Moves, Metaphors and Their Interrelation

in Abstracts of Climate Change Articles in High-Impact Scientific Journals

Evgeniya Astafyeva

(s2162717)

Leiden University

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Abstract

Climate change is a scientific discipline that received extensive attention from both specialists and general public. This puts additional pressure on scientific writers in this domain to use language means successfully to render their ideas to such a wide readership. Manty studies have researched the use of rhetorical moves and metaphors in scientific writing, but never in climate change writing and never in interrelation. This thesis, therefore, aims at bridging this gap and studies rhetorical moves, metaphors and the ways they may be interrelated in abstracts of climate change research articles in high-impact journals *Science Advances* and *Nature Climate Change*. It has been found that many abstracts in the data favor the Introduction-Purpose-Product-Conclusion structure, and overall the Product move is obligatory for all abstracts. However, *Science* data showed more variation both in the use of moves and in the usage of metaphors. The results of this study could be a starting point for a more in-depth research in the area, as well as of use to those studying scientific discourse for academic or practical reasons.

Keywords: abstracts, rhetorical moves, metaphors, climate change

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If we open Publication Manual of the American Psychological Association, one of the most referenced handbooks in terms of academic writing style, we will read that "the author who is frugal with words…increases the chances that the manuscript will be accepted for publication" (2013, p.67). Arguably, this means that an academic writer must follow a clear-cut rhetorical structure throughout their writing and be as precise and laconic as possible, allowing for the reader to read smoothly through the writing, always knowing what to expect.

It is also recommended in the same manual to "use metaphors sparingly" and "avoid mixed metaphors": while conceding that metaphors might aid in rendering complicated ideas, the authors of the APA manual still claim that "metaphors can be distracting" and writers should "use figurative expressions with restraint and colorful expressions with care; these expressions can sound strained or forced" (Publication Manual of the American Psychological Association, 2013, p.70). Figurative language, mostly in the shape of metaphors, is, therefore, not welcome in academic texts: even though it might help a reader understand a complicated academic concept, due to the chance of the reader being misled by it a metaphor should be seen as a last resort.

However, anyone who has read some amount of scientific research will know that these recommendations are far from being universally followed. There are some authors who employ more figurative language in their scientific writing, some authors' language use can be indeed called 'colorful'; there is a visible mismatch between what is taught and recommended in academic writing literature and what is being written in reality (Santos, 1996).

It cannot be argued that there exists a vast variety of rhetorical structures and figurative language use among academic writers. It is especially visible in research article abstracts, which are in the forefront of research, acting as a welcome wagon for the readers potentially interested

in reading the research further (Santos, 1996). It is, therefore, deemed beneficial to look at research article abstracts in more detail and see some patterns in their rhetorics and figurative language usage, since they receive the most visibility on the part of the readership and therefore could show the patterns of rhetorical moves and figurative language usage that influence the readership the most, since they are arguably always the first thing a reader encounters in a research article.

This study will be focused on research article abstracts in the domain of climate change. Taking this set of disciplines as a core for data collection is beneficial to this study in many ways. Climate change research is of enormous importance nowadays, and it can be said that research articles in this domain receive heightened attention both from the members of the professional community and from the public. It is hardly contestable that "the ability to build and maintain consensus on issues such as climate change fundamentally depends upon expertise, ensconced in professional opinion" (Lefsrud & Meyer, 2012, p.1478).

In this view, abstracts and their linguistic structure are of great interest for research, since their visibility is even higher in the domain of climate change. Scientific writers of climate change research are in a situation of great awareness of their writing being scrutinized by a great amount of both their peers and laymen of various groups: general public, policymakers, and other stakeholders. An overview of linguistic means used in those research article abstracts could provide a framework that can gauge the role of scientific communication in climate change, as well as investigate how effective certain linguistic techniques are in a situation where a broadly raised awareness of the topic is called for (Nerlich, Koteyko, & Brown, 2010).

This study will look at two linguistic phenomena in climate change abstracts: rhetorical moves and scientific metaphors. Both these phenomena have been studied separately before, but never have they been collated to see any potential connection between their usage by scientific writers in climate change article abstracts. The next section of this study will review previous

literature on the subjects and provide further evidence of the research gap that this study is aiming at fulfilling.

Literature Review

Academic Writing and Discourse Communities

There exists an extensive body of research on what constitutes academic writing in English, as well as a lot of textbooks stating the rules of successful academic writing. Since this study highlights possible interrelation between scientific writing rhetorics and the usage of figurative language, it is beneficial to first look at the way these concepts are approached in the literature on academic English.

Bennett, in a 2009 study, sets out to review and analyze 41 English academic style manuals to test the hypothesis that there is consistency within prescriptive tradition as to what constitutes academic English. The results confirm that there is a certain consensus among the writers of the manuals as to the features of academic style, despite some differences in target readership, genre and discipline. These features are what, according to Pinker (2014), makes most academic writing "turgid, soggy, wooden, bloated, clumsy, obscure, unpleasant to read, and impossible to understand" (p.11). Freeman (2018) notices a paradox where many style handbooks use figures of speech, but caution against their usage. One of the manuals, however, singled out by Bennett, Freeman and Pinker, talks about researchers' signature style that shows playfulness, originality and imagination. The author of "Stylish Academic Writing", Helen Sword (2012, as cited in Sergi, 2014), admits that there is a big gap between what is considered to be good writing and what is published in academia, noticing that stylish papers are exceptional rather than normal. However, in every field Sword analyzed there was "a healthy minority" of papers written elegantly and with grace (Sword, 2012, as cited in Pinker, 2014, p.11).

The aim of this research is, to some extent, to see the patterns in academic writing that make the papers resemble each other, or, on the other hand, differ in style – seeing which writing

might pertain to the 'healthy minority' Sword talks about. Bennett (2009) mentions a lot of research into academic style and its rhetorics which suggests variation between academic genres, disciplines or approaches within a single discipline. (Bennett cites, among others, Bhatia, 1993; Hyland, 2000; Samraj, 2002; Swales, 1990; all reviewed later in this thesis). Arguably, the differences might lie in variations between and within the discourse communities.

Swales is one of the first to talk about discourse communities, saying that "publication is seen as documentary evidence that the writer qualifies for membership in the target discourse community" (Swales, 1990, p.7). According to Hyland (2006), in discourse communities meaning is created in interaction. Scientists within the communities wish to transfer new knowledge to other members of the same community; therefore, the choice of strategies depends on the structure of interaction between these members within a community (Martín-Martín, 2005). Hyland (2006) writes that certain recognized relationships within the community will persuade the writers to construct the message in certain ways, in order to appeal to the readership. Understanding the way meaning is constructed in society is aided by understanding the interplay between genre and community. Many studies have concluded that differences between discourse communities are reflected in the language (Deignan, Littlemore, & Semino, 2013).

In Hyland's view, interdisciplinary differences between the discourse of such communities would be visible in research article (RA) abstracts, which will be the focus of this research paper. Hyland argues that rhetorical practices are connected to the aims of a certain discipline. For instance, he cites Samraj's (2002) research results as an indication that researchers in sciences strive to stress that their results are important and applicable in real world, while in the humanities the highlight would be on the fact that the topic has not been researched before, and not necessarily on the results' applicability.

It has to be noted that in this researcher the terms 'academic discourse' and 'scientific discourse', as well as 'academic writing' and 'scientific writing', will be used interchangeably, as

the general assumption is that all academic domains share several common features (Herrmann, 2013); arguably, there exists a very wide, broad discourse community of scientists, academics, scholars – those engaged in research of some kind and, thus, sharing the features in their discourse.

Research Article Abstracts

A research article abstract, in genre analysis, has long been considered a separate genre, worthy of separate studies (El-Dakhs, 2018). Sharing the opinion that a research article abstract is a recognized genre, Bhatia (1993) says that this genre emerged due to members of a research community striving for well-understood and comprehensible communication.

The term 'abstract' is derived from Latin *abstrahō* ('to drag, pull away from') (Atanassova, Bertin & Larivière, 2016). It has emerged as a tool to project the research to the audience. The abstract serves as an analogue of marketing techniques to sell the full article to the reader. It informs an uncertain reader what the article contains, hopefully persuading them to read the full piece. It also serves as an aid to those who did read the full text to remember the contents. Lastly, abstracts save time to those readers who are only marginally interested in the research and want to only know a selected part, for instance, the method or the results (Santos, 1996). Doró (2013), in line with Hyland's (2006) ideas of discourse communities, states that the main function of an abstract is to provide an effective summary, as well as to persuade the reader to read the full research: thus, constructing an abstract in a specific way is one of the conventions within a discourse community that helps the writer to achieve the goal of appealing to the readership of this specific community.

While an abstract is a separate genre recognized in genre analysis research, it is, nevertheless, a genre having very close ties with introductions. Bhatia in his work of 1993 states that research article abstracts and research article introductions are often almost identical, giving an example where such relationship is clearly observed. The author is free to paraphrase or even completely re-use phrases from the body of the article, so the abstract, in the end, conveys quite

limited information about the research (Atanassova et al., 2016). However, the fact that research article abstracts and introductions exist in such close interrelation gives us an opportunity to use research on research article introduction to partly explain some features of research article abstracts, as will be exemplified further in this paper.

Rhetorical Moves in Research Article Abstracts

A three-move model.

Pioneering work on rhetoric move structure in academic texts was done by Swales (1981; 1990). Also being the author on major early works on genre analysis, Swales defines a move as "a discoursal or rhetorical unit that performs a coherent communicative function in a written or spoken discourse" (Swales, 2004, p.228-229). Move research over time has focused on comparisons of move types used in the writing of native and non-native English speakers, novice and expert users of English, between different languages, across disciplines, and different points in time.

Swales proposes a model of rhetorical move structure for research article introductions. However, the results are still interesting in terms of move analysis in abstracts because these two genres are very close, the introduction just being more elaborate (Bhatia, 1993). Swales' research gained a lot of recognition and was later successfully applied to research article abstracts, after they started attracting more attention in linguistic research. Swales' CaRS (Create-a-Research-Space) Model is summarized in Table 1:

Move	Step	Explanation
1: Establishing a territory	1	Claiming centrality and or/
	2	Making topic generalizations and/or

	3	Reviewing items of previous research
2: Establishing a niche	1A	Counter-claiming or
	1B	Indicating a gap or
	1C	Question-raising or
	1D	Continuing a tradition
3: Occupying a niche	1A	Outlining purposes or
	1B	Announcing present research
	2	Announcing principal findings
	3	Indicating research article structure

Table 1. *CaRS move model (Swales, 1990, p.141)*

The model is employed, for instance, in "Academic writing for graduate students" (Swales & Feak, 1994), a manual to introduce international students into their discourse community (Muangsamai, 2018). However, Freeman (2018) provides critique of the textbook – its revised, 2009 version – for praising more vague, non-informative abstract endings.

