



**The New Post-IPCC Climate
Science -
and Implications for Teaching
Sustainability**

**A talk to the NAS Faculty of Cabrillo
College**

Aug 25, 2017

You're all smart science and engineering people, and so ... prepare to drink from a firehose of new climate science! Here we go! (I'll post this .pptx online for your more leisurely review)



**The last IPCC Assessment Report (AR5)
digested the science from 2012 and
before**

**That was 5 years ago, and a lot of
science has happened since then.**

First, IS the IPCC's

“Summary for Policy Makers”

– which is the only document the vast majority of the press, the public, policy people, and legislators see – Is it really the unbiased Gold Standard?

...or has it been “spun up” by UN members’ political agendas bent on not compromising competitive economic growth?

It's a Consensus Document: ALL Must sign off or it doesn't stay in the Report

- **Yet...** *“Authors for the IPCC reports are chosen from a list of researchers prepared by governments and participating organizations, and by the Working Group/Task Force Bureau, as well as other experts known through their published work. The choice of authors aims for a range of views, expertise and geographical representation, ensuring representation of experts from developing and developed countries and countries with economies in transition.”* ([source](#))
- **“range of views”**... includes those UN politicals and even a few fossil fuel corporate scientists.
- **Therefore, only the lowest levels of “alarm” can get approval**, despite what published research says, and yet the specified purpose is digestion of published research relevant for climate policy formation. **Cross purposes!**
- **Therefore not surprising that we have...**

...Tampered Carbon Budgets: IPCC's Prof. David Wasdell ([source](#)) "A Document of Appeasement"

- *"Wasdell said that the draft submitted by scientists contained a +2C 'carbon budget'..., but the final version approved by governments (Summary for Policy Makers =SPM) significantly amended the original metric to increase the amount of carbon that could still be emitted. (and this is the version Policy people (and Press) use)"*
- IPCC Carbon Budgets are, today, not credible

From [this talk](#) by the UK's Premier Climate Research Centre Head Prof. Kevin Anderson, in conversation with political climate policy senior people

- **Political scientist** (at request left un-named): *“Too much has been invested in +2C for us to say it’s not possible – it would undermine all that’s been achieved. It’ll give a sense of hopelessness, that we may as well just give in”* – (30 min into [the talk](#))
- **Anderson**: *“Are you suggesting we have to lie about our research findings?”*
- **Political scientist**: *“Well, perhaps just not be so honest – more dishonest...”*

Then, even this watered down version becomes the target for right wing/fossil fuel interests to slander as being lies by “alarmist” grant-grubbing scientists. Corporate media’s “false balance” completes the mis-education of the public

|←—— John Q. Public ——→|

IPCC AR5
Science

IPCC AR5
Summary for
Policy Makers

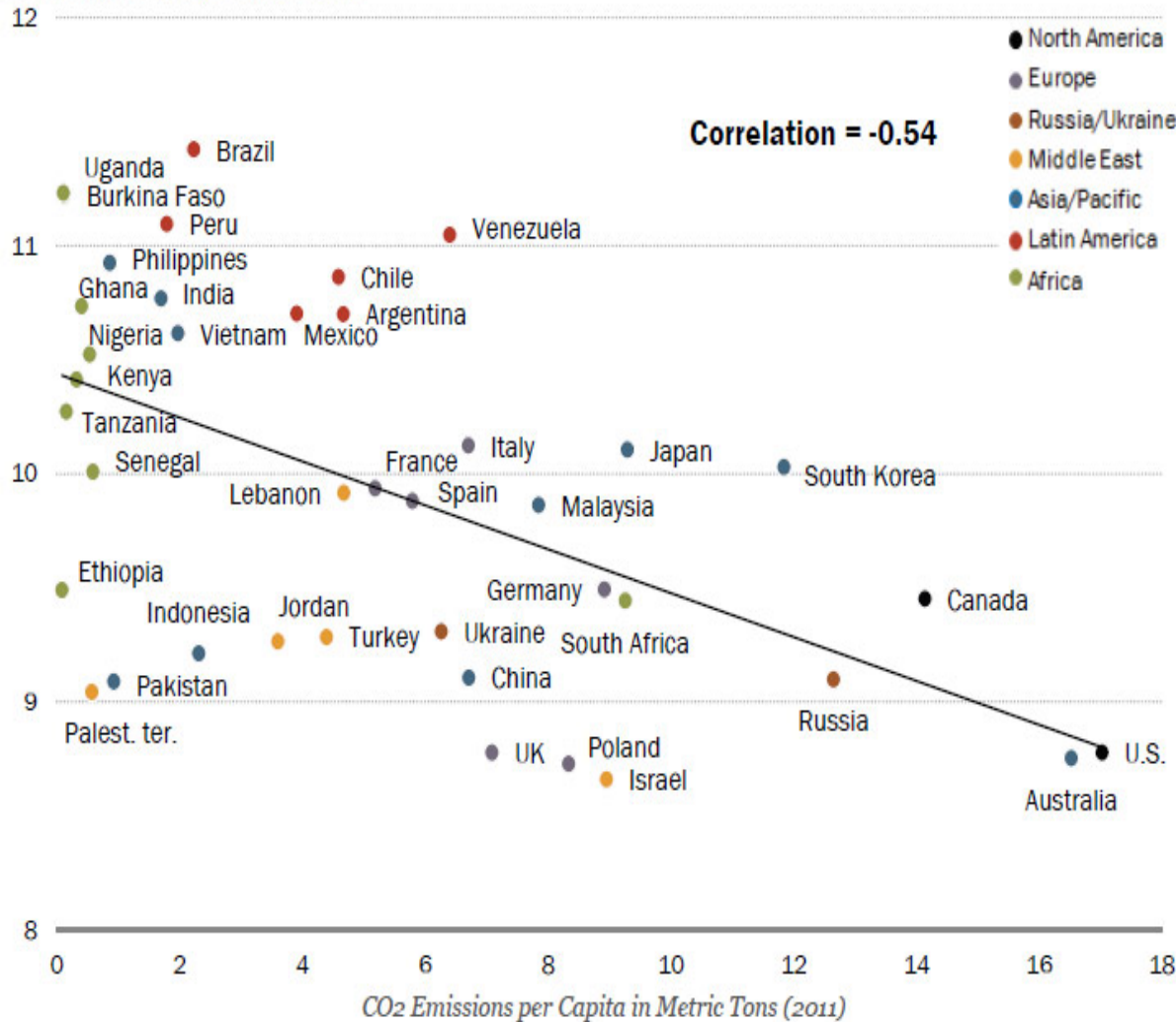
Conservatives,
FF Industry

The politicisation of the IPCC's summary reports are corroborated by other IPCC scientists...

*In a [letter](#) addressed to senior IPCC chairs dated 17th April, [Prof Robert Stavins](#) - a lead author for the IPCC's Working Group 3 focusing on climate mitigation - complained of his "frustration" that **the government approval process "built political credibility by sacrificing scientific integrity."***

High CO₂ Emitters Are Less Intensely Concerned about Climate Change

Global climate change concern scale*

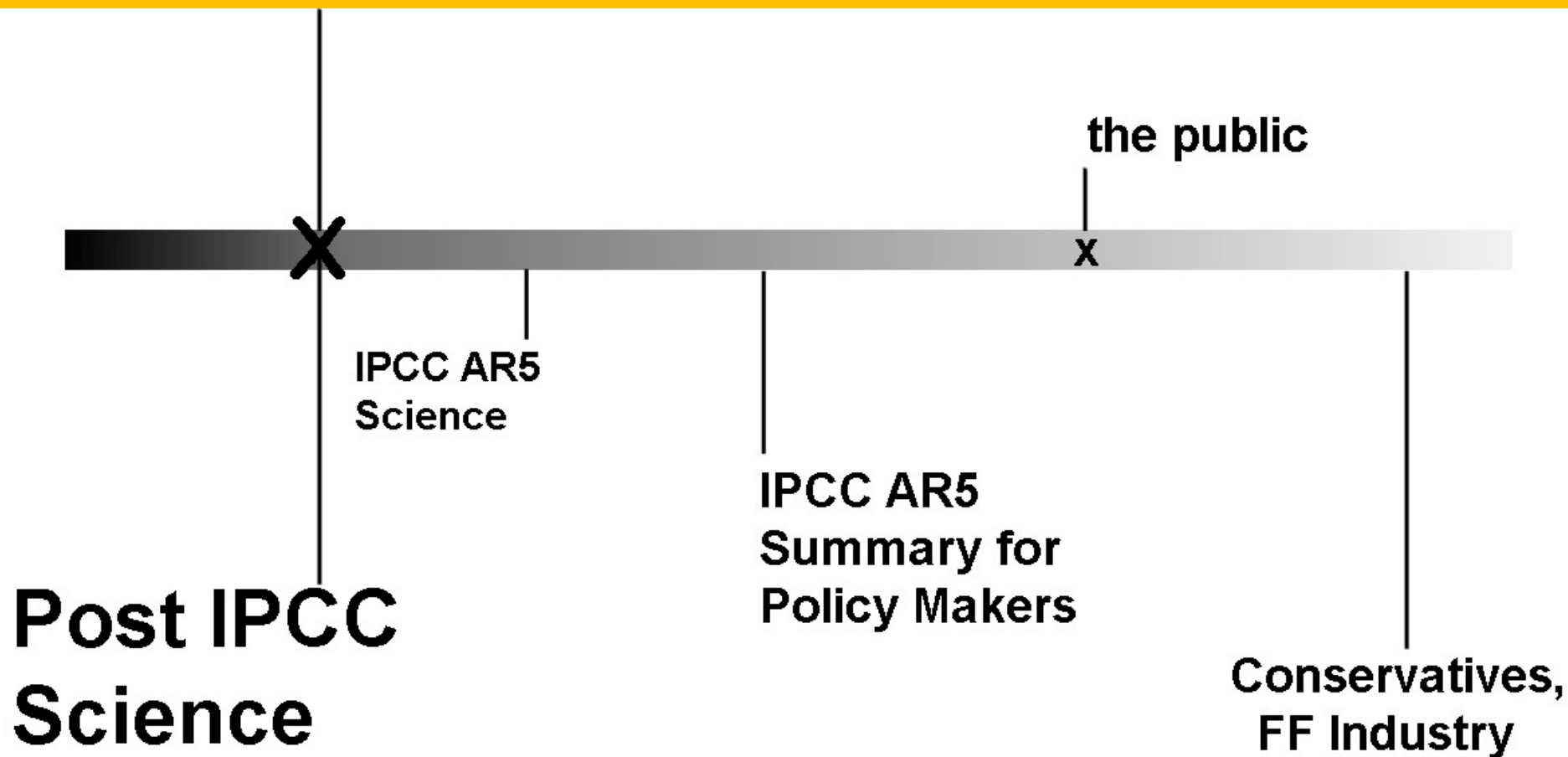


* Concern about global climate change is measured using a three-item index ranging from 3-12, with 12 representing the most concerned about climate change. Respondents were coded as 4 if they believe climate change is a very serious problem; if they think climate change is harming people now; and if they say they are very concerned that climate change will harm them personally at some point in their lifetime. The mean score for each country is used in this analysis. (See [Appendix](#) for more details.)

Source: Spring 2015 Global Attitudes survey. Q32, Q41 & Q42. Data for CO₂ emissions per capita from World Bank Data Bank, accessed August 5, 2015.

Indeed, The highest CO₂ emitting countries are the most politically motivated to minimize the perception of climate danger. U.S. (2015) the worst!

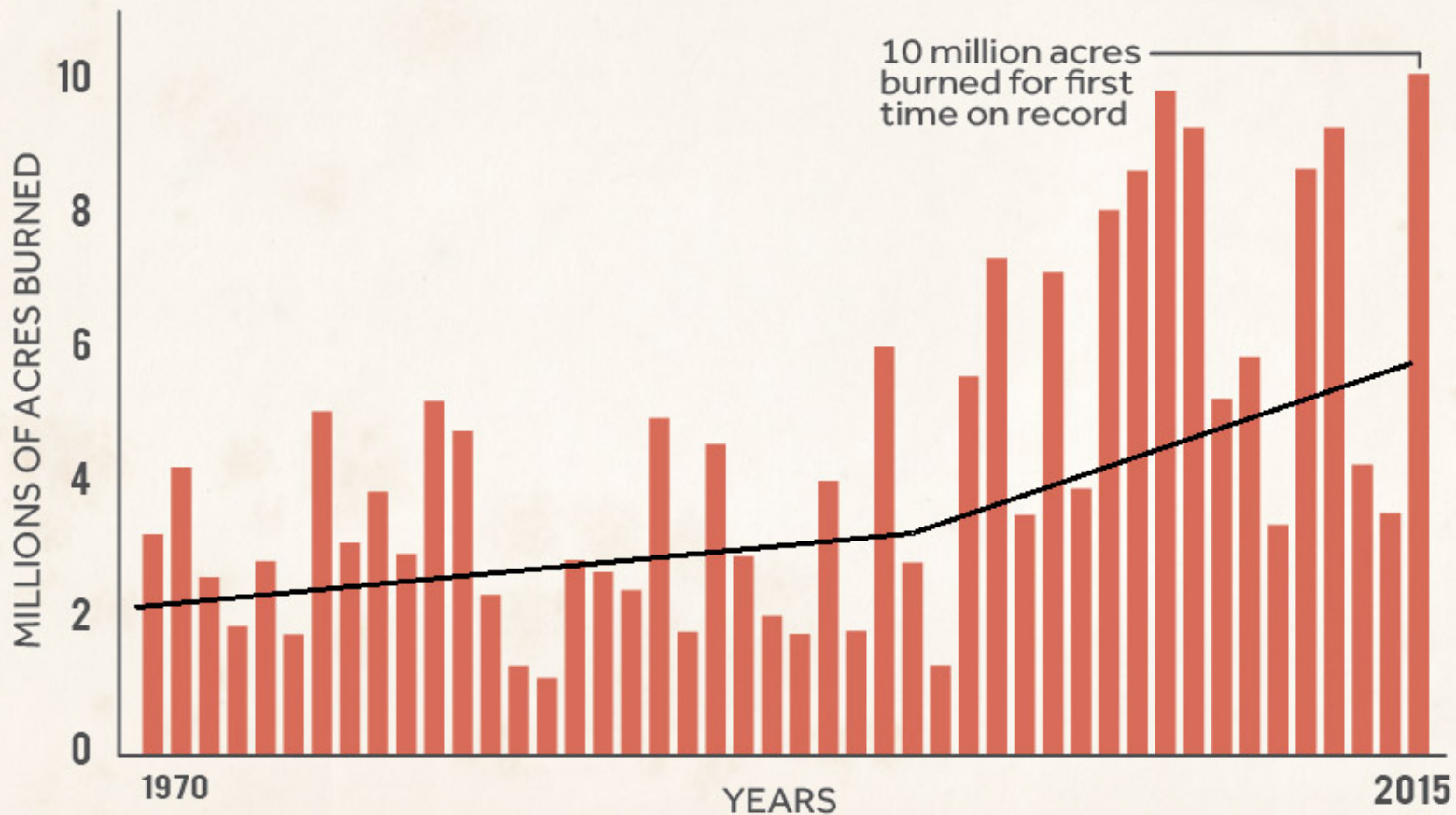
But worse still - far from being “alarmist”, even the largely good-faith IPCC AR5 main report is significantly too optimistic, based on Post-IPCC Science I’ll highlight now



Missing Physics from the IPCC Modelling...

IPCC Models Do Not Include: Increasing wildfires and their smoke (80+% are human-caused: [Balch et al. 2016](#))

Wildfires Reach a Major Milestone in 2015



IPCC Models Do Not Include: Ice surface meltwater generates algae and other microbe colonies which further darken the ice, absorbing more sunlight

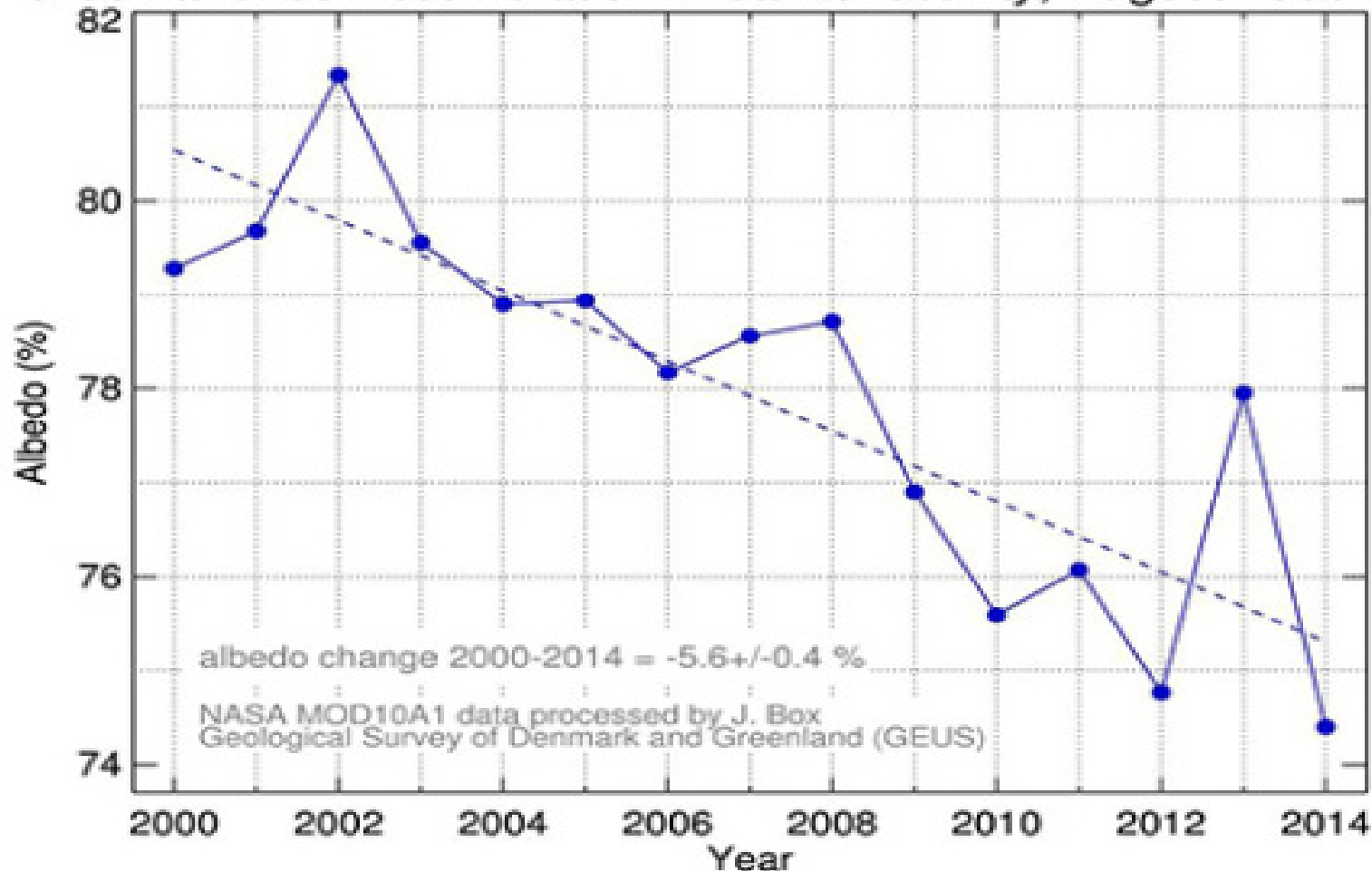


Yes, that's Greenland ice below.



