

WIND AS MODEL, MEDIA, AND EXPERIENCE

Reading Wind Diffractively: Elemental Chiasmus as Theory and Method

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Wind itself, many have noted, is invisible. In both the archive and the field, we encountered the difficulty of getting wind into view ourselves, foregrounded by the many strategies developed to capture wind with the help of various proxies, instruments, and representations. Facing this difficulty, we here draw together work from elemental media theory and feminist new materialism to develop a novel theoretical and methodological approach to wind we call “elemental chiasmus.” We begin by acknowledging wind’s ephemeral nature. Instead of delineating wind as a definite object, we argue that wind is momentarily stabilised and rendered legible when it metaphorically “diffracts” through other elemental media. Across three sections, we trace different practices of elemental mediation which provide wind with a specific shape: In “Aeolian sensing,” we highlight past and present practices of atmospheric sensing which give wind horizontal and vertical shape by diffracting through particulate matter, sound, and electromagnetic waves. In “Aeolian geology,” we undertake an elemental reading of John Muir’s field notes to highlight his application of elemental chiasmus in making sense of both long-term geologic change and short-term changes in wind and weather. In “Aeolian art,” we finally turn to the artistic work of Leonardo Da Vinci and Vincent Van Gogh to demonstrate how their related strategies of linear disegno and pastose capture wind by diffracting it through water and oil. Viewed together, wind “comes to matter” or accrues meaning through an iterative and open “diffractive reading” across elements; a method we call elemental chiasmus.

1. Introduction

Studying different practices of measuring, taxonomizing, and representing wind—both in the archive and in the meteorological field—foregrounded, for us, how difficult it is to get wind into view, requiring different technological instruments as well as media of sensing and representation (on sensing, see

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Gabrys 2019; Schneider and Zemanek 2020; Hepach and Lüder 2023). In this piece, we aim to show how ephemeral wind is rendered momentarily stable and observable through different practices of elemental mediation.

The nature of media and mediation is a question of ongoing contestation within media theory, with some arguing that “There Are No Media” (Horn 2007) whereas others, considering recent work expanding the scope of media theory to the elemental, ask the question: “What is not a medium?” (Peters 2022). In emphasizing the performativity of mediation over and against a static notion of media, we follow “anti-ontological” (Horn 2007, 8) work in (German) media theory. Instead of theorizing media as “a given, observable object,” we too will instead “engage with processes, transformations, and events” (Horn 2007, 8; on “cultural techniques,” see Siegert and Peters 2012).

More recently, Starosielski (2019, 3; emphasis by authors) has extended this analytical approach to media’s elements, which she recasts as “processual, dynamic, and *intra-active*.” Instead of viewing the elements as fixed in “a stable ontological space in which difference is either flattened or hard-coded,” Starosielski (2019, 4) argues that inquiring “into the elements of media” might instead “open up new sites for tracking where difference materializes.”

With media theory’s renewed attention to the elemental in view, Peters (2022, 2) has argued that although not everything *is* a medium, it *could be*. Further emphasizing the processuality of mediation, Peters writes: “Being a medium is not a permanent *state*. It is the *condition* of being in the middle” (Peters 2022, 2; emphasis by authors). Turning to examples of elemental mediation, Peters (2022, 2) highlights that to “most people, lakebeds, arctic ice, and cave formations are just mud, ice, and rock; but to those with eyes to see, they are valuable records, climate proxies, full of data about earth history” (Peters 2022, 2). Importantly, this does not mean that meaning is projected into the elements. Instead, those with eyes to see “are decrypting inscriptions that are very much full of significance, only not recorded in language or by human hand” (Peters 2022, 2). Attending to elemental mediation then “invites a specific way of thinking about reading, about the materialization of intelligence in middle things” (Peters 2022, 2–3; on nature as articulate, communicative, and intentional, see Kirby 2008, 228).

Unlike mud, ice, and rock, wind cannot be the object of an elemental reading in the same way as the examples above. Wind presents no surface for human or nonhuman inscription. Wind is instead rendered stable and legible where it intersects with other elemental media (sometimes facilitated by technology) that help afford and sustain its meaning (on wind as “stratospheric infrastructure,” see McCormack 2017).

In the examples to follow, we present different practices of rendering wind legible or sensible as an object. In doing so, we argue that no single practice of mediation can capture the wind in and of itself as some objective reality

independent of observation. In each case, wind will bear the mark of the particular relation or elemental mediation through which it emerges as or congeals into something observable. Each example, to borrow Starosielski's (2019, 4) language, tracks where "difference materializes" as wind.

To unpack where and how wind materializes, we borrow theoretical language from Barad's "agential realism," in which meaning and matter, observation and the observed cannot be disentangled either and are, instead, co-constitutive through "agencies of observation" (Barad 1996, 172). In advocating for a relational ontology—an ontology appropriate for understanding relational phenomena such as wind—Barad too negates the possibility of describing any objective reality apart from experience/measurement/agencies of observation—for example, "things-in-themselves or things-behind-phenomena" (Barad 1996, 176). Instead, Barad (1996, 176) centers "things-in-phenomena" or simply "phenomena" in which all aspects involved in agencies of observation are entangled (on phenomena, see Barad 2007, chap. 3; on entanglement, media, and phenomenology, see Hansen 2017; Hepach 2021). One such phenomenon par excellence is, we argue, wind.

Complementing anti-ontological and elemental work in media theory, we then do not reflect on representations of a presumed objective element or object called wind, but instead account for "how practices matter" (Barad 2007, 90) by restaging different moments in which wind specifically "*comes to matter*" (Barad 2007, 152; emphasis in original), in which wind accrues meaning through different elemental media, such as sound, light, ice, water, rock, or oil (for an "operational ontology" in media theory building in part on Barad, see Parikka 2023).

This accrual of meaning develops as "difference materializes" (Starosielski 2019, 4) or "pattern[s] of difference" (Barad 2007, 71) emerge with each elemental medium through which wind passes, giving wind an element- and medium-specific shape. In each example, wind is not *reflected* but, borrowing the metaphor from both Haraway (1992) and Barad, *diffracted*—that is, thrown into specific relief by a medium. To name one everyday example observable when looking out the window: the branches and leaves give specific shape to wind's direction, intensity, and undulating movement in passing through a tree's canopy. Wind is, metaphorically, diffracted through the tree and cannot, in virtue of the relationality inherent to wind and things-in-phenomena more generally, be disentangled from the leaves and branches that facilitate wind's shape. Wind-in-tree is a "pattern of difference" or "difference materialized" in that, as a phenomenon, it can be reduced to wind or tree patterns, but emerges through the entanglement of both.

Supplementing Peters's discussion of elemental reading, we will now develop a diffractive methodology of reading wind across three sections. Whereas the first section on "aeolian sensing" delves into past and present practices

of wind sensing, the remaining two sections shift from the digital to the analog. “Aeolian geology” subjects the field notes of John Muir (1838–1914) to a close elemental reading, revealing his remarkable ability to read across media ecologies. “Aeolian art” shifts attention from text to image and turns to artistic practices, focusing on recent art historical analyses of the drawings of Leonardo Da Vinci (1452–1519) as well as a newly, diffractively discovered elemental dimension to the *Wheat Fields* series of Vincent van Gogh (1853–1890).

This eclectic choice of examples across different media and historical periods is deliberate, as it allows us to attend not only to patterns of difference within one phenomenon or example but also between and across them. Foregrounding the practices and agencies of observation at play in generating unique patterns of difference establishes “reading wind diffractively” as an iterative and open exercise across different media. This elemental and diffractive attention to wind means reading different relational wind phenomena “through one another in attending to and responding to the details and specificities of relations of difference and how they matter” (Barad 2007, 71; on diffractive reading, see Geerts and Van der Tuin 2021).

To emphasize how wind is suspended between the different practices through which it comes to matter, we introduce the following, titular concept into media theory debate around “the elemental”: *elemental chiasmus*. Instead of focusing in on the specificity of a single element, elemental chiasmus seeks to keep the specificity of multiple elements and their logics of mediation in view at the same time. This is of particular importance when the object of media-theoretical analysis—in our case, wind—is itself not a medium but instead mediated or rendered legible by diffracting through different elements. By drawing the chiasmatic—from the ancient Greek *chiasmós* (χιασμός), or to mark with or, recognizing the letter χ, to cross over (Pape 1914, 1355)—into media theory, we draw *out* how *differences* across elemental media come to make wind matter. χ marks the spot of wind in the in-between of these elemental mediations.

In emphasizing the multiple elemental agencies at play through this chiasmatic strategy, we build on recent work in “post-human materialisms” (van der Tuin 2019, 818) and “new material feminism” (Jagger 2015, 321) in that we too “give the materiality of matter a more active role” (Jagger 2015, 322) and emphasize the “agency of matter” as well as the “interimplication of the material and the symbolic” (Jagger 2015, 321; for a feminist meteorology based, in part, on Barad’s work, see Neimanis and Walker 2014). Elemental chiasmus, our examples will show, is a materialist “diffractive mode of analysis” (Barad 2007, 73).

2. Aeolian Sensing

As many have pointed out, the study of wind is haunted (and inspired) by its apparent invisibility and intangibility. Like air or water, wind is not an *object* of experience. Instead of pointing at the wind, one invariably points *into* or *through* it; we do not touch it; we touch *in* it (Ingold 2007, S29). However, wind is not so much an elemental *volume* that one can put in a jar like air or water but an elemental *force*. To enter a wind does not require one to pierce a surface. Instead, wind is the elemental volume of air brought into motion, as the sun heats the earth's surface unevenly, leading to temperature and pressure differentials. Wind is, in a manner of speaking, kinetic luminescence.

Whereas Ingold (2007, 29–30) has written extensively on how wind is not touched but felt, presenting no surface and instead immersing the subject in the “fluxes of the medium,” Howe (2019) has argued from a more-than-human perspective that wind

is seen only in those places where it *touches* or moves something else. [...] Ultimately wind is only ever made visible through its impact and influence on other matter, other materials, and other things. Wind's ontology refuses to take separateness as an inherent feature of the world. Its relationality exists as an inverse allegory to the teleology of extraction that operates in one direction, to one end and for a singular purpose. And this is, in part, wind's value—it has an existential precondition that *appears only in the context of contact*. Wind is touching, mutual, moving. (Howe 2019, 11; emphasis by authors)

The relational ontology inherent to wind—its emergence through intra-actions of sun and earth, land and water, high and low pressure, what it moves and touches—extends to what moves with(in) the wind, too. Wind is not only a force that bears down on objects, such as trees or a wind turbine's blade, but is itself saturated: saturated with temperature, humidity, dust, and/or other particulate matter as well as living material such as bacteria, viruses, pollen, insects, and other microorganisms. This saturation allowed for the study of global wind currents unavailable to immediate perception as early as the nineteenth century. The dust collected on sailboats far from land in the 1830s by Christian Gottfried Ehrenberg (see [figure 1](#)) made legible the long journeys and aerial currents on which the particles had been transported (Vismann 2013, 32).

