

# Ozone Depletion Appears to Play the Dominant Role in Global Warming Throughout Earth History

Peter L. Ward

US Geological Survey retired  
Science Is Never Settled  
Jackson, Wyoming

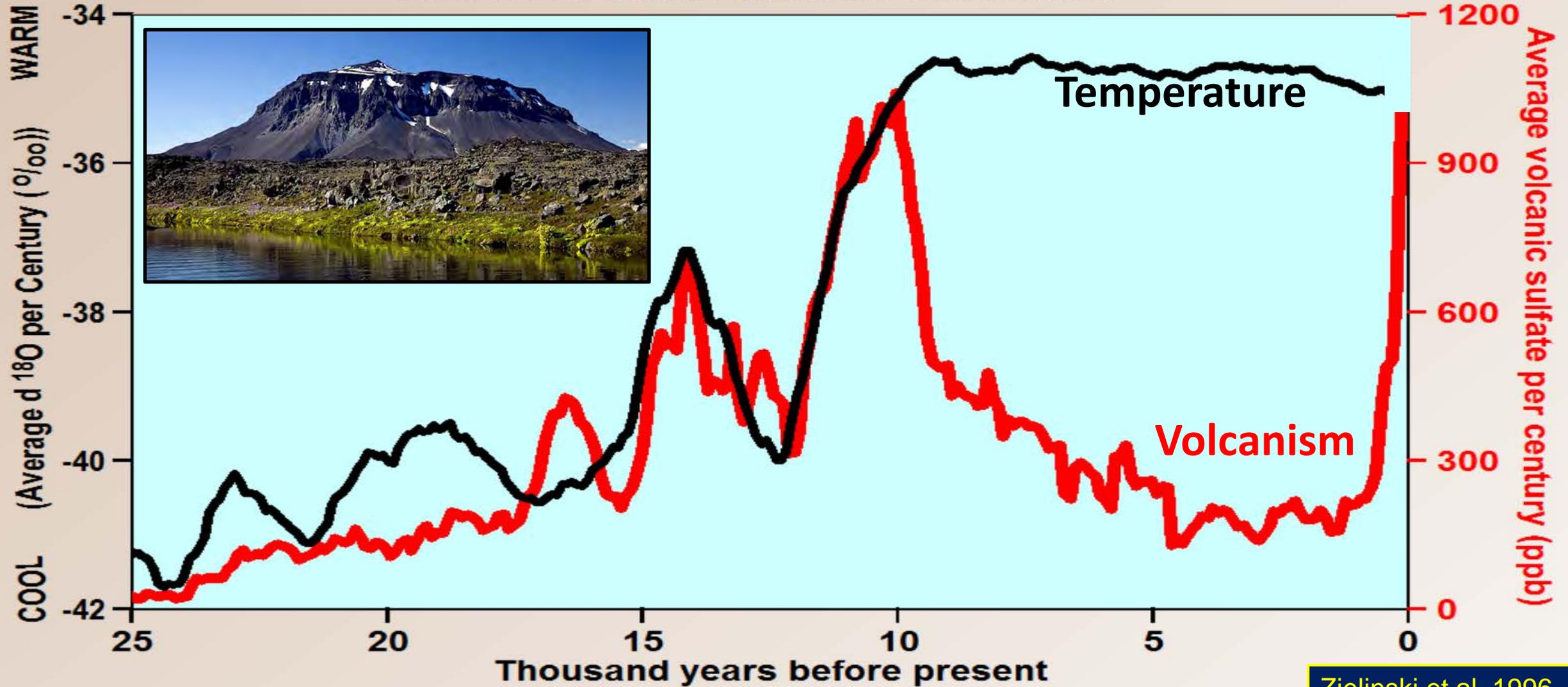


4<sup>th</sup> Santa Fe Conference on  
Global & Regional Climate Change  
February 9, 2017

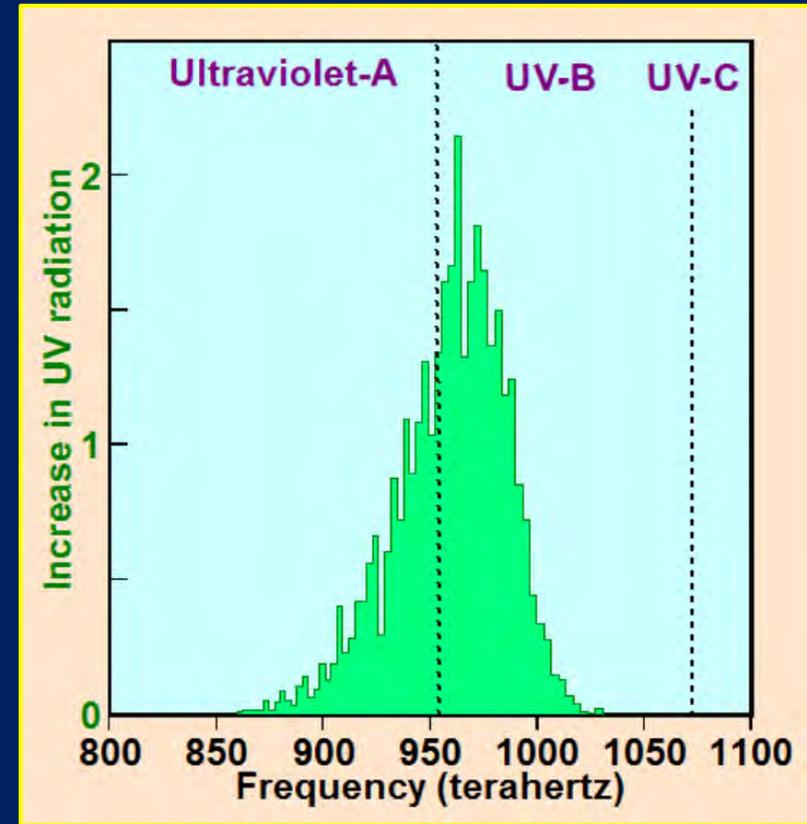
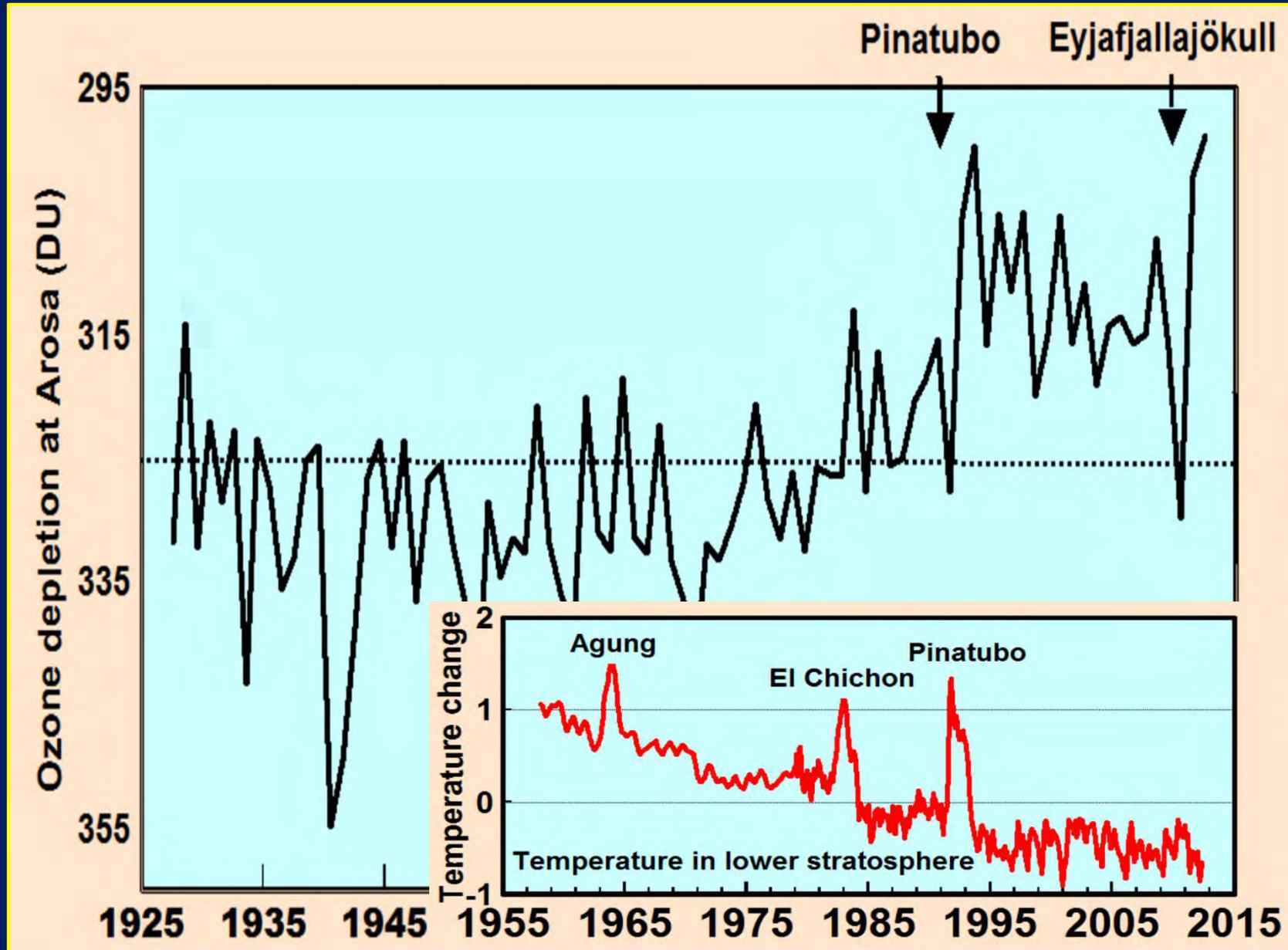


