

From Montreal to Kyoto – Can we learn some lessons?

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Abstract. The Vienna Convention for the Protection of the Ozone Layer, and the subsequent Montreal Protocol, represent a uniquely successful international attempt to solve a global environmental problem. This paper undertakes a qualitative analysis of which elements contributed to this success, and then compares the case of ozone depletion with that of climate change. Based on this comparison, the paper discusses whether and how lessons learnt from the success of the Montreal Protocol could be applied to the Kyoto Protocol, and which additional actions might ensure a greater chance of success for the ongoing international efforts to reduce greenhouse gas emissions.

Introduction

The 20th century has been characterised by a growing awareness of Earth being a finite system with limited resources, and the human population having an increasing global impact on those resources.

In response to arising global problems of environmental degradation, the world community has increasingly attempted to negotiate global solutions. It recognised that problems caused by a large group of individual emitters spread around the globe require a global effort to avoid or reduce the impact of the problem. The success of global environmental solutions therefore hinges upon the collaboration and recognition of a common responsibility by all nations.

This paper investigates which elements of the Vienna Convention for the Protection of the Ozone Layer, and the subsequent Montreal Protocol, may have led to its high degree of success and international collaboration across developed and developing nations' boundaries. The paper then tries to identify parallels, but also important differences, to the case of climate change, and discusses which of the lessons learnt from Montreal could or should be applied to increasing the chances of long-term success of the Kyoto Protocol through scientific research, policy-making, and public awareness building.

A brief history of the Montreal Protocol

Chlorofluorocarbons (CFCs), the first man-made ozone-depleting substances, were invented in 1928 and put to regular industrial use in foam blowing, refrigeration and as aerosol propellants, with a heavy increase in demand from the early 1970s. The first warning that human activities could affect the stability of the ozone layer were sounded by Crutzen (1970), followed by the seminal work by Molina and Rowland (1974) on the potential effects of CFCs.

Concern about the effect of increasing CFC production on the ozone layer led to the United Nations Environment Programme holding an expert meeting in 1977 and, together with the World Meteorological Organisation,

establishing the Coordinating Committee on the Ozone Layer in 1981.

Work by this committee led to the signing of the Vienna Convention for the Protection of the Ozone Layer in March 1985. The Convention called for all Parties to undertake research and necessary actions to limit anthropogenic damage to the ozone layer, but was non-specific about which gases were most relevant. Most importantly, the Convention did not mandate any emission reductions.

In May 1985, Farman *et al.* (1985) published their observations of the Antarctic ozone hole. This sparked a period of intense polar atmospheric research, with a rapidly converging evidence that heterogeneous reactions of chlorine gases, derived from CFCs, were responsible for the seasonal reduction in ozone concentrations over Antarctica.

The Montreal Protocol was signed in 1987, mandating legally binding limits to the production of CFCs for developing countries. Spurred by growing evidence about the role of CFCs and other halons in both polar and mid-latitude ozone depletion, subsequent amendments to the Protocol mandated more rapid phase-out of substances and increased the range of substances covered, including a comprehensive time-table for phase-out of ozone depleting substances by developing countries over the next few decades. This was accompanied by the development of CFC replacement substances with a much lesser (or zero) ozone depletion potential, largely by the same companies that to date had manufactured CFCs,

Owing to the Montreal Protocol and its subsequent amendments, chlorine levels in the atmosphere are now roughly at their peak, and the peak of ozone depletion is expected during the first decade of the 21st century. A gradual recovery of the ozone layer is expected by 2050, assuming that no other atmospheric changes (such as climate change) will further delay this recovery process. Recent research indicates that this assumption may be too optimistic (Shindell *et al.*, 1998). It may be worth noting that even the optimistic recovery time represents a time lag of about 30 years from the discovery of an environmental risk to the maximum direct environmental damage, and a lag of 80 years before the environmental perturbation will have been reduced to levels comparable prior to anthropogenic interference. This latter time scale of course also assumes that no irreversible damage has occurred to ecosystems or human systems, and hence a reversal to pre-perturbation state is in fact possible (WMO, 1998).

