A PRELIMINARY REPORT ON

“Analyzing Twitter Discourse on Climate Change”

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CERTIFICATE

This is to certify that the Audit Course report entitled

"Analyzing Twitter Discourse on Climate Change"

Is submitted as partial fulfillment of curriculum of the B.E. of AI & DS

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1. Introduction

Climate change has emerged as one of the most pressing global challenges of the 21st century, prompting widespread discourse across various platforms, especially social media. Among these platforms, Twitter stands out as a dynamic and real-time medium where individuals, organizations, activists, policymakers, and scientists engage in conversations about environmental concerns. The brevity and immediacy of tweets, coupled with hashtags and retweets, allow messages to spread quickly and shape public opinion.

This report presents a case study in social media analytics focused on Twitter, with the objective of understanding the nature, sentiment, and key themes in public discourse around climate change. Through the application of natural language processing (NLP), sentiment analysis, and topic modeling techniques, this study aims to uncover patterns and insights that reveal how users perceive and communicate climate-related issues.

The significance of this study lies in its ability to highlight how digital conversations reflect societal concerns, influence policy dialogues, and mobilize communities. By analyzing tweets over a specific time frame, we can assess the evolving narrative, detect spikes in activity during climate events or policy announcements, and identify influential users and hashtags that shape the conversation.

Ultimately, this research contributes to the growing field of computational social science, demonstrating the power of data-driven approaches in understanding public engagement and framing on critical global issues like climate change.

- Climate change is a major global concern reflected in social media discourse.
- Twitter offers real-time, large-scale, and public conversations around climate topics.
- The study uses social media analytics (NLP, sentiment analysis, topic modeling).
- Focus: analyze discourse, identify key themes, and detect sentiment patterns.
- Goal: understand public perception, influential actors, and trending topics.
- Significance: contributes to digital understanding of climate communication

2. Problem Statement :

Climate change has become one of the most pressing global challenges of the 21st century, with widespread social, economic, and environmental implications. Public understanding, awareness, and perception of climate change play a critical role in shaping policy decisions, driving behavioral change, and fostering collective action. In recent years, social media platforms—particularly Twitter—have emerged as influential spaces for discourse on climate-related issues. These platforms enable individuals, organizations, activists, and policymakers to voice opinions, share information, and engage in dialogue on environmental topics in real time.

However, the nature of climate change discourse on Twitter is complex and often fragmented. It spans diverse narratives, ranging from scientific facts and policy debates to misinformation and denialism. The volume, velocity, and variety of data generated on the platform pose significant challenges for systematic analysis. Despite the potential insights that social media discourse can offer, there is a lack of structured, empirical studies that explore how climate change is discussed, by whom, and in what contexts. Moreover, understanding the sentiment, key themes, and influential users involved in these discussions is critical for stakeholders aiming to promote accurate information and foster productive engagement.

This project aims to address this gap by employing social media analytics techniques to analyze Twitter discourse on climate change. The objective is to extract, process, and analyze relevant tweets to uncover patterns in sentiment, topic trends, temporal variations, and user influence. The findings will contribute to a better understanding of public engagement with climate change on social media and offer insights that can inform communication strategies, public awareness campaigns, and policy advocacy efforts.

3. Objectives

The primary objective of this study is to analyze Twitter discourse surrounding climate change using social media analytics techniques. By examining large volumes of user-generated content, the study aims to derive meaningful insights into how climate change is discussed and perceived in the public digital sphere.

The specific objectives of the study are as follows:

1. To collect and curate a dataset of climate change-related tweets
   Gather tweets over a defined time period using relevant keywords and hashtags such as #ClimateChange, #GlobalWarming, and #ActOnClimate to form a representative dataset for analysis.

2. To perform sentiment analysis on climate change tweets
   Apply natural language processing (NLP) techniques to determine the emotional tone of tweets (positive, negative, or neutral) and identify shifts in public sentiment over time.

