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# A medical language for climate discourse

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Innovative communication theories propose that we understand messages not by decoding their meaning but by inferring what speakers intend to express. However scientifically accurate the messages climate scientists have put forward, the appropriate inferences may not have been drawn by most of their audiences. One of the main reasons may be that scientific metaphors allow for multiple interpretations, yet, because of their expressive power, they impact discourses disproportionately. Climate communication took a path of euphemistic scientific expressions partially due to the noble scientific norms of self-restraint and modesty, but the hidden implications of climate jargon distort the way non-experts think about the heating climate. Consequently, the current climate jargon hinders informed decisions about Earth's life support systems. Changing the softened expressions of climate language, from the cool of basic research to the heat and compassion of medical contexts, may allow for more productive public and political debates – which may lead to more powerful policy solutions. Speaking and thinking in medical terms could turn the perception of worst case scenarios from hypotheticals or doomism to life-saving interventions. We typically start reducing fever before it gets out of control, let alone crosses a threshold of potential death. Instead of putting on a positivist mascara, a calm and serious discussion of safety measures in medical terms, for example, talking about climatic tipping cascades as metastases, could foster a more honest evaluation of the required legal and regulatory steps to keep our home planet habitable.

## KEYWORDS

climate change, metaphor, figurative language, communication, discourse, policy, climate communication, scientific communication

## Highlights

- The policy implementation of scientific knowledge typically regulates responsibility and safety.
- Climate policy is an outlier compared to other high risk legal domains like aviation or medicine and often treats climate matters akin to driving or smoking.
- Policy and legal regulation often derives from the language of public and political discourse.
- The language of climate communication and the legal framing of climate policy could be converted into a domain of medical science from that of basic research.
- Medical decisions are better, if not based on financial or ideological considerations, while they are still evaluated scientifically and regulated by policy.

## 1 Introduction

There is a disconcerting schism between the communication of science and the science of communication: experts of particular research areas are not typically specialists in communication at large. Thus, the discrepancy between the dire warnings of climate scientists and the lackluster and slow moving political reaction may be due to a communication gap between climate scientists, the general public, and political and economic decision makers. The present paper aims to dig into the mechanisms of this gap in hope of narrowing it.

Outside of their area of expertise, even scientists resort to common-sense knowledge, which, in the case of communication science, is based on classical information theory (Shannon and Weaver, 1949): messages are encoded, transmitted through a channel, and decoded by the receiver, a bit like sending Morse code. More recent theories suggest, however, that the gist of human communication happens before encoding and after decoding. Models of inferential communication (Grice, 1975; Sperber and Wilson, 1986; Wilson and Sperber, 2004) propose that instead of looking up some previously agreed upon meaning for sounds or words from a dictionary (i.e. a mental lexicon), we constantly try to infer (i.e. actively construct) what the speaker intends to express by uttering those specific words, in that specific context and social situation. Instead of communication requiring some kind of language or code, it may be language and its use that require unique communication abilities. These include attributing communicative intentions to the speaker, and recovering intended meaning through a host of inferential mechanisms. Lexicalized word meaning is only one source of evidence for figuring out what was meant by what was said, among the manners of the speaker, the social context, etc. These mechanisms set us apart from the rest of the animal kingdom, as human communication is not simply signaling (Grice, 1957; Scott-Phillips, 2015).

Uttering certain phrases and expressions, in the belief that it is clear, frank, and straight forward information transmission, does not guarantee that the audience is going to decode and interpret the message in the way it was originally intended. More specifically, the devastating nightmare scenarios hidden inside climate science publications may be blatantly obvious for experts of the relevant fields, but may be understood by non-experts as such only if they are communicated explicitly. They may be missed or misunderstood if phrased in the cool of the scientific jargon however accurate it may be.

