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***Taming the Politics Monster: how is science engaged with the politics of its research?***

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Abstract:

Policy to address climate change does not match the scale and severity of the problem as defined by scientific research. While climate science can make valuable contributions towards climate policy, its actual significance should not be judged without a consideration of the politics which run through climate change science-policy interfaces. In order to assess the role and uses of science in political matters, two case-studies are considered: the debates around the health risks of tobacco smoking and the theory of nuclear winter.

In this exploratory piece, I propose that an exposition of the monster metaphor provides an insightful lens of analysis for the politics in and of science (the *politics monster*). Throughout the case studies, an ongoing learning process is observed in the political application of science, in attempts to tame the monster. The different strategies employed progress from ‘monster-exorcism’, to ‘monster-embracement’, ‘monster-adaptation’ and ‘monster-assimilation’. Similar processes are also evident in the climate change ‘debate’. From the evidence considered, there is little suggestion that these strategies relate strongly to the implementation of policy. This is used to suggest that climate science could become more deeply engaged in creative processes of politics to inspire more policy activity, while considering the effects that each strategy could induce.

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*Source: Smithsonian, May 1st 2014*

# Introduction

Broad scientific consensus on the characteristics of anthropogenically forced climate change is no longer a recent development (Oreskes, 2004; Doran & Zimmerman, 2009). In general, climate science has produced highly credible knowledge, through legitimate processes, to produce outcomes relevant to a multitude of societal and environmental issues (Cash et al., 2003; Dessai et al., 2009; Sarkki et al., 2013). Climate change, in its conception as a (biophysical) scientific problem, is not absolutely solvable – some uncertainties are fundamental in human understandings of the environment (Curry & Webster, 2011). However, for a scientific problem, the level of agreement on key aspects, such as the trend of accelerated global warming and the attribution of this trend to human-sourced greenhouse gas emissions, is unusually high, widespread and consistent over at least the past two decades (Cook et al., 2013; Mann, 2015).

In spite of such consensus on a robust base of evidence, there is a lack of policy activity which sufficiently addresses, or even looks to address, the problem in its many forms. This is not a new concern, nor one which has lacked attention (Stern et al, 2006; Camillus, 2008). Significant work has been undertaken to address the causes (mitigation) and effects (adaptation) of climate change, albeit unequally between regions, time periods and scales of enquiry (the role of individuals is often overemphasised in policy initiatives) (Shove, 2010; McGrail, 2013). Nevertheless, greenhouse gas emissions continue to rise, the effects of climate change continue to impact vulnerable populations and an apparent lack of political impetus to act, at the national scale in particular, persists (IPCC, 2018). Even where the generalisation of “policy inactivity” does not hold, climate policy is often perceived to lack the credibility, legitimacy and suitability to sufficiently resolve the scale of the issues at hand (Bulkeley & Newell, 2015).

Where does this leave science? There would seem to be many other factors at play behind the inactivity on climate change, at an individual, psychological level (e.g. Gifford, 2011) through to the collective, societal scale (e.g. Shove, 2010). Uncertainty and complexity in the scientisation of the climate change problem will inevitably and necessarily persist (Houghton, 2015). It seems unlikely, therefore, that more of the same from climate science will gain much traction in the policy arena, especially given its failure in the past to do so (Hulme, 2009).

In this paper, broadly, I examine whether and how science contributes to initiating policy change for such problems, for which resolutions appear to lie beyond a purely scientific problematisation. In particular, I consider possible insights from how scientifically-defined problems have related to policy change for two case studies somewhat analogous to climate change. Both have been related in diverse ways to climate change (e.g. Oreskes & Conway, 2010; Parthemore et al., 2018) but their potential for discerning ‘lessons learnt’ remains underexploited (Wynne, 2010). They are the issues around the harmful health effects of tobacco smoking (hereafter referred to as ‘smoking’) and those around the theory of nuclear winter following a significant nuclear exchange (hereafter referred to as ‘nuclear winter’). For reasons discussed in the section below, the case studies will be analysed through a political lens, where politics is understood as a process of “bargaining, negotiation and compromise” (Pielke, 2004, p.414) which decides “who gets what, when and how” (Laswell, 1958). In doing so, it is hoped that the insights offered can be of value in understanding what role, if any, science can play in addressing climate policy inactivity.

First, it is helpful to take a step back and gauge the current context within which climate change science-policy interfaces exist. While not exhaustive, this overview enables their role to be evaluated, along with factors in their ‘environments’ which may contribute to their apparent failings. This ensures that the case study material, which offers a rich and diverse database, can be usefully concentrated towards valuable insights relevant to current issues at these climate science-policy interfaces.

## Science-policy: a misnomer with reason and consequence

For a range of societal problems, scientific research is one important consideration of many in formulating policy, and equally an important contributor to the ultimate decision-making process and implementation (Perrings et al., 2011). Decisions surrounding policy should be widely informed, with scientific facts and values clearly articulated within that process (Saner, 2007). However, the afore-mentioned case studies (smoking, nuclear winter and climate change) all exemplify some element of miscarriage here - where scientific work detects, characterises and determines attribution of a problem, but policy does not respond in a timely, relevant manner (van den Hove, 2007).

In the case of smoking, the considerable delays in policy-enshrined acceptance of tobacco-related health risks traces to over 100 million premature deaths worldwide so far (Frieden & Bloomberg, 2007). For nuclear winter, there is little in nuclear-state policies or planning which accounts for its theorised global effects (Baum, 2015). Catastrophic costs could plausibly follow from inaction on this front in the event of nuclear war – which has rarely been more likely than at present (Robock & Toon, 2012). Shortcomings of climate policy could inflict damages of comparable or greater magnitude (IPCC, 2018). Climate science may have placed anthropogenic climate change on many diverse agendas, across disciplines, sectors, cultures and geographical scales (Crate, 2008). However, on arguably the most pertinent scale to the problem – the international stage – policies and even pledges from individual nations fall short of global agreements (Climate Action Tracker, 2019). The tragedy of the commons is in full flow, with accumulative failures of policy in this regard mapped onto increasingly destructive projections for socio-economic futures (Crist, 2007).

Here, the cost of inaction, apathy or delay will be and already is counted in grave economic terms, ecological damage, increasing vulnerability or (masses of) human lives (Hansen et al., 2012). This motivates the research endeavour here and elsewhere, so that the potential for robust climate science to well inform the policy-making process is realised (Lemos & Rood, 2010; van Enst et al., 2014). The “super wicked” characteristics of the climate change issue – especially of time running out and irrational future discounting – only deepen this imperative (Levin et al., 2007; 2012). Realising climate science’s policy potential also requires the effective allocation of resources (time, money, effort etc.). The production of scientific knowledge is a resource-intensive process. While I do not wish to understate the intrinsic value of developing and advancing our knowledge of the climate system, a lack of policy outcomes from existing climate science brings current research endeavours into question (Medin & Bang, 2014). If scientific investigation of climate change were framed as a multi-million-dollar industry, would that be money well spent (Sarewitz & Pielke, 2007)?

