

# Scientific Consensus and International Climate Cooperation

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## Abstract

Uncertainty has traditionally been considered an impediment to international cooperation, and international institutions are typically thought to exist to reduce uncertainty. By contrast, I argue that scientific uncertainty sometimes *enables* cooperation by expanding the bargaining range. I test this with a new dataset of state-scientist interactions within the Intergovernmental Panel on Climate Change (IPCC). I show that states have ideological preferences over science which leads them to influence the IPCC's influential Assessment Reports. They are most able to do so when the underlying science is uncertain, but that these generally reflect political compromises between states who usually disagree. Such compromises on science are then associated with greater compromise on policy issues at the UNFCCC. Building on these findings, I argue that agreements like the Paris Accord incorporate an 'optimal' amount of scientific uncertainty to enable broader participation.

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# 1 Introduction

When states bargain over highly technical issues, uncertainty about the state of the world is typically thought to make it harder to reach agreement. However this may not always be the case: in some instances, scientific uncertainty can improve the odds of cooperation by expanding the range of acceptable bargains. Negotiators, constrained by politics at home, are more likely to find agreement if there are a range of policy options on the table. In this sense, scientific consensus on policy options may undermine, rather than reinforce, international cooperation.

To illustrate this counterintuitive hypothesis, this paper focuses on climate change, where we traditionally contrast political *disagreement* between states with universal *agreement* and consensus among scientists. Consensus within the professional community, however, may present a constraint on policy making. As example, the Paris Agreement states that signatories will try to prevent the average temperature of the Earth’s atmosphere from rising by 2C over the pre-industrial average, preferably no more than 1.5C. These goals are peculiar because climate scientists intensely disagree on whether or not they are achievable (Livingston and Rummukainen, 2020).<sup>1,2,3</sup> Instead of undermining the agreement, this lack of consensus allowed scientists in institutions like the Intergovernmental Panel on Climate Change (IPCC) to reach “a compromise between what is deemed possible and desirable” in the form of the Paris Agreement goals (Geden, 2015). Here, scientific uncertainty seems to have aided agreement by allowing scientists to deviate from the norms of their broader professional community.

I argue that this phenomenon may be a structural feature of international cooperation over highly technical domains. On issues ranging from global public health to the environment, there is a tension between the scientific community and international cooperation. In bargaining over a technical agreement, negotiators begin with the state of scientific knowledge. States, however, have preferences over the shape of international agreements, based not only on science but on their own political interests. When the epistemic community of scientists is marred by internal disagreement and uncertainty, institutional bureaucrats have more degrees of freedom in the bargaining space. As result, they are more likely to devise an international agreement. In this sense, scientific certainty undermines, rather than aids, international cooperation.

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<sup>1</sup>Some scientists argue that without the quick deployment of currently non-existent technologies, emissions cuts alone will fail to prevent a temperature rise greater than 2C. Others are more optimistic, arguing that while politically difficult, limiting warming to 1.5C is “not yet a geophysical impossibility” (Millar et al., 2017).

<sup>2</sup>Dyke, James, et al. “Climate scientists: concept of net zero is a dangerous trap” *The Conversation*, 22 April 2021

<sup>3</sup>Nuccitelli, Dana, “Climate scientists debate a flaw in the Paris climate agreement” *The Guardian*, 29 March 2018

I test this by undertaking a detailed analysis of the primary institution in-charge of collecting and then signaling to negotiators the international scientific consensus on climate change: the Intergovernmental Panel on Climate Change (IPCC). States negotiate with IPCC scientists and each other in plenary sessions to decide a mutually agreeable representation of the science behind climate change. This representation, called the IPCC's *Assessment Report*, aims to be a comprehensive summary of the state of scientific consensus over climate change. Assessment reports then form the basis of policy negotiations over at the UN Framework Convention on Climate Change (UNFCCC). Using newly digitized data on the IPCC's assessment process and UNFCCC policy negotiations, I establish three main empirical findings.

First, I find that when states negotiate over the language of the report, their preferences over science mirror their preferences over climate change policy. I use an ideal point model to simultaneously scale states and statements on the same underlying latent ideological scale, revealing that states' preferences over science fall along familiar political lines. For example, statements that emphasize the economic burden of mitigating global warming are favored by large polluting states who often point to the difficulties of mitigation in policy negotiations. Similarly, states that are most vulnerable to the effects of climate change emphasize statements that detail the economic toll of unmitigated warming on their societies.

Second, when states try to alter statements in the report to reflect their preferences, they are more likely to come to a compromise position when the IPCC signals greater uncertainty. While these uncertain statements are also likely to be the subject of state attempts to alter science, the IPCC changes these statements to placate states with divergent preferences more often than on relatively certain science.

Lastly, I show that pairs of states that reach compromise over science are more likely to reach compromise in policy negotiations at the UNFCCC. Using panel data on dyadic agreement rates, I show that dyads that were originally on opposite sides of an IPCC intervention but subsequently came to a compromise are more likely to agree after the IPCC plenary sessions than before. This effect is large but diminishes over time. This suggests that agreement over science has a pacifying effect on agreement over policy, even if temporarily.

Overall, these results imply that rather than the Paris Agreement example being an outlier, successful agreements are more likely when some uncertainty exists within the scientific community. Rather than a straightforward linear relationship between scientific consensus and political agreement, a strong scientific consensus that forms before governments have a chance to negotiate

and adjust will end up hindering political agreement. Therefore, there exists an optimal level of scientific uncertainty will maximize the chances of agreement.

In addition to explaining puzzling stylized facts about climate change agreements, I also contribute to bridging the gap between work on international institutions and epistemic communities. While scholars of international institutions have increasingly recognized the importance of understanding the makeup of international bureaucracies and their staff (Fang and Stone, 2012; Chwieroth, 2013; Kennard and Stanescu, 2019), it is rarely acknowledged that the legitimacy of an international organization often stems from an associated epistemic community of experts (Haas, 1992).<sup>4</sup> The broader scientific community associated with a given international issue serves as an extremely influential non-state actor, yet we have very little work on how this outside actor influences cooperation inside international institutions. For its part, the epistemic communities literature acknowledges the role of the scientific community in informing state interests in international interactions, but often equates scientific consensus and certainty with a greater likelihood of international cooperation.

More broadly, I add to recent work that highlights how self-interested actors use information, rather than traditional tools of coercion, to extract favorable outcomes in international relations (e.g. Carnegie, Clark and Zucker (2021)). Perlman (2020), for example, shows how firms deploy their privileged access to scientific information to obtain favorable international health and safety standards. In a mechanism that is analytically very close to the one in this paper, Carnegie and Carson (2020) show how international institutions sometimes deliberately hide information to enable states to overcome a ‘disclosure dilemma’ and cooperate. Similarly, within the realm of international security, scholars have shown that secrecy Carson (2016) and ‘strategic ambiguity’ (Baliga and Sjöström, 2008) can help states avoid costly conflict.

The rest of the paper is organized as follows. The next section introduces the case of climate change cooperation and the IPCC and the role it plays in the larger climate change regime. Section 3 fleshes out the theory in detail, generating testable hypotheses for the empirical analysis. Section 4 follows on from this and presents the data I extract from the IPCC process to test the hypotheses in Section 3. Section 5 tests the theory with detailed empirical analyses. Section 6 concludes the paper and discusses avenues for further research.

