Bringing Peace to the Climate Wars

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Science Is Never Settled

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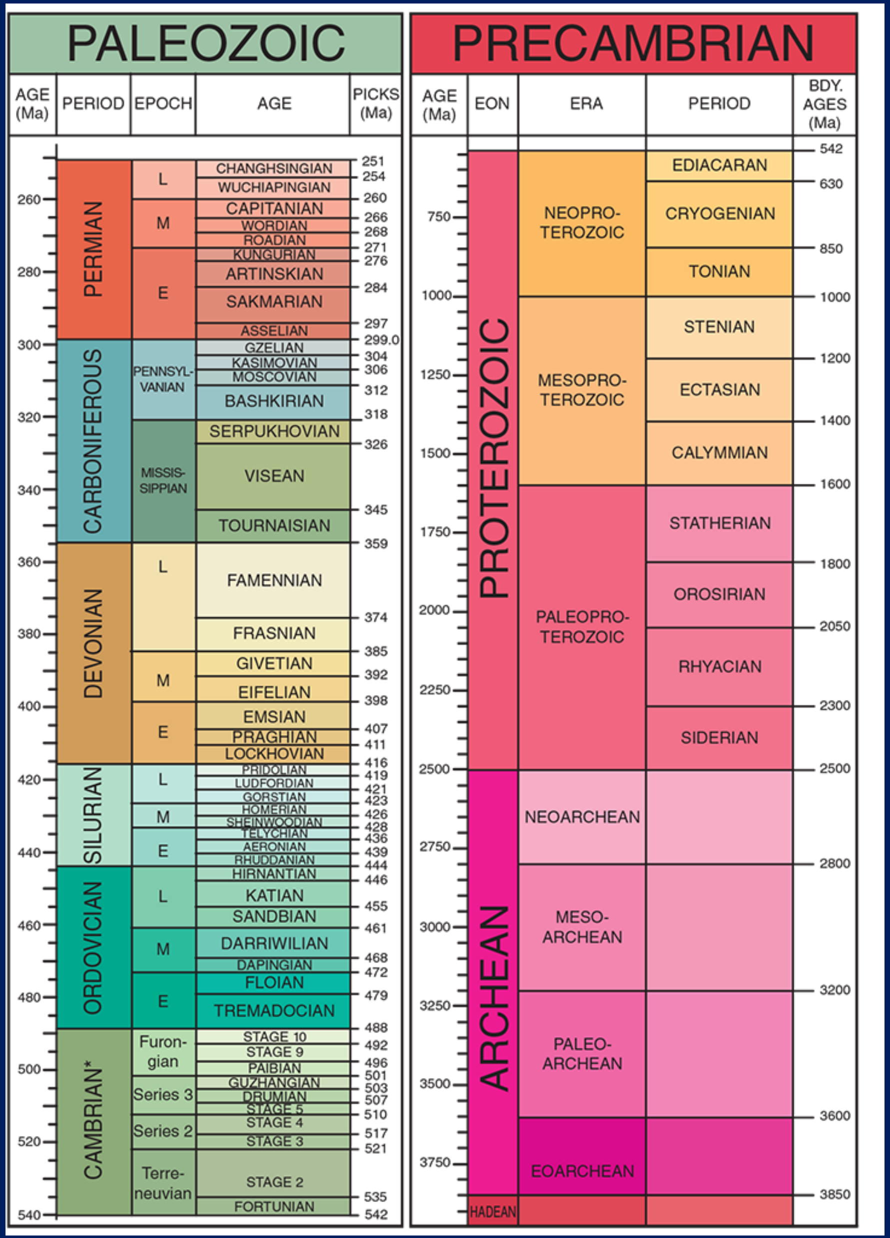
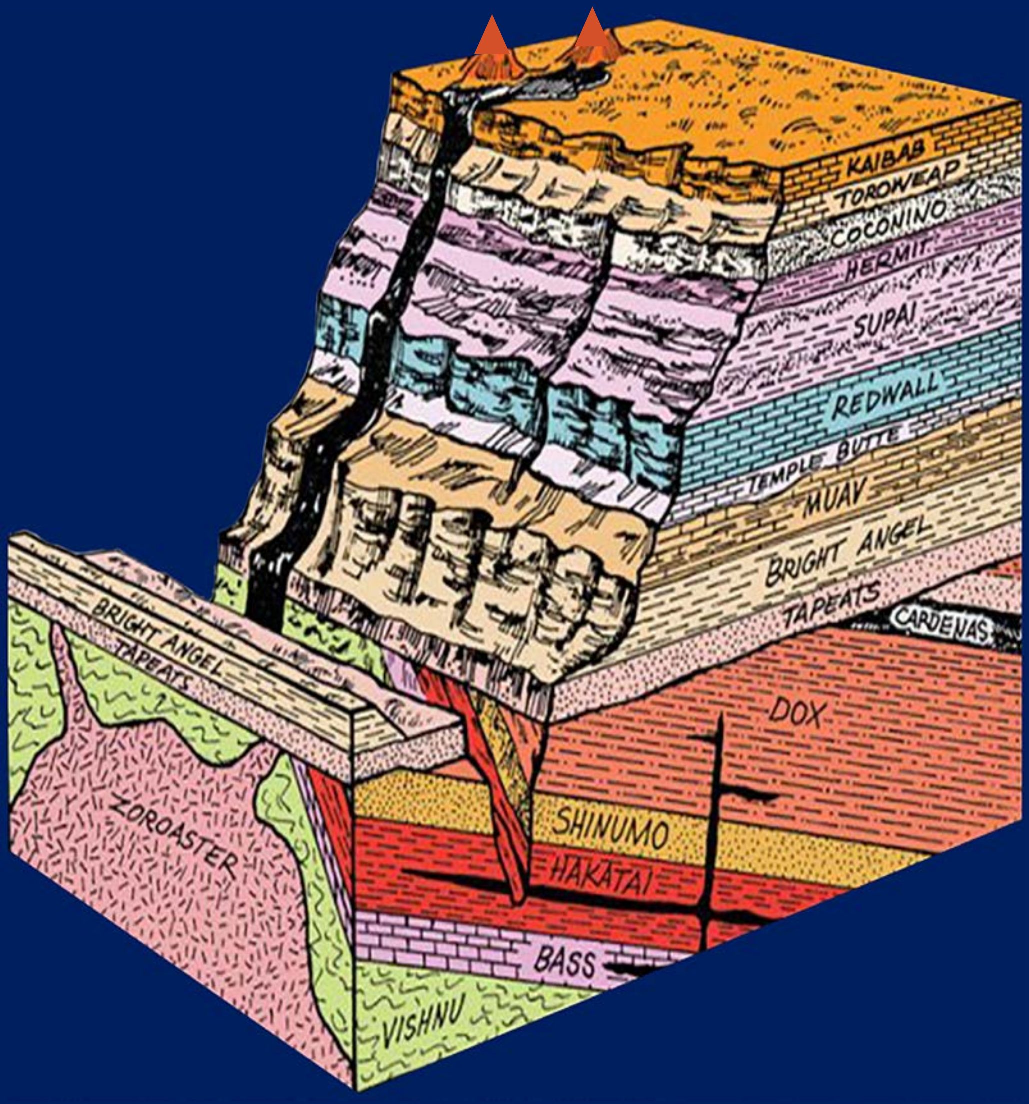
These three conclusions redefine the climate wars in important ways,
providing an opportunity, with a little humility on all sides,
for all of us to work together for the benefit of humanity.

What causes the sudden changes in fossils and sediments?





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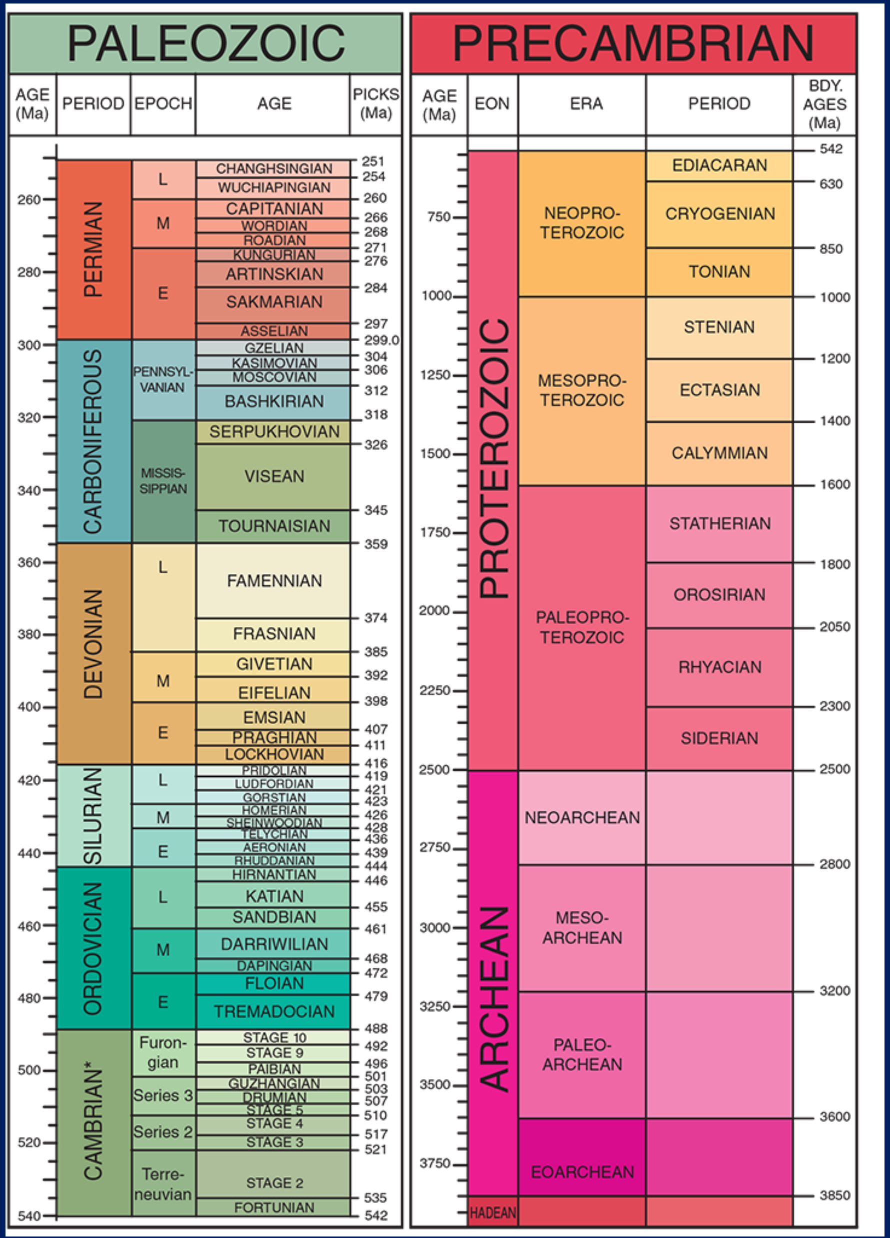
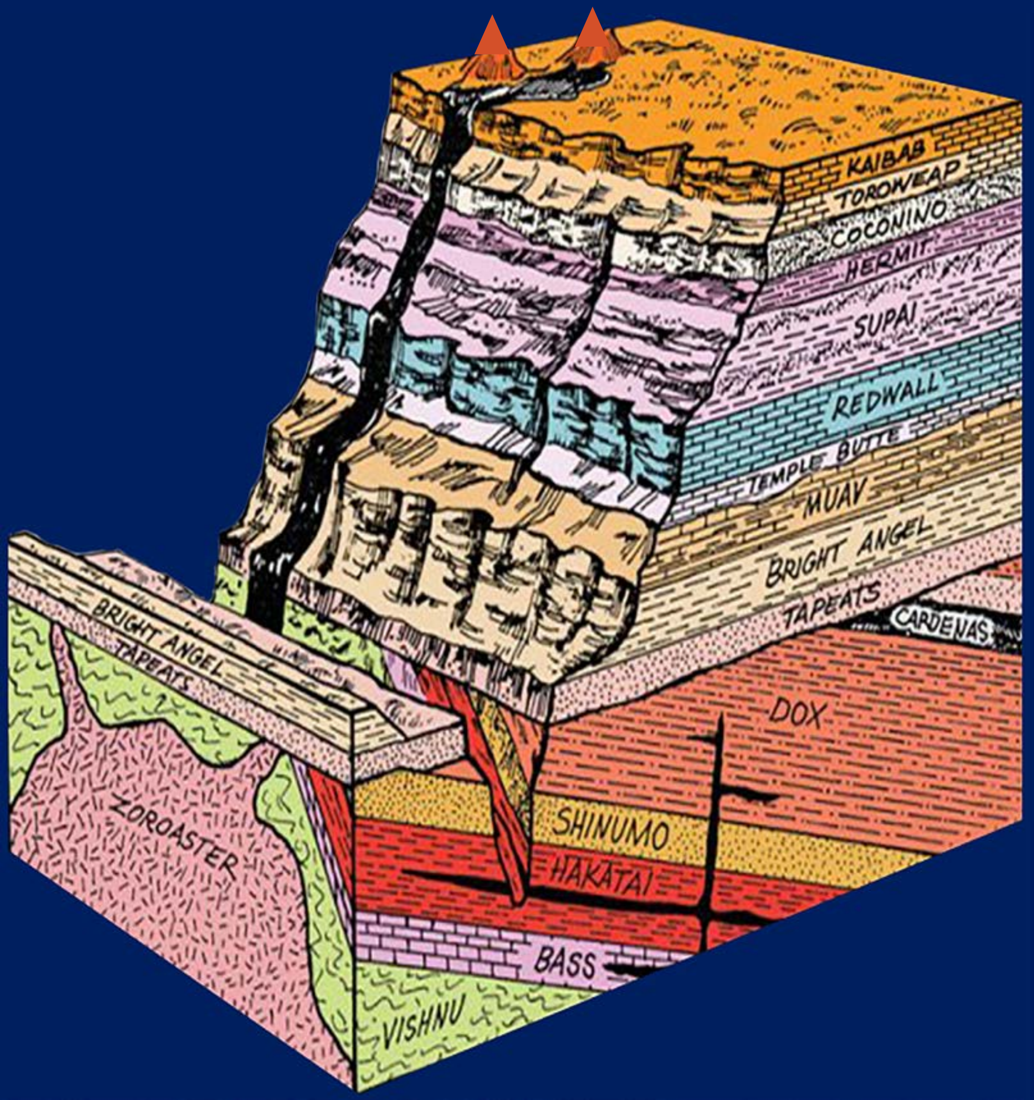
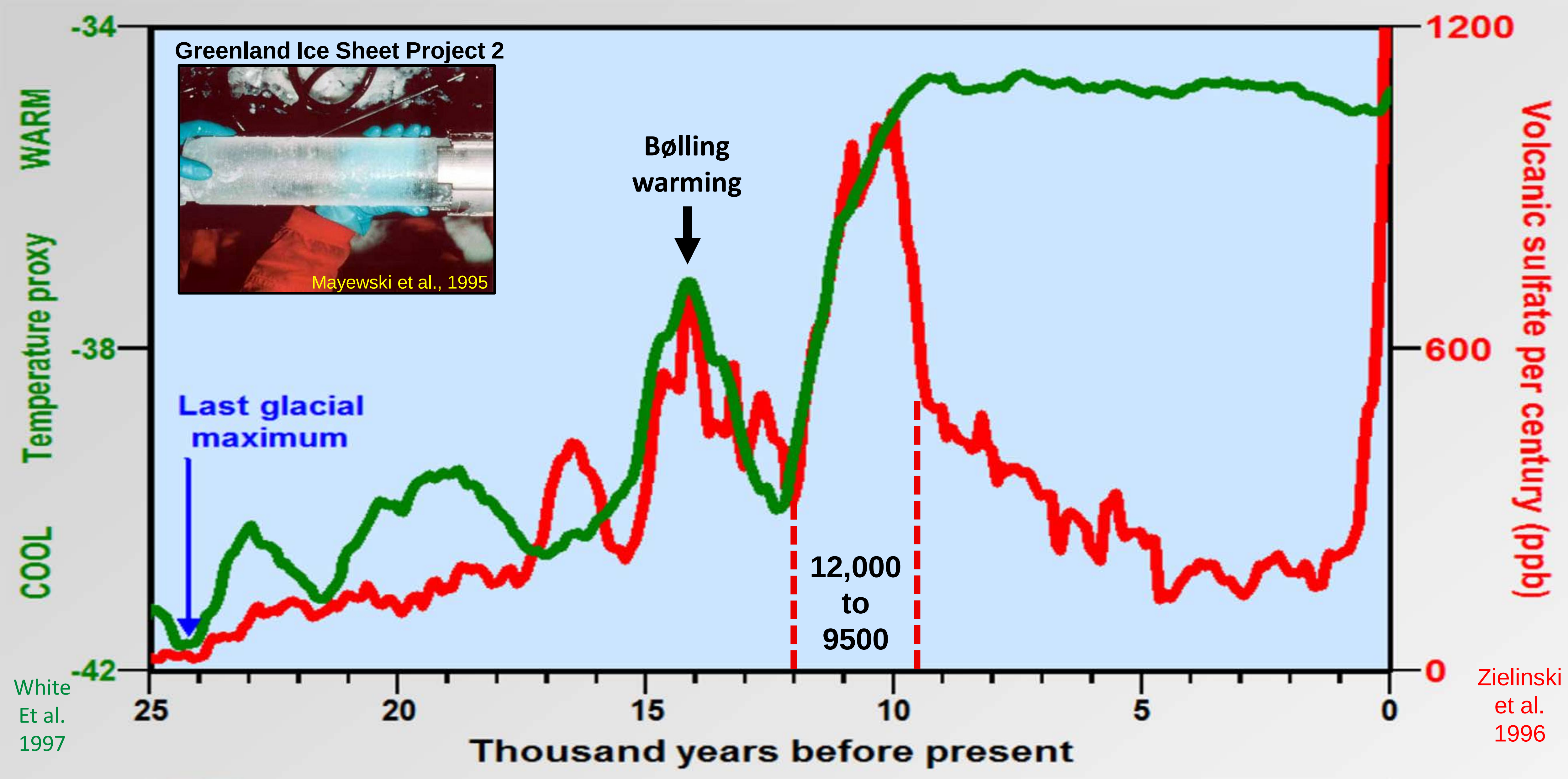




Large Igneous Provinces (LIPs)

The enigma: Volcanism ended the last ice age



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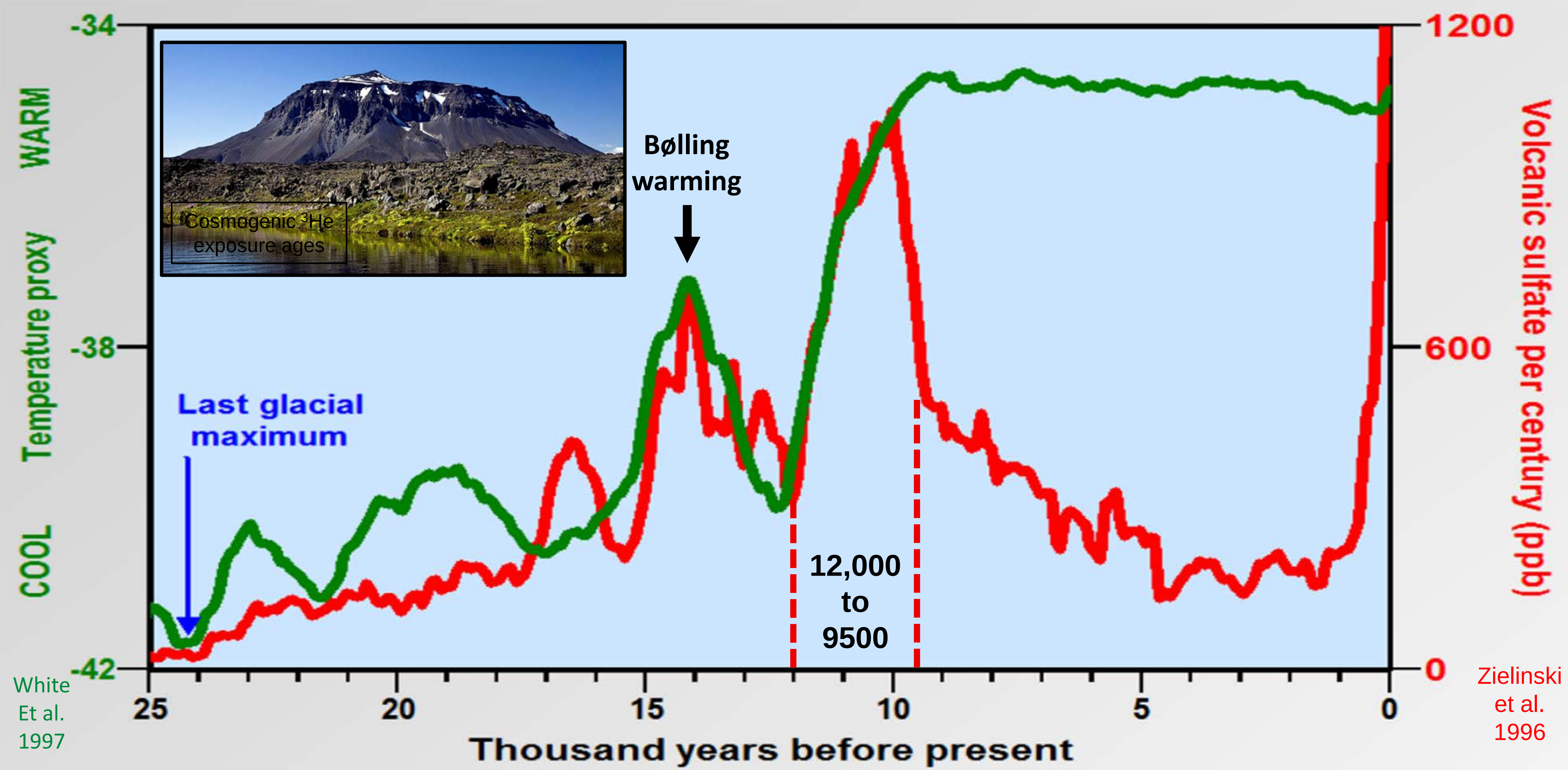
Basaltic volcanism ended the last ice age



White Et al. 1997

Zielinski et al. 1996

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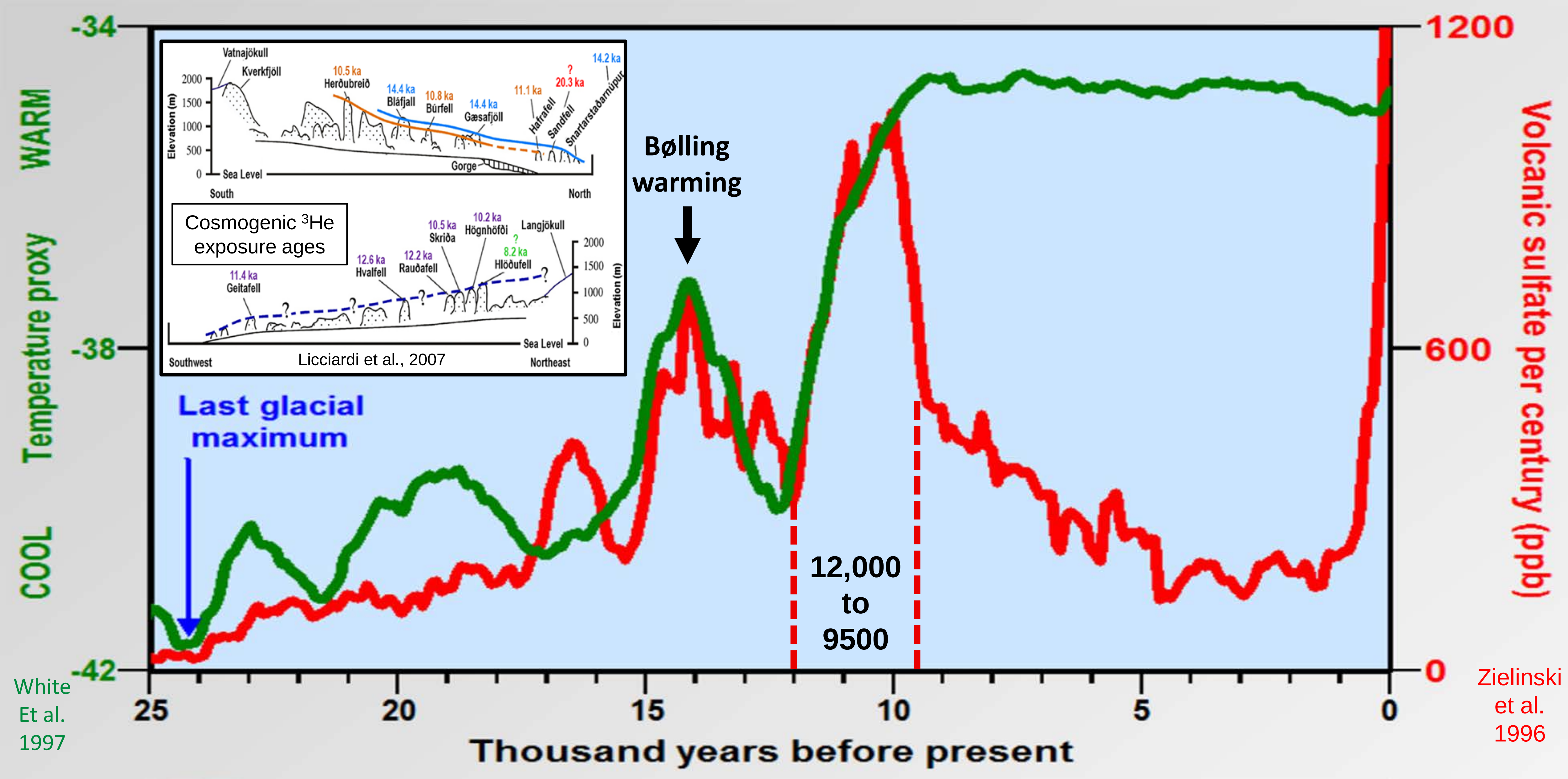

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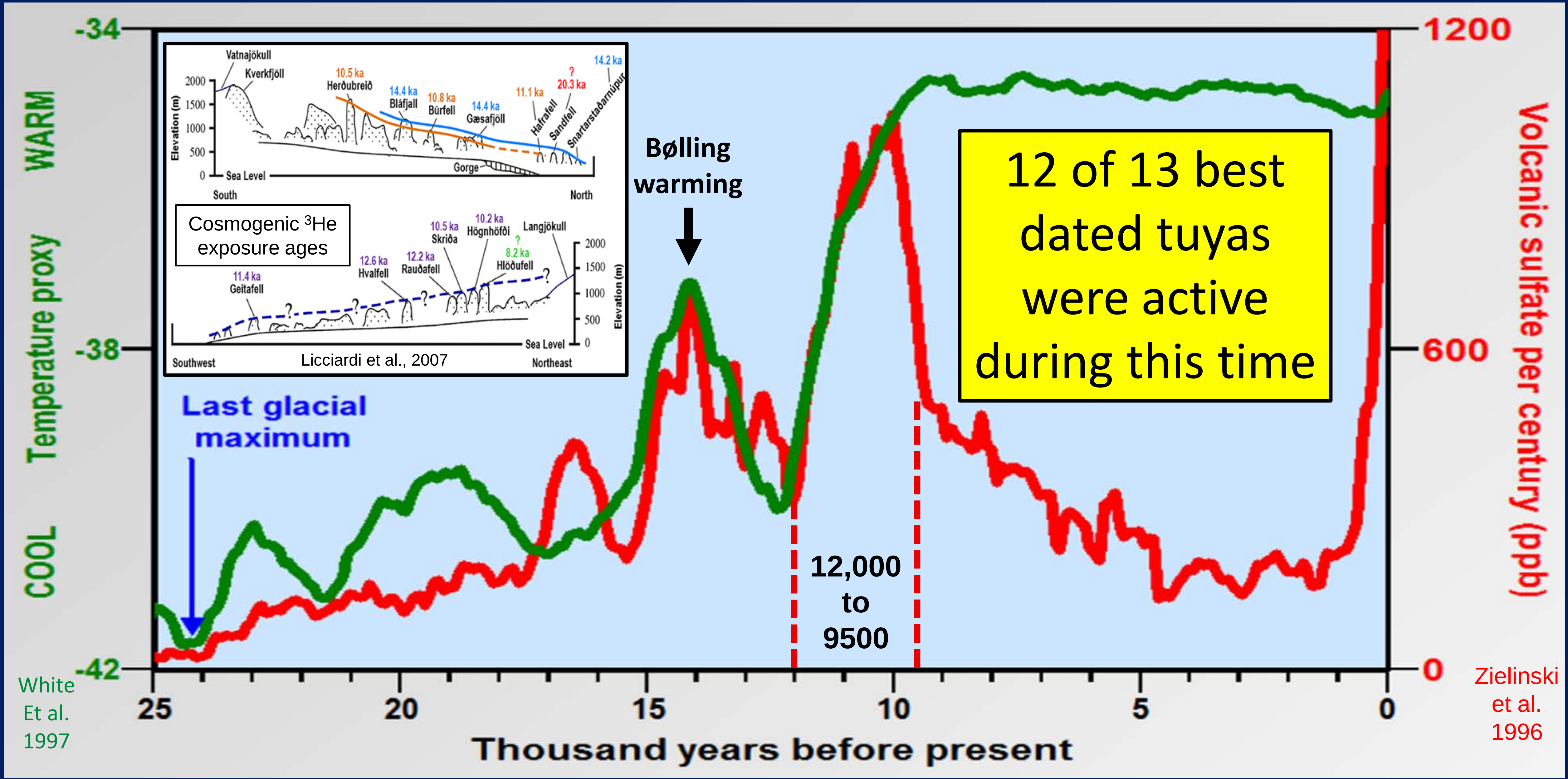


Bárðarbunga 2014

Aerially extensive flood-basaltic eruptions

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Occur in rift zones

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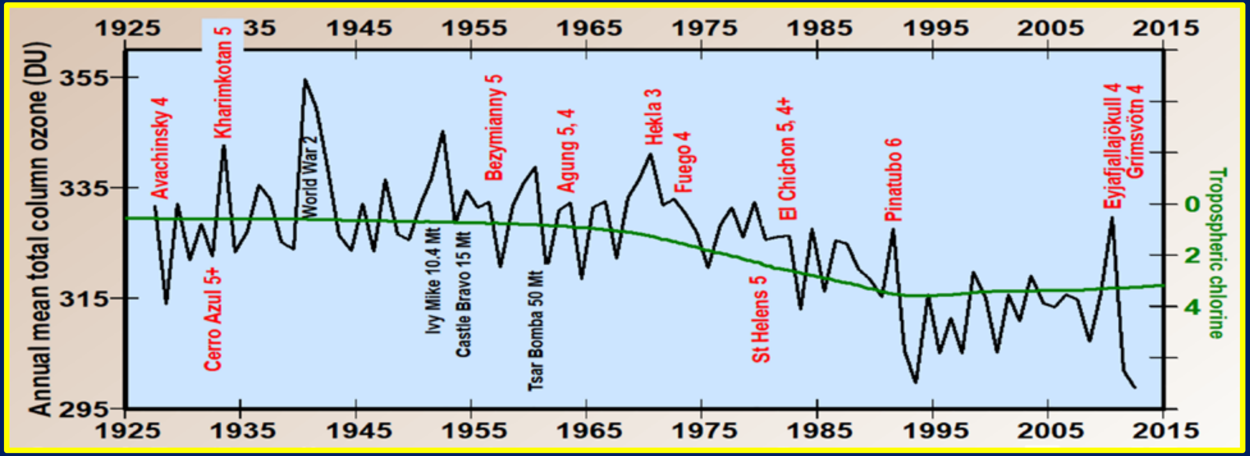
Chlorine and bromine deplete ozone, warming Earth GLOBALLY many degrees within years



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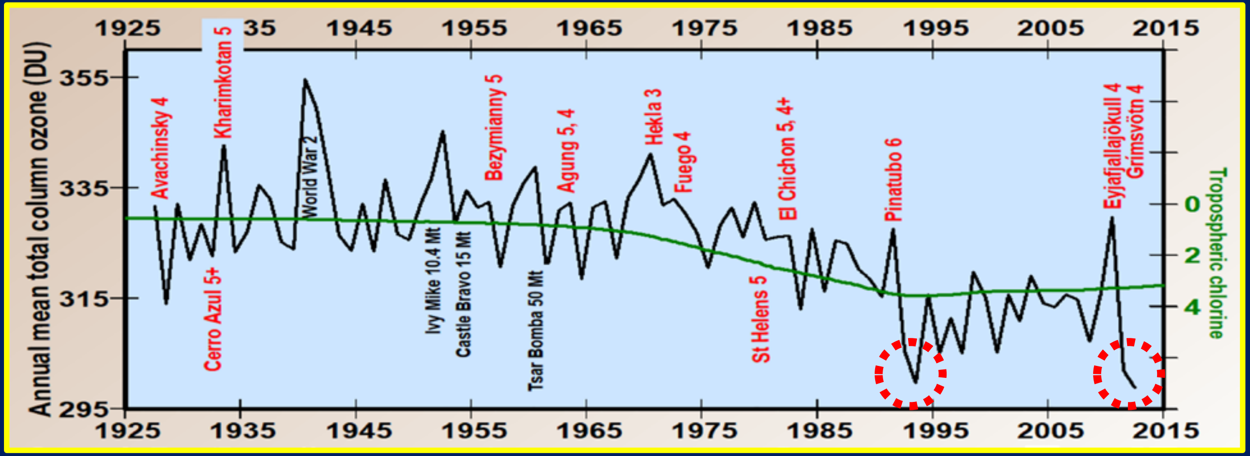

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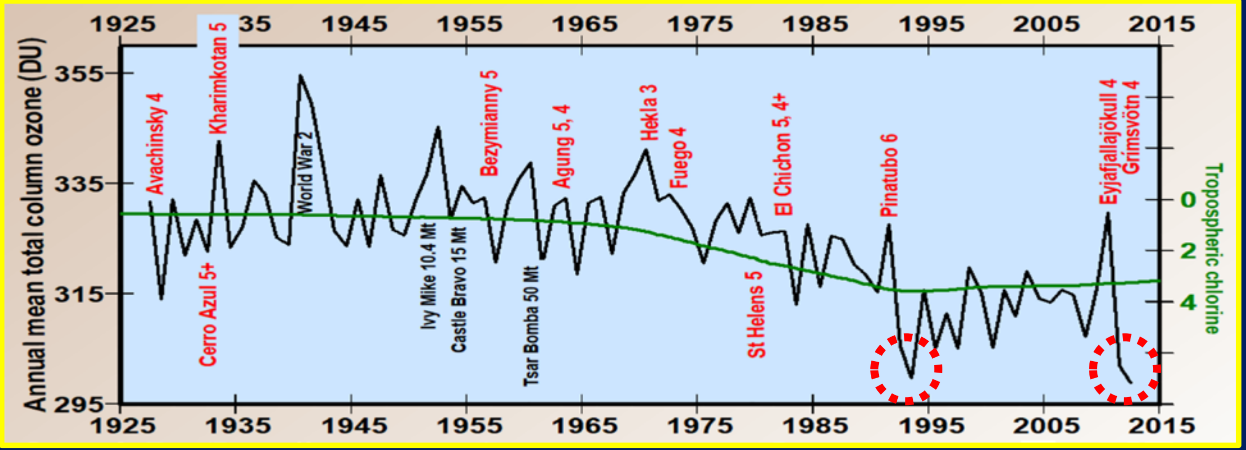

Amount of global warming is determined by the duration and aerial extent

Bárðarbunga 2014

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Aerosol **forming** explosive eruptions

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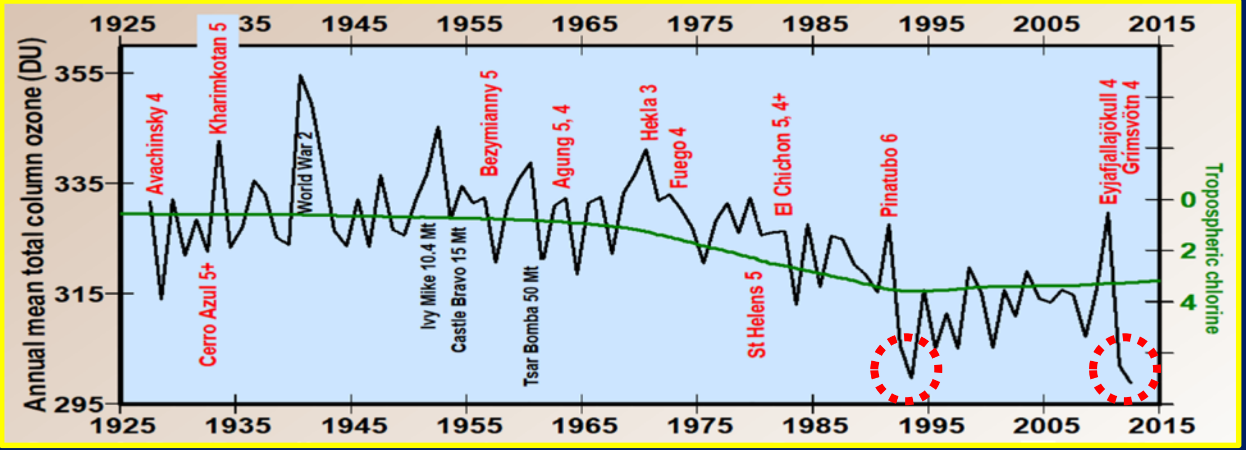

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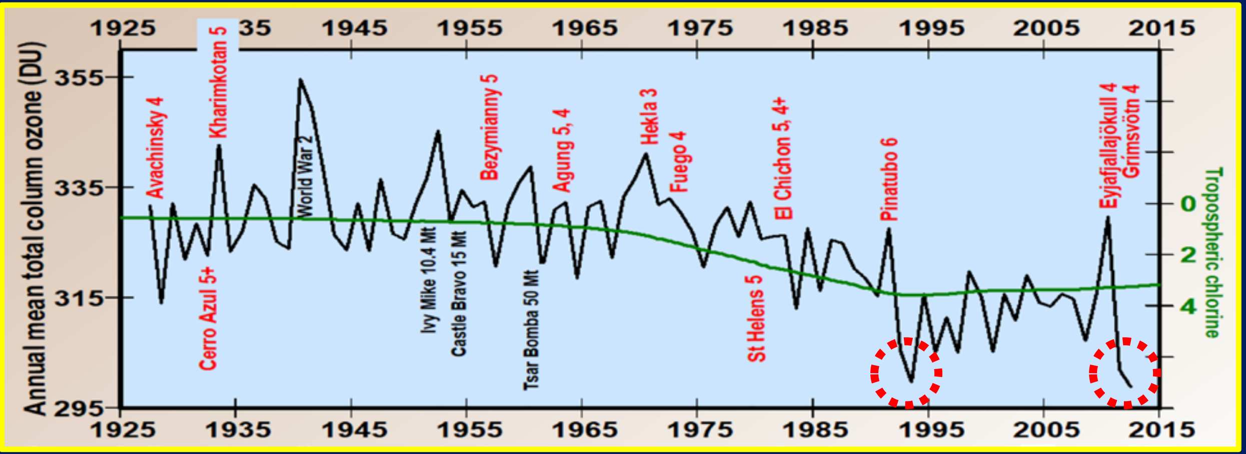

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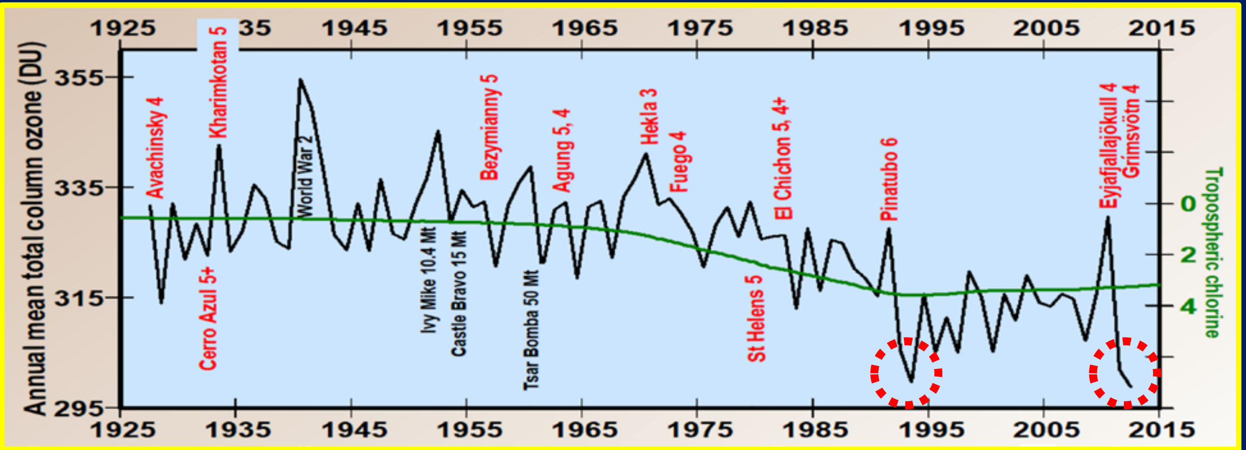