Success elements of the Montreal Protocol

The success of the Montreal Protocol is by no means complete yet. Issues such as illegal trade in CFCs and trade in CFC-reliant technology, phase-out by developing countries and economies in transition, and the use of some important substances such as methyl bromide pose continued challenges to complete the task. Nonetheless, the Montreal Protocol has been a success story, hailed widely

as a model for the resolution of other global environmental problems.

So what has made the Montreal Protocol successful? I suggest that the following elements were critical in it gaining widespread acceptance across both developed and developing countries:

- The Protocol included a grace period for developing countries, allowing them a gradual approach to phasing out CFCs and to adopt new technology and learn lessons from the experiences of developed nations;
- An agreed long-term time frame ensured that participation by developing countries was a certainty from the outset and encouraged industrialised nations to lead the process;
- The precautionary principle was applied in a way that enabled continued revision of scientific evidence and stepwise tightening of targets;
- A dramatic environmental event (the ozone hole) signalled the seriousness of the problem to the public mind, despite the fact that the ozone hole resulted in limited direct damage to inhabited areas;
- The discovery of technological solutions (CFC replacements) was a key to bring major companies “on board” and convince major industrialised nations such as the USA to sign up to the Protocol;
- Technology transfer to developing nations through a multilateral fund and through targeted assistance programmes was important for developing countries to ensure that the Protocol increased international equity.

Scientific challenges in the Montreal process

The process of successful negotiation and implementation of the Montreal Protocol was not without pitfalls and challenges. Most notable was continued scientific scepticism about the very existence, and later seriousness of the problem. The scepticism ranged from informed caution not to go overboard with speculation about likely culprits and solutions, to attitudes by some protagonists which are difficult to reconcile with a purely scientific agenda. Scepticism thus both served to maintain integrity of the scientific process, but also seriously delayed acceptance of the need to reduce CFC emissions by some nations and major industry players, despite the fact that this need was widely recognised in the scientific community.

At the same time, the event of the ozone hole, and subsequent revisions of the chemical mechanisms involved in ozone depletion highlight the limited capability of science to forecast the major perturbations of complex Earth systems. Such inevitable “surprises” can either reduce or exacerbate the environmental effects originally predicted by the first simplified models. In the case of ozone depletion, much of the scepticism about the seriousness of the problem or feasibility of solutions proved to be ill-advised in hindsight. However it must be realised that this is not necessarily because the sceptics did not understand the science sufficiently well (nobody did in the beginning), but because it was exactly this lack of a complete understanding of the problem that necessitated and justified a precautionary approach, well before all relevant chemical and dynamic mechanisms were fully

understood.

As already noted, the projected time lag between the first serious attempt to limit CFC emissions (Montreal Protocol, year 1987) and eventual recovery of the ozone layer (year 2050) serves as a powerful reminder of the inertia of complex Earth systems, and of the time it may take to eliminate global human perturbations from such systems once they have been set in motion. This projected lag of course assumes optimistically that climate change will not interfere with the recovery timeline, and that ozone depletion as a phenomenon is indeed a reversible process.

Parallels to climate change

At first sight, striking parallels appear between the problems of ozone depletion and climate change. Both issues can be described as environmental problems with potentially significant and long-lasting global impacts, caused by the emission of long-lived gases released as by-products of industrial activities. In both cases, emissions by industrialised nations are responsible for the bulk of emissions to date.

The similarities obviously go further. In both cases, the complexity of the system and rapid evolution of scientific knowledge does not permit a clear prediction of the future effects of emissions, but only a range of plausible scenarios and associated risk analysis. Consequently, the precautionary principle has been applied in international treaties, which commit nations to reduce emissions only in a stepwise approach, accompanied by regular independent assessments of the scientific knowledge. Both climate change and ozone treaties accepted an “action gap” between industrialised and developing nations, with initially only industrialised nations accepting binding obligations to reduce emissions. This staggered approach is characterised by the phrase “common but differentiated responsibilities”. Similarly to the Vienna Convention, the Framework Convention on Climate Change and its Kyoto Protocol contain financial assistance to developing countries to monitor and reduce their emissions where possible. The Clean Development Mechanism (CDM) represents a market instrument to assist the transfer of clean technology to developing countries.

