Making climates: solar radiation management and the ethics of fabrication[1]

Maialen Galarraga and Bronislaw Szerszynski

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In light of the increasing probability of dangerous climate change, a range of different geoengineering techniques – large scale, deliberate interventions into climate processes and systems – are being proposed as ways of preventing excessive warming of the global climate. Amongst these are various solar radiation management (SRM) approaches to geoengineering: techniques that would work by altering the albedo (reflectivity) of the earth and thus modulating the energy budget between earth and space. There have been proposals for applying such techniques at the Earth's surface (such as painting roofs white, covering deserts with plastic, cultivating more reflective varieties of crops), in the troposphere (cloud-albedo enhancement) or stratosphere (particle injection), and in Earth orbit (sun shields) (Royal Society, 2009).

Such technological interventions would, in an important sense, be making the climate. The very definition of geoengineering means that it is intentional and planned; the full-scale implementation of solar radiation management would thus result in a climate that was an artefact – a climate that has not just been *disturbed* by human intervention, but has been *intentionally shaped* by human intervention. For the first time,

we would have a made climate, and this provokes significant questions. As many other contributions to this volume argue, SRM clearly raises ethical issues about whether such interventions should go ahead, and how the risks and benefits could be shared justly (see also Jamieson, 1996; Corner & Pidgeon, 2010; Gardiner, 2011). But in this chapter we approach the normative dimensions of solar radiation management in a rather different way, by reflecting on what exactly it would mean for humanity to 'make' the climate, and how this might draw us into a new relation with nature.

We thus construe the normative in a much broader way than is usual. Drawing on the philosophy and anthropology of technology, we approach the act of human making, what Aristotle called *poiesis*, as something that has to be grasped as a whole, rather than decomposed into a set of technical questions to be answered by scientists and engineers on the one hand, and a set of ethical and political questions to be answered by philosophers, moralists and politicians on the other. We treat the bringing of new things into being not simply as one kind of activity that human beings may or may not engage in, but as something that shapes and conditions the kind of beings that humans are in the world; not as an addition to an original, natural, non-technical humanity, but as in some sense constitutive of the human. We suggest that any specific normative judgements about what we as humans do with our powers to make things ought to be situated against this background of how we understand the nature of *poiesis*, of human making.

More specifically, we argue that debates around geoengineering research have been shaped by one particular imaginary of making – one specific understanding of what it is to make something – which has had the unhelpful consequence of occluding crucial dimensions of what it would mean to make the climate. In order to develop this

argument, we first focus on the nature of artefacts, distinguishing two ways in which something can be understood as 'made', and use this distinction to think about what kind of entity a made climate would be. We then suggest that making is usually understood as 'matter taking form', but then present three very different accounts of how the en-forming of matter takes place, accounts that we call 'producing', 'educing', and 'creating' respectively. Finally, we show how each of these models of making imply a particular kind of maker, a particular version of the human agent, and explore how these three different visions of the human as maker can help illuminate the ways of making that are currently being enacted in the field of geoengineering – and ways in which this might be reconceptualised.

Made things

There are many different ways that artefacts could be categorised, but most pertinent to our argument is a distinction that can be made in the way that different kinds of artefact persist over time. Made things, like other entities, do not all endure in the same way. Here we want to distinguish 'stable' from 'metastable' artefacts. ***Stable artefacts***, such as tables and chairs, endure in a way that depends on minimising the exchange of material and energy across their boundaries. For example, when making a table, the wood is typically planed, sanded and varnished, in order to prevent bits of wood from breaking off the table, and water from penetrating it. This is because the natural tendency of a stable artefact is to persist, but to the extent that its boundedness is not maintained it slowly degrades by losing order and separation from its environment. In the language of Gilles Deleuze, with this kind of artefact, it is the *extensive* properties such as length,

volume and mass – the properties that together comprise its stable, completed form – which are most important. *Intensive* differences such as temperature, pressure and density are either seen as accidental and not constitutive of it being the kind of artefact that it is – or, if they are essential to its operation, they are typically seen as subordinated to and derivative of the artefact's extensive properties – for example, the power and internal dynamics of an internal combustion engine are seen as a result of its size and shape, and not vice versa.

