Seven Strategies of Climate Change Science Communication for Policy Change: Combining Academic Theory with Practical Evidence from Science–Policy Partnerships in Canada

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Abstract Science–policy communication around climate change is complicated. Climate science communicators would benefit from a synthesized list of messaging strategies that is accessible and practical, but still supported by robust theory. We conducted interviews with participants in partnerships between climate scientists and climate policy makers in Canada. This revealed a number of favoured messaging techniques, which we then analyzed through the lens of communication theory (based on a combination of relevant literatures). The result is a set of seven ready-to-use science–policy messaging strategies vetted both empirically and theoretically. They acknowledge the contextual richness of the Canadian cases being studied but are also sufficiently based on abstract theory to be applied to climate change communication in other cases. Namely, it is important to 1) use the language of "risk" instead of "uncertainty"; 2) highlight effects on everyday activities; 3) emphasize short-term impacts, which can then be linked to the long-term issue; 4) highlight success stories of adapting to the problem; 5) focus on local solutions, which can then be tied to national or global solutions; 6) target politically tractable issues to trigger progress on intractable ones; and 7) facilitate audience ownership of both the problem and its potential solutions.

Keywords Canada • Climate change • Communication theory • Messaging strategies • Science–Policy interfaces

Introduction

We often assume that policy making is a linear and rational process; identification of a clear problem is followed by careful consideration of possible alternatives and implementation of the best solution (see Howlett et al. 2009). Basically, we expect accumulated knowledge about a given issue to precipitate policy action on that issue. But climate change policy, on a global scale, has demonstrably failed to follow this process. Considerable scientific knowledge and expert consensus about climate change is available, but implementation of solutions has been woefully insufficient. Still, there remains a belief that the situation will improve as scientists add additional evidence, improve their data, increase certainty, and arrive at an even stronger consensus. By assuming that policy makers will make the right decisions as soon as enough information is provided to them, this "deficit model" misses that the root of the problem is on the

policy side, not the science side (see Lawton 2007). Policy makers are obligated to prioritize their own jurisdiction above others, must respond to public opinion, and are limited by short-term election cycles, all of which may preclude climate action. Given such constraints, scientists will not be able to encourage climate action by merely providing more and better information.

However, scientists do not have any control over the idiosyncrasies of the policy realm (not to suggest that an overhaul of the policy process is even possible). What, then, can scientists do to address the problem? The key is in the space between the science and policy realms—that is, the relationships that scientists cultivate with policy makers and how they choose to communicate scientific information. Accordingly, the purpose of this chapter is to develop a useful list of climate science–policy messaging strategies that have both theoretical and practical support.

Of course, we are not the first to suggest that communication is a fruitful area through which to improve our efforts in addressing climate change, so let us take a moment to delineate the scope and objectives of the chapter. First, our target audience is climate scientists, not policy makers, so our recommendations will be aimed at the former, not to suggest that there is no room for improvement with the latter. Second, our focus is on communication from scientists to policy makers, not from scientists to the public. Of course, we acknowledge that broader outreach is very important, and that there is overlap between science–policy and science–public communication (see Richards et al. 2013), especially since public opinion informs policy. Third, it is not our goal to revisit general messaging strategies that are useful in most situations (e.g. avoiding jargon, using visuals, encouraging questions), but rather to identify specific approaches that are uniquely suited to climate science–policy communication. Overall, we believe that practitioners in this area will benefit from a list of strategies that: is accessible and ready to use (i.e. demonstrated in practice), has some theoretical justification, and is fairly comprehensive. We do not mean to suggest that these tactics will be particularly novel, but rather that it is important to bring them together in a way that is more useful to scientist communicators, grounded in real-world practice.

The chapter proceeds as follows. First, we review pertinent academic literature on science–policy interfaces and communication theory. The relevant bodies of work have many insights to offer, but also some deficiencies to address—they work best in combination. Second, we elaborate our methods for gathering practical evidence, namely interviews targeting climate science–policy relationships in Canada. Third, we discuss the results of those interviews, identifying seven messaging strategies and supporting them with empirical evidence from interview quotations as well as theoretical evidence from communication theory, grounding a conversation among the literatures. Fourth, we conclude by extracting overall lessons.

