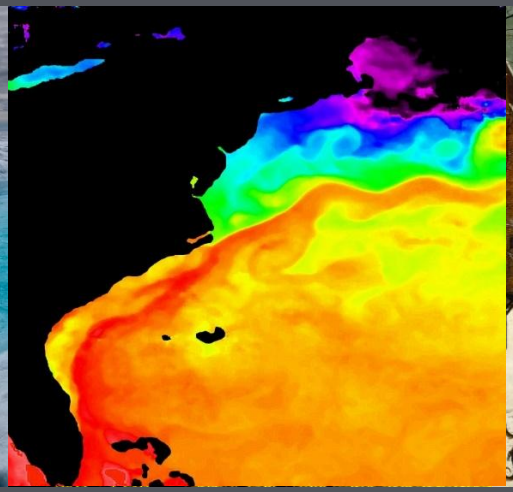
Department of Meteorology

University of Reading

Mike Lockwood



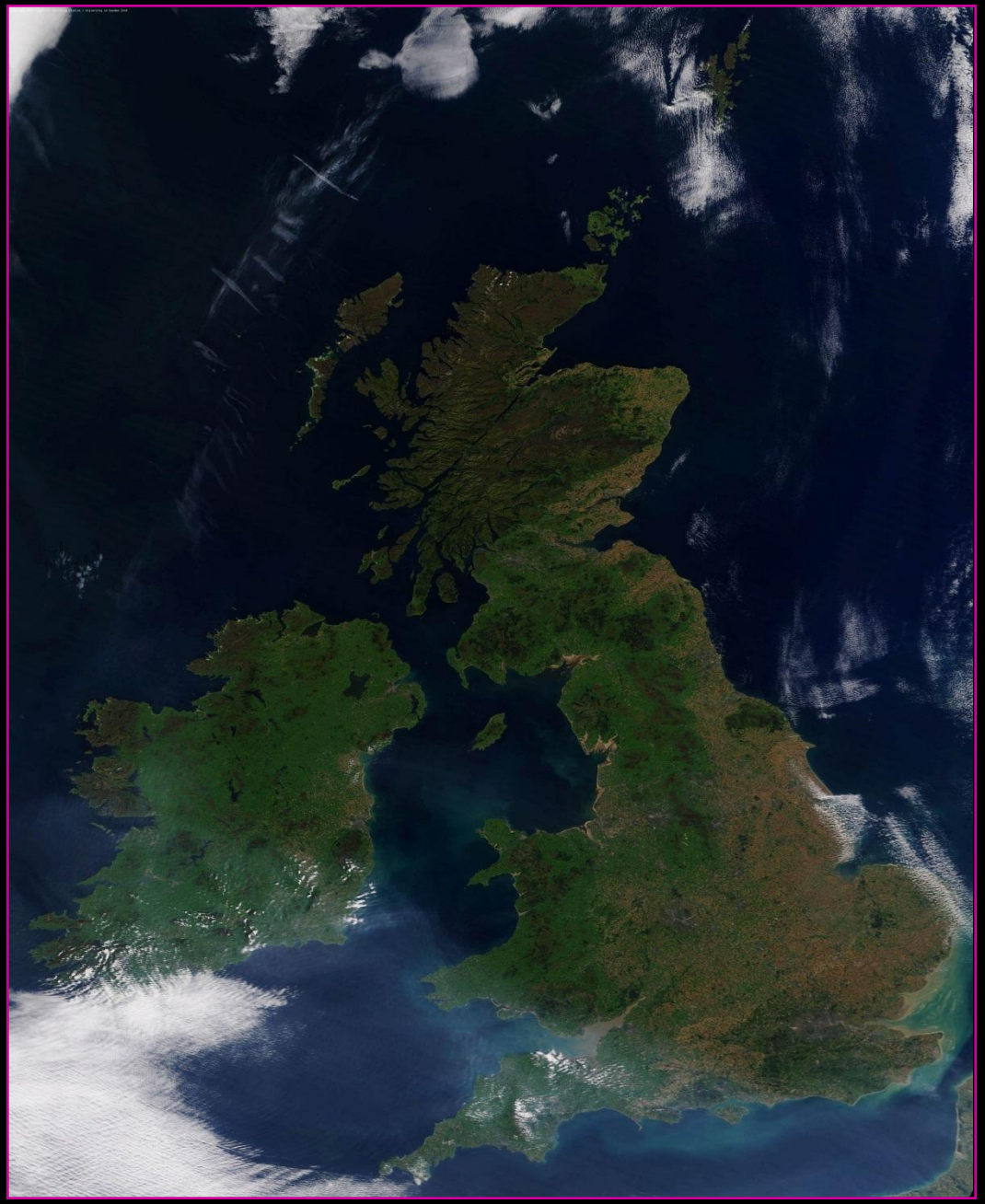



Frost Fairs, the Little Ice Age, Climate Change…..and Art

Harwell Parish History Group

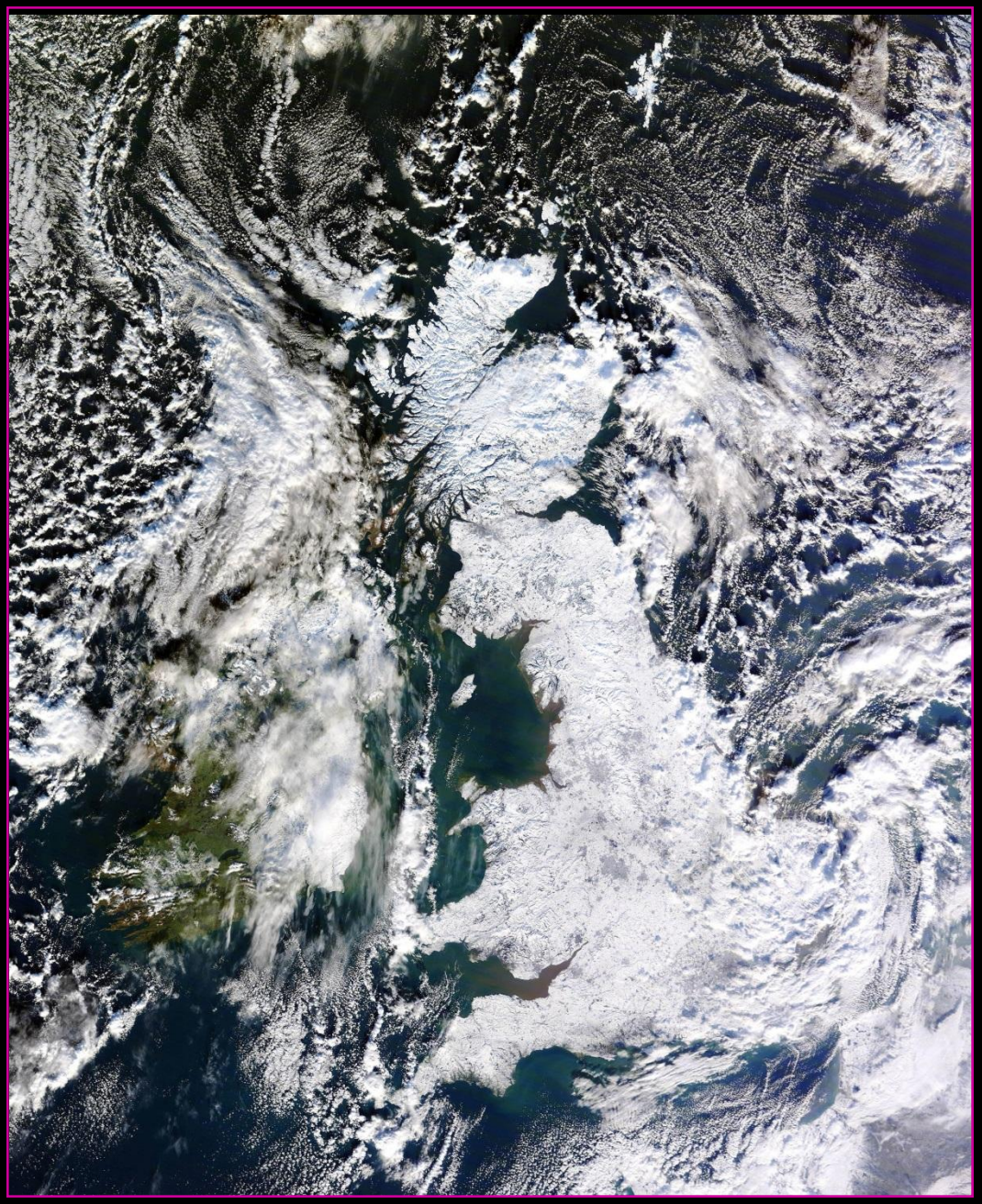
20th March, 2019

William A. Anders (24 December 1968)



7 January 2010

NASA Terra satellite image



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Brace yourselves for a 'mini ice age': This winter set to be coldest in 300 YEARS

By FIONA MACRAE FOR THE DAILY MAIL
CREATED: 17:43, 29 December 2010

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View comments

If you thought last week was as cold as you could bear it, brace yourself. Forecasters say the worst is yet to come, and this winter could be the harshest since the Thames froze over more than three centuries ago.

Temperatures for December are the coldest on record, with the average reading close to minus 1c – almost six degrees below normal.

And with forecasters warning that this winter's 'mini ice age' might last until mid-March, this winter could be the worst since 1683-84 when a fair was held on the Thames.

Whiteout: South London was covered by a blanket of snow on December 19 and forecasters are now warning that this winter's 'mini ice age' could last until mid-March

Dear Daily Mail, what ?!!

1. The only "forecasters" saying this must be basing it on tea leaves, or that the cows are lying down, or the fur on a Hedgehog Caterpillar, or that their left knee is aching more than usual
2. Actually, December 1890 was colder and winter 2010/11 was the 114th coldest in 351 years
3. Just silly - an "age" lasts rather longer than a winter!!!
4. A dusting of snow is not an "ice age" in any shape or form

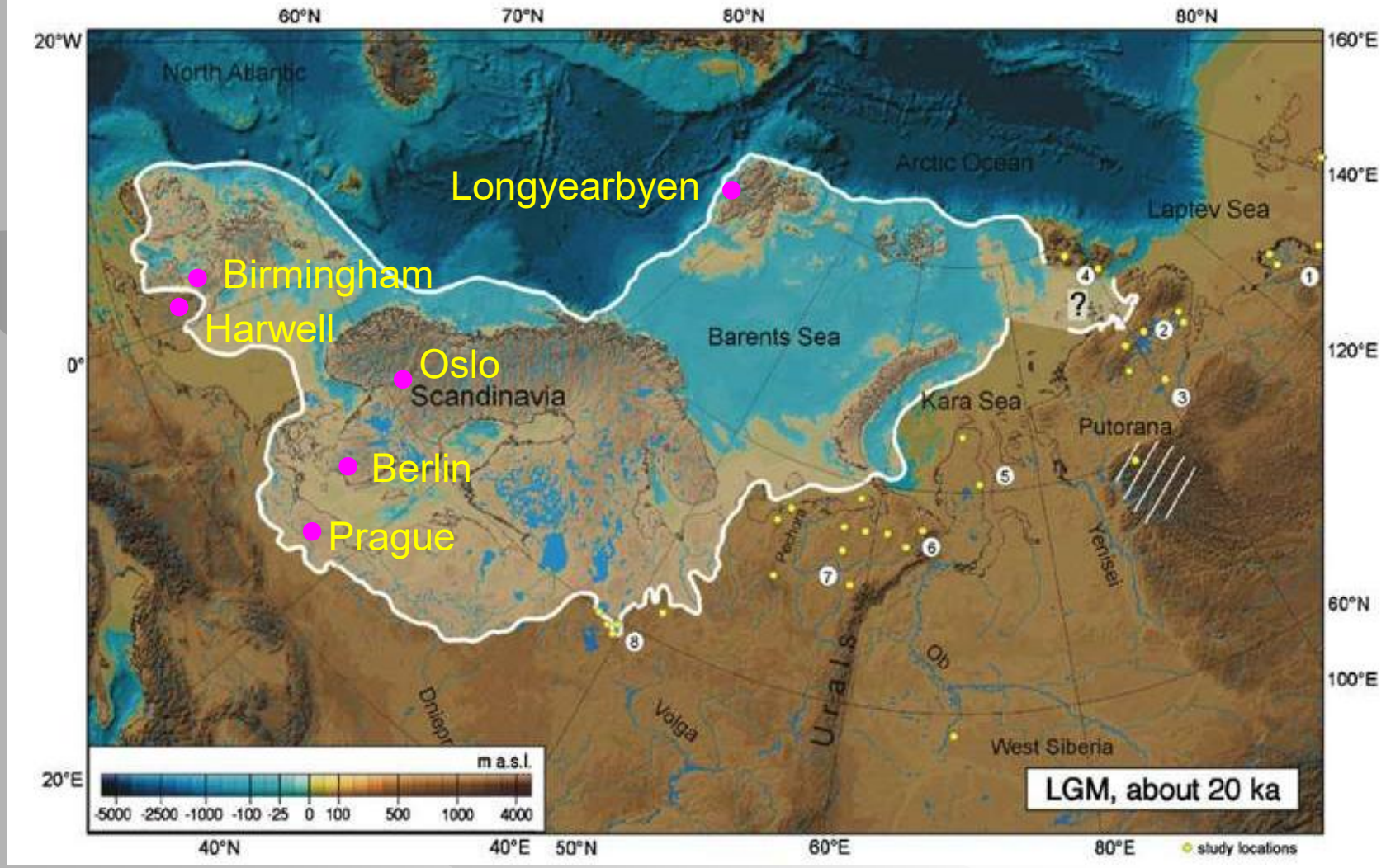
What an Ice Age Looks Like

- On top of the Greenland and Antarctic Ice sheets

Do any people live on ice sheets?

- not permanently, no: some venture onto them – but they live on the edges
- these Inuit in 1900 are spear - hunting for salmon in a river in Greenland, away from the ice sheet

The Eurasian ice sheet maximum extent in the last ice age (≈20,000 years ago)



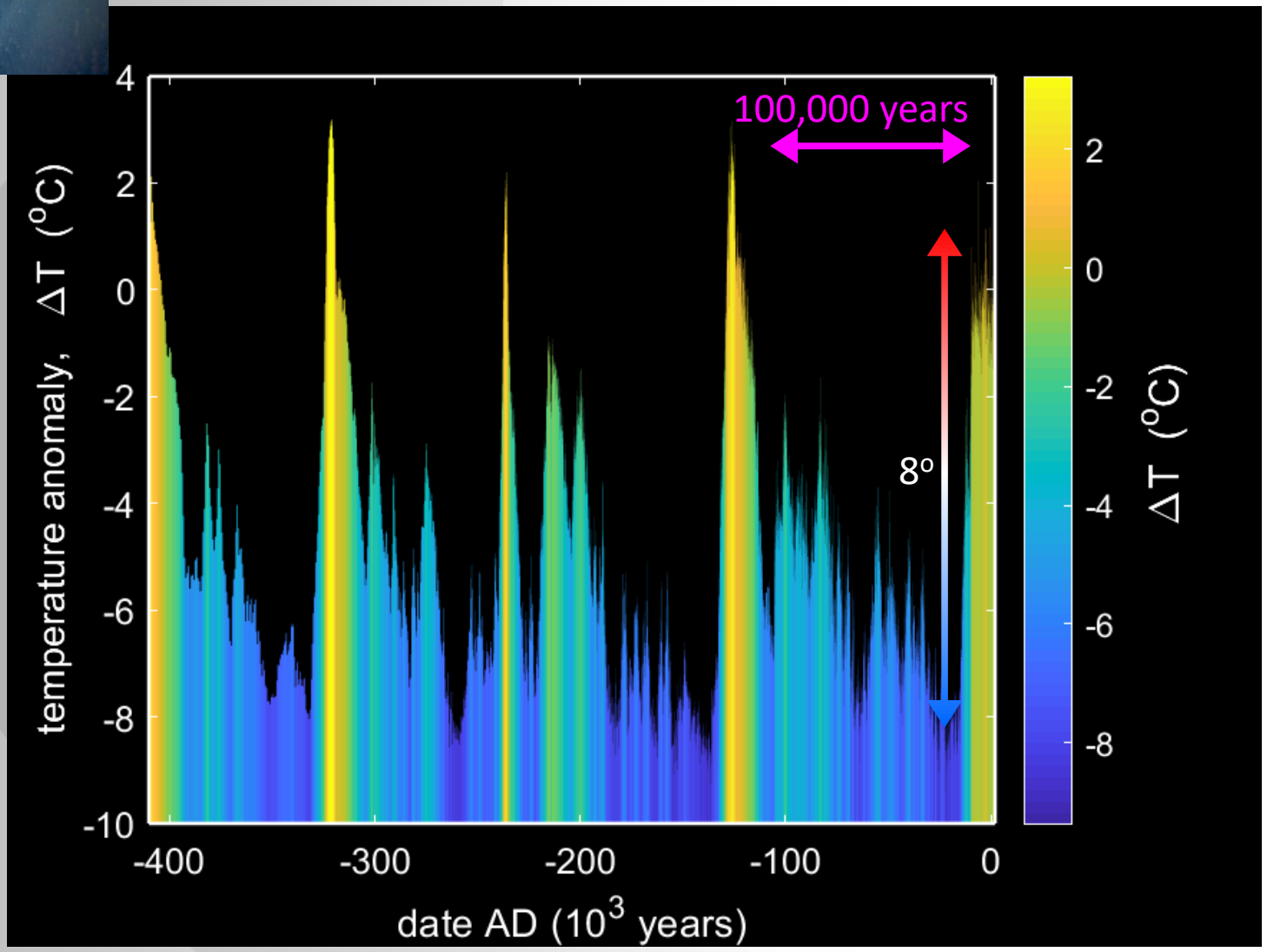
Even today permanent settlements are only on the edges of ice sheets

- Longyearbyen, Svalbard - 650 miles from the North pole and the world's most northerly town

Even today permanent settlements are only on the edges of ice sheets

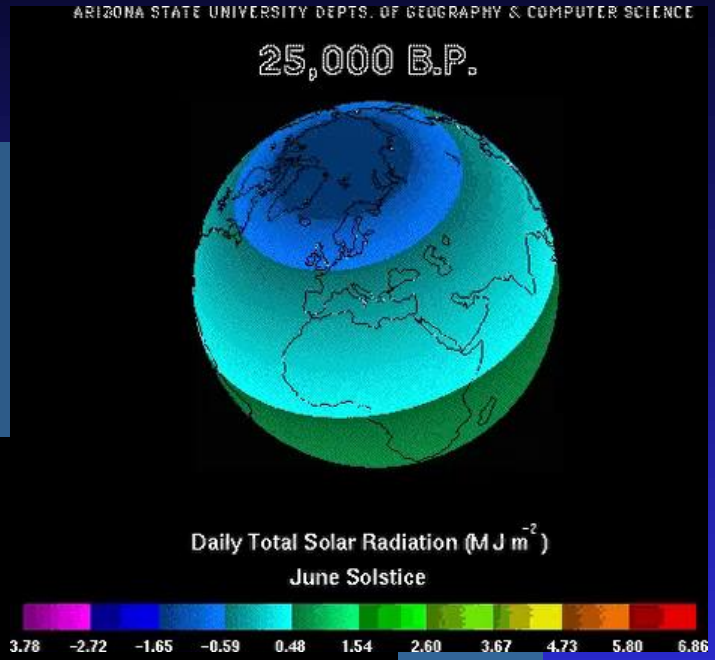
- Longyearbyen, Svalbard - 650 miles from the North pole and the world's most northerly town
- …. is ice free in summer

Real Ice Ages and Warm Interglacials

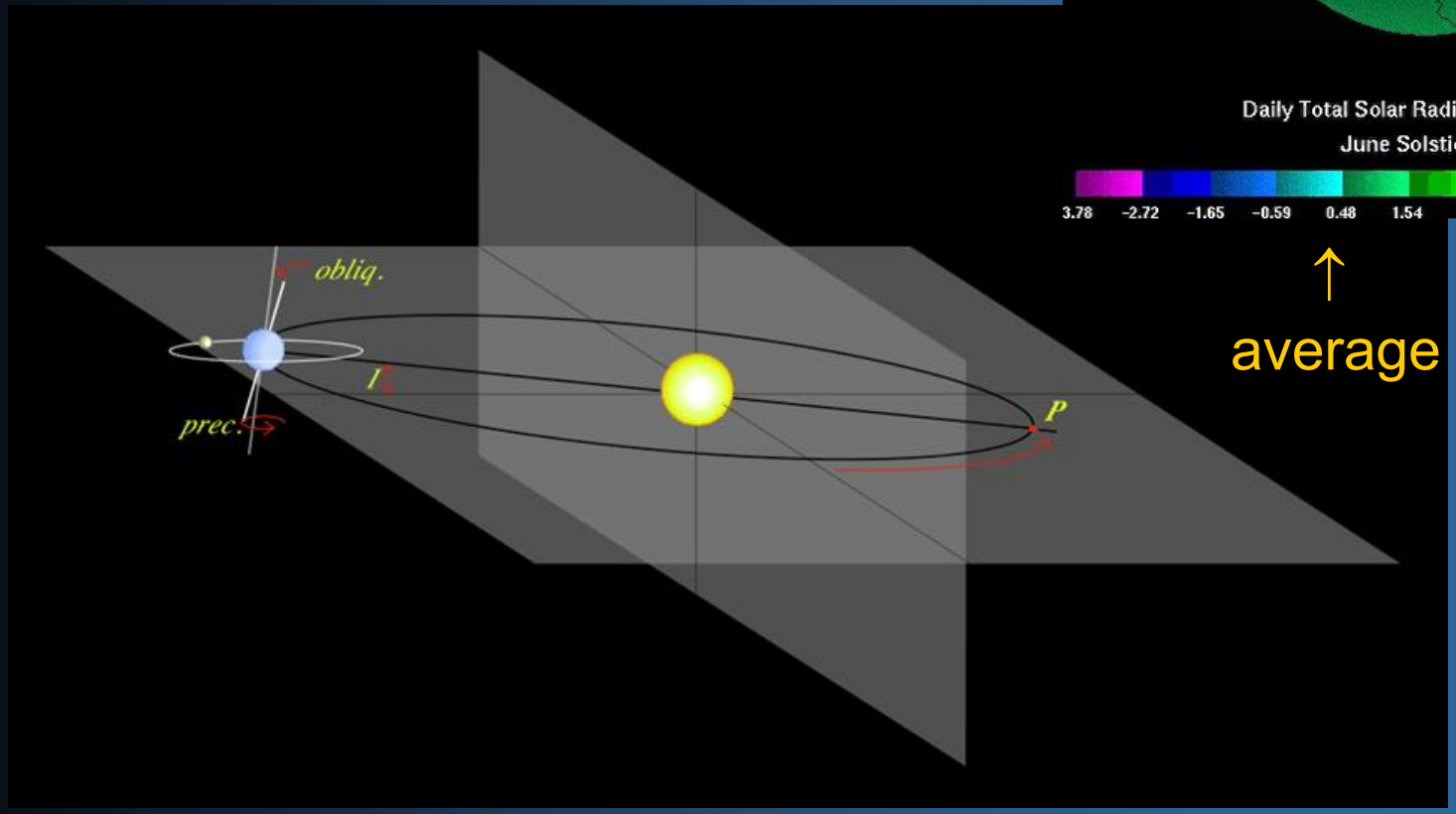


Milankovitch Cycles

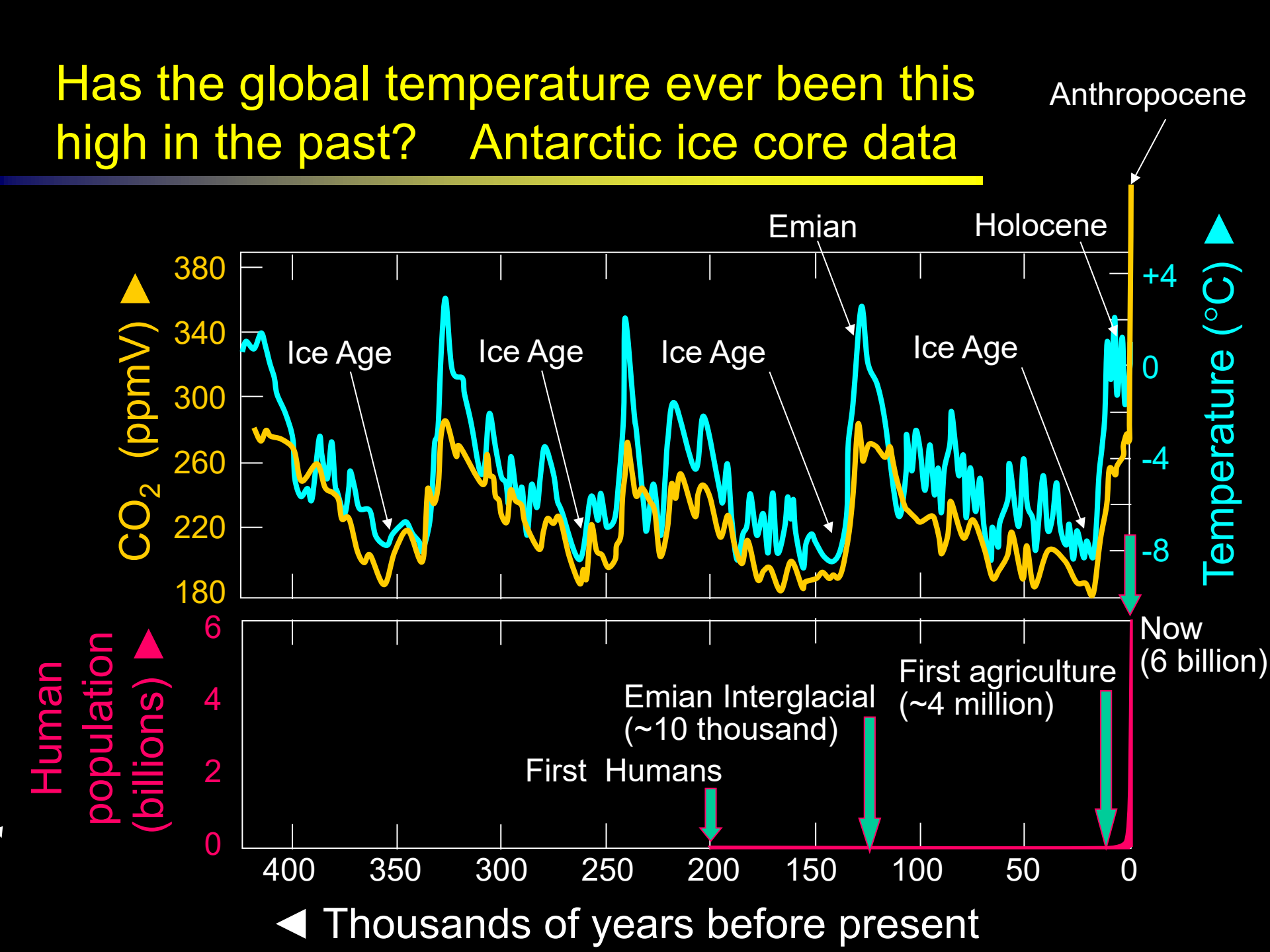
- cycles in Earth's orbit eccentricity
- precession of the equinoxes
- cycles in Earth's axial tilt (obliquity)



↑ average insolation

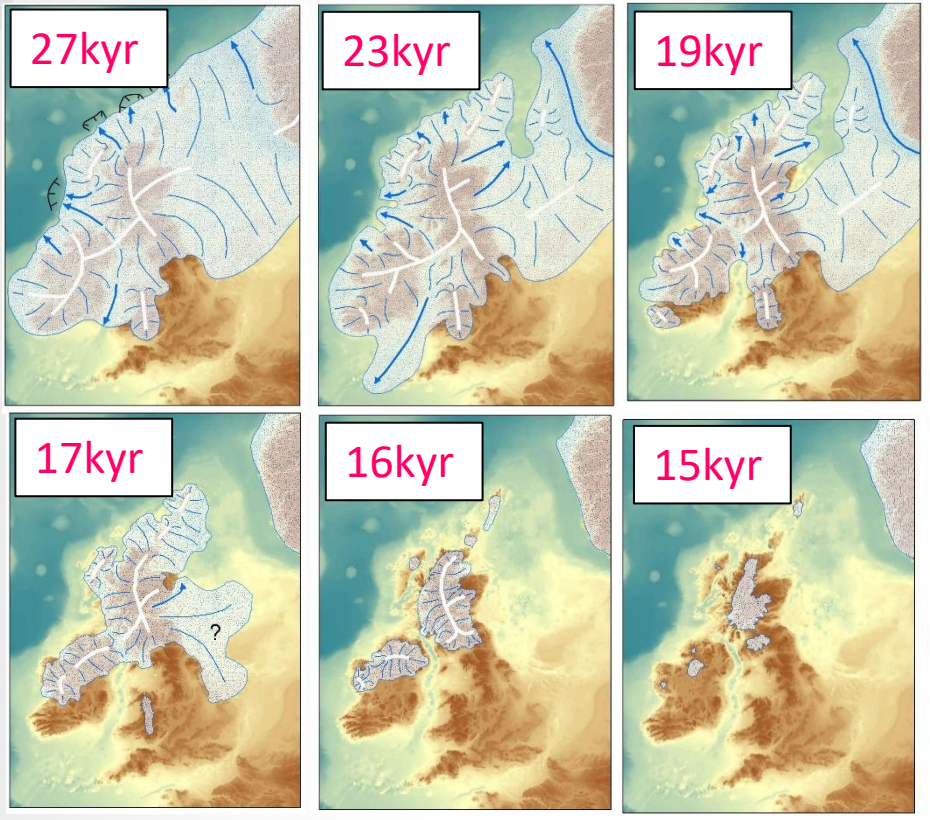


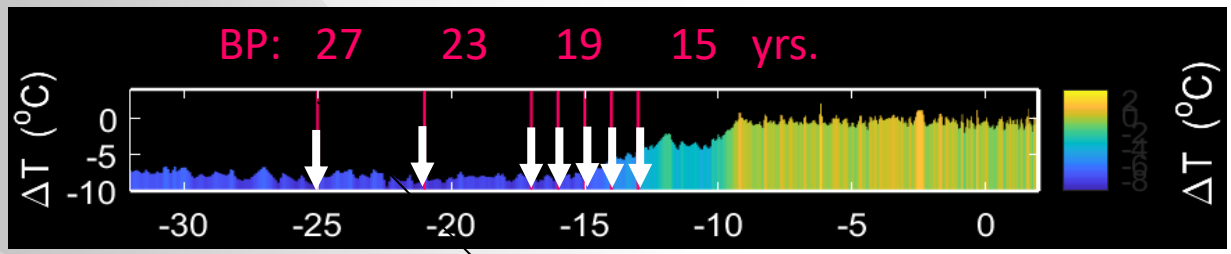
Has the global temperature ever been this high in the past? Antarctic ice core data



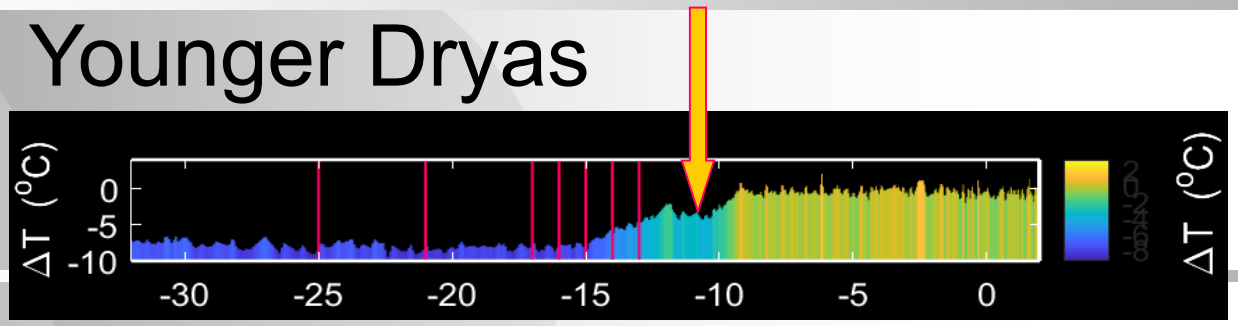
The end of the last Ice Age

- Average Temperature in south-east England ≈ –8ºC
- (Temperature range –25ºC to +8ºC: from pollens and insect fossils)
- Temperature rise interrupted at 13 to 11 kyr BP, the "Younger Dryas" – named after the flower *Dryas Octopetala* (above) that thrived in all Europe at the time

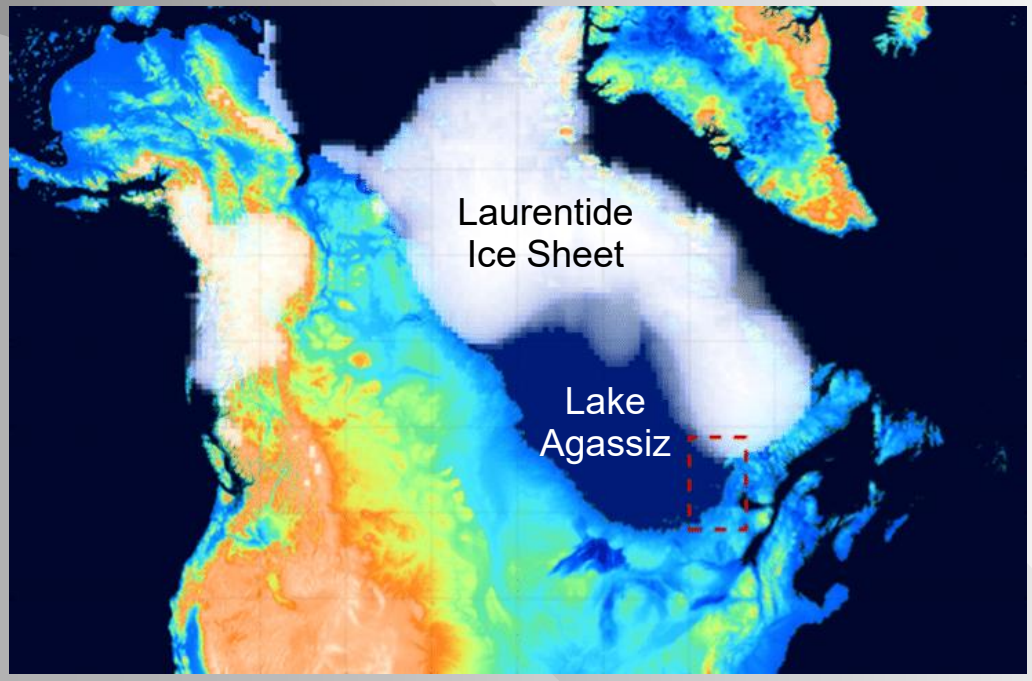


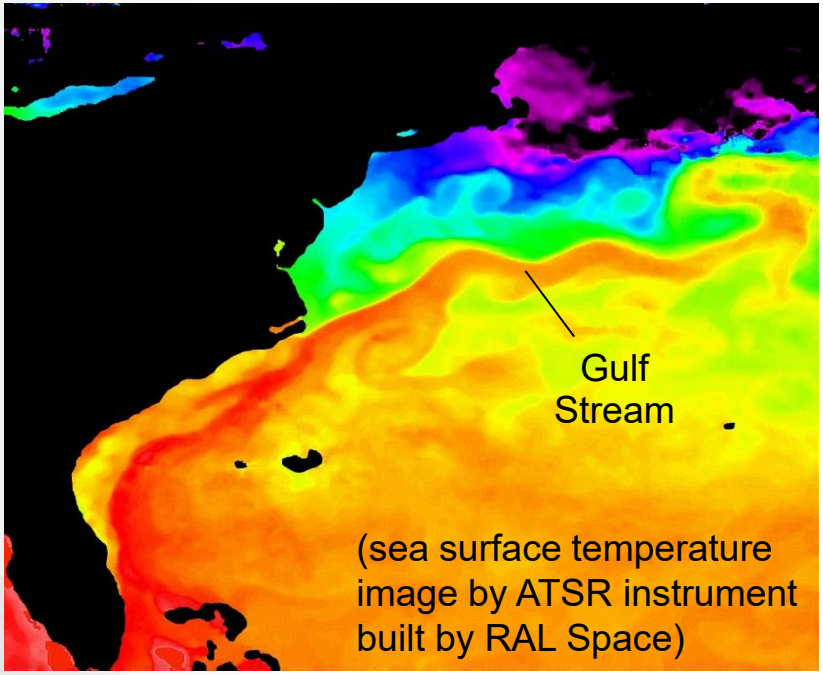


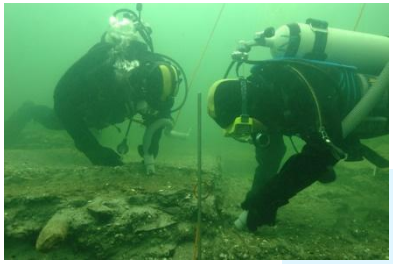
Younger Dryas



- Younger Dryas thought to be caused by cold meltwater from the north American “Laurentide” ice sheet that formed the huge lake Agassiz breaking into the Atlantic and disrupting the gulf stream

