinson of the Oregon Institute of Science and Medicine, were distributed to scientists around the country by a former president of the National Academy of Sciences—Dr. Frederick Seitz. The article was written to appear as if it had been published in the *Proceedings of the National Academy of Science* but in actuality had never been published anywhere. In 2007 the article reappeared with some minor editing, and was said to have been published in the *Journal of American Physicians and Surgeons*.[40] A very prestigious sounding journal, but actually produced by another professor at the Oregon Institute of Science and Medicine. The article is full of errors, and picks and chooses the data it uses to make its claims, ignoring volumes of data that contradicts the opinions of the writers—who, by the way, have no background in any area of climate research. The website currently claims to have received signatures from 31,487 scientists, but most have no background in climate change research, a third are engineers, many are doctors, not scientists, and quite a few were actually deceased.[41] Some of the scientists who originally signed the petition based on concerns about some of the early data, have now changed their minds, but cannot remove their names from the petition.

Now if I had not done some research and found convincing arguments that rebutted the Petition site paper and its claims, I might have wondered if there wasn't something to their interpretation of the data. The more you read on climate change websites, especially some of the more respectable blog sites on the topic of climate change, the more you start to wonder if there is not some validity to some of the arguments about the interpretation of the data being collected and how the modeling is being done. The problem is that there are two sides to this issue at all. There should be just one side—the side of science—and all scientists should be working together in constructive ways to figure out the problem of climate change. However, the scientific community has become as polarized as political parties—maybe because of politics. Maybe it's just that the dissenting voices come across so much "louder" on the internet, which provides a platform for them that was not there in the past. When I began planning this unit, I thought I would find definitively "good" and "bad" sources and would be able to direct my students toward those. What I have found is that most often the level of expertise required to distinguish between good and bad sources is beyond my abilities, much less the abilities of my students. It is no wonder that the general public, and politicians who are making policy decisions, do not know what to think about climate change. Scientists need to do a better job of making the climate science understandable to the average person without watering it down so much that the strength of the data gets lost in the process. The inflammatory rhetoric on both sides does a disservice to science. Instead of trusting that the scientific process and the checks and balances of peer review will guide scientists, the public may begin to think

that science is biased and political and something that we can vote for or against if we don't like the results.

Identifying good science and good sources

A good scientific source will present results and conclusions arrived at using good science. So what does that look like? First, the scientist should collect data honestly—recording and reporting what was observed as objectively as possible without bias. Methods used for collecting data should be selected so that variables are controlled and uncertainty is reduced as much as possible. When uncertainty remains, it is reported and taken into consideration when analyzing results. Conclusions are based on all relevant and valid data and are presented logically and without the use of language that reflects bias about the results. Skepticism is a cornerstone of science. Scientists question everything in order to find answers. *Will this variable affect the data? Can it be controlled, and if not, what will be the impact on the results? What amount of uncertainty will there be in the data as a result of the limitations of the experimental procedure or method of measurement?* Scientists examine evidence to determine if it either supports or disproves a hypothesis—always accepting that new evidence might change the conclusion. Through questioning, errors can be uncovered, new insights can be made, and more reliable explanations ultimately obtained. Scientific studies are submitted for peer review before being published. In peer review, scientists who are familiar with the field of study evaluate the paper and may or may not recommend it for publication. If approved, this is no guarantee that the paper is error free, but the chance that a fraudulent paper gets published is reduced.[42] Today, for good or for bad, additional peer review is being conducted informally on blog sites on the internet.

Most primary sources of information on climate change research are going to be too difficult for most students to understand. So that leaves secondary sources such as review articles (the IPCC report is one), books and articles in scholarly journals and magazines and on websites where the original research is cited.

Just as scientists are skeptical when it comes to evaluating methods, results and conclusions, similarly students need to be skeptical of the sources they use, evaluating them for bias, reliability, relevancy, and timeliness. Just because it's on the internet doesn't mean it's true. Teaching students to be skeptical about what they read, and discriminating in their selection of sources, will give them a skill that will be useful in many areas of their lives.

