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Geoengineering or Planet Hacking?

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With climate change occurring due to increasing levels of carbon dioxide in the atmosphere, one solution that has been proposed is the technological one of geoengineering. This means that we (human beings) would "solve" the problem of increasing carbon dioxide by applying an engineering solution on a planetary scale. Various geoengineering solutions have been proposed, including carbon capture from the atmosphere and storage, ocean iron fertilization, adding reflective aerosols into the lower stratosphere, spraying seawater into the atmosphere to enhance marine clouds, launching giant reflectors into space to reflect sunlight, and so on. All these solutions raise ethical questions such as who decides which of these options is safe to pursue? what will be the impact of the proposed solution on people living in different parts of the planet, particularly on the poor? can a country pursue one of the options unilaterally? This article explores these issues and tries to bring a Christian perspective to them.

The title of this article, "Geoengineering or Planet Hacking?" is deliberately provocative in that the question of whether we (human beings) can engineer a solution to the problem of increasing levels of carbon dioxide in the atmosphere is an emotive one. At one end of the spectrum lie those who think that human technological ingenuity can solve almost any problem. At the other end of the spectrum are those who, aware of the hubris from which humanity so easily suffers, think that any attempt to mess with Earth's natural environment is more like computer hacking, likely to cause more harm than good, and morally questionable.

Polarization of views and inevitable adversarial responses are often the outcome of discussions on this topic, so generating more heat than light. For Christians the question arises: is there a biblical perspective that can be brought to bear on the question? This article seeks to explore this issue. At the very least, Christians are called to be peacemakers (Matt. 5:9) and perhaps called to shed light on the issue rather than simply generate heat.

The Problem

Climate change denial continues to plague the discussion of the impact of fossil fuel use (coal, gas, oil) by human beings on Earth and how humanity should respond. However, scientifically, the observations both of increasing carbon dioxide (CO_2) in the atmosphere, which in 2013 exceeded 400ppm for the first time in the recent geological past,[1] and of global warming are difficult to deny. The recent publication of the Working Group I (WGI) IPCC fifth assessment report (AR5)[2] strengthens the

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evidential basis for human-induced climate change and states

> Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.

It goes on to say that

> Human influence on the climate system is clear. This is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system.

and

> It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century.

Furthermore:

> Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.[3]

In light of the above, there is a clear need to cut the amount of CO_2 in the atmosphere and so reduce the potentially devastating effects that global warming is likely to inflict on the planet. The impacts will be particularly severe for those living in more vulnerable areas of the earth who are, to use biblical terminology, the poor and the needy of the earth.

The best solution is that we (human beings) take the actions necessary to limit climate change, namely by making "substantial and sustained reductions of greenhouse gas emissions." However, to date and on a global scale, there has been little progress on implementing this solution. The lack of political will is evident in the outcomes of the various recent so-called COP (Conference of the Parties) meetings linked to the United Nations Framework Convention on Climate Change (UNFCCC). The lack of progress in substantially reducing greenhouse gas emissions has led some to propose an alternative approach—that of geoengineering—which is aimed at mitigating, by technological means, the effects of continued emission of CO_2 and other greenhouse gases.

Some Geoengineering Solutions

A recent UK Royal Society report has reviewed various geoengineering proposals and the reader is referred to that report for more details.[4] In this article, only a brief description of some of the proposed geoengineering solutions is given. As noted in the report, the solutions can be classified in two categories: (1) CO_2 removal techniques; and (2) solar radiation management. The former mitigates the effects of climate change by seeking to remove CO_2 from the atmosphere; the latter seeks to reflect some of the sun's light and heat back into space. Note that the former approach also has the advantage of reducing the impact of ocean acidification due to increasing CO_2,[5] while the latter does not. In this brief article, there is not space to describe all the possible techniques, so only a few examples of the two types will be discussed—sufficient to illustrate the ethical issues that geoengineering raises.

