



Climate Change: Opportunity and Risk

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April 2022

Editor: World Scientific Climate Encyclopedia

Gabelli Fellow and Visiting Scholar, Fordham U.

Book: *Quantitative Finance and Risk Management, A Physicist's Approach*

QUIZ (not a poll)

- What do YOU think about the opportunities and risks involved with climate change?
- Will revisit after the talk

Bottom Line up front

- **Opportunity: Tens of TRILLIONS \$ business investment + operations**
 - **Plus co-benefits**
- **Risk: Potentially disastrous damage to the human race if robust climate action NOT increased starting now**
 - **Already damaging and costing \$**
- **Climate Change Risk & Opportunity Officer: JOBS JOBS JOBS**

Outline of Talk

- Part 1: Review/Introduction (30 min)
- Part 2: Climate Action Examples (30 min)
- Appendix: Deeper Dive / Models (15 min)
- **TALK = OVERVIEW**
 - **EACH SLIDE** needs 1 hr. talk for details
 - **Lots of slides, little time => will be fast !**
 - **May postpone Appendix**

What are the climate change issues?

- I. The Physical Science Basis
- II. Impacts, Adaptation, and Vulnerabilities
- III. Mitigation of Climate Change
- **Climate change:** set of changing climatic phenomena, time averaged (e.g. 30 years)
- **Global warming:** trend (up) of global average temperature of climate change.
- **Carbon budget:** Maximum of Carbon in atmosphere for livable world

CLIMATE ACTION: URGENT

- **VISION:** Make/keep livable, just world
- **MISSION:** “Eliminate” carbon emissions
 - Mostly CO₂ (+ methane ...=> CO₂e)
- There are huge **opportunities**
- Need more climate **risk management** for bad possibilities
- Optimism, Courage, Persistence

TOP LINE: Global Warming is *the most severe long term Survival and Justice Issue*

- **Science is CLEAR and experts AGREE**
 - Global warming trend of climate change exists, mostly due to carbon dioxide CO2 emissions from burning fossil fuels
 - **“Carbon Budget” is main constraint (physics)**
- **Survival Issue**
 - Disasters are made worse – many types
 - Impacts seen now. **WARNING** – can get MUCH worse
 - We have **VERY LITTLE TIME** to enhance climate action
- **Justice and Ethics Issues**
 - Climate Justice, Intergenerational Equity
 - Who gets to emit what, consistent with carbon budget
- ***There will be no place to hide for anyone***

CO2 in atmosphere highest in 3 million years. Weight CO2 emitted/person/year =



Climate = Human Survival Issue

- **Disasters are made worse due to Global Warming**
 - More crop failures,
 - Worse fresh water shortages,
 - Sea level rise,
 - Ocean acidification,
 - More intense fires,
 - Worse extreme weather/hurricanes,
 - More droughts,
 - More flooding,
 - More severe heat waves,
 - More disease,
 - Severe species extermination,
 - More political instability and loss of civil rights,
 - More climate migration,
 - Increased conflict (wars/national insecurity/terrorism),
 - **Economic/finance systemic disruption (possible breakdown)**
 - **+ TIPPING POINTS, IMPACT FEEDBACKS, IRREVERSIBLE**
 - **Attribution studies improving for GW influence on disasters**

Climate Risks to Business

- **All the risks listed above, plus**
 - Reputation risk (loss of social contract)
 - Regulation risk (Europe, US ...)
 - Transition risk (to renewable economy)
 - Technology risk (enhanced via transition)
 - Stranded asset risk (fossil fuels)
 - Lost Opportunity risk (\$Trillions)
 - Contagion risk (supply chains ...)
 - **WORST Risk may be induced INSTABILITY of financial/economic system**

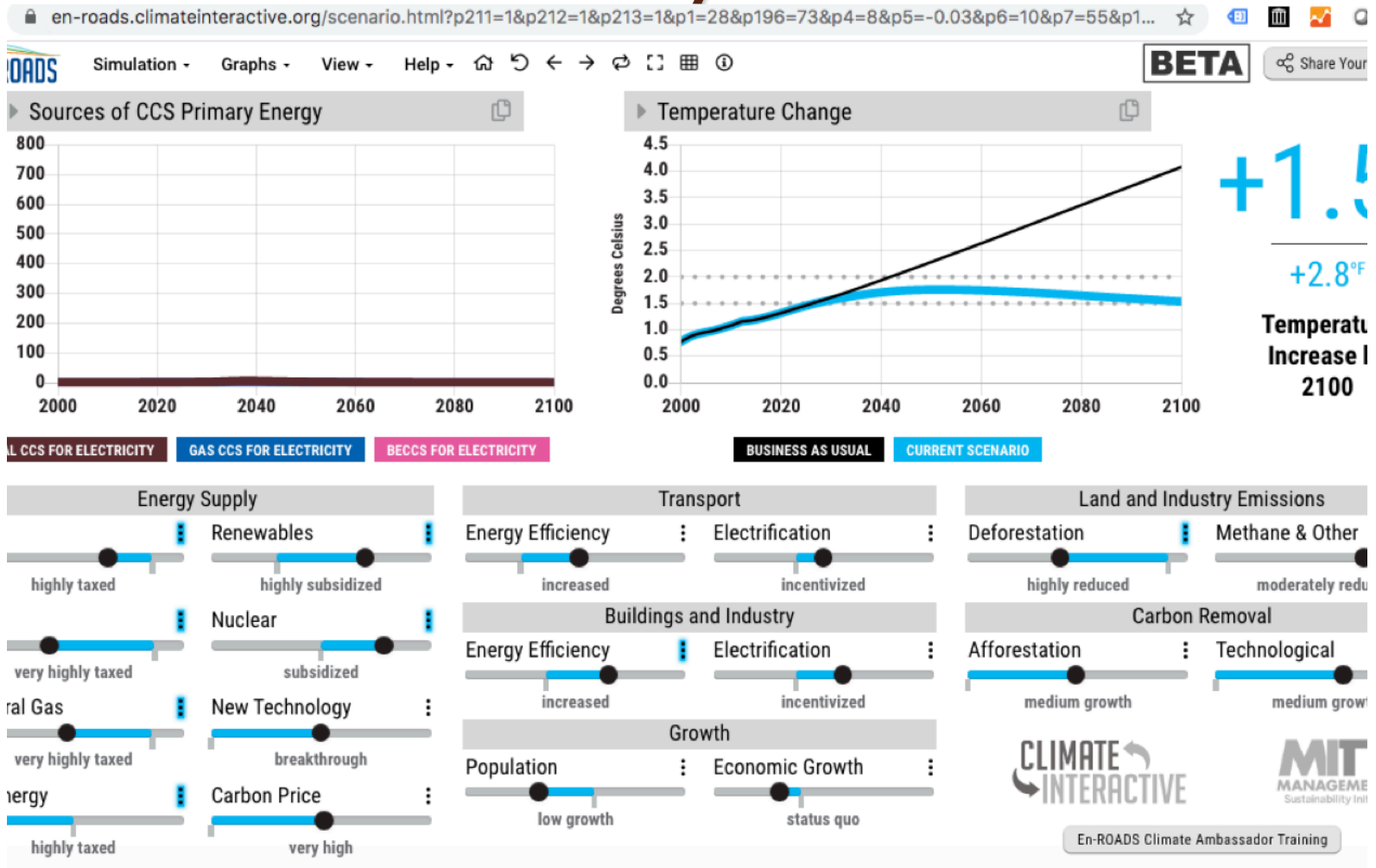
ACTION: We **CAN** mitigate Climate

- **Climate Change Risk Management**
 - Change: All Deliberate Speed to **renewables**
 - Action: **All levels** - local to global – needed
 - Individuals,
 - NGOs (Environment, Faith, Investors ...),
 - Businesses,
 - Cities,
 - States,
 - National,
 - International

Climate Action: “**AND**”, not “**OR**”

- **Mitigation: Make climate less severe**
- **Substantial now, NEED MORE**
- **100 Climate Actions, no silver bullet**
- **CLIMATE ACTION = PORTFOLIO**
 - Will review in Part 3
 - Price on Carbon can stimulate climate action
- Adaptation for what we can't mitigate, with increased resilience

EnRoads (MIT) Climate Scenario Simulator – run it yourself!



Livable World vs. Unlivable World

Note $+2^{\circ}\text{C} = +3.6^{\circ}\text{F}$

- Paris Agreement: “Well Under” $+2^{\circ}\text{C}$
 - Relative to preindustrial levels
 - Target: $+1.5^{\circ}\text{C}$
- Disasters **much** worse at $+3^{\circ}\text{C}$
 - At $+4^{\circ}\text{C}$ we have an **unlivable planet**
- **Latest** Glasgow COP26: If all pledges are carried out, can achieve $+2^{\circ}\text{C}$ (estimate)
 - Better than $+3^{\circ}\text{C}$ previous to Glasgow
 - Not enough for $+1.5^{\circ}\text{C}$

Business is Key for Climate

- Need n \$Trillions for renewable economy
 - Private Capital **does have** \$Trillions scale
 - Governments **don't** have \$Trillions scale
 - Renewable Economy now unstoppable
- Need Govt. (policy, \$) + Business (\$\$\$)
 - “GFANZ committed to managing assets totalling over \$130 trillion in line with 1.5 degrees.” Mark Carney, 2021
- Lots of **OPPORTUNITY**

JOB**S** in Climate Risk Management?

- **YES YES YES**
- Climate Change Opportunity and Risk Management is now underway and **WILL BE THE NORM** in the future of
 - Corporations
 - Wall Street
 - Governments
 - Academia

“Climate change poses a **major risk to the stability** of the U.S. financial system and to its ability to sustain the American economy.”

MANAGING CLIMATE RISK IN THE U.S. FINANCIAL SYSTEM

Report of the Climate-Related Market Risk Subcommittee,
Market Risk Advisory Committee of the
U.S. Commodity Futures Trading Commission

Climate Opportunity/Risk Action: Corporate Climate Risk Reporting and Action - TCFD (M. Bloomberg): **Guidelines to Regulation?**

The logo for the Task Force on Climate-Related Financial Disclosures (TCFD) is displayed on a blue rectangular background. The acronym 'TCFD' is written in large, bold, white capital letters on the left. To its right, a vertical white line separates it from the full name 'TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES', which is written in smaller, white, all-caps text across two lines.

TCFD | TASK FORCE ON CLIMATE-RELATED
FINANCIAL DISCLOSURES

“Climate is top risk” - Davos World Economic Forum

Long-Term Risk Outlook

Top 10 risks by likelihood and impact over the next 10 years

Multistakeholders

Likelihood

- Extreme weather
- Climate action failure

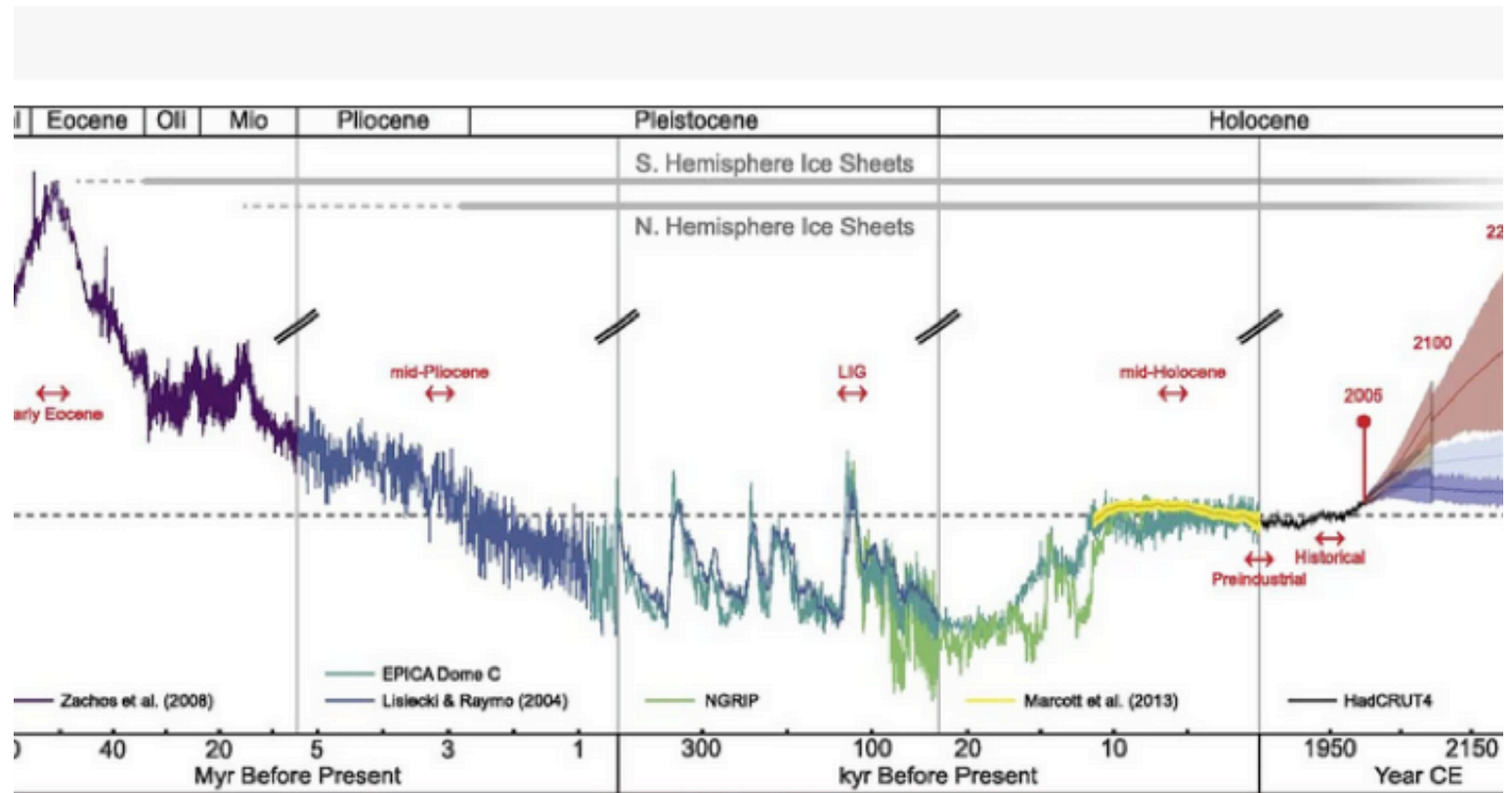
Impact

- Climate action failure
- Weapons of mass destruction

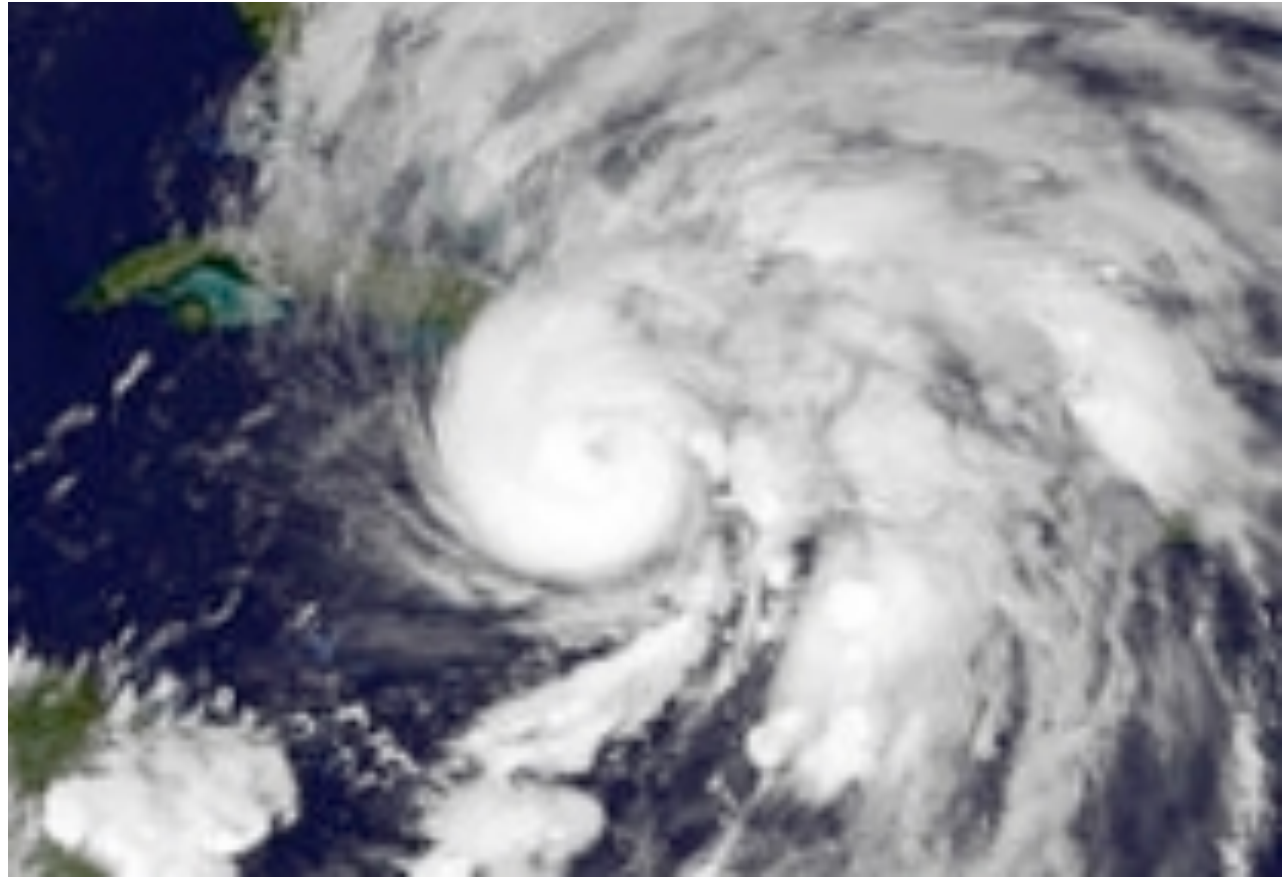
Climate Opportunity/Risk Action Co-benefit: **Reduce Financial/Economic Crisis Risk**

