When Climate Scientists Speak, Do Policymakers Respond? A Computational Study

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Abstract

Do policymakers respond to scientists when climate change enters public debate? This study examines science-policy dynamics through computational analysis of 266,271 articles from 20 Canadian newspapers (1978-2025). Using machine learning models trained on 4,000+ annotations (F1 > 0.8), we track monthly discourse coalitions of the top 1,000 scientific and political authorities, measure their stability through Jaccard similarity coefficients, and examine causal relationships with thematic framing. We identify a fundamental paradox: stable political coalitions suppress scientific discourse by 40%, while political instability increases scientific frame usage by 151%. Granger causality tests reveal asymmetric influence, with political coalition changes powerfully preceding both political and scientific frame shifts, while scientific coalitions show weaker predictive power. The analysis identifies three distinct regimes: science-led (1980-1987), contested (1988-1997) marked by economic frame emergence, and politics-led (1997-present). This transformation seems to reflect not scientific failure but successful political reframing of climate change from technical problem to governance challenge. Federal elections seem to create windows of opportunity where coalition instability temporarily weakens political control and enables scientific influence. Higher turnover rates in scientific coalitions compared to political coalitions reveal structural weakness in how scientific knowledge enters public discourse. The Canadian Climate Framing (CCF) database, processing 9.2 million annotated sentences through 65 categories, demonstrates how computational approaches can address longstanding questions about expertise and democracy. These findings suggest that effective science communication requires strategic timing aligned with political transitions rather than continuous information provision.

1 Introduction

Do policymakers respond to scientists when climate change enters public debate? This question lies at the heart of evidence-informed policy yet remains empirically under-explored. While scholars have long theorized about science-policy interactions in climate governance, systematic evidence of how and when political actors engage with scientific knowledge remains elusive. This paper addresses this gap through comprehensive analysis of Canadian climate discourse over four decades.

The relationship between scientific expertise and political action represents a central challenge in democratic governance. Extensive literature examines climate communication (Haas 2004; Peters 2007), framing effects (Druckman 2001; Park, Liu, and Vedlitz n.d.), and media-policy relationships (Liu, Lindquist, and Vedlitz 2011; Bolstad and Victor 2024). These studies reveal that scientific knowledge enters policy debates through processes of translation, mediation, and political interpretation. However, most rely on limited samples or qualitative approaches that cannot capture systematic patterns across extended time periods. What remains unclear is whether political actors actually respond to scientific interventions.

To investigate this question, we employ the Canadian Climate Framing (CCF) database, a comprehensive resource containing 266,271 climate-related articles from 20 major Canadian newspapers (1978-2025). The CCF infrastructure enables us to track not just what is said about climate change but who says it and how their presence shapes public understanding. Through machine learning models trained on over 4,000 expert annotations (F1 $>$ 0.8), we identify scientific and political actors, classify thematic frames, and extract named entities to construct monthly networks of discourse participants. This computational approach transforms each article into structured data that captures actor presence, interpretative frameworks, and networks of actors across 9.2 million annotated sentences.

Our analysis centers on discourse coalitions: networks of actors whose collective presence in media coverage shapes how climate change is understood. These coalitions function as interpretative communities that promote specific ways of understanding climate issues. Scientific coalitions emphasize empirical evidence and technical solutions. Political coalitions frame climate change through partisan competition and policy debates. The stability of these coalitions determines whether established narratives persist or alternative frameworks can emerge. We track coalition membership monthly through the top 1,000 authorities identified via named entity recognition, then measure stability through Jaccard similarity coefficients that capture membership continuity over time.

The Canadian context provides an ideal setting for examining science-policy dynamics. With its Westminster parliamentary system, regular electoral cycles, and resource-dependent economy (Lachapelle, Borick, and Rabe 2012; Isopp 2024), Canada experiences predictable political disruptions that create natural experiments for studying coalition dynamics. Ten federal elections during our study period generate measurable variations in coalition stability that enable causal inference about how political changes affect scientific discourse.[1]

Our findings reveal a paradoxical relationship between political stability and scientific influence. Stable political coalitions suppress scientific discourse by 40%, while political

[1]This working paper adopts a primarily empirical and inductive approach. Our efforts have focused on constructing and validating the CCF database as a tool for large-scale discourse analysis. Future work will develop formal theoretical propositions based on these empirical findings.

instability increases scientific frame usage by 151%. Granger causality tests demonstrate that political coalition changes powerfully precede both political ($F = 21.53$, $p < 0.001$) and scientific frame shifts ($F = 70.52$, $p < 0.001$), while scientific coalitions show weaker predictive power. The analysis identifies three distinct regimes in Canadian climate discourse: a science-led period (1980-1987) where scientific framing dominated, a contested phase (1988-1997) marked by the rise of economic framing, and a politics-led era (1997-present) where political actors control interpretative frameworks. This transformation reflects not scientific failure but the successful political reframing of climate change from a technical problem to a governance challenge.

These findings challenge conventional assumptions about science-policy relationships. Political actors do not ignore scientific knowledge. Instead, they actively control when and how it enters public discourse. Coalition stability emerges as the key mechanism that determines whether scientific voices can influence climate debates. This paper demonstrates how the CCF database enables new forms of empirical investigation into longstanding questions about expertise, democracy, and environmental governance.

2 Methods

This study draws on the Canadian Climate Framing (CCF) database, a comprehensive machine-learning-annotated corpus of 266,271 climate-related articles from 20 Canadian newspapers spanning 1978–2024. The database comprises 9.2 million sentence-level analytical units, each annotated across 65 hierarchical categories covering thematic frames (economic, health, security, justice, political, scientific, environmental, cultural), actors and messengers, events, solutions, emotional tone, geographic focus, and named entities. The complete methodology for database construction, including data collection procedures, the 65-category annotation framework, machine learning training protocols (BERT for English, CamemBERT for French), and validation metrics (macro $F1 = 0.866$), is detailed in Lemor, Pillod, and Taylor (2025). The following section describes the specific analytical approach used to examine scientist-policymaker dynamics within this annotated corpus.

