Text from the Centennial Museum

For more information – please go to www.ipyroam.org

To The Ends of the Earth: UTEP goes to the poles.

What comes to mind when you hear about the polar regions – the Arctic and Antarctic? Snow, ice, darkness, isolation, cold? We often assume these places are identical; however, they each have very unique characteristics and there are many misconceptions about their nature. The Arctic is in the northern hemisphere, while Antarctica is at the southern tip of the planet. Polar bears live only in the Arctic, while penguins are found only in Antarctica. However, they also share some similarities. They both have been attracting explorers for hundreds of years. Did you know that, for many years, people from UTEP have been travelling to the Arctic and Antarctica as tourists, researchers and support staff? Here are the stories of their adventures and the messages they send to you about how change in these awe-inspiring places affects people all over the world. Come with us as we take you on a journey out of the frying pan and into the freezer...

Antarctic Facts

- Antarctica is 98% covered in ice and contains 90% of all ice on the Earth. This ice holds more than 70% of all fresh water on the planet.
- Antarctica is the only continent that has never had an indigenous human population.
- Antarctica has been governed by international treaty since 1961; many countries have claims to parts of Antarctica but all are suspended while the treaty is in effect.
- The coldest air temperature on Earth (-90°C/-129°F) was recorded near the South Pole in Antarctica.

Arctic Facts

- The North Pole is not on land, but in the Arctic Ocean.
- Native people have inhabited the Arctic for nearly 20,000 years.
- The Greenland Ice Sheet is the largest Arctic glacial mass and contains 10% of the world's freshwater. If it were to melt, the world's sea level would rise by 7 meters (21 feet).

- The Arctic is warming at twice the rate of the rest of the Earth as a result of climate change. The Arctic Ocean could be ice free in summer by 2050.

Poles Apart: Differences between the Arctic and Antarctica

- Antarctica is a continent surrounded by ocean whereas the Arctic is a sea surrounded by land.
- The Arctic has indigenous people whereas Antarctica does not. There are towns in the Arctic, but only scientific research bases in Antarctica.
- The Arctic has polar bears but no penguins; Antarctica has penguins but no polar bears. Both are threatened by global warming, and polar bears face imminent extinction when the sea ice critical for their survival is lost.
- The Arctic has diverse plant life including some trees. There are only two small species of flowering plants in Antarctica.
- In the Arctic summer is between June and September, which is winter in Antarctica; the Antarctic summer is between December and March, which is winter in the Arctic!

What is climate change?

- Climate change is a natural process that has occurred throughout the Earth's history. Only a few degrees change in average global temperature make the difference between an ice age and the relatively warm world in which we now live. Only a few more degrees of change would put us in a very hot world, unlike anything experienced in human history to date.
- In the distant past, the Earth's climate has changed as the result of:
    - Changes in the amount of heat output from the sun.
    - The orientation of the Earth to the sun, and the position of the seas and continents on the globe, both affecting how much heat is absorbed from the sun.
    - Changes in the chemical composition of the Earth's atmosphere due to meteorite collisions with the Earth, volcanic eruptions, wild fires, and the evolution of plants and other life on Earth.
- Current rates of climate warming are dramatic in comparison to any climatic change experienced on Earth over the past million years.
- One of the greatest challenges now facing us is to understand how climate change will impact humans and the world we live in - and how to best adapt.

What is causing climate change

- Many natural and human-made gases trap energy from the sun within the Earth's atmosphere – like a greenhouse. Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), water vapor (H_2O), and chlorofluorocarbons (CFCs) are the most important greenhouse gases.

- The concentration of all the greenhouse gases has increased in the Earth's atmosphere over the past century, as a result of the burning of fossil fuels such as oil, coal and natural gas, and the worldwide removal of native forests.

- Ice-covered surfaces reflect energy from the sun back in to space; dark surfaces like the ocean trap more heat energy from the sun. As glaciers, ice caps and sea ice melt around the world, less heat energy will be reflected and more will be trapped, warming the globe.

- The "Greenhouse Effect" refers to the effect whereby light is allowed to enter a greenhouse (or the Earth's atmosphere), while greenhouse gases trap the heat within the atmosphere and reflect it back towards the Earth. This warms the Earth's surface and lower atmosphere (see diagram).

How is climate change affecting the polar regions?

- Climate warming in the Arctic is occurring twice as fast as the global average. The Antarctic Peninsula is also warming quickly.

