Unsettling the Apple Cart: Koonin on Climate

December 2021

Ross McKitrick

A series prepared for the Climate Discussion Nexus





About Us

The Climate Discussion Nexus is a crowd-funded organization formed in 2018 by a group of citizens concerned about expensive, ill-planned energy policies intended to reduce carbon dioxide emissions. Our writings and videos are available online at <u>climatediscussionnexus.com</u>. We encourage you to sign-up for our weekly email newsletter and follow us on social media including YouTube, Facebook, Twitter and Rumble.

In this series University of Guelph professor Ross McKitrick offers his commentary on *Unsettled: What Climate Science Tells Us, What it Doesn't, and Why it Matters* by Steven E. Koonin, physicist and former Obama Administration official

Part I: What we know about warming.

Koonin responds early on (p. 14) to the inevitable charge that he's not a "climate scientist" by pointing out, correctly, that no one is. Climate involves countless specialized processes including physics, chemistry, geology, meteorology, computer science, statistics and more. No one can claim to have mastered them all. At best people can master two or maybe three components of the topic. In my experience very few people in climate science have advanced training in statistics and don't realize common errors in their methods. Koonin is an expert in computational physics and energy systems—two very relevant disciplines. In 2013 he was asked to lead a committee preparing a statement on climate change for the American Physical Society, and he came away from the experience unsettled, so to speak, about the many deficiencies of the science which neither he nor the general public had been told about. He wrote a lengthy essay for the *Wall Street Journal* about the experience, which drew angry responses from some colleagues for giving "ammunition to the deniers." To his credit Koonin didn't back away, instead he dug in for a fight.

Koonin draws a distinction between scientists wanting to inform versus those wanting to persuade. He sees a lot of the latter in the climate field, who state openly that they want to motivate action, which raises doubts about their objectivity.

In the early chapters one thing that stands out to me is how much of the mainstream science he accepts without challenge. Under the theme of "What we know about warming" he fully accepts the standard view of the warming effect of carbon dioxide and other greenhouse gases, he accepts the standard data showing warming since the 1800s, he takes the hockey stick paleoclimate picture pretty much at face value and he believes carbon dioxide emissions will continue to warm the planet in the future. Then he surprises the reader by arguing that these are not problems. He explains the (again, standard) calculations showing that a further doubling of carbon dioxide levels above the present level would have only minimal

effects on the greenhouse blanket, which he likens to adding a second layer of black paint to a window: the first one made all the difference whereas the second one is redundant. Doubling carbon dioxide in the atmosphere would only increase the greenhouse warming effect by about 1 percent, and the effect on temperatures is likewise very modest. The insiders know this, but the message gets heavily distorted en route to the public.

Koonin does mention problems with the surface thermometer record (such as urbanization-induced warming biases and lack of data from the oceans). And he is very aware of the problems of using computer models to predict the future. But his approach in the opening chapters is to say, in effect, I don't need to poke holes in the main features of the science (though I could if asked to). If I simply take what the climate experts say at face value and write out the numbers carefully, they add up to something very small. With so much chatter about the climate crisis and the coming catastrophe (which Koonin would have heard while working as a senior energy official in the Obama administration), working through the details caused him to realize how big the gap is between the scientific reality and what the public is being told. A lot fell into place, including his realization that we are making disastrous policy errors based on a very distorted picture of climate science. To which I add my complete agreement and gratitude that he has been willing to join the battle. That makes this book immensely important.

> working through the details caused [Koonin] to realize how big the gap is between the scientific reality and what the public is being told.

Part II: Muddled Models

Being a physicist, Koonin notes the strange fact that there are about 40 major computer climate models in the world and they vary quite a bit in the results they produce. Why "being a physicist"? Because it means climate models aren't "just physics" as some defenders claim. If they were we would only need one since all the models would come to the same conclusion. And the models don't just disagree about future warming. They even disagree about the current average temperature, with the range spanning about 3°C. That's three times the observed warming of the 20th century that the models purport to be able to explain. Which doesn't add up. And as Koonin dug further into the IPCC reports and the underlying literature he found the problems quickly mounted.

