



Climate Science as Counterculture

A Ciência Climática como Contracultura

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ABSTRACT: This article investigates climate science as a cultural object. By pursuing the “logic of its aporias”, it is shown that climate science emerged at the confluence of the objective development of the means of production (constituting a “planetary general intellect”) and the countercultural movement of the 60s, which put ecology at its center, but was broader than mere “environmentalism”. This resulted in the emergence of new forms of sensibility and a qualitative transformation of the natural sciences, which recognized the autonomy and complexity of nature. The constitution of climate science is reconstructed by taking the IGBP’s Amsterdam Declaration as historical archive, and by discussing biographical aspects of representative scientists, in mediation with their work and their world-historical context. Yet, the limits of climate science are those of counterculture. Climate science and its institutions preserve aspects of the previous mechanistic science as well as remaining traces of commodity fetishism.

Keywords: Climate Science; Counterculture; Culture Critique.


RESUMO: Este artigo investiga a ciência climática como objeto cultural. Perseguindo a “lógica de suas aporias”, mostra-se que a ciência climática emergiu na confluência do desenvolvimento objetivo das forças produtivas (constituindo um “intelecto geral planetário”) e do movimento contracultural dos anos 60, que colocou a ecologia como motivo central, mas era mais amplo do que um mero “ambientalismo”. Isto resultou na emergência de novas formas de sensibilidade e uma transformação qualitativa nas ciências naturais, que passaram a reconhecer a autonomia e complexidade da natureza. A constituição da ciência climática é reconstruída tomando-se a Declaração de Amsterdam do IGBP como arquivo histórico, e discutindo aspectos biográficos de cientistas representativos, em mediação com o seu trabalho científico e contexto histórico-mundial. Contudo, os limites da ciência climática são aqueles da contracultura. A ciência climática e suas instituições preservam aspectos da velha ciência mecanicista, assim como traços remanescentes do fetichismo da mercadoria.

Palavras-chave: Ciência Climática; Contracultura; Crítica Cultural.

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INTRODUCTION

When Jimi Hendrix delivered his performance of the *Star-Spangled Banner* in Woodstock using feedbacks to evoke the sounds of the Vietnam War, he had an unsuspected comrade in a pioneer climate scientist: Jule Charney, who as a MIT professor led the Universities National Antiwar Fund (UNAF) after the invasion of Cambodia. During a meeting of the National Academy of Sciences, Charney, a renowned meteorologist, strongly opposed a suggestion by Edward Teller (the father of the hydrogen bomb) to use weather modification as a military weapon in Vietnam. Hendrix and Charney had something in common also in the manner of thinking: both used feedbacks as forms of expression. While Hendrix used his guitar, Charney was an innovator in the conceptualization of positive feedbacks as disruptive of ecosystems, by showing that the alteration of the vegetation-albedo feedback was causing the collapse of the Sahel. This was particularly sensitive to him, who was fond of the desert landscapes of California, Arizona, and New Mexico (Hammond 1970; Fleagle 2001, 76; Charney and Quirk 1975; Charney and Platzman 1987, 154-155). This essay will show that this approximation of political motives and forms of sensibility between the guitar player and the climate scientist was not contingent. In 1972, Marcuse already pointed out that the colonial war in Vietnam was a form of “ecocide” that “attacks the sources and resources of life itself” (2005, 173-174). These world-historical developments, it will be argued, are at the root of climate science, possibly the main source of critique of capitalism today.

The main purpose of this article is to demonstrate that besides objective conditions – the development of scientific abstractions, computers, satellites, and other observation systems – the development of climate science was made possible by a related subjective transformation of sensibilities toward nature related to the countercultural movement of the 1960s-70s. Yet, climate science has arisen out of capitalist modernity itself, and the reports of the IPCC, side by side with its critical core, contain elements such as the interest rate for the discount of future environmental impacts and the idea of “ecosystem services”, revealing the persistence of commodity fetishism, the naturalization of commodified relations (Jappe 2006, ch. 2; Cunha 2015; IPCC 2014a, 319; IPCC 2014b, 228-232). This article also explains this antinomy documented in IPCC reports.

