TITLE: Knowledge circulation between experts and the press in the field of climate change: a corpus-based approach using terms as data

ABSTRACT: As a mediator between specialists and the general public, the press plays a crucial role in disseminating climate knowledge. Yet, this process remains under-documented, despite the inherent challenges it implies. The press' mission of scientific popularisation can involve a relative transformation of expert discourse (Nikitina 2020), which may manifest in the selection of the pieces of knowledge disseminated or in the way knowledge is represented. In this article, terms are used as data to document the circulation of climate knowledge, as we compare the terminology representative of international climate expertise with that used diachronically in a corpus of generalist British and US newspapers. To that aim, we rely on tools from Textual terminology such as term extractors and frequency comparisons (Picton 2009). Particular attention is also given to instances of denominative and conceptual variation and their implications regarding the dissemination of climate knowledge.

TITRE : Circulation des connaissances entre les experts et la presse dans le domaine du changement climatique : une approche sur corpus utilisant les termes comme données

RESUME : En tant que médiateur entre les spécialistes et le grand public, la presse joue un rôle crucial dans la diffusion des connaissances autour du changement climatique. Ce processus reste néanmoins peu documenté, alors qu'il ne va pas de soi. En effet, la mission de popularisation scientifique assumée par la presse peut impliquer une relative transformation du discours d'expertise (Nikitina 2020), qui peut se manifester dans le choix des connaissances diffusées ou dans la façon dont ces connaissances sont représentées en discours.

Dans cet article, nous nous appuyons sur les termes pour documenter la circulation des connaissances sur le changement climatique, en comparant la terminologie représentative de l'expertise climatique internationale et celle mobilisée en diachronie dans un corpus de presse généraliste anglophone. À cette fin, nous nous appuyons sur des outils issus de la terminologie textuelle tels que les extracteurs de termes et les empreintes de fréquences (Picton 2009). Nous prêtons également une attention particulière aux phénomènes de variation dénominative et conceptuelle, dont nous interrogeons à

chaque fois les implications vis-à-vis de l'enjeu de diffusion des connaissances autour du changement climatique.

MOTS CLES : Analyse du discours, changement climatique, Linguistique de corpus, médias, Terminologie textuelle, variation terminologique

1   Introduction

Given the stakes involved in the circulation of knowledge on climate change, understanding how the press carries out this process is key to being able to optimise it, as this instance plays a key role in shaping public opinion (Van Dijk 2005). Yet this dissemination process remains relatively under-documented, as most studies have tended to focus on the treatment of climate change from a qualitative perspective (Weingart et al. 2000; Carvalho 2007; Brand & Brunnengräber 2012) and without specifically accounting for the circulation of specialised knowledge. The development of quantitative approaches in applied linguistics, notably relying on statistics-based tools from corpus linguistics, has yet allowed for broader and more comprehensive perspectives to emerge, as illustrated by Biros & Peynaud's (2019) and Song et al.'s (2021) combination of corpus linguistics and discourse analysis to respectively compare mediatic coverage of climate change in the US, the UK and China and analyse the way the International Panel on Climate Change (IPCC) is represented in three types of documents, newspapers included. Through this study, we extend the diagnostic offered by these emerging perspectives by adopting a large-scale diachronic approach to climate knowledge dissemination. This approach allows us to identify trends over time in the types of knowledge represented, facilitating the generalisation of results compared to strictly qualitative approaches. Besides, we rely on an analysis of the circulation of terms to document that of climate knowledge, drawing on the assumption that terms index specialised knowledge (Cabré 1998, 81). This allows us to directly compare journalistic discourse with that of experts and better understand, by contrast, the specificities of the former. It is also a way to identify patterns such as the emergence of new concepts in the press or the under- or overrepresentation of categories of terms compared to expert discourse.

2   Theoretical and methodological framework: addressing a societal issue from a terminological perspective

2.1   The ambiguous position of the press regarding knowledge transmission

As a specialised community (Peynaud 2018), the press has a double mission. First, it plays a key role in the dissemination of knowledge and information to the general public (Charaudeau 2010). Secondly, the media contributes to shaping public opinion by highlighting different points of view on a given topic, *a priori* in a balanced manner (2010). Besides this double mission – defined by Charaudeau as its *symbolic function –,* the press also has a *pragmatic function* (2010). The latter is motivated by economic imperatives, such as the necessity to generate enough profit for a given press organism to maintain its activities. It thus may involve resorting to specific strategies to increase or retain their readership (2010; Gotti 2014, 27). Thus, to be understood by a broad audience, journalists may have to simplify the topic they are covering if the latter is highly specialised, a process which might lead to a relative alteration of knowledge. For instance, through an analysis of how the IPCC is represented in UN reports, Earth Negotiations Bulletins, and general press articles, Biros and Peynaud (2019, 190) showed that, unlike the first two types of discourse, the press does not account for the scientific process that allows the IPCC to arrive at the conclusions presented in its reports, nor for the level of uncertainty associated with these results. In addition, to face competition, different press organisations tend to target a specific segment of the political spectrum in the country they operate in. This often results in representing only those opinions that align with the ideology the newspaper sympathises with, or portraying ideas contrary to this ideology in a negative light (Carvalho 2007; Charaudeau 2010). As such, this pragmatic rationale may conflict with the press' symbolic function and the necessity of representing a balanced set of opinions, all the more so as it often results in articles being imbued with ideology (2010; Fairclough 1995, 54-69). Because climate change has primarily been addressed from specialised perspectives (ie. the scientific community and international organisations), the transformation involved by this recontextualization (Fairclough 2003, 51) of climate knowledge could be particularly significant when the media cover climate issues.