Interestingly, the parallels also extend into the criticism of the underlying science, and the proposed actions to reduce emissions. Scientific scepticism over the evidence for climate change has been expressed by (almost) the same people, using (almost) the same structure of arguments, as in the earlier case of ozone depletion. For example, claims are that the scientific uncertainty does not warrant action beyond the no-regrets level, that the Kyoto Protocol is too complex, the solution is more costly than the damage, or the damage is marginal compared to other pressures. A common theme in both the public perception and the reaction by the concerned industry is that the polluting gases are considered essential for a developed standard of living. A reduction in the emission of those gases is equated with a threatened reduction of wealth.

Where climate change differs from ozone

Despite these parallels, there are key differences

between climate change and ozone depletion. Perhaps most importantly, CFCs were specifically manufactured for a limited and clearly defined range of industrial uses, whereas greenhouse gases are ubiquitous by-products of almost every form of energy production, industrial, agricultural or transport process. It is therefore not easily possible to invent “substitutes” for greenhouse gases – their generation is an accident of civilisation, not part of a specific industrial process. At present, alternatives for the very processes that generate greenhouse gases are limited in depth and comprehensiveness.

On a geopolitical level, it is interesting to observe that the impacts of climate change are likely to fall disproportionately on developing countries in the subtropics and tropics, whereas the impacts of ozone depletion are most significant in mid- to high-latitude countries where developed countries or countries with economies in transition are located.

With regard to long-term international policy, the current climate change regime contains no clear “entry point” where developing countries will accept binding emissions targets, nor is there a clear long-term target for global greenhouse gas emissions or concentrations (whereas the long-term target for CFCs was relatively promptly agreed to as “zero”). The simplicity of this figure minimised equity concerns that would have resulted from different emissions targets for developed and developing nations, and the agreed long-term time frame for CFC phase-out even for developing countries generated certainty in developed nations that they were not leading the global effort for nothing. These elements are clearly missing in the current climate change policy framework.

But even between developed countries, the existence of sinks and an emissions trading framework for greenhouse gases opened major philosophical differences between countries about “morally” permissible options (Pearce, 2001) to reduce emissions – that is, the need to reduce gross emissions as proposed by the European Union versus the use of sinks and trading called for by, amongst others, the Umbrella Group¹.

The increased globalisation of markets, and omnipresent occurrence of greenhouse gases makes the risk of carbon leakage much higher than for CFCs, which were more easily controlled as exported or specifically manufactured goods.

As this discussion shows, there are clear differences between climate change and ozone depletion which make climate change a more complex problem with more difficult solutions both technologically and politically. Do these differences therefore mean that the scientific and international policy debate on climate change at present is only as far advanced as the ozone depletion issue was in 1985 (the time of the Vienna Convention), and hence we should recognise the existence of a potential problem, but not undertake action beyond no-regrets options and increased research?

I believe that such a history-fatalistic conclusion would be misguided. In contrary, some vital lessons from Vienna and Montreal can be learnt and applied to advance

scientific knowledge about and political responses to climate change.

Some essential lessons to further progress in climate change science and policy

In the following paragraphs I will describe the lessons for science, policy and public awareness that I believe can be drawn from the preceding analysis of parallels and differences between climate change and ozone depletion.

Science. In the area of scientific knowledge and research, a crucial lesson from the (comparatively benign) example of ozone depletion is the inertia of both natural and human systems in recognising a problem, devising a solution, and reducing the actual environmental perturbation. Climate change caused by greenhouse gases will exhibit an inertia orders of magnitude (centuries to millennia) greater than that of ozone depletion. This fact not only needs to be communicated more widely, but also incorporated into research designs that consider feedback mechanisms not just across space and between different types of ecosystems, but also across time in orders of decades, centuries and even millennia.