The above is indicative of the significance of optimising science-policy interfaces, while also suggestive of their prevailing conceptualisation, especially amongst the scientific community: that good science feeds into good policy in a uni-directional, linear manner (Saner, 2007; Perrings et al., 2011). Such status, combined with such philosophies, pre-supposes a vision of what ought to be, rather than what actually is (Hume, 1739). On one hand, this vision loses touch with reality, where policy is in fact the product of a wider multitude of inputs beyond the scientific field (Watson, 2005; Tyler, 2016). On the other, it engenders the politicisation of science, as those who subscribe to it are drawn into the political act of restricting policy choice to ‘what the science says’, within a value-free, objective façade (Pielke, 2004; Sheldon, 2016). In fact, politics shape the objectives, processes and outcomes of both science and policy (Weingart, 1999). Scientific research matters, but the evocations of a ‘science-policy interface’ compels the titled labelling, that of a misnomer with reason, largely because of the pervasion of politics in co-producing both science and policy (Spruijt et al., 2014).

To expand, consider the implications of a linear model of science into policy. This implicitly places science as the chief driver for policy change. In this logic, the aforementioned shortcomings of climate change policy are justified by shortcomings in climate change science (Wynne, 2010). By extension, science is perceived to have boundless capabilities, where the policy problem will be solved as soon as the scientific problem is evaluated, and uncertainty eliminated. This is counterproductive: climate change is problematised in the sphere of science, diverting or obscuring attention away from the sphere of policy, where appropriate action can be taken.

Realising the limitations of the linear model is not some ground-breaking epiphany, yet implicit acceptance still prevails in both scientific and policy-making communities (Wesselink et al., 2013; Stenmark, 2017). Why? Within the scientific community in particular, attitudes of ‘scientism’ may account for some level of persistence. Broadly, this describes a worldview where scientific knowledge and practices, under a guise of objectivity, are given an unparalleled authority in determining intellectual processes and practical outcomes. The advocacy for technocracy, engendered by this ideology, is largely a reaction to challenges to scientific hegemony, where ‘unscientific’ processes such as common sense or instinct are favoured (Sorell, 1991). Naturally, it is in the interests of the scientific community at large to preserve the power that scientism and the linear model prescribes to them. If nothing else, these interests revolve around a continual supply of funding, resources and structural facilitators, for a balance of demand- and supply-driven research (Sarewitz & Pielke, 2007; van Enst et al., 2014)

The prevalence of the linear model goes beyond just scientific self-interest. In a wider sense, it is a *deeply political project*, to conceal the real implications of the political cultures, ideologies and interests which guide any stakeholder’s engagement with climate change (Oreskes & Conway, 2010). To give climate science a semblance of influence is to make it an easy target (Wynne, 2010). Fundamental concepts in science, such as uncertainty and complexity, can be exploited and worked to the interests of any stakeholder (van der Sluijs, 2008). Yet the linear model explains policy decisions in the apparently power-free and value-neutral terms of scientific evidence, such that deficient climate policy can be tied to real or perceived deficiencies in climate science.

Thus, climate science sits at the mercy of a double-edged sword: purported as the source of inaction and reticence in policy, and simultaneously disempowered to make much difference to this widely-preached belief or to the policy itself. The rhetoric arising from societal scientism and the linear model is damaging to the reputation of science and constrains the potential contributions that scientific findings can make to policy recommendations (Sarkki et al., 2013). This is the “consequence” to which the section heading alludes. The lack of progress on the Paris COP21 agreements are testament to this on a global scale, even if it does not universally hold at every scale of enquiry (e.g. effective decarbonisation within some cities; Bulkeley & Newell, 2015; IPCC, 2018). Further, as politics are mapped onto science, the exposition of the linear model serves to deny any such process, concealing any values or power relations which run through the scientific practice (Levins & Lewontin, 1985). In doing so, knowledge and power are superficially disconnected (Medin & Bang, 2014). Climate change science, policy and the interfaces between them are not conceptualised as they are in reality – political at their cores (Hoppe, 2009; Spruijt et al., 2014).

## Focus: Politics in Science

Therefore, while there is a sense that the potential use of science in climate policy is underexploited, this should be weighed against overstating the importance of science to policy. The linear view central to widely-observed enactments of science-policy interfaces is misleading for and damaging to both science and policy (e.g. Hoppe, 2009). The pervasion of politics into both, and their interaction at science-policy interfaces, appear to lie beneath these consequences. However, just as these politics underpin the current failings of science-policy interfaces in addressing climate change, so too do they hold the crucial path to resolving them (Stone, 2002; Giddens, 2008).

Thus, this paper homes in on the role of science in inherently political problems, where science’s influence is in contention. In this respect, the smoking and nuclear winter case studies are well-placed to offer valuable insights for climate change. Given historic and current politicisation within and across science, there is interest in examining how science can engage with politics so that its policy relevance can be realised without acting at the expense of itself or effective, holistic policy.

My two principal research questions follow from this. The first, principal question concerns *process*: in what ways does science engage with the implicit and explicit politics of its work? This can contribute to understanding the political acts encompassing and intertwined with climate science. The second concerns *agency*: in what balance is science actively shaping or passively being shaped by dominant political discourses? This can construct a sense of how significant the political engagements identified by the first question are or will be in actual climate policy outcomes.

Before proceeding, a clarification: “science” covers a broad remit and is rarely cohesive in its outputs or monolithic in its practices (within the scientific community alone). Here, in recognition of this diversity and complexity of meaning, “science” is taken to include any activity at the science-policy interface which fits more under the label of science. I am interested in the broad activities of science, encompassing any from individuals or collectives at the relevant science-policy interface (beyond just the traditional scientific community), which appear to be directed at tackling the political dimensions of its body of knowledge.

# Methods and Materials

*“But there isn’t a theorem in the world which couldn’t be falsified by monsters.” (Lakatos, 1976)*

In order to engage with politics at the science-policy interface, the monster metaphor will be a central device for analysis. The metaphor has roots in identifying theories and models which run counter to the intuitive nature of mathematical proofs (Feferman, 2000). In more recent cultural study, its definition and application have developed to how I seek to employ it here: “a phenomenon that sits in two categories that were thought to be mutually excluding” (van der Sluijs, 2005, p.88). As the phenomenon challenges traditional binary, black-and-white conceptualisations of how things are, ambiguity and doubt reign, promoting reactions of fear and fascination (Smits, 2006).