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<sup>4</sup>For two notable exceptions, see Chwieroth (2015); Farrell and Quiggin (2017)

## 2 The Case: Climate Change Cooperation and the IPCC

When states first sought out to address the problem of climate change, they faced two collective challenges. First, they needed a forum to bargain over climate change policy, such as how much each country should reduce its emissions as part of an international agreement on climate change. For this purpose states created the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, which gathers state representatives together each year in a Conference of Parties (COP) session.

Second, they needed to better understand the science behind climate change. While this may seem at first like a relatively apolitical need, political considerations colored the method in which states decided to obtain scientific information about climate change. As Bodansky (2001) shows, the nascent climate change regime was originally located in the United Nations Environmental Program (UNEP), which brought together activist-oriented scientists in a series of international conferences in the 1980s. The UNEP process involved very little government intervention and so scientists raised the alarm on climate change early as a significant problem requiring international action. Powerful states, especially the US under the first Bush administration, pushed for the creation of the IPCC in 1988 to “reassert governmental control” over the dissemination of climate science. Powerful states wanted to strictly control the boundaries of what climate science could report on and the degree to which it could go from reporting science to suggesting policy.

Therefore, states decided to resolve the two problems, deciding policy and understanding science, in the same way: by creating a venue for political negotiation. How does the IPCC work as a venue for political negotiation? At irregular intervals, the IPCC creates ‘assessment reports’ that are supposed to provide a comprehensive overview of the state of knowledge about climate science in an approachable way.<sup>5</sup> While its official goal is to “provide governments at all levels with scientific information that they can use to develop climate policies”, in reality national governments already know the contents of the report before its final version is published (IPCC, 2021). This is because the last stage of the report consists of inter-governmental negotiations over the language of the report, as described in greater detail in Subsection 2.1.<sup>6</sup>

For a government which cares about the shape of a climate change agreement, the contents

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<sup>5</sup>The IPCC does not conduct any research on its own, but rather tries to summarize and represent the state of scientific consensus in an accessible way to policymakers.

<sup>6</sup>As (Voeten, 2021, p.27) states, institutions like the IPCC “matter not so much because they have expertise that states do not have. After all, many of the panel members are state employees and the knowledge is often in the public domain. However, the organization matters in that it restricts the supply of expert advice by offering a focal understanding of expertise.”

of the published IPCC report matter a great deal. The assessment report is widely cited and is often the basis of national and subnational climate change policy (see National Research Council (2001) for an example from the US). The assessment reports is also mentioned widely in news reports (Freudenburg and Muselli, 2010) and academic papers (Costinot, Donaldson and Smith, 2016; Acemoglu and Rafey, 2018) about climate change. For our purposes, the IPCC’s reports form the basis of political negotiations over international climate change agreements at the UNFCCC. For example, after the IPCC’s Special Report on 1.5C Warming (SR15) was released, popular media commentary pointed out the fact that the findings of the report would be used downstream in climate change negotiations:

*“SR15 will be used by many countries for different ends in the climate change negotiations. Small island states, for whom the report holds special significance, will wield it as powerful ammunition in the call for greater ambition in NDCs, and will urge greater efforts toward completing the Paris Agreement work programme at COP 24. Others will use the report’s findings to underline that the costs of transition, especially in fossil-fuel dependent economies, are daunting, and international support for a just transition is necessary. The US will likely argue that the high costs of action identified in the report mean that other socially desirable investments are preferable to those combating climate change.”*

**-Earth Negotiations Bulletin Vol. 12 No. 734 Page 21**

## **2.1 The IPCC Assessment Process**

In this paper, I take a quantitative look at the process of negotiations over science at the IPCC. In order to set the stage for that analysis, I first describe the IPCC’s assessment process. Each assessment cycle, the three working groups of the IPCC work on individual working group reports. Additionally, in every assessment cycle, the three working groups collaborate to produce a ‘synthesis report’. Table 1 shows the constituent part of the 5th Assessment Report, the most recently fully released report.

Each working group reviews and represents a specific set of scholarly work. Working Group I reviews the scientific basis for climate change, establishing that human activity is causing and will continue to cause changes in the Earth’s climate. Working Group II reviews the impacts of climate change on human and natural ecosystems, as well as methods of adapting to these impacts.

Working Group III assesses the state of knowledge around mitigating the drivers of climate change, specifically greenhouse gas emissions. It discusses both options for mitigation as well as different emissions trajectories and how much warming to expect in each scenario. Lastly, the synthesis report brings together the most important insights from all three working groups and is jointly produced by all three working groups.

Each working group also produces a Summary for Policymakers (SPM), which ends up receiving the most media and policy attention. When news outlets or court cases quote an IPCC Assessment Report, the most often refer to “headline statements” in the SPM, which are deliberately designed for the lay reader<sup>7</sup>. Consequently the SPM receives a disproportionate amount of scrutiny from IPCC member states.

Table 1: Constituent Reports of the 5th Assessment Report

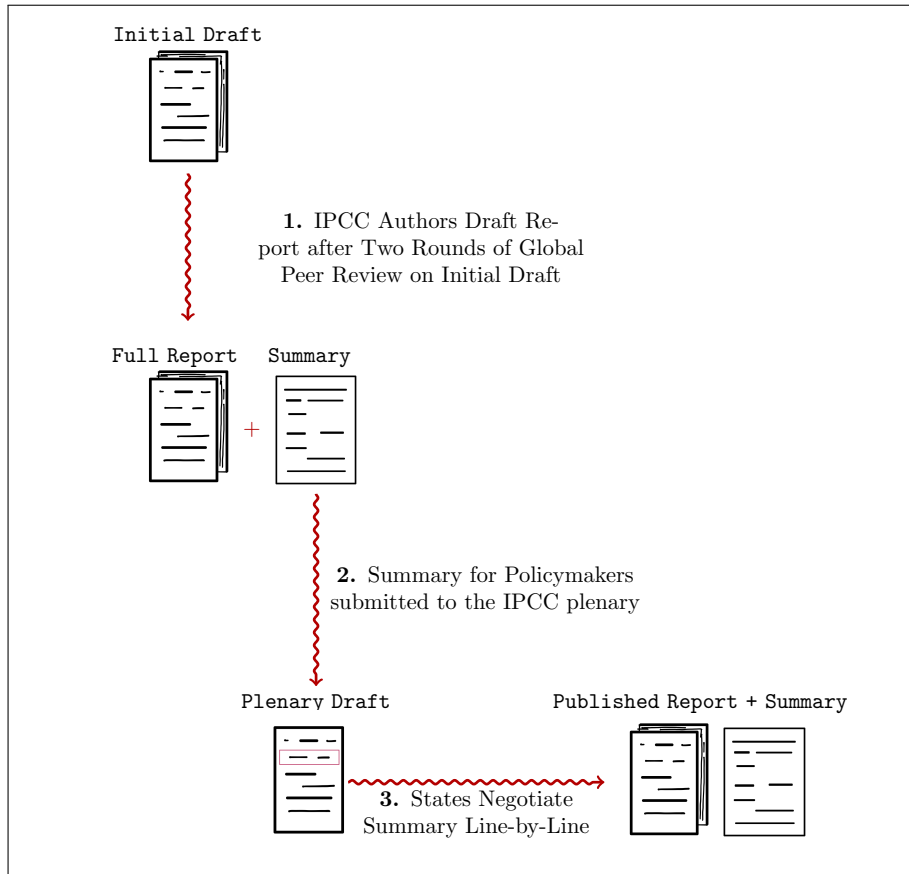
Authors	Official Name	Focus
Working Group I	The Physical Science Basis	Connection between human activity and climate change
Working Group II	Impacts, Adaptation, and Vulnerability	Effects of climate change on society
Working Group III	Mitigation of Climate Change	Options and pathways to mitigate climate change
Working Groups I-III	Synthesis Report	Combine Insights from Working Groups I-III

*Note: Each report has its own Summary for Policymakers, which is the most widely cited and used part of the report. In this paper I do not use the Synthesis report, since it is a summary of the other three working group reports.*

This role of power is reflected in the IPCC’s assessment process, shown in Figure 1. For each working group report, the full report and its Summary for Policymakers is first drafted by the relevant IPCC working group bureau. These drafts then go through a period of global peer review in which experts from any part of the world are invited to submit comments requesting changes to the report. While governments do also submit comments at this stage, they have no formal *de jure* power to force changes to the report. Consequently the end result of this peer review, the “final government draft”, reflects the discretion of the IPCC authors in responding to the international scientific community.

