Neglected UK historic evidence for a medieval non-anthropogenic global sea-level rise of 5m: portent of the Modern Rise

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NEGLECTED BRITISH HISTORIC EVIDENCE FOR A 5M MEDIEVAL GLOBAL SEA-LEVEL RISE: PORTENT OF THE MODERN RISE

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England and Wales excel for studying 2-0ka eustasy, being stable (c.1mm/y GIA subsidence) and rich in published archaeological evidence for sea-level (SL) change, e.g. buried Roman structures reveal a c.3m Roman fall preceded a c.5m pre-Norman rise, while many Norman towns and castles have a seadock stranded a few meters above today's high-tide line. SL high- and lowstand values deduced here correlate (and notably scale) to warm and cold peaks on Ljungqvist's (2010) Northern Hemisphere temperature curve: Roman Warm Period (peak at c.160CE), highstand of +5m (rel. to present mean SL); Dark Ages Cold Period (DAP; c.530) +2m lowstand; Medieval Warm Period (MWP; c.950) +7m high; Little Ice Age (LIA; c.1690) -30cm low. Similar meter-scale interglacial SL oscillations are likewise known from the previous interglacial, MIS5e. Scarcity of reported geological evidence for the proposed MWP 7m SL high may reflect (1) brevity (<20y?) precluding reef- or bench formation, (2) coalescence with MIS5e raised-shore features, and (3) proneness of raised intertidal encrusting fauna (barnacles etc.) to dissolution by rain. Contrary consensus that 2-0ka SL change is minor (<30cm) is largely based on saltmarsh core dates that point to continuous 2-0ka peat growth. However, a kink in all core age-depth graphs (linear trend of C14-dated samples is <50% as steep as post-C14 trend) suggests C14-age exaggeration by an unknown estuarine reservoir effect (brackish saprobes fix CO2 released by older, deeper plant decay?); projecting the post-C14 line gives core-bottom ages <0.5ka. The modern SL rise, which, based on tide-gauge records, began c.1780 (lagging c.90y behind start of modern warming, i.e. LIA peak), is likely locked into eventually exceeding the 5m Medieval Rise, as Ljungqvist shows (1) the modern warming already exceeds DAP-MWP warming, and (2) mean temperature since c.1950 arguably exceeds the MWP acme. However, to date, c.325y after modern warming began, the Modern Rise is just 30cm, so to surpass the Medieval Rise of 5m in c.420y, a further 4.7m (min.) is predicted in the next c.100y, implying fast acceleration from today's 2.5mm/y, to >5cm/y by 2050, then probably >10cm/y for decades, driven by polar ice-sheet surge once the buttressing ice shelves melt. Cutting mankind's emissions will not reduce the imminent natural 5m (min.) SL rise.

Session No. 295

Recent Advances in Environmental Geoscience II
Wednesday, 28 September 2016: 1:30 PM-5:30 PM

Overlooked geological and human-historical evidence that sea-level rise will approach or exceed IPCC worst-case scenario, regardless of human action

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Abstract of talk given 30th August 2016 at 35th International Geological Congress, Cape Town, South Africa

Longer abstract (2 pages) on same topic, presented 1 month before ...

This review omits citations to save space. The current sea-level (SL) rise began c.1700CE (earliest tide gauges), totals c.30cm so far, and is gradually accelerating (now c.2.5mm/y). The Intergovernmental Panel on Climate Change (IPCC) is alarmed, believing no other centennial rise or fall since 2ka exceeded 1mm/y or 25cm total. This starkly contradicts archaeological evidence in tectonically stable England where a 3-5m (sic) SL change for each of the Roman Regression (RR; Roman occupation 43-410CE), Romano-British Transgression (RBT, = Dunkirk II Transgression) and Little Ice Age Regression (LIR) is demanded by: (i) mapped c.200CE and c.1000CE coastlines now far (10s km) inland, c.5-6m above modern mean SL (MMSL); (ii) at least 1.5m progressive downshift of excavated Londinium quays; (iii) late Roman hut floors c.1m below MMSL in London; and (iv) many examples of 1000-1500CE lowland "reclamation" and supposed "silting" of former estuary-head ports. The RR-RBT SL cycle was driven by a renowned climate cycle (Roman Warm Period (RWP)-Dark Ages Cold Period-Medieval Warm Period (MWP)), of the solar-driven, millennial (1-3ky) type pervading the Phanerozoic geological record. Based on Ljungqvist's NH temperature curve, the RR was c.200-500CE (cooling), RBT c.500-1000 (warming), and LIR c.1000-1700. Corresponding SL changes estimated here, adjusted for 1-2 mm/y GPS-measured subsidence, are RR 3m (starting 5m above MMSL), RBT 5m and LIR 7m; the implied RBT rate of rise was 5m in 500y (av. 10mm/y; faster at inflection). Similar rises and timings are indicated by a high-resolution SL curve based on Red Sea foram isotopes: 2m fall (150-550CE), 7m rise (550-950; 17mm/y), 6m fall (950 to 1750 end of 5-point-smoothed curve). Moreover, the same curve shows other 5-14m oscillations since 8ka in the current interglacial and, in the previous interglacial, two rises and two falls of 4-13m, with peak rise rates of 11 and 20mm/y (coral data show even faster rates). IPCC's contrary belief in non-oscillating SL since 2ka is based on

(coral data show even faster rates). IPCC's contrary belief in non-oscillating SL since 2ka is based on four kinds of evidence: (1) Italian seaside fish tanks constructed c.2ka, now drowned only 1-2m; (2) in Caesarea, Israel, <1m variation in bottom elevation of 64 coastal water wells thought to span c.0-1100CE; (3) on Kiritimati atoll, <1m elevation contrast among coral microatolls dated 6-0ka; and (4) peri-Atlantic saltmarsh peat 1-3m thick whose microfossils and C14 ages suggest <1m SL variation since 2ka. However, all four are flawed: (1) the fish-tank evidence is blind to later rises and falls whose sum equals the net drowning, corrected for 1-2mm/y GPS-measured subsidence; (2) the wells in Israel are only weakly dated (typology of latest pottery shards identified at base of fill) and could all be 5th-6th century (SL low), gradually backfilled by later cultures due to rising brackish water driven by the RBT; (3) microatoll ages are clustered and have wide error bars allowing centennial gaps, each likely to hide a fast metric rise that drowned the microatolls and submerged the low-lying atoll too deeply for highstand recolonisation; and (4) all peat age-depth graphs comprise two linear segments (C14-dated- vs younger samples) that oddly meet at a sharp inflection, usually interpreted as a sudden increase in SL rise but more likely indicating C14-age exaggeration by an overlooked estuarine reservoir effect; projecting the post-C14 segment back in time suggests the entire peat section is post-1400CE (i.e. post-dates most of LIR). Intertidal fixed biological indicators, likewise said to indicate near-stable SL since 2ka, in fact intrinsically underestimate SL oscillations, being easily eroded/dissolved during and after SL fall, and hard to find after a rise; and again centennial gaps may conceal highstands. In flooded Cosquer Cave, France, a claim that a Paleolithic painting of two legless horses slightly (cm-dm) above the water level reflects leg erasure by the rising (but calm) sea water and implies SL was never higher, fails because (i) the supposed erasure line is not horizontal (c.30°) and (ii) most (>10) other paintings higher on the walls and ceiling are head-and-shoulders only, or at least footless. Moreover, all Cosquer paintings are faint, consistent with immersion during higher SL (MWP), unlike sharp coeval paintings in terrestrial caves worldwide. In conclusion, in the latest natural millennial climate cycle (MWP-Little Ice Age-Modern Warming), SL rise is now accelerating out of the 1700CE lowstand, towards a peak rate likely to approach or exceed IPCC's worst-case prediction of 15mm/y by 2100. SL rise and the causative warming (not yet quite as warm as RWP or MWP?) will probably last another 200-400y and exceed 4m, whether or not humans cut emissions.

Agenda

1. Introduction: smooth or oscillating sea level (SL) since 2ka?

2. UK historical evidence for a post-2ka metre-scale SL rise & fall, contrary to Intergovernmental Panel on Climate Change (IPCC)

3. Failure of IPCC arguments for unchanging (<25cm) SL since 2ka

4. Good correlation of proxy temperatures (Medieval Warm Period) & proposed Medieval SL highstand

5. Global temperature/SL change is due to inconstant sun, not CO2

6. Conclusion

This is a reconnaissance of UK **historical** evidence for post-2ka SL fluctuations

by a **geologist** (me) ...

- doctorate in sedimentary geology, 1982-86, Oxford
- 30 yrs as a petroleum geologist/sedimentologist, concerned almost daily with ancient sea levels

NB Of 255 co-authors of the 14 chapters of IPCC's "Climate Change 2013: The Physical Science Basis", the number of geologists of any kind (except 7 glaciologists) = **ZERO**

based on ...

since November 2015, my private,

full-time literature research

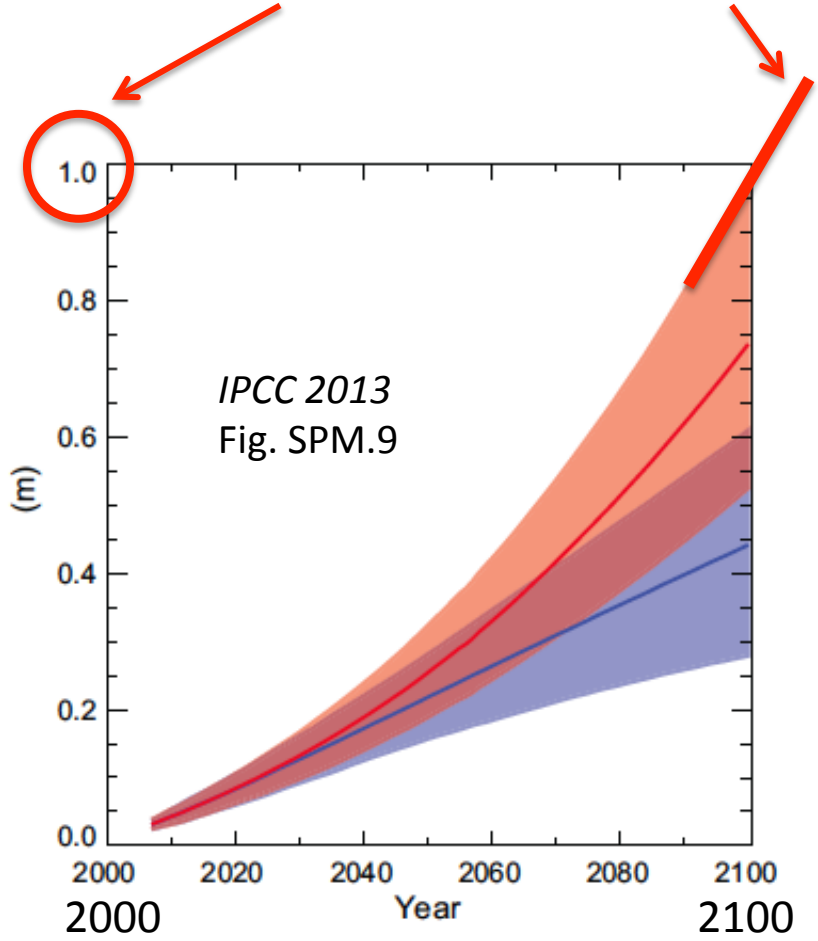
on climate- & sea-level change

Unpaid, i.e. impartial (contrast IPCC)

IPCC 2013 "Summary for Policymakers" worst-case prediction ...

By 2100, SL 1m higher & rate of rise 1.7cm/y (now 2.5mm/y),

unless humans cut emissions.



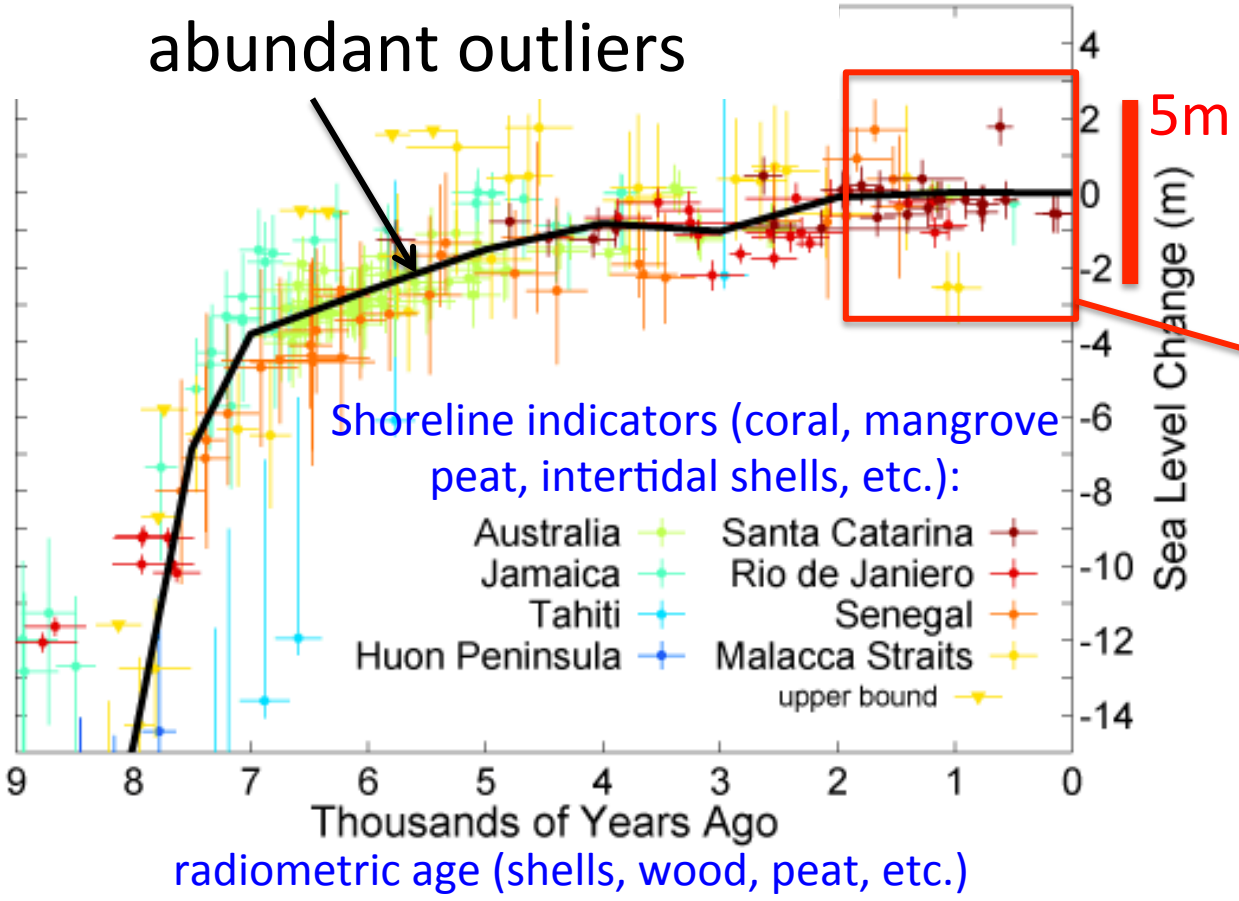
Instead I propose here:

1) SL rise will be much higher, and faster

2) Humans are not to blame

Eustatic SL 8-0ka, smooth or oscillating ?

Most workers accept this smoothed curve, despite abundant outliers



2-0ka.

