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Unveiling Hate Speech Dynamics: An Examination of Discourse Targeting the Spanish Meteorological Agency (AEMET)

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Abstract

This article examines hate speech directed at AEMET, the Spanish meteorological state agency, on the social media platform X. We analysed nearly half a million messages posted between 31 December 2021 and 19 April 2023, using hate speech detection algorithms, text mining techniques, and qualitative analysis to identify patterns and themes in the discourse. Our research reveals a troubling reality, with around 25% of the messages collected displaying some degree of hostility towards AEMET, its staff, and its scientific work. A considerable amount of hate speech was expressed through derogatory comments and insults aimed at meteorologists, which is indicative of a wider trend of anti-intellectualism and scepticism of scientific expertise. Furthermore, the spread of conspiracy theories, particularly those related to geoengineering and chemtrails, highlights the spread of misinformation within online communities. This study emphasises the importance of acknowledging and addressing the spread of hate speech in meteorology and scientific communication. By emphasising the negative effects of such language on public perception and trust in scientific institutions, this article advocates for collaborative efforts to promote a culture of informed dialogue and evidence-based discourse. The results highlight the importance of combating hate speech and misinformation to protect the integrity and credibility of scientific institutions such as AEMET.

Keywords

AEMET; anti-intellectualism; disinformation; hate speech; meteorology; X/Twitter

1. Introduction

The last decade has been marked by a severe crisis of confidence that has affected the credibility and reputation of most organisations. The effects of the 2008 economic crisis have recently been compounded by the Covid-19 pandemic, creating a scenario of erosion and disaffection in which citizens demand more attention and solutions from institutions. In this context, disinformation, whose main objective is to create divisions and polarise society, emerges as another threat that exacerbates the weaknesses of democracies. According to the World Economic Forum (2024), disinformation will become the most relevant global risk in the next two years, as digital disinformation campaigns aim to undermine public trust in institutions and sow doubts about democratic processes (García-Orosa, 2021).

Recently, UNESCO (2023) presented an action plan for combating disinformation. The work was based on a survey ($N = 8,000$) conducted in 16 countries that were to hold elections in 2024. The survey found that 85% of citizens were concerned about the impact of disinformation and 87% believed that it had already had a major impact on political life in their country. However, disinformation is also a major problem in other areas, such as security and public health. This fact was demonstrated globally during the Covid-19 pandemic, making the flow of information from institutional sources and international organisations even more necessary (Ferreira Caceres et al., 2022). Thus, the WHO has taken various actions and entered into various collaborations, both through its own media and with third parties such as Wikipedia (Fidalgo, 2020) or, more recently, TikTok (WHO, 2024), to provide reliable health information and limit misinformation.

In the face of this new framework, the European Union has developed several measures to improve the resilience of the population and mitigate the impact of disinformation, including legislative measures such as the Digital Services Directive, an early warning system, and a new compendium on cybercrime (European Commission, 2024).

The latest Winter Eurobarometer Survey (2022) found that 69% of European citizens surveyed often came across information and news that they believed misrepresented reality or was even false, a percentage that rises to 78% in the case of Spain (European Union, 2024). Similarly, 76% of European respondents believed that the existence of news or information that distorts reality or is even false was a problem in their country, a view shared by 83% of Spanish respondents. This situation is likely to worsen as artificial intelligence becomes more widespread. On average, 74% of respondents in 29 countries believed that AI will make it even easier to create fake news or images in a very realistic way (IPSOS, 2023).

The public seems to feel disconnected from institutions, which is reflected in many works dealing with trust. This crisis also seems to be global. The 2024 Edelman Trust Barometer found that 63% of citizens surveyed in 28 countries ($N = 32,000$) did not trust political leaders, 61% did not trust business leaders and 64% felt the same way about journalists and the media (Edelman Trust, 2024). In all cases, distrust had risen by between one and three points since the same survey had been conducted the previous year. However, scientists enjoy high prestige and a good reputation when it comes to trust in authority figures: 74% of the respondents believed scientists tell them the truth about innovations and technologies. This puts scientists ahead of technical business experts, CEOs, and journalists as the most representative figures in terms of credibility.

This sentiment is also reflected in the specific data for Spain, which has one of the highest levels of mistrust of the 28 countries surveyed by the Edelman Trust: 81% of Spanish citizens in the survey did not believe political leaders, 79% did not believe journalists, and 73% did not believe business leaders. There was also a fear of misinformation among 61% of the respondents. There is a perception that these leaders manipulate the truth by making claims that they know are false or exaggerated. According to the same report, 51% of the population think that science is too politicised and 61% feel that government and research organisations have too much influence on the scientific community.

