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Framing an ethics of climate management for the anthropocene

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Abstract In addition to carbon dioxide, it is becoming increasingly clear that there are numerous other potent agents of anthropogenic forcing (e.g. methane, ozone, black carbon) at work in the climate system today. The typical ethical framing of climate change has not yet accommodated this complexity. In addition, geoengineering has often been presented as a Plan B that would simply counter unintentional (and positive) anthropogenic forcing with intentional (and negative) anthropogenic forcing. This paper attempts to better address the complexity by outlining an ethical framework for reducing all anthropogenic forcing, a position it labels the 'climate imperative.' The paper considers geoengineering alongside various other anthropogenic forcing activities and discusses what the climate imperative would say about each of them. On this analysis, GHG and black carbon reductions remain a priority. At the same time, the framing reveals a significant ethical difference between geoengineering through solar radiation management and through carbon dioxide removal.

The release of the Intergovernmental Panel on Climate Change's Fifth Assessment Report in 2013/14 may mark the moment when geoengineering establishes itself securely on the international policy agenda. One way climate engineering has been presented is as a "Plan B" that may be required if "Plan A" (i.e. emissions reduction) happens too slowly (Royal 2009a, b, v, Scott 2012). There are numerous problems with this framing. One is that it risks presenting climate engineering as an *alternative* to emissions reduction, as if geoengineering could entirely obviate the need to reduce greenhouse gas emissions. A second is that it lumps all types of geoengineering in the same category, even though there are profound differences between what the various technologies are designed to do. A third is that the A-B framing

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paints a misleading and restrictive picture of the climate situation humanity faces. It dichotomizes a situation which in reality is much more complicated.[1] There needs to be a better way to frame the challenge of transitioning to a safer climate, one that more accurately reflects the complexity of what is actually going on.

For a better framing, it helps to be guided by scientific terminology. Atmospheric scientists talk about the warming problem in terms of *anthropogenic forcing*. This number (measured in watts per square meter) represents the "net" change in solar irradiance caused by human activities. This may also be a helpful frame for ethicists to think about the climate problem. In addition to considering the need to reduce "net" anthropogenic forcing, here we introduce the idea of reducing "gross anthropogenic forcing," the total amount of forcing (both positive and negative) caused by human activities. Conceptualizing the climate problem in terms of the need to reduce both "gross" and "net" anthropogenic forcing turns out to avoid the A-B framing problems mentioned above and offers more cogent, if still challenging, recommendations for policy. To explore some of the advantages of considering the ethics of climate management in these terms, an illuminating news story helps point the way.

1 A tangled tale of forcings

A recent article in *Global Biogeochemical Cycles* reported that the smokestacks of oceangoing vessels are depositing much more soluble iron on the ocean surface than previously thought (Ito 2013). A study by Akinori Ito of the Japan Agency for Marine-Earth Science and Technology found that, contrary to previous rough estimates of 1–2 % solubility, nearly 80 % of the iron by-product of burning marine bunker fuel can be water soluble. Ito's models indicate that up to 40 % of soluble iron in high-latitude North Atlantic and North Pacific oceans may now come from combustion in marine vessel engines. Due to predicted growth in marine traffic this could rise to 60 % by 2100.

Soluble iron is an essential nutrient for phytoplankton growth. This means that these deposits may be leading to enhanced phytoplankton populations in regions often deficient in the nutrients required for marine life. The *New Scientist* accordingly reported Ito's results under the banner "Ships Inadvertently Fertilise the Oceans" (Hecht 2013) noting that ocean going vessels may be sowing up to 1000 tonnes of soluble iron in the oceans per year in an unintended plankton fertilization experiment.

