

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

4,800

Open access books available

122,000

International authors and editors

135M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



---

# **Study of Impacts on Continuous Shrinkage of Arctic Sea & Sea Level Rise – Can Glaciers be Growing and Creating New Challenges to UK & USA?**

---

Bharat Raj Singh and Onkar Singh

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/58766>

---

## **1. Introduction**

Present state of environment and continuous occurrence of natural disasters has made it inevitable for the environmentalists and scientists to extensively study and carry out detailed analysis of the following threats faced by civilization across the entire globe:

- Fast shrinkage of the polar ice and by 2040, there will be no polar ice seen during summer.
- Fast rise in the Sea Level,
- Danger for species like: polar bear etc.
- Ice sheets, where it meets the Atlantic sea, that this area may be affected by cold waves, heavy snow falls and intense storms.
- Permafrost may create further warming which cannot be reversed.

It is evident that the entire Arctic tundra region is melting, the frozen layer of soil known as permafrost is the growing concern and is considered as a threat by the scientists. The permafrost that is formed due to the fossils of the plants is undergoing transformation of being thawed and decomposes under climatic change for the past tens of thousands of years.

The continuation of this process is sufficient enough for the releasing of the methane gas causing irreversible global warming. Northern Alaska, USA and some other Arctic regions show the phenomenon of Termokarsts, where the melted permafrost layer lead to the collapse of the ground to hollow.

Another consequence is Tundra fires. Studies show that Tundra fires are also being a factor of region warming. The alarming rates of these fires as noted by scientists suggest that the Arctic could turn into a lethal source of methane in not less than a decade.

Whole community of the scientists involved, in the research and fieldwork is helping us to understand the growing threat of melting permafrost in the crucial Arctic region.

According to Dr. Hansen, our planet is on a dangerous course of passing irreversible tipping points with disastrous consequences. The melting of permafrost in turn releases toxic methane gases, resulting into more warming of the atmosphere.

Thus, it is essential to act promptly to avoid further catastrophic warming and stabilize the planet on which all lives depend, as permafrost's melt is a potential source of runaway global warming.

In this paper, authors are focusing mainly on the shrinkage of the polar ice and its serious effects on humanities, especially in January to March in USA and UK as well as on the entire global lively hoods.

## 2. Global warming fast facts

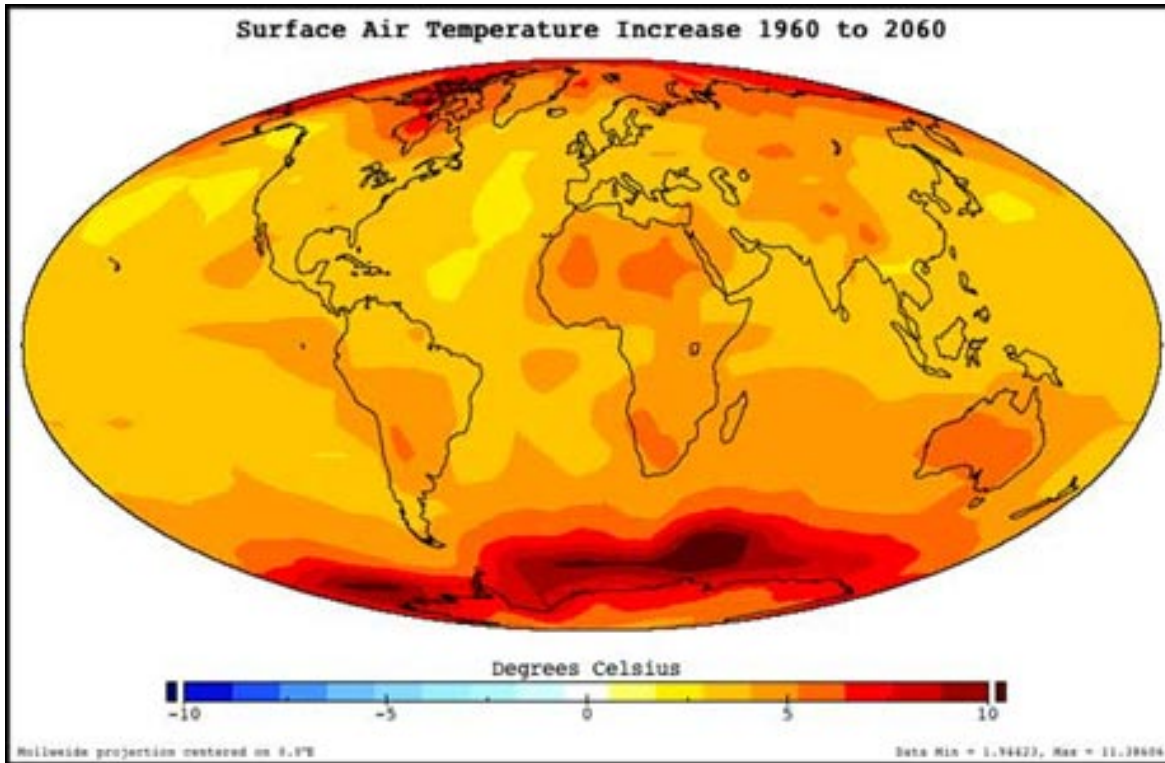
It is a fact that Global warming is human-caused and it will continue for centuries even if greenhouse-gas emissions are stabilized as per the experts of the International Panel of Climate Change (IPCC) report-2007 as shown in Fig.1. The human activities not only linked with human activity to Earth's warming temperatures but its continued effect is causing rise in the seas' level, more intense storms, heavy snow fall and a host of many other environmental maladies[1-9].

Speaking at a press briefing in Paris, France on February 2 2007, the executive director- Achim Steiner, United Nations Environment Programme stated that the climatic change on our planet is undergoing drastic change due to the "Fossil fuel use, agriculture, and land-use.

Still there are many myths that climate change is regular process and there is as such no effect of global warming which is responsible for climate change, intense storms, heavy snow fall or cold waves. Majority of people still say that the ice age likely to advance in the near future.

Let us believe this theory for a moment then questions comes:

- i. Whether the earth's solar orbit is shrinking that makes the earth closer to the Sun and causing rise in the temperature? If so, the rotation of the earth around the Sun i.e. 364.256 days should get reduced.
- ii. As per the above thought process, if the ice age is likely to advance then why intense storms affecting islands near the coastal areas; why cold waves are advancing towards plane from hilly glaciers; why the Arctic sea is shrinking and causing heavy snow fall experienced in the USA & UK in January 2014?



Source: Map courtesy NASA

**Figure 1.** A world map plots the annual average rise in the surface air temperatures from 1960 to 2060 based on the past measurements and future projections.

The truth remains that due to exploitation of the earth's resources and burning of huge quantity of fossil fuel, industrialization etc., global warming is now visible and damaging the climatic conditions, that is mainly caused by humans. This is further justified by global warming fast facts.

### 2.1. Is the change clear?

Actually-Yes, Our earth is showing clear changes in the climate: According to a study conducted by NASA's Goddard Institute for Space Studies- the average temperature has risen by 1.4 degrees Fahrenheit (0.8 degree Celsius) since 1880.

The last two decades of 20<sup>th</sup> Century had been the hottest in 400 years and it clearly shows the rate of warming. Moreover, the United Nations' Intergovernmental Panel on Climate Change (IPCC) reports that since 1850 among the last 12 years of climate; 11 years have been found the warmest.

In another very interesting study published by the Multinational Arctic Climate Impact Assessment Report of 2000 and 2004 showed that the average temperatures in Western Canada, Eastern Russia and Alaska have risen twice the global average temperature.

It may seem hypothetical but can be true that by 2040 the ice-caps at Arctic may not be seen because it is melting at rapid rate which can lead to a great threat to the habitation of the polar bears and other species of the region.