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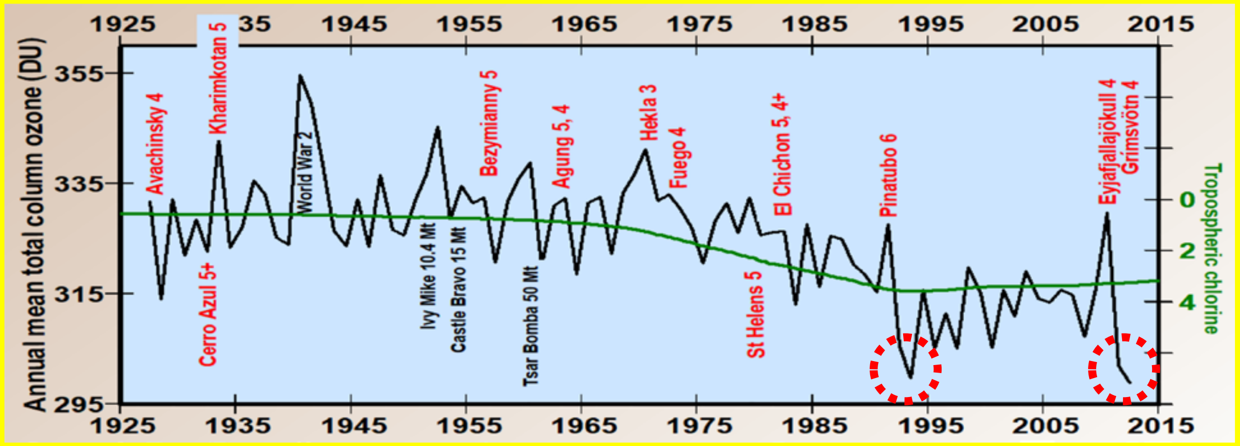

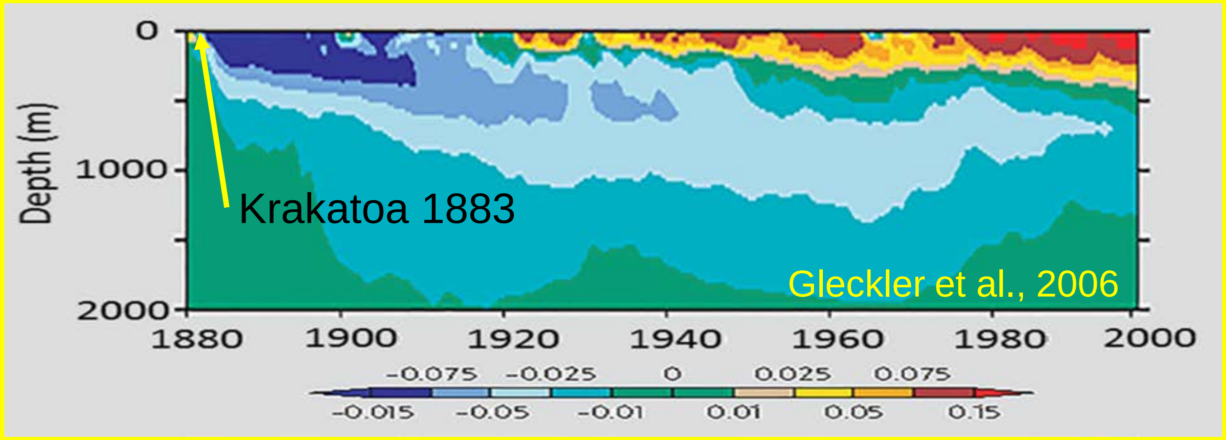

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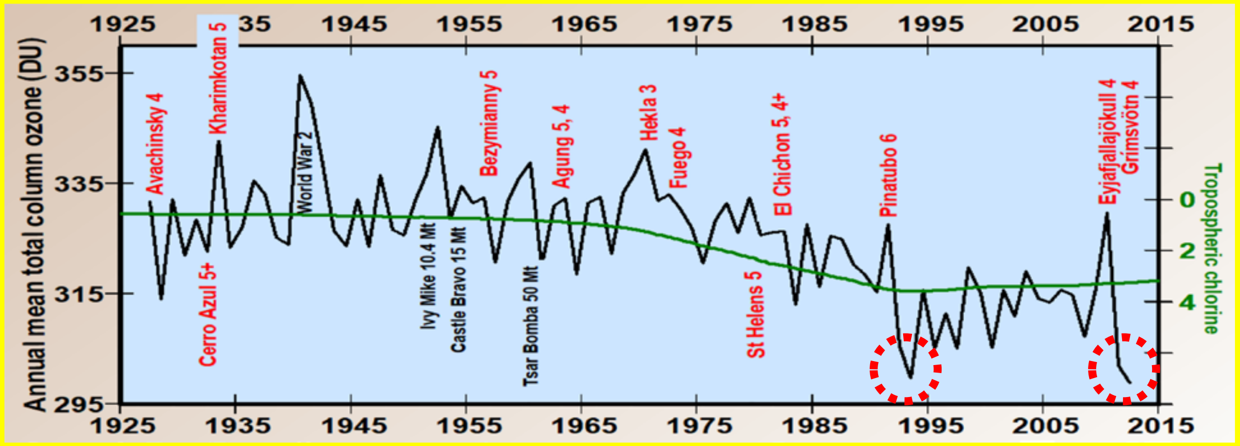

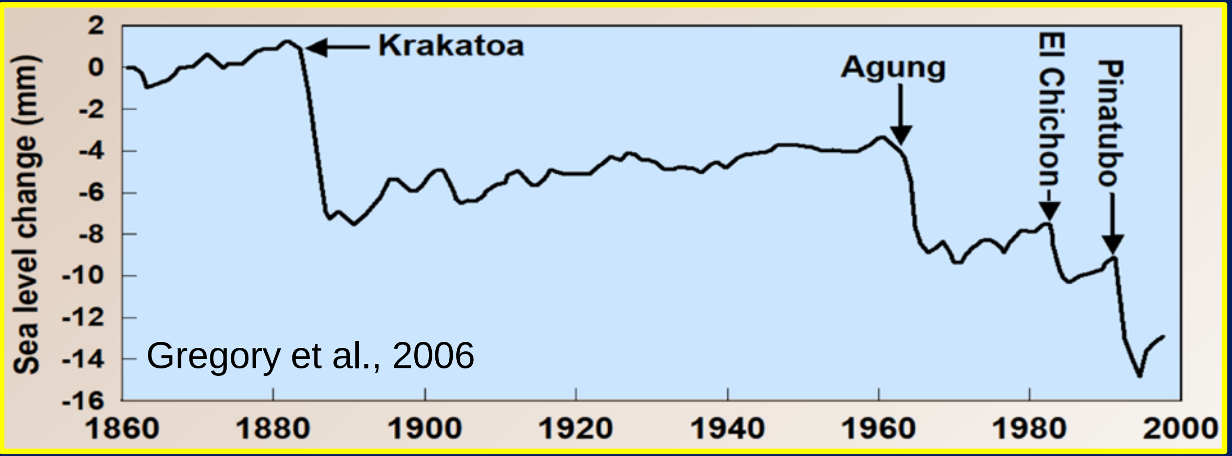

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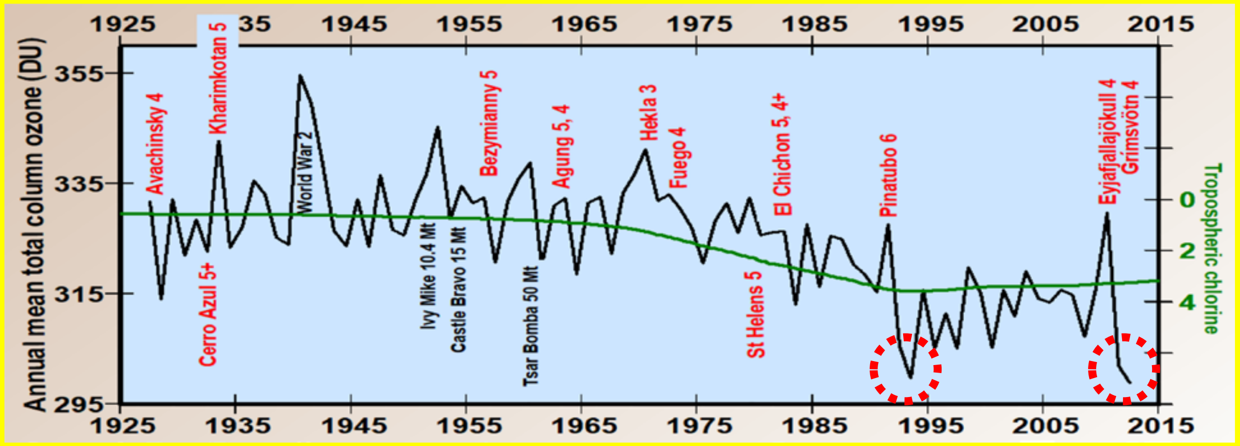

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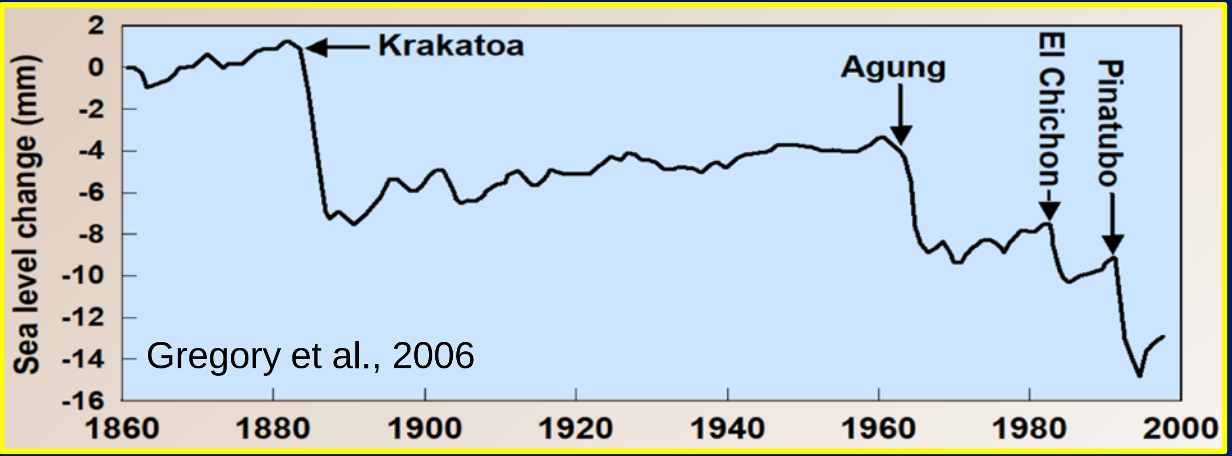
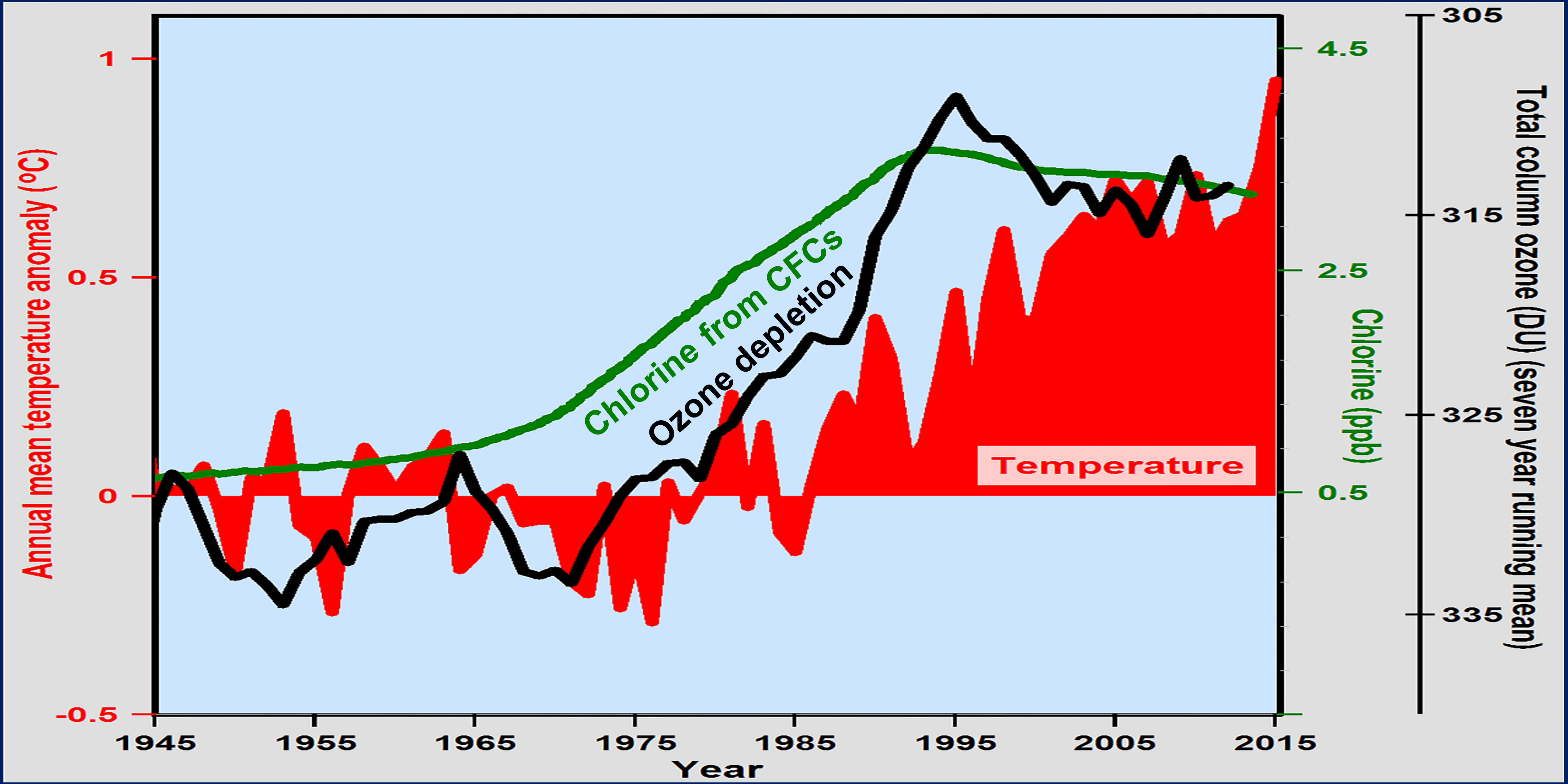


Amount of global cooling is determined by the number of eruptions per century

Human-caused global warming



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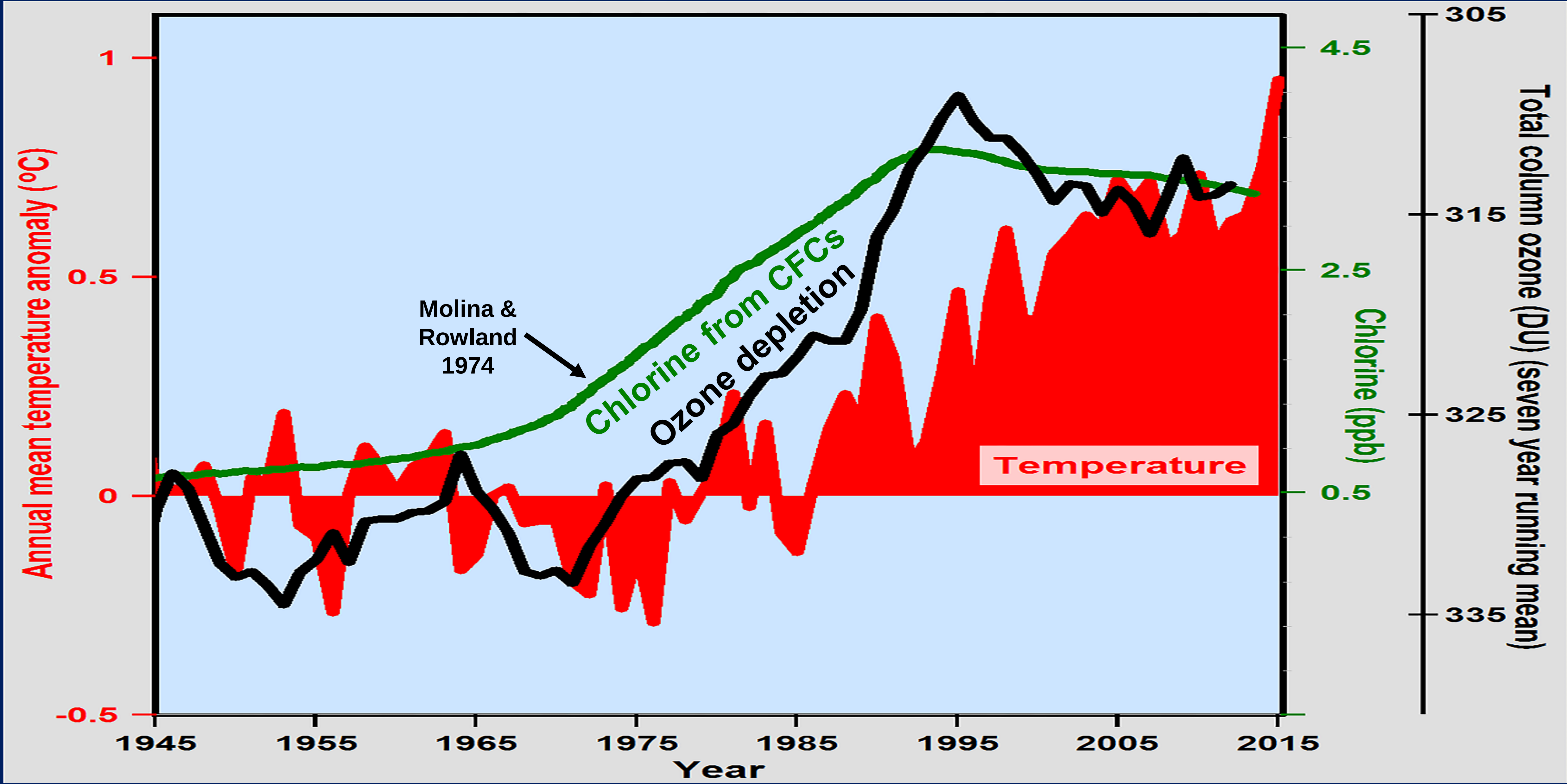

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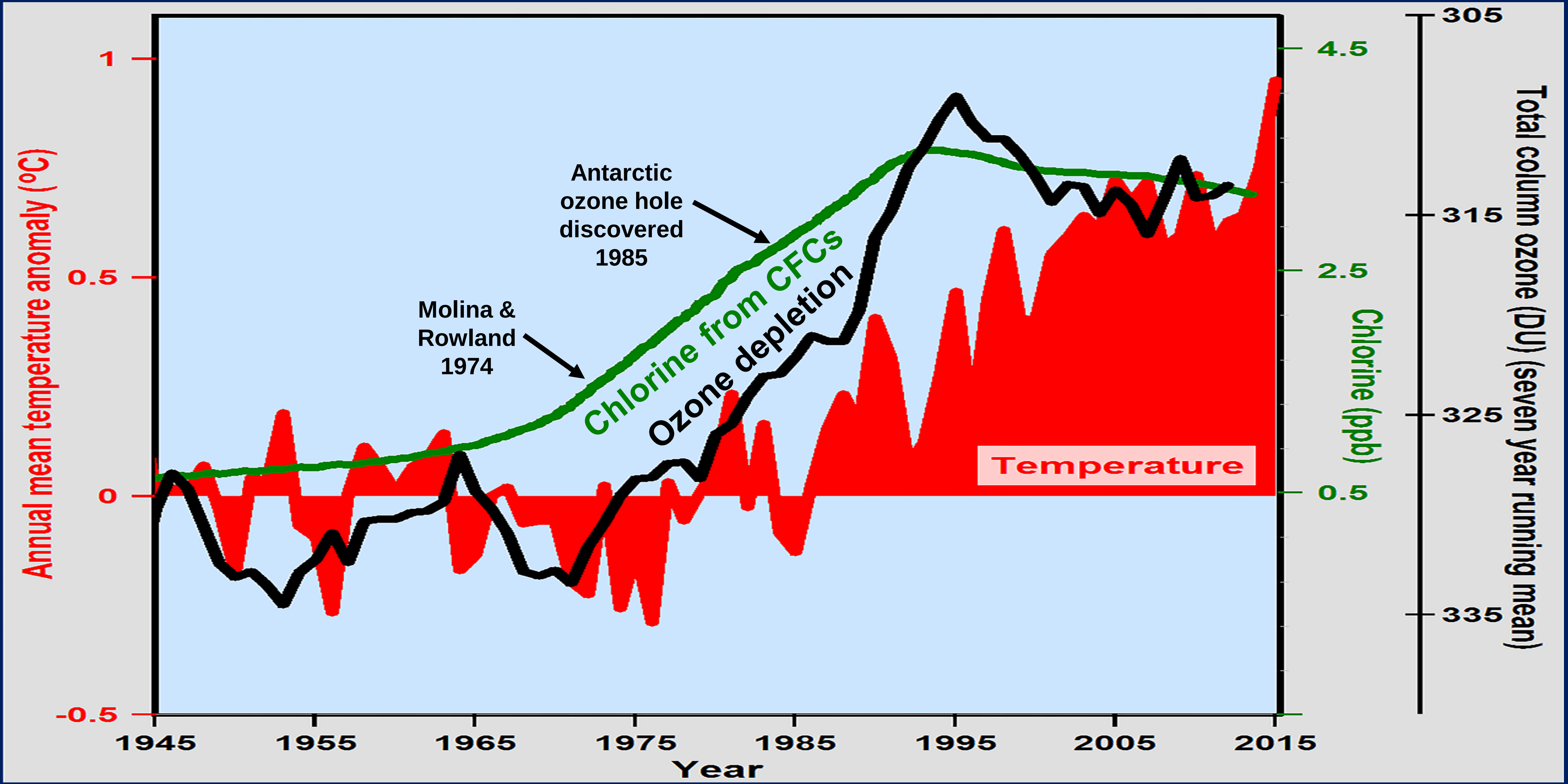

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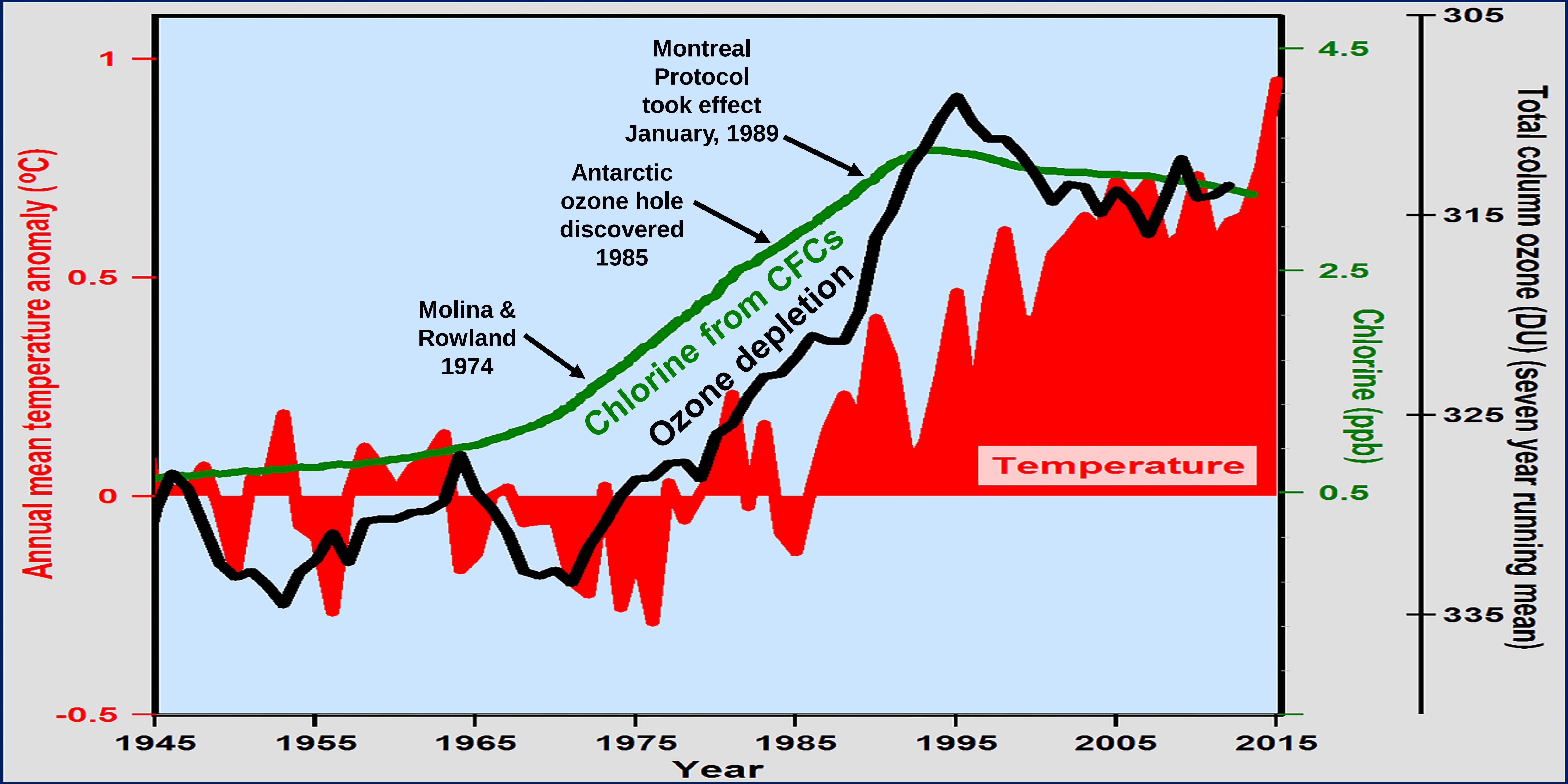

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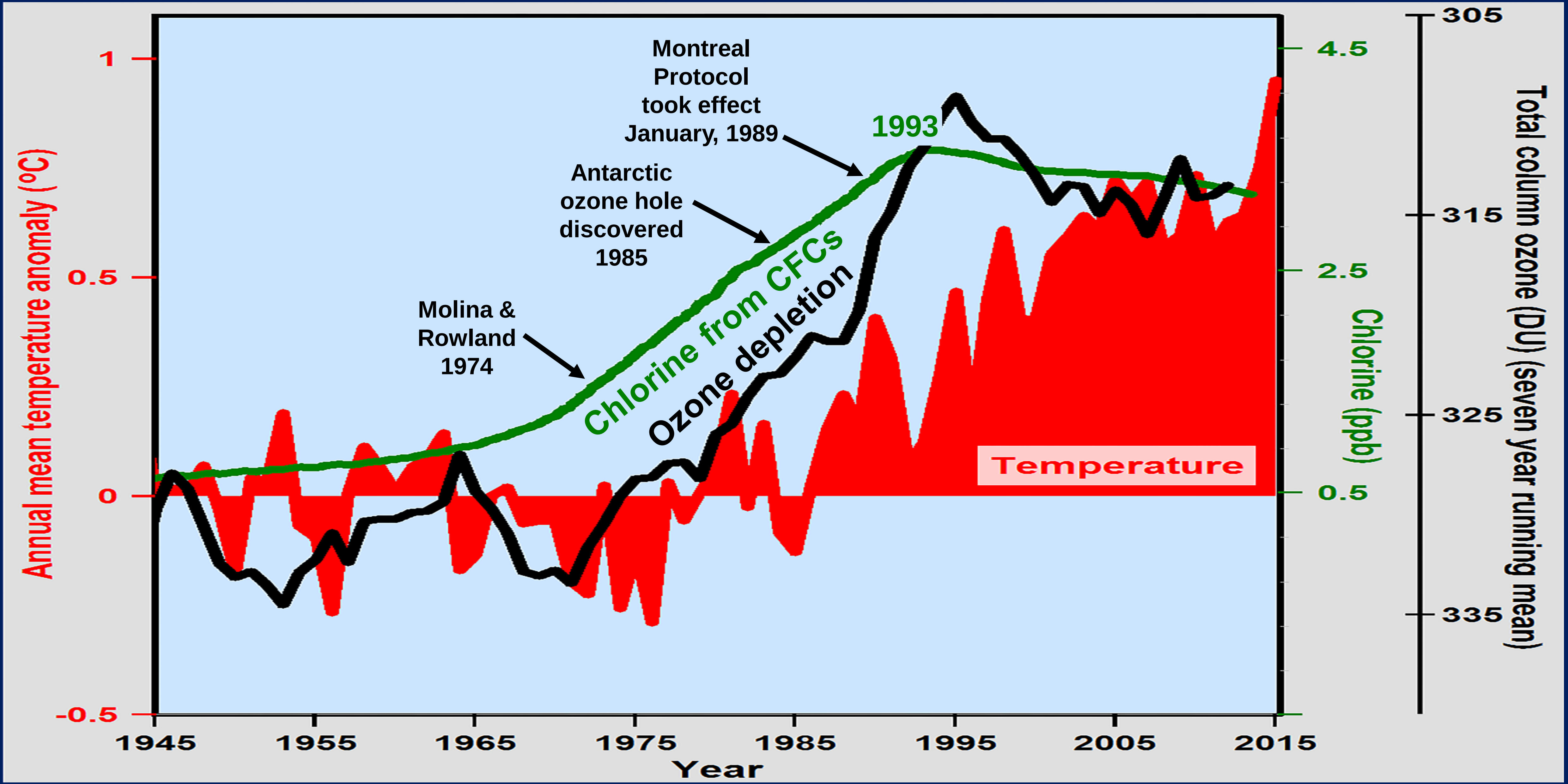

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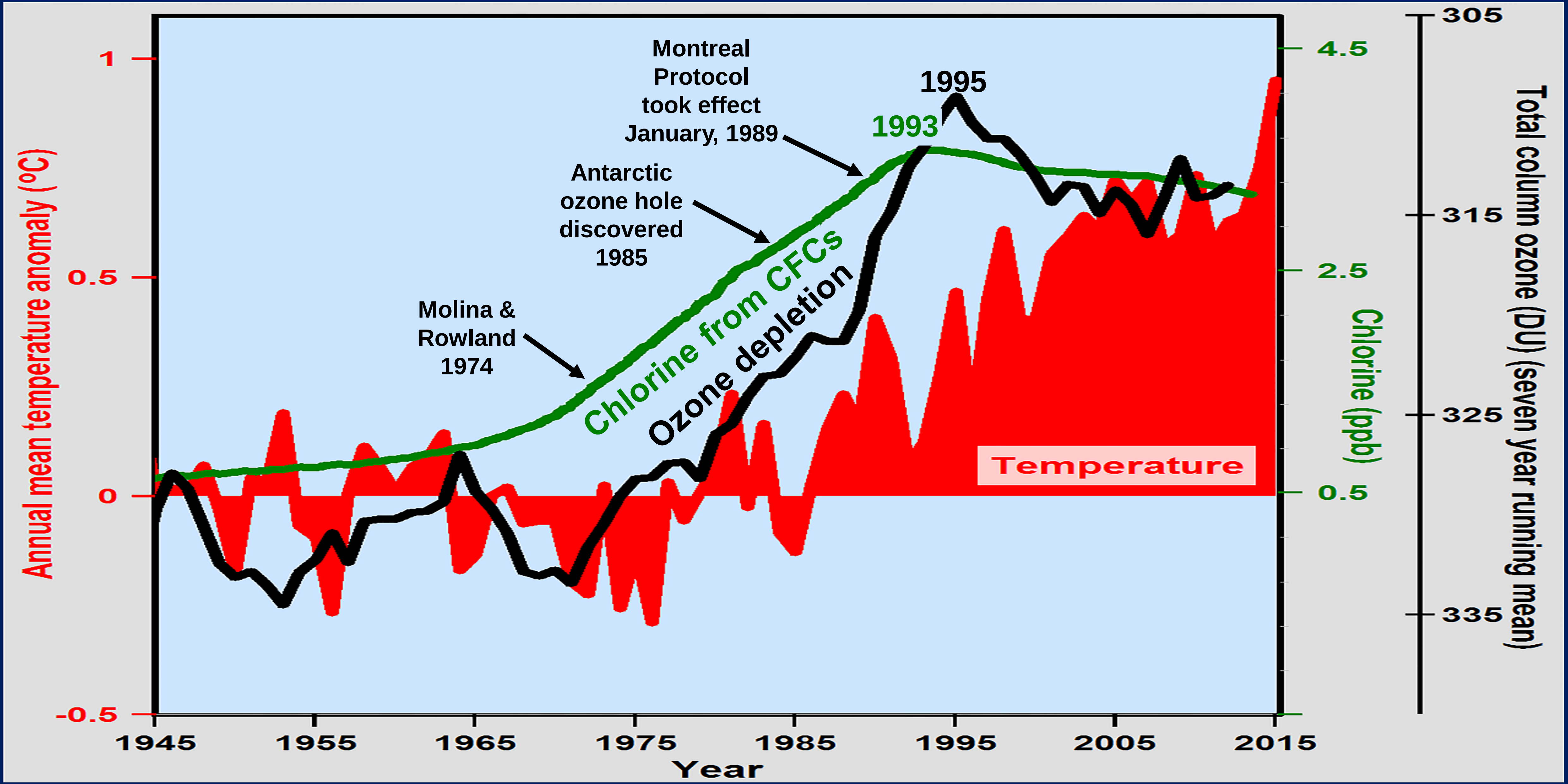

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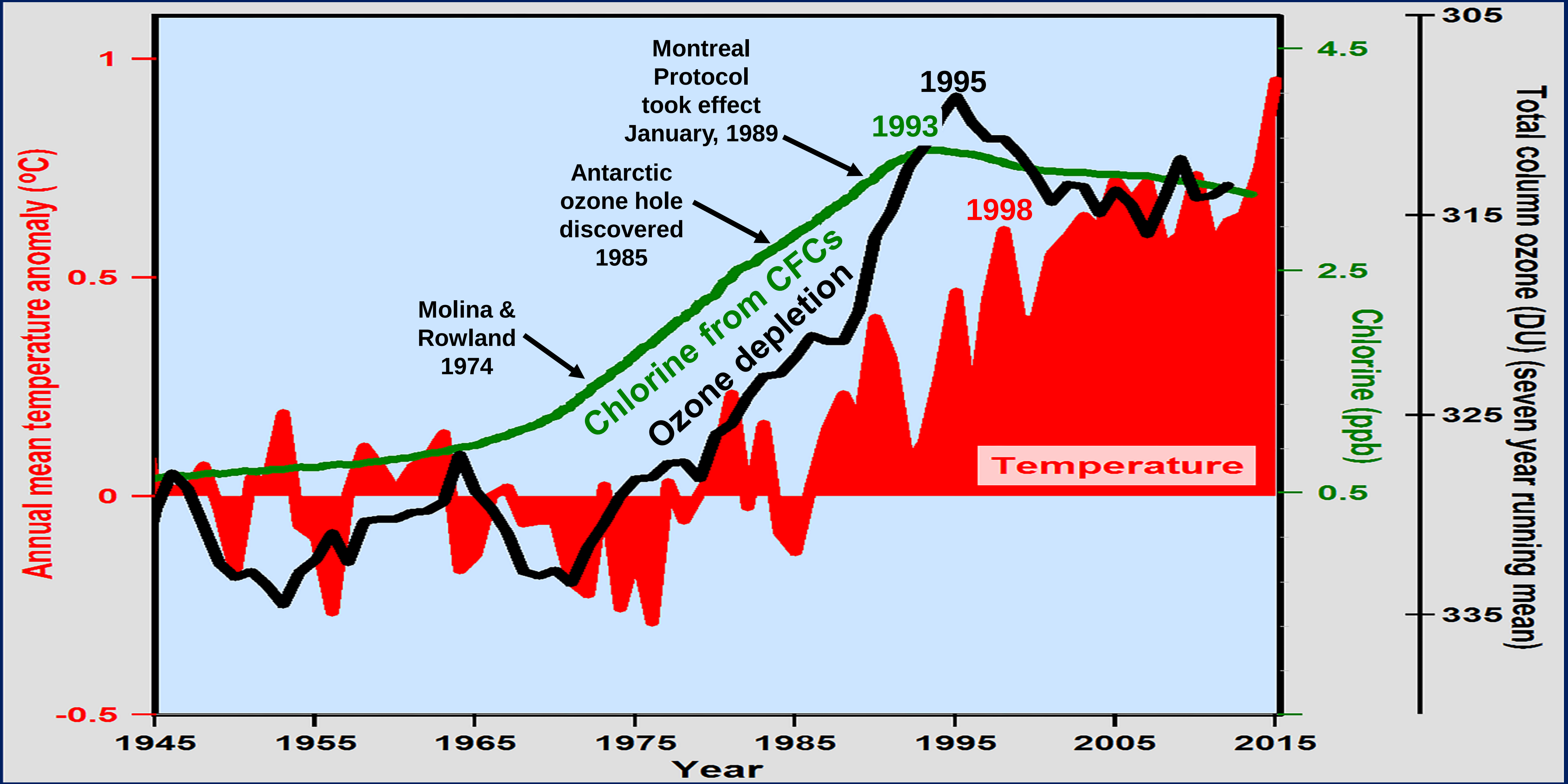

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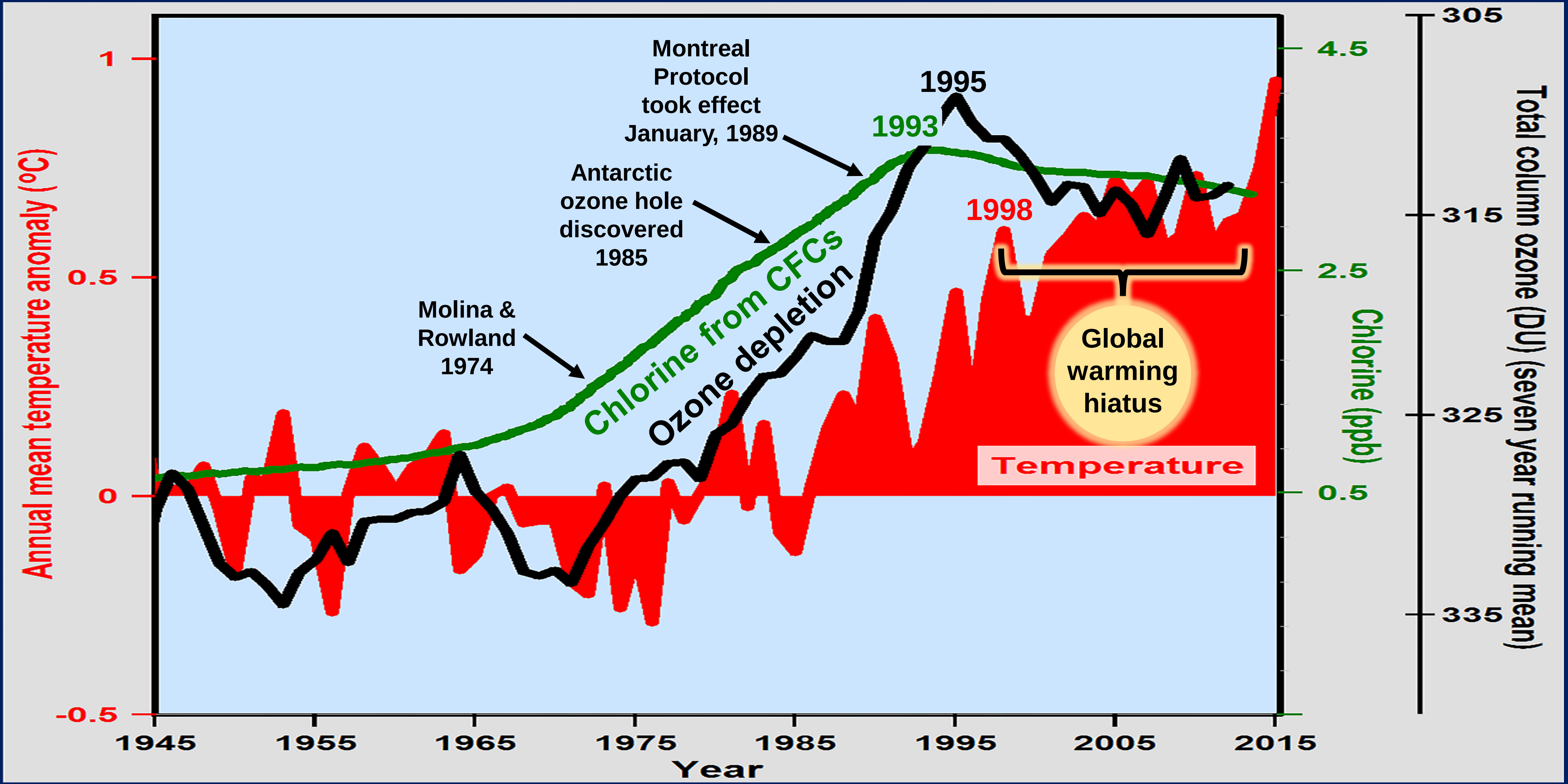

