Iceland – Past, Present and future climate

A review of current theories and bibliography

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Cover photograph by Kristinn Arnar Guðjónsson
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1. Introduction

The fallowing text is a review of current ideas relating to climate and climate change in Iceland. It is intended to be an informal introduction to the topic and therefore only loose reference is made to the source of information in the text. The last chapter however contains a comprehensive list of current and relevant references that were used in compiling this review. It should be acknowledged that the review draws a great deal from a report by the Icelandic Science Committee on Climate Change: Hnattrænar loftslagsbreytingar og áhrif þeirra á Íslandi.[1] (Translated title: Global climate changes and their effects on Iceland.)

2. Changes in global climate

Long term changes of climate can be caused in number of ways. They can be due to natural processes and human activity. Below is a list of the most commonly cited reasons for long term climate change within the scientific literature[2].

- Change in topography, global position and size of landmasses due to plate movement.
- Change in the tilt of the earth's axis and in its progression and trajectory around the sun.
- Change in solar activity resulting in increased (warming) or reduced (cooling) solar radiation.
- Change in the composition of the atmosphere due to natural processes or human activity. This includes changes in the amount of greenhouse gases such as carbon dioxide and methane but also changes in the amount of dust and ash particle.
- Changes in oceanic circulations on a global scale.
- Changes in the ALBEDO of earth's surface due to natural processes or human activity.

It is worth adding to this list the possible effects of catastrophic events. Until recently it has been the accepted view that catastrophic events such as asteroid collisions and volcanic eruptions cause relatively short term changes in climate. More recent studies indicate that events such as super volcanic eruptions can trigger long term and catastrophic changes in earth's climate and environment and may in some cases have caused mass extinctions of life.

The focus in the past decades has first and foremost been on atmospheric processes and interactions. This is partly due to the realization that human activity is strongly affecting the chemical makeup of the atmosphere.

It became apparent in the late nineteen hundreds that the existence of the atmosphere increases earths mean annual temperature. Certain gases within the atmosphere reduce the loss of energy from earth while having no effects on incoming solar radiation. These gases are in modern references called *greenhouse gases* and the process is called *greenhouse warming*

Halldór Björnsson et. al. 2008.

Halldór Björnsson et. al. 2008.

or *greenhouse effect*. The effects of these gases are in other words similar to that of a glass ir a greenhouse. It allows the shortwave radiation of the sun to enter while reducing the amoun of outgoing long wave radiation (figure 2-1).

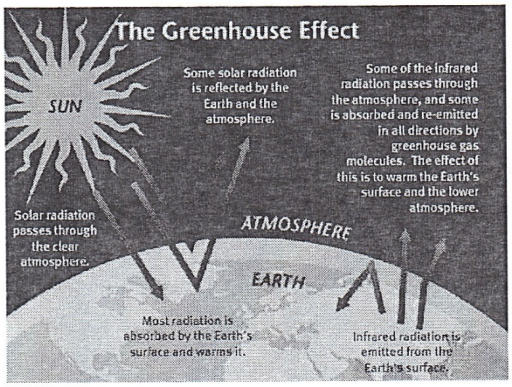

Figure 2 - 1: The diagram explains the main processes in greenhouse warming. The greenhouse gases trap in the earth´s rays without affecting the incoming sun´s radiation. Source: http://www.bigskyco2.org/

It has recently been calculated that the warming due to natural greenhouse effects is greater thar 30°C thus the earth´s mean annual temperature at sea level is 15°C instead of -18°C[1]. If thi: natural greenhouse effect was not present the earth would be covered with ice. Natura greenhouse gases are generated in differen ways but biological and volcanic processes are the most significant in this production.

The most active greenhouse gas is carbon dioxide (CO_2) which is produced through the burning of fossil fuel. The release of CO_2 into the atmosphere has increased greatly since the beginning of the industrial revolution in 1750. This has been confirmed through direc measurements and through the use of proxy measurements e.g. ice and sediment cores (figur 2-2 and table 2-1).

It is worth noting that the total amount of CO_2 in the atmosphere prior to the industrial revolution was only 280 ppm (0,028%). This minuscule amount is enough to generate a natural greenhouse effect of 30°C. Since 1750 the amount has increased to 376 ppm in 2003 and is estimated to be as great as 550-970 ppm in 2100 (table 2-1).

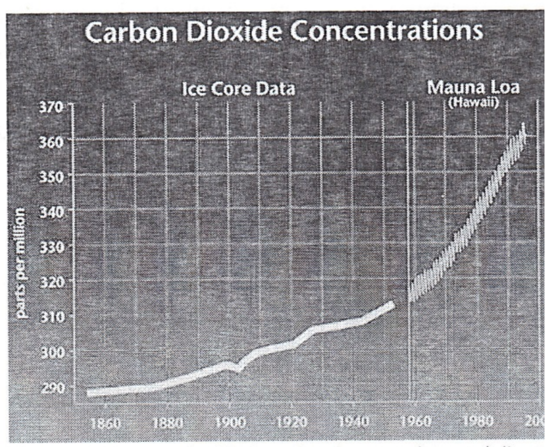

Figure 2-2: Increase in CO_2 based on ice core data and direct measurements at Mauna Loa, Hawaii. The graph shows a steady increase during the period in question. Source: http://myclimatechange.net

Manny studies have shown a strong relationship between CO_2 concentrations in the atmosphere and mean annual temperatures. This can for example be seen in figure 2-3 which compares the CO_2 concentrations based on ice core data from the Antarctic and temperature data from the sam cores based on oxygen isotopes. A very strong correlation exists between the two variables. I addition it is worth pointing out that the temperature trends for the past 250 years are parall with the increase in CO_2 (figure 2-4).

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[1] Jóhann Ísak Pétursson & Jón Gauti Jónsson 2004.

