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WITH CONTRIBUTIONS BY

Salome Asega
Carolina Caycedo with
Lupita Limón Corrales
Raven Chacon
Jesse Chun
Asia Dorsey
Taraneh Fazeli and
Cannach MacBride
Pablo Helguera
Emmanuel Iduma
Mary Maggic
Shannon Mattern
V. Mitch McEwen with
Nadir Jeevanjee
Rashaun Mitchell with
Silas Riener
Romy Opperman
Rasheedah Phillips
Leanne Betasamosake Simpson with
Maria Hupfield
Ultra-red with
Robert Sember
Underground Resistance

EDITED BY

Re'al Christian
Carin Kuoni
Eriola Pira

THE NEW SCHOOL
VERA LIST CENTER
FOR ART AND POLITICS

Amherst
College
Press

ON CLOUD TIME AND PROTOCOLS

V. Mitch McEwen in Dialogue with Nadir Jeevanjee

As climate becomes human[2]—affected by the complete human sphere of politics, urban and regional planning, logistics, economy, and revolt—it seems important to discuss climate as something other than a problem. We can be subsumed in the totality of this problem if we lack a space to think or feel outside of it. The matter of thinking "outside of climate" might be articulated through the concept of time—not only "past time" or "out of time" but another time.

The speculations presented here follow Black Quantum Futurism's prompt to consider and resist Greenwich Mean Time as an instrument of colonialism and globalization. The ubiquity of Greenwich Mean Time plays that colonial trick of naturalizing itself so completely that any alternatives quickly demand a remaking of the world.[3] At my convening with climate scientist Nadir Jeevanjee at the Vera List Center for Art and Politics, we invited alternative time protocols toward superseding or evading the colonial temporal order. We ventured into the question of cloud temporality: How do clouds matter in something other than the matter of solid substance, certainty, and earthiness, where "earthiness" can mean something different from soil, rock, land, and extracted minerals? How do clouds constitute another earthiness, another real, which might invite cloudy ways of conceiving space-time?

Temperature defines the strata of space within clouds. This is the first significant way of knowing clouds that I learned from Jeevanjee.

The quantification of clouds in physics is based on dynamic moving aspects of air and water—pressure, temperature, and evaporation.[4] Defining clouds by their distance above us allows cloud movement and temperatures to be calculated in relation to strata of air pressure. But the cloudiness of clouds—their fuzzy edges, their drifting—makes these calculations infinite. Until Jeevanjee's work, most cloud scientists described clouds through their linear distance from the water—water being both a flatter surface than land and directly related to how clouds emerge. Within a distance-centered framework, clouds are generally grouped by height, and their temperature explains their air pressure and evaporation rates. Jeevanjee's research flipped that paradigm. By replacing one category of markers with another, he completely changed the protocols of cloud descriptions. His research took the idea of temperature dynamics and advanced the concept of "temperature coordinates," in which the location of clouds can be described via temperature. Not a cloud one mile above us, but a cloud in a drifting clump of forty degrees. When was the cloud? Where was the cloud? How warm was the cloud? These become deeply interrelated questions and shift the protocols for cloud science.

Jeevanjee made pages of formulas to answer these quetions, which become measurable through considering temperature as a space-time of cloud formation. Most of the Earth is composed of tropical oceans, he points out. This planetary space of tropical oceans is called the troposphere. Our limited understanding of clouds, oceans, and the troposphere as earthy entities may be due to the difficulty to lay claim on them—to define them in terms of property, extraction, or another form of colonial expressions. But what does "earthy" mean? Why does it mean soil and not clouds?

As an architect, I am not often called on to consider cloud-time and what it might mean for human collective time or space-time. And yet it is extremely relevant to political empowerment: the relationships between poetry and revolution, between music and social movements are precisely "cloudy," in this way of cloud time. In a coherent movement or a critical mass, one recognizes the exchange of feelings and energy as both a tempo and an emotional state. This poethic[5] temperature (let's call it that) makes clusters of experience legible to a collective in motion. Usually, you have to be there—at the protest, the sit-in, the riot, the hours-long activist meeting—in order to be there. But sometimes, you can be almost-there, in the wake of it. There is something of a temperature-based constitution of the where and when of social political movements. This may be cloud-time.

