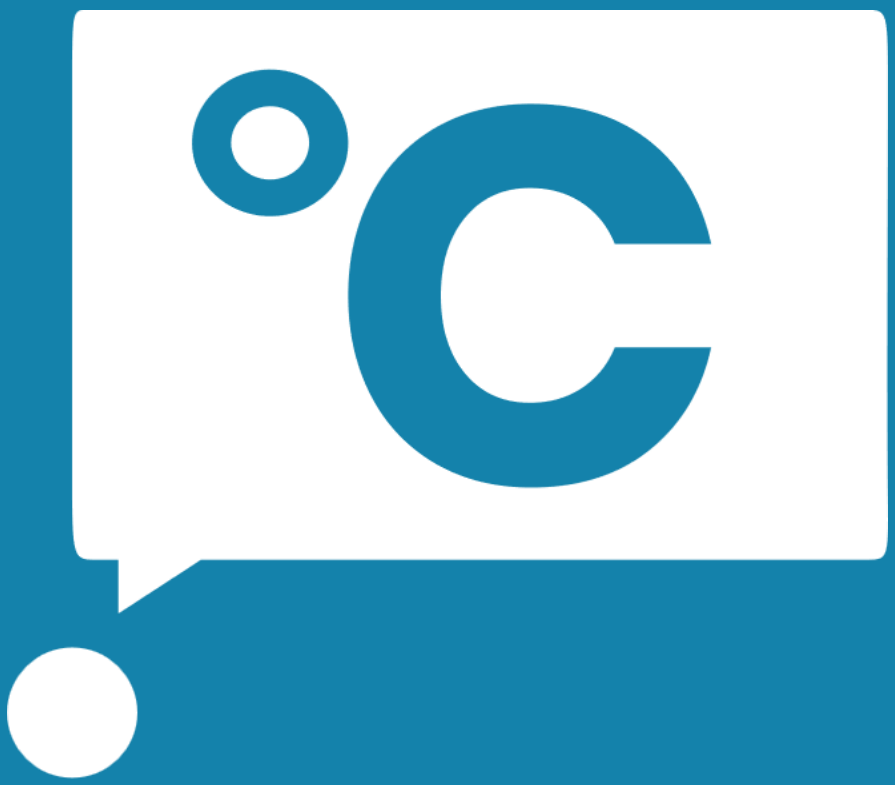


Scientific literature review on climate change media literacy challenges and solutions

Produced in October 2026
By LAB University of Applied Sciences in the frame of the CLIMAware project

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Background information

This document was produced by LAB University of Applied Sciences with the contribution of CBioHub as part of the CLIMAware project, co-funded by EACEA under Grant Agreement number: 101246545, CREA-CROSS-2025-MEDIALITERACY. The project is implemented under the coordination of My Madeira Island from Portugal. The project will be implemented for 24 months, from March 2026 to February 2028, and aims to combat climate change misinformation and disinformation across Europe by enhancing media literacy, fostering critical thinking, and equipping citizens, disadvantaged groups, educators, and media professionals with innovative tools, training and resources to identify and counter disinformation. For more information about our initiative, you may visit the official website: www.climaware.eu

Summary

Alternative world views, disruptive narratives and emerging digital media environment challenge the public understanding and perceptions of climate change. In response, this study seeks to answer the following research question *How can a scientific approach be used to address common climate change misconceptions and strengthen public understanding?* To address the research question, 16 peer-reviewed articles were selected and categorised into four thematic areas: (1) denialism, (2) misinformation and disinformation, (3) governance, and (4) education. The findings were analysed accordingly and then compared with the results of the CLIMAware survey report (D2.1), conducted earlier in 2026, to provide additional context and practical relevance. The review concludes that a scientific approach can effectively address climate change misconceptions and strengthen public understanding by combining accurate evidence with insights into the psychological, social and political drivers of climate denial and scepticism. The literature demonstrates that misconceptions are rarely caused solely by a lack of knowledge. Therefore, simply presenting scientific facts is often insufficient. Instead, science-based interventions should integrate clear communication of the scientific consensus, climate literacy education, inoculation against misinformation and audience-specific message framing. Both the literature review and the CLIMAware survey suggest that efforts to counter climate misinformation should move beyond a sole focus on climate change denial, and instead address locally relevant narratives, misconceptions and media environments. Educational interventions should strengthen epistemic skills, such as evaluating evidence, recognising misleading argumentation and rhetorical techniques, and understanding how scientific knowledge is generated, while incorporating approaches such as prebunking and inoculation. Furthermore, enhancing digital media and AI literacy, including source verification, algorithm awareness and the recognition of AI-generated content, may help build resilience to misinformation and support informed participation in climate governance.

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Contributors	Apostolos Malamakis and Christos Karkanias – CbioHub (Annex II)
Peer Reviewer 1	Apostolos Malamakis and Christos Karkanias - CBioHub
Peer Reviewer 2	Anastasia Mazur - MMI
Coordinator	Anastasia Mazur - MMI

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Introduction

Climate change is a highly complex issue, both as a scientific phenomenon and as a societal challenge, which complicates efforts to understand and communicate it effectively. Scientific knowledge is essential for fostering a comprehensive understanding of climate change and for informing the development of appropriate mitigation and adaptation strategies. At the European level, the role of scientific knowledge in policymaking, the formation of public opinion, and the recognition of misinformation is indispensable. Nevertheless, the construction of evidence-based understanding is currently being challenged by a variety of interconnected factors and contemporary developments.

Science denial means rejection of a proposition on which a scientific consensus exists (Diethelm & McKee 2009). In other words, denialism relies on the use of rhetorical arguments to create the impression that a legitimate scientific debate is still ongoing, even when there is broad scientific consensus on the issue (McKee 2010). Science denialism is particularly common in issues that are politically controversial and characterised by conflicting interests among different stakeholder groups. Examples of such issues include vaccination, the denial of certain diseases or historical events and climate change. Despite significant scientific advances, denialism appears not only to persist but also to be accelerating. According to McKee et al. (2010), this trend can be attributed to three main factors. First, the emergence of Web 2.0 has created unprecedented opportunities for individuals to share information and exchange ideas. Second, in some countries, the rise of partisan media has enabled conspiracy theories and misleading narratives to reach wider audiences. Third, corporate actors have increasingly exploited these developments to advance their own interests. In the context of climate change, oil companies in particular have played a significant role in promoting and amplifying narratives that challenge the scientific consensus.

Misleading narratives about climate change are typically characterised by both a content layer and a technique layer. While the content layer concerns the substantive claim being made, the technique layer consists of the rhetorical strategies used to support and legitimise that claim. One of the most influential frameworks for identifying such strategies is the FLICC taxonomy of denial techniques, which includes *fake experts, logical fallacies, impossible expectations, cherry-picking* and *conspiracy theories* (Diethelm & McKee 2009). At the content level, climate misinformation commonly falls into five broad claim categories: *it is not real, it is not us, it is not bad, climate solutions will not work,* and *the experts are unreliable* (Coan et al. 2021).

In addition to denialism, another significant challenge stems from increasing political polarisation and the rise of right-wing populism. While populism generally refers to a political approach that claims to represent ordinary people against a perceived elite, science populism extends this divide to the domains of knowledge production and public policymaking (Lerner et al. 2025). It is characterised by the belief that two opposing groups, ”ordinary people” and the ”elite,” are engaged in a struggle over who has the authority to shape knowledge and influence policy decisions. Within this framework, the elite is typically understood to include academics, scientists, experts, and government agencies. (Eberl et al. 2023)

Science populists typically draw on two distinct narratives to support their worldview. The first is the belief that the academic elite have monopolised the concept of ”truth” by recognizing only knowledge produced through scientific research as valid. In contrast, science populists argue that truth should also be grounded in the experiences, feelings, and common sense of ordinary people. This perspective suggests that they may be more sceptical of information generated through conventional scientific methods. (Mede & Schäfer 2020) The second narrative is that the academic elite use science-based decision-making in ways that undermine the interests of ordinary citizens. According to this view, scientists do not make recommendations solely because they are scientifically justified; rather, they are perceived as promoting research agendas that serve their own interests, such as advancing their careers, increasing their influence, or securing additional funding. (Eberl et al. 2023)

As the media landscape undergoes significant transformation, alternative narratives and worldviews are becoming increasingly influential. These trends are amplified by the widespread circulation of misinformation and disinformation through alternative media channels, contributing to public confusion and challenging evidence-based

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understanding of issues such as climate change. Consequently, the early 21st century has often been characterised as a *post-truth era,* in which appeals to emotion and personal beliefs have become more influential in shaping public opinion than objective facts (Harsin 2018).

Among the key drivers of the changing media landscape are the exponential rise in social media use and the growing prevalence of AI-generated content, both of which have fundamentally altered how information is created, disseminated, and consumed (Yin 2023). At the same time, the role of traditional media as a gatekeeper of democratic discourse has weakened, while new forms of digital power have emerged, reshaping how information is produced, distributed, and consumed (Lata 2024).

Europe has recently confronted several overlapping crises, including those associated with climate change, the war in Ukraine, and migration. Such crises may contribute to the increased circulation of misinformation and disinformation, as periods of uncertainty and social disruption often create opportunities for misleading narratives to gain traction (Shashbazi & Bunker2024). From a societal perspective, this is particularly concerning because it may undermine public trust, exacerbate polarisation, and threaten social stability and resilience.

All of the above-mentioned challenges and disruptions in the information environment, together with the emergence of alternative worldviews, present significant challenges to public understanding and perceptions of climate change. In response, this study seeks to answer the following research question:

> *How can a scientific approach be used to address common climate change misconceptions and strengthen public understanding?*

The aim of this review is to identify evidence-based approaches and solutions that can be utilised in the implementation of the CLIMAware project and, more broadly, in efforts to combat climate change misinformation and promote informed public engagement with climate science. The review builds upon previous research while also taking into account the findings of a survey (D2.1) on climate change misconceptions conducted within the CLIMAware project in 2026, thereby combining insights from both the existing literature and project-specific empirical data. See Annex II for the specific misconceptions identified in the CLIMAware study (D2.1) and addressed with scientific evidence by CBioHub.

Methodology

The literature review was implemented by LAB's research team, including four members with different scientific backgrounds (environmental and sustainability, human geography, business and administration). This enabled triangulation and discussions during the whole process, which added value and enabled a well-prepared research framework and deepened the analysis phase.

Based on the research question, the research team, in collaboration with the university library, formulated search term combinations, which were fed into the Scopus and Web of Science databases. The search was narrowed down to English language peer-reviewed articles and review articles published in 2015 or later.

The search term combinations were the following:

("climate change") AND (misconception* OR misinformation OR knowledge gap* OR public understanding) AND (scientific evidence OR science)
("climate change") AND (misconception* OR misinformation OR myth* OR denial*) AND (education OR "public understanding" OR literacy)

The first search term combination was decided to be broad, to involve several possible combinations, whereas the second combination narrowed down the findings significantly. The database's functions of "relevance" (importance of content) and "newest" (as the misconception debate is quite recent) and "most cited" were utilised to scan the most central hits. The researchers prepared an assessment framework, a matrix for comparing the relevant articles

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in both technical perspectives (impact factor of the journal, year of publication, citations, European context) and based on numerically assessing the quality of the content, focusing especially on the relevance of the abstract. In addition, the articles were divided into content categories to ensure that all relevant perspectives of the research question would be covered in the final selection.

Table 1. Assessment framework categories.

Category type	Category elements
Article information	Author(s) Title Name of Journal Impact factor of Journal Year of publication Number of citations European context (Y/N) Quality score for abstract (1-5)
Content category	Denialism Mis- and disinformation Education, school solutions Gamification, interactive solutions Governance, politics, decision-making Media literacy, advertising, AI based content Social media Scientific understanding, fact-checking

During this individual research phase, each researcher assessed 16-63 articles. The choice of category into which we divided the articles in each case was a compromise, but in each case based on the researcher's view of the main topic covered in the article in question.

After this, the researchers came together to make the final selection of the 16 most relevant articles for the literature review. The articles were agreed upon based on the matrix, considering a combination of content assessment and technical perspectives. Figure 1 shows the steps in the search process. The selected articles are listed in Table 2. An elaborated version of the table, see ANNEX I. Other literature that is specifically referred to and is in a central role in the above articles will also be referenced, even though these additional articles will not be otherwise described in detail.

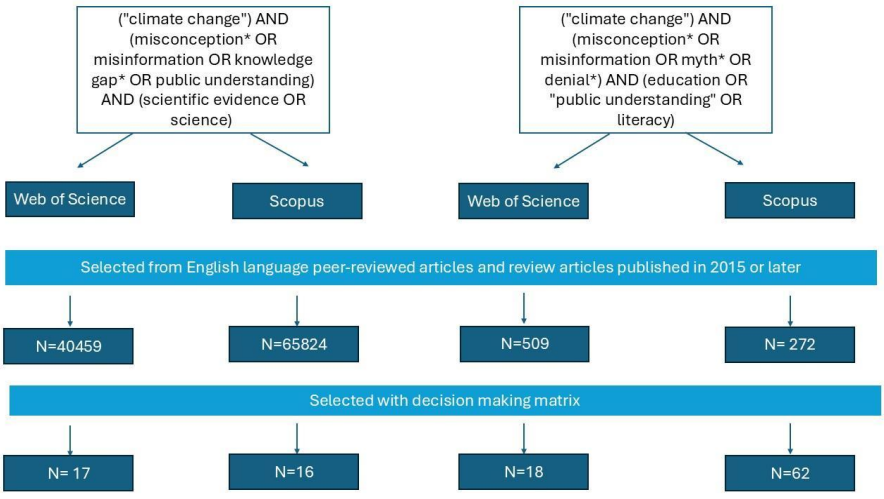


Figure 1. Illustration of the methodology

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Table 2. Articles selected for the literature review (see more detailed list in Annex I).

Author(s)	Year of publication	Title	Category
Cook, J., Lewandowsky, S., Ecker, & Ullrich K. H.	2017	Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence	Scientific understanding, fact-checking
Monroe, M. C., Plate, R. R., Oxarart, A. et al.	2019	Identifying effective climate change education strategies: a systematic review of the research.	Education, school solutions
Maertens, R., Anseel, F. & van der Linden, S.	2020	Combatting climate change misinformation: Evidence for longevity of inoculation and consensus messaging effects	Mis- and disinformation
Treen, K.M.D., Williams, H.T.P. & O'Neill, S.J.	2020	Online misinformation about climate change	Mis- and disinformation
Sharon A.J. & Baram-Tsabari A.	2020	Can science literacy help individuals identify misinformation in everyday life?	Education, school solutions
Compton, J., van der Linden, S., Cook, J. & Basol, M.	2021	Inoculation theory in the post-truth era: extant findings and new frontiers for contested science, misinformation, and conspiracy theories.	Mis- and disinformation
Hornsey M.J. & Lewandowsky, S.	2022	A toolkit for understanding and addressing climate scepticism	Denialism
Jylhä, K.M., Stanley, S.K., Ojala, M. & Clarke, E.J.R.	2023	Science Denial A Narrative Review and Recommendations for Future Research and Practice	Denialism
Doss, C., Mondschein, J., Shu, D. et al.	2023	Deepfakes and scientific knowledge dissemination	Media literacy, advertising, AI based content
Cook, J., Ecker, U. K. H., Trecek-King, M. et al.	2023	The cranky uncle game—combining humor and gamification to build student resilience against climate misinformation.	Gamification, interactive solutions
Mendy, L., Karlsson, M. & Lindvall, D.	2024	Counteracting climate denial: A systematic review	Denialism
Logemann, H. T., Rode, J. B., Maertens, R. & van der Linden, S.	2025	The gateway (mis)belief model: How misinformation impacts perceptions of scientific consensus and attitudes towards climate change	Governance, politics, decision-making
Nicolosi, E., Medina, R. , Brewer, S. et al.	2025	The new denial: climate solution misinformation on social media	Social media
Ejaz, W., Altay, S., Fletcher, R. & Nielsen R.K.	2025	Trust is key: Determinants of false beliefs about climate change in eight countries	Mis- and disinformation
Kresin, S., Kremer, K., Nehring, A. & Buessing A.G.	2025	Students' awareness and conceptions of science-related communication mechanisms on social media	Social media
Wang, M. & Akin, H.	2026	Effects of epistemic beliefs, science populism, and social media use on climate change misperceptions	Scientific understanding, fact-checking

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Findings

Denialism

Despite over 50 years of communicating the climate change adversaries and agreed scientific consensus on the matter, climate denial is still widespread. (Hornsey & Lewandowsky 2022; Mendy et al. 2024). It has been discovered that climate denialism and ways of counteracting it have not been properly explored. (Mendy et al. 2024). Another name for climate denialism in research is climate scepticism, and it is claimed by Hornsey and Lewandowsky (2022) that the term ”climate scepticism” is a wider term which has broader and more flexible implication of usage. However, in this literature report, climate scepticism and climate denialism are perceived as interchangeable terms, where both mean a human reasoning which demonstrates dismissal of well-established scientific evidence or method proving the climate change in the socio-environmental domains (Jylhä et al. 2023).

Jylhä et al. (2023) in their article ”Science Denial: A Narrative Review and Recommendations for Future Research and Practice” provided an extensive review on the origins of science denial, as well as the basis of it. They defined science denial as the dismissal of well-established scientific evidence or the scientific method to gather reliable evidence. That is, people can reject certain information that has been researched scientifically and/or consider scientific practices to provide insufficient methodology altogether. Denial of scientific evidence tends to build on pseudoscientific claims, which are claims that relate to scientific research topics, are founded on unreliable evidence, and aim at creating deviant doctrine by being presented as the most reliable knowledge.
The exposure to disinformation is not a full explanation for why scientific knowledge can be disputed. Importantly, several psychological factors can interfere with the general goal of inferring correct conclusions. Due to our limited cognitive capacity, humans use simple heuristics (mental shortcuts) rather than complex algorithms when interpreting events and information. Some information is also processed more carefully than others, and some are dismissed due to a motivation to discard threatening or undesirable messages. Individuals are also more inclined to believe (or at least express support for) such messages that are conveyed by someone they identify with and consider reliable or that enable them to express certain personal identities, such as being a free-thinker or a nonconformist. Indeed, one explanation for science denial is motivated reasoning: noticing, interpreting and recalling information in ways that confirm strongly held worldviews, identities and other preconceptions. This process tends to be implicit and can entail various strategies, such as approaching or avoiding certain information, selectively searching specific types of memories, or creatively combining knowledge to construct new beliefs that provide seemingly logical bases for the desired conclusion. (Jylhä et al. 2023).

Science denial, particularly climate change denial, has commonly been studied concerning ideological variables and sociopolitical identities. Higher scores on climate change denial are typically found among conservatives and right wing adherents, reflecting motivated reasoning. When an issue is polarised, individuals may take cues from political leaders on which opinions are most appropriate and aim to express and protect their sociopolitical identity by agreeing with the views of their political ingroup. Climate change may have become polarised because the solutions to the crisis typically involve threats to the existing socioeconomic status quo. These climate mitigation solutions increase government regulation or tax emissions, thus challenging the free-market philosophy of less government interference in the economy. (Jylhä et al. 2023).

Science denial can also reflect an attempt to cope with difficult emotions in relation to risks. If risks threaten something important for a person, like a worldview, people sometimes use different self-protection strategies to cope with the threat/risk. Some emotional aspects, like unconstructive emotion regulation, are closely related to motivated reasoning. Indeed, one of the goals of motivated reasoning is to restore and maintain a positive emotional state that may be threatened if one’s cherished worldviews and identities are challenged. Denial of the science around a threat could also be related to trying to find hope, that is, a less constructive way to cope with difficult feelings. There was discovered that climate hope could sometimes be based on de-emphasising the threat in various ways, such as by arguing that scientists exaggerate the problem. This denial-based hope is negatively associated with different kinds of climate engagement in different countries. (Jylhä et al. 2022).

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Emotions also influence the uptake of scientific facts through misinformation. For example, misinformation campaigns seem to be particularly effective in inducing antivaccination attitudes if they make people feel angry. In addition, anger is related to accepting misinformation regarding COVID-19 and misinformation in general. When people are angry, they use heuristics and are more certain in their judgments, which could explain these results. Also, positive emotional states like feeling happy are sometimes related to shallow information processing and certainty in judgments which may make people more gullible regarding false scientific claims. One theoretical explanation is that emotions are part of a basic human defence system working at a preconscious level. When the situation is experienced as such, people do not bother to use systematic information processing but rely on heuristics to save resources for more uncertain situations. This shallow information processing makes people less inclined to question false information (Jylhä et al. 2023).

Hornsey and Lewandowsky in the article ”A toolkit for understanding and addressing climate scepticism” (2022) explore climate scepticism. If climate scepticism is viewed as motivated reasoning, as a process of rationalising conclusions already reached, it became transformative, as it changes the critical question from ”Why do people reject climate science?” to ”Why would people want to reject climate science?” One pragmatic answer to the question is vested interests: for some, climate change is an inconvenient truth in that it implies painful sacrifice. It is psychologically unrealistic to expect that anybody could appraise climate science with perfect objectivity, but it might be especially unrealistic when change is painful (for example, for individuals whose livelihood is reliant on fossil fuel industries or for people with a large carbon footprint that is costly to shrink). Rather than engaging with solutions that are painful, it may be easier to reject the science by embracing slivers of scientific dissent, clinging to baseless conspiracy theories or shifting standards of proof as a function of how convenient the evidence is. For others, climate change is an inconvenient truth not because it costs them materially but because the implications of the science upset their ideological worldview. Mitigating climate change is often construed as requiring big government solutions designed to regulate the freedoms of individuals and businesses. Rather than aligning with solutions that people find ideologically objectionable, the temptation is to reject science that suggests these solutions are necessary (a phenomenon referred to as solution aversion). (Hornsey & Lewandowsky 2022).

One can also view climate scepticism as political fellowship, where climate science is drawn into the culture wars. By the 2000s, a degree of climate scepticism became baked into the cluster of arguments that describe and prescribe one’s political loyalties as conservative in some countries. Political conservatism is one of the most replicated and most discussed predictors of climate scepticism in the literature. People’s beliefs and attitudes about climate science have become a shorthand way of signalling political loyalty. This raises the possibility that people do not always make up their minds about climate science themselves, but rather take their cues from elites within the political party with which they identify. (Hornsey & Lewandowsky 2022).

Furthermore, Hornsey and Lewandowsky (2022) see climate scepticism as an organised disinformation. They have noted evidence that disinformation about climate change is disseminated in a coordinated manner through well-funded, often global networks. They also mention the lack of research on organised climate denial in Europe, which could be beneficial. In most European countries, all mainstream political parties subscribe to the scientific consensus on climate change and, at least until recently, rejection of climate science represented a fringe opinion. This is particularly true in Germany, Europe’s biggest economy, which is considered a leader in the energy transition from fossil fuels to renewables. One consequence of the broad acceptance of climate science across the European mainstream is that explicit denial groups are more marginalised. This marginalisation has softened somewhat since the recent electoral successes of far-right parties across Europe, which has created space for the public expression of climate scepticism.

According to Hornsey and Lewandowsky (2022), the driver of scepticism comes on two levels: collective and individual. Collective-level drivers are represented by industrial vested interests, misinformation campaigns, political partisanship and culture war rhetoric, political populism, climate-sceptical media and fossil fuel reliance. Individual-level drivers are represented by personal vested interests, personal and social identities, free market ideology and political followership. Collective level processes reinforce and coach individual actors to view climate change through the lens of vested interests, identity, ideology and political loyalty. Individual-level processes enable and reward the efforts of collective interests to scramble the science on climate change.

