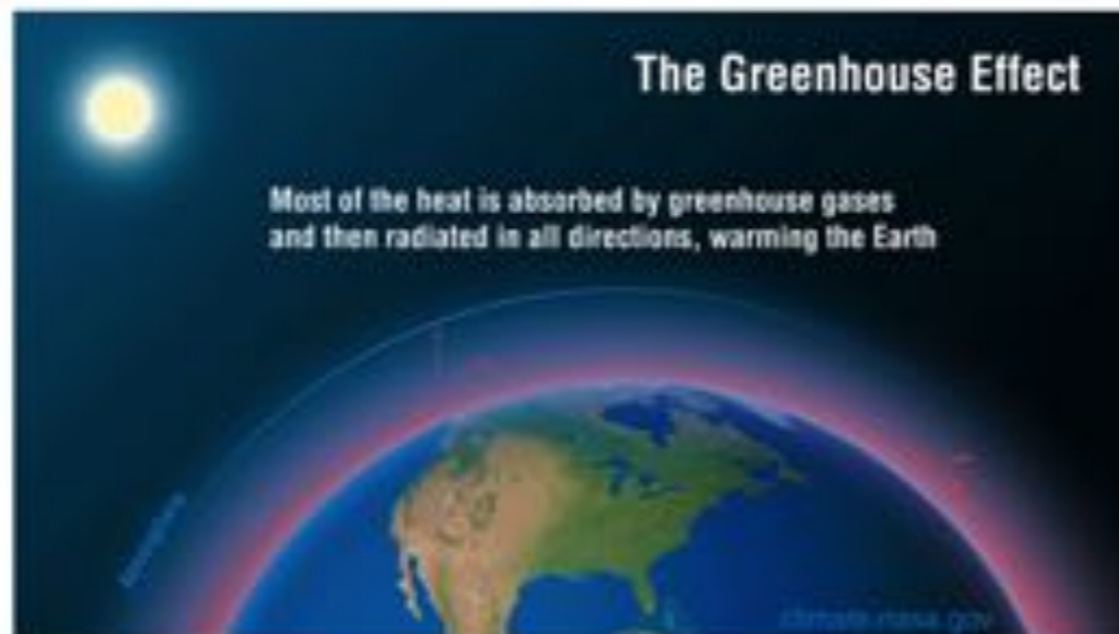


The Causes of Climate Change



A simplified animation of the greenhouse effect. Credit: NASA/JPL-Caltech (Download the high-resolution version [here](#).)

[en español](#)

Scientists attribute the global warming trend observed since the mid-20th century to the human expansion of the "greenhouse effect" — warming that results when the atmosphere traps heat radiating from Earth toward space.

We Live in a Greenhouse

Life on Earth depends on energy coming from the Sun. About half the light reaching Earth's atmosphere passes through the air and clouds to the surface, where it is absorbed and then radiated upward in the form of infrared heat. About 90 percent of this heat is then absorbed by the greenhouse gases and radiated back toward the surface.

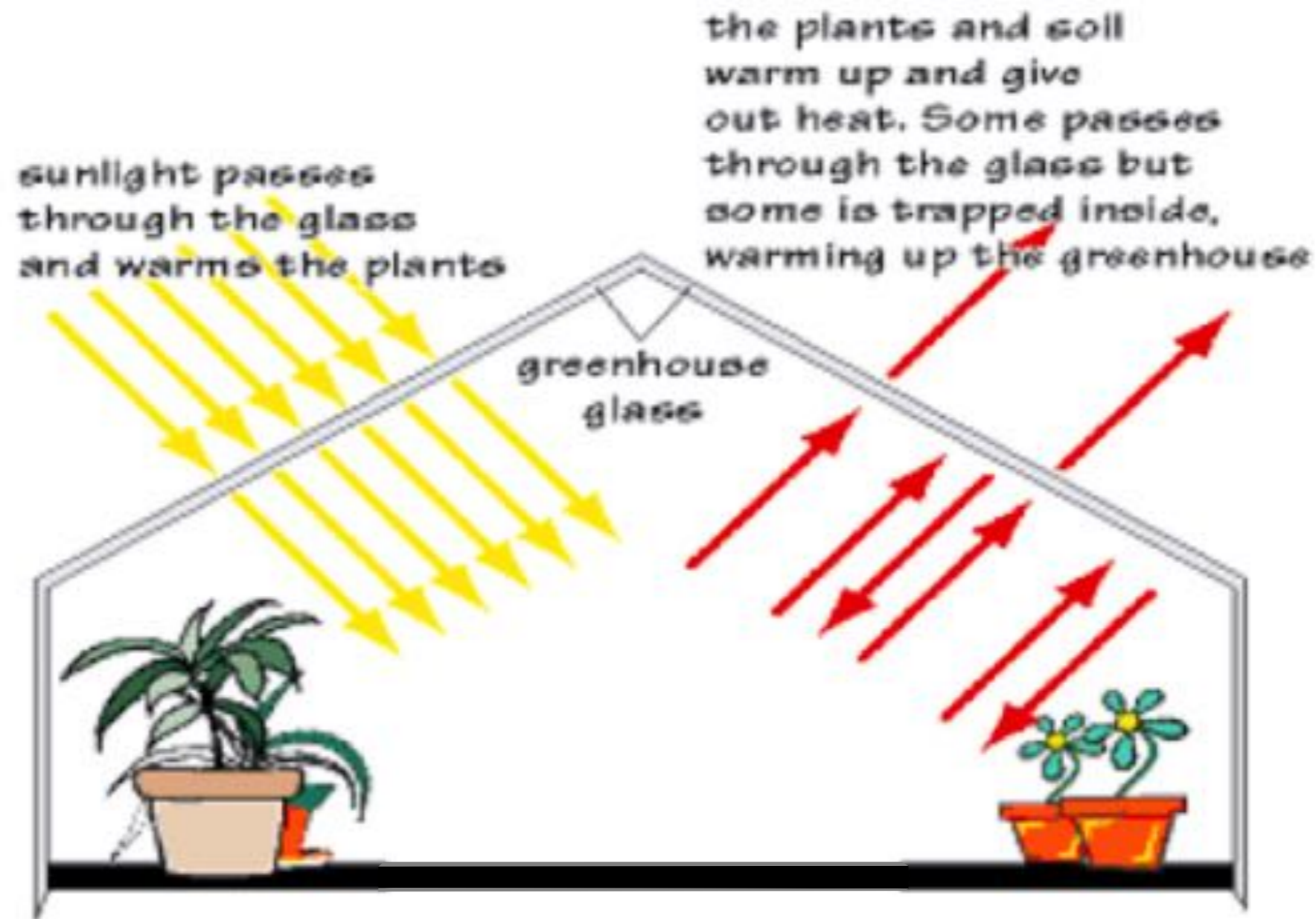
Is the Sun to Blame?



The Sun image from NASA's STEREO mission.

through a window. This could, in fact, increase the indoor temperature far above the out-door air temperature, even in moderate climates, through what is known as the 'greenhouse effect'. Window glasses are practically transparent for short-wave infra-red radiation emitted by the sun, but almost opaque for long-wave radiation emitted by objects in the room. The consequence of this is that the radiant heat, once it has entered through a window, is trapped inside the building.

Greenhouse





The Greenhouse Effect



KidMinds.org

26% of solar energy is lost in space



19% of solar energy is absorbed by clouds and atmosphere

Some heat passes through the atmosphere



Atmosphere contains green gases

Greenhouse gases trap heat. This heat goes back down to warm the surface.

About half of solar radiation is absorbed by the Earth's surface and warms it.

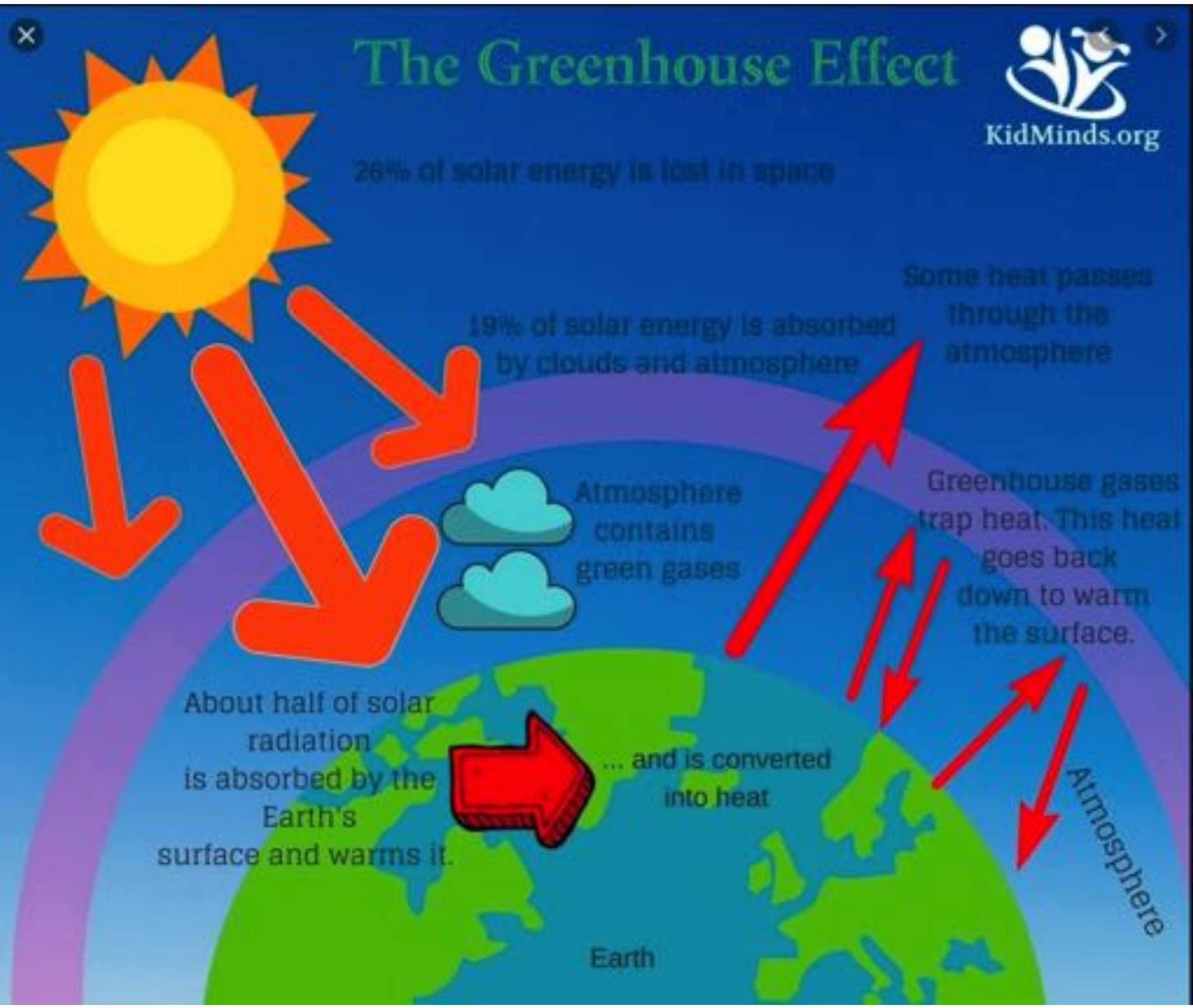


... and is converted into heat



Atmosphere

Earth



0:00

Timeline of the earth

12:00 midnight



The Earth is formed out of debris around the solar **protoplanetary disk**. There is no life. Temperatures are extremely hot, with frequent volcanic activity and hellish-looking environments. Possible early oceans or bodies of liquid water. The **Moon** is formed around this time probably due to a **protoplanet's collision into Earth**.