CONTEXT AND METHODS

The core underlying procedure is to consider climate models as cultural objects. According to Adorno (1983), the “substance of culture resides not in culture alone but in its relation to something external, to the material life-process.” (29). The task of culture criticism, therefore, must be to “decipher the general social tendencies which are expressed in these [cultural] phenomena”, thus becoming “social physiognomy”. By pursuing the “logic of its aporias”, criticism can perceive these antinomies as those of society (30, 32). Cultural objects and society, in short, are in a relation of subject and object. Under this light, the internal transformations of natural science will be put in

relation with the corresponding social and technological changes that were conditions of possibility for the emergence of climate science. As climate models are a cultural object constituted in relation to nature, an additional layer of complexity has to be considered. Society and nature cannot be conflated, but society requires a metabolism with nature for its reproduction. Yet, perceptions of nature are historically specific: in the case of capitalism, it is mediated by abstract labor, and, by extension, by the development of technology, on the one hand, and subjectivity on the other, mutually conditioning each other (Postone 1993, 171-179), thus producing a “second nature” (Adorno 2006). Methodologically, this essay will trace the mediation between nature, contemporary climate science, and the countercultural movement of the 1960s by analyzing the biography of representative scientists, their scientific work and institutional and world-historical context. Such a use of biographies overcomes the duality between functionalism and methodological individualism by conceptualizing the “dialectic of internalization of externality and externalization of internality” and reconstructing the relation between biographical arc and shared experiences that constitutes historical individuals (Postone 1993, 41-42; Mills 1959; Bourdieu 1977, 72; Harris and McQuade 2015).

The propositions advanced will build upon three research strands in the current literature. One current tends to locate the origin of climate science in the Cold War and its institutional developments, structuring, and funding (Doel 2003; Masco 2010; Edwards 2010). Another focuses on a qualitative transformation in the natural sciences occurring by the last third of the twentieth century, with the recognition of the autonomy of nature and the development of complexity and the post-mechanistic notion of emergence (Merchant 2016; Sève et al 2005; Lee 2011). A third strand focuses on subjective transformations occurring in the 60s and 70s as a consequence of social movements identified as Civil Rights, Antiwar, May 1968, New Left, Earth Day. Although considered to be defeated, these movements left enduring marks, with a special focus on ecological issues (Marcuse 1992; 2005; Wallerstein 1989; 2004). By relating those objective and subjective transformations, it is suggested that while there were indeed important technological, infrastructural, and institutional developments during the Cold War, this alone cannot explain a shift from an instrumental approach to the more biocentric, tendentially liberatory vision that developed from the 1960s on. This is recognized by Doel (2003) as the development of “two distinct environmental sciences”, one “geophysics centered”, the other “biology centered”. Mahran et al (2012) recognize in the Stockholm Conference of 1972 the emerging influence of an environmental movement. However, this aspect remains marginal as “environmentalism”, without relation to the internal developments of natural sciences.

Prior shifts in the perception of nature are illustrative. According to Burt (2003), the predictive power of the Ptolemaic and Copernican systems was objectively the same when the last was formulated. What favored the Copernican system was the historical transformation of the time: the Renaissance, its discoveries of different lands and consequent relative decentering of Europe. Hessen (2009) and Grossman (2009) argue that the mechanistic worldview that came to dominance from the sixteenth century

onward was derived from the technological innovations of early capitalism: ballistics, mining, navigation. They fostered the development of mechanics, astronomy, the compass. However, for Postone, the “paradigms of classical physics [...] are related to the alienated structures of the commodity form.” (Postone 1993, 176; Sohn-Rethel 1989, 55n23). They conceive subjectivity and objectivity as ahistorical (transcendental), which reduces science to the question of correlating them, while, according to Postone, subjectivity and objectivity are both historically constituted. Therefore, the roots of mechanistic mathematical thinking are not in classical physics per se, but mathematization does express a deeper level of constituted subjectivity and objectivity as structured by the commodity-form (such as abstract time and space).

Just as with the previous Newtonian/Cartesian revolution, there were social conditions that were necessary for the qualitative shift generative of climate science, as will be developed.

THE “PLANETARY GENERAL INTELLECT”

Postone (1993) proposed the notion of “trajectory of production”, by which the objective immanent dynamic of capitalism produces a rising organic composition of capital which furthers the development of science in production. This constitutes a “general intellect” (Marx 1993, 704-706) for the production of commodities based more on the general state of science and technology than on direct living labor, which at the limit explodes the law of value. By intensifying the tension between what is and what ought, for example in the tension between scientific mass industrial production on the one hand, and structural unemployment and ecological destructiveness on the other, the immanent development of capitalism produces “shearing pressures” that point beyond itself, to a situation in which material abundance, ecological rationality, and the reduction of toil to a minimum could be envisioned.