It has previously been used to provide rich insight and intellectual depth of understanding vis-à-vis uncertainty in climate science (e.g. Webster & Curry, 2011). Uncertainty calls into question the Boolean logic central to common dialectics in thinking about climate science, such as knowledge vs ignorance, facts vs values or objectivity vs subjectivity. How the scientific community grapples with the less comfortable, fuzzy logic operations, which the uncertainty monster demands, can be usefully organised into various strategies of ‘taming’ the monster. They are as follows (following van der Sluijs, 2005 & Smits, 2006):

* *Exorcism* (and hiding) aims to expel the monster
* *Adaptation* (also described as *simplification*) aims to transform the monster so that it better fits within existing binaries
* *Embracement* (also described as *detection*) aims to welcome the monster with open arms, accepting it as an inevitable product of a wonderfully complex world
* *Assimilation* aims to adapt the monster and reconstruct the cultural lens through which one perceives it

## The Politics Monster

Here, inspired by the uncertainty monster, the politics monster is proposed. The linear view of science and policy, as discussed above, places the two concepts in opposition. However, the politics which contextualise, disseminate into and co-produce both challenge this widely-held framing.

The lines which demarcate the realm of science from the realm of policy become blurred when the politics monster is active (or enraged). Discomfort arises not only from the confusion this creates, as with the uncertainty monster, but also the very nature of the politics monster. Politics ignites concerns over equality, justice and conflicts of interests or values (to name a few), which induce anxiety and distrust. In other words, the politics monster brings about two-fold, synergistic fears: the fact that it is a monster and the fact that it is a political one.

The politics monster pervades into the (false) dichotomies discussed for the uncertainty monster (knowledge vs ignorance, prediction vs speculation etc.), but the focus here is on its role in science vs policy (van der Sluijs, 2005). In particular, the monster metaphor was employed to gain insight into how science attempts or is used to manage political situations which inevitably arise at the science-policy interfaces (i.e. the first research question).

To achieve this, primary (documentary records) and secondary (academic literature) sources were consulted the case studies of smoking and nuclear winter. Both are (or have been) high-profile problems and involve high stakes. Crucially, both issues were flagged and characterised by scientific research, but did not follow a linear path into policy and initiated highly politicised debates.

In the following sub-sections, the underlying (and seemingly dominant) scientific and political narratives for each case study are outlined, with emphasis on how they interrelate. A more comprehensive summary of each is well beyond the scope of one paper, so the information here is selected as the necessary supporting information for later analysis and discussion. Beyond time constraints, the use of the monster metaphor, my “personal lens” and the current availability and bias of information in primary and secondary sources are all factors shaping the framing of the case studies as they are. Other framings are possible, but the selection, omission, marginalisation and prioritisation of information here reflects personal judgements, based on the relevance (and credibility) of said information for addressing the core research question.

## Smoking

The history of tobacco smoking is perhaps defined by its rise and fall in the 20th century (Brandt, 2007). Mechanisation of cigarette production and high-profile marketing campaigns saw cigarette smoking popularised in the first half of the century; research unveiling its link to rising lung cancer incidence, and the ensuing, predominantly political debates, prompted a steady global demise from the 1980s onwards (Proctor, 2011).

To characterise the second half of the century as the ‘fall’ is perhaps inaccurate. Given the latency between cigarette smoking and its detrimental health impacts, and the only recent global peak in cigarette consumption (due to non-Western rise in demand), the problem lies more in the near future, rather than being confined to the past (Frieden & Bloomberg, 2007). This is testament in large part to the tactics employed by ‘Big Tobacco’ in response to scientific findings detrimental to their own commercial interests. The narrative explored here is focussed on now well-documented industry manipulation of the science, which appears the dominant engagement of science with politics in smoking discourses (Oreskes & Conway, 2010).

## Nuclear Winter

“Nuclear winter is not amenable to experimental verification—at least not more than once” (Sagan, 1984)

Unlike the harmful effects of tobacco smoking, or those of anthropogenic climate change, nuclear winter has not been observed. It is ‘just’ a theory, but one which has carried considerable weight in discussions of nuclear warfare at all levels (Robock & Toon, 2012). It describes the catastrophic climatic perturbations that would follow an interstate nuclear conflict of sufficient proportions, whereby smoke from burning material would spread across the stratosphere. With less solar radiation reaching Earth’s surface, the subsequent global cooling could be significant. Major agricultural failures could ensue, posing existential threats to both human beings and wider civilisation (Parthermore et al., 2018). The theory was the product of many converging areas of research, though it was the so-called TTAPS paper which first coined the phrase (Turco et al., 1983).

This is a scientific theory inseparable from the politics of the late Cold War, which formed the dominant context for its early development and debate. Commentaries tend to focus on the political acts of the theory’s proponents, most notably Carl Sagan, and the subsequent backlash (Sheldon, 2016). The theory was used in highly divergent ways between and within the US and USSR, to different ends and with different outcomes (Rubinson, 2014). However, largely due to availability of records, the focus here is on the American context. In particular, Ronald Reagan’s 1983 “Star Wars” speech and subsequent establishment of the Strategic Defence Initiative (SDI) defined the political debate, as these promoted the idea of a winnable nuclear war, which the theory of nuclear winter rejected (Lepore, 2017).

Similarly to tobacco smoking, however, this is another issue which cannot be consigned to history. Most basically, this is because active nuclear weapons still exist, so the risk of nuclear winter persists (Baum, 2015).

# Results and Discussion

In the case studies offered by smoking and nuclear winter, the use of the monster metaphor seems apt for the politics around the science-policy nexus. If nothing else, the fear of and interest in politics in these cases makes a ‘politics monster’ seem appropriate.

Moreover, the exposition of science in the political field (most notably the activities of the scientific community) shows evidence of all four strategies of monster-treatment identified by Smits (2006). Assimilation is less clear in both case studies, however, perhaps as an artefact of the historical context within which the monster is discussed (more in section 3.4). There appears to be dynamic interaction between the strategies over time, whereby the dominance of strategies rises and falls in relation to each other. Van der Sluijs (2005) describes this as an “ongoing learning process” (p.92), the details and validity of which will be discussed in section 4. In this section, the sequence of dominant strategies (the learning process) traced through the case studies will structure the analysis.