When evaluating sources, students should look for the author and try to find out something about their level of expertise, and their intention for writing the article. Is the information in the article presented in an objective and balanced way? If it is not a primary source, does the author cite the original sources used for the article? Original

sources should be checked out to see if the information the article is based on is reliable. Is the author writing for a particular organization, publication, or website? If so, is it a trustworthy site?[43] "Googling" the author's name will provide information on his background, but may also turn up other articles by the author, or positive and negative critiques of the article. The domain name may be helpful. Websites on the internet are grouped into various domains based on the type of organization sponsoring the website, and identified with a particular suffix. A ".gov" site would be a federal government site. Sites with the suffix ".edu" are used by colleges or universities. Sites that end in".org" are usually run by non-profit organizations, which are also reliable, but may sometimes have a particular focus and viewpoint. They may also be funded by sponsors with a commercial interest.[44] For example, the site for the Global Warming Petition Project is a ".org" site, run with donations, but with a definite agenda. If a site name ends in ".com" it is a commercial site and will have a vested interest in presenting a particular viewpoint in order to sell its product. Anything that doesn't fit into these categories often ends up in the ".net" group, which must be carefully assessed before using.[45]

A good way to get a feel for a site is to scan it to find the "About us" link which will often provide information on the site author or the organization that runs the site.[46] There may also be information on the organization's board and who their important sponsors are. Students can use the contact information found on most websites to request information about the author or website not provided on the site. Often, at the bottom of a webpage is a "Last Updated" date that will let you know how current the information is and how well the site is updated and maintained. [47] The tone of the article will also give an indication of whether it is a serious balanced article or an article with an agenda.

Lesson Plans & Activities

Students will be introduced to the unit on climate change with images of the NC coast, beach homes along the shoreline, wildlife, and coastal businesses. Then the images will show hurricanes, flooding, storm damage, and erosion along the coast line. *Is this what's in North Carolina's future? Or is it all a lot of hype? What is the science behind global warming?*

In preparation for the website evaluation activity, I will present background information on the IPCC and what the latest reports have to say about the basic causes and effects of global warming. Since many of the websites make reference to the IPCC reports, students need to have an understanding of how it works.

Evaluating Sources

To introduce students to the importance of evaluating websites and resources, I will show them the website for the Global Warming Petition Project and have them discuss their initial impressions of it. Then we will do a side by side comparison of the review article from the website and the rebuttal paper "Analysis by Michael MacCracken of the paper

‘Environmental Effects of Increased Atmospheric Carbon Dioxide’ by Arthur B. Robinson, Noah E. Robinson, and Willie Soon”.[48] Depending on the level of your students, you may want to pull out selected portions of both papers to use, as some of the material in both papers will be very technical.

Students will then use a modified version of the CRAP test[49, 50] that I have named “A Tale of Two Websites”,(see Appendix) to evaluate two online sources on climate change. The CRAP test has students evaluate a site based on its “Currency”, “Reliability”, “Authority”, and “Purpose and Point of view”. Students will be given one of the following pairs of sites to evaluate and compare in regard to an assigned topic on climate change:

http://climate.nasa.gov/index (NASA site, whose info is consistent with the IPCC) and http://www.climatechange101.ca/ (a global warming skeptics website) The focus for review of these sites will be global temperatures.

http://epa.gov/climatechange/ (the EPA website) and http://en.wikipedia.org/wiki/Climate_change (the Wikipedia page on global warming) The focus of review will be evidence or indicators of climate change.

http://dsc.discovery.com/tv-shows/curiosity/topics/worst-effects-global-warming.htm and http://www.greenpeace.org/usa/en/campaigns/global-warming-and-energy/ (Greenpeace website on global warming). The focus for review of these sites will be the effects of climate change.

The selection of these sites will allow students to compare three mainstream sites on global warming with a global warming skeptic site, Wikipedia, and an environmental activist site. Students will work in small groups to evaluate one of the pairs of websites, compare the information on their assigned topic available at each site, and then jigsaw with members of the other teams to present and discuss their topics and the results of their evaluations. Following this lesson, students will find information on possible solutions for global warming using a different website or source on global warming and evaluate it using the same evaluation rubric.

Global Warming Role Play

To introduce this activity, I will show students examples of news headlines and a clip from The Colbert Report that pokes fun of North Carolina’s decision to ignore predictions about sea level rise. Students will try to get into the minds of the lawmakers and other parties involved as they research and take on the roles of various community members and special interest groups. Directions for the assignment follow.

