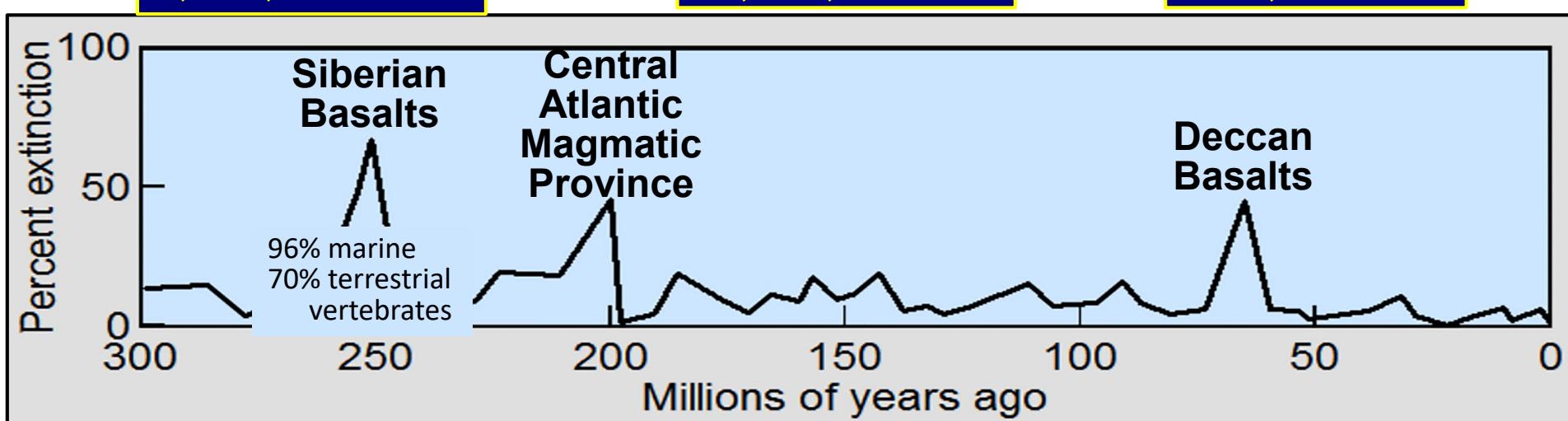
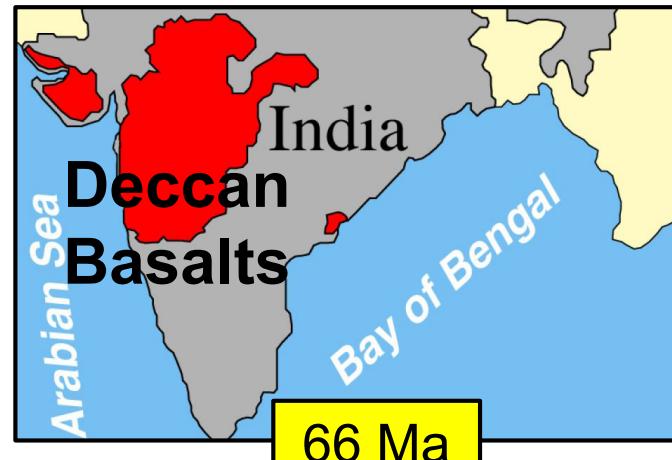
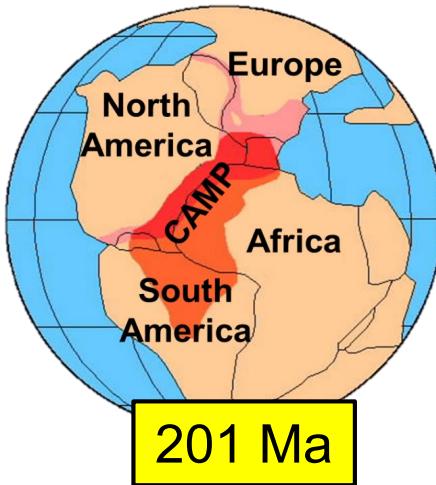


V43J-0310: The 2018 Kilauea eruption along the East Rift Zone is becoming voluminous enough to cause substantial global warming just like other extensive, effusive, sub-aerial, basaltic lava flows found worldwide

But the eruption stopped 8 days after the abstract deadline.  
The warming effects were minimal.

