Why Canada should ratify the Kyoto Protocol

by William Leiss and Stephen Hill

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Part 1: "What, me worry about global warming?" (Golfing in December)

Part 2: "Carbonomics" (Take the numbers with a grain of salt)

Part 3: "Riding the tiger" (Let's jump while we still can)

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Overview: We make the case that Canada should ratify the Kyoto Protocol in a series of three short papers. In Part 1 we ask: What exactly does the citizen have to believe about climate change science in order to be in favour of Kyoto ratification? And is the rational basis of that belief really as controversial or bizarre as it is sometimes made out to be? In Part 2 we look at the recent spate of publicity about the economic costs of Kyoto compliance, where the numbers are all over the map and worst-case scenarios abound; we suggest that a more unbiased look at the economics of carbon as a commodity would have a calming effect. In Part 3 we suggest that the key question from a policy analysis standpoint is: Having balanced the uncertainties in economic impact forecasts for Canada's Kyoto compliance against the uncertainties in the climate change forecasts, which uncertainties should trouble us the most? In other words, comparing the possible consequences of being wrong about one or the other, which outcome should worry us more? Our answer leads us to conclude that, from the standpoint of good risk management, it is clearly in Canada's best interest to ratify the Kyoto Protocol as soon as possible.

Part 1: "What, me worry about global warming?" (Golfing in December)

During the early parts of the last two Canadian winters, media reports showed delighted Western Canadians happily golfing in November and December. Winter 2001-2002 was the 19th consecutive season with above-normal temperatures and it is hard to persuade Canadians they should find something to worry about.

Climate science is a devilishly complex business and the average citizen who has heard the federal government may ratify the Kyoto Protocol in 2002[1], over the anguished complaints of some provincial and industry leaders, may be excused if he or she wonders what's behind all this gnashing of teeth. Most recently, Canadians have encountered a barrage of propaganda designed to persuade them the chances of economic disaster that will inevitably follow Canada's ratification of Kyoto are more certain to occur, and are far scarier in their likely consequences, than are the chances of ruin from inaction on climate change risk.

Throughout this campaign, there has been no fair and adequate representation of what the Third Assessment Report (TAR), produced by the Intergovernmental Panel on Climate Change (IPCC), actually says. Nor has there been any hint as to why so many distinguished climate scientists regard the results of this vast consensus project as highly credible. Perhaps the anti-Kyoto elements actually believe our citizens are so well-informed about climate science they need no further reminder.

Climate science is complicated, but the reasons why Canada and others should ratify the protocol are not. The case for Kyoto can be seen as a matter of common sense.

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[1] Readers unfamiliar with Kyoto should See Appendix A at the end of this document for background information.

This approach to Kyoto ratification begins by posing some basic questions: Exactly what propositions from climate science do our citizens have to believe in order to conclude Kyoto ratification is a good idea? How should our citizens decide who to put their trust in? Does climate science describe both a risk and a path of risk-reduction with sufficient clarity to justify our taking that path now?

Many of the recent participants in the anti-Kyoto chorus have left the impression with the public that substantial doubts vex climate science, so much so that any predictions of future trends and impacts are unreliable. Therefore, any action now is ridiculous.

Is this the case? No. Our citizens would do well to disregard entirely these fatuous claims. Yes, the future always contains an element of unpredictability, and yes, the climate forecasts contain a range of outcomes. There is, of course, some legitimate disagreement among reputable climate scientists over various aspects of their work, as there always is in every branch of science. But stating these caveats ought not to obscure the essential point, namely, there is a strong consensus among reputable climate scientists on all of the matters directly relevant to the Kyoto ratification decision. There are also a few reputable scientists who are on the outer edges of the distribution of viewpoints, whose views are not reflected in the IPCC consensus positions.

Focusing on the consensus science position is an extremely important issue, especially for major Canadian industry sectors. These sectors have spent the past decade seeking to persuade governments and other stakeholders to adopt a risk-based approach to decision making, an approach which includes the notion that sound science should form the cornerstone of all decisions.

Sound science is simply the established consensus position of independent scientific researchers as summed up in the weight of evidence found in the current set of academic peer-reviewed publications. On all subjects there will be smaller numbers of reputable scientists whose positions are "outliers," relative to the consensus position. However, it is imperative, as industry representatives have argued strenuously, that society's risk-based decision making should be based on the consensus position. Thus, what we have seen in the Kyoto debate - where some industry representatives refer to the views of the small minority of scientists who seek to undermine the credibility of the IPCC consensus - calls into question the fundamental principles of risk-based decision making.

It is actually quite a simple exercise for Canadians to decide who to believe. They simply need to look around for a few independent Canadian scientists of international reputation who have taken the trouble to prepare an overview of current climate science. There is such data, published in December 2001, co-authored by three well-regarded Canadian scientists of international repute: Professors Gordon McBean, Andrew Weaver, and Nigel Roulet, of the University of Western Ontario, University of Victoria, and McGill University, respectively.

We present here selected highlights from their recent article:[2,3]

1. Greenhouse gas concentrations influence the global climate and are known to cause a natural greenhouse effect.
2. Greenhouse gas concentrations are now already at levels not seen for the past 400,000 years.

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[2] "The Science of Climate Change: What do we know?" *Isuma: Canadian Journal of Policy Research,* vol. 2, no. 4 (Winter 2001). Available online at www.isuma.net.

[3] In Appendix B, the reader will find a few charts and graphs that illustrate some of the most important features of climate science that help to characterize the risk associated with global climate change.

3. Greenhouse gas concentrations are forecast to at least double within the next century.
4. The climate system has two delayed sequential effects: (a) a time delay between rising greenhouse gas emissions and a new equilibrium level of greenhouse gas concentrations and then (b) a long time delay before there is an equilibrium climate response to those changes.
5. Human actions are now a significant source of greenhouse gas emissions and thus produce an enhanced greenhouse effect.

The bottom line is: A: Greenhouse gas concentrations influence climate. B: Human actions now influence greenhouse gas concentrations. C: Therefore human actions influence climate change.

The scientists we have referred to, say there is some direct evidence of our complicity in these upward trends. This is based on chemical analysis of the different isotopes of carbon in the atmosphere, through which scientists can detect the signature of old carbon that represents the long-buried fossil fuels we humans have burned since the beginning of the Industrial Revolution.

But mostly, it is a matter of common sense. Is it reasonable to believe, knowing that there is a strong relation between greenhouse gases and climate, that the addition by us of massive quantities of carbon dioxide and methane to the atmosphere, at an accelerating rate over merely a few hundred years (a brief episode in climate history), would have no impact on climate patterns? Indeed, this is so convenient a belief, in terms of our naked self-interest as a species, that we should be immediately suspicious of it. Current human emissions of greenhouse gases around the planet total about nine gigatonnes annually (that is, nine billion tonnes) of carbon equivalent. This figure is rising and according to some projections, is unlikely to level off at less than 15 gigatonnes annual carbon equivalent, every year, unless action is taken to limit and reduce it. From a common-sense perspective, is it reasonable to believe we can continue

this pattern and claim our actions have no consequences for climate change? We think not. On the contrary, this should be regarded as an incautious belief, inconsistent with the way we manage our exposure to all kinds of other risks.

Certainly one of the major findings of climate science, which every expert accepts, is that there is significant variation in the climate record (including greenhouse gas concentrations and global mean temperature) that originate in purely natural processes. It is also assumed by every expert that these natural processes are still at work. There is no dispute here. What is at issue is whether the incremental impact of human activity in the era of global industrialization beginning around 1800, is of any significance - specifically, whether or not this impact is of enough significance to become an independent variable in climate forcing. The only sane answer to this question is "probably yes." What is pertinent to the question is the supposition, among the majority of contemporary climate scientists, that greenhouse gas concentrations are a major factor in climate variation, rather than a trivial one. So it all comes down to what kind of risk-takers we are, collectively.

Let's see if using Pascal's wager can help us.[4] The famous 17th-century French mathematician offered his wager as a way of deciding whether to believe in God, and this was the first time probability and decision theory had been used for this purpose. For Pascal's question we substitute the proposition: Are humans responsible in significant part for climate forcing? Pascal admitted we can never know for certain whether God

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[4] For the original version of Pascal's wager see: Leiss, William. 2001. *In the Chamber of Risks: Understanding Risk Controversies*. Montreal: McGill-Queen's University Press. pages 261-2. Pascal's wager has also been described as the Maximin Rule in decision theory and readers seeking further information on this should see pages 23-28 of *Scientific Uncertainty and Environmental Problem Solving*, edited by John Lemons. 1996. Blackwell Science: Cambridge, Mass.

exists until it is too late to matter (after we die), just as we concede we may not know for sure the answer to our climate-forcing question until after it is too late to take remedial action. Pascal says the way to answer our respective questions is to array the consequences of our beliefs in the form of a decision matrix with four possible outcomes:

A. Suppose human actions are in fact significant for climate forcing:

1. If we believe this, and act accordingly in time, we can possibly avoid some serious adversity in the future.
2. If we do not believe this, and do not act, we may possibly provoke adversity for future generations.