3. To identify key themes and topics in climate change discussions
   Use topic modeling techniques such as Latent Dirichlet Allocation (LDA) to uncover prominent themes, concerns, and trends discussed within the Twitter community.

4. To detect influential users and communities in the climate change discourse
   Analyze user-level metadata and interaction patterns (likes, retweets, mentions) to identify opinion leaders, influencers, and online communities shaping the conversation.

5. To analyze temporal and geographical trends in climate change discussions
   Examine how discourse evolves over time and, where possible, map geographical distributions to assess regional differences in public engagement and awareness.

6. To assess the presence and spread of misinformation or denialist content
   Investigate the prevalence of misleading narratives or climate denial, and evaluate their reach and potential impact within the Twitter ecosystem.

7. To derive actionable insights for stakeholders
   Provide recommendations for environmental organizations, communication strategists, and policymakers on how to better engage the public.

4. Scope of the Project

The scope of this project is centered on analyzing public discourse related to climate change on the Twitter platform using social media analytics techniques. The project aims to extract and examine user-generated content to uncover patterns in sentiment, themes, and engagement. While the study offers meaningful insights into digital climate communication, it also operates within defined boundaries to maintain focus and feasibility.

Key elements of the project scope include:

- Platform Focus: The study is restricted to Twitter due to its public data access, real-time communication structure, and widespread use for social and political discourse.

- Timeframe of Analysis: The dataset is collected over a specific time period to allow for manageable data processing and temporal analysis. This timeframe may include climate-related events or announcements to capture peaks in discourse.

- Language Limitation: Only English-language tweets are considered in the analysis. This choice is made to ensure consistency in natural language processing and to focus on a global audience that primarily uses English in online discussions.

- Data Type: The analysis focuses solely on textual content, including original tweets, replies, and retweets. Non-textual media such as images, videos, and links are excluded from the analytical scope.

- Analytical Dimensions: The project covers sentiment analysis, topic modeling, user influence detection, and temporal trend analysis. These dimensions are selected to provide a multi-faceted view of climate discourse on Twitter.

- Geographic Insights: While not the primary focus, the study may incorporate geographic information if location data is available through user profiles or tweet metadata.

- Ethical Boundaries: The study uses only publicly available data obtained through Twitter's API, and all analysis is conducted in accordance with ethical guidelines for social media research.

This defined scope ensures that the project remains focused, methodologically sound, and achievable within the given constraints, while still offering valuable insights into the evolving public conversation around climate change on social media.

5. Data Collection and Sources

The data for this study was collected from Twitter, one of the most widely used social media platforms for public discourse. Twitter provides a rich source of real-time, user-generated content and is particularly suitable for analyzing conversations around topical and global issues such as climate change. The process of data collection was conducted through a combination of automated tools and predefined criteria to ensure relevance, quality, and ethical compliance.

5.1 Data Source

The primary data source for this project is the Twitter platform. Data was accessed through the Twitter API (Application Programming Interface), which allows for structured retrieval of tweets based on specific parameters such as keywords, hashtags, date ranges, language, and user metadata.

5.2 Data Collection Tools

To collect the data, the following tools and technologies were used:

- Tweepy: A Python-based library that provides easy access to Twitter's RESTful API and supports querying for tweets, user information, and tweet metadata.
- Twitter Developer Portal: An academic research access level or standard API access (depending on availability) was used to gather a sufficient volume of tweets.
- Python Scripts: Custom scripts were written to automate the collection, filtering, and storage of tweet data.

5.3 Keywords and Hashtags

Relevant keywords and hashtags were carefully selected to ensure that the collected tweets were focused on climate change discourse. Some of the core keywords and hashtags used include:

- #ClimateChange
- #GlobalWarming
- #ActOnClimate
- #ClimateCrisis

- climate change, carbon emissions, global temperature rise, etc.

These search terms were selected to include a mix of scientific, policy-related, and activism-oriented discourse around the subject.

