2.2 GOOD REASONS FOR TRUSTING CLIMATE SCIENCE COMMUNICATION

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Science is communicated in many contexts. It is explained in formal and informal educational settings. It is offered to policymakers in blue-ribbon reports and personal testimony. But there is an additional context of particular interest to climate scientists: the communication of findings, theories and predictions in the context of the often-heated policy controversies characteristic of American democracy. Unlike in more controlled settings, when communicating in the course of controversy the climate scientist is liable to encounter active disagreement: doubt, distrust, outright dismissal, and even direct personal attack.

The goal of this paper is to deepen our understanding of the communicative methods climate scientists can use to gain their audiences' trust, even the face of such open disagreement. We draw on interdisciplinary scholarship from both humanistic and social scientific approaches to communication in order to extend existing research on source factors in persuasion and risk communication.

We begin by reviewing the significance of trust for communication, and in particular for communication of scientific results to the general public. We give some reason to believe that gaining and maintaining trust is a challenge, especially for climate scientists. We argue that although the extensive social scientific literature on source factors contains many insights for how to gain the trust of audiences in many situations, these communicative methods are unlikely to be successful in settings such as the controversy over climate change, where open disagreement can be expected. Instead, we suggest that an approach to trust drawn from work in philosophy, economics, sociology, and humanistic research on communication may support successful communication of climate science. We review a series of examples of communicative methods that are successful in situations of open disagreement, and propose that in general, a communicator can overcome an audience's deep skepticism and establish an relationship of trust by committing himself to a long-term relationship and making himself vulnerable for consequences should the relationship go wrong. This account of trust casts an interesting light on the otherwise surprising result that citizens trust media weathercasters almost as much as they trust climate scientists. It also provides a grounds for some novel approaches to communicating climate science. We close with suggestions about future areas of research on trust and science communication.

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1. CLIMATE SCIENCE COMMUNICATION AND THE PROBLEM OF TRUST

1.1 The Centrality of Trust for Successful Science Communication

It has long been recognized that the impact of any message is in part due to the trust the recipients place in the messenger. Already in ancient Greece, the philosopher Aristotle identified the speaker's *ethos*—his reputation for virtue, wisdom, and goodwill—as one of the basic sources of persuasion. Contemporary scholarship on communication has of course done much to extend and confirm this basic insight. Starting with Carl Hovland's ground-breaking study (Hovland et al. 1953) the literature has documented the importance of "source factors" in securing an audience's favorable reception of a message (O'Keefe 2002). Risk communication research is one of the fields that has examined the influence of trust on message acceptance, and has given support for a strong correlation between increased trust and greater acceptance of lower risk judgments (Poortinga and Pidgeon 2005; Trumbo and McComas 2003). Trust has been recognized as a major factor in successful risk communication (Slovic 1993) with only personal knowledge of the risk as possibly being more influential (Sjoberg 2001).

There are reasons to believe, moreover, that scientists in particular face a special need to rely on trust when communicating their knowledge to citizens. For it is trust, not understanding, that can bridge the knowledge gap between expert and layperson.

A substantial stream of research in psychology has documented that experts do not only know *quantitatively* more about their field than laypersons, they also know in a *qualitatively* different fashion, literally perceiving the world in a different way. The expert's knowledge enables him to identify and manipulate significant patterns in phenomena that are invisible to the novice's eyes (Ericsson and Charness 1994; Ross 2006). Along

the same lines, work in the social studies of science has stressed the key role that "implicit knowledge" plays in expert scientific theorizing (Collins and Evans 2007). In neither view does the expert's knowledge consist of discrete, fully explicit units that are capable of being transferred directly from one person to another. These theories thus imply that communication of scientists' expert knowledge outside the community of scientists is likely difficult or impossible.