Water’s Rising--

The North Carolina State Legislature is concerned about the possibility of sea-levels rising and flooding coastal communities. In order to make plans for the future, they need to have the best information they can get to determine if this is a real possibility, how long they might have before it becomes serious, and how it will affect the communities and the environment.

You will begin by working with other students who have been assigned the same role. Discuss the background information on your character, and what their response might be to the issue of sea-level rise. Answer the following questions as your character would:

1. Who do you represent? What is your point of view and interest in this issue?

2. What is your understanding of global warming and rising sea levels? Be as detailed as possible. You are making your decisions based on that information. Cite sources for your information.

3. What do you want the NC Legislature to do about the possibility of rising sea levels? If you are a congressman, what information or group's opinion might help you the most in making plans for the coastal region?

You will take on one of the following roles. Use the websites as a starting point for researching your character's position on this issue:

Senator Burke--a NC Senator from a western county: The people in the western part of the state that Senator Burke represents enjoy going to the coast for vacation. They are concerned that a lot of state money is used to protect, repair and rebuild structures on the beach after a big storm and then again after the next big storm. Why should they have to pay for this folly through their taxes and increased insurance rates?

http://dcm2.enr.state.nc.us/slr/NC%20Sea-Level%20Rise%20Assessment%20Report%202010%20-%20CRC%20Science%20Panel.pdf (North Carolina Sea-Level Rise Assessment Report March 2010)

http://www.nc-20.com/sealevelrise.htm (Website of the group lobbying for Bill 819)

http://www.postandcourier.com/article/20130313/PC16/130319716/1006 (Article in the Post & Courier on rising insurance rates near Charleston, S.C.)

Representative Patricia McElraft--NC State Representative from one of the coastal counties: The landowners and business owners in your county are afraid that the new report about future sea level rise will mean they will not be able to rebuild if a storm damages their property, they will not be able to get insurance, or the rates will be too high, and no one will want to buy their property. You have been asked to sponsor a bill to protect the rights of landowners to be able to continue to use and rebuild on their property in exemption of the setback rules.

http://www.ncga.state.nc.us/gascripts/members/viewMember.pl?sChamber=House&nUserID=570 (Biography on Rep. McElraft)

http://www.nc-20.com/sealevelrise.htm --(NC-20 website)

Michele Walker--a member of the Coastal Resource Commission: You have to report to the lawmakers and explain how sea-levels are predicted to rise and what this might mean for coastal communities.

http://dcm2.enr.state.nc.us/about_dcm.htm (Coastal Resource Commission website)

http://dcm2.enr.state.nc.us/slr/NC%20Sea-Level%20Rise%20Assessment%20Report%202010%20-%20CRC%20Science%20Panel.pdf (North Carolina Sea-Level Rise Assessment Report March 2010)

Tom Thompson--member of NC-20: You represent a group composed of coastal county governments, citizens and businessmen. You have your own scientists who say that the sea level rise predictions are flawed and that it will not be as bad or may not even happen. You argue that plans for future development should not be held hostage by something that only might happen.

http://www.newsobserver.com/2012/06/20/2147302/how-sea-level-rules-would-hinder.html (News & Observer article written by Thompson.)

http://www.nc-20.com/sealevelrise.htm --NC-20 website.

Rob Lamme--a member of the NC Coastal Federation: Your group is concerned about the environmental consequences of sea-level rise. Report to the lawmakers about the environmental consequences of sea level rise and how planning for that rise can help mitigate the effects.

http://www.nccoast.org/Blog-Post.aspx?k=716cda3f-df75-4a9b-9dcc-cab3c99bb2c8 (Article on sea level rise and Bill 819)

http://www.nccoast.org/ (Website for NC Coastal Federation)

Amy Marsh—a member of Defenders of Wildlife: Your concern is for the wildlife that will be displaced by rising sea levels. You want the lawmakers to set aside land on higher ground near current wildlife refuges so that when sea levels rise, wildlife will have a place to go.

http://www.defenders.org/sites/default/files/publications/executive_summary_understanding_the_impacts_of_climate_change_on_fish_and_wildlife_in_north_carolina.pdf (Article: *Understanding the impacts of climate change on fish and wildlife in North Carolina*)

http://www.defenders.org/sites/default/files/publications/national-wildlife-refuges-and-sea-level-rise.pdf (article—*National Wildlife Refuges and Sea-Level Rise*)

