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FROM OBSERVATION TO UNDERSTANDING: EMBEDDING ARTISTIC PRACTICE FOR MORE EFFECTIVE CLIMATE RESEARCH

ABSTRACT

The article explores the potential held by artistic practice – especially visual arts and photography – as an embedded element of climate change research. Drawing on historical and contemporary examples, it argues that art should not merely serve as a vehicle for science communication, but as an epistemic partner in the production of climate knowledge. The paper critiques current collaboration models such as artist residencies and calls for the deeper, earlier integration of artists into research design, knowledge framing, and public engagement. Through case studies, pilot projects, and evaluation frameworks, it proposes the development of interdisciplinary networks and co-creative methodologies that support the cultural and emotional dimensions of climate understanding towards inspiring more meaningful public action.

KEY WORDS: climate change, art and science, interdisciplinary collaboration, visual communication, artistic practice

Od opazovanja k razumevanju: vključevanje umetniške prakse za učinkovitejše raziskovanje podnebnih sprememb

IZVLEČEK

Prispevek raziskuje potencial umetniške prakse, zlasti vizualnih umetnosti in fotografije, kot sestavnega dela podnebnih raziskav. Zgodovinski in sodobni primeri interdisciplinarnih sodelovanj razkrivajo, da umetnost ne bi smela biti le orodje za posredovanje znanosti, temveč bi morala biti tudi epistemološki partner v raziskovalnem procesu. Članek izpostavlja omejitve obstoječih modelov

sodelovanja, kot so umetniške rezidence, in zagovarja zgodnjo vključenost umetnikov v oblikovanje raziskav, komunikacijske strategije in oblikovanje pomena. Na osnovi primerov dobrih praks, pilotnih projektov in evalvacijskih metod, prispevek predlaga oblikovanje mreže in novih modelov sodelovanja med umetniki in znanstveniki s ciljem povečati javno razumevanje in odziv na podnebno krizo.

KLJUČNE BESEDE: podnebne spremembe, umetnost in znanost, interdisciplinarno sodelovanje, vizualna komunikacija, umetniška praksa

1 Introduction

Public awareness and risk perception are closely linked to how well people understand the human causes of climate change and potential solutions (Lee et al. 2015). Yet much of climate science remains difficult to access, often communicated through specialist language and complex modelling frameworks that limit broader understanding and, most critically, meaningful engagement (Jasanoff 2010; Edwards 2010). Communication is, of course, only one part of a larger picture. Persistent inaction also stems from entrenched political-economic interests – such as fossil fuel lobbying, growth-driven economic systems, and regulatory inertia – that actively obstruct (Klein 2014; Brulle 2014) or obfuscate (Oreskes and Conway 2010) meaningful action. While this paper does not claim that scientific communication is the root cause of climate inaction, it argues that creative, visual communication plays a crucial, and often overlooked, role in shaping how knowledge circulates, how publics are mobilised, and how interdisciplinary collaboration can unfold more richly.

Interdisciplinary collaborations between climate scientists and artists offer an under-developed but powerful way to expand participation and reframe abstract, technical concepts in ways that resonate across cultural and cognitive boundaries (Lakoff 2010; Nurmis 2016). While art has historically been used to illustrate or popularise science, embedding artistic practice from the outset of research allows it to act as an epistemic partner – challenging assumptions, generating new questions and enriching the interpretive and emotional dimensions of climate knowledge. Both art and science share a deep history of making the unseen visible, interpreting complexity, and extending collective understanding. In the context of climate change – where data can be obscure, contested, or culturally distant – visual creativity can translate specialised knowledge into accessible, affective forms that sustain engagement and foster inclusive dialogue among researchers, policymakers, and publics.

Addressing the integration gap requires more than producing new visuals: it calls for a fundamental rethinking of climate communication as a co-creative

process embedded within research design. This paper traces the historical and contemporary contexts of art–science collaborations, examines the symbolic complexities of representing climate science visually, and proposes practical strategies – network-building, pilot projects and rigorous evaluation methods – for overcoming barriers. Drawing on my experience as both a visual artist and interdisciplinary researcher, I aim to show how creative collaboration can function not merely as an adjunct to science communication but as a foundational practice for building public understanding, emotional engagement, and collective action towards climate change mitigation and adaptation.

2 A (very) brief history of art–science collaboration

Any hesitancy around collaboration between scientists and artists may stem from the perception that art–science partnerships are a relatively recent phenomenon. From a British perspective, many such collaborations emerged in the 1990s, shaped by the "public understanding of science" paradigm – the idea that art can help communicate scientific knowledge along with its social, cultural and ethical dimensions. This has included efforts to popularise science and convey its more visual aspects, often aiming to broaden public engagement with scientific ideas and principles. Yet, the entanglement of art and science reaches much further back. Early cave paintings, for example, reflect detailed empirical observations of animal behaviour, movement and anatomy. Philosophers like Plato and Pythagoras saw harmony across mathematics, music and art, rooted in proportions and geometric form. Renaissance figures like Leonardo da Vinci and Albrecht Dürer combined artistic skill with scientific investigation, while the Scientific Revolution relied increasingly on illustration as a method of inquiry. During the Enlightenment, artists worked alongside scientists to document botany, zoology and anatomy discoveries. In this light, art and science are not simply compatible but are historically and conceptually intertwined.

However, these collaborations were gradually strained by the increasing specialisation of academic and industrial disciplines. The rise of scientific positivism during the Industrial Revolution further prioritised quantifiable knowledge, especially where it aligned with economic and technological advancement, reinforcing disciplinary divides throughout the 19th Century. Yet artistic movements such as Naturalism persisted in depicting reality through observation and method, sustaining the shared foundations, at least intellectually, that have long connected art and science: observation, experimentation, creativity, and representation.

