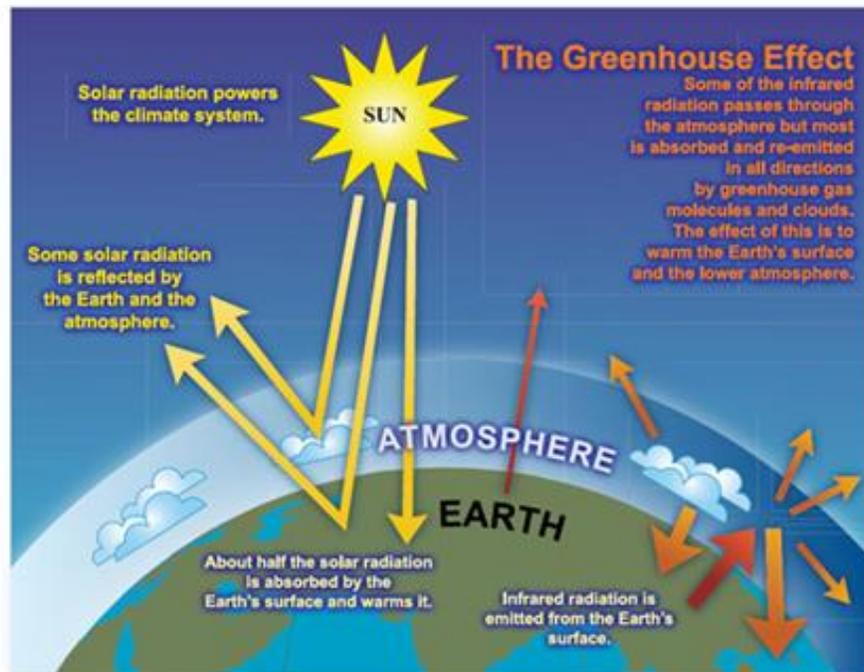


2. Global Observations of Climate Change Impacts to Date

Kirsten Zickfeld is a prominent climate scientist in the Geography Department at Simon Fraser University in British Columbia. She explained in her testimony before the Citizens' Hearings that greenhouse gases in our atmosphere are selective absorbers. They let incoming light pass through Earth's atmosphere, but they absorb radiant heat energy being reflected back from Earth, preventing some of it from leaving our atmosphere. They therefore play a crucial role in warming our planet's surface temperatures, making them suitable for a great diversity of life on Earth.