Background Literature

The scholarly field of science–policy interfaces has an intuitive relevance to the issue of climate science–policy communication. Analyzing a few key pieces of work will show that this field is quite adept at describing barriers between the realms of science and policy, but has room to provide more useful communication recommendations for scientists. Bradshaw and Borchers (2000), for instance, compare the characteristics of scientists and policy makers, especially with regard to views on uncertainty. However, their suggested solutions to this problem are somewhat vague (i.e. communicate more with the public) and impractical (i.e. policy makers should see uncertainty the same way climate scientists do). The conceptual framework of Cash et al. (2002)

is perhaps a little more valuable. They argue that scientists traditionally have focused too much on credibility, and not enough on the salience and legitimacy of produced information. They recommend primarily macro-level changes, such as managing boundary organizations for accountability and cooperation. This is not particularly helpful to individual science communicators, especially if no such boundary institution is present. Likens (2010) points out further barriers between the science and policy realms. For example, they have different priorities and speak different languages. His suggestions—that environmental scientists learn about the policy process, explain things carefully, and look for new ways to communicate—are fairly broad. A similar set of science–policy tensions are identified by Mead (2015), but the more novel contribution of his is observing that researchers often make policy recommendations without considering the politics of the issue (i.e. trade-offs with other priorities). Still, the solutions that follow are quite rudimentary; scientists should collaborate with policy makers, speak their language, and be taught about policy during training. This field of work ultimately makes very important observations about science–policy interactions, which serve as a crucial background to challenge of climate change communication, but few specific messaging strategies with immediate relevance to individual scientists are suggested.

Theories of deliberative rhetoric also provide relevant insight on science–policy exchanges. The emerging strategies are more coherent and precise than those offered by the literature on science–policy interfaces, but less attention is paid to the unique nature of climate scientists as generators and transmitters of knowledge. Dating back to Aristotle, theories of deliberative rhetoric deal with the issue of translating truth claims into persuasive messages for policy-making audiences (Kock 2014, Timmerman 2002, Yack 2006). These theories distinguish between communicating necessary knowledge, or certainty, and contingent knowledge, or uncertainty (Danisch 2010). While the first is associated with philosophy and science, communities that build knowledge about what is true, the second is associated with politics and expedient choice, deliberation about what is most likely to secure 'the good life' for citizens in the future (Kock 2014). Specifically, messages should aim to persuade listeners that a proximate, imminent threat to 'the good life' requires attention, and that one proposed 'best course' of action is most likely to meet this threat for now, given local contingencies and priorities (Danisch 2010, Kock 2014, Timmerman 2002 p. 89, Yack 2006). Messages typically revolve around two imagined futures: one to be averted because it threatens harm (see O'Leary 1993, O'Leary 1997), and one to be sought because it promises advantages (Yack 2006). The objective is to evoke a reaction of 'civic fear' (see Innocenti 2011, Pfau 2007). Science communicators may be more successful if they see reasoning as "a contest for attention and allegiance" requiring that they "compete to advise" policy makers about "how to pursue our common good" (ibid. p. 427). These theories provide much more specific messaging advice than the literature on science-policy interfaces, but do not acknowledge the unique challenges of climate change messaging, and may come across as overly 'philosophical' to scientists that are looking for practical strategies, and are not scholars of communication or politics.

A final relevant field is contemporary environmental communication (i.e. in contrast to the rather 'ancient' theories of deliberative rhetoric). Some exemplary pieces will demonstrate that this field is perhaps the most capable of suggesting practical messaging strategies for climate scientists, although the focus seems to be primarily on general (i.e. science–public) communication, and there is some nuance that may be difficult to translate into concrete tactics. Schwarze (2006) observes that melodramatic messaging tends to get criticized as a simplistic approach that only perpetuates controversies. However, it may be beneficial in situations where a

