

Climate Throughout Geologic Time Has Been Controlled Primarily by the Balance Between

**Cooling Caused by
Major Explosive
Eruptions of
Evolved Magmas
Typical of
Island Arcs**

and

**Warming Caused by
Voluminous Effusive
Eruptions of Basaltic Magma
Typical of Subaerial Ocean
Ridges, Island Chains, and
Continental Flood Basalts**



1815 Mt. Tambora, Indonesia

Largest volcanic eruption in recorded history

Volcano Explosivity Index = 7

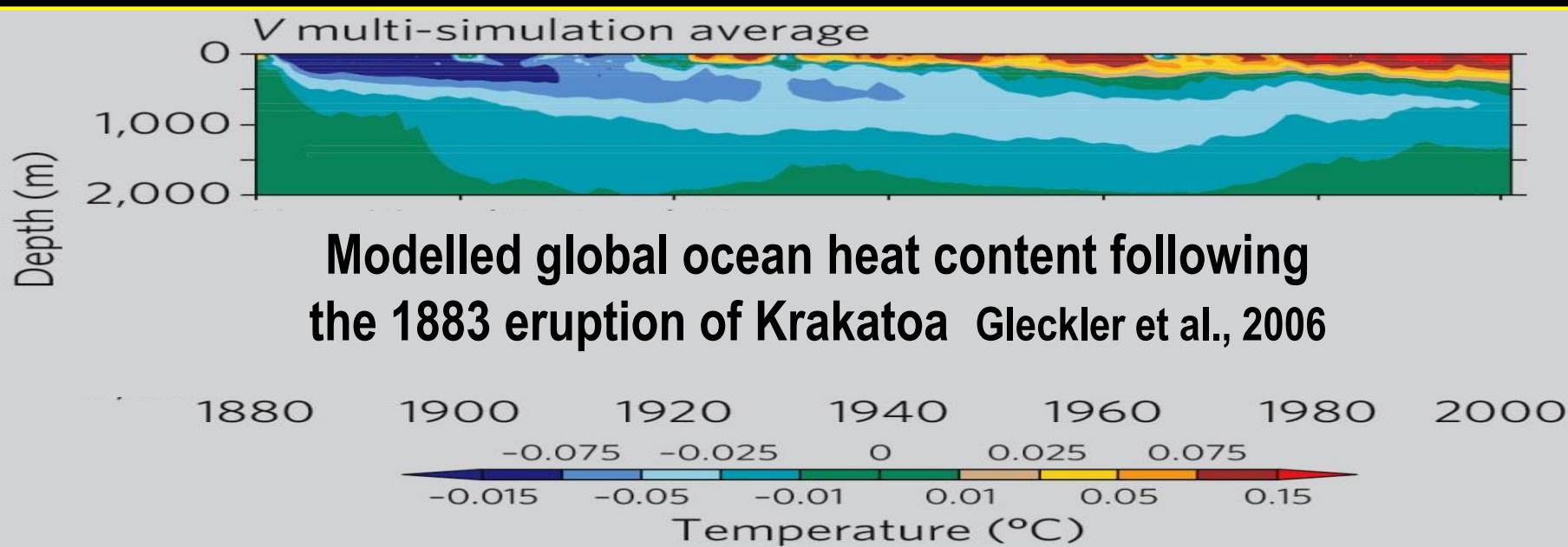


**Lowered world temperatures
0.4 to 0.7 °C**

**1816
Year There Was No Summer
The Poverty Year**

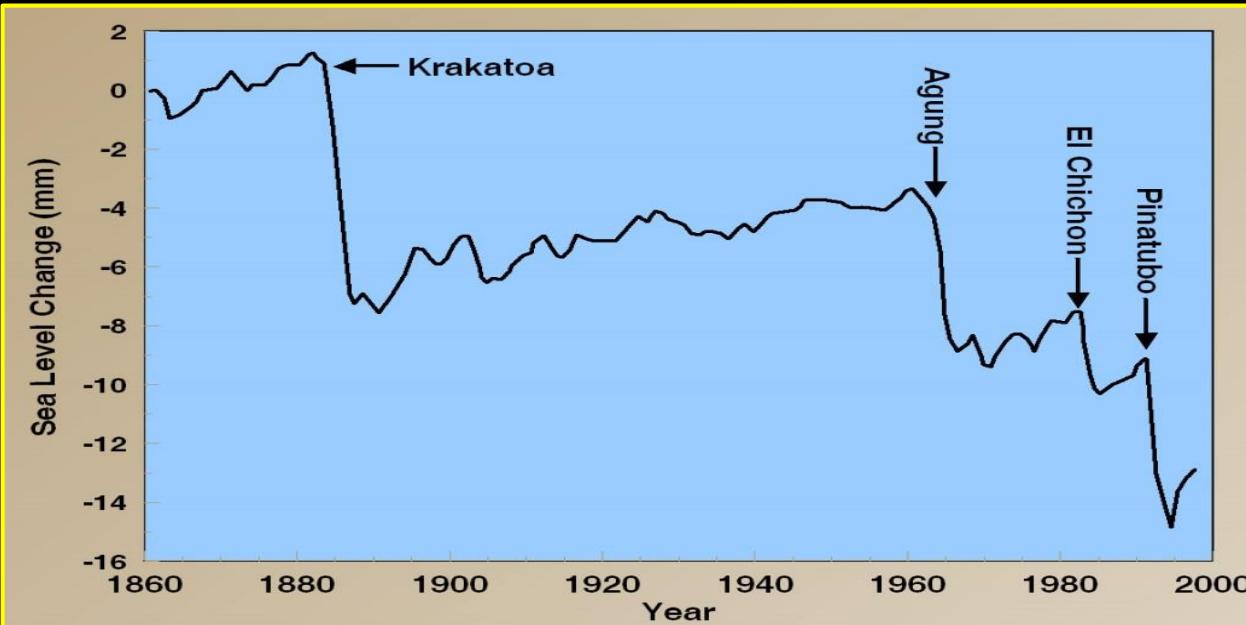
**Krakatau 1883 (6)
Santa María 1902 (6?)
Novarupta 1912 (6)
Agung 1963 (5)
El Chichón 1982 (5)
Pinatubo 1991 (6)**