One of the influential studies using Swales' (1990) CaRS model was done by Samraj (2002). The research, like Swales', focuses on research article introductions rather than abstracts. Samraj found that moves can be optional or obligatory, much like many other researchers yet to be cited in this thesis. Moreover, another notable thing relevant to the current study is the fact that the rhetorical structures varied across two disciplines that, at first glance, are not so far from each other (conservation biology and wildlife behavior). Samraj argues that researchers in conservation biology adopt a move structure that allows them to better convey the topicality of their research, stressing its real-world importance, unlike wildlife behavior scholars. Hyland (2006) cites Samraj's research as an indication to the formation of distinct discourse communities.

A study by Marefat & Mohammadzadeh (2013), exploring various move models across native and non-native English abstracts in literature, found that the CaRS model best suited their

corpus (while still not being completely applicable). In another study of the same year, based on a 3-move model, we can observe some differences in results for various disciplines: in this case applied linguistics, applied economics and mechanical engineering (Sabouri & Hashemi, 2013). Hanidar (2016), who studied research article abstracts in biology, mechanical engineering, linguistics and medicine, similarly found some interdisciplinary variation.

The CaRS model, being the first one to emerge, has been also cited in criticism of move analysis in general. It has been, for instance, claimed that move analysis would always remain subjective, while admitting a rather explicit nature of the criteria, namely in the CaRS model (Crookes, 1986). Crookes (1986) also cites lack of empirical validation as one major problem of move analysis.

Four-move models.

One 4-move model that has been the most visible throughout the past century is IMRaD. The IMRaD structure for scientific articles has been gradually adopted by a big number of scientific publications in the course of the twentieth century, after, at its beginning, the norms of scientific writing started to deviate more and more from the literary style (Sollaci & Pereira, 2004). After World War II IMRaD was recommended at several international scientific conferences (see e.g. International Committee of Medical Journal Editors, 1997, as cited in Sollaci and Pereira, 2004). Sollaci and Pereira, who studied the increased use of IMRaD in medical journals, concluded that the biggest rise in the usage was seen between 1955 and 1975. They do not have a definite explanation to this trend but hypothesize that other fields of science were an influence – therefore, IMRaD structure was already widely used in scientific publications. Huth (1987, as cited in Sollaci and Pereira, 2004) suggests that the increase of usage of IMRaD is due to editors who insisted on clear formatting of the papers.

After wide adoption of IMRaD structure in scientific articles, the same structure was increasingly being applied to abstract structure. This is a summary of the IMRaD model, as it is used in research article abstracts:

> "Section 1 (Introduction). This may outline the author's purpose or objective, the goals of the research or the problems that the author wishes to tackle.
>
> • Section 2 (Methods). Here the author indicates the way the problem has been studied or the goal set out: this might include the data used and the methodology followed.
>
> • Section 3 (Results). In this section a summary of the general findings appears.
>
> • Section 4 (Discussion). This move might include an interpretation of the results, some implications for further research or applications of the findings". (Lorés, 2004, p.283)

The same author's research suggests that there might be a combinatory structure between the CARS and the IMRaD model. Such combinatory structure would be an indicator of an informative-indicative research article abstract type, while clear CaRS structure represents indicative abstracts, and fully IMRaD-based abstracts are to be considered informative (Lorés, 2004). The distinction between informative and indicative abstracts has been present in the literature (Day, 1988; Graetz, 1985; Jordan, 1991; as cited in Lorés, 2004; Martín-Martín, 2005; Ventola, 1994). Indicative (and, according to Lorés, CaRS-structured) articles aim at helping the readers understand the scope of the research, indicating the main findings but not going into the process step-by-step. Informative abstracts, on the other hand, are research article articles in miniature and report on every step within the article itself, hence the IMRaD structure, which mirrors a typical research article composition.

Another 4-move model that has been applied to research of abstracts is one by Bhatia (1993). Its structure is, in fact, very similar to IMRaD: Introducing purpose; Describing methodology; Summarizing results; Presenting conclusions. Bhatia argues that an abstract is aimed at giving the reader exact but concise understanding of the full article, by means of answering the following questions:

"*1) What the author did*

2) How the author did it

3) What the author found

4) What the author concluded" (Bhatia, 1993, p.78)

The 4-move models continue to attract attention among researchers and research article writers. For instance, Wang and Tu (2014) have concluded that 4-move structures, especially IMRaD, were used more often in their corpus, which included applied linguistics research article abstracts.

Five-move models.

There are two research article abstract models that include five rhetorical moves. These models have sparked a lot of interest among researchers.

One of these models was developed by Santos (1996). His definition of move is the following: "move is to be considered as a genre stage which has a particular, minor communicative purpose to fulfill, which in turn serves the major communicative purpose of the genre" (Santos, 1996, p.485). Doró (2013) points out that Santos' model is very similar to IMRaD, with one exception of moves 1 and 2, which seem to be an extended version of IMRaD's Introduction move. It is visible from Santos' model description in Table 2:

Move#	Description	Function	Question
1	Situating the research	Setting the scene, topic generalization	What has been known about the field/topic of research?
2	Presenting the research	Setting the purpose of the study, research questions/hypotheses	What is the study about?
3	Describing the methodology	Describing the materials, subjects, variables, procedures	How was the research done?
4	Summarizing the findings	Reporting the main findings of the research	What did the research find?
5	Discussing the findings	Interpreting the results, giving recommendations, implications, applications	What do the results mean? So what?

Table 2. *Santos' move model (Santos, 1996)*

Additional to the general 5-move structure as shown in Table 2 (move balance), Santos (1996) also recognizes move embedding, in which blending of moves into the same statement occurs, as well as move reversal, where moves may occur in a reversed sequence. These three features are, according to Santos, genre-specific of abstracts. Can, Karabacak and Qin (2016) observed the same features in their corpus of applied linguistics research article abstracts. They hypothesize that combining moves allows the authors to maintain the flow and convey more information under the conditions of limited space. The order of moves in an abstract is normally the one exemplified in Table 2; however, there were many deviations observed, as well. One finding in Sabouri and Hashemi's 2013 article, which is in line with the idea of move embedding, suggests the existence of so-called hybrid moves: rhetorical structures in which more than one move can be singled out.

Santos was classifying the moves according to their essentiality – that is, whether a move was obligatory or optional in an abstract. If the move occurred in more than 80% of the cases in the corpus, it was considered obligatory. It has been observed by Can et al. (2016) that most studies on rhetorical moves have focused on the same aspect of moves. They themselves found moves 1 and 5 to be non-obligatory in their corpus, which is consistent with what Santos found in his own work. Al-Shujairi, Ya'u and Buba (2016) observed the same results in their corpus of applied linguistics and TESL abstracts. Doró (2013) cites their results as similar to the ones Doró obtained, with moves 2, 3 and 4 being obligatory. However, there was some inconsistency in her findings, as move 1 was considered obligatory in one of the journals and optional in another.

One research using Santos' model that is especially important to this thesis was conducted by Oneplee (2008). She studied moves in research articles published in *Nature* and *Science* journals, which are the basis of the corpus of this paper, as well. Oneplee found all five moves from Santos' model present in the scientific articles in the journals in question. An interesting point is that abstracts in *Science* focus more on moves 1, 4 and 5, which is different from the findings of Santos and other scholars studying linguistic research article abstracts. Another revelation about abstracts in these journals was that only in 11% of the cases in the corpus the authors employed move 3 (discussing the methodology), while it was considered to be almost omnipresent in most other studies of the matter.

The other five-move model, which has been used extensively in rhetorical move research in abstracts, is Hyland's model. His research on discourse communities and the way writers construct narratives to apply to members of particular communities (Hyland 2000, 2002, as cited in Hyland, 2006) led him to study concrete rhetorical moves with which this is done. Hyland's model of moves is summarized in Table 3:

Move	Step	Description
1. Introduction		Establishes the context of the paper, motivates the research
	1	Arguing for topic prominence
	2	Making topic generalizations
	3	Defining terms, objects, or processes
	4	Identifying a gap in current knowledge
2. Purpose		Indicates purpose, thesis or hypothesis, outlines the intention behind the paper
	1	Stating the purpose directly
3. Method		Provides information on design, procedures, assumptions, approach, data, etc.
	1	Describing the participants
	2	Describing the instrument or equipment
	3	Describing the procedure or conditions
4. Product		States main findings or results, the argument, or what was accomplished
	1	Describing the main features or properties of the solution or product
5. Conclusion		Interprets or extends results beyond the scope of the paper, draws inferences, points to applications
	1	Deducing conclusions from results
	2	Evaluating value of the research
	3	Presenting recommendations

Table 3. *Hyland's move model (Hyland, 2000, as summarized in Saboori & Hashemi, 2013)*

Various scholars adopted Hyland's model for their research on rhetorical moves in various contexts. Zanina (2017) researched native English abstracts in management RAs as opposed to the ones written by Russian speakers and found a stricter conformity to Hyland's model in the native English ones. El-Dakhs (2018) had similar results for linguistics abstracts, where Hyland's model was generally followed, with occasional omission of move 1 and with a focus on move 4 in more prestigious journals – El-Dakhs argues that this is because the results are the author's main selling point. Rashidi and Meihami (2018), studying scientometrics, found a similar trend to stress moves 3 and 4, arguably because those parts are more convincing to the reader, and frequent omission of move 5. A more recent study of Amnuai (2019), studying accounting research article abstracts of native and non-native (Thai) English speakers, corroborates previous research with findings of the more obligatory character of moves 2, 3 and 4, and a more optional character of moves 1 and 5.

The 5-move models have been used excessively in rhetoric structure research. Wang and Tu (2014), for instance, conclude that the 5-move models have a clearer framework. Saboori and Hashemi (2013), as well as Abarghooeinezhad and Simin (2015), who studied engineering abstracts, all cite Hyland's model as influential and a more elaborated one. Al-Shujairi et al. (2016), using both Santos' and Hyland's models in their study (sometimes somewhat confusingly switching between them), resort to Hyland's model in the end, since it has been based on material from various fields of knowledge. It also seems to be the case that Hyland's model is used in the majority of the more recent studies (e.g. Amnuai, 2019; El-Dakhs, 2018; Rashidi & Meihami, 2018; and others).

Scientific Metaphor

It has been mentioned earlier that figurative language is not officially welcome in scientific texts. Textbooks advise against it; many suppose that the usage of figurative language, metaphors included, goes against the premise of neutrality of scientific texts, and metaphors are too imprecise, confusing and ambiguous; many believe that there is, in fact, no figurative language to be found

in scientific discourse (Shuttleworth, 2017; Freeman, 2018; Taylor & Dewsbury, 2018; Steen, 2010). However, there is a wealth or research on scientific metaphors that acknowledges their existence and importance.