It is a remarkable achievement of scientists, journalists, and activists that the reports of the anthropogenic destruction of Earth's climate- and ecosystems have finally worked their way through to the general public despite decades of anti-science disinformation campaigns. There have been unprecedented developments in climate legislation in the past years. However, "climate anxiety" and "doomism" are on the rise, the accusation of "alarmism" is leveled at those who bring up the worst case scenarios of climate change, and despite renewed promises, political decision making is still stalling, faltering, or even being reversed. Consequently, time is running out for a frank discussion of the options left to sustain a technological civilization, which presupposes mild and predictable weather patterns, necessary for large-scale agriculture.

Because Earth's climate is a complex natural system, the information that reaches non-experts is unavoidably simplified and

thereby may give rise to unintended implications. One of the most prominent means for condensing and conveying the essence of scientific findings has been metaphorical expressions. Metaphors are not only excellent rhetorical tools (Aristotle 322 BC, 1991), and they are not only abundant in everyday language (Lakoff and Johnson, 1980), but they play a central role in scientific debates and communication (e.g., Wuppuluri and Grayling, 2021) by invoking analogical reasoning (Gentner et al., 2001). The way we talk about particular subjects strongly influences the trajectory of the discourse and thereby the way we think about them. Metaphors are not always helpful, however, neither in science nor in its communication.

## 2 Metaphors of climate science

While scientific metaphors are intended to elucidate some aspect of a model or theory, they may create confusion or misunderstandings not only in scientific but in public discourse as well (Forgács, 2022). Although a metaphor may not seem to be more than an illustrative example, it implies an entire scientific model (Gigerenzer and Murray, 1987), even if it is not intended as such. Many metaphors led science down the rabbit hole, sometimes for extended periods, before they were abandoned. Sometimes their remnants, the derived expressions, linger on as linguistic relics. Electricity is not a fluid, even though we still talk about electric "currents"; the solar system model of the atom was rejected swiftly, but the expression "atomic orbital" is still in use. Even the best placed scientific metaphor carries unintended implications and requires clarification regarding which parts of the metaphorical analogy needs to be discarded or retained. The metaphors of climate science are no exception. They are exceptionally hazardous, however, because they concern an existential threat.

A number of studies provide an excellent analysis of the explanatory efficiency of both existing and newly proposed climate metaphors. Some provide a thorough overview of the metaphors currently in use (Nerlich and Hellsten, 2014; Shaw and Nerlich, 2015; Flusberg and Thibodeau, 2023), while other studies found that certain metaphors work better than others (Russill, 2011; Deignan et al., 2019). However, from a communication efficiency standpoint, even if these expressions have modified the mannerisms of the discourse, they seem to have failed to lead to substantial policy, economic, or legal action commensurate with the magnitude of the issue.

There are several problems with the expressions currently most widely used in climate communication, be they metaphorical or not (Forgács and Pléh, 2022). Many of the circulating buzzwords have positive emotional value (e.g., "warm," "green," or "ecofriendly"), others are passive in tone ("catastrophe," "crisis," or "breakdown"), and some serve strategic green washing, softening up and playing down the looming existential danger ("net zero," "offsetting," "carbon negative" or "climate neutral"). One of the reasons for this problematic language is that vested interests have been tampering with the public discourse on climate science for decades. For example, the US government preferred "climate change" to "global warming" because the former is less specific, thus sounds less alarming (Burkeman, 2003). Neither of them are expressive of an existential threat, however. The word "change" may have so positive overtones that it was successfully utilized in election campaigns (Levine et al., 2011). The term "climate change" was exploited for decades to question the anthropogenic transformation of Earth's climate, by pointing out its

natural fluctuations. Recently, “change” has been replaced in some progressive journals by “catastrophe,” “collapse,” “crisis” or “breakdown,” however, these innovative terms still use a passive voice and thereby imply helplessness: that it may not be possible to counter the blind forces of nature and that humans bear no responsibility. Active terms, such as “climate destruction” or “climate suicide” would not only acknowledge human responsibility but thereby could restore agency and foster taking action. The allegedly more threatening expression, “global warming,” is still rather benign, as “warming” and “warmth” are emotionally positive words in most contexts (Osgood, 1962)—unlike “global burning” or “overheating.” These two most frequently used terms do not seem to be well placed to express something gravely serious as the potential collapse of global weather and ecosystems.

