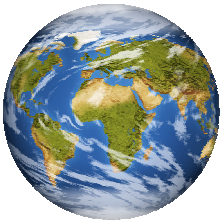
SPQ – Module 7 – Global Warming in the Antarctic



We live in the age of global warming. There are dire predictions about the cataclysmic environmental changes that will lead to extinction, population displacement, water shortages and starvation. Despite the fact that there are some outspoken individuals who maintain that global warming is not the byproduct of human activity, virtually all credible scientists believe this to be the case.

In simple terms, global warming is the rise in mean global temperature due to the increase in greenhouse gases. Greenhouse gases are atmospheric molecules capable of absorbing heat. Greater concentrations of greenhouse gases provide the atmosphere greater capacity to heat up. There is little debate that global temperatures are rising.

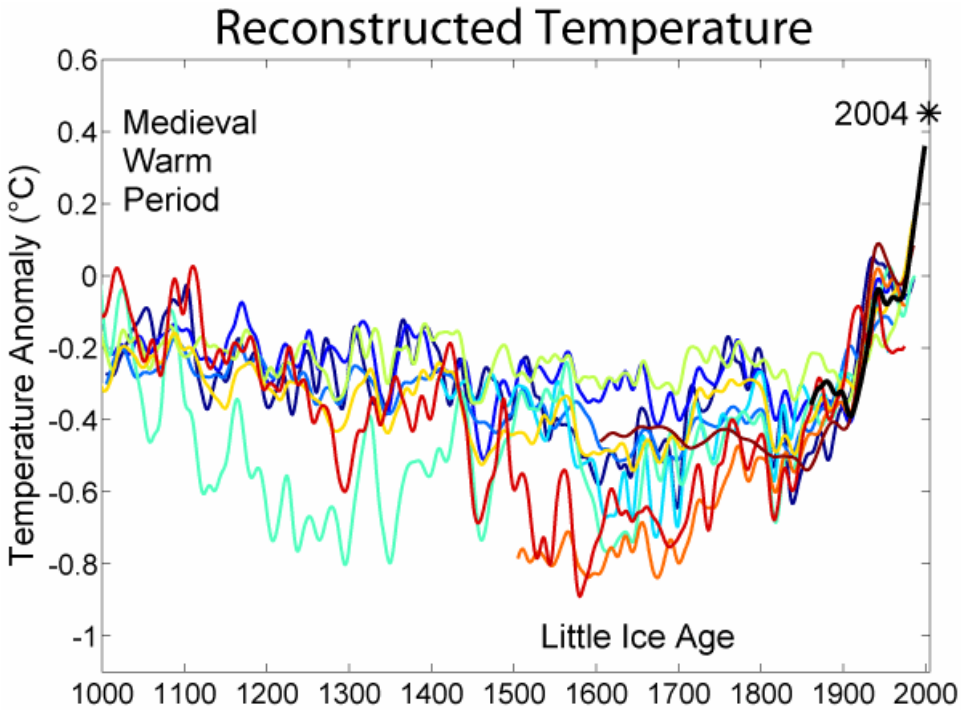


Figure 1: This image is a comparison of 10 different published reconstructions of mean temperature changes during the last 1000 years. (Source: This figure was prepared by Robert A. Rohde for the Global Warming Art project).

As the name implies, Global Warming is a global phenomenon. Nonetheless the Polar Regions are uniquely situated to function as barometers of global temperature change, and also have significant influence on the state of global climate. While there has been an increase in average worldwide temperature of about 0.9 degrees, the mean increase in temperature in the Canadian Arctic over the same period has been more than double that value. Satellite images of Arctic sea ice over the past 30 years have shown alarming reductions during the summer melt. If current trends continue, scientists estimate that summers in the Arctic Ocean could become ice-free by the end of the century. Richard Weber who has been traveling to the North Pole for almost 25 years, reports that the sea ice is now noticeably thinner than it was when he first visited the region in 1986.