problem is unrecognized or poorly defined (e.g. new environmental challenges), and can serve as a call to action. Foust and Murphy (2009) add that, for climate change, the 'comic' (i.e. positive and opportunistic) frame is likely to be more useful than the 'tragic' (i.e. negative and dramatic) frame at this point, but should not be used to justify the status quo and paint the problem as mere inconvenience. Specifically, they propose framing the issue as urgent but manageable, promoting human agency, and linking climate change to other important issues (e.g. energy independence). Acknowledging that fear appeals can, at the same time, make climate change seem important as well as leave the audience feeling unable to do anything about it, O'Neill and Nicholson-Cole (2009) recommend emphasizing local impacts and actions, with only some attention given to the global context. The collective theme of these pieces is that communicators are faced with the challenge of finding a balanced messaging approach. It should not be too negative, which may disempower the audience or be dismissed as alarmism, and not be too positive, which may facilitate apathy (also see Russill and Nyssa 2009). This is an extremely useful concept, emerging among some specific and practical strategies from the field, but practitioners may still be unclear on what such balanced messages would look like in the reality of communicating with policy makers. As well, there is an opportunity to synthesize the various techniques into a more comprehensive 'handbook' form (i.e. works in this field tend to cover only one or a few strategies each).

Ultimately, while these three areas are highly relevant to the challenges of climate science–policy communication, none of them, on its own, embodies the trifecta of specific messaging strategies, attentiveness to climate change, and focus on policy making audiences. Also, because they are all comprised of academic literature (as opposed to best practice documents or grey literature), there is room for more attention to practice. This is not to suggest that the existing suggestions are necessarily 'impractical' but rather that they are not reaching their full potential of accessibility and usability for scientists. In order to facilitate some conversation and synthesis among the literatures, and to ground their recommendations in practice, this chapter treats a case study of climate science–policy relationships as a starting point. We investigate which messaging strategies are used by science communicators in practice (i.e. who are not necessarily familiar with the academic literature), and then show how those same tactics have theoretical support from the collective scholarly work, necessitating some combination and application of the relevant literary areas. The empirical evidence suggests *that* such emerging strategies can be successful, while the theoretical analysis provides insight on *why* this is so.

Methods

This chapter is part of a larger research project (see Richards 2015) that seeks to determine how science–policy partnerships can be designed to bridge the gap between consensus climate science and the insufficient policy response. One aspect of a productive science–policy partnership is the use of effective messaging strategies by scientists. Thus, while the larger project embodied a number of research questions, the particular one relevant to this chapter is: What science messaging strategies are useful for communicating with policy makers about climate change? As stated in the previous section, we wanted to take a problem-based approach to this question, grounded in practice, so we did not start with any specific hypotheses from the above literature—the research approach was exploratory and inductive. In short, both scientists and policy makers involved in climate science–policy partnerships were interviewed about their interactions, including the messaging strategies employed therein.

Although this study was exploratory, it was also meant to provide some solid empirical evidence for effective messaging strategies. Consequently, multiple Canadian cases were examined in order to ensure the investigation was sufficiently broad as well as conscious of the unique contexts surrounding individual scenarios of climate communication to policy makers. The first selected case was the local-level relationship between municipalities in British Columbia (BC) and the Pacific Climate Impacts Consortium (PCIC), a University of Victoria research institute that focuses on regional climate impacts and adaptation. The second case chosen was the regional-level relationship between the BC provincial government and the Pacific Institute for Climate Solutions (PICS), a research network centred at the University of Victoria, which studies both climate impacts and remedies (e.g. mitigation policy). The third case was the national-level relationship between the federal government of Canada and the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), a research funding institution. The Canadian focus was due to both the location of the investigators and the fact that science–policy interfaces have been understudied in Canada (i.e. compared to Europe, the US, and Australia).

The interviews took place between January and April 2014. Altogether, we interviewed 7 experts from the science side, 11 representatives of the policy side, and 2 intermediaries. These were semi-structured, audio-recorded, one-on-one interviews conducted in person or by telephone. The open-ended questions relevant to climate messaging included:

- How often does communication occur?
- How is communicated information generally used by the groups that receive it?
- How effectively do you think climate science is translated into policy action?
- What is needed to ensure a productive translation?

Of course, since the questions were open ended, they were followed by specific prompts for further information and general catch-all questions (e.g. What other successes or challenges are associated with the dialogue?). The interviews ultimately functioned as flexible discussions, such that the interviewee was able to ‘teach’ the interviewer about the most relevant aspects. The findings from these interviews are reported in the next section.