Thermal Effects Last a Long Time and Cummulate

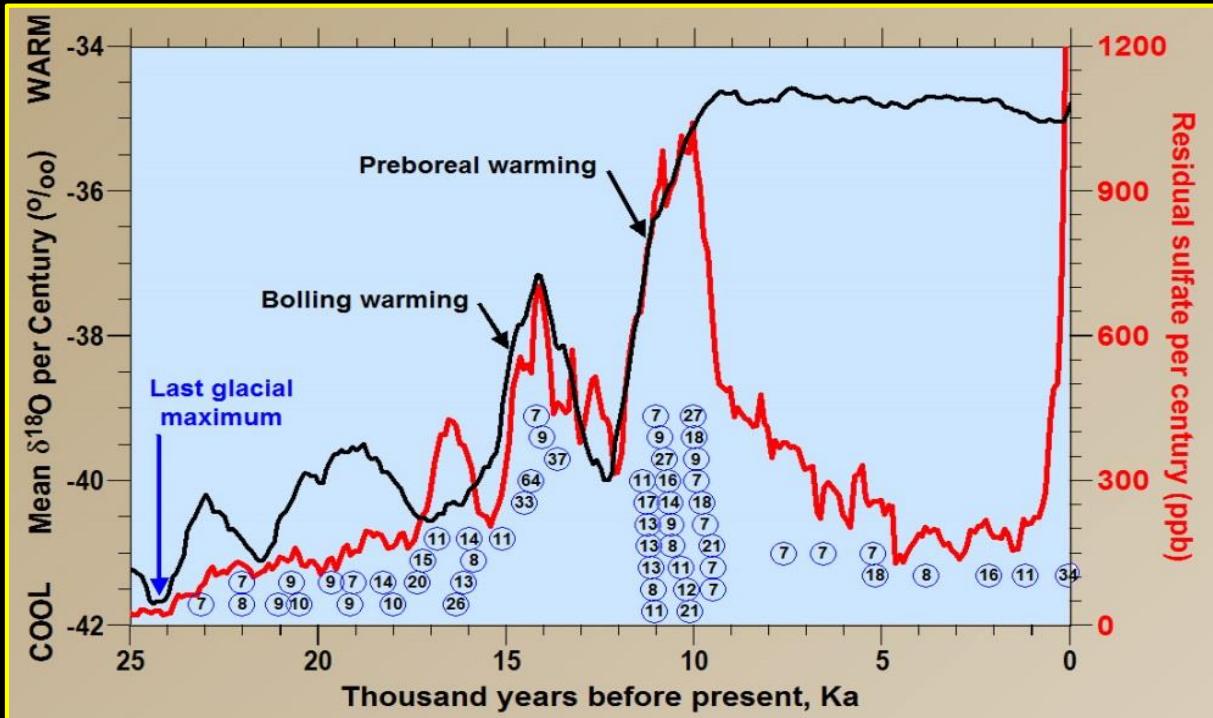


Modelled sea level change following the larger volcanic eruptions

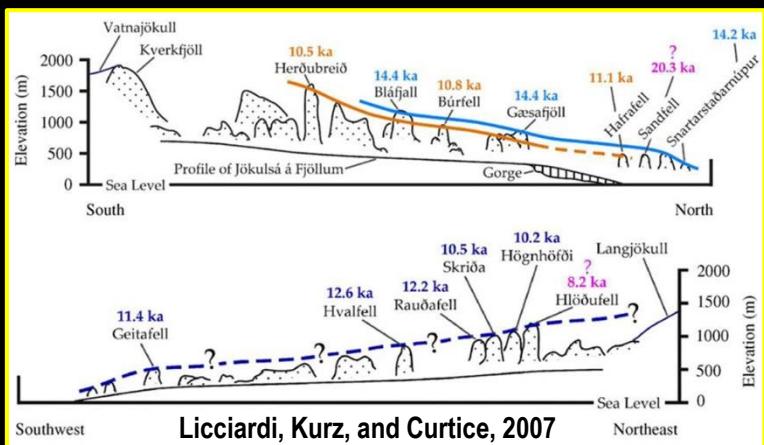
Gregory et al., 2006



Last Ice Age Ended During Massive Volcanism in Iceland from 11,750 to 9,375 years BP



Basaltic, effusive
volcanism was
substantial and nearly
continuous in Iceland
during the Bolling and
Preboreal warmings

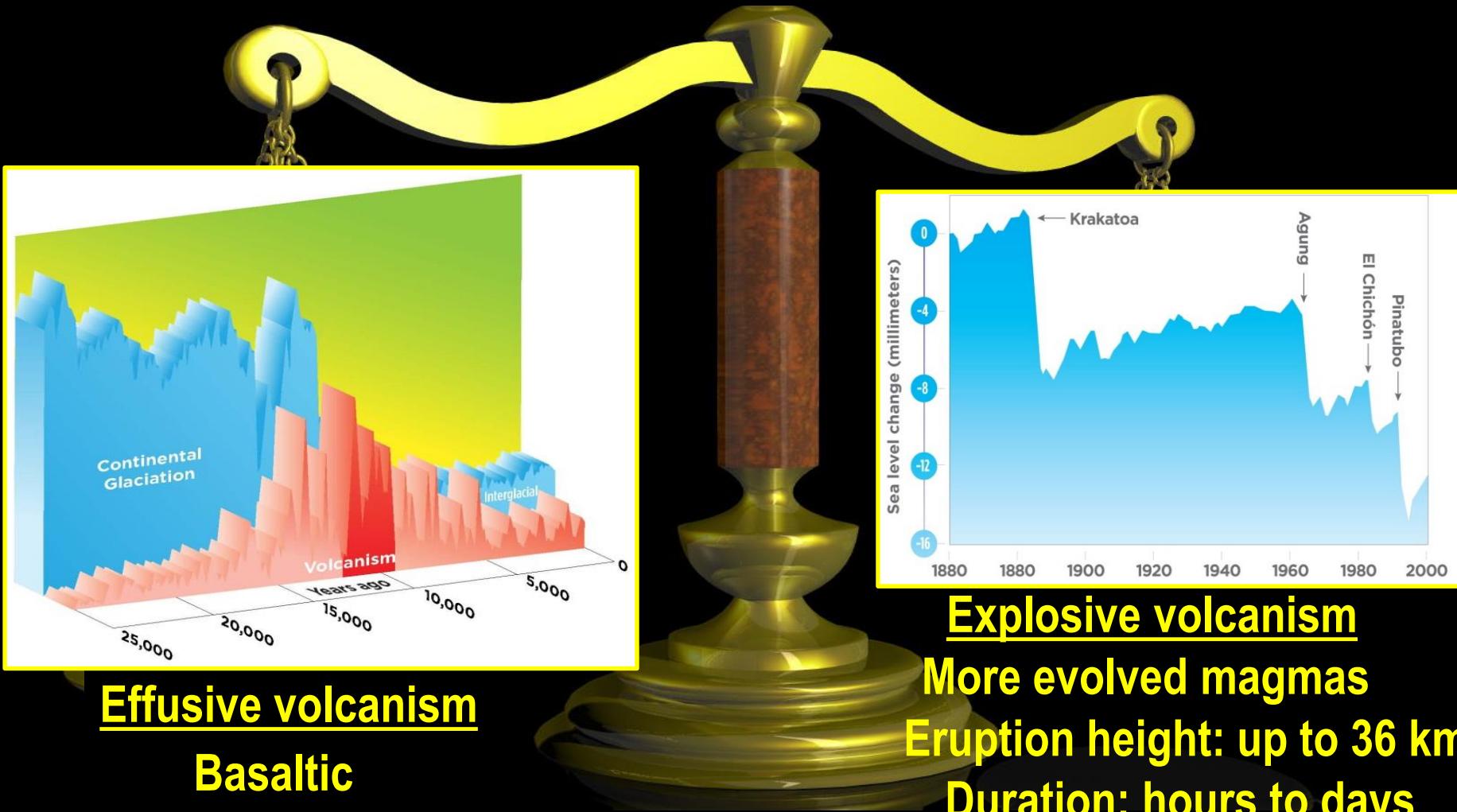


^3He exposure
ages and ice
surface at end
of last ice age

A tuya or table mountain formed
by eruption of basalt under ice

12 of the 13 dated tuyas
in Iceland had their final
eruptive phase during
the Preboreal warming