Wind and its currents are conventionally represented and mapped with arrows running parallel or moving lines pointing or following a distinct direction on a two-dimensional plane, such as in the television weather report. However, wind is, in fact, not a uniform blowing movement; it is three-dimensional and consists of different turbulences and shifting winds and gusts, which vary in relation to the height above the ground.



Figure 1: “Fog-dust” from the “sea of darkness,” collected on January 16, 1833, off the coast of Cape Verde (Ehrenberg 1849).

Since 1905 the weather observatory in Lindenberg, Germany, has sought to measure “vertical profiles of atmospheric variables (e.g., temperature, humidity and wind)” in the so-called “Lindenberg column” (Deutscher Wetterdienst [DWD], n.d.; for a detailed history, see Neisser and Steinhagen 2005). Measurements began in the early twentieth century with “so-called meteorographs attached to kites or captive balloons” and are now undertaken through a combination of in situ sensor systems attached to masts, free-flying balloons, and “active and passive ground-based remote sensing techniques” (Deutscher Wetterdienst [DWD], n.d.). The latter, sophisticated remote sensing techniques can themselves not “see” the wind either. Light (lidar), sound (sodar), and radar sensing are dependent on the saturation of wind, inferring wind speed and direction through the movement of particles, differences in temperature structure, or turbulent eddies, respectively (for a visualization of wind speed and direction measured by a wind profiler, see [figure 2](#)). Each mode of sensing is accompanied by its own modes of interference and obstruction. Insects, birds, and dense clouds can confuse, whereas smoke and other air pollution at high altitudes enable readings.

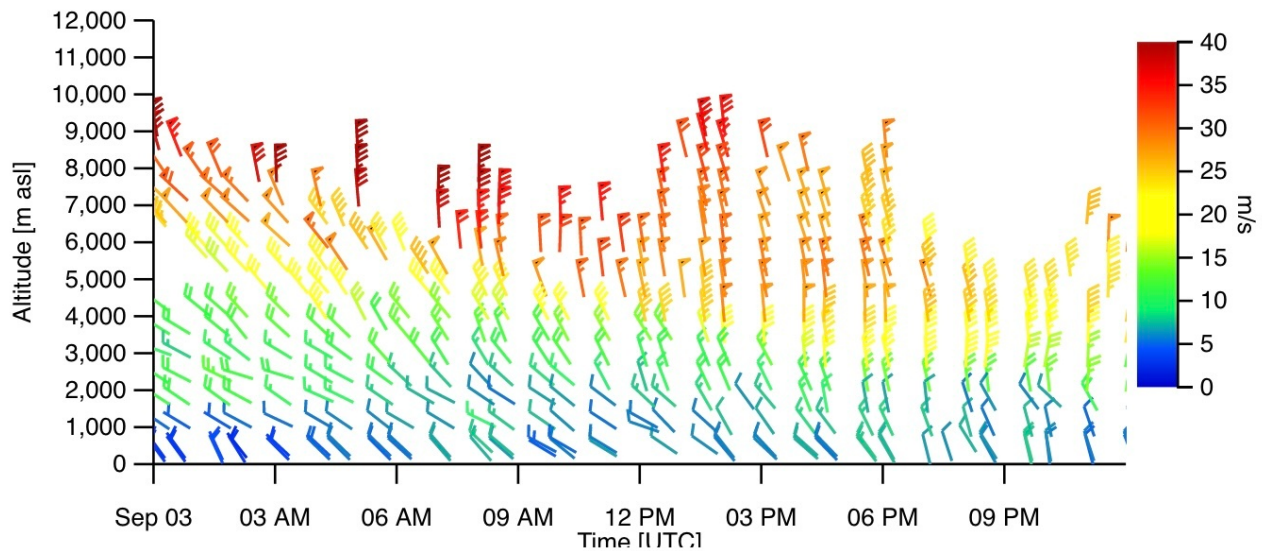


Figure 2: Wind profiler (radar) reading from Lindenberg, Germany, September 3, 2023.¹

Lidar's and light's ability to pierce the atmosphere has also allowed measurements of particles drifting in the air to take place from outer space. NASA's and CNES's CALIPSO satellite monitored aerosols and clouds via lidar until July 2023. Passing over the surface of the earth in shifting orbits, as Ehrenberg had done two centuries earlier over the ocean, CALIPSO measured aerosols in the vertical structure of the atmosphere, offering insight, for instance, into tropospheric and stratospheric wildfire smoke in much higher altitudes than those Ehrenberg could access (see [figure 3](#)).

Recent, renewed attention to wildfire smoke in 2023 due to plumes drifting from remote regions of Canada to densely populated cities such as New York and across the Atlantic Ocean brings wind's horizontal dimension back into focus (see [figure 4](#)). Demonstrating the basic principle behind remote wind sensing, radio stations in New York were being replaced by stations from Philadelphia playing at the same frequency as the radio signals physically diffracted from the dense smoke above (News 12 Staff 2023). As New York experienced the worst air quality in the world on June 7, 2023, users across North America turned to air quality and smoke plume monitoring apps and web pages, such as the EPA's AirNow Fire and Smoke Map, to estimate their own exposure to the toxic air, paying close attention to the changing winds (Jiménez 2023).

This brief and selective overview of past and present practices of sensing and visualizing wind introduces the various agencies of observation at work throughout history that give wind shape across different spatial and temporal resolutions, involving different elemental (and technological) media in the

¹ See https://e-profile.eu/wp_profile?measurement_date_str=2023-09-03&instrument_mode=0&instrument_type=WP&q_size=80&q_show=true&zoom_level=7.

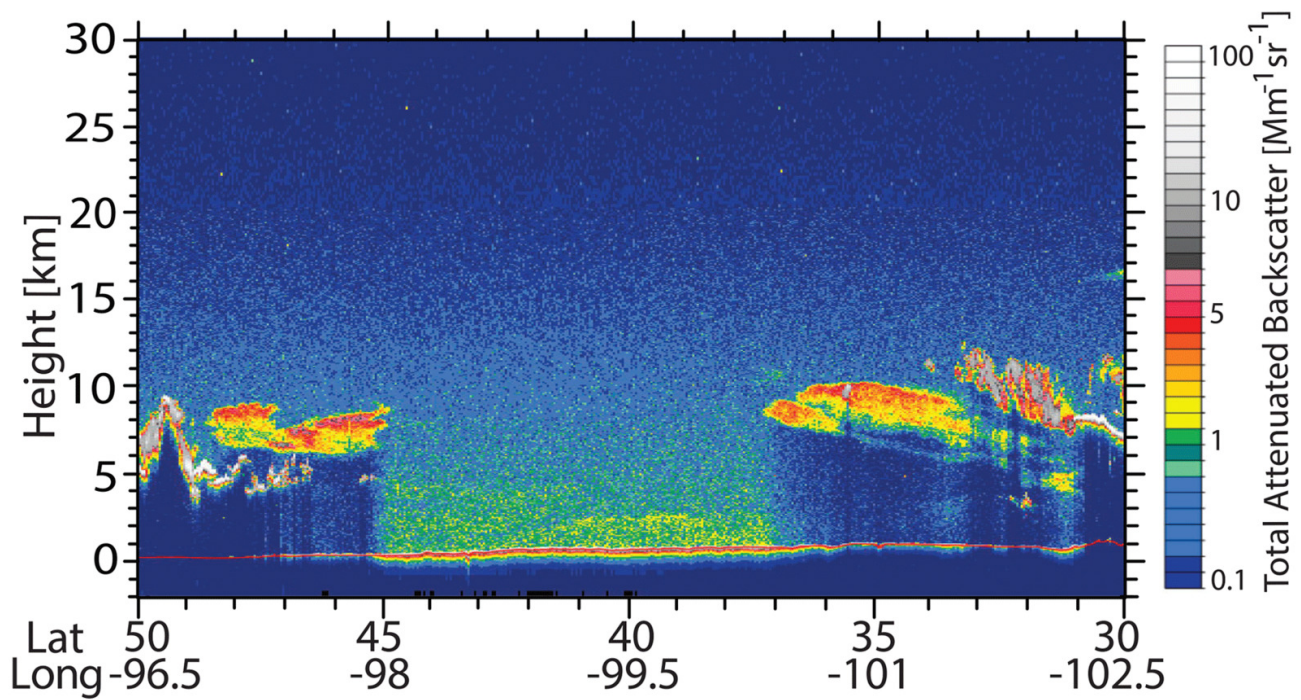


Figure 3: CALIPSO lidar observations of tropospheric smoke over North and South Dakota and over Texas on 13 September 2020, around 9:15 UTC. The smoke layers (in yellow to red) originated from British Columbia (North and South Dakota plume, travel time of 24 h) and from California (Texas plume, 2–5 d of travel time) (Ansmann et al. 2021, 9799).

process. Wind's directions, speeds, and trails through horizontal and vertical space emerge through patterns of difference that result from multiple diffractions. In Ehrenberg's slides, wind as a pattern of global circulation emerges through patterns of difference between the organic and inorganic matter suspended in moving air, captured in filters, stabilized on slides, viewed through a microscope, and finally sketched out on paper to be read. In more recent scientific work, wind is caught as patterns of difference emerge through electromagnetic waves intra-acting with suspended particles too. These patterns are again recorded and visualized in different representational media, as plots of wind barbs across time and altitude or as a spectrogram of the atmosphere.

Both past and present-day wind sensing are then sites of elemental chiasmus in practice. Wind is read and meaning accrued—that is, made “capable of formulation” (Benjamin 1972, 7)—by diffracting through different elemental media, each facilitating a different perspective on wind across its horizontal and vertical dimensions, respectively, foregrounding differences in saturation, temperature, or turbulence. Even CALIPSO's satellite/remote sensing, looking down at the earth from its orbit, does not allow a view from nowhere, from a presumed Archimedean point. Instead, wind comes into view through complex shifts and overlays in elemental as well as technological and representational media.