- Arctic sea ice is disappearing faster than predicted and the Arctic Ocean could be ice free in the summer by 2050. Already there is 40% less sea ice in the Arctic than there was 30 years ago. The ice caps of Greenland and the Antarctic Peninsula are also retreating.

- Reduction in sea ice will have devastating consequences for polar bears, ice-dependent seals, and native people for whom these animals are a primary food source.

- Many plant and animal species in the Arctic and on the Antarctic Peninsula are extending their ranges to higher latitudes as temperatures become warmer.

- Permafrost (permanently frozen ground) is thawing in many areas of the Arctic. This changes ecosystems and destabilizes human dwellings such as buildings, roads and runways.

The International Polar Year - IPY

- The International Polar Year is a large international scientific program focused on the Arctic and the Antarctic from March 2007 to March 2009.

- The IPY is being lead by the International Council for Science (ICSU) and the World Meteorological Organization (WMO).

- IPY 2007-09 is the fourth polar year, following those of 1882-3, 1932-3, and 1957-8.

- The current IPY involves scientists from over 60 nations collaborating in more than 200 physical, biological and social science projects.

UTEP's role in the IPY

UTEP has 3 official IPY projects, in addition to several other research activities occurring in the Arctic and Antarctica. All projects are funded by the US National Science Foundation (NSF).

1. Twenty people from UTEP travelled to Antarctica over winter break 2007 to learn about and participate in polar research (IPY-ROAM).

2. Sites in the Arctic that were first researched more than 30 years ago are being revisited to assess response of Arctic landscapes to climate change (IPY – Back to the Future).

3. The 2008 National Conference for the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) was funded on a grant led by UTEP researchers to celebrate the IPY and train students in global change.

In addition, researchers at UTEP are involved in polar projects that are:

- Examining the response of Arctic tundra to experimentally altered warming, flooding and drying (Biocomplexity study).
- Assessing how changes in Arctic tundra ecosystems in northern Alaska and Russia alter species diversity and ecosystem function.
- Building mapping software that researchers and the general public interested in the Arctic and Arctic research can access on the internet.
- Bringing researchers together from all over the Arctic to share their ideas and methods for doing different measurements.
- Developing scientific instrumentation and software to help researchers collect data in the harsh environmental conditions of the Arctic.

For more information about these projects, please go to www.ipyroam.org.

ANTARCTICA

IPY-ROAM

IPY-ROAM:
International Polar Year: Research and Educational Experiences in Antarctica for Minorities

Program Goals:

- To increase the number of underrepresented minorities in the sciences
- To increase public awareness about the Polar Regions.

Program Outline:

- We recruited 17 undergraduates, 7 graduate students and 5 teachers from across the US in order to teach them about the polar sciences.
- Participants took an on-line course in Antarctic System Science; visited Washington DC to learn about US environmental policy and the National Science Foundation; designed and completed research projects in terrestrial and marine ecology, geosciences, tourism policy, and education while on a 10-day trip to Antarctica.

- Upon their return, participants analyzed data, presented research results at international conferences, and performed outreach activities.
- Some of their impressions of Antarctica are on the wall labeled "Out of the Frying Pan and Into the Freezer".

Four UTEP faculty, 14 UTEP students and 2 teachers from El Paso areas schools participated in this program, together with 15 other participants from across the country.

UTEP goes to Antarctica!

ROAMers travelled to Antarctica for 10 days in December 2007, where they made 8 landings in the Antarctic Peninsula region.

1. A trip to shore begins with zodiacs being loaded onto the ocean. Then the passengers walk down the gangway, get into the zodiacs and travel to shore.
2. Before they can get off the zodiac, a member of the ship's expedition staff briefs them about how to reduce their impact on the fragile and unique environments found at each site.
3. While on shore, ROAMers collected data for their research projects in terrestrial and marine ecology, geosciences, tourism policy, and education and outreach. Tourists get to explore the unique environment found at each site.
4. After about 2- 3 hours, we get back on the zodiacs, head back to the ship and travel to our next destination!
5. Everyone must wash their boots after returning from shore so that we do not transfer any potential diseases or exotic species between sites.

Education and Outreach

One of the primary goals of IPY-ROAM is to increase public awareness about the polar regions. Besides designing the museum display you are visiting right now, we also developed lesson plans that teachers can use in the classroom (available at www.ipyroam.org), are developing a documentary film, and have participated in many outreach activities.