Studies show that there is rapid melting of the glaciers and mountain snows in the last few decades. To state is more clearly out of 150 odd glaciers in the Montana's Glacier National Park, only 27 glaciers are left to us since 1910. Furthermore in the Northern Hemisphere, it is shown that thaws are now a week earlier in spring and freezing about a week later.

According to the experts, due to this change, the Coral reefs that are very sensitive to small changes in water temperature suffered the worst bleaching because of the stress recorded in 1998. They have added to their conclusion that these events are to increase in frequency and intensity in the next 50 years with the rise in the sea temperature.

Wildfires, Heat waves and Strong tropical storms also attribute in part to climate change.

## 2.2. Factor behind it?

Yes, Burning fossil fuels and deforestation are its chief culprits. Burning of fossil fuels in transport as shown in Fig. 2, industrialization & power plants etc. and cutting of forests, known as deforestation are major contribution.



Figure 2. Burning fossil fuels through Transport Sector

### 2.2.1. Greenhouse gases trap heat

Owing to the excessive combustion of the fossil fuels, carbon dioxide ( $\text{CO}_2$ ) and other greenhouse gases are released into the atmosphere, trapping heat and warming the atmosphere.  $\text{CO}_2$  levels, today, are around 400 parts per million (*ppm*), that is 40% more than the highest natural level coming from coal and oil in the past 800,000 years, which varies from 180 to 300 *ppm*.

### 2.2.2. Losing forests makes it worse

Since deforestation is worldwide and trees are the major source for absorbing the excessive  $\text{CO}_2$  from the atmosphere, therefore, concentration of  $\text{CO}_2$  level in the atmosphere is on the hike that is allowing the heat to trap by making the atmosphere go warm.



Carbon dioxide, or CO<sub>2</sub>, is the most dangerous greenhouse gas but, we cannot also ignore the contribution of Methane gas which damages the atmosphere equally to CO<sub>2</sub>. As a matter of fact Methane's damaging percent to the atmosphere is less as it emits less CO<sub>2</sub> than coal. In fact, methane has the potential to undo much of the greenhouse gas benefits if shifted from coal to natural gas. An increase in the methane gas emissions is clear from quick expansion in natural gas development and an aging pipeline infrastructure. Methane emissions require us raising the bar on detection because whatever cannot be measured cannot be fixed. Low cost air pollution monitors are needed to be tapped for invention by the tech innovators to detect methane leaks in real-time [10-12]. Emissions of methane alone are not enough to study the cause of major changes in the climate: deforestation and the burning of fossil fuels such as coal.

### 2.2.3. So what do we do about it?

Keeping in view the rapid rate in the climate change; what we need to do is to come forward and learn about the dire consequences of the ecological imbalance and trying hands on recycling and buying local produce.

## 3. What sea-ice loss means for development in the arctic

Prediction for ice-free summers cannot be ruled out because of the shift of climatic cycle leading in the aggravation of global warming. Animals such as polar bears and walruses highly depend upon icy climate as shown in Fig.3.



Credit: World Wildlife Fund- August 23, 2012.

**Figure 3.** Threatening for polar bears that depend on the ice for habitat

On the contrary, ice shrinkage and melting has also paved way for increased shipping, tourism, oil, gas exploration and fishing too. It cannot be also denied that this change can pose challenge for the nations to grapple with the worst scenario to happen, as stated by a postdoctoral researcher during an address to the audience at Columbia University on Wednesday, September, 19, 2012.

Anne Siders researcher with the Columbia Center for Climate Change Law, one of the panel of researchers, discussed about the science as to how sea-ice de-freezing is taking place.

A predictably open Arctic Ocean creates opportunities and challenges for nations that ring the Arctic region. Here are some of them:

### **3.1. The opportunities**

#### *3.1.1. Fishing*

According to the US National Oceanographic and Atmospheric Administration (NOAA), it can be said that rise in ocean temperature may create favorable conditions for the development of new commercial fisheries within the Arctic. Whereas, a U.S. plan of 2009 prohibits commercial fishing in U.S. waters.

#### *3.1.2. More ship traffic*

In terms of distance coverage through sea, thousands of miles of a trip could be cut when travelling along Northwest passage north of Canada or even the Northern sea route over Russia that a use to travel through the Panama Canal or the Suez Canal. Michael Byers, a professor of political science at the University of British Columbia made clear in an article in the Canadian newspaper "The Globe and Mail", that between 1906 and 2006, only 69 ships, in 2010, 18 and in 2011, 22 ships traveled through Northwest Passage. As per the Canadian Broadcasting Corporation reports, dwindling of the ice in the area has caused the trips to take place on cruise ships and private yachts.

#### *3.1.3. Gas and oil*

Offshore the Arctic region, according to the U.S. Geological Survey (USGS) in 2008, Arctic holds 90 billion barrels of oil, 1670 trillion cubic feet (47.3 trillion cubic meters) of natural gas and 44 billion barrels of natural gas liquids and a search for these resources is underway. On Monday, Sept. 17, 2012 the oil company Shell cleared that it has delayed the process of drilling the Alaskan Arctic coast until next year in reference to the stating situations.

### **3.2. The problems**

#### *3.2.1. Inadequate maps*

Since the NOAA's maps and other navigational information is unavailable, it becomes difficult for the ships to ply through the route as the sea-ice is thick and impenetrable. Moreover,

according to NOAA, the waters of Arctic that are charted were surveyed using obsolete technology dating back to the 1800s.

### *3.2.2. Little infrastructure or support*

Siders say that though the coastline of Alaska is twice that of other 48 states, then too, there are limited resources regarding search, rescue operations and even to oil spill cleaning. One of the coast guard commandants of the region, Robert Papp, told to the media that, "we have almost no capability and in order to have a permanent availability of us, we need to do more investments on the infrastructure." It becomes necessary to bring in the example of a cruise ship, MV Clipper Adventure, which, in 2011, ran aground along the Northwest Passage and its passengers had to be rescued by the then coast guards.

### *3.2.3. Territorial disagreements*

A CNN Money reports of the year 2008, said that far over the continental shelves, the Arctic coastal nations - the United States, Canada, Russia, Norway and Denmark (Greenland; a Danish territory) - are seeking to lay claim apart from the United States as it is not a party to the U.N. law of the sea treaty. Aligning the other territorial issues, Canada maintains that the Northwest Passage is sovereign Canadian territory, while U.S. and other nations advocates for international strait.

Siders adds, "there shall not be any more aggravating conditions, in terms of climate worsening, as that of the present in the Arctic region. The people are helpless but to work in spine chilling cold, dark and in the middle of storm."