2.1 Analyzing scientist-policymaker dynamics in climate discourse

Having established the comprehensive annotated CCF database, we now develop a methodology to analyze the dynamics between scientific and political actors in Canadian climate discourse (Figure 1). The analysis proceeds in two complementary stages. First, we conduct exploratory temporal analyses to establish baseline patterns in frame evolution and actor presence in the full dataset. We calculate monthly proportions and apply LOESS smoothing[2] to identify long-term trends and cyclical patterns. Second, we perform the detailed coalition analysis described below, which leverages the annotated variables from the CCF framework to track how coalitions of scientists and policymakers evolve over time and influence the framing of climate issues. The approach combines network analysis techniques with

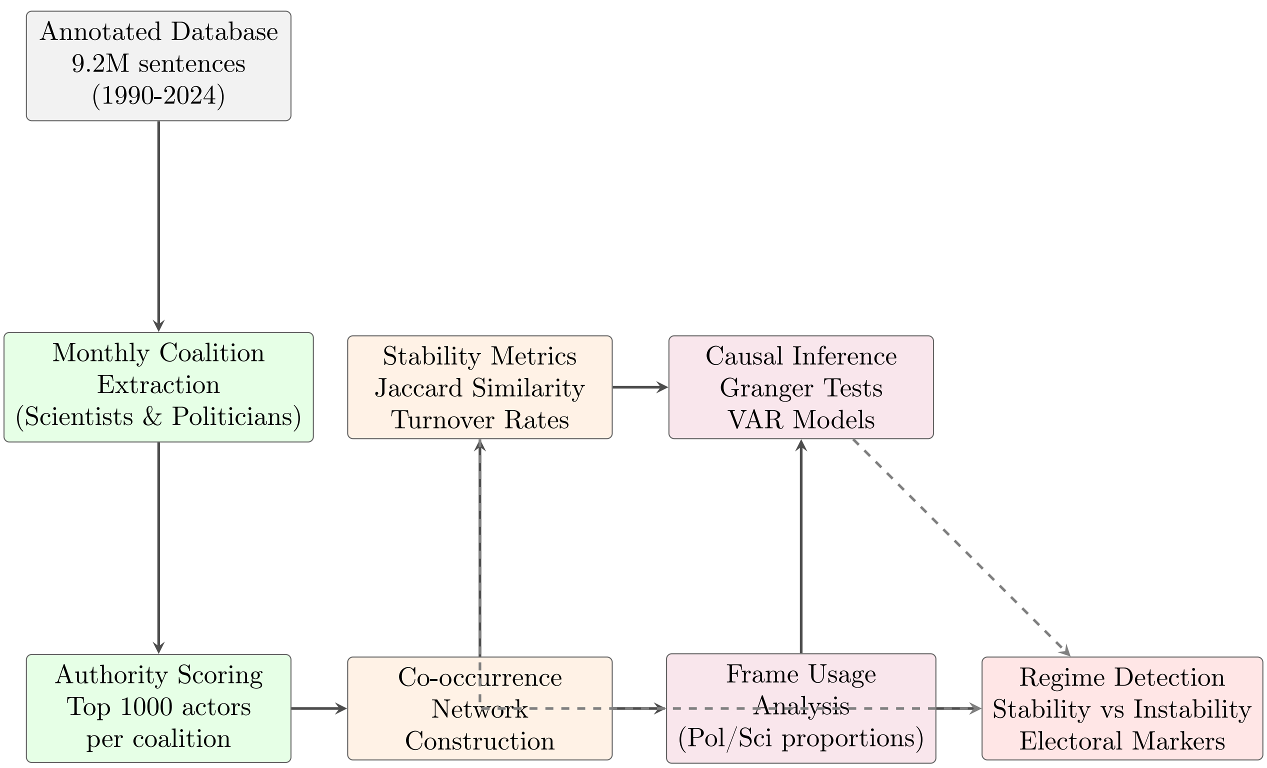
[2] LOESS (Locally Estimated Scatterplot Smoothing) is a non-parametric regression method that fits local polynomials to subsets of data, with weights decreasing as distance from the point of estimation increases. This approach reveals underlying trends while preserving important local variations in the time series.

time series econometrics to examine bidirectional relationships between actor coalitions and discourse patterns.

2.1.1 Coalition extraction and authority identification

The coalition extraction process begins with monthly aggregations of the annotated corpus spanning from January 1990 to December 2024, providing 408 temporal observations for longitudinal analysis. The analysis starts in 1990 rather than the database's earliest date (1978) because the sparse coverage in earlier years, often fewer than 10 articles per month before 1988, creates unstable coalition estimates and unreliable network structures. The post-1990 period ensures sufficient article density for robust statistical inference while capturing the emergence of climate change as a sustained policy issue following the 1988 Toronto Conference and IPCC establishment.

Each month's data undergoes systematic processing to identify distinct discourse coalitions based on the CCF *Messenger* variables. We focus specifically on two messenger categories from our annotation framework (see Lemor, Pillod, and Taylor 2025): sentences where the variable *Natural Scientist* equals 1 form the scientific coalition, while those where *Public*



Processing flow: Solid arrows indicate primary data flow. *Integration:* Dashed arrows show analytical integration.

Figure 1: Schematic overview of the coalition dynamics analysis pipeline, illustrating the transformation from annotated sentences to causal inference and regime identification.

Official equals 1 constitute the political coalition.[3] This distinction is supposed to capture the divide between the "two communities" of knowledge producers and policy actors in climate discourse.

Within each coalition's monthly corpus, we use the pre-existing Named Entity Recognition annotations—specifically the *PER* (person) and *ORG* (organization) variables already computed in the CCF database (for NER performance metrics, see Lemor, Pillod, and Taylor 2025)—to identify all mentioned individuals and institutions. Each identified entity receives an authority score that combines citation frequency with article diversity.[4] We retain the top 1,000 authorities per coalition each month, a threshold that captures the core discourse participants while maintaining computational tractability for network analysis.

Thus, by "coalition of actors" we operationally mean the set of actors identified as authoritative according to our metric: the entities ranked among the top 1,000 by authority score. This definition relies on the reasonable empirical assumption that the combination of visibility (number of mentions) and breadth of coverage (number of distinct articles) reflects an actor's capacity to shape or structure media debate. In practice, this approach privileges central and recurring actors in public discourse, while limiting the disproportionate influence of repeated appearances within a single article. It therefore constitutes a reproducible and measurable approximation of media authority. We therefore treat this set as a "coalition" of political or scientific actors, since together its members act as authoritative representatives of their respective communities.

2.1.2 Network construction and coalition dynamics

The extracted authorities form the basis for constructing monthly co-occurrence networks that reveal the relational structure of climate discourse. In these networks, nodes represent individual authorities while edges connect entities mentioned within the same article, with edge weights proportional to co-occurrence frequency. This representation captures not only who participates in climate discourse but also which actors appear together to show potential coordination, conflict, or shared framing.