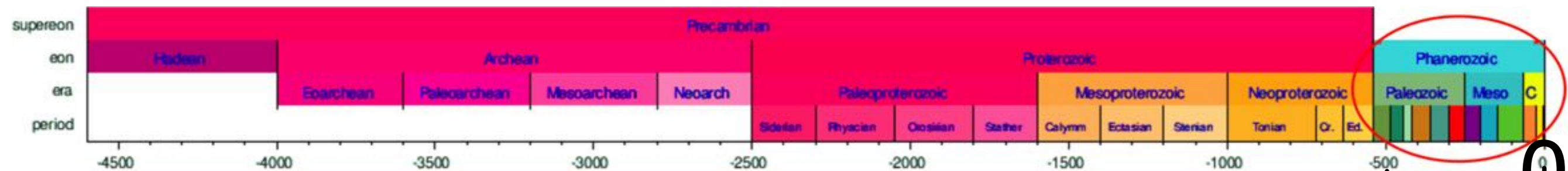
Prokaryote life, the first form of life, emerges. Continents of Ur, Vaalbara and Kenorland may have existed around this time. The atmosphere is composed of volcanic and greenhouse gases.

After about 2.5 billion years, oxygen generated by photosynthesizing single-celled organisms began to appear = beginning of the Proterozoic

Proterozoic

The name of this eon means "early life". **Bacteria** begin producing oxygen. Plants, later animals and possibly earlier forms of fungi form around this time. "Snowball Earth" periods. The early continents of **Columbia, Rodinia** and **Pannotia**, in that order, may have existed in this eon.

10:45 dinosaurs
Complex life, including vertebrates, begin to dominate the Earth's ocean in a process known as the **Cambrian explosion**. **Pangaea** forms and later dissolves into **Laurasia** and **Gondwana**, which in turn dissolve into the current continents. Gradually, life expands to land and familiar forms of plants, animals and fungi begin appearing, including annelids, insects and reptiles, hence the eon's name, which means "visible life". Several **mass extinctions** occur, among which birds, the descendants of non-avian dinosaurs, and more recently mammals emerge. Modern animals — including **humans** — evolve at the most recent phases of this eon.



-4.5 billion

Eons are divided into eras, which are in turn divided into periods, epochs and ages

500 million years
Phanerozoic Eon

The first eon was the **Hadean**, when the Earth had cooled enough for continents and the earliest known life to emerge

Earth formed around **4.54 billion** years ago, approximately one-third the age of the universe, by accretion from the solar nebula.

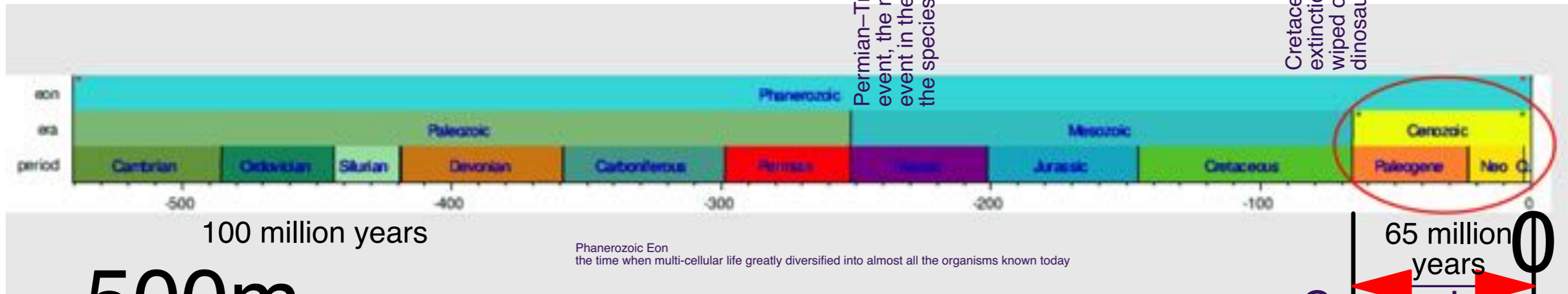
Timeline of the Phanerozoic Eon

10:45 dinosaurs

Phanerozoic Eon
 Complex life, including [vertebrates](#), begin to dominate the Earth's ocean in a process known as the [Cambrian explosion](#). [Pangaea](#) forms and later dissolves into [Laurasia](#) and [Gondwana](#), which in turn dissolve into the current continents. Gradually, life expands to land and familiar forms of plants, animals and fungi begin appearing, including [annelids](#), [insects](#) and [reptiles](#), hence the eon's name, which means "visible life". Several [mass extinctions](#) occur, among which [birds](#), the descendants of non-avian dinosaurs, and more recently [mammals](#) emerge. Modern animals—including [humans](#)—evolve at the most recent phases of this eon

Permian–Triassic extinction event, the most severe extinction event in the fossil record; 95% of the species on Earth died out.

Cretaceous–Paleogene extinction event that wiped out the dinosaurs. 11:40 PM



100 million years

-500m

Phanerozoic Eon
 the time when multi-cellular life greatly diversified into almost all the organisms known today

65 million years

Cenozoic ("new life") era

The Paleozoic ("old life") era was the first and longest era of the Phanerozoic eon, lasting from 542 to 251 Ma.[22] During the Paleozoic, many modern groups of life came into existence. Life colonized the land, first plants, then animals. Two major extinctions occurred. The continents formed at the break-up of Pannotia and Rodinia at the end of the Proterozoic slowly moved together again, forming the supercontinent Pangaea in the late Paleozoic.[citation needed]

The Mesozoic ("middle life") era lasted from 251 Ma to 66 Ma.[22] It is subdivided into the Triassic, Jurassic, and Cretaceous periods. The era began with the Permian–Triassic extinction event, the most severe extinction event in the fossil record; 95% of the species on Earth died out.[137] It ended with the Cretaceous–Paleogene extinction event that wiped out the dinosaurs.[citation needed].

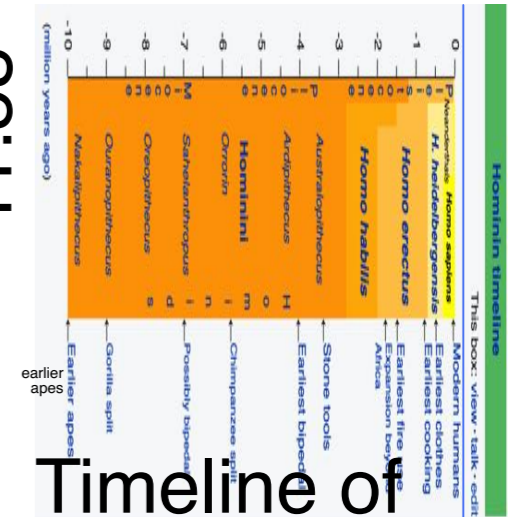
The Cenozoic ("new life") era began at 66 Ma,[22] and is subdivided into the Paleogene, Neogene, and Quaternary periods. These three periods are further split into seven subdivisions, with the Paleogene composed of The Paleocene, Eocene, and Oligocene, the Neogene divided into the Miocene, Pliocene, and the Quaternary composed of the Pleistocene, and Holocene.[138] Mammals, birds, amphibians, crocodilians, turtles, and lepidosaurs survived the Cretaceous–Paleogene extinction event that killed off the non-avian dinosaurs and many other forms of life, and this is the era during which they diversified into their modern forms.[citation needed]

11:40 PM

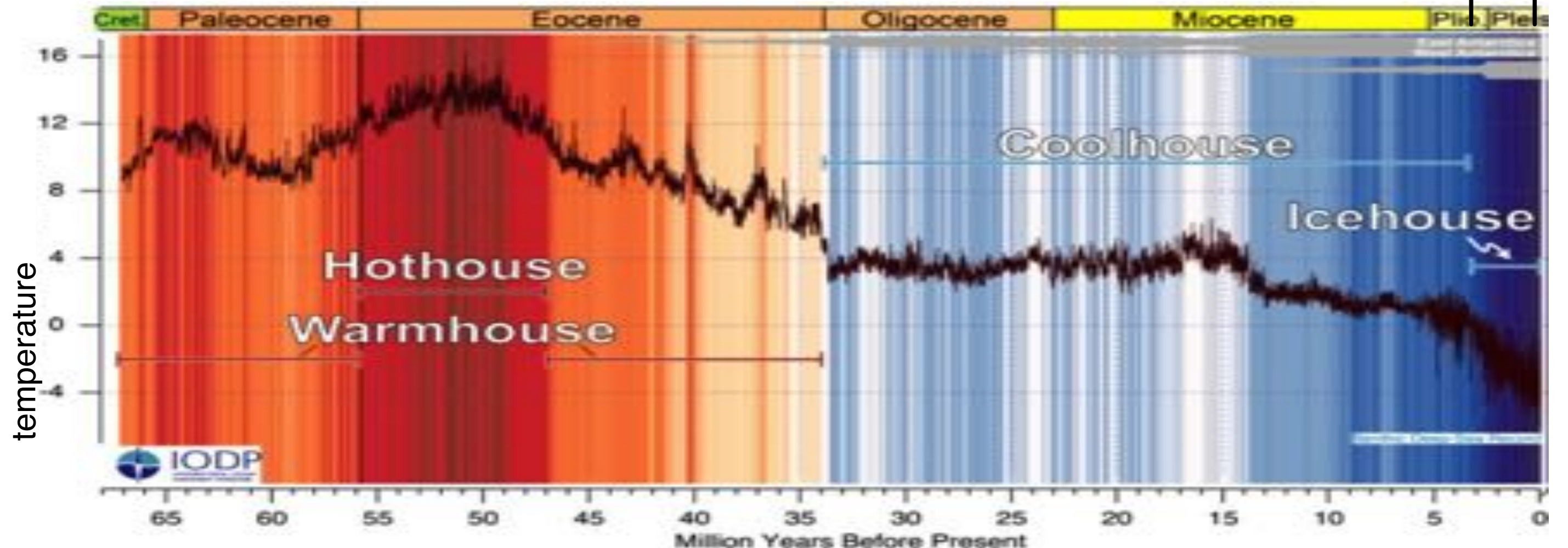
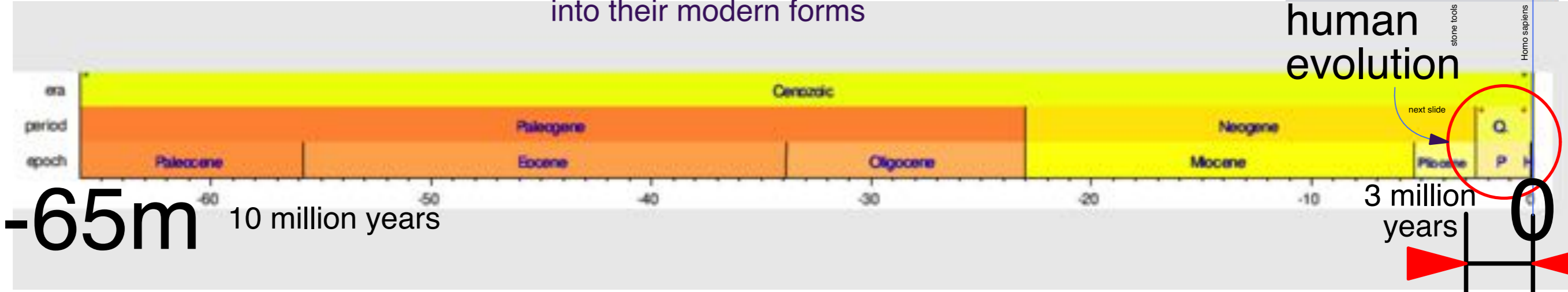
The Cenozoic ("new life") era