## **4. Arctic summers ice free by 2040,**

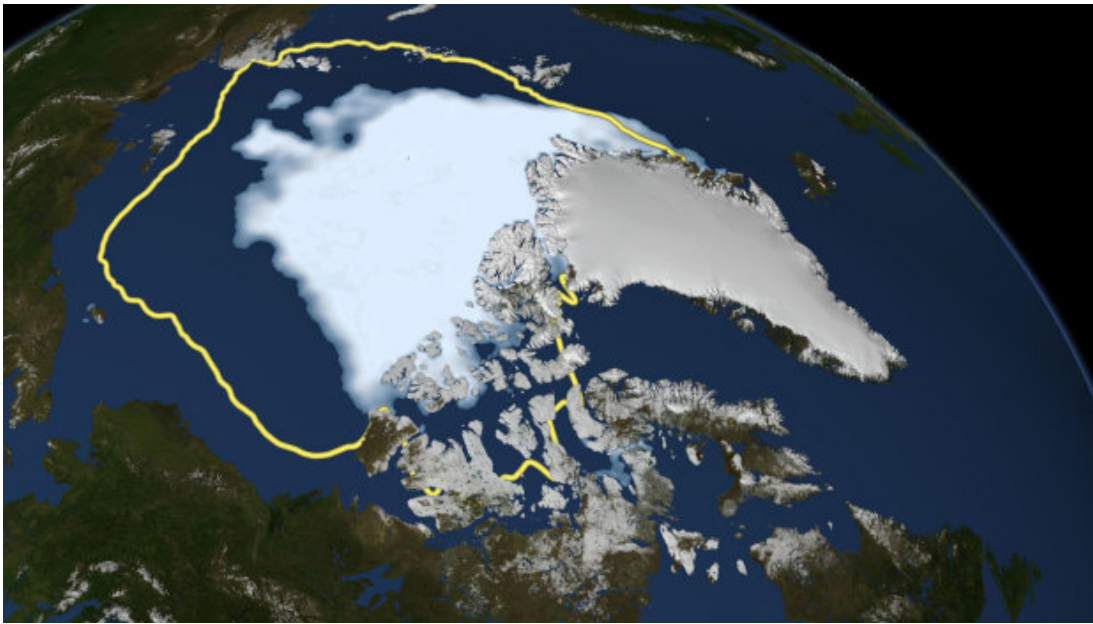
### **4.1. Study predicts**

As per a recent study related to the global warming and its impact upon the sea-ice (see Fig. 4.) the summers in the Arctic Ocean may be ice free by 2040 when predicted through computer models while working on the greenhouse emissions and its impact especially by carbon dioxide (CO<sub>2</sub>) from coal-fired plants and carbon mono-oxide by the automobiles.

The results of the computer study on the effect of the greenhouse gases on the atmosphere seemed alarming as it showed a steadily decline in the sea-ice level for decades and then abruptly disappearing.

Bruno Tremblay, an assistant professor of Atmospheric and Ocean Sciences at McGill University in Montreal, Canada that there are tipping points in the system and when we reach them things accelerate in a nonlinear way[14].





(Source: NASA satellite- by U.S. National Snow and Ice Data Center)

**Figure 4.** Satellite Images of Arctic Sea Ice in white on Sept. 16, 2012 and with the yellow line from 1979 to 2000, considering average.

#### **4.2. How is It happening?**

By September, the summer melt reduces ice cover to its minimum where with the arrival of the winters, it refreezes the sea-ice.

One of the simulation models study that in the last ten years, the ice coverage area has shrunk from about 2.3 million square mile (6 million square kilometers) to 770,000 square miles (2 million square kilometers).

Research & Studies according to the North American map shows that very small percent of sea ice shall be left along the north coastal regions of Green land and Canada. Whereas, the left of the ocean basin shall remain ice free throughout the summer.

Another, larger study shows that the winter ice shall defreeze from about 12 feet (3.7 metres) to three feet (one metre) thick.

Tremblay added to this study by saying that, "The oceans of Arctic do not absorb much of the sun's radiation for gets reflected into the space because the oceans at Arctic acts as giant mirror."

But it can also be stated that as the warmer average temperatures melt the ice, the mirror shrinks and so other part of the ocean creates further warming due to more absorption of the Sun's energy.

This ice shrink causes more warming due to more heat absorption.

"It goes into a positive feedback loop - a very efficient way of getting rid of the ice cover," as said by Tremblay.

Study of the climate models suggest that ocean circulation pattern can be altered due to global warming further driving warmer Atlantic waters into the Arctic.

"That is a positive feedback as well and it enhances the melting of the ice."

#### **4.3. Serious consequences**

Adding to the dire consequences regarding drastic changes in the region's climatic conditions, Tremblay suggests we could reach saturation point as we head towards a rise in temperature. That could happen at the latest by 2020 or 2030.

The dearth of constant cold conditions in the Arctic sea-ice might be perishable on animals such as polar bears that is the only habitation of it [15].

It would cause grave danger for the local residents to crave for their square meal, as they are mainly dependent upon fish as their staple food.

The only advantage left before us would be of transportation that would become feasible for the ships to sail [16].

## **5. Some recent winter storm studies**

### **5.1. A big winter storm threatens U.S. and hit Canada with a cold snap**

Thousands of commercial flights were canceled on Thursday, Jan 02, 2014, while a winter storm moves from the northeastern United States over a region with a 100 million [17]. While, Canada faces one of the worst cold snaps in recent winters with temperatures up to 41<sup>0</sup> degrees below zero in cities like Winnipeg in the Midwest, the 29<sup>0</sup> below zero in Toronto, the most populous city in Canada.

El portal FlightAware.com, which monitors air traffic, It is reported that by the local noon 2.233 flights within, to or from the United States suffered delays and 1.419 had been cancelled. The National Weather Service has warned that the winter storm "will cause serious disorders" remainder of week, with a mantle of snow and temperatures below freezing point across the region.

Is it expected to cause Blizzard Snow Storm tonight on Long Island, NY? New York authorities have indicated that this could block traffic on the Long Island Expressway, if driving conditions on the highway are too dangerous. It is also expected that in the city of New York snow accumulation reaches the 23 centimeters and in Albany to 35 inches, with temperatures between 26 and 35 degrees Celsius.

### 5.1.1. Heavy snowfall followed by very low temperature

The private weather service AccuWeather has indicated “very cold air was still affecting the upper Midwest, and “another wave of cold air hit parts of northeast after the blizzard with snow and could bring the coldest conditions in several years”.

Very low temperatures followed by snowfall are “a brutal combination”, commented meteorologist Tom Moore, of the Weather Channel TV station: “People who are in a vulnerable state will really suffer”, Efe Ambrose reports. “It is a set of circumstances very, very dangerous”, He added. Meanwhile Massachusetts Governor, Deval Patrick, who has authorized all state government employees to return home up to three p.m. on January 02, 2014.

Forecasters warned that a second wave of cold weather will affect the country on Sunday, particularly in the central area. On Sunday, January 05, 2014, Packers while playing in his field one of the matches of the final round of the National Football League at that time, En Green Bay in Wisconsin, temperature could fall from 28 degrees to below zero degree.

### 5.1.2. Cold wave in Canada

The storm is also affecting Canada, facing one of the worst cold snaps in recent winters with temperatures up 41 degrees below zero. From the central part of the country to the Atlantic coast, Thursday January 02, 2014, thermometer markings are at below 20 degrees below zero that, together with the effect called wind, put the wind chill below -30 degrees Celsius.

The authorities have warned that under these conditions, exposed parts of the body are likely to be frozen in minutes and advised for limiting spacewalks to a minimum.

In Northern Ontario, where there are large urban centers but if small indigenous communities, temperatures are reaching -50 degrees Celsius. En Montreal, the main city of the province of Québec, the temperature in the morning on January 02, 2014, was -38 degrees Celsius.

The utility of the province has requested that the energy consumption of appliances is reduced between 16.00 and 20.00 hours to cope with the expected extra demand due to low temperatures. In the province of Nova Scotia, on the Atlantic coast, forecasters predict that in addition to temperature extremes, the region will suffer a severe storm that deposited between 15 and 30 inches of snow in the next few hours.

En Toronto, where last week a 250,000 people went without electricity several days due to an ice storm, temperatures were at -29 Celsius with the wind effect. Although Toronto Hydro has ensured that all its customers have recovered the service after the ice storm, in some areas were taking intermittent outages due to the extra energy to fight the cold. Municipal authorities in Toronto have also enabled extra beds in shelters to accommodate more homeless. While, on the west coast of Canada, the situation is more moderate. The city of Vancouver is planning a maximum temperature today January 02, 2014, 8 degrees and likely to follow rains.

## 5.2. Midwest faced another round of snow, dangerous cold air

The Midwest is facing yet another snowstorm for the second half of the weekend with dangerously cold air to follow on *Sunday, January 5, 2014, USA*. The onslaught of the bone chilling cold breezes could develop in some areas.

The intensity of the snow shall be felt across the lower Great Lakes and in the Mid-Mississippi Valley through Sunday affecting Chicago, Detroit and St. Louis.

The rising of the storm shall also bring snow and slippery travel in Ohio and Tennessee valleys on Sunday morning to Sunday night (January 5, 2014), with the rising of the ice concern in the Northwest.