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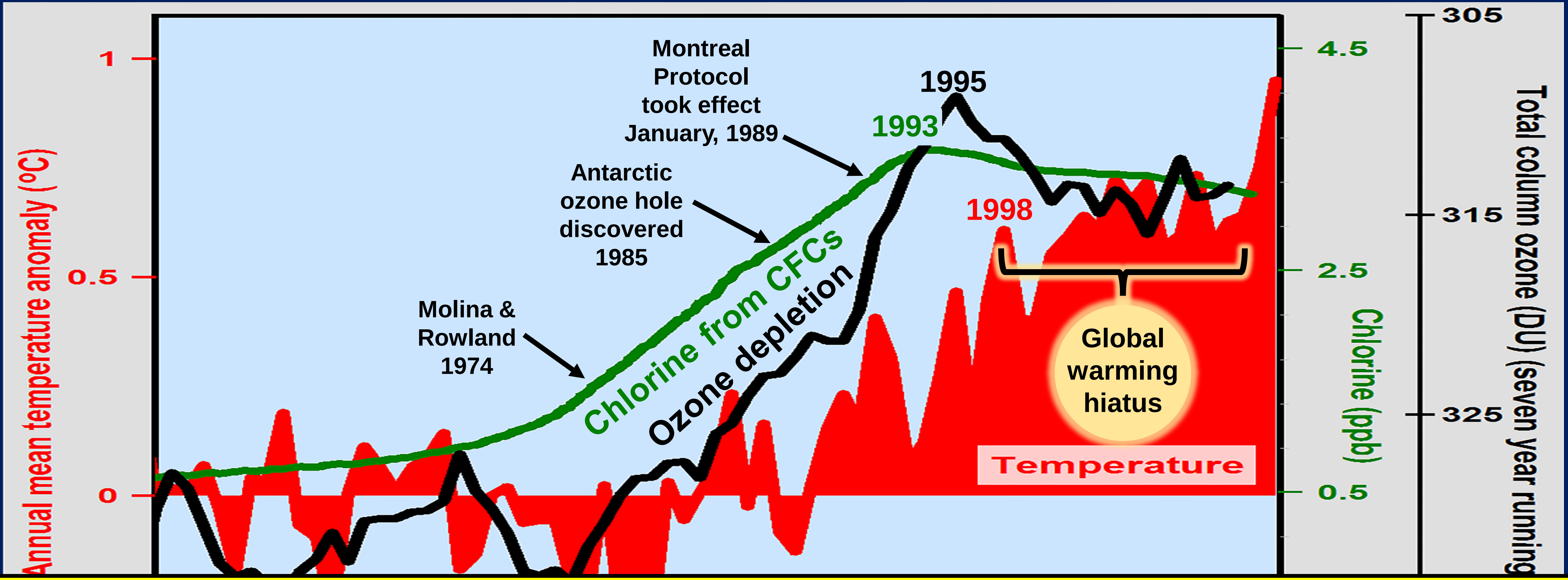
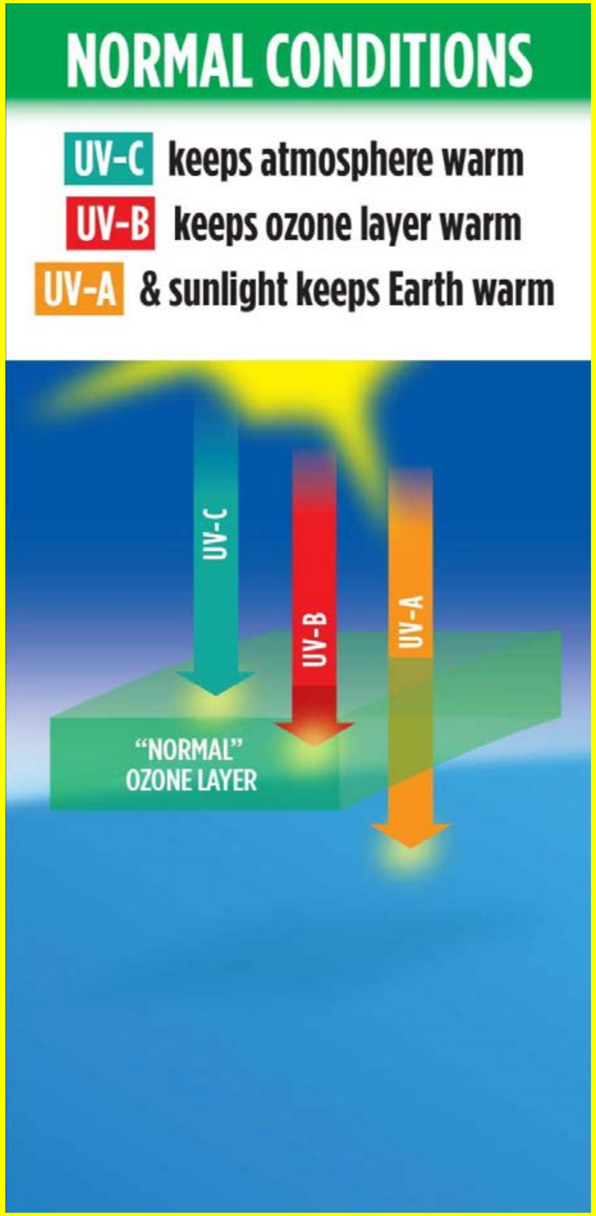


Increasing CFCs caused increasing warming from 1970 to 1998
The Montreal protocol stopped the increases
BUT ozone remained depleted

The effects of ozone depletion and of aerosols



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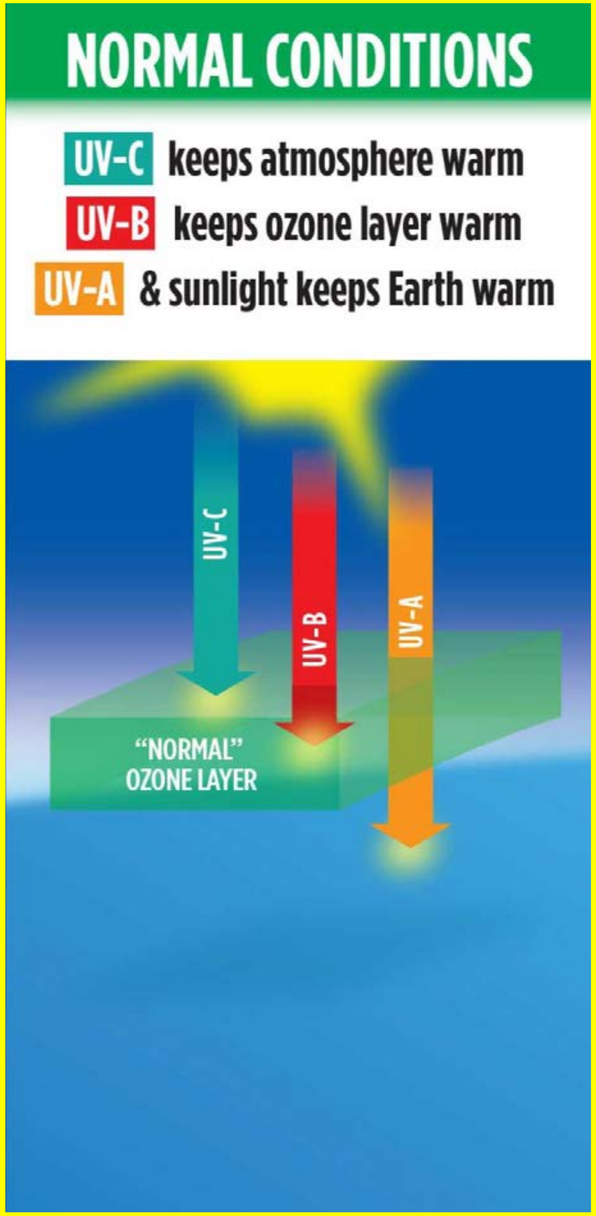

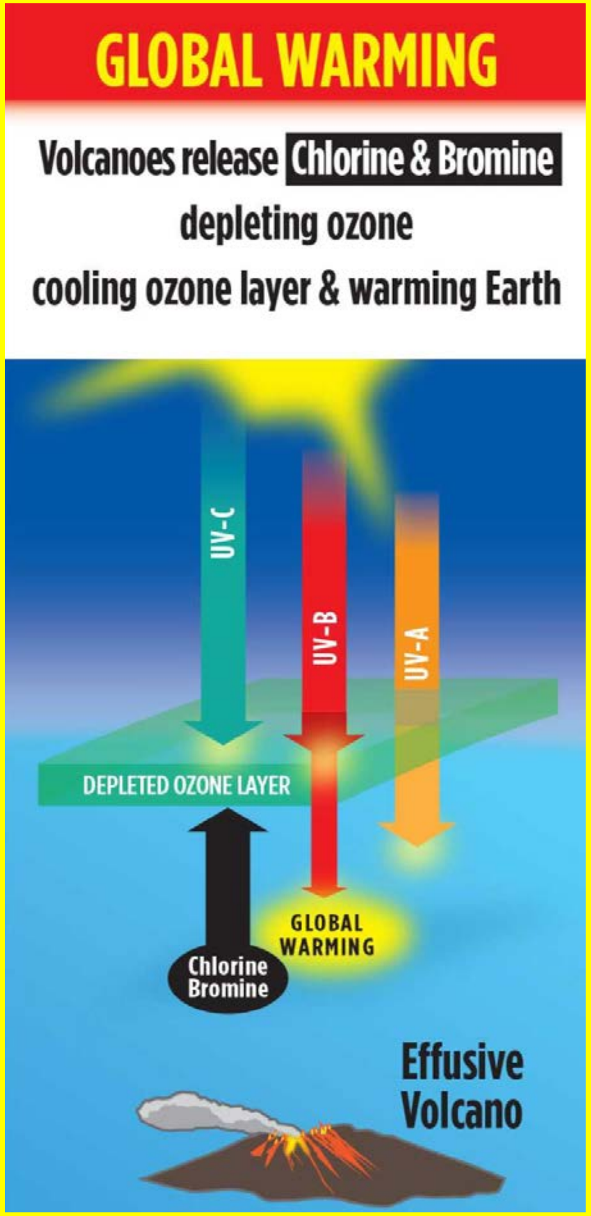

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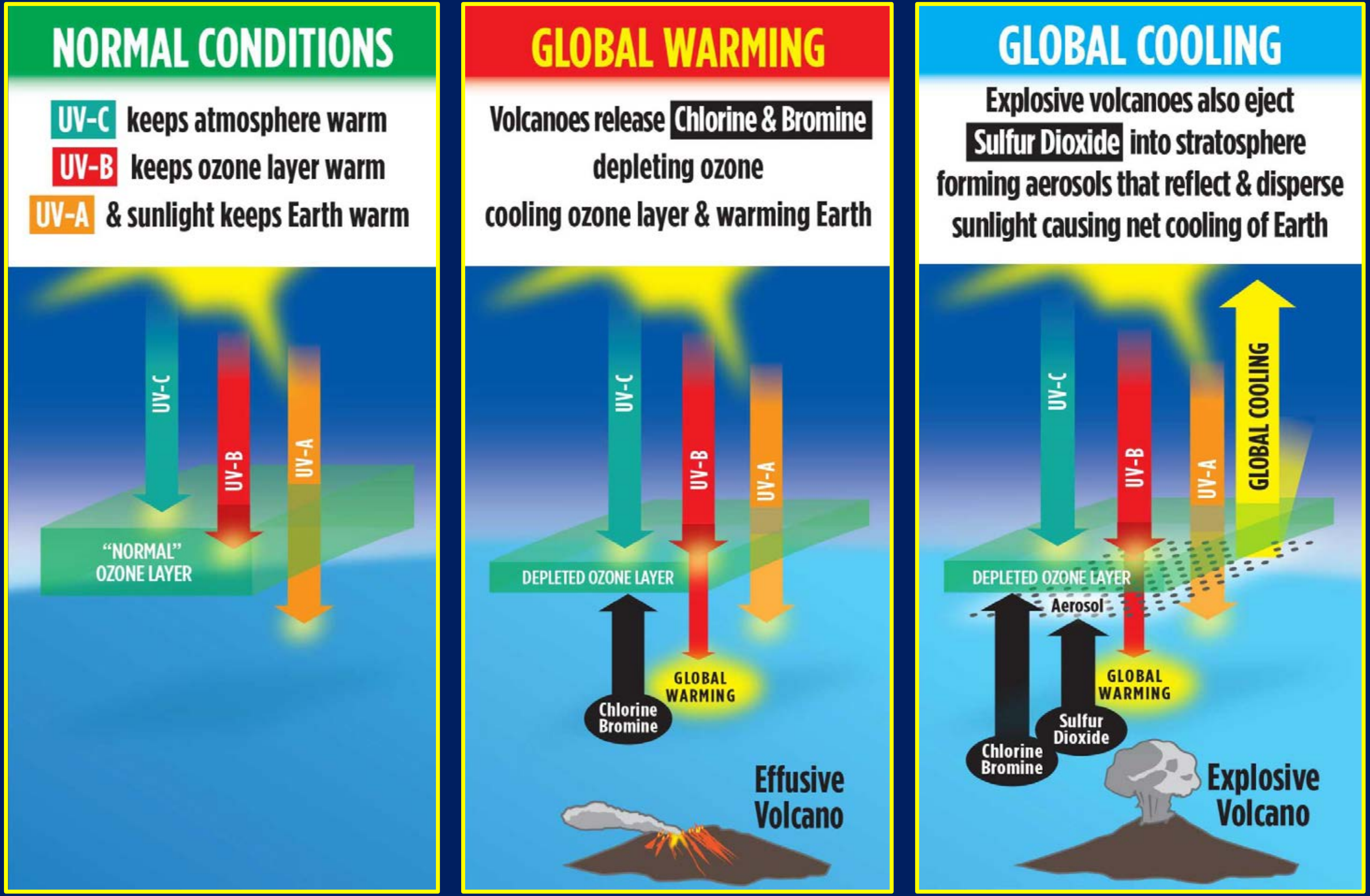

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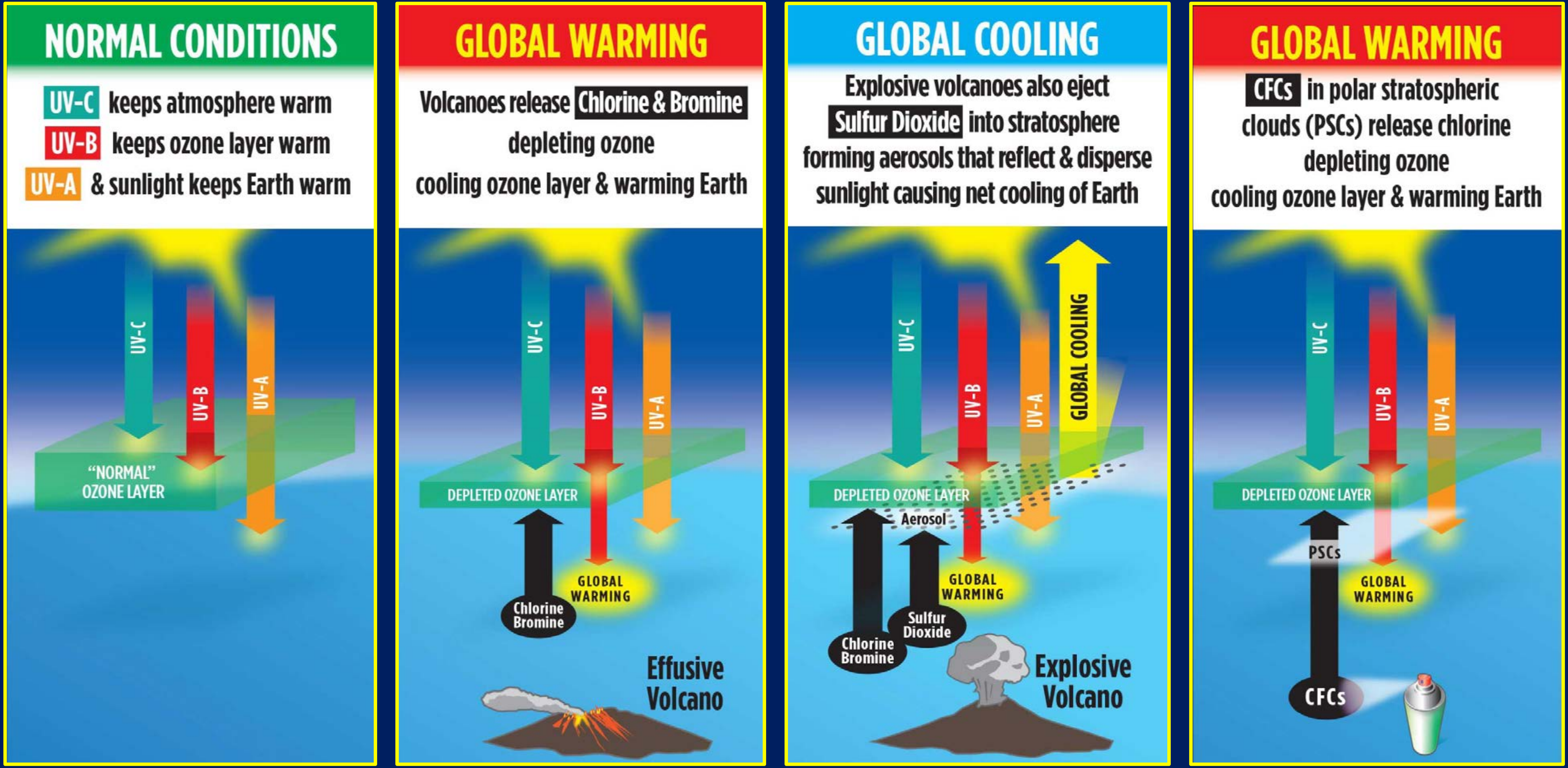
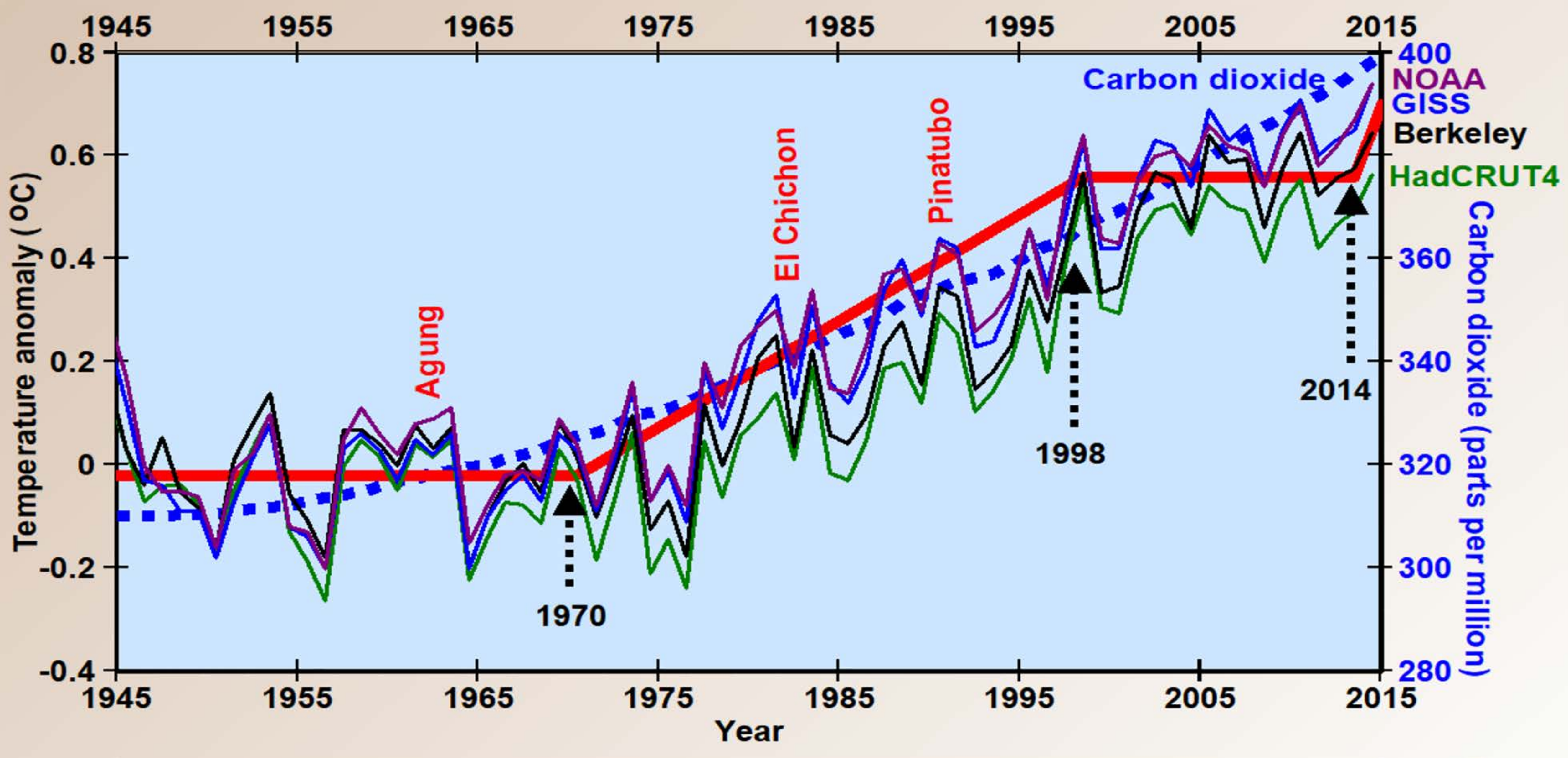
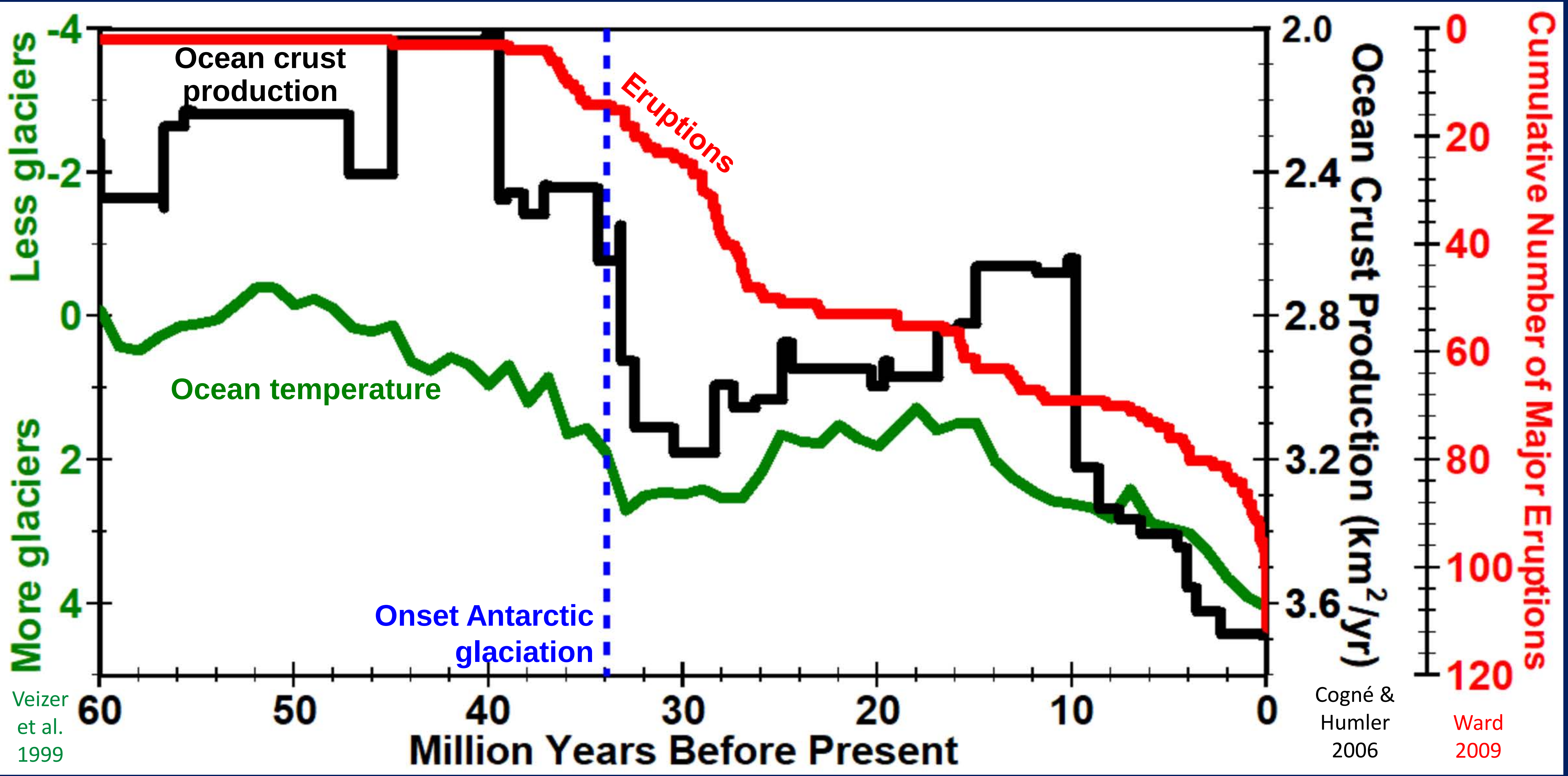


Changes in temperature trends



Major cooling when there is major subduction



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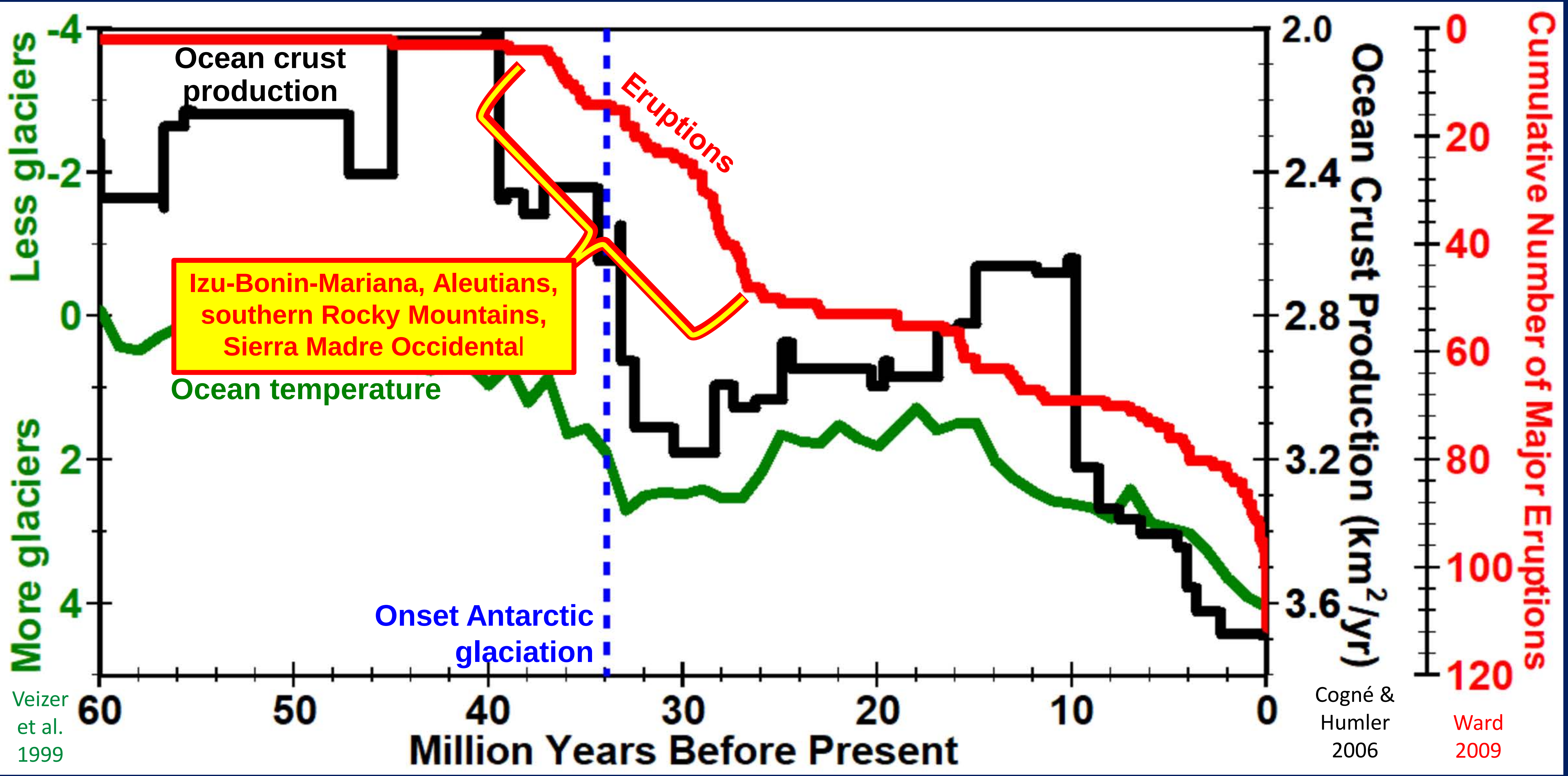

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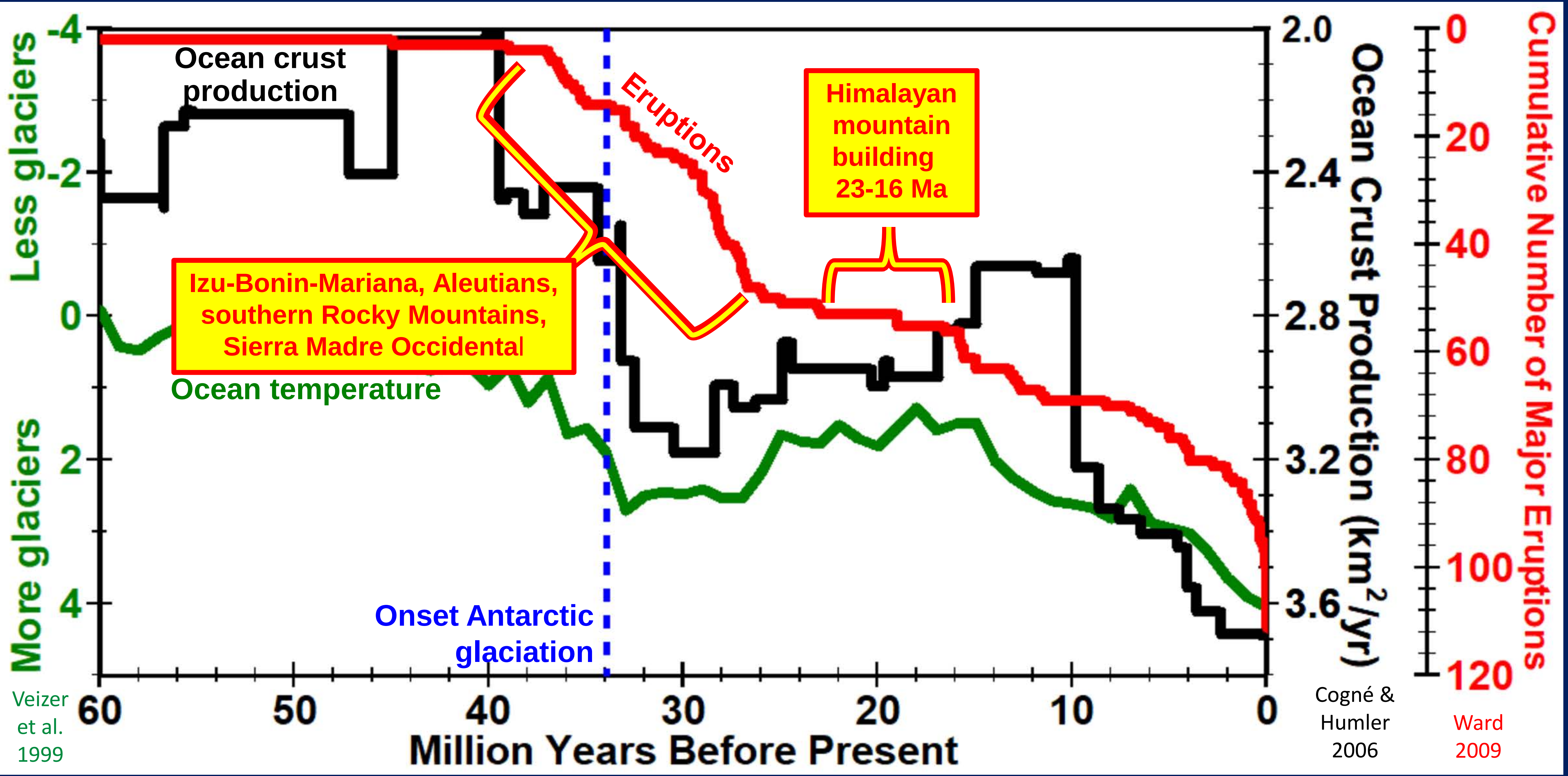

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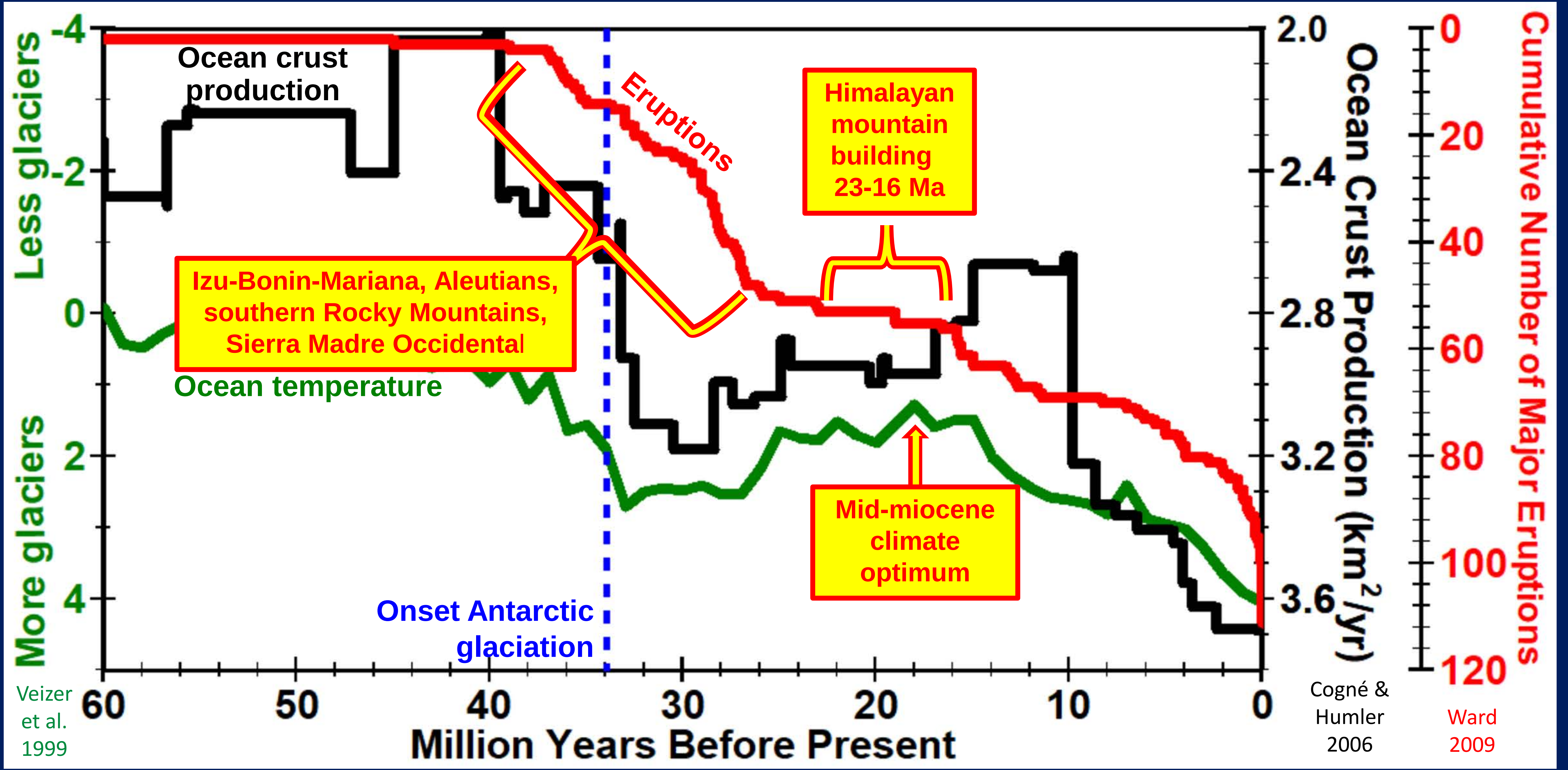

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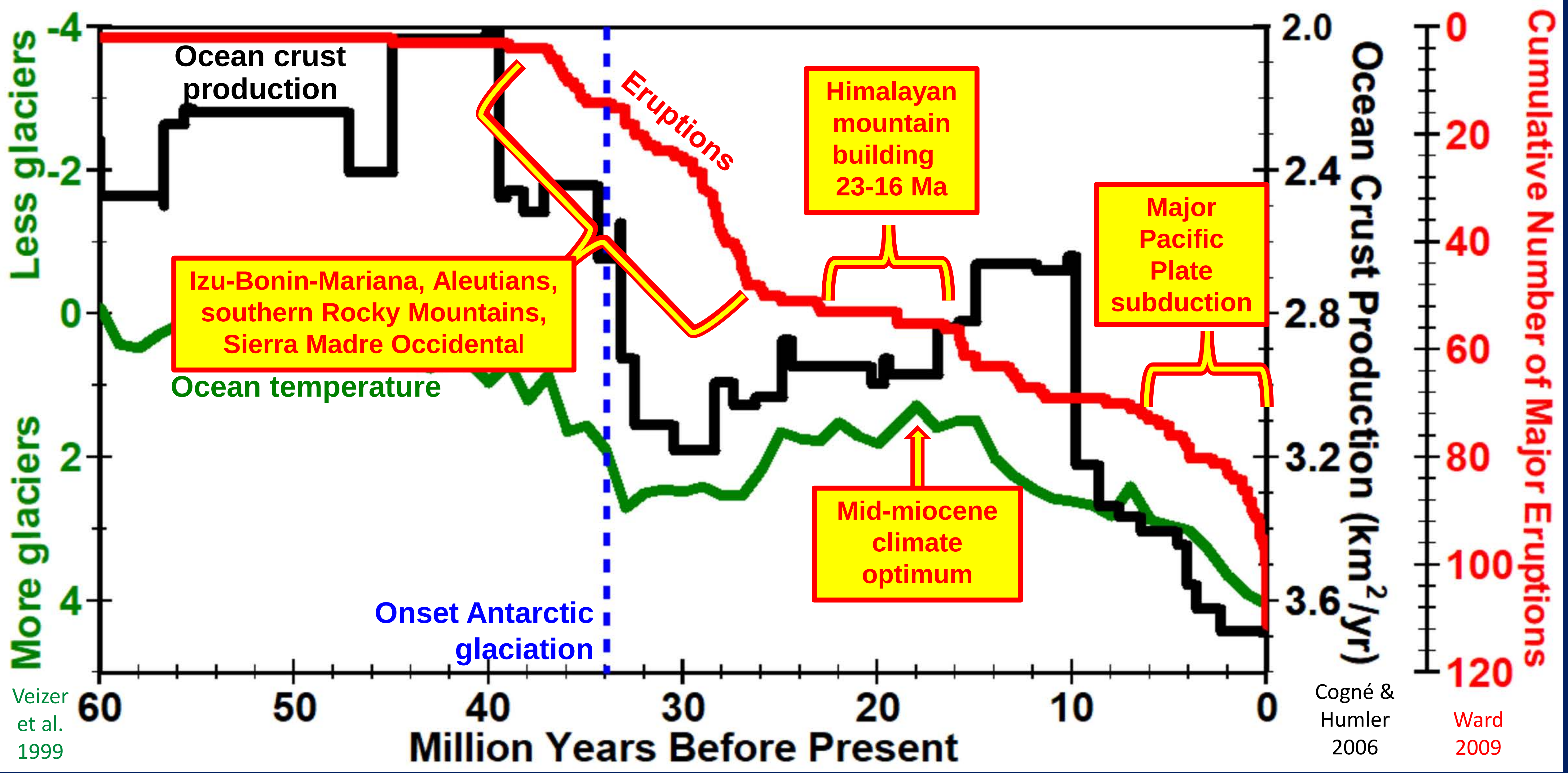
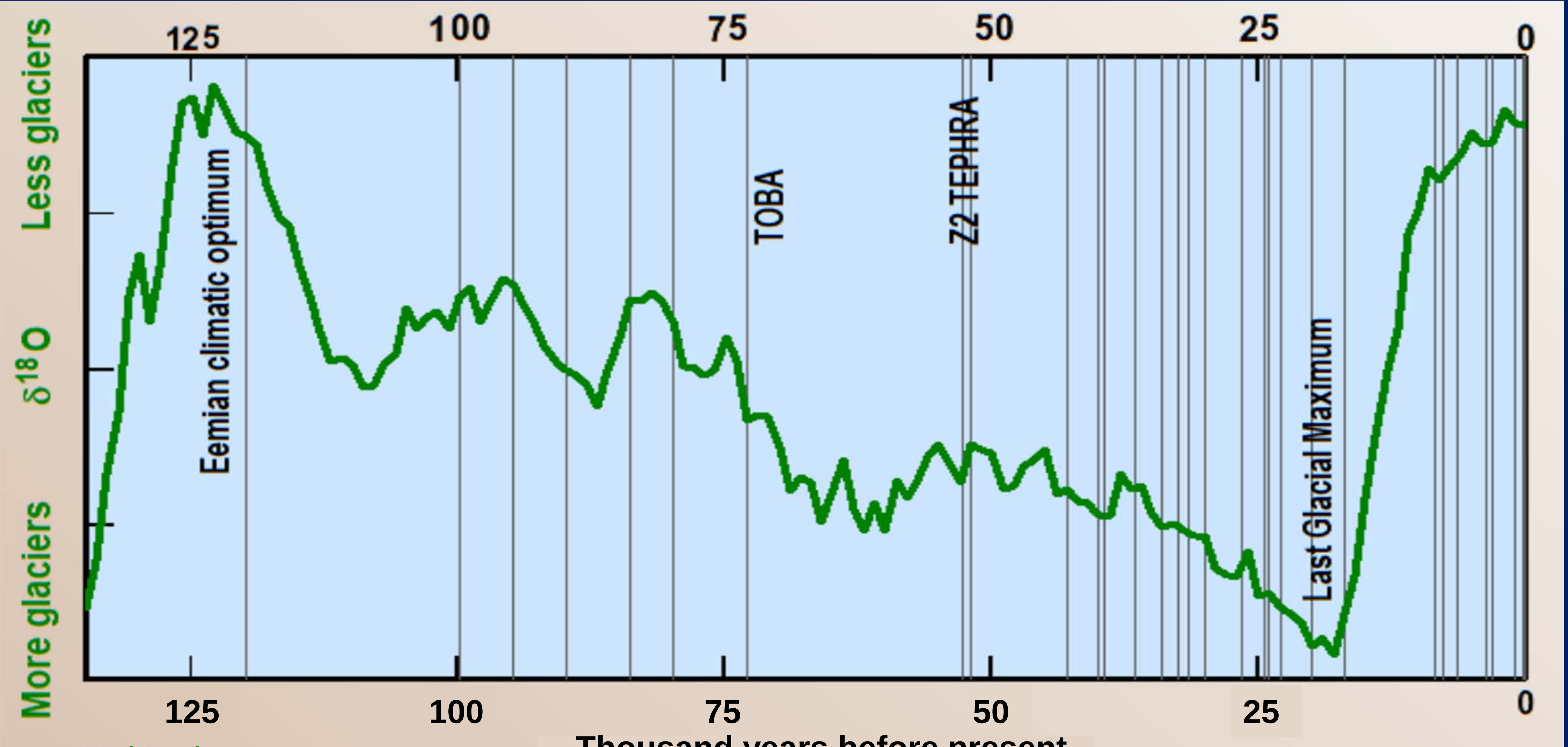