Koonin first studied climate models almost 30 years ago as part of a team advising the U.S. government on the prospects for high-powered scientific computers to advance climate prediction. He describes the way the models organize the physical layout of the atmosphere and oceans and the resulting proliferation of processes that need to be explained. The first problem is that many key phenomena, such as cloud formation, involve processes that are simply unknown. So modelers have to make educated guesses about what goes on. The next problem is that many processes are known but take place on too small a scale for models to be able to compute them all in a reasonable amount of time. So again, modelers resort to approximations. Then a further problem arises that to initialize the model requires detailed information about the history of the oceans and atmosphere and such data simply don't exist. So... approximations again.

All the shortcuts would not be a problem if in the end they could accurately predict the climate. But here we run into another big issue. The models on average do poorly at reproducing the 20th century warming pattern, even though modelers can look at the answer and tune the models to try and reproduce it. They don't warm enough from 1910 to 1940 and they warm too much after 1980. Both errors point to the likelihood that they depend too much on sensitivity to carbon dioxide and don't account for long-term natural variations.

Koonin sticks the blade in even further by showing evidence that the most recent generation of climate models (called CMIP6) are even more spread out in their predictions, and do even worse at reproducing the past, than did the last generation of models. This is the opposite of what you'd expect in science. But it is consistent with what would happen if modelers are trying too hard to build in a predetermined answer.

If this claim is true, some readers might object, then scientists would know about it and we'd hear about it. But a repeated theme in Koonin's book is

the contrast between what the insiders know and discuss among themselves, versus what gets told to the public. Koonin gives an example of a recent report from the US National Academy of Sciences on "geoengineering" – which refers to modifying the reflectivity ("albedo") of the planet's surface to cool the atmosphere. The National Academy cautioned that the state of climate modeling and the uncertainties around albedo cooling make it impossible to provide reliable assessments of the risks and consequences of geoengineering. But, as Koonin points out, the exact same limitations apply to climate modeling of the effects of greenhouse gases, for all the same reasons, yet we are never told that by official science organizations. Instead scientists and journalists alike repeatedly present model simulations as if they are reliable forecasts of the future.

Part III: Koonin on Hyping Heat

The middle chapters of *Unsettled* cut through the rhetoric around extreme weather like a tornado. It is one of the most important topics for someone like Koonin to tackle since he links important scientific information about trends in weather hazards with the glaring dysfunction of the mechanisms by which the public get informed about them. In his tour of the deceptions around climate extremes Koonin presents a series of case studies in which the media and political rhetoric is shown to be a distortion of government assessment reports, which are in turn shown to be distortions of the underlying data and research. In chapter 5 he begins by showing how evidence that the US climate has become less extreme over the past century was manipulated to support headlines claiming the opposite. The data were grossly manipulated in a misleading way, and the scientific institutions (including the National Academy of Sciences) whose job it is to stop it from happening stood silently by.

Chapter 6 opens with some insightful comments about "attribution studies" in which experts rush to the microphones after a damaging storm and claim their models show it was caused at least in part by greenhouse gases. "I'm appalled that such studies are given credence," Koonin objects. "It's like a spiritual adviser who claims her influence helped you win the lottery – after you've already won it."

Koonin then begins his dive into the data with a discussion of a famous graph in the 2017 US Climate Science Special Report (part of the National Climate Assessment) that appears to show a dramatic increase in the rate of weather extremes in the US from the 1930s to the present. A glance at the figure appears to show an accelerating increase in record high temperatures. But later in the report another graph appears showing annual maximum temperatures in the US have declined considerably since the 1930s. How could both be correct?

Koonin enlisted University of Alabama meteorologist John Christy to get the underlying data and help figure out what was going on. Christy produced a chart showing that the



...another graph appears showing annual maximum temperatures in the US have declined considerably since the 1930s





incidence of record highs per year (defined as the number of US locations in each year that recorded their maximum value over the entire sample from 1895 to 2016) peaked in the 1930s then fell and thereafter had no trend over the 120 year span. But the number of locations showing a record cold temperature had declining steadily. The two together implied that the US climate was becoming less extreme.