From the point of view of organisational communication, disinformation particularly affects institutions, especially the most visible ones (the Spanish government or the royal family), followed by local and regional institutions (Rodríguez-Fernández, 2019). This trend can also be seen in the aftermath of the Covid-19 pandemic, with almost 23% of an analysed set of fact-checking verifications in Spain over one month being related to these organisations (Almansa-Martínez et al., 2022).

2. Disinformation and Hate Speech: Science and Climate Change and Its Impact on Society

Climate denial is "the use of rhetorical arguments to create the appearance of a legitimate debate where none exists, with the ultimate aim of rejecting a proposal or claim on which there is widespread consensus" (Diethelm & McKee, 2009, p. 2). Through this type of denial, narratives are disseminated that influence popular beliefs about issues of real importance to society. These narratives include the denial of climate change or, for example, the existence of so-called "chemtrails," condensation trails from aeroplanes that are said to be a weather modification system (Asmelash, 2024).

Social networks, including YouTube, are currently the main sources for the dissemination of denialist discourse (Vicente Torrico & González Puente, 2023). In addition to the highly viral nature of the content and the difficulty of content curation, there is also the generation of new discourses that are less obvious but are in line with the denial of climate change. In an analysis of 12,058 videos from 96 climate denial YouTube channels, 70% were found to contain "new" narratives about climate impacts, solutions, and current climate science (Center for Countering Digital Hate, 2024). Here the arguments are less overt and more subtle, and include those made by climate delayers calling for a delay in policy action to mitigate climate change. This type of discourse is more dangerous because it appears more reasonable and can therefore generate more persuasion and influence than more aggressive and blunt discourse (Dionis, 2022). As Jiménez-Gómez and Martín-Sosa (2022, pp. 533–534) point out, two basic frameworks can be observed: the ideological one, in which the idea of freedom of expression functions as the main vector, and the economic one, with "a sceptical attitude towards the measures to be adopted in the face of climate change."

Influencers also play an important role as potential disseminators of disinformation. Nieto-Sandoval and Ferré-Pavia (2023) identify influencers as the actors who publish most videos on climate change on TikTok, more than media or institutions, and also point out that the content posted by influencers does not identify the sources of their information. Among the conclusions of this study is the observation that the sample of users analysed accepted climate change as a fact, but did not propose ways to change this, being merely passive subjects.

On the other hand, it should be noted that organisations can also act as disseminators of disinformation to benefit their activities or to clean up their image (Olivares-Delgado et al., 2023). Exxon, for example, promoted disinformation campaigns on climate change by funding 43 organisations between 1998 and 2005 to challenge the scientific consensus on the phenomenon. The economic contribution amounted to almost $16 million (Union of Concerned Scientists, 2007). At the same time, the company was processing relevant scientific information on the harmful effects of its activities, while publicly issuing communiqués that contradicted this internal data. Similar information laundering has been carried out by the tobacco industry for decades (Supran et al., 2023).

This "corporate disinformation" is often issued by companies whose products and services pose a threat to society, and entails them generating alternative or denialist narratives to manipulate and reduce negative public perceptions. Some researchers call these practices "dark PR" (Ennis, 2023), although the term is also used, along with its synonym "black PR," to describe "negative influence campaigns aimed at damaging the reputation of a competitor or political opponent" (Rodríguez-Fernández, 2023, p. 122). To this, we can add practices such as greenwashing, which violates the expectations of "consumers" by deliberately misleading them about the company's environmental practices or the benefits of its products/services (Santos et al., 2024).

Work carried out in Spain shows that misinformation on climate issues has an important belief niche: 85% percent of respondents ($N = 8,000$) believed it to be true that human activity causes extreme weather events, and half of the respondents believed that patent holders restrict the supply of cancer drugs to increase their profits or that genetically modified foods are unsafe (Wiesehomeier & Flynn, 2020).

In the fields of health, science, and climate change, these disinformation campaigns on social networks go hand in hand with the generation of hate speech aimed at attacking the social actors involved (Rodrigo Cano & Del Río Álvarez, 2021) to discredit their discourse, undermine the credibility of their research and influence the adoption of measures that entail economic or social changes. In the case of climate change, for example, and as reflected in the volume of reviews, institutions appear to be the most affected actors, followed by activists, the media, and scientists (Vicente Torrico et al., 2024).