With this kind of artefact, the act of fabrication is completed when the artefact has been made: in Aristotle's (1956) terms, this kind of making is a *kinesis*, an instrumental action, one whose goal lies outside it. This kind of fabrication is thus a self-destroying process, in that when the artefact is made, and made stable, the process thereby loses its purpose and naturally finishes (Arendt, 1958, p. 143). In such cases, if the action is continued or repeated after completion, this must be for reasons external to the process – for example, once a craftsperson has finished making a table, he or she might make another table; but this would not be because the making of a table requires it, but, for example, because the table-making is embedded in a larger structure of action such as artisanal labour (Arendt, 1958, p. 143).

By contrast, **'*metastable artefacts*'**, such as fires, fields and gardens, are artefacts that maintain their existence dynamically through the controlled exchange of material and energy with their environment. This kind of artefact is a subset of what the Nobel prize-winning chemist Ilya Prigogine called 'dissipative structures' (Prigogine and Glandsorff, 1971). Dissipative structures – such as living organisms, ecosystems or societies, but also abiotic structures such as cyclones, fires, hurricanes and convection cells – are open

systems that are far from equilibrium, so exchange energy and/or matter with their environment as described by the second law of thermodynamics. However, *because* they are far from equilibrium, non-linear rather than linear dynamics are able to dominate, which allows processes of self-organisation to arise (Shao et al., 2002, p. 57). Such structures can thereby avoid moving to thermodynamic equilibrium and thus actively maintain their existence – not just despite, but because of their dissipative form – by exporting entropy to their surroundings. Certain kinds of flows of energy and matter thus take place which, rather than cancelling out intensive differences, maintain them (De Landa, 2005, p. 82; see also Bogue, 1989, pp. 61-2). These are self-organising systems, in which the form evolves out of the interactions of matter: in contrast to the stable artefacts discussed above, the extensive properties of metastable artefacts are the result of the ongoing play of intensive differences.

An artefact that has this kind of mode of persistence might exhibit a range of different dynamics over time. It may actively maintain or even increase its internal order and distinctiveness from its environment. It may have its own inherent tendency to stability, due to the existence of 'attractors', 'singularities' or 'basins of attraction' – more-or-less stable dynamic states to which it naturally evolves over time. It might be extinguished suddenly and catastrophically. But it might also persist, but become progressively less artefactual, if the metabolic exchange across its boundary is not continually modulated. For example, a camp fire in a forest can become a forest fire. This kind of artefact thus requires a continuous action of tending, cultivating and care to maintain it in its artefactual state. With this kind of artefact it is thus inherent that the making is never complete – in Aristotle's (1956) terms it is an *energeia*, an ongoing kind

of action which never reaches a natural terminus. As Hannah Arendt says, with such artefacts, "[a] true reification ... , in which the produced thing in its existence is secured once and for all, has never come to pass; it needs to be reproduced again and again in order to remain within the human world at all" (1958, p. 139).

We will make use of this distinction later in this chapter. The 'natural' – or at least non-geoengineered – global climate is clearly a metastable rather than a stable entity: the (extensive) shape of the atmosphere's complex dynamic structure of atmospheric cells, wind belts, cyclones, anti-cyclones and so on is a dynamic product of the (intensive) dissipation of energy from the equator to the poles. We should therefore ask whether a climate made through solar radiation management would necessarily be a metastable artefact, one which would need to be constantly tended and modulated. But we should also ask about how the form of a made climate would emerge from our interactions with climate processes. In the next section we thus move from the 'made' to 'making' – from thinking about what a 'finished' artefact is, to exploring different accounts of what it is to make something.