Results and Discussion

We were able to extract seven distinct climate science–policy messaging strategies from the collective interviews. This is not to say that each strategy was reported by every interviewee (especially since messaging strategies were not the primary focus of the interviews—see above). Rather, these are techniques reported and well explained by at least one participant (often more), with relevant insights from at least a few others. In this section, we elaborate each strategy with evidence and rationale from the interviews, and add our own application of the scholarly literature. We draw primarily on the theories of deliberative rhetoric, in order to provide a common thread for the discussion, but ultimately apply all three of the above literary fields. This approach results in a set of strategies that are grounded in practice, but also have theoretical justification. Specifically, the seven strategies emphasize: risks of inaction, everyday impacts, short-term effects, success stories, local solutions, political tractability, and audience ownership.

Risks of Inaction

There is no escaping the plain fact that climate data is complex and uncertain. Focusing too much on this uncertainty in an effort to be transparent, however, can be counterproductive, because policy makers have little tolerance for it (see Bradshaw and Borchers 2000 and the "double bind" in Russill and Nyssa 2009). One municipal planner argued that it is difficult to prioritize uncertain future considerations over immediate matters. The problem is elaborated in this comment from a CFCAS scientist:

> When you have scientists talking, there will always be a certain degree of uncertainty attached to it—and the message sent—the general public pick up on the uncertainty as the message as opposed to the higher probability. So it is a real danger, when we talk about science, because the scientist wants to be exact and clear, but what I think happens is they obfuscate the message more often than not.

The suggestion here is that lower uncertainty and higher probability are perceived differently, even though they mean essentially the same thing. This implies that "we predict a flood in the next five years, but there is a 30% chance we are wrong" is less effective than "we predict a 70% chance of a flood in the next five years"—the latter highlights the risks of not acting. Another municipal planner added that if liabilities and risks are communicated correctly, organizations like PCIC can make it almost impossible not to act.

The importance of highlighting the risks of not acting—and the higher probability of a threatening future—becomes clear when considered from the perspective of deliberative rhetoric. Persuading an audience that policy action is required hinges on the audience perceiving a clear, imminent threat to the public good that warrants attention. Crafting a message that clearly characterizes this threat and makes it salient for the audience helps focus their attention on the very problem that demands a policy solution. This does not mean fabricating false, exaggerated, or manipulative appeals to fear, but rather speaking to what Pfau (2007 p. 221) calls 'civic fear', which helps the audience collectively perceive risks to the community and motivates them to deliberate and take appropriate and timely action (also see Schwarze 2006). Indeed, messaging that invokes 'civic fear' is a crucial first step towards mobilizing policy action, as it is "designed to open up political debate" and incline people towards deliberation (Pfau 2007 pp. 220–221). Innocenti (2011 pp. 277–278) adds that fear appeals, when used in this way to encourage "collective foresight" rather than "compliance," function as "civically responsible" emotional appeals.

Everyday Impacts

Highlighting potential day-to-day impacts can make climate science seem more practical for policy makers. Interviewed representatives of government reported that they generally hear too much about the science and not enough about the "so what"—that is, economic and social implications, as well a visible impacts (see Cash et al. 2002 and Likens 2010). Witness this quote from a federal civil servant:

> The public is seeing more extreme weather events—and we all know you can't relate any one particular extreme weather event, with certainty, to climate change… My friends in the scientific community—they're too careful not to go too far. But sometimes… you have to take an opportunity to really push

> something forward, and even though you want to choose your words carefully… I think that these extreme weather events are tell-tale… I think one has to be a little bit opportunistic about getting out, in reaching to the public so that the public's concern will, in the end, put more pressure on government.

That is, scientists are trained to let data speak for itself, but other audiences require context and framing in order to see the significance of that data. A softer example, pointed out by a CFCAS scientist, would be highlighting the impact of climate change on outdoor skating rinks, which will limit future opportunities for Canadians to play hockey, a treasured national pastime.

This strategy helps audiences collectively perceive climate change as a clear and imminent threat to 'the good life', which warrants policy attention and deliberation. To prompt the 'civic fear' required for policy makers to categorize climate change as a legitimate and pressing threat, the object of that fear (e.g. harmful climate impacts) must be actively and strategically characterized as likely to cause people pain or agitation in their day-to-day lives. As Pfau (2007 p. 222) argues, the destruction and inconvenience of the threat must be characterized as "near at hand—both temporally and spatially" and "likely to affect oneself". Effective messaging can make the impacts of climate change salient—even sensate—through careful wording and framing. Of course, too much melodrama can be counterproductive (see Foust and Murphy 2009 and Russill and Nyssa 2009), so winter sports decline may be a better example of everyday impact than deadly storms.