From these networks, we derive several key metrics that characterize coalition dynamics over time. Coalition stability between consecutive months is quantified through the Jaccard similarity coefficient, which measures the proportion of authorities remaining constant relative to the total membership across both periods.[5] Complementing this stability measure, we

[3] The messenger variables in the CCF framework identify the source or speaker in each sentence through machine learning classification. *Natural Scientist* captures climate scientists, atmospheric physicists, and other natural scientists (see Lemor, Pillod, and Taylor 2025). *Public Official* identifies elected officials, government ministers, civil servants, and policy advisors at federal, provincial, and municipal levels.

[4] The authority score formula $A_i = f_i \times \log(1 + d_i)$ weights citation frequency f_i by the logarithm of unique article mentions d_i. This logarithmic transformation prevents entities mentioned repeatedly in single articles from dominating those with broader media coverage. For example, an entity mentioned 100 times across 50 articles receives a higher score than one mentioned 100 times in 5 articles.

[5] The Jaccard similarity coefficient, widely used in ecology and information science to measure set similarity, is calculated as $J(C_t, C_{t-1}) = |C_t \cap C_{t-1}|/|C_t \cup C_{t-1}|$ where C_t represents the coalition at time t. The coefficient ranges from 0 (completely different sets) to 1 (identical sets). In our context, it captures month-to-month continuity in discourse participants, with higher values indicating stable coalitions and lower values suggesting rapid turnover in media voices. Typical values in our data range from 0.05 to 0.20, indicating that 5-20% of the combined membership persists between months.

calculate turnover rates as the sum of new entrants and departures normalized by coalition size, providing insight into the velocity of change within each discourse community.

The analysis also examines inter-coalition dynamics by identifying actors who simultaneously appear in both scientific and political coalitions. These boundary-spanning entities, typically comprising 8-12% of total authorities, potentially serve as knowledge brokers or policy entrepreneurs who translate scientific findings into political discourse. Network density, calculated as the ratio of actual to possible edges, provides an additional measure of coalition cohesion, with denser networks suggesting more coordinated or centralized discourse patterns.

2.1.3 Impact analysis and causal inference

To assess whether and how coalition dynamics influence frame usage patterns, we employ a suite of time series econometric techniques designed to identify causal relationships while controlling for temporal dependencies. Frame usage is operationalized as the monthly average proportion of sentences per article containing each frame type (*Political* or *Scientific*). It provides a continuous measure of discourse emphasis that ranges from 0 (frame absent) to 1 (frame present in every sentence). The analysis begins with Spearman rank correlations between coalition stability metrics and these frame proportions across the full 34-year period to identify persistent associations between coalition dynamics and discourse patterns.[6]

Moving beyond correlation, we implement Granger causality tests to examine whether changes in coalition composition statistically precede shifts in framing patterns.[7] Tests are conducted at multiple lag structures (1, 2, and 3 months) to capture both immediate reactions and delayed responses in the discourse system. The implementation uses the `statsmodels` package's `grangercausalitytests` function, which performs F-tests comparing restricted models (excluding lagged values of the potential causal variable) against unrestricted models (including these lags). Results are computed for all pairwise combinations of coalition stability measures and frame proportions, with additional tests examining instability effects by inverting the Jaccard similarity scores.

We further estimate Vector Autoregression (VAR) models incorporating four endogenous variables: political stability, scientific stability, political frame proportion, and scientific frame proportion.[8] The VAR framework captures the full system dynamics and feedback loops between coalitions and frames. Optimal lag selection is determined via the Akaike Information Criterion,[9] and impulse response functions are computed to trace the temporal propagation

[6] Spearman rank correlation is a non-parametric measure that assesses monotonic relationships between variables without assuming linear associations or normal distributions. This robustness is particularly important given the bounded nature of our proportion variables (ranging from 0 to 1) and the potential for non-linear dynamics in discourse evolution. The correlation coefficient ranges from -1 (perfect negative monotonic relationship) to +1 (perfect positive monotonic relationship).

[7] Granger causality tests whether past values of one time series contain information useful for predicting another series beyond what the series' own past provides. Granger causality identifies predictive relationships rather than true causation.

[8] VAR models treat all variables as endogenous and model each as a linear function of its own lagged values and the lagged values of all other variables in the system. This approach captures interdependencies without requiring strong assumptions about causal direction.

[9] The Akaike Information Criterion (AIC) balances model fit against complexity by penalizing additional parameters: $AIC = 2k - 2\ln(L)$ where k is the number of parameters and L is the likelihood. Lower AIC

of shocks through the discourse system.

2.1.4 Temporal segmentation and regime identification

The final analytical step involves segmenting the time series to identify distinct regimes in science-policy discourse relationships. We classify each month into stability or instability regimes based on political coalition Jaccard similarity scores.[10] This classification enables comparative analysis of discourse dynamics under different coalition stability conditions.

We integrate Canadian federal election dates as exogenous temporal markers to examine how democratic transitions affect coalition dynamics. Ten federal elections occurred during our study period (1993, 1997, 2000, 2004, 2006, 2008, 2011, 2015, 2019, 2021) and provide "natural experiments" for examining the relationship between political transitions and discourse dynamics. The analysis examines pre-election, election, and post-election periods to capture anticipatory effects, immediate disruptions, and recovery trajectories.

This temporal segmentation framework enables the identification of what we term "windows of opportunity": periods characterized by specific configurations of coalition instability that may facilitate changes in discourse patterns. The methodology allows for systematic comparison of frame usage, coalition composition, and network structures across different stability regimes, providing a comprehensive framework for understanding the temporal dynamics of climate discourse.

values indicate better models, with the criterion preventing overfitting while ensuring sufficient lags to capture temporal dynamics.

[10] Quartile-based classification is a standard approach in regime identification that divides the distribution into four equal parts. The top quartile (Q4) contains the 25% highest values (most stable periods), while the bottom quartile (Q1) contains the 25% lowest values (most unstable periods). This approach is robust to outliers and provides sufficient observations in each category for statistical comparison while capturing the extremes of the stability distribution.

3 Results

3.1 Temporal evolution of climate framing (1978-2024)

Figure 2 presents the evolution of eight thematic frames in Canadian climate coverage across 46 years of media discourse.

The scientific frame (blue line) shows high proportions exceeding 40% in the early period (1978-1995), followed by a gradual decline. The political frame (red line) exhibits the opposite pattern, starting below 1% and rising to exceed the scientific frame around 2015, maintaining dominance through 2024. Economic framing (orange line) rises from 2% to between 15-25% throughout the entire period. Environmental framing (green line) maintains proportions below 10% across most time points. Other framings show minimal presence.

