



Framing and accuracy of AMOC reporting in Dutch journalistic media: comparing scientific research papers and news articles

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Abstract

10 The Atlantic Meridional Overturning Current (AMOC) may be approaching a tipping point, with potentially significant environmental and societal consequences. Here, we examine the framing and accuracy of Dutch news articles reporting on the AMOC slowdown or potential collapse using peer-reviewed scientific research papers. In total, we analysed 17 scientific papers and 73 news articles published between 1999 and 2025 using qualitative coding, and eight scientists were interviewed to assess their opinion on the representation of their research in these news articles. Our analysis reveals that Dutch news
15 articles often omit methodological detail and scientific uncertainties, while emphasizing the timing of an AMOC collapse. Dutch news articles simplify terminology, use types of exaggeration, and localize information to engage a broader public. Although most interviewed scientists consider the media coverage of their research adequate, they identify areas for improvement and propose solutions. Overall, Dutch journalistic media often accurately convey the core concepts of AMOC-related scientific research papers, but place strong emphasis on societal consequences and opportunities of an AMOC collapse.

20 1 Introduction

The Atlantic Meridional Overturning Circulation (AMOC) is a large-scale ocean circulation system that distributes heat from the tropics to the North Atlantic (Bower et al., 2019), influencing global and regional climate (van Aken, 2007). Climate models project further AMOC weakening if global warming continues (Intergovernmental Panel On Climate Change (IPCC), 2022; Van Westen et al., 2025). Although a near-future AMOC collapse is plausible, consensus on the timing of the potential
25 tipping point or the reversibility of its impacts is limited (Ditlevsen and Ditlevsen, 2023; Rahmstorf et al., 2015; Van Westen et al., 2024). The AMOC's stability depends on balanced freshwater and buoyancy fluxes, ocean temperature, and other feedback mechanisms that affect deep-water formation (Rahmstorf et al., 2015; Sinet et al., 2025; Thornalley et al., 2018; Van Westen et al., 2024). Continued global warming could increase freshwater input from precipitation, river discharge, ice melt, and ocean temperature, reducing surface water density and weakening overturning circulation (Caesar et al., 2018; Toggweiler
30 and Si, 2025). A weakened AMOC could reduce northward heat transport, thereby decrease North Atlantic sea surface temperatures, expand Nordic (sea-)ice cover, shift atmospheric circulation patterns, and cause sea level rise along European



coastlines (Caesar et al., 2018). These impacts would affect ecosystems, agriculture, economies, and societies (Thornalley et al., 2018; Van Westen and Baatsen, 2025).

35 Given the AMOC's role in global climate, reducing the risk of a potential AMOC collapse requires effective mitigation of global warming. Accurate communication of scientific research may be needed to enhance public awareness and informed climate policy (Bolsen and Shapiro, 2018). And given that AMOC weakening can lead to regional cooling despite global warming (Van Westen and Baatsen, 2025), accurate and nuanced reporting of the AMOC and its impacts is essential for public comprehension.

40 An increase in scientific research articles about a possible AMOC collapse and its impacts have led to more frequent coverage in Dutch news articles, where Dutch climate research reporting is largely triggered by press releases rather than direct correspondence with the published scientific research papers (Vestergård, 2011; Vonk et al., 2024b). Because news articles reach a broad audience, the accuracy and completeness of the information they present are fundamental for public comprehension. Journalists often omit or simplify scientific terminology and rely on information conveyed in press releases (Bossemma et al., 2019; Hijmans et al., 2003). Prior research indicates that information accuracy and completeness regarding
45 climate science varies (Pellechia, 1997; Vestergård, 2011).

The goal of science communication is to present information that is accurate, understandable, and relevant to the public, thereby increasing awareness, trust, and public understanding (Bossemma et al., 2019; Intemann, 2022; Smeets, 2021). However, in climate communication, exaggeration or selective framing can lead to inaccurate information transfer from scientific papers to the news. Extreme negativity may provide a distorted perspective for non-experts (Intemann, 2022), and omitting scientific
50 terminology and uncertainties can reduce news accuracy. Journalists may also include comments from external scientists to provide diverse perspectives, but a decontextualized statement can contribute to misinterpretation (Bossemma et al., 2019).

Scientists do not always agree with how their research is represented in journalistic media. Although scientists and journalists differ in writing styles, goals, and constraints, maintaining accurate communication is essential. Imprecise vocabulary, phrasing, and misleading time notations can make scientific findings appear more dramatic than intended.

55 To address, among others, these challenges in AMOC communication and improve information transfer and communication regarding the AMOC, we examined the framing of the information transferred between peer-reviewed published scientific papers and the corresponding Dutch news articles between 1999 and 2025. We applied framing analysis to identify differences and similarities in primary concepts, terminology, and tone (Baralt, 2011). We then interviewed scientists who have published AMOC-related research, thus providing further insight into how they perceive the representation of their research in Dutch
60 journalistic media.



2 Methods

2.1 Creating a dataset for textual analysis of newspaper articles and scientific papers

We selected news articles using Lexis and the PlumX metrics in the Scopus Research portal of the University of Utrecht. The Lexis search query included publications from 1990 onward, using the terms “AMOC” and “Golfstroom”. The year 1990
65 coincides with the release of the first IPCC Assessment Report, after which climate tipping points were increasingly discussed (Stocker et al., 2025), the availability of longer-term AMOC observations, and the digitalization of Dutch newspapers began. Because of digitalization and the journalistic urge to reach a broad audience, both traditional newspaper articles and online journalistic news-related sources (e.g., Nu.nl, NOS, and Scientias) were included and coded equivalently. We only included news articles that have an evident reference to a scientific paper and include identical news articles, defined as articles with
70 identical text and published in different newspaper agencies, only once. The final dataset of 73 news articles includes national (e.g., NRC Handelsblad) and regional (e.g., Tubantia) journalistic outlets.

We initially selected the scientific papers from references cited in the news articles. In a second filtering step, we used the Altmetric Details Page API, Altmetric Explorer with API, and the Dimensions Analytics to assess each scientific paper’s citations. To be included, at least one news article had to appear within twenty days of the paper’s publication and contain at
75 least one full paragraph discussing the research findings. In a third filtering round, we selected scientific papers that were most frequently represented in news articles. We excluded review papers and studies focusing solely on the Gulf Stream because they lack data on AMOC strength. The final dataset contains 17 scientific papers published between 1999 and 2025 (Baker et al., 2025; Boers, 2021; Bryden et al., 2005; Caesar et al., 2018, 2021; Ditlevsen and Ditlevsen, 2023; Hansen et al., 2001; Liu et al., 2023; Rahmstorf et al., 2015; Rühlemann et al., 1999; Smeed et al., 2018; Smolders et al., 2024; Thornalley et al., 2018;
80 Van Westen et al., 2024, 2025; Van Westen and Baatsen, 2025; Willis, 2010). Authors may appear as co-authors on multiple studies. Five news articles are based on two scientific papers: four of these news articles refer to both Thornalley et al. (2018) and Caesar et al. (2018), and one news article refers to Ditlevsen and Ditlevsen (2023) and van Westen et al. (2024).

2.2 Conducting interviews for responses by scientists

To gain insight into scientists’ perspectives on the accuracy of journalistic communication and information transfer between
85 their published research papers and a corresponding Dutch news article, we conducted semi-structured interviews with seven of the scientists whose work appears in the dataset. Scientists were selected based on their authorship of AMOC-related research and their diverse research institutions. Their scientific papers introduced original theories or methods regarding AMOC strength and received notable attention in Dutch journalistic media. The scientists included physical oceanographers, dynamical meteorologists, mathematicians, and statisticians. We also interviewed a climate-oceanography expert who did not
90 (co-)author any of the scientific papers in the dataset, but whose expert’s commentary was frequently cited in the news articles. In the interviews, we explored how scientists define scientific truth, how they perceive the information transfer from scientific papers to news articles, how they evaluate journalistic framing, and possible improvements in communicating AMOC research.