John Hartford—you represent the insurance industry. Your company insures many homes and businesses along the coast. Every time there is a hurricane your company takes a hit. Now scientists are saying that sea levels will rise creating an even bigger problem. Lawmakers control how much you can raise your insurance rates, and you have to prove to them that there is a reason to do so.

http://www.postandcourier.com/article/20130313/PC16/130319716/1006 (Article in the Post & Courier on rising insurance rates near Charleston, S.C.)

http://www.postandcourier.com/article/20130313/PC16/130319714/1006/fight-rising-seas-or-retreat (Article in the Post and Courier on sea walls)

All students who are assigned to each role will meet together to research, discuss and define their position by answering questions 1-3. On day two, we will form new groups with one member from each of the original groups to represent the different roles. Each member of this small working group will present their position and come up with a consensus opinion on what the NC Legislation should do about this potential problem. All groups will make a final presentation to the class. (Students who are willing to really get into their roles could come dressed as their character.)

Notes (*Chicago formatting by bibme.org*)

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[6]Ibid.

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Teacher Resources

http://www.eci.ox.ac.uk/ University of Oxford clearinghouse for research on climate change. This site provides access to research papers.

http://www.climatedata.info/index.html Climate Change Data—a “neutral” website that assesses and reports on climate change data. It is run by a hydrologist and a microbiologist. Their goal is to present information about the research on climate change in a more understandable and unbiased format.

http://www.climate.org/ --Climate change website

http://www.grida.no/files/publications/ClimateInPeril.pdf --A very user friendly summary of the IPCC report for the average person. Simplified graphs and graphics will be understandable to students. Published by the United Nations Environment Programme.

http://www.world.org/weo/climate --World Environmental Organization; Links to Top 100 climate change sites.

http://www.c2es.org/about --Center for Climate and Energy Solutions , a good site that uses good sources to summarize the problem and also addresses the business economics

of climate change. Surprisingly financially supported by GE, HP, Shell, Duke Energy, and other big businesses. Formerly the Pew Center on Global Climate Change.

http://www.fs.fed.us/ccrc/ --USDA Forest Service Climate Change Resource Center. Good basic climate change information, especially about how climate change will affect forests, ecosystems and wildlife and their management.

http://www.aaas.org/ American Association for the Advancement of Science; international nonprofit; publishes peer-reviewed journal Science and website Science NetLinks for teachers with lessons and resources.

http://svs.gsfc.nasa.gov/ClimateEssentials/ --NASA site with satellite images by climate change topic

http://www.informationisbeautiful.net/visualizations/climate-change-deniers-vs-the-consensus/ --This site takes all kinds of data and creates visual representations of it. Includes a side by side comparison of the global warming skeptics' and the global warming scientists' interpretation of climate data.

http://www.ncdc.noaa.gov/ --National Climate Data Center of the National Oceanic and Atmospheric Administration.

http://www.nccoast.org/Blog-Post.aspx?k=716cda3f-df75-4a9b-9dcc-cab3c99bb2c8 --NC Coastal Federation blog article with links to articles and videos of NC lawmakers.

http://www.scientificamerican.com/article.cfm?id=north-carolina-sea-level-rises-desipte-senators --Scientific American article: North Carolina Sea Level Rises Despite State Senators

http://www.ncleg.net/gascripts/BillLookUp/BillLookUp.pl?BillID=H819&Session=2011#history –NC General Assembly site for history of House Bill 819.

http://www.nccoast.org/Article.aspx?k=46f88670-10f4-4991-a1aa-1f1320ee5860 –North Carolina Coastal Federation article on the Sea-level Rise Bill

http://royalsociety.org/uploadedFiles/Royal_Society_Content/News_and_Issues/Science_Issues/Climate_change/climate_facts_and_fictions.pdf --March 2005 article published by The Royal Society with point by point rebuttal of climate change denier arguments.

http://invigorate.royalsociety.org/ks4/we-just-don%27t-know!.aspx –Activity to introduce students to uncertainty in science

http://www.ipccfacts.org/how.html --Site run by the UN with information about the IPCC .