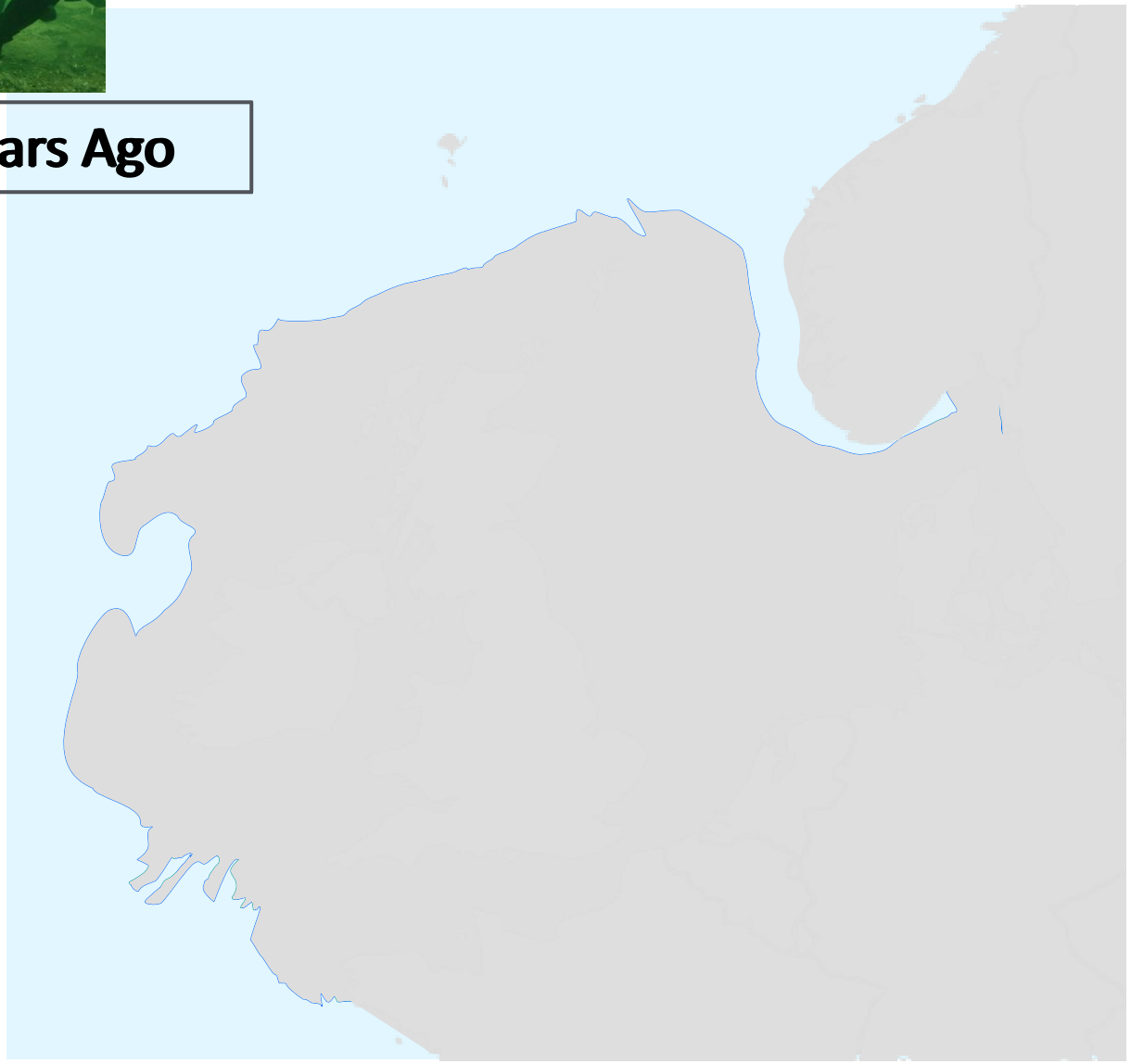






Doggerland

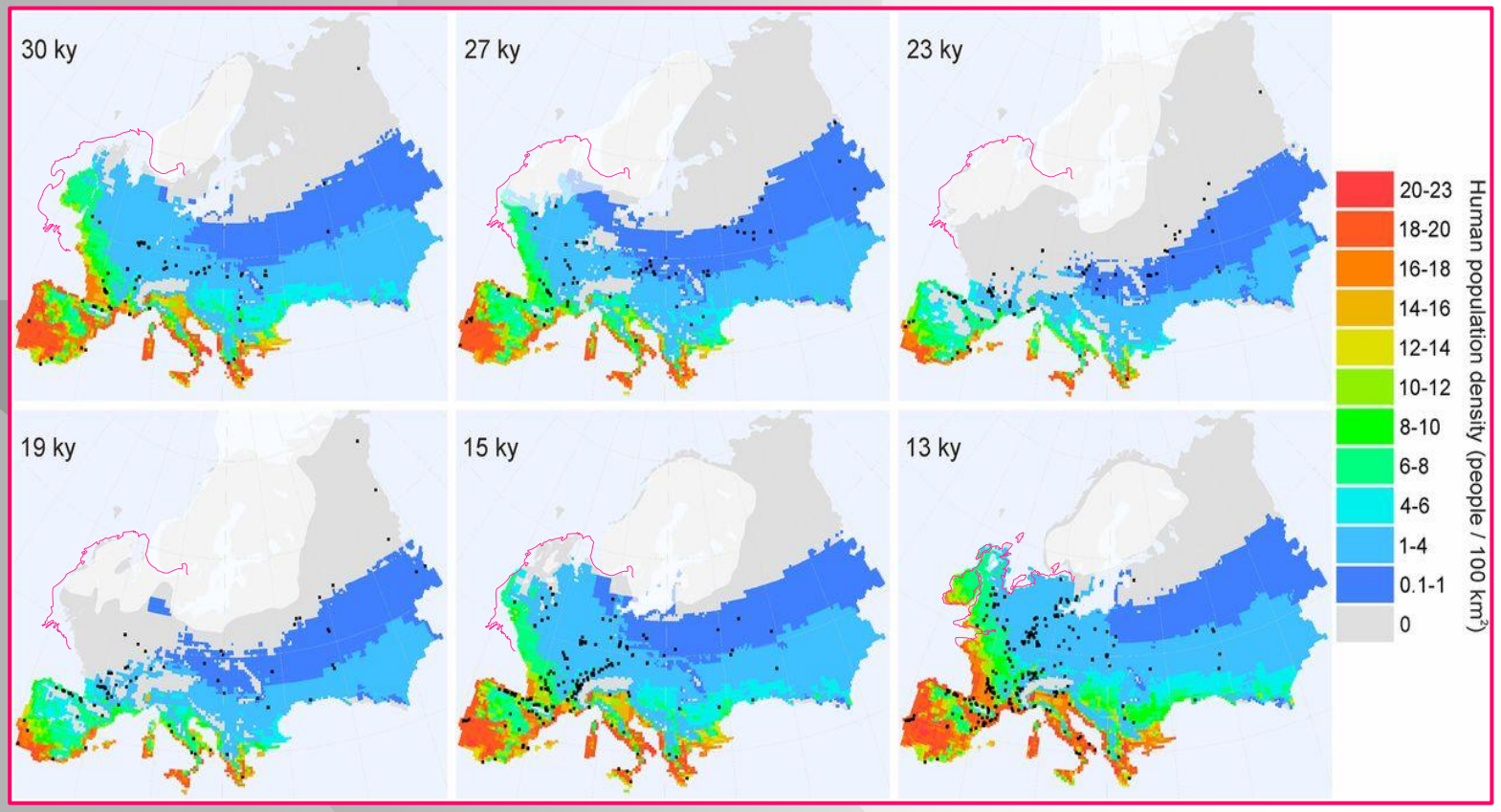
38,000 Years Ago



30 kyr BP
23 kyr BP
13 kyr BP
7 kyr BP

Migration from Britain & Doggerland to Southern Europe and back

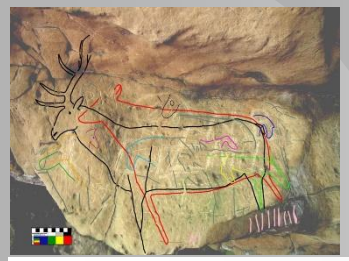
Tallavaara et al. 2015, doi: 10.1073/pnas.1503784112



people in an area the size of greater London:

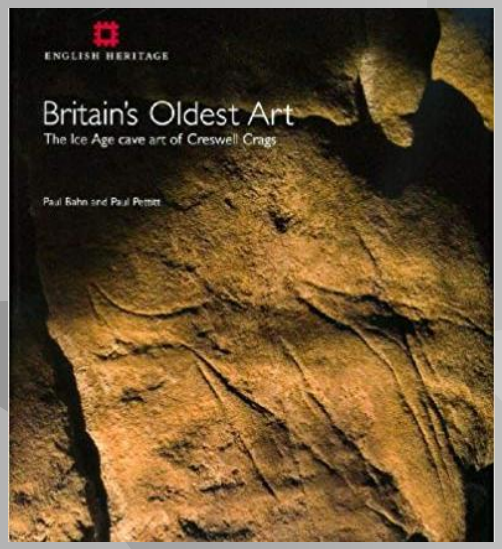
314-361
286-314
251- 282
220-251
188- 220
157- 188
126-157
94- 126
63- 94
16-63
2- 16
0

(total # of people in Britain by 13kyr BP ≈ 20, 000)

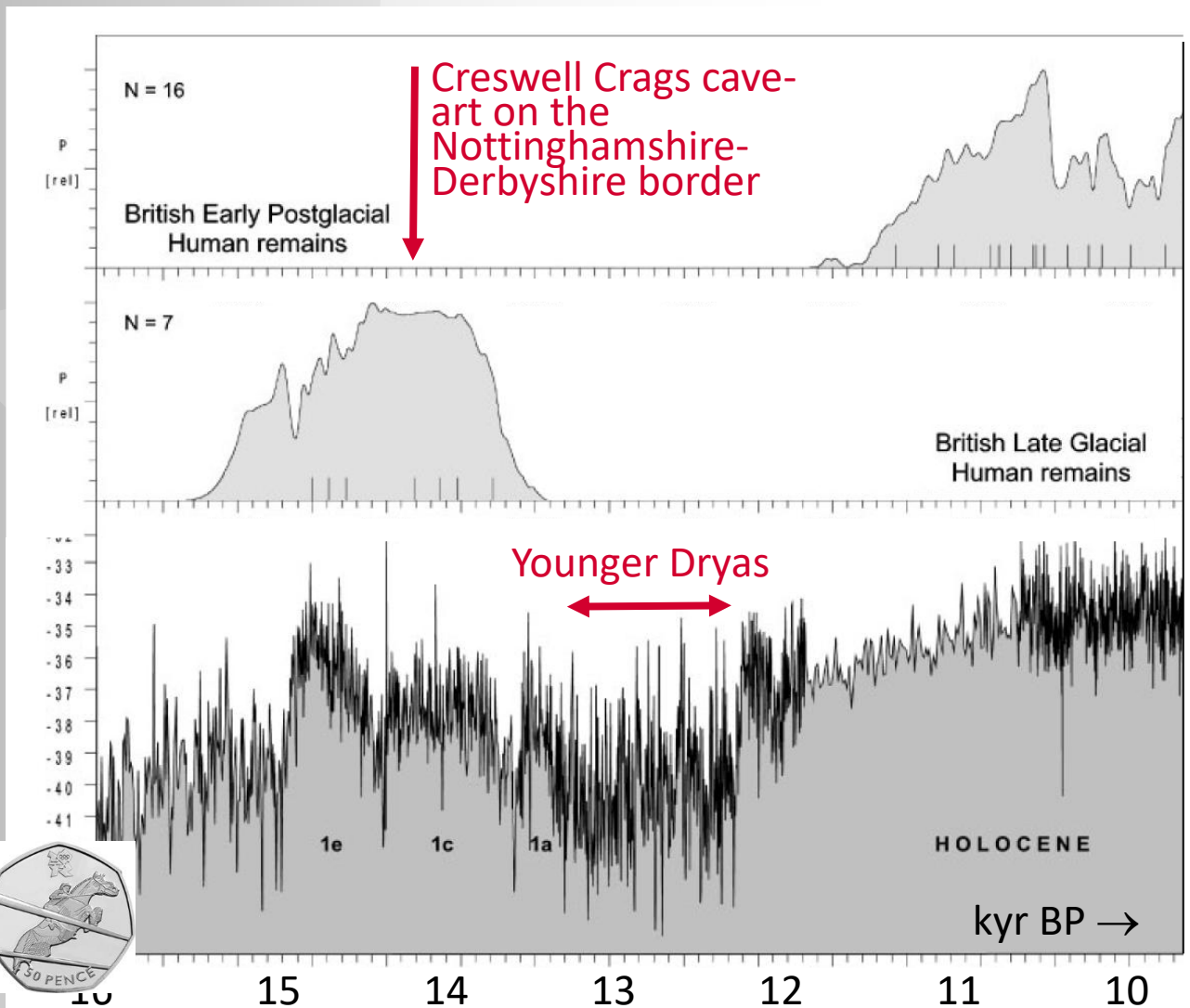


Gaps in archaeological finds of dated human remains in Britain

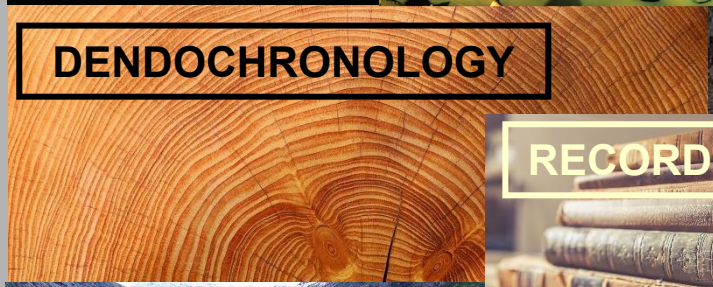
Barton et al. 2003, doi: 10.1002/jqs,772

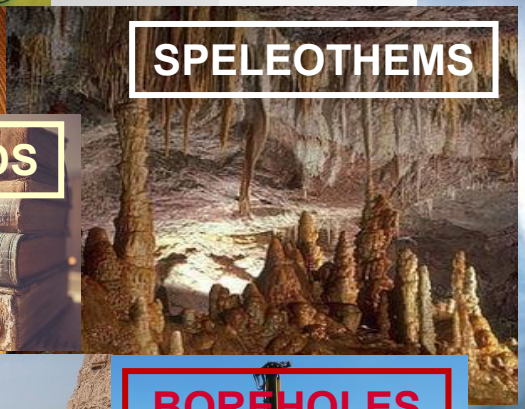


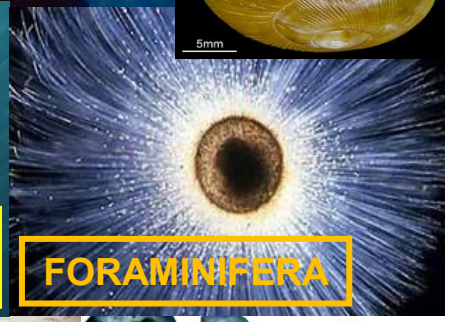
7.3cm

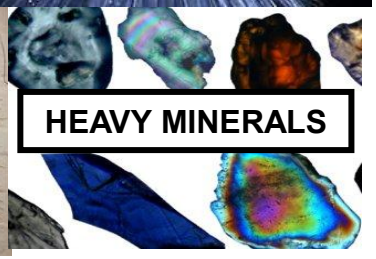


Reconstructing past temperatures, including



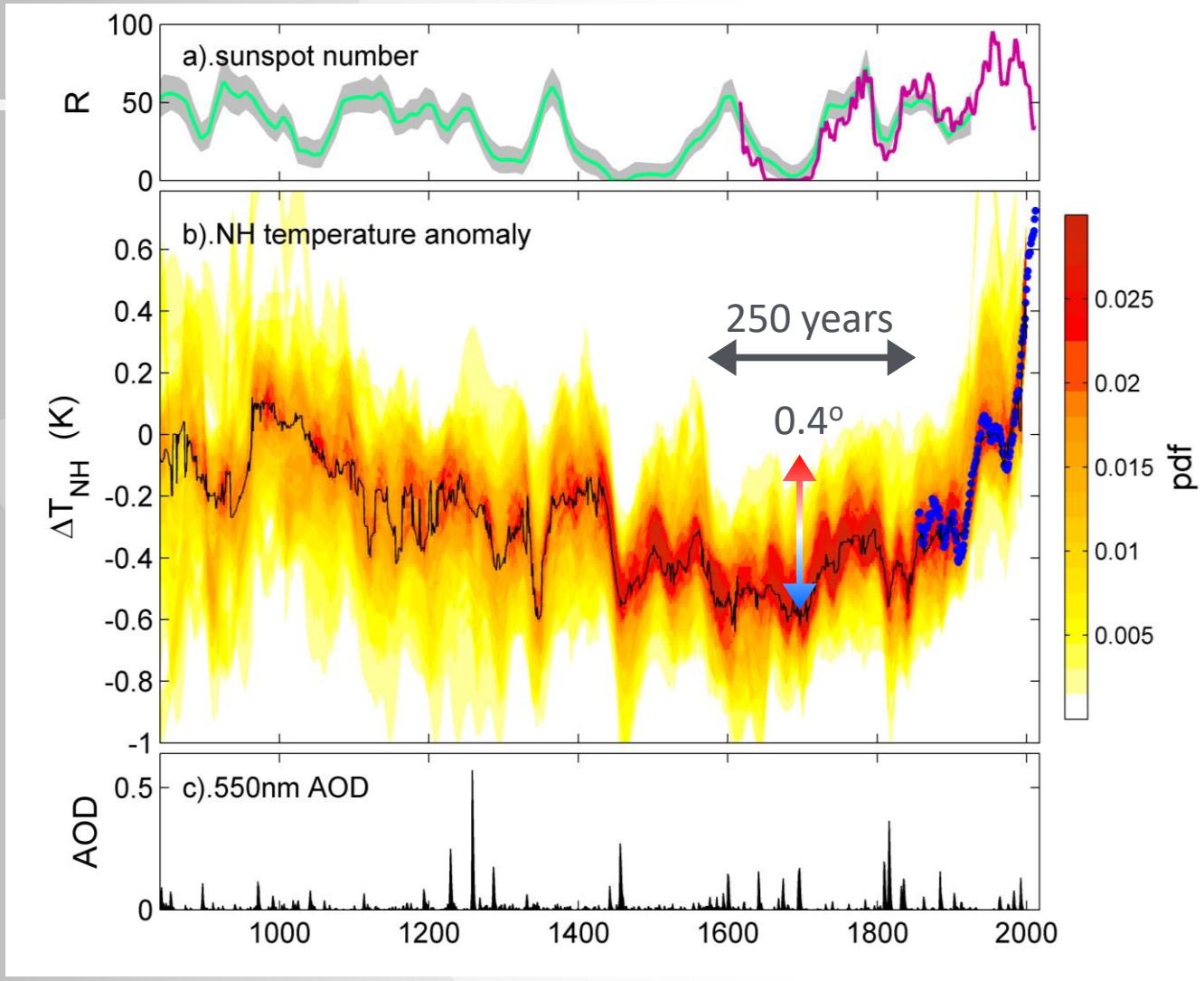




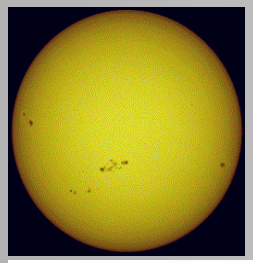


The “Little Ice Age”

- Northern hemisphere temperature anomaly, ΔT_{NH} reconstruction
- Based on data from boreholes, corals, sclerosponges, ice cores, insect numbers, instrumental data, pollens, lake levels, loess (wind-blown silt), glacier extents, plant macrofossils, diatoms, molluscs, foraminifera, dinoflagellates, ostracods, heavy minerals, grain-size, trace elements in speleothems, dendrochronology & historical records (recorded freeze/thaw dates, harvest yields & dates, etc.)



- *Masson-Delmotte, V., and 16 other authors (2013) doi:10.1594/PANGAEA.828636.*



A Frost Fair on the River Thames

- The great frost fair of 1684 painted by an unknown artist. The painting is generally known as “Frost fair on the Thames, with old London Bridge in the distance”.

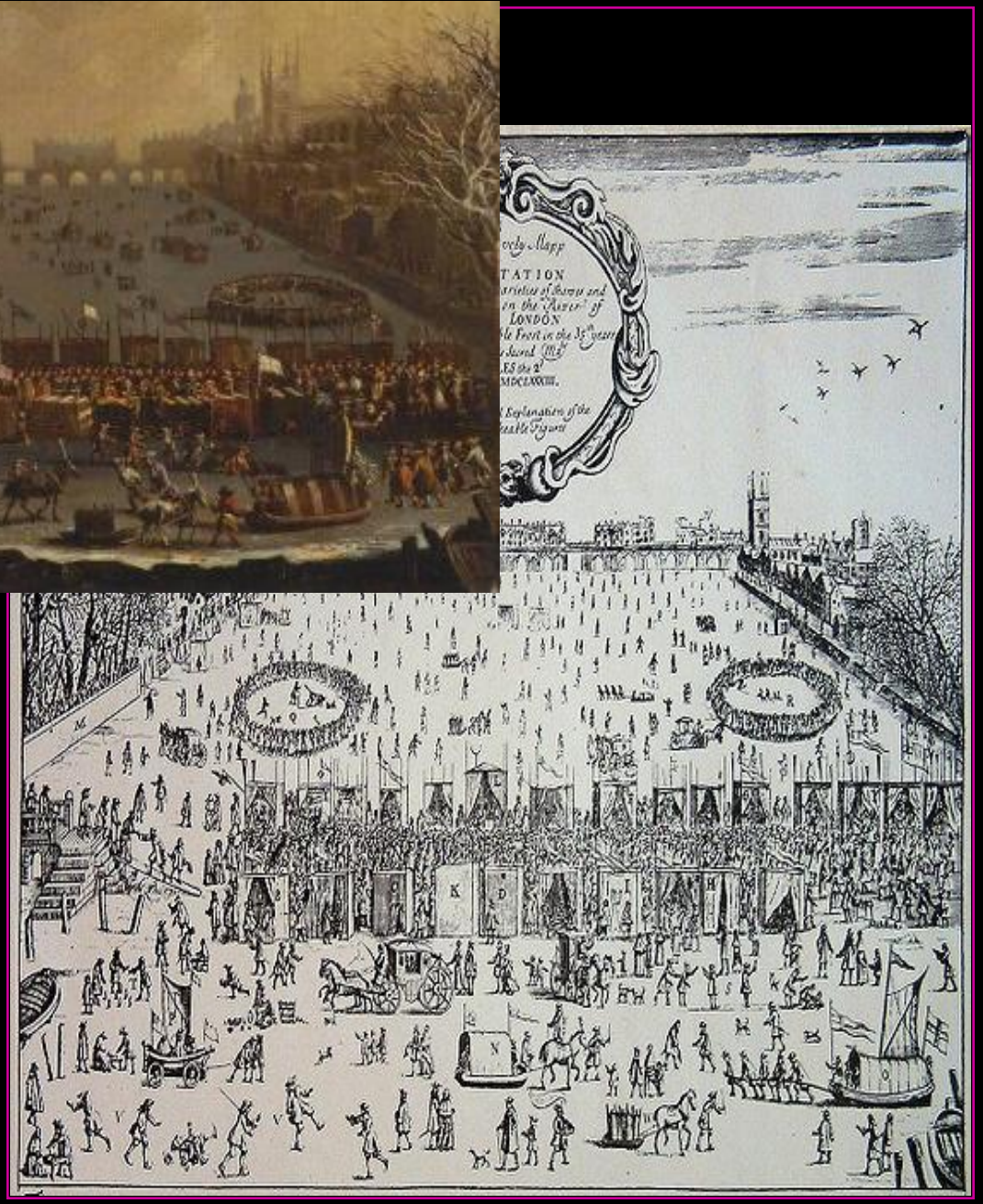
(The Paul Mellon Collection, Yale Center for British Art, New Haven, Connecticut).

A Frost Fair on the River Thames

- paintings of frost fairs are often attributed to Flemish painter Thomas Wyke (1616 - 1677) - like this one of the 1654 frost fair is by engraver James Stow (c.1770-1823) and is listed as "from an original drawing by Jan Wyk" (the son of Thomas Wyke 1652-1702)

January 1684

A Frost Fair on the Thames in London. Probably by William Faithorne (1616 – 1691), English painter and engraver who had a shop near Temple Bar.

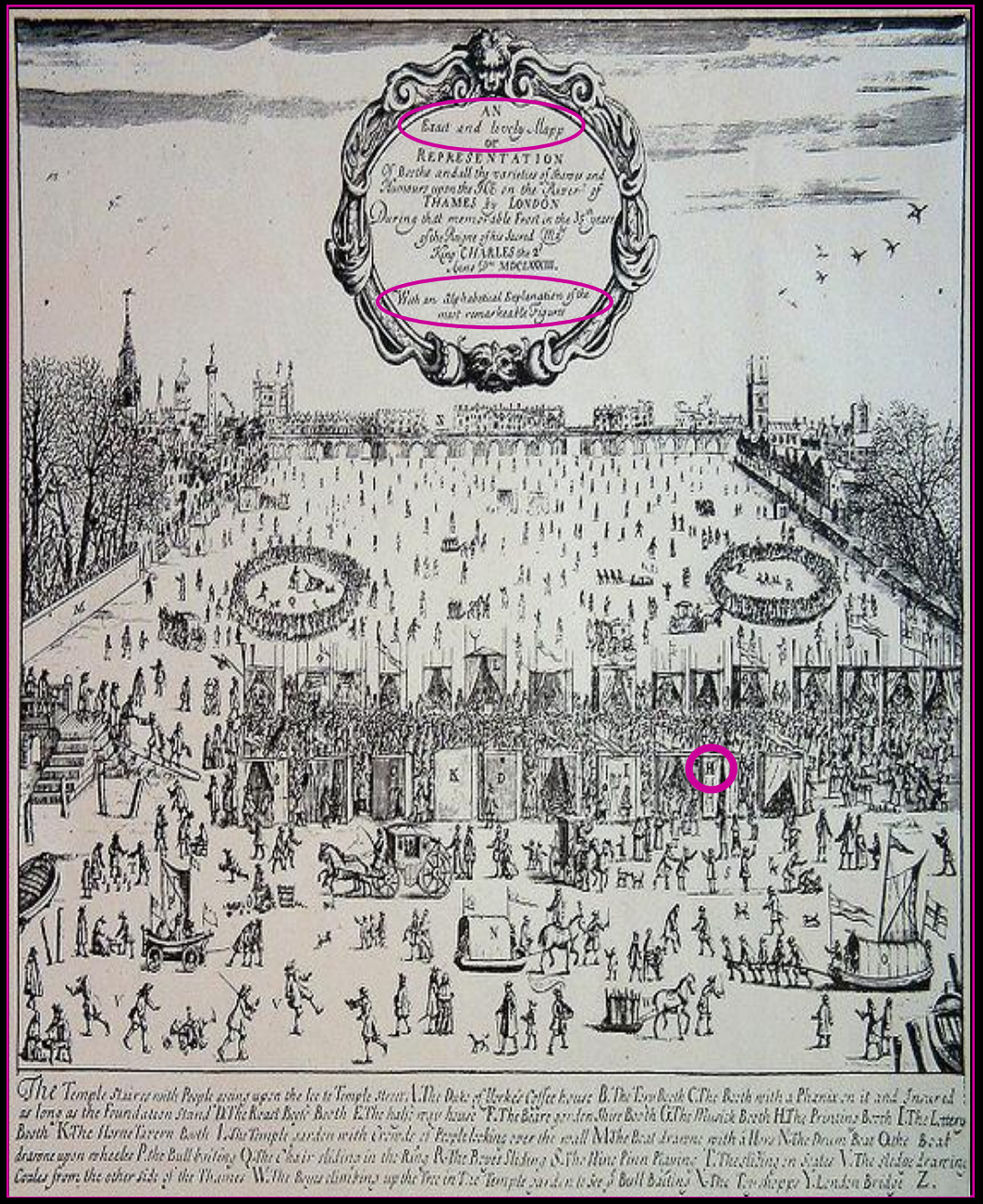


Same scene – once thought to be painted by Jan (a.k.a.John) Wycke (son of Thomas), but now generally listed as “unknown artist”

"An exact and lively mapp … with an alphabetical explanation of the most remarkable figures"

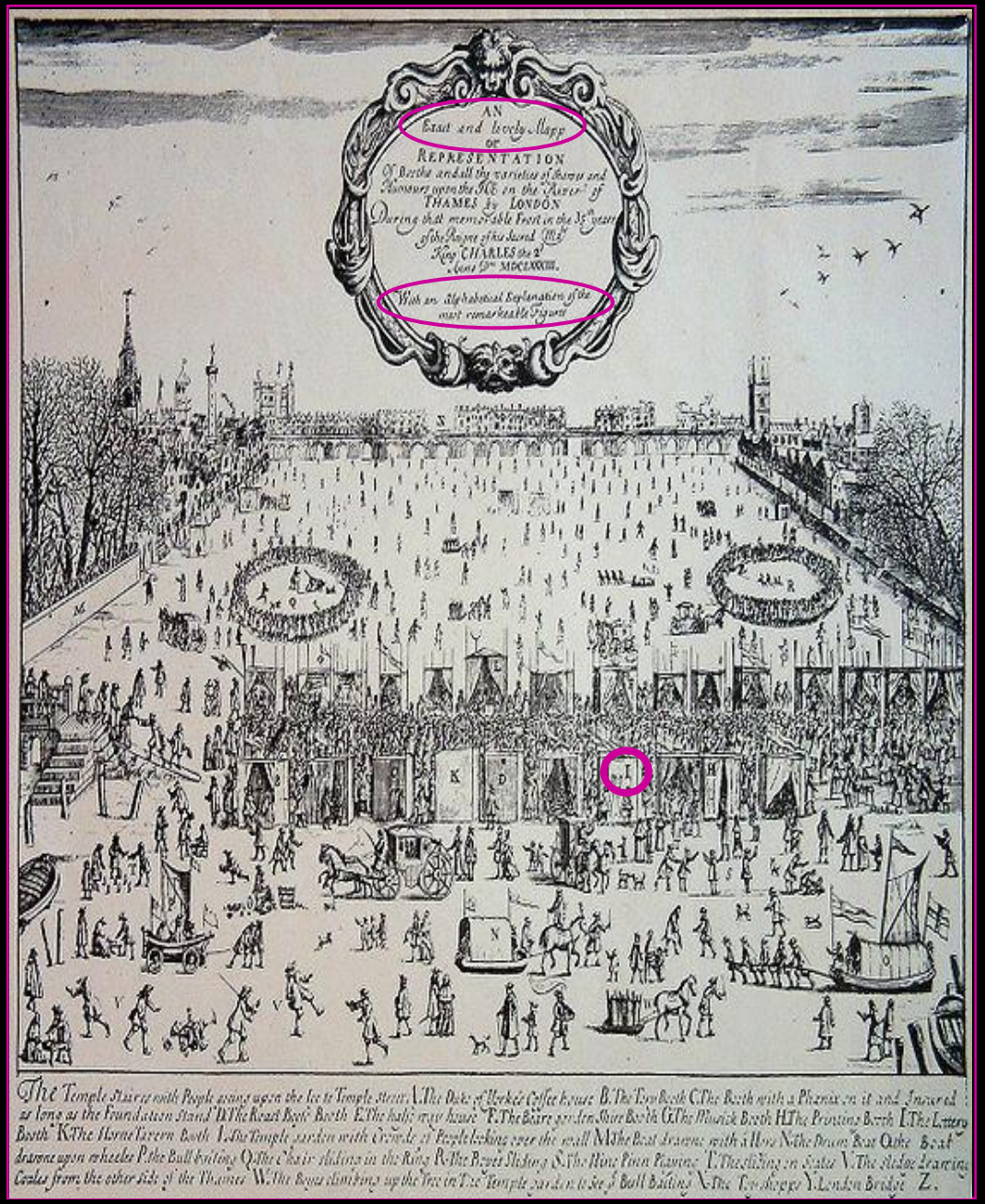
"An exact and lively mapp … with an alphabetical explanation of the most remarkable figures"