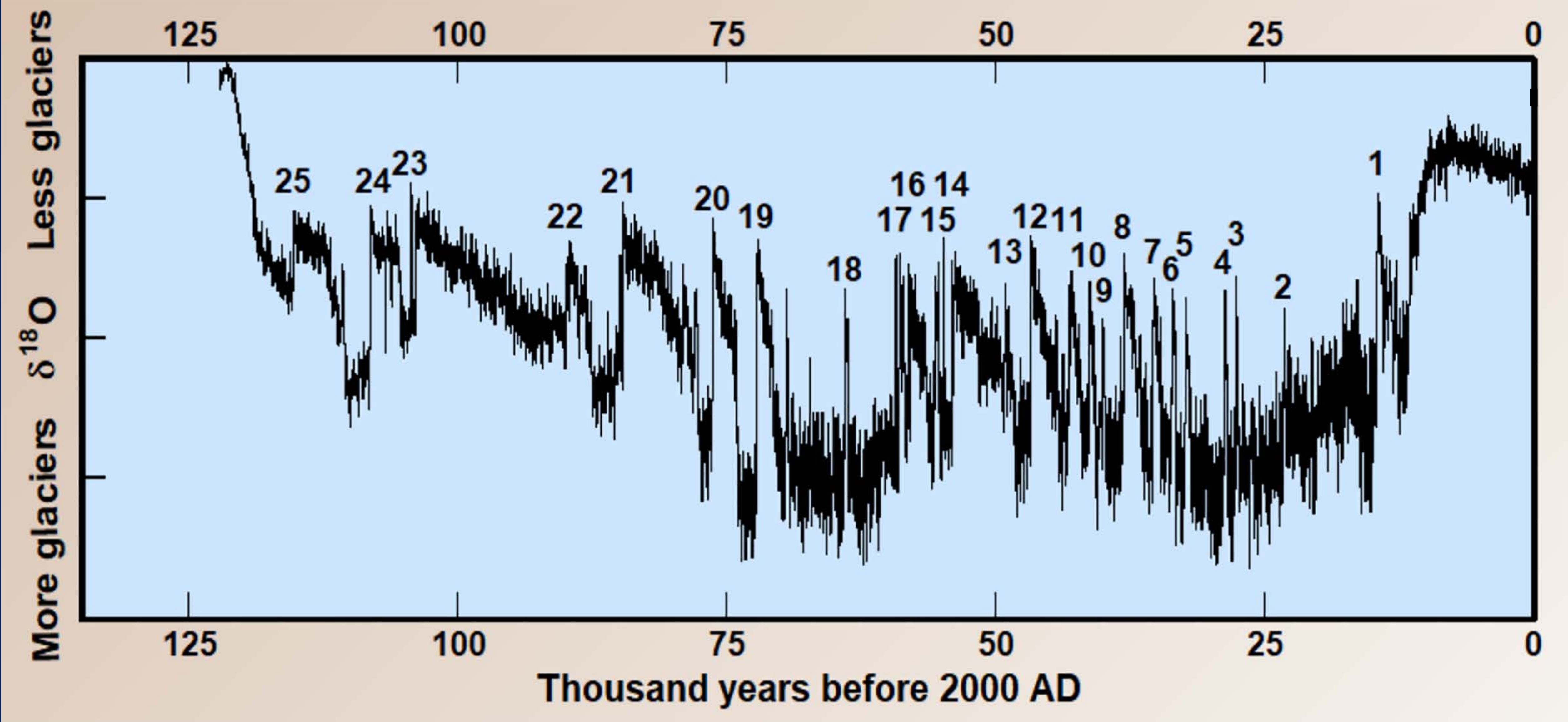
Stack of 57 globally distributed deep sea $\delta^{18}O$ records



Lisiecki et al. 2005

Erratic sequences of rapid warming followed by slower cooling

Dansgaard-Oeschger events observed in Greenland ice



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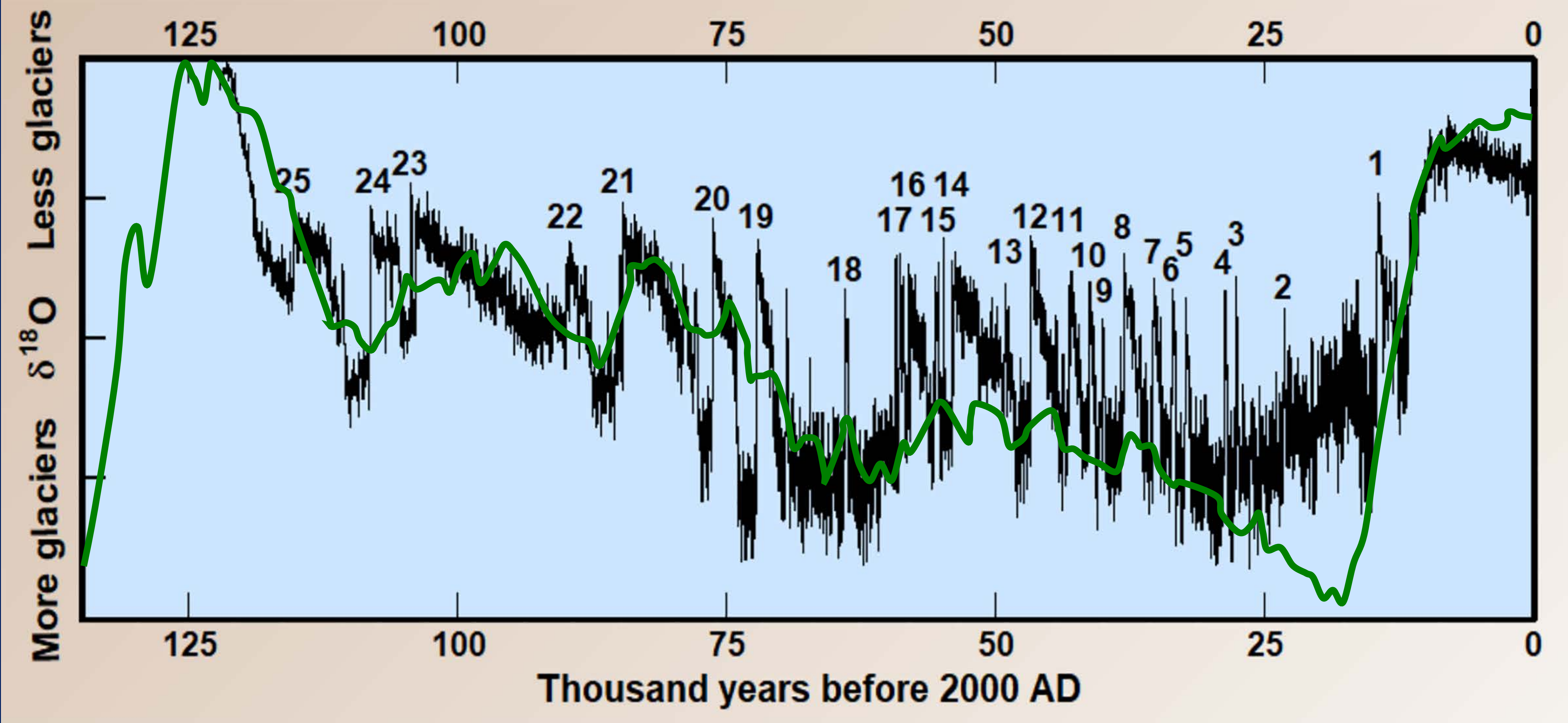

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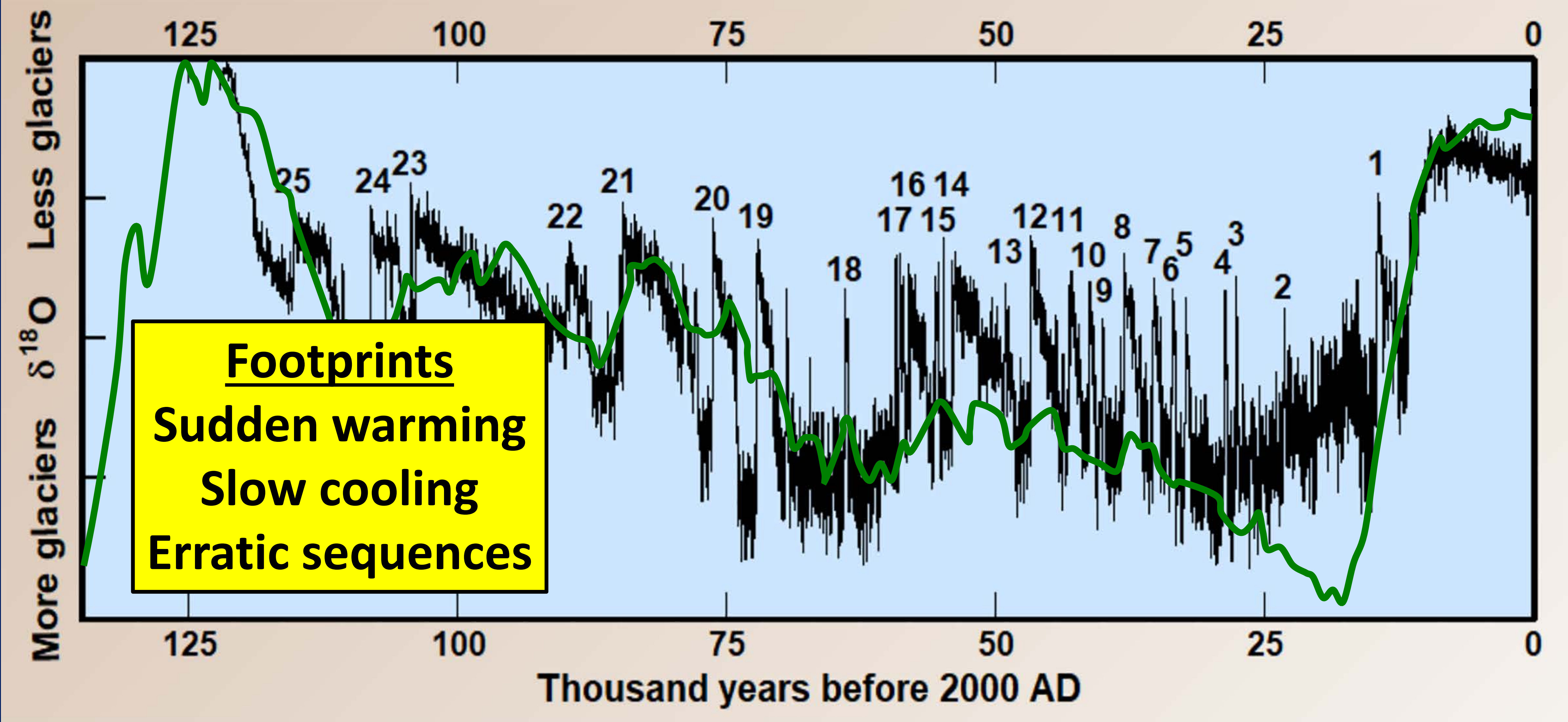
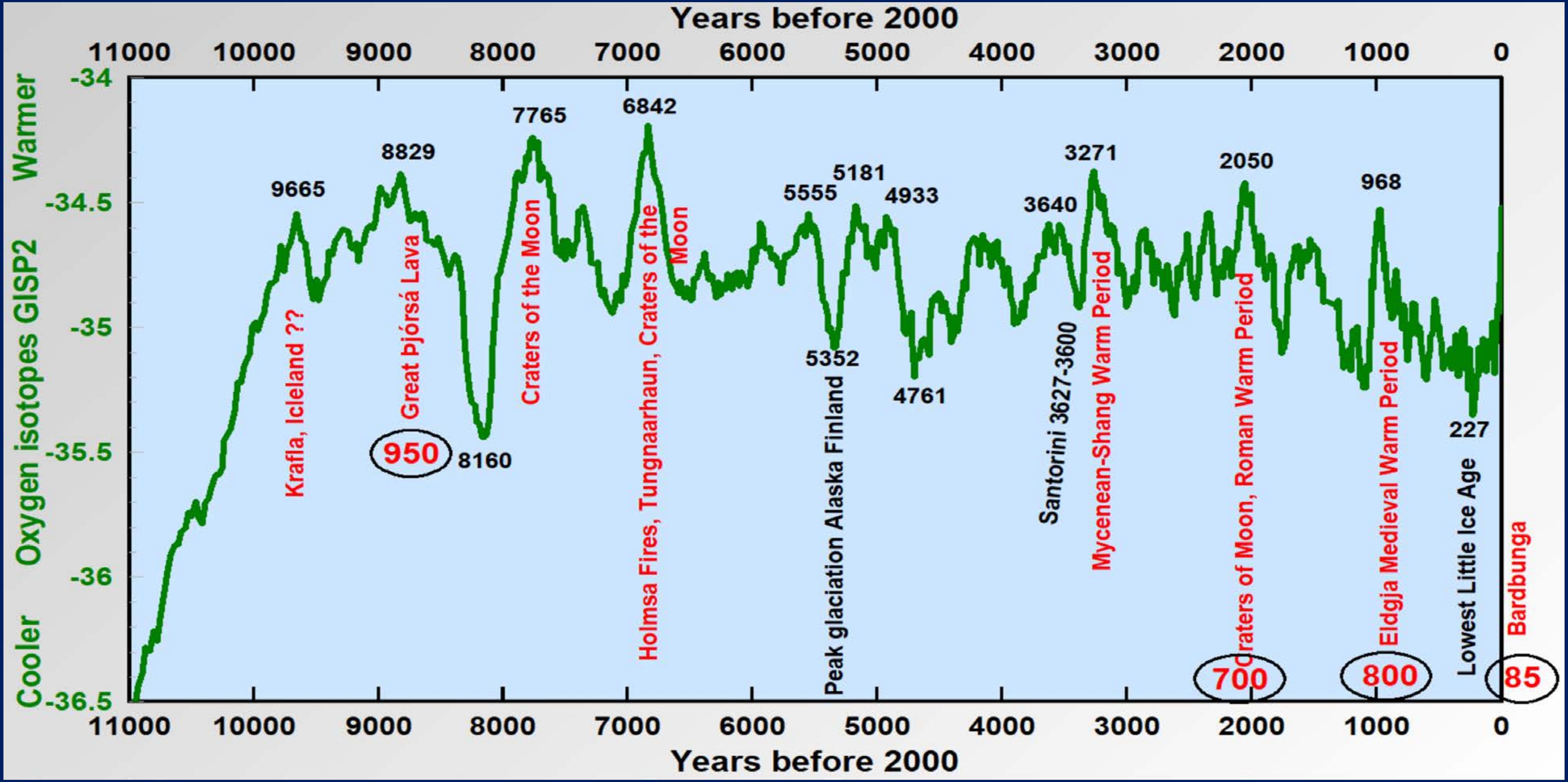
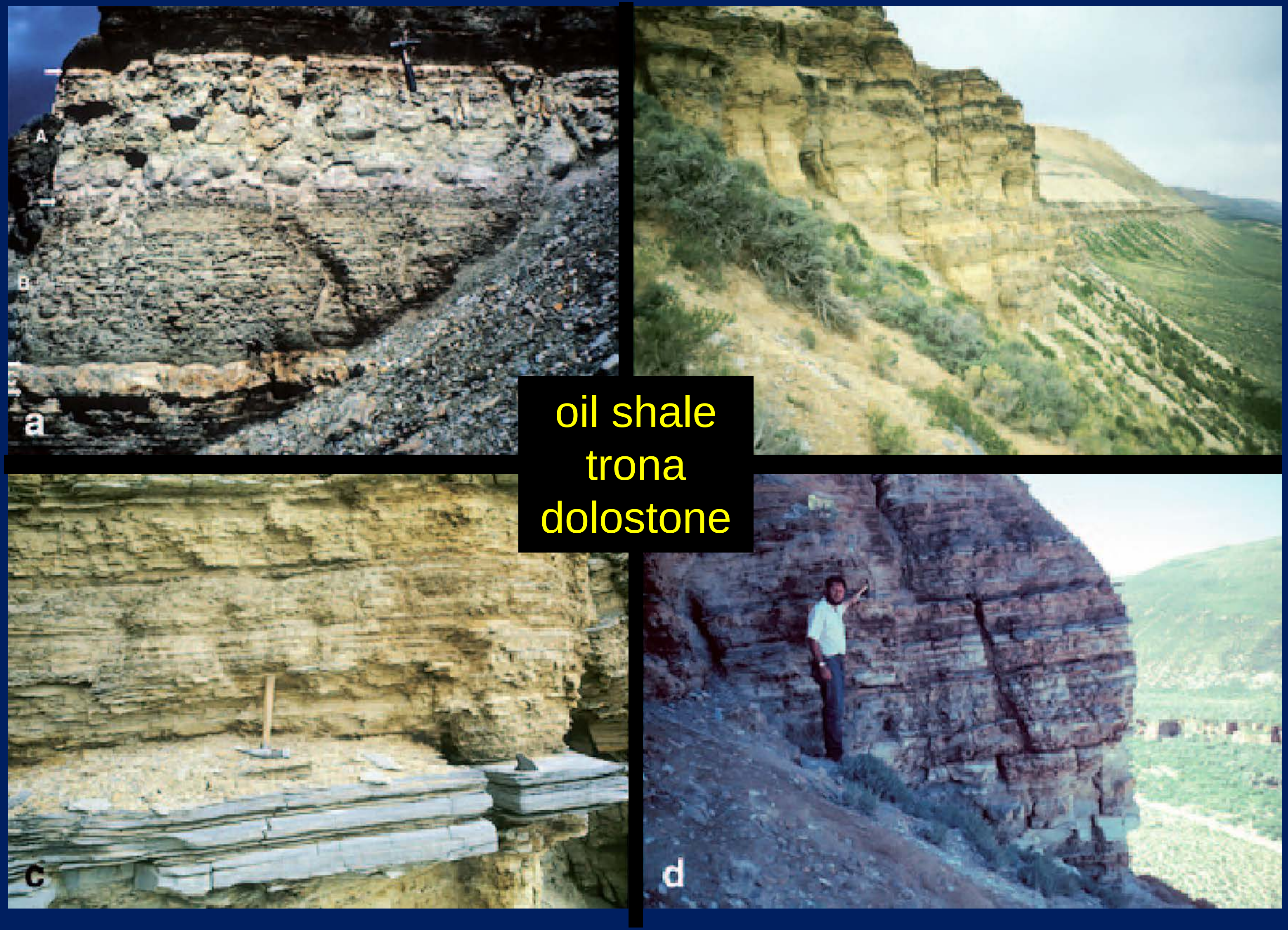


Holocene temperatures and volcanism



Eocene Green River Formation in Wyoming

53 to 48 million years ago



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trona
dolostone

Surdam, 2013

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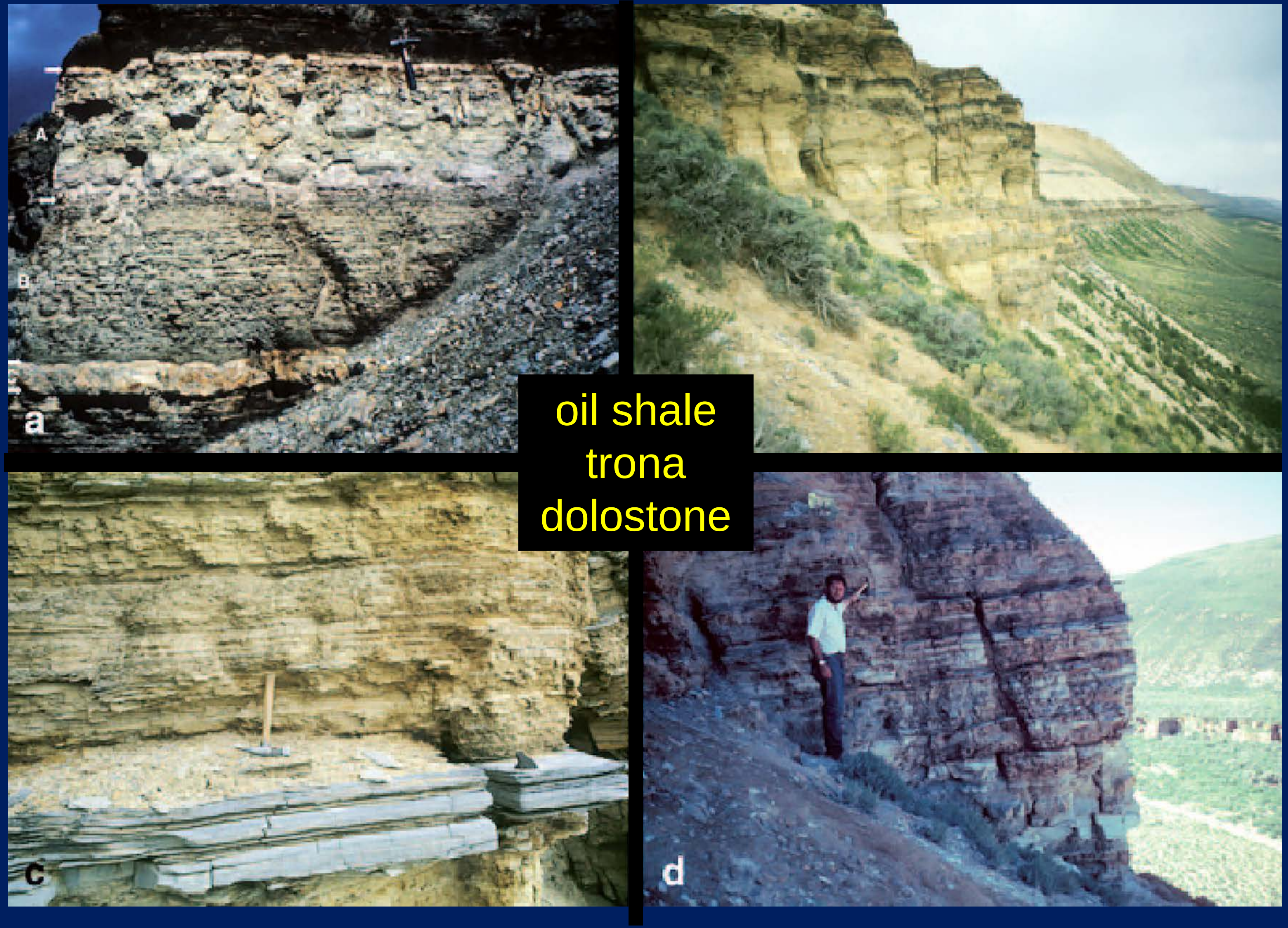

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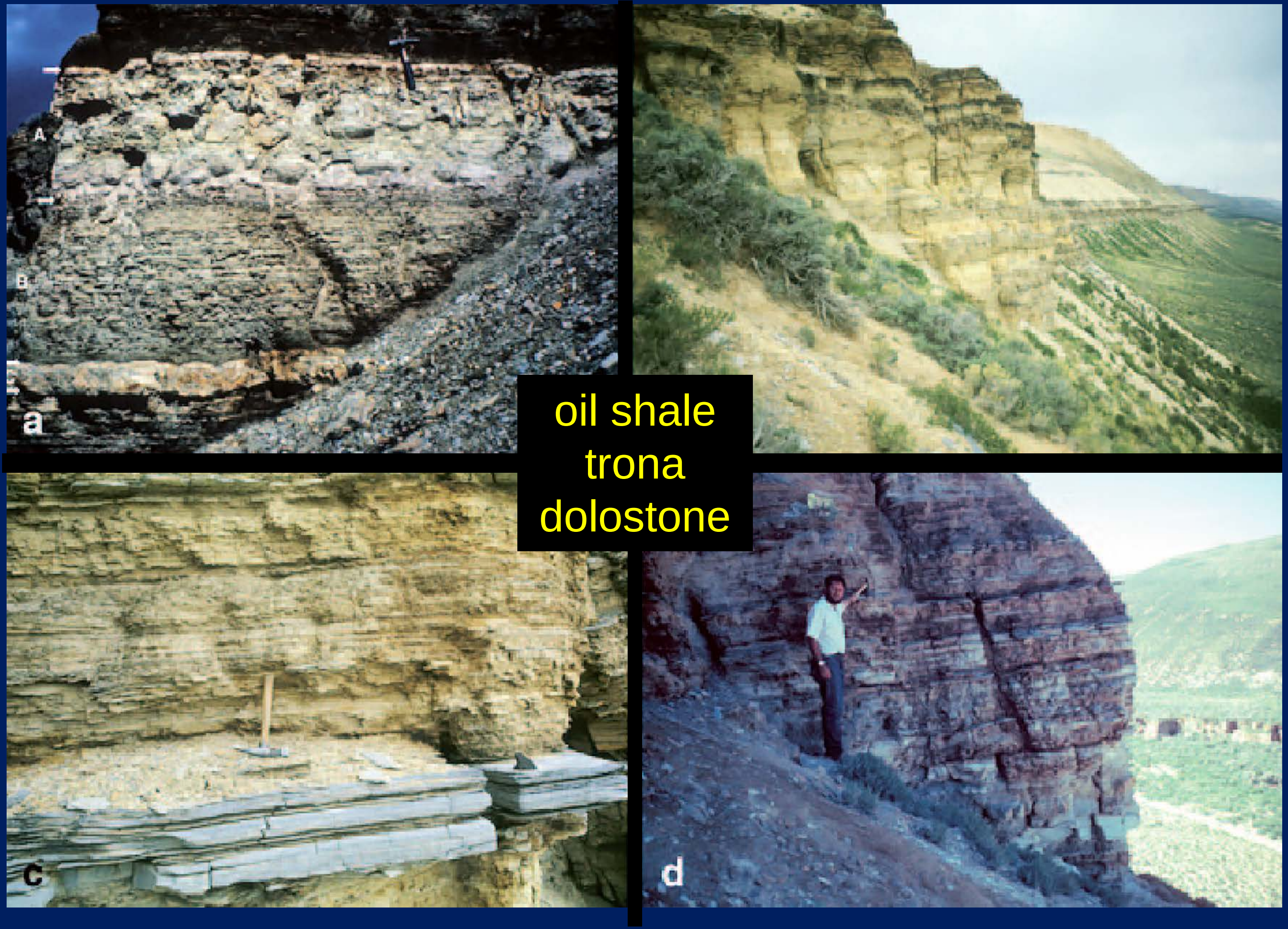
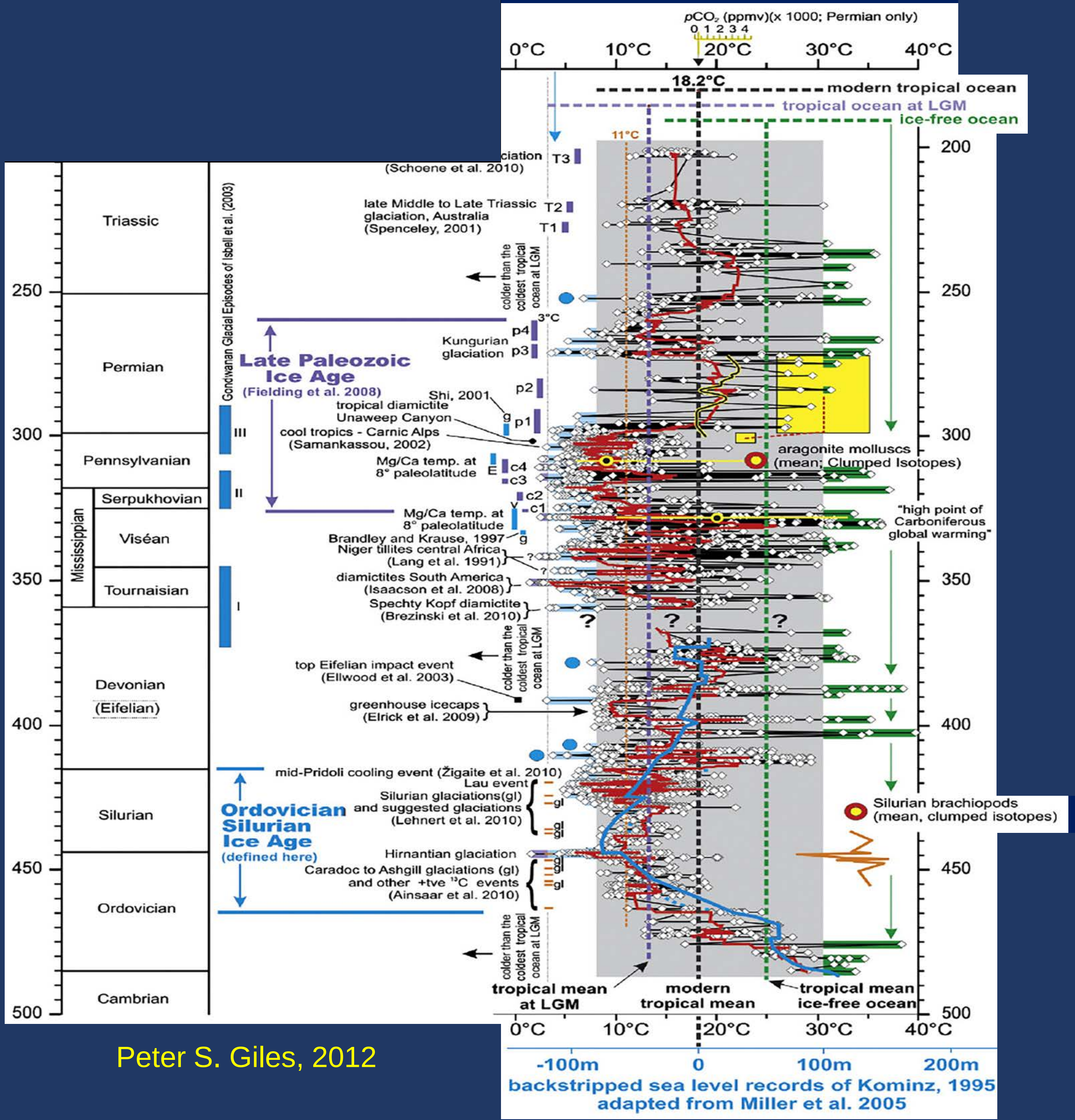


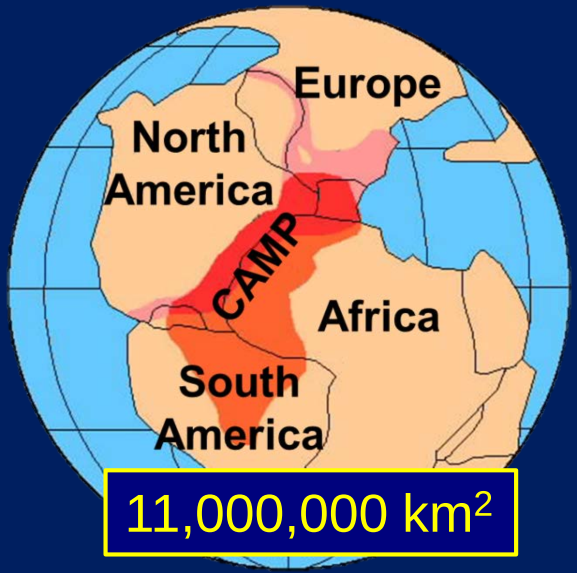
Surdam, 2013

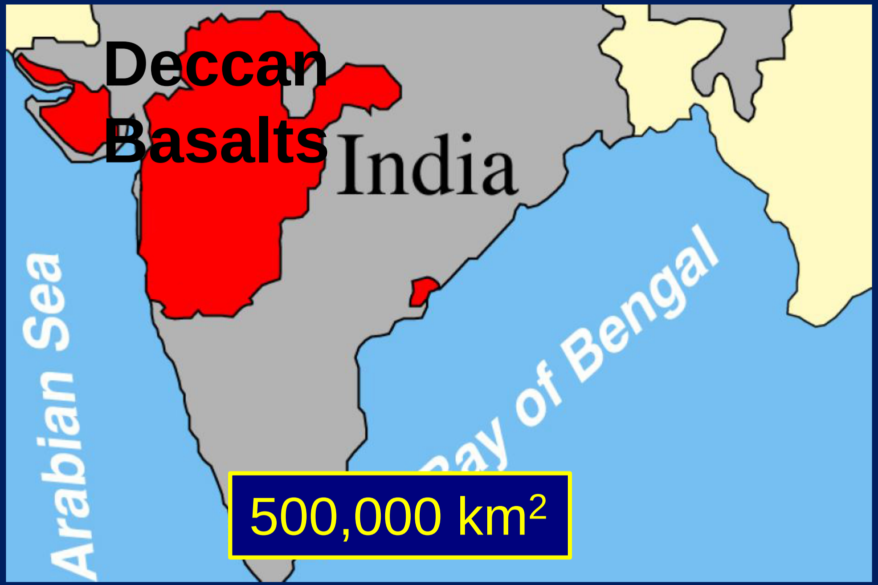
Paleozoic brachiopod habitat temperatures

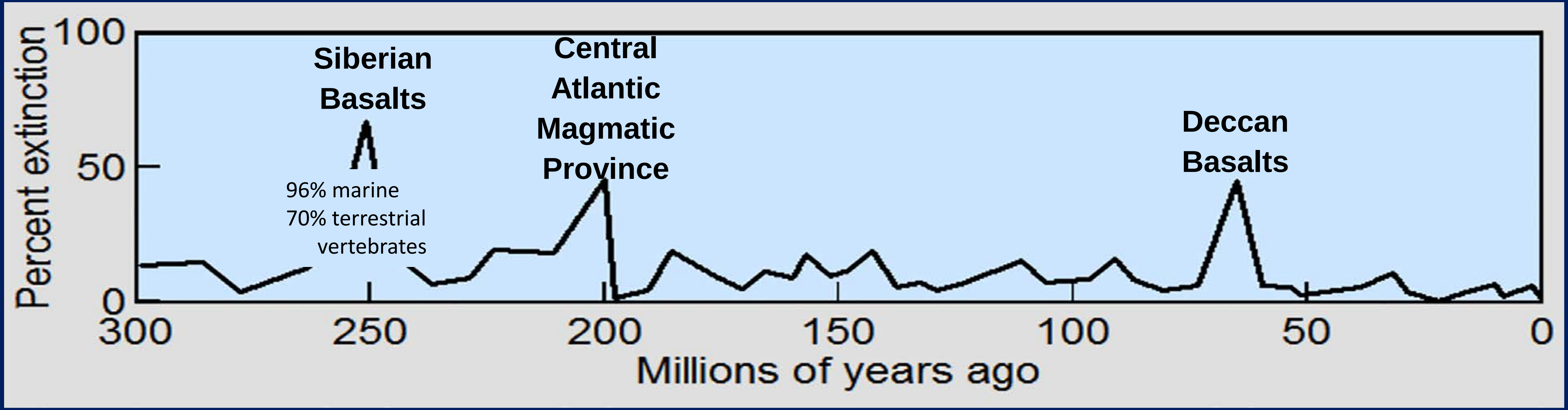


Peter S. Giles, 2012

Examples of flood basalts and large igneous provinces

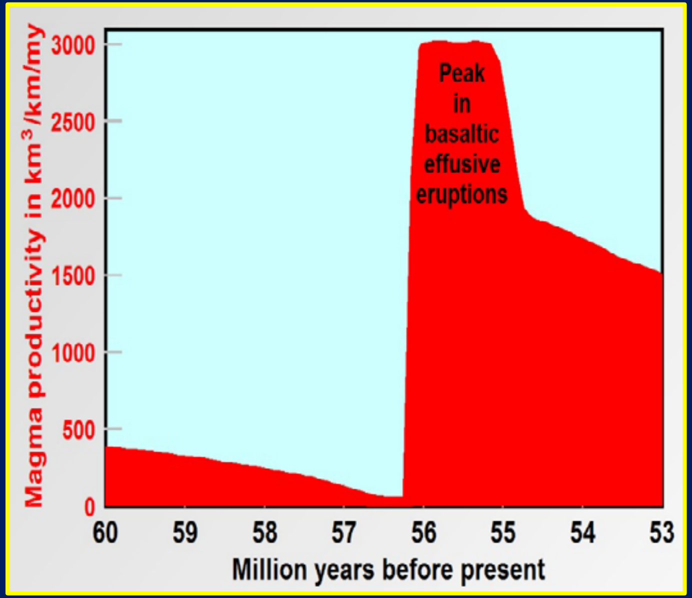


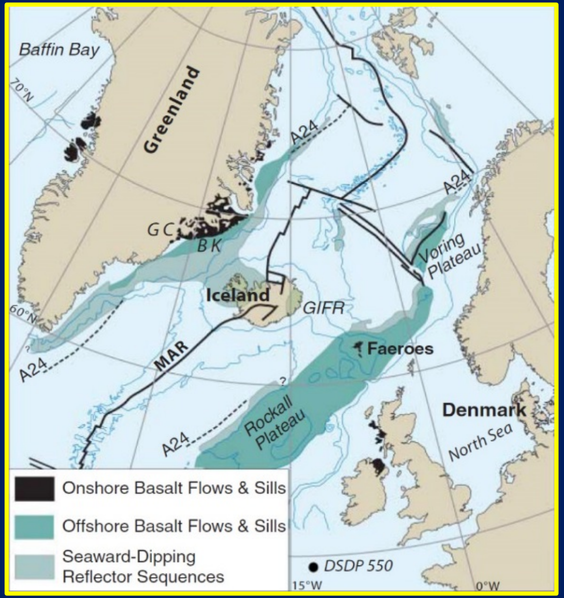




Paleocene-Eocene Thermal Maximum

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





Storey et al. 2007

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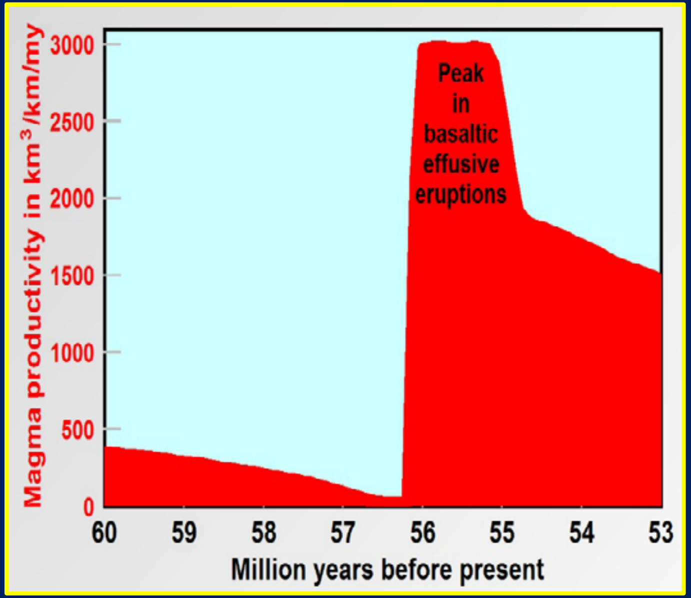
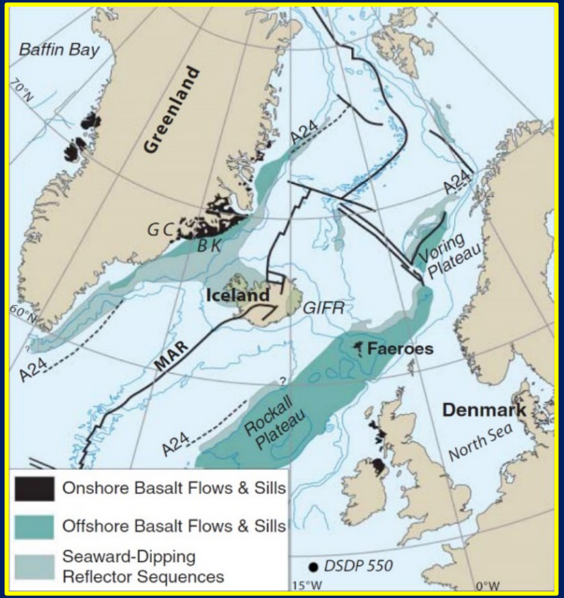
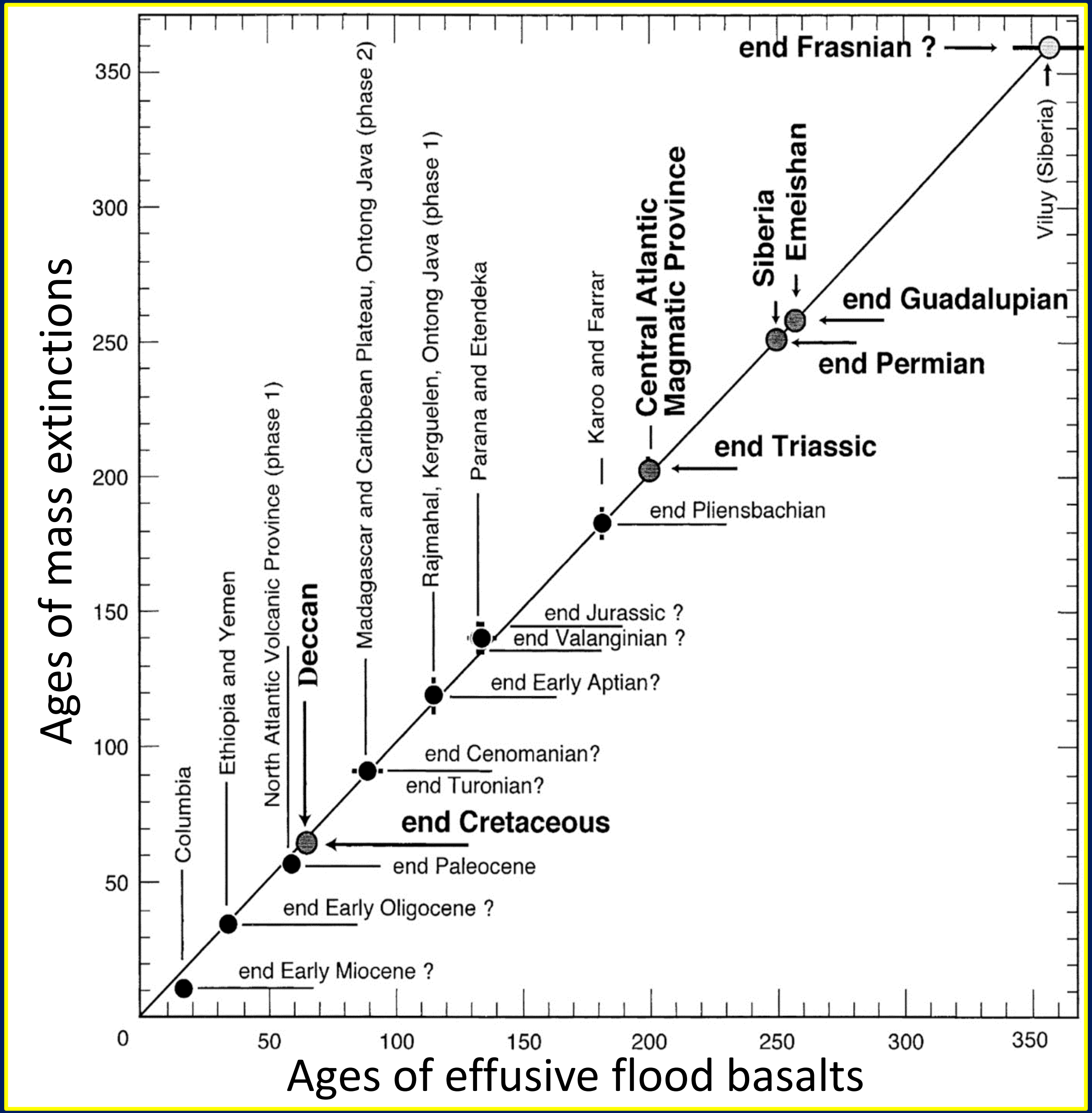