The Delicate Balance Between Global Warming and Global Cooling

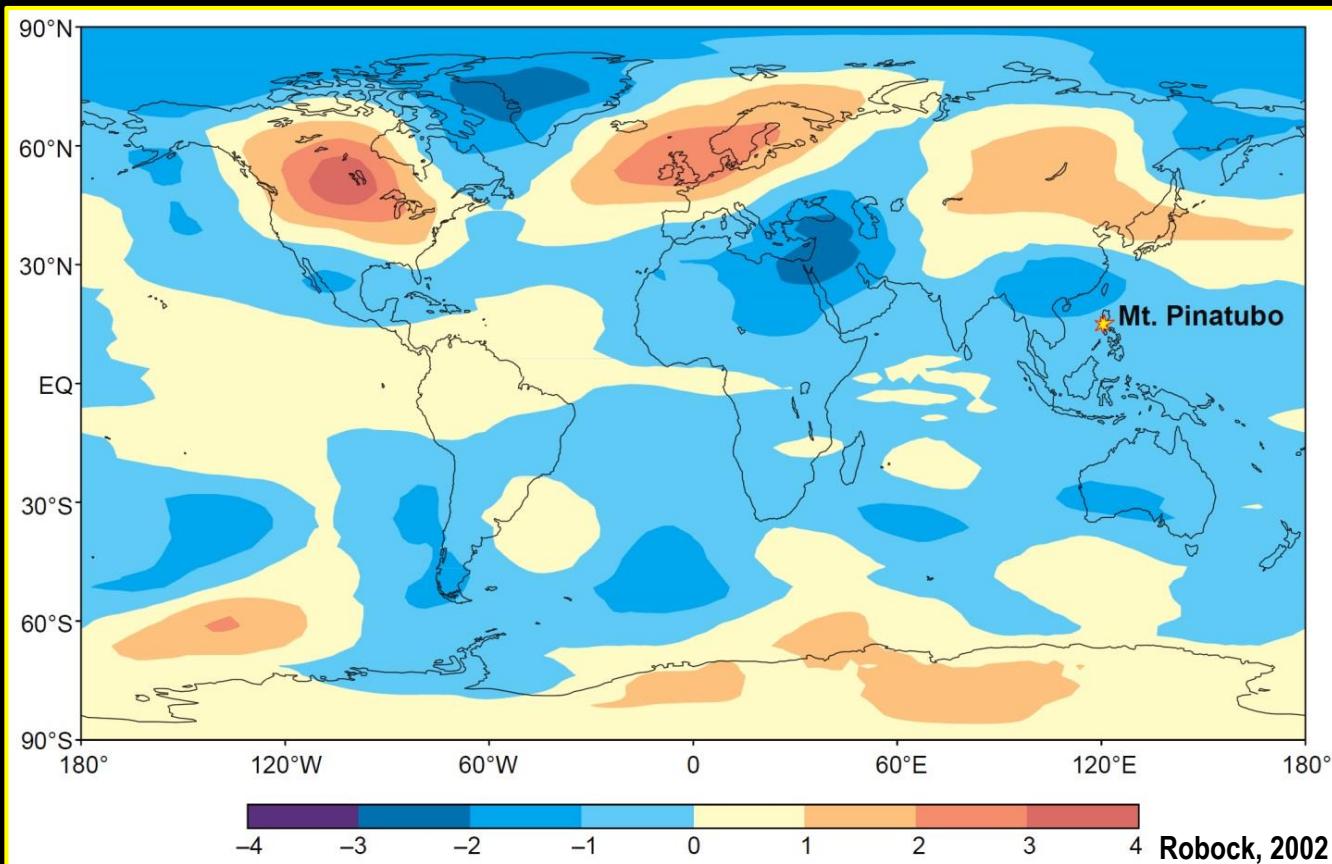


Explosive volcanism
More evolved magmas
Eruption height: up to 36 km
Duration: hours to days
Forms an aerosol in the lower stratosphere

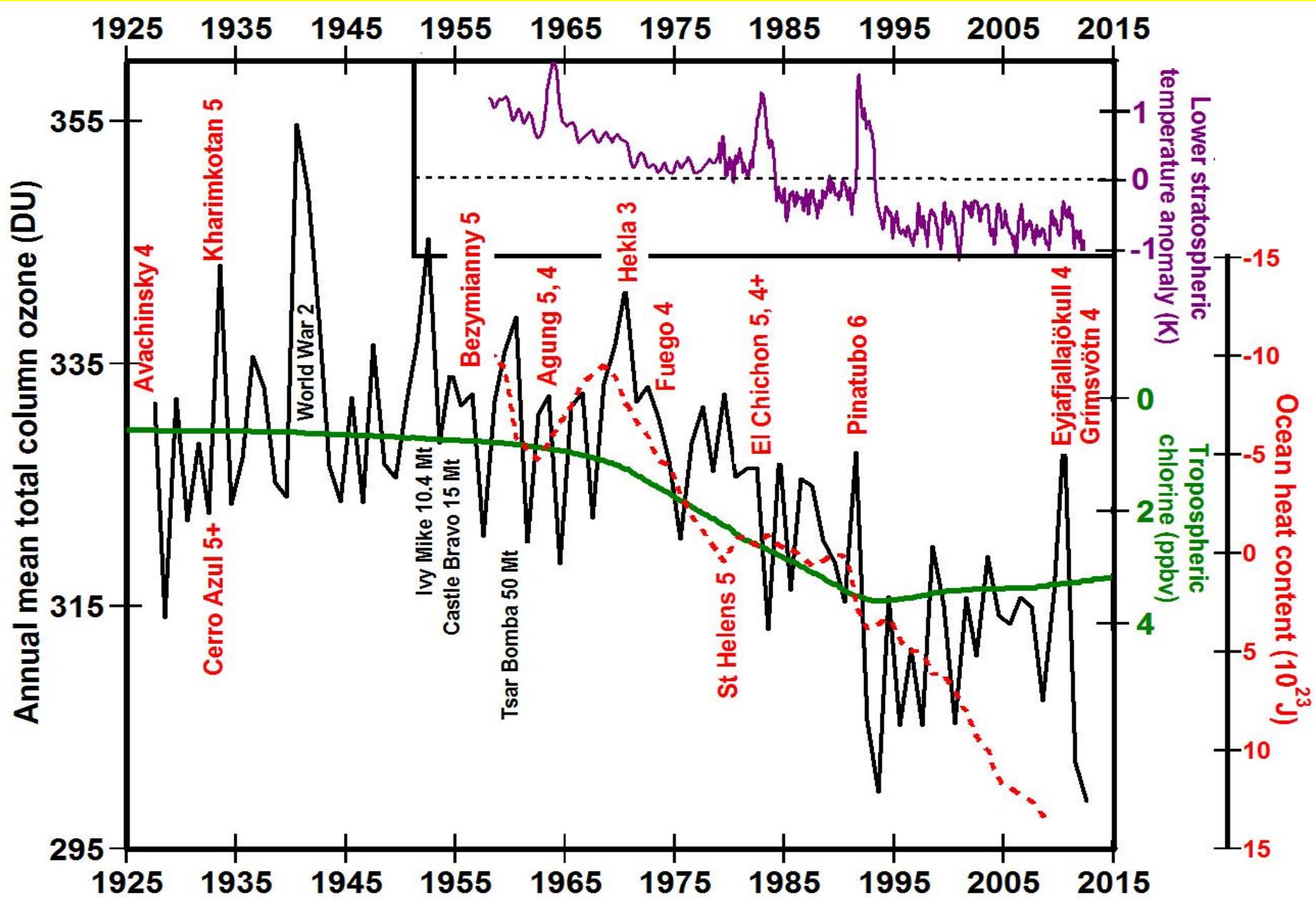
But Large Explosive Eruptions also Deplete Ozone Leading to Winter Warming



Pinatubo, 1991



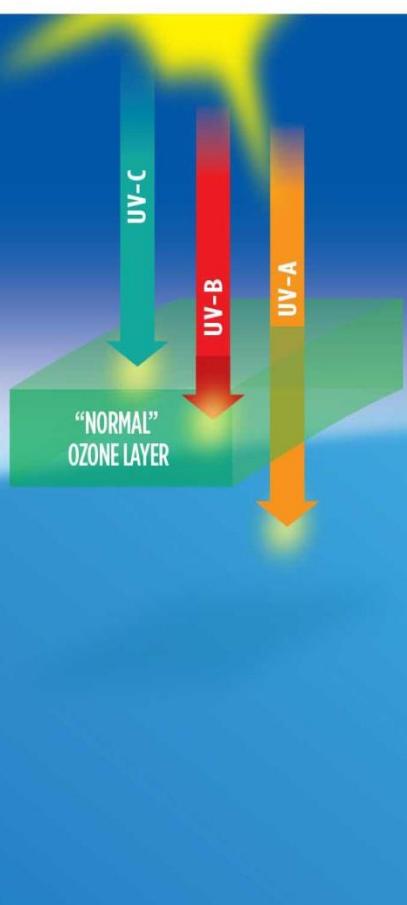
Average Annual Ozone Measured at Arosa, Switzerland