The exact size of the impact of marine fuel combustion on plankton growth is not important for current purposes. What is important is that ocean fertilization is one of the methods proposed by climate engineers for the removal of carbon dioxide (CDR) from the atmosphere (Royal 2009a, b). Ito's study shows that ships might already be unwittingly engaging in this form of climate modification. If so then marine traffic has at least three distinct types of climate impact. First, it contributes to global warming through the emission of carbon dioxide. Second, it deposits soluble iron in the ocean that sequesters carbon (through uptake by plankton) in the ocean depths. Third, particulates in the emissions facilitate cloud formation in the troposphere, reflecting back solar energy that would otherwise be absorbed by the ocean (Eyring et al. 2010). Ocean-going vessels therefore engage in at least three types of anthropogenic forcing, all unintentional, but all now scientifically documented.[2]

While the example of the ocean-going ships is striking, it is likely that it is not particularly unusual. Numerous human activities contribute both positively and negatively to radiative

[1] Additional framing challenges are discussed by Gardiner (2010) and Scott (2012)

[2] A fourth potentially significant forcing effect comes from the emission of black carbon particles from engine exhaust.

forcing through unintended – if not always unknown – side-effects. Examples include the masking effects of emissions from coal fired power plants, the albedo impacts of black carbon from hydrocarbon burning, the albedo properties of particulates generated by farming, the non-CO_2 greenhouse gas emissions from coal/oil/gas production, the off-gassing of GHGs from municipal waste facilities, the particulate emissions from cook stoves and brick kilns, the escape of ozone-safe (but climate-dangerous) refrigerants, the effects of dark surfaces across urban areas, the list goes on. This partial list illustrates how human activities are implicated in climate in a much more complex and tangled fashion than today's discussion of climate change – and potential responses through geoengineering – often suggests. The idea that an analysis of the climate problem should pitch GHGs (*unintentional positive forcing*) on the one hand against geoengineering (*intentional negative forcing*) on the other is a gross oversimplification. Human activities create multiple forcings, mostly unintentional, going in both directions. Reducing the dangers of global warming through some version of "climate management" is likely to involve many more considerations – and perhaps many more options – than often thought. What, then, is the ethically sound thing to do about all these anthropogenic forcings?

2 Climate forcing, environmental ethics, and the anthropocene

It has long been conceded, even by those who advocate for serious geoengineering research, that the whole idea of intentionally manipulating the climate creates unease. Ken Caldeira, for example, admitted "When I first seriously considered the idea of solar geoengineering about 15 years ago, I thought the idea was loony" (Caldeira 2013). David Keith, Edward Parson, and Granger Morgan have likewise observed "It is a healthy sign that a common first response to geoengineering is revulsion" (2010, 427). These sentiments display what might be termed a "presumptive argument" against climate manipulation, an argument that resonates strongly in much of the environmental community (Preston 2011).

The heart of the presumptive argument is that it is morally appropriate to restrain human interference with nature.[3] Though not a universally shared sentiment, many people don't want a thoroughly manipulated earth. As one of the first to apply this concern to climate change, Bill McKibben lamented how, in a warming world, "…each cubic yard of air, each square foot of soil, is stamped indelibly with our crude imprint, our X" (McKibben 1989, 96). The loss of independent nature, which he characterized as "the separate and wild province, the world apart from man to which he adapted and under whose rules he was born and died" (48), would be a cause for regret. McKibben's popular position struck a lasting chord.

The position finds philosophical support from numerous quarters. Dale Jamieson, for example, has articulated a "common sense" presumption that 'it is wrong to interfere dramatically with fundamental natural processes" (Jamieson 1996, 325). Paul Taylor claims a prima facie duty of "non-interference" (Taylor 1986). Holmes Rolston, III requests an attitude towards the earth of "gratitude, wonder, respect, and restraint" (Rolston 2012, 46). Either because they value historical ecological processes in themselves or because they think it prudent to stick close to the climate in which modern humans have evolved, these thinkers are all cautious about dramatic interference with earth systems. Whether justified philosophically by an account of natural historical value, a preference for nature over artifice, considerations of proper human virtue and character, or simply a fear about the possibility of harmful consequences, many environmental ethicists caution against grand manipulations of nature. This is a presumption shared by

[3] Fully defending this claim would require a lot of work in environmental ethics, work only hinted at here (see Preston 2011).

broad sections of the public (Mercer et al. 2011, NERC 2009, Corner, Parkhill, Pidgeon, and Vaughan 2013).[4] It is a presumption that also provides ethical guidance on anthropogenic forcing.