Let us stress that we are not saying that we as lay folk are *incapable* of understanding science. Most of us could understand—if we were willing to invest the purported "10,000 hours" of intensive practice that has made the scientist the scientist that he is. Most of us, however, are quite right in not choosing to do this; as Stephen Shapin has commented,

> for practical reasons alone we are unlikely to subject scientists' claims to effective personal skepticism. If indeed we know these things at all, we take on faith the principles of aerodynamics and hydrostatics, the role of DNA in heredity and development, the chemical structure of benzene (Shapin 1995).

Shapin continues by noting that it is not only ordinary citizens who for practical reasons are unable to assess the scientific results communicated to them; scientists themselves "are largely in the position of laypersons when it comes to the specialist knowledge of other types of scientists." It seems impossible, for example, for anyone to gain expertise in *all* the sciences necessary to reach sound conclusions about matters as complex as global climate change. Science has become remarkably successful in part by an elaborate division of labor; one only needs to take a look at the range of programming at this conference to confirm this. It is likely that scientists working in fields at different "ends" of the sciences embraced within American Meteorological Society may have difficulties in understanding in detail each other's knowledge; how much more so between AMS scientists and the ordinary person on the Seattle street?

The knowledge gap between expert scientists and lay citizens means that citizens are not in a good position to assess the scientific content of scientists' messages (Collins and Evans 2007; Goodwin 2010). They are not capable of assessing, for example, whether data has been collected according to sound methods and analyzed without distortion. In fact, ordinary folk are not even in a good position to assess the *expertise* of the scientists communicating with them; as Collins & Evans have noted, only someone with equal or greater expertise can reliably test the extent of another's knowledge (Collins and Evans 2007; Walton 1997). Citizens are thus "epistemically dependent" on scientists for scientific knowledge (Hardwig 1985, 1991). Not fully able to assess the scientific grounding of the message, citizens are instead faced with the task of judging whether to place their trust the scientific messenger. Indeed, “even the most carefully developed risk messages are destined to fail if people do not trust the messenger" (McComas 2006) As Nisbet & Scheufele have put it, a cognitively "'miserly' public relies heavily on their trust in science and scientists as a dominant heuristic in reaching judgments about policy matters" (Nisbet and Schuefele 2009).

1.2 Gaining Trust as a Challenge for Climate Science Communication

The centrality of trust is not necessarily a problem for those who would communicate science, since science in general remains one of the most trusted institutions in the U.S. According to a AP-National Constitution Center poll in August, 2010, 83% of Americans are at least somewhat confident in those in charge of scientific institutions, a significantly higher level of trust than was granted to large businesses, Congress, or the traditional or new media (2010). The most recent polling by the Center for Climate Change Communication ("CCCC") reached an almost identical result; respondents considered scientists the best source for information on global warming, with 81% trusting them "somewhat" or "strongly" (Leiserowitz et al. 2010a). This substantial reservoir of public trust is an important resource for scientists attempting to communicate their current understanding of climate change.

There are, however, several reasons for concern about whether the public's trust is sufficient to promote the successful communication of climate science. First, both polls also reveal that less than 30% of Americans are "very confident" of or "strongly trusting" in scientists. This suggests that the public's generalized trust in scientific institutions while broad, is not deep, and may be readily displaced by other factors. The shallowness of public trust seems confirmed by the 9 point decline in public trust that occurred in the year after the unauthorized release of internal emails from the Climate Research Unit ("Climategate") (Leiserowitz et al. 2010b). NAS president Ralph Cicerone has argued that such quick shifts in

public opinion show "the fragile nature of trust between science and society" (Cicerone 2010). At a minimum, they suggest that public trust is something that the scientific community needs to actively maintain.

Second, trust may not lead to successful communication because trust in climate scientists is not distributed evenly. According to CCCC polling, the roughly one quarter of the population that are "dismissive" and "doubtful" of the existence of anthropogenic climate change also have the least trust in science. Indeed, close to half of the "dismissive" group actively *dis*trust climate scientists as sources of information about climate change (Leiserowitz et al. 2010a). This is not a particularly surprising result, since the same cognitive processes (e.g., confirmation bias) that would lead to rejection of the existence of climate change are likely to also impact assessments of the credibility of the experts who are reporting it (Kahan et al. forthcoming). In order to reach these "doubtful" and "dismissive" groups, climate scientists need to work to earn trust where little may have existed before.

