LANGUAGE & CLIMATE CHANGE DISCOURSE: THE IPCC SPECIAL REPORT ON GLOBAL WARMING OF 1.5°C

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Abstract - This research reviews how methodologies in Applied Linguistics have been applied to major aspects of climate change and sustainability discourse. Subsequently, a selection of those methods are applied to the most recent IPCC 'Special Report' on Global Warming of 1.5° C. Through comparison with existing data on the AR-Series Reports, a number of insights into the unique nature of the Special Report are achieved. Moreover, the Register Analysis framework, pervasive in wider Applied Linguistics, is shown to be efficacious, and this paper thereby constitutes a foundation upon which the increasingly proliferate reports of both the IPCC and also other key sustainability texts can be approached.

Keywords - Applied Linguistics; Climate Change Discourse; IPCC; Register Analysis

I. INTRODUCTION

Climate Change (and the web of interconnected sustainability issues it is intertwined with) is perhaps the most pressing issue facing the world today. Accordingly, there has been substantial discussion on the role within the response of the humanities and social sciences. Despite a huge focus on language choices, both within the IPCC and in the wider public dialogue about their reports, the field of Science Communication [i] has been the active/informative source and arena for academic discussion. Despite a huge range of methodologies being at its disposal, the discipline of Applied Linguistics has, arguably, been comparably more passive, with a moderate body of research using climate change discourse as a subject-matter, but the conclusions arising from that body being comparably inert, perhaps even impotent, as well as conspicuously absent from the public and professional dialogue about IPCC reports. This paper will proceed by first, offering a brief summary of Applied Linguistics work to-date (Section II), and then outlining the key features of the IPCC and its reports (Section III). Then, an overview of the theoretical aspects of the selected methodologies for application to the SR15 Report is given (Section IV). Results are then synthesized in the form of a register analysis (Section V), with some additional remarks about the future and implications of these findings in the concluding portion (Section VI). As will be seen, the SR15 Report can be best understood as a continuation of the changes previously identified throughout the AR-Series reports, and Applied Linguistics methods have an important part to play in our understanding of these key sustainability texts.

II. APPLIED LINGUISTICS & CLIMATE CHANGE DISCOURSE

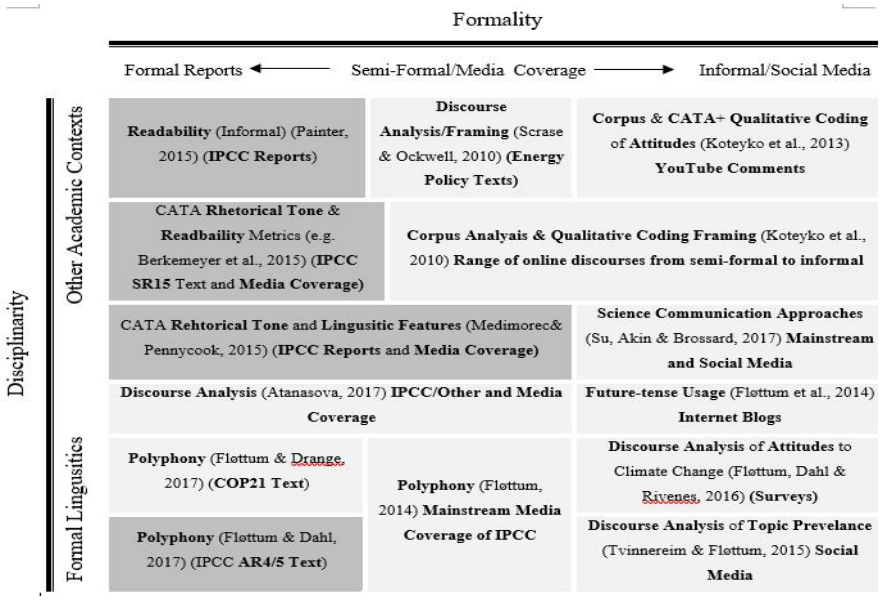

Fig. 1 Summary of Linguistics Research on Climate Change Discourse

Fig. 1 above shows a summary of Applied Linguistics work directed at climate change discourse to date. This (representative, not comprehensive) set are arranged by disciplinarily (the extent to which works are within formal disciplinary Applied Linguistics) and formality (of the subject matter/object(s) of analyses on the x and y axes respectively. Much of the work on language within science communication directed at climate change discourse can be located in interdisciplinary journals such as Language and Communication, where few papers are published by recognized Linguistics academics, and where the main tools of linguistics making an impact are various types of discourse and frame analyses[ii]. Extensive reviews of research in climate communication language[iii] as well as surveys of the purposefully inter and trans-disciplinary journal Climatic Change reveal a broad dominance of the behavioral sciences, and whole volumes on climate communication might not mention any micro-textual or corpus-driven research whatsoever. Further, although there is a growing amount of linguistics work on climate change discourse generally, the bulk of this has been directed at media coverage, as well as some studies on corporate and political documents[iv]. The shaded areas in Fig. 1 represent methodologies (ScaPoLine polyphony analysis, CATA; Readability; micro textual analyses) that have been applied to formal climate change discourse texts. This paper attempts to replicate these methods under the framework of a register analysis, and apply that framework to the latest special report from the IPCC.