B. Suppose human actions are not in fact significant for climate forcing:

1. If we believe this, and act accordingly, we will save ourselves any economic costs of taking action.
2. If we do not believe this, and act accordingly, we will waste any resources we have devoted to adjusting our economy to reduce climate change risk.

Pascal suggests we compare the two downside risks and ignore everything else. The downside risks - the bad things that may happen as a result of our choices - are represented by outcomes A2 (provoke serious adversity) and B2 (waste some economic resources). We contend that, given the possible range of economic costs (see Part 2 Friday), A2 represents a significantly worse outcome than B2, and taking action now is a sensible thing to do.

To sum up: There is a strong consensus, among reputable Canadian climate scientists, to the effect that reliable evidence supports the five key propositions about our climate listed above. And these propositions are uncontradicted by any evidence advanced by other reputable Canadian scientists.

Moreover, this list of uncontroverted propositions is all that is required from climate science to provide a rational basis for affirming that Canada should ratify Kyoto. Whatever else we choose to believe, there are solid reasons to believe humans are

influencing the global climate. And that is all we need from the climate scientists to justify action now.

Climate change is a risk scenario, that is, a matter of probabilities or chances. In Canada we use risk scenarios (or risk estimates) every day in order to forecast possible harms from many sources and to allocate resources to reducing those risks even though we do not know with complete certainty that the harms will occur, or to whom, or with what degree of severity.

Our argument does not depend on making predictions about specific types of adverse impacts from future climate change. We take a risk-based perspective on climate change, which runs something like this: The global climate system is a unified process involving massive energy transfers throughout the subsystems of oceans, land masses and atmosphere, driven by the sun's energy and variation in the Earth's orbit, as well as by other natural and human-originating developments. Because it is based on such a massive and complex energy-transfer system, global climate can be expected to have a great deal of inertia, so that it is not amenable to short-term manipulations involving any of its individual drivers. Paradoxically, there is in the climate record, evidence not only of gradual trends, but also of sudden, abrupt episodes of warming and cooling, suggesting there are also elements of instability in the climate system.

The preceding 10,000 years of climate history (the period within which human civilization has arisen) has been a period of relative climate stability. During that time, up until 1800, human actions were of no consequence so far as climate patterns were concerned. But this changed, and since 1800 we have been adding massive amounts of greenhouse gases to our atmosphere, over what is in climate history terms a short period

of time. As a result, there is a strong probability our actions have become a contributing factor in triggering change.

From a common-sense standpoint, citizens are well aware that our mode of life is closely adapted to what we have come to regard as normal climate and weather patterns. Some of our important economic sectors, such as agriculture, forestry, recreation and tourism are dependent on the continuation of established patterns, as they relate to rainfall and snowfall, heat and forest fires and insect pest populations. Our urban settlements are at risk from major disruptions in the established patterns of floods and drought, extreme weather, high summer heat and other factors. We have an obvious self-interest in the maintenance of climate stability, and therefore it is very much in our interest to take steps to maintain it. So, a program of risk reduction is a way of seeking to protect ourselves.

Yes, such eventualities are all uncertain. We appear to have a choice between two competing sets of uncertainties. One set is about economic impacts and the other is about environmental impacts. This is, admittedly, a nasty little dilemma for us. So, one way of trying to avoid it is to say: Couldn't we just take a little more time, to see if, according to the further development of climate science, we really have to make these emissions reductions?

Indeed, taking more time to decide is sometimes a legitimate response to uncertainty. But is it the right thing to do in this case? We suggest it is not, for specific reasons:

1. Greenhouse gas emissions around the globe are not stable, but rather are increasing, which means we cannot hope to achieve the key policy objective (stable or declining concentrations) without much further effort.
2. The delayed effects between emissions and ultimate climate responses occur over such a long time (more than a century) that the effects of our actions, taken now

or in the near future, cannot make a difference for some considerable period of time (so we should act sooner rather than later).

3. The result of the first two points is to build a large element of de facto irreversibility into future possible climate change, and the major adverse impacts on us potentially following if the risk scenarios that predict these outcomes are ultimately borne out.
4. There is a low probability that the essential climate science propositions listed above, which encourage us to ratify Kyoto now, will be modified by future science to suggest we should not have acted earlier.

Therefore, we cannot improve matters by waiting longer. Common sense tells us we should act in a precautionary way. And we need to act now.

Part 2: Carbonomics (Take the numbers with a grain of salt)

The public policy debate surrounding the Kyoto Protocol has reached a fever pitch in Canada. The decision whether or not to ratify the international agreement has become front-page news.

What is the average person to make of the colourful headlines and ideas being put forward? Will Kyoto create an economic doomsday? Will it spur the economy to find innovative and alternative energy systems? Will Kyoto do anything about the risk of a changing climate?

There appears to be no end to the estimates on how much it will cost to meet the requirements of the Kyoto Protocol, and many are using these estimates as the reason to either ratify or reject the plan (see Tables 1 and 2). Those favouring a rejection of the accord, the anti-Kyoto chorus, suggest the cost of compliance would be overly onerous and would put Canada at a competitive disadvantage, particularly with the U.S. which has removed itself from the agreement. Those who favour ratification suggest meeting the required reductions in greenhouse gases would encourage innovative technologies and practices, making Canada more competitive because of our increased energy productivity. Who is right? Should Canada ratify Kyoto?

Table 1. A sample of recent comments about the Kyoto protocol.

Perrin Beatty, President and CEO of Canadian Manufacturers & Exporters[5]	"The government's economic analysis seriously underestimates the costs to meet Canada's Kyoto target. It does not consider the impact that higher costs would have on the competitiveness of Canadian industry or on investments in Canada, especially since our major trading partner, the United States, is not party to the Kyoto protocol.… Our calculations show that, if Canada were to meet its Kyoto target, at least 450,000 jobs would be permanently lost in Canada's manufacturing sector by 2010…. Net job losses across our national economy would be even greater. Apart from these economic dislocations, all Canadians would have to drive less, drive smaller cars or take public transit that would, in turn, require massive infrastructure spending on the part of governments. We would have to re-insulate our homes, change our furnaces, windows and appliances, at an average expense of around $30,000 per household. We would pay up to 100% more for electricity, 60% more for natural gas and 80% more for gasoline, while paying more taxes, in part to finance the purchase of emission credits."
Michael Murphy, senior vice-president of policy, Canadian Chamber of Commerce[6]	"Canada will have to 'shut down pieces of the economy' if it ratifies the Kyoto protocol."
Pierre Alvarez, President, Canadian Association of Petroleum Producers[7][8]	"We remain agnostic on the question of Kyoto per se. Governments are going to have to make a decision on whether they should proceed or not and whether Kyoto is the right mechanism. That's not for industry." "Our major competitors – Venezuela, Mexico, and OPEC – are not in the agreement. Yet they all supply into the United States market… To date it's been impossible to determine what the federal government's implementation strategy is going to be, in terms of: how are costs to be spread across the economy, across different sectors."
Aldyen Donnelly, President, Greenhouse Emissions Management Consortium.[9]	"If Canada signs on to it as it now stands, it will elicit trade sanctions for noncompliance 'that's going to make softwood lumber [disputes] look like kindergarten."
Bob Peterson, outgoing CEO of Imperial Oil[10]	"Kyoto is an economic entity. It has nothing to do with the environment. It has to do with world trade…. This is a wealth-transfer scheme between developed and developing nations. And it's been couched and clothed in some kind of environmental movement. That's the dumbest-assed thing I've heard in a long time."
Elizabeth Witmer, Ontario Minster of Environment[11]	"This whole conversation about signing the Kyoto agreement has been done in a vacuum. Tell us what the impact is going to be."

[5] Beatty, Perrin. 2002. "Our climate change strategy must reflect Canadian realities." National Post, 27 February FP15.

[6] Jaimet, Kate. 2001. "Kyoto would 'shut down' economy: Oil, gas, electricity to be the hardest hit Chamber of Commerce official warns." Ottawa Citizen. A6. 25 November.

[7] Nguyen, Lily. 2002. "'Agnostic' oil patch seeks Kyoto clarity: Some firms don't see climate treaty as a threat." Globe and Mail. B1. 16 March.

[8] Spears, Tom. 2001. "Oil industry scoffs at plan to cut gases: Petroleum makers slam government's 'blind approach' to global warming." Ottawa Citizen. A8. 28 November.

[9] Jack, Ian and Carol Howes. 2001. "Ottawa thinking twice about Kyoto: Goodale." National Post. FP2. 29 November 29.