Before advancing, it is worth addressing two common replies leveled against the presumptive argument. One is to protest…."It's too late!" Nature is already thoroughly impacted by human activities. McKibben, after all, declared that the age of untouched nature had "ended." It is past time for wistfully romanticizing a former pristine era. A second reply challenges the wrongful separation of humans from nature implicitly assumed by McKibben and others. Manipulating nature is part of what organisms do, including humans. Each reply is consistent with the suggestion that we now live in the Anthropocene, a "post-natural" era in which humans can – and should – carefully and intentionally manipulate nature according to deliberately chosen principles (Marris 2011). A sequence of essays in Cole and Yung's collection, *Beyond Naturalness*, argues that the idea of a "natural" past we should strive to preserve is utterly unhelpful (2010). The new era of the Anthropocene demands that humans consciously take up a pro-active management mantle. Not for nothing did the same Nobel Prize-winning chemist responsible for first making the idea of geoengineering respectable also push the idea of the Anthropocene (Crutzen and Stoermer 2000, Crutzen 2006). Crutzen's seminal role in both discussions effectively tied the idea of climate engineering to the Anthropocene. It may be time to accept conscious human management of a "post-natural" climate.

What must be noted, however, is that even if we do live in a post-natural era, the past remains instructive. There is no need to embrace the illusion of a return to a pristine, prelapsarian age in order to find valuable guidance in earlier conditions. Arguably, the widely articulated goals of limiting atmospheric concentration of carbon dioxide to 450 (or even 350) parts per million or limiting temperature increases to 2 °C are themselves concessions to the fact that previous benchmarks provide helpful metrics. The UNFCCC's (1992) call to avoid "dangerous anthropogenic interference" suggests the current problem exists relative to a safer baseline drawn from the past. The whole idea that anthropogenic forcing is causing a worrying exit from the Holocene suggests that we still recognize the past as providing some guidance for the future.

It is also noteworthy that restoring an approximation of previous conditions is perhaps more plausible with climate than it is with heavily disturbed terrestrial landscapes. With large-scale terrestrial change, factors such as species extinction, habitat fragmentation, urbanization, and other entrenched material changes make some human impacts more or less irreversible. With climate, on the other hand, the goal is not to restore a particular physical state of land and biota but to recreate functionally similar atmospheric processes. Since these processes are physical, chemical, and thermodynamic, barriers to reversal are not as permanent as they are with landscape. While any attempt to recapture precisely the climate of some previous time would be futile, a world with climatic processes restored to an approximation of what existed before the dramatic changes that began in the 1850's might still be a reasonable goal.

If it is true that the past provides some useful guidance then questions about whether we have already experienced the "end of nature," become "post-natural," or "entered the Anthropocene" are secondary. It does not matter if you are a wistful romantic about the past or an eager agent of the anthropocene. In both cases, you have an interest in doing something about the "dangerous interference" caused by current anthropogenic forcing. Common and ethically defensible ground can be found on the goal of working to reduce – and certainly not

[4] Arguably it is also embedded in the UNFCCC's (1992) call to reduce "dangerous anthropogenic interference" with the climate system.

to increase –anthropogenic forcing. For the sake of a convenient label, call this goal of reducing anthropogenic forcing the "climate imperative." Since it refers to *all* anthropogenic forcing, the imperative dictated by the presumptive argument seeks a reduction both in net *and in gross* anthropogenic forcing. How this climate imperative might work in practice can start to be illuminated with another anecdote involving those sooty ships.