Finally, a generalized trust in science will not necessarily translate into trust in particular scientists on particular occasions or, perhaps, particular topics (ScientificAmerican 2010). There is ample evidence that individual climate scientists are not benefitting from generalized trust. Dr. James Hanson, Dr. Michael Mann, Dr. Phil Jones, Dr. Kevin Trenberth, Dr. Gavin Schmidt—these are only a few of the prominent scientists who have been subjected to gross personal attacks in response to their efforts to communicate about climate change. Similar instances of open distrust and challenge are likely to be encountered by scientists who attempt to speak out in less prominent ways.

The public's trust in climate scientists is thus substantial, but it may also be fragile, unequally distributed, and potentially not active on specific occasions. Trust, in short, should not be taken as a "given"; instead, it is a valuable resource that needs to be actively maintained (American Meteorological Society 2011; Weingart 2002). As Leiserowitz, Maibach et al. have concluded, "finding ways to rebuild … trust should become an important priority for the scientific community, lest it risk a growing marginalization of science-based information in the policy-making process" (Leiserowitz et al. 2010b).

1.3 The Insufficiency of Source Factors for Gaining Trust in the Climate Controversy

An obvious approach to rebuilding trust is for scientists to make conscious use of the results of the extensive scholarship in the communication discipline on source factors. Persuasion literature has a long history of examining how to increase trust in a message through manipulating source factors, such as the communicator's expertise, attractiveness or similarity with the audience. Early research suggested that a message from a source that is more physically attractive or similar to the audience should likely be more accepted (Brinol and Petty 2009); other factors which have been linked to credibility include fluent delivery, humor and likeability (O'Keefe 2002). Indeed, some of the communication literature addressed to scientists advises them how to make use of such factors when addressing public audiences. Dean (2009), for example, gives recommendations about dress and vocal delivery, and Meredith (2010) adds pointers about humor and "personality." Less research-based, but still worthy of note, Randy Olson's *Don't Be Such A Scientist* (2009) is a powerful appeal to scientists to show themselves to be people their audience can like.

This is important advice that will enhance scientists' efforts to communicate with the general public. It is unlikely, however, that simply enhancing such source factors will be sufficient to establish trust in climate science communication. This is because factors such as likeability and attractiveness are unlikely to survive the critical scrutiny they will encounter in a controversy as heated as that over climate science. Explaining why this is so will require a brief detour through the psychology of human information processing.

It is now widely accepted that humans have two distinct approaches to processing information (Center for Research on Environmental Decisions 2009; Evans 2003). The elaboration likelihood model (ELM) (Petty and Cacioppo 1981) and the later heuristic-systematic model (HAM) (Chaiken et al. 1989) differentiate the two pathways for processing information by amount of cognitive elaboration involved. The "heuristic" pathway ("system 1") represents low elaboration and is the pathway used to quickly encode information with little use of mental resources. In contrast, the "systematic" pathway (or "system 2") represents high elaboration and is the pathway used when an individual chooses to carefully scrutinize the incoming information. The majority of daily information is processed through the heuristic route as it would be too mentally taxing to direct

full attention to every incoming stimulus. The systematic pathway is reserved for information perceived as being worth the extra processing effort (Eagly and Chaiken 1993).

The influence of source factors on message acceptance interacts strongly with the pathway for information processing. Research has found that source factors lose their effect or even reverse direction depending on the processing strategy in which the message was encoded (Brinol and Petty 2009; Tormala et al. 2007). In the case of low elaboration, system 1 processing, source factors do act as heuristic cues that allow for evaluation of the information with little regard for the content (Chaiken 1980; Hovland et al. 1953; Kelman and Hovland 1953). In the case of high elaboration, system 2 processing, by contrast, the effects of heuristics including credibility and likeability diminish. As O'Keefe explains:

> For issues of little personal relevance, receivers may be content to let their opinions be shaped by the communicator's apparent credibility; for such an issue, it is not worth the effort to follow the details of the arguments. But for highly relevant topics, receivers will be more likely to attend closely to the details of the message, to scrutinize the communicator's arguments and evidence, and to invest the effort involved in thinking closely about the contents of the message—and the comparatively greater importance of the message contents means that the communicator's credibility will play a small role than it otherwise might have (O'Keefe 2002).