Carbon Dioxide Removal

Atmospheric carbon capture and storage: Essentially the idea is to capture the CO_2 from the atmosphere and then store it (possibly in liquid form). Various methods have been suggested to capture the CO_2, and it is unclear how effective these would be in practice (some are similar to those being developed for carbon capture from power plants). Perhaps a more challenging issue is how to dispose of the captured CO_2, and proposals include pumping the liquefied gas into oil- or gas-field reservoirs that have been exhausted of their resources. Of course, the problem is that, in the longer term, there may be leakage (akin to the problem with storing radioactive waste). If the leakage were abrupt and severe, it could raise the CO_2 levels in the atmosphere rapidly, seriously exacerbating the global warming problem.

Ocean iron fertilization: CO_2 is absorbed into the ocean and used by photosynthesizers (mainly algae—microscopic plants) in their growth. Some of this carbon makes it into the deeper ocean as part of the food chain in the form of organic matter, faecal pellets, and detritus. As it sinks, some portion is consumed by bacteria, and CO_2 is released back into the water at depth. This so-called "biological pump" influences the concentration of CO_2 in the surface waters and thus its absorption from the atmosphere. Potentially the biological pump could draw down more CO_2 into the ocean if more algal growth could

be stimulated in the ocean surface waters. The limiting factor for such growth is usually nutrients, and in some regions of the ocean (for example, in the large expanse of the Southern Ocean), iron is the limiting nutrient. Hence it has been proposed that ocean iron fertilization could lead to the enhancement of the biological pump and thus to a reduction of atmospheric CO_2.[6] However, by this means, only a small fraction of the carbon will make it into the deep ocean or into the ocean sediments.[7]

Solar Radiation Management

Injection of sulphate aerosols into the lower stratosphere: In some respects, this proposal mimics the effect of volcanic eruptions that increase the aerosol load in the atmosphere and that cool the earth by the reflection of sunlight. Significant dips in global air temperatures have been observed following major volcanic eruptions.[8] If the sulphate aerosol load could be increased sufficiently in the lower stratosphere, where such aerosols already occur naturally, then this would lead to a cooling of the planet.[9] The delivery of the sulphate aerosols or their precursors (e.g., hydrogen sulphide or sulphur dioxide) to the lower stratosphere would need to be ongoing and the delivery method would need to be by aircraft, rocket, or balloon.

Enhancement of marine cloud reflectivity: In rather simplified terms, if the number of cloud condensation nuclei (CCNs) could be increased in those areas of the marine atmosphere that are relatively dust free, then the low-level marine cloud albedo could be increased, thus reflecting more sunlight back to space. One idea is to generate the necessary CCNs from seawater by producing fine particles of sea salt that are sprayed into the atmosphere above (possibly from a ship).[10] Of course, this method requires, as with the previous one, an ongoing generation of CCNs to be effective.

Solar reflectors in space: This would require the launching of solar radiation reflectors into near-Earth orbit so that they could intercept the sunlight falling on the planet. Basically, the idea is that of "mirrors in space." Probably a large number of small reflectors would be deployed. An alternative would be to place a reflector at the so-called Lagrange point 1 (L1) about 1.5 million km from the earth. There the effect of the sun's and the earth's gravitational pulls are such as to ensure that the reflector remains stably in place between the two as the earth orbits the sun.

It should be noted that all of the proposed geoengineering solutions have both technical problems, in terms of implementation, and potential drawbacks, in terms of impact.[11] In addition, there is also the potential for things to go wrong. For example, should an implemented means of solar radiation management fail, there could be a consequent rapid rise in global air temperatures with potentially catastrophic effects. As noted above, a similar problem could arise with CO_2 storage. Should the storage solution fail, then there could be a significant release of CO_2 into the atmosphere, thus accelerating global warming in a potentially catastrophic manner.

The Ethical Questions

While the proposed geoengineering solutions raise many interesting technical and scientific questions, not least the simple one of "Will they work?," they also raise ethical questions regarding their development and use. Preston gives a comprehensive discussion of the ethics of geoengineering but does not consider a Christian perspective.[12] Here some of the key questions are highlighted to set the scene for a possible Christian response.