# The Greatest Amount of Volcanism Recorded in Greenland Ice Occurred Precisely at the End of the Last Ice Age

GISP2 Borehole Summit Greenland



# Volcanism Is Well Observed to Deplete the Ozone Layer



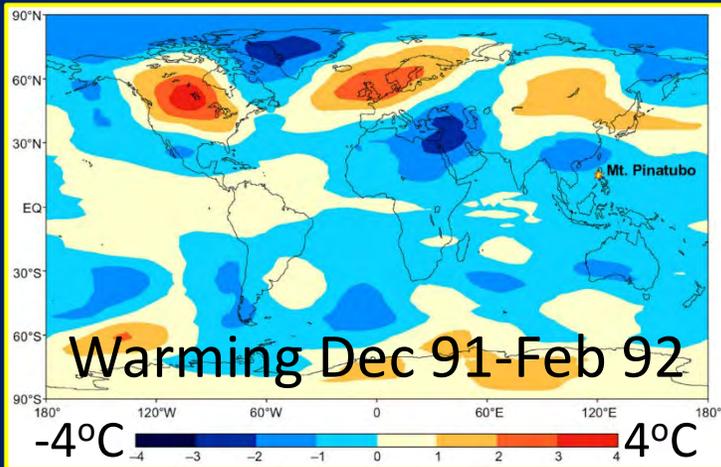
Madronich 1993

Measured arriving at Earth's surface where it is absorbed most efficiently by ground-level ozone pollution and by the oceans

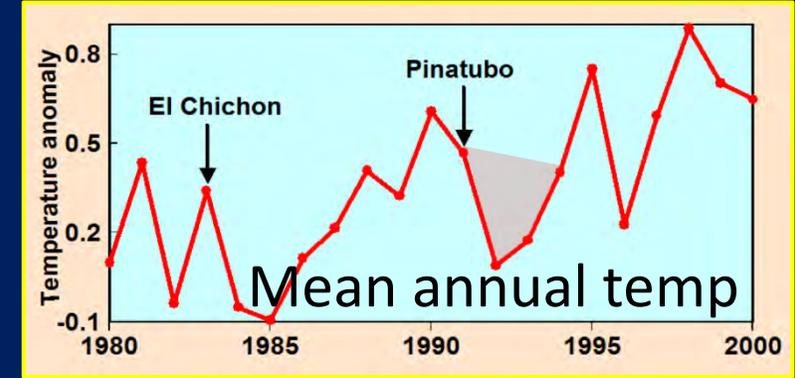
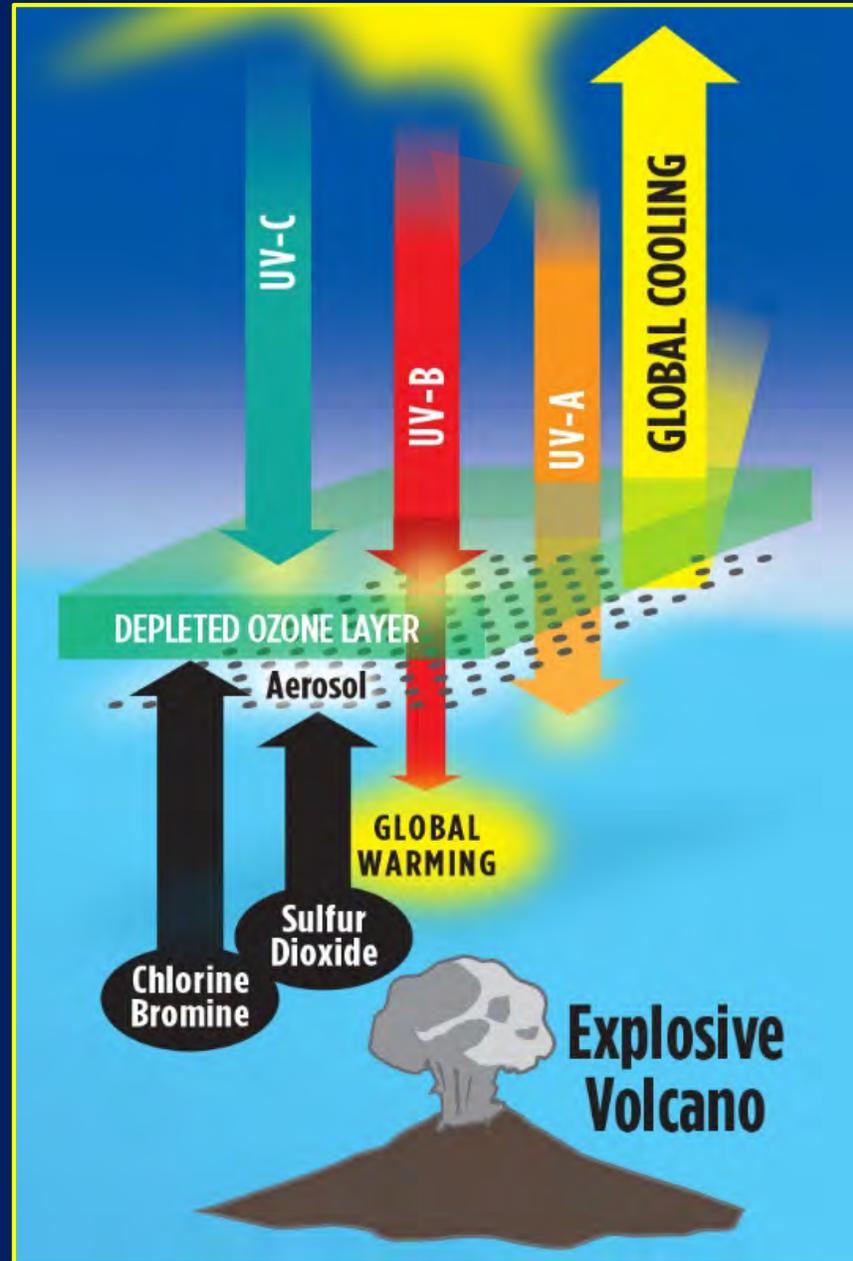
# Explosive Volcanoes Cause Net Global Cooling by Forming Aerosols