[10] Jang, Brent. 2002. "Imperial Oil executives mince no words on Kyoto or anything else." Globe and Mail. B9. March 13.

Editorial, National Post[12]	"Next month [April 2002], Mr. Anderson plans a major cross-Canada tour to promote his Kyoto agenda. From what we see so far, Canadians can expect more of the same from Mr. Anderson's travelling Kyoto medicine show: Misinformation, fear-mongering, distortion and exaggeration."
Ross McKitrick, University of Guelph economist[13]	"The bottom line for Canada is that Kyoto will precipitate a recession that will cause a permanent reduction in employment, income and the size of our economy. And if global warming is going to happen, Kyoto will do nothing whatsoever to prevent it or even slow it down. Why are we still considering it?"
David Anderson, Minister of Environment[14]	"With regard to commitments with respect to ratification, the government has, time after time, committed itself to two things: one, to having full consultation with the provinces and territories, interested stakeholders and the public at large prior to a decision on ratification; and second, to having a plan in place which does not unfairly penalize any region of the country. Those are our preconditions for a ratification decision."
Jean Chretien, Prime Minister[15]	The government wants to implement the Kyoto protocol and we have negotiated to improve it. We are still asking to have clean energy exports of Canada recognized.[16] We are talking with the provincial governments at this time to reach an agreement between all the partners. We have to make sure that we make a contribution to ensure that the climate of the world improves in the years to come….We have nothing to gain by trying to frighten people when we do not have all of the facts. When we do have all of the facts, we will make the right [decision].

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[11] Toulin, Alan. 2002. "New Kyoto proposal draws fire: Environment Minister's framework plan sees Alberta, Ontario facing biggest costs." National Post. 7 March.

[12] Anonymous. 2002. "Kyoto fear mongering." National Post editorial. 14 March.

[13] McKitrick, Ross. 2002. "Kyoto's real cost: While there is little chance the Kyoto Protocol will improve the environment, it will definitely hurt the economy, possibly even triggering another recession." National Post, 26 February. FP17.

[14] Baxter, Jamie. 2002. "Kyoto accord may not happen at all: Minister." National Post. 19 March.

[15] Hansard. House of Commons. 27 February 2002. Jean Chretien. Available at: www.parl.gc.ca/37/1/parlbus/chambus/house/debates/150_2002-02-27/HAN150-E.htm#Int-147289.

[16] While Canadian negotiators may *still* be asking for clean energy exports, Canada was unable to secure credit for emissions from energy exports in the Bonn and Marrakesh negotiations. This means we will not receive credit for shipping natural gas and electricity to the U.S. which reduces their emissions if it supplants other more carbon-intensive energy. Canada has signed and agreed to the text of the Marrakesh Accord and it is unlikely that other nations will be willing to re-open these negotiations after the fact. The Canadian Association of Petroleum Producers (CAPP) was well-represented by the federal government on this issue at the Bonn and Marrakesh negotiations (See Steven Chase and Heather Scoffield. "Oil patch wants credits for exports: Natural-gas, crude-oil sales abroad offset Kyoto obligations, petroleum producers say." Globe and Mail. 22 August 2001. pg. A5.), but other parties to the agreement had serious reservations about clean energy exports . It is interesting to note how many of the anti-Kyoto chorus have recently suggested that Canada's ratification of Kyoto hinges on the receiving credit for these so-called clean energy exports (e.g., see "Climate Change – A National Issue Affecting All Canadians" Note for an address by Nancy Hughes Anthony President and CEO of The Canadian Chamber of Commerce, March 4, 2002. Available at: www.chamber.ca/public_info/2002/speeches/speech020304.pdf.) full well knowing that the international community is unlikely to accede our requests.

Table 2. It's a numbers game. Examining some of the recent economic cost estimates and associated impacts proffered by various stakeholders in Canada's Kyoto game.

Canadian Manufacturers and Exporters[17]	• $40 billion and 450,000 manufacturing sector jobs, with larger job losses for the economy as a whole. • We would have to: "drive less, drive smaller cars, or take public transit that would, in turn, require massive infrastructure spending on the part of governments; • "Re-insulate our homes, change our furnaces, windows and appliances; • "Pay up to 100% more for electricity, 60% more for natural gas, and 80% more for gasoline; and • "Pay more taxes, in part to finance Canada's purchase of emission credits."
Alberta Government[18]	• $2.9-5.5 billion annually for Alberta or 2-3 percent GDP • $23-40 billion per year for Canada by 2010.
Canadian Chamber of Commerce[19]	• Up to 2.5% drop in GDP by 2010 • "[T]his is equivalent to an average year of economic growth…. It would mean $30 billion less in income for Canada…. about $1000 per person less that we would have to spend…. If we consider that total annual public spending on health care today is about $67 billion, then a 2.5 per cent decline in GDP would equal almost half of our current public health care budget."
Environment Canada[20]	• $500 million per year; or • 1.0% decline in GDP (or $10 billion) over the next eight years
Industry Canada[21]	• Review of other studies showed a range of 0 to 2.3% GDP losses in 2010 from stabilizing energy-related emissions of greenhouse gases at 1990 levels. • "[Even without international trading], the costs of [Kyoto] compliance are only likely to be modest if domestic implementation is achieved through a cost-effective scheme. That is to say, a scheme with limited sectoral exemptions. If exemptions are too

[17] Canadian Manufacturers & Exporters. 2002. "Pain without gain: Canada and the Kyoto protocol." February. 21 pp. Available at www.cme-mec.ca/kyoto/index.html. Despite the fact that they indicate the cost prediction provided in their report come from the Climate Change Secretariat (Analysis & Modelling Group November 2000 report), the CME report stresses that, "The economic analysis and modelling exercises undertaken by the Canadian government and Canada's Climate Change Secretariat seriously underestimate the costs that would be involved in Kyoto compliance."

[18] Government of Alberta. 2002. "Albertans & climate change: A strategy for managing environmental and economic risks. February. Available at www3.gov.ab.ca/env/climate/docs/climate_change_strategy.pdf. The bulk of the cost estimates are contained in Appendix A. Within the report, the Alberta government states: "Single point forecasts ignore the real range of uncertainties and risks. Only by being explicit about risks and uncertainties can we identify, consult and agree on the policies needed to minimize costs and manage risks" (page 10). This is sound advice but hardly reflected in the tone of the Alberta government press release and its single point forecast accompanying the report, titled "Kyoto could cost Canada up to $40 billion, study shows."

[19] Hughes Anthony, Nancy. 2002. "Climate Change – A National Issue Affecting All Canadians" Notes for an address by the President and CEO of The Canadian Chamber of Commerce, 4 March. Available at: www.chamber.ca/public_info/2002/speeches/speech020304.pdf.

[20] Environment Canada. 2002. "Costs of Kyoto – What we know." Available at: www.ec.gc.ca/minister/speeches/2002/020318_t_e.htm.

	broad, or poorly designed, the welfare cost of complying with Kyoto commitments is likely to be dramatically higher" (pg. 34).
Dutch Report (RIVM)[22]	• 0.02% of GDP by 2010.
NCCP AMG	• 0-3% reduction in GDP, depending upon the assumptions. The worst case scenario, Canada achieving its reduction without any international help and no credits for sinks, could result in a 3% drop in GDP over the next decade, that is the economy will grow by 27 percent instead of 30 percent, which is roughly $40 billion in lost economic output.
Diane Francis, CEO Council, Bob Peterson[23]	• To meet the emission cuts by 2010, all thermal power plants would have to be converted to nuclear plants. • A 6% reductions means eliminating 139 megatonnes of greenhouse gases by 2010. Stopping all economic growth between now and 2010 could save 120 Mt. • Another 27 Mt could be saved if Canada eliminated 50% of all automobiles from the road. • Alternatively, some 30 Mt could be saved if only one car per family was allowed. • Outlawing cars forever would save 45 Mt. • A total ban on exports from Canada's forestry, mining, oil and gas, chemical and cement business would cut 80 Mt.

[21] Wigle, Randall. 2001. "Sector impacts of Kyoto compliance." Working Paper Number 34. Industry Canada Research Publications Program. March. Available at: strategis.ic.gc.ca/SSG/ra01796e.html.

[22] den Elzen, M.G.J. and A.P.G. de Moor. 2002. "The Bonn Agreement and Marrakesh Accords: An updated analysis." RIVM report 728001017/2001. Dutch Ministry of Environment.

[23] Francis, Diane. 2002. "Kyoto Accord a bad deal for Canada." National Post. FP3. February 19. Ms. Francis was so impressed with these numbers, which were provided to her by Bob Peterson of Imperial Oil and the CEO Council according to her response to an email inquiry from us, she repeated them verbatim a second time in her column on March 12, 2002.