Storey et al. 2007

Associated with end of time units



Courtillot and Renne 2003

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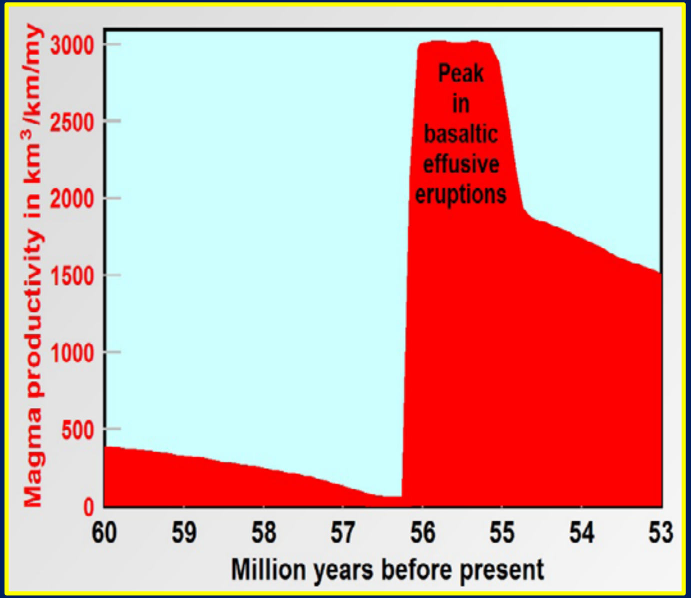

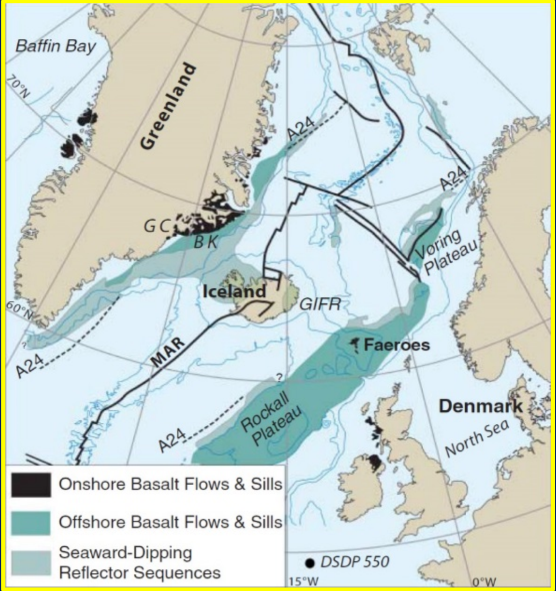

Storey et al. 2007

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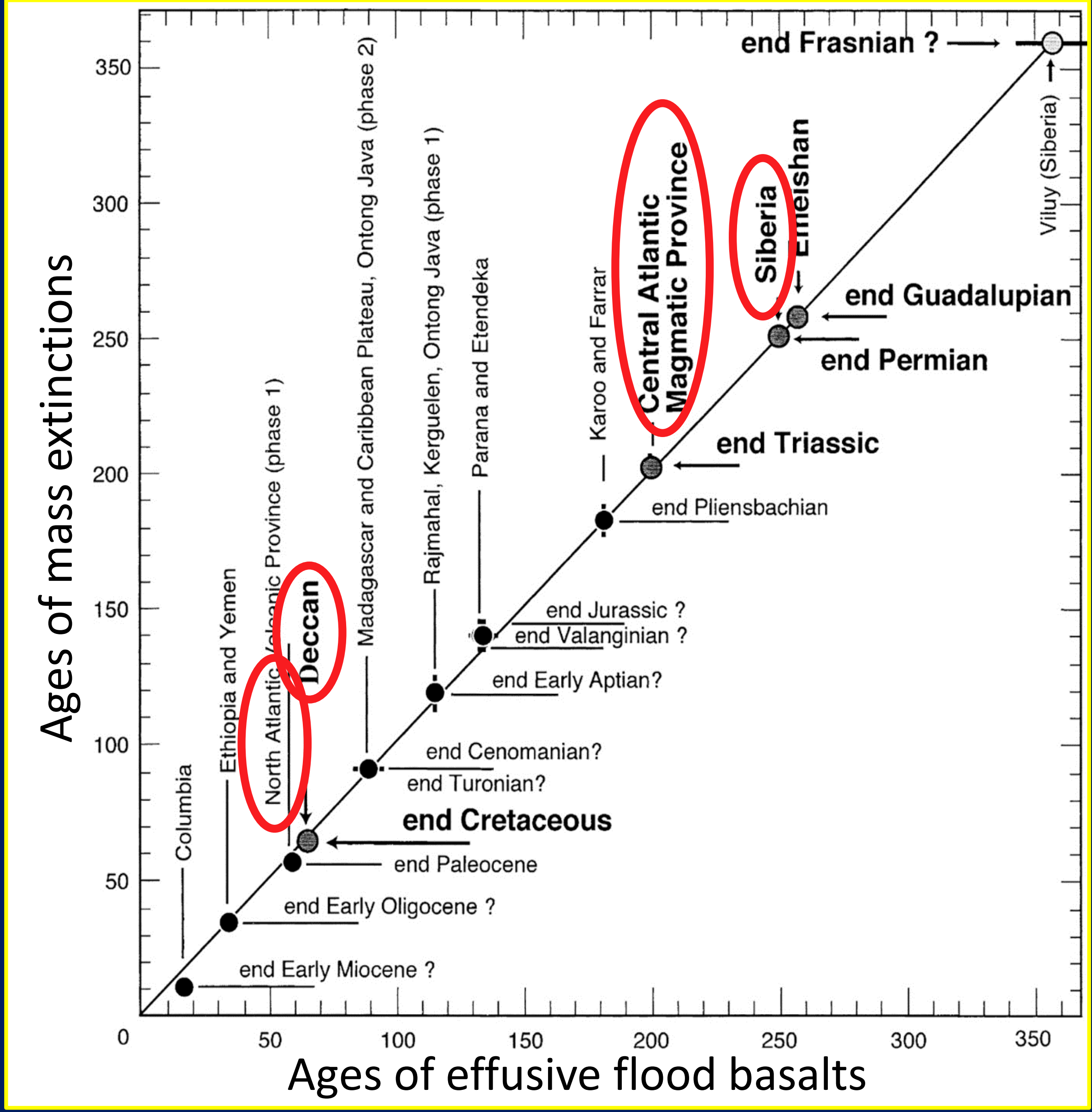
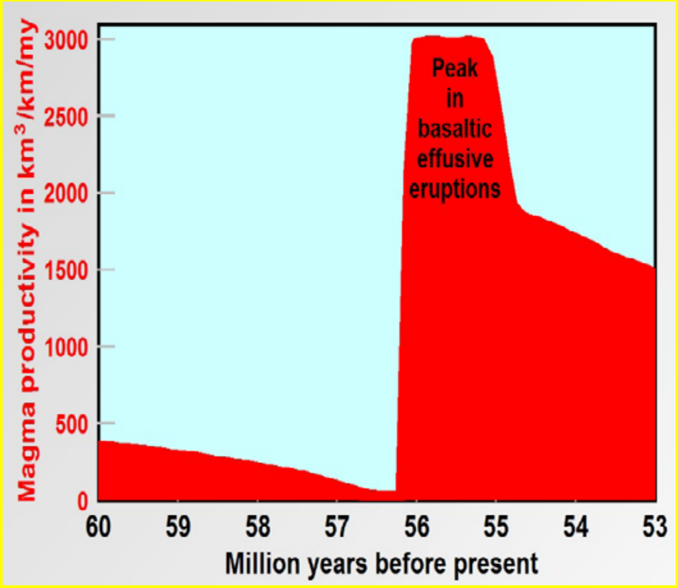
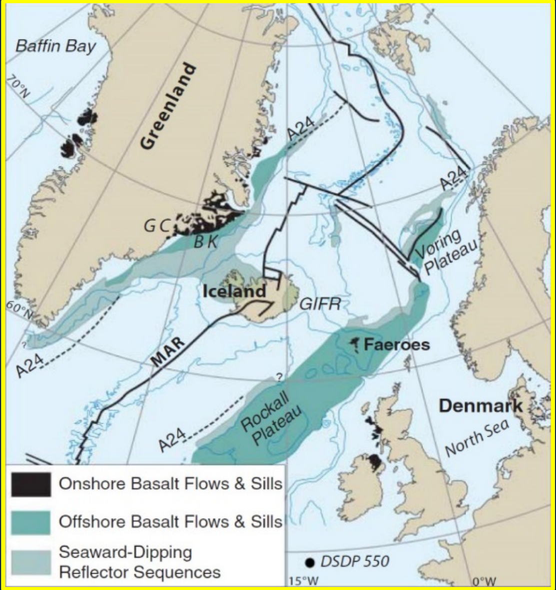


Courtillot and Renne 2003

Paleocene-Eocene Thermal Maximum

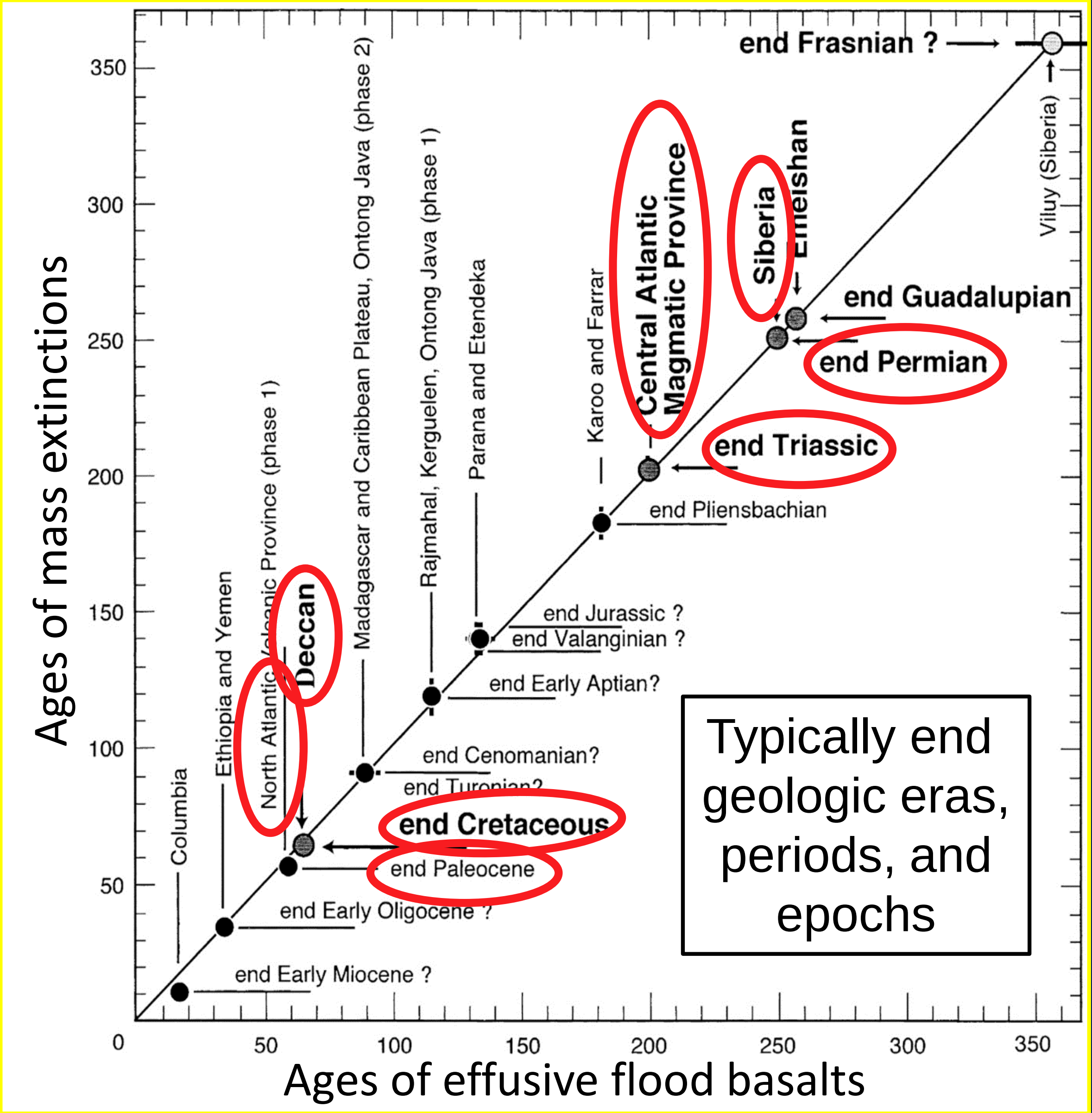
Extrusion of basaltic magma reached a peak 56 million years ago during the rifting of the Greenland-Norwegian Sea





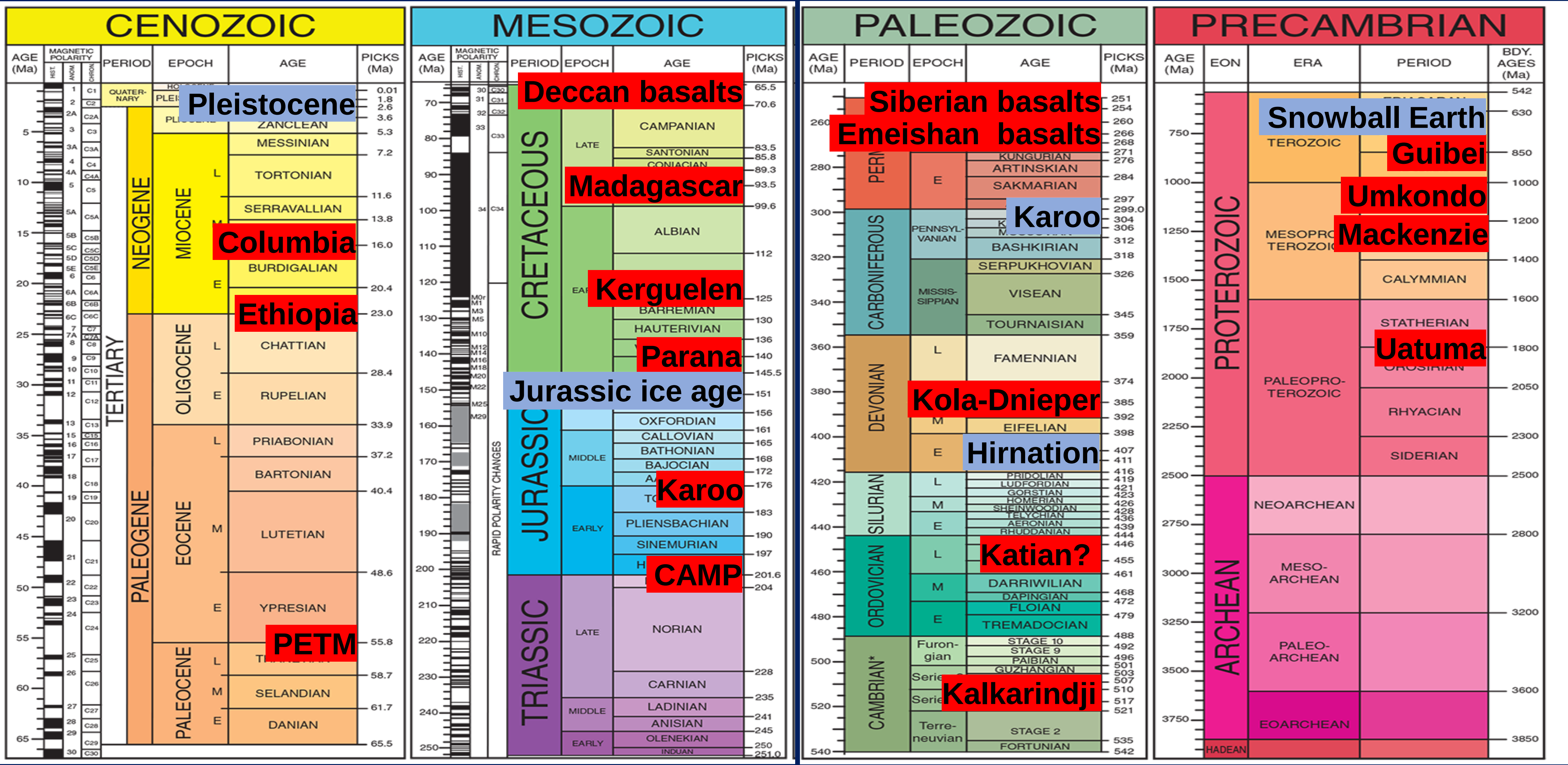
Storey et al. 2007

Associated with end of time units



Courtillot and Renne 2003

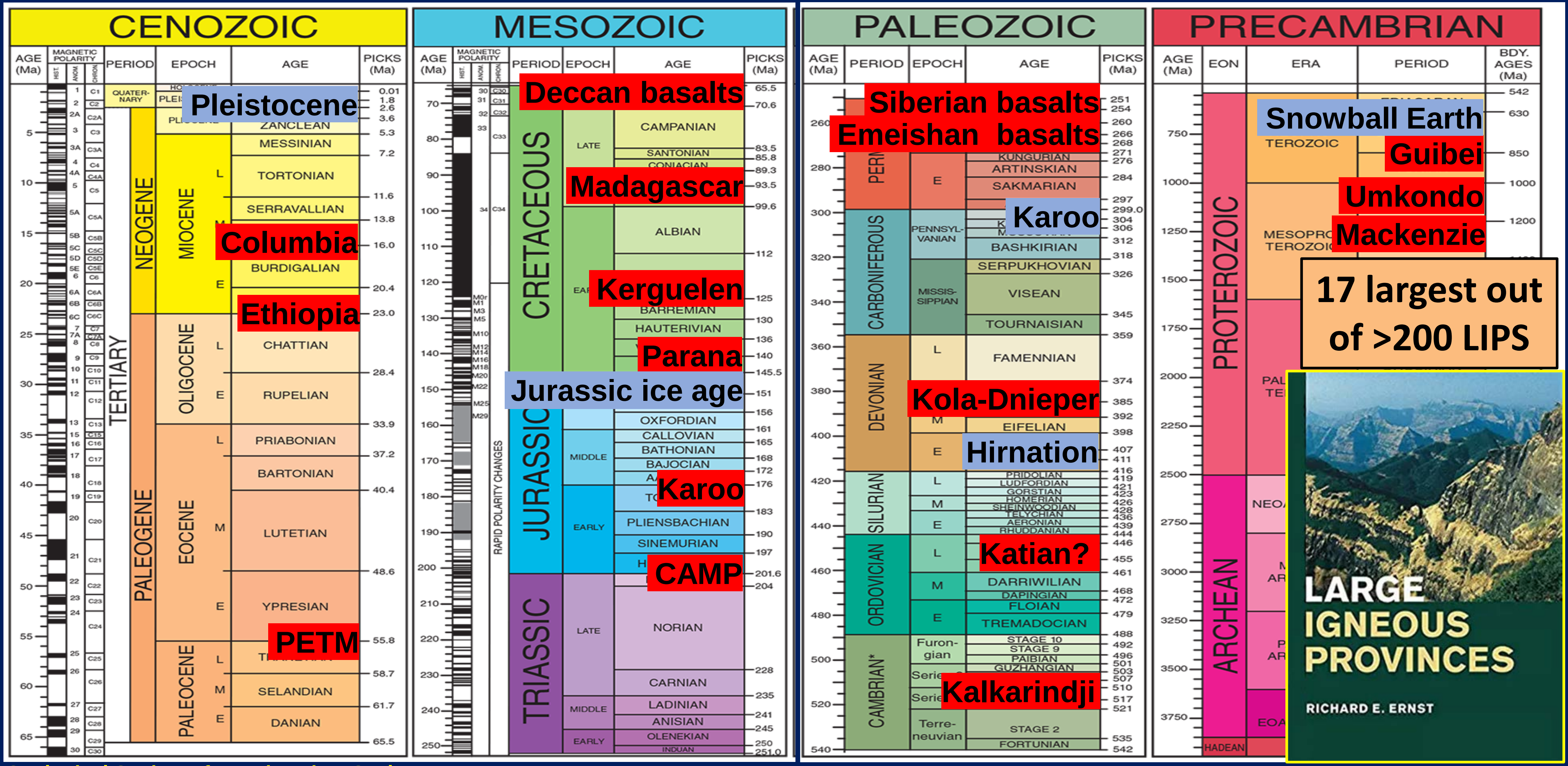
Large Igneous Provinces punctuate the geologic time scale



Geological Society of America Time Scale

Ages of LIPs from Ernst 2014

Large Igneous Provinces punctuate the geologic time scale



Geological Society of America Time Scale

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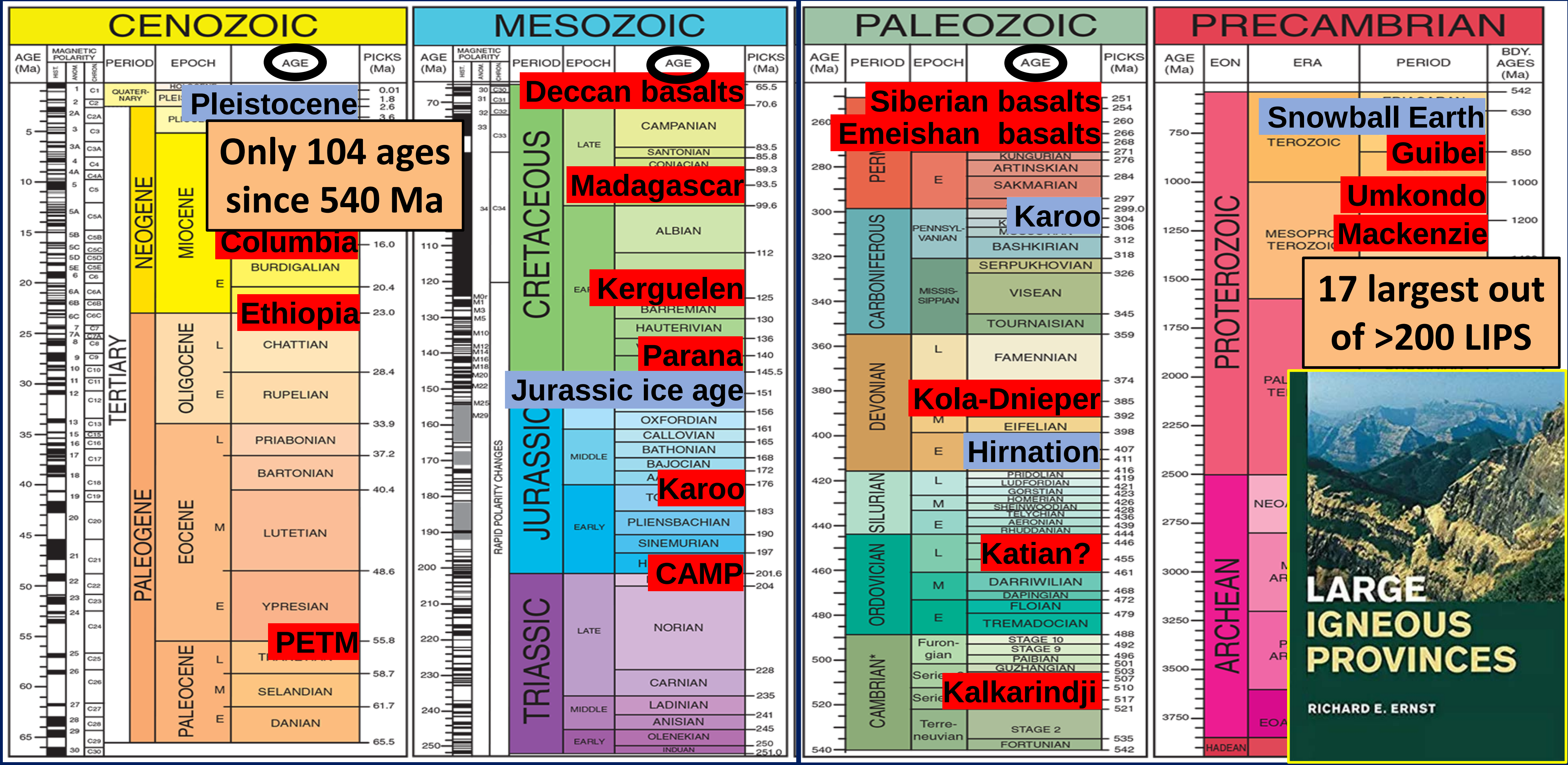

Geological Society of America Time Scale

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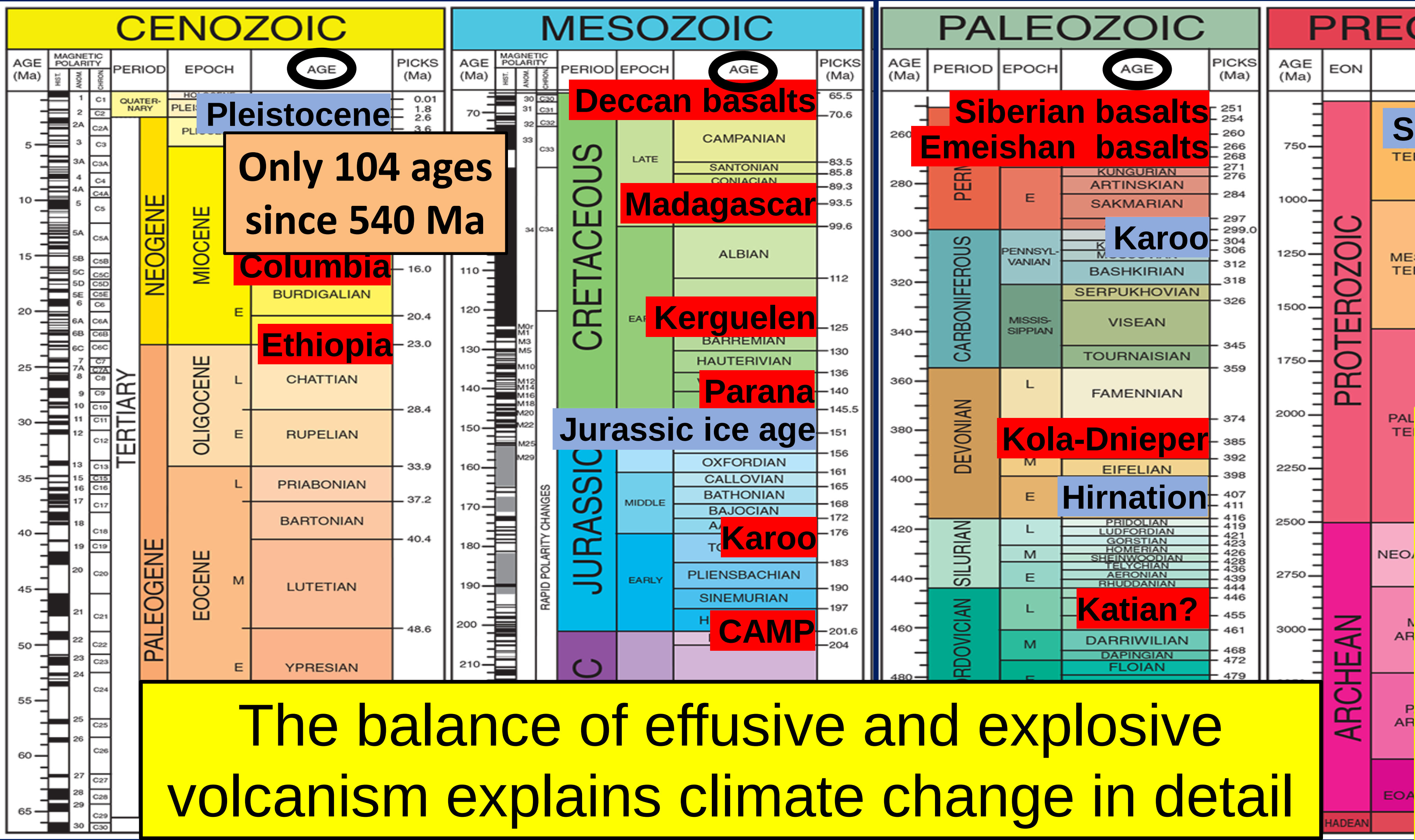
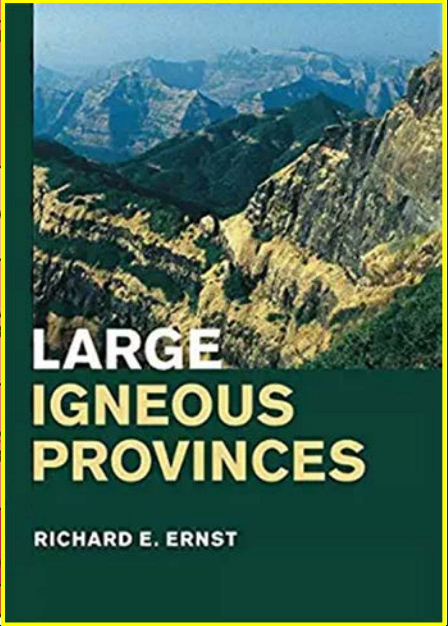
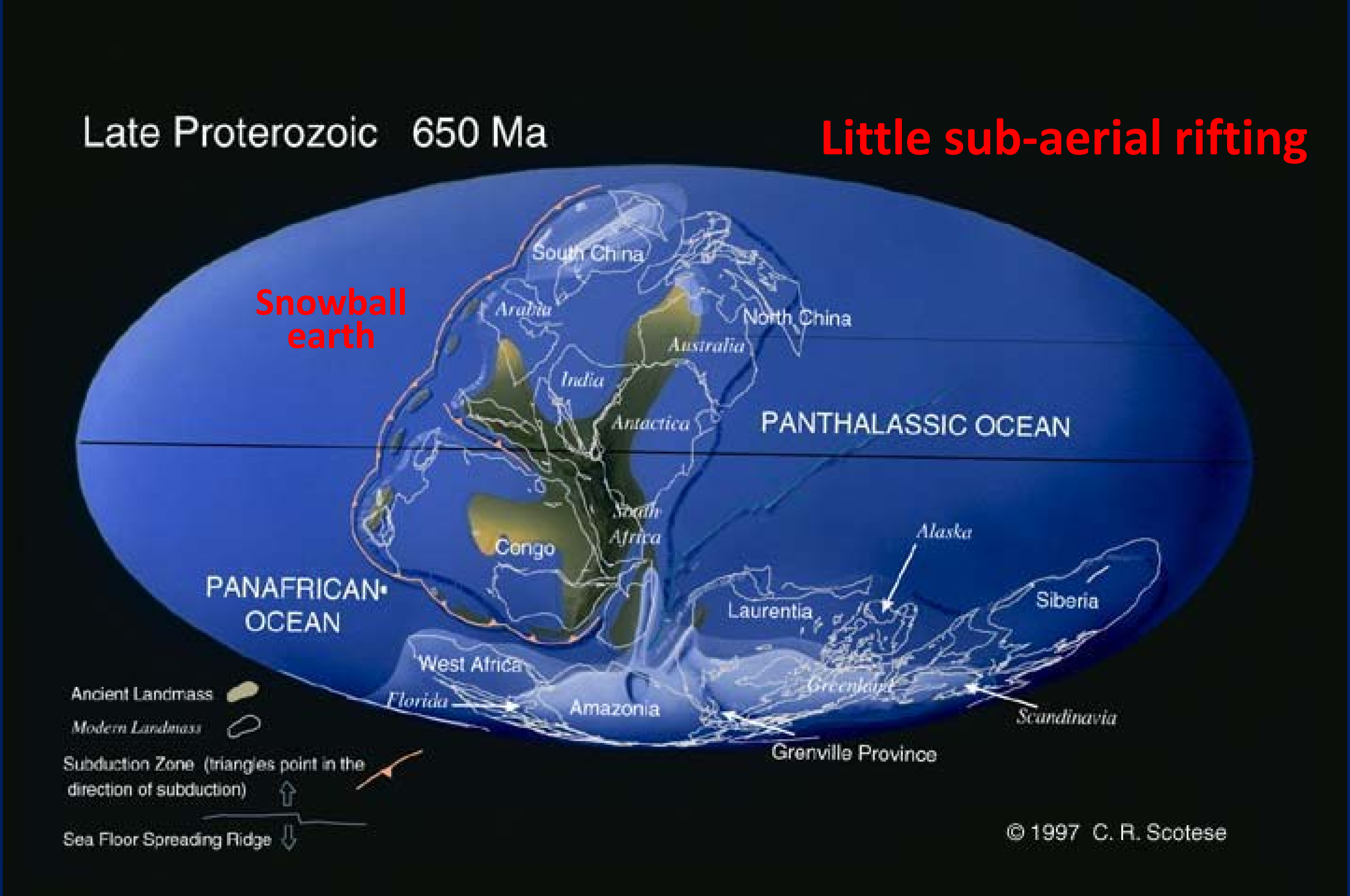




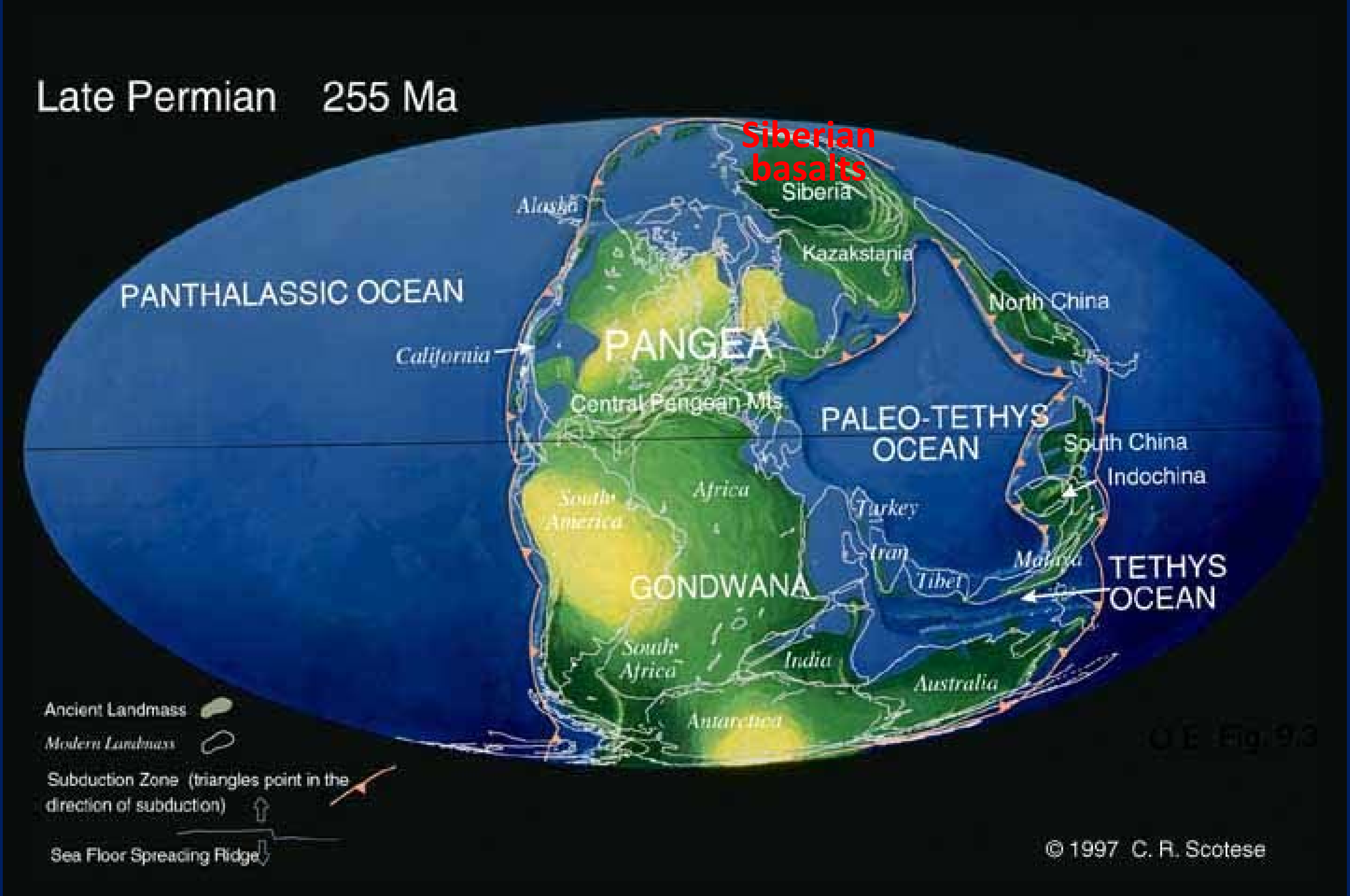
The balance of effusive and explosive volcanism explains climate change in detail

Geological Society of America Time Scale

Ages of LIPs from Ernst 2014

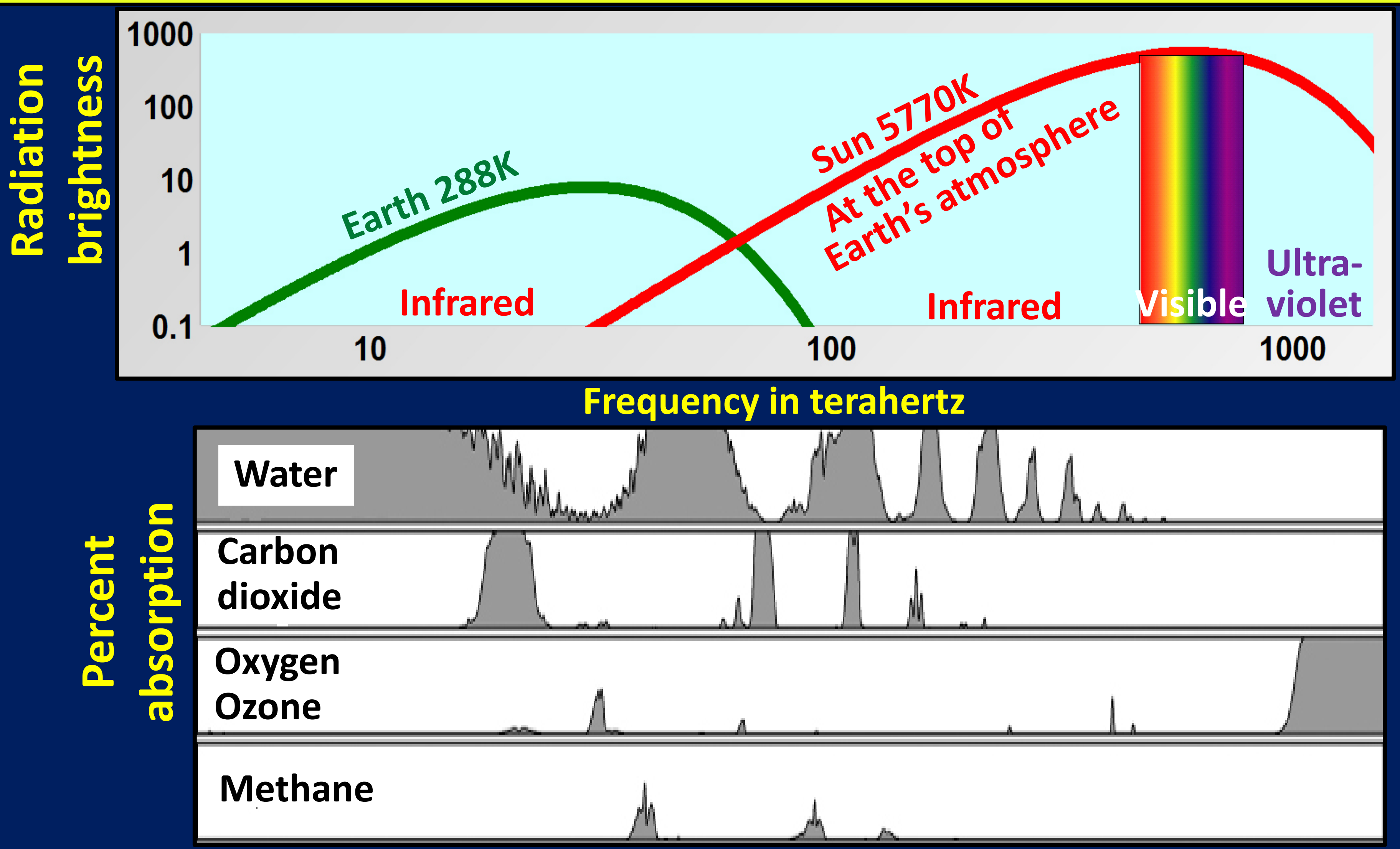


Late Proterozoic 650 Ma
Little sub-aerial rifting
Snowball earth
South China
Arabia
North China
Australia
India
Antarctica
PANTHALASSIC OCEAN
South Africa
Congo
Alaska
Siberia
Laurentia
PANAFRICAN OCEAN
West Africa
Greenland
Florida
Amazonia
Scandinavia
Grenville Province
Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge
© 1997 C. R. Scotese

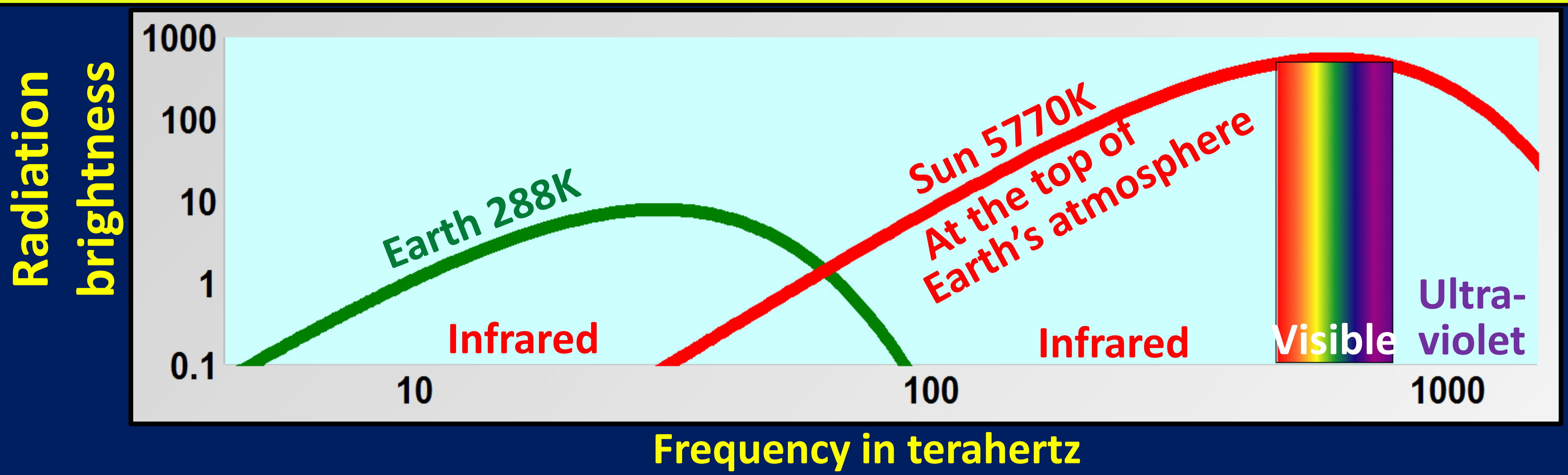

Late Permian 255 Ma
Siberian basalts
Siberia
Alaska
Kazakstania
PANTHALASSIC OCEAN
North China
PANGEA
California
Central Pangean Mts
PALEO-TETHYS OCEAN
South China
Indochina
South America
Africa
Turkey
Iran
Tibet
Malaya
TETHYS OCEAN
GONDWANA
South Africa
India
Australia
Antarctica
Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge
© 1997 C. R. Scotese

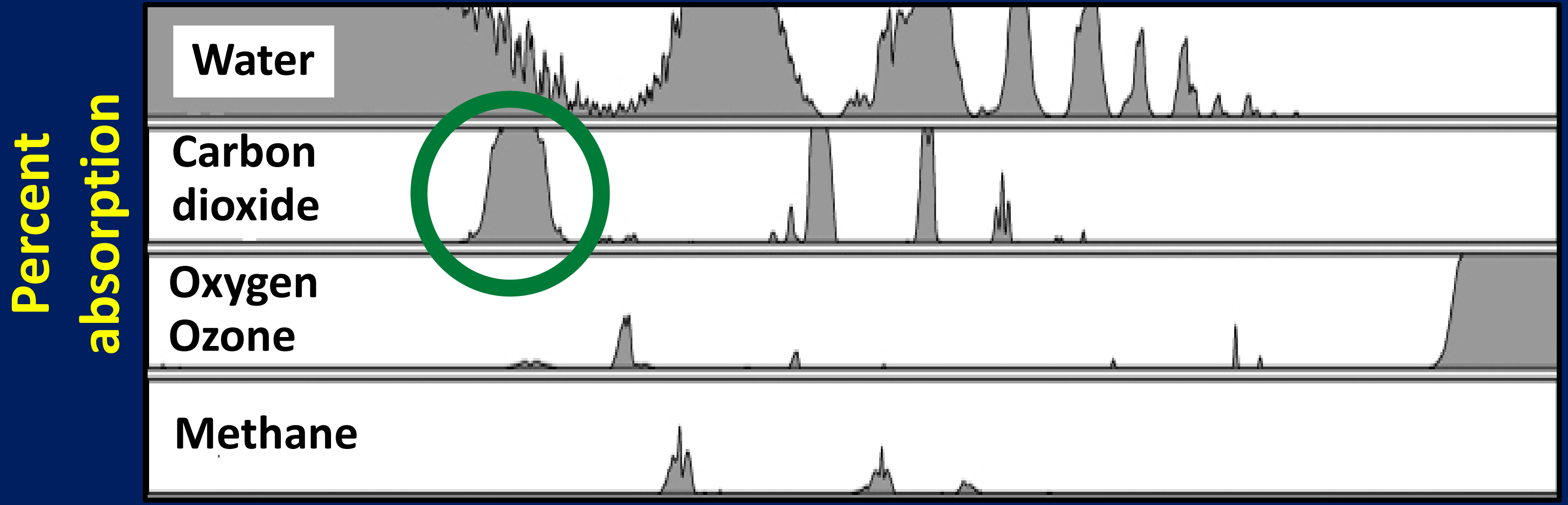

What IS heat ?