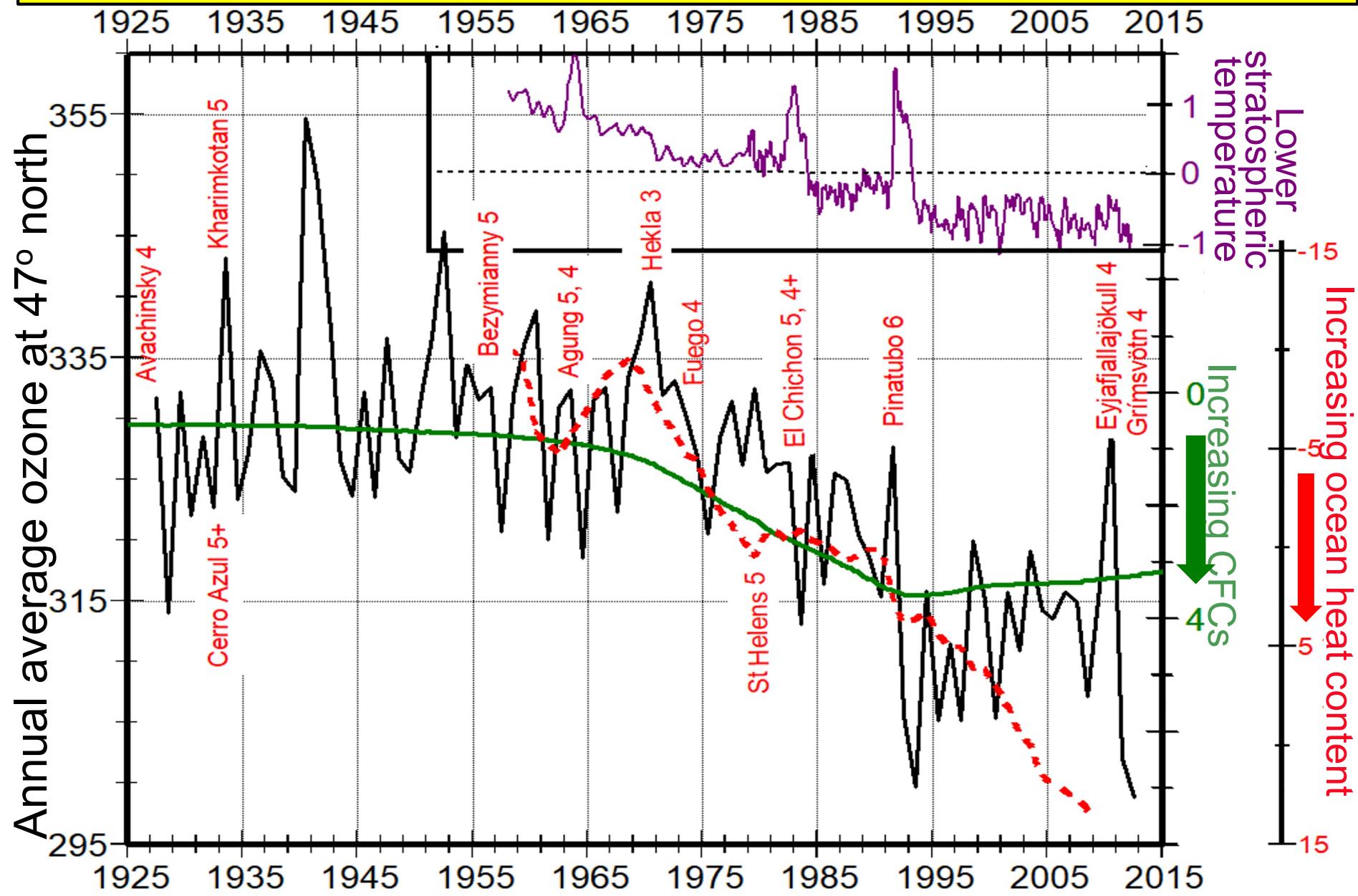
Peter L. Ward, US Geological Survey retired

The greatest warming and mass extinctions were contemporaneous with the largest basalt flows in Earth history



During extrusion of the Siberian basalts equatorial ocean temperatures exceeded 40°C with major acidity. There was widespread acid rain and substantial ozone depletion.

The greatest ozone depletion ever observed followed the 1991 Pinatubo eruption, the largest since 1912



Lavas from Bárðarbunga volcano in central Iceland covered 85 km<sup>2</sup> of land in 6 months, a rate of 14 km<sup>2</sup> per month

Lavas flowed out from Bárðarbunga volcano in central Iceland, from Aug 29, 2014 to February 28, 2015, the largest basaltic eruption since 1783.

A rate of 14 km<sup>2</sup> per month



2016 was the hottest year on record. Temperatures rose from 2014 to 2016 at a rate five-times faster than they had risen from 1970-1998 when warming appears caused by ozone depletion caused by production of CFC gases.



# The greatest volcanism recorded in Greenland ice was precisely during the period of major warming at the end of the last ice age

The greatest concentrations of volcanic sulfate per century recorded in the GISP2 borehole under Summit Greenland began with the Preboreal warming around 12,000 ka and continued for 2500 years. The second greatest concentrations began with the Bølling warming 15,000 ka. The continuity of volcanism is shown by the circled numbers, which are the number of contiguous ice layers containing volcanic sulfate.

