

Tomás Saraceno - Aerocene  
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Publication: Studio Tomás Saraceno  
Editing: Tomás Saraceno, Ignas Petronis, Vesilj Stitnikov, Anna Garbuglia, Sofia Lemos  
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www.aerocene.com  
www.tomasaraceno.com  
#ifyforchange #aerocene

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Tomás Saraceno  
Aerocene is a project about friendship, about the relationship between air, universes, humans, sun, animals, plants, planets. It is a project showing how shared enthusiasm become the commune ground to shared dreams. Where the time becomes another one, where energy and inspiration are endless resources. I can only hope that this family will grow even bigger. Thanks to all of you that make this journey in the air. Only together we will make it! Thanks for the endless commitments my dear comrades!

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Solutions COP21, during United Nations Climate Change Conference COP21, 2015, Paris.  
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This was day before yesterday! The sun was so strong that one after the other we started to dive to the stars, we held each other to the earth, with sand bags, ropes and gloves... The access to the space seems open again, this time without rockets and tickets. Endless thanks to the board of White Sands launch: Rob La Frenais, Kerry Doyle, Karla Frusto, Michael Wyatt, Tom and Marija Mirkovic, John Powell, Ewen Chardonnat, Nicola Triscott, Frederik Jacobi, Anthony Langdon, Astrovandistas, Gravity by its Absence artists' group, and Rubin Centre for the Visual Arts, as well as for everybody else who took part.

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# Aerocene

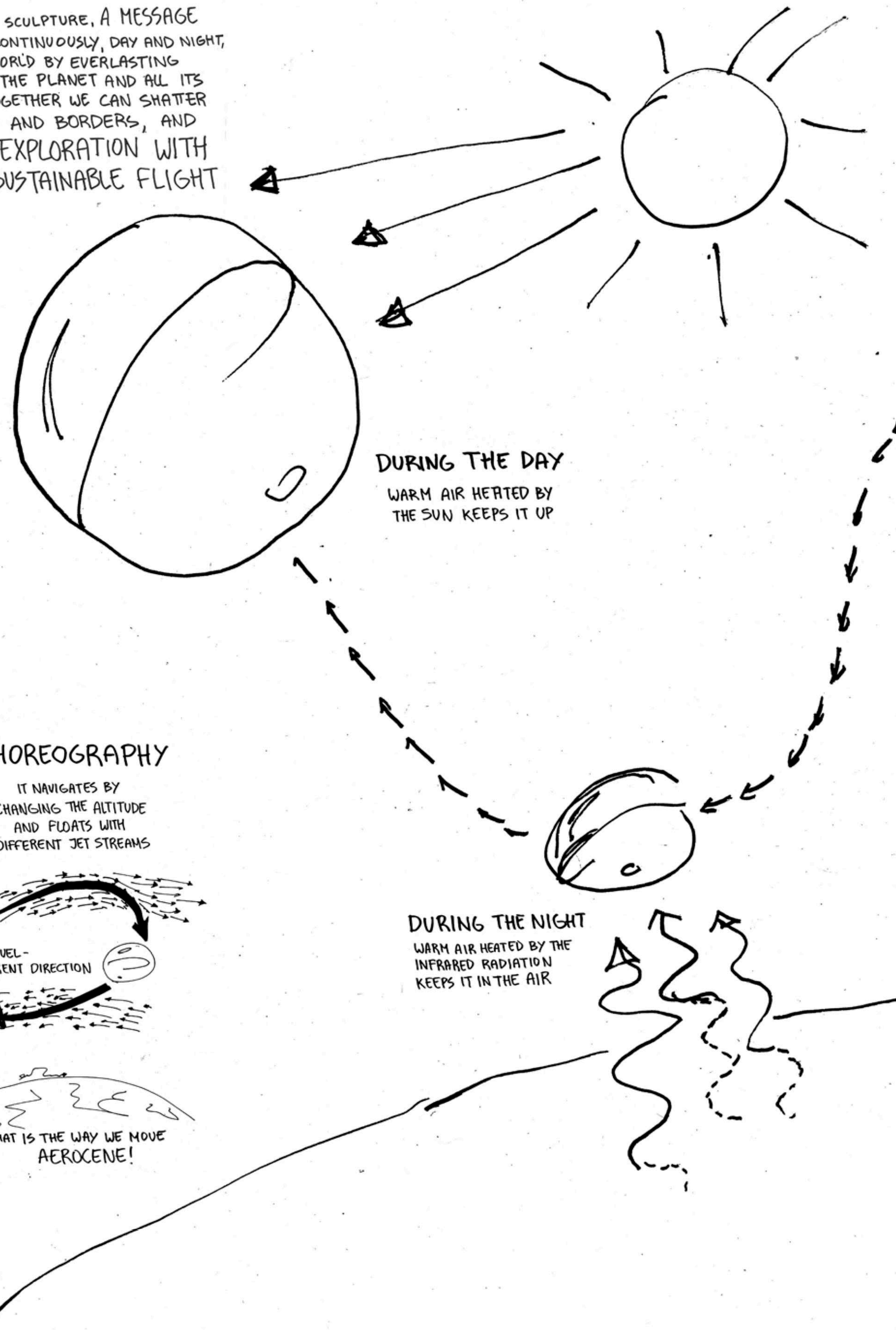
AROUND THE WORLD TO CHANGE THE WORLD

Tomás Saraceno, Aerocene - Cloud Cities, 2016  
Artist's view, collage

An art project by Tomás Saraceno,  
presented during United Nations  
Climate Change Conference COP21  
at Grand Palais, Paris 2015

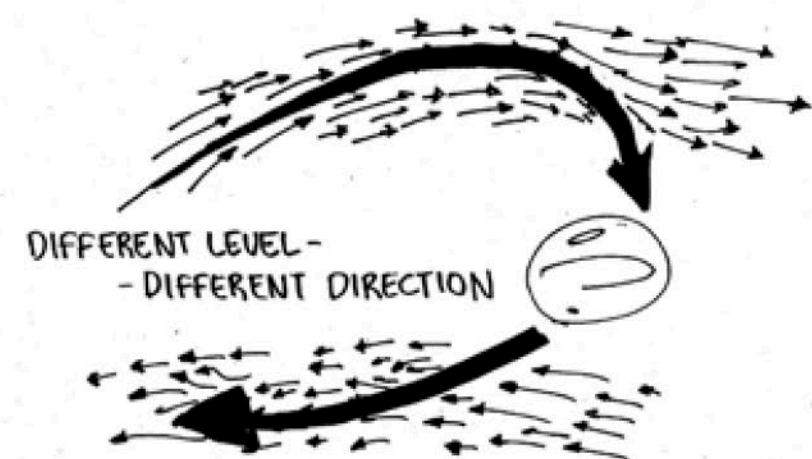


AEROCENE IS A SCULPTURE, A MESSAGE THAT FLOATS CONTINUOUSLY, DAY AND NIGHT, AROUND THE WORLD BY EVERLASTING ENERGIES OF THE PLANET AND ALL ITS DWELLERS. TOGETHER WE CAN SHATTER ALL RECORDS AND BORDERS, AND REINVENT EXPLORATION WITH THE MOST SUSTAINABLE FLIGHT



## CHOREOGRAPHY

IT NAVIGATES BY CHANGING THE ALTITUDE AND FLOATS WITH DIFFERENT JET STREAMS



# Keep it in the air

**Aerocene** follows the sun and the rivers of the wind: with this we fly in unimaginable ways!

**Aerocene** - inflated by the air. Lifted by the sun. Carried by the wind

**Aerocene** dances with the earth and the sun to the thermodynamic music and choreography of the cosmic forces. #flyforchange

**Aerocene** is a new epoch that will come through collective efforts, defining together the future mode of existence. Aerocene is a sculpture, a mode of moving, living and being-together.

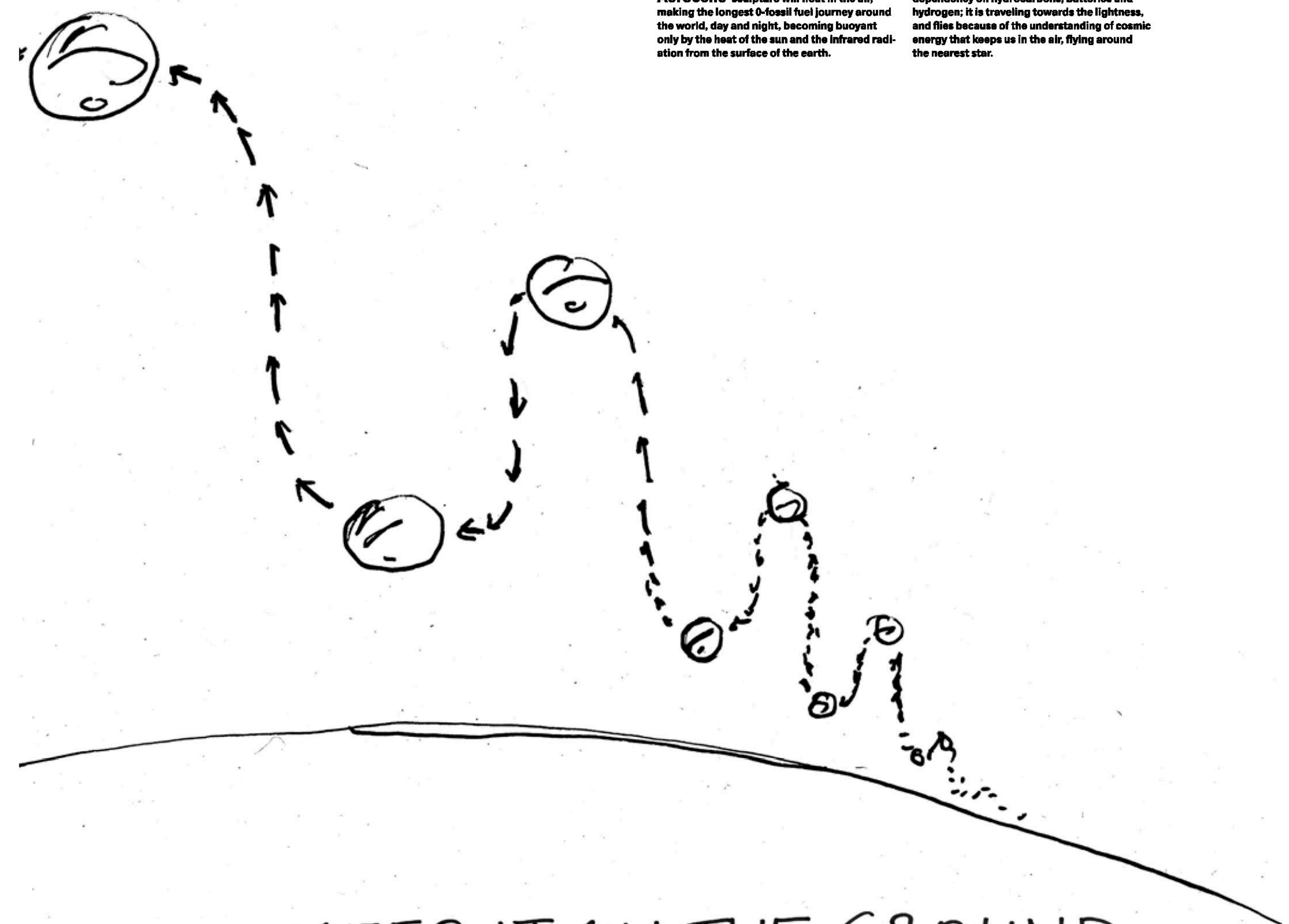
**Aerocene** sculpture will float in the air, making the longest 0-fossil fuel journey around the world, day and night, becoming buoyant only by the heat of the sun and the infrared radiation from the surface of the earth.