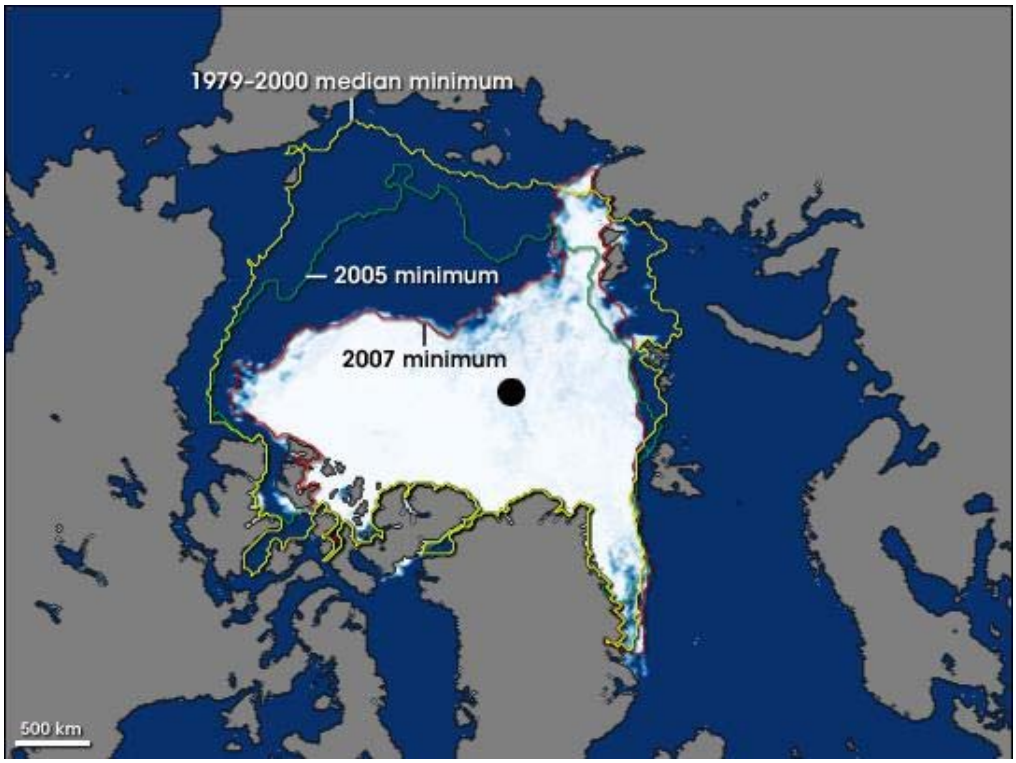


Figure 2: Arctic Sea ice record minimums over the period 1979 - 2007 (Source: NASA).

The Antarctic will certainly not be ice free in one hundred years. While Arctic ice is a floating cap that is on average 9 feet thick and gradually drifts with ocean currents, the Antarctic ice cap has an average depth of 7,000 feet, with its greatest depth reaching more than 15,000 feet (more than 4.5 kilometers!). Another significant difference is that while the Antarctic ice cap sits firmly on land, Arctic ice is subject to the warming influence of the ocean water upon which it floats. Lastly, the Arctic ice is at sea level, whereas the Antarctic ice cap rests in colder air at high elevation.

It would seem logical then that Antarctic ice would not be melting as quickly as Arctic ice. Overall, this trend appears to be born out by scientific studies demonstrating that there have been relatively minor changes in ice thickness and temperature overlying the central Antarctic. There are however areas of the Antarctic that appear more sensitive to global warming, notably the Antarctic Peninsula and the floating ice shelves.