An example of this reality, and of how hate speech is one more element in disinformation strategies, can be found in the digital conversation directed at AEMET, the Spanish meteorological state agency. AEMET is a Spanish institution that began its activities in the nineteenth century under a different name (Palomares Calderón, 2015). It is dedicated to "the development, implementation and provision of meteorological services of national competence and support for the exercise of other public policies and private activities, contributing to the safety of people and goods and the welfare and sustainable development of Spanish society" (Agencia Estatal de Meteorología, 2024). Recently, AEMET has suffered attacks on its work and has received insults and threats that have been publicly denounced by the institution itself (El Rastreador, 2023). Conspiracy theorists accuse the agency of "climate manipulation," "provoking drought as one of the objectives of the satanic 2030 agenda," "fumigation, sterilisation," or "population control." These attacks have increased sharply since the Covid-19 pandemic, to the point that in 2023 a message had to be published on social networks with the following text:

> AEMET in #SocialNetworks. We understand it as a space for meeting and closeness with society, amateurs and professionals. We share our work and our knowledge. We respect freedom of expression and welcome interaction. But NOT everything goes. ("La AEMET responde," 2023)

It should be noted that at the end of October 2024, during the final revision of this article, Spain faced one of the greatest weather disasters in its history, as a result of isolated depression at high levels (DANA), with the peninsula being devastated. The Autonomous Community of Valencia suffered the worst consequences, with more than 200 deaths. In the context of this crisis, disinformation became an additional problem, with AEMET being one of the most affected institutions and the target of numerous pieces of false content. Among the countless hoaxes that circulated, it was said that AEMET manipulated the weather, that its parameters were modified to simulate climate change, and that historical records showed that it manipulated its categorisations ("Hoaxes, disinformation," 2024).

3. Objectives

Taking into account this socio-communicative context, this research has the main general objective to explore the presence of hate speech in communications on the social network X against AEMET.

Our specific objectives are:

1. To identify the presence and characteristics of hate speech against AEMET on X, by analysing the topics, the intensity and the target of the hostile messages.
2. To study the diffusion of conspiracy and denial theories and their links with hate towards AEMET, assessing how concepts such as geoengineering and chemtrails fuel hostility towards this institution on social networks.
3. To evaluate the structure and nature of the groups responsible for this hate speech, using network analysis to understand the links between the senders of this type of message.
4. To reflect on the need to propose effective strategies to reduce hate speech and misinformation in meteorology and science communication, encouraging evidence-based dialogue and respect for science.

4. Methodology

The study was carried out on hate speech in messages on the social network X/Twitter that mention one of the accounts of AEMET, namely its main account or the delegated accounts it has in each of the Spanish Autonomous Communities. The collection was carried out on 21 April 2023, using the history of messages posted between 31 December 2021 and 19 April 2023 (one year and four months) to obtain a continuum of discourse that is independent of isolated events or campaigns. The choice of X was made because it is a social network with high penetration in Spain (43% of the Spanish population searches for information or content of interest on social networks, and 48% of these individuals choose X; see We are Social, 2023). As well as being one of the most widely used social networks in the country, X has been identified as one of the biggest distributors of misinformation, hoaxes, and hate speech (Arce-García & Díaz-Campo, 2024; DeVerna et al., 2024). It has also been shown that hate speech on X leads to an increase in offline hate crimes in Spain (Arcila Calderon et al., 2024). The network has been singled out for its failure to remove disinformation, although, like other networks, it has a very low level of removal even after complaints (Bergsmanis-Korats & Haiduchyk, 2024). Its ability to provide a wide range of data for academics made it stand out from other platforms until mid-2023, the time of the arrival of its new owner Elon Musk. Its primary use in disseminating information made it a unique source.

As some of the messages were recovered at a later date, they could have been deleted by their authors at that time or even removed by the social network X itself for violating its rules. However, the European Union ("Twitter and other social media," 2022) and the Center for Countering Digital Hate (2023) have reported that more than 80% of hate messages are not deleted.

The messages were collected using the academictwitteR library on the X/Twitter API 2.0, under the academic account (Barrie & Chun-ting, 2021) using R software. The following analyses were then carried out to understand the structure of the groups participating in the conversation, the identification of hate, its main topics, and the structure and nature of the hate speech emitters.

Network analysis was carried out using graph theory (Barabasi, 2016) to determine the structure of the relationships between users based on the retweets issued. The data were transformed using R software and then processed using Gephi software version 10.1. They were represented graphically using the ForceAtlas2 algorithm (Jacomy et al., 2014), and grouped by cluster or modularity (Chen et al., 2020) using the Louvain algorithm (Blondel et al., 2008). The nature and behaviour of each group was also analysed by identifying aspects such as average edge length, average degree, network diameter, eigenvector, mediation, and the number of edges.