**Aerocene** sets off for the longest synergetic journey around and with this planet.

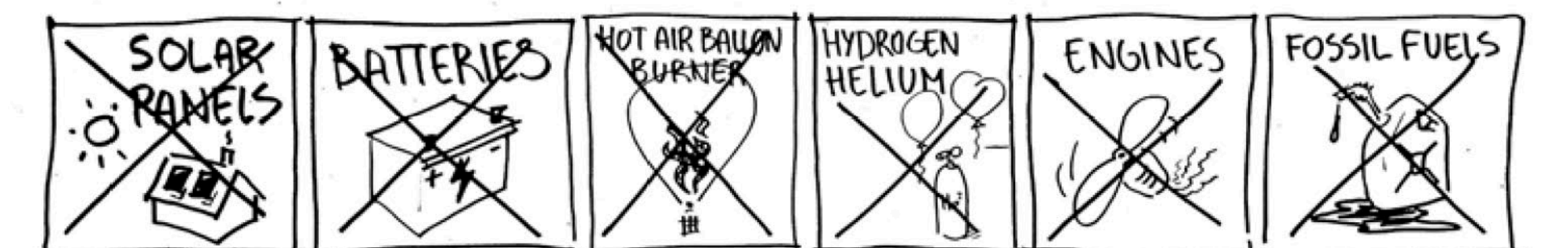
Keep it in the air and achieve the impossible. Let's keep resources in the ground and demonstrate that by working together we can make it.

**Aerocene** begins now as a past-becoming-future technology; in the near future, it will define the age of the post-fossil-fuel travel, a pace of living that is in tune and at the whim of the wind.

**Aerocene** is a new journey that cuts off the dependency on hydrocarbons, batteries and hydrogen; it is traveling towards the lightness, and flies because of the understanding of cosmic energy that keeps us in the air, flying around the nearest star.

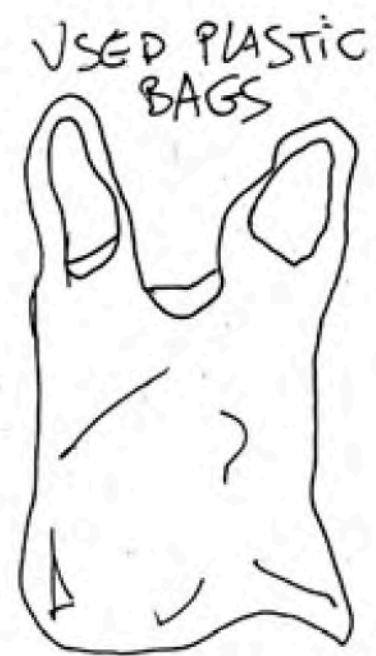
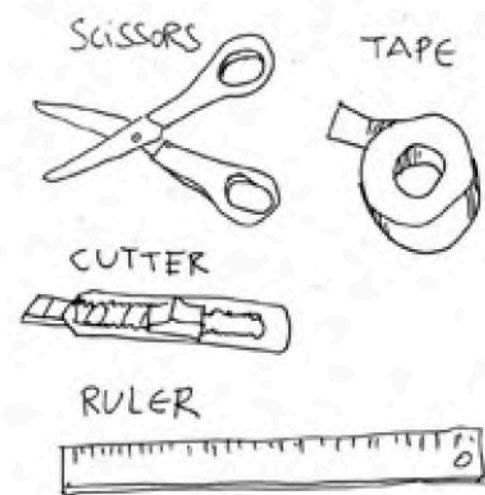


## KEEP IT ON THE GROUND

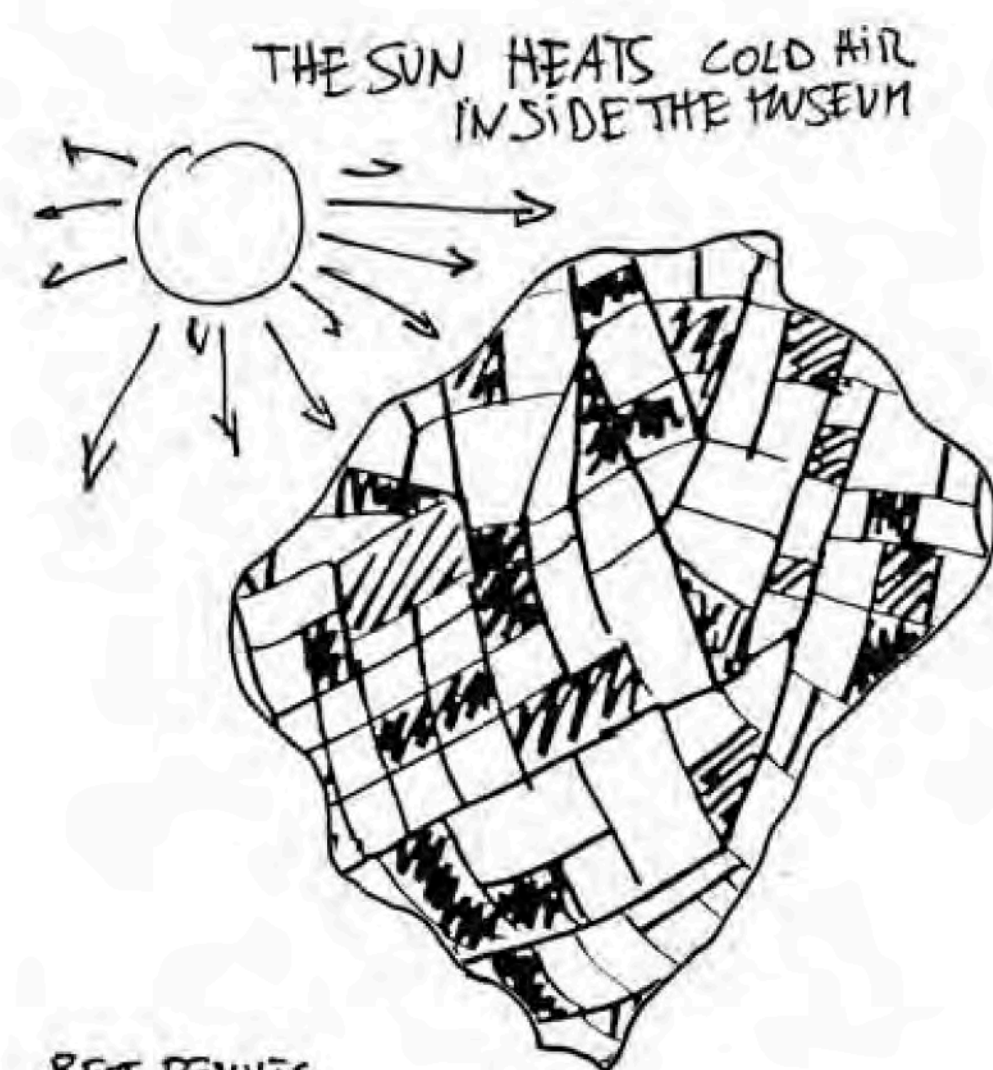
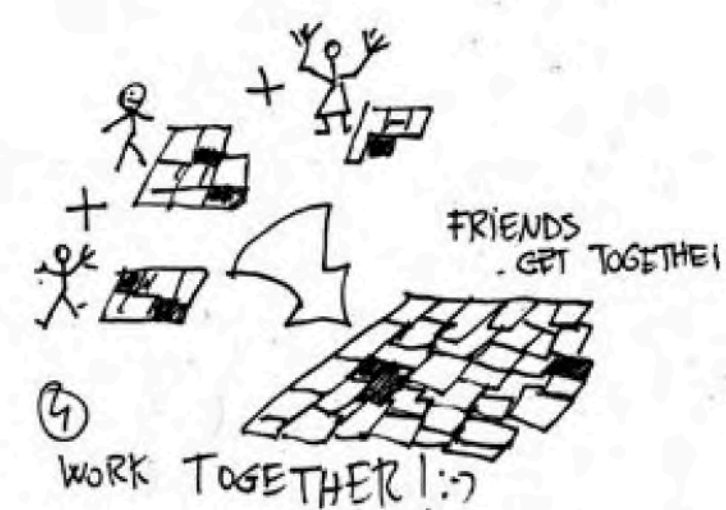
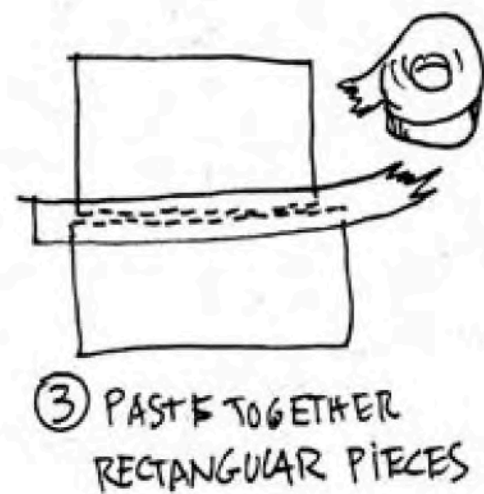
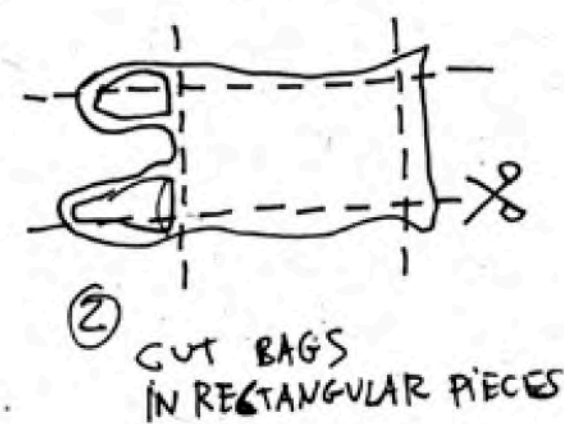




# How to build it



HOW WE DO IT:



BEST RESULTS  
CLEAR SKY  
NO WIND



FLOAT IN THE SKY!