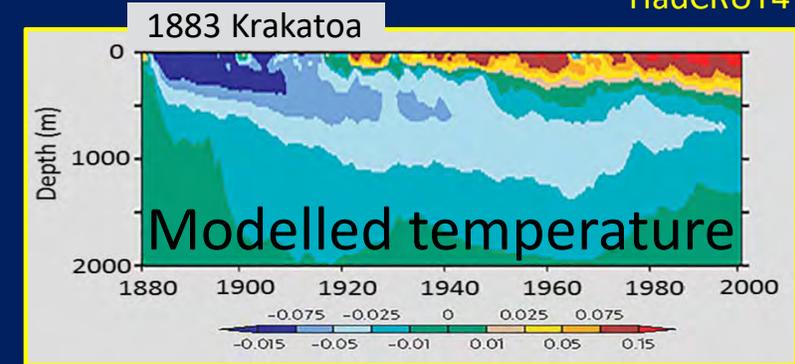
USGS



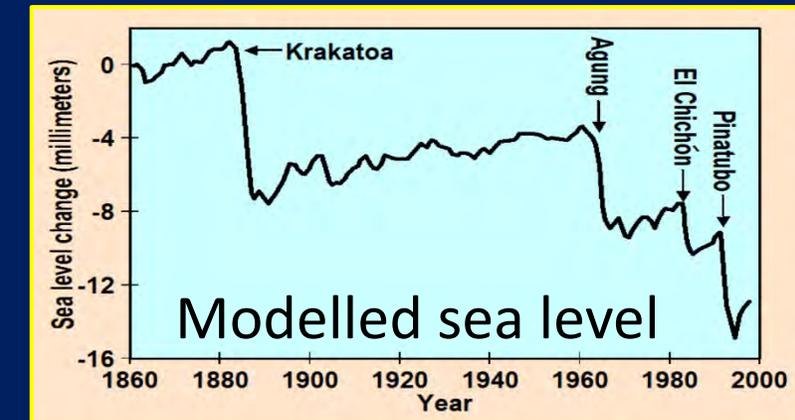
Robock 2002



HadCRUT4



Gleckler et al. 2006



Gregory et al. 2006

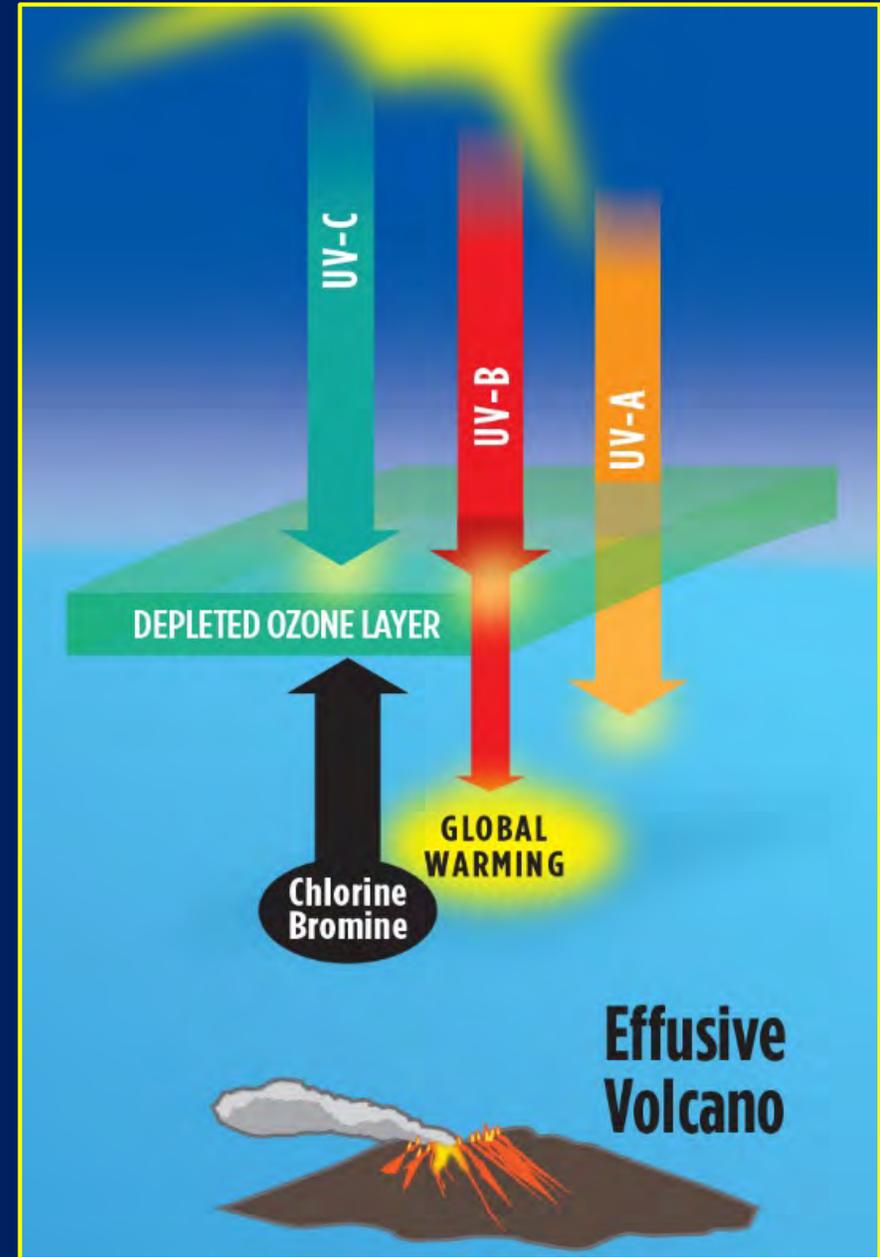
# Effusive Basaltic Volcanoes, On the Other Hand, Cause Net Global Warming

Bárðarbunga (Aug 2014 to Feb 2015) in central Iceland

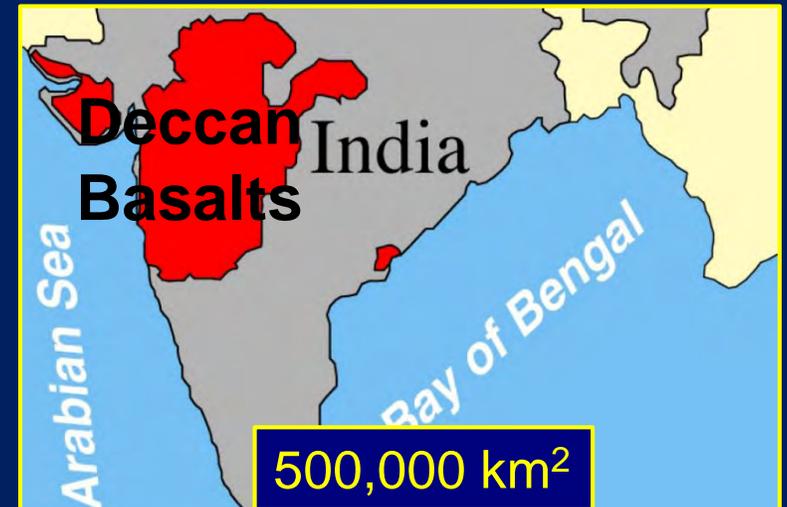
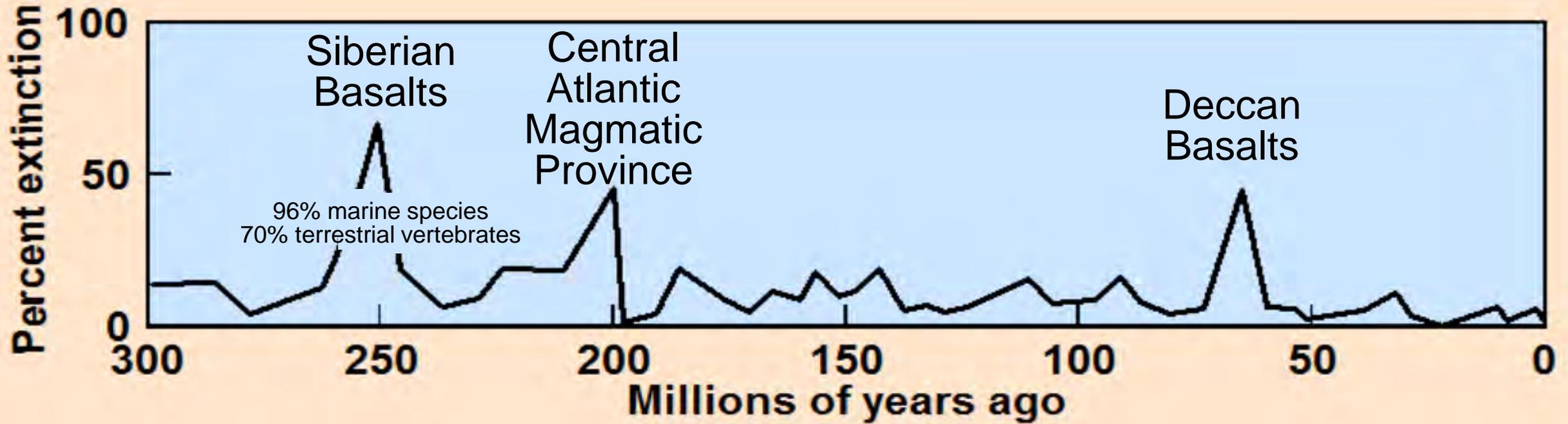


© Arctic-Images/Corbis

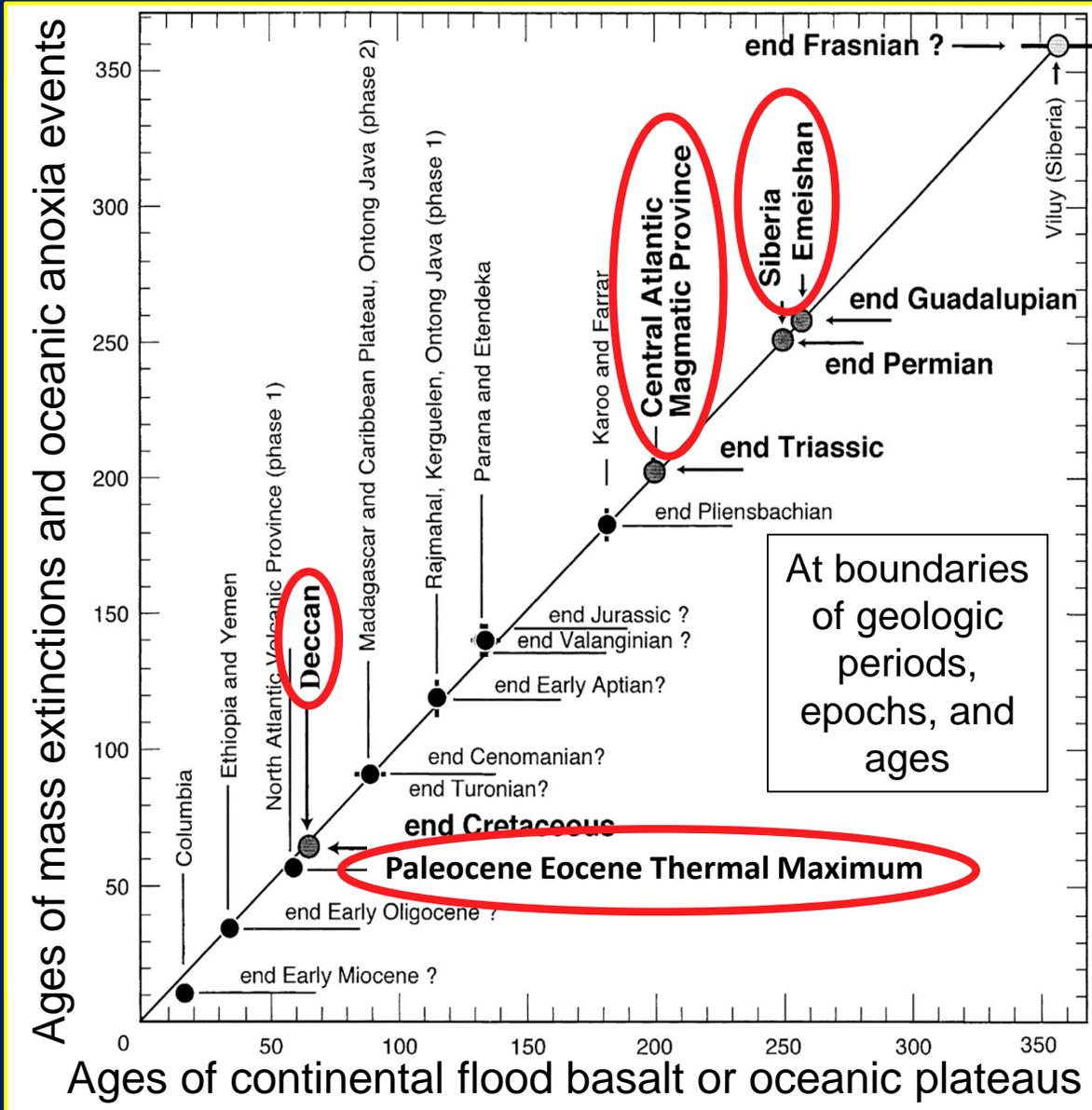
Bárðarbunga (2014) 84 km<sup>2</sup> 2015-2016 hottest years  
Laki (1783) 565 km<sup>2</sup> Warm phase of Little Ice Age  
Eldgja (935) 800 km<sup>2</sup> Medieval warm period  
Craters of the Moon (200 BC) 700 km<sup>2</sup> Roman warm period



# The Largest Flood Basalts Caused the Largest Mass Extinctions



# Extinctions Versus Flood Basalts

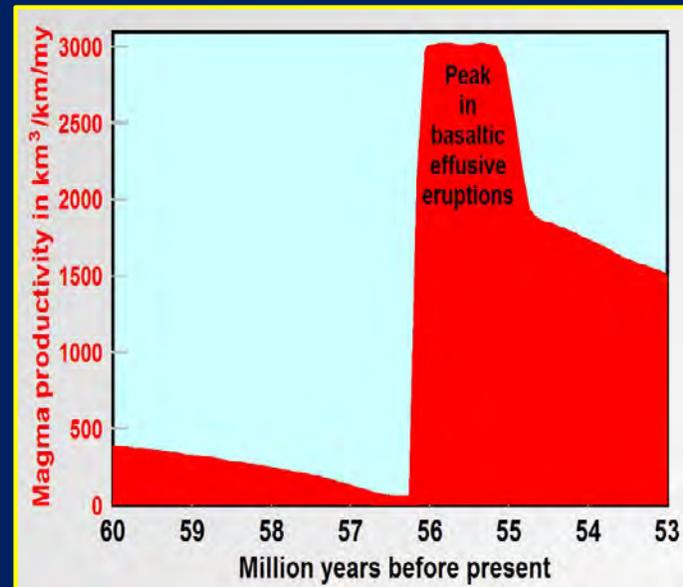


Courtillot and Renne 2003

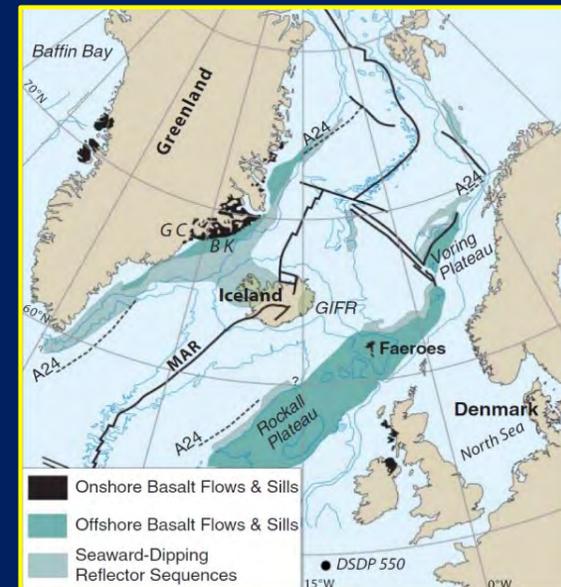
# Paleocene Eocene Thermal Maximum

Extrusion of basaltic magma reached a peak 56 million years ago during the opening of the Greenland-Norwegian Sea

Sea surface temperatures rose 6°C

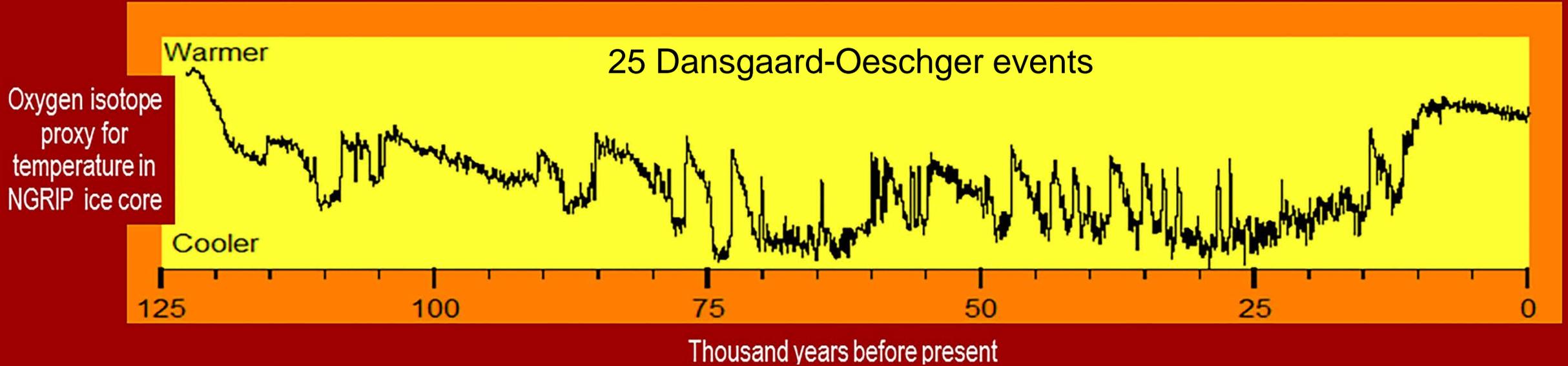


Storey et al. 2007



# The Footprints of Climate Change

Sudden warming followed by much slower cooling in erratic sequences averaging 5000 years



Timing is erratic, not cyclic



Large effusive basalt flows cause sudden warming

Bárðarbunga 2014

© Arctic-Images/Corbis



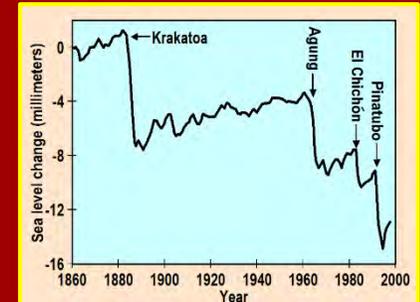
Peter Hartree



USGS

Large explosive volcanic eruptions cause slower cumulative cooling

Pinatubo 1991



Gregory et al., 2006

# 5000 Year Sequences in the Green River Formation, Southwestern Wyoming

**Around 50 Ma**

Temperate Climate

**Mud Lake  
Florida  
Oil shale**

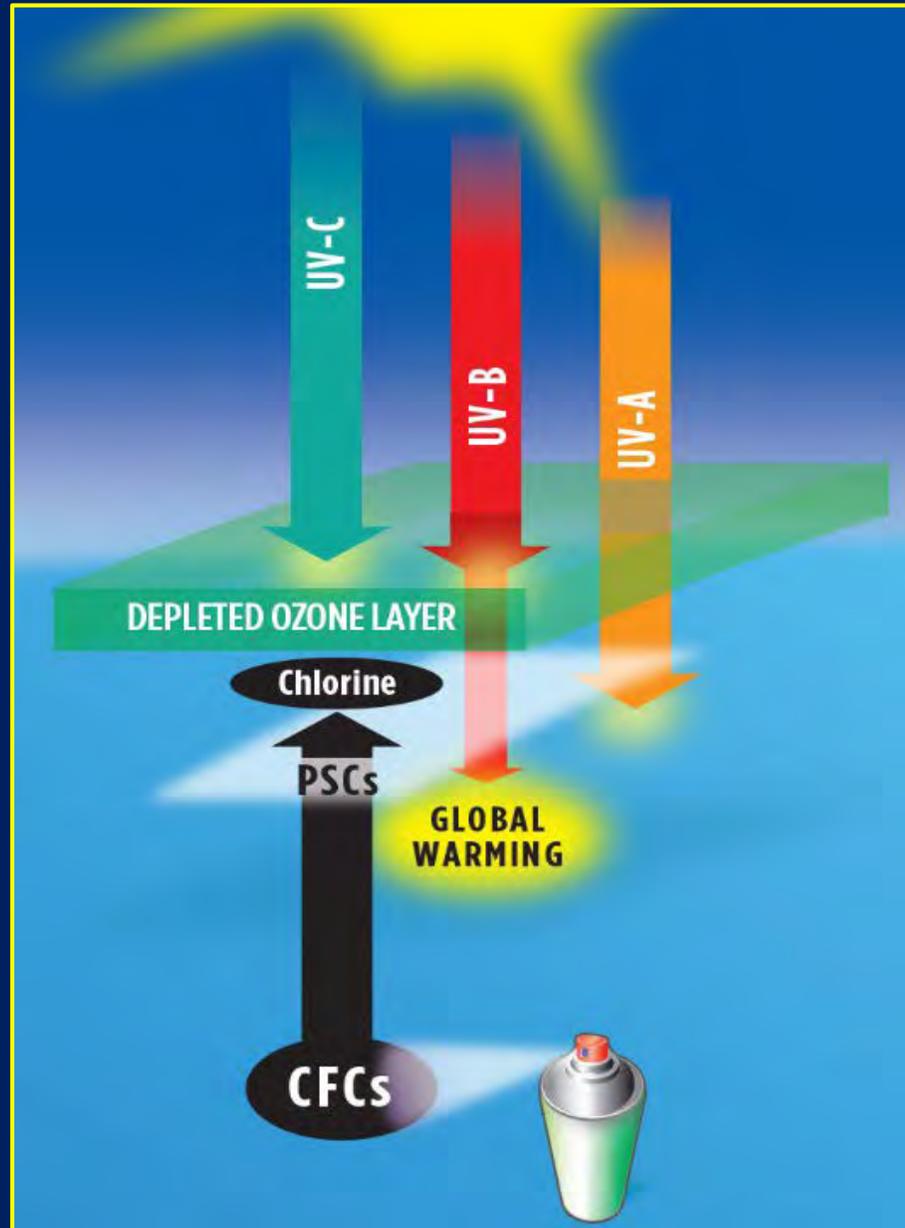
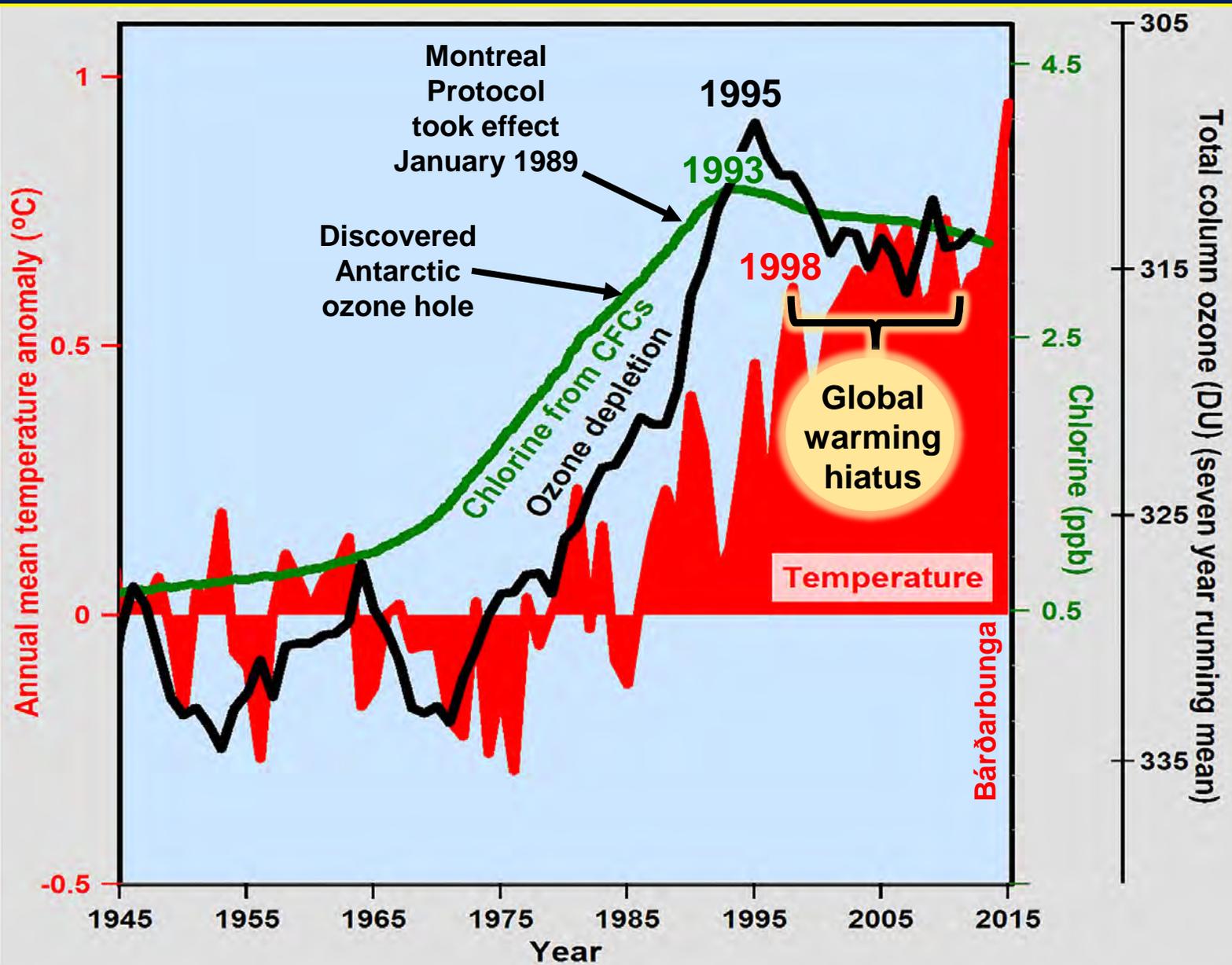
Very Hot Climate

Trona

**Lake Magadi,  
Kenya  
Trona**

**oil shale  
trona  
dolostone**

# Ozone Is Also Depleted by Chlorofluorocarbon Gases (CFCs)



# Primary Conclusions

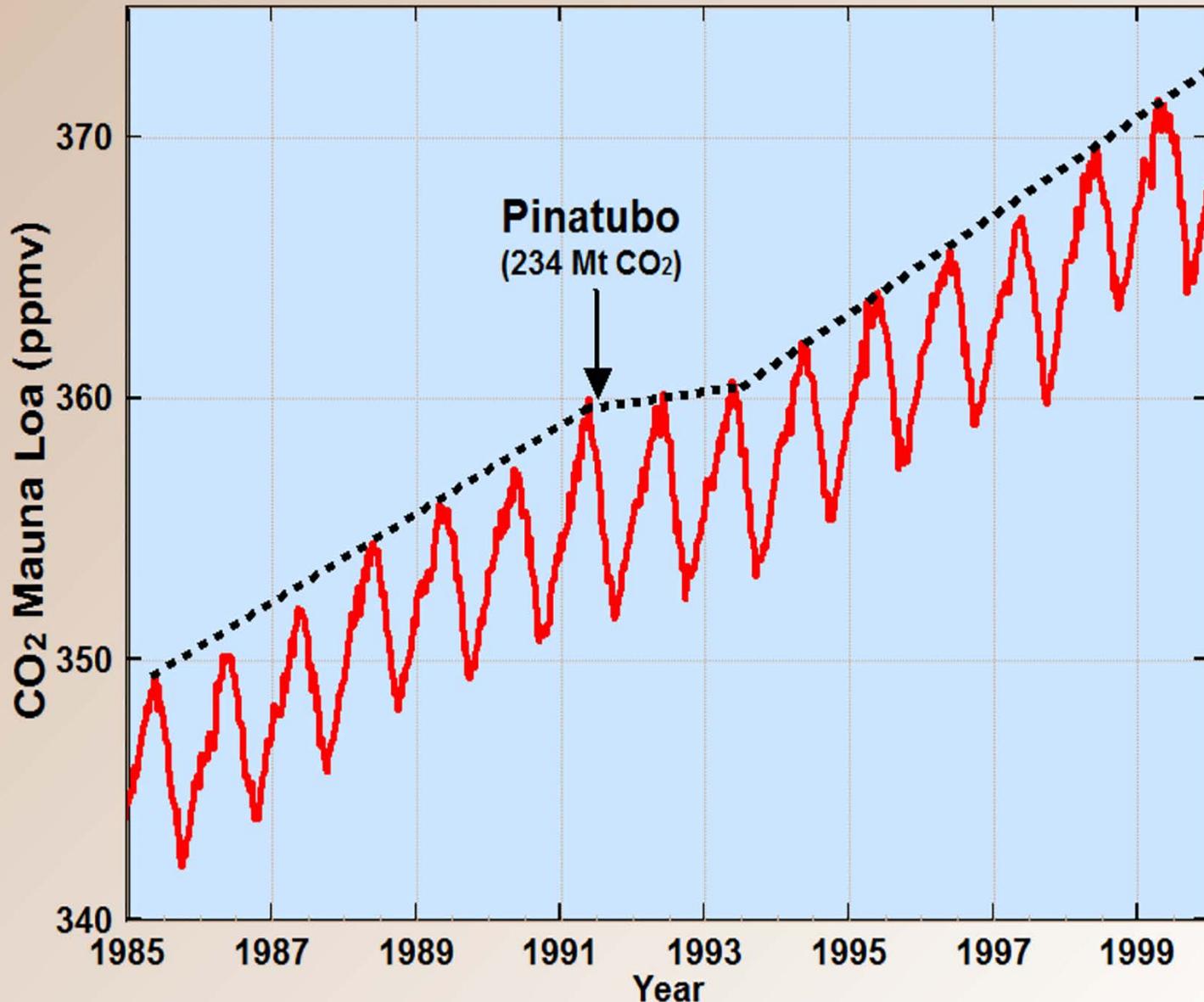


Aerosols, formed by explosive volcanism provide a clear explanation for slow, incremental global cooling observed throughout Earth history



Ozone depletion, caused by effusive basaltic volcanism or by CFC gases provides a clear explanation for each of the numerous periods of sudden global warming observed throughout Earth history

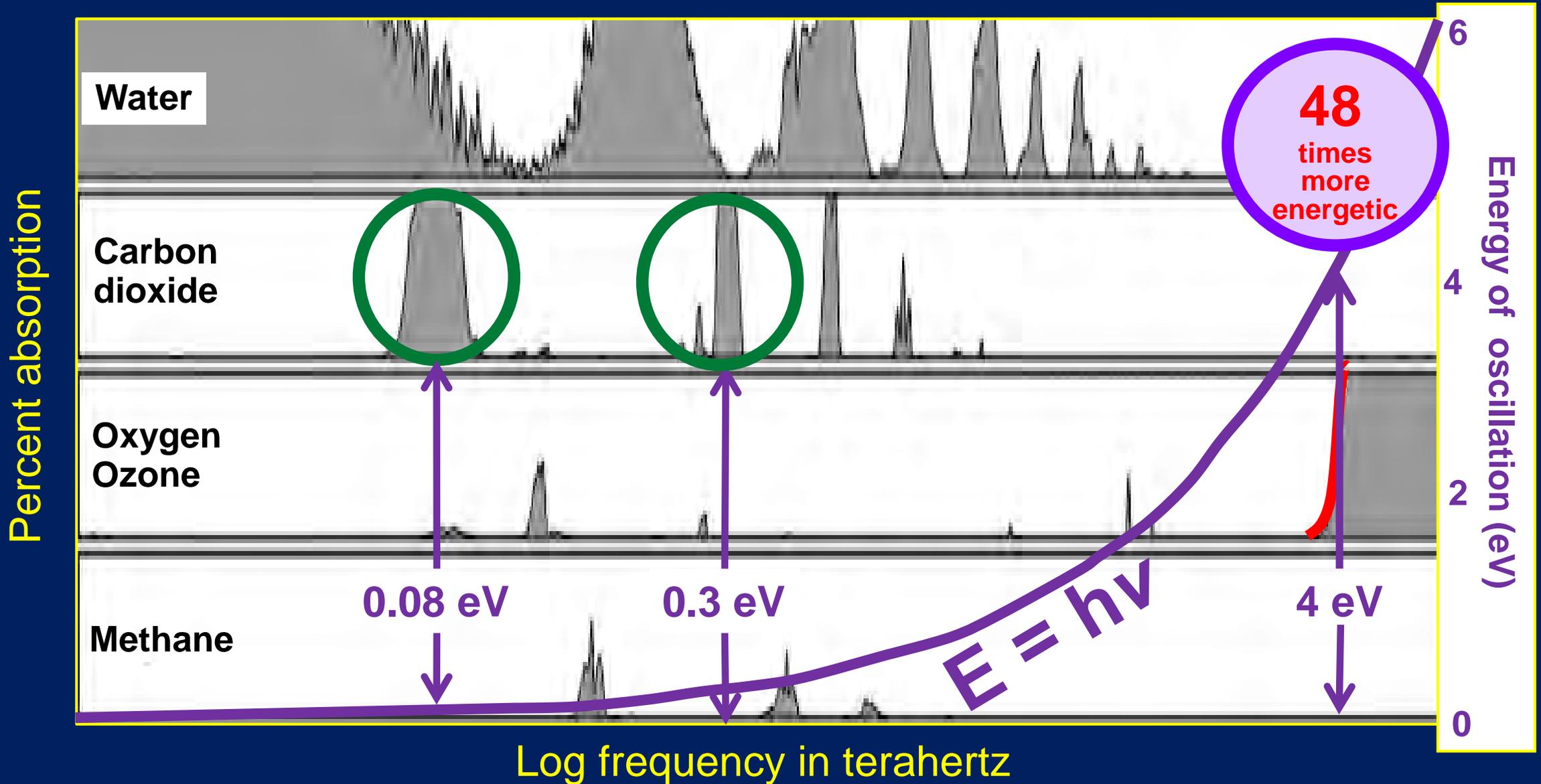
# What About Greenhouse Gases?



Throughout geologic time, before humans, can we explain the concentration of CO<sub>2</sub> in the atmosphere simply as a proxy for ocean surface temperature based on the known solubility of CO<sub>2</sub> in water?

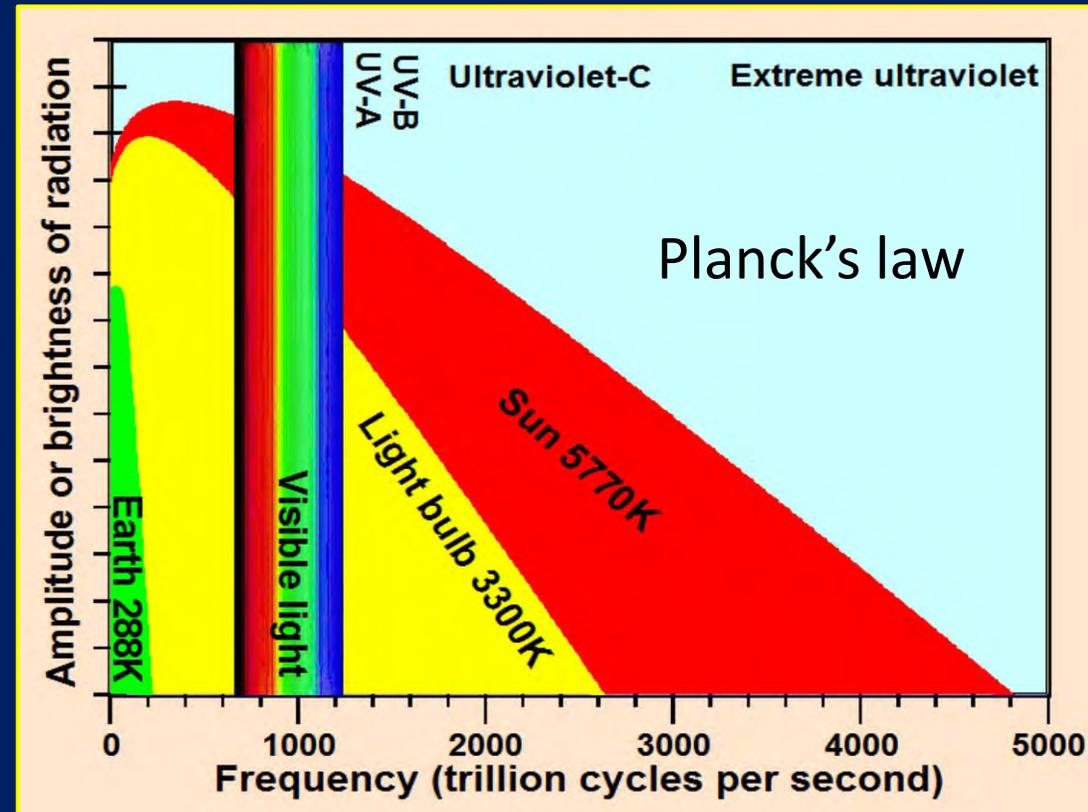
Well, Peter, that's a nice story, but we all know for sure that there are not enough photons of UV radiation reaching Earth to cause the observed warming!!

# The UV Energy Reaching Earth When Ozone is Depleted Is 48 Times More Energetic than the IR Energy Absorbed by CO<sub>2</sub>



# Thermal Energy in Matter Consists of Oscillations of All The Degrees of Freedom, of All the Bonds That Hold Matter Together

1. The more degrees of freedom, the higher the heat capacity of the matter
2. When matter is heated, the amplitudes of oscillation increase for every frequency of oscillation, especially at high frequencies
3. These oscillations on the surface of matter induce electromagnetic radiation where the amplitudes of oscillation at each frequency of oscillation, as a function of temperature, are described by Planck's law
4. Hotter bodies radiate higher frequencies
5. The higher the frequency, the hotter the absorbing body will become



For thermal energy:

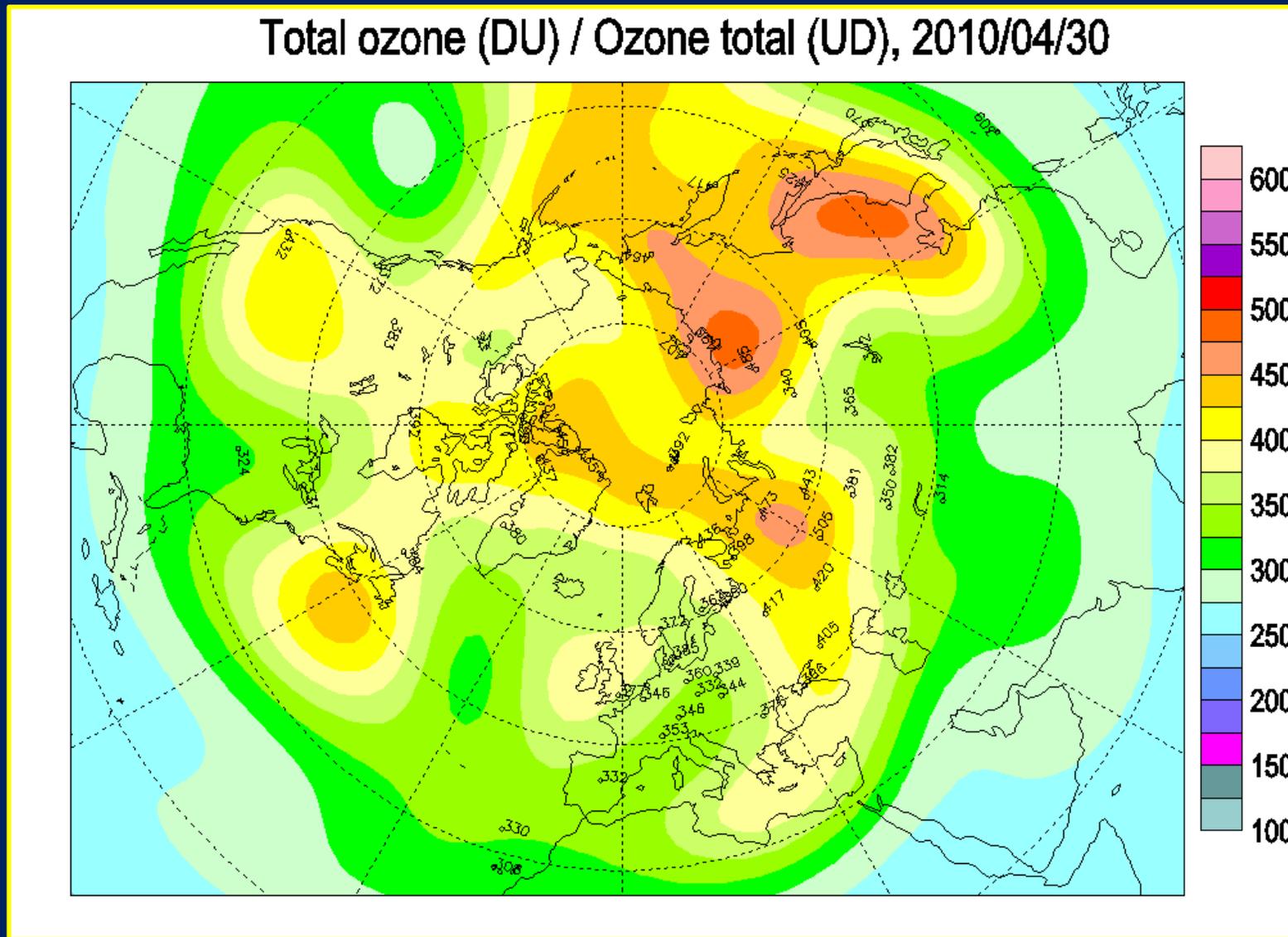
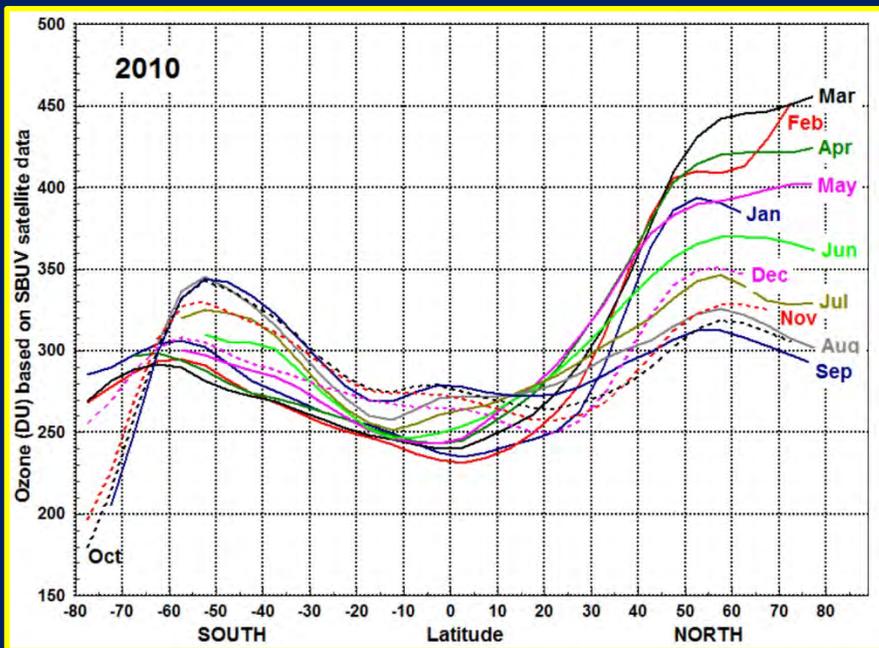
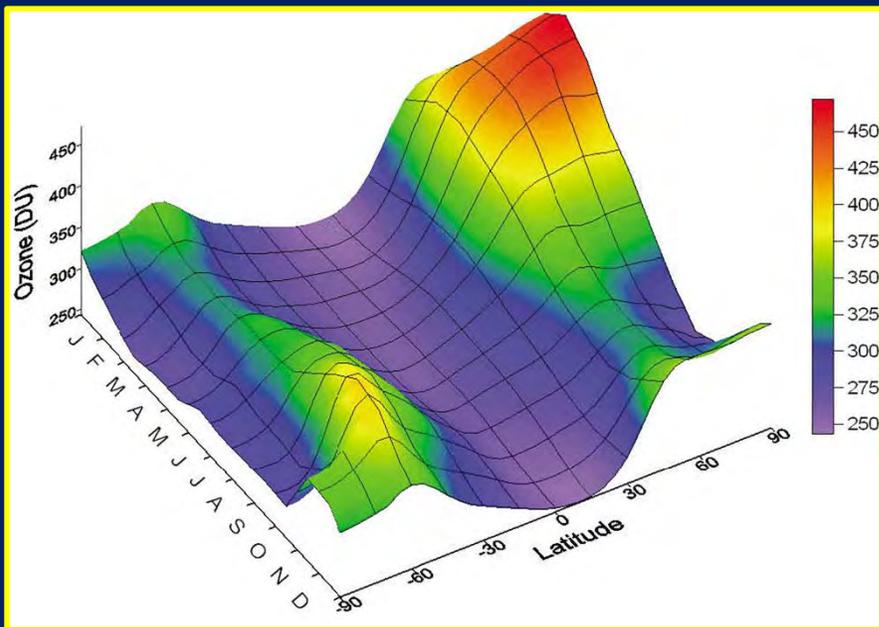
Frequency content determines temperature