2.2   A corpus-based approach using terms as data

2.2.1 From knowledge diffusion to terminological variation

Our analysis aims to account for the circulation of climate knowledge between the press and climate experts by considering the variety of concepts and ideas that define climate knowledge in those two discourses. This perspective might allow one to identify potential gaps in the mediatic treatment of climate change compared to expert discourses (or conversely), notably if some categories of concepts turn out to be relatively underrepresented in one of the latter.

Yet, since knowledge is relatively abstract and challenging to observe comprehensively on a large scale, it is essential to identify a specific unit to facilitate its analysis. As carriers of knowledge and the building blocks of specialised discourses, terms constitute a unit through which knowledge circulation may be observed on a relatively large scale. Although she focused on knowledge evolution rather than circulation, it is this approach that Picton (2009) adopted in her PhD dissertation, where the observation of term frequencies and their variation across various corpora allowed her to account for the evolution of knowledge in the field of particle physics. Pertaining to Textual terminology (Bourigault and Slodzian 1999; Condamines and Picton 2022), this approach notably implies building comparable corpora from authentic texts and relying on statistical clues such as frequencies and specificity scores to account for term variation. Variation can occur across corpora representing different periods, a phenomenon defined as diachronic variation (Freixa 2022). It can also be observed across communities representing different geographical contexts (diatopic variation), or different degrees of specialisation (diastratic variation) (2022). In that respect, the observation of such variation can respectively inform us about the evolution of knowledge in a specialised domain (Picton 2009) or about differences in the way it is represented across various communities (Condamines and Picton 2014; Humbert-Droz 2021).

Since we are here interested in the transmission of knowledge between climate experts and the press, two communities representing different degrees of specialisation, our analysis involves studying terminological diastratic variation. However, as knowledge transmission occurs over time, it is also essential to account for the way the terminology mobilised by the press varies diachronically. Additionally, considering diachronic variation might be a way to determine the *direction* of term and knowledge circulation: did key climate terms first appear in expert discourses or were they first mobilised by the press? Addressing this question can provide a more comprehensive view of knowledge circulation about climate change, notably by enabling one to see if this process is

characterised solely by a top-down diffusion model (from specialists to non-specialists) or by a bottom-up one, which would lead us to reconsider the role of the press in the field of climate change.

2.2.2 Description of the corpora

Our reliance on the study of both diachronic and diastratic variation to account for climate knowledge circulation requires building relatively complex corpora. To represent climate expertise, we rely on a corpus made of reports by several intergovernmental organisations (IGOs) which have dedicated part or the whole of their work to climate change, as well as reports published by environmental non-governmental organisations (NGOs), which have also acquired the status of expert in the field of climate change. All reports were published between 2007 and 2022. To account for the processual dimension of term and knowledge diffusion, this corpus was subdivided into three diachronic sub-corpora, representing the periods surrounding two major conferences of the parties (COPs) in the history of climate governance, namely COP 15 (2009) and COP 21 (2015) and a most recent corpus representing the period between COPs 25 and 26 (2019 and 2021 respectively), which were the two most recent COPs at the time of the study.

As for the press corpus, it is composed of articles published by broadsheet newspapers from the British and American press over the same period as expert reports, and representing various political opinions. Articles were collected from the database Europress using a specific set of keywords sharing the modifier *climate* (such as *climate action, climate change, climate crisis*) along with terms like *global warming, global heating*, *IPCC,* and *greenhouse effect*. However, while using Europress facilitates access to press articles from subscription-based newspapers, it also constrains us to draw from newspapers that are registered in that database. Thus, while all the newspapers listed below were accessible in the most recent period represented, only *The Daily Telegraph, The New York Times,* and the *Financial Times* were accessible to build the first sub-corpus. The composition of the resulting corpora is described in Table 1 below[1]:

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[1] The two corpora can be accessed at https://www.ortolang.fr/market/corpora/climate-discourses/v3.2 in the files 'Corpus-OIG (IGOs)' and 'Corpus-ONG (NGOs)' for the full corpus expert, and 'Corpus-press' for the media.

Table 1. Description of the expert and press corpora

Genre	Word count	Number of documents[2]	Entities	Period
IGO + NGO reports	556 154	31	*UNFCCC, IPCC, UNDP, UNEP, UN, UNCDF, UN-REDD, World Bank, World Meteorological Organization[3]* + Greenpeace, Oxfam, FoE, WWF, EDF, EJF, NRDC, the Climate Group, the Climate Institute[4]	2007-2011
	998 100	48		2014-2017
	657 615	50		2019-2021
Press articles	425 266	344	*The Daily Telegraph, The Guardian, The New York Times, Financial Times, USA Today*	2008-2011
	451 498	487		2014-2017
	486 419	469		2020-2021

We thus obtain three sub-corpora of relatively comparable sizes for the press, which together form a total corpus of 1,363,183 words. The latter is thus nearly half the size of the expert corpus, which contains 2,598,743 units. In our analyses, it will therefore be necessary to rely on relative frequency to compare the occurrences of specific terms between these two corpora.