Making things

In the previous section we have already distinguished between two forms of making: the time-delimited making that terminates in the production of stable artefacts, and the ongoing practices of cultivation and tending required to maintain the form of metastable ones. But there are other distinctions that we need to make before we look at the making of climates, distinctions that will start to complicate this contrast. In this section we thus draw on a number of philosophers to develop three different accounts of what it is to

make something, which respectively we call *production* (imposing existing forms onto matter), *eduction* (drawing forms out of the potentiality of matter), and *creation* (creating radically new forms by rearrangements of matter) – all of which are relevant to thinking about what it might mean to make climates. In one sense, they are describing different kinds of processes used in the making of things; in another, they are competing accounts of what it is to make something – 'imaginaries' – each of which can lead us to conceive of making in a particular way, guiding the manner in which making proceeds and constraining our awareness of what it at stake when something is made.

All three of these understandings of making could be described as 'hylomorphic', in the sense that they have their origins in Aristotle's understanding of making as involving some kind of dynamic relationship between matter and form.[2] In the *Physics*, Aristotle (1929) develops an understanding of objects, whether natural or artificial, as a compound of two metaphysically distinct elements: matter (*hyle*) and form (*morphe* or *eidos*). Matter for Aristotle was anything from which a thing is composed, whether material or immaterial, animate or inanimate. For Aristotle, form is actuality, the shape that a thing needs to have to be what it is (for example, a bronze statue is only a statue by virtue of its form; without that form, it is simply bronze). Matter, by contrast, is pure potentiality – it has the potential of becoming different things. For example, clay is a potential bowl, and also a potential brick; it only actually becomes one of these things when suitably en-formed. But as we shall see, although the three different ideas of making that we shall consider use the language of form and matter, they understand the nature of making in very different ways.

Our first model of making is ***production***, understood here as the imposition of an existing form onto formless matter. The clearest cases of production in this sense would be activities like using a mould to give a form to setting clay or dough, or using a machine press to cut and shape sheet metal, but a wide range of other fabrication processes are conceptualised and organised in these terms. The first thing to emphasise about this model of making is the passive role that it ascribes to matter. Aristotle follows Plato in arguing that in the act of fabrication reason is guided by *eidos* or form: Plato had argued that the craftsman making or repairing a weaving shuttle, like the demiurge who made the universe from formless matter, allows his hands to be guided not by the matter (*hyle*) out of which the artefact is to be made but by the eternal, unchanging form (*eidos*) of the finished product. Hannah Arendt also follows this understanding of fabrication as guided by form – by a model, whether beheld in "the eye of the mind" or in a physical plan (1958, pp. 140-1). Fabrication for Arendt involves a relation of domination towards nature and matter; even the material worked on by the fabricator has had to be wrested from nature. Heidegger suggests a similar view when he argues that, in the production of equipment, of useful things such as a stone axe, "stone is used, and used up. It disappears into usefulness. The material is all the better and more suitable the less it resists perishing in the equipmental being of the equipment" (1977, p. 171).

Our second account of making artefacts is what we call ***eduction***. Whereas production involves the imposition of form onto matter from outside, in eduction form is drawn out from the potentialities of matter itself.[3] This model of making thus has a very different understanding of how a stable form emerges, one that is closer to the tending and cultivating of metastable artefacts. In Deleuze's terms, whereas production involves

"commanding matter", eduction requires one to "surrender" to it, so as to be able to coax a physical system towards one of its "singularities", a threshold beyond which self-ordering takes place (Protevi, 2001, p. 9). Ingold describes this as a difference between 'architectonic' and 'textilic' making (Ingold, 2010b, p. 92-93). According to Ingold, eduction involves a kind of 'weaving', a following of the inclinations of matter and an intervening in fields of force and flows of materials in order to shape the way that they unfold and stabilise. Whereas making-as-production prioritises the final form, making-as-eduction focuses on the process of formation itself, and sees any final, stable form merely as the frozen last episode of a series of transformations of material (Mackenzie, 2002, p. 47; Ingold, 2010a, p. 3). Thus, whereas production focuses on the *extensive* characteristics of the resulting, actualised form, eduction attends more to the role of the *intensive* potentialities involved in the bringing of forms into being.