3.2 Cyclical dynamics between scientists and policymakers

Figure 3 reveals an interesting relationship between scientific and political voices in Canadian climate discourse, this time from 1990 to 2024.

The visualization demonstrates patterns in both actor presence and framing strategies. *Natural Scientists* (blue dashed line) start at approximately 30% in 1990, decline to around 8% by 2015, and remain low (5-8%) through 2024. *Public Officials* (red dashed line) show

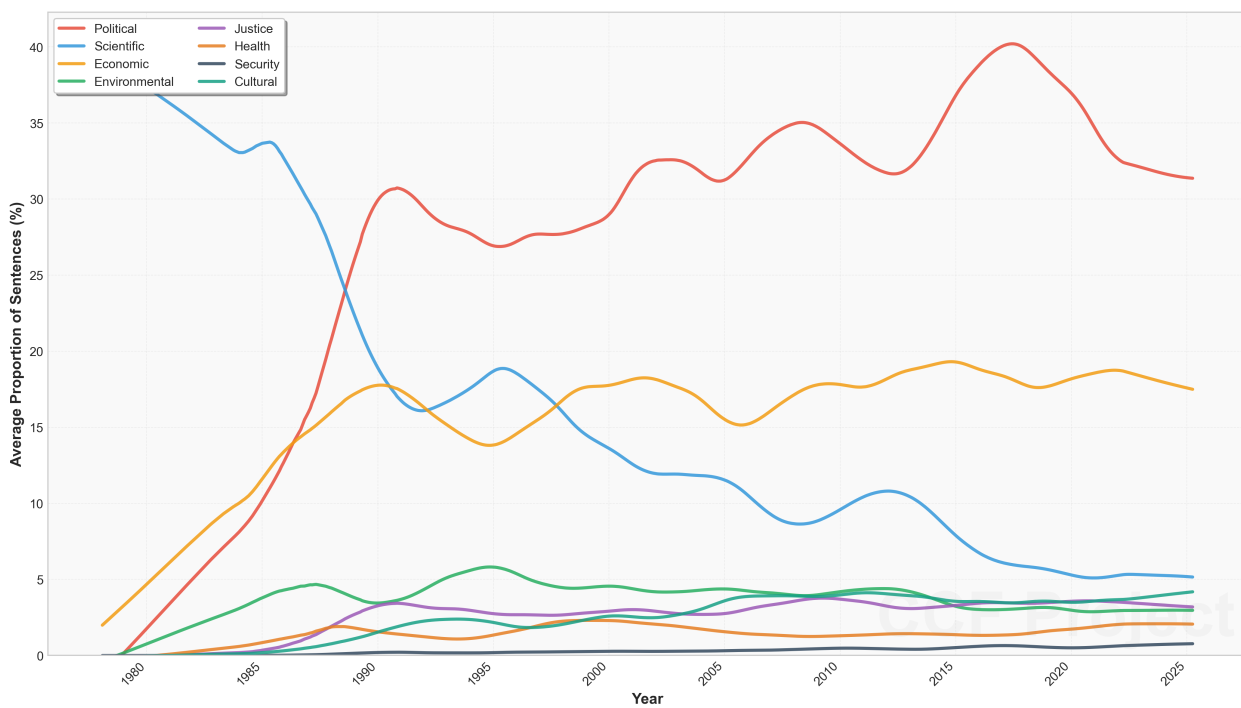


Figure 2: Temporal evolution of thematic frames in Canadian climate discourse (1978-2024). Lines represent LOESS-smoothed monthly proportions of sentences containing each frame type. The analysis encompasses 266,271 articles from 20 major Canadian newspapers, with proportions calculated at the article level and aggregated monthly.

more dramatic variations, starting around 15% in 1990, peaking near 33% in 2003, and maintaining high levels (30-40%) through recent years with notable peaks around 2017-2020. The thematic frames (solid lines) reveal a complete reversal: scientific framing (blue) dominated early (around 25% in 1990) but declined steadily to just 5% by 2024, while political framing (red) rose from 22% to consistently exceed 30-40% after 2015. The close alignment between actors and their corresponding frames—scientists with scientific framing, policymakers with political framing—suggests that who speaks strongly influences how climate change is discussed.

3.3 Discourse coalition dynamics and stability

Figure 4 presents the evolution of scientific and political discourse coalitions from 1990 to 2024.

Panel A displays political discourse coalition sizes (blue bars, positive values) and scientific discourse coalition sizes (purple bars, negative values) ranging from approximately 200 to 1000 members, alongside political (red line) and scientific (purple line) frame proportions. Panel B shows Jaccard similarity coefficients[11] fluctuating between 0.05 and 0.20

[11] Discourse coalition stability is measured using the Jaccard similarity coefficient: $J(C_t, C_{t-1}) = |C_t \cap$