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Hornsey and Lewandowsky (2022) collected and demonstrated the major sceptical beliefs about climate science, where climate change is perceived not to be happening, not being caused by humans, not being harmful and climate solutions are not seen as effective. They suggested six strategies for reducing the damaging effects of climate scepticism, which can act as helpful interventions in forming scientific understanding based on the facts. In addition, they noted that any intervention must target two levels: individual factors that render people susceptible to rejecting climate science and organised dissemination of misinformation and contrarian lobbying efforts.

Appealing to sceptics through value-based frames
In many nations, climate scepticism is particularly strong among conservatives. For this group of the population, the climate change message will be more effective if they are framed in the ways which are aligned with conservative values. Examples may be using such rhetoric as reinforcing energy security as a way of maintaining a way of life or as an expression of individual responsibility.

Appealing to sceptics through co-benefits
Sceptics may not be influenced by traditional messages that focus on the importance of action to save the environment. However, they may be influenced by the argument that focuses on co-benefits of action in terms of promoting green jobs, stimulating technological innovation or maintaining public health.

Leveraging climate-friendly actors within the conservative movement
Conservatives are more likely to be persuaded about the reality and urgency of climate change if those messages are presented by respective figures in the conservative movement.

Establishing norms
Norm-based interventions can have positive effects independent of political persuasion, because they appeal to our social nature. People are more likely to act in a certain way which is perceived as valuable by other people.

Consensus messaging
Successfully communicating consensus messages such as: ”97% of climate scientists agree that climate change is happening and is largely caused by humans” has positive downstream influences on climate-friendly attitudes, beliefs and behaviour.

Embedding climate-friendly actions in social practice
Positive action is more likely if these actions are embedded in a network of social practices so that it becomes part of the flow of one's day and part of one's social life.

Simultaneously, Mendy et al. (2024) in the work entitled: ”Counteracting climate denial: A systematic review” claim that understanding the form of denial is central for counteraction. It is fundamental to understand peoples' positions and roots of their attitude in order to be able to change it. This group of researchers has conducted a literature review of 65 articles, where they underpinned the counteractive responses to climate denial.

Understanding the form of denial is central for counteraction
The decision to intervene to change an attitude should be based upon understanding how strongly one holds those attitudes, and whether it is directed towards climate science, the knowledge-making process or the responses to climate change. The debunking is less effective in dislodging misinformation and may lead to backfire if conflicting with worldviews.

Message frames can appeal to targeted audiences
Message framing not only increases audience receptivity to information, but it can also affect behaviour change and support for mitigation. Where behaviour change is the aspired outcome, it can be effective to disassociate climate from behaviours to avoid politically contentious issues; communicators can rather assert benefits of behaviour change, for example, for household economy and health. For those sceptical about behaviour change, it may be beneficial to acknowledge a low impact of individual behaviour on the climate while asserting other advantages. Four key message frames are proposed to foster climate mitigation: emphasising systems-sanctioned change for those with systems-justification ideologies; relating actions to political and cultural affiliations and identities;

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removing misperceptions of social norms to demonstrate that action is socially sanctioned; and enabling self-affirmation by allowing people to be open with their beliefs and curating deeper conversation space.
Framing messages to be empathic, informative and persuasive can also reduce denial. Nature videos with a mixture of both positive and negative tones were more effective in increasing environmental concern, rather than one tone alone or neither tone. Where denial is the emotional protection in face of alarming scientific information, emotionally empowering communication can reduce denialism and increase behaviour change.

Inoculation reduces the uptake of misinformation
Misinformation can confuse the public and increase climate denial. Inoculation can counteract these causes. The strategies vary in the literature to focus on specific content or logic in misinformation. Inoculation is typically studied immediately prior to exposure; however, some limited longitudinal effects have been found. One review of inoculation explains the method of exposing individuals to a mild form of misinformation to equip people with mental defences without becoming victim to the misinformation within the inoculation. Active and passive methods exist, respectively where rebuttals are made by participants or provided for them.

Education and science communication remain central
Increasing climate literacy or social media literacy have been proposed. Improved communication methods for the IPCC are asserted based on the premise that low scientific understanding risks denial in the public. Accordingly, accommodating to the skillsets of audiences through reducing complexity, considering enquiry skills, using relatable models and experiential learning techniques is all suggested. Specific pedagogical techniques are mentioned including agnotology, humbling experiences and the use of extra-curricular projects and social justice perspectives in climate courses. Including images and certainty ranges could also improve science messages, and more clearly communicating scientific methods. Increasing critical thinking skills and cognitive consistency is suggested, as well as improving educators' understandings of climate science.

Meeting conflicting worldviews and deliberation may shift belief
The review revealed that few studies explore deliberation or intergroup relations. As it was found, the denialism is associated with intergroup conflicts and asserts the value of improving intergroup relations. It was found that denialists could temporarily migrate their beliefs across different discourses of denialism through participating in deliberative forums.

Methods to expose motivated agendas are understudied
Together with methods used to help to change beliefs, legal efforts should also be directed towards the economic and political structures of misinformation. Online, climate misinformation can be targeted through detecting malicious accounts or through punitive measures. It could also be strategic for scientists to reveal the funding of different false experts and the economic interests in sowing doubt, not least as it provides to the public a reason for believing that some information might be considered false.
In addition to the providing list of the responses to climate denial, they also introduced the summary of intentions of counter-interacting the climate denial (Mendy at al. 2024):

Targeting epistemic beliefs
Most counteraction efforts can be considered to aim for affecting the public understanding of climate science, though deliberative methods and the strategies that expose agendas appear least likely to consider influencing epistemic beliefs. By contrast, inoculating the public against misinformation, and education and scientific communication, overwhelmingly focus on these outcomes.

Science advocacy
There are strong assertions within the reviewed articles about the important role of the scientist and of science in society. As such, a few strategies aim to advocate for climate science. Science advocacy stands out as a complex and divisive issue though, and there are differing assertions about the separation of science and policy in the public eye.

Changing response attitudes
Based upon theorisations that values underpinning policy and behaviour preferences could be swayed, message framing largely focuses on influencing response attitudes. Inoculation and exposing agendas are least likely to

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consider these outputs. It can be assumed, though, that reducing the capacities of vested interests, or neutralising their spread of disinformation by inoculation, could produce long-term outcomes related to response attitudes and successful climate mitigation.

Counteracting motivated denial
The next intention is the aspiration to counteract vested-interest groups and their work. Such intentions can be realised through reducing the risk of misperceptions through inoculation. Some studies argue for revealing funding, networks and techniques of denial organisations. Education and scientific communication and message framing were least likely to aim to counteract motivated denial.

As a summary, Mendy et al. (2024) noticed that different strategies had different intentions, except for a strong general commitment to foster the public understanding of climate science. The reviewed studies also focus on the reputation of climate change science, albeit message framing strategies appear more interested in influencing response attitudes, for example, support for mitigation policies. For inoculation strategies, counteracting vested interests was the second most common preferred outcome.

The review by Mendy et al. (2024) adds a systematic and comprehensive description and analysis of the research focusing on counteractive interventions to climate denial. It further accounts for the empirical evidence of the effectiveness of various interventions and documents the intentions of counteractions. The many divergent findings identified within the literature indicate significant research gaps. Also, they commented on the review done by Hornsey and Lewandowsky (2022) described above in the current paragraph with the comment that: ”*they provide important contributions and recommendations, but as shown here, results and conclusions still point in different directions on some key issues. Some of this may be attributed to the different drivers of climate denial and the different purposes for intervention.”*

As a conclusion, Mendy et al. (2024) review shows that no advice can be given on how to universally counteract climate denial. For those interested in doing so, there are three guiding questions given: first, is it epistemic or response denial that is to be engaged with? Different strategies are suitable for specific forms of denial, and for specific drivers. Second, what are the preferred outcomes of a counteraction intervention; is it changing minds, behaviour or policies? If the intention is to increase support for behaviour change or political action (response denial), then message framing strategies might be more helpful than inoculation against misinformation. The review accounts for the different ways in which strategies have been developed to affect a number of different outcomes. Third, what is one’s own role – for example, a scientist, expert or politician – and how might it be perceived and the intervention be interpreted? In some cases, using other trusted sources to communicate the message may be necessary.

Social media has grown to play an increasingly important role in the communication of science to the public. At the same time, climate change disinformation, as in the spreading of falsehoods has grown expansively over the years. It was noted by Nicolosi et al. (2025) in their work entitled: ”The new denial: climate solution misinformation on social media” that the trend of ”New Denial” regarding climate change misinformation on social media has grown over the past five years.

The researchers had noted some of the general trends of climate solution misconceptions existing in social media, which they highlighted for analytical work and understanding the public of social media users. The trends were described as repetitive search terms which appeared to be most common and the interpretation behind each of the search terms noted.

Climate control
Here the dominant theme is centred on the anxieties surrounding control and power. Conspiratorial narratives often framed climate initiatives as an ”agenda”, a pretext for totalitarian governance and personal restriction, ranging from broad societal concerns to specific policy anxieties. The discourse is often intertwined with other concerns, notably the COVID-19 pandemic, reinforcing perceptions of a broader plan to manipulate public fear and curtail individual liberties. Climate activists, particularly high-profile figures frequently faced the accusations of hypocrisy for behaviours perceived as incompatible with their advocacy such as frequent air travel.

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Green fossil fuels
In this search term, the most prevailed theme is centred on the perceived hypocrisy of green energy, with arguments asserting that its production and implementation rely heavily on fossil fuels, mining, harmful chemicals and environmentally damaging practices. Economic scepticism emphasised a perception of a high cost and potential infeasibility of green energy with concerns about raising gas prices and overall economic viability. Some individuals expressed anxieties about national security, fearing increased foreign dependency for fuels and potential negative impacts on global power dynamics. Allegations regarding the reliability, scalability, and safety of green energy technologies, raised alarms around susceptibility to natural disasters and resource limitations. Fears of inflation, energy shortages, and compromised national security abounded, often framed within a narrative of government overreach and corruption

Climate cult
The most prominent theme in this search term was climate denial or the false claim that climate science is unscientific, incorrect or a hoax. Users presented manipulated or outright false data to support this claim. A prominent theme focused on the conspiratorial belief that climate change science and solutions are like COVID-19 measures, in that both are part of a broader scheme to control people's lives. Framed in a negative light, climate solutions were frequently linked with other progressive advocacy issues, including reproductive rights, free college tuition, addressing systemic racism, education reform, combating homophobia and transphobia, gender equality, immigration reform, affirmative action, and stricter federal regulations. Warnings were prevalent that pursuing climate solutions would result in a disastrous outcome, encompassing various consequences such as increased debt, heightened energy dependence, the potential for World War III, insufficient heating during winter months, and widespread poverty.

Green Scam
Here green energy is seen as a scam. The prevalent assertion that climate change solutions are not genuinely about protecting the environment but rather a deceptive and corrupt scheme driven by financial motives sometimes specified to enrich specific individuals or entities, often singling out Democrats, wealthy elites or green energy companies. People who support climate solutions faced widespread criticism, ranging from scepticism to mockery, labelled as "woke" or "brainwashed", further undermining their credibility. Some went as far as to project that climate solutions would result in disasters, especially negative economic impacts like increased wealth disparity. Many promoted the misinformation that fossil fuels are indispensable, claiming green energy solutions are ineffective or non-existent.

Green lies
This category describes the misinformation that climate change science and solutions (using the term "green") were lies or false information. Some social media posts referenced climate solutions causing environmental damage, social impacts and some further criticised proponents of climate solutions for example as communist ploys.

Climategate
The term "Climategate" usually refers to a controversy that emerged in 2009 when an unknown actor leaked emails from the University of East Anglia's Climatic Research Unit. Climate sceptics falsely claimed these emails revealed scientific misconduct and a conspiracy to fabricate evidence of human caused global warming. A common thread of misinformation falsely asserted that climate science is not legitimate and is being debunked by "real science". This narrative often accused the IPCC or climate scientists of deliberately manipulating or cherry-picking data to support a predetermined agenda. It painted climate change reporting as a trick, scandal, hoax or a conspiracy, with some suggesting that media outlets orchestrated it to deceive the public. To this end, many users criticised climate scientists to discredit their claims, accused of being "extremists", "alarmists", "liars", and "dogmatic". Misinformation in this category also frequently painted green technology as toxic, dangerous, and prone to failure.

Climate alarmists
The label "climate alarmists" suggests that climate change is not an urgent problem, and those claiming it is so wrong, wilfully ignorant, extreme, unreasonable, or have ulterior motives. Generally, many promoted climate change denial here, including a denial of climate impacts, with an underlying suggestion of a wilful and purposeful

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campaign of misinformation on the part of climate scientists. Several users accused ”climate alarmists” of having other motivations or purposes than environmental protection, and of being hypocritical in not responding to other disasters.

Solar Scam
Here, solar power is viewed as a scam. Many tweets falsely portrayed solar energy as extremely toxic and dangerous, claiming that it causes pollution, requires extensive mining, and ultimately leads to environmental destruction that far outweighs its benefits. A significant number of arguments centred on the economic aspects of solar energy, alleging that it is a scheme for profiteering, exorbitantly expensive, or unfairly subsidised by taxpayers.

Solar pollution
This category centred around claims that solar power causes an unreasonable amount of pollution compared with the benefits that it creates. This misinformation often claimed that solar and other renewable energy lead to increased waste and pollution due to mining and environmental destruction. This narrative falsely asserted that these renewable energy sources are detrimental to the environment, despite their potential to reduce reliance on fossil fuels and decrease greenhouse gas emissions. These claims also often exaggerated the resource intensity and environmental impact of solar energy.

In addition, they suggested a few ideas for countering above-mentioned forms of climate solution misinformation based on the scientists' findings, such as connecting with conservative audiences, motivation of climate solution supporters, proof of climate solutions working, shifting towards climate solutions messaging, refining who is delivering the messages and what their content is.

Connecting the conservative audiences
Researchers suggest showcasing down-to-earth stories of individuals and communities that support and benefit from climate solutions. Emphasising how climate solutions support energy independence and local job support can help the narrative of national energy independence and economics. With a highlight of conservative ideologies with the mission of building the conservative environmental movement could help to demonstrate how climate solutions are aligned with conservative values.

Motivations of climate solutions supporters
To help clear the motivations for promotion of climate solutions, there has been suggested few tactics. Comparing profits and subsidies of climate solutions to those of the fossil due industry for targeting misinformation about unfair tax benefits for renewable adopters. In order to counter misinformation about the motives of climate solution supporters and the efficacy of solutions, researchers suggest humanising the issues and showcasing the real-world impact. By sharing stories of various groups and their actions, the climate solutions become more ”human”. For example, climate scientists dedicating their life to research and facing of the everyday challenges they face in understanding and addressing the climate change. Business owners in the climate solutions sector could show their passion for innovation and the positive economic impact their companies are creating. Everyday people who use renewable energy, showing how these solutions improve their lives through lower bills. SMEs benefiting from climate solutions demonstrating how these businesses are thriving by adopting sustainable practices, creating jobs and contributing to the local economies.

Climate solutions work
To combat the doubts about effectiveness of climate solutions, researchers suggest providing accessible and transparent information. For instance, comparing the pollution generated during production and operation to the scientific reduction in carbon emissions achieved could help to demonstrate the net positive impact of climate solutions. Clear explanations with illustrations describing everyday life could counter misinformation. To address concerns about the effectiveness and reliability of climate solutions, provide concrete examples of successful projects and innovative technologies, specifically highlighting growing reliability and affordability of those solutions. Another suggestion proposes direct addressing and refuting common false claims with evidence-based information.

Shift towards climate solution messaging

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To recognise the evolving landscape, the researchers recommend prioritising efforts to counter misinformation on climate solutions rather than engaging in debates about the existence of climate change. This shift promises to be more impactful in achieving the goal of addressing climate change.

The one who delivers the messages
Due to clear results of socio-economic background of the responders, the ones who are not agreeing with climate change recognition, are particularly right-wing conservatives who targeted scientists, ”elite” and democrats.

Message content
It was recommended by authors to create quick and short impactful facts content, which could be easily understood and reposted in social media. Using impactful photos, cartoons, memes, short videos could prove to be popular content for the public. The content of most popular messaging noted is simple, direct, impactful and occasionally contains humour.

How to address the spread of climate solution misinformation on social media
A grassroots approach involving developing counter-narratives with messaging that appeals to misinformation audiences is a direct way to counter climate solution misinformation that does not rely on the decision-making of inaccessible actors.

As a conclusion, the world’s leading authority on climate change, the Intergovernmental Panel on Climate Change (IPCC) is urging that the next few years are crucial to limit warming. To accomplish this, there is an overwhelming need currently to push forward climate solutions and remove any barriers that stand in their way. It was suggested by authors on this paper to everyday social media users, policymakers and advocates to use the methods and insights provided in this paper to provide a direct intervention in the countering of the climate sciences misinformation and promotion of the benefits of climate solution information.

The CLIMAware survey results showed that climate denialism was a rare occurrence in the respondents' answers, furthermore, very few stated that climate change is not happening. Political elites appear throughout the corpus as the most frequently named vector of denial claims. Beyond the ten responses citing political leaders without a specific claim, statements attributed to the current US administration recur across the Portuguese, Greek, Finnish, Spanish and Ukrainian material as the archetype of encountered denial, with Portuguese respondents in particular repeatedly citing presidential statements that ”global warming is nonsense”. The pattern indicates that, in these samples, high-salience denial is experienced primarily as an elite import with a named foreign face rather than as an anonymous social-media phenomenon.

There were also country-based different shapes of denial:

- The Finnish material is dominated not by denial but by the futility narrative, where the size of Finland and its contribution to the global picture is seen very small on the global scale and Finland has been already doing enough of the effort in the green transition.
- The Spanish corpus is saturated with classic science denial, frequently attributed to right-wing media and politicians, and it also contains the corpus's only fringe conspiracies, especially connected to the actions of the US.
- The Portuguese corpus leads on outright denial which is overwhelmingly foreign-sourced and Trump-attributed and is the only national corpus with concrete AI-fabrication anecdotes.
- The Greek corpus is small but distinctive in that its contrarian current runs through respondents' own voices rather than reported claims.
- The Ukrainian corpus is marked above all by low salience, since the priorities are focused on the current warfare situation and climate science is not seen as a priority theme at the moment.

It was noted in the survey results that respondents who rely only on social media for their climate information hold noticeably more misconceptions than people who also or only use traditional media. AI is already part of the picture. More than half of respondents have come across AI-generated climate content, most often fake images of extreme weather, and a quarter have asked an AI chatbot about climate change. Those users generally trusted the answers,

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but they were no better than anyone else at recognising AI-generated content. Guidance for the public on using AI tools has not kept up with how quickly people have adopted them.

Respondents were asked how often they check the original source before believing climate information on social media, and 40% responded always or often, 27% responded sometimes, 27% responded rarely or never and 5.0% do not use social media. In general, the figures of the report show that social media influences are the least trusted category as a source of climate information (where the climate scientists showed the highest score).

Mis- and disinformation

Mis- and disinformation is perhaps the largest single challenge area to improving the quality of media literacy regarding climate change. The amount of scientific literature on this sub-topic has been added to significantly in recent years and there was a large and broad body of publications from which to choose in selecting those for this review. In order to avoid repetition, unless specifically stated here or where a distinction is pointed out, when misinformation is referred to, disinformation can also be understood to be involved.

The first article, Treen et al. (2020), looks specifically at online misinformation issues dealing with climate change, and is also quoted from here to define the central terminology, as it does so particularly clearly.
The second article under the mis- and disinformation topic, Cook et al. (2017) investigates the effectiveness of using so-called inoculation methods to counteract the potential harm of misinformation. The third article, Maertens et al. (2020) also looks at inoculation and balances its benefits against the harmful effects of deliberate misinformation messages.

The fourth article, Campton et al. (2021), like the previous two, also deals with mis- and disinformation from the inoculation theory aspect. In this case the terms prophylactic inoculation and therapeutic inoculation are defined and used to describe how we can have an impact either before people risk getting misinformed or to better inform them and correct the damage done afterwards, respectively.

The fifth and final article dealing with mis- and disinformation concentrated on here, Ejaz et al. (2025), reports on a study of a range of countries with different socio-economic profiles, with the purpose of ascertaining what factors, or determinants, contribute to belief in misinformation.

This first article to be dealt with under the heading mis- and disinformation is by Treen et al. (2020) and entitled ”Online misinformation about climate change”, thereby specifically emphasising that on-line sources are the focus.
Starting with a literature review Treen at al. points out that although there was a good range of literature available on the individual topics, climate change, misinformation and online /social media, it was very limited what was to be found in terms of articles where these three areas all overlapped. This they overcame by searching using two of these topics at a time and then assessing the suitability of the results. It should also be taken into account that this article was published in 2020 and since then there has been more literature involving combinations of these search terms published, some of which can be found elsewhere in this document. After describing the background, mentioning earlier harmful disinformation in other fields before proceeding on to that of climate change, the aim of the article is then simply stated through a breakdown into five questions about misinformation as follows: What is it? Who is involved? How is it spread? Why does it matter? and What strategies exist to counteract it?

This article sets out at an early stage to define and distinguish between the concepts of misinformation and disinformation. This is done well with the aid of Figure 2. below, where it is first shown in colour code everything that constitutes information, of which misinformation is then shown to be a subset, with disinformation being a subset of this again. Illustrated in this way the point is stressed that all disinformation is a form of misinformation, but the reverse does not apply: all misinformation is not disinformation, the central distinction being that disinformation is intended to deceive the audience or recipient, while for misinformation this is not always the case.

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Figure 2. Hierarchy of information, misinformation and disinformation (Treen et al. 2020)

Treen et al. then proceed with the second question mentioned above, namely that of who is involved in spreading misinformation about climate change. In starting to answer this a categorisation devised by Bjornberg et al. (2017) is referred to: (a) scientists, (b) governments, (c) political and religious organisations (d) industry (often oil & coal, but also others), (e) media, especially those of right wing leaning, (f) the public, especially politically conservative white males. It also points out that funding to produce climate change misinformation is provided by an identifiable group of sources, namely those with corporate vested interests, such as from the above-mentioned industrial sectors. The initial message then gets passed on through what is called an ”influencers echo chamber”, getting both repeated and amplified. These influencers are different people in the media, including newer forms such as bloggers (which presumably would include vloggers and podcasters), but also by politicians and other people in positions of power. It is the social media aspect that then gets special attention in the article because of how rapidly information spreads in it compared to traditional types of media.

The next question looked at in the article is how misinformation about climate change spreads. Here one theoretical model that is described is the epidemic (contagion) model. This included the idea that the information can be (more easily) spread to those who are more susceptible to being reached by it. In the analogy with an infectious disease, they would be a person weaker for some reason and so more likely to catch it, with the weakness now being based on human behaviour. Online social networks are very much based on understanding the tendency for all humans to feel the need to be linked to others with whom they share common characteristics. This phenomenon is called *homophily*. Profiles of people allow them to be matched; this occurs in practice by liking or friending others or their comments on social media platforms. Also, it is easy for users to leave groups they might be in if they find that others do not share their views. Bhagwat et al. (2026) climate change is a kind of belief system, where certain people who use social media are brought together by their ideologies that involve social norms about climate change. These people are then likely to be more susceptible than others to being involved in spreading, consuming and also accepting misinformation on the topic of climate change.

Then the question of why misinformation matters was investigated in Treen at al. (2020) An analogy is made with early tobacco industry is pointed out, as discussed by Oreskes and Conway (2011), where there was a strategy of seeding feelings of doubt and scepticism about links between tobacco, smoking and cancer. Similarly with climate change this phenomenon is evident.