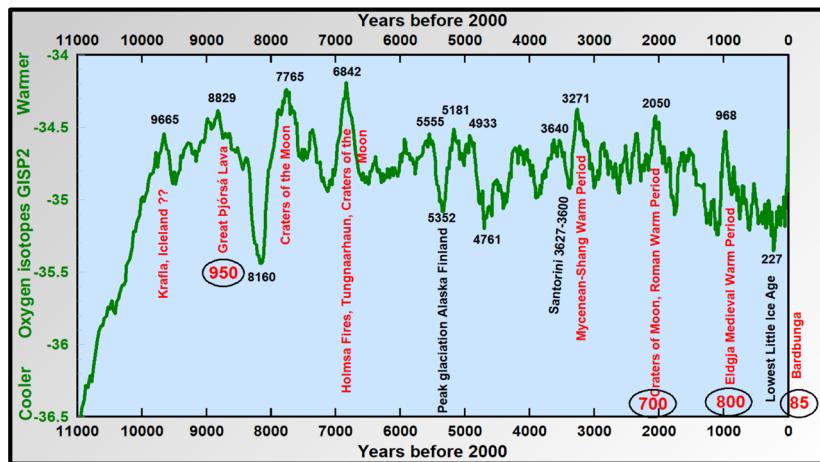
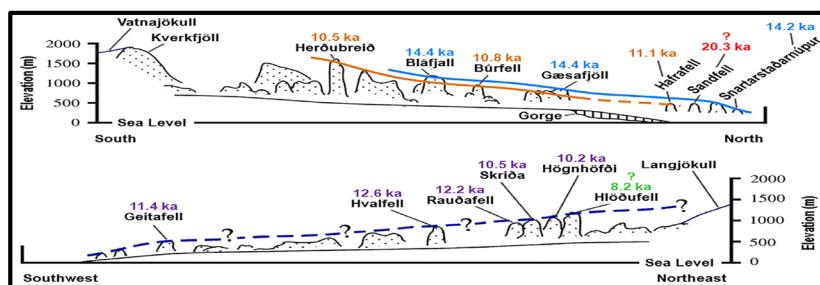
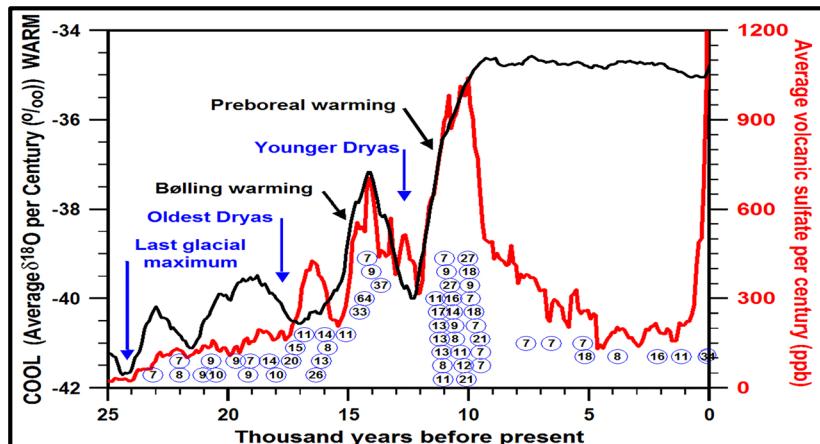
This volcanism was located in Iceland and it was basaltic.



Sub-glacial basaltic volcanic eruptions build vertically through the ice forming broad-shouldered tuya or table mountains.

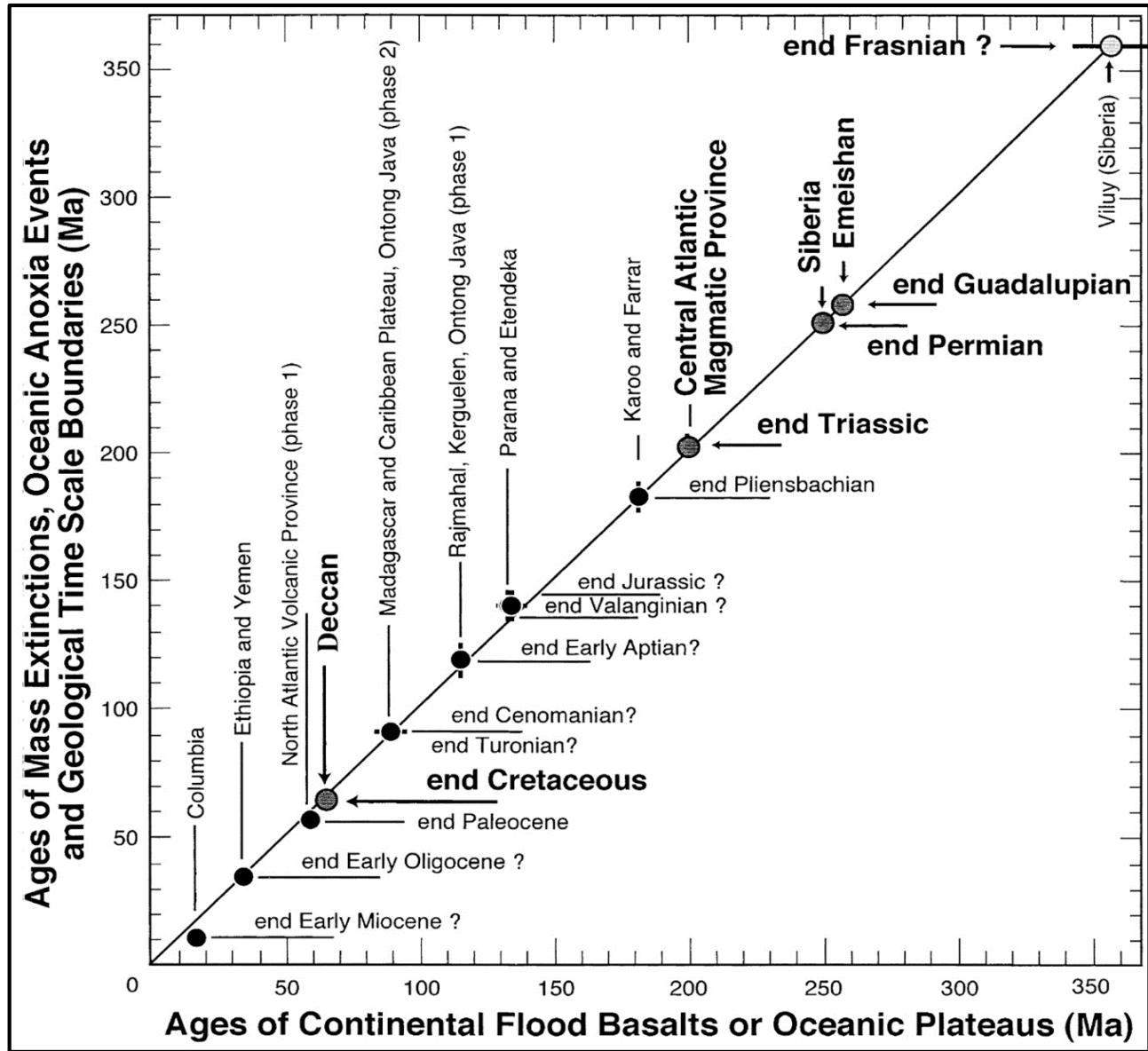
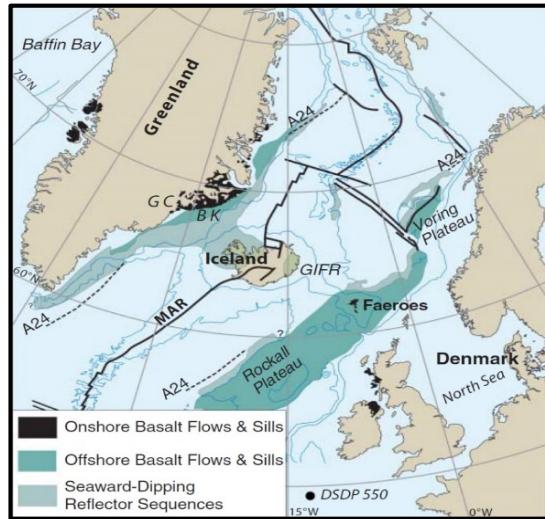
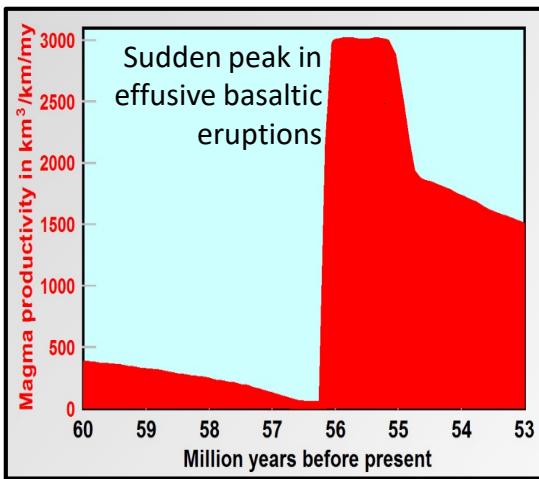
Cosmogenic  $^{3}\text{He}$  measurements of basalts on top of these tuya show that their final eruptive phases were either during the Bølling or the Preboreal warmings (Licciardi et al. 2007)