III. THE IPCC & THE SR15 REPORT

The IPCC has the self-stated function of producing "neutral, policy-relevant but not policy prescriptive"[v] reports, which are absolutely central in informing the United Nations Framework Convention on Climate Change (UNFCCC). The tensions in this aim and the highly politicized and complex report generation procedures, together with the central role of the IPCC and the reports they generate within climate change discourse, make them an important and interesting object of study. The SR15, a special report from the IPCC, has been given attention similar to that of the AR-Series reports. This makes it an interesting object of study and invites comparison with prior reports. The main aim of the study, as discussed, is to conduct a register analysis of the SR15 SPM. Given that in the situational characteristics portion of the register analysis, a discussion of the procedures and conditions within which the SR15 Report is produced is offered, it would be redundant to cover those aspects here. However, it is important to note that while the AR-Series of reports are part of an ongoing set of assessment documents, covering wide climate change data, problems and solutions, and having instantiations at the Group level (three subject-matter distinguished Working Groups, and a Task Force and Task Group), with synthesis, summary, Summary for Policymakers (SPM) reports being issued. For reasons of limited space, only those aspects of this web of expertise, production, and issuance that directly impact the linguistic features under analysis are discussed (primarily, in the situational characteristics portion of the register analysis). Before turning to the methodological features, it worth mentioning first, the general trajectory towards more explicit/rigorous rules culminating in codification post-1992 Rio Summit, and the now extensively reviewed and examined procedures of line-by-line approval [vi] make this document one of the intensely complex and political in existence. A final brief remark regarding the focus on the SPM document is also pertinent; given that it is the most widely read and disseminated component of both IPCC reporting and climate-change/sustainability discourse more generally, this seems justified, and follows the bulk of research approaches to date (thereby also allowing maximal opportunities for comparison). Finally, and again due to space this cannot, unfortunately, be discussed in detail, in addition to the enormous burdens the IPC must work under (maintaining the seemingly paradoxical policy non-prescriptivity principle, the (at times) intensely political line-by-line consensus process, the sheer challenge of synthesizing and presenting a comprehensible yet comprehensive picture in essentially lay terms, and abiding by the strict internal procedures of language use (more on this later), the IPCC has been simultaneously and repeatedly accused repeatedly of both under and overplaying the climate crisis, with accusations of 'alarmist' language being especially common. Add to this the self-conscious and often publicly commented upon[vii] desire to control the reception of the reports, and their interest and importance is made even more salient to the reader.

IV. METHOD(S)

This section provides an outline of the methods used. First, the register analysis is outlined. The situational analysis offers a more comprehensive account of the systems and processes, as well as some of the political pressures, expectations, and purposes of the IPCC reports Following this, the selected linguistic features are discussed. ' Situational characteristics' include but are not limited to the physical-temporal context [viii] Register analysis requires that texts be situated first on a continuum of specificity-generality, with an important next step being an attempt to situate the register not just in terms of communicative purpose, but also as a culturally-embedded enterprise. Although linguistic features can be expected to be identified at any level of generality, the more specific a level specified for the investigation of a register, the