<sup>7</sup>See for example: “Climate science is supporting lawsuits that could help save the world” *Nature*. 08 September 2021

Figure 1: **The IPCC's Assessment Process**



Next, the Summary for Policymakers is sent to a plenary session of the IPCC where it is negotiated line-by-line by IPCC member states, who must reach a consensus in order for the report to be published. This is the most political contentious part of the IPCC process, since the stakes of even minor changes in language over science have downstream consequences for policy negotiations. Countries intervene on specific statements in the report, and coalitions often form in support or opposition to the intervening countries. Sections of the report are assigned to IPCC staff called “Coordinating Lead Authors”, whose job it is to represent the original authors of the report and negotiate changes to the language that preserve the scientific integrity of the IPCC.

After states have agreed to the final shape of the report by consensus, the report is officially published. This institutional structure allows social scientists a privileged view into the interaction between the epistemic community and powerful states. By studying this process quantitatively, I hope to understand better the relationship between political agreement and the inherent uncertainty and disagreement within the science.



### 3 A Theory of Epistemic Disagreement and Political Agreement

Before proceeding with an empirical analysis of the IPCC, it is important to discipline our theoretical expectations from the data. How should we understand the process of negotiations over science? And how do negotiations over science affect negotiations over policy? In this section I present a theoretical framework that endogenizes the communication of scientific consensus to states by international institutions.

I argue that international institutions balance two objectives when communicating science. First, they try to remain within the ambit of a broader epistemic community that they belong to. Second, they try to facilitate agreement between states who find agreement difficult. In balancing these two objectives, I argue that scientific uncertainty reduces the impact of the first of these two objectives, since the epistemic community is less likely to be able punish norm violations. In doing so, uncertainty facilitates the second of these two objectives, making international agreement more likely.

Before discussing the mechanics of the theory in a formal model, I make explicit three assumptions embedded in the model:

**Assumption 1: Science has broad public legitimacy** Few would doubt that publics in most countries hold the scientific community in high regard. Especially in democratic countries, policies that are perceived as having a stamp of approval from the scientific community are thought of as more legitimate than those that go against that consensus (Bertsou and Caramani, 2020).

**Assumption 2: States care about their agreements being seen as scientific** Why would states care about the scientific community's stamp of approval? This follows in a straightforward way from the first assumption and by assuming that states want public support for agreements that they sign. More broadly, states want their political arrangements to be endorsed by institutions seen as technocratic and more objective, such as the UN Security Council or the World Bank (Abbott and Snidal, 1998; Doshi, Kelley and Simmons, 2019).<sup>8</sup>

Because states care about a reputation for scientific legitimacy, they often deploy scientific arguments in international negotiations. Since many technical negotiations take place in the shadow

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<sup>8</sup>How do we square this with the observation that states like Saudi Arabia often seem to attack the scientific consensus on climate change? I argue that conditional on signing an agreement, states like Saudi Arabia are especially likely to want scientific approval for their agreement, as it would counteract their reputation for going against scientific consensus.

of public opinion, a state whose bargaining position is seen to be on the “side of the science” gains leverage over the other state.

**Assumption 3: The epistemic community maintains legitimacy by strong internal norms** While technocrats and international organization staff are formally agents of states, in reality in any sufficiently technical issue area, these individuals are embedded into a broader epistemic community. While most of the literature has focused on understanding when states will exert more or less influence on these bureaucrats<sup>9</sup>, it is rarely mentioned that the epistemic community might also exert a countervailing influence on these individuals.

Following Haas (1992), I assume that epistemic communities are defined by their shared beliefs, and experts who stray from the consensus might face very real material consequences as a result (Davis Cross, 2013). However, there may be variation within an epistemic community in how uniformly its members share a given belief. I assume that straying from the consensus view is less professionally costly for experts if the consensus view is uncertain or subject to more disagreement within the community.

**Model** Armed with these assumptions, we can now understand the three-way interaction between the epistemic community, its representative experts, and state governments. The basic crux of the model is the following: if an expert in an international institution can tweak the presentation of scientific knowledge freely, she can calibrate scientific communication in a way that makes agreement possible between states. However, if the expert’s presentation of science strays too far from the epistemic community’s consensus, she pays a professional cost that is inversely proportional to the degree of certainty within the epistemic community.

Two states,  $A$  and  $B$  negotiate over an agreement represented by a variable  $a \in [0, 1]$ . For concreteness, we can think of  $a$  as the level of greenhouse gas emissions that state  $B$  must reduce in order to mitigate the impact of climate change (on both states). In this setting a strong climate change treaty would be one where  $a$  is close to 1, while a weak treaty would have  $a$  closer to 0.

We assume that state  $A$  prefers a strong treaty, so that its payoff from an agreement is  $U_A(a) = a$ , and symmetrically the payoff for state 2 is  $U_B(a) = 1 - a$ . Suppose that both states have an outside option, defined as their payoff if no agreement is reached. While state  $B$  has outside option equal to zero, state  $A$ ’s outside option is  $\nu$ . This outside option can be thought of as the magnitude

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<sup>9</sup>See for example in Copelovitch (2010); Johns (2007); Fang and Stone (2012)

of damage from unmitigated climate change. However, neither state knows the value of  $\nu$ , and need to rely on experts in an international organization to decide a value of  $\nu$  before they can negotiate.

Suppose the expert in the international institution chooses a value  $\nu^i$  that represents the institution's communication of the scientific consensus. If the actual epistemic community's consensus view is  $\nu^e$ , the expert pays a professional cost  $\sigma(|\nu^i - \nu^e|)$ , where  $\sigma$  is the level of scientific consensus within the epistemic community about the value of  $\nu$ .  $\sigma = 1$  denotes perfect certainty and consensus and  $\sigma = 0$  denotes complete lack of consensus. In addition to the cost of violating professional norms, the expert gets an additional payoff of 1 in case *any* agreement is signed between the two states.

Once the expert decides  $\nu^i$ , states bargain according to an unspecified bargaining protocol. I follow Johns (2007) in employing the cooperative *Nash Bargaining Solution* to understand the likelihood and nature of the agreement as a function of the level of scientific uncertainty. In the final stage of the game, states reach agreement only if the value of  $\nu^i \leq 1$ . In this case, the Nash Bargaining solution will be an agreement  $a^* = \frac{1+\nu^i}{2}$ . State *A*'s utility from this agreement is  $U_A(a^*) = \frac{1+\nu^i}{2}$ , while state *B* gets  $U_B(a^*) = \frac{1-\nu^i}{2}$  (Muthoo, 1999).

