Narratives of Scale in the Anthropocene

Imagining Human Responsibility in an Age of Scalar Complexity

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Chapter 3

Time Depth: Jean Epstein, Michel Serres and Operational Model Time

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3 Time Depth

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A hissing silence. While the sound cannot find its signal-to-noise ratio between monophonic interferences and crackling static, we can see arrested images of low tide. A motionless landscape, ossified bushes, still images of humans. A coastal Holocene landscape, set in Brittany (Figure 3.1).

Then, perceptible movement. Wrinkles appear in the sea, and life-giving micro-amplitudes emerge out of the grey continuum of the Breton black-and-white still life. The bushes are now shaking slightly. A first recognizable sound lands: a weak wave breaks upon the beach. A breeze—nonhuman—pushes a wooden door open, as if it were a superhuman will. Mortal eyes watch this gap in the wall opening, spellbound. Two women, one old, one young, sit and knit and spin and remain silent (Figure 3.2).

The door, though, is not speechless. As an instrument, it lends an indicative language to the wind. It opens up to let a breath of air level the information divide between the inside and the outside, thus associating the nonhumanity of the wind—a medium by itself—with the humanity of the mortal eyes. The young woman, being in love and thereby receptive to the invocation of the wind, immediately understands: "It's a sign," she says. "A bad sign" (0:02:48) (Figure 3.3).

A faint breeze widens the angle of a door, thus indicating an omen. Something may or may not come. An announcement, not a prophecy. "No sign, it's just the wind" (0:04:12), her fiancé reassures her, before setting out to sea to fish for sardines. "The wind frightens me," she answers. Yet the wind immediately takes this whisper away, abducts the confession from the young man's comprehension.

As announced by the wind and its indicating instrument, the door, the breeze turns into a storm. After an anxious night, in which the young woman's song is cut against the roar of the churning sea, the old woman tells the young one about the ancient "Tempestaires," the "Tempest Masters" or storm healers, "who knew how to control a storm and make it obey them." "They would make the sea calm down," she explains. "But these are old stories, you shouldn't believe them anymore, no" (0:11:20) (Figure 3.4).

Instead of disbelieving, the young woman sets off in search of a Tempestaire. Only an intervention in the earthly events can soothe her anxiety.

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Figure 3.1 Jean Epstein, *Le Tempestaire* (0:01:21) (© La Cinémathèque française).

Figure 3.2 Jean Epstein, Le Tempestaire (0:02:28) (© La Cinémathèque française).

Figure 3.3 Jean Epstein, *Le Tempestaire* (0:02:32) (© La Cinémathèque française).

Figure 3.4 Jean Epstein, *Le Tempestaire* (0:09:54) (© La Cinémathèque française).

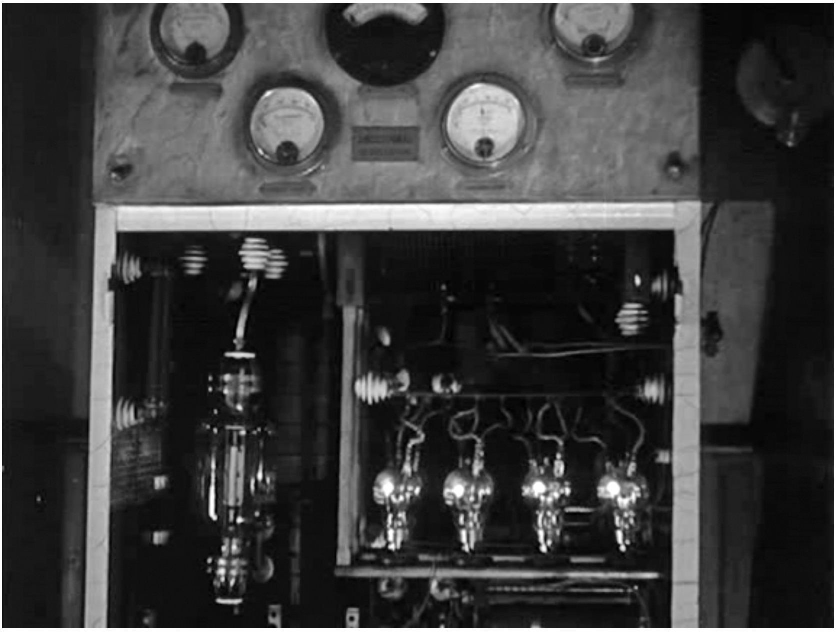

Figure 3.5 Jean Epstein, *Le Tempestaire* (0:14:29) (© La Cinémathèque française).

At first, the heroine turns to those who have delegated their knowledge to the apparatuses. An endless string of choppy Morse code sounds as she enters a lighthouse, the situation room monitoring the storm. Airily, a technician points at the large metal cabinet behind him (which he does not operate, but cleans and looks after, "services"). "A healer?" he muses. "There's the radio, it doesn't heal but it relieves the navigator" (0:14:08). Thus, we learn that the five electron tubes, glowing in a chamber visible at the heart of the cabinet, are a wireless (Figure 3.5).

Disappointed, she turns to another technician. And indeed, this one knows where the old Tempestaire lives, saying that he could probably be elicited to give "a good weather forecast" (0:14:19) with a bottle of liquor. This old man, Père Floc'h, can be seen in the next shot, as he, too, is cleaning, but this time a garden, apparently forking the wind out of the scrub. Having finished his work, he closes the door to his house, a half door that can regulate the exchange between the inside and the outside in a staggered manner.

When the young woman hurries to him, the Tempestaire, however, is not keen to talk and refuses at first. Only her beseeching eyes soften him. Again, a tall cabinet, this time an artfully decorated wooden one, from which the storm healer pulls out a glass orb (Figure 3.6).

Time-lapsed clouds, cut, Tempestaire, cut, clouds, cut, Tempestaire. The storm tamer begins his work and the film editor starts his own. Inside the

Figure 3.6 Jean Epstein, *Le Tempestaire* (0:19:14) (© La Cinémathèque française).

glass ball, the roaring surf is televised, and then superimposed with a long shot of the roaring sea coast. Four times in hard cuts, including missing half seconds, the image of the electronic tube cabinet from the lighthouse pops up in between. While the Tempestaire blows on the orb like a bony Zephyr, the filmed surf *rewind*s backward. Sea and rock separate, spray becomes wave. Finally, the storm calms down, the crystal ball shatters on the floor. Instantaneously, the fiancé appears at the open door, his dry scarf hanging limply. Last scene: the two humans of the future walking between sea, sky and land (Figure 3.7).

The hard-cut arrangement of the Tempestaire blowing into his glass orb, the wireless and the roaring sea exemplifies a primeval scene. It realizes a visual handover between mythical and modern practices of weather control, between human agency, electronic futurities and geological vastness, and it does all that in the very historical moment when electronics and computer-aided simulation set out to become the dominant epistemic form in which natural and geophysical phenomena are transcoded. The visual interlacing of the three protagonists—the storm, the stormhealer and the wireless—celebrates a generous productivity of both myth and modern technology, and, by extension, the near-mythical powers of time manipulating cinema that neatly captures the hybrid temporalities in which humans are situated in dealing with the natural world, right in a moment when the world becomes otherwise.

Figure 3.7 Jean Epstein, *Le Tempestaire* (0:21:27) (© La Cinémathèque française).

Finis terrae, exorgium maris

Jean Epstein shot *Le Tempestaire*[1] (1947) in the winter months of 1946/47 on the island of Belle-Île-en-Mer, off the Atlantic coast of Brittany—Finis Terræ, as the region has been called since Roman times. Ever since his film of the same name, *Finis Terrae* (1928), Epstein sought to fulfill his programmatic quest for new "approaches to truth" (Epstein 1981). In crossfading the "abundance of the real" of the harsh Breton coast with the educing powers of the "intelligent machine" of the cinematograph, he found an aesthetic technique through which "the fantastic should be unveiled rather than manufactured" (Schneider 2012, 196f.; Epstein 1946). Toward the end of this 20-year-long, and biographically terminal, "maritime period" of Epstein's work, the winter storm captured in *Le Tempestaire* provides the mise-en-scène for a lost world at the very margins of a continent devastated by machine warfare. "In the original script," notes the filmmaker James June Schneider, Père Floc'h "collapses and dies from exhaustion" (Schneider 2012, 204).