Theorists of eduction emphasise that even the making of identical, stable artefacts with a form that is planned in advance might in practice be closer to eduction than production in character. Thus, in Gilbert Simondon's account of making a brick from clay and mould, he argues that it is not the case that the clay is pure 'matter' and the rectangular mould pure 'form', or that the mould actively impresses the form onto the passive clay. In order to be able to take the form of a brick, clay has to be in a state of metastability – apparently stable and inert, but full of potentialities. The clay's capacity to take a form, and its capacity to hold a form, are one and the same. The mould does not impose a form; it rather provokes an "internal resonance" that transforms the potentialities in the clay into a determinate equilibrium. Similarly, the form-making does not just take place at the surfaces where the clay touches the mould, but all the way

through the ensemble of the tamped clay and the tensioned mould around it (Simondon, 1964, pp. 37-43). Furthermore, the distinction between a finished, enduring artefact and one that has to be continually cultured and tended may be illusory, because of the need for "ongoing processes of formation" (Mackenzie, 2002, p. 49). For example, not only the artisans who make artefacts, but also the users of artefacts constantly have to improvise, shore up and repair, to allow the artifact to endure. As Ingold remarks, "[l]ike life itself, a real house is always work in progress and the best that inhabitants can do is to steer it in the desired direction" (Ingold, 2010b, p. 94).

Our third model of making is ***creation***. Whereas with 'eduction' the distinction from 'production' was the former's emphasis on the autonomy of *matter* – its potentiality to suggest form – with creation the emphasis is on the autonomy of *form* – the capacity to create a new *eidos* that is not wholly determined by anything that pre-exists it. Here we are mainly drawing on the work of Cornelius Castoriadis, who emphasises the capacity of human beings to bring into being radically new forms. Castoriadis argues that producing artefacts in the sense discussed above is really not making anything new, because it is simply impressing existing forms onto existing matter. "If we imprint upon a mass of bronze an *eidos* that is already given, we are merely repeating what essentially, as an essence – *eidos* – was already there, we are creating nothing, we are imitating, we are *producing*. Conversely, if we make *another eidos*, we are doing more than 'producing', we are *creating*" (1987, p. 197). Once a new kind of thing is brought into being, the further reproduction of its form in material form will constitute 'production' – the proliferation of instances and copies of, or variations on, the original artefact (1987, p. 180). But the initial act of creating a new 'type' – a tool (such as a knife or an adze), an

institution (such as a temple or a school), or a social phenomenon (such as inheritance or an election) – is an "ontological genesis", the emergence of radical novelty, which can be understood neither as the imposition of a existing form onto matter, nor as the mere drawing out of a form that was already lying latent in matter. Creating is *ex nihilo* (out of nothing), and thus implies a departure from the Platonic paradigm of a timeless world of ideas (*eide*) that represents everything that could ever be. Understanding making as creation also requires us to understand time as genuinely historical, as an irreversible sequence whereby what comes into being (the created *eidos*) is unique, and pertains to a specific point in history.

The notion of making as creation challenges traditional Western ideas of matter as 'ready given', as stable, as simply discovered and made use of by living beings. Life (the living being) does not encounter a ready-given '*world-out-there*' but creates it and in doing so, also posits itself *as* a living being. As Suzi Adams puts it, "[p]rior to the emergence of the living being there is neither "world" nor "meaning"" (Adams, 2007a, p. 85). Castoriadis differentiates a number of levels in this self-creation, from the living being up to the emergence of human society (Adams 2007a) and it is at the level of the human that this theory interests us more here. According to Castoriadis, each new form of society is the emergence of a new *eidos*, the 'opening up of a world', a radically new way of organising thought and action. For example, the notion of 'individual' that arises during the European Renaissance cannot simply be derived from the concept of the human being in the same way as the calf is derived from the cow – it adds something new, in that sense it is an invention of another version of the living being, rather than a mere reproduction. For Castoriadis, acknowledging this fundamental self-creative capacity of

ourselves *qua* humans constitutes us as autonomous entities and enables us to put into question (and consequently re-build accordingly) the world that we have created (Adams, 2007a; Hansen, 2009).