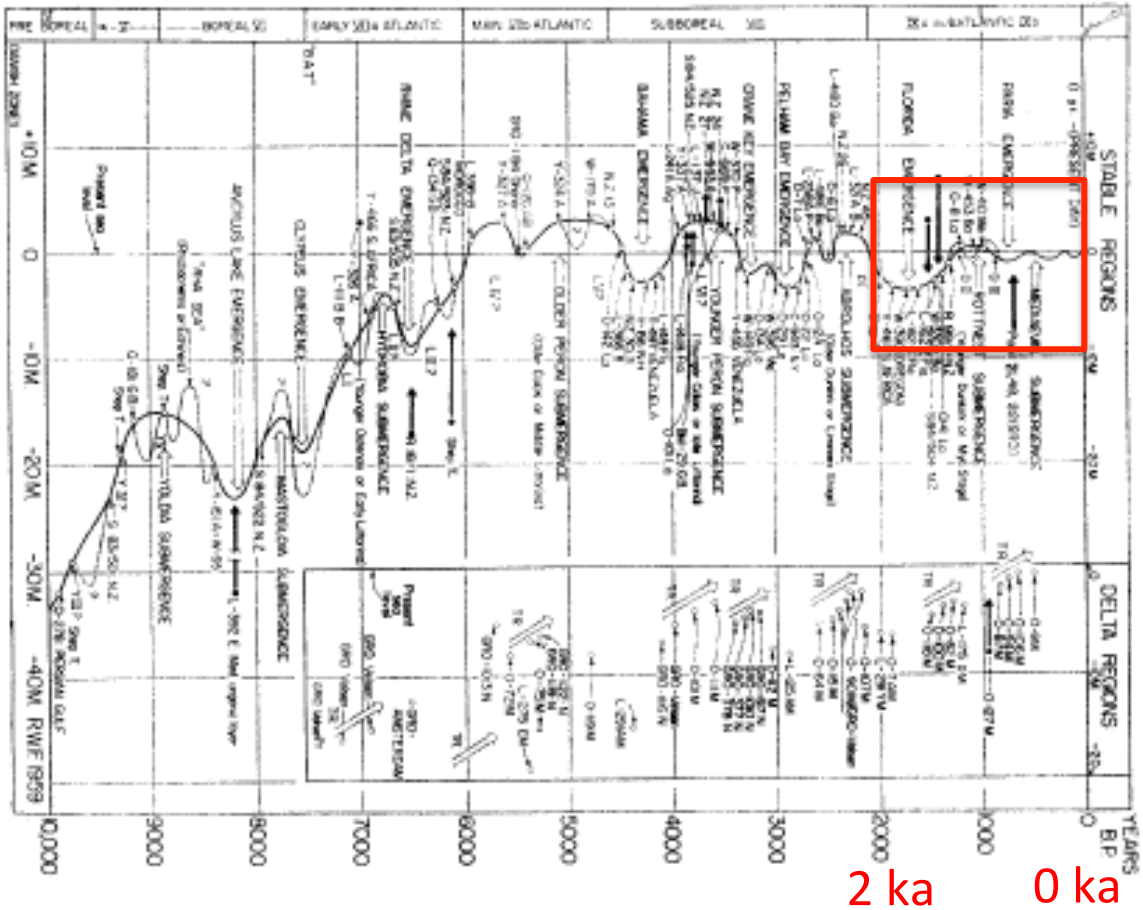
Many outliers.

UK archaeology gives dozens more

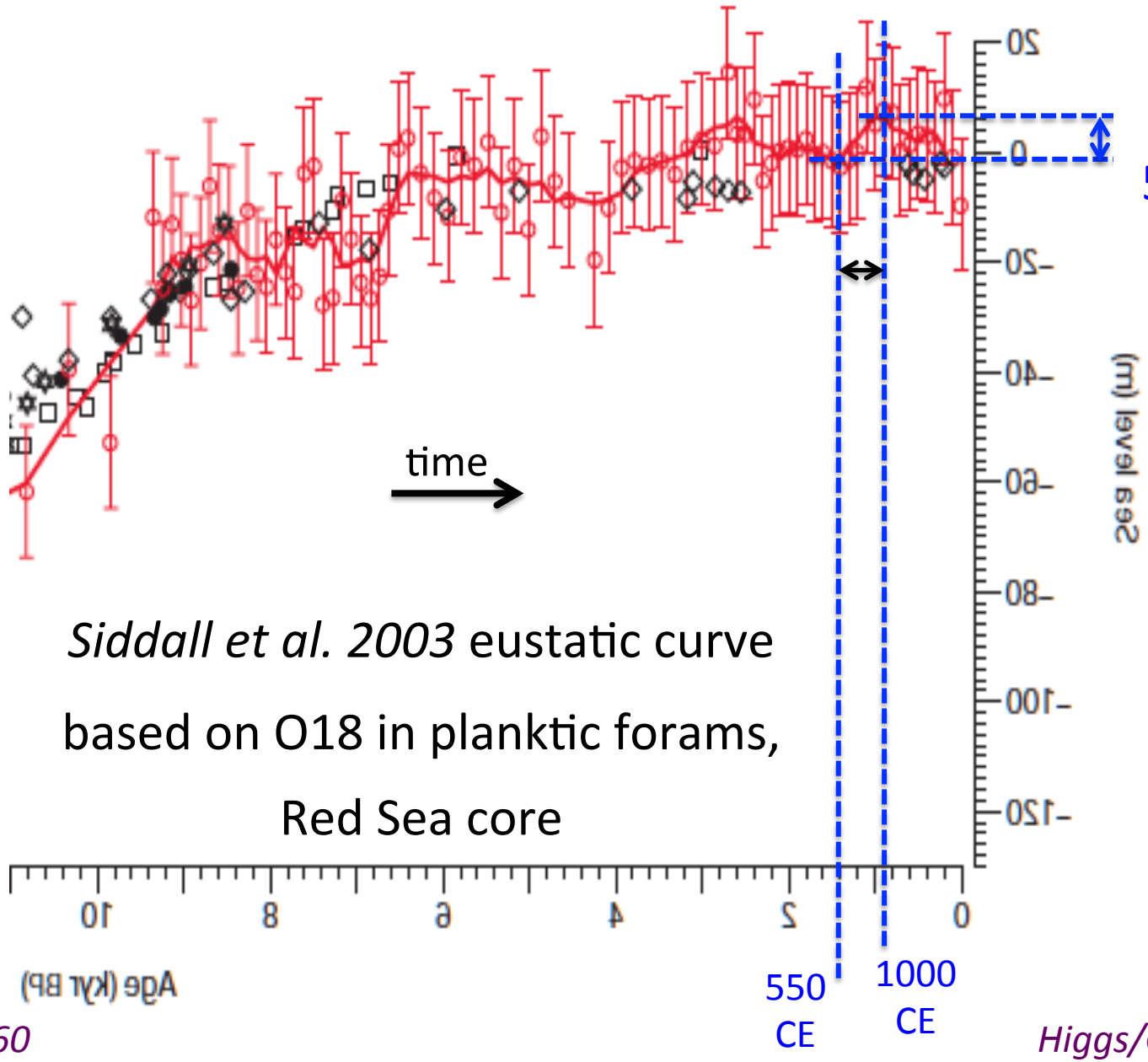
R. A. Rohde compilation, Wiki.
"A small number of extreme outliers were dropped."
https://commons.wikimedia.org/wiki/File:Holocene_Sea_Level.png

Fairbridge 1961 ... famous oscillator, widely rejected

"radiocarbon dated eustatic curve ... for stable ... regions"

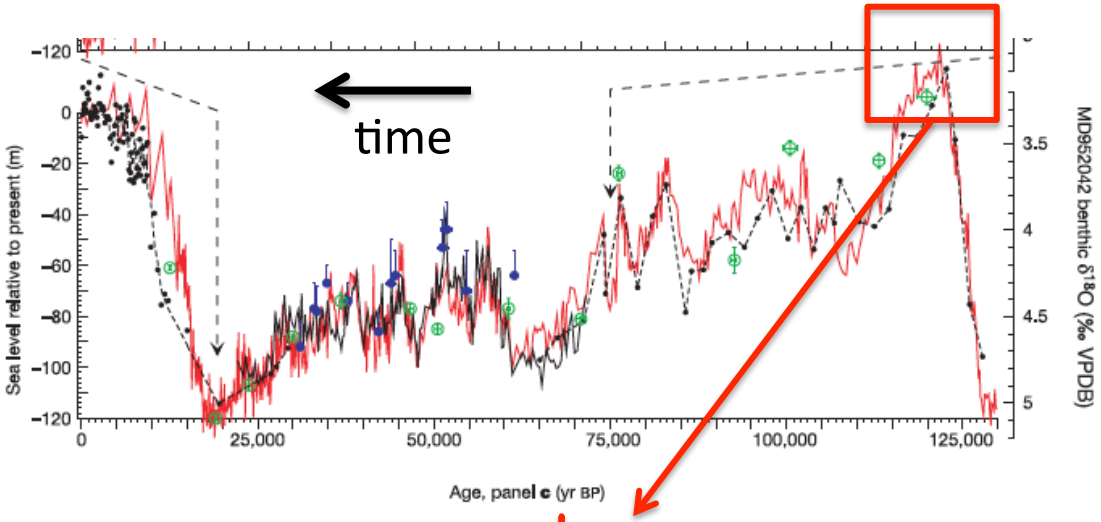


Support for Fairbridge ...



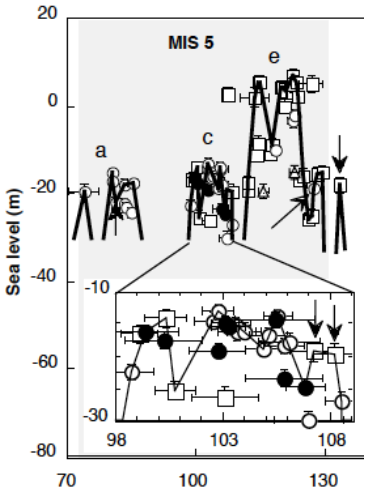
c. 8m rise, 550-1000CE, i.e. early medieval

More support for Fairbridge: evidence for brief (1-5ka), m-scale, SL oscillations during previous interglacial plateau

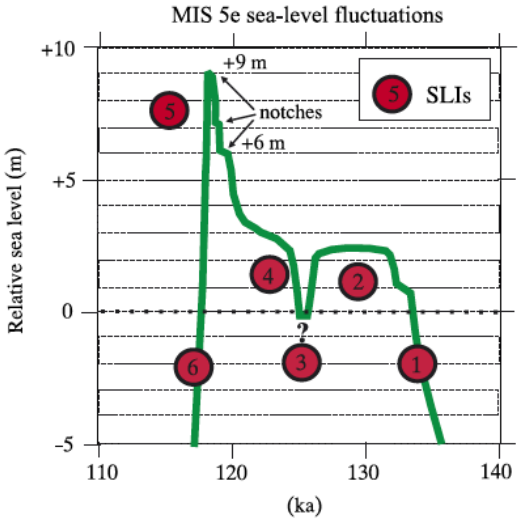


Shackleton et al. 2000 (red curve), in *Siddall et al. 2003*

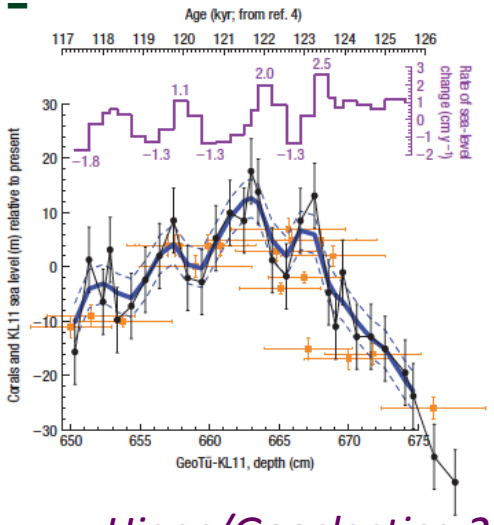
Barbados corals, *Thompson & Goldstein 2005*



Multiple global sites, reefs, notches, etc., *Hearty et al. 2007*

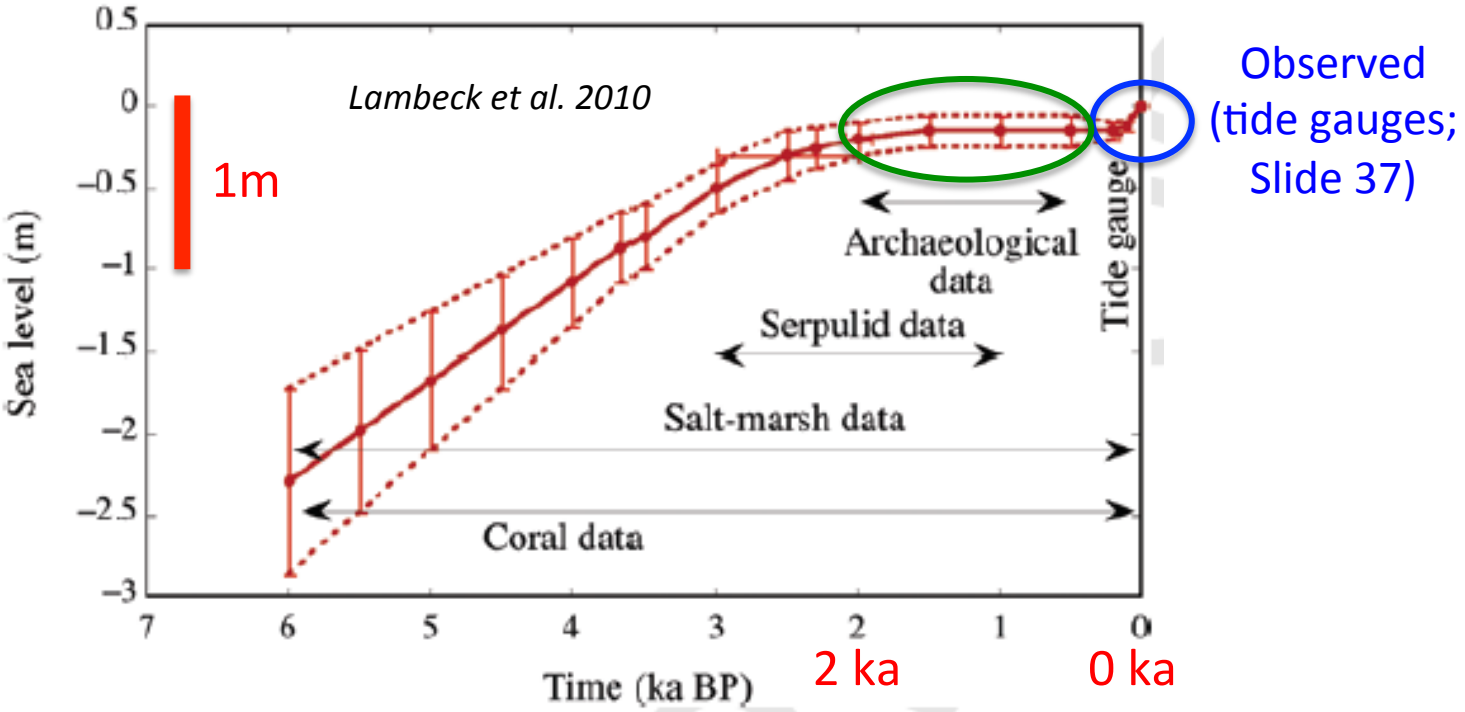


Red Sea core, O2 isotopes in forams, *Rohling et al. 2008*



But IPCC 2013 elected to smooth (reject outliers)