Still, what is the end of the land, *finis terræ*, is only the beginning of the sea. About 3,000 nautical miles further west, at the other end of the Atlantic, an electron tube apparatus was being projected during the same winter months of 1946/47, a device which was supposed to deliver not only "a good weather forecast," but also to realize the Tempestaire's work itself.

In Princeton, New Jersey, the television pioneer Vladimir Kosma Zworykin and the much younger mathematician and theoretical physicist John von Neumann were pondering on a comprehensive scheme of electronically guided weather control.

Zworykin, the famous developer of the iconoscope tube and vice president of the Radio Corporation of America (RCA), had already circulated a short proposal among a few scientifically like-minded colleagues in the Princeton and Washington area in late 1945. In this proposal, he laid out his vision for global weather control, "a goal," he stated, that should be "recognized as eventually possible by all foresighted men" (Zworykin 1945). Zworykin suggested that rainfall could be triggered by shockwaves, or clouds seeded with ice or dust. Longer-term climatic improvements, in turn, could be achieved by large-scale changes in vegetation and alterations to deserts, mountains and glaciers. He also proposed geoengineering techniques such as the extensive use of flamethrowers, igniting spilled oil on the sea's surface or detonating atomic bombs to affect local heat balances and thereby divert ocean currents or hurricanes.[2]

In essence, Zworykin's argument was that of an electronics engineer. He proclaimed that relatively small amounts of selective energy input (like atomic bombs) might discharge or control far greater amounts of energy (hurricanes), thus triggering a phenomenon either to develop or to reverse. The analogy here can be seen in the design of the triode valve: much as the control grid attenuates the electron current, so the controlled detonation of nuclear bombs would attenuate the nascent upflow of water and energy from the sea. Formulated to the extreme, Zworykin's conceptual model arranges the whole tropical Atlantic into a kind of super cathode ray tube, promising an interventionist laboratory that would divert all hurricanes between cathode Africa and anode America in a controlled fashion.

However, treatment must follow diagnosis. Zworykin's megalomaniac scenarios for weather and climate control required an essential precondition: a precise and, if possible, globally scaled prediction of the generation and further evolution of weather phenomena by electronic computing devices. Here, his fellow Princetonian, John von Neumann came into play. Since the spring of 1945 von Neumann had been trying to drum up support for constructing an experimental computer at his own institution, the Institute for Advanced Study. Von Neumann shared Zworykin's enthusiasm, but rejected his idea of a statistical approach to weather prediction. Instead, he advocated the use of brute computational force to tackle the challenge of solving the thermo- and hydrodynamic equations governing the evolution of weather systems (cf. Rosol 2017).

Thus, in the winter of 1946/47, the younger man commissioned the older one to develop storage tubes for an electronic computer meant to integrate the thermo- and hydrodynamic equations representing atmospheric motion, i.e. the wind. In this very moment, numerical weather forecasting and electronics merged in a somewhat phantasmagoric scenery of weather control. Zworykin's original pamphlet represents a rather peculiar and hypertrophic point of departure for a phenomenal historical trajectory that leads from postwar America to today's climate and Earth system modeling. In this datable and locatable "marriage" of predictive meteorology, modern computer design and cybernetics, the modern simulation sciences were formed, and with them a scientific practice which today constitutes the material and epistemic core of knowledge production in the vast majority of the natural, engineering and even social sciences.

While, at the western end of old Europe, the final exercise of a magical technique of weather control was being staged on film, a physical-mathematical technique of calculating and managing the weather was being worked on at the eastern end of the New World. That doesn't necessarily mean that one indigenous technique died and a technoscientific discipline took over, as a romanticized or pessimistic interpretation of Epstein's film would assert. Instead, positions and powers in the order of the symbolic world were reordered, cut against each other and reformatted. Although the electron tubes of the lighthouse are merely part of a wireless sending and receiving ships' messages, their offsprings will soon become the electronic valves which also switch between two states by opening up or closing electric circuits. Just like doors, in the language of the film.

"In its nature," says Jacques Lacan just a few years after the physical-mathematical techniques had joined forces with cybernetics and then swashed back to France, "the door belongs to the symbolic order, [as] it opens up either on to the real or the imaginary, we don't know quite which […] [it is] the symbol par excellence" (Lacan 1988, 302). The two wooden doors showcased in Epstein's film that regulated, leveled and mixed the inside with the outside in staggered ways are merely transcended by the realization of "cybernetised doors"[3]: digital electronic gates, or flip-flops that carry out a logical chain of feedbacks, in which openings trigger closings and closings trigger openings. This "passing into the realm of realisation of cybernetics" (ibid.) has indeed unhinged the door as such:

> In a space where inside and outside are thus folded, wired, and coupled into each other as feedback loops, doors as cultural techniques have lost their moorings […] [and] no one knows anymore whether a door opens to the imaginary or to the real.
>
> (Siegert 2015, 205)

However, what has been passed on is their indication and exemplification of the symbolic world, which is, again with Lacan, "the world of the machine" (Lacan 1988, 47). For the Polish emigrant Epstein, the opening door was "a sign" unveiled by the "truthfulness" of the cinematic camera, truthful with regard to the storm and the natural elements. For the Russian emigrant Zworykin and the Austro-Hungarian emigrant von Neumann, the truthfulness of the "sign" would be a matter of signal fidelity in the computing machine that calculates that very same storm.

Operative time

Long before it has become dependent on the inside-and-outside indiscriminate performance of logical gates in a computer, science has had to use epistemic doors. Simulations and other cultural techniques of the exemplary that help opening up either to the imaginary or to the real represent, in fact, ubiquitous functional principles of doing science ever since its beginnings (Serres 2002–2003). Making an experiment, even a physical one, means formatting aspects of an unreducible real world into a world of the symbolic. In other words: epistemological order is generated by means of instantiating and empowering certain technical media. Only these make it possible to differentiate, exclude, enclose, (re-)couple, calculate and argue. Conducting a virtual experiment, i.e. a computer simulation, makes no difference. This is particularly the case in what can be regarded as simulation's archetype: numerical weather forecasts, born in the years of 1946/47, and now, after growing in complexity to first climate and then Earth system models, became the most instrumental epistemic formations for comprehending but also narrating the very Anthropocene scaling that is the subject of this book.

Simulation is a universal technique, most powerfully employed in studying the evolution of dynamical systems, no matter whether these represent population dynamics, chemical reactions or weather systems. What is special about simulation in geophysical disciplines such as meteorology, climate science, hydrology and sedimentology is that they function by establishing and balancing specific concepts of instability: nonlinear dynamics, emergence, chaos, complexity. The radically empirical undertaking of the geosciences can only succeed in a context-related, local, "case by case," or "point by point" way; i.e. it is always only applicable to a certain temporally and locally defined problem. Space and time variables have to be set and constrained, e.g. by the initial atmospheric conditions for the hourly prediction of weather systems, be they located west of Brittany or east of the Bahamas; in the boundary conditions set for modeling Earth system sensitivity on the basis of specific emission scenarios in the twenty-first century; or in the reconstruction of the climate of the entire Holocene. In that sense, time is made operative; it is the time of the model, or model time.

Interestingly, the climate and Earth system sciences can do all this with astonishing heuristic sufficiency, while simultaneously placing a high value on efficiency, i.e. on computing time, choice of model, etc. A combination of technical media, practices, operations and concepts stabilizes the knowledge of the unstable by quantifying and comprehending it in its respective specificity, locality, and—more than anything else—its particular temporality, while keeping themselves highly flexible and adaptable to the complex system they are attempting to represent. The matters of the "geo" are always in flux and, hence, so is its science. Putting it provocatively, one might say that climate and Earth system simulation does mimesis on what Bronislaw Szerszynski has called the "living memory" of the fluid itself, "a memory of energy, stored in motion and intensivity, that has to be continually maintained in action or it almost literally evaporates" (Szerszynski 2019, 229). In that sense, model time is operative because climate time is operative.

