Climate Change 101

What is "climate change"?

This is the best definition we found:

"The earth is faster now"

-Mabel Toolie, Elder, Savoonga, as shared by Caleb Pungowiyi

http://www.arcus.org/Publications/EIFN/Earth_Faster_front.pdf

Climate Change is the common name used for the recent faster, bigger, and different changes in the weather over the past couple of decades.

Climate change is a change or variability in the "average weather" of a region. This means a change in the temperature, precipitation, winds and/or storms that a region experiences over a specific period of time. **Global** climate change refers to these changes **over the Earth** as a whole.

Climate change can occur naturally. Our climate is controlled by a balance between energy received from the sun and radiation the Earth loses to space. Any changes in our environment, either natural or human-induced, that alter this balance can affect our climate.

We will talk about this more, but it is important to know that the current Climate Change includes increasing **climate variability** for different factors and regions. In Alaska, this seems to be the case for at least some environmental/weather events. Observations of greater unpredictability and in snow, rain, and storm strength and frequency are common.

An example of precipitation variability is that the total amount of water from rain and snow in one year may average almost the same in a region , but *when* it falls (which can determine if it will be rain or snow), and/or how *hard/fast* it falls can be different. Alaska Natives know everything is connected.

This variability affects plants and animals and ice and snow conditions. So it affects logistics like our ability to travel for subsistence - and socializing and hub freight options in the winter.

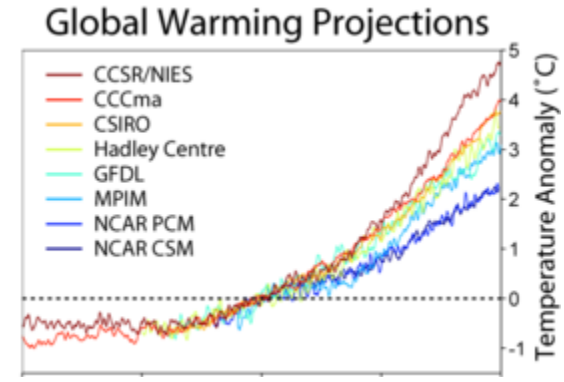
How much climate variability there will be or what the average conditions might be is not known as well. But climate change models do predict climate *variability, and increases in that variability for at least some weather factors,* to continue.

Primary resources used: Inuit Tapiriit Kanatami Environmental Department
http://www.itk.ca/environment/climate-change-index.php

What is "global warming"?

Global warming is often used to mean "climate change". But to researchers, global warming is just a part of climate change. Global warming is specific to temperature. It is the increase in average temperature of the Earth's air and oceans in recent decades. See the graph to the right on how fast the average temperature over the whole earth is expected to rise, based on different science models. The temperatures are given in Celsius (C), not Fahrenheit (F) degrees that we normally use. "Celsius" is the temperature that most researchers and other countries use. For example, 32 F (when water freezes) equals 0 C. To switch from C to F, or F to C, click here: http://www.wbuf.noaa.gov/tempfc.htm

Convert temperatures



Calculations of global warming prepared in or before 2001 from a range of climate models assuming no action is taken. Reproduced from http://en.wikipedia.org/wiki/Global_warming#Climate models on 12/14/2007

How are temperatures changing in Alaska?

We all know that Alaska is warming. The average increase over the last 5 decades is about 3.4°F throughout all of Alaska. Overall, the Arctic is the warmest it has been in 400 years. However, when looking at Alaska *by season*, the **biggest change has occurred in winter and spring**, with the least change in autumn. Winter temperatures have increased 6.3°F—almost twice the average increase. In general, those of us in the far north of Alaska are seeing greater temperature differences than in the far south.

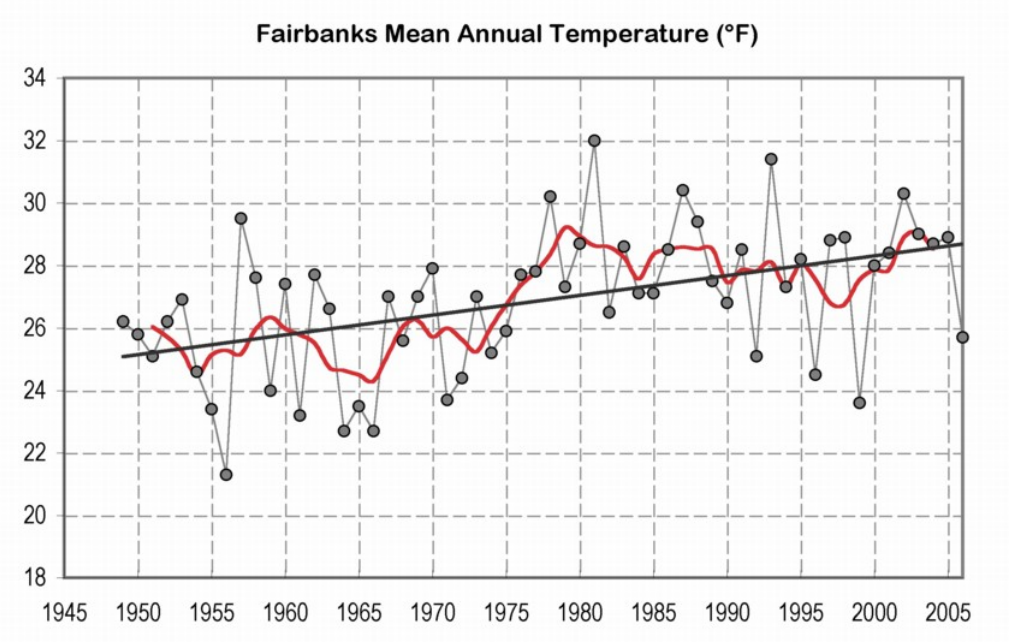
The change in temperature does not follow a straight line. As villages know, temperatures can be colder or warmer for one or more years. The variation can be really big. Temperatures can change a lot more in a season from day to day. Seasonal temperatures can also be much more different from year to year.