11:58

Mammals, birds, amphibians, crocodilians, turtles, and lepidosaurs survived the Cretaceous–Paleogene extinction event that killed off the non-avian dinosaurs and many other forms of life, and this is the era during which they diversified into their modern forms



Timeline of human evolution



10 million years after the dinosaur extinction, Paleocene-Eocene Thermal Maximum, saw temperatures 16 degrees Celsius above modern levels driven by a massive release of carbon into the atmosphere, thought to be the result of huge volcanic eruptions in the North Atlantic. As carbon dioxide disappeared from the atmosphere over the next 20 million years, ice sheets started to form in Antarctica and the planet entered a coolhouse phase,

BACK TO THE HOTHOUSE

THE most detailed analysis of how the climate has evolved since the age of the dinosaurs confirms that the planet has entered a new period of change, scientists say.

Climate change risks pushing the planet into a “hothouse” state not seen for 45 million years that could be reached in three centuries, the analysis suggests.

The study draws on geological samples drilled from ocean beds to reveal how

temperatures have risen and fallen over 66 million years.

The data provides the clearest picture yet of how the Earth has drifted between climatic states. The temperature peaked 52 million years ago in a “hothouse” phase – there was no ice in Antarctica and temperatures were between 12C and 16C warmer.

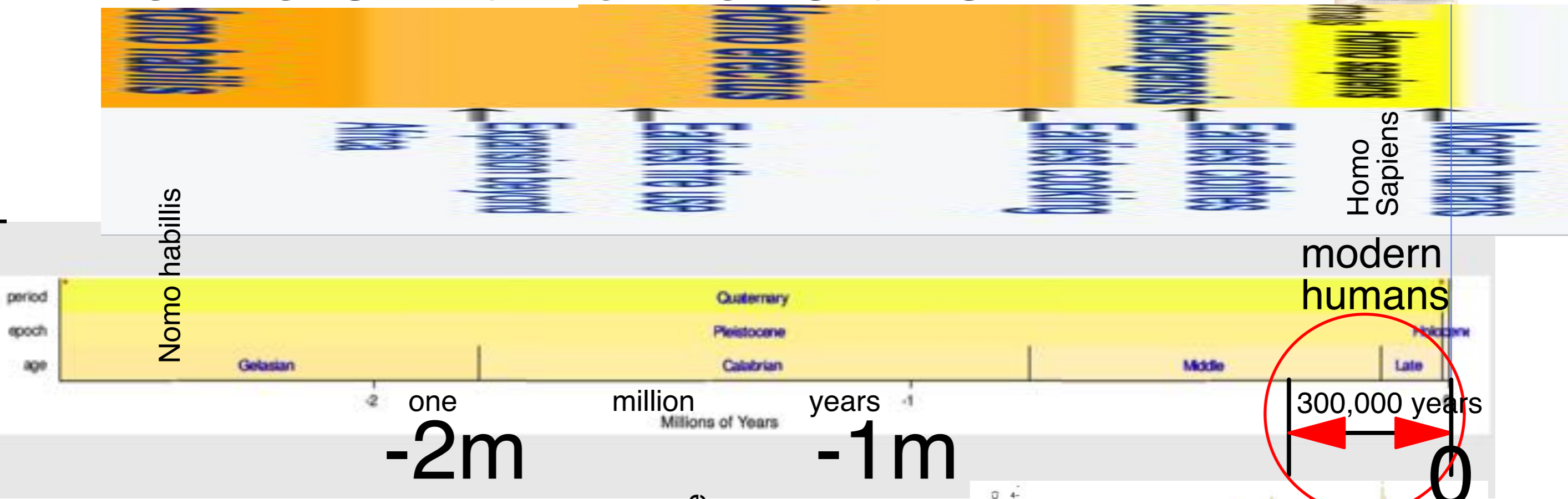
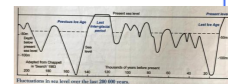
The present pace of global warming caused by man-made emissions has not been seen before, the study says.

12th Sept 2020 CM p22

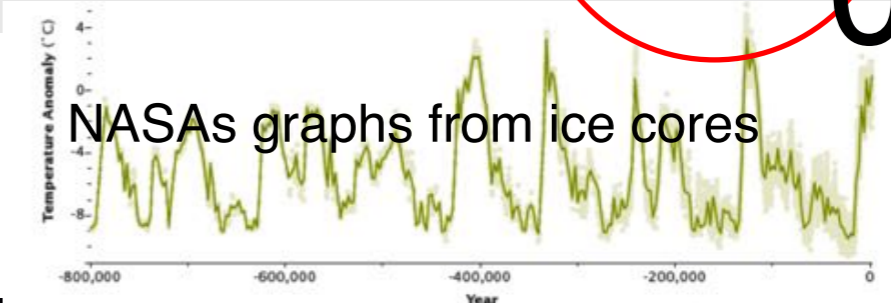
The groundbreaking research, with author unacknowledged by the CM (we understand it was from the University of Bremen Center for Marine Environmental Sciences in Germany and published in the journal “Science”) was based on decades of research around fossilized shell cores. It gives our best ever understanding of how and why the climate has changed since the age of the dinosaurs.

2 minutes to now, human ancestors walked the planet 23:58

Timeline of human evolution



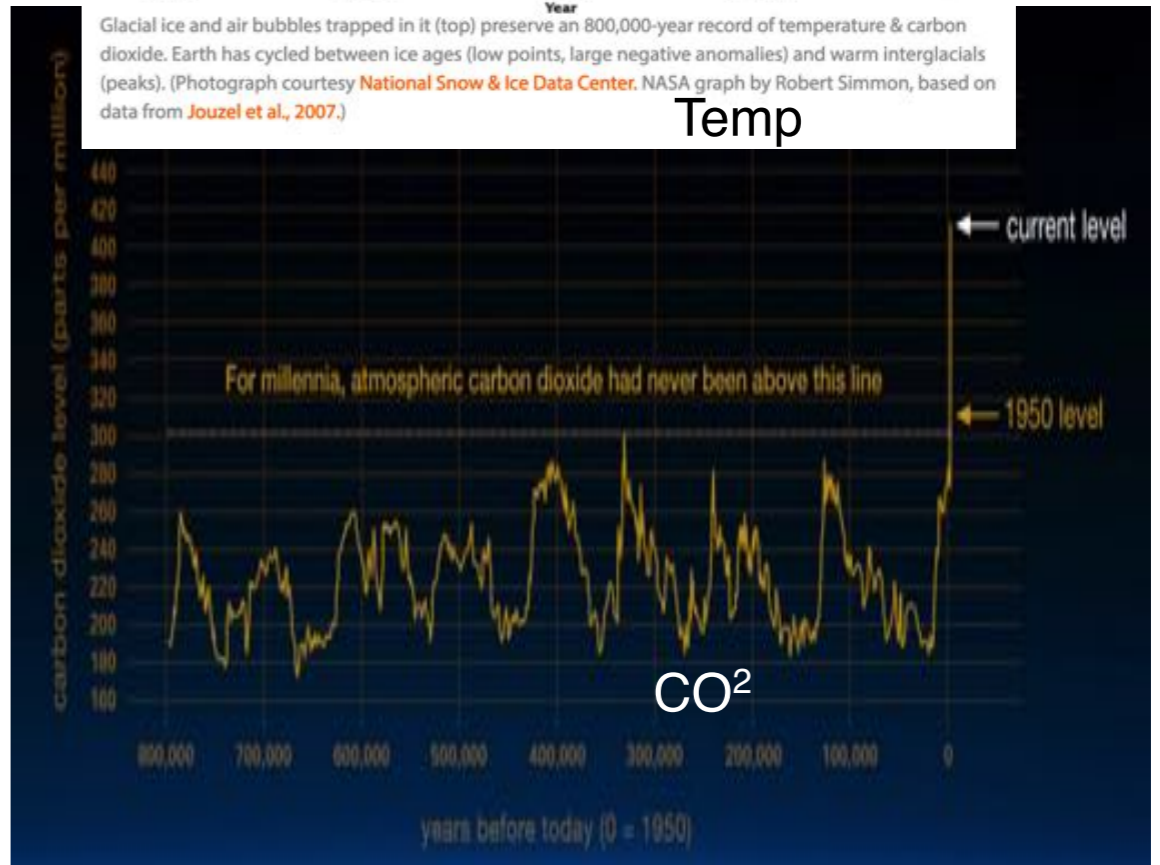
fire use



Cycles also play key roles in Earth's short-term weather and long-term climate. A century ago, Serbian scientist Milutin **Milankovitch** hypothesized the long-term, collective effects of changes in Earth's position relative to the Sun are a strong driver of Earth's long-term climate, and are responsible for triggering the beginning and end of glaciation periods (Ice Ages).

Earth's climate has changed throughout history. Just in the last 650,000 years there have been seven cycles of glacial advance and retreat, with the abrupt end of the last ice age about 11,700 years ago marking the beginning of the modern climate era — and of human civilization. Most of these climate changes are attributed to very small variations in Earth's orbit that change the amount of solar energy our planet receives.

melting of snow and ice at the end of cyclical glacial periods was driven by changes in the Earth's orbit. As snow and ice melted on the planet, the albedo, or reflectivity, of the earth declined, with land and ocean absorbing more heat from the sun (think the reflectivity of cars in a parking lot versus the hot blacktop of the parking lot itself). As the planet slowly warmed, a warmer and better-mixed ocean released CO₂ into the atmosphere, which amplified the warming that was already in progress. In all, temperature typically increased by 6°C (11° F) over thousands of years during these interglacial periods, and one third of this increase was a result of the CO₂ that outgassed from the ocean once warming began. Therefore, CO₂ was not the initial cause of melting ice on the planet. It merely amplified a signal that was already in progress.