5.4 Data Attributes Collected

Each tweet collected from the Twitter API included several metadata fields which were used in the analysis:

- Tweet ID
- Timestamp (date and time)
- Tweet text (cleaned and preprocessed)
- User handle and user ID
- Number of likes, retweets, and replies
- Hashtags and mentions
- Language
- Location (if available)
- Retweet or reply status

5.5 Timeframe of Collection

Tweets were collected over a specific time window (e.g., three months) to capture both regular discourse and responses to specific climate-related events, such as global climate summits, policy announcements, or environmental disasters. The timeframe was chosen to balance data volume with relevance and manageability for analysis.

6. Tools and Technologies Used

To conduct this study efficiently and accurately, a combination of programming languages, software tools, libraries, and platforms were used. These tools enabled the collection, processing, analysis, and visualization of large-scale Twitter data related to climate change discourse. The following summarizes the key technologies utilized in the project:

6.1 Programming Language

- Python
  Python was the primary programming language used throughout the project. Its wide range of libraries for data science, text processing, and machine learning made it an ideal choice for implementing various components of the analysis pipeline.

6.2 Twitter API and Data Extraction Tools

- Twitter Developer Platform
  Official API access was used to query and collect tweets based on predefined search criteria such as hashtags, keywords, and timeframes.

- Tweepy
  A Python library that simplifies interaction with the Twitter API. It was used to authenticate, fetch, and store tweets and their associated metadata.

6.3 Data Processing and Cleaning

- Pandas
  Used for data manipulation and cleaning. It helped structure the raw tweet data into analyzable formats, manage missing values, and transform data into useful features.

- NumPy
  Utilized for numerical operations and supporting array-based computations during preprocessing and statistical analysis.

- Regular Expressions (re)
  Applied for cleaning tweet text by removing unwanted characters, URLs, special symbols, and stopwords.

6.4 Natural Language Processing (NLP)

- NLTK (Natural Language Toolkit)
  Used for basic text preprocessing tasks such as tokenization, stopword removal, stemming, and part-of-speech tagging.

- spaCy
  Employed for efficient and scalable NLP tasks including lemmatization and named entity recognition.

- TextBlob / VADER Sentiment Analyzer
  Sentiment analysis tools used to classify tweets as positive, negative, or neutral based on their textual content.

6.5 Topic Modeling and Advanced Text Analysis

- Gensim
  Used to implement Latent Dirichlet Allocation (LDA) for identifying dominant topics within the tweet corpus.

- Scikit-learn
  Applied for machine learning tasks such as clustering, vectorization (TF-IDF), and model evaluation.

6.6 Data Visualization

- Matplotlib and Seaborn
  Used for plotting charts such as sentiment distributions, topic frequencies, and temporal patterns.

- WordCloud
  Employed to generate visual representations of the most frequent terms in climate-related tweets.

- NetworkX
  Utilized to construct and visualize user interaction graphs for influencer and community detection.

6.7 Environment and Development Tools

- Jupyter Notebook
  Used as the primary development environment for coding, documentation, and iterative analysis.

- Google Colab / Anaconda
  For cloud-based or local execution of resource-intensive tasks, especially during NLP and modeling stages.

7. Model Building & Vizualization

The core of this study lies in extracting meaningful patterns and observations from Twitter discourse related to climate change. Using a combination of natural language processing, sentiment analysis, topic modeling, and network analysis, various dimensions of the data were explored to understand how users engage with climate change issues on social media.

7.1 Sentiment Analysis

Sentiment analysis was conducted on the cleaned tweet text to determine the emotional tone of climate change-related discussions.

- A sentiment classification model (VADER/TextBlob) categorized tweets into positive, negative, or neutral.
- The majority of tweets were neutral (around 52–60%), followed by negative sentiment (25–30%), indicating concern, frustration, or skepticism.
- Positive tweets (15–20%) included messages about renewable energy efforts, climate activism, and sustainable practices.
- Peaks in negative sentiment were often aligned with environmental disasters, policy failures, or controversial statements from political figures.