Are temperatures getting more unpredictable? Many of us have observed that temperatures seem to be getting more unpredictable. Researchers from UAF Fairbanks looked at **statistics of weather station temperatures** from Year 1950 to Year 2000 in Alaska. An increase in variability was only found in a few locations for a few seasons. They did find monthly temperature anomalies (extremes) to be increasing a bit. Temperature is just one measure of what the weather and environment is like. If you are observing more and more unpredictable weather for your Village, then it is more unpredictable. In Alaska, warming up means we will "cross" the freezing temperature line more often. And with the change in precipitation and storm patterns that is happening, whether we will have snow or rain (or windy or calm) will change. Snow and ice and its condition, and many other detailed

weather and environment factors are what we look for in winter to carry out subsistence and travel to our families in other villages. So temperature predictability is not the same as weather predictability.

The bottom line: In general, *Temperatures* might be changing back and forth in Alaska as much as they always have. The average temperature is still slowly getting warmer. But *weather* may be changing more and thus becoming more and more unpredictable.

Here is an example of the average increase in temperature for Fairbanks. The straight line is what is called a "linear projection" or "linear best fit". The dots are the actual annual temperature for each year. The variability is related to the width of the band above and below the line, which is pretty constant:



The period 1949 to 1975 was much colder in Alaska than the period from 1977 to 2006. However, in **most** of Alaska, there has been a small increase in average **annual** temperature since 1977. Part of this may be because **every 2 – 4 decades there is a shift in how the wind flows.** When this change happens one way, more warm air usually comes to Alaska in winter time. When it shifts the other way, less warm air usually comes to Alaska in winter. Western researchers call this "the Pacific Decadal Oscillation" or PDO. Have you ever heard of "El Nino"? The PDO is similar, only it happens less often. In 1976, the PDO shifted to its "warm" setting. Some researchers think there was a small shift back again in 1997, but that is not clear yet.

Want to impress a western researcher? Say PDO in a sentence casually. For example: "it isn't clear what effect the PDO has on our own village's warmer temperatures because we don't have enough rural weather stations in Alaska for precise local predictions." Act surprised if they don't know what PDO means.

Again, the **seasonal change** in weather **can be different** from the **annual change** in weather. **Winter temperatures have increased more than other season temperatures**. This means that Winter temperatures are more different from past winter temperatures, than Fall temperatures are from past Fall temperatures. Many Global Climate Change reports talk about annual temperature changes. **This means an average over the whole year.** A simplified math example is if average winter temperatures were 10 degrees warmer, and all the other season averages were 0 degrees warmer (i.e. they stayed the same), then the annual temperature change reported would be 10 divided by 4 seasons) = 2.5 degrees warmer for the year. **In villages we live by the seasons, so the annual temperature increase does not tell the full story we need to know.**

There is a good site to see seasonal differences for several cities throughout Alaska. These cities are where the National Weather Service (NWS) has weather stations. The NWS looks at the recordings from these stations, satellite images, and some other reports to predict your local weather.

1. **Total temperature change by season.** Click on this link: http://climate.gi.alaska.edu/ClimTrends/Change/TempChange.html Scroll down to the bottom of this page to the charts. The right-side chart is color coded. Boxes that are orange, yellow, and red show the highest difference from normal. Boxes that are white are almost no change. Boxes that are blue mean that the season on average has been colder than normal. The left-side chart shows the actual average temperatures.
2. Note, just above the seasonal change charts, Figure 2 shows the **Annual average temperature** change for the whole state. You can see how much warmer the temperatures have been since 1977.

Because the **temperatures since 1977 are more similar** to today, they may represent better what is happening in Alaska and your region now.

Click here http://climate.gi.alaska.edu/ClimTrends/Change/7706Change.html to see the change in annual temperatures between 1977 and 2006:

Do you see a difference between the graphs that start at 1949 and the ones that start at 1977 for your area?

To see average temperature, **precipitation, snowfall, and snow depth** by the month, click on the city below. These villages and cities have National Weather Service stations, which generally have the best weather information:

Anchorage	Fairbanks	McGrath
Annette	Gulkana	Nome
Barrow	Homer	St. Paul
Bethel	Juneau	Talkeetna
Bettles	King Salmon	Valdez
Big Delta	Kodiak	Yakutat
Cold Bay	Kotzebue	

Photo: www.trekearth.com

Village Weather: Other Village weather is forecast by the National Weather Service through a combination of Hi-Tech and Low-Tech methods, including some local and pilot observations. To see **current weather, ice, snow, and breakup history** for most Villages, go to http://www.zendergroup.org/docs/weather.pdf

Future Temperatures State-wide Overview: If researchers who make climate models had all of the detailed information that Alaska Natives have, and they had that for every place on earth, they would be able to make really good prediction of temperatures and seasons and weather and how it will impact the earth. But they do not have this information. So climate forecast models vary a lot. And the predictions are not very detailed when it comes to Alaska. They all predict increased temperatures for Alaska. Predictions are anywhere between 5 F and 18°F for the state by the year 2100 for the annual average. Again, the temperature changes will be different seasonally and different throughout the State, with winter temperatures changing the most. For a large scale map of predicted Alaska winter temperature differences by YR 2090, click here http://maps.grida.no/go/graphic/temperature-increase-in-the-arctic-2090-scenario. Alaska is at the top left-hand. The degrees given are in Celsius. Multiply the Celsius degrees by 1.8 to get Fahrenheit. So the numbers are 1.8 times higher than Celsius. Using the medium temperature predictions, winter temperatures for the far north will average a lot warmer – about 19 degrees, with the southern Alaska winters warming up closer to 8 degrees Fahrenheit.

Resources used in this section:

- Alaska Climate Research Center, UAA at http://climate.gi.alaska.edu/
- National Oceanic and Atmospheric Administration (NOAA) Arctic Theme Page: How and Why researchers study climate change in the Arctic, at http://www.arctic.noaa.gov/essay_bond.html
- Want to know more about what affects the **variation in Alaska's weather**? Check out this very detailed paper. Remember, this paper talks about air and water circulation forces that contribute to Alaska's weather. It is not intended to discuss whether these circulation forces are changing in their pattern or intensity. http://pafc.arh.noaa.gov/climvar/climate-paper.html
- UN Environmental Programme/Grid Arendal Maps and Graphics http://maps.grida.no/
- Walsh, J. E., I. Shapiro and T. L. Shy, 2005: On the variability and predictability of daily temperatures in the Arctic. Atmosphere-Ocean, 43, 213-230

What do climate models predict for my Village in the future???

Global climate models are complex, large-scale models that currently only predict global region effects. For example, see the vegetation section further below to click on an image that gives you a general sense of the resolution in Alaska. Part of the reason they look at very large areas is that the quality accurate data needed to make high resolution (i.e. smaller scale) models do not exist. And the large-scale circulation patterns and forces that are recognized to affect general global climate are not the same as medium- or local-scale patterns and forces. As expert observers of the weather and climate, Villages recognize the tremendous amount of data needed to make local weather and climate predictions.

The University of Fairbanks SNAP Program (**S**cenarios **N**etwork for **A**laska **P**lanning) has a great page that uses a standard global climate model with local historical weather information to predict average

monthly temperatures, rain, and snowfall for your specific Alaska Village up until the year 2090. For the SNAP page, click here: **http://www.snap.uaf.edu/**

This page is programmed for researchers, so it is not very user-friendly. Just click here http://www.snap.uaf.edu/community-charts to go to the predicted monthly mean (i.e. average) temperatures till 2090, and look up your village. **Find your village. Above the chart, there is a "Temperature" and a "Precipitation" tab for each community.**

These predictions are the best predictions **specifically for your village at this time using current models.** They are a good way for your village to see the temperature and precipitation trend to expect, based on your past weather and based on a climate change model that is commonly used by the top western climate change researchers in the world.

As an Alaska –oriented effort, SNAP is trying to apply large-scale models to see what they mean for Alaska and its regions specifically. For example, they are working on a how the Yukon Flats area will be affected by Climate Change – and looking at that from all facets – animals, plants, humans. So this would be a good site to check out occasionally as they post their results.

How are storms changing in Alaska?

Storms relate to climate change as well. First, let's look at the basics of what causes a storm:

What do high pressure and low pressure systems or "cells" mean?

A "high" is an area where the air's pressure is higher than the pressure of the surrounding air. A "low' is where it's lower. These high and low system/"cell" areas can be hundreds of miles wide, and are circular shaped. Pressure is just what it sounds like. If you apply high pressure to something it will be pushed to a place where there is less pressure. Air does the same thing – it is forced away from high pressure. When it moves, it is called a wind. Also, warm air moves to cold air. When air moves some place, it leaves behind a "hole" . Air from somewhere else moves in to fill the hole.

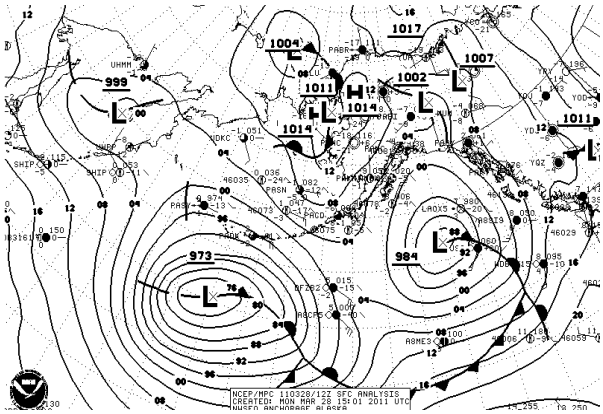
"Highs" tend to have: clear skies, no storms, and drier, warmer in summer, colder in winter. Day and night time temperatures are very different. Winds are lower.
"Lows" tend to have: cloudy skies, storms, and wetter, cooler in summer, warmer in winter. Day and night time temperatures are close to the same. Winds are higher.

So very different pressure compared to the adjacent region **means a big storm.** There is an extra amount of pressure on the air to move from the high pressure area to the low pressure area, so it will move very quickly with great force. You will see a **storm when the air above you is forced quickly from a high pressure cell to a low pressure cell.** The bigger the difference in pressure between those two cells, **the more the force on the air, and the bigger the storm.**

The local highs and lows above Alaska are what brings our weather. The different global circulation patterns and their oscillations affect the high and low cell areas that we see in Alaska. They affect the cell location, frequency, length, size, and strength. Climate change tends to come with bigger and less predictable differences between highs and lows. Again – this is the increase in variability that Climate change comes with. This can mean the bigger storms, as well as the periods of warm weather in the middle of winter (or cold weather in spring or summer).

Ocean Swells: Big ocean swells are usually from a big storm in another part of the ocean. So we can get big swells as well because climate change is also bringing bigger storms to other parts of the world.

Another oscillation that affects Alaska storms: The **Arctic Oscillation** (AO) affects Alaska and also shifts back and forth. The **negative pattern**, or "phase" brings higher-than-normal pressure to us, and **less storms**. The area north of Seattle and just below Alaska will tend to get more storms. The **positive phase** brings the opposite conditions. **Alaska gets more ocean storms and wetter weather.** The AO also tends to makes Greenland and Newfoundland colder. In recent years, the AO has been mostly in its positive phase, **so it tends to bring more snow and rain and storms to Alaska**. Read more on AO on NOAA's website at http://www.arctic.noaa.gov/essay_bond.html .



A well-known issue for coastal villages is that the storms are often happening now when there is no sea ice to protect their coastlines. This results in higher erosion. For a powerpoint and summary of a discussion on Alaska Storms effects on coastal (and some river) erosion, click here: http://www.uaf.edu/accap/telecon_archive.htm#10-9-07

Once on the link above, look just below and you will see a presentation and summary of **how climate change is affecting weather** forecasting.

The above presentations are quite technical, and may be difficult to use for community education. Here is less technical general summary of climate change effects from DEC's air quality folks. This includes several storm outcomes – erosion, landfill spreading, etc.
http://www.dec.state.ak.us/air/doc/aciac_jan07-2pg-c.pdf

Current Storms: Do you want to help the National Weather Service in their storm and several/extreme weather and river ice conditions advisories for your community? See this document http://www.zendergroup.org/docs/weather.pdf and read about the NWS Weather Spotter and River Spotter programs (http://www.arh.noaa.gov/spotter/) and the steps you need to do, or contact us at lzender@zendergroup.org.

The earth is moving - Permafrost melt, Erosion, Uplift

Permafrost melt and/or erosion are happening in many parts of Alaska. Southeast communities are facing land upheaval as glaciers recede. These issues occur naturally without climate change, and they occur at accelerated rates with climate change. As Villages we know Climate Change is happening. But even folks who don't think it is happening, know that that Alaska is seeing tremendous permafrost, erosion, and glacial melt problems that must be addressed.

Here is the most comprehensive site for Alaska erosion problems:
http://www.poa.usace.army.mil/en/cw/index.htm

Ocean Acidification

Worldwide emissions of carbon dioxide from fossil fuel burning are threatening marine organisms, including corals that secrete skeletal structures and support oceanic biodiversity by providing a source of calcium up the marine food chain.

Ocean acidification means that the ocean is becoming more acidic. Oceans worldwide absorbed about 11 billion tons of carbon between 1800 and 1994. Oceans are naturally alkaline --- the opposite of acidic, and they are expected to remain so, but the interaction with the increased carbon dioxide is making them less alkaline. The increased acidity lowers the concentration of "carbonate". Carbonate combines with Calcium to make coral reefs and the skeletons of many marine organisms. If you have ever taken a calcium vitamin supplement to protect against bone loss – chances are you are actually swallowing calcium carbonate – a solid form of calcium.

This increased acidity (or more technically, a decreasing alkalinity) is considered by leading scientists to be one of most dramatic changes in ocean water in at least the past 650,000 years. Ocean acidification won't stop until the increased carbon dioxide (CO_2 – pronounced "C" "O" "2") produced by human activity stops (see below for greenhouse gases). But CO_2 takes many decades to decrease. Even if all the CO_2 production was stopped now, the CO_2 in the atmosphere that is contributing to global warming and being absorbed by the ocean as well, won't disappear for about a half-century.

"Calcification" is the process of taking dissolved calcium (naturally present in ocean and many river waters) and making it into a solid bone building block. It slows down in less alkaline water. Coral "calcification" keeps decreasing as the oceans become more acidic. This means they grow more slowly, or their skeletons become less dense-- like osteoporosis in humans. As a result, reef structures are threatened because corals may be unable to build reefs as fast as erosion wears them away.

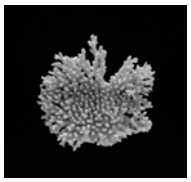
Effect on Fish and Marine Mammals:

Some ocean plankton also are affected. For example, shelled pteropods (sort of a small snail) are an important food source for salmon, mackerel, herring, and cod. If calcifying organisms such as pteropods are unable to sustain their populations, many other species that depend on them may be affected.

Alaska has what are termed "cold-water reefs" along its coasts and in the Bering Sea, which provide habitat for many important fish species. Cold water reefs – sometimes called cold water calcifying ecosystems – are thought to be more at threat from acidification than warm water systems. That is because of the way chemistry works – temperature affects the absorption of carbonate – colder water makes the formation of solid calcium carbonate – the bone-type structure – more difficult as it is. So increasing the difficulty of making bone by increasing the acidity means Alaska coral, shell-like plankton, mollusks like clams, crabs, and oysters, will be affected first by acidification, before warmer water ecosystems. The term you might hear or read about is "under-saturation" of calcium. Significant and potentially substantial or devastating health damaging effects are expected within 50 years that will affect their populations.

The fish species or populations that depend on them for some or all of their bone building are expected to be affected as well. The effect this process will have on these fish is not known yet. We just know that eating these foods helps them build their skeletons and likely also serves other health functions.

You should know that the concern you hear about warm water coral reefs is compounded by "mass bleaching" effects - in which the warming water from climate change releases algae from the coral, and essentially kills them. This process is different from the ocean acidification that warm water reefs also are experiencing.



Alaska Specific Ocean Acidification Programs:
NOAA Alaska Fisheries Science Ocean Acidification"
http://www.afsc.noaa.gov/HEPR/acidification.php
Alaska Marine Conservation Council (advocates for protection of Ocean and animals):
http://www.akmarine.org/our-work/address-climate-change/ocean-acidification

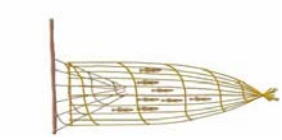
Also, here is good site that compiles many of the projects and latest findings and ideas about ocean acidification, as well as looks at policies that can address it:
http://www.ocean-acidification.net/

References and adapted excerpts for this section:

- *University Corporation for Atmospheric Research Quarterly (UCAR coordinates with NCAR - National Center for Atmospheric Research) http://www.ucar.edu/communications/quarterly/summer06/seasick.jsp*
- *NSF/NOAA/USGS Ocean Acidification Report: http://www.ucar.edu/communications/Final_acidification.pdf (Really large download)*

What are the regional effects in Alaska villages?

Where you are and who you are is how you know "climate change". Because the Arctic is warming faster, researchers believe they can assess and document global climate change faster and easier in the Arctic regions. Melting of sea ice also has far-reaching consequences on marine life throughout the world, as well as political and economic considerations that often bring funding attached.



We at Zender Group hope that much **more funding** comes to **all Alaska Villages** to address their climate change issues. Because the environment is part of everything we do and who we are, every village that depends on subsistence is affected by climate change. Because we live with our environment, Alaska Villages feel the impacts of climate change much more than urban areas. The climate change issues we face are different through the State, but they all affect our subsistence.

Rain or snow has increased for most of Alaska, but not for the Southeast, and not for the Interior during the summer, particularly around Fairbanks. Precipitation (rain or snow) is expected to **increase about 20 to 25% in the north and northwest**, and **decrease about 10% in the South**.

Temperatures: Overall, temperatures are increasing the fastest in the North in the winter season. Villages surrounded by ocean (a "maritime" climate) are seeing the smallest temperature changes. Seasonal temperatures have a slightly different pattern depending where you are. For seasonal graphs, click here http://climate.gi.alaska.edu/ClimTrends/Change/TempChange.html to find the Alaska city nearest you. Some places are getting slightly cooler in the Fall, including Interior near Fairbanks, Western Alaska near Bethel, and Kodiak. The yearly average temperatures for all of the places has still increased.

Soils: Although rain and snow is increasing in most parts of the state, the overall warming will still make **soils drier throughout most off the state**, regardless of increased rain or snow. This is due to the increased evaporation that happens with warming. Evaporation brings water vapor up from the earth and into the air.

Vegetation:

To see a climate model prediction for vegetation changes in Alaska by YR 2090, click here http://www.usgcrp.gov/usgcrp/Library/nationalassessment/images/ak-eco.jpg. This prediction assumes medium changes. Some models predict bigger changes, others smaller. You can see the biggest overall change in Alaska is that the tundra and forests of western and Interior Alaska are predicted to be replaced by evergreen forests that are mostly now limited to the Aleutian chain, Bristol Bay and Southeast areas. Again, note that the detail is not great and there is uncertainty exactly where the boundaries will be. So if your village is located near a boundary area, you need to know that the boundary line may actually fall above or below you. Researchers can't tell right now. But it gives you a general idea of what changes to expect. In nature, vegetation and land types don't change on a line, but through a broader band.

Plants are like animals. They are used to certain temperatures and conditions. Warmer temperatures might make your normal plants more likely to get disease from insects and animals they are not used to, or can lead to less snow for insulation, more sun and wind burn, and threats from new plants that live easier in the new weather conditions and may crowd out your normal plants.

In **South-central Alaska,** spruce bark beetles killed more than 4 million acres of trees. With longer warmer summers, the beetle reproduce faster. When Winter temperatures are not cold enough, more beetles survive. Because of recent summer heat and drought, the trees could not make enough protective pitch to keep beetles out.

In **Southeast** over 500,000 acres yellow cedar has died-off. Because of warmer temperatures, there has been less snow to protect the tree roots, and to stop early dehardening of the leaves. If there is a late freeze, the leaves and roots are harmed, which can kill the trees.

Other serious warming-related diseases that have damaged or killed large numbers of trees include the larch saw fly, spruce bud worm, birch leaf miner, aspen leaf miner, spruce aphid, and birch leaf rollers.

Glacier melt:

Glacier melt is affecting rivers and their water chemistry in the North, and land and river issues in the Southeast. It is tied to several processes that impact our environments.

River temperatures:

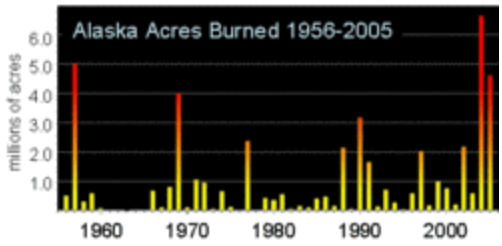
Stream ecologist Sue Mauger has been documenting a less dramatic, but unprecedented rise in water temperature in Alaska's rivers and streams. "We are finding that the water temperatures are increasing and that the numbers of days they're exceeding, the water temperature is increasing, the numbers of hours per day they're increasing, and the maximum temperatures are increasing."

Ponds and Wetlands: Water bodies throughout almost all of Alaska are shrinking. In a study of what has happened to closed ponds in the past 50 years, the number of ponds in Copper River Basin decreased by 54%, in Minto Flats by 36%, and in Innoko Flats by 30%.

Wetlands in studied areas in the Kenai decreased by 88% from 1950 to 1996. According to soil core samples, trees and shrubs are now in Kenai areas for the first time in at least the last 8,000 to 12,000 years. These and other studies confirm our own observations and Elder histories of disappearing and shrinking ponds.

Loss of ponds and wetlands has many impacts. Those of us who are losing them know how many things are changing. Our wild greens can look different or not be as easy to find. Birds who use ponds must go elsewhere.

Fires



Alaska Acres Burned, 1956-2005. (Source: NOAA National Climate Data Center http://www.ncdc.noaa.gov/oa/ncdc.html)

To view a good powerpoint presentation and summary on Climate Change and Fire in Alaska given by UAF Alaska Center for Climate Assessment and Policy (ACCAP), click here: http://www.uaf.edu/accap/telecon_archive.htm#8-21-07.

Vegetation has also been impacted by record breaking fire seasons in Alaska. In 2004, over 6.6 million acres burned, in the largest Alaska fire season ever documented. In 2005, approximately 4.6 million acres of Alaska burned, the third largest area ever recorded. Cumulatively, during these two years, over 25% of the forests in the northeast sector of Alaska burned. These burn rates are consistent with global warming models and predictions.

Villages across Alaska breathe in smoke from these fires, as do wildlife. Very few of our Villages have air quality monitors, so there is not a lot of information on health impacts in Villages. Here are the general health impacts from breathing wildfire smoke: http://www.epi.alaska.gov/eh/wildfire/CDC_WildfireFactSheet.pdf

Want to have an approximate measure of the air quality health from a fire near your villages? The Fairbanks NorthStar Borough developed a visible air quality guide: http://co.fairbanks.ak.us/airquality/Docs/ParticulateLevels.pdf
This does not apply to fires at dumps or in town, which can carry hazardous elements that can be of additional concern.