The first question is whether geoengineering solutions should be considered at all. Would this simply allow people to avoid tackling the problems of human-induced climate change by the obvious expedient of reducing our carbon emissions because they think that there is a technological fix "just around the corner"? Therefore, even considering geoengineering may be problematic from an ethical perspective. It could encourage an irresponsible attitude in people regarding future fossil fuel use.

Given the many uncertainties surrounding geoengineering, the next question is, should research be carried out to examine the potential and the pitfalls of the various geoengineering options? If research is acceptable, what type of research? Theoretical and modelling work has no actual impact on the planet, whereas the addition of sulphate aerosols to the stratosphere or iron to the oceans does.[13] There is also the question of the scale of any experimental work—at what scale do such experiments become

unacceptable because of their possible (perhaps unknown) consequences? Who decides?

Assuming that research suggests that a particular geoengineering approach may be feasible, who has the right (or, more likely, the power) to decide that it should be implemented? What if the solution leads to uneven benefits across the globe, alleviating problems in one area and exacerbating them elsewhere, while overall being good for the planet as a whole? Will the rich and powerful impose their preferred solution on the weak and vulnerable? History would suggest that this is not an unlikely outcome, but is it an acceptable one?

Finally, assuming that a geoengineering solution has been implemented, what is the "exit strategy"? How do you decide whether a geoengineering solution is no longer necessary and should be discontinued? What might be the consequences of such a decision—who benefits and who might suffer?

The standard ethical approaches to such questions fall into three main categories:[14]

1. consequentialist: in which the value of the outcome is the primary consideration;
2. deontological: in which the "right" thing to do is the primary consideration and the outcome is secondary;
3. virtue-based: in which character-related issues, such as arrogance, are the primary consideration.

None of these takes into account the existence of the Christian God per se, nor the possible implications of that existence for ethical decision making with regard to the questions raised by geoengineering.[15] The Royal Society report gives very little space to ethical considerations and concludes, with regard to ethics, that

> many of the ethical issues associated with geoengineering are likely to be specific and technology dependent.

and that

> overall it is clear that ethical considerations are central to decision-making in this field. However when evaluating the role that different approaches to geoengineering could play, it is not possible to make simple yes or no decisions on the basis of ethical reasoning.[16]

Therefore, the question arises: is there a specifically Christian ethical stance than could or should be taken on the issues raised by geoengineering?

A Possible Christian Response

To begin with, it is worth noting that there is probably no single so-called "Christian response" that can be made to the issues raised by geoengineering. Therefore, what follows is a possible response, aimed at stimulating thinking and discussion, and certainly not the "last word" on the topic.[17] Many approaches can be adopted in developing Christian ethics,[18] and it goes beyond the scope of this brief article to interact with them. Instead, a number of key issues will be addressed and possible responses proposed in a more ad hoc fashion.

In an earlier paper, I outlined an approach to environmental ethics based on the biblical metanarrative (the "big story" of the Bible—creation through to new creation—Genesis to Revelation).[19] This drew on the work of Christopher Wright[20] and Tom (N. T.) Wright.[21] It is not my purpose to repeat the arguments of that paper here. Rather, I want to pursue two aspects of that thinking that seem relevant to the issue of geoengineering. First, the need to think and live eschatologically: that is, in the light of the future God intends for his creation.[22] Second, the need to return to Jesus's first and second commandments—to love God and to love our neighbor (Matt. 22:37–40)—when thinking through issues related to the ethics of geoengineering.

Since the concept of thinking and living eschatologically may be less familiar to readers than Jesus's commandments, I will briefly describe what this means here.[23] Focusing on the ultimate end (*eschaton*) should affect our ethical thinking in the here and now, as it holds forth a picture of a future reality which has already begun through Jesus's death, resurrection, ascension, and sending of the Holy Spirit (this is the "now and not yet" aspect of the kingdom of God).[24] Therefore, it would be inconsistent for believers to continue acting as if this future hope had no present relevance.[25] As part of living eschatologically, we are aiming to realize the prayer, "your kingdom come, your will be done on Earth as it is in heaven" (Matt. 6:10). This means that we are working in the present for an earth that reflects the

coming new creation, in part, because of the continuity between this world and the one to come.[26]