In this context, an investigation of climate models reveals that they make use of certain “thought abstractions” in the study of thermodynamics, historical geology, ecosystems which were developed under the command of capitalist real abstractions in economic undertakings, but go beyond them because are generated in relation with nature (see Sohn-Rethel 1989, 12; Cunha 2020a). Thermodynamics arose out of the formalization of the workings of the steam engine, which was developed for the drainage of mines and later powered the system of machinery of large-scale industry in eighteenth and nineteenth century Britain (Muller 2007, ch. 1-3; Cunha 2020b). Historical geology stemmed from early modern mining in Central Europe and colonial explorations (Rudwick 2005). The notion of relatedness between different species of plants and animals could not have arisen without the imperial botanic gardens which collected species from distant locations and allowed their systematic comparison (Dayton 2000; Brockway 1979). Together with the infrastructure fostered by the Cold War (such as satellites, surveillance of the physical environment), this “general intellect”, initially developed for the production of commodities, constitutes a “planetary general intellect” by the last third of the twentieth century, a vast system

of conceptualization, monitoring, and prediction of the development of the Earth System (Cunha 2020a).

In the constitution of the “planetary general intellect”, the computer is as condition of possibility for the enormous volume of calculations required by accurate climate models. Edwards (2010) shows the importance of the Cold War in its conception. However, a central figure in this was the meteorologist Jule Charney, whose antiwar political activity was already mentioned. After solving the complex mathematics of large-scale atmospheric dynamics, he worked together with John van Neumann in the 40’s to apply his “quasi-geostrophic theory” for weather prediction using the ENIAC. Born in the US, Charney descends from a Russian-Jewish family with a rich tradition of revolutionary Marxist activity, both in his father’s and mother’s side. Among them was his cousin Baruch Charney Vladek, elected twice for the City Council of New York, as a socialist and labor leader, and an uncle, Avram Zalmon Litman, who was a socialist unionist in Chicago and St. Louis. Both Vladek and Litman were in jail due to their political activities in the 1905 Russian Revolution, and decided to emigrate to the US. Charney referred to these and other revolutionaries in his family as “interesting people”. It is not difficult to imagine that this background contributed to his vision while working in international cooperation in meteorology as a counterpoint to the Cold War. Upon contact from Kennedy’s scientific advisor, he led a team that provided the expertise for a UN resolution on the peaceful use of outer space and meteorology in light of space technology (UNOOSA 1961). Subsequently, he was a central figure in the Global Atmospheric Research Program (GARP), which was fundamental to collect atmospheric data on a global scale and constitute the “planetary general intellect”. In 1979, he was the main author of the report by the National Academy of Sciences that came to be known as the Charney Report, a landmark study of climate change (Charney and Platzman 1987; Litman 1962; Lindzen, Lorenz and Platzman 1990; National Academy of Sciences 1979).

Charney can be considered a transitional figure between the survivalist environmental sciences and the tendentially critical, liberatory climate science that developed after the 60s, and he seems to disprove any attempt to one-sidedly reduce climate science to militaristic motives, by being a socialist antiwar activist at the heart of the development of meteorology and the ENIAC. This political dimension of Jule Charney is elided in recent literature that emphasize the relation of climate science with the Cold War (see e. g. Edwards 2010, 118; Doel 2003, 651). His transitional position can also be seen in the fact that he brought the young James Hansen and Carlos Nobre to the stage, two key contemporary climate scientists. Hansen was a major reference in the Charney Report, and later would bring global warming to the cover of the *New York Times* after a testimony in the US Congress in 1988. Nobre later did important research on tipping points of the Amazon (Shabecoff 1988; Moura 2010).