http://www.skepticalscience.com/ --Most Used Climate Myths--gives a point by point rebuttal of climate change denier arguments based on published scientific papers—and at different levels. Click on one of the topics on the thermometer in the side bar and you will see the rebuttal, along with the data, presented at a basic, intermediate or advanced level of explanation. The site is put out by a team of people interested in explaining what science has to say about climate change. It is authored and led by John Cook, a Climate Communication Fellow for the Global Change Institute at the University of Queensland. He is not a climate change scientist, so the answers on the site do not come from his own research, but from peer-reviewed scientific papers. The site is funded by donations from users. Still, there is an argumentative tone to the site.

http://www.petitionproject.org/ Global Warming Petition Project. Contains a link to the article by the Robinsons that denies the existence of anthropogenic causes of global warming.

http://www.climatesciencewatch.org/file-uploads/Comment_on_Robinson_et_al-2007R.pdf -- Michael MacCracken rebuttal to Global Warming Petition article.

http://www.colbertnation.com/the-colbert-report-videos/414796/june-04-2012/the-word---sink-or-swim --Stephen Colbert video clip on NC's sea level legislation. Funny!

http://dcm2.enr.state.nc.us/slr/NC%20Sea-Level%20Rise%20Assessment%20Report%202010%20-%20CRC%20Science%20Panel.pdf --North Carolina Sea-Level Rise Assessment Report March 2010

http://www.nc-20.com/sealevelrise.htm --NC-20 website.

http://e360.yale.edu/feature/north_carolina_costly_mistake_on_climate_change/2543/ -- Yale E360 opinion piece by Rob Young**,** a professor of coastal geology at Western Carolina University and director of the Program for the Study of Developed Shorelines.

http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf --Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science and Technical Subjects. Most user friendly version of Common Core Standards I have seen anywhere.

http://eduscapes.com/tap/topic32.htm --Teacher Tap—professional development resource on technology for teachers. Great information for evaluating internet and other types of sources

http://www.emich.edu/ift/mod2/frames.php?reference=16 --another good site on evaluating websites and online sources.

http://www.emich.edu/ift/mod2/lesson3.php --Website comparison checklist using the CRAP method.

http://kscinfolit.wordpress.com/2012/02/14/worksheet-c-r-a-p-website-evaluation-checklist/ --Keene Info Lit Bank—a literary resources website. C.R.A.P. Website Evaluation Checklist, posted by kscinfolit. Fancy version of crap checklist.

http://www.eufic.org/article/en/expid/Understanding-scientific-studies/ --A really good summary of how to evaluate a scientific study. May be too difficult for students. Sponsored by the European Food Information Council.

http://www.usg.edu/galileo/skills/unit07/internet07_08.phtml --Online Library Learning Center. Helpful info on evaluating websites.

http://web.archive.org/web/20050213165850/http://www.aip.org/pt/vol-55/iss-3/p35.html#fig1 --Douglas article, *The Puzzle of Global Sea-Level Rise*, on the puzzle of global sea level rise.

http://theseamonster.net/2012/06/sea-level-rise-101/ --A blog site on the oceans run by science professors from several universities. The article is Sea Level Rise 101, by John Bruno, marine ecologist at UNC-CH.

http://topics.nytimes.com/top/news/science/topics/globalwarming/index.html --New York Times articles on Global Warming and Climate Change. Most have links to original research papers.

http://www.co2science.org/index.php --CO2 Science—a skeptic site.

http://sciencecases.lib.buffalo.edu/cs/ --National Center for Case Study Teaching in Science. An EXCELLENT site with case study lesson plans that are really great. Several are on climate change, including “The Petition: A Global Warming Case” that uses the Global Warming Petition Site as inspiration.

Student Resources—

http://www.nsf.gov/news/special_reports/degree/launch.jsp --National Science Foundation site. Video clips in which experts explain various aspects of climate change as well as how the IPCC works. Great for students.

http://www.epa.gov/climatestudents/index.html --A kid friendly site for exploring climate change. Run by the Environmental Protection Agency.

http://concord.org/activities/modeling-earths-climate --Modeling earth's climate. Students can change factors that affect climate and see what happens.

http://www.informationisbeautiful.net/visualizations/climate-change-deniers-vs-the-consensus/ --This site takes all kinds of data and creates visual representations of it. Includes a side by side comparison of the global warming skeptics' and the global warming scientists' interpretation of climate data.

http://flood.firetree.net/ --Interactive Google map showing effects of sea level rise.

http://www.climatedata.info/index.html --simplified summaries of scientific research.

http://www.epa.gov/osw/education/teens/climate.htm --EPA resource on climate change for teens.