Next, as a sort of solution seeking question, it was asked what can be done about misinformation related to climate change. Fernandez and Alani (2018) discuss ”socio-technological solutions” for this purpose in their review of literation in solutions to misinformation, outlining four strategies to help stop misinformation from spreading online. They are as follows: inoculating against misinformation; responding to misinformation with facts and correct information; the early detection of malicious accounts; and finally, the use of ranking and selection and removal mechanisms. Fernandez and Alani (2018) add that this last one would require online and social media platforms, like Google and Facebook to actively prevent or reduce content that their users point out to be misinformation. The challenging approach of using algorithms to combat misinformation is pointed out by Leetaru (2018), as it might not be effective and could also prevent the free circulation of material, going so far as to actually alter the existing algorithms that give people their worldviews is also mentioned in this regard. Then a further, nontechnical

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solution to online misinformation mentioned is that of introducing regulation to control. A number of governments both in Europe and elsewhere have introduced some kind of regulatory responses to misinformation. In this regard the difficult questions of freedom of speech and democratic rights are brought up. Yet another solution proposed to answer the question of what can be done about misinformation is covered by Zucker (2019) through using the ”PARCS” technique, an acronym from the words Purpose, Author, Relevance, Currency, and Sources of information (PARCS), whereby each of these aspects is critically considered to assess the reliability or authenticity of the information. Another interesting concept referred to and proposed here by Bedford (2010) is to use *agnotology* as a teaching tool, this word means the direct study of intentionally culturally induced ignorance or doubt, which is what misinformation is, as a teaching tool about climate change. There followed a discussion containing concerns about the potential dangers involved, but it was defended later by the same author by arguing that since the scientific community have reached near unanimous agreement on anthropogenic climate change, that such risks of the use of agnotology would now be minimal.

The article finished with a discussion on future directions and then comes to some useful conclusions. It is recognised that malicious accounts on social media also contribute to the spread of misinformation, with bots, spammers and astroturfers being mentioned in this regard. Bots are automated user accounts and can be used to manipulate algorithms (Lazer et al. 2018). Spammers are people who insert deceptive profiles into the social network in an effort to prey on innocent community users and to pollute these communities (Webb et al. 2008). While astroturfers, according to Lee et al. (2013) form artificial grassroots campaigns and manipulate search engines, they consist of large groups of online platform users, who could be paid, to spread links to possible malicious content. It was found that much of the research into climate change misinformation focuses on the network of those actors who finance, produce and further amplify misinformation from what is called by Treen et al. A sceptic/denialist/contrarian viewpoint. While they found that there was also research into ways to counteract this misinformation. The article concludes with a call for further research into climate change misinformation on social media.

The study ”Neutralising misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence” by Cook et al. (2017) is about the implementation of inoculation messages. The study emphasises that inoculation, or prebunking, is an effective strategy for reducing the impact of climate misinformation before people encounter it. In this context inoculation means that rather than trying to correct false claims after exposure, warning people in advance about common misleading techniques and explaining why those techniques are deceptive can significantly reduce the influence of misinformation.

The theoretical framework of the study is grounded in inoculation theory originally presented by McGuire in 1961 (Compton 2012), which proposes that people’s resistance to persuasion can be strengthened by 1) warning individuals of an upcoming misinformation threat and 2) disproving the misleading argument before exposure.

The article by Cook at al. (2017) is based on two experiments, whereby the first one tested the effects of the type of inoculation against one particular type of misinformation, namely that involving ”false balance” media coverage. This is where reliable scientific news is presented at the same time as views from ”contrarian scientists”, as if to imply that the information provided by both was equally valid. The inoculation part then involved explaining how the concept of false balance should be noted and the participants should be wary of it. After being carried out on a group of over a thousand US participants the main result was that firstly false balance-type misinformation did decrease the acceptance of anthropogenic global warming (AGW), but then that the inoculation against this type of misinformation served to neutralise the negative effects. What remained an open question was what the relative influence was of also providing positive consensus information together with the inoculation process; this may also have contributed to the neutralising effect. Another issue considered in the discussion on the meaning of the results, as was also found by Cook & Lewandowski (2016) was that it seems that in general consensus information moderates the influence of ideology, so it is pointed out that further research would be needed to ”try to pinpoint boundary conditions under which consensus information may polarize”.

The second experiment had similarities to the first, but concentrated on a different type of misinformation (in fact, by definition it is disinformation), namely that type which specification sets out to instil doubt about the scientific consensus on climate change. One way of doing this is through the use of people who are not really experts in the

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climate field to cast double, they are so-called ”fake experts”. This time the experiment was carried out on 400 participants, also in the US. The main result was that the fake expert treatment led to polarisation of attitudes to the causes for climate change, but then inoculating against it by explaining the workings of the fake expert disinformation technique in particular served to fully neutralise the polarising effect of the earlier doubt-casting message. One interpretation of why this worked so well was that participants (especially those who were ”free-market supporters”) felt strongly about their right to be correctly informed and therefore strongly resist being misled.

Comparing experiments 1 and 2, the difference was that they used different types of misinformation, but nevertheless, the results were the same in both finding that inoculation neutralised the negative influence of misinformation on perceived consensus. Just that experiment 2 went further to demonstrate that inoculation also neutralises the polarising effect of misinformation about the acceptance of AGW, that of perceived consensus and of policy support. They both showed that the consensus information partially moderated the biasing influence of political ideology, consistent with other studies, such as that by van der Linden et al. (2015).

Cook et al. (2017) consider inoculation theory particularly suitable for climate communication because climate misinformation often relies on recurrent rhetorical techniques. It is, however, stressed in this article that there are dangers involved when we challenge people's ”worldviews”, meaning their fundamental beliefs in how society should operate. This can lead to potential backfiring of providing the corrective evidence as part of inoculation, which could even have the opposite effect of strengthening their existing beliefs. This was noticed in the case of AGW in an earlier article by the same first author in Cook et al. (2016), where people with strong support for free unregulated markets became less accepting of climate change after attempted inoculation. The efficacy of consensus information fits well with other research (van der Lieden et al. 2015), that found that perceived scientific consensus is a gateway belief (a concept covered extensively elsewhere in this literature review) which can predict a variety of climate attitudes, including policy support.

The central finding by Cook et al. (2017) is that inoculation messages successfully neutralise the negative effects of climate misinformation, particularly misinformation designed to undermine perceptions of the scientific consensus on anthropogenic global warming. In terms of the time dimension this article looks at the immediate effects of inoculation.

The inoculation method of dealing with misinformation is also the focus of the next article to be reviewed, but while Cook et al. (2017) bases its investigations on participants being supplied with logic-based inoculation (such as fake experts) the following article concentrates of participants getting fact-based inoculation (e.g. a petition misrepresenting scientific agreement). There are also differences in terms of the research goals, the former asked mainly if inoculation can neutralise misinformation, while the latter asks mainly if inoculation lasts over time; both answering these questions in the affirmative.

The article ”Combatting climate change misinformation: Evidence for longevity of inoculation and consensus messaging effects” by Maertens et al. (2020) has a lot in common with the previous one, it was written three years later and takes a different approach and has some more refined conclusions. An additional difference not pointed out above, is that this time there is a delay in the time dimension; with a pretest, an immediate post-test and a third test one week later. Initially a number of studies are quoted showing the strong positive relationship between expertise in climate scientists and consensus that climate change is human caused, but the introduction is nicely concluded by pointing out that most people are not climate science experts and need to make their own conclusions often amid *a cloud of (mis)information*.

This article was based on a several-layered study carried out to determine how so-called doubt sowing about climate change from misinformation could be countered in advance by effective inoculation. Inoculation in this context is also referred to as prebunking here, the same concept used earlier by Cook et al. (2017) and quoted above for a process that happens in advance, as opposed to debunking, which would be normally carried out after misinformation has been spread. In a carefully controlled scientific experiment various interventions are applied over specified time periods and their relative effects determined. A starting point is from the concept of Perceived Scientific Consensus (PSC). It is first tested among the target group using a clear question: ”To the best of your

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knowledge, what percentage of climate scientists have concluded that human caused climate change is happening?" On the basis of the answers given the political persuasion of the individuals was determined on a Likert scale ranging from very liberal to very conservative.
The consensus message used was a simple statement: "97% of climate scientists have concluded that human-caused climate change is happening".

The misinformation statement was: "31,487 American scientists have signed a petition stating that human caused climate change is not happening". This is a real petition (Oregon Global Warning Petition) that has since been debunked.

There were two parts to the inoculation statement used, the first one being more general: "Some politically motivated groups use misleading tactics to try to convince the public that there is a lot of disagreement among scientists" and then specifically referring to the petition above it was explained that the petition is debunked, containing bogus signatories and still 31,487 is not really a large number, as it would be only 0.35 of US science graduates.

The explanations of the interventions (see Figure 3 summary). Using these three messages, although rather complicated due to the heterogenicity of those tested, the experiment was summarised as follows -where four different groups of people were given combinations of the three messages (or none at all in the case of the control group) and the resulting beliefs tested after a designated period.

		INTERVENTION		
		T2		T3
		Consensus Message	Inoculation	Misinformation
CONDITION	Control Group	x	x	x
	Consensus Group	✓	x	x
	Balanced Group	✓	x	✓
	Inoculation Group	✓	✓	✓

Figure 3. A table summarising the different interventions in the experiment carried out (Maertens et al. 2020)

In keeping with good science, testing of the results was performed on the basis of four hypotheses, as follows: Hypothesis (H) 1. This was the baseline hypothesis and was stated: In all intervention groups, consensus messaging has an initial positive effect on perceived scientific consensus.

Then to find how well the effect of the consensus messaging would survive over a relatively short time span the second hypothesis reads: H2. The consensus message will retain its positive effect after one week.
The next step was to test if after this one week a misinformation message is given whether it has a significant negative effect. H3. Misinformation presented one week after the consensus messaging treatment reverses the consensus messaging effect back to baseline.

Then finally, and really what can be taken as the overall aim of the experiment: H4. When an inoculation treatment is added to the consensus message, the consensus effect remains significant, even after a misinformation attack one week later. The results were reported and based on a pilot study carried out two years after the initial interventions, broken down according to the previously stated hypotheses.

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In the article ”Inoculation theory in the post-truth era: Extant findings and new frontiers for contested science, misinformation, and conspiracy theories” by Compton et al. (2021) some new and useful terminology is introduced and defined. *Prophylactic inoculation*, which means protecting people before they encounter misinformation. It is also described as conventional pre-emptive inoculation. *Therapeutic inoculation* is then defined as helping people who already hold misinformed beliefs to become more resistant to future misinformation. The concept of a *post-inoculation talk* (PIT) is then introduced, meaning the discussion and sort of rehearsal that occurs after an inoculation message has been applied, it is the intention that it can then help to strengthen, up-keep, and spread resistance to misinformation. Since Compton et al. does not expressly deal with climate change, rather just including it as one issue among others where inoculation theory is relevant, it gives good examples and analogies from these other fields as well. Having been written during the time of the COVID-19 pandemic (misinformation), interesting parallels are pointed out between virology and the virality of the misinformation around it, the title of a referenced article by Depoux et al. (2020) sums this up well: The pandemic of social media panic travels faster than the COVID-19 outbreak.

Inoculation theory as a whole and the medical analogy is taken further in Compton et al. (2021), pointing out that the basis for conventional vaccinations, like the annual influenza (flu) shot, is that weakened versions of the anticipated more virulent strains are used in order to stimulate the body’s immune system to produce antibodies. This weaker version does not make the patient sick, as in the analogy with persuasive inoculation, where weakened versions of the possible future more persuasive misinformation message are given and these then motivate the mind’s defence system. The analogy continues in comparing the need for so-called booster shots to be given later to prevent the effects of the initial treatment from wearing off. PIT in this sense serves the same purpose, that of helping therapeutic inoculation produce longer-lasting effects. The analogy is not perfect, but close enough, keeping in mind that therapeutic inoculation itself can be more compared to treating an existing infection and then preventing reinfection while PIT does not require that the person has even been really ”infected” with more serious misinformation in the first place, but rather PIT strengthens and prolongs resistance by rehearsing and discussing the arguments. It is pointed out that those who have been inoculation against misinformation (by prophylactic inoculation) talk more about the issue and also serve to spread the inoculation message, further taking the analogy to include social spreading and herd immunity to be achieved from the protection of inoculation in the medical sense (van der Linden, 2018).

In the conclusions section Campton et al. (2021) stress how a combination of both pre-emptive (prophylactic) and retroactive (therapeutic) inoculation messaging should be used across a range of scientific areas to protect desirable attitudes and beliefs and change undesirable ones and then further make the new attitudes and beliefs more resilient. They also add in the conclusions that source credibility issues are particularly important when applying inoculation theory to scientific issues, pointing out that more research is needed specifically in the context of contested science, like whether the views of a single scientist or the consensus among many scientists is confers more resistance against attacks on the overall scientific consensus.

Comparing the three papers containing the inoculation theory approach, Campton et al. (2021) discusses both approaches to the inoculation method (logic-based and fact-based) from the two previous articles reviewed and argues that logic-based inoculation may provide participants with broader protection, because it teaches the misinformation technique itself. This article also puts more emphasis on pre-and post-treatments of inoculation against misinformation for maximum and long-lasting impact.

The article ”Trust is key: Determinants of false beliefs about climate change in eight countries” by Ejaz et al. (2025) is the most recent of the several articles on climate change mis- and disinformation reviewed, and so it potentially benefits from all the previously mentioned articles and many others published on the overall topic. It is then in a good position to point out and stress right from the start that to date research on belief in misinformation about climate change has disproportionately focused on WEIRD (Western, Educated, Industrialised, Rich, and Democratic) countries. Therefore, in order to make up for this and redress the balance a survey was carried out that included a total of eight countries, or which three were non-WEIRD: Brazil, India and Pakistan. Additionally, one was non-western – Japan. The other countries were the US, France, German and the UK.

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This article starts by listing the arguments used by contrarians are defined by Coan et al. (2021): (1) global warming does not occur, (2) humans are not the cause, (3) the impacts are not bad, (4) solutions will not work and (5) climate science is unreliable. It is then pointed out that by contradicting mainstream climate science these five claims come under the definition of misinformation. From this it follows that belief in the same five claims can be taken as a belief in climate misinformation. Then in attempting to identify the main media sources of information for the public in general about climate change an earlier article with the same lead author is referenced (Ejaz et al. 2022) where television was found to be the single largest medium source, with other online media being listed as holding positions equal importance, including news websites and social media platforms.

The positive effects of using news to improve political knowledge and climate change attitudes are well known for the US and Western European countries, but less so for other countries, but an article by Porter & Wood (2021) that also included WEIRD countries shows that there is some evidence suggest that exposure to fact checks reduces people's belief in misinformation in general. Still, to increase the overall knowledge about climate news consumption and information about climate change a survey was carried out by Ejaz et al. In 2022 in all eight countries listed above. As well as being different kinds of countries in several ways, there was also diverse histories of scepticism, climate vulnerability and policy existing between them and evident prior to the study.

The central purpose of this article, as stated in the title is to identify determinants of false beliefs about climate change and to this purpose four research questions were formulated, here they are, together with preliminary answers to them found:

1. What socio-demographic variables are associated with false beliefs about climate change? The answer to this research question, after analysing the survey results was that men, younger people, those who identified and right wing, as being in the centre or preferring not to answer were all more likely to agree with climate change-related misinformation. This was the case despite variation between the different countries. Interestingly also, the level of education for the most part was not significantly associated with misperceptions about climate change.
2. What types of media use are associated with false beliefs about climate change? For this research question the findings were that traditional (offline) news media, TV, radio and printed newspapers were associated with lower false beliefs about climate change. However, so too were social media. There was no significant connection found between the use of online news media and false beliefs. Nevertheless, it was found that the effect of offline media was consistent across the countries when testing for trust in media, while that of social media is inconsistent across different countries and not statistically consistent in trust issues.
3. Which information sources are associated with false beliefs about climate change? A noteworthy answer to this research question was that regardless of the type of medium involved (offline, online or social media), those respondents who recalled being exposed to climate change information from scientists or from environmental activists showed lower levels of false belief. On the other hand, and with some differences in the type of media), those who recalled being exposed to climate change information from celebrities or energy companies on offline and online media, or those exposed to international organisations on social media were all more likely to hold false beliefs about climate change.
4. How is trust in different information sources associated with false beliefs about climate change?
It was found that higher trust in scientists, environmental activists, international organisations and the news media was associated with lower false beliefs about climate change. In contrast to this, trust in politicians, celebrities and energy companies was associated with stronger false beliefs about climate change. No statistically significant difference was found in the case of trust in government and charities.

The above information is based on a survey with 8541 online respondents from all eight countries in 2022. It is pointed out that in France, Germany, Japan, the UK and the US internet availability and use is high, and so the fact that it was carried out online is not likely to have much influence on the results. However, in India and Pakistan, and to a certain extent in Brazil an online survey does not easily reach groups of the population besides younger English speakers; these factors need to be taken into account when analysing and interpreting the results.
Figure X below summarises all in one graphical illustration the central results of the survey in the article by Ejaz et al. (2025), with both the main predictors of false beliefs and the main information sources for the different countries being demonstrated. The way to interpret it, without worrying about the exact numbers of the coefficients given, is

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that negative numbers (values below zero) mean fewer false beliefs about climate change, while positive numbers (those above zero) have more false beliefs about climate change for that category.

Comparing and contrasting different countries was another main purpose of this article and the results can be clearly seen from Figure 4., although some clarification is needed or can help with this. Here we will look at a few interesting comparisons pointed out from the findings of Ejaz et al. (2025). In terms of cross-country differences those responding from India had the strongest false beliefs about climate change, yet the Indian coefficient for offline media use is strongly negative because respondents who consumed more traditional news media were considerably less likely to believe climate misinformation, while those who use online media or much more likely to do so (see the last and second last set of lines in fig. 4 respectively).

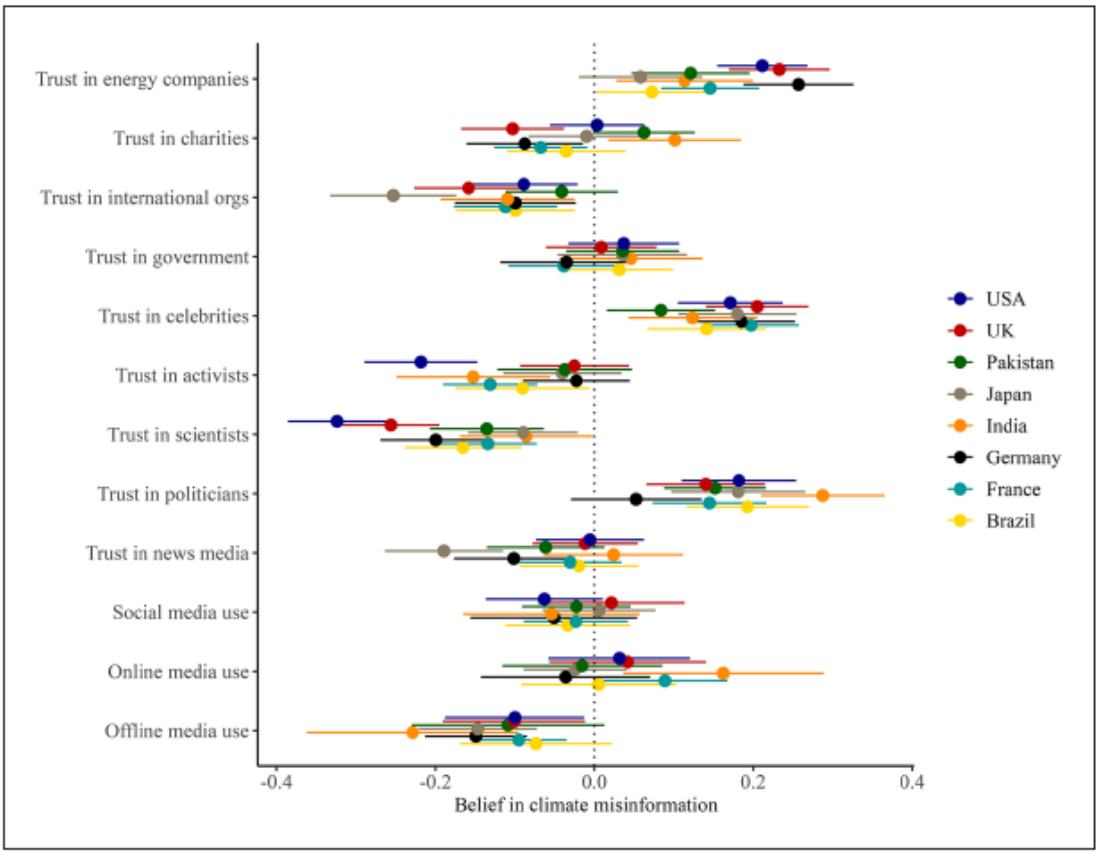


Figure 4. A summary table of results about predictors of false beliefs about climate change and trust in information. Below zero means fewer false beliefs, above zero more false beliefs about climate change. The error bars around the coloured dots for the countries show 95% confidence intervals. (Ejaz et al. 2025)

In France also, online news was strongly associated with false beliefs about climate change. In Japan and Germany trust in news media as a whole was linked to lower false beliefs about climate change. One common thing for all the countries was that trust in scientists led to lower false beliefs, while trust in celebrities was universally associated with more false beliefs.

For all except Germany, trust in politicians was linked to stronger climate misinformation beliefs. In other words, of the eight countries, for Germany alone trusting politicians does not appear to make people more or less susceptible to climate misinformation. The reader can only speculate as it was not studied directly, but German politicians may be perceived as being more aligned with the scientific consensus on climate change, rather than there being a link between political trust and misinformation beliefs in that country.

Another example is that, except for the case of Pakistan (or to a lesser extent for this country), trusting international organisations more was associated with lower levels of false belief about climate change.
Higher trust in energy companies was linked to a higher level of false beliefs about climate change, except (or less evidently so) for the case of Japan.

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As an overall summary discussion and in order to recognise common patterns observed, we return to the first section of the title of the article, namely what the determinants of false beliefs are. The authors found that trust in sources of information about climate change is a better predictor for false beliefs about climate change than both the type of media used to get information and the amount of exposure to different kinds of information in the topic. Another conclusion, in this case one of concern, is that overall offline news is associated with lower levels of false information at the same time as the use of the internet with its digital media (online news), as confirmed by Newman et al. (2023). It was then pointed out that online media sources can be more heterogenous and that there are both positive and negative aspects to it. A paradox is that, for example, while social media can act to help people with low trust in scientists to be exposed to climate denialist news, it can also help those with high trust in scientists to obtain more reliable information about climate issues. Following from this came the recommendation that future research could look into unwinding the causal pathways through which different kinds of trust can affect false beliefs about climate change. Also, it is stressed that interventions aimed at targeting the most vulnerable groups to reduce their belief in misinformation could help a lot, examples of these are those with low trust in scientists and high trust in celebrities.

The article concludes by pointing out that the strongest determinants of false beliefs found across the right countries studied were those of: identifying as right wing (as opposed to left wing), using less offline news, trusting scientists, environmental activists and international organisations less, while having more trust in politicians, celebrities and energy companies as information sources about climate change. In other words, it is the characteristics, attitudes and beliefs of people, not simply what they are exposed to (and through what different media), that tell us most about the effect of all kinds of information, including misinformation on people.

In the survey carried out as part of the CLIMAware project, questions of mis- and disinformation played a central role. The CLIMAware survey findings broadly support the conclusions drawn from the literature reviewed in this section dealing with mis- and disinformation. There is consistency with Treen et al. (2020), Cook et al. (2017), Maertens et al. (2020), Compton et al. (2021) and Ejaz et al. (2025), in the way that the survey found that contemporary climate misinformation is less characterised by outright denial of climate change and more by a distrust of experts and scepticism regarding climate solutions. The survey also confirmed the key role of trust in scientists and scientific consensus, supporting earlier work on the gateway belief and inoculation theory. However, it is worth noting that the survey also revealed that respondents frequently evaluated arguments according to whether they agreed with the conclusion made, rather than the quality of the reasoning itself, which provides particularly strong support for technique-based media literacy and inoculation approaches. Another matter is that the survey highlighted the growing relevance of AI-generated climate misinformation, an area only beginning to receive attention and not really covered in the articles reviewed here, all of which were published before 2026. The survey report points out some differences between countries, such as how the Spanish sample demonstrated the most resistant to contrarian misinformation, while in the Greek context climate misinformation resonates less as science denial, while the findings in this section of the review, notably in the case of Ejaz et al. (2025) also pointed out differences between the right countries covered (all of which were different to the countries of the CLIMAware survey). The comparison is therefore not relevant in the context of individual countries, but the overall idea is confirmed that significant enough variations between different geographical areas exist in terms of media consumption and what (mis)information is received and how people react to it.