ROAM participants visited many El Paso middle- and primary schools, told students about global change and polar science, and asked students to pledge to reduce their carbon footprint. Students created and signed a fabric "Promise Banner" to solidify their pledge. ROAM-ers photographed these banners in Antarctica and returned them to the classrooms. Approximately 500 students from various schools locally and abroad participated in the promise banner program. Later in this display, you will learn about relatively easy ways to reduce your own carbon footprint.

Antarctic Animals…

Antarctic krill (*Euphausia superba*) are a primary food source for whales, penguins, seals and many birds in Antarctica. Krill are shrimp-like organisms that use fine hairs on their legs to strain food from the water and scrape algae off of sea ice (kind of like a comb). Krill are considered a keystone species, one that is critical for the survival of many other species. The loss of keystone species can result in major ecosystem shifts or even collapse.

Krill are dependent on the food available on sea ice. Recent studies have shown that both krill densities and sea ice extent have been declining in the Southern Ocean since the 1970s. These effects may be amplified with a warming climate, as there may be less sea ice and consequently, less krill. With the loss of krill, the many species that depend on it for food may also decrease in number.

Penguins are flightless, marine birds that are highly specialized for diving and swimming and spend as much as 80% of their time in the water. Their flippers are modified wings used to propel them through the water, and their webbed feet are used to steer. To avoid stopping to take breaths while swimming, penguins use a method of swimming called porpoising, where they swim rapidly below the surface and propel themselves out of the water in a low arc to take a quick breath. Most penguins feed primarily on krill.

Long term trends in warming, and reduced sea ice extent, may negatively affect many penguin populations. In particular, Adélie penguins (*Pygoscelis adeliae*), which prefer areas of sea ice and are confined to areas below the Antarctic Circle, may show declines in population numbers with warming.

Antarctic skuas (*Catharacta antarctica*) are very large and powerful, territorial birds that often form their territory on the edge of penguin colonies, where they can feed on penguin eggs and young chicks. Pairs of skuas are faithful to each other and their breeding territory, year after year. Two eggs are hatched by the female; however, the younger is usually killed by the older chick due to fighting or by preventing it from getting food.

The ***wandering albatross*** (*Diomedea exulans*) has the largest wingspans of any bird - up to 3.7 meters (12 feet) from tip to tip – and relies on this huge wingspan, as well as the wind, to keep it airborne. They easily travel thousands of kilometers, flapping their wings as little as possible and gliding through the air to conserve energy. You can often find these birds following ships and fishing vessels in search of food, such as krill or squid. Sadly tens of thousands of these flying giants drown each year when they get caught in fishnets. According to the World Conservation Union's (IUCN) Red List, 11 species of albatross that depend on the Antarctic environment are listed as threatened or vulnerable, including the wandering albatross, whose numbers continue to decline.

Sailors believed that wandering albatross were the souls of the dead sailors doomed to wander the oceans forever, and that is was extremely bad luck to kill one. The Rhyme of the Ancient Mariner by Samuel Taylor Coolidge famously tells of this peril.

Crabeater seals (*Lobodon carcinophagus*) are the most numerous seal in Antarctica, and the world. They have unique multi-lobed teeth that are designed to sieve krill, their primary diet item (not crab!), from the water. They spend most of their life in and around pack ice, where they swim in groups. They are slim, and mottled brownish white.

Leopard seals (*Hydrurga leptonyx*) are very aggressive hunters. Their large mouths and extremely sharp teeth are ideal for hunting and catching penguins. Their name comes from their spotted coat.

The ***Weddell Seal*** (*Leptonychotes weddellii*) is one of the least aggressive seals. They maintain breathing holes in the Antarctic ice with their teeth - this allows them to stay in the Southern Ocean year-round.

The ***Southern Elephant Seal*** (*Mirounga leonina*) is one of two species of elephant seal, and one of the largest mammals on earth (after elephants and some whales). Elephant seal males are often 10 times heavier than females. Males can grow to 6 meters (20 feet) in length, and can weigh up to 3,600 kg (7940 lbs).