The maker of climate

In the previous section we looked at three different idealised accounts of the ways in which artefacts might be made, accounts which differed in their understanding of the relationship between form and matter in the act of making: production (the imposition of existing forms onto matter), eduction (modulating intensive differences to create stable, enduring artefacts), and creation (bringing radically new forms into being, and thus creating a 'world'). In this section we will explore how these different models of making each imply a different vision of the 'maker' of things, and how these different visions of the maker might shape the understanding and practice of climate engineering through solar radiation management. We propose three archetypal makers, corresponding to production, eduction and creation respectively. We name these the ***architect***, the agent of production who dictates in advance and from up on high what is going to be produced, the ***artisan***, who facilitates the potentialities of the material on which he or she is working in a constant process of formation, and the ***artist***, who brings something radically new into existence, and thereby creates a world.

The ***climate architect*** is the agent who it is imagined can impose a new form onto the matter of climate. We develop this term from Paul Protevi's commentary on the work of Simondon and Deleuze, in which the 'architect' is a figure imagined to command matter from a distance, who, in Simondon's words, "imposes a form onto a passive and

indeterminate matter" (Simodon 1964, p. 48-9; see also Protevi, 2001, p. 8). This is the picture of the maker of climate which currently dominates the contemporary discourse of geoengineering**,** one which involves, firstly, forming a predefined idea of a possible climate to be achieved and, secondly, actualising that form by somehow impressing it onto the matter of climate. The climate architect is an idealised, imagined figure who knows in advance the form that they want the climate to take; who can identify the process whereby they can provoke the climate to take it; and who can carry out that process and bring the matter of climate into the desired form. If uncertainties are acknowledged in this way of thinking about making the climate, they are seen as factors that are exogenous to the process of production itself, and as in principle capable of being ironed out by future technical refinements.

This 'productive' way of thinking about making climates is arguably encouraged by the central role played by computer models in climate science, including geoengineering research. Despite the awareness of individual climate scientists about the limits of their computer models, there is still a tendency to treat climate models as 'truth machines' that can reveal the actual form of future climates under various mitigation and geoengineering scenarios (Wynne, 2010). In SRM research, for example, computer-based simulations of specific interventions are used to generate representations of possible future climates in the form of tables, graphs and maps. This kind of scientific practice has the effect of rendering climate as pure information *in silico* – as form stripped of matter. This dematerialised, formal climate can then be imagined as something that can be recombined with matter, and thus made actual.

But imagining a climate architect is to imagine a world in which the 'matter' of made climates is "fixed, stable, and uneventful" (Mackenzie, 2002, p. 40). But even if a made climate was continually modulated, would it really be possible to impress a predetermined form onto the metastable climate system? To use Heidegger's language, could the matter of climate be made to "disappear into usefulness", to give its being up to a form chosen by us to serve the wellbeing of humanity? In the case of making a brick, the process of en-forming the clay with the help of the mould is dependent on the clay having been purified – for example, by removing any clots or stones that would act as "parasitic singularities" and disrupt its en-forming (Simondon 1989, p. 42). Yet the climate cannot be purified in this way. Like an organism, the climate system is continually in formation, with constant adjustments of flows of energy and matter, temperature inversions and boundaries between pressure systems. What happens in an instant and more-or-less irreversibly in the making of a brick happens continuously in a metastable entity like the climate system, as inherent incompatibilities – tensions between different intensive states – are continually resolved through processes of internal resonance and exchange of energy (Mackenzie, 2002, p. 50). This suggests that the uncertainties in climate models are not mere 'noise' that could in principle be erased, but are the result of potentialities that are intrinsic to the way that the climate maintains and develops its form over time. It also suggests that a more appropriate model for the making of climates might be eduction, and a more appropriate figure for the maker of climates the artisan.