Timeline of modern humans

300-130 ka
Reconstruction of H. neanderthalensis

Fossils attributed to H. sapiens, along with stone tools, dated to approximately 300,000 years ago, found at Jebel Irhoud, Morocco[47] yield the earliest fossil evidence for anatomically modern Homo sapiens. Modern human presence in East Africa (Gademotta), at 276 kya.[48] A 177,000-year-old jawbone fossil discovered in Israel in 2017 is the oldest human remains found outside Africa.[49] However, in July 2019, anthropologists reported the discovery of 210,000 year old remains of a H. sapiens and 170,000 year old remains of a H. neanderthalensis in Apidima Cave, Peloponnese, Greece, more than 150,000 years older than previous H. sapiens finds in Europe.[50][51][52]

Neanderthals emerge from the Homo heidelbergensis lineage at about the same time (300 ka).

Patrilineal and matrilineal most recent common ancestors (MRCAs) of living humans roughly between 200 and 100 ka[53][54] with some estimates on the patrilineal MRCA somewhat higher, ranging up to 250 to 500 kya.[55]

160,000 years ago, Homo sapiens idaltu in the Awash River Valley (near present-day Herto village, Ethiopia) practiced excarnation.[56]

80-50 ka MIS 4, beginning of the Upper Paleolithic.

Early evidence for behavioral modernity.[58] Appearance of mt-haplogroups M and N. Southern Dispersal migration out of Africa, Proto-Australoid peopling of Oceania.[59] Archaic admixture from Neanderthals in Eurasia.[60][61] from Denisovans in Oceania with trace amounts in Eastern Eurasia.[62] and from an unspecified African lineage of archaic humans in Sub-Saharan Africa as well as an interbred species of Neanderthals and Denisovans in Asia and Oceania.[63][64][65][66]

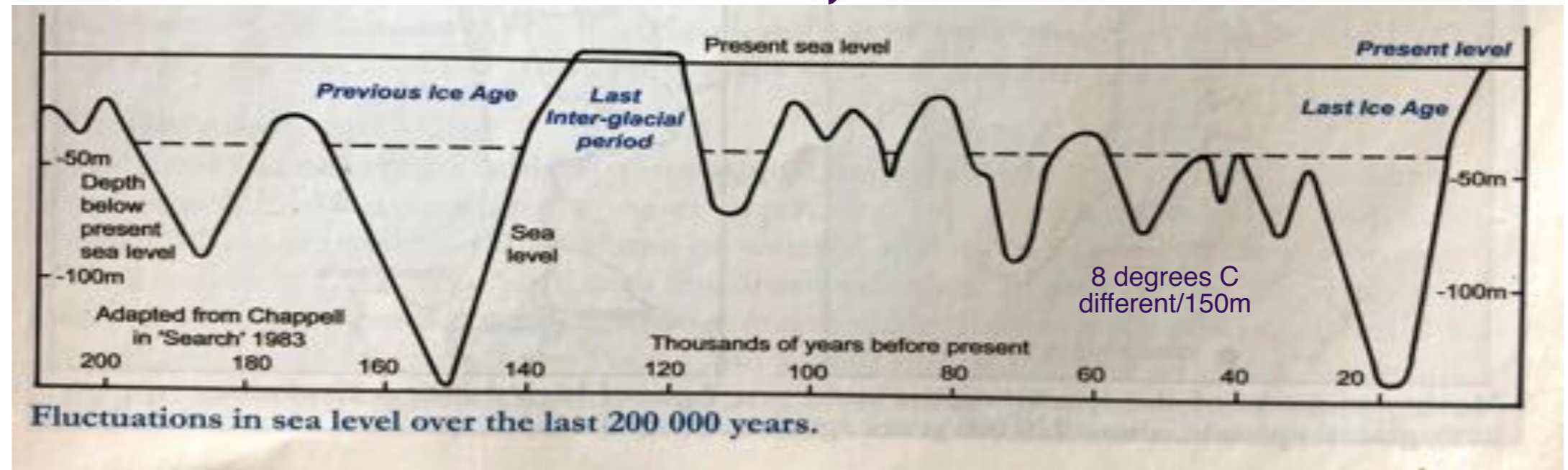
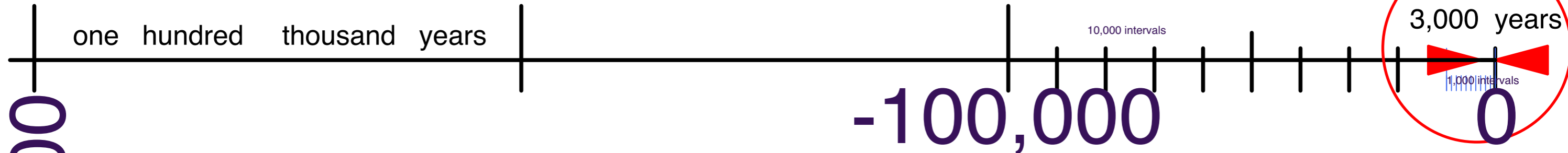
aboriginal people in Australia

50-25 ka Reconstruction of Oase 2 (c. 40 ka)

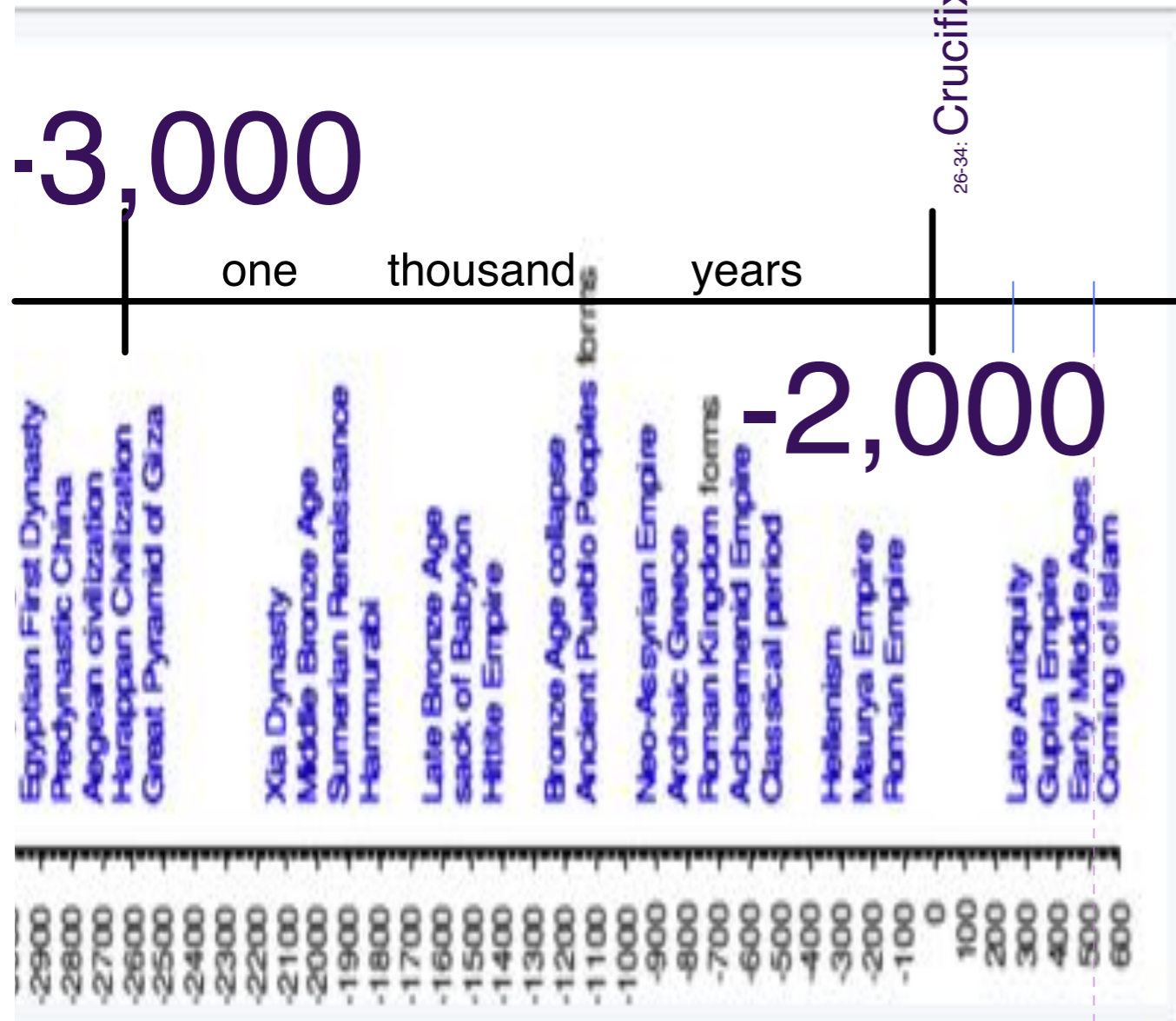
Behavioral modernity develops, according to the "great leap forward" theory.[67] Extinction of Homo floresiensis.

[68] M168 mutation (carried by all non-African males). Appearance of mt-haplogroups U and K. Peopling of Europe, peopling of the North Asian Mammoth steppe. Paleolithic art. Extinction of Neanderthals and other archaic human variants (with possible survival of hybrid populations in Asia and Africa.) Appearance of Y-Haplogroup R2; mt-haplogroups J and X.