IPCC forecast rests *entirely* on this SL curve by *Lambeck et al. 2010*
*(*republished by *IPCC* as Fig. 5.17f of *Masson-Delmotte et al. 2013*; co-lead author Lambeck)



Measured rise since 1880 30cm, current rate 2.5mm/y

Interpreted rises/falls 0-1800CE <25cm per few 100y,
i.e. rates <1mm/y ("medium confidence")

IPCC's conclusion: the post-1800 30cm rise & current *rate* (2.5mm/y)
are exceptional, therefore must be caused by humans

England & Wales ideal for studying 2-0ka SL changes:

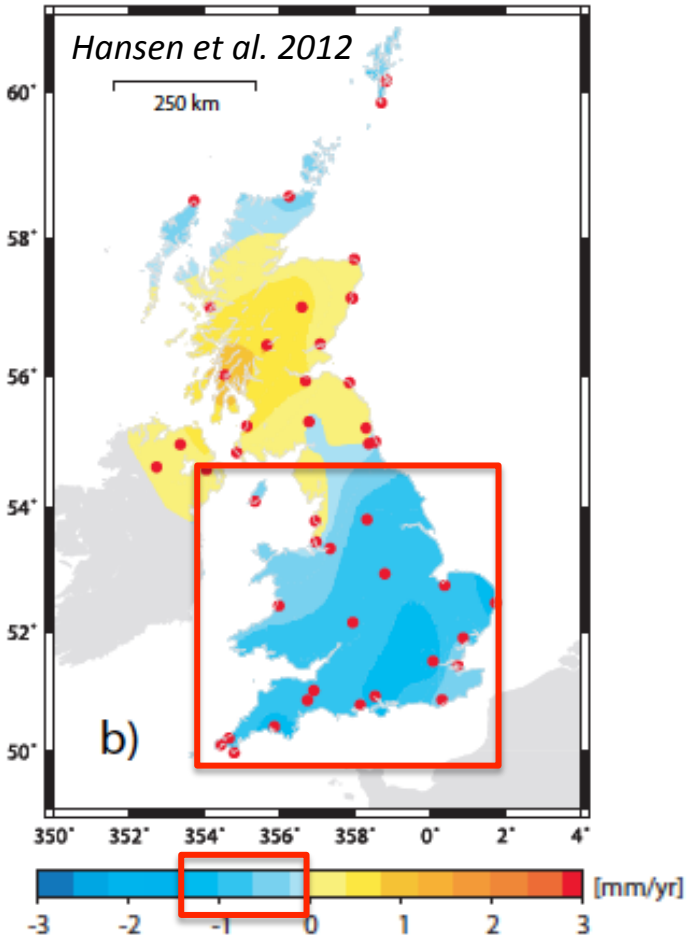
1) dozens of archaeological "benchmarks" of former SL *(e.g. town wharfs, castle quays),* dated by written records (ignored by IPCC)

2) tectonically stable (c.1mm/y GIA subsidence)

GPS

Bedrock sites (red dots) subside c.1mm/y (1m/ky)

Quaternary areas subside faster (compaction; drained peat shrinkage) c.2m/ky



Example of *neglected* UK evidence for a medieval m-scale eustatic rise & fall ...

Somerset Levels, SW England

blanketed by intertidal "Roman Clay"

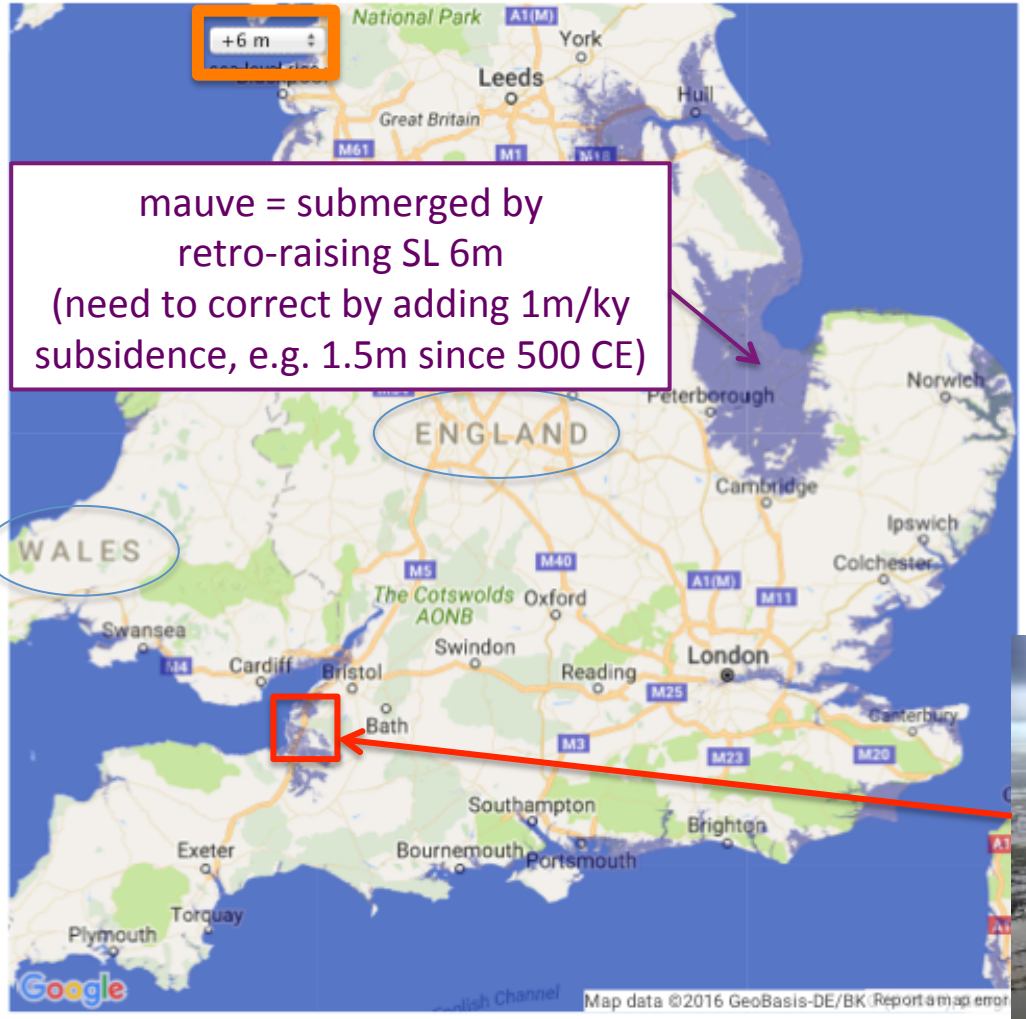
(named by British Geological Survey)

- which overlies 3rd-4th century (C) Roman salt factories

- & was resettled (i.e. supratidal) from 11th C onward

Somerset Levels

http://flood.firetree.net/



Tingle.

- very flat

- coastal clay belt <1m above high spring tide level (HSTL)

- inland peat belt below HSTL

- prone to flooding

Crucial publication overlooked by IPCC:

H. Godwin 1943

"Coastal Peat Beds of the British Isles and North Sea: Presidential Address to the British Ecological Society"

Journal of Ecology

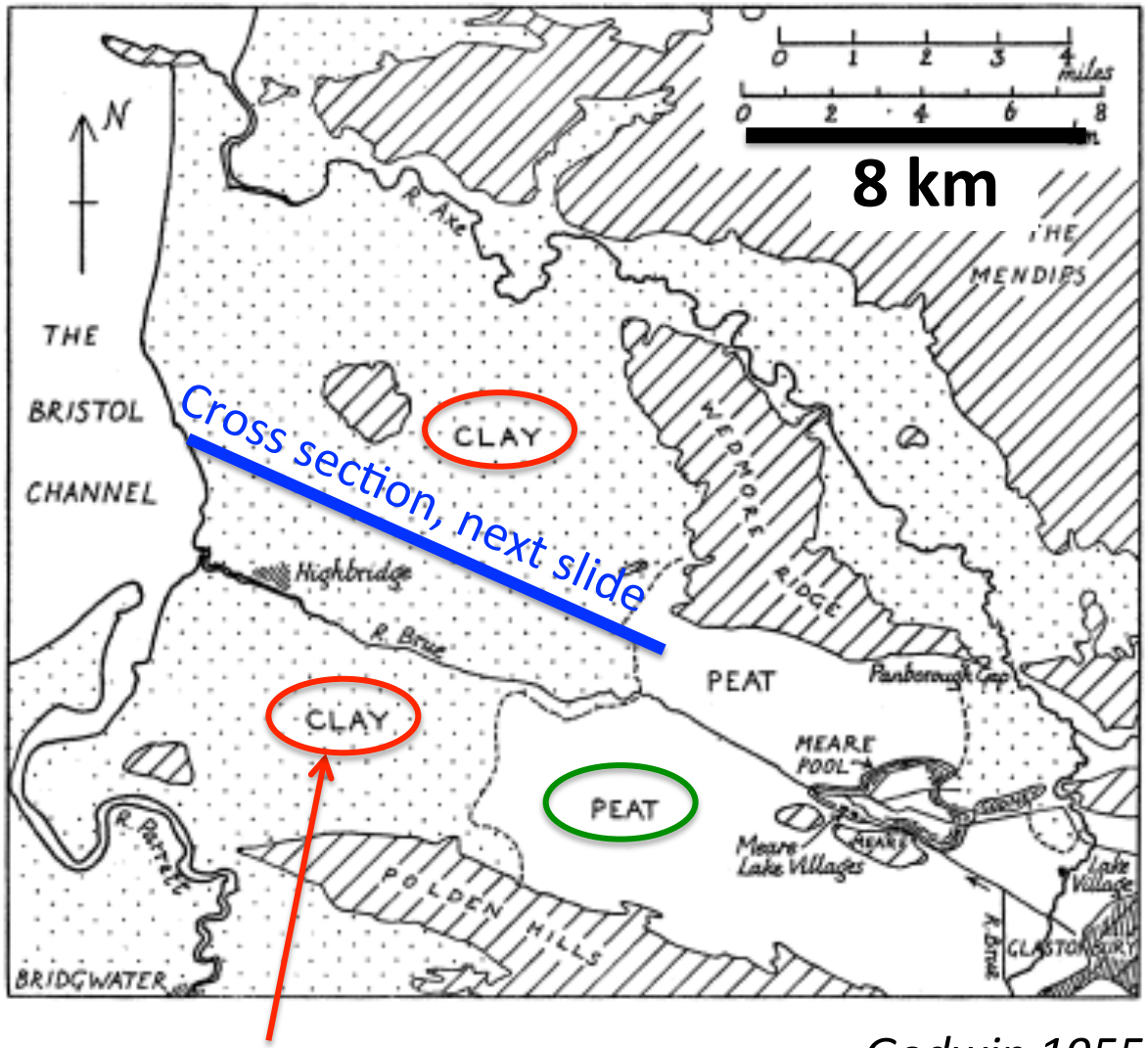
Sir Harry Godwin, FRS

- b.1901 - d.1985
- PhD Cambridge 1926
- >40 years lecturing in Cambridge
- Elected FRS 1945
- Elected Professor of Botany 1960
- Knighted 1970
- World-famous botanist & pioneer of radiocarbon dating & investigation of Quaternary sea-level changes
- Commemorated by Godwin Laboratory for Palaeoclimate Research, Department of Earth Science, Cambridge

Somerset Levels =

flat area of coastal

clay & inland peat



Godwin 1955

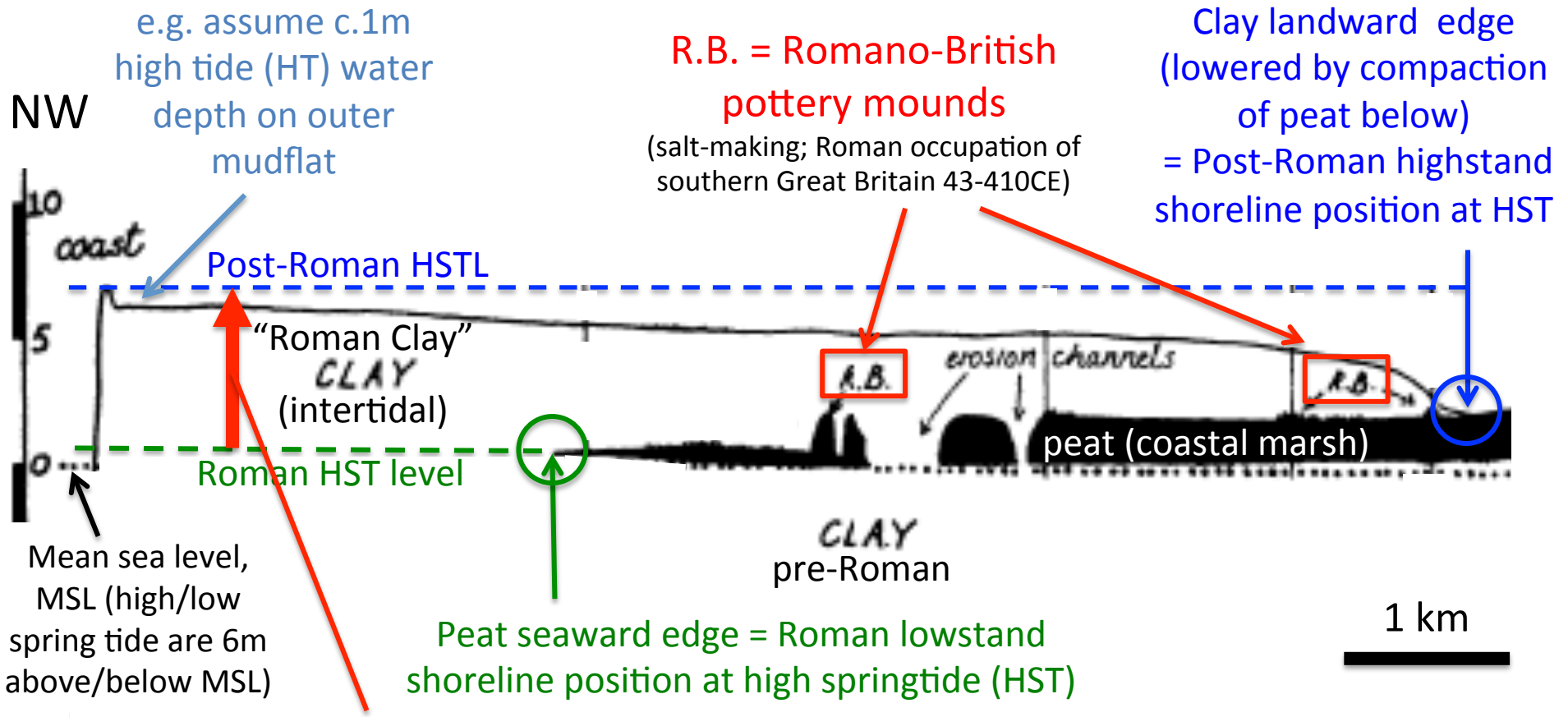
"Roman Clay"

= intertidal, based on forams,

lamination, sinuous channel fills

Somerset Levels cross section (location, see Slide 19)

Godwin 1943



Apparent post-Roman rise in HSTL = c.7m

>8m after decompacting Roman Clay

Mean sea level (MSL) rise likewise >8m, unless tidal range has changed

(1m less MSL rise per 2m increase in tidal range)

