

# Flawed Approaches (and a New Approach) to Environmental Challenges

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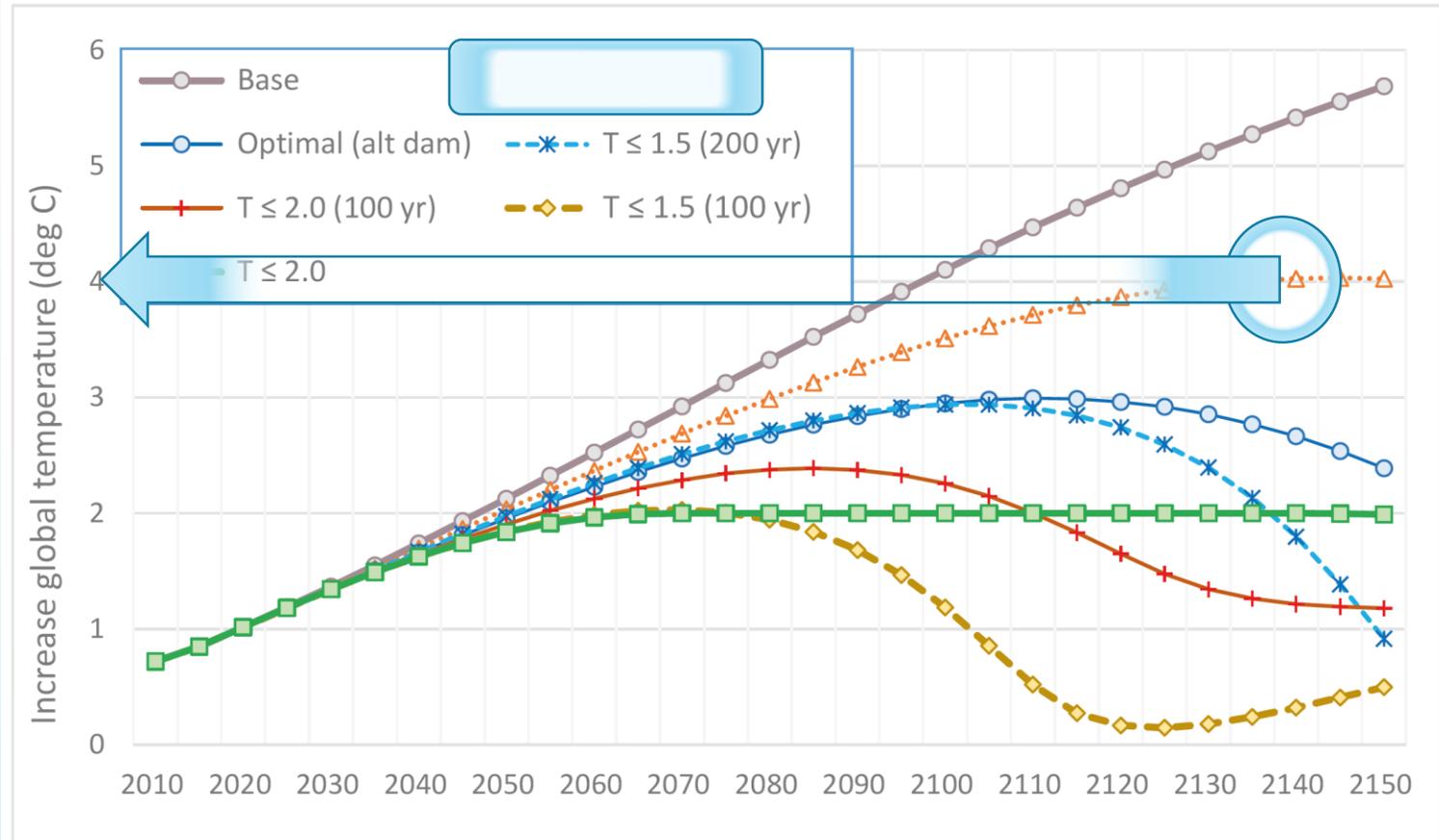
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# The 2018 Nobel Prize in Economics was awarded...

- To “[William D. Nordhaus](#) ‘for integrating climate change into long-run macroeconomic analysis’”
- Key slide from Nordhaus’s Nobel Prize speech on December 8, 2018...
- **Optimal** time path of global temperature stabilizes at **4°C above pre-industrial levels** in 2140...