And So: IPCC Models Don't Include Summer Albedo dropping in the Greenland

Greenland Ice Accumulation Area Reflectivity, August 2000-2014

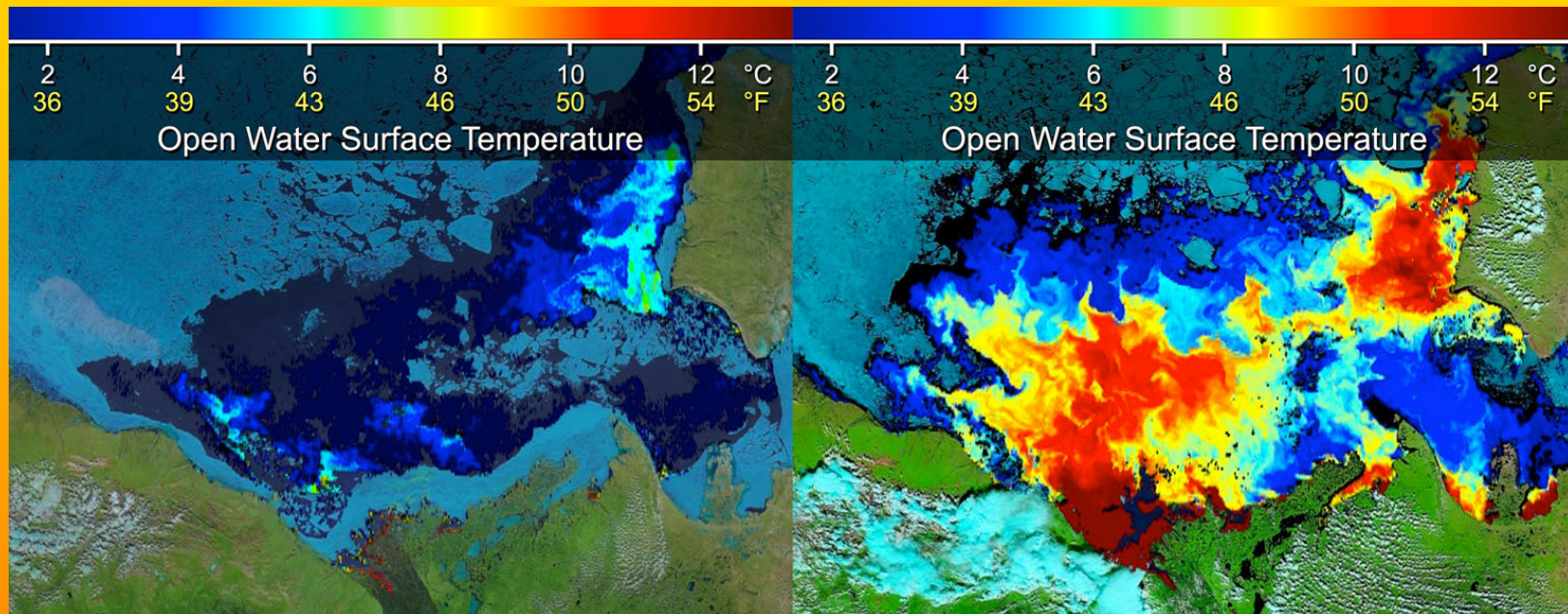




IPCC Models Do Not Include:

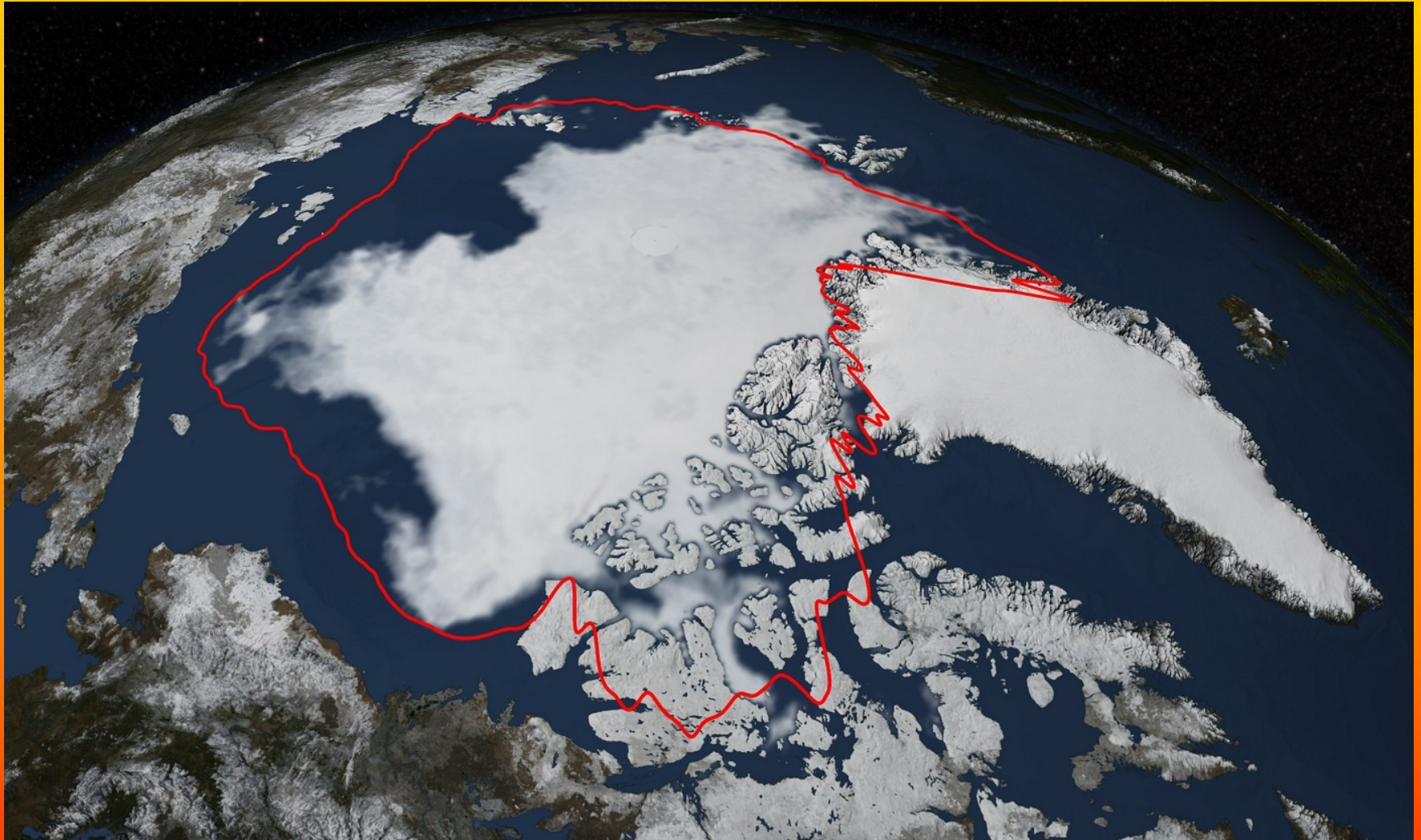
Surface melt on
Greenland generating
rivers of water driving
hydro-fracturing, driving
heavier water through
lighter ice, generating
moulins – taking water
miles deep, softening the
base of the ice sheet,
accelerating glacier speed

IPCC Models do not include: The large heat influx from warm river water into the Arctic Ocean (Ngheim *et al.* 2014, described here)



- These images show sea surface temperatures of the Beaufort Sea where Canada's Mackenzie River discharges into the Arctic Ocean, as measured by the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on NASA's Terra spacecraft. The image at left was obtained June 14, 2012, before discharged waters from the Mackenzie River (located in the bottom center of the image) broke through the adjacent sea ice barrier (shown in light blue) stuck along the shore of the Mackenzie River delta. The image at right, acquired July 5, 2012, shows the extensive intrusion of heat carried by the river waters once they breached the sea ice barrier (shown in yellow, orange and red). Scientists saw an increase of 11.7 degrees Fahrenheit (**+6.5 degrees Celsius**) in the surface temperature of the open water, which enhanced sea ice melt.

**IPCC Models Do Not Include: Non-linear
breakup of thinning Arctic sea ice, driven by wind and
waves as more open water wind fetch appears, and
subsequent iceberg drift south past Greenland.**



ALL of these contribute to the dramatic underestimation of sea ice loss. Implications?...



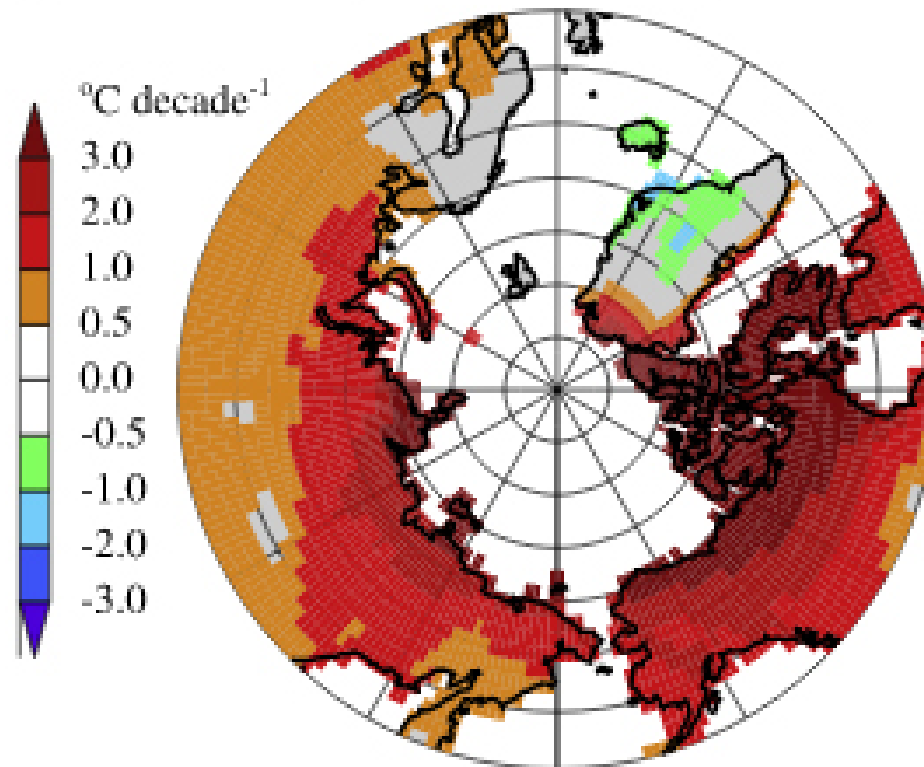
MINIMUM ANNUAL ARCTIC SEA ICE: IPCC MODELS VS **OBSERVATIONS**

base chart: <http://www.realclimate.org/index.php/archives/2012/04/arctic-sea-ice-volume-piomas-prediction-and-the-perils-of-extrapolation/>
modified by Barry Saxifrage (VancouverObserver.com and VisualCarbon.org) to include orange line showing PIOMAS volume data in 1,000s of km³ from <http://psc.apl.washington.edu/wordpress/research/projects/arctic-sea-ice-volume-anomaly/data/>

This Loss of the Arctic Ocean's Ice ...sends a pulse of heat 1500 km south of the Arctic shorelines
(Lawrence *et al.* 2008), across the Permafrost.

Below: temperature trend map. Hot in Siberia, but even hotter in North America. So if Siberia melts, North America will as well, and likely sooner

(c) T_{air} trend:
during sea-ice loss periods



[Vaks et al. 2013](#), showed from Paleo data that the tipping point for the melt of ~all Siberian permafrost (and therefore all global permafrost), occurs at +1.5C above pre-industrial temperatures.

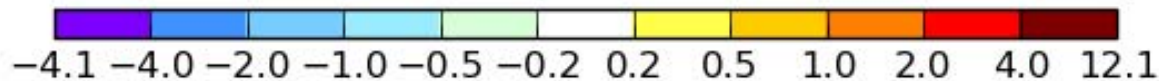
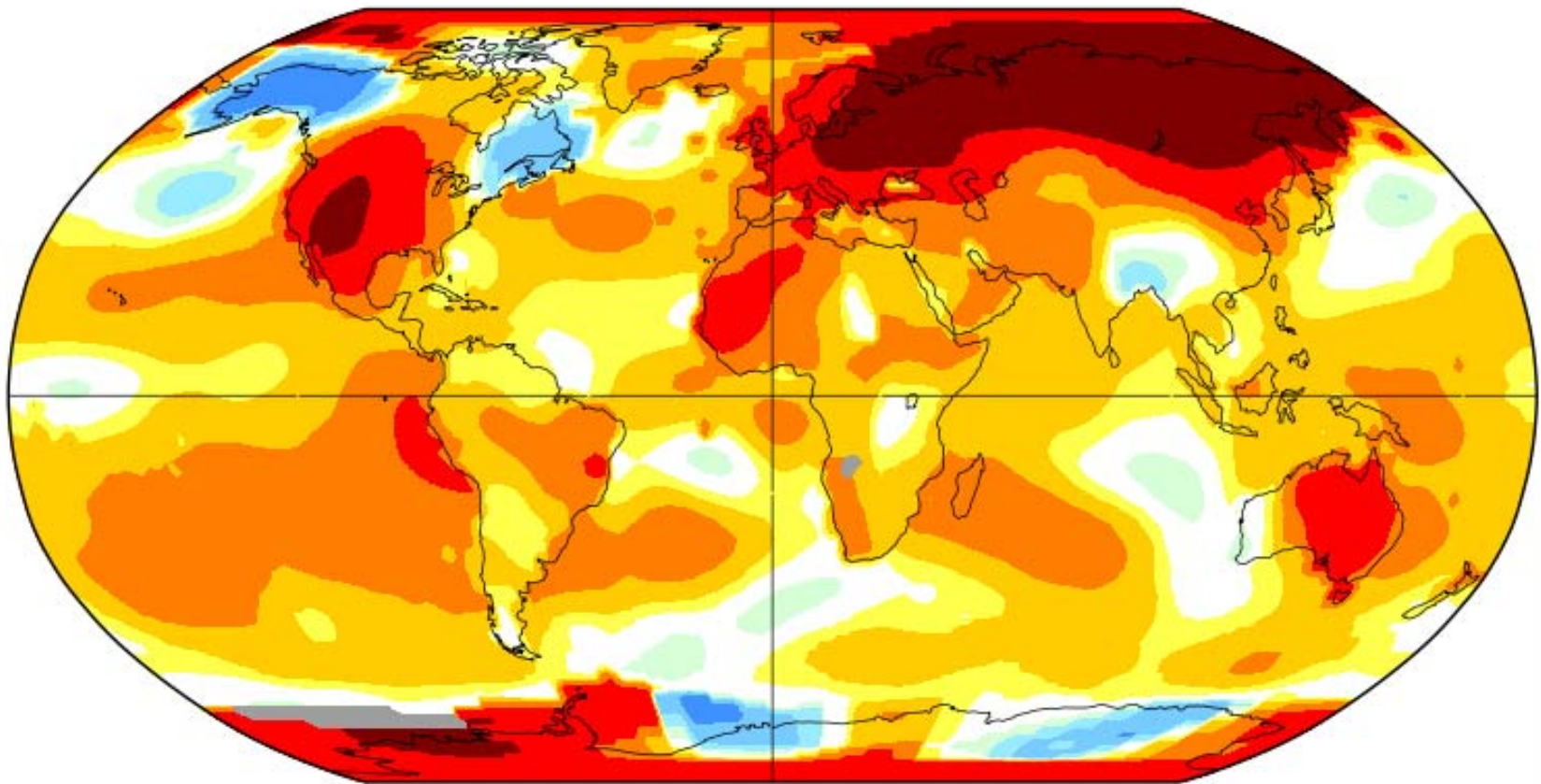
- From the paper's conclusion section: *“Warming of ~1.5°C (i.e., as in MIS-11) causes a substantial thaw of continuous permafrost as far north as 60°N... Such warming ...can potentially lead to **substantial release of carbon trapped in the permafrost into the atmosphere.**”* (see [interview on YouTube](#))
- **How Close Are We.....?**

**March 2017, we were at +1.4C (1.13C + 0.254C to convert 1951-80 back to Pre-Industrial baseline)
(trend curve at +1.25C, avg'ing over year)**

March 2017

L-OTI(°C) Anomaly vs 1951-1980

1.13



Is the Carbon Release in Thawing Permafrost Incorporated into the IPCC Assessment Reports and Projections?

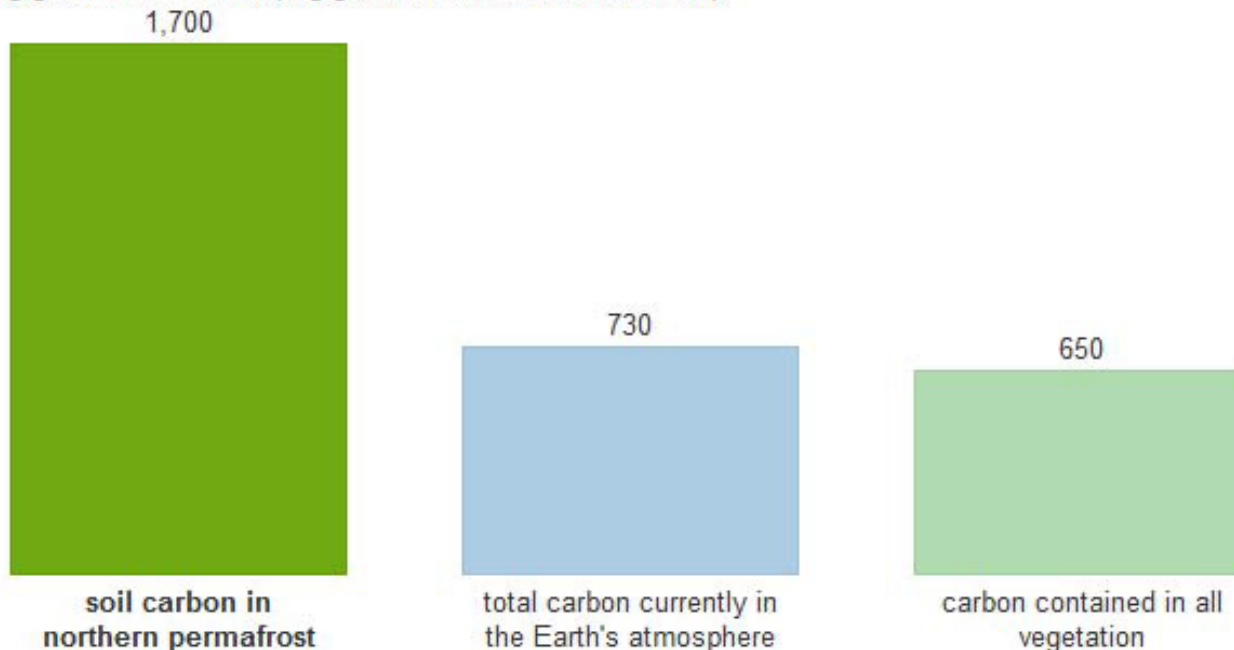
- **No.**

- *“The concept is actually relatively new,”* says Dr. [Kevin Schaefer](#) of the National Snow and Ice Data Center at the University of Colorado in Boulder. *“It was first proposed in 2005. And the first estimates came out in 2011. Indeed, the problem is so new that it has not yet made its way into major climate projections”, Schaefer says.*

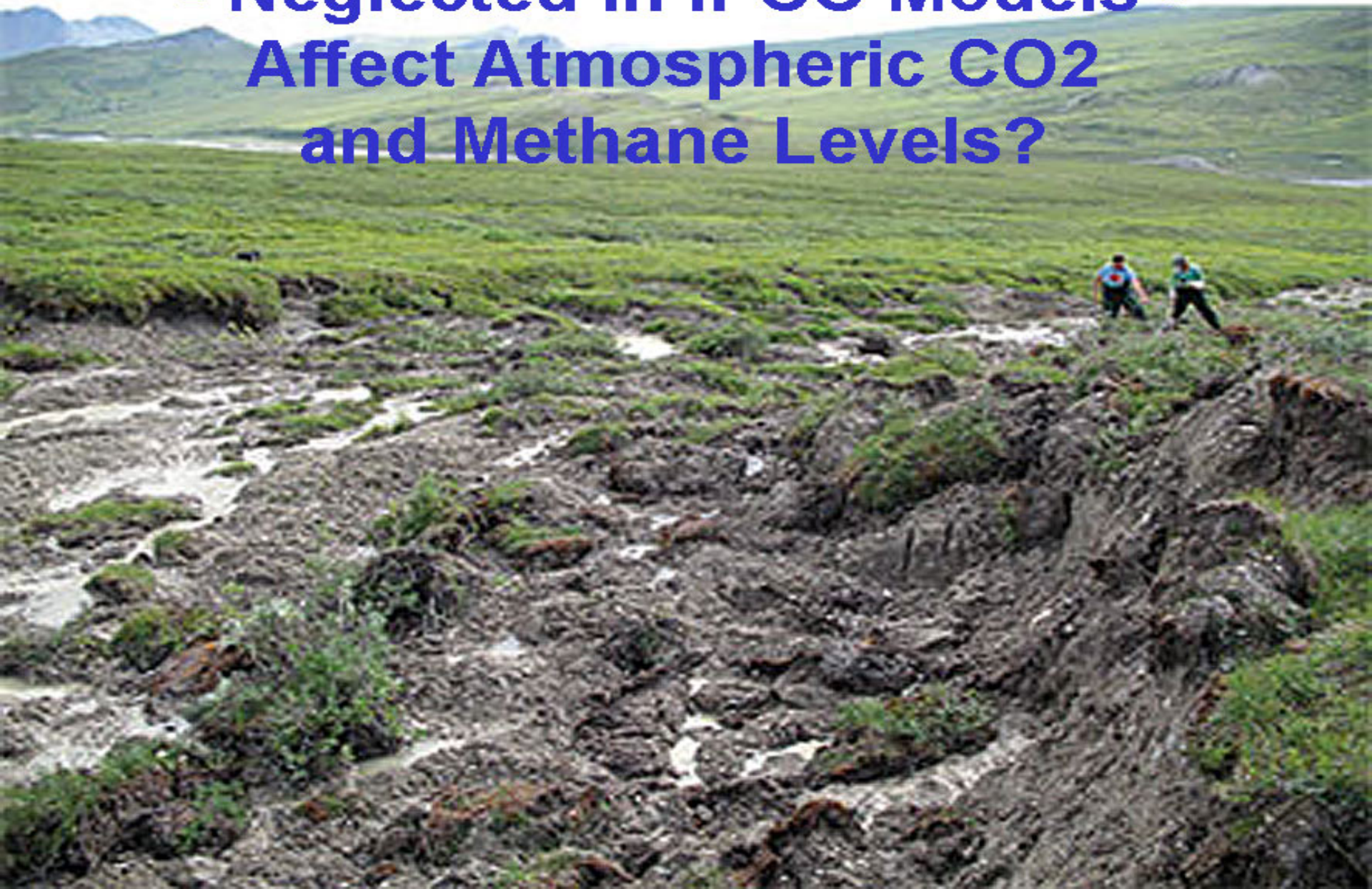
There's more carbon in the permafrost than in the entire atmosphere plus the entire biosphere's vegetation... combined