On a collective scale, the field of science first attempts to tame the politics monster through exorcism and then embracement, without any explicit acknowledgement of its presence. In order, adaptation and assimilation tend to follow, as the monster is more explicitly and openly recognised. This progression is neither rigidly sequential nor prescriptive, but instead alludes to an organic process, laden with overlap, interaction and stochastic variation. Many strategies may be evident in any one place at any one time amongst any one demographic. As such, the proposals here are intended as guiding ideas for dissecting monster strategy evolution, supported by evidence, rather than an absolute, deterministic framework.

## Monster-exorcism (including monster-hiding)

At the point of scientific breakthrough, even (on occasion) through to the convergence of scientific consensus, the emergence of a research discovery is marked by strategies of monster-exorcism. The politics monster may be consciously or unconsciously hidden or expelled, as science attempts to ‘just get on’ with the science. The linear model of science into policy is strongly evident, with clear boundaries marking the realm of science and that of policy. They are perceived as divergent, distinct practices, with no place for politics. It seems unlikely that at least some of the political dimensions of the research are not realised by the scientific community itself, so the exorcism strategy would appear to be deliberate and/or neglectful.

At the conception of nuclear winter theory and as smoking’s harm to health was first realised, monster-exorcism would appear to be preferred largely so that robust science remained the focus (Dorries, 2011). That, or the science was so far removed from the formal political arena that political implications of the research were not deemed to be the concern of science. The work of Richard Doll and Austin Hill in the British Medical Journal provided one of the most compelling lines of evidence for the link between tobacco smoking and lung cancer (Doll & Hill, 1950; 1954). The motivation seems to be finding scientific answers to questions posed by trends in public health:

“the great increase in the number of deaths attributed to cancer of the lung in the last 25 years justifies the search for a cause in the environment” (Hill & Doll, 1950)

In summarising the body of research at the time, Hill & Doll (1954) imply a value-based judgement of the significance of the above endeavour, within which they were heavily involved:

“All these studies *agree* in showing that there are more heavy smokers and fewer non-smokers among patients with lung cancer than among patients with other diseases. With one exception […] these differences are *large enough to be important*.” *(my emphasis)*

Their self-defined objective is not one of “knowledge for knowledge’s sake”, for they clearly acknowledge that their research is of importance to public health and subsequently construct an idea of scientific consensus. A problem is identified and deemed to be of sufficient weight to be published and characterised as such to the academic community, with consensus-building yielded as supporting evidence to their argument (Proctor, 2011). In these acts of social engagement, planned and implemented as expressions of values, scientific objectivity is upheld and policy (or perhaps just societal) relevance implied. But the inevitable “dirtying of hands” (Bijker, 2003) in the process is not recognised. Given the normative conceptions of science at the time, as yet unaffected by the influential ‘tobacco strategy’ that followed, exorcism in this case seems to be more akin to (unwitting) hiding than to (active) expelling of the politics monster (Brandt, 2012).

Similar accounts, based on scientific process and consensus, were published in journals from different countries spanning at least four distinct medicinal disciplines throughout the 1940s and early 1950s. The confluence of so many diverse strands of information, without coalition (towards a desired policy outcome), suggest that hiding was not always deliberative, as the politics monster cannot have been seen in every case. For example, the underlying knowledge in the field of cellular pathology (one line of evidence) is unlikely to have been formed with political applications to tobacco regulation in mind. That the tobacco industry was aware of and covertly contributing to the burgeoning research case of smoking’s health risks, as indicated in concurrent internal communications, shows a more purposeful strategy of politics monster-exorcism (Proctor, 2011). The link to cancer and strong body of evidence, privately known and discussed in the industry, did not warrant outward-facing political engagement while customers stuck to the smoking habit (Dakin, 1953; Cameron, 1956). Exorcism was a delaying tactic, buying the industry time until the monster became too big to hide or expel (Brandt, 2012).

“Nuclear winter” is in itself testament to a more pre-meditated, calculating deployment of exorcism strategies - but in order to serve science’s own interests.

“the leadership of NASA was eager to avoid friction with Washington on sensitive issues such as nuclear conflict and was thus averse to seeing terms like “nuclear war” or “nuclear weapons” in the titles of its scientific publications” (Dorries, 2011)

NASA, who employed some of the TTAPS group, actively tried to depoliticise any scientific outcomes, largely to minimise risk to their government funding. Turco et al.’s (1983) alternative of ‘nuclear winter’ temporarily appeased their governing administration. However, blocking a planned presentation of the initial results of their research at the 1982 American Geophysical Union meeting was just one intervention of many, symbolic of NASA’s concern for science in a politically-divisive environment (Sagan & Turco, 1990). These attempts were fruitless, given how recognisable and politicised the theory was to become (Badash, 2001). Earlier research, such as that of Crutzen & Birks (1982), which paved the way for the TTAPS study, had already been presented with explicit political motivation for disarmament (Dorries, 2011). Perhaps, therefore, strategies of exorcism from NASA were naïve or inappropriate.

Ultimately, these strategies are all pre-destined for failure, not least because the uncertainty and complexity in scientific research creates ample breeding ground for politics and politicisation (Carey, 1983). An inherent denial of politics in science or policy is perhaps naïve and short-sighted (Hoppe, 2009). Exorcist strategies try to cut off the monster’s head, but even if successful, many more inevitably grow. For smoking, the implications arising from the initial links to lung cancer caught the attention of smokers, public health organisations and tobacco companies (Brandt, 2012). With the research alarming and inconvenient for many, conflicts of interests and values inevitably arose. The void of political consideration in lung cancer research perhaps confounded this, resulting in science losing control of its research as its management of the trade-off between credibility and legitimacy tipped heavily toward the former (Proctor, 2011; Sarkki et al., 2013). For nuclear winter, the research touched on issues that were already more overtly politicised in the high-stakes political environment which characterised the Cold War years (Rubinson, 2014). Even though some scientists working on the theory averted politics as far as possible, the political implications arising from their research testify to a monster too big to hide and too enraged to exorcise (Dorries, 2011). The phase is short-lived, never genuine (in that politics and values are never absent from scientific work) and necessitates a strategy that at least acknowledges the political corollaries arising from research.

## Monster-embracement

*“the Nuclear Winter scenario could not serve the needs of Soviet leaders better if it had been designed for that purpose” (Seitz, in Lepore, 2017)*

Following the inevitable failure of the exorcism strategy, science recognises that the politics monster is inherent to the area of research being undertaken, or simply that it is too big to hide. However, perhaps in efforts to conserve science’s perceived objective authority, the politics monster cannot be openly acknowledged or even implied, discounting strategies of monster-adaptation. Instead, the opportunities that the monster presents can be capitalised upon, aided by cultures exalting scientism, so that the findings of scientific research can be furthered or questioned according to the interests of the scientific body involved. Often under a guise of continued exorcism, monster-embracement strategies take hold in and of science.

Nuclear winter theory implicitly welcomed the politics monster in its early publicity campaigns, fronted by public figures such as Sagan and Stephen Jay Gould. In the organising of their own scientific seminars and workshops (and rejecting invitations to those where they suspected to be met with scepticism), the scientists working on the theory could rapidly establish a consensus position and entrench and expand scientific support (Badash, 2001). Such consensus held political and social weight, which served to depoliticise the theory. As a precaution against any misuses of scientific objectivity, Gould in particular detached scientific facts from values, to be clear that the theory was not a political crusade but an absolute truth to be reckoned with (Sheldon, 2016). However, this value of neutrality in science simply formed the basis of a moral and political campaign:

“Nuclear winter also helps to clarify what seems to me the near certainty that any “conquest” in nuclear war could only become the ultimate Pyrrhic victory as an unforgiving climate propagates its chilling effects upon any aggressor” (Gould, 1985, cited in Sheldon, 2016)

The emotive, urgent language which characterised his writing and oratory on the matter created more than just a “scientific deterrent” that could be used as a “moral deterrent” by others outside the scientific sphere (Gould, 1984, cited in Sheldon, 2016). One only needs to look at the very evocation of deterrence, let alone countless appearances of scientists before congressional audiences, to realise that this evocation of science was a valuable political tool (Sheldon, 2016). In the Soviet Union, the value-neutral authority of the theory became the subject of a different political debate, between the state (for use as anti-Western propaganda) and scientists (as a symbol of free speech). Critically though, all these examples demonstrate an apparent exorcism of the politics monster, underscored by the actual politicisation of scientific debate – strategies of monster-embracement (Rubinson, 2014).

The (self-defined) benefits of politicising the issue at hand are realised, and a polarisation of the issue can be broadly identified, between supporters and cynics of the scientific proposal. Further research efforts and science communication tend to follow from the ‘camp’ chosen. The reasons for support (or rebuttal) may or may not be political in nature, but the politics monster is pervasive. To evoke Smits’ (2006) conceptualisation of Frankenstein’s monster, the monster is only so as its creator lost control and failed to take any active responsibility for its actions. Therefore, a minority of actors interested in the politicisation of science, for the advancement of their own interests and values, may be sufficient for the relevant field of science to become widely politicised.

Scientific debates become political debates dressed as scientific debates, with new and existing stakeholders in the debates wittingly or unwittingly picking a side. With the politics monster new onto the science scene for many, the fears aroused are matched or exceeded by fascination. Consequently, potential methods of monster manipulation towards the arguments of one’s own camp become subject to experimentation and strategisation. Critically, underlying politics remain concealed and never outwardly recognised (nor inwardly, in some cases).

Embracement breeds political tribalism, which is observed in both ‘scientific’ debates around smoking and nuclear winter. Oreskes & Conway (2010) identify a suspicion of government regulation as the core rationale for people and organisations who consistently question the existence and severity of environmental and public health risks. It is often the same people, the same organisations and the same tactics involved – indeed, some (e.g. S. Fred Singer, the Heartland Institute) have associated more with the sceptical ‘camp’ in both case studies and in the debate around climate change (Lepore, 2017). For smoking, the science supporting regulation was a threat to the neoliberal project of rolling back the state; for nuclear winter, the science supporting the theory went against any belief that the US could win a nuclear war, drawing in anti-communist and patriotic ideologies against the science (Oreskes & Conway, 2010; Robock & Toon, 2012). In both cases, the theories and supporting data were engineered towards the preferred conclusions of the political tribe to which one associated. Science, in deployment by scientists and others, embraced the politics monster, perceiving the opportunities it afforded for advancement of a political cause or ideology.

## Monster-adaptation

Where embracement can bring about political deadlock, with the various ‘camps’ making little headway in the supposedly ‘scientific’ debate, strategies of monster-adaptation can set in motion scientific and political progress. These strategies are based on fitting the politics monster to forms that are more comfortably amenable to existing scientific practices and epistemologies. In a similar vein to embracement, the potential for politics to serve one’s own interests in the ‘scientific’ debate is realised. Whereas embracement strategies seek to exploit this potential, adaptation strategies are more concerned with seeking a monopoly on this potential, attempting to manage the politics monster so that it works solely to the interests of one’s own ‘camp’. In this way, advantage in the political debates around the scientific issues is sought.

Key to these strategies is transforming the politics monster so that one’s understanding of the problem at hand appears purely scientific and objective, disguising the value-laden, subjective judgements which led to this. Hence the methods of transforming the monster must resemble those that science and scientists will be accustomed to. Therefore, this describes practices where political agendas are channelled into scientific forms, namely debates around complexity or uncertainty (a monster in itself). For instance, scientific uncertainty was elaborated upon by tobacco industry-sponsored projects to manufacture doubt around lung cancer research detrimental to their commercial success (Samet & Burke, 2001). Conversely, the implications of modelling uncertainty were frequently downplayed in favour of the theory of nuclear winter, which often underpinned arguments for denuclearisation (Lepore, 2017).

It is also key that, while internalising the politics of one’s own science, the politics of others’ contradictory science are externalised and exposed to scrutiny. Thus, in phases of adaptation, the recognition of the politics monster at the science-policy interface is increasingly explicit - but only selectively, to suit one’s own agenda. In a letter to Carl Sagan, Edward Teller (1983) exemplifies this aspect of monster-adaptation:

“I can compliment you on being, indeed, an excellent propagandist – remembering that a propagandist is the better the less he appears to be one”

Teller, as an advocate for Reagan’s SDI, repeatedly emphasised the uncertainty and simplicity of the climate simulations used to formulate the nuclear winter theory (Badash, 2001; Dorries, 2011). In this quote, he reduces Sagan to a propagandist, rather than scientist, in an attempt to discredit Sagan’s scientific credentials and contributions to the (pseudo-)scientific debate. This line could just as reasonably be levelled at Teller. In fact, it typifies the type of ‘boundary work’ which underscores strategies of monster-adaptation: insisting on the objectivity of apolitical science which supports one’s own ‘camp’, while dismissing all contradictory evidence as political fodder (Gieryn, 1983). Strategies of boundary definition, which determine the (in)validity of a person’s or group’s contribution based on the relevance and strength of scientific credentials, epitomise long phases of debate over nuclear winter (Jasanoff, 1990).