H. The Musick Booth



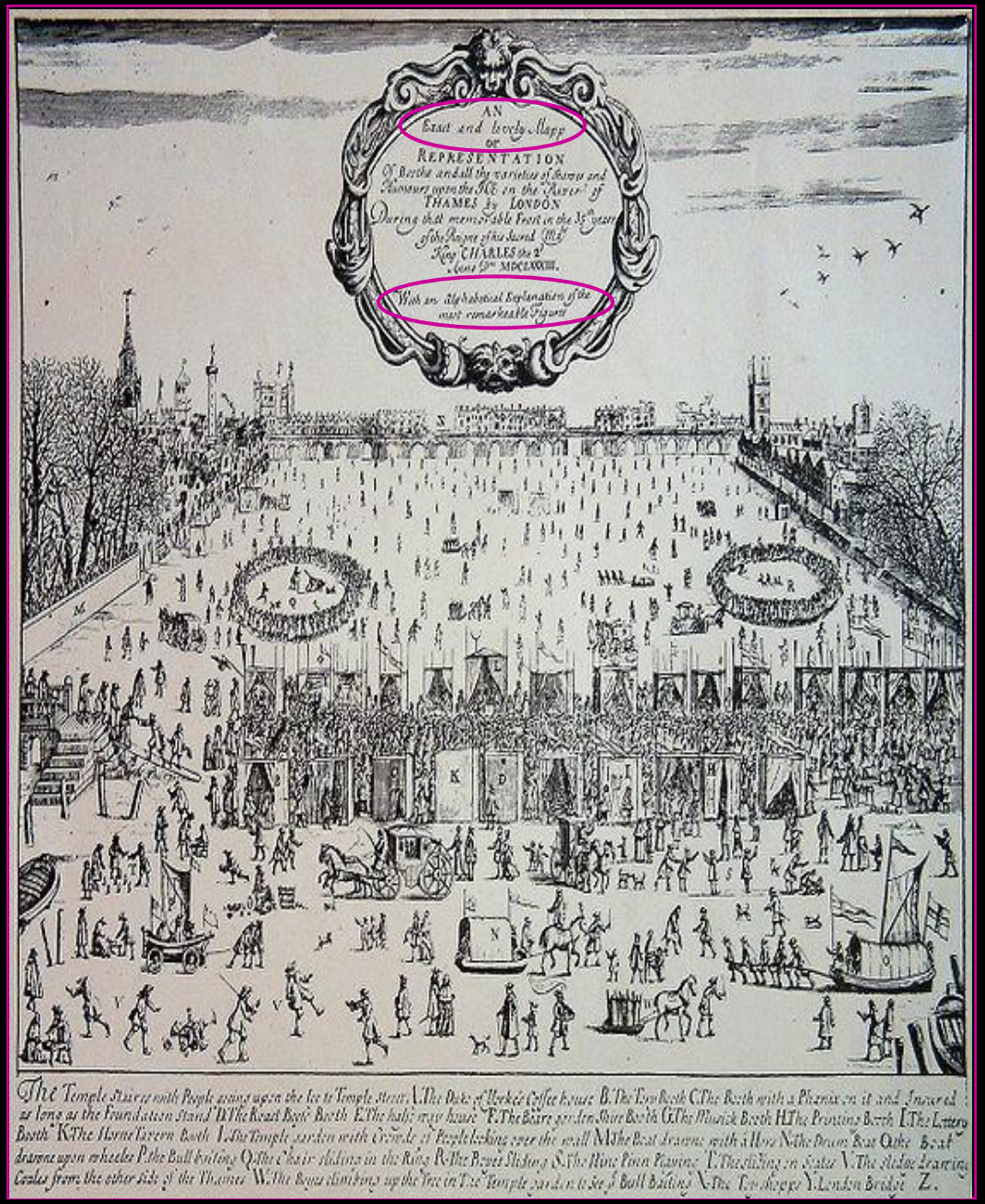
"An exact and lively mapp … with an alphabetical explanation of the most remarkable figures"

I. The Printing Booth



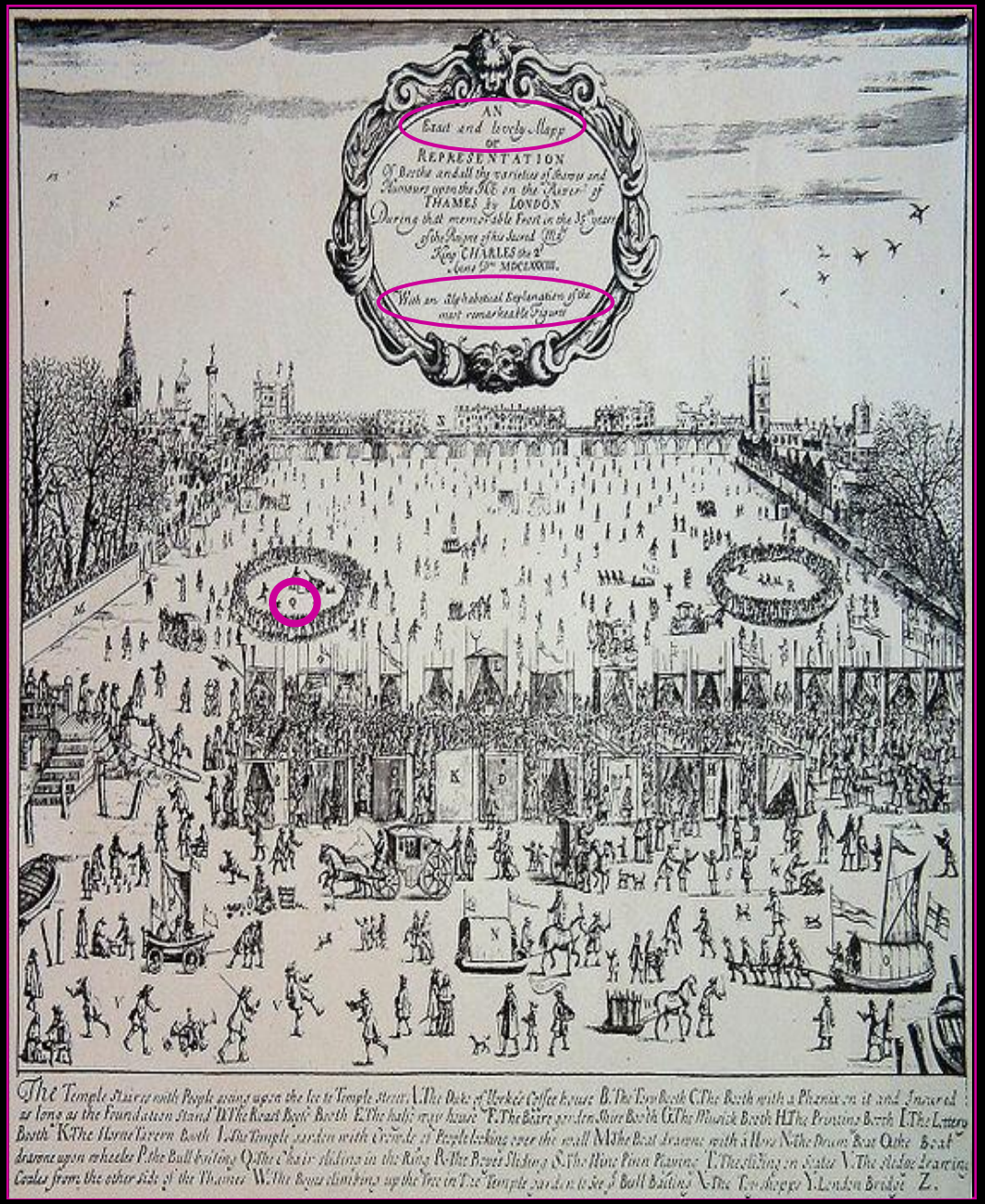
"An exact and lively mapp … with an alphabetical explanation of the most remarkable figures"

E. The Roast Beefe Booth



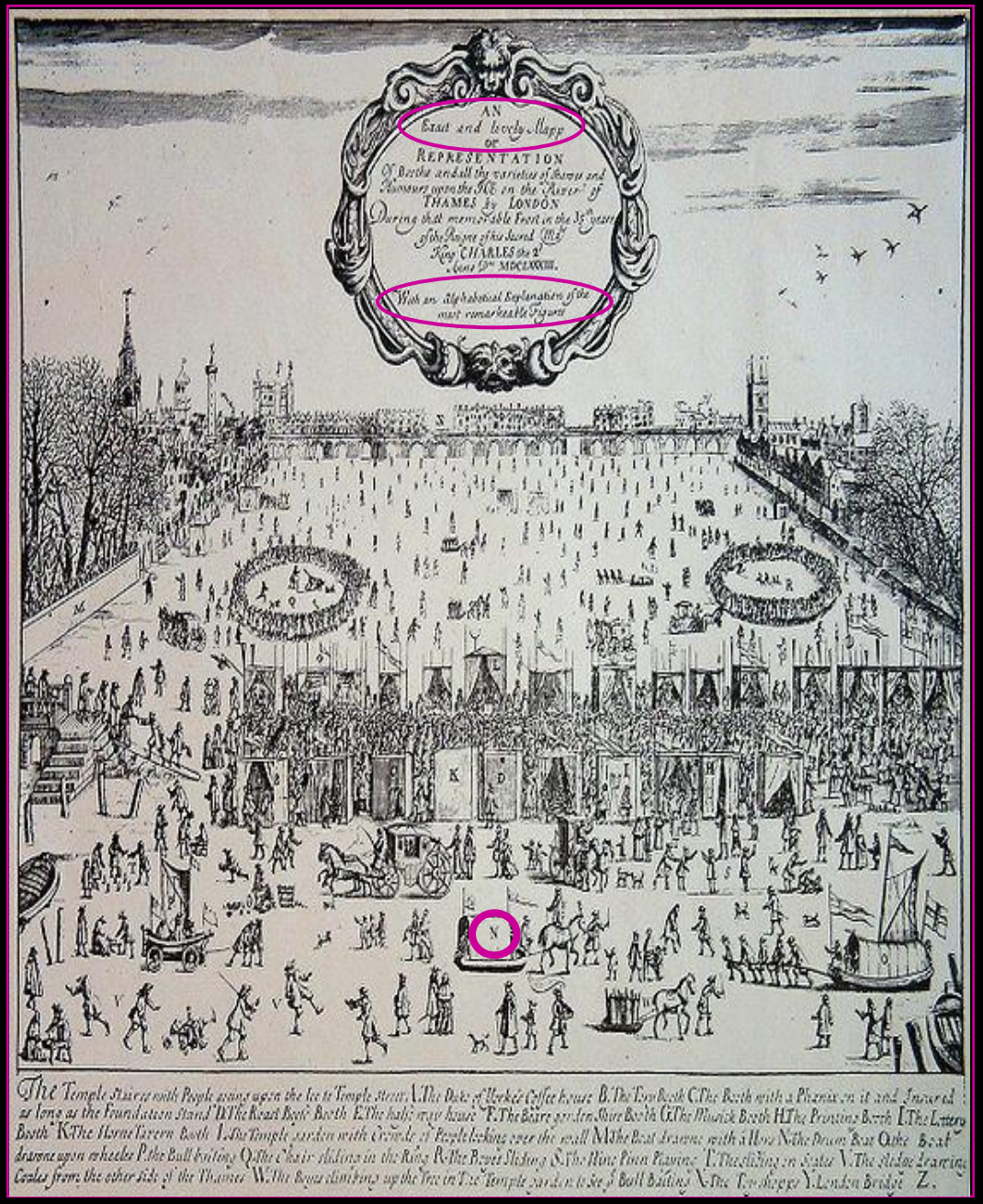
"An exact and lively mapp … with an alphabetical explanation of the most remarkable figures"

Q. The Bull Baiting



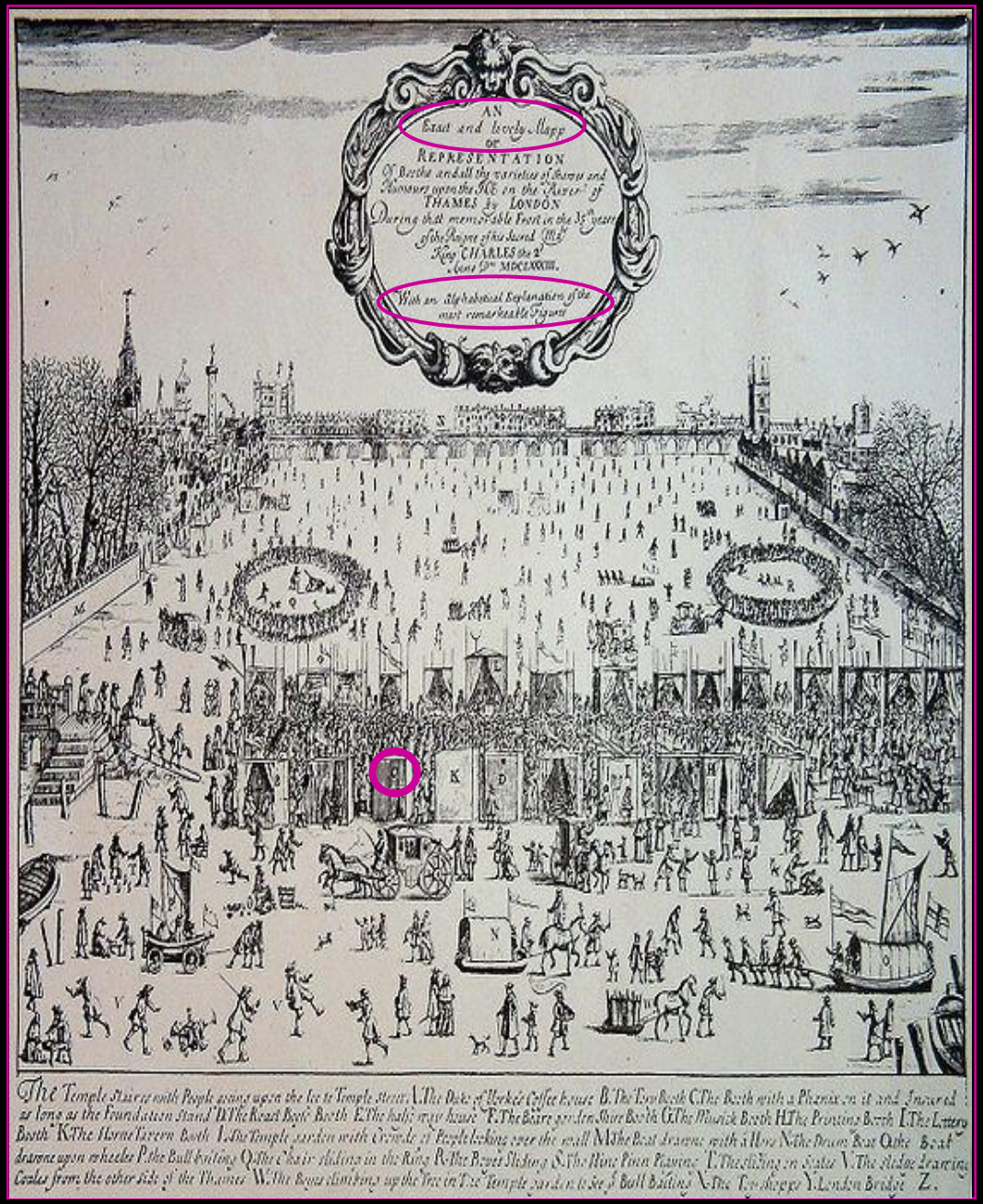
"An exact and lively mapp … with an alphabetical explanation of the most remarkable figures"

N. The Boat drawne with a Hors



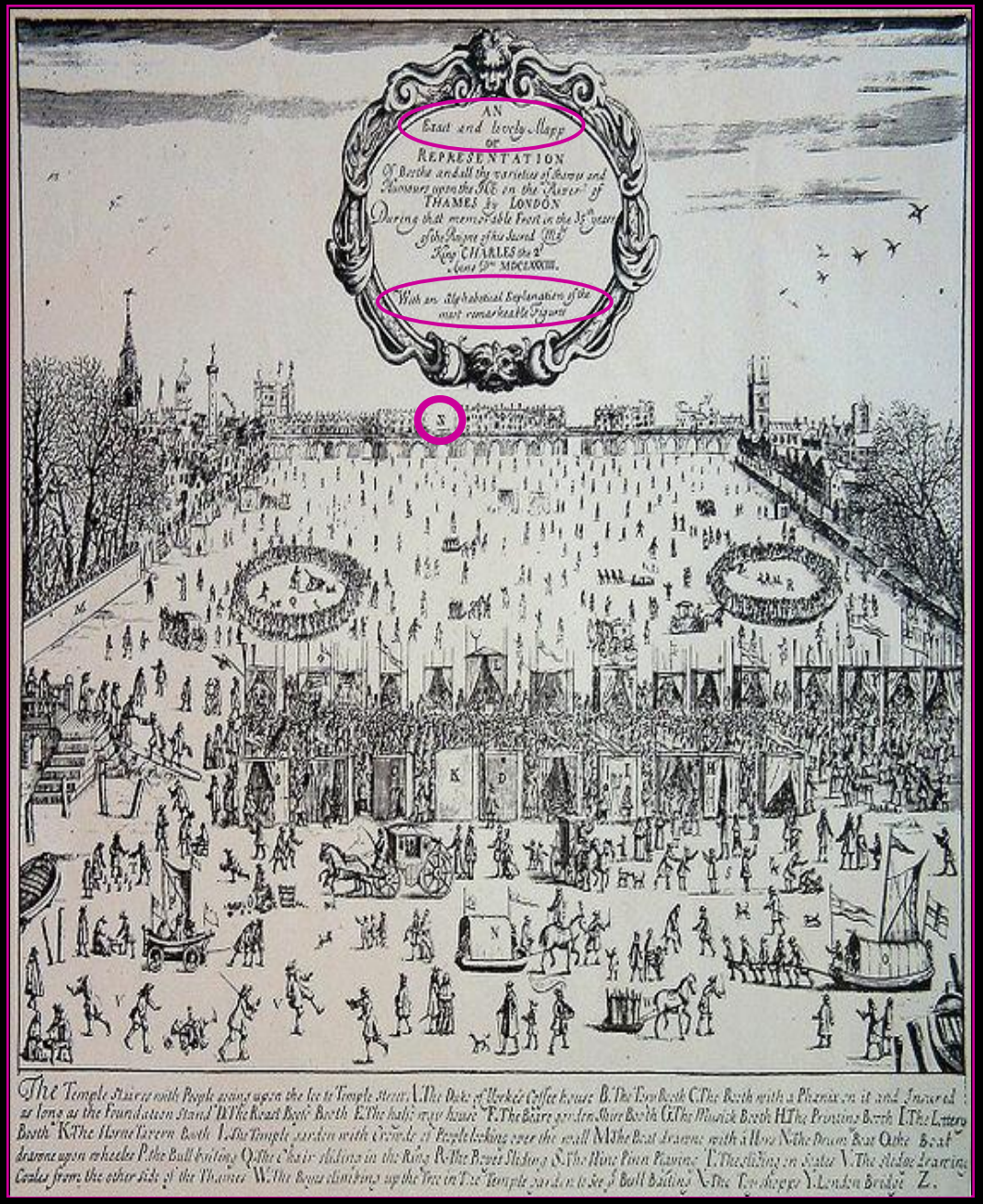
"An exact and lively mapp … with an alphabetical explanation of the most remarkable figures"

C. The Tory Booth



"An exact and lively mapp … with an alphabetical explanation of the most remarkable figures"

Z. London Bridge



First event to be called a “Frost Fair” was in 1608, but….

- 250 the river frozen solid for six weeks and social gatherings were held on it
- 695 Thomas Tegg (1835) reports that the Thames froze for over six weeks that booths to sell goods were erected on it
- 923, 1150 & 1410 frozen river used to bring in goods by horse and cart for 14 weeks - but no frost fair is mentioned. (Shortages of food? Puritanical government?)
- 1309 Fires lit and sports organised on the frozen river - such events recorded in 1408, 1435, 1506, 1514, 1537, 1565, & 1595
- 1400-1600 Reports of river freezing became more common as number of chroniclers increased – events often recorded if Royalty involved

- 1537 Henry VIII, took his queen at the time (Jane Seymour) on a sleigh on the river from Whitehall to Greenwich
- 1564/5 Elizabeth I is said to have walked and, in some accounts practiced archery, on the frozen Thames. Reports of a very cold winter throughout Europe
- 1608 First event called a frost fair held. It is probable that they became fashionable through the influence of Flemish immigrants from the Low Countries

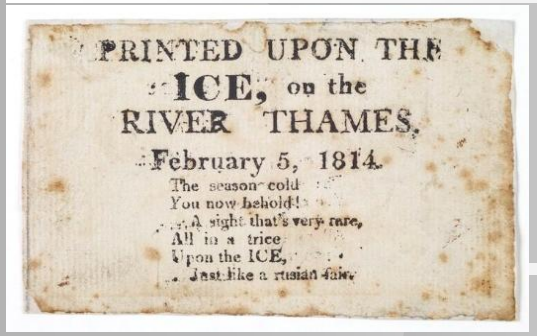
- Abraham Hondius, “A Frost Fair on the Thames at Temple Stairs, 1684”

- Recorded frost fairs in 1608, 1621, 1635, 1649, 1655, 1663, 1666, 1677, 1683/4 (a very cold year), 1695, 1709, 1716, 1739/40, 1768, 1785, 1788, 1795, and 1814
- 1776 was very cold and the river froze. But no frost fair held as London was also hit by an influenza epidemic, that is estimated to have killed 40,000 people in England

- 1740 The frozen river and unpassable roads led to severe shortages but a frost fair still held. Andrews (1887) quotes an observer at the time

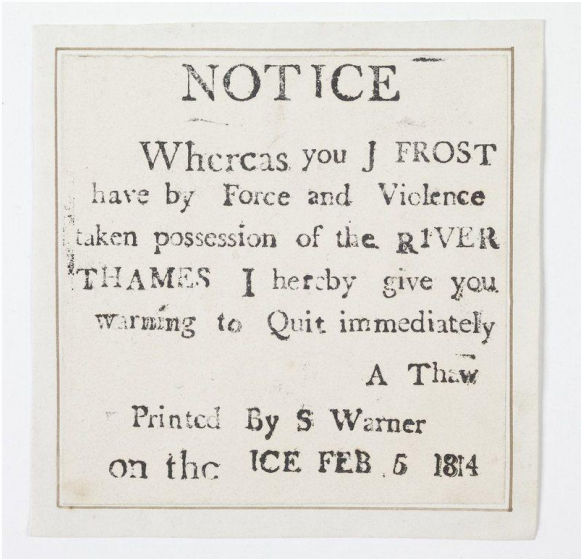
"*the watermen and fishermen ... and the carpenters, bricklayers... walked through the streets in large bodies, imploring relief for their own and families' necessities; and, to the honour of the British character, this was liberally bestowed. Subscriptions were also made in the different parishes, and great benefactions bestowed by the opulent, through which the calamities of the season were much mitigated*

True to a degree: Sir Robert Walpole, effectively Britain's first PM, personally donated £1000 –almost £0.1m at today's prices. Forced the King to also donate (but much less!)


PRINTED UPON THE
ICE, on the
RIVER THAMES,
February 5, 1814.
The season cold
You now behold!
A sight that's very rare,
All in a trice
Upon the ICE,
Just like a Russian fair.

The Last Frost Fair, 1-4 February 1814

- Printing presses moved onto the ice
- An elephant led across the river at Blackfriars
- Part Village fete, part illegal rave. A lot of hot “Purl” - a mix of gin and wormwood wine, similar to vermouth, sold in “fuddling tents” - made out of sails and propped up with oars
- Ice broke up suddenly after just 4 days. Several people fell into the river: reports talk of two men saved but two men seen floating on a floe were never seen again

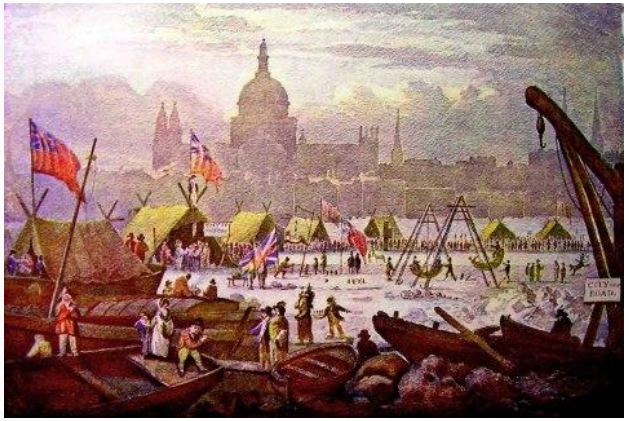

NOTICE

Whereas you J FROST have by Force and Violence taken possession of the RIVER THAMES I hereby give you warning to Quit immediately

A Thaw

Printed By S Warner on the ICE FEB 5 1814

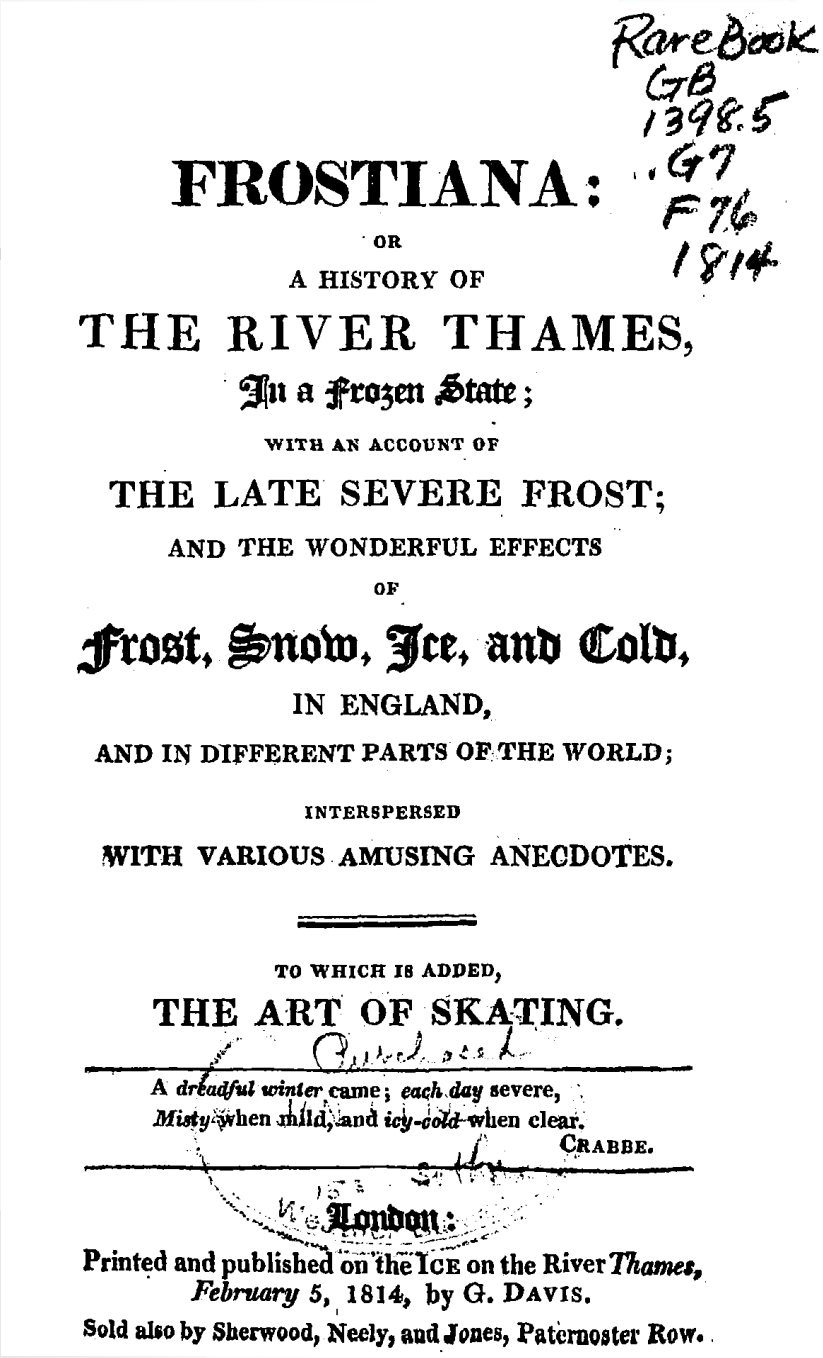
- “Frost Fair 1814 – from a drawing in the collection of Mr Gardner”



Frostiana

- Davis, G. (1814) “Frostiana - or a History of the River Thames in a frozen state, with an account of the late severe frost and the wonderful effects of frost, snow, ice and cold in England and in different parts of the world; interspersed with various amusing anecdotes; to which is added, the art of skating”

Sherwood, Neely, and Jones, Paternoster Row, London



FROSTIANA:

OR

A HISTORY OF

THE RIVER THAMES,

In a Frozen State;

WITH AN ACCOUNT OF

THE LATE SEVERE FROST;

AND THE WONDERFUL EFFECTS

OF

Frost, Snow, Ice, and Cold,

IN ENGLAND,

AND IN DIFFERENT PARTS OF THE WORLD;

INTERSPERSED

WITH VARIOUS AMUSING ANECDOTES.

TO WHICH IS ADDED,

THE ART OF SKATING.

A *dreadful winter* came; *each day* severe,
Misty when mild, and *icy-cold* when clear.
CRABBE.

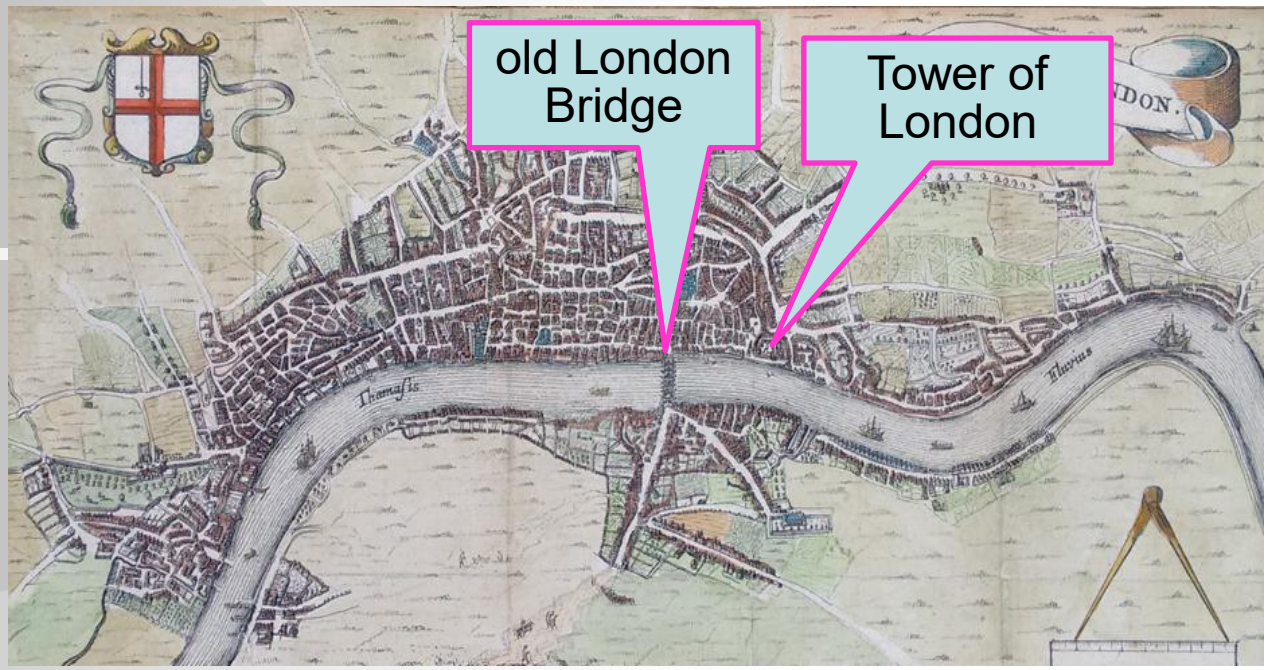
London:

Printed and published on the ICE on the River *Thames*,
February 5, 1814, by G. DAVIS.

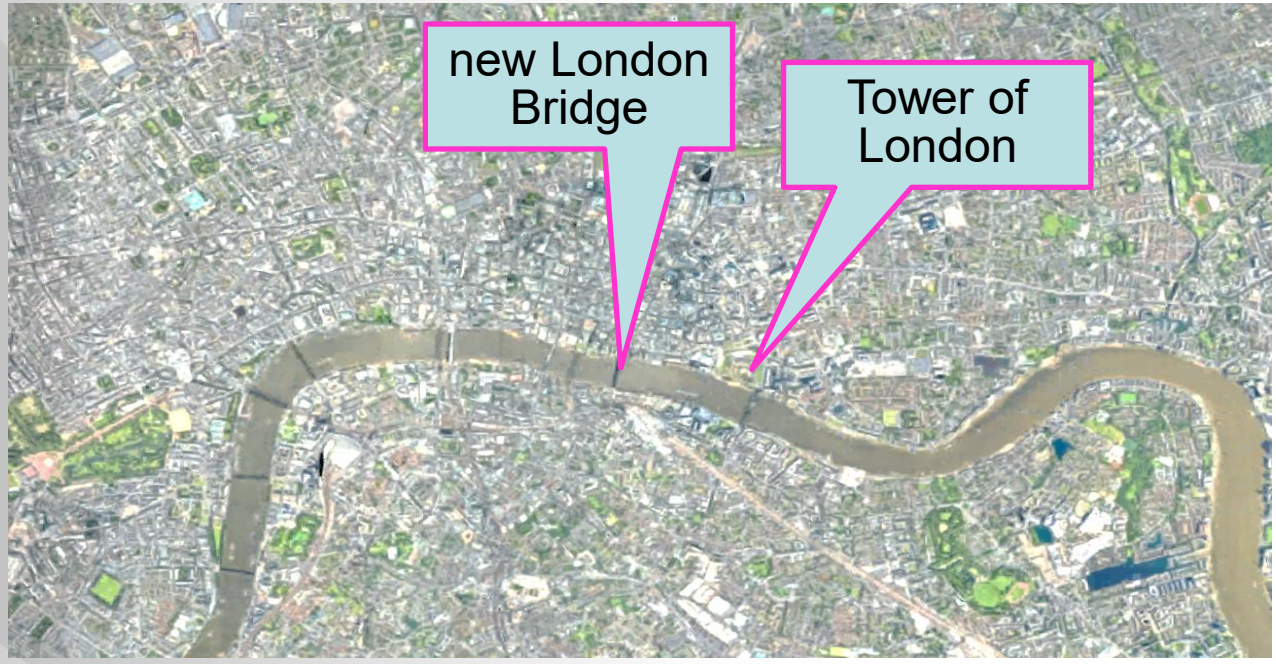
Sold also by Sherwood, Neely, and Jones, Paternoster Row.

The Thames in London

- Rutger Hermannides 1661 map of London, from *Britannia Magna*.