The massive store of carbon in Arctic permafrost

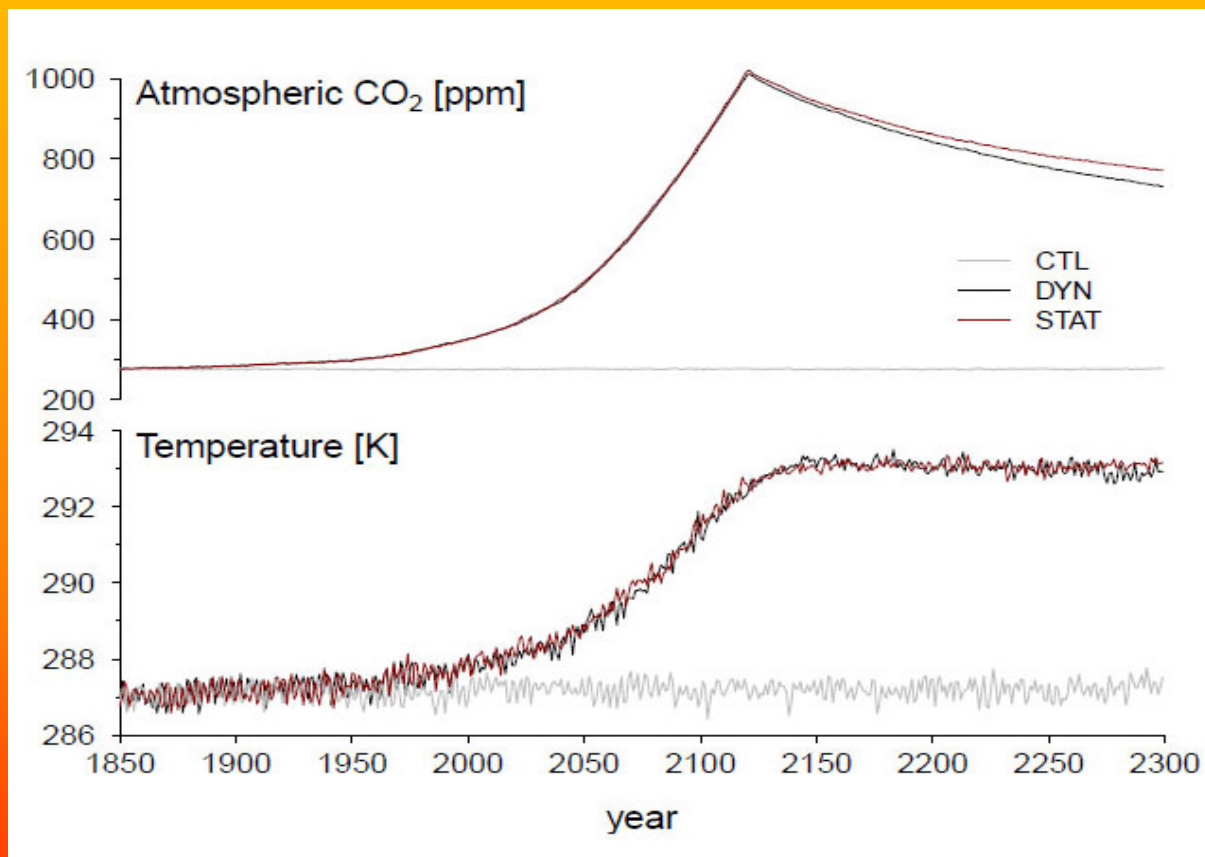
In gigatons of carbon (a gigaton is a billion metric tons).



How Will This Thawing Permafrost - Neglected in IPCC Models - Affect Atmospheric CO₂ and Methane Levels?

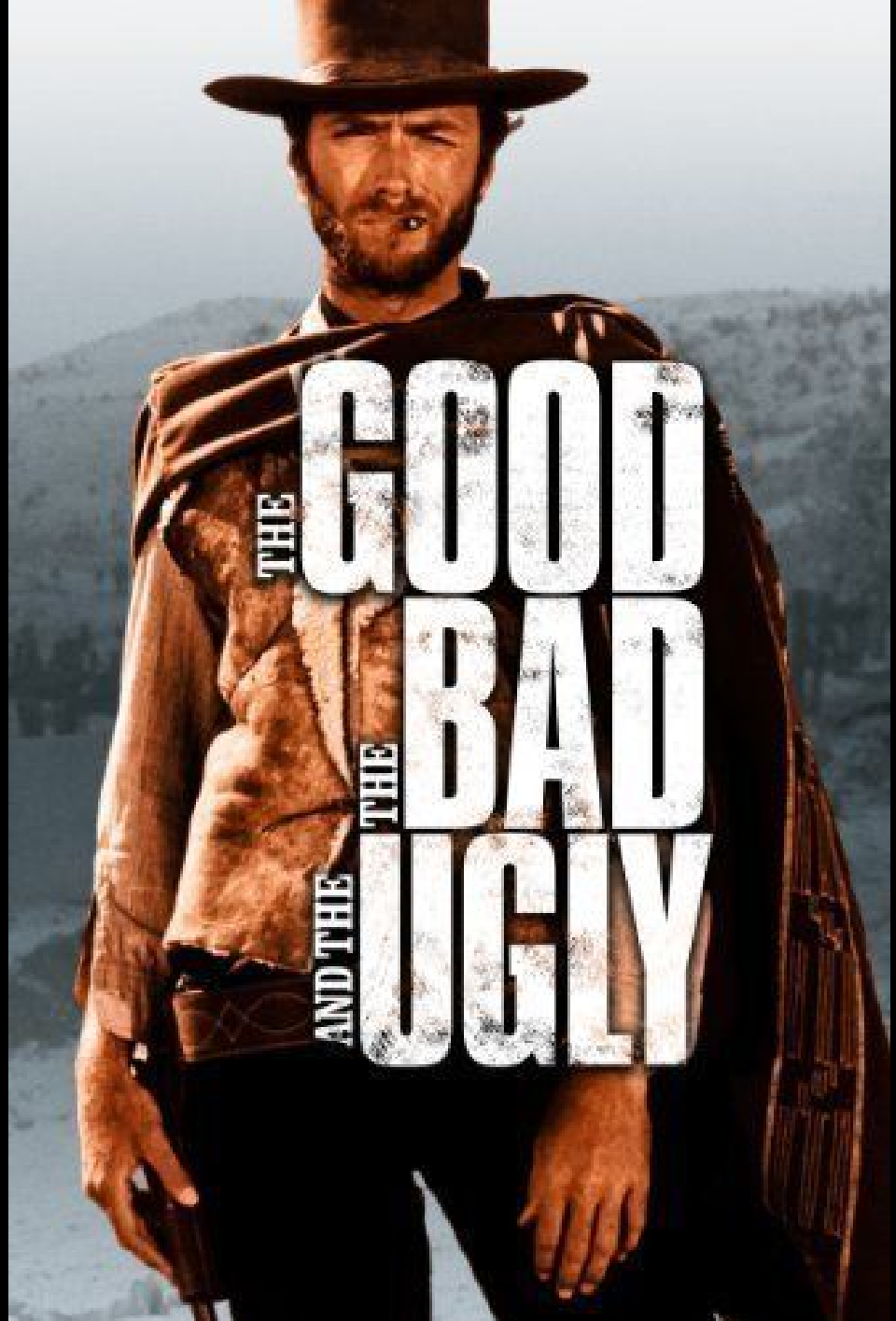


The IPCC had been using the work of [Solomon *et al.* 2009](#), [Mathews and Weaver 2010](#), and others, who assumed no additional GHG sources, so ending Anthropogenic emissions lets ocean and land absorption drop CO₂. But T only stays constant, due to ocean thermal inertia and the fact the Earth hasn't heated up enough to reach radiative balance.



Now Let's Include
the Permafrost
Carbon Feedback...

- THE GOOD
- THE BAD
- THE UGLY



First, We Need to Introduce a Convenient Number: ECS

- ECS = Equilibrium Climate Sensitivity (to CO₂)
- Take pre-industrial atmospheric CO₂ levels of 280ppm, double it to 560ppm, and then wait for global temperatures to rise until they reach “equilibrium” (equilibrium for fast climate feedbacks only, the slow ones take a few THOUSAND years and make ECS higher)
- That temperature rise is called ECS. Averaged over the past few million years, it’s about ECS=3C (+- ~1.3C)

[MacDougall *et al.* 2012](#) re-calculated atmospheric CO₂ assuming an immediate end to all human CO₂ and sulfate emissions, but including the Permafrost Carbon Feedback . Assuming ECS = 3.0C, we see that CO₂ does not fall, instead flattening, as permafrost emissions fully compensate for ocean/land absorption.

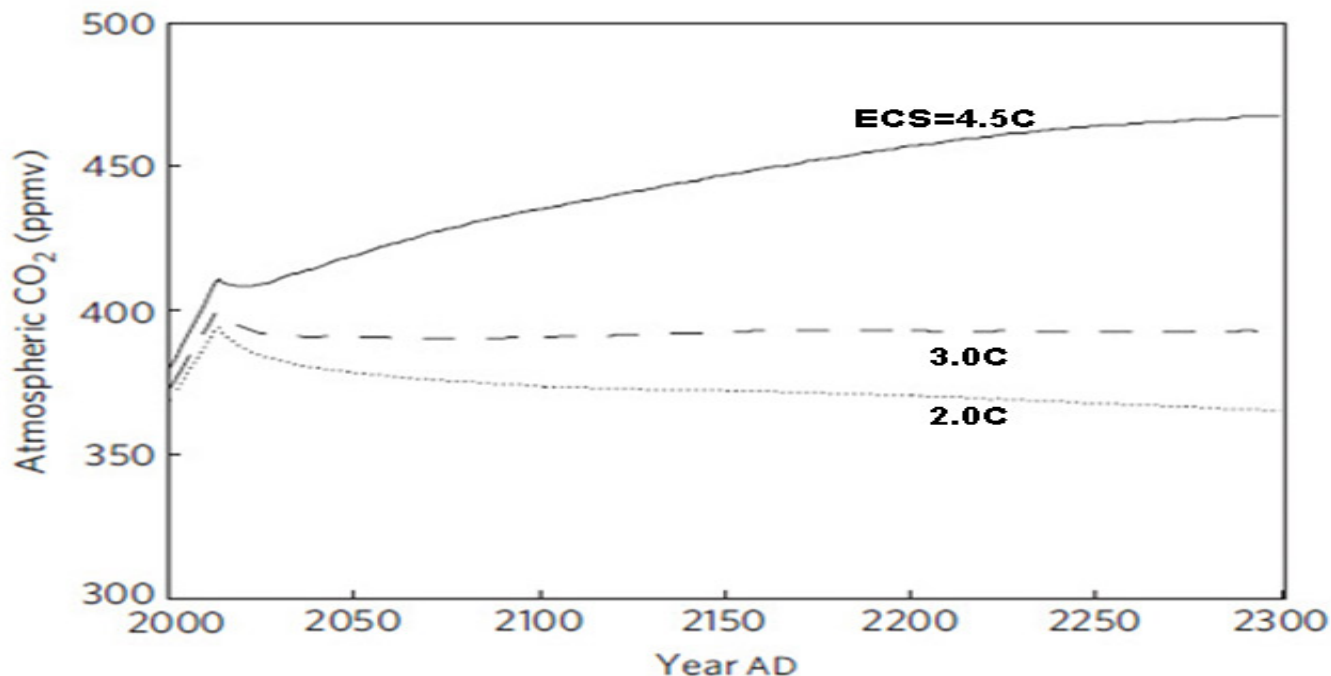
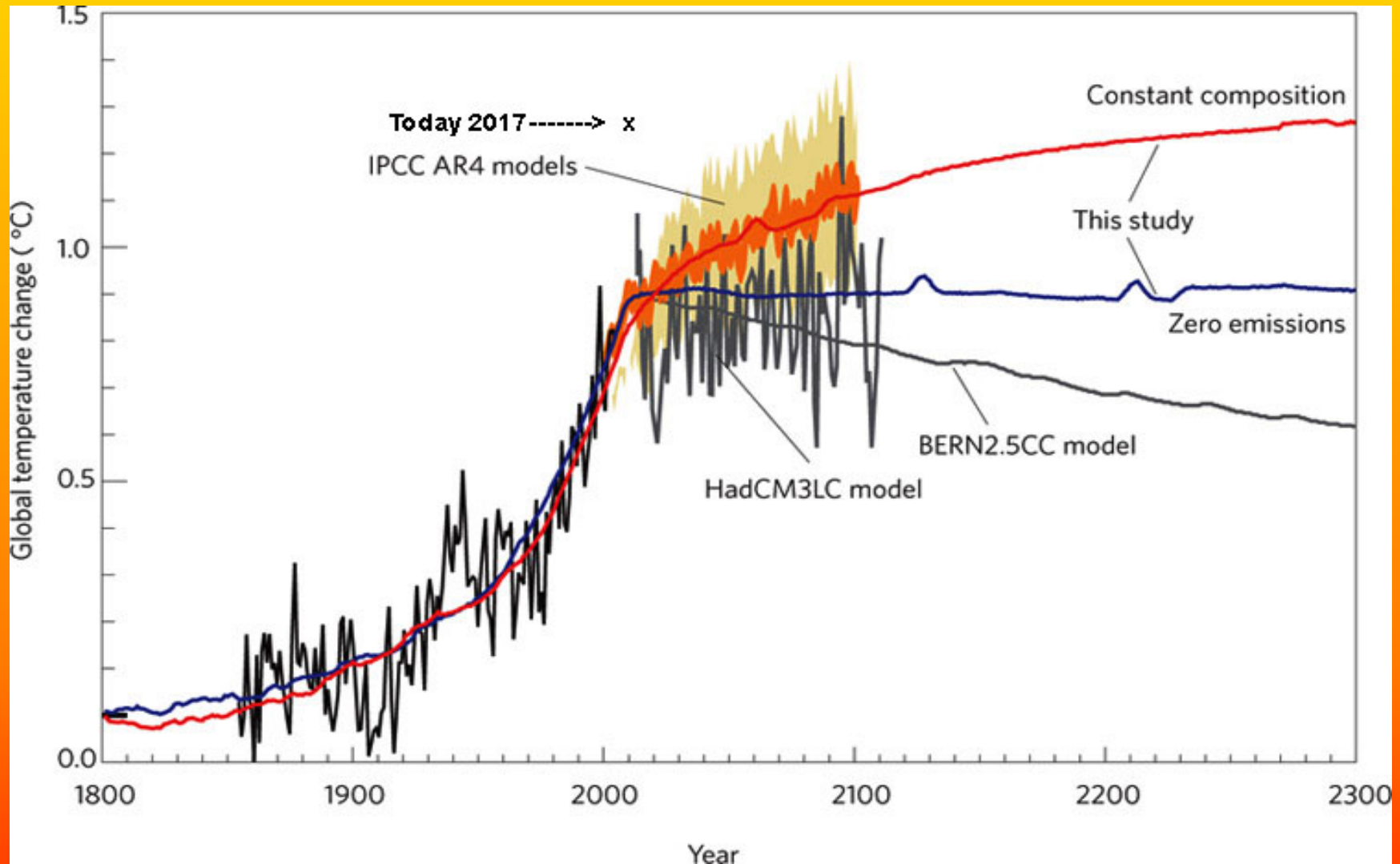


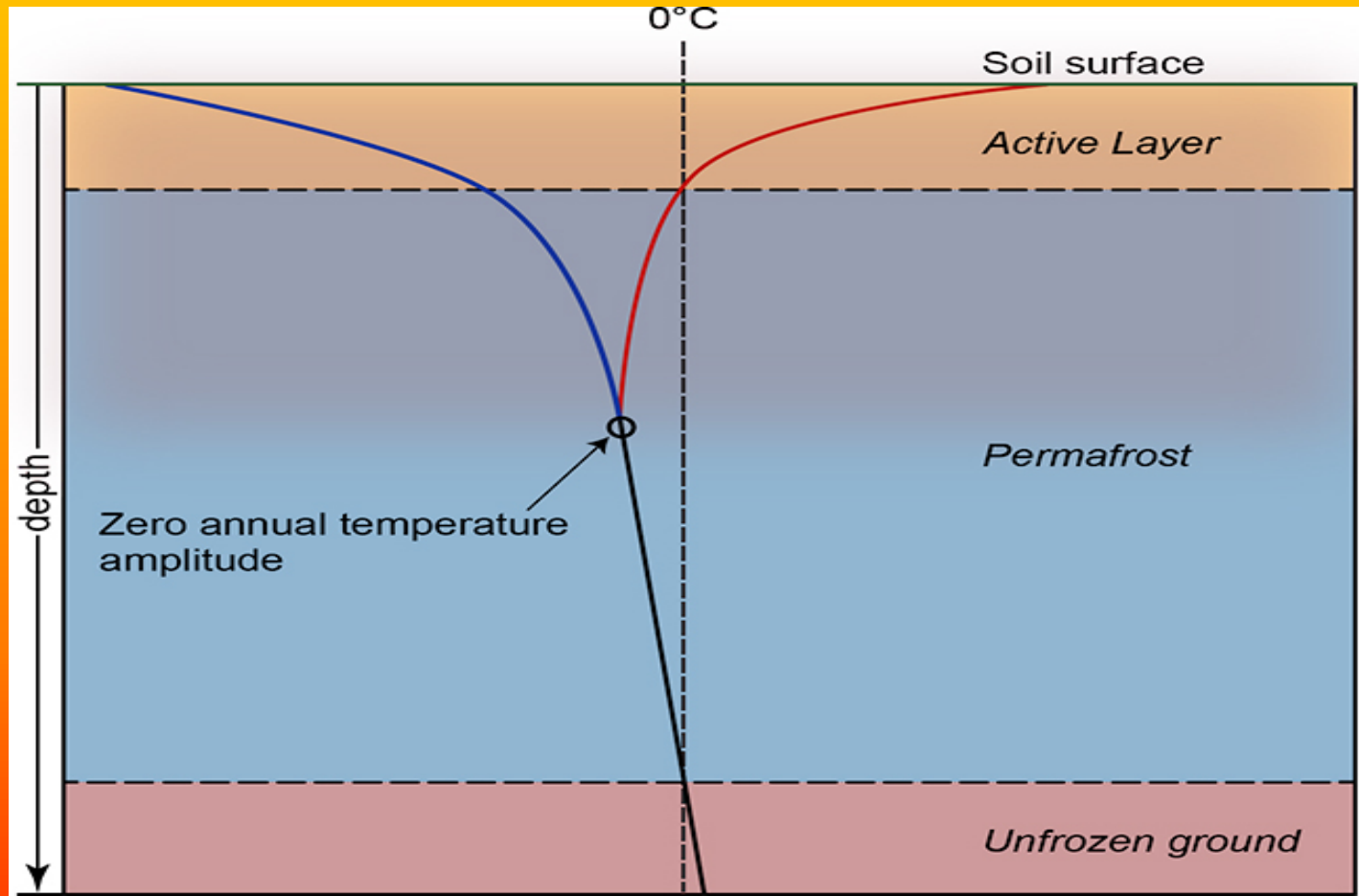
Figure 3 | Evolution of atmospheric CO₂ concentration in response to a cessation of anthropogenic CO₂ and sulphate emissions in the year 2013. The dotted line represents the response for a climate sensitivity (to a doubling of CO₂) of 2.0 °C, the dashed line a climate sensitivity of 3.0 °C and the solid line a climate sensitivity of 4.5 °C.