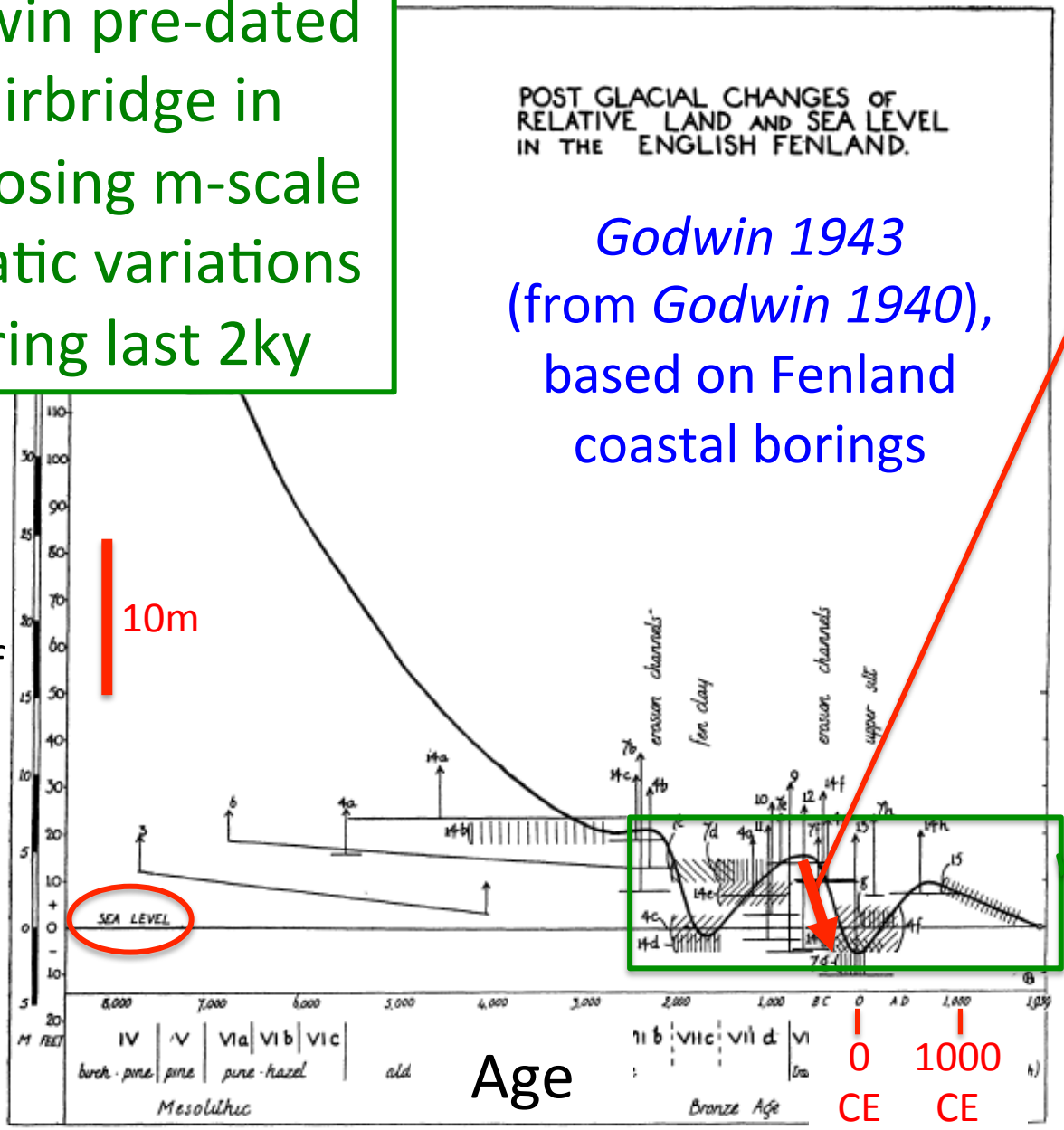
Godwin (1943) called this SL rise the "Romano-British Transgression" (RBT)

"evidence ... demonstrates ... marine transgression in Romano-British times"

"There is some indication that there may have been a eustatic rise in sea-level during Romano-British times"

Godwin interpreted the rise as eustatic (i.e. global; not just local subsidence), based on abrupt upward change from peat to intertidal mud on both W & E coasts of England (Fens & Somerset Levels)

Godwin pre-dated Fairbridge in proposing m-scale eustatic variations during last 2ky



Godwin 1943 (from *Godwin 1940*), based on Fenland coastal borings

Relative land level (inverse of rel. SL)

↓

SL higher

c.6m rel. SL rise, culminating 0 CE (NB dating was poor, based on archaeology & calibration of Fen pollen to Swedish varved clay pollen)

Metre-scale relative SL oscillations since 2500 BCE

Can't reflect yo-yo tectonics (uplift, subsidence) as southern Great Britain is stable

i.e. must be eustasy

Fig. 23. Curve representing relation of land-level to sea-level in the Fenland throughout the period shown on the base-line. The convention of constant sea-level has been used. The numbered lines and shading represent the indices from which the curve was constructed. (Reproduced from *Philos. Trans.*)

Independent evidence for a metre-scale eustatic *fall* since Roman times (i.e. after 410 CE):

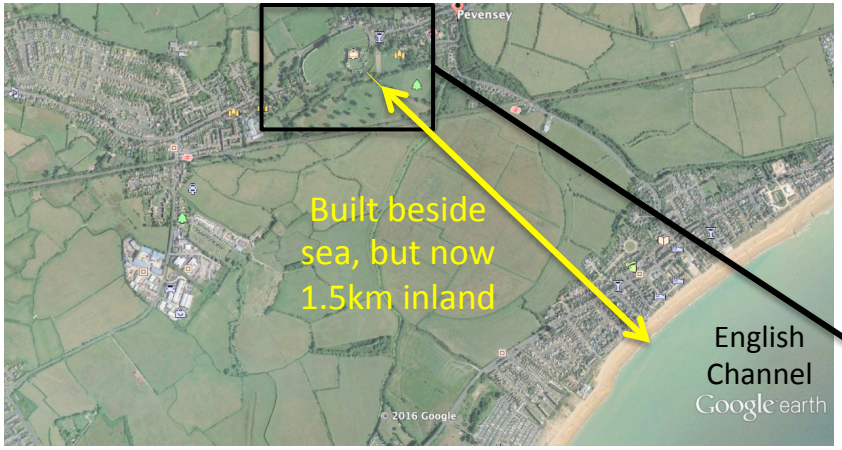
1. resettlement of Somerset Levels coastal-clay belt (i.e. no longer intertidal) from 11th C onward

2. *dozens* of former ports & seaforts, now 1-25km inland & 2-7m above SL

e.g. Pevensey Castle...

Pevensey Castle, S coast UK

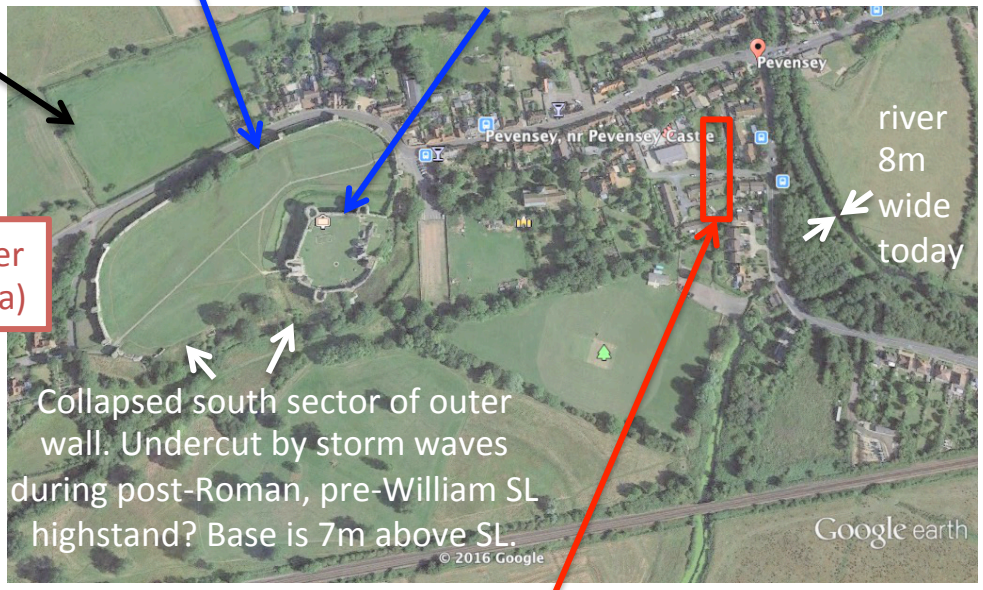
William the Conqueror's fleet landed here, 1066



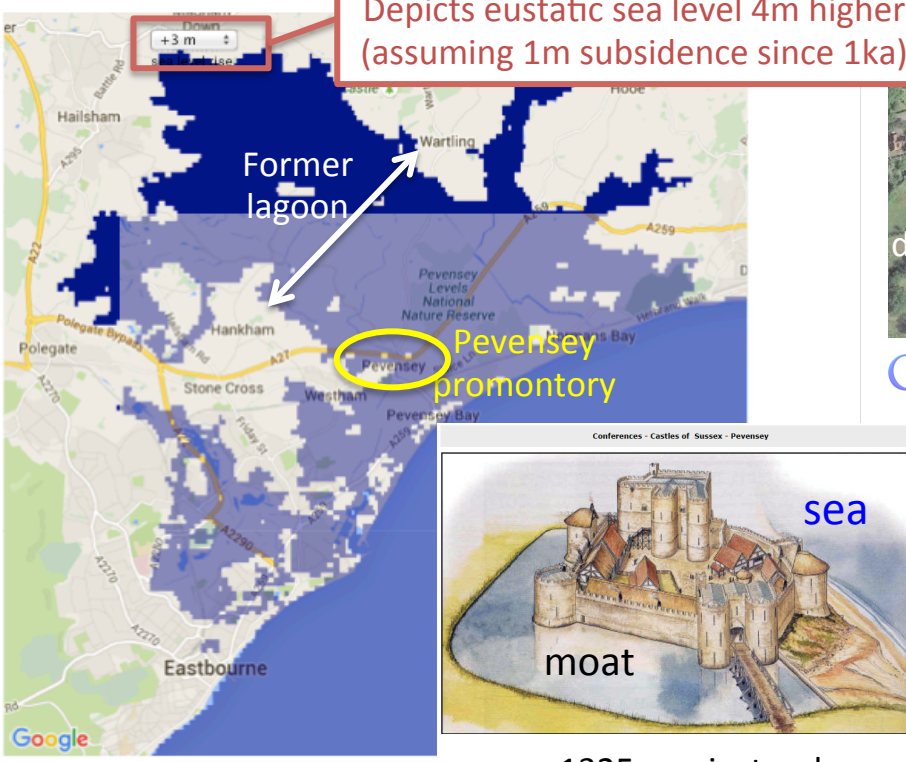
Google earth miles 1 km 1

Roman outer wall c. 300 CE

Norman inner castle c. 1100 CE



Google earth feet 1000 meters 300



c.1325, conjectural.
Castle Studies Group
©English Heritage

Site of excavated early 13th C docksite. Current ground elevation is 4m above mean SL (MSL); restores to 5m, after allowing for 1m/ky subsidence (Slide14). Tidal range in former Pevensey lagoon might have been, for example, 2m above & below MSL.

Higgs/Geoclastica 2016

Wikipedia: Antony McCallum

Another example:

Bodiam Castle,

built 1386 ...

... had "a harbour capable of accommodating two warships"

(Cracknell 2005) ...

... but today is stranded 25km upriver

Sea level rise. Brought to you by Alex Tingle.
Elevation data provided by NASA

Bodiam Castle

Google earth

feet 900
meters 200

Today's river is just 7m wide !

Solution: retro-raise sea level by 5.5m

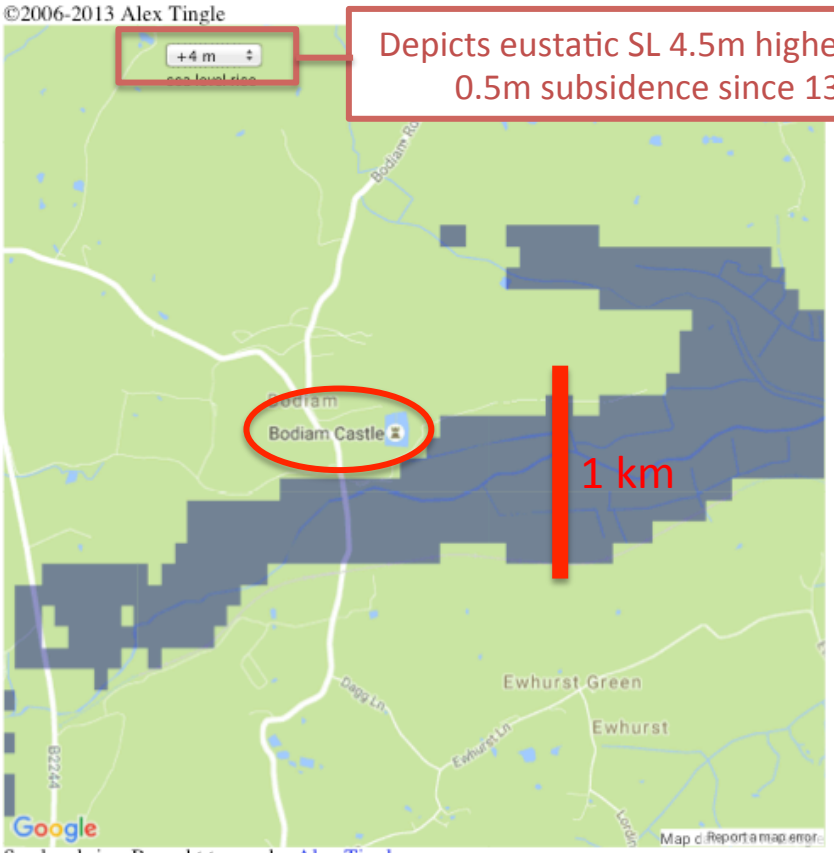
Depicts eustatic SL 5.5m higher (assuming 0.5m subsidence since 1386 CE)

Bodiam near estuary head

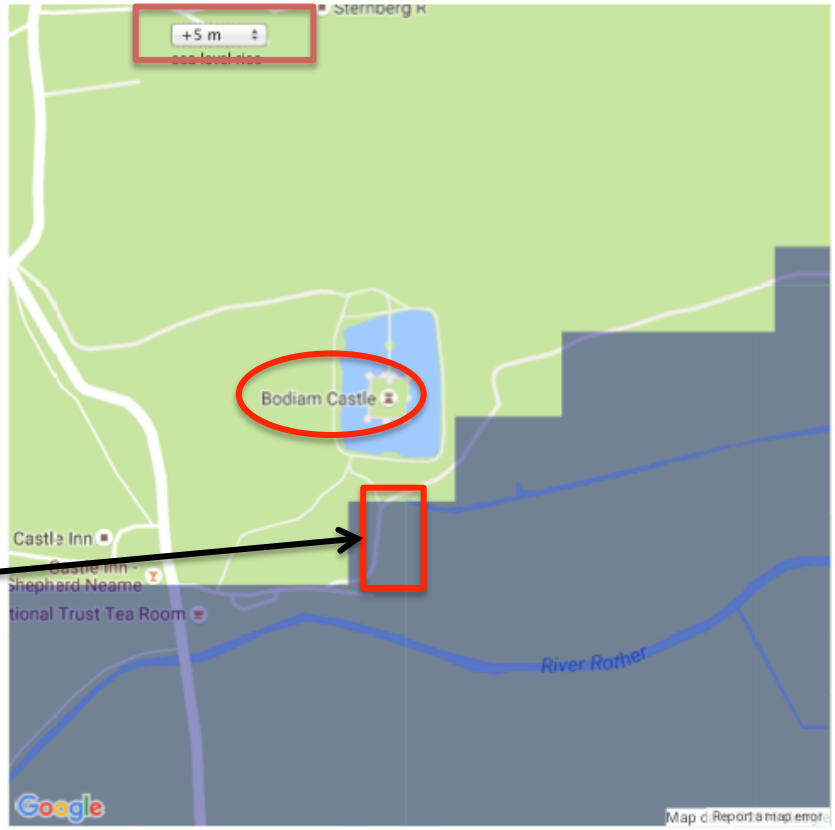
Nuclear power station!