Scientific understanding and governance

Scientific understanding plays a central role in climate governance, as effective policymaking and societal responses depend on public trust in scientific evidence and expertise. Although there is overwhelming scientific agreement that climate change is primarily caused by human activities, public perceptions of this consensus often differ from reality. Misconceptions about the level of scientific agreement can undermine acceptance of climate science and weaken support for mitigation policies. Misinformation has emerged as a significant challenge to evidence-based climate governance because it can distort public perceptions of scientific knowledge and create uncertainty about established scientific findings.

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In their article ”The gateway (mis)belief model: How misinformation impacts perceptions of scientific consensus and attitudes towards climate change” Logemann et al. (2025) address this issue through the Gateway (mis)Belief Model (GmBM). The GmBM is a developed version of the Gateway Belief Model (GBM), which was originally developed by van der Linden (2015). The GBM is a model of attitude change which emphasises the positive impact of communicating scientific consensus subsequently leading to higher support for public action. The model proposes that when people learn that there is overwhelming agreement among climate scientists regarding human-caused climate change, their perception of scientific consensus increases. This acts as a ”gateway belief” that subsequently strengthens their belief that climate change is real and human-caused, increases concern about its impacts, and ultimately raises support for climate mitigation policies and public action. On the other hand, the GmBM extends the original model by examining the effect of misinformation (Figure 5.). The GmBM examines the negative pathway on how climate misinformation affects perceptions of scientific consensus and subsequent attitudes towards climate action. Building on the GBM, Logemann et al. (2025) argue that perceived scientific consensus functions as a key mechanism linking scientific knowledge to public attitudes and policy support. The model proposes that misinformation weakens perceptions of scientific agreement, which then cascades into reduced belief in climate change, lower concern about its impacts, and diminished support for climate policies. In other words, while the GBM explains how communicating scientific consensus promotes acceptance of climate science and support for climate action, the GmBM demonstrates how misinformation can reverse this process by undermining perceptions of scientific agreement and, consequently, weakening climate-related beliefs and policy support.

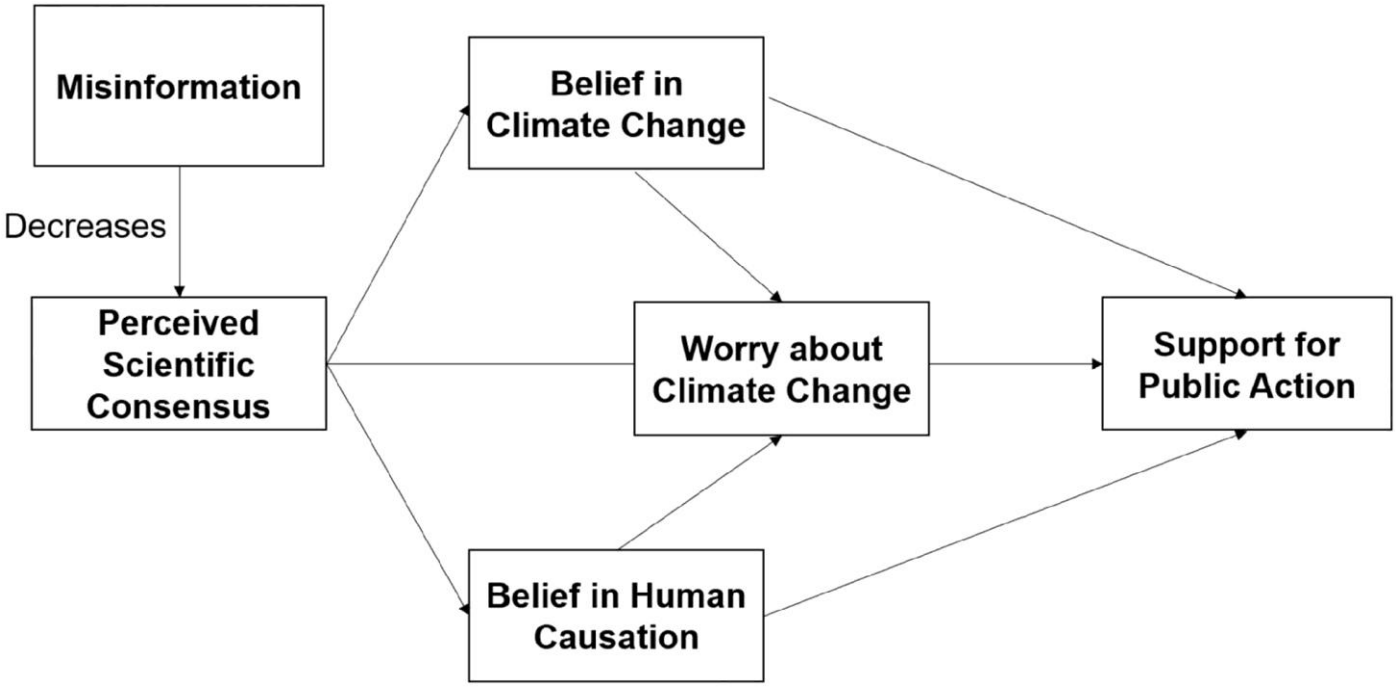


Figure 5. Gateway (mis)Belief model (Logemann et al. 2025).

Logemann et al. (2025) tested the GmBM through re-analysing two earlier experimental studies including new data. The data was gathered in two online studies in the United States (1: N=207 and 2: N=755). The first experiment was designed to examine whether exposure to climate misinformation could influence individuals' perceptions of scientific consensus and, through this mechanism, affect climate-related beliefs and attitudes. Participants were randomly assigned to different information conditions. The experimental manipulation exposed participants either to information highlighting the scientific consensus on climate change or to misinformation suggesting that substantial disagreement exists among scientists.

Participants' perceptions of scientific consensus, climate-related beliefs, concern, and support for climate action were measured before and after exposure to misinformation. The results demonstrated that misinformation significantly reduced participants' estimates of scientific agreement. Importantly, the effects were not limited to consensus perceptions. Lower perceived consensus was subsequently associated with weaker acceptance of climate

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science and reduced concern about climate change. Misinformation influenced attitudes primarily through indirect pathways, supporting the GmBM. Experiment 1 provided evidence that misinformation can disrupt a key cognitive mechanism underlying public understanding of climate science. Rather than directly changing policy preferences, misinformation first creates uncertainty about expert agreement, which then influences related beliefs and attitudes.

The second experiment by Logemann et al. (2025) involved a similar setting as the first experiment, but participants were provided with misinformation as a way to test inoculation strategies. The researchers again exposed participants to climate misinformation and measured the same set of variables relating to climate beliefs, concern, and support for action. This experiment allowed assessing whether the relationships identified in the first experiment could be reproduced under different conditions. The results closely mirrored those obtained in Experiment 1. Participants exposed to misinformation reported lower perceptions of scientific consensus than those in the control conditions. These reduced perceptions were again associated with lower acceptance of climate science and reduced concern about climate change. Experiment 2 supported the hypothesis that perceptions of scientific agreement function as a gateway through which misinformation exerts its broader effects. The second experiment also indicated that concern may play a particularly important role in translating scientific understanding into policy support and behavioural intentions.

Logemann et al. (2025) demonstrate that scientific consensus serves as a crucial governance-related communication tool, shaping public understanding and support for climate action. The study therefore contributes to understanding how scientific approaches can be used to counter climate change misconceptions and strengthen informed public engagement in climate governance. At the same time, the findings suggest that providing accurate scientific information alone may not be sufficient if misinformation simultaneously erodes public perceptions of scientific consensus. Effective communication strategies should therefore focus both on communicating climate science accurately and on strengthening resilience against misleading information. This finding aligns closely with the aim of this literature review, which seeks to identify science-based approaches for addressing climate misconceptions and enhancing climate literacy.

The two experiments presented by Logemann et al. (2025) provide strong empirical support for the Gateway (mis)Belief Model. The studies demonstrate that misinformation influences public understanding indirectly by undermining perceptions of scientific consensus. Once confidence in expert agreement decreases, individuals become less likely to accept climate science, less concerned about climate change, and less supportive of climate-related action. From a governance perspective, these findings highlight the importance of safeguarding the integrity and visibility of scientific consensus within public discourse. Effective climate governance therefore requires not only the production of high-quality scientific knowledge but also communication strategies that help citizens understand the state of scientific evidence and resist misinformation.

Climate misconceptions often originate not from a lack of information but from distorted perceptions of scientific agreement. This suggests that climate communication should focus not only on correcting factual inaccuracies but also on strengthening public understanding of how scientific consensus is formed and why it represents a reliable indicator of scientific knowledge. Effective climate communication therefore requires both education and misinformation resilience. The findings highlight the value of inoculation and prebunking approaches, which help individuals recognise and resist misleading information before misconceptions become established. Consequently, in CLIMAware we could draw on both the GBM and GmBM to develop evidence-based interventions that improve climate literacy while strengthening resistance to common climate change misconceptions.

A limitation of the study is that both experiments were conducted with predominantly liberal and well-educated United States' samples. The findings may not be directly transferable to European contexts where acceptance of climate change is generally higher and political polarisation around climate issues is lower. In addition, the experiments rely on survey-based measures of beliefs, concern, and policy support rather than actual behavioural outcomes. Although attitudes and intentions are important predictors of behaviour, the study does not directly demonstrate whether changes in perceived scientific consensus lead to measurable changes in climate-related actions.

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Overall, the study demonstrates that scientific consensus serves as a critical gateway belief in climate communication, and that misinformation can undermine public understanding by weakening perceptions of expert agreement. These findings by Logemann et al. (2025) highlight the importance of combining consensus communication with evidence-based misinformation resistance strategies to strengthen climate literacy and informed engagement with climate action.

In their recent article Wang and Akin (2026) studied ”Effects of epistemic beliefs, science populism, and social media use on climate change misperceptions”. This article complements the GmBM paper; instead of experimentally testing the effect of a particular misinformation message, it examines people’s ways of deciding what counts as knowledge, their attitudes toward scientific expertise, and their social-media use are associated with climate misconceptions. The paper helps in understanding the cognitive and social conditions under which misconceptions are accepted.

Wang and Akin (2026) distinguish between misinformation and misperception. While misinformation is information that is false or misleading, misperception occurs when an individual accepts such a claim as true, or rejects a proposition supported by scientific evidence. The theoretical framework is based on the idea that climate change misconceptions are not determined solely by access to information but also by the cognitive frameworks individuals use to evaluate knowledge and expertise. Wang and Akin (2026) draw on the concept of epistemic beliefs, which describe how people determine what is true and trustworthy. Three epistemic orientations are presented: faith in intuition for facts, referring to reliance on personal feelings and instincts; need for evidence, reflecting a preference for scientific evidence when evaluating claims; and truth is political, the belief that facts are shaped by political power and interests. Individuals who value evidence are more likely to hold scientifically accurate beliefs, whereas those who view truth as politically constructed may be more susceptible to misconceptions. Wang and Akin (2026) therefore argue that climate change misconceptions are influenced not only by scientific literacy but also by fundamental beliefs about how knowledge is produced and validated.

Furthermore, Wang and Akin (2026) discuss science populism, which portrays ordinary people as more trustworthy than experts and questions the legitimacy of scientific authority. According to this perspective, scientists may be viewed as self-interested elites whose knowledge is less reliable than common sense or personal experience. Wang and Akin (2026) further connect these cognitive orientations to the contemporary social media environment. While social media are often assumed to spread climate misinformation and foster climate misconceptions, previous evidence has been inconsistent. Consequently, the study examines whether mainstream and alternative social media use directly contribute to climate misconceptions or whether they instead shape how epistemic beliefs and science populism influence individuals' perceptions of climate change. This framework positions climate misconceptions as the outcome of interactions between personal belief systems, trust in scientific expertise, and information environments rather than simple exposure to misinformation alone.

The study by Wang and Akin (2026) is based on an online survey of 1,405 adults in the United States conducted in 2023. Participants reported how frequently they obtained science and technology information from nine social-media platforms. Climate change misperceptions were measured through beliefs about whether global temperatures are rising and whether human activities contribute to climate change. The results showed that individuals with a stronger need for evidence were less likely to hold climate change misconceptions, whereas science populism and the belief that truth is politically constructed were associated with higher levels of misperceptions. Contrary to common assumptions, neither mainstream nor alternative social media use had a direct effect on climate change misperceptions. Instead, social media use moderated the relationship between cognitive orientations and climate change beliefs.

The authors point out that cognitive factors are strongly associated with climate change misconceptions, whereas social media use alone was not directly associated with misconceptions in this study (Wang and Akin, 2026). Climate misconceptions are influenced less by a lack of information and more by how people evaluate evidence, expertise, and scientific authority.

A key limitation of the study is its cross-sectional design, which prevents firm conclusions about whether cognitive orientations cause climate change misperceptions or whether existing climate beliefs influence epistemic

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orientations. Furthermore, social media use was measured broadly as a source of science and technology information rather than direct exposure to climate misinformation. Consequently, the conclusion that social media has limited effects on climate change misperceptions may be overstated. The study is implemented in the United States, which limits its generalisability to the European context.

According to Wang and Akin (2026) climate literacy depends not only on what people know, but also on how they judge knowledge claims. Overall, the study shifts attention away from misinformation alone and towards the cognitive foundations of climate literacy. The findings suggest that climate misconceptions are shaped by epistemic beliefs, attitudes towards scientific expertise, and broader understandings of how knowledge is produced and validated.

The main message is that climate misconceptions cannot be attributed straightforwardly to social-media exposure. Cognitive orientations shape climate change misconceptions because they influence how individuals evaluate evidence, perceive scientific expertise, and determine what constitutes reliable knowledge, thereby affecting the acceptance or rejection of climate science. More fundamental orientations concerning evidence, truth, expertise, and relations between scientists and the public may be at least as important. The article suggests that strengthening public understanding of climate change requires more than communicating scientific facts. Effective interventions should also address how people evaluate evidence, whom they trust, and how they understand the role of science in society.

From the perspective of the CLIMAware project, the study implies that effective climate communication should combine accurate scientific information with strategies that strengthen evidence-based reasoning, trust in scientific processes, and critical evaluation of information sources. Consequently, improving public understanding of climate change requires addressing not only climate knowledge itself but also the ways in which people evaluate scientific evidence and expertise (Wang & Akin, 2026).

The articles by Logemann et al (2025) and Wang and Akin (2026) provide theoretical foundations that support the survey's recommendations. A strong common theme is that climate misconceptions are not primarily a problem of missing information. This is confirmed by Wang and Akin (2026) and stated in the CLIMAware survey findings from the practical perspective: "Teaching should focus on how misleading claims are built, rather than only on which claims are false." People need skills for evaluating claims, evidence, and expertise, not merely more climate facts.

Climate misinformation affects public attitudes primarily by reducing perceptions of scientific consensus. Logemann et al. (2025) demonstrate that misinformation creates uncertainty regarding the level of expert agreement, which subsequently weakens belief in anthropogenic climate change and reduces concern about its consequences. The CLIMAware survey findings suggest that rather than endlessly chasing specific false claims, it is more effective to train people to recognise the underlying techniques of misinformation such as fake experts, conspiratorial reasoning or cherry-picking. These findings fit with the GmBM, where the theoretical rationale comes from GmBM and the practical recommendation is FLICC style inoculation.

The importance of scientific consensus appears in both articles, and the survey findings also identify consensus denial as one of the most relevant misinformation themes. The findings of Logemann et al. (2025) indicate that effective climate communication should combine accurate communication of scientific consensus with inoculation and prebunking strategies. The GmBM suggests the path: scientific consensus > stronger acceptance of climate science > higher concern > greater policy support that aligns with the survey's practical communication recommendations. Enhancing public awareness of the strong scientific agreement on climate change may increase resilience to misleading information. Such approaches can support both climate literacy and informed participation in climate governance.

One central perspective is that Wang and Akin (2026) identify that distrust of experts increases misperceptions. A practical implication for fighting this would be to put trusted scientists at the centre of climate communication.

Contrary to common assumptions, Wang and Akin (2026) found no direct relationship between the use of social media and climate change misperceptions. Instead, social media use moderated the effects of epistemic beliefs and

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science populism on climate attitudes. Their findings suggest that information environments interact with existing cognitive orientations rather than independently producing misconceptions. The CLIMAware survey findings similarly do not see platforms as the central problem. The issue is not the platform itself, but how information is interpreted and who is perceived as trustworthy.

Overall, both articles and the survey findings point toward the same direction. Misinformation works by undermining perceptions of scientific consensus (Logemann et al. 2025) and acceptance of consensus depends on epistemic beliefs and trust in expertise (Wang & Akin 2026). Therefore, interventions should teach people how to evaluate information, recognise manipulation techniques, and understand why expert consensus matters. Consequently, effective climate literacy interventions should combine science communication, misinformation resilience, and support for evidence-based evaluation of knowledge claims.

The role of science education in identifying misinformation

This section examines how different educational strategies, gamification and specific scientific literacy skills can help address common misconceptions about climate change and strengthen public understanding of the issue. In addition, it addresses emerging challenges and potential solutions in climate education arising from the increasing use of artificial intelligence and online media contents. Finally, the themes discussed in this chapter are reflected in the findings of the CLIMAware survey report on climate change misconceptions.

In their position paper ”Can science literacy help individuals identify misinformation in everyday life?”, Sharon and Baram-Tsabari (2020) examine which components of scientific literacy (SL) are most relevant for addressing misinformation at the individual level and how scientific literacy can support informed decision-making in everyday life. Their main emphasis is on socio-scientific issues, such as climate change and vaccination, which are often highly controversial and frequently accompanied by misinformation, and public scepticism.

Their first argument is that the components of SL most relevant to identifying misinformation in everyday life have received limited attention in the scientific literacy literature. This argument is based on Sharon and Baram-Tsabari’s analysis of the seven components of scientific literacy identified in the National Academies report (2016), using the *Grasp of Evidence* framework (Golan Duncan et al. 2018).

Drawing on this analysis, Sharon and Baram-Tsabari highlight four key dimensions that contribute to an individual's ability to recognise and evaluate misinformation: (1) an understanding of scientific practices, (2) the ability to identify and assess relevant scientific expertise, (3) epistemic knowledge, and (4) dispositions and habits of mind, such as inquisitiveness and open-mindedness. According to the authors, three of these four dimensions (dimensions 2, 3 and 4) are not commonly incorporated into prevailing definitions of scientific literacy.

The first dimension (1) understanding of scientific practices refers to an individual's ability to analyse and evaluate scientific evidence. Individuals who possess this dimension of scientific literacy can critically assess the evidence behind the knowledge claims and are also capable of asking informed questions about the quality of the evidence underlying scientific conclusions. The second dimension, (2) identifying and judging appropriate scientific expertise, refers to an individual's capacity to evaluate the scientific credibility of individuals and publications as well as to assess the strength of the scientific consensus surrounding specific claims. The third dimension, (3) epistemic knowledge, refers to an understanding of the nature and justification of knowledge. Strengthening this dimension is crucial for addressing misinformation, as it enables individuals to understand that misleading claims may stem from insufficient scientific evidence or errors in reasoning.

The authors’ second argument ”Intellectual virtues, such as open-mindedness, should be placed in the centre of science education” refers to the last dimension, (4) dispositions and habits on mind. This dimension encompasses intellectual dispositions, including a desire to seek knowledge, strive for accuracy, pursue understanding, base beliefs on sound reasoning, and exercise intellectual diligence. In the fight against misinformation, intellectual

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virtues are crucial, as they can help individuals overcome cognitive shortcuts and motivated reasoning driven by deeply rooted identities and pre-existing worldviews.

In the context of the CLIMAware project, the authors' findings are particularly relevant, as they draw on the identified core dimensions of SL to propose a number of practical recommendations. The main focus of these recommendations is on intellectual virtues that according to Sharon and Baram-Tsabari should be central to science education.

According to the authors, the first step in fostering intellectual virtues in educational settings is direct instruction on their nature and significance. This includes helping students understand what intellectual virtues, such as open-mindedness, are, why they are essential for both scientists and non-experts engaging with scientific information, including policymakers, and which behaviours, dispositions, emotions, and motivations are associated with them.

The second step is to expose students to exemplars of intellectual virtues in real-world contexts. These may include real or fictional individuals who exhibit virtuous reasoning and decision-making. Historical events and figures can likewise provide powerful illustrations of how intellectual virtues are applied in practice.

The third step is to provide students with opportunities to practice these intellectual virtues themselves, for example through classroom discussions and debates on socio-scientific issues such as climate change. This can foster open-mindedness, critical thinking, empathy, and a sense of responsibility, while also strengthening students' willingness and capacity to contribute to solving societal challenges.

Lastly, the authors emphasise the importance of creating learning environments in which intellectual virtues become a natural part of everyday classroom practices and interactions. This includes adopting teaching and assessment practices that promote understanding, critical thinking, and reflective inquiry. More broadly, achieving this goal requires support from both educational systems and policymakers. Such support may take the form of curriculum reforms, pre-service and in-service teacher training, and other structural measures designed to foster the development of intellectual virtues and strengthen students' ability to critically evaluate information and evidence.

The main limitation of this study is its exclusive focus on individual-level characteristics related to scientific literacy. As highlighted in the previous study in this literature review (Hornsey & Levandowsky 2022), the development of climate-related misconceptions and climate scepticism is influenced by both individual and collective factors. Therefore, this study of Sharon and Baram-Tsabari (2020) provides only a partial solution on how science literacy can help to combat climate change related misinformation.

In their review article ”Identifying effective climate change education strategies”, Monroe et al. (2017) examined a variety of global climate change education strategies. Through their analysis of 49 studies, they identified six themes associated with effective climate change education. Two of these themes were common to environmental education in general: (1) providing information that is personally relevant and meaningful to learners, and (2) utilising active, learner-centred pedagogical approaches. The remaining four themes were specific to complex socio-environmental issues such as climate change: (3) engaging learners in deliberative discussions, (4) fostering interactions with scientists, (5) addressing misconceptions, and (6) involving students in school- or community-based projects.

The first theme, (1) providing information that is personally relevant and meaningful to learners, is based on the idea that distant and global threats, such as climate change, should be contextualised in ways that make them personally relevant. This can be accomplished through the use of case studies and examples that relate climate change to learners' local communities or geographically relevant contexts, fostering a stronger personal connection to the issue.

The second theme, (2) utilising active, learner-centred pedagogical approaches, encompasses hands-on and inquiry-based learning opportunities, such as field trips, role-playing activities, simulations, and laboratory examinations. To further engage learners and capture their interest, visual materials such as drawings, illustrations and cartoons are often employed. Inquiry-based learning activities are particularly noteworthy, as they enable students to construct their own understanding and draw conclusions based on evidence, they have gathered themselves.

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The above-mentioned pedagogical approaches have been widely recognised as effective in both science and environmental education. However, the authors emphasise that climate change should be recognised as a highly complex issue. Educators must not only address the scientific complexities of climate change but also take into account social factors, such as group identities, personal values, lack of political will and the media's practice of balancing opposing viewpoints. These factors can make both understanding the issue and identifying appropriate solutions more challenging. Consequently, educators face the difficult task of creating learning environments that encourage openness to diverse perspectives while simultaneously addressing and correcting misconceptions, many of which are reinforced by socio-cultural influences.