Michel Serres' communication theory offers an approach to how this mimetic function of simulation sciences can be made productive for the humanities. Throughout his work Serres not only continuously made attempts to translate the sciences of the physical (the lighthouse in Epstein's film) into the language of anthropology and literature, of myths and legends, of experience and suffering (Epstein's filming of the lighthouse) (Serres 1995). He also considers both these domains of knowledge to be isomorphic, by attributing them principles of communication: mediations, transmissions, interferences and the founding of relationships. If one assumes, as Serres did, that agency in nature and culture takes place on the basis of the exchange of information, the translation difficulties between their respective sciences become less of a problem.

Another angle on this subject is given by Serres' topological theory of history: his figuration of a folded time in which distant events, theories or practices can appear very near, while those nearby can become quite distant. In the manner of a folded, crumpled handkerchief, in which points on the surface that are woven far apart from one another can suddenly also adjoin each other, Serres' model folds historical time, so that the linear spacings of a smooth, metric space-time of a history of knowledge turns into a dynamic, contextual and swirling network of relationships (Bennett and Connolly 2012). In the more than two millennia old didactic poem *De rerum natura* by Lucretius, for example, Serres sees a modern climatological physics at work, a physics in the sense of a qualitative thinking of the form of inclination, the small deviation within the laminar flow of matter, that addresses turbulence and chaos in essentially the same manner as is done today (Serres 2000). Such folding of *historical* time, however, is not just a matter of historiography for Serres, but it is in accordance with something much more fundamental, namely, the *ontological* basis for both geophysical and living systems, or what he has termed "Biogea": a single, circular entity that combines Earth and life (Serres 2012). "All times converge in [a] temporary knot" (Serres 1982, 75), he writes, an entanglement characterized by the eternal homeorhetic flow of natural systems, i.e. dynamical (fluid) systems that remain stable through their flux, returning to an inherent trajectory, even when their (solid) surroundings change, like "a river that flows and yet remains stable in the continual collapse of its banks and the irreversible erosion of the mountains around it. One always swims in the same river, one never sits down on the same bank" (ibid.).

As we turn our gaze onto the unfolding of the Anthropocene today, a similar figuration appears, although on a slightly different and rather perplexing level than historical time. Within the operative model-data bind of current climate modeling we realize that a geohistoric event like the Paleocene Eocene Thermal Maximum (PETM), a notable carbon anomaly which took place 55 million years ago, marks the closest geological analogue to our current climatic transition (McInerney and Wing 2011; Gingerich 2019). Suddenly, because it affects our present, something like an abrupt climate transition that took place 55 million years ago comes frighteningly close, while the all too familiar world of late modernity, say 55 years ago, with its still somewhat stationary climate in which generic history was able to unfold, may very soon seem very far away. Or, as the charismatic geologist and climatologist Richard B. Alley noted, when comparing the PETM with the Anthropocene: "things get out of place and out of time, as it were" (Alley 2009).

It literally depends on today's decisions on how far we catapult the climatic boundary conditions of the planet back behind the (astronomically driven) climate changes of the Quaternary and into CO_2-rich periods of Earth's history. While we have already left the unassailable Holocene domain and the warm periods of the last few interglacial periods—or to be more precise: the relatively stable glacial–interglacial limit cycle of the past 2.5 million years—our view will even have to go far beyond the middle Pliocene about 3–4 million years (Ma) ago, when the atmospheric CO_2 concentration was at about the current level and a corresponding 2–3°C higher global temperature prevailed. We would even have to go back behind the climate optimum of the Miocene before 17 Ma, whose global temperatures of 4–5°C we will probably reach in the next 100 years if emissions go on unabated, a level which translates into a sea level rise of 10–60 meters in the longer term. Indeed, if rapid decarbonization is not achieved, if strategies and technologies to remove carbon dioxide from the atmosphere are not available in time and no climate engineering Zworykin–Zephyr Tempestaire can do its healing and taming, we will see internal biogeophysical feedback processes in the Earth system coming into play as tipping-point cascades will be touched off rather sooner than later. If that is the case, the climate system will be set on a pathway in which it will once again reach, in the far future, the record highs of the last 40–50 Ma during the Eocene: a Hothouse Earth (Zeebe and Zachos 2013, Burke et al. 2018, Steffen et al. 2018). Like in a geological time-lapse, today's politics are contracting and short-cutting millions of years of the past and thousands of years of the future into a single, uniform frame of reference. The geological axiom, since Charles Lyell, that "the present is the key to the past" is exchanged with the paleoclimatological maxim that "the past is key to the imminent future" (cf. Rosol 2017a).

How do we know about all of these temporal contractions? The answer, of course, is simulation science: the baroque architectures of climate and Earth system models and the necessary computing capacities to run virtual experiments with them. However, in order to just comprehend such a figure of topological climate time, we do not need to invoke the simulation of ancient climate events—although I would speak in favor of the epistemic powers of such hindcasts. We can also resort to a medium more generic to, certainly, the mid-twentieth century, and thereby a moment in history concurrent to the momentous take-off of the Anthropocene itself (Zalasiewicz et al. 2017). When Jean Epstein's cinema orchestrates the breaking of waves with its condensation, acceleration, deceleration or reverse of black-and-white images and experimental sounds, an entire "logic of variable time" (Epstein 2012, cf. Epstein 1946, 88) reveals itself, a logic of time axis manipulations and temporal interferences. The cinematographic apparatus according to Epstein is a "time-thinking machine" that realizes "a form of thinking by the rules of analysis and synthesis that, without [it], humans would have been incapable of implementing" (Epstein 1946, 18).

As evidenced by *Le Tempestaire*, Epstein understood cinematography as the one authorized to salvage the heterochronous ontology of meteorological, mythical and technical time. Serres, who joined the École Navale near Brest in 1949, and thus took over the Breton outpost of ontological media philosophy precisely when Epstein left, endorses this view but goes even beyond. "Let us suppose a camera has been filming the west coast of Brittany, with its indentations and islands, for millions of years and we could unwind this film in a few minutes," he evokes in his book *Northwest Passage*, "then we would see a flame […] the edge of the sun" (Serres 1990, 51–52, transl. by the author). Where the land ends and the sea begins is a function of geological time. Still, Serres' paleographic time-lapse is itself only evocative through the possibility of the contractions and unfoldings that the thinking machine of the cinematograph provides. Even prior to having become calculable in the operational model time of computer simulations, the flaming coastline of Earth time has entered the symbolic world through the imaginary of a flickering canvas.

Serres' and Epstein's evocations and manipulations of plural time regimes—from the fleeting time of marine spray to the human time of a breeze to the deep time of geology—are what can be called "time depth": the saturatedness[4] of the world with multiple temporalities that interfere with each other and that are constructed and thus uncovered by technical media. Time depth as both topic and formal treatment of an empirical reality is not restricted to cinematography or computer simulation as such. Literature, for instance, has not only long been concerned with temporal scalings as a subject but also experimented, on a formal level, with narratological techniques of restructuring, interlocking and cutting different temporalities and causalities. These textual "simulation" strategies now become essential tools in the challenge to find "poetic and narrative forms which are adequate to the problems of latency, entanglement and scale that the Anthropocene confronts us with" (Horn 2020, 169). The point here, however, is that computer simulations not aesthetically adopt but operationalize temporal experiments in order to understand the natural (and increasingly social) processes which define the Anthropocene in the first place. Moreover, they reveal elements of the many interconnected and convoluted times in the geosphere and the anthroposphere through these operationalizations: a storm evolving over days and passing through overnight, multi-decadal ice sheet dynamics and latencies spanning multiple centuries in ocean circulation patterns, sudden ecosystem collapse and likewise sudden collapse of economies, the geological times of natural carbon sequestration and the industrial times of artificial carbon sequestration, the quick return, within decades, to climate states of previous geological epochs, etc. While such a clash of temporalities may indeed be rendered comprehensible through language and narrative form, technical media and their micro-temporal mobilization and manipulation of macro-temporal time axes bind them back, "by the rules of analysis and synthesis," to the non-fictional space of the Anthropocene as such.