- Transition risk from fossil fuels to renewable energies
 - Resolve supply/demand imbalances
 - Electric grid improvements (HVDC network)
- Myriad severe climate impacts
 - Supply chain disruptions, direct hits (PG&E)
- Descendants over-leveraging with huge debts to cope with climate impacts

Climate Opportunity/Risk Action Co-benefit: Reduce Temperature Rise – now out of human civilization range, earth is heating up



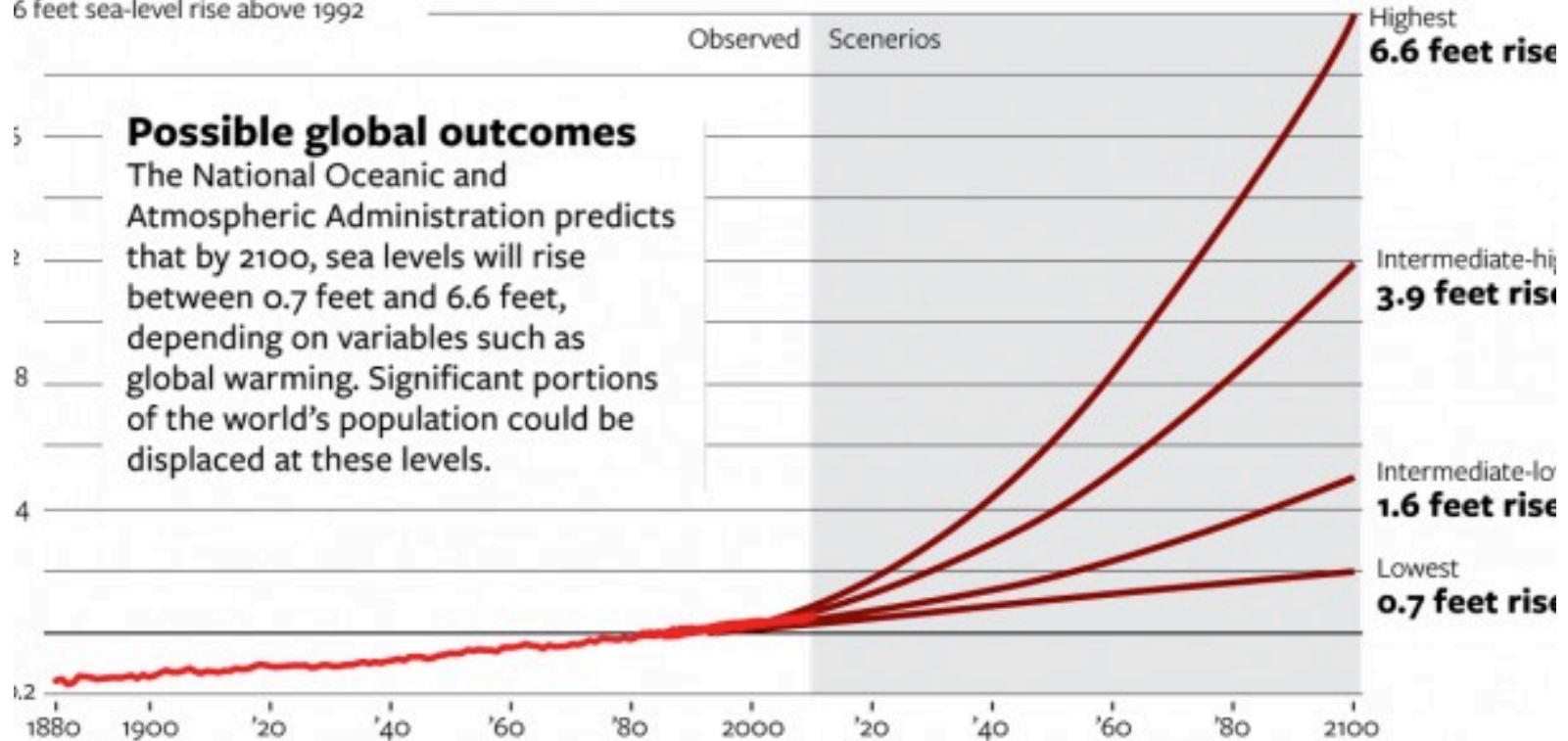
Climate Opportunity/Risk Action Co-benefit: **Reduce Worse Extreme Weather**



Climate Opportunity/Risk Action Co-benefit: Improve Livability, reduce Sea Level Rise

Sea-Level Rise

6 feet sea-level rise above 1992



Possible global outcomes
The National Oceanic and Atmospheric Administration predicts that by 2100, sea levels will rise between 0.7 feet and 6.6 feet, depending on variables such as global warming. Significant portions of the world's population could be displaced at these levels.

Scenarios from NOAA for 2013 are calculated using tidegauge observations from 1983-2001, taking the midway point (1992) as the starting point.

Climate Opportunity/Risk Action Co-benefit: **Reduce Suffering** (Sandy, Katrina)



- Union Beach, NJ New Orleans, LA

Climate Opportunity/Risk Action Co-benefit: Reduce negative Climate Health Impacts

Traceable evidence of the impacts of climate change on humanity

[References](#) [Entries](#) [Info](#)

Climatic change → Impact ↓	Natural cover change	Drought	Warming	Heatwaves	Storms	Precipitation	Floods	Fires	Sea level	Ocean climate change
Health										
Malnutrition		✓	✓		✓	✓	✓			✓
Mental health		✓	✓	✓	✓		✓	✓		✓
Suicide		✓	✓	✓	✓	✓	✓			✓
Depression		✓		✓	✓		✓			
Risk of accidents	✓		✓	✓	✓				✓	✓
Affective disorder			✓					✓		
Life satisfaction		✓	✓	✓	✓		✓			✓
Educational attainment		✓					✓			
Death	✓	✓	✓	✓	✓	✓	✓	✓		
Pathogen diseases	✓	✓	✓	✓	✓	✓	✓			✓

Climate Opportunity/Risk Action Co-benefit: **Improve Security, reduce Increasing Security Risk (Climate = “Risk Multiplier”)**



Climate Opportunity/Risk Action Co-benefit: Reduce Climate Migration, Political Instability

BROOKINGS

CLIMATE AI CITIES & REGIONS GLOBAL DEV INTL AFFAIRS U.S. ECONOMY U.S. POLI



FUTURE DEVELOPMENT

Climate migration and climate finance: Lessons from Central America

Sarah Bermeo · Friday, November 19, 2021

FUTURE DEVELOPMENT

Climate Opportunity/Risk Action Co-benefit: **Reduce Increasing Damaged Crops**

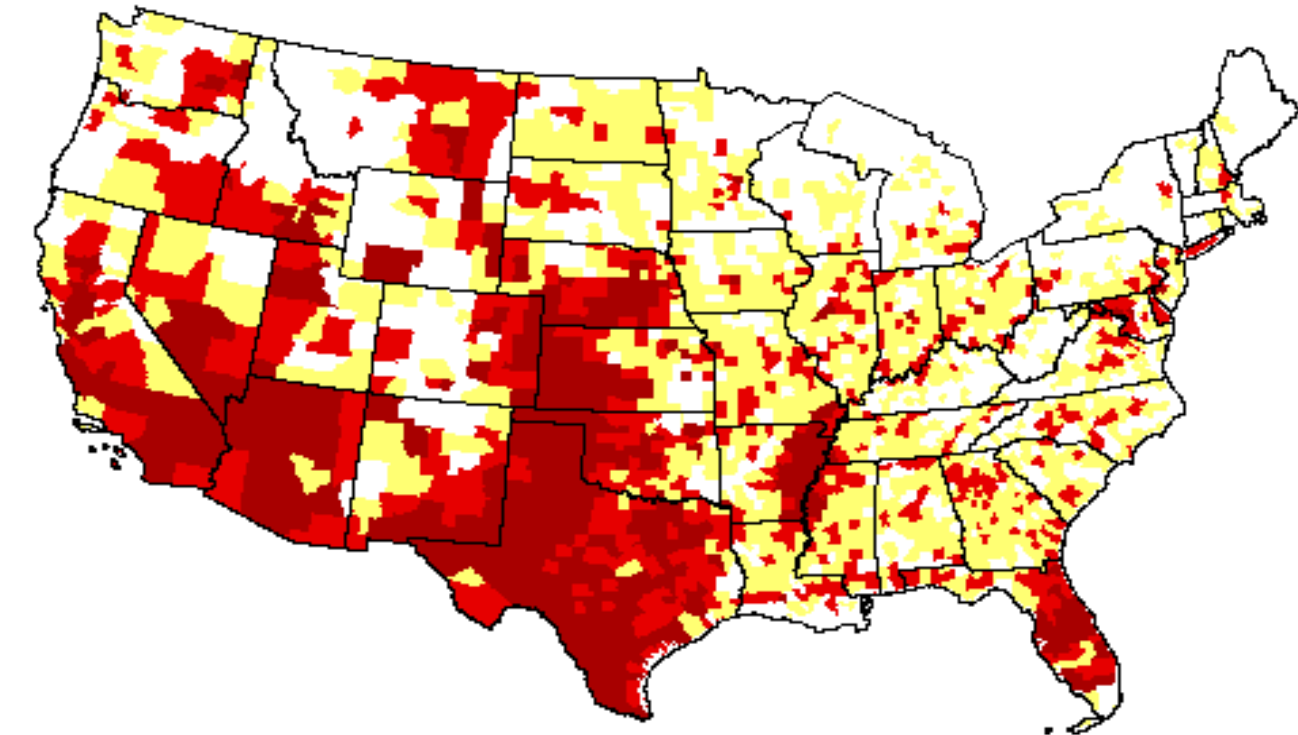


Climate Opportunity/Risk Action Co-benefit: **Reduce Intensified Fires**

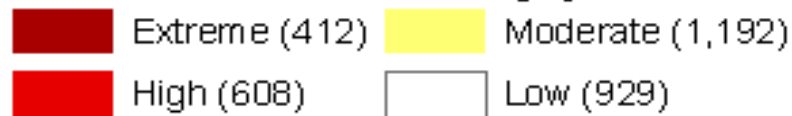


Climate Opportunity/Risk Action Co-benefit: **Reduce Water Shortages**

Water Supply Sustainability Index (2050) With Climate Change Impacts



Number of Counties for each Category in Parentheses

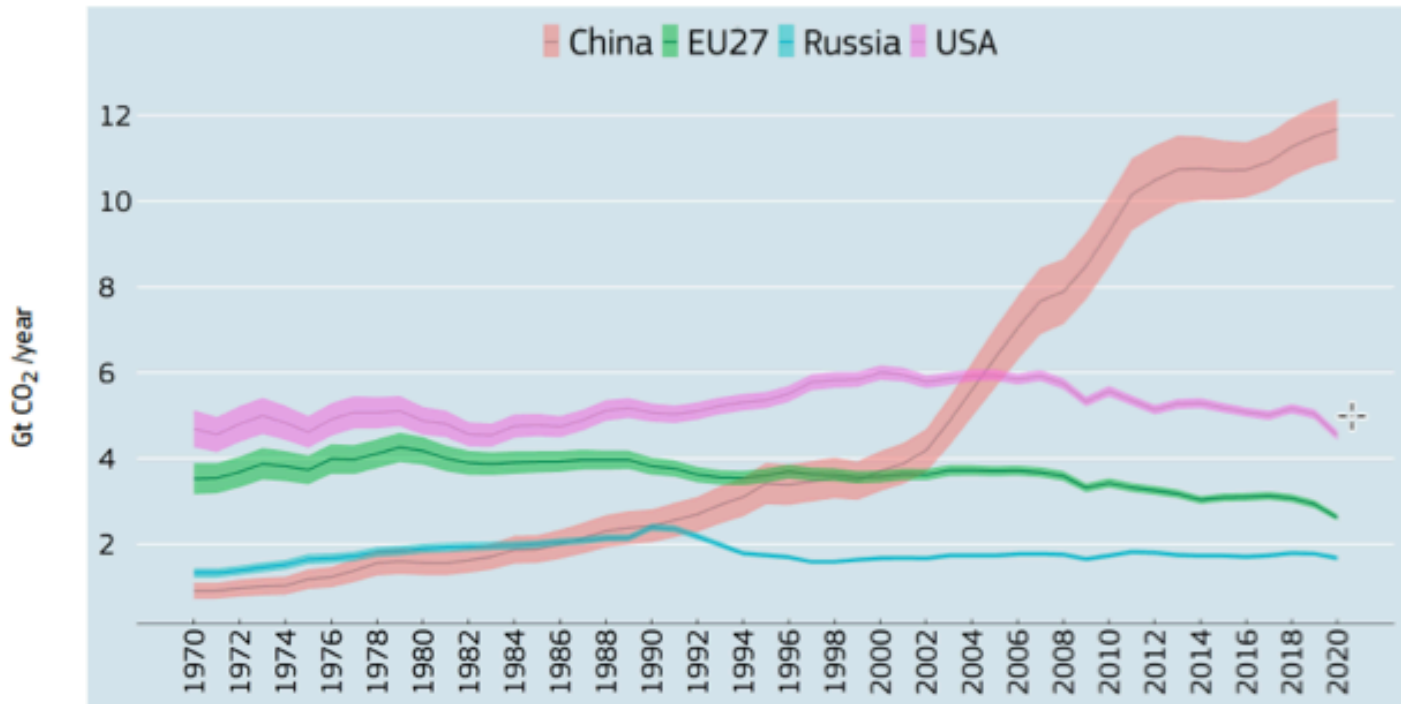


Climate COP Conferences

- Copenhagen, Paris, Glasgow
 - National Determined Contributions NDCs
 - Voluntary NDC by each country
 - Enhanced ambition announcements Glasgow
 - Steady difficult progress
 - China/India Net Zero pledges & energy equity
 - Need more short term ambition (2030)
 - Recognition: Climate is everybody's problem
 - Less (but not zero) obstruction, free-riding
 - All must agree on COP negotiated outcome

Annual CO₂ emissions

Figure 3. Annual CO₂ emissions in top emitting countries and the estimated uncertainty (coloured bands), 1970-2020 (Gt CO₂/yr).



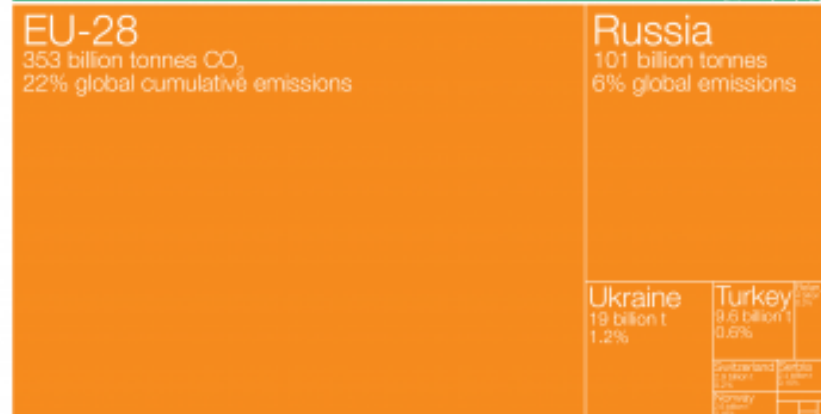
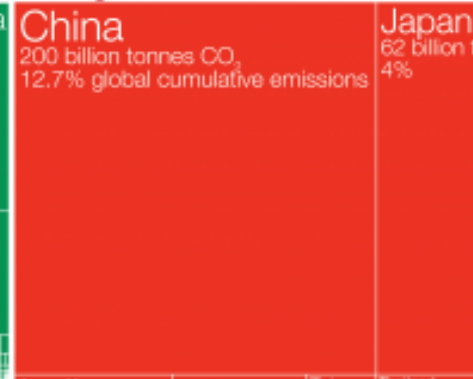
Source: JRC, 2021.