Short-Term Effects

While climate change science is complex and involves several dimensions, part of communicating effectively is knowing which dimensions to emphasize, that is, which information to make salient (even though all of the information is important) in order to promote a perception of potential harm and motivate action. One strategy is to highlight the short-term impacts over the long-term ones, even though the broad climate action argument has traditionally been dominated by the latter. A CFCAS scientist explained further:

> Climate change and the implications of climate change—they're long-term in essence. It's difficult to get people to focus on it unless they start seeing it happening, and where you start to see it happen is in the more frequent severe events, whether that's droughts, floods, or whatever, or ice storms. That's when people start to say "wait a minute, something is happening here—this is not the weather I would normally expect, so what's happening?"—that's when you start to get their attention a little more.

A good example of a short-term effect that could be highlighted, prevalent in the municipal case, is the expanding range of the Mountain Pine Beetle (i.e. normally kept in check by cold winters), which has already caused whole forests to turn red and die. This very visible present-day impact helped spur adaptation planning in the community of Prince George. There are also political reasons for the short-term emphasis, given the nature of electoral cycles.

Emphasizing short-term over long-term impacts is another way to make the harmful potential impacts of climate change appear close at hand, a prerequisite to inciting the 'civic fear' required to prompt public deliberation and policy debate (see Pfau 2007 p. 221). As O'Leary (1993) contends in his theory of apocalyptic rhetoric (which revolves around anticipated risk), for a future to be perceived as a threat to the community, it must be perceived as temporally

proximate. Impacts must be perceived to be looming or even *present*, even though they will result from an imagined (if highly likely) *future*. They must be given a kind of imminence, in order to persuade audience members that those impacts "will concern them directly" (ibid. p. 405). However, as discussed above, it is important to avoid messaging that is too dramatic.

Success Stories

Another strategy for moving away from the hard science and making the implications more 'real' for policy makers is to focus on positive success stories of adaptation or mitigation, instead of adopting a largely negative tone (see "comic frame" in Foust and Murphy 2009). Consider the remarks of a municipal intermediary, who was very experienced with conversations between scientists and policy makers:

> A lot of the stuff that we're talking about, with the science presentations, is sometimes hypothetical and based on computer models and all this other stuff. But stormwater systems people get—the community engineer knows all about it, and you start to put some of these numbers in front of them and they go "oh geez, that could be a problem"—but to have an example of where there's been some success stories would be very valuable for other communities to see, and maybe some light-bulbs go off.

Different audiences can make sense of different emphases, but success stories tend to get traction with any type of audience. The best example, mentioned by several interviewees, was the community of Castlegar successfully weathering a flood because they had done prior adaptation planning and simply (and inexpensively) increased the frequency of culvert maintenance.

This 'flip-side' of communicating climate information reflects the fact that deliberative rhetoric revolves around two imagined futures: one that is fearsome, should 'the best course' *not* be taken; and another that is more hopeful and filled with the promise of safeguarding (even improving) 'the good life' of citizens, should 'the best course' be taken (see Yack 2006). In theory, both futures are necessary: the first (fearful) opens up policy debate (see Schwarze 2006), while the second (hopeful) guides policy action. Balanced messaging invokes both, taking care to characterize not just the dark future that compels action, but the brighter future that suggests a solution is possible (and to suggest a trajectory for shaping the future). As Pfau (2007 p. 223) argues, "there must be some hope of being saved" for deliberative rhetoric to persuade; fears must appear surmountable (see "human agency" in Foust and Murphy 2009 and "self-efficacy" in O'Neill and Nicholson-Cole 2009). An effective communicator avoids "overwhelming the audience with 'things fearful beyond human strength'" and demonstrates what can be achieved that is within the audience's power to realize (ibid.; quoting Aristotle). Similarly, O'Leary (1993 p. 393) argues that public discourse revolving around anticipated risk must oscillate between fear and hope—between "terror and triumph"—to exhort people to action. Without a hopeful destination and "a specific danger *that can be assessed and guarded against*" (O'Leary 1997 p. 294; emphasis added), the audience will likely remain paralyzed by fear or prone to inaction (O'Leary 1993, O'Leary 1997).