> There is not simply one time, but a plurality of times which depend on certain media: deep time, narrative time, micro time, or, as one might say, the respective innate times [Eigenzeiten] of media and their corresponding time objects [...] media environments that make it possible to collectivize heterochronous time objects. [...] Appropriate models for the Anthropocene Earth [...] therefore have to link spatial and temporal scales and make them relate to each other.
>
> (Balke et al. 2018, 7f. transl. by author)

As its most eminent and powerful media environment, Earth system models couple and synchronize the temporal horizons of atmospheric, geological, biogeochemical, hydrological and increasingly sociotechnical processes through fractal codes and the innate times of microprocessors. Not as a clash, but as a composite of scales.

Human time, however, seems indeed smashed in between these multiple temporalities, oscillating between the "anaesthetic fields 'above' and 'below' the human dimension": "If deep time is the time dimension that exceeds the capacity of human consciousness, then micro time is the time dimension of electronic circuits that (permanently) undermine human perception" (ibid, 6, transl. by author). So we have to finally ask ourselves: Is time depth only a feature of the meteorological and geological, revealed by the operative agency of the camera and the Earth system model? Is the time of the human really that precarious and scarce as it seems? Michel Serres:

> We are always swimming in this same river. Its peaks and shores crumble, the rocks erode, the humus mixes with the alluvial torrent but not a single liquid molecule has gone missing in Garonne since the beginning

> of the world. The hard, the solid, it doesn't last; only soft water lasts. Under the sun, from April to October, this fluid evaporates, running everywhere in wandering clouds, but with the rumbling thunderstorm, here are the same snows, the same rains and the same waves, returned. We are always swimming in this same water that—statistically—turns, whose round clock indicates less the temporal than the eternal. Nothing could be more stable in memory and history than the processual turbulence that eddies in this vortex, like in my body—that middle-knot of Garonne—and like that divine wind, they say, blew upon the primal waters, in a cyclone. In my body and across the world, Garonne circulates. My time goes and life passes, this eddy remains.[5]
>
> (Serres 2012, 26)

Again, what Serres performs here is to elaborate the epistemological isomorphism between the systems-thinking of the physical sciences and the anthropology of myths and legends, experience and suffering. From the perspective of the hydrological cycle, the molecules and geological epochs, the human body is less a part of a temporally truncated *culture* than an eternal immersion in the constant flow of "Biogea." "Rocks are not nouns but verbs—visible evidence of processes," is a saying among geologists (Bjornerud 2018, 8).[6] Here, Serres verbalizes something more comprehensive, not just a natural process detached from humans, but a dynamical model of human-Earth-flow itself, and to which this chapter adds: a model made visible and construable, in the first place, through technical media.

This particular power of media was not left unnoticed by contemporaries of the old Epstein and the young Serres. Jacques Lacan was one point in case, as we have seen. Another one was philosopher Max Bense, who wrote about cybernetics as a paradigmatic

> meta-technology. Technology has hitherto been essentially a phenomenon of the surface of the inhabited and habitable sphere: what is now emerging before our eyes is deep technology; we experience its penetration into the fine structures of the world, into the immaterial components […]. The cybernetic expansion of modern technology thus means its expansion under the skin of the world.
>
> (Bense 1998, 436, transl. by author)

In Epsteins montage of the Tempestaire's glass orb, televising a raging sea, and the glowing electron tubes, a mediatic handshake-as-handover is at play that invites technologies' expansion to get under the skin of the world and join the populated space of knowledge, myths and science. What is the end of a storm tamer's life and his magical practice is only the beginning of a new-born generation of other symbol-manipulating practices, indigenous and global, soothing and frightening at the same time.

Conclusion

Le Tempestaire is not one of Epstein's "nature films," i.e. the neorealistic ethnocinematographies that defined his early films in the Breton series. It does not capture a locally colored myth of rugged people on barren coasts. It does not capture a winter storm. Instead the wind is, like in a pantheist drama, a divine protagonist who, while blowing "upon the primal waters, in a cyclone," spells and announces, frightens and agitates and thereby levels thermo- and hydrodynamic information. Moreover, the film is the cinematographic blurring or liquefaction of a fractal coastline between sea, land, human and time. While the foaming emulsion of air and water successfully gnaws at the geological stubbornness of the rocks, both technological modernity and phantasmagorical myth swirl together in the time-manipulated noise of the Breton long shot. "Finistère" writes Michel Serres in his Biogea, "a community of islanders allied with the west wind, whose dominating voice had taught more about itself to them than to anyone else. … Oh, do I remember lighthouses", he chants, even though their "trade was dying, replaced by electronics" (Serres 2012, 95f). Epstein's films and Serres' writings both think and realize the geological *fluidum* in a radical way that finds its sensual counterpart in the terrifying and delightful play of the elements in *Finis Terræ*, the end and origin of the world, where old stories die and get reborn as deep technologies.

To argue at epistemic eye level with the Earth system sciences therefore means acknowledging the eternal circulation of the physical and biogeochemical materiality of our existence, revealing itself (again) in the existential conditions wrought forward by the dawn of the Anthropocene. Not to place humans in an unpolitical eternity, but, quite to the contrary, to acknowledge the monstrosity of the human-made epoch and to help understand what the new terrain of political action (or non-action) is. A storm is coming, the signs are bad. Where land is now, the sea will be soon: a geological time-lapse and, thus, a world in flames happening on human timescales and visible to human eyes.

"My hope rests on the present evolution of knowledge," writes Serres in *Biogea*. "Complex, global, and connected, the life and earth sciences require communication, interferences, translations, distributions, and transitions […]. Under penalty of collective extinction, let us, like Empedocles, see the necessity to unite wisdom and knowledge" (Serres 2012, 75f). Appropriating Serres' topological method, Empedocles here could be substituted for Epstein: the legendary founder of the doctrine of the four elements air, fire, earth and water for the ethnographic filmmaker uniting the legend of the sage and his mastery of the elements with the technical knowledge of just these elements. Empedocles died by throwing himself into Mount Etna, returning himself to the elements, wanting "to think like the mountain" (ibid, 79.) as Serres insists; Epstein, in 1926—two decades and one world war before filming *Le Tempestaire*—stands on the edge of the still active, still "living" volcano and takes the viewpoint of Mount Etna to reflect on the animism of the cinematograph, and how objects take on airs. Only 2,500 years of human history separate them superficially.

Notes

1 I am grateful to Marie Bendl for introducing me to this film.

2 A splendidly illustrated feature story about Zworykin and his climate and weather engineering proposals appeared in a popular magazine a few years later (Winter 1948). It is unsettling to note that this idea has not been abandoned today, as evidenced by a pretty-much 1940s era-minded "foresighted man" who, when hurricane Dorian formed in the Mid-Atlantic, reportedly asked: "Can't we just nuke it?" (Swan and Talev 2019).

3 Lacan 1988, 302: "If there are machines which calculate all by themselves, add, do sums, do all the marvellous things which man had until then thought to be peculiar to his thinking, it is because the fairy electricity, as we say, enables us to establish circuits, circuits which open and close, which interrupt themselves or restore themselves, as a function of the existence of cybernetised doors."

4 "Saturated time" could be understood similar to mathematical model theory, where a "saturated model" denotes a model that realizes, within a mathematical structure, as many complete "types," i.e. existing or possible elements, with certain properties that are consistent with each other.

5 The Garonne is a river in the Aquitaine region of southwest France. In his childhood Serres helped out his father, a bargeman dredging sand from the Garonne. In a metapoetic twist, the repeated return of Serres' writings to the topic of the stability of ideas through time—from *Hermes* (1977) to *Biogée* (2010)—is a performance of his own historiographical concept.

6 The term "timefulness" is employed by Bjornerud in the sense of "a clear-eyed view of our place in Time, both the past that came long before us and the future that will elapse without us" (17) and thereby in oppositon to the timelessness of current human actions and politics. As such, the term of "time depth" is related but not exhausted by "timefulness."