3 Reducing gross forcing

In 2008, the International Maritime Organization adopted a rule mandating reductions in the sulphur content of marine fuel from 4.5 to 0.5 % by 2020 and down to 0.1 % by 2020 in certain Emission Control Areas (ECA's) near human populations. The reductions were to reduce deaths from air pollution in port cities and their environs. It is estimated that cutting sulphur content could save up to 60,000 lives per year (Corbett et al. 2007). Unfortunately, an unintended side-effect of the regulation is to reduce the masking of solar radiation that combustion of sulphur-heavy fuel provides. This unintended masking by particulates and related cloud formation is substantial, with marine fuel comprising a large portion of the sulfates in parts of the atmosphere (e.g. 10–44 % off the California coast (Dominguez et al. 2008)). It is estimated that the reduction in masking that the IMO's regulation will cause is the equivalent to 10 years of warming through GHG emissions (Morton 2009, Lauer et al. 2009). The IMO, however, made its decision entirely on the basis of pulmonary health and without consideration of climate impacts. This one decision on pollution regulation is also (unintentionally) a major climate policy decision.

The case shows how the tangled tale of anthropogenic forcing makes climate management an extremely complex task. The masking provided by particulate emissions from hydrocarbon burning plays a significant role in keeping temperatures down (Mickley et al. 2012). Particulates from marine vessels, passenger aircraft, and coal-fired power plants all cool the climate at the same time as other aspects of these emissions warm it. As a result, some would argue that this is not the time to reduce masking. Some would even argue that masking should be increased. Studies have already been done on the efficacy of enhancing masking by dirtying the fuel in high-flying passenger aircraft (Laakso et al. 2012). In these discussions, the lines between intentional geoengineering and pollution management start to look increasingly blurry. Ethicists still might use the "doctrine of double effect" to draw a line between actions done expressly for one purpose (e.g. climate management) and actions done primarily for a different purpose (e.g. ocean transportation) albeit with known side-effects.[5] But with increasing awareness of how complex and interwoven climate forcing phenomena can be, is there a better way to keep the ethical lines clear?

The idea of turning the reduction of gross anthropogenic forcing into a climate imperative provides assistance in these tricky arenas, allowing one to say a number of things both about greenhouse gas emissions and about different forms of climate management. Some of the lessons are intuitive and obvious. Others are more complex. All of them show how the climate imperative can help guide policy.

a) *Carbon dioxide emissions* are one of the main causes of anthropogenic forcing today and the original source of the concern about climate change. The need to reduce these emissions and the forcing they create is by now fairly uncontroversial worldwide. The rationale for so doing usually centers on concern about the human and environmental consequences of unchecked

[5] For an application of this to geoengineering, see Keith 2000/1 and Morrow 2014.

warming but it also includes the more general sentiment that there is a moral need to reduce the human impact on nature. The fact that reducing CO_2 fits squarely with the climate imperative of reducing gross anthropogenic forcing comes as no surprise since these emissions have practically defined the climate problem from the start.

b) *Carbon dioxide removal* (CDR) technologies are being researched so that carbon already emitted to the atmosphere might be captured and sequestered somewhere safe for the long term. As Heyward (2013) has pointed out, CDR might properly be thought of alongside emissions reduction as a form of mitigation of greenhouse gases. The IPCC has long held that mitigation takes two forms: the reduction of greenhouse gas emissions and the enhancement of carbon sinks (Metz et al. 2007). If CDR involves developing technologies to capture and safely sequester carbon underground (or undersea) then it amounts to a form of greenhouse gas mitigation through carbon sink enhancement.