To identify the presence of hate speech in the set of selected messages, the Syuzhet library in R was used. This has pre-established lexicons for sentiment levels and polarity, among other things (Jockers, 2017). The algorithm detects hate speech when it finds words previously classified as such and determines their intensity when these words are combined with related words that can modulate their value. For this purpose, we used the Spanish hate lexicon developed by Said-Hung et al. (2023), which contains 7,210 words or lemmas, both simple and compound, identified as hate speech in informational contexts. The use of this Spanish-specific lexicon avoids problems associated with the detection of hate speech in other languages and communicative contexts, as it does not require the translation of lemmas for automatic classification by the algorithm, which increases the reliability of the results. This lexicon-based detection method is one of the established approaches in machine learning systems for hate speech detection, achieving a reliability of around 80%, as reported by Alkomah and Ma (2022).

Using text mining, and after removing words or "stopwords" that do not add sense or meaning to a message (such as articles, adverbs, etc.), messages identified as hateful were plotted in two dimensions using a multidimensional scaling (MDS) graph. In addition, a graph was created showing the frequency of words that occur in the messages identified as hateful. The words are represented by colours that indicate their grouping into clusters, which are formed according to the frequency with which these words occur together. This grouping was done using the k-means algorithm with a value of $k = 7$, to identify a sufficient number of themes. With this technique, we tried to identify the main themes of hate speech within each of the clusters identified in the first point.

5. Results

A total of 480,559 messages were obtained in the data collection, of which 148,345 (30.9%) were direct messages, 5,715 (1.2%) were quotes, and 326,499 (67.9%) were retweets. This means that the majority of messages were in support of others through a simple retweet.

The temporal distribution of the broadcasts over the period of analysis of a year and four months is more or less uniform, although certain periods show increases in the number of messages. The network analysis formed from the retweets, shown in Figure 1, shows a very compact network around the different official AEMET accounts (general, Valencia, Canary Islands, Madrid, etc.) as well as the emergency broadcasting accounts of 112 (the emergency telephone number in Spain). This network has a modularity of 0.661, an average path length of 4.849, and a network diameter of 13. It has 61,415 nodes (accounts) and 114,109 edges (forwards).

This is a fairly cohesive network, except for one cluster, shown in blue in Figure 1, which the algorithm distances from the other clusters and which is formed from 8.84% of the total network. This cluster has 5,431 nodes (8.84%) and 11,615 edges (10.18%), so it has a greater number of connections between the nodes than the rest of the clusters detected. Although it is a cluster far from the centre of the network, it has a wide interconnection with the main accounts in its eigenvector values: @mOrtiz_RT, @purereason1972, @A_Moon73, and @JMurilloSanchez. Among the main accounts in the above cluster, only one account of a public figure was identified: @ldpsincomplejos (eigenvector 0.01), the account of radio journalist Luis del Pino, who moved from esRadio to the Intereconomía group and elToroTV in 2024 ("Luis del Pino cambia," 2024). All of the above-mentioned accounts published between 200 and almost 800 messages citing the AEMET accounts during the period analysed. Although the accounts do not represent clear influencers, they do represent accounts with high levels of mediation between accounts: @GeoingenieriaMu (centrality 499,754.29), @Empecinado101 (406,134.14), @877rfm (386,721.02), and @JMurilloSanchez (288,162.43). All these accounts are linked to conspiracy theories and accusations against AEMET. These conspiracy theories are not found in the rest of the identified clusters.
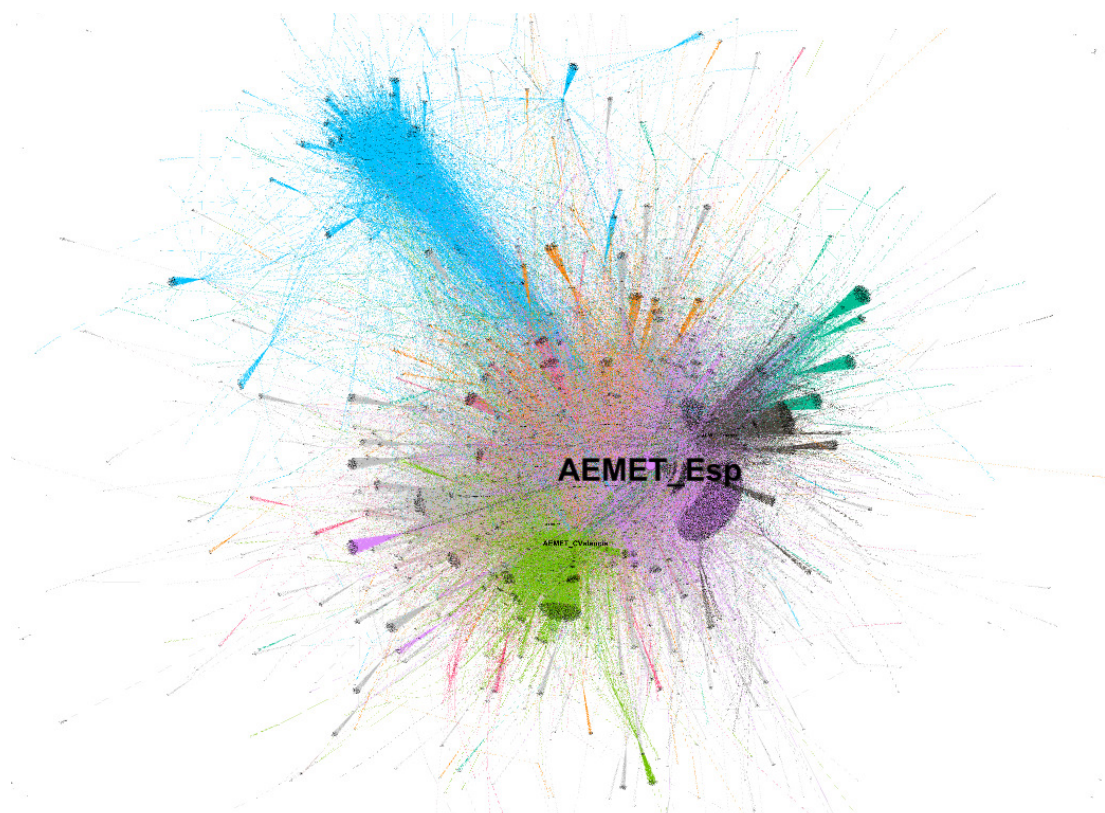