To analyze the most interesting case, suppose the epistemic community decides, with certainty  $\sigma$  that  $\nu^e > 1$ . This is equivalent to scientists deciding that the level of emissions cuts required to prevent catastrophic warming are equivalent to drastic slowdowns in economic growth. Now, in order to reach even a minimal agreement, the expert has to signal  $\nu^i = 1$ , suffering a professional cost equal to  $\sigma(\nu^e - 1)$ . For this to be worth the utility from an agreement, it has to be true that

$$\frac{\sigma + 1}{\sigma} > \nu^e$$

Since the left hand side of this inequality is decreasing in epistemic certainty  $\sigma$ , this implies that the greater the value of the epistemic consensus  $\nu^e$ , the less certain the epistemic community has to be in order for experts in international institutions to take the professional risk of straying far from the consensus.

This highly stylized model generates a strong set of hypotheses:

**H1** States will have preferences over science that mirror their preferences over policy.

In other words, since science decides the bargaining range, states will prefer science that invalidates agreements that they do not favor and legitimizes agreements they prefer. Since states have preferences over the presentation of science, they will try to alter scientific communication. When

will they reach a compromise?

**H2** States that disagree will be more likely to reach compromise on the presentation of scientific facts when the underlying science is uncertain.

When the science is uncertain, negotiators and bureaucrats will have greater room to maneuver and present science in creative ways to get agreement between states. When states do reach a compromise on science in this way, this should show up as greater agreement over policy:

**H3** Pairs of states that reach agreement over science will reach agreement over policy.

I test these hypotheses by using newly digitized data on the the process of scientific consensus within the IPCC. The next section describes the data gathered to conduct this test.

## 4 Data and Measurement

I use three sources of data to create a dataset of state-scientists interactions in the creation of the IPCC’s 5th Assessment Report (AR5), as shown in Figure 2. My main unit of analysis is the scientific statement, as stated in the Summary for Policymakers (SPM) of a given working group report.

Data Type	Source	Details	Time Period
Scientific Statements	IPCC (2011)	Plenary and Published Drafts of Summaries for Policymakers in the 5th Assessment Report	2013-2014
IPCC Plenary Negotiations	Earth Negotiations Bulletin (ENB)	Interventions and coalitions around scientific statements	2013-2014
UNFCCC Policy Negotiations	Earth Negotiations Bulletin (ENB)	Interventions and coalitions around agenda items in the Conference of Parties (COP) and meetings of the UNFCCC Subsidiary Bodies	2011-2015

Table 2: Documents Included in Analysis

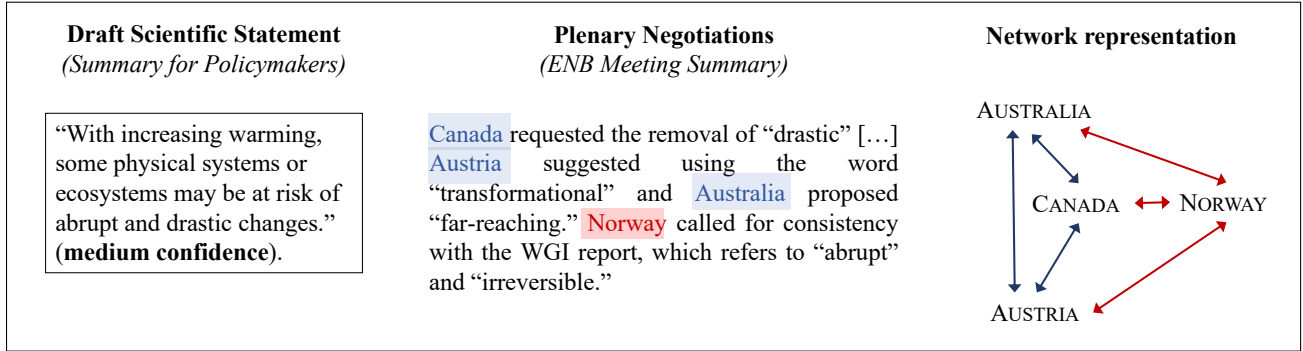
### 4.1 Measuring International Cooperation

The main dependent variable in this paper is international cooperation. Measuring cooperation at a granular level is difficult. Since climate change agreements are not regular occurrences but the outcome of regular rounds of negotiations over minutiae, I use the formation of coalitions in IPCC and UNFCCC negotiations as a proxy for levels of agreement and cooperation between states.

#### 4.1.1 Measuring State Attempts to Alter Science

I link scientific statements in the IPCC’s draft Summaries for Policymakers (SPM) to plenary negotiations over that statement, found in the Earth Negotiations Bulletin (ENB) meeting summaries. Figure 2 shows the an example of a scientific statement in the Working Group II draft report that Canada raised intervention on. Canada was supported in the intervention by Austria and Australia, but opposed by Norway. For each such intervention, I create a network representation where countries are nodes and edges between nodes represent support or opposition.

Figure 2: **Processing Negotiations over Science**



#### 4.1.2 Statement Level Variables

I use these data to create two measures that describe inter-state agreements and disagreements at the IPCC plenary. First, for statement  $i$ , I create a binary variable  $Intervention_i$  that indicates whether a given statement in a Working Group draft Summary for Policymakers received an intervention by any state. Then I create another binary variable  $Compromise_i$  that indicates, for the subset of statements that received an intervention, whether the intervention ended in a compromise position being reached for the final text.  $Compromise_i = 0$  then indicates an extreme outcome of either the intervention resulted in the intervening state(s)’ requesting being fulfilled or being rejected. Table 3 shows the summary statistics of these two variables by Working Group of the AR5:

Working Group	#Statements	#Interventions	#Interventions Ending in Compromise
Working Group I	81	28	17
Working Group II	81	66	25
Working Group III	95	72	37

Table 3: Summary Statistics

In aggregate, the frequency of interventions seems to be highest for Working Group III, followed by Working Groups II and I. This seems to reflect the nature of scientific topics covered by the groups. Since Working Group III reports on the most policy-relevant science, it might be the venue that sees the most contentious political debates.

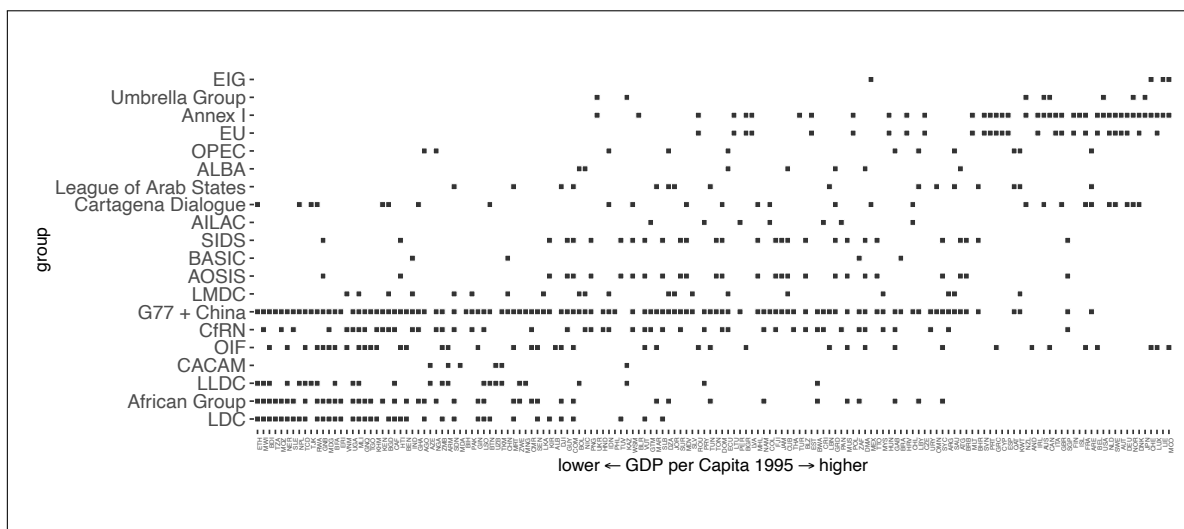
### 4.1.3 Measuring Policy Agreement

In addition to state-to-state cooperation at the IPCC, I also use data from the Earth Negotiations Bulletin (ENB) summaries of policy negotiations at 13 UNFCCC climate change conferences from 2011 to 2015. These include larger meetings called Conferences of the Parties (COP), as well as concurrent meetings of the Subsidiary Bodies to the UNFCCC.<sup>10</sup>