Besides the computer, the development of space science and its infrastructure resulted in the first image of the Earth taken from space in the 60s (see Grevsmühl 2014). It made possible the comparison of the Earth with its neighbor planets, Mars and Venus, highlighting the special character of the blue planet. The investigation of

the possibility of life on Mars inspired James Lovelock and Lynn Margulis (1974) to develop their Gaia theory by suggesting that a planet bearing life would have an out-of-equilibrium atmosphere. The investigation of Venus led Hansen to foresee the dangers of a “Venus effect” (runaway climate change) on Earth (Hansen 2009). Here, originally militaristic developments were subjectively resignified. This detection of a qualitative uniqueness of the Earth that cannot be reduced to mechanical laws already suggests that climate science cannot be reduced to a mere collection of elements of early modern natural science, plus computers and satellites. Merchant (2016) , Sève (2005), and Lee (2003) have shown that by the last third of the twentieth century natural science has undergone a qualitative shift. From the point of view of the history of ideas, Merchant has shown that there was a shift from a science that aimed at the control of nature to a science that recognized the autonomy of nature, by conceptualizing complexity, non-linearity. From the standpoint of philosophy, Sève notes that the qualitative shift represented by complexity and non-linearity brought to the fore the problem of emergence: the constitution of systemic properties that are the result of relations between parts and whole, and cannot be reduced to the parts. Coming from the world-system perspective, Lee argues that the rise of complexity studies was a result of the decline of American hegemony and its structures of knowledge, also under pressure of social movements of the end of the 60s (ch. 7). In the next section, the internal constitution of climate science itself will be discussed.

ROOTS OF CLIMATE SCIENCE: THE IGBP AMSTERDAM DECLARATION AS HISTORICAL ARCHIVE

The Amsterdam Declaration of the International Geosphere-Biosphere Program (IGBP) (2001) is described by that institution as “historic”, resulting from a “major conference”. Recently, it was the only forum listed in the history of Earth System Science besides the International Geophysical Year of 1957-8 by important practitioners (Steffen et al 2020). As such, it represents a consolidated consensus in the development of climate science. Therefore, it can be used as an archive to retroactively track the theories, ideas, and meanings that were generative of climate science, as well as their historical context.

Its first point, which refers to a “self-regulating system”, is clearly derived from the Gaia theory developed by James Lovelock and Lynn Margulis (1974). Lovelock regarded himself as an “independent scientist” who quit a secure job in the British public sector to pursue science on his own terms. In his youth, he states in his autobiographical account that he was a socialist, that he was “dialectically materialized”, a pacifist, and an enthusiastic supporter of the Republicans in the Spanish Revolution. He reveals that he learned biology by reading the British Marxist H. B. S. Haldane. Prior to the formulation of the Gaia hypothesis, he worked with research in chemistry and medicine, which points to a non-mechanistic and restorative approach in relation to the Earth, which he called “geophysiology” (Lovelock 1986; 2000). Lynn Margulis was a biologist who challenged the view of biological evolution by competition. She proposed a then highly controversial theory of symbiogenesis, according to which

species evolve mainly not by competitive natural selection, but by symbiotic associations (the original paper was rejected by some fifteen journals before publication) (Sagan 1967; Sagan 2021; Brockman 1996, 135). She was eventually proven right when it was shown that the mitochondria in eukaryotic cells were originally free-living prokaryotic organisms. Margulis had a taste for heterodox scientific theories throughout her life, and experimented LSD (when it was legal). She reported her views on the theme in the journal *The Psychedelic Review*, questioning why the “consciousness expanding drug movement” encountered so much hostility (Sagan 1964; Normand 2016). Gaia theory was initially considered non-scientific, published only by countercultural journals. Its acceptance as “serious” science began with an invitation for a conference by Bert Bolin, who mediated the publication of Lovelock and Margulis by the renowned meteorology journal *Tellus*. Bolin would later become chair of the IPCC, illustrating how Gaia transitioned from counterculture to established science (Lovelock 2000, x, 253).

The second point of the Amsterdam Declaration alludes to the notion of the Anthropocene proposed by Paul Crutzen and Eugene Stoermer: “Anthropogenic changes to Earth's land surface, oceans, coasts and atmosphere and to biological diversity, the water cycle and biogeochemical cycles are clearly identifiable beyond natural variability”. It is important to note that this is an anti-Gaia concept, as stressed by Crutzen himself, who was critical at least of the strong (healing) Gaia hypothesis, claiming that the climate system encompasses many positive feedbacks (hurting Gaia). A Gaia and an anti-Gaia principle in the Declaration points to an institutional arrangement of internal disputes. Crutzen lived through the occupation of his native Netherlands by Nazi Germany. He moved to Sweden in 1958 and started working as a programmer at Stockholm University, which by that time was doing pioneer research on acid rain prompted by reports by non-academic scientists. He was soon invited to work with meteorology, but preferred to do research on tropospheric chemistry. He deciphered the problem of the destruction of atmospheric ozone by CFCs, highlighting the “non-linearity” of the chemical reactions involved. In the 80s, while punk bands were singing antinuclear songs, he published a paper whose title that could name one of those songs – “Twilight at Noon” – conceptualizing the notion of “nuclear winter”. This he considered, “from a political point of view”, “by far” his most important scientific achievement. Carl Sagan (who was married to Lynn Margulis and was Lovelock's colleague at NASA) and his collaborators continued the research in the US, leading a national antinuclear campaign. In 2002, Crutzen made the Anthropocene concept famous by publishing an article in *Nature* (Crutzen 1982; 1995; 2002a; 2002b).