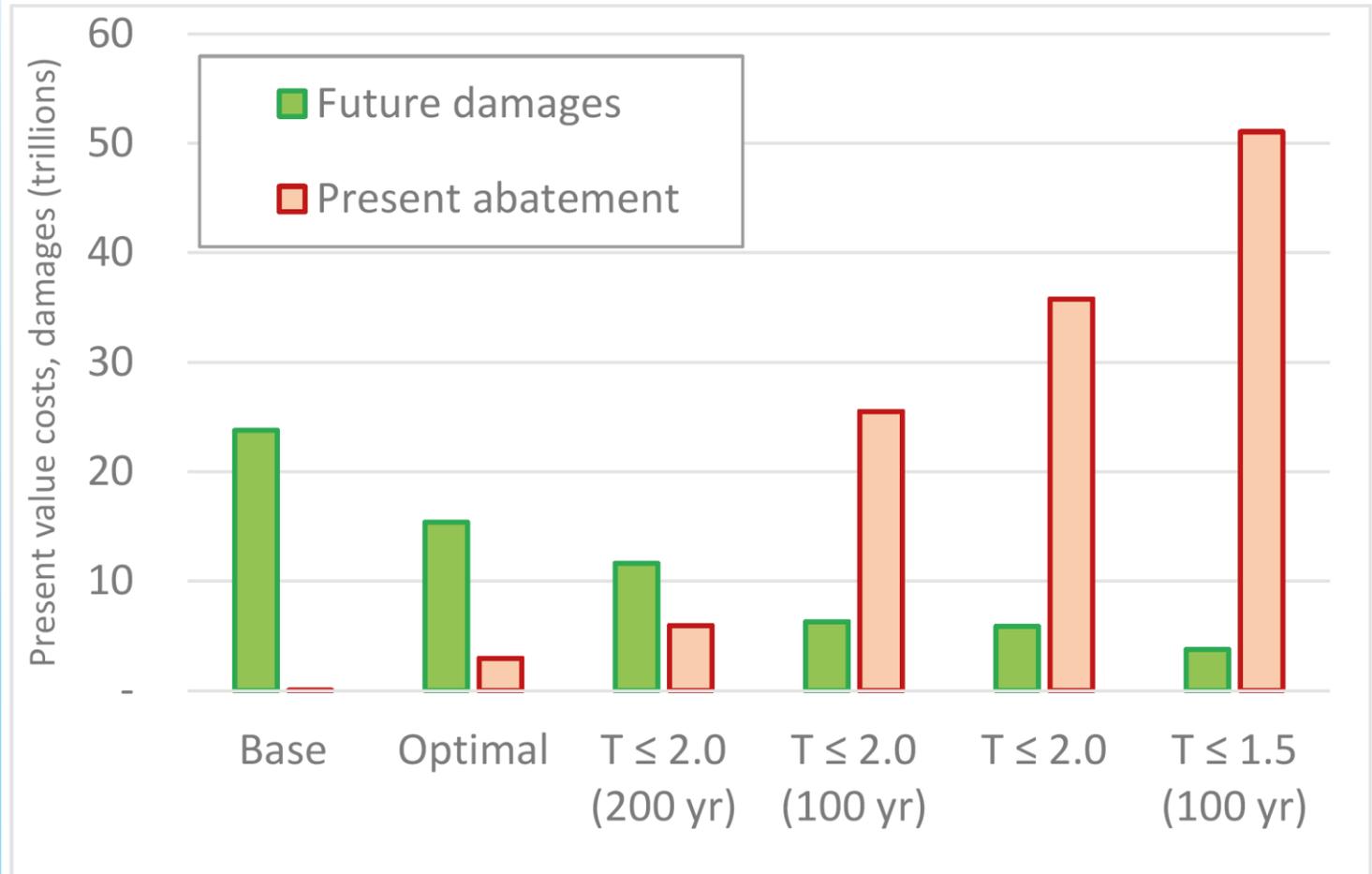
## *Temperature trajectories in different policies*



# Nordhaus Nobel Prize Speech December 8, 2018

- Why optimal? Minimizes sum of costs of abatement & costs of climate change
- No abatement (“Base”)
  - Temperature > 6°C above pre-industrial levels
  - Net Present Value of Damages ≈ \$23 trillion,
  - Cost of abatement \$0
- Optimal abatement
  - Temperature +4°C
  - Damages NPV ≈ \$15 trillion
  - Cost of abatement ≈ \$3 trillion

## *Abatement costs & damages, alternative policies*



# Climate Scientist, June 2018: “The Nature of the Challenge”

- Six months before Nordhaus described 4°C as “optimal”, climate scientist Will Steffen (PhD Industrial Chemistry) described it this way...

**Climate Change 2018**

**The Nature of the Challenge**



Will Steffen

Emeritus Professor, Australian National University  
Senior Fellow, Stockholm Resilience Centre

## Is a 4°C world inhabitable?

- **Most of the tropics and subtropics will be too hot for human habitation.**
- **Changing temperature & rainfall patterns will likely make current large agricultural zones unproductive.**
- **Sea-level rise of 20-40 m ultimately likely, drowning coastal cities, agricultural areas and infrastructure.**
- **Maximum carrying capacity of ~1 billion humans (today's population is 7.5 billion)**