Effects of Ozone Depletion and Aerosols

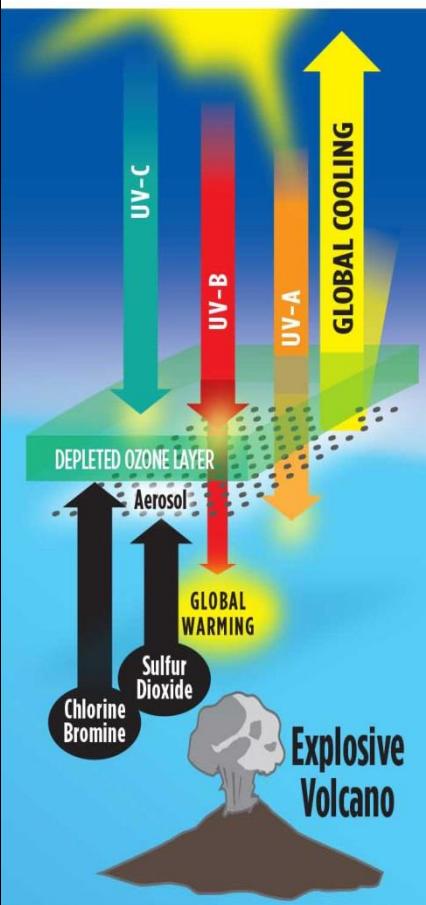
NORMAL CONDITIONS

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



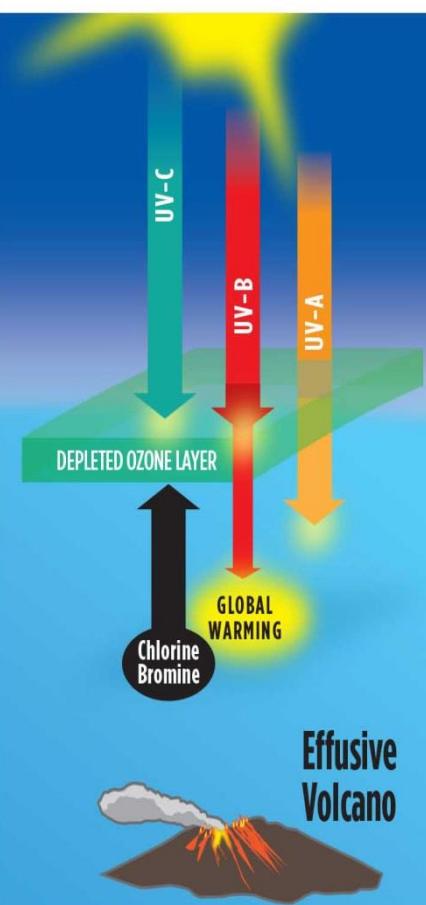
GLOBAL COOLING

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



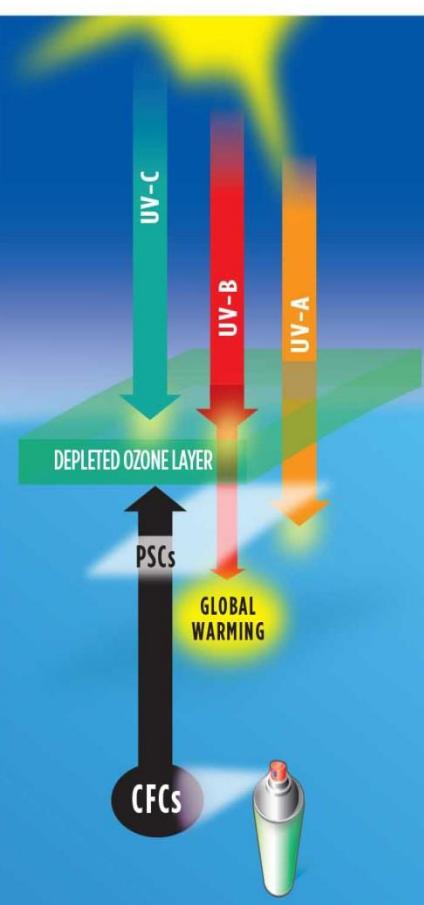
GLOBAL WARMING

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

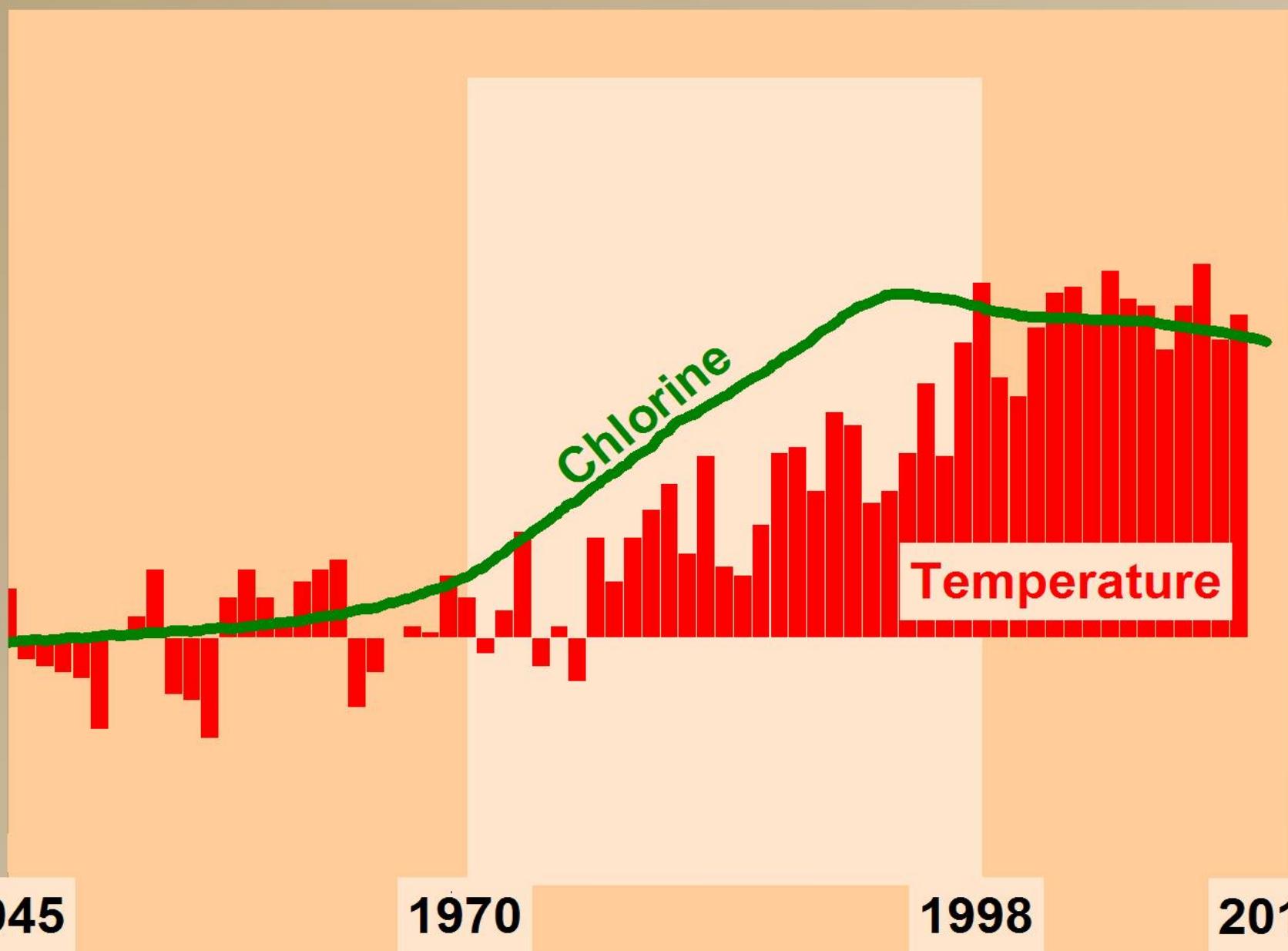


GLOBAL WARMING

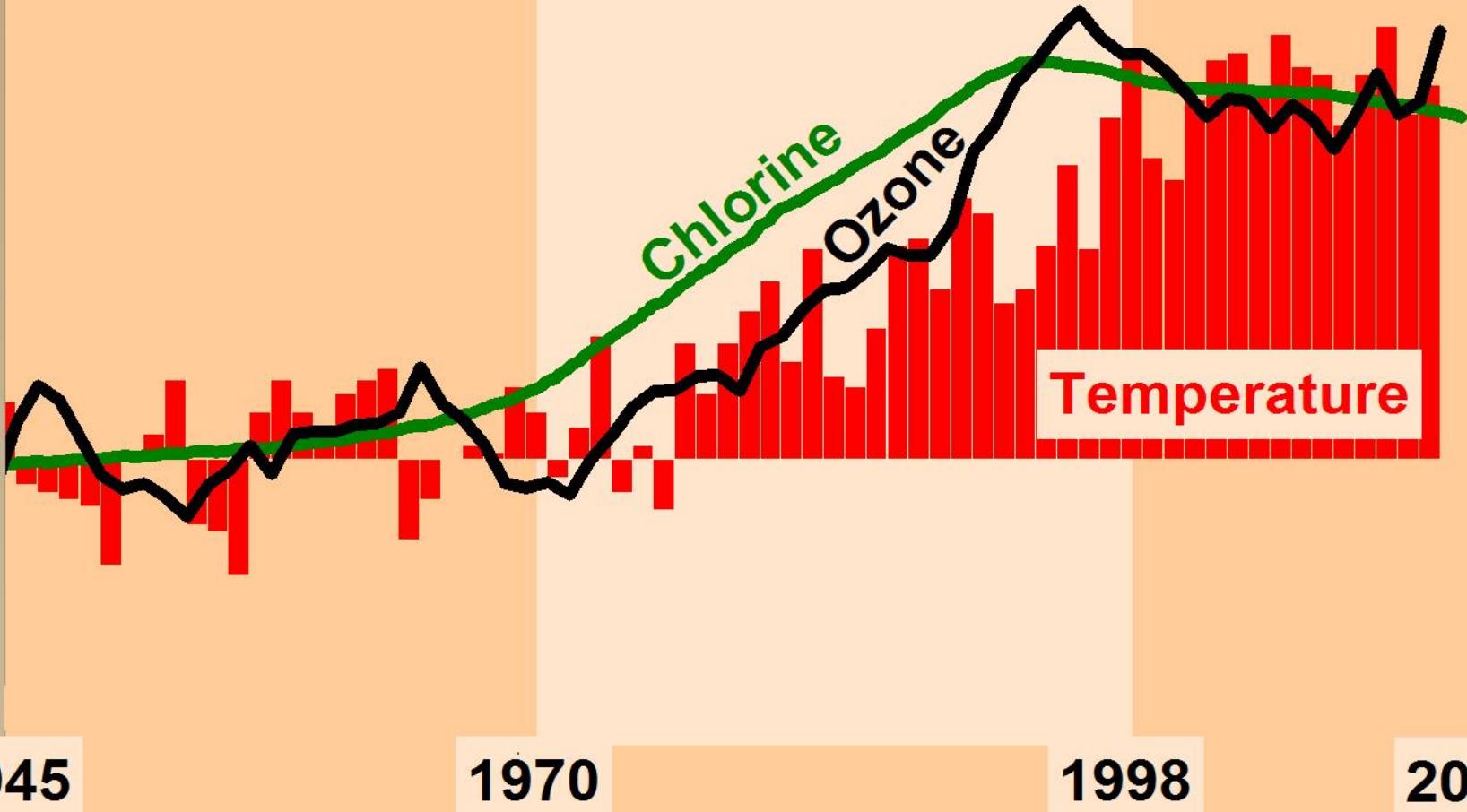
CFCs in polar stratospheric clouds (PSCs) release chlorine depleting ozone cooling ozone layer & warming Earth