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3 Time Depth

Jean Epstein, Michel Serres and Operational Model Time

Christoph Rosol

A hissing silence. While the sound cannot find its signal-to-noise ratio between monophonic interferences and crackling static, we can see arrested images of low tide. A motionless landscape, ossified bushes, still images of humans. A coastal Holocene landscape, set in Brittany (Figure 3.1).

Then, perceptible movement. Wrinkles appear in the sea, and life-giving micro-amplitudes emerge out of the grey continuum of the Breton black-and-white still life. The bushes are now shaking slightly. A first recognizable sound lands: a weak wave breaks upon the beach. A breeze—nonhuman—pushes a wooden door open, as if it were a superhuman will. Mortal eyes watch this gap in the wall opening, spellbound. Two women, one old, one young, sit and knit and spin and remain silent (Figure 3.2).

The door, though, is not speechless. As an instrument, it lends an indicative language to the wind. It opens up to let a breath of air level the information divide between the inside and the outside, thus associating the nonhumanity of the wind—a medium by itself—with the humanity of the mortal eyes. The young woman, being in love and thereby receptive to the invocation of the wind, immediately understands: "It's a sign," she says. "A bad sign" (0:02:48) (Figure 3.3).

A faint breeze widens the angle of a door, thus indicating an omen. Something may or may not come. An announcement, not a prophecy. "No sign, it's just the wind" (0:04:12), her fiancé reassures her, before setting out to sea to fish for sardines. "The wind frightens me," she answers. Yet the wind immediately takes this whisper away, abducts the confession from the young man's comprehension.

As announced by the wind and its indicating instrument, the door, the breeze turns into a storm. After an anxious night, in which the young woman's song is cut against the roar of the churning sea, the old woman tells the young one about the ancient "Tempestaires," the "Tempest Masters" or storm healers, "who knew how to control a storm and make it obey them." "They would make the sea calm down," she explains. "But these are old stories, you shouldn't believe them anymore, no" (0:11:20) (Figure 3.4).

Instead of disbelieving, the young woman sets off in search of a Tempestaire. Only an intervention in the earthly events can soothe her anxiety.

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Figure 3.1 Jean Epstein, *Le Tempestaire* (0:01:21) (© La Cinémathèque française).

Figure 3.2 Jean Epstein, Le Tempestaire (0:02:28) (© La Cinémathèque française).

Figure 3.3 Jean Epstein, *Le Tempestaire* (0:02:32) (© La Cinémathèque française).

Figure 3.4 Jean Epstein, *Le Tempestaire* (0:09:54) (© La Cinémathèque française).

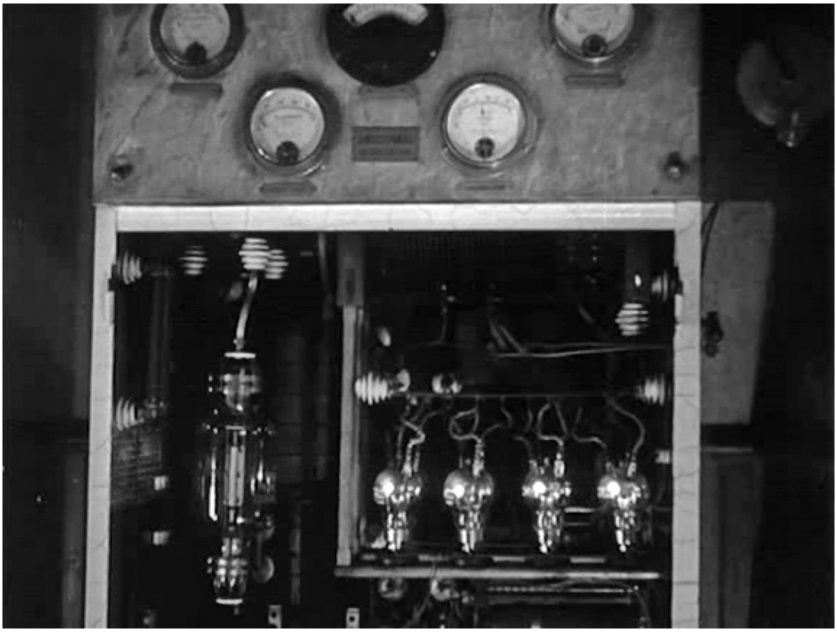

Figure 3.5 Jean Epstein, *Le Tempestaire* (0:14:29) (© La Cinémathèque française).

At first, the heroine turns to those who have delegated their knowledge to the apparatuses. An endless string of choppy Morse code sounds as she enters a lighthouse, the situation room monitoring the storm. Airily, a technician points at the large metal cabinet behind him (which he does not operate, but cleans and looks after, "services"). "A healer?" he muses. "There's the radio, it doesn't heal but it relieves the navigator" (0:14:08). Thus, we learn that the five electron tubes, glowing in a chamber visible at the heart of the cabinet, are a wireless (Figure 3.5).

Disappointed, she turns to another technician. And indeed, this one knows where the old Tempestaire lives, saying that he could probably be elicited to give "a good weather forecast" (0:14:19) with a bottle of liquor. This old man, Père Floc'h, can be seen in the next shot, as he, too, is cleaning, but this time a garden, apparently forking the wind out of the scrub. Having finished his work, he closes the door to his house, a half door that can regulate the exchange between the inside and the outside in a staggered manner.

When the young woman hurries to him, the Tempestaire, however, is not keen to talk and refuses at first. Only her beseeching eyes soften him. Again, a tall cabinet, this time an artfully decorated wooden one, from which the storm healer pulls out a glass orb (Figure 3.6).

Time-lapsed clouds, cut, Tempestaire, cut, clouds, cut, Tempestaire. The storm tamer begins his work and the film editor starts his own. Inside the

Figure 3.6 Jean Epstein, *Le Tempestaire* (0:19:14) (© La Cinémathèque française).

glass ball, the roaring surf is televised, and then superimposed with a long shot of the roaring sea coast. Four times in hard cuts, including missing half seconds, the image of the electronic tube cabinet from the lighthouse pops up in between. While the Tempestaire blows on the orb like a bony Zephyr, the filmed surf *rewind*s backward. Sea and rock separate, spray becomes wave. Finally, the storm calms down, the crystal ball shatters on the floor. Instantaneously, the fiancé appears at the open door, his dry scarf hanging limply. Last scene: the two humans of the future walking between sea, sky and land (Figure 3.7).

The hard-cut arrangement of the Tempestaire blowing into his glass orb, the wireless and the roaring sea exemplifies a primeval scene. It realizes a visual handover between mythical and modern practices of weather control, between human agency, electronic futurities and geological vastness, and it does all that in the very historical moment when electronics and computer-aided simulation set out to become the dominant epistemic form in which natural and geophysical phenomena are transcoded. The visual interlacing of the three protagonists—the storm, the stormhealer and the wireless—celebrates a generous productivity of both myth and modern technology, and, by extension, the near-mythical powers of time manipulating cinema that neatly captures the hybrid temporalities in which humans are situated in dealing with the natural world, right in a moment when the world becomes otherwise.

Figure 3.7 Jean Epstein, *Le Tempestaire* (0:21:27) (© La Cinémathèque française).

Finis terrae, exorgium maris

Jean Epstein shot *Le Tempestaire*[1] (1947) in the winter months of 1946/47 on the island of Belle-Île-en-Mer, off the Atlantic coast of Brittany—Finis Terræ, as the region has been called since Roman times. Ever since his film of the same name, *Finis Terrae* (1928), Epstein sought to fulfill his programmatic quest for new "approaches to truth" (Epstein 1981). In crossfading the "abundance of the real" of the harsh Breton coast with the educing powers of the "intelligent machine" of the cinematograph, he found an aesthetic technique through which "the fantastic should be unveiled rather than manufactured" (Schneider 2012, 196f.; Epstein 1946). Toward the end of this 20-year-long, and biographically terminal, "maritime period" of Epstein's work, the winter storm captured in *Le Tempestaire* provides the mise-en-scène for a lost world at the very margins of a continent devastated by machine warfare. "In the original script," notes the filmmaker James June Schneider, Père Floc'h "collapses and dies from exhaustion" (Schneider 2012, 204).