One analogy that might be useful in capturing the notion of the ***climate artisan*** is provided by David Turnbull's (2000; see also Ingold, 2010b) account of the practice of

cathedral building in the Middle Ages. Before architecture became associated with abstract, pure geometrical forms that only exist in the mind or on paper, medieval master builders worked alongside and coordinated their masons on site, and the plan of the building emerged out of the task of making, measuring and assembling. There was no abstract a priori idea of what was to be designed, no standardised, homogenous material to be carved and assembled; rather, building the cathedral meant surrendering to the medium, and allowing the form to emerge out of the process of building. Similarly, the climate artisan would not seek to identify the final form of the made climate in the mind, or *in silico*, and then try to achieve it in matter; instead, they would allow the form to emerge out of their interactions with matter, through recursive learning and adjusting. Their focus would be less on the desired form to be taken by the climate, and more on the actual process whereby the en-forming of climate might take place. They would thus treat computer models not as truth machines which can be used to reveal the future, but as laboratories or sandpits in which skills can be learnt and instincts sharpened – in which the beginnings of a "feeling for climate" might be cultivated, comparable to the "feeling for the organism" described by the biologist Barbara McClintock (Fox Keller, 1983). Just as the mould in Simondon's brick-making example is, in a sense, a frozen manifestation of the moulding hands of the fabricator (Simondon, 1989, p. 40), we can similarly consider the "moulding hands" of the climate artisan as being virtually presenced through the mediating technologies of computer models and SRM delivery systems.[4]

However, the climate artisan model also has its limitations as a way of understanding the maker of climate. The necessity for the artisan to follow the inclinations of matter in order to educe form means that, in the case of powerful,

metastable natural phenomena, it is more the case that the actions of the artisan are governed by the material to which they have harnessed themselves than the other way round. John McPhee's detailed descriptions of heroic attempts to control river floods, mountains landslides and lava flows show how ambiguous is the phrase "the control of nature" when dealing with such phenomena (1989). When humans progressively entangle themselves in the potentialities of matter in order to modulate the dynamics of nature's becoming, 'control' typically becomes at best a two-way process, and one in which the intentions of the humans become conditioned by those of nature. Geoengineering by solar radiation management is likely to be just such a scenario, one in which the climate artisan becomes tied to the continuous task of modulating climatic processes and thus subject to their logic. As James Lovelock suggests, if we start to use SRM, we are likely to be fating ourselves to a continuous process of correction and adjustment in order to counteract the unanticipated effects of each intervention, and will quickly find ourselves "enslaved in a Kafka-like world from which there is no escape" (Lovelock, 2008, p. 3888). The climate artisan would thus be not *homo faber*, the human being as the fabricator of the enduring things of a made world, but *animal laborans*, the labouring animal who serves the endless processes of life's self-maintenance (Arendt, 1958). The movements of the climate artisan would be determined by the resistances and inclinations of matter – like the craftsman of preindustrial societies who, because of the simple tools at their disposal, had to learn and perform complex "habits, gestures and schemes of action", often working in teams, in order to complete technical operations such as shoeing a horse, building or threshing (Simondon, 1989, pp. 77-9),

But the 'climate artisan' model also suffers from another crucial limitation. Like the climate architect, the climate artisan imagines the final form of a made climate as in some sense pre-existing its actualisation – perhaps not in the 'matterless form' of an *in silico* modelled climate, but latent in the matter of climate, to be coaxed out through a series of transformations and adjustments. Neither the climate architect nor the climate artisan is oriented towards the radical novelty that made climates might entail. Similarly, like that of the climate architect, the horizon of thought of the climate artisan does not contain the place for an awareness of how making a climate could also be the making of a world. For this kind of orientation we need to move beyond both the climate architect and the climate artisan.