Energy absorbed by greenhouse gases

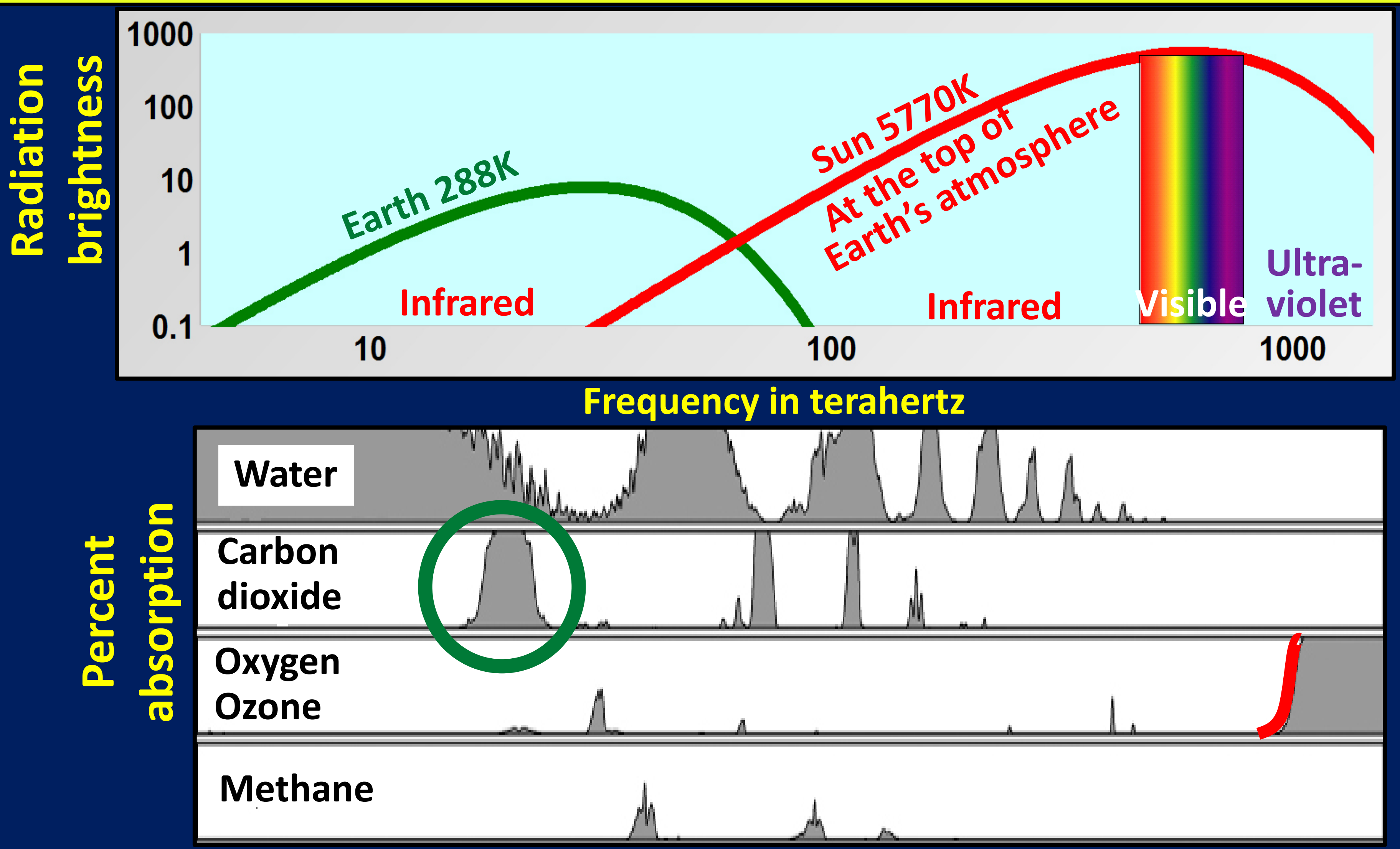


Energy absorbed by greenhouse gases

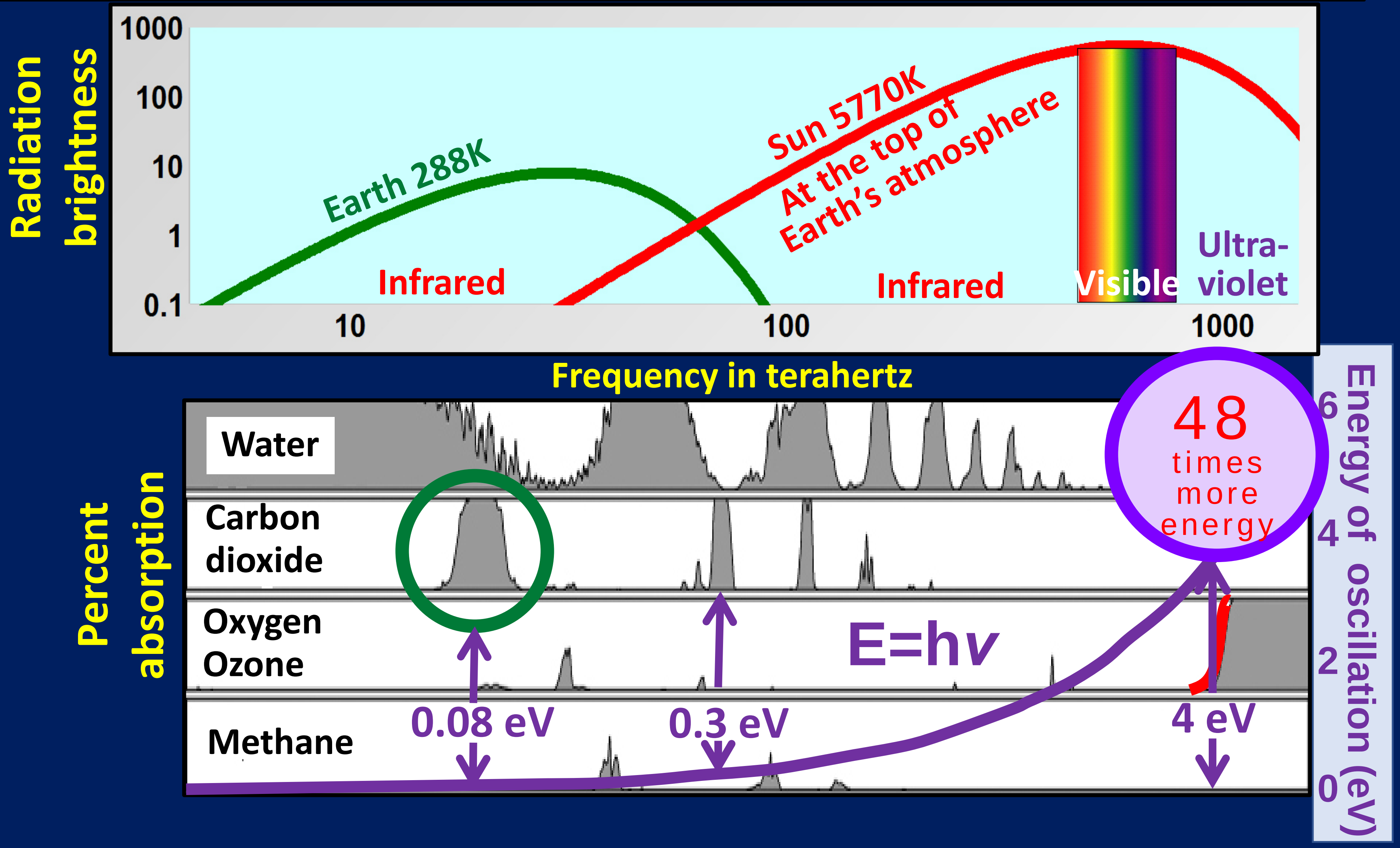




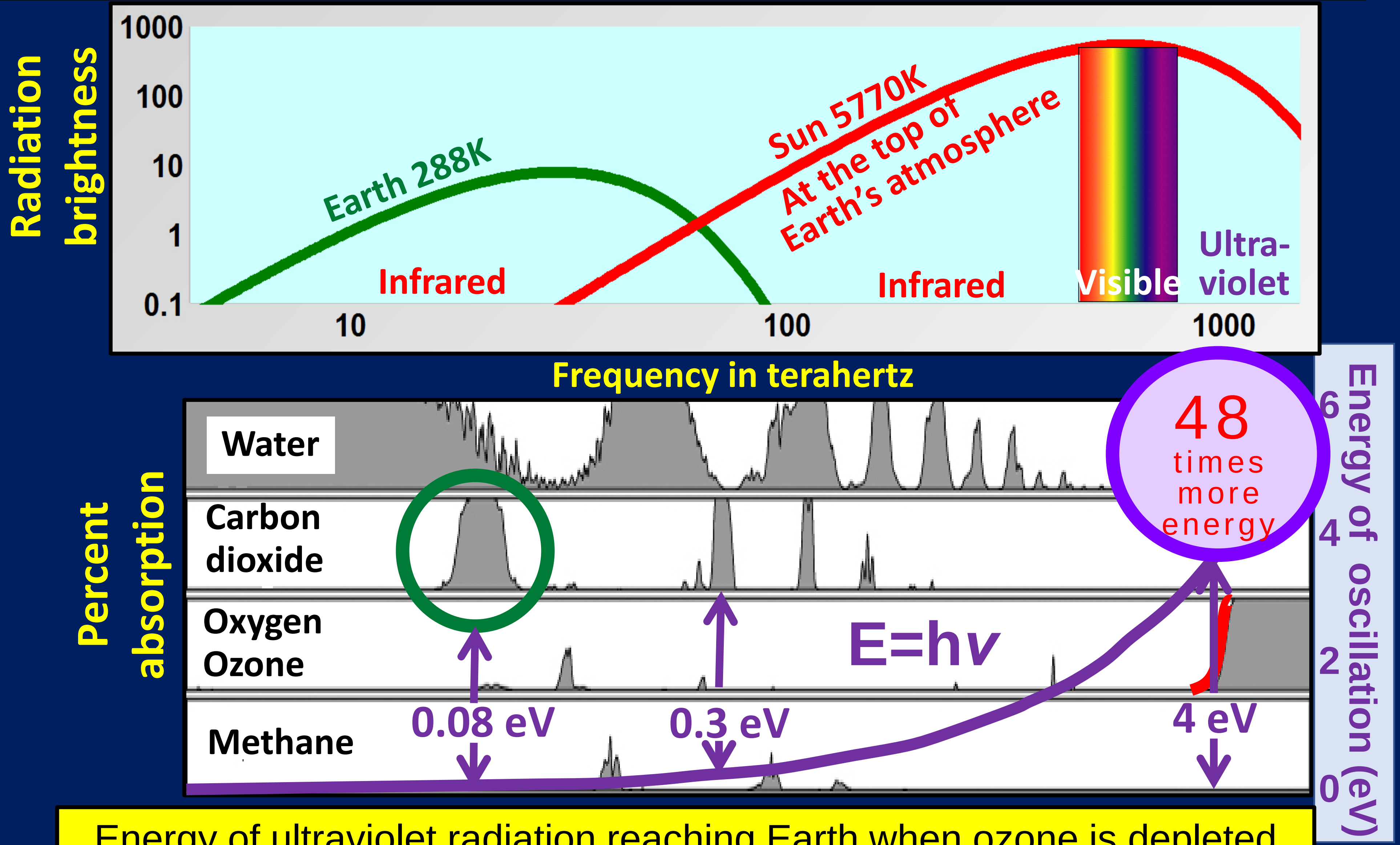
Energy absorbed by greenhouse gases



Energy absorbed by greenhouse gases

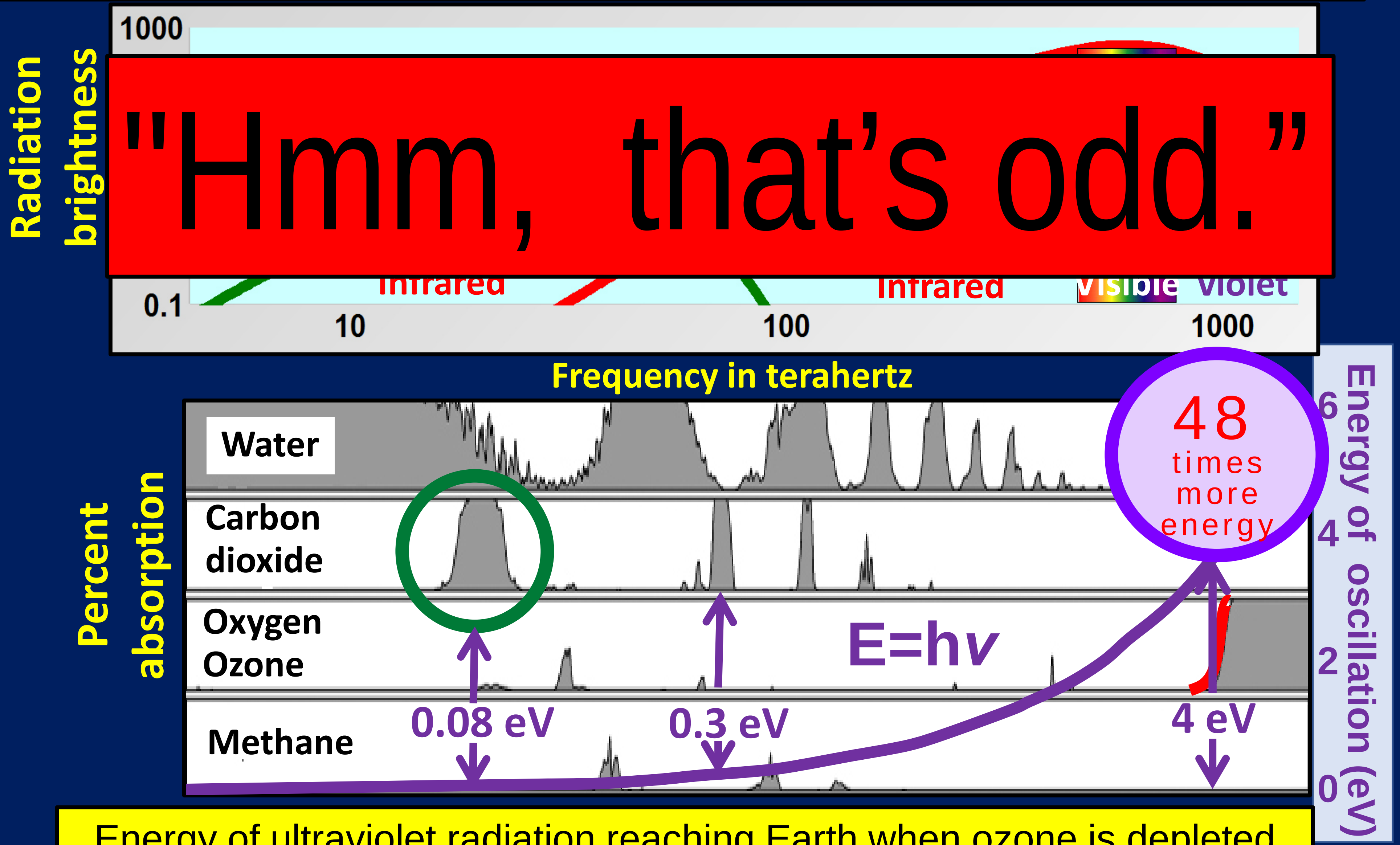


Energy absorbed by greenhouse gases



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

Energy absorbed by greenhouse gases



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

But we cannot see radiation. We see its effects.

But we cannot see radiation. We see its effects.

We cannot see frequency. We see the effects of frequency.

But we cannot see radiation. We see its effects.

We cannot see frequency. We see the effects of frequency.

Frequency of oscillation of all the bonds holding matter together

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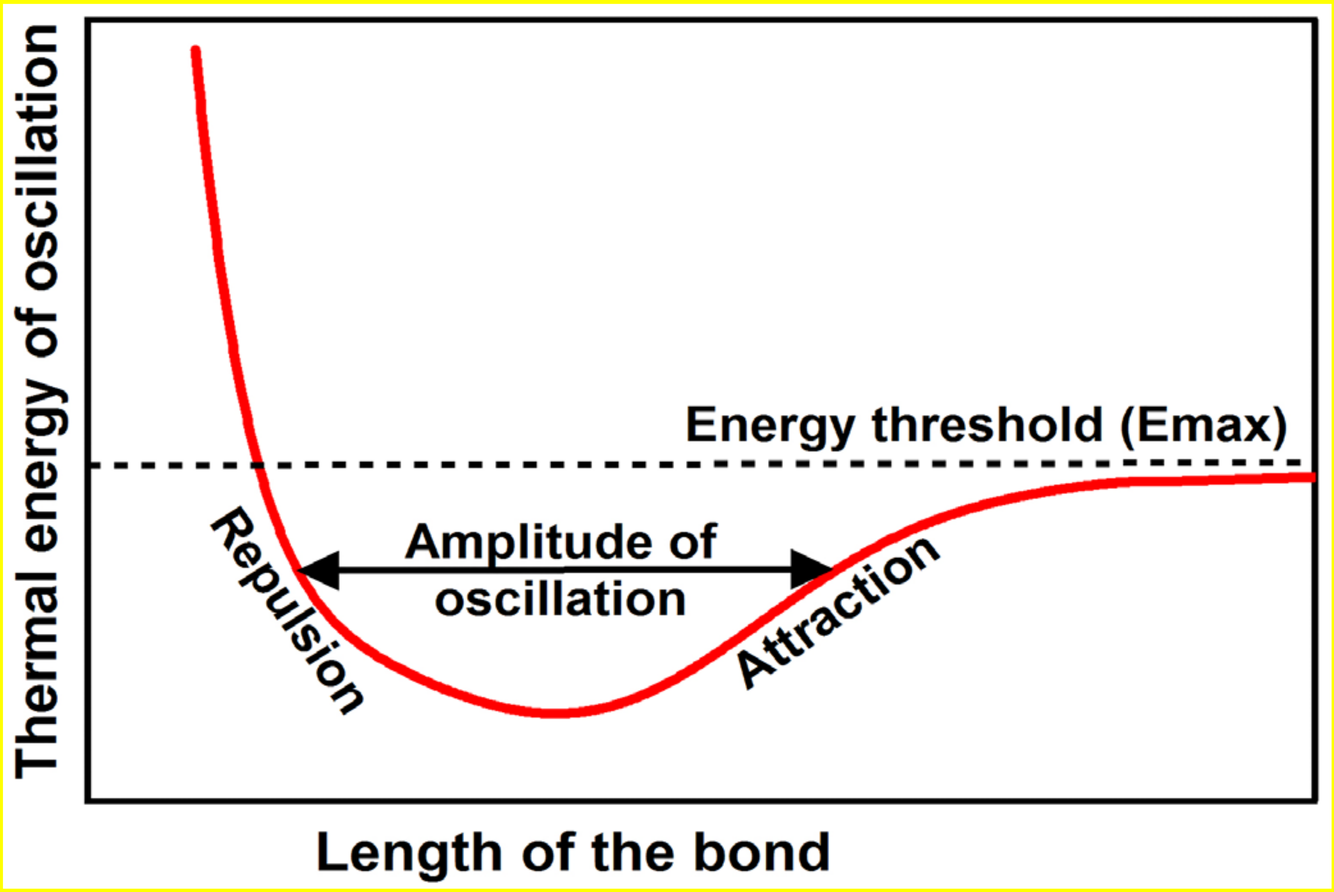
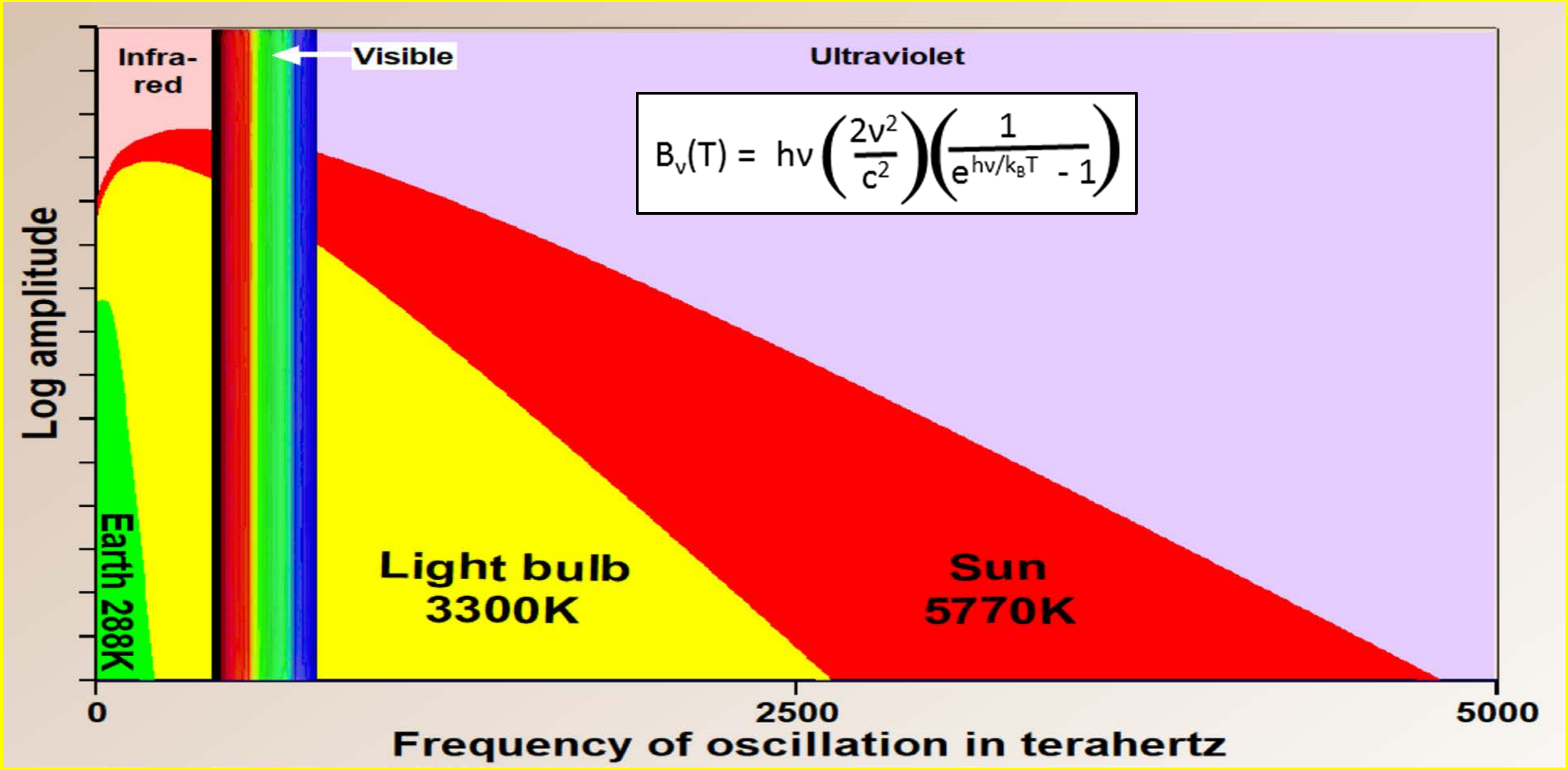
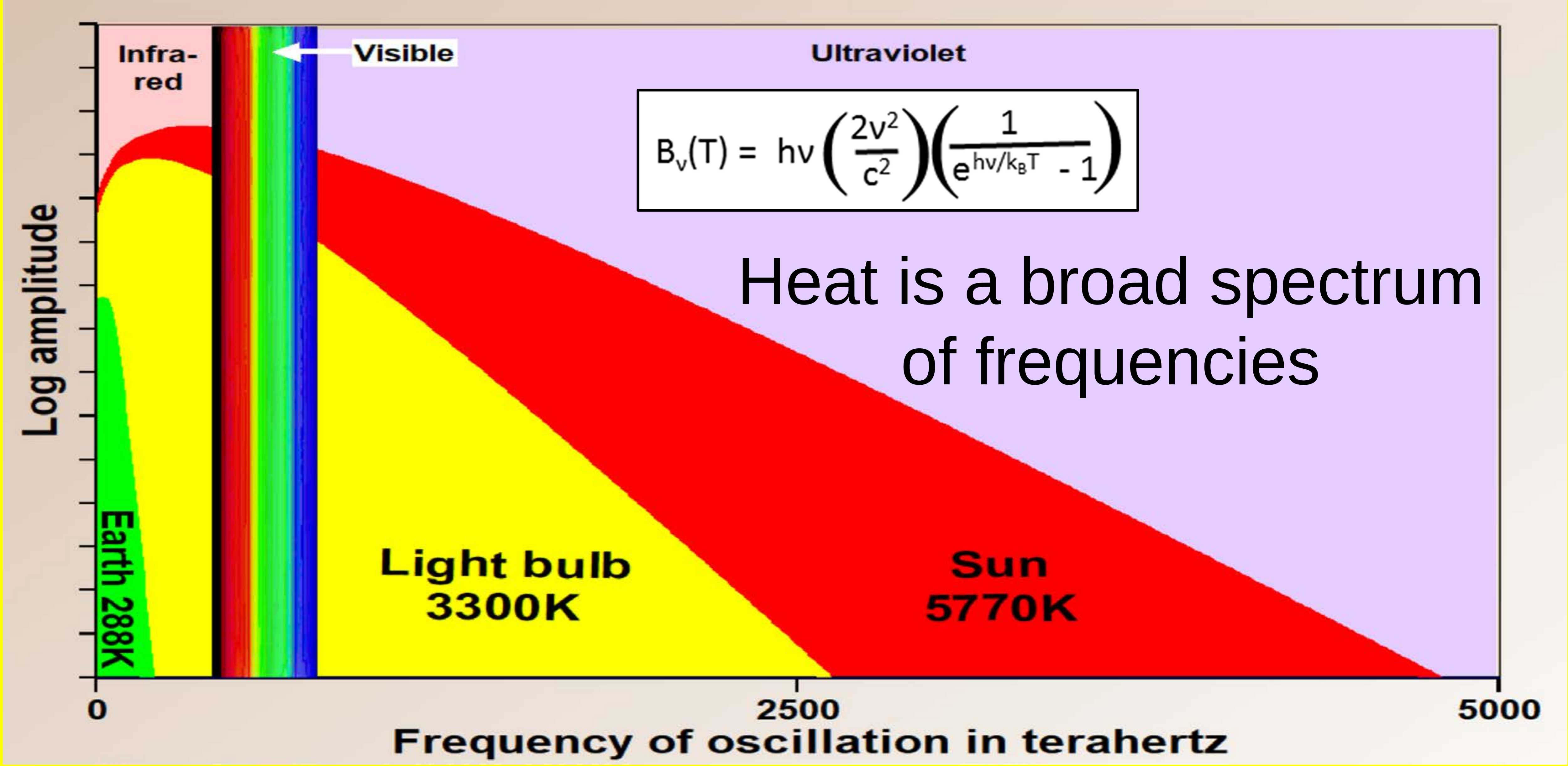
Frequency of oscillation of all the bonds holding matter together



Planck's empirical law (1900) describing observed radiation



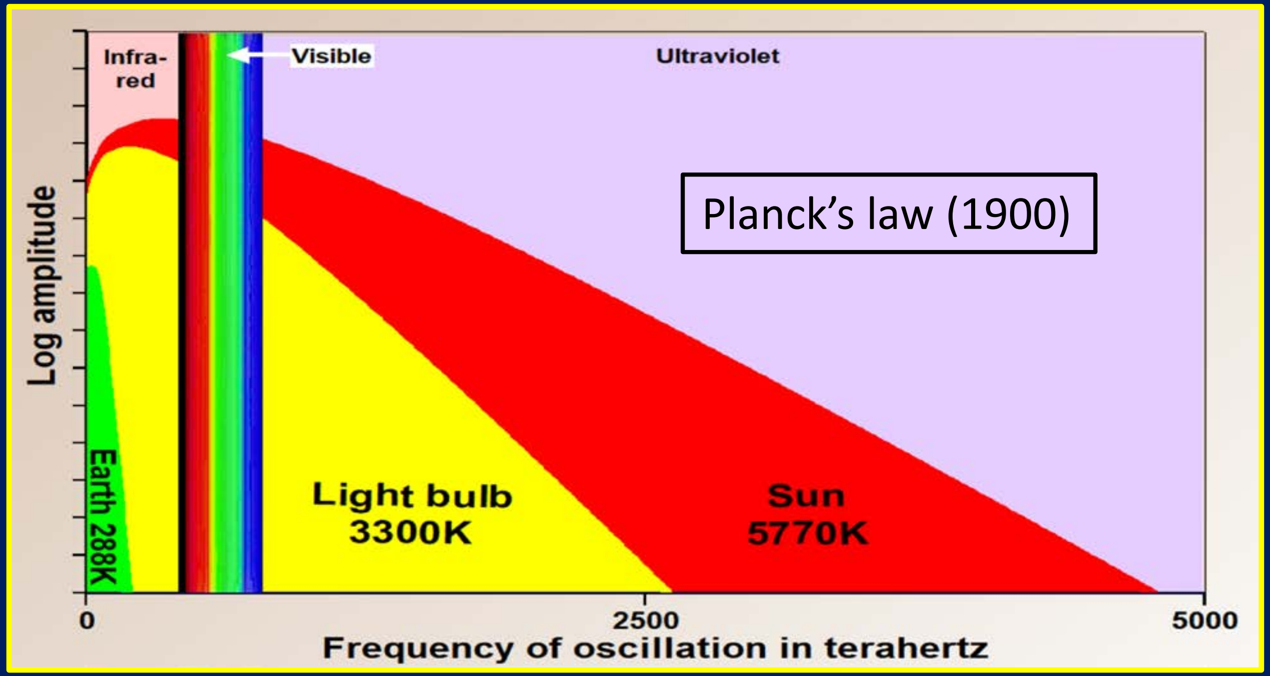
Planck's empirical law (1900) describing observed radiation



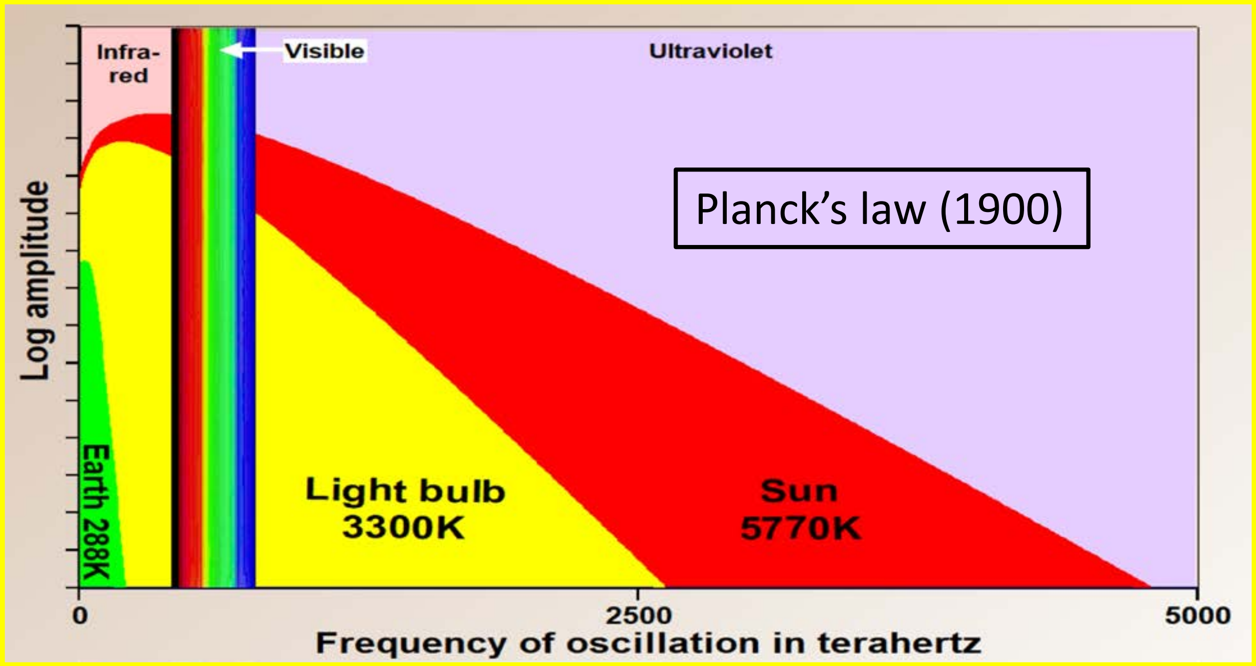
$$B_\nu(T) = h\nu\left(\frac{2\nu^2}{c^2}\right)\left(\frac{1}{e^{h\nu/k_BT} - 1}\right)$$