We conducted two interviews in person, and five via Microsoft Teams. Six interviews were one-on-one, and one interview was with two scientists. Three interviews were carried out in Dutch, the other four in English, and lasted between 30 and 60 minutes. The corresponding quotes have been translated literally and checked to ensure the meaning was preserved. During the interview, each scientist received one news article referring to their own scientific paper or to a paper on which they had previously provided commentary. We selected the news articles to cover a broad range of topics related to AMOC research and variables identified in the framing codebook. Selection criteria included comprehensiveness of frame variables, explicit reference to the scientific paper, and a length of at least three paragraphs but no longer than one A4 page of text. Three of the five selected articles used headlines that addressed societal relevance using terms such as “warned”, “extremely cold”, or “closer than thought”. To ensure authentic responses, we first asked scientists for their general impressions. The interviews then addressed their definition of well-constructed content, scientists’ impact on society, the occurrence of specific frame elements, possible causes of inaccurate AMOC communication, societal consequences, and possible refinements. We then transcribed all interviews using Microsoft Word or Teams, and removed filler words, stuttering, and unnecessary repetitions while preserving the original meaning.

2.3 Coding of frames

We conducted a systematic coding process of the different frames of each scientific research paper, news article and interview, using a hybrid descriptive coding approach and the NVivo 15.3.0 software. This led to two codebooks: one for the texts and one for the interviews. Because the scientific papers and news articles differ in information density, the coding categories are generalized to include a broader range of information detail. We coded on paragraphs level, to preserve the contextual meaning of individual sentences while preventing the omission of detailed AMOC information. Our codebook builds on the framework developed by Vonk et al. (2024b). The coding process follows the definition of framing by Entman (1993): *“to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation”*, and uses open coding based on Entman’s four core functions of framing: *“problems”*, *“causes”*, *“moral judgments”*, and *“remedies”*. To capture recurring frames on the AMOC slowdown or collapse in greater detail, we developed additional categories using the grounded theory methodology (Glaser and Strauss, 2017). During this process, we highlighted text segments to identify potential additional themes and to examine whether these themes appeared across multiple scientific papers and news articles. When potential themes reoccurred, we added these as a new or refined category. The broader main categories found are defined as “elements”, subcategories as “variables”, and even more detailed groups as “specifications”. Each paragraph is single-coded into one or multiple frame elements, variables, or specifications to identify the core concepts. The final codebook consists of 12 frame elements, 47 frame variables, and 33 specifications.



The twelve main frame elements of the codebook are: (1) Consequences of the AMOC weakening or collapse, (2) Opportunities due to the AMOC weakening or collapse, (3) Attribute of responsibility for causing the AMOC weakening or collapse, (4) Attribute of responsibility for treatment, (5) Urgency to take action, (6) Treatment recommendation, (7) Scientific frame, (8) Working of the AMOC, (9) Statement on the AMOC weakening or collapse, (10) Steady AMOC, (11) Gulf Stream, and (12) External experts. An element can be further elaborated into variables and specifications. An overview of all categories is provided in Te Koppele and Van Sebille (2026).

We assessed the accuracy, consistency, and trustworthiness of our codebook using intercoder reliability (Lombard et al., 2002; O'Connor and Joffe, 2020). In a two-stage process, we ended up with an intercoder reliability (using the method of Ting, 2011) of 0.72 for the scientific research papers and 0.96 for the news articles.

In the interview, we found 5 frame elements using deductive coding: (1) Define problems or similarities, (2) Diagnose causes, (3) Suggestion of remedies, (4) Moral judgments, and (5) Additional subject matters. Each frame element contains two to six frame variables derived from the results using the framing codebook for the texts. We then used inductive coding to further distinguish the roles of scientists and journalists within the causal and responsibility frames.

Unlike the codebook for the texts, which codes individual paragraphs, the interview codebook codes entire responses. Coding complete responses allows repetitions and explanations to be captured as one coherent opinion, ensuring an accurate understanding of the scientists' message. The intercoder reliability for this interview codebook was 0.93.

Results

3.1 Textual analysis of newspaper articles and scientific papers

In table A1, we present the distribution of all coded frame elements, variables, and specifications across the seventeen scientific research papers and the seventy-three corresponding Dutch news articles. This data is also visualised in Figure 1. Our data shows that, in general, there is a good agreement between the frames in the scientific research papers and the news articles. The prevalence of many of the frame variables is roughly similar.

There are a few notable exceptions, though. The Gulf Stream is never confused with the AMOC in the scientific research papers – as could be expected. However, the two terms are used interchangeably in more than half of the news articles. It could similarly have been expected that news articles would contain much more frame elements about the working of the AMOC – which would be assumed as known for the readers of the scientific research papers.

Perhaps more surprising is that the scientific research papers focus more on the (intrinsic/internal) variability of the AMOC strength than the news articles. Also surprising is that the frames about uncertainty are much more prevalent in the scientific research papers than in the news articles: 82% of the papers refer to uncertainty in the data while only 18% of the news articles copy that. The call for further research, which 76% of the scientific research articles have, is rarely transferred to the news articles.

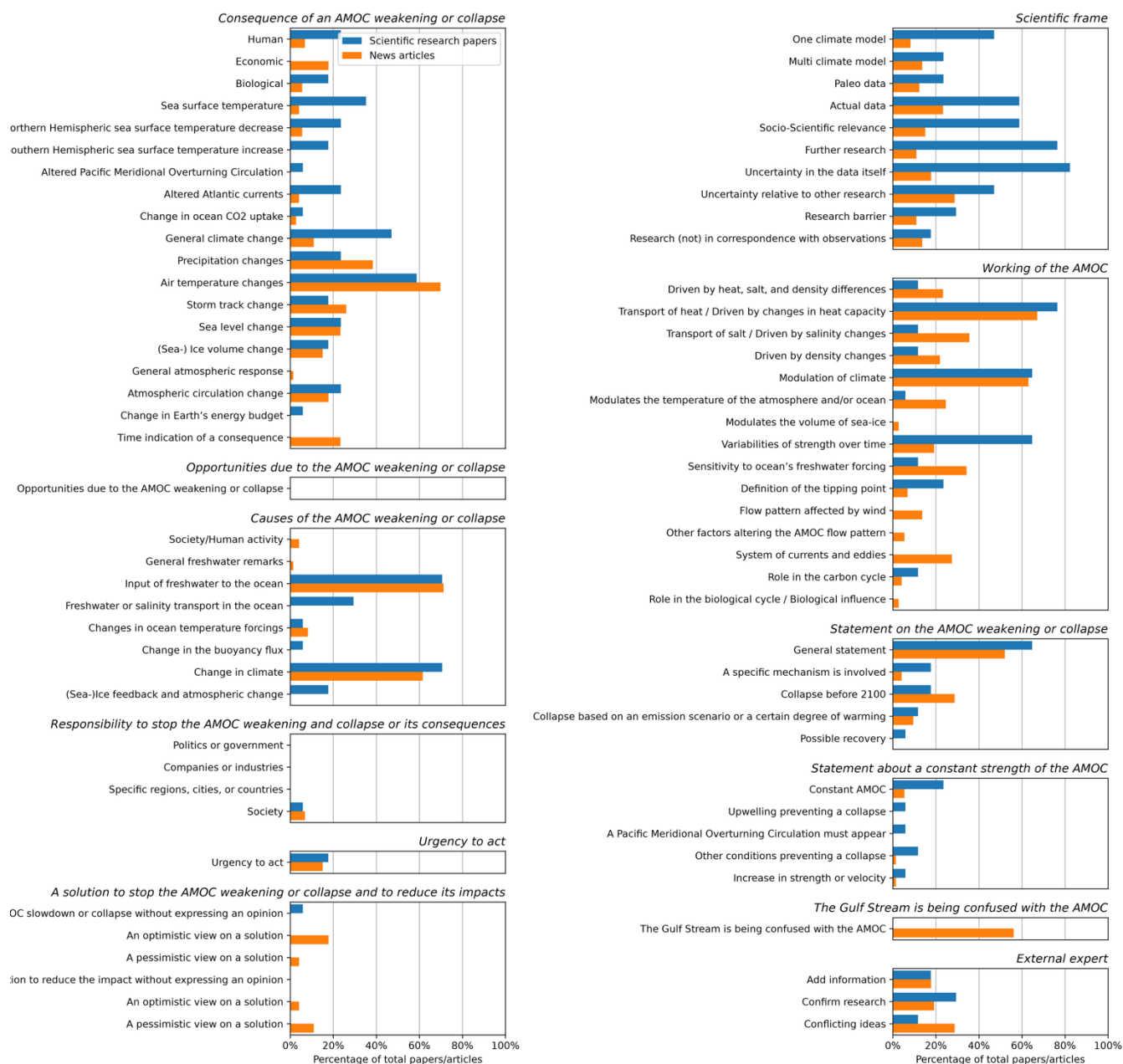


Figure 1: The percentages of scientific research papers (blue, n=17) and news articles (orange, n=73) coded across all frame variables, grouped by their frame element.