Some of the most widely-identified tactics employed by the tobacco industry, in relation to the growing body of scientific evidence for the harmful health effects of smoking, were akin to strategies of monster-adaptation. They sought to manipulate scientific outcomes to manufacture doubt around and divert attention from the scientific findings that were most inconvenient for their interests (Ong & Glantz, 2001). To that end, industry-funded research programs and institutes, purported as independent, proliferated. The Tobacco Industry Research Committee, while less covertly named than most tobacco-sponsored research initiatives, was one key player (Brandt, 2012). They became an instrumental voice for the joint collusions of the tobacco industry, under the pretences of science:

“It is believed that the word ‘Research’ is needed in the name to give weight and added credence to the Committee’s statements” *(Hill & Knowlton, 1953, cited in Brandt, 2012 – working with tobacco industry)*

Public relations campaigns, such as those designed by the Hill & Knowlton firm, exploited the valuable scientific concept of scepticism (where evidence questions conclusions), using the scientific dissent of a minority of researchers (obliging or not) to inflate the debate to political controversy and support denialistic statements (where pre-conceived conclusions question evidence) (Oreskes & Conway, 2010). In these ways and more, the tobacco industry sought to gain control of science, so that the politics monster would be embraced within the scientific community. As discussed above, only a minority needed to embrace the monster for politics to disseminate throughout the scientific issue. The tobacco industry would have a greater chance for influence in a political debate but could not directly challenge the high levels of public and government trust in science at the time:

“A flamboyant campaign against the anti-smoking propagandists would unquestionably alienate much of the support of the moderates in both scientific and lay publics” *(Hill & Knowlton, undated, cited in Brandt, 2012)*

So it was critical to utilise well-established scientific practices to maintain salience and authority (i.e. adaptation). In doing so, they could legitimately politicise the debate and control it to their own ends, without too much question. The media’s penchant for controversy and a well-publicised but disingenuous commitment to good science and public health consolidated a misconception of scientific debate amongst the public and policy-makers (Brandt, 2012). In other words, the ‘tobacco strategy’ was to play to the strengths of science, to simultaneously promote yet conceal their desire for political gain (towards tobacco deregulation; Mann, 2012). The exposure of tobacco industry tactics means that these are some of the most blatant examples of adaptation, but that is not to preclude other groups from acting in their own interests under pseudo-scientific disguise – including ‘independent’ scientists (Medin & Bang, 2014).

In terms of monster-adaptation, although remnants of a linear science-policy view persist (e.g. scientism), co-production of and between the two is more greatly realised. In the activities of boundary definition discussed, science and the scientific community appear to have some control over the politics monster. However, the tobacco strategy is indicative of a common exposition of science such that science becomes a passive enabler of its own politicisation (Weingart, 1999). Thus, on the basis of the case studies described, it is unclear whether adaptation strategies in or of science can ever truly tame the politics monster. Practices pertaining to simplification of politics into scientific form will predictably fail, as the complexities of political and policy arenas are not helpfully amenable to such reductionism nor hegemony from one particular set of interests (Hoppe, 2009; Hajer, 2015).

## Monster-assimilation

Assimilation of the politics monster builds on adaptation strategies, where it has been moulded into scientific forms. They depend upon certain normative scientific cultural understandings, including, in many cases, the linear model of science into policy. Assimilation marks the rethinking of science and policy, such that they are perceived as convergent practices with politics actively shaped by and shaping both. The politics monster is placed at the centre of authority within science-policy (elements of embracement), manipulated towards particular values and interests (elements of adaptation) and re-framed such that (elements of) its monstrosities in scientific and policy-related affairs are re-imagined. In this additive sense, the “ongoing learning process” amongst those concerned with science culminates with strategies of assimilation, where science learns to live with the politics monster (van der Sluijs, 2005).

Assimilation is not as much a rethinking of the politics monster itself, which monster-adaptation has already partially attempted. It more reflects a cultural reconstruction of science (and policy), so that the politics monster is recognised as a core cause and effect in scientific and policy debates. Attitudes of scientism are replaced by more reflexive understandings of the role of science, such as post-normal science (Funtowicz & Ravetz, 1993). Smoking and nuclear winter are both issues typical of the post-normal world, with ‘facts uncertain, values in dispute, high decision stakes’. However, much of the discussion has so far revolved around events and attitudes which pre-date post-normal thinking. Therefore, it would appear that the case studies show little evidence of complete assimilation.

However, partial assimilation can be observed at times. The vacancy of values from science in nuclear winter debates, as depicted in terms of embracement (section 3.2.), was a disjuncture from the democratic and civic virtues associated with 20th century science up until that time (Jewett, 2012; Cohen-Cole, 2014). It did help to re-define scientific engagement with political matters, though is certainly not indicative of learning to live with a prominent politics monster at science-policy interfaces. It was not so much a re-imagining of science, but a re-affirming of selected scientific principles, such that the artificial separation of science and policy persisted.

The wider popular activism of Sagan and supporters of the nuclear winter theory can be read as efforts of assimilation. Sagan’s decision to publish the worst-case scenarios of nuclear winter research, with doubt minimal and consensus allegedly reached, in the popular *Parade* magazine and the *Foreign Affairs* journal, was a point of controversy (Sheldon, 2016). The timing, months *before* the TTAPS paper was published in *Science*, has seen the articles labelled at variance with proper scientific practice (Badash, 2001; Oreskes & Conway, 2010). However, in light of Sagan’s (and others’) urgent and hasty advocacy, it seems more likely that these were semi-coordinated attempts to reframe science as a socially and politically engaged endeavour, with the benefits of scientism perpetuated (Lepore, 2017). Such active efforts to “redefine science” (Rubinson, 2016) were not just motivated by anti-nuclear beliefs (as can be said of monster-adaptation strategies), but an underlying philosophy that science could answer any societal question or issue in a way that ascended politics (Dorries, 2011). That these run counter to the post-normal conception of science for which many in the environmental movement advocate today is archetypal of the monster-assimilation’s downfall: in the words of van der Sluijs (2005, p.91), *“changing the categories by which we judge the monster is likely to create new monsters, as every categorisation is an imperfect reduction of complexity”.*

The tobacco industry, a decade later, opted too for monster-assimilation in covert advocacy for “sound science” in research related to the dangers of passive smoking. In collaboration with other industries subject to inconvenient scientific scrutiny, public-facing proclamation of research as ‘sound science’ or ‘junk science’ formed part of an adaptation strategy focused on boundary definition. Further though, multifarious attempts to inflate scientific standards of proof to a point where any regulation was difficult to justify more closely resemble monster-assimilation (Ong & Glantz, 2001). Although the scientific community naturally warmed to the idea of sound science, the assimilation efforts here appeared too extreme and disingenuous to succeed, especially as more evidence (health and industry malpractice) mounted against tobacco (Samet & Burke, 2001).