Still, what is the end of the land, *finis terræ*, is only the beginning of the sea. About 3,000 nautical miles further west, at the other end of the Atlantic, an electron tube apparatus was being projected during the same winter months of 1946/47, a device which was supposed to deliver not only "a good weather forecast," but also to realize the Tempestaire's work itself.

In Princeton, New Jersey, the television pioneer Vladimir Kosma Zworykin and the much younger mathematician and theoretical physicist John von Neumann were pondering on a comprehensive scheme of electronically guided weather control.

Zworykin, the famous developer of the iconoscope tube and vice president of the Radio Corporation of America (RCA), had already circulated a short proposal among a few scientifically like-minded colleagues in the Princeton and Washington area in late 1945. In this proposal, he laid out his vision for global weather control, "a goal," he stated, that should be "recognized as eventually possible by all foresighted men" (Zworykin 1945). Zworykin suggested that rainfall could be triggered by shockwaves, or clouds seeded with ice or dust. Longer-term climatic improvements, in turn, could be achieved by large-scale changes in vegetation and alterations to deserts, mountains and glaciers. He also proposed geoengineering techniques such as the extensive use of flamethrowers, igniting spilled oil on the sea's surface or detonating atomic bombs to affect local heat balances and thereby divert ocean currents or hurricanes.[2]

In essence, Zworykin's argument was that of an electronics engineer. He proclaimed that relatively small amounts of selective energy input (like atomic bombs) might discharge or control far greater amounts of energy (hurricanes), thus triggering a phenomenon either to develop or to reverse. The analogy here can be seen in the design of the triode valve: much as the control grid attenuates the electron current, so the controlled detonation of nuclear bombs would attenuate the nascent upflow of water and energy from the sea. Formulated to the extreme, Zworykin's conceptual model arranges the whole tropical Atlantic into a kind of super cathode ray tube, promising an interventionist laboratory that would divert all hurricanes between cathode Africa and anode America in a controlled fashion.

However, treatment must follow diagnosis. Zworykin's megalomaniac scenarios for weather and climate control required an essential precondition: a precise and, if possible, globally scaled prediction of the generation and further evolution of weather phenomena by electronic computing devices. Here, his fellow Princetonian, John von Neumann came into play. Since the spring of 1945 von Neumann had been trying to drum up support for constructing an experimental computer at his own institution, the Institute for Advanced Study. Von Neumann shared Zworykin's enthusiasm, but rejected his idea of a statistical approach to weather prediction. Instead, he advocated the use of brute computational force to tackle the challenge of solving the thermo- and hydrodynamic equations governing the evolution of weather systems (cf. Rosol 2017).

Thus, in the winter of 1946/47, the younger man commissioned the older one to develop storage tubes for an electronic computer meant to integrate the thermo- and hydrodynamic equations representing atmospheric motion, i.e. the wind. In this very moment, numerical weather forecasting and electronics merged in a somewhat phantasmagoric scenery of weather control. Zworykin's original pamphlet represents a rather peculiar and hypertrophic point of departure for a phenomenal historical trajectory that leads from postwar America to today's climate and Earth system modeling. In this datable and locatable "marriage" of predictive meteorology, modern computer design and cybernetics, the modern simulation sciences were formed, and with them a scientific practice which today constitutes the material and epistemic core of knowledge production in the vast majority of the natural, engineering and even social sciences.

While, at the western end of old Europe, the final exercise of a magical technique of weather control was being staged on film, a physical-mathematical technique of calculating and managing the weather was being worked on at the eastern end of the New World. That doesn't necessarily mean that one indigenous technique died and a technoscientific discipline took over, as a romanticized or pessimistic interpretation of Epstein's film would assert. Instead, positions and powers in the order of the symbolic world were reordered, cut against each other and reformatted. Although the electron tubes of the lighthouse are merely part of a wireless sending and receiving ships' messages, their offsprings will soon become the electronic valves which also switch between two states by opening up or closing electric circuits. Just like doors, in the language of the film.

"In its nature," says Jacques Lacan just a few years after the physical-mathematical techniques had joined forces with cybernetics and then swashed back to France, "the door belongs to the symbolic order, [as] it opens up either on to the real or the imaginary, we don't know quite which […] [it is] the symbol par excellence" (Lacan 1988, 302). The two wooden doors showcased in Epstein's film that regulated, leveled and mixed the inside with the outside in staggered ways are merely transcended by the realization of "cybernetised doors"[3]: digital electronic gates, or flip-flops that carry out a logical chain of feedbacks, in which openings trigger closings and closings trigger openings. This "passing into the realm of realisation of cybernetics" (ibid.) has indeed unhinged the door as such:

> In a space where inside and outside are thus folded, wired, and coupled into each other as feedback loops, doors as cultural techniques have lost their moorings […] [and] no one knows anymore whether a door opens to the imaginary or to the real.
>
> (Siegert 2015, 205)

However, what has been passed on is their indication and exemplification of the symbolic world, which is, again with Lacan, "the world of the machine" (Lacan 1988, 47). For the Polish emigrant Epstein, the opening door was "a sign" unveiled by the "truthfulness" of the cinematic camera, truthful with regard to the storm and the natural elements. For the Russian emigrant Zworykin and the Austro-Hungarian emigrant von Neumann, the truthfulness of the "sign" would be a matter of signal fidelity in the computing machine that calculates that very same storm.

Operative time

Long before it has become dependent on the inside-and-outside indiscriminate performance of logical gates in a computer, science has had to use epistemic doors. Simulations and other cultural techniques of the exemplary that help opening up either to the imaginary or to the real represent, in fact, ubiquitous functional principles of doing science ever since its beginnings (Serres 2002–2003). Making an experiment, even a physical one, means formatting aspects of an unreducible real world into a world of the symbolic. In other words: epistemological order is generated by means of instantiating and empowering certain technical media. Only these make it possible to differentiate, exclude, enclose, (re-)couple, calculate and argue. Conducting a virtual experiment, i.e. a computer simulation, makes no difference. This is particularly the case in what can be regarded as simulation's archetype: numerical weather forecasts, born in the years of 1946/47, and now, after growing in complexity to first climate and then Earth system models, became the most instrumental epistemic formations for comprehending but also narrating the very Anthropocene scaling that is the subject of this book.

Simulation is a universal technique, most powerfully employed in studying the evolution of dynamical systems, no matter whether these represent population dynamics, chemical reactions or weather systems. What is special about simulation in geophysical disciplines such as meteorology, climate science, hydrology and sedimentology is that they function by establishing and balancing specific concepts of instability: nonlinear dynamics, emergence, chaos, complexity. The radically empirical undertaking of the geosciences can only succeed in a context-related, local, "case by case," or "point by point" way; i.e. it is always only applicable to a certain temporally and locally defined problem. Space and time variables have to be set and constrained, e.g. by the initial atmospheric conditions for the hourly prediction of weather systems, be they located west of Brittany or east of the Bahamas; in the boundary conditions set for modeling Earth system sensitivity on the basis of specific emission scenarios in the twenty-first century; or in the reconstruction of the climate of the entire Holocene. In that sense, time is made operative; it is the time of the model, or model time.

Interestingly, the climate and Earth system sciences can do all this with astonishing heuristic sufficiency, while simultaneously placing a high value on efficiency, i.e. on computing time, choice of model, etc. A combination of technical media, practices, operations and concepts stabilizes the knowledge of the unstable by quantifying and comprehending it in its respective specificity, locality, and—more than anything else—its particular temporality, while keeping themselves highly flexible and adaptable to the complex system they are attempting to represent. The matters of the "geo" are always in flux and, hence, so is its science. Putting it provocatively, one might say that climate and Earth system simulation does mimesis on what Bronislaw Szerszynski has called the "living memory" of the fluid itself, "a memory of energy, stored in motion and intensivity, that has to be continually maintained in action or it almost literally evaporates" (Szerszynski 2019, 229). In that sense, model time is operative because climate time is operative.