To begin our review of "carbonomics" (the economics of carbon), it is important to understand what is meant by costs. Essentially, costs reflect the relative value of scarce resources. Taking action to reduce greenhouse gas emissions and to increase the size of carbon sinks diverts resources from other priorities.[24] Costs manifest themselves from the effort required to deal with that type of change, whether that change is in how we consume energy or in how we respond and adapt to a changing climate.

By choosing to take action on climate change, we divert our efforts and attention from other, perhaps more appealing choices. The objective of any analysis of costs is to measure the changes in human welfare or utility that would result from these efforts. In analysing costs, it is important to look at both sides of the ledger book.

The side of the ledger stressed by the anti-Kyoto position is the cost of addressing the risks of climate change. Efforts to stabilize greenhouse gas concentrations at some level in the future, require a reduction in emissions[25], the majority of which result from burning fossil fuels. This will entail technological and behavioural innovations, a shift to less carbon-intensive fuels and increased development of renewable energy. The economic costs that might result from meeting the Kyoto targets reflect the degree that climate protection policies shift us from our current practices, or what is called the business-as-usual scenario.

In the long run, these changes could significantly shift how energy is consumed, its role in economic growth and the way we live our lives. In this regard, there would be

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[24] Markandya, Anil, Kirsten Halsnaes et al. 2001. "Costing Methodologies." Chapter 7 from Working Group III of the IPCC Third Assessment Report. Cambridge University Press: Cambridge, UK.

[25] Reduction in greenhouse gases emissions can, under the Kyoto Protocol, be made to any of 6 different greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons,

changes in human welfare, although it is presumptuous to assume these changes would all be negative.

In the short run, a carbon-constrained economy will increase the cost of using energy, creating winners and losers. Those who emit large amounts of greenhouse gases will be placed at a disadvantage relative to those who emit less.

The greater the resiliency society has for enabling technological and behavioural changes to address climate change, and to address economic vulnerabilities and dislocations of those most severely affected, the lower the short-run costs should be. Measuring this sort of thing is far from trivial. Still, economists make valiant efforts to make sense of the costs related to meeting the Kyoto targets.

On the other side of the ledger - the side stressed by the pro-Kyoto movement - are the costs associated with a changing climate. The exact impacts from climate change are, however, difficult to know with any precision. It is difficult enough to put a value on the climate, without trying to figure out what the costs of any potential changes to it, particularly those many decades in the future, might be. While these may be significant, placing an economic value on them is a guessing game.

In Part 1 of this series, we argued that the scientific basis for climate change is sufficient to justify initial precautionary action, first in the form of emission reductions in line with Kyoto, and, thereafter, further actions as circumstances warrant.

The essence of our argument is this:

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perfluorocarbons, sulphur hexafluoride), although carbon dioxide is the most important of these gases to climate change.

(1) Cost estimates are based on economic models and are uncertain, just as the predictions of climate impacts are uncertain.

(2) The cost estimates for meeting the Kyoto targets ignore the benefits of managing the risks of climate change, whatever these might be.

(3) The likely economic costs represent an acceptable course of action, granted certain assumptions about the risks of climate change.

Understanding what ratifying the Kyoto Protocol might mean for Canada is, literally, attempting to predict the future. Predictions of costs rely on economic models, each with its own set of assumptions and notions of how the economy works. Depending on the how the model operates, as well as the input assumptions, the resulting costs can vary widely, from a small net benefit to what some argue is a tremendous cost.

The Canadian Manufacturers and Exporters, an industry association which has been very vocal on the possible costs of Kyoto, makes these comments about the economic models: "Different models have been employed by economists to assess the impacts of Kyoto compliance on the Canadian economy. But there is no consensus in the findings. And, regardless of the modelling methodology employed, there are still big gaps between the assumptions that they use and the reality of how the Canadian economy actually works. In short, the models are incomplete, their assumptions are often wrong and their findings are unreliable at best."[26]

In Canada the framework for understanding how the Kyoto targets might be achieved and what doing so might mean to our lives and economy was carried out under

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[26] Canadian Manufacturers & Exporters. 2002. "Pain without gain: Canada and the Kyoto protocol." February. 21 pp. Available at www.cme-mec.ca/kyoto/index.html. Quoted from pg. 10.

the auspices of the National Climate Change Process.[27] This process included 16 different tables, with representation from federal and provincial public servants, industry and environmental groups. Each table examined various options for addressing climate change within their respective issue or sector. One of these groups was the Analysis and Modelling Group (AMG), which assessed the economic and social impacts of different paths to achieve the Kyoto targets.

The AMG rolled up much of the work from the other 15 tables in conducting its analysis. The net result of the AMG analysis was an estimate of between zero and three-per-cent decline in GDP by 2010 if Kyoto were ratified, which implies, in the worst case, that the economy will grow by an estimated 27 per cent instead of 30 per cent by 2010.[28] The work of the AMG continues and new estimates are expected in late April. Environment Canada has given indications the new cost estimates will be in the low end of the zero to three-per-cent range,[29] primarily because the cost of international credits may be lower than previously expected. Table 3 shows the range of possible economic impacts from meeting the Kyoto Protocol targets using three different economic forecasting models.

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[27] www.nccp.ca

[28] We ignore for the time being the ongoing debate regarding the merits of using the GDP to measure human welfare. Many environmentalists argue the metric is flawed and should be replaced by some form of green GDP. See www.rdprogress.org and www.nrtee-trnee.ca/indicators for more information.

[29] Environment Canada. 2002. "Costs of Kyoto – What we know." Available at: www.ec.gc.ca/minister/speeches/2002/020318_t_e.htm.

Table 3: Range of forecasted economic impacts from three models

Model used in AMG process	**Percent GDP Decline in 2010**
CIMS-TIM	1.8-2.9
Markal-TIM	0-2
CaSGEM	0.3-0.9

To help make sense of the diverse cost predictions, John Weyant of Stanford University identified four factors that explain most of these differences:[30]

1. What is the nature of the model and how does it represent the ability of consumers and industry to find technological innovations and alternatives?

Most models examine the cost-effectiveness of meeting a pre-existing emissions target, such as Kyoto; they are not trying to balance the myriad costs of climate impact with the costs of climate mitigation and adaptation in search of an optimal trade-off.
Those advocating for economic efficiency might argue for less stringent targets and longer time frames to reach them; those advocating for more effective climate protection would desire more stringent targets. Cost-effectiveness models, however, can only provide some indication about how much it will cost to reach the established targets that we have before us.

There are numerous economic models available to analyse the costs of mitigating climate change; we are aware of 16. Some examine the costs from a macroeconomic level (top-down models) while others focus at a microeconomic level on how existing

[30] Weyant, John P. 2000. "An introduction to the economics of climate change policy." Pew Centre on Global Climate Change. July. 51 pp. Available at www.pewclimate.org/projects/econ_introduction.pdf.

and emerging technologies will diffuse throughout the economy (bottom-up models). Bottom-up models tend to provide more favourable estimates of the costs of climate mitigation policies.[31]

Simon Fraser University economist Mark Jaccard describes difficulties with each approach:[32]

He says, a shortcoming of the bottom-up approach is its failure to recognize that some, perhaps many, technologies are not perfect substitutes in the eyes of businesses and consumers; to switch to the low-greenhouse gas technology, some kind of inducement, penalty or regulation is required. The size of financial inducement or penalty gives an indication of the extra value consumers and businesses attribute to their currently preferred technology. Jaccard adds the size of inducement reflects the costs of switching away from current practices and these costs need to be included in the models. Top-down models incorporate these costs by using historical data on the elasticity of energy prices.

He believes the top-down approach can also be criticized. Historically derived relationships between relative prices and consumption may not accurately indicate consumer preferences in the future as new technologies, with different characteristics, become available. In addition, if the historical price-consumption relationships of top-down models are not technology specific, but are instead aggregated for an entire sector

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[31] Wigle, Randall. 2001. "Sector impacts of Kyoto compliance." Working Paper Number 34. Industry Canada Research Publications Program. March. Available at: strategis.ic.gc.ca/SSG/ra01796e.html.

[32] Jaccard, Mark. 2001. "Costing greenhouse gas abatement: Canada's technological and behavioural potential." ISUMA. Winter. pg. 47. Available at www.isuma.net.

or the whole economy, they are of little help to policy makers seeking to probe the effect of technology-specific policies.

As a result, some models strive to blend the best of both approaches, a hybrid model. In an effort to be robust and thorough, the AMG incorporated findings from two micro-models into a macro-model. It compared these results with a Department of Finance macroeconomic model.[33]

2. What is the forecast of emissions that would occur under a business-as-usual scenario? The higher the projected future emissions, the greater the effort and costs of reducing emissions to meet the Kyoto target.