The National Assessment graph was constructed in a different way, first by using a different definition of extremes and second by reporting the ratio (rather than the numbers) in each year of hot versus cold extremes. That last step was key. It meant that even though both hot and cold extremes were going down, since the cold extremes were going down faster, the ratio would appear to be rising. "[There] is no arguing that it is shockingly misleading" said Koonin, describing the effect of the graph.

Multiple US government agencies were involved during the report-writing phase, and many agencies had a chance to object to the deception. The National Academy of Science reviewers offered a mild and diplomatically worded protest of the overall presentation of data on extreme temperatures, but evidently did not follow up because the report got worse, not better, after the completion of expert review.

The graph in question was quickly seized upon by multiple news agencies who made it one of their key headlines. And none of the report-writing officials who knew better spoke up to correct the record. Thus the massive apparatus of government science agencies and the media bigwigs who preen constantly over their supposed commitment to the truth combined forces to mislead the public into believing that a climate system becoming less extreme over time was instead becoming more extreme and dangerous.

What else have they misled everyone on? Koonin is just getting started.

Part IV: Koonin on Tempest Terrors

Everybody's heard that storms and hurricanes are becoming more common and more severe, and greenhouse gases are going to make it all worse. But what everybody doesn't hear is those claims are groundless. And at the heart of the problem are the various official "assessment reports", which Koonin says present a summary "spin" inconsistent with their own findings, and of the underlying research. In chapter 6 of *Unsettled*, "Tempest Terrors", Koonin begins with a scary headline claim about Atlantic hurricanes in the 2014 US National Climate Assessment, which was coupled with a scary chart showing them trending upward after 1980. Then he shows the text of the report stated the opposite, as did the paper on which the claims were allegedly based. So what is actually scary here is the extent to which government agencies are willing to misrepresent things.

The 2014 National Climate Assessment showed a graph with a strong upward trend in hurricane strength beginning in 1980. But the underlying paper, Koonin discovered when he checked into it, said "there are *no* significant trends beyond natural variability in hurricane frequency, intensity, rainfall or storm surge flooding" (emphasis in original). So he went back to the government report and kept reading. Notwithstanding the fact that the headline message in the summary was that storms were getting more severe and numerous, buried in a back appendix was this statement:

There has been no significant trend in the global number of tropical cyclones nor has any trend been identified in the number of US landfalling hurricanes.

So which is it? It turns out the message in the back pages was the one supported by the science, including previous IPCC reports and published scientific papers, while the summary message was a falsehood.

The next National Climate Assessment, in 2017, did exactly the same thing. It put a weasley statement in the summary that insinuated human activities were causing more and more



hurricanes. But in the detailed sections deep in the report it admitted they were not confident there even were any upward trends. And the National Academy of Science panel that reviewed the section, instead of calling them out, suggested they focus attention on the short section of the data with an upward trend.

It is not just government science bodies that mislead. Koonin discusses another study that looked at satellite data and found a slight upward trend in hurricanes in the North Atlantic, which also said the causes were not understood and could be due to natural variability. But when *USA Today* reported on the story they waived away the caution and declared "Human-caused global warming has strengthened the wind speeds of hurricanes, typhoons and cyclones around the globe."

Having established the plainly dishonest nature of hurricane reporting, Koonin goes on to look at US tornado activity. Tornadoes are mysterious creatures, and while it is known that they are spawned by thunderstorms, it is not clear why it happens at some times and not at others. Which obviously means they can't be predicted far in advance which in turn means it's not possible to predict whether warming will cause more of them or not. And indeed the IPCC has avoided making such projections, largely because they recognize their models don't simulate them with any accuracy. But as Koonin shows that doesn't stop the press from running regular stories insinuating that greenhouse gases will make tornadoes worse.

There are some areas of climate science where we should give the experts the benefit of the doubt since they are dealing with complex, difficult subjects. But Koonin's chapter shows that, on the issue of storms, hurricanes and tornadoes, the scientists and journalists who prepare the high-profile reports and splashy news articles don't deserve the benefit of the doubt. They are untrustworthy, and they have misled us so often we can no longer take anything they say at face value.



There has been no significant trend in the global number of tropical cyclones nor has any trend been identified in the number of US landfalling hurricanes.