The Greenhouse Effect



1/17/2014

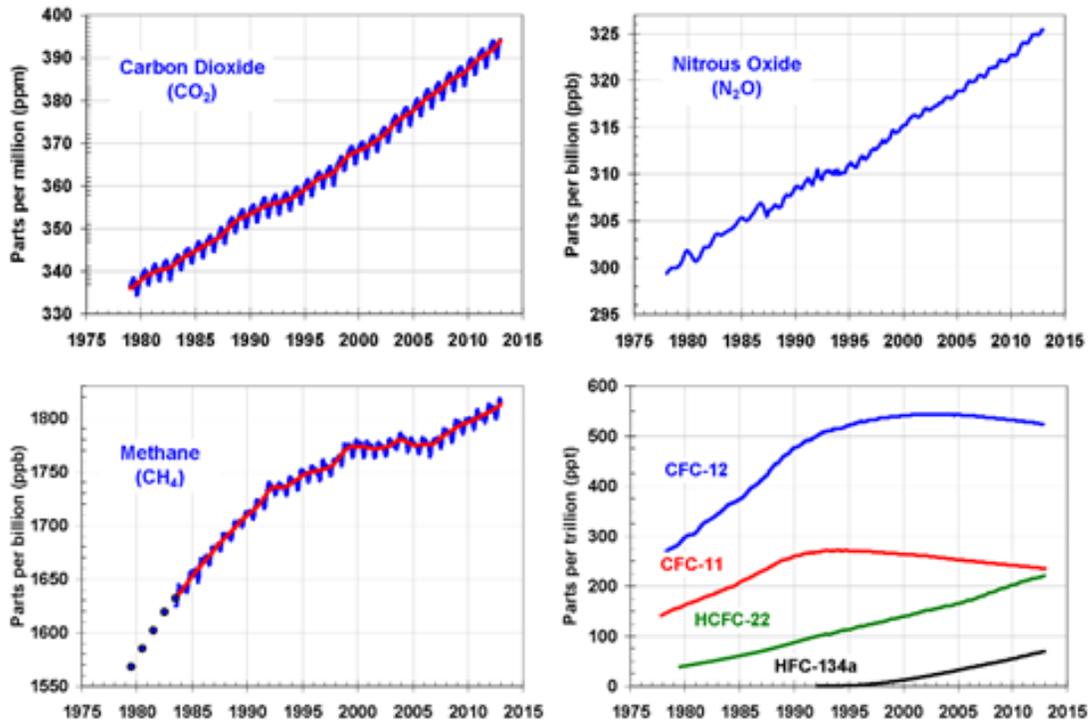
Climate Hearings, Nov. 2 2013

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SLIDE PRESENTED AT THE HEARINGS BY DR. KIRSTEN ZICKFELD

However, **the recent addition of large amounts of manmade greenhouse gases to the natural greenhouse gases already present in the atmosphere is creating an imbalance in the Earth's climate system.** Atmospheric carbon dioxide levels, for instance, have risen from 280 parts per million (ppm) in 1750 to 325ppm in 1970 and then to 396ppm by 2013, largely because of fossil fuel burning and deforestation. Clearly, most of the increase has occurred over the past 40 years. The levels of other crucial greenhouse gases like methane and nitrous oxide have also gone up significantly. The Intergovernmental Panel on Climate Change reports that **greenhouse gas concentrations are now higher than they have been at any time over the past 800,000 years.** The inevitable result is that the average global surface temperature of the Earth is rising.

Carbon dioxide, nitrous oxide and methane continued to rise in 2013 due to manmade emissions.

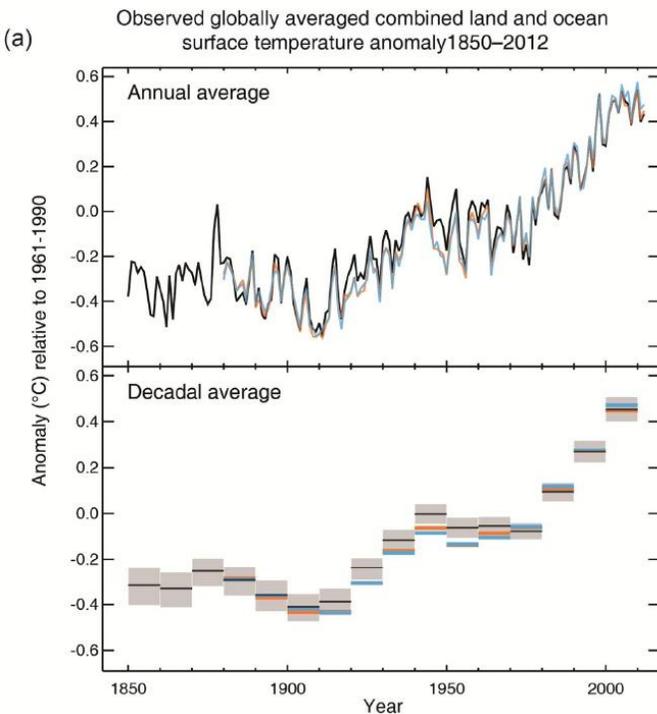


Source: Global Average Abundance of Long Lived Greenhouse Gases Figure 2, The NOAA Annual Greenhouse Gas Index 2013, National Oceanic and Atmospheric Administration Earth System Laboratory, Summer of 2013.