I use a string search algorithm to identify instances of countries engaging in interventions in a given negotiation session at the UNFCCC. For each such intervention, I extract instances of countries supporting each other or opposing each other in UNFCCC interventions.<sup>11</sup>

A large portion of UNFCCC negotiations involve interventions by negotiating blocs rather than individual countries (Rietig, 2014). Figure 3 lists these negotiating blocs with their membership. When I observe a negotiating bloc making an intervention on a given agenda item, I record that as if every member state of the bloc supported each other in the intervention. See Appendix Section A for more details on how I processed the Earth Negotiations Bulletin.<sup>12</sup>

Figure 3: Negotiating Blocs at the UNFCCC



The x-axis denotes the a country's 1995 GDP per capita. Black squares indicate that the column country is a member of the row bloc.

<sup>10</sup>The subsidiary bodies meet twice each year, typically once in the spring without the COP, and once in the winter with the COP.

<sup>11</sup>I exclude opening statements from countries and blocs since they are likely to be largely ceremonial and pre-prepared.

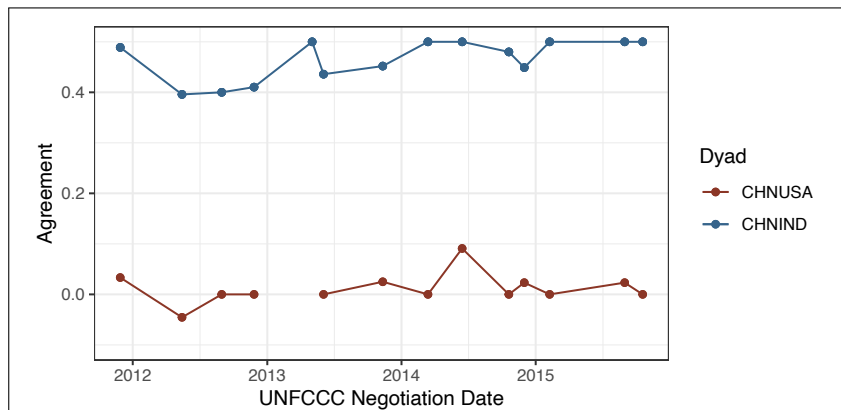
<sup>12</sup>Genovese (2014) presents an alternative measure of state ideal points that rely on documents called 'National Communications' that some states submit to the UNFCCC before negotiations begin. I rely on alliances made and disagreements that arise within a negotiation rather than pre-negotiation communication, since these are less likely to be perceived as cheap talk.

Using these data, for every dyad  $\{i, j\}$  and negotiation date  $t$ , I calculate a variable  $Agreement_{ijt}$ , defined as:

$$Agreement_{ijt} = \frac{NetSupport_{ijt}}{TotalInterventions_{it} + TotalInterventions_{jt}}$$

In words,  $Agreement_{ijt}$  is the number of times  $i$  and  $j$  supported each other at session  $t$ , minus the number of times they opposed each other ( $NetSupport_{ijt}$ ), divided by the total number of times both of them were part of any intervention in the conference. Figure 4 plots the agreement rate between China and either the US or India over the given time period.

Figure 4: **Agreement on Policy Over Time for Two Example Dyads**



The x-axis denotes the date of a given climate change conference at the UNFCCC.

While the China-USA dyad seems to have a very low agreement rate, the China-India dyad has a much higher agreement rate, according with our intuition that China and India are ideologically closer in climate change negotiations than China and the US.

## 4.2 Measuring Scientific Uncertainty

The main explanatory variable in this paper is scientific uncertainty. IPCC assigns each headline statement in a given Summary for Policymakers (SPM) a given level of certainty using a standardized uncertainty reporting criteria (Mastrandrea et al., 2010). The IPCC assigns statements a qualitative category of uncertainty depending on whether probabilistic measurement of uncertainty is possible.

For a given statement, given the scientific literature, if a probabilistic measure of uncertainty is possible to provide, the IPCC uses its “likelihood” based categories. These range from “exception-



ally unlikely” to “virtually certain”. In the middle of this scale, for the most uncertain assessments, the IPCC uses “about as likely as not”.

If a probabilistic judgment of uncertainty is not possible, the IPCC uses a combination of evidence quality (limited, medium or robust) and scientific agreement (low, medium, high) to come up with an assessment of a statement’s “confidence”. This ranges from “very low confidence” to “very high confidence”, with “medium confidence in the middle”.

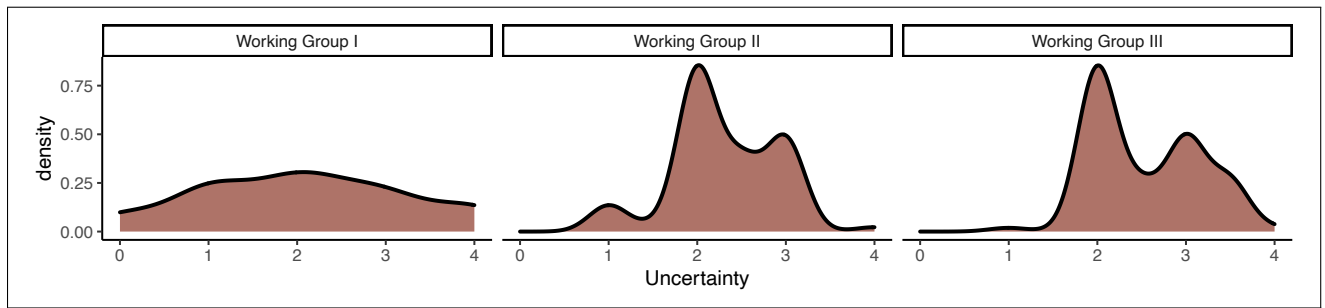
In this paper, I only use statements that have either a likelihood or confidence level assigned to them by the IPCC. I convert these categories into a quantitative measure ranging from 0 to 4. Table 4 shows how I assign numerical values to different confidence/likelihood designations. In cases where a statement has multiple confidence designations assigns to different parts, I average the value of designations for that statement.

Table 4: **Quantified Measure of Statement-Level Uncertainty**

<b>Uncertainty (Quantified)</b>	<b>Confidence</b>	<b>Likelihood</b>
4	Low	About as likely as not
3	Medium	Likely, Unlikely
2	High	Very Likely, Very Unlikely
1	Very High	Extremely Likely, Extremely Unlikely
0	-	Virtually certain

Figure 5 the distribution of this numerical measure of uncertainty across statements across the three Working Group Summaries for Policymakers (SPMs). While Working Group I, which reports on the physical basis of climate change has a fairly even split between certain and uncertain statements, uncertainty is much higher in Working Groups II and III. This likely reflects the different topics covered by these different documents. While atmospheric science behind climate change (Working Group I) is relatively certain, there exists more uncertainties in the wide range of impacts of climate change on human societies and natural ecosystems (Working Group II) and the costs and benefits of different mitigation options (Working Group III).