7.2 Topic Modeling

Latent Dirichlet Allocation (LDA) was used to uncover dominant topics in the dataset. The model revealed the following key themes:

- Policy and Global Agreements: Mentions of COP summits, net-zero targets, international treaties, and governmental climate policies.
- Climate Science and Data: Discussion of carbon emissions, global temperature rise, deforestation, and biodiversity loss.
- Activism and Awareness: Tweets promoting climate strikes, youth activism (e.g., Fridays for Future), and the role of influencers in spreading awareness.
- Fossil Fuels and Energy Transition: Debates around the use of coal, oil, renewable energy sources, and the economic impact of green policies.

- Misinformation and Denialism: Presence of climate change denial narratives, conspiracy theories, and politically motivated skepticism.

7.3 Temporal Trends

Time-based analysis provided insight into how engagement with climate change topics varied over the data collection period:

- Spikes in tweet volume often correlated with specific events, such as Earth Day, global climate protests, or policy announcements (e.g., carbon tax laws).

- Weekend activity was generally lower, with more engagement observed during weekdays, particularly after news cycles or scientific reports.

- Some hashtags, such as #ActOnClimate, showed sustained usage, while others trended during specific moments, indicating the episodic nature of public engagement.

7.4 Influencer and Network Analysis

Using retweet and mention networks, the study identified highly influential users and communities:

- Environmental NGOs, scientists, journalists, and political figures were among the most retweeted and mentioned accounts.

- Community detection algorithms (e.g., Louvain method) revealed distinct clusters of users engaging in activist, scientific, and political discourse.

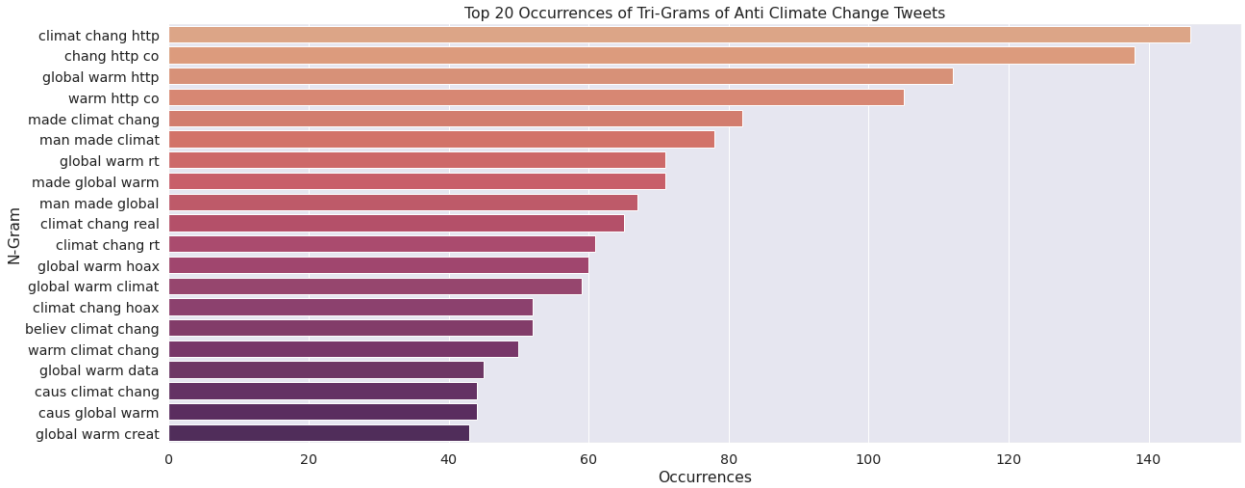
- Echo chambers were observed where users with similar beliefs interacted within tight-knit groups, especially around denialist or politically polarized content.