Heyward has also pointed out that, whereas emissions reductions can only slow the rate of increase of GHG concentrations in the atmosphere, the enhancement of carbon sinks could both slow the increase and eventually also reduce existing concentrations of GHGs, enabling "…retrospective action on levels of GHG concentrations" (2013, 26). James Meadowcroft (2013) similarly characterizes CDR as combining "emissions offsetting" with "climate recovery" suggesting that CDR can be thought of as a form of environmental restoration. As forms of restoration, CDR and other negative emissions technologies reduce gross anthropogenic forcing to levels more consistent with an earlier time. In practice there are serious technological, ecological, physical, and social constraints on just how fast CDR could make this happen (Tavoni and Socolow 2013). The technique is, however, consistent with the goal of reducing anthropogenic forcing due to CO_2 so it fully accords with the climate imperative.

c) *Solar Radiation Management* techniques attempt to offset the impacts of warming temperatures by manipulating the albedo of certain terrestrial or atmospheric surfaces in order to reflect back incoming short-wave radiation. The SRM schemes receiving the most attention are those that increase the albedo of marine clouds in the troposphere and those that deploy reflective agents to the stratosphere. Proponents of the latter cite the impacts of past volcanic eruptions on global climate as evidence that such technologies would be effective.

Even in their current research stages and before any large-scale field trials, SRM proposals have generated a large amount of public controversy (Brown 2012) and considerable ethical suspicion (Preston 2012). Concerns include worries about unintended side-effects, doubts about the possibility of legitimate governance, the continuation of ocean acidification, the potential for harm to the ozone layer, and the prospect of perpetual SRM in the absence of progress on emissions. Any of these concerns could alone prove decisive against SRM deployment. But one can also use the climate imperative to argue that SRM is, at the very least, morally inferior to CDR. Rather than reducing current forcing, SRM increases gross anthropogenic forcing by adding another forcing agent (albeit a negative instead of a positive one) to the mix of anthropogenic drivers. In an attempt to reduce net forcing, SRM increases gross forcing while also leaving the original GHG forcing problem in place. By increasing gross forcing, it conflicts with the climate imperative.

The fact that intentional SRM adds to gross anthropogenic forcing provides reason to be suspicious of it. It is also clear why lumping SRM and CDR together under the same geoengineering label is deeply misleading. Admittedly, both target the global energy balance and attempt to reduce net forcing. But while CDR does so through reducing an existing form of anthropogenic forcing, SRM intentionally adds a new forcing agent. This is a different reason to support the conclusion Heyward also reached, that intentional SRM is an "analytically distinct" category of response to climate change from either emissions reduction or CDR (Heyward 2013, 25).

d) Discussion of the role of *black carbon*, *methane*, *ozone*, *and other anthropogenic drivers* of the climate problem has recently accelerated (e.g. UNEP 2011a, b). Carbon dioxide is not the only greenhouse gas and greenhouse gases are not the only sources of anthropogenic forcing. Examples of other forcing agents include methane, black carbon, ozone, hydroflourocarbons, nitrous oxides, sulphates, and more. These other agents of climate change can also be assessed through the lens of the climate imperative.

Methane's potency as a greenhouse gas has recently made it an increasingly important part of the climate discussion. Methane is over 20 times more effective (by weight) at trapping heat in the atmosphere than carbon dioxide. It is also a precursor to ozone (which itself acts as a greenhouse gas in the troposphere as well as negatively impacting crop production). The impact of black carbon as an albedo modifier is also significant. Black carbon absorbs heat, either at ground level by darkening surfaces with high albedo such as snow or light colored sand, or by absorbing warmth directly into the troposphere when suspended there. The relatively short atmospheric lifespan of both methane (12 years) and black carbon (several weeks) mean that most of the climate forcing from these two agents is from relatively recent emissions. One important advantage of this short lifespan is that future reductions in their emissions can have relatively rapid climate impacts compared to reductions in longer-lived forcing agents such as carbon dioxide.

The climate imperative applies to methane in the same straightforward fashion in which it applies to a greenhouse gas such as CO_2. To reduce the anthropogenic forcing of greenhouse gases, methane emissions must be reduced. The imperative to reduce black carbon is also straightforward, though here the relevant forcing is not connected to the greenhouse gas problem. Black carbon is an albedo modifier. In effect this makes it an agent of unintentional solar radiation management, one with warming rather than cooling effects. As argued above with SRM, anthropogenic albedo modifiers run contrary to the climate imperative. They add to the number of anthropogenic forcing agents. The climate imperative mandates the reduction of gross anthropogenic forcing. Recent work suggests that significant and rapid reductions in radiative forcing could be achieved by reducing anthropogenic sources of black carbon (Shindell et al. 2012, UNEP 2011a, b). With black carbon, reductions in forcing can also be regionally specific, offering even greater benefits in vulnerable areas such as the Himalayan and Arctic regions.