Romans chapter 8 suggests that there is both continuity and discontinuity between the present creation and the new creation, just as there is between our present bodies and our resurrection bodies. The latter is exemplified in Jesus, whose resurrection body was clearly both different from, yet similar to, his mortal body (Luke 24:13–49; John 20:19–29). As Tom Wright states,

> Jesus' resurrection is the beginning of a new project … to colonize Earth with the life of heaven. That, after all, is what the Lord's prayer is about …
>
> When the final resurrection occurs, as the centrepiece of God's new creation, we will discover that everything done in the present world in the power of Jesus' own resurrection will be celebrated and included, appropriately transformed.[27]

Therefore, how we live and, in this context, how we treat God's Earth, will, in some way, affect the new creation to come, and this should shape our thinking and our behavior in the present.

Having discussed what it means to think and live eschatologically, it is now time to examine the ethics of geoengineering. Perhaps the most worrisome and important aspect from a Christian perspective is that the geoengineering approach to solving the climate change problem is, at the bottom line, the potential that one of the technologically advanced and richer nations might impose its will on the less technologically advanced and poorer nations. Given the biblical emphasis on God's concern for the poor and needy[28] and Jesus's second commandment to love our neighbor (as noted above), it is clear that from a Christian perspective any potential geoengineering solution must meet God's requirement of love and justice for the poor and needy of this world. Therefore, any geoengineering solution that further disadvantages the poor and needy of the earth must be deemed unacceptable. For example, should a solar radiation management geoengineering solution lead to cooling of the earth overall, but at the cost of changed weather patterns that lead to increased drought in sub-Saharan Africa, where people are already starving and dying due to drought, this would not be acceptable. Of course, to determine the acceptability, or otherwise, of any proposed geoengineering solution requires research, though it is arguable whether research per se would ever provide a sufficiently robust answer on which to base a decision.

If the need for love and justice for the poor and needy has been satisfactorily addressed, what else should Christians take into account when assessing whether geoengineering solutions should be pursued? Let's begin with the simplest issue: should geoengineering be considered at all? From an eschatological point of view, the new creation will not require geoengineering, so perhaps we should learn to live in this creation in a way that does not require it either. However, this is hardly a decisive argument as there are many other things that will not be required in the new creation, but are required in the here and now—medicine being the most obvious example. Turning then to Jesus's commandments, loving God clearly includes caring for his creation.[29] If geoengineering is likely to become an excuse for not caring for God's creation, that is, an excuse for humanity to continue to misuse and harm the earth, then it should not be considered at all. Given the sinful nature of human beings this point needs to be taken seriously. In contrast, the criterion of loving our neighbor might lead to the opposite conclusion if we are convinced that a geoengineering solution might help those in greatest need—the poor of the world. This leads naturally to the question of research.

Should geoengineering research be pursued? An eschatological perspective does not seem to offer much guidance here. However, the commands to love God and to love our neighbor perhaps do. Our creative abilities, including the ability to do science and engineering, are God given and their pursuit is one means of serving and loving him. Likewise, research can be to the benefit of our neighbor, thus, an expression of love—medical research being a good example.[30] In a similar manner, it may be argued that we should pursue geoengineering research as it may provide a "cure" for an "ill" Earth (to use a perhaps questionable medical analogy). The question is whether the "cure" is worse than the "illness." Here, the particulars of any geoengineering solution have to be taken into consideration, but research may help us to delineate the advantages and disadvantages of different geoengineering proposals. Therefore, we might conclude that carrying out research in geoengineering is acceptable.[31]

Should research show that a geoengineering solution might be acceptable, the next question that arises is, should it be implemented? Here an eschatological perspective comes into play. As Christians, we are to live in the light of the future (as noted above), and, in some sense, what we do now affects the new creation. Jesus's wounds were visible after the resurrection (John 20:25–27), so perhaps the "wounds" that we inflict on the earth will be too?[32] This surely requires that any decision regarding geoengineering must be one that is for the good of the earth rather than for doing it harm. For example, injecting sulphate aerosols into the atmosphere could lead to an increase in acid rain. Though this is thought to be a small effect, it could be a significant impact in areas that do not already suffer from the effects of acid rain.[33] Therefore, here each geoengineering proposal needs to be evaluated in this light as a first step.