The third point of the Declaration refers to non-linearities, feedbacks, and the notion of system. It is stated that the “simple cause-effect paradigm” became obsolete; “surprises abound”. This is directly related to the observations by Sève and collaborators on the problem of emergence, and can be considered the foundation of all other points. Conceiving the biogeosphere as a totality had already been proposed by Vernadsky in early revolutionary Russia (Vernadsky 1998; Rispoli 2014). Notably, in chemical engineering, certain kinds of reactors are known to present multiple steady states that are dynamically analogous to the alternative states of many climate models.

A seminal article states that “a reactor which finds itself in the neighborhood of an unstable state makes an effort to leave that neighborhood”, a remarkable recognition of the autonomy of nature even in controlled technological systems (Bilous and Amundson 1955). More widely known is Edward Lorenz’s notion of the “butterfly effect”, out of which he derived his notion of “making not exact [meteorological] forecasts but the best forecasts which the atmosphere is willing to have us make”. All these conceptualizations reveal an astonishment with the complexity of nature. The mechanical view of nature was consistently challenged by at least one important scientist, Ilya Prigogine, who proposed a “new alliance” between man and nature, questioning their Cartesian separation, and would later become a major reference for Immanuel Wallerstein (Prigogine and Stengers 1984). One of the main proponents of the notion of feedback in the climate system is James Hansen (2009). He preaches civil disobedience against climate change, and was arrested several times, having stated that “jail threats did not dissuade Martin Luther King – and intergenerational justice is a moral issue of comparable magnitude to civil rights” (Cope 2017). But “emergence” appears most clearly in climate science in Hans-Joachim Schellnhuber’s ambitious proposition of “geocybernetics”, in which he states the limits of transcendental Kantianism by noting that “world climate”, contrary to particular climate phenomena, cannot be perceived by any individual person. Rather, it is an emergent property of a “scientific-medial complex” that fosters a “global subject”, equated with the Hegelian *Weltgeist* (1998, 30-31; Schellnhuber and Kropp 1998). Schellnhuber was originally a quantum physicist who became interested in Gaia and was Angela Merkel’s scientific advisor on climate (Mossman 2008).

Fourthly, the Declaration refers to “critical thresholds and abrupt changes”, which became later known as “tipping points” (see Lenton and Williams 2013). The last term was coined by Schellnhuber. He stated that a sudden temperature change of the Holocene would not produce a gradual change, but rather the “collapse of subsystems” cascading to the whole system, a process comparable to the collapse of a human organism after the failure of one of its organs (Schellnhuber 2014, 431-2). Here the influence of Lovelock’s “geophysiology” is evident, but pointing to a limit to negative (healing) feedback is also a nod to Crutzen’s Anthropocene. In this sense, the fourth point is a synthesis of the first and second points, by stating that the Gaian behavior of the Earth System exists but can be disrupted. Before Schellnhuber, however, several others referred to “tipping points” (although not using this name) to processes occurring in other systems. The French mathematician René Thom (1975) developed the “theory of catastrophes” to model embryogenesis, which was applied in different problems of ecological systems (Scheffer et al 2001), and Charney and Quirk (1975) proposed a dynamic of the Sahara, which is similar to the dynamic proposed by Oyama and Nobre (2003) on the transition of the Amazon from forest to savannah.