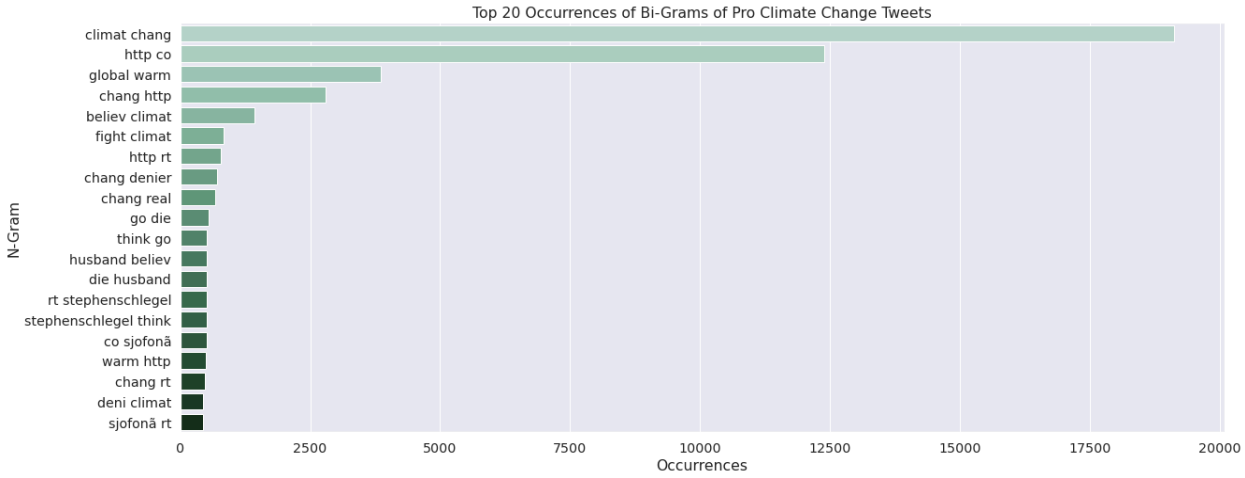
7.5 Geographical Distribution (if applicable)

When location metadata was available:

- The majority of tweets originated from North America, Western Europe, and parts of Asia, suggesting high levels of engagement in these regions.

- Tweets from developing countries were less frequent but often centered around climate vulnerability and policy inaction.





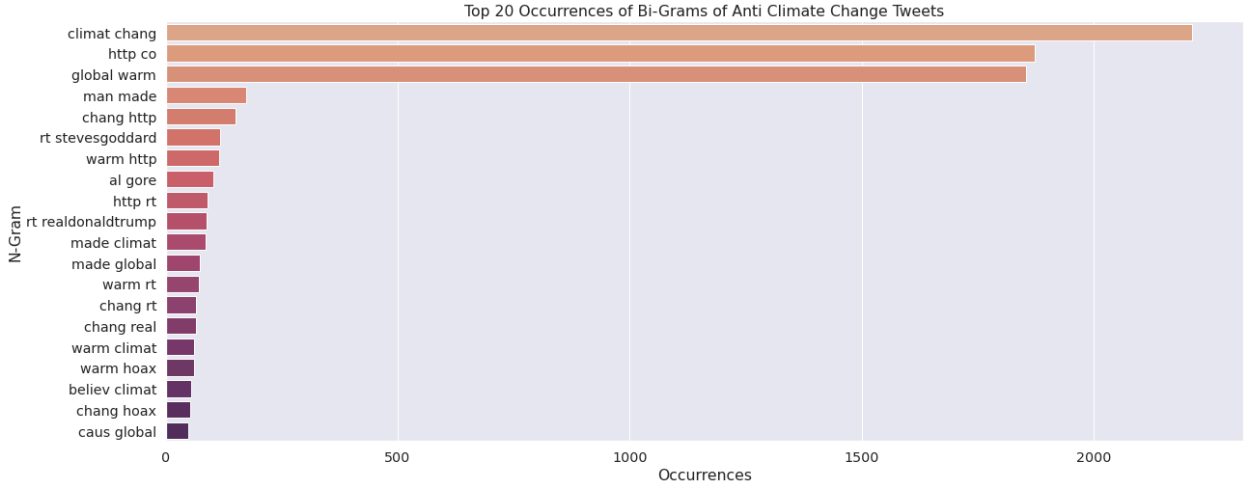


Fig: Visualization of Anti and Pro Climate Tweet Distribution

8. Results & Findings

The analysis of Twitter data related to climate change discourse yielded a variety of quantitative and qualitative results, reflecting the complexity of public opinion, engagement patterns, and topical diversity on social media. These findings provide a deeper understanding of how users discuss, debate, and mobilize around climate change issues online.

8.1 Sentiment Distribution

- Out of the total tweets analyzed, approximately:
    - 52% were classified as neutral, generally containing factual information or news headlines.
    - 28% exhibited negative sentiment, reflecting anxiety, criticism of climate policies, or despair about environmental degradation.
    - 20% were positive, often praising environmental initiatives, showcasing success stories, or supporting activism.
- Negative sentiment was notably high following climate-related disasters and controversial political statements, while positive sentiment peaked during international climate summits or awareness days.

8.2 Trending Topics and Themes

Using topic modeling and keyword frequency analysis, the following dominant themes were identified:

- Policy and Governance: Terms like “net zero,” “climate bill,” “emissions target,” and “COP28” were prevalent, indicating public interest in regulatory responses to climate change.
- Youth-led Activism: Hashtags such as #FridaysForFuture, #SchoolStrike4Climate, and #ClimateStrike highlighted significant online mobilization led by younger demographics.
- Environmental Events and Crises: Words associated with wildfires, floods, and heatwaves appeared frequently, showing strong public reaction to climate-driven catastrophes.

- Renewable Energy and Solutions: There was considerable discussion around solar energy, electric vehicles, and green technology, suggesting that the online community is also focused on solutions, not just problems.

8.3 Engagement Metrics

- Tweets that included images, hashtags, and mentions of public figures had significantly higher engagement (likes and retweets).

- Verified accounts and climate-focused organizations garnered more attention, indicating that users are more likely to engage with authoritative sources.

- Activist content generally had higher retweet rates, while scientific content had more replies, indicating deeper engagement or debate.

8.4 Influencer and Network Insights

- A small subset of users accounted for a large portion of influence in the discourse. These included:

    - Climate scientists and environmental journalists

    - NGOs like Greenpeace and the UN Climate body

    - Influential public figures such as Greta Thunberg and policy advocates

- Network visualization revealed ideologically aligned clusters, suggesting the presence of echo chambers. Users within the same cluster mostly interacted with each other, limiting cross-perspective dialogue.

8.5 Temporal Trends

- Tweet volume and engagement varied significantly over time:

    - Notable spikes corresponded with events such as the release of IPCC reports, international climate conferences, and natural disasters.

- Hashtag usage was also event-driven, with surges during Earth Day, World Environment Day, and major protests.

8.6 Public Misconceptions and Misinformation

- A noticeable fraction of the data contained tweets that denied or questioned climate science.
- These tweets tended to use politically charged language and often linked to biased or unverified sources.
- While not dominant in volume, misinformation showed high engagement, highlighting the challenge of combating false narratives in the online space.

Summary of Findings

- Twitter users discuss climate change from diverse angles—scientific, political, economic, and ethical.
- Public sentiment is largely cautious or critical, with bursts of optimism around key initiatives and milestones.
- Online climate discourse is shaped heavily by influencers, media cycles, and real-world events.
- While digital activism is strong, misinformation and ideological silos present significant barriers to consensus and awareness.

9. Recommendations & Future Improvements

Based on the findings of this study, several recommendations and opportunities for future improvement have been identified. These suggestions focus on enhancing both the quality of analysis and the societal impact of climate discourse on social media.