Nevertheless, today there is still a sharp divide between what we consider artistic and scientific knowledge. C.P. Snow's (1959) influential Rede Lecture

warned that the division between the sciences and the humanities posed a serious threat to the future of knowledge production and argued that the cultures of the arts and sciences had become mutually unintelligible, with little understanding or appreciation for one another's methods, languages, or values. He believed this divide was holding back innovation, policy development, and the capacity to address global challenges like poverty, energy and education, especially in a time that required interdisciplinary solutions to increasingly multifaceted problems. The debate sparked decades of academic discussion about interdisciplinarity, the nature of knowledge, and the structure of education and research.

Numerous developments since have helped re-establish the relevance of art–science collaborations. The rise of novel and hybrid technologies has also been pivotal. Utilising emerging technological tools (such as the computer) as artistic apparatus was directly influenced by György Kepes, who founded the Centre for Advanced Visual Studies (CAVS) at MIT in 1967. CAVS was influential in its mandate to absorb "new technology as an artistic medium" through encounters between scientists, artists, engineers and industry (Massachusetts Institute of Technology 2025). A new collaborative language emerged within new shared instruments of artists and scientists. The emergence of doctoral programmes within visual arts subject areas has also led to more cross-disciplinary opportunities among researchers. There has also been a vast increase in cross and inter-disciplinary funding opportunities that encourage collaboration and cross-disciplinary thinking, and a steadily growing desire to re-"legitimise" practice research amongst artists.

Alongside these structural and technological developments, artists have increasingly assumed new cultural responsibilities, moving beyond the gallery to engage directly with public spaces, communities, and pressing social and environmental challenges. This shift has expanded the scope of artistic practice, aligning it more closely with questions of knowledge production, while also increasing interest in the impact of practice-based research. As Friedrich von Borries (2015) notes, an important shift began in the second half of the 20th century when artists started reflecting critically on the "scientification" of the world – referring to the expanding influence of scientific rationality, metrics, and systems thinking across many domains of life. In response, many artists adopted scientific methods not only as creative tools but also as objects of inquiry and reflection. These developments saw artists moving beyond gallery conventions into ecological, public, and socially engaged projects, culminating in high-profile moments like Documenta 13 in 2012, which placed artistic research at the centre of an internationally significant exhibition. Such reflexive engagement has both complemented and interrogated scientific perspectives within Western knowledge systems, helping to lay the conceptual groundwork for contemporary art–science collaborations.

3 Why interdisciplinarity for climate communication?

Building on the intertwined history outlined above are numerous contemporary art–science initiatives oriented toward enhancing the cultural visibility of science and increasing its ethical and societal resonance, like the British Science Festival, the Wellcome Collection's exhibition programme, and the Science Museum's Dana Research Centre events. While such initiatives are valuable, many artists remain wary of being positioned primarily as communicators of scientific content. This over-instrumentalisation risks narrowing artistic practice to a supportive function, rather than recognising its capacity to challenge, reframe, and co-produce scientific meaning. Capacities that are central to more embedded and reciprocal forms of collaboration. While art has a long history of instrumentalisation, this is not its most useful purpose. There is much more potential to merge the symbolic knowledge contained within both disciplines – particularly in this moment of layered, complex, and "wicked" societal problems – into a hybrid language that can communicate with logic, empathy, and a united authority.[1] Thus, this paper advocates for deeper, more reciprocal forms of collaboration, where artistic practice is embedded within scientific inquiry not to illustrate it, but to question, enrich, and reimagine its frameworks for the benefit of both disciplines.

The more than 88,000 papers published on climate change reflect the immense scope and interdisciplinary complexity of the field (Lynas et al. 2021). Yet for all this output, climate change remains a difficult phenomenon to represent because its drivers are often invisible, its timescales are vast, and its impacts are often distributed unevenly. Unsurprisingly, studies have shown that people relate more easily to environmental problems that are easier to visualise, such as air pollution (Nisbet 2009). This makes the visual dimensions of climate change – how we see, picture, and imagine it – pressing concerns in both climate communication research and the environmental humanities. However, a persistent assumption continues to shape these discussions: that the epistemological gulf between the sciences and the visual arts is too vast for meaningful collaboration. In practice, these domains are already deeply entangled. Scientific practice has long relied

1. The term *wicked problem* was first introduced by Rittel and Webber (1973) to describe complex social issues that are difficult or impossible to solve definitively due to incomplete or contradictory knowledge, changing requirements, and entangled political, cultural, and economic dimensions. Climate change is widely recognised as a quintessential wicked problem because its causes, consequences, and responses are distributed unevenly across space, time, and social groups – demanding cross-disciplinary, adaptive, and context-specific approaches.

on visual tools not only to document evidence but also to define what counts as evidence in the first place. Moreover, core scientific values such as objectivity and observation are themselves rooted in visual conventions that have been critically explored by artists, historians, and theorists alike.

As both an instrument of scientific observation and a medium of artistic interrogation, photography offers a uniquely fertile space for dialogue between the arts and sciences. Its dual and continually evolving role – as both a tool of empirical documentation and a vehicle for subjective interpretation – has profoundly shaped our collective understanding of the planet, influencing not only the practice but also the perception of science (O'Reilly 2018). Photography extends the scope of observation beyond individual experience, enabling forms of shared witnessing that have transformed scientific and public discourse alike. As Daston and Galison (2007) note in *Objectivity*, before photography became central to scientific experimentation, researchers often relied on "imperfect" human senses – for instance, Arthur Worthington's mental image of liquid droplets – to document phenomena. The arrival of photography allowed scientists to claim greater objectivity, anchoring knowledge in seemingly mechanical images. Yet artists, historians, and theorists quickly recognised that the camera was no neutral instrument: its images always abstract, frame, and strip away context. Bruno Latour (1993) further argued that the very divide between "nature" and "culture", a foundational assumption of modern science, was itself a fiction of modernity.[2] In the context of climate science, this history underscores a critical point: presenting knowledge as culturally neutral can obscure the very social, political, and emotional dimensions needed for inclusive and resonant communication.