Finally, as a consequence of the second, third, and fourth points, the Declaration elaborates further by stating that “the Earth System has moved well outside the range of the natural variability exhibited over the last half million years at least”, and “their magnitudes and rates of change are unprecedented. The Earth is currently operating

in a no-analogue state”. The main piece related to this point develops the notion of “safe operating space” (Rockstrom et al 2009). Here one can see echoes of the idea of “spaceship Earth”, “stewardship of the planet”, and cybernetic control. It is easy to dismiss these propositions as technocratic. However, they point back to the Tektology developed by the left-Bolshevik Bogdanov, who anticipated Wiener’s cybernetics (Bogdanov 1980; Rispoli 2020). “Spaceship Earth”, a notion that appears in Schellnhuber’s “geocybernetics” (1998), was proposed by Buckminster Fuller (1969) as a way of making rational use of technology to guide the development of the planet, promoting a “different aesthetic of technology” which stressed a “symbiotic relationship between human civilization and the natural world” (Deese 2009). His geodesic was adopted as the architecture of habitation by Drop City, the first hippie commune (Curl 2006), and ended up used as one of the possible forms of a grid for mathematical climate calculations (what was first suggested by Edward Lorenz) (Williamson 1968, see acknowledgements). Another important development was the design of Cybersyn by Stafford Beer in Allende’s Chile, a cybernetic system for the control of a socialized economy (Medina 2011).

What emerges from this reconstruction of climate science from the Amsterdam Declaration is that recurrent themes form a pattern: the recognition of the complexity and autonomy of nature (as emergence, tipping points, non-linearities); antimilitarism; socialism and echoes of the Russian Revolution; the utopian use of technology; cure, restoration, the living organism instead of the machine as a metaphor; all indicating a distancing from mechanistic science. The new science of climate models tends to represent the Earth System as a living, dynamic entity, recognizing its complexity and autonomy, configuring a post-positivist, tendentially ecofeminist treatment of nature. Scientific knowledge and infrastructural developments alone are not enough of an explanation for this shift. Non-linear, complex natural processes were known at least since Poincaré in the nineteenth century, while the infrastructure of the Cold War developed a deep understanding of the physical environment, but remained bound to an instrumentalist approach. The subjective development of a “new sensibility” resulted, in the case of scientists, in its embedment in mathematical climate models as “objectification of the species-life of man” (Marx 1992, 329): in the recognition of the complex, non-linear “autonomy of nature”. This was a later development, in the sequence of the social movements of the 60s. Recently, Roque (2021) independently arrived at similar conclusions.¹

CRITIQUE AND COMMODITY FETISHISM IN CLIMATE SCIENCE AS LEGACY OF COUNTERCULTURE

In 1969, at the peak of the countercultural movement, Marcuse saw the development of a “new sensibility”. In 1975, in the phase of reaction, he still maintained that “it is wrong to speak of its [the New Left] ‘failure’”, because “there are indications that the ‘message’ of the New Left has spread and been heard beyond its own spheres”

¹ I thank an anonymous reviewer for pointing this out.

(Marcuse 2005, 187). In 1979, he stressed that the ecological movement, besides being political, is also a “psychological movement of liberation”, because “the protection of the life-environment will also pacify nature within men and women” (1992, 36). Similarly, for Wallerstein (1989), “after 1968” ecologists “would ever again accept the legitimacy of ‘waiting’ upon some other revolution”. He defined 1968 as a “world revolution” that challenged both American hegemony and the traditional Left. It raised questions on the “structures of knowledge”, such as “physical scientists who did war-related research and social scientists who provided material for counterinsurgency efforts”, and then questioned “neglected areas of work” and the “underlying epistemologies of the structures of knowledge” (2004, 16). It was this social and intellectual environment that made possible for Adorno and Marcuse to keep alive a utopian idea that could be scoffed at by classic modern rationality: that of nature as a subject. Adorno argued that human agency could aid in this task, as the technique that “is said to have ravished nature”, “under transformed relations of production [could] as easily be able to assist nature and on this sad earth help it to attain what perhaps it wants.” (Adorno 1997, 68). Following Adorno, Marcuse, wondering whether it is “true that the recognition of nature as a subject is metaphysical teleology incompatible with scientific objectivity”, highlights that it is not a question of nature’s conscious volition, but of its liberation by humanity. The idea of liberation of nature “stipulates no such plan or intention in the universe”, it is “the possible plan and intention of human beings, brought to bear upon nature.” But it does suggest that “nature is susceptible to such an undertaking, and that there are forces in nature which have been distorted and suppressed” that could support and enhance human emancipation (Marcuse 1972, 66). According to Marcuse, “scientific concepts” could be grounded in an “experience of nature as a totality of life to be protected and ‘cultivated’”, and technology could be used for the reconstruction of the life environment. It is suggested that this “utopian” consideration of nature by the late Marcuse and Adorno had as a condition of possibility the social movements that started in the 60s. It was absent in Adorno’s earlier, more pessimistic work, when together with Horkheimer he conceptualized the reduction of nature to “substrate of domination” (Horkheimer and Adorno 2002, 6). In Marcuse, after the pessimism of the “one-dimensional man”, it represented the return to the Orphic myth of *Eros and Civilization* (1955) at a higher level of concreteness, referring to scientific concepts and restorative technology (1969, 1972). The confluence of new sensibilities and advanced forces of production produced possibly the most significant “shearing pressure” of contemporary society, climate science. It embeds aspects of this liberatory idea of restoration and the recognition of nature as a subject. Remarkably, it conceptualizes layers of time (geological, ecosystemic) that conflict with capitalist abstract time and the related unidirectional historical time (see Postone 1993).