SLIDE PRESENTED AT THE HEARINGS BY PETER PREBBLE

Kirsten Zickfeld stressed that there are natural fluctuations in the Earth's surface temperatures from year to year, and that changes of significance in average global temperature can only be properly assessed over a decade or more. If one compares average global temperature over the period 1850 to 1900 with average global temperature over the period 2003 to 2012, the average surface temperature of the Earth has risen by 0.78 degrees Centigrade. The bulk of that temperature increase has occurred in the last three decades. **The United Nations Intergovernmental Panel on Climate Change (IPCC) has concluded that it is extremely likely (95% confidence) that human influence has been the dominant cause of the observed warming since the mid-20th century.**

Observed Changes in Temperature



- Global mean temperature increased by 0.78°C from 1850-1900 to 2003-2012
- Each of the last three decades has been successively warmer than any preceding decade since 1850

IPCC (2013)

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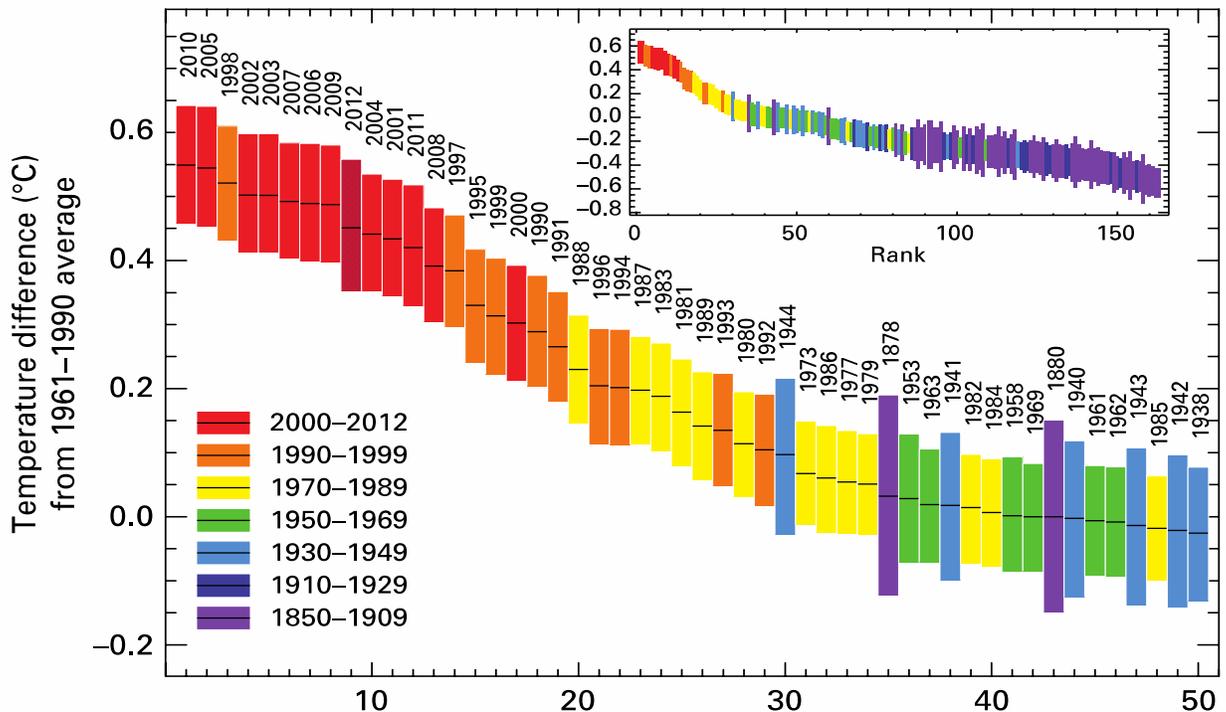
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SLIDE PRESENTED AT THE HEARINGS BY DR. KIRSTEN ZICKFELD

Elaine Wheaton, Adjunct Professor at the University of Saskatchewan provided additional clarity on the significance of the warming trend at a global level by pointing out that despite natural variation, global average temperatures have been consistently above the 20th century average temperature for every one of the past 27 years.