From St. Louis to Chicago, Indianapolis, Detroit, Cleveland and London, Ontario the heaviest snow is forecast to fall.

Hit severely by the strong snow showers, dipping temperature and bone chilling freeze; transportation and travelling has become extremely difficult. The cities that had been caught by bone chilling storming winds, dipping temperature blended with heavy snow pour are: Memphis and Nashville, Ten; Louisville and Lexington, Ky.; Cincinnati and Columbia, Ohio; Charleston and Morgantown, W.Va.; Pittsburgh and Bradford, Pa.; Jamestown and Rochester, N.Y.; Toronto, Ottawa and Ontario I-40, I-64 and I-65 on Sunday night i.e., on January 5, 2014.

While addressing to the audience a sign of caution for severe conditions in Eastern Ohio to West Virginia and from Western Maryland to Western Pennsylvania, has been raised by a senior meteorologist Dale Mohler in Western New York on Monday & Tuesday [18].

Areas compressed with strong winds, plunging temperatures and heavy rainfall are likely to face whiteout conditions. It should be brought into the notice that the conditions in the climate are likely to be worsen in south of Buffalo, the New State and in the south of Watertown, Tug Hill region.

Mohler said that intense climatic conditions could close down major interstate highways, including I-79, I-80, I-81, I-90 and Route 219, for January 06-07, 2014. He added that there might be some possibility of some people being caught off guard and stranded by the storm due to dangerous cold wave blast and is also said that the new wave of frigid air shall reach the interstate highway I-95 Northeast on Monday, January 05, 2014.

Detroit experience afternoon highs just above zero Monday and Tuesday whereas, Chicago is not expected to exceed 10 degrees below on Monday.

During early February of 1996, it was the last time that Chicago faced such cold weather conditions where the temperatures remained below zero around the clock for a couple of days.

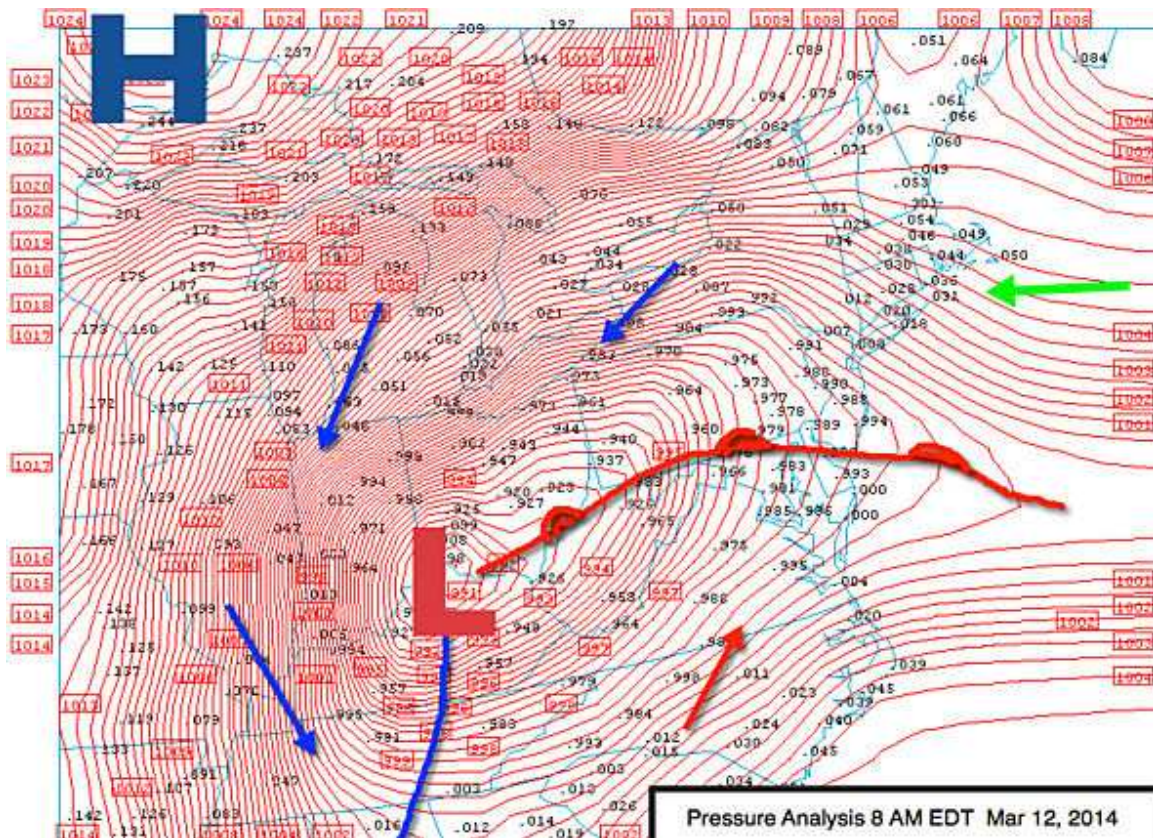
### **5.3. Storm and cold wave attack the northeast**

A strengthening storm centered near Cincinnati, Ohio, on Mar 12, 2014, at 8 a.m., struck the New England coast tomorrow morning. Amazing temperature changes are occurring with this system. For example, at St Louis, the temperature was 80 °C at 4 p.m. yesterday.

This morning, 14 hours later, there was mix of snow and rain and it was 56. Heavy gusty thunderstorms announced the arrival of the cold front, and there could be a band of heavy showers and thunderstorms all the way to the Middle Atlantic coast tonight. Several inches of snow blanketed Chicago, and Buffalo will have blizzard conditions this afternoon and evening of Mar 12, 2014.



There will be a rapid freeze-up overnight from Boston to Washington, D.C., and temperatures will stay below freezing in all but the southernmost part of that area all day tomorrow. However, the high pressure area marking the center of the cold air mass will be east of Virginia by Friday, and the southwesterly flow behind it will take the cold air away quickly.



Source: AccuWeather.com

Figure 5. Pressure Analysis

This pressure map shows the storm center. The front to the east (re-line) marks the boundary between warm air to the south and progressively colder air to the north as shown in Fig.7.

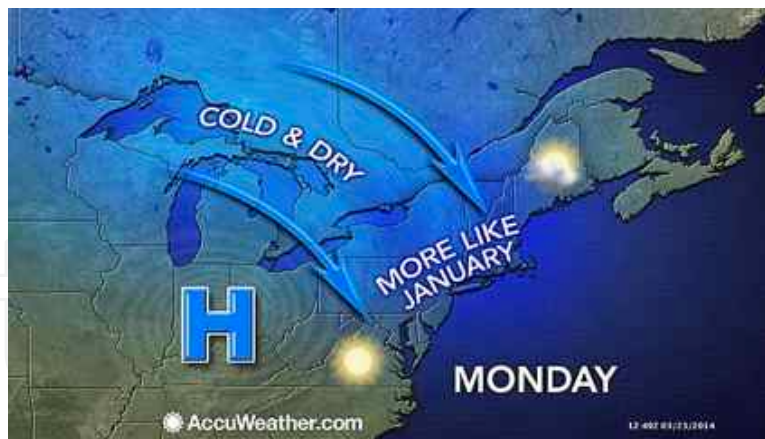
#### 5.4. Feel another cold wave passes more likely in January than March 2014

Across the Midwest and East the dipping temperature shall set the stage for heavy snow despite the official arrival of spring over the next several days feeling more or like January.

In continuation to this temperature conditions, this cold front has opened way for fresh arctic air to erase mild start to spring in the Midwest and East. Now the warmth of the weather conditions that of 50s in Boston, 60s in New York City and 70s in Washington-DC, on Saturday, March 29, 2014, seem disappear.

The typical January readings (in terms of average temperature, not what was recorded during this past frigid January 2014) elucidate the cold spell producing high and low temperatures at par.





