

# A hybrid listening to atmospheric processes

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## Abstract

This paper delves into main aspects that support my environmental sound artistic practice, centered around atmospheric processes. It leads to elaborate on the media installation *Augury*, which surrounds the concept of *hybrid listening* to atmospheric phenomena. The proposed approach on *hybrid listening* investigates the merge of mediated, embodied, and situated knowledge, to assist how we sense our atmosphere beyond our human capacity, by translating environmental signals into audible and immersive perception. *Hybrid listening* is informed by past meteorological insights, including ancient to modern weather science, deepening into a profound temporal perspective. In consonance to this conference's theme inquiry about *symbiotic imaginary*, *hybrid listening* melds selected meteorological narratives that lead human sensibility to interplay with more-than-human dimensions: living organisms and technical systems. By means of interactive instruments, this research brings this symbiotic ensemble into an immersive sound encounter with the atmospheric milieu. These instruments harmonize with the convoluted ecological dynamics of the atmosphere—an intricate interplay of matter and agency.

## Keywords

hybrid listening, atmospheric attunement, deep time, weather divination, ubiquitous computing.

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## Introduction

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In recent years, my artistic research has experimented in the realm of environmental sound, with a specific focus on the intricate energies and processes of the atmosphere, notably the wind and the electromagnetic spectrum.<sup>2</sup> This interest appeared from my exploration of generative and indeterministic methods in sound creation, leading to an exploration dedicated to capturing and making audible pervasive aspects of atmospheric phenomena. To transmute these intangible energies into auditory experiences, I harnessed the affordances of ubiquitous computation, employing networks of on-site electronic weather sensors driven by microcontrollers.<sup>3</sup> These experimental incursions merged into a series that contemplates the fusion of the sonic ecologies with technology, unveiling augmented perceptions of surrounding processes catalyzed by the concealed forces of the atmosphere.<sup>4</sup>

Through crafting sensory media devices, it was possible to translate weather data into sound, harnessing environmental sensors to extract real-time insights from the movements, forces, and air quality of the wind. These data streams were converted from electrical impulses into audible compositions, effectively sonifying their subtle transition and tangible essence.<sup>5</sup> However, while this methodology has become somewhat customary in contemporary media art,<sup>6</sup> capturing atmospheric phenomena through sensing traces back to an extensive history preceding the advent of computation and electronic media.<sup>7</sup> This historical backdrop encompasses a tapestry interwoven with artistic, scientific, technological, and mythological threads, constituting a fertile ground for fostering a symbiotic imaginative space placed around atmospheric processes.

Historian of science, Liba Taub makes a comprehensive study of ancient meteorology, noticing register techniques to decode repeatable and predictable phenomena in the weather, unraveling correlations within atmospheric events.<sup>8</sup> Taub underlines how ancestral weather wisdom was dedicated to elucidating immediate dynamics and prognosticating future conditions. Her study promotes that inscription tools and methodologies proved crucial to clarify the spatial-temporal dynamics of weather, enabling registration and comparison of sequential events. Simultaneously, predictive strategies encompassed the observation of animal behavior, linking with planetary cycles that persist in today's atmospheric knowledge.

Conceiving the atmosphere as a medium facilitates a holistic comprehension of the intricate web connecting sensing and perception within its realm. This perspective elucidates the nuances between environment and observer, sensation and cognition, and consciousness and perception. By echoing existing contributions surrounding our atmospheric milieu and its role as a communicative medium,<sup>9</sup> my exploration centers into the realm of weather sensing media, highlighting an environmental awareness of the reciprocal influences between organisms and their surroundings. Central to this investigation is the notion of *atmospheric attunement*, a concept that echoes our complex experience with our environments. This notion accentuates the parallels between biological entities and technical systems in adapting and responding to processual atmospheric dynamic.