## Build together Museo Aero Solar!

By collecting plastic bags, you help to clear out the plastic pollution - one of the biggest environmental problems of nowadays. The tools needed to make the bags into a flying museo are simple: scissors, cutters and some tape. During COP21 Aerocene will be accompanied by the collective action, carried out in multiple collection points in the city; and a collective building of Museo Aero Solar, organised together with Palais de Tokyo.

For more information visit [www.aerocene.com](http://www.aerocene.com), sign in and help to keep the message floating in the air. It is an open source platform, distributing shared knowledge and know-hows.

Everyone can build Aerocene: from a reused plastic bag to the journey around the world.

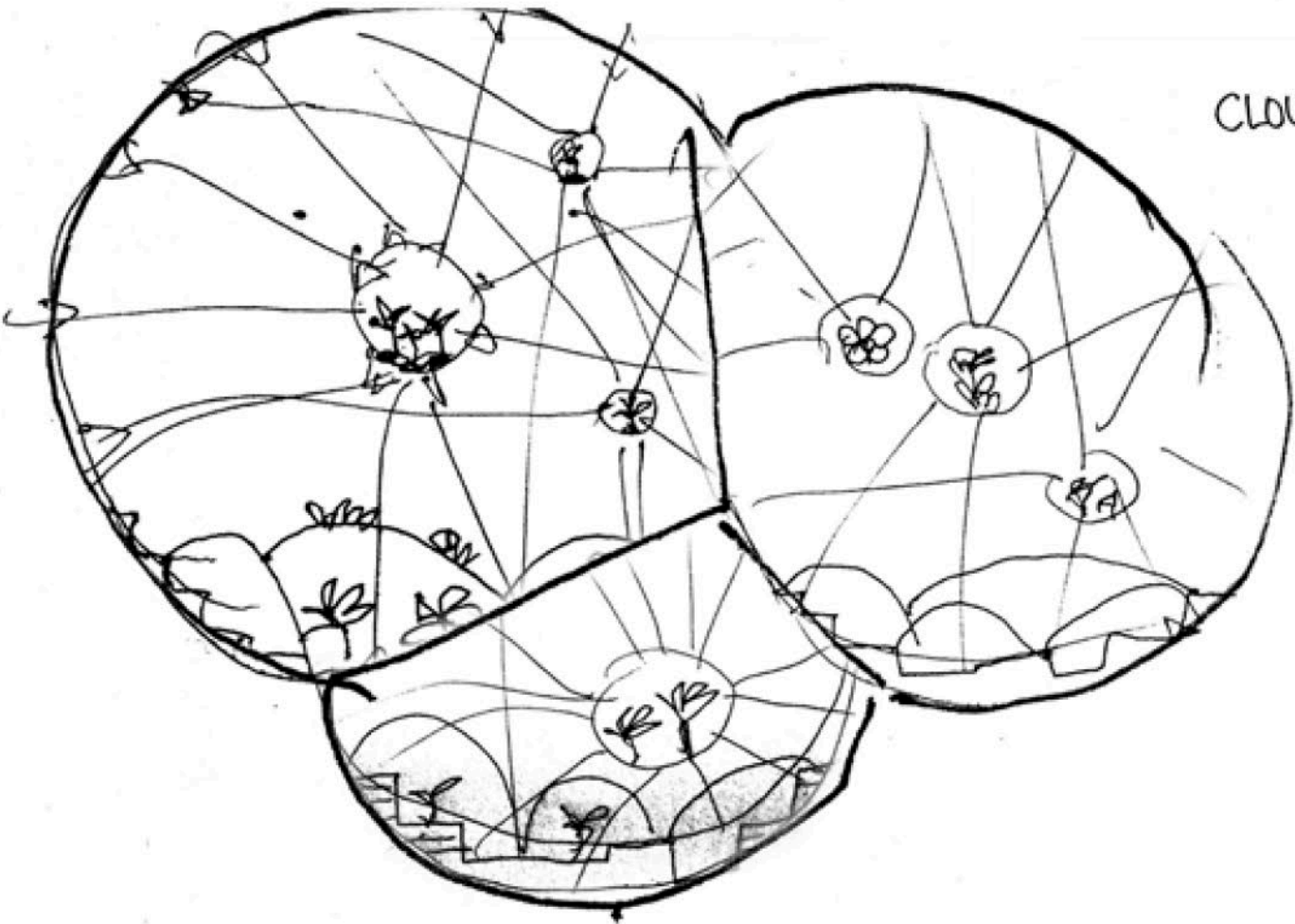


Museo Aero Solar  
In Prato, Italy, 2009

Museo aero solar is a flying museum, a solar balloon completely made up of reused plastic bags, with new sections being added each time it travels the world, thus changing techniques, drawings and shapes, and growing in size every time it sets sail in the air. Museo aero solar stands for a different conception of space and energy, both anomalous and forceful at the same time. The core of the museo resides in the inventiveness of local inhabitants, not in its image among collective action and art, do-it-together technology and experiment. It is a voyage back/forward in time. In the past 8 years, the Museo Aero Solar has already landed in more than 21 cities.  
[www.museoaerosolar.wordpress.com](http://www.museoaerosolar.wordpress.com)