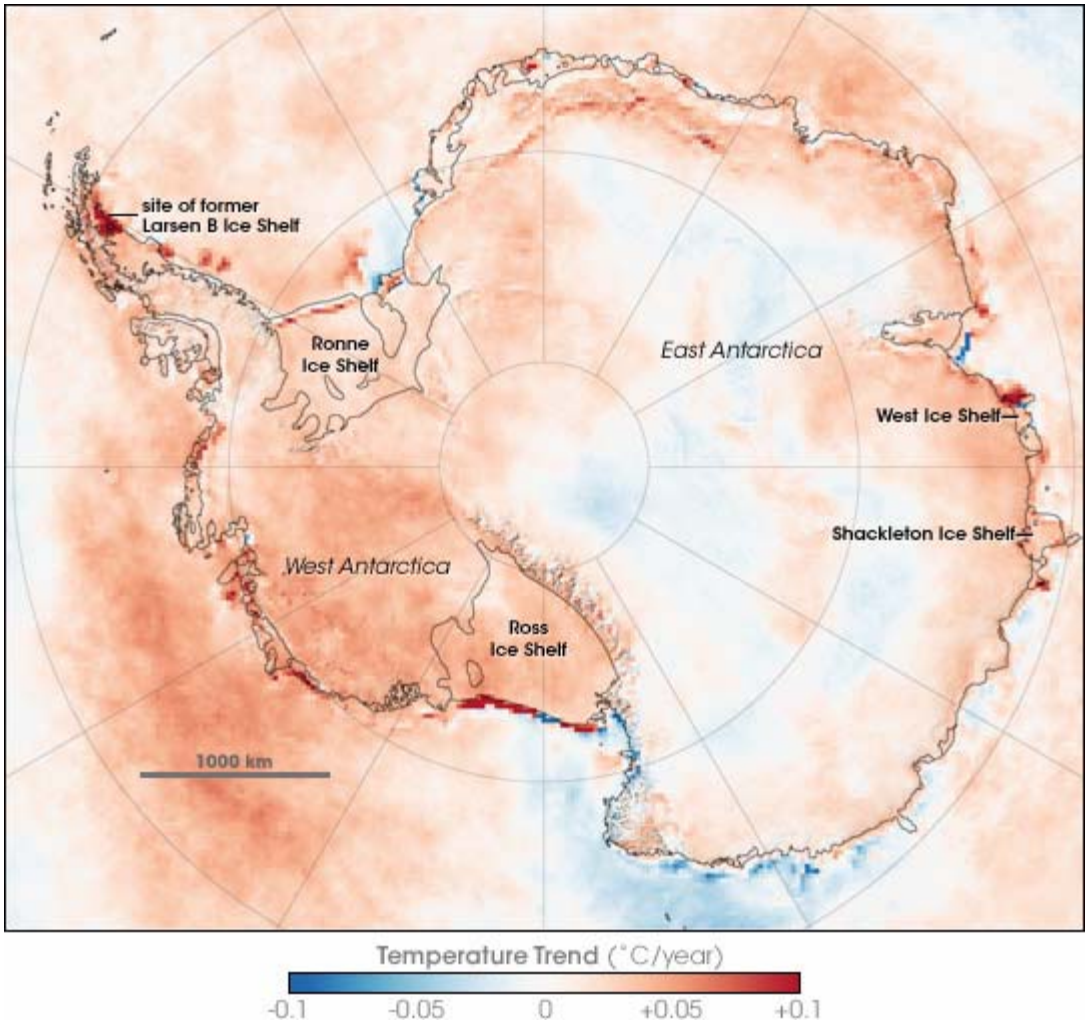


Figure 3: Map showing Antarctic surface temperature trends between 1981 and 2007. Across most of the Antarctic the temperature increased, in some areas warming approaching 2 degrees Celsius during the period. The most dramatic changes are the red areas associated with iceberg calving and the collapse of the Larsen B ice shelf. In these cases, satellites saw a change from cold ice to relatively warm open water. (Source: NASA).

The rise in average temperature in the Antarctic Peninsula has likely contributed to the collapse of ice shelves like the Larsen B shelf in 2002. The loss of ice shelves will only serve to accelerate global warming through a positive feedback loop governed by the reflection of solar energy. Albedo is an index of the ability of a surface or material to reflect the suns radiation. Snow has one of the highest albedos, and in Antarctica the snow on average reflects about 80% of all solar radiation. In other words only about 20% of the warmth the sun offers is retained in Antarctica.

Water on the other hand has a particularly low albedo, particularly wavy water like one tends to find on the ocean. What this means is that when a snow covered ice shelf collapses into the ocean, much of the solar radiation that was being reflected away from the earth by the snow is now absorbed into the ocean, causing it to warm up. Overall this means that the earth is now absorbing or retaining more heat. The warmer the ocean becomes from this retained heat the faster further ice shelves are melted, which in turn further accelerates the warming of the ocean. This is the principle of positive feedback.

The ice shelves of Antarctica including the Ronne (from which Ray, Richard and Kevin are setting out) and the Ross (from which Amundsen and Scott set out) are thought to have an important cooling effect on the oceans of the world. These vast floating seas of ice are thought to cool the water as it flows below them causing a current of dense cold water that flows to the bottom of the ocean. These currents form part of the global thermohaline circulation that cycles frigid dense deep water northward, and warmer surface waters to places like the east coast of the United States and Northern Europe ensuring more temperate climates in these locations. In this manner the Ice Shelves are thought to help regulate global temperature.