Basaltic lava flows covering 700 to 950 km<sup>2</sup> in Iceland and in the Craters of the Moon area of the Snake River Plain in Idaho were contemporaneous with periods of sudden warming throughout the Holocene. There is still a great deal of work needed to identify large basalt fields formed during this period and to determine the precise dates of eruption.

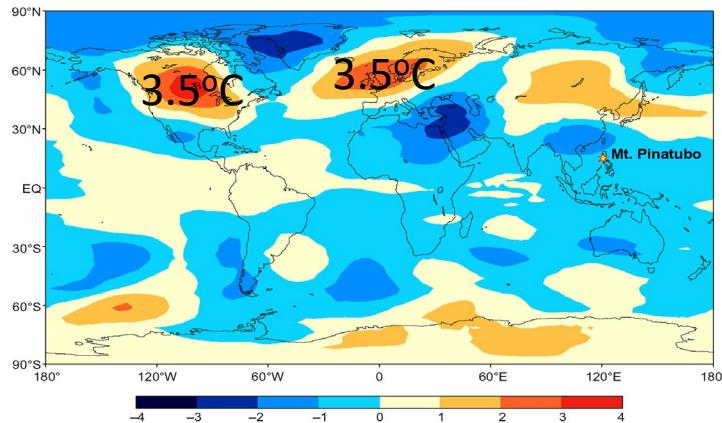


Basaltic lavas form in sub-aerial rift zones and typically occur at the end of geologic time units during rapid changes in climate

The Paleocene-Eocene rapid warming occurred as Norway rifted from Greenland

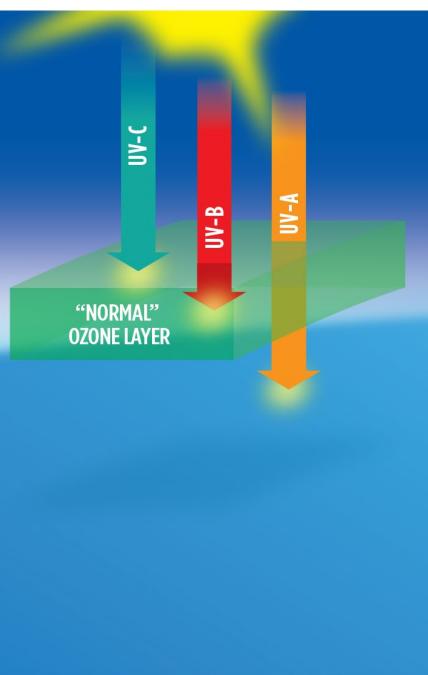


Ozone depletion after the Pinatubo eruption caused warming of up to 3.5°C from December 1991 to February 1992 before aerosol cooling became widespread