MOVING, DWELLING, BEING TOGETHER - WITH ALL THE SPECIES

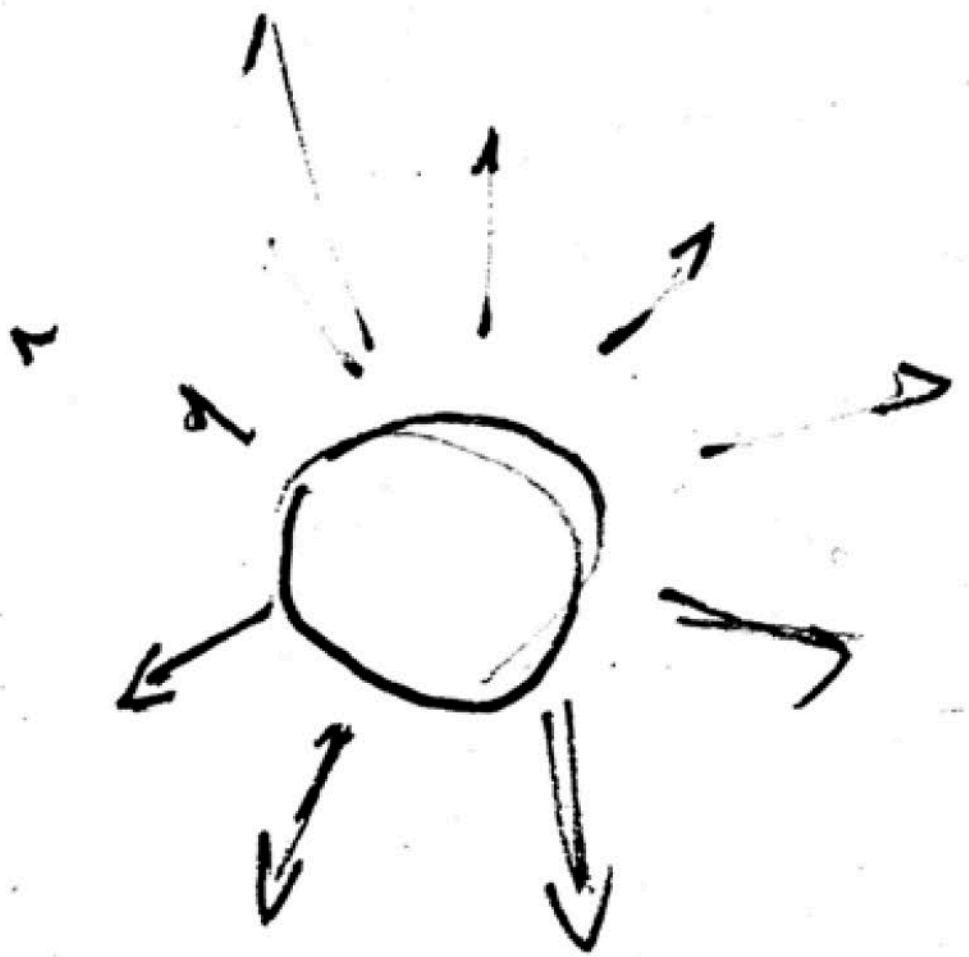


CLOUD CITIES ON THE MAKING

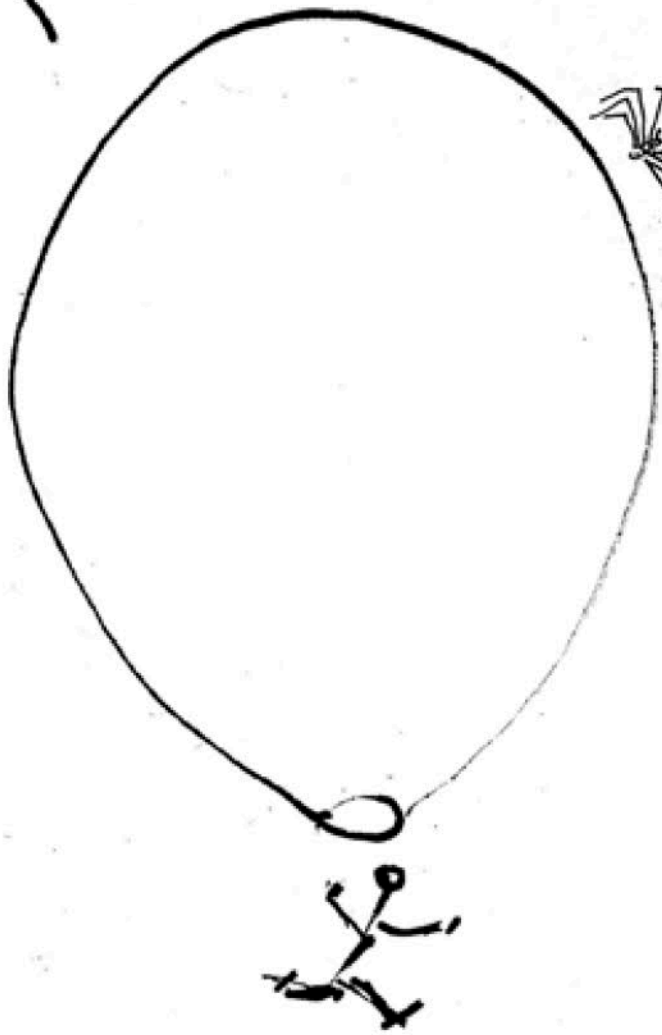
WHEN AEROCENE REACHES THE SCALE OF CLOUD CITIES IT REMAINS ALOFT INDEFINITELY



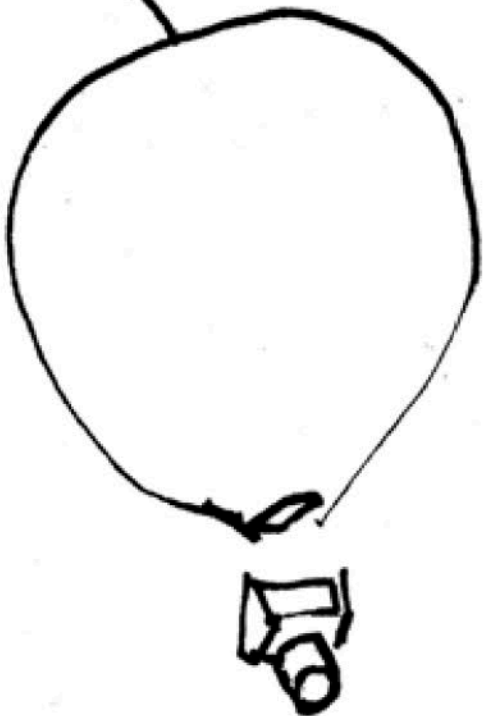
TRAJECTORY  
JOIN THOUSANDS IN TRACKING AND PREDICTING THE PATHS OF THIS ARTISTIC EXPERIMENT



THE AIR IS A SUPER HIGHWAY, AN OCEAN OF UNEXPLORED LIFE, AN ESTIMATED 25,000,000 ORGANISMS PER SQUARE MILE, TRAVERSING THE EXPANSE ABOVE OUR HEADS LIKE THE BALLOONING SPIDER, WE CAN REACH NEW HEIGHTS, PILOTING OUR GOSAMER ORBS TO NEW WORLDS OF COOPERATIVE LIVING



RISE UP!  
BE ONE OF THE BRAVEST, LET THE SUN LIFT YOU!



PAYLOAD  
MAKE A SUGGESTION OF A PAYLOAD FOR THE NEXT FLIGHT!



HOW TO BUILD IT  
BUILD A FLYING SCULPTURE OUT OF USED PLASTIC BAGS



# Explore the interconnected world

We tend to think of ourselves as living on the surface of the planet; but we also live on the bottom of an ocean of air.  
Jonathan Renouf

**Aerocene's** message bears the deep understanding of life on this floating planet. It is a message of simplicity, ethics and cooperation for a tumultuous world divided by geopolitics. Aerocene is a message that calls us back to a symbiotic relationship with the Earth.

**Aerocene** is a message for democratically distributed information, open-source and common-copy know-hows that empower the civic science.

**Aerocene** is traveling sculptures that cross art frontiers between art, architecture and science: becoming a visionary open participatory platform of knowledge production and distribution.

**Aerocene** comprises a multitude of mobile sculptures that fly fuel-less and borderless while collecting and distributing the insights on the changes in our common environmental sphere of life.

**Aerocene** changes the world with its ideas of both metaphorical and real inhabiting of the world. And abstract concepts become form: "Simultaneous and democratic knowledge." "Frontierless mobility." Perception of the other."

For more information visit [www.aerocene.com](http://www.aerocene.com), and help to keep the message floating in the air. It is an open source platform, distributing shared knowledge and know-hows.

Come to hear the Aerocene's voices!  
The symposium at Palais de Tokyo, 6th December at 3 pm, 2015.





Museo Aero Solar  
in Prato, Italy, 2009  
[www.museoaerosolar.wordpress.com](http://www.museoaerosolar.wordpress.com)

Pierre Chabard

# Air Crafted

A social model as such proposes a new vision for humanity, where hierarchies and pre-defined identities and organisational models are discarded in favour of horizontal, equal and immediate interactions between individuals within the aerosolar time-space. The principles that Saraceno relies on and articulates in his visions, such as participative actions, co-creation and do-it-together practices, make this future society less apparent as complex body of entangled social, political, and economical, and more similar to a cyber-network, driven by an artistic aerosolar artifice.

Besides momentary workshops, and without the actual experience of living above the clouds, this community of *aerosolar becoming* virtually exists as an online social network. Saraceno says that his aim is "to build a city in the air, just as we're building Linux or Wikipedia today."<sup>2</sup> Thus, *Museo Aero Solar* is not only a sculpture, a museum made of reused plastic bags, but also a blog, a website, YouTube channel, Facebook community, Twitter hashtags, Instagram galleries, open Dropbox folders, wiki-tutorials, etc. To participate in *Museo Aero Solar* in one way or another is also to float in blogosphere, the space that is extremely fluid and open. These features of communication channels reciprocate with the internal logic of the project.

Tomás Saraceno sees the clear link between the three realities, or three types of networks: the ecosystem of digital media, the atmosphere of the globe with its co-dependant climate fluxes and flows, and the aerosolar society that inhabits it. The project of *Aerocene* seems to part from the roots, found in *underground*, counter-activism of the whole aerosolar initiative. Nevertheless, it goes forth with a de-poling of the world, and draws on a global and de-territorialised community living in the borderless sky. A social model as such proposes a new vision for humanity, where hierarchies and pre-defined identities and organisational models are discarded in favour of horizontal, equal and immediate interactions between individuals within the aerosolar time-space.

#### Scarcity or abundance?

The intelligibility of *Museo Aero Solar*, *Becoming Aerosolar*, and *Aerocene* lies in the peculiar lightness of the way they translate, articulate (and hijack) the gravest problems of our times. The contemporary atmospheric condition is distinguished by violent meteorological phenomena, and rising concentration of toxic gases and particles that constitute the most invisible pollution. Saraceno chooses to hijack global warming, and to treat its causality – the greenhouse effect – diametrically. He does not call for an immediate and definitive measure. Rather on contrary, his vision employs the physical, thermodynamic process of warming, and makes it the main energy source – free and unlimited. This research, supported by collaborations with scientific teams of NASA and CNES, thus materializes in the ultrathin membrane, a tiny wall between interior and exterior that enables the sculpture to harness the energies of the Sun and the Earth, and go aloft.<sup>3</sup>

The similar logic overruns the position taken towards the Anthropocene.

The term comes from the new geological strata, the one mostly formed by the human activities of over-production and accumulation of artificial, synthetic or composite materials, which are produced by transforming natural resources in an irreversible manner. Keeping this in considerations, aerosolar undertakings challenge traditional ecological positions by building its material base on plastic. *Museo Aero Solar* workshops bear the capacity to stitch more than 20,000 plastic bags together and thus refuse become a resource. While downgrading, downsizing and austerity have been eagerly adopted by the dominant discourse nowadays, Saraceno reveals, exploits (and denounces) this form of abundance that flows from an erroneous patterns and habits of production and consumption. Ambiguous, dynamic, less subversive than transgressive, his aerosolar can be seen as sublime parasites, or radical enterprises of diverting our inherited world.

#### Resistance or escapology?

Saraceno's *aerosolar undertakings*, and, namely, *Aerocene*, imply unrestricted movement across borders of art, architecture, and science. The 'chimerical', highly prolific results of Saraceno's research impair disciplinary boundaries by keeping political commitments and unbounded creative spirit. The highly advanced scientific knowledge that enters the project is met with the philosophy of low-tech, the methods of *bricolage*, decreased velocity and collaborative work. Celebrated in the well-established scene of contemporary art, Saraceno's works permanently urge to transgress it and to escape the immune sphere that, according to Sloterdijk, symbolizes our over-developed world. Besides the playfulness of interactivity, his architectural artistic interventions bring sensations ranging from weightless levitation to vertigo, from disorientation to unique sensitivity to another being. Precisely these "anomalous" settings and feelings empower the aerosolar future projections, and its ambitious initial realisations.

In the current ecological discourse, science and technology are summoned together to curb climate change. As in "sustainable" architecture, the blind solutions go to the matter of isolation that is treated as a theoretical aim and a practical claim. Contrary to the repressive inclinations of the two, Saraceno does not resist the climate, the atmosphere, or weather. He chooses to engage with its prodigious dynamics, and to rely on its thermodynamic fortune. "When Cloud Cities are in use, we will have learned to live on Spaceship Earth. To have the know-how to build a cloud city, you'll need to know the wind, weather and temperature,"<sup>4</sup> he says. The first lesson to learn here, under *Aerocene*, is to hinder the accumulation of protective layers we tend to enclose ourselves into: instead of producing artificial climates, we should learn to inhabit the one that (still) exists and surrounds us.

A longer version of this essay has been published in French in *Criticat*, biannual architecture review, n°16, fall 2015, of [www.criticat.fr](http://www.criticat.fr).

- 1 "Museo Aero Solar," last modified July 27, 2015, <https://museoaerosolar.wordpress.com>.
- 2 "Museo Aero Solar," <http://museoaerosolar.weebly.com>.
- 3 Félix Mallé, "Un 'joncill ordifié' autour d'un espace défilant à Milan," *Criticat* 2 (2008): 112–123.
- 4 Mara Ferreri, Alberto Pesavento, Bert Theis, "Isola: Arte e comunità contro l'Eco-gentrification a Milano," *European Institute for Progressive Cultural Policies*, June 2009 (<http://www.eipcp.net/a/1244798425/>).
- 5 Inés Kzenstein, "Tomás Saraceno: A View from Buenos Aires," ed. Meredith Malone and Igor Matjanovic, in *Tomás Saraceno: Cloud-Specific*, (St. Louis: Mildred Lane Kemper Art Museum, 2014) 43.
- 6 Tomás Saraceno and Breislaw Szeremyski, "Devmons solaires", *Anthropocene Moment* symposium, 11th October 2014, Musée des Abattoirs, Toulouse, France.
- 7 Kiss László, "Walking on air: Getting Cloud-Specific with Tomás Saraceno," *The Huffington Post*, May 2012. ([http://www.huffingtonpost.com/kiss-laszlo/walking-on-air\\_h\\_1555668.html](http://www.huffingtonpost.com/kiss-laszlo/walking-on-air_h_1555668.html))

Architecture



# Piloting the Aerocene

How to grasp, in feeling as much as in thought, the promise of new forms of life in the air? This question, and the promise that sustains it, runs through the work of Tomás Saraceno, and takes shape in the form of the sphere with which we are confronted at the Grand Palais. Prepared through careful arts of fabrication, through processes of inflation, this promise can only be realized, however, in the vital act of releasing something – and eventually many things – into the air. In Saraceno's works, acts of release become ethical, aesthetic, and political occasions of profound importance and affective energy via which a cluster of possible futures for being and becoming airborne can be rendered explicit, foregrounded, made palpable. This cluster of possible futures take shape around the speculative form of what Saraceno calls the *Aerocene*, a concept-in-motion for imagining and devising new forms of life in the air that are sustained by little more than the elemental conditions in which they move.