Resources used in this section:

- Climate Change Impacts on the United States
  The Potential Consequences of Climate Variability and Change, By the National Assessment Synthesis Team, US Global Change Research Program, published in 2001, updated 2004.
  Overview: http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewalaska.htm
  Alaska Chapter: http://www.usgcrp.gov/usgcrp/Library/nationalassessment/10Alaska.pdf (Black and white, easy download) http://www.usgcrp.gov/usgcrp/Library/nationalassessment/10C.pdf (Color figure appendix)
- Alaska Climate Research Center, UAA at http://climate.gi.alaska.edu/

- Williams, Deborah (Lead Author); Howard Hanson (Topic Editor). 2007. "Impacts of global warming in Alaska." In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). [Published February 16, 2007; Retrieved September 26, 2007].<http://www.eoearth.org/article/Impacts_of_global_warming_in_Alaska

- State of Alaska Department of Conservation (DEC) Wildfire Page http://www.dec.state.ak.us/air/smokemain.htm and State Health and Social Services Wildfire page
- *Paul Duffy and T. Scott Rupp, University of Alaska,* UAF ACCAP FIRE AND CLIMATE CHANGE IN ALASKA, http://www.uaf.edu/accap/telecon_archive.htm#8-21-07

What is causing Climate Change now?

Primary Factors Contributing to Climate Change	
Natural Factors:	**Human-induced Factors**
▪ Changes in solar activity ▪ Changes in Earth's orbit ▪ Volcanic emissions	▪ Increasing concentrations of greenhouse gases in the atmosphere ▪ Land use change ▪ Enhanced atmospheric aerosols

Inuit Tapiriit Kanatami Environmental Department using the source: Climate change: the basics. Natural Resources Canada, Climate Change in Canada Web site.

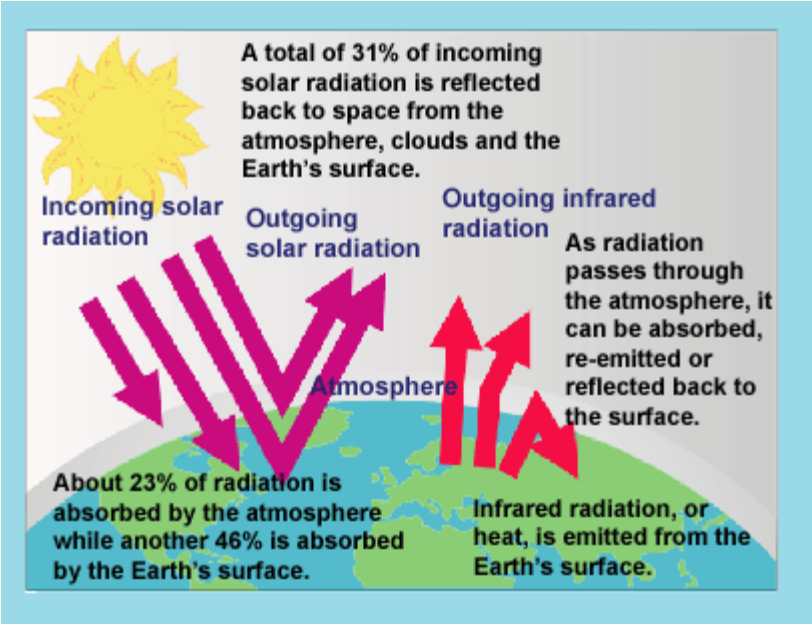
How does the Earth regulate climate?

Source used in the following section: Degrees of Variation- Climate change in Nunavut, Climate change the basics, Natural Resources Canada, http://adaptation.nrcan.gc.ca/posters/nu/nu_01_e.php

For understandable, but more detailed and technical information on the Greenhouse effect, we recommend: http://earthguide.ucsd.edu/virtualmuseum/climatechange1/02_1.shtml

The Greenhouse Effect - The Earth's natural thermostat...

The Earth's temperature is regulated by a natural system known as the 'greenhouse effect'. Naturally occurring greenhouse gases, such as water vapour, CO_2, methane, nitrous oxide, and ozone, trap radiation in the atmosphere which helps to keep the Earth warm enough to support life. Problems can arise when the concentrations of these naturally occurring gases are increased and new greenhouse gases like chlorofluorocarbons (CFCs) are added to the system.



Radiation and the atmosphere

(Data from Environment Canada, 1994)

Did you know?