Michel Serres' communication theory offers an approach to how this mimetic function of simulation sciences can be made productive for the humanities. Throughout his work Serres not only continuously made attempts to translate the sciences of the physical (the lighthouse in Epstein's film) into the language of anthropology and literature, of myths and legends, of experience and suffering (Epstein's filming of the lighthouse) (Serres 1995). He also considers both these domains of knowledge to be isomorphic, by attributing them principles of communication: mediations, transmissions, interferences and the founding of relationships. If one assumes, as Serres did, that agency in nature and culture takes place on the basis of the exchange of information, the translation difficulties between their respective sciences become less of a problem.

Another angle on this subject is given by Serres' topological theory of history: his figuration of a folded time in which distant events, theories or practices can appear very near, while those nearby can become quite distant. In the manner of a folded, crumpled handkerchief, in which points on the surface that are woven far apart from one another can suddenly also adjoin each other, Serres' model folds historical time, so that the linear spacings of a smooth, metric space-time of a history of knowledge turns into a dynamic, contextual and swirling network of relationships (Bennett and Connolly 2012). In the more than two millennia old didactic poem *De rerum natura* by Lucretius, for example, Serres sees a modern climatological physics at work, a physics in the sense of a qualitative thinking of the form of inclination, the small deviation within the laminar flow of matter, that addresses turbulence and chaos in essentially the same manner as is done today (Serres 2000). Such folding of *historical* time, however, is not just a matter of historiography for Serres, but it is in accordance with something much more fundamental, namely, the *ontological* basis for both geophysical and living systems, or what he has termed "Biogea": a single, circular entity that combines Earth and life (Serres 2012). "All times converge in [a] temporary knot" (Serres 1982, 75), he writes, an entanglement characterized by the eternal homeorhetic flow of natural systems, i.e. dynamical (fluid) systems that remain stable through their flux, returning to an inherent trajectory, even when their (solid) surroundings change, like "a river that flows and yet remains stable in the continual collapse of its banks and the irreversible erosion of the mountains around it. One always swims in the same river, one never sits down on the same bank" (ibid.).

As we turn our gaze onto the unfolding of the Anthropocene today, a similar figuration appears, although on a slightly different and rather perplexing level than historical time. Within the operative model-data bind of current climate modeling we realize that a geohistoric event like the Paleocene Eocene Thermal Maximum (PETM), a notable carbon anomaly which took place 55 million years ago, marks the closest geological analogue to our current climatic transition (McInerney and Wing 2011; Gingerich 2019). Suddenly, because it affects our present, something like an abrupt climate transition that took place 55 million years ago comes frighteningly close, while the all too familiar world of late modernity, say 55 years ago, with its still somewhat stationary climate in which generic history was able to unfold, may very soon seem very far away. Or, as the charismatic geologist and climatologist Richard B. Alley noted, when comparing the PETM with the Anthropocene: "things get out of place and out of time, as it were" (Alley 2009).

It literally depends on today's decisions on how far we catapult the climatic boundary conditions of the planet back behind the (astronomically driven) climate changes of the Quaternary and into CO_2-rich periods of Earth's history. While we have already left the unassailable Holocene domain and the warm periods of the last few interglacial periods—or to be more precise: the relatively stable glacial–interglacial limit cycle of the past 2.5 million years—our view will even have to go far beyond the middle Pliocene about 3–4 million years (Ma) ago, when the atmospheric CO_2 concentration was at about the current level and a corresponding 2–3°C higher global temperature prevailed. We would even have to go back behind the climate optimum of the Miocene before 17 Ma, whose global temperatures of 4–5°C we will probably reach in the next 100 years if emissions go on unabated, a level which translates into a sea level rise of 10–60 meters in the longer term. Indeed, if rapid decarbonization is not achieved, if strategies and technologies to remove carbon dioxide from the atmosphere are not available in time and no climate engineering Zworykin–Zephyr Tempestaire can do its healing and taming, we will see internal biogeophysical feedback processes in the Earth system coming into play as tipping-point cascades will be touched off rather sooner than later. If that is the case, the climate system will be set on a pathway in which it will once again reach, in the far future, the record highs of the last 40–50 Ma during the Eocene: a Hothouse Earth (Zeebe and Zachos 2013, Burke et al. 2018, Steffen et al. 2018). Like in a geological time-lapse, today's politics are contracting and short-cutting millions of years of the past and thousands of years of the future into a single, uniform frame of reference. The geological axiom, since Charles Lyell, that "the present is the key to the past" is exchanged with the paleoclimatological maxim that "the past is key to the imminent future" (cf. Rosol 2017a).

How do we know about all of these temporal contractions? The answer, of course, is simulation science: the baroque architectures of climate and Earth system models and the necessary computing capacities to run virtual experiments with them. However, in order to just comprehend such a figure of topological climate time, we do not need to invoke the simulation of ancient climate events—although I would speak in favor of the epistemic powers of such hindcasts. We can also resort to a medium more generic to, certainly, the mid-twentieth century, and thereby a moment in history concurrent to the momentous take-off of the Anthropocene itself (Zalasiewicz et al. 2017). When Jean Epstein's cinema orchestrates the breaking of waves with its condensation, acceleration, deceleration or reverse of black-and-white images and experimental sounds, an entire "logic of variable time" (Epstein 2012, cf. Epstein 1946, 88) reveals itself, a logic of time axis manipulations and temporal interferences. The cinematographic apparatus according to Epstein is a "time-thinking machine" that realizes "a form of thinking by the rules of analysis and synthesis that, without [it], humans would have been incapable of implementing" (Epstein 1946, 18).

As evidenced by *Le Tempestaire*, Epstein understood cinematography as the one authorized to salvage the heterochronous ontology of meteorological, mythical and technical time. Serres, who joined the École Navale near Brest in 1949, and thus took over the Breton outpost of ontological media philosophy precisely when Epstein left, endorses this view but goes even beyond. "Let us suppose a camera has been filming the west coast of Brittany, with its indentations and islands, for millions of years and we could unwind this film in a few minutes," he evokes in his book *Northwest Passage*, "then we would see a flame [...] the edge of the sun" (Serres 1990, 51–52, transl. by the author). Where the land ends and the sea begins is a function of geological time. Still, Serres' paleographic time-lapse is itself only evocative through the possibility of the contractions and unfoldings that the thinking machine of the cinematograph provides. Even prior to having become calculable in the operational model time of computer simulations, the flaming coastline of Earth time has entered the symbolic world through the imaginary of a flickering canvas.

Serres' and Epstein's evocations and manipulations of plural time regimes—from the fleeting time of marine spray to the human time of a breeze to the deep time of geology—are what can be called "time depth": the saturatedness[4] of the world with multiple temporalities that interfere with each other and that are constructed and thus uncovered by technical media. Time depth as both topic and formal treatment of an empirical reality is not restricted to cinematography or computer simulation as such. Literature, for instance, has not only long been concerned with temporal scalings as a subject but also experimented, on a formal level, with narratological techniques of restructuring, interlocking and cutting different temporalities and causalities. These textual "simulation" strategies now become essential tools in the challenge to find "poetic and narrative forms which are adequate to the problems of latency, entanglement and scale that the Anthropocene confronts us with" (Horn 2020, 169). The point here, however, is that computer simulations not aesthetically adopt but operationalize temporal experiments in order to understand the natural (and increasingly social) processes which define the Anthropocene in the first place. Moreover, they reveal elements of the many interconnected and convoluted times in the geosphere and the anthroposphere through these operationalizations: a storm evolving over days and passing through overnight, multi-decadal ice sheet dynamics and latencies spanning multiple centuries in ocean circulation patterns, sudden ecosystem collapse and likewise sudden collapse of economies, the geological times of natural carbon sequestration and the industrial times of artificial carbon sequestration, the quick return, within decades, to climate states of previous geological epochs, etc. While such a clash of temporalities may indeed be rendered comprehensible through language and narrative form, technical media and their micro-temporal mobilization and manipulation of macro-temporal time axes bind them back, "by the rules of analysis and synthesis," to the non-fictional space of the Anthropocene as such.