A similar perspective was provided by David Sauchyn, head of the Prairie Adaptation Research Collaborative at the University of Regina. Sauchyn noted that **July 2013 was the 341st consecutive month with a global temperature above the 20th century average.**

Hottest to Coldest Years- Global temperatures were above average for 27 consecutive years (WMO 2013)



SLIDE PRESENTED AT THE HEARINGS BY DR. ELAINE WHEATON

The increase in average global temperature has not been uniform across the globe. The warming influence has been more significant in high northern latitudes. This helps explain why Arctic summer sea ice cover is shrinking and why Greenland is melting. Kirsten Zickfeld noted that, in general, **the cryosphere is responding very sensitively to the warming that has already occurred.**

Peter Prebble, Director of Environmental Policy with the Saskatchewan Environmental Society, provided the Hearings with more information about the scale of this response. Citing the latest data published by IPCC he noted that the Greenland ice sheet lost an average of approximately 215 billion tonnes of ice each year between 2002 and 2011, while the world's mountain glaciers lost approximately 275 billion tonnes of ice annually between 1993 and 2009. Meanwhile, the Antarctic ice sheet is estimated to be losing 147 billion tonnes of ice per year. As this ice melts, enormous volumes of water enter the world's oceans, causing a world-wide increase in sea levels.

Melting of ice sheets and mountain glaciers is not the only cause of sea level rise. A second important cause is thermal expansion. As oceans waters become warmer, the molecules of seawater expand slightly, and this also pushes up sea levels.

The combined effect of these forces is an acceleration in the pace at which our oceans are rising. IPCC (2013) reports that the average annual rate of sea level rise between 1901 and 2010 was 1.7 millimetres. However, **from 1993 to 2010, global sea level rise averaged 3.2 millimetres per year.** That trend has worrisome consequences for many coastal communities and island nations in the decades ahead, giving them less time to adapt, and making them increasingly vulnerable to storm surges, salt water intrusion, and loss of some inhabited coastal areas completely.

Peter Prebble drew attention to the increase in extreme weather being experienced around the globe as a result of climate change. For example, as the atmosphere warms, it has an increased capacity to hold more water vapour, and that has led to heavier precipitation events and more serious flooding. United Nations data indicates the number of climate related disasters caused by flooding has tripled since 1980. A second example of extreme weather is the trend toward more hot weather extremes, which in turn increases the risk of drought and forest fires. In 2010, for instance, 18 countries broke national records for their hottest day to date. More recently, **in 2012 the United States faced its warmest year in 118 years of record keeping. That brought with it extended drought that covered more than half the nation. In 2013 Australia set a new continent-wide temperature high, and experienced its hottest summer on record.** Amidst intense heat and widespread bush fires, some Australian states were forced to institute a new category to warn the public of fire risk that goes beyond extreme: ‘catastrophic’.

Michael Swandt provided the Hearings with important information on the health impacts of climate change. He drew attention to **World Health Organization estimates that climate change now causes over 150,000 additional deaths each year worldwide.** A very wide variety of other negative health impacts result from climate change. Prominent among them are temperature-related effects such as fainting, heat stroke and worsening of existing heart and lung disease. Elevated temperatures can also bring with them changes to air quality, including the increased conversion of nitrogen oxides to ground-level ozone. This leads to inflammation of airways, exacerbation of asthma, and chronic obstructive pulmonary disease. Also of concern as temperatures rise is the spread of infectious diseases such as West Nile Virus, Lyme disease and malaria. These infectious diseases increase and spread because climate change causes longer transmission seasons, and alters the geographical and seasonal distribution of the relevant carrier insects.

Michael Swandt emphasized that people are also experiencing health impacts because climate change increases the intensity of extreme events such as hurricanes and flash floods. In these circumstances, health impacts include drowning, lacerations, fractures and head injuries, as well as delayed effects such as waterborne illness and increased mental health stress.

Some of the most significant long term health effects of climate change are likely to stem from its impact on sea levels and on agriculture. In countries like Bangladesh, sea level rise is already causing salination of freshwater aquifers and forcing people to relocate their homes – with serious health consequences. Michael noted that in countries where climate change causes decreased accessibility to nutritious food, due to severe drought or severe flooding, health impacts can range from malnutrition and micronutrient deficiencies to heightened vulnerability among women and children.

Toddi Steelman, Executive Director of the School of Environment and Sustainability at the University of Saskatchewan drew attention to the important issue of social vulnerability from climate change. She emphasized that **the elderly, the young, the infirm and the poor are particularly vulnerable,** as are communities in downstream areas that are subject to impacts such as more intense flood events.