But Flat atmospheric CO₂ (orange) and leads to continued Rising temperatures (Matthews and Weaver 2010) [here](#), because of the existing 0.6 W/m² of radiative imbalance

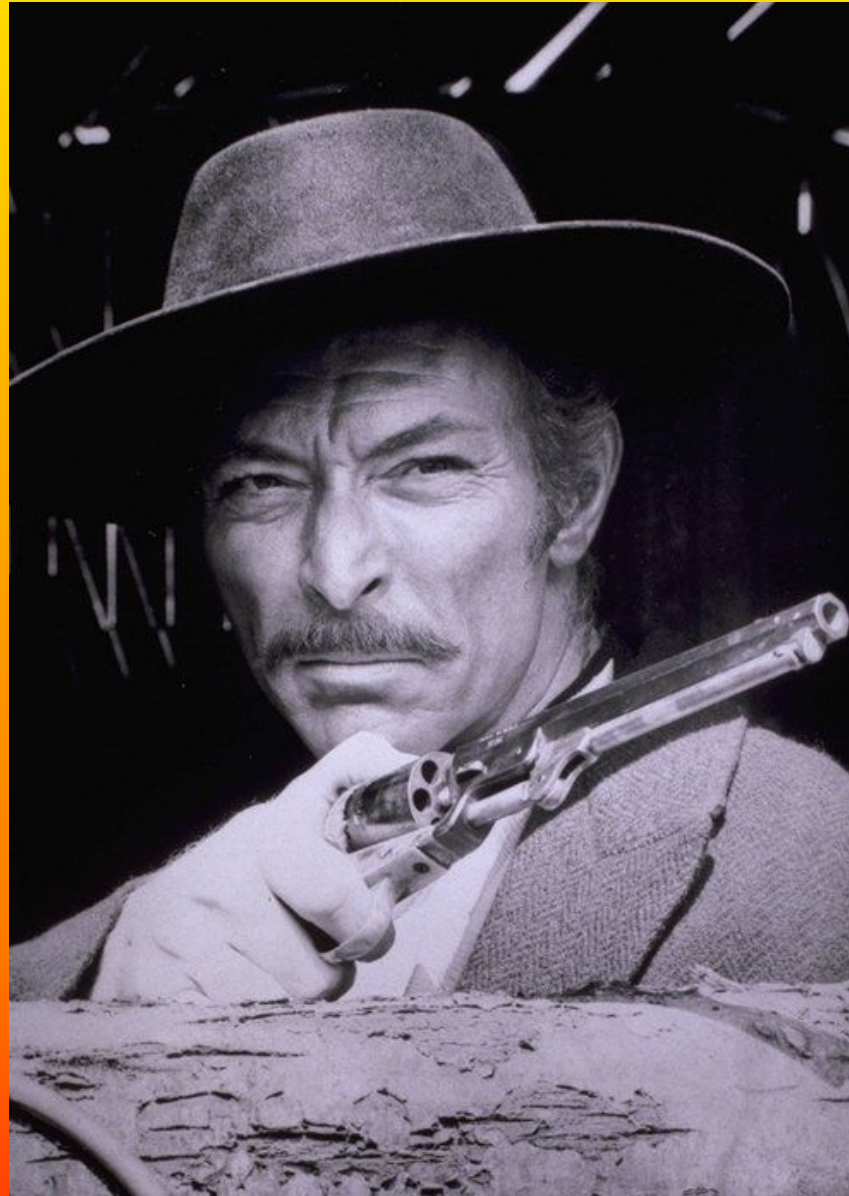


A Closer Look: **THE GOOD**

[Schadel et al. 2014](#) finds the depth of the active layer (the annual freeze/thaw layer near surface) 40% smaller than the earlier estimate used by [MacDougall's 2012](#) work.



THE BAD



IPCC Models Don't Include: trapped methane in frozen lakes, which is quickly lost when the permafrost thaws



IPCC Models Do Not Include: Pingos melting and filling with deep methane, then exploding and leaving large craters. While it would take many many thousands of such craters to be a significant force in climate...



... more are being discovered all the time



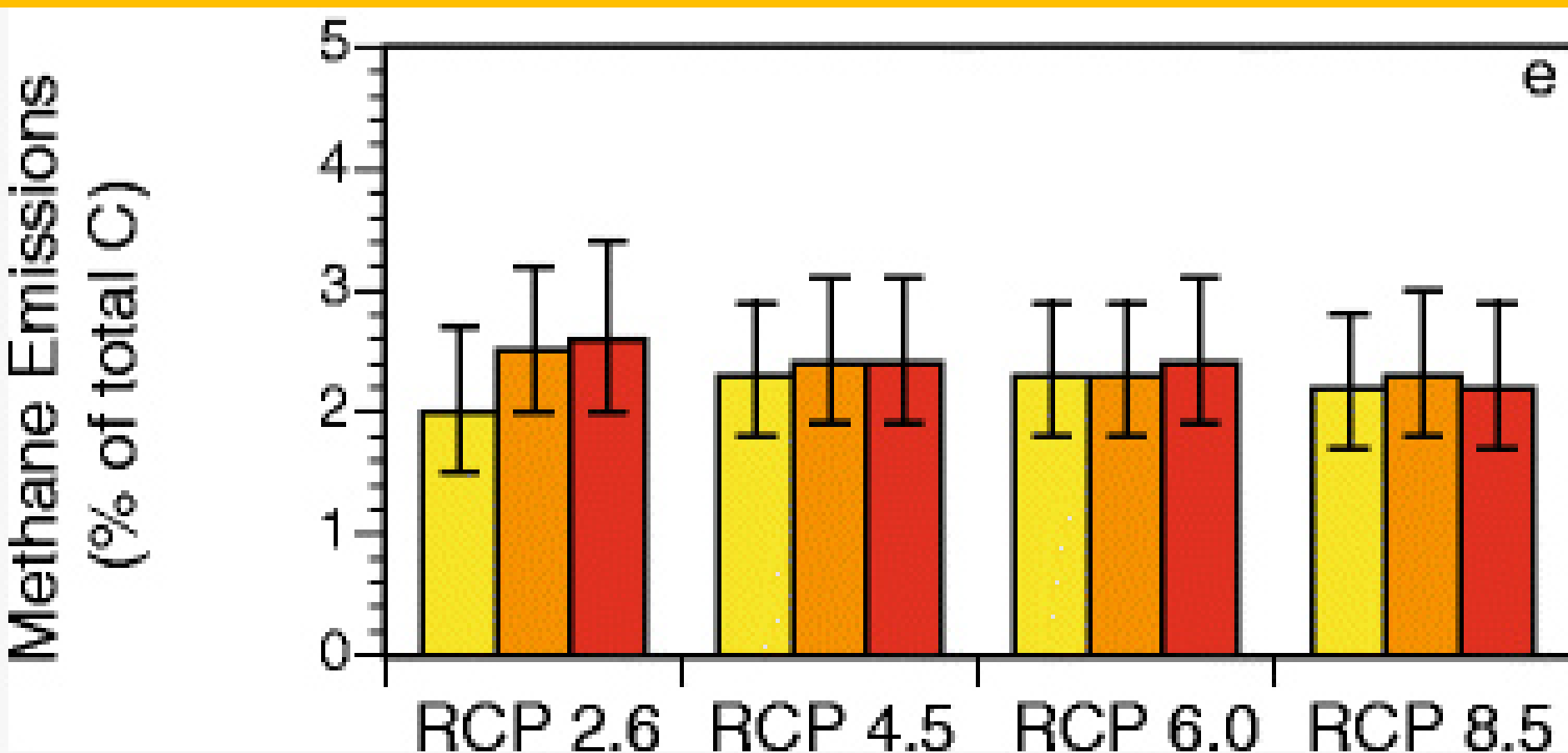
New in 2017, scientists are discovering...



- ...Over **7,000 new domes filled with methane** and “*are ready to explode*” (*link above*), in the Yamal and Gydan Peninsulas alone

**So How Much
Methane is there, in
melting Permafrost?**

Expert Consensus: 2.3% of emerging carbon will be in the form of methane ([Schuur et al. 2013](#)) - regardless of human emission scenario. (bar colors are for years 2040, 2100, 2300)



This is **BAD**

Because there's NO methane in the
MacDougall *et al.* 2012 curves

- ...The climate model used by MacDougall *et al.* 2012 (the [UVic model](#)) makes the simplifying assumption that all permafrost carbon emissions are as CO₂.
- The missing Methane must be added in.



**Methane's a
far more
powerful GHG
than CO2: So
what does this
mean for
greenhouse
forcing?**

“If just 1% of the permafrost carbon released is methane, it will have the same greenhouse impact as the other 99% that is released as carbon dioxide.”

- ...explains Dr. Charles Miller, P.I. of NASA's Carbon in the Arctic Vulnerability Experiment ([2013](#)).
- **2.3% of tundra carbon atoms emerging as methane means $2.3\%/2.75 = 0.84\%$ by mass as methane, vs. CO₂**
- **If 1% (mass) methane doubles the warming of pure CO₂, then 0.84% almost doubles it**

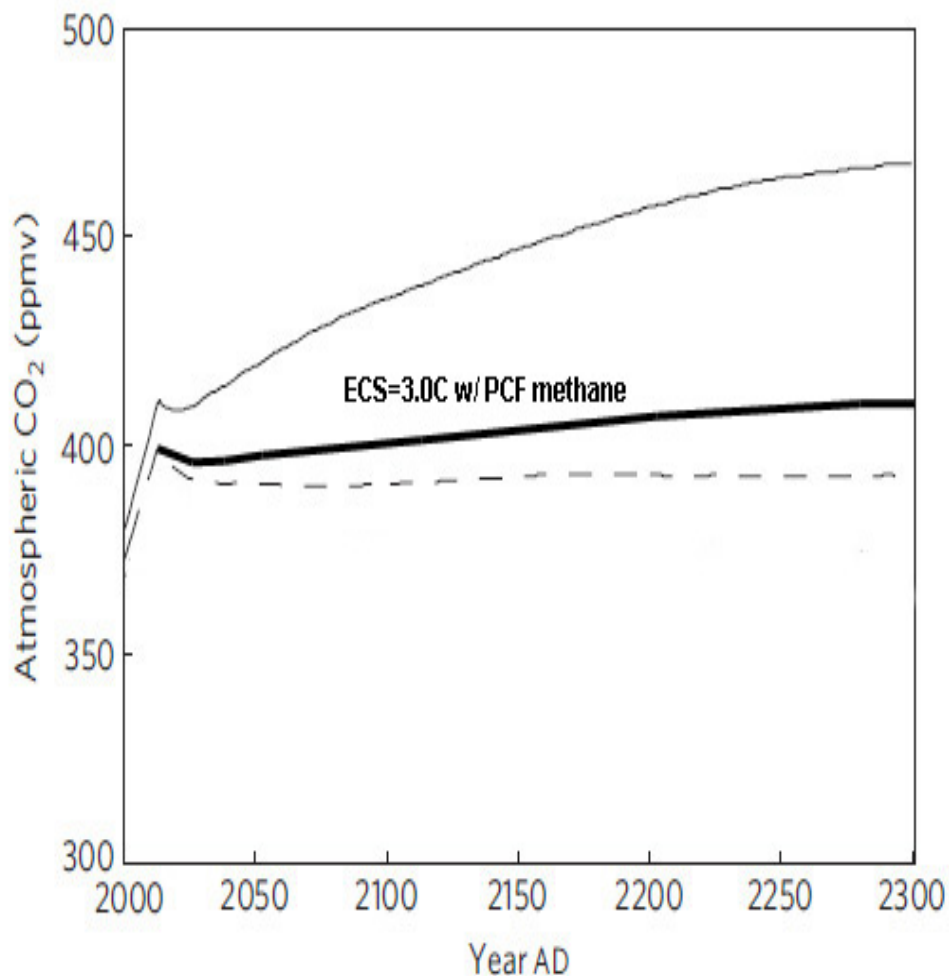


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Here's that [MacDougall et al. 2012](#) graph for ECS=3C, with added (dark) curve after correcting for smaller active layer but including methane.

Again, this is after turning off ALL human emissions in 2013).

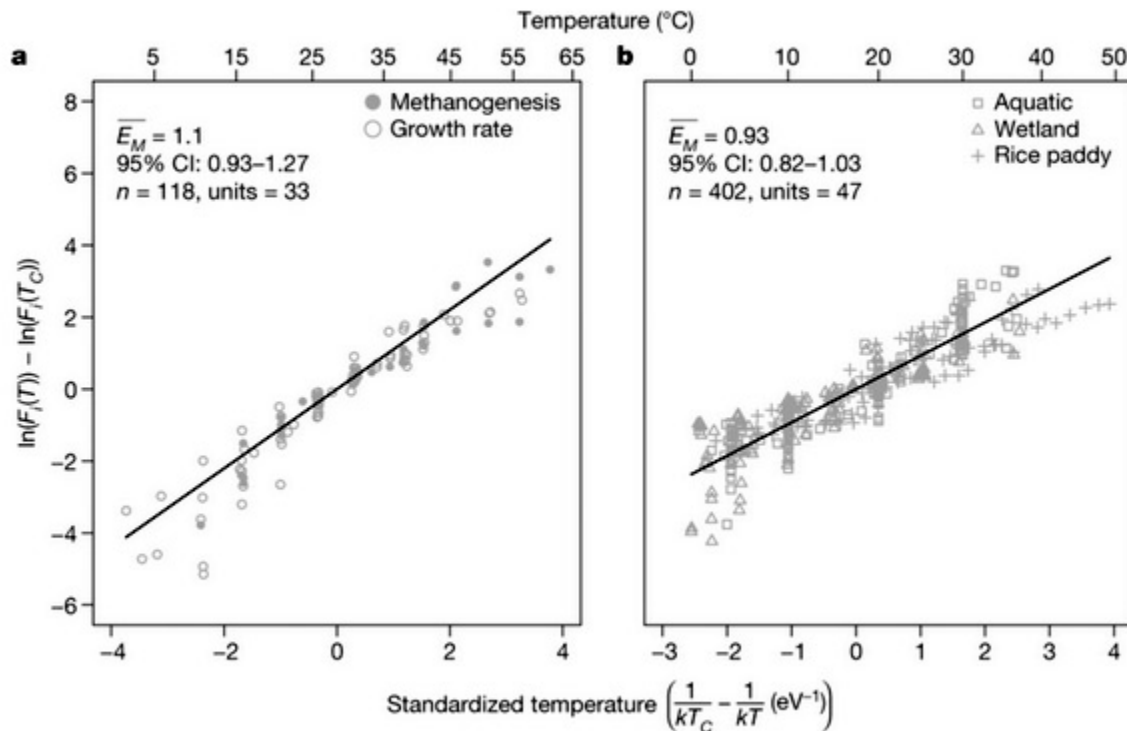
Note we're already at 410 ppm in 2017

But wait - it's worse...

The MacDougall *et al.* modelling neglects...

- * permafrost loss from **stream and coastal erosion**
- * **thermokarst degradation**, which may double the actual release rate
- * any **active layer melting below 3.3m depth**, yet melting will gradually deepen the active layer
- * Much of the Alaskan and Siberian permafrost soil is fine-grained **Yedoma** permafrost, which releases its CO₂ very rapidly to the atmosphere when thawed. Even, within weeks ([Spencer *et al.* 2015](#)).
- **None of this is included in any projections yet**

MacDougall *et al.* also does not include non-Arctic methane, and IPCC Models Do Not Include the strong temperature dependence of global wetlands methane emissions



Caption

Figure 1: Temperature dependence of CH₄ production and related processes at population and community levels. Temperature dependencies for methanogen populations in culture (a) and anaerobic microbial communities from natural sediment samples (b) are separately characterized using mixed-effects models by fitting Boltzmann-Arrhenius functions with experimental-unit-level random effects on the apparent activation energy and rate at fixed... [+](#)

0 Recommendations

- Methane emission rates from natural systems go up a strong 14% per 1C temperature rise. (2016 study)

Newer Work - Even Worse: [Zona et al. 2016](#) show, contrary to assumptions, that methane emissions do not end when the Arctic autumn freeze sets in, but instead stay high through December and beyond, thus ~DOUBLING the Arctic methane emissions. Does this mean double AGAIN the calculations we just did? (not clear - won't do here)

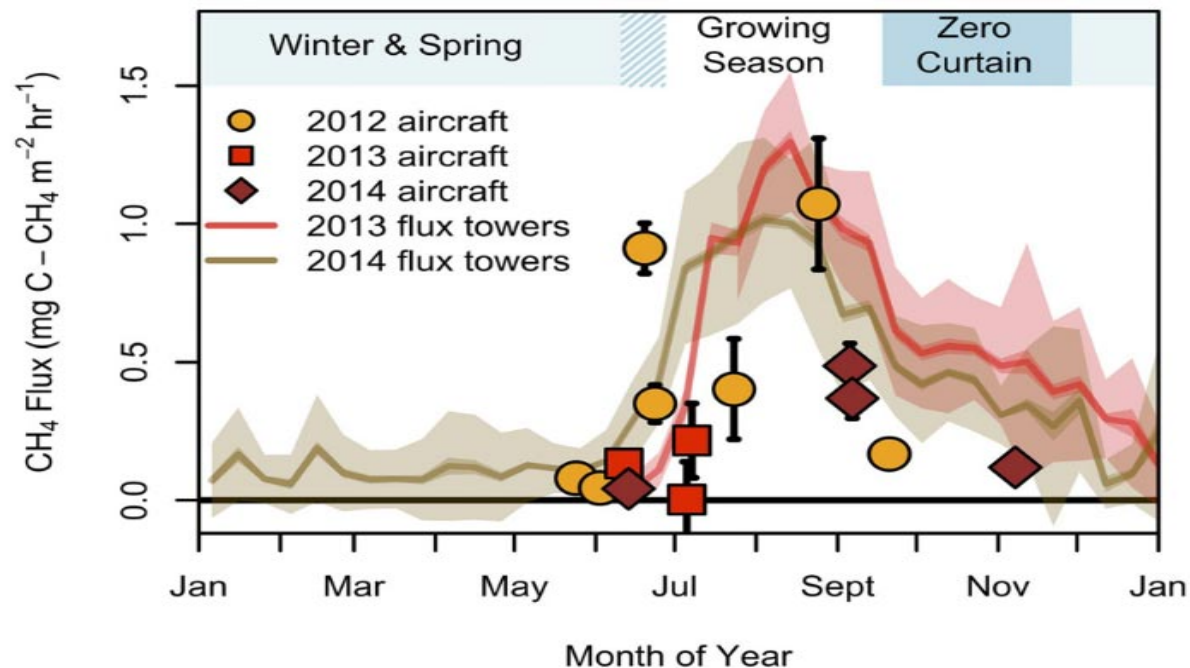


Fig. 4. Ten-day block average of the five EC flux towers over a 300-km transect across the North Slope of Alaska (shaded bands) for 2013 (red) and 2014 (brown), with the mean (solid line), 95% confidence intervals (darker shade), and SD in the CH₄ data (lightest shade). The regional fluxes of CH₄ calculated from the CARVE aircraft data for the North Slope of Alaska are shown for 2012 (yellow circles), 2013 (red squares), and 2014 (brown diamonds). The mean dates for the onset of winter, the growing season, and the zero curtain are indicated in the band on top. Regional scale fluxes of CH₄ (mg C-CH₄ m⁻² h⁻¹) showed similar seasonal pattern to the EC flux towers across multiple years.

What is atmospheric methane actually doing?

Data: Rising even faster than CO₂, and re-accelerating in the past decade.