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Nadir Jeevanjee: I'm at the Geophysical Fluid Dynamics Laboratory, a national climate modeling center associated with Princeton University. Before I was a scientist, I was a drummer and kept time. Then as a physicist, thinking about time, and space, and relativity, it is space-time that I hear cropping up a lot.

When talking about the concept of how to coordinatize space-time, the key question is how to assign numbers to where and when things happen. There are deep connections to Einstein's physics of relativity, essentially pointing out that the way we assign the coordinates is arbitrary.

V. Mitch McEwen: We're going to get into cloud-time! But first, I think one of the most important things is that the planet is mostly ocean, mostly water. When talking about climate, we're talking about atmosphere, we're talking about anything planetary, we're really talking about water. What you talk about is a troposphere, the lowest region of the atmosphere extending from the Earth's surface.

One of the things that is really important in terms of this geography of time is that when you're thinking of the planet as a troposphere, as this most "earthy" space, if I understand it correctly in, it is actually a tropical space. It's a tropical ocean space. And the temporality of clouds invites us to "feel" time and to do that in a way that makes temperature and embodiment a part of how time becomes instantaneous and accessible to multiple entities. That there are multiple temporalities in the ocean. There's deep space in the ocean where things change at different rates.

Nadir Jeevanjee: When I transitioned from music to physics, and then finally to earth science, it was illuminating to think about the center of the Earth as a tropical ocean. If we had to boil the Earth down to one geographical space, from a climate point of view, it would be a tropical ocean. Why is that? I'm a native Californian living on the East Coast; I have always lived in the middle latitudes that many of us are familiar with. The tropics work fundamentally differently. The tropics is where most of the sunlight comes in. It's where most of the rain falls.

The places we live in here in the middle latitudes stay warm because of the tropics, where the sun evaporates water from the ocean and then that water gets transported to the middle latitudes. That water, as it rises, cools, and condenses, makes raindrops. Those raindrops are actually concentrated sunshine. They release heat energy when they condense, and the heat they release is the same heat that went into evaporating those water molecules off the ocean surface.

You get that heat back when you make the raindrop. That raindrop heats the air that then gets sent our way up here in the middle latitude. The tropics is really the furnace for the whole planet. That's where all the heat is generated.

In this process, the sunlight comes in and then, as you say, creates two layers of the ocean through the process of evaporation. First, we have this shallow ocean box and then this deep ocean box. The first one is maybe a few hundred feet down. The second one goes down thousands and thousands of feet. The bottom of the ocean is ten thousand feet down or more. The sunshine comes in, and then where the clouds come into it is where you get this evaporation off the surface as little water molecules.

I'll draw them as little H2O molecules, little Mickey Mouses, and then they rise and make clouds (figure 1). When they do that, when they condense to make raindrops, there's heat that gets released, the same heat that came from the sun to evaporate them in the first place.

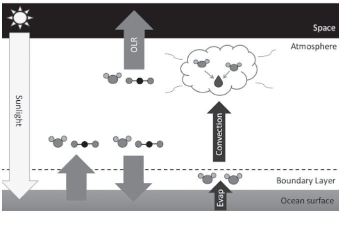

Figure 1. Schematic of energy flows through the climate system. Sunlight heats up the surface (yellow arrow), but this energy cannot be radiated away because it is blocked by greenhouse gas molecules (red arrows at bottom). So, the surface cools off by evaporation, and these evaporated water molecules eventually condense higher up to make clouds, giving off a heat of condensation in the process. Schematic courtesy of Nadir Jeevanjee.

V. Mitch McEwen: When I think about the sky in a pictorial sense, I think about a horizon line over land, where clouds blend into the land. In a way, one could imagine the ownership of the land extruding up into the sk. And that the terms of landed property could be extrapolated to the sky in a sense that ties into the history of landscape painting and Manifest Destiny. For me, part of what is so significant about this is that the physics you are diagramming is all related to the ocean. This is all still the troposphere, this whole dynamic of what makes the atmosphere.

Nadir Jeevanjee: Definitely, and in most places, the land gets its water from the ocean. My motivation for studying climate science is, of course, climate change. What you see here in this diagram is the shallow ocean, the deep ocean, and then this arrow represents the heat that we're trapping from carbon dioxide.

This diagram is describing that you've got a shallow and a deep ocean, which means that there's a shallow and a deep time of climate change. Because, as we all already know, if you've got a small pot of water, you can heat that quickly. If you've got a big pot, it takes longer.