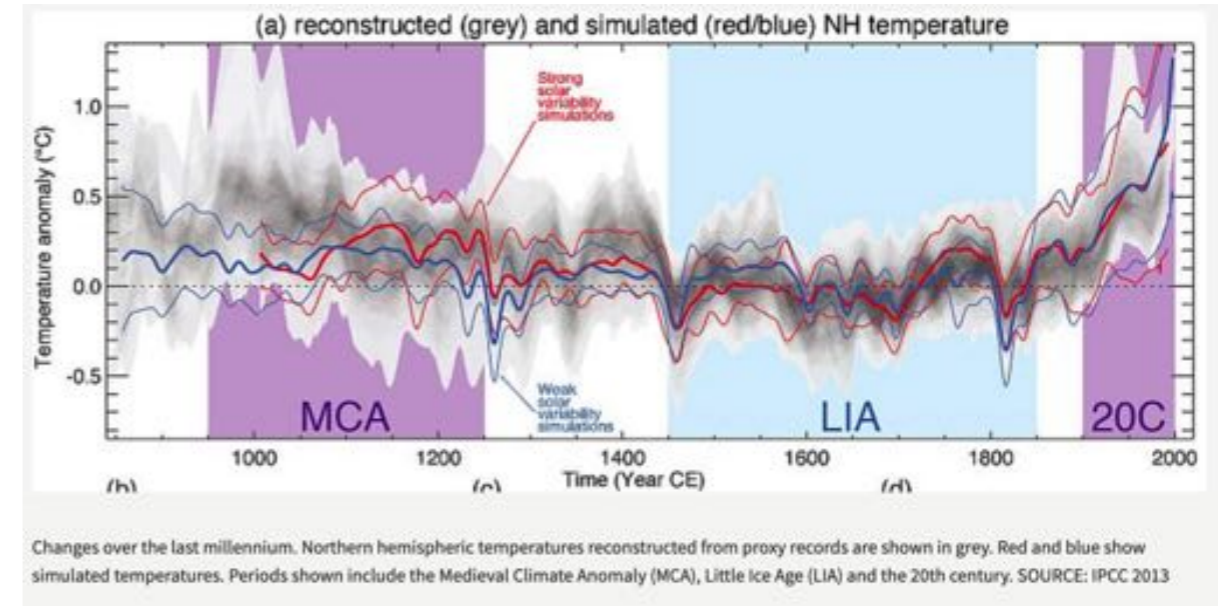
recorded history



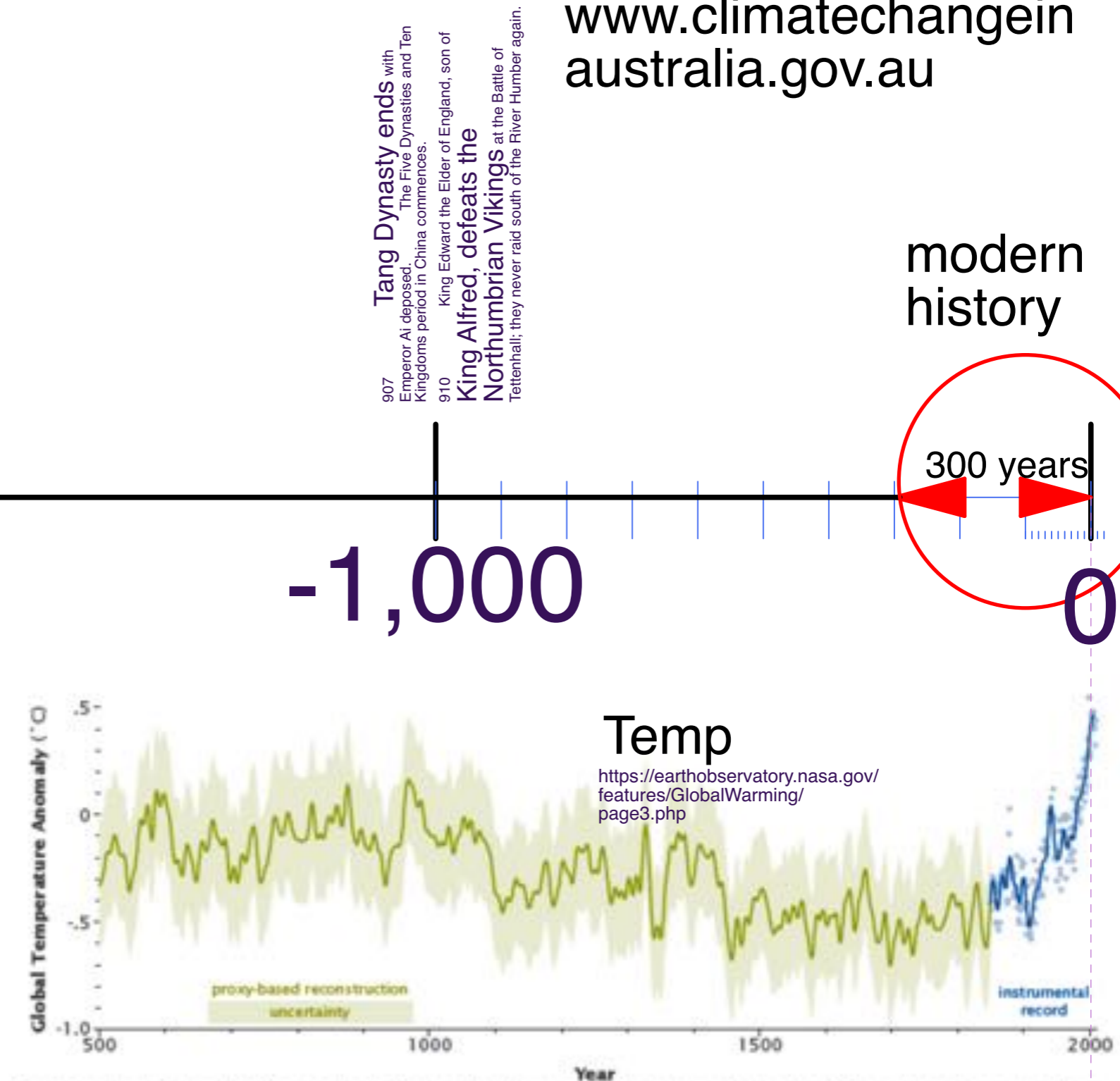
Timeline of recorded history



26-34: Crucifixion of Jesus Christ, exact date unknown.



Changes over the last millennium. Northern hemispheric temperatures reconstructed from proxy records are shown in grey. Red and blue show simulated temperatures. Periods shown include the Medieval Climate Anomaly (MCA), Little Ice Age (LIA) and the 20th century. SOURCE: IPCC 2013



907 Tang Dynasty ends with Emperor Ai deposed. The Five Dynasties and Ten Kingdoms period in China commences.
910 King Edward the Elder of England, son of King Alfred, defeats the Northumbrian Vikings at the Battle of Tettenhall; they never raid south of the River Humber again.

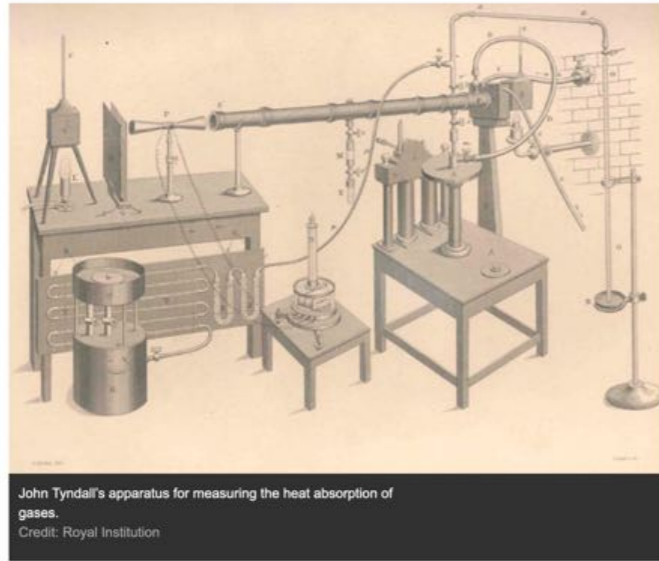
www.climatechangeinaustralia.gov.au

Timeline of modern history

270 years

milliseconds

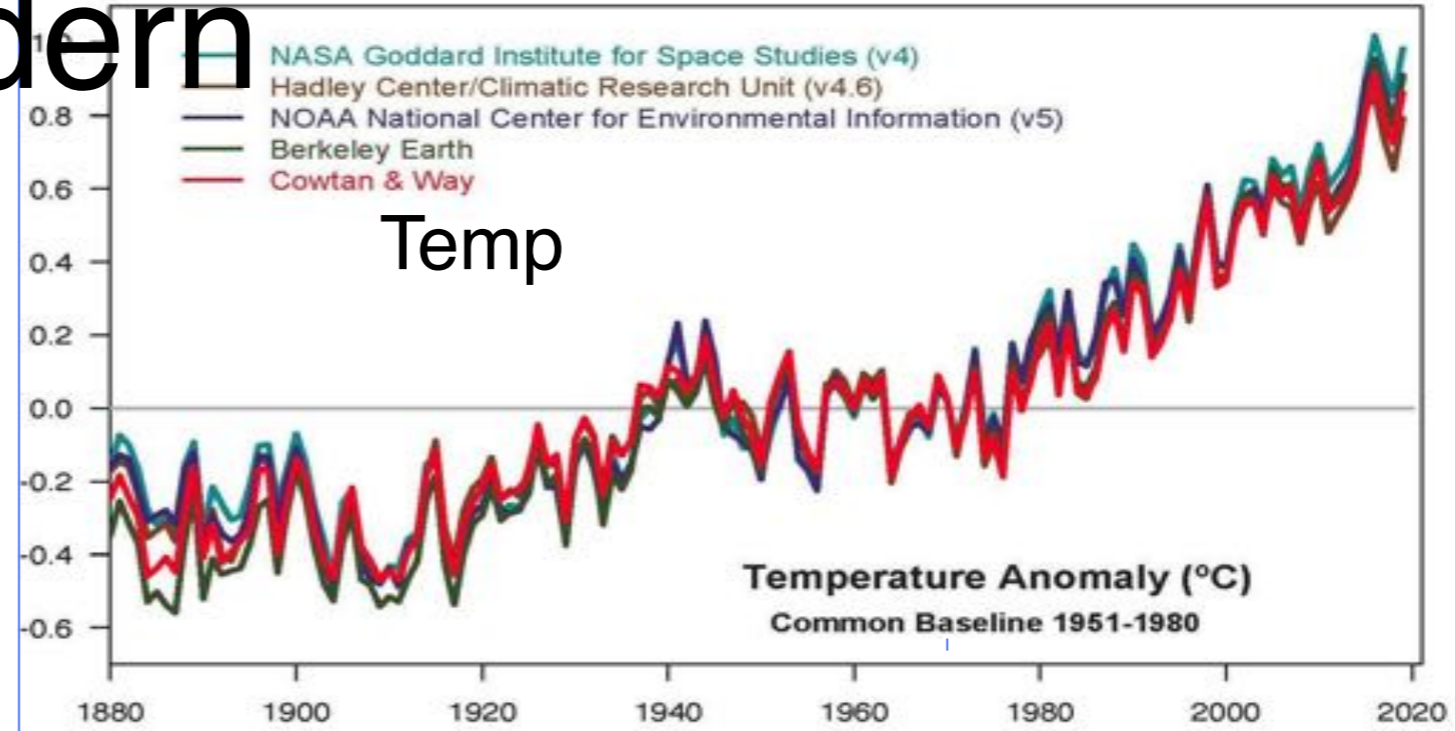
160 years ago, on 18 May 1859, the Irish physicist John Tyndall wrote in his journal 'the subject is completely in my hands'. This is no cryptic note. Just nine days earlier he had set up his complex and clever new apparatus at the Royal Institution in London to try to detect the absorption of heat by gases. Now, he had done it. And as far as he knew, no-one had done it before him.