My proposed notion of *hybrid listening* embarks on a quest to forge an alternative techno-embodiment of atmospheric processes. Rooted in a symbiotic potential of combining organic and artificial dimensions, this endeavor aims to establish an attuned relationship with the atmosphere. The envisioned system harmonizes the capabilities of technical frameworks with the situated and embodied dimensions intrinsic to the extensive temporal canvas of Meteorology. Drawing inspiration from archaic sources, these paradigms shape the contours of ubiquitous and embodied computational systems, offering a novel perspective on our engagement with atmospheric phenomena.

## Atmospheric Soundscapes

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Previously in my career (2012 - 2016) I experimented with creating soundscapes employing kites as instruments to amplify the wind's forces during this activity. Adopting a Sonic Interaction Design approach, I delved into an intricate interplay between the kite's motion and sound, grasping a dynamic equilibrium between human control and environmental agency.<sup>10</sup> Through the fusion of sonic digital media with existing tools like kites, a realm of augmented and novel agency emerged, fostering interaction with the encompassing environment.

These initial experiments spurred me to delve into a fragmented history of weather measurement instruments, unearthing a rich tapestry of artistic scientific endeavors. This inquiry allowed me to delve into a broader spectrum of experiments where human and technological senses converge in the environment. Among these historical figures, Athanasius Kircher, a

polymath and instrument inventor, stood out. His creation, the Aeolian Harp,<sup>11</sup> seamlessly blended musical instrument craftsmanship with an animistic ethos, resonating with meteorological exploration by granting voice to the surrounding atmosphere.<sup>12</sup>

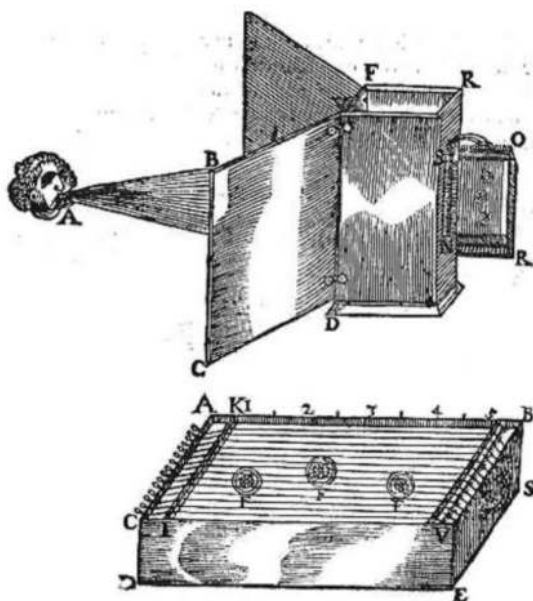


Figure 1. Aeolian harp. Athanasius Kircher. *Musurgia Universalis*.

These ancestral artifacts possessed the capacity to translate environmental dynamics, offering insights into the flow of wind through the medium of musical sensitivity and artisanal skill<sup>13</sup>. Among other inventions of this kind, these devices could convince society by demonstrating meteorological knowledge through artistic expression. Besides, this perspective is useful to trace contemporary practices that meet at the intersection of art, science, and technology.

Notably, these ancient manifestations harbor mythological and speculative concepts that connect with representations and myths. One could argue that the aeolian harp confers a more-than-human “voice” to air and wind dynamics. These artifacts resonate with the atmospheric medium and become perceivable for humans. By building upon these insights, my project entitled *Aeolian Artefacts*<sup>14</sup> generates immersive soundscapes from wind energy and that is transmitted into the “ether.” This device sources wind detection through microphones across four points, generating soundscapes that mirror the wind’s intricacies at each sensing point. The resultant auditory output is transmitted via FM radio, speculating artistically on potential correlations between wind and electromagnetic energies.



Figure 2. *Aeolian Artefacts* - Environmental sound device, responsive to wind flux.