To address this challenge, Monroe et al. (2017) propose four additional teaching strategies, the first of which is (3) engaging learners in deliberative discussions. These discussions help learners develop a deeper understanding of both their own and others' perspectives and knowledge regarding climate change. They also encourage learners to engage more critically with the topic by examining concepts in greater depth, comparing different perceptions, considering alternative viewpoints, and reflecting on their existing knowledge. Active student participation, rather than passive listening, has been identified as an important factor in promoting learning gains. Furthermore, researchers suggest that epistemic discussions, often referred to as "how do we know?" conversations are particularly valuable for holistic learning.

The second additional theme, (4) fostering interactions with scientists, refers to promoting collaboration between scientists and educators as well as creating opportunities for direct interaction between scientists and students. Collaboration between scientists and educators helps ensure that scientific information is communicated accurately and in a meaningful way. On the other hand, opportunities for students to interact directly with scientists can also enhance their interest in science and increase their engagement with climate-related topics. Furthermore, developing an understanding of climate science and of how scientific knowledge is generated through the use of data, evidence, and technology are important components of effective climate change education.

The third additional theme, (5) addressing misconceptions, refers to the notion that climate change misconceptions can be effectively challenged through active student engagement, guided discussions, and carefully designed instructional materials. Effective instruction builds on students' prior knowledge, minimizes the use of technical terminology, presents complex concepts progressively, and focuses on the core ideas needed to support conceptual change.

Lastly (6) involving students in school- or community-based projects, refers to educational interventions that extend beyond the classroom and provide learners with opportunities to engage in climate change projects within their schools or local communities.

While the study provides valuable insights, it leaves several questions unanswered that are highly relevant to the CLIMAware project. Specifically, it does not explore whether personal relevance facilitates the correction of misconceptions, how misconceptions should be addressed among different age groups, or whether non-formal educational actors can support learners in distinguishing scientific misconceptions from socially reinforced beliefs. The study also does not examine what motivates individuals to engage with climate change, whether particular climate impacts resonate more strongly with learners of different ages, or whether empowering community initiatives can influence adherence to social norms and worldviews. In addition, it does not address differences in how climate change is integrated into educational systems across countries. These areas warrant further attention when designing and implementing CLIMAware activities.

In their exploratory study "The cranky uncle game—combining humour and gamification to build student resilience against climate misinformation", Cook et al. (2023) investigate the role of humour in environmental education by integrating a digital game with classroom activities designed to foster students´ critical thinking. The study focuses on *Cranky Uncle*, a digital game designed to strengthen resistance to climate disinformation by combining logic-based active inoculation with humourous cartoon elements. Using the archetypal "Cranky Uncle" character, the game exposes players to common rhetorical techniques employed in climate science denial. By engaging with these techniques in a playful context, players learn to identify and critically assess misleading arguments.

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To assess the effectiveness of an educational approach that integrates a serious game, humour, and classroom activities to strengthen students' science and media literacy skills, Cook et al. (2023) presents key findings from three case studies. The authors also explore the creative potential of active inoculation through humour as a means of fostering resilience to misinformation. Two of the three case studies were implemented in classroom settings, whereas the third targeted a broader audience by engaging local communities.

The classroom activities involved engaging in the digital game *Cranky Uncle*, followed by a writing assignment that allowed students to apply the misleading fallacies and rhetorical techniques they had learned while playing the game. The results were promising since students improved both their ability to recognise misleading arguments and their capacity to construct such arguments themselves. Participant feedback was also positive, indicating that the assignments were successful in fostering critical thinking and helping students recognise misinformation in the wider information environment.

The third case study demonstrated the use of the game in a more diverse learning environment by organising critical-thinking activities among local communities. In this context, communities competed to determine which group could achieve the highest score in the Cranky Uncle game. While the intervention showed promise as an inoculation strategy, the authors cautioned that community-driven approaches may trigger adverse reactions when participants are exposed to inoculation messages drawn from real-world examples. This is an important consideration for educators and practitioners planning similar activities.

Drawing on the findings of the case studies, Cook et al. (2023) argue that humour-based pedagogical approaches can make complex and often abstract scientific information more accessible and engaging for learners. Furthermore, these approaches may help students develop the communication skills needed to participate as active, informed, and critically engaged members of society. The strength of humour-based educational content, particularly when combined with visually engaging materials, lies in its ability to capture students' attention, motivate active information seeking, reinforce memory retention, and illustrate complex issues in a concrete and accessible manner. When incorporated into educational games, humour enhances the appeal of instructional content, fosters a positive learning atmosphere, and encourages participants to revisit the game even after the learning activity has ended. Finally, the authors emphasise that addressing complex societal challenges such as climate change requires broad, interdisciplinary approaches. Serious games combined with humour can support this objective by drawing on insights and methods from multiple fields, including science, technology, psychology, education, and the arts. This interdisciplinary perspective is something that is also reflected in the CLIMAware project.

As *Artificial Intelligence* (AI) becomes increasingly capable of generating convincing scientific misinformation, it poses substantial challenges not only to the individuals' media literacy, but also to the science education system as a whole. Given these concerns, Doss et al. (2023) examined in their article "Deepfakes and scientific knowledge dissemination" how vulnerable U.S. education stakeholders are to science deepfakes and the factors that moderate this vulnerability.

Their study targeted adults, educators (teachers and principals), and students ranging from 12-year-olds to higher education students. The participants were exposed to authentic and deep-fake videos in which individual public figures and scientists dealt with climate change. Following exposure, participants were asked to identify whether the video was genuine or a deepfake. The research addressed three main dimensions: (1) the ability of respondents to distinguish authentic videos from deepfakes, (2) the characteristics of the videos that affect detection accuracy, and (3) the respondent characteristics that influence vulnerability to deepfakes.

The key findings regarding the first study question revealed that about 27%–50% of the respondents were unable to correctly determine the authenticity of a video. Overall, adults and educators were less successful in identifying deepfake videos than authentic ones, whereas middle school and higher education students were more likely to correctly identify deepfake videos than authentic videos**.**

To identify the video characteristics that influenced detection accuracy, the researchers examined both visual cues, such as facial features and overall video quality, and social cues, including the perceived credibility of the

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information presented. The findings indicated that respondents were more likely to correctly identify deepfakes when they focused on the visual aspects of the videos. However, reliance on visual cues did not improve their ability to recognise authentic videos. Notably, respondents who relied on social cues, such as the credibility of the content and the identity of the speaker, were more likely to correctly identify both deepfake and authentic videos.

Regarding respondents' characteristics, the most notable finding was that the ability to detect deepfake videos declined with age in both the general adult population and the teacher population. Political orientation also appeared to play a somewhat contradictory role in deepfake detection. Among the general respondent population, self-identified conservatives were less likely than self-identified liberals to correctly identify deepfakes. However, this pattern did not hold among educators. Trust in information sources, such as social media and newspapers, was also associated with increased vulnerability to deepfakes. As the authors noted, the mechanisms underlying these relationships remain somewhat unclear, highlighting the need for further research. Nevertheless, the findings provide a basis for several practical implications and educational interventions aimed at improving deepfake detection and reducing susceptibility to misinformation.

The authors concluded that deepfakes have already reached a level of sophistication that can cause substantial confusion, leaving a wide range of stakeholders vulnerable to misinformation. In particular, older individuals were found to be more susceptible to deep-fake content, highlighting the need for targeted educational interventions for this population. Media literacy approaches that teach individuals how to verify information and critically evaluate digital content may therefore represent a promising strategy for reducing vulnerability to deepfakes.

Based on their findings, the authors also suggested that repeated exposure to potential deepfakes may increase confusion and further exacerbate the effects of deepfake misinformation. To counter this challenge, appropriate education on the nature and identification of deepfakes is essential.

Furthermore, educating information consumers to assess the social characteristics of digital content, such as source credibility and speaker identity, may be a more robust long-term strategy than focusing solely on technical indicators of manipulation. This is valid because deep-fake generation technologies are developing rapidly and are likely to produce content that is virtually indistinguishable from authentic videos, reducing the effectiveness of relying on visual cues to identify manipulated content. On the other hand, prior knowledge and awareness have been shown to promote cognitive reflection and reduce overall susceptibility to misinformation.

From a CLIMAware perspective, a key limitation of the study is its exclusive focus on the United States, which may restrict the applicability of the findings to other national contexts. In addition, the study does not include all relevant climate change communicators, such as politicians, nor does it examine the full spectrum of deepfake content, including fabricated scientific results. Finally, it does not consider the growing role of chatbots and generative AI technologies in producing and amplifying climate-related misinformation.

In their study ”Students' awareness and conceptions of science-related communication mechanisms on social media,” Kresin et al. (2025) examined German tenth-grade students’ awareness and understanding of science-related communication mechanisms on social media. Their work draws on the Nature of Science (NOS) media communication mechanisms framework proposed by Höttecke and Allchin (2020) (see Table 3.). The study was situated in the context of climate change-related information and sought to address the following research questions:

> Which social media communication mechanisms are students aware of in the context of climate change information?
> How are simple and elaborate students' conceptions of social media communication mechanisms in the context of climate change characterized?

The term *simple* used in RQ 2 denotes conceptions that are superficial, uncritical, or erroneous, whereas *elaborate* refers to conceptions that are well-developed, differentiated, and highly sophisticated. To capture a broad range of students’ awareness and conceptions of social media communication mechanisms, seven focus group interviews involving 26 students were conducted in 2022.

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Table 3. The results from analysis of the interviews coded by the Nature of Science (NOS) media communication mechanisms framework (Höttecke & Allchin 2020) and indicated literature (Kresin et al. 2025).

Mechanisms proposed by Höttecke and Allchin (2020) and inductively added mechanisms	**Definitions from the coding manual derived from Höttecke and Allchin (2020) and indicated literature**
Media gatekeeping	Preserving the trustworthiness of claims by examining reliability of information
Conflict of interest	Journalistic norms, like objective report of information, collide with interests of the information sources
Confirmation bias	Tendency to develop personal filters based on initial impression of a topic where similar instances to the personal belief tend to stand out, while counterexamples are less likely to be noticed
Motivated reasoning	To confirm own beliefs, scientific evidence is actively cherry-picked, and expertise is evaluated based on whether one agrees with the claims
Echo chamber	Algorithmic selection through user behavior in social media are linking people with similar ideas, reinforcing existing beliefs and prohibit nonconformity
Filter bubble	Algorithms are presenting information based on existing preferences and are limiting exposure to new issues and critical perspectives leaving the user confronted with a specific constellation of content
Spiral of silence	The silencing of countering voices as a result of people aligning ideas with ideas that are counted as legitimate in groups to increase social acceptance
False-consensus effect	Overestimating the overall acceptance of claims in the population due to limited exposure to other perspectives
Inductively added mechanisms	**Definition from coding manual based on indicated literature**
Algorithm	Automized selection of content based on user-personalization (Alvarado & Waern, 2018)
Misinformation cascade	False news travel faster and more broadly, because social media networks are rewarding shareability (Jasser, 2019)
Shadow banning	Partial algorithmic censorship of online accounts without the knowledge or consent of the user (Jones, 2023)
Bots	Autonomous online program that can interact with systems or users (Wang et al., 2018)
Microtargeting	Marketing strategy of advertisers that use consumer data to identify preferred commercial content of small target groups (Barbu, 2014)

Based on the analysis of the interviews Kresin et al. found that students were aware of all the media communication mechanisms proposed by Höttecke and Allchin (2020), except for the spiral of silence. Among these mechanisms, gatekeeping and the filter bubble appeared to be the most familiar to students. Analysis of the responses further revealed that students' understanding was largely grounded in their own experiences as social media users.

Notably, among the mechanisms identified inductively during the coding process, the algorithm-related category emerged as by far the most prominent in students' responses. References to algorithms frequently appeared not only as a distinct mechanism but also in students' explanations of other media communication mechanisms. This prominence may partly reflect the central role that artificial intelligence and algorithms currently play in public discourse. In addition, algorithms underpin many other media communication phenomena, making them fundamental to understanding mechanisms such as filter bubbles, echo chambers, and the spread of science denial and misinformation in social media environments. As a result, understanding how algorithms operate provides an essential foundation for students' comprehension of science-related communication online. Therefore, the authors argue that algorithm literacy should be an integral component not only of media and science literacy but also of a reconceptualised understanding of the NOS.

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Kresin et al. also highlighted that, based on their findings, bots and microtargeting are frequently employed as deceptive strategies for spreading scientific misinformation on social media. Consequently, the ability to recognise and understand these mechanisms should be considered an integral component of scientific literacy.

Students' conceptions of social media communication mechanisms related to science content differed considerably in their level of elaborateness. While simpler responses merely recognised the existence of these mechanisms, more elaborate conceptions revealed a deeper understanding of their functioning, implications, and potential risks. Furthermore, students described ways in which they could actively manipulate or make use of these mechanisms, indicating a sophisticated understanding of how social media environments shape access to and engagement with science-related information.

The above-mentioned findings suggest that students recognise that not all information shared on social media is trustworthy and that users may be exposed to different content, including information related to climate change. However, students are only partly equipped to identify and navigate science denial and misinformation within the informal learning environments provided by social media and educational interventions are needed to strengthen the student's ability to recognise underlying communication mechanisms.

Based on their findings, Kresin et al. (2025) propose several implications for science education. First, algorithm literacy should be integrated into contemporary science media literacy. Second, a key objective of science media literacy should be to foster an understanding of the underlying logic of social media platforms, including the commercial interests that drive them and the ways in which these interests may contribute to challenges in the communication of scientific information. Third, students' awareness of and personal experiences with media communication mechanisms should be acknowledged and utilised in science education. Fourth, familiar concepts such as filter bubbles, gatekeeping, and algorithms provide promising entry points for instruction. Fifth, teaching should move beyond students' personal experiences toward a deeper understanding of how media communication mechanisms operate systematically and how they shape the perception and interpretation of scientific information. In this regard, inoculation-based approaches may play a crucial role. Finally, small-scale experiments that allow students to influence media communication mechanisms in social media environments, such as creating a second account or following people with different viewpoints, can help illustrate their concrete effects and foster a more sophisticated understanding of how these mechanisms function.

From the perspective of the CLIMAware project, several limitations should be considered when applying these findings in practice. First, the study was exploratory in nature, and the sample size was relatively small. In addition, the research focused exclusively on Instagram and on climate change-related content, which limits the generalisability of the findings to other social media platforms and contexts.

It is also important to recognise that social media communication is constantly evolving, shaped by ongoing societal debates, technological developments, and changing communication practices. Consequently, social media communication should not be viewed as a static phenomenon but rather as a socially constructed one, whose forms and practices are continuously influenced by social norms, platform policies, and regulatory frameworks. These dynamics should be taken into account when designing CLIMAware interventions aimed at strengthening learners' resilience to climate misinformation in social media context.

A key finding of the CLIMAware survey (2026) was that individuals often need support in evaluating the quality of information and arguments. In particular, respondents were more likely to accept arguments when they agreed with the conclusion, suggesting that motivated reasoning can reduce the level of critical scrutiny applied to information that confirms existing beliefs. According to Sharon and Baram-Tsabari (2020), important dimensions of scientific literacy that help counter motivated reasoning include *epistemic knowledge*, which enables individuals to recognise weaknesses in evidence and reasoning, as well as *intellectual dispositions and habits of mind* that promote accuracy and encourage beliefs to be grounded in evidence and sound reasoning. Fostering scientific literature at the individual level may therefore represent a promising strategy for combating misinformation and strengthening resilience against misleading information also in CLIMAware context. However, activities should not focus solely on

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individual-level characteristics, as susceptibility to misinformation is also shaped by broader social and cultural contexts, including social norms, group identities, and shared worldviews (Hornsey & Levandowsky 2022).

In addition, the CLIMAware survey found that respondents were less likely to deny the physical reality of climate change than to accept misleading claims targeting climate experts and proposed solutions. Notably, one of the most strongly endorsed items reflected *psychological distancing*, namely the perception that *"it won't affect us."* To counter such beliefs, Monroe et al. (2017) advocate educational approaches and communication that present climate information in ways that are personally relevant and meaningful to learners. By connecting climate change to learners' own lives and local contexts, such approaches can foster a deeper understanding of the global nature of the issue and help overcome the tendency to distance oneself from its consequences. Furthermore, humour-based educational content, combined with appealing visual materials, can make this complex topic more relatable and accessible, encouraging engagement also at the emotional level as suggested by Cook et al. (2023).

Regarding AI-generated climate misinformation, more than half of the CLIMAware respondents reported having encountered AI-generated climate-related content, most frequently fake images of extreme weather events. Despite this exposure, only 21% felt very or extremely confident in their ability to recognise AI-generated climate content, such as deep-fakes or manipulated images, whereas 39% expressed little or no confidence in doing so. (CLIMAware 2026) Notably, confidence decreased consistently with age, reflecting patterns observed in study of actual detection performance (Doss et al. 2023). According to Doss et al. (2023), older individuals are more vulnerable to deepfake content because their ability to distinguish authentic videos from manipulated ones tends to decline with age. Both the findings of the survey and this literacy review highlight the importance of strengthening AI literacy and critical evaluation skills, particularly among older populations.

Doss et al. (2023) also suggested that repeated exposure to potential deepfakes may increase confusion and further exacerbate the effects of deepfake misinformation. A similar pattern was evident in the CLIMAware survey, where respondents reported the greatest difficulty in distinguishing accurate climate information from misinformation in countries where they encountered AI-generated content most frequently, rather than in countries with the highest levels of climate-related misconceptions. The results indicate that frequent exposure to AI-generated material can undermine confidence in evaluating information and make it increasingly difficult to distinguish between authentic and manipulated content.

The CLIMAware survey found that people who rely exclusively on social media for climate information hold noticeably more misconceptions than those who also use, or primarily rely on, traditional media sources (CLIMAware 2026). This aligns with the findings of Kresin et al. (2025), who demonstrated that German students are only partly prepared to identify and navigate science denial and misinformation in social media environments and are as such prone to online media disinformation. Kresin et al. (2025) results highlight also the need for educational interventions, including algorithm literacy, to strengthen learners' ability to recognise and critically assess the communication mechanisms that influence the content they encounter online. (Kresin et al. 2025) Similar educational interventions could also prove valuable within the CLIMAware context.

According to the CLIMAware survey (2026), climate scientists were by far the most trusted source of climate information, while influencers and politicians received the lowest levels of trust (CLIMAware 20206). This finding supports the importance of social cues, such as source credibility and speaker identity, in evaluating digital content, as suggested by Doss et al. (2023). From a practical perspective, the results indicate that climate communication should increasingly be built around trusted scientific experts and science institutions. Giving climate science a more visible role in public communication may enhance the perceived credibility of climate information and help audiences navigate a complex and often contested (online) information environment.

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Conclusions

A scientific approach can effectively address climate change misconceptions and strengthen public understanding by combining accurate evidence with insights into the psychological, social, and political drivers of climate denial and scepticism. The literature demonstrates that misconceptions are rarely caused solely by a lack of knowledge. They are often rooted in motivated reasoning, identity protection, emotional responses, ideological commitments, and exposure to organised misinformation. Therefore, simply presenting scientific facts is often insufficient. Instead, science-based interventions should integrate clear communication of the scientific consensus, climate literacy education, inoculation against misinformation, and audience-specific message framing. Research suggests that climate information is more effective when it aligns with people's values, highlights practical co-benefits such as economic opportunities and public health, and is delivered by trusted messengers within relevant social or political groups. Furthermore, improving critical thinking skills, explaining scientific methods transparently, and exposing the interests behind disinformation campaigns can increase resilience to misleading claims.

Effective climate governance requires communication strategies that help citizens understand scientific evidence and resist misinformation. For example, social media strategies need to be revised to be accessible, relatable, and focused on demonstrating how climate solutions work in practice. Overall, the reviewed literature suggests that a scientific approach is most effective when it goes beyond correcting facts and addresses the underlying cognitive, emotional, and social factors that shape public attitudes. By combining scientific evidence with strategic communication and education, it is possible to reduce misconceptions and promote a more informed public understanding of climate change.

Climate change misconceptions can be addressed through a scientific approach by systematically studying how misinformation comes about, how it is spread and believed in. This can be done by experimentally testing interventions such as inoculation and consensus communication, by promoting the critical evaluation of information sources, and by strengthening trust in scientific expertise. Research reported in the literature and reviewed here shows that when correctly carried out, prebunking misinformation and improving media literacy as a whole, can and do also contribute to significantly reducing false beliefs and strengthening public understanding of climate science.

Literature identifies several educational interventions that can support individuals in critically navigating climate-related information and evaluating the credibility of the content they encounter. These pedagogical approaches operate at different levels, from learner-centred approaches focused on individual development to the creation of novel learning environments. A common feature across these approaches is the contextualisation of climate change within learners' own experiences and everyday realities. They also emphasise active learner engagement through various pedagogical methods such as deliberative discussions, gamified learning activities, and small-scale experiments or projects. More broadly, these approaches seek to enhance individuals' understanding of the epistemic nature of science, climate change, and emerging information technologies, including social media platforms and AI.

Practical implications

The findings of both the literature review and the CLIMAware survey suggest that efforts to address climate misinformation should move beyond a narrow focus on outright climate change denial. Denial of the physical reality of climate change was relatively rare among survey respondents, while misconceptions were more commonly linked to distrust of experts, scepticism toward climate solutions and narratives emphasising the limited significance of local climate action. The results also demonstrate that misinformation is strongly shaped by political and social contexts. Climate denial narratives were frequently associated with political elites rather than anonymous online actors, while considerable differences emerged between countries regarding the dominant forms of misinformation and scepticism. These findings indicate that climate communication and literacy initiatives should be tailored to local contexts and address the specific narratives that resonate within different audiences. Rather than relying on

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universal messages, interventions should respond to locally relevant misconceptions, societal priorities and media environments.

A consistent message emerging from the literature and the CLIMAware survey is that misinformation is not primarily a consequence of insufficient climate knowledge in the European context. Instead, individuals often struggle to evaluate the quality of arguments, evidence, and expertise. The survey respondents frequently assessed climate-related claims according to whether they agreed with the conclusion rather than the strength of the reasoning, highlighting the influence of motivated reasoning. Consequently, educational interventions should place greater emphasis on epistemic skills, such as evaluating evidence, identifying weaknesses in reasoning, recognising misleading rhetorical techniques, and understanding how scientific knowledge is produced. These findings support technique-based media literacy, prebunking, and inoculation approaches that focus on recognising recurring patterns of misinformation, such as fake experts, cherry-picking, conspiratorial reasoning and attacks on scientific consensus. Strengthening public understanding of scientific consensus may be particularly valuable, as both the literature and the survey findings suggest that misinformation often operates by undermining perceptions of expert agreement and trust in science.

The results further highlight the growing importance of digital, media and AI literacy. Respondents who relied exclusively on social media for climate information held noticeably more misconceptions than those who also used traditional media sources, while a substantial proportion reported rarely or never verifying original information sources. At the same time, AI-generated climate content has become a common part of the information environment. More than half of respondents had encountered AI-generated climate material, yet confidence in identifying such content remained low, particularly among older respondents. The findings suggest that educational efforts should increasingly address algorithm literacy, source verification, AI-generated content, deepfakes and the mechanisms through which online platforms shape information exposure. Importantly, both the survey and the reviewed literature indicate that the problem lies not primarily in the communication platforms themselves but in how information is interpreted and who is perceived as trustworthy. As climate scientists and scientific institutions emerged as the most trusted sources of climate information, future communication strategies should place credible scientific expertise at the centre of public engagement efforts. Combining science communication, misinformation resilience, AI literacy and locally relevant climate education may therefore offer the most effective approach for strengthening climate literacy and supporting informed participation in climate governance.