Baleen ***whales*** do not have teeth, but strain small marine organisms using comb-like plates called baleen hanging from the roof of their mouth. Their primary food source is krill; adult blue whales can eat up to 4500kg (9900 lbs) of krill per day. Baleen whales have 2 blowholes and have strange and complex songs. Southern Right, Minke, Blue and Humpback whales are among the baleen whales seen in Antarctica. Minke whales (*Balaenoptera acutorostrata*) are the smallest (9 meters, 30 feet) and most numerous baleen whale. Humpback whales (*Megaptera novaeangliae*) travel over 25,000 km (15,500 miles) per year during their migrations in search of food and good habitat. They can be found in both the Arctic and Antarctica.

Antarctic Vegetation

There are only 2 native species of flowering plants in Antarctica: Antarctic hair grass (*Deschampsia antarctica*) and Antarctic pearlwort (*Colobanthus quitensis*). Both species occur in areas first colonized by mosses and lichens, or in rocky areas where moisture and warmth are elevated. In more extreme southern latitudes, they are replaced by lichens and mosses; however, it is suggested that any increase in temperature in the regions could substantially increase the distribution of vascular plants in coastal Antarctica.

Both plant taxa are well adapted for the cold Antarctic environment and are capable of taking advantage of the brief, austral summer growing season. For example, both plants

- trap and store solar radiation in either tight tussocks (*Deschampsia)* or dense “cushions” close to the ground (*Colobanthus*).
- have leaves much like desert plants that are adapted to living in low water environments.

Lichens are important early successional species in terrestrial Antarctica. This means that they can colonize bare rock and soil in extreme environments or recently disturbed areas and ultimately produce and trap soil, which can help other plants get established.

Mosses are adapted to colonizing harsh environments. They tend to grow in sheltered areas and/or areas where moisture accumulates. According to the Australian Antarctic Division, mosses have been collected from as far south as 84° 30' (the South Pole is at 90°).

Humans in Antarctica

Antarctica is often thought of as a pristine land untouched by human disturbance. However, this is no longer the case. For a more than a hundred years people have been traveling to Antarctica for both work and play.

Exploration

Many explorers and adventurers have challenged themselves in the Antarctic, but it wasn't until the early 1800s that humans, sealers in the fur trade, first stepped foot on the Antarctic continent.

Some of the greatest stories of heroism, scientific exploration and adventure come from the race to the South Pole in the early 1900s.

- An Englishman, Robert Falcon Scott, was the first to attempt the land crossing in 1902; however, his team of 3 men made it less than halfway to the South Pole after their sled dogs perished and the men had to pull their supplies behind them on sledges.
- One of Scott's team, Ernest Shackleton, made the second attempt to reach the South Pole in 1908. Like the first attempt, the men were consigned to pulling their sleds after their ponies died. They traveled 700 miles, but turned back, exhausted, 97 miles short of their goal.
- The race reached a new intensity in 1911, when both Scott and a Norwegian named Roald Amundsen, announced their intent to reach the Pole. Amundsen's team, having trained with the Eskimos in the Arctic, was well prepared. They travelled 20 miles per day on skis, and had two expert dogsledders pull their gear. Again, Scott's team resorted to man-hauling their sledges. Scott's team traveled 10 miles per day and arrived at the South Pole to find the remains of Amundsen's camp. Amundsen had successful reached the pole one month previously on December 14th, 1911. Amundsen's team made it back to their ship 99 days after they left it, while Scott's team never survived the return journey.
- Not one to be outdone, Shackleton made his third polar expedition in 1914. His goal was a Trans-Antarctic expedition from the Weddell Sea to the Ross Sea, a trip of 1,800 miles. The advertisement to recruit men is reported to have read:

"Men Wanted: For hazardous journey. Small wages, bitter cold, long months of complete darkness, constant danger, safe return doubtful. Honour and recognition in case of success."

- Unfortunately, Shackleton's ship got stuck in the pack ice surrounding Antarctica and was crushed. After fifteen months living on ice, hunting seal and penguins for food, the ice began to melt. All 28 men got into the lifeboats they had salvaged from the ship and set sail for the nearest solid land, a small, uninhabited island about 100 miles (161 km) away. Arriving on the remote island 6 to 8 days later, Shackleton and five of his men then set sail in one of the lifeboats to seek rescue from a whaling camp on South Georgia Island, which was an additional 800 miles (1500 km) away. After a series of heroic adventures, Shackleton eventually rescued all of his men with no lives lost.
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Perhaps Sir Raymond Priestley, who accompanied Shackleton to Antarctica in 1907, said it best: *"For scientific discovery, give me Scott; For speed and efficiency of travel give me Amundsen; but when disaster strikes and all hope is gone, get down on your knees and pray for Shackleton".*

Tourism

The numbers of tourists visiting Antarctica has been increasing steadily since the 1990s; most tourism occurs by ship. Approximately 25,245 visitors came to Antarctica in 2005-2006, which is more than double the number observed in 2001-2002 (IAATO). There has been a call among the scientific and international community to monitor and regulate tourism in Antarctica, as many scientists believe this human impact could grow and be detrimental to both the environment and the wildlife. Recent high-profile accidents include the sinking of the tourist ship MS Explorer in November 2007.