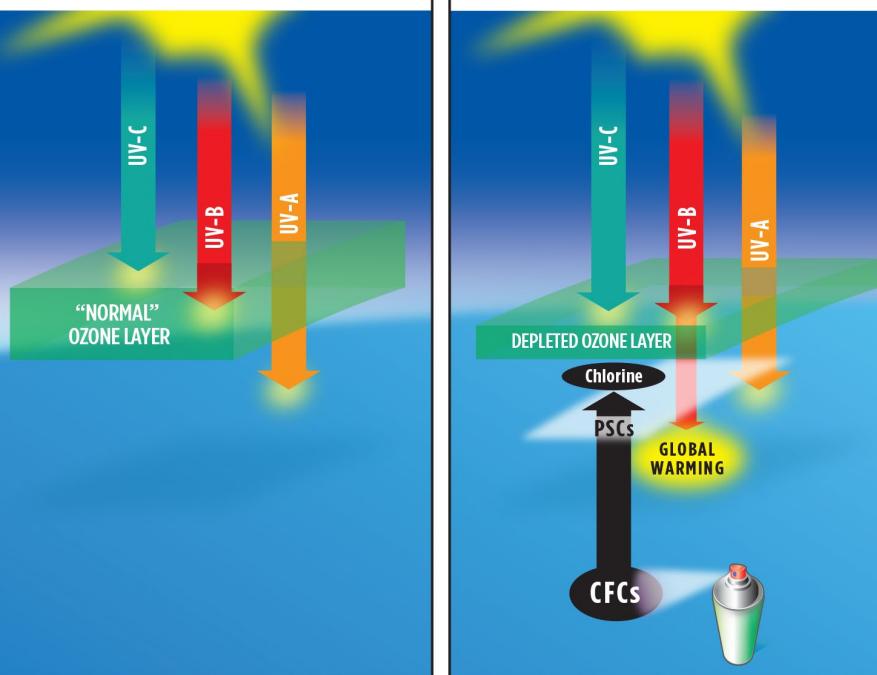
### NORMAL CONDITIONS

UV-C keeps atmosphere warm  
UV-B keeps ozone layer warm  
UV-A & sunlight keeps Earth warm



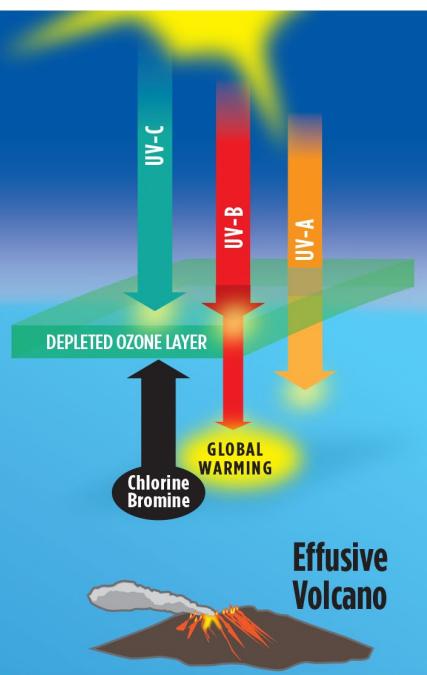
### GLOBAL WARMING

CFCs in polar stratospheric clouds (PSCs) release chlorine depleting ozone  
cooling ozone layer & warming Earth



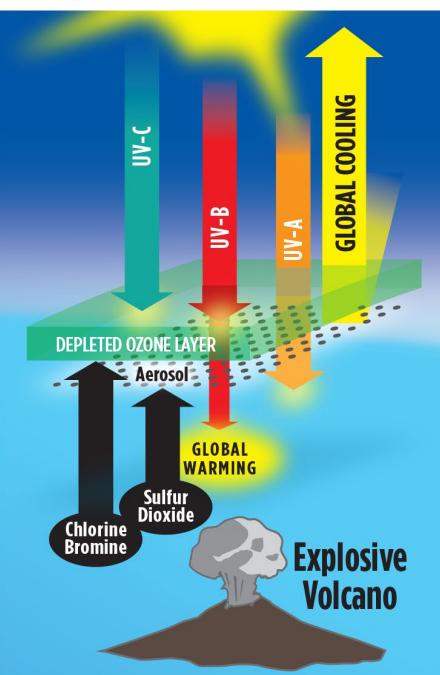
### GLOBAL WARMING

Volcanoes release Chlorine & Bromine  
depleting ozone  
cooling ozone layer & warming Earth



### GLOBAL COOLING

Explosive volcanoes also eject Sulfur Dioxide into stratosphere forming aerosols that reflect & disperse sunlight causing net cooling of Earth



# Lavas on the lower East Rift of Kilauea volcano in Hawaii covered 36 km<sup>2</sup> of land in 3 months, a rate of 12 km<sup>2</sup> per month