Expertise, for example, can prime acceptance, but only if the information is perceived as personally relevant and ambiguous; unambiguous information loses the persuasive influence of expertise under high elaboration. In high elaboration settings, increased credibility can even *decrease* acceptance when thoughts are predominantly negative and the recipient has high certainty of their thoughts on the issue (Brinol and Petty 2009).

The challenge for climate science communication is that many of the factors that trigger highly elaborated, system 2 processing will be present in heated public controversies. Personal relevance of the message to the audience, the audience's prior knowledge about the topic, and the presence of multiple, competing messages on the topic have all been identified as increasing the likelihood of elaborated processing (O'Keefe 2002). Controversial settings will obviously include many contradictory messages; those individuals most actively and vociferously distrustful of scientific messages will likely be highly engaged with the issue, and will have through that engagement amassed a large set of beliefs on the topic. Thus where trust is most needed, appeals to credibility heuristics are least likely to be least effective.

In fact, within controversial settings the use of source factors to persuade may turn out to be worse than ineffective. Lay audiences do examine scientific messages for potentially manipulative persuasive strategies (Kolstø et al. 2006). Polling by the CCCC, for example, found that among Americans who had followed the "Climategate" story, close to 70% thought that scientists had misrepresented their results in order to make global warming appear worse (Leiserowitz et al. 2010b). But as Scheufele & Nisbet (2009) have acknowledged, "if the public feels like they are simply being marketed to, this perception is likely to only reinforce existing polarization and perceptual gridlock…[When] public engagement is defined, perceived, and implemented as a top-down persuasion campaign, then public trust is put at risk." Thus, it is possible that in the context of system 2/high elaboration processing, scientists who intentionally make themselves more likeable, attractive, or humorous will be seen as attempting to persuade by less than fully rational means, and their messages met with distrust.

A similar conclusion has been reached within risk communication research. Early research in the field viewed message acceptance as an challenge for compliance (Brinol and Petty 2009; Palenchar and Heath 2007), and scientists often hold similar views (Holmes et al. 2009; The Royal Society 2006). However, more recent studies view message acceptance as an interplay of a set of shared social relations (Palenchar and Heath 2007). Under this paradigm, studies emphasize that generating trust is less about manipulation of source factors but rather concerns increasing transparency, openness and commitment. Because the public is rarely able to evaluate risk managers directly, these social factors become more important (White and Johnson 2010). While there are multiple current models of how to build trust with risk communication all hold perceptions of openness and honesty as significant factors (Peters et al. 1997; White and Johnson 2010).

Because of these considerations, some have recommended that climate scientists restrict themselves to "nonpersuasive communication" (Fischhoff 2007). But even messages that disavow persuasion and are free of intentional use of

persuasive techniques still need to gain the trust of audiences in order to be attended to, considered, and believed. If climate scientists cannot rely exclusively on source factors to rebuild trust with those doubtful or dismissive of climate science, what communicative means do they have to establish relationships of trust with these audiences?