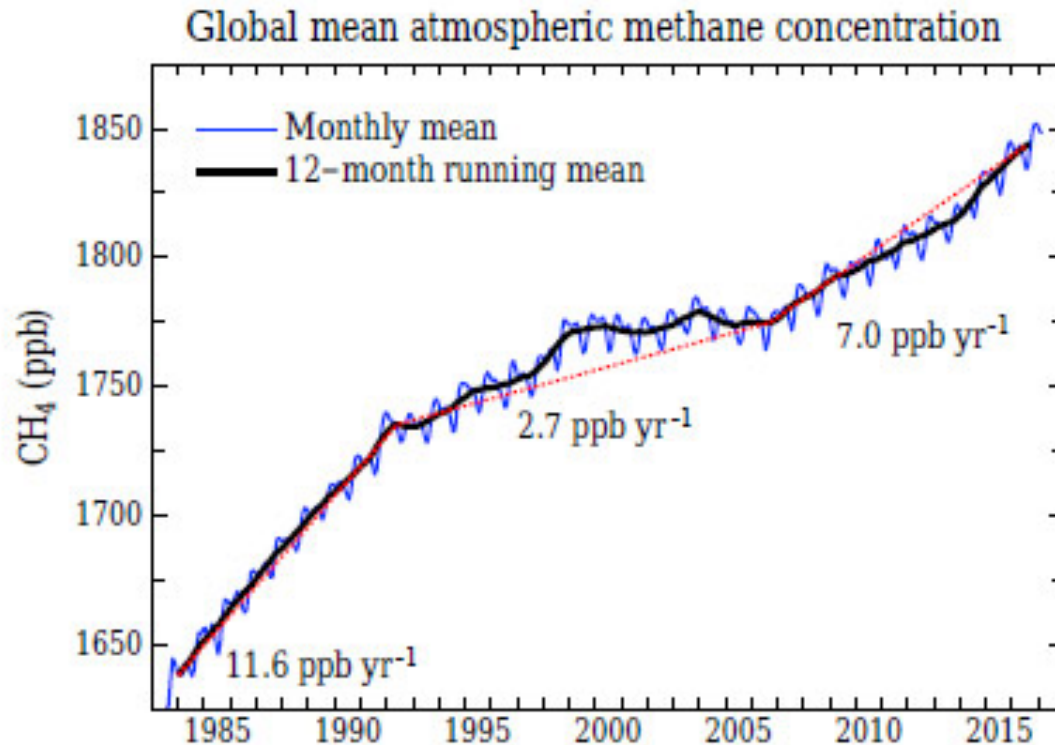


Figure 7. Global CH₄ from Dlugokencky (2016), NOAA/ESRL (http://www.esrl.noaa.gov/gmd/ccgg/trends_ch4/). End months for three indicated slopes are January 1984, May 1992, August 2006, and February 2017.

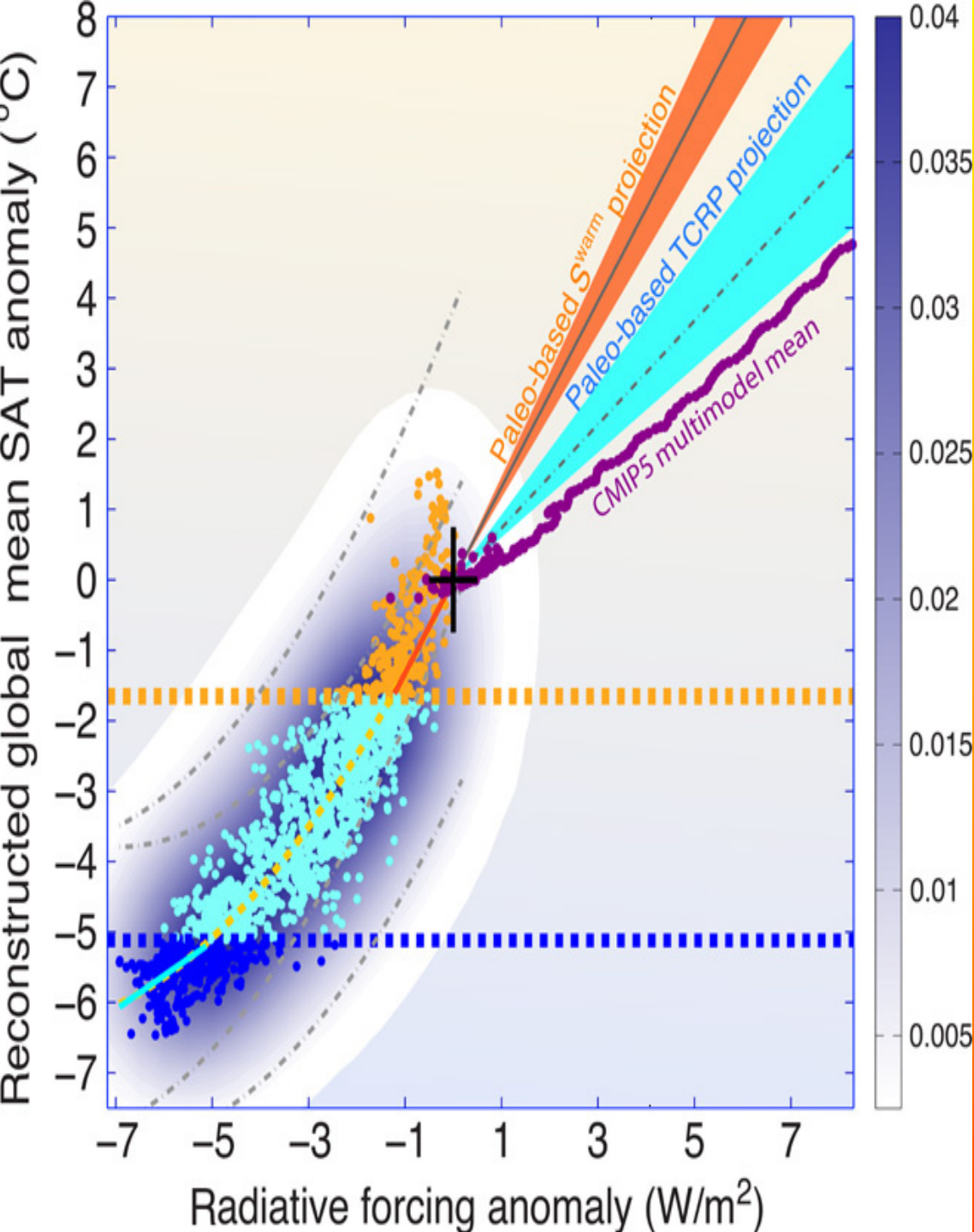
That was the **BAD**, Now... the **UGLY**



**What if ECS is not +3C per CO2
Doubling, but is actually higher?**

**While ECS=3C fits well with past paleo
data for the Ice Age cycles averaged as a
whole, new work is in fact showing that ...**

**ECS is HIGHER in HOTTER
climate states**



The best study is the most recent – by [Friedrich *et al.* \(2016\)](#) who find strong upward curvature in climate forcing vs. global temperature; This says higher ECS applies during interglacials' higher temperatures.

Their (orange) fit is **ECS=4.88C**

Other Post-IPCC studies from the past few years agree (from [von der Heydt et al. 2016](#)). Within each of these studies you'll see HIGHER ECS for HOTTER climate states. This is NOT in the IPCC projections!

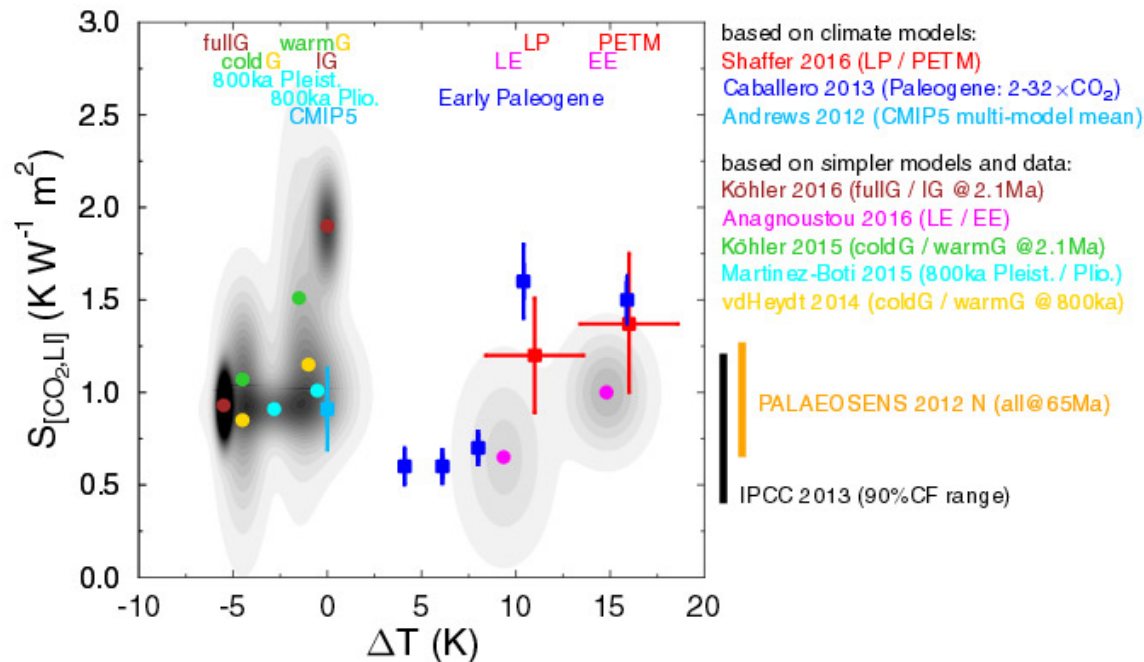


Fig. 1 Published paleo-based values of $S_{[CO_2,LI]}$ (specific equilibrium climate sensitivity parameter caused by CO₂ radiative forcing and corrected by variations in land-ice (LI) feedbacks) indicating its state dependence. Only studies published after the PALAEOSENS review paper [21] are considered. For comparison, the state-independent values from PALAEOSENS, and from the IPCC report [3], and the CMIP5 multi-model mean for present day [41] are also shown. All values of $S_{[CO_2,LI]}$ were given as mean (or most likely) $\pm 1\sigma$, apart from IPCC, which is the 90 % confidence (CF) range. Climate background states are given by ΔT from pre-industrial and are marked as estimated ranges (or $\pm 2\sigma$). In [42], further corrections for other slow feedbacks have been calculated, which has been ignored here, leading to

different values of ΔT than published. To increase the clarity of the figure, the data-based results are visualised by *colour-coded circles* (mean values), while their uncertainties are combined in a cumulative probability density distribution (*grey shading*) assuming normal distributed values. Results based on climate models are shown by *colour-coded squares* (mean) including their uncertainties (*bars*). *G* glacial, *IG* interglacial, *LE* late Eocene, *EE* early Eocene, *LP* pre-PETM/late Paleocene, *PETM* Paleocene-Eocene thermal maximum. Reference numbers of the given citations: IPCC 2013 [3], PALAEOSENS 2012 [21], Andrews 2012 [41], Caballero 2013 [43] vdHeydt 2014 [20], Martinez-Boti 2015 [44] Köhler 2015 [32], Anagnostou 2016 [42], Köhler 2016 [45], and Shaffer 2016 [46]

Even this may be too conservative

- ...Since during the past Ice Age interglacials, atmospheric CO₂ never rose above 280 ppm
- We're at 410 ppm now, and rocketing higher

560 ppmv = doubling of pre-industrial CO₂

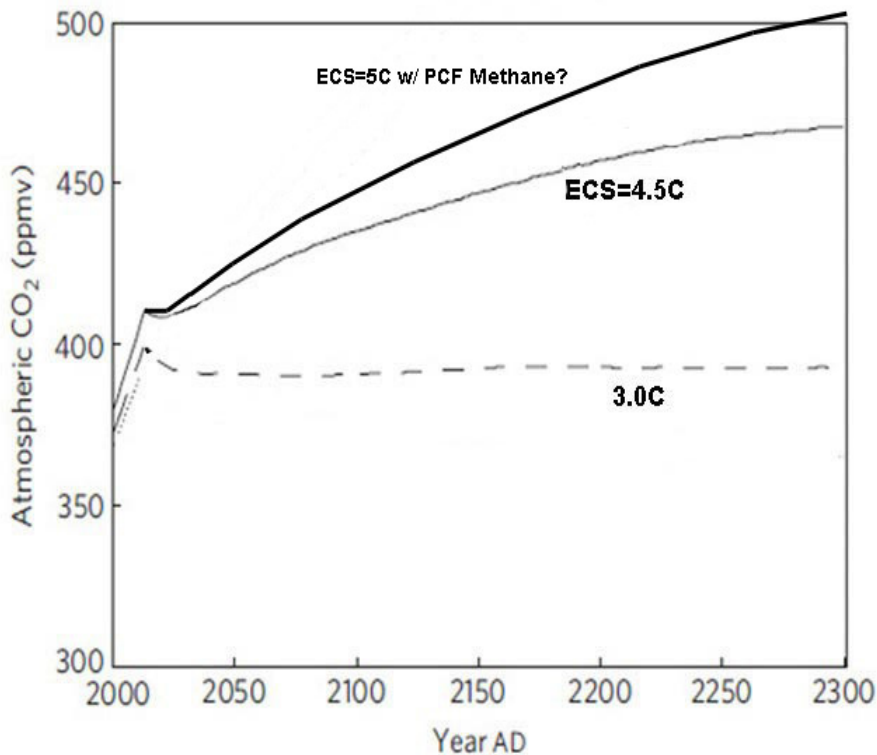


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UGLY!

ECS=+5C leads to atmospheric CO₂ equivalent rising to over 500 ppm by year 2300

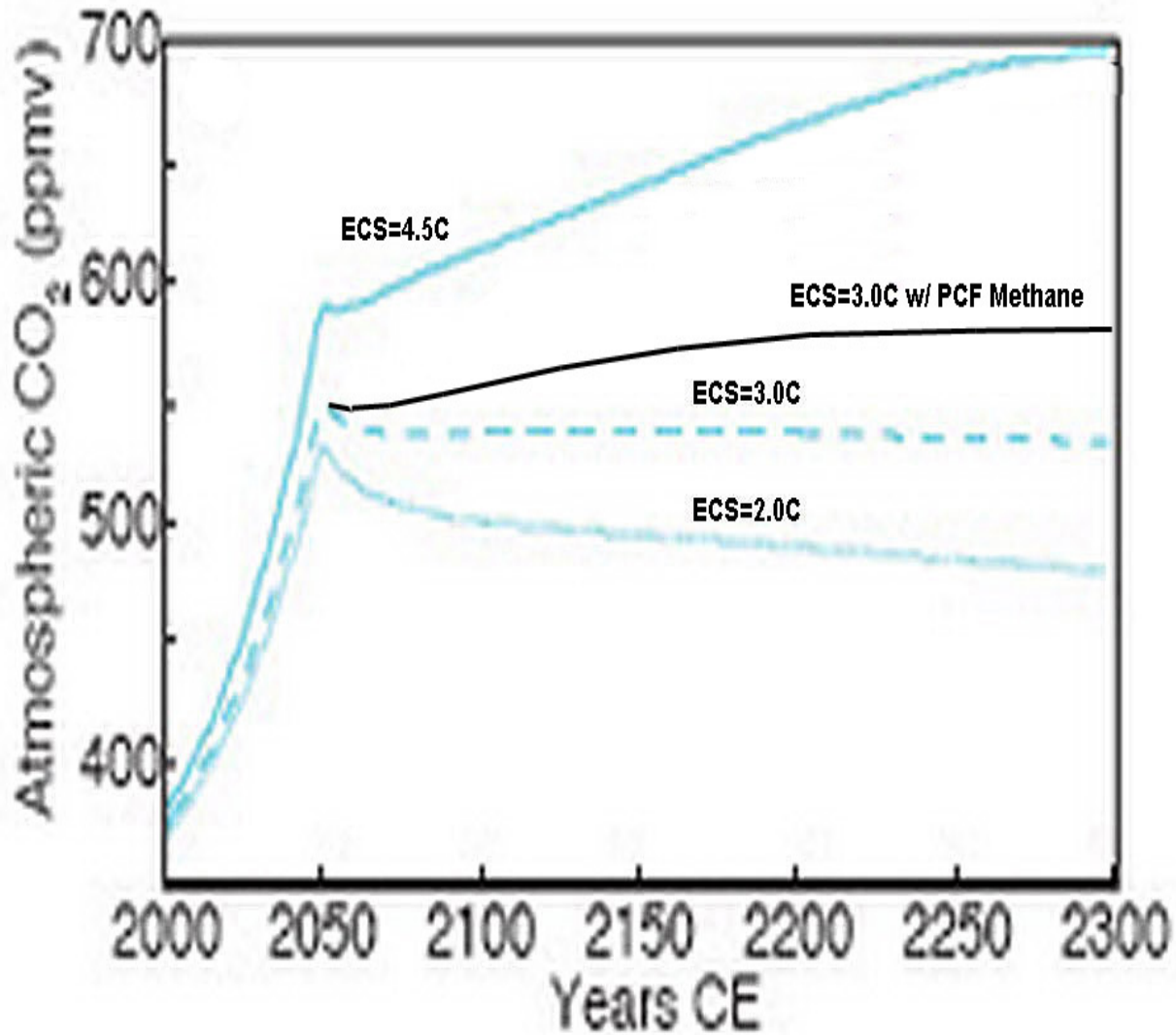
And that's after ending all Fossil Fuel burning in 2013!

**But of course... We Didn't shut down
carbon-based Civilization in 2013. So
NOW what?**



Assume we work HARD, and end ALL global fossil fuel burning, even in the most rapidly developing 3rd World countries, by late in this century, as many energy analysts think is the best–case scenario

- **Let’s approximate that by “Business as Usual”, then full shutdown at year 2050, just 32 years from now.**



Shutdown in 2050

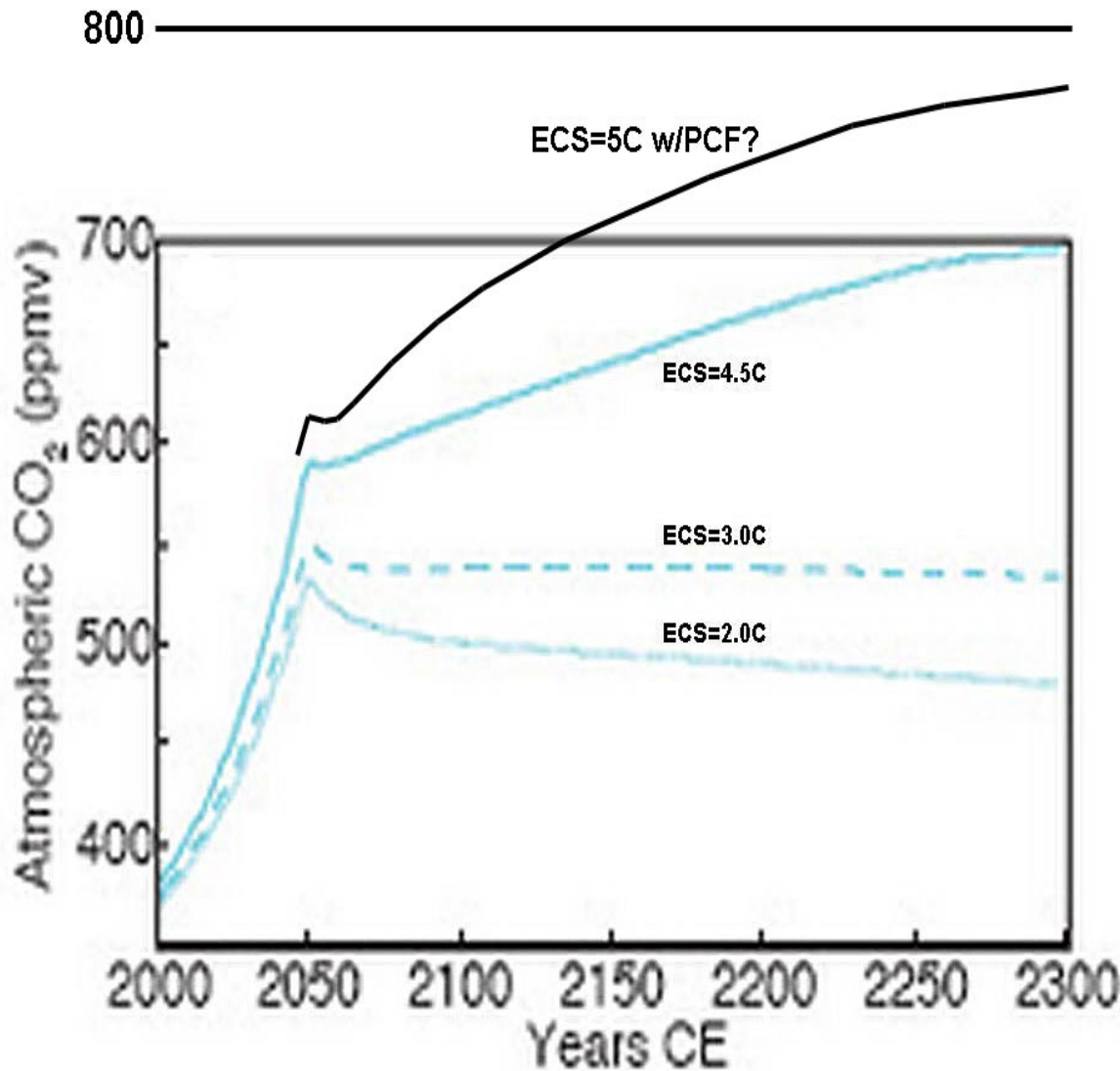
**Be optimistic
- take the mild
assumption of
ECS=+3C.
Then CO2 still
doubles, and
hence global
temperatures
pass +3C
above pre-
industrial.**

As the award-winning website “SkepticalScience”’s [summary](#) of this work says... ***“Unfortunately, there are several good reasons to consider the outlook in MacDougall et al. as rosy; as the authors themselves make clear.”***

- These effects are just from triggered permafrost CO2 and methane thaw alone, and are missing thermo-karst methane, coastal/stream erosion, *Zona et al*’s doubled methane from cold season emissions, tropical wetland temperature dependence, and more...