Figure 1. Retweet network around AEMET accounts.

5.1. Hate Speech Analysis

The hate detection algorithm identified a total of 119,084 hate messages (24.78% of the total number of messages) posted by 36,599 accounts. Of the messages, 26,122 (21.9%) were direct messages, 845 (0.7%) were quoted, and 92,117 (77.4%) were retweets. Analysis of the retweets shows that 10.85% of the hate messages came from the group previously identified as conspiracy theorists, but there are a large number of messages with hate content that were directly posted. Thus, 31.8% of the hate messages were sent against the general account of @AEMET_Esp, 9.46% against @AEMET_CValenciana, 6.66% against @AEMET_Andalucia, 6.03% against @AEMET_Canarias, 4.42% against @AEMET_Madrid, 3.33% against @AEMET_Murcia, 2.66% @BBFFLuchaCyl and 2.52% against journalists from El País, RTVE, Cope or Maldita (@vbenayas, @Eltiempo_tve, @Maldito_clima, @Divulgameteo).

The most commonly used words in the hate speech, as shown in Figure 2, falling among the messages in the third quartile with the highest average hate intensity (> 0.25), reflect clear insults such as "sons of bitches," "criminals," or "shit." There are also expressions such as "fuck" and "scare," as well as the names of the official accounts of AEMET and some of its offices in Valencia, the Canary Islands, the Balearic Islands, Aragon, Madrid, and Andalusia. In other words, the hatred is mainly generated around personalised insults, with accusations of trying to 'scare' the population with their announcements and weather warnings.
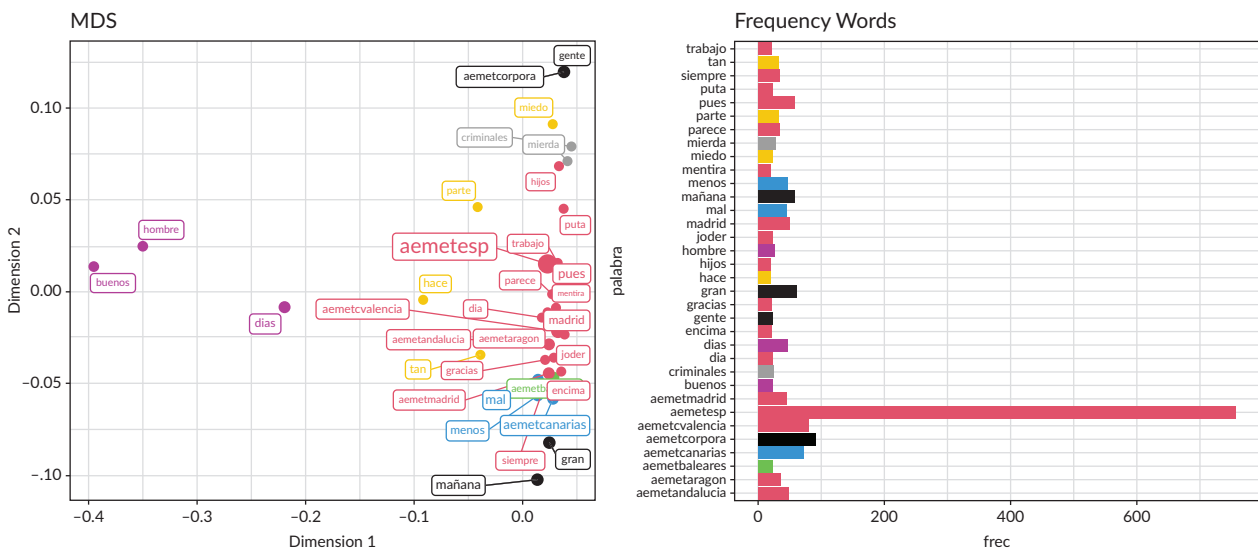

Figure 2. MDS and frequency analysis of the words most frequently used in hate speech against AEMET.