John Tyndall's apparatus for measuring the heat absorption of gases.
Credit: Royal Institution

Tyndall soon established that carbon dioxide and water vapour were among the gases that absorbed heat, and also that they radiated heat, the physical basis of the greenhouse effect. In making these discoveries, Tyndall set the foundation for our modern understanding of the

Tyndall soon established that carbon dioxide and water vapour were among the gases that absorbed heat, and also that they radiated heat, the physical basis of the greenhouse effect

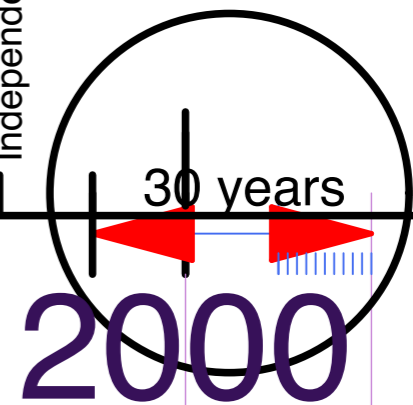


Temp

Temperature Anomaly (°C)
Common Baseline 1951-1980

Svante Arrhenius, in 1896, was the first to use basic principles of physical chemistry to calculate estimates of the extent to which increases in atmospheric carbon dioxide (CO₂) will increase Earth's surface temperature

1963 - a millisecond ago, Kenya gains Independence



1800

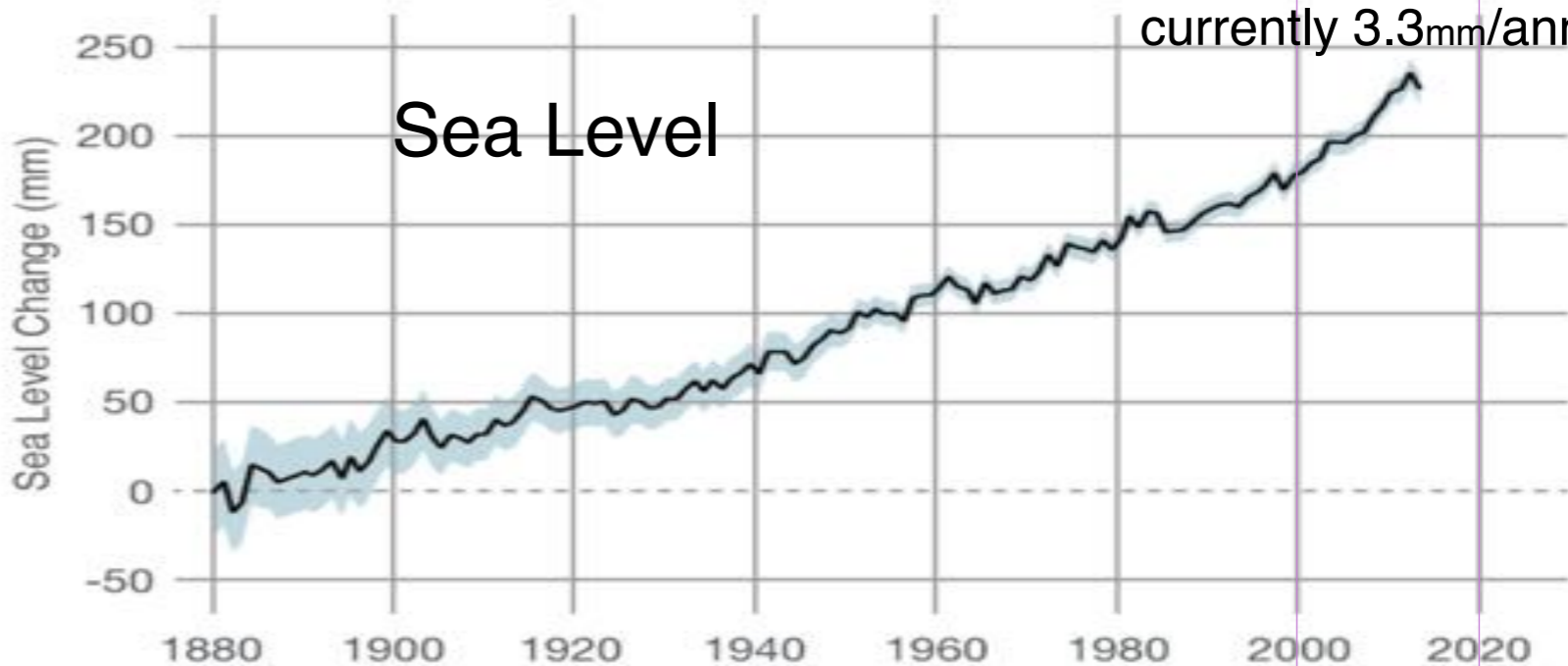
one hundred years

1900

2000

GROUND DATA 1871-2013

Data source: Coastal tide gauge records.
Credit: CSIRO

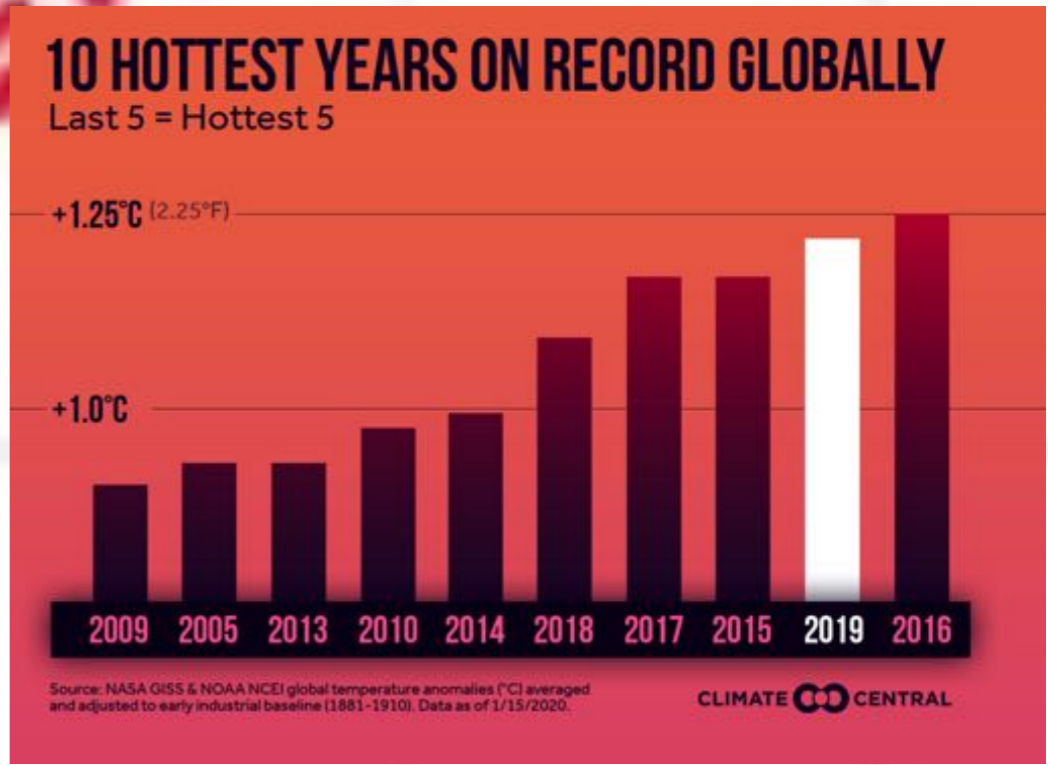
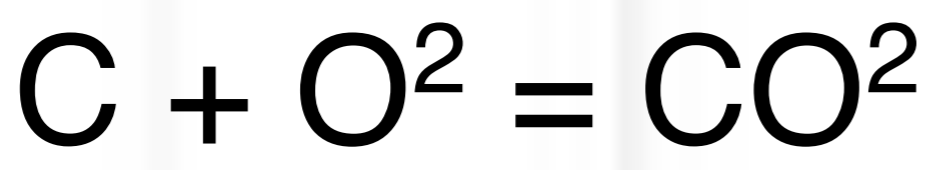
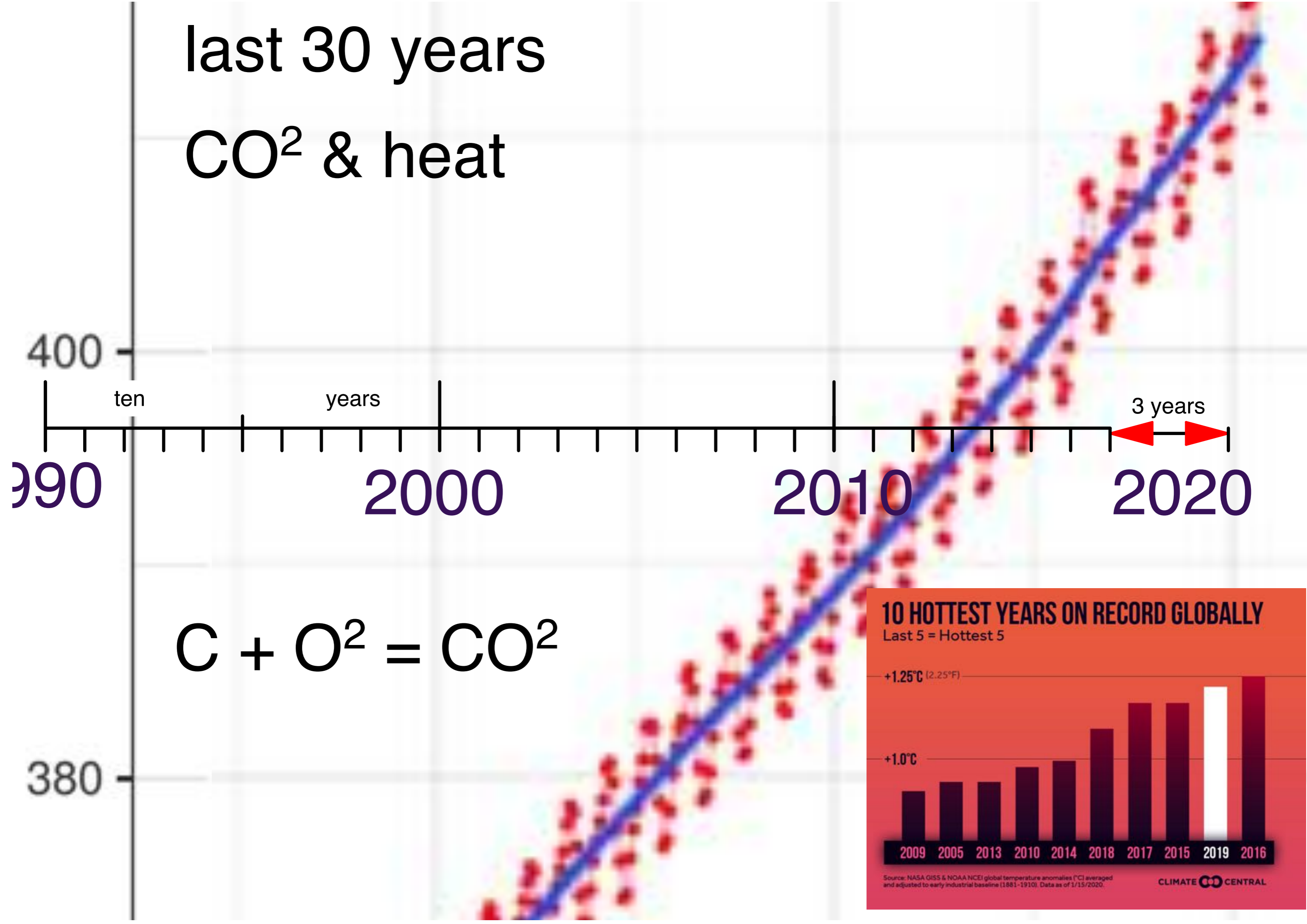