In the acts of release through which the promise of the *Aerocene* emerges, Saraceno revives a form of *aerostatic* experimentalism which, anticipated by earlier journeys and travels in the air, involves learning to sense, to feel, and to understand the condition of being airborne.<sup>1</sup> Whereas earlier vehicles for this kind of experimentalism were powered by hydrogen, helium, or hot air, Saraceno's are solar-powered. And one of these works, the spherical envelope installed at the Grand Palais has the potential to become, through the act of release, a solar-powered vehicle for undertaking this kind of experimentalism.

While the success and achievement of this experimentalism depends on detailed scientific and technical knowledge, it goes well beyond these domains of expertise, drawing together and diagramming new formations of the technical, the aesthetic, and the ethico-political. Thus, central to this aerostatic experimentalism is the possibility of amplifying the feeling of being in the air, of making palpable variations in atmospheric worlds about which most of us have little awareness and of which we have an increasingly insulated experience. Saraceno is an activist and advocate for these atmospheric worlds, working to reveal them and to enhance our aesthetic awareness of their complexity because he knows that doing this is central to a renewal of ethical sensibilities across

different spheres of life. He knows that the feeling of becoming airborne does not end with the brief acceleration of aerodynamic takeoff or the view from a passenger window. He knows that this feeling extends to experiences of *aerostatic* attunement in which craft, body, and atmosphere sometimes become co-extensive and co-intensive. And he wants to make this feeling more accessible by devising, for instance, tracking technologies that make it possible to generate distributed infrastructures of atmospheric awareness, allowing the movements of aerosolar sculptures to be sensed remotely, at a distance, and across different bodies. The promise here is of the generous elaboration of a mode of collective enquiry for sensing the conditions of being in the air.

The importance of the act of release to Saraceno's *aerosolar* work means that central to its ethical and political potential is the invitation it offers for a return to, and a renewal of, the figure of the pilot and of the skill of piloting.<sup>2</sup> These days the pilot has perhaps become a problematic, diminished figure. A figure encapsulated in an almost hermetically sealed cabin in which the elemental outside is only ever sensed fibre-optically, and for whom the force of flight control surfaces is dampened. A figure routinized into the background through checklists and automation, only becoming public through heroic or suicidal acts of control or through ghostly traces of voice recorders. A figure who, through the operation of remotely-controlled drones, performs their work at a clinical distance.

Saraceno's work invites us to revisit and affirm different senses of the pilot and of the craft of piloting. On one hand, each of Saraceno's works is a pilot project for *aerosolar* futures to come. Their ongoing, circumstance-specific experimentalism performs a tentative yet exuberant form of piloting that pulls together bodies, devices, infrastructures, and concepts into new situations of collective assembly. Indeed, this is the way Saraceno uses concepts like the *Aerocene* or *Becoming aerosolar*. Rather than simply applying them, or employing them as frameworks, he pilots them by putting them to work to animate relations of co-fabrication and co-fabulation whose achievement is never guaranteed in advance. As a form of experimental empiricism, piloting is therefore critical to Saraceno's mode of inventing and circulating objects, concepts, and affects. Seen in this light, the *Aerocene* does not therefore aim to represent the real conditions of the present as we find it. Rather, for all of us concerned about these conditions, the *Aerocene* performs a "piloting role" in that it "constructs a real that is yet to come, a new type of reality".<sup>3</sup>

Then again, through the act of release, Saraceno asks us to think about piloting, rather pragmatically, as a responsive craft of becoming aerostatic and becoming aerosolar. Here the pilot is not so much in charge of a craft that travels despite the circumstances in which it finds itself. Rather, piloting becomes the very craft of sensing, feeling, and responding to the elemental variations of these circumstances. In the case of Saraceno's aerosolar sculptures, piloting is an incremental tending of the trajectories of these works in response to variations in heat, light, cloud cover, and so forth. Understood thus, the pilot is akin to a choreographer in motion, whose works are composed

not only of objects but also of the trajectories traced by these objects as they travel, always in material collaboration with the trajectories of their surroundings.<sup>4</sup> Indeed, the object, such as it is, is always an opening onto a possible way of moving, catalyzing a meticulously informed experimentalism in which deviations are joyous, dirigibility is only ever partial, and the envelope is always a shape of change that never fully closes in on itself. This is a craft of piloting which searches for opportunities for being led astray by eddies and up-draughts in sensory experience, and all in the hope that new inclinations in conceptual, ethical and political thought might emerge. A craft of piloting that is about acquiring enough technical expertise to facilitate experiments with the feeling of being in the air, with all the senses of stillness and motion this entails.

Crucially, Saraceno's work elaborates a craft of piloting that performs and makes palpable a new kind of political physics of the air. Through the promise of the act of release, Saraceno asks us to re-imagine piloting as the crafting of modes of collective participation in the tending of forms of life in the air. This requires – indeed demands – ongoing commitment to speculative leaps. Imagine, for instance, as you look at this sphere, its release into the air. The mere fact of this body in the air will render it powerful as an affective attractor: an object of ethical and political attention. And left to its own devices, it might well circumnavigate the earth. But under certain circumstances imagine that the safety of this *aerosolar* body depends on being piloted and tended in relation to variations in heat from the sun, in infrared radiation from the earth, and in the thermo-dynamic winds of the atmosphere. And, further, now imagine that the responsibility for this piloting is distributed amongst an innumerable group of people, some on the ground, and some in the air. What would it mean, and what would it involve, for this group of people to take responsibility, collectively, for the altitude, direction, and speed of this *aerosolar* body? What would it mean to devise a way of responding to variations in the elements, to movements of the envelope in response to these variations, and to the responses of other people? And what if there were many of these *aerosolar* bodies in motion, all in the air at the same time? What new kinds of elemental intelligence would be required to sustain this experiment? What would it be like, in other words, to acquire the capacity to devise and choreograph political technologies for collectively piloting the *Aerocene*?

To consider these questions is to begin to appreciate something of the significance of Saraceno's *aerosolar* works, and of the import of his ongoing collaborative experiments and speculations. It is to become open to the promise of these experiments in piloting the *Aerocene*: the promise of new senses of being and becoming atmospheric, new feelings for the air conditions that sustain worlds, and new shapes of thought for an aerosolar life we are only just beginning to grasp.

1 See, for instance, Mason, Monck. *Aeronaustica; or, sketches illustrative of the theory and practice of aerostation: comprising an enlarged account of the late aerial expedition to Germany* (London, PC Westley, 1838); and McCormack, Derek. "Aerostatic spacing: On things becoming 'lighter than air'." *Transactions of the Institute of British Geographers* 34.1 (2009), 25–41.

2 See also Michel Serres, *Romeo*. (Paris: Editions Le Pommier, 2007)

3 Deleuze, Guille, and Guattari, Félix. *A thousand plateaus: capitalism and schizophrenia*. Trans Brian Massumi (London and Minneapolis: University of Minnesota Press, 1987), 142.

4 On this understanding of choreography see Manning, Erin. *Relationscapes: Movement, Art, Philosophy* (Cambridge, MA: MIT Press, 2009).



Tomás Saraceno  
Air-Port-Citrou-Claud-City, 2010  
Saché, Atelier Calder, France

Tomás Saraceno has been one of the first ten people worldwide who have accomplished a rise from the ground using only the heat of the sun.





Tomás Saraceno  
Untitled (Island Series), 2008

Oliver Morton

# The fixed

500 years ago the people of Louth, a prosperous market town in east England, conquered the sky. At the west end of their church, St James's, they built a tower and spire of phenomenal grace. Over ten years it rose from nothing to a pinnacle height of 90m: as high as the near slopes of the Lincolnshire Wolds, the low chalk hills below which Louth nestles; higher than the glaciers that shaped the flat plain on which it has sat since first settled sometime after the most recent ice age.

The spire was made from stone – sandstone quarried on the far side of the wolds. It was made from wool, trade in which was the source of the wealth with which the town paid the 305 pounds, seven shillings and sixpence that the spire cost. It was made from the food which that money bought for the builders and their families, and from their faith – faith both in the God that the spire glorified and in the masons whose knowledge ensured that its walls would not tumble, that its beams not buckle, and that its tower would not fall. It was made from sound; from the grunts of labour, the rhythm of chisel and song, the harmony of hymns, the whistling of the wind, the chimes of the bells that all of them knew – knew – would one day hang in their new-made heights.

And just as it was made of sound, it was made out of the air in which sound lives. The fibre-trapped insulating air that gave Louth's wool the warmth men valued; the air from which the crops that fed the men took their carbon; the winds which, with the waves, had ground older rock to sand 200 million years before. The air they breathed, and into which the spire grew, and which it celebrated; the air of its inner spaces, bright lit through thin-columned high-arched windows; the air celebrated by its most spectacular features – the flying buttresses that spring from the pinnacles that top the tower to the mighty spire itself, not solid supports but open frameworks of stone, ideas built into and through the air.

All the air in the world has blown past Louth since then, and with the winds, change. The great spire of Lincoln Cathedral, across the wolds, which when Louth's spire was built was the tallest man-made structure in the world, succumbed to lightning and fire, its height not to be matched again for centuries. Louth itself rose up in a rebellion savagely put down, its priest hanged at Tyburn. The wool trade faded, and new trades grew – a boy schooled in Louth, John Smith, sailed across the Atlantic to a new settlement in Virginia. The land was enclosed; the railway came; the railway went; small fields grew large again as machines replaced men in the land's cultivation. On the flat fens between the wolds and the sea, where once a line of windmills ground flour and pumped

water, the masts of wind turbines now rise white and thin almost to the height of the church; off the coast they rise higher still. And still the spire stands, a part of the air and a resistance to it, a solid spike in the changing sky, an anchor for a weathercock ever turning in the wind.