Yet, it does so in contradictory form, conditioned by the limits of counterculture. For Marcuse (2005), in part the movement was co-opted or suppressed by the establishment. But in part it was self-destructed by not developing adequate forms of organization, divisions, anti-intellectualism, “politically powerless anarchism” and “narcissistic arrogance”. Importantly, the revolt was carried out by “minority groups that exist outside or on the margins of the material production process”, remaining

isolated (185). Marcuse (1972) himself pointed to a “counterrevolution”, which would later be called “neoliberalism”. That militaristic motives were not completely superseded is apparent in certain geoengineering projects (Scheffran 2019). Cooptation can also be seen among climate scientists, many of whom work for governments and corporations, a situation which refrains a more overtly oppositional approach. The late Lovelock is naively uncritical of capitalist corporations and neoliberalism, which is undoubtedly related to the fact that his work as an “independent scientist” relied on consultancies for multinationals. Crutzen (2002b) points to this as the reason of Lovelock’s initial underestimation of the effect of CFCs. Yet, probably out of hopelessness, Crutzen (2006) himself proposed a dubious “active scientific research” on geoengineering, while Hansen believes that a “fee and dividend” scheme can solve the problem of climate change (Hansen and Miller 2020). Relying more on the State, Schellnhuber (1999) awkwardly tries to reconcile “Leviathan” and “teledemocracy” in his geocybernetic approach, while Rockstrom, Klum, and Muller (2015) use neoliberal language (“no business on a dead planet”) in their account of “planetary boundaries”. These positions that stick to commodified “solutions” reveal a dualistic interpretation in which the climate crisis is not seen as part of a more fundamental crisis of the capitalist system (Postone 2017). If capitalism was forced to accept climate science by social movements, it strives to turn it into instruments of profit, such as emissions trading and corporate “sustainability” schemes, which reinforce the structuring of social life by the commodity-form. This is internalized in IPCC reports with the use of “ecosystem services” (imposing value into ecosystemic relations) and the use of the interest rate to discount future environmental impacts and compound capital gains in “cost-benefit analyses”. The interest rate is the most fetishized form of capital, as it naturalizes the accumulation of capital projecting it into the future (IPCC 2014a, 319; IPCC 2014b, 228-232; Cunha 2015). Yet, it should also be stated that climate science can be used by others for their own purposes. For example, new forms of social movements use the “planetary general intellect” as inspiration in “mock tribunals” that treat nature as the offended subject (Cassegard and Thron 2017), and critical theorists use the prognostics of climate science when they conceptualize the global socioecological crisis.

CONCLUSIONS

By investigating the constitution of climate science as a cultural artifact, this research historically grounds its liberatory as well as fetishizing moments. The “logic of aporias” of climate science and its related institution (IPCC), which unites a fierce objective critique of capitalism with fetishized capitalist motives is then deciphered as a result of the confluence of counterculture and its limits and the development of technology and its contradictions. This produced a post-positivist science that is potentially liberatory, yet is refrained from its full force by its remaining commodified and militaristic elements. In this sense, the IPCC reports document the social conflicts that are developing presently regarding nature and society. In this context, this article offers elements for a critique of science that is historical instead of essentialist, and for

avoiding the inconsistency of a one-sided critique of science coupled with the use of its prognostics on climate change.

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