Table 2-1	Carbon Dioxide Concentration in the Lower Atmosphere	
	CO_2 Concentration*	
Year	Percent (%)	Parts per million
1750	0.028	280
1888	0.029	290
1985	0.035	345.9
2003	0.038	375.6
2020 (estimate)	0.047	470
2050 (estimate)	0.053	530
2100 range (est.)	0.055-0.097	550-970

***See Chapter 3 and pp.219-245 in IPCC Working Group I, *Climate Change 2001, The Scientific Basis* (Washington: Cambridge University press, 2001). 2003 data measured at Mauna loa Climate Observatory, Hawaii, see http://cdiac.esd.ornl.gov/ftp/maunaloa-co2**

Table 2-1: CO_2 concentration in the lower atmosphere based on ice core data, measurement and estimates based on computer models. From the onset of the industrial revolution in 1750 to the present day the concentration has increased from 280 ppm to 376 ppm. According to IPCC computer models the concentration could be as high as 970 ppm at the end of this century. This is by far the highest concentration observed on earth in the past 600.000 years (see figure 2-3 below)

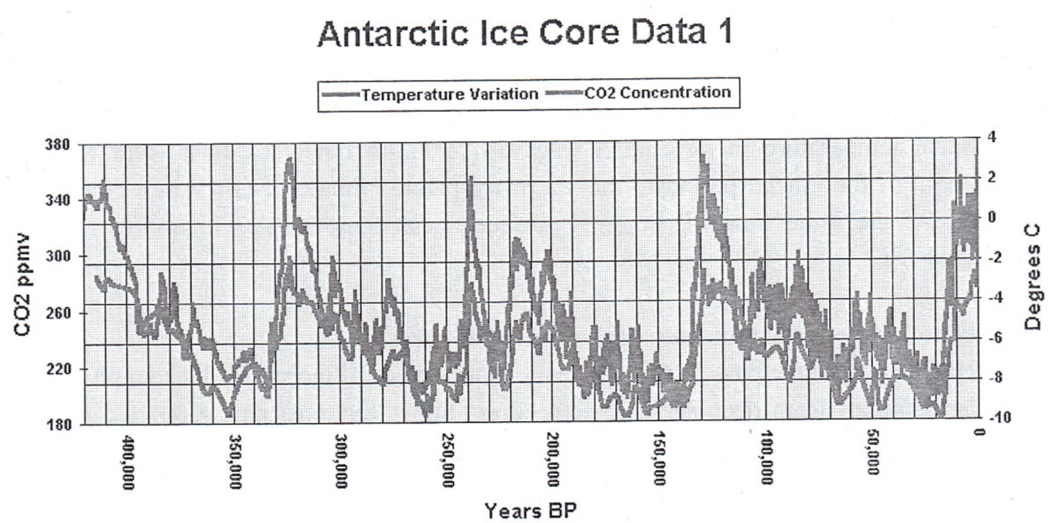

Figure 2-3: Correlation between temperature (based on oxygen isotopes) and CO_2 concentration the last 450.000 years based on an ice core from the Antarctic. This confirms the strong relationship between the two variables in addition to showing that present day concentrations are the highest observed during the period in question. Computer models predict that these extreme present day concentrations may double in the next 100 years. Source: http://www.exo.net.

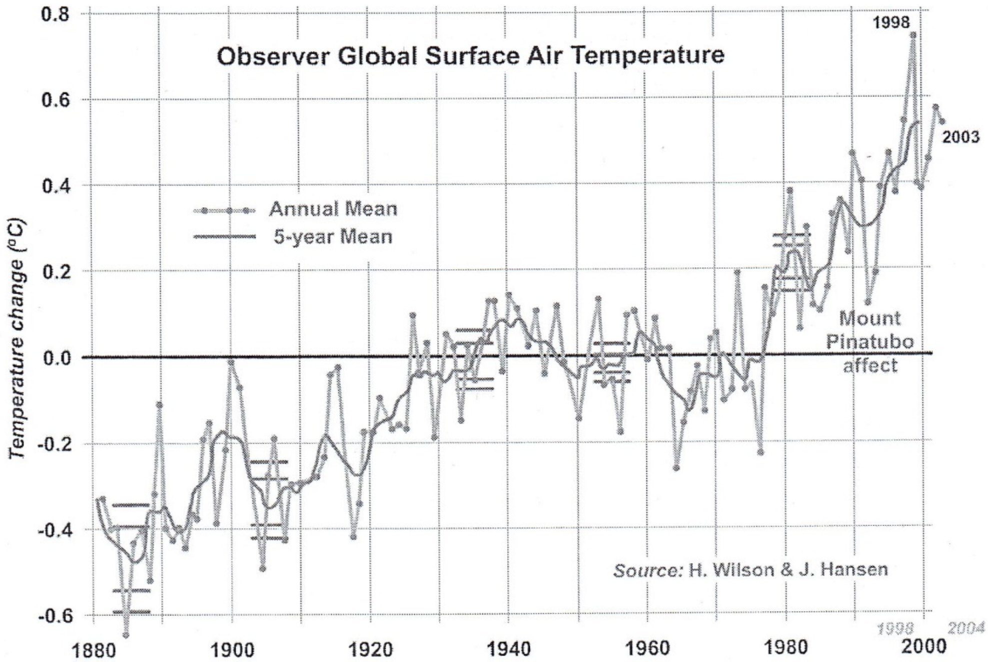

Figure 2-4: Observed trends in global surface temperature from 1880 to 2003. The main tendency through the period is an increase or warming. The decades from 1930-1960 show stable temperature while the 10 years from 1960-1970 are the only that show downward trend in the 5 year mean. It is interesting to compare this figure with figure 2-2.

3. Past climate in Iceland.

Paleoclimates can be reconstructed using different types of proxy data. The fossil record tells a tale of changes in climate and biology. Ice and sediment cores also contain important information about changes in the past. Recent studies on ice cores from Greenland show for example that the last glacial period of the ice age ended abruptly and that within 50 years the mean annual temperature in Greenland went up 15°C. In other words it went from the freezing cold of the glacial period to the warm temperate climate of today in a course of a lifetime[1]. At the same time the summer surface ocean temperatures in northern Iceland increased by 8°C[2].