In cases such as black carbon and ozone there might also be important human health and crop productivity benefits to be gained from their reduction. Shindell et al. suggest that a suite of black carbon and methane measures put in place alongside current GHG measures would prevent 0.7 to 4.7 million annual premature deaths from outdoor air pollution and increase annual crop yields by 30 to 135 million metric tonnes (Shindell et al. 2012). Black carbon emissions impact precipitation patterns and so their reduction may also have the potential to address shifting monsoonal patterns (Meehl et al. 2008). These win-win possibilities illustrate a range of important "co-benefits" from reducing anthropogenic forcing (Olson 2011a, b). As Shindell et al. remark "Protecting public health and food supplies may take precedence over avoiding climate change in most countries, but knowing that these measures also mitigate climate change may help motivate policies to put them into practice" (187). Such co-benefits reinforce the wisdom of the climate imperative.

e) The cases discussed so far follow fairly uncontroversially from the climate imperative. Ocean going vessels are emblematic of an additional set of cases where matters become more complicated and the issues more multi-disciplinary. As already seen, emissions from marine vessels contribute to anthropogenic forcing in three (or more) ways; by adding to greenhouse gases, by sequestering atmospheric carbon, and by increasing cloud albedo. In these cases of multiple forcings, the decision-making process is far from straightforward. The discussion below is somewhat idealized to illustrate the way the climate imperative might offer a basic framework in difficult cases.

At first, the recommendation for sooty ships most consistent with the climate imperative seems to be to reduce all three of the anthropogenic drivers (gross forcing), whichever direction they may point. While this should certainly be the long-term goal, the situation may be a little more complicated in the near-term and the timing of these reductions more contingent. If greenhouse gases in the atmosphere continue to be viewed as the main driver of anthropogenic forcing, then the carbon sequestration that may be happening from the soluble iron falling onto the ocean surface is on balance reducing, rather than adding to, anthropogenic forcing. By reducing existing climate forcing CDR is restorative not additive and is consistent with the climate imperative. Under ideal conditions that were conducive to human health, one could imagine a transitional phase that prioritized the reduction of greenhouse gases, while allowing the sequestration from the soluble iron deposits to continue for the present.

Similar conclusions about delaying implementation of regulations could apply to the SRM effects of the sulphate particles emitted from marine engines. Deliberately adding sulphur to the fuel in order to increase the reflectivity of emissions would amount to intentionally increasing gross anthropogenic forcing and would be precluded by the climate imperative. But rapidly eliminating sulphur from the marine fuel also has a significant impact on global temperatures. In a dilemma between pollution clean-up and climate warming Crutzen himself noted in his seminal paper (2006, 211), it may prove to be non-ideal but *transitionally just* (Simmons 2010) to implement a more delayed phasing in of the sulphur regulations in order not to cause a rapid increase in global temperatures. One could not justify adding to gross forcing by increasing sulphur content but one might be able to justify maintaining sulphur content until it was safe to remove it. Temporarily leaving the sulphur and its masking effects in place does not *increase* gross forcing. Timing the reduction of the elimination of that negative forcing may provide considerable climate benefits while remaining consistent with the letter of the climate imperative.

In principle, then, instead of mandating immediate reductions of all three forcing vectors, one could try to create more GHG efficient marine engines, while concerning oneself less with the soluble iron and sulphates emitted from the smokestack (at least on the open ocean).[6] Such a path would not be inconsistent with the climate imperative. The long-range goal would remain to eliminate all the anthropogenic forcing agents when prudent to do so. What this recommended path allows is the possibility of managing anthropogenic forcings in such a way that no single regulation suddenly delivers warming equivalent to ten years of greenhouse gas emissions.