A selection of the most hate-filled messages is shown in Table 1. It can be seen that the hatred mainly revolves around climate change denial, conspiratorial aspects (climate manipulation, Illuminati, elites, viruses, and NATO), or the 2030 Agenda (the UN's sustainable development goals).

Hate messages have a median of seven retweets and an average of 79.87, while they receive hardly any likes, with a median of 0 and an average of 0.68. The accounts spreading hate also show certain characteristics:

1. They have a high level of activity on the network: The median number of messages they have written is 20,217 (6.92 messages per day) and the average is 51,253 (17.55 per day) in their history.

2. They are accounts of a nano-influencer nature, as they often appear in astroturfing-type campaigns (Arce-García et al., 2022; Ong et al., 2019), with a median of 631 followers and 588 accounts followed.

3. The level of hate is high enough to generate emotions in the listener, but it is not at such a high level that it could be detected by algorithms or even constitute a crime, as other research has shown (Arce-García et al., 2024). Thus, they have an average level of hate per message, with a median of 0.2105 and a mean of 0.2234 (on an average scale from 0 to 1).

Table 1. Examples of climate-themed hate speech.

	Example
1	@MADRID @AEMET_Esp This is the freedom that the PP uses as a flag, they are brainless this City Council all dictatorship and populism and liar, who would think of closing the parks with shadows to avoid the heat wave, PP you give stumbles of organisation you are only commissioners card sharks
2	@AndaluciaJunta @AEMET_Esp @AEMET_Andalucia We have everything against us, damn it: the weather, which doesn't rain, snow or get cold; politics, a pot of crickets, each one more shrill, inept and disloyal; the virus and, as a consequence, the crisis; the Ukrainian conflict, which they want to get us into a war by the nose, etc.
3	@HbCecilia @MADRID @AEMET_Esp So? Agenda 2030 has nothing to do with ideologies. It is a dictatorial imposition of globalist elites and big corporations. Politicians are just their puppets. It doesn't matter if they are left or right wing.
4	@vbenayas @Rub_dc @AEMET_Esp Another LIE. Since there is data there have been other heat waves with higher temperatures. for now no station has exceeded the maximum for the month of June. less lying. justifying a farce with lies is shameful. So there is no climate change in Asturias? https://t.co/ct7iTaKZNP
5	AEMET_Andalucia MURDERERS HDLPS ILLUMINATIS, YOU WILL PAY, EVERY TIME PEOPLE KNOW MORE ABOUT THE PLANNED NEW WORLD ORDER AND ITS CRIMINAL AGENDA, THE SAME AS THE STONES OF GEORGIA WILL HAPPEN TO ALL THE SATANISTIC AND CRIMINAL STUPIDITY, STOP UN-NATO, NO TO THE ARTIFICIAL MODIFICATION OF THE GENOCIDE CLIMATE https://t.co/Gc8k9Nyppa
6	@Carolina_adh19 @Davicin93 @MADRID @AEMET_Esp Shut up damn bot, you're replying to everyone, don't you have a life? It's absurd that you close it and that's it. It's a beautiful morning and it's not hot at all. I work every day inside the Retiro and this is absurd so shut the fuck up.
7	@ledblues72 @AEMET_Esp That's the problem, they play God, No! They are true Satanist psychopaths, they control all levels of society, 95% of the money is in their power, and they can sink the global economy with a simple war, or by creating a health problem. Ag2030
8	@greenpeace_eng @MonicaParrill @AEMET_Esp Anomalous is that a few years ago you were saying that by this time Valencia would be under the waters of the Mediterranean. Your predictions and scaremongering are rubbish that only aims to impoverish the middle class to subject them to the dictatorship of the "ecohappysustainable."
9	@AEMET_Esp MURDERERS, HDLPS, NO MORE ARTIFICIAL CHEMICAL SUMMERS, GENOCIDES...WHO ARE YOU GOING TO FOOL AT THIS POINT, THE CLIMATE IS MANIPULATED AND PUTS IT IN THE BOE OF SPANISH MAFIA STATE AND PROGRAMMED AGENDAS WE WANT HEADS TO ROLL AND THIS ARTIFICIAL AERIAL CLIMATE GENOCIDE https://t.co/0GxV4nlWYZ
10	@MADRID @AEMET_Esp All to put fear into people...what a load of bullshit measures. Buy the Globalist Agenda 2030 pin because it is what is causing this among many other things, and it is the only thing we have to fight against, and not against these little shit politicians who are just errands.