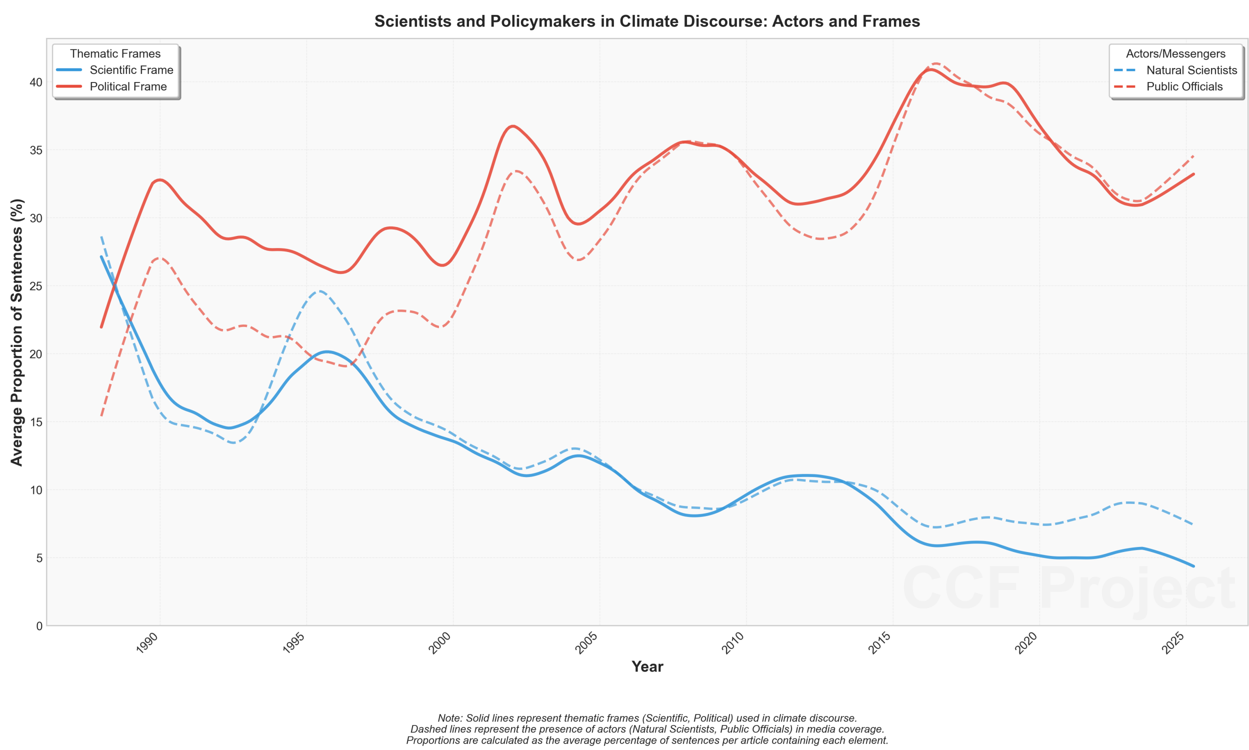


Figure 3: Scientists and policymakers in climate discourse: Actors and frames (1988-2024). Solid lines represent thematic frames (Scientific frame in blue, Political frame in red) while dashed lines indicate the presence of actors (Natural Scientists in blue, Public Officials in red) in media coverage. All values show the average proportion of sentences per article containing each element, smoothed using LOESS with a 10% bandwidth.

for both coalitions. Dotted lines indicate federal elections (1993, 1997, 2000, 2004, 2006, 2008, 2011, 2015, 2019, 2021). Panel C reveals turnover rates[12] varying between 0.8 and 0.9, with political coalitions (blue) generally showing smaller turnover than scientific coalitions (purple). The higher scientific turnover suggests that scientists tend to intervene individually and episodically on specific issues, while politicians maintain sustained engagement over extended periods. Panel D illustrates coalition composition through stacked areas, with political-exclusive members (blue), shared members (orange, approximately 100-200 individuals), and scientific-exclusive members (purple). The scientific discourse coalition thus appears more fragile, with less stable membership over time.

$C_{t-1}|/|C_t \cup C_{t-1}|$, where C_t represents the set of top 1,000 authorities in the coalition at month t. Values range from 0 (completely different membership) to 1 (identical membership). A value of 0.15 means 15% of the combined membership from both months remains the same.

[12]Turnover rate is calculated as (new entrants + departures)/($2 \times$ coalition size). A rate of 0.85 indicates that 85% of the discourse coalition changed from the previous month, combining both entries and exits.

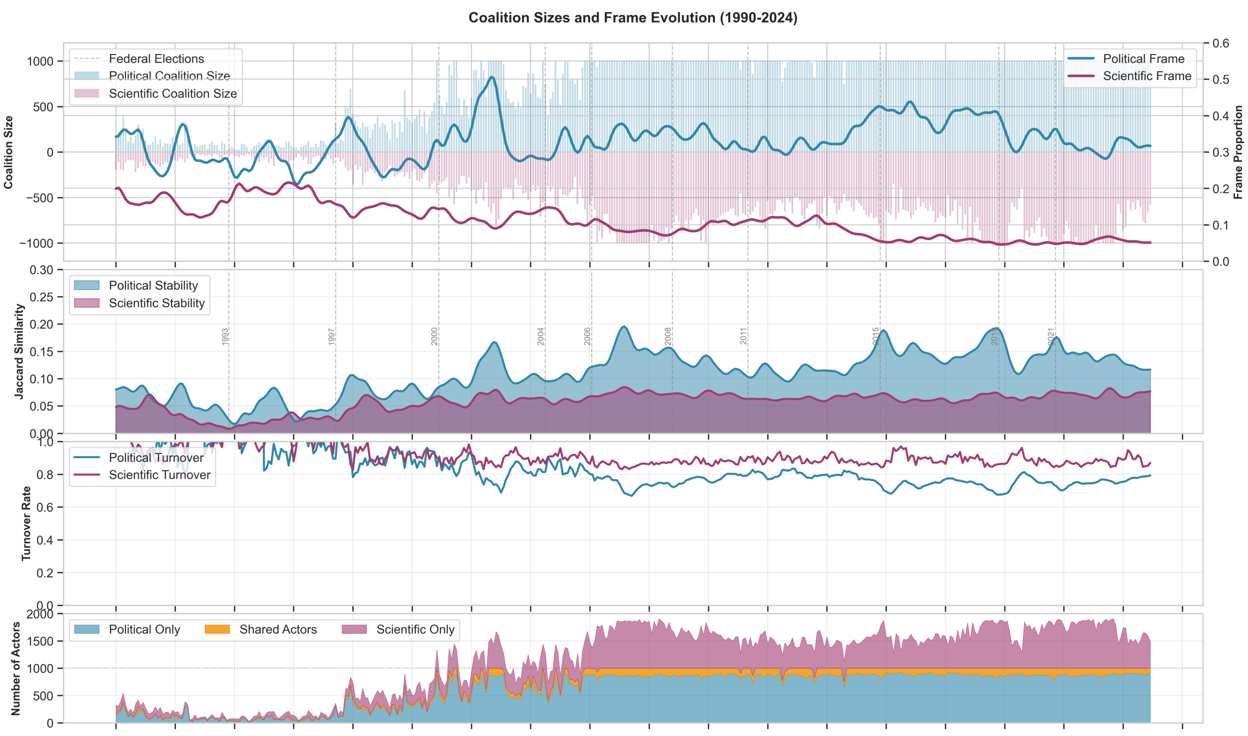


Figure 4: Coalition dynamics and frame evolution (1990-2024). Panel A shows coalition sizes (bars) and frame proportions (lines) over time. Panel B displays Jaccard similarity coefficients measuring month-to-month coalition stability with federal elections marked by vertical dashed lines. Panel C presents turnover rates within each coalition. Panel D illustrates the composition of coalitions and distinguish exclusive members from those spanning both communities.

3.4 Political stability and frame suppression

Figure 5 examines how political coalition stability affects discourse patterns.