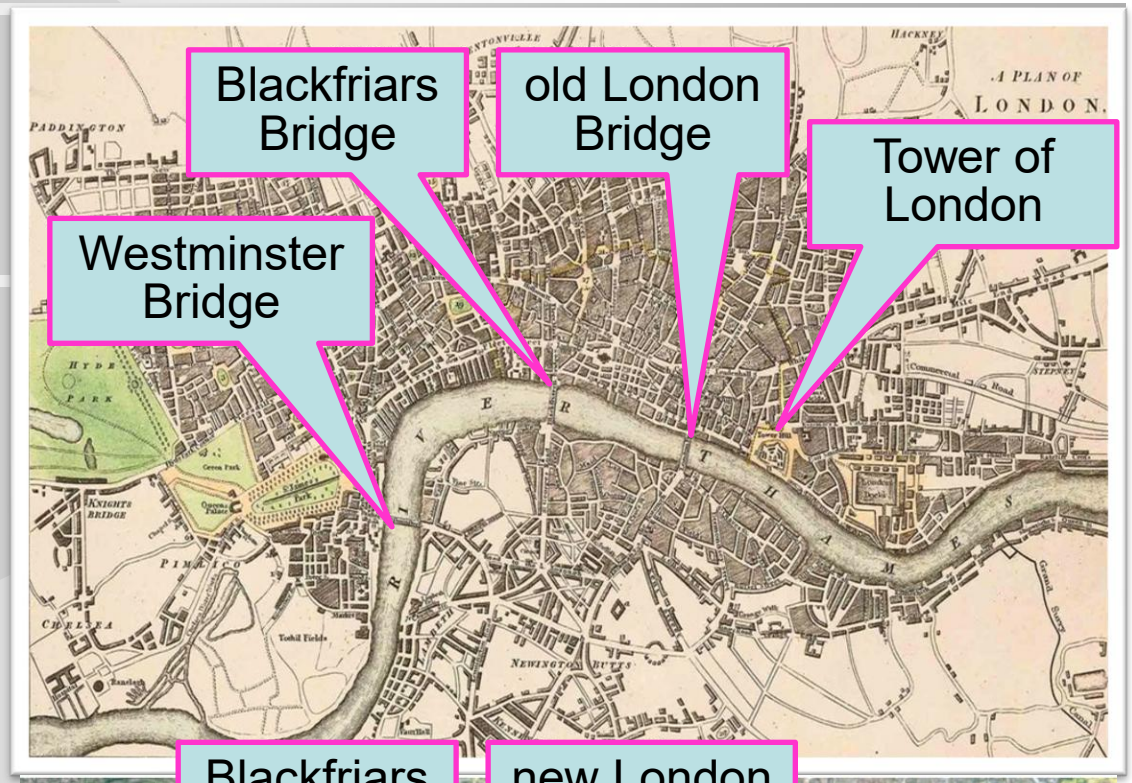


- Google Maps satellite image 2018

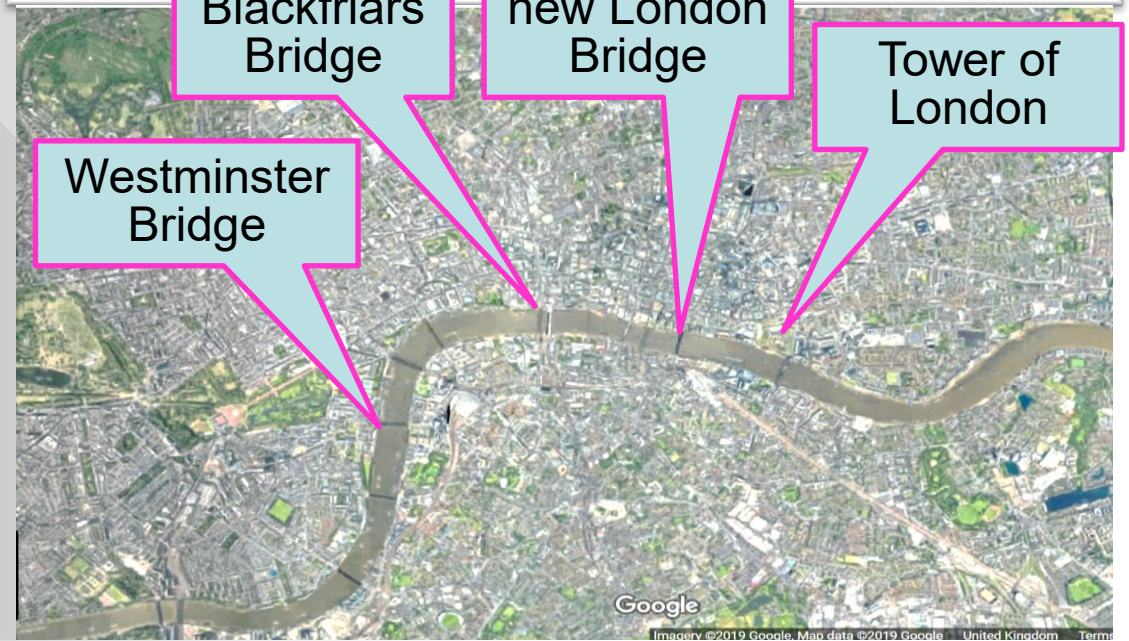


The Thames in London

- "A Plan of the Cities of London and Westminster, and borough of Southwark", 1746



- Google Maps Satellite Image 2018



The Thames in old London

- Claude de Jongh (1615–1663), “Old London Bridge from the West”

Compared to today, in the 18th century the Thames in London was:

- wider
- shallower
- slower
- much, much smellier (in truth a highly polluted open sewer)
- tidal but with smaller reach than the 7m it has now
- easily blocked at the narrow arches of old London Bridge with its weir and 4 large mill wheels

- Freezing of Thames in London was a pile-up of ice floes caught by the narrow arches of London Bridge
- Ice constantly moved and cracked by tides
- Not at all like the smooth, uniformly-thick ice that formed on the non-tidal Thames at Windsor in 1963 (that you could ride a bike on)

- Jan Griffier “The Thames during the Great Frost of 1739”

- Abraham Hondius, “The Frozen Thames, 1677”

Note Southwark Cathedral is to the right (at the south end of London Bridge): we are looking East, so this is dawn not dusk and we are looking at the revellers still there from the night before

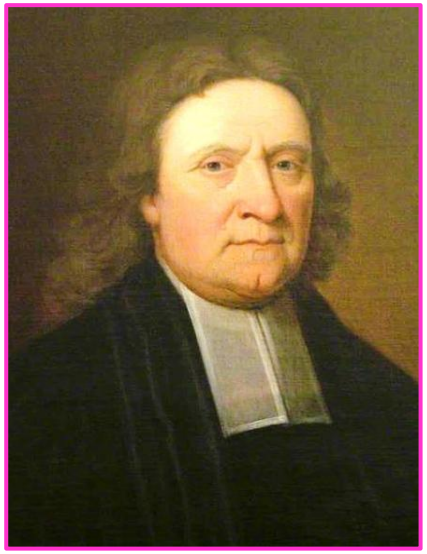
Central England Temperature (CET)

- Manley (1953,1974) Parker et al (1992)
- Monthly 1659 to present
- Maintained by the MO

- Longest instrumental temperature record in the world
- Rural areas (avoids “urban heat islands”)
- Representative of a roughly triangular area between Bristol, Lancashire & London

William Derham (1656 – 1742)

(painting by George White)

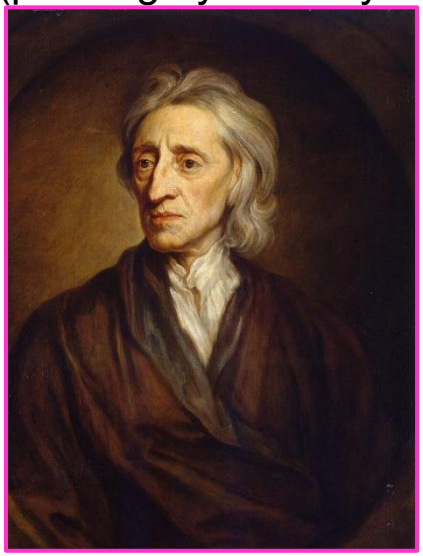


- Rector at Upminster, Essex and Canon of Windsor
- A fine scientist and science writer, elected Fellow of the royal Society in 1703
- Measured the speed of sound in 1709
- His temperature measurements from Upminster are a key early part of the Central England Temperature record (1645-today)

- Observed aurora between 1707 and 1728
- In Upminster (Essex), Chelsea, Oxford, Somerset, Staffordshire, Wiltshire and Windsor, Redbridge and Southampton

John Locke(1632 – 1704)

(painting by Godfrey Kneller)

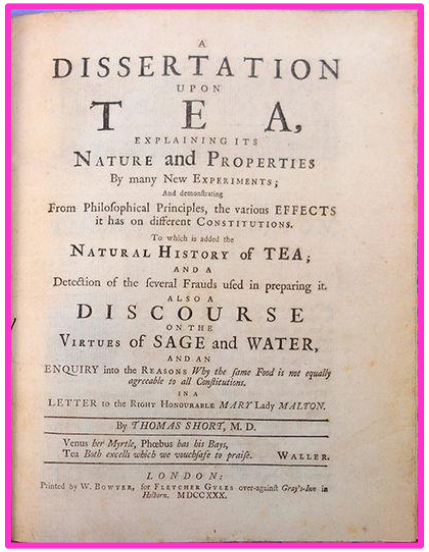


- English philosopher and physician, widely regarded as one of the most influential of Enlightenment thinkers and commonly known as the "Father of Liberalism"

- A leading thinker on empirical science, elected Fellow of the Royal Society in 1668

- His temperature measurements from Oxford (1666/7), London (1668-1692) and Ongar (Essex, 1692-1703) contributed to the CET

Thomas Short(c.1690 – 1772)



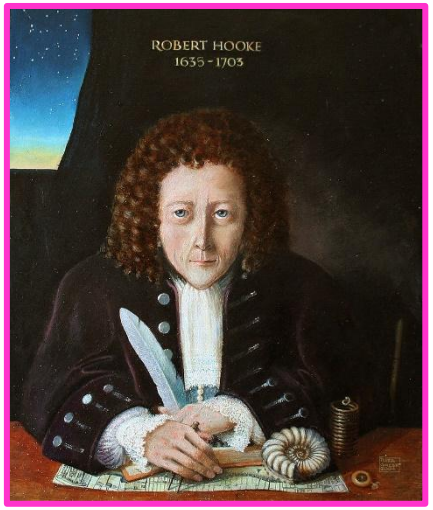
A
DISSERTATION
UPON
TEA,
EXPLAINING ITS
NATURE and PROPERTIES
By many New EXPERIMENTS;
And demonstrating
From Philosophical Principles, the various EFFECTS it has on different CONSTITUTIONS.
To which is added the
NATURAL HISTORY of TEA;
AND A
Detection of the several Frauds used in preparing it.
ALSO A
DISCOURSE
ON THE
VIRTUES of SAGE and WATER,
AND AN
ENQUIRY into the REASONS *Why the same Food is not equally agreeable to all Constitutions.*
IN A
LETTER to the RIGHT HONOURABLE *MARY* Lady *MALTON.*
By *THOMAS SHORT*, M. D.
Venus her *Myrtle*, Phœbus has his *Bays*,
Tea *Both excells which we vouchsafe to praise.* WALLER.
LONDON:
Printed by W. BOWYER, for FLETCHER GYLES over-against *Gray's-Inn* in *Holborn.* MDCCXXX.

- Scottish physician and scientist who settled in Sheffield
- Developed and published a treatment for dysentery, with William Steele

- Very interested in the medicinal properties of tea and other fluids
- His temperature measurements from Sheffield (1734-1756) contributed to the CET

Robert Hooke(1635–1705)

(reconstructed portrait by Rita Greer, 2004)



- Scientist, experimenter
- Worked for Robert Boyle and later ”curator of experiments” for the Royal Society, a post he held from 1662: and so arguably the world’s first paid scientist
- Architect – very important to the reconstruction of London after the great fire
- Hooke’s law: stress proportional to strain up to elastic limit
- Experiments on gravity led to acrimony with Isaac Newton, who had all his works and portraits destroyed
- Developed the Royal Society standard thermometer and observed temperature in London

Thomas Hughes(1692–1768)

(there is no known portrait of him)

- A doctor and surgeon practicing in Stroud, Gloucester
- A careful amateur meteorologist and recorder of natural phenomena
- His diary contains quantitative records of rainfall and temperature –the latter being a major contribution to the Central England Temperature record

- Reported aurora on 70 nights between 1771 and 1805
- In Stroud

“ …. et al. …..”

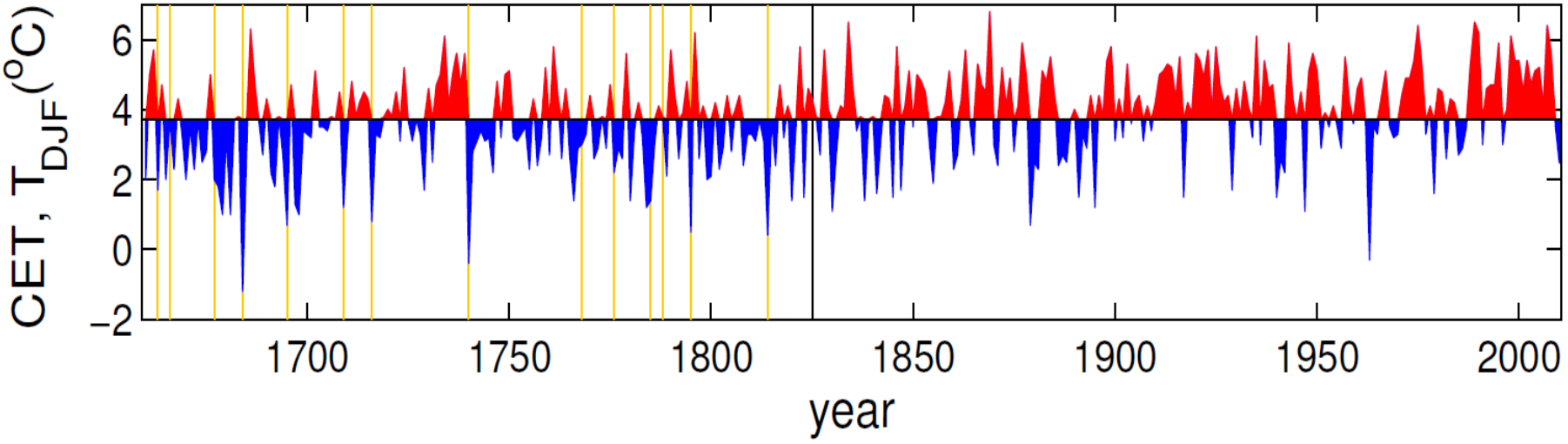
(Radcliffe Observatory, Oxford)

- Francis Hawksbee (London 1724–1729)
- James Jurin (London 1728–1750),
- Thomas Barker (Lyndon, Rutland 1736–1798),
- George Lynn (Southwick, Northamptonshire 1726–1740
- John Dalton (Kendall, Manchester, 1766-1844)
- Luke Howard (Plaistow, Tottenham and Stratford 1806–1830)
- the Radcliffe Observatory (Oxford from 1815 to date)

Central England Temperature (CET)

Winter Means (DJF)

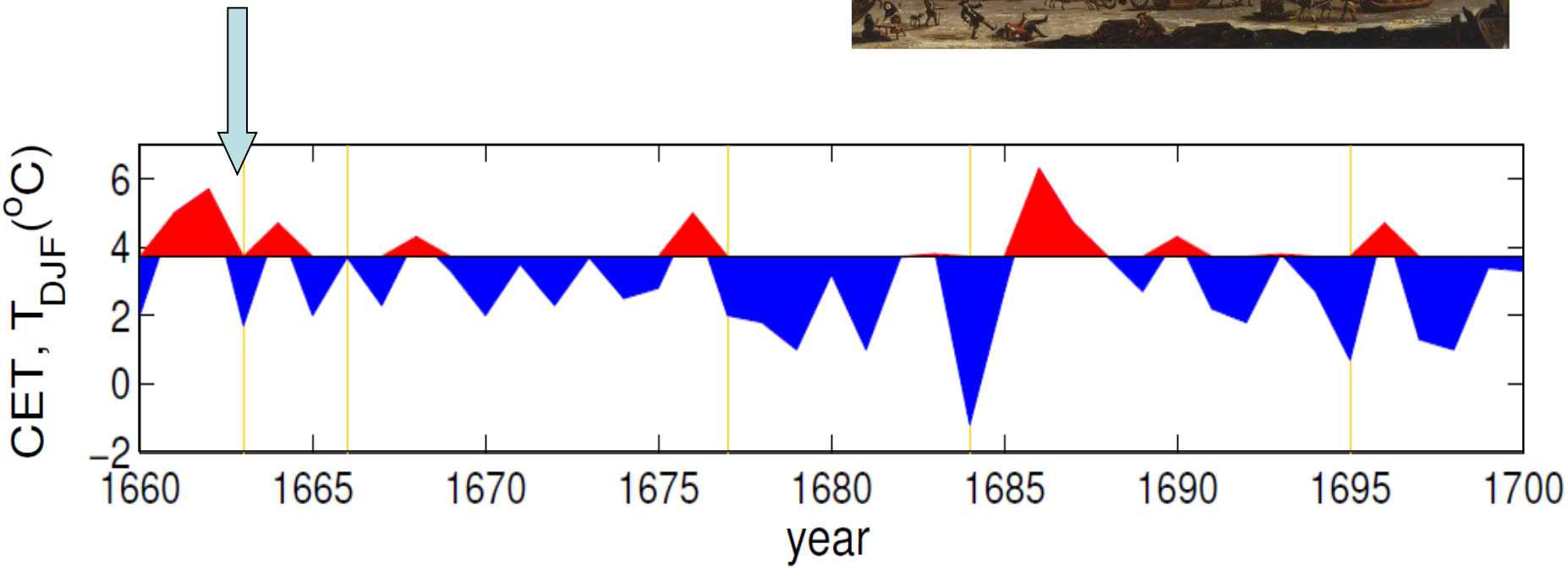
- show upward drift
- (linear) rate of rise $dT_{ann}/dt = 0.37\ ^{\circ}C\ c^{-1}$



Frost Fairs on the Thames

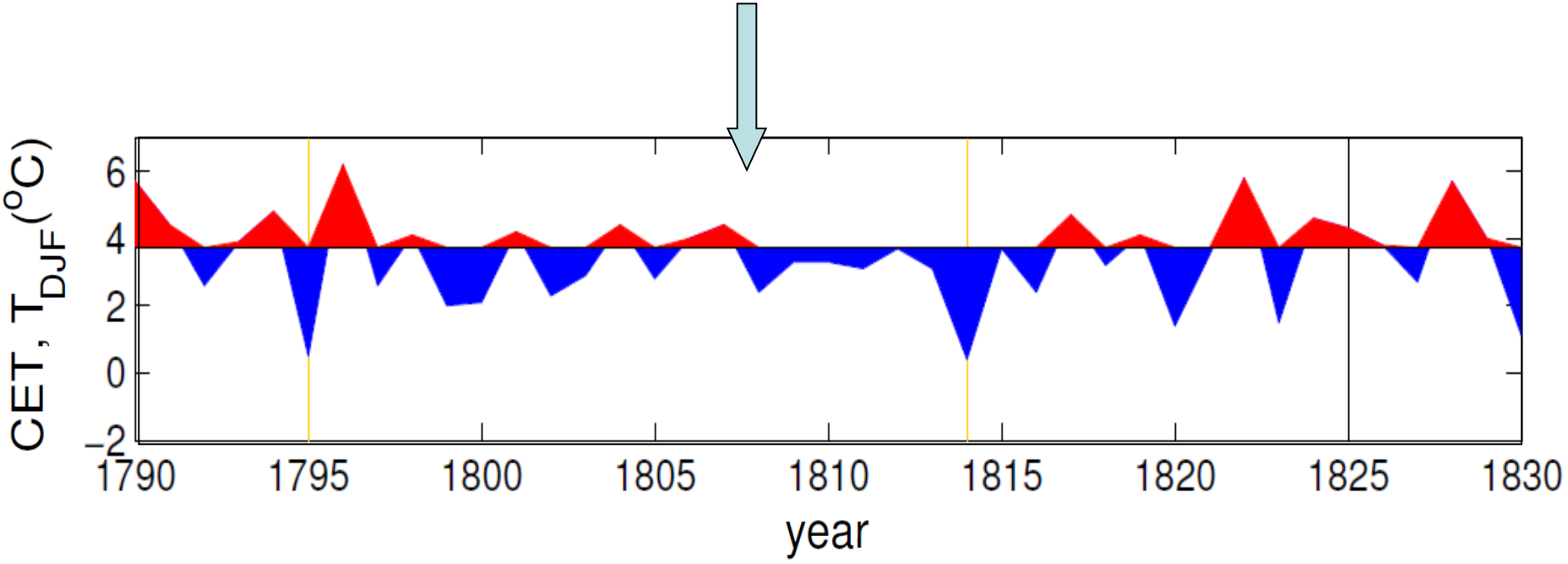
- e.g. Winter 1683/4.

- N.B. notice how warm the next year was!



Frost Fairs on the Thames

- The last one was 1813/14. Painted by Luke Clenell (1781 – 1840)



London Bridge

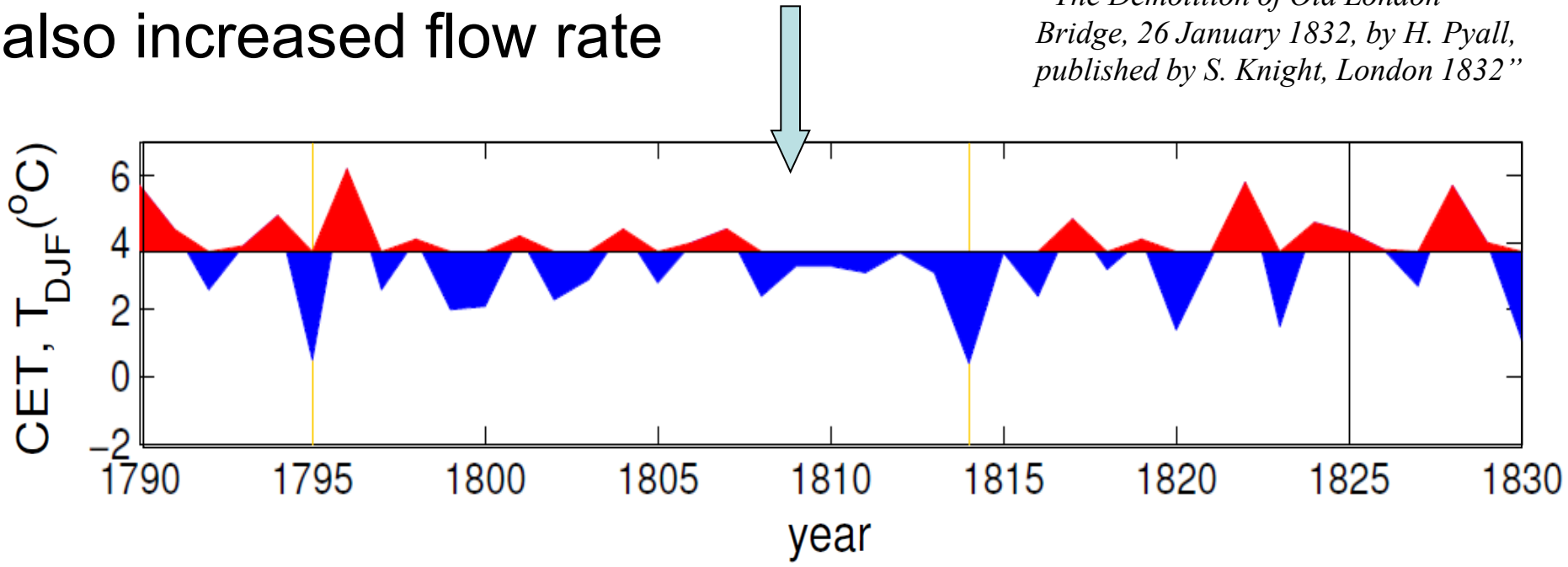
Samuel Scott
(1753) "*(Old) London Bridge*"

- Note the white water down-stream: Old London Bridge acted as a weir

London Bridge

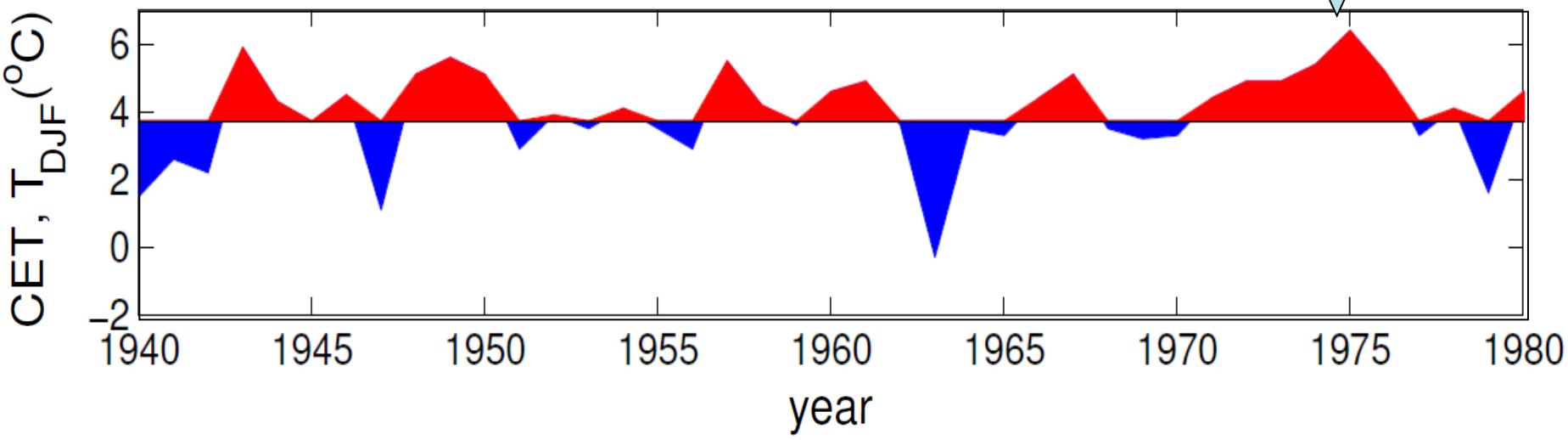
- in 1831/2 old London Bridge demolished: it had acted as a salt water barrage, and a wier and its narrow arches were often and easily blocked
- later the embankments also increased flow rate

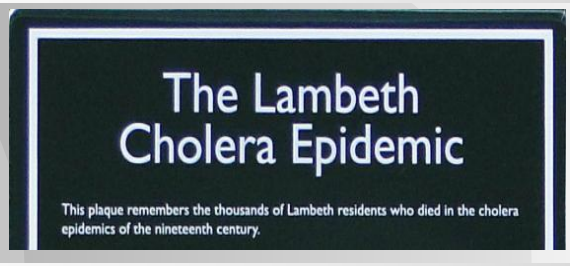
"The Demolition of Old London Bridge, 26 January 1832, by H. Pyall, published by S. Knight, London 1832"



Thames Freezing Over

- 1963 Thames at Windsor





The Thames Embankments

- Westminster without the Victoria embankment (opened 1870 at a cost of £1.26m = £142m at today's prices)
- The embankments were urgently needed as sewers to clean up the river. The Lambeth Cholera Epidemic of 1848-49 killed at least 2,000 people (from dipping buckets into the river there for drinking water). But only after "the Great Stink" in July and August 1858, were the demands that something be done listened to
- Victoria embankment was in place in 1900-1901 when Monet moved to London during the Franco-Prussian War

The Thames Embankments

- Canaletto (1751) "*Chelsea from the Thames at Battersea Reach*"

- Westminster without the Chelsea embankment (opened 1874)

- Frederick Brown (1883) "*An impromptu dance - a scene on the Chelsea Embankment* "

- Canaletto (1746) "*Westminster Bridge on Lord Mayor's Day*"

- Canaletto (1746) “The Thames and the City of London from Richmond House”

- detail of the South Bank reveals beaches and a series of breakwaters and small landing piers which would slow the river flow

The Thames Embankments

- Not having fun: river police training

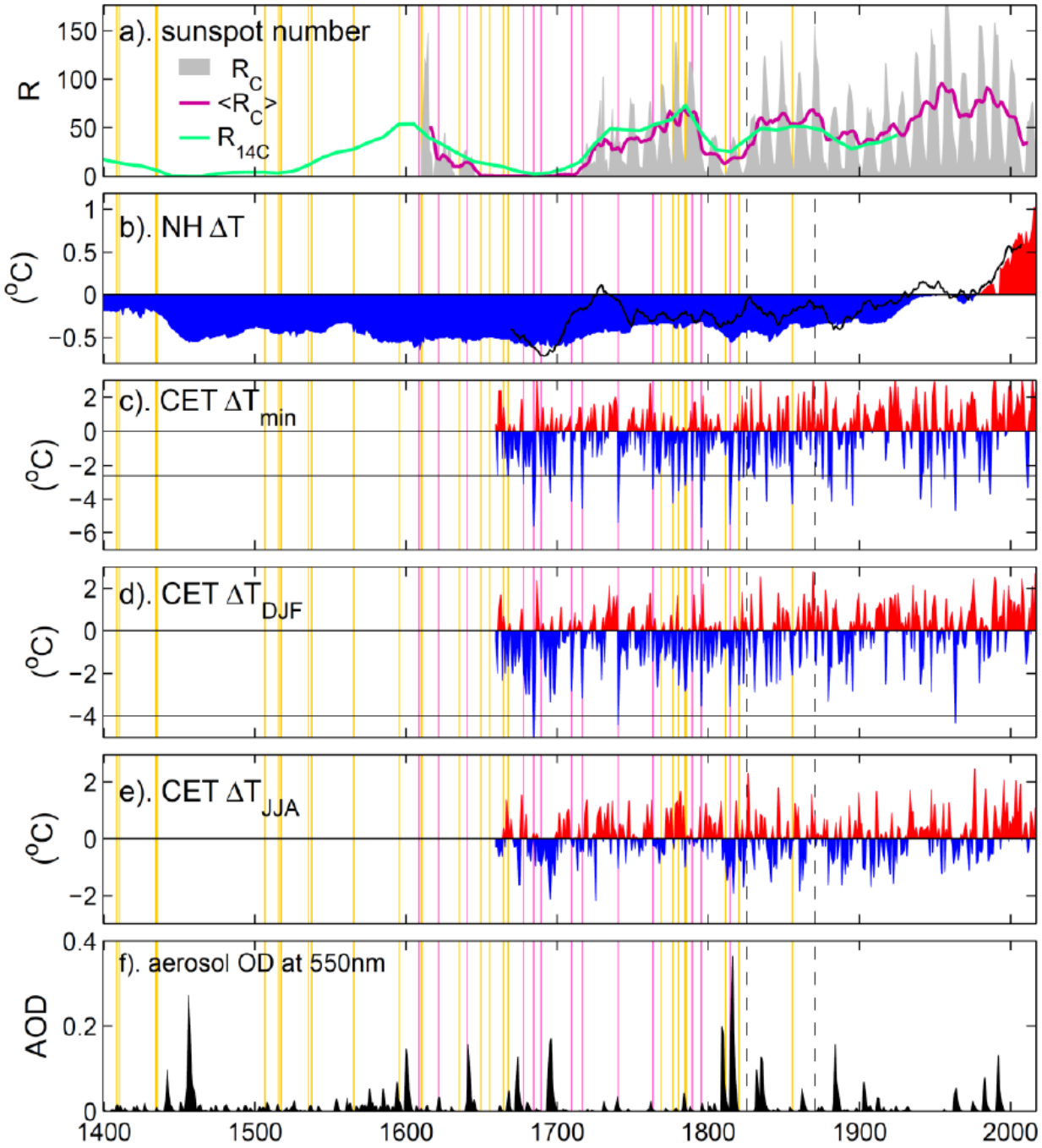
- Having fun: swimming, strolling and sitting on the new south bank embankments (note the Yablochkov candles still there today installed from1878 when the Victoria Embankment became the first street in Britain to be permanently lit by electricity).

The Thames Embankments

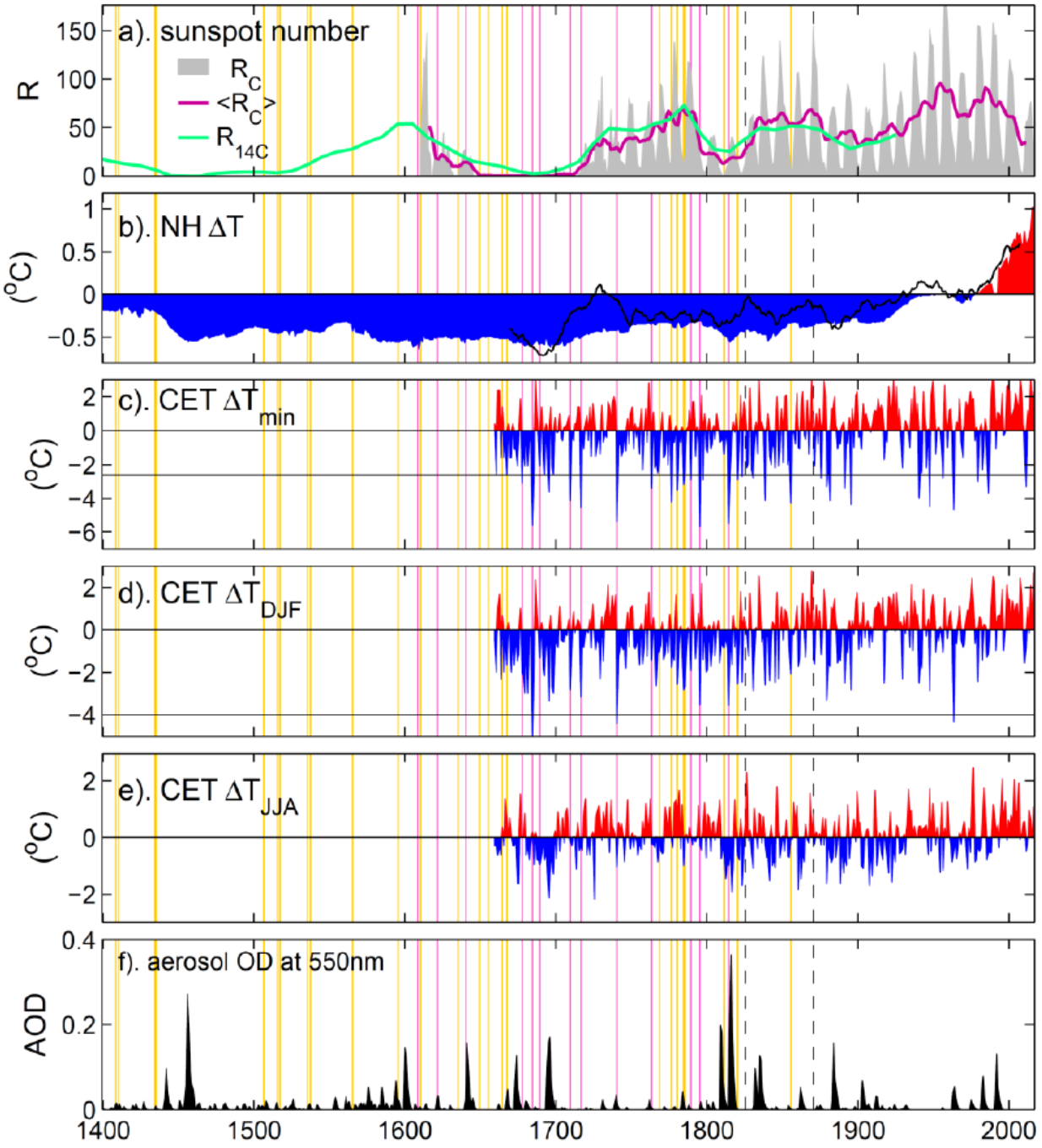
- the south bank embankment as a hospital ward. TB patients from St. Thomas' Hospital get some "fresh" air, May 1936

Thames Freezing Over

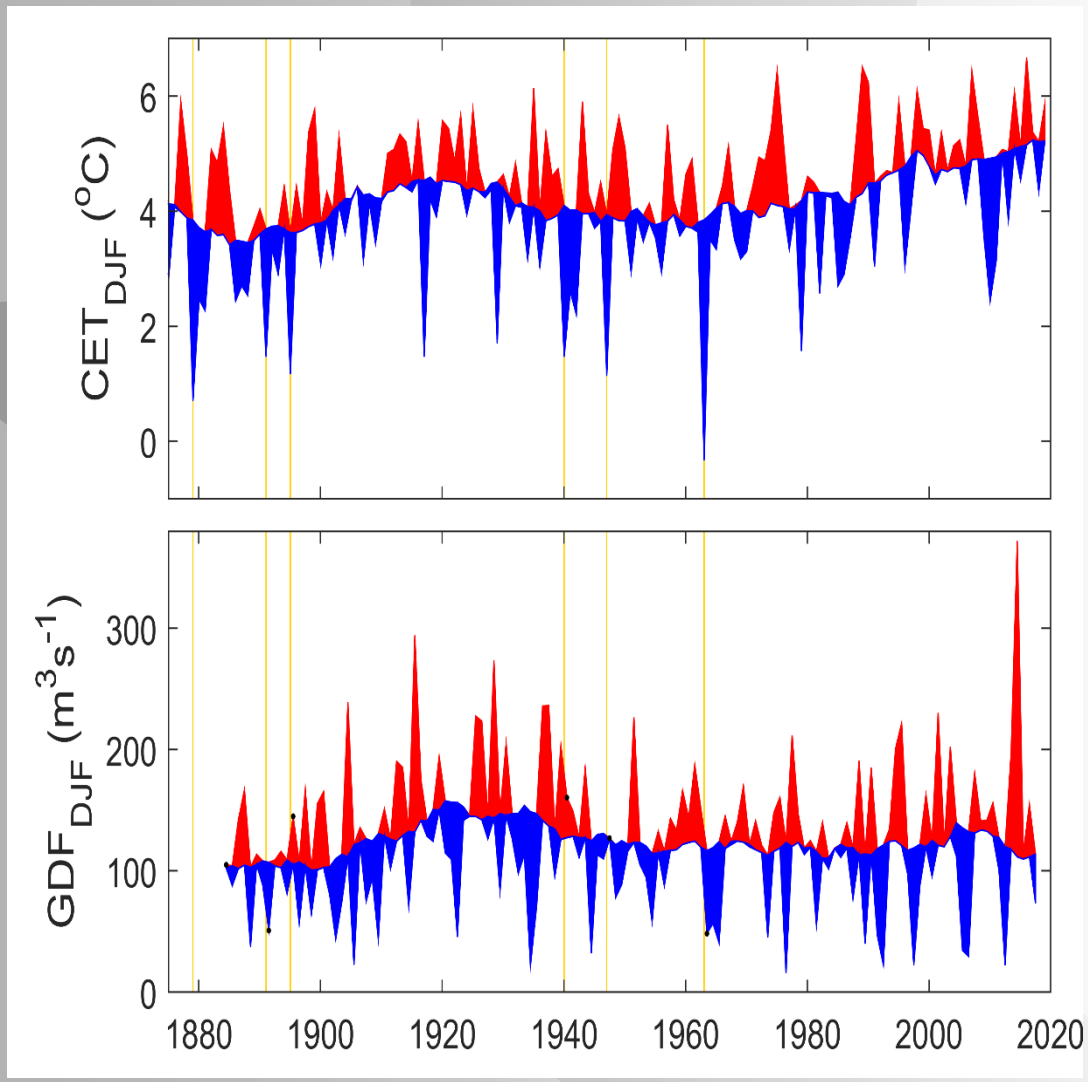
- Orange lines are dates when the Thames in London froze hard enough for people to walk on it
- Mauve lines are dates of full frost fairs



- Sunspots
- North hemisphere temperature, ΔT_{NH}
- Annual mean CET
- Winter CET
- Summer CET
- Volcanic aerosols

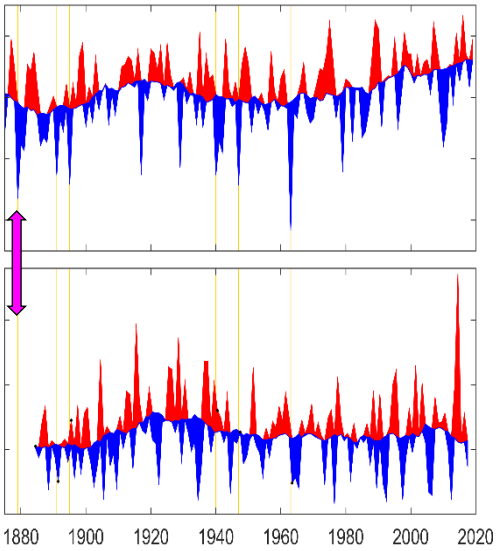


After the riverine improvements, when did the Thames freeze?



- average December-January-February CET
- orange lines are known freeze years in (enough for skating) between Oxford and Teddington (1880, 1891, 1895, 1940, 1947, and 1963)
- Average Gauge Daily Flow (GDF) for D-J-F measured at/near Teddington lock

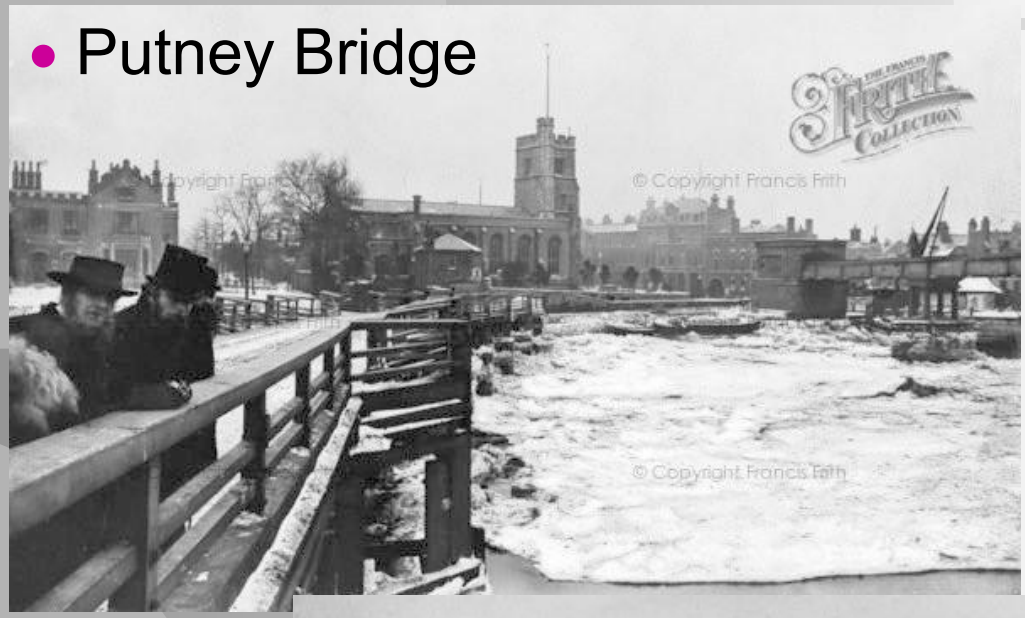
Winter of 1880-81

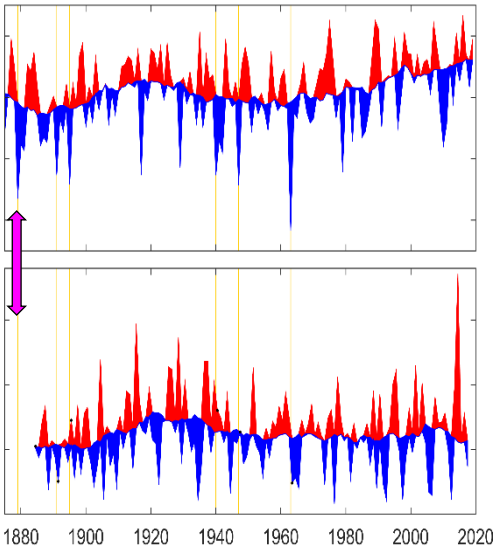


- Gathering on the frozen river at Twickenham, 1881

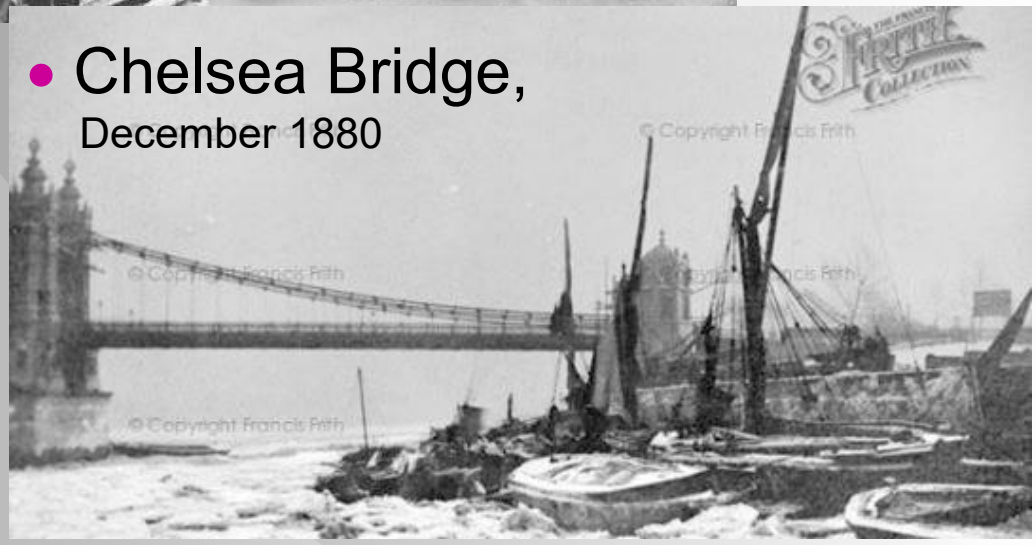
Winter of 1880-81

- Putney Bridge

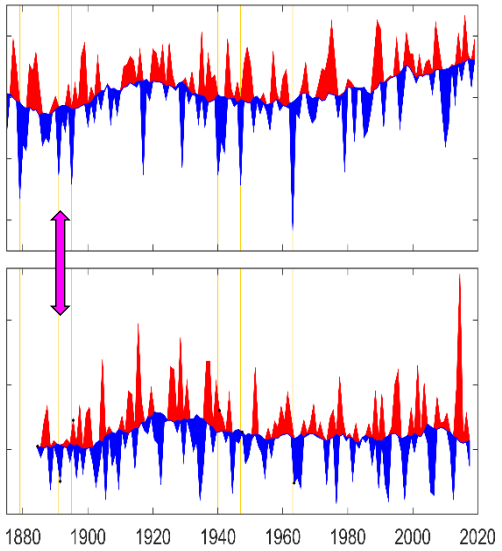




- Chelsea Bridge,
  December 1880

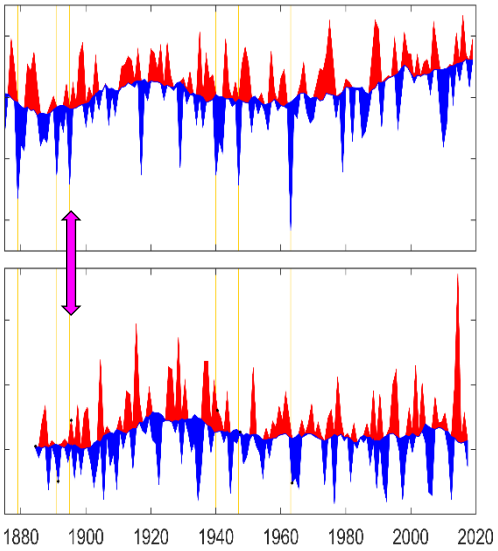


Winter of 1890-91



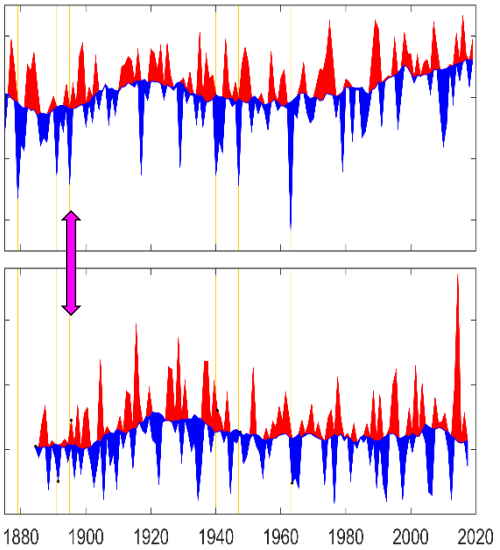
- Ice yachting at Henley on Thames

Winter of 1894-95



- Policemen Skating on the Thames, c.1900 (probably 1895)

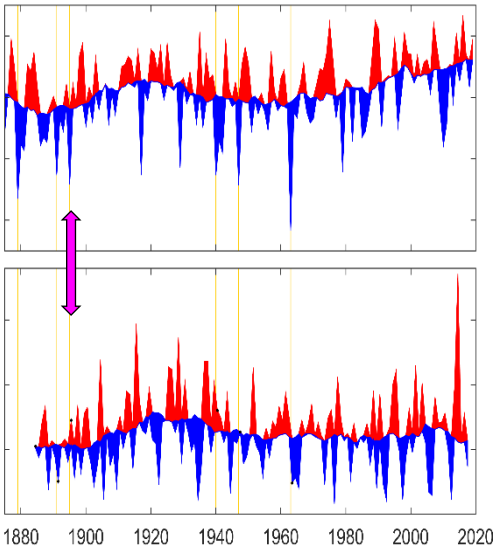
Winter of 1894-95



- Christmas Day, 1894 at (top) Oxford and is it Abingdon?

Winter of 1894-95

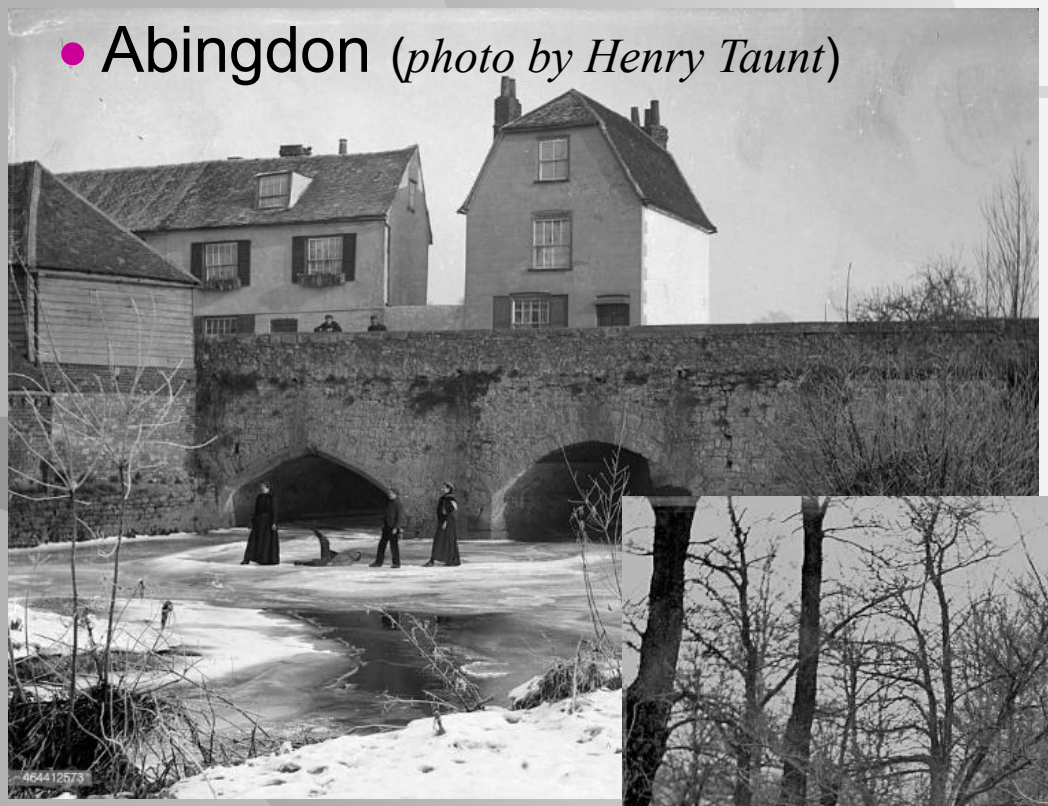
- Floes at Tower Bridge

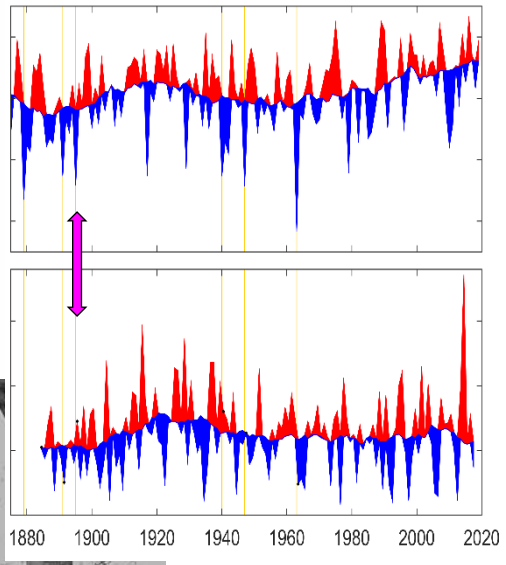


- skaters at Henley

Winter of 1894-95

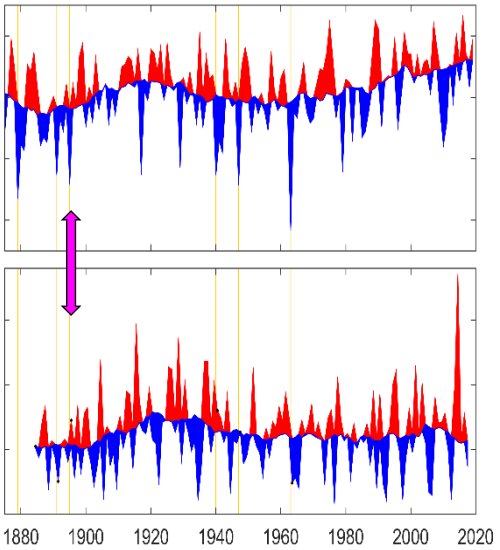
- Abingdon (*photo by Henry Taunt*)





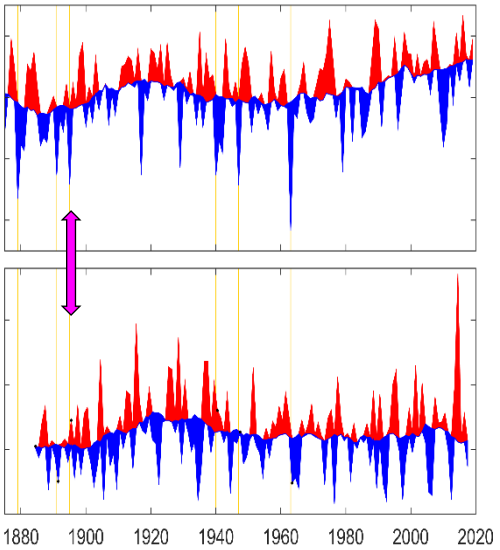
- Abingdon “on a Thames tributary” (the Ock?)

Winter of 1894-95



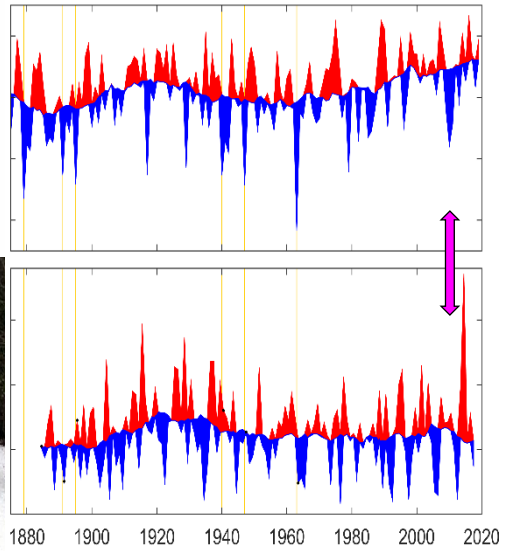
- Horse-drawn carriage on the ice, Oxford February 1895 *(photo by Henry Taunt)*

Winter of 1894-95



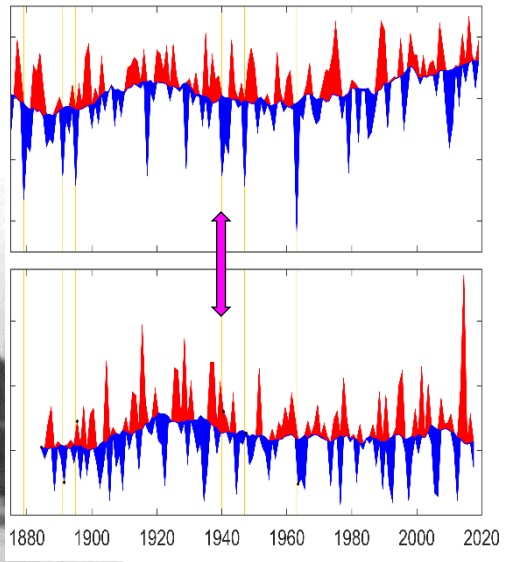
- Horse-drawn carriage on the ice, Oxford February 1895

Winter of 2010-11



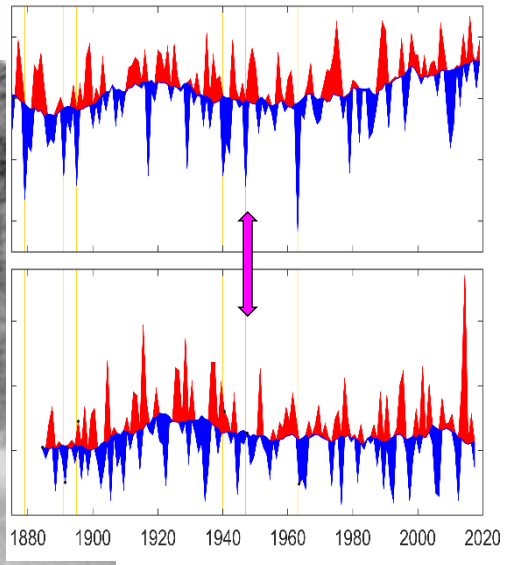
- An "accident" Grand Union Canal, West Lothian

Winter of 1939-40



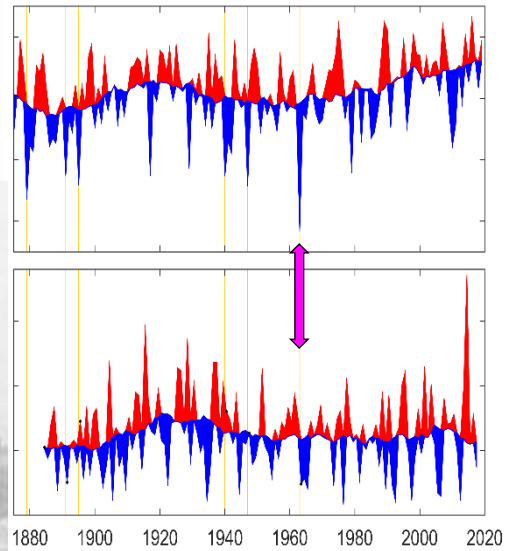
- January 1940, a tug icebreaker at Sunbury

Winter of 1946-47



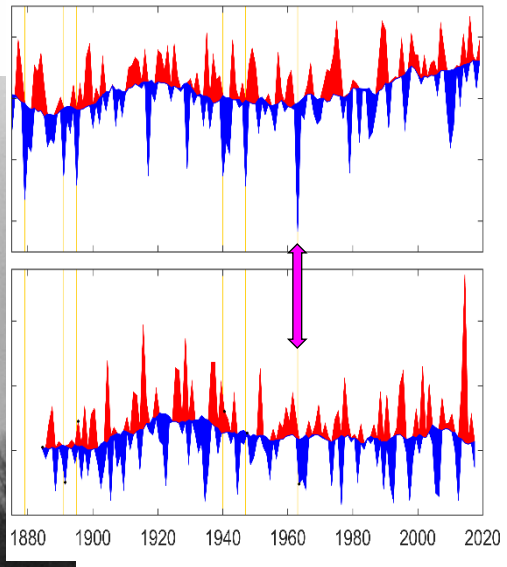
- 27 February 1947, Man walks up the Thames near Kew

Winter of 1962-63



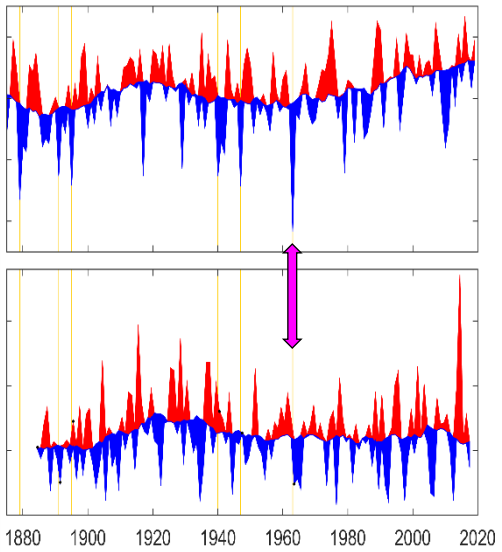
- David Joel cycles to work along the Thames at Windsor

Winter of 1962-63



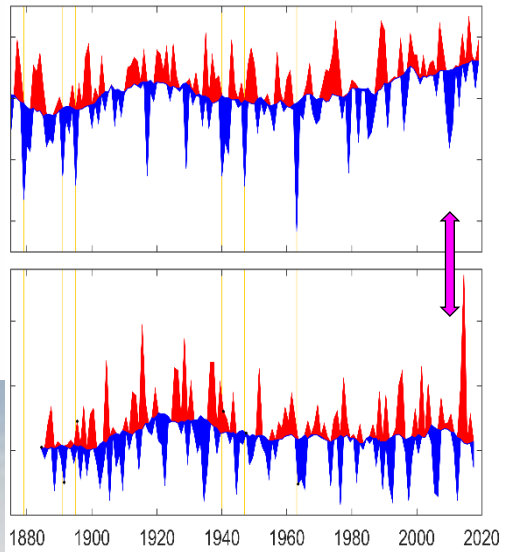
- cyclists on the river at Abingdon

Winter of 1962-63



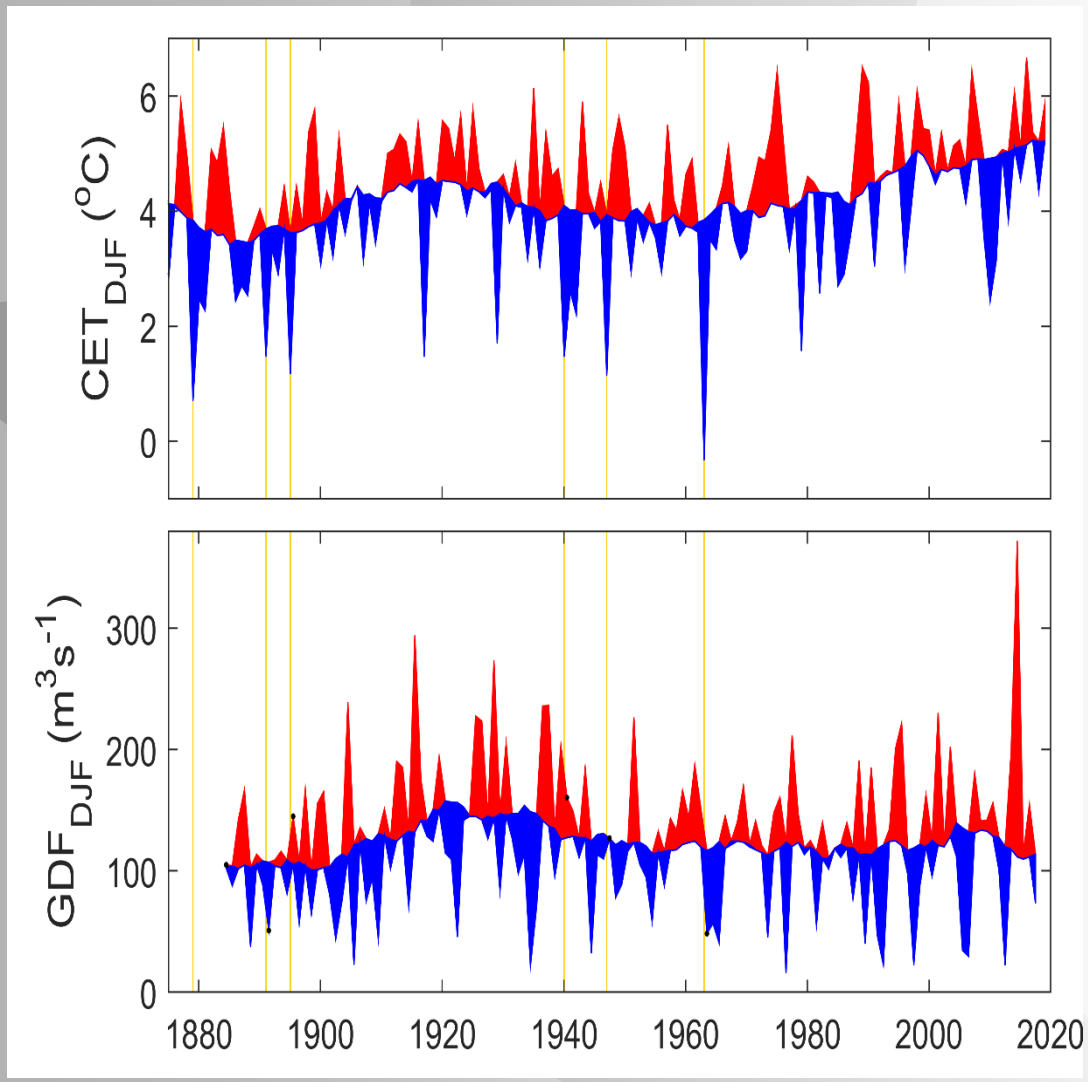
- Party on the Thames, Shepperton

Winter of 2010-11



- Thames at Tower Bridge

Is the loss of Thames freeze events a sign of climate change?



- separating climate change from natural variability is always difficult
- ….but "detection attribution" analysis using climate models gives the answer "yes"
- Karoly, D.J. & Stott, P.A. (2006), Anthro-pogenic warming of Central England Temperature, *Atmosph. Sci. Lett.*, **7**: 81-85. doi:10.1002/asl.136

- The first ever specific winter landscape painting:

  Pieter Brueghel the Elder: “Hunters in the Snow” (1565)

SAINT ANSELM ABBEY

(& college, in Manchester)

- Saint Anselm of Canterbury (1033—1109)
- Monk and Philosopher
- “things were harmful in proportion to the number of senses which they delighted”

such religious doctrine meant that artists were not painting to delight - or even record – they were painting to inspire piety

- Giotto (c.1267-1337) was one of the first Western painters to depict realistic human gestures and expressions – but did not worry about surroundings or landscapes
- Ambrogio Lorenzetti in his Sienna frescoes and in his “Effects of Good Government in the City and Countryside” (1337-39) is the first western painter to really paint landscapes
- But winter was still to be survived and feared – not celebrated. Only in Books of Hours and prayer books did miniature paintings appear, usually in relation to a calendar. This is one is for February and is attributed to Paul Limbourg (and his brothers) (painted between 1412 and 1416)

A Dynasty of Dutch Masters

- Pieter Bruegel (also Brueghel) the Elder
- born c. 1525-1530, died 9 September 1569
- A radical innovator for combining landscapes and peasant scenes
- Also painted winter scenes which had been deemed an ugly, dangerous season unworthy of art
- Lived in Antwerp and Brussels
- In 1552 he made a pilgrimage to Rome and travelled throughout Italy

"The Painter and the Buyer" (1565) - possibly a self portrait

A Dynasty of Dutch Masters

- Jan Bruegel (also Brueghel) the Elder
- 1568 – 13 January 1625
- Was just 1 year old when his father Pieter Bruegel the Elder died
- Became famous for paintings of flowers and his grotesque “hell paintings” but also re-worked his father’s paintings

Jan Breughel with his second wife and their eldest children, painted by Rubens

A Dynasty of Dutch Masters

- Pieter Brueghel the Younger
- born 1564 died 1638
- His father Pieter Brueghel the Elder died when he was 5
- after the death of their mother in 1578, Jan and Pieter lived with their widowed grandmother Mayken Verhulst, who taught them drawing and painting and a reverence for their father.
- She also gave Pieter all his father's sketches and notes and he is famous for the painting he made from them

Pieter Brueghel the Younger drawn by Anthony van Dyck

Often used to say/imply that Europe was unremittingly cold during the “Little Ice Age”

Hunters in the Snow

- Is not a Painting of Antwerp!
- Almost certainly painted from memory of when he crossed the Alps travelling to Italy
- Painted in 1565 – the same winter that Elizabeth 1 walked on the Thames
- One of 12 paintings commissioned in 1565, by a wealthy patron in Antwerp, Niclaes Jonghelinck, who asked him to paint a series of paintings of each month of the year
- Did he paint all 12 ? 6 are known and 5 survive
- Hunters in the Snow is the painting for January and is now often used to imply unremitting cold in Europe
- None of the other surviving 4 show a winter scene

The other surviving works

- ”The Harvesters”
- The painting for August
- A hot summers day, again not Antwerp, probably painted from memories of Tuscanny

Pieter Brueghel the Elder: “The Harvesters” (1565)

The other surviving works

- ”The Gloomy Day”
- The painting for February
- Gloomy, yes, but not snow-bound and again not Antwerp

Pieter Brueghel the Elder: “The Gloomy Day” (1565)

The other surviving works

- ”The Return of the Herd”
- Probably the painting for November
- Gloomy, a bit, but not snow-bound and again, not Antwerp

Pieter Brueghel the Elder: “The Return of the Herd” (1565)

The other surviving works

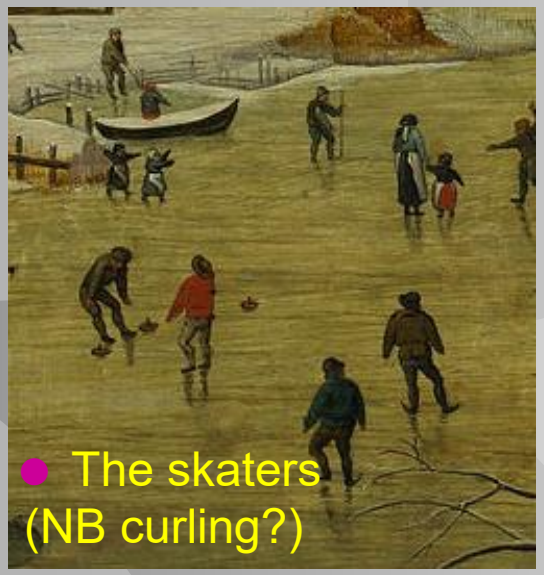
- ”The Hay Harvest”
- the painting for June/July
- Hot and again, not Antwerp

Pieter Brueghel the Elder: “The Hay Harvest”

Another winter scene by Brueghel the Elder (also painted in 1565)

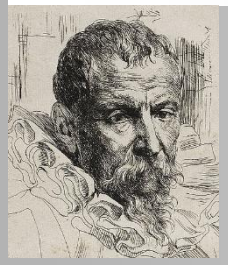
Pieter Brueghel the Elder "Winter Landscape with skaters and Bird Trap" (1565)

“Winter Landscape with …. Skaters ..... and Bird Trap” (?)



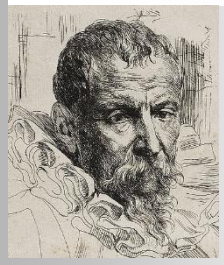
- The skaters (NB curling?)

- The Bird Trap



Pouncing

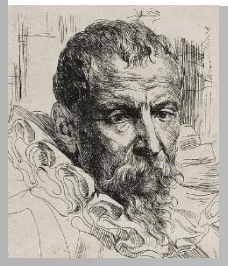
- Pieter Brueghel the Younger copied many of his father's paintings and sketches using a technique called "pouncing"
- A from of tracing using a semi-transparent paper and tracing along the lines of the image by making pinholes on the top sheet of paper. This is then laid on a new canvas and a powder such as chalk, graphite or pastel is forced through the holes to leave an outline on the working surface below
- One of the most frequently copied works of his father was the "Winter Landscape with Skaters and a Bird-trap". This work was reproduced by Pieter Brueghel the Younger at least 47 times and the workshop he set up made 271 known copies!



Pieter Brueghel the Younger

- Pieter Brueghel the Younger was brought up to revere his dead father
- It is known his paintings were very often based on his father's sketches (now mainly lost)
- It is quite possible this was from a sketch made by his father in 1565

Pieter Brueghel the Younger "Four Seasons: Winter" (date unknown)



…. and Brueghel the Younger's other 3 seasons are snow-free

A few other snow scenes from the low countries

Joos de Momper the Younger, ‘Winter’ (c1610)

Jacob Grimmer, ‘winter’ (1595)

Jan Abrahamsz Beerstraten ‘The Castle of Muiden in Winter ‘ (1658)

Lucas van Valckenburg ‘Winter landscape near Antwerp with snowfall‘ (1575)

Hendrick Avercamp ‘Winter Scene on a Frozen Canal’ (c.1620)

Sebastiaen Vrancx ‘Winter pleasures‘(1600)

Aert van der Neer, ‘View of River in Winter ‘(1660)

My favourite from the “Antwerp school”

Jacob Grimmer, ‘Winter Landscape with people skating on a frozen river and hunters in the foreground’ (c 1580,before 1590)

Art is never all it seems!

- The history of the young orphaned Breughel boys suggests that many of their winter paintings map back to their fathers sketches made in the winter of 1564 – the year Elizabeth I is said to have practiced archery, on the frozen Thames
- After ‘Hunters in the snow’ (1565), painters from the low countries (and Antwerp in particular) such as the Breughel sons, Jacob Grimmer, Aert can der Neer, Hendrick Avercamp (above), Sebastiaen Vrancx, Jan Abrahamsz Beerstraten, Jacob van Ruisdael, Lucas van Valckenburg, Joos de Momper the Younger all started painting winter landscapes. There is an element of artistic fashion here: it may even be that they were painting cold winters because they were quite rare, as opposed to the modern interpretation that they were common

- In 1658, King Charles X Gustav of Sweden and his engineer Erik Jönsson Dahlbergh led the Swedish army over the frozen straits from Germany to Denmark
- crossed near the modern Great Belt Fixed Link, East Bridge (above)
- Led to Treaty of Roskilde in which king Frederick handed over Denmark's entire eastern half to Sweden

Johan Philip Lenke: "The Swedes crossing the ice over to Zealand in 1658."

Do I “believe” in the “theory” of climate change?

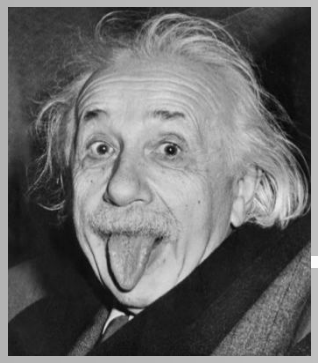
- Well yes! – just like I believe in the theory of gravity
- “believe” to a scientist means it has predictive power
- “theory” to a scientist means a collection of ideas and mathematical equations that can be used to make quantitative predictions that can be tested

♣ Some theories do not fit the observations - they are wrong

♦ Some theories fit most of the observations but break down in extreme conditions (e.g. Newton’s theory of gravity)

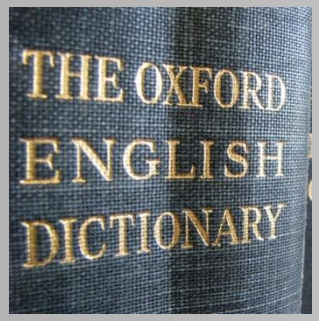
♠ Some theories are unnecessarily complex most of the time but are needed in extreme conditions (e.g. Einstein’s theory of relativity)

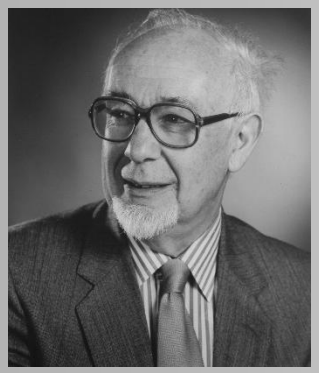
♥ Some theories are counter intuitive but fit everything that we know (e.g., quantum mechanics)



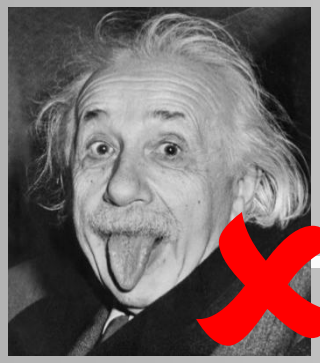
Science

/ˈsʌɪəns/
(noun)





- Cambridge Dictionary: “(knowledge from) the careful study of the structure & behaviour of the physical world, especially by watching, measuring, and doing experiments, and the development of theories to describe the results of these activities”
- Wikipedia: “(from Latin *scientia*, meaning knowledge) is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe.”
- OED: “A systematically organized body of knowledge on a particular subject.”
- John Michael Ziman (1925-2005): “….′consensibility′, leading to **consensus**, is the touchstone of reliable knowledge”



Science Consensus

/saɪəns kən ˈsɛnsəs/
(compound noun)

- Wikipedia: “the collective judgment, position, and opinion of the community of scientists in a particular field of study. Consensus implies general agreement, though not necessarily unanimity”

The solar science community at the STEREO-3/SOHO-22 Workshop: “Three Eyes on the Sun: Multi-spacecraft studies of the corona and impacts on the heliosphere” Bournemouth, UK April/May 2009

Climate change: there IS an overwhelming scientific consensus

OPEN ACCESS

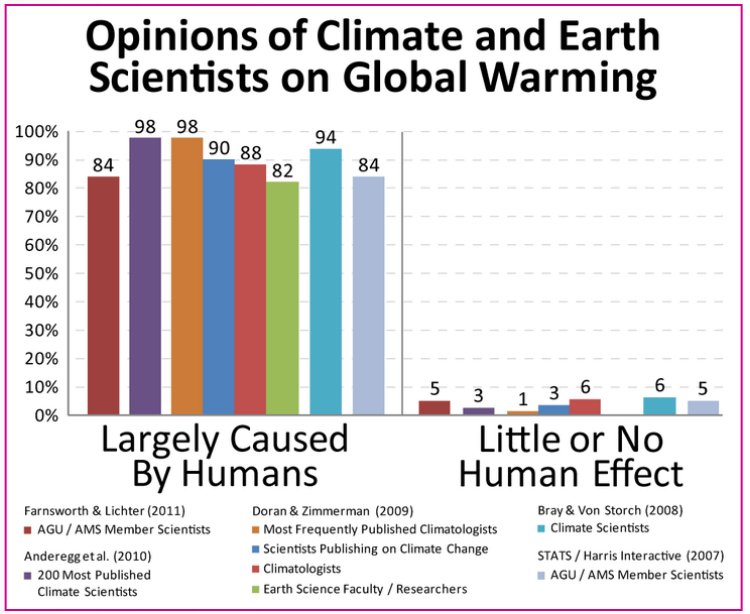
IOP PUBLISHING — ENVIRONMENTAL RESEARCH LETTERS

Environ. Res. Lett. 8 (2013) 024024 (7pp) — doi:10.1088/1748-9326/8/2/024024

Quantifying the consensus on anthropogenic global warming in the scientific literature

John Cook[1,2,3], Dana Nuccitelli[2,4], Sarah A Green[5], Mark Richardson[6], Bärbel Winkler[2], Rob Painting[2], Robert Way[7], Peter Jacobs[8] and Andrew Skuce[2,9]

[1] Global Change Institute, University of Queensland, Australia
[2] Skeptical Science, Brisbane, Queensland, Australia
[3] School of Psychology, University of Western Australia, Australia
[4] Tetra Tech, Incorporated, McClellan, CA, USA
[5] Department of Chemistry, Michigan Technological University, USA
[6] Department of Meteorology, University of Reading, UK
[7] Department of Geography, Memorial University of Newfoundland, Canada
[8] Department of Environmental Science and Policy, George Mason University, USA
[9] Salt Spring Consulting Ltd, Salt Spring Island, BC, Canada



↑ Survey of all papers published 1991-2011 using keywords "climate change" and "global warming" (11944 of them)
97% of papers agree that the "theory" that human activities are causing global warming has predictive power

Ways of dismissing what we don't want to hear, #1: "MRDA"

"Well he would [say that], wouldn't he"

Mandy Rice-Davies
(Old Bailey,1963)

An aphorism frequently applied to marginalise scientists and to allow scientific findings to be ignored

Internet Slang:
"MRDA" =
"Mandy Rice Davis Applies"

Two irrelevant factoids about the Profumo Affair

1. "Do you mind!? If it wasn't for me – you couldn't have cared less about Rachman"
MRD and Keeler lived at 1 Bryanston Mews West, owned by slum landlord Peter Rachman. The Profumo affair threw a light on him and his business practices which even became known as "Rachmanism" and led to the 1965 Rent Act

2. John Profumo was my dad's boss at the war office

Ways of dismissing what we don't want to hear, #1: "MRDA"

"an elaborate conspiracy in which hundreds of climate scientists have twisted their results to support the climate change theory in order to protect their research funding - Sounds plausible to us."

The Cooler Heads Coalition

Funded by the Competitive Enterprise Institute. Donors: Charles and David Koch, ExxonMobil, Phillips Oil, Alliance of Automobile Manufacturers, Marathon Petroleum, Murray Energy Corporation, Ford, Volkswagen, American Coalition for Clean Coal Electricity, Emerson Electric, Monsanto, Americans for Prosperity, Association of American Fuel and Petrochemical Manufacturers, JP Humphreys Foundation, Claws Foundation, Google, Facebook .....

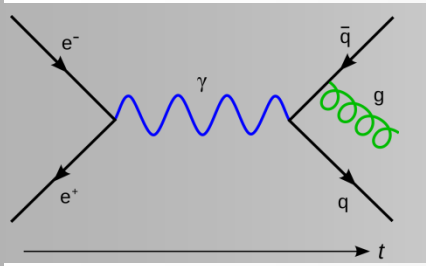
and many, many, many more

(also embraced by Donald J. Trump in his 2016 Campaign)

Two things that Mandy almost certainly never knew about scientists*

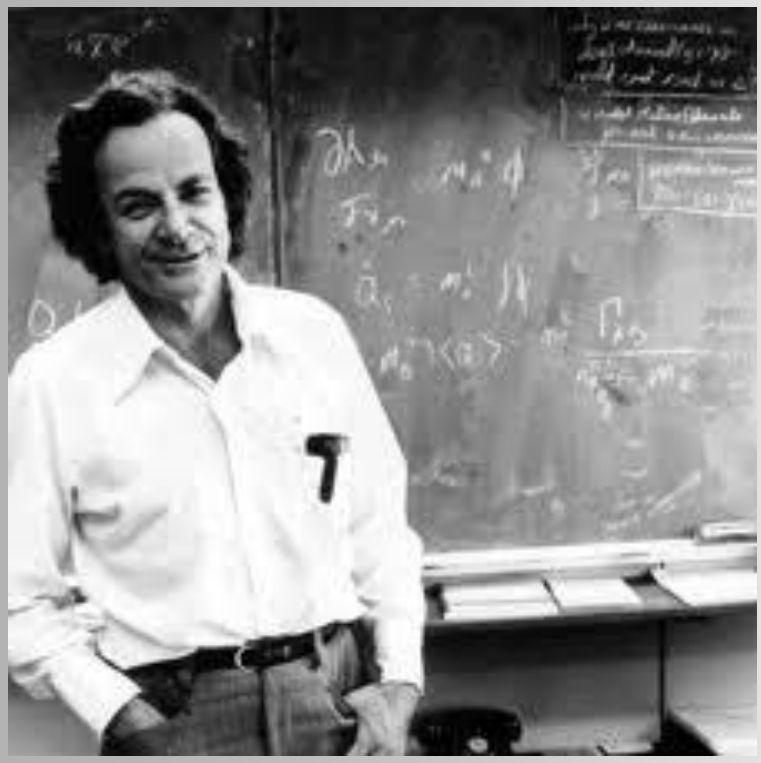
- 1. What every scientist lives for is to become famous for being right
- 2. What every scientist dreads is to become notorious for being wrong

* *And is not understood by the Cooler Heads Coalition, nor the Competitive Enterprise Institute nor Lord Lawson's Global Warming Policy Foundation nor any other "libertarian" pressure group with "charity" status*



two other quotes from 1963

(The Feynman Lectures on Physics, Caltech, 1963)



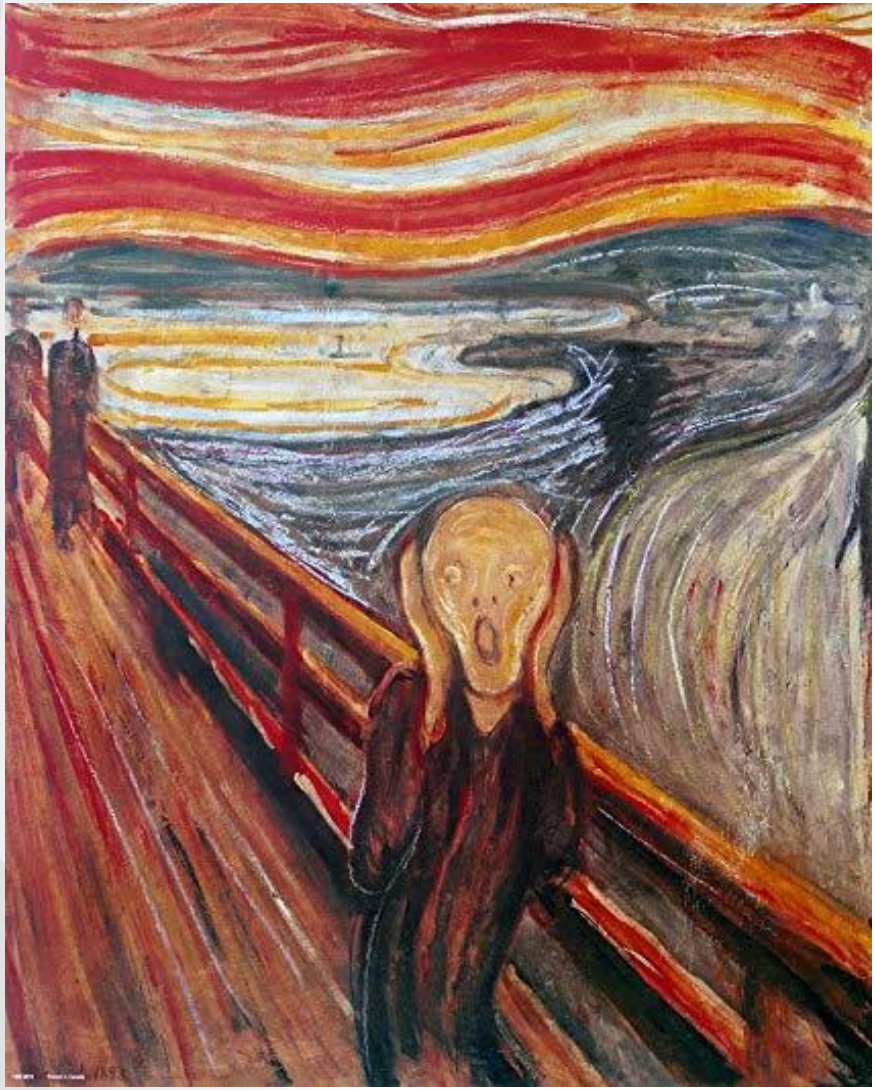
"The first principle is that you must not fool yourself and yourself is the easiest person to fool"

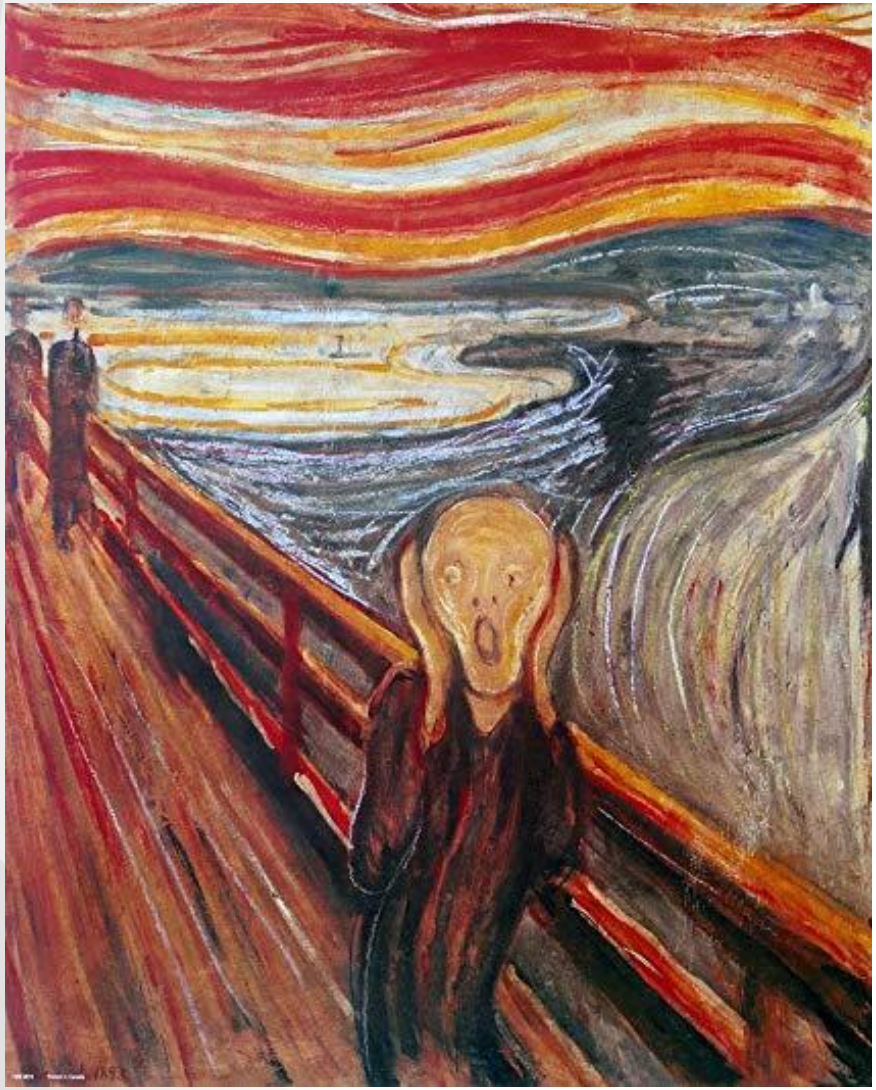
"reality must take precedence over public relations, for Nature cannot be fooled"

Richard P. Feynman
(1918-1988)

So to sum ALL that up!

- the “little ice age” wasn’t anything like a real ice age: beware semantic arguments based on the idea that it was
- neither the start nor the end of Thames frost fairs had anything to do with climate ….
- ….. although it is true Thames freezing events are much rarer now than they were because of climate change
- art tells us about people and society. It may hold some clues about science – but art it is subjective to interpret and there are always unknown factors – good science is exclusively and ruthlessly objective





Department of Meteorology

University of Reading

Mike Lockwood

(University of Reading, UK)

THANK YOU FOR LISTENING

Department of Meteorology

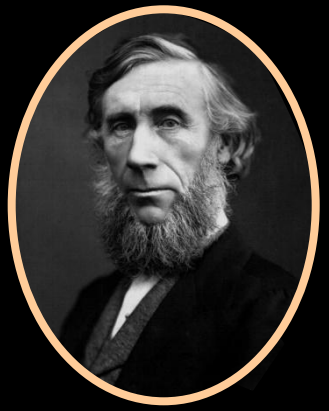
University of Reading

Mike Lockwood

(University of Reading, UK)

SPARES!

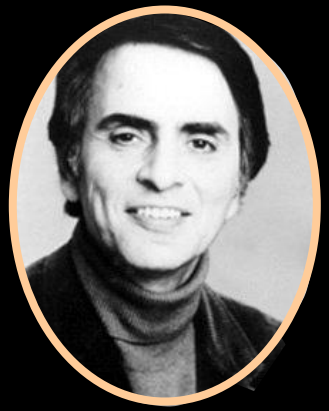
The Greenhouse Effect



- First experiments showing how atmospheric gases absorb infrared by Irish physicist John Tyndall (1856)

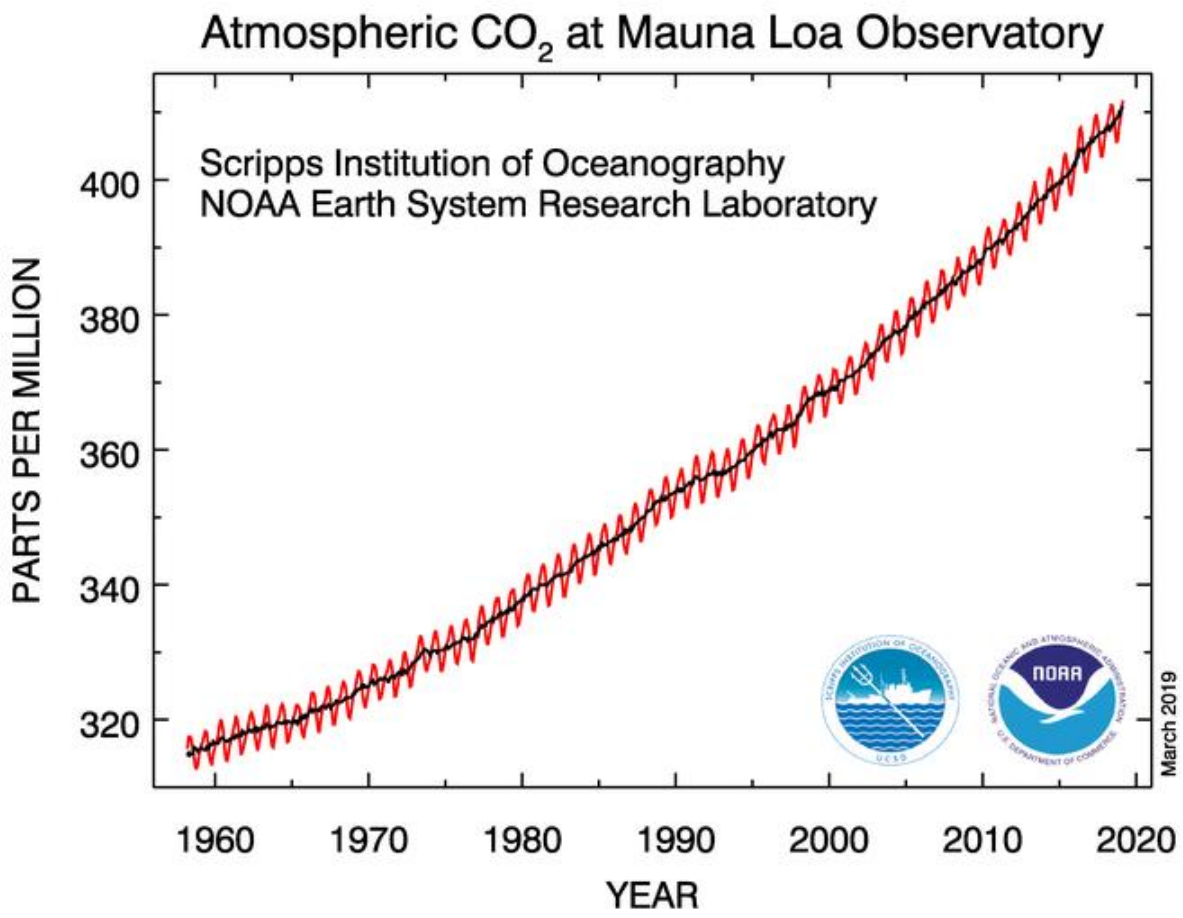
- Planetary greenhouse effect first suggested by Swede Svante Arrhenius (1896)

- CO_2 rise first linked to Earth's temperature rise by Englisman Guy Stewart Callendar (1939)



- American Carl Sagan helped prove there was a runaway CO_2 greenhouse effect on Venus (1960)

Do I “believe” in the “theory” of climate change?



- Yes! – just like I believe in the theory of gravity

- Ice cores show the pre-industrial level was 270 ppm

^{13}C and the carbon cycle

* ("isotopic fractionisation")

$[^{13}CO_2]$ / $[^{12}CO_2]$ decreases with anthropogenic rise in $[CO_2]$

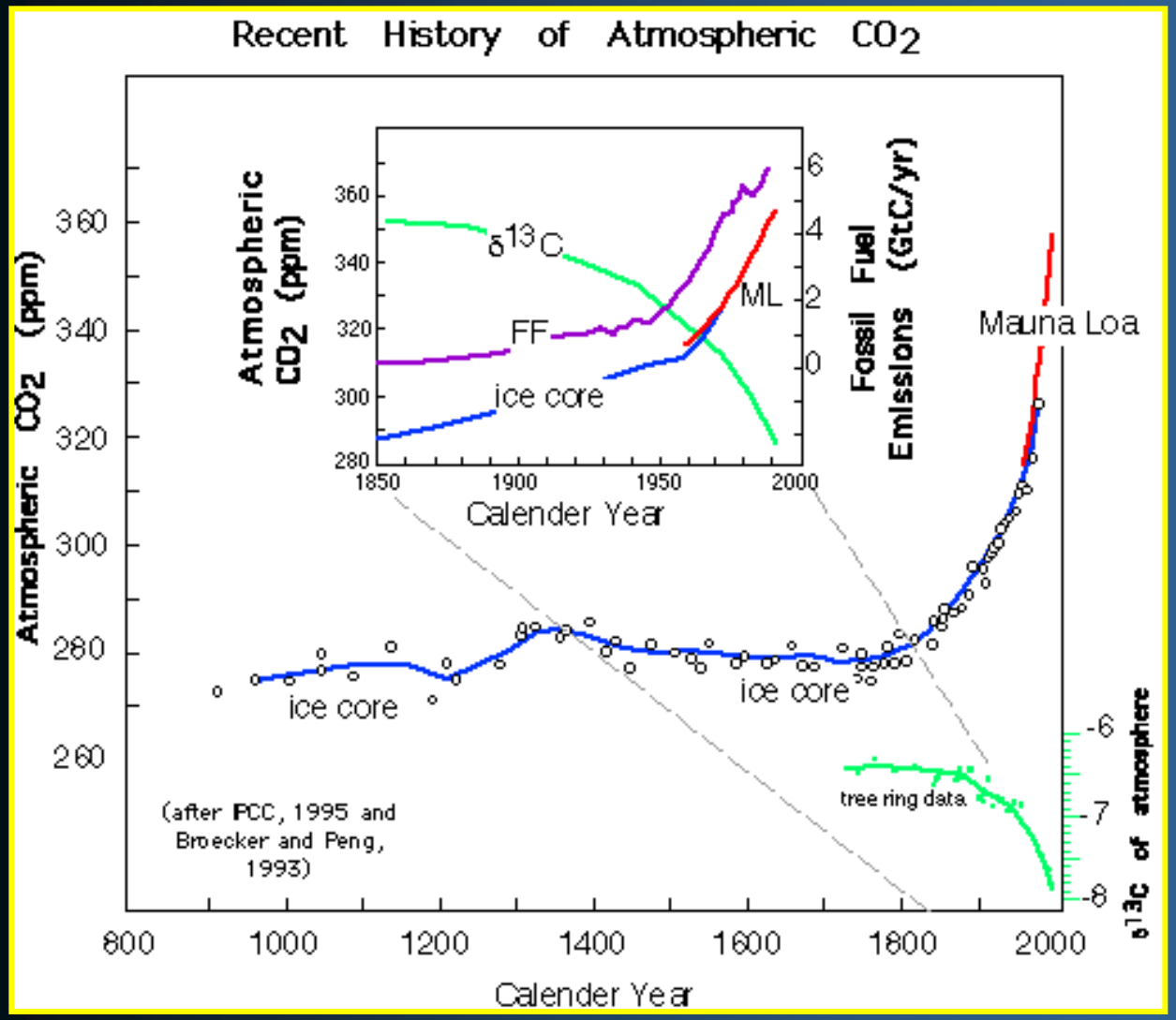
^{12}C is taken up 2% more than ^{13}C by plants and trees*

TROPOSPHERE

reduced $[^{13}C]$ / $[^{12}C]$

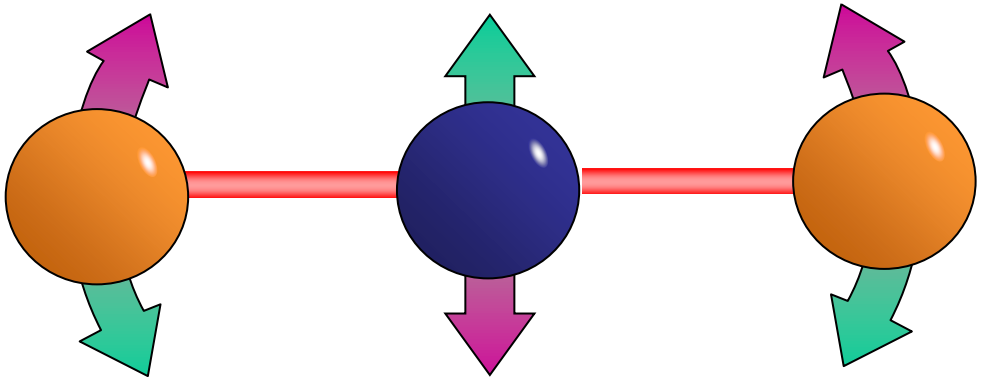
reduced $[^{13}CO_2]$ / $[^{12}CO_2]$

The "2nd Suess Effect": dilution of $^{13}CO_2$ by burning of fossil fuels

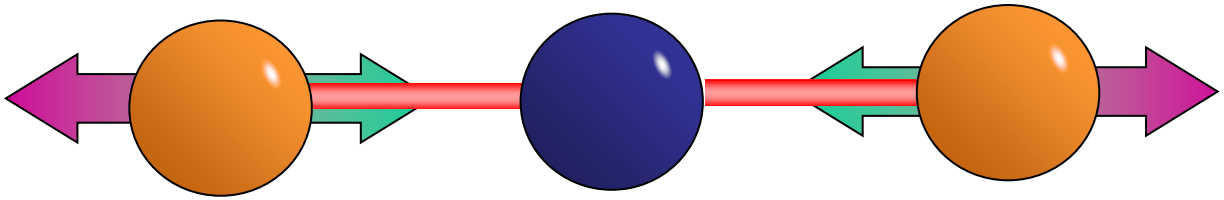


- green line shows $\delta^{13}C$, related to the fraction of ^{13}C in CO_2 which has declined exponentially as estimated fossil fuel use (FF) and atmospheric CO_2 has risen