2. COMMUNICATION METHODS FOR EARNING TRUST IN THE MIDST OF DISAGREEMENT

2.1 Investigating Reasons for Trust

We have argued that appeals to low elaboration, heuristic, system 1 processing are unlikely to be sufficient to gain the trust of doubtful and dismissive audiences in the midst of the controversy over climate change. The obvious alternative is to gain trust by appealing instead to more highly elaborated, system 2 cognitive processes—that is, by giving *reasons* for trust. In the following we present one method climate scientists can use to earn the trust of audiences. It is a method that has been explored, sometimes independently, by several research programs that approach behavior through a "rationalistic" lens. Relevant prior work includes one strand among the philosophical accounts of trust in general (Hardin 1996, 2001, 2006), as well as focused accounts from speech act philosophy of why we ever trust what someone says (Moran 2006; Stampe 1967). Work in economics, political science and sociology has also examined the reasons people can use for going ahead with transactions of various sorts under conditions of "asymmetric information"—when one party has some key knowledge of the true state of affairs, which the other party cannot confirm, but must merely trust (Arrow 1985; Eisenhardt 1989; Mitnick 2008; Moe 1984; Shapiro 1987, 2005; Sharma 1997). Finally, similar theories have been developed within the communication discipline, especially in economic approaches to communication (Wildman 2008), and in argumentation theory—communication that manages to succeed even in the face of deep disagreement (Goodwin 2010; Kauffeld 1998, 2001, 2009).

Investigations of low-elaboration, system 1 processing have used experimental methods to reveal the cognitive heuristics audiences are in fact using, often without conscious awareness. By contrast, investigations of high-elaboration, system 2 processing can also use humanistic methods such as conceptual analysis and pragmatic reconstruction to expose the kinds of reasons audiences *ought* to accept as good—a normative or value question. A strong reason is one that can withstand critical scrutiny from well-informed, highly engaged, skeptical audience (Perelman and Olbrechts-Tyteca 1969). In the following, we use a series of paradigmatic examples to identify and analyze one set of good reasons that can be used to establish trust even between those who disagree.

2.2 Commitment, Vulnerability and the Creation of a Relationship of Trust

Example 1: Offering hostages. Let us imagine a medieval world, where a pair of neighboring domains have been at war with each other for a long time. The lord of one says he wants to make peace. Why should the lady of the other believe him? For all she knows, Lord One might just be setting her up for a sneak attack.

What can Lord One do to overcome this legitimate distrust? One possibility is to add to his offer of peace an additional offer of his child as a hostage. By doing so, he invites Lady Two to draw two conclusions.

First, Lady Two knows that Lord One has an interest of his own in serving her interests. She can therefore expect that in their future relations Lord One will take her interests to heart. Such a convergence of interests gives Lady Two grounds for relying on Lord One's future good behavior. It provides her with some security, and may be enough for her to agree to stop fighting.

Still, the relationship that emerges from such a deal is not what we would ordinarily call a relationship of trust. The offering of a hostage also invites a second inference, however. By giving a hostage, Lord One has made himself vulnerable—vulnerable to Lady One in a way she can be confident she can enforce. Lady Two can reason that Lord One would not make himself thus vulnerable unless he was committed, now, to keeping the peace. So the offer of a hostage gives good evidence not only of his future behavior, but also of his present motives. She can presume, therefore, that Lord One is telling the truth when he says he wants peace. She can trust him, and consider entering into a more peaceful relationship with him.

Trading children back and forth is cumbersome. Let us go on to examine a similar, but lighter weight, method for earning trust.

Example 2: Offering a warranty. Fast forwarding to the present day, consider why anyone would buy a used car. This is the classic

case of "asymmetric information" (Akerlof 1970). The dealer says that the car in good shape, but he, not the buyer, is in possession of the information needed to make such a judgment—who the previous owner was, for example, and what has gone wrong with the car before. Why should a buyer ever believe what the dealer says?

One method the dealer can take to overcome this legitimate distrust is to add to his representations about the car an offer of a warranty. If the car turns out to be bad, the dealer will fix or replace it. As before, this allows the buyer to draw two conclusions.

First, the buyer can now expect that if the car turns out bad, at least he won't be significantly harmed. By obligating himself to fix the car, the dealer has entered into a potentially long-term relationship with the buyer, and made his future conduct more predictable. He is now committed to serving the buyer's interest in having a working vehicle. The buyer can now agree to the transaction with some degree of confidence, even if he does not trust the dealer or his representation.