The next step is to consider Jesus's two commandments. Loving God surely means caring for what he created: after all, "the Earth is the Lord's" (Ps. 24:1). Christopher Wright states,

> Trashing someone else's property is incompatible with any claim to love the other person.
>
> … our treatment of the earth will be … a measure of our own relationship with the creator …[34]

Therefore, any geoengineering proposal must be compatible with caring for God's Earth. Again, the geoengineering solutions will need to be evaluated on a case-by-case basis. This may be a problematic criterion to apply in practice, as our mistreatment of the earth in terms of fossil-fuel use may lead to consequences in which the application of a geoengineering solution may be the lesser of two evils (do nothing vs. do something). Fortunately, we are not yet at that stage and, as noted in the Royal Society geoengineering report,[35] the safest way to ameliorate human-induced climate change is to cut back human emissions of greenhouse gases. Unfortunately, however, this is a solution that western society seems to find hard to accept.[36]

Perhaps the decisive commandment in considering the implementation of a geoengineering solution is Jesus's second one, to love our neighbor as ourselves. As noted earlier, the Bible suggests that God has a special care for the weak and the needy of the earth, and if we are to love our neighbor, we too have to care for the weak and needy, as he does. Since global warming is leading to changing weather patterns that have the most impact on the marginalized of this world, it is likely that some of the geoengineering proposals will do the same. For example, it is almost certain that solar radiation management will have an effect on the earth's weather as incoming solar radiation drives our weather on a global scale. In contrast, carbon capture and storage may have less impact. Perhaps research will clarify the scale and the size of the impact of particular geoengineering solutions, thus enabling a more informed approach in considering the ethical issues. However, given the complexity of the earth's system, research may not provide clear answers.

In addition, all research suffers from some limitations and the actual implementation of a geoengineering solution may have unforeseen consequences that cannot be anticipated in advance (a not uncommon problem in moving from scientific idea to technological implementation). What is clearly unacceptable is the imposition of a geoengineering solution without the consent of the people who will be affected by it. Unfortunately, there are already people travelling down this road, as shown by a relatively recent unauthorized and unethical attempt to carry out ocean iron fertilization on a large scale.[37]

Finally, assuming that a geoengineering solution has been implemented, what needs to be considered in making the decision as to when and how it should be curtailed? This can be dealt with briefly as the issues that this raises are similar to those discussed regarding the implementation of a geoengineering solution. The impact on the earth and on the poor and needy are the key considerations that need to be taken into account again.

To conclude this discussion, I note that, in all this, there is the constant danger of hubris. Too often scientists and engineers have thought that we can solve the world's problems through science and engineering, only to find that the solution creates more problems than it solves. In approaching all the issues—ethical and practical—related to geoengineering, it is good to take note of the fact that humility is a uniquely Christian virtue and an antidote to hubris.[38] Therefore, we should adopt a humble approach, following in Jesus's footsteps.

Conclusions

Geoengineering or planet hacking? Which group should the Christian side with in this debate? Those who have confidence in human technological solutions to the problem of increasing atmospheric CO_2? Or those who, wary of human hubris, see these efforts as planet hacking—more likely to cause harm than good?

The above shows that there is no simple or even single Christian answer to these questions, and taking sides is unlikely to lead to much progress. However, taking a cautious approach and being willing to admit that there is much that we do not know seems a wise way forward (applying humility). It may be that the earth's condition will become so dire due to global warming that geoengineering may be the only solution, but that point seems to be some way off yet. In the meantime, applying the approach outlined above, based on an eschatological perspective and Jesus's first and second commandments, should enable us to begin to address the ethical issues raised by geoengineering from a Christian perspective.

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I am grateful to my colleagues at the National Oceanography Centre (Katya Popova, Josie Robinson, and Andrew Yool) with whom I have been able to carry out research on the science of ocean iron fertilization, which stimulated a wider interest in the problem of geoengineering and led to the writing of this article. The views expressed in this article are entirely my own, however.