Figure 5: Distribution of Uncertainty By Working Group



*The x-axis denotes the quantitative value given to a statement, reflecting its uncertainty. A value of 0 corresponds to the IPCC's "very high confidence" or "virtually certain" designations, whereas a value of 4 corresponds to "low confidence" or "neither likely nor unlikely".*

## 5 Empirical Analysis and Results

Armed with these data, In this section, I present three sets of findings. First, I establish that the draft IPCC report presented to states is political in the sense that individual scientific statements have ramifications for international agreement, and that states’ preferences over science correspond to their preferences over policy. Second, I show that the ability of states to alter science depends on scientific uncertainty. Uncertain statements get more interventions in the plenary. At the same time, I show that uncertain science leads to more compromise positions in the text. Lastly, I show that greater compromise at the IPCC is associated with greater compromise at the UNFCCC.

### 5.1 IPCC Science is Political

#### 5.1.1 Estimation

In order to show this, I estimate a simple Bayesian Item-Response Theory (IRT) model with the data (Clinton, Jackman and Rivers, 2004; Bonica, 2014). I assume that scientific statements and states can be defined by their position in a common latent ideological space. Formally, suppose that state  $i$  has ideal point  $\theta_i \in \mathbb{R}$  and that a given statement  $c$  in the draft version of the report has its own ideal point  $\gamma_c \in \mathbb{R}$ . Once a statement is presented to states in the IPCC plenary, state  $i$  is more likely to request a change to the statement the farther its ideal point is from the statement. Formally, if  $ProposeChange_{ic}$  is a binary variable recording whether state  $i$  requested a change to statement  $c$ , I assume that:

$$Pr[ProposeChange_{ic} = 1] = \text{logit}^{-1}(\alpha_i + \beta_c + (\theta_i - \gamma_c)^2)$$

Where  $\alpha_i$  is a state-specific “verbosity” parameter capturing a state’s tendency to make intervention in the plenary (regardless of the statement).  $\beta_c$  is analogously a statement-specific “difficulty” parameter that captures the tendency of a statement to receive *any* interventions. The term  $(\theta_i - \gamma_c)^2$  captures the preference misalignment between state  $i$  and statement  $c$ .  $\text{logit}^{-1}$  is the inverse logistic function.

Conditional on a state proposing a change, I also assume that another state  $j$  will oppose this change ( $OpposeChange_{jc} = 1$ ) with probability:

$$Pr[OpposeChange_{jc} = 1] = \text{logit}^{-1}(\alpha_j + \beta_c - (\theta_j - \gamma_c)^2)$$

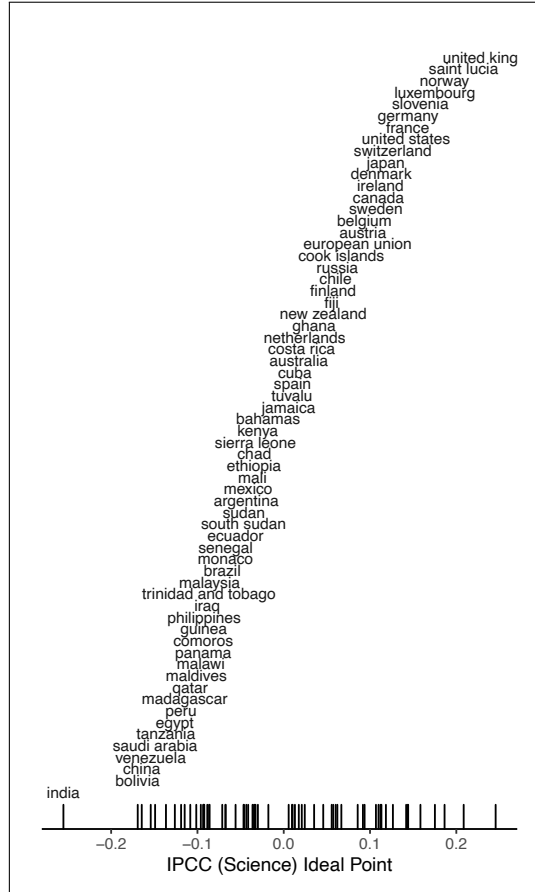
In words, state  $j$  will oppose state  $i$ 's proposed change to statement  $c$  if its ideal point is close to the ideal point of the statement.

I estimate the parameters in the model above using MCMC in `stan` with standard normal priors on all parameters  $(\alpha, \beta, \theta, \gamma)$ . I only include IPCC member states that participated in at least one intervention for the 5th Assessment Report. Appendix Section A presents more details on the estimation and model diagnostics. The model recovers estimated posterior distributions for all parameters, and I use the mean of the posterior as the estimated value for the state and scientific statement ideal points.

### 5.1.2 Results

Figure 6 shows the recovered ideal points for the 63 states who participated in at least one intervention. The ideal points seem to correspond to an intuitive Global North-South dimension. Early industrialized countries in the global North, such as the United States and the United Kingdom are on the higher end of the ideological spectrum, while newly industrialized and industrializing countries such as India, China and Brazil are on the polar opposite end of the recovered spectrum. Countries that are small and/or vulnerable to climate change such as small island states are clustered in the middle.

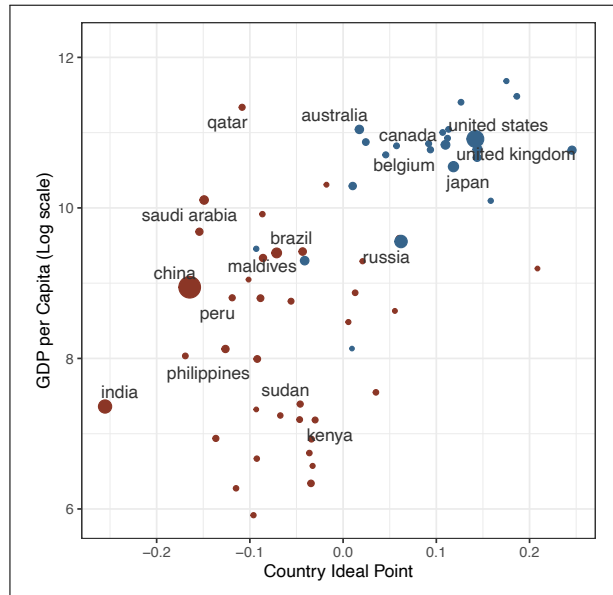
Figure 6: Recovered Country Ideal Points



Countries are arranged in order of their ideal point rank, from low to high.

This corresponds strikingly well with the predominant cleavage in international climate change negotiations (Gupta, 1997). Since the 1990s, agreement over climate change has been impeded primarily by an impasse between newly developing states, who want room to develop (and therefore pollute) and highly industrialized countries, who point to the increasing share of emissions from the developing world (Najam, Huq and Sokona, 2003). To more formally show this, Figure 7 shows the relationship between the recovered ideal points and country characteristics that are usually predictive of their positions in climate change agreements.