3. 1 Climate history based on deep ocean sediment cores.

The climate history of the past 20 million years is presented in figure 3-1. This graph is based on oxygen isotopes from deep see sediment cores[3] but is for most part supported by other proxy data[4]. The oldest dated rock in Iceland is 16 million years old[5]. Older rock at the base of the island may be as old as 20-25 million years. The graph therefore covers the climatic history of Iceland.

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[1] Dansgaard, W. et. al. 1989.
[2] Knudsen, K.L. et. al. 2004.
[3] Zachos, J. et. al. 2001.
[4] e.g. Lisiecki; L.E. & Raymo, M.E. 2005.
[5] Þorleifur Einarsson 1991.

The climate at the beginning was much warmer than currently. A slight deterioration of climate can be seen from 14 to 12 m.y.a. after that the temperatures remain stable for 6-7 million years. About 7 m.y.a. temperature drop enough for glaciers to start forming on the highest peaks in Iceland. The past 4-5 million years have been marked by numerous (20-25) "glacial" and "interglacial" periods[1] similar to those that typify the ice age. This is further confirmed in the geological record (see chapter 3.3). The official start of the ice age is however set at 2,7 m.y.a. when cold ocean fauna becomes dominating in the sea north of Iceland[2]. The length of the glacial and interglacial periods during the ice age varies but in the last 600.000 years the glacial periods have lasted 100.000 years and the inter glacial periods 20.000 years.

The ocean cores from around Iceland are in many other ways revealing. The summer surface sea temperature north of Iceland was 3-4°C at the maximum of the last glacial period (20.000 years ago) but 11.500 years ago it increased to 8°C[3]. Studies on ocean and lake cores show that at the beginning of the Holocene (9.000-10.000 years ago) the mean annual temperature was 2-4°C higher than the present day temperature[4].

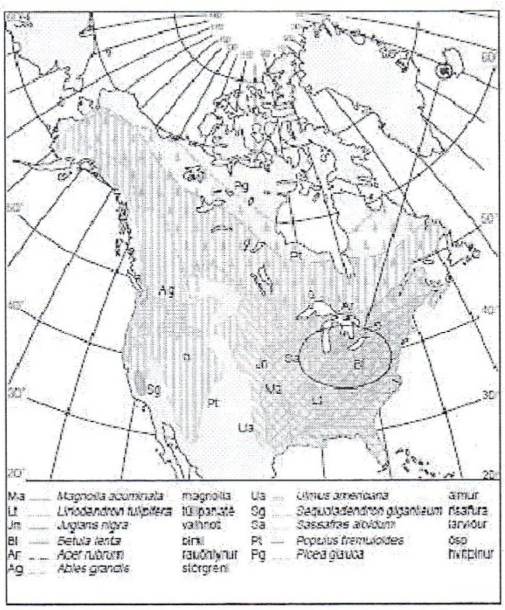

Figure 3-1: The map shows the present day distribution of the tree species found in the fossil record at Brjánslæk in north-west Iceland. These fossils are 12 million years old. Source: Walter Friedrich & Leifur A. Símonarson 1981.

3. 2 Geological record and climate.

Plant fossils from the oldest geological sections in Iceland (ranging in age from 10 to 15 m.y.) show that the climate was warm and humid during the mid tertiary. The fossil record suggest that the warmest period was 12 m.a. at which time the mean annual temperature was 10°C higher than the current temperature[5]. The tree flora that grew in Iceland at that time is currently found in warm temperate climates on the east coast of North – America (around latitudes of 20-45°) (figure 3-1). When the climate was the mildest the mean temperature of the warmest month was higher than 20°C and the mean temperature of the coldest month was well above freezing. The fossil record also indicates that the climate became colder towards the end of the tertiary period. In short the fossil record confirms the findings from ice, lake and ocean cores.

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[1] Lisiecki, L.E. & Raymo, M.E. 2005.
[2] Þorleifur Einarsson 1991.
[3] Knudsen, K.L. et. al. 2004.
[4] See for example Ran, L. et. al. 2008.
[5] Halldór Björnsson et. al. 2008.

3. 3 Climate during the late glacial period and the Holocene

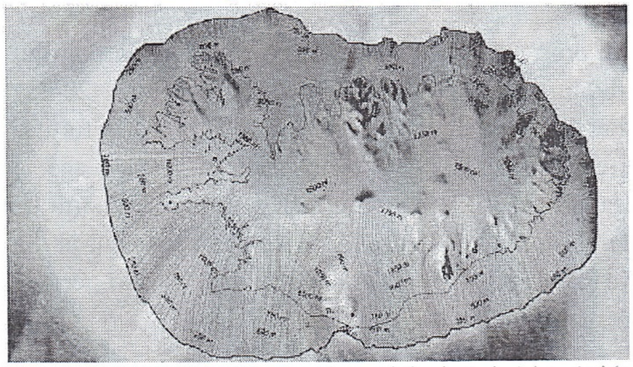

Figure 3-2: The extent of the ice sheet of the last glacial period in Iceland (20.000 y.a.)

The ice sheet of the last glacial perioc was at its maximum 20.000 y.a[1]. A that time global sea level was 100 n lower than the present day level. Th warming started 18.000 y.a. and it ha: been argued that large parts o Iceland were ice free 14.000 y.a During the cooling of Younger Drya: the ice sheet grew in size anc extended to the costs[2]. The recorc indicates a sharp warming 11.700 y.a with a short recession 11.000 y.a (Preboreal cooling)[3]. The warming that then fallowed marked the end of the last glacia period. At this time the Irminger stream (a warm offshoot of the North Atlantic stream (Golf Stream) that circles Iceland) had acquired its current strength.