Notes

[1]N. Jones, "Troubling Milestone for CO_2," *Nature Geoscience* 6 (2013): 589.

[2]IPCC, *Climate Change 2013—The Physical Science Basis*, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge: Cambridge University Press, 2013).

[3]All the quotes are taken from the IPCC *Climate Change 2013—The Physical Science Basis*, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Summary for Policymakers (Switzerland: IPCC, 2013), 2, 13, 15, and 17. With regard to the recent "hiatus" in global temperature rise, see K. E. Trenberth and J. T. Fasullo, "An Apparent Hiatus in Global Warming?," *Earth's Future* 1 (2013): 19–32.

[4]Royal Society, *Geoengineering the Climate: Science, Governance and Uncertainty* (London: Royal Society, 2009), http://royalsociety.org/policy/publications/2009/geoengineering-climate/.

[5]On ocean acidification, see Royal Society, *Ocean Acidification Due to Increasing Atmospheric Carbon Dioxide*, Policy Doc. 12/05 (London: Royal Society, 2005), http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2005/9634.pdf.

[6]J. H. Martin, "Glacial-Interglacial CO_2 Change: The Iron Hypothesis," *Paleoceanography* 5 (1990): 1–13; R. S. Lampitt et al., "Ocean Fertilization: A Potential Means of Geoengineering?," *Philosophical Transactions of the Royal Society A* 366 (2008): 3919–45.

[7]Lampitt et al., "Ocean Fertilization."

[8]See, for example, P. Minnis et al., "Radiative Climate Forcing by the Mount Pinatubo Eruption," *Science* 259 (1993): 1411–5.

[9]This proposal has been given more credence due to being advocated by the Nobel prize winner Paul Crutzen. P. J. Crutzen, "Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma?," *Climatic Change* 77 (2006): 211–20.

[10]S. Salter, G. Sortino, and J. Latham, "Sea-Going Hardware for the Cloud-Albedo Method of Reversing Global Warming," *Philosophical Transactions of the Royal Society A* 366 (2008): 3989–4006. Interestingly, Salter was one of the pioneers of alternative energy in the 1970s, namely of wave power (S. H. Salter, "Wave Power," *Nature* 249 [1974]: 720–4). Had these ideas been pursued more seriously by governments then, this might have led to significant availability of non-CO_2 producing forms of energy by now, thus alleviating the current climate change problems.

[11]Royal Society, *Geoengineering the Climate*.

[12]C. J. Preston, "Ethics and Geoengineering: Reviewing the Moral Issues Raised by Solar Radiation Management and Carbon Dioxide Removal," *WIREs Climate Change* 4 (2013): 23–37. He does not consider a Christian perspective; hence, I am writing this article.

[13]At this point, I should declare a personal interest. I am involved in computer modeling studies of ocean iron fertilization: see J. Robinson, E. E. Popova, A. Yool, M. Srokosz, R. S. Lampitt, and J. R. Blundell, "How Deep Is Deep Enough? Ocean Iron Fertilization and Carbon Sequestration in the Southern Ocean," *Geophysical Research Letters* 41 (2014): 2489–95.

[14]See section 4.3 of Royal Society, *Geoengineering the Climate*.

[15]Note that there are Christian versions of the ethical approaches listed here. For example, Tom Wright, *Virtue Reborn* (London: SPCK, 2010), takes a Christian virtue ethics approach.

[16]Royal Society, *Geoengineering the Climate*.

[17]Since this article was originally submitted (February 2014), a book was published in April in the UK relevant to the topic: M. Northcott, *A Political Theology of Climate Change* (London: SPCK, 2014). Chapter 3, "Engineering in the Air," discusses geoengineering, placing it in the larger context of climate change. However, Northcott's book focuses on developing a political theology rather than addressing the ethics of geoengineering per se.