Notes: PP stands for Partido Popular, the main centre-right party in Spain; HDLPS is a son of a bitch; BOE is the Official State Bulletin of Spain.

As for the appearance of other conspiratorial elements in the hate speech, "chemtrails" appear in 804 messages, "geoengineering" in 1,670 messages, "Covid-19" in 97, "vaccines" in 62, "the HAARP project" (the high atmosphere research antennas that are said to cause catastrophes; see Arce-García & Díaz-Campo, 2024) in 251, and "Agenda 2030" in 688 messages. Elements such as "fumigation" (204) or the "spread of poison" (57) also appear. Thus, in many hate messages, the attack on AEMET is linked to the dissemination of well-known conspiracy theories.

The analysis of the self-descriptions of the accounts in the third quartile with the highest average hate associated with the messages is shown in Figure 3. It can be seen that these users define themselves mainly under the following associated themes: "family" together with "freedom" and "agenda"; "truth" and "freedom"; "Spanish" or "from Spain" together with "father," "life," "lover," "nature," "death," and "account"; and "meteorology enthusiast." There is therefore a clear trend of accounts that define themselves as Spanish, for freedom, family, life, and nature, as well as meteorology amateurs.
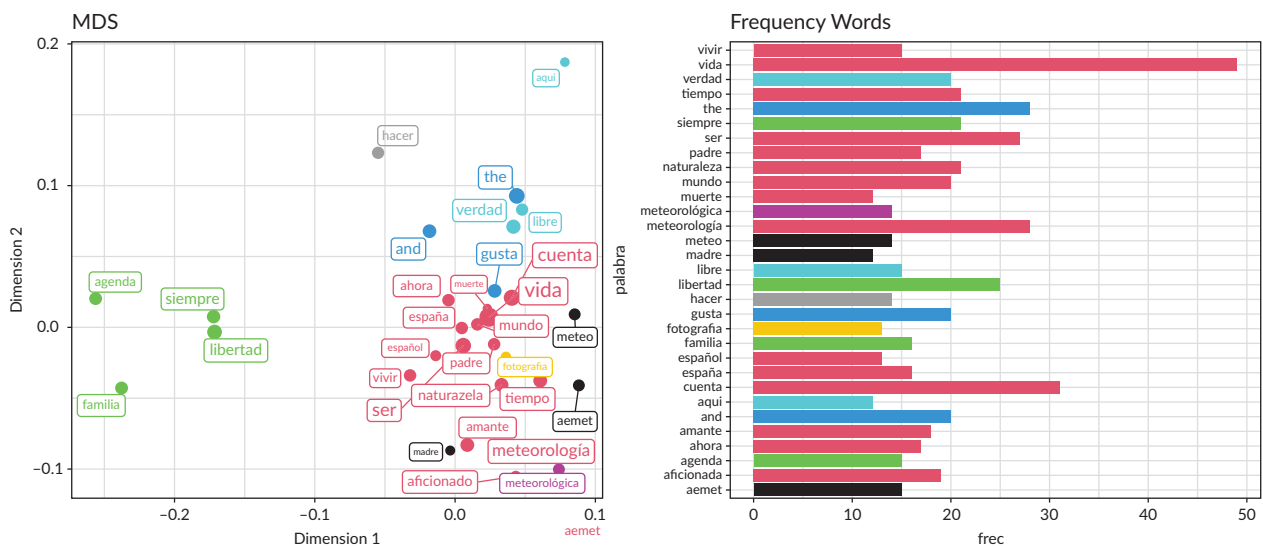

Figure 3. MDS and frequency analysis of the most commonly used words in the description of the accounts with the highest average hate load.

6. Conclusion

This research analyses hate speech against AEMET) on the social network X. Using hate speech detection algorithms, text mining techniques, and qualitative analysis, patterns of hostility against AEMET were studied for messages posted between 31 December 2021 and 19 April 2023. The results show a significant percentage of messages with hate content, driven by conspiracy theories and climate change denial and related to scientific scepticism.

On the extent of hate speech and its impact on public trust (specific objectives 1 and 2), one of the most striking findings of the study is the significant proportion of messages containing hate speech towards AEMET: Around 25% of the texts analysed show some degree of hostility. This suggests that a significant part of the online public conversation about the Spanish state agency is characterised by negative emotions, ranging from direct insults to questions about the professional integrity of scientists and meteorologists.