Part V: Koonin on Precipitation Perils

Theoretical physicist Steven Koonin moved with his wife to Chevy Chase, Maryland in May 2009 to join the Obama Administration as Under Secretary for Science in the Department of Energy. Seven months later the snowiest winter ever recorded hit the Capital area, including a storm dubbed "Snowmageddon". But in Chapter 7 of his book *Unsettled*, "Precipitation Perils – From Floods to Fires" Koonin resists the temptation to treat the event as proof (or disproof) of anything related to climate, and instead presents a graph of Washington DC snowfall totals from 1889 to 2018, within which it becomes clear that 2009 was an outlier against the context of a long, slow decline in average snowfall in the Washington area. When talking about precipitation, it takes a lot of data to establish the context, and that gives plenty of openings for the cherry-pickers to engage in trickery.

The declining trend in DC snowfall leads Koonin into the larger topic of precipitation trends, and specifically questions related to trends in snowfall, rainfall, droughts, flooding and wildfires. Here Koonin makes a radical departure from just about every other public commentator on the subject when he says (p. 130) "We'll turn to the data to answer those questions." And that approach makes it inevitable that this chapter would skewer yet another batch of alarmist slogans. Anyone who works with precipitation data (as I have done) knows it is extremely variable and trends in one location may run counter to those in nearby locations. And while one can easily cherry-pick data to tell a story, long term big-picture conclusions are extremely elusive.

Koonin begins his survey by explaining the physical basis of climate modelers' view that global warming will intensify precipitation. But he then shows long term (115 year) graphs of global and US precipitation rates, which show minor net increases but with very large natural variability and extended periods with trend reversals. The view that there is no

The view that there is no detectable trend [in precipitaton rates] is supported by published literature and past IPCC reports detectable trend is supported by published literature and past IPCC reports, both of which Koonin quotes.

He also shows data indicating that an increase in heavy precipitation events was observed in the US from 1910 to 2015. But he notes the changes are uneven across regions (and John Christy and <u>I have shown</u> that the apparent trends disappear using longer datasets where available.) Koonin further observes that the IPCC draws only a tepid conclusion regarding whether such increases are observable globally. As for average Northern Hemisphere snow cover, season-specific data show reductions in Spring and Summer since the 1960s, but increases in Winter, with no annual trend after the late 1980s despite the observed warming. Yet, as Koonin notes, the most recent US National Assessment states as one of its key findings, with no explanation or accompanying pesky data, that Northern Hemisphere snow cover snow cover metrics "have all declined."

Turning to floods and droughts, Koonin again finds that the recurring pattern is the absence of a pattern. US data on flooding indicates a wide variety of changes over time, as does global data, which leads the IPCC to have only "low confidence" even in the sign (positive or negative) of the trend globally. Likewise with droughts: Despite the repeated use of local drought events as journalistic "proof" of climate change, both US and global data show much variability but no long-term trend. If anything, droughts in the 20th century appear to have been shorter and milder than those in past centuries. Yet - as Koonin notes and his readers by now will have anticipated this information is "entirely absent" (p. 141) from the 2014 US National Climate Assessment. The 2017 report contained a brief mention of the evidence of the past millennium, but then devoted twice as much space to discussing the California drought then ongoing.

It is ironic that one of the false charges leveled against Koonin is that he doesn't understand the difference between weather and climate. Of course he does, and carefully distinguishes the two throughout his analysis driven by, of all things, data. That charge should instead be leveled against the National Assessment authors, who ignored millennial-scale evidence in favor of a highlighting short-term local drought event (which

reversed to wet conditions shortly after the report was published).

After also reviewing the evidence on wildfires (spoiler alert: they're declining globally) Koonin ends his chapter by examining a 2015 speech by former Central Banker and now full-time UN climate guru Mark Carney, in which the latter grabbed hold of a 2014 forecast by the UK Met Office and used it as a basis to warn his audience that UK winter rainfall would go up by 10 percent over the next 5 years. The data show that it instead fell by almost 40 percent over the forecast interval. Carney, of course, learned nothing from this episode. But Koonin's readers will by this point have learned that science bureaucracies, and their cheerleaders like Carney, are not to be trusted.