Second, the offer of the warranty also allows the buyer to draw some conclusions about the dealer's motivations. In offering the warranty, the dealer has made himself vulnerable to pay the costs of repair—vulnerable in a way that the buyer can be confident he can enforce. The buyer can reason that the dealer would not do this unless the dealer expected those repair costs to be low. So the warranty gives the buyer a reason to trust the dealer and take under consideration his claim that the car is a good one.

Warranties are of course just words. An offer of a warranty can only create a reason for trust in an environment where buyers are confident of their ability to enforce them; for example, an environment that includes Better Business Bureaus to complain to and court systems in which to sue. Again something lighter weight is needed: a method for securing trust in the absence of elaborate institutional backings.

Example 3: Offering a commitment to the truth. At the most general level, everyday statements raise the same problems of distrust as medieval warfare or used car sales. A speaker gives her auditor new information; the speaker, not the auditor, is in a better position to know whether or not it is true. Why should an auditor ever believe what he is told?

An offer of information does not, like offers of hostages and warranties, make the speaker's future conduct more predictable; the auditor is not necessarily being invited to infer anything about what the speaker will in the future do. However, if there is an expectation of an ongoing relationship between the speaker and auditor, the speaker is making herself vulnerable within it. And that does allow the auditor to make an inference about her motivations.

In saying something, the speaker is committing herself to the truth of the matter. If what she says turns out to be false, the auditor can come back and blame her. In serious cases, he can take actions such as cutting off all further relations with her, or announcing to the community at large that she's a liar. The auditor can presume that she would not open herself to criticism and reproach in this way, unless she was confident in the truth or at least defensibility of the information she is providing. So her commitment to her statement gives her auditor reason to trust her, and consider what she has said.

Summary. Let us step back and identify the communicative method for gaining trust that is evident in each of these examples.

In each case, trust arises against the background of some form of ongoing relationship. By offering either a hostage or a warranty, the offeror lays the groundwork for future interactions, and the offer of information takes place within the course of an ongoing relationship. In each case, within that ongoing relationship the offeror makes himself vulnerable—vulnerable to negative consequences that the recipient of the offer can reliably impose. The recipient can exact vengeance on the hostage he holds, can claim repairs under the warranty, or can reproach the offeror. In each case, the recipient can now reason that the offeror would not make himself thus vulnerable, unless he was confident of success: confident in the peace he was offering, the quality of the used car, or the truth of the information. The offeror's open acceptance of vulnerability thus gives the recipient a reason to trust him, and take his offer under consideration.

Accepting vulnerability within an ongoing relationship provides a reason or grounds for trust, but it does not necessarily demand trust, or "cause" it to arise in all cases. In technical terms, the reason for trust is defeasible—like other reasons for action, it can be outweighed or "defeated" by appropriately strong counter-considerations. If the medieval lord has dozens of spare children, if the car dealer has no ties in the neighborhood, and if the speaker is known not to care about his reputation—in all these cases the offer will likely be insufficient to gain the recipient's trust. On the other hand, the reasons for trust created by these offers can not only be weakened

by counter-considerations, but also strengthened by adding supplementary commitments. The medieval lord can offer his obviously beloved firstborn child, the used car dealer can have his warranty backed by a national chain of repair shops, and the provider of information can make more specific commitments to defend the truth of what she is saying. The method we have outlined is a general communicative strategy for creating trust: like all strategies, it will not always succeed, but it will be able to be adapted to the needs of a specific situation.

Note that this account of gaining trust starts from the assumption that the trusting party will be skeptical or even openly hostile. Further, this communication method for gaining trust will work even when it is noticed and subjected to scrutiny. Indeed, openly drawing attention to and explaining the communicative method may even strengthen it. Where someone can*no*t say "trust me, because I am attractive, which is a well-established factor for eliciting trust," someone can say, "trust me, because I am giving you these reasons to presume that I am trustworthy". These communicative methods do not have the appearance of being manipulative; they are fully avowable.