BUT => Cumulative CO2 is what matters for global warming (U.S. #1)

North America
457 billion tonnes CO₂
29% global cumulative emissions



Asia
457 billion tonnes CO₂
29% global cumulative emissions

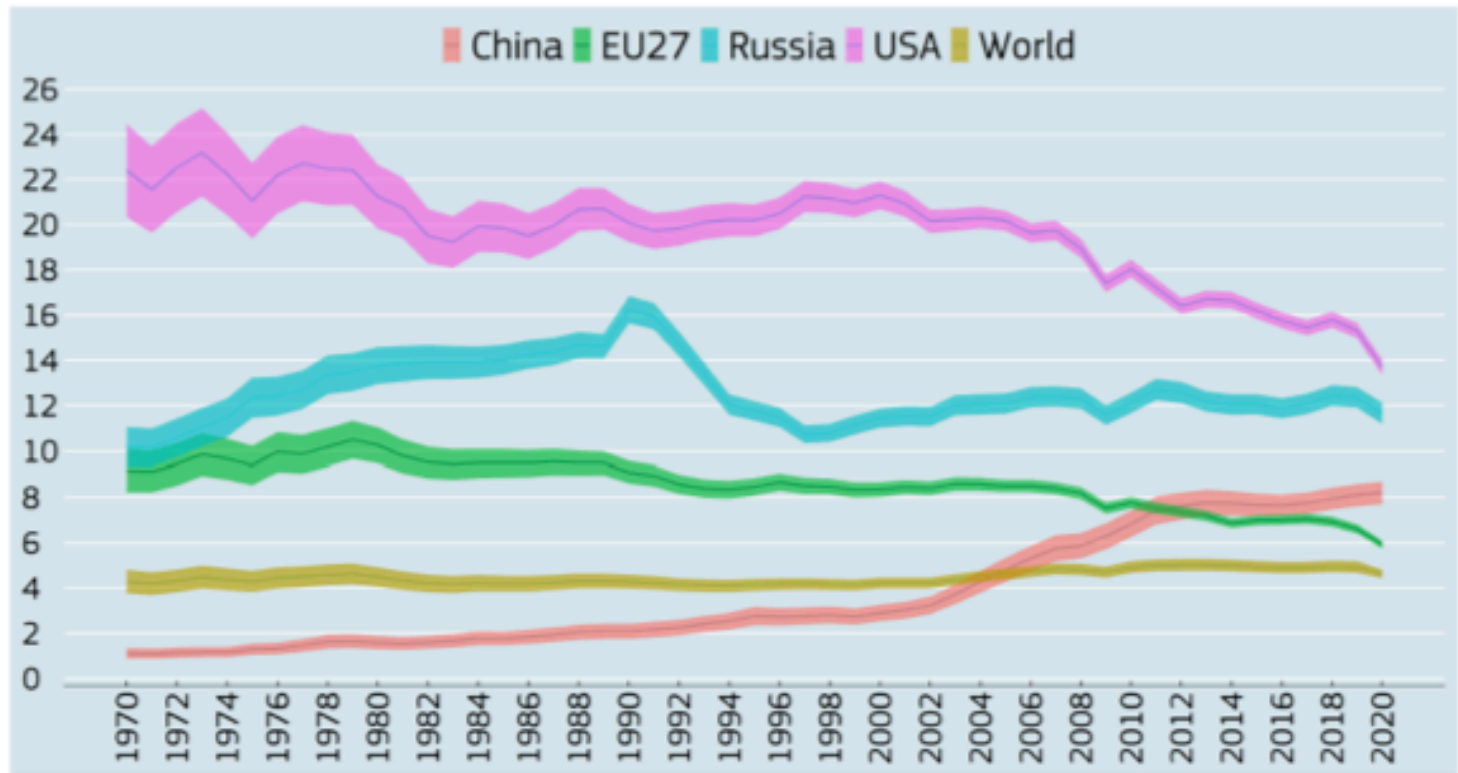


Europe
514 billion tonnes CO₂

Africa 43 billion tonnes CO₂ 3% global emissions
South America 40 billion tonnes CO₂ 3% global emissions

Per-capita GHG (equity, negotiating)

Figure 4. Annual per capita CO₂ emissions in top emitting countries and the estimated uncertainty (coloured bands), 1970-2020 (t CO₂/cap/yr).



Source: JRC, 2021.

Sub-national US climate action



Business Net-Zero Commitments Emissions **Scope 3** most important

PRESS RELEASE

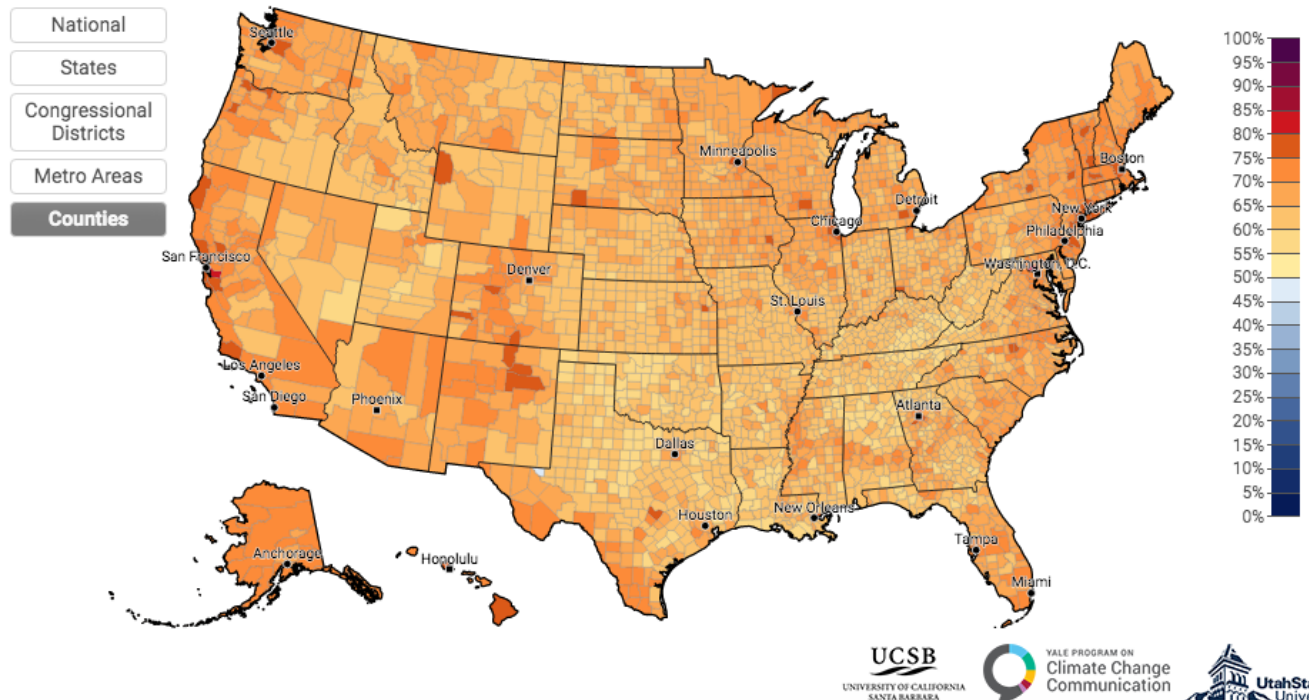
July 21, 2020

Apple commits to be 100 percent carbon neutral for its supply chain and products by 2030

Attitudes (Yale) – More people want climate action

Select Question: Corporations should do more to address global warming
Absolute Value

Click on map to select geography, or: Select a State Select a County



NGO Action – including **closing coal plants** (*Beyond Coal*, M. Bloomberg)



Long Branch, NJ ▾

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Communities are ready for 100%

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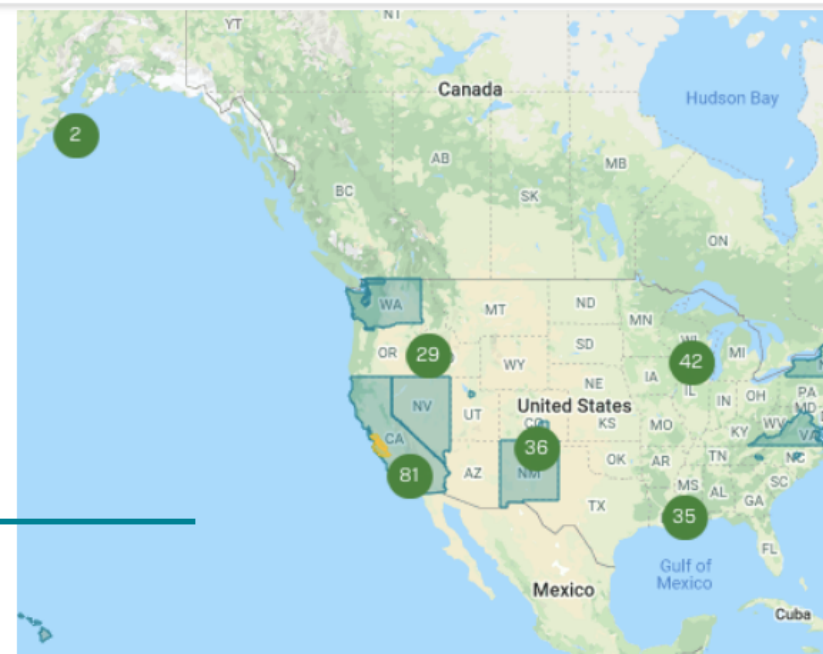
[Explore Our Map](#)

170+

Committed Cities & Towns

60+

Active Campaigns



Uncertainties

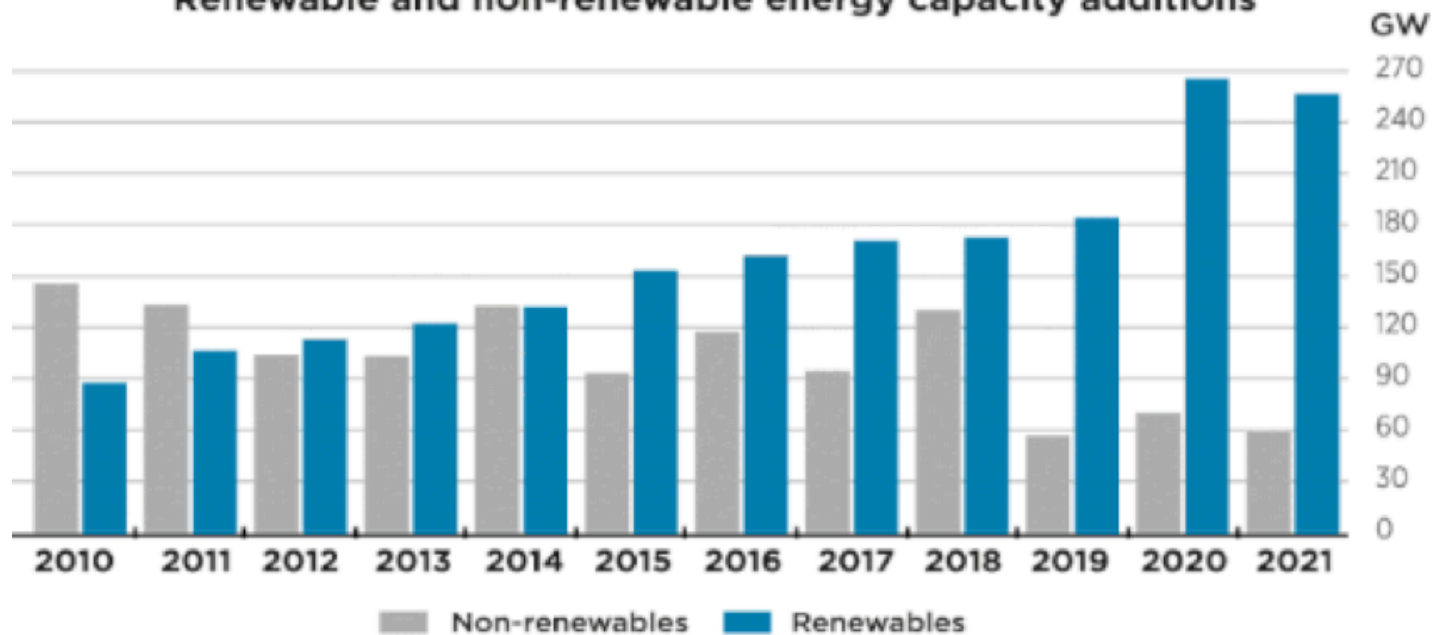
- Uncertainties exist => need risk management for bad possible outcomes
- **Most uncertainty: human behavior**
- What are uncertainties in outcomes if not enough action? **Bad or Catastrophic**
- Other uncertainties
 - Climate science uncertainties
 - Economic model uncertainties
 - Precautionary Principle

SDGs = All Social Justice issues are tied together with Climate Action (SDG 13)



Renewable Energy taking off

Renewable and non-renewable energy capacity additions



Climate Summary in 12 words





Climate Change: Opportunity and Risk – Part 2

Jan W. Dash, PhD
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Editor: World Scientific Climate Encyclopedia

Gabelli Fellow and Visiting Scholar, Fordham U.

Book: *Quantitative Finance and Risk Management, A Physicist's Approach*

Climate Opportunity/Risk Action

- **CLIMATE ACTION – WHY? Review:**
- **MITIGATION** - reduce global warming
 - Avoid worst climate impacts - COBENEFITS
 - Leave livable world to descendants
 - Take advantage of opportunities
- **ADAPTATION** - cope with impacts of global warming
 - RESILIENCE aims at better adaptation

Opportunity: Tens of Trillions of \$USD for investment (+ operations)



Lost Opportunity problem

- Climate action scale potential > Industrial revolution, digital revolution
- Buggy whip company problem – miss the train, lose opportunity
- Same problem for countries that drag their feet and obstruct climate action
- **Factoid: Renewable economy is ramping up, now unstoppable**

Acting Now: Cheaper than waiting

Article | [Open Access](#) | [Published: 08 June 2020](#)

Assessing the costs of historical inaction on climate change

[Benjamin M. Sanderson](#)  & [Brian C. O'Neill](#)

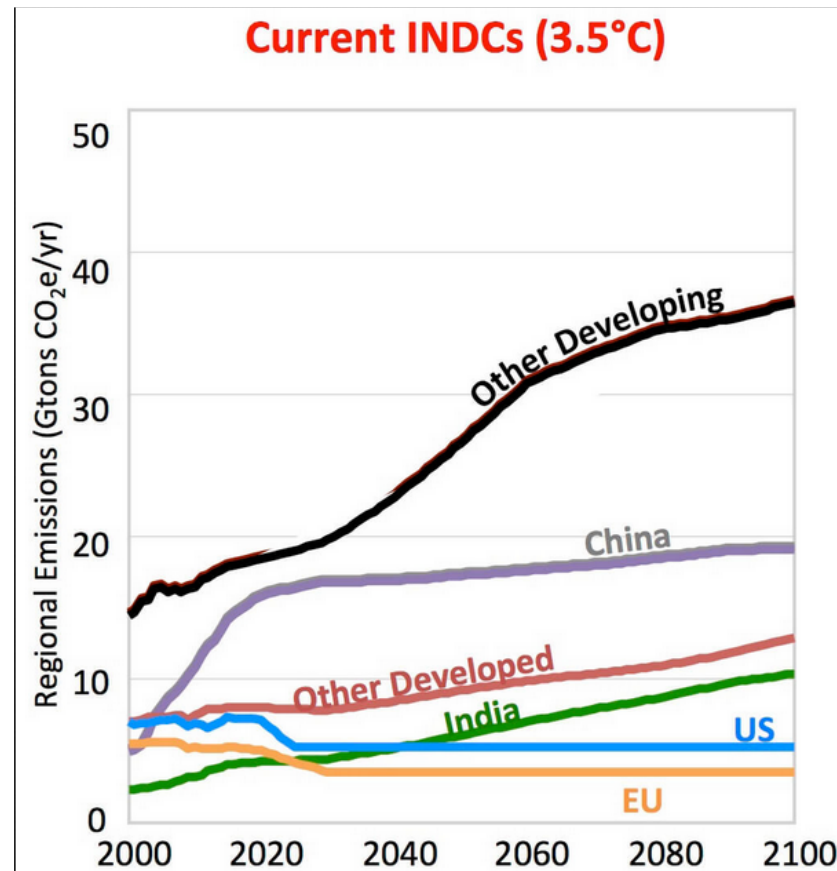
[Scientific Reports](#) **10**, Article number: 9173 (2020) | [Cite this article](#)

17k Accesses | **12** Citations | **317** Altmetric | [Metrics](#)

Abstract

We consider alternative history scenarios in which explicit climate mitigation begins before the present day, estimating the total costs to date of delayed action. Considering a 2(1.5) degree Celsius stabilization target, peak costs are greater and reached sooner with a later start to mitigation, reaching 15(17)% of global GDP in 2085(2070) for a 1990 start and 18(35)% in 2080(2035) for a 2020 start. Further mitigation delay costs a best estimate of an additional 0.5(5) trillion dollars per year. Additional simulations show how optimal mitigation

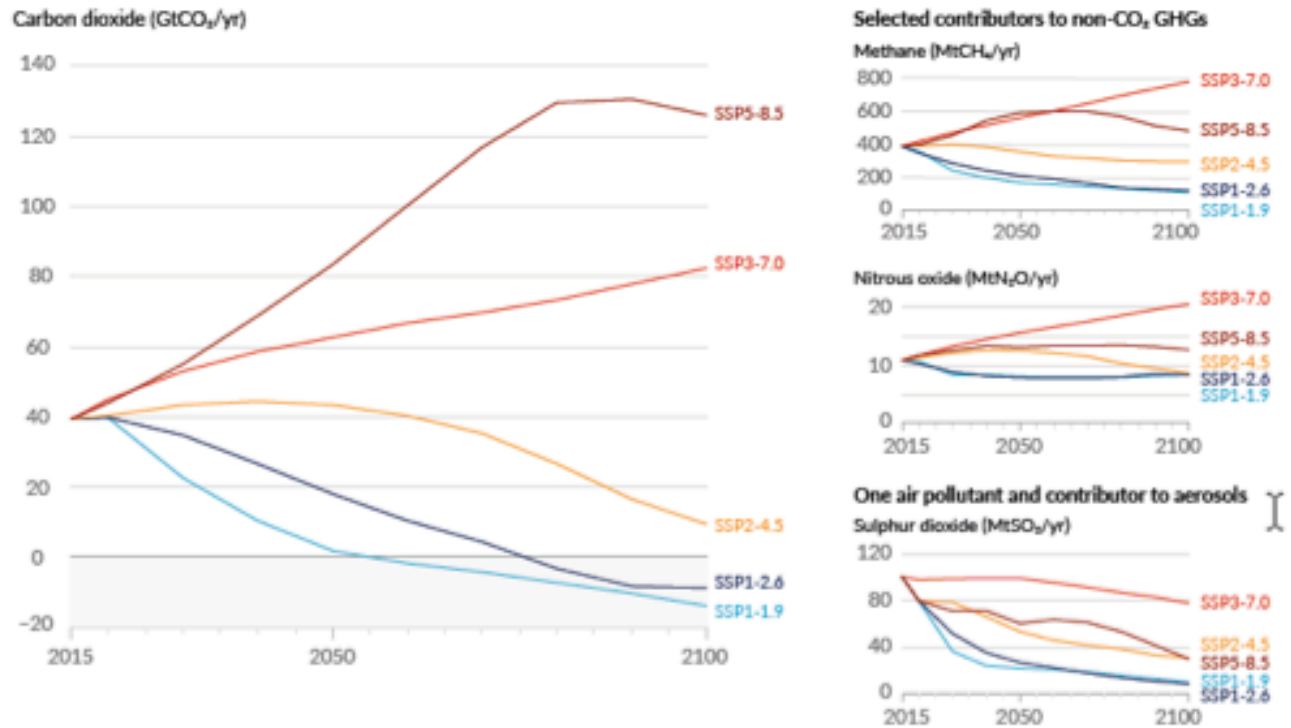
Action – **Support goals: COP26: down from +3.5°C (Paris NDCs) to +2°C (better).**



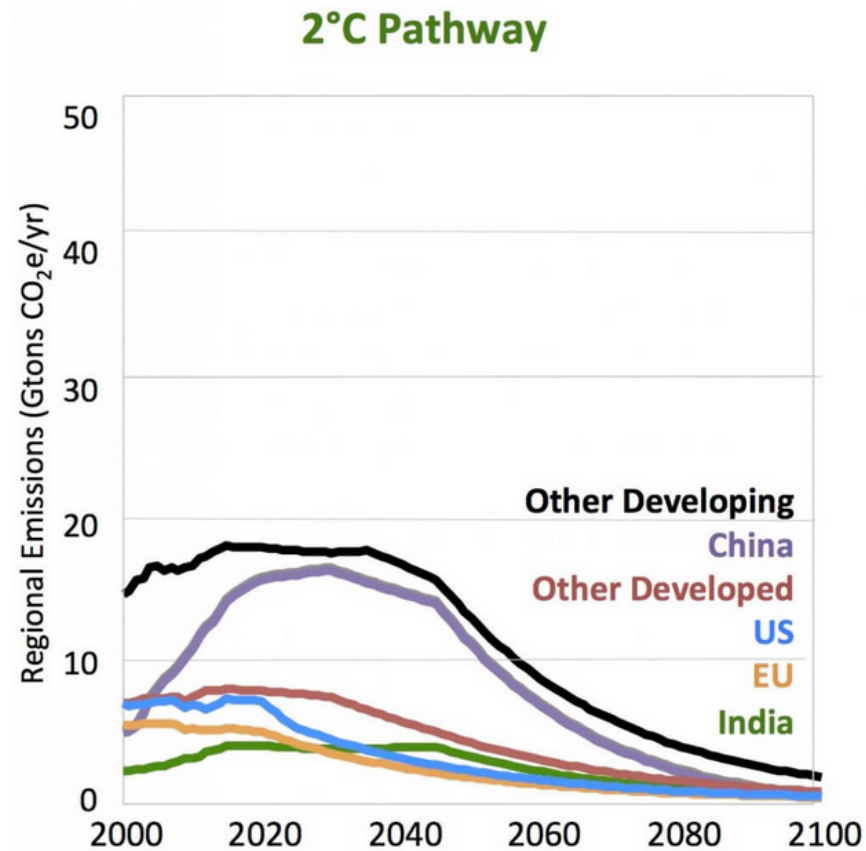
Scenarios to 2100 (CO₂/year)

Future emissions cause future additional warming, with total warming dominated by past and future CO₂ emissions

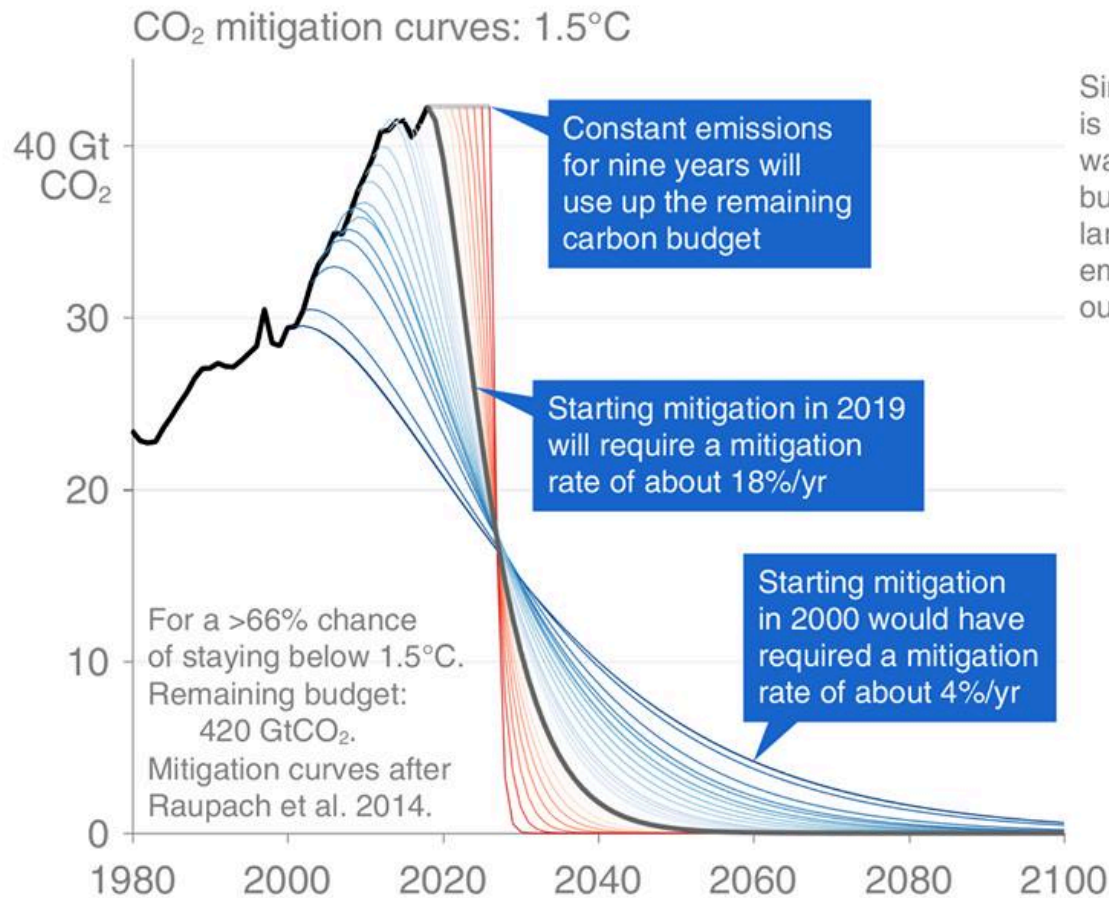
(a) Future annual emissions of CO₂ (left) and of a subset of key non-CO₂ drivers (right), across five illustrative scenarios



Emissions of all countries must markedly decrease by 2050 if only +2°C in 2100



Scenarios of CO₂ reduction for +1.5 degree world in 2100 – **URGENT SPEEDUP NOW**



Since 18%/yr mitigation is impossible, the only way to achieve this budget is with very large "negative" emissions: pulling CO₂ out of the atmosphere.

@robhie_andrew • Data: GCP • Emissions budget from IPCC SR1.5

Temps. (2050) vs. Carbon budgets.

Note linear: Temp. vs. Cum. Carbon

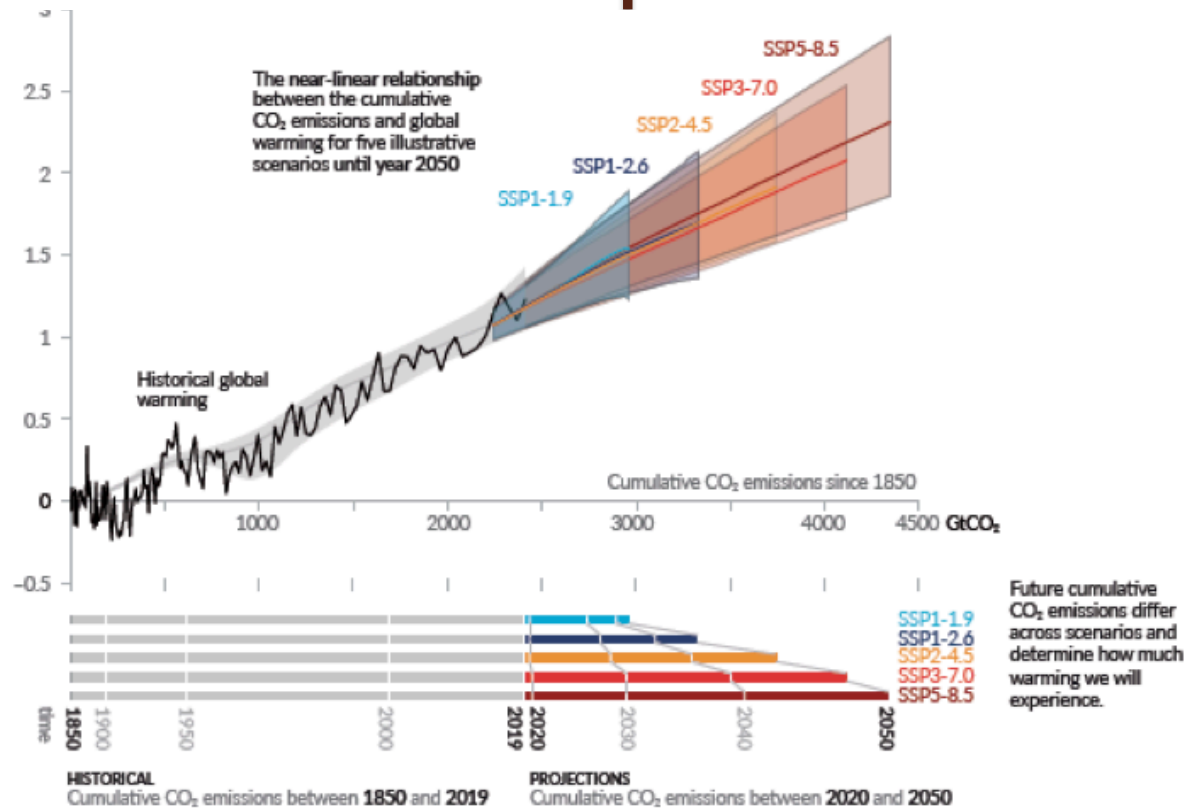
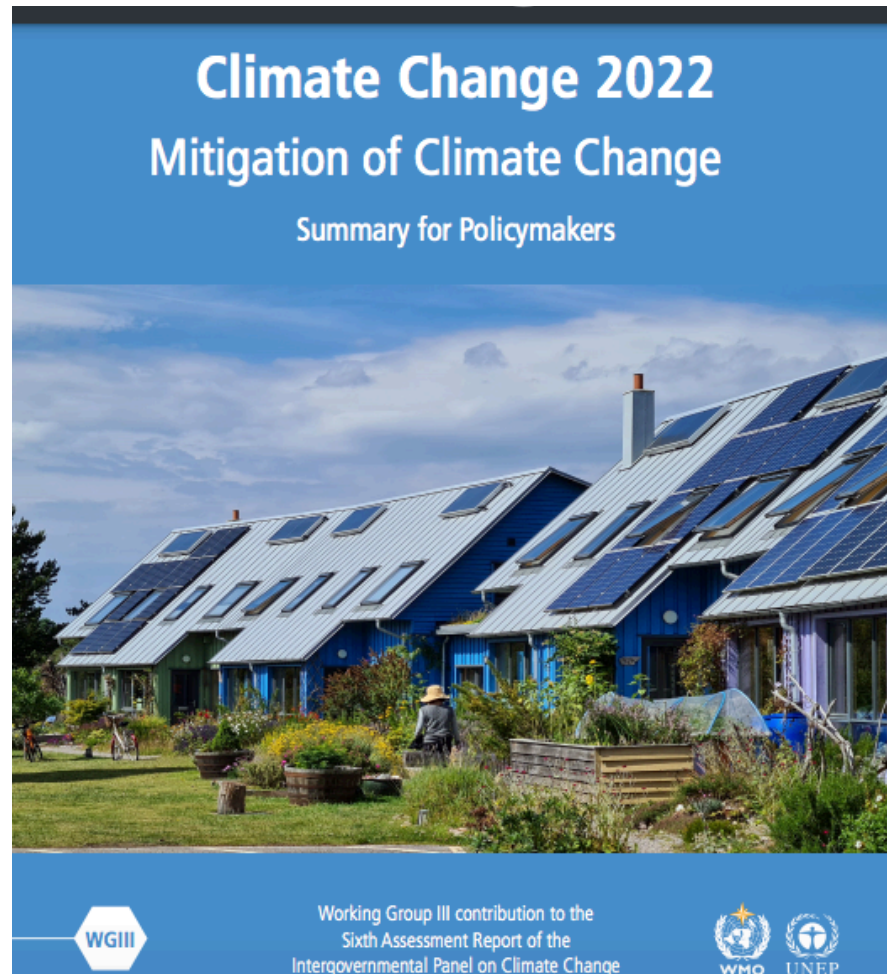


Figure SPM.10 | Near-linear relationship between cumulative CO₂ emissions and the increase in global surface temperature

Top panel: Historical data (thin black line) shows observed global surface temperature increase in °C since 1850–1900 as a function of historical cumulative carbon dioxide (CO₂) emissions in GtCO₂ from 1850 to 2019. The grey range with its central line shows a corresponding estimate of the historical human-caused surface warming (see Figure SPM.2). Coloured areas show the assessed *very likely* range of global surface temperature projections, and thick coloured central lines show the median estimate as a function of cumulative CO₂ emissions from 2020 until year 2050 for the set of illustrative scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and

IPCC Reports: Mitigation (2022) + Science (2021), Impacts (2022)



PROJECT DRAWDOWN

- Comprehensive list – 100 climate actions
- Actions are available now
 - New technology will help but not needed
 - Both cost and benefits estimated
- **Benefits far outweigh costs**

Huge Benefits - OPPORTUNITY

**PROJECT
DRAWDOWN.**



email sign up

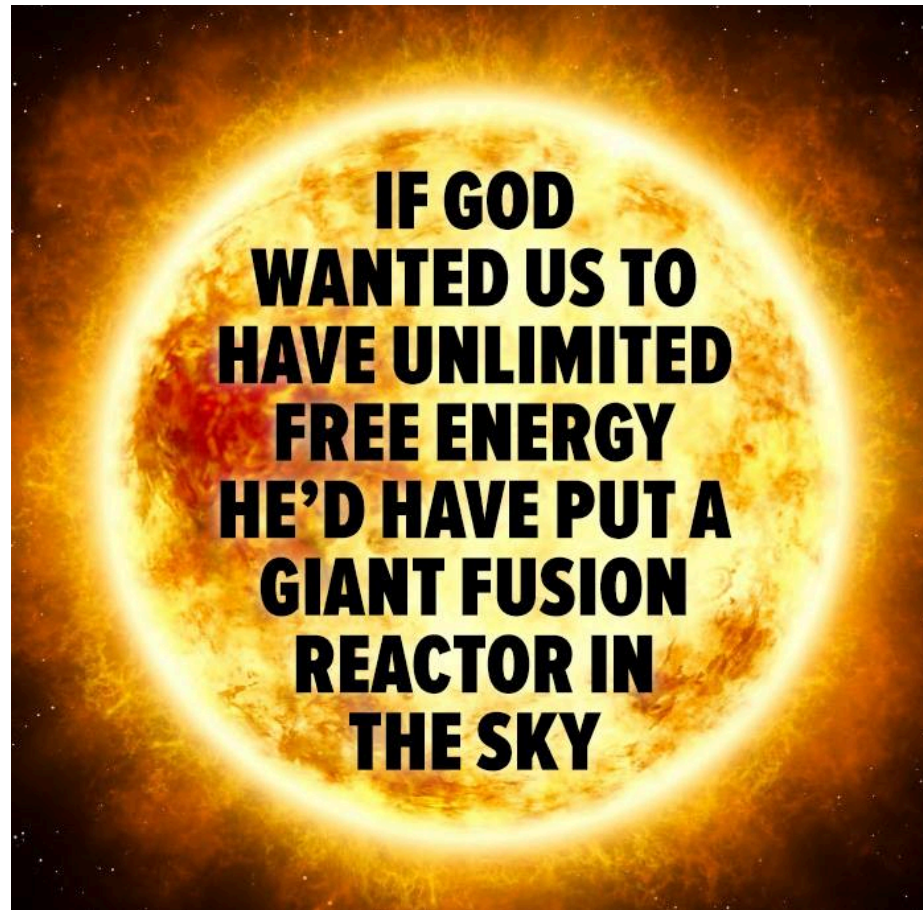
donate

Rank	Solution	Sector	REDUCTION (GT)	NET COST (BILLIONS US \$)	SAVINGS (BILLIONS US \$)
26	Electric Vehicles	Transport	10.80	\$14,148.00	\$9,726.40
2	Wind Turbines (Onshore)	Electricity Generation	84.60	\$1,225.37	\$7,425.00
8	Solar Farms	Electricity Generation	36.90	\$-80.60	\$5,023.84
27	District Heating	Buildings and Cities	9.38	\$457.10	\$3,543.50
10	Rooftop Solar	Electricity Generation	24.60	\$453.14	\$3,457.63
54	Walkable Cities	Buildings and Cities	2.92	N/A	\$3,278.24
43	Airplanes	Transport	5.05	\$662.42	\$3,187.80
40	Trucks	Transport	6.18	\$543.54	\$2,781.63
31	Insulation	Buildings and Cities	8.27	\$3,655.92	\$2,513.33
37	Mass Transit	Transport	6.57	N/A	\$2,379.73
16	Conservation Agriculture	Food	17.35	\$37.53	\$2,119.07
11	Regenerative Agriculture	Food	23.15	\$57.22	\$1,928.10
46	Water Saving - Home	Materials	4.61	\$72.44	\$1,800.12
49	Cars	Transport	4.00	\$-598.69	\$1,761.72
33	LED Lighting (Household)	Buildings and Cities	7.81	\$323.52	\$1,729.54
20	Nuclear	Electricity Generation	16.09	\$0.88	\$1,713.40
42	Heat Pumps	Buildings and Cities	5.20	\$118.71	\$1,546.66
23	Farmland Restoration	Food	14.08	\$72.24	\$1,342.47
62	Telepresence	Transport	1.00	\$107.70	\$1,310.50

Huge CO2 Reductions

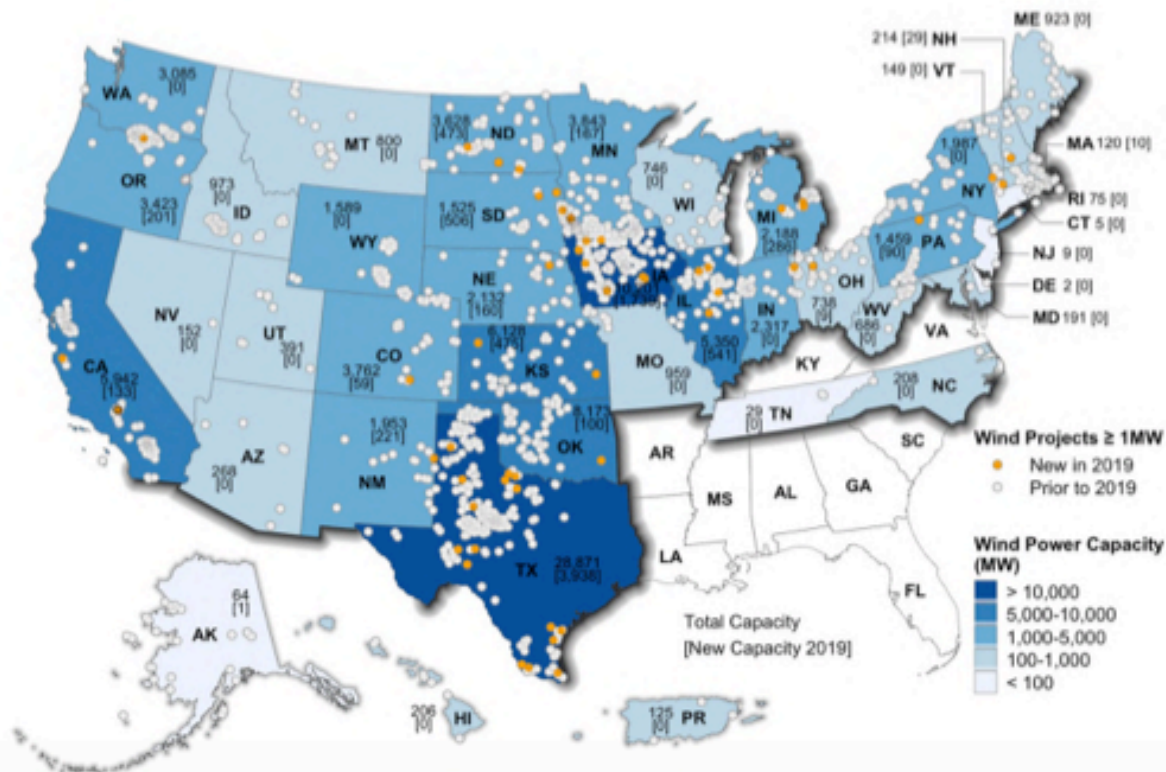
Rank	Solution	Sector	TOTAL ATMOSPHERIC CO2-EQ REDUCTION (GT)	NET COST (BILLIONS US \$)	SAVINGS (BILLIONS US \$)
1	Refrigerant Management	Materials	89.74	N/A	\$-902.77
2	Wind Turbines (Onshore)	Electricity Generation	84.60	\$1,225.37	\$7,425.00
3	Reduced Food Waste	Food	70.53	N/A	N/A
4	Plant-Rich Diet	Food	66.11	N/A	N/A
5	Tropical Forests	Land Use	61.23	N/A	N/A
6	Educating Girls	Women and Girls	51.48	N/A	N/A
7	Family Planning	Women and Girls	51.48	N/A	N/A
8	Solar Farms	Electricity Generation	36.90	\$-80.60	\$5,023.84
9	Silvopasture	Food	31.19	\$41.59	\$699.37
10	Rooftop Solar	Electricity Generation	24.60	\$453.14	\$3,457.63
11	Regenerative Agriculture	Food	23.15	\$57.22	\$1,928.10
12	Temperate Forests	Land Use	22.61	N/A	N/A
13	Peatlands	Land Use	21.57	N/A	N/A
14	Tropical Staple Trees	Food	20.19	\$120.07	\$626.97
15	Afforestation	Land Use	18.06	\$29.44	\$392.33

Climate Opportunity/Risk Action: Support Solar Energy



Climate Opportunity/Risk Action: Support Wind energy

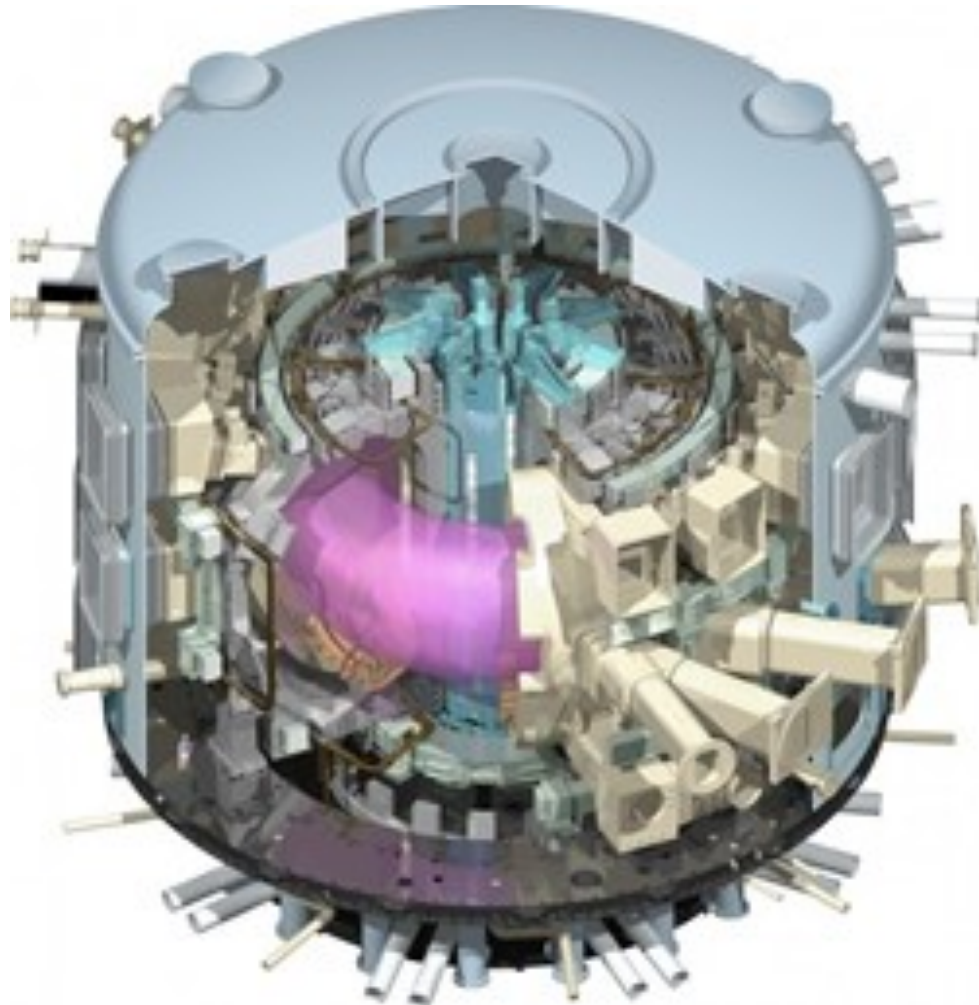
U.S. wind power installations, end of 2019



Climate Opportunity/Risk Action: Support **Electric Vehicles**

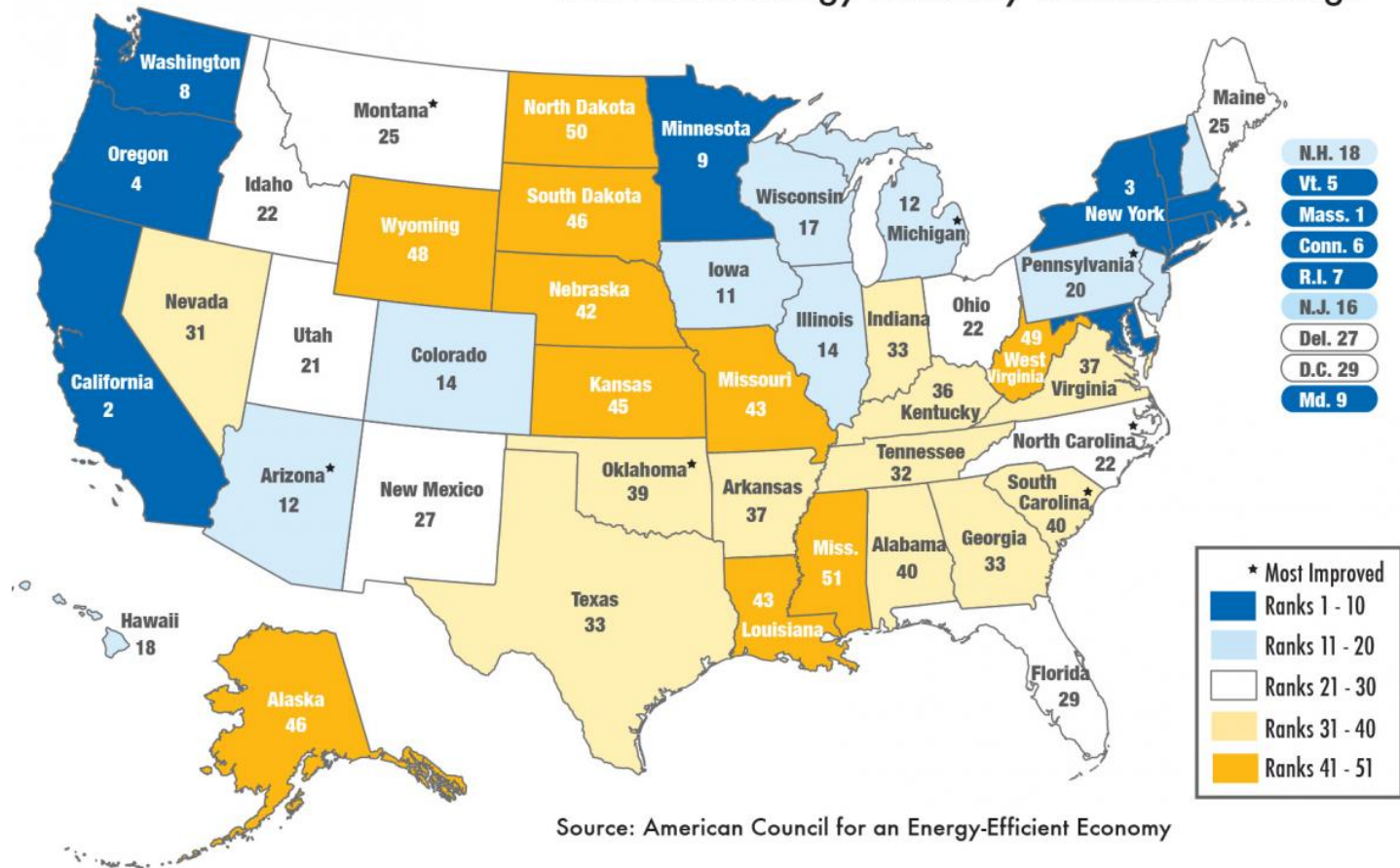


Climate Opportunity/Risk Action: Support Fusion (ITER + ...) No Joke.



Climate Opportunity/Risk Action: Support Energy Efficiency

2012 State Energy Efficiency Scorecard Rankings



Source: American Council for an Energy-Efficient Economy

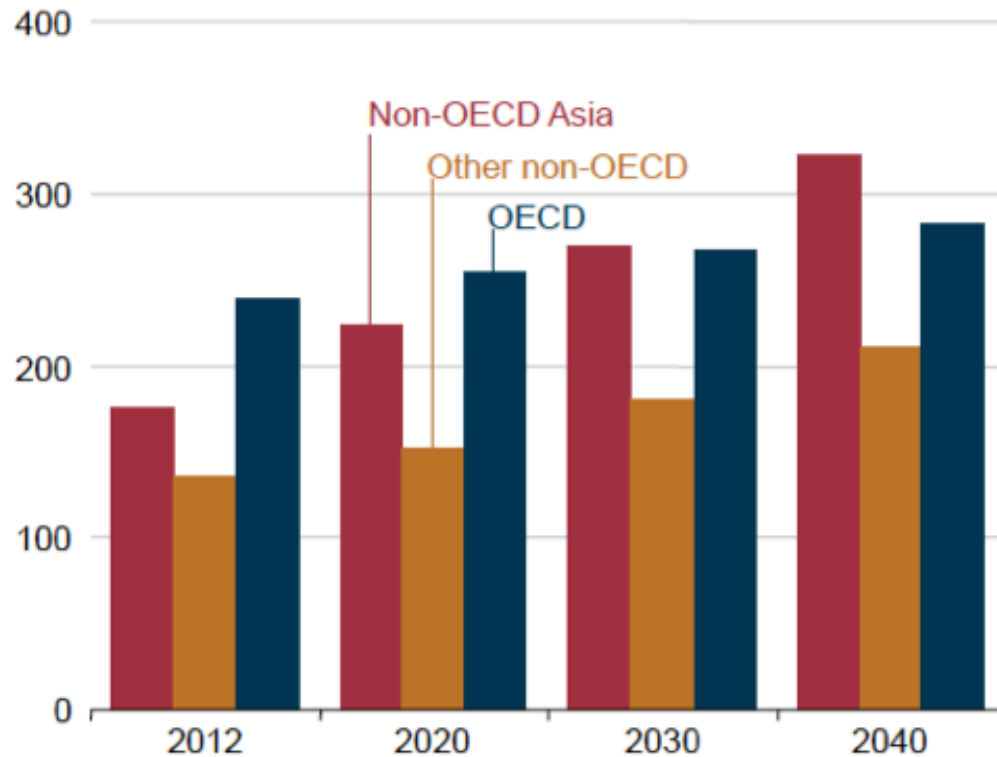
Risk Management Action – Learn about climate lawsuits: Database



COLUMBIA LAW SCHOOL

Climate Opportunity/Risk Action: Reduce Energy use (per capita)

Figure ES-1. World energy consumption by country grouping, 2012–40 (quadrillion Btu)



Climate Opportunity/Risk Action: **CDR CO2 Reduction**

Now 410ppm – need 350ppm = CDR 60ppm

FORESTS: KEY TO A SUCCESSFUL PARIS AGREEMENT



INCLUDE FORESTS

INCREASE FINANCE

SOLIDIFY COMMITMENTS

WWF

FOREST AND CLIMATE PROGRAMME

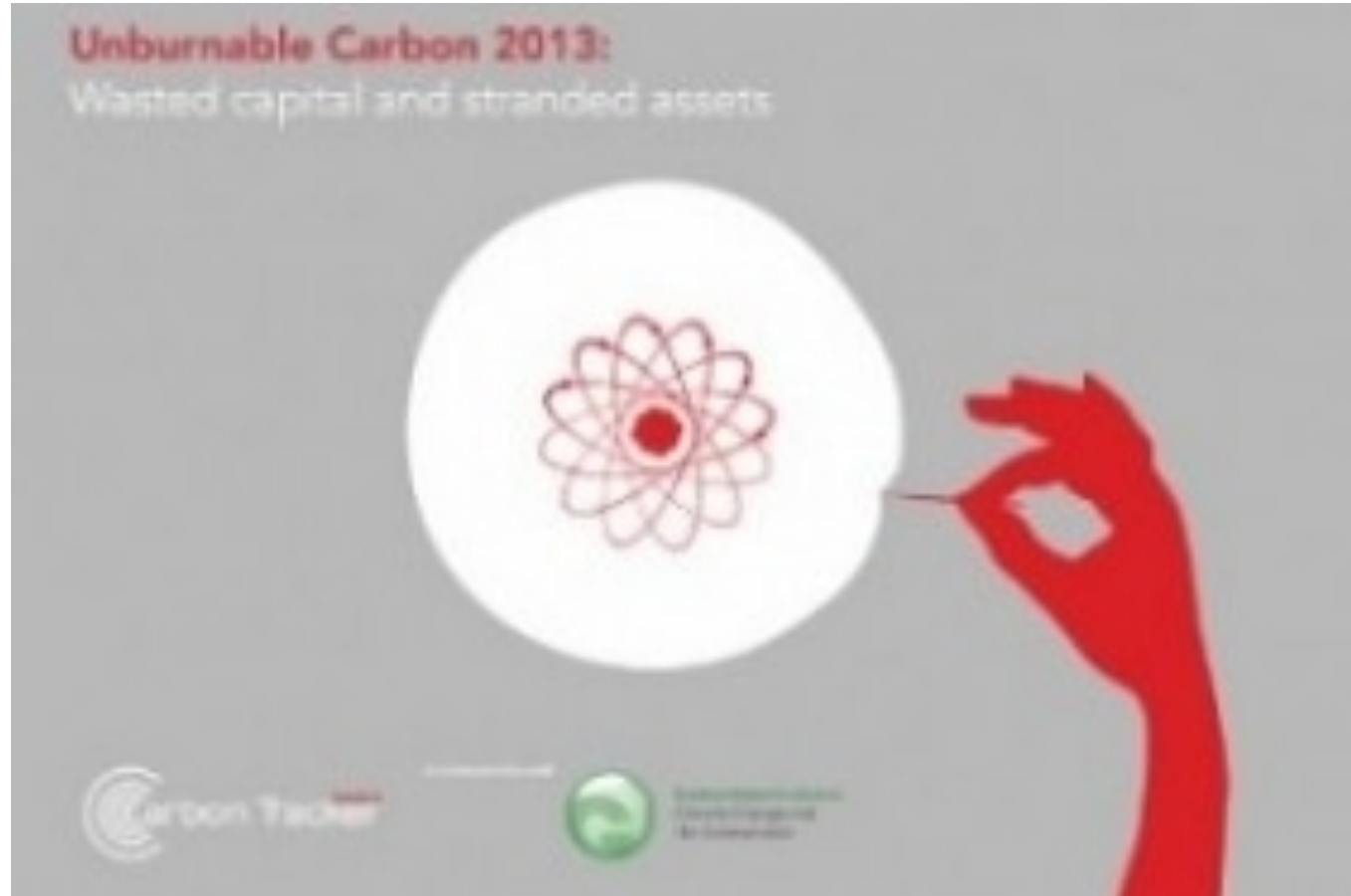
- Forests are a key part of the global carbon cycle. The trees within them absorb carbon as they grow and emit it as they age or are cut down. Deforestation and forest degradation are the largest sources of CO₂ emissions after the combined emissions from all cars, trucks, trains, planes and ships in the world.
- If current trends continue over the next 11 years, 11 of the world's most ecologically important forest landscapes will be lost.
- We will not be able to close the emissions gap or address climate change if we do not include forests in the Paris agreement. Agricultural practices also must be included, as most of the world's deforestation is caused by expanding agriculture.
- Adequate and predictable finance for reducing emissions from deforestation and degradation in developing countries (REDD+) is needed in the agreement if we want to achieve the broader mitigation and sustainable development goals.
- Money is needed for a variety of approaches, such as properly managing protected areas, increasing enforcement to prevent illegal logging and strengthening forest governance.
- Funding for all forest conservation initiatives, including REDD+, must be allocated and used in a way that safeguards the rights of indigenous people and local communities to their land and way of life.
- The public sector plays a leading role in reducing deforestation and degradation. But this sector cannot solve the issue alone, especially at the pace that is needed.
- Companies in the private sector must also play a role by bringing their "deforestation-free" commitments – most which are about imposing the way they produce and source food and commodities – to life in a fair and effective manner.
- Forest conservation strategies created and implemented by national governments via REDD+ can lay the foundation for the private sector to meet its commitments.

Climate Opportunity/Risk Action: Support Research (e.g. Batteries; lots of new tech)




Climate Opportunity/Risk Action

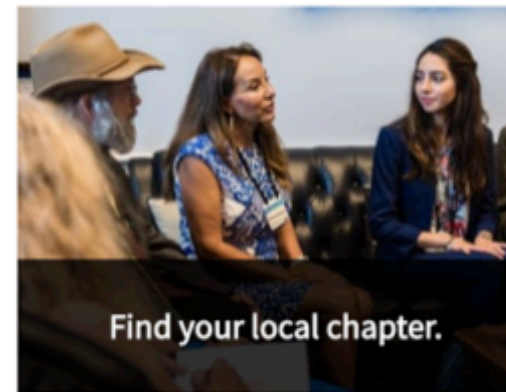
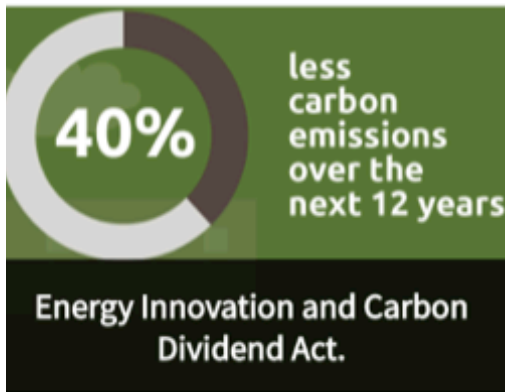
Divest: Stranded Assets



Climate Opportunity/Risk Action: Citizens' Climate Lobby (Carbon Fee-Dividend)

 Citizens' Climate Lobby

[About](#) [Our Climate Solution](#) [Blog](#) [Take Action](#) [Donate](#) [Join CCL](#)



Climate Opportunity/Risk Action: Action (+ letters + marches + ...)



Promote responsible climate journalism – resource is the CSRRT



Climate Opportunity/Risk Action: Promote reports: Risky Business



Climate Opportunity/Risk Action - The Arts: “Solartopia”, Pete Seeger

PETE SEEGER'S "SONG FOR SOLARTOPIA!"

SOLARTOPIA words & music by
Harvey Wasserman
& Pete Seeger

Chorus: Doo'tcha know we're gonna have a - so-lar-topia - so-lar-topia - so-lar-topia
Doo'tcha know we're gonna have a - so-lar-topia
all over God's green world. 1. We'll learn how to

Verses

lots of melody variations possible in the verses but keep the chorus. Remember: an editorial in rhyme is usually not a good song. Nor is making a song official help it. Sing on. Pete.

Copyright © 2007 by Pete Seeger & Harvey Wasserman

In early 2007, the legendary folksinger Pete Seeger penned the classic anthem *Song for Solartopia*. In the spirit of the Green Revolution, he put out a call for verses, and offered this sage advice:

"An editorial is not a song. Tell a story, paint a picture, make people smile."

Since then, tens of thousands of Solartopians have sent their words to www.solartopia.org, where Pete's original chorus can still be heard.

Verses need to paint a picture, tell a story. A gang of young people getting jobs and saving the world
Pete

Over the years, collections of the verses have been posted and spread throughout Solartopia. You are more than welcome to contribute your own.

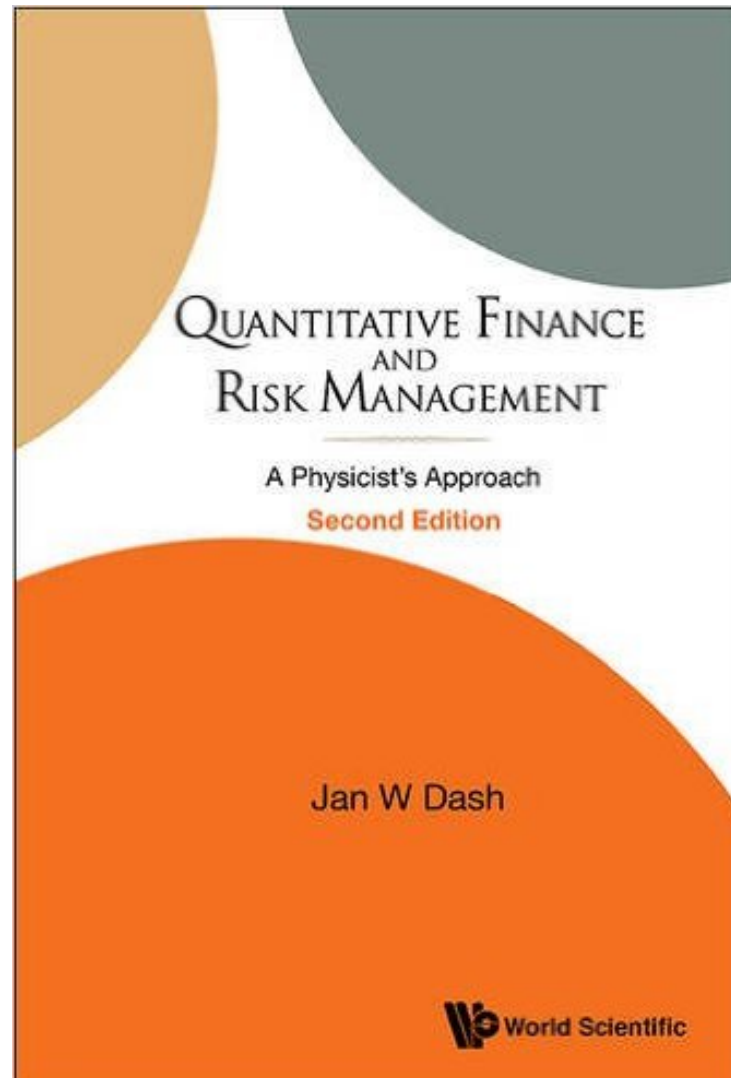
Climate Opportunity/Risk Action: Support **Climate Education**



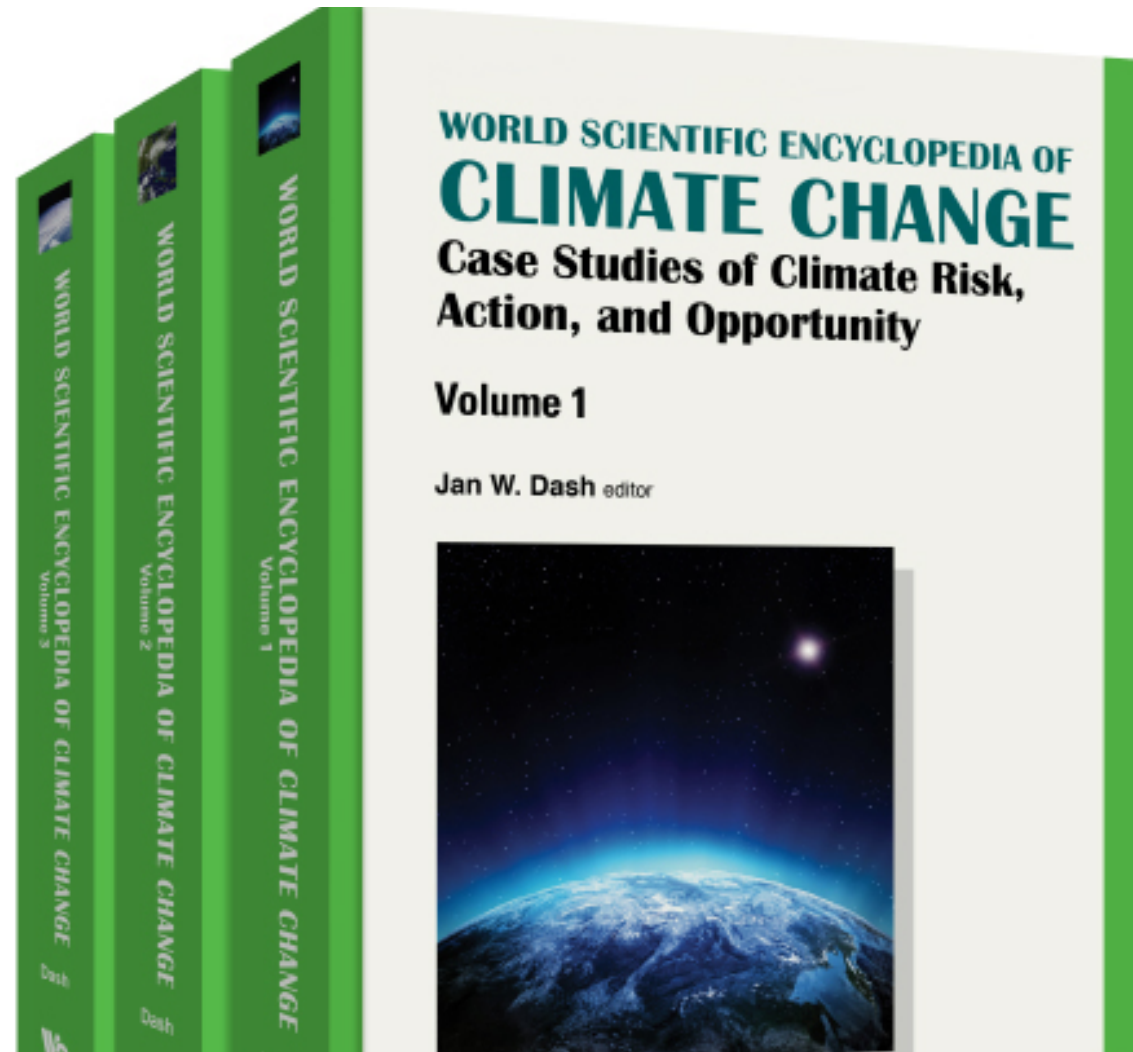
Climate Opportunity/Risk Action: Promote reliable sources: RealClimate.org

The image shows a screenshot of the RealClimate.org website. At the top, there is a dark blue navigation bar with white text links: "start here", "home", "about", "data sources", "RC wiki", "contributors", "index", and "archive". Below the navigation bar is a large banner image featuring a bright orange sun on the left and a blue ocean with white icebergs on the right. Overlaid on the banner is the text "RealClimate" in a large, bold, yellow font, with the tagline "Climate science from climate scientists" in a smaller, italicized, yellow font below it. To the right of the banner is a search box with a "Search" button and radio buttons for "Site" and "Google Custom Search". Below the search box is a badge for "SCIENTIFIC AMERICAN 2005 Science & Technology WEB AWARDS". At the bottom right, there is a green button that says "Guide to RC plugger" and "ZVON.org". Below the button is the text "Recent Comments".

Ch. 53: Climate Change Risk Management



Climate Encyclopedia



Climate Encyclopedia Contents

#	Vol 1	Vol 2	Vol 3
1	Climate Encyclopedia Overview	Climate and Economics	Climate and Policy
2	Climate and Finance	Climate and Justice	Climate Impacts
3	Climate Action	Climate and Morality	Climate Risk Management
4	Climate Mitigation	Climate and Food	Climate and Renewable Energy
5	Climate and Business	Climate and Technology	Climate and Electricity
6	Climate and Youth	Climate Science	Climate and Transportation
7	Climate and Health	Climate Adaptation	
8	Climate and Faith	Climate Law	
9	Climate and the Arts		
10	Climate Education		
11	Climate Consensus		
12	Climate Conferences		

New: Journal of Climate Action, Risk, Policy

- **Vision:** Provide resources catalyzing the more urgent, substantial, and pivotal climate action solutions by
 - Business of all types
 - Government at all levels
 - Academia
 - NGOs

Climate Change Academy of Risk and Opportunity (proposal)

- Mission: help galvanize business climate risk evaluation and opportunity
- Catalyze a new C-Suite level profession, **Climate Change Risk and Opportunity Officer, CCROO**.
- Propose high standard guidelines for CCROO, taught by universities + practitioners.
- My talk: https://youtu.be/HmvH2o3-6_o

M.S. in CLIMATE RISK AND OPPORTUNITY - GUIDELINES

I. Risk Management

- i. Corporate Finance and Risk Management
- ii. Quantitative Financial Risk Management

II. Climate Change - Basics

- iii. The Physical Science Basis of Climate Change
- iv. Impacts of Climate Change, Vulnerabilities, Adaptation
- v. Mitigation of Climate Change

III. Specialized Topics in Risk and Opportunity

- vi. Climate Change, Business and: Finance, Economics, Policy
- vii. Economic / Climate Models, viii. Financing, ix. Scenario Analyses, x. Tail Risk, xi. Uncertainties, xii. Data, xiii. Tools, xiv. Systems
- xv. Reporting and Regulation, xvi. Investors, xvii. International, xviii. Academic, xix. Political
- xx. Sectors, xxi. Cross-discipline Communication
- xxii. Intergenerational Equity, xxiii. Justice and Climate

Details (1 hour talk / topic)

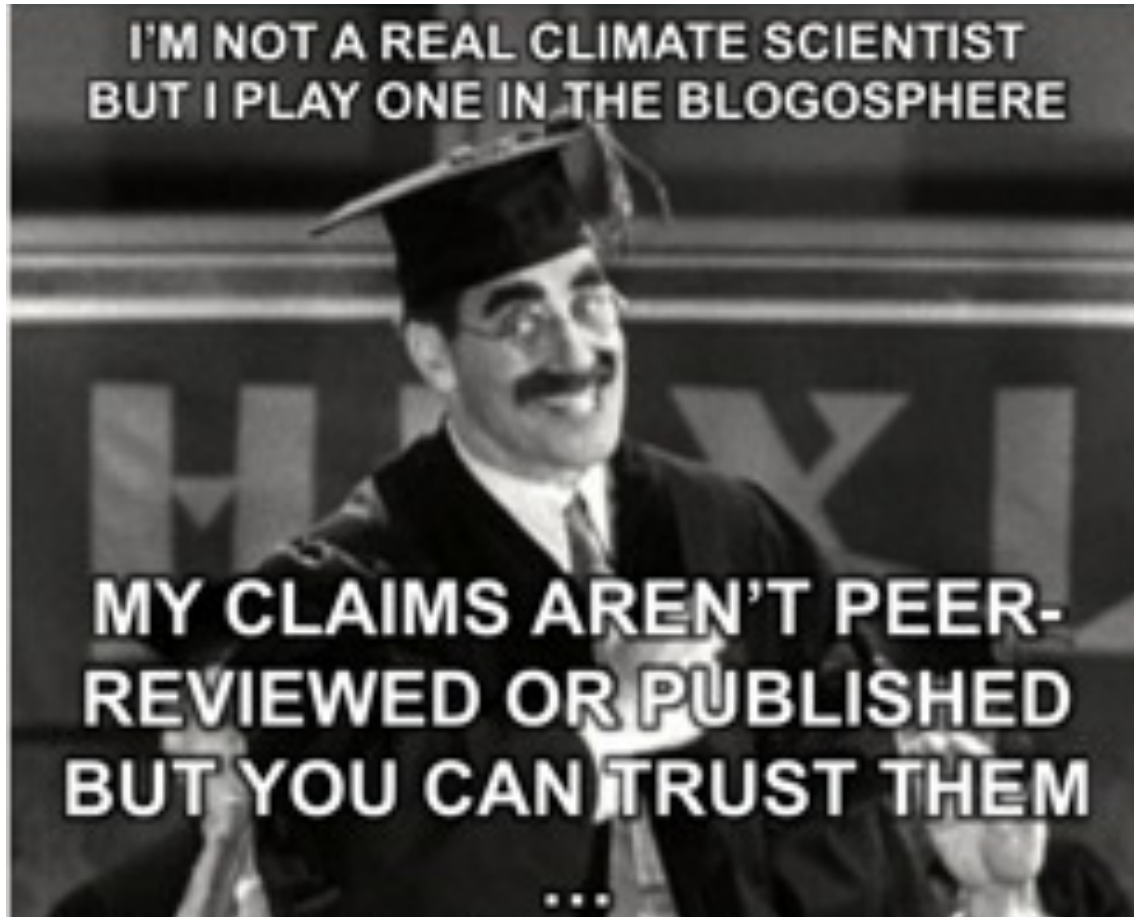
SUGGESTED CCROO COMPETENCIES LIST

-
- ⁱ **Corporate Finance and Risk Management:** Real world corporate case studies, Strategic planning, Project finance, Debt, Credit, Operational Risk, Supply chains, Real options ... - Master's degree level
- ⁱⁱ **Quantitative Financial Risk Management:** Markets, Statistics, Regulations, VAR, Financial model risk, Counterparty risk, Systemic risk, Crises, Trends, Portfolios... - Master's degree level
- ⁱⁱⁱ **The Physical Science Basis of Climate Change:** Data, Theory, Models; Carbon emissions (cumulative, current, future, per-capita, country) ... Tech. Sum. IPCC v1; <https://www.ipcc.ch/report/ar5/wg1/technical-summary/>
- ^{iv} **Impacts of Climate Change, Vulnerabilities, Adaptation:** Time scales, Meaning of "1.5 and 2 degrees", Physical risk, Transition risk, Health, Security, Economic and political instabilities, Food, Water, Sea level rise, Migration, Biodiversity, Growth; Resilience strategies, Derivatives, Insurance; Geography, Climate attribution; Case studies; Feedback/enhancement between impacts ... - Tech. Sum. IPCC v2; <https://www.ipcc.ch/report/ar5/wg2/technical-summary/>
- ^v **Mitigation of Climate Change:** Decarbonization, Scopes 1,2,3; Carbon budget, Drawdown, Electricity, Grid (stability, national HVDC, storage), Renewables, Fission/Fusion, Fossil fuels, Efficiency, Regulation, Policies, Carbon pricing, Agriculture, Forests, Diet, Industry, Transport, Buildings, Heat pumps, New technologies, Hydrogen, Carbon Capture and Storage, Divestment, Stranded assets, Life cycle, Circular economy, Raw materials, Subsidies, Offsets, Geoengineering...- Tech. Sum. IPCC v3; <https://www.ipcc.ch/report/ar5/wg3/technical-summary/>
- ^{vi} **Business and Finance, Economics, Policy:** Survey and Case studies – World Scientific Climate Change Encyclopedia level; <https://www.worldscientific.com/worldscibooks/10.1142/11526#t=aboutBook>
- ^{vii} **Economic / Climate Models:** Integrated Assessment Models including climate damage, Regional vs. global climate modeling, Social Cost of Carbon, Discount-rate models, Nonlinearities ...

Details (2)

- viii **Financing:** Scaling and types of financing, Project finance case studies, Green bonds, Institutions, Instruments ...
- ix **Scenario Analyses:** Nature of climate scenarios, Bayesian (e.g. +2 degrees at 2100), Specific scenarios (IPCC, Sky...), Climate VAR, Scenarios with mitigation, Climate stress tests, Path dependencies, Nonlinearities ...
- x **Tail Risk:** Extreme events (past, projected), Case studies (Sandy, French heat wave...), Confidence levels...
- xi **Uncertainties:** Climate sensitivities, Human behavior, Model parameters, Precautionary principle ...
- xii **Data:** Vendors, GHG inventories, Temperature, Food, Water, Land cover, Data gaps and spikes, AI/ML, Sources ...
- xiii **Tools:** Buy vs. Build, EnRoads and CRoads (MIT), Stock price sensitivities, Web-based tools ...
- xiv **Systems:** Vendors, IT management, Monte-Carlo long-term simulations, Speed and accuracy ...
- xv **Reporting and Regulation:** TCFD, Climate risk and opportunity, Business participation, Transition risk, Regulation, Climate law ...
- xvi **Investing:** CERES, Investor pressure, Impact investing, Reputation risk, Contagion ...
- xvii **International:** UNFCCC, COP conferences, Paris Agreement, NDCs, Enhanced ambition, Tech transfer, Financing
- xviii **Academic:** Sustainability/risk MS programs, Practitioner courses, ACCO, Webinars, Conferences ...
- xix **Political:** US (Federal, State), Europe, UK, China, India, Russia, Brazil, Asia, M.East: (Past, Current, Future) ...
- xx **Sectors:** Sector-dependent climate risks and opportunities
- xxi **Communication:** Priorities, Media, Complexity, Psychology, Science/risk denial, Planning, Negotiation ...
- xxii **Intergenerational Equity:** “Leaving a livable world”, Youth climate movement, Urgency and ethics ...
- xxiii **Justice and Climate:** SDGs, ESGs, Business sustainability, Climate and Social/Environmental justice/pollution, Economic development, Population, COP24 just transition, Faith organizations, NGOs, Indigenous peoples ...

Climate Opportunity/Risk Action: **Oppose Climate Denier (Science /Risk) obstruction**



Four tranches of climate science/ risk denial of Global Warming (GW)

1. GW exists (deniers deny)
 2. GW is caused by humans (deniers deny)
 3. GW has severe impacts (deniers deny)
 4. GW can be mitigated (deniers deny)
- **Climate science/risk denial - huge risk - climate action is obstructed**
 - **Long history. Moving from 1,2 to 3,4**

Contrarian Pseudo-Science Fallacies



Skeptical Science
Getting skeptical about global warming skepticism

Home Arguments Software Resources Comments The Consensus Project Translations About

Search... GO

Twitter Facebook YouTube Pinterest

Posts Comments Email

MOST USED Climate Myths

and what the science really says...

- 1 Climate's changed before
- 2 It's the sun
- 3 It's not bad
- 4 There is no consensus
- 5 It's cooling
- 6 Models are unreliable
- 7 Temp record is unreliable

Global Warming & Climate Change Myths

Here is a summary of global warming and climate change myths, sorted by recent popularity vs what science says. Click the response for a more detailed response. You can also view them sorted by taxonomy, by popularity, in a print-friendly version, with short URLs or with fixed numbers you can use for permanent references.

	Climate Myth	vs	What the Science Says	
1	"Climate's changed before"		Climate reacts to whatever forces it to change at the time; humans are now the dominant forcing.	
2	"It's the sun"		In the last 35 years of global warming, sun and climate have been going in opposite directions	
3	"It's not bad"		Negative impacts of global warming on agriculture, health & environment far outweigh any positives.	
4	"There is no consensus"		97% of climate experts agree humans are causing global warming.	

Much More in Climate Action Portfolio

- Decarbonize heavy industry (steel), shipping, aviation, cement ...
- Eat Less Meat (or Grass-Fed)
- Hydrogen, 4th gen. fission, geothermal ...
- Heat pumps, co-generation ...
- Reduce Reuse Recycle
- Reduce Plastics (oil-based)
- Offsets (tricky)
- Not: Geo-engineering e.g. SRM (bad idea)

QUIZ REVISITED

- What do YOU think about the opportunities and risks involved with climate change?
- Did anything change?

CLIMATE CHANGE OPPORTUNITY, RISK MANAGEMENT – Last words

- **OPTIMISM** – no other choice
- **COURAGE** – difficult with obstruction
- **PERSISTENCE** – not a sprint
- **WE ALL CAN HELP** –
 - LOOK CLIMATE ACTION OPPORTUNITY,
 - APPLY CLIMATE RISK MANAGEMENT
- **IF YOU ARE ALREADY ACTIVE,**

Thank You !





Climate Change: Opportunity and Risk – Appendix

Jan W. Dash, PhD
April 2022

Editor: World Scientific Climate Encyclopedia

Gabelli Fellow and Visiting Scholar, Fordham U.

Book: *Quantitative Finance and Risk Management, A Physicist's Approach*

Climate Change Risk Management – Formal (See IPCC reports, also my book, Ch. 53)

Introduction

There are three basic aspects of risk management:

- If possible, estimate the probability **P** of a hazardous event, or of a class of such events
- Estimate the event impact **I** of loss/damage of exposure **E**, assuming the event occurs
- Estimate the cost **C** to reduce the risk of a hazardous event to an acceptable level.

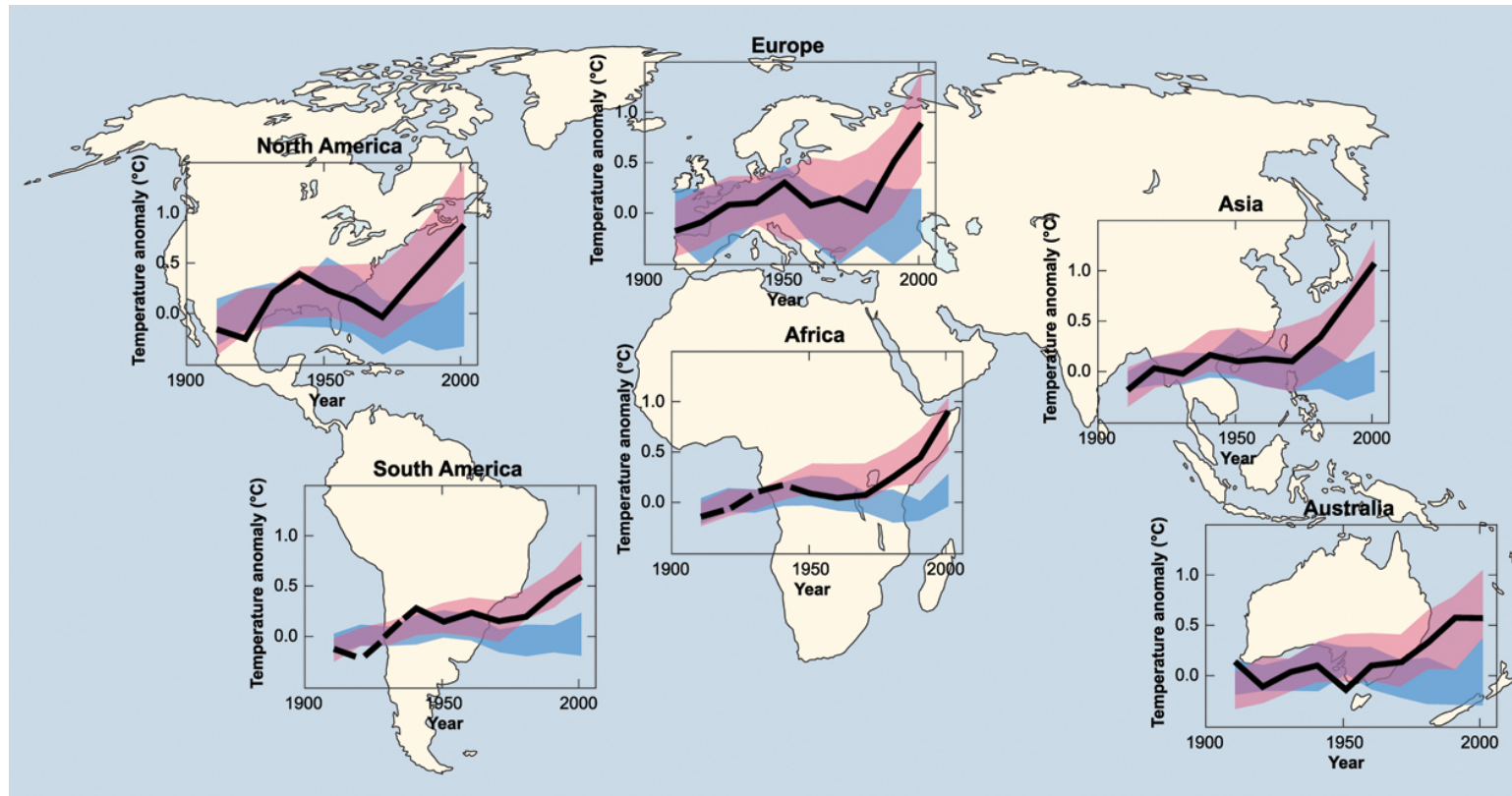
Climate Models (I)

- Based on Physics
 - Nobel Prize 2021 - Manabe, Hasselmann
- Global and detailed regional versions
- Global warming via CO₂ (known 19th century), not dependent on models
- Model Use: forecasts, attributions ...
- Stable model results in time through generations with increasing sophistication
- Atmosphere, land, ocean, ice ... input

Climate Models (2)

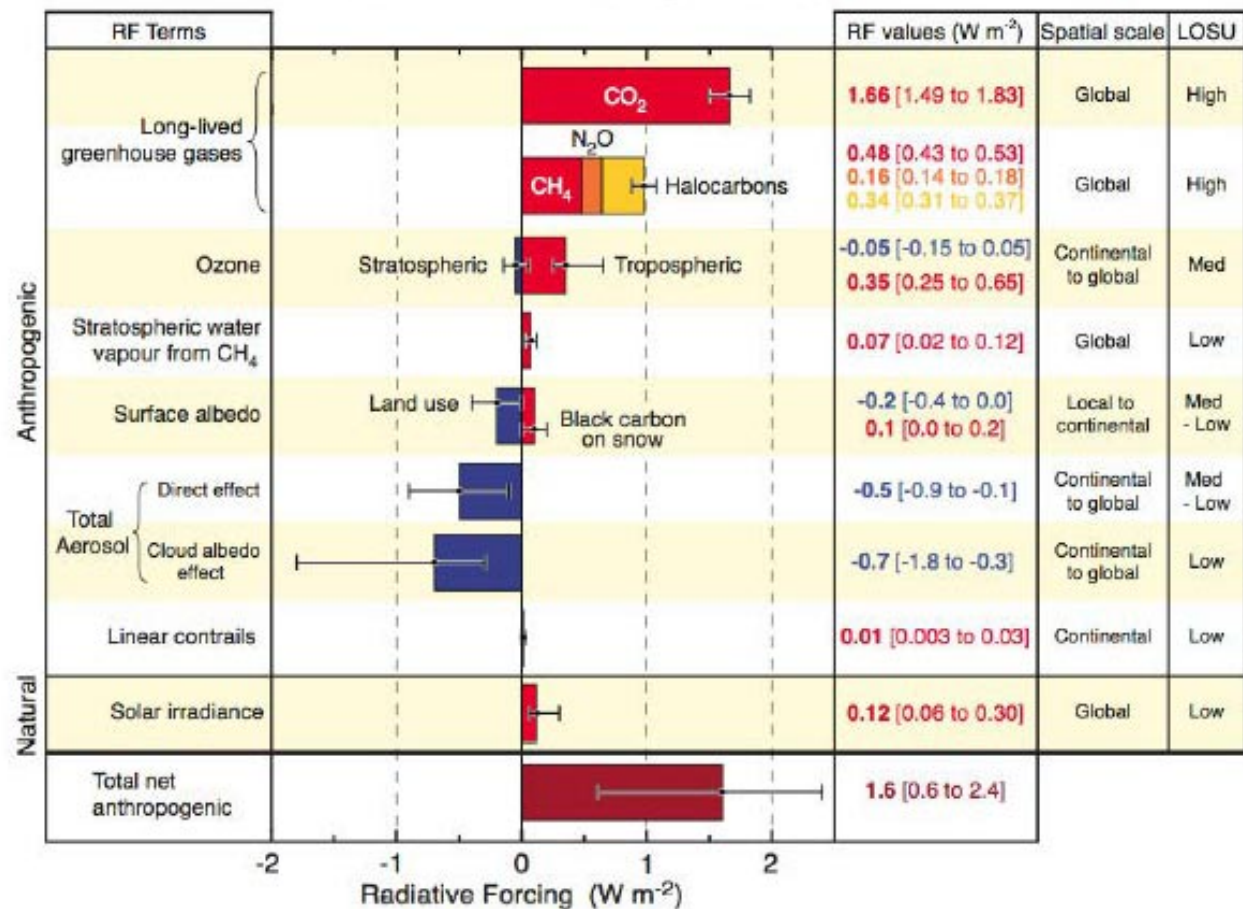
- Temperature change **OUTPUT**, not input
- **Both** human and natural causes input
- Climate models **DO WORK** when tested
 - Not every detail is reproduced
 - Models can't/don't include everything
 - Uncertainties in output estimated for climate models and are reported
 - Misunderstandings exist, critiques exaggerated
 - **Confusion between mathematics and science**

Climate Models vs. T data: **Human + Natural** agrees, ok. **Natural only** disagrees, NOT ok.