We've got this heat that's being trapped in this shallow layer, which warms up pretty fast, on a time scale of maybe three to five years, but this deep ocean, four thousand meters/twelve thousand feet down, this takes hundreds to thousands of years, although even minuscule change may have enormous impact since the temperatures down there are normally so stable. There is definitely a deep time of climate change that we often don't think of. This deep time shows that while the temperature changes may be minimal, we'll have an impact thousands of years into the future, even if our civilization and humanity are gone (figure 2).

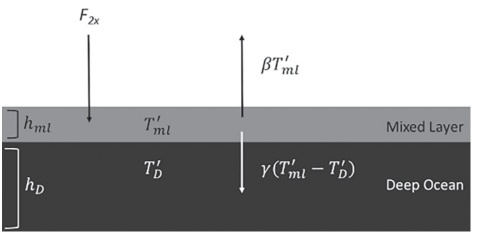

Figure 2. Schematic of the shallow ocean ("mixed layer") and deep ocean. The "F2x" arrow indicates the trapped heat from CO2. The downwards white arrow represents the slow transfer of this heat to the deep ocean. Schematic courtesy of Nadir Jeevanjee.

There's also a deep time of the CO2 that we put in the atmosphere. We dug it up from underground, and it took tens of millions of years to sequester it down there, and in a matter of decades, we suck it up, and we blow it into the atmosphere. That means there's a deep time to the changes that are coming. There are some that we feel soon, but then there are others that will take centuries or millennia to fully realize, which we, as humans, may no longer experience. That's where the time and the physical space meld together.

V. Mitch McEwen: We can already recognize that whole systems are failing—or that they produce failure by design, that they produce disruption by design. Now I want to take a moment to highlight where I think we can make connections to the troposphere and clouds that we can bring into human practices and consciousness. One is this presumed space that we were talking about in this diagram and how it disrupts something like a horizon line and the significance of land because disrupting land also disrupts colonial land and its terms.

Thinking about the idea of surface temperature, you talk about boundary layers, these slow timescales. What is the potential of a coordinate space that is no longer spatial but actually based on temperature? In other words, if we switch some of the protocols of cloud data capturing in theoretical physics, can we better understand climate change? Can we shift from a coordinate space to a coordinate temperature?

I'm going to pass it back to you, but first, let me unpack this a bit. It relates to the flux divergence that you talk about. There's a way that in order to measure clouds, we need to measure our own experiences, our own feelings. I don't know about you, but sometimes I feel cloudy to myself, right?

Part of what is at stake with clouds is what I would call individuation. I know you use your own language around things like bulk plumes, fluxes, and flux divergence, but really, the science of clouds is a science of flows. I'm thinking of individuation in the way that poet Fred Moten talks about it in terms of Blackness as a universal machine.

That part of the thinking of Blackness in terms of Black studies is something other than the individual biography, individual greatness, or the individual artist being an individual genius. I think we're all invited into something other than individuation in this symposium with the mode of artistic practices. Part of what I hear from Nadir's cloud science is also a science of collectivity. That collectivity is a protocol for conducting science.

There's a way in which the science of flows and collectivity is already temporal and part of the science that you're doing on clouds. I think you're doing science around these systems that are changing drastically because it allows you to also map these broken systems. The Greenwich Meridian Time, for instance, is a broken system because of white supremacy, which is also a broken system because of colonization. I want to shift from this map of the troposphere to discuss this GIF.

Nadir Jeevanjee: This is a simulation using computer models that we develop of this tropic's only picture of the world (figure 3). The surface is there in blue, those colors that you see are the amount of rainfall hitting any point of the surface at any time, and then that moisture gets transported up by the clouds. You've got this whole population of individuals, but they are all part of the same cycle of energy and water.

That is the climate, that is how the energy flows from the sun through us. We take our portion of it and then the rest flows out to space in the form of infrared energy. These clouds are key. Each individual cloud is a key component of this process, but it turns out that in science, and perhaps more broadly, it makes sense to describe these collectively. Each individual cloud, as you can see, it's kind of chaotic. They all have their small differences, but it turns out that they actually have a lot in common. The best way to describe it is by thinking of them as one collective entity and describing their behavior collectively.