Local Solutions

Another strategy related to privileging particular dimensions of climate information is to focus on local solutions over global solutions (see O'Neill and Nicholson-Cole 2009), even though the latter are still extremely important. Witness this characterization of the issue, from a federal civil servant:

> There are two aspects to the problem, or two aspects to the solution, and one is to mitigate greenhouse gas emissions… it only affects global greenhouse gas concentrations and global climate—so that's not a particularly detailed or fine decision that you have to make at a local or regional scale. The other aspect of the solution is adaptation… something that happens locally… You can start thinking about what stormwater-handling infrastructure around your town might look like, change building codes accordingly.

The implication is that it is easier to motivate action on local adaptation than global mitigation, especially when specific information about regional climate impacts is available. This is because global climate mitigation is a tragedy-of-the-commons situation, whereby jurisdictions that take action only capture a tiny fraction of the benefits they produce, but local climate adaptation is more of a straightforward policy problem. Of course, it would be irresponsible to completely ignore mitigation, but an interviewed intermediary surmised that communicating about adaptation can subsequently make policy makers more receptive to the problem of mitigation. Indeed, in smaller municipalities, it is likely the same person who would be responsible for both adaptation and mitigation.

This call for more focus on local solutions reflects the extent to which, within deliberative rhetoric, the threats compelling deliberation must be perceived as 'close-by' to persuade the audience they are 'real' (Pfau p. 222), just as solutions need to be perceived as 'close-by' to appear feasible. Audiences are more likely to act on proposals that involve their immediate spatial proximity: their person, their home, their domain. Not only is such proximate space more likely to be perceived as within their immediate power to control and influence, but it is more likely to be familiar and of interest. In deliberative rhetoric, wherein communicators must compete with each other for the "attention" and "allegiance" of the audience (see ibid. p. 427), appeal to spaces that are familiar and easily called to mind are more likely to fix and retain the audience's focus.

Political Tractability

Another dimension that can be considered, in order to increase messaging effectiveness, is the policy sector being targeted, or the type of outcomes being emphasized. That is, while the broad climate action argument often focuses foremost on environmental outcomes (e.g. coral bleaching, biodiversity loss, forest health), these may not be relevant to the mandate of a given government. Consider the comments of a provincial civil servant:

> No amount of facts or evidence is going to convince a government… you're not going to convince them with an academic paper. So I think the willingness is the first necessary condition, unless it was… around a co-benefit that that government did care about that could then show them how climate fit in… all the things government does care about like their deficits, and risk management, and health,

> and communities are all things that are intimately woven with climate. Often there's a bit of a shift to talking about healthy communities instead of talking about climate.

If the environment is not a particular priority for a government (see Mead 2015), it is important for climate scientists to frame the issue as not just an environmental one (see Foust and Murphy 2009). Depending on the current policy priorities of that jurisdiction, they could highlight economic impacts (e.g. crop vulnerabilities), health impacts (e.g. heat stroke), or social impacts (e.g. reduced tourism). The policy process can be quite chaotic and seemingly arbitrary, after all.

This alignment of messaging with audience priorities resonates nicely with theories of deliberative rhetoric, which insist that political deliberation prioritize civic issues, the public good, and good government over issues of truth (Kock 2014). Political decisions aim to secure 'the good life' of citizens through prudent choice, but what counts as a 'good' choice invariably depends on the needs and priorities of the particular political community or constituency. As Timmerman (2002 p. 91) argues, "the issue of expediency drives public affairs" and deliberative rhetoric tries to influence judgments about which future choices and actions are most expedient for the public in question; all other factors are "incidental". Effective messaging, then, highlights how outcomes intersect with the most pressing concerns in the community and how desirable outcomes conveniently align with existing policy priorities and processes.

Audience Ownership

Given the complications involved, it is no surprise that policy makers may be resistant to climate science information. The strategy of facilitating audience ownership targets this challenge directly. One federal civil servant elaborated:

> You can imagine going through a negotiation, and if the negotiation turns into a battle of experts, it's not going to go very far—whereas if the starting point for the negotiation is an understanding of the science that has received a sign-on from the participants in the negotiation, then there's, in principle, a common basis of understanding.