A final example: broadcast weather predictions. Our approach provides an interesting take on why the public turns to weathercasters for climate science information. Television weather reporters are the public's second most trusted source for information about global warming (Leiserowitz et al. 2010a), a finding that has raised concerns because a majority of this group appears to believe there is no scientific consensus on the topic (Homans 2010; Maibach et al. 2010). What is the basis for the public's trust? Undoubtedly, weathercasters are selected for broadcast jobs in part because they are good looking, likeable, and humorous—in other words, because they activate the credibility heuristics of their audience's system 1 cognitive processes. But in addition, the public has *good reasons* for trusting weathercasters. It is clear that local television and radio stations have a strong interest in securing public attention over the long term. Furthermore, errors in weather prediction are immediately apparent to the public, who need no expert knowledge to distinguish rain from shine. The public can also be confident of its ability to inflict harm on the weathercasters' employers, simply by changing the channel. Because of these factors, the audience can presume that weathercasters will work very hard indeed to serve their interest in accurate weather information. Moreover, since predictions do frequently go awry, the public will also have plenty of opportunities to observe how the weathercaster handles being wrong. Does he try to evade responsibility? Or does he admit his mistake, apologize, and go on with renewed effort? Finally, some Canadian radio stations are apparently trying to enhance their trustworthiness and secure more attention by offering a weather guarantee. If their predictions are off by more than 3º C, the station's "members" are entered into a raffle for a cash prize (e.g., 680News 2011). Weathercasters are making themselves more trustworthy by taking on additional responsibilities and making themselves more vulnerable. Based on the previous statistic, the public is apparently willing to transfer this trust from weather predictions to broader questions of climate science.

2.3 Good Reasons for Trusting Climate Science Communication

On the account we have given here, to establish trust with dismissive and doubtful audiences, climate scientists will have to commit themselves to a long-term relationship, and make themselves vulnerable within it. Let us briefly review some of the challenges in achieving this pair of objectives.

The first challenge will be to create opportunities for scientists to interact with doubtful and dismissive audiences on an ongoing basis. Previous research on public participation in scientific assessments has stressed the importance for establishing trust of extended interactions between scientists on the one hand and citizens and policy-makers on the other (Dietz and Stern 2008; Mitchell et al. 2006). The same research has revealed some of the pitfalls that may occur along the way. In a controversy as heated as that over climate change, there may be few obvious "meeting places" in the real or virtual worlds where climate scientists and those who doubt their testimony can interact on a regular basis. Each opinion group on the issue appears to talk mostly to itself, maintaining its own discussion spaces, trusted information sources, and public advocates. (Oddly enough, the AMS itself may be one of the leading organizations bringing together those with divergent views.) Climate scientists interested in establishing relationships of trust with doubtful and dismissive audiences should take advantage of what venues there are, and work to open new, long-term conversations where they can.

Given the history of debate on climate issues, personal animosity and abuse are other

challenges climate scientists will likely face once they identify a suitable venue and offer to open an extended relationship. It should be noted, however, that the scientist's willingness to proceed despite the possibility of such abuse may actually serve as a reason for trust. The second objective for establishing trust is for the communicator to make herself vulnerable in a way that the audience can reliably enforce. By openly committing herself to an ongoing relationship with all the personal risks that implies, the scientist is giving her skeptical audience a good reason to conclude that her views are at a minimum sincere and well-considered.

In addition to making themselves vulnerable simply by committing to an ongoing conversation, scientists may need to seek methods for making themselves vulnerable to doubtful and dismissive audiences regarding possible weaknesses in their theories. It is probably worthwhile to consider that from a doubting citizen's point of view, it may often appear that climate scientists can never be wrong. The scientists have almost exclusive possession of the information on which they base their claims and of the knowledge they use to analyze that information. Further, when some information *appears* to undermine their theories, scientists are capable of explaining it away in ways that laypersons are unable to challenge. Scientists are certainly vulnerable to each other—that, after all, is what peer review is all about. But to lay audiences they may appear invulnerable, and because of that, untrustworthy.