International Association of Antarctica Tour Operators (IAATO)

Many outfitters taking travelers and adventurers to Antarctica are voluntary members of the International Association of Antarctica Tour Operators (IAATO). This group advocates, promotes and practices safe and environmentally responsible private sector travel to Antarctica. IAATO operators have agreed to adopt voluntary standards to keep visitors from disturbing wildlife and works with travelers to increase their awareness of minimizing the problems that can be caused by an increased human presence in the area. Passengers must be briefed before leaving tourist ships as to what can be seen at the site, where they should and should not go, and the locations of any particular dangers or environmentally sensitive areas.

Research bases

Approximately 30 nations, all signatory to the Antarctic Treaty, send scientists to perform research in Antarctica. The numbers of researchers on land in Antarctica ranges from approximately 4,100 in summer to 1,000 in winter. In addition, hundreds of scientists also conduct research aboard ships in the Southern Ocean. The United States has 3 research stations operating year-round in Antarctica: McMurdo Station, Admundsen-Scott South Pole Station and Palmer Station. The British Antarctic Survey runs Port Lockroy, where scientists complete research on the impact of tourism on penguins and operate one of the only post-offices in Antarctica! Money raised at the post office helps fund research at the station.

Despite the relative isolation and severe conditions found in Antarctica, much of the research done there is highly significant to the rest of the world. For example, research in Antarctica includes the study of the hole in the ozone layer, research on global sea levels and satellite communications.

Regulation of Antarctica

The Antarctic Treaty

The 12 nations who had been active in and around Antarctica during the second International Polar Year (1957-1958), also called the International Geophysical Year, drafted and signed the Antarctic Treaty. Since coming into effect in 1961, the Antarctic Treaty has been widely recognized as one of the most successful international agreements. Antarctica is the only continent on earth set aside as a reserve, dedicated to peaceful activities and scientific research.

Although territorial claims are often indicated on maps of Antarctica, this does not signify a legal recognition of these claims. Territorial claims are based primarily on discovery and occupation of the claimed area. The Treaty does not recognize, dispute, or establish territorial claims, and no new claims may be asserted. Although both have research bases in Antarctica, neither Russia nor the United States have made territorial claims on the continent.

Ice shelves are collapsing

An ice shelf is a thick slab of ice that extends out over the ocean, and is attached to a land-based ice sheet or glacier. Ice shelves slowly move towards the ocean and their leading edge breaks off and falls in to the ocean – a process known as calving. While calving of ice shelves does not raise sea level, because they are already resting on the ocean surface, glaciers inland of ice shelves may move more quickly towards the sea as their lead edges disappear and this can contribute to sea level rise

Large tabular icebergs form or calve from the edges of ice shelves over a period of 10 or more years. More recently, however, this calving of ice shelves has been occurring at a faster rate. Because they are exposed to both warmer air and ocean temperatures, ice shelves respond more quickly than ice sheets or glaciers to rising temperatures. The fastest rate of ice shelf retreat has occurred on the Larsen Ice Shelf, on the northeastern Antarctic Peninsula. In summer 2002, more than 3000 km^2 (1160 square miles) of the Larsen B ice shelf broke apart. This was the largest single ice shelf disintegration event in 30 years of ice shelf monitoring (Source: National Snow and Ice Data Center).

ARCTIC

Sea ice is disappearing in the Arctic and is having an impact on:

Polar bears (*Ursus maritimus*)

- Polar bears are marine mammals because they spend most of their lives on sea ice floating on the Arctic Ocean. They feed mostly on seals that live around sea ice.
- Polar bear populations are declining. The weight, reproductive success, and size of polar bears have decreased in recent decades.
- Studies predict that somewhere between 70 and 100% world's polar bears may disappear by the middle of this century.
- The decline in polar bear numbers is clearly linked to the decline in sea ice consequent to global warming.
- On May 14 2008, the US listed the Polar Bear as threatened under the US Endangered Species Act.

Native people

Indigenous peoples of the Arctic depend on animals that live on and near the ice like whales, walrus, seals and fish to provide food and other products. Along with thinning and reduction of its area, sea ice is forming later and breaking up earlier than occurred in the past. In many parts of the Arctic, this has shortened the length of the hunting season for these animals. The changing sea ice conditions also make the ice more dangerous for the hunters. Finally, the availability of some species is changing as migration patterns alter in response to global warming.

Coastal erosion

Decreased sea ice coverage in the Arctic Ocean means greater areas of open water. As storms pass over these larger areas of open water, more waves build up. Sea ice itself normally helps to calm wave action,

so the loss of the ice means more intense waves. As a result of this wave energy, increased rates of coastal erosion are being documented around the Arctic. Increased rates of erosion are threatening coastal communities, sites of archeological significance, ecosystem functioning and biodiversity.

Glaciers, ice sheets and sea level rise

- Scientists at the U.S. Geological Survey estimate that if all of the ice sitting on land in Greenland and Antarctica melted it would cause global sea levels to rise by about 215 feet, or 65 meters.
- Over the past 100 years, sea level has risen by approximately 20cm (8 inches).
- Factors that have contributed to sea level rise include:
    - Thermal expansion (when a liquid warms it expands).
    - Melting glaciers.
    - Thawing permafrost (although this is not well understood).
- In 2007, the Intergovernmental Panel on Climate Change (IPCC) predicted that global average sea level will rise between 0.6 and 2 feet (0.18 to 0.59 meters) over the next century.
- Approximately 10% of the human population on Earth lives within 10 meters (32 feet) of the ocean. Most of these people are in Asia, especially Bangladesh, and several island nations, such as Vanuatu, Maldives, Tuvalu, and Kiribati are only a couple meters above sea level. There is a chance that whole island nations may be lost over the next century due to sea level rise. The impact of sea level rise on the human population is likely to lead to a rise in the number of climate change refugees.

Arctic terrestrial environments are responding to climate change.

Permafrost is thawing

- Permafrost is permanently frozen ground. Increasing air temperature in the Arctic is warming the surface of the permafrost.
- In some places warming of permafrost has been recorded 20 meters (65 feet) below the ground surface – it takes a lot of warming and several decades for the effects of surface warming to penetrate this deep into the ground!
- In many areas, thawing permafrost has resulted in slumping of the land surface. Consequences can include: more surface water and structural failures of buildings and other infrastructure such as railways and oil and gas pipelines.

Thawing permafrost could enhance greenhouse warming

- Carbon from the atmosphere accumulates in plants as they grow. At the end of the growing season, the leaves of many Arctic plants die and fall to the ground. Since the ground in the Arctic is often waterlogged, cool and slightly acidic, these leaves do not decompose. This process has been ongoing in the Arctic for thousands of years, and thus a large amount of carbon has accumulated in Arctic soils. In fact, about 25% of the soil organic carbon on Earth is found in the Arctic.
- Over time, this soil organic carbon becomes incorporated into the permafrost where it is stored in conditions much like a freezer where we store our food, safe from bacteria and fungi that would consume it. When permafrost thaws, these organisms can 'feast' on the newly unfrozed carbon, which can result in the loss of soil organic carbon to the atmosphere as carbon dioxide or methane. Carbon dioxide and methane are powerful greenhouse gases and can lead to warmer conditions in the Arctic.

- Warmer air temperatures have the capacity to thaw more permafrost in Arctic tundra and allow even more greenhouse gases to be released to the atmosphere, which can further stimulate greenhouse warming. This is an example of a **positive feedback cycle**: the warmer the Arctic becomes, the more potential there is for old stored carbon in Arctic soils to be released to the atmosphere further stimulating warming. So far, scientists are unsure of the magnitude of this feedback cycle or what factors may further quicken or slow this phenomenon.

Tundra grasslands are changing to shrublands

- Grass-like plants and herbs are generally able to tolerate much colder growing conditions than woody plants like shrubs or trees.
- As temperatures warm in many regions of the Arctic, grassland tundra ecosystems are being replaced by shrublands and, in some places, treelines are moving further north and/or up mountainsides.
- These changes in the distribution and composition of plant ecosystems are causing other changes in Arctic ecosystems. For example:
    - Forests and shrublands are darker surfaces than grassland ecosystems and trap more heat energy from the sun, thereby warming the Earth's surface.
    - More nutrients are flowing into Arctic streams and lakes from melting permafrost.
    - Leaves of shrubs may decompose at a different rate than grasses or herbs, thereby 'trapping' nutrients for a longer or shorter period of time.
    - Many animals, including grizzly bears, red foxes, wolves, moose, and arctic hares, appear to be moving north into areas where they have not been seen before.

IPY: Back to the Future (BTF)

Program Goals:
We are determining how Arctic terrestrial ecosystems have changed over the past 25 or more years and assessing if such changes are likely to continue in the future. This project is helping us understand how climate change is affecting Arctic ecosystems.

Program Outline:

- Resample sites established 25-65 years ago in northern Alaska, Baffin Island (Canada) and West Greenland.

- Compare results with those collected by other researchers around the Arctic doing similar types of measurements to determine how the Arctic is changing.

- See the thoughts and impressions of students involved in this program on our "Out of the Frying Pan and into the Freezer" wall.

UTEP in the Arctic

Many UTEP students have spent the last 4 summers living and working in Barrow, Alaska. Barrow is located on the Arctic Ocean and is the northernmost settlement in the United States. When students arrive in May or June, the landscape is covered with ice and snow, but by the time they leave in late August, it has been transformed into a green and brown tundra landscape rich in plant and animal life. While in this area of Arctic tundra, students have been interacting with the diverse local community, which includes many Inupiat people, and:

- Assessing how Arctic tundra ecosystems have changed over the past 40 years and how these changes are reflected in altered species diversity and ecosystem function.
- Examining the response of Arctic tundra to experimentally altered warming, flooding and drying.
- Recording coastal erosion and the factors leading to recently observed increased rates of erosion along the Barrow coastline.
- Building mapping software that displays current and historic research sites and trends on the internet.
- Developing and utilizing cutting-edge scientific instruments to help collect data in the harsh environmental conditions of the Arctic.

Arctic animals

Polar bears (*Ursus maritimus*) have white fur so they blend into the icy landscape and can sneak up on their preferred prey items, like seals.

Ringed seals (*Pusa hispida*) get their name from their fur coat, which includes dark spots surrounded by lighter "rings". They live throughout the Arctic, where they feed on fish. They are the primary prey of polar bears.

Walrus (*Odobenus rosmarus*) are marine mammals, with prominent tusks and whiskers and are related to the seals. They spend most of their time in shallow water near Arctic sea ice hunting for food, such as clams and worms, which live in the soft sediment at the bottom of the ocean.

Lemmings are small, herbivorous (plant-eating) rodents that live in the Arctic tundra. Their populations often grow very large very quickly when conditions are favorable.

Moose (*Alces alces*) and Caribou (*Rangifer tarandus*) are members of the deer family. Caribou tend to be more common in the tundra, while moose, which feed on shrubs and trees, are found near the edge of the tundra.

Muskoxen (*Ovibos moschatus*) are large herbivores that roam across the Arctic tundra in large herds.

Grizzly Bear *(Ursus arctos horribilis)* live on all northern land masses. Their ranges can overlap with polar bears, with whom they are closely related, but grizzlies live on land, while polar bears spend most of their time on the sea ice. Recent studies have shown that these 2 bear species are able to breed with each other and form grizzly-polar bear hybrids.

Arctic fox (*Vulpes lagopus*) are found throughout the Arctic and eat a diet composed largely of lemmings. They are well camouflaged animals whose fur is brown, like the tundra, during summer, and white during the snowy winter months.

The Arctic Ground Squirrel (*Spermophilus parryii*) is a small, herbivorous rodent that is very vocal. They are called a "sicsic" by the native Inuit because of the calls they make when communicating with each other.

Arctic birds

Snowy owls (*Bubo scandiacus*) are found throughout the Arctic, where they nest on the ground and feed primarily on lemmings and other small rodents. Adult male snowy owls are almost pure white in color, while females and young birds have some darker plumage. When snowy owls are born, they have white-grey, fluffy, down and the nest where they live is defended carefully by both parents.

Spectacled Eiders (*Somateria fischeri*) are sea ducks that breed on the coastline of the Arctic tundra. Males and females of the species look very different, with females being largely brown, while the males have a black body, white back and green head.

The Arctic Skua (*Stercorarius parasiticus*), or Jaeger, nests in the Arctic tundra and feeds on lemmings and other rodents. They are very protective of their nests and will dive at any animals (or humans) that get too close!