And yet now that change is no longer the sky's only story.

As part of the celebrations of the spire's 500th year, a local artist, Gary Woods, conceived of a work that would honour both the building and the change that it had seen. In 1844, when the spire was scaffolded for repair, another artist, William Brown, had climbed to the top, lashed himself in place and sketched a panorama of the town, the wolds, the flat fens leading to the North Sea, later turning the sketches into a celebrated panorama. Woods wanted to do something similar, but in the modern style. And so he commissioned video images of the spire from the point of view of a UAV hanging still and steady in the sky nearby. These video works, like Brown's panorama, give wide views of Louth in its setting between fen and wold; indeed, as you watch, bits of Brown's original panorama fade in and out, the old underlying the new. But these new panoramas differ from their predecessors in two crucial and interconnected ways. While their field of view is fixed, the images they represent move; a post van drives along Westgate, tennis players pace their court. And in the centre and foreground of the fixed field of view is the top of the spire itself. It is no longer a means by which such panoramas can be seen, but something which can be part of them – because to hang still in the sky is no longer something you need a connection to the Earth do.

The story of human flight has to date been almost entirely a story of movement – of racing the clouds, of outrunning the winds, of speed no grounded traveller can dream of. The age of the UAV hanging steady as a weathercock brings the world of flight new stillness. A UAV can stay on station where it chooses, held still not by stone or rope but by the energy that positions and powers its motors and the information sucked in by its sensors, the first varying constantly in response to the other. Transparent as the air is to light and radio, every point in the GPS-saturated atmosphere has access to the information needed to fix something there, as long as it can process information in the proper way. The historian Simon Schaffer reminds us that settlements are not settlements just because people settled there, but because the precise location has been settled by surveyors and their instruments, by sextants and telescopes. In this way all parts of the atmosphere can now instantly be settled. Airs flow as they have across the centuries,

though some now trace out new Anthropocene patterns. But within that change there are now buttresses of ideas and energy can hold any point of view fixed – not always, not under all circumstances, but in general principle. The air can be held in ecstatic stillness.

This new fixity where once all was fluid is an inversion of recent changes in the way we understand what goes on below. The once-solid-to-us Earth, we now see, is a nest of flows and currents, a slow, dense, opaque counterpart to the atmosphere circulating above. The folding of the crust brings up waves of rock such as the gentle-swelling wolds; the ebb and flow of ice shapes their sides and surfaces. The sinking of the planet's crust into the mantle below pulls continents across the face of the Earth, buckling their borders, and creating new oceans between them. Beneath this cycling tumult, plumes of deeper warmth rise from the core through the lower mantle from like smoke in still air. In the core itself currents of liquid iron twist and turn above a seemingly solid kernel that is melting on one side as it crystallises on the other.

**A settlement is a choice, not a fate.  
Just as not all that is solid must  
melt into air, not all that flowed free  
must be fixed.**

So: above a fixed but flowing Earth, a flowing air in which things can be fixed. There is a fear to be felt at this, fear that flight which once felt like the freedom of flow can now be pinned to coordinates and thus controlled. A fear of drone eyes that hover forever with Hellfire at their command, of new lines of power cut across the sky. But there are surely possibilities both richer and lighter – more airy, if you will. A settlement is a choice, not a fate. Just as not all that is solid must melt into air, not all that flowed free must be fixed. To stand still where once one could but fly or fall is to have a new option. To stand, to fly, to fly, to stand. The flowing ground, the static air – what places and potentials for new masons, what sounding points for new bells, for sprites and spires reaching down towards change from stillness above, for diaphans and elelsons. Now breaths; new sounds; new spaces; new glory.

— For Jane Burton, Nesta Roberts and Katharine Morton, *see* *Loft*

# and flowing air



# Aerocene: Becoming Aerosolar

A collaboration between  
**Tomás Saraceno, Visiting Artist**  
**Leila Kinney, MIT Center for Art, Science & Technology (CAST)**  
**Lodovica Illari and Bill McKenna, MIT Department of Earth, Atmospheric and Planetary Sciences**

**Introduction**  
One of the oddest sensations of hot air balloon flight is the feeling of absolute stillness and extreme quiet. A paradox: moving with the wind eliminates the feeling of wind and thus a feeling of movement. Tomás Saraceno is fascinated by – or, more accurately, creatively obsessed by – airborne movement of all kinds, from the astonishing phenomenon of “kiting” spiders that create parachutes of gossamer silk, catch updrafts and drift through the jet stream to propel themselves hundreds of miles from land, to the ongoing series of prototypes for floating biospheres fueled by wind and solar heat that he has created for more than fifteen years, *Air-Port /Cloud-Cities*. They are speculative models for alternate ways of living – and alternate ways of flying. Saraceno would like to propose zero-carbon emission flight, make your reservations now for Aerosolar Airlines, as he has been known to say!

As the inaugural Visiting Artist for MIT’s Center for Art, Science & Technology (CAST), beginning in Fall 2012, Saraceno brought these multifaceted interests into creative dialogue with multiple departments across the Institute. Moving among practical, theoretical and hypothetical considerations, Saraceno discussed everything from nanoengineered materials to solar energy to weather patterns to the origins of the universe, asking architects, engineers and scientists in diverse fields to imagine with him what a different reality might look like. A wide-ranging foray into disparate areas of expertise led Saraceno to develop a productive collaboration with Lodovica Illari, a climatologist whose specialty is large scale atmospheric dynamics, and Bill McKenna, whose architectural training led him to her EAPS (Earth, Atmospheric and Planetary Sciences) lab to work on visualizations of geophysical fluid dynamics. Sharing a mission “to make people understand what is not intuitive” (her words), they began with “Weather in a Tank,” a series of rotating fluid laboratory experiments created by Illari and Professor John Marshall.

*Aerocene* is the latest node in Tomás Saraceno’s continuous experimentation with solar balloons, which include his own do-it-yourself versions, (e.g., *59 steps to be on air*, *sun power*, 2003), crowd-sourced variations made with plastic shopping bags (*Museo Aero Solar*, ongoing since 2007), and a residency at CNES (Centre Nationale d’Études Spatiales), spent immersed in studying their MIR (*Montgolfière Infra-rouge*) solar balloon flights. Now Illari and McKenna have used the MIR flight data to visualize the possibilities for a new series of solar balloons that could monitor the chemical components of the stratosphere and measure their effect on climate change. But there is more than a gathering scientific data in the offering. In keeping with his capacity to work at multiple scales, modes of expression and registers of engagement, Saraceno also sees these balloons as “lighter-than-air sculptures” and as an opportunity for a highly distributed network of participants to monitor their progress, predict the weather collectively, and raise awareness of our technological disruptions of planet Earth. The scenarios outlined below link technical expertise to visionary thinking and material realities to a future “jet stream art research center” – “Cloud Cities” in the making.

**An example from the past**  
**Montgolfière InfraRouge (MIR)**  
Recently Saraceno has focused upon infrared/solar balloon technology which he has dubbed aerosolar: a balloon with zero energy consumption that can fly using radiation from the sun during the day and radiation from earth during the night. This technology, originally developed by CNES (the Centre National d’Études Spatiales) in the 1970s, can be used as an inspiration, Saraceno believes, for how mankind could begin to live in symbiosis with the earth, sparking the imagination and inspiring the public to think about conservation at a time when the earth is at risk from overpopulation and climate change.

The *aerosolar* balloon is “zero-energy” and yet can circumnavigate the globe much like the albatross of the southern oceans, but flying much higher, even up in to the stratosphere. One could imagine using such balloons to monitor the ozone and other chemicals in the troposphere and stratosphere with nearly zero energy cost.

In collaboration with Saraceno, Illari’s group at MIT has studied the data from past balloon flights carried out by CNES, and begun planning future flights of solar balloons that are being developed with Saraceno and his group. Since 1971 CNES has been supporting a program of long-duration scientific flights using hot air balloons, MIR (Montgolfière InfraRouge). The MIR is a very light hot-air balloon, which is heated by solar fluxes during the day and infrared radiation from the Earth at night (see Fig. 1).

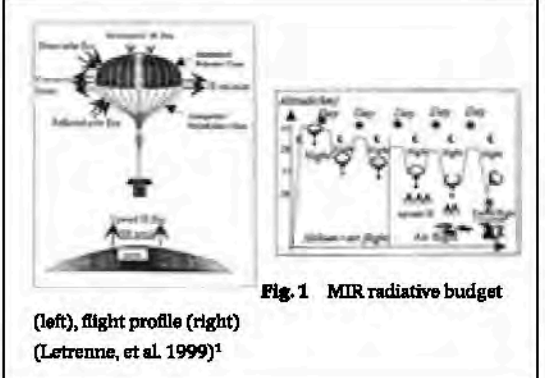
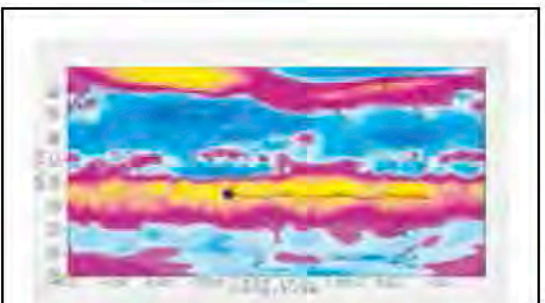
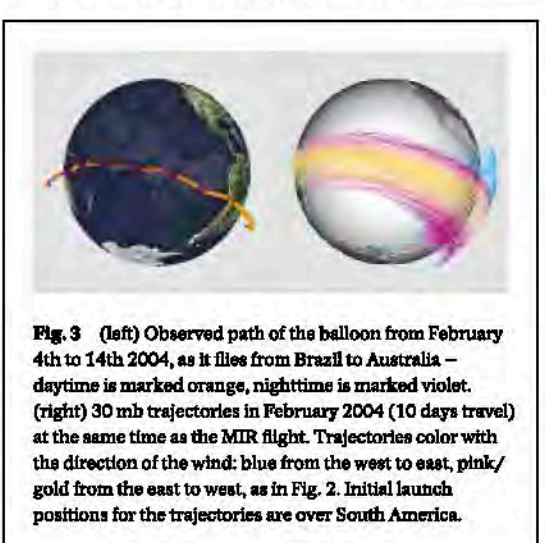


Fig. 1 (left) shows the MIR radiative budget. The balloon is heated by upwelling infrared fluxes from the earth through the night-hours, then direct and reflected solar fluxes during day-time. The initial ascent to the stratosphere is made possible using helium gas. After 2 or 3 days, the helium is completely evacuated and the MIR then flies only using hot air – see Fig. 1 (right).