Most studies that have been done on temperature changes during the Holocene in Iceland are based on lake and ocean cores and pollen analyses on peat from wetlands (see for example Caseldine, C. et. al. 2006, Halldórsdótir, M. 1995, Hannesdóttir, H. et. al. 2006, Jiang, H. et. al. 2005 and Eiríksson, J. et. al. 2006. These studies show that it is possible to divide the Holocene into three climatic periods (see figures 3-2 and 3-3).

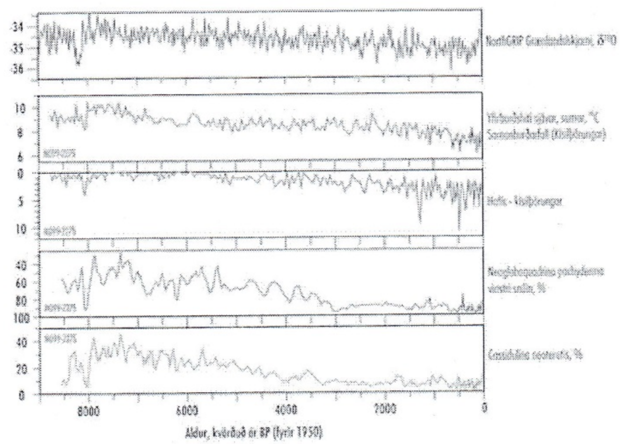

Figure 3-2: Climate change in Iceland during the Holocene. Continue record from ocean cores from the sea floor north of Iceland. Variatio in oxygen isotopes are shown at the top and other temperatu proxies in lower graph show that the temperature is the highest at th beginning of the period. The cooling starts 7000 y.a. and is increase 3000 y.a. It is also interesting to note a short (600 years) cooling climate 8200 y.a. Source: Halldór Björnsson et. al. 2008.

1. Relatively warm period at the beginning of the Holocene where the temperatur reaches a maximum 7.000 y.a. (Holocene thermal maximum). Mean annua temperature increased 4°C from 10.500 y.a. to 7.000 y.a. Birch was the dominatin tree plant and the tree line was higher than the current tree line.
2. A sign of cooling is seen in the geological record 6.000 y.a. It can be argued that pric to that the island was ice free. A cycle with 1500 year period can be detected in th thermal record for the past 5000 years.

[1] Norðdahl, H. & Pétursson, H. 2005.
[2] Norðdahl, H. & Pétursson, H. 2005.
[3] Flowers, G.E. et. al. 2008.

3. A cool period from 2.500 y.a. with a maximum during the Little Ice Age (1300-1900 A.C.). During Little Ice Age glaciers in Iceland were at their greatest extent since the late glacial period. Studies show that the maximum of the period is between 1750 and 1850 at which time mean summer temperatures were 2°C lower then present day means[1] (see chapter 3.5).

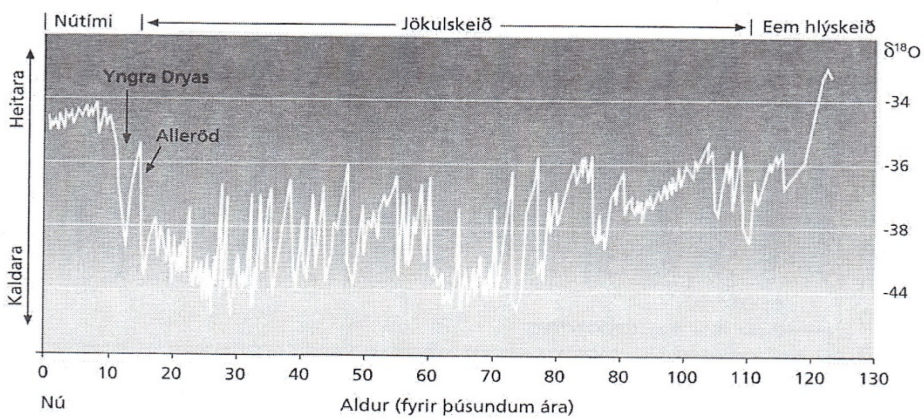

Figure 3-3: Oxygen isotopes in a 3 km long ice core from the Greenland glacier showing climate variability during the last glacial period, late glacial period and the Holocene. The last glacial period started 120.000 y.a. but the greatest cooling started 40.000 y.a. reaching a minimum in temperature 20.000 y.a. The warming is very rapid after the Older Dryas 14.300 y.a. with a maximum during the Alleröd period. This warming is interrupted with a sharp cold period (Younger Dryas) 12.900-11.500 y.a. The thermal maximum in the early Holocene can easily be seen here. Source: Helgi Björnsson 2009.

3. 4 Climate during historical times (872-2000)

Traditionally the history of Iceland is divided into several periods. The first extends from the beginning of settlement in 872[2] to the establishment of Alþingi (parliament) in 930 and is called the Settlement period. The Commonwealth period is from 930 to 1262 when Iceland fell under Norwegian rule. The Colonial period is from 1262-1944 at which time Iceland was under Norwegian (1262-1380) and Danish rule (1380-1944). Last is the Independents period from 1944 to present day.

Figures 3-4 and 3-5 show climate trends in Iceland from the beginning of settlement around 800 AC. Figure 3-4 is based on lake cores from northern Iceland while figure 3-5 is based on an ice core from the Greenland glacier. The main trends are obvious:

1. At the beginning of settlement the temperatures are high. This is confirmed by the fact that wheat and barley were grown extensively in the island during this period. At this

[1] Flowers, G.E. et. al. 2008 & 2009.

[2] Until recently no human artefacts had been found below the 872 tephra layer (Landnámslag). Therefore beginning of settlement has traditionally been set at 872 A.C. Recent studies however indicate that this might be as early as 730 A.C.

time glacier were much smaller than now and many of the first settlers built their farm in areas that currently are glaciated[1].

2. The climate starts deteriorating around 1250 an improvement is seen around 1400 bu the Little Ice Age minimum is between 1550-1750.
3. The present day climate is warm and similar to the climate at the beginning o settlement.