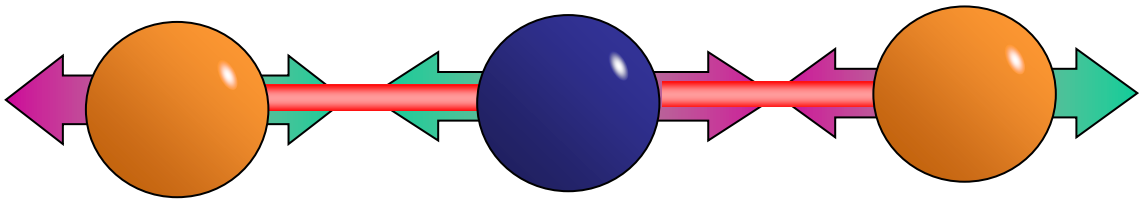
CO_2



(a) Bending mode

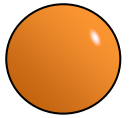


(b) symmetric stretch



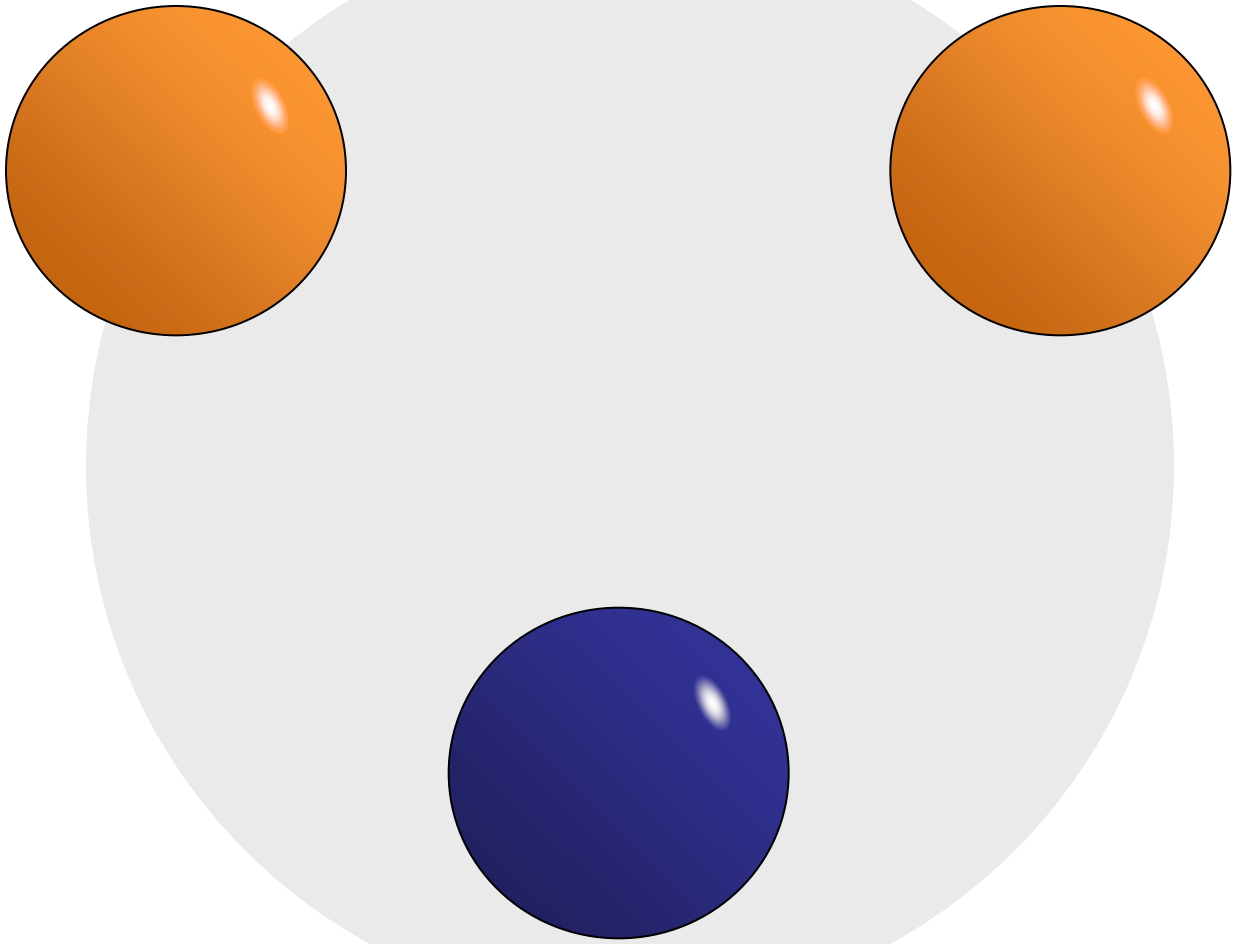
(c) asymmetric stretch

Carbon



Oxygen

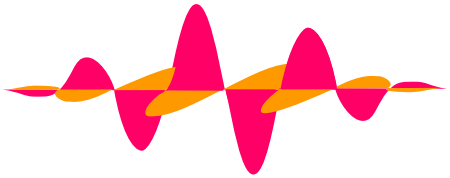
a CO_2 molecule



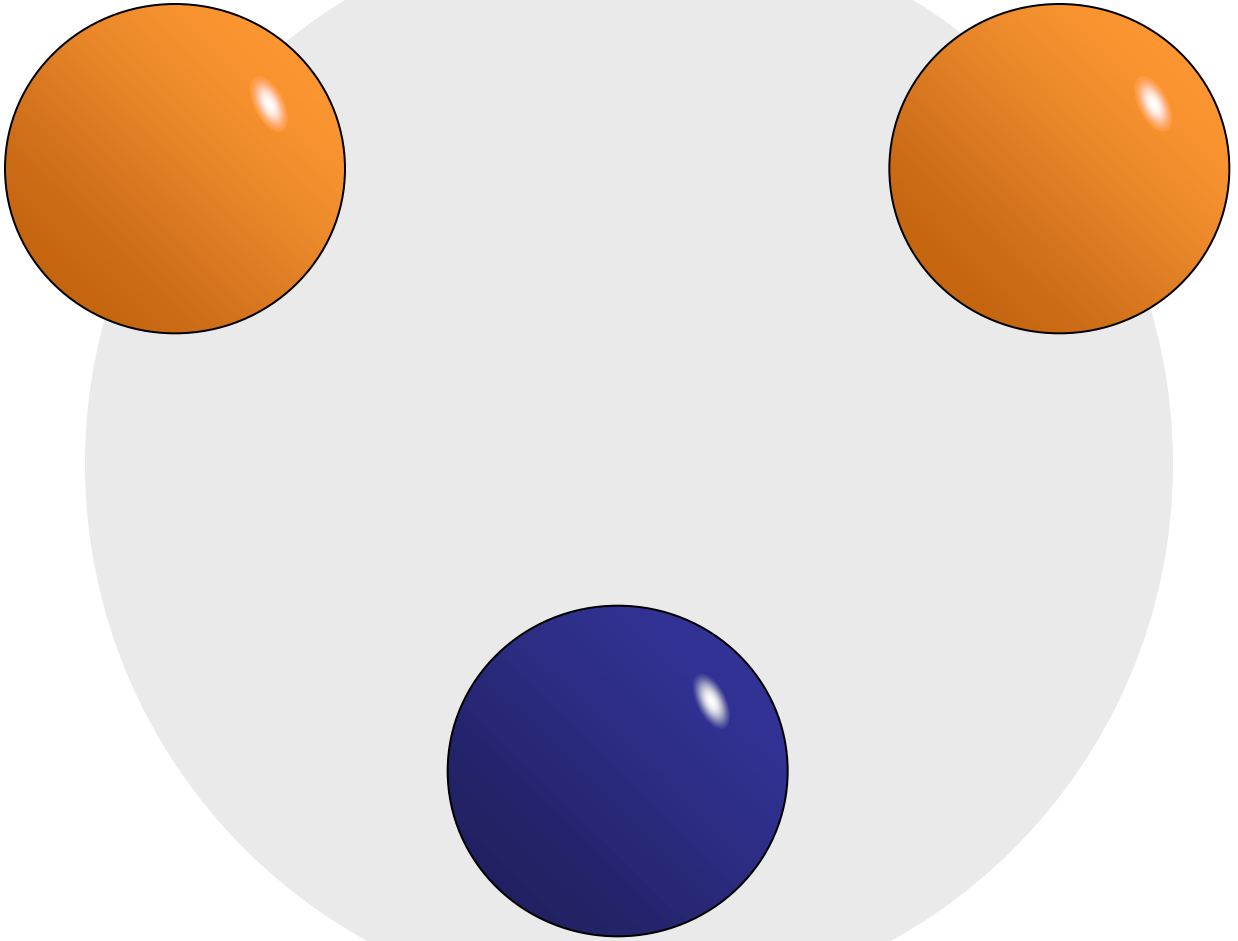
Carbon

Oxygen

SW Photon



a CO_2 molecule

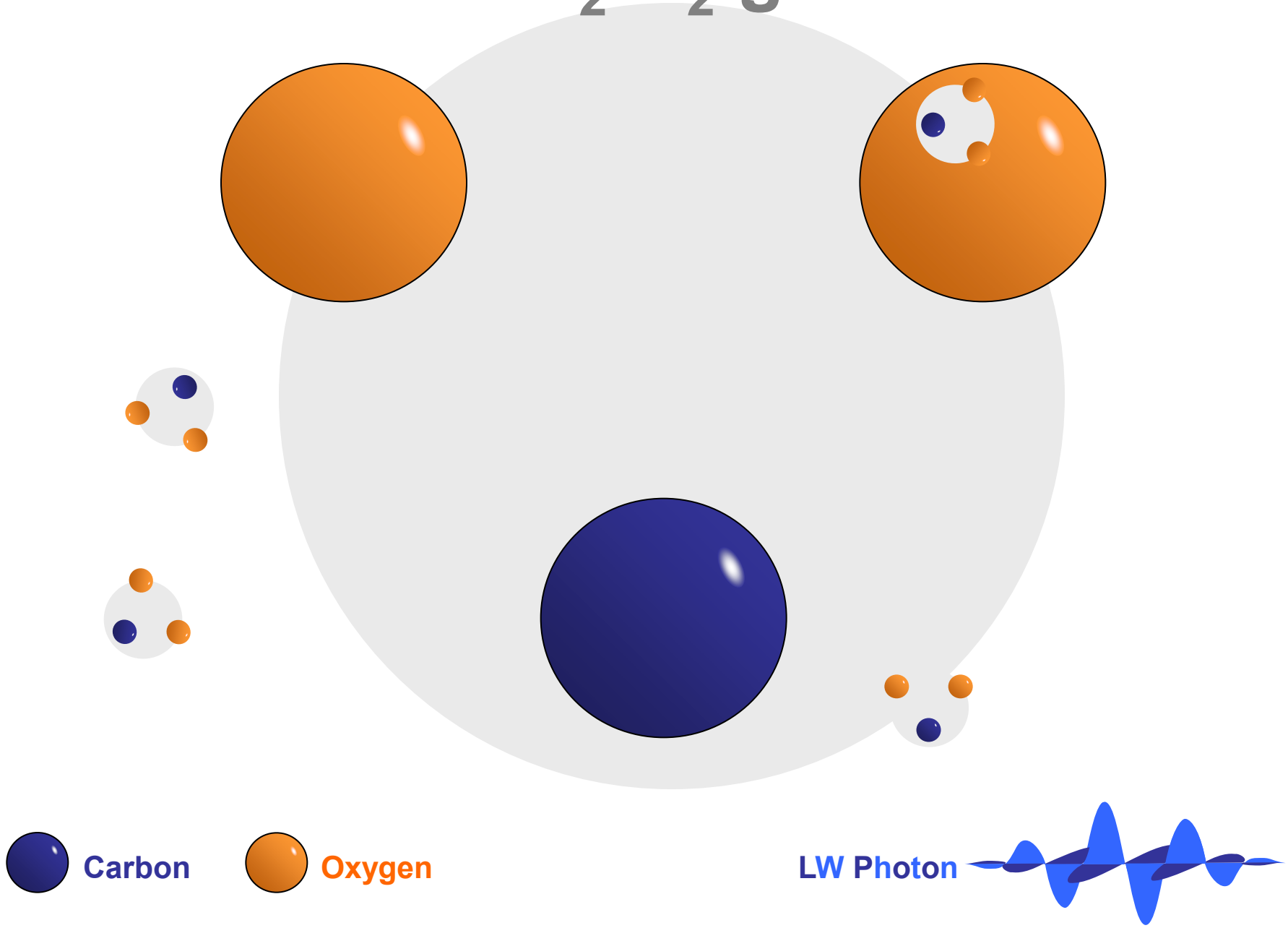


Carbon

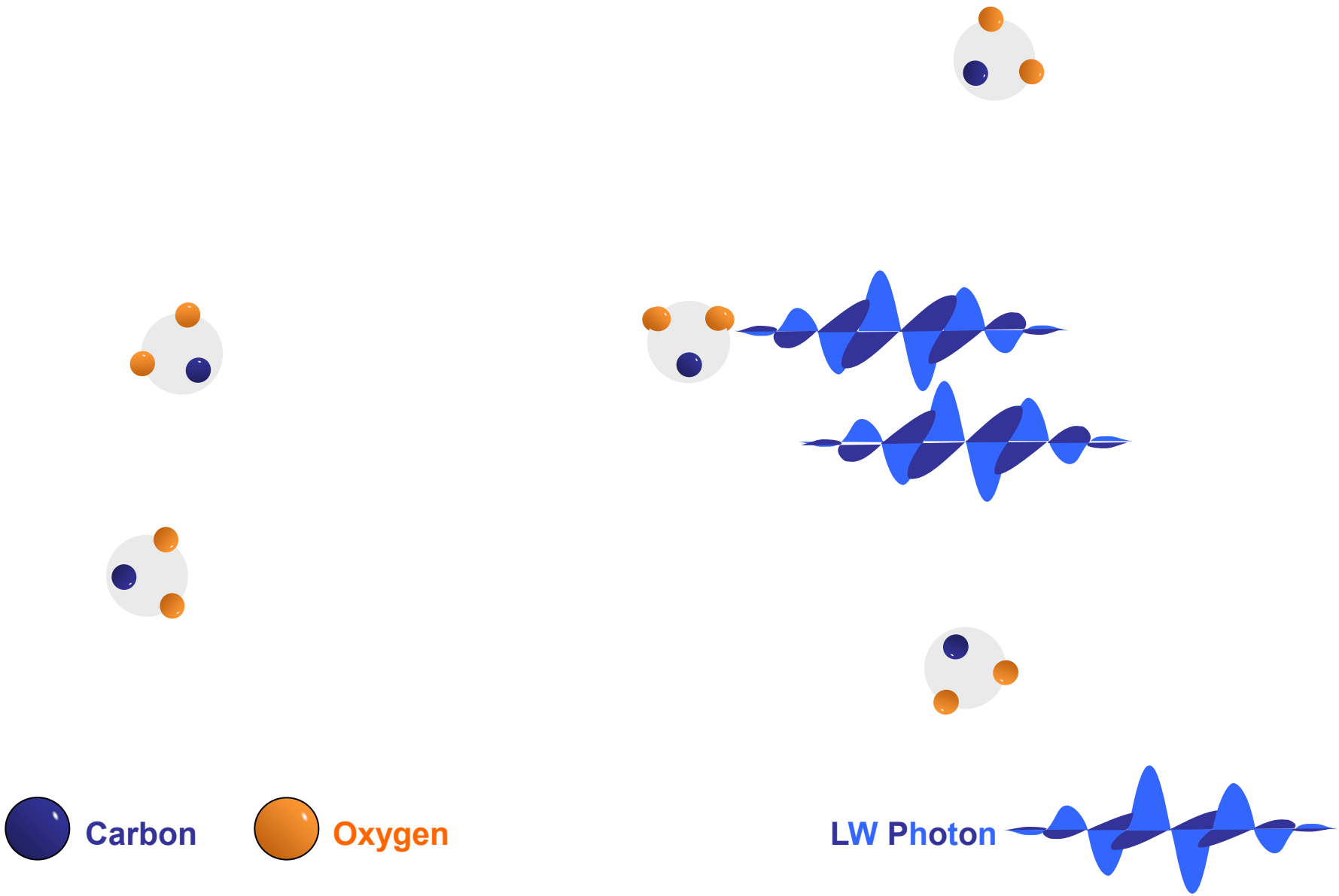
Oxygen

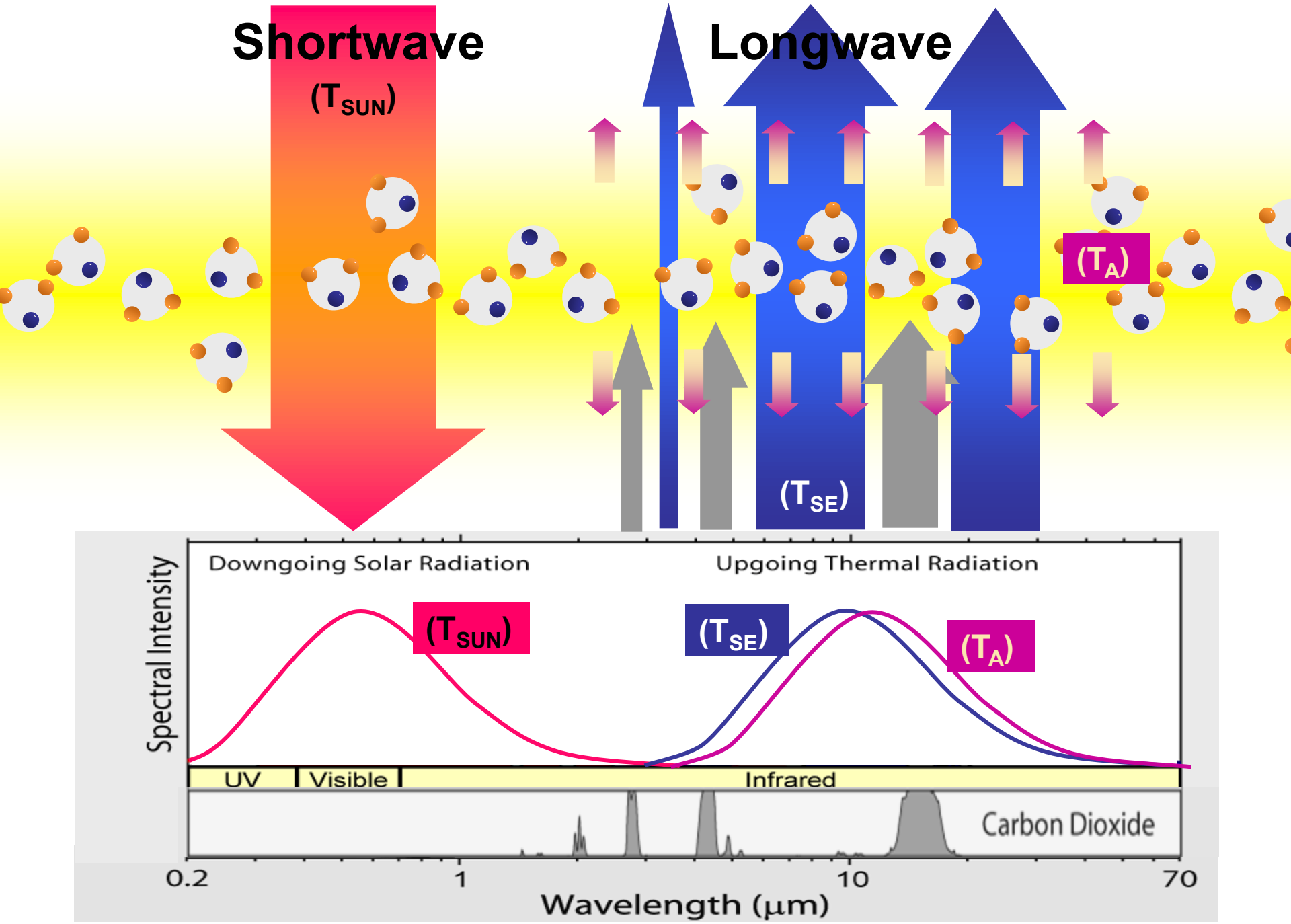
LW Photon

a CO_2 Molecule

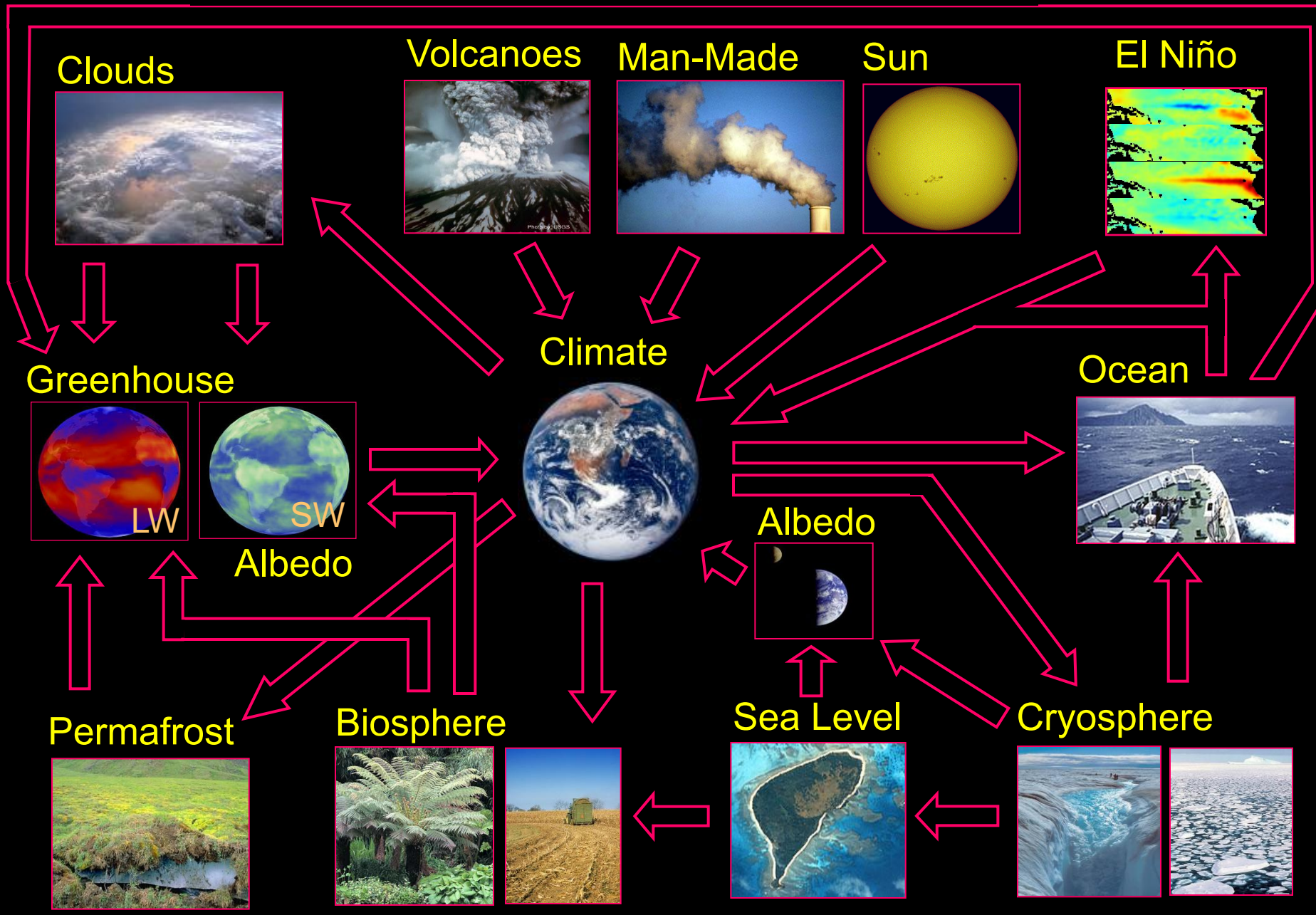


a CO_2 gas

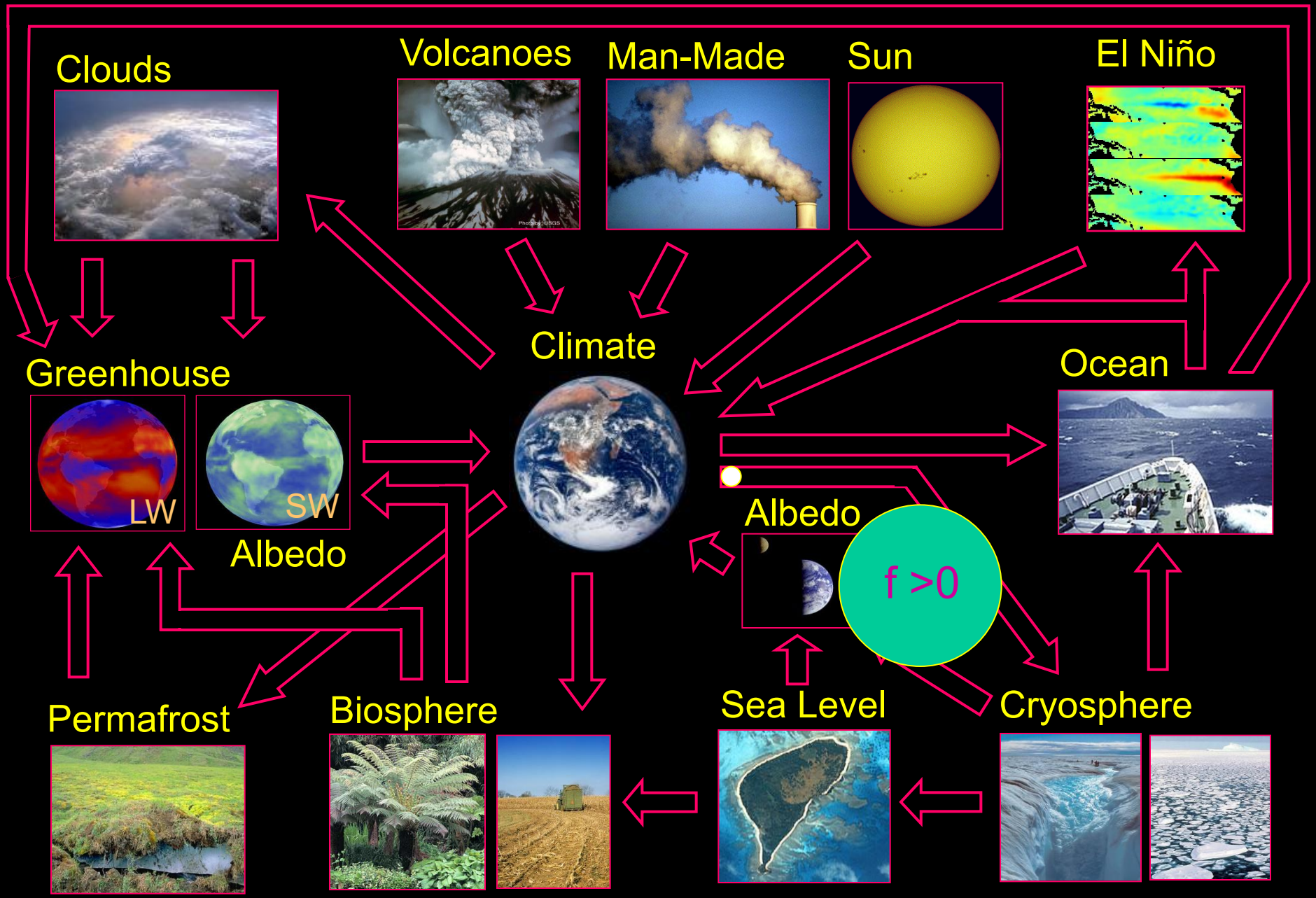



Shortwave
(T_SUN)
Longwave
(T_A)
(T_SE)
Downgoing Solar Radiation
Upgoing Thermal Radiation
(T_SUN)
(T_SE)
(T_A)
Spectral Intensity
UV
Visible
Infrared
Carbon Dioxide
0.2
1
10
70
Wavelength (μm)

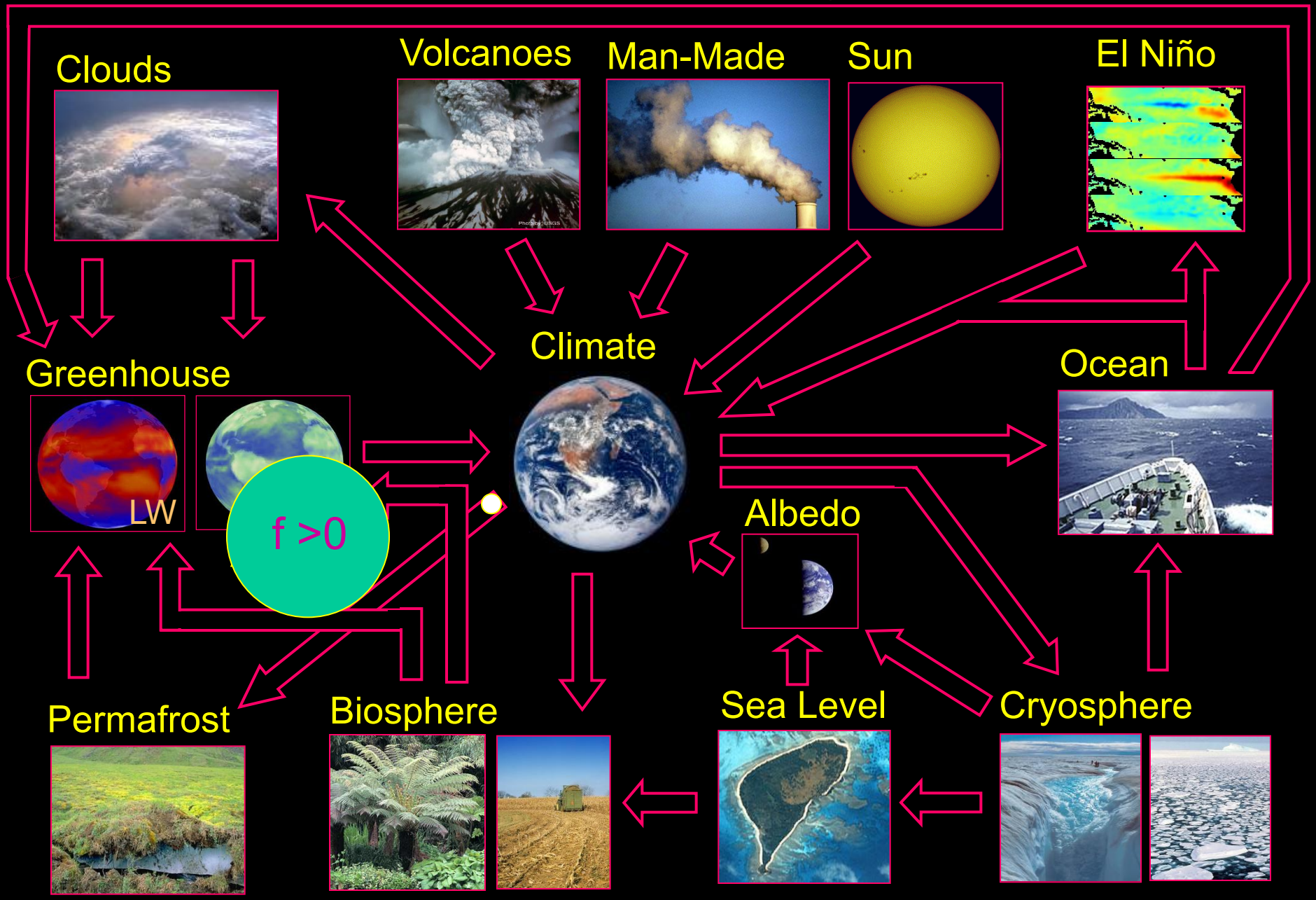
Climate Feedbacks



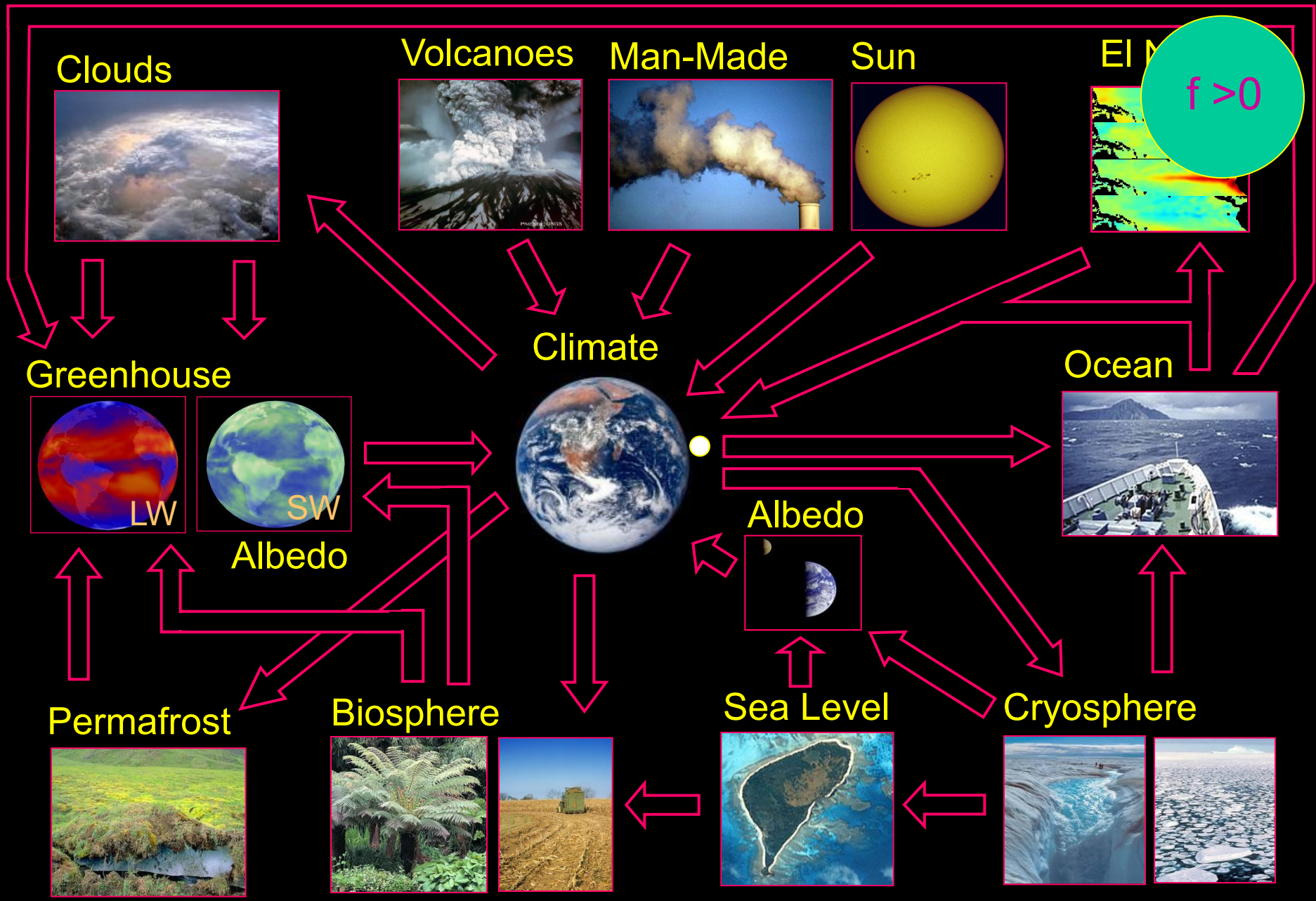
Climate Feedbacks: Loss of Sea and Land Ice



