The Role of Coherence in Climate Change Science: a methodological proposal

Author: Fiammetta Corradi, *Università degli Studi di Pavia*

Please cite this article as:

Corradi F. (2025), *The Role of Coherence in Climate Change Science: a methodological proposal*, in «Cambio. Rivista sulle trasformazioni sociali», doi: 10.36253/cambio-17902.

This work was supported by the project *Young entrepreneurs of creative environmental imagery (YECEI)*, under the PRIN 2022 PNRR Programme, Mission 4 – Component 2, and funded by the European Union – NextGenerationEU (Project Code: P2022KEKHR , CUP: F53D23010870001).

The Role of Coherence in Climate Change Science: a methodological proposal

FIAMMETTA CORRADI

Università degli Studi di Pavia

fiammetta.corradi@unipv.it

Abstract: Even about climate change, where there is a majoritarian consensus about its causes and effects, science proves to be a matter of polyphonic discursive constructions, competitive storytelling and creative narratives, where coherence and contradictions play a major role in persuading of the "truthiness" of a scientific account. This work aims at showing it empirically, through a systematic discourse analysis carried out applying a new revisitation of the Toulmin's Model (1959) to a negationist publication promoted by the Climate Change Intelligence Group (Clintel). The findings confirm that counternarratives on climate change check coherence in mainstream arguments, looking for contradictions between evidence and models (be their descriptive, explanatory, or predictive) and between competing models. In addition, deniers detect some recurrent argumentative fallacies in the mainstream account advocated by the IPCC (Intergovernmental Panel for Climate Change): omissions, cherry picking from literature and databases, fallacies of relevance and accuracy (with regard to descriptions), logical mistakes (with regard to explanations) and statistical flaws (with regard to predictions), together with common rhetorical expedients, like hiding good news and presenting only worst-case scenarios. A discussion of the advantages and limitations of the model closes the essay, together with the prospect of possible research avenues to further understand the current epistemological debates about climate change "science".
Keywords: Coherence, Argumentation analysis; Toulmin's method; Climate change denial; fallacies.

INTRODUCTION

As already pointed out by Anthony Giddens (1990; 2009), climate change is not only an essential ingredient of "radicalized" modernity, where risk is global and calls for corrective policies inspired by expert knowledge and a new form of institutional trust, but also one of the most challenging and complex transformations society is undergoing. Not by chance, Ulrich Beck considers it an example of the current "metamorphosis of the world" (2016), which he distinguishes conceptually from change:

> change in society brings a characteristic future of modernity into focus, namely permanent transformation, while basic concepts and the certainties that support them remain constant. Metamorphosis, by contrast, destabilizes these certainties of modernity. It shifts the focus to 'being in the world' and 'seeing the world', to events and processes which are unintended, which generally go unnoticed, which prevail beyond the domains of politics and democracy as side effects of radical technical and economic modernization. They trigger a fundamental shock, a sea change which explodes the anthropological constants of our previous existence and understanding of the world. Metamorphosis in this sense means simply that what was unthinkable yesterday is real and possible today. [Beck, 2016, pp. xi and xii].

Climate change is also a global "perverse effect" of combined local instrumental actions, presenting to capitalist society the bill of its insatiable appetite for natural resources. As Beck himself recalls in another work (2010, p. 255), reference to its anthropogenic drivers can already be found in Max Weber's far-sighted forecast: "bis der letzte Zentner fossilen Brennstoff verglüht ist" (until the last ton of fossil fuel has burnt

to ashes). Among classical authors in economic sociology, Karl Polanyi (1944), unmasking the dangerous transformation of land, money and human labor into "fictitious commodities" through the self-regulated market, argues that liberal capitalism threatens the very existence of nature and humankind: a return to a "substantial" economy and a radical "re-embeddedness" of nature and society was already deemed decisive in the mid-1940s. By contrast, Daniel Bell dismisses economic limits to growth and stigmatizes the "apocalyptic hysteria of the ecological movement" (1999; 487), placing much hope and trust on technology and laying the groundwork for ecomodernism. Zygmunt Bauman (2007) thematizes climate change within the conceptual framework of "liquid modernity", where circumstances change quicker than it takes for people to adapt to them, undermining all notions of durability, liquefying the solidity of social institutions and relational bonds, and dramatically increasing individual uncertainty and loneliness. While calling for a brand-new consumer ethics, he acknowledges the incapability of the nation state of addressing planetary-scale problems like climate change: an argument become popular through the mantra "*global* problems need *global* solutions" (which remains true for climate change, even when its most visible and dramatic effects impact upon the *local* level, like in the case of extreme weather events).

Nowadays an overwhelming share of scientists (more than 99%) agrees that the theory of anthropogenic global warming (AGWA), theorized since 1988 by the United Nations Intergovernmental Panel for Climate Change (IPCC), is correct and sound (Lynas *et al.*, 2021; Myers *et al.*, 2021). Hence attention, in sociology as in other social sciences, shifts (maybe too) quickly to issues related to policy measures: the necessity to radically reduce carbon fossil emissions and turn towards renewable sources of energy; or to the speediness of their actual implementation, which remains largely unsatisfying. Despite the efforts undertaken since the Paris Climate Agreement (2015) was signed by 196 Parties (with the twice repeated retrievals of the USA, decided by Donald Trump), the world remains far from the goal to keep the rise in global surface temperature below 2°C (3,6 °F), above pre-industrial levels (preferably, around 1.5°C, 2.7°F). The European Commission itself, in the State of the Union *Progress Report Climate Action* (2023) about the advancements of the EU Green Deal, stresses the urgency to speed up the energy transition to become the first climate neutral continent by 2050.

No doubts that delays in the actualization of pro climate policies worldwide are imputable more to economic and political reasons than to strictly scientific ones; nonetheless, it is surprising that sociologists have not yet closely examined the resistance against the mainstream account (advocated by the IPCC), recently put forth *on the battlefield of science*, by heterodox groups of sceptics or outright denials, claiming, at various titles, to be "climate change experts". While there *is* an extensive literature mapping the widespread phenomenon of climate change denial, in the USA (Gounaridis and Newell, 2024) and in Europe (Lübke, 2022), the existing studies of my knowledge differ in purposes and methods from mine. On the one hand, social scientists have examined denial by non-experts rather than by scientifically trained people, or scientists, recently focusing on young people (see Ojala, 2021). Moreover, as confirmed by excellent literature reviews (Björnberg *et al.*, 2017; Mendy *et al.*, 2024; Cologna *et al.* 2024), empirical studies – usually carried out through surveys – aim at probing *degrees* of trust (or distrust) in science and scientists and testing their possible correlations with other variables (like income, political orientation, religious affiliation etc.), instead of studying qualitatively social processes of trust attribution or authority recognition. Hence, we still lack an exploration of the struggle internal to the scientific community *for the acknowledgement of knowledge* about climate change *as a science*, as well as a full assessment of the impacts of internal scientific dissent on people's trust in climate change accounts. Incidentally, quantitative data collection methods are probably not the most adequate tools to approach the complexity of confidence attribution to scientific truths and to understand the arguments eventually backing trust (or distrust) in scientific arguments. On the other hand, there are already many attempts to understand the interdependence between political orientations, ideology and climate change denial (Dunlap and Jacques, 2013), especially in the political far-right (Forchtner 2020; Forchtner and Lubarda, 2023). While a growing body of literature shows that environmental discourses in general, and climate change in particular, tend to become depoliticized (mainly through ecomodernism), there are scholars who uncover new processes of politization after "the end of nature" (Hällmark, 2023). On this line, Frank Fischer (2017; 2021), moving from a critical discussion of the

notion of post-truth[1], examines the *meanings* attached to scientific theories by climate change deniers. He reaches the following conclusions:

> from a closer examination of the arguments of climate deniers […], we can glean the reality that, despite appearances to the contrary, the basic concern is not about facts per se (or what the deniers see as the information presented as facts); rather, it is about the meanings attached to them. As part of a political camp that regards anything the 'other side' says with extreme skepticism, climate deniers simply reject the findings of climate researchers based on what they see to be the motives behind their studies (2021, p. 21).

But which argumentative strategies do scientifically trained climate change deniers rely on, to convince of the unsoundness of mainstream scientists' arguments and in favour of the scientific status of their own claims? More generally, what if *the stake* on the scientific battleground about climate change is not basically or in the first place, political or ideological, but rather *epistemological* (concerning the status of "scientific" knowledge)?
To start answering these questions, three obstacles, that so far have hindered sociological research on the topic, need a preliminary discussion. First, and maybe most obviously, the high degree of complexity and interdisciplinarity of climate change science discourages non-experts from closely examining the contents and logics of scientific arguments about this "hyper-object of study" (Craig, 2021). Although it can be comforting that the current level of specialization and compartmentalization of scientific sectors makes it hard even for well-trained natural scientists to *assess* the argument validity of their colleagues versed into climate change issues, it is no good excuse for social scientists to avoid observing *how* in practice the objectiveness of scientific arguments is discursively constructed, debated or rebutted by experts.
Secondly, analysing the internal scientific debates about climate change requires some familiarity with the epistemological perspectives about truth and objectivity currently shared in the realm of natural sciences. There, the old positivistic epistemological approach[2], (today named "scientific realism" by philosophers of science) has been overcome, under shifts in paradigm brought about by revolutionary advancements, especially in physics (Castellani, 2005; Massimi, 2005). Scientific realism holds that true scientific theories tell exactly what the world is and how it works: scientists' mission is to discover hidden mechanisms ruling external realities – knowledgeable *independently from* any cognitive framework. Over time, this perspective has proven naïve, for various reasons. Not last, the fact that long hold theories (like geocentrism, for example) resulted drastically wrong, once new theoretical paradigms came about to revolutionarily subvert everything known before, even former ways to see the world (Kuhn, 1962). As Bas van Fraassen argues (1980), much of the confusion in the physical sciences between a *semantic* meaning of truth and its *epistemological* dimension can be finally dissolved substituting scientific realism with "constructive empiricism": the latter understands the pursuit of any scientific enterprise as providing *empirically adequate* theories, namely, theories where there is at least one *model* that "saves the phenomena", adequately accounting for current empirical evidence. Criticizing the tendency to make hypostases of the products of scientific inquiry, and "putting in brackets" the ontological implications of a scientific image of the world, this form of constructivism foregrounds the thematization of the role of *coherence* in scientific arguments: a direction in which the present work moves the first steps, retrieving previous conceptual analyses (Corradi, 2007)[3].

[1] As Zimmer commented on the New York Times (13 October 2010), in a post truth world "the *feel* of truth, or truthiness, is the only thing that matters". Not by chance the word "truthiness" was included by Merriam-Webster in its dictionary, and the notion of post-truth was awarded "word of the year" in 2016 by Oxford Dictionaries.
[2] As known, in the 1890's *Methodenstreit*, the *Naturwissenschaften* – right the sciences that at that time were contributing from various fields to form the embryos of climate change science – were considered by sociologists as the unquestioned and exemplary paradigm of scientific objectivity. This is not the rule anymore. For instance, Jasanoff (2004) argues persuasively that the images of the natural and social world we nurture strongly depend upon the ways *we choose* to inhabit and live in it.
[3] In that work, drawing on Jon Elster's book *Logics and Society*, it emerged a definition of coherence as "absence of conceptual, logical and practical contradictions". In addition, exploring the sematic relationship between coherence and rationality, the former was considered a formal requisite of the latter. Hence, coherence turned to be a necessary, but a not sufficient requirement for a proposition to be rational.

Thirdly, it cannot be a coincidence that we are still missing systematic qualitative analyses about climate change arguments and counterargument: from a methodological point of view, we are not very well equipped to study scientific debates. On the one hand, representatives of the so-called critical discourse analysis approach (CDA) – rich in methodological proposals (Wodak and Meyer, 2009) – have not investigated empirically technical scientific discourses. Which is a shame, being the theoretical tenets and critical mission of CDA not only positively sharable, but also potentially heuristic once applied to the present issue. According to Fairclough and Wodak (1997, 271-80), within CDA discourse is conceived as a form of social action constitutive of society and culture and its historical embeddedness is openly acknowledged. The scope of CDA is described as "interpretative" and "explanatory" and its target are social problems and political issues (climate change is certainly both). Dominance, social inequalities, discrimination and other forms of power abuse are challenged starting from the assumption that power relations are discursive, and that through critical analysis they can be unmasked, exposed and resisted (Fairclough 1985; 1989). The relationship between language (text and talk) and the power-order (political struggle, social conflict) can bridge the micro and macro levels of analysis (Knorr-Cetina and Cicourel, 1981)[4]. More generally, CDA researchers share the view that the language/power-order relationship is reciprocal, self-confirming and self-enforcing: discourses do not merely reflect the social status quo with its unfair power distribution; instead, they contribute to its construction, legitimization, justification and reproduction. CDA perspective also suits well the analytical conceptualization of the notion of social imaginary recently elaborated by Colombo and Rebughini about climate change (article currently under revision), emphasising the role of power, hegemony and emotions in discursive and argumentative battlefields, where the status quo is contested and potential "alternative possibles" prospected. On the other hand, as I argued elsewhere (Corradi, 2016), CDA empirical applications are often unsatisfying, for two apparently contrasting reasons: either they rely too much on computer-*driven* content analysis (in some cases resulting only in colourful, but meaningless word-clouds); or they lack a sufficient degree of standardization, vexing the replicability of non-automatized analyses.

It is high time to dispose of some standardized model to systematically analyse arguments aspiring to the status of science. To begin, I suggest thinking of climate change experts (be they academic scientists or professionals in related field) as social agents who, being scientifically trained, share the ambition to better understand nature and its mechanisms through *models*, and to convince their peers of their arguments' validity and coherence. In this perspective, climate change arguments are social products, constructed by communities of inquirers who build *models* of the world that aim at winning over competing models for their accuracy in describing and explaining existing evidence and for their ability in foretelling future facts about climate change. Scientific accounts can also be read as *narratives (or counternarratives)*, made of different phases or stages logically and/or chronologically ordered: descriptions, explanations and predictions.

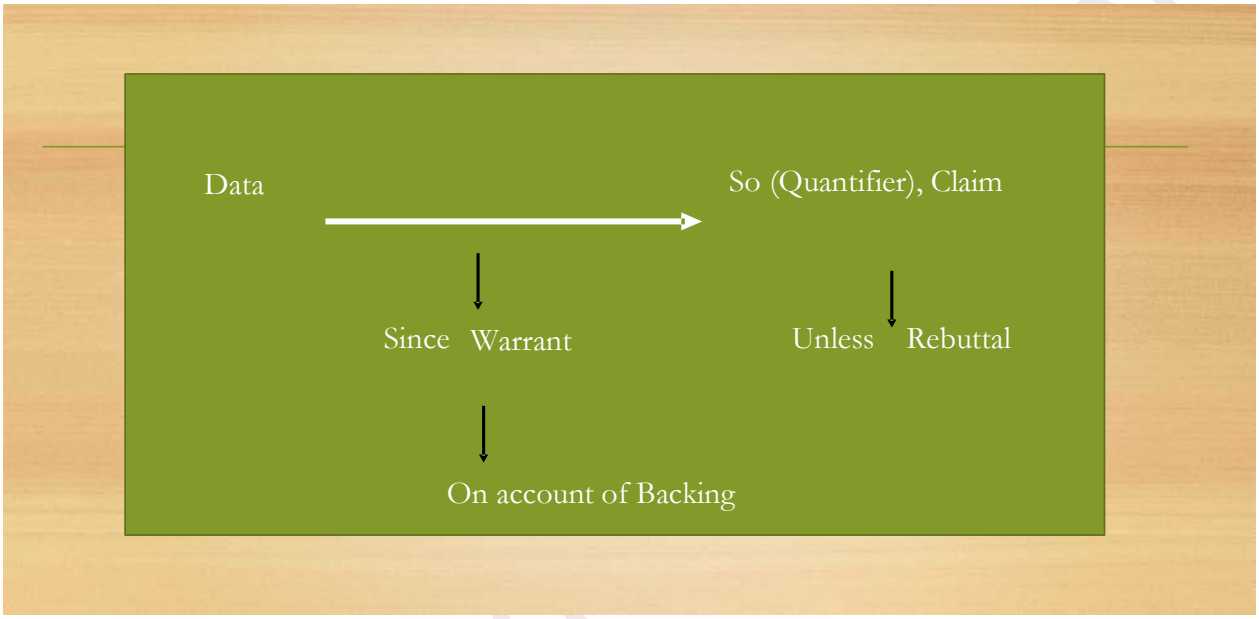
The expositive order of the present work entails two distinct, but correlated parts. In the first, a revision of the Stephen Toulmin's model (1959) is proposed to foster a systematic, standardized but non automated analysis of descriptive, explanatory and predictive scientific accounts. In the second part, with exemplificative purposes, the model is applied to a case study: the Climate Intelligence Group, contesting the mainstream theory of global warming. The conclusive remarks discuss the findings and some limits of the model, at the same time prospecting new avenues for empirical research.

[4] In Luke's words (2002, 100): "CDA involves a transparent shunting backwards and forth between the microanalysis of texts using varied tools of linguistic, semiotic and literary analysis, and the macro analysis of social formations, institutions and power relations that these texts index and construct".

METHODOLOGY: A REVISITATION OF THE TOULMIN'S MODEL

The present methodological approach builds on the model for analysing argumentation fist proposed by the philosopher of language Stephen Toulmin, in *The Uses of Arguments* (1959). Conceived to systematically analyse the anatomy and physiology of any kind of argument (from syllogisms to everyday arguments)[5] this model elects as unit of analysis the *proposition* and entails 6 elements, with different roles and functions (figure 1).

Figure 1. Stephen Toulin's original model to analyse any argument (1959).



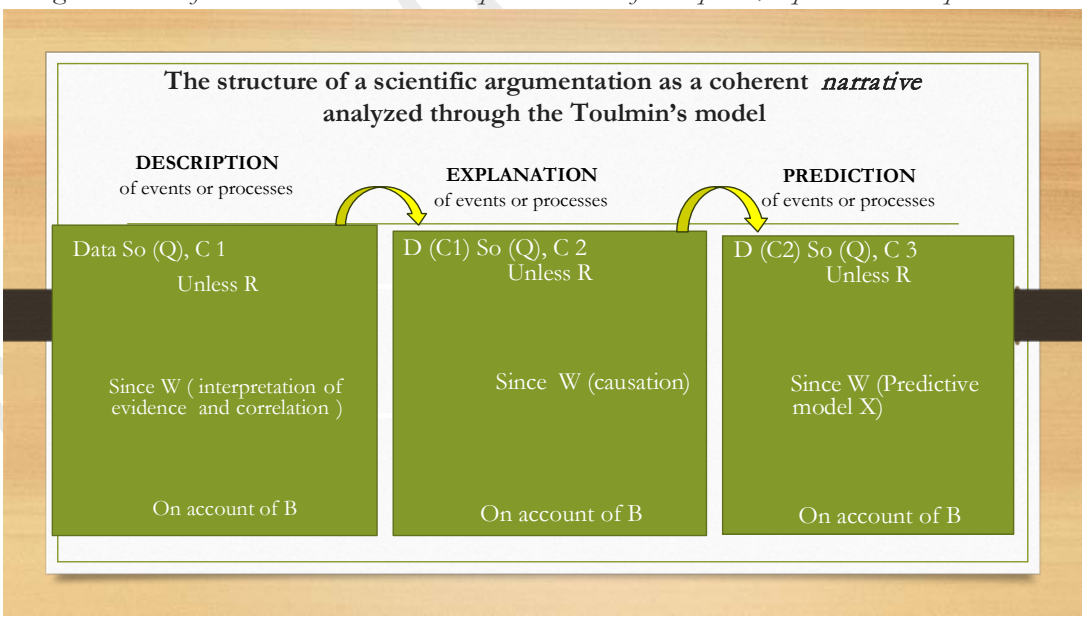
Data, warrant and *claim* (or *conclusion*) represent the core components of any reasoning, while *backing, qualifier* and *rebuttal* are additional elements (with interesting tasks, as will be clarified), whose presence is not essential for an argument to deserve its proper name. The basic structure of any argument, according to Toulmin, entails a *claim*, factual evidence as premise (*data*), and a rule (or conditional statements in the form "if…then") that legitimates the passage, acting as a normative "bridge", from data to conclusion (*warrant*). Warrants can also remain implicit, but a claim asserted without at least one datum and a warrant (clearly deducible, if implicit) is *not* an argument, but an assertive statement. Warrants can be of different types: from logical inferences (deductions, inductions or abductions) to the Weberian "rules of experience" (that prevail in everyday arguments). The three other elements of the model express respectively: the reliability of the warrant, supporting it with further evidence (*backing*), the degree of certainty of a claim (by means of modal *qualifiers*) and finally the argumentative openness, through the anticipation of possible recusations or objections (*rebuttals*). Already at this first level of analysis argumentative flaws can be detected out of 1) wrong/incorrect data; 2) illogical reasoning (eventually hidden) inside the warrant; 3) rhetorical fallacies in the claim (for example, using the typology of fallacies proposed by D' Agostini, 2010)[6]. To serve the pursuit of analysing scientific arguments about climate change the model needs special adaptations. First, a classification of possible types of scientific claims is essential to distinguish among descriptive, explanatory and predictive statements. Descriptive claims conclude that datum 1 (or a sum

[5] Toulmin argues that his model applies to any kind of argumentation, from the ones *more geometrico demonstrata,* to ordinary ones, that are often simil-syllogistic and can make use of the Weberian "rules of experience". For an extensive discussion of this point and others related to the Toulmin models' uses to assess arguments see the comprehensive work by Hitchcock, D. and Verheij, B., (eds.) (2006).

[6] Her typology has proved its many advantages in previous applications of the model, on political discourses supporting (or opposing) the war on Islamic Terrorism (Corradi, 2013), central bankers' speeches about monetary policies (2019), and laypeople's debates about European identity on digital platforms (2020).

of data) is evidence of X; or, in alternative, that there is a *correlation* between evidence A and evidence B. Explanatory claims conclude that evidence A/B is due to a certain law, rule or mechanism (the warrant); or, in alternative, that evidence A *causes* evidence B (the descriptive correlation is here explained through a model that, introducing a direction in the relationship between A and B, allows to identify cause and effect). Predictive claims, finally, forecast future evidence based on explanatory claims formerly proved empirically adequate or through predictive *models* whose parameters are modified according to some theory. These types of claims do not exhaust the possible kinds of utterances that legitimately belong to the realm of science. Evaluations also play a key important, especially when at stake is the assessment of emergency states. Data can be evaluated differently, in the case of climate change, depending on overall alarmist or non-alarmist perspectives. In addition, descriptive claims often (implicitly) entail evaluations. It is up to the analyst to develop a sensibility for such meaningful overlapping. To further adapt the Toulmin's model to the splitting of scientific arguments, it can be strategic to lessen one of the original model requirements: the choice of the single proposition as unit of analysis. However, it would be advisable to limit this choice to only one case: when the warrant hosts a covering-law or an explicative mechanism made of logically related propositions. Another element deserving revisitation for the present work purposes is the backing. In the original example provided by Toulmin himself, the backing was a legislative norm[7]. In the case of scientific arguments, the backing can eventually host literature references and/or redirections to other pertinent datasets. Overall, a scientific narrative can be imagined as theoretically composed by three main moments or stages – description, explanation and prediction – corresponding to distinct but subsequent "blocks" of arguments, below split through the proposed model (see figure 2). Each "block" can be checked to assess the richness of a description, the adequacy of an explanatory model and the reliability of a predictive model. However, this framework drives the attention specifically on the *consistency* of a scientific narrative.

Figure 2. Scientific accounts as narratives: the plot is a series of descriptions, explanations and predictions.

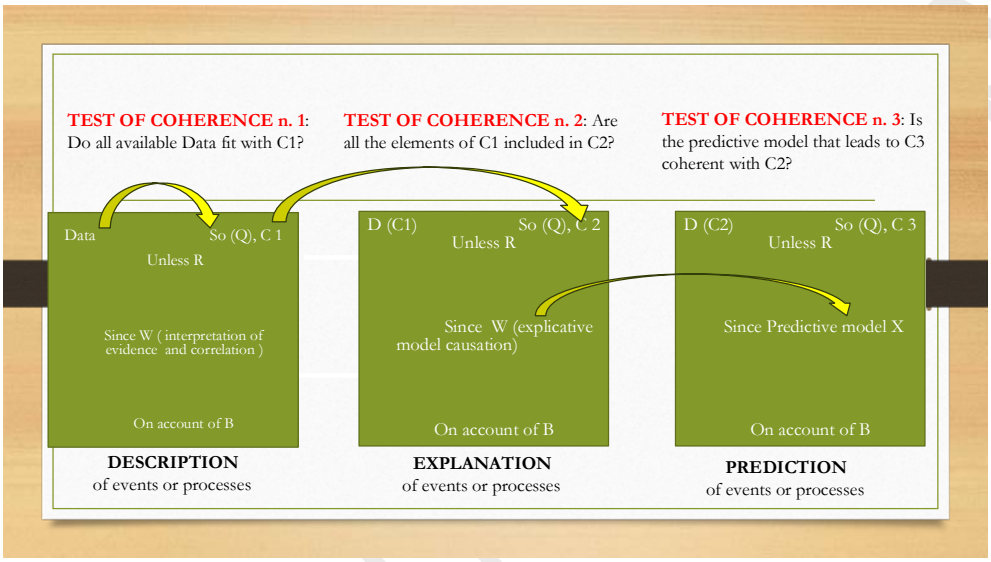


So considered, a scientific account results as a narrative, whose "plot" can be more or less coherent, depending on the sequence of descriptions, explanations and predictions about some event or process. A good

[7] Toulmin's example of how to split the argument "Harry is a British subject because he was born in Bermuda": *data*: Harry was born in Bermuda; *claim*: Harry is an English subject; *warrant*: since a man born in Bermuda is generally a British subject; *backing*: on account of legal statute n. X; *qualifier*: generally; *rebuttal*: unless he is a naturalized American.

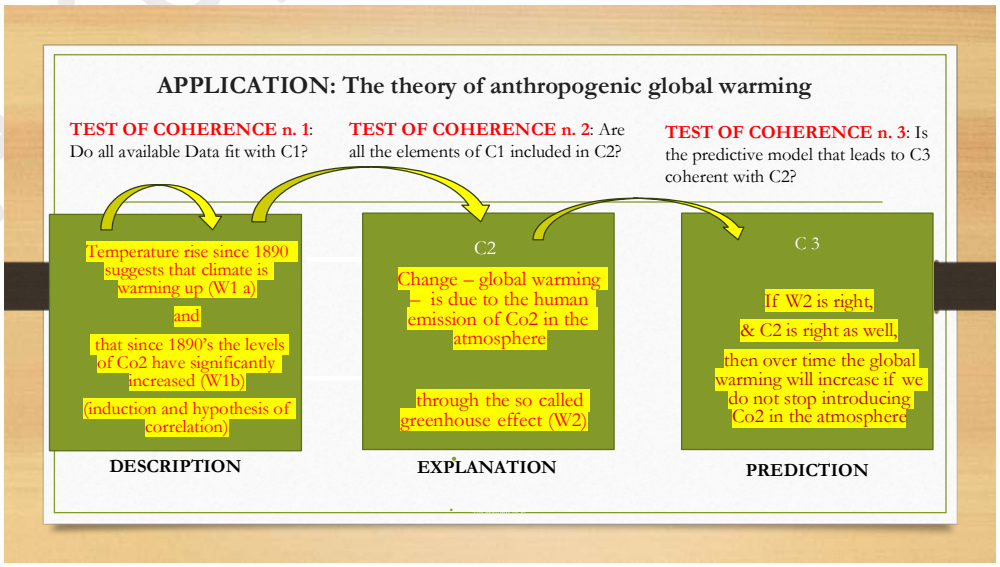
exemplification of a coherent scientific account is provided by the Darwinian theory of evolution (which nowadays only creationists and a few Lamarckian scientists, repute invalid). Piling data were first considered as evidence of the differentiation of species over time; then, an explanatory mechanism was discovered as adequately accounting for such differentiation (the sexual selection of the fittest); finally, implications were drawn from the theory, to foresee with high degrees of certainty that living species will continue to differentiate to keep up with changes in the environment (although the trajectories of evolution can hardly be forecast). This example helps understanding that the van Fraassen's notion of "empirically adequateness" can be further specified in terms of tests of coherence – or matching correspondences – between evidence and models and among models (figure 3).

Figure 3. Examples of possible tests of coherence within a scientific narrative.



Once applied to the mainstream theory of anthropogenic global warming, the one advocated by the Intergovernmental Panel on Climate Change, the model drives attention on some crucial passages (figure 4), in which *coherence is at stake* – and can be questioned and denied. As the following paragraph will prove, climate change deniers hint right at those crucial passages where coherence is at stake. Moreover, they also unmask – or at least claim so – logical fallacies, evidence omission, data cherry picking and other argumentative flaws in the advertised "definitive" narrative of climate change.

Figure 4. Possible tests of coherence for the theory of anthropogenic global warming.



APPLICATION TO A CASE STUDY: THE CLIMATE INTELLIGENCE GROUP (CLINTEL)

The findings here displayed stem from a systematic application of the proposed model to the arguments developed by climate change experts belonging to the Climate Intelligence Group and network, linking worldwide hundreds of climate change denials. Established in 2019 by the geophysicist Guus Berkhout (with a long carrier in the petrol industry), CLINTEL has promoted a World Declaration entitled *There is no climate change emergency*, signed by more than a thousand scientists and climate related professionals (latest subscriber is Nobel Prize winner F. Clausar)[8]. CLINTEL has also fostered the self-publication of a book significantly titled *The Frozen views of the IPCC. An Analysis of AR6* (by the science journalist Crok and the petrol physicist May 2023), on which the present analysis focuses. Consequently, the outcomes of the analysis regard a counter-narrative about climate change written by scientists, science journalists and other climate experts in a self-financed publication[9] (Andy May Editor). Since such arguments are punctually developed starting from the views of the IPCC – in particular, from its latest report (2023, AR6) – the reader might be misled in thinking that the present findings can be used to assess the arguments' validity on both sides. This scope is not only beyond the present work's purposes, but also the writer's scientific competences: in no way results should be interpreted as hinting at the most reliable (or empirically adequate) arguments on the issue. Neither is this work directly an in-depth inquiry about the *institutional* reputation of CLINTEL or of the IPCC, the latter already examined and defended by Peter Stott in *Hot Air: The inside story of the Battle Against Climate Change Denial* (2021). Rather, the present findings do show *how* sceptic or negationist scientists and other science experts argue against the mainstream account about climate change and on which argumentative strategies they rely on to contest it. A series of synoptic tables, presented and discussed below (tab. 1-5), allows a systematic comparison between IPCC and CLINTEL's perspectives *as presented by contrarians*. Each table, dedicated to one thematic topic, displays four columns. In the first column, the type of claim is classified; in the second, the IPCC argument on the topic is analyzed applying the adaptation of the Toulmin's model described above *in the way deniers present it*; in the third, the counter-narrative on the same topic is analyzed; in the fourth, contradictions, logical mistakes, argumentative fallacies *detected by contrarians themselves* are listed. Let's start with descriptions about climate history and the "Hockey stick" debate (Tab. 1).

Table 1. Scientific description and counter-description about climate history.