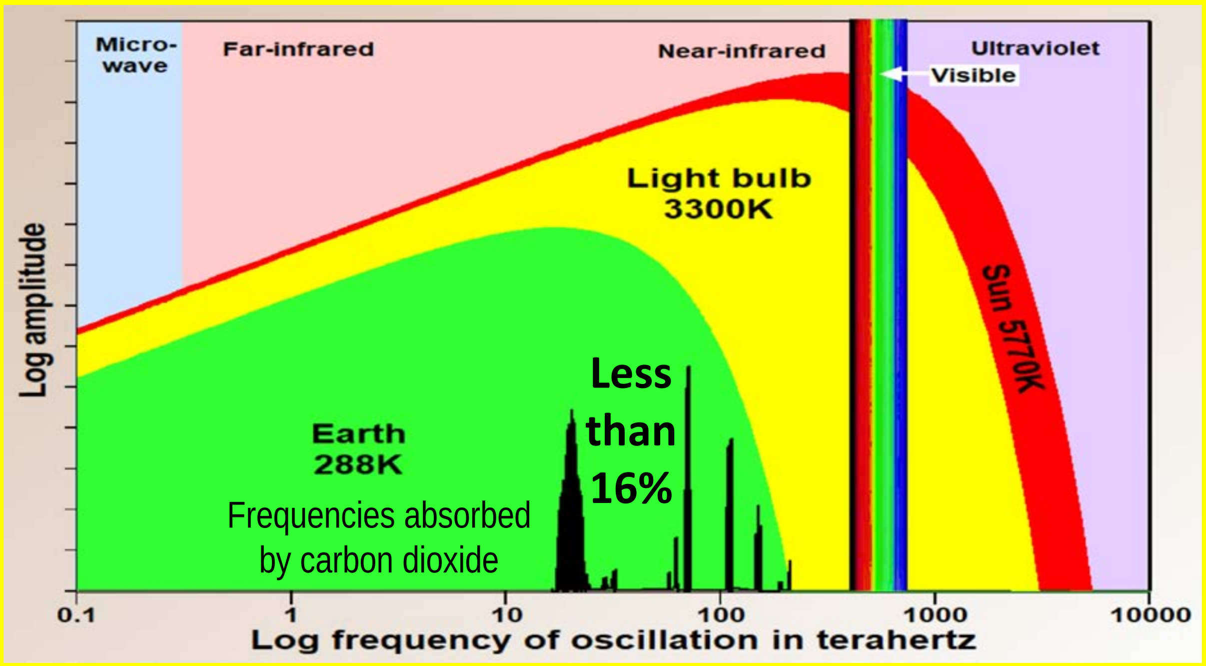
Heat is a broad spectrum of frequencies

Electromagnetic radiation is a broad continuum of frequencies

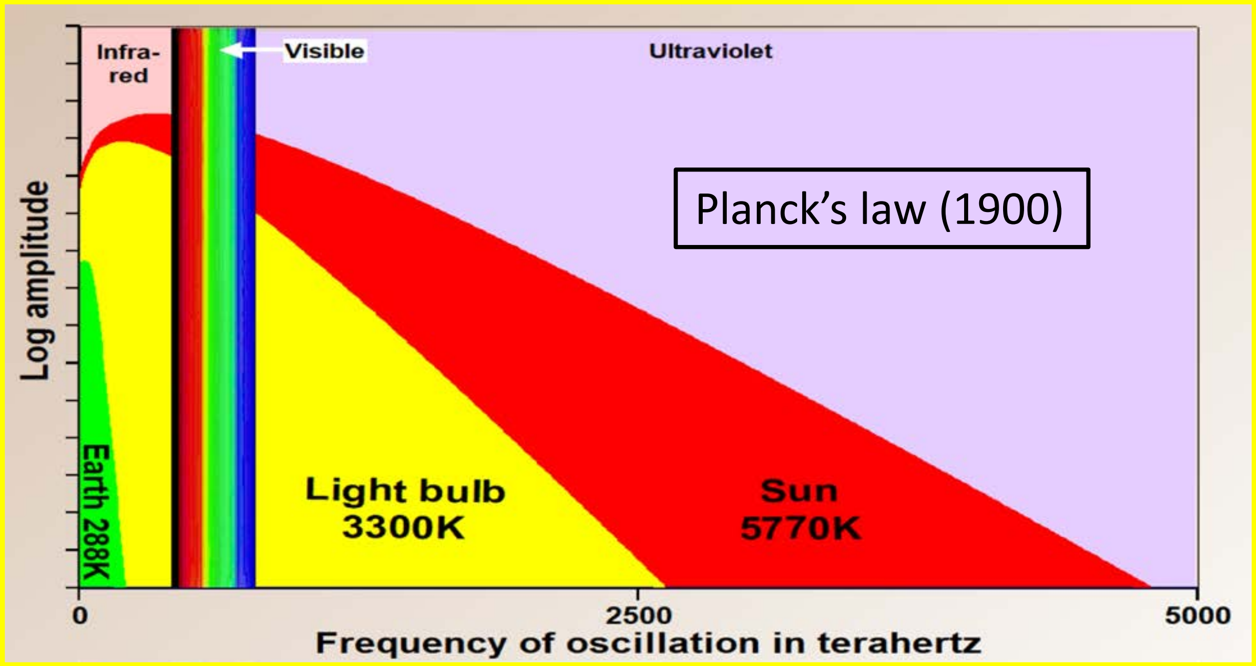


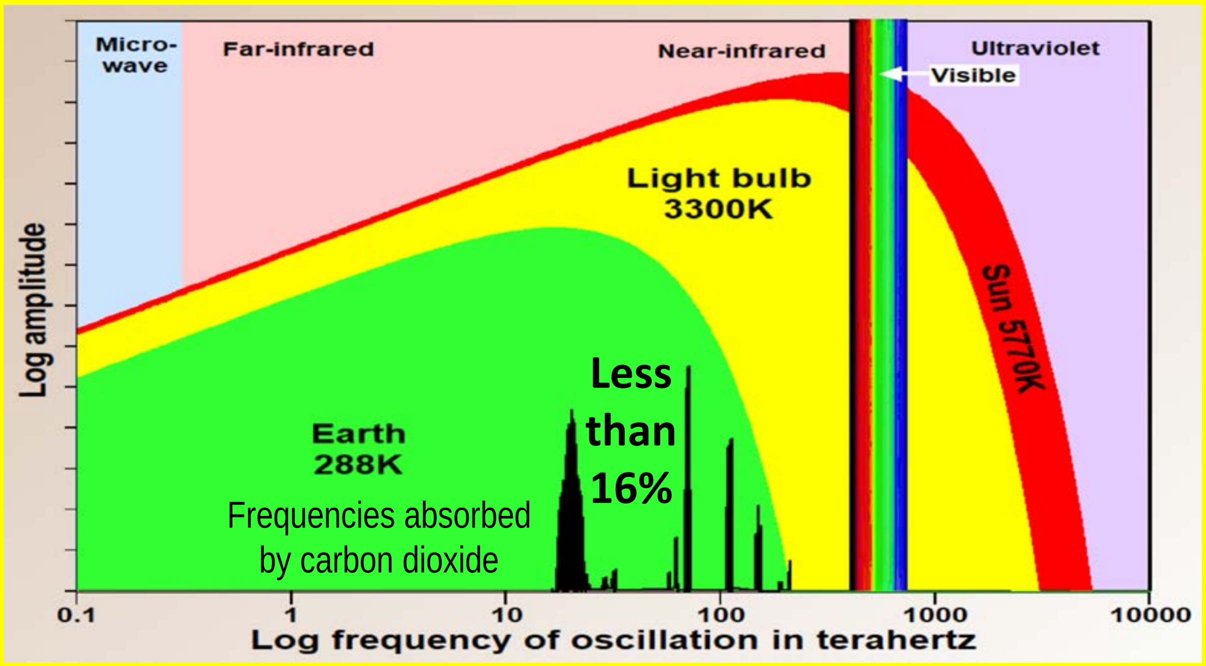
Electromagnetic radiation is a broad continuum of frequencies

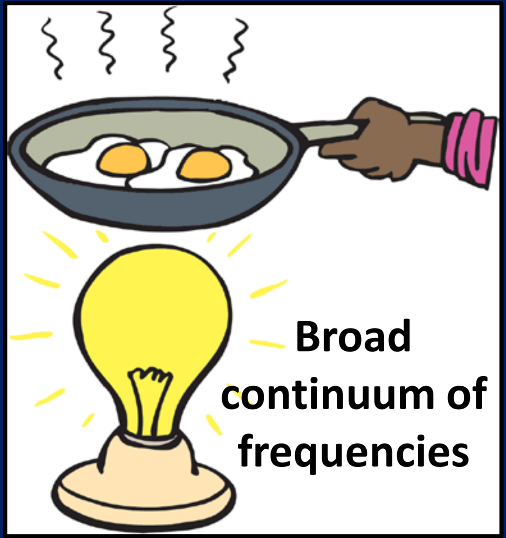




Electromagnetic radiation is a broad continuum of frequencies

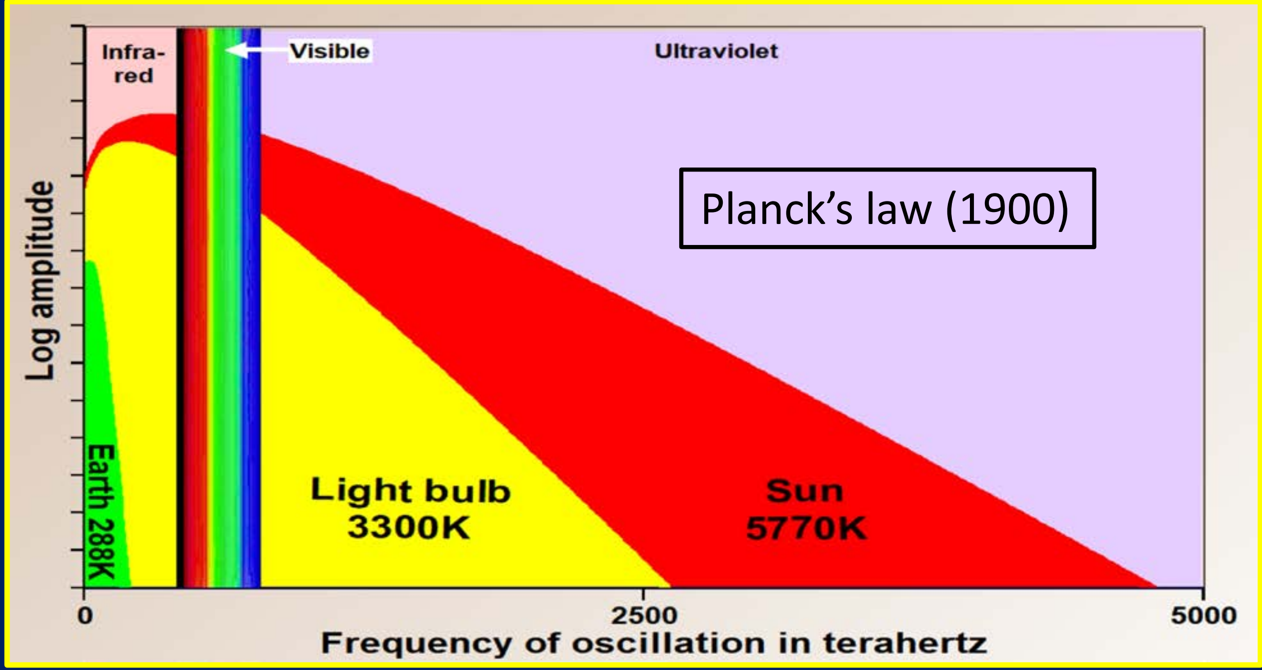


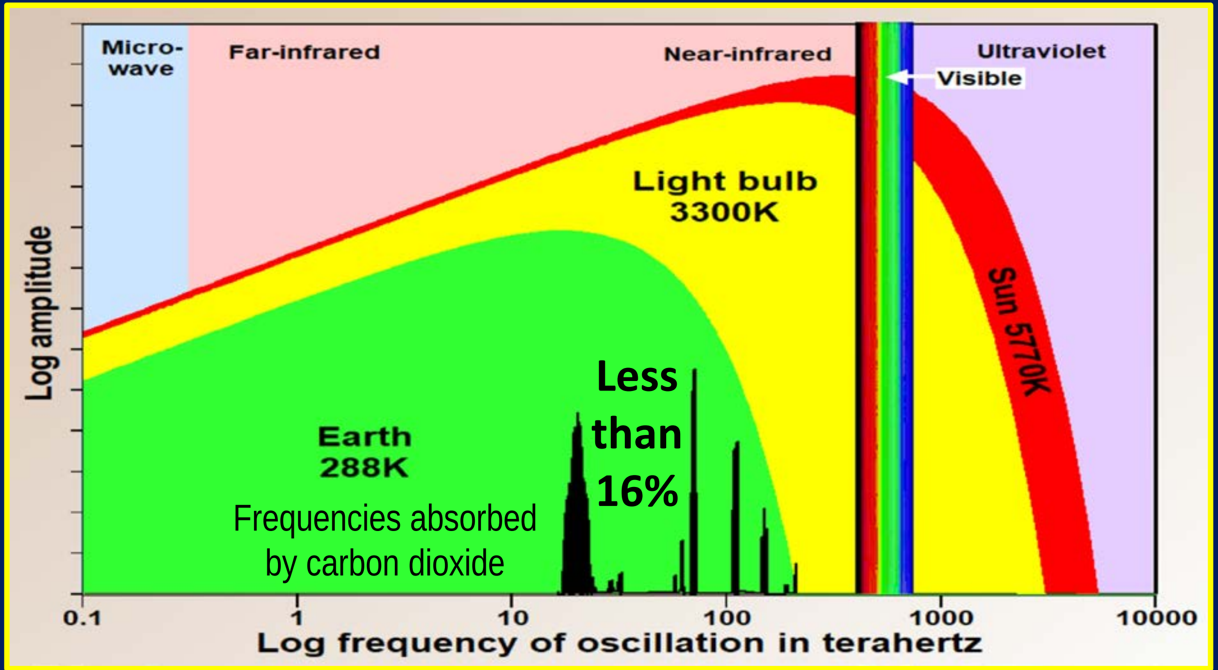


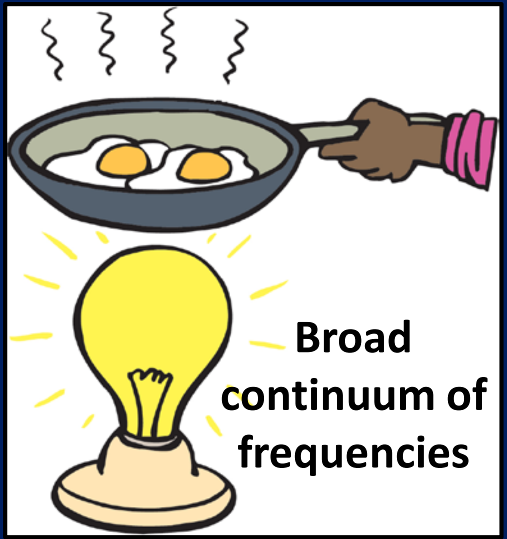


A light bulb emits a broad range of frequencies (heat) just to produce a narrow range of visible light

Electromagnetic radiation is a broad continuum of frequencies

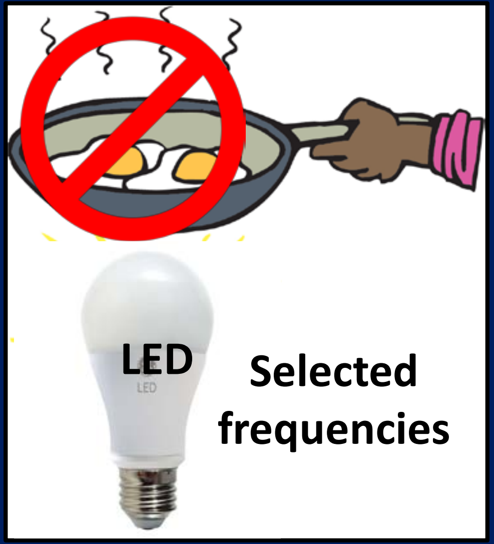




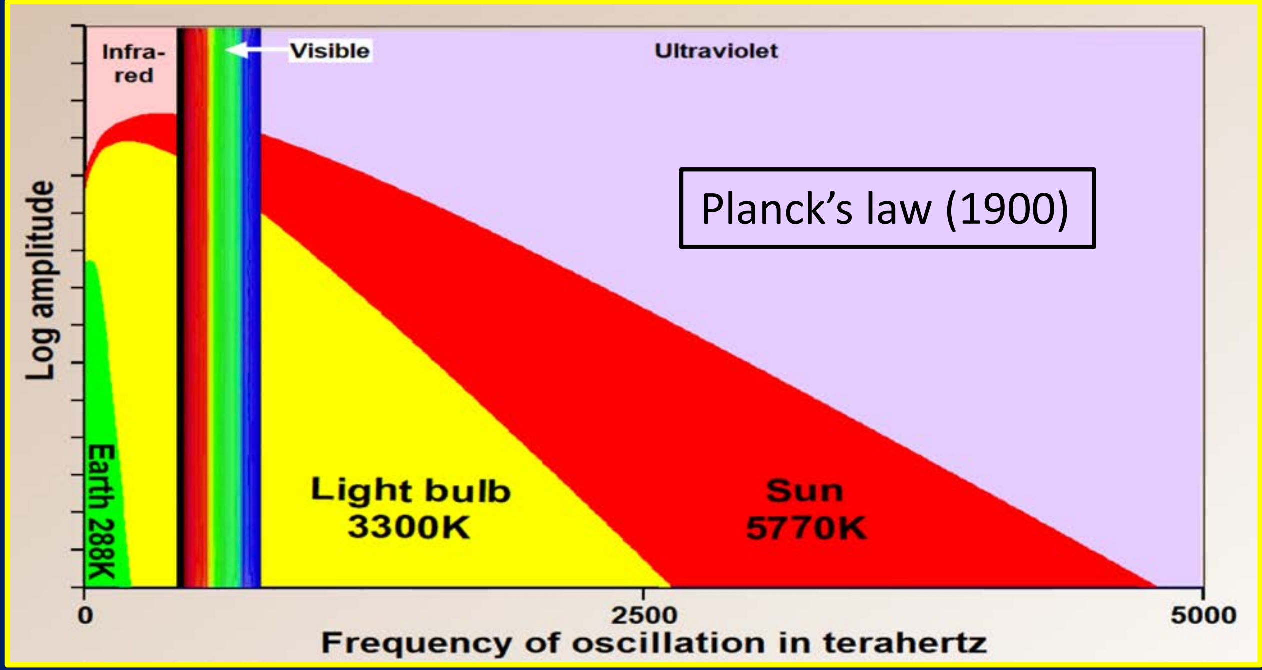


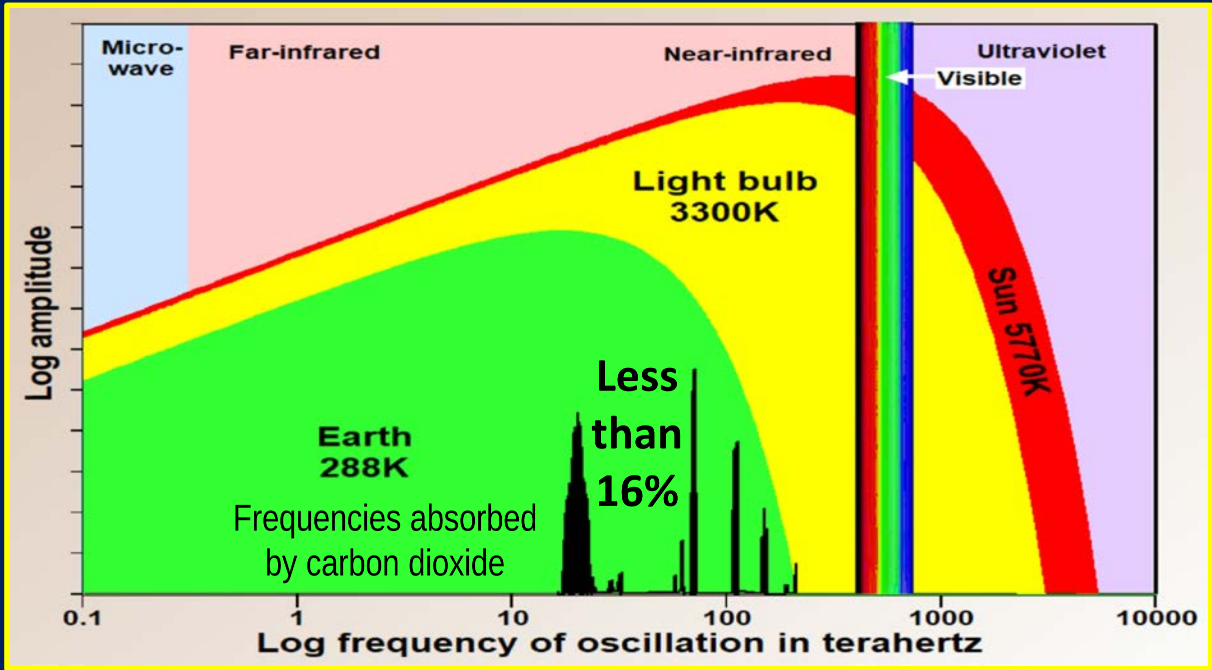
A light bulb emits a broad range of frequencies (heat) just to produce a narrow range of visible light

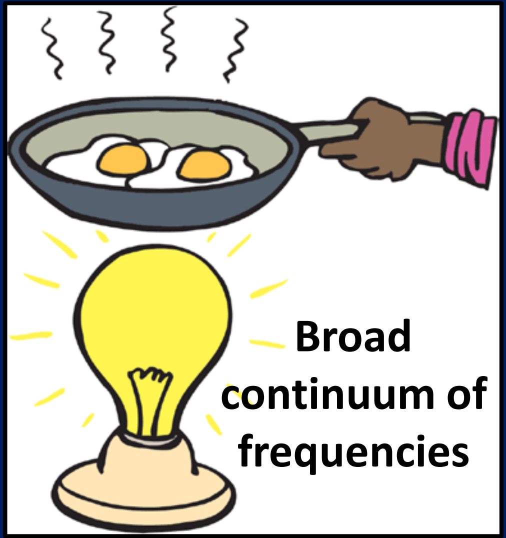
LEDs emit a narrow range of visible frequencies without emitting heat



Electromagnetic radiation is a broad continuum of frequencies

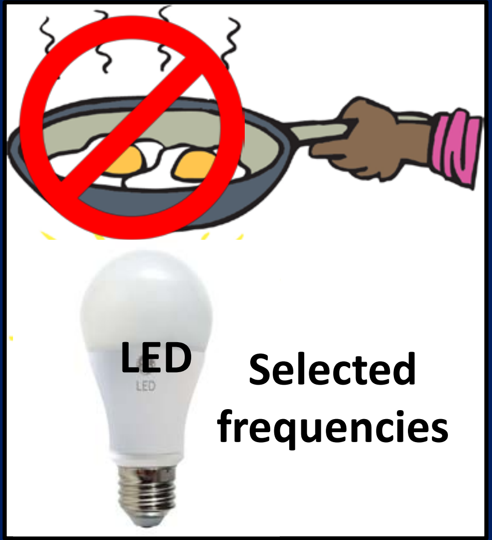






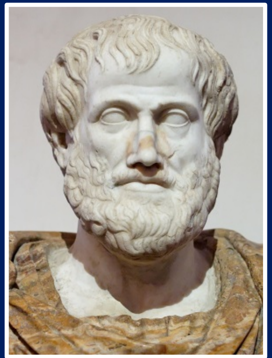
Greenhouse gases simply do not absorb a broad enough range of frequencies, that we perceive as heat, to be a significant cause of global warming.

Greenhouse-warming theory appears to be mistaken.




How does heat travel
through matter and
through air and space?

Waves



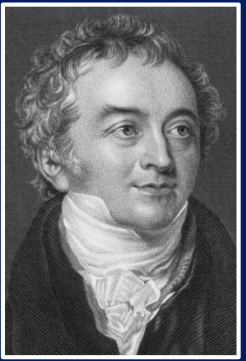
Aristotle 340 BC

Descartes 1630

Huygens 1678

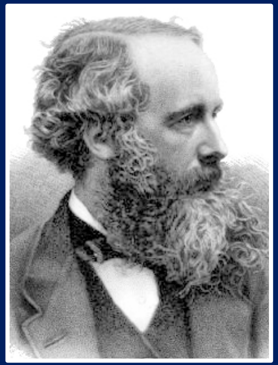
Hooke 1680

Fresnel 1814



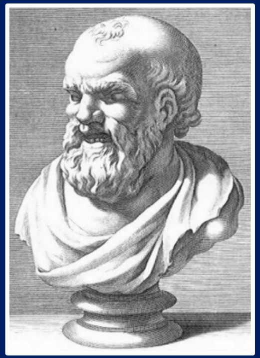
Young 1803

Faraday 1830

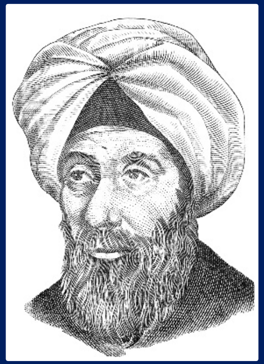


Maxwell 1865

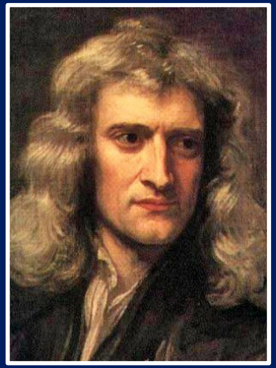
Particles



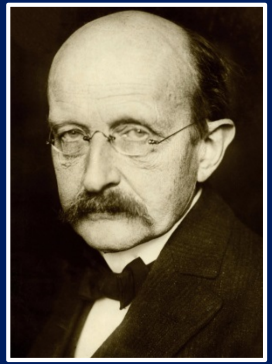
Democritus 410 BC



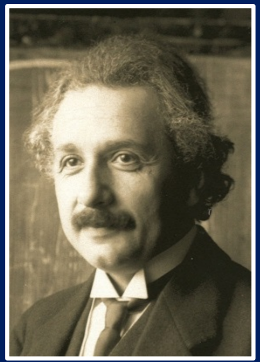
Alhazen 1000



Newton 1670

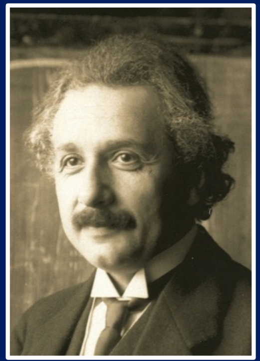


Planck 1900

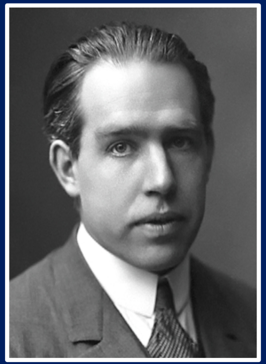


Einstein 1905

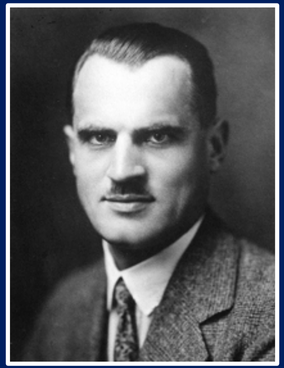
Wave particle duality



Einstein 1905



Bohr 1912



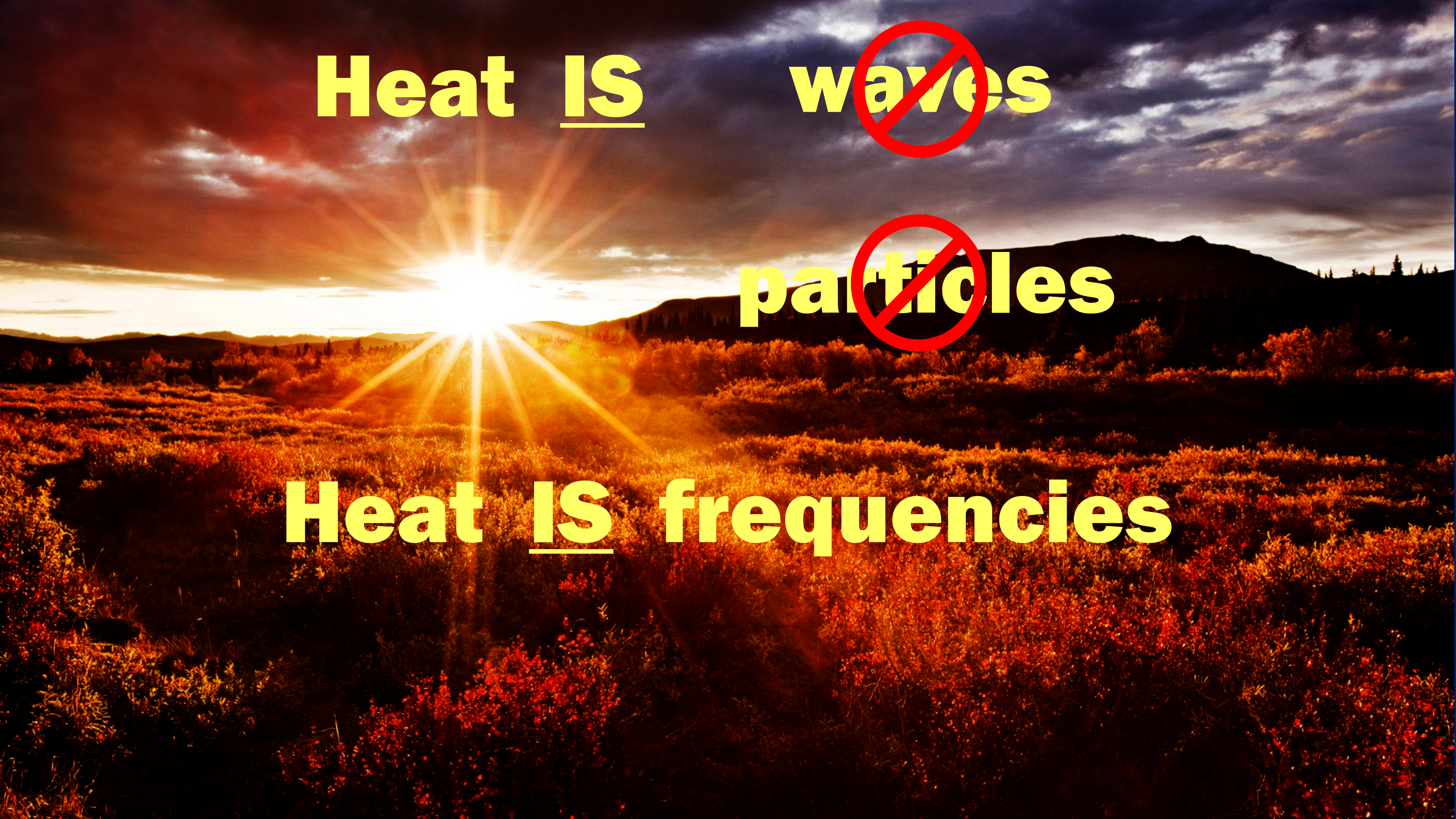
Compton 1922

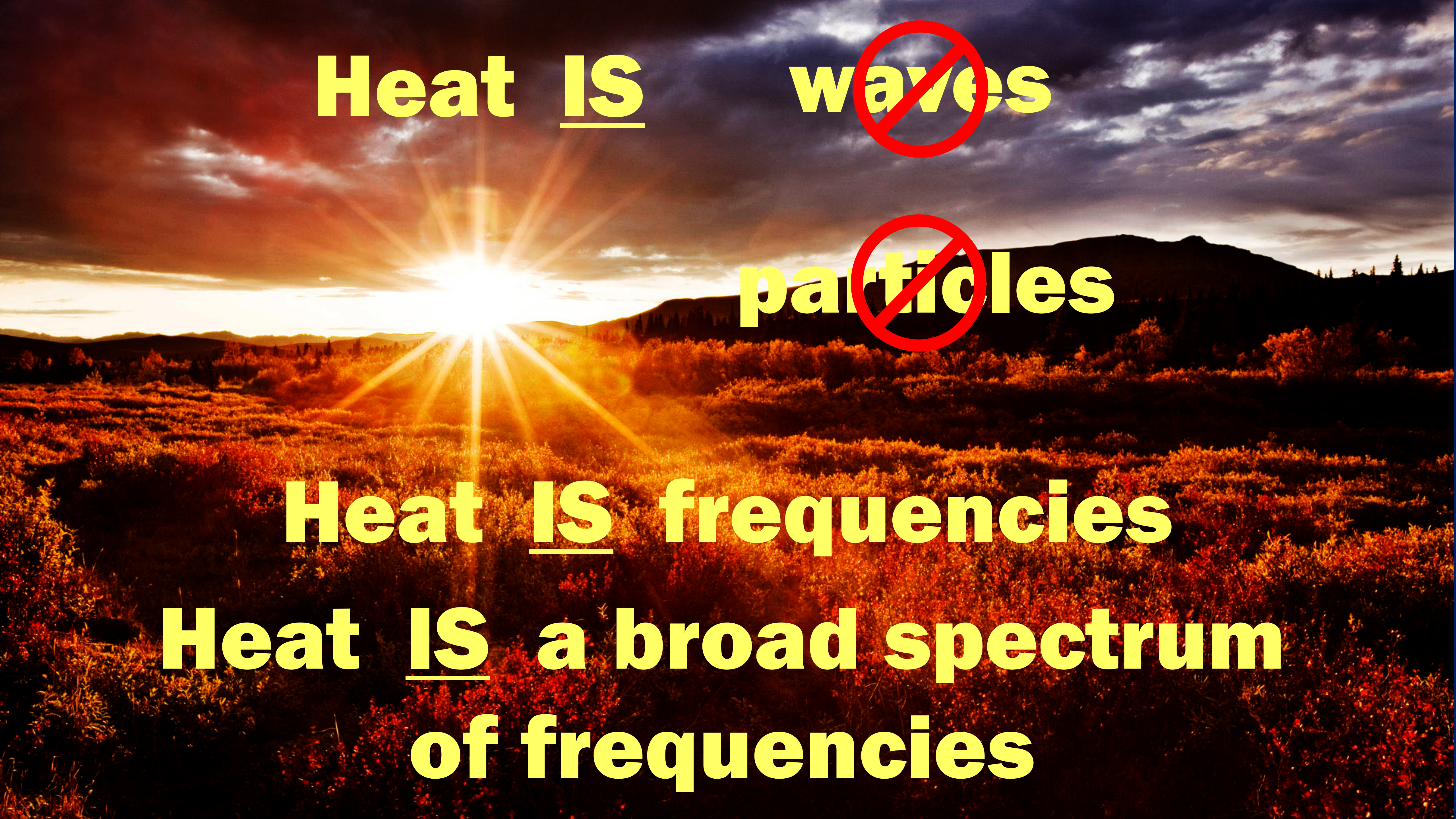
de Broglie 1924


Heat IS


Heat IS waves


Heat IS
waves
particles


Heat IS waves
particles
Heat IS frequencies

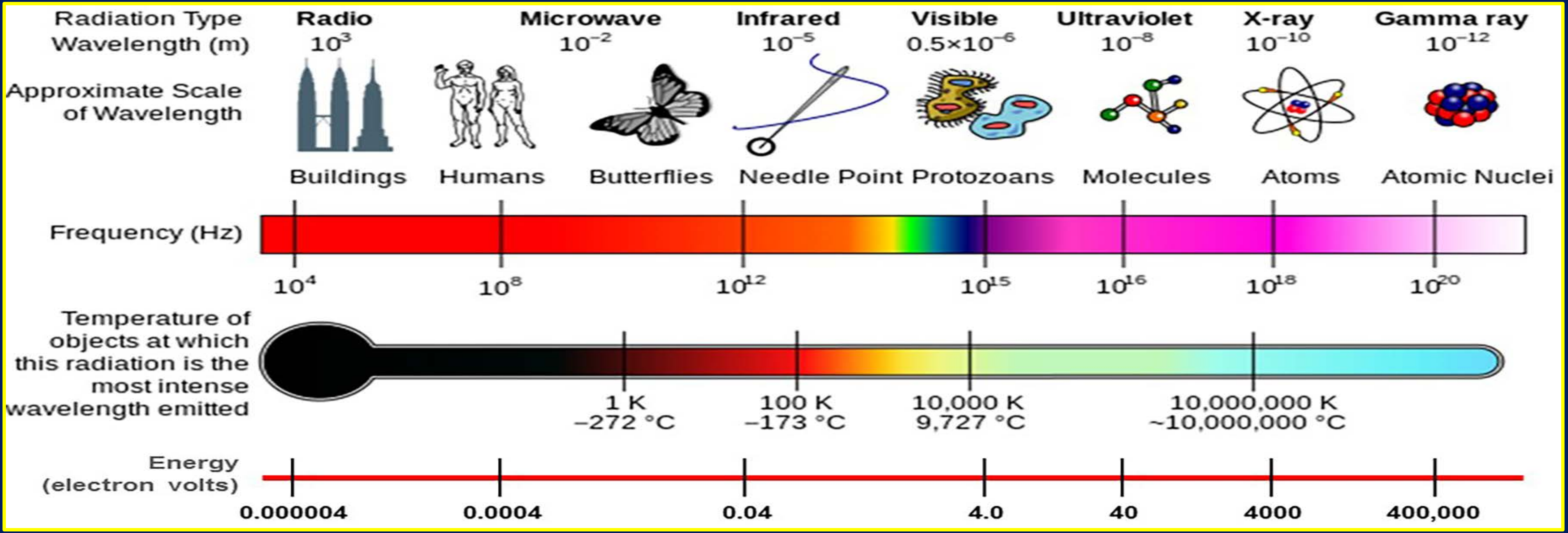

Heat IS ~~waves~~
~~particles~~
Heat IS frequencies
Heat IS a broad spectrum of frequencies

The Planck-Einstein Relation

$$E = h\,v$$

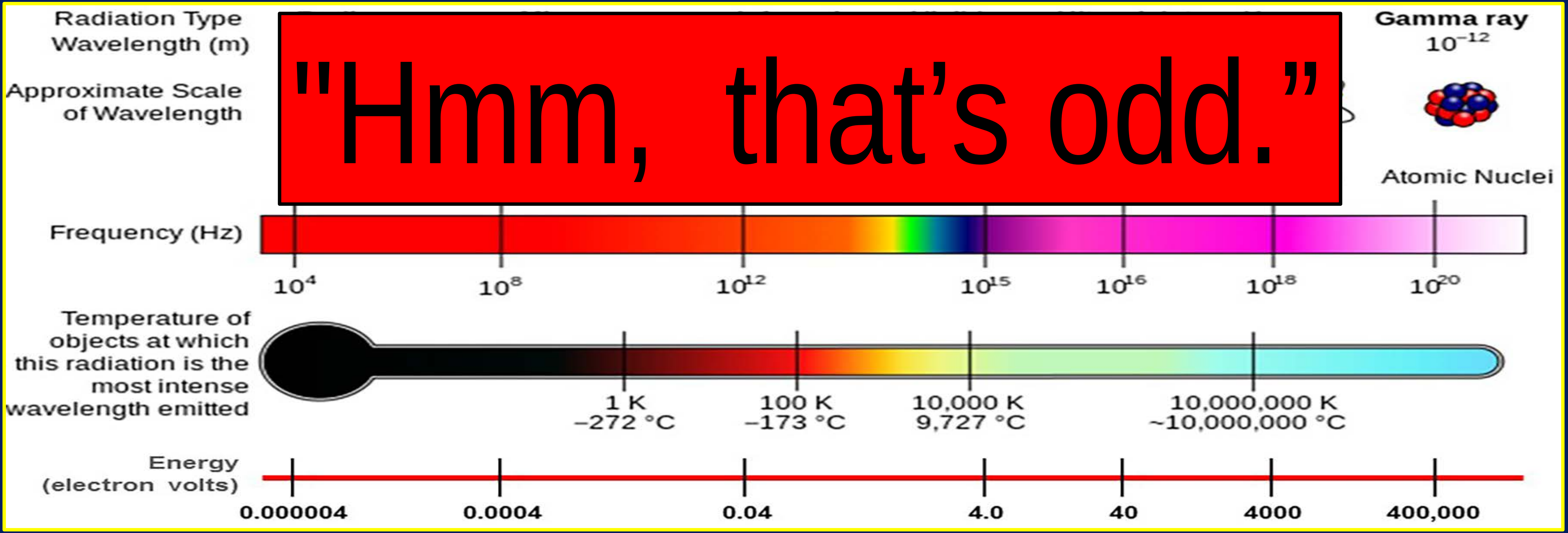
The Planck-Einstein Relation

$$E = h\,\nu$$



The Planck-Einstein Relation

$$E = h\,v$$

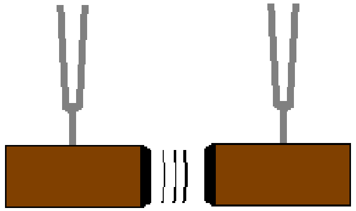


"Hmm, that's odd."