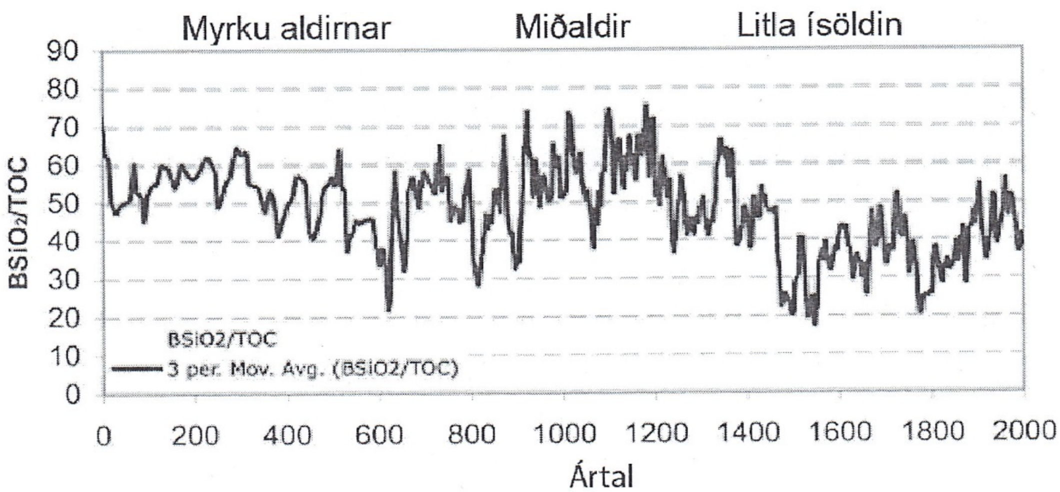

Figure 3-4: The ratio between silica and carbon of organic origin from a lake core in Iceland. This ratio is thought t reflect summer temperatures. Low values indicate colder temperatures. The onset of the Little Ice Ages is marked b colder summer temperatures between 1250 and 1300. The coldest part is around 1500 and 1800. It is interesting to not that the relatively warm middle ages (Miðaldir) are interrupted with short cold periods. Source: Halldór Björnsson et. a 2008.

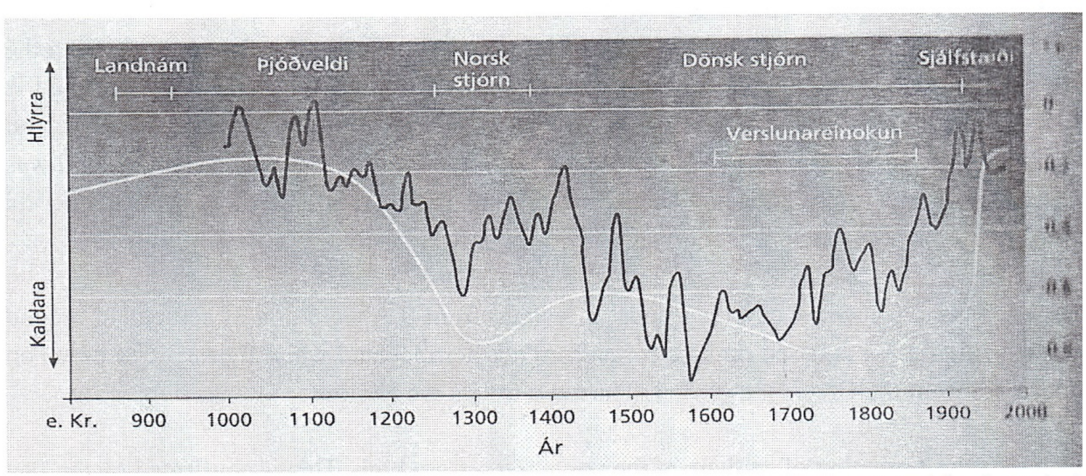

Figure 3-5: Oxygen isotopes in ice cores from the Greenland glacier are thought to be representative of the climate in th northern hemisphere. The graph shows a similar trend as seen in figure 3-3. The temperatures are high during th settlement period (800-930) and the Commonwealth period (900-1250) but the climate starts deteriorating around 125 an improvement is seen around 1400 but the minimum is between 1550-1750. The present day climate is similar to th climate at the beginning of settlement. Source: Helgi Björnsson 2009.

[1] Helgi Björnsson 2009.

The first instrumental measurements of climatic variables were conducted in 1798 (Stykkishólmur) and since 1830 they have been carried out constantly for three parts of the island (Reykjavík, Stykkishólmur and Teigarhorn).

Strong correlation is between temperatures in the different parts of the island e.g. a warm period in one part corresponds to warm periods in other parts. This connection can be interrupted when sea ice is found along the north coast. In such conditions warm episodes in the south can coincide with cold ones in the north.

Winds dictate the temperature in the summer at which time the correlation between different regions is the weakest. As a rule the interior is colder then the coastal areas. Calm weather in the summer can offset this though causing warmer conditions in the interior. Calm weather in the winter time tends to increase coldness in the interior.[1] The temperature trend for Stykkishólmur is shown in figure 3-6.

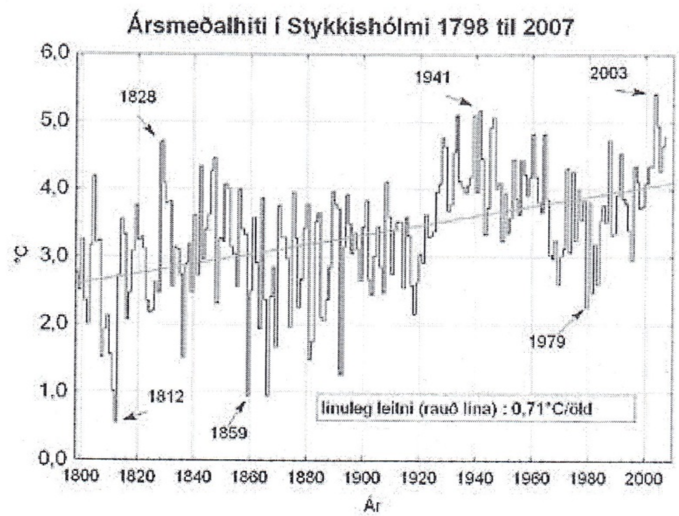

Figure 3-6: Temperature at Stykkishólmur west Iceland from 1798 to 2003. The trend is upward and temperature is increasing 0,71°C/100 years. The record also shows great variability in the record. The cold period at the end of the 19th century is apparent as is the warm period from 1920-1950. Shorter cold periods can also be detected around 1965 and 1979 (source: Halldór Björnsson et. al. 2009).