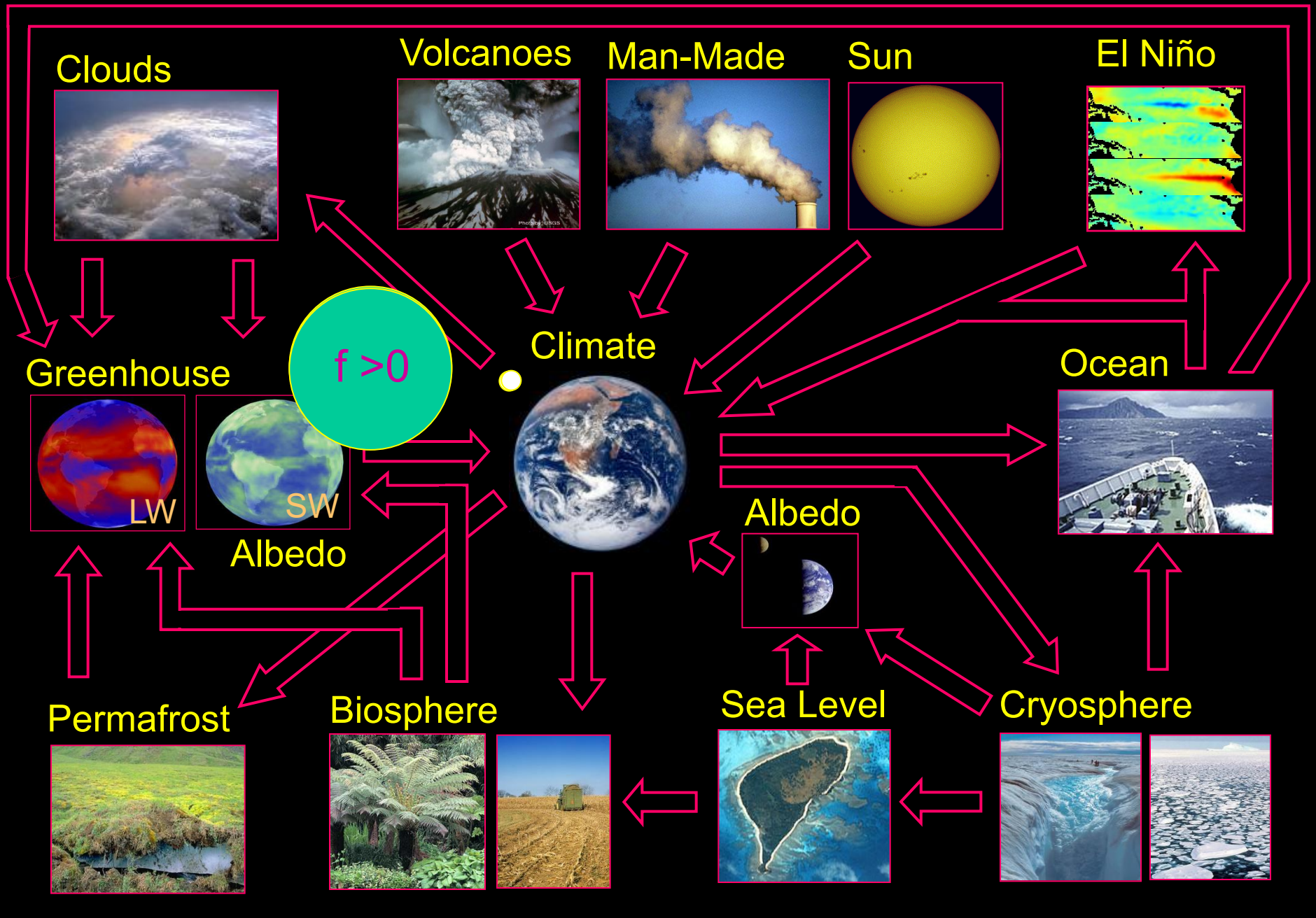
Climate Feedbacks: Melting Permafrost



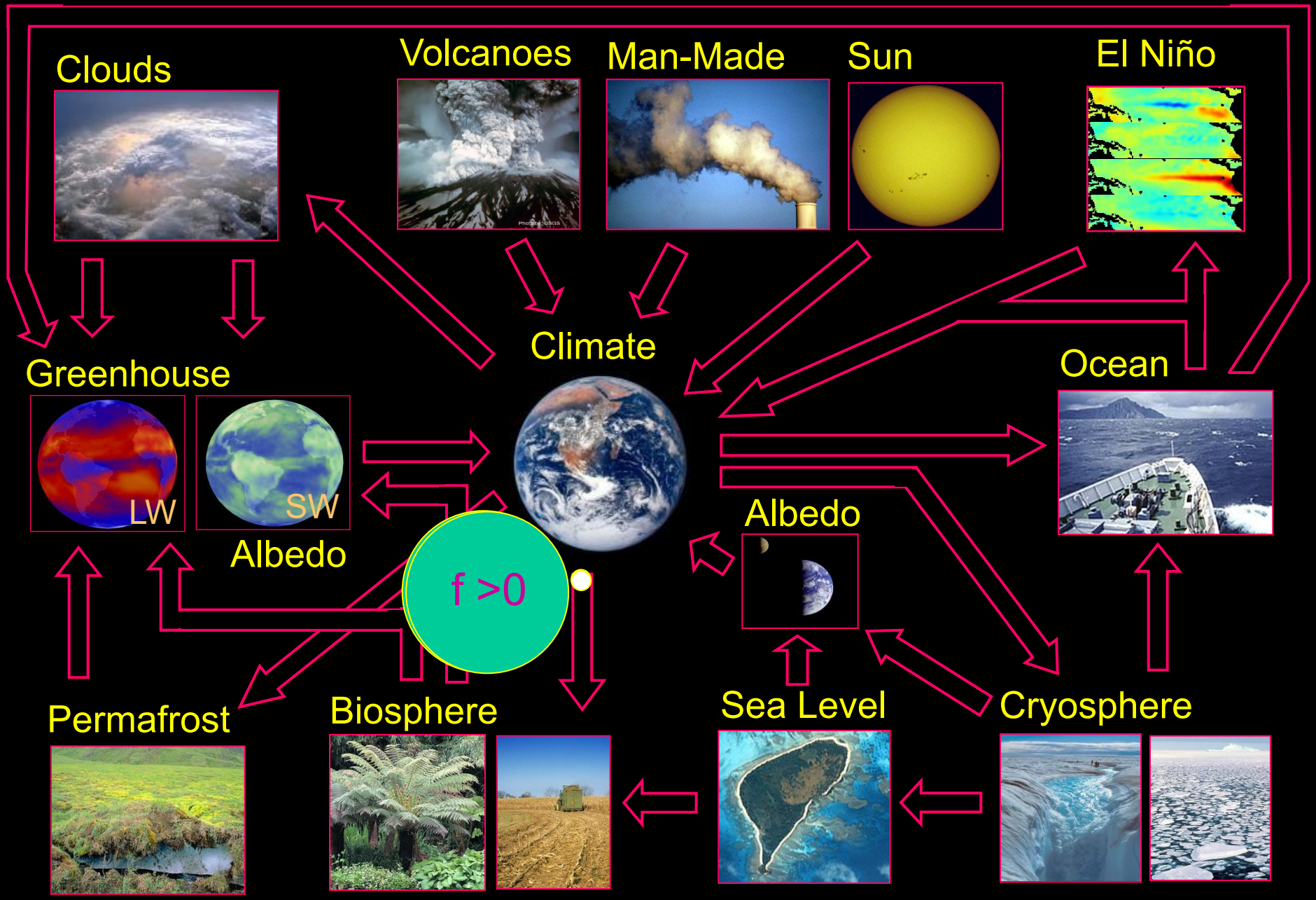
Climate Feedbacks: Warming Oceans



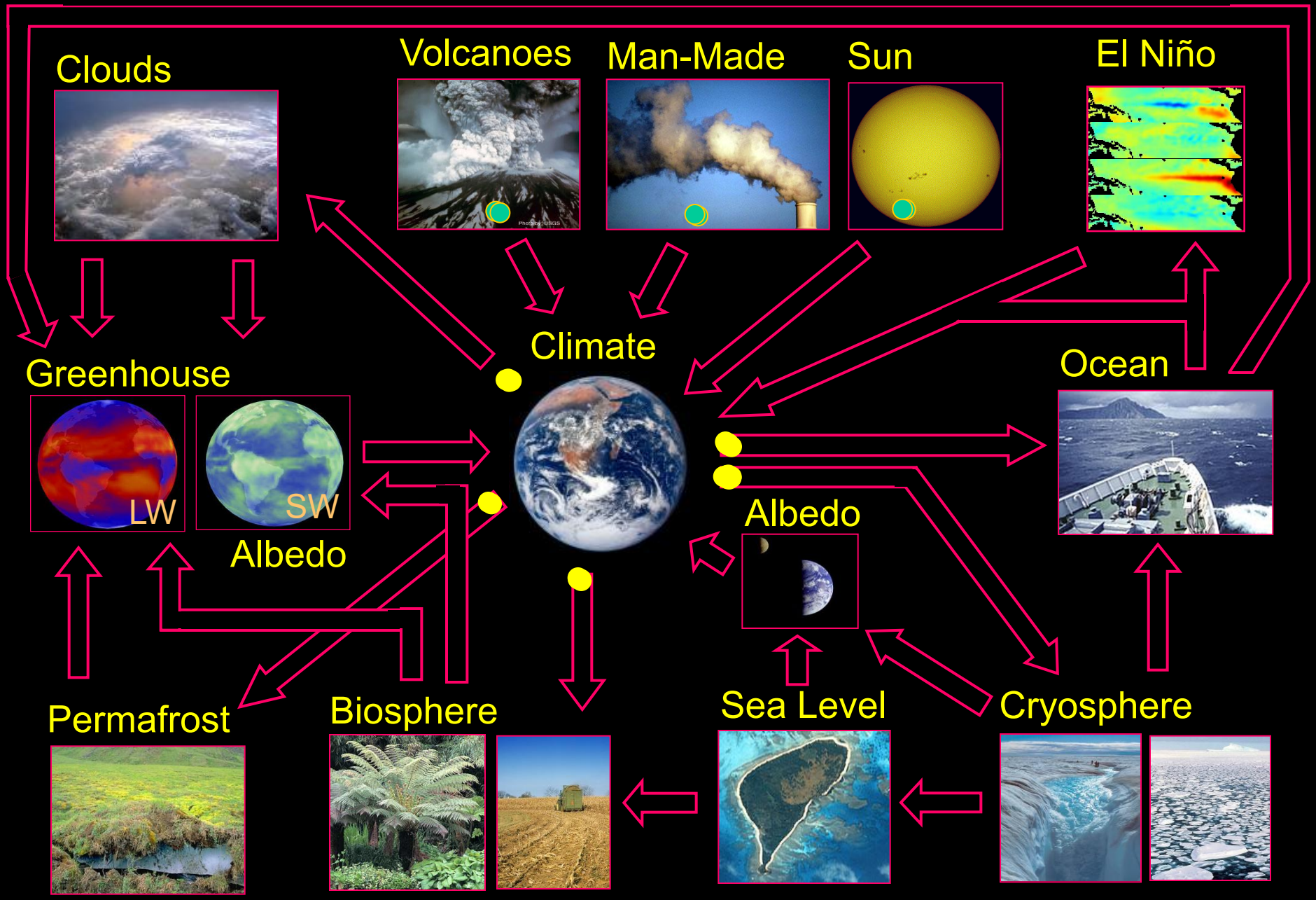
Climate Feedbacks: Clouds



Climate Feedbacks: Biosphere Response



Climate: Numerical Models



So to sum ALL that up!

- the “little ice age” wasn’t anything like a real ice age: beware semantic arguments based on the idea that it was
- neither the start nor the end of Thames frost fairs had anything to do with climate ….
- ….. although it is true Thames freezing events are much rarer now than they were because of climate change
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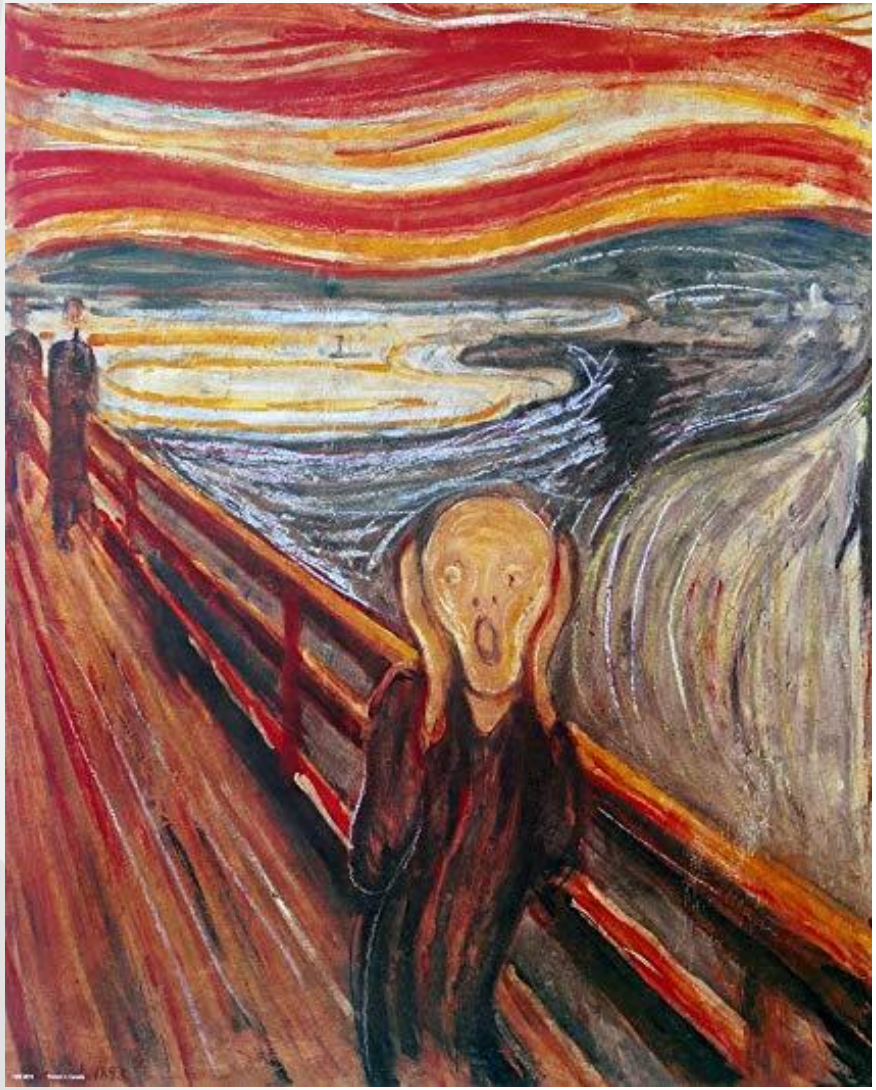

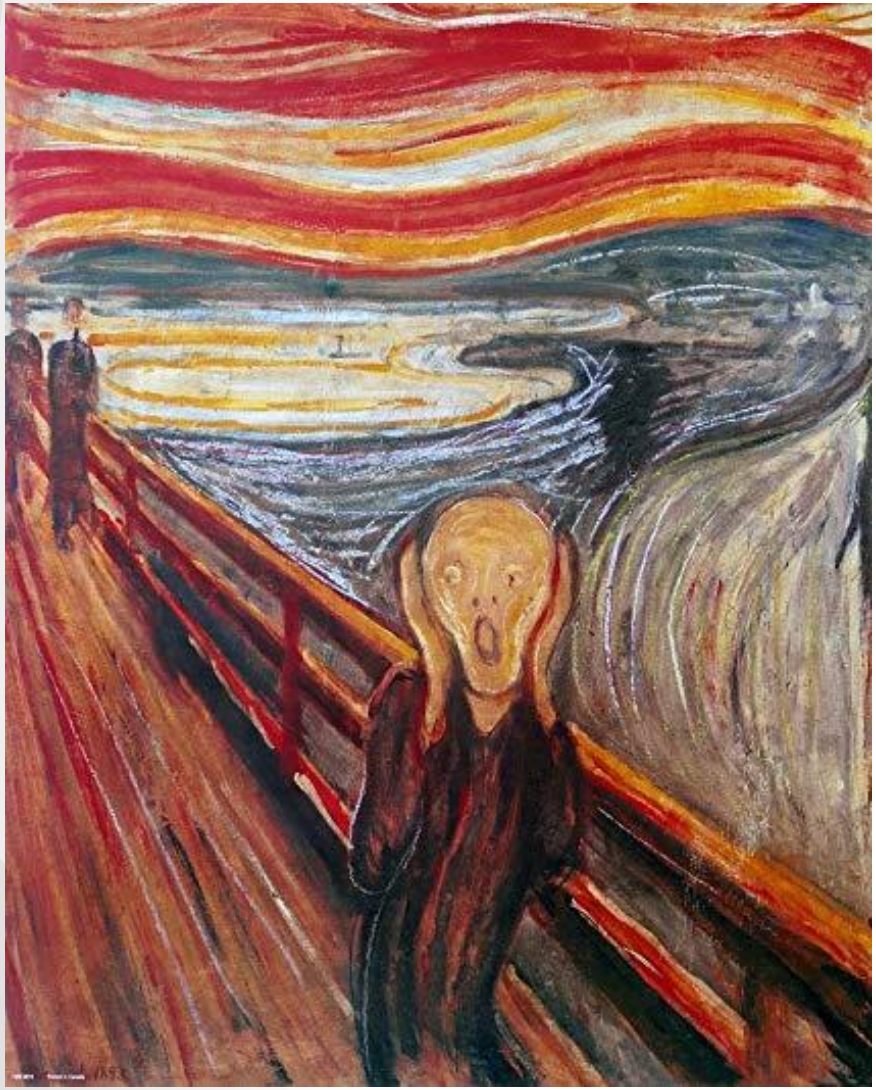

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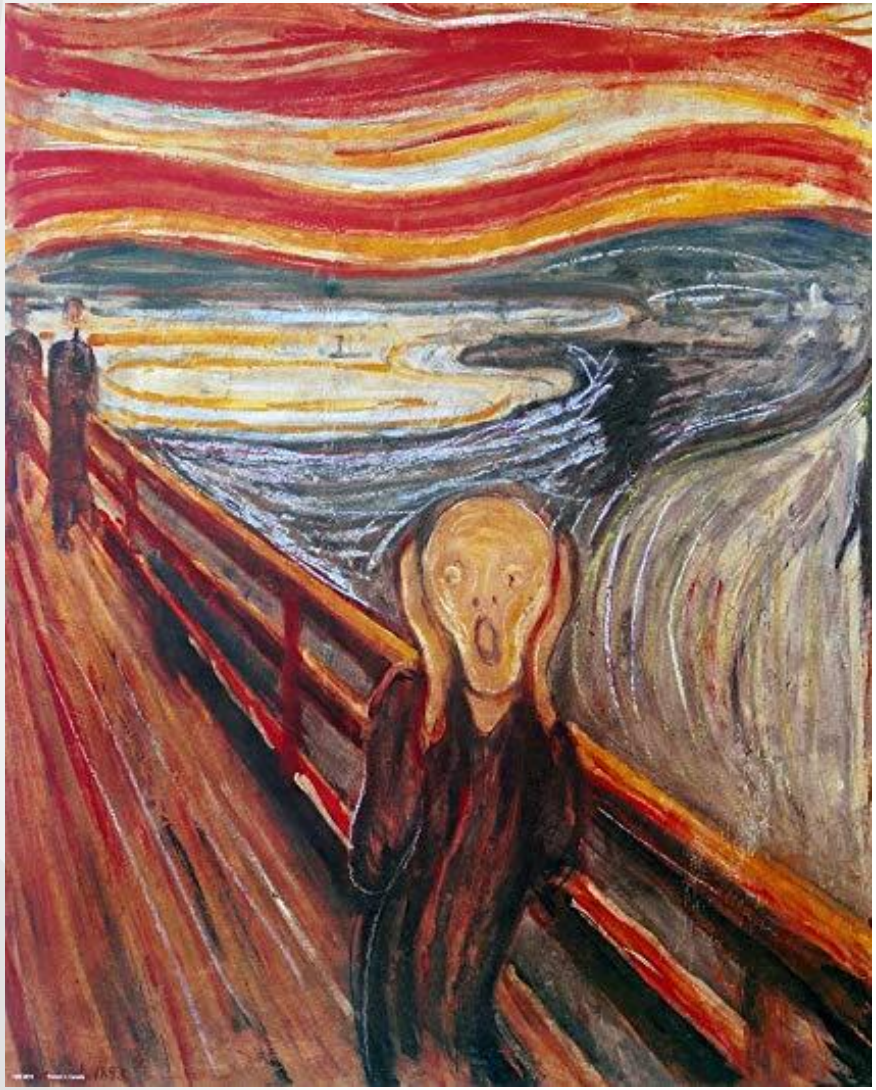
- neither the start nor the end of Thames frost fairs had anything to do with climate ….
- ….. although it is true Thames freezing events are much rarer now than they were because of climate change
- art tells us about people and society. It may hold some clues about science – but art it is subjective to interpret and there are always unknown factors – good science is exclusively and ruthlessly objective



^{14}C and the carbon cycle

^{14}C

- $\tau_{1/2}$ = 5370 yr
- $< q_G > = 2$

atoms $cm^{-2}s^{-1}$

GALACTIC COSMIC RAYS

STRATOSPHERE (≈2/3)

$^{14}C+0 \rightarrow {}^{14}C0$; $^{14}C0+0H \rightarrow {}^{14}C0_2+ H$

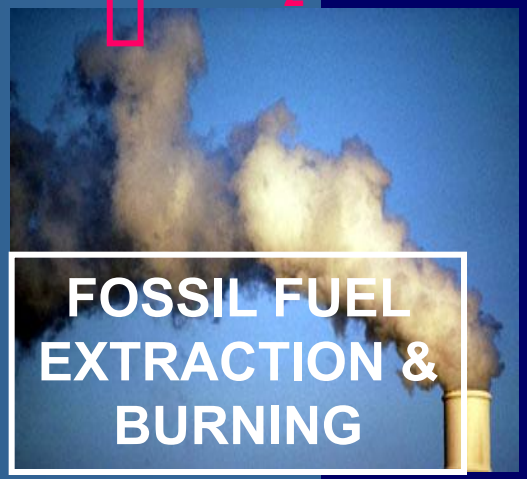
TROPOSPHERE (≈1/3)

$[^{14}CO_2] / [^{12}CO_2]$ decreases with anthropogenic rise in $[CO_2]$

plus ^{12}C & ^{13}C

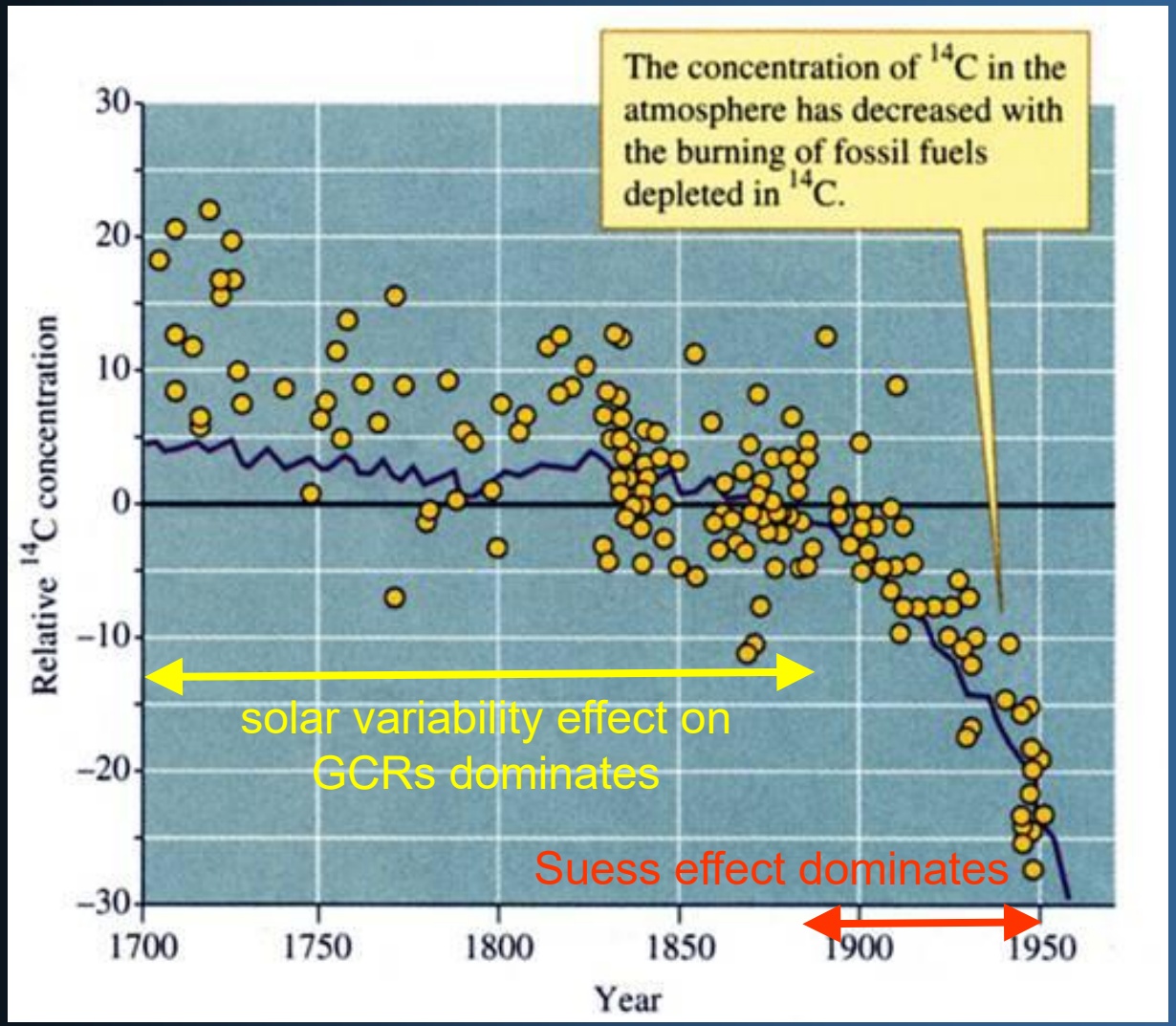
^{12}C & ^{13}C

$^{12}CO_2$ & $^{13}CO_2$



$t > \tau_{1/2}$ allows beta decay $^{14}C \rightarrow {}^{14}N + \beta$

The “Suess Effect”: dilution of $^{14}CO_2$ by burning of fossil fuels

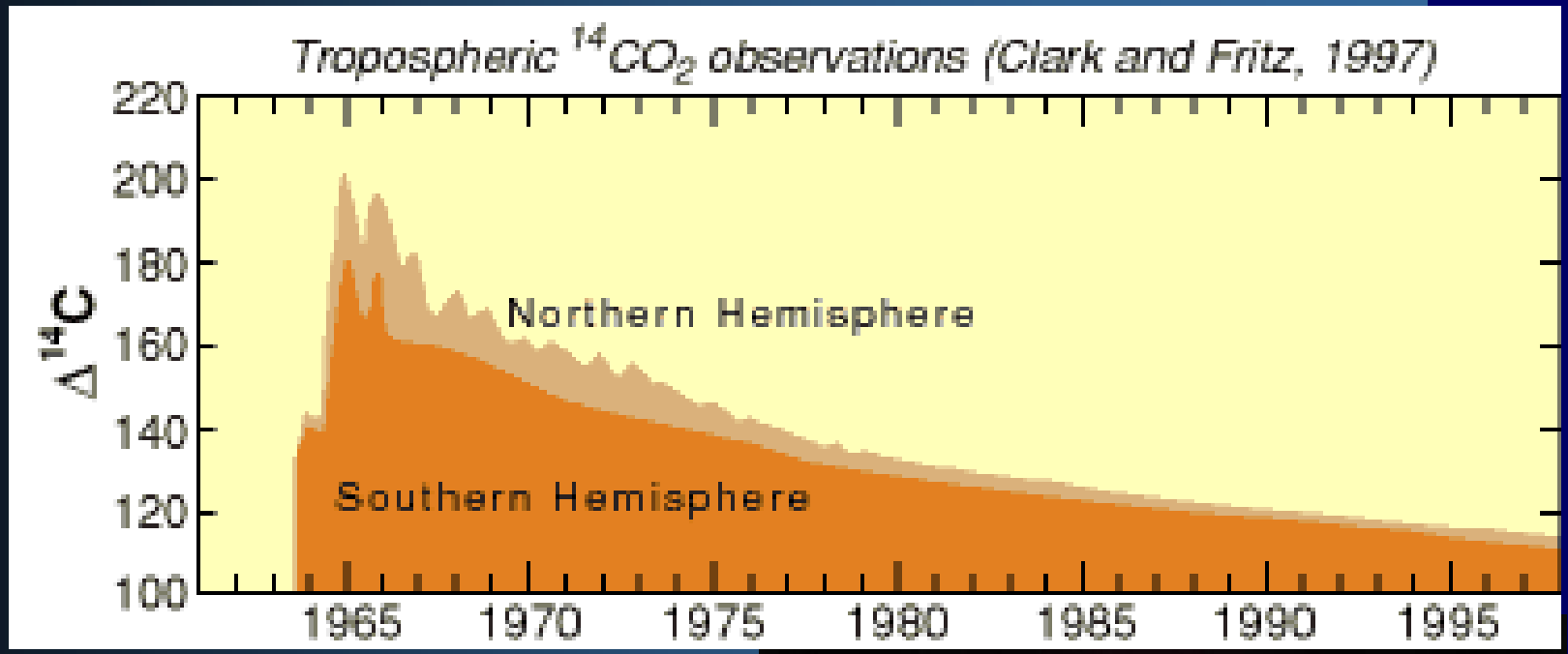


$k \times [\,^{14}C\,] / [\,^{14}C + ^{13}C + ^{12}C\,] \rightarrow$

- from Bacastow & Keeling (1974)
- fossil fuels give 5×10^{15} kg of CO_2 per annum, GCRs give 7.5 kg of $^{14}CO_2$ per annum
- ^{14}C cannot be used this way after 1950 because of airborne nuclear bomb tests

$^{14}CO_2$ from nuclear bomb tests

$$\frac{k \times [\,^{14}C\,]}{[\,^{14}C + {}^{13}C + {}^{12}C\,]} \rightarrow$$



- non-underground nuclear bomb tests added relatively copious $^{14}CO_2$ to the atmosphere

^{14}C & ^{10}Be: spallation products from O, N & Ar

^{14}C

- $\tau_{1/2}$ = 5370 yr
- $< q_G >$ = 2 atoms $cm^{-2}s^{-1}$

^{10}Be

- $\tau_{1/2} = 1.5 \times 10^6$ yr
- $< q_G >$ = 0.018 atoms $cm^{-2}s^{-1}$

GALACTIC COSMIC RAYS

STRATOSPHERE (≈2/3)

TROPOSPHERE (≈1/3)

$^{14}C + O \rightarrow {}^{14}CO$; $^{14}CO + OH \rightarrow {}^{14}CO_2 + H$

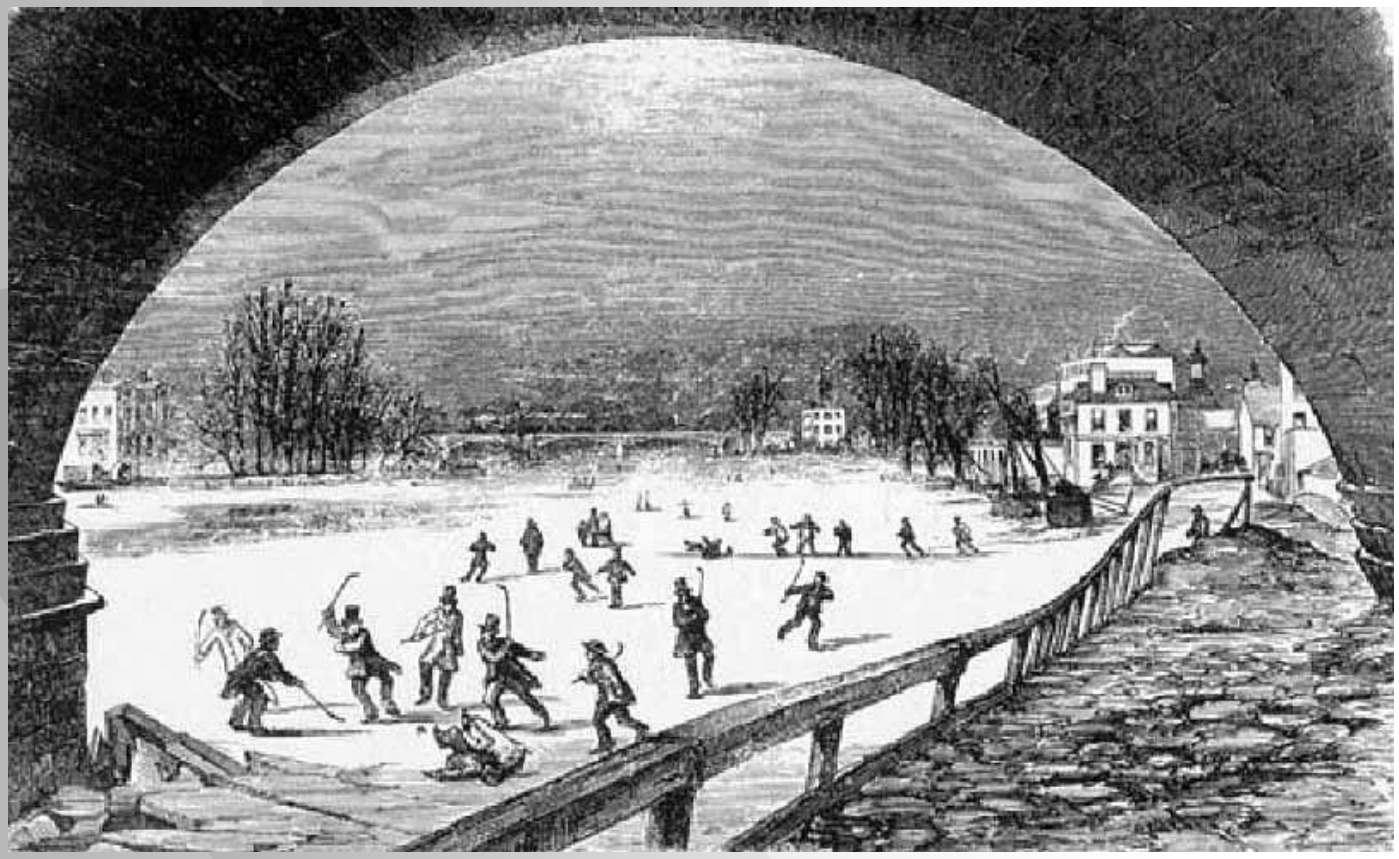
(~1 year) *(~1 week)*

OCEANS

^{10}Be + AEROSOL

BIOMASS

ICE SHEETS



- The Thames frozen at Richmond Bridge, 1855

Frostiana

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