## “Optimal” versus “Uninhabitable”?

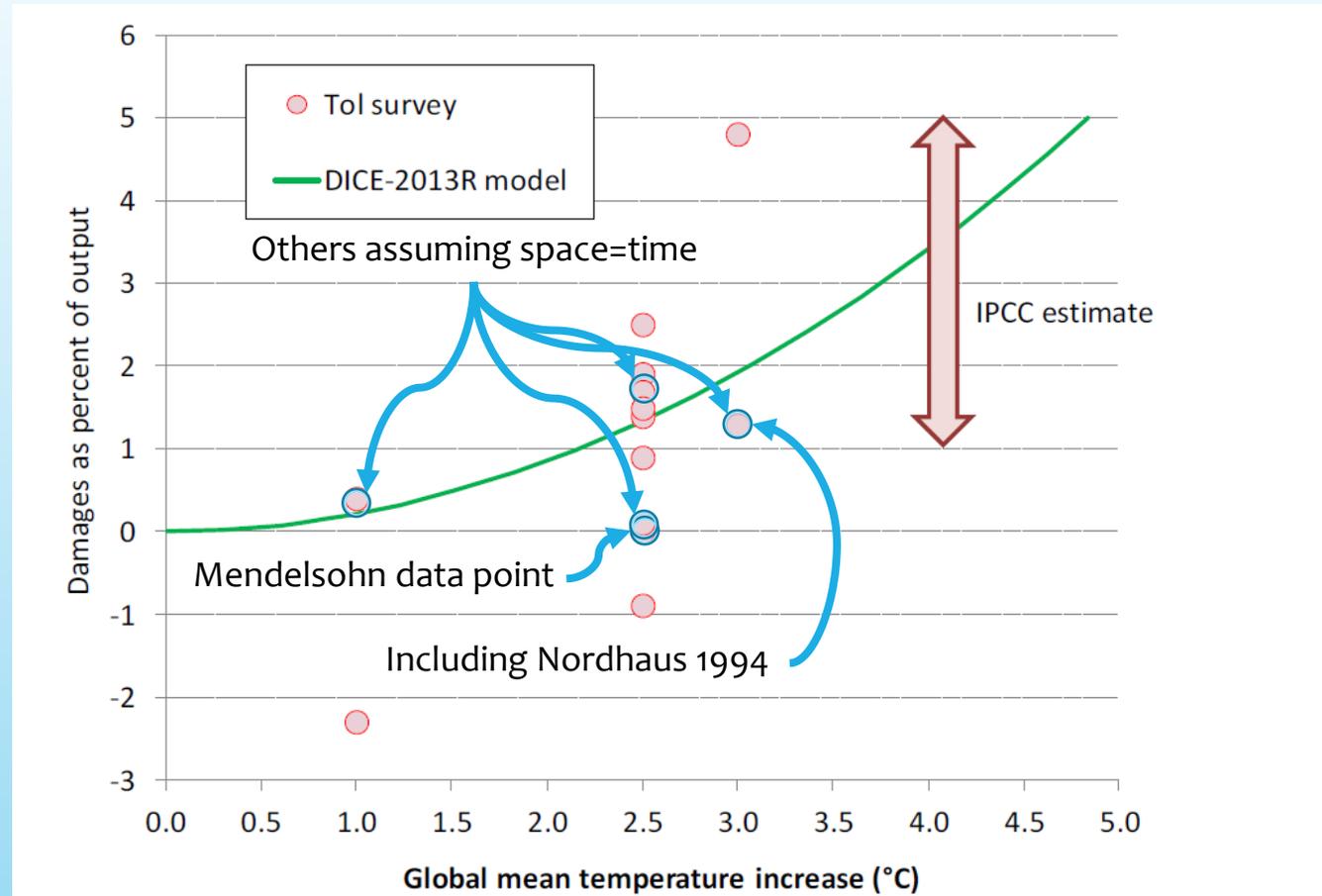
- Can these be squared with each other? Are economists just applying a high discount rate to the same estimates of damage?
- **No:** they’re calculating totally different estimates, using three methods, including:
  - direct estimates of the welfare impacts, **using observed variations (across space within a single country)** ... to discern the effect of climate....
    - **assumes that the observed variation of economic activity with climate over space holds over time as well** ...
  - What did they do?:
    - Took data on today’s temperature & income by regions (normally in USA)
    - Found a weak, quadratic relationship between temperature & GDP
    - **Assumed same relationship applies as massive increase in retained solar energy heats the biosphere...**

## “the *statistical approach*”

- Mendelsohn, 2000 p. 41
  - “The climate-response functions in these studies were quadratic in temperature...
    - Countries that are currently cooler than optimal are predicted to benefit from warming.
    - Countries that happen to be warmer than optimal are predicted to be harmed by warming...
  - The Cross-sectional climate-response functions imply ... from \$97 to \$185 billion of ***benefits***, with ***an average of \$145 billion of benefits a year.***”

# Damage function

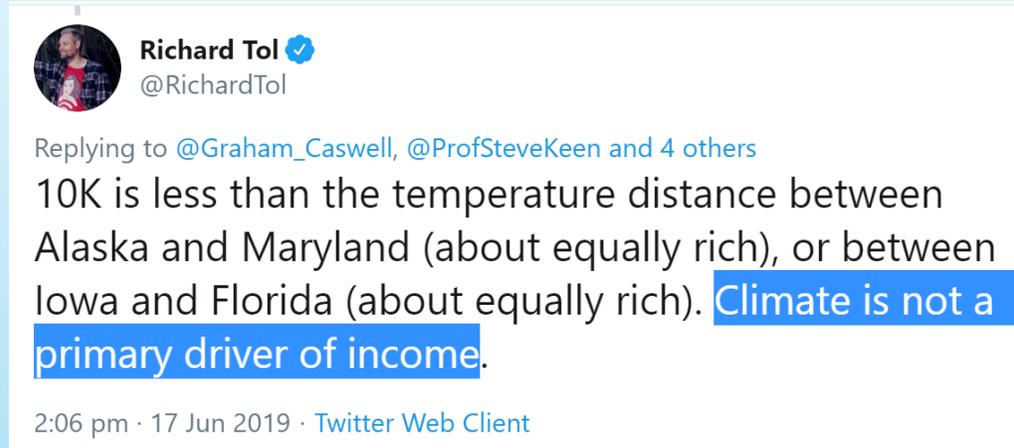
- [Nordhaus's DICE model](#)'s quadratic "damage function" fitted to 14 "data points" like this *derived by economists* about climate change induced temperature rises & GDP...
- Coefficient reduced to 0.00227 in [Nordhaus 2018](#):
  - 1 degree causes 0.227% fall in GDP
  - 2 degrees causes < 1% GDP fall
  - 4 degrees just over 3.6% fall
  - Even 10°C causes just a 23% fall over *what GDP would be in the complete absence of Global Warming...*



**Figure 2. Estimates of the Impact of Climate Change on the Global Economy**  
This figure shows a compilation of studies of the aggregate impacts or damages of global warming for each level of temperature increase (dots are from Tol 2009). The solid line is the estimate from the DICE-2013R model. The arrow is from the IPCC (2007a). [impacts\_survey.xlsx]