The Pectoral Sandpiper (*Calidris melanotos),* Red Phalarope (*Phalaropus fulicarius*), Dowitcher (*Limnodromus* sp.) and Dunlin *(Calidris alpina*) are all from the same family of waders or shorebirds. Each species has long legs to help them wade through shallow waters as they search for invertebrate food. They all breed in the Arctic tundra but migrate to other regions of the world during the cold Arctic winter.

Arctic vegetation

Arctic vegetation has survived many glaciations over the past several million years. During warm periods when large glaciers retreated, Arctic vegetation withdrew to a small ring around the Arctic Ocean and to the tops of mountain ranges. During cold periods, Arctic vegetation expanded in area. The future of Arctic vegetation may be threatened as the Arctic tree line moves further north and shrubs begin to dominate many Arctic landscapes with climate warming.

Many Arctic plants have known medicinal, food and survival properties that the Inuit have used for thousands of years. Did you know that the fluff of the arctic cotton grass was once used by the Inuit as a type of down to pad thick animal skin coats and keep them warm during winter?

Icy facts!

- Icebergs are white in color when they contain bubbles of air, but can become blue as the bubbles are compressed out under pressure.
- Less than 10% of an iceberg is visible above water. Hence, the phrase: “tip of the iceberg”, which indicates that only a small part of a much bigger problem has been revealed.
- The *Titanic*, which sank in 1912 off the coast of Newfoundland, ran aground on the underwater portion of an iceberg
- The largest iceberg ever observed was 295 km (183 miles) long by 37 km (25 miles). This is approximately the size of Hudspeth County or 4 times the size of El Paso County!

How does change at the poles affect the US southwest?

Climate change is not only occurring in the Polar Regions. Did you know the climate of the US southwest is also changing? In fact, the US southwest is considered to be one of the regions in the US affected most by climate change.

Recently, scientists have discovered the following:

- Air temperature in the US southwest has increased by more than 1 degree Celsius over the past half century.
- It is likely that air temperature in the US southwest will rise by 3.5 to 4 degrees Celsius over the next century.
- Winter storm tracks from the west have moved further north since the 1970's and many of the US southwest desert states are receiving less winter rains than before.
- Climate change is likely to result in a more extreme climate in the US southwest – some years will be extremely wet and other years will be extremely dry. Droughts are also likely to continue longer than they used to.

By using tree ring analysis, socioeconomic modeling and analysis of human health data, researchers have been able to make the following links to these changes in climate:

- It is likely there will be more forest fires and dust storms as a result of drier conditions.
- Higher temperatures and lower precipitation mean higher rates of evapotranspiration. It is likely farmers will have to irrigate more to sustain their crops even though there is likely to be less water available for them to irrigate.
- Society is likely to be negatively impacted by rising incidence and cost of climate-related insurance payouts such as those resulting from floods, tornados, hurricanes and droughts.
- Certain health concerns such as allergies, insect spread disease, and skin ailments are likely to increase as certain plant species and ecosystems respond to changes in climate.

What is your Carbon Footprint?

Your *personal* carbon footprint is the sum total of all greenhouse gases which are emitted due to YOUR activities in a given day, month, year or lifetime! A small carbon footprint means you contribute less to global warming. There a many websites where you can calculate your own carbon footprint (see www.ipyroam.org).

Ways to reduce your carbon footprint

- Drive a more efficient vehicle; drive less aggressively; drive less or car pool, walk or take public transport – and lobby your local government for more public transport options.
- Turn the thermostat down by 2 degrees in the winter, and up by 2 degrees in summer.
- Replace incandescent light bulbs with compact fluorescents that use less energy, last longer and are more efficient.
- Turn off and unplug electronic devices not in use. When replacing appliances or electronics, buy more efficient ENERGY STAR products.
- Buy locally grown foods, avoid highly-processed and over-packaged foods and eat less meat: transporting, processing and packaging foods, as well as raising livestock, are all significant energy users.
- Plant a tree to take up CO_2 from the atmosphere.
- Invest in alternative energies – such as a hybrid vehicle, biodiesel, and solar or wind power.
- Conserve water: use native plants, capture rainwater, take showers rather than baths.
- Offset your carbon emissions by purchasing carbon credits to support alternative energy research and the construction of alternative energy solutions.
- Reduce, reuse and recycle.