Part VI: Koonin on apocalypses that ain't

In chapters 8 and 9 of *Unsettled* Koonin tackles four topics where the dominant narrative is catastrophe but the reality is anything but. Which, of course, rather neatly describes the entire book up to this point. But Koonin's wrecking ball keeps swinging and finding new targets, from sea levels to heat-driven mortality to crop yields to warming and growth. And on all of them, it's amazing how far the conventional wisdom is from the facts.

Including on Chapter 8's topic of sea levels. After reviewing some geological-scale evidence of sea level variability (which shows, among other things, that they rose rapidly after the end of the last glaciation then began dramatically slowing about 7,000 years ago) he looks at the 20th century evidence. And here the choice of time scale matters. Over the past 120 years sea levels rose by about 2 mm per year on average. And over the past 20 years or so, they have risen by about 3 mm per year, which on its own suggests they are accelerating. But you can't compare a 120-year trend to a 20-year trend because there were also 20-year periods prior to 1950 when sea levels rose by 3 mm or more per year, before slowing down again from 1950 to the 1980s. On 20year time scales the picture therefore is a variable rate of change, which makes it hard to pin the current rate of sea level rise on greenhouse gases.

Such findings are unwelcome nowadays, to put it mildly. Koonin recounts how, when he explained these things in a newspaper op-ed in 2014 a climate scientist accused him of cherry-picking. But that scientist's argument was based on comparing the most recent 20-year interval to a 67-year interval early in the 20th century – precisely the sort of invalid comparison of apples and cherries Koonin had counseled against.

Somewhat more remarkable was the response of two scientists working on the draft Fourth National Climate Assessment, which made the usual claim about sea level rise accelerating. Koonin sent that same data and analysis to the Report Lead Author and to the Lead Author for the chapter on sea level rise. Both thanked him and admitted that no one had pointed it out. The sea level expert in particular admitted that, had anyone mentioned it they'd probably have discussed it in the report. Alas, they said, the draft is too far along to change, so they declined to make any revisions. Again, verdict first, trial afterwards, with unseemly evidence excluded. The dominant narrative includes that sea levels are rising faster and faster and will continue to do so, along with other disasters. So after showing why even the lowest IPCC sea level rise projections for lower Manhattan would require a dramatic increase from current and historical trends, Koonin moves on in the next chapter to three climate hot button topics: heat-related mortality, crop yields and the effect of warming on economic growth. Each time the pattern is identical. A scientist (or economist) puts out a climate forecast with a range of potentially negative implications and highlights the worst-case scenario, which the media then amplifies into even worse-sounding terms and treats as the most probable outcome. Then someone steps up and explains that the projection runs strongly counter to historical trends with no explanation why they will change, or that the climate-related harm is a trivial offset against a much larger trend of ongoing improvements, or both, and gets called names for doing so.

In the case of one lurid projection of rising climate-related mortality, Koonin shows that the author, economist Michael Greenstone of the University of Chicago, had testified before Congress that climate change would dramatically increase death due to hot weather, without mentioning, first, that his study admitted such large uncertainties that it could not confidently project any increase at all, and second that the only case where a large increase loomed was based on the bogus <u>RCP8.5 scenario</u>, while more realistic scenarios showed a large probability of climate-related mortality declining. Just as news coverage of other "studies" showing climate change would cause global crop yields to fall did not mention that it was, at worst, a slight slowing down of the ongoing upward-march in global per capita food production.

Koonin then recounts how he was invited to speak to a large investment organization on climate science and economic impacts. I can only imagine that such an audience, after a steady diet of lunacy from the Mark Carneys and Larry Finks of the world, would have found Koonin baffling when he showed them data from the IPCC's own report on economic impacts which concluded that climate change would only result in a small diminishing of global economic growth, and only if warming was rather large compared to past trends. In effect it would mean that the US economy would take 72 years to quadruple in size instead of 70 years, not exactly the apocalypse. More like within the margin of measurement error.

It is in this context that Koonin relates one of the most remarkable, yet unsurprising, quotes from his various travels in government.