So finally we turn to the figure we call the ***climate artist***, who approaches the making of climates as an act of creation in the sense that we are using it here. Being a climate artist would involve thinking through the idea that making climate would inevitably involve creating climatically novel states. This kind of making of climate is likely to be unavoidable, simply because of the impossibility of simply returning the climate to its preindustrial state. For example, if it is really the case that the pattern of stratospheric aerosol injection needed to restore the temperature distribution to that of a low-CO_2 planet is not the same as the distribution needed to restore the hydrological cycle, then judgements about which climate is desirable are unavoidable (Ban-Weiss and Caldeira, 2010; Lunt et al., 2008). In such circumstances, even though geoengineering has been defined in terms of the intention to ameliorate the effects of raised CO_2 levels – as if it were the returning of the matter of climate to its preindustrial form – it would be problematic to describe SRM as climate 'restoration' or 'remediation'. The climate artist

would understand the creation of novel climates not as an accidental failure of geoengineering interventions to accurately 'counter the climate effects of past greenhouse gas emissions' (Bipartisan Policy Center Task Force, 2011, p. 3), as if this would recreate the preindustrial climate, but as an intrinsic aspect of making the climate, the implications of which need to be reflected upon.

But a climate artist would also have to recognise climate creation, like the creation of a work of art, as world-making. The climate artist goes beyond the architect and the artisan in that (s)he approaches the making of climates not as the mere assembling of climatic processes but as the actualisation of "something more" (Castoriadis, 1984, p. 234). A climate artist would realise that the creation of climate might also mean the bringing into being of a new kind of society, with a new articulation of what climate is and how we relate to it. Both the climate architect and the climate artisan imagine that it is possible to maintain some kind of continuity and consistency between the goal formed in advance and the final achievement of a made climate. A climate artist, by contrast, would recognise that the creation of a new *eidos* produces a historical rupture, a new context in which ways of thinking and forming intentions can be utterly transformed. Seeing SRM as involving creation in this sense means that it could not simply be a judged as a means to an end, and thus as capable of being deemed 'successful' or 'unsuccessful' by criteria set in advance. Instead, its deployment would have "changed the end in changing the means" (Latour 2002, p. 252); it would have created a new world, a new kind of society, in which geoengineering itself is likely to take on new meanings, be put to new uses, and be judged in new ways. Discussions about what constitutes

'responsibility' in geoengineering research, deployment, and governance need to engage with such challenging but crucial dimensions.

Furthermore, if geoengineering were to be the *creation* of climates then, as atmospheric entities and processes became the matter of made climates, this would alter what they were for us. Thinking of a made climate as a 'work' enables us better to grasp how creating a climate could change not only the form but the very matter of climate. Castoriadis points out that all societies have to deal with something that they treat as matter – i.e., that which resists the will but is malleable. But what *counts* as matter, how it resists, and how it is malleable, is different in every society: for example, only in our society can hydrogen atoms be fused together (Castoriadis, 1987, p. 355). Similarly, in a geoengineering society the matter of climate would become matter in a radically new way, because of our very ability to manipulate it. The question, however, would be whether the made climate would be treated as 'equipment', judged by its mere utility, or as a 'work', judged by its world-making power. In the first case, the matter of climate would be expected to simply "disappear into usefulness"; in the second, it could be allowed to "shine forth" in a new way, as the matter taken up into a work of art is given a new way of presencing itself (Heidegger, 1977, p. 172). The climate artist thus has to take on another level of responsibility: to attend to the way that making climates will change what the climate, the sky, and the weather are for us –their meaning, and place in human society.

Conclusion

In this chapter we have explored different kinds of artefacts, and different models of making, in order to try to open up some new questions about geoengineering techniques such as SRM. We have argued that the discussion of the science, governance, and ethics of geoengineering has been dominated, explicitly or implicitly, by a particular 'imaginary', a particular idea of what it is to make something: that of 'production', as involving the bringing together of a pre-existing form and pre-existing matter. We have suggested that the reality of SRM is likely to be inadequately captured by this way of thinking about making, and that we need to consider alternative accounts of what it is to make something if we are to appreciate much of what would be at stake. We used the ideas of 'eduction' and 'creation' in order to suggest other ways of thinking about how the task of making an artificial climate might unfold. Of course, the three models we have discussed are ideal types – any real-world implementation of SRM is likely to combine elements of more than one of them. But we would argue that the distinctions that we have drawn between the three models allow us to identify important points of divergence between different ways that SRM might be conceived, with significant implications.