Intensity and amount determine rate of heating

Ultraviolet-B raises the temperature of your skin high enough to be burned

All the infrared in the universe cannot burn your skin





# Thinking in terms of ozone offers explanations of:

Polar amplification

Why warming greatest in the northern hemisphere

Possibilities for teleconnections

Observed changes in circulation in southern oceans

Why and how ocean heat content is rising

Ways of driving ENSO and other oscillations

Direct link between weather and climate (Dobson)

FOREWORD BY DAVID BENNETT LAING  
Assistant Professor of Geology, Retired, University of Maine  
Author, *The Earth System: An Introduction to Earth Science*

# WHAT REALLY CAUSES GLOBAL WARMING?

Greenhouse Gases or  
Ozone Depletion?

PETER LANGDON WARD, PHD

Free copies of my book, papers,  
pamphlets, and bumper stickers  
are available at this meeting.

# Volcanoes Rule

WhyClimateChanges.com

# Science Is Never “Settled”

WhyClimateChanges.com

[peward@wyoming.com](mailto:peward@wyoming.com)

## **The dominant role of ozone depletion in global warming throughout Earth history**

**Peter L. Ward, US Geological Survey retired**

All four major analyses of global surface temperatures (NOAA, HadCRUT4, GISS, and Berkeley Earth) agree that the world warmed at least one degree Fahrenheit from 1970 to 1998 and then warmed another half degree since 2013 at a rate nearly 5 times faster. Such warming can only be caused by adding heat to the earth-atmosphere system. Most of this heat is stored in the oceans. Ocean heat content has been rising consistently since 1970. Where is this heat coming from? Greenhouse gases simply do not absorb enough heat to play the major role in global warming, but there is another well-documented source.

The ozone layer, 12 to 19 miles above Earth, absorbs ultraviolet-B radiation, the highest-energy solar radiation reaching the lower stratosphere. When the ozone layer is depleted, more of this high-energy radiation is measured to reach Earth's surface, increasing our risk of sunburn and skin-cancer. Since 1970, ozone depletion has been observed clearly in the Antarctic Ozone Hole, the Arctic, and, in lesser amounts, throughout mid-latitudes. Temperatures on the Antarctic Peninsula rose 12 degrees from 1951 to 2003, more than observed anywhere on Earth in the past 1800 years.

Ultraviolet-B radiation is 48 times more energetic than infrared radiation absorbed most strongly by carbon dioxide. Higher energy means higher heat content of the radiation. Ultraviolet radiation penetrates oceans tens of meters—efficiently raising ocean heat content.

Global warming from 1970 to 1998 was caused by humans manufacturing CFC gases, known to deplete the ozone layer. The increase in global warming was stopped in 1998 by the UN Montreal Protocol mandating a phasing out of CFC gas production beginning in 1989.

Warming beginning in 2014 was caused by the eruption of Bárðarbunga volcano in central Iceland. Starting in late August, Bárðarbunga extruded 33 square miles of basaltic lava in merely six months, the highest rate of basalt production since 1783. Voluminous basaltic lava flows covering tens to millions of square miles have been contemporaneous throughout Earth history with periods of major warming and major mass extinction. Chlorine and bromine gases emitted by basaltic lavas deplete the ozone layer. Basaltic volcanism in Iceland from 11,750 to 9,375 years ago warmed the world out of the last ice age. The eruption of Bárðarbunga caused 2016 to be the hottest year ever recorded by thermometers.

Climate models overestimate the heat contained in infrared radiation and underestimate the heat contained in ultraviolet radiation. In other words, they overestimate the role of greenhouse gases and underestimate the role of ozone depletion. The mathematics, developed by Arrhenius 120 years ago, is based on a fundamental misunderstanding in physics concerning radiant energy. We now know that radiant energy is simply a function of frequency of oscillation of the bonds holding the radiating matter together, not a function of wave amplitude and bandwidth as currently calculated in climate models.

What is most surprising is that scientists have never demonstrated in an experiment how much air is warmed when concentrations of carbon dioxide gas are increased. Experiments are fundamental to the scientific method. As Steven Chu, Nobel physicist and former Secretary of Energy wrote “The final arbitrator of any point of view are experiments that seek the unbiased truth.”

The only experiment reported in the scientific literature concerning greenhouse gases was done in 1900 by a physicist, Knut Ångström ([JustProveCO2.com/papers/Angstrom1900English.pdf](http://JustProveCO2.com/papers/Angstrom1900English.pdf)). He showed, in two different ways, that warming caused by increasing concentrations of carbon dioxide is minimal.

In 2017, scientists need to carry out such experiments if they wish to defend greenhouse-warming theory ([JustProveCO2.com](http://JustProveCO2.com)). Such experiments are so unlikely to be successful that I am offering \$10,000 to the first scientist who can do such an experiment successfully ([WhyClimateChanges.com/challenge/](http://WhyClimateChanges.com/challenge/)).

Ozone depletion remains at much higher levels now than in 1970. Therefore, ocean heat content will continue to rise and glaciers will continue to melt, but the major global warming predicted by climate models is highly unlikely. We need to be concerned about ozone depletion, not increasing concentrations of greenhouse gases.

These new scientific data and insights show that we should be able to move forward together burning fossil fuels safely, minimizing pollution, and meeting the rapidly increasing energy needs of a rapidly developing world. It also makes sense to work together developing renewable sources of energy because fossil fuels are unlikely to last more than a few generations and because renewable energy sources are beginning to make economic sense, especially in regions lacking major energy distribution infrastructure.

The challenge in the New Year is to meet increasing energy needs while making the world safer for our grandchildren. It is time to bring peace to the climate wars and all work together for a better world.

*Dr. Ward, a geophysicist and leader at the U.S. Geological Survey for 27 years, worked in retirement for a decade tracking down enigmas in climate science. He is author of “[What Really Causes Global Warming? Greenhouse Gases or Ozone Depletion?](#)” from Morgan James Publishing, many scientific papers, the website [WhyClimateChanges.com](http://WhyClimateChanges.com) and #WhyClimateChanges.*