Implications and recommendations for the project

1. Climate misconceptions are shaped less by a lack of information than by how people evaluate evidence, expertise, and knowledge claims. Therefore, climate literacy interventions should focus on **developing critical evaluation skills rather than simply providing more facts**.

2. **Inoculation and misinformation resilience are more effective than fact correction alone.** Effective climate communication should combine consensus communication with inoculation and prebunking approaches that help people recognise misleading arguments and misinformation techniques. The goal should be to strengthen independent evaluation of information rather than merely debunk individual false claims.

3. A clear implication from the literature reviewed is that learning should not end when information is presented, but rather there is much benefit to be achieved from carrying out **post-inoculation discussion** (PIT), because it helps to maintain and strengthen resistance to misinformation over time. There are also benefits to be gained through the potential ”social diffusion” of misinformation resistance. Therefore, there it is a need for the PIT concept to be built into the activities to be developed by the project, it is recommended that this be done in workshop situations or classroom discussions, through peer-learning activities, reflective exercises, and otherwise if possible, through such things as online discussion forums.

4. There is a need for activities to **target the most vulnerable members of the population** specifically. More and better information on-line or elsewhere alone will not solve the problems involved. So, after identifying

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the groups at greater risk of ”succumbing” to dis- and misinformation, ways need to be developed for best reaching them in a tailored manner, without a one-size-fits-all approach. The project could do well to focus on those groups identified as most vulnerable from the survey and to match methods identified and outlined in the literature review for best addressing each type of group. Where individual solutions are not outlined in the literature new ones could be devised in the project as part of the Work Package (WP) 3 and 4 activities.

5. When planning the workshops for WP3 and WP4 in the CLIMAware project, **attention could be paid to denialism levels, trends as well as strategies** described in bullet points in the denialism section. Hornsey & Lewandowsky (2022) for example can provide good guidelines on formulating the materials to target denialism. When disseminating in WP5, some of the social media findings from Nicolosi et al. (2025) article on social media major trends related to misinformation could be followed for better targeting of the climate sceptic or denialist audience.

6. While planning CLIMAware project activities WP3 and WP4, attention should be paid not only to individuals' ability to understand and engage with scientific information, but also to **ensuring that messages are relevant to their lived experiences and communicated in an accessible manner**. Humour, gamification and visual communication can make complex issues such as climate change easier to understand and more engaging, thereby enhancing the effectiveness of science communication.

7. **The project’s educational interventions (WP3 and WP4) should partly focus on making the underlying mechanisms of social media**, such as algorithms, bots, and microtargeting practices, **more transparent and understandable.** By increasing awareness of how these platforms function, individuals may be better equipped to recognise and critically evaluate information circulating online. From the perspective of social media-related misinformation, educational and awareness-raising measures should be implemented across all age groups. However, special attention should be directed towards older adults, particularly in relation to AI-generated deepfake content.

8. Perceptions of scientific consensus play a key role in shaping climate beliefs and support for climate action. **Trust in scientific expertise** strengthens acceptance of climate science, whereas misinformation and expert distrust can undermine it. Therefore, climate communication should increasingly be built around trusted scientific experts and science institutions. Giving climate science a more visible role in public communication may enhance the perceived credibility of climate information and help audiences navigate a complex and often contested information environment. While planning project interventions, **consideration should be given to the role that local climate experts could play** in both the implementation of activities and the dissemination of results to relevant stakeholders.

References

Alvarado, O. & Waern, A. 2018. Towards algorithmic experience. Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems. 286, 1–12. Cited 16th Oct 2026. Available at https://doi.org/10.1145/3173574.3173860

Barbu, O. 2014. Advertising, microtargeting and social media. Procedia—Social and Behavioral Sciences. Vol. 163, 44–49. Cited 16th Oct 2026. Available at https://doi.org/10.1016/j.sbspro.2014.12.284

Bedford, D. 2010. Agnotology as a teaching tool: Learning climate science by studying misinformation. Journal of Geography. Vol. 109(4), 159–165. Cited 16th Oct 2026. Available at https://doi.org/10.1080/00221341.2010.498121

Bhagwat, S. A., Economou, A. & Thornton, T. F. 2016. The idea of climate change as a belief system: Why climate activism resembles a religious movement. GAIA - Ecological Perspectives for Science and Society. Vol 25(2), 94–98. Cited 16th Oct 2026. Available at https://doi.org/10.14512/gaia.25.2.8

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Bjornberg, K. E., Karlsson, M., Gilek, M. & Hansson, S. O. 2017. Climate and environmental science denial: A review of the scientific literature published in 1990-2015. Journal of Cleaner Production. Vol. 167, 229–241. Cited 16th Oct 2026. Available at https://doi.org/10.1016/j.jclepro.2017.08.066

Coan, T.G., Boussalis, C., Cook, J. & Nanko, N. 2021. Computer-assisted classification of contrarian claims about climate change. Scientific Reports. Vol 11(1), 22320. Cited 16th Oct 2026. Available at https://doi.org/10.1038/s41598-021-01714-4

Compton, J. 2012. Inoculation theory. In Dillard, J.P. & Shen, L. (eds.). The SAGE handbook of persuasion: Developments in theory and practice. 2nd ed. SAGE Publications: New York, USA. 220– 236. Cited 16th Oct 2026. Available at https://doi.org/10.4135/9781452218410

Compton, J., van der Linden, S., Cook, J. & Basol, M. 2021. Inoculation theory in the post-truth era: extant findings and new frontiers for contested science, misinformation, and conspiracy theories. Social and Personal Psychology Compass. Vol 15(6). Cited 16th Oct 2026. Available at https://doi .org/10.1111/spc3.12602.

Cook, J., Ecker, U. K. H., Trecek-King, M., Schade, G., Jeffers-Tracy, K., Fessmann, J., Kim, S.J., Kinkead, D.,Orr, M., Vraga, E., Roberts, K. & McDowell, J. 2023. The cranky uncle game—combining humor and gamification to build student resilience against climate misinformation. Environmental Education Research. Vol. 29(4), 607–623. Cited 16th Oct 2026. Available at doi: 10.1080/13504622.2022.2085671.

Cook, J. & Lewandowsky, S. 2016. Rational irrationality: Modeling climate change belief polarization using Bayesian networks. Topics in Cognitive Science. Vol. 8(1), 160-179. Cited 16th Oct 2026. Available at https://doi.org/10.1111/tops.12186 PMID:26749179

Cook, J., Lewandowsky, S., & Ecker, U.K.H. 2017. Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence. PLoS ONE. Vol 12(5), e0175799. Cited 16th Oct 2026. Available at https://doi.org/10.1371/journal. Pone.0175799

Cook, J., Oreskes, N., Doran, P.T., Anderegg, W.R., Verheggen, B., Maibach, E.W., Carlton, S.J., Lewandowsky, S., Skuce, A.G., Green, S.A., Nuccitelli, D., Jacobs, P., Richardson, M., Winkler, B., Painting, R. & Rice, K. 2016. Consensus on consensus: a synthesis of consensus estimates on human-caused global warming. Environmental Research Letters. Vol. 11(4), 048002. Cited 16th Oct 2026. Available at DOI 10.1088/1748-9326/11/4/048002

Depoux, A., Martin, S., Karafillakis, E., Preet, R., Wilder-Smith, A., & Larson, H. 2020. The pandemic of social media panic travels faster than the COVID-19 outbreak. Journal of Travel Medicine. Vol. 27(3). Cited 16th Oct 2026. Available at https://doi.org/10.1093/jtm/taaa031

Diethelm, P., & McKee, M. 2009. Denialism: What is it and how should scientists respond? European Journal of Public Health. Vol. 19(1), 2–4. Cited 16th Oct 2026. Available at https://doi.org/10.1093/eurpub/ckn139

Doss, C., Mondschein, J., Shu, D. Wolfson, T., Kopecky, D., Fitton-Kane, V.A., Bush, L. & Tucker, C. 2023. Deepfakes and scientific knowledge dissemination. Scientific Reports. Vol. 13, 13429. Cited 19th Oct 2026. Available at https://doi.org/10.1038/s41598-023-39944-3

Eberl, J. M., Huber, R. A., Mede, N. G., & Greussing, E. 2023. Populist attitudes towards politics and science: how do they differ? Political Research Exchange. Vol. 5(1). Cited 19th Oct 2026. Available at https://doi.org/10.1080/2474736X.2022.2159847

Ejaz, W., Altay, S., Fletcher, R., & Nielsen, R. K. 2025. Trust is key: Determinants of false beliefs about climate change in eight countries. New Media & Society. 27(9), 5281-5300. Cited 19th Oct 2026. Available at https://doi.org/10.1177/14614448241250302

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Ejaz, W., Mukherjee, M., Fletcher, R. & Nielsen, R.K. 2022. How We Follow Climate Change: Climate News Use and Attitudes in Eight Countries. Oxford: Reuters Institute for the Study of Journalism. Cited 19th Oct 2026. Available at DOI: 10.60625/risj-89jy-c376

Fernandez, M., & Alani, H. 2018. Online Misinformation: Challenges and Future Directions. In: Champin, P.-A. & Gandon, F. (eds.) WWW '18 Companion: The 2018 Web Conference Companion. Lyon, France. April 23–27 2018. New York, USA: ACM. Cited 19th Oct 2026. Available at https://doi.org/10.1145/3184558.3188730

Golan Duncan, R., Chinn, C. A., & Barzilai, S. 2018. Grasp of evidence: Problematizing and expanding the next generation science standards' conceptualization of evidence. Journal of Research in Science Teaching. Vol. 55(7), 907–937. Cited 19th Oct 2026. Available at https://doi.org/10.1002/tea.21468

Harsin, J. 2018. Post-Truth and Critical Communication Studies. In: Matthew Powers (ed.), Oxford Research Encyclopedia of Communication. New York: Oxford Academic. Cited 11th Sep 2026. Available at https://doi.org/10.1093/acrefore/9780190228613.013.757

Höttecke, D. & Allchin, D. 2020. Reconceptualizing nature-of-science education in the age of social media. Science Education. Vol. 104(4), 641–666. Cited 19th Oct 2026. Available at https://doi.org/10.1002/sce.21575

Jasser, J. 2019. Dynamics of Misinformation Cascades. In: Liu, L. & White, R. (eds.) Companion Proceedings of The 2019 World Wide Web Conference. San Francisco, USA. May 17-19 2019. New York: Association for Computing Machinery. 33–36. Cited 19th Oct 2026. Available at https://doi.org/10.1145/3308560.3314194

Jones, C. 2023. Search engine discourse analysis: how 'shadowban' affects policy. Information, Communication & Society. Vol. 27(5), 1025–1042. Cited 10th Oct 2026. Available at https://doi.org/10.1080/1369118X.2023.2232847

Kresin, S., Kremer, K., Nehring, A., & Büssing, A. G. 2025. Students' awareness and conceptions of science-related communication mechanisms on social media. Journal of Research in Science Teaching, 62(3), 756–791. Cited 19th Oct 2026. Available at https://doi.org/10.1002/tea.21973

Lata, K. 2024. The Impact of Digital Media on the Decentralization of Power and the Erosion of Traditional Gatekeepers. International Journal of Trend in Scientific Research and Development. Vol. 8(1), 1014-1017. Cited 19th Oct 2026. Available at URL: www.ijtsrd.com/papers/ijtsrd64544.pdf

Lazer, D. M. J., Baum, M. A., Benkler, Y., Berinsky, A. J., Greenhill, K. M., Menczer, F. & Zittrain, J. L. 2018. The science of fake news. Science. Vol. 359(6380), 1094–1096.

Lee, K., Tamilarasan, P., & Caverlee, J. 2013. Crowdturfers, campaigns, and social media: Tracking and revealing crowdsourced manipulation of social media. In: Kiciman, E. Proceedings of the International AAAI Conference on Web and Social Media. Vol. 7(1). July 8-11 2013 Cambridge, Massachusetts USA. USA: Association for the Advancement of Artificial Intelligence. 331–340. Cited 19th Oct 2026. Available at https://doi.org/10.1609/icwsm.v7i1.14384

Leetaru K. 2018. Even the data ethics initiatives don't want to talk about data ethics. Forbes. Cited 19th Oct 2026. Available at https://www.forbes.com/sites/kalevleetaru/2018/10/23/even-the-data-ethics-initiatives-dont-want-to-talk-about-data-ethics/#a8178381fba6.

Lerner, B., Hubner, A.Y. & Shulman, H.C. 2025. Science populism impacts perceptions of credibility across scientific professions. Scientific Reports. Vol. 15, 28465. Cited 19th Oct 2026. Available at https://doi.org/10.1038/s41598-025-14115-8

Logemann, H. T., Rode, J. B., Maertens, R., & van der Linden, S. 2025. The gateway (mis)belief model: How misinformation impacts perceptions of scientific consensus and attitudes towards climate change. British Journal of Psychology. Vol. 117(S1), S137–S156. Cited 19th Oct 2026. Available at https://doi.org/10.1111/bjop.70022

Co-funded by the European Union

Lu, J. G. 2023. Cultural differences in humor: A systematic review and critique. Current Opinion in Psychology. Vol. 53, 101690. Cited 19th Oct 2026. Available at https://doi.org/10.1016/j.copsyc.2023.101690

Maertens, R., Anseel, F. & van der Linden, S. 2020. Combatting climate change misinformation: Evidence for longevity of inoculation and consensus messaging effects. Journal of Environmental Psychology. Vol. 70, 101455. Cited 19th Oct 2026. Available at https://doi.org/10.1016/j.jenvp.2020.101455.

Mede, N. G., & Schäfer, M. S. 2020. Science-related populism: Conceptualizing populist demands toward science. Public Understanding of Science. Vol. 29(5), 473-491. Cited 19th Oct 2026. Available at https://doi.org/10.1177/0963662520924259

Monroe, M. C., Plate, R. R., Oxarart, A., Bowers, A., & Chaves, W. A. 2019. Identifying effective climate change education strategies: a systematic review of the research. Environmental Education Research. Vol. 25(6), 791–812. Cited 19th Oct 2026. Available at doi: 10.1080/13504622.2017.1360842.

Newman, N., Fletcher, R., Eddy, K., Robertson, C. T., Nielsen, R. K. 2023. Digital news report 2023. Oxford: Reuters Institute for the Study of Journalism. Cited 19th Oct 2026. Available at DOI: 10.60625/risj-p6es-hb13.

Oreskes, N., & Conway, E. M. 2011. Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming. New York, NY: Bloomsbury Publishing.

Porter, E. & Wood, T. J. 2021. The global effectiveness of fact-checking: evidence from simultaneous experiments in Argentina, Nigeria, South Africa, and the United Kingdom. Proceedings of the National Academy of Sciences of the United States of America. Vol. 118(37), e2104235118. Cited 19th Oct 2026. Available at https://doi.org/10.1073/pnas.2104235118

Shahbazi, M. & Bunker, D. 2024. Social media trust: Fighting misinformation in the time of crisis. International Journal of Information Management. Vol. 77, 102780. cited 19th Oct 2026. Available at https://doi.org/10.1016/j.ijinfomgt.2024.102780.

Sharon, A. J. & Baram-Tsabari, A. 2020. Can science literacy help individuals identify misinformation in everyday life? Science Education. Vol. 104, 873–894. Cited 19th Oct 2026. Available at https://doi.org/10.1002/sce.21581
Treen, K. M. d., Williams H. T. P. & O'Neill, S.J. 2020. Online misinformation about climate change. WIREs Climate Change. Vol. 11(5), e665. Cited 19th Oct 2026. Available at https://doi.org/10.1002/wcc.665

van der Linden, S. 2018. The future of behavioral insights: On the importance of socially situated nudges. Behavioural Public Policy. Vol. 2(2), 207–217. Cited 19th Oct 2026. Available at https://doi.org/10.1017/bpp.2018.22

van der Linden, S., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. 2015. The scientific consensus on climate change as a gateway belief: Experimental evidence. PLoS One. Vol. 10(2), e0118489. Cited 19th Oct 2026. Available at https://doi.org/10.1371/journal.pone.0118489

Wang, P., Angarita, R., & Renna, I. 2018. Is this the era of misinformation yet. In: Champin, P.-A. & Gandon, F. (eds.) Companion of The Web Conference 2018 on The Web Conference 2018—WWW'18. April 23 - 27 2018. Lyon, France. Republic and Canton of Geneva, Switzerland: International World Wide Web Conferences Steering Committee. 1557–1561. Cited 19th Oct 2026. Available at https://doi.org/10.1145/3184558.3191610

Webb, S., Caverlee, J., & Pu, C. 2008, Social honeypots: Making friends with a spammer near you. In: Collaboration, Electronic messaging, Anti-Abuse and Spam Conference. Mountain View, California, USA. Aug 21-22 2008. Cited 19th Oct 2026. Available at URL: http://www.ceas.cc/2008/papers/ceas2008-paper-50.pdf

Co-funded by the European Union

Yin, L. 2023. The Changing Landscape of Media Communication: An Analysis of the Impact of New Media Marketing on News Consumption and Consumer Behavior. International Journal of Education and Humanities. Vol. 11(3), 9-12. Cited 19th Oct 2026. Available at https://doi.org/10.54097/ijeh.v11i3.14436

Zucker, A. 2019. Using Critical Thinking to Counter Misinformation. Science Scope. Vol. 42(8), 6–9. Available at https://doi.org/10.2505/4/ss19_042_08_6

ANNEX I. Elaborated reference list

Author(s)	Year of publication	Title	Journal	Citations (May 2026)	DOI	Category
Cook, J., Lewandowsky, S., Ecker, & Ullrich K. H.	2017	Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence	PLoS ONE	750	https://doi.org/10.1371/journal.pone.0175799	Scientific understand-ding, fact-checking
Monroe, M. C., Plate, R. R., Oxarart, A., Bowers, A. & Chaves, W. A.	2019	Identifying effective climate change education strategies: a systematic review of the research.	Environmental Education Research	911	https://doi.org/10.1080/13504622.2017.1360842	Education, school solutions
Maertens, R., Anseel, F. & van der Linden, S.	2020	Combatting climate change misinformation: Evide nce for longevity of inoculation and consensus messaging effects	Journal of Environmental Psychology	135	https://doi.org/10.1016/j.jenvp.2020.101455	Mis- and dis-information
Treen, K.M.D., Williams, H.T.P. & O'Neill, S.J.	2020	Online misinformation about climate change	Wiley Interdisciplinary Reviews-Climate Change	425	https://doi.org/10.1002/wcc.665	Mis- and dis-information
Sharon A.J. & Baram-Tsabari A.	2020	Can science literacy help individuals identify misinformation in everyday life?	Science Education	138	https://doi.org/10.1002/sce.21581	Education, school solutions
Compton, J., van der Linden, S., Cook, J. & Basol, M.	2021	Inoculation theory in the post-truth era: extant findings and new frontiers for contested science, misinformation, and conspiracy theories.	Social and personality Psychology Compass	187	https://doi.org/10.1111/spc3.12602	Mis- and dis-information
Hornsey M.J. & Lewandowsky, S.	2022	A toolkit for understanding and addressing climate scepticism	Nature Human Behaviour	95	https://doi.org/10.1038/s41562-022-01463-y	Denialism

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Jylhä, K.M., Stanley, S.K., Ojala, M. & Clarke, E.J.R.	2023	Science Denial A Narrative Review and Recommendations for Future Research and Practice	European Psychologist	35	https://doi.org/10.1027/1016-9040/a000487	Denialism
Doss, C., Mondschein, J., Shu, D. et al.	2023	Deepfakes and scientific knowledge dissemination	Scientific reports	65	https://doi.org/10.1038/s41598-023-39944-3	Media literacy, advertising, AI based content
Cook, J., Ecker, U. K. H., Trecek-King, M., Schade, G., Jeffers-Tracy, K., Fessmann, J., Kim. S.C., Kinkead, D., Orr, M., Vraga, E., Roberts, K. & McDowell, J.	2023	The cranky uncle game—combining humor and gamification to build student resilience against climate misinformation.	Environmental Education Research	93	https://doi.org/10.1080/13504622.2022.2085671	Gamification, interactive solutions
Mendy, L., Karlsson, M. & Lindvall, D.	2024	Counteracting climate denial: A systematic review	Public Understanding of Science	34	https://doi.org/10.1177/09636625231223425	Denialism
Logemann, H. T., Rode, J. B., Maertens, R. & van der Linden, S.	2025	The gateway (mis)belief model: How misinformation impacts perceptions of scientific consensus and attitudes towards climate change	British Journal of Psychology	4	https://doi.org/10.1111/bjop.70022	Governance, politics, decision-making
Nicolosi, E., Medina, R. , Brewer, S. et al.	2025	The new denial: climate solution misinformation on social media	Global Sustainability	4	https://doi.org/10.1017/sus.2025.10016	Social media
Ejaz, W., Altay, S., Fletcher, R. & Nielsen R.K.	2025	Trust is key: Determinants of false beliefs about climate change in eight countries	New Media & Society	20	https://doi.org/10.1177/14614448241250302	Mis- and dis-information
Kresin, S., Kremer, K., Nehring, A. & Buessing A.G.	2025	Students' awareness and conceptions of science-related communication mechanisms on social media	Journal of research in science teaching	11	https://doi.org/10.1002/tea.21973	Social media
Wang, M. & Akin, H.	2026	Effects of epistemic beliefs, science populism, and social media use on climate change misperceptions	Public Understanding of Science	3	https://doi.org/10.1177/09636625251343510	Scientific understand-ding, fact-checking

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ANNEX II. Misconceptions from the CLIMAware survey and scientific evidence for debunking them

Authors: Apostolos Malamakis and Christos Karkanias, CBioHub

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1. Purpose and scope of this annex

This annex answers, one by one, the eighteen climate misconceptions that the CLIMAware survey (D2.1) measured, with the peer-reviewed and institutional evidence that debunks each of them.

Twelve misconceptions come from two parts of the survey. Ten are from the section 'Beliefs about climate change', which covers the five CARDS claim families (C1-C5), and two are contrarian claims from the section 'Recognising misleading arguments'. Five further entries address country-specific misconceptions from Greece, Portugal, Spain, Finland and Ukraine, and a final entry gives an overview across countries. Together they form the basis for the eighteen WP3 Fact Sheets.

Each entry has the same five parts, so that WP3 can lift them directly into a Fact Sheet. It states the claim as people meet it, summarises what the survey found, explains in plain language what the science says, names the misleading technique behind the claim using the FLICC taxonomy (fake experts, logical fallacies, impossible expectations, cherry picking, conspiracy theories), and closes with a one-sentence key message. Survey percentages refer to respondents who agreed or strongly agreed, unless stated otherwise. Because the sample is opt-in and climate-attentive, these figures describe respondents, not national populations, and are likely to understate misconception levels in the general public.

Version 0.2 adds Section 4 with five country-specific entries (M13 to M17), one for each partner country. They follow the same five parts and are explained in Section 4.

2. The twelve misconceptions at a glance

The most accepted claims are about distance, solutions and trust, not about whether warming is real. Table 1 lists the twelve misconceptions in the order they are answered below.

Table 1. Misconceptions measured in the CLIMAware survey, ordered by acceptance. M1 to M10 are Q4 belief items (% agree or strongly agree); M11 and M12 are the Q6 and Q7 scenario arguments (% rating them 7 to 10 on a 0 to 10 reliability scale). Source: D2.1, Sections 5.1 and 5.2.

No.	Misconception	CARDS family	Survey result (D2.1)	Main FLICC technique	Key message
M1	Climate change will mostly affect future generations and other countries, not us	C3 It's not bad	14.6% agree; Greece 22.4%	Cherry picking (relies on outdated, future-only framing)	The impacts are already here, in Europe and in our own regions.
M2	Renewables are too unreliable to replace fossil fuels	C4 Solutions won't work	13.8% agree; Ukraine 20.2%, Spain 6.2%	Impossible expectations	Reliability comes from the whole system, not from one power plant.