For, although they are models of making – about the practice of forming matter – this does not mean that they deal solely with the technical. We have tried to show that, embedded at the heart of apparently practical questions of how it may or may not be possible to shape the climate, there are profound normative issues. The conventional way of thinking about the ethics of technology would lead one to imagine that the science and technology of geoengineering is completely distinct from issues of ethics and governance, separated by the gulf that divides fact from value, is from ought. But the very idea of making the climate has to draw on particular models of fabrication, and the choice

between these models raises metaphysical questions about the human place in the world as a fabricating being. These models do not necessarily by themselves lead to specific moral positions on the permissibility and acceptability of particular acts, the distribution of risks and benefits, or the right to be consulted. But they force us to think about what it is to be a being that makes things, and what it might mean to bring the climate into the orbit of human making. What kinds of responsibility are inherent in the act of making? Does the making of climate only involve responsibility in respect of the final, made, extensive form? Or should we attend more to the responsibilities internal to the ongoing, and perhaps endless, action of making the climate, conceived as a vocation, a praxis, in which a climate artisan binds themselves in relations of responsiveness to the inherent inclinations of climate, its singularities and intensities? Furthermore, should making the climate be seen as also involving an awareness of the world-making power of creative acts, and thus a responsibility for and to the kind of world that geoengineering might bring into being?

We have represented the climate artist as in some way the more comprehensive of the three models of the maker of climate, in terms of the kinds of responsibility which it is possible to conceive within its horizon of thought. However, we should make it clear that we are not advocating any of the three roles. All of them, in different ways, are deeply disquieting prospects, and spelling them out should be enough to make clear what a serious step it would be for geoengineering to go ahead – if this needed to be made clear at all. It is not at all certain that humanity has the ability to take on any of these three roles in respect of the climate. However, the idea of the climate architect is perhaps

the most worrying of the three, because of the difficulty of articulating important dimensions of the ethics of making within its terms of reference.

Recent technological developments such as those in biotechnology have prompted reactions from the public that scientists are 'playing God' (Davies, 2006). Other writers have embraced the language of becoming-God in a more positive way, in order to try to call humanity to a greater awareness of its power and responsibility in the Anthropocene epoch (Lynas, 2011). If explorations into the feasibility and desirability of geoengineering the climate continue, we can expect such language to be drawn upon by both opponents and proponents as a way of expressing the seriousness of the step that we are considering. But another way to frame the key question that we have been pursing in this paper is to ask: what *kind* of god would we become if we started to make the climate? It would be better to reflect on such questions in advance, before we find ourselves being drawn into a role that we have not freely chosen.

Notes

[1] Earlier versions of this paper were presented at a seminar at the Institute of Advanced Study, Durham University, on 14 November 2011 and at the workshop *Terra infirma: Experimenting with geo-political practices*, University College London, on 27 January 2012. The authors would like to thank Christopher Preston, Adrian Mackenzie, Andy Jarvis, Kathryn Yusoff, and participants at the above events for helpful comments and suggestions. Maialen Galarraga gratefully acknowledges the support of EPSRC/NERC grant EP I014721/1, Integrated Assessment of Geoengineering Proposals (IAGP). Bronislaw Szerszynski would

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[2] 'Hylomorphism' is usually reserved for the kind of making we are calling 'production' – the imposition of form onto matter – but we prefer to use it in a broader way that applies to all three of our models of making. Amongst theorists of what we will call 'eduction' there is an attempt to get away from the language of 'matter' and 'form', in favour of the idea of an active 'material' with its own singularities and tendencies, that is open to and captures cosmic 'forces' and 'intensities' (Deleuze and Guattari 1988, pp. 337-50). But for the sake of simplicity we are remaining with the language of form and matter in describing 'eduction'.

[3] The term 'eduction', like 'education', is derived from the Latin *educere* 'to lead out, bring out', itself derived from *ducere*, to lead, the root of 'produce', 'reduce', 'deduce,' 'induce', and so on.

[4] Some elements of a climate artisan approach are explored by Lempert and Schlesinger (2001), and Jarvis et al. (2009).

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