While the practice of photography was increasingly adapted to serve the aims of the scientific method, its integration introduced new epistemic challenges, chief among them the separation of image from reality. As Mitchell (2005) argues, this tension generates a critical space in which both artists and scientists must ask what images say about the world, and how they shape our understanding of it. This paradox is especially evident in widely circulated NASA satellite images of Arctic ice loss or the iconic *Blue Marble*. Though presented as transparent records of environmental truth, such images are technologically mediated and aesthetically curated, sustaining the illusion of detached observation while

2. While the nature-culture divide is not a *practical* requirement for everyday scientific experimentation, it is a foundational epistemological assumption underpinning how modern knowledge systems, institutions, and societies have historically separated scientific (natural) and social (cultural) knowledge.

evoking powerful emotional responses.[3] Recognising these dynamics opens new opportunities for meaningful art–science collaboration. Photography, in particular, provides a potent site of interdisciplinarity – where visual art can not only enhance scientific communication but also help reframe the questions science asks, embedding humanities-based reflection into empirical knowledge production.

As theorists, artists, and researchers increasingly interrogate the dominance of scientific rationality, it becomes essential to examine how scientific knowledge is framed and received by different publics. Scientific communication is never neutral; the language, imagery, and metaphors used profoundly influence interpretation (Haraway 1988). In climate change, where data is often contested and predictive models fail to resonate with lay audiences, framing becomes even more critical. Susan Sontag (1977) observed that repeated exposure to shocking images erodes their emotional impact – a phenomenon first identified in images of war, but also evident in climate imagery. George Lakoff's (2010) theory of cognitive framing similarly shows that people interpret information through pre-existing "frames" that filter acceptance or resistance. When the dominant frame within communication is apocalypse or catastrophe, shocking imagery may initially provoke urgency but can quickly lead to fatigue and disengagement. To sustain engagement, communicators must shift the frame rather than intensify the imagery – focusing, for example, on scientific process, local collaboration, and solution-building to establish participatory and hopeful narratives. Frame-shifting, or the strategic recontextualisation of an issue to activate new interpretive pathways, has proven effective even in polarised contexts. For example, in bipartisan political debates, it enables meaningful dialogue between parties that hold fundamentally different worldviews by reframing issues in ways that resonate with alternative values or identities (Doornbosch et al. 2025). In the context of climate communication, interdisciplinary collaborations between scientists and artists offer a powerful way to embed such frame-shifting mechanisms. Artists can introduce metaphors, sensory modes, and narrative strategies that activate different cognitive schemas, reaching audiences that may not engage with conventional scientific discourse.

While visualisation remains central to scientific practice, the growing complexity of contemporary research methods presents a challenge that interdisciplinarity can help solve: many scientific instruments no longer produce

3. With current AI image generation technologies like Google Gemini now producing images resembling photographs – generated via text-based prompts – both the danger and utility of photographs will increase.

images or data that are easily legible to non-specialists. As Bruno Latour observed in *Laboratory Life* (1986), the production of scientific knowledge increasingly relies on "inscription devices" – tools that transform material phenomena into symbolic representations, such as graphs, models, or code. These devices are often opaque, their inner workings obscured through processes of "black-boxing", where meaning becomes inaccessible to those outside specialised domains (Morin et al. 2012). This opacity can contribute to an epistemic culture of uncertainty, where climate data can be misunderstood, mistrusted, or dismissed due to its abstract and highly specialised form.

The difficulty is not abstraction itself, as both art and science function abstractly, but *how* that abstraction is communicated. Scientific abstraction, whether in the form of non-pictorial data (like statistical models or code) or complex visualisations (like technical graphs), often relies on specialised symbols that may feel cognitively or culturally distant from lived experience. By contrast, artistic abstraction often operates through metaphor, sensory affect and narrative, offering forms of symbolic engagement that are emotionally and intuitively accessible to the global majority. For example, while certain paleoclimate terms like "karst systems" or "U-Th dating" hold little meaning for the general public, creative representations can re-symbolise these invisible and cryptic scientific processes, translating climate knowledge into affective, embodied experience. Here, artistic practices offer complementary strengths – particularly in empathising, perspective-taking, and narrative persuasion. Rather than simplifying complex information, art can re-symbolise it – translating abstraction into sensorial and affective experience and helping map complexity through intuition, aesthetics, and embodiment (Demos 2016: 31–62).

Beyond reframing abstraction, participatory approaches such as citizen science offer a way to integrate the interpretive strengths of artistic practice with the empirical rigour of climate research (DITOs Consortium 2019). Citizen science projects invite publics to become active contributors to data collection and interpretation, making abstract scientific processes tangible through hands-on engagement. When artistic methods are embedded within these initiatives, participants are not only gathering information but also shaping the ways it is represented, discussed, and acted upon. This participatory ethos complements the collaborative values found in other long-standing knowledge traditions, helping to expand the communicative reach of climate science while fostering a sense of shared ownership in the research process.

Finally, in broadening the landscape of collaboration, it is essential to recognise the long-standing knowledge systems that predate contemporary scientific methods. Indigenous knowledge systems – rooted in deep, place-based

understandings of ecosystems, cyclical time, and relational ethics – offer vital perspectives on sustainability, resilience and climate adaptation. As scholars such as Whyte (2017) and Johnson et al. (2016) argue, these forms of knowledge are not simply supplemental to scientific ones but challenge the assumptions and priorities of Western science. Including Indigenous methodologies within interdisciplinary climate research aligns with decolonising aims and helps reframe dominant narratives by embedding values of reciprocity, care, and responsibility to notions of discovery. This broader epistemic landscape not only diversifies the cognitive tools available to researchers but also opens pathways to more just, context-sensitive environmental action.

These representational gaps underscore the value of interdisciplinarity – not just to improve communication, but to foster deeper public understanding and participation. Artists and scientists both work within symbolic systems; bridging them expands the ways knowledge can be visualised, shared and acted upon. Recognising this convergence prepares the ground for embedding artistic practice not simply as illustration, but as an epistemic partner in the research process.

4 The case for embedding art into climate research

Building on these communicative strengths, the next challenge is *embedding* artistic practice from the outset of climate research, and moving beyond add-on models like traditional artist residencies. The "two cultures" debate highlights the persistent structural and epistemic divide between art and science, which can complicate the development of genuinely shared methodologies – even where both aim to better understand and respond to the world. Contemporary barriers to collaboration range from institutional constraints (Hicks et al. 2010) to the difficulty of translating complex scientific data into narratives or visual forms that resonate across disciplines. This highlights a need for shared vocabularies and becomes even more urgent as the boundaries of scientific inquiry are themselves being redrawn. As Bruno Latour argues, climate change has turned the laboratory "inside out," transforming it into a "worldwide lab" where knowledge production unfolds not in isolation but within the broader cultural and political atmosphere (Latour 2004). In this expanded laboratory, climate change presents a complex, contested problem with no singular solution, and where public engagement is deeply entangled with cultural values. Rather than reinforcing the divide between the objective scientist and the expressive artist, this paper adopts Latour's (1993) view that such categories are modern constructions. Scientific knowledge, like artistic practice, is embedded in cultural, visual, and emotional imaginaries – recognising this opens the door to more

symmetrical and imaginative collaborations. Both art and science can visualise the unseen, foster emotional engagement, and mobilise collective action, though they often do so through distinct methods and traditions. While scientific practice demands rigour and objectivity, this does not preclude abstraction, creativity, or emotional resonance. Our dominant institutional and communicative norms must not obscure imaginative and relational dimensions – dimensions that artistic practice can help illuminate.

Returning briefly to the history of art–science collaborations helps clarify the opportunities now available for imagining and enacting new forms of alliance. Historically, many benefits of such collaborations have emerged from the artist-in-residence (AiR) model, which still dominates the contemporary art–science landscape. AiRs became more common as scientific experiments expanded in scale, often supported by substantial public funding. This, in turn, created an imperative to disseminate and justify scientific work to non-specialist audiences. In many large-scale science projects, a portion of public funding is allocated to artistic dissemination to support communication and community engagement. Notable examples include CERN's residency programme, which brings artists into direct contact with scientists in the laboratory, and IRB Barcelona's initiative, which fosters post-anthropocentric microbiology literacy and encourages collaborations exploring microcellular landscapes. These AiRs have undoubtedly brought new audiences and understanding to particle physics and microbiology. However, they are often tied to physical spaces, highly specialised equipment, or simply massive budgets. AiR programmes are still too often conceived as by-products of scientific inquiry, positioned primarily in a communicative role rather than as platforms for philosophically or methodologically investigative engagement.[4] This model also presents specific challenges for the climate sciences, which rely primarily on data collection dispersed across natural sites worldwide and on integrating information from multiple sources and methods. Such data is stored and shared via data centres – such as the ECMWF Data Centre (Tecnopolo di Bologna), which houses major European climate data – rather than requiring on-site access to a centralised facility. This decentralised and distributed nature

4. The budget for artistic and philosophical explorations into such things as the meaning, ramifications or rationale for new and possibly disruptive discoveries (e.g. the Higg's Boson, dark matter, or quantum quarks) are minute when compared to a project's initial scientific funding, and always occur after the science project has already been initiated. As an example, in 1997 the Large Hadron Collider project cost 4.71 billion dollars to initiate and has an annual budget of 1.7 billion USD as of 2022. It offers residencies worth 18,000 USD, which represents approximately 0.00001% of its annual operating budget, or metaphorically, a single grain of sand on an entire beach.

makes climate science an ideal testing ground for co-imagining genuinely new strategies for embedded collaboration, unconstrained by the traditional residency model.

As hinted at in the last section, the social and cultural dimensions of climate change are another vital reason why involving artistic collaboration benefits the scientific study of climate. In *Why We Disagree about Climate Change*, Hulme (2009) argues that climates have both a physical reality and cultural meaning that should be considered inseparable. This argument points to the potential benefits of collaboration amongst scientists and artists in creating the transdisciplinary space and required language to address a holistic "idea of climate" – one that is not solely science or art. This does not, however, imply watered-down science or art-as-a-service, but space and language in which both sides can acknowledge that climates are more complex than any single discipline can alone represent with any finality. If climate science seeks to inform and influence decision-making in culturally diverse and politically complex contexts, then partnerships with other disciplines – including the arts – can offer crucial complementary perspectives and methods.

Since the early 2000s, the *Cape Farewell* project has brought forth interdisciplinary thinking and new visual strategies that can better communicate the urgency of climate change than traditional models. One of its most well-documented initiatives is *Pollution Pods* (2016) by artist Michael Pinsky. This immersive installation, exhibited over 30 times internationally and visited by over 30,000 people, recreates the atmospheric conditions of five urban environments using climatically controlled chambers. Visitors "[s]tep inside a series of climatically controlled pods and compare five contrasting global environments, where the air quality, ozone, nitrogen dioxide, sulphur dioxide and carbon monoxide levels... [are] recreated" (Cape Farewell 2025). *Pollution Pods* was commissioned and used as a research tool by the team behind the Climart research project (Norwegian University of Science and Technology), where psychology, natural science and art converged to study how climate related art is received by audiences. The team found that participants' intentions to act on climate issues increased (ranging from slight to strong) after engaging with *Pollution Pods* (Sommer et al. 2019). Combined with other findings that attempt to parse what kind of art leads to bigger audience impacts, their study affirms that art can function as a powerful tool in environmental communication.