<u>Each</u> frequency causing resonance is how we perceive the world

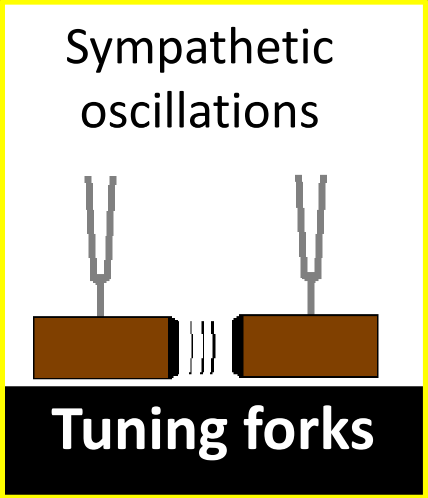
<u>Each</u> frequency causing resonance is how we perceive the world

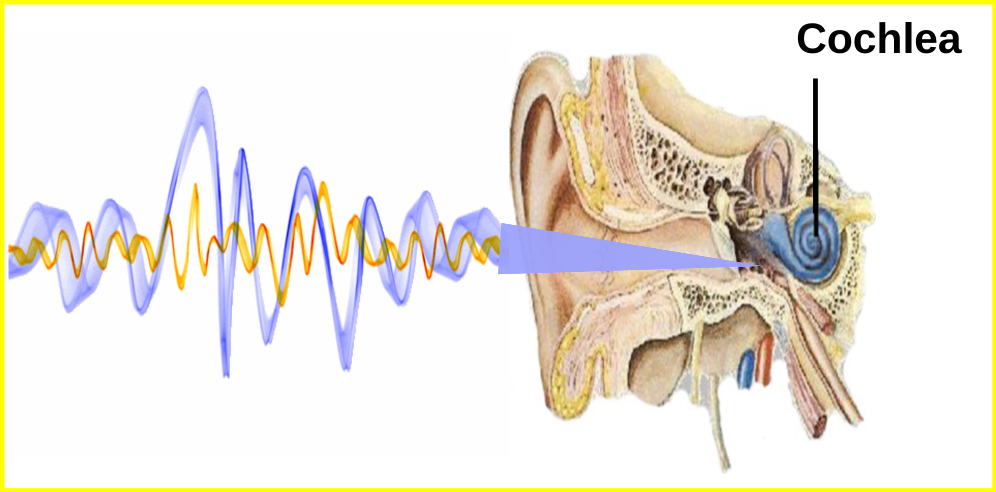
Sympathetic oscillations



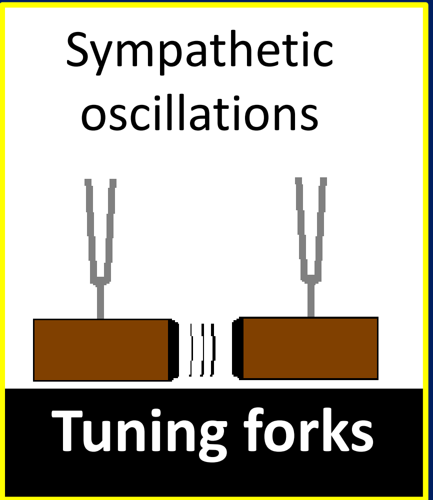
Tuning forks

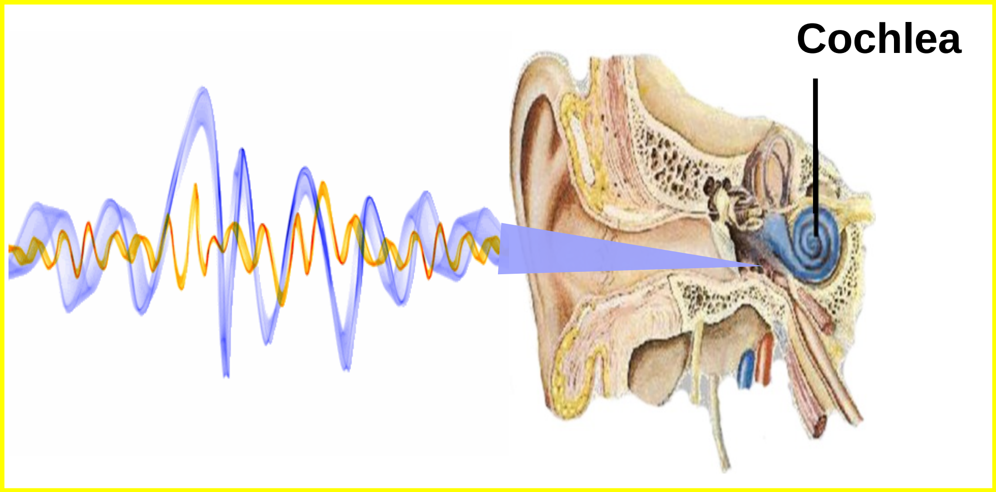
Each frequency causing resonance is how we perceive the world

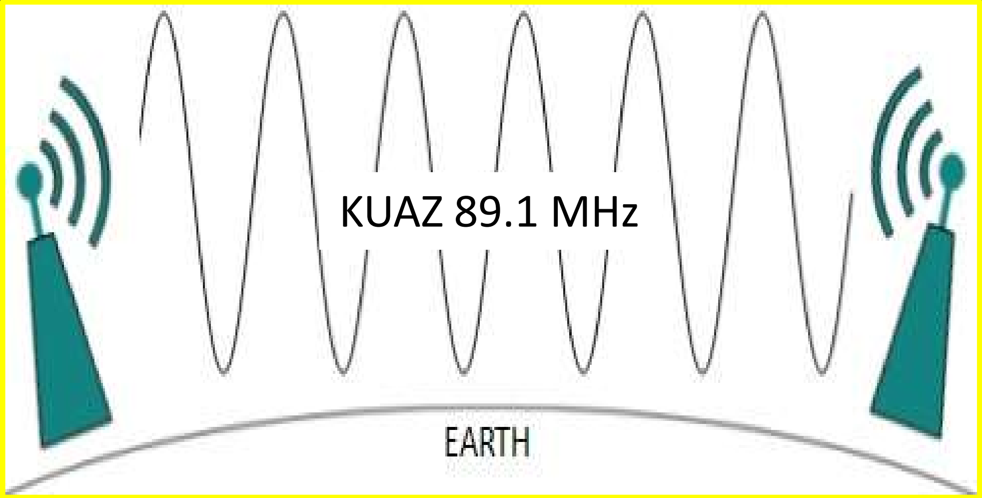




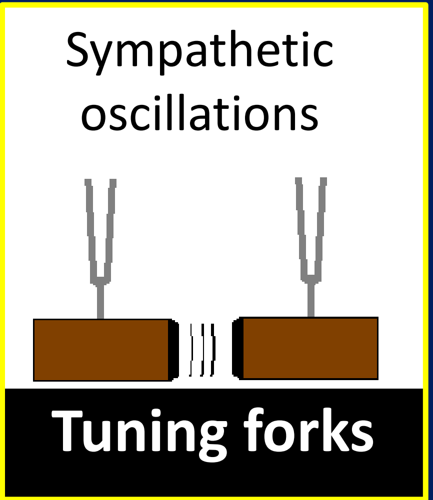
<u>Each</u> frequency causing resonance is how we perceive the world

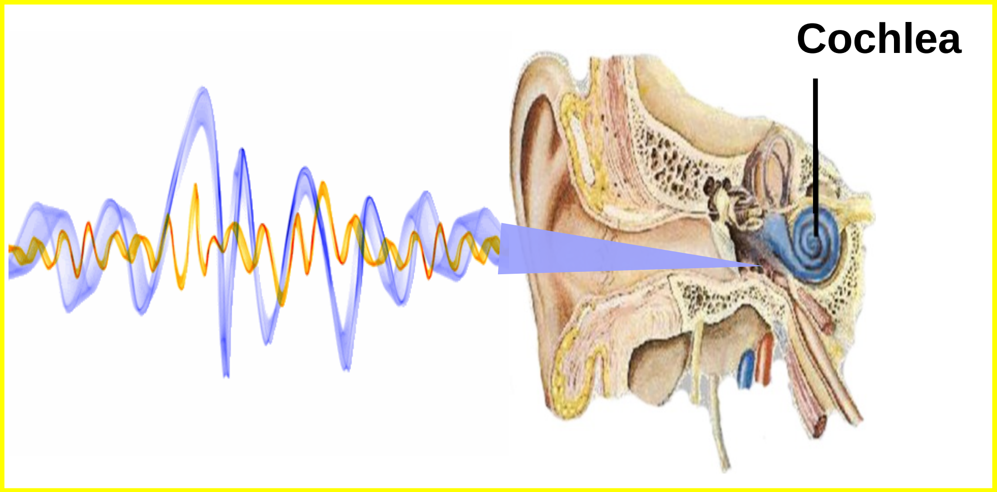


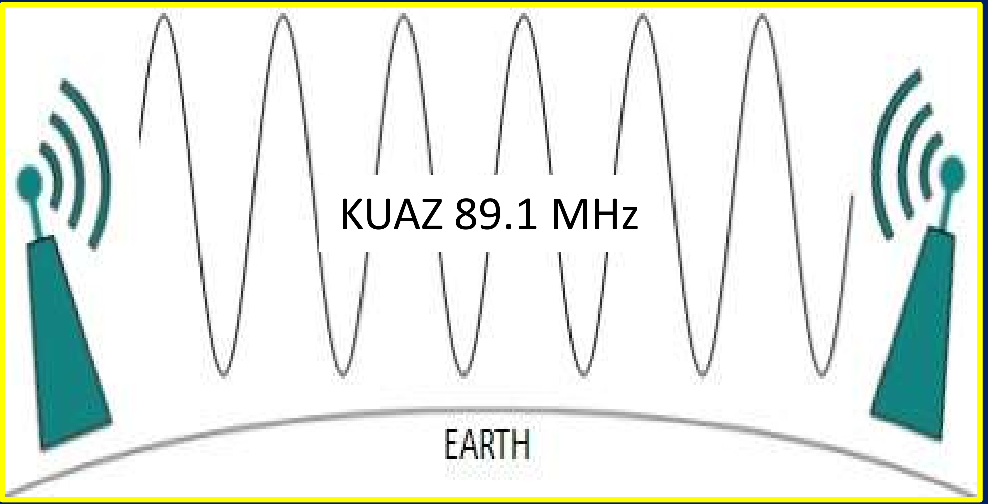


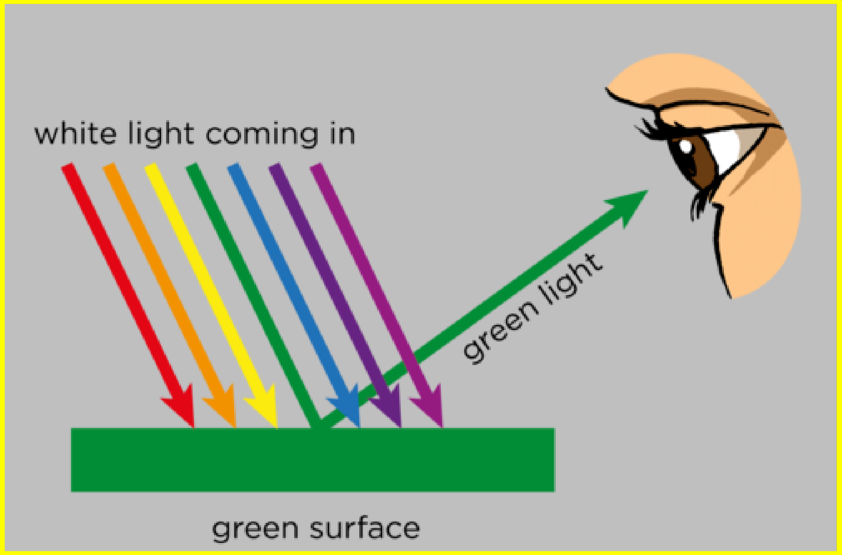


Each frequency causing resonance is how we perceive the world

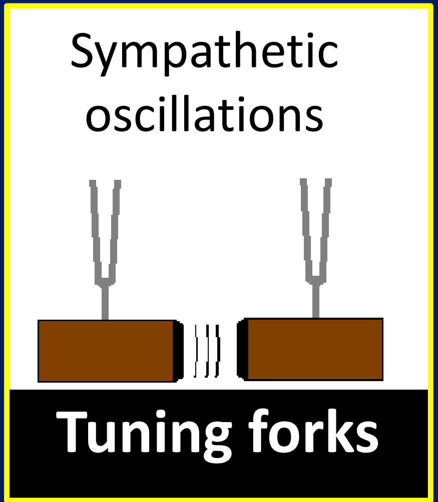


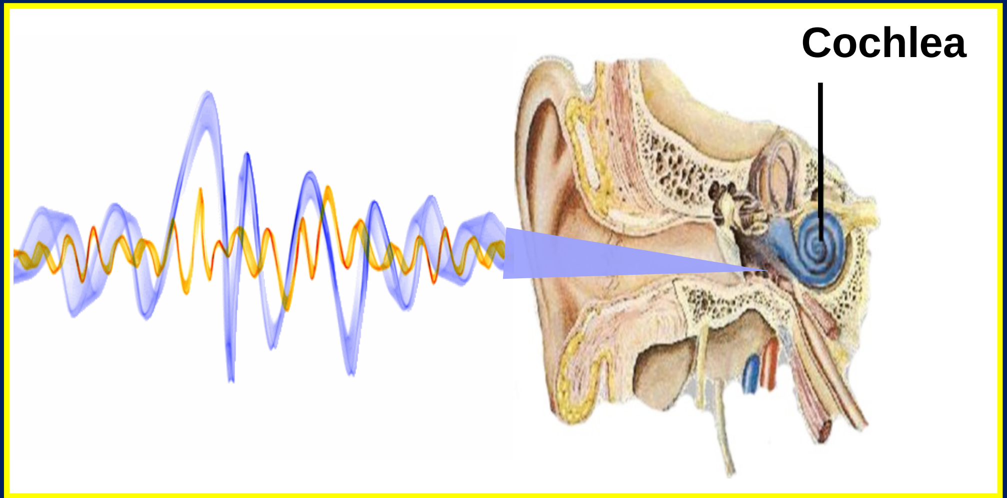


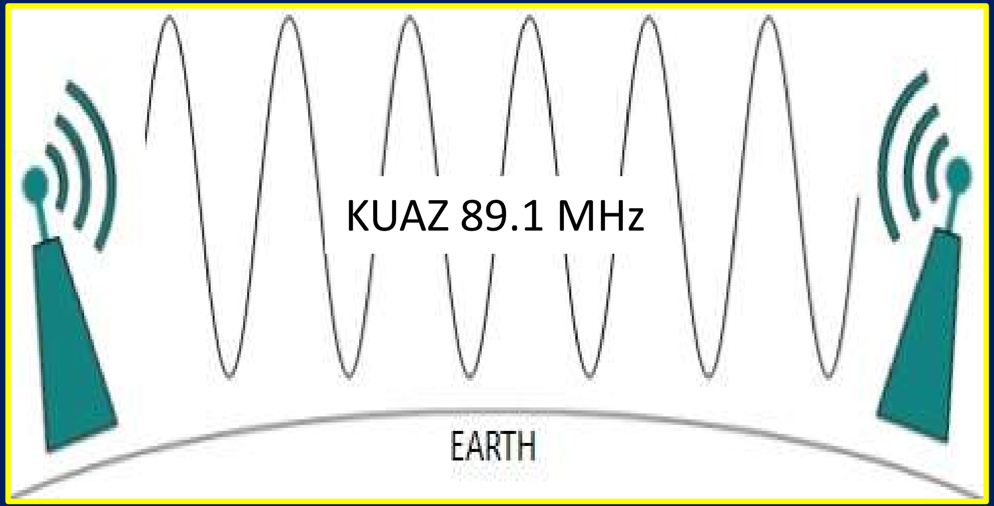


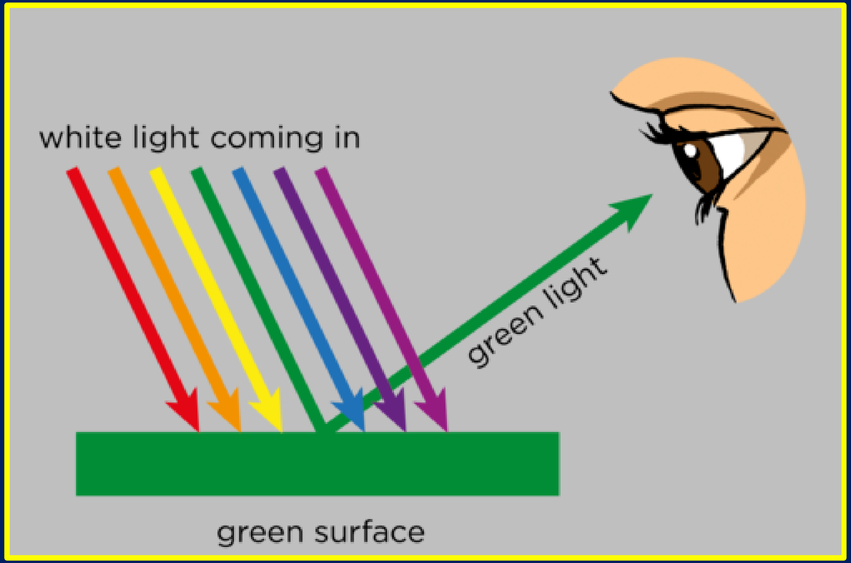


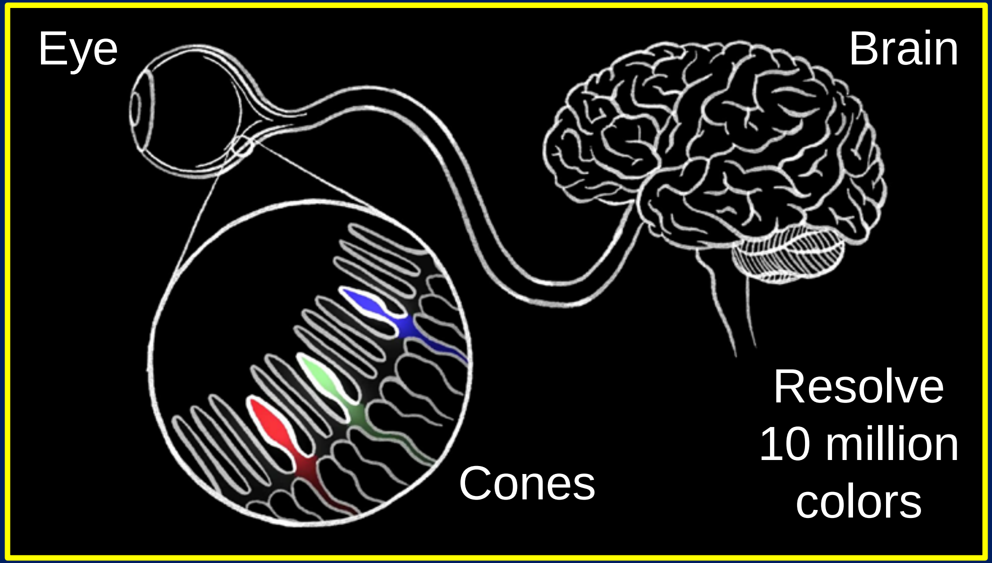
Each frequency causing resonance is how we perceive the world



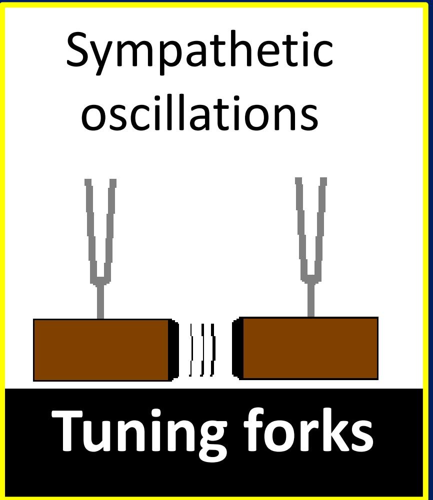


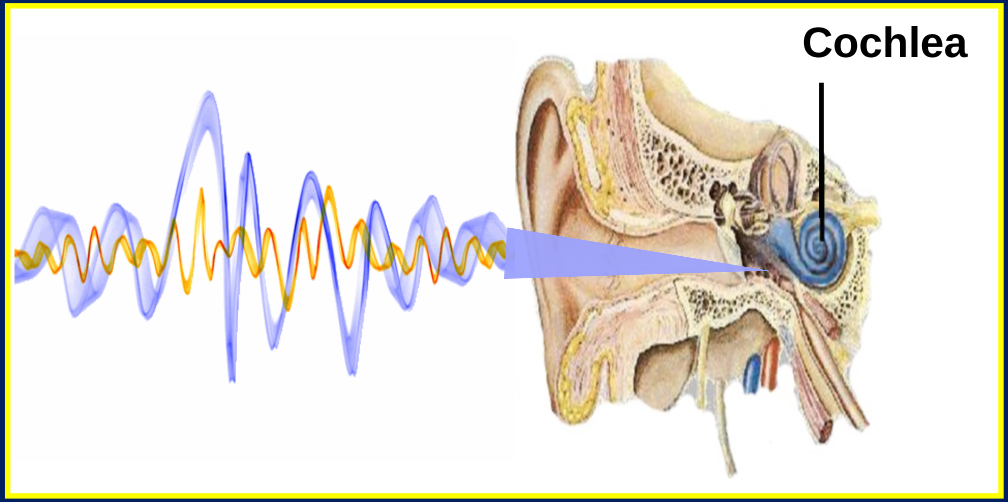


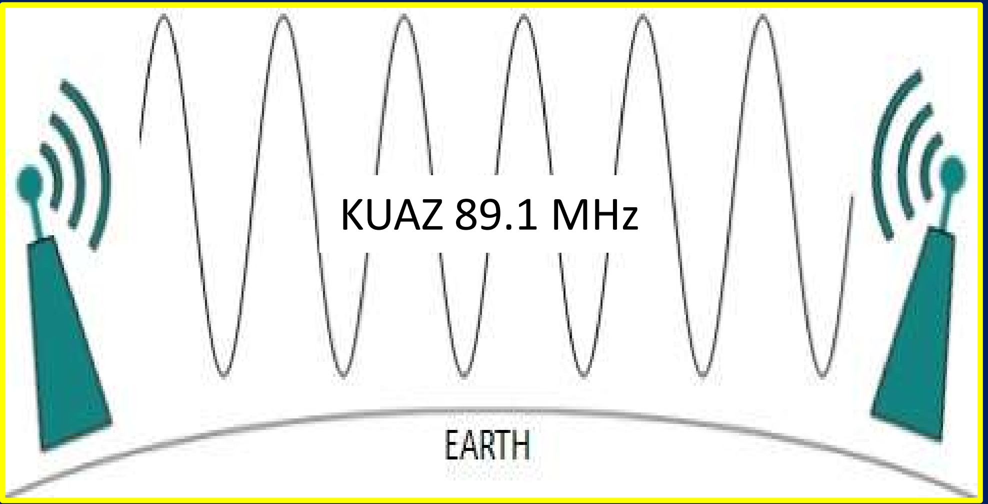


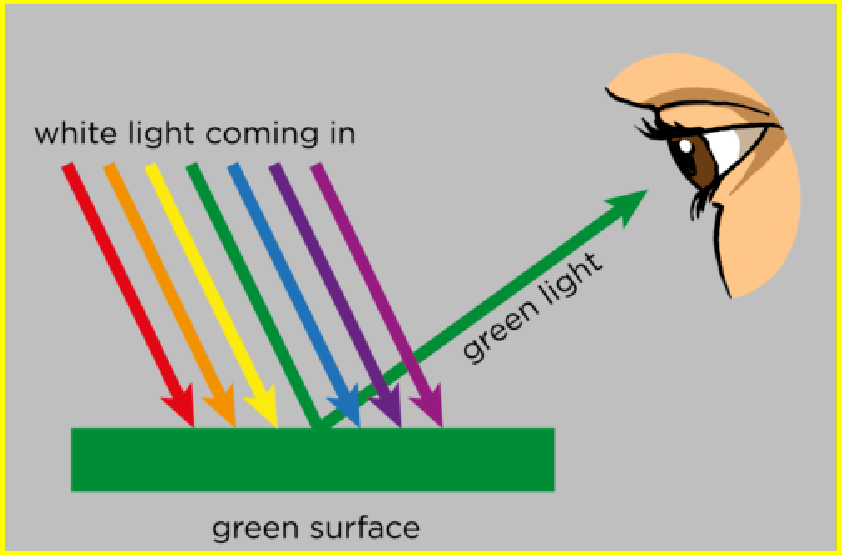


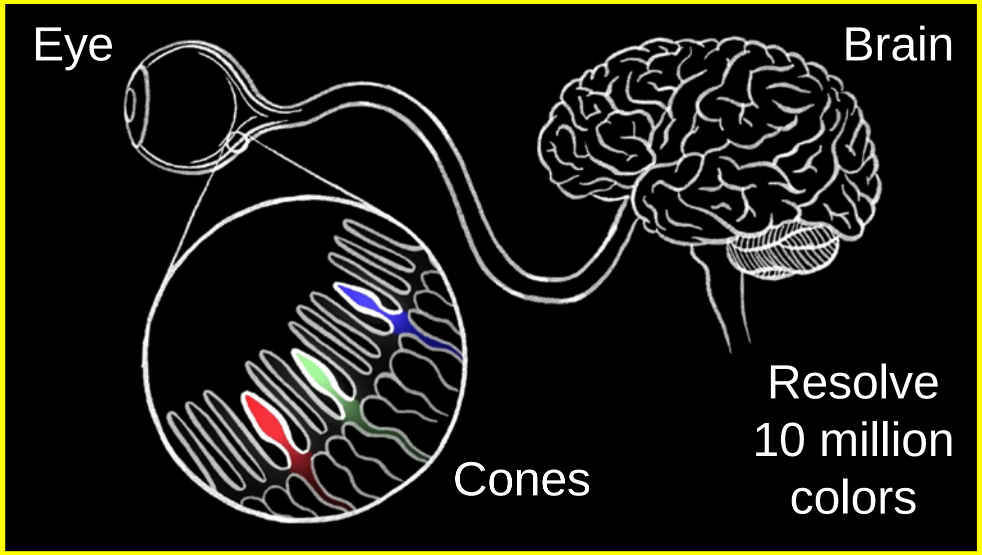
Each frequency causing resonance is how we perceive the world

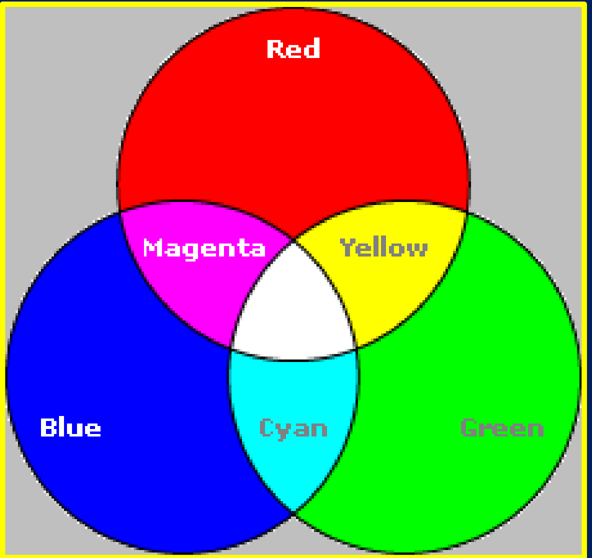












Volcanoes Rule

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Where is the heat?

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Volcanoes Rule

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Where is the heat?

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Heat flows by resonance

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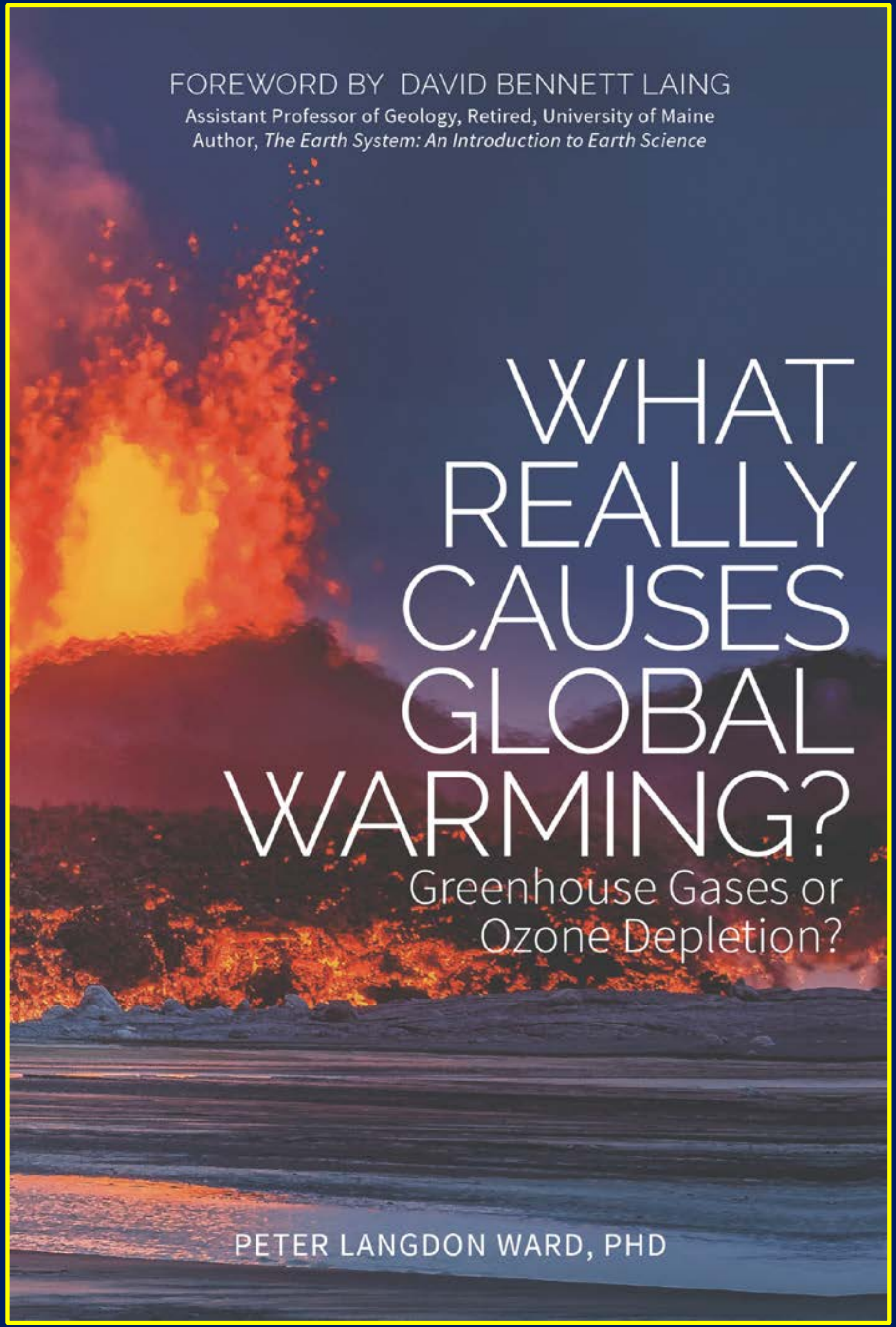
Implications



Implications

We can burn fossil fuels without overheating Earth

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But we must minimize air pollution

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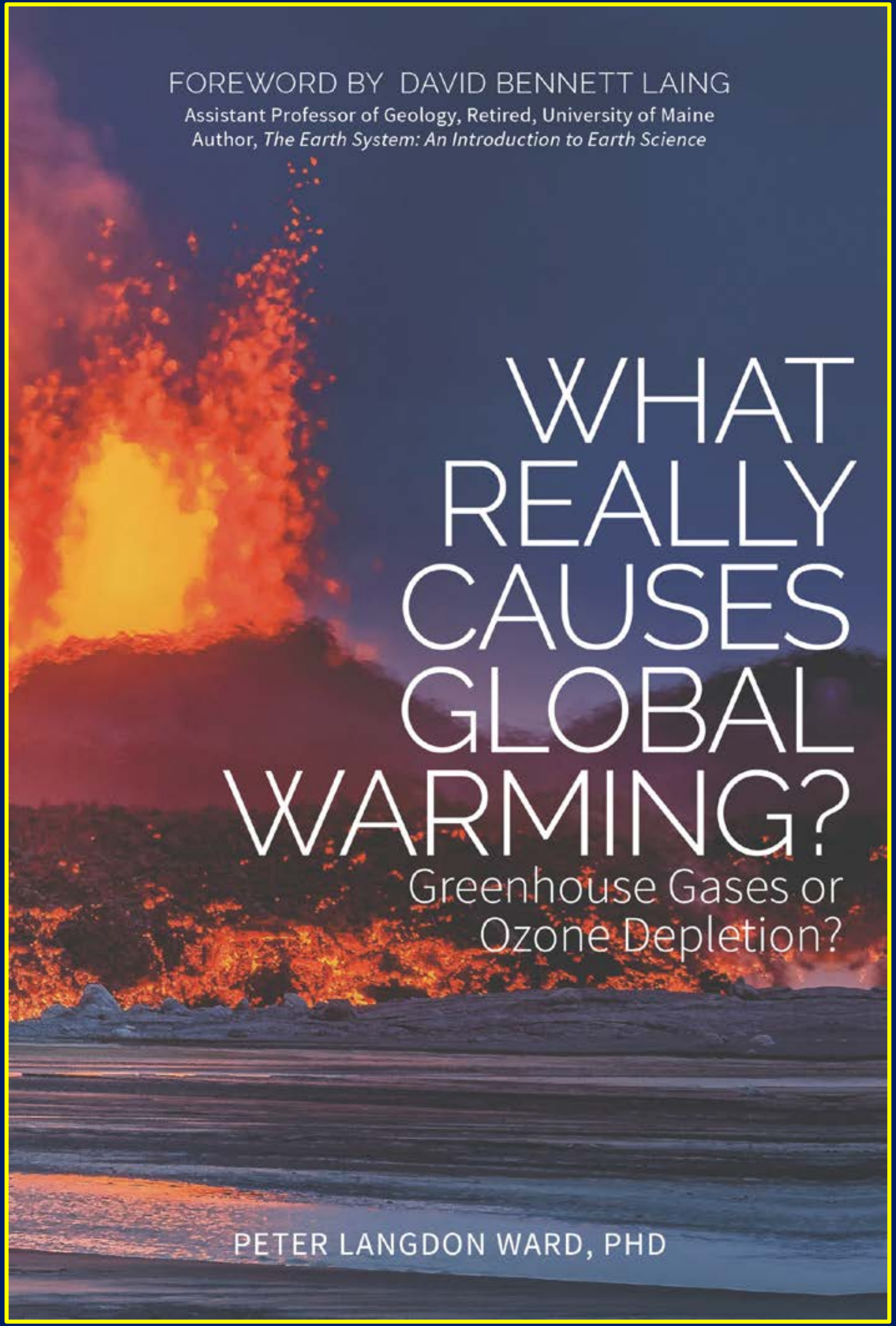

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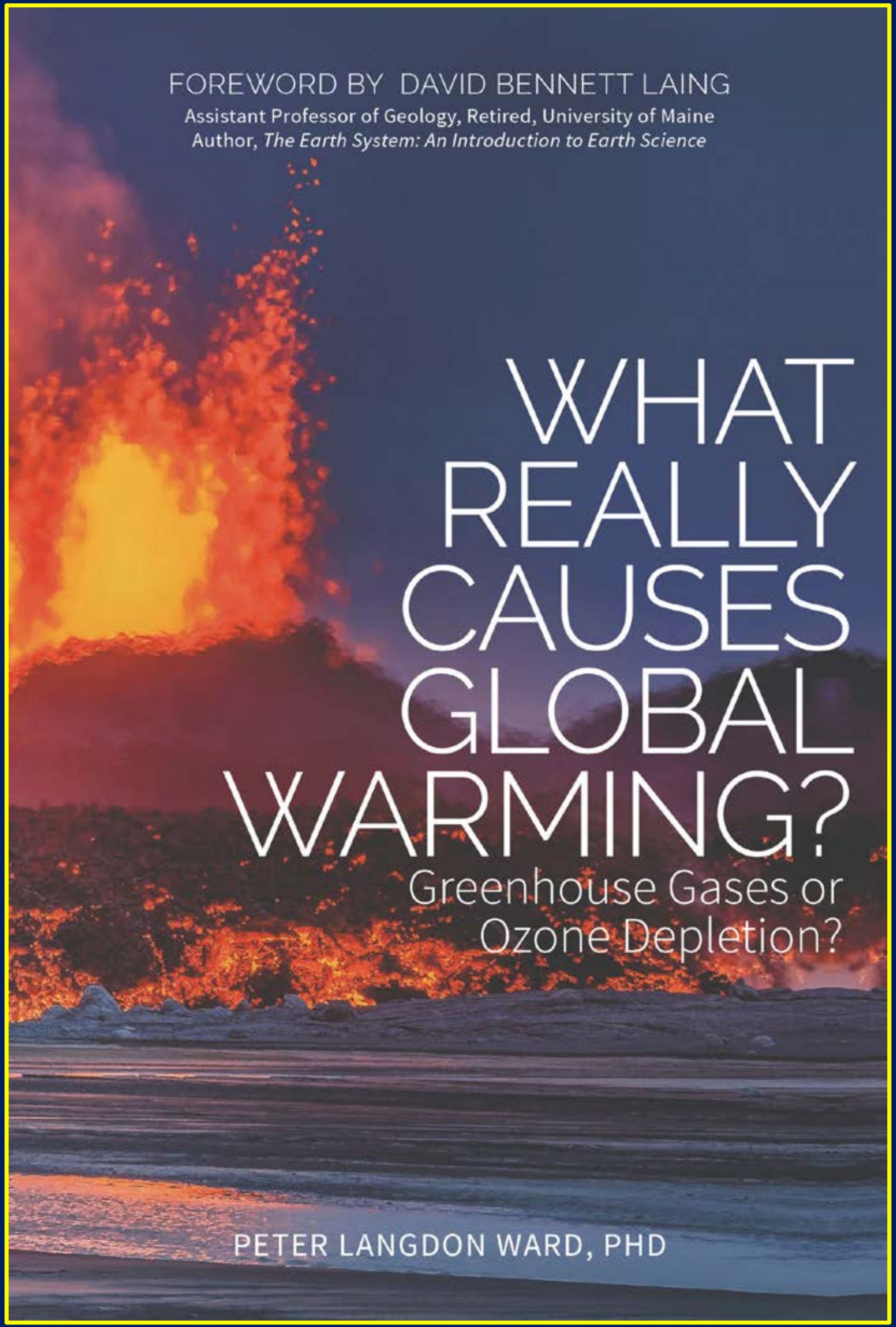

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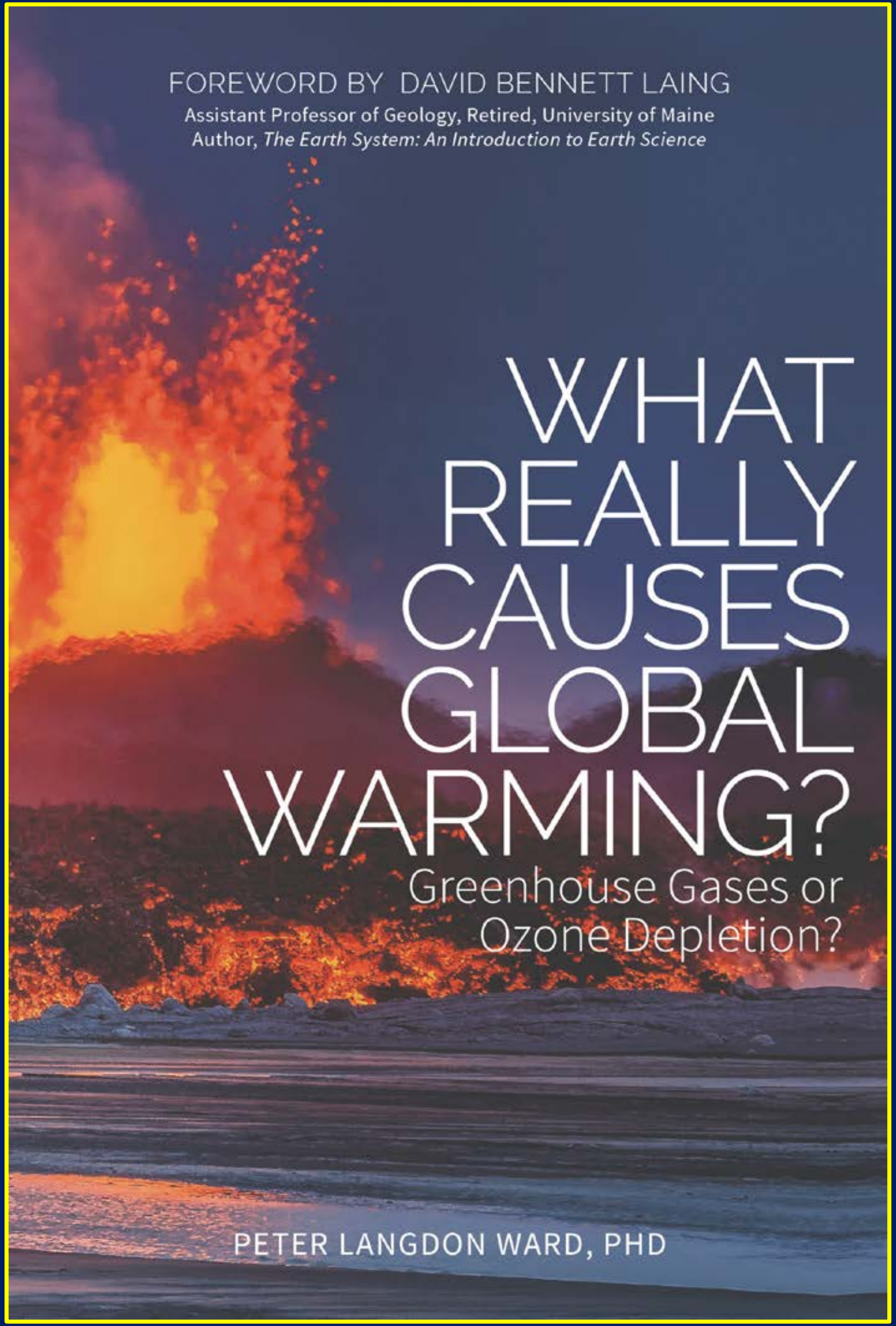

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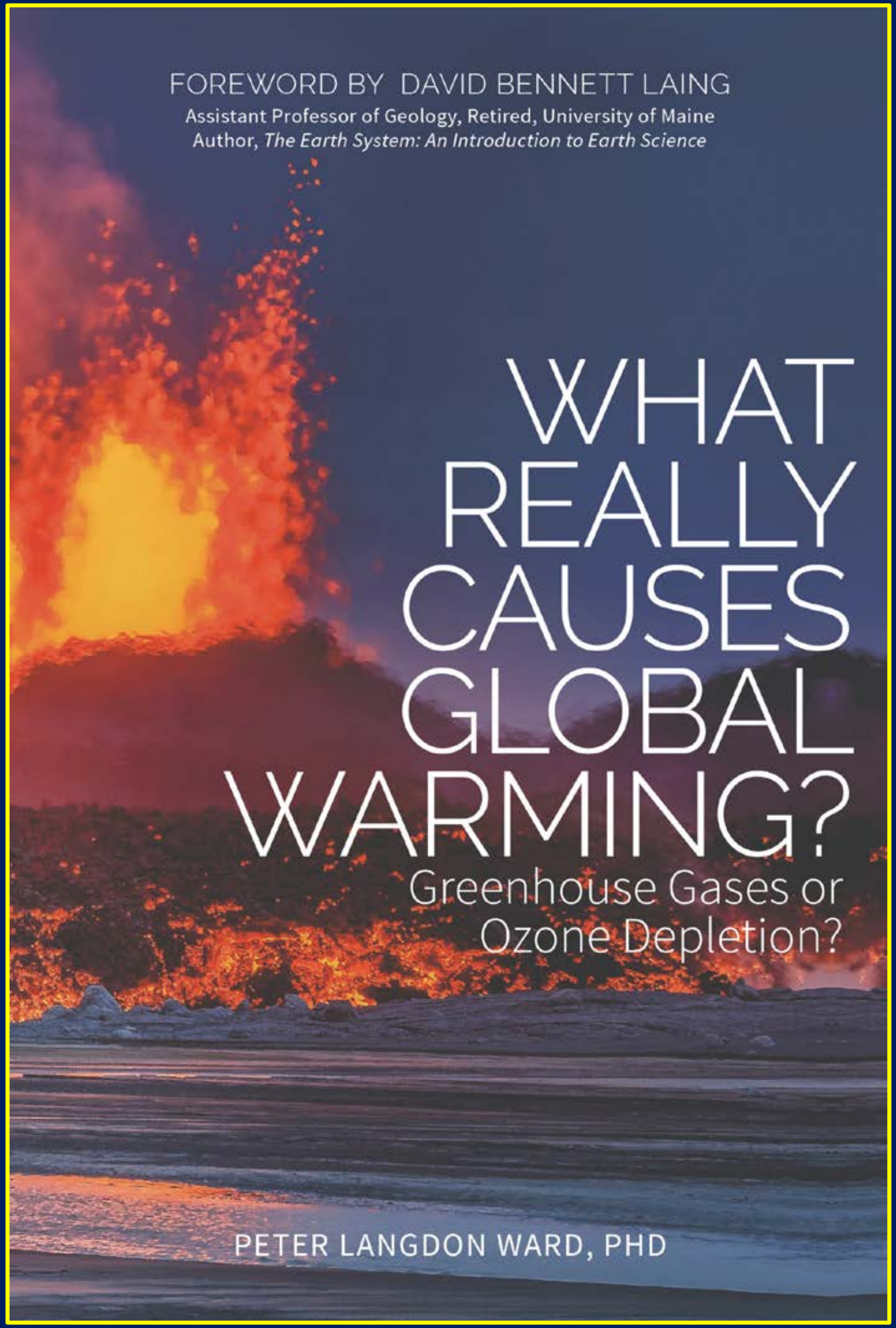

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