The impact of this type of message goes beyond the mere emotional or personal damage to AEMET and its professionals, as this hate speech creates a climate of misinformation that contributes to the erosion of public trust in AEMET and its staff, leading to scepticism about science in general (which is the attitude of denialists and conspiracy theorists). This kind of mistrust can have serious consequences, such as a lack of preparedness for climate emergencies or an indifference to critical weather warnings, putting both public safety and environmental sustainability at risk.

Concerning conspiracy theories as a catalyst for hate speech (specific objective 2), our analysis of the messages shows that much of the hatred towards AEMET is linked to the spread of conspiracy theories, particularly those related to geoengineering and chemtrails. These theories, which claim that AEMET and other scientific institutions are manipulating the weather for dark purposes, have been promoted by certain online communities driven by very specific interests. Messages citing these theories not only misinform but also create an environment of hatred, the radicalisation of opinion, and rejection of scientific evidence.

The spread of these theories reflects a wider phenomenon of anti-intellectualism and the rejection of science, fuelled by a distrust of elites, governments, and international institutions. This study highlights how conspiracy theories, based on false or distorted information, can act as a catalyst for hatred and misinformation, exacerbating social polarisation and fostering a hostile attitude towards scientific knowledge and professionals.

On the structure of the hate network in social networks (specific objective 3), another important aspect of the study was the identification of the actors and network structure behind the hate speech on X. Using network analysis techniques, we were able to visualise how certain groups and user accounts were clustered around the dissemination of hate messages. In particular, we identified a cluster of highly interconnected users who specialise in spreading conspiracy theories related to AEMET and meteorology in general.

Concerning impact, this particular group, although relatively small compared to the total number of users, is highly influential because of the number of retweets and quotes they generate. Messages from this cluster tend to be disproportionately shared, amplifying the reach of hate speech and conspiracy theories. These aspects are consistent with Granovetter's (1973) sociological theory that the weak links are the ones who end up contributing the main ideas to the group. Similarly, the most influential accounts within this network tend to be those that promote a discourse of rejection of public policies related to climate change, linking them to global political agendas such as the UN's 2030 Agenda.

On the need for strategic responses to mitigate hate and misinformation (specific objective 4): The purpose of this study is not only to highlight the problems caused by hate speech but also to suggest possible solutions to mitigate its negative effects. First, institutions such as AEMET must implement effective communication strategies that not only provide clear and accurate information but also directly address myths and conspiracy theories circulating on social media. Greater transparency in science communication can help reduce uncertainty and mistrust.

It is also important to foster collaboration between scientific institutions, social media platforms, and governments to develop strategies to limit the spread of hate speech and misinformation. This could include implementing more effective algorithms to detect and remove harmful content, as well as supporting media literacy initiatives that help the public identify and challenge false information.

Finally, it is essential to promote a culture of respectful and evidence-based dialogue on social media. The study shows that hatred towards scientific institutions such as AEMET is motivated not only by manipulation or ignorance but also by increasing social and political polarisation. To counter this phenomenon, it is important to foster an environment in which the exchange of opinions is encouraged and discussed in a constructive and reasoned manner, without resorting to hostility or misinformation.

In the field of meteorology, hate speech not only affects public perception but can also have a direct impact on scientific work. Social pressure and smear campaigns can discourage scientists from interacting with the public or even communicating their research openly. This chilling effect can limit the advance of scientific knowledge and restrict public access to accurate and high-quality information.

In addition, the spread of conspiracy theories about climate control and weather manipulation directly affects the perception of the current climate alert. Denial that extreme weather events are a result of global warming finds support in these theories, undermining global efforts to mitigate and respond to climate change.

6.1. Future Implications and Recommendations for Future Research

This study lays the groundwork for future research in the area of hate speech and its relationship to science. Given that the phenomenon of hatred towards scientific institutions is not unique to AEMET, future research could focus on other scientific fields where hate campaigns, misinformation, and scepticism similarly affect public credibility and trust. For example, vaccination research, renewable energy research, or even medicine in general are areas in which hate speech and conspiracy theories have had a significant impact.

In addition, it would be beneficial to extend the research to allow comparisons between different countries or cultural contexts to identify similarities and differences in the spread of conspiracy theories and hate speech towards science. By exploring how other contexts deal with these issues, new strategies and models may emerge that can be applied to a wider setting.

Hate speech towards AEMET, as demonstrated in this study, is not just an isolated manifestation of online hostility, but part of a wider problem related to distrust of science and the spread of conspiracy theories generated by a clear interest in misinformation. Addressing these issues requires a combination of efforts: improving scientific communication, strengthening content moderation on social media platforms, and promoting a culture of respectful, evidence-based dialogue. Only a collaborative and informed response can mitigate the impact of hate and misinformation on scientific institutions and protect their integrity and credibility in the future.

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