In this situation, further assertions of confidence in scientific results may actually lead to further doubts. Instead, our analysis suggests the apparently paradoxical conclusion, also proposed by Brian Wynne (1992) that climate scientists may be more trusted if they present themselves as less certain. Instead of stressing the inerrant consensus that backs their statements, it may provide a stronger reason for trust if they openly made themselves vulnerable to criticism for any mistakes they may make.

In order to make themselves vulnerable and thus earn trust, scientists will need to accomplish two interlinked goals. First, scientists will need to develop, convey and commit to standard metrics or indicators of climate change that are usable by non-scientists (Bowman et al. 2009). In contrast to the data sets and models that are in the almost exclusive possession of scientists, these indicators need to be apparent to laypersons in the same way that whether a used car is working is apparent. Second, having committed themselves to a set of indicators, scientists will need methods for assuring the public that they will in fact be held responsible and bear the consequences, if it turns out that their commitments are wrong. Something like simple embarrassment at having to publicly retract claims may be a sufficient penalty.

In sum, to successfully communicate the risks of climate change, scientists must accept a risk themselves—the risk of being shown to be wrong in specific ways. By committing themselves to an ongoing relationship, and by granting the public the power to hold them accountable for errors, climate scientists give even doubtful and dismissive audiences good reasons to trust them.

3. CONCLUDING REMARKS

In this paper, we have only sketched the outlines of one communicative method scientists can use to earn trust even in the face of open disagreement. There is plenty of room for future collaboration between climate scientists and communication scholars adopting both humanistic and social scientific approaches, e.g. on the design of appropriate metrics and indicators that will satisfy the needs of both scientists and laypersons. Case studies of specific attempts to earn trust would also enlarge our understanding of the repertoire of good reasons climate scientists can use to convey their results. The role of the media needs to be examined: for example, the way that the public's (dis)trust of the traditional media may color their trust in the scientists whose voices are reported; or how scientists might use new media to establish an ongoing relationship even with doubtful and dismissive publics.

In particular, we would like to note the way our approach may cast new light on methods for communicating uncertainty. Successful communication of uncertainty is undoubtedly one of the most pressing challenges facing science communicators, on climate change (American Meteorological Society 2011) and many other topics. Studies have confirmed that nonexperts are unfamiliar with the scientific treatment of uncertainty, and are poor at processing uncertainty information (Johnson and Slovic 1995; Kuhn 2000). The approach we have taken here suggests a way of reframing uncertainty into more familiar terms. Instead of attempting to communicate the probability that an event will happen, or the cognitive strength of the expert's belief in the event, degrees of certainty and uncertainty might be communicated by enlarging or restricting the scope of the responsibility scientists are willing to take for the event occurring. By analogy, in the context of used car

sales an enforceable "double your money back" or "lifetime" guarantee effectively communicates much more certainty than a 30 day limited warranty for repairs, excluding the cost of labor. A tie between uncertainty estimates and attributions of responsibility has already been confirmed in a recent study by Dieckmann et al. (2010), which found that audiences are less likely hold forecasters responsible when they understand the uncertainty of the forecast. This is a line of research which deserves further development.

The facts about climate change do speak for themselves—to those with the expert knowledge to listen to them. The rest of us have to listen to scientists. Until we become experts ourselves, we likely have few ways of figuring out which of the purported scientific theories are correct, or even which of the competing claimants for our attention have real expertise. We layfolk do, however, have the practical knowledge or *phronesis* accumulated through ordinary transactions to help us figure out who can be trusted. We are most of us well equipped to make "*social* judgments about *who* ought to be agreed with, not *scientific* judgments about *what* ought to be believed" (Collins and Evans 2007). Or as Harry Collins once remarked, "the expertise that we need to deal with [scientists] is the well-developed expertise of everyday life; it is what we use when we deal with plumbers" (Collins and Pinch 1998).

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