In Canada, the official projection is the Canada Emissions Outlook (CEO), first prepared in 1997 and then updated in 1999 and 2002.[34] The projection uses factors such as expected economic and population growth, expected technological and industrial sectors development (the decommissioning of a nuclear plant in Ontario, the development of oil sands in Alberta), and the rate of energy-efficiency improvements without other policy incentives or price changes.[35]

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[33] These models include the MARKAL (operated by McGill) and CIMS (developed at Simon Fraser University) energy-technology models, and the CaSGEM (developed by Department of Finance) and the Infometrica Model. The former two models are more closely aligned with bottom-up and hybrid approaches while the later two models are top-down models. In the AMG process, the CIMS and MARKAL models provided input to the Informetrica Model while the CaSGEM used other input assumptions.

[34] The most recent projections are available within Canada's Third National Report on Climate Change available at: www.climatechange.gc.ca/english/3nr/index.html.

[35] This last factor is defined by a coefficient referred to as the Autonomous Energy Efficiency Improvement (AEEI). (Markandya, Anil, Kirsten Halsnaes et al. 2001. "Costing Methodologies." Chapter 7 from Working Group III of the IPCC Third Assessment Report. Cambridge University Press: Cambridge, UK.). The presumed AEEI in any model will be crucial in setting the base-case scenario.

Normally, it would seem prudent to develop a range of business-as-usual scenarios and then develop a range of costs to reflect these.[36] However, the AMG used the CEO projections as the single basis for cost projections. The government of Alberta criticized this approach and suggests that Canada's business-as-usual forecast underestimates the size of the "gap" between expected emissions and the Kyoto target.[37]

3. What are the rules and policy regime surrounding reductions, both domestically and internationally? Are the rules flexible to facilitate economic efficiency? For instance, it is well recognized that market approaches - setting either a price via carbon taxes or an emissions ceiling with permit trading and then allowing the market to find the most efficient reductions - will result in greater efficiency for meeting a specific target.

At the international level, rules were established in Bonn and Marrakesh for three flexibility mechanisms: international trading of emissions reductions, joint implementation and the clean development mechanism. The potential and expected cost of international trading is a significant component in Canada's cost analysis: It is much cheaper if we can buy less-expensive international credits rather than find ways to reduce emissions domestically, particularly if we can buy the excess credits belonging to Russia at a reasonable price.

The withdrawal of U.S. from the Kyoto Protocol has reduced the expected international demand for Russian credits, often referred to as "hot air." This reduced

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[36] Markandya, Anil, Kirsten Halsnaes et al. 2001. "Costing Methodologies." Chapter 7 from Working Group III of the IPCC Third Assessment Report. Cambridge University Press: Cambridge, UK.

[37] Government of Alberta. 2002. "Albertans & climate change: A strategy for managing environmental and economic risks. February. Available at www3.gov.ab.ca/env/climate/docs/climate_change_strategy.pdf.

demand should in theory reduce the cost for international permits. But the way that Russia deals with these hot air credits remains a wildcard. If it is not willing to sell all of the hot air on the international markets, then the price will not be as low as expected.[38] The worst-case scenario (a three-per-cent reduction in GDP by 2010) developed for the AMG models considered how Canada could meet the Kyoto targets without any international trading of emissions - all reductions would be met domestically.

International trading rules established in Marrakesh should improve upon the three-per-cent decline in GDP, so any trading with Russia should reduce this cost. From a domestic standpoint, the AMG examined possible domestic policy paths for achieving the Kyoto targets, primarily varying by the extent that permit trading was allowed (either for large emitters only or others as well). As well, economist Randall Wigle of Wilfrid Laurier University found in a study for Industry Canada that the more industry sectors given exemptions from meeting reduction targets, the less economically efficient this would be for Canada as a whole.

4. How are the benefits of reducing greenhouse gas emissions considered, if at all, in the economic model? This includes so-called co-benefits, those health and environmental benefits that result from improved air quality associated with climate policies, and the direct benefits that arise many years in the future from maintaining a stable climate.

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[38] Many people in Russia retain a preference for central control over markets and would be hesitant to allow the government to sell credits. As well, Russia may want to hold on to credits for the next Kyoto compliance period (i.e., post 2012) when U.S. is could be back in the international market. See Reinstein, Robert A. 2002. "The outlook for International GHG Credits." Background paper prepared for the Canadian Chamber of Commerce. 10 February. Available at: www.chamber.ca/public_info/2002/reinstein.pdf.

Estimates of the costs of reducing emissions often ignore the co-benefits associated with reductions. The AMG estimated $300-500 million a year in benefits associated with improved health from better air quality. In addition, some economists have attempted to put an economic value on the long-term impacts of climate change. These estimates are even more fraught with uncertainty than the cost estimates of taking action.

The cost predictions of meeting Canada's Kyoto obligations are uncertain, and vary according to the assumptions and types of models that create them. We think it is plausible to guess that actions to meet the requirements of Kyoto will incur some costs to the Canadian economy, because reducing greenhouse gas emissions diverts attention and resources from other priorities.

We agree that it is important to determine these costs as accurately as possible, but it is also important to remember that uncertainty will always surround the predictions. We also suggest it is a plausible supposition that the actions for meeting Kyoto will not likely be overly costly, particularly if the opportunities for trading international credits with Russia come to fruition.

Without a doubt, creating the incentives to shift away from business-as-usual requires that the cost of carbon-intensive energy increase. This will impact the economy in some way, requiring changes in how we consume energy. It is important that we find fair and efficient means to manage this change.

"Riding the tiger": Let's jump while we still can

Over the past two days we have made two simple contentions:

1. Canadians should be wary of getting too frightened by statements about how much Kyoto compliance will cost because costs are being estimated based on economic forecasting models, which use a variety of assumptions, and the eventual reality can be different from the forecasts.
2. Thinking about the costs of Kyoto ought not to take place in isolation from thinking about the risk of climate change and its impacts, or more precisely, the risk estimates which are based on the climate forecasting models used by scientists in Canada and elsewhere to predict possible future climate patterns.

We concede there are significant uncertainties about the ultimate outcomes in both of these dimensions, and that, in the short term, those uncertainties will stay with us.

But, the policy question requires an answer: Despite these uncertainties, what should we do now? Should Canada ratify the Kyoto Protocol, committing itself to achieve reductions in greenhouse gas emissions? This requires us to ask which set of uncertainties is potentially the worst one; the one that possibly could do our descendants and us the most harm? This approach asks us to compare the downside risks of competing scenarios that have different types of uncertainty attached to them.

In the competing-risk forecasts, each has its own downside risk, that is, how much harm it is possible to encounter, not necessarily in terms of the worst-case scenario, but, say, if the mid-range projections were to play out in reality. We suggest that, where policy choices are framed by competing options, both of which have major uncertainties, setting the downside risks alongside each other for comparison is a sensible procedure.

We seek to show Canadians can and should react to (or manage) what is called climate change risk, in just the same way as we have learned to do for a whole range of other health and environmental risks. By definition, risks carry inherent uncertainties about outcomes, and yet, both governments and industry manage many such risks on behalf of citizens all the time, by incurring costs to reduce them to a level that is regarded as acceptable.

This is done first by estimating risks, a process that is a kind of forecasting of possible harm, because it is impossible to get direct evidence of harm for a simple reason: We do not intentionally conduct experiments on humans by exposing them to various doses of possibly harmful substances to see what happens. Instead, we devise indirect techniques, such as experimenting on laboratory animals, and then use extrapolation models to predict likely human effects. This is the way we set standards or limits for human exposures to thousands of potentially dangerous (but also very useful) substances, whether they are chemicals, metals, minerals or gases.

Second, enforcing the limits to exposure for all of those substances is done by incurring real costs, for example, by installing pollution-control equipment or providing safety gear. For many substances we cannot know for certain where the exact limit of safe exposure is (it also varies among individuals), so safety factors are used to provide some margin for error. This, too, costs money. In the end, this is just the application of a straightforward precautionary approach, which is done routinely across a wide range of activities every day.

But, these days at least, almost no one proposes to scrap all of that busy precautionary activity in favour of an alternative which, for example, would have us find

out where the limits of safe exposure are by waiting until the bodies fall and then counting them.

Back to climate change. In part 1 we reviewed briefly some of the things that reputable Canadian scientists, who are well-regarded by their peers, are saying to the citizens of this country about climate change risk. Here we want to go on to ask: Does that risk analysis provide an adequate basis for the policy choice that Canada should ratify the Kyoto Protocol? Is that set of propositions, in itself, enough to warrant our taking the next step and saying, Canada should ratify Kyoto now, because

> *whatever other uncertainties there are about conclusions to be drawn from climate forecasting, the possible adverse impacts of future unconstrained growth (using mid-range scenarios) in greenhouse gas emissions and concentrations are potentially so momentous, that they outweigh the consequences of possible adverse economic impacts now (using mid-range rather than worst-case scenarios)?*

This is the crux of the matter so far as the policy choice facing Canadians is concerned. If we try to improve our chances of making the right choice by waiting a bit longer, we may be much worse off, because of the consequences of the long delay in climate responses to changes in greenhouse gas concentrations. If we are going to act, we'd best act now.