Inertia also has important consequences for accepting uncertainties, for the longer the inertial time frame of a complex system is, the more it is guaranteed that there will be new discoveries and surprises in our understanding of the system. The inertia of the climate system, and the inability to stop its consequences, is one of the prime reasons why proactive, anticipatory action to reduce greenhouse gas emissions and adapt to climate change is necessary and beneficial *despite* incomplete understanding of the system.

A related scientific issue that warrants further discussion is the role of long-term monitoring of key atmospheric parameters. The detection of change relative to an established baseline is crucial to test models and make predictions about future changes and their likely impacts. Yet funding systems tend to have lesser regard to monitoring compared to new original research projects, because the latter is perceived to be more innovative and promising of returns. The maintenance of scientific human capacity in fields which are not currently regarded as leading edge research faces a similar problem. Both long-term data monitoring and scientific capacity cannot quickly be resurrected if the discovery of an environmental problem requires rapid research progress.

A further lesson from the history of research in ozone depletion and climate change is that phenomena in complex Earth systems may be closely linked despite intuitive attempts to regard them as separate. The growing connection between historically different research fields does not present a problem as such, but it would if the expertise and experience that has been built up in one area does not get transferred efficiently to the other one. The experience of providing scientific advice to policymakers and industry on ozone depletion is a prime example of dealing with uncertainties in an evolving field of knowledge, and of working with industry to find solutions in a practicable and co-operative way – a body of experience that clearly should be transferred as efficiently

¹ USA, Canada, Australia, New Zealand, Norway, Iceland, Ukraine, Russia, Japan, Kazakhstan

as possible to the field of climate change. While the expertise of many scientists spans both areas, policymakers often tend to maintain institutional separations for much longer.

Policy. One of the key blocks to widespread and effective implementation of the Kyoto Protocol by industrialised nations, and research on options to reduce greenhouse gas emissions, is uncertainty about future participation by developing countries. The fact that eventually all countries will need to accept binding emissions targets to achieve stabilisation of greenhouse gases in the atmosphere, but that as yet there is little evidence of a willingness by developing nations to accept binding obligations, is frequently used to discredit efforts by developed nations in reducing their emissions first. Experience from the Montreal Protocol seems to indicate that the early setting of an entry point and long-term emissions target for developing nations, even if far into the future, may enhance the willingness of industrialised countries to implement solutions that go beyond no-regrets actions.

The transition from the Vienna Convention to the Montreal Protocol also suggests that, not surprisingly, the availability of plausible solutions to the problem are essential to gain support from industry and leading industrialised nations. In particular, solutions should be consistent with industrial processes and standards of living in industrialised countries. For example, the replacement of CFCs with HCFCs and HFCs was a perfectly normal process of industrial innovation, almost invisible to the consumer. In contrast, the abandonment of refrigeration to avoid CFC emissions clearly would have been inconsistent with the norms of western lifestyle and hence would have been regarded as unacceptable. It appears highly likely that solutions to global warming need to step out of their sometimes spartan and zealously green image if they are to find widespread acceptance and support from either industry, policymakers, or the general public.

At the same time, the rapid progress of solutions in either CFC replacements or energy efficiency and alternative energy sources demonstrate that induced technological change can rapidly and significantly lower projected costs and increase capacity. Static forecasts of the costs of solving environmental problems, ignorant of the potential for creative innovation, have clearly been shown to be an insufficient basis for full cost-benefit analyses of such solutions and tend to overestimate costs in sectors that have a high potential for innovation (SEI, 1999). The fact that this applies to both the technological solutions to reduce emissions, and to options to technologically adapt to the impacts of either climate change or ozone depletion, cannot be used to discount the need to research solutions and put supportive policy frameworks in place. In contrary, it only underlines the fact that mitigation of emissions and adaptation are research and policy programmes that need to go hand in hand.

Public and industry awareness. A major source of public and industry resistance against accepting the very existence of an environmental problem, and the need to develop and implement solutions, is the connection that is

drawn between the “offending activity” (i.e. the emission of CFCs or greenhouse gases), and “lifestyle” (i.e. to have refrigeration and aerosol spray cans, or to have individual transport, a warm home, or a productive industry). In the public mind the two appear virtually identical, and hence any suggestion that the offending activity may need to be reduced or stopped is considered identical with a suggestion that the lifestyle that is linked to it may need to be abandoned (Pearce, 2001).