4. Current climatic conditions in Iceland[2].

Climate in Iceland is dynamic and dictated by two main factors. First is the fact that warm surface currents carry warmth to the region and second is the fact that the island is on the

[1] Halldór Björnsson 2008.

[2] This chapter is to large extent based on a summary found on a webpage compiled by the University of Iceland. The URL is http://notendur.hi.is/oi/climate_in_iceland.htm this webpage is in turn base on information from the Icelandic Meteorological Office.

boundary between warm moist air masses from the south and cold dry air masses from the north. The combination of these two factors causes the mean annual temperature to be 8°C higher than the average for this latitude. This marginal nature of Icelandic climate makes i sensitive to any minor changes in air and ocean circulation.

4. 1 Ocean currents and sea temperatures

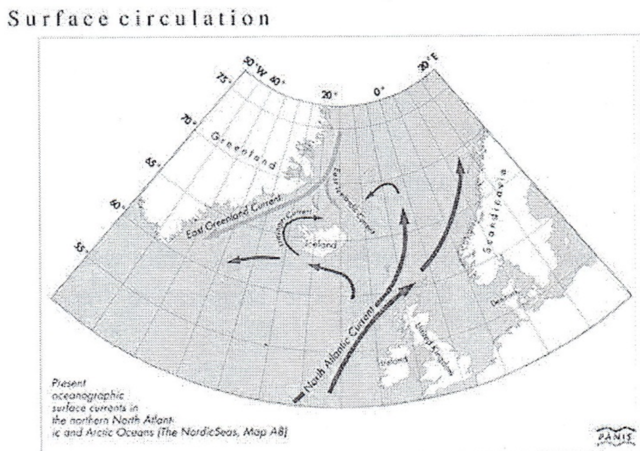

Figure 4-1: Present oceanographic surface currents around Iceland. Image source: http://www.hi.is/~jeir/panis_currents.html

Iceland, located at 63-67°N and 18-23°W, has considerably milde climate than its location just soutl of the Arctic Circle would imply. A branch of the Gulf Stream, the Irminger Current, flows along the southern and the western coas greatly moderating the climate (Figure 4-1). The cold Eas Greenland Current flows west o Iceland, but a branch of tha current, the East Icelandic Current approaches Iceland's northeast- and east coasts. This is reflected in the coastal sea surface temperature around Iceland. They are generally close to +2°C during the coldest months (January-March) Sea temperatures rise to over +10°C at the south- and west coasts of Iceland during the summer, slightly over +8°C at the north coast, but are coolest at the east coast where summe sea temperatures remain below +8°C. During years with heavy sea ice off northern Iceland sea temperatures during summer can remain close to winter temperatures.

4. 2 Climate of Iceland

A simple classification of Icelandic climate puts it as cool temperate maritime, reflecting tha it is very influenced by the cool ocean waters around Iceland. A map of the annual mea temperature (Figure 4-2) shows that only along the coasts of southern and southwester Iceland do temperatures reach 4-6°C, but are lower in other parts of the island.

The average temperature of the warmest month, July, exceeds 10°C in the lowlands o southern and western Iceland, but is below that in other parts of the country (Figure 4-3). Thi makes the larger part of Iceland belonging to the arctic climate zone. The warmest summe days around Iceland can reach 20-25°C, with the absolutely highest temperatures recorded a around +30°C.

Winters in Iceland, on the other hand, are generally very mild for this northerly latitud (Figure 4-4). The coastal lowlands have mean January temperatures close to 0°C, and only i the highlands of central Iceland do the temperatures stay below -10°C. The lowest winte temperatures in northern Iceland and the highlands are generally in the range -25 to -30°C with -39.7°C the lowest temperature ever recorded.

The pattern of precipitation in Iceland reflects the passage of atmospheric low pressure cyclones across the North Atlantic Ocean from south-westerly directions, exposing the south coast to heavy precipitation (Figure 4-5).

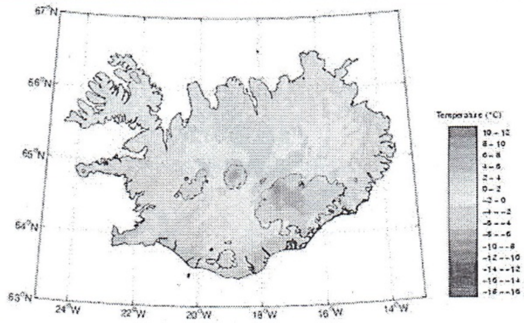

Figure 4-2: Annual mean temperatures in Iceland. Image source: Veðurstofa Íslands at http://www.vedur.is/vedurfar/vedurfarsmyndir

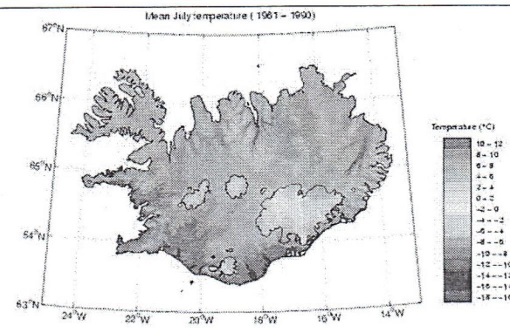

Figure 4-3: Mean July temperature in Iceland. Image source: Veðurstofa Íslands at http://www.vedur.is/vedurfar/vedurfarsmyndir