But should we act now? Here we must confront the strong objection that, no matter what the climate science says, Canada should not ratify Kyoto because literally nothing will be achieved. In other words, it has been said that by ratifying Kyoto and complying with our resultant obligations to cut emissions, Canadians will incur real costs

in return for no environmental benefit whatsoever. This turns out to be a completely spurious claim.

Canada's compliance with its Kyoto emissions reductions targets for greenhouse gases means our emissions need to be reduced to six per cent below 1990 levels (minus any credits we are allowed to claim, for example, for soil and forest carbon management). Using fossil fuel energy generates atmospheric pollutants in significant quantities. That is why saying that there are no environmental benefits (not to mention the health benefits) to be had from reducing some of our worst air pollutants is nonsensical.

But in fact there is a hidden message here. The astonishing assertion that there is no environmental benefit from Kyoto ratification alludes indirectly to a basic truth about Kyoto emissions reduction targets generally - namely, that those emissions cuts are not big enough to come anywhere near what is required if we wish to stabilize greenhouse gas concentrations at some point in the future. Achieving Kyoto targets, and then doing nothing more, would merely delay the doubling of greenhouse gas concentrations for one decade. Thus if the only environmental benefit we seek is to stabilize greenhouse gas concentrations, we cannot derive this benefit from Kyoto compliance alone; further emissions reductions targets will be necessary.

But is it really necessary to point out that, in order to achieve an ultimate goal, one has to start taking some initial steps? Is it really necessary to point out that, if attaining the ultimate goal is likely to entail making a long and arduous journey, over terrain that will not remain stable but rather will get rougher with the passage of time, we ought to get started now.

We have not yet mentioned the most curious aspect of all, for the notion that there is no environmental benefit from Kyoto compliance, understood as referring to the too-limited emissions reductions targets in the protocol, derives its limited credibility only from accepting the climate science model projections for increasing greenhouse gas emissions and concentrations.

These are the same models that are, allegedly, according to the anti-Kyoto elements, so imperfect as to be useless as a guide for policy action. So it seems that the climate models are good enough when they serve to make a point about the incompleteness of the Kyoto negotiations, which no knowledgeable person has ever doubted anyway, but not good enough to support a risk-management strategy aimed at reducing the risk of our experiencing serious climate change impacts over the long term. One cannot have it both ways.

The no-benefit contention often also includes a direct reference to another genuinely serious problem in global greenhouse gas management, namely, that as a result of the incompleteness of the Kyoto Protocol, Canada would be incurring costs to reduce emissions while other non-signing parties such as China and India likely will be increasing theirs. These increases by other parties are likely to be large enough that there will be net increases in total greenhouse gas emissions of human origin, as Canada struggles to comply with our Kyoto targets for the first commitment period, 2008-2012.

This is true: Certainly for that period, and almost certainly for one or more subsequent ones, that is what will happen. Unfortunately for the anti-Kyoto elements, conceding this point does not grant even weak support to the position there is no benefit from adherence to Kyoto targets. Countries such as Canada, legitimately can be called

upon to start reducing their emissions now, while it is equally appropriate for others to be increasing their emissions for some time yet, for a very simple reason: Canada and other nations of the industrialized West are almost entirely responsible for creating the climate risk problem as it now exists.

This follows from delayed effects: Rising greenhouse gas concentrations occurring now and to occur in the near future are primarily a residue of the history of the West's industrialization beginning in the 19th century, the period when the rest of the world remained locked into the premodern pattern of life, as well of the social changes initiated elsewhere by the West's colonial domination during the 19th and 20th centuries. The anthropogenic share of current greenhouse gas concentrations are the condensed remainder of emissions that are largely our responsibility, and that is why it is not only eminently fair, but also just, that we should take action for some time before others' responsibilities begin to kick in. Part of the very real benefit to Canadians and others that accrues from Kyoto ratification is the inducement it provides for others to follow suit later, as they must do if both we and they are to reduce climate change risk.

Considered purely from a practical standpoint, China and other non-signing countries simply are not going to take climate change risk reduction seriously unless they have seen the West demonstrate its willingness to act first. The benefit to us of acting now is to up the likelihood others will act later. Those parallel responsibilities of others, rightfully do not exist now but they will arise in the foreseeable future. Reducing the risk of climate change will be a labour spanning decades; in order to have any hope of stabilizing greenhouse gas concentrations at around 1,100 parts per million, which is four times the preindustrial number (about 280 parts per million in 1800), with a target date

early in the 22nd century, the larger industrializing nations such as China and India will have to be brought into the post-Kyoto process, through the setting of emissions control levels for all significant human sources, probably not later than 2020, perhaps sooner.

This mission, the creation of a low-carbon industrial future for all nations of the world, including technology transfer gifts from West to East, represents an enormous task whose success is itself highly uncertain. In other words, there is the possibility that, even if we and other countries start to get serious now about Kyoto compliance, in the full knowledge that this is only the first of many necessary steps, in the end we may fail. There is some chance it may be already too late, that there is such momentum in humanity's carbon-based economy that it cannot be reined in, at least, not in time to do any good in reducing climate-change risk.

There is no way to estimate those probabilities at present. Given what is at stake, however, we maintain there is no serious case to be made for being unwilling even to try to succeed.

Finally, we must take up one other objection which for many Canadians may appear to trump, all by itself, all the reasons why we should ratify - namely, our American cousins are not going to do this, and, therefore, we cannot, since our economies are so closely linked. To reduce our emissions when the Americans aren't, will make our industries uncompetitive, it is alleged. Like all the other excuses reviewed in this series, this one, too, is based on specious reasoning.

The anti-Kyoto campaigners may have been surprised to read the March 19, statement by Paul Cellucci, the U.S. ambassador to Canada, in which he proclaims the U.S. intends to take strong action “over time” to “slow and, as the science justifies, stop

and ultimately reverse emissions growth."[39] According to Cellucci, the U.S. government will spend $4.5 billion on emissions reductions strategies next year alone, largely on the development of energy-efficient technologies. So there is the real prospect that U.S. industry will be helped by U.S. government-sponsored research funding to become more energy efficient, while at the same time some sectors in Canadian industry will be doing little except complaining that there is no benefit for us to do likewise. This will guarantee some Canadian industries indeed will become uncompetitive with the U.S., not because of Kyoto ratification, but because some in our nation will have helped to prevent it from happening. Obviously the Canadian economy is not the economic powerhouse that the U.S. economy is, and Canadian governments cannot provide by themselves the kind of huge research budgets to support technological innovations that are common there. U.S. government research subsidies are so large that it can afford to go it alone in its response to global climate change risk in the short term. Canada and most other nations cannot follow suit. But thought of another way, the U.S. decision represents an advantage for Canada, in that emissions trading credits will be cheaper in the world market, because the U.S will not be competing for them (only those that ratify Kyoto can use these credits). The only thing we will be not be able to do, if we ratify while the U.S. does not, is generate any credits by transactions with U.S. entities.

The simple message to those among our captains of industry who have been propagating visions of economic doom resulting from Kyoto ratification is this: Ease up on the doomsday rhetoric and get on with the job of making Canadian industry more energy-efficient. If this seems too daunting a task, perhaps a quick look at British

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[39] Cellucci, Paul. 2002. Washington's better idea." Globe and Mail. 19 March. Pg. A17.

Petroleum might help.[40] In mid-March, this large petroleum producer announced not only that it had achieved company targets for emission reductions - 10 per cent below its 1990 levels (which includes all its growth since then) - but that it had done so at no net cost to the company as a result of energy cost savings.

The case against Kyoto ratification made to Canadians in recent months fails in part because it does not attempt to evaluate fairly the accumulated results of reputable climate science, and in part because its own rhetorical structure is a patchwork of half-articulated premises and evasive arguments.

Once these obstructions are cleared away, a fresh look at the balance of probabilities and uncertainties we confront encourages us to believe the opposite. It is reasonable for Canadians to suppose the risks associated with future unconstrained and still-accelerating growth of emissions from human sources are far more serious than are the contrasting risks, namely, the chance that beginning Kyoto compliance now will cause Canada to suffer major blows to its economy for no offsetting benefits.

The case to be made for Canada to ratify the Kyoto Protocol as soon as possible, on the other hand, rests on a straightforward application of the same principles of risk management that we use in this country every day to make decisions, where the potential adverse impacts are serious and the processes giving rise to them may have irreversible consequences.

The downside risk in the climate forecasts is defined by the fact we are already riding the tiger of increasing global greenhouse gas concentrations. Not only that, but the tiger's momentum is accelerating, so that, the longer we stay on, the wilder the ride gets.