The experience with development of CFC replacements shows that consumer resistance against eliminating the “offending activity” shrinks to virtually nil, and can even result in active support for new, environmentally friendly alternative products and processes, if the message can be transmitted that the “lifestyle” is not automatically in question (Pearce, 2001). This apparently simple observation has not yet been transmitted into the field of climate change, where for many consumers and industry the concept of reducing greenhouse gas emissions is equated with a loss of comfort, mobility, or productivity – despite the fact that many energy efficient solutions such as housing insulation, improved public transport systems, or reduction of ruminant methane emissions would plausibly lead to an increase in comfort, combined with an increase in productivity.

Consumers are a powerful force for change once they can be motivated to support “green products”, and the newly generated market forces form a part of the induced technological change which can drive innovation much more rapidly along than historical development paths would suggest. It is therefore crucial for policymakers to assist new industries in developing and expanding economic niches by providing clear information to the general public about the benefits of adopting new technologies and products.

Clearly, the benefits to consumers of buying greenhouse or ozone-friendly products does not immediately lie in their effect on the climate or ozone layer, because every single action contributes only a small fraction of the total required change. The recognition of short-term and immediate co-benefits is therefore likely to be important when purchasing a “green” product that involves an extra up-front cost. Examples are the benefits on public health and reduced congestion from cleaner transport fuels and increased public transport, or improved health and comfort and long-term cost savings from housing insulation and energy efficient appliances.

Impacts. It can only be hoped that there is one lesson that climate change will not need to copy from ozone depletion, which is the occurrence of a catastrophic change in the global system with a potentially very high impact.

For action on ozone depletion, the discovery of the ozone hole, coupled with the realisation that skin cancer is a very real threat to everybody (and one that may be linked to the commonplace experience of sun burn) most likely played a major role in public acceptance of action to reduce production and release of CFCs into the atmosphere. By comparison, climate change as an event is projected to proceed as a gradual change of parameters, and particularly for those people with the highest per-capita emissions of greenhouse gases, the effects of climate

change may be the least discernible in the short to medium term. This constellation is counterproductive to action by industrialised nations and may necessitate a more comprehensive public awareness about the global effects of climate change, its inertia and long-term risks, and development of a more inclusive ethic of global equity.

Conclusions and remaining problems

Even if the described lessons could simply be learnt and acted upon, some important problems in the area of climate change remain. These concluding paragraphs list some of those issues, but do not attempt to propose any further solutions.

The inertia of the climate system, and hence the time gap between emission of greenhouse gases and impacts of climate change, raises the problem of intergenerational equity. The problem is not caused by the same human generation that will suffer its consequences, and cause and effect in climate change can span many human generations. In the spatial dimension, intercontinental equity and distribution of impacts versus emissions is a more readily present, but no more easily solved problem.

Uncertainty will remain a feature of climate change for decades to come, and therefore scepticism about required degree of action will remain even if the existence of climate change becomes universal. As discussed, scepticism can be both a virtue in the scientific description of a problem, and a millstone around the neck of technological innovation and behavioural change that could address the problem. There is a risk that analysis in hindsight will tend to either fully discredit scepticism where it proved wrong, or hail scepticism as supreme virtue where history indeed did prove it right in one instance. A more mature approach in policy and public awareness to scientific uncertainty and the related progress of knowledge will be needed to find an adequate balance. Closely related to this is the need for a more thorough discussion of the benefits and limitations of the precautionary principle in addressing environmental problems.

Above all, I believe that it is crucial to preserve continuity in the increasingly fast moving field of scientific

policy advice and environmental decision-making. I hope that the discussion in this paper has shown the many lessons that could be learnt, or at least should be discussed, between two closely related fields of both scientific research and international agreements. It is likely that an examination of other areas of environmental policy would similarly enrich discussion on the subject of climate change.

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