Economists and policy analysts widely agree that, no matter how you crunch the numbers, and even with the most pessimistic assumptions, climate change is expected to have only small effects over the coming century, most of which will be ameliorated by ensuring poor countries develop and grow rich. Koonin was discussing this consensus with someone he describes as a "prominent environmental policymaker" who responded "Yes, it's unfortunate that the impact numbers are so small."

Read that line again.

A life spent in the vast elite climate bureaucracy, or dreams of forcing through a dramatic social and economic transformation with climate change as the lever, has so warped this person's thinking that he or she actively wishes for more harm and even catastrophe to befall the world and is sad that it's not going to happen.

These are the psychopaths who want to rule the global economy and micromanage our lives. How did they get to be in charge both of the science and the policy process? And how can this situation be remedied? To these momentous questions Koonin turns next.

Next week: Who broke the science and why.

Economists and policy analysts widely agree that, no matter how you crunch the numbers, and even with the most pessimistic assumptions, **climate change is expected to have only small effects over the coming century**, most of which will be ameliorated by ensuring poor countries develop and grow rich.

Part VII: Koonin on who broke the system

Steven Koonin spent years as an insider in government and academic circles where the climate crisis was taken as gospel. He began entertaining doubts after participating in a 2014 American Physical Society workshop on climate science where critics of the consensus were given time to present some arguments, which led him to check more of the basic data and scientific literature for himself. And that examination eventually led him to the realization not just that the science was off but that the scientific institutions we rely on to inform us about climate change have lost their objectivity. Including the Intergovernmental Panel on Climate Change, the US National Climate Assessment and even the US National Academy of Science. He remarks bluntly (p. 189) "when it comes to climate, those institutions frequently seem more concerned with making the science fit a narrative than with ensuring the narrative fits the science." And in the early chapters of Unsettled he documents examples where they were caught "summarizing or describing data in ways that are actively misleading." This problem is a big one, and with everything that's now at stake, we have to find ways to fix it.

"When it comes to climate, those institutions [the Intergovernmental Panel on Climate Change, the US National Climate Assessment and even the US National Academy of Science] frequently seem more concerned with making the science fit a narrative than with ensuring the narrative fits the science."

Of course when it comes to accounting for the hysteria around climate there is a lot of blame to go around. Koonin discusses the role of the media, activists and politicians who are caught up in self-serving promotion of narratives (usually alarmist and catastrophist) for either monetary or political reasons. But we hardly expect any better of them.

There might have been a time in the past when people expected the news media to be balanced and objective. Or maybe not: since 1956 the *New York Times* has made a big show of weighing presidential candidates carefully then endorses the Democrat every time. But if it were ever so, those days are long gone and the problem is getting worse not better.

It doesn't help that, as many others have noted, the internet has forced news organizations to attract internet traffic to stay afloat, and the best way to do that is to become click-driven peddlers of sensationalism. Climate exaggeration fills that need. And people have adjusted their expectations of the media downward to match the collapse of journalistic standards. But we do expect better of the major scientific institutions.

We also expect better of scientists themselves, and Koonin doesn't spare them. He says that many scientists not involved with climate research fall prey to a phenomenon he calls "climate simple." The concept is borrowed from Dashiell Hammett's 1929 novel *Red Harvest* in which he describes characters who get so deranged by extended participation in violence that they become "blood simple," meaning prolonged stress renders them less intelligent. And "climate simple", Koonin explains, occurs when "otherwise rigorous and analytical scientists abandon their critical faculties when discussing climate and energy issues." The image is brilliant, and sadly accurate.

What then can be done? Koonin offers in Chapter 11 a proposal drawn from military planning and complex engineering projects: a Red Team. In a Red Team exercise, a group of experts is asked rigorously to question and pull apart someone else's draft project, such as an expert report. As an Obama Administration insider, Koonin spent several years pushing for a Red Team review of the 4th US National Climate Assessment. And ironically he eventually got a hearing for his proposal during the Trump Administration. But in addition to opposition from some within the Administration itself it faced furious opposition from the Democrats, who even put forward a bill in the Senate to forbid any funding for projects that "challenge the consensus on climate change" which as Koonin points out amounted to a shocking attempt to enforce a political orthodoxy on climate research.