In this and all examples of assimilation, the desired adjustment(s) to perceptions of or within science are intended to direct the politics monster in a way favourable to the interests and values of their proponents. To resonate with Douglas (1966) and Smits (2006), it is perhaps at this stage when the monster is perceived as a miracle in equal measure. While inherent values and interests may not be fully transparent, politics is explicitly placed at the heart of science and of policy in complete assimilation. The very dialectic from which the politics monster originates is resolved in one respect. However, without complete political consensus and cooperation in assimilation, the monster will persist in some form, or new iterations (as above) will arise.

# Further Discussion

The mantra of “all models are wrong, but some are useful” is just as pertinent to the politics monster concept proposed here as it is to IPCC climate models (Curry & Webster, 2011), those used by Turco et al. (1983) for nuclear winter’s first portrayal, or those used to estimate the global health fingerprint of cigarette smoking (Frieden & Bloomberg, 2007). The employment of the metaphor in this science-policy context undoubtedly paints a certain picture and frames it in certain way, with many other pictures and frames possible and valid. Nevertheless, the framework that the “monster-theory” instigates appears to offer useful insights of when science gets political. Section 3 offers theoretical and empirical (case-study) support for the monster metaphor as applied here.

Previously, Smits (2006) has suggested that the taming strategies are organised along a spectrum of tolerance of the monster in question. In the case of the politics monster, this is somewhat true - though they also seem to be helpfully organised along a further axis, such as the degree of explicit acceptance of the monster (Figure 1). This may help to elucidate the successes and failures of each strategy, and why their popularity might vary according to cultural or political context.



*Figure 1: the monster-management strategies can be approximately organised according to their degrees of tolerance and explicit acceptance of the politics monster.*

## Application to Climate Change

### Process

The progression of politics monster-management outlined for the issues around smoking and nuclear winter also appear to prevail in climate change politics. The parallels between the two case studies and climate change are well-documented, so it is unsurprising that parallel strategies of monster-management are observed in climate change science-policy discourse (e.g. Nilsson et al., 2009; Oreskes & Conway, 2010; Lepore, 2017).

Exorcism in science characterises the introduction of any scientifically-defined societal problem onto political agendas, and anthropogenic climate change was no exception (Ref). Strategies of embracement and adaptation have been employed by an array of stakeholders involved in science’s engagement with politics. This includes but is not limited to: the scientific community (e.g. the politicised reactions to *The Sceptical Environmentalist* documented by Pielke, 2004), industry (e.g. the fossil fuel-funded attacks on scientists in Mann, 2015), policy-makers (e.g. the ‘report wars’ described by Wesselink et al., 2013), indigenous communities (e.g. the links to western science in Arctic-based activism analysed by Crate, 2008) and politicians (e.g. the political opportunities outlined in the 2006 Stern Review and 2008 Giddens Report). Exploitation of scientific uncertainty and inherent complexity in the climate system to political ends, especially akin to adaptation, are well documented in academic (e.g. Brugnach et al., 2007 on climate models) and popular circles (e.g. the 2012 *Merchants of Doubt* documentary).

Assimilation strategies, aimed at re-framing science and re-assessment of the politics monster, are also outlined in theory in many, diverse academic disciplines on environmental issues. These include contributions from post-normal science, science and technology studies and the politics of expertise (Spruijt et al., 2014). Shove’s (2010) call to the social sciences for broader engagement in climate change science is one such example of an assimilation strategy proposed in academia. Perhaps motivated by the ‘reason’ discussed in section 1.2., monster-assimilation in or of science for politics is yet to be clearly evident in mainstream climate change discourse.

It should be noted that there are significant points of difference between the case studies and climate change. The distinction between ‘wicked’ policy problems, as defined by Rittel & Webber (1973), and the characteristics of ‘super wicked’ problems (Levin et al., 2007) perhaps suitably captures this. While smoking and nuclear winter evoke aspects of both, the climate change problem seems to more firmly belong to the latter. In terms of the engagement of science with politics, the suggestion that “those who seek to end the problem are also causing it” seems especially pertinent (Levin et al., 2012). Perhaps, with a wider set of interests and values converging on the production and application of climate science, the challenges that the politics monster poses are even more complex and even less predictable.

### Agency

With some benefit of hindsight (remembering that these are not case studies confined to history), one can ask: how effective are these strategies of monster management? This is critical for evaluating the role of science in profoundly political problems. Does the scientific community ever effectively tame the politics monster towards effective policy outcomes? Indeed, to what extent can the scientific community control the monster, if at all?

For the nuclear winter case study, consider this: the Cold War concluded in the late 1980s. As the Soviet Union fell, those scientifically invested in the theory were caught up in debate over the uncertainties in model parameters (adaptation), and the item fell off scientific agendas shortly afterwards (Rubinson, 2014). The theory did not attain full acceptance in anti-nuclear protest groups, which themselves have been identified as relatively inconsequential in the unravelling of the Cold War (Sheldon, 2016). However, it has been since shown that the very public campaigns (embracement/assimilation) of some scientists were crucial in persuading political leaders and officials of the theory’s validity, although direct links between motivation to act and policy action are difficult to discern (Lepore, 2017). International political agreements over subsequent decades have coincided with a reduction in nuclear weapon arsenals (Robock & Toon, 2012). Nevertheless, the threats that nuclear winter pose persist to an extent that warrants continued scientific and political engagement (Baum, 2015). Consequently, there is recent evidence of adaptation strategies dominating scientific discourses (e.g. Mills et al., 2008; Parthermore et al., 2018). From its initial conception through to its present-day debate, the relationship between monster-management and policy outcomes appears haphazard.

For the tobacco smoking case study, consider this: evidence of harmful health effects converged in the 1930s through to the early 1950s, yet, worldwide, there are currently over 1 billion smokers and an associated economic externalities equivalent to 1.8% (US$1436bn) of global gross domestic product (Goodchild et al., 2018). In crude terms, good science has not led to good policy. The strategies of embracement, adaptation and assimilation attempted by the tobacco industry are partly attributable to significant policy delays, yet the latter half of the 20th century is still punctuated with regulatory tightening on their activities (Brandt, 2007; Nilsson et al., 2009). Arguably, the greatest policy progress has been made in some countries since the exposure of the Big Tobacco tactics and the return of more exorcistic research initiatives (Oreskes & Conway, 2010). Again, monster-management strategies in or of science seem to have implications, but little consistent association with policy change.