[18]See, for example, R. Hays, *The Moral Vision of the New Testament: A Contemporary Introduction to New Testament Ethics* (London: Continuum, 1997); B. Witherington, *The Indelible Image: The Theological and Ethical Thought World of the New Testament*, vol. 1, *The Individual Witnesses* (Downers Grove, IL: InterVarsity Press, 2009); B. Witherington, *The Indelible Image: The Theological and Ethical Thought*

World of the New Testament, vol. 2, *The Collective Witness* (Downers Grove, IL: InterVarsity Press, 2010). Surprisingly, B. Brock, *Christian Ethics in a Technological Age* (Grand Rapids, MI: Eerdmans, 2010), discusses neither climate change nor geoengineering, and there is only passing mention of environmentalism and of engineering.

[19]M. A. Srokosz, "God's Story and the Earth's Story: Grounding Our Concern for the Environment in the Biblical Metanarrative," *Science and Christian Belief* 20 (2008): 163–74.

[20]See C. J. H. Wright, *The Mission of God: Unlocking the Bible's Grand Narrative* (Nottingham: IVP, 2006).

[21]See N. T. Wright, *Surprised by Hope* (London: SPCK, 2007).

[22]This would be the equivalent of the new creation "lens" that Hays's *Moral Vision* uses in considering ethical issues (along with the cross and community).

[23]For a more detailed exposition, see N. T. Wright, *Surprised by Hope* and Srokosz, "God's Story and the Earth's Story."

[24]On the "now and not yet" of the kingdom of God, see the reprinted and now classic text, G. E. Ladd, *The Presence of the Future* (Grand Rapids, MI: Eerdmans, 1996).

[25]This also negates Marx's criticism of religion as the opiate of the people and the unreality of the more recent Left Behind series of books, as it avoids escapist fantasy.

[26]On the continuity/discontinuity between the present creation and the new creation, see M. B. Stephens, *Annihilation or Renewal: The Meaning and Function of New Creation in the Book of Revelation* (Tübingen: Mohr Siebeck, 2011).

[27]N. T. Wright, *Surprised by Hope*, 305 and 306.

[28]There are too many references to quote them all but see, for example, Deuteronomy 15:11; Psalm 72:12–13; Proverbs 22:22–23; Isaiah 3:15; and Mark 10:21.

[29]Srokosz, "God's Story and the Earth's Story."

[30]I hasten to add that I do not think that all medical or other research is done out of love for God or for our neighbor. There are too many counterexamples. For the Christian, I think that the saying attributed to St. Bernard of Clairvaux is apt:

> There are many who seek knowledge for the sake of knowledge: that is curiosity. There are others who desire to know in order that they may themselves be known: that is vanity. But there are some who seek knowledge in order to serve and edify others: and that is love.

[31]Given my earlier confession that I am involved in geoengineering research, it might be argued that my view here is not entirely objective. I am willing to concede that point in light of Jeremiah 17:9, but I am happy to leave God to judge, as in 1 Corinthians 4:4.

[32]Subsequent to writing this, I discovered that D. Wilkinson, *Christian Eschatology and the Physical Universe* (London: T&T Clark, 2010) makes a similar point in his chapter 7 on "The Future of Matter." In fact, the whole book is very relevant to the eschatological perspective taken here.

[33]P. J. Rasch et al., "An Overview of Geoengineering of Climate Using Stratospheric Sulphate Aerosols," *Philosophical Transaction of the Royal Society A* 366 (2008): 4007–37.

[34]C. Wright, *The Mission of God*, 414 and 403.

[35]Royal Society, *Geoengineering the Climate,* ix, "Headline Messages."

[36]Although other nonwestern nations now emit significant amounts of greenhouse gases, the western nations have most benefited from such emissions in the past. Therefore, it could be argued that they should make sacrificial cuts in emissions first, recalling Jesus's words, *"From everyone who has been given much, much will be demanded; and from the one who has been entrusted with much, much more will be asked"* (Luke 12:48).

[37]M. Lukacs, theguardian.com, October 15, 2012, http://www.theguardian.com/environment/2012/oct/15/pacific-iron-fertilisation-geoengineering.

[38]M. A. Srokosz, "Humility: A Neglected Scientific Virtue?," *Science and Christian Belief* 25 (2013): 101–12. Of course, this is a Christian virtue ethics approach (see note 15 above).

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