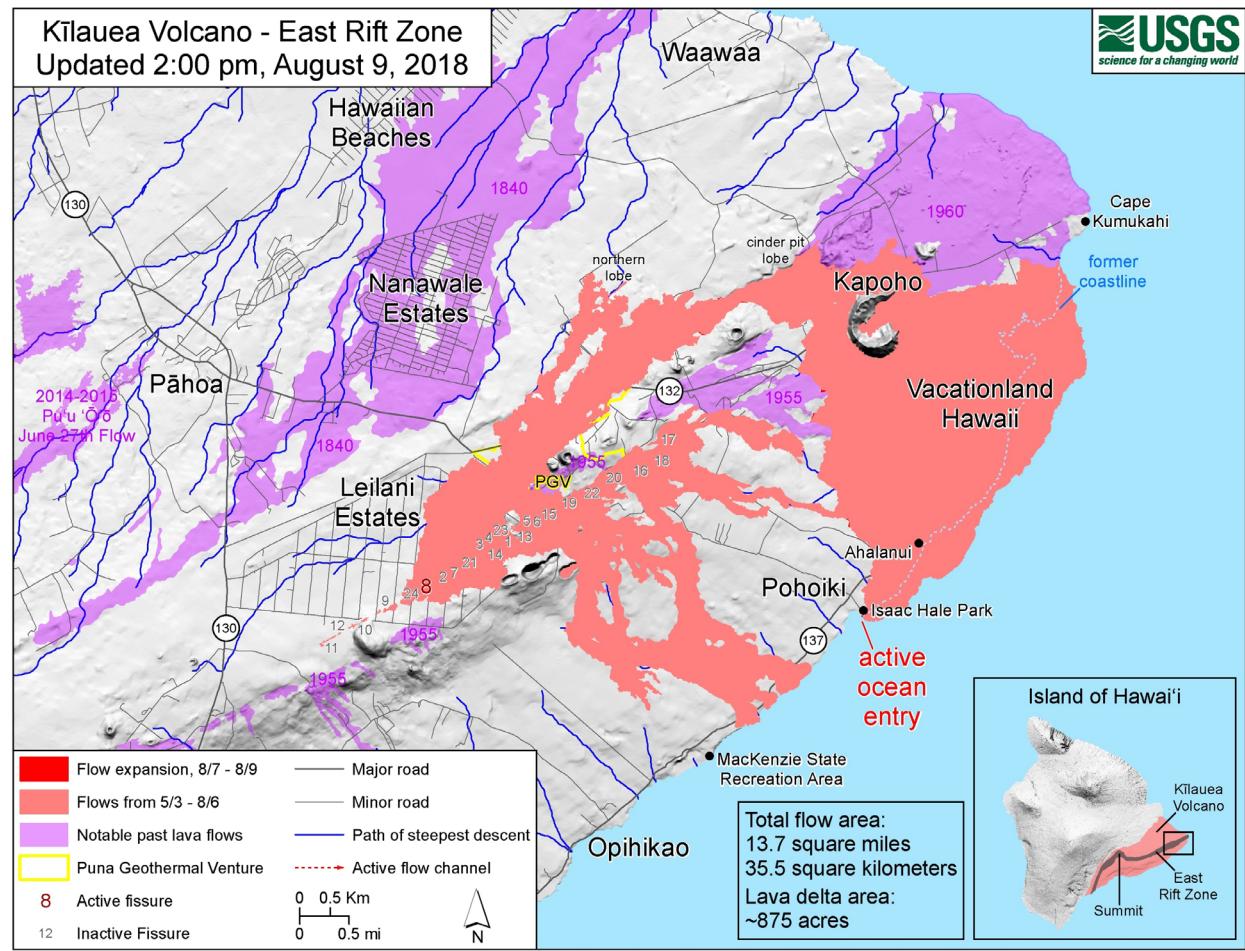
Lavas flowed out of the East Rift from May 3 to August 9, 2018 at a rate similar to Bárðarbunga but only lasting half as long.



A rate of 12 km<sup>2</sup> per month

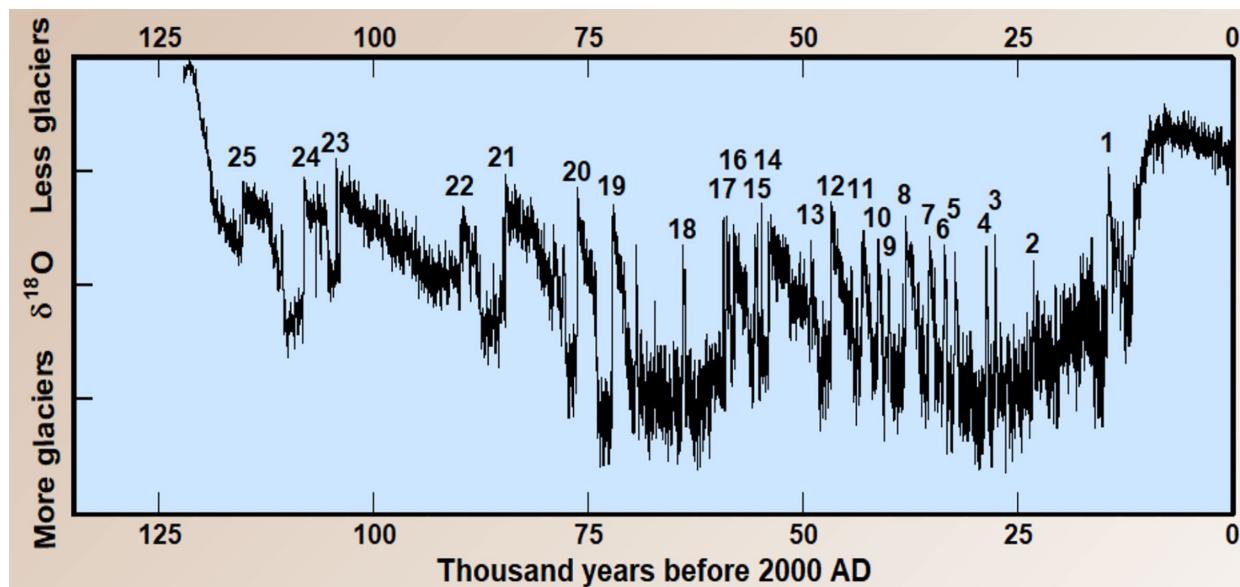
This was a rate much faster than usual in Hawaii. The Puu Oo eruption began in January 1983. By the end of 2016, lava had been extruded over an area of 144 km<sup>2</sup>, only 0.36 km<sup>2</sup> per month.