more specific those features can be expected to be. For the SR15 SPM, this can translate into selection of a level of resolution that positions the text as an example of climate change discourse, formal reports, IPCC reports, IPCC SPMS, etc. (in increasing specificity). As will be seen the complex origination and multiple audiences/functions of the SR15 SPM mean that appraising the situational characteristics is problematic. Generally, the potential sources in general register analyses are varied, yet as will be seen, this study has to rely heavily on the publicized information on the intents, purposes, participants and procedures of the IPCC report generation (although this also includes supplementary sources that provide criticism and/or further insights into those features, beyond the information made available by the IPCC itself). Next the methods underpinning the 'Linguistic features' portion of the register analysis require examination. The SPM text was prepared by removing all introductory, reference, and footnotes. Partially this decision was made to ensure comparability with other datasets[ix]. To facilitate comparability within practical constraints, two comparative corpora were compiled and used. First, a corpus was generated consisting of a randomly selected section from each of the five SR15 WG-generated chapters (they all have between 5-7 sections). These were prepared according to the same procedures described above for the (complete) corpus generated from the SR15 SPM text. The comparably much smaller and/or Chapter-specific sections such as "1.7 Storyline of the Report" (SR15 Ch1) and "Knowledge Gaps" (various chapters) were discounted. These are both substantially shorter and less technical in their content, mainly serving to introduce the main sections/chapters. Accordingly, to ensure samples were of the likely more complex materials, they were not chosen. The finished product was a corpus of 17,850 words (the SPM corpus comprises 7,739 words). This comparison should allow for the SR15 SPM to be placed within or apart from the AR-Series' register. Since the overarching aim of this study is to provide as much insight and context for the SPM as possible, and given the availability of comparable data for general science literature, the IPCC-AR5-WGI 'The Physical Science Basis' and the NIPCC response. The features chosen for study were: noun-phrase modifiers (as both an index of nominalization and indicator of density/abstractness, passive voice incidence, word frequency, word concreteness, number of words before main verb (another indicator of syntactic complexity) and textual lexical diversity (a standard measure of text cohesion calculates as the mean length of sequential word strings in a text. Corpora were analyzed with Coh-Metrix and results expressed in relative frequency per 100 words. Coh-Metrix data is an automatic data retrieval method, yet has been shown to be accurate in almost all measures used[x]. Coh Metrix also provide lexical indices norms for science texts across grade levels through reference to a subset of the TASA (Touchstone Applied Science Associated) corpus. Additionally, the SR15 SPM was subjected to keyword analyses using ANTCONC, with the BAWE corpus used as a reference corpus. If the main desired outcome had been to distinguish the SPM from scientific publications more generally, then a corpus of scientific articles would have been more appropriate. However, since the formalized IPCC scalar expressions were known in advance to constitute a likely candidate for a register marker set, a wider scope for comparable keyword frequency was desirable. As discussed, register features and markers are unique and pervasive and non-unique yet pervasive linguistic features within a register. Since readability comparisons are partially set against college texts elsewhere in this study, the BAWE corpus was chosen. Results of keyword extractions are intended to complement the other linguistic features and expand the register analysis. In addition to the IPCC formalized expressions, keyword analysis has the potential to identify vocabulary features that constitute such markers/features. ANTCONC was used to generate frequency lists for each of the scalar expressions. Concordance searches were then used to investigate the issue of mixed qualitative-quantitative usage identified in respect to the AR5 SPM by Fløttum and Dahl (2014). Also, the relative and potential concurrent usage of confidence and likelihood measures was investigated using ANTCONC concordance searches. As discussed earlier, the IAC review specifically advises against their co-usage because of identified problems with culturally-contingent interpretation/translation[xi] and reception by non-expert audiences[xii]). Results were calculated relative to 1,000 words, and compared with the AR4 and AR5 findings from Fløttum and Dahl (2014). Fløttum and Dahl (2014) do not, unfortunately, provide any statistical data or even a basic count of incidences of 'internal polyphony'. They do note, problems of unavoidable subjective judgement notwithstanding, an increased amount of such devices in the AR5, compared to the AR4. Using their examples as a guide, and with reference to a word frequency list generated using ANTCONC, the possible connectives but, not, and even if were examined on a case-by-case basis for traces of internal polyphony. The few potential cases are of little interest or bearing on this study. In addition, the SR15 SPM is investigated for the other features of (un)certainty used in their study. FRE scores are calculated through adjusted ratios of total words/sentences and total syllables/words (See Appendix C). Barkemeyer et al. (2016) provide data for comparison from previous IPCC SPMs, scientific publications, quality press and tabloid press articles.

Stocker and Plattner provide baseline data for the headline statements from the synthesis report of AR5. The first step was to calculate FRE scores for the SR15 SPM and SR15 headline statements. The former results were compared with the SR1-5 SPMs, and the latter compared with the AR5 headline statements data. Stockner and Plattner point out that the headline statements are a key device used by the IPCC to overcome the problems of multi-level, knowledge-variant stakeholders through intentionally simplified and condensed summaries (2016), and counter Barkemeyer et al.'s quite critical readability analysis/discussion with a section-specific analysis. To try and get further insight into what other factors might affect readability, the grey-coloured box inlays (an increasingly used tool for improving communication and a product of the IPCC developmental reviews) were subjected to FRE analysis, and together with a chapter-by-chapter FRE analysis, compared to both the SR15 SPM and overall range of IPCC AR-Series SPMs. Thus, this study extends Stockner and Plattner's approach of treating headline statements separately, but also offers a genuinely novel aspect by treating each chapter separately. DICTION was used to generate 'Optimism' and 'Certainty' scores for comparison with the AR-Series SPMs. The same prepared SR15 SPM text was used for the initial analysis. As the z-scores for Barkemeyer et al. (2016) are shown relative to the average of all AR-Series SPM's, it was necessary to create DICTION optimism scores for each AR-Series SPM to examine any trends across the IPCC SPMs and/or compared with the SR15 SPM. This also precluded any comparison of any DICTION results with their extensive corpus of quality-sorted media and scientific articles on the respective IPCC SPMs. At the time of writing, the authors have yet to respond to a request for that data. To complement and expand upon the DICTION sentiment analysis, the SR15 SPM was subjected to a LIWC analysis. This allowed extraction of information about the proportion of 'Tentative' and 'Emotional' categorized words (expressed as an aggregate of positive/negative emotional words), allowing comparison with Medimorec and Pennycook, (2015). However, whereas their study was used to compare the IPCC AR5 WGI Report with the largely reactionary climate sceptic NIPCC report (Heartland Institute, 2013; Hertzberg, 2015), this study compared the results with a parallel LIWC analysis of both the AR-Series SPMs and the modest corpus of associated media coverage used for the DICTION analysis and outlined above. Thus, while they were able to show a significant difference between the reactionary and climate-skeptical NIPCC report, the present study is aiming to track changes or trends across time in those scores within the IPCC publication range.

V. RESULTS & DISCUSSION

Lexical Measure	SR15 Report		Indices*		Comparisons**	
	SPM	WG1-5	K1-College	K11- College	2013 WGI	2013 NIPCC
Modifiers per noun phrase	1.12	1.13	0.76(+48%)	0.91 (+24%)	1.055	0.985
Passive Voice Incidence	12.12	11.87	4.23 (+186%)	5.52 (+119%)	4.329	2.735
Noun Incidence	341.77	343.57	234.36 (+46%)	279.5 (+22.3%)	343.91	320.82
Word Frequency	2.71	2.93	3.07 (-11.5%)	3.02 (-10.1%)	2.789	2.823
Word Concreteness	373.99	371.44	397.31 (-5.9%)	389.17 (-3.9%)	375.83	380.33
Words before main verb	6.70	6.45	3.70 (+81%)	5.08 (+32%)	1.45	0.98
Textual Lexical Diversity	69.04	65.97	59.75 (+15.6%)	54.10 (27.6%)	79.29	96.41

Fig. 2 Linguistic Features

Fig.2 shows the shows the normalized frequencies for the linguistic features selected for analysis. First, note that the SPM does not differ significantly from the sampled chapters corpus in any of the linguistic features examined (paired t=0.9197, p¬=>0.05 (0.3932)). Likewise, no statistically significant difference across paired categories emerge in comparison with the 2013 WGI and NIPCC reports was found. However, considering individual linguistic features, a number of interesting differences can be seen. The level of noun phrase modifiers shows increased nominalization and suggest higher levels of density/abstraction compared to the 2013 reports, and significant increases compared to the highest indices science texts. The stark difference in words before a main verb suggests much higher levels of syntactic complexity, and the continued trend in nominalization together with the spike in passive voice usage (by far, the biggest difference across all comparisons) shows a move towards less explicitness that might be explained by the more predictive/future-orientated content of SR15 Report, but may also be explained through the general observation from other studies that the IPCC is, as seen in this thesis elsewhere perhaps affected by both internal and wider public debates over their reporting, becoming more cautious. Finally, textual lexical density has also increased slightly in the SR15 SPM. Although not discussed here, keyword analysis shows a unique lexis in the AR15 report. Regarding ANTCONC frequency analysis of scalar expressions (Fig. 3), the first point of note is that in the SR15 SPM, the qualitative agreement scale is not used at all (for confirmation, the original document was re-checked to ensure that any usage had not migrated to footnotes). However, there were three cases of non-technical evidential referents/summaries, in all cases being used in the same informational sections (two in same sentences, one in following but connected sentences) as formal scalar quantitative confidence measures. Thus, while the evidence/agreement scalar expressions themselves have been entirely eschewed, discussion of evidential agreement has not. This raises interesting questions as to why this might be. One possible explanation could

be the subject matter, but the sudden and abrupt dropping of this segment of the scalar expression might also show that the IPCC is reacting to criticism of its failure to adhere to the IAC suggestions in the AR5 SPM (WGI SPM, in particular). The IPCC has a record of reacting to criticism of language use in reports following that criticism. Examples shown below.