> There is not simply one time, but a plurality of times which depend on certain media: deep time, narrative time, micro time, or, as one might say, the respective innate times [Eigenzeiten] of media and their corresponding time objects [...] media environments that make it possible to collectivize heterochronous time objects. [...] Appropriate models for the Anthropocene Earth [...] therefore have to link spatial and temporal scales and make them relate to each other.
>
> (Balke et al. 2018, 7f. transl. by author)

As its most eminent and powerful media environment, Earth system models couple and synchronize the temporal horizons of atmospheric, geological, biogeochemical, hydrological and increasingly sociotechnical processes through fractal codes and the innate times of microprocessors. Not as a clash, but as a composite of scales.

Human time, however, seems indeed smashed in between these multiple temporalities, oscillating between the "anaesthetic fields 'above' and 'below' the human dimension": "If deep time is the time dimension that exceeds the capacity of human consciousness, then micro time is the time dimension of electronic circuits that (permanently) undermine human perception" (ibid, 6, transl. by author). So we have to finally ask ourselves: Is time depth only a feature of the meteorological and geological, revealed by the operative agency of the camera and the Earth system model? Is the time of the human really that precarious and scarce as it seems? Michel Serres:

> We are always swimming in this same river. Its peaks and shores crumble, the rocks erode, the humus mixes with the alluvial torrent but not a single liquid molecule has gone missing in Garonne since the beginning

> of the world. The hard, the solid, it doesn't last; only soft water lasts. Under the sun, from April to October, this fluid evaporates, running everywhere in wandering clouds, but with the rumbling thunderstorm, here are the same snows, the same rains and the same waves, returned. We are always swimming in this same water that—statistically—turns, whose round clock indicates less the temporal than the eternal. Nothing could be more stable in memory and history than the processual turbulence that eddies in this vortex, like in my body—that middle-knot of Garonne—and like that divine wind, they say, blew upon the primal waters, in a cyclone. In my body and across the world, Garonne circulates. My time goes and life passes, this eddy remains.[5]
>
> (Serres 2012, 26)

Again, what Serres performs here is to elaborate the epistemological isomorphism between the systems-thinking of the physical sciences and the anthropology of myths and legends, experience and suffering. From the perspective of the hydrological cycle, the molecules and geological epochs, the human body is less a part of a temporally truncated *culture* than an eternal immersion in the constant flow of "Biogea." "Rocks are not nouns but verbs—visible evidence of processes," is a saying among geologists (Bjornerud 2018, 8).[6] Here, Serres verbalizes something more comprehensive, not just a natural process detached from humans, but a dynamical model of human-Earth-flow itself, and to which this chapter adds: a model made visible and construable, in the first place, through technical media.

This particular power of media was not left unnoticed by contemporaries of the old Epstein and the young Serres. Jacques Lacan was one point in case, as we have seen. Another one was philosopher Max Bense, who wrote about cybernetics as a paradigmatic

> meta-technology. Technology has hitherto been essentially a phenomenon of the surface of the inhabited and habitable sphere: what is now emerging before our eyes is deep technology; we experience its penetration into the fine structures of the world, into the immaterial components […]. The cybernetic expansion of modern technology thus means its expansion under the skin of the world.
>
> (Bense 1998, 436, transl. by author)

In Epsteins montage of the Tempestaire's glass orb, televising a raging sea, and the glowing electron tubes, a mediatic handshake-as-handover is at play that invites technologies' expansion to get under the skin of the world and join the populated space of knowledge, myths and science. What is the end of a storm tamer's life and his magical practice is only the beginning of a new-born generation of other symbol-manipulating practices, indigenous and global, soothing and frightening at the same time.

Conclusion

Le Tempestaire is not one of Epstein's "nature films," i.e. the neorealistic ethno-cinematographies that defined his early films in the Breton series. It does not capture a locally colored myth of rugged people on barren coasts. It does not capture a winter storm. Instead the wind is, like in a pantheist drama, a divine protagonist who, while blowing "upon the primal waters, in a cyclone," spells and announces, frightens and agitates and thereby levels thermo- and hydro-dynamic information. Moreover, the film is the cinematographic blurring or liquefaction of a fractal coastline between sea, land, human and time. While the foaming emulsion of air and water successfully gnaws at the geological stubbornness of the rocks, both technological modernity and phantasmagorical myth swirl together in the time-manipulated noise of the Breton long shot. "Finistère" writes Michel Serres in his Biogea, "a community of islanders allied with the west wind, whose dominating voice had taught more about itself to them than to anyone else. … Oh, do I remember lighthouses", he chants, even though their "trade was dying, replaced by electronics" (Serres 2012, 95f). Epstein's films and Serres' writings both think and realize the geological *fluidum* in a radical way that finds its sensual counterpart in the terrifying and delightful play of the elements in *Finis Terræ*, the end and origin of the world, where old stories die and get reborn as deep technologies.

To argue at epistemic eye level with the Earth system sciences therefore means acknowledging the eternal circulation of the physical and biogeochemical materiality of our existence, revealing itself (again) in the existential conditions wrought forward by the dawn of the Anthropocene. Not to place humans in an unpolitical eternity, but, quite to the contrary, to acknowledge the monstrosity of the human-made epoch and to help understand what the new terrain of political action (or non-action) is. A storm is coming, the signs are bad. Where land is now, the sea will be soon: a geological time-lapse and, thus, a world in flames happening on human timescales and visible to human eyes.

"My hope rests on the present evolution of knowledge," writes Serres in *Biogea*. "Complex, global, and connected, the life and earth sciences require communication, interferences, translations, distributions, and transitions […]. Under penalty of collective extinction, let us, like Empedocles, see the necessity to unite wisdom and knowledge" (Serres 2012, 75f). Appropriating Serres' topological method, Empedocles here could be substituted for Epstein: the legendary founder of the doctrine of the four elements air, fire, earth and water for the ethnographic filmmaker uniting the legend of the sage and his mastery of the elements with the technical knowledge of just these elements. Empedocles died by throwing himself into Mount Etna, returning himself to the elements, wanting "to think like the mountain" (ibid, 79.) as Serres insists; Epstein, in 1926—two decades and one world war before filming *Le Tempestaire*—stands on the edge of the still active, still "living" volcano and takes the viewpoint of Mount Etna to reflect on the animism of the cinematograph, and how objects take on airs. Only 2,500 years of human history separate them superficially.

Notes

1 I am grateful to Marie Bendl for introducing me to this film.
2 A splendidly illustrated feature story about Zworykin and his climate and weather engineering proposals appeared in a popular magazine a few years later (Winter 1948). It is unsettling to note that this idea has not been abandoned today, as evidenced by a pretty-much 1940s era-minded "foresighted man" who, when hurricane Dorian formed in the Mid-Atlantic, reportedly asked: "Can't we just nuke it?" (Swan and Talev 2019).
3 Lacan 1988, 302: "If there are machines which calculate all by themselves, add, do sums, do all the marvellous things which man had until then thought to be peculiar to his thinking, it is because the fairy electricity, as we say, enables us to establish circuits, circuits which open and close, which interrupt themselves or restore themselves, as a function of the existence of cybernetised doors."
4 "Saturated time" could be understood similar to mathematical model theory, where a "saturated model" denotes a model that realizes, within a mathematical structure, as many complete "types," i.e. existing or possible elements, with certain properties that are consistent with each other.
5 The Garonne is a river in the Aquitaine region of southwest France. In his childhood Serres helped out his father, a bargeman dredging sand from the Garonne. In a metapoetic twist, the repeated return of Serres' writings to the topic of the stability of ideas through time—from *Hermes* (1977) to *Biogée* (2010)—is a performance of his own historiographical concept.
6 The term "timefulness" is employed by Bjornerud in the sense of "a clear-eyed view of our place in Time, both the past that came long before us and the future that will elapse without us" (17) and thereby in oppositon to the timelessness of current human actions and politics. As such, the term of "time depth" is related but not exhausted by "timefulness."

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