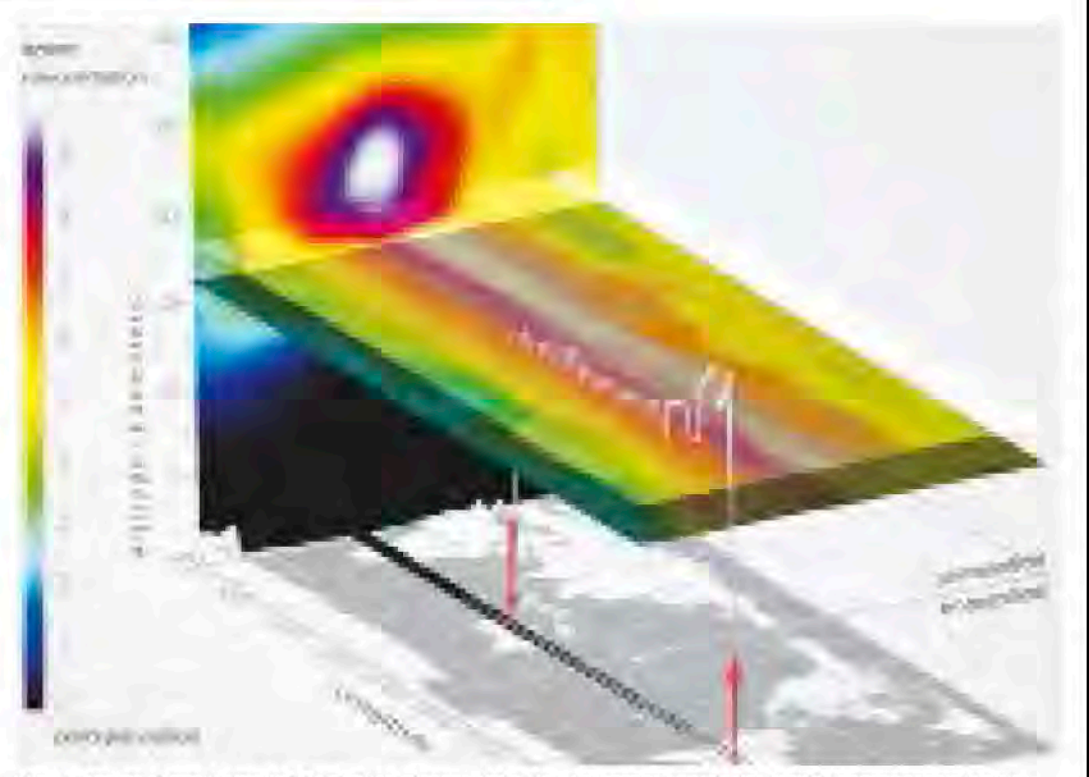


**MIR flight from Brazil to Australia (February, 2004)**  
As shown in Fig. 2, the balloon cycles up and down in the stratosphere following the sun’s diurnal cycle. It is carried along by the winds from São Paulo to NW Australia, rising during the day, sinking at night, before rising again with the sun.



**Acknowledgements**  
Lodovica Illari acknowledges support from the Frontiers in Earth Science Dynamics (FESD) “Ozone and Climate Project” of the National Science Foundation (US). Bill McKenna acknowledges support from MIT Center for Art, Science & Technology (CAST) and Prof. Glenn Fillet (EAPS). Tomás Saraceno has been a Visiting Artist with CAST since 2012.

**MIR flight and ozone (February, 2004)**  
The MIR balloon could be a great tool to monitor the ozone distribution in the stratosphere if it were instrumented with an appropriate measuring device. The following images show the track of the 2004 MIR flight together with the observed ozone distribution at that time. In Fig. 4 we see it sampling high ozone concentration in the stratosphere along the equator. See Marshall et al.<sup>2</sup> for the impact of the ozone on climate.



**Looking to the future**  
When and where would it be best to launch a balloon, perhaps one of Saraceno’s? How do we choose? To get a better idea, it is important to check the climatological distribution of the wind throughout the year. Fig. 5 shows isosurfaces of the zonal wind in January (left) and July (right): inside this surface, the wind speed is greater than 25 meters per second. It is clear that in the Northern hemisphere flow tends to be strong and mostly toward the east in winter. A band of flow from east to west tends to dominate the tropical atmosphere, but its location shifts with the seasons as the Hadley Cell migrates across the equator.



Hovmöller diagrams at various pressure levels, as in Fig. 6, can help us choose an appropriate time of the year to launch a balloon along specific tracks. To repeat flights from Brazil to Australia in the stratosphere, we should choose a month between January and March, because then the flow is strong east to west. In fact, several MIR flights in the tropical stratosphere were launched from Brazil in February (Fig. 2), or Ecuador in March. Similarly, let’s suppose we want to fly a balloon from Boston to Paris: when would a launch lead to the fastest travel time? We find that it is also best to launch in January to March, when the flow from west to east at the jet level (250 mb) is very strong, as can be seen in Fig. 6 (right).

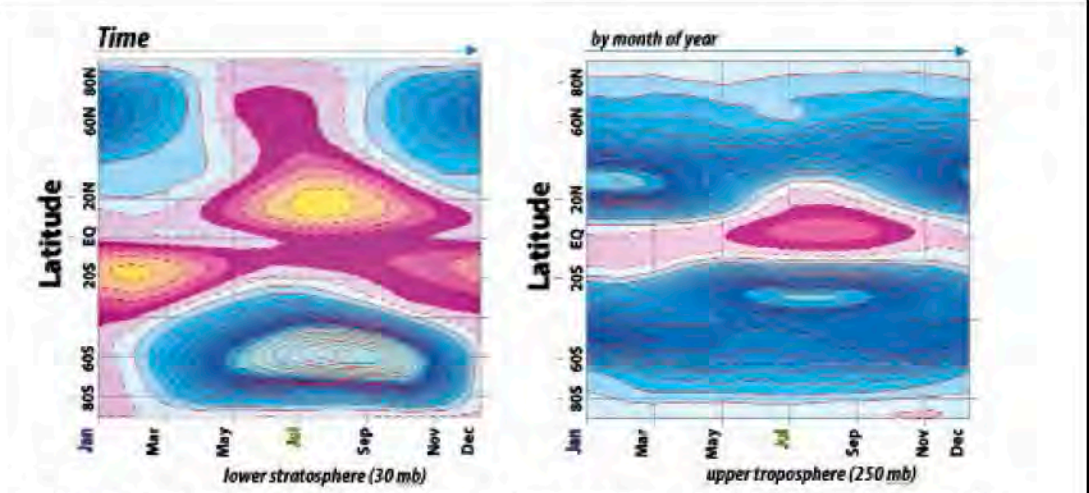
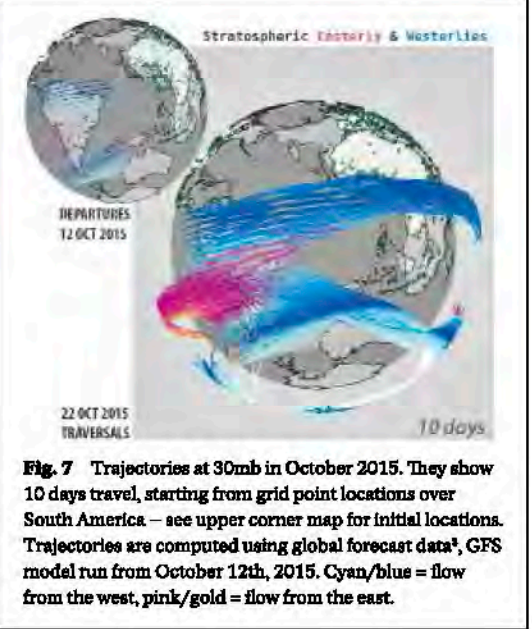


Fig. 6 Hovmöller diagrams of the zonal wind as a function of time over a year, 1981–2010 monthly averages. Flow from the west is marked in cyan/blue, while flow from east to west is marked in pink/gold, color scale as in Fig. 2. 30 millibar pressure level – stratosphere (left) and 250 millibar pressure level – troposphere (right).



**Trajectories from current forecast data for the stratosphere**  
If we were planning to launch a balloon into the stratosphere from South America now, in October 2015, as we write this article, where might it be carried by the prevailing winds? We can use the NCEP global model forecast data\* to figure this out.

Fig. 7 shows typical trajectories at 30 mb starting from different locations over South America. It is clear a track from east to west is dominant from tropic to mid-latitudes, whereas at high latitudes and close to the equator, tracks progress from west to east.

**Trajectories from forecast data in the troposphere – circulation to Paris**  
For fun, we consider flights to Paris by balloon at the tropospheric jet stream level. At this time of year (October), what air currents are already en route? When is best to catch a ride? To find out, we have computed backward trajectories for 5 days starting at locations near Paris in western Europe – see Fig. 8.



In October, the flow is typically not very zonal, and therefore, it is not surprising that we might reach Paris in 5 days starting from very different locations over the US, for example, Texas, the East Coast or even the Caribbean Islands.

**Summary**  
Tomás Saraceno’s vision of flying solar balloons between cities might be rather futuristic, but such technology could be used to sense the lower stratosphere at almost zero energy cost. The lower stratosphere is a critical layer where the chemistry of ozone, methane and other chemicals has a fundamental impact on our climate. Concentrations of these chemicals are not well known and there is a clear need to better monitor these constituents. We could imagine having a large array of solar balloons, moving with the flow, and measuring constituents all over the stratosphere.

Because the balloons need IR radiation at night, there are only limited regions on the earth where the balloons can stay up for a long period. These are mainly the regions of sinking of the Hadley cell where there are no clouds. This is a limitation at the moment but we feel that it is worth revisiting the possibilities of flying some solar balloons again to measure the stratosphere more accurately than has been done in the past.

The IR/solar balloons could be the answer. With their low energy consumption, they are the best example of green technology for atmospheric sensing!

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Letrenne, et al. (1999); French Long Duration Balloon Activity: The Infrared Montgolfière (MIR), Proceedings AIAA International Balloon Technology Conference, 28 June – 1 July, 1999, Norfolk, VA.  
2 MIT (EAPS) John Marshall, Susan Solomon, Lodovica Illari Frontiers in Earth System Dynamics: NSF-funded project on the climate implications of the ozone hole <http://ozoneandclimate.squarespace.com/>  
3 NCEP (Global Forecast System) GFS - <http://www.emc.ncep.noaa.gov/>  
4 UCAR (Unidata) IDV - <http://www.unidata.ucar.edu/software/idv/>



Tomás Saraceno  
Aerocene, launches at White Sands Natural Park, 2016  
The launches in White Sands and the symposium “Space without Rockets”, initiated by Tomás Saraceno, were organized together with the curators Rob La Fra-nais and Kerry Doyle for the exhibition “Territory of the Imagination” at the Rubin Center for the Visual Arts.