A metaphor, in the view of Johnson-Sheehan (1997), is "a device for changing perspective … a way of seeing something in terms of something else, thus shifting our point of view" (p.179). In the framework of Conceptual (Cognitive) Metaphor Theory (CMT), metaphor is an essential part of knowledge-building and understanding the world. The theory, gaining popularity in the late 1970s, after pivotal works by Ortony (1979) and Lakoff and Johnson (1980) were published, has not emerged from nowhere: the ground for it has been prepared by a number of scholars from antiquity to 1960s – Aristotle, Descartes, Kant, Nietzsche and, more recently, Richards, Black and Ricoeur; to name but a few (Herrmann, 2013). It has to be noted from the beginning that in this study the focus will be on linguistic, genre-specific and discursive aspects rather than on the cognitive aspect of metaphors. Nevertheless, it cannot be denied that CMT has informed the scholarly community immensely on the nature and aspects of metaphor in general and in scientific discourse in particular, and many scholars have embraced the idea of metaphor's ubiquity and mental power (Herrmann, 2013). It has, therefore, been judged to be beneficial for this study to look at some aspects of CMT and various studies of scientific metaphor based on it, and several concepts will be used in this study's analysis.

According to Lakoff and Johnson (1980), metaphors help our understanding of complex ideas by thinking about them in terms of other, familiar concepts; thus, a specific mental model is created in a new domain in need for describing, using concepts from another domain. It is logical to assume that metaphors have an pervasive role in scientific discourse, regardless of the opinions of those who are against their usage: metaphors aid at understanding complex scientific concepts using familiar knowledge from different domains, challenging to change scientific hypotheses and conceptions of reality, and serving as foundation for cognition (Caballero, 2013; Johnson-Sheehan,

1995; 1997; Kuhn, 1962, as cited in Steen, 2010; Shuttleworth, 2017; Taylor & Dewsbury, 2018). Metaphors also often serve as a basis for naming new ideas: the language would become cumbersome if a completely new word was created for every new scientific concept, therefore, metaphorical word creation is used instead (Knudsen, 2003; Štambuk, 1998). Contrary to common belief, a metaphor is sometimes unavoidable if you want to achieve clarity (and not vice versa) (Braithwaite, 2006, as cited in Shuttleworth, 2017); metaphor's assumed ambiguity can become an incentive for creative thinking and scientific exploration (Larson, 2011). Taylor and Dewsbury (2018) claim that, due to interdisciplinary nature of research nowadays metaphor is a useful tool to bring researchers together and keep them on the same page; scientists and educators should acknowledge metaphor's power while understanding it critically, and more interdisciplinary collaboration is needed to create common metaphorical representations of concepts.

The mechanism of metaphorical mapping lies in the basis of metaphor creation in CMT: there is a relation between the target and the source domain, and links are set up between elements of these domains; metaphorical expressions occur when a linguistic representation pertaining to the source domain is used to refer to some aspect of the target domain (Dancygier & Sweetser, 2014; Herrmann, 2013; Lakoff & Johnson, 1980;). Research has posited that several conceptual metaphors like this, e.g. ARGUMENT IS WAR, underlie scientific discourse (Steen, 2010). Scientific metaphors, however, rarely take a simple 'X is Y' implementation, they usually represent a whole cluster of terms (Johnson-Sheehan, 1997; Lakoff & Johnson, 1980). Several researchers have proposed a basic metaphorization scheme, similar to that of Lakoff and Johnson (1980), earlier. Black (1962), for instance, talks about the principle subject and the subsidiary subject, and the metaphor is a filter where the principle subject (focal word) is regarded through the metaphorical expression, which causes a semantic shift. Hesse (1965), using Black's idea to project it to scientific genre, speaks about metaphors altering the concepts of reality; the principle

subject is renamed into the referent. Goatly (2011, first published in 1997) further develops the terminology and talks about the vehicle, the topic and the grounds of a metaphor.

There have been a few studies that looked at various aspects and functions of scientific metaphors. Influential research by Boyd (1993, as cited in Knudsen, 2003), for instance, resulted in the scholar proposing a division of metaphor types into theory-constructive and pedagogical (exegetical) metaphors. The former are representations of original scientific thought and terms, while the latter have an explanatory and pedagogical function. However, Knudsen herself (2003) has found that in her corpus of specialist and non-specialist (popularized) scientific texts it was often impossible to differentiate between the two types in regard to specific metaphors. It has been concluded that exactly the same metaphorical expressions can be found in both functions, so the borderline between the two types proposed by Boyd is vaguer than he posited. Deignan et al. (2013) say that theory-constructive metaphors also transfer genres to become pedagogical, thus, differentiation is problematic. In this study this distinction is, therefore, not going to play a role.

Another issue concerning metaphor, especially vivid while studying scientific discourse, is metaphor's conventionality versus originality (Herrmann, 2013). Gibbs (1994, as cited in Herrmann, 2013) claims that scientific metaphors often become conventionalized due to overuse; this, however, happens in the minds of domain specialists rather than lay readers (Cameron, 2003, as cited in Herrmann, 2013; Low, 2008, as cited in Herrmann, 2013; Semino, 2008, as cited in Herrmann, 2013). Davidson (1979, as cited in Herrmann, 2013), proposed similar concepts of emergent, guiding metaphors versus dead metaphors (see also Dorst, 2011, for personification). In this view it is interesting to consider the distinction of metaphor proposed by Knudsen (2003). Knudsen suggests that there is a difference between closed and open metaphors. Arguably, the more familiar the metaphor becomes and the more it is ingrained into the discourse, the less it can be recognized as figurative by the discourse community (e.g. scholars in a particular domain). Thus, this kind of term-like metaphor in a scientific text is closed for development, it has become

a non-marked expression. Closed metaphors constituted 1% of all the text in Knudsen's specialist writing corpus (from *Science* journal). It has been noticed, however, that closed metaphors are often reused – 'opened up' – in popularized non-specialist texts about scientific concepts. The current study, looking only at specialist scientific text, will examine the openness of metaphors and test whether Knudsen's findings can be extrapolated to a slightly larger scientific corpus.

One more issue that is often addressed in studies of figurative language is distinction between metaphor and more direct forms of figurative devices like simile. Knudsen (2003), for example, talks about the difference between metaphor and simile and argues that a simile represent similarity between source and target, while metaphor claims identity, which is stronger. Another problematic type of metaphorical expression is personification, which may be identified differently depending on different analyses employed for its study (Dorst, 2011). In this view, Herrmann (2013) makes a comprehensive distinction between direct, indirect and implicit metaphorical forms, following a metaphor identification procedure known as MIPVU (described in Steen, 2010). Direct forms, including simile and analogy, are often signaled, and both the referent and the topic are present in the sentence. Indirect metaphor is what we might call metaphor proper, where an expression is used indirectly to convey some cross-domain connection. Implicit metaphor is based on lexico-grammatical substitution: it builds on cross-domain mapping established elsewhere in the text, and linguistically often includes pronouns or some forms of ellipsis. It is suggested by previous research that direct metaphor would be more widespread in academic writing; however, in Herrmann's research indirect metaphor was found to be quite common as opposed to direct and implicit metaphorical expressions (see also Steen, 2010). In this study these three forms of metaphor will be studied to determine whether similar relations will be found in a different corpus.

Climate Change Discourse

According to Nerlich, Koteyko, & Brown (2010), a great many governments now accept the anthropogenic nature of climate change; government communication, therefore, has turned to promoting ways of fighting climate change, rather than attempts to prove its inevitability. However, not everyone accepts this viewpoint. Debate about climate change has been ever present since mid-1980s (Young & Dugas, 2012); Lefsrud and Meyer (2012) report persistence of certain skepticism towards climate change concept, even though broadly and on average there seems to be consensus on its existence.

Climate change issues represent interdisciplinary expertise intertwined; it is evidence of a shift in scientific thought that has been brought about by pressing environmental issues (Rademaekers, 2014). Even though it is a rather complicated scientific topic, it has, nevertheless, shown high presence in various types of genres apart from the scientific: media, political, educational genres, as well as in discourse of various concerned parties in the society; these discourses under an umbrella term 'climate change discourse' might be characterized by different usage of linguistic features and different interpretation of concepts (Fleming, Vanclay & Wilson, 2014; Young & Dugas, 2012). All of the concerned groups are struggling to develop complex yet dynamic mechanisms to tackle the issue, and language is inevitable part of this system and, as it would, represents its own dynamics; its role cannot be left unattended (Nerlich et al., 2010).

One issue of linguistic choice, quite prominent at the start, is the choice of nomination of the discipline itself. Many scientists prefer the term 'climate change' to 'global warming', since global warming is just one aspect of a much more complex issue: "global warming is just a symptom of planetary ill health, like a fever" (Somerville, 2006, p.2). However, while 'climate change' is believed to be a broader and therefore a preferable term, it is still not uncommon to see 'global warming' used in its stead. Luntz (2002, as cited in Villar & Krosnick, 2001) hypothesized that the public would see 'climate change' as a less grave issue than 'global warming'. Whereas

"global warming has catastrophic connotations attached to it, climate change suggests a more controllable and less emotional challenge" (p.142). However, Villar and Krosnick, in a study of the views in the USA and Europe, have found that, on average, both 'global warming' and 'climate change' are seen as equally serious. Nevertheless, objective measures show that carbon emissions are still on the rise, therefore pointing at the fact that current way of climate change communication in the global society should be yet altered (Nerlich et al., 2010).

Analysis of climate change discourse and the way it shapes public opinion has been increasingly present in research for a few decades (Nerlich et al., 2010). With the issue of climate change pressing the scientists, the governments, the public and other parties to take a standpoint, it has been researched what the features and particular structure of climate change discourse in various genres are, and how those might affect the recipients' opinion. A lot of this research has focused on media representations of climate change (Young & Dugas, 2012, is one example among many). However, for the purposes of this thesis it is more beneficial to investigate prior research in terms of climate change scientific writing, and similar genres. Moreover, according to Fleming et al. (2014), scientists are generally the only universally acceptable producers of knowledge, therefore, scientific climate change discourse is of utmost importance for linguistic analysis.

However, first a note should be made that this research is concerned with scientific writing proper, and the materials will include texts from acclaimed peer-reviewed journals. This type of writing is not to be confused with so-called conservation writing (Johnson-Sheehan & Morgan, 2008). Johnson-Sheehan and Morgan postulate that conservation writing is a new genre emergent in the fields of biology, ecology, and environmental policies. It might be easily confused with scientific writing since scientific evidence is still at its core, and the structure will often be a familiar IMRaD pattern; however, conservation writing is purposefully more politically loaded.

As we examine scientific genre, though, it has been noted that in the area of climate change research the writers, while preserving the qualities of scientific writing such as impartiality and

accuracy, should be aware of the high prominence of this area of research and of increased public interest, therefore potentially alter their writing to accommodate to various parties that might use it. Arguably, the members of the public interested in climate change research constitute a somewhat looser discourse community; climate change discourse itself, due to its multidisciplinary character, might in fact represent the discourse of not one but several intertwined discourse communities (Deignan et al., 2013). Therefore, linguistically discourse within this complex community should be constructed accordingly. For instance, Hassol (2008, as cited in Nerlich et al., 2010) mentions, among other examples, the scientists' use of the word 'enhanced' in the meaning of 'increased', which may mislead lay readers into interpreting 'enhanced' as something positive while it might not be, as in the case of 'enhanced ozone depletion'. In Hassol's view, more colloquial language should be adopted, especially when dealing with words that might be of different meaning across social groups. One of the techniques he suggests is using metaphors, which will be reviewed further in this study.

In "Not just words", a *Nature Climate Change* editorial of September 2014, a similar problem is addressed. It is also argued that in the climate change domain it is, perhaps, most important to maintain the clarity of communication to a highest degree, due to immense interest of the public, the politicians and other interested parties. There is danger that research may be misinterpreted by the media or popular scientific writers. Therefore, while it might be quite challenging to move away from scientific writing conventions, climate change scientists should aim at simplifying their writing and revert from using heavily loaded, obscure technical terminology of the field, while preserving scientific accuracy.

Sarewitz (2004) points out another problem connected to high public interest to climate change research. Ironically, the fact that a wealth of research in the domain exists, a lot of studies are in direct debate and discord with each other, and it is, therefore, simply impossible for lay readers to understand the topic. Additionally, in this situation, called by Sarewitz 'excess of

objectivity' (p.389), various parties may always find a piece of research to back their views that are meant to mislead the public.

It has been noted earlier that there is a number of people, certain scientists among them, that would be skeptical about anthropogenic climate change. In their 2015 study, Medimorec and Pennycook tested the hypothesis that the scientists that show clear skepticism towards the issue, representing a more politically conservative group, would use more conservative language. However, their results showed that in reports written by these scientists (members of Nongovernmental International Panel of Climate Change, noted for being prominent skeptics) language usage is less conservative than one by their less skeptical counterparts, members of Intergovernmental Panel on Climate Change, who, for instance, used more hedging language tools, representing a more cautious and conservative language trend. This research shows that within the scientific communities some features of language use (including rhetorical features, addressed partly by this study) may differ in accordance with the standpoint the writer takes towards the issue at question, which is crucial because climate change research has a particular role in society nowadays, and it is easy to mislead the readership.

Some linguistic differences have also been found in the way writing differs in scientific journals that are the source of material for this study as well: *Science* and *Nature*. Hulme et al. (2018) have found difference in the way the journals frame climate change problems in their editorials, attributing that to political differences of publications, different institutional histories, or difference in editorial practices. *Nature,* for instance, has been consistent in stressing governance challenges of climate change and commenting more on policy measures and instrumentation. *Science*, on the other hand, has recently retracted from direct comment on policies, while retaining its focus on scientific and technological challenges of climate change and, more recently, addressing its communication challenges. While this study is focused not on editorials but on abstracts, where, hypothetically, much less opinionated language than in editorials

will be found, it is still interesting to follow Hulme et al.'s lead and see whether some differences between the journals will be found.

Metaphors in Climate Change Discourse

As has been shown in the previous section, a lot of research on climate change discourse exists; much of this research has metaphors at it focus. Overall, climate change discourse and figurative language involved in it are interesting for linguistic exploration because of various discourse communities involved (Deignan et al., 2013). Many influential studies have looked at climate change metaphors in popularized scientific genre and the media, but there are some that highlight scientific metaphors in expert discourse as well. In this section an overview of these studies will be given.

Most studies reviewed here had as its premise the belief, discussed in the previous sections, that metaphors are an important tool for shaping public opinion and educating them about science. One study, however, sets out to challenge this belief to a point. An article by Van der Linden et al. (2014) explores pedagogical and communicative efficiency of communicating climate change consensus to the general public through metaphors alongside pie charts and plain explanatory text. They note that many before them have admitted that anthropogenic climate change is not being transferred well enough from the expert domain to the public one. However, little has been researched as to what could be an effective way to do it. It has been assumed that metaphors are a universal way out, and they have been ubiquitous: the authors cite, among others, *greenhouse effect*, *atmospheric blankets*, *time bombs*, *tipping points*, and *overflowing bath tubs* (Russill, 2011, as cited in Van der Linden et al., 2014). Van der Linden et al.'s study yielded interesting results: empirical evidence suggests that plain text and pie charts have been significantly more effective than metaphors in their sample.

These results do not, however, mean that metaphors are not worthy of study, they merely indicate that sometimes other means can be more successful in communicating scientific

information, but the success rates for metaphors show that they were also relatively useful for communication. For instance, research by Thibodeau, Frantz, and Berretta (2017), which studies the effect of various metaphors on the people's views in expert and non-expert communities, has yielded the results that somewhat counter those in Van der Linden et al. (2014). Using self-reported attitude data and correlational measures, they found out, among other results, that the metaphoric item *the earth is our home* resonates well both among experts and among non-experts, the latter including some climate change deniers. The authors argue that certain metaphors like this can help people adopt a more responsible standpoint regarding the natural world, given that simple communication of scientific knowledge has, so far, failed in the task of convincing the population definitively of the urgency of climate change issues.

Somerville, in his compelling article of 2006, gives a comprehensive metaphoric comparison of climate change studies with medical science. Fundamentally he argues that people should be aware of this parallel and act accordingly. For instance, there seems to be an almost unanimous agreement among the vast majority of scientists as to the existence of anthropogenic climate change. However, many non-experts choose not to believe this. Such situation would not occur in the domain of medical science: if medical experts agree that a certain disease exists and is deadly, most laymen would not try to deny this fact. *Earth being sick* is, indeed, one of the metaphors of climate change discourse, and, according to Somerville, it should receive more attention, as, in medical sphere, the well-being of the patients is in their own hands. Perhaps medical realia metaphorically extrapolated to climate change discourse might help educate the public better about climate change realia.

Larson (2011), in his book *Metaphors for environmental sustainability: redefining our relationship with nature*, argues for the sustainability of metaphors in environmental discourse. In his view, some metaphors, despite being catchy, might not serve this purpose well. In the book he gives a list of various metaphors used in environmental discourse (without, however, singling out

climate change discourse), and discusses in detail such metaphors as *progress*, *competition*, *barcoding* and *meltdown*, which he calls feedback metaphors due to their close interrelation with society and its values. Larson cites this type of metaphors as the most crucial for the discourse building, and this type of metaphors could be seen as sustainable and effective in environmental communication.

Various studies have focused on climate change metaphors and their usage in governance discourse. Koteyko et al. (2010, as cited in Deignan et al., 2013), have looked at so-called carbon compounds, including such metaphoric units as *carbon diet* and *carbon footprint*, in government reports. They argue that the usage of these compounds can advise us on the way various stakeholders frame climate change debate, and the usage of the carbon compounds varies between discourse communities. Shaw and Nerlich (2015) reviewed various policy documents concerning climate change between 1992 and 2012, to find that the use of metaphors in such discourse is somewhat simplified, presenting climate change scenarios as either impacted or non-impacted, aiming to govern through the lens of cost-effect regulation. Climate change is often portrayed as a mythical foe to be fought (in the impacted scenario). Such metaphor usage, according to Shaw and Nerlich, represents a reductionist representation of climate change.

Cohen (2011) has looked at a combination of sources from both government reports and the media (newspapers) in the UK to study increased military metaphor usage in connection to climate change. According to Cohen, both political and media discourse has become rife with figurative military representations of the 'war against climate change'. Employing terminology that brings back the memory of World War II, like rationing under the constant threat of Nazi attacks and invasion, arguably communicates the urgency of the issue and helps fight skepticism, portraying climate change as a universal powerful enemy and the danger that need to be fought off together (Oreskes, 2011). Oreskes (2011), however, counters this view, saying that one of the causes for the resistance might be avoiding unpleasantness, and in this case a strong warfare

metaphor might be counterproductive. Oreskes proposes a metaphor of *carbon tax* as an alternative to *carbon rationing*.

Some research on climate change metaphors has also focused on media discourse, especially newspapers. Nerlich et al. (2011, as cited in Deignan, 2013) studied newspapers from years 2006-2009 and the usage of the metaphor *carbon diet*. They found that through the idea of dieting, which is arguably easier for laymen to comprehend than complex scientific notions, the media are trying to communicate these ideas to the general public.

Other researchers devoted their studies to comparing media and scientific discourse. Nerlich and Hellsten (2014) looked at two of the most pervasive metaphors when it comes to climate change: *greenhouse effect* and *carbon footprint*. They have found that *greenhouse effect* first made its appearance in scientific articles in the 1960s, and the peak of its usage in scientific texts preceded the peak of its usage in news media. This is thought to be due to the fact that the metaphor itself originated in the scientific community and is associated with the risks of climate change. On the other hand, *carbon footprint* is associated with discourse of risk management policies, and its usage reached its peak in the media before it entered the scientific discourse. In scientific discourse it first appears in 2007, in the *Nature* journal.

Another, more recent study by van der Hel, Hellsten and Steen (2018) investigated the *tipping point* metaphor in the genres of scientific writing and the media. The scientific texts in the corpus included some from high-impact journals *Nature* and *Science*, the ones making up the corpus of this study. According to the authors, the *tipping point* metaphor is not monolithic and can be used in various discourses for various purposes. They state that since 2005 the *tipping point* metaphor, first used in scientific texts, was picked up by the media: in both genres it conveyed the idea of imminent danger that climate change posed. The metaphor then, however, was transformed in the scientific genre from a rhetoric device into a theoretical concept, going in line with Knudsen's (2003) theory of closed and opened metaphors, described earlier in this study. A similar

conclusion was made by Deignan (2017), who studied scientific texts and the *balance* metaphor, and found support to the claim that metaphors lose their metaphoricity after a period of usage within the scientific domain. Deignan et al. (2013) compared popular scientific discourse and expert scientific texts to find the same results: in their corpus, metaphors *equilibrium*, *balance*, *model*, *scenario* and *greenhouse gases* were seen to achieve a certain level of demetaphorization in specialist discourse, without explanations of the notions, while popular scientific authors tended to 'open up' those metaphors. (See also Deignan, Semino, & Paul, 2017, for similar findings). It is also interesting to see that Deignan et al. (2013) provide a metaphor tokens ratio for both kinds of texts; for scientific writing it was approximately 1/26,5; thus, one in 27 words had figurative meaning. Another finding about specialist discourse metaphors claims that in scientific texts a lot of metaphors are personifications of the data and materials (e.g. *the data allow us to see*), but this is, arguably, a feature of any or most scientific discourse, not only the only in the climate change domain.

Rationale of the Study

As has been shown in this literature review, the existing body of research in the areas of interest to this study is extensive. However, there seem to be a few understudied areas that this thesis paper will aim to address.

While in general rhetorical moves in research article abstracts have been well studied before, there is only one study (a Master's thesis by Oneplee, 2008) that focused on both *Science* and *Nature* journals, and that study used Santos's (1996) framework of analysis. Moreover, Oneplee's study is not very recent. This research will employ Hyland's (2006) paradigm; moreover, the research area has been narrowed down to include only climate change research article abstracts: this sub-genre has not yet been investigated in move research, and its analysis could yield some important results as to what concerns its rhetorical composition in the light of immense prominence of the topic.

There has been extensive research, especially in the recent years, on climate change discourse and metaphors. Various specific metaphors, for instance, 'carbon compounds', have been analyzed, as well as whole genres. However, the majority of climate change discourse and metaphor research looks at popularized scientific (Deignan et al., 2013; Knudsen, 2003), media (Cohen, 2011; Deignan et al., 2013; Nerlich et al., 2011; Nerlich & Hellsten, 2014; Oreskes, 2011; van der Hel, Hellsten & Steen, 2018) or political (Cohen, 2011; Koteyko et al., 2010; Shaw & Nerlich, 2015) discourse, thus putting more emphasis on non-expert communication or its comparison with scientific discourse. This research will focus on scientific genre only and attempt to see whether the usage of metaphor in high-quality specialist discourse complies with the results of previous studies (e.g., those by Deignan, 2017; Knudsen, 2003; Hulme, 2018; and others, reviewed in the previous section). The journals in this corpus have a vast readership and could be interesting examples of scholars presenting their research to a wide audience, but within scientific discourse community regulations. This will potentially call for specific usage of rhetorical features (including rhetorical moves), as well as potential use of metaphors as a way of conceptualizing their findings to be clearer for a wider audience.

One of the most notable novelties of this research, however, will be the analysis of possible interrelation between rhetorical moves and metaphor usage in climate change research article abstracts. No study on the combination of these aspects has been found to date; therefore, it could be a valuable addition to both genre and discourse analysis, should any significant connection be found. It has been argued that "by focusing on the rhetorical use of metaphor in and across genres" metaphor can be presented "as something that can be expanded, changed, and re-used in agreement with changes in the genre contexts where it is used" (Caballero, 2013, p.1).

This research, therefore, would aim to answer the following questions:

1) What are the rhetoric moves used in abstracts of climate change articles in popular, high-impact scientific journals?

2) Is scientific metaphor used frequently in abstracts of these articles?
3) Is the usage of scientific metaphor connected to the usage of certain moves?

Method

Instrument

Rhetorical moves identification.

This study will adopt Hyland's (2006) five-move framework to identify and classify rhetorical moves found in abstracts of research articles. This moves structure is presented and described in the Literature Review section and summarized in Table 3.

Metaphor identification.

Distinguishing between figurative and literal meanings is not an easy task for a researcher, and many scholars have attempted to devise a comprehensive way of identifying figurative language with as much precision as possible (Gibbs, 2012). In this research, a combination of two of such frameworks will be used, namely, Metaphor Identification Procedure (MIP) (Pragglejaz Group, 2007) and Metaphor Identification Procedure Vrije Universiteit (MIPVU) (Steen, 2010); the latter being a revised version of the former. It has been judged that for the purposes of this study MIP is not detailed enough and does not allow for a more elaborate metaphor classification, whereas some aspects of MIPVU, on the contrary, would be excessive for this research. Further both frameworks will be presented, and a combined revised framework of metaphor identification in this study will be described.

MIP.

MIP has been well received by scholars and provides a comprehensive framework that can be used by researchers in various disciplines to distinguish figurative meanings, as it provides a

set of reliable criteria for different empirical investigations (Gibbs, 2012). Gibbs claims that MIP has been shown to be replicable and reliable, despite certain degree of variability that is bound to exist between raters. MIP has thus been used in many metaphor studies, including those focusing on scientific genre (see, for example, Low, 2008; Low, Littlemore, & Koester, 2008; Semino, 2008; all cited in Herrmann, 2013). MIP is deemed to be well suited for genre analysis, as it provides a flexible and reliable operational way of identifying metaphors, independent of the type of discourse or the discipline (Herrmann, 2013; Pragglejaz Group, 2007).

The scholars of the Pragglejaz Group suggest the following steps of metaphor identification, contained in the MIP:

> "1. Read the entire text–discourse to establish a general understanding of the meaning.
>
> 2. Determine the lexical units in the text–discourse
>
> 3. (a) For each lexical unit in the text, establish its meaning in context, that is, how it applies to an entity, relation, or attribute in the situation evoked by the text (contextual meaning). Take into account what comes before and after the lexical unit.
>
> (b) For each lexical unit, determine if it has a more basic contemporary meaning in other contexts than the one in the given context. For our purposes, basic meanings tend to be
>
> —More concrete [what they evoke is easier to imagine, see, hear, feel,
>
> smell, and taste];
>
> —Related to bodily action;

—More precise (as opposed to vague);

—Historically older;

Basic meanings are not necessarily the most frequent meanings of the lexical unit.

(c) If the lexical unit has a more basic current–contemporary meaning in other contexts than the given context, decide whether the contextual meaning contrasts with the basic meaning but can be understood in comparison with it.

4. If yes, mark the lexical unit as metaphorical."

(Pragglejaz Group, 2007, p.3)

MIPVU.

MIPVU is a revised and enhanced MIP procedure. It has been devised to make MIP more precise, and also to make it more in line with Cognitive Metaphor Theory. Their procedure runs as follows:

"1. Find metaphor-related words (MRWs) by examining the text on a word-by-word basis.

2. When a word is used indirectly and that use may potentially be explained by some form of cross-domain mapping from a more basic meaning of that word, mark the word as metaphorically used (MRW).

> 3. When a word is used directly and its use may potentially be explained by some form of cross-domain mapping to a more basic referent or topic in the text, mark the word as direct metaphor (MRW, direct).
>
> 4. When words are used for the purpose of lexico-grammatical substitution, such as third person personal pronouns, or when ellipsis occurs where words may be seen as missing, as in some forms of co-ordination, and when a direct or indirect meaning is conveyed by those substitutions or ellipses that may potentially be explained by some form of cross-domain mapping from a more basic meaning, referent, or topic, insert a code for implicit metaphor (MRW, implicit).
>
> 5. When a word functions as a signal that a cross-domain mapping may be at play, mark it as a metaphor flag (MFlag).
>
> 6. When a word is a new-formation coined, examine the distinct words that are its independent parts according to steps 2 through 5."
>
> (Steen, 2010, p.25-26)

MIP/MIPVU framework combination in this study.

As has been noted before, this study will use a combined approach, because it has been found beneficial to examine metaphor usage mostly based on MIP, but also taking some classification aspects from MIPVU framework. The steps that will be followed in this research have, therefore, been determined to be as follows:

> 1. Read the entire text–discourse to establish a general understanding of the meaning.

2. Determine the lexical units in the text–discourse.

3. (a) For each lexical unit in the text, establish its meaning in context.

(b) For each lexical unit, determine if it has a more basic contemporary meaning in other contexts than the one in the given context.

(c) If the lexical unit has a more basic current–contemporary meaning in other contexts than the given context, decide whether the contextual meaning contrasts with the basic meaning but can be understood in comparison with it.

4. If yes, mark the lexical unit as metaphorical.

5. When a word is used *indirectly* and that use may potentially be explained by some form of cross-domain mapping from a more basic meaning of that word, mark the word as metaphorically used (MRW, indirect).

6. When a word is used *directly* and its use may potentially be explained by some form of cross-domain mapping to a more basic referent or topic in the text, mark the word as direct metaphor (MRW, direct). (Note from the author: such direct metaphors will include, among others, similes).

7. When words are used for the purpose of lexico-grammatical *substitution*, or when *ellipsis* occurs, as in some forms of *co-ordination*, and when a direct or indirect meaning is conveyed by those substitutions or ellipses that may potentially be explained by some form of cross-domain mapping from a more basic meaning, referent, or topic, insert a code for *implicit* metaphor (MRW, implicit).

The framework shown above will be used for metaphor identification and classification throughout this study. The metaphors, when identified, with thus be classified into direct, indirect or implicit. Another way of classification will be into closed or open metaphors, proposed by Knudsen (2003). Lastly, following Goatly's seminal study (2011), the metaphors will be classified linguistically, according to their part of speech.

Lexical units.

One of the issues with MIP/MIPVU procedures deals with the way to identify lexical units in a text. Overall, the general strategy for determining the boundaries between lexical unit is the criterion of their non-decomposability. In this study an orthographical word will be considered a lexical unit in most cases, with four exceptions.

A universally difficult unit for analysis is phrasal verbs. In both MIP and MIPVU framework studies, the scholars choose to analyze phrasal verbs as one lexical unit; the same strategy will be adopted in this study. The second exception, following Steen (2010), will be proper nouns: such instances will be considered as one lexical unit. Thirdly, compounds are another notion where several words will be treated as one lexical unit in this study, following Steen (2010) and the standards of MIPVU procedure. It is especially crucial to make this distinction in climate change discourse and metaphor analysis, since several metaphorical compounds in climate change articles have already been analyzed (see. e.g. Koteyko et al., 2010, as cited in Deignan et al., 2013, for so-called 'carbon compounds'). In this study it has been decided that compound words will be treated as one lexical unit guided by their spelling: they are a single lexical unit if they can be spelt as separate words, one word or separated with a hyphen. Compounds like 'carbon footprint', on the other hand, will be treated as separate units where only one component (e.g. 'footprint' in 'carbon footprint') is metaphorically used; however, this metaphorical usage is nevertheless determined by the words combinability (thus, 'footprint' is only metaphorical *because* it is

combined with ‘carbon’).Similarly, the fourth instance of single lexical unit analysis is so-called polywords like ‘let alone’ or ‘al right’, which are not variable and are treated as a continuous unit in a text (Nattinger & DeCarrico, 1992, as cited in Pragglejaz Group, 2007): thus, they are treated as a single unit in MIP.

Dictionary reference.

In case any difficulty was met at determining the basic meanings of the words, or establishing the lexical unit boundaries, Macmillan Dictionary Online was used, supplemented by Online Etymology Dictionary.

Corpus

The corpus of this study comprises in total 92 abstracts of research articles on climate change. 55 of the abstracts come from the *Science Advances* journal, and the other 37 abstracts are taken from *Nature Climate Change* journal. The corpus totals 15539 words, 9792 in the *Science* selection and 5747 in the *Nature* selection.

Some descriptive statistics on the two parts of the corpus can be found in Tables 4 and 5 below. It can be observed that the mean abstract size in the whole corpus amounts to 169 words per abstract. However, if we look at Table 5 where the information on abstract size is split by journal, some differences can be seen: abstracts in *Nature Climate Change* (NCC) tend to be shorter than those in *Science Advances* (SA) (mean size of 155 words in the former against 178 words in the latter). It is also obvious that abstracts in NCC have less size variation, with standard deviation of just 16.84, against that of SA, where it amounts to 45.42, and, furthermore, abstracts in SA can be both shorter and much longer than those in NCC, the longest one in SA surpassing the longest one in NCC by full 124 words.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Words	92	116,0	325,0	168,902	38,2410
Valid N (listwise)	92				

Table 4. *Descriptive statistics on the whole corpus.*

Descriptive Statistics

Journal		N	Minimum	Maximum	Mean	Std. Deviation
N	Words	37	128,0	201,0	155,324	16,8491
	Valid N (listwise)	37				
S	Words	55	116,0	325,0	178,036	45,4292
	Valid N (listwise)	55				

Table 5. *Descriptive statistics on the corpus split by journals. N* – Nature Climate Change *journal; S* – Science Advances *journal.*

Selected articles were published between January and December 2018. This study can be seen as an exploration of the issues in question, therefore a period of one year was deemed appropriate to analyze the general state, without making any temporal-comparative assumptions.