## The Deep Time of Sensing the Atmosphere

Meteorology was originated in the context of the Ancient Greece, back when it was thought that weather was influenced by the astral events occurring outside our planet, such as comets, visible from our planet.<sup>8</sup> The root term meteor has a meaning connected to time-related phenomena, thus reading the sky has been associated for a long time with the sequence of time.<sup>15</sup>

Taking a deep-time perspective on sensing and comprehending the atmosphere involves an examination of tools, methods, and artifacts. Rather than isolating them by their technological or embodied nature, my proposal advocates for their amalgamation. This integration encompasses not only the physical aspects but also the embedded meanings and narratives inherited from ancient meteorological myths, interwoven with contemporary scientific revelations regarding atmospheric phenomena. This approach to a deep time of sensing the atmosphere informs my artistic practice to give a context for designing a sound instrument with certain affordances valued in the history of these tools, methods, and artifacts.

Historian and media theorist Maximilian Hepach highlights an intriguing parallel between mythology and phenomenology in their capacity to conceptually encapsulate the fleeting yet enduring temporal intricacies of atmospheric climate and weather.<sup>16</sup> Both historical and modern perceptions of climate share a celestial genesis—a vantage point akin to that of a divine entity observing Earth from the cosmic expanse. Aligning with Platonic reasoning, Hepach consider that these mythological frameworks don't stand in opposition to rational discourse; instead, they play a role in altering our perceptual landscape, unfurling novel interpretations and avenues of experience.

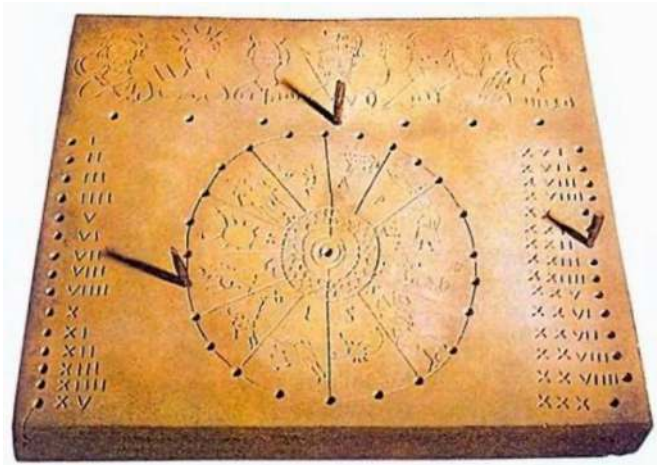


Figure 3. The Greek-Roman Parapegmata. Public domain.

## Ancient Meteorology

Exploring the Aeolian Harp's role as a weather instrument prompts an investigation into analogous historical manifestations.<sup>6</sup> The legacy of the Greek-Roman School of Meteorology<sup>8</sup> sprouted from philosophical inquiry aimed at unraveling the intricacies of weather and eventually evolved into predictive practices. Hesiod, the poet active around 750-650 BC, inaugurated Astro-meteorology, interweaving astral events with weather predictions. Ptolemy's approach to Astro-meteorology hinged on the interplay of stellar risings and settings, attributing his prognostications to cosmic harmony.<sup>8</sup>

Among the commonly utilized ancient weather instruments was the Parapegmata—a prevalent fixture in Greek-Roman cities.<sup>8</sup> This inscription-based medium resembled a calendar but was tailored for weather forecasting. By sequencing and combining events, it provided estimations of forthcoming weather, wind patterns, bird sightings, and river levels. This holistic approach embraced cues from natural phenomena and animal behavior as indicators of impending weather conditions.

Aristotle's meteorological treatise marked a watershed moment, describing weather through observations of the four elements and their interactions—earth, water, and wind—attributing phenomena like tornadoes and storms to their interplay. This marked the advent of weather observation and measurement methodologies. Early precision instruments, such as the hygrometer, were employed to gauge humidity levels in soil and air. The device compared the density of a charcoal sheet exposed to the air with an unexposed one.

Mythological narratives in Homer personified the winds, aligning them with cardinal points. This led to visual representations, such as the wind rose and anemographic chart. Jansson's 17th-century wind chart, a colonial navigation tool, personified thirty-two wind directions, associated with racial traits from their regions.<sup>17</sup> It featured nomenclature in six languages, including Greek, Latin, and Dutch. Along these lines, Alexander Humboldt's isothermal chart guided settlers to regions with European-like weather, aiding colonization in temperate or cold environments.<sup>18</sup>

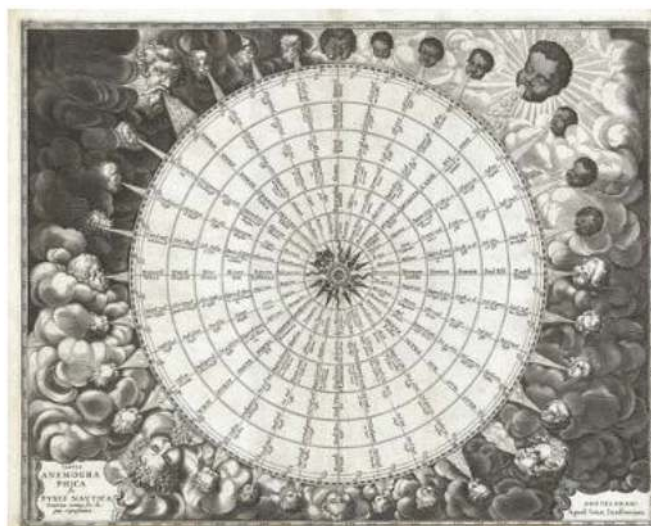


Figure 4. Jansson's *Anemographic chart*.1650.

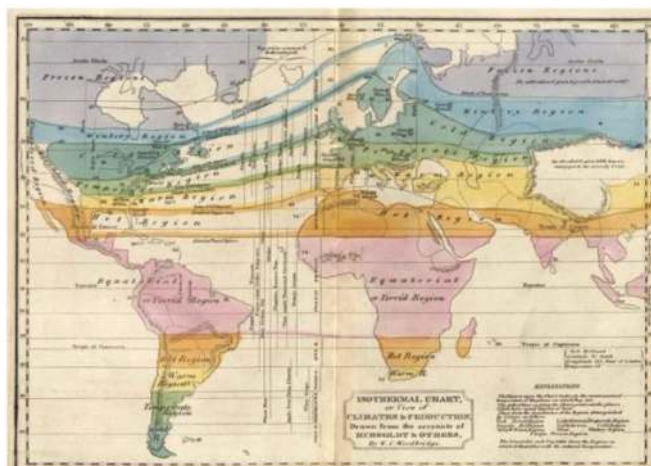


Figure 5. *Isothermal chart* by Alexander Humboldt. 1823.

## Atmospheric-related divination

Aeromancy, an ancient art, entails predicting broader life-affecting occurrences through the observation of clouds, wind patterns, and changes in animal behavior. Augury and Ornithomancy, divination practices rooted in interpreting bird behavior, further enrich this tradition.

Augury, foundational to ancient Rome,<sup>19</sup> offers a unique approach to engaging with the atmosphere's imperceptible dimensions.

Recent scientific revelations align with these divinatory practices. Many migratory birds possess magneto-reception, primarily located in their beaks where magnetite particles bestow a sense of geographic orientation.<sup>20</sup> Additionally, their eyes harbor cryptochromes capable of detecting planetary magnetic fields.<sup>21</sup> Their infrasonic sensitivity enables them to anticipate storms and extreme weather conditions.<sup>22</sup>

Another case of divinatory practices which pertains to my artistic research is the case of Scrying, which proceeds from the Aztec culture and the use of obsidian artifacts, based on the myth of the smoking mirror "*Tezcatlipoca*." Aztecs had rituals of divination to invoke the agency of the lord of the smoking mirror to enable them to see beyond what was imperceptible by human senses.<sup>23</sup>

Art and Science scholar Hannah Star Rogers explores technologies as modern divination tools. She posits that these can assign meaning by directing attention to the otherwise imperceptible aspects of the natural world, expanding our interpretation of phenomena beyond our regular senses. Rogers emphasizes the synergy of embodied and technology-driven atmospheric sensing, bridging the ancient art of divination with modern technology. Conceiving weather events through this lens involves an empirical analysis across diverse perceptual phenomena, discerning patterns from elements like oxygen composition, orientation, temperature, and electromagnetism.<sup>24</sup>

Viewing atmospheric sensing through a divinatory perspective encourages contemplation of the environment to seek answers. Can uniting ancient and contemporary worldviews offer glimpses into the future or unveil the unseen facets of our current reality?