He went on to identify the IPCC as an example, but various other interviewees suggested that the same principle applies to similar cases at smaller scales. Collaborations between scientists and government on research or monitoring projects will increase the receptivity of policy makers to the resulting information (see Mead 2015). More simply, the government's own data or reports can be incorporated (e.g. cited) in scientific studies. Another approach is for scientists to liaise with one contact from government, discuss the information, and then get that person to present it to others in the relevant department. Finally, individual workshops or presentations can start with some audience input (e.g. personal observations of weather anomalies).

This final messaging strategy reflects the kind of communication required when dealing with complex, contingent knowledge (rather than absolutes). As Danisch (2010 p. 174) observes, "wherever deliberation occurs (even in scientific and technical contexts), contingency serves as a backdrop". This means that deliberative rhetoric traffics in propositions that might or might not be true—propositions that are then linked up in chains of reasoning along with accepted truths and a host of contested and uncertain claims. All of this makes for rather unstable communication. Within such a communicative context, lacking absolutes to guide reasoning, communicators and audiences must work together to both establish and then draw on a body of

common knowledge to guide “reasoned judgments about public affairs” (ibid. p. 175). In a way, then, deliberative rhetoric rests on a body of common knowledge that emerges from “consensus and collaboration” between communicators and their audiences, and “requires that the audience co-produce it” (ibid. p. 176). Effective messaging ensures that such a body of common knowledge is established and in place before proceeding.

Conclusion

Combining the experiences of experts at the climate science–policy interface with the support of robust concepts from the field of communication theory has allowed us to propose seven well-supported messaging strategies, for use by scientists in communicating with policy makers about climate change. The emerging theme of the identified strategies is that climate messaging should be direct and relevant, acknowledge the audience’s perspective and psychological tendencies, and balance positive and negative framing. In coming to these conclusions, we addressed some gaps in the individual bodies of prior literature, which are most useful when combined and grounded in practice. Of course, we should acknowledge the excellent work of other contemporary authors that are helping to bridge such gaps. Jarreau et al. (2015), for instance, propose some similar strategies based on environmental psychology and a case study in the US, but not specifically in the context of climate change. Nunes et al. (2016) provide a detailed and practical (but academic) account of successful climate science–policy messaging in Brazil, drawing primarily on tactics emphasizing the local and economic impacts of climate change (i.e. our fifth and sixth strategies). We hope that our own work, combined with studies like these ones, will be useful to climate science communicators. The abstract foundation of communication theory lends flexibility to our strategies so that they might be applied in contexts besides Canada, and at multiple scales of government.

We would like to close with some notes about the limitations of this study and potential further work. First, the empirical support for our seven strategies is based on the opinion of a small number of practitioner experts, and there is still room for more rigorous testing (e.g. actual experiments that solicit responses from policy makers to hypothetical climate messages, more systematic investigations into the variety of strategies that are used across a large number of cases). Recall that this was primarily an exploratory study, so its purpose was to generate a strong and persuasive hypothesis about climate science–policy messaging (i.e. the list of prospective strategies), not to extensively test such a hypothesis, which may be a useful focus for a future study. Second, a broader observation emerging from the interviews is that the success of messaging (and science–policy interaction as a whole) depends heavily on the general relationship that has been established between the scientist communicators and the government audience (see the literature on science–policy interfaces, such as “boundary organizations” in Cash et al. 2002). A lot of messaging power comes from connections, time, and experience. Having a good informal rapport will afford some elasticity to the messaging. That is, even if a particular strategy falls flat, the information might get uptake anyway. Similarly, a bad or hostile relationship (e.g. where the same scientists have been publicly critical of government) may preclude even the most thoughtful messages getting through. Indeed, scientists may have to choose between ‘influence from within’ (direct communication and a good relationship with government) and ‘influence from without’ (indirect interaction through encouraging the public to put pressure on government). Scientist communicators should keep these limitations in mind but

also consider the seven strategies. If they do so, we believe they stand a better overall chance of translating climate scientific consensus into the necessary policy action.

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