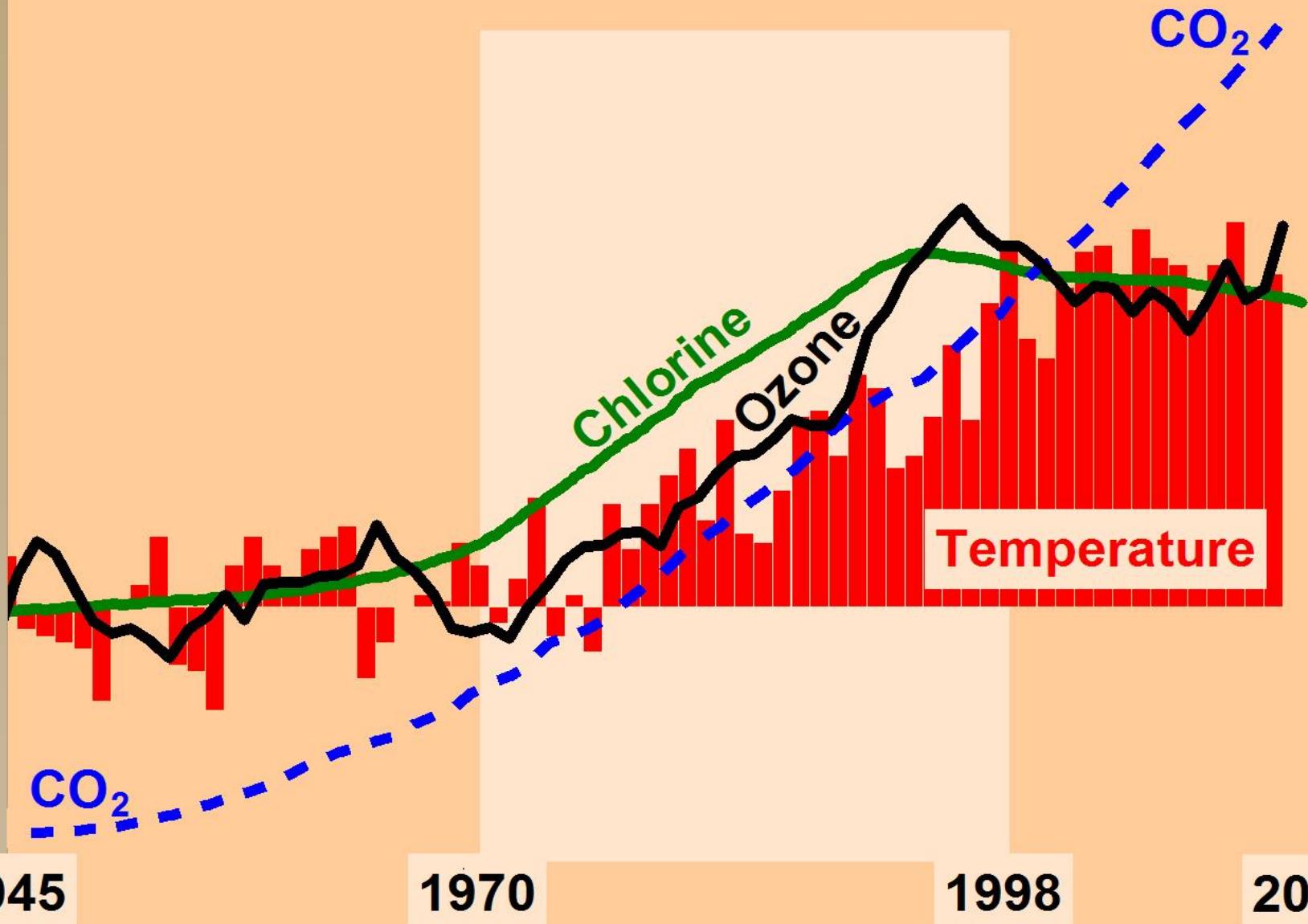
Global Warming 1970 to 1998



Global Warming 1970 to 1998

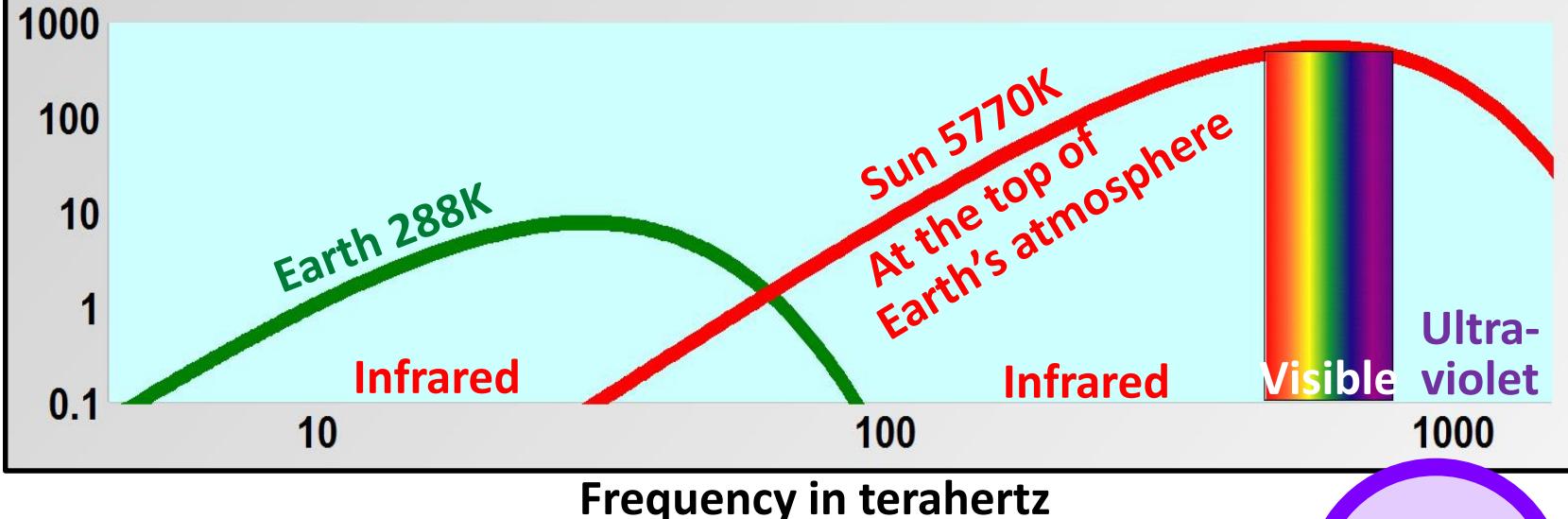


Global Warming 1970 to 1998

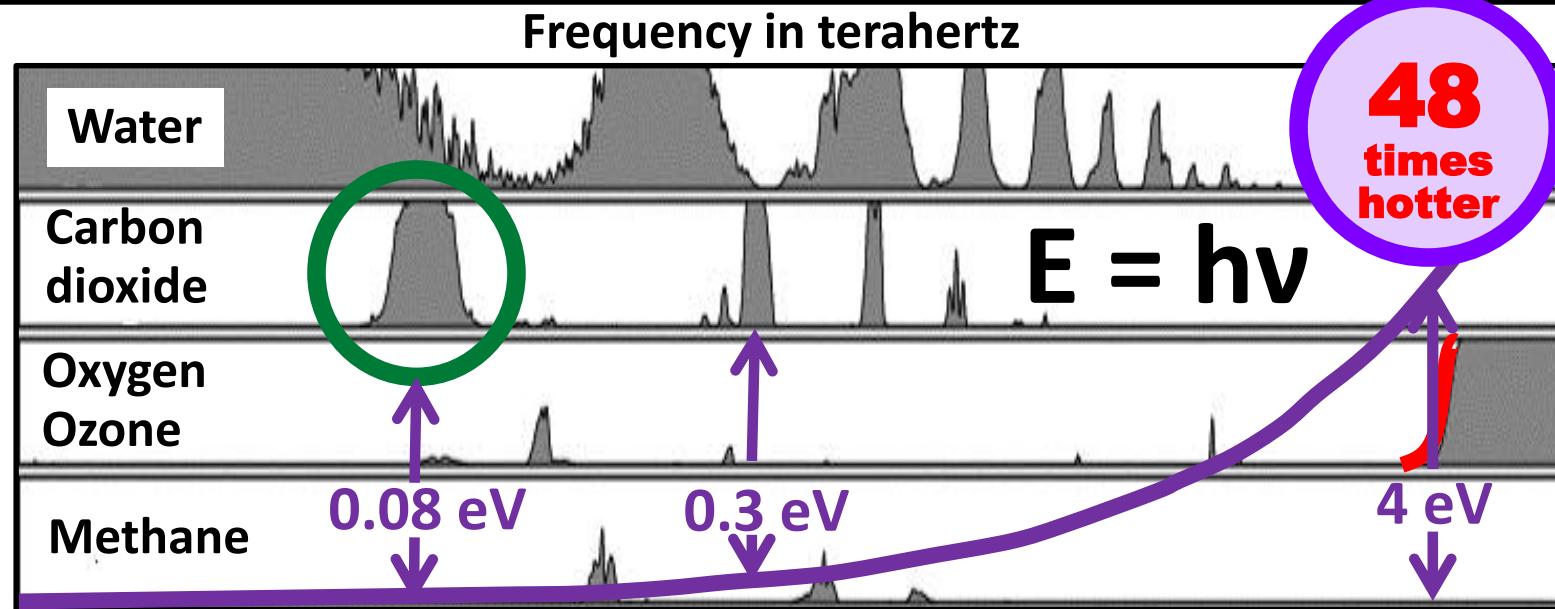


Energy Absorbed by Greenhouse Gases

Radiation
brightness



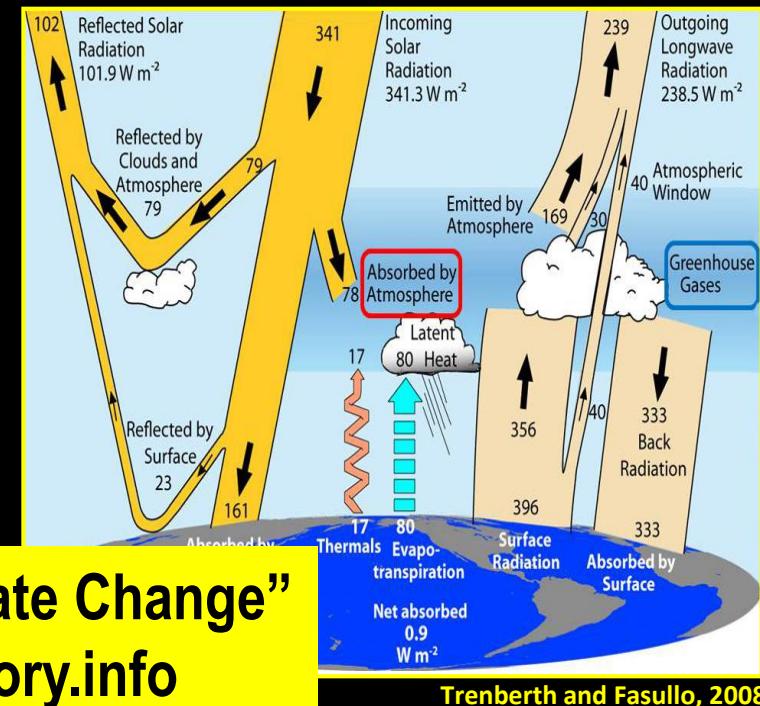
Percent
absorption



Energy of ultraviolet radiation reaching Earth when ozone is depleted is at least 48 times hotter than energy absorbed by greenhouse gases