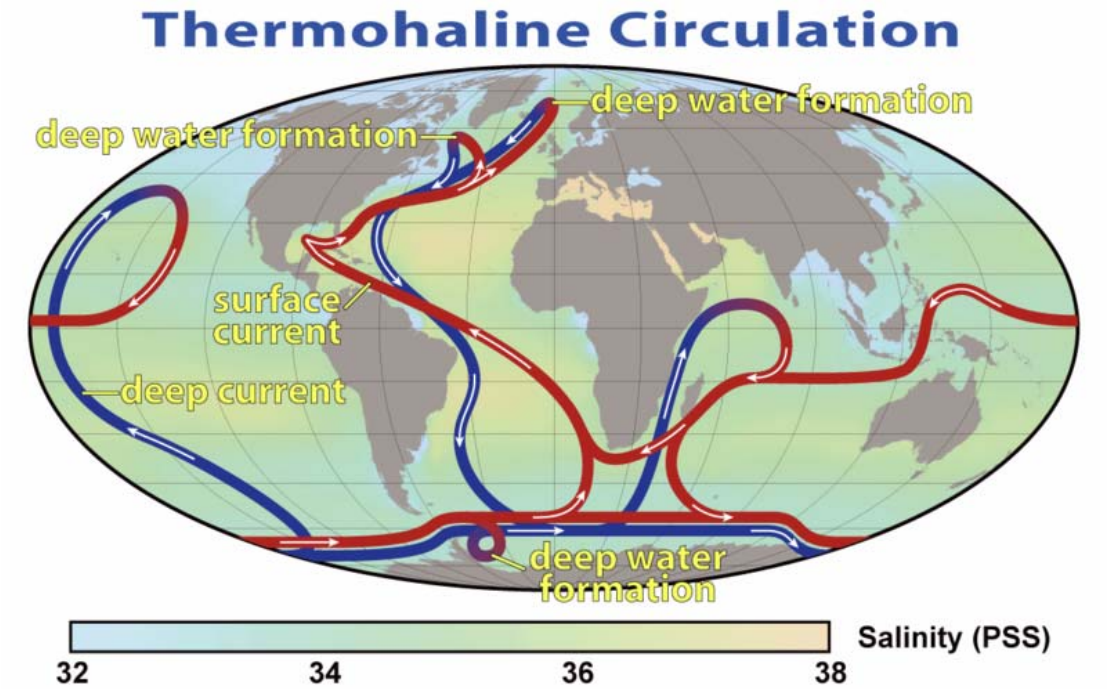


Figure 4: Map showing the pattern of thermohaline circulation that carries the cold dense waters of the Antarctic around the globe. The deep water formation indicated off the coast of Antarctic represents the cooling effects of the ice shelves. (Source: Robert Simmon, NASA.)

The Ross and the Ronne Ice Shelves, which cover about 1 million square kilometers of ocean, are legitimately felt to be the most vulnerable element of the Antarctic ice sheet. Some scientists are suggesting that as global temperatures increase and ocean waters warm, the massive ice shelves of the Antarctic will be steadily eroded in a manner similar to the collapse of the Larsen B ice shelf in 2003. Loss of these ice shelves will cause water levels to rise, increase the oceans absorption of solar radiation (heat) and promote the melting of the Antarctic Ice Cap. Since the ice shelves are thought to have a significant effect on circulating ocean currents (thermohaline circulation) their disappearance could have a significant impact on global climate.

Antarctica is the proverbial 'icehouse of the world', exporting cold dense air and water to other parts of the globe. There is little doubt that the loss of the Antarctic Ice Cap would have a profound effect on global climate. Although satellite studies reveal that the coastal glaciers of

Did You Know?

The thickest ice in the world is found in Wilkes Land, Antarctica, where it reaches a depth of 15,669 feet (4,776 meters).

the Antarctic Peninsula are melting into the sea at an accelerating rate, the Antarctic Ice cap seems to have been relatively stable since data began to be collected. Some scientists even suggest that the Ice Cap may grow with global warming, for warmer temperatures may bring greater snowfall to the continent. Even if the average temperature over the ice cap rises a few degrees it will still be well below freezing and the ice cap will slowly increase in depth with the added snow.

Irrespective of the course of climactic history that Antarctica will chart, it now seems irrefutable that human activity is causing precipitous change to the earth's climate. Collectively there must be a will to get our house in order before it is ruined, for there seems to be little option for relocation.