Source: AccuWeather.com

**Figure 6.** Cold wave passes more likely in January than Monday, March 24, 2014 by Kristina Pydynowski

According to the weather source, the cold temperature during end of March 2014 shall be roughly not more than 15 to 20 degrees below normal in the Midwest and Northeast whereas in the Upper Midwest up to 25 degrees below normal.

By Wednesday, Duluth and International Falls, Minn., will experience at least two days of highs in the teens and subzero overnight lows this week. Highs in the 20s will return to Minneapolis, Detroit and Chicago. Temperatures will be held to the 30s southward to St. Louis and Cincinnati on Tuesday.



**Figure 7.** Lexington weather

March 24, 2014, Monday will be a cold day across the Northeast with highs in the teens and lower 20s across most of the St. Lawrence Valley, 20s southward to I-84 and 30s in Pittsburgh, New York City, Philadelphia and Atlantic City.

The latest arctic blast may set the stage for generally nuisance snow to spread across the Midwest Monday to Tuesday, while an Eastern New England is facing the threat of a blizzard at midweek.

In the wake of the blizzard, Wednesday will feel even colder than Monday across the Northeast as blustery winds howl on the storm's backside.

Outdoor spring sports and activities are ramping up at the collegiate and high school levels, and the cold threatens to cause problems for participants and spectators.

“The cold could force the cancellation or postponement of some scheduled events,” stated AccuWeather.com Meteorologist Mike Doll.

Athletes will be able to put the winter jackets, extra layers of clothing, hats and gloves they will need to keep themselves warm over the next several days back into the closet later this week with another brief surge of warmth expected.

### 5.5. North American cold wave in the year 2013-14

The American Cold Wave (2013-2014) adversely affected Canada and the Eastern United States that extended from December 2013 to April 2014 with 2 episodic twists; first in December 2013 and the second in early 2014 caused by the southward shifts of the North Polar Vortex [19].

The first wave of record breaking cold air pushed into the Eastern U.S. that too before the temperatures receded to a moral stable range from December 6-10, 2013. A heavy snowfall (Fig. 7.) was recorded on January 2, 2014 by an Arctic cold front associated with the nor'easter that tracked across Canada and the United States resulting in the dipping of the temperature to unprecedented stages, and low temperature records were broken across the United States. Consequencing the closure of the roads, Business schools and cancellation of mass flights, with its effect [20-23]. In the same context, around 187 million residents of the continental United States were taken into its grip as the freezing cold air pushed in to the Eastern U.S. extending further towards the southern region from the Rocky Mountains to the Atlantic Ocean until it started receding from December 6-10, 2013 affecting more than 200 million people [24].

This happened due to the weakening of the Polar Vortex an abnormally cold trend swayed in the Eastern and Central United States, on December 1, 2013 from December 6 to 10, 2013. But, a sudden Stratospheric Warming (SSW) led to the breakdown of the regular Polar Vortex and subsequent southward movement of tropospheric Arctic air beginning on January 2, 2014, cutting down the cold rate [25].



Source: Wikipedia

**Figure 8.** Satellite image of the severe winter weather took on January 2, 2014

As a result of the unusual contrast between cold air in Canada and mild winter temperatures in the United States, the jet stream deviated to the south (bringing cold air with it), as being stated by the UK Met Office. This led to the bitter wind chills and worsening the impacts of the record cold.

#### 5.5.1. Recorded temperatures

- **United States of America**

The temperature at this stage on January 5, 2014, Green Bay, Wisconsin was -18 °F (-28 °C) whereas, the previous low recorded temperature was in 1979 [26].

Babbitt, Minnesota was recorded the coldest place in the country at -37 °F (-38 °C) on January 6, 2014. Owing to this, the bitter cold air reached near Dallas experiencing a low temperature of 16 °F (-9 °C).

On January 6, 2014, the low temperature recorded at O'Hare International Airport in Chicago was -16 °F (-27 °C) where, the previous record was -14 °F (-26 °C) set in 1884 and tied in 1988 [27]. For the cold wave coverage in Chicago [28], the National Weather Service (NWS) adopted the Twitter hash tag # Chiberia (a portmanteau of Chicago and Siberia) [29-30]. Stiffing winds exceeded at 23 mph, when Chicago set its all time wind chill record of -82 °F (-63 °C) in 1983, but it could not be broken since NWS adopted a new wind chill formula in 2001 [31].

As compared to the average recorded temperature of last time i.e. below 18 in January 13, 1997; on January 6, 2014 it was recorded to be 17.9 °F (-7.8 °C) that is longest on record during a period of 17 years [32].

On January 6-7, 2014, Detroit hit a low temperature of -14 °F (-26 °C) and on January 7, 2014, at least 49 record lows for the day were set across the country [33]. On January 7, 2014, the high temperature of -1 °F (-18 °C) was only the sixth day in 140 years of records to have a subzero high [34]. On January 7, 2014, the temperature in Central Park in New York City was 4 °F (-16 °C). In 1896 for the day set, temperature was recorded low since its data collection initiated by the government [35]. On the other hand Pittsburgh bottomed out at -9 °F (-23 °C), setting a new record low on January 6-7, 2014 and Cleveland also set a record low on those dates at -11 °F (-24 °C). Temperatures in Atlanta fell to 6 °F (-14 °C), breaking the old record for January 7 of 10 °F (-12 °C) which was set in 1970. At Georgia, the temperatures fell to -6 °F (-21 °C) at Brasstown Bald, Georgia [36]. Tampa experienced a low of 34 °F (1 °C) in January 2014 after the cold air moderate and it reached even to the subtropical Florida.

- **Canada**

The eastern prairie provinces, Ontario, Quebec and the Northwest Territories that were the coldest parts of Canada experienced the hit of the weather. However, only Southern Ontario set temperature records.

Winnipeg was the coldest city in Canada during the hit of the early cold waves [37]. On January 5, 2014, the daily high in Saskatoon was -28.4 °C (-19.1 °F) with a wind chill of -46 °C (-51 °F)[38].

In Hamilton, Ontario a cold temperature record of -24 degrees C (-11 degrees F) was set. Whereas in London, Ontario it was -25 degrees (-13 degrees F) [39].

### 5.5.2. Related extreme weather

From the American Plains and Canadian Prairie Provinces to the East Coast a heavy snowfall or rainfall occurred on the leading edge of the weather pattern and due to the cold wind factor, strong winds prevailed throughout the freeze making the temperature feel at least ten degrees Fahrenheit colder than it actually was. Some places along the Great Lakes were also under wind warnings, in addition to the rainfall, snowfall, ice and blizzard warnings [40].

- **United States of America**

Boston experienced a temperature of 2 degrees F (-17 degrees C), on January 3, 2014 along with the wind chill and over 7 inches (180 mm) of snow. Whereas, Boxford, Massachusetts recorded a record snow fall of 23.8 inches (600 mm). Fort Wayne, Indiana had a record low of -10 °F (-23 °C) temperature. In Michigan, over 11 inches (280 mm) of snow fell outside Detroit and temperature around the state reached almost 0 °F (-18 °C). An official closure of government offices and school were announced after New Jersey had experienced a heavy snow fall of over 10 inches (250 mm) [41].

O'Hare and Midway Airports observed cancellation of their 1200 flights due to the snowfall between 5-7 inches (13 cm-180 mm) on January 5, 2014. [42]. Moreover, the Freezing rain caused a Delta Air Lines flight to skid off a taxiway and into a snowbank at John F. Kennedy International Airport, but with no injuries [43].

Further a fall of snow between 0.5 and 2 inches (1.3 and 5.1 cm) in Tennessee region and was lighter farther south [44].

A record breaking freezing cold with 4 degrees F (-16 degree C) on January 7, 2014, in 116 years, was recorded at New York city that came after days of unseasonably warm temperature, with daytime high dropping as much as 50 degrees Fahrenheit overnight [45].

- **Canada**

On January 5 and 6, 2014, in most parts of Canada, the front brought rain showers and snow event, which became the second nor'easter in nor'easter in less than a week in Nova Scotia and Newfoundland [46]. The onset of the front marked the end of this weather event bringing the bitterly cold temperatures with it. Due to lake-effect snow Southwestern Ontario also suffered again second time with heavy snow fall whole day on January 6 and 7 and part of January 8 [47], but Northwest Territories and Nunavut did not experience such chilling cold, but had a record-breaking blizzard on January 8, when further freezing cold towards south was coming to an end.

On other hand entire regions of Ontario and Quebec were undergone blizzard warnings [48]. Montreal has only suffered -24 °C with wind-chill factor overnight from January 6 to 7, when the same locations in Quebec have gone low temperature up to -34.5 °C on the night of January

2 to 3 and up to  $-41^{\circ}\text{C}$  on the night of December 25 to 26, which were also seemingly unrelated to the cold wave, but nearing records.

Canada experienced steady winds blow under the deep freeze around 30 to 40 kilometres per hour (19 to 25 mph). The winds reached 70 km/h (43 mph) with a gust as high as 100 km/h (62 mph) along the north shores of Lake Erie bringing local wind chill levels as low as to  $-48^{\circ}\text{C}$  ( $-54^{\circ}\text{F}$ ) [49]. Several Ontario locations experienced cryoseisms or frost quakes along Lake Ontario and the St. Lawrence Valley [50].

- **Mexico**

A Tehuano wind event was created by the cold air that blew at 41 km (76 km/h; 47 mph) [51], from the Bay of Campeche into the Gulf of Mexico reaching Saltillo in the Northeast bringing temperature as low as  $-6^{\circ}\text{C}$  ( $21^{\circ}\text{F}$ ) [52].

1 centimeter (0.39 in) of snow grains were accumulated at Monterrey and registered a temperature of  $-1^{\circ}\text{C}$  ( $30^{\circ}\text{F}$ ) [53].

### 5.5.3. *Impact on electric power and transport*

This extreme cold condition set for the cancellation of thousands of flights and seriously affected other form of transport. Many power companies in the affected areas asked their customers to conserve electricity.

- **United States**

Close to 100 daily snowfall records were broken across the northeastern, southeastern and south central United States, during the first episode of the cold wave, which extended from December 6–10, over 150 daily precipitation records [54] and [55]. Numerous airline flights were cancelled and there were reports of power outages [56-59].

Evan Gold of weather intelligence firm “Planalytics” called the storm and the low temperatures, the worst weather conditions event for the economy since Hurricane Sandy just over a year. It was not only nearly 200 million people were affected but calculated impact on Gold at \$5 billion. Airlines were cancelled a total 20,000 flights after the storm began on January 2, 2014 with accumulated loss of \$50 to \$100 million [60]. Jet Blue airlines were adversely affected as its 80 percent flights go through New York City or Boston and were under major hit. Tony Madden, Federal Reserve Bank stated that as many schools closed, parents forced to remain home from work and vice-versa. He said that even people who could work from home, might not have done as much, excepting the insurance industry and government costs for salting roads, overtime and repairs [61-70].

Temperatures fell from  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ) in the Middle Tennessee between January 5 and 6, 2014 dropping to a high of  $-13^{\circ}\text{C}$  ( $9^{\circ}\text{F}$ ) on Monday, January 6, 2014 in Nashville. The power supply was interrupted leaving around 1200 customers to sit in dark in Nashville and around 7500 in Blount County [71]. The Tennessee Emergency Management Agency declared a state of emergency. Around 24,000 residents suffered power supply in Indiana, Illinois, and Missouri [72].



The power problem was reported by the Weather Channel in several states, abandoning cars on the highways in North Carolina and freezing rain in Louisiana [73].

- **Canada**

In late January 5, 2014 in Newfoundland, over 190,000 customers were left without electricity when the power supply could be restored by the next day [74].

Severe influence was on the air transportation which got delayed in Montreal and Ottawa. Some flights even got cancelled at Toronto Pearson International Airport due to low temperature and power cut [75-76]. ExpressJet, a partner of United Airlines, cancelled its flights into and out of Winnipeg, stating that the combination of extreme low temperatures and ice crystals exceeded safe operating guidelines for their airplanes [77].

#### *5.5.4. Ecological impact*

According to an opinion on the loss of ash trees, the spokesperson of the US Department of Agriculture in North America said that the extreme freezing conditions delayed the progressive loss of ash trees through it in North America [78]." The repudiation is based on scientific studies of under bark temperature tolerances of emerald ash borer in Canada [79-81].

### **5.6. New York City May 3, 2014 facing the dangers of 21st century great power war**

World War I triggered with the assassination of Sarajevo. It was a beginning of the three decades of great power competition and warfare that culminated in the development and use of the atomic bomb. This was an era of militarized completion between rising and declining powers, intense disputes over territory and resources, arms racing, complex military alliances, rising nationalism and religious tensions. The beginning of this century, like the last, also is defined by deepening economic interdependence and competition, revolutionary advances in communications, and the belief that great power war would end civilization, as we know it, is thus, unthinkable. Yet from the Persian Gulf to the East China Sea there are more than enough wild cards to spark incidents that could spiral towards war.

Other cause of the war to begin was the pressure of the capitalist firms that have gained sufficient power in much of the world to write their own rules within economic framework. Intractable global economic crisis, with the actions essential to break the impasse thwarted by the extreme accumulation of wealth and power by elites determined to keep things as they are.

## **6. Results and discussion**

From the above study, following points noticed that:

- In a span of ten years, sea ice coverage shrunk from about 2.3 million square miles (6 million square kilometers) to 770,000 square miles (2 million square kilometers).

- Expectation is that by 2040 or earlier the Arctic region may face ice-free summer since the Arctic ice is rapidly disappearing. Polar bears and indigenous creatures are already suffering from the sea-ice loss.
- Only the north coasts of Greenland and Canada shall remain covered with sea ice whereas rest of the ocean basin shall remain ice free through the summer (According to North America map).
- Glaciers and mountain snows are rapidly melting-for example, Montana's Glacier National Park now has only 27 glaciers, versus 150 in 1910.
- Winter ice will thaw from about 12 feet (3.7 meters) to 3 feet (1 meter) thick.
- Cold air in Canada and winter temperatures in the United States lead to bitter wind chills and worsening the impacts of the record cold temperatures on January 02, 2014.
- On January 06, 2014 Babbit, Minnesota was the coldest place in the country at (-) 37<sup>0</sup> F and cold reached to Dallas, experienced low temperature of (-)16<sup>0</sup> F.
- On January 03, 2014, Boston had a wind chill and over 7 inches snow whereas Boxford, Massachusetts recorded 23.8 inches of snow and schools and government offices were closed.
- In Canada, the major city Winnipeg was found coldest with temperature of -37 °C (-35 °F), on January 6, 2014 while it was -36 °C (-33 °F) on January 07, 2014, but it did not go above -25 °C (-13 °F) on both days.
- During the cold wave, there was heavy load on the power supply that got tripped and left nearly 1200 customers in Nashville and around 7500 customers in Blount County, without power supply. Between January 5 and 6, 2014, temperatures fell from 10 °C (50 °F) to -13 °C (9 °F) in Middle Tennessee, and the Tennessee Emergency Management Agency declared a state of emergency.
- Nearly 24,000 residents suffered power failure in Indiana, Illinois, and Missouri, USA.
- Owing to the power failure in Newfoundland, Canada, on January 5, 2014 around, 190,000 customers were left without power and air transportation was delayed at airports of Montreal and Ottawa. Almost all the flights were cancelled at Toronto Pearson International Airport due to the de-icing concerns.