IPCC Label	N	Per 1k	AR4*	AR5*	Notes/Collocations
Likelihood All hits in Section A					
Virtually certain	0		0	0.618	
Extremely likely	0		0	0.309	
Very likely	0		2.197	2.266	
Likely	5	0.588	3.042	5.459	Likely between (2); likely range (2)
More likely than not	0		0.169	0.206	
About as likely as not	0		0	0.206	
Unlikely	2	0.235	0	0.206	Unlikely to cause (2)
Very unlikely	0		0.507	0.206	
Exceptionally unlikely	0		0	0	
Extremely unlikely	0		0.169	0.206	
Confidence					
Very high confidence	7	0.824	0.169	0.824	
High confidence	122	14.353	0.169	4.120	
Medium confidence	72	8.471	0	3.708	
Low confidence	1	0.118	0	1.545	
Very low confidence	0		0	0	
Non-technical use			1.014	0.824	
Evidence and Agreement					
Robust evidence	0		0	0.103	
Medium evidence	0		0	0	
Limited evidence	0		0	0.103	
Non-technical use	0		0.507	1.339	
High agreement	0		0	0	
Medium agreement	0		0	0	
Low agreement	0		0	0	
Non-technical use	3		0.169	0.103	Several lines of evidence (2); multiple lines of evidence

Fig. 3 Formal IPCC Feature Usage

Non-technical lingusitic devices	N	Per 1k	AR4*	AR5*	
Impersonal constructions					
there is/are	8	0.944	1.859	4.429	
Epistemic expressions					
may	10	1.180	0.338	0.515	
could	13	1.534	0.845	0.206	*Could affect; could alter; could experience; could +be + limited/enhanced/triggered*
Passive Constructions + Research Verbs					
projected	17	2.006	n/a	n/a	
associated	19	2.242	n/a	n/a	
Conditional expressions					
if+would, could, (other verb)	1	.118	1.183	0.412	
Imprecise qualifiers					
mainly	0		0.676	0.103	
many	11	1.298	1.014	1.339	*Especially in reference to species, climates, contexts*
generally	3	0.354	0.338	0.103	
Booster words					
improvement(s)/improved	1	0.118	1.859	0.927	
better	0		0.507	0.206	
new	0		1.521	0.515	
Contrasting expressions					
but	9	1.602	2.366	1.422	
however	0		0.676	0.618	
even if	2	0.235	0.507	0.103	
not	8	0.944	2.873	1.957	

Fig. 4 Non-Technical Linguistic Devices

A.1.3. Trends in intensity and frequency of some climate and weather extremes have been detected over time spans during which about 0.5°C of global warming occurred (medium confidence). This assessment is based on several lines of evidence, including attribution studies for changes in extremes since 1950. B.1.1. Evidence from attributed changes in some climate and weather extremes for a global warming of about 0.5°C supports the assessment that an additional 0.5°C of warming compared to present

is associated with further detectable changes in these extremes (medium confidence). B.5.7. There are multiple lines of evidence that since AR5 the assessed levels of risk increased for four of the five Reasons for Concern (RFCs) for global warming to 2°C (high confidence). The second point of note is the comparably more uniform and less frequent use of likelihood and confidence scalar expressions. Only seven instances are used, with the five 'likely' usages collocating with range estimates (likely between x and y; likely range of) and the two 'unlikely' usages collocating with negative predictions of contribution to global warming (unlikely to cause…). The obvious possible explanation for the difference (compared to the AR4/5 SPMs) is the heightened emphasis on the future, a possibility supported by the fact that usage is zero after section A ('Understanding Global Warming of 1.5°C), with sections B and C focused on projections and pathways, respectively (i.e. predictive-orientation) The observed trend of increased confidence scales from AR4-5 (Fløttum & Dahl 2014, pp.70-72), a trend spanning across all IPCC reports (e.g. Grundmann 2014) is even more marked in the SR15 SPM. Again ANTCONC concordance results shows that the observation in Fløttum and Dahl (2014, pp.71) that the IPCC are not employing the IAC principle that usage of likelihood measures renders confidence measure usage redundant (InterAcademy Council 2010, pp.31) with five of the seven likelihood scales used in unison with a confidence scale is consistent with findings for the SR15 SPM. Fig. 4 shows non-technical linguistics devices, with comparison from Fløttum and Dahl (2014). To allow for possible emergent examples of the sub-categorizations used in their study, ANTCONC word frequency list was used to identify possible additional examples. However, no interesting (additional) cases were found. The first overall point emerging from comparison is the outright and relative-term decrease in non-technical devices of all kinds. Regarding impersonal constructions, fewer are used in the SR15 SPM (proportionally), reflecting the downward trend from AR5 to AR4. Moreover, in the SR15 SPM they are never used without a formal confidence scalar expression. In an exceptional (comparative) case, the epistemic expressions may and could are both more prevalent in the SR15 SPM, with may especially in use throughout the trajectory/pathways sections (B, C) and could in the 'Global Response' section (D). This is unsurprising given the future-oriented focus of the SR15, and the clustering of non-technical devices in section D might also be read as an attempt by the IPCC to steer a course between possible policy description/prescription through (intra-textually) rare, non-formal hedging. The following examples show this aspect, and suggest that the increase in epistemic (non-technical) devices is due to the special subject-matter of the SR15 SPM, with virtually all usage relating to some future projection/possibility. B.2.2 Sea level rise will continue beyond 2100 even if global warming is limited to 1.5\x81\x8BC in the 21st century (high confidence). Marine ice sheet instability in Antarctica and/or irreversible loss of the Greenland ice sheet could result in multi-metre rise in sea level over hundreds to thousands of years B.5.1 (…) Poverty and disadvantage are expected to increase in some populations as global warming increases; limiting global warming to 1.5\x81\x8BC, compared with 2\x81\x8BC, could reduce the number of people both exposed to climate-related risks and susceptible to poverty by up to several hundred million by 2050 (medium confidence). That this is a content/temporal focus-driven feature and (likely, analysis of the AR6 SPM in 2020 will be interesting to confirm) not an emergent feature of IPCC hedging more generally, can be seen in the clustering of may and could in parts D (where solutions are frequently discussed in terms of policies) and C (where almost all usage is relative to Carbon Dioxide Removal (CDR) and other solutions). The IPCC self-stated aim of non-policy prescriptivism seems to be the best explanations for the usage in these cases:

C.3.4 Most current and potential CDR measures could have significant impacts on land, energy, water or nutrients if deployed at large scale (high confidence)… Feasibility and sustainability of CDR use could be enhanced by a portfolio of options deployed at substantial, but lesser scales….

D.5.1 Directing finance towards investment in infrastructure for mitigation and adaptation could provide additional resources. This could involve the mobilization of private funds by institutional investors, asset managers and development or investment banks, as well as the provision of public funds. Government policies that lower the risk of low-emission and adaptation investments can facilitate the mobilization of private funds and enhance the effectiveness of other public policies. Fløttum and Dahl note but do not include data on passive constructions without expressed agents, especially with research verbs and intentionally or otherwise, giving the "impression of certainty" (2014, p.72). From the ANTCONC word frequency list, projected and associated were subjected to concordance searches showing extensive use of these devices, yet again never without use of a confidence scale measure. The markedly reduced usage of conditional expressions (just a single instance in the SR15 SPM), especially in the context of the subject matter difference (trajectories/pathways) might indicate a deliberate move by IPCC authors and/or a result of the increase in scalar usage to achieve similar rhetorical ends (epistemic expressions combined with confidence scalar expressions). In any case, the findings confirm those of Fløttum and Dahl (2014, p.

74-59) in showing that IPCC SPMs are increasingly distinguished from wider scientific discourse in their greatly reduced usage of hedges and hypothetical+modal constructions (Hyland, 1998; Fløttum et al., 2016). Imprecise modifier usage is broadly consistent with prior publications, but the majority of usage is of many, which serves to indicate ranges of contexts, species, and causes/effects, with concordance plotting showing highly clustered usage in Section B, where they serve in place of enumeration of categorical listings, for example a large group of marine species being discussed, where in principle that list could be enumerated:

A.3.1 Impacts on natural and human systems from global warming have already been observed (high confidence). Many land and ocean ecosystems and some of the services they provide have already changed due to global warming (high confidence).

B.2.3 Increasing warming amplifies the exposure of small islands, low-lying coastal areas and deltas to the risks associated with sea level rise for many human and ecological systems, including increased saltwater intrusion, flooding and damage to infrastructure (high confidence). The use of mainly/generally, seen in the AR4/5 SPMs as devices of orienting discourse towards certainty (Fløttum & Dahl 2014, p.75-6) are nearly absent in the SR15 SPM. However, two of the three instances of their use are worth noting in detail, since they are arguably some of the rare instances of breakdown in 'message discipline' (use of any non-formal devices of hedging):

A.1.2. Warming greater than the global annual average is being experienced in many land regions and seasons, including two to three times higher in the Arctic. Warming is generally higher over land than over the ocean. (high confidence)

B.1.3. Risks from droughts and precipitation deficits are projected to be higher at 2°C compared to 1.5°C of global warming in some regions… There is generally low confidence in projected changes in heavy precipitation at 2°C compared to 1.5°C in other regions.

The second example above is particularly confounding, since the confidence measures (the original text typesetting informs the reader that "low confidence" is being used as a scalar expression) are meant to present a homogenized appraisal of the evidence! Both of the above cases serve, if anything, to highlight the quite extraordinary message discipline (formalized expressions only, no qualitative-quantitative scalar expression co-usage) of the rest of the document. This point is also borne out in the comparably much lower incidence and near non-usage of booster words and contrasting expressions, respectively. As discussed further in Section 5, the two main findings from this part of the analysis are first, that there are some specific features of the non-technical expressions that differ from the AR4/5 SPMs, and that those differences are reasonably explicable in terms of the content differences (especially the focus on pathways/trajectories), and second, that the AR15 SPM overall, considered in respect of these non-technical but also the technical linguistic device usage, represents a much more strictly composed document overall, in that linguistic features are more consistent and limited to register features. For reasons of space the results of readability are not shown. However, the key points are first, that those results show the trajectory of decreased readability being continued from the SR-series into the AR15 report, and second, there is additional evidence for a link between political tension and complexity that might warrant further investigation. Finally, box inlays and SPMs, as well as introductory and conclusion chapters, are (in terms of readability metrics) not achieving the likely aims. Additional research papers showing these results are forthcoming. Fig. 5 and Fig. 6 show results from the CATA content analyses. As Fig. 5 shows, DICTION 'Optimism' scores do not differ substantially either among the AR-Series SPMs, nor between those considered as a set and the SR15 SPM. Interestingly, the DICTION rhetorical coding for 'Certainty' did not differ substantially, either. The DICTION scores for numerical and temporal terms were included due to the relatively high case-by-case variance for each subtype (compared to the other DICTION dictionary groupings). Appendix E shows the raw DICTION optimism scores for the AR1-5 (mean= 50.106), SR15 SPM and categorized media coverage. Again, the lack of significant difference between the SR15 SPM DICTION 'Optimism' scores and the mean AR-Series 'Optimism' scores can be seen. Reflecting on the results as compared to Barkemeyer et al. (2006) is interesting, since the overall trend of all coverage being less optimistic (in terms of DICTION scores) is preserved. Also noteworthy is the starkly reduced 'Optimism' scores for the AR3 SPM, which accords with the findings in Barkemeyer et al. (2016, p.313) (although not quite significant Z=-1.46546, p=>0.05 (0.7146)), and which they suggest might be explicable in terms of the (wider) political tensions characterizing the report process.

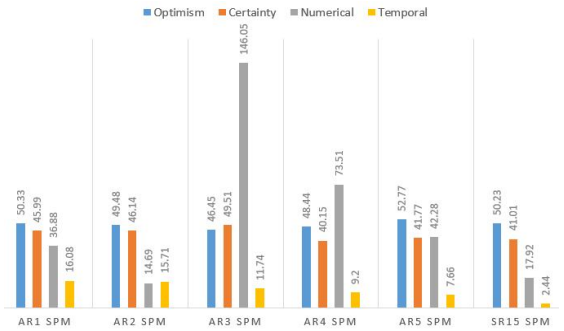

Fig. 5 CATA Analysis (DICTION)

As Fig. 6 shows, the LIWC tentativeness and emotion scores for the SR15 SPM, and each of the AR-Series SPMs (as well as the mean, for comparison purposes). LIWC scores are shown as proportion of total words in that SPM document. LIWC tentativeness scores generally mirror those of the DICTION certainty results, especially in the much higher use of tentative words (Z=1.16).

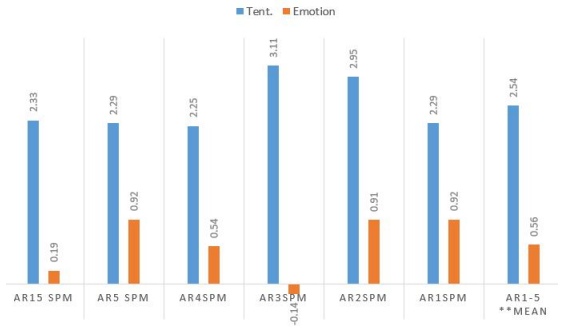

Fig. 6 CATA Analysis (LIWC)

Raw data comparisons (Appendix E) shows the trajectories of AR-Series and the SR15 SPM over time in terms of DICTION Optimism/LIWC Emotion Z scores (shown in dark/light red, paired t = -57.005; p is < .00001) and DICTION Certainty/LIWC Tentativeness scores (shown in dark/light blue, paired t = -29.120; p = < .00001), showing correlation between the two sets of measurements. Moreover, the results here confirm the findings in Medimorec and Pennycook, that the IPCC literature, far from the charges of 'alarmism' aimed at them, continue to produce literature that is both less emotional and more tentative in tone than climate-skeptic equivalents (2015, see table 1). Also worth noting is Hyland's research into hedging in scientific research articles (1998, p.200-207) shows hedging words to be used at a rate of about 2.0 per 100 words, showing comparably higher usage in the entire IPCC publication series under examination here (although, Medimorec & Pennycook (2015) note some possible issues with comparability).

VI. CONCLUSION

As has been seen, a register analysis is a fruitful approach. First, the situational analysis of the SR15 SPM is characterized by immense procedural and content complexity, and broad functional dimensions that extend far beyond the mere provision of scientific information. What emerges is rather an institution that is under consistent but dynamic pressure to produce information that fulfills multi-level epistemological functions, but whilst being subject to contemporaneous internal political stresses, a growing consciousness of the post-delivery report agenda setting and public discourse roles, and extra-institutional expectations for consistently improving performance. Such pressures are reflected in the lexical features of the SR15 SPM, with results from this thesis showing broad conformity with register-specific features of comparably higher levels of concreteness, noun-phrase modification, lexical diversity, and indicators of nominalization (as compared to scientific text indices). Moreover, evidence of increased lexical density, complexity and lexical evidence of caution seen in comparably higher levels of passivity and pre-main verb lexical density raise the possibility of subject-specific explanations that can be clarified through extension of these research methodologies to the AR6 Report when it is published later in 2019. This is also the case with many of the other observations of linguistic features, such as the usage of may and could noted earlier, where although the special subject-matter seems to be the key factor, clarification through analysis of the upcoming AR6 SPM will help to support that conclusion (or not). Moreover, keyword analyses show a register-specific set of vocabulary that characterize the report series, and compliment quite uniquely deliberate and publicized register markers set. The Biberian register analysis framework also allows for the varied linguistic features investigated in this thesis to be brought together in light of the situational analysis. Broadly speaking, results support the placement of the AR15 SPM within a consistent register of IPCC Reports, but with emergent factors that speak to this register being both dynamically responsive to the wider climate change discourse, possibly including fluctuating internal tensions, and moving towards a more consistent use of scalar expressions that also means severely reduced/nonuse of linguistic devices of (un)certainty. The IPCC scalar expressions are a clear register feature, but with some observable usage trends across time: first, a previously identified trend away from qualitative term usage accords with absolute absence in the SR15 SPM- although, this led to evidence of non-formalized evidential expressions; and second, IAC prescription that likelihood measures ought to render confidence measures redundant is still not being strictly adhered to. A strict and sudden disappearance of non-technical device usage, along with the general findings, speak to a register moving towards stricter adherence to rules (showing that the usage of the terms is becoming standardized as a register feature), and plausibly reacting to the published linguistic-focused critiques specifically, and one increasingly distinguishable from wider scientific discourse in all these respects. Due to these features, the traces of identifiable clause-arrangement rooted polyphony were extremely limited. The trajectory of readability is a worry, with a more nuanced sectional analysis of chapters, box-inlays, and headline statements showing that these internal organizational strategies are not working in stemming this trend.

Possible future research might attempt to operationalize the concept levels of internal/external political pressures as a predictor of (un)readability, and as with all results, application of all these methods to the impending AR6 report might help to provide context. Both DICTION and LIWC results speak to a downward trend in certainty and increased tentativeness, accompanied by continued reductions in emotion/optimism. These features are important since they act to demarcate the IPCC register from climate change revisionism (e.g. NIPCC report) and show how linguistics can provide important contributions in undermining the credibility of accusations of alarmism. Indeed, the linguistics approaches adopted here generally suggest that such criticism is not warranted.

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[i] See e.g. [Priest, 2016]
[ii] See e.g. [Koteyko Atanasova, 2016] & [Schäffer O'Neill, 2017]
[iii] See e.g. [Nerlich, Koteyko, Brown, 2009]
[iv] See e.g. [Boykoff Boykoff, 2004] & [Painter, 2013]
[v] [IPCC, 2018]
[vi] [IPCC, 2019]
[vii] See e.g. comments made by Hoesung Lee [Lee, 2015]
[viii] [Biber Conrad, 2009]
[ix] Especially the data in [Fløttum Dahl, 2014] & [Medimorec Pennycook, 2015]
[x] See e.g. [Dowell, Graesser, Cai, 2016]
[xi] [Budescu, Por, Broomell, Smithson, 2014]
[xii] [Patt Schrag, 2003]