One of the central metaphors of climate science has been the “greenhouse” effect / gases. Its implications are dubious on multiple levels. First off, “green” is a positive term, a calming color. More importantly, a greenhouse is a fragile, eloquent building designed specifically to trap heat. Explaining a catastrophic overheating by a technological advancement engineered to protect and nurture plants and produce food in cold climates may be quite confusing. Moreover, the image implies that overheating can be reversed just as quickly and easily as opening the windows of a greenhouse, which could have contributed to a wait-and-see attitude (Chen, 2012). Finally, although the term was coined by scientists, Earth’s atmosphere functions as a metaphorical greenhouse at all times, which may leave non-experts wonder, why it may be a grave concern suddenly?

Since metaphors can be easily misinterpreted or even distorted, along their literal senses, experts play a key role in specifying which parts should or should not be transferred from the surface form (the source of the metaphor, e.g., *greenhouse*) to the deep content (the target of the metaphor, e.g., *atmosphere*). Some have proposed potential novel climate metaphors (Volmert, 2014; Armstrong et al., 2018; Bernstein and Hoffmann, 2019), but most of them are still rather problematic, and none of them has brought about the long awaited communication breakthrough. For example, both the “blanket” metaphor (i.e., CO<sub>2</sub> covers our planet as a blanket) and the “bathtub” metaphor (i.e., greenhouse gases fill the atmosphere as water fills a bathtub) (Armstrong et al., 2018), are again a bit too comfy images for a potential cataclysm. The “fractal carbon trap” may capture a profound scientific truth, but it is complex, abstract, not imageable, and it seems to require extensive explanation (Bernstein and Hoffmann, 2019). It should be possible to create terms that require less deliberation to deliver a punchy message. Abandoning the comforting worlds of gardening or bedrooms would make climate metaphors less exposed to strategic misinterpretations as well. Terms like “oven” or “furnace effect” may be more difficult to turn into something harmless.

### 3 Transforming climate communication

Fixing climate metaphors will not solve the communication problem in and of itself, but novel metaphors could help revitalize the global discussion of the remaining climate policy options. The idea is not to prescribe a novel, correct way to speak, as linguistic change is driven by blind social mechanisms, such as memes (Dawkins, 1976) or epidemics (Sperber, 2001), but scientist and journalists could come

up with novel terms and see which sticks. A novel language of innovative metaphorical and literal expressions, which is frank and powerful, negative in emotional valence and active in tone, may reshape the communicational space. It could get the discourse of climate science out of the deadlock of momentary political and economic “realities” by putting biological, physical, and technological constraints to the forefront.

Importantly, during the often hostile anti-science communication environment of the past decades, a positivist corporate language of progressive-sounding techno-euphemisms has also been created. Nowadays, a novel communication strategy is emerging from the fossil fuel industry that instead of denying, selectively acknowledges scientific findings, in order to continue inserting false inevitabilities (e.g., the indispensability of natural gas) and self-serving misinformation (Mann, 2021). Innovative buzzwords have been introduced to climate models, a “net zero” cosmetics of techno-jargon, promoting fictitious technologies, mostly to justify continued carbon emissions (Dyke et al., 2021): “carbon capture,” “carbon sinks,” “carbon storage” or “carbon removal.” These ideas and technologies might work someday, but after decades of postponing, there does not seem to be enough time left for them to be sufficiently upscaled. Yet the currently available green technologies seem to be more than sufficient. Pledges for the next 26 years and smart accounting do not need to be accepted as the basis for meaningful discussions. Alarming, certain ways of talking about the climate have become taboo: discussing worst case scenarios is often framed as “alarmism,” expressing hopelessness in the face of decades of inaction as “doomism,” and demanding actual zero emissions as “unrealistic.” Were there no taboos, what could climate communication talk about? A medical frame could help put climate change in a new perspective based on safety and risk avoidance rather than surrender and risk management.