## 7. Conclusions

From the study, it is found that Arctic Sea (Polar Ice) is shrinking very fast due to climate warming, particularly in warm summers. It is only on account of manmade effect of global warming. Thus, the following conclusions are listed below to act upon to fight with the dire consequences of fast shrinkage of Arctic sea, glaciers ice melt:

- There are very strong signs already been seen in the rate of sea ice change for the last one decade.
- Happening by 2020 or 2030 is not unrealistic while most of the ocean basin will remain ice free through the summer from the North America map.
- By 2040 only a small amount of sea ice will remain along the north coasts of Greenland, USA and Canada.
- The permafrost, that is a component for increase in the tundra fires, has the potential to turn the entire Arctic region from a vast carbon sink into a potentially lethal source of methane in less than a decade by enhancing the shrinkage of Arctic Sea.
- There are possibilities to grow glacier near north coasts due to heavy ice sheets meeting in the Atlantic sea.
- Ice sheets meeting to Sea-water may not convert quickly into water and create pressure drop, snow fall, extreme temperature drop to minus (-) 60-70 degree centigrade.
- USA & UK northern region may get affected with cold waves, disasters, intense storms, heavy snow falls and living life may not become conducive.
- The cold waves, extreme temperature drop may force living population in North American and Europeans to find new places for their living.
- Asian region especially India surrounded by three sides from sea and fourth side from Himalayan hills, may also affected badly with cold waves, disastrous intense storms, heavy snow falls nearby Himalayan glacier region; may cause heavy loss to the livelihood.

It is expected that the situation may go bad to burst every year and will continue in till next decade. During winter, New York, Britain and Canada i.e., northern belt, may suffer with extreme weather conditions such as: intense storm, heavy snow fall and power disruption.

Since the permafrost melt also confirms as a potential source of runaway global warming due to heavy methane availability, thus it is need of the hour to act very fast to help in stopping Climate Change due to Global Warming by adopting means to Save Earth and Save Life for happy living.

## **Acknowledgements**

Enormous and extensive support provided by the management of School of Management Sciences, Lucknow, with a profound guidance under Harcourt Butler Technological Institute, Kanpur, has been a gliding way in accomplishing this project. Author Prof. Bharat Raj Singh expressed his special tribute to his mother Jagpatti Devi Singh who encouraged him to devote entire life for rendering the services to the human beings, though she had now left us for heavenly abode, leaving behind, her blessings for us.

## Author details

Bharat Raj Singh<sup>1\*</sup> and Onkar Singh<sup>2</sup>

\*Address all correspondence to: [brsingh1ko@yahoo.com](mailto:brsingh1ko@yahoo.com)

1 Director, School of Management Sciences, Lucknow, Uttar Pradesh, India

2 Vice Chancellor, Madan Mohan Malviya University of Technology, Gorakhpur, Uttar Pradesh, India

## References

- [1] Archer, David. 2006. *Global Warming: Understanding the Forecast*. Hoboken, NJ: Wiley-Blackwell.
- [2] Environmental Defence Fund, "Global Warming Myths and Facts," Accessed: January 17, 2009.
- [3] Global Warming, Union of Concerned Scientists: Citizens and Scientists for Environmental Solutions. 2008. Accessed: November 27, 2008.
- [4] IPCC Fourth Assessment Report: Climate Change 2007. Intergovernmental Panel on Climate Change. Accessed: November 21, 2008.
- [5] Montague, Fred. 2006, *Environmental Notebook: Observations, Principles, Trends, and Ideas about Life on Earth*, Wanship, UT: Mountain Bear Ink.
- [6] National Geographic News. "Global Warming Fast Facts." Accessed: January 14, 2009.
- [7] Walker, Gabrielle and Sir David King. 2008. *The Hot Topic: What We Can Do about Global Warming*. Orlando, FL: Harcourt, Inc.
- [8] Weart, Spencer R. 2003. *The Discovery of Global Warming*. Cambridge, MA: Harvard University Press.
- [9] H. MacMillan, *Winds of change, 1914-1939* (London: 1966), 575; quoted in Michael Sherry, *The Rise of American Air Power: The Creation of Armageddon* (New Haven: 1987), 74.
- [10] Methane studies fact sheet (Website: [http://www.edf.org/sites/default/files/methane\\_studies\\_fact\\_sheet.pdf](http://www.edf.org/sites/default/files/methane_studies_fact_sheet.pdf))
- [11] Methane Study at University of Texas, FAQ page (web: <http://www.edf.org/climate/methane-studies/faq>).

- [12] Methane Research Studies, Roster of Scientists (web: <http://www.edf.org/climate/methane-studies/partners>).
- [13] Stefan Lovgren, Arctic Ice Levels at Record Low, May Keep Melting, Study Warns", National Geographic News, October 3, 2005.
- [14] Bruno Tremblay, Journal *Geophysical Research Letters* -presented at the fall meeting of the American Geophysical Union in San Francisco, California, December 12, 2006.
- [15] Sean Markey, "Polar Bears Suffering as Arctic Summers Come Earlier, Study Finds", National Geographic News, September 21, 2006.
- [16] John Roach, National Geographic News, December 12, 2006, Codie Awards.
- [17] Susana Romero, 2014, A big winter storm threatens U.S. and hit Canada with a cold snap, Jan 02, 2014(web: <http://blog.susanaromeroweb.com/?p=6623&lang=en>).
- [18] Dale Mohler, 2014, "Blizzard conditions may develop from eastern Ohio to West Virginia, western Maryland, Western Pennsylvania, Before Its News, January 05, 2014, USA.
- [19] Gutro, Rob. "Polar Vortex Enters Northern U.S.". Retrieved January 8, 2014.
- [20] "N America weather: Polar vortex brings record temperatures". *BBC News – US & Canada* (BBC News Online). January 6, 2014. Retrieved January 6, 2014.
- [21] Calamur Krishnadev (January 5, 2014). "'Polar Vortex' Brings Bitter Cold, Heavy Snow To U.S.". *The Two Way*. National Public Radio. Retrieved January 6, 2014.
- [22] Preston, Jennifer (January 6, 2014). "'Polar Vortex' Brings Coldest Temperatures in Decades". *The Lede* (The New York Times). Retrieved January 6, 2014.
- [23] "Arctic Monday for 140 million as 'POLAR VORTEX' barrels across the US: 4,400 flights canceled, schools closed as far south as ATLANTA and the coldest temperatures recorded in 20 years". *Daily Mail* (London). January 6, 2014. Retrieved January 7, 2014.
- [24] Associated, The (January 7, 2013). "5 Things To Know About The Record-Breaking Freeze". NPR. Retrieved January 8, 2014.
- [25] Spotts, Pete (January 6, 2014). "How frigid 'polar vortex' could be result of global warming (+video)". *The Christian Science Monitor*. Retrieved January 9, 2014.
- [26] DeMarche, Edmund (January 4, 2014). "'Polar vortex' set to bring dangerous, record-breaking cold to much of US". *FoxNews.com* (Fox News). Retrieved January 6, 2014.
- [27] "Chicago Gripped By Record Cold; Schools Closed, Public Transit Delayed". WBBM-TV. January 5, 2014. Retrieved January 8, 2014.
- [28] "'It's too darn cold': Historic freeze brings rare danger warning". CNN. January 6, 2014. Retrieved January 8, 2014.