ALL effects (“forcings”) in climate models, both natural + human

- Biggest effect is CO₂



Integrated Assessment Model IAM

- Economic model + Climate model work together in an IAM; simplified inputs
- Assume scenarios
- Economic model: Linear perturbative
 - Problems: Climate damage, Non-linear shocks, hits on growth, outliers
 - Choice of discount rate (next slide)
- Climate model: Sets the background
 - “Forcings” depend on human behavior

Discount rate r assumed in IAM - HUGE Effect (factor 2 for $dr/r = 1\%$)

- (Big) hurdle rates - private capital rate for projects should not be relevant for policy decisions
 - Discounts grandchildren (future impacts seem small)
 - **Why should our grandchildren pay for today's credit?**
 - Recent (non-hurdle) rates very low
- Economic models for rates not very helpful
 - Econ. modeling for discount rate unstable (DeCanio)
 - **Paradox: More growth \Rightarrow bigger rate \Rightarrow less climate action \Leftrightarrow BUT more climate impacts reduce growth**

Climate Value at Risk “CVAR”

- Advanced climate risk assessment
- Include many scenarios instead of just one
 - Thereby include uncertainties
- **Assess risk at specified confidence level with model pdf**
 - Proposed in 2016 book (Dash)
 - Calculations (Dietz ...)
 - Need measures for illiquid assets, long times

Time Scales

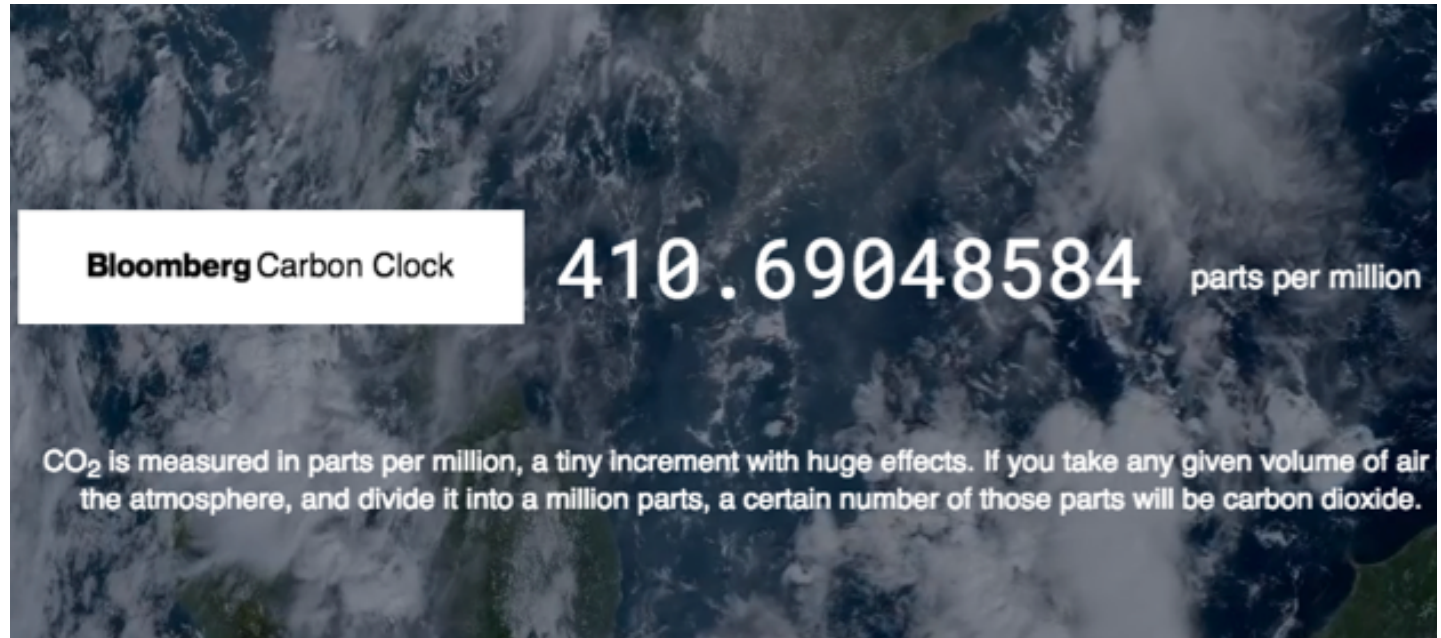
- Urgent – enhanced action need NOW
- Climate impacts are occurring today
- Climate impacts may/will get much worse
- Climate risk time scales: years
- Long Term: Year 2100 (not so distant)
 - Shakespeare lived 400 years ago
- N.b. Geologic time scales give some information, but need to be careful.
 - Human-induced climate change much faster

DATA DATA DATA

- Becoming more sophisticated, better coverage
- Oceans: Argo floats (submarine robots)
- Land: Direct measurements (urban, rural)
 - Temperature differences used - important
- Satellites pros and cons
 - **Satellite GHG emissions measurements coming !! Huge positive development !!**
 - Satellites **don't** measure ground temperature
- GHG emission data need cleaning

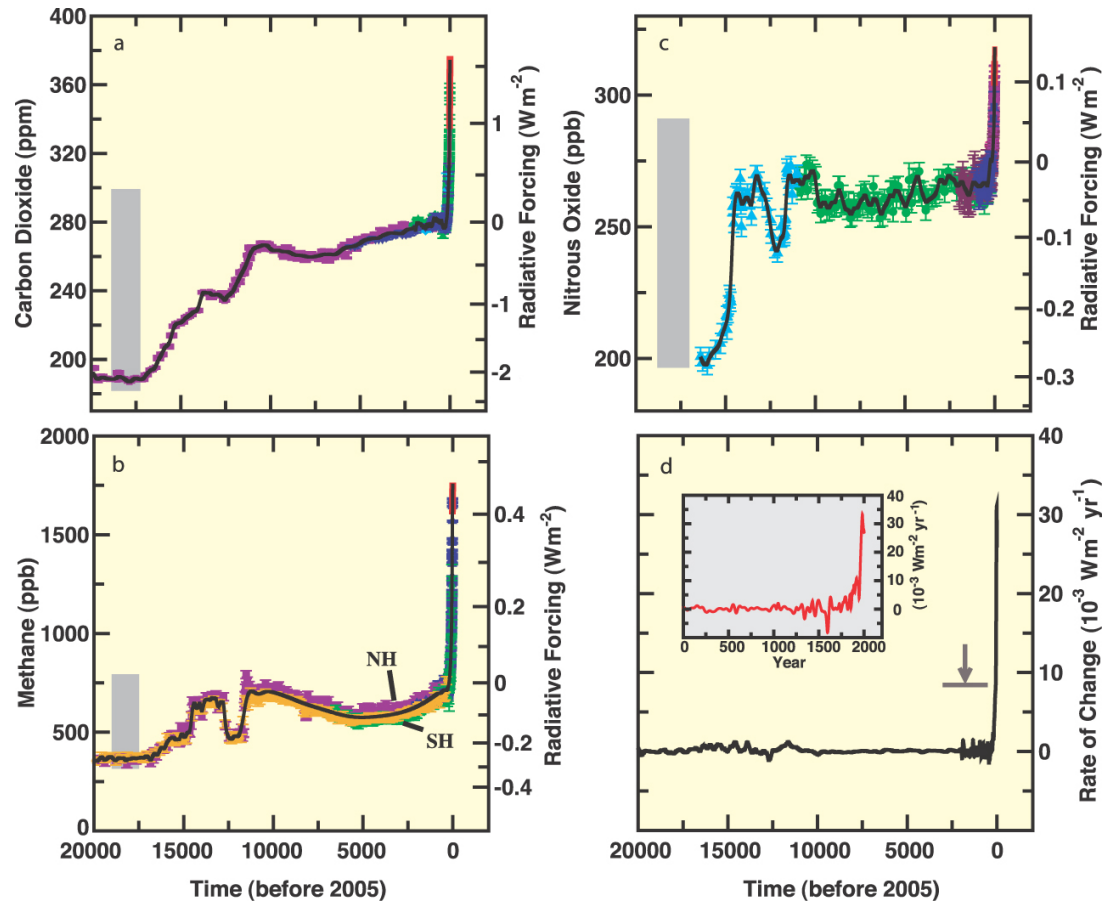
Bloomberg Carbon Clock

Roston, Dash, Zhang



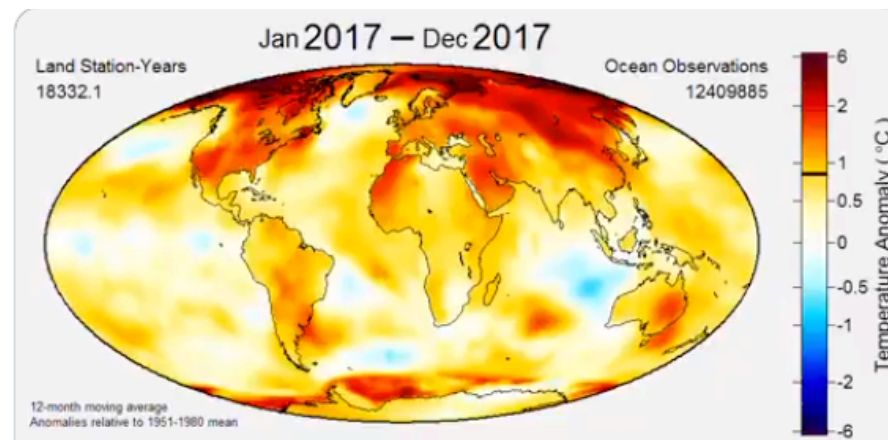
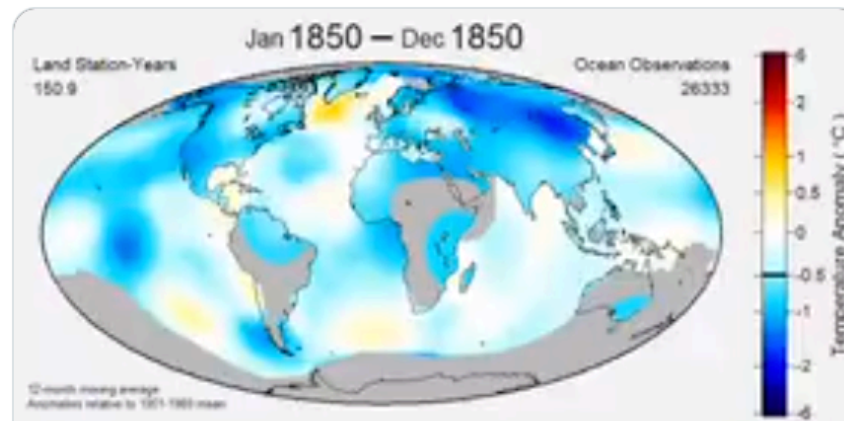
Recent Global Warming is due to Human Generated Greenhouse Gases CO2...

20,000 years
of data;
CO2 spike
is recent,
continuing.
Methane...
IPCC 2007

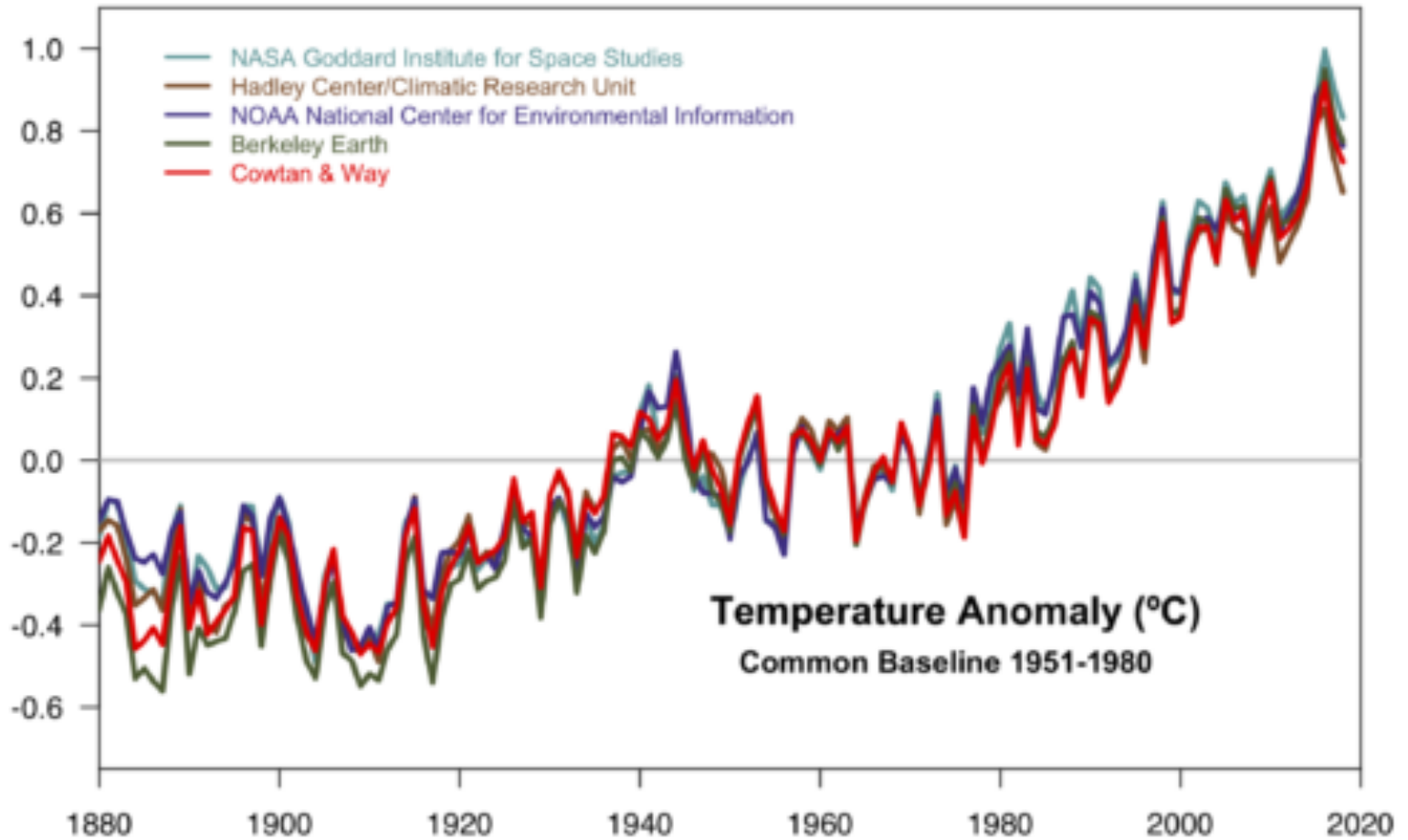


Movie – data for global warming

- <https://twitter.com/RARohde/status/954018594848993280>



Data sources agree



Climate Models and Data Agree