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No.	Misconception	CARDS family	Survey result (D2.1)	Main FLICC technique	Key message
M3	Sea-level rise has been exaggerated by the media and scientists	C1 It's not happening	13.5% agree; Greece 20.5%	Conspiracy theory; cherry picking	Sea-level rise is measured, and it is speeding up.
M4	The climate has always changed naturally; current change is not mainly human	C2 It's not us	12.7% agree	Logical fallacy (false analogy)	Past natural change does not explain today's fast warming.
M5	Individual actions are pointless	C4 Solutions won't work	12.4% agree	Logical fallacy (false dichotomy)	Personal and collective action work together and spread.
M6	The near-universal scientific agreement is exaggerated	C5 Experts are unreliable	12.1% agree; only 66.0% affirm the consensus	Fake experts; magnified minority	More than 99% of recent climate studies agree humans cause warming.
M7	Climate models have been wrong too often to be trusted	C5 Experts are unreliable	9.7% agree; 7.5% "don't know"	Impossible expectations; cherry picking	Models from the 1970s onward predicted today's warming well.
M8	Cold winters and snowstorms show warming is not happening	C1 It's not happening	7.8% agree	Cherry picking (weather vs climate)	One cold week is weather; decades of data are climate.
M9	A warmer climate will bring more benefits than harm to my country	C3 It's not bad	5.5% agree	Cherry picking	Small local gains are far outweighed by losses.
M10	More CO2 is good because plants need it	C3 It's not bad	4.8% agree; 5.4% "don't know"	Logical fallacy (oversimplification)	CO2 is not the only thing plants need, and heat and drought cut yields.
M11	Current climate change is mostly caused by the sun (Q6)	C2 It's not us	4.0% rated the argument reliable	Fake expert	The sun has not warmed; the planet has.
M12	Scientists exaggerate climate change to get research funding (Q7)	C5 Experts are unreliable	12.6% rated the argument reliable; Greece mean 3.56 vs 2.76 overall	Conspiracy theory	Science has, if anything, erred on the side of caution.

3. Misconceptions answered

M1. "Climate change will mostly affect future generations and other countries, not us"

This was the most accepted statement in the whole survey, with 14.6% agreement overall and 22.4% in Greece. It is one of only three items whose differences between countries remain significant after correction for multiple testing. Psychologists call this belief psychological distance, the feeling that climate change is far away in time, place or relevance.

The evidence shows that the impacts are already here. Human activity has warmed the planet by about 1.1°C, and hot extremes have become more frequent and more intense across most land regions since the 1950s (IPCC 2021). Europe is the fastest-warming continent, warming about twice as fast as the global average since the 1980s (C3S & WMO 2026). The European Climate Risk Assessment identifies southern Europe as a hotspot where heat, drought, wildfire and flood risks combine (EEA 2024). A local example is Storm Daniel, which flooded Thessaly, Greece in September

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2023. Attribution scientists found that human-induced climate change made rainfall as extreme as this up to 10 times more likely and up to 40% more intense in the wider region of Greece, Bulgaria and Türkiye (Zachariah et al. 2023; see also Flaounas et al. 2025).

This misconception does not use a single FLICC technique. It rests on cherry picking from older climate messaging, which often showed distant images such as polar ice and the year 2100. Research shows that people who see climate change as closer in time and place are more concerned and more willing to act (Spence, Poortinga & Pidgeon 2012). Communication should therefore use local, recent and verifiable events, without claiming that every single disaster is caused by climate change alone.

> **Key message :** ***Climate change is not a future problem for other people. It is already changing the weather in Europe and in our own regions.***

M2. "Renewable energy sources such as wind and solar are too unreliable to replace fossil fuels"

This was the second most accepted statement (13.8%). It reached 20.2% in Ukraine, where energy security is a daily concern, and only 6.2% in Spain.

The evidence shows that renewables already carry a large share of Europe's electricity. In 2025, renewable sources supplied nearly half of Europe's electricity (C3S & WMO 2026). Between 2010 and 2019 the unit costs of solar energy fell by 85%, of wind energy by 55% and of lithium-ion batteries by 85%, and power systems based mainly on renewables are becoming increasingly viable (IPCC 2022). The variability of sun and wind is real. It is managed at the level of the whole system, through stronger grids and interconnections between countries, storage, flexible demand and other low-carbon sources. The Iberian blackout of 28 April 2025 is often used as proof of the claim. The final report of European grid operators found no single cause. The central problem was weak voltage control, and many renewable plants were operating in a mode that did not help control voltage. The experts recommend that all generators, including solar and wind, take part in voltage control (ENTSO-E 2026). The lesson concerns grid rules, not renewable energy as such.

The claim uses impossible expectations. It asks each wind turbine or solar panel to provide steady power alone, a standard that no single power plant of any type meets. It often adds cherry picking, by presenting one failure as proof of the whole technology.

> **Key message :** ***No single power plant is reliable alone. Reliable electricity comes from a well-designed system, and renewables are already a large part of it.***

M3. "Sea-level rise has been exaggerated by the media and by scientists"

This was the third most accepted statement (13.5%, plus 4.9% "don't know"). In Greece it reached 20.5%, the highest national figure for any item in the C1 family. The claim moves the argument away from the science and towards distrust of the people who report it.

The evidence shows that sea-level rise is measured, not only predicted. Global mean sea level rose by about 20 cm between 1901 and 2018. The rate of rise was 1.3 mm per year between 1901 and 1971, 1.9 mm per year between 1971 and 2006 and 3.7 mm per year between 2006 and 2018, so it nearly tripled (IPCC 2021). These numbers come from tide gauges and, since the early 1990s, from satellites. Sea level will continue to rise for centuries because the deep ocean and the ice sheets respond slowly (IPCC 2021). A review of past assessments found that scientists have more often underestimated than overestimated climate change, including sea-level rise (Brysse et al. 2013).

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The claim uses a conspiracy theory, because it assumes that scientists and journalists share a motive to scare the public. It is often supported by cherry picking, for example a single harbour where the land itself is rising. Some headlines do overstate the science by presenting the highest scenario as a certain prediction. The answer is to check the ranges given in scientific assessments, not to reject the measurements.

> **Key message :** ***Sea-level rise is measured by tide gauges and satellites. It has nearly tripled in speed over the last century.***

M4. "The climate has always changed naturally; current changes are not mainly caused by humans"

This statement was accepted by 12.7% of respondents. It had the lowest "don't know" rate in the survey (1.4%), which shows that people hold firm views on the cause of climate change. In the Greek open-text answers, some respondents named human causation itself as the misleading claim.

The first half of the statement is true. The climate has changed naturally in the past, for example between ice ages, and those changes show how strongly the climate responds when the energy balance changes. The second half is false. It is unequivocal that human influence has warmed the atmosphere, ocean and land. The best estimate is that human activity caused essentially all of the warming since the late 19th century, while the sun and volcanoes together contributed between −0.1°C and +0.1°C (IPCC 2021). The warming since 1970 has been faster than in any other 50-year period in at least the last 2,000 years (IPCC 2021). The physics of how CO2 traps heat has been known since the 19th century (Arrhenius 1896), and observations show the human fingerprint directly. For example, the upper atmosphere is cooling while the lower atmosphere warms, which is the pattern expected from greenhouse gases and not from a stronger sun (Santer et al. 2023).

The claim uses a logical fallacy, a false analogy. It argues that because climate changed naturally before, it must be changing naturally now. This is like arguing that because forest fires happened before people existed, no fire today can have a human cause.

> **Key message:** ***The climate has changed naturally before, but today's warming is much faster and is caused by humans burning fossil fuels.***

M5. "Individual actions to reduce emissions are pointless because they don't make a real difference"

This statement was accepted by 12.4% of respondents, with little difference between countries. It was the dominant theme in the Finnish open-text answers, often in the form "there is no point doing anything in little Finland when China and America emit much more". The same comparison with China and the United States appeared in every country.

The evidence shows that changes in how people travel, eat, heat their homes and use energy matter at scale. The IPCC estimates that such demand-side measures could reduce emissions in the end-use sectors by 40% to 70% by 2050, compared with current trends (IPCC 2022). A review of household options found that living without a car, switching to an electric car, flying less, using renewable electricity and eating a plant-based diet are among the actions with the largest savings per person (Ivanova et al. 2020). Individual choices also spread to others. Households are more likely to install solar panels when their neighbours have done so (Bollinger & Gillingham 2012). Individual and collective action are not alternatives. People who change their own habits also vote, influence their workplaces and shape what businesses offer.

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The claim uses a logical fallacy, a false choice between individual action and action by governments or large countries. The comparison with China or the United States adds a second fallacy. Almost every country, region or person is a small share of the total. If every small contributor waited for the largest ones, most emissions would never be reduced.

> **Key message:** ***Every share of emissions looks small on its own. Together, personal choices, community action and policy make the difference, and each one strengthens the others.***

M6. "The claim that almost all climate scientists agree on human-caused climate change is exaggerated"

This statement was accepted by 12.1% of respondents. A second survey item measured the same gap from the other side. Only 66.0% agreed that the large majority of climate scientists attribute recent climate change mainly to human activity, while 13.6% disagreed. This happened in a sample where trust in scientists was higher than trust in any other source.

The evidence shows that the agreement is real and has grown stronger. Several independent studies, using different methods, found a consensus of 90% to 100% among publishing climate scientists that humans are causing recent warming, with most estimates near 97% (Cook et al. 2016). A review of 88,125 climate studies published between 2012 and 2020 found that more than 99% agree that recent warming is mainly human-caused (Lynas, Houlton & Perry 2021). A survey of Earth scientists found 98.7% agreement, rising to 100% among those with the most publications on climate (Myers et al. 2021). This matters because how much agreement people think exists among scientists strongly shapes their other climate beliefs and their support for action (van der Linden et al. 2015).

The claim uses fake experts and a magnified minority. It presents a few dissenting voices, or petitions signed by people without climate expertise, as if they balanced thousands of studies. Media debates that place one scientist against one contrarian can create the same false impression of a split.

> **Key message:** ***More than 99% of recent climate studies agree that humans are causing global warming. The debate among scientists on this question is over.***

M7. "Climate models have been wrong so often that we cannot trust their predictions"

This statement was accepted by 9.7% of respondents. It also had the highest "don't know" rate in the survey (7.5%). This points to real uncertainty about how models perform, rather than firm rejection, and makes it a good topic for simple explanation.

The evidence shows that climate models have predicted global warming well for decades. A study compared 17 projections published between 1970 and 2007 with what actually happened. Once differences between the assumed and the real amounts of greenhouse gases were taken into account, 14 of the 17 projections matched the observed warming (Hausfather et al. 2020). Models are built on the laws of physics and tested against past climates, not fitted to recent temperatures. Uncertainty remains about some regional details and about how people will act. This is why scientists publish scenarios, which say what will happen if emissions follow a certain path, not fixed forecasts.

The claim uses impossible expectations, because it asks climate models to predict the exact temperature of every year, as a weather forecast does for tomorrow. It often adds cherry picking, by choosing one model or one short period that went differently from the long-term trend.

> **Key message:** ***Climate models from the 1970s onward correctly predicted the warming we see today.***

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M8. "Cold winters and recent snowstorms show that global warming is not really happening"

This statement was accepted by only 7.8% of respondents, the second-lowest figure in the survey. The simplest form of denial therefore finds little support. Cold-weather claims still circulate, however. One Portuguese respondent described a realistic AI-generated video of a man ice-skating on a frozen Douro river during the January cold spell.

The evidence shows that weather and climate are different. Weather is what happens over days. Climate is the pattern over decades and across the whole planet. Cold spells still happen in a warming world, but cold extremes have become less frequent and less severe across most land regions since the 1950s, while hot extremes have increased (IPCC 2021). In 2025, at least 95% of Europe had above-average annual temperatures (C3S & WMO 2026). Scientists are still studying whether the fast warming of the Arctic makes some cold spells in Europe more likely, and this question is not yet settled (Cohen et al. 2020).

The claim uses cherry picking. It selects one cold week in one place and ignores decades of global data. The same error is made in the opposite direction when a single cold snap is presented as proof that climate change is getting worse, as M17 explains.

> **Key message:** ***One cold week is weather. Decades of measurements across the planet are climate, and they show clear warming.***

M9. "A warmer climate will, on balance, bring more benefits than harm to my country"

This statement was accepted by only 5.5% of respondents, but it is one of three items whose differences between countries remain significant after correction. In the open-text answers it appeared in local forms, for example that warming is good for Finnish tourism.

The evidence shows that some local gains exist, such as milder winters or longer growing seasons in the north, but they are far smaller than the losses. A global study found that economic productivity peaks at an average annual temperature of about 13°C and falls steeply in hotter places (Burke, Hsiang & Miguel 2015). Southern Europe is already above this level. For Greece, the Bank of Greece Climate Change Impacts Study Committee estimated that, without action, climate change would reduce Greek GDP by 2% per year by 2050 and more by 2100, with a cumulative cost of about €701 billion by 2100. Agriculture was found to be the most affected sector, followed by tourism and coastal areas (Bank of Greece CCISC 2011). The European Climate Risk Assessment finds major climate risks in every European region, including the north (EEA 2024).

The claim uses cherry picking. It selects one possible benefit, such as a lower heating bill or a longer summer season, and ignores heat, drought, wildfire, flood and crop losses.

> **Key message:** ***A few warmer winter days do not balance the costs of heat, drought, fire and floods. For countries like Greece, the costs are far larger.***

M10. "More CO2 in the atmosphere is good because plants need it to grow"

This statement had the lowest acceptance in the survey (4.8%) but a relatively high "don't know" rate (5.4%). This suggests that some respondents are unsure about the science, which makes it a useful topic for simple explanation.

The evidence shows that the claim is partly true and mostly misleading. Plants do use CO2, and satellite data show that a quarter to a half of the Earth's vegetated land became greener between 1982 and 2009, mainly because of more

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CO2 in the air (Zhu et al. 2016). But plants also need water, nutrients and suitable temperatures. Heat and drought from climate change have already reduced the growth of global agricultural productivity by about 21% since 1961 (Ortiz-Bobea et al. 2021). Crops grown under higher CO2 also contain less zinc and iron, which matters for human nutrition (Myers et al. 2014).

The claim uses a logical fallacy, oversimplification. It takes one true fact about plants and presents it as the whole picture.

> **Key message:** ***CO2 is not the only thing plants need. The heat and drought that CO2 brings are already reducing harvests and making food less nutritious.***

M11. "Climate change is mostly caused by the sun" (survey scenario Q6)

The survey presented this claim through a retired engineer with a popular YouTube channel and more than one million subscribers. Respondents rejected it clearly. The mean reliability rating was 1.63 out of 10, 86.2% rated it between 0 and 3, and only 4.0% rated it 7 or higher. The claim is still worth answering because the technique behind it is common and transfers easily to other topics.

The evidence shows that the sun has not caused the recent warming. Satellite measurements since the late 1970s show no increase in the sun's energy that could explain it, and the IPCC estimates that the sun and volcanoes together contributed between −0.1°C and +0.1°C to the warming since the late 19th century (IPCC 2021). If the sun were the cause, the whole atmosphere would warm. Instead, the upper atmosphere is cooling while the lower atmosphere warms, which is the fingerprint of greenhouse gases (Santer et al. 2023).

The claim uses a fake expert. An engineer may be skilled in his own field, and a large audience may make him look credible, but neither makes him a climate scientist. Presenting people without relevant expertise as authorities is one of the most common techniques of science denial (Diethelm & McKee 2009; Cook, Ellerton & Kinkead 2018).

> **Key message:** ***Popularity is not expertise. Measurements show that the sun's energy has not increased, while the planet has warmed.***

M12. "Scientists exaggerate climate change because they receive more research funding when they say it is dangerous" (survey scenario Q7)

Respondents rejected this argument less firmly than the fake expert. The mean rating was 2.76 out of 10, 68.9% rated it between 0 and 3, and 12.6% rated it 7 or higher. Greece had the highest national mean (3.56). In Greece trust in scientists remains high, while trust in media and public institutions is low, so suspicion about motives can attach to science through the institutions around it.

The evidence does not support the claim. The basic physics of human-caused warming was worked out in the 19th century, long before modern research funding existed (Arrhenius 1896). Research funding is competitive, and a scientist who disproved human-caused warming with strong evidence would win great recognition, not lose it. The scientific agreement holds across many countries with different governments and funding systems (Lynas, Houlton & Perry 2021). A review of past assessments found that climate scientists have tended to be cautious and to underestimate rather than exaggerate (Brysse et al. 2013).

The claim uses a conspiracy theory. It assumes a hidden shared motive among thousands of scientists in many countries, and it cannot be disproved, because any evidence against it can be explained away as part of the plot.

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Research shows that a general tendency towards conspiracy thinking is linked to the rejection of climate science (Lewandowsky, Oberauer & Gignac 2013).

> **Key message:** ***Climate science is checked by thousands of independent scientists in many countries. If anything, scientists have been too cautious, not too alarming.***

4. Country-specific misconceptions

This section adds five entries, one for each partner country, so that every national exhibition has a Fact Sheet built on its own context. Each entry takes the narrative that D2.1 ranked highest in that country and that M1 to M12 do not already answer. Table 2 lists the five entries in the order of each country's Climate Misconception Index (CMI), highest first.

Table 2. Country-specific misconceptions added in version 0.2. Source: D2.1, Sections 5.1 to 5.7.

No.	Misconception	Country	Basis in D2.1	Main FLICC technique	Key message
M13	Wildfires are caused by arsonists, not by climate change	Greece	Not a survey item; Greek open-text answers on human causes; highest national CMI (2.29)	Logical fallacy	Heat, drought and wind decide how far a fire goes.
M14	Climate and the environment can wait until the war is over	Ukraine	Lowest climate concern (3.04); 7 of 22 open-text answers say climate news hardly reaches them	Logical fallacy	Clean, local energy is harder to attack.
M15	Finland already does enough; climate policy hurts export industry	Finland	Open-text answers on policy costs (C4); strongest political pattern (ρ = .46)	Cherry picking	Clean power is a reason to invest in Finland.
M16	If a picture or video looks real, it really happened	Portugal	61.9% met AI-generated climate content; 52.9% find it harder to tell true from false	Fake evidence	Check the source, not just the picture.
M17	This flood proves that climate change is getting worse (Q5)	Spain	65.9% rated the flawed argument reliable; Spain mean 8.05 of 10	Cherry picking	One event is not proof.
M18	Overview: how climate myths are built	All	Technique items Q5 to Q7: only 7.1% judged all three arguments with the same scepticism	All five FLICC techniques	Learn the tricks, and you can spot new myths.

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M13. Greece: "Wildfires are caused by arsonists, not by climate change"

The Greek sample recorded the highest Climate Misconception Index of the five countries (2.29 on a 1 to 5 scale). D2.1 ranks three narratives first in Greece: exaggeration, psychological distance and doubt about human causes. The first two are answered in M3, M12 and M1. This entry takes the third, in the form most visible in Greek public debate after every fire season: the claim that large fires are only the work of arsonists, so climate has nothing to do with them. The claim was not a separate survey item. It is chosen because four Greek respondents named human causation itself as the misleading claim, and because European fact-checkers have documented how fires, floods and drought are used to deny climate change in Greece, Italy and Spain (Maldita.es, Facta & Ellinika Hoaxes 2024). In Greece these beliefs are not linked to political position, so the answer should rely on evidence and scientists rather than on political framing.

The evidence shows that both things can be true at the same time. A fire needs a spark, dry fuel and weather that lets it spread. In the Mediterranean, most fires are started by people, through accidents, negligence or arson (Barbero et al. 2020). Climate change does not light the fire. It makes the hot, dry and windy conditions in which a spark becomes a disaster more common. In the French Mediterranean region, human-caused climate change explains nearly half of the long-term increase in fire weather since 1958. Fire weather as extreme as in the 2003 season was expected less than once in 500 years without climate change, and about once in ten years in today's climate (Barbero et al. 2020). The IPCC projects a further increase in fire weather across the Mediterranean at 2°C of global warming and above (IPCC 2021). In August 2023 the fire near Alexandroupoli in Evros burned more than 810 km², the largest wildfire in the EU since records began in 2000 (European Commission 2023).

The claim uses a logical fallacy, a false choice. It presents arson and climate change as alternatives, when they work together: one supplies the spark, the other makes the landscape ready to burn. The claim is sometimes linked to conspiracy theories that fires are set on purpose to serve hidden interests. Police investigations of arson and scientific studies of fire weather answer different questions, and both are needed.

> **Key message:** ***A person may light the match, but heat, drought and wind decide how far the fire goes. Climate change is making those conditions more common.***

M14. Ukraine: "Climate and the environment can wait until the war is over"

The Ukrainian sample recorded the second-highest Climate Misconception Index (2.27) and the highest score of any country for distrust of experts (C5, 2.56). Its top-ranked narrative, that renewables are unreliable (20.2% agreement), is answered in M2. The second is the effect of the war on attention to climate. Ukraine had by far the lowest climate concern in the survey (3.04 on a 1 to 5 scale), and 7 of 22 Ukrainian open-text answers said that climate information hardly reaches people at present. One respondent named as the most misleading claims that the human factor is negligible and that Russia is not committing ecocide in Ukraine. This entry answers the idea, often unspoken, that climate and nature are a topic for peacetime only.

The evidence shows that the war and the climate are connected. The Initiative on GHG Accounting of War estimates that Russia's full-scale invasion caused about 311 million tonnes of CO2-equivalent emissions in its first four years, from fighting, fires, attacks on energy infrastructure, damaged buildings and rerouted flights (de Klerk et al. 2026). After three years the total was already similar to the yearly emissions of Austria, Hungary, Czechia and Slovakia together (de Klerk et al. 2025). In 2025 alone, about 1.39 million hectares of natural land burned in Ukraine (de Klerk et al. 2026). Energy choices are also security choices. Large power plants are easier targets for missiles and drones. For this reason, the Ukrainian government encouraged smaller, decentralised generation, including rooftop solar with

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batteries on hospitals, schools, homes and businesses (IEA 2024). Clean and local energy helps to keep the lights on today and lowers emissions after the war.

The claim uses a logical fallacy, a false choice between security and climate. It treats them as competing priorities, when the war itself damages the climate and nature, and when the same energy choices can serve both. The aim of this Fact Sheet is not to ask people at war to worry more, but to show that the two topics are linked.

> **Key message:** ***The war also damages the climate and nature. Clean, local energy is harder to attack and keeps working when large power plants are hit.***

M15. Finland: "Finland already does enough, and climate policy threatens the competitiveness of our export industry"

The Finnish sample had a lower Climate Misconception Index (1.92), but its open-text answers were dominated by claims against climate solutions. The most common form, that a small country cannot make a difference next to China and the United States, is answered in M5. This entry takes the second form, policy-cost delay, voiced by a respondent who wrote that Finland already does enough and that the green transition threatens the competitiveness of its export industry. In Finland these beliefs follow political lines more closely than in any other country (ρ = .46 between right self-placement and the Index), so the answer should rest on economic facts that people across the political spectrum can check.

The evidence shows that the costs of climate action are real but small, and that the benefits are large. The IPCC estimates that the action needed to keep warming below 2°C would make global GDP 1.3% to 2.7% lower in 2050 than under current policies. This estimate does not include the benefits of avoided climate damage, which are likely to outweigh these costs over the century (IPCC 2022). In Finland, the green transition has become a reason to invest. Finland has set in law the target of carbon neutrality by 2035 (Climate Act 423/2022). The Confederation of Finnish Industries (EK) tracks planned green transition projects in Finland worth more than €300 billion, and about €8.5 billion of such investments were expected to be completed in 2025 alone (Business Finland 2025). EK names affordable clean electricity as a major competitive advantage for these projects (Peljo 2023). To protect European industry, the EU now applies a carbon border adjustment, so that imports of goods such as steel, cement and aluminium pay a carbon price similar to European producers (European Union 2023).