# “the *statistical approach*”

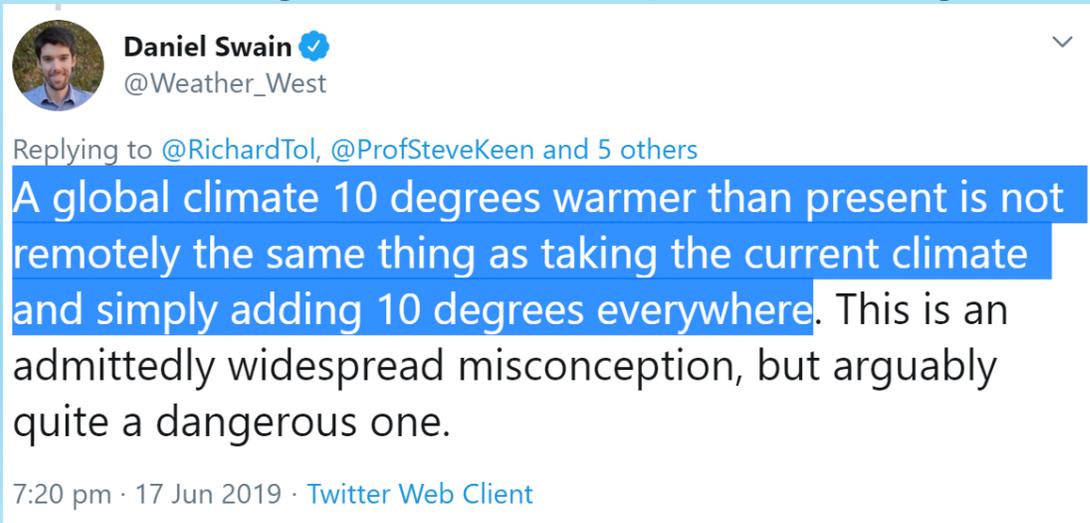
- These conclusions are valid if **and only if** the **assumption** “that the observed variation of economic activity with climate over space holds over time as well” is valid...



- Tol ([IPCC author 1995-2014](#)) was unmoved



- Meteorologist: this assumption is dangerous!



# Unrealistic and dangerous “data”

- What these economists did:
  - Compared “GDP” in two places with different temperatures **while the level of energy in the biosphere remained constant**
- What Global Warming will do:
  - **Dramatically increase the level of energy in the biosphere**
- Local Temperature → GDP relationship gives **no** information about Global Temperature → GDP relationship
- A linear example **purely for the sake of exposition**
  - Assume temperature at any location is a linear sum of Global plus local deviation
  - Assume linear relationship between GDP and temperature

# Unrealistic and dangerous “data”

- Hypothesis: “GDP per capita is a function of Temperature”

- $GDP_{(PerCapita)}(G_T, G_L) = \alpha_1 \times G_T + \alpha_2 \times G_L + \varepsilon$

- What Mendelsohn, Nordhaus, etc., effectively did:

- $GDP(G_T, Florida) = \alpha_1 \times G_T + \alpha_2 \times 7 + \varepsilon$

- $GDP(G_T, Dakota) = \alpha_1 \times G_T + \alpha_2 \times -10 + \varepsilon$

- $GDP(G_T, Florida) - GDP(G_T, Dakota) = 17 \times \alpha_2$

$\alpha_1 \times G_T$  cancels out

- Solve for  $\alpha_2 = \frac{GDP(G_T, Florida) - GDP(G_T, Dakota)}{17}$

- “We have no information on  $\alpha_1$ , so **let's assume  $\alpha_1 = \alpha_2$** ”

# Unrealistic and dangerous “data”

- Like having only North-South data on a mountain
- Tell hikers East-West is safe because North-West is flat



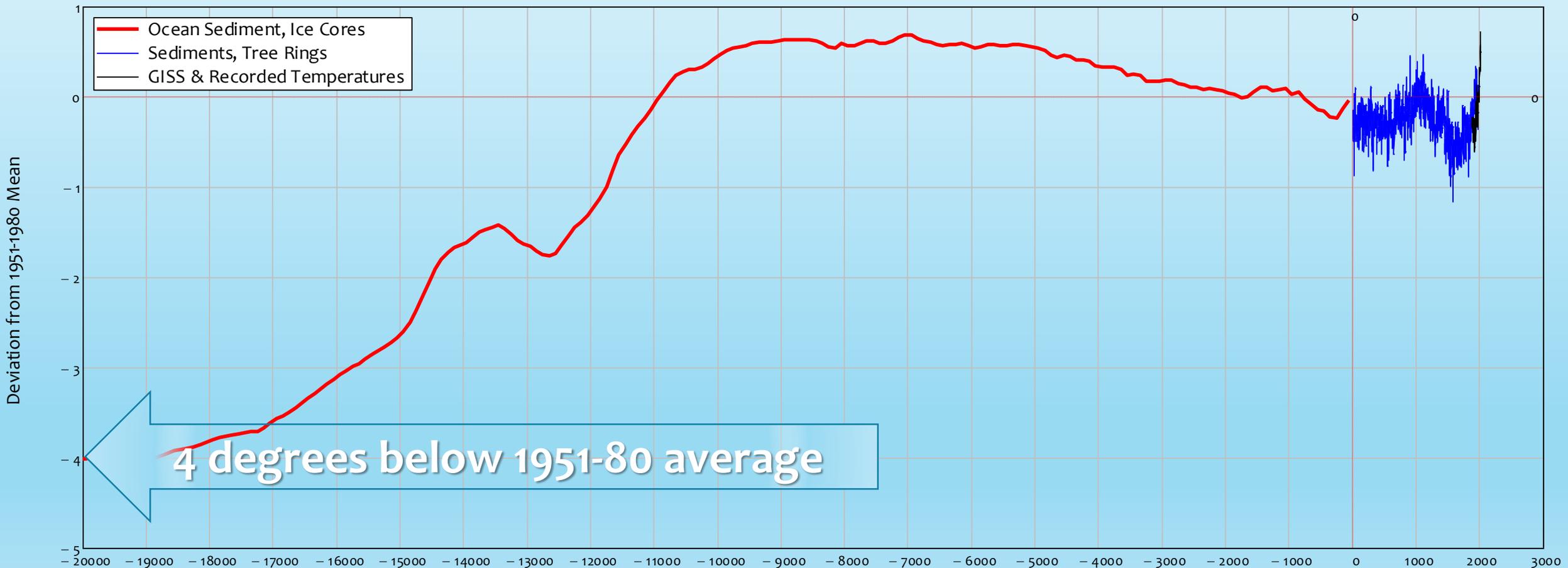
- This fatally unrealistic climate “data” was used to calibrate equally unrealistic “damage functions”...



# Unrealistic and dangerous “damage function”

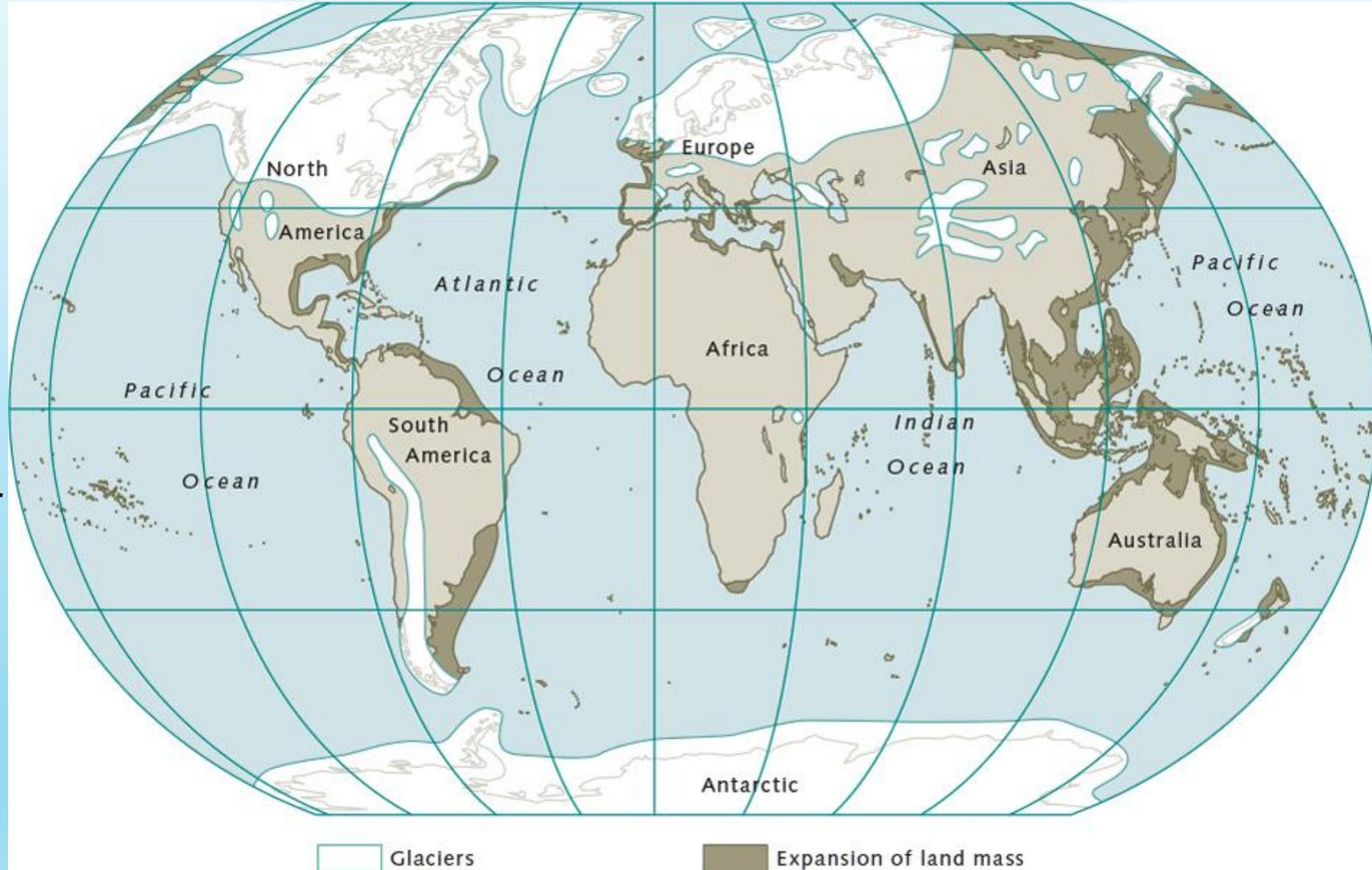
- Absurdity of using Geographic data to predict consequences of Global Warming may be hard to grasp, since humans haven’t experienced such high global temperatures
- But humans have experienced low global temperatures—the last Ice Age:

Global Average Temperature since 20,000 BCE



# Unrealistic and dangerous “damage function”

- Planet (20,000 years ago) at 4 degrees below pre-industrial temperatures
- Nordhaus prediction?
  - **3.6% fall in GDP**
- Sheer nonsense!
- Canada, US from New York north, most of Northern Europe, under 1km of ice
- **No way we can predict that world simply by extrapolating from current Temperature → GDP data**



# Unrealistic and dangerous “damage function”

- Main reason Nordhaus ignores tipping points?
  - Cost-benefit analysis is impossible with discontinuities
    - Climate ***economists***’ response: *ignore tipping points*
    - Climate ***scientists***’ response: ***abandon cost-benefit analysis***
    - [Steffen et al 2018](#):
      - ***the contemporary way of guiding development founded on theories, tools, and beliefs of gradual or incremental change, ... will likely not be adequate to cope with this trajectory.*** (p. 8257)

# What should be done?

- Remove economists from the IPCC, or at least include:
  - (a) non-mainstream climate economic modellers (Campiglio, Garrett, Giraud, Grasselli, Jackson, Keen, Monasterolo, ...)
  - (b) climate scientists to vet damage estimates by economists
- **At present, Nordhaus & economists in the IPCC are providing ammunition for climate change deniers/trivializers to attack other WGs and undermine Global Warming policy...**

**Bjorn Lomborg**  
@BjornLomborg

Replying to @SamanthaJPower

Dear Samantha. Yes, climate is problem, but nowhere to extinction

**10**

**Key Economic Sectors and Services**

Coordinating Lead Authors:  
Douglas J. Arent (USA), Richard S.J. Tol (UK)

**Executive Summary**

This chapter assesses the implications of climate change on economic activity in key economic sectors and services, on economic welfare, and on economic development.

**For most economic sectors, the impact of climate change will be small relative to the impacts of other drivers (medium evidence, high agreement).** Changes in population, age, income, technology, relative prices, lifestyle, regulation, governance, and many other aspects of socioeconomic development will have an impact on the supply and demand of economic goods and services that is large relative to the impact of climate change. {10.10}

10:16 am · 19 Oct 2017 · Twitter Web Client

Area of the circles represents weights assigned to each study  
Source: W. D. Nordhaus and A. Moffat, NBER Working Paper No. 23646

**“High Agreement”**

# What should be done?

- Use data from climate scientists—for example, [Steffen et al. 2018 assessment of tipping elements & tipping cascades](#)
- Not “data” made up by economists