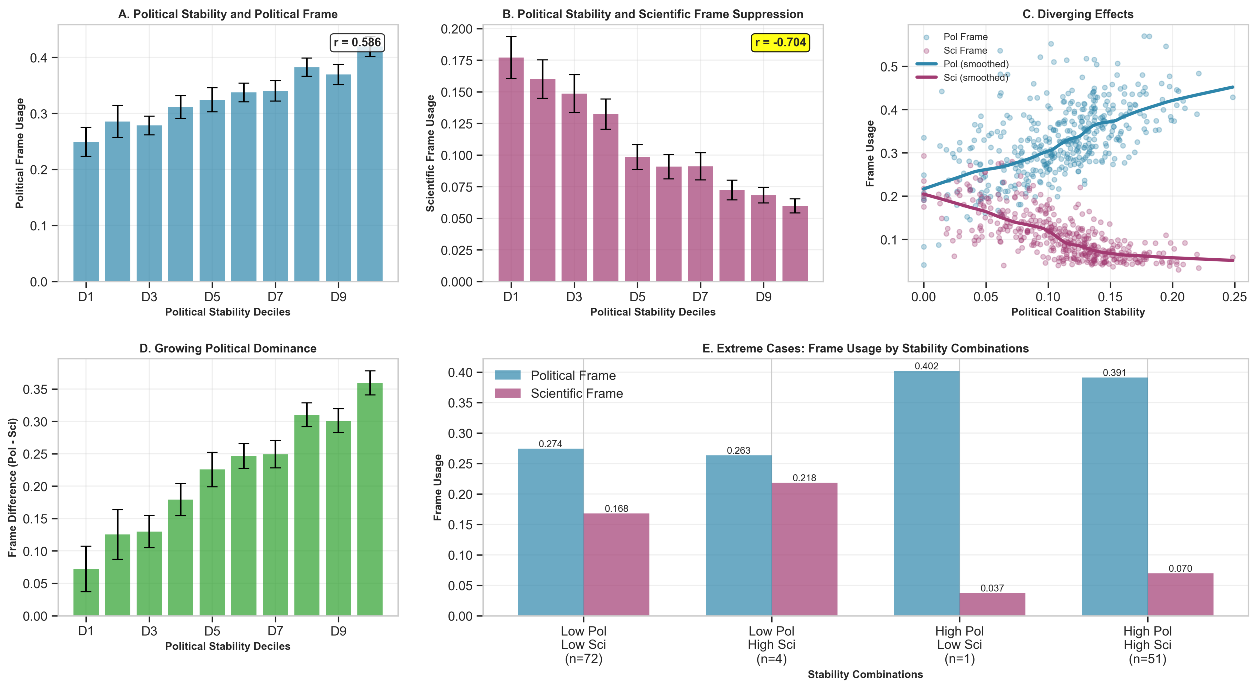


Figure 5: Effects of political coalition stability on discourse patterns. Panel A shows political frame usage across stability deciles. Panel B shows scientific frame usage across stability deciles. Panel C presents scatter plots with LOESS curves for both relationships. Panel D demonstrates the difference between political and scientific frames across stability deciles. Panel E compares frame usage under different stability combinations. Error bars represent 95% confidence intervals.

Panel A shows political frame usage[13] increasing from approximately 0.25 in the lowest stability decile[14] (D1) to 0.40 in the highest (D10). Panel B reveals scientific frame usage decreasing from 0.175 in D1 to around 0.050 in D10, with error bars indicating 95% confidence intervals. Panel C displays scatter plots where each point represents a month, with LOESS smoothed curves showing negative correlation for political frames (r = -0.704) and positive correlation for scientific frames (r = 0.585). Panel D illustrates the growing divergence between political and scientific frames as stability increases, with the difference shifting from 0.05 in low stability to 0.35 in high stability periods. Panel E presents a matrix comparing frame usage across combinations of political and scientific stability quartiles. Periods with high political stability (top 25%) and low scientific stability (bottom 25%) show the highest

[13]Frame usage represents the average proportion of sentences per article containing the specified frame (Political or Scientific) in that month. A value of 0.30 means 30% of sentences in articles that month contained the frame.

[14]Stability deciles divide all months into 10 equal groups based on their Jaccard similarity scores. D1 contains the 10% least stable months (lowest Jaccard values), while D10 contains the 10% most stable months (highest Jaccard values).

political frame usage (0.42 ± 0.02) and lowest scientific frame usage (0.05 ± 0.01). Conversely, periods with low political stability and high scientific stability exhibit the opposite pattern, with political frames at 0.26 ± 0.02 and scientific frames at 0.18 ± 0.01. The differences in frame usage across these regimes are statistically significant ($p < 0.001$).

3.5 Political instability as opportunity

Figure 6 examines the relationship between political instability and scientific discourse opportunities.

Panel A displays political frame usage decreasing with instability,[15] fluctuating between 0.40 and 0.25. Panel B shows scientific frame usage increasing from approximately 0.05 in the most stable periods (D1) to 0.17 in the most unstable periods (D10), with a positive linear trend. Panel C presents a comparison between stable and unstable periods,[16] with stable periods (bottom 25%, n=103) and unstable periods (top 25%, n=105), showing political frames at 0.389 and 0.267 respectively, while scientific frames increase from 0.066 in stable periods to 0.165 in unstable periods. The difference in scientific frame usage ($\Delta = +0.100$,

[15] Instability is defined as $1 -$ Jaccard similarity. High instability (D10) represents months with the greatest coalition turnover, while low instability (D1) represents the most stable periods.

[16] Stable periods are defined as the bottom 25% of instability scores (highest Jaccard similarity), while unstable periods are the top 25% (lowest Jaccard similarity). The extreme case comparison isolates the strongest effects.