Sea level rise. Brought to you by Alex Tingle.
Elevation data provided by NASA

Bodiam Castle



zoom:



A 5m retro-rise
(5.5m corr. for subsidence)
makes supposed docksite
accessible by ships

Historians incorrectly blame inland stranding of former ports & castle docks in southern Great Britain entirely on "silting" of an estuary, lagoon or bay

"Silting" is simply sedimentation (causing coastal progradation) by excess sediment supply; it can occur during rising, falling or static SL

The stranded wharfs are 3-7m above modern SL (after adding 1-2m to correct for subsidence), therefore

real sea-level fall must have occurred,

moving the shoreline seaward, with or without "silting"

Ask any sedimentologist !

The SL fall was global (eustatic), not relative (tectonic), as

1) it followed a SL rise
(Romano-British Transgression)

2) southern GB is subsiding
(Slide 14)

IPCC believes:

A) "The magnitude of centennial-scale global mean sea level variations did not exceed 25 cm over the past few millennia (medium confidence)"
Masson-Delmotte, Lambeck et al. (in IPCC 2013)

B) Holocene SL was never higher than today

based on 5 lines of evidence -

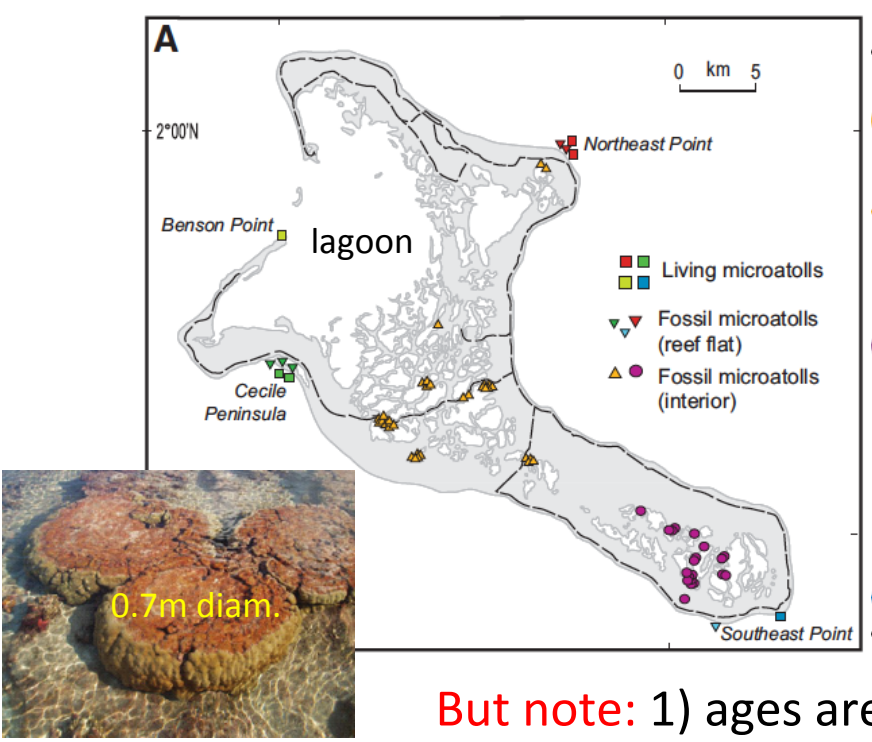
1. Italy: coastal fish tanks built at SL c.2ka , now drowned only 1-2m
   Lambeck et al. 2004a
2. Israel (Caesarea): coastal water wells roughly dated as spanning 0-1100 CE, bottom elevation varies <1m *Sivan, Lambeck et al. 2004*
3. Pacific island Kiritimati atoll: coral microatolls span 6-0 ka, elevation varies <1m
   Woodroffe, Lambeck et al. 2012
4. peri-Atlantic saltmarshes: foram associations in surficial peat cores 1-3m long dated 2-0ka indicate <25cm SL change *Numerous papers by Gehrels et al., Kemp et al. (see Slides 33-37)*
5. France: Paleolithic paintings on limestone cave walls supposedly erased by rising sea water
   Lambeck & Bard 2000

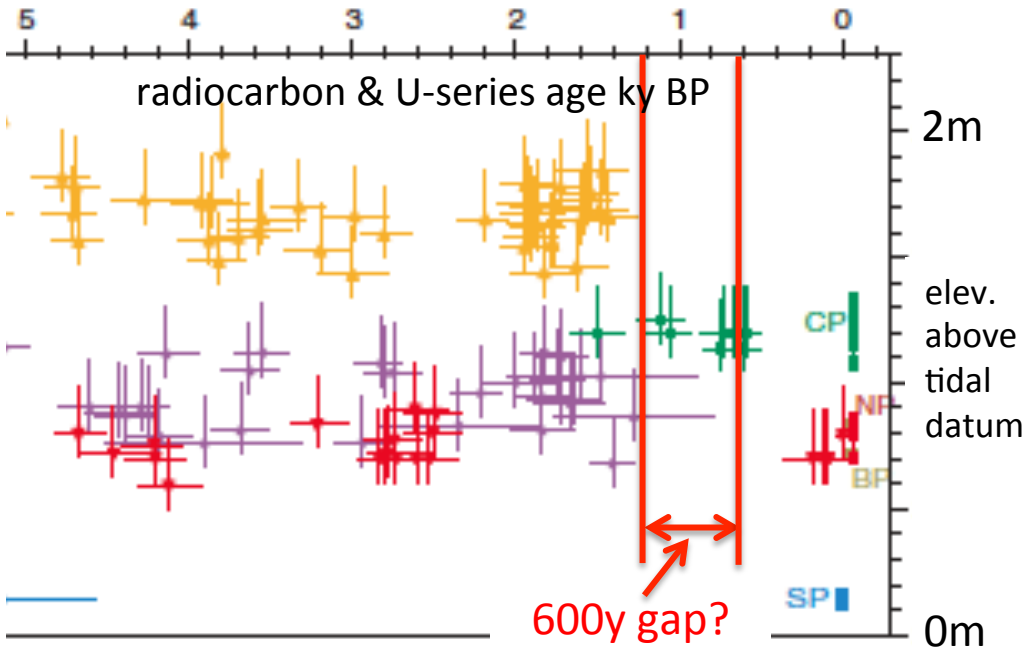
But all 5 arguments are flawed (see Slides 2-4, 32-41), e.g. ...

Flawed evidence 3: Kiritimati (Christmas Island)

"Mid-Pacific microatolls record sea-level stability over the past 5000y" *Woodroffe, Lambeck et al. 2012*

Coral microatolls dated 6-0ka differ <1m in elevation:





But note: 1) ages are clustered & error bars wide

2) >99% of island is <4m above SL (max. c.13m, Joe's Hill dune)

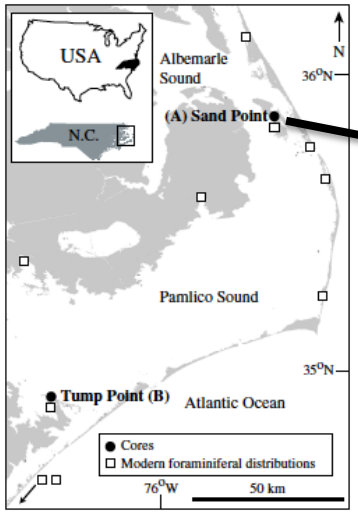
Possible scenario:

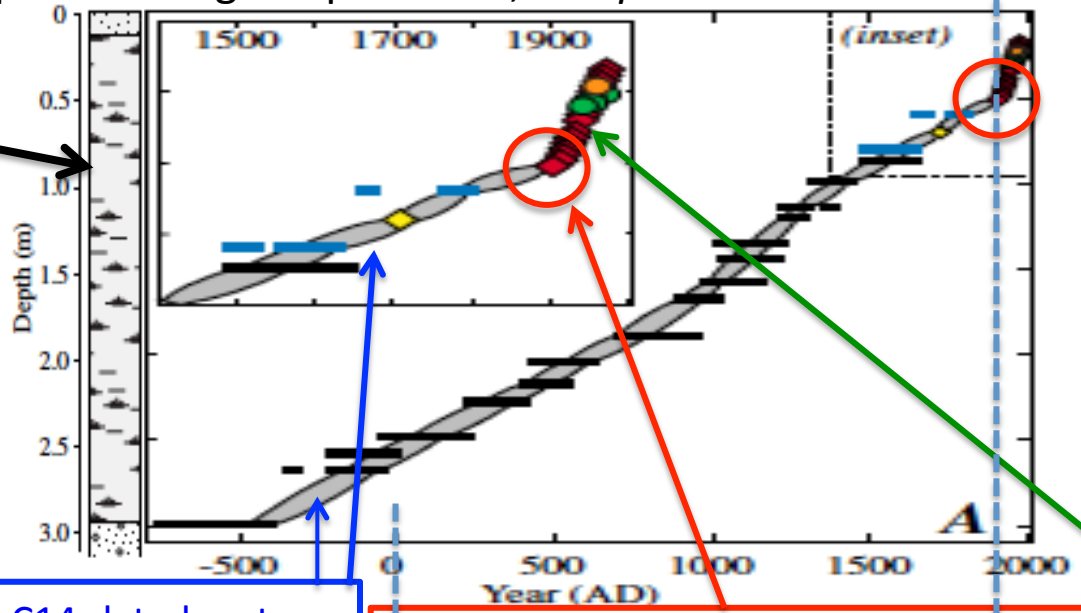
- wide error bars 'hide' a Medieval m-scale SL rise & fall (cf. Slide 47)
- rise rapidity (>10mm/y at inflection; see Slide 52) drowned existing corals
- rise transgressively planed off coastal dunes
- at highstand, entire island was under water, too deep (m) for coral recolonisation

Flawed evidence 4: peri-Atlantic saltmarsh (USA, Canada, UK, Iceland) peat cores, 1-3m long, whose C14 dates, foram associations & lack of erosion surfaces suggest eustatic SL varied <25cm since 2ka

e.g. *Gehrels et al. 2002, 2005, 2006; Kemp et al. 2009, 2011, 2013, 2014, 2015*

Example of typical core age-depth curve, *Kemp et al. 2011*:





Age Model Key

- *Bchron* age (95% conf)
- AMS ^{14}C
- HP AMS ^{14}C
- Bomb-spike AMS ^{14}C
- ^{137}Cs (1963)
- *Ambrosia* (1700-1740)
- ^{210}Pb

pollution events & pollen marker

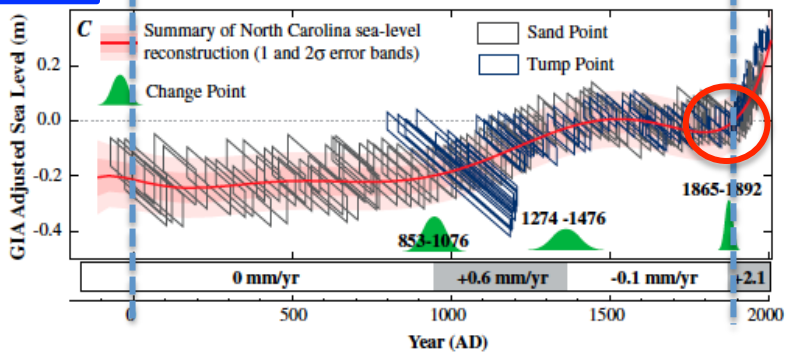
All age-depth curves show 3 features:

1. C14-dated sector; near-linearity suggests "stable" eustatic SL

2. Dog-leg, interpreted as sudden onset of "rapid" SL rise at 1870 +/-50y

3. Sector too young (<200y) to date by C14 (wide errors)

Derived eustatic SL:



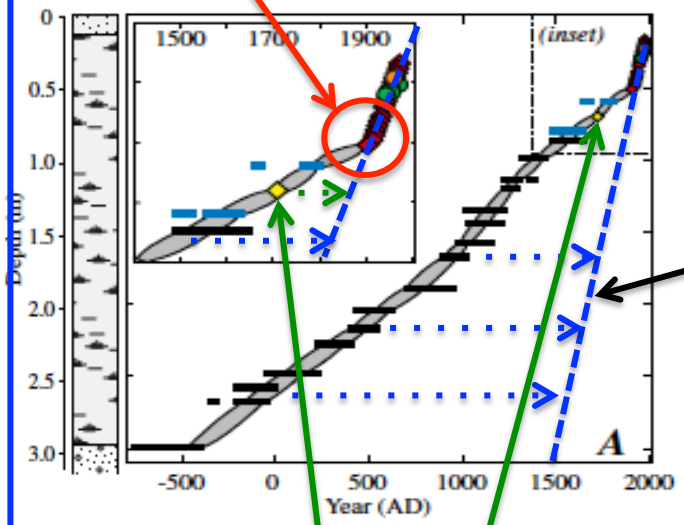
All authors interpret dogleg as peat accumulation rate jump due to sudden start of rapid SL rise, after 1800 (implying manmade) BUT …

1) Why sudden?

2) Why does dogleg coincide *exactly* with change of dating technique, from C14 to (younger) pollution horizons?

More likely:

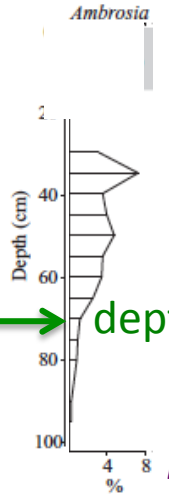
Dogleg is an artefact of false (too old) C14 ages caused by an overlooked estuarine reservoir effect, e.g. brackish saprobes fix CO2 released by decay of deeper, older plant material ?



Upper (post-C14) sector extrapolates to c.1500 CE, i.e. entire core might post-date most of Little Ice Age regression (cf. Slide 51). Indeed, accumulation of 3m peat in 500y (6mm/y) is compatible with eastern USA subsidence (GPS 1-5mm/y; Sella et al. 2007).

Suspect non-C14 data point …

Kemp et al. 2009: at 0.7m, upward-increasing *Ambrosia* first reaches 2% of total pollen, dated "A.D. 1720 ± 20 (after Cooper et al., 2004)". In fact Cooper et al. used 1% (not 2%) & said *approximately* 1720 & "The uncertainty of this date is not known". The 2% marker might instead be much younger.