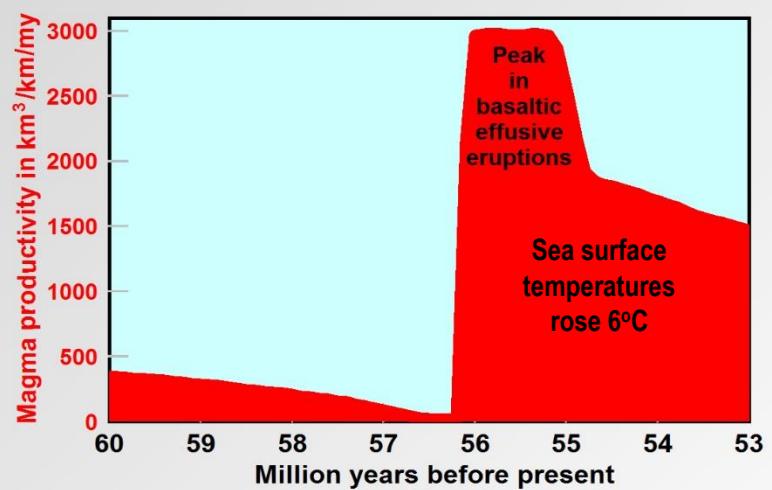
Greenhouse Gas Theory is Simply Wrong

1. There simply is not enough energy absorbed by greenhouse gases
2. The bonds holding greenhouse gases together are clearly observed to absorb radiation, but not to raise temperature
3. The assumption that greenhouse gases slow cooling of Earth ignores the fact that heat is transferred through the troposphere primarily by convection
4. The assumption that greenhouse gases radiate heat back to Earth breaks the Second Law of Thermodynamics
5. You do not stand next to a cold stove to warm up
6. A thermal body cannot warm itself



Paper on “The Thermodynamics of Climate Change”
is available at OzoneDepletionTheory.info

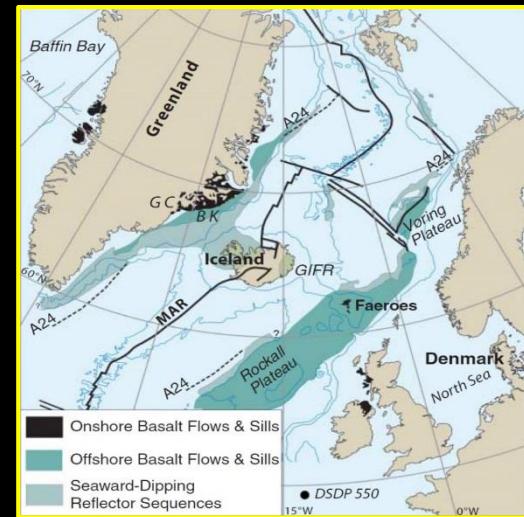
Major Temperature Change During Major Volcanism



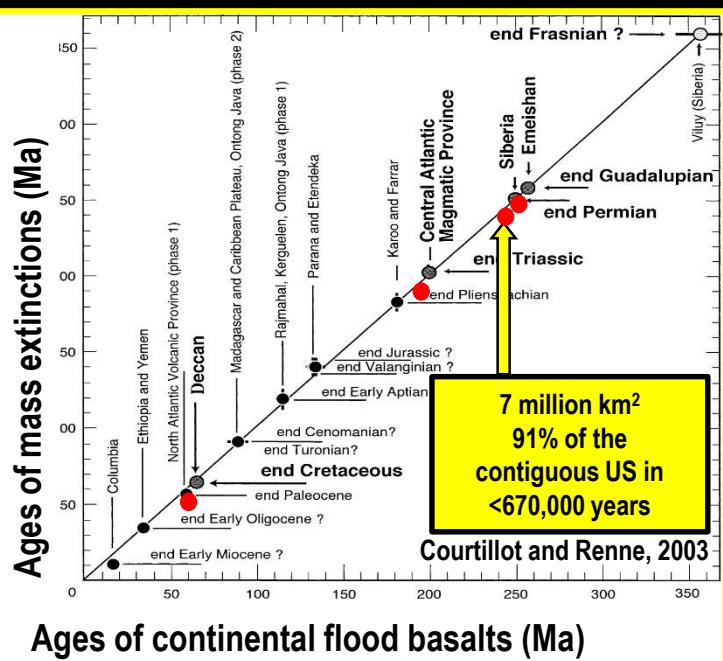
Paleocene Eocene **Thermal Maximum**

Extrusion of basaltic magma reached a peak 55 to 60 million years ago during the opening of the Greenland-Norwegian Sea. Temperature also reaches a peak.