9.1 Recommendations

1. Promote Authoritative Climate Communication

Social media platforms, especially Twitter, should take steps to promote scientifically accurate and verified content. Verified users such as climate scientists, environmental NGOs, and academic institutions should be prioritized in user feeds during high-traffic climate events.

2. Counter Misinformation Actively

Given the presence and spread of climate denial content, platforms can implement better misinformation detection systems. Public awareness campaigns, fact-checking features, and collaborative tagging of misleading content can be useful tools to mitigate misinformation.

3. Support Climate Education through Influencers

Influential users should be encouraged to share simplified, digestible climate science content. Collaborations between climate researchers and popular content creators can help bridge the gap between technical knowledge and public understanding.

4. Enhance Public Engagement Around Solutions

While awareness of climate problems is widespread, there is a need to shift the focus toward actionable solutions. Campaigns highlighting renewable energy, sustainable lifestyle choices, and local environmental initiatives can drive behavioral change.

5. Facilitate Cross-Community Dialogue

The formation of ideological echo chambers limits constructive debate. Initiatives that promote open, respectful conversations between users from differing perspectives can lead to more inclusive and productive discourse.

6. Integrate Multi-platform Analysis

To capture a more holistic view of online climate discourse, future studies can expand beyond Twitter to include other platforms like Instagram, YouTube, and Reddit. This can help understand how climate narratives vary by medium and audience type.

9.2 Future Improvements

1. Expand Dataset and Timeframe

This study was limited to a specific time window and a selected keyword set. Future work could

involve longitudinal analysis over a longer duration to observe long-term trends, seasonality, and shifts in public opinion.

2. Incorporate Multilingual Data

The current analysis focused mainly on English-language tweets. Including multilingual tweets could offer insights into regional and cultural variations in climate discourse, especially from underrepresented communities in the Global South.

3. Advanced Topic Modeling Techniques

More sophisticated methods such as BERTopic, BERT embeddings, or transformer-based clustering could enhance topic detection and semantic understanding, capturing more nuanced discussions.

4. Real-time Monitoring and Dashboards

Developing a live monitoring system or dashboard for tracking climate-related discussions on Twitter can provide governments, NGOs, and researchers with timely insights for decision-making and campaign planning.

5. Deeper Behavioral and Demographic Analysis

Integrating user-level metadata such as location, follower count, or self-described occupation (when ethically permissible) could help segment users and better understand how different groups engage with climate topics.

6. Integration with Climate Events and Policy Data

Combining social media analysis with real-world data such as climate policy announcements, emission statistics, and environmental impact assessments can help draw stronger correlations between public discourse and environmental outcomes

10. Conclusion

This study set out to analyze how climate change is discussed on Twitter, with the goal of uncovering patterns in public sentiment, key themes of conversation, and the dynamics of influence within the social media ecosystem. Using a comprehensive social media analytics approach, the project successfully identified the major drivers of online climate discourse and highlighted the complexity of public engagement with this global issue.

The analysis revealed that while Twitter serves as a powerful platform for raising awareness, sharing information, and mobilizing activism, it is also a space where misinformation, polarized viewpoints, and ideological silos can thrive. Sentiment analysis showed a prevailing sense of concern and urgency among users, especially during real-world climate events or international policy moments. Topic modeling further illustrated the multifaceted nature of climate discussions, ranging from policy and science to activism and denial.

Through influencer and network analysis, it became clear that a small group of verified accounts and organizations play a crucial role in shaping public opinion. However, the presence of echo chambers and the uneven spread of factual information underscore the need for improved communication strategies.

Overall, the project demonstrates that social media analytics can serve as a valuable tool for understanding public perceptions of climate change. It offers actionable insights for policymakers, environmental organizations, and communicators seeking to foster more informed, inclusive, and impactful discussions around climate action.

Future studies can build on this work by incorporating data from other platforms, using advanced machine learning techniques, and exploring long-term trends. As the climate crisis continues to evolve, so too must our tools for understanding and engaging with the digital public sphere.

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