It was also opposed by many people in the media and even from prominent scientists. Koonin explains that many of them are under the illusion that the existing report review processes are sufficiently adversarial and that no further challenge is required. But as Koonin explains (as have others,

including <u>me</u>) the review process for IPCC and National Assessment reports are nothing like a Red Team. While the report drafts are subject to review, authors are free to ignore critical comments and to leave adverse data out of their writeup. If a one-sided author team is selected the review process won't force them to be balanced.

In the end the Red Team idea was never approved. Koonin still believes it is needed, but I think it is 20 years too late for any government to pull it off. Even if a government came to support the idea, the research funding environment has been so warped for so long, and the alarmist narrative has been so dominant within academia, that it is hard to imagine finding a group willing and able to take on the job. No matter how good the Red Team report might turn out to be, the stigma attached to helping that side of the issue would scare away many potential participants. And there would still be the question of how a detailed Red Team report could cut through the noise and get communicated to the public.

Readers will probably be disappointed that there is no simple solution to a deep cultural problem that has overtaken large segments of the scientific community. Eventually, perhaps decades in the future, scientific truth will prevail. Especially as members of the public learn to dig into the data for themselves and not to place uncritical faith in what they are told "the science" says, even when the message is coming from scientific institutions we were once able to trust.

In the meantime, another kind of truth is going to prevail, but on a much shorter time scale: the truth concerning policy options.

Part VIII: Koonin on the chimera of carbon-free

A big challenge of climate policy is that it is the stock, or total amount, of carbon dioxide in the atmosphere, and hence the concentration, that affects the climate. But all we can control is the flow, or annual emissions. And because the stock is so large compared to the flow, the concentration changes very little, and only very slowly, in response even to large changes in emissions. Now add the fact that carbon dioxide emissions are more closely tied to economic prosperity than any other type of air emissions, which means it is very difficult to cut global emissions even by a small amount, and you begin to grasp why global climate policy is, and will continue to be, a costly failure. In chapter 12 of *Unsettled* Koonin recounts the process by which he came to understand this reality, and his realization that both when he worked at BP Energy and later for the Obama administration, if he said it out loud he'd probably have been fired. The numbers are undisputable, and the conclusions don't depend on one's assumptions about how carbon dioxide affects the climate. Global CO2 emissions have been rising for decades, despite efforts to cut emissions that started in earnest in the 1990s. To stop the global concentration of CO2 from rising further would require global emissions to fall by more than half. Some developed countries (such as the US) have at least temporarily stabilized their emissions, largely by switching from coal to gas for electricity generation, but they haven't actually cut them. CO2 emissions are unavoidably tied to fossil fuel use, and economic activity depends on energy. There are 5 times as many people in the developing world as in the developed world, and they want more energy. If India attains even the lowest per capita fossil fuel usage levels currently enjoyed by developed countries, global CO2 emissions will rise by 25 percent. Realistic outlooks for global energy use through the 21st century indicate that fossil fuels will still dominate the world energy supply. The Paris Treaty, if fully implemented, would barely change the global CO2 concentration by 2100, and by implication, would have almost no climatic effect. And yet countries are not on track even to do that much.

Partial measures won't cut it, either. As Koonin notes, if developed countries impose draconian emission reduction policies, the carbon-intensive manufacturing activities will simply move elsewhere. Indeed this has already been happening, so some of the emission "reductions" in places like the US and Canada should more properly be seen as simply relocations, especially to China. Despite the current fondness for promising "Net Zero" by 2050, under current technology it simply isn't going to happen. We can learn to adapt to whatever changes come to the climate, but we aren't going to stop them.

Digging further into the topic, in Chapter 13 Koonin looks more closely at the US. What would it take for the US to become carbon neutral? Electricity and transportation infrastructure cannot simply be rebuilt overnight to accommodate a new technology. They change slowly for the same reason the atmospheric CO2 concentration changes slowly: the stock of equipment and technology is large compared to the flow. Koonin points out that the repeated call for a "Manhattan Project" approach to climate change is inapt. The Manhattan Project

didn't aim to transform a large system already embedded in society, it aimed to build a single new gadget for a single client. It also got to work in secret with an effectively unlimited budget: it didn't have to run its spending plans by the taxpayers each election.