Storey et al., 2007

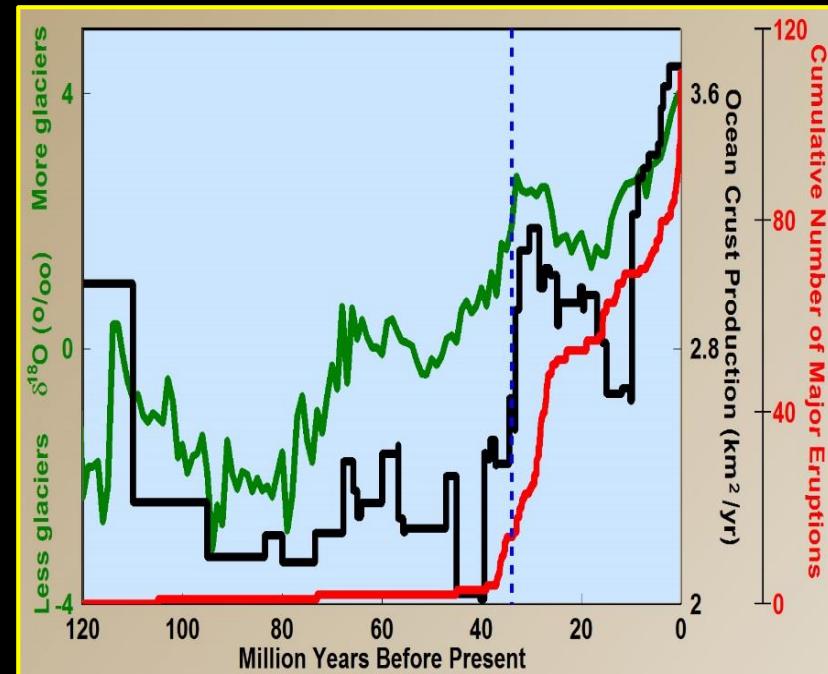


Flood Basalts and Mass Extinctions

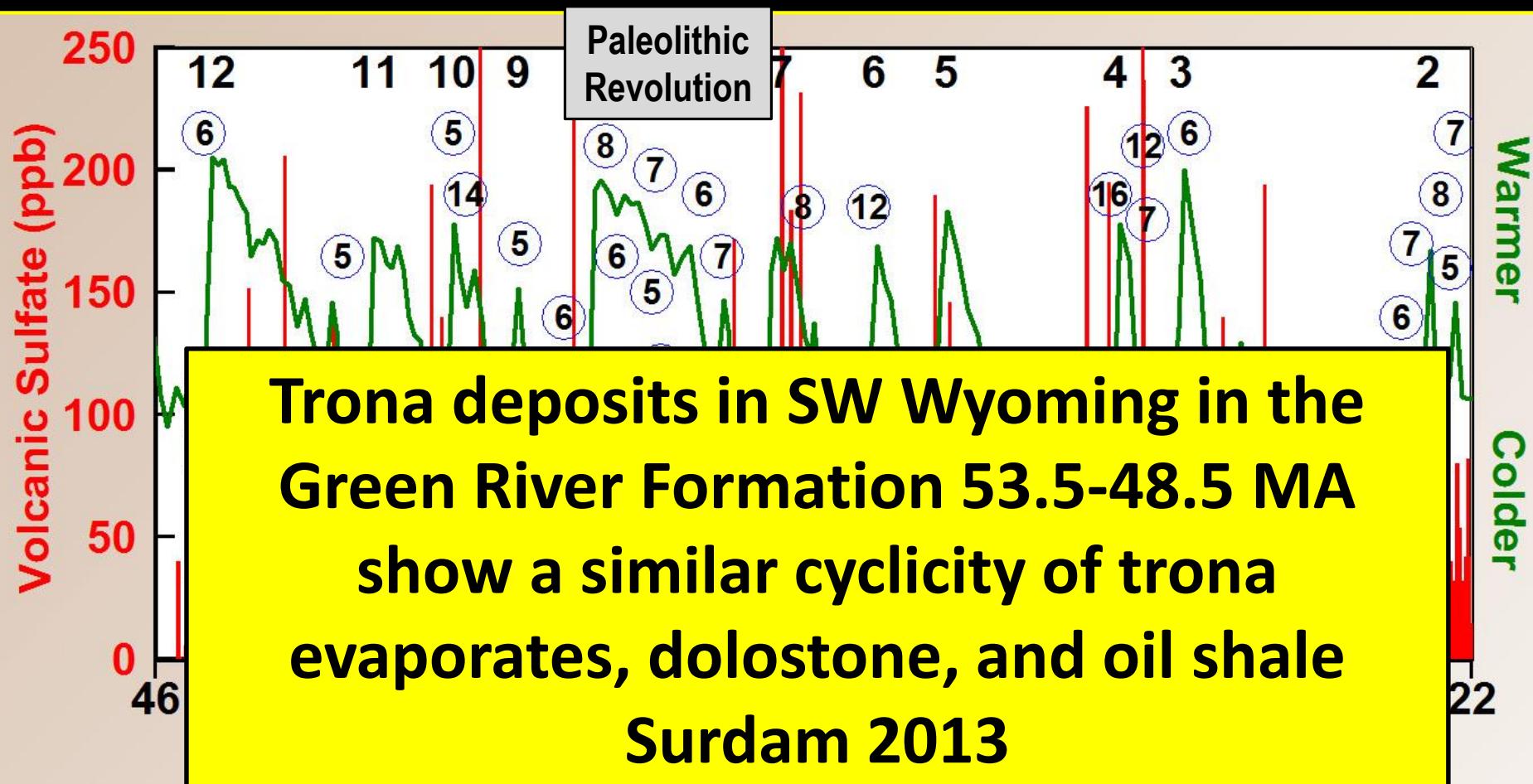


- Flood basalts
- lead to:
- Lethally hot climate
- Acidic oceans
- Ozone depletion
- Plant mutations
- Mass extinctions

Massive Expansion of Ice in Antarctica at 34 Ma



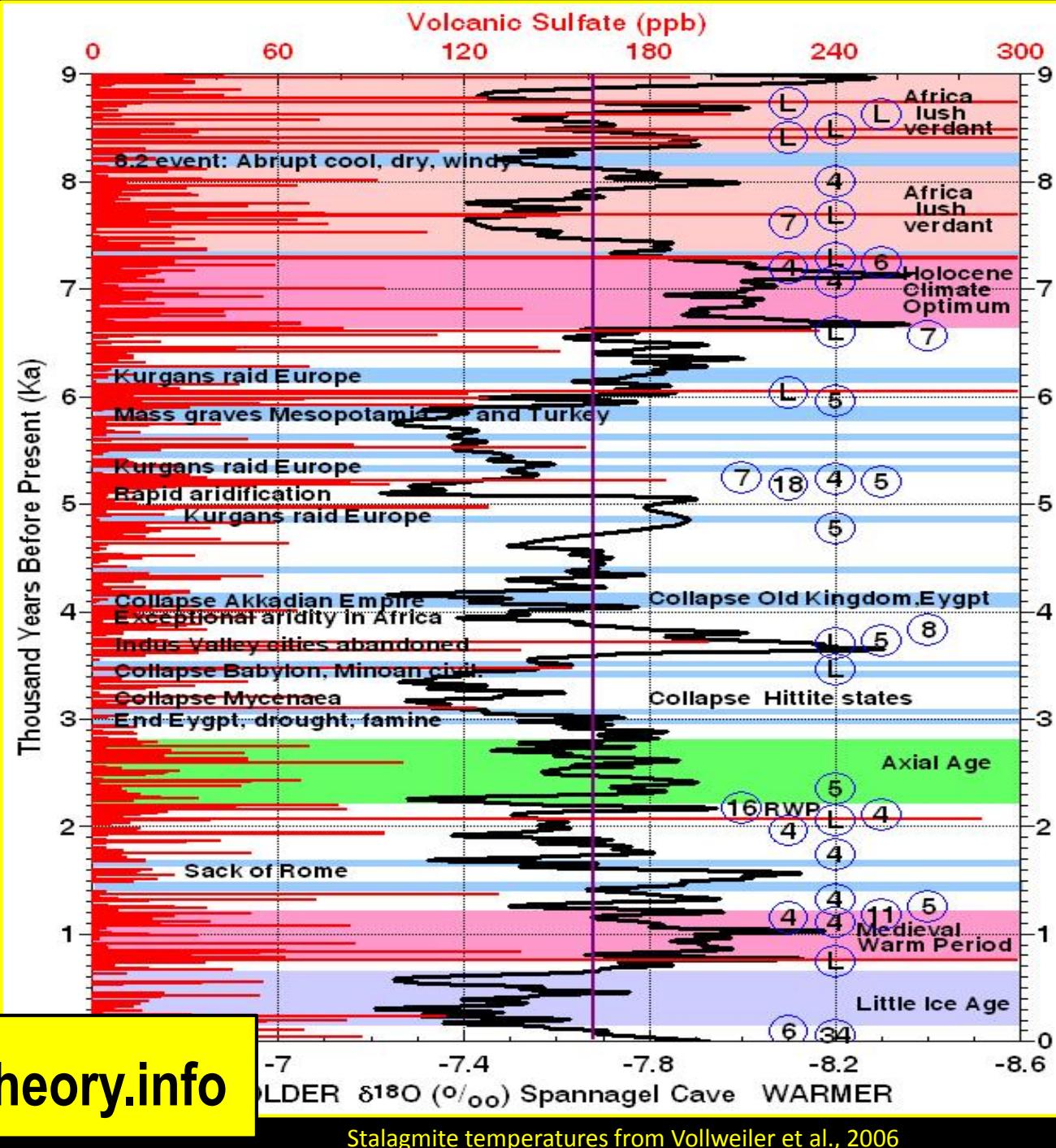
Dansgaard-Oeschger Sudden Warmings Caused by Effusive Volcanism Primarily in Iceland?



Brachiopod Habitat Temperatures
in the Paleozoic Giles 2012

In the last 9000 years
 volcanism (red)
 shows a close
 relationship to
 temperature (black)
 and to
 human history

Ward 2009



Conclusions

1. Explosive volcanoes form aerosols in the lower stratosphere, reflecting sunlight, cooling Earth
2. Effusive, basaltic volcanoes deplete ozone, warming Earth
3. The balance between cooling and warming is controlled by plate tectonics
4. Sudden changes in volcanism show a close relationship to sudden changes in geologic epochs, ages, and evolution of life on Earth

Volcanoes rule!