You can actually take this, which is simulated on a supercomputer. It's complicated, and you can boil it down with pencil and paper, where at each sort of level in the atmosphere, whenever there's a cloud, it turns out that the amount of moisture it has, its temperature, is pretty similar at a given height, no matter which cloud or when the cloud is. It could be a cloud here at this point in space and time or one later, but if you look at it at the same height, it's got the same properties.

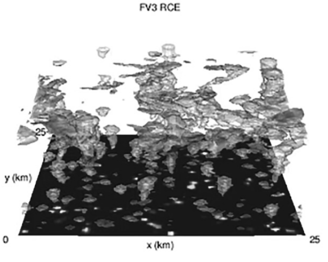

Figure 3. Snapshot of simulation of a "tropics-only" world with widespread clouds and convection. The ocean surface is blue, with other colors representing intensity of rainfall at the surface. The clouds flow individually but act collectively, and share many characteristics (humidity, density of cloud drops) especially when viewed in "temperature space" rather than in height or pressure space. Simulation still courtesy of Nadir Jeevanjee.

Now we can go back and touch on coordinates and temperature. The way that people usually coordinatize this and in ways, and remember time is a coordinate, we have our space coordinates and that's just a theme of this conference is what do these coordinates mean. They have an intrinsic meaning. Are they arbitrary? What are other coordinates that we could use?

V. Mitch McEwen: We're going to make a radical—it's just a little bit of a rupture, but I want to shift from cloud time in the pure theoretical physics to cloud time as something that maybe is already practiced in a Black reality. The way Rasheedah Phillips talks about that, we as Black people have needed to navigate Greenwich Mean Time, similarly to how our ancestors navigated through the stars in terms of locating fugitive potentials. Protocols navigate metrics. We have mostly been talking about metric systems, which arrange protocols but cannot be reduced to them.

From there, I want to ask you about the instantaneous because this is something that you work on. You have taught me about the distinction between steady-state and equilibrium. Within this temperature temporality, there is a temporality of what is instantaneous that actually takes time.

Nadir Jeevanjee: It relates to that shallow, deep ocean thing that we were talking about before in that the climate is the whole system and the pieces are coupled, but they're coupled on different timescales. The surface ocean and atmosphere appear to communicate quickly, but then in the deep ocean, it takes hundreds of years to know and truly feel the changes that are happening up here and come into a steady state with them, where the energy they're receiving is the same as the energy they're putting out. In that way, what we consider instantaneous depends on a reference frame.

The three to five years that it takes the surface ocean to adjust to what's happening in the atmosphere is instantaneous from the point of view of the deep ocean; three to five years is nothing. When we're thinking in terms of this deep climate time or this deep time, again, relative to a concrete change that's happening here, the adjustment time here is invisible. It's instant. Obviously, from the point of view of the ocean, that takes three to five years to change. There are atmospheric changes that happen on the time scale of weeks, and those are instant.

V. Mitch McEwen: We might consider the way that we learn from and feel each other's knowledge also in cloud-time. The way that a conversation can happen over the course of an hour, be transcribed over the course of weeks, edited over the course of months, and read by a reader outside of this room, in a manner of minutes—that also traverses time. There is energy dissipated and condensed at various moments of that process.

1 This text is an edited and condensed excerpt of McEwen and Jeevanjee's exchange on clouds, offered at Black Quantum Futurism's Prime Meridian Conference and presented by the Vera List Center for Art and Politics at The New School in 2022.

2 The term Anthropocene emerged from scientists at the opening of this century to demarcate significant human impact on Earth's geology. There are other terms and other ways of understanding this crisis, whether Plantationocene or simply Modernity, but they share an entanglement with questions of what it means to be human.

3 The premise of the Prime Meridian Unconference resonated with what philosopher Denise Ferreira da Silva calls Black Poethics, a consideration of aesthetic and ethical intentions. "What is the Black Poethic Intention? Is it an ethics, which, instead of the betterment of the World as we know it aims at its end?" Denise Ferreira da Silva, "Toward a Black Feminist Poethics: The Quest(ion) of Blackness Toward the End of the World," *The Black Scholar* 44, no. 2 (Summer 2014): 82.

4 See Nadir Jeevanjee and David M. Romps, "Mean Precipitation Change from a Deepening Troposphere," *Proceedings of the National Academy of Sciences* 115, no. 45 (November 6, 2018): https://orcid.org/0000-0002-6657-896X.

5 Ferreira da Silva, "Toward a Black Feminist Poethics."