In the case of research article abstracts from *Nature Climate Change*, all articles published in that journal in the abovementioned period were taken to be part of this corpus, since the journal deals exclusively with the domain of climate change research, which is in the focus of this study. As to what concerns *Science Advances*, which is a multidisciplinary journal, a search was conducted,

and after looking through the list of articles in which the phrase 'climate change' was found, articles pertaining to climate change research were manually selected.

The choice of the journal sources of the abstracts was by no means random. *Science Advances* and *Nature Climate Change* are parts of big conglomerates of high-impact scientific journals, *Science* and *Nature*, respectively. Hulme et al. (2018) write that "through their editorializing practices, leading international science journals such as *Nature* and *Science* interpret the changing roles of science in society and exert considerable influence on scientific priorities and practices" (p.1). The 2-year impact factor numbers for these journals reach 11.511 for SA, and as high as 19.181 for NCC (InCites Journal Citation Reports, n.d.). It is safe to assume that these publications are among the most read and most cited in the domain of climate change research. Since the aim of this research is to examine potential interplay of rhetorical moves and metaphor usage by scientists with most influential writing, research article abstracts from journals with such high impact were deemed most appropriate to investigate the genre, to look at patterns of usage by scientific writers who are bound to reach an immensely wide audience.

Procedure and Analysis

The data in the corpus was collected by accessing the website catalogue of *Nature Climate Change* and *Science Advances* journals. All abstracts are open to the public, so no special access procedure was necessary. The abstracts from a chosen period (01.2018-12.2018) were copied into separate Microsoft Word documents (for NCC and SA) and were given codes (e.g., NCC16 or SA39).

First, the number of words in each abstract was calculated using Microsoft Word algorithms. Then I proceeded with analyzing the abstracts in terms of rhetorical moves, in accordance with Hyland's scheme. Each move was color-coded for better visual representation. The results were put into Microsoft Excel data table, a fragment of which can be seen in Figure 1.

Each entry in the table includes the code of the abstract; five columns for presence/absence of a certain move (orange color represents that the moves are embedded); number of words in an abstract; the order of moves; some elaborations on the move contents; indication of whether the article pertains to hard or social sciences; and a comments section. The analysis of moves was reviewed in two weeks, and some adjustments were made.

Abstract #	Move 1	Move 2	Move 3	Move 4	Move 5	Words	Order of moves	Move 1 steps	Move 2 steps	Move 3 steps	Move 4 steps	Move 5 steps	Science	Comment
SA27	+	+	+	+	+	220	1232345	generalization	intention	approach, instrument	findings	conclusions	hard	
SA28	+	-	+	+	+	144	134345	generalization		data, instrument	findings	conclusions	hard	
SA29	+	+	-	+	+	250	1245	generalization	intention	-	findings	recommendations	social	
SA30	+	-	+	+	+	195	14345	generalization, gap	-	instrument	product	value, conclusions	hard	

Figure 1. *Sample view of the data analysis of rhetorical moves.*

The second step of the analysis was to identify metaphors in the abstracts. Firstly, the abstracts had to be split into lexical units. The parameters by which lexical units were defined can be found in the Instrument section. After this, in accordance with the framework developed for metaphor identification in this study (see Instrument section for a detailed overview), metaphorical units were identified and marked; sometimes, where language intuition was not enough, dictionaries were employed to check for a more basic or an earlier existing meaning. The metaphors were then transferred into a specially created Microsoft Excel table, an excerpt from which can be found in Figure 2. The analysis included determining the part of speech of the metaphorical unit; whether it was a direct, indirect or implicit metaphor (Steen, 2010); whether it was a proper metaphor, personification or simile; whether it was open or closed (Knudsen, 2003); in which rhetorical move it was found; and whether it was part of a ‘carbon compound’ (Koteyko et al., 2010, as cited in Deignan et al., 2013). It has to be noted that, after some general patterns were identified in the metaphor usage, not the whole sample of abstracts was used for metaphor identification: 25 NCC and 25 SA abstracts were randomly sampled to represent metaphor usage

in the journals. Given the number of metaphors yielded from these 50 abstracts, it has been deemed sufficiently representative.

1	Abstract #	Wording	Part of speech	Direct/Indirect/Implicit	Type (metaphor proper, personification, simile)	Close/Opened	Move	Lex.units	Carbon compound?
70	NCC14	met	verb	indirect	proper	close	4	143	
71	NCC15	cost	noun	indirect	proper	close	1	136	yes
72	NCC15	obscures	verb	indirect	proper	close	1	136	
73	NCC15	show	verb	indirect	personification	close	4	136	

Figure 2. *Sample view of the data analysis of metaphorical units.*

Upon identifying both the rhetorical moves and the metaphors in research article abstracts, they were coded and analyzed for patterns of usage. Several Pearson correlations and logistic regression analyses were run in SPSS between the variables available. The results of the analysis can be found in the next section of this paper.

Results

Rhetorical Moves

Frequency.

The frequency of rhetorical moves throughout the abstracts in the data can be seen in Table 6:

	NCC (37)	SA (55)	Total (92)
Move 1	37 (100%)	52 (94,55%)	89 (96,74%)
Move 2	24 (64,86%)	35 (63,63%)	59 (64,13%)
Move 3	24 (64,86%)	36 (65,45%)	60 (65,22)
Move 4	37 (100%)	55 (100%)	92 (100%)
Move 5	30 (81,08%)	50 (90,91%)	80 (86,95%)

Table 6. *Frequency of rhetorical moves. In number of abstracts having a said move. NCC* – Nature Climate Change *journal, SA* – Science Advances *journal*

As can be seen from Table 6, Move 4 (Product) is seen in virtually every abstract in the data, closely followed by Move 1 (Introduction), which is only missing in three abstracts in the sample. All of these three abstracts come from *Science Advances*. Conclusions Move (5) is the third in frequency of appearing, at 87% of abstracts having it. Abstracts in SA features this move 10% more often than those from NCC. Finally, Moves 3 (Method) and 2 (Purpose) stand at 65% and 64% frequency, respectively, with very close numbers across the two journals, too.

A similar frequency value for Moves 2 and 3 begged the question whether it is often that both these moves are missing from the same article. However, analysis shows that such combination occurs only 12% of the time (for 4 research article abstracts in NCC and 7 in SA).

Embedded moves.

Often the moves in the abstracts appeared embedded (two or more moves were merged in one sentence). The frequency of embedded moves appearance can be observed in Table 7.

	NCC (37)	SA (55)	Total (92)
2 moves embedded	18 (58,65%)	30 (54,55%)	48 (52,17%)
3 moves embedded	3 (8,11%)	1 (1,82%)	4 (4,35%)
2 + 2 moves embedded	0	2 (3,54%)	2 (2,17%)
Total moves embedded	21 (56,76%)	33 (60%)	54 (58,70%)

Table 7. *Frequency of embedded moves. In number of abstracts having embedded moves. NCC* – Nature Climate Change *journal, SA* – Science Advances *journal*

The pattern where two moves in the abstracts were embedded turned out to be rather frequent – it could be found in more than half of the abstracts in the corpus. A situation where three moves were merged into one sentence was much less frequent, as well as a situation where the abstract included four embedded moves: two in one sentence and two in another – this only occurred in two abstracts in Science Advances.

Order of moves.

The abstracts in the sample showed a wide variety of patterns of move presence and sequence. An overview of moves order patterns can be found in Table 8.

Order	NCC	SA	Total
1-2-4-5	7	7	14
1-3-2-4-5	4	7	11
1-2-3-4-5	5	5	10
1-4-5	2	6	8
1-3-4-5	2	5	7
1-4-3-4-5	2	3	5
1-3-4-3-4-5	2	2	4
1-2-4	1	2	3
1-2-4-3-5	0	3	3
1-3-2-3-4-5	2	1	3
1-4	1	1	2
1-3-4	2	0	2
1-2-4-5-4-5	1	1	2
2-4-5	0	1	1
1-2-3-4	1	0	1
1-3-2-4	1	0	1
1-4-3-5	0	1	1
1-4-5-3	1	0	1
1-5-4-5	1	0	1
3-2-4-5	0	1	1

1-2-1-3-4	0	1	1
1-2-1-4-5	0	1	1
1-2-1-3-4-5	0	1	1
1-3-2-1-4-5	1	0	1
2-3-4-2-4-5	0	1	1
1-2-3-2-3-4-5	0	1	1
1-2-3-2-4-3-5	0	1	1
1-3-2-3-1-4-5	1	0	1
1-3-2-3-2-4-5	0	1	1
1-3-4-3-4-3-4	0	1	1
1-4-5-4-3-4-5	0	1	1

Table 8. *Patterns of order sequence. In number of abstracts with a said sequence. Includes abstracts with embedded moves. NCC* – Nature Climate Change *journal, SA* – Science Advances *journal*

Overall, 31 move sequence combinations were discerned. As can be seen, move sequences 1-2-4-5, 1-3-2-4-5 and 1-2-3-4-5 were among the most frequently used in the sample. The classic Hyland pattern 1-2-3-4-5 is among these, as expected, however, a similar patter with inverted moves 2 and 3 is used as frequently and even slightly more, though this is only true about Science Advances (whose data overall shows more variation in moves order). The most frequently used pattern, 1-2-4-5, follows the classic Hyland order but is missing Move 3. The following example shows this most frequent pattern:

> "Organic matter burial in mangrove forests results in the removal and long-term storage of atmospheric CO2, so-called "blue carbon." However, some of this organic matter is metabolized and returned to the atmosphere as CH4. Because CH4 has a higher global warming potential than the CO2

> fixed in the organic matter, it can offset the CO_2 removed via carbon burial. We provide the first estimate of the global magnitude of this offset. Our results show that high CH_4 evasion rates have the potential to partially offset blue carbon burial rates in mangrove sediments on average by 20% (sensitivity analysis offset range, 18 to 22%) using the 20-year global warming potential. Hence, mangrove sediment and water CH_4 emissions should be accounted for in future blue carbon assessments". (Rosentreter et al., 2018)

The color coding in the abovementioned example is as follows: yellow represents Move 1 (Introduction), green – Move 2 (Purpose), violet – Move 4 (Product), and blue – Move 5 (Conclusions). As can be seen from this example, the Results and the Introduction moves also tend to contain more words than the Purpose and the Conclusions moves (as well as Methods move, not represented here). Very often Move 2 would be, for instance, just part of a full phrase, embedded with another move.

Statistical analyses.

Some statistical analysis was performed to determine potential statistical relations between different variables in the data, however, no significant correlations were found, e.g. between presence of a certain move and a number of words in the abstracts; between the presence of a certain move against presence of other moves; between the presence of a certain move and a type of science (hard or social) that the abstract belongs to. The type of science also did not seem to correlate with the number of words in the abstract, nor did any visible pattern emerge in its connection to the move sequence patterns.

Metaphors

Overall in the data (50 randomly selected abstracts, 25 from *Nature Climate Change* and 25 from *Science Advances*, 8134 words in total) 457 tokens and 227 types of metaphors were found. The metaphorical units, therefore, account for 5,62% of all the words in the sample. As for the distribution across journals, 264 tokens of the metaphorical units were found in NCC, and 193 – in SA. Pearson correlation run between the number of metaphors in an abstract and the corresponding number of lexical units showed as not significant.

Parts of speech.

Analysis of the frequency of various parts of speech of metaphorical units showed that metaphors tend to be mostly nouns (188 tokens, 41,14%) or verbs (146 tokens, 31,95%), however, adjectives (63 tokens) and prepositions (42 tokens) were also present in the data (13,79% and 9,19%, respectively). The least frequent categories were adverbs (17, 3,72%) and pronouns (only 1 token of which was found in the data). Table 9 shows the part of speech distribution across two journals in the sample.

	NCC (264)	SA (193)
adjective	35	28
adverb	15	2
noun	93	95
verb	91	55
preposition	29	13
pronoun	1	0

Table 9. *Distribution of parts of speech of metaphorical units across journals in the data. NCC* – Nature Climate Change *journal; SA* – Science Advances *journal*.

As is visible from Table 9, there are some discrepancies in the proportion of metaphors found in the two journals. While the amount of metaphors overall is about a fourth more in NCC

than in SA, the part of speech patterns show a different proportion. For instance, when it comes to adverbs, there are almost none in SA against 15 in NCC, and there are almost half more verbs in NCC than in SA. However, there is almost an equal number of noun metaphors in both journals, with SA even preceding NCC by a fraction.

Direct, indirect and implicit metaphors.

In the data only 10 direct metaphors and 1 implicit metaphor were identified; the rest of the metaphorical units in the data turned out to be indirect metaphors. The direct metaphors tend to be nouns (logistic regression analysis significant at 0,002). The only implicit metaphor was represented by a pronoun 'that' (also the only pronoun metaphor in the data).

Personifications and similes.

Most of the metaphorical data is represented by 'metaphors proper'. They accounted for 369 tokens in the data. There were 88 tokens of personification identified in the sample (19,26% of the metaphorical units). 62 personifications were found in NCC, and 26 – in SA. No similes were found in the sample.

Contrary to the general parts of speech trend, most personification (62 tokens, 70,45%) tend to be verbs. There were also 13 adjectives and 12 nouns identified as personifications.

Closed and open metaphors.

Only closed metaphors were found in the data, none of the metaphorical units was 'opened up' in the text of the abstract. All metaphors seemed to have reached a certain level of calcification, or demetaphorization, in this professional discourse sample.

Carbon compounds.

There were 51 tokens of carbon compounds found in the data, 27 in NCC and 24 in SA. The types of compounds included such units as 'carbon balance' (2 tokens), 'carbon burial' (2

tokens), ‘carbon capture’ (1 token), ‘carbon cost’ (1 token), ‘carbon feedback’ (2 token), ‘carbon flow’ (1 token), ‘carbon flux’ (1 token), ‘carbon footprint’ (5 tokens), ‘carbon input’ (1 token), ‘carbon inventory’ (1 token), ‘carbon penalty’ (1 token), ‘carbon pool’ (1 token), ‘carbon release’ (1 token), ‘carbon residence’ (1 token), ‘carbon sequestration’ (4 tokens), ‘carbon sink’ (4 tokens), ‘carbon stock’ (13 tokens), ‘carbon storage’ (5 tokens), ‘carbon turnover’ (1 token), and ‘carbon uptake’ (3 tokens). None of the units represented personification, all were metaphors proper.

Interplay of Metaphors and Moves

Looking at the metaphors appearing in particular moves, these are the results of the frequency: most metaphors appear in Move 4 (165, 36,11%) and in Move 1 (126, 27,57%), then follows, expectedly, Move 5 (79, 17,29%), and the least amount of metaphors is found in Move 2 (52, 11,38%) and Move 3 (34, 7,44%).

In Table 10 an overview of metaphors appearance in moves split by parts of speech and by journal can be seen.

Move	Part of speech	NCC	SA	Total
1	adjective	7	8	15
	adverb	0	1	1
	noun	31	28	59
	preposition	6	3	9
	pronoun	0	0	0
	verb	31	11	42
	total	75	51	126
2	adjective	3	4	7
	adverb	3	0	3
	noun	8	12	20
	preposition	6	3	9
	pronoun	1	0	1
	verb	7	5	12

	total	28	24	52
3	adjective	6	6	12
	adverb	7	0	7
	noun	4	1	5
	preposition	2	1	3
	pronoun	0	0	0
	verb	5	2	7
	total	24	10	34
4	adjective	16	7	23
	adverb	5	0	5
	noun	29	38	67
	preposition	11	5	16
	pronoun	0	0	0
	verb	33	21	53
	total	94	71	165
5	adjective	3	3	6
	adverb	0	1	1
	noun	19	17	36
	preposition	4	1	5
	pronoun	0	0	0
	verb	14	17	31
	total	40	39	79

Table 10. *Metaphors of various parts of speech appearing in different moves. NCC* – Nature Climate Change *journal; SA* – Science Advances *journal*

As can be seen, the general pattern is for nouns and verbs to prevail across the moves, as is expected given the part of speech representation of metaphorical units discussed above. There are, however, a few interesting points that will be addressed in the Discussion section.

As for patterns of personification distribution, they can be viewed in Table 11 below:

Move	Type of metaphor	NCC	SA	Total
1	proper	51	45	96
	personification	25	5	30
2	proper	28	23	51
	personification	1	0	1
3	proper	21	9	30
	personification	3	1	4
4	proper	73	65	135
	personification	21	6	27
5	proper	29	25	54
	personification	12	14	26

Table 11. *Distribution of metaphors proper and personifications across rhetorical moves. NCC* – Nature Climate Change *journal, SA* – Science Advances *journal*.

The numbers are, again, more or less predictable, with SA generally having fewer metaphors than NCC; however, Move 5 shows an interesting alteration of the pattern, discussed in more detail in the Discussion section.

Discussion

Rhetorical Moves

As is seen in Table 6 in the Results section, a conclusion can be made that only Move 4 (Product) is an obligatory move in the *Nature Climate Change* and *Science Advances* data of this study. It was present in every one of the 92 abstracts researched for this thesis, with no exceptions. It corroborates the findings of previous research. For instance, El-Dakhs (2018) found that there was more focus on Move 4 in more prestigious journals in his sample, arguably because the results are the main selling point of the article. Similarly, in this study's sample of highly prestigious

journals the results section is never omitted from an abstract. Perhaps it is true to say that the writers are projecting their writing on the needs of the reader, who, while surveying an abstract, will mostly want to know what the finding of the study were, that's why Move 4 was omnipresent in all the abstracts.

Move 1 (Introduction) is in a more interesting situation considering the sample in this thesis. It seems to be completely obligatory for the research article abstracts in the *Nature* journal, while for *Science*, even though the move was present 95% of the time, still there were three articles out of 55 that did not employ the introductory move, going straight to the purpose or methodology. This is one example of *Science Advances* journal showing less uniformity of structure that *Nature Climate Change*.

Move 5 (Conclusion), on the other hand, was slightly less present in NCC, though still being quite frequent at 81%. It was, however, slightly more often present in SA, where the frequency stood at 92%, nearing that of obligatory. It can be observed in Table 8, too, that, whenever the introductory move 1 was missing, the conclusive move 5 was always present in the abstract. Perhaps it is still a compulsory feeling for the writers to either start off the article by some general information or finish with a generalization: there was no article that was missing both Move 1 and Move 5.

There is, however, a relative conformity in the way authors in NCC and SA employ Moves 2 and 3 – standing at roughly 65%, these moves were employed the least in the data. This goes against the finding of some previous studies (e.g., Amnuai, 2019), and even Oneplee (2008), who also studied a similar corpus (not focused on climate change, however). She found a striking 11% frequency of Move 3 in her data, which is extremely low, but this does not go in line with the data in this research, where Move 3 was, even though the least frequent along with Move 2, still present in more than half of the research article abstracts in the data of this work. It could be due to the fact that this thesis only focused on climate change domain, and for scientists in this set of

disciplines it might be still important to indicate the methodology used, arguably for more credibility, as the research will invariably attract a lot of attention due to the specificity of the topic.

The percentages for Move 2 and 3 looked so similar, especially for NCC, that a separate analysis was made to check whether article that omit Move 2 would also tend to omit Move 3. This, however, happened not so frequently – only 12% of the time; though it was slightly more frequent for SA, once again showing a slightly more diverse nature of this journal's writing.

Embedded moves (Santos, 1996), or, in Sabouri and Hashemi's (2013) terminology, hybrid moves, were found to be rather frequent in the data. Overall, more than half of the abstracts displayed some pattern of move embedding.

The most common embedding pattern was shown to be a 2-move embedding, where two moves were merged into a single phrase, like in this abstract from a research article by Cristofari et al. (2018).: "Here, we use a biophysical ecological niche model validated through population genomics and palaeodemography to reconstruct past range shifts and identify future vulnerable areas and potential refugia of the king penguin the Southern Ocean". It is visible that Move 3 (Method) (color-coded pink) precedes Move 2 (Purpose) (color-coded green), and the two moves are merged into one sentence.

Another, much less frequent pattern of move embedding, was a three-move hybrid model, as in this example from Melet, Meyssignac, Almar, and Le Cozannet (2018, Nature Climate Change): "Here, using 23 years (1993–2015) of global coastal sea-level observations, we examine the contribution of these latter processes to long-term sea-level rise, which, to date, have been relatively less explored". In this example moves 3, 2 and 1 (in this sequence) are merged in one sentence. Additionally, we can observe move reversal of moves (Santos, 1996) in this example.

The third embedding pattern included four embedded moves, two in one sentence and two in another. This unusual pattern, only found in two articles in *Science Advances,* again shows the variety of structures in *Science*, as opposed to *Nature*.

Overall, the frequency of move embedding shows that, in line with previous research (Can, Karabacak and Qin, 2016; Sabouri and Hashemi, 2013; Santos, 1996), this trend is genre specific of abstracts and it was to be expected that a certain amount of these embedded patterns be found in the data. In fact, it is even more frequent to come across an abstract with embedded move than one with non-embedded moves. Arguably, this is done by authors for cohesion and conciseness.

If we look at the patterns of move sequence, from Table 8 it is visible that, even though the traditional Hyland's 1-2-3-4-5 pattern is still used by authors in the sample, it is not the most frequently used one. The most frequent pattern, following Hyland's order, omitted the Method move. The second frequent pattern displayed move reversal, where the Method move came before the Purpose move. Patterns where Move 2 was omitted were also frequent.

Overall, looking at the table, it is also possible to note that, again, the abstracts in *Science* show more variety in move sequence patterning than those in *Nature*. Examining the patterns that occurred only once in the sample, it is visible that twice as often such rare unusual pattern occurred in *Science Advances*, which again supports my claim that *Science Advances* article abstracts show more variety and less uniformity than those in *Nature Climate Change*.

Metaphors

The data surveyed for metaphor identification showed 457 tokens and 227 types of metaphorical units. This is more than 5% of all the lexical units in the sample, which is five times more than, for instance, Knudsen (2003) found in her data. Overall, contrary to popular beliefs, scientific texts prove to have a lot of metaphorical units, even if many of them might have calcified and are not perceived as figurative language anymore. For example, the adjective 'elevated',

showing nine tokens in the data, may not be perceived as a metaphorical unit in professional discourse; likewise, the noun ‘scenario’ is used extensively in climate change discourse and is not, perhaps, perceived as a metaphor anymore.

It is noteworthy that in our data the number of metaphors in an abstract did not correlate with the number of lexical units: that means that the mere size of an abstract is not a predictor of the amount of metaphors that will be found in it. Interestingly, while abstracts in SA tend to be slightly longer, there were considerably more metaphors found in NCC abstracts than in those coming from SA. Another noteworthy fact is that there was also no abstract in the data in which no metaphorical unit was found: they were present throughout the sample, ranging from 2 to 21 metaphorical units per abstract.

Many metaphors in this study can be seen as typical of climate change scientific discourse, for instance, the carbon compounds (enumerated in the Results section). There are also tokens of such metaphors as ‘food web’, ‘heat wave’, ‘ozone shield’, ‘greenhouse gases’, ‘hotspot’, ‘tree of life’, ‘scenario’, associated with climate change research. Some metaphors, however, can be seen as pertaining to the domain of scientific writing in general. These are exemplified by tokens of such metaphors as ‘target’, ‘suggest’, ‘show’, ‘play a role’, ‘sensitive’, ‘reflect’, ‘mechanism’, ‘investigate’, ‘find’, ‘highlight’, ‘contribute’. As can be seen, such general scientific metaphors often tend to be verbal constructions.

Looking further at the part of speech distribution (Table 9), a fact that stands out is that nouns, a category most numerous among others, in the SA data slightly outnumber the nouns in NCC, while all other categories show a trend more proportionate to the total metaphor distribution in these journals. This shows that, though there were fewer metaphorical units found in SA, many of the ones that were found were nouns, even more than those in NCC.

It would be logical to make a guess whether, if abstracts in SA favor nouns as metaphors, there were also more direct metaphors found in SA (as it has been shown with a logistic regression

analysis that direct metaphors are often nouns). However, nothing definitive can be said on that matter: there are 5 direct metaphors found in NCC, and 6 in SA. Given that overall there are fewer metaphors in SA, perhaps we could conclude that there is a certain tendency towards employing nouns as direct metaphors in SA, but the data is too small for such a claim. Interestingly, only one implicit metaphor was found in all the data. Overall, the results considering indirect, direct and implicit metaphors mirror those obtained by Herrmann (2013), who also found that indirect metaphors are prevalent in scientific text.

As to what concerns personifications, there are three times more of them identified in NCC that in SA. Contrary to the general part of speech trend in the data, where nouns prevail, for personification the tendency is to be represented mostly by verbs. This is in line with previous research on personification. For instance, Dorst writes that personification is "often realized by verbs and adjectives rather than nouns (2011, p.120). While it is hard to claim the same thing for adjectives based in our sample, it is definitely possible to confirm this trend for verbs used as personification.

In line with Knudsen's research of 2003, all the metaphors in our specialist scientific corpus were identified as closed. Knudsen claims they are 'opened up' only in popularized scientific texts, but investigating this was not the focus of this research. Perhaps this data could be used in the future to test this assumption.

As for carbon compounds in our data, it could be said, following Deignan et al.'s (2013) idea about this kind of metaphors and others in climate change discourse, that they have seen a significant process of demetaphorization in specialist discourse and are used now as specialist terms without alluding to their original metaphorical nature. Again, probably popularized scientific discourse could yield more information on the way such metaphors could become 'opened up'. For instance, in the data of this thesis 'carbon footprint' metaphor collocates with such verbs as e.g. 'increased', 'is exerted'. These verbs are collocations commonly found with terminology is

scientific texts. If the metaphor was opened up, at least the verb ‘to leave’ could be used to indicate the origin of the footprint metaphor. It is also sometimes evident in the writing that the author is aware of using figurative language: for example, in one instance where quotation marks are used to mark it – ‘ “kill” mechanism’. But, as such, the data in this study shows that most of the metaphors have calcified to the point where it is hard to determine their figurative status for a professional user of language in this discourse community.

Interplay of Metaphors and Moves

Overall it can be seen that metaphors appear in different moves more or less proportionately to the frequency of the moves’ appearance in the abstract: that is, Move 4 is an obligatory move in our data and appears in every abstract, moreover, it has been show that it typically takes up a considerable amount of words in an abstract; therefore, it is expected that most metaphors would appear in it. The rest of the pattern does not seem to be contradicting this trend: Move 2 follows Move 4 both in frequency of appearance and in amount of metaphors; they are followed by Move 5, Move 2 and Move 3, exactly the order in which the moves go when it comes to their frequency.

The parts of speech distribution shows mostly a similar trend, however, the tendency of SA to employ more noun metaphors in the abstracts is seen again if we look at the distribution of noun metaphors in Moves 2 and 4 – where it is expected that the numbers for SA would be always smaller than those for NCC, since there are generally fewer metaphorical units found in SA, we in fact see more noun metaphors in SA in these moves. This again shows a greater variability in the texts of SA abstracts. It might be also true that the language in SA also tends to be more concrete; and more figurative language is employed in the form of nouns to better state the purpose and describe the results.

It could also be seen from Table 10 that slightly more verbs are employed in Move 5 in SA than in NCC. It could be connected to the fact that SA slightly outnumbers NCC in the number of personifications in Move 5 (Table 11). It has been established that in our data most personifications

are verbs, that is why we could see this connection. It is interesting that in SA writers use more personifications in the conclusion move, it may be due to the fact that in the conclusion the authors put forward their findings in such a way that the findings would be 'speaking for themselves', so to speak: they can say that their results 'challenge', 'contribute' or 'support' something, showing the results as a separate being worth noticing. It might be the case that such way of presenting the conclusion highlights the findings even more and, arguably, draws more attention to the importance of the results themselves rather than the contribution of the scientists, which could be true for climate change domain, where it is of immense importance to communicate the results to the public, and drawing undue attention to oneself might prove counterproductive.

It is also visible from the way adverbial metaphors are employed in Moves2, 3 and 4 that they appear only in *Nature Climate Change* in these moves: this is another example of NCC being more coherent in its abstracts structure than SA: most of these adverbial metaphors constitute the adverb 'here", as in 'here we investigate', 'here we show' and similar constructions, appearing often in NCC data, almost as if one writers consults the abstracts in previous issues and takes them as a template for their own writing. The 'here we' construction was, on the other hand, never met in *Science Advances*.

Conclusion

This thesis aimed at investigating some aspects of abstracts of climate change research articles in high-impact journals. It has been deemed beneficial to look at rhetorical moves in these abstracts to see what are the peculiarities of rhetorics in this genre and discipline; metaphors were also studied to uncover the extent to which figurative language is used in scientific text of such wide coverage; a novel approach of this thesis was to try and connect the usage of rhetorical moves and scientific metaphors to see their potential interrelation.

First, it is notable that the findings concerning the rhetorical moves aspect of this study both confirm the results of some previous research and contradict the results of some other

previous studies. It has been found for our data that Move 4 (Product) is obligatory for all the abstracts, which is in line with some previous research on rhetorical moves in scientific abstracts. Move 4 was followed by Move 1 (Introduction) and Move 5 (Conclusion), which pattern was also accounted for in earlier research. However, Move 2 (Purpose) and Move 3 (Method) were present in our data to a much higher degree than in the previous studies using a similar corpus. Arguably, in the domain of climate change, where high visibility of the research and a great interest of a lot of parties demands higher credibility, more scientific writers resort to explaining their purpose and especially the methodology to achieve more academic transparency and gain more credibility with the wide readership.

From the analysis of rhetorical moves it already becomes apparent that *Science Advances*, one of the two journals used as a corpus for this study, shows more variation in its abstracts' structure than the other journal in the data, *Nature Climate Change*. For instance, only in the *Science Advances* data there were several abstracts that forgo employing Move 1 (Introduction), whereas it was present in all the abstracts in the *Nature Climate Change* part of the data. Also, looking at the patterns of moves embedding and the patterns of move sequence within an abstract, it is visible that *Science Advances* is not as coherent as *Nature Climate Change* and employs a much wider variety of different patterns, while *Nature Climate Change* appears to be somewhat more monolithic in its rhetorical structure.

A similar conclusion can be drawn from the usage of metaphors in the corpus. Overall there are fewer metaphors found in *Science Advances* data, but proportionally more of those metaphors in *Science Advances* appear to be nouns. This trend is also visible if we look at the interplay of moves and metaphors, where for Science Advances considerably more metaphors found in Move 2 and 4 were nouns. This is arguably due to a more declarative style employed by *Science Advances* writers, who favor the use of noun metaphors. However, this is mere speculation, as it has been also found that all of the metaphors in the data are closed and none of them are opened

up, therefore, it is quite possible that most of the metaphors in this scientific genre have achieved a certain terminology status and are, therefore, demetaphorized and not perceived as figurative language anymore.

Another conclusion that could be drawn from the joint analysis of rhetorical moves and metaphors is that the authors in *Science Advances* might prefer to use more verbal personifications in Move 5 (Conclusion). It might be due to the fact that these authors, unlike those in *Nature Climate Change*, prefer to present their findings and conclusions as separate concepts that are personified, so that they could 'speak for themselves' and act as separate beings, which could, arguably, be more persuasive to the reader.

Overall this research can be called exploratory and illustrative. It would be unwise to make strong claims upon revising a corpus limited to one year, however, several trends have been detected that could be potential material for further study. With a bigger corpus it could be visible whether these are long-term patterns or a recent development in the data. In any case, the value of this thesis is in detecting these possible patterns and revealing them so that further studies could focus on them more closely.

Another value that could be attributed to this study is its pedagogical application. Academic writing in English is nowadays a skill as valued as ever, and this thesis gives more insight into how successful scientific writers published in high-impact journals may use the rhetorical and figurative means available to them to appeal to a very wide readership under the conditions of very close scrutiny, due to the climate change discipline's high visibility. It could be useful for those who study academic writing for scientific or practical purposes to know these details about the data in this thesis's corpus.

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