Changes in ozone or global temperatures, if they occurred, were too small to resolve over this 3 month period.

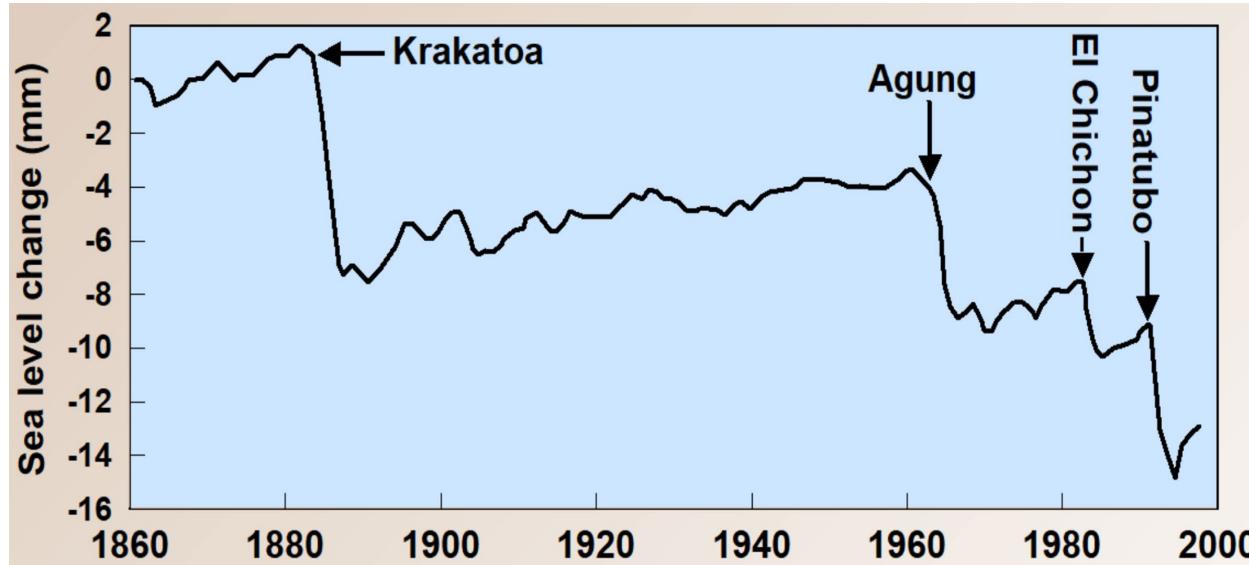


# The footprints of climate change in ice cores: Erratic sequences of rapid warming followed by slow, incremental cooling over millennia

25 times in the past 120 ka, air in Greenland was warmed within years apparently due to basaltic eruptions in rift zones, but cooled slowly and incrementally over millennia apparently due to aerosols formed by large explosive eruptions that reflected sunlight cooling Earth 0.5°C for 2 to 4 years. Several large eruptions per century led to incremental cooling.