Figure 7: Ideal Points Correspond to Political Interests



Note: *Red* denotes members of the G77+China negotiating bloc at the UNFCCC, while *Blue* denotes non-members. The size of each dot corresponds to the total greenhouse gas emissions from that country. (Source: World Bank (2014))

Now, having seen that negotiations over science divide countries along familiar ideological lines, we can move to examining the recovered ideal points of the scientific statements themselves. Table 5 shows examples of some recovered scientific statements that fall in one of three ideological positions: far left (close to developing countries), far right (close to industrialized countries) and middle (close to vulnerable and adaptable countries).

Table 5: **Examples of Scientific Statements with their Recovered Ideal Points**

Recovered Ideal Point ( $\gamma$ )	Closest Countries	Scientific Statement
0.44	United Kingdom, Saint Lucia, Norway	“A growing share of CO2 emissions from fossil fuel combustion in developing countries is released in the production of goods and services exported, notably from upper middle income countries to high income countries. Total annual industrial CO2 emissions from the non-Annex I group now exceed those of the Annex I group using territorial and consumption accounting methods, but per-capita emissions are still markedly higher in the Annex I group.”
0.13	Switzerland, Japan, United States	“Reduction of subsidies to fossil fuels can achieve significant emission reductions at negative social cost.”
0.02	Costa Rica, Australia, Netherlands	“Distribution of impacts: Risks for disproportionately affected people and communities are generally greatest in low-latitude, less-developed areas, and are moderate at recent temperatures because of regionally differentiated climate-change impacts on food production.”
0.02	Costa Rica, Australia, Netherlands	“It is extremely likely that human influence on climate caused more than half of the observed increase in global average surface temperature from 1951-2010.”
-0.15	Saudi Arabia, Venezuela, Tanzania	“It is about as likely as not that sustained globally net negative CO2 emissions, i.e., net removal of CO2 from the atmosphere, will be required to achieve the reductions in atmospheric CO2 in this scenario by the end of the 21st century.”
-0.24	India, China, Bolivia	“Mitigation policy may devalue endowments of fossil fuel exporting countries, but differences between regions and fuels exist (medium confidence). The effect of mitigation on coal exporters is expected to be largely negative while natural gas exporters could benefit in the medium term as coal is replaced by gas.”

As the table shows, the model seems to have recovered statements that, while are ostensibly summaries of scientific literature, have direct implications for the nature of climate change agreements. For example, the first statement, which has a high ideal point, claims that emissions of CO2 from non-Annex-I (roughly meaning developing) countries now exceeds those from Annex-I countries<sup>13</sup>. This statement clearly aids countries like the United States, as it provides them with ammunition against states like China and India in climate change negotiations.

Similarly, the last statement claims that mitigation will hurt the economy of fossil fuel producers. This statement clearly aids the bargaining position of countries like Saudi Arabia, who can use this in climate change negotiations to ask for lower levels of CO2 mitigation.

<sup>13</sup>The Annexes were groupings of countries as part of the Kyoto Accord. Annex-I countries were industrialized Northern countries that had binding emissions cuts imposed on them. Emissions cuts were non-binding for non-Annex I countries in consideration for their status as lower income countries.

Taken together, this section has established that the draft of the IPCC’s report has clear political implications. Scientific statements polarize countries, recreating political divisions that we typically see in climate change negotiations. Moreover, countries understand the advantage of having science on their side, and their attempts to shape the report reflects clear political priorities. This establishes strong evidence for **H<sub>1</sub>**.

## 5.2 Uncertain Statements Get More Interventions

### 5.2.1 Estimation

Given that the report is political, when do states ask for changes to the report? From the discussion in Section 3, I expect that statements where scientists signal the most uncertainty are most likely to garner an intervention from a state, since these statements are where the epistemic community is weakest to police scientific communication.

To test this, I conduct analyses at the statement level. For statement  $i$ , I estimate models of the following form using OLS:

$$Intervention_i = \beta_0 + \beta_1 Certainty_i + \gamma_{\rho(i)} + \alpha_{\psi(i)} + \epsilon_i \quad (1)$$

$Intervention_i$  here denotes a statement-level outcome, specifically whether *any* state proposed a change to the statement. The Working Group report that a given statement  $i$  belongs to is denoted  $\rho(i)$ , so  $\gamma_{\rho(i)}$  are report fixed-effects. In order to ensure that uncertainty is not proxying simply for a difference among different types of scientific topics, I control for sections of the report. The section that a given statement  $i$  belongs to is denoted  $\psi(i)$ , so  $\alpha_{\psi(i)}$  are section fixed-effects.



## 5.2.2 Results

Table 6: Uncertain Statements Get More Interventions

	<i>Dependent variable:</i>		
	<i>Intervention<sub>c</sub></i>		
	(1)	(2)	(3)
Uncertainty	0.068* (0.039)	0.040 (0.039)	0.071* (0.042)
Dep. Var. Mean	0.505	0.505	0.505
Report Fixed Effects?	N	Y	Y
Section Fixed Effects?	N	N	Y
Observations	329	329	329
R <sup>2</sup>	0.011	0.066	0.133
Adjusted R <sup>2</sup>	0.008	0.058	0.103
Residual Std. Error	0.499 (df = 327)	0.486 (df = 325)	0.474 (df = 317)

*Note:* \*p<0.1; \*\*p<0.05; \*\*\*p<0.01  
Standard errors are clustered at the statement level.

Table 6 presents the results. Column 3 shows, as expected that uncertain statements are more likely to garner an intervention in plenary than uncertain statements, all else equal. This provides direct evidence for **H1**, that states will be more likely to request changes to science the more uncertain the science is. The magnitude is substantial, going from a high confidence statement to a low confidence statement is associated with a 14 percentage point higher likelihood of intervention, a 28% increase over the average.

## 5.3 More Compromise When Science is Uncertain

### 5.3.1 Estimation

Having established that scientific statements represent different political interests and that states try to change statements more when the science behind them is more uncertain, the natural next question is: when do states succeed in doing so, and how does this affect the ideology of the report?

To answer this question, I estimate the following equation on the subset of statements that received an intervention:

$$Compromise_i = \beta_0 + \beta_1 Certainty_i + \gamma_{\rho(i)} + \alpha_{\psi(i)} + \epsilon_i \quad (2)$$

Where  $Compromise_i$  is a binary variable that records whether an intervention ended in a compromise between the proposing state(s) and the report authors.  $Compromise_i = 0$  denotes situations where either the proposing states succeed or fail to change the language of the report.

### 5.3.2 Results

Table 7 presents the results from estimating the model from Equation 2. As column 3 shows, conditional on receiving a proposal to change the language of the statement, interventions on uncertain statements are more likely to end in a compromise position reflected in the text. The effect sizes are substantial. Going from a high confidence statement to a low confidence statement is associated with a 40 percentage point increase in the likelihood of compromise (an 84% increase over the average). This suggests that IPCC scientists are more likely to find a compromise position if the science is uncertain, as predicted by **H2**.

Table 7: Uncertain Statements Get More Compromise

	<i>Dependent variable:</i>		
	<i>Compromise<sub>c</sub></i>		
	(1)	(2)	(3)
Uncertainty	0.204*** (0.072)	0.201*** (0.072)	0.204*** (0.072)
Dep. Var. Mean	0.476	0.476	0.476
Report Fixed Effects?	N	Y	Y
Section Fixed Effects?	N	N	Y
Observations	166	166	166
R <sup>2</sup>	0.067	0.095	0.108
Adjusted R <sup>2</sup>	0.061	0.078	0.050
Residual Std. Error	0.485 (df = 164)	0.481 (df = 162)	0.488 (df = 155)

*Note:*

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Standard errors are clustered at the statement level.