It is critical to note that any such decision about temporarily leaving an anthropogenic

[6] The physics and chemistry of combustion engines may well make idealized goals of this kind difficult to attain in practice.

forcing agent in place would have to be fully consistent with other extremely important considerations such as human pulmonary health, the well-being of non-human animals, the ecological health of the ocean, and other relevant considerations such as civil rights and socio-economic justice. These considerations could easily trump any conclusions drawn from the climate imperative. Leaving any forcing agent in place would require a robust and thorough justification. Discussion about how to prioritize policy decisions would be difficult and multi-disciplinary and would involve experts from climate science, marine ecology, human health, engineering, risk assessment, and other relevant disciplines. These decisions would need to be made with extreme caution. The climate imperative, after all, is also a response to the desirability of avoiding danger and harm.

f) *White roofs*, *reforestation*, *crop albedo*, etc. represent a whole other set of activities that contribute to anthropogenic forcing. In these cases, decision-making is also complicated and will likely need to be done on a case-by-case basis. White roofs, for example, a locally-deployed and globally insignificant form of SRM, may change albedo but only at regionally significant levels, cooling cities and urban hardscapes while bringing down power consumption. Even though white roofs are technically anthropogenic forcing agents, the local reduction in power consumption they enable may contribute to an important reduction in greenhouse gas emissions. Reforestation efforts may both sequester carbon and decrease surface albedo, while at the same time delivering substantial ecological and natural resource benefits. These ecological and resource benefits would have to be weighed against any anthropogenic forcing reforestation creates. Changes in crop albedo through bioengineering techniques will have natural resource as well as albedo impacts. There might also be other salient considerations, such as the ethical challenges presented by GMO's and the corporate dominance they enable, that would speak to the wisdom of the GMO path. In all of the above cases, the climate imperative remains the guiding norm, with challenging multi-disciplinary decisions required on a case-by-case basis. Anthropogenic forcing is deeply woven into current habits and practices. Efforts to reduce it must be carefully thought through.

4 The anthropogenic forcing frame

The climate imperative outlined above is a clear improvement on what might always have been a highly suspect "Plan A-B" characterization of geoengineering and climate change. It avoids the simplistic framing of geoengineering as an alternative to emissions reduction, it does not put CDR and SRM in the same analytic category, and it can accommodate the fact that GHG emissions are often tied in with other types of anthropogenic forcing.

There are a number of additional advantages offered by the climate forcing framing. *First*, it avoids the worry that contemplating geoengineering could detract from conventional efforts at mitigation and it keeps CO_2, the main forcing issue of concern, at the forefront of the discussion. *Second*, it serves as a reminder to identify and to reduce other significant forcing agents such as anthropogenic black carbon, methane, and ozone. *Third*, it provides a strong caution against intentionally deploying SRM which would only add to gross anthropogenic forcing. *Fourth*, it is consistent with the possibility of a phased withdrawal of some forcing agents in order to avoid rapid warming at a time when the global community can little afford it. It comes with flexibility built into it. *Fifth*, it avoids the dangerous conclusion that the new age of the anthropocene provides license for humanity to add forcing agents as they see fit in a risky juggling act. Rather, consistent with some strongly held environmental intuitions, it finds previous atmospheric conditions to be a safer option than conditions some powerful interests might choose today if they had license.

Rather than indolence in the face of climate change, the climate imperative does require intentional and fully deliberated climate management through a phased reduction of anthropogenic forcing agents. Some environmentalists will lament that this in effect turns humanity into intentional geoengineers. However, under the climate imperative, the climate is managed for the express purpose of providing a safe transition beyond the dangers of current anthropogenic forcing. The imperative demands uncovering the widest possible range of both intentional and unintentional anthropogenic forcings and figuring out intelligent ways to reduce them. Pursuit of this goal offers the tantalizing and significant promise, sometime ahead, of a controlled end to climate management.

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