**Even UGLIER! Take ECS=+5C as
so many new studies indicate**





Shutdown in 2050

Then permafrost melt
drives atmospheric
CO₂e close to 770 ppm.

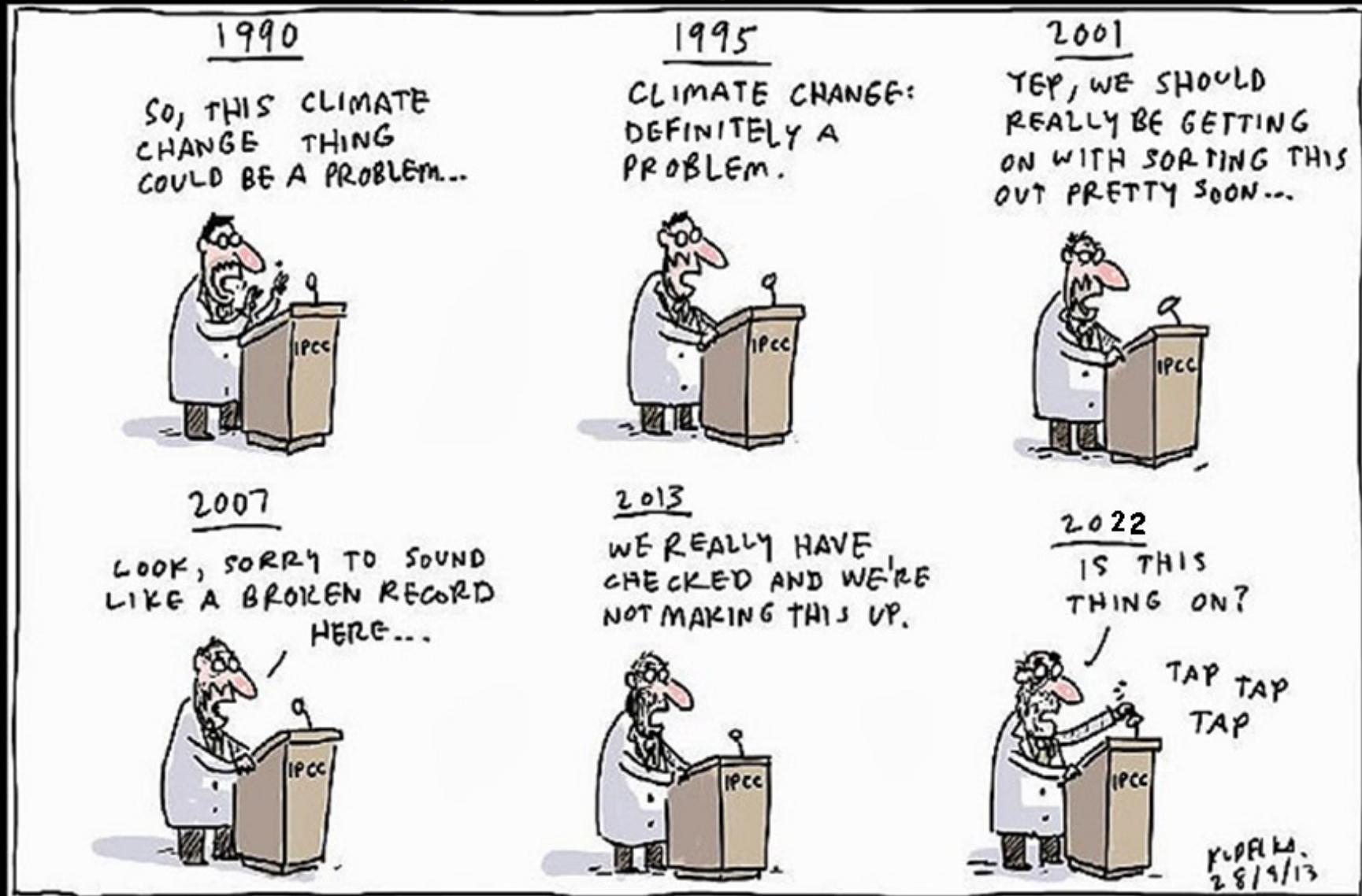
This corresponds to
a global
temperature rise of
~6.9C.

Again, this is
including hard work
to eliminate FF
emissions in coming
decades

Even +4C Rise Is Judged “Incompatible with an Organized Global Society”

- Tyndall Climate Centre head Prof. Kevin Anderson summarizes... *“a 4 degrees C future is incompatible with an organized global community, is likely to be beyond ‘adaptation’, is devastating to the majority of ecosystems, and has a high probability of not being stable.”* (meaning, it continues hotter).
- Think this is doomsday poppycock? Nobel physicist and former Secretary of Energy under Obama – Dr. Steven Chu – entirely independently, finds it highly likely that we’ll exceed 550-600ppm CO2 equivalent
- The path we’re on is sheer madness

When the stakes are climate chaos and mass extinctions, IPCC scientists (with a few exceptions) haven't been appropriately forceful communicators



But Wait - Now Consider the Thermodynamics Obeyed by Civilization Itself

- Cloud physicist **Prof. Tim Garrett** had the insight to investigate civilization as a thermodynamic system, creating order (civilization) out of disorder by the utilization of energy. Can ONLY apply to a closed system (i.e. the **global** system, you can't consider individual countries alone, because of flows of economic and material flows across borders)...
- **Prediction...**

The sum total of all past global inflation-adjusted spending should be directly proportional to current primary energy consumption rate (regardless of source)

The Garrett Relation Confirmed: 9.1mW to support every dollar ever spent

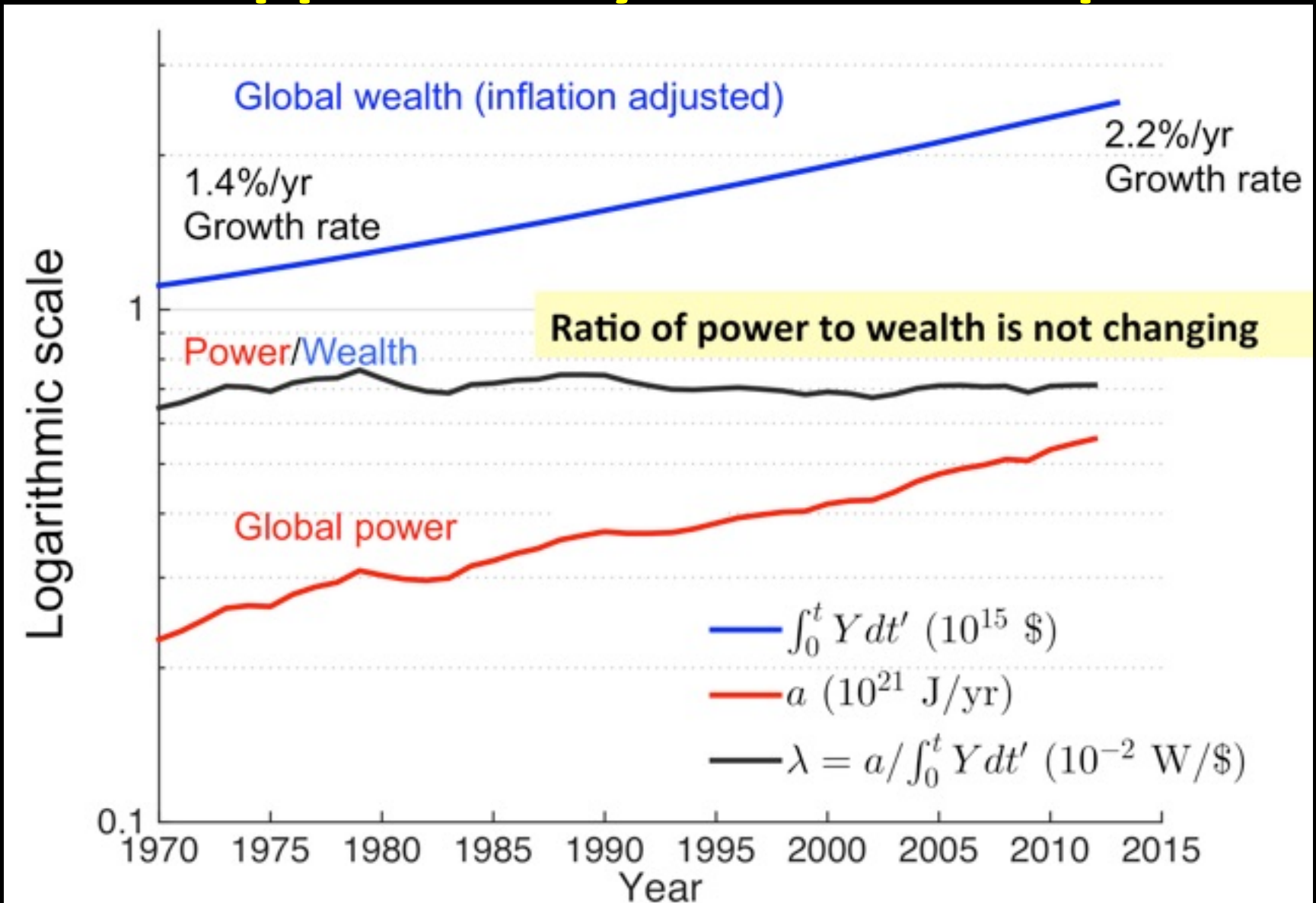
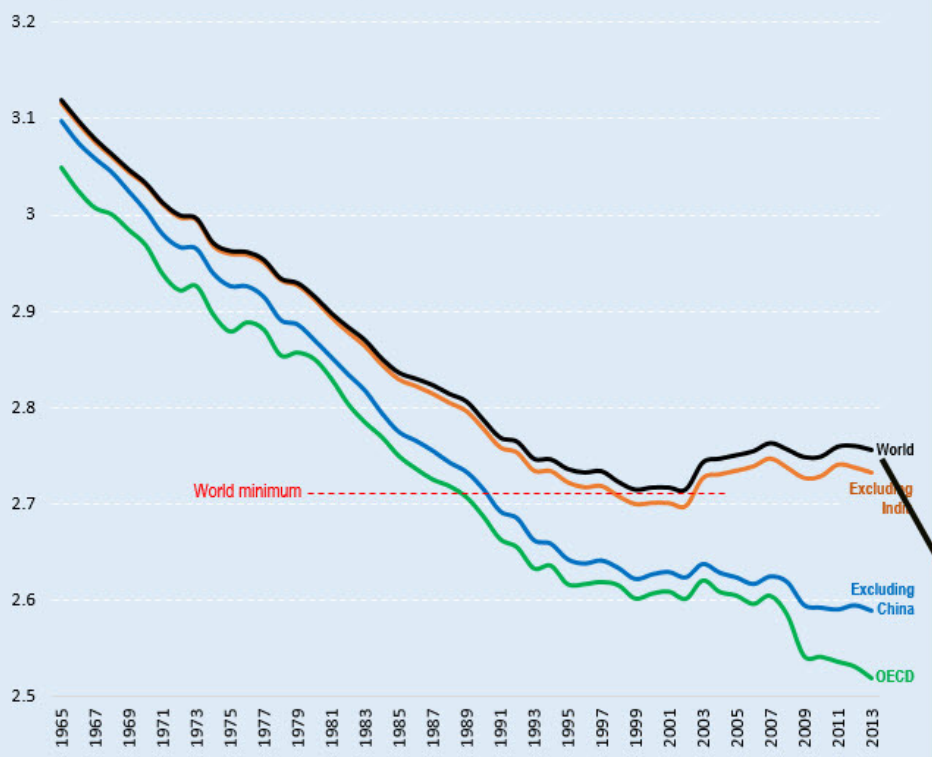


Exhibit-2: CO2 Intensity of Energy Use (metric ton/toe)
(Source: BP Statistical Review 2014)



trend of linear approximation to exponential halving time of 50 years

Let's assume we de-carbonize our energy sources at an exponential rate, with halving time of 50 yrs – steep by historical standards...

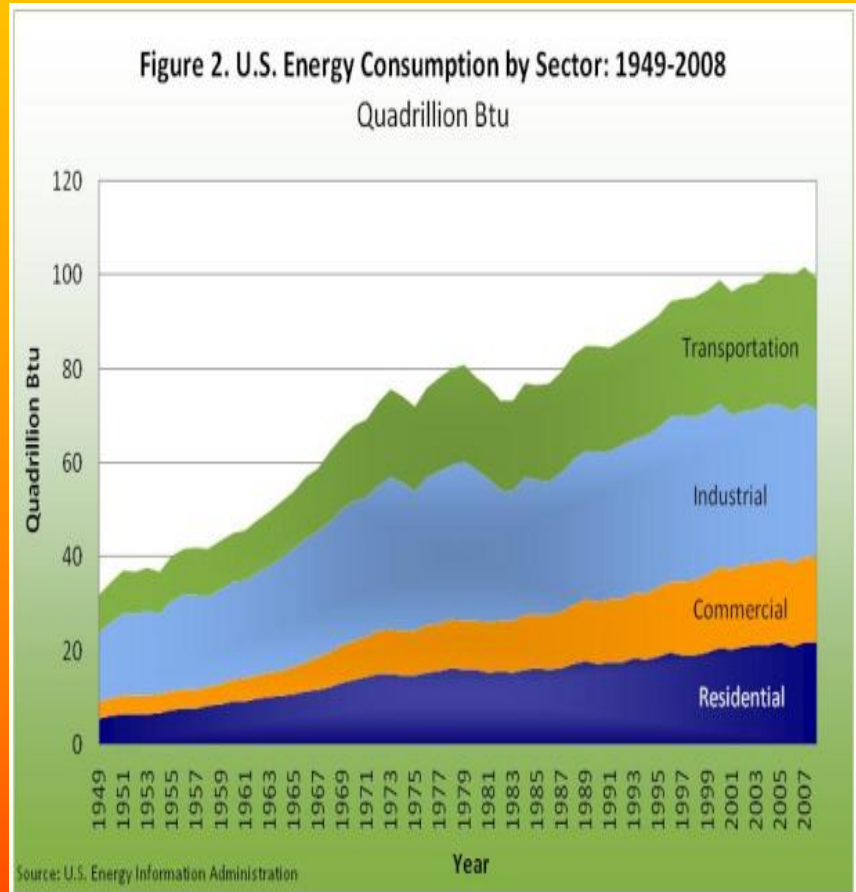
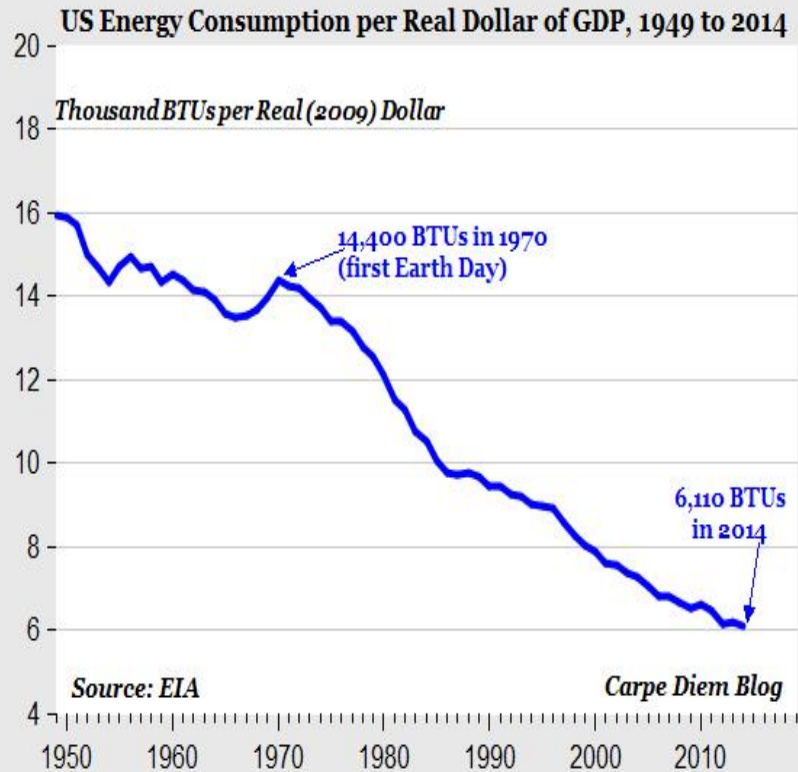
Why So Hard to Reduce CO2?

- “Jevon’s Revenge”!
- Increasing energy efficiency has been going on for centuries! That efficiency leads to savings, and those savings are SPENT.
- SPENT, to expand civilization further, and therefore by the Garrett Relation, expand its energy consumption rate
- By itself, increasing efficiency will not save us from a CO2 climate disaster unless we forbid ourselves from expanding civilization with those savings
- It’s like walking 5 mph down, on an up-escalator going 10 mph!

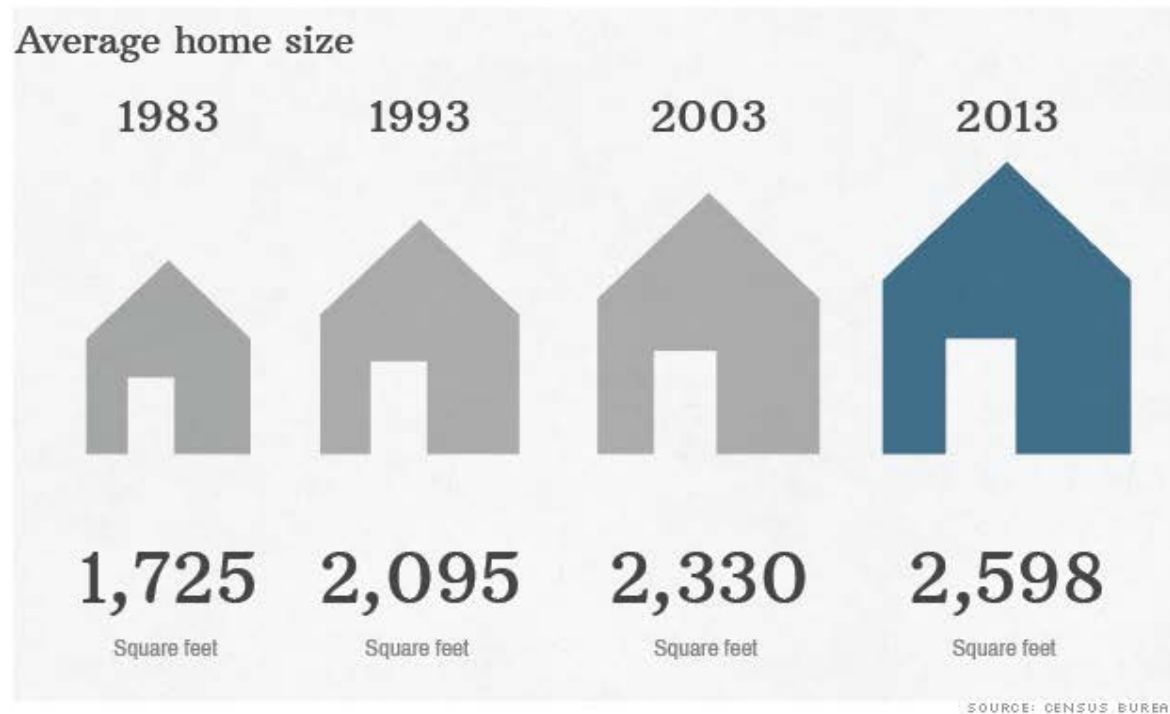
Increasing energy efficiency? – we've been doing it since the Dawn of Mankind!

70 yrs of spectacular increases in U.S. Energy Efficiency! Has it lowered our Consumption?...

No! Energy consumption continues to rise, even given our off-shoring of much manufacturing to Asia

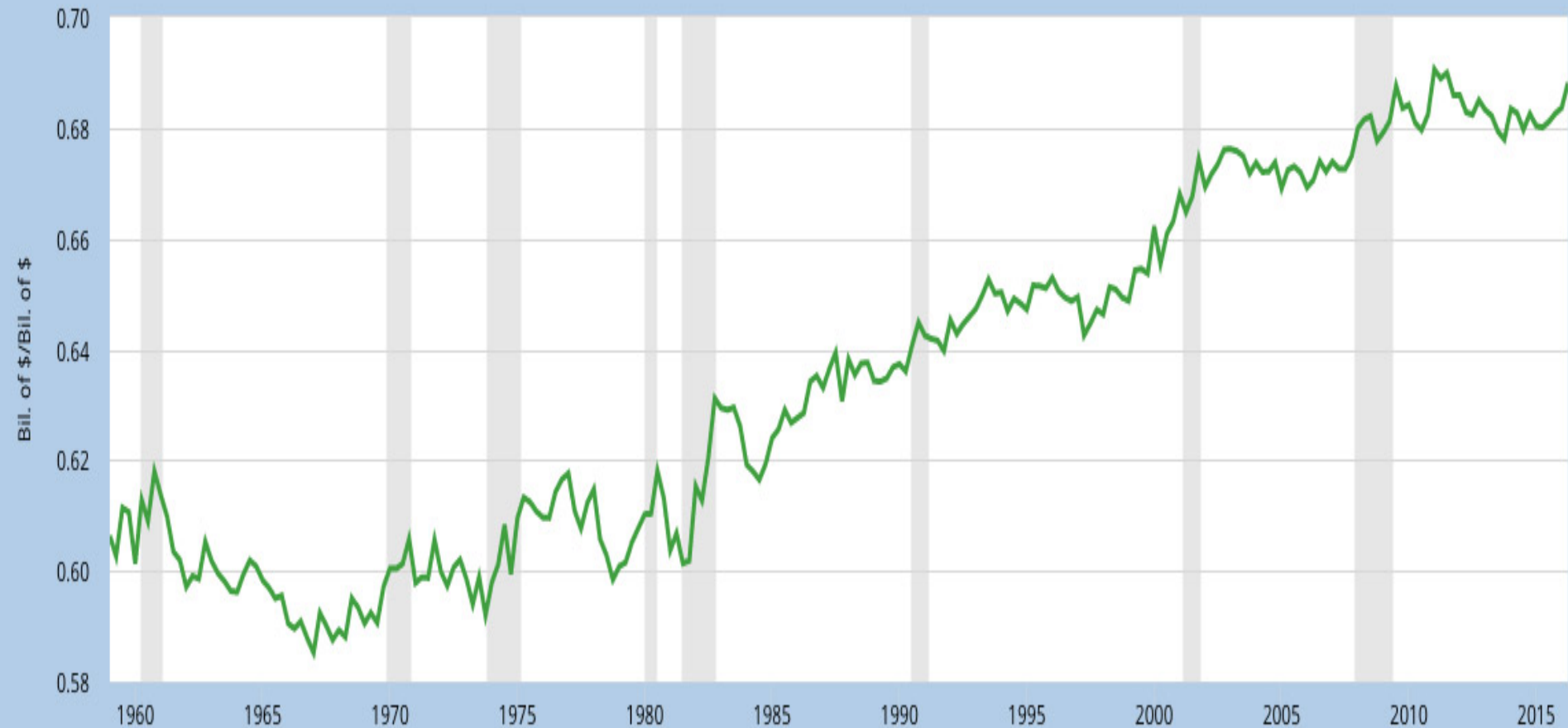


Even in the wealthy U.S. ...We do NOT save our efficiency gains. We SPEND them; on Bigger Homes...



...on more consumption spending per \$ of GDP

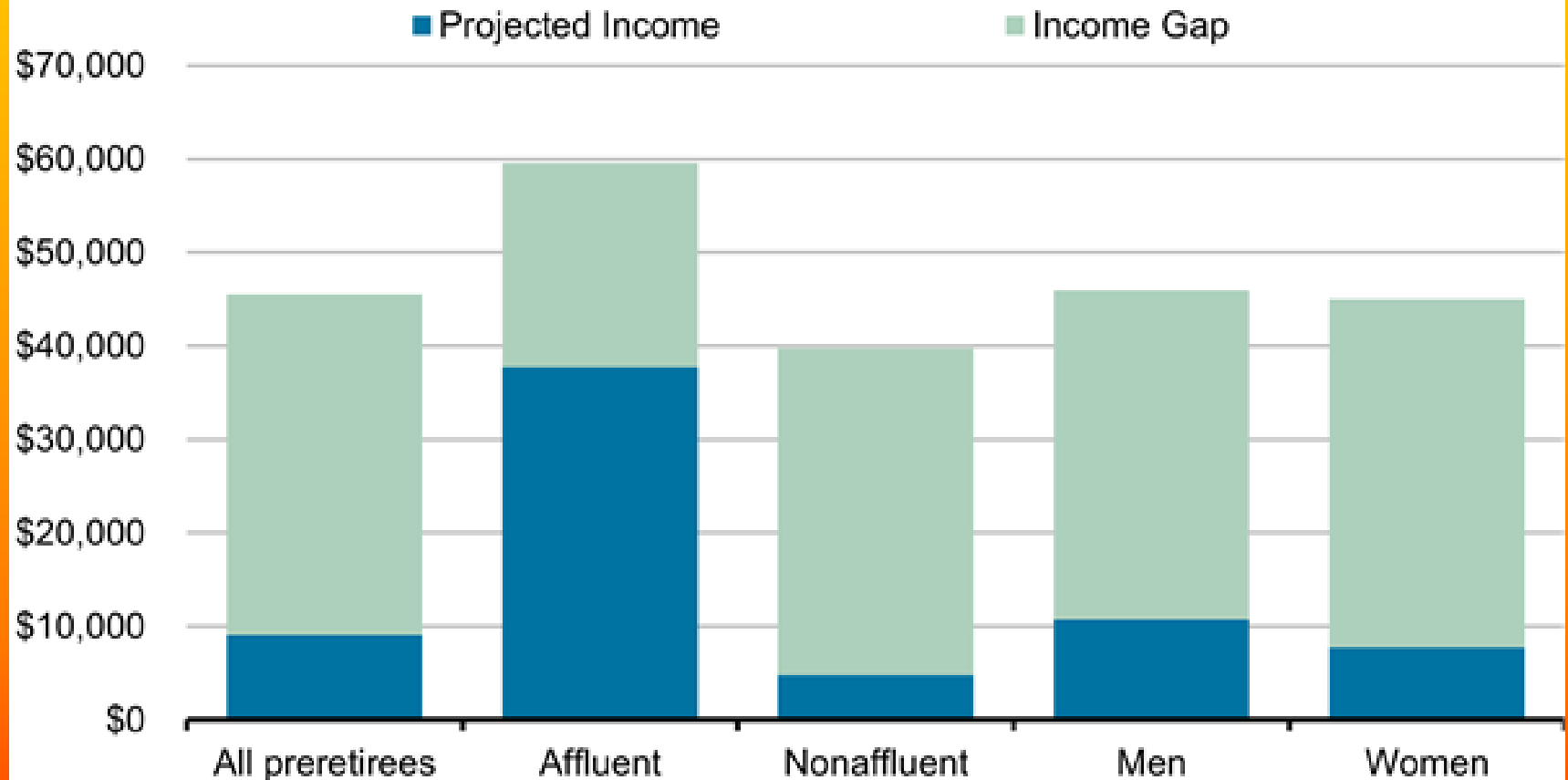
FRED  Personal Consumption Expenditures/Gross Domestic Product



We're NOT Saving... even for our own retirement

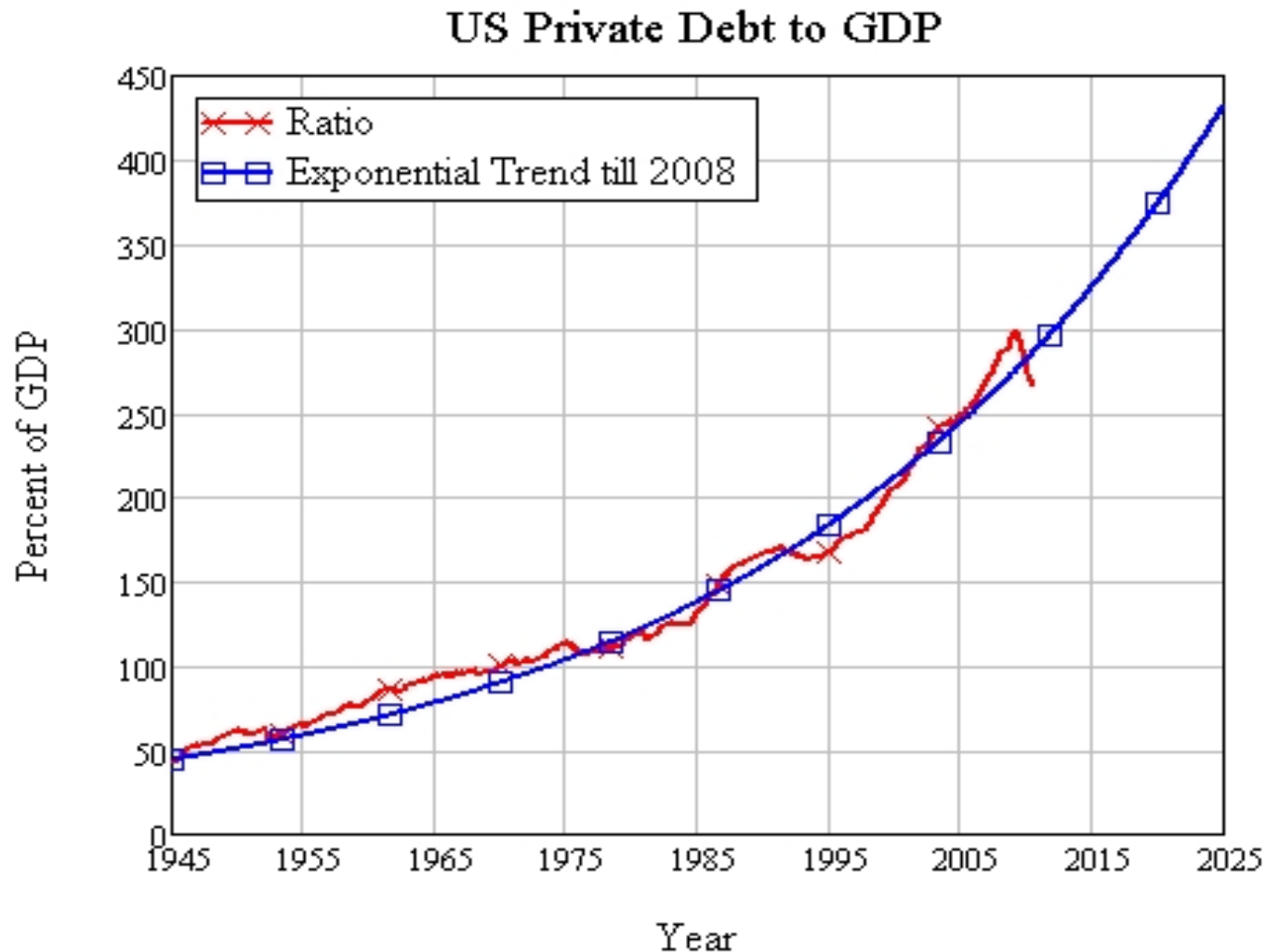
'A Very Unpleasant Surprise'

The gap between baby boomers' savings and desired annual retirement income

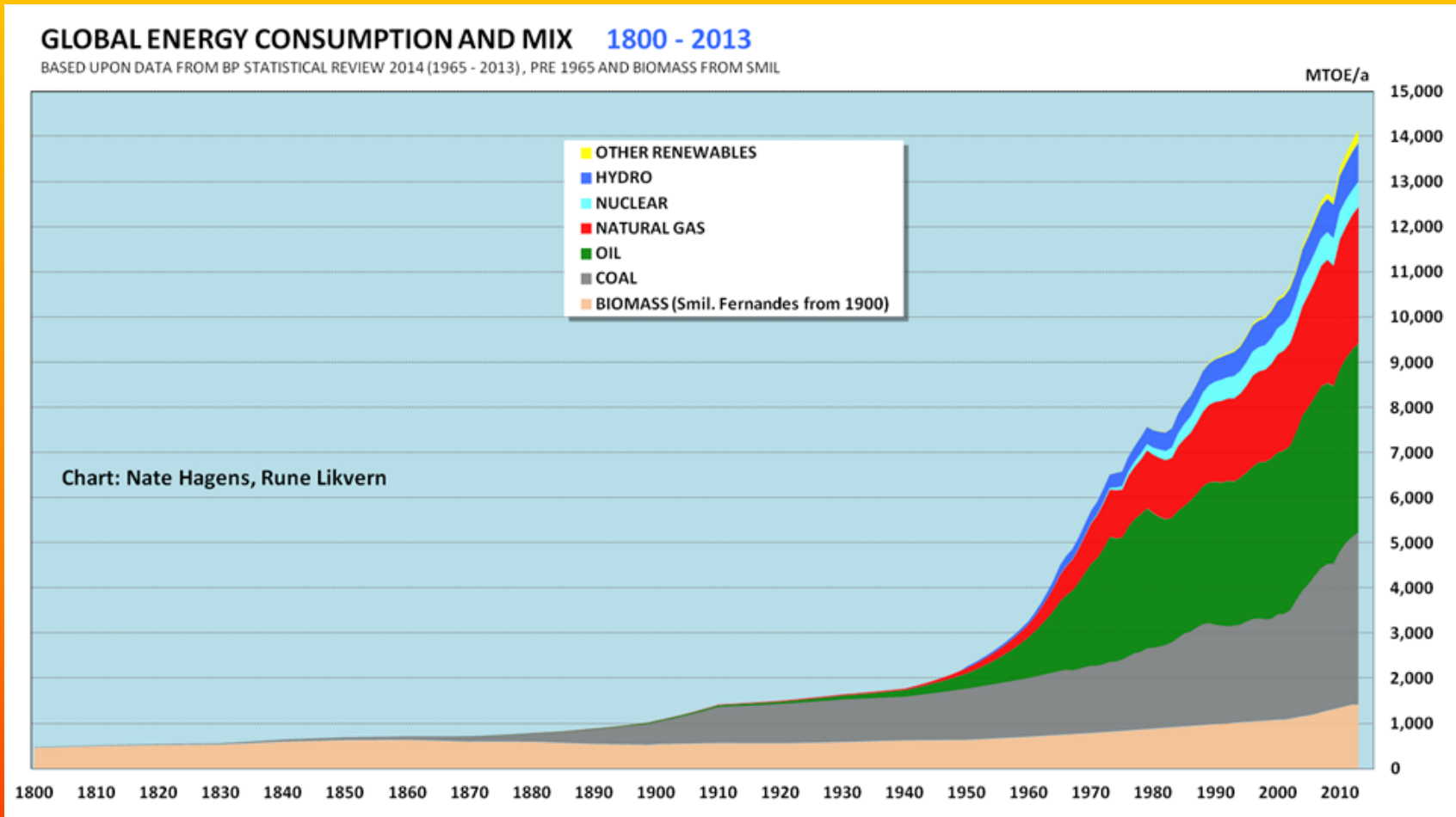


Source: BlackRock | WSJ.com

We SPEND. Not stopping with bankrupting ourselves, we even spend our children's and grandchildren's inheritance: Debt/GDP is exponentially increasing



Civilization will exploit ANY and ALL energy it can lay hands on. Yes, new power plants are increasingly solar and wind, when cheaper, but only in part, and older FF plants will not be unplugged just to save the planet, they'll be unplugged at the end of their natural lives... The tiny blip of yellow is non-hydro renewables, on top of steeply rising fossil fuels underneath. Hydro and Nuclear have not grown for decades



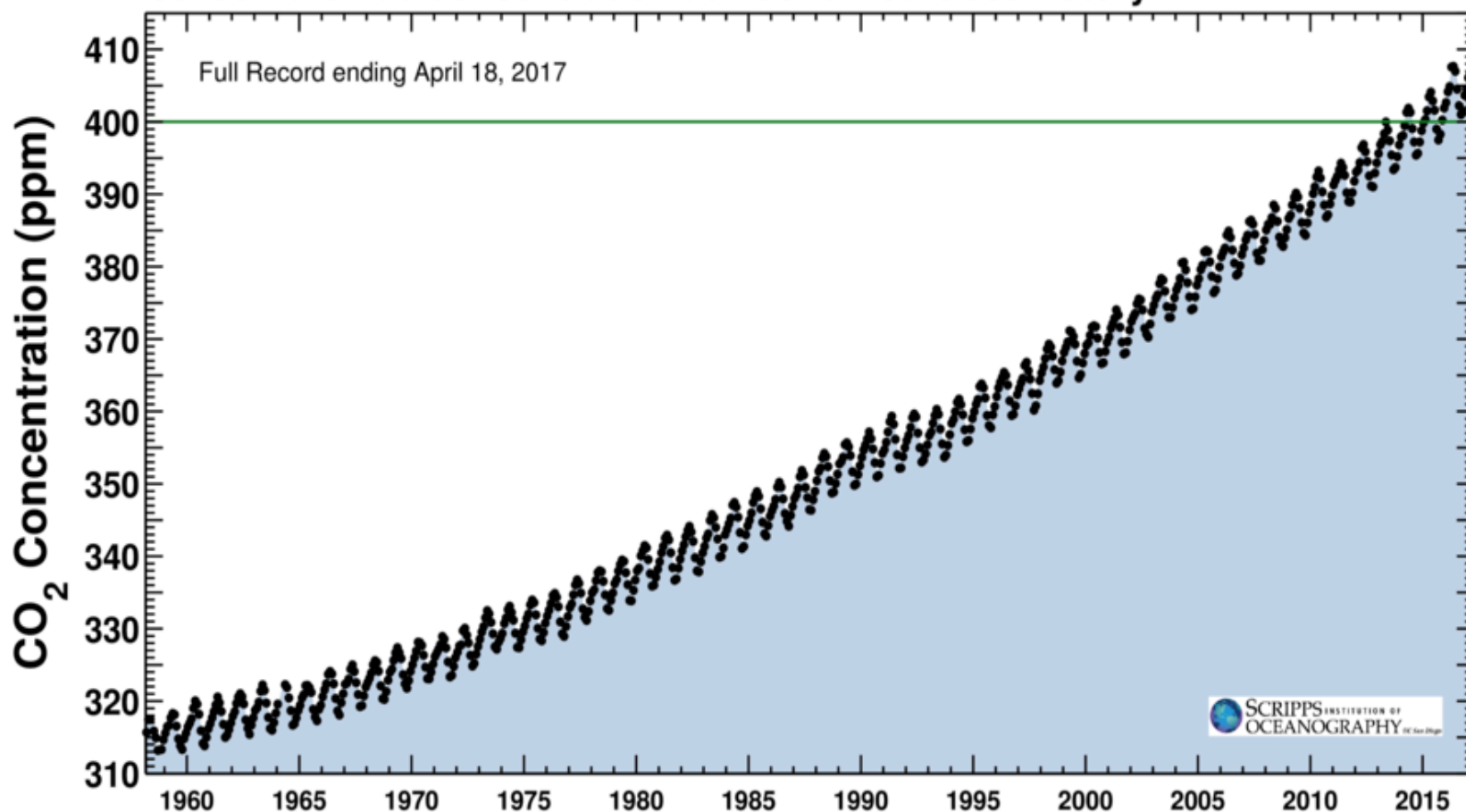
So: in the Real World: CO₂ Continues to Accelerate with no break