The claim uses cherry picking. It counts the costs of climate policy and leaves out the benefits and the cost of doing nothing. The phrase "already does enough" is a form of delay: it accepts the problem but argues that the next step belongs to someone else.

> **Key message:** ***For Finland, climate action is not only a cost. Clean, affordable electricity is now one of the main reasons industry chooses to invest here.***

M16. Portugal: "If a picture or video looks real, it shows something that really happened"

This entry is about how misinformation reaches people, rather than about one climate claim. Across the survey, 59.0% of respondents had met problematic or suspected AI-generated climate content in the past twelve months. The most common form was fake images of extreme weather (44.5%). In Portugal the encounter rate was 61.9%, and 52.9% of Portuguese respondents found it harder than two years ago to tell true from false climate information, the highest share among the five countries. Portugal also provided the clearest example: a realistic TikTok video, later found to be AI-generated, of a man ice-skating on the frozen Douro river during the January cold spell. Only 21.2% of all

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respondents felt very or extremely confident that they could recognise AI-generated content, and confidence fell with age.

The evidence shows that looking carefully is no longer enough. In a study published in 2022, people who tried to tell real photos of faces from AI-generated ones were right only 48% of the time, about the same as guessing. Even after training, accuracy rose only to 59%, and the fake faces were rated as more trustworthy than the real ones (Nightingale & Farid 2022). What still works is checking the context rather than the picture: who posted it first, whether the national weather service or trusted news report the same event, and whether the same image appears elsewhere with a different date or place. This is called lateral reading, and studies show that it is how professional fact-checkers judge online material (Wineburg & McGrew 2019). Fake images work in both directions. The frozen Douro suggests that warming is not real, while fake disaster images exaggerate real events. Both damage trust in genuine evidence.

The misleading technique here is fake evidence. It is not one of the five FLICC categories, but it often carries them. A fabricated image is an extreme form of cherry picking: it does not select a convenient fact, it creates one.

> **Key message:** ***Seeing is no longer believing. Before you share an image of extreme weather, check who posted it first and whether weather services or trusted news report it.***

M17. Spain: "This flood proves that climate change is getting worse" (survey scenario Q5)

This is the only entry in the annex whose conclusion supports climate action. The survey tested it through scenario Q5, which claimed that a single record cold snap in February 2025 proves that extreme weather will become more frequent. Overall, 65.9% rated this flawed argument as reliable (7 to 10), while the same respondents rejected the contrarian arguments of M11 and M12. Only 7.1% judged all three arguments with the same scepticism. Spain recorded the lowest Climate Misconception Index (1.69) but the highest rating for the flawed argument (mean 8.05 out of 10). Respondents who rated their own judgement highest were slightly more likely to accept it.

The evidence shows that one event alone cannot prove a trend, in either direction, as M8 explains for cold spells. The right question is how much climate change altered the event. Attribution science answers it by comparing today's climate with a cooler world without human-caused warming (Otto 2017). For the DANA floods in Valencia in October 2024, a rapid analysis found that rainfall like this has become about 12% heavier and about twice as likely in today's climate, which is about 1.3°C warmer than before industrialisation. The scientists noted that this was a partial, rapid study (World Weather Attribution 2024). Studies of similar Mediterranean storms also show that the size of a disaster depends on where people live and how prepared they are, not only on the rain (Zachariah et al. 2023).

The claim uses cherry picking and over-generalises from one case. It is the same technique as M8, with the opposite conclusion. It matters because overclaiming gives opponents an easy target. D2.1 found that part of the audience notices exaggeration on the pro-climate side and puts it in the same category as denial.

> **Key message:** ***One event is not proof, even when it seems to confirm what we already believe. Ask what studies say.***

M18. Overview: "How climate myths are built"

This entry is not about one claim. It explains the techniques behind all of them, so that visitors can recognise them in claims they have never seen before. D2.1 shows why this is needed. Respondents clearly rejected the fake expert (M11) and the funding conspiracy (M12), but 65.9% accepted an equally flawed argument when its conclusion supported climate action (M17). Only 7.1% of those who rated all three arguments judged them with the same

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scepticism. Respondents who rated their own judgement highest were slightly more likely to be misled, and a higher level of education did not protect them. People judged the arguments by their conclusion, not by their quality.

Researchers group the techniques of science denial into five families, known as FLICC (Diethelm & McKee 2009; Cook, Ellerton & Kinkead 2018). Each one can be explained in one line and recognised in many different claims.

Fake experts. People without relevant expertise are presented as authorities, or a few dissenting voices are made to look like a split in science. Examples in this annex: M6, M11.

Logical fallacies. The conclusion does not follow from the facts, for example through a false choice or a false analogy. Examples: M4, M5, M10, M13, M14.

Impossible expectations. A level of certainty or performance that nothing can meet is demanded, and the science or the solution is rejected for failing it. Examples: M2, M7.

Cherry picking. The few facts that fit are selected and the rest are ignored. Examples: M1, M3, M8, M9, M15, M17.

Conspiracy theories. A hidden plot among scientists or institutions is claimed. The claim cannot be disproved, because any evidence against it becomes part of the plot. Examples: M3, M12.

With AI tools, a further technique has become common: fake evidence, where images, videos or quotes are made up (M16). The claims themselves fall into five families, known as CARDS: it's not happening (C1), it's not us (C2), it's not bad (C3), solutions won't work (C4) and experts are unreliable (C5). A study of two decades of contrarian texts found a shift away from denying that warming is happening and towards attacks on solutions and on scientists (Coan et al., 2021). The CLIMAware survey found the same pattern in what people believe. In every partner country, claims against solutions (C4) and against experts (C5) were more widely accepted than claims that deny the science itself.

Learning the techniques works like a vaccine. People who are shown how a misleading technique works before they meet it become more resistant to new claims that use it (Cook, Lewandowsky & Ecker 2017). In a field study on YouTube, short videos that explained techniques such as false choices and scapegoating improved people's ability to recognise manipulation (Roozenbeek et al. 2022). Because the survey showed that people are most easily misled by claims they agree with, this Fact Sheet should present the techniques as tools that can be used for any conclusion, and should include at least one pro-climate example (M17). In an exhibition, the sheet works best at the entrance, so that visitors carry the five techniques to the other sheets, while each sheet still names its own technique in one line.

> **Key message:** ***Every climate myth uses a small set of tricks. Learn the tricks, and you can spot new myths before they fool you, including the ones you would like to believe.***

5. How to use this annex

Three practical points follow for the WP3 Fact Sheets.

1. Each Fact Sheet should lead with the fact, name the myth once, explain the technique that makes it misleading, and close by repeating the fact, as recommended in The Debunking Handbook 2020 (Lewandowsky et al. 2020). The key messages at the end of each entry in Sections 3 and 4 are written for this purpose.
2. Explaining the technique matters as much as correcting the claim, because people who learn to recognise a technique become more resistant to new claims that use it (Cook, Lewandowsky & Ecker 2017).

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3. Fact Sheets must not overclaim. Every number in this annex can be traced to a source in the following references and the same discipline should apply to the illustrated versions.

6. Seventeen creative triggers for the CLIMAware artists

This section turns the seventeen misconceptions into short statements that artists can use as a starting point for their work in WP3. Each statement corresponds to one entry in Section 3 or 4, keeps the same number (M1 to M17) and rests on the evidence presented there. The statements are not slogans or captions. They are triggers, meant to open a question, an image or a story, and artists are free to interpret them in their own medium and style. Artists may combine statements or focus on the one closest to their local context.

M1. Somewhere else, someday, is already here, in places we know by name.

M2. No single light keeps a city lit. A network does.

M3. The sea keeps its own records, and they show it is rising faster than before.

M4. Nature has changed the climate before, slowly. This time the hand on the dial is ours, and it is moving fast.

M5. Small is not the same as pointless. Every big change is made of small ones that spread.

M6. Ninety-nine voices say the same thing and one voice shouts. Which one do we hear?

M7. Fifty years ago, scientists drew a line into the future. Today we are living on it.

M8. A cold morning does not cancel a warming century.

M9. A warmer winter is a small gift that comes with a very large bill.

M10. More air does not help a plant whose roots are thirsty.

M11. The sun has not changed. We have.

M12. Science is thousands of people trying to prove each other wrong and still reaching the same answer.

M13. A match is small. The dry summer around it is not.

M14. When the big power plant goes dark, the solar panel on the school roof keeps the lights on.

M15. Clean power is not a cost the factory pays. It is the reason the factory comes.

M16. The river never froze. The video did.

M17. Even when the storm agrees with you, ask for the evidence.

M18. Five tricks, a thousand myths. Learn the tricks once, and the myths lose their power.

7. References cited in this annex

Arrhenius, S. 1896. On the influence of carbonic acid in the air upon the temperature of the ground. The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science. Vol. 41(251), 237–276.

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Bank of Greece Climate Change Impacts Study Committee. 2011. The environmental, economic and social impacts of climate change in Greece. Athens: Bank of Greece.

Barbero, R., Abatzoglou, J. T., Pimont, F., Ruffault, J., & Curt, T. 2020. Attributing increases in fire weather to anthropogenic climate change over France. Frontiers in Earth Science. Vol. 8, 104. Cited 29th Oct 2026. Available at doi.org/10.3389/feart.2020.00104

Bollinger, B., & Gillingham, K. 2012. Peer effects in the diffusion of solar photovoltaic panels. Marketing Science. Vol. 31(6), 900–912. Cited 29th Oct 2026. Available at https://doi.org/10.1287/mksc.1120.0727

Brysse, K., Oreskes, N., O'Reilly, J., & Oppenheimer, M. 2013. Climate change prediction: Erring on the side of least drama? Global Environmental Change. Vol. 23(1), 327–337. Cited 29th Oct 2026. Available at https://doi.org/10.1016/j.gloenvcha.2012.10.008.

Burke, M., Hsiang, S. M., & Miguel, E. 2015. Global non-linear effect of temperature on economic production. Nature, 527, 235–239. Cited 29th Oct 2026. Available at https://doi.org/10.1038/nature15725

Business Finland. 2025. Finland Q2 2025 business snapshot: A springboard for innovation and growth. Helsinki: Business Finland.

C3S & WMO. 2026. European State of the Climate 2025. Germany: Copernicus Climate Change Service & Switzerland: World Meteorological Organization. Cited 29th Oct 2026. Available at doi.org/10.24381/zy93-sb27

Climate Act (Ilmastolaki) 423/2022. Finlex. Cited 29th Oct 2026. Available at https://www.finlex.fi/fi/lainsaadanto/2022/423

CLIMAware. 2026. Survey report on misconceptions related to climate change. Greece: CBioHub. Cited 29th Oct 2026. Available at https://lab.fi/sites/default/files/2026-08/climaware_d2_1_v1.0_cbiohub.pdf

Coan, T.G., Boussalis, C., Cook, J. & Nanko, N. 2021. Computer-assisted classification of contrarian claims about climate change. Scientific Reports. Vol 11(1), 22320. Cited 16th Oct 2026. Available at https://doi.org/10.1038/s41598-021-01714-4

Cohen, J., Zhang, X., Francis, J., Jung, T., Kwok, R., Overland, J., Ballinger, T.J., Bhatt, U.S., Chen, H. W., Coumou, D., Feldstein, S., Gu, H., Handorf, D., Henderson, G., Ionita, M., Kretshmer, M., Laliberte, F., Lee, S., Linderholm, H.W., Maslowski, M., Peings, Y., Pfeiffer, K., Rigor, I., Semmler, T., Stroeve, J., Taylor, P.C., Vavrus, S., Vihma, T., Wang, S., Wendisch, M., Wu, Y. & Yoon, J. 2020. Divergent consensuses on Arctic amplification influence on midlatitude severe winter weather. Nature Climate Change. Vol. 10, 20–29. Cited 29th Oct 2026. Available at https://doi.org/10.1038/s41558-019-0662-y

Cook, J., Ellerton, P., & Kinkead, D. 2018. Deconstructing climate misinformation to identify reasoning errors. *Environmental Research Letters*. Vol. 13, 024018. Cited 29th Oct 2026. Available at DOI 10.1088/1748-9326/aaa49f

Cook, J., Lewandowsky, S., & Ecker, U. K. H. 2017. Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence. PLOS ONE. Vol. 12(5), e0175799. Cited 29th Oct 2026. Available at https://doi.org/10.1371/journal.pone.0175799

Cook, J., Oreskes, N., Doran, P. T., et al. (2016). Consensus on consensus: A synthesis of consensus estimates on human-caused global warming. Environmental Research Letters. Vol. 11, 048002. Cited 29th Oct 2026. Available at DOI 10.1088/1748-9326/11/4/048002

de Klerk, L., Shlapak, M., Zibtsev, S., Myroniuk, V., Soshenskyi, O., Vasylyshyn, R., Krakovska, S. & Kryshtop, L. 2025. Climate damage caused by Russia's war in Ukraine: 36 months of full-scale war (preliminary assessment). Ukraine: Initiative on GHG Accounting of War. Cited 30th Oct. Available at https://en.ecoaction.org.ua/wp-content/uploads/2025/02/20250224_ClimateDamageWarUkraine36monthsENprelim-1.pdf

de Klerk, L., Shlapak, M., Zibtsev, S., Myroniuk, V., Soshenskyi, O., Vasylyshyn, R., Krakovska, S., Kryshtop, L. & Bun, R. 2026. Climate damage caused by Russia's war in Ukraine: 48 months of full-scale war. Ukraine: Initiative on GHG

Co-funded by the European Union

Accounting of War. Cited 30th Oct. Available at https://en.ecoaction.org.ua/wp-content/uploads/2026/02/climate-damage-rusagression_48months_en-2s.pdf

Diethelm, P., & McKee, M. 2009. Denialism: What is it and how should scientists respond? European Journal of Public Health. Vol. 19(1), 2–4. Cited 30th Oct 2026. Available at https://doi.org/10.1093/eurpub/ckn139

EEA. 2024. European Climate Risk Assessment. EEA Report 01/2024. Denmark, Copenhagen: European Environment Agency. EEA Report 01/2024. Cited 30th Oct 2026. Available at https://www.eea.europa.eu/en/analysis/publications/european-climate-risk-assessment/european-climate-risk-assessment-report/@@download/file

ENTSO-E. 2026. Grid incident in Spain and Portugal on 28 April 2025. ICS Investigation Expert Panel final report. Brussels: ENTSO-E. Cited 30th Oct 2026. Available at https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/Publications/2025/iberian-blackout/Final%20Report%20on%20the%20Grid%20Incident%20in%20Spain%20and%20Portugal%20on%2028%20April%202025.pdf

European Commission. 2023. Statement by the Commission spokesperson on EU support to Greece for the Evros wildfire, 29 August 2023, citing the Emergency Response Coordination Centre and EFFIS data. Brussels: European Commission.

European Union. 2023. Regulation (EU) 2023/956 establishing a carbon border adjustment mechanism. Official Journal of the European Union L130. Vol. 66, 52–104. Cited 30th Oct 2026. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2023:130:FULL

Flaounas, E., Dafis, S., Davolio, S., Faranda, D., Ferrarin, C., Hartmuth, K., Hochman, A., Koutroulis, A., Khodayar, S., Miglietta, M.M., Pantillon, F., Patlakas, P., Sprenger, M. &Thurnherr, I. 2025. Dynamics, predictability, impacts and climate change considerations of the catastrophic Mediterranean Storm Daniel (2023). Weather and Climate Dynamics. Vol. 6, 1515–1538. Cited 30th Oct 2026. Available at https://doi.org/10.5194/wcd-6-1515-2025

Hausfather, Z., Drake, H. F., Abbott, T., & Schmidt, G. A. 2020. Evaluating the performance of past climate model projections. *Geophysical Research Letters*. Vol 47, e2019GL085378. Cited 30th Oct 2026. Available at https://doi.org/10.1029/2019GL085378

IEA. 2024. Ukraine's energy security and the coming winter. Paris: International Energy Agency. Cited 30th Oct 2026. Available at https://www.iea.org/files/cec49dc2-7d04-442f-92aa-54c18e6f51d6/UkrainesEnergySecurityandtheComingWinter.pdf

IPCC. 2021. Summary for Policymakers. In: Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S-L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J.B.R., Maycock, T. K., Waterfield, T., Yelekçi, O., Yu, R. & Zhou, B. (eds.). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. 3–32. Cited 30th Oct 2026. Available at doi:10.1017/9781009157896.001.

IPCC. 2022. Summary for Policymakers. In: Schukla, P.R., Skea, J., Reisinger, A., Slade, R., Fradera, R., Pathak, M., Al Khourdajie, A., Belkacemi, M., vanDiemen, R., Hasija, A., Lisboa, G., Luz, S., Malley, J., McCollum, D., Some, S., Vyas, P. (eds.) Climate Change 2022 - Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press. 3–48. Cited 30th Oct 2026. Available at doi: 10.1017/9781009157926.001.

Ivanova, D., Barrett, J., Wiedenhofer, D., Macura, B., Callaghan, M., Creutzig, F. 2020. Quantifying the potential for climate change mitigation of consumption options. Environmental Research Letters. Vol. 15(9), 093001. Cited 30th Oct 2026. Available at doi: 10.1088/1748-9326/ab8589

Lewandowsky, S., Cook, J., Ecker, U., Albarracin, D., Amazeen, M., Kendou, P., Lombardi, D., Newman, E., Pennycook, G., Porter, E., Rand, D. Rapp, D., Reifler, J., Roozenbeek, J., Schmid, P., Seifert, C. Sinatra, G., Swire-Thompson, B. van

Co-funded by the European Union

der Linden, S. Vraga, E. Wood, T. & Zaragoza, M. 2020. The Debunking Handbook 2020. Cited 30th Oct 2026. Available at https://doi.org/10.17910/b7.1182

Lewandowsky, S., Oberauer, K., & Gignac, G. E. 2013. NASA faked the moon landing—therefore, (climate) science is a hoax: An anatomy of the motivated rejection of science. Psychological Science, 24(5), 622–633. Cited 30th Oct 2026. Available at https://doi.org/10.1177/095679761245768

Lynas, M., Houlton, B. Z., & Perry, S. 2021. Greater than 99% consensus on human caused climate change in the peer-reviewed scientific literature. Environmental Research Letters, 16, 114005. Cited 30th Oct 2026. Available at doi: 10.1088/1748-9326/ac2966

Maldita.es, Facta, & Ellinika Hoaxes. 2024. Denialism in Italy, Spain and Greece stemming from drought, floods and forest fires: How conspiracy theories misrepresent extreme events to deny climate change. Maltida.es. Cited 30th Oct 2026. Available at https://maldita.es/clima/20240628/negacionismo-italia-espana-grecia-sequia-inundaciones-incendios/

Myers, K. F., Doran, P. T., Cook, J., Kotcher, J. E., & Myers, T. A. 2021. Consensus revisited: Quantifying scientific agreement on climate change and climate expertise among Earth scientists 10 years later. Environmental Research Letters. Vol. 16, 104030. doi: 10.1088/1748-9326/ac2774

Myers, S. S., Zanobetti, A., Kloog, I., Huybers, P., Leakey, A.D.B., Bloom, A.J., Carlisle, E., Dietterich, L. H., Fitzgerald, G., Hasegawa, T., Holbrook, N.M., Nelson, R.L., Ottman, M.J., Raboy, V., Sakai, H., Sartor, K.A., Schwartz, J., Seneweera, S., Tausz, M., Usui, Y. 2014. Increasing CO2 threatens human nutrition. Nature. Vol. 510, 139–142. Cited 30th Oct 2026. Available at https://doi.org/10.1038/nature13179

Nightingale, S. J., & Farid, H. 2022. AI-synthesized faces are indistinguishable from real faces and more trustworthy. Proceedings of the National Academy of Sciences. Vol. 119(8), e2120481119. Cited 30th Oct 2026. Available at https://doi.org/10.1073/pnas.2120481119

Ortiz-Bobea, A., Ault, T. R., Carrillo, C. M., Chambers, R. G., & Lobell, D. B. 2021. Anthropogenic climate change has slowed global agricultural productivity growth. Nature Climate Change, 11, 306–312. Cited 30th Oct 2026. Available at https://doi.org/10.1038/s41558-021-01000-1

Otto, F. E. L. 2017. Attribution of weather and climate events. Annual Review of Environment and Resources. Vol. 42, 627–646. Cited 30th Oct 2026. Available at https://doi.org/10.1146/annurev-environ-102016-060847

Peljo, J. 2023. Finland is well positioned for green investments. In: State Treasury of Finland Annual Review 2023. Helsinki: State Treasury. Cited 30th Oct 2026. Available at https://www.treasuryfinland.fi/annualreview2023/

Roozenbeek, J., van der Linden, S., Goldberg, B., Rathje, S., & Lewandowsky, S. 2022. Psychological inoculation improves resilience against misinformation on social media. Science Advances. 8(34), eabo6254. Cited 30th Oct 2026. Available at DOI: 10.1126/sciadv.abo6254

Santer, B. D., Po-Chedley, S., Zhao, L., & Taylor, K.E. 2023. Exceptional stratospheric contribution to human fingerprints on atmospheric temperature. Proceedings of the National Academy of Sciences. Vol. 120 (20), e2300758120. Cited 30th Oct 2026. Available at https://doi.org/10.1073/pnas.2300758120

Spence, A., Poortinga, W., & Pidgeon, N. 2012. The psychological distance of climate change. Risk Analysis. Vol. 32(6), 957–972. Cited 30th Oct 2026. Available at https://doi.org/10.1111/j.1539-6924.2011.01695.x

van der Linden, S., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. 2015. The scientific consensus on climate change as a gateway belief: Experimental evidence. PLoS One. Vol. 10(2), e0118489. Cited 19th Oct 2026. Available at https://doi.org/10.1371/journal.pone.0118489

Wineburg, S., & McGrew, S. 2019. Lateral reading and the nature of expertise: Reading less and learning more when evaluating digital information. Teachers College Record. Vol. 121(11), 1–40. Cited 30th Oct 2026. Available at https://doi.org/10.1177/016146811912101102

Co-funded by the European Union

World Weather Attribution. 2024. Extreme downpours increasing in southern Spain as fossil fuel emissions heat the climate. World weather attribution. Cited 30th Oct 2026. Available at https://www.worldweatherattribution.org/extreme-downpours-increasing-in-southern-spain-as-fossil-fuel-emissions-heat-the-climate/

Zachariah, M., Kotroni, V., Kostas, L., Barnes, C., Kimutai, J., Kew, S., Pinto, I., Bloemendaal, N., Yang, W., Vahlberg, M., Singh, R., Thalheimer, L., & Otto, F. E. L.2023. Interplay of climate change-exacerbated rainfall, exposure and vulnerability led to widespread impacts in the Mediterranean region. London: Imperial College Press. Cited 30th Oct 2026. Available at https://spiral.imperial.ac.uk/bitstream/10044/1/106501/14/scientific%20report%20-%20Mediterranean%20floods.pdf

Zhu, Z., Piao, S., Myneni, R. B., Huang , M., Zeng, Z., Canadell, J.G., Ciais, P., Sitch, S., Friedlingstein, P., Arneth, A., Cao, C., Cheng, L., Kato, E., Koven, C., Li, Y., Lian, X., Liu, Y., Liu, R., Mao, J., Pan., Y., Peng, S., Peñuelas, J., Poulter, B., Pugh, T.A.M., Stocker, B.D., Viovy, N., Wang, X., Xiao, Z., Yang, H., Zaehle, S. & Zeng, N. 2016. Greening of the Earth and its drivers. Nature Climate Change, 6, 791–795. Cited 30th Oct 2026. Available at https://doi.org/10.1038/nclimate3004

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