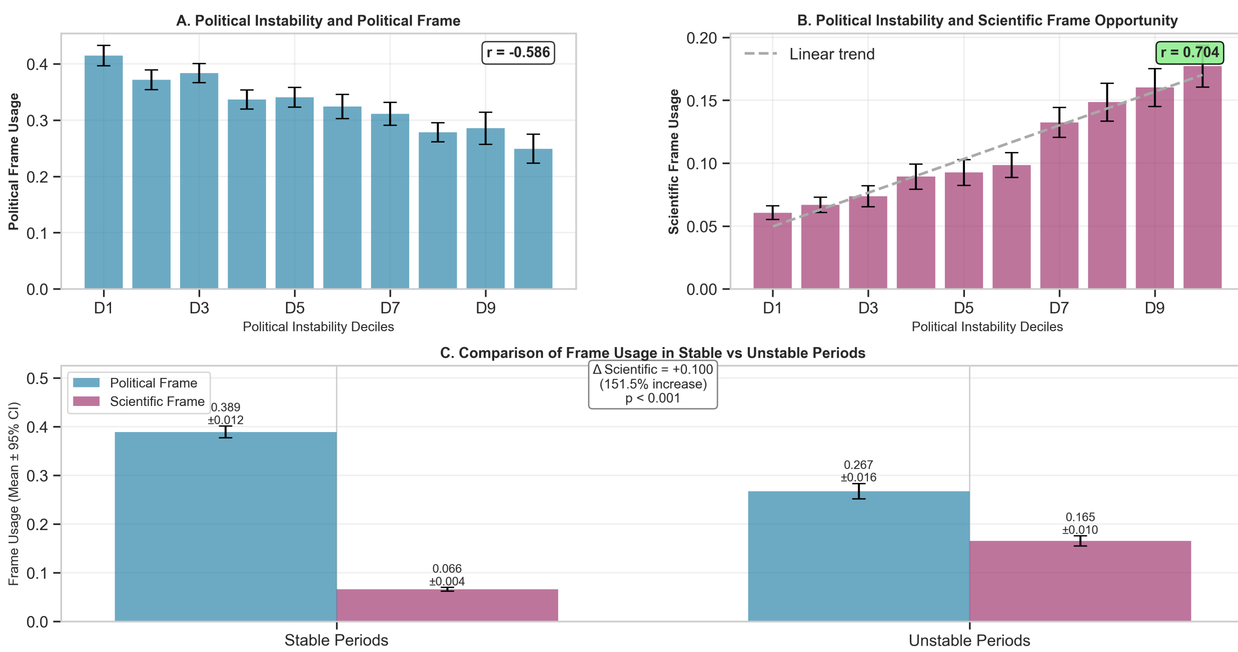


Figure 6: Political instability and scientific discourse. Panel A shows political frame usage across instability deciles. Panel B shows scientific frame usage across instability deciles with linear trend. Panel C compares frame usage between stable and unstable coalition periods with 95% confidence intervals and sample sizes.

representing a 151.5% increase) is marked with statistical significance ($p < 0.001$).

3.6 Temporal causality patterns

Table 1 presents Granger causality tests examining whether changes in coalition stability statistically precede changes in framing patterns.

The results reveal strong but asymmetric causal relationships. Political coalition stability shows extremely strong Granger causality for both political ($F = 21.53$, $p < 0.001$) and scientific framing ($F = 70.52$, $p < 0.001$) at 1-month lags, with effects persisting across all tested lags. Scientific coalition stability also shows significant causal relationships, particularly for scientific framing ($F = 39.93$, $p < 0.001$) and to a lesser extent for political framing ($F = 9.26$, $p = 0.002$), though these effects are weaker than those from political coalitions. The instability analysis (bottom panel) confirms that political disruption powerfully precedes increases in scientific framing, with identical magnitude to the stability effect ($F = 70.52$, $p < 0.001$) ande demonstrate that political instability creates substantial opportunities for scientific discourse.

Table 1: Granger causality test results for coalition stability and frame usage relationships

Causal Relationship	**Lag**	**F-statistic**	**p-value**	**Significance**
Political coalition effects				
Political stability → Political frame	1 month	21.53	0.000	***
Political stability → Political frame	2 months	10.40	0.000	***
Political stability → Political frame	3 months	5.15	0.002	**
Political stability → Scientific frame	1 month	70.52	0.000	***
Political stability → Scientific frame	2 months	18.33	0.000	***
Political stability → Scientific frame	3 months	10.70	0.000	***
Scientific coalition effects				
Scientific stability → Scientific frame	1 month	39.93	0.000	***
Scientific stability → Scientific frame	2 months	12.40	0.000	***
Scientific stability → Scientific frame	3 months	8.36	0.000	***
Scientific stability → Political frame	1 month	9.26	0.002	**
Scientific stability → Political frame	2 months	4.36	0.013	*
Scientific stability → Political frame	3 months	2.42	0.065	·
Instability effects (inverse relationships)				
Political instability → Scientific frame	1 month	70.52	0.000	***
Political instability → Scientific frame	2 months	18.33	0.000	***
Political instability → Scientific frame	3 months	10.70	0.000	***

Note: Granger causality tests examine whether past values of one variable improve predictions of another variable beyond its own past values. Tests performed using Vector Autoregression with optimal lag selection via AIC. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, · $p < 0.10$, ns = not significant. Political instability represents the inverse of political stability (1 - Jaccard similarity). Analysis covers 420 monthly observations from 1990-2024.

4 Discussion

4.1 Three regimes of climate discourse transformation

The temporal analysis reveals a fundamental transformation in how climate change is framed in Canadian media that seems to progress through three distinct regimes that reflect shifting power dynamics between scientific and political discourse coalitions.

The "Science-led regime (1980-1987)" represents the period when climate change was primarily understood as a scientific problem requiring technical expertise. Scientific framing maintained dominance above 25% (Figure 2), with scientific actors comprising approximately 25% of quoted sources (Figure 3). During this phase, the scientific discourse coalition effectively controlled how climate change was interpreted and discussed. The frame alignment, where scientific actors promoted scientific framing, demonstrates how discourse coalitions shape public understanding by establishing dominant interpretative frameworks.

The "Contested regime (1988-1997)" marks a critical transition where neither scientific nor political discourse coalitions maintained stable control. This period is contested because the economic frame enters prominently into the discourse. Indeed, 1997 represents the pivotal year when the economic frame overtakes the scientific frame (Figure 2), while the political frame had already surpassed scientific framing since the late 1980s. Notably, scientific messengers remained more prominent than political actors through the mid-1990s, a period where scientific voices persisted even as economic and political frames gained dominance. The instability in frame dominance suggests that competing discourse coalitions were struggling to establish their preferred narratives. This created what we might term a "framing battle" where different interpretations of climate change competed for public acceptance.

The Politics-led regime (1997-present) represents climate change's complete transformation into a political issue where science seems to serve as supporting information rather than driving force. Political framing consistently exceeds 35-40% while scientific framing drops below 6%. This shift does not indicate scientific failure but rather reflects how established political discourse coalitions have successfully reframed climate change from a problem requiring scientific understanding to one demanding political action. The persistent alignment between political actors and political framing (Figure 3) demonstrates how discourse coalitions maintain control over interpretative frameworks. The political discourse coalition, through its institutional continuity and network cohesion (Figure 4), has effectively marginalized scientific voices and reframed climate change as a matter of political debate, electoral strategy, and policy negotiation.

4.2 Political instability as windows of opportunity for marginalized voices

Our findings reveal a paradoxical relationship: stable political discourse coalitions seem to suppress alternative framings, while instability creates opportunities for marginalized voices, particularly scientists, to influence public debate. When political coalitions maintain stability (Jaccard similarity > 0.15), political frames dominate at 40% while scientific frames remain suppressed at 5% (Figure 5). However, during periods of high instability, scientific frame usage increases by 151.5% (Figure 6).