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[2] Note that the number of documents differs widely between the two corpora, as IGO and NGO reports are far longer than press articles and are more rarely produced.

[3] UNFCCC (United Nations Famework Convention on Climate Change), IPCC (Intergovernmental Panel on Climate Change), UNDP (United Nations Development Program), UNEP (United Nations Environment Program), UN (United Nations), (United Nations Capital Development Fund), UN-REDD (United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries).

[4] FoE (Friends of the Earth), WWF (World Wildlife Fund), EDF (Environmental Defense Fund), EJF (Environmental Justice Foundation), NRDC (Natural Resources Defense Council).

2.2.3 Description of the tools

Keeping with the tradition of Textual terminology, we use statistical tools for extracting terms from corpora and accounting for diachronic and diastratic variation. For term extraction, we rely on a measure of the specificity score using the textometric software TXM (Heiden et al. 2010), considering as candidates any unit whose score is above 3.09 (Drouin 2003). The validation of the terminological status of those candidates is then performed using the criteria defined in Bureau (2023, 131-137), which draws on L'Homme (2004, 52-82) and adapts them to the specificities of the field of climate change[5].

To facilitate the comparison of the terms used by climate experts and the press, we represent them into four tree diagrams, one for the expert corpus and one for each press sub-corpus. Those diagrams are made of the semantic categories indexed by the terms, categories which are inferred from their terminographic definitions when available and by observing the meanings that they are the most frequently associated with in our corpora using concordance lines. Those diagrams are thus divided into two broad categories, a first one representing concepts pertaining to the description of climate change, its manifestations, consequences, and causes (coined [DESCRIBING CLIMATE CHANGE] in the tree diagram[6]), and a second one accounting for strategies to address this issue ([ADDRESSING CLIMATE CHANGE]). These two broad categories are sub-divided into more specific ones, such as [RISKS AND IMPACTS], [CAUSES], and [ASSESSMENT TOOLS] for the first one, and [EMISSION REDUCTION], [RESILIENCE & ADAPTATION STRATEGIES], [PROMOTING EQUITY], and [RESOURCE MANAGEMENt] for the second one. If it allows for a visual representation of the knowledge indexed by the terms used in our corpora, this approach is relatively time-consuming and constrains us to categorise only a sample of all the terms extracted (which are more than 1700 in the expert corpus). For the expert terminology, we thus categorise the terms whose frequency is equal or above thirty, which represents about 23% of the total list of terms. For the press sub-corpora, we rely on relative frequency (RL) to make comparisons possible between the three corresponding diagrams and thus categorise the terms whose RL is equal or superior to fifteen. The difference in threshold between the two types of corpora is motivated by the fact that the expert corpus is almost six times larger than each press sub-corpus, so that a threshold of 30 in the latter would have resulted in very few terms to be represented in the diagrams. The resulting samples in the press are yet proportional to that of the

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[5] The lists of terms can be accessed at https://www.ortolang.fr/market/corpora/climate-discourses/v3.2, in the file 'Tableurs_Données_Corpora'.
[6] All tree diagrams can be accessed at https://hdl.handle.net/11403/climate-discourses. They are located in the file 'Arbres_Conceptuels_Termes (tree diagrams)'.

expert corpus since the threshold of 15 allows us to categorise 24%, 23% and 21,5% of the list of terms respectively representing COP15, COP21 and COP25/ 26 in the press. We then compare the resulting trees with one another, the visual representation allowing us to relatively easily identify the families of terms that are each time more or less represented.

To be able to interpret the results of this comparison as an evolution in the journalistic treatment of climate change over the period or as an actual difference in the way experts and journalists deal with climate change, it is essential to guarantee that the terminological variation observed is statistically significant. To that aim, we rely on a measure of the χ^2 goodness-of-fit, which can be obtained by comparing the expected frequency of a term with the frequency observed in discourse (Picton 2009, 112-113). We use Excel formulas to automate this calculation, and we rely on the χ^2 distribution table from Muller (1968: 179 in Picton 2009, 113) to interpret the results, based on 2 degrees of freedom when comparing the relative frequencies diachronically, and of one when comparing the RL of a term between an expert and journalistic sub-corpus[7]. Like Picton (2009), we consider to be significant only the χ^2 cases where P = 0.01 at most: if χ^2 is greater than or equal to 9.210, it means there is less than a 1 in 100 chance that the observed variation is due to the size difference between the various diachronic sub-corpora. However, to ensure the relevance of the χ^2, we only apply it to terms that totalize at least 30 occurrences in the entire press corpus (2019, 116-117). Because terms excluded by this filter may still provide relevant information for our research question, we choose to consider them by comparing their relative frequencies between the different sub-corpora, while qualifying the significance of such observations in our analyses. Additionally, we supplement this study of term frequencies with an analysis of the cotexts they occur in, to see if we can identify potential clues that could inform the interpretative work. When relevant, these cotextual analyses are also complemented by research and reading of documents dealing with the concept indexed by the term under study.

3   Documenting knowledge transmission between climate experts and the press: diagnostic

In the following sections, we analyse the terms that are shared by the two communities in each period, paying particular attention to the categories of terms that are central in expert discourses but tend not to be adopted by the press or underrepresented in the latter corpus. We also account for the units that appear only in the press corpus, to identify any potential denominative variants of terms originating

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[7] The degree of freedom is obtained by adding together the number of categories under study, and by substracting one to the result. The categories at stake correspond to the three periods represented by our diachronic corpora when analysing variation diachronically, and by one expert and one journalistic corpus when taking a diastratic perspective.

from expert discourse and to have a more comprehensive representation of the themes treated in press discourse.

3.1 COP15

3.1.1 [DESCRIBING CLIMATE CHANGE]

In the press, the section [DESCRIBING CLIMATE CHANGE] predominantly features terms that describe the physical aspects of climate change. For example, media sources mention various physical entities typically studied by climatologists when discussing the risks and impacts of climate change (e.g., *sea ice, ice sheet, ozone layer, atmosphere, ozone, permafrost*), as well as references to its potential physical consequences (e.g., *drought, flooding, extreme weather events or disasters, melting, temperature rise, cooling*). However, certain terms describing disasters are notably absent from media coverage during this period, appearing neither in the tree diagram nor in the list of extracted terms. These units include *(ocean) acidification, deforestation*, and *ocean warming,* which correspond to the subcategory of [SLOW ONSET EVENTS], as well as *extreme heat (days | waves | events)[8]*, *tropical cyclones*, and *adverse weather* for the subcategory of [EXTREME CLIMATIC EVENTS]. Regarding the causes of climate change, the connection between fossil fuels, greenhouse gases, and human activity ([SOCIO-ECONOMIC AND DEMOGRAPHIC BEHAVIOURS]) appears to be addressed by the media. This is evidenced by the presence of terms related to the eponymous sub-category, such as *coal-fired power, gas, oil, coal, fuel, petrol, natural gas, drilling, carbon dioxide, black carbon, methane, human activity*, etc. It is noteworthy that the greenhouse gases mentioned are primarily carbon dioxide and methane, whereas nitrogen and nitrous oxide, which are present in expert terminology, are completely absent from this initial list of terms. We also identify two terms related to the evaluation of uncertainty (*confidence* and *uncertainty*) in the eponymous category. Since these terms also have meanings in general language, we decide to analyse their cotextual environment to determine which meaning is activated in the press. We observe that in most cases, the unit *uncertainty* is used to refer to climate change, suggesting an alignment with the 'expert' version of the term:

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[8] This notation accounts for compounds whose heads were truncated during the extraction process but for which we were actually able to identify several recurrent heads when looking at concordance lines. Note that when more than three heads referring to different concepts were identified for a given truncated term, the latter was deleted from the list of terms.

[1] The continuing **scientific uncertainty**[9] about the pace of climate change should make us more concerned, not less. (FT-2008-14)[10]

[2] Now, despite the high credibility of climate modelers, there is still **tremendous uncertainty** in their long-term forecasts. (NYTx1)

[3] There is **little uncertainty** when it comes to explaining why the Earth is warming, says Prof Palmer. The big question is what happens next. (Telegraphx7)

In [1], the uncertainty refers to the pace at which climate change may evolve, while it concerns long-term climate forecasts and the origins of climate change in excerpts [2] and [3] respectively. We also identify five occurrences of the term *scientific uncertainty*, indicating an awareness of the specialised meaning of *uncertainty*. However, the system for evaluating uncertainty used by experts (and most notably by the IPCC), characterised by the adjectives 'low', 'medium', and 'high' to which are assigned predefined probabilities (Mastrandrea et al. 2010), is not adopted by the press. Instead, the level of uncertainty is conveyed through non-specialized adjectives like 'tremendous' or 'little' (excerpts [2] and [3]), which have a purely qualitative meaning. Sometimes, the level of uncertainty is entirely ignored, as in [1], where the uncertainty is simply described as enduring. Regarding *confidence*, a concordance line analysis reveals that it is the general sense of 'feeling' that is predominantly activated ('a feeling of having little doubt about yourself and your abilities, or a feeling of trust in someone or something' (Cambridge Dictionary [online])), leading us to exclude it from our list of terms for this period.

3.1.2 [ADDRESSING CLIMATE CHANGE]

The section [ADDRESSING CLIMATE CHANGE] turns out to be represented by terms related to the issue of energy transition, predominantly referring to [CLEAN ENERGY SOURCES] (*renewable energy, nuclear energy, solar power, wind power, solar energy, alternative energy, clean coal*). Among these, the terms *alternative energy* and *clean coal* are specific to the media. If the modifier *clean* motivates the categorisation of *clean coal* in the [CLEAN ENERGY SOURCES] subcategory, the fact that its head

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[9] In all the examples, the typography in bold results from our intervention.

[10] A reference corresponding to the name of the file – here, a press article – from which the extract was taken is added after each quote from our corpora. The first three letters refer to the name of the publication – here, Financial Times–, the second element to the date of publication, and the last is a number that distinguishes the given article from others published the same year and in the same newspaper.

denotes a fossil fuel leads to inquiry further into the cotexts of use this term. This allows us to identify a definition and thus better understand the meaning of the modifier 'clean' in this compound:

> [4] '**Clean coal**' is a term coined by the industry decades ago, referring to its efforts to reduce local pollution. Using new technology, clean coal plants sharply reduced the number of sooty particles spewed into the air, as well as gases like sulfur dioxide and nitrous oxide. The technology has minimal effect on carbon emissions. (NYT-2008-18)

Thus, the coal in question is labelled 'clean' due to efforts to reduce greenhouse gas and particulate emissions during its production. However, the conclusion drawn by the journalist ('the technology has minimal effect on carbon emissions') suggests that this technology and, by extension, the use of the modifier 'clean' to designate it, is primarily a form of greenwashing. This example underscores the communicative function of terms, which, beyond indexing knowledge, can play a key role in the communication strategies of the community using them.

Additionally to this first set of observations, two motifs attract our attention. First, the categories [ENERGY TRANSITION], [EMISSION REDUCTION] and [GOVERNANCE] appear to be overrepresented in comparison to other forms of response to climate change. For instance, there is no term explicitly referring to the reduction of inequalities, and the topics of resilience and adaptation on the one hand, and resource management, on the other, are represented only by the units *adaptation* and *conservation* respectively. The term *resilience* appears only twice in this sub-corpus and was thus not deemed specific enough to be represented in the tree diagram, whereas it has 36 occurrences in the corresponding expert sub-corpus. This difference is statistically significant, as there is less than 1 in 100 chances of it being due to size effect ($\chi2 = 15.04$, considering the 2 occurrences of this term in the press corpus). Concerning the systemic tools for governance, this subcategory turns out to be represented by 17 different denominations, four of which (*cap-and-trade system, binding treaty, climate change conference*, and *climate change treaty*) are specific to the press. While several of these terms are denominative variants (*climate conference/climate change conference, climate treaty/climate agreement, international agreement/global agreement*), they nonetheless indicate significant media interest in the topic of climate governance. This finding can be explained by the press' role as a mediator of current events, which differs from the function of expertise in that it tends to focus on actualized events and facts, such as conferences and political decisions (Peynaud 2018).

3.2 COP21

3.2.1 DESCRIBING CLIMATE CHANGE]

This second tree diagram reveals that new terms appeared around COP 21. Among the terms denoting [SLOW-ONSET EVENTS], examples include *extinction* and *erosion*, both of which are also used in expert discourse. Analysing the concordance lines for these terms in the press corpus reveals that they most often refer to the extinction of animal or plant species ('species extinction', 'wildlife extinction', 'extinction of certain trees') and coastal erosion ('coastal erosion', 'island's erosion', 'along the shore'). While similar references are found in the expert corpus for *extinction*, the term *erosion* tends to refer to a greater variety of phenomena in the latter corpus, where it can denote genetic erosion (ie. 'erosion of genetic variability in a population', UNEP-2007-2), soil erosion, or river bank erosion. Similarly, this term appears in compounds that specify the cause of the erosion, such as *water erosion* or *wind erosion*. As such, it seems that only a portion of the knowledge indexed by the term *erosion* is picked up by the media around COP 21.

On the other hand, we do not observe any particular evolution in the representation of [EXTREME WEATHER EVENTS]: the risk of flooding (*flood, flooding*) remains the only type of risk with a relative frequency of 15 or higher in this sub-corpus, while the other two terms in this category refer to hypernyms of this type of events (*extreme weather event, disaster*). A new term yet appeared in the category of [SOCIO-ECONOMIC RISKS AND IMPACTS], namely *migration,* which is present in the expert corpus as early as the period surrounding COP 15. This term is predominantly used in articles from the British newspaper *The Guardian* (19 out of 23 occurrences), which tends to explicitly present migrations as a potential consequence of climate change (e.g., '*Forced migration* is framed as a political issue but **climate change and inequality are fuelling the catastrophe** and business has a role to play in solving it' (Guardian-19)). The fact that most occurrences of *migration* appear in *The Guardian* suggests that the mediation of knowledge by the press is relatively heterogeneous, as not all newspapers adopt domain-specific concepts in the same way. In this example, the newspaper's political stance could play a significant role in framing the issue of migration as related to climate change: known for its left-leaning, socio-liberal perspective, *The Guardian* is more likely to address the social consequences of climate change than more conservative newspapers.

Regarding the treatment of the [CAUSES] of climate change, we observe a greater diversity of terms denoting fossil fuels, such as *fracking, extraction, pipeline, coal power, (coal) mining, shale (gas)*, and *diesel*. Among these, *fracking* (hydraulic fracturing) and *shale (gas)* are specific to the press' tree diagram, as they were too infrequent in the expert corpus to have been extracted by the specificity score. These two terms turn out to mostly appear in British newspapers (*The Guardian* and *The Telegraph*, which account for 93% of the occurrences of the modifier 'shale' and 85% for 'fracking'), as the development of shale gas was both considered and debated in the UK during this period (e.g. 'First, Britain is not going to see a US-style "shale revolution"; the economics don't stack up, and **British people don't want fracking**.' (Telegraph-87)). The cotexts of those terms also display references to Donald Trump's election as President of the United States in 2016, whose agenda included continuing the development of shale gas in the US. These various elements thus highlight the influence of parameters external to the field of climate change on the terminology used by the press – in this case, political news –, which can lead the latter to resort to concepts that are relatively less employed in expert discourse.

3.2.2 [ADDRESSING CLIMATE CHANGE]

A first noticeable evolution among the category of terms denoting responses to climate change is the appearance of new units denoting renewable energy sources in the [ENERGY TRANSITION] sub-section. Three of these units (*clean energy, sustainable energy,* and *green energy*) in fact constitute denominative variants of *renewable energy*, a term already present around COP 15, thus indicating that their appearance in this more recent tree is not motivated by the dissemination of new knowledge. However, their emergence around COP 21 could suggest a greater entrenchment of the concept of renewable energy (Picton 2009, 200), especially since the relative frequency of the term *renewable energy* has significantly increased between the first and second press sub-corpora ($\chi 2 = 38.25$), rising from 108 to 202 occurrences (an increase of over 50%).

Another noticeable feature of this second tree diagram is the appearance of the terms *resilience* and *climate justice*. The presence of the former seems to indicate a diffusion of expert terminology into media discourse, since it is present in the expert corpus from COP 15, where it occurs 36 times. In contrast, it is more difficult to interpret the appearance of *climate justice* as the result of a knowledge dissemination process: the number of occurrences of this term is low in both the first media sub-corpus and the one representing climate expertise (totalling 2 and 4 occurrences, respectively), while

its frequency increased in both types of discourse starting from the period around COP 21. However, this increase is significant only for the press corpus ($\chi2 = 25$ vs. 7 in the expert corpus). At the same time, the majority of occurrences of this term (20 out of 27) in the latter corpus come from articles published from 2015 onwards, the year following the release of the special report 'What Now for Climate Justice', published by the International Institute for Climate Action and Theory (Bond et al. 2014) during a press conference held at COP 20 in 2014. As such, it is relatively difficult to determine the direction of circulation of this term: does the evolution in its frequency indicate a concurrent interest from both communities in this concept? In the case of the press, is this interest related to the publication of the aforementioned report, or to the multiplication of initiatives related to climate justice in the broader societal context? While the scope of our study does not allow us to answer these questions, we can use this example to question the idea of linearity in the process of knowledge transmission, as the observed data tend to challenge the prototypical conception of a top-down approach, from enlightened experts to non-specialists.

Regarding the category [SYSTEMIC RESPONSES], as in the tree representing the period around COP 15, it is primarily represented by terms denoting tools of governance. This sub-category thus features two new variants, namely *climate accord* (a variant of *climate agreement*) and *climate (change) summit* (a variant of *climate conference*). We also identify two terms referring to financial tools: *climate finance* and *divestment*. The latter, a portmanteau word formed from the truncated form -*vestment* – derived from the noun *investment* –, and the negative prefix *di-*, refers to the fact of withdrawing or ceasing to invest capital in a company (Cambridge Dictionary [online] n.d.). Of these two terms, only *climate finance* appears in the first expert and journalistic sub-corpora, where its relative frequency is 70 and 3, respectively. Its relative frequency then significantly increased between the first two sub-corpora, both in the press ($\chi2 = 11.9$) and in expert reports ($\chi2 = 22$). As for *divestment*, it appears in the lists of terms extracted in both types of discourse only from the second sub-corpus, where it has a relative frequency of 53 in the press and 19 in the expert corpus. As such, the data do not allow us to assert that this term circulated from expert discourse to the press, all the more so as this unit is statistically more used by the press than by experts ($\chi2 = 95.8$). An analysis of the cotexts where it occurs in both corpora gives us some clues as to why there is such a difference in the number of occurrences between the two corpora: *divestment* appears multiple times as modifier of the nouns 'campaign' and 'movement', suggesting that this term refers to a relatively specific and time-bound socio-economic phenomenon. Since the press is not subjected to the constraints of

scientific knowledge production, it tends to be more amenable to reacting to current events and, therefore, to addressing socio-economic phenomena occurring within a relatively short time frame, such as a 'divestment campaign'.

3.3   COP25/ 26

3.3.1 [DESCRIBING CLIMATE CHANGE]

In the most recent journalistic sub-corpus, new units are mobilised to designate extreme weather events, such as *wildfire, storm, hurricane, extreme heat (wave / event), tornado*, and *winter storm*, which did not appear in the trees representing the first two sub-corpora. Among these terms, *tornado* and *winter storm* are also absent from the list of terms extracted from the expert corpus and, in the press corpus, they appear almost exclusively in American newspapers. This can be explained by the fact that tornadoes and winter storms primarily occur in the US, highlighting the influence of the geographical context on the terminology used by the press.

This latest journalistic sub-corpus is also marked by the emergence of four new units to designate contemporary climate change: *global heating, climate emergency, climate breakdown*, and *warming planet*. Among these, the last two do not appear in the list of terms representing climate expertise, unlike *global heating, climate crisis*, and *climate emergency*, which have a total relative frequency above 30 in the latter corpus and thus also appear in the tree diagram. Although they share the same referent (climate change), these variants are not semantically equivalent: the head 'heating' (*global heating*) implies a higher level of warming than 'warming', while the heads 'breakdown', 'emergency', and 'crisis' carry negative connotations that are absent from the concept of change denoted by the head of *climate change*, emphasising the severity of the phenomenon. This observation raises questions about the origin of these terms, given that the presence of connotations seems incompatible with the imperative of objectivity and neutrality that is typically associated with expert discourse (Cabré 1998, 112). At the same time, the importance of these two parameters might vary depending on the type of experts, with NGOs having potentially a higher propensity to resort to connoted language than intergovernmental organisations such as the IPCC since they also have an activist function. Therefore, to better understand how these compounds have disseminated, we propose to compare their relative frequencies in the discourse of the two expert communities considered separately and in the media (Figures 1, 2 and 3 below). Those relative frequencies are calculated by dividing the number of occurrences of the term in a sub-corpus by the total number of

occurrences in the corresponding sub-corpus and multiplying the result by 440,000. This normalisation base corresponds to the rounded average of the total number of occurrences in each sub-corpus (press, intergovernmental organisations, and NGOs)[11].

Figures 1, 2 and 3. Evolution of the relative frequencies of *carbon crisis, carbon emergency* and *global heating* in the IGO, NGO and press corpora between the periods around COPs 15 and 25/ 26.
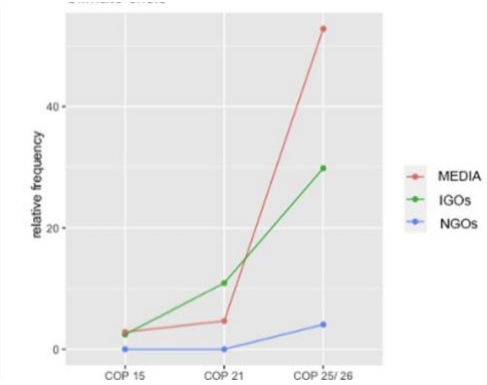
Figure 1. *climate crisis*
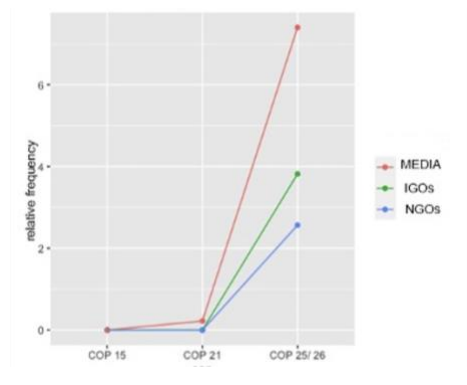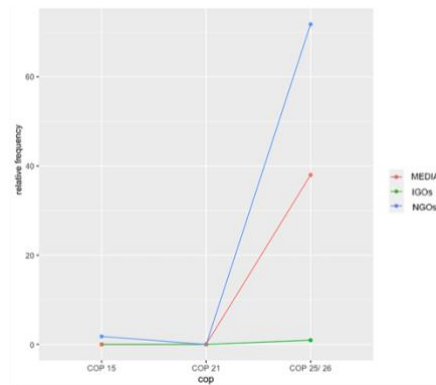
Figure 2. *climate emergency*

Figure 3. *global heating*

A striking feature in these three graphs is the relatively significant gap between the curves representing the evolution of the RL in the IGO corpus compared to those observed in the NGO and journalistic corpora: IGOs only start using *climate crisis* and *climate emergency* from the last sub-corpus (and to a lesser extent than NGOs and the media), and *global heating* presents only one occurrence in this same sub-corpus. This initial observation aligns with the hypothesis formulated above: NGOs and the media would be more likely to use these connoted units than IGOs. Comparing

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[11] (425 266 + 451 498 + 486 419 + 247 410 + 557 644 + 576 338 + 308 794 + 440 720 + 467 837)/9 ≃ 440 000

the total frequencies of these three units in the entire IGO corpus with those in the NGO corpus on the one hand, and in the media corpus on the other, reveals that there is each time a significant difference in frequency between the two corpora ($\chi2$ = 232.12 and 225.8, respectively). Nevertheless, these variants are not absent from IGOs' reports, as *climate crisis* and *climate emergency* are mobilised in the most recent subcorpus (RL = 19 and 12, respectively. They are then used by the UNFCCC, the World Bank, UNEP, and UNDP but are absent from the IPCC reports. As such, the presence of *climate crisis* in the media and NGO discourses since COP 15 suggests that this unit has in fact circulated from these two communities to the discourse of IGOs, except for the IPCC reports.

Additionally, we note a significant increase in the relative number of occurrences of these three compounds starting from COP 21 in the NGO and media corpora. This evolution can be associated with the signing of the Paris Agreement in 2015 and could indicate a shift in the climate debate at that time, marked by an exacerbated sense of urgency. This interpretation tends to be corroborated by the use of the units 'urgent' (one occurrence) and 'urgency' (seven occurrences) in the latest IPCC reports (published between 2021 and 2023), while these were absent in previous reports.

All in all, the diffusion pattern of these three units proves to be atypical if we consider that the terms of a domain are typically introduced by experts in that field. On the other hand, the characteristics of the units in question – which do not introduce new knowledge as they are variants of *global warming* and *climate change* and which carry certain connotations – make them atypical compared to a prototype whereby terms are defined as neutral units carrying specialised knowledge, which could explain this particular diffusion pattern.

2.3.2 [ADDRESSING CLIMATE CHANGE]

Around COPs 25/ 26, the press mobilised three new terms pertaining to the category of [emission reduction]: *net zero (carbon) (emission), decarbonisation,* and *(carbon) neutrality*. The latter already appeared in the second expert and journalistic sub-corpora, where their relative frequencies were yet not significant enough to represent them in the corresponding diagram. This increase in frequency around COPs 25/ 25 is congruent with the signing of the Paris Agreement in 2015, which made decarbonisation a global objective. By contrast, other forms of responses such as resilience and climate justice are associated with a smaller variety of terms and lower relative frequencies: for example, the category [ENERGY TRANSITION] is represented by 12 different terms – which amounts to a total relative frequency of 1237, while the categories [RESILIENCE & ADAPTATION STRATEGIES]

and [PROMOTING EQUITY] are both represented by only 3 different terms, whose total relative frequencies respectively amount to 90 and 97.

In fact, a broad perspective on this third diagram highlights an imbalance between the two macro-categories around which it is structured, as the category [DESCRIBING CLIMATE CHANGE] displays more terms than [ADDRESSING CLIMATE CHANGE], whereas the distribution appears more balanced in the expert tree. This observation suggests that the diffusion of expert knowledge to the media is relatively heterogeneous, which could be motivated by the specificities of the press as a discourse community (see section 3.1.2, §3). Thus, because they have not necessarily been developed and implemented, responses to climate change tend to involve a certain level of uncertainty and as such do not correspond to *facts* per se. On the contrary, the consolidation of scientific consensus on the reality of climate change and its anthropogenic causes tends to bring the manifestations of this phenomenon closer to the epistemic category of *fact*, while the solutions to respond to it are far from consensual. As such, covering the manifestations and risks of climate change seems more 'press-friendly' than reporting on potential solutions to address it.

3   Discussion

The diachronic analysis of the most represented terms in each journalistic sub-corpus has highlighted a certain diffusion of expert terminology to the press: the presence of numerous references to extreme weather events shows that the media tend to emphasise the link between these disasters and climate change, and do so increasingly over the period. The anthropogenic origin of climate change also seems to be relatively well understood by the media, as evidenced by the presence of terms referring to fossil fuels and greenhouse gases in the three sub-corpora. However, a comparative analysis of these terms in discourse would be necessary to assess how the concepts they designate are treated in the press, especially since we have identified clues of potential conceptual variation between media and expert discourses (cf. our analysis of the terms *biomass* and *uncertainty*). Thus, the adoption of expert terminology by the press does not necessarily mean that the knowledge indexed by a given term is also assimilated by this community, as the conceptual content of terminological units can be relatively simplified, notably to make it more accessible to a heterogeneous readership. Furthermore, issues of adaptation, resilience, resource management, and climate justice have proven to be less represented in press discourses compared with other forms of responses such as the promotion of renewable energy, even though these concepts are central among the responses to climate change mentioned in expert discourses. It is therefore worth wondering whether their

underrepresentation in the media could negatively influence the ability to address climate change, which is conditioned by a certain awareness of the tools and strategies that are available to do so (Moser 2006). Conversely, we have identified several units that are more frequently mobilised by the press than by experts, such as *fracking*, *shale gas, winter storms,* and *tornadoes*. This pattern can be motivated by characteristics specific to each type of discourse, such as the principle of proximity to its readership or the focus on facts for the press (Peynaud 2018, 2-3), principles that may not necessarily align with the treatment of hypothetical and uncertain solutions but can favour the coverage of updated, immediate, and national events. Consequently, these differences invite one to relativise the idea of a top-down knowledge diffusion model, where knowledge emanates from science, which then disseminates it to lay audiences, whose 'ignorance' would confer it a subordinate position in the overall process. Rather, they lead one to consider the existence of different diffusion channels, each governed by its own rules but jointly contributing to defining what climate change means for society. This perspective is not without consequences though. Since terms and the knowledge they index are typically defined as characteristics of specialised discourses, considering that they might also emerge from the media invites one to rethink this conceptualisation: do terms that are primarily mobilised by the press – or even introduced by it – index knowledge (in which case, the use of the words *concept* and *term* for the units in question should also be examined)? While the examples of *fracking* and *shale gas* – which have terminological entries in Termium+ and are relatively neutral – suggest an affirmative answer, it is more challenging to draw such a conclusion for connoted units such as *climate breakdown*, *climate emergency* or *climate crisis,* which are not lexicalised and carry connotations. As such, we propose to consider these compounds as constituting a form of interface between the domain of climate change and everyday language (Bureau 2022). Their introduction in press discourse can be interpreted indeed as illustrating a form of imitation of climate experts' terminology, relying on the use of the term *climate change* as their basis, which originates from climatology. Incorporating some of the formal and referential characteristics of a specialised unit tends to give these compounds the appearance of a term, which could in turn confer a certain scientific credibility to the discourse using them. At the same time, the use of relatively ambiguous head nouns such as 'chaos', 'breakdown' or 'crisis' can leave room for the receiver to imagine the most apocalyptic scenarios, thus giving these compounds a certain persuasive power, based on fear. In that respect, these interface-terms materialise a certain tension in the field between the necessity to inform and the necessity to act, which tends to blur the boundaries between specialised and general discourses.

4   Conclusion

In this article, we have presented a methodology to analyse the circulation of specialised knowledge on climate change between experts and the press. We relied on a statistics-based observation of diachronic and diastratic terminological variation across corpora representing these two communities, and categorised the most frequent terms in the latter in tree diagrams, based on their meanings. This approach facilitated comparison between the corpora and allowed us to identify patterns that could then be explored further using discourse analysis (DA). Resorting to DA proved necessary to account for phenomena of determinologisation in the press, confirming that the use of a climate term by the press does not mean that the specialised content it indexes is activated. As such, future research could endeavour to analyse semantic variation around a greater set of climate terms.

Overall, this combined methodology allowed us to highlight a relative imbalance in the representation of climate change in the press over the period, as it appeared to cover more the manifestations and risks of climate change than ways of addressing it, while no such pattern was observed in the expert corpus. Considering that citizens are more likely to engage in climate action if they are informed about potential solutions (American Psychological Association 2009, 24), this imbalance is not to be neglected if the press wants to foster its role as a key agent in the ecological transition.

Acknowledgements

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