Without the Earth's natural greenhouse effect the average Earth temperature at sea level would be about 0 degrees Farenheit – instead what it is now - 59 degrees warmer ? 0 degrees is okay for many of us in Alaska, but the ecosystems and seasons and air and ocean circulation patterns that help to support Alaska's diverse plant and animal life depend on warmer temperatures in the lower and middle latitudes. For example, the rich marine life that feeds our salmon and seals and whales depend on ocean currents that are driven by warmer climates south. So the Greenhouse effect has been helpful in regulating the temperature of the Earth.

Natural carbon in our Earth...

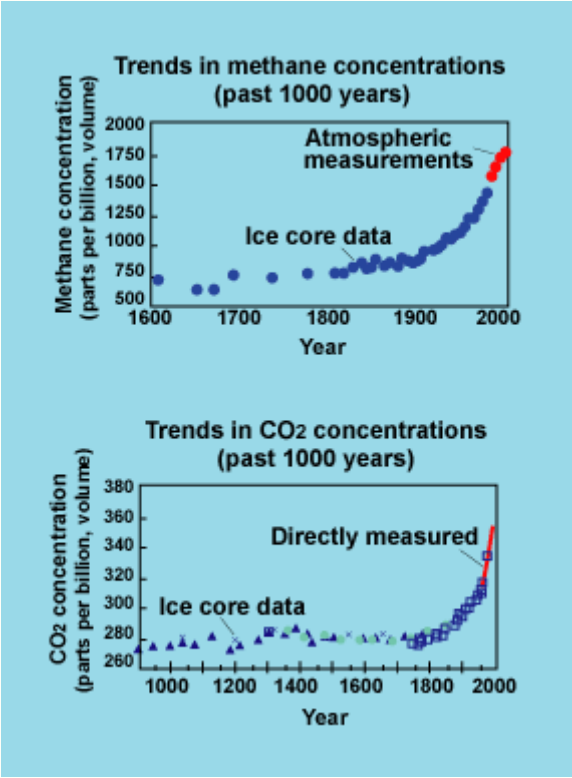
Carbon is a part of the Earth's natural system. Within the Earth, it is present as fossil fuels and in sedimentary rocks. It is also stored at the Earth's surface in vegetation and soil, and in the oceans as inorganic carbon dissolved in the sea water. In the atmosphere, carbon occurs mainly as carbon dioxide (CO_2). Before the Industrial Revolution, CO_2 and other greenhouse gases such as methane (CH_4), that were put into the atmosphere were balanced by processes of natural removal, so atmospheric concentrations of these gases did not vary much.

Did you know?

Greenhouse gases accumulate in the atmosphere because their molecules have life spans of decades or even centuries.

CO_2 buildup...

Since the start of the Industrial Revolution in the 1700s, atmospheric concentrations of CO_2 have increased by 30%. Climate researchers predict that over the next 40 to 60 years these concentrations will double from their pre-industrial levels. Virtually every researcher agrees that the primary cause of the expected buildup of CO_2 is from human activities. The exact portion caused by humans is not known, but estimated reasonably well. What is being researched now is the exact amount of buildup, exactly how much and how fast it will affect the climate, local-scale effects, and to what extent the changes will initiate unforeseen or little known indirect effects.



Trends in methane and CO_2 concentrations
(Environment Canada, 1999a)

Did you know?

Human activity is currently responsible for emitting 30 million tons of CO_2 each year, 12 million tons of which accumulate in the atmosphere.

The greenhouse gases

Source: The Greenhouse Gas summary is excerpted from:
http://www.dnr.state.wi.us/org/caer/ce/eek/earth/air/global.htm

The main gases that cause the greenhouse effect are:

- water vapor
- carbon dioxide, or CO2
- methane
- nitrous oxide

Some "greenhouse gases" (http://dnr.wi.gov/climatechange/gases.htm) occur naturally in the Earth's atmosphere. But scientists measuring the gases say the amount of gases in the atmosphere has increased in the past few decades. For instance, the amount of CO2 in the atmosphere is 30% greater than what it was 150 years ago. Scientists believe CO2 levels will rise another 30% during the next 50 years.

The increase in greenhouse gases is expected to raise the average global temperature of the planet by 2 to 9 degrees Fahrenheit over the next 50 to 100 years.

Most of the increase is due to human activities, like:

- burning gasoline to drive cars and trucks
- burning oil, coal or wood to produce electricity
- heating, cooling, and other activities like burning forests to clear land

All these activities, and many others, release greenhouse gases into the atmosphere. With greater amounts of greenhouse gases in the air, more heat will be trapped, and the Earth will get warmer and warmer.

Where can I find a Dictionary of Climate Change Terms?

For NOAA's climate change dictionary, or go to
http://www.cpc.ncep.noaa.gov/products/outreach/glossary.shtml

Where can I go for some more overview documents?

As you know by now, climate change has so many different impacts and so many different terms and research areas and organizations. If you want to become an expert in everything with climate change, you will be the first person on the planet. Something you are already an expert in is the local impacts that are happening now.

Please visit http://www.zendergroup.org/climate.html for more resources for specific Alaska climate change related topics.