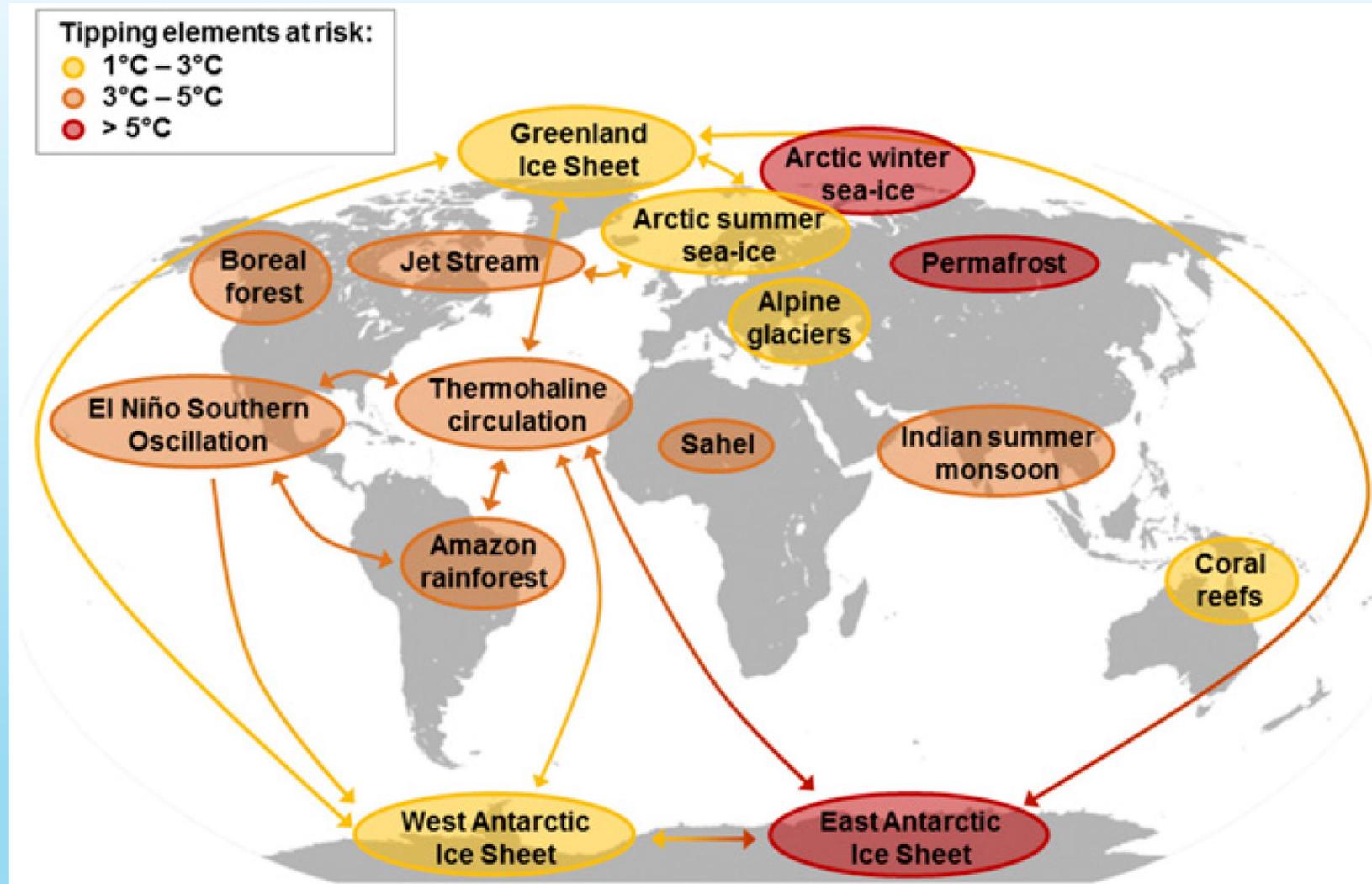


Fig. 3. Global map of potential tipping cascades. The individual tipping elements are color-coded according to estimated thresholds in global average surface temperature (tipping points) (12, 34).



# Conclusion

- My arguments are independent of my [well-known criticisms of Neoclassical economics](#)
  - Other economists have rightly criticized Nordhaus & IAMs before:
    - [DeCanio 2003](#): “The result of this modelling failure has been a bias against bold and timely action ... and pervasive paralysis in the political debate” (p. 153)
    - [Pindyck 2017](#): “integrated assessment models (IAMs) have crucial flaws that make them close to useless as tools for policy analysis...”
    - IAM-based analyses of climate policy create a perception of knowledge and precision that is illusory and can fool policymakers into thinking that the forecasts the models generate have some kind of scientific legitimacy.” (p. 100)
  - No Neoclassical should defend IAMs **simply because the authors are Neoclassical**, given the appallingly unrealistic assumptions on which their models are based
    - ***This is not an academic game***
      - ***Human society should not be sacrificed on the altar of the patently absurd “simplifying assumptions” of economists***

# Conclusion

- For more, see my Patreon site [www.patreon.com/profstevekeen](https://www.patreon.com/profstevekeen):
  - [Playing DICE with Life on Earth: Nordhaus's Damage Function](#)
  - [The mythical economic data on climate change \(1\): Nordhaus's 1994 survey of "experts"](#)
  - [Bjorn Lomborg, The Gullible Environmentalist](#)
  - [An extraordinary Twitter Exchange with Richard Tol](#)

# Economists' Data on Climate Change

- [Nordhaus's DICE model](#)'s “damage function” fitted to 14 “data points” like this *derived by economists* about climate change induced temperature rises & GDP...

Table 1

## Estimates of the Welfare Impact of Climate Change

(expressed as an equivalent income gain or loss in percent GDP)

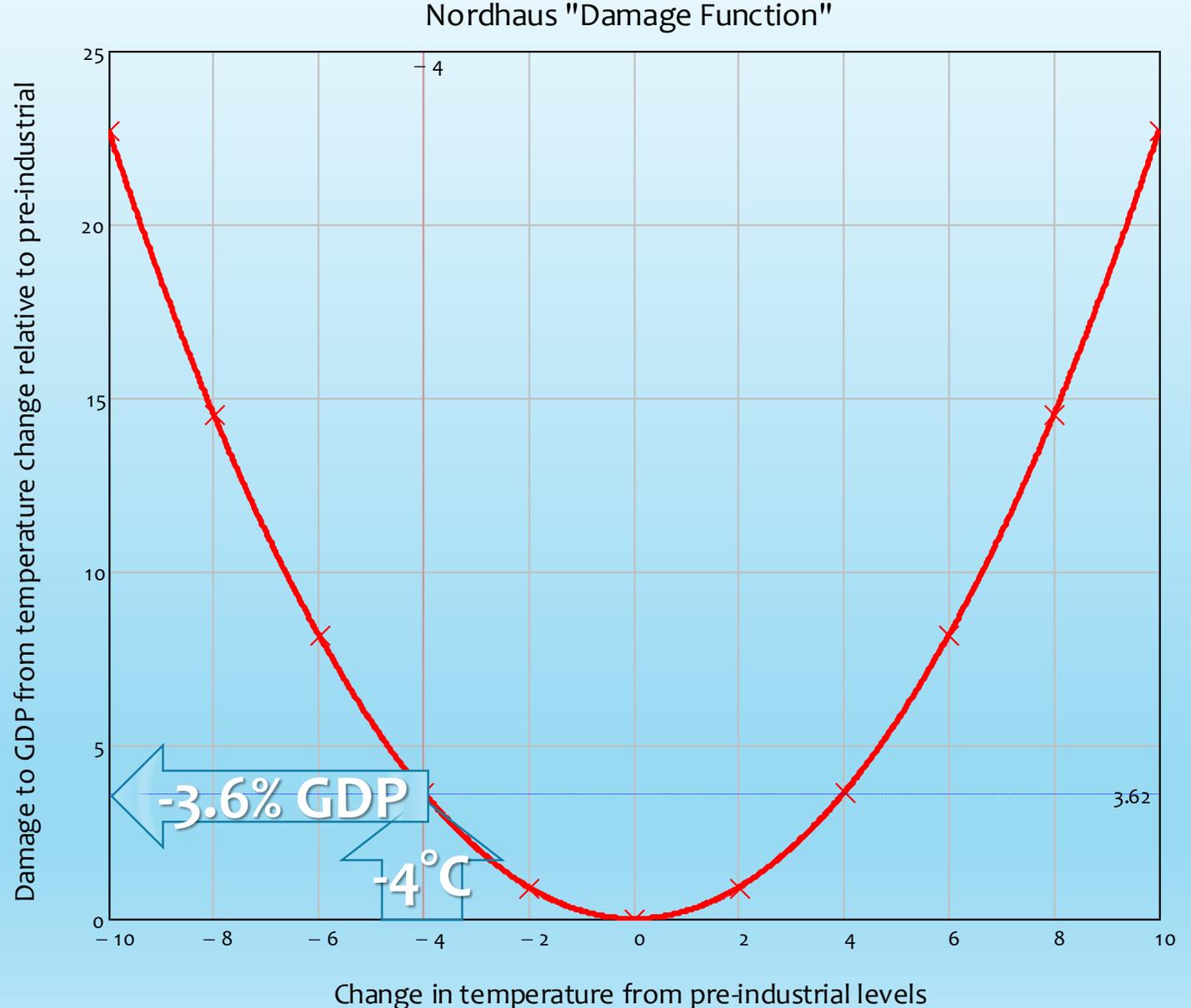
Study	Warming (°C)	Impact (% of GDP)	Worst-off region		Best-off region	
			(% of GDP)	(Name)	(% of GDP)	(Name)
Nordhaus (1994a)	3.0	-1.3				
Nordhaus (1994b)	3.0	-4.8				
		(-30.0 to 0.0)				
Fankhauser (1995)	2.5	-1.4	-4.7	China	-0.7	Eastern Europe and the former Soviet Union
Tol (1995)	2.5	-1.9	-8.7	Africa	-0.3	Eastern Europe and the former Soviet Union
Nordhaus and Yang (1996) <sup>a</sup>	2.5	-1.7	-2.1	Developing countries	0.9	Former Soviet Union
Plambeck and Hope (1996) <sup>a</sup>	2.5	2.5	-8.6	Asia (w/o China)	0.0	Eastern Europe and the former Soviet Union
		(-0.5 to -11.4)	(-0.6 to -39.5)		(-0.2 to 1.5)	