- [29] "Metra plans on normal schedule for evening rush; CPS classes to resume Wednesday". *Chicago Sun-Times*. January 6, 2014. Retrieved January 8, 2014.
- [30] "ChiBeria,' Chicago's biggest chill in nearly 20 years, headed our way". WLS (AM). January 5, 2014. Retrieved January 8, 2014.
- [31] January 18, 2011 (2011-01-18). "Ask Tom why: What was the lowest wind chill ever recorded in Chicago?". [Articles.chicagotribune.com](http://Articles.chicagotribune.com). Retrieved 2014-01-15.
- [32] Borenstein, Seth (January 10, 2014). "Weather wimps?". *Salisbury Post*. Associated Press. p. 1A.
- [33] Doyle Rice (7 January 2014), List of record low temperatures set Tuesday USA Today
- [34] Coldest Arctic Outbreak in Midwest, South Since the 1990s Wrapping Up, [weather.com](http://weather.com), Jon Erdman and Nick Wiltgen, January 8, 2014
- [35] "Extreme Cold Wave Invades Eastern Half of U.S.". *Weather Underground*. January 7, 2014. Retrieved January 7, 2014.
- [36] Record-setting cold turns deadly *Macon Telegraph* 7 January 2014
- [37] Daily Data Report for January 2014 Canada government site
- [38] "Daily Data". [Climate.weather.gc.ca](http://Climate.weather.gc.ca). November 12, 2013. Retrieved January 8, 2014.
- [39] "At -24 C, Hamilton sets cold temperature record – Latest Hamilton news – CBC Hamilton". [Cbc.ca](http://Cbc.ca). January 19, 1994. Retrieved January 8, 2014.
- [40] "Alerts for: Simcoe – Delhi – Norfolk – Environment Canada". [Weather.gc.ca](http://Weather.gc.ca). April 16, 2013. Retrieved January 7, 2014.
- [41] "Snow, cold disrupt large swath of US; more to come". *Boston Globe*. Associated Press. 3 January 2014. Retrieved January 10, 2014.<sup>[dead link]</sup>
- [42] "Winter storm 2014 strikes Midwest, Northeast; Snow storm 'Hercules' followed by 'polar vortex'". *WLS-TV*. 5 January 2014. Retrieved January 8, 2014.
- [43] Fitzsimmons, Emma G. (January 5, 2014). "Jet Skids Into Snowbank at J.F.K. Airport". *New York Times*. Retrieved January 8, 2014.
- [44] "Dangerously Cold Temperatures Settle Into Mid-State". *WTVF News Channel 5*. January 6, 2014. Retrieved January 6, 2014.
- [45] Associated Press, The (January 7, 2013). "Record low temperatures in New York City". *Fox News*. Retrieved January 8, 2014.
- [46] "Deep freeze extends from Winnipeg east to Newfoundland". [Cbc.ca](http://Cbc.ca). 2014-01-02. Retrieved 2014-01-15.
- [47] [nurun.com](http://nurun.com) (2014-01-07). "Schools closed, blizzard warning continued". [Lfpress.com](http://Lfpress.com). Retrieved 2014-01-15.

- [48] "Weather Alerts – Environment Canada". Weather.gc.ca. December 5, 2013. Retrieved January 7, 2014.
- [49] North America's big freeze seen from space BBC News, January 9, 2014
- [50] "'Frost quakes' wake Toronto residents on cold night – Toronto – CBC News". Cbc.ca. January 3, 2014. Retrieved January 7, 2014.
- [51] Satellite Blog, CIMSS (January 3, 2014). "Tehuano wind event in the wake of a strong eastern US winter storm". *Space Science and Engineering Center*. University of Wisconsin-Madison. Retrieved January 8, 2014.
- [52] "Synop report summary". Saltillo: Ogimet. Retrieved January 11, 2014.
- [53] "76393: Monterrey, N. L. (Mexico)". *Professional information about meteorological conditions in the world*. Ogimet. Retrieved 30 January 2014.
- [54] "U.S. Daily Precipitation Records set on December 6, 2013 | Extremes | National Climatic Data Center (NCDC)". Ncdc.noaa.gov. Retrieved 2013-12-08.
- [55] "U.S. Daily Snowfall Records set on December 6, 2013 | Extremes | National Climatic Data Center (NCDC)". Ncdc.noaa.gov. Retrieved 2013-12-08.
- [56] "Dallas, TX Weather Forecast from Weather Underground". Wunderground.com. Retrieved 2013-12-06.
- [57] Donna Leinwand Leger and Doyle Rice, USA TODAY (December 7, 2013). "Snow, sleet and ice drive into eastern USA". Usatoday.com. Retrieved 2013-12-08.
- [58] Jalelah Ahmed. "Winter storm halts travel; more snow forecast for Northeast | Al Jazeera America". America.aljazeera.com. Retrieved 2013-12-10.
- [59] 21 hours ago. "Icy weather sends Texas' December power use to new record – Yahoo News". News.yahoo.com. Retrieved 2013-12-10.
- [60] "Deep freeze may have cost economy about \$5 billion, analysis shows". Durangoherald.com. 2014-01-10. Retrieved 2014-01-15.
- [61] Karnowski, Stevework (9 January 2014). "Deep freeze may have cost economy about \$5 billion". News & Observer. Associated Press. Retrieved January 10, 2014.
- [62] "Today in Energy". U.S. Energy Information Administration. Retrieved 1 March 2014.
- [63] Castellano, Anthony (January 3, 2013). "At Least 13 Died in Winter Storm That Dumped More Than 2 Feet of Snow Over Northeast". *ABC News*.
- [64] "North America arctic blast creeps east". *BBC News*. January 7, 2014. Retrieved January 7, 2014.
- [65] "OIA Can't Deice Frozen Jets". AviationPros.com. January 7, 2010. Retrieved January 7, 2014.

- [66] Kyle Arnold (January 6, 2014). "Sky Writer: Frozen aircraft fuel stalling nationwide air travel". Tulsa World. Retrieved January 13, 2014. "American Airlines said Monday that it's so cold in Chicago that airline fuel is freezing and they can't refuel planes. "Fuel and glycol supplies are frozen – at ORD (Chicago's O'Hare) and other airports in the Midwest and Northeast," said American Airlines spokesman Matt Miller."
- [67] "Service Alert". Amtrak. Retrieved January 7, 2014.
- [68] "Passengers stuck on Amtrak train 8 hours; Amtrak cancels some Chicago train service". WLS-TV. January 6, 2014. Retrieved January 8, 2014.
- [69] "500 passengers spend night on stranded Amtrak trains". Chicago Tribune. WGN-TV. January 7, 2014. Retrieved January 8, 2014.
- [70] Bone-Chilling Temps Shut Down Detroit People Mover, CBS News, January 7, 2014
- [71] Hayley Harmon (January 4, 2014). "Cold weather knocks out power for 7500 Blount County residents". WATE News. Retrieved January 9, 2014.
- [72] 'Historic and life-threatening' freeze brings rare danger warning, CNN, January 6, 2014
- [73] "Winter Storm Pax Update: Hundreds of Thousands Lose Power, Drivers Abandoning Cars on Charlotte and Raleigh Highways". The Weather Channel. 12 February 2014. Retrieved 12 February 2014.
- [74] CTVNews.ca Staff (January 6, 2014). "Power restored to majority of customers in Newfoundland". *CTV News*. Bell Media. Retrieved January 6, 2014.
- [75] "Pearson airport delays: What you need to know". *CBC News*. January 7, 2014. Retrieved January 7, 2014.
- [76] "Extreme cold causes more delays, cancellations at Pearson". *CP24*. January 7, 2014. Retrieved January 8, 2014.
- [77] "Winnipeg deep freeze as cold as uninhabited planet – Manitoba – CBC News". *Cbc.ca*. Retrieved January 7, 2014.
- [78] Ziezulewicz, Geoff (January 6, 2014). "Cold weather could limit ash borer threat". Chicago Tribune. Retrieved January 8, 2014.
- [79] Purvis, Micheal (February 28, 2014). "Deer in danger from cold weather, but emerald ash borer likely not significantly affected, say scientists". Sault Star. Retrieved February 28, 2014.
- [80] Spears, Tom (February 4, 2014). "False hope: Deep freeze poses no threat to tree-munching emerald ash borer". Ottawa Citizen. Retrieved February 4, 2014.
- [81] Vermunt, Bradley; Cuddington, Kim; Sobek-Swant, Stephanie; Crosthwaite, Jill. "Cold temperature and emerald ash borer: Modelling the minimum under-bark temperature of ash trees in Canada". *Ecological Modeling* (Springer). 235–236: 19–25. doi:10.1016/j.ecolmodel.2012.03.033. Retrieved 24 June 2012.