Policy, technology, demographic and economic forces all mean that global CO2 emissions are going to keep rising. The Paris Treaty, with its strange and ambiguous goal of keeping warming to under 2°C (an arbitrary number which Koonin shows is not supported by economics, even if we had such precise control over the climate to make it operational) cannot circumvent the challenges that make it almost certain to fail. Meanwhile, as Koonin notes, we see politicians outbidding each other by proposing ever more ambitious targets 15 or 30 years down the road, long after they will be out of office. Perhaps they too realize that the alternative is to tell the truth, and get fired.

Part IX : Koonin on Plan(s) B

In the closing chapter of *Unsettled* Koonin writes "I began by believing that we were in a race to save the planet from catastrophe. Since then I've evolved to become a public critic of how The Science of climate science is presented." As a one-time believer in the catastrophe, but also someone who understood that global carbon dioxide emissions were not going to be reduced in the way many politicians and activists wanted, Koonin spent a lot of time looking at the alternatives, namely geoengineering and adaptation. And as always, he found rigid orthodoxies were getting in the way of serious and open debate. But reality has a way of biting back.

Geoengineering options generally revolve around tinkering with the reflectivity of the Earth's surface (such as by painting roofs white) so as to reflect more sunlight away and cool the planet, or by injecting aerosols into the stratosphere so as to shade the surface. The first is probably too expensive and ineffective to make a difference. The second could, apparently, be done using artillery shells that spread hydrogen sulfide at very high altitudes. And it's cheap enough that a single government could take it on, or even a wealthy individual. But there are many questions about who should do it, and where, and what the effects would be. Also the effects would probably only be temporary so if whoever was doing it got tired of it, the effects would soon wear off.

Another geoengineering option is to build a machine that sucks carbon dioxide out of the air. Actually we already have lots of them—they're called trees; but there aren't enough of them to counter the CO2 emissions each year. But suppose someone came up with a machine that could do even more than all the world's trees? The problem then would be what to do with all the CO2. There are very limited options for pumping it underground (so-called Carbon Capture and Storage) or deep under the ocean, and it is too expensive simply to store it in tanks.

Still, maybe with more research a geoengineering strategy might be found which could be kept in reserve as a last-minute option in the unlikely event warming became a crisis. Alas, this is where the politics gets in the way: in polite circles one does not discuss anything but greenhouse gas mitigation. The last thing politicians and activists want is an inexpensive, effective strategy that neutralizes the effects of carbon dioxide and lets the world carry on using fossil fuels. How would they convince the world to embrace the Net Zero agenda and all the policy apparatus that goes with it, if for a modest cost the whole problem could be made to go away?

In suggesting this reasoning determined the response to his queries I am extrapolating from comments in Koonin's chapter. But the hints are there. Climate policy is not about finding the least-cost and most effective solutions to the supposed problem. It is about the energy transition crusade and social engineering aimed at eliminating fossil fuel use. Yet, for all the reasons discussed before, it is simply unlikely to happen, nor should it.

Which brings the discussion finally around to the simplest, most effective, and least costly response of all: adaptation. Koonin describes his years living in Pasadena California when he taught at CalTech, where he and everyone else lived with the reality of constant earthquakes, mostly small but occasionally large. What did they do? They adapted, by hardening their built infrastructure and maintaining a constant readiness in case of a large earthquake emergency. Humans have always adapted to whatever natural hazards they were faced with. And they always will, instinctively and automatically, including to whatever the climate brings over the coming century. The adaptation will be local, proportional and more effective at reducing risk than anything activists have been pushing.

That consideration brings Koonin to his final thoughts, describing his intellectual odyssey on this massive topic, and his learned judgments regarding what is really going on. Our scientific institutions have failed us with regards to communicating climate science, and too many individual scientists have been silent as it happened. Koonin has done what he can to tip the scales back towards sanity, and he bravely battles on against his many detractors. We can only respond with gratitude, and a wish that there were a thousand more like him.

That concludes the series. Now please read the book.