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[40] www.bp.com/centres/press/stanford/index.asp.

It may not be too late to jump off now. But the longer we hang on, the scarier it will be when we eventually take the leap - as we must, sooner or later.

Appendix A: Background to the Kyoto Protocol

Negotiations for the 1992 United Nations Framework Convention on Climate Change (UNFCCC) led to an agreement that "the ultimate objective of this Convention… is to achieve… stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

Parties (i.e., countries) that signed this convention have met seven times since its inception to promote and review implementation of the agreement. Important of these Conferences of the Parties (COP) was the third meeting in December 1997 in Kyoto, Japan. This meeting tried to put firm numbers to the original UNFCCC commitments made by the richer nations of the world (Annex B nations) by requiring specific targets for greenhouse gas reductions within each nation. For instance, Canada agreed to average reductions of 6 percent, using 1990 as the base year, by the period 2008-2012 while the U.S. agreed to reductions of 7 percent, and the European Union to 8 percent. The Kyoto Protocol includes flexibility mechanisms – for which specific rules were not worked out and agreed to until the November 2001 Marrakesh Accord – by which Annex B countries can reduce the costs of meeting emission targets. These include emissions trading between Annex B countries, joint implementation where Annex B countries undertake emission reduction projects in other Annex B countries for credit against their national targets, and the Clean Development Mechanism where Annex B countries receive credit for projects undertaken in non-Annex B countries. The Kyoto Protocol comes into force

as a legally binding agreement once 55 countries representing at least 55 percent of the emissions of the Annex B countries have ratified it.[41]

The emission-reduction targets set in the Kyoto Protocol represent a first step toward the long-term reductions required to stabilize atmospheric concentrations of carbon dioxide.[42] Despite this, the targets of the Kyoto Protocol are proving very difficult to meet. In Canada, 1990 emissions were 607 megatonnes of carbon dioxide equivalent (Mt CO_2E) making our Kyoto target 571 Mt CO_2E. By 1999, emissions were 15 percent above 1990 levels (699 Mt CO_2E) and by 2010, emissions in Canada are predicted to be 770 if we continue business as usual.[43]

The Bush administration in the United States has removed the U.S. from the Kyoto Protocol. The Bush White House feels that the Kyoto targets for the Protocol cannot be achieved without significant economic cost and that the Protocol is ineffective because it exempts developing countries such as China and India. The U.S. Senate unanimously voted against ratifying the Protocol. In a 13 March 2001 letter, President Bush states "I oppose the Kyoto Protocol because it exempts 80 percent of the world,

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[41] The Kyoto Protocol to the United Nations Framework Convention on Climate Change. Article 25, paragraph 1. Available at www.unfccc.org. The 55/55 hurdle became even more daunting with the withdrawal of the U.S., the world's largest single nation emitter of greenhouse gases.

[42] Robert Watson, chairman of the IPCC Third Assessment Report, has said "If one wants to meet the ultimate goal of the convention – that is, stabilization of greenhouse gas concentrations – it would require far more than Kyoto. It would emissions reductions not only in industrialized countries but also in developing countries" (see Toulin, Alan. 2002. "UN Pokes Holes in Kyoto Plan." National Post. pg. A1. March 20). The IPCC Second Assessment Report estimated that stabilization of greenhouse gas concentrations at about double pre-industrial levels (550 ppm) would require average per capita emissions of approximately 5 tonnes per year for this century. Current average North American emissions are 20 tonnes per person while average African emissions are less than 1 tonne per person.

[43] Prediction of business as usual emissions is, as with any forecast, uncertain. Canada's Third National Report on Climate Change, updated from the second report in 1997, has changed 57 Mt CO_2E to the 2010 business as usual prediction due to changes in assumptions such as activity in specific industrial sectors and economic forecasts.

including major population centers such as China and India, from compliance, and would cause serious harm to the U.S. economy. The Senate's vote, 95-0, shows that there is a clear consensus that the Kyoto Protocol is an unfair and ineffective means of addressing global climate change concerns."[44] When pressed by reporters about his position on climate change and the Kyoto protocol, Bush later said (as quoted on CBC online, www.cbc.ca, 29 March 2001), "I will not accept anything that will harm our economy or hurt our American workers. I'm worried about the economy and the lack of an energy policy and the rolling blackouts in California."

The Canadian government agreed to ratify the Kyoto Protocol in Bonn, Germany (COP6) in 2000 and then agreed to the detailed rules for implementing Kyoto contained within the legal text of the Marrakesh Accord (COP7) in November 2001. According the government press release after the Marrakech meetings, the Prime Minister indicated that the federal government would ratify the Kyoto Protocol in 2002, after consultation with stakeholders and the public.[45]

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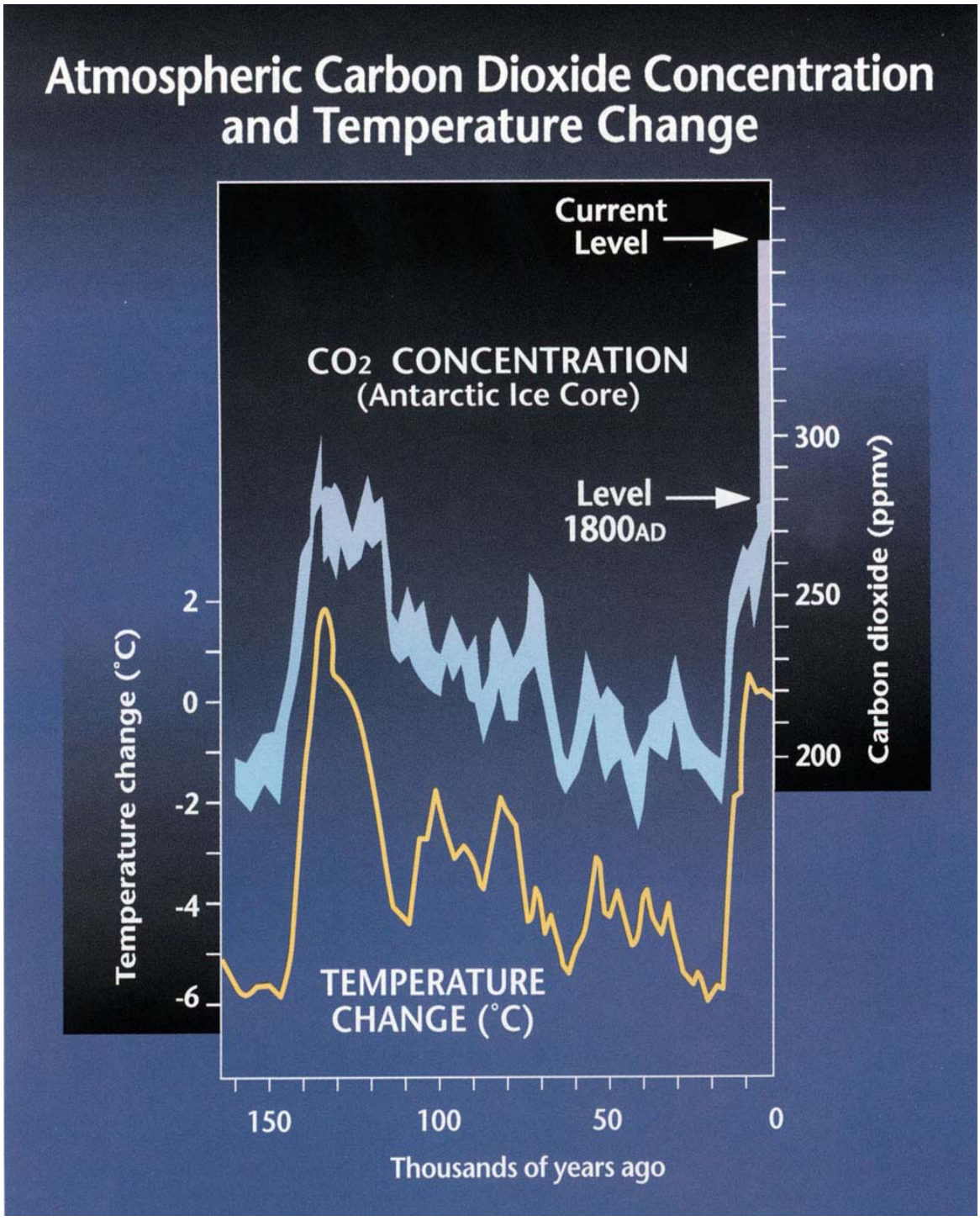
[44] Text of a letter from the President to Senators Hagel, Helms, Craig, and Roberts. Available at www.whitehouse.gov/news/releases/2001/03/20010314.html.

[45] Environment Canada. 2001. "Major Agreement Achieved on Kyoto Protocol, Government of Canada press release. November 10. Available at www.ec.gc.ca/Press/2001/011110_n_e.htm.