Sea Level

currently 3.3mm/annum

remember back to the late and lazy evening of the planet when it contentedly sequestered all that carbon produced by the plants and animals. And then, in the last five milliseconds, we managed to burn a considerable portion of it

last 30 years CO² & heat



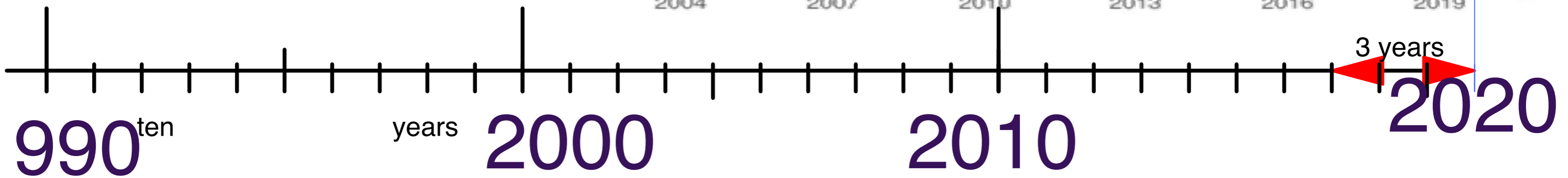
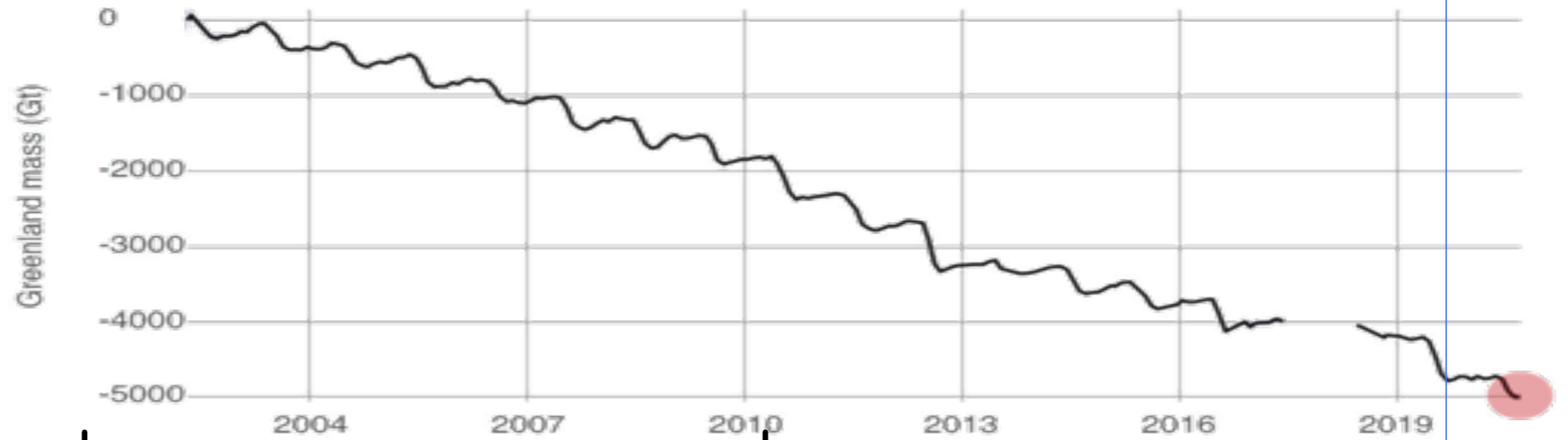
last 30 years
ice sheets

GREENLAND MASS VARIATION SINCE 2002

Data source: Ice mass measurement by NASA's GRACE satellites.
Gap represents time between missions.
Credit: NASA

RATE OF CHANGE

↓ 279.0
billion metric tons per
year

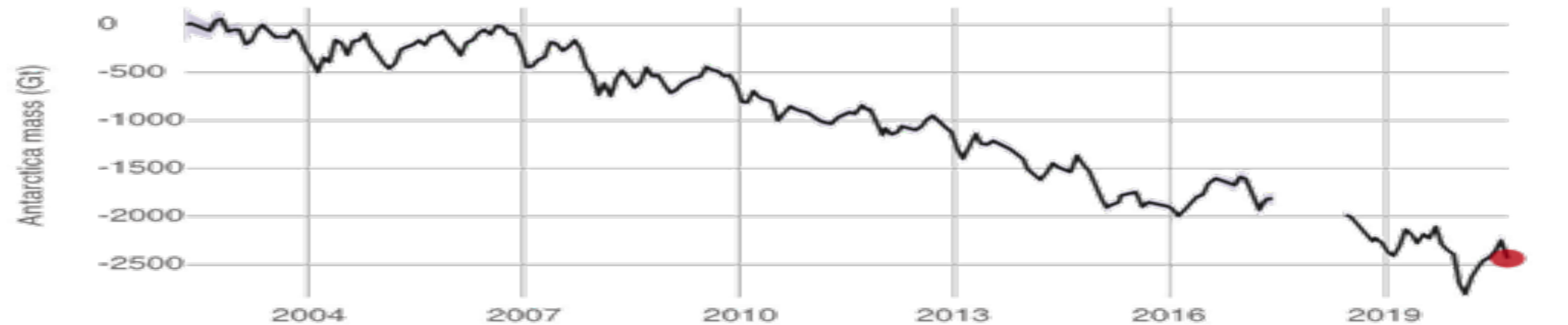


ANTARCTICA MASS VARIATION SINCE 2002

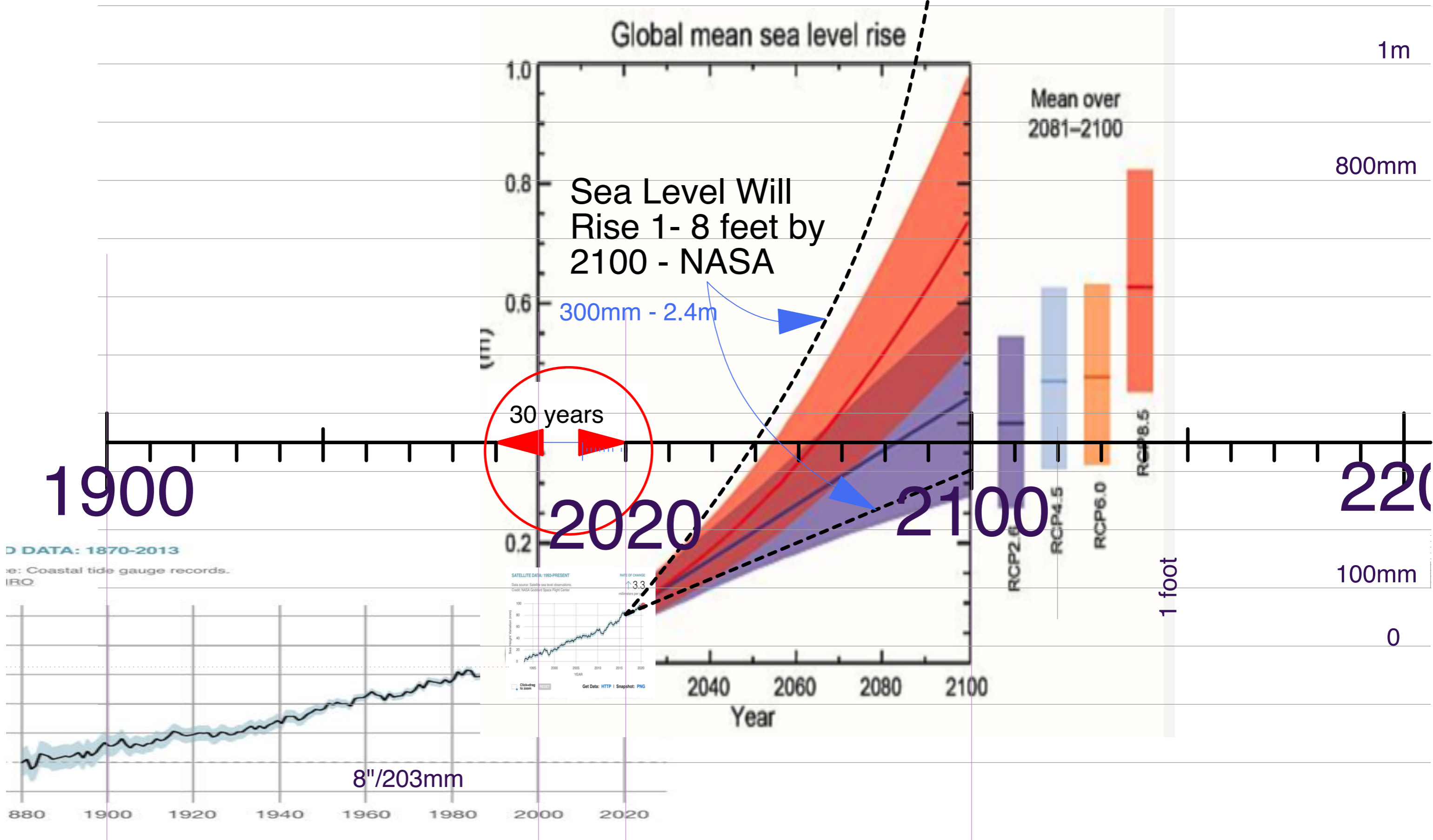
Data source: Ice mass measurement by NASA's GRACE satellites.
Gap represents time between missions.
Credit: NASA