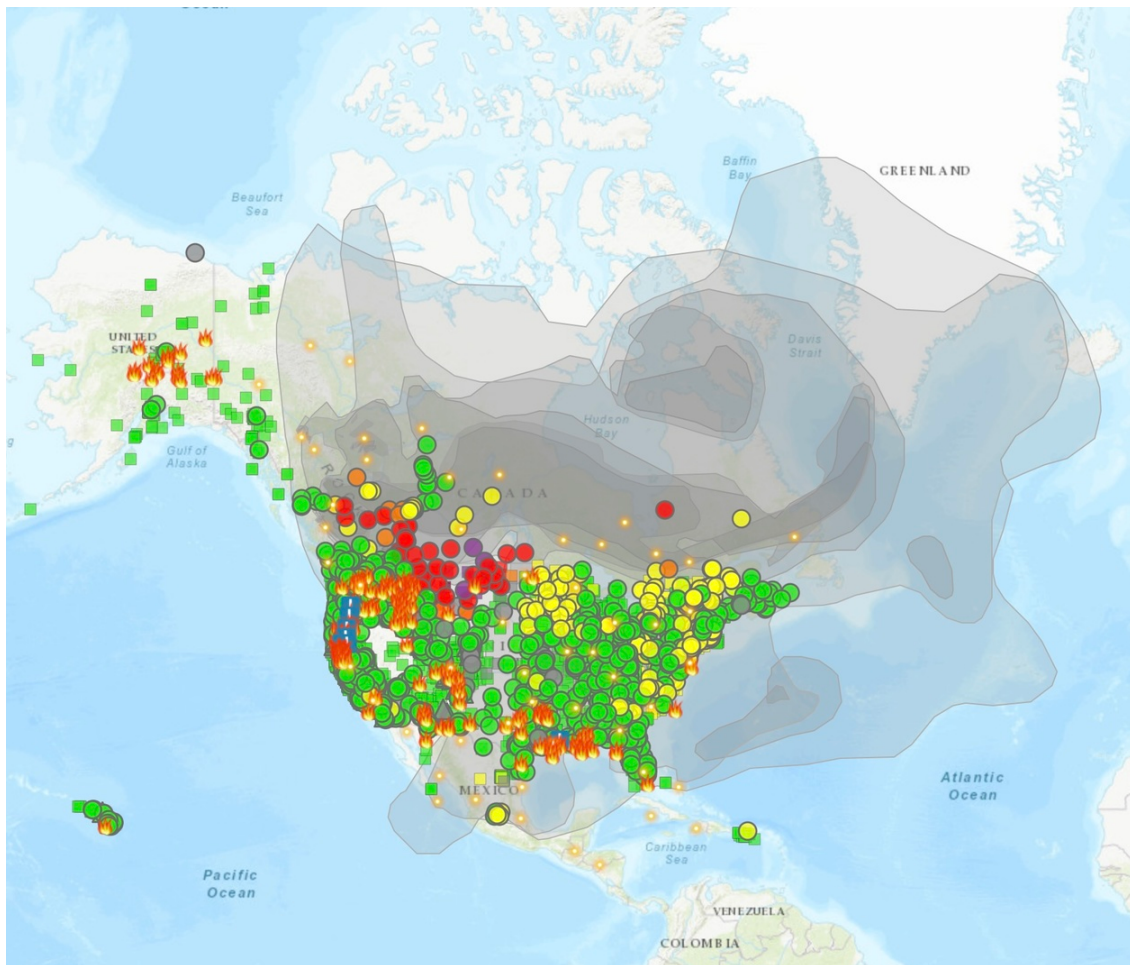


Figure 4: Screenshot of the AirNow Fire and Smoke Map from September 5, 2023, showing fires, air quality readings, and smoke plumes.²

3. Aeolian Geology

At first sight, wind and rock—the aeolian and the geological—might appear at opposite ends of an imagined spectrum of the elemental. One is ephemeral and intangible, the other solid and stationary. They seem to inhabit different spatialities (above and below) and temporalities (fast and slow). However, with larger timescales, wind comes into view as a force inscribing patterns of difference into geological media, each affording a distinct temporality: diffraction in extreme slow motion. Wind-eroded rocks, so-called *ventifacts*, record dominant winds tens of thousands of years into the past (Ives 1964, 225). Within the rock, deposited volcanic ash and fossilized pollen indicate wind vectors when their point of origin is known (Ives 1964, 226). The evenness of their deposition, in turn, points to the strength and continuity of the winds. The “sediment accumulations of eolian dunes are formed by wind” where the “deposited grain sizes and sedimentary geometries are directly linked to wind conditions during transport,” facilitating insights into

² See <https://fire.airnow.gov>.

“decadal to millennial changes of wind direction and storminess” (Lindhorst and Betzler 2016, 1). In now arid areas of the earth, lakes existed during “the glacial phases of the Pleistocene” (Ives 1964, 226), the currents of which were caused by wind, leaving traces in the sediment. The perhaps oldest record can be found in fossilized dunes, which archive wind as far back as the Jurassic Period (Ives 1964, 228). As Lindhorst and Betzler (2016, 1) explain, “[c]ontinuous instrumental-based weather observations go back less than two centuries; the geological record, however, contains an archive of past wind activity that is basically unread.”

This brief overview of the study and shape of wind on geologic timescales is one literal example of aeolian geology. This section introduces John Muir as an aeolian geologist in another sense: crossing over the elements of wind, ice, and rock to make sense of geologic change as well as aerial currents. Muir is perhaps best known to a wider public due to his historic role in declaring Yosemite a national park, paving the way for the establishment of the National Park System in the United States (for a critical account of this history, see Spence 1999; Cronon 1996).

However, his work is also emblematic of the evolution of nature writing at the turn of the century, where Muir departs from Transcendentalists such as Ralph Waldo Emerson and Henry David Thoreau and paves the way for “the genre of naturalist autobiography” (Elder 1981, 375) to follow, including the work of Aldo Leopold and Annie Dillard. What differentiated Muir from Transcendentalism was, in principle, his emphasis on the power of immediate experience over literary reflection (Elder 1981, 377), of scientific explanation over “suggestions of transcendence” (Elder 1981, 380). His writing, Elder (1981, 379) notes, was “[u]nburdened with too many abstractions” and instead approached “nature with attentiveness and humility.” Our interest lies in *this* Muir and his unique elemental and diffractive phenomenology of wind, stone, air, and ice, which he successively developed over the course of seventy-eight largely unpublished field note journals written between 1867 and 1913.³ Across these journals, Muir makes sense of his extensive exposure to the elements, attuning himself to the temporalities of his environment and carefully developing his own language to make sense of or translate the elemental. In doing so, he followed his own optical desire to “feel like a flake of glass through which light passes” (Badè 1924a, 6).

The material journals themselves are palimpsests: handwritten text with passages crossed out, overwritten, oversketched, overprinted with impressed plants, torn, and soiled by the elements (see [figure 5](#)). But they also embody

³ The journals are publicly accessible online on the University of the Pacific library’s website (<https://scholarlycommons.pacific.edu/jmj/>). In sum, the journal scans are comprised of 3,421 records (covers and spreads), 679 of which include a mention of “breeze,” “storm,” or “wind.” Transcriptions of most journals are provided by the John Muir Transcription Project (<https://www.pacific.edu/university-libraries/find/holt-atheerton-special-collections/john-muir-papers/transcriptions/>).

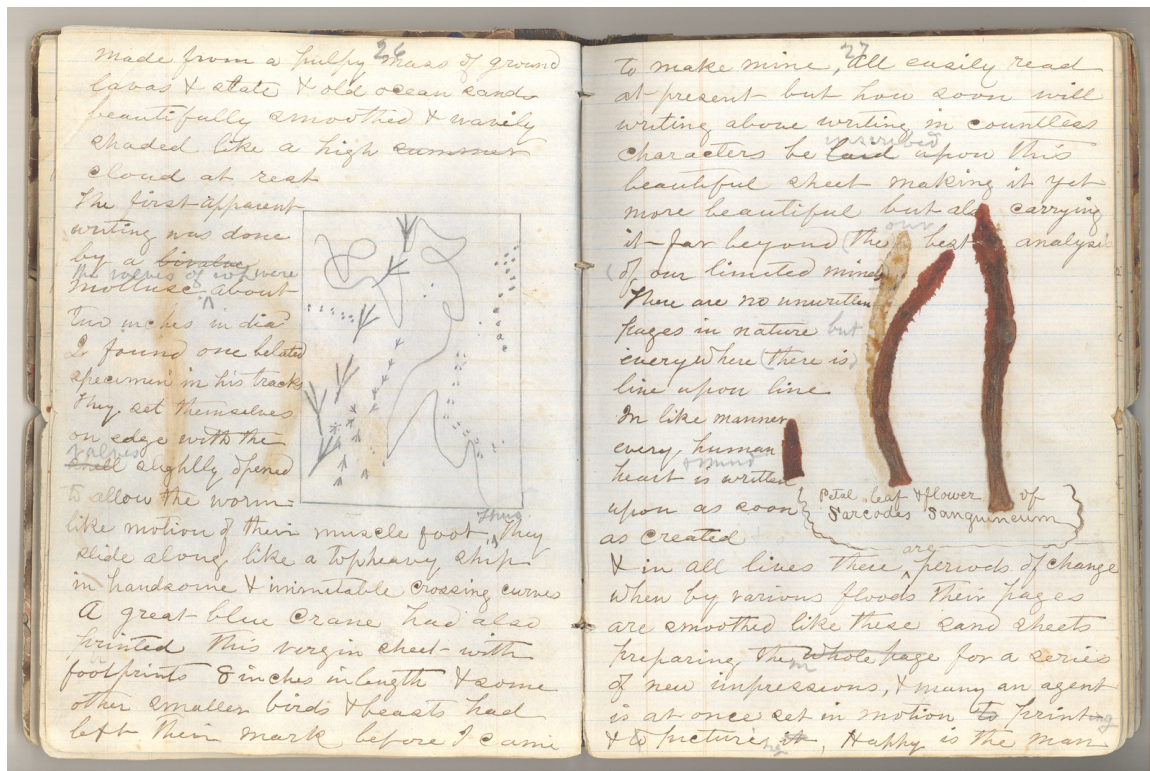


Figure 5: A scan of his 1869 journal (Muir 1869a, 26–27. John Muir Papers, Holt-Atherton Special Collections and Archives, University of the Pacific Library. ©1984 Muir-Hanna Trust).

a broader palimpsestic or chiasmatic vision, overlaying different elements and epochs. For this piece, we focus on his earliest journals leading up to his glacial theory of Yosemite's formation.

The first excerpts from the journals we share introduce the breadth of Muir's elemental vision. In his perhaps most evocative aeolian observation, documented in the very first journal, Muir superimposes the sudden onset of a breeze, the involuntary nature of human memory (a Proustian *mémoire involontaire* half a century before the publication of the *Recherche*), the ocean, and the forest:

To-day I reached the sea. While I was yet many miles back in the palmy woods, I caught the scent of the salt sea breeze which, although I had so many years lived far from sea breezes, suddenly conjured up Dunbar, its rocky coast, winds and waves; and my whole childhood, that seemed to have utterly vanished in the New World, was now restored amid the Florida woods by that one breath from the sea. [...] How imperishable are all the impressions that ever vibrate one's life! We cannot forget anything. Memories may escape the action of will, may sleep a long time, but when stirred by the right influence, though that influence be light as a shadow, they flash into full stature and life with everything in place. For nineteen years my vision was bounded by forests, but to-day, emerging from a multitude

of tropical plants, I beheld the Gulf of Mexico stretching away unbounded, except by the sky. What dreams and speculative matter for thought arose as I stood on the strand, gazing out on the burnished, treeless plain! (Badè 1917, 344–45; originally appears in Muir 1867, 131–32)

In his second journal, sailing off the coast of the Bahamas, Muir makes use of “*conceptual displacement*” (Jue 2020, 4) by submerging geologic change into the ocean to contract time before resurfacing:

All is changeful—the hills & vales of ocean rise & fall & go from place to place & so do those of the land & of the ocean bottom the difference is caused by time & o those beings who are not held by time *land waves* rise & fall fast as those of the water. [...] So the sea surface is like the earth surface & perhaps the *seas of heat & light & air are hilly & wavy*. (Muir 1868; emphasis by authors)⁴

The third journal and excerpt take us to the region Muir is perhaps best known for exploring: California. Muir spent the first quarter of 1869 in Twenty Hill Hollow, located someplace between what are today the towns of La Grange and Snelling. Muir’s media-dense observation of water currents emerging and receding in a dry creek in Twenty Hill Hollow reveals further dimensions of media in his journals:

In the course of a few hours after the close of a rain [Dry Creek] will retire within its banks, leaving many flat, smooth, fresh sheets of sand. I like to watch the first writings upon these fresh new-made leaflets of Nature’s own making. One of these pages was made last night and was already written upon when I saw it this morning. It is [26] made from a pulpy mass of ground lavas and slate and old ocean sands, beautifully smoothed and wavyly shaded like a high cloud at rest. The first apparent writing was done by a mollusk, the valves of which were about two inches in diameter. I found one belated specimen in his tracks. [...] A great blue crane had also printed the virgin sheet with footprints 8 inches in length and some other smaller birds and beasts had left their mark before I came [27] to make mine, all easily read at present, but how soon will writing above writing in countless characters be inscribed on this beautiful sheet, making it yet

⁴ Although there is not clear evidence for this, the style and syntax of these notes, when compared with the previously cited section, might themselves result from the elemental milieu in which they were written, Muir’s ship rocking back and forth in the ocean. Reflecting on the syntax of later journal entries from Yosemite, Heitschmidt (2013, 178) writes: “His poetic structure and polysyllabic words also convey the rhythm and cadence of winter’s soft falling snow as well as his morning and artistic gazing.”

more beautiful but also carrying it far beyond our analysis (of our limited minds). There are no unwritten pages in nature, but everywhere line upon line. (Muir 1869a, 25–27)

Muir describes the creek's bed as a sheet of paper, as a protogeological medium of inscription itself, written over, in time, by various animals. The difficulty of reading this sheet of nature leads Muir to reflect on the limits of human cognition and stands in for his later greater project to “read” the origin of Yosemite Valley as a whole. The pages of Muir's journal, on which he writes this account, themselves become a medium not only of his writing but also of the tracks he records, the plants he impresses, and the weather he exposes the journal to (see [figure 5](#)).

Later, in 1869, Muir moved east to Yosemite itself, where he developed a keen scientific interest in the valley's geology. In Muir's time, the question of Yosemite Valley's geomorphological history was contested. The state geologist tasked with answering this question by the California Legislature was, in 1860, Josiah D. Whitney, who was later made professor of geology at Harvard in 1865 (Badè 1924b, 274–75). That same year, he would go on to give a first answer in the first volume of a book series on the geology of California.

The domes, and such masses as that of Mount Broderick, we conceive to have been formed by the process of upheaval itself, for we can discover nothing about them which looks like the result of ordinary denudation. The Half Dome seems, beyond a doubt, to have been split asunder in the middle, the lost half having gone down in what may truly be said to have been “the wreck of matter and the crush of worlds.” (Whitney 1865, 421)

During his studies at the University of Wisconsin in the 1850s, Muir had become well acquainted with an alternate theory to explain the formation of geological features: Louis Agassiz's glacial theory had been published a few years earlier, in 1840 (Wolfe 1973, 76; for an account of Agassiz's racism, see Gould 1981, 74–81; Yusoff 2024, chaps. 3, 4). In a letter to his close friend Jeanne Carr, Muir observed early that “Whitney says that the bottom has fallen out of the rocks here which I most devoutly disbelieve” (letter to Jeanne Carr, April 13, 1870, cited in Badè 1924b, 215). In a later letter, Muir expands:

I can do much of this ice work in the quiet, and the whole subject is purely physical, so that I can get but little from books. All depends upon the goodness of one's eyes. No scientific book in the world can tell me how this Yosemite granite is put together, or how it has been taken down. Patient observation and constant brooding above the rocks, *lying upon them for years as the ice did*, is the way to arrive at the truths which are



Figure 6: Composite: views from Sentinel Dome nos. 1, 2, 3; photographs nos. 19, 20, and 21. California Geological Survey. 1868. (Whitney 1868, xix–xxi)

graven so lavishly upon them. (letter to Jeanne Carr, September or October 1871, cited in Badè 1924b, 300; emphasis by authors)

Muir (1871) would go on to publish his theory of glacial erosion that same year in the *New York Daily Tribune*, his first published article. The elemental chiasmus between geologic sedimentation, erosion, and the pages of a book, implicit in Muir’s writings from Twenty Hill Hollow, turns explicit in the opening of this article. Considering Muir’s skepticism of published books on Yosemite’s geology, it is difficult not to detect a distinct undertone here, too: the embodiment of nature—“lying like ice”—proving theory wrong:

Two years ago, when picking flowers in the mountains back of Yosemite Valley, I found a book. It was blotted and storm-beaten; all of its outer pages were mealy and crumbly, the paper seemed to dissolve like the snow beneath which it had been buried; but many of the inner pages were well preserved, and though all were more or less stained and torn, whole chapters were easily readable. In this condition is *the great open book of Yosemite glaciers* today; its granite pages have been torn and blurred by the same storms that wasted the castaway book. (Muir 1871)

In letters from the same year, Muir condenses the superimposition of geology and writing into the concept of “mountain manuscripts,” with “glacial footprints in the rocks worn by the storms and blotting chemistry of ages” (letter to Catharine Merrill, July 12, 1871, cited in Badè 1924b, 289). In another letter from 1871, Muir writes of “reading new chapters of glacial manuscript” (letter to Jeanne Carr, August 13, 1871, cited in Badè 1924b, 291). Whitney, for his part, discounted Muir’s views as those of a “shepherd” and “ignoramus” (Badè 1924b, 288; Wolfe 1973, 133).

Although understanding geology through the metaphor of books and reading was not, in itself, new (for an earlier example of “mountain manuscripts,” see Rudwick 2014, 161), Muir’s journals reveal how the meaning of “mountain manuscript” began to encompass or overflow into other elements too, paving the way toward an aeolian geology. One early indication of this is given as Muir’s attention is drawn toward Tis-sa-ack (also known as South Dome or Half Dome), visible in the left third of [figure 6](#). Reading Tis-sa-ack like a meteorological instrument, Muir first highlights that “the barometer of our valley” is “divided into an unreadable number of degrees” of which “only four or five points are understood by us” (Muir 1869b, 4). The

weight of the atmosphere is indicated by the rising & falling of a cloud upon its [face]. On the morning of Dec 15th the barometer cloud [descended to] touched the snow point [hung low on Tissiack] long fleecy [downy] rolls of mist came softly down the [canons] or floated about in masses in the open valley, like ice[bergs] in the sea [...] (Muir 1869b, 4)

At the end of this observation, Muir submerges Yosemite Valley such that the top of the valley is the surface of an ocean where mists float on aerial currents “like ice[bergs] in the sea.” This diffractive translation from wind to ice and back allows Muir to saturate and materialize air, giving it a shape wind can move. “The valley,” Muir later writes,

contains many mansions, for the wind & clouds. During the glowing hours of this resting day inert or slow moving bodies of air slept in rock chambers [cavities] & in the shelter of steep walls like lakes & pothole of air, each atmospheric lake & [rivulet] had a temperature of its own but as the coming of night they floated about in companies & in walking half a mile my face was bathed with air of all temps [temperatures] & qualities hot cold & balmy in startling suddenness of succession I seemed to walk through narrow zones of [the breezes of] summer winter & spring [...]. (Muir 1869b, 14–15)

The valley’s geology not only provides the home of winds and clouds but also plays a crucial role in their creation, such that “[h]eated masses of air form currentless ovens of chambered & bushy rocks were lifted by new born winds & borne whole or in fragments about the open gulf of the valley” (Muir 1869b, 22). Condensing his oceanic analogy, Muir writes of a “[d]eep blue atmospheric sea without a tingeing shadow or island or barrier of continental cloud” (Muir 1869b, 23). He concludes his observation by switching back and forth from the ocean to the air and back, describing the sky as “coastless windless tideless” (Muir 1869b, 23).

In his later visits to Yosemite, Muir increasingly interweaves the language of ice and geology to render legible experiences of air and wind. Confronted with strong and unpredictable winds at the top of the valley, Muir (1873a, 42) notes how “masses of air” rolled down upon him “from [above] like icebergs.” Contracting the elemental superimposition of air and ice, Muir (1873a, 42) calls these masses of air “air bergs” (a diffractive neologism), of “all sizes & variable in temp [temperature],” “ragged in outline & angular, move like rocks of an avalanche.” These are contrasted with the masses of air or atmospheric lakes, which “are formed in currentless nooks” at “the bottom of the valley” and “drift out by night with calm motion exactly like icebergs in a calm sea” (Muir 1873a, 42–43).

After making sense of the movement of air through the language of ice, Muir again reverses this elemental chiasmus to understand geological change through the language of wind. Looking at the valley from above, Muir observes how a “noble wind torrent” sweeps down Tenaya Canyon, “filling the whole valley from wall to wall boiling & [eddying]” in side canyons, “sweeping upwards over the tips of the valley as the Yosemite glacier did” (Muir 1873a, 71–72). Turning his attention to the mountains, Muir explains how “wind swept up the curves of these peaks just as the glrs [glaciers] wh [which] carved [them] once swept down [carrying] snow dust” (Muir 1873a, 73). In a later journal from the same year, Muir makes sense of differences in “accumulations of rocky debris” by imagining “the grand central glacier that flowed down through valley filling it from wall to wall like a wind” (Muir 1873b, 22–23). This aeolian geology allows Muir to diffractively accelerate literal and figurative glacial change to the valley’s geomorphology to a timescale commensurate with human perception, playing with patterns of difference between wind, rock, and ice. As Heitschmidt (2013, 177) has argued previously, “processes on the earth” are here “re-created in the sky”; the emerging images are then “not oppositional, but correlative.”

Concluding our discussion of Muir and hinting at future work, we draw attention to his usage of arrows to make sense of glacial movement. As he draws these lines through now ice-free landscapes, they involuntarily look, to the (un)initiated, like dominant winds viewed from below ([figure 7](#)) and above ([figure 8](#)).

4. Aeolian Art

Attempts to capture the wind in art face a similar difficulty to scientific wind sensing: in his discussion of an early art historical example, Welsch (2018, 52) highlights that Leonardo da Vinci was “highly aware” of how difficult it is to capture the wind, to make “the incomprehensible tangible.” In Leonardo’s own words, “Wind itself is not visible” (cited in Welsch 2018, 52). This fact led him to develop two diffractive strategies to bring out wind’s patterns of difference. First, one should “consider and arrange well

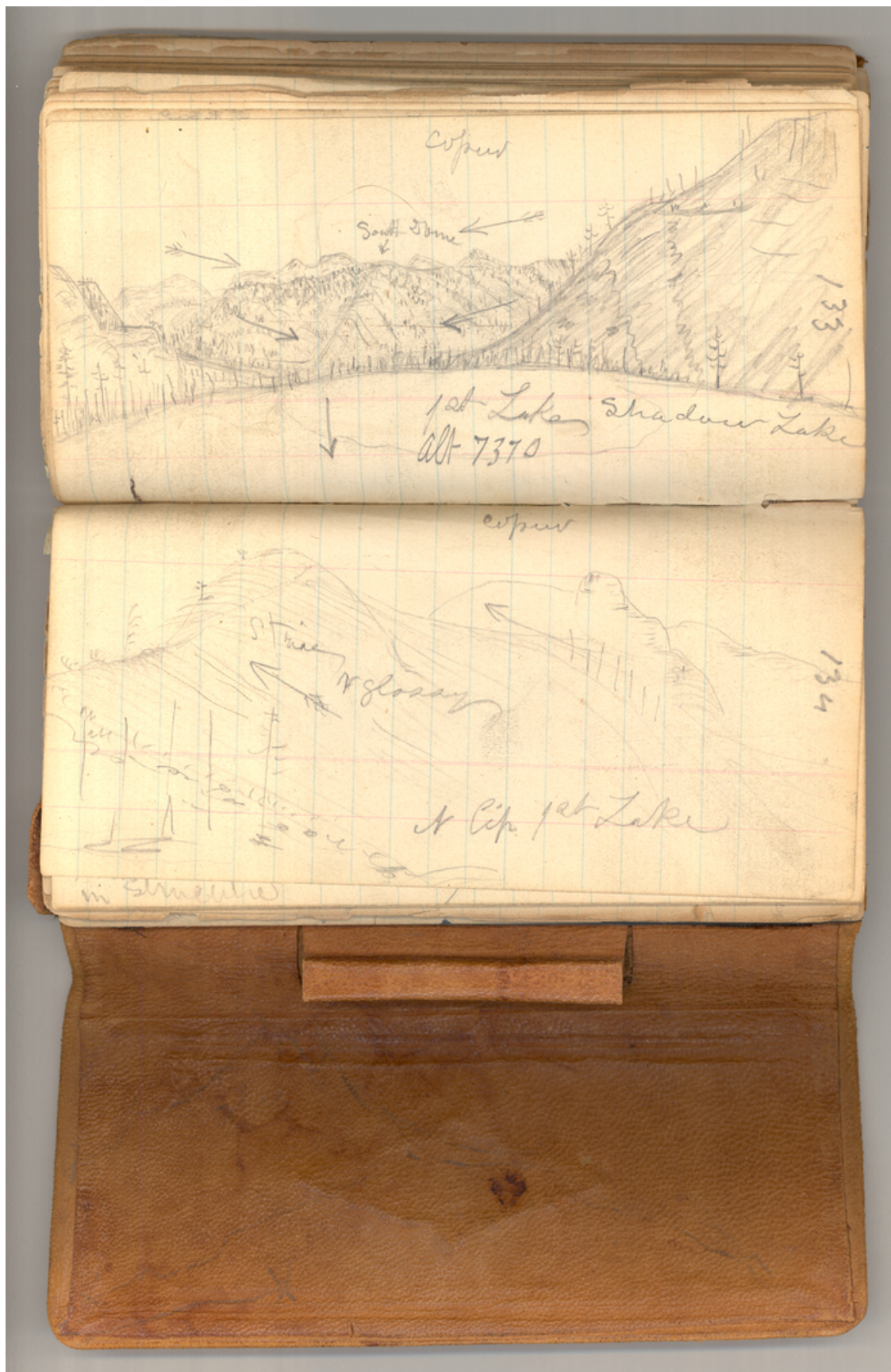


Figure 7: Sketch of South Dome (Muir 1872, 133–34. John Muir Papers, Holt-Atherton Special Collections and Archives, University of the Pacific Library. ©1984 Muir-Hanna Trust).

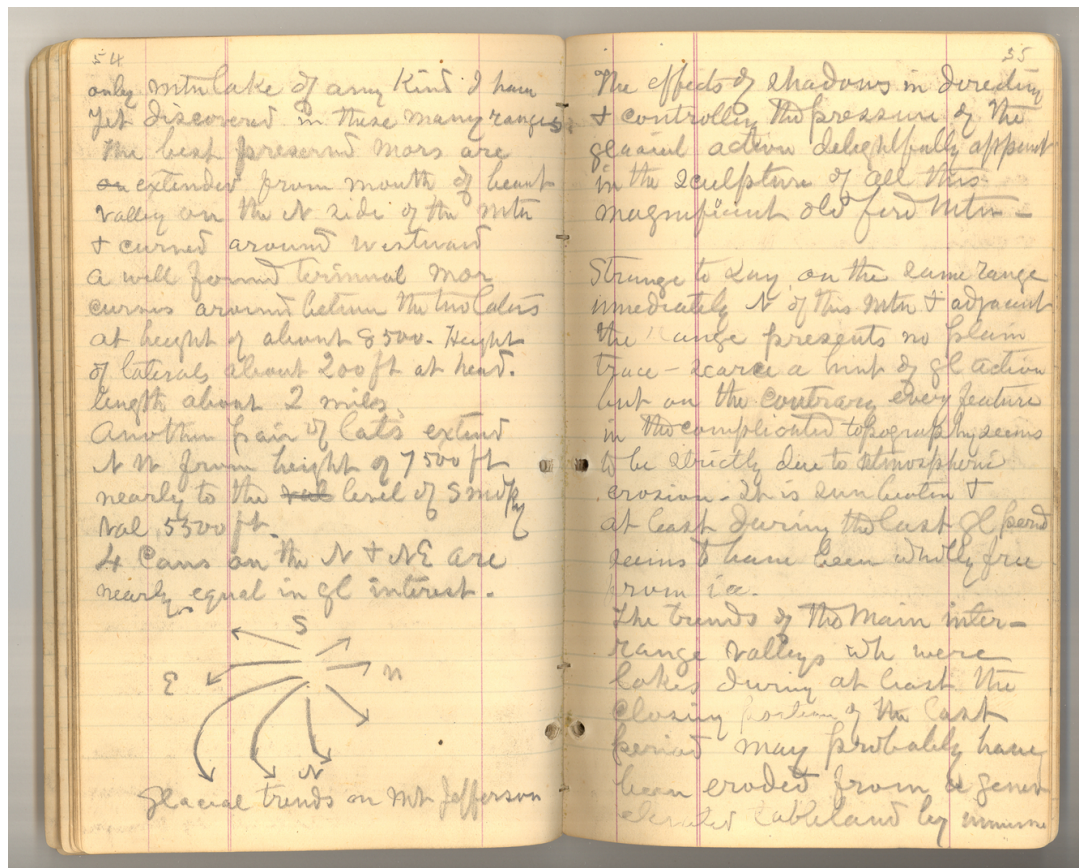


Figure 8: Glacial trends on Mt. Jefferson (Muir 1878, 54–55. John Muir Papers, Holt-Atherton Special Collections and Archives, University of the Pacific Library. ©1984 Muir-Hanna Trust).

its effects as seen” (cited in Welsch 2018, 52). Secondly, Leonardo suggests a “methodical maxim of conceiving wind representations according to the model of water movements” (Welsch 2018, 53). This second strategy has led most, according to Welsch (2018, 54), to mistake Leonardo’s drawings of wind for drawings of water or floods. Hence, the following black chalk drawing is exhibited as *A Deluge* (see [figure 9](#)).

Welsch (2018, 57) argues that this sheet represents movements of air and not water. Following both of Leonardo’s strategies for drawing wind, it shows

the effect of the storm on inorganic nature, on rocks. [...] One might well assume that Leonardo tries to illustrate here how he imagines the emergence of certain formations in the Dolomites, so that his depiction concerns the historical evolution of morphological traits. The drawing does not represent a momentary view, but rather depicts a process that extends over a long period of time [...]. (Welsch 2018, 57)

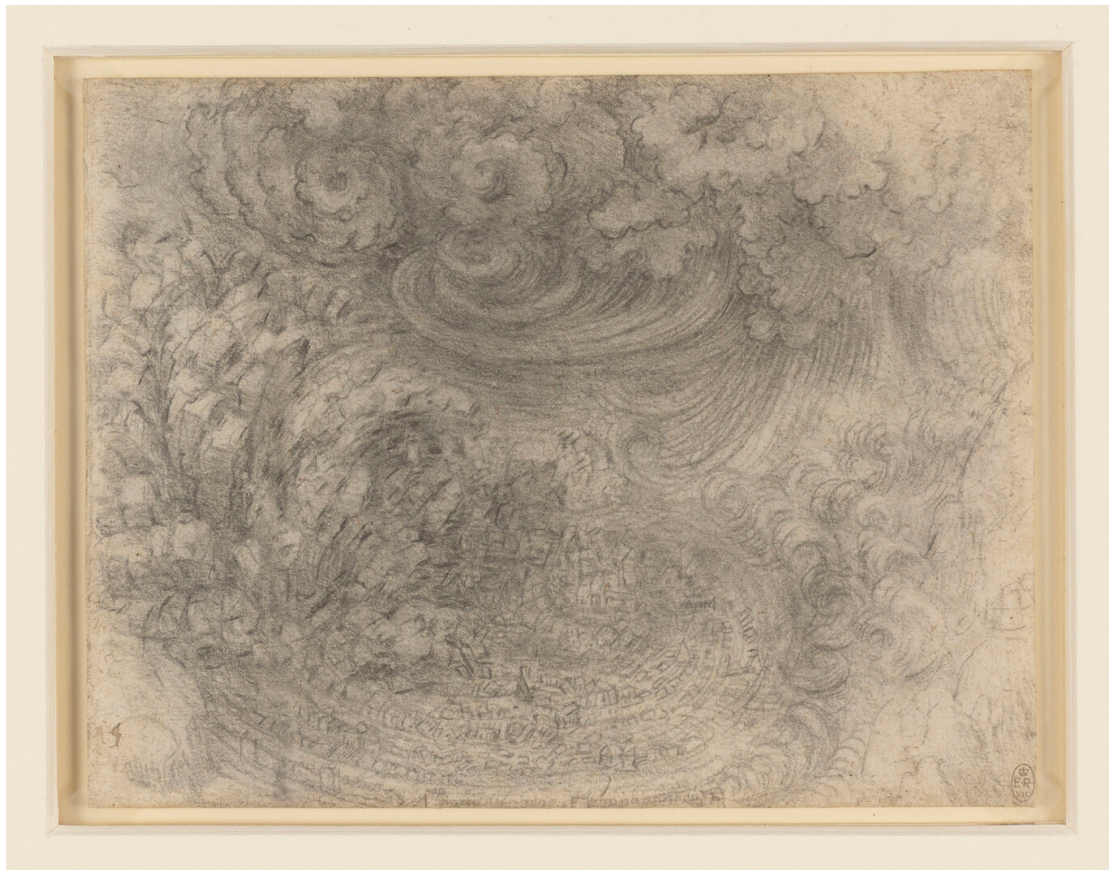


Figure 9: Leonardo da Vinci. *A Deluge* (c. 1517–18). Black chalk. 16.3 x 21.0 cm (sheet of paper). RCIN 912378.

Much like Muir would attempt three centuries later, Leonardo practiced elemental chiasmus by submerging a mountain range “underwater.” Like Muir’s ambiguous arrows, Leonardo’s drawings still bear the mark of the elemental chiasmatic strategy behind their representation, revealing their diffractive nature.

Leonardo’s lines of wind are then less lines of similarity (iconic lines) than diagrammatic lines—that is, lines of force that render visible that which is not visible to the naked eye. By means of their course and pattern, they reveal a possible field of power and patterns of difference, which are drawn into the air by the wind. Leonardo fills the invisible airspace, which seems to be completely empty, with a riot of lines, revealing that space is packed with an energetic field of force. His drawings aim “to expand the limits of what can be perceived beyond the usual” (Welsch 2018, 62). Representing what is unavailable to ordinary perception draws attention to the fact that science, art, and “especially drawing” (Welsch 2018, 62) are, for Leonardo, all possible forms of research. As in Muir’s later writings and drawings, “[t]heory and perception merge here and fertilize each other” (Welsch 2018, 63). In summary, Leonardo’s

drawings present diagrams of wind courses that are scientifically correct but are hidden from normal perception. But the scientifically and theoretically educated eye sees differently and

perceives more than the physical eye. And Leonardo's claim and unique achievement is to share with us his *radar-like vision* of wind movements and flow patterns. What we see in these drawings is, although a natural phenomenon, not simply to be seen in nature, but here brought out into its full visibility. Leonardo develops a presentiveness aiming at the inner structure of phenomena which goes beyond the standard perceptiveness. The scientist Leonardo has gone beyond the dogma of simple visibility. (Welsch 2018, 63; emphasis by authors)

Returning to the late nineteenth century, Vincent van Gogh's work has received particular attention for its apparent meteorological and cosmological scientific accuracy, too (Gedzelman 1990; Aragón et al. 2008), and has, more recently, been itself subject to literal electromagnetic radiation scans revealing a new aeolian and elemental dimension of his work (Hale and Centeno 2023). In a letter from 1888 to Emile Bernard, Van Gogh explains,

I'm still living off the real world. I exaggerate, I sometimes make changes to the subject, but still I don't invent the whole of the painting; on the contrary, I find it ready-made—but to be *untangled*—in the real world." (Jansen et al. 2009, #698; emphasis by authors)

Taking Van Gogh's process of untangling further, physicists have argued that Van Gogh's swirling brushstrokes and patterns "display the mathematical structure of fluid turbulence" (Aragón et al. 2008, 275). By applying Andre Kolmogorov's early 1941 theory of turbulence to Van Gogh's late painting *Starry Night* (1889), as well as to three other paintings from that period, they show by means of statistical methods that he painted turbulent flow in fluid dynamics and luminance realistically—that is, according to the principles of modern physics and cosmology. They go on to observe "that in most landscapes with stormy skies the powerful swirling style extends to the overall painting" (Aragón et al. 2008, 280), perhaps questioning their overall scientific realism.

Although Gedzelman (1990) was purportedly interested in the meteorological accuracy of Van Gogh's painting, comparing his works and letters to the meteorological record, his interpretation of Van Gogh's "swirling paintings" was clearly influenced by his understanding of Van Gogh's mental state:

Everything seems almost to flow, bending or wavering almost as in a nightmare, but still remaining clearly identifiable: the tortuous branches of the olive trees, the contorted and upthrust

moundlike hills and angular peaks, the undulating ground, clouds, and cypress and the swirling galaxy. (Gedzelman 1990, 110)

These cosmological and meteorological studies surface a latent desire to question or prove the accuracy of Van Gogh's paintings as representations of reality. Returning to Van Gogh's own use of "untangling" through the prism of Barad's theory questions the very possibility of arriving at some object *wind* that can be accurately captured, representationally or otherwise. Through the lens of agential realism, wind as a phenomenon is instead the result of different intra-actions between both psychical and physical, immaterial and material, human and nonhuman. The question if the Mistral—the dominant wind in southern France, mentioned in forty-five of Van Gogh's letters—is a movement of Van Gogh's outer or inner world, torturing olive trees or his soul, is left undecided.

Van Gogh's desire to untangle "the real world" indicates that his painting took place *en plein air*, although not always in fair weather. He painted even in strong wind and rain by attaching his easel to pegs that were driven fifty centimeters into the ground (see letters in Jansen et al. 2009, #628, #377, #259, #591). Many of his letters to his brother reveal that he paid special attention to the wind; to its rise and fall, to different Beaufort scales, to its sound in different trees and how it moves things, but also how it affects and hinders his painting. On a more philosophical and spiritual level, he talks about wind as a breath of life, but also its biblical meaning in the story of Elijah in the Old Testament, in which wind plays a destructive role (1 Kings 19:3–15). Wind is a constant nonhuman companion for the outdoor painter, who is out and about with his easel in all weathers. Van Gogh as a painter is weathered, too, as are the trees and landscapes he paints and as are his paintings. Wind is a never-ending, infinitely replenishing magnitude he can rely on. "Anyway, it was 48 then, it's 84 now. The mill is there no longer, the wind is still there. However, try to know for yourself where you actually are, as I try to know it for myself" (Jansen et al. 2009, #461).

From an elemental perspective, Van Gogh's late pastose *Wheat Fields* series, which includes *Cypresses with Two Figures* (June 1889), *Cypresses* (see [figure 10](#)), *Wheat Field with Cypresses* (July 1889) or *Starry Night* (June 1889), and also *Landscape Under Turbulent Skies* (April 1889), are of particular interest beyond their claimed accurate representation of turbulence. Describing *Cypresses with Two Figures* in an 1890 letter, Van Gogh writes that the

study [...] depicts a group of [cypresses] in the corner of a wheatfield on a summer's day when the mistral is blowing. It is therefore the note of a certain blackness enveloped in blue moving in great circulating currents of air, and the vermilion of the poppies contrasts with the black note. (Jansen, Luijten, and Bakker 2009, #853)

Art history has analyzed these images through the lens of the cypress tree. In the catalogue *Van Gogh's Cypresses*, which accompanied an exhibition at the Metropolitan Museum in New York bringing his cypress paintings together, art historian Susan A. Stein (2023) evokes the flamelike figures of the cypresses. She highlights how “readings of the cypresses as barometers of his psychic state” (Stein 2023, 17) became notorious in art history, again reflecting a desire for purported accuracy. Drawing art historical attention away from the represented tree toward the material wood, Bailey (2018, 81) points to how Van Gogh took Japanese woodcuts, such as Hokusai’s *The Great Wave* (1831), as a model for his work. Van Gogh himself foregrounded the arabesque style of paintings such as *Starry Night*, “their lines [...] contorted like those of the ancient woodcuts,” lacking “personal will, feeling in the lines” (Jansen et al. 2009, #805).

Foregrounding a further material dimension of this series, Van Gogh painted not with watercolors but with oil paints characterized by pastosity—that is, by a particular thickness. Unlike watercolor, for example, oil paint does not run if left undiluted. Van Gogh applied oil paint so that the texture of his brushwork remains clearly visible as a trace, as a gesture on the canvas (see [figure 11](#)). He sculpts “the impasto into waves of marbled color [...] using extra-thick impasto and dynamic, rhythmic brushwork that was particularly well suited to capturing the landscape on a windy day” (Hale and Centeno 2023, 101). Thinking back to Leonardo, Van Gogh’s way of painting fluid elements—waving grasses and trees, the winds and clouds—is diffracted through wood(cuts) and drawing, as they are characterized by a specific pattern of difference: a sort of three-dimensional linear disegno.

The pasty quality of oil paint also means that it is sticky. In preparation for the Metropolitan Museum exhibition, museum conservators turned electromagnetic waves from the literal to the figurative sky in *Cypresses*:

Hale and Centeno, using a microscope and the chemical process known as XRF (for X-ray fluorescence mapping), discovered a few new things. Among them was the surprising presence of rock matter in the pigment. Sand and limestone pebbles—the largest is a quarter-inch in diameter—are embedded across the surface of the canvas, especially in the impastoed foreground. (Solomon 2023)

How did the stones end up on the canvas? Solomon, an art critic for the *New York Times*, speculates that Van Gogh perhaps threw the stones and sand on his paintings as part of his process. The geological presences in Van Gogh’s pastose foregrounds the heterogeneous agencies at play in capturing wind. Van Gogh seems to have been proud to paint even in strong winds, his easel attached tightly to the ground. In Scheveningen in 1882, for example, he painted in the dunes despite gales, storms, and rain. In a letter, he recollects how he had “to scrape everything off twice because of the thick layer of sand



Figure 10: Vincent van Gogh. *Cypresses* (June 1889). Oil on canvas. 93.4 cm × 74 cm (bpc | The Metropolitan Museum of Art).

completely covering” the canvas. Still, sand made it onto or into his paintings, most notably in *Seascape near Les Saintes-Maries-de-la-Mer* (see [figure 12](#) and Vellekoop et al. 2013, 100–101). The wind also blew “clouds of sand” into his eyes (Jansen, Luijten, and Bakker 2009, #259). Some years later, in a letter to his brother the same year he painted *Seascape*, Van Gogh writes, “How I’d make a painting of it if there wasn’t this bloody wind!” (Jansen et al. 2009, #639).

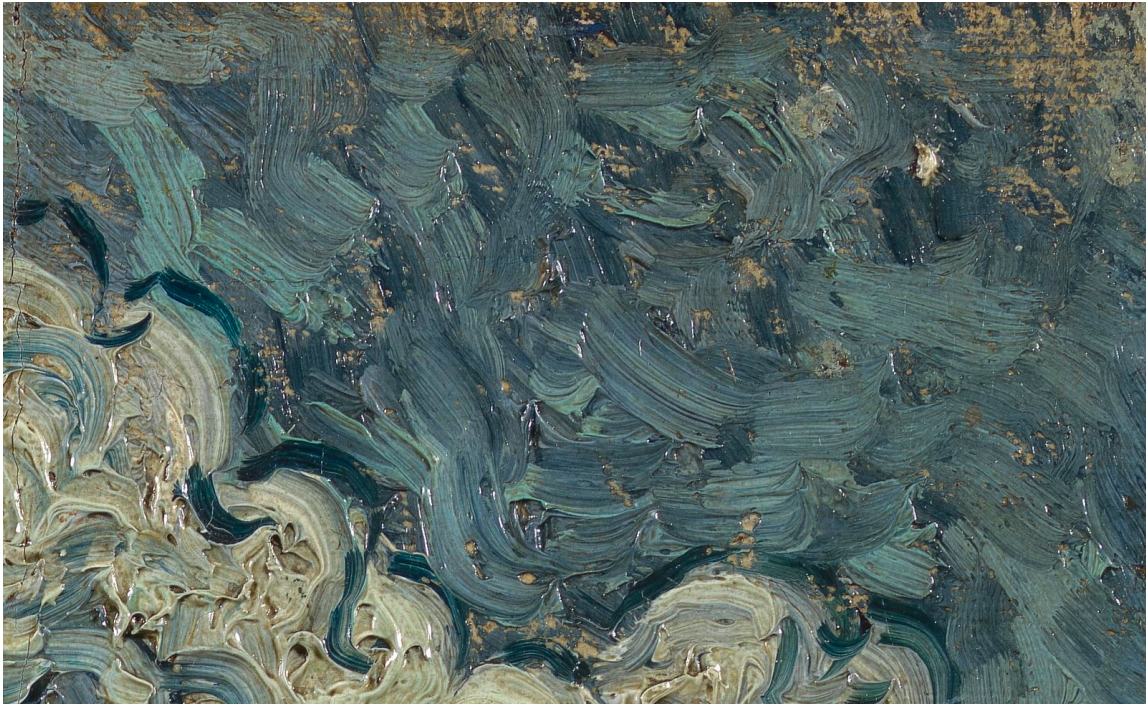


Figure 11: Top right corner: Vincent van Gogh. *Cypresses and Two Women* (February 1890). Oil on canvas on panel. 43.5 cm x 27.2 cm. Van Gogh Museum, Wikimedia, public domain: https://commons.wikimedia.org/wiki/File:Cipressen_en_twee_vrouwen_-_s0147V1962_-_Van_Gogh_Museum.jpg

When he was able to paint his *Cypresses*, Hale and Centeno (2023, 102), part of the Metropolitan Museum’s conservator and research scientist teams, infer that the sheer “weight of the impasto,” which gives the aerial currents their plasticity, “may have contributed to the painting apparently falling or being blown forward onto the ground from Van Gogh’s portable easel or as he was gathering his materials to head back to the asylum.” A closer investigation of the “scores of sand particles and small pebbles” as well as “pieces of brown vegetal matter” indenting the impasto suggests that “the painting fell facedown rather than the stones and vegetal matter being blown onto the fresh paint by a strong wind” (Hale and Centeno 2023, 102–3). “In any case,” Hale and Centeno (2023, 103) conclude, “they provide vivid new evidence that *Cypresses* was painted mostly out of doors” (see [figure 13](#)).

Like Muir’s notebooks, Van Gogh’s cypress paintings are palimpsests, chiasmatically relating different elements to each other. Evidencing the “inseparability of the material and semiotic” (Barad 1996, 172), the paintings capture wind’s intra-actions as it blows the easel over or brings the paint or sky and trees into motion. The elemental nature of oil paint—its ability to create impasto and document the traces of brushstrokes like the traces left by glaciers in Yosemite Valley’s stone—mediates the turbulent nature of wind, not visible to the naked eye, on the canvas in a distinctive, three-dimensional diffractive pattern. Directing electromagnetic radiation onto the canvas as the meteorologists in Lindenberg do toward the sky makes legible deep material inscriptions of the wind into the paint.



Figure 12: Vincent van Gogh. Seascape near Les Saintes-Maries-de-la-Mer (June 1888). Oil on canvas. 50.5 cm x 64.3 cm. Google Arts & Culture, Wikimedia, public domain: https://de.wikipedia.org/wiki/Datei:Vincent_van_Gogh_-_Zeegezicht_bij_Les_Saintes-Maries-de-la-Mer_-_Google_Art_Project.jpg



Figure 13: Pebble in the center of the image. From Van Gogh's Cypresses (bpk | The Metropolitan Museum of Art).

5. Elemental Chiasmus as Method

Elemental chiasmus is a practice of conceptualizing already implicit in everyday life. Perhaps the most conspicuous example is the elemental metaphors we use—floating an idea, a sinking feeling—through which our understanding of ourselves and the world around us is diffracted through different elemental media (Lakoff and Johnson 2003). The more immaterial the object we are trying to describe or capture—an idea, a feeling, the wind—the more reliant we seem on borrowing explanatory logic from different elemental milieus (for an extensive discussion of wind as metaphor, see Guldin 2023). Throughout this piece, we have shown that this is not only true for the language in which we think, speak, and write but also applies to embodied experience (Muir), to the materials of artistic expression (Van Gogh), and to the technological instruments through which the atmosphere is sensed (radar/sodar/lidar). Returning to an earlier argument (Peters 2022), from the world we borrow the elemental media, their language, their meaning, the patterns of difference they afford that help us make sense of it. Reading the above examples in reverse, it is then not only true that different elemental mediations help render wind legible. Wind itself challenges us to explore the elucidating potential of other elements.

By highlighting both historical and present-day practices of capturing wind through elemental media, we have further elaborated on media theory's recent interest in the elemental on both a conceptual and an empirical level. By bringing this work into conversation with (feminist) new materialism and Barad's agential realism, we developed a media-theoretical account of wind that does justice to both wind's ephemeral nature and the different practices of mediation at play in making wind legible. With the concept of elemental chiasmus, we contribute a further mode of "elemental analysis" to media theory that pays "attention to mediation" (Starosielski 2019, 1–2) as opposed to reifying either media or elements. In drawing together material from different historical periods and across disciplines, our "elemental research" into wind turned into "a contact zone" that, alongside other recent work in elemental media theory, pushes, experiments with, and redraws "the boundaries of media studies" (Starosielski 2019, 3). We hope our work might serve as an example "to open up, to destabilize, and to saturate existing ways of environmental thinking" (Starosielski 2019, 4) by revisiting heterogeneous material through an elemental and chiasmatic media lens.

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REFERENCES

- Ansmann, Albert et al. 2021. "Tropospheric and Stratospheric Wildfire Smoke Profiling with Lidar: Mass, Surface Area, CCN, and INP Retrieval." *Atmospheric Chemistry and Physics* 21 (12): 9779–9807. <https://doi.org/10.5194/acp-21-9779-2021>.
- Aragón, J. L. et al. 2008. "Turbulent Luminance in Impassioned van Gogh Paintings." *Journal of Mathematical Imaging and Vision* 30 (3): 275–83. <https://doi.org/10.1007/s10851-007-0055-0>.
- Badè, William Frederic. 1917. *The Writings of John Muir: Volume 1*. Boston, MA: The Riverside Press Cambridge.
- . 1924a. *The Life and Letters of John Muir*. Boston, MA: The Riverside Press Cambridge.
- . 1924b. *The Life and Letters of John Muir*. Boston, MA: The Riverside Press Cambridge.
- Bailey, Martin. 2018. *Starry Night: Van Gogh at the Asylum*. London: White Lion.
- Barad, Karen. 1996. "Meeting the Universe Halfway: Realism and Social Constructivism without Contradiction." In *Feminism, Science, and the Philosophy of Science*, edited by Lynn Hankinson Nelson and Jack Nelson, 161–94. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-009-1742-2_9.
- . 2007. *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham, NC: Duke University Press. <https://doi.org/10.2307/j.ctv12101zq>.
- Benjamin, Walter. 1972. "A Short History of Photography." *Screen* 13 (1): 5–26. <https://doi.org/10.1093/screen/13.1.5>.
- Cronon, William. 1996. "The Trouble with Wilderness; or, Getting Back to the Wrong Nature." In *Uncommon Ground: Rethinking the Human Place in Nature*, edited by William Cronon, 69–90. New York, NY: W. W. Norton.
- Deutscher Wetterdienst (DWD). n.d. "Lindenberg Columnn." Accessed April 9, 2023. https://www.dwd.de/EN/research/observing_atmosphere/lindenberg_column/lindenberg_column_node.html.
- Ehrenberg, Christian Gottfried. 1849. *Passat-Staub und Blut-Regen: ein großes organisches unsichtbares Wirken und Leben in der Atmosphäre*. Berlin: Königliche Akademie der Wissenschaften.
- Elder, John C. 1981. "John Muir and the Literature of Wilderness." *The Massachusetts Review* 22 (2): 375–86.
- Gabrys, Jennifer. 2019. "Sensors and Sensing Practices: Reworking Experience across Entities, Environments, and Technologies." *Science, Technology, & Human Values* 44 (5): 723–36. <https://doi.org/10.1177/0162243919860211>.
- Gedzelman, Stanley David. 1990. "The Meteorological Odyssey of Vincent van Gogh." *Leonardo* 23 (1): 107–16. <https://doi.org/10.2307/1578474>.
- Geerts, Evelien, and Iris Van der Tuin. 2021. "Almanac: Diffraction & Reading Diffractively." *Matter: Journal of New Materialist Research* 2 (1): 173–77. <https://doi.org/10.1344/jnmr.v2i1.33380>.
- Gould, Stephen Jay. 1981. *The Mismeasure of Man*. New York: Norton.
- Guldin, Rainer. 2023. *Philosophie des Windes. Versuch über das Unberechenbare*. Bielefeld, Germany: transcript Verlag. <https://doi.org/10.1515/9783839468432>.
- Hale, Charlotte, and Silvia A. Centeno. 2023. "Untangling Nature. Van Gogh's Materials and Process." In *Van Gogh's Cypresses*, edited by Susan Alyson Stein, 93–110. New Haven, CT: Yale University Press.

- Hansen, Mark B. N. 2017. "Media Entangled Phenomenology." In *Philosophy After Nature*, edited by Rosi Braidotti and Rick Dolphijn, 73–98. London: Rowman & Littlefield.
- Haraway, Donna. 1992. "The Promises of Monsters: A Regenerative Politics for Inappropriate/d Others." In *Cultural Studies*, edited by Lawrence Grossberg et al., 295–337. New York: Routledge.
- Heitschmidt, Gregg. 2013. "Articulating Wild Spaces: John Muir's Lexical Wonderland." *CEA Critic* 75 (2): 175–82. <https://doi.org/10.1353/cea.2013.0018>.
- Hepach, Maximilian Gregor. 2021. "Entangled Phenomenologies: Reassessing (Post-)Phenomenology's Promise for Human Geography." *Progress in Human Geography* 45 (5): 1278–94. <https://doi.org/10.1177/0309132520987308>.
- Hepach, Maximilian Gregor, and Catharina Lüder. 2023. "Sensing Weather and Climate: Phenomenological and Ethnographic Approaches." *Environment and Planning F* 2 (3): 350–68. <https://doi.org/10.1177/26349825231163144>.
- Horn, Eva. 2007. "Editor's Introduction: 'There Are No Media.'" *Grey Room* 29:7–13. <https://doi.org/10.1162/grey.2007.1.29.6>.
- Howe, Cymene. 2019. *Ecologies: Wind and Power in the Anthropocene*. Durham, NC: Duke University Press. <https://doi.org/10.1215/9781478004400>.
- Ingold, Tim. 2007. "Earth, Sky, Wind, and Weather." *Journal of the Royal Anthropological Institute* 13 (s1): S19–38.
- Ives, Ronald L. 1964. "Winds of the Past." *Weatherwise* 17 (5): 224–35. <https://doi.org/10.1080/00431672.1964.9941041>.
- Jagger, Gill. 2015. "The New Materialism and Sexual Difference." *Signs* 40 (2): 321–42. <https://doi.org/10.1086/678190>.
- Jansen, Leo et al., ed. 2009. *Vincent van Gogh: The Letters. The Complete, Illustrated and Annotated Edition*. London: Thames and Hudson.
- Jiménez, Jesus. 2023. "These Apps Can Help You Monitor Air Quality." *The New York Times*. 2023. <https://www.nytimes.com/2023/06/08/us/air-quality-aqi-apps-smoke.html>.
- Jue, Melody. 2020. *Wild Blue Media*. Durham, NC: Duke University Press. <https://doi.org/10.1515/9781478007548>.
- Kirby, Vicki. 2008. "Natural Convers(at)ions: Or, What If Culture Was Really Nature All Along." In *Material Feminisms*, edited by Stacy Alaimo and Susan Hekman, 214–36. Bloomington, IN: Indiana University Press.
- Lakoff, George, and Mark Johnson. 2003. *Metaphors We Live By*. Chicago, IL: University of Chicago Press. <https://doi.org/10.7208/chicago/9780226470993.001.0001>.
- Lindhorst, Sebastian, and Christian Betzler. 2016. "The Climate-Archive Dune: Sedimentary Record of Annual Wind Intensity." *Geology* 44 (9): 711–14. <https://doi.org/10.1130/G38093.1>.
- McCormack, Derek P. 2017. "Elemental Infrastructures for Atmospheric Media: On Stratospheric Variations, Value and the Commons." *Environment and Planning D: Society and Space* 35 (3): 418–37. <https://doi.org/10.1177/0263775816677292>.
- Muir, John. 1867. "July 1867-February 1868: The 'Thousand Mile Walk' from Kentucky to Florida and Cuba." *John Muir Journals* 1. <https://scholarlycommons.pacific.edu/jmj1/>.
- . 1868. "March 1868, Crossing the Panama Isthmus." *John Muir Journals* 2. <https://scholarlycommons.pacific.edu/jmj2/>.
- . 1869a. "January-May 1869, Twenty Hill Hollow." *John Muir Journals* 3. <https://scholarlycommons.pacific.edu/jmj3/>.

- . 1869b. “November 1869 - circa. August 1870, Yosemite Year Book.” *John Muir Journals* 4. <https://scholarlycommons.pacific.edu/jmj4/>.
- . 1871. “Yosemite Glaciers. The Ice Streams of the Great Valley. Their Progress and Present Condition. Scenes among the Glacier Beds.” *New York Daily Tribune*, 1871.
- . 1872. “September-October 1872: Tuolumne.” *John Muir Journals* 7. <https://scholarlycommons.pacific.edu/jmj7/>.
- . 1873a. “January-May 1873: Yosemite Fall, Ice Cone, Etc.” *John Muir Journals* 9. <https://scholarlycommons.pacific.edu/jmj9/>.
- . 1873b. “May-June 1873: Yosemite Falls, Rainbows, Avalanches.” *John Muir Journals* 10. <https://scholarlycommons.pacific.edu/jmj10/>.
- . 1878. “June-August 1878, Geodetic Survey from Sacramento to Wasatch Mountains, Utah.” *John Muir Journals* 26. <https://scholarlycommons.pacific.edu/jmj26/>.
- Neimanis, Astrida, and Rachel Loewen Walker. 2014. “Weathering: Climate Change and the ‘Thick Time’ of Transcorporeality.” *Hypatia* 29 (3): 558–75. <https://doi.org/10.1111/hypa.12064>.
- Neisser, J., and H. Steinhagen. 2005. “Die Historie des Meteorologischen Observatoriums Lindenberg 1905–2005.” *promet* 31 (2–4): 82–114.
- News 12 Staff. 2023. “What Happened to Your Radio Station? The Signal Could Be Affected by Smoke from Nova Scotia Wildfires.” 2023. <https://bronx.news12.com/what-happened-to-your-radio-station-the-signal-could-be-affected-by-smoke-from-nova-scotia-wildfires>.
- Pape, Wilhelm. 1914. *Handwörterbuch der griechischen Sprache. Griechisch-deutsches Handwörterbuch*. Braunschweig: Vieweg & Sohn.
- Parikka, Jussi. 2023. *Operational Images: From the Visual to the Invisual*. Minneapolis: University of Minnesota Press. <https://doi.org/10.5749/9781452970929>.
- Peters, John Durham. 2022. “What Is Not a Medium?” *Communication +1* 9 (1): 1–5.
- Rudwick, Martin J. S. 2014. *Earth’s Deep History. How It Was Discovered and Why It Matters*. Chicago: University of Chicago Press. <https://doi.org/10.7208/chicago/9780226204093.001.0001>.
- Schneider, Birgit, and Evi Zemanek. 2020. “Spürtechniken. Von der Wahrnehmung der Natur zur Natur als Medium – Einleitung.” *Medienobservationen* 0 (0): 0.
- Siebert, B., and J. D. Peters. 2012. “Doors: On the Materiality of the Symbolic.” *Grey Room* 47:6–23. https://doi.org/10.1162/GREY_a_00067.
- Solomon, Deborah. 2023. “Van Gogh and the Consolation of Trees.” *The New York Times*, 2023. <https://www.nytimes.com/2023/05/11/arts/design/van-gogh-cypresses-met-museum.html>.
- Spence, Mark David. 1999. *Dispossessing the Wilderness: Indian Removal and the Making of the National Parks*. Oxford University Press.
- Starosielski, Nicole. 2019. “The Elements of Media Studies.” *Media+Environment* 1 (1): 0.
- Stein, Susan Alyson, ed. 2023. *Van Gogh’s Cypresses*. New Haven, CT: Yale University Press.
- van der Tuin, Iris, et al. 2019. “New Concepts for Materialism. Introduction.” *Philosophy Today* 63 (4): 815–22. <https://doi.org/10.5840/philtoday2019634294>.
- Vellekoop, M. et al. 2013. *Van Gogh’s Studio Practice*. New Haven, CT: Yale University Press.
- Vismann, Bettina. 2013. “Schwebende Auswahl: Klassifizierung der Stäube im 19. Jahrhundert.” In *Staub: Eine interdisziplinäre Perspektive*, edited by Daniel Gethmann and Anselm Wagner, 29–40. Münster: LIT.

- Welsch, Wolfgang. 2018. "Water or Wind? Leonardo Da Vinci's Drawings Windsor 12377–12386 Reinterpreted." *International Journal of Art and Art History* 6 (2): 51–65. <https://doi.org/10.15640/ijaah.v6n2a6>.
- Whitney, J. D. 1865. *Geology: Report of Progress and Synopsis of the Field-Work, From 1860-1864*. Philadelphia, PA: Caxton Press.
- . 1868. *The Yosemite Book: A Description of the Yosemite Valley and the Adjacent Region of the Sierra Nevada, and of the Big Trees of California*. New York, NY: Julius Bien.
- Wolfe, Linnie Marsh. 1973. *Son of the Wilderness: The Life of John Muir*. Madison, WI: University of Wisconsin Press.
- Yusoff, Kathryn. 2024. *Geologic Life: Inhuman Intimacies and the Geophysics of Race*. Durham: Duke University Press. <https://doi.org/10.1353/book.123469>.