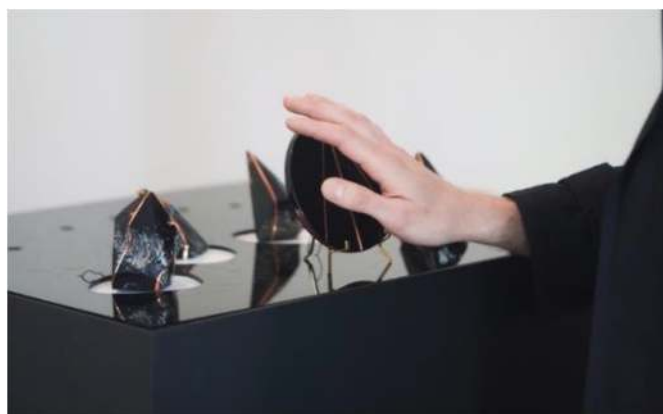


Figure 6. Scrying obsidian mirror and pieces used in the media installation Augury.

## Modern Meteorology

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Conceiving atmospheric processes within an interconnected framework emerged as a paradigm in the early 20th century, giving rise to contemporary meteorology. This shift marked a departure from earlier empirical methods and ushered in the foundation of weather science.<sup>25</sup> Meteorologists of that era focused on surface conditions, employing sparse weather stations interconnected through telegraph lines, supplemented by limited upper air measurements conducted by Aerologists utilizing kites and balloons.<sup>26</sup> The drive for robust predictive science was contingent on key advancements, including wireless telegraphy and the advent of weather modeling and statistical analysis.<sup>27</sup>

Analogous to an ocean of oxygen, the atmosphere possesses a reservoir of energy dwarfed by that contained in oceans, contributing to its relatively mild temperature fluctuations. The ceaseless circulation of winds and currents, both large and small, occurs in perpetual vortices termed solenoids, striving for equilibrium yet never fully attaining it. Toward the end of the 19th century, statistical aggregation gained prominence, coupled with the establishment of climatology as a field of practice.<sup>27</sup> Vilhelm Bjerknes, a Norwegian scientist, catalyzed a transformation by synthesizing empirical meteorology with physical laws in the late 19th century. He devised a method anchored in the principles of thermodynamics for weather prediction. His prognostications hinged on calculating seven parameters: velocity across three dimensions, pressure, density, temperature, and humidity. Bjerknes' background in electrodynamics and wireless telegraphy conferred insights into studying hydrodynamic waves coursing through the real fluid atmosphere. Such methodologies aimed not to supplant intuition but to amplify it. Bjerknes' pioneering efforts culminated in the inception of the Bergen School, pioneering scientific weather analysis and forecasting. This school revolved around meteorological observations, data assessment tools, and models elucidating atmospheric structures.<sup>25</sup>

## Computer-Based Atmospheric Predictions

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Despite the integration of telegraphic networks across various weather stations, empirical weather prediction remained inherently imprecise. Consequently, the shift towards computational weather models and numerical forecasting emerged as the novel cornerstones in

meteorology.<sup>15</sup> This transformative juncture propelled Meteorology into the vanguard of civilian computing utilization, paralleled only by nuclear science endeavors. The inception of Numerical Weather Prediction coincided with the nascent era of computing, led by John Von Neumann. His vision recognized the convergences between nuclear science and the intricate nonlinear physics governing weather phenomena.<sup>27</sup>

This synergy led to a crucial moment when the ENIAC computer was deployed to test weather forecasting utilizing models developed by the Bergen School. By connecting disparate data points from various weather parameters, this approach sought to forecast weather outcomes. Midway through the 20th century, global implementation of weather forecasting via the ENIAC proved successful, yet refining computer models to approximate human forecasting capabilities required several subsequent decades.<sup>27</sup>

## Atmospheric synthetic cognition

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The evolution of remote sensing in Meteorology emerged as a standardized practice, driven by the need for computational environmental awareness and the monitoring of atmospheric dynamics. This paradigm shift ushered in an era where sensing networks and computing models replaced human intervention, particularly within the realms of satellite and radio technologies. This transition to sensor-computing diminished the influence of human bias in information acquisition, reaching beyond the limits of human perception.