One of the barely discussed issues with climate destruction is that in natural systems quantitative changes eventually induce a qualitative transformation. Climate reports have typically presented linear increases of CO<sub>2</sub> leading to linear temperature and sea level rise. A qualitative shift to the Hothouse state of Earth (Steffen et al., 2018), however, may terraform the planet rapidly and irreversibly. On a Hothouse Earth, large scale agriculture may not be feasible, and our ape physiology may tolerate temperatures only at the polar jungles. Invisible tipping points may induce a tipping cascade (Rocha et al., 2018; Lenton et al., 2019), even below the magical number 1.5°C, much sooner and faster in pace than most realize.

Partly in the name of scientific restraint and objectivity (Brysse et al., 2013), climate models have been systematically underpredictive (e.g., Hansen et al., 2023; Armour et al., 2024; Schmidt, 2024). For the sake of credibility, journal editors have been strategically rooting out strong language from scientific publications. These factors together strongly contributed to a failure of communicating the dire consequences of postponing or softening countermeasures. Probabilities have been discussed as present chance instead of future certainties, and worst case scenarios have been dismissed as fearmongering. Raising awareness, education programs, and protest movements mostly failed in the past 30 years, while humankind had sufficient time to carry through a gradual shift away from fossil fuels.

In contrast to the lackluster reactions, all the necessary technology seem to be available, and there is a rather broad agreement that the costs are around 2% of global GDP (The World Bank Group, 2021). There is still sufficient time for a technological transformation until

2030, the point of no return hypothesized by the UN (United Nations, 2019). There have been comparable technological transitions during the two World Wars of the 20<sup>th</sup> century. Voluntary action by individuals, companies or states is important but so far has been partial and limited. Only a global regulatory, policy driven technological shift seems to be appropriate in scale. Such technological shifts have happened before, with leaded fuels and CFCs in refrigerators, however, they require a shift in legal regulation and policy. Which in turn require electoral-societal pressure on policymakers. A factual and conscientious language could create the appropriate framework for an effective public and political discourse.

A medical framework for climate policy may not only make the height of the stakes a lot more clear for the general public, but it may also allow for more powerful policy proposals than the currently dominant scientific, economic or environmental frames (Badullovich et al., 2020). In high-risk legal contexts, such as aviation or modern medicine, safety takes precedence over economic, political, or social considerations (but not in spite of them). The point here is not simply to discuss climate change in terms of public health, but framing its consequences and opportunities in medical terms. Medical decisions typically prompt more personal involvement, more level-headed, and more long-term thinking than economic, political, or even environmental considerations. For example, losing a limb may sound not only tragic but unreasonable as an economic decision, while in the context of a sepsis, it may be a great opportunity to avoid death. Such a medicalization of climate discourse could translate into legal arguments and climate policy appropriate for a medical-type of emergency. Instead of keeping an intellectualizing distance, political and economic decision makers may gain a better understanding of climate predictions, not as statistical chances and hypotheticals, but as probabilities turning into certainties sooner rather than later. When bitten by a deadly poisonous snake, one should not wait for symptoms to appear but seek medical help immediately.

Just like medical decisions, environmental decisions are better if they are not driven by financial or ideological considerations, and the climate of Earth has a lot more to do with our health than our finances. In a medical framing a frank discussion is less of a threat than a potentially life saving step. A doctor talking about the beauty of life instead of the diagnosis is irresponsible. Addressing the collapse of the Amazonas (De Bolle, 2019), the Greenland ice sheet (Box et al., 2022), or the five tipping points we already have passed (Armstrong McKay et al., 2022) may allow for a better preparation for surgical interventions than musings about the number of centimeters of sea level rise in a hypothetical distant future. Framing the sustained fossil fuel subsidies (Parry et al., 2021) as a lethal addiction may allow for better medical treatment than paying lip service to sustainability using a corporate jargon (Dyke et al., 2021). Focusing on high polluters and global emissions inequality (Chancel, 2021), instead of comprehensive behavioral change typically aimed at low-income individuals, may allow for framing overconsumption as self-poisoning substance abuse. A medical framework could also render positivist and opportunistic climate messaging obsolete, because there is no need to put a mascara on reality, if there is a remedy. Talking about the potential upending of large-scale agriculture as starvation in industrialized countries, instead of being stunned by the sensational media reports of natural disasters we summoned upon ourselves for at least the next 30 years, could foster long term planning. From a medical perspective, the

question is typically not how the probability of death increases with various regimes of limited treatment, but what is the minimal threshold for a possible death. Given that there is no guarantee that Earth does not spiral into a Hothouse even below 1.5°C, discussing scenarios of 2 or 3°C may be a questionable risk management strategy. In fact, at the current level of emissions, we have five years and even then, only 66% chance of not overshooting the 1.5°C limit (IPCC, 2018). When a child has fever, we typically do not wait and see if it remains under a lethal level with 66% chance, but act immediately. The public support for climate change policy is broadly underestimated even in the US, despite rampant climate skepticism, even among political leaders (Frantz, 2022).

A medical context could help global political and economic leaders realize that climate destruction is not some sort of unpredictable inconvenience, but an ever more likely systemic disruption: a collapse of supply, technological, and knowledge chains, societal structures and potentially, large scale agriculture, any of which may upend technological civilization. The climate is not changing; it is being destroyed. Natural systems are not of concern; they are being mutilated. Biodiversity is not lost; it is being killed off. Technological civilization and the *Homo Sapiens* friendly biosphere of our home planet Earth can still be saved if our policies recognize that humanity is in an intensive care unit by now. Changing our language could change our debates, our perspectives, and our policies as well.

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## References

- Aristotle 322 BC (1991) in *“On Rhetoric”: A Theory of Civic Discourse*. ed. G. A. Kennedy (UK: Oxford University Press)
- Armour, K. C., Proistosescu, C., Dong, Y., Hahn, L. C., Blanchard-Wrigglesworth, E., Pauling, A. G., et al. (2024). Sea-surface temperature pattern effects have slowed global warming and biased warming-based constraints on climate sensitivity. *Proc. Natl. Acad. Sci.* 121:e2312093121. doi: 10.1073/pnas.2312093121
- Armstrong, A. K., Krasny, M. E., and Schuldt, J. P. (2018). “Using metaphor and analogy in climate change communication,” in *Communicating climate change: a guide for educators*. eds. A. K. Armstrong, M. E. Krasny, and J. P. Schuldt (Cornell University Press), 70–74.
- Armstrong McKay, D. I., Staal, A., Abrams, J. F., Winkelmann, R., Sakschewski, B., Loriani, S., et al. (2022). Exceeding 1.5°C global warming could trigger multiple climate tipping points. *Science* 377:eabn7950. doi: 10.1126/science.abn7950
- Badulovich, N., Grant, W. J., and Colvin, R. M. (2020). Framing climate change for effective communication: a systematic map. *Environ. Res. Lett.* 15:123002. doi: 10.1088/1748-9326/aba4c7
- Bernstein, S., and Hoffmann, M. (2019). Climate politics, metaphors and the fractal carbon trap. *Nat. Clim. Chang.* 9, 919–925. doi: 10.1038/s41558-019-0618-2
- Box, J. E., Hubbard, A., Bahr, D. B., Colgan, W. T., Fettweis, X., Mankoff, K. D., et al. (2022). Greenland ice sheet climate disequilibrium and committed sea-level rise. *Nat. Clim. Chang.* 12, 808–813. doi: 10.1038/s41558-022-01441-2
- Bryse, K., Oreskes, N., O’Reilly, J., and Oppenheimer, M. (2013). Climate change prediction: erring on the side of least drama? *Glob. Environ. Chang.* 23, 327–337. doi: 10.1016/j.gloenvcha.2012.10.008
- Burkeman, O. (2003). Memo exposes Bush’s new green strategy | environment. The Guardian. Available at: <https://www.theguardian.com/environment/2003/mar/04/usnews.climatechange>
- Chancel, L. (2021). Climate change and the global inequality of carbon emissions, 1990–2020. In World inequality lab | Paris School of Economics. Available at: <https://wid.world/news-article/climate-change-the-global-inequality-of-carbon-emissions/>
- Chen, X. (2012). The greenhouse metaphor and the greenhouse effect: a case study of a flawed analogous model. *Res. Topics Wind Energy* 2, 105–114. doi: 10.1007/978-3-642-29928-5\_5
- Dawkins, R. (1976). *The selfish gene*. Oxford Univ Press. New York.
- De Bolle, M. (2019). Policy brief 19-15: the Amazon is a carbon bomb: how can Brazil and the world work together to avoid setting it off? Peterson Institute for International Economics, 1–8. Available at: <https://www.piie.com/publications/policy-briefs/amazon-carbon-bomb-how-can-brazil-and-world-work-together-avoid-setting%0Awww.piie.com>
- Deignan, A., Semino, E., and Paul, S.-A. (2019). Metaphors of climate science in three genres: research articles, educational texts, and secondary school student talk. *Appl. Linguis.* 40, 379–403. doi: 10.1093/applin/amx035
- Dyke, J., Watson, R., and Knorr, W. (2021). Climate scientists: concept of net zero is a dangerous trap. *Conversation*.
- Flusberg, S. J., and Thibodeau, H. (2023). Why is mother earth on life support? *Metaphor Environ Discourse*. 15, 522–545. doi: 10.1111/tops.12651
- Forgács, B. (2022). “The pragmatic functions of metaphorical language,” in *A Life in cognition - studies in cognitive science in honor of csaba pléh*. eds. J. Gervain, G. Csibra, and Kovács (Cham: Springer), 41–57.
- Forgács, B., and Pléh, C. (2022). “The fluffy metaphors of climate science” in *Metaphors and analogies in sciences and humanities: Words and worlds*. eds. S. Wuppuluri and A. C. Grayling (Cham: Springer), 447–477.
- Frantz, C. M. (2022). To create serious movement on climate change, we must dispel the myth of indifference. *Nat. Commun.* 13:4780. doi: 10.1038/s41467-022-32413-x
- Gentner, D., Bowdle, B. F., Wolff, P., and Boronat, C. (2001). “Metaphor is like analogy” in *The analogical mind*. eds. D. Gentner, K. J. Holyoak and B. N. Kokinov (Cambridge, MA: The MIT Press), 199–253.
- Gigerenzer, G., and Murray, D. J. (1987). *Cognition as intuitive statistics*. US: Psychology Press.
- Grice, H. P. (1957). Meaning. *Philosophical Rev* 66:377. doi: 10.2307/2182440
- Grice, H. P. (1975). “Logic and conversation,” in *Speech Acts*. eds. P. Cole and J. L. Morgan (New York: Academic Press), 41–58.
- Hansen, J. E., Sato, M., Simons, L., Nazarenko, L. S., Sangha, I., Kharecha, P., et al. (2023). Global warming in the pipeline. *Oxford Open Climate Change* 3:kgad008. doi: 10.1093/oxfclm/kgad008
- IPCC, Allen, M., Babiker, M., Chen, Y., De Coninck, H., Connors, S., et al. (2018). “Summary for policymakers,” in *Global Warming of 1.5°C*. eds. V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, et al. (Cambridge University Press), 1–24.
- Lakoff, G., and Johnson, M. (1980). *Methaphors we live by*. Chicago: The University of Chicago Press.
- Lenton, T. M., Rockström, J., Gaffney, O., Rahmstorf, S., Richardson, K., Steffen, W., et al. (2019). Climate tipping points — too risky to bet against. *Nature* 575, 592–595. doi: 10.1038/d41586-019-03595-0
- Levine, K. J., Clark, N., Haygood, D. M., and Muenchen, R. A. (2011). Change: how young voters interpreted the messages sent during the 2008 presidential election season. *Am. Behav. Sci.* 55, 479–501. doi: 10.1177/0002764211398075
- Mann, M. E. (2021). *The new climate war: The fight to take Back our planet*. New York: PublicAffairs.
- Nerlich, B., and Hellsten, I. (2014). The greenhouse metaphor and the footprint metaphor. *TATuP - Zeitschrift Für Technikfolgenabschätzung in Theorie Und Praxis* 23, 27–33. doi: 10.14512/tatup.23.2.27
- Osgood, C. E. (1962). Studies on the generality of affective meaning systems. *Am. Psychol.* 17, 10–28. doi: 10.1037/h0045146
- Parry, I., Black, S., and Vernon, N. (2021). “Still not getting energy prices right: a global and country update of fossil fuel subsidies,” in *IMF Working Papers (Issue 236)*. Available at: <https://www.imf.org/en/Publications/WP/Issues/2021/09/23/Still-Not-Getting-Energy-Prices-Right-A-Global-and-Country-Update-of-Fossil-Fuel-Subsidies-466004>
- Roche, J. C., Peterson, G., Bodin, Ö., and Levin, S. (2018). Cascading regime shifts within and across scales. *Science* 362, 1379–1383. doi: 10.1126/science.aat7850
- Russell, C. (2011). “Temporal metaphor in abrupt climate change communication: an initial effort at clarification” in *The economic, social and political elements of climate change*. ed. W. Leal Filho (Berlin Heidelberg: Springer), 113–132.
- Schmidt, G. (2024). Climate models can’t explain 2023’s huge heat anomaly — we could be in uncharted territory. *Nature* 627:467.
- Scott-Phillips, T. C. (2015). Meaning in animal and human communication. *Anim. Cogn.* 18, 801–805. doi: 10.1007/s10071-015-0845-5
- Shannon, C. E., and Weaver, W. (1949). *The mathematical theory of communication*, vol. 97. Urbana: The University of Illinois Press.
- Shaw, C., and Nerlich, B. (2015). Metaphor as a mechanism of global climate change governance: a study of international policies, 1992–2012. *Ecol. Econ.* 109, 34–40. doi: 10.1016/j.ecolecon.2014.11.001
- Sperber, D. (2001). “An objection to the memetic approach to culture” in *Darwinizing culture: The status of Memetics as a science*. ed. R. Aunger (Oxford: Oxford University Press), 163–173.
- Sperber, D., and Wilson, D. (1986). *Relevance: communication and cognition*. Oxford: Blackwell.
- Steffen, W., Rockström, J., Richardson, K., Lenton, T. M., Folke, C., Liverman, D., et al. (2018). Trajectories of the earth system in the Anthropocene. *Proc. Natl. Acad. Sci. USA* 115, 8252–8259. doi: 10.1073/pnas.1810141115
- The World Bank Group (2021). *World Bank Group Climate Change Action Plan 2021–2025: Supporting Green, Resilient, and Inclusive Development*. The World Bank Group. Available at: <https://hdl.handle.net/10986/35799>
- United Nations. (2019). Only 11 years left to prevent irreversible damage from climate change, speakers warn during general assembly high-level meeting. United Nations General Assembly. Available at: <https://www.un.org/press/en/2019/ga12131.doc.htm>
- Volmert, A. (2014). *Getting to the heart of the matter: using metaphorical and causal explanation to increase public understanding of climate and ocean change*. Available at: [https://www.frameworksinstitute.org/wp-content/uploads/2020/03/occ\\_metaphor\\_report.pdf](https://www.frameworksinstitute.org/wp-content/uploads/2020/03/occ_metaphor_report.pdf)
- Wilson, D., and Sperber, D. (2004). “Relevance theory” in *Handbook of pragmatics*. eds. L. Horn and G. Ward (Oxford: Blackwell), 163–176.
- Wuppuluri, S., and Grayling, A. C. (2021). *Metaphors and analogies in sciences and humanities: Words and worlds*. Cham: Springer — Synthese Library.