This pattern illuminates how discourse coalitions function as gatekeepers of public debate. Stable coalitions, that is to say those with consistent membership month-to-month, maintain control over interpretative frameworks. Political stability enables dominant actors to perpetuate their preferred frames, effectively excluding alternative interpretations. The strong Granger causality results ($F = 70.52$, $p < 0.001$) confirm that political coalition changes precede frame shifts, demonstrating the power of discourse coalitions to shape narrative trajectories.

Federal elections emerge as critical disruption points where coalition stability drops but only for recent elections (2008, 2015, 2019, 2021) (Figure 4, Panel B). It is possible that these electoral transitions have fragmented established political networks and weakened their control over discourse; though qualitative analysis should explore this further. During these windows of opportunity, scientific voices could gain enhanced media access and their interpretative frameworks receive greater attention. This suggests that democratic transitions, rather than representing obstacles to evidence-based policy, may actually facilitate the integration of scientific knowledge into public debate.

4.3 The fragility of scientific discourse coalitions

The consistently higher turnover rates in scientific coalitions (0.85-0.90) compared to political coalitions (0.80-0.85) reveal a structural weakness in how scientific knowledge enters public discourse (Figure 4, Panel C). Scientists seem to intervene more individually and episodically and to respond to specific events or findings, while politicians seem to maintain sustained engagement, potentially through institutionalized roles and party structures.

This fragility has profound implications for science communication. The scientific discourse coalition may lack the continuity that enables political coalitions to maintain narrative control. Individual scientists may achieve temporary media prominence, but without stable network structures, they cannot sustain alternative framings against organized political discourse coalitions. The limited overlap between coalitions (100-200 shared members representing 8-12% of total authorities) further indicates that few actors successfully bridge scientific and political discourse communities.

The asymmetric Granger causality results reinforce this interpretation. While political coalition changes strongly predict both political and scientific frame usage, scientific coalition changes show weaker predictive power, particularly for political frames. This asymmetry suggests that scientific discourse coalitions react to political dynamics rather than shaping them. Scientists respond to political openings rather than creating them.

4.4 Discourse coalitions as architects of climate understanding

Frames represent more than rhetorical choices; they constitute fundamental interpretative structures that determine how phenomena are understood, what solutions seem appropriate, and who appears qualified to speak. Our results demonstrate that discourse coalitions, that is to say networks of actors with sustained media presence, function as architects of these interpretative frameworks.

The tight correlation between actor presence and frame usage ($r > 0.7$) indicates that frames do not emerge spontaneously but are actively promoted by specific discourse coalitions. When political actors dominate media coverage, political frames prevail, potentially transforming climate change into a matter of party politics, electoral strategy, and policy debate. When scientists gain voice, scientific frames emerge, with more discussion about evidence and technical solutions.

This relationship explains why coalition stability matters. Stable discourse coalitions can maintain consistent framings over time. The current politics-led regime's persistence since 2015 demonstrates how, once established, dominant discourse coalitions create self-reinforcing narrative structures. Political actors quote other political actors, political frames beget political responses, and climate change becomes locked into political interpretative frameworks.

4.5 Implications for science-policy communication

The dominance of political discourse coalitions and the suppression of scientific frames during stable periods challenges conventional approaches to science communication. Traditional models assume that providing more scientific information will influence policy, but our findings suggest that the structure of discourse coalitions determines whether scientific knowledge can even enter public debate.

The evidence that political instability enhances scientific discourse by 48-151% suggests that timing matters more than content. Rather than continuously producing reports and holding press conferences, scientific organizations might achieve greater impact by strategically engaging during periods of political transition. The 2-3 month lag between coalition changes and frame shifts provides a window for coordinated scientific intervention during political disruptions.

Furthermore, the fragility of scientific discourse coalitions points to a need for institutional reforms. Creating more stable scientific networks, perhaps through sustained science communication organizations or formal science advisory structures, could help maintain scientific presence in public discourse even during periods of political stability.

These findings also suggest reconsidering the relationship between consensus and influence. The scientific community often emphasizes consensus as a communication strategy, but our results indicate that political fragmentation, not consensus, creates opportunities for scientific influence. This paradox—that political disorder enables scientific order—reveals the fundamentally political nature of public knowledge integration.

5 Conclusion

This study demonstrates that policymakers do respond to scientists in climate discourse, though through complex mechanisms mediated by discourse coalition. Analysis of 266,271 articles from Canadian media (1978-2024) reveals three key findings that challenge conventional understanding of science-policy relationships.

First, political discourse coalitions fundamentally control how climate change is framed. The Granger causality tests show that political coalition changes powerfully precede both political ($F = 21.53$, $p < 0.001$) and scientific frame shifts ($F = 70.52$, $p < 0.001$), while scientific coalitions exhibit weaker predictive power. This asymmetry confirms that political actors shape narrative trajectories rather than merely respond to scientific input.

Second, we identify a paradoxical stability effect: stable political coalitions suppress scientific discourse by 40%, while political instability increases scientific frame usage by 151%. Federal elections and other political disruptions create windows of opportunity where scientific voices gain temporary influence. This finding inverts traditional assumptions about consensus and suggests that political fragmentation, not stability, facilitates science integration.

Third, the evolution through three distinct regimes reveals climate change's transformation from scientific problem to political challenge. The science-led regime (1980-1987) gave way to contested terrain (1988-1997) before establishing political dominance (1997-present). This shift reflects not scientific failure but successful political reframing of climate change as a governance issue where science provides supporting rather than driving evidence.

The fragility of scientific discourse coalitions compounds these dynamics. Higher turnover rates (0.85-0.90) compared to political coalitions (0.80-0.85) indicate that scientists lack the continuity necessary to sustain alternative framings. Scientists seem to intervene episodically on specific issues while politicians maintain continuous engagement through established structures.

These findings have practical implications. Strategic timing matters more than message content for scientific influence. The 2-3 month lag between coalition changes and frame shifts provides windows for coordinated intervention during political transitions. Building more stable scientific networks could help maintain scientific presence even during periods of political stability.

Methodologically, this study demonstrates how computational approaches can address questions previously limited to small-scale analysis. The integration of machine learning, network analysis, and time series econometrics provides a framework applicable to other contested policy domains.

In conclusion, discourse coalitions function as architects of public understanding. Political actors do not ignore science but actively control when and how scientific knowledge enters public debate. Recognizing these dynamics and strategically exploiting moments of political instability may prove essential for integrating scientific evidence into climate governance.

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