RATE OF CHANGE

↓ 149.0
billion metric tons per
year



next 200 years sea level

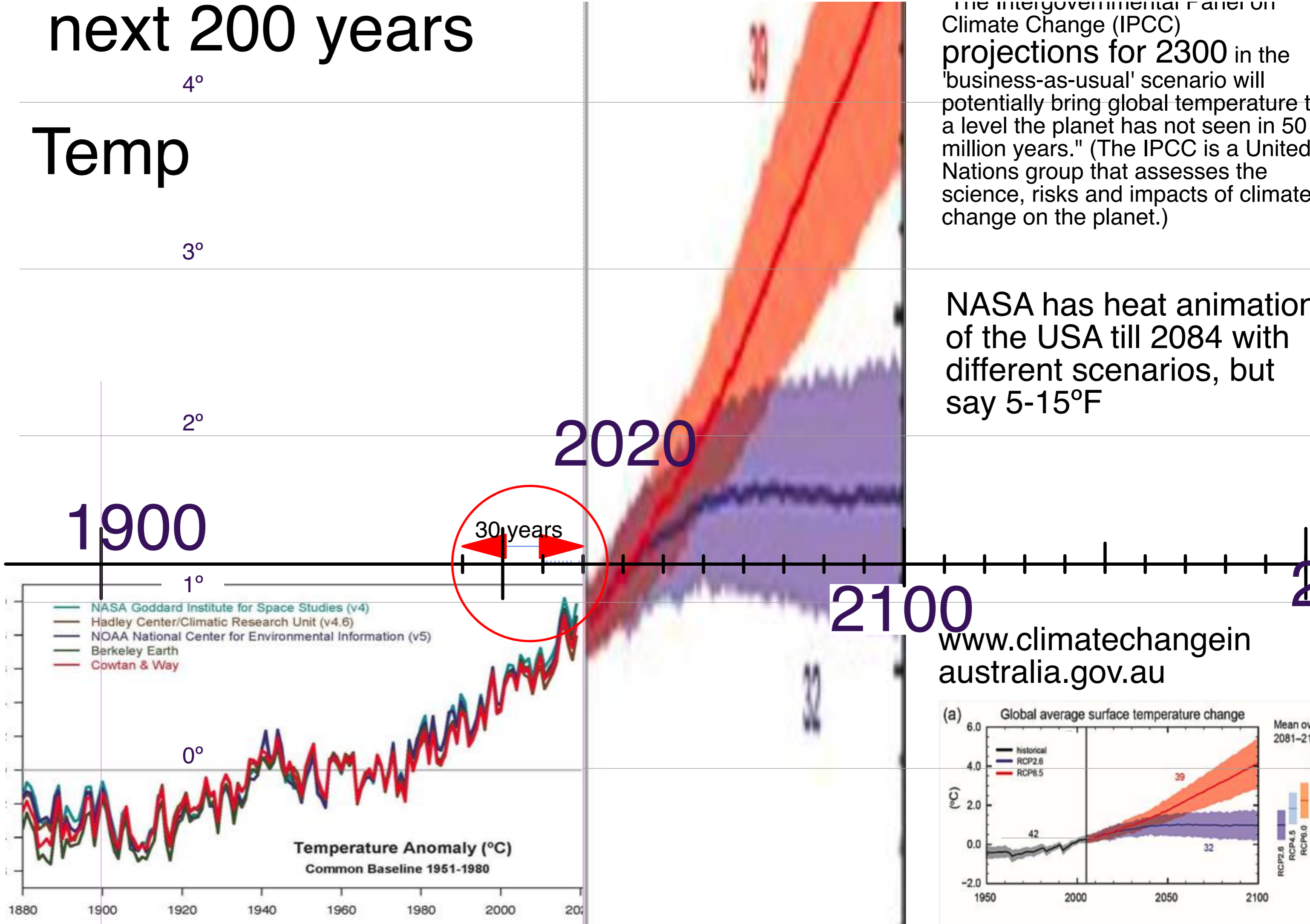


next 200 years

Temp

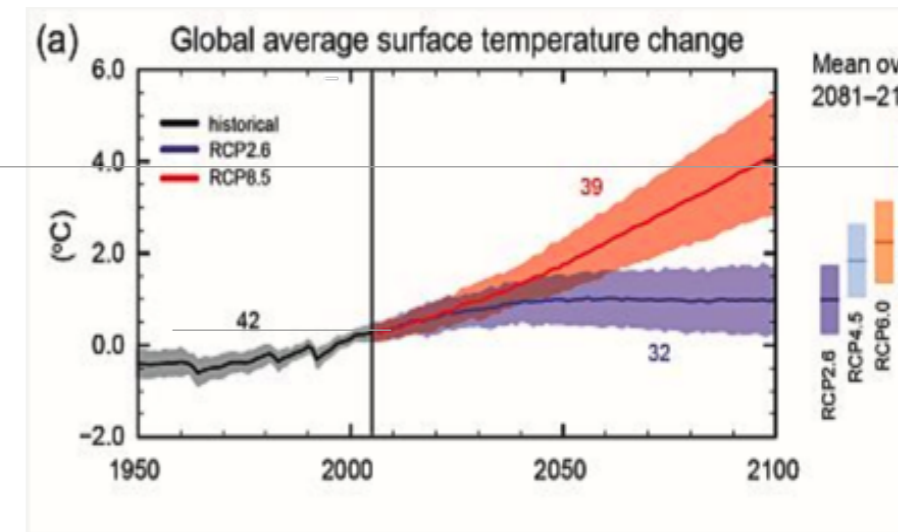
The Intergovernmental Panel on Climate Change (IPCC) projections for 2300 in the 'business-as-usual' scenario will potentially bring global temperature to a level the planet has not seen in 50 million years." (The IPCC is a United Nations group that assesses the science, risks and impacts of climate change on the planet.)

NASA has heat animation of the USA till 2084 with different scenarios, but say 5-15°F



2100

www.climatechangeinaustralia.gov.au



Coal comfort for regional jobs

Adani's Carmichael mine is expected to lead the charge for several others over the next decade, writes **Ashley Pillhofer**

WITH the gates to the Galilee Basin now flung open, it looks more likely than ever one of the world's largest untapped thermal coal fields will become the economic powerhouse of regional Queensland.

The long-fought approval of the controversial Adani Carmichael project was considered the lynchpin on which the opportunities in the Galilee depended.

Now, there is movement. Research commissioned by The Greater Whitsunday Council of Mayors shows opening the Galilee Basin would generate almost \$4 billion and support more than 13,000 jobs across the Isaac, Mackay and Whitsunday regions.

Isaac Mayor Anne Baker, an advocate for sustainable mining, says responsible management of the Galilee's "vast untapped" coal and gas resources would grow the region.

If development in the basin only reached one-quarter of its capacity, estimates from the Queensland Resources Council show this would produce about \$290 million in royalties each year. This would cover salary costs of 4000 police constables, teachers or nurses.

QRC chief executive Ian Macfarlane says the Adani project has acted as a "punching bag" for the mines that would follow.

"They've been subjected to far more criticism and scrutiny than they deserve," he says. "We are all for a rigorous process but it was politicised."

"Adani has paved the way for five for six new mines and established the baseline for environmental approvals, the black-throated finch and in terms of water. So all that nitty-gritty stuff, the process going forward will be a little bit clearer and a bit more predicate."

There are seven mine project proposals for development in the Galilee and 13 coal mining lease applications exist. Of those, three approved licences were granted to Adani and five conditional licences were granted to MacMines.

Mr Macfarlane would not be drawn on which project would be the first to follow Adani's footsteps. But, he says he is "optimistic" at least two or three more projects would come to fruition in the next 10 years.

MacMines's China stone - Galilee Basin
Once expected to create more than 3000 operational jobs and just as many for construction, the future of MacMines's China Stonethermal coal mine is unclear.

The MacMines project, 300km west of Mackay, includes open-cut and underground mines with a projected production rate of 38 million tonnes per annum.

In March, the company chose to not progress its conditional leases. MacMines told the Department of Natural Resources Mines and Energy at the time it was committed to converting the development of the coal deposit but at a later date.

A resource industry researcher told Insight he believed Chinastone could be pulling out of its mining leases due to "economics".

Kevin's Corner - Galilee Basin
The \$6 billion GVK Hancock development includes an underground and open-cut coal mine with the ability to produce 30 million tonnes of thermal

per year.

Kevin's Corner will follow the company's adjacent Alpha Coal Project. The mine is designed to be a stand-alone project that will ramp up to full production in five to seven years. Once operational, it is expected to employ 2500 during construction and 1600 to 1800 during operations.

Alpha Coal - Galilee Basin

It is the jewel in the GVH Hancock crown and possibly even of the Galilee. Alpha Coal's open-cut operation has an expected mine life of more than 30 years with the possibility of further development with capitalisation of underground resources.

On top of the significant \$6.8 billion investment to develop the mine, a further \$4 billion has been proposed for adjoining rail and port infrastructure, which would also be used by the Kevin's Corner project.

Combined, both Kevin's Corner and Alpha Coal would produce a combined resource of 7.9 billion tonnes of thermal coal.

AMCI's South Galilee Coal Project

Approved by the Department of Environment in 2015, the South Galilee Coal project proposes an open-cut and underground thermal coal operation near Alpha.

The \$4.2 billion project is estimated to have a yield of up to 17 million tonnes per annum. Thermal coal mines from South Galilee would be exported through the Port of Gladstone.

The project is estimated to support 1600 construction jobs and 1288 operational jobs.

Waratah Coal's North Alpha Mining

Clive Palmer's Waratah Coal's North Alpha Project would comprise two open-cut and four underground longwall mining operations adjacent to the Adani Carmichael project.

Coal handling preparation plants and a rail spur transportation network to Galilee Coal Project rail network would be developed at the site. The project would eventually mine 56 Mtpa of run-of-mine coal will start with a 10 Mtpa mining operation before increasing.

Waratah Coal's China First Coal Project - Northern Export Facility

The Galilee Coal Project, also referred to as the China First Coal Project, is a 40 megatonne per annum thermal coal mine and 453km rail network to the port of Abbot Point, from where the coal would be exported.

Comprising two open cut operations and four underground longwall mining operations Waratah Coal has also proposed coal handling preparation plants, a 453km rail network to Abbot Point, as well as a port facility.

In December 2013 approval was granted for the mine and rail components, the port will undergo a separate approval process.

The Courier Mail July 2019

Oz walking on hot coals

AUSTRALIA could be responsible for up to 17 per cent of the world's carbon emissions by 2030, new research suggests.

A report by Berlin-based science and policy institute Climate Analytics has found planned coal and gas expansions could push Australia's share of emissions higher over the next decade.

Australian coal could be responsible for 12 per cent of global emissions by then.

The Australian Conservation Foundation's Gavan McFadzean said coal and gas were the cause of the "climate crisis", with Australia the number one exporter of both.

"This report confirms Australia is on track to become one of the world's worst contribu-

tors to climate damage," he said.

Climate Analytics said when emissions from Australia's current coal, oil and gas exports (3.6 per cent of global total) are added to domestic emissions (1.4 per cent of global total), Australia's global climate pollution footprint is about 5 per cent.

"With planned coal and gas expansions, Australia could account for up to 17 per cent of global emissions by 2030, with Australian coal responsible for 12 per cent of global emissions by then," Mr McFadzean said.

He called on the Federal Government to keep fossil fuel reserves in the ground and facilitate a rapid transition to renewable energy.

SSCD Daily July 2019

HARRY FACES MUSIC

PRINCE Harry could face a "telling off" by the Queen after his public comments on the upcoming US election caused controversy, reportedly angering senior members of the royal family.

It comes as royal staff have reportedly been told to ready Prince Harry's one-time home, Frogmore Cottage, for his arrival back to the UK, but there has been no mention of whether Meghan Markle and son Archie will join him.

"Staff at Windsor have been told to prepare for the possibility Harry could come back," a source reportedly told The Sun newspaper.



Meghan and Harry.

The Courier Mail
Oct 2020 p5

Same paper p17

Celebrities in clarion call on climate change

PRINCE William and Pope Francis on Saturday joined activists, artists, celebrities and politicians in a free streamed TED event aimed at mobilising and unifying people to confront the climate crisis.

"The shared goals of our generation are clear," William said in a video message kicking off the event, dubbed Countdown. "Together we must protect and restore nature, clean our air, revive our oceans, build

a waste-free world and fix our climate." For more than five hours the second-in-line to the British throne and other speakers delved in the climate crisis, the need for action, and what can be done.

Solutions posed included ways of farming that welcome wildlife as well as crops; transportation systems powered by electricity; cities designed for people instead of cars; economies that thrive by keeping

the planet healthy, and voting for political leaders keen to end the climate crisis.

"We are living during a historic moment marked by difficult challenges," Pope Francis said while urging people of all faiths to unite to protect Earth.

The Pope joined other speakers in saying the climate crisis was real and backed by science, and needed to be urgently confronted in ways that were socially just.

Countdown also focused on ways in which damage to the environment also fuels social and racial injustice. British MP David Lammy called for climate and social justice leaders to join forces, and for a new international "ecocide" law to criminalise "the most severe actions against nature itself".

TED head Chris Anderson called Countdown "a clarion call" to tackle the daunting challenges of climate change.