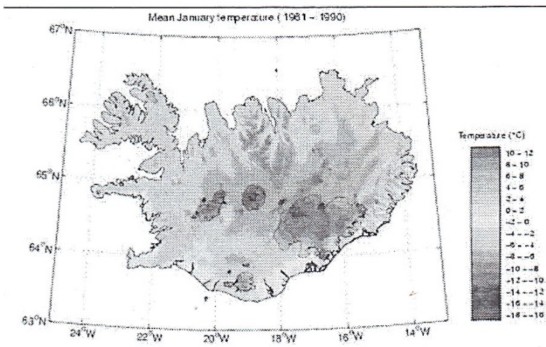

Figure 4-4: Mean January temperature in Iceland. Image source: Veðurstofa Íslands at http://www.vedur.is/vedurfar/vedurfarsmyndir

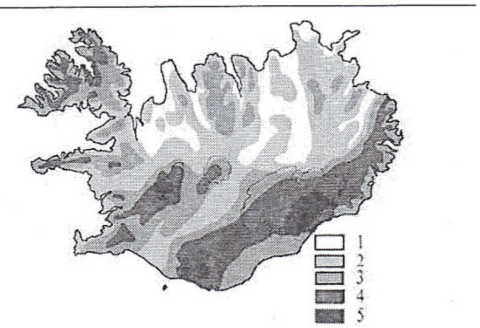

Figure 4-5: Mean annual precipitation in Iceland for the period 1931-1960: 1. < 600 mm; 2. 600 – 1199 mm; 3. 1200 – 1999 mm; 4. 2000 – 3999 mm and 5. > 4000 mm. Figure source: http://www.nnv.is

4. 3 Weather extremes in Iceland.

As stated above Iceland enjoys a relatively mild weather with small diurnal and annua extremes. The biggest annual differences are found furthers from the coastline wear the temperate effects of the ocean is at minimum. Table 4-1 contains information on weathe extremes in Iceland.

Table 4-1: Weather extremes in Iceland 1830-2010

Weather variable	Location	Value	Date
Highest temperature	Teigarhorn (SE Iceland)	30,5°C	22.06.1939
Lowest temperature	Grímstaðir (NE Iceland)	-38,0°C	21.01.1918
Greatest 24h precipitation	Kvísker (SE Iceland)	293,3 mm	10.01.2002
Greatest mean 10 min wind	Esja (SW Iceland)	62,5 m/s	10.01.1998
Strongest gust	Gagnheiðarhnúkur (SW-Iceland)	74,2 m/s	16.01.1995
Lowest pressure	Vestmannaeyjar (S-Iceland)	919,7 hPa	02.12.1929
Highest pressure	Reykjavík (SW-Iceland)	1058,5 hPa	03.01.1841

Source: http://www.vedur.is/vedur/vedurfar/upplysingar/vedurmet/

5. Predicted changes in climate.

The IPCC (International Panel on Climate Change) has created computer models to predict climate change in the coming century. The panel uses different scenarios and sub-scenarios The different scenarios make different assumptions about population changes and the release of greenhouse gases. A2 is the worst scenario assuming continues population growth and little changes in CO_2 release while B1 is the best scenario assuming that population growth stops in the middle of the 21st century and a reduction in the release of greenhouse gases[1].

Figure 5-1 shows global warming at earth´s surfaces for the different scenarios. As was to be expected the A2 scenario shows the greatest increase in temperature (3,6°C) while the B1 scenario shows the least change (1,8°C).

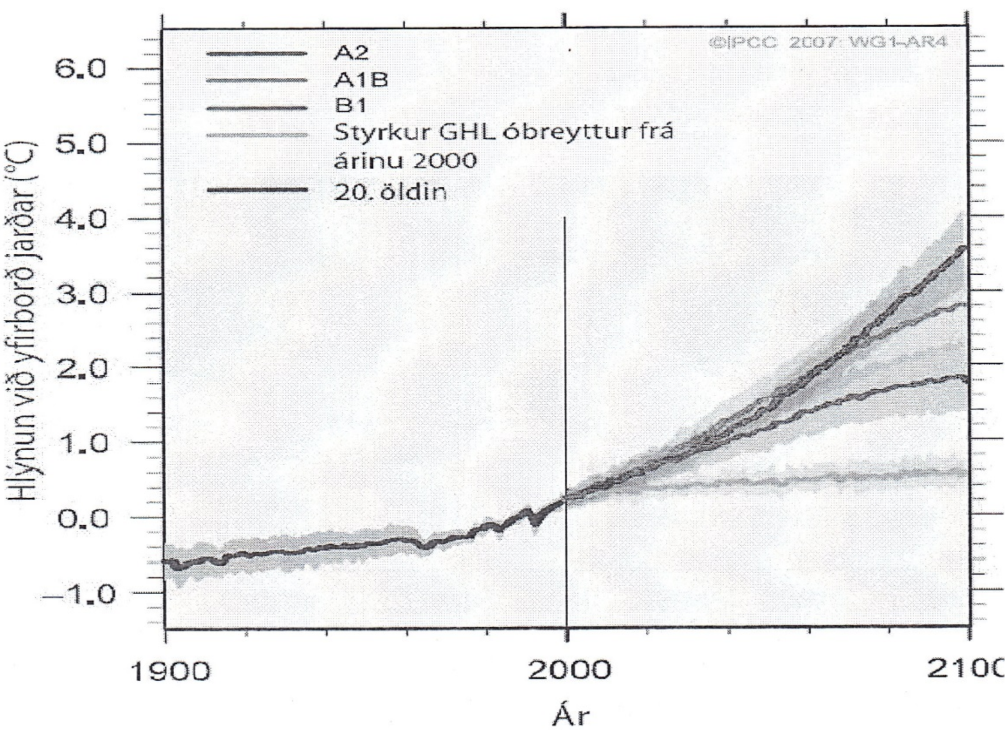

Figure 5-1: predicted change in global surface temperature (mean annual) for different scenarios based on several models run by the IPCC.