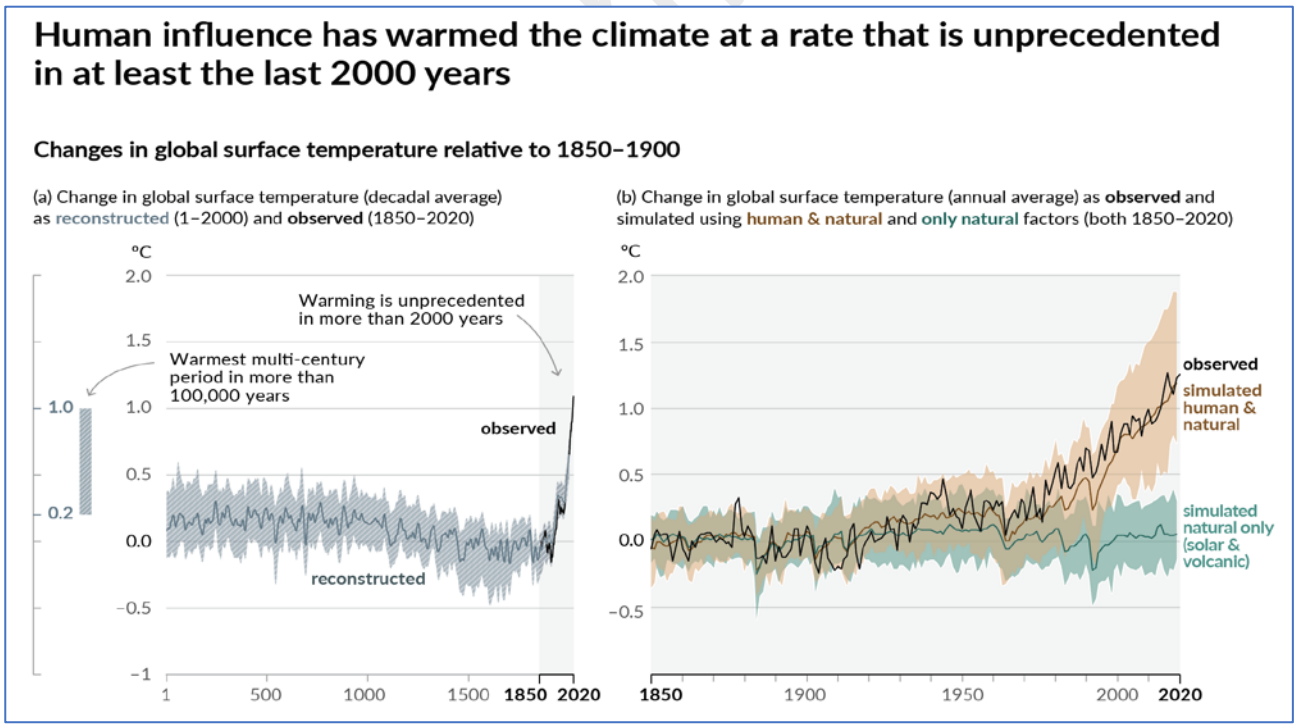
TOPIC and TYPE OF CLAIM	Claims by the IPCC (AR6)	Counterarguments by CLINTEL	Types of critique argumentative fallacies
CLIMATE HISTORY DESCRIPTION	*Claim*: "Global surface temperatures are more likely than not (*qualifier*) unprecedented in the past 125.000 years"	*Claim*: This claim is untenable *Warrant:* it erases counter-evidence. *Data*: the so-called Holocene Thermal Maximum or Holocene Climatic Optimum (from 9800 to 5700 before present).	OMISSION DATA ERASING
NEW HOCKEY STICK DESCRIPTION	*Claim*: (and even) in the last 2000 years!	*Claim*: This claim is untenable. *Data*: Medieval Warm Period and the Little Ice Age. *Backing:* 5 references of critical remarks about hockey stick graph.	DATA ERASING LITERATURE OMISSION

[8]The website advertises: "A global network of over 1900 scientists and professionals has prepared this urgent message. Climate science should be less political, while climate policies should be more scientific. Scientists should openly address uncertainties and exaggerations in their predictions of global warming, while politicians should dispassionately count the real costs as well as the imagined benefits of their policy measures". www.clintel.org.

[9] The book, edited by Andy May Editor (May is one of the co-editors) and advertised through the website as translated into German, Dutch and Danish, is not available in open-access. It can be bought through the CLINTEL website, or on Amazon.com (e-book about 10 euros; paperback 35 euros).

The first descriptive statement contested by CLINTEL's authors concerns global surface temperatures. They are considered by the IPCC "more likely than not" (a qualifier) as unprecedented in the past 125.000 years. The contrarians argue that this claim is "untenable", because it erases the so called Holocene Thermal Maximum – a period from 9800 to 5700 before present that witnessed very high global temperatures. This critique turns around one implicit warrant: a descriptive conclusion is unsound if it overlooks or erases factual evidence (which remains true even when the certainty of the claim is attenuated by a qualifier, in this case, "more likely than not"). The same warrant is used about the so called "hockey stick" in the second critique, contesting the IPCC's claim about global surface temperature being without precedents in the last 2000 years. Once more, the AR6 report would be guilty of fallacy of omission, erasing data about both the Medieval Warm Period and the Little Ice Age. More specifically, it would have made improper usage of the so-called hockey stick graphs, "used by the IPCC to claim that the current warming in unprecedented in the last 1000 or 2000 years []. They are trying to send the message that these were only regional phenomena, with little consequence globally" (ivi, p. 22). Moreover, similar versions of the "hockey stick" graph were "heavily criticized for major deficiencies in their paleoclimatic proxies and the statical methods used to construct it" (in this case the backing is made of 5 bibliographic references)[10]. Below is a figure showing the hockey stick graph implemented by AR6, in the *Summary for Policy Makers* 1.a. (on the left).

Figure 5. Two graphs from the IPCC AR6 report. Synthesis Report and Summary for Policymakers.



[10] To further strengthen their argument, Crok and May show two juxtaposed figures extracted from distinct IPCC reports (p. 22, respectively AR6 Working Group 1, fig. 2.11 on the left; and AR6, Summary for Policy Makers 1.a, on the right) in which the hockey stick graph by Kaufmann et al. (2020) and the IPCC "new" hockey stick are compared. In the first, the peak is around the Holocene Thermal Maximum, with an estimation rate of 90%. Their comment: "The uncertainty is as large or larger than the total global warming".

The image on the right side of the figure shows the difference between observed and simulated global surface temperatures in presence of anthropogenic action and without it (solar and volcanic changes). Concerning explanatory claims, it is discussed below.

Table two displays counterarguments about three indicators – global mean surface temperature, snow cover and sea level rise – that the IPCC deems relevant to describe climate change. The *relevance, adequateness and accurateness* of three parameters in providing a fair description of climate change are now at stake.

Table 2. Scientific narrative and counternarrative about three climate change indicators.

TOPIC and TYPE OF CLAIM	**Claims by the IPCC (AR6)**	**Counterarguments by CLINTEL**	**Types of critique argumentative fallacies**
GLOBAL MEAN SURFACE TEMPERATURE **DESCRIPTION/ EVALUATION**	*Claim*: The global mean surface temperature is the most relevant variable to be considered to assess climate change	This claim, even though it has become iconic, is unsound: the ocean temperature is the most relevant descriptive variable *Warrant*: a change in their temperature is proportionally much more important than a change in the surface temperature *Data:* they contain much more zettajouls of energy than the surface	FALLACY OF RELEVANCE (with regard to description)
SNOW COVER **DESCRIPTION/ PREDICTION**	*Claim*: Tendential snow decrease over time *Data*: Synthetic dataset (out of 7 databases)	*Claim*: it is unsupported by evidence On *data*: the dataset is hybrid. On *backing* literature: The work by Connolly, that is mentioned, is not FULLY mentioned (the conclusions are omitted).	DATA CHERRY PICKING to avoid contradictions + LITERATURE CHERRY PICKING
SEA LEVEL RISE **DESCRIPTION/ EVALUATION**	*Claim*: "the sea level rise is accelerating". *Data*: the so-called "sea level budget method model". Backing: (Frederiske et al. 2020)	*Claim*: The IPCC claim is supported by thin evidence AND the IPCC is too quick in assuming that a swing upwards in that indicator equals an acceleration in sea level rise. *Data*: that model is not the most reliable indicator for evaluating sea level changes. The so called "tide gauge records" should have been used instead. *Counterclaim*: evidence of tide gauge records in Stockholm contradicts predictions based on the IPCC model.	FALLACY OF ACCURACY (not of relevance because there is a better indicator available). This other model hints at the phenomenon named "Atlantic Multidecadal Oscillation" CONTRADICTION between predicted levels and observations.

The claim about growing global mean surface temperature, previously contested based on evidence, is now criticized about its appropriateness to adequately describe clime change. Another indicator, global average ocean temperature, according to CLINTEL's authors, is instead more relevant, because a change in their temperature is proportionally much more important than a change in the surface temperature(warrant), given the bigger ocean heat content (datum).

The third indicator, snow cover, is not disapproved per se; rather, its usage by the IPCC as proof of global warming. The counterargument, in this case, is twofold. On the one hand, the presumed tendential decrease over time of snow cover is unmasked as a mix of evidence and predictions, stemming from statistical elaborations over an "hybrid" database (which is effectively the outcome of 7 databases united, merging measures and data from models). On the other hand, the backings (the literature references) used by the IPCC are charged of "cherry picking" practices: the critical work by Connolly, that is quoted, is not *fully* quoted; in particular, his remarkable conclusion that "climate models are unable to simulate the *increasing* trend in snow cover" is omitted. Closing this counterargument is also an intuitive reasoning that to non-experts might sound convincing: "Warming could mean more evaporation and more precipitation, including in the form of snow". The argument ends underscoring a lack of transparency: the graph showing a decrease in snow cover was added to the ARW6 report only after the review process, so that "reviewers were unable to check the validity of this radically new dataset" (ivi, p. 30). Very interesting is also the discussion about sea level as indicator of global warming, revealing a contradiction between predicted levels and observations. First the CLINTEL team suggests that the IPCC claim "the sea-level rise is accelerated" is based on thin evidence and is not accurate, because it relies on the so-called "sea level budget method model" (proposed by Frederiske *et al.*, 2020), which assumes that a swing upwards in that indicator equals an acceleration in sea level rise. According to doubters, instead, the sea level is rising, but not so fast: there is another model based on another indicator ("tide gauge records") that better describes the phenomenon named "Atlantic Multidecadal Oscillation", a huge variability in sea levels over time. This second model, but not IPCC's, is able to avoid contradiction between the IPCC predictions and recent observations, like the tide gauge records in Stockholm. Since a model that fulfils the purpose to correctly forecast more evidence is preferable (warrant), than the IPCC's one should be substituted. The CLINTEL team piles it on highlighting a presumed fallacy of accuracy: "it is extremely surprising that the modelled effect of this change should appear in 2020 as a rather marked step change in the relative sea level. Had the modellers instead have modelled their sea level data from an earlier date, e.g., 1950, which would have been entirely possible, that conflict between measured and modelled data would immediately have become apparent" (ivi, p 33). The comment upon this fallacy is *tranchant*: "it seems that this tool was not produced to test the validity of scientific data. It was instead an attempt to alarm the user" (ivi, p. 34).

Mirroring the order of the counterarguments presented by Crok and May, the following table (tab. 3) displays two evaluative argumentation that are key to foreground alternative explanatory arguments and forecasts: climate sensitivity to doubling the amount of CO2 in the atmosphere and reliability of the related predictive models.

Table 3. Evaluation about climate sensitivity to carbon dioxide and the reliability of climate models.

TOPIC and TYPE OF CLAIM	Claims by the IPCC (AR6)	Counterarguments by CLINTEL	Types of critique argumentative fallacies
CLIMATE SENSITIVITY TO CO2 to doubling the quantity in the atmosphere **EVALUATION (KEY TO PREDICT THE FUTURE CLIMATE)**	*Claim*: The likely (66%) effective climate sensitivity range is between 2,5° C and 4° C. *Backing*: Sherwood et al. 2020	*Claim*: The likely (66%) effective climate sensitivity range is between 1,75° and 2,7° C (much lower) *Backing*: Lewis replicated analysis found statistical flaws and other shortcomings in Sherwood.	INTENTIONAL OMISSION (of contrasting literature)
RELIABILITY OF CLIMATE MODELS **EVALUATION (IT INVALIDATES FUTURE PREDICTIONS)**	*Claim*: The adopted climate models are reliable	*Claim*: The adopted climate models are unreliable *Warrant* 1: they are affected by a mistake: global and tropical tropospheric air temperatures are too high relative to observations *Backing*: Ross McKitrick *Warrant* 2: If the impact of anthropogenic greenhouse gas emissions is removed from climate models, the results match observations in the tropical tropospheric air temperatures much more closely.	ERROR in model parameter COUNTER-EVIDENCE

As to climate sensitivity to changes in carbon dioxide levels, the war is on the magnitude of impact. Two contrasting assessments with same likeliness probability (66%) are confronted: the one by IPCC (backed by the academic scientist Sherwood), fixing that range between 2,5 and 4 degrees and the one by CLINTEL (backed by the "independent scientist" Lewis), identifying a much *lower* range, between 1,75 and 2,7 degrees. In this case, the critique is levelled at the omission of reference to contradicting literature (Lewis finds statistical flaws and other shortcomings in Sherwood et al.). More complex is the controversy around the reliability of predictive models on climate change, contested through two complementary argumentative strategies. On the one hand, based on the study by McKictrik (an economist specialized in environmental economics) it is claimed that the models adopted by the IPCC are affected by a mistake in the computation of global and tropical tropospheric air temperatures (too high relative to observations); on the other hand, an alternative claim is proposed on the basis of evidence (according to McKicktric, chapter 8): if the impact of anthropogenic greenhouse gas emissions is removed from the climate models, the results match observations in the tropical tropospheric air temperatures much more closely: a statement that blatantly contradicts the IPCC figure reported here on figure 5, on the right (but is coherent with the CLINTEL's view that there is a systematic overestimation of global air temperature by the IPCC).

Turning now to alternative explanatory arguments, table 4 showcases the assessment of the sun's role in climate change.

Table 4. Scientific explanation and counter-explanation of climate change.

TOPIC and TYPE OF CLAIM	Claims by the IPCC (AR6)	Counterarguments by CLINTEL	Types of critique argumentative fallacies
SUN'S ROLE IN CLIMATE CHANGE EXPLANATORY	*Claim*: The sun activity is less relevant than the anthropogenic component to explain climate change.	*Claim*: a correlation is not a causation, but it cannot be ignored either. *Data*: Medieval Warm Period higher solar activity & Little Ace Age lower solar activity *Warrant*: the climate changes and the solar activity changes (sunspots, auroras and solar proxies) correlate well.	CHERRY PICKING from literature

In this case the two perspectives clash drastically. According to the AR6, the sun activity is less relevant than the anthropogenic component to explain current climate change. The physicist Nicola Scafetta and the industrialist and politician (SPD) Fritz Vahrenholt, authors of chapter 6 titled "Why does the IPCC downplay the Sun?", argue instead that even though it is true that a correlation is not a causation, it cannot be ignored either; in the case of climate change *history*, climate changes and solar activity changes (sunspots, auroras and solar proxies) correlate well, as proved by higher solar activity during the Medieval Warm Period and lower solar activity during the Little Ice Ace. Displaying many case studies confirming their own claim and discussing the indirect effects of sun on climate through some "sun-related amplifiers" (like the Ultraviolet and Cosmic amplifiers), they find once more a case of intentional literature cherry picking: "It appears that the conclusions presented in the IPCC AR6 are consistent only with a portion of the published scientific literature, the portion that minimize the role of the sun so as to maximize the anthropogenic component" (p. 35). Finally, a table summing up predictions and evaluations about possible climate change scenarios (tab. 5).

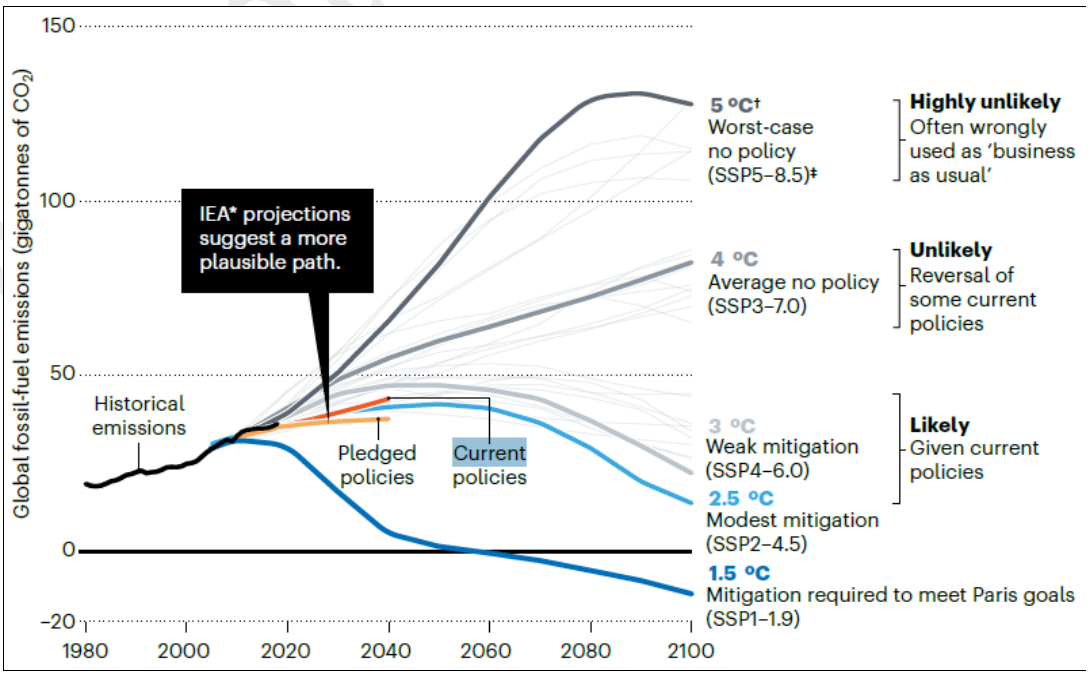
Table 5. Scientific predictions about climate change scenarios depending on human action.

TOPIC and TYPE OF CLAIM	Claims by the IPCC (AR6)	Counterarguments by CLINTEL	Types of critique/ argumentative fallacies
EMISSION SCENARIOS PREDICTION/ EVALUATION	*Claim*: the worst emission scenarios are likely	*Claim*: the worst emission scenarios proposed by the IPCC are "highly unlikely" *Backing*: Hausfather and Peters in *Nature* 2020.	OVERWEIGHT TO BAD SCENARIOS – ALARMISM
FLOODS DESCRIPTION/ EVALUATION	*Claim*: Climate is becoming more extreme with time *Data*: there is no increasing trend in tropical cyclones and floods	*Claim*: it is not true that climate is becoming more extreme *Data*: there is no increasing trend in tropical cyclones and floods	HIDING THE GOOD NEWS CONTRADICTION between claim and data (even the ones presented by IPCC!)
EVALUATION	*Claim*: Human had low impact upon droughts at a regional scale (AR6, WG1 pp. 1578-1579)	*Backing*: Klotzbach 2018 *Claim* (by Crok): there is self-contradiction between WG1 and Summary for Policy Makers (AR6,	CONTRADICTION between two parts of the same report (scientific and summary for policy makers).

		WG1, SPM A.3.5.) in which it stated that human influence has increased "compound" flooding. (i.e. the combination of two or more flooding events)	
DISATER LOSSES **EXPLANATION** **EVALUATION**	*Claim*: Disaster losses (in $) has increased over time	*Claim*: This claim is invalid. *Warrant*: the relationship between climate related-disasters and losses (in dollars) is spurious. *Claim 2*: the nominal costs for disaster losses must be normalized. *Backing*: 54 papers with normalization procedures state that the costs associated with the extreme weather events could not be attribute to human activities. I.e. Pielke 2019.	INVALID INFERENCE: LOGICAL FALLACY LACK OF COMPREHNSIVENESS, TRANSPARANCY AND OBJECTIVITY N.B. In previous reports of IPCC normalization of data was applied.

Crok himself, science journalist and co-editor of the Frozen Views of IPCC, evaluates the AR6 predictions about *human impact* upon different aspects of climate change, C02 future emissions, floods and disaster losses (Cap. 11). First, he notices that: "the IPCC admission that the higher emissions scenarios, SSP5-8.5 and SSP3-7.0 are unlikely, *is deeply buried* in the report and unlikely to be read by policy makers". Then, he shows the predictive evaluation proposed by another study (published in *Nature* and reported below), according to which the two worst emission IPCC scenarios ("business as usual" and "reversal of some of current policy") are respectively highly unlikely and unlikely.

Figure 6: Possible Futures, Hausfather and Peters, in Nature, vol. 577, October 30, 2020.



Alarmism, hiding good news and overestimation of impacts of human action on climate change by the IPCC also regard floods and disaster losses. In the case of floods, moreover, Crok emphases an internal contradiction between two parts of the same report by IPCC, Working Group 1 report stating that "Human had low impact upon droughts at a regional scale" (AR6, WG1 pp. 1578-1579) and the Summary for Policy Makers (AR6, WG1, SPM A.3.5.) stating that human influence has increased "compound" flooding. (i.e. the combination of two or more flooding events). The critiques of lack of transparency, comprehensiveness and objectivity are levelled also against the IPCC arguments about disaster losses (quantified in US dollars), that are claimed to have been increasing over time. More importantly, Crok detects a serious logical fallacy in the explanation provided by the IPCC about the relationship between climate change related disasters and the quantification of losses. Such relationship is not direct but *spurious*: there are *at least* four intervening variables: the demographic boom from 2 to 8 billion people, the increase in the number of infrastructures, the rise in their costs and finally the rate of inflation. Moreover, the nominal costs for disaster losses should be normalized. This latest argument seems particularly strong, since there are at least 54 papers adopting normalization procedures proving that the costs associated with the extreme weather events could not be attribute to human activities. Finally, normalization of data was applied in previous IPCC reports, which effectively sounds a bit suspicious.

CONCLUSIVE REMARKS

Through the empirical analysis of a case study, this work suggests that not only in the realm of politics, but even within the scientific community (at large) there is still strong opposition against the theory of anthropogenic global warming accepted by most scientists. More specifically, the findings show that CLINTEL group's counternarratives on climate change check coherence in mainstream arguments, looking for contradictions *between evidence and models* (be their descriptive, explanatory, or predictive) and between competing models. In addition, they detect some recurrent argumentative fallacies: omissions, cherry picking from literature and databases, fallacies of relevance and accuracy (regarding descriptions), logical mistakes (regarding explanations) and statistical flaws (regarding predictions), together with common rhetorical expedients, like hiding good news and presenting as plausible worst-case scenarios. Certainly, these outcomes are far from being exhaustive of how scientific *objectiveness* is build up and defended by sceptics and deniers in climate change science; nevertheless, they suggest that contrarians aim at deconstructing the opponent's arguments based on their *epistemological invalidity*. In this way, they face mainstream representatives directly on the scientific battleground, instead of hinting at their ideological or political motives (as found by Fischer, see introduction). Further empirical explorations on the issue – for example analysing counterarguments advocated by science experts in other monographies (like Craig, 2021; Prestininzi, 2022) or on dedicated digital platforms (like "Wattsup with that") – could tell if CLINTEL's discursive strategy is a rule or rather an exception. Other research paths, using mixed qualitative methods and triangulation strategies, could eventually provide a better comprehension of the reasons and feelings backing different argumentative strategies on the issue: for instance, in-depth interviews with PhD students from climate change related disciplines could shed light on how young scientists argumentatively react, once exposed to deniers' counternarratives (a work currently in progress).

Yet, to discover that a scientific "definitive settlement" about climate change is farther to be achieved than positively advertised is a sociologically relevant outcome, worth of deeper reflection and future inquiry. For instance, it raises new research questions about the impact of dissent *inside* the scientific community on people's trust in science (an issue that witnessed renovated sociological interest during the

last COVID pandemic). In addition, it hints at further research on the institutionalization processes and problems of scientific careers and disciplines, with special regard to recently born, multidisciplinary and interdisciplinary ones, like climate change science. Not last, it ignites critical reflections about the politicization of scientific dissent and on the role of social media in spreading fake news and /or unsound scientific arguments.

As to the proposed methodology, the revisitation of the Toulmin's model overall fulfilled its aims quite satisfactorily, allowing through its elements a clearly replicable splitting of the arguments about climate change. Three adaptations proved useful: the classification of the claims (and alleged arguments) in descriptive, explanatory, evaluative and predictive; the re-interpretation of the backing in terms of relevant specialistic literature; the possibility to consider covering laws or logically related propositions as warrant. The interpretation of a scientific argumentation as a narrative made by distinguishable stages, whose plot can be more or less coherent, looks promising and eventually transferable to other kinds of argument (for instance, political ones). Nonetheless, there are margins for improvement. For example, the sophistication of the tests of coherence within van Fraassen's empiricist constructivism; the clarification of the role of evaluations in scientific arguments; a more systematic comparison of qualifiers (expressing various degrees of certainty about claims). Moreover, it must be admitted that the proposed method has severe limits in its application. Not only it is time consuming, but it also requires practice and skills to be applied fairly, i.e. in a way that would easily lead to intersubjective consensus by expert analysts. Besides, I am not sure that its eventual automatization in a future software could successfully overcome both limits. However, the degree of standardization attained so far allows to be quite confident that in the future young, passionate and rigorous researchers would choose to give it a trial, eventually on other scientific issues.

REFERENCES

Bauman Z. (2007), *Liquid Times: Living in an Age of Uncertainty*, Cambridge: Polity Press

Beck U. (2010), *Climate for Change, or How to Create a Green Modernity?* in «Theory, Culture & Society», 27 (2-3): 254-266

Beck U. (2016), *The Metamorphosis of the World*, Cambridge: Polity Press

Bell D. (1999), *The Coming of Post-Industrial Society: A Venture in Social Forecasting*, New York: Basic Books

Björnberg K.E., Karlsson M., Gilek M. and Hansson S.O. (2017), *Climate and environment science denial: A review of the scientific literature published in 1990-2015*, in «Journal of Cleaner Production», 167, 229-241

Castellani E. (2005), *Verità e scienze fisiche*, in: S. Borutti e L. Fonnesu. (eds), *La verità. Scienza, filosofia, società*, Bologna: il Mulino, 13-33

Cologna V, Kotcher J, Mede NG, Besley J, Maibach EW, *et al.* (2024), *Trust in climate science and climate scientists: A narrative review* in «PLOS Climate», 3(5): e0000400

Colombo E. and Rebughini P. (article currently under revision), *Hegemonies of the Social Imaginary: An Analytical Conceptualisation. Social Imaginary as battlefield. Towards a possible critical thought*

Corradi F. (2007), *Note sul concetto di coerenza* in «Rassegna Italiana di Sociologia», a. XLVIII, 2, 213-242

Corradi F. (2013), *Giustificare la guerra al terrorismo: ricchezza e qualità dell'argomentazione pubblica*, in F. Rositi (ed.), *La ragione politica: i discorsi dei leader politici*, Napoli: Liguori. 49-100

Corradi F. (2016), *Beyond the Obvious. Suggestions to Empower Critical Discourse Analysis*, in «Sociologia Italiana AIS Journal of Sociology», 8, 39-60

Corradi F. (2019), *Towards a Critical Sociology of Finance*, Salt Lake City: American Academic Press. ISBN 978-1-63181-991

Corradi F. (2020), *Assessing the quality of argumentation in digital public spheres: a case study from Twitter @debatingeurope* in «Sociologia Italiana AIS Journal of Sociology», 15, 39-64

Craig D. (2021), *There is No Climate Crisis*, Bournemouth: Original Book Company.

D'Agostini F. (2010), *Verità avvelenata. Buoni e cattivi argomenti nel dibattito pubblico*, Torino: Bollati Boringhieri.

European Commission, State of the Union. *Progress Report 2023, Climate Action*. https://climate.ec.europa.eu/document/download/60a04592-cf1f-4e31-865b-2b5b51b9d09f_en

Fairclough N.L. (1985), *Critical and descriptive goals in discourse analysis* in «*Journal of Pragmatics*», 9, 739-63.

Fairclough N.L. (1989), *Language and Power*, London: Longman.

Fairclough N.L. and Wodak, R. (1997), *Critical Discourse Analysis* in van Djik, T.A (ed.), *Discourse studies. A Multidisciplinary Introduction*, Vol. 2.

Fischer F. (2017), *Climate Crisis and the Democratic Prospect. Participatory Governance in Sustainable Communities*, Oxford: Oxford University Press

Fischer F. (2021), *Truth and Post-Truth in Public Policy. Interpreting the Arguments*, Cambridge: Cambridge Elements Public Policy

Forchtner B. (ed), (2020), *The Far Right and the Environment. Politics, Discourse and Communication. Fascism and the Far Right*, New York: Routledge

Forchtner B. and Lubarda B. (2023), *Scepticism and beyond? A comprehensive portrait of climate change communication by the far right in the European Parliament* in «*Environmental Politics*», 32:1, 43-68

Giddens A. (1990), *The Consequences of Modernity*, Stanford: Stanford University Press

Giddens A. (2009), *The Politics of Climate Change,* Cambridge: Polity Press

Gounaridis D. and Newell J. (2024), *The social anatomy of climate change denial in the United States*, in «Scientific Reports», 14 (1): 2097

Hällmark K. (2023), *Politicization after the 'end of nature': The prospect of ecomodernism*, in «*European Journal of Social Theory*», 26 (1) 48-66

Hausfather Z. and Peters G.P. (2020, *Emissions: 'the business as usual' story is misleading* in «Nature», 577, October 20, 618-620

Hitchcock D. and Verheij B. (eds.) (2006), *Arguing on the Toulmin Model. New Essays in Argument Analysis and Evaluation*, New York: Springer

IPCC - Intergovernmental Panel on Climate Change (2023). *Sixth Assessment Report* (AR6), *Synthesis Report Climate Change 2023* https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf

Summary for Policy Makers https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf

Jasanoff S. (2004), *States of Knowledge: The Co-Production of Science and Social Order*, London: Routledge

Knorr-Cetina K. and Cicourel A.V. (eds) (1981), *Advances in Social Theory and Methodology. Towards an Integration of Micro-and Macrosociologies*, London: Routledge

Kuhn. T. (1962), *The Structure of Scientific Revolutions,* Chicago: Chicago University Press. Fourth Edition, With an Introductory Essay by Ian Hacking, 201

Lübke C. (2022), *Socioeconomic roots of climate change denial and uncertainty among the European population* in «*European Sociological Review*» 38.1: 153-168

Luke A. (2002), *Beyond science and ideological critique: Developments in critical discourse analysis*, in «Annual Review of Applied Linguistics», 22, 96-100

Lynas M., Houlton B. Z., Perry S. (2021), *Greater than 99% consensus on human caused climate change in the peer-reviewed scientific literature,* in «Environmental Research Letters», 16 (11): 114005

Massimi M. (2005), *Oggettività e verità in meccanica quantistica e filosofia della scienza* in S. Borutti e L. Fonnesu (eds.) *La verità. Scienza, filosofia, società*, Bologna: il Mulino, 35-62

Mendy L., Karlsson M. and Lindvall D. (2024), *Counteracting climate change denial: A systematic review*, in «*Public Understanding of Science*», 33 (4) 504-520

Myers K. F., Doran P. T., Cook J., Kotcher J. E. and Myers T. A. (2021), *Consensus revisited: quantifying scientific agreement on climate change and climate expertise among Earth scientists 10 years later* in «*Environmental Research Letters*» 16 (10): 104030

Ojala M. (2021), *To trust or not to trust? Young people's trust in climate change science and implications for climate change engagement* in «Children's Geographies» 19:3, 284-290

Polanyi K. (1944), *The Great Transformation*, New York: Farrar & Rinehart

Prestininzi A. (ed.) (2022), *Dialoghi sul clima. Tra emergenza e conoscenza*, Catanzaro: Rubbettino. Con la collaborazione del CERI, Centro di Ricerca Previsione Prevenzione e Controllo dei Rischi Geologici, Università Sapienza di Roma

Toulmin S.E. (1959), *The Uses of Argument*. Cambridge: Cambridge University Press

Stott P. (2021), *Hot Air. The Inside Story of the Battle Against Climate Change Denial*, London: Atlantic Books

van Frassen B.C. (1980), *The Scientific Image*, Oxford: Oxford University Press

Wodak R. and Meyer M. (eds.) (2009), *Methods of Critical Discourse Analysis*, London: Sage

Zimmer B. (2010), *Truthiness*, in «*New York Times*», October 13
http://www.nytimes.com/2010/10/17/magazine/17FOB-onlanguage-t.html