Unidata’s Integrated Data Viewer4 was used for most of the plots.  
NCEP Reanalysis data provided by the NOAA/OAR/ESRL  
PSD, Boulder, Colorado, USA via THREDDS.





Tomás Saraceno  
Aerocene, 2018

Aerocene sculptures and their journey around the world with 0-fossil fuel are the result of the long-term research commitment. The project has benefitted numerous collaborations with science institutions (French National Space Agency, the Massachusetts Institute of Technology, the Center of Art, Science and Technology – CAST, and Earth, Atmospheric and Planetary Science Department – EAPS, to mention few), and has already provided a fruitful basis for art and science exchange.

Sanford Kwinter

# High Altitude,

The bladder inflates slowly to claim a vast parcel of the air ocean. The solar stream courses onto and through it as the various component materials convert light energy into units of heat. The internal numbers build like steam in a locomotive chamber...

Three-dimensional warfare is said to have begun in China in the first years of the Common Era with the practice of manned flight on massive kites to reconnoiter enemy movements.<sup>2</sup> Perhaps more plausibly, kites were reportedly used by the Chinese as battlefield signaling systems, while the most vivid story of all recounts the use of an Aeolian kite designed to produce unearthly sounds when launched in the dead of night over the enemy camp during a famous battle of the early Han Dynasty, a gambit that successfully frightened the opposing army off.<sup>3</sup> It took nearly 2000 years from the dawn of the kite era until the physical and behavioral properties of gases were well enough noticed for the Montgolfier brothers to concoct the great “globes aerostatiques” that found experimental deployment in the Napoleonic Wars. Yet the first militarily effective use of balloons arrived only with the American Civil War although even here, as in the cases above, the airships in question remained tethered rather than released in free flight. *Controlled aeronautics* in fact makes its entrance in sky history only with the rise of machine aviation in the early 20th century – first with propeller aircraft, and later in the form of guided missiles of all kinds. Today, in yet a further phase in this indeterminate history, we see emerging the soon-to-be ubiquitous phenomenon of the unmanned, remote- or automatically-piloted drone. And yet fully controlled flight is not the summit ambition of our modernity. Deeper still, and possessing an even greater magical hold on the imagination, has been the thermodynamic fantasy of achieving propulsive motion, or action of any kind, by agency of a ‘work-for-free’ mechanism.<sup>4</sup>

Entropy, it is true, never decreases, but this does not mean that the strategy of moving it around is either expensive (energetically or temporally) or does not itself constitute an engine of a peculiarly magical kind. In fact, it is the very nature and fact of entropy’s *dynamism* that affords a landscape of unfamiliar pathways and opportunities rarely grasped fully by the modern technological imagination trained and compelled to seek advantage only in ‘take-what-you-want-and-pay-for-it’ setups where the rule of the ledger sheet and the balance book holds sway. In other words, the simple fact that potential of one type (in this case, energy) endlessly and ineluctably decreases, migrates or transforms in any free environment does not mean new and different potentials are not continuously generated elsewhere as a direct result of these very developments. For the relentless cleaving and changing of the universe’s ‘matter flow’ establishes *the rule of the differential* in nature, and following from it the irrepressible reality of the gradient without which nothing would ever happen, and thanks to which so many great things not yet imagined, easily could.

Once, importantly, in the middle of the last century, the discrepant model of the clock was opposed to that of the cloud with a view to re-connecting thought to the empirical outcomes of actual nature, and away from the controlled and artificial conditions of the laboratory setting.<sup>5</sup> Today the logic most wondrously sensed and tapped by inventors, dreamers, scientists and makers of speculative – read plastic and sensuous – work, is that of weather, a system of unceasing innovation, in which nothing is wasted, in which no component fails to assert its influence, and in which, despite the abundance of behaviors and forms it throws up, no causes are dissociable from their effects. The attraction here, in the words that Karl Popper once used to describe something pretty close to it, resides in the idea of “plastic controls” that not only accept but actually celebrate indeterminacy in the temporal form world, that relinquish the hard control of our rationalist (read here ‘mechanist’) traditions. Today we are increasingly seeing the pervasive gradient/differential in nature as the wellspring of form and of the work equations that produce it.<sup>6</sup>

For all these reasons – indeed because of this overarching trend in historical ontology – sky has become a place, a plenum, a place to move and think differently. Indeed it is becoming both a mode of thought itself and the foundation of an emerging ethos or system of *ethos*.

Sky is an ocean (as Buckminster Fuller used to proselytize) only here it is one just as replete as the aqueous one around and below us that is awash with currents, strata, weather systems, differentials of density, temperature, direction, humidity, pressure and their shifting, always provisional and developing correlations. It is a system that generates singularities (points where qualitative changes occur) and tendencies at every moment and in every place. But here is the broncad rule that governs: *Nature always reduces the gradient* (the inescapable Second Law applied now to every manifestation of form).

The simple process by which it works is no other than this: energy flows from higher, hotter, and denser to lower, cooler, and rarer. To sublimate the gradient nature *sets into motion a flow*. These flows, in sum, are today what matter more. One no longer concerns oneself solely with absolute values that represent averages of uneven distributions or conversely with isolated and discontinuous points. These flows and their reductions are becoming at once the stuff of science and of the ecological and artistic imagination alike.

The *Aerocene*, it might be said, is the name of a new ecological space that grasps into unity both the scientific and the artistic imagination and the neurological apparatus itself. For it targets primarily an attitude of *sensing energy*, sensing potential, sensing in a vast and only apparent void what the ancient Chinese geomancers, ink wash painters and military strategists referred to as ‘shi’ – the inbuilt propensity of any situation, position, or configuration to develop (flow) in a specific direction and in a certain way.<sup>7</sup> Every moment flows into the next and every place abets or resists this flow in just the manner that is specific to it. When prehended together these variables form an ocean of particularities rife with harvestable action and energy.

A critical and moving component in the perception-confounder launch of a colossal airship like the *Aerocene* is the assembly of a membrane from supermarket tote bags whose function is to establish the most paltry of separations between an inner and outer atmosphere. The fragility of the surrounding film is sufficient nonetheless to both delay and capture the impetus toward thermal equilibrium that no force or thing can forever escape, and in so doing to convert it for a time – perhaps for a very long time indeed – into manifest, even sublime semi-directed motion. What is pitched into aesthetic relief here in a way that would be entirely familiar to late 19th century (embryological) biologists and 1980s (nonlinear) mathematicians alike, is the salience of what is known as the *separatrix*, the marvelously subtle boundary point or line between two or more valleys and on which a process precariously hangs before it is forced to choose a direction of motion or fall. A ball for example can balance only for so long on a pinnacle or crest before it must yield to the infinitesimal atmospheric imbalances that set it fleeing to one of its several topographical destinies. But the ball can be said, in the moments before the system ‘breaks’ or launches, to be in a state of infinite sensitive search. Its job is to sense gradients. This is the physics and politics of the *Aerocene*.

*The bladder inflates slowly to claim a vast parcel of the air ocean. The solar stream courses onto and through it as the various component materials convert light energy into units of heat. The internal numbers build like steam in a locomotive chamber, but the expenses here are so vast that the tiniest differential in temperature measures results in exponential expansion – so much less pressure than required by the iron horses of yesterday yet in service of so much more startling effect. It is of course not the difference in temperature, but the consequent ones of dilation, displacement and relative weight that induce, at one threshold moment and no other, the liftoff and rise. The drama plays out at such gigantic scale all while connected to a variable so meager and demure that the spectacle simply fails to read as physics at all.*

But then that is presumably why we have come: to bear witness to the singing of a new era in technics, sensation, and knowledge in the face of which the dogmas that for long subtended thought and behavior in a presumed universe of grave and fated things, now fall or, shall we say, now molt into air.

1 [https://en.wikipedia.org/wiki/High-altitude\\_military\\_parachuting](https://en.wikipedia.org/wiki/High-altitude_military_parachuting)  
2 John Buckley, *Air Power in the Age of Total War* (London: University College London Press, 1999), 22–23.  
3 Barthold Lueder, “The Prehistory of Aviation,” *Field Museum of Natural History*, Vol. 18(1)(1928): 34.  
4 ‘The concept of ‘work for free’ dates back to a thought experiment devised by James Clerk Maxwell in his 1872 *Theory of Heat* that Lord Kelvin later memorialized as “Maxwell’s Demon”. In the experiment in question a sentient agent is posited who has the ability to control the passage of molecules from one chamber to the other simply by recognizing which are fast and which are slow and letting the slow pass into one chamber and the fast into the other. In this way the warm air is sequestered from the cool and without adding heat, energy or work their migrations will have brought about an increase in the temperature of one part of the system and a cooler one in the other – hence flagrantly contradicting the Second Law. The idea of work for free, despite the objections legitimately raised regarding the cost of the demon’s presence and labors, has been endlessly and equally legitimately hypothetically revived by practitioners such as Leo Szilard (Szilard engine) in physics, and Stuart Kauffman (“order for free”) in biology. The Second Law may be globally invariable but probing its many defects and open flanks at a variety of sub-global scales has proven consistently fruitful for both science and thought.  
5 Karl Popper, *Of Clouds and Claws: An Appendix to the Problem of Rationality and the Freedom of Man* in *Objective Knowledge: An Evolutionary Approach* (Oxford: Oxford University Press, 1972).  
6 Eric Schneider and Dorion Sagan, *Into the Cool: Energy Flow, Thermodynamics, and Life* (Chicago: University of Chicago Press, 2005).  
7 Francois Jullien, *La Propension des Choses* (1992) translated as *On the Propensity of Things: Toward a History of Rificacy in China* (New York: Zone Books, 1995).

# Low Opening (H.A.L.O.)<sup>1</sup>



On the

[...] (T)o be able to start a revolutionary movement the human beings should be mobilized not only on the level of the spirit but also on the level of the body. The human spirit can be mobilized through an ideology but, according to Chizhevsky the degree of mobilization of the human body, like of all the organisms living on the Earth, is dependent on the cycles of solar activity.

# Political Influence

During the period of modernity we got accustomed to the understanding of the human beings as determined by the social milieu in which they live, as knots in the informational networks, as organisms depending on their environment. In the times of globalisation we learned that we are dependent on everything that happens around the globe – politically, economