

CLIMATE MODELING ACCURACY AND PUBLIC TRUST: MEDIATION OF COMMUNICATION CLARITY AND MODERATION OF SCIENTIFIC LITERACY

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Abstract

Climate modeling plays a crucial role in predicting climate change impacts and guiding public policy. However, public trust in climate science depends not only on the accuracy of climate models but also on the clarity of communication and the audience's scientific literacy. This study investigates the effect of climate modeling accuracy (CMA) on public trust (PT), emphasizing the mediating role of communication clarity (CC) and the moderating effect of scientific literacy (SL). A quantitative survey of 260 respondents from diverse demographics was conducted, and data were analyzed. Findings indicate that CMA significantly enhances PT, with communication clarity partially mediating this relationship. Clear explanations and transparent reporting of modeling assumptions increase public comprehension and confidence. Scientific literacy moderates the CMA–PT link, with individuals possessing higher scientific literacy demonstrating stronger trust in accurate climate models. The results highlight the combined importance of technical precision, effective communication, and audience understanding in fostering trust in climate science. Practically, scientists and policymakers should prioritize transparent, accessible communication strategies and consider varying levels of scientific literacy to enhance public engagement and confidence in climate projections.

Keywords: *Climate Modeling, Public Trust, Communication Clarity, Scientific Literacy,*

Introduction

scenarios, guiding mitigation strategies, and informing policy decisions (IPCC, 2021). The accuracy of

climate models (CMA) directly influence their reliability in projecting temperature, precipitation, and extreme weather events (Knutti et al., 2013). While model precision is vital, public trust in climate science depends on more than technical accuracy; it is also shaped by how scientific information is communicated and by individuals' understanding of science (Leiserowitz et al., 2021).

Communication clarity (CC) plays a pivotal role in mediating the relationship between CMA and public trust. Scientific information often involves complex data, assumptions, and probabilistic forecasts, which can confuse the general public (Moser, 2010). Clear, transparent, and accessible communication helps bridge the gap between model outputs and public understanding, enhancing confidence in climate predictions (van der Linden et al., 2015).

Scientific literacy (SL) is another critical factor that moderates this relationship. Individuals with higher scientific literacy can critically evaluate model information, understand uncertainties, and interpret results more accurately (Miller, 2004). In contrast, those with lower scientific literacy may struggle to comprehend model outputs, reducing trust even when models are accurate.

This study examines how CMA influences public trust in climate science, with CC as a mediator and SL as a moderator. By integrating technical accuracy, communication, and audience characteristics, the research provides insights into strategies for improving public engagement with climate science. Understanding

these mechanisms is essential for enhancing trust, promoting evidence-based decision-making, and encouraging public support for climate policies.

Literature Review

Climate modeling accuracy (CMA) is fundamental to climate science, as it predicts future climatic trends and informs global mitigation strategies (Knutti et al., 2013). Accurate models increase confidence in climate projections and policy recommendations. However, technical precision alone does not guarantee public trust (PT). Studies have shown that while scientists often focus on model robustness, the public evaluates credibility based on comprehension and perceived transparency (van der Linden et al., 2015).

Public trust is the willingness to rely on scientific information and experts to guide decisions (Gauchat, 2012). Trust in climate science is critical for the adoption of sustainable behaviors, policy support, and engagement in mitigation efforts (Leiserowitz et al., 2021). Factors influencing trust include perceived competence, transparency, and clarity of communication (Moser, 2010).

Communication clarity (CC) mediates the relationship between CMA and PT. Complex climate models involve probabilistic forecasts, numerous variables, and technical jargon that can confuse the public (Nisbet, 2009). Clear communication, including simplified summaries, visualizations, and explicit explanation of uncertainties, enhances comprehension and trust (van der Linden et al., 2015). Studies confirm that audiences are more likely to trust models when information is presented clearly, bridging the gap between technical accuracy and perception (Maibach et al., 2008).

Scientific literacy (SL) moderates the CMA–PT relationship. Individuals with higher SL can interpret model outputs, understand uncertainties, and critically assess claims, resulting in stronger trust when models are accurate (Miller, 2004). Conversely, low scientific literacy increases susceptibility to misunderstanding or skepticism, even with accurate information (Kahan et al., 2012). Previous studies suggest that considering the audience's scientific literacy is essential for effective climate communication and public engagement (Cook et al., 2017).

The theoretical framework integrates Theory of Reasoned Action (TRA), emphasizing belief-based evaluation in shaping trust, and Cognitive Load Theory, highlighting the impact of complexity on comprehension (Ajzen & Fishbein, 1980; Sweller, 1988). Together, these theories suggest that CMA influences PT through CC, and SL determines the strength of this relationship. Despite advances in climate communication research, few studies examine the simultaneous effects of technical accuracy, communication clarity, and literacy on public trust, which this study addresses.

Theoretical Framework

Conceptual Model:

Climate Modeling Accuracy → Public Trust



Communication Clarity (Mediator)

Scientific Literacy (Moderator on CMA → PT)

Hypotheses:

- H1: CMA positively affects public trust.
- H2: Communication clarity mediates the relationship between CMA and public trust.

- H3: Scientific literacy moderates the relationship between CMA and public trust.

Methodology

A quantitative cross-sectional survey was conducted with 260 respondents from the general public, including diverse educational backgrounds. A structured questionnaire measured climate modeling accuracy perception, communication clarity, scientific literacy, and public trust using a 5-point Likert scale.

SmartPLS was employed to conduct PLS-SEM, evaluating reliability, convergent and discriminant validity, and path significance. Mediation and moderation analyses were performed with 5,000 bootstrap resamples. This approach allows testing of direct, indirect, and interaction effects simultaneously, providing robust insights into the relationships among CMA, communication clarity, scientific literacy, and public trust.

Data Analysis

Measurement Model Assessment

Construct	Cronbach's Alpha	Composite Reliability	AVE
Climate Modeling Accuracy	0.92	0.94	0.71
Communication Clarity	0.89	0.91	0.67
Scientific Literacy	0.88	0.90	0.65
Public Trust	0.91	0.93	0.69

Interpretation

All constructs meet reliability and convergent validity thresholds (Cronbach's alpha >0.7, CR >0.7, AVE >0.5). CMA demonstrates strong reliability ($\alpha = 0.92$, CR = 0.94) and variance explained (AVE = 0.71). Communication clarity, scientific literacy, and public trust similarly show high reliability and validity. Discriminant validity was confirmed via the Fornell-Larcker criterion, ensuring constructs are distinct. The measurement model validates the questionnaire items, ensuring that subsequent structural model analyses for direct, mediating, and moderating relationships are based on robust and reliable data.

Structural Model Assessment

Path	Beta	t-value	p-value	Result
CMA → Public Trust	0.48	7.21	0.000	Supported
CMA → Communication Clarity	0.56	8.34	0.000	Supported
Communication Clarity → Public Trust	0.41	5.76	0.000	Supported
CMA → Public Trust (via Communication Clarity)	0.23	4.11	0.000	Mediated
Scientific Literacy × CMA → Public Trust	0.19	3.45	0.001	Moderated

Interpretation

CMA significantly predicts public trust ($\beta = 0.48$, $p < 0.001$), supporting H1. CMA positively influences communication clarity ($\beta = 0.56$, $p < 0.001$), and communication clarity significantly predicts public trust ($\beta = 0.41$, $p < 0.001$), confirming H2. The indirect path via communication clarity ($\beta = 0.23$, $p < 0.001$) shows partial mediation, indicating that clear communication translates modeling accuracy into trust. The interaction between scientific literacy and CMA is significant ($\beta = 0.19$, $p = 0.001$), supporting H3. Higher scientific literacy amplifies the effect of model accuracy on trust, showing that individuals with greater understanding of science are more responsive to accurate climate models. Overall, results demonstrate that technical accuracy, clear communication, and audience literacy collectively shape public trust in climate science.

Conclusion

This study confirms that climate modeling accuracy significantly enhances public trust. Communication clarity partially mediates this relationship, emphasizing that clear, accessible explanations of modeling methods and assumptions are critical for fostering confidence. Scientific literacy moderates the CMA–PT link, indicating that higher literacy enhances sensitivity to model accuracy, strengthening trust.

Practically, these findings highlight the importance of integrating technical accuracy with effective communication strategies and audience-tailored messaging. Scientists and policymakers should prioritize transparent, jargon-free communication while considering varying literacy levels among the public. Doing so can improve public comprehension, engagement, and support for climate policies. Ultimately, fostering public trust through accurate modeling, clear communication, and literacy-sensitive approaches is essential for effective climate action.

Discussion

The findings align with Theory of Reasoned Action and Cognitive Load Theory, demonstrating that belief in scientific credibility and comprehension of complex information are key determinants of trust. Communication clarity bridges the gap between technical accuracy and perception, reducing cognitive overload (Sweller, 1988). Scientific literacy further moderates trust formation, reflecting individuals' capacity to interpret probabilistic and complex model outputs (Miller, 2004).

The study contributes to climate communication literature by empirically validating the combined role of accuracy, clarity, and literacy in shaping public trust. It underscores the necessity of transparent reporting and educational strategies to enhance comprehension. Policy implications include developing literacy-sensitive communication campaigns, interactive visualizations, and simplified summaries of climate model findings. Future research could explore longitudinal effects, cross-cultural differences, or other moderating factors such as media exposure or political ideology.

Future Recommendations

1. Develop simplified, accessible summaries and visualizations of climate models.
2. Promote science literacy programs to improve public understanding of climate science.
3. Tailor communication strategies to different literacy levels.
4. Enhance transparency by clearly explaining uncertainties and assumptions in models.
5. Conduct longitudinal studies to assess the persistence of trust over time.

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