Latest CO₂ reading

April 18, 2017

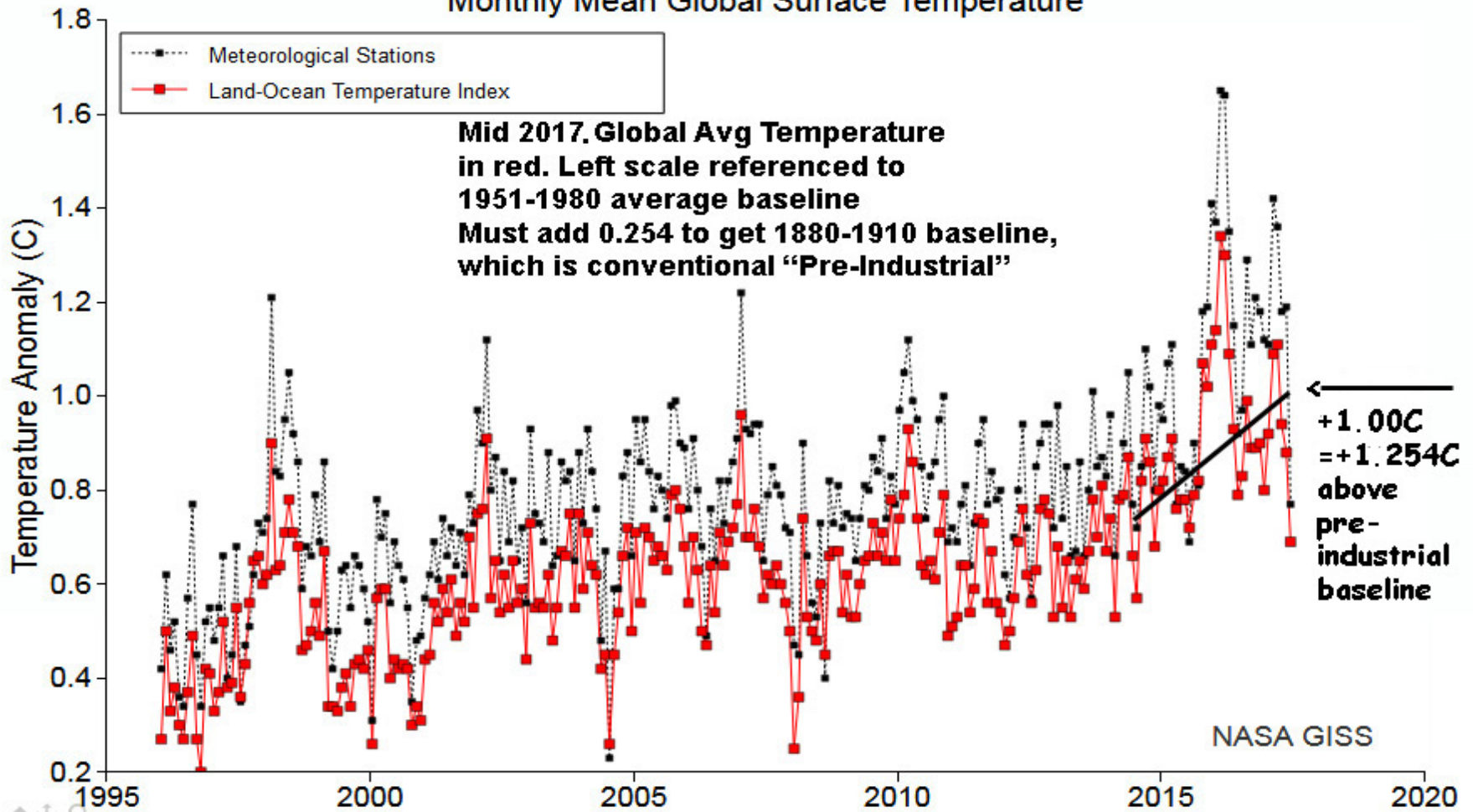
410.28 ppm

Carbon dioxide concentration at Mauna Loa Observatory

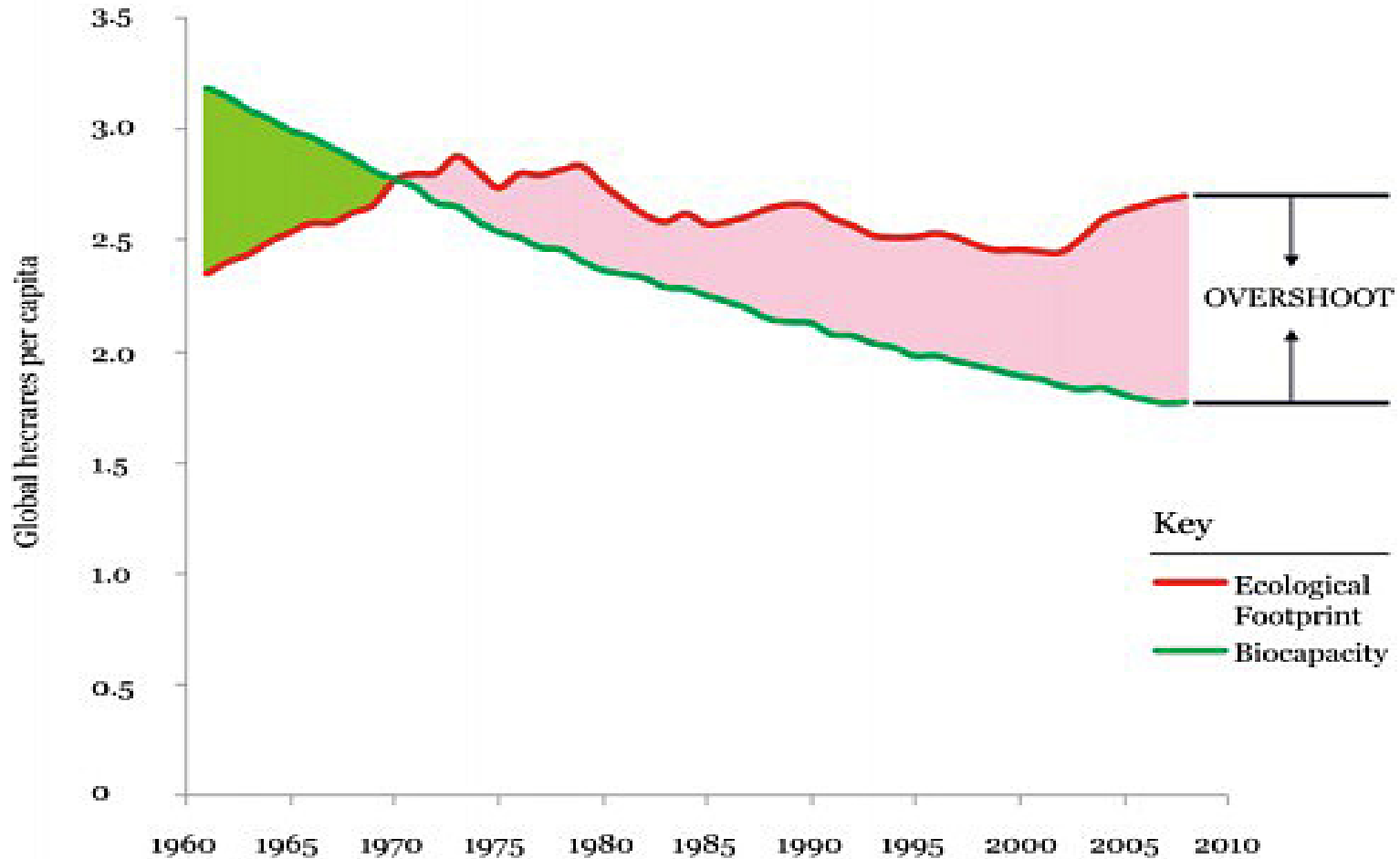


And as the Arctic Ocean rapidly loses its ice cover, global temperatures are accelerating

Monthly Mean Global Surface Temperature




Bottom Line: Sustainability on a finite Earth requires an end to the growth paradigm, and that won't happen without painful globally enforced policy, because it runs against the grain of our genetic inherited desires.



A Late Insert...

- I can't consider this talk complete without responding to a complaint I've heard second hand – that my talks are “negative”, a “downer” and no one wants to hear that sort of thing.
- **Yes, we instead want...**

A man in a dark suit, light blue shirt, and striped tie stands with his arms raised in a celebratory gesture. He is smiling and looking upwards. The background is a bright blue sky with a rainbow arching across it. On the left side, a large amount of US dollar bills are falling from the top, creating a dense stream of money. The overall scene conveys a sense of success and financial achievement.

Powerful Affirmations to Attract & Manifest WEALTH

But Mother Nature does not care about your desires. Her laws will be obeyed. Period. No Negotiation

- And the numbers don't pencil out. Resist the temptation to complacency induced by those who want to "sell" you on "hope", and pamper their popularity along the way. "Hope" - that smart people in a lab somewhere will let us have cake/eat too.
- We're passing tipping points right now. Not in 20 years... NOW. If your house was on fire, and the smoke alarms blared, would you complain and grumble that the smoke alarm is "a downer" and you don't want to hear it?
- Time scales are long, for the massive climate system. But they are also long for the massive civilization in which we live. We need to act as if this is the emergency that it actually is.
- Consider WW II. We complacently "hoped" for the best for years, But meanwhile, Europe was doomed to ruins, and Indo-China raped, before effective action happened. We only roused ourselves when attacked by Japan.
- I expect we'll only consider doing UNcomfortable things for climate when the disasters come too thick and fast to ignore. But by then, our hot, humid future will be too far along to avoid without REVERSE climate change, which will be very painful.
- **Nolthenius' First Law: People Learn the Hard Way**

Sorry!

The lifestyle you
ordered is currently
out of stock

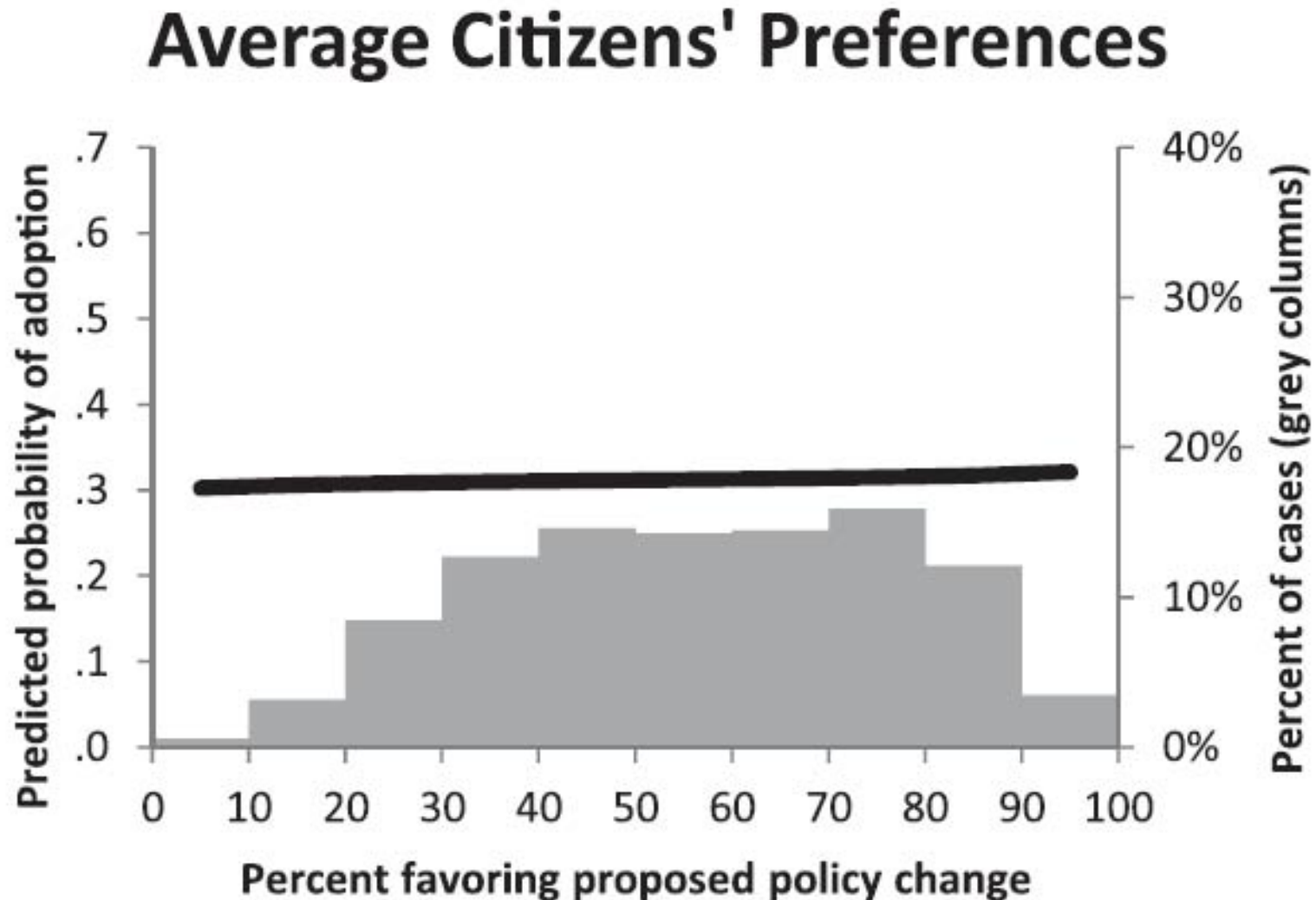
Garrett's work, however, includes no permafrost thaw

- So the reality will be worse than those red curves.
- My extensions to this work involve the inflation term, and have important implications. No time to elaborate here, alas. See [this talk](#)
- I also plan to extend the work to more drastic assumptions of decarbonization.

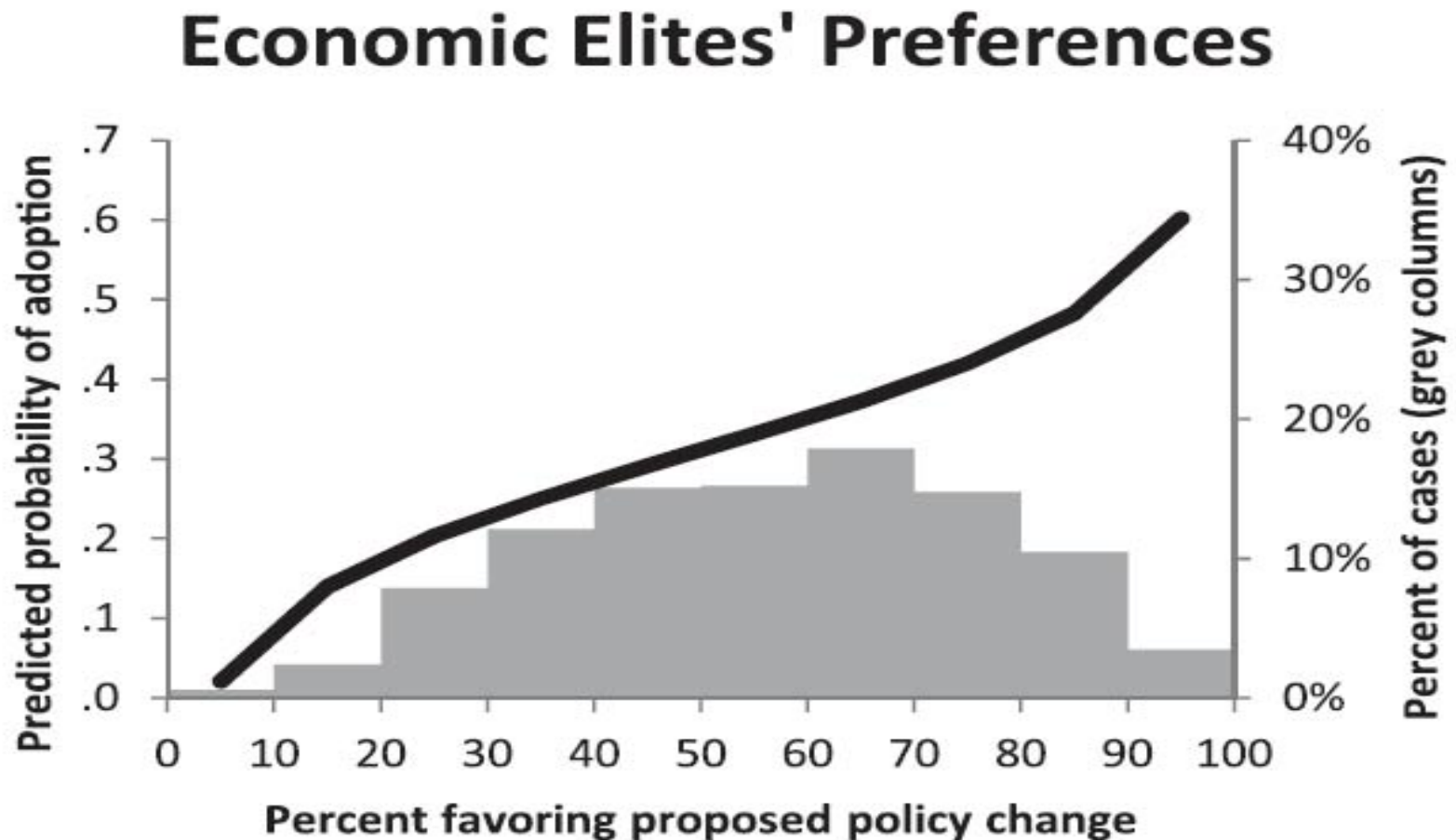
So What do We Tell our Students to Do?

- Encouraging voluntary individual conservation has psychic value, but ~no climate value. The U.S. is a minor contributor to additional CO2 now.
- **Only GLOBAL actions can affect LOCAL climate** – unlike almost any other environmental problem. Even inspiring 1 billion of the high-carbon wealthy nation people to somehow cut their carbon footprint in HALF, only cuts annual CO2 emissions by a negligible 13%.
- **Techno-fixes are essential, but highly unlikely to succeed in a civilization committed to growth.**
- **We need to create and enforce Global Governmental Policy.**
- **How? Shall we Write our Congressman?**

Alas, There is ZERO correlation (=flat trend) between what legislation is desired by average citizens, and what actually gets adopted (Princeton researchers [Gilens and Page 2014](#))



...Near-Perfect correlation between what the Economic Elites want and what gets adopted. True over 20 years of both Republican and Democratic Executive, Legislative, and Supreme Courts. This is a deep systemic dysfunction.



Yikes! Can we Trust the Economic Elites? It Appears Not: Psychopaths in Corporate CEO Boardrooms

- ...fully 21% of Corporate CEO's fit the diagnosis as psychopaths, the same fraction as found in prisons. ([Brooks et al. 2016](#), published in *The European Journal of Psychology*)
- In the general population, using their criteria, the rate is only 1%

Your Political Influence: ZERO!

It is not noble to “HOPE” that banging your head against a brick wall will break the wall before it breaks your head... and your heart

“We Are What We Repeatedly Do” –
Aristotle

What does that say about our Congress’s Integrity? (and for the Executive branch...)

What could go wrong?

Exxon Mobil at State.

Goldman Sachs at Treasury.

Fast food at Labor.

Anti-gay Attorney General.

"King of Bankruptcy" at Commerce.

Public education foe at Education.

World Wrestling Entertainment at SBA.

Climate change denier at EPA.

Mitch McConnell's wife at Transportation.

...

And a Twitter-addicted,
reality TV show-producing president.

Sustainability Needs a New Rebel Alliance (led by **Our Students**. Oldsters got them INTO this mess, and resist reconsidering strategies)




I Offer This Strategy: Occupy DC with 1 million strong, and Not Leave Until...

- 28th Amendment to the Constitution, guaranteeing unspoiled commons to future generations (oceans, air, great forests...)
- Carbon Tax and Dividend, at ~\$300/ton CO2 level just for starters
- End subsidies to Fossil Fuel interests (5% of global GDP!)
- Institute 1 (really, less) -child-per-family, globally
- Lawsuits against governments for discriminatory failure to protect the most vulnerable among us
- End “Citizens United”.
- Fund research on CO2 air capture and other climate interventions which safely trace us backwards along the system trajectory we followed to get here.
- See my [.pdf on “Policy”](#) for much, much more...

**Tell your interested students – Take Astro 7 –
the most detailed and complete course on
climate at Cabrillo College**

Astro 7: Planetary Climate Science



Cabrillo College Rm 806 Tuesdays 2:45-5:50pm
**A non-mathematical UC/CSU transfer course for the
intelligent layman on planetary atmospheres, especially
Earth climate and current climate change: the science,
the politics, the future. Civilization and its limitations.
Strategies - Policy, Economics, and Technological**