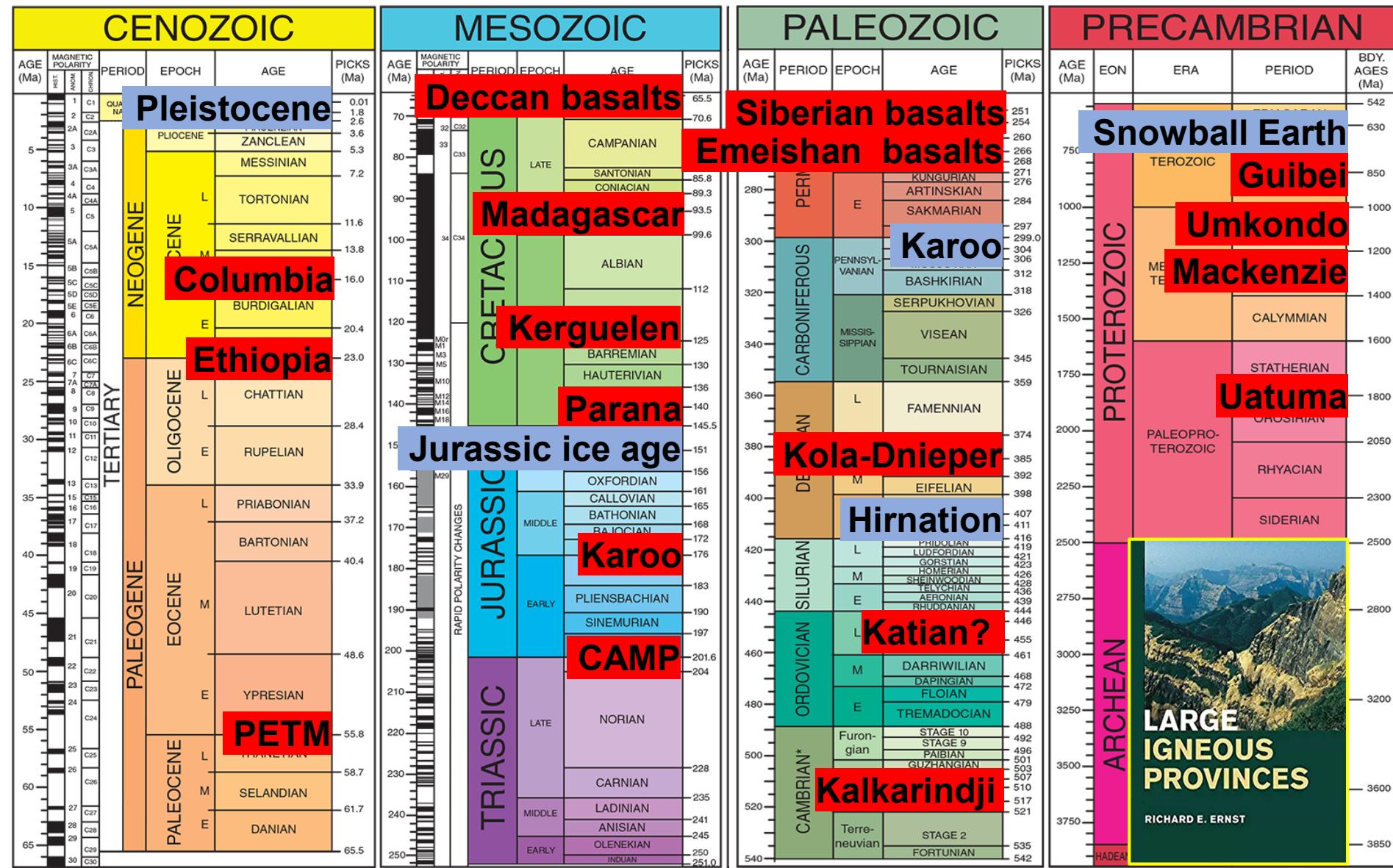


Cooling the ocean surface for a few years affects ocean temperatures for nearly a century (Gleckler et al., 2006). Thus several major, explosive, volcanic eruptions per century over millennia can increment the world oceans down into ice-age conditions. (Sea level modelling by Gregory et al., 2006).



Large basaltic provinces tend to punctuate the geologic time scale

They appear to cause the sudden changes in climate and species



## How does extensive basaltic volcanism cause global warming?

Periods of sudden global warming throughout Earth history are contemporaneous with extensive basaltic lava flows covering hundreds to **millions** of square kilometers. The larger the flow, the greater the warming, the longer the warming lasts, and the greater the associated ocean acidification and mass extinctions

All volcanic eruptions of sufficient size are observed to deplete the ozone layer most likely by emission of chlorine and bromine gases. The depletion and related warming is greatest in winter months. Major explosive eruptions also form aerosols in the lower stratosphere that cause net cooling.

Basaltic magmas contain 10 to 100 times more volatiles per cubic kilometer than more evolved magmas (Palais and Sigurdsson, 1989; Freda et al., 2005; Self et al., 2008; Webster, Baker, and Aiuppa, 2018)

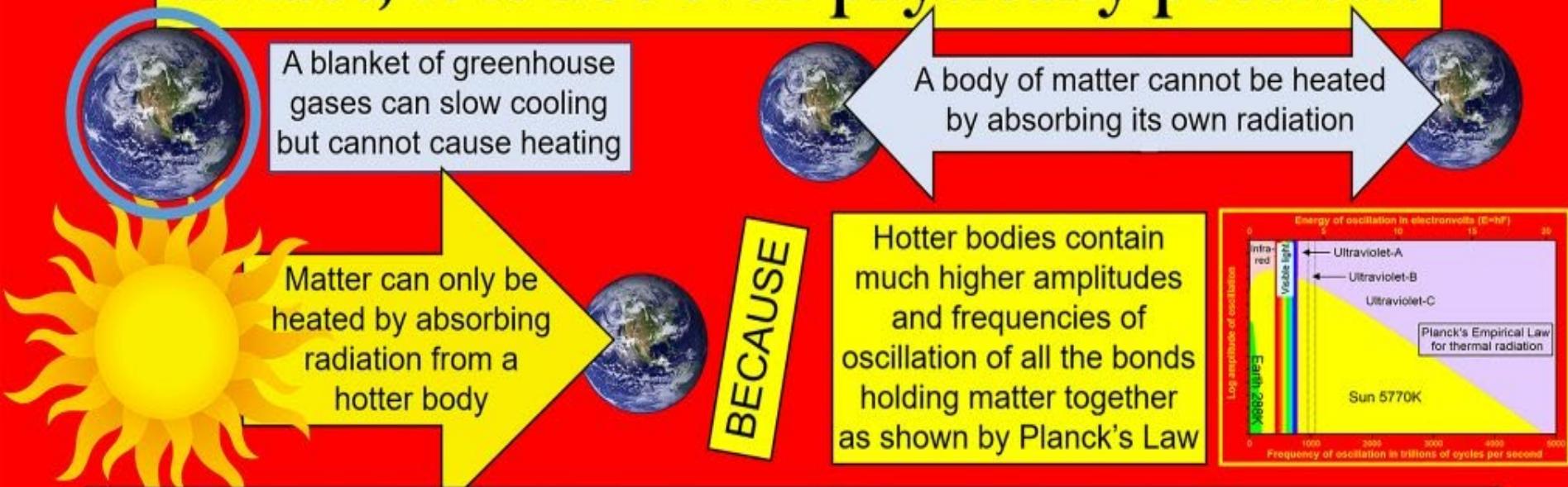
There is still work to be done to understand how chlorine and bromine emitted at the surface can rise into the stratosphere without being washed out. Convection of heat above the hot lavas must play a role.

Ozone depletion explains global warming throughout Earth history in far greater detail, with far greater precision than greenhouse-warming theory

The Globe Warmed One Degree Centigrade Since 1970

But, greenhouse warming theory is mistaken!

In fact, it is not even physically possible!



Warming from 1970 to 1998 was caused by humans depleting the ozone layer, allowing more very hot solar ultraviolet-B radiation to reach Earth

Get much more detail at Booth 650 in the Exhibit Hall