Appendix B: Graphics

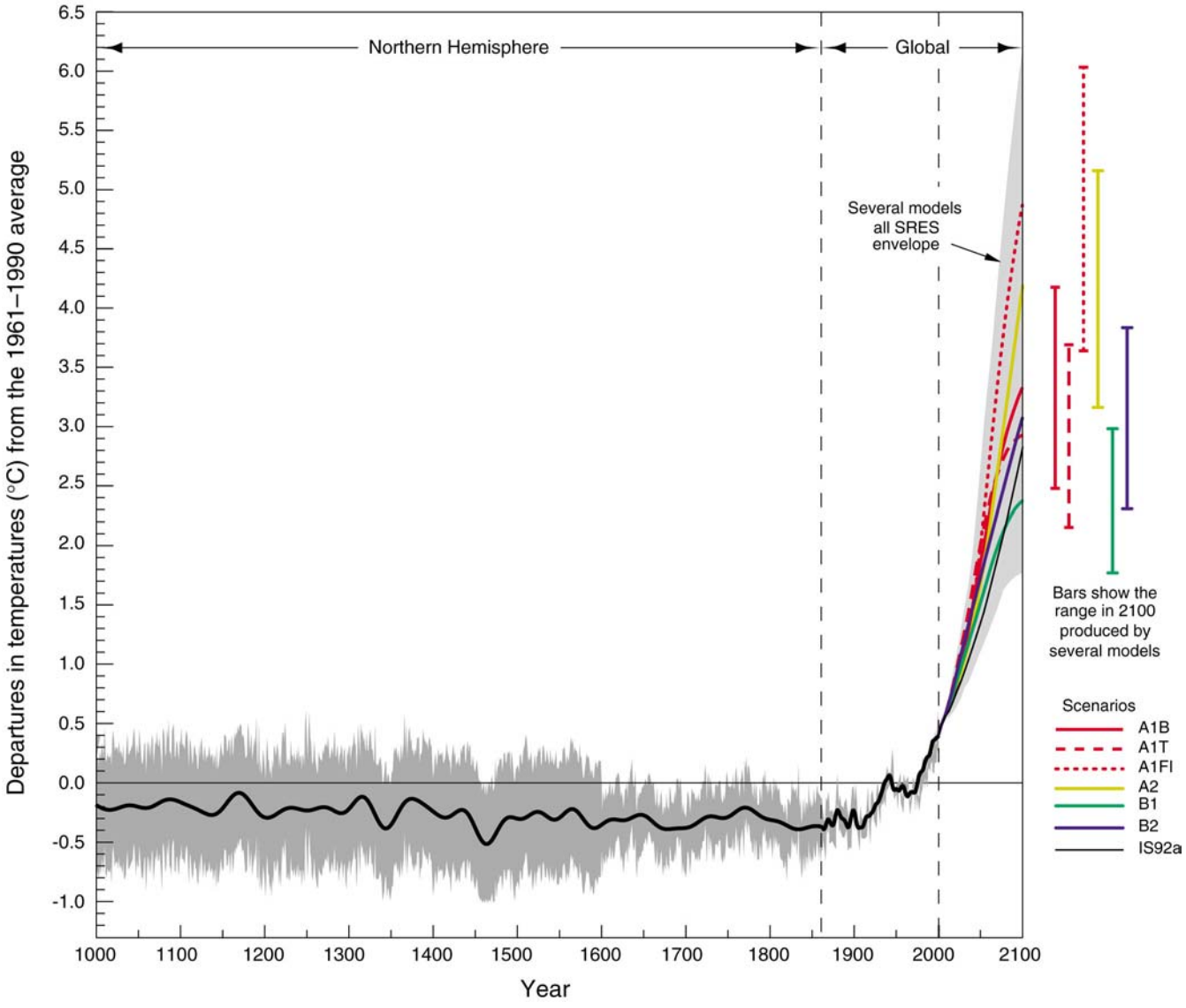
#1: "Atmospheric Carbon Dioxide Concentration and Temperature Change"

Source: Office of Science and Technology Policy. 1997. *Climate change: State of Knowledge.* Executive Office of the President, Washington, DC. Figure 5.



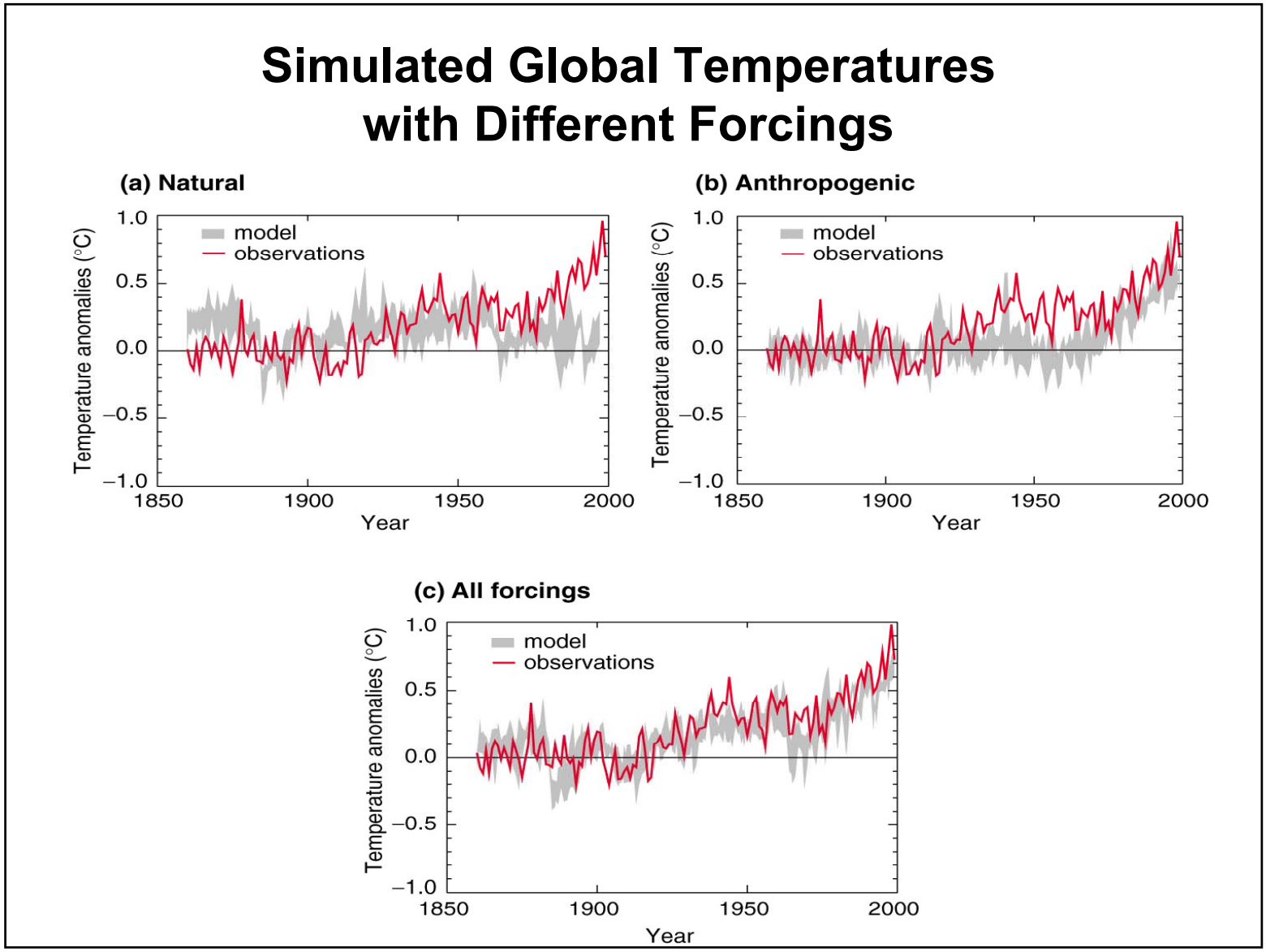
#2: "Variations in the Earth's temperature – 1000 to 2100."

Source: Union of Concerned Scientists, IPCC TAR Presentation materials. Available at www.ucsusa.org. See also Figures 2.20 and 9.14 from the IPCC TAR WG I "Climate Change 2001: The Scientific Basis." Available at www.ipcc.ch.



#3: "Simulated Global Temperatures with Different Forcings"

Source: D. Whelpdale, Environment Canada. See also Figure 4 in the Summary for Policy Makers of the IPCC TAR WG I "Climate Change 2001: The Scientific Basis." Available at www.ipcc.ch. Figure 4 is based on Figure 12.7 from the complete IPCC TAR WG I report and is available at www.ipcc.ch/pub/tar/wg1/450.htm#fig127.



#4: "Atmospheric Carbon Dioxide" projections.

Source: