Climate Conversations: Role Playing Resources

Suggestions for discussions with parents or the public:

- Be well prepared with understanding of the basics, sources of information, process of science.
- Use positive phrasing during discussion.
- Help examine sources of information for strength of science and credibility.
- Provide opportunities to express viewpoints and concerns.
- Validate others' concerns; many have legitimate worries about the future.
- Stick to the science - stay away from emotional arguments.
- Reassure that as a science educator, you use validated, credible science resources.
- Avoid personal attacks and don't take arguments personally.

Suggestions for classroom discussions:

- Build a respectful environment for discussing different viewpoints.
- Establish classroom rules for the discussion and for finding and presenting evidence so that the discussion is based on facts, not opinion.
- Preview all materials, especially visual media that will be used to make sure that your information comes from trusted and credible sources.
- Expect students to show respect for others and their point of view by using active listening skills.
- Explain to students that they can challenge ideas, but do not allow personal attacks.
- Control the discussion so that every student has an opportunity to talk and express ideas, including the introverts.
- Encourage students to explain reasons why they have a particular point of view.
- Help students to examine sources of information.
- Provide closure to the discussion. The class does not have to reach consensus, but there should be agreement to suspend discussion respectfully.

Structured Academic Controversy
http://serc.carleton.edu/sp/library/sac/index.html

Information about Role-Playing
http://serc.carleton.edu/sp/library/roleplaying/index.html

Role-playing scenarios
http://serc.carleton.edu/sp/library/roleplaying/scenario.html

Climate Conversations: Facilitator Resources

A. Weather Predictions

Climate and weather are very different things, and the level of predictability is comparably different. Climate is defined as weather averaged over a period of time -- generally around 30 years. This averaging smooths out the random and unpredictable behavior of weather. Think of it as the difference between trying to predict the height of the fifth wave from now versus predicting the height of tomorrow's high tide. The former is a challenge -- to which your salty, wet sneakers will bear witness -- but the latter is routine and reliable.

Based on comprehensive data from multiple sources, NOAA bases its climate reports on 10 measurable planet-wide features used to gauge global temperature changes. The relative movement of each of these indicators proves consistent with a warming world. Seven indicators are rising: air temperature over land, sea-surface temperature, air temperature over oceans, sea level, ocean heat, humidity and tropospheric temperature in the “active-weather” layer of the atmosphere closest to the Earth’s surface. Three indicators are declining: Arctic sea ice, glaciers and spring snow cover in the Northern hemisphere.

http://www.noaanews.noaa.gov/stories2010/20100728_stateoftheclimate.html

http://nrc.noaa.gov/plans_docs/2010/ForecastUncertainty_StateofScience_12_22_09_fin.pdf

B. Carbon Dioxide is good for us!

There are some key climate drivers that have both natural sources and human sources, and scientists are able to distinguish between them. The changes that have occurred in natural climate drivers in recent decades would likely have caused a small amount of cooling, not warming. During the past century, human activities have been the only sustained source of the extra heat-trapping gases that have been added to the atmosphere. Scientists have demonstrated that the primary human source (80 percent) is the burning of coal, oil, and natural gas, and the secondary human source (20 percent) is deforestation and other land use changes.

During the past 50 years, the sum of solar and volcanic forcings would likely have produced cooling. IPCC, 2007, p. 5

As a result of human activities, the present carbon dioxide concentration of about 385 ppm is about 30 percent above its highest level over at least the last 800,000 years. GCRP, 2009, p. 6

As temperatures and atmospheric carbon dioxide increase, many scientists are concerned how these changes will affect plants. Scientists have known for some time that increased concentrations of carbon dioxide causes the stomata to close, resulting in lower transpiration rates and increased water efficiency in plants. Information on how carbon dioxide affects transpiration at the level of plants in the field is more limited.

http://www.csrees.usda.gov/newsroom/impact/2008/nri/10141_carbon_dioxide.html

While food production may benefit from a warmer climate, the increased potential for droughts, floods and heat waves will pose challenges for farmers. Additionally, the enduring changes in climate, water supply and soil moisture could make it less feasible to continue crop production in certain regions.

http://www.epa.gov/climatechange/effects/agriculture.html

C. Questionable data

Using various tools and techniques, including climate models, radar and weather-balloon observations, satellite data, etc. climate researchers are working to understand the impacts of global and regional climate change. A climate reference observing network is a group of stations that collect highly accurate data for the purpose of determining climate variability and trends. This requires long periods (decades) of records where there are minimal human influences on the environment in the immediate vicinity of the stations.

NOAA is part of several climate reference observing networks both nationally and internationally. For example, the U.S. Climate Reference Network or USCRN) operates in 114 locations in the 48 contiguous States capturing real-time measurements of surface temperature, precipitation, wind speed, and solar radiation at a fine scale using highly accurate and frequently calibrated meteorological instrumentation. To detect *regional* climate change over the next 50-100 years, there are approximately 1200 stations in the Historical Climatology Network which collect daily and monthly records of basic meteorological variables (precipitation and temperature). These stations collect observations every five minutes.

The NOAA National Climatic Data Center (NCDC) is one of the world's premier centers for archiving, processing, and researching climate data. The Center has a mission to describe the climate of the United States and NCDC acts as the Nation's Scorekeeper regarding the trends and anomalies of weather and climate.

D. Small changes can't be very bad.

Small changes in the global temperatures can cause large effects. Here's an example.

The Little Ice Age was a time of cooler climate in most parts of the world. Although there is some disagreement about exactly when the Little Ice Age started, records suggest that temperatures began cooling around 1250 A.D. The coldest time was during the 16th and 17th Centuries. By 1850 the climate began to warm. During the Little Ice Age, average global temperatures were 1-1.5 degree Celsius (2-3 degrees Fahrenheit) cooler than they are today. The cooler temperatures were caused by a combination of less solar activity and large volcanic eruptions. Cooling caused glaciers to advance and stunted tree growth. Livestock died, harvests failed, and humans suffered from famine and disease.

The Little Ice Age was not a true ice age because it did not get cold enough for long enough to cause ice sheets to grow larger.

http://www.windows2universe.org/earth/climate/little_ice_age.html

One degree may sound like a small amount, but it's an unusual event in our planet's recent history. Earth's climate record, preserved in tree rings, ice cores, and coral reefs, shows that the global average temperature has been stable over long periods of time. Furthermore, small changes in temperature correspond to enormous changes in the environment.

For example, at the end of the last ice age, when the Northeast United States was covered by more than 3,000 feet of ice, average temperatures were only 5 to 9 degrees cooler than today.

http://climate.nasa.gov/effects/

E. Consensus among scientists?

The evidence for human-induced climate change is so strong that scientists are in unusually strong agreement about it. A January 2009 poll of more than 3000 earth scientists found that 82 percent of them, regardless of their specialties, agree that human activity is a significant contributor to changing average global temperatures. The consensus is even stronger among active climatologists who publish the majority of their work on climate studies: 97.4 percent agree! This level of consensus is astonishing in a community where reputations are made by proving others wrong.

12 Doran, P.T. and M.K. Zimmerman, 2009. "Examining the Scientific Consensus on Climate Change." *Eos: American Geophysical Union* Vol. 90, p. 22-23. Available at:

http://tigger.uic.edu/~pdoran/012009_Doran_final.pdf

F. Natural Cycles

The Earth's climate has changed throughout history. From glacial periods (or "ice ages") where ice covered significant portions of the Earth to interglacial periods where ice retreated to the poles or melted entirely - the climate has continuously changed.

Scientists have been able to piece together a picture of the Earth's climate dating back decades to millions of years ago by analyzing a number of surrogate, or "proxy" measures of climate such as glacier ice cores, tree boreholes, tree rings, glacier lengths, pollen remains, and ocean sediments, and by studying changes in the Earth's orbit around the sun. During the last 2,000 years, the climate has been relatively stable. Scientists have identified three departures from this stability, known as the Medieval Climate Anomaly (also referred to as the Medieval Warm Period), the Little Ice Age and the Industrial Era. Research studies have shown that:

- There is a high level of confidence that the global average temperature during the last few decades was warmer than any comparable period during the last 400 years.
- Present evidence suggests that temperatures at many, but not all, individual locations were higher during the past 25 years than any period of comparable length since A.D. 900. However, uncertainties associated with this statement increase substantially backward in time.
- Very little confidence can be assigned to estimates of hemisphere average or global average temperature prior to A.D. 900 due to limited data coverage and challenges in analyzing older data.

http://www.epa.gov/climatechange/science/pastcc.html

Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in human-caused greenhouse gas concentrations. It is likely that there has been significant human-caused warming over the past 50 years averaged over each continent (except Antarctica) During the past 50 years, the sum of solar and volcanic forcings would *likely* have produced cooling. Observed patterns of warming and their changes are simulated only by models that include human-caused forcings.

Human-caused warming could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change. Climate change is *likely* to lead to some irreversible impacts.

http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

G. It’s the Sun!

It's reasonable to assume that changes in the sun's energy output would cause the climate to change, since the sun is the fundamental source of energy that drives our climate system.

Indeed, studies show that solar variability has played a role in past climate changes. For example, a decrease in solar activity is thought to have triggered the Little Ice Age between approximately 1650 and 1850, when Greenland was largely cut off by ice from 1410 to the 1720s and glaciers advanced in the Alps.

But several lines of evidence show that current global warming cannot be explained by changes in energy from the sun:

- Since 1750, the average amount of energy coming from the Sun either remained constant or increased slightly.

- If the warming were caused by a more active sun, then scientists would expect to see warmer temperatures in all layers of the atmosphere. Instead, they have observed a cooling in the upper atmosphere, and a warming at the surface and in the lower parts of the atmosphere. That's because greenhouse gasses are trapping heat in the lower atmosphere.

- Climate models that include solar irradiance changes can’t reproduce the observed temperature trend over the past century or more without including a rise in greenhouse gases.

Since 1978, a series of satellite instruments have measured the energy output of the sun directly. The satellite data show a very slight drop in solar irradiance (which is a measure of the amount of energy the sun gives off) over this time period. So the sun doesn't appear to be responsible for the warming trend observed over the past 30 years.

Longer-term estimates of solar irradiance have been made using sunspot records and other so-called “proxy indicators,” such as the amount of carbon in tree rings. The most recent analyses of these proxies indicate that solar irradiance changes cannot plausibly account for more than 10 percent of the 20th century’s warming.

http://climate.nasa.gov/causes/

H. I Like warm weather climates.

Altered frequencies and intensities of extreme weather, together with sea level rise, are expected to have mostly adverse effects on natural and human systems. Human-caused warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized.

There is new and stronger evidence of observed impacts of climate change on unique and vulnerable systems (such as polar and high mountain communities and ecosystems), with increasing levels of adverse impacts as temperatures increase further. There is an increasing risk of species extinction and coral reef damage.

http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

Global climate change has already had observable effects on the environment. Glaciers have shrunk, ice on rivers and lakes is breaking up earlier, plant and animal ranges have shifted and trees are flowering sooner.

Effects that scientists had predicted in the past would result from global climate change are now occuring: loss of sea ice, accelerated sea level rise and longer, more intense heat waves.

The potential future effects of global climate change include more frequent wildfires, longer periods of drought in some regions and an increase in the number, duration and intensity of tropical storms.

http://climate.nasa.gov/effects/