Pinsky, Michael (2019): Pollution Pods [Photograph]. Exhibited at COP25, Madrid.

While results such as these are promising, more research is needed to assess whether short-term motivation leads to long-term behavioural change, and how the positive interdisciplinary activity of *Pollution Pods* can be recreated more often. Drawing on a long tradition of activist art and photography, repeated and diverse encounters with such work – rather than one-off experiences – are more likely to leave lasting impressions. Exhibitions like *Pollution Pods* offer direct, affective encounters with climate issues, helping to make abstract phenomena tangible and personally relevant. Roosen et al. (2017) argue that precisely such emotional resonance can foster more profound understanding and individual action. Similarly, Spence et al. (2011) demonstrate that perceiving climate-related art can reduce feelings of uncertainty around climate change and enhance viewers' belief in their own ability to make a difference: two essential factors in motivating behavioural engagement. Their findings reinforce the value of emotional and perceptual engagement in strengthening public agency, especially among those who may feel overwhelmed or disconnected from scientific messaging. In short, *Pollution Pods* exemplifies how art can provide meaningful climate experiences, particularly for those who have not yet been directly affected.

The overarching Climart project not only studied the effects of climate-related art but also exemplified how co-designed interdisciplinary initiatives can foster meaningful and lasting collaborations between artists and scientists. Notably, the project demonstrated that when artistic practice is integrated from the outset of imagining communicative impact, rather than added at the margins, it can produce both measurable impact and sustained relationships. Encouragingly, a growing number of initiatives and communities are now embracing similar models. For instance, TBA21-Academy seeks to foster "new forms of knowledge emerging from the exchanges between art, science, policy and conservation" (TBA21-Academy 2025), supporting ocean-focused projects that cross disciplinary and geopolitical boundaries. Meanwhile, Résidences 1+2 has established a programme of residencies that explicitly pair photography with scientific research, operating on the principle that "both question the world by making the invisible visible... giving us a different way of seeing" (1+2 Photographie and Sciences 2025).

Critically, however, collaboration can only be successful if it is beneficial for both scientists and artists (Moser 2016). A recent example demonstrating the positive effects of interdisciplinary collaboration in both disciplines is "6&6", which paired six artists and six scientists as they explored conservation issues in the Sonoran Desert in California. It resulted in many positive outcomes, with scientists becoming more inclined to integrate an artistic approach from the start of a scientific project, and to enhance critical thinking about communicating both the process and the results of the science more creatively (Clark et al. 2020). The project also revealed how interdisciplinary dialogue could expand scientists' perspectives, prompting them to view "scientific problems in a broader... more creative context" (Clark et al. 2020). Similarly, Kagan (2015) observes that artists working in transdisciplinary collaborations with scientists often acquire new methodological skills, ecological literacy, and systematic approaches to critical self-reflection – developments that can enhance their confidence and ability to understand and communicate complex issues effectively. As Kagan (2015) further argues, such collaboration supports the development of "an aesthetics of complexity," a critical framework for addressing what climate change increasingly represents: a *wicked problem* – a challenge that is highly complex, socially contested, and resistant to definitive solutions. Wicked problems require adaptive, pluralistic approaches, and collaboration across disciplines is essential to generate the layered, culturally responsive strategies they demand.

Considering the positive experiences that interdisciplinary collaboration can foster, embedding artists within scientific research contexts represents a natural step toward continually reimagining the role and value of diverse knowledge systems within present culture. Such partnerships can also encourage productive forms

of reflection within research teams, including greater openness to questioning methodological assumptions and the broader social implications of emerging technologies. Given that the climate crisis is, in part, entangled with technological and industrial developments shaped by scientific knowledge, it is both reasonable and necessary to explore new intersections between the sciences, humanities, and creative practices. These collaborations offer a powerful opportunity not only to communicate more effectively, but to collectively imagine alternative futures grounded in critical, innovative, and inclusive approaches to knowledge production.

5 Understanding barriers and establishing networks

As a practising visual artist who has visited over 40 laboratories and field research stations, I can attest to the challenges of navigating highly technical environments – from particle accelerators to complex climate models. In hindsight, I would have benefitted enormously from a network of likeminded individuals who had already negotiated these boundaries, offering guidance, shared vocabularies, and potential collaborators. In the absence of such support, many of these collaborations were hard-won, often requiring extended periods of introductions, exchanges of motivations, and attempts to predict possible outcomes before any shared work could begin. As demonstrated by the above histories and emerging collaborative models, enthusiasm for interdisciplinary work often grows significantly once artists and scientists collaborate. In my own experience as both a researcher and visual artist, such engagements frequently sparked mutual curiosity and revealed unexpected common ground. However, these opportunities often arose serendipitously rather than through structured pathways, and normalising interdisciplinarity may be key to significantly advancing the scope and impact of climate communication.

Many researchers – particularly in the early stages of project development or careers – are likely unsure how to initiate interdisciplinary collaboration or how to align such work with disciplinary norms and institutional expectations. This paper, therefore, aims to contribute toward establishing more straightforward guidelines and best practices that can support systematic, reciprocal engagement between climate scientists and visual artists. While there is a growing body of research on art–science collaboration, much of it remains piecemeal or case-specific, with limited attention to embedding artistic practice throughout the whole research cycle. This lack of established frameworks can lead to hesitation and sometimes unintentionally create barriers to collaboration, particularly when many existing funding structures still do not readily accommodate cross-disciplinary approaches.

Overcoming the barriers to interdisciplinary collaboration requires more than enthusiasm – it demands structural and cultural change beginning at the earliest stages of research. A growing body of literature suggests that fostering awareness of different disciplinary values, methods, and communication norms enables researchers to better engage diverse publics and expand the reach of their work (Barry et al. 2008). Building on this, embedding artistic collaborators from the design and grant-writing phases has been shown to enhance methodological creativity, broaden engagement, and access new communities and institutions (Braund and Reiss 2019). To normalise such approaches, interdisciplinary partnerships must be supported from inception – not only by institutional frameworks and funding mechanisms, but also through the cultivation of new researcher cultures that are reflexive, inclusive, and comfortable working across disciplinary divides.

A realistic first step toward improving interdisciplinary collaboration is to envision what might be considered an ideal model – one grounded in the lessons of past and present projects – and then work backward to identify the necessary pathways that can support it (see Fig. 1). Successful collaborations tend to be planned as interdisciplinary from the outset, often beginning at the grant-writing stage. They also engage relevant cultural partners with a stake in the research, involve diverse communities that bring a range of perspectives, and contribute to the training of practitioners who are more comfortable navigating interdisciplinary terrains. Crucially, these collaborations must cultivate a shared vocabulary, foster two-way, non-hierarchical communication, and establish clear points of interaction where mutual learning and evaluation can take place.

Figure 1: Key Considerations for Art–science Project Collaboration.

Early-Stage Integration	Artists and scientists co-develop research aims and methods from the proposal phase.
	Creative thinking embedded in project framing, not just communication.
Mutual Stakeholder Engagement	Cultural institutions, NGOs, and local communities involved as active collaborators.
	Shared investment in outcomes and dissemination pathways.
Diverse Knowledge Systems	Inclusion of epistemologies beyond Western science (e.g., Indigenous, experiential, or affective knowledge).
	Recognition of both empirical data and cultural meaning as valid forms of insight.
Two-Way, Non-Hierarchical Communication	Dialogic structures that encourage equal voice and agency.
	Mechanisms to resolve disciplinary tensions through mutual learning.
Shared Vocabulary and Reflexive Practice	Time and space for building common language and expectations.
	Ongoing reflection on roles, assumptions, and power dynamics.
Training and Capacity Building	Support for early-career researchers to develop interdisciplinary fluency.
	Opportunities for artists and scientists to learn each other's methods and cultures.
Flexible and Multi-Modal Evaluation	Use of both qualitative and quantitative measures.
	Emphasis on process, audience engagement, and long-term impact—not just outputs.

A particularly valuable area of future research – still underdeveloped in the current literature – is a deeper exploration of the barriers that climate scientists face when engaging with arts-based researchers, and vice-versa. We need a more detailed account of the institutional, epistemic, and cultural dynamics that shape such collaborations, including the assumptions, priorities, and systemic constraints that may limit engagement on both sides. One promising approach would involve conducting extensive interviews with Earth scientists and artists – both those who have collaborated across disciplines and those who have not. Individual circumstances would help identify the specific barriers that arise when artists and scientists seek to apply for (often discipline-specific) funding or communicate their work through interdisciplinary means. Such research could inform the development of shared vocabularies, baseline collaborative frameworks, and practical guidance for establishing productive working relationships prior to funded opportunities. Encouragingly, there are recent initiatives to build upon – such as the Swiss Artists-in-Labs programme and Australia's CLIMARTE network – which demonstrate how long-term institutional partnerships can support artists not merely as communicators, but as contributors to knowledge production. Disseminating these insights across disciplinary boundaries, including at traditional scientific conferences, could help demystify collaboration and challenge lingering assumptions, while encouraging broader uptake. Addressing this knowledge gap is a critical step toward building more sustainable, integrated research cultures.

Despite clear complementarities between artistic and scientific motivations, there remains a critical gap in the mechanisms that bring these communities together. Climate science presents a fertile basis for alignment, yet its decentralised nature often means that collaborative opportunities arise sporadically, if at all. A dedicated network focused on *picturing climate* – broadly conceived – could provide the connective tissue needed to align shared goals and diverse expertise. What remains missing is the infrastructure to convert overlapping interests into structured, lasting partnerships.

A well-designed digital platform that goes beyond typical academic dissemination websites could help bridge this gap, facilitating dialogue, co-creation, and knowledge exchange. Supporting both international exchange and local collaboration, it could help researchers and artists in shared regions or field sites find one another. Features such as interactive mapping of expertise, curatorial highlights of exemplary projects, and algorithmic matchmaking based on interests, location, or complementary skills would make points of contact visible and actionable. UX and UI design would play a central role in mediating between scientific and artistic cultures, while multilingual and accessible design would

widen participation. Community moderation, thematic collections, and open discussion spaces could sustain an inclusive and respectful dialogue. Crucially, showcasing a range of pilot projects would demonstrate the tangible benefits of interdisciplinary collaboration and inspire further engagement.

For maximum impact, the network must extend beyond artists and scientists to include climate communicators, curators, historians, NGOs, local communities and policymakers. Hybrid international conferences could address pressing, real-world climate communication challenges, with global discussions cascading into regionally driven gatherings. These localised forums would surface underrepresented perspectives and embed research in community contexts. As funding bodies and higher education institutions increasingly prioritise demonstrable impact – via mechanisms such as the UK's Research Excellence Framework – this model could deliver outcomes meeting both scientific and cultural criteria. In this reciprocal exchange, climate research could inform site-specific artistic interventions tailored to community concerns, while artists gain access to the tools, methodologies, and tacit knowledge of climate science, enriching each discipline's capacity to act meaningfully in public and research contexts. Showcasing these collaborations through targeted pilot projects and detailed case studies would not only make the benefits of such a network tangible but also provide a practical foundation for scaling interdisciplinary climate communication in the years ahead.

6 Pilot projects, case studies and evaluating success

"Moments of convergence," as Buller (2009) describes, emerge when collaboration is treated as an active, situated process of assembling knowledge and practice. As Barrett and Bolt (2007) argue, practice-led research generates knowledge that is embodied, intuitive, and context-specific – qualities essential for addressing complex, real-world challenges and positively influencing diverse communities. To foster more such moments, well-documented pilot projects and case studies are needed, offering tangible models to guide others. This requires clear buy-in to the idea that co-creation can lead to more effective climate communication, demonstrably engage communities, and produce positive impacts that can be evidenced. Crucially, creative climate communication must be funded in parallel with climate research for it to be successful, aligning with the "impact" and evaluation agendas of major funders such as REF or Horizon Europe.

There are multiple pathways for advancing art–science collaborations within the emerging, hybrid field of climate communication, and the most compelling next steps will be those that align creative ambition with clear routes to

interdisciplinary funding. While any definitive list will necessarily remain open, the greatest opportunities often emerge where the priorities of scientists, artists, and external stakeholders intersect. Targeted initiatives could include: (i) mentorship pilot projects linking artists and scientists from underrepresented communities in the Global South, where climate impacts are often most acute; (ii) hybrid AiR programmes embedded within temporary field research sites near UNESCO sites or cultural institutions; (iii) Indigenous knowledge projects integrating alternative knowledge economies into contemporary climate understanding; (iv) climate justice initiatives drawing on Indigenous cartographic traditions, postcolonial ecological aesthetics, or Global South storytelling; and (v) citizen science collaborations where data collection and interpretation are co-produced with publics, using artistic methods in protocols and feedback systems. For scientists seeking funding for new climate research, embedding even a single high-quality creative dissemination case study – linked to a growing network of like-minded researchers – could help establish a durable culture of interdisciplinarity in a domain where it is urgently required.

Case studies act as blueprints for best practice, while acknowledging both the individuality and the challenges of each collaboration. Ideally, scientists, artists, curators, and community organisations work from place-based or conceptual concerns that carry shared meaning for all involved. Diversity in team composition, methods, and context is essential, and when combined with thoughtful design, case studies can capture tensions as they emerge while pointing toward evolving best practices. Artists and scientists will not always share the same goals, and differences in priorities, timelines, and epistemologies are common. Ignoring these differences risks undermining the work. Even with strong personal rapport, contrasting modes of practice can create tensions over research focus, narrative framing, and intended audiences. Anticipating such differences allows collaborators to prepare more effectively, document common pitfalls, and provide valuable guidance for others, which is equally as important as recording successes.

Projects such as *The Colour of the Climate Crisis* by Kisilu Musya in Kenya, or Sámi artists' visual responses to Arctic science, or environmental sensing initiatives like *Making Sense* (Ars Electronica) are not themselves roadmaps for case studies, yet they exemplify how artistic interventions can foreground perspectives historically marginalised in Western scientific discourse. As Gabrys and Yusoff (2012) note, such work can generate new "scales of visibility" and "alternative conceptual paradigms" that expand the cultural and interpretive reach of climate research. Systematically documenting and disseminating such examples within a collective archive would not only guide future projects and

strengthen future funding applications as a resource to reference, but also provide embedded evaluation evidence, helping to normalise art–science collaboration as a process that is method-generative as well as communicative.

Importantly, pilot projects also underscore the practical and economic value that artists bring to interdisciplinary teams. Unlike many research specialists, artists often require minimal infrastructure, working without expensive laboratories or technical equipment, yet contribute meaningfully through their expertise in visual and cultural communication. When embedded from the outset, artists can act as key facilitators of public engagement, cultivating new audiences for both their own work and the broader research initiative. To maximise this impact, pilot projects should set clear expectations for cultural dissemination within research planning, including budget allocations that reflect the essential communicative role of the arts in climate science. By formalising such norms, we not only enhance the effectiveness of interdisciplinary research but also take a critical step toward mainstreaming collaborative models that are both impactful and sustainable.[5]

Demonstrating the practical and cultural value of these collaborative models, however, depends on thoughtful evaluation, which brings its own set of conceptual and methodological challenges. Although some may argue that assigning educational or evaluative functions to art risks instrumentalising it, this paper recognises such functions as complementary rather than reductive. However, one of the greatest challenges in evaluating the effectiveness and impact of collaboration between artists and scientists is collecting and digesting metrics associated with artistic outputs. In terms of audiences, this mirrors the culturally reflective question of what makes "good" art – a question inspiring decades, if not centuries, of debate. Yet, in the focused arena of climate communication, some earlier examples have already offered a few solutions to understand audience reception of climate-related art. For example, if and how audiences engage with climate-related artistic outputs can be investigated via partner relationships, such as including surveys and exit interviews at museums or using participatory observation and feedback forms during community-based installations or public events. Digital exhibitions can be measured via metrics and analytics embedded within websites, alongside interactive components, to better understand whether or not they enhance viewers' understanding of concepts. Drawing from frameworks in environmental psychology (e.g., Klöckner 2015)

5. As a final personal example, I have stretched the smallest of budgets to produce photo-stories, artists book works and experimental films; thus, firmly believe that even modest sums and costs of participation can be well worth the "return on investment" for research teams in terms of impact.

or cultural impact assessment (Roosen et al. 2017), these metrics can inform scalable strategies for future interdisciplinary work.

One of the advantages of focusing on the *educational* components of climate change research (i.e., how and why climates are studied vs. climate change in general) is that the focus is on building climate-related knowledge, vocabularies, and engagement rather than falling into a binary of good vs. bad (or true vs. untrue). Since it has been shown that *understanding* how climates function is an excellent predictor of climate awareness and one's ability to parse the politics of climate change (Lee et al. 2015), the production and evaluation of such knowledge gathering becomes somewhat easier. By that, I mean it is not necessary to determine whether an artwork has shifted a viewer's stance on climate change (e.g., from climate denier to climate activist), but rather what understanding of how climates function and are studied has been gained from viewing it. Success could then be judged more simply by analysing the knowledge or insights acquired, avoiding the more subjective question of "what is good art?". Again, the reasonable concern amongst artists is that art may be reduced to a didactic function standing only in service to science; however, this argument is flimsy, considering all artworks aim to deliver new knowledge and inspire intellectual debate. In the case of climate-related art, this new knowledge should sometimes focus not only on increasing a viewer's understanding of the process, implications and predictions of climate research but also on translating the quiet urgency, deep care, and existential curiosity that lie in the heart of why scientists seek to understand the climate. Making art both educational and artistically relevant *is,* I argue, the great challenge of any visual artist working today.

Another essential consideration is evaluating the effectiveness of collaborations, such as: how effective it is to include an artist in science teams (or vice versa)? What value do collaboration and interdisciplinarity bring to answering complex questions? Is communication of climate issues enhanced, and does climate research find new audiences? As mentioned above, these complex questions are well suited to a case study approach. A photographic artist paired with a scientist studying caves and an established museum will likely provide vastly different outputs and engage different audiences than, perhaps, a multimedia artist paired with an Arctic climate systems researcher collaborating with a grassroots/experimental gallery.

A deceptively simple but essential question to ask at the outset of any case study design may simply be: *What is the core purpose of this research?* This question can help shape mixed-method evaluation approaches that include qualitative interviews, reflective writing, exhibition analytics, and social impact assessments. Crucially, embedding artists from the beginning allows these

evaluation criteria to evolve alongside the research itself. In doing so, evaluation becomes not an afterthought but an integral part of the collaboration, and one that values meaning-making as much as measurement. Importantly, flexibility here refers to adaptive, context-specific application of a rigorously designed mixed-method framework – one that uses systematic protocols to ensure data remains comparable across projects and transferable to future collaborations (again highlighting the need for stronger networks). While evaluating the impact of interdisciplinary collaborations can be challenging – particularly given the range of artistic methods and audiences – this complexity should be seen as a strength rather than a limitation. Just as scientific specialisations are highly individual, so too are artistic practices and the communities they engage.Project partners, too, bring distinct mandates, priorities, and cultural contexts. This diversity reflects the expansive reach and opportunity of creative approaches in addressing climate change's cultural, emotional, and cognitive dimensions – but only if creativity within climate science is embraced in scale.

Rather than applying rigid, standardised metrics, flexible, co-designed evaluation frameworks that honour both scientific inquiry and artistic engagement should be adopted. Several models from related disciplines also offer promising templates for evaluating art–science collaborations. For example, Theory of Change (developed initially for social impact work) helps teams map how artistic interventions might lead to long-term social, emotional, or behavioural outcomes. It is particularly effective at identifying the smaller, often-overlooked steps that contribute to broader change (Weiss 1995). Participatory Action Research (PAR), widely used in education and community development, supports collaborative goal-setting and co-designed evaluation methods, making it especially valuable in community-engaged art projects. Outcome Mapping, meanwhile, is well-suited for interdisciplinary work due to its non-linear approach to change. It acknowledges that progress may be indirect and emergent, rather than following a strict cause-and-effect trajectory. Collectively, these frameworks move beyond narrow, quantitative metrics and allow researchers to track more diffuse but meaningful outcomes, such as shifts in understanding, empathy, or civic engagement.

Additionally, assessing the effectiveness of artistic interventions requires long-term engagement, as attitudinal or behavioural change often emerges gradually rather than immediately. This underscores the need for longitudinal studies and follow-up evaluation to fully understand the impacts of art–science collaborations, something that project partners are well-suited for, contrasting strict funder timelines and budgets. Finally, clear, flexible evaluation strategies not only serve researchers and artists but also provide stakeholders (e.g., funders,

institutions, and policymakers) with evidence of impact. In the context of rising demands for demonstrable public engagement and research "impact" (as defined by REF or Horizon Europe), effective evaluation is not optional – it is central to embedding artistic practice credibly within scientific research cultures.

7 Conclusion

Shifting cultural norms in climate science and its communication requires creativity, community engagement, and a shift toward more dynamic, narrative-based methods – precisely where visual arts and artists can excel. Challenging traditional divisions between art and science can reinvigorate public interest, creating space for more diverse, meaningful engagements with the climate crisis. The interconnected and abstract nature of climate change resists reductive messaging; instead, communicating its urgency demands plural narratives that invite reflection, empathy, and dialogue. Trading simplicity for breadth allows for new insights to emerge – insights that are best realised when the arts are fully embedded within climate research, not as afterthoughts but as co-creators of knowledge.

To normalise this approach, networks and pioneering pilot projects must pave the way. These initiatives not only build collaborative capacity but also address practical barriers such as disciplinary dissonance, unequal access, and a lack of shared vocabulary. Embedded artists can help develop evaluative frameworks that evolve with the research itself, contributing to new modes of understanding that go beyond data delivery. Comprehensive case studies – grounded in real-world collaborations – can serve as proof of concept, helping to secure funding, engage policymakers, and guide future partnerships. A digital, publicly accessible network could further support this work by offering matchmaking tools, showcasing best practices, and housing adaptable toolkits for interdisciplinary integration.

Ultimately, embedding artistic practice in climate science is not a luxury but a necessity. Interdisciplinary collaboration fosters more than aesthetic engagement – it reshapes how knowledge is produced, how impact is defined, and how publics are brought into dialogue. Climate science, with its dispersed and complex realities, demands new, embedded forms of engagement that reflect the emotional, social, and cultural dimensions of the crisis. The most powerful collaborations will redefine research culture itself: where artists, scientists, and communities co-produce new forms of knowledge. The task ahead is not simply to picture climate, but to reimagine how we know, feel, and act upon it – together.

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