It is important to keep in mind that this is a global prediction. The magnitude and even the direction of change can differ from one region to the other. While the warming might be small in one area even non-existing it can be greater than the global average in another area.

It is predicted that the warming in Iceland will be 0,2°C/10 years for the first part of the century (all scenarios). For the later part of the century the warming will be between 1,4 2,4°C/10 years depending on the scenario chosen. The warming will be concentrated on the

[1] Halldór Björnsson et.al. 2009

winter months but to lesser extend on the summer months. It is predicted that precipitation ir Iceland will increase in the later part of the 21st century (about 2-3% for every degree that th(temperature goes up). This increase will mostly be confined to the summer months. Th(number of cold spells in winter time will be reduced but the number of heat "waves" in th(summertime will increase. Winter snow cover will be reduced[1].

Sea temperatures around Iceland will increase in the 21st century and drift ice disappear fron Icelandic waters.

5.1 Environmental changes in Iceland due to climate change

It is difficult to predict the environmental consequences of these climate changes but th(following has been suggested[2]:

- Sea temperature will increase around the island. The magnitude of this increase i: uncertain and depends to a large extent on vertical mixing of the ocean water.
- Sea ice from Greenland will disappear completely from Icelandic waters in lat(summer. The amount of Icebergs may however increase.
- The size and volume of glaciers will decrease drastically (most glaciers almost gone ir 2100) (figure 5-1 and 5-2). Low rising flat domes (e.g. Langjökull) will decrease ir size more rapidly than other glaciers.
- The number of marginal glacial lakes will increase and spring floods from glacier will be bigger and more catastrophic. To begin with the bed load of glacial rivers wil increase but as their flow decreases with smaller glaciers so will the bed load decrease
- Geographical location of glacial river channels will changes
- Isostatic re-bounce will cause land lift in certain areas but may in more distal area cause the lowering of land.
- The reduction of ice mass will cause increased production of magma at the boundar of the mantel and the crust which in turn will increase volcanic activity and possibl induce long-lasting flood eruptions (shield volcanoes)
- The sporadic permafrost found within the interior of Iceland will disappear.
- Very large changes in Iceland's flora and fauna both on land and in the ocean ar predicted. Species that currently identify milder climates will become permaner inhabitants. At the same time species that prefer colder climates disappear. This tren has already been observed in vegetation, insect fauna and birdlife and is expected to b accelerated in the coming decade. The overall impact is not sure but some importar species will be lost at same time new beneficial species will be introduced. Th greatest worry concerns the interdiction of parasitic spices to the environment (man of which could not thrive in the colder climate of the 20th century[3].

[1] Halldór Björnsson et. al. 2009.
[2] Halldór Björnsson et. al. 2009
[3] It is important to note that only the most important changes are listed here.

V. A Toast to Iceland
by Stephanie Goodman

This group dreamt for a while of the Land of the Nice,
Coming to the island more scientific than most,
And found it could've been named for its floods, fire, or ice,
We learned so much in a week…so here goes a toast:

To the experiences we had as we visited these places,
To the Blue Lagoon's exfoliating mud we put on our faces.

To lessons with Grace on which birds we should watch,
Her smile glowing so brightly, the temperature turned up a notch.

To tutoring from Jennie on all my questions in Chem,
More questions? Check YouTube! She'll answer all of them.

To the laughs we've shared from the jokes cracked by Davo Wavo,
To bribing Russell Crowe so we could might see the cave-o.

To Matthew, the shepherd, herding 17 sheep,
Onto the bus so we can all get some sleep.

To Amy teaching us about topography on Mars,
To snack time on the bus, passing 'round candy bars.

To Mom, the shoeless, whose boots someone stole!
Who Me? No way! Must've been a troll!

To John's explanation of magma chambers under the mountain,
To the group getting soaked by Kristinn's big geyser fountain.

To Kathy and Roger putting their camera on loan,
While coming so close to losing the other camera they own.

To Sandy heading home, but first through Minnesota,
You won't really leave Scandinavia, but you sure won't need your coat-a.

To bouncing around on the lava moss meadow,
To driving around and – Stop!! There's a rainbow!

To Dave hanging back for pics at the scenic stops,
Don't worry about him, he'll still beat you to the top!

To national monuments with red and blue waving flags,
To Ingrid thinking, "Now where are my bags?"

Here's to Pat's awesome enthusiasm filling us with cheer,
And after a week, all 17 of us are still here.

Here's to Eric's lectures drawing a crowd,
With such wisdom, if they listened, even the volcanoes would be proud.

To Rowan taking pictures of all the Earth's crust,
And at the top of the mountain it's "Volcano or bust!"

And a one huge toast to our great Fearless Leader!
The globe's better half, the Earth needs Kristinn to complete her!

For a week he did it—he put up with our sass,
But Phil and I know that we kicked volcanic ash!

Showing us glaciers, outwash plains and active volcanoes,
Iceland could stop these floods if they didn't use so much Drano.

Think Kristinn will miss us? I do! When we aren't so near,
Maybe he'll shed one small troll tear.

But don't be too sad Kristinn, you can come visit,
Seattle's geology is calling you name like it's kismet.

And thank you all for taking me under your wings, spreading your knowledge,
'Cuz I didn't know anything. Heck! I'm in college!

So let's finally raise our glasses to our wonderful travels,
That we'll remember long after our wool sweaters unravel.

We'll look at our group pictures with a genuine smile,
And know our time in Iceland was really worthwhile.

When we see marshmallow farms lining the road,
Or Aya-forgot-my-yogurt gets stuck in your throat,
Remember this week, and you'll be inspired,
Because you've seen the country of ice, water and fire.