Superficially, these are hardly the ‘success stories’ of the science-policy interface. Nor do they appear to offer consistent evidence of science effectively dealing with or using the political implications of research to the ends of policy development for the issue at hand. This is true irrespective of the dominant monster-management strategy of the time. In short, therefore, for smoking and nuclear winter, the politics monster seems to have more agency in controlling policy outcomes, rather than any strategies science employs or is employed within to tame it. To stretch the metaphor’s application, science holds onto one leg of the politics monster, but cannot steer it effectively. Care should be taken in discerning the implications of this – it should not be taken to mean that it doesn’t matter how science engages with the political. The case study evidence is positively disjunctive to such a conjecture. However, it could offer some useful direction for climate science in grappling with climate change politics and even helping to break the glass ceiling of climate policy inactivity.

## Implication for Climate Change

*“The more complex and elusive our problems are, the more effective trial and error becomes, relative to the alternatives” (Harford, 2011, p.35)*

In the exposition of the monster metaphor, it is apparent that politics shape scientific and policy outcomes, perhaps more so than the other way around. The dominance of each strategy at any one time appears to be related to the political environment of the time, and a reaction to the political shortcomings of previous strategies. Critically, there is no perceived relationship between policy action and the monster-management strategies of or in science. Any one strategy is capable of bringing about policy stalemate or activity (which could entail a variety of outcomes). Diffuse connections of cause and effect between the activities or exploitations of science (monster management) and policy outcomes may exist, but often require some benefit of hindsight to detect. Moreover, owing to the primacy of politics perceived here, problems at science-policy interfaces grow in complexity and unpredictability. A lack of defined structure and predictive capacity limit the capability of scientific engagement with climate change, not only from a biophysical perspective but also policy and political perspectives (Hoppe, 2005).

It seems inappropriate, therefore, to prescribe the role that climate science should take in engaging with the implicit and explicit politics interwoven into research. Many resources are invested in enhancing science’s engagement with the politics monster, but the cases of smoking and nuclear winter indicate that any such efforts will likely be futile (Sarawitz & Pielke, 2007).

I argue that such a finding should have a liberating effect on climate science. In the conception of climate change as a ‘super wicked problem’, Levin et al. (2012) suggest an ‘applied forward reasoning’ approach of progressive incremental changes, which ‘constrain our future selves’ to low-carbon futures (Cashore & Howlett, 2007). Such a strategy requires a strong utopian vision of what the (climate) future should look like, and rapid unravelling of path dependent processes towards this, including scientific work and interpretation constrained to that political vision. This seems at odds with the non-linear, almost stochastic progression of climate policy and science demonstrated here and does not account for the parallel progression of climate politics in shaping (and being shaped by) future science-policy outcomes.

The smoking and nuclear winter case studies might suggest that over-investing resources in strategizing and constraining the role of science, as ‘applied forward reasoning’ advocates, is wasteful and misguided. Policy activity on climate change, which is presumably more desirable than the current inactivity, may or may not be influenced by any scientific engagement with politics. Therefore, providing a negotiation of credibility, legitimacy and relevance continues in climate science, its use and activities in relation to politics (monster management) could be more open to experimentation (Sarkki et al., 2013). Politics is, after all, a promising route to climate policy action, so a greater scope of imagination for science’s engagement with politics may unlock some of the potential contributions from climate science to policy (Stone, 2002).

In a final turn of the monster metaphor, I emphasise that a monster and a miracle are one of the same (Douglas, 1966). In a statement analogous to assimilation, the politics in and of science are as much a force for discomfort as they should be a force for optimism. With greater focus on the latter conceptualisation, along with the liberation from rigid strategies of monster-management, perhaps climate science would become less constrained to finding technocratic ‘solutions’ to the problem, and more conducive to breaking policy deadlock through creative processes of politics.

## Further Research

The monster metaphor, as applied to politics at science-policy interfaces, is in its relative infancy. The evidence consulted to support its exposition, in all three case studies discussed, has not been considered in a wider, more systematic review. Thus, this paper is exploratory in nature, and leaves ample space for further and deeper engagement with the ideas discussed, in both theoretical and empirical studies. The recommendations listed below suggest starting points:

1. Alternative stories and narratives in the cases of smoking, nuclear winter and climate change could be explored, and the validity of the monster metaphor and the “ongoing learning process” described could be amended accordingly.
2. The strategies employed by and for science are the product of a multitude of factors and initiate a multitude of consequences, across a range of timescales. A closer study of causes and effects of each set of strategies, with a focus on climate change, could prove revealing. A study of individual policies, and the strategies of politics monster-management apparent in their conception, could determine whether the strategies used affect the policy’s implementation or efficacy.
3. Different aspects from different case studies may relate more or less to the climate change situation. A more nuanced approach than the one taken here, where the closest similarities of other political problems to climate change were discerned (e.g. the international cooperation required for nuclear policy; the vulnerability to industry manipulation in smoking regulation), could provide a more refined contribution.

# Conclusion

This paper has detailed a preliminary exploration of the insights that the problems surrounding tobacco smoking and nuclear winter may yield for the science-policy interfaces relating to climate change. In particular, given an alarming lack of climate policy at present, discernments of the role of science in political problems were sought. The exposition of the politics monster appears to give rise to a greater understanding of how science engages and is engaged with the politics intrinsic to and product of its own practice. The strategies in the scientific community and beyond, for the use of science in politicised issues, can be thought of as an “ongoing learning process”, as van der Sluijs (2005) suspected for uncertainty, from exorcism, to embracement, to adaptation, to assimilation. This fluid process is perhaps a manifestation of growing acceptance (tolerance) to and honesty about the politics monster.

A question of agency was also investigated. The politics monster appears to have more important ramifications for policy outcomes than any strategies around science that try to tame it for that very purpose. Each strategy does have causes and effects, some of which may appear more beneficial or progressive than others. While these can be broadly generalised, they are perhaps more indicative of the problem’s political contingencies and inherent complexities. Therefore, from a binary perspective of policy activity, it does not greatly matter how science engages or is engaged with the political aspects of its research, and the outcomes of any one strategy does not seem conducive to prediction. Critically, however, this assessment only reflects the successful implementation of policy to address a part of the problem, rather than the effectiveness of said policy.

To repeat my earlier question: where does this leave climate science? It is somewhat disempowered to inspire policy change alone, though this is surely symbolic of the misleading linear model of science-policy interfaces. However, it is also unshackled, such that its actions in the political sphere may take a more creative, experimental turn. A reconceptualisation of science, akin to assimilation, which emphasises the inherent politics of the scientific endeavour and the opportunities which this may present, may be one way of many to inspire breakthrough in climate policy. As such, a starting point could be to target the climate science-policy interfaces; in particular, to challenge the political reasons which maintain the largely counter-productive linear understanding and separation of these convergent practices. It pays to remember that just as the politics monster may be the root to the present-day climate change problem, it is a necessary part of a resolution.

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