## 5.4 Is Compromise over Science Associated with Compromise over Policy?

### 5.4.1 Estimation

Lastly, I test whether reaching a compromise at the IPCC plenary is associated with reaching compromise over policy issues at the UNFCCC. To do this, I first create a variable at the dyad level  $Compromise_{ij}$ , which equals one if the dyad  $\{i, j\}$  ever reached a compromise at one of the three IPCC plenary sessions for the 5th Assessment Report, and zero otherwise.

To test whether compromise at the IPCC predicts agreement at the UNFCCC, I estimate a difference-in-differences regression at the dyad-date level, where date denotes the date of a UNFCCC negotiation session. I estimate a difference in differences regression of the following form:

$$Agreement_{ijt} = \sum_t \beta_t Compromise_{ij} * \mathbb{1}\{Date = t\} \tag{3}$$

$$+ \tau_{ij} + \mathbb{1}\{Date = t\} + \epsilon_{ijt} \tag{4}$$

Where the time-varying coefficients  $\beta_t$  denote the estimated effect of *Compromise<sub>ij</sub>* on *Agreement<sub>ijt</sub>* at date  $t$ .  $\tau_{ij}$  and  $\mathbb{1}\{Date = t\}$  are unit (dyad) and time (negotiating session) fixed effects. I cluster standard errors at the dyad-level.<sup>14</sup> I only include dyads whose members participated in the IPCC plenary negotiations for the 5th assessment report, leaving 64 countries and 2016 unique (undirected) dyads for each of the 13 UNFCCC negotiation sessions.

The IPCC plenary sessions range from September 23 2013 to April 7 2014. This means that  $\beta_t$  coefficients that are from UNFCCC negotiations before September 2013 serve as placebo checks, as they capture the (fictitious) effect of compromise at the IPCC on agreement at the UNFCCC.

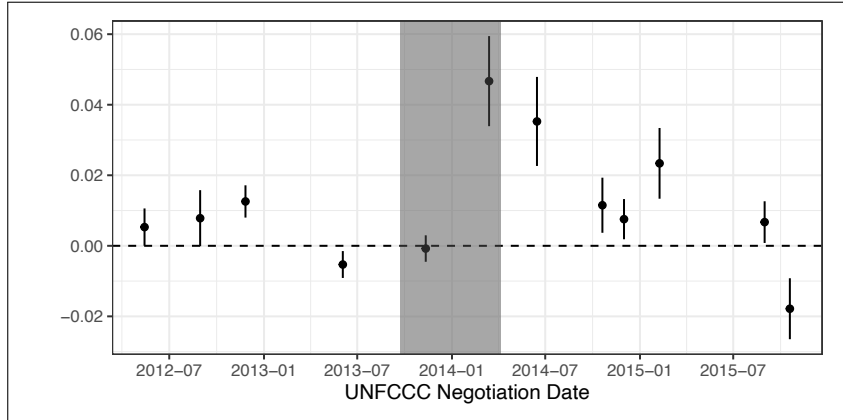
## 5.4.2 Results

Does compromise over science predict subsequent agreement over policy? Figure 8 plots the estimated from estimating Equation 3. While coefficients from before the IPCC period are substantively small, the coefficients become strongly positive and statistically significant right after the IPCC period. Substantively, the largest coefficient suggests that compromise at the IPCC is associated with a  $\frac{1}{4}$  of a standard deviation higher agreement rate at the UNFCCC.

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<sup>14</sup>Estimating differences in differences regressions with unit and time fixed effects is known to rely on strong assumption of linear additivity of treatment effects. In Appendix B.1, I show use the estimator suggested by Imai and Kim (2019) to show that the results here are robust to their alternative estimation. I also show that the results hold when we account for unobserved correlation of errors across dyads.

Figure 8: **Compromise over Science Predicts Compromise over Policy**



*The shaded region denotes the time period of IPCC plenary negotiations.*

However, this effects diminishes over time, and is negative or zero by October 2015, suggesting that on average, the compromise reached at the IPCC did not carry through as permanent agreement at the UNFCCC. This also likely reflects the fact that soon after the IPCC plenary, while states might have come to a compromise over existing scientific facts, new scientific findings and statements get produced constantly that states have not had the opportunity to come to an agreement on. If this is true, policy negotiations could soon again be marked by disagreements between states rooted in different interpretations of recent science. This establishes suggestive, but not conclusive evidence for  $H_3$ .

Nevertheless, this result does suggest that compromise at the IPCC leads to more compromise at the UNFCCC. Taken together, the results establish three salient findings. First, states have preferences over the presentation of science that mirror their preferences over policy. Second, this leads states to try to alter scientific statements to benefit their bargaining position in policy negotiations. However, often states come to a compromise position on science, and this happens much more often when the underlying science is uncertain, suggesting that uncertainty creates room for compromise. Lastly, this compromise on science leads to greater compromise on policy, even if only transiently.

## 6 Conclusion

Scientific knowledge is crucial to international cooperation in a wide array of issues. Before states can agree on a vaccine sharing facility, for example, they need to know what percentage of their

population needs to be immunized to reach herd immunity. To reach an agreement to share nuclear fuel for peaceful purposes, states need to know thresholds of enrichment that make that fuel usable for military weapons. And to reach agreement on environmental externalities, states need to know scientific facts about the costs of the externality. In each of these examples, the consensus of the epistemic community has real ramifications for international cooperation. Will greater scientific consensus lead to more cooperation?

In this paper, I hypothesized that greater certainty and consensus within an epistemic community may be detrimental to cooperation between states. International institutions in charge of signaling the epistemic community's consensus to states might be more able to play the role of broker if there is disagreement within the epistemic community. I test this hypothesis using data from the IPCC, the most prominent institution in charge of signaling the scientific consensus on climate change to states. I showed that scientific uncertainty increases the scope for states to influence scientific communication, but that the net result of this influence might actually be greater agreement between states.

These results help explain why international coordination on climate change often seemed to be strongest in 1980s and very early 1990s, a time when scientific uncertainty around climate change was particularly high. Even as scientists were urging a cautious approach that included more research into the problem, a Republican US president signed onto the first ever international treaty on climate change in 1992, the UN Framework Convention on Climate Change (UNFCCC).

It should be mentioned however, that I do not take a stance on whether greater agreement as defined in this paper is normatively a welfare enhancement for the modal citizen of the world. While scientific uncertainty might allow for broad participation in an agreement such as Paris, this agreement might not be optimal from the perspective of a person living in a highly climate vulnerable setting. If countries use the unrealistic nature of the Paris agreement goals to resist taking mitigation action, this deteriorates the welfare of vulnerable populations.

Future research should investigate the domestic underpinnings of these results. How do publics and interest groups in the negotiating countries react to scientific uncertainty? While rational publics might see through agreements based on uncertain science, motivated reasoning publics might go along with agreements like Paris because they want to believe that the agreement will deliver on their promises. Incorporating such behavioral elements into a two-level game model would be a substantial step forward in this literature.

Lastly, future research should connect the presentation and interpretations of science to its

underlying political economy. While states attempt to use their *de jure* veto power at the IPCC to influence science, richer states also have the option of manipulating science by threatening to cut funding to scientific research establishments at home. Scientific uncertainty, then, might not be exogenous to the negotiation process, but a deliberately constructed outcome of a process of political bargaining between states and scientists at home.

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