Postmodern literary critic Katherine Hayles delves into the hybrid convergence of organic and artificial systems attuned to the atmosphere, an alternative mode of interaction with atmospheric processes comes to light through the notion of Cognitive Assemblages.<sup>28</sup> According to literature scholar Mark B. N. Hansen, these kinds of assemblages, founded upon ubiquitous computing and environmental computation, encompass technical systems like smart dust, characterized by a micro-temporality of sensing and engendering sensations that precede conscious human cognition [Hansen]. While devoid of consciousness, these cognitive systems enable a direct and immediate connection to the sensory world, enabling the synthesis of peripheral information or even facilitating novel forms of experiential cognition that transcend conscious-related representation and memory. This technical attunement empowers humans to immerse themselves

fully in the act of sensing, prioritizing sensory engagement over the perception of atmospheric phenomena.<sup>29</sup>

In this framework, ubiquitous computing manifests as cognitive assemblages through networks of sensors, receptors, actuators, and their programmed cognitive processes. This combination engenders a procedurally distributed approach to atmospheric sensing across expansive territories, seamlessly merging "natural" environments with the synthetic cognition furnished by computers. Jennifer Gabrys looks at how these novel sensor technologies are primed for atmospheric operation; for instance, gauging pollution levels and generating reports that inform public policies.<sup>9</sup> In this context, the atmosphere transforms from a foundational backdrop into a dynamic context that shapes and is shaped by sensor technologies, akin to the integration of the aeolian harp's music into the natural soundscape.

For technical systems, atmospheric sensing transpires primarily within the physical medium, devoid of conscious awareness. Sensibility precedes perception, embracing direct interaction with the sensory realm itself, transcending specific objects accessed by consciousness [29]. Ubiquitous computing and pervasive sensing systems facilitate the catalysis of sensation, operating on a micro-temporal scale that transcends human perception and adheres to non-biological technical protocols.<sup>29</sup> This synthetic framework engenders a hybrid attunement to atmospheric processes, synthesizing information in a peripheral manner and fostering novel cognitive experiences unburdened by conscious-related representation and memory of atmospheric encounters.

Along these artificial sensing and cognitive processes, Katherine Hayles's concept of Nonconscious cognition is useful to elucidate the nuances of synthetic atmospheric sensing, encapsulating emergent effects, fluid mutations, and transformations. While remaining beyond human perception, these technical systems infuse our atmosphere with meaning, utilizing somatic markers such as chemical or electrical signals coherent to their operations. This interaction harnesses the cognitive potential of computational media, adapting to the dynamic shifts of an environment like our atmosphere.<sup>28</sup>

## Embodied Atmospheric Attunement

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Media theorist Desiree Förster underscores a kind of atmospheric sensing from an embodied perspective, wherein atmospheric processes, though invisible,

envelops us in a multi-sensory embrace, engaging our senses through various channels such as touch, scent, sound, and respiration. While the immediate perception of atmospheric shifts might elude us, their profound impact on our environment remains undeniable<sup>30</sup>.

Atmosphere(s) intertwine with our sensory experiences, reciprocally rendering the perceiver and their act of sensing palpably present. This way, contemplating atmospheres as environments for a diverse array of organisms underscores their capacity to abruptly recalibrate awareness, thrusting themselves from the backdrop to the forefront of our attention.<sup>30</sup>

Navigating the realm of an ever-transforming atmosphere necessitates to become familiar with its dynamic essence, thus fostering the need for attunement. Atmospheric attunement entails developing an acquaintance with these atmospheres by discerning the effects they exert on our physical and cognitive faculties. This process of attunement involves aligning with something approaching, yet not entirely present—an ephemeral unity with the world, a connection that transcends comprehensive grasp. For instance, the Deep Listening methodologies pioneered by composer Pauline Oliveros<sup>31</sup> exemplify a form of attunement to acoustic reflections from our surroundings, exemplifying a mode of engagement.

As such, atmospheric attunement encompasses an engagement with the intangible, an intimate negotiation with the ever-shifting currents of our surroundings. It calls us to forge an implicit unity, an interaction that defies conscious awareness and perception, yet binds us momentarily with the vast mosaic of atmospheric processes.

## Atmospheric hybrid listening interface

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Building upon the concepts outlined earlier, a visionary instrument emerges—a conduit for crafting immersive soundscapes that echo the deep-time of atmospheric sensing and synthetic cognition. This innovative instrument draws from diverse realms, uniting the threads of ancient practices, modern technology, and *hybrid listening*.

The essence of this multichannel instrument lies in its capacity to synthesize soundscapes from the intricate mosaic of atmospheric events and dynamics, seamlessly merging the temporal layers of deep-time sensing and contemporary synthetic cognition. By crafting sensory instruments calibrated to discern atmospheric nuances,

a novel form of hybrid listening takes shape, an amalgamation of embodied and technical attunement that spans the spectrum of wind and natural radio.

At its core, this instrument embodies a divinatory approach, akin to augury, where weather stations serve as modern-day augurs. This convergence births a symphony that resonates with the rhythms of the atmosphere, a sonic reflection of the flow of meteorological phenomena. The soundscape generated becomes a medium for extended listening of the surrounding weather, transcending geographical boundaries as it carries the ambiance of distant sensor stations to the ears of the listeners.

An intricate web of ubiquitous computing systems breathes life into this interface, orchestrating remote operations and ushering in an array of atmospheric data streams. These streams, point out to predict the possibilities of future events, guiding users into a profound attunement to atmospheric processes. This interface paints a canvas of sound, bridging time and space, where the fusion of ancient and modern, tangible and synthetic, coalesce to forge an auditory tapestry that harmonizes humanity with the intricate cadence of the atmosphere.



Figure 7. Prototype of a multichannel interface for atmospheric soundscape immersion.

## Conclusions

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In this paper, I have delved into the landscape of my artistic exploration and research centered around the art of sensing the atmosphere to craft captivating soundscapes, underlining two milestone projects: *Aeolian Artefacts*, and *Augury*. Drawing inspiration from the rich panorama of meteorological history, I've traced the interplay between ancient mythologies and scientific advancements in meteorology, culminating in the

conceptualization of an ongoing developing instrument—a conduit for attuning to the intricate rhythms of atmospheric processes.

This exploration underscores the symbiotic relationship between embodied engagement and synthetic interfaces. The instrument's inception rests upon a foundation of hybrid connections, weaving together the threads of mythology and scientific inquiry into an evolving work in progress. The bridge between ancient wisdom and modern understanding of our atmosphere provides the underpinning for an instrument that fuses human sensibility with technological agencies that extend our experience about the weather.

As this artistic research unfolds, the embodiment and synthetic attunement to atmospheric processes will be explored further through the lens of interaction design. The forthcoming stages of development will navigate uncharted territories, transforming concepts into tangible experiences. Through this dynamic interplay, the aspiration is to create an instrument that serves as a gateway—a harmonious amalgamation of past and present, mythology and science, ultimately offering a profound auditory connection to the ever-shifting atmosphere.

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## Author Biography

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Juan C. Duarte Regino is a Mexican artist-researcher and current Ph.D. candidate at Aalto University in Finland. His research revolves around the exploration of the symbiotic relationship between nature and technology through environmental sound.

His artistic endeavors have gained recognition and have been showcased at prestigious events and venues such as the ISEA, NIME, CTM Festival, Spiral Gallery,

Pixelache, IAMAS, RIXC, Media Art Histories, Ujazdowski CCA, Goethe Institut, ETH Zurich, and Medialab Matadero. [<https://www.juanduarteregino.com>]

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