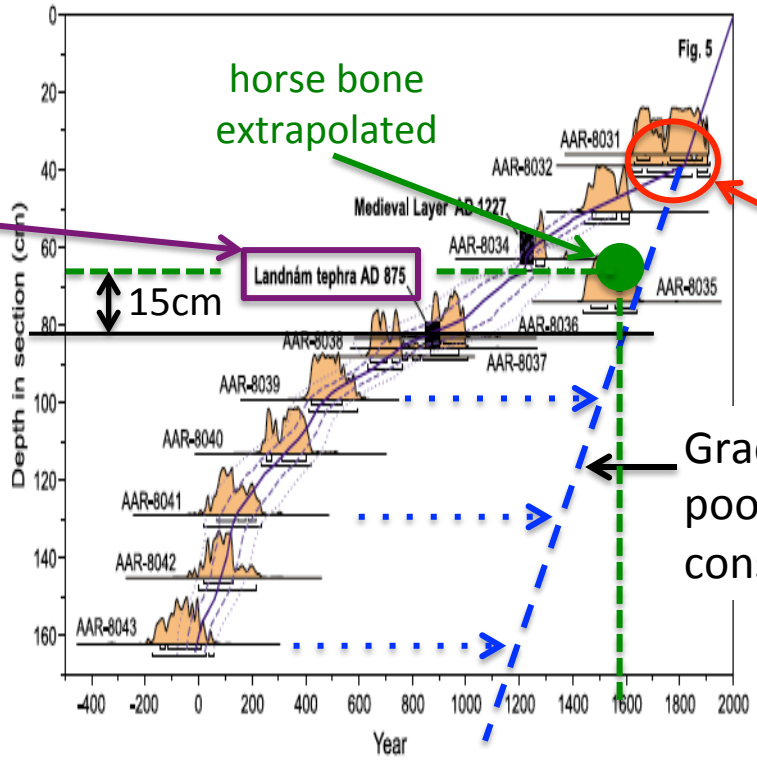
depth 70cm

Another peat core

Gehrels et al. 2006, Iceland, Creekbank Section 3A

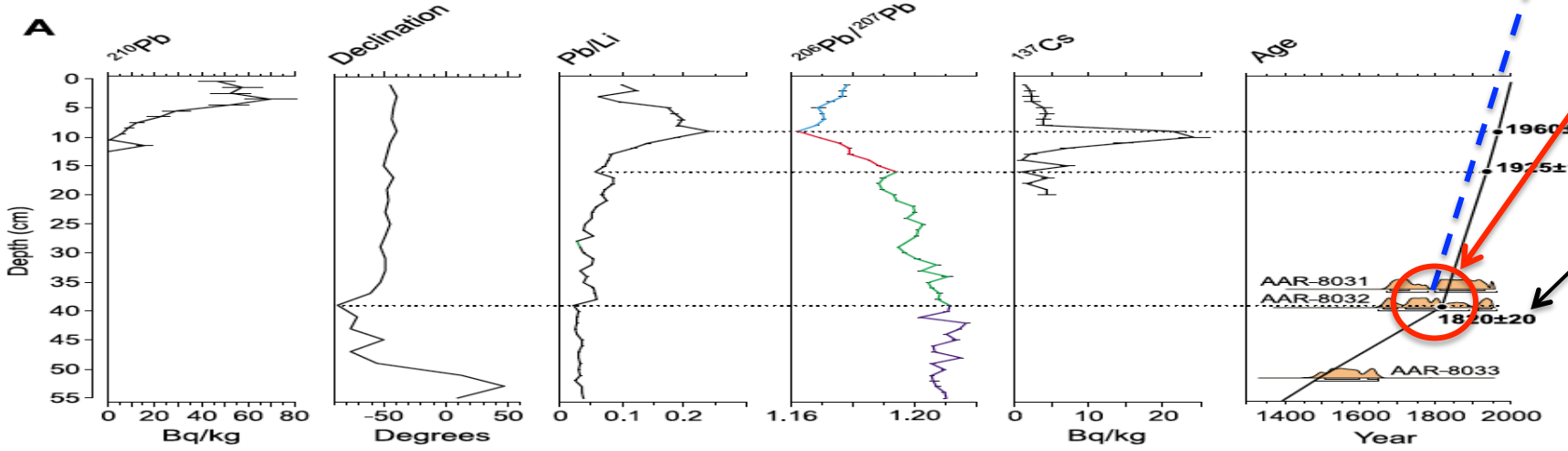
Suspect non-C14 data point …

Authors identified Landnám Tephra (dated elsewhere by others as 875 CE) based on the bracketing peat C14 ages. But if C14 ages are too old (Slide 34), this may in fact be a much younger tephra, as also suggested by a horse bone dated 1578 CE +/-58 lying only 15cm above it in Creekbank 2A, 1km away (Slide 36)



Dogleg

Gradient poorly constrained



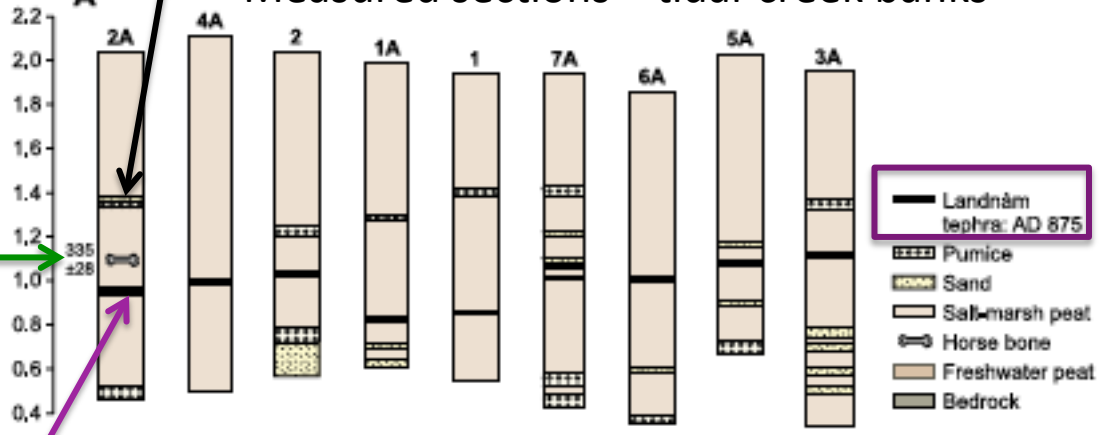
Pollution markers, weakly dated

Change in Pb conc'n & swing in magnetic declination

Gehrels et al. 2006, Iceland

Pumice layer presumed correlative with the "Mediaeval Layer", which was dated elsewhere by others as 1226/27 CE (incompatible with horse-bone date below)

Measured sections = tidal-creek banks



Horse bone C14 age 335, calibrated age 1520-1636 CE (dated by *Gehrels et al. 2006*)

Presumed Landnám tephra, dated elsewhere by others as 875 CE.

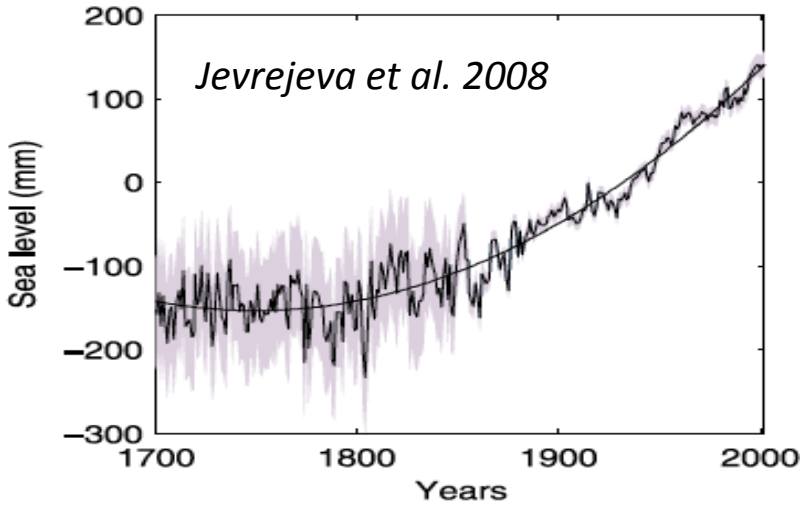
Evidence *against* this being the Landnám Tephra:

1) In the study area the tephra is white (*Gehrels et al. 2006*). Contrast *Wastegard et al. 2003 (*ref. in *Gehrels et al. 2006)*: "In SW Iceland the layer is two-coloured, with a lower light-coloured part and an upper dark-coloured part".

2) The horse bone lying 15cm above it is dated 1578 +/- 58, so if the tephra is genuinely 875 CE, the intervening 15cm accumulated in 700 years (i.e. average 0.2mm/yr), in contrast to 1m between the horse bone and today's saltmarsh surface (i.e. 500y; av. 2mm/y, ten times faster)

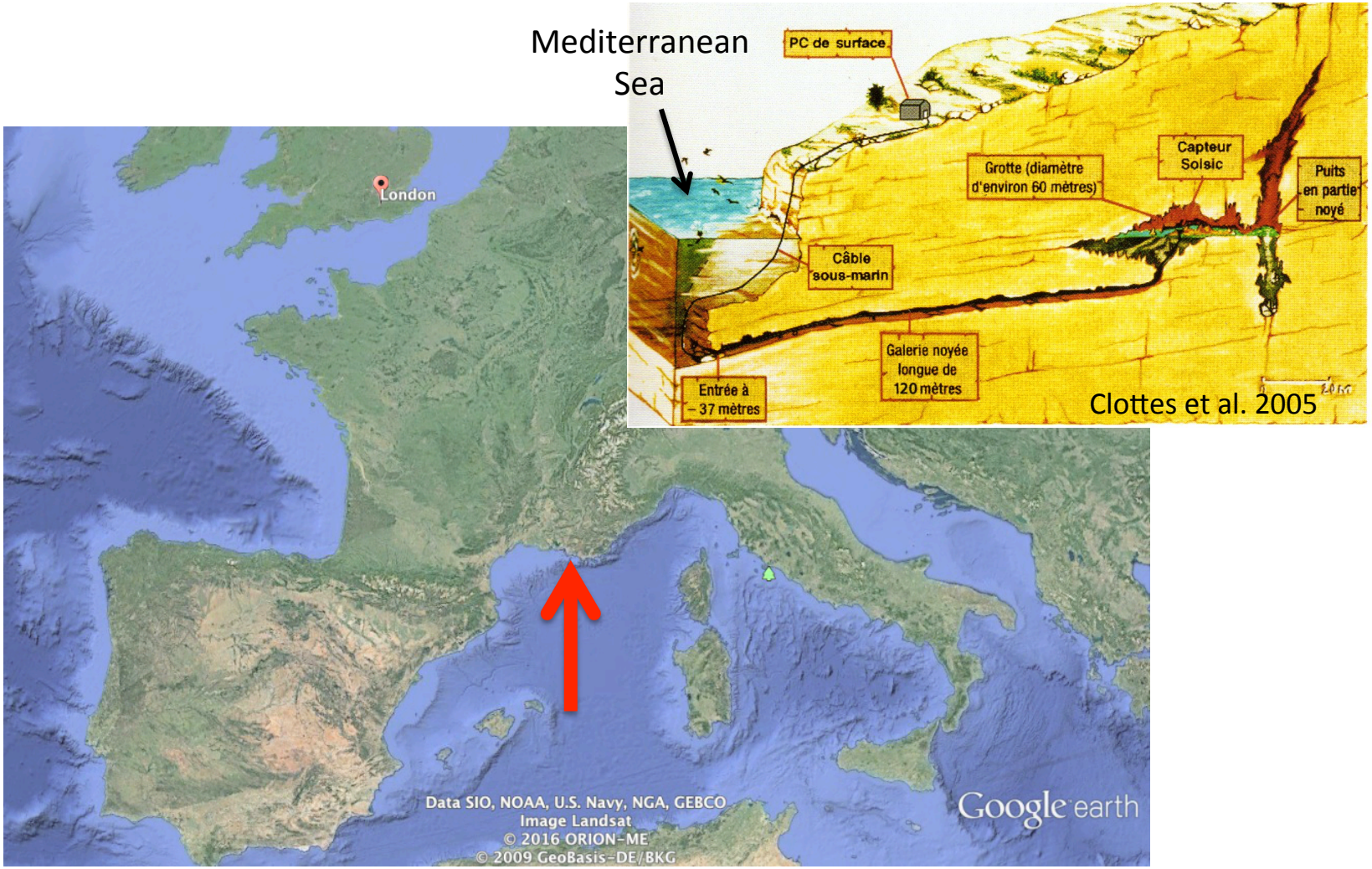
Thus the peat cores may indicate SL has fluctuated <30cm since c.1500 CE only, instead of since 0 CE (2ka)

cf. tide-gauge measurements since 1700 ...



Flawed evidence 5: Cosquer Cave, France

c.22ka Paleolithic paintings on limestone cave walls



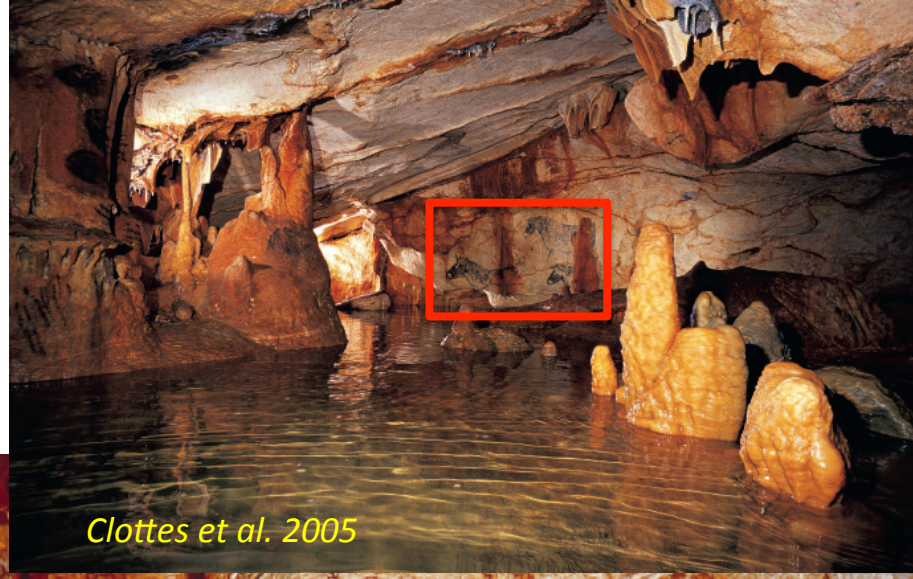
Lambeck & Bard 2000

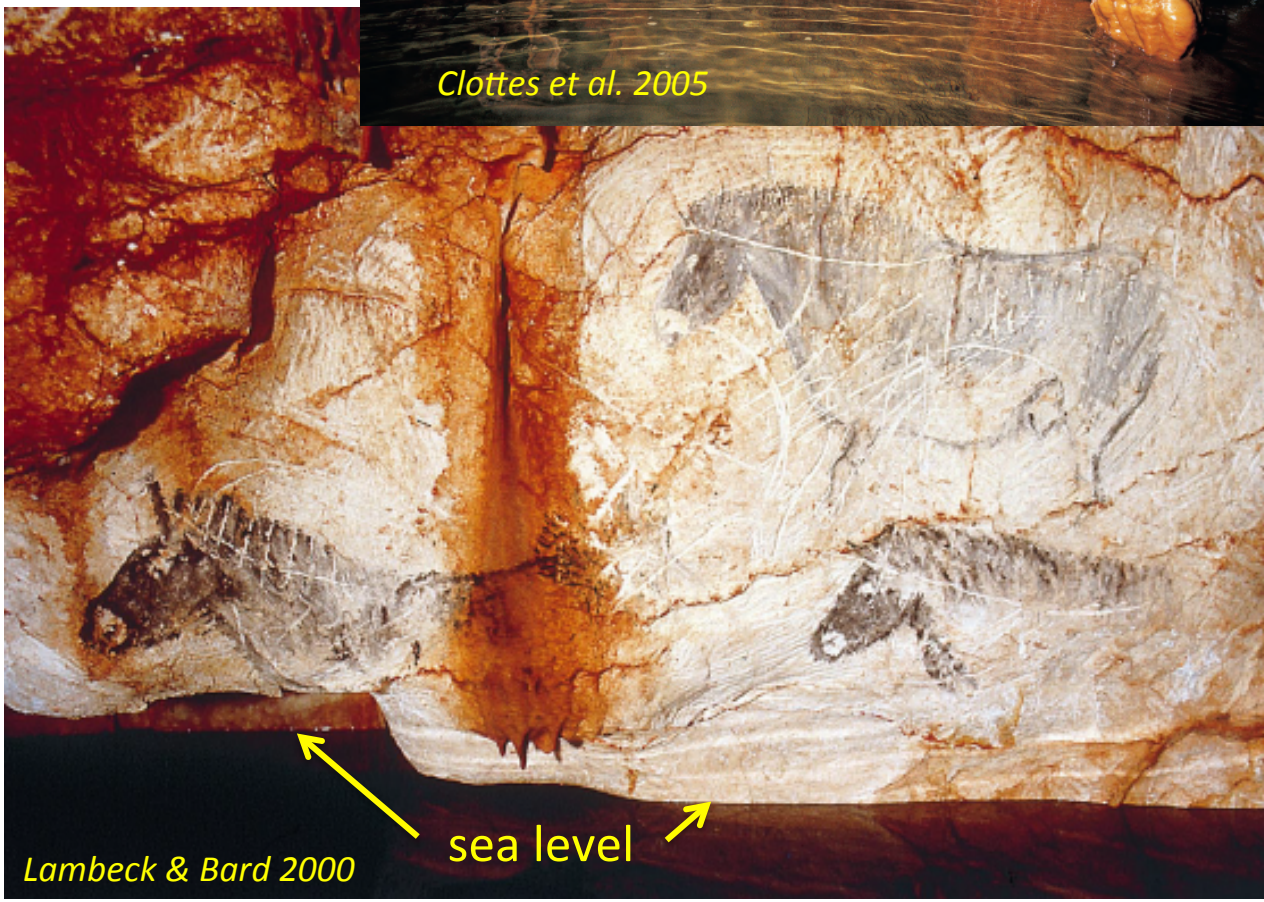
"horse's legs ... damaged only up to ... 0.5m above present mean sea level"

implying:

1) rising sea water erased the legs (by dissolution; water calm)

2) since 22ka, SL never higher than today





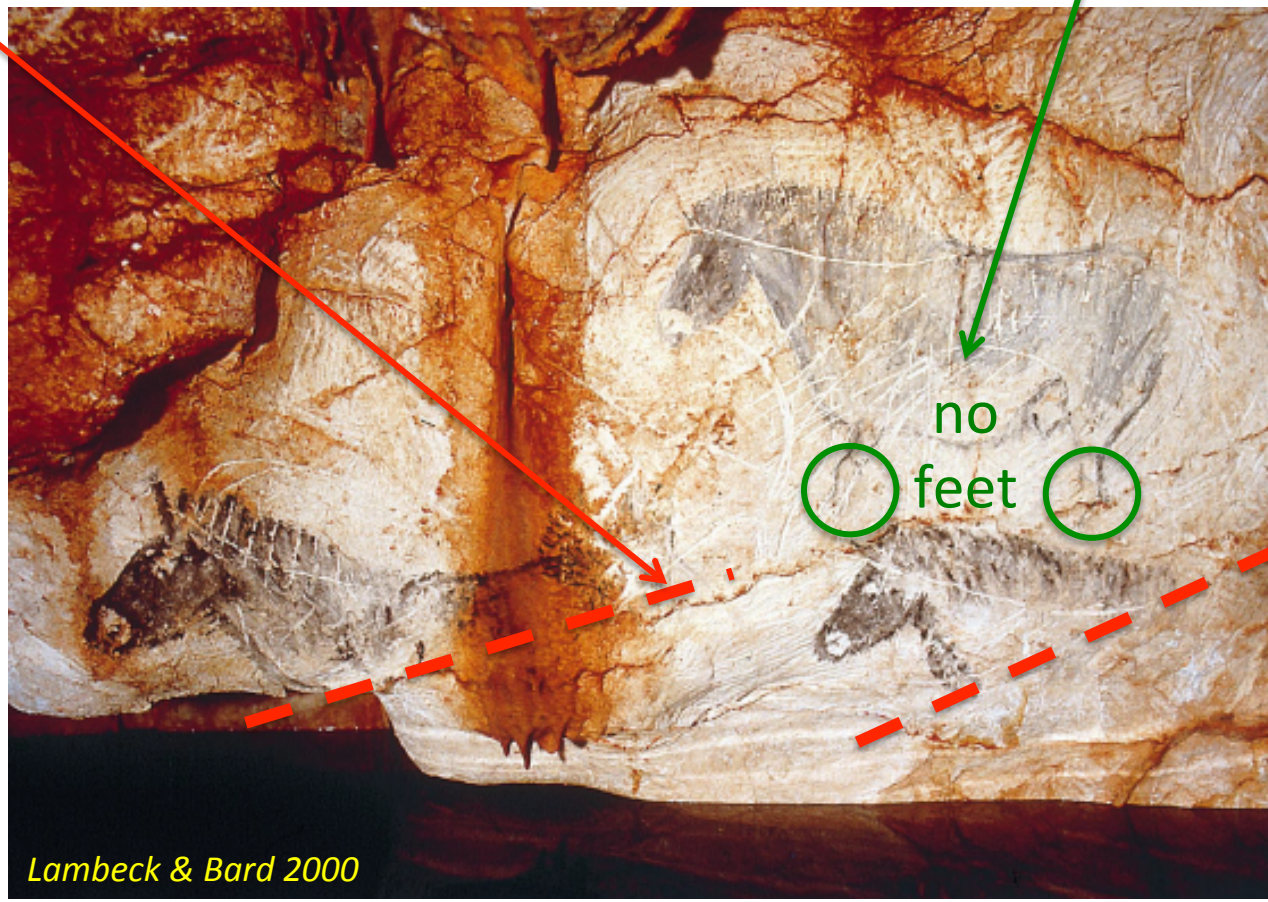
contradictions ...

1) “damage” lines not horizontal

2) other (higher) paintings likewise just head-and-shoulders; or at least footless

3) calcite is *stable* in sea water.

In fact the paintings have a calcite veneer (Clottes & Courtin 1996)



Cosquer cave, *Morhange et al. 2001*:

"Indisputable traces of a Holocene vertical oscillation above present sea level have never been found in Provence. This is proved, for example, by the preservation above present sea level of some half-submerged palaeolithic horses (Fig. 7; Vouvet et al., 1996), painted on a wall of the Cosquer cave near Marseilles. The lower part of the painting only has been blotted out by sea water, whereas any recent positive level oscillation would have also destroyed the upper part of the painting."

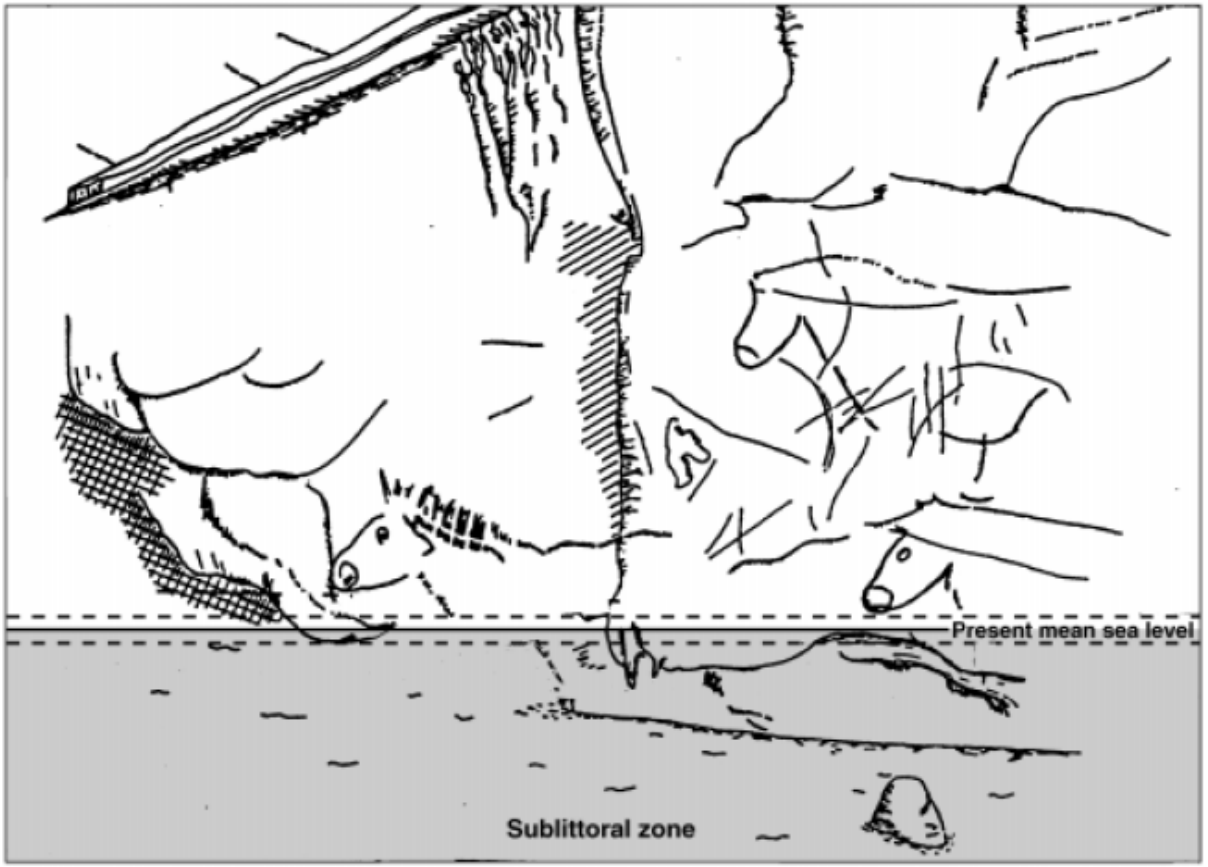


Fig. 7. The negative proof of the absence of a Holocene relative sea level above present datum supported by the painted horses on a wall of a half-submerged paleolithic cave near Marseilles (modified from Vouvet et al., 1996).

Cosquer evidence does not preclude a m-scale SL oscillation, covering/uncovering the paintings

Question: Why isn't evidence for the medieval highstand seen worldwide ? e.g. raised beaches, limestone notches

Answer: It *is*

.. but usually attributed to last interglacial (elevation is similar in many places)

or misattributed to tectonism

by *circular reasoning, e.g. ...*

Reviews of W & E Mediterranean Holocene "tidal" notches:

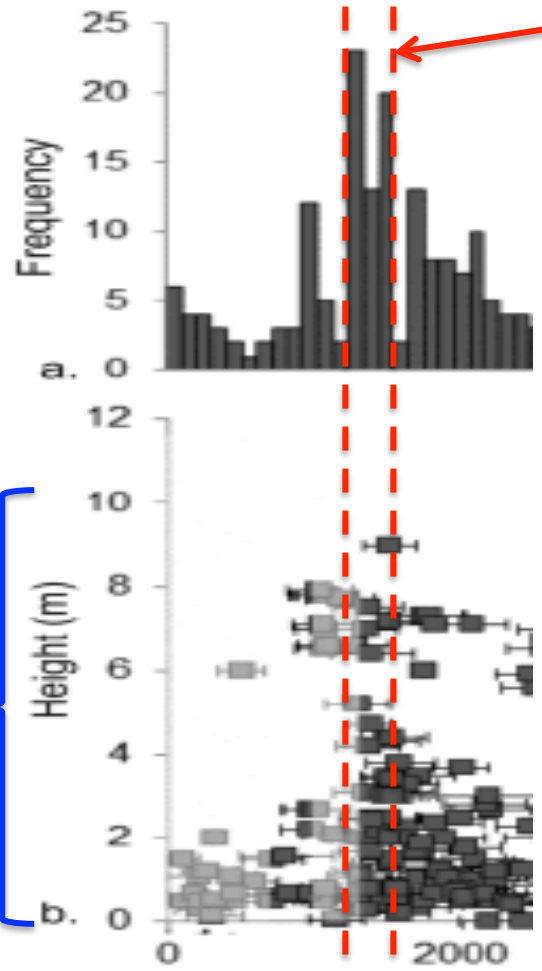
Antonioli et al. 2015, Boulton & Stewart 2015

Antonioli et al. 2015

Both accept *model* of *Lambeck, Antonioli et al. (2004b, 2011)* that Holocene eustatic SL was never higher than now ...

... so they attribute raised Holocene notches entirely to uplift, but ...

Review of E. Mediterranean Holocene notches, *Boulton & Stewart 2015*



1200-1500BP (450-750 CE) notches:
1. most abundant
2. reach highest
3. median elevation c.5m

Authors attribute elevation above modern SL entirely to uplift

Alternative interpretation ...

Spread in age & height reflects:

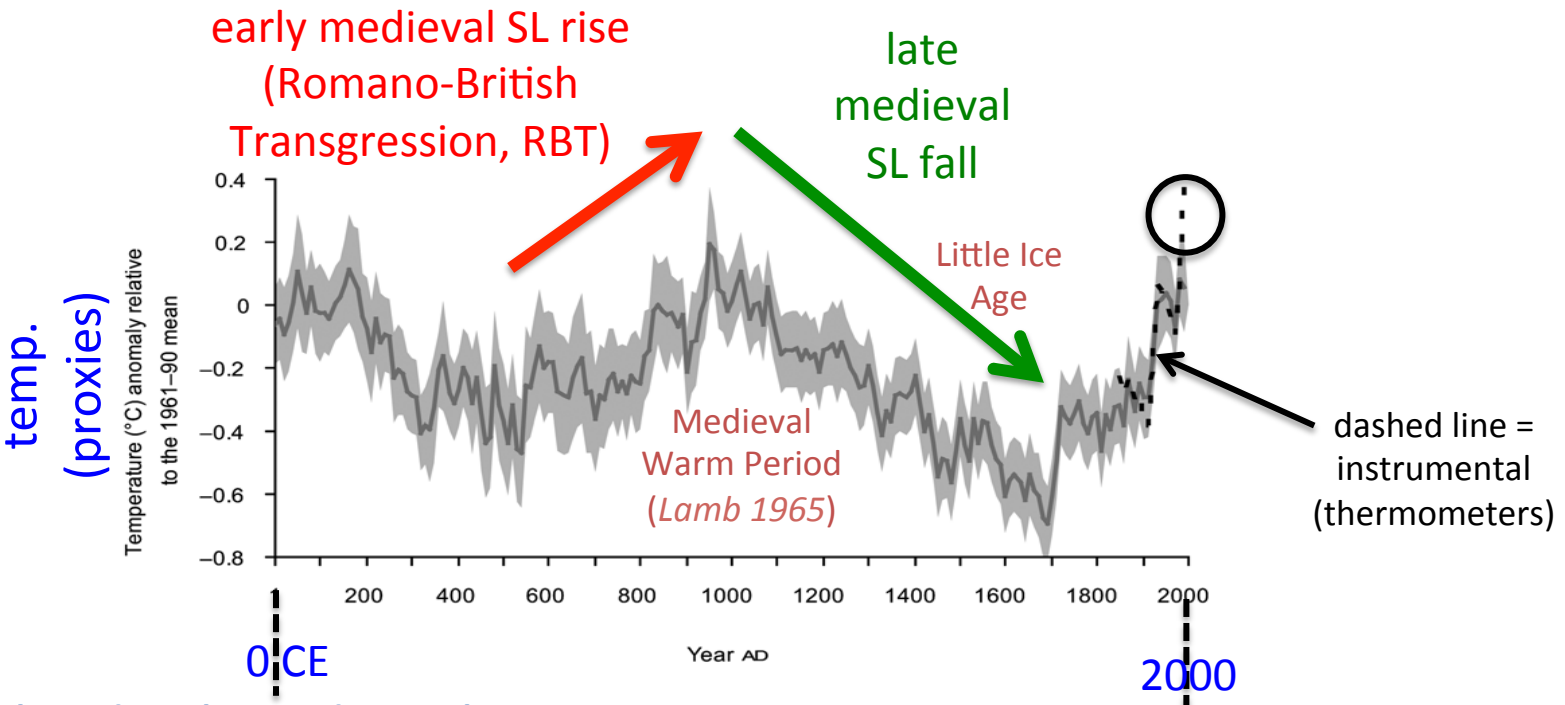
1. Medieval c.5m SL rise & fall, spanning c.1ky, overprinted by ...
2. subsidence or uplift (incl. coseismic)
3. uncertain ages, based on "dating of organisms that form the biological rim covering part of the notch" (*Antonioli et al. 2015*)

What's *driving* this eustasy?