While hardly any of the scientific research papers contain a solution to stop the AMOC weakening or collapse and to reduce its impacts, quite a few of the news articles have added this frame, and surprisingly often in an optimistic tone. Interesting is also that while a few of the news articles emphasize human activity as a separate cause for AMOC weakening or collapse, the scientific research papers make this connection by referring to anthropogenic greenhouse gas emissions (often in the



introduction of a paper). Furthermore, some of the news articles that provide dates of a possible collapse do so by referring to a specific year, without any error margins or uncertainties – while the scientific research papers often do include these, providing a time range for possible collapse.

Finally, both scientific research papers and news articles discuss a wide range of consequences of AMOC weakening or collapse; although there seems to be a subtle difference where the scientific research papers take a global perspective and the news articles focus on regional impacts and economic impacts. Northern Hemisphere SST changes are addressed more often in the scientific research papers, and Southern Hemisphere SST changes are only mentioned in scientific research papers that already discuss the SST. The scientific research papers, however, provide detailed descriptions of the processes and model input values required to initiate a tipping point, whereas most corresponding news articles include general statements.

3.2 Responses by scientists

Most scientists who we interviewed evaluated the representation of AMOC-related research in the Dutch news articles positively. One scientist offered a neutral remark, noting that different target audiences and time constraints affect how journalists present scientific research.

The scientists described several priorities they consider important when communicating AMOC-related research. Scientists aim to raise public awareness about the results and their broader impacts; with the ultimate goals that it reaches politicians who will take appropriate action. Consequently, the scientists emphasized considering the timescales involved, when communicating the possibility of a collapse. They highlight that the AMOC does not collapse instantaneously, and that preventive measures can already be implemented. The scientists considered basic concepts, the introduction of new models, and nuance essential for enhancing public understanding.

The scientists have varied specific remarks about the information transfer between the scientific research paper and the news article we showed them. Criticism was focused on the use of exaggerated terms, inaccurate scientific concepts, and the replacement of the AMOC with “the Gulf Stream”. Some scientists noted incorrect geological terminology, such as referring to the Gulf Stream Extension region as the Gulf of Mexico or describing “ocean sediment sites” as “drilling locations”.

Several scientists expressed concern that simplified representations of their research could contribute to public misinterpretations concerning the possibilities and validity of the results, especially when core concepts or nuanced conclusions were omitted. One news article was criticized for contextualizing its conclusions using findings from an unrelated research paper. Multiple scientists noted that scientific uncertainties are portrayed as mere ignorance, rather than as an inherent part of the research process. Furthermore, confidence intervals are misrepresented by citing the soonest possible collapse date, and the differences between predictions and possible outcomes of the research are unclear:

“They write it as though we are wizards that can look into the future ... In that case, we give a prediction. Which is different from saying this will happen whatever you do. This will happen. This is really not what we did.” – Scientist 2



A few scientists expressed concern about the use of external experts in news articles. These concerns include decontextualized citations, the inclusion of experts from disciplines unrelated to marine sciences, and an inaccurate use of two-sidedness that presents one viewpoint as equivalent to the scientific consensus:

200 *“So, if you have a sort of prevailing consensus, and then you have that one oddball who thinks differently, to pit them against each other as equals...”* – Scientist 7

The scientists also expressed positive remarks and understanding about the representation of their research in news articles. Although exaggerated terms and the substitution of the AMOC with the Gulf Stream were not preferred, some scientists acknowledged that it can be understood from a journalistic perspective:

205 *“They always mention the AMOC somewhere. Then they go back to the Gulf Stream. Yes, I think that's fine from their journalistic expertise, because they obviously know better how to write this for a broad audience.”* – Scientist 3

All scientists accepted the simplification of research findings, provided that the main message remains intact. They highlighted the importance of nuance and that exaggeration is not present in all news articles. They expressed that error margins may be excluded if the conclusion is clearly stated:

210 *“This was news, and I don't think you delay the news because it's only three standard deviations.”* – Scientist 4

Finally, multiple scientists viewed two-sidedness positively, provided it is interpreted and framed correctly. They noted that different perspectives can be valuable if there are clear differences between scientific disagreement and personal opinion:

“Of course, it has a little bit of flavour of this: “Let's get the opinions from both sides or from different sides”. On the other hand, this is science. Of course, we can have our disagreements, but they're hopefully not opinions. They are hopefully, let's
 215 *say, informed beliefs.”* – Scientist 2

The scientists appreciated that their scientific research papers use scientific terminology that may be difficult for non-experts to understand. Examples are specific climate models and climate scenarios. The term “AMOC” can be confusing for audiences unfamiliar with the subject, which may lead to journalists substituting it with familiar terms:

“I think even if the journalists know that our study is not about the Gulf Stream, but about the AMOC or thermohaline circulation, they like to use a term that the public kind of connects something to.” – Scientist 8
 220

The scientists also understood that, to improve comprehension and awareness, news articles often focus on the local environment, which can result in the omission of broader global processes. Furthermore, the methodology and scientific uncertainties regarding the timing and research itself are often difficult to convey to the public and could therefore be excluded in news articles. As a result, the news articles tend to report the most extreme scenario despite its confidence intervals:

225 *“And of course, we have large uncertainties, and the uncertainty in the study is different from the confidence within a statistical model of the thing. This is a complicated sort of scientific discussion that we have among each other, which is way beyond what we can really convey to the general public.”* – Scientist 1

“When we say uncertainty, we often mean something different than what ordinary people see as uncertainty.” – Scientist 5



Some scientists acknowledge that inaccuracies originate from how researchers themselves communicate the conclusions.

230 Scientists are expected to communicate their research in a comprehensive and precise manner, rather than resorting to sensationalism and exaggerations for recognition:

“And gone are the days when I think newspapers tend to be just dry and provide you with some factual information or newsreader at night, like it's a lot more sensationalist, is my guess.” – Scientist 6

A few scientists noted that journalists should aim to be concise while still including relevant details, such as confidence
235 intervals. It is assumed that journalists may unintentionally misinterpret uncertainties and AMOC variability due to limited statistical competence and conceptual misunderstanding. Others believe journalists are prejudiced and will select phrases that amplify their perspective:

“This is just variability, seasonal or inter-annual variability in the ocean. Not climate change. But the media, I would say, interpreted it as climate change.” – Scientist 4

240 Moreover, inaccuracies in news articles are largely attributed to media constraints. Editorial requirements, headline choices, and the need for intriguing headlines often lead to exaggeration and misrepresentation. Despite the word limitation, scientists acknowledge the journalists’ attempt to reduce information as accurately as possible:

“But it could very well be, and I think that is a decision we do not have to make as scientists, that my commentary at that moment is too complicated, too complex, and takes up too much space for what they can and may do.” – Scientist 5

245 The scientists proposed several methods to reduce inaccuracies and mistaken theories in the news articles. They suggested incorporating scientific terminology where possible, detailed descriptions of key concepts, avoiding decontextualized phrases, enhancing communication between scientists and journalists, and improving journalistic research approaches could enhance the quality of news articles.

Scientists noted that both the methodology and the main results could be summarized more concisely, preferably in one
250 sentence. Scientific certainty should be conveyed briefly, with emphasis on potential solutions rather than limitations, and including an accurate reference to the AMOC. External experts are expected to provide a well-substantiated opinion. For more extensive articles, one scientist suggested including informative figures and an explainer box on the AMOC to enhance reader understanding.

Some scientists emphasized that improving news articles depends on effective communication between scientists and
255 journalists. Both are expected to remain unbiased and factually accurate. Given time constraints, journalists should ensure they understand the fundamental principles of the AMOC and consult multiple sources before publication. It is the responsibility of the media organizations to assign climate-specialized journalists to AMOC-related topics and to limit the use of sensational headlines:

*“That's also why in the case of a story like this, we have to be very careful that we could control the narrative, and we're not
260 rolling along with the narrative.”* – Scientist 1



Some scientists believe that journalists should retain discretion to determine how an article is written, provided it remains factually accurate. Others argue it is the responsibility of a scientist to convey their main conclusions in a way that is understandable to all interested:

265 *“And that’s also why I think even though you put numbers on confidence intervals and all the statistics, we have to know exactly how to communicate this in a way that is sort of for people, understandable for people, and usable for decision makers, stakeholders, and so on.”* – Scientist 1

“The author has the right to tell their story more or less in their own words and to choose to do so. I just don’t want it to be factually inaccurate.” – Scientist 5

4. Conclusions and Discussion

270 Our analysis indicates that climate change-related frames, particularly global warming, increased meltwater input, and climate-theoretical clarifications, are prominent in both scientific research papers and news articles. The scientific research papers emphasize the relevance and reliability of the findings and analyse them within a global framework. Their explanations are comprehensive and include scientific geophysical terminology. In contrast, news articles present concise, causal narratives that rely on simplified descriptions of the AMOC system and focus on societal consequences, global warming, and frequently
 275 specify a concrete year for a potential AMOC collapse. The writing style is characterized by simplified scientific terminology, shortened methodological descriptions, and an emphasis on the urgency to act.

Quantitatively and qualitatively, frames concerning AMOC functioning, research conclusions, and temporal indications appear frequently in both articles. Although methodological descriptions in scientific research papers are accurate when included in the news articles, explanations of AMOC dynamics and palaeoceanographic data are not consistently included in news articles.

280 When discussing research uncertainties and future improvements, scientific research papers focus on model limitations, data constraints, and theoretical considerations; whereas news articles emphasize causal explanations and temporal framing – and often highlight consequences.

Quotes from external experts in news articles primarily serve to strengthen the research’s credibility, especially regarding the estimated timing of an AMOC collapse and its expected impacts. Occasionally, quotes provide solely general approval,
 285 describing the research as “scientifically good work”. Interviewed scientists generally consider the news articles as broadly accurate, yet they prefer to moderate the certainty conveyed regarding the timing of the AMOC collapse. They attribute inaccuracies in the news articles partly to a scientist’s explanation of complex scientific concepts and analyses and partly to journalistic constraints, including limited time, insufficient educational background, simplification, and the need to present multiple viewpoints. Effective communication is presumed to improve news articles, which requires shared responsibility
 290 among scientists, journalists, and media organizations.

These findings partly align with Vonk et al. (2024a), who analysed ocean climate change in press releases. Like Vonk et al. (2024a), the news articles analysed here largely omit the term anthropogenic. Vonk et al. (2024a) report that press releases



communicate the human-driven ocean warming by emphasizing severity and urgency rather than explicitly using the term. Negative tones regarding global warming and ecosystem impacts are present in press releases and observed in news articles when addressing the urgency to reduce emissions. Consistent with Vonk et al. (2024a), news articles don't combine causal explanations and treatment recommendations. Finally, while scientific research papers mention climate-related opportunities in biological and research development, such opportunities were absent from both scientific research papers and news articles analysed in this study.

This study also supports Fahy and Nisbet's (2011) statement that climate-related news articles must provide contextualized, socially relevant, and accurate information. Journalists must adapt to evolving media environments while maintaining accuracy in scientific reporting. The importance of high-quality content in environmental journalism and scientific research, which must be understandable to enhance societal recognition, is emphasized. Repeated engagement with the AMOC may improve public comprehension by helping readers become more familiar with scientific terminology. Afterward, news article accuracy can be improved.

The rapid rate of news production limits the ability of non-specialized journalists to develop original news articles and reflect the categories emphasized in scientific research papers (Gunter et al., 1999; Tanner, 2004). Sampling methods and research uncertainties are often overlooked, and results may be presented as more speculative (Gregory and Miller, 2000). The demand for quick, accessible news and the desire for international recognition can contribute to flawed or exaggerated representations of scientific findings (Fahy and Nisbet, 2011). This study extends this previous research by qualitatively analysing the information transfer between scientific research papers and news articles, assessing whether the communicative challenges identified in earlier studies also appear in Dutch journalistic media representations of AMOC weakening and collapse.

4.1 Framing

Different media outlets emphasize different frames (Bolsen and Shapiro, 2018), yet news articles generally focus on human, economic, and environmental consequences, often combining these elements. This aligns with findings from a Portuguese study that found an emphasis on economic, environmental, and scientific narratives across three newspaper agencies, though with variation across the outlets (Setlik et al., 2025). Bolsen and Shapiro (2018) identify political conflict as a recurring frame by analysing US media coverage. In contrast, most news articles analysed here emphasize economic consequences and the feasibility of solutions while largely excluding political viewpoints. This suggests that Dutch journalists aim to provide neutral information. However, communicating in ways that also address the needs of various audiences, including governments, could further enhance public understanding:

"If we are serious about our warning here, we have to, as scientists, not only communicate the science, which I think the paper can actually be read by a lot of people, also outside our field, but we are also obliged to get the right impact to communicate in a language that is manageable in some sense from a political viewpoint." – Scientist 1

Dutch news articles expand on the basic theoretical descriptions found in scientific research papers by clarifying, e.g., components of ocean circulation or situating the AMOC within biogeochemical cycles. This can simplify AMOC-related



concepts and may lead to misunderstanding. On the contrary, ter Mors et al. (2023) found that Dutch newspaper articles rarely elaborate on the components of carbon capture and storage (CCS). Instead, news articles mentioned scientific terms without an elaborate explanation. The differences likely reflect the distinct communicative goals. CCS reporting focuses on safety and outcomes of implementing CCS techniques, while news articles reporting on the AMOC aim to inform the public about potential global climatic consequences, which may require a deeper understanding of physical processes.

As also found by Hijmans et al. (2003), methodological details, future research, and research limitations are frequently omitted in the news articles analysed here. However, news articles do include temporal uncertainties regarding the AMOC tipping point. The absence of methodological information and research uncertainties could affect the public's perception of the study's credibility.

The news articles predominantly focus on climatic consequences, often localising information by highlighting its relevance in specific regions and their inhabitants, reflected in the emphasis on the Northern Hemisphere. Research in climate-change communication suggests that localized framing could enhance public understanding and increase perceived credibility of scientific research papers and news articles (Dewulf et al., 2017; Feygina et al., 2020).

4.2 Language, terminology, and public understanding

Our finding that the term “anthropogenic” is used less often in news articles than in scientific research papers aligns with Johns and Jackquet (2018), who observed a reduced emphasis on anthropogenic causes in American ocean science news articles. In the United States, the emphasis on human-induced climate change in scientific news reports may be influenced by political leadership that expresses skepticism toward anthropogenic global warming (Liu and Huang, 2024).

Another finding concerns the communication of temporal frames. Scientific research papers report uncertainty ranges concerning the timing of a possible AMOC collapse, whereas news articles often report the minimum value of these intervals and omit scientific uncertainties (Hijmans et al., 2003; Karpouzoglou et al., 2022; Sumner et al., 2016; Woloshin and Schwartz, 2002). While including statements about the possibility of an AMOC collapse could improve understanding and enhance accuracy, it may lead to distrust and disagreement regarding the research's main message (Intemann, 2022). Conversely, tipping points found to occur before 2100 are accurately included in news articles, likely because the impacts are expected to occur within a human lifespan.

Within the broader framework, AMOC-related articles could either support public understanding or contribute to policy divergence, as described by Nisbet et al. (2009). They argue that different climate-change frames can alter public interpretation. Emphasizing catastrophic consequences may deepen comprehension of potential impacts, but without scientific uncertainties, it can add to alarmism (Ransohoff and Ransohoff, 2001). Such alarmism could induce opposing effects on scientific credibility and the urgency to act. Conversely, omitting alarmism by accepting human-caused AMOC weakening may create public confusion about the significance of potential impacts.

Scientists prefer to avoid alarming statements, yet they recognize that AMOC research often produces results that can be perceived as alarming. One scientist explained that their aim is to communicate findings more concisely and translate them



effectively for the public, while recognizing that the research itself contains alarming implications. These conflicting opinions illustrate the challenge of balancing scientific accuracy with clear and concise communication (Dahlstrom, 2021; Hijmans et al., 2003; Morton et al., 2011):

“It doesn't even have to be alarming, but it can be more concrete and still try to make that translation sometimes. And you know, what I'm publishing these days is all very alarming.” – Scientist 3

The scientists we interviewed differ in how they view AMOC-related inaccuracies in news articles. Their preferences vary, among others, in how time intervals are reported, how the term “AMOC” is used, and whether including two-sided perspectives adds value to a news article. However, they agree that inaccuracies in news articles arise from ineffective communication between the scientists and journalists, limited understanding of scientific methods, or misinterpretations by journalists, also identified by Dempster et al. (2022). Additionally, pressure on scientists to publish in high-impact journals, journalists' preconceived ideas, and profit-driven media can contribute to superficial news articles. These findings align with Rubin (2019), who argues that both news outlets and readers' susceptibility to “fake” information contribute to disinformation and misinformation.

Some interviewed scientists believe that journalists who report on the AMOC only have a superficial understanding of the topic. Because journalists rely primarily on the scientific publication itself and work under significant time pressure to publish a news article (Hout and Leuven, 2016; Schwitzer, 2008), their questions tend to be cursory (Furlan, 2017). According to the scientists, these limitations lead to inaccurate interpretations and the omission of essential information. The increased news output supports this assumption, leaving little time for in-depth research and making press releases a main source (Hout and Leuven, 2016). Journalists may also be prejudiced and focus on their interests (Hijmans et al., 2003), while scientists emphasize their duty to clarify their findings and elucidate when needed.

Both journalists and scientists deal with obligations and the desire to attract professional attention (Olenick et al., 2019; Ransohoff and Ransohoff, 2001). Scientists may seek recognition within the scientific community through publication in high-impact journals (Fire and Guestin, 2019), which can influence the narrative in press releases (Schat et al., 2017). They may (un)intentionally exaggerate the significance of their research by using complex scientific terminology or emphasizing specific features (Caulfield and Condit, 2012; Fanelli, 2010), while minimizing uncertainties and negative results. Conversely, ocean-related press releases have been found to use personification to interact directly with the audience (Vonk et al., 2024a). As a result, the final news article may adopt a journalistic angle that further overemphasizes statements:

“That's the combination of journalism and science, where the wrong things are actually being used. Both the most spectacular thing is taken from the scientific data, and then the journalist who takes it even further.” – Scientist 7

Sensationalism and hype are also regularly observed and arise from differences in scientific and journalistic writing styles as well as the public's perception of the AMOC (Caulfield and Condit, 2012; Gunter et al., 1999; Ransohoff and Ransohoff, 2001; Shuchman and Wilkes, 1997; West and Bergstrom, 2021). Consequently, news articles may highlight worst-case scenarios, emphasize lower-bound estimates of a possible AMOC collapse, and appeal to emotion rather than providing



balanced information for the public (Ransohoff and Ransohoff, 2001). Media pressures and the urge for name recognition may encourage sensationalism and hype.

Communicating the timing of an AMOC collapse remains a persistent disagreement among the interviewed scientists. Reporting precise years in which a collapse may occur provides clarity but risks creating misleading certainty when corresponding scientific uncertainties are not included. Nuanced temporal indications incorporate these uncertainties but may fail to convey urgency and relevance when the potential societal impacts lie in the distant future. Simplifications can enhance public comprehension but reduce scientific accuracy (Scheufele and Krause, 2019).

4.3 Tone of the text

The low occurrence of treatment recommendations and opportunity-focused frames following a potential collapse is in accordance with Johns and Jacquet (2018). They argue that solutions and optimistic language are often replaced by narratives emphasizing immediate action and the need to prevent a collapse (Bolsen and Shapiro, 2018). The vocabulary implies death and the vastness of the weakening, to motivate public concern. The news articles use pessimistic vocabulary when addressing economic and societal consequences and the urgency to act.

However, Witte and Allen (2000) demonstrate that “alarmistic tactics” can be counterproductive in medical sciences. By comparison, using more encouraging language in news articles could enhance engagement in climate action and strengthen research credibility (Myers et al., 2012). Similar findings are reported by Nisbet (2009), who observed that global warming headlines can include a “be very worried” tone.

In contrast, the scientific research papers analysed here do not employ terminology such as “death”. Scientific research papers prioritize presenting their discoveries and, when relevant, refer to taking measurements in general terms. Their language is expected to communicate speculative theories and carry only accepted meanings (Yngve and Wąsik, 2006):

“And gone are the days when I think newspapers tend to be just dry and provide you with some factual information or newsreader at night, like it's a lot more sensationalist, is my guess” – Scientist 6

4.4 Implications and limitations

This study adopts a similar approach to Vonk et al. (2024a) and Vonk et al. (2024b), who examined the journalistic representation of ocean-related press releases and their corresponding newspaper articles. While these studies found that journalists predominantly rely on press releases as a source, influencing the framing of ocean plastic and climate research in news coverage, here we used frames to analyse the information transfer. Because clustering of frames may alter their definition, each coded paragraph is analysed individually.

This research provides new insight into how AMOC-related information is transferred from a published scientific research paper to a Dutch news article. The socioeconomic and environmental problem frames identified here are consistent with those found in prior ocean climate communication research (Vonk et al., 2025). However, political responsibility, often present in



comprehensive climate articles, was absent in both scientific research papers and news articles. This suggests that journalists do not necessarily expand on the information present in scientific research papers.

425 A limitation of this study is the exclusion of the corresponding press releases. Because press releases often act as an intermediary between scientists and journalists, omitting them may overlook information that affects how scientific research papers are translated into news articles. The presence or absence of quantitative framing or qualitative detail in news articles may reflect priorities in press releases rather than in the scientific research paper itself. Contrarily, excluding press releases allows for a direct comparison between scientific research papers and news articles.

430 The limited dataset allows for context-specific conclusions. Only a relatively small sample size within the scope of AMOC-related research was selected, and the corresponding journalistic media are limited to those retrievable through NEXIS. Although the chosen scientific research papers present original research on AMOC slowdown or possible collapse, the news articles provide a generalized interpretation of the scientific studies. The limited sample size, therefore, confines the conclusions to the specific articles analysed.

435 Journalistic research methods and writing constraints may also influence the accuracy of news articles, but these are beyond the scope of this study. Word count restrictions, a journalist's educational background, and the editorial priorities can affect the inclusion of details and aspects relevant to AMOC research. The influence of exaggeration in headlines and images on public interpretation was beyond scope.

4.5 Recommendations

440 News articles are generally well written and occasionally use exaggeration to engage the public. While such exaggerations are understandable given journalistic aims, the primary message of the scientific research paper should remain accurate. Ensuring consistent and precise use of scientific AMOC terminology could enhance accuracy. Analysing the accuracy over time could provide insight into how public understanding evolves and whether increased familiarity with terminology leads to more precise news articles. Such an analysis would need to account for the differing definitions of accuracy between scientists and
 445 journalists, which may influence how AMOC-related findings are represented.

To reduce inaccuracies and improve the quality of news articles, further research could investigate a journalist's prior knowledge and how this affects the accuracy of their news reports. A better understanding of a journalist's background knowledge could help optimize information transfer between scientists and the journalistic media. Preferably, news articles remain concise while including additional information, without requiring more time investment from journalists. Future
 450 research could assess whether shared guidelines for explaining AMOC processes and corresponding terminology would improve news accuracy. Over time, consistent AMOC reporting could enhance public understanding:

"I guess just over and over again, very slowly, it seeps into the public's consciousness a little bit more" – Scientist 6

Media agencies could also consider employing specialized journalists to cover climate change topics. Future studies could investigate whether specialized science journalists increase research credibility in news articles rather than integrating two-
 455 sidedness. Additionally, it would be valuable to investigate whether the accuracy differs across newspaper agencies.



Overall, news articles are likely to improve when journalists and scientists communicate effectively. If journalists have sufficient time to study the scientific research paper and receive additional input from the scientist, the resulting news articles are expected to be more accurate. In conclusion, science communication is shaped by different perspectives of scientists, journalists, and the public, and can be adjusted to improve both accuracy and public understanding.

460 *“Ultimately, science isn't something static. It may be viewed by several people from different perspectives.” – Scientist 3*

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Code/Data availability

470 All code books, data and python scripts are available at <https://doi.org/10.5281/zenodo.19627691>.

Author contributions

YMJtK designed the codebooks, did the survey, analysed the data and wrote a thesis version of the manuscript. EvS then reworked that thesis into a draft of the manuscript. All authors edited the manuscript.

Competing interests

475 EvS is a member of the editorial board of Geoscience Communication. The authors have no other competing interests.

Ethical statement

The Ethics and Privacy Quick Scan of the Utrecht University Research Institute of Information and Computing Sciences classified this research as low risk, requiring no further ethical review or privacy assessment.



Generative Artificial Intelligence (AI)

- 480 The authors used AI for minor editing of texts and for creating python code for generating Figure 1.

References

- van Aken, H. M.: The Oceanic Thermohaline Circulation: An Introduction, Springer, 2007.
- Baker, J. A., Bell, M. J., Jackson, L. C., Vallis, G. K., Watson, A. J., and Wood, R. A.: Continued Atlantic overturning circulation even under climate extremes, *Nature*, 638, 987–994, <https://doi.org/10.1038/s41586-024-08544-0>, 2025.
- 485 Baralt, M.: Coding Qualitative Data, in: *Research Methods in Second Language Acquisition*, edited by: Mackey, A. and Gass, S. M., Wiley, 222–244, <https://doi.org/10.1002/9781444347340.ch12>, 2011.
- Boers, N.: Observation-based early-warning signals for a collapse of the Atlantic Meridional Overturning Circulation, *Nat. Clim. Chang.*, 11, 680–688, <https://doi.org/10.1038/s41558-021-01097-4>, 2021.
- Bolsen, T. and Shapiro, M. A.: The US News Media, Polarization on Climate Change, and Pathways to Effective Communication, *Environmental Communication*, 12, 149–163, <https://doi.org/10.1080/17524032.2017.1397039>, 2018.
- 490 Bossema, F. G., Burger, P., Bratton, L., Challenger, A., Adams, R. C., Sumner, P., Schat, J., Numans, M. E., and Smeets, I.: Expert quotes and exaggeration in health news: a retrospective quantitative content analysis, <https://doi.org/10.12688/wellcomeopenres.15147.2>, 8 July 2019., 2019.
- Bower, A., Lozier, S., Biastoch, A., Drouin, K., Foukal, N., Furey, H., Lankhorst, M., Rühls, S., and Zou, S.: Lagrangian Views of the Pathways of the Atlantic Meridional Overturning Circulation, *JGR Oceans*, 124, 5313–5335, <https://doi.org/10.1029/2019JC015014>, 2019.
- 495 Bryden, H. L., Longworth, H. R., and Cunningham, S. A.: Slowing of the Atlantic meridional overturning circulation at 25°N, *Nature*, 438, 655–657, <https://doi.org/10.1038/nature04385>, 2005.
- Caesar, L., Rahmstorf, S., Robinson, A., Feulner, G., and Saba, V.: Observed fingerprint of a weakening Atlantic Ocean overturning circulation, *Nature*, 556, 191–196, <https://doi.org/10.1038/s41586-018-0006-5>, 2018.
- 500 Caesar, L., McCarthy, G. D., Thornalley, D. J. R., Cahill, N., and Rahmstorf, S.: Current Atlantic Meridional Overturning Circulation weakest in last millennium, *Nat. Geosci.*, 14, 118–120, <https://doi.org/10.1038/s41561-021-00699-z>, 2021.
- Caulfield, T. and Condit, C.: Science and the Sources of Hype, *Public Health Genomics*, 15, 209–217, <https://doi.org/10.1159/000336533>, 2012.
- 505 Dahlstrom, M. F.: The narrative truth about scientific misinformation, *Proc. Natl. Acad. Sci. U.S.A.*, 118, e1914085117, <https://doi.org/10.1073/pnas.1914085117>, 2021.
- Dempster, G., Sutherland, G., and Keogh, L.: Scientific research in news media: a case study of misrepresentation, sensationalism and harmful recommendations, *JCOM*, 21, A06, <https://doi.org/10.22323/2.21010206>, 2022.



- 510 Dewulf, A., Boezeman, D., and Vink, M.: Climate Change Communication in the Netherlands, in: Oxford Research Encyclopedia of Climate Science, edited by: Von Storch, H., Oxford University Press New York, NY, <https://doi.org/10.1093/acrefore/9780190228620.013.455>, 2017.
- Ditlevsen, P. and Ditlevsen, S.: Warning of a forthcoming collapse of the Atlantic meridional overturning circulation, *Nat Commun*, 14, 4254, <https://doi.org/10.1038/s41467-023-39810-w>, 2023.
- 515 Entman, R. M.: Framing: Toward Clarification of a Fractured Paradigm, *Journal of Communication*, 43, 51–58, <https://doi.org/10.1111/j.1460-2466.1993.tb01304.x>, 1993.
- Fahy, D. and Nisbet, M. C.: The science journalist online: Shifting roles and emerging practices, *Journalism*, 12, 778–793, <https://doi.org/10.1177/1464884911412697>, 2011.
- Fanelli, D.: Do Pressures to Publish Increase Scientists’ Bias? An Empirical Support from US States Data, *PLoS ONE*, 5, e10271, <https://doi.org/10.1371/journal.pone.0010271>, 2010.
- 520 Feygina, I., Myers, T., Placky, B., Sublette, S., Souza, T., Toohey-Morales, J., and Maibach, E.: Localized Climate Reporting by TV Weathercasters Enhances Public Understanding of Climate Change as a Local Problem: Evidence from a Randomized Controlled Experiment, *Bulletin of the American Meteorological Society*, 101, E1092–E1100, <https://doi.org/10.1175/BAMS-D-19-0079.1>, 2020.
- 525 Fire, M. and Guestrin, C.: Over-optimization of academic publishing metrics: observing Goodhart’s Law in action, *GigaScience*, 8, giz053, <https://doi.org/10.1093/gigascience/giz053>, 2019.
- Furlan, P.: A critical eye or uncritical reverence?: Why some reporters neglect to challenge prestigious medical/health sources, *Australian Journalism Review*, 39, 51–65, 2017.
- Glaser, B. G. and Strauss, A. L.: *The Discovery of Grounded Theory: Strategies for Qualitative Research*, 1st ed., Routledge, <https://doi.org/10.4324/9780203793206>, 2017.
- 530 Gregory, J. and Miller, S.: *Science in public: communication, culture, and credibility*, 1. paperback print., Basic Books, Cambridge, Mass, 2000.
- Gunter, B., Kinderlerer, J., and Beyleveld, D.: The Media and Public Understanding of Biotechnology: A Survey of Scientists and Journalists, *Science Communication*, 20, 373–394, <https://doi.org/10.1177/1075547099020004002>, 1999.
- 535 Hansen, B., Turrell, W. R., and Østerhus, S.: Decreasing overflow from the Nordic seas into the Atlantic Ocean through the Faroe Bank channel since 1950, *Nature*, 411, 927–930, <https://doi.org/10.1038/35082034>, 2001.
- Hijmans, E., Pleijter, A., and Wester, F.: Covering Scientific Research in Dutch Newspapers, *Science Communication*, 25, 153–176, <https://doi.org/10.1177/1075547003259559>, 2003.
- 540 Hout, T. V. and Leuven, S. V.: Investigating ‘Churnalism’ In Real-Time News, in: *The Routledge Companion to Digital Journalism Studies*, edited by: Franklin, B. and Eldridge, S. A., Routledge, London ; New York : Routledge, 2017., 117–125, <https://doi.org/10.4324/9781315713793-12>, 2016.
- Intemann, K.: Understanding the Problem of “Hype”: Exaggeration, Values, and Trust in Science, *Can. J. of Philosophy*, 52, 279–294, <https://doi.org/10.1017/can.2020.45>, 2022.



- Intergovernmental Panel On Climate Change (IPCC): The Ocean and Cryosphere in a Changing Climate: Special Report of the Intergovernmental Panel on Climate Change, 1st ed., Cambridge University Press, 545 <https://doi.org/10.1017/9781009157964>, 2022.
- Johns, L. N. and Jacquet, J.: Doom and gloom versus optimism: An assessment of ocean-related U.S. science journalism (2001–2015), *Global Environmental Change*, 50, 142–148, <https://doi.org/10.1016/j.gloenvcha.2018.04.002>, 2018.
- Karpouzoglou, T., Muilwijk, M., Lauber, J., Tsiouvalas, A., and Brehmer-Moltmann, J.: BOLD STATEMENTS in environmental and climate science communication, <https://doi.org/10.5194/gc-2022-14>, 13 December 2022., 2022.
- 550 te Koppele, Y. M. J. and van Seville, E.: The Accuracy of the AMOC Reports in Dutch Journalistic Media. A Comparative Study of Scientific Literature and Dutch News Articles. The Dataset., <https://doi.org/10.5281/ZENODO.19627691>, 2026.
- Liu, M. and Huang, J.: Framing responsibilities for climate change in Chinese and American newspapers: A corpus-assisted discourse study, *Journalism*, 25, 1792–1811, <https://doi.org/10.1177/14648849231187453>, 2024.
- Liu, Y., Moore, J. K., Primeau, F., and Wang, W. L.: Reduced CO₂ uptake and growing nutrient sequestration from slowing overturning circulation, *Nat. Clim. Chang.*, 13, 83–90, <https://doi.org/10.1038/s41558-022-01555-7>, 2023.
- 555 Lombard, M., Snyder-Duch, J., and Bracken, C. C.: Content Analysis in Mass Communication: Assessment and Reporting of Inter-coder Reliability, *Human Comm Res*, 28, 587–604, <https://doi.org/10.1111/j.1468-2958.2002.tb00826.x>, 2002.
- Morton, T. A., Rabinovich, A., Marshall, D., and Bretschneider, P.: The future that may (or may not) come: How framing changes responses to uncertainty in climate change communications, *Global Environmental Change*, 21, 103–109, 560 <https://doi.org/10.1016/j.gloenvcha.2010.09.013>, 2011.
- Myers, T. A., Nisbet, M. C., Maibach, E. W., and Leiserowitz, A. A.: A public health frame arouses hopeful emotions about climate change: A Letter, *Climatic Change*, 113, 1105–1112, <https://doi.org/10.1007/s10584-012-0513-6>, 2012.
- Nisbet, M. C.: Communicating Climate Change: Why Frames Matter for Public Engagement, *Environment: Science and Policy for Sustainable Development*, 51, 12–23, <https://doi.org/10.3200/ENV.51.2.12-23>, 2009.
- 565 O’Connor, C. and Joffe, H.: Inter-coder Reliability in Qualitative Research: Debates and Practical Guidelines, *International Journal of Qualitative Methods*, 19, 1609406919899220, <https://doi.org/10.1177/1609406919899220>, 2020.
- Olenick, M., Flowers, M., Maltseva, T., and Diez-Sampedro, A.: Research in Academia: Creating and Maintaining High Performance Research Teams, *Nursing Research and Practice*, 2019, 1–3, <https://doi.org/10.1155/2019/8423460>, 2019.
- Pellechia, M. G.: Trends in science coverage: a content analysis of three US newspapers, *Public Underst Sci*, 6, 49–68, 570 <https://doi.org/10.1088/0963-6625/6/1/004>, 1997.
- Rahmstorf, S., Box, J. E., Feulner, G., Mann, M. E., Robinson, A., Rutherford, S., and Schaffernicht, E. J.: Exceptional twentieth-century slowdown in Atlantic Ocean overturning circulation, *Nature Clim Change*, 5, 475–480, <https://doi.org/10.1038/nclimate2554>, 2015.
- Ransohoff, D. F. and Ransohoff, R. M.: Sensationalism in the media: when scientists and journalists may be complicit 575 collaborators, *Eff Clin Pract*, 4, 185–188, 2001.
- Rubin, V. L.: Disinformation and misinformation triangle: A conceptual model for “fake news” epidemic, causal factors and interventions, *JD*, 75, 1013–1034, <https://doi.org/10.1108/JD-12-2018-0209>, 2019.



- Rühlemann, C., Mulitza, S., Müller, P. J., Wefer, G., and Zahn, R.: Warming of the tropical Atlantic Ocean and slowdown of thermohaline circulation during the last deglaciation, *Nature*, 402, 511–514, <https://doi.org/10.1038/990069>, 1999.
- 580 Schat, J., F. G. Bossema, M. E. Numans, I. Smeets, and P. Burger: Medisch nieuws in de media (2.2), <https://doi.org/10.17026/DANS-Z9W-H6PN>, 2017.
- Scheufele, D. A. and Krause, N. M.: Science audiences, misinformation, and fake news, *Proc. Natl. Acad. Sci. U.S.A.*, 116, 7662–7669, <https://doi.org/10.1073/pnas.1805871115>, 2019.
- 585 Schwitzer, G.: How Do US Journalists Cover Treatments, Tests, Products, and Procedures? An Evaluation of 500 Stories, *PLoS Med*, 5, e95, <https://doi.org/10.1371/journal.pmed.0050095>, 2008.
- Setlik, J., Morais, C., and Dos Santos, E.: Ocean Science Coverage in Digital Journals in Portugal, *Environmental Communication*, 19, 1503–1525, <https://doi.org/10.1080/17524032.2025.2490077>, 2025.
- Shuchman, M. and Wilkes, M. S.: Medical Scientists and Health News Reporting: A Case of Miscommunication, *Ann Intern Med*, 126, 976–982, <https://doi.org/10.7326/0003-4819-126-12-199706150-00008>, 1997.
- 590 Sinet, S., Von Der Heydt, Anna. S., and Dijkstra, H. A.: Meltwater from West Antarctic ice sheet tipping affects AMOC resilience, *Sci. Adv.*, 11, eadw3852, <https://doi.org/10.1126/sciadv.adw3852>, 2025.
- Smeed, D. A., Josey, S. A., Beaulieu, C., Johns, W. E., Moat, B. I., Frajka-Williams, E., Rayner, D., Meinen, C. S., Baringer, M. O., Bryden, H. L., and McCarthy, G. D.: The North Atlantic Ocean Is in a State of Reduced Overturning, *Geophysical Research Letters*, 45, 1527–1533, <https://doi.org/10.1002/2017GL076350>, 2018.
- 595 Smeets, I.: Vijf grote uitdagingen in de wetenschapscommunicatie, *Tijdschrift voor Communicatiewetenschap*, 49, 185–197, <https://doi.org/10.5117/TVC2021.2.005.SMEE>, 2021.
- Smolders, E. J. V., van Westen, R. M., and Dijkstra, H. A.: Probability Estimates of a 21st Century AMOC Collapse, <https://doi.org/10.48550/ARXIV.2406.11738>, 2024., 2024.
- 600 Stocker, T. F., Jones, R. G., Hegglin, M. I., Lenton, T. M., Hegerl, G. C., Seneviratne, S. I., Van Der Wel, N., and Wood, R. A.: Reflecting on the Science of Climate Tipping Points to Inform and Assist Policy Making and Address the Risks they Pose to Society, *Surv Geophys*, 46, 421–442, <https://doi.org/10.1007/s10712-024-09844-w>, 2025.
- Sumner, P., Vivian-Griffiths, S., Boivin, J., Williams, A., Bott, L., Adams, R., Venetis, C. A., Whelan, L., Hughes, B., and Chambers, C. D.: Exaggerations and Caveats in Press Releases and Health-Related Science News, *PLoS ONE*, 11, e0168217, <https://doi.org/10.1371/journal.pone.0168217>, 2016.
- 605 Tanner, A. H.: Agenda Building, Source Selection, and Health News at Local Television Stations: A Nationwide Survey of Local Television Health Reporters, *Science Communication*, 25, 350–363, <https://doi.org/10.1177/1075547004265127>, 2004.
- Ter Mors, E., Van Leeuwen, E., Boomsma, C., and Meier, R.: Media Coverage of Carbon Capture and Storage: An Analysis of Established and Emerging Themes in Dutch National Newspapers, *Energies*, 16, 2056, <https://doi.org/10.3390/en16042056>, 2023.
- 610 Thornalley, D. J. R., Oppo, D. W., Ortega, P., Robson, J. I., Brierley, C. M., Davis, R., Hall, I. R., Moffa-Sanchez, P., Rose, N. L., Spooner, P. T., Yashayaev, I., and Keigwin, L. D.: Anomalously weak Labrador Sea convection and Atlantic overturning during the past 150 years, *Nature*, 556, 227–230, <https://doi.org/10.1038/s41586-018-0007-4>, 2018.



- Ting, K. M.: Confusion Matrix, in: Encyclopedia of Machine Learning, edited by: Sammut, C. and Webb, G. I., Springer US, Boston, MA, 209–209, https://doi.org/10.1007/978-0-387-30164-8_157, 2011.
- 615 Toggweiler, J. R. and Si, W.: A New Role for the AMOC During the Ice Ages, *Paleoceanog and Paleoclimatol*, 40, e2024PA004973, <https://doi.org/10.1029/2024PA004973>, 2025.
- Van Westen, R. M. and Baatsen, M. L. J.: European Temperature Extremes Under Different AMOC Scenarios in the Community Earth System Model, *Geophysical Research Letters*, 52, e2025GL114611, <https://doi.org/10.1029/2025GL114611>, 2025.
- 620 Van Westen, R. M., Kliphuis, M., and Dijkstra, H. A.: Physics-based early warning signal shows that AMOC is on tipping course, *Sci. Adv.*, 10, eadk1189, <https://doi.org/10.1126/sciadv.adk1189>, 2024.
- Van Westen, R. M., Vanderborght, E., Kliphuis, M., and Dijkstra, H. A.: Physics-Based Indicators for the Onset of an AMOC Collapse Under Climate Change, *JGR Oceans*, 130, e2025JC022651, <https://doi.org/10.1029/2025JC022651>, 2025.
- Vestergård, G. L.: From journal to headline: the accuracy of climate science news in Danish high quality newspapers, *JCOM*, 10, A03, <https://doi.org/10.22323/2.10020203>, 2011.
- 625 Vonk, A., Bos, M., and Van Sebille, E.: How frames and narratives in press releases shape newspaper science articles: the case of ocean plastic pollution, *Geosci. Commun.*, 8, 297–317, <https://doi.org/10.5194/gc-8-297-2025>, 2025.
- Vonk, A. N., Bos, M., Smeets, I., and van Sebille, E.: A comparative study of frames and narratives identified within scientific press releases on ocean climate change and ocean plastic, *JCOM*, 23, A01, <https://doi.org/10.22323/2.23010201>, 2024a.
- 630 Vonk, A. N., Bos, M., and Van Sebille, E.: Journalism Versus Churnalism: How News Factors in Press Releases Affect Journalistic Processing of Ocean Plastic Research in Newspapers Globally, *Journalism Studies*, 25, 2031–2050, <https://doi.org/10.1080/1461670X.2024.2409836>, 2024b.
- West, J. D. and Bergstrom, C. T.: Misinformation in and about science, *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*, 118, <https://doi.org/10.1073/pnas.1912444117>, 2021.
- 635 Willis, J. K.: Can in situ floats and satellite altimeters detect long-term changes in Atlantic Ocean overturning?, *Geophysical Research Letters*, 37, L06602, <https://doi.org/10.1029/2010GL042372>, 2010.
- Witte, K. and Allen, M.: A Meta-Analysis of Fear Appeals: Implications for Effective Public Health Campaigns, *Health Educ Behav*, 27, 591–615, <https://doi.org/10.1177/109019810002700506>, 2000.
- 640 Woloshin, S. and Schwartz, L. M.: Press Releases: Translating Research Into News, *JAMA*, 287, 2856, <https://doi.org/10.1001/jama.287.21.2856>, 2002.
- Yngve, V. and Wąsik, Z.: *Hard-Science Linguistics*, Continuum International Publishing, London, 397 pp., 2006.



Appendix A

645 **Table A1. The number and percentages of files coded for each scientific research paper and Dutch news article across all frame elements, variables, following the order of the framing codebook for the text comparison.**

Frame element	Frame variables	Scientific papers (n = 17)		News articles (n = 73)	
<i>Consequence of an AMOC weakening or collapse</i>	Human	4	24%	5	7%
	Economic	0	0%	13	18%
	Biological	3	18%	4	5%
	Sea surface temperature	6	35%	3	4%
	Northern Hemispheric sea surface temperature decrease	4	24%	4	5%
	Southern Hemispheric sea surface temperature increase	3	18%	0	0%
	Altered Pacific Meridional Overturning Circulation	1	6%	0	0%
	Altered Atlantic currents	4	24%	3	4%
	Change in ocean CO2 uptake	1	6%	2	3%
	General climate change	8	47%	8	11%
	Precipitation changes	4	24%	28	38%
	Air temperature changes	10	59%	51	70%
	Storm track change	3	18%	19	26%
	Sea level change	4	24%	17	23%
	(Sea-) Ice volume change	3	18%	11	15%
	General atmospheric response	0	0%	1	1%
	Atmospheric circulation change	4	24%	13	18%
	Change in Earth's energy budget	1	6%	0	0%
	Time indication of a consequence	0	0%	17	23%
<i>Opportunities due to the AMOC weakening or collapse</i>		0	0%	0	0%
<i>Causes of the AMOC weakening or collapse</i>	Society/Human activity	0	0%	3	4%
	General freshwater remarks	0	0%	1	1%
	Input of freshwater to the ocean	12	71%	52	71%
	Freshwater or salinity transport in the ocean	5	29%	0	0%
	Changes in ocean temperature forcings	1	6%	6	8%



	Change in the buoyancy flux	1	6%	0	0%
	Change in climate	12	71%	45	62%
	(Sea-)Ice feedback and atmospheric change	3	18%	0	0%
Responsibility to stop the AMOC weakening and collapse or its consequences	Politics or government	0	0%	0	0%
	Companies or industries	0	0%	0	0%
	Specific regions, cities, or countries	0	0%	0	0%
	Society	1	6%	5	7%
Urgency to act		3	18%	11	15%
A solution to stop the AMOC weakening or collapse and to reduce its impacts	A solution to stop the AMOC slowdown or collapse without expressing an opinion	1	6%	0	0%
	An optimistic view on a solution	0	0%	13	18%
	A pessimistic view on a solution	0	0%	3	4%
	A solution to reduce the impact without expressing an opinion	0	0%	0	0%
	An optimistic view on a solution	0	0%	3	4%
	A pessimistic view on a solution	0	0%	8	11%
Scientific frame	One climate model	8	47%	6	8%
	Multi climate model	4	24%	10	14%
	Paleo data	4	24%	9	12%
	Actual data	10	59%	17	23%
	Socio-Scientific relevance	10	59%	11	15%
	Further research	13	76%	8	11%
	Uncertainty in the data itself	14	82%	13	18%
	Uncertainty relative to other research	8	47%	21	29%
	Research barrier	5	29%	8	11%
	Research (not) in correspondence with observations	3	18%	10	14%
Working of the AMOC	Driven by heat, salt, and density differences	2	12%	17	23%
	Transport of heat / Driven by changes in heat capacity	13	76%	49	67%
	Transport of salt / Driven by salinity changes	2	12%	26	36%
	Driven by density changes	2	12%	16	22%
	Modulation of climate	11	65%	46	63%
	Modulates the temperature of the atmosphere and/or ocean	1	6%	18	25%
	Modulates the volume of sea-ice	0	0%	2	3%



	Variabilities of strength over time	11	65%	14	19%
	Sensitivity to ocean's freshwater forcing	2	12%	25	34%
	Definition of the tipping point	4	24%	5	7%
	Flow pattern affected by wind	0	0%	10	14%
	Other factors altering the AMOC flow pattern	0	0%	4	5%
	System of currents and eddies	0	0%	20	27%
	Role in the carbon cycle	2	12%	3	4%
	Role in the biological cycle / Biological influence	0	0%	2	3%
<i>Statement on the AMOC weakening or collapse</i>	General statement	11	65%	38	52%
	A specific mechanism is involved	3	18%	3	4%
	Collapse before 2100	3	18%	21	29%
	Collapse based on an emission scenario or a certain degree of warming	2	12%	7	10%
	Possible recovery	1	6%	0	0%
<i>Statement about a constant strength of the AMOC</i>	Constant AMOC	4	24%	4	5%
	Upwelling preventing a collapse	1	6%	0	0%
	A Pacific Meridional Overturning Circulation must appear	1	6%	0	0%
	Other conditions preventing a collapse	2	12%	1	1%
	Increase in strength or velocity	1	6%	1	1%
<i>The Gulf Stream is being confused with the AMOC</i>		0	0%	41	56%
<i>External expert</i>	Add information	3	18%	13	18%
	Confirm research	5	29%	14	19%
	Conflicting ideas	2	12%	21	29%