**Mendelsohn: +2.5°C causes 0.1% rise in GDP**

Boyer (2000)						
Tol (2002)	1.0	2.3	-4.1	Africa	3.7	Western Europe
		(1.0)	(2.2)		(2.2)	
Maddison (2003) <sup>a,d,e</sup>	2.5	-0.1	-14.6	South America	2.5	Western Europe
Rehdanz and Maddison (2005) <sup>a,c</sup>	1.0	-0.4	-23.5	Sub-Saharan Africa	12.9	South Asia
Hope (2006) <sup>a,f</sup>	2.5	0.9	-2.6	Asia (w/o China)	0.3	Eastern Europe and the former Soviet Union
		(-0.2 to 2.7)	(-0.4 to 10.0)		(-2.5 to 0.5)	
Nordhaus (2006)	2.5	-0.9 (0.1)				

# Unrealistic and dangerous “damage function”

- Nordhaus’s function  $D(t) = 0.00227 \times (T_{AT}(t))^2$  is symmetric
- It can be applied to “Global Cooling” as well as Global Warming
- What damage does it predict global GDP would suffer from a 4 degree fall in global temperature?
  - 3.6% fall in GDP...
- What would the planet look like?
- Much like 20,000 years ago at the peak of the Ice Age...



# Assumptions in Economics

- Methodological issue: *Is it valid to criticize a model for its assumptions?*
- Economists tend to reject assessment of assumptions on Friedman's dictum:
  - “Truly important and significant hypotheses will be found to have "assumptions" that are wildly inaccurate descriptive representations of reality, and, in general, *the more significant the theory, the more unrealistic the assumptions* (in this sense).<sup>12</sup>” (Friedman “[The Methodology of Positive Economics](#)”, p. 14)
- Typical refrain to criticism: “Well, we have to make some *simplifying assumptions*”
  - Few read Friedman's footnote:
    - “12. The converse of the proposition does not of course hold: ***assumptions that are unrealistic (in this sense) do not guarantee a significant theory.***”
  - Nordhaus/Tol/Mendelsohn et al “variation of economic activity with climate over space holds over time as well” assumption ***is the most unrealistic and dangerous “simplifying assumption” in the history of economics...***

- Earth's average temperature in the absence of greenhouse gases is minus 18°C
  - Pre-industrial greenhouse gases add 33°C: global average temperature is +15°C
- Local deviations (across [continental USA by State](#)) range from -10°C (North Dakota) to +7°C (Florida)...
- *GreenhouseTemperature* =  $G_T(t)$
- *LocalDeviation* =  $G_L(t)$ , Range:  $-10 < G_L(\text{Today}) < 7$

# Unrealistic and dangerous “damage function”

- All IAMs (“Integrated Assessment Models”) use polynomial “damage functions”
  - Necessarily imply no discontinuities
  - Nordhaus’s is the mildest of all—just a quadratic (with its trivial coefficient)
- Justified by an appeal to a survey of climate scientists by [Lenton \(2008\)](#):
  - “The current version assumes that damages are a quadratic function of temperature change and **does not include** sharp thresholds or **tipping points**, but this is **consistent with the survey by Lenton et al. (2008)**.” ([Nordhaus & Sztorc 2013](#), p. 11)
- [Lenton et al.’s actual conclusion](#):
  - “**Society may be lulled into a false sense of security by smooth projections of global change.**
  - Our synthesis of present knowledge suggests that **a variety of tipping elements could reach their critical point within this century** under anthropogenic climate change.” (Lenton 2008, p. 1792)

- Simple first-pass example: Goodwin model with energy as key input to production, and feedback from available energy to production (Fossil Fuel only here) ...