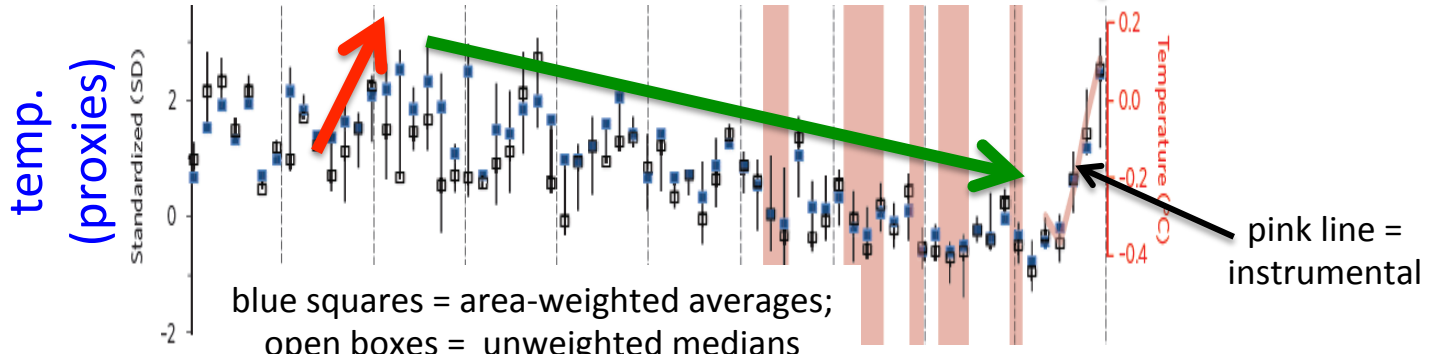
Apparent correlation with *temperature* ...

2-0ka temp. from proxies (tree rings, ice cores, etc.)

e.g. Northern Hemisphere, land, *Ljungqvist 2010*



World, land, *Ahmed et al. 2013*



Higgs/Geoclastica 2016

What drives the temperature/SL changes?

Not mankind/CO2, because the post-Roman transgression (eustatic rise):

1) predated industrialization by c. 1ky

2) was followed by a m-scale *fall*

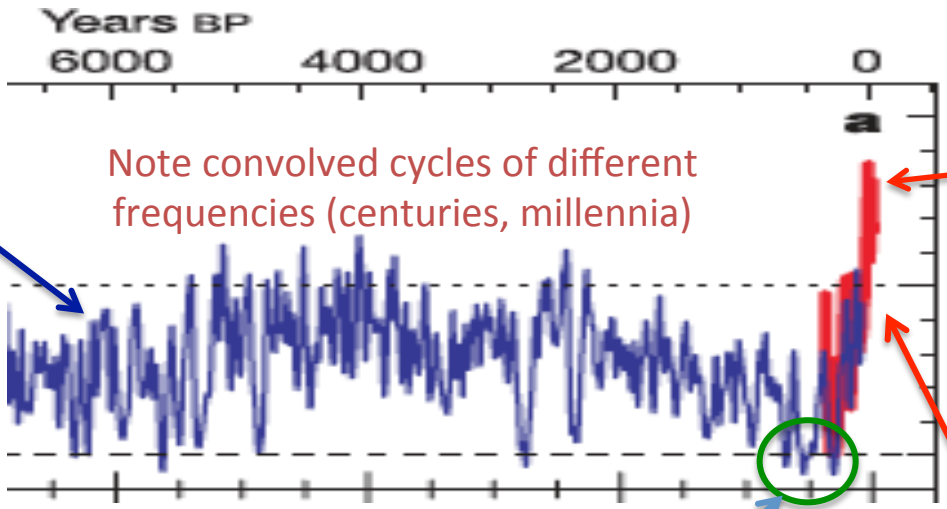
Phanerozoic sedimentary column is replete with cycles lasting 0.5-2ka, attributed (*many* authors) to **solar fluctuations**

Explanation ? …

The sun pulsates ...

Solanki et al. 2004 -

Solar activity, based on sunspot-number proxy (tree-ring C14, produced by galactic cosmic rays, which decrease with increasing solar activity)



sunspot counts, in red

Since Little Ice Age, large increase in solar activity (by chance coincides with mankind's industrial CO2 emissions)

BUT ... eruptions of (solar-reflective) volcanic aerosols & ash occasionally mask relationship between solar output & Earth's temperature

Persistent Solar Influence on North Atlantic Climate During the Holocene

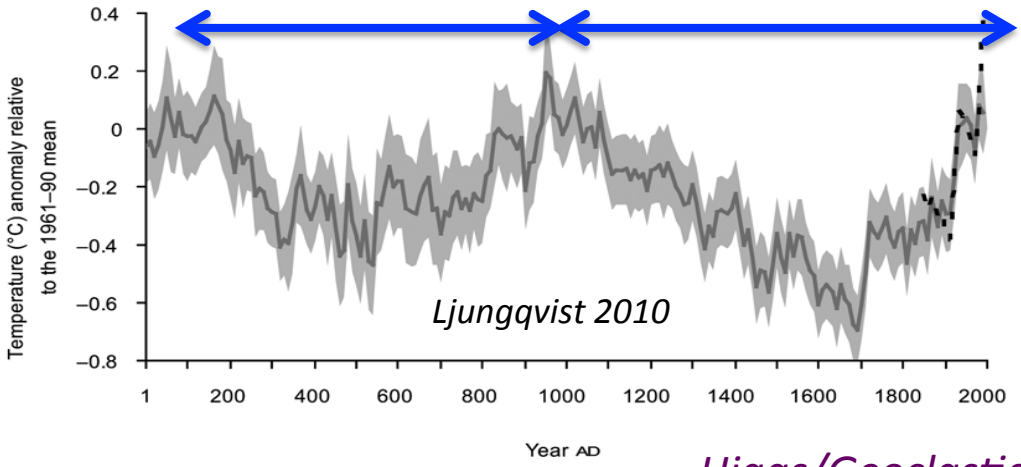
2001

Gerard Bond,[1]* Bernd Kromer,[2] Juerg Beer,[3] Raimund Muscheler,[3] Michael N. Evans,[4] William Showers,[5] Sharon Hoffmann,[1] Rusty Lotti-Bond,[1] Irka Hajdas,[6] Georges Bonani[6]

Surface winds and surface ocean hydrography in the subpolar North Atlantic appear to have been influenced by variations in solar output through the entire Holocene. The evidence comes from a close correlation between inferred changes in production rates of the cosmogenic nuclides carbon-14 and beryllium-10 and centennial to millennial time scale changes in proxies of drift ice measured in deep-sea sediment cores. A solar forcing mechanism therefore may underlie at least the Holocene segment of the North Atlantic's "1500-year" cycle. The

Holocene no exception

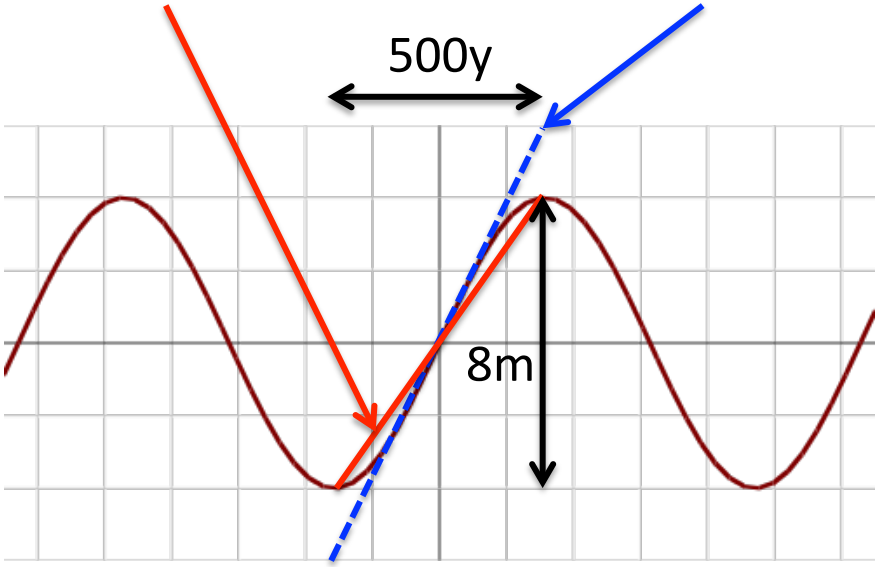
two solar-driven Bond Cycles



Rate of medieval rise ?

> 8m RBT (Slide 20) in c. 500y (cf. Slide 47, Ljungqvist curve)

implies *average* > 1.6 cm/y, *faster* at inflection ....



cf. Siddall et al. 8m in 450y (Slide 11) = av. 1.8cm/y

i.e. today's 2.5 mm/y (IPCC) is trivial

Today's world temperature possibly exceeds post-Roman peak temp ...

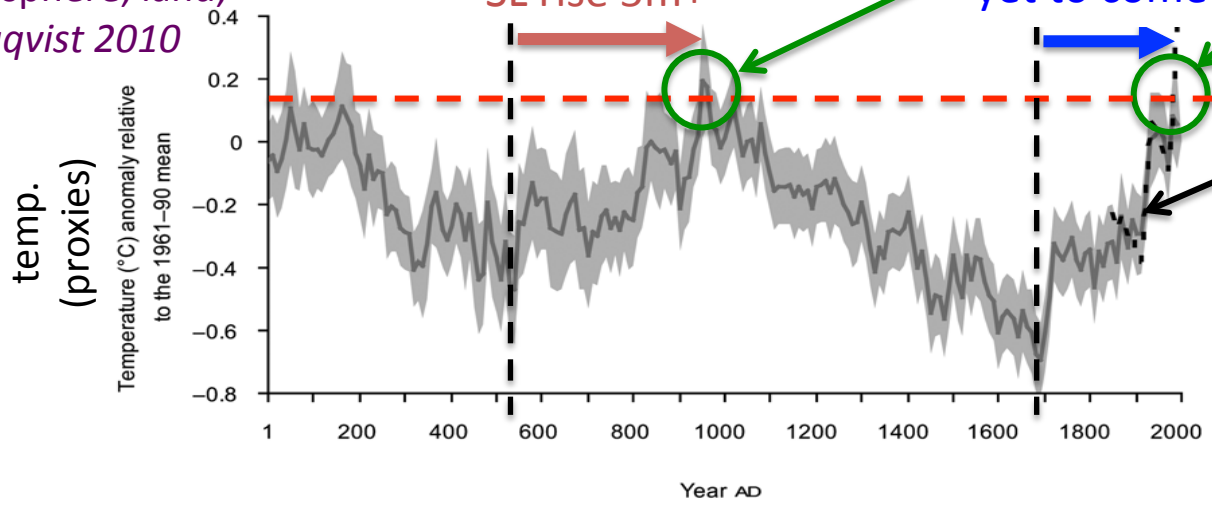
so are we locked into another m-scale SL rise ?

& are such rises largely achieved in just a few decades ?

Modern SL rise only 30cm so far (Slide 37); c.5m yet to come ?

post-Roman SL rise 5m+

N. Hemisphere, land,
Ljungqvist 2010



dashed line = instrumental (thermometers)

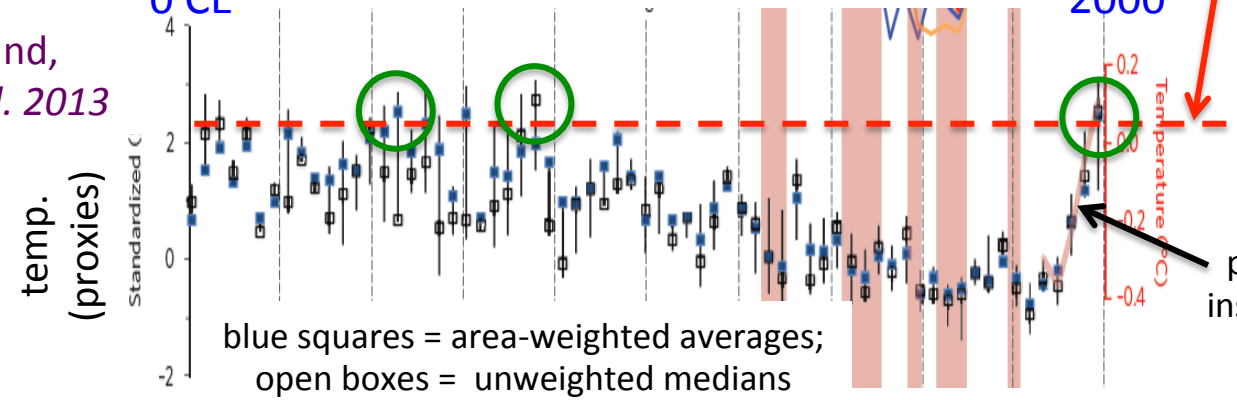
Threshold temp. for m-scale SL rise ?

Corresponds to critical minimum Antarctic ice-shelf "safety band" (*Fürst et al. 2016*) ?

0 CE

2000

World, land,
Ahmed et al. 2013



blue squares = area-weighted averages;
open boxes = unweighted medians

pink line = instrumental

Crossing the critical threshold temp. may trigger, after melting (in progress) of the Antarctic ice sheet's buttressing ice shelves is sufficient, catastrophic ice-sheet retreat by ice-cliff failure, cf. *Pollard et al. 2015*

- causing SL rise to accelerate drastically ?
- some time between now and 2050 ?
- to >5cm/yr (cf. today's 2.5mm/y) in the space of a few years, months or weeks ?
- peaking at >10cm/y for decades ?
- for a total rise of several metres by 2100 ?

Google reveals no English-language contemporary *written records* of a post-400 CE, pre-1000 catastrophic SL rise (metres within decades)

This interval largely coincides with the chaotic, violent "Migration Period" of mass barbarian population movements in Europe (c. 400-700 CE; first half of enigmatic "Dark Ages")

Were these migrations partly *caused* by catastrophic SL rise, rendering low coastal regions uninhabitable ?

Written records in China, India ?

Similarly, I've found no contemporary mention of late medieval SL *fall*

This may simply mean the fall was slower than preceding rise, less detectable/remarkable in a human lifespan

Conclusion: SL *will* rise 5m+ in the next 100y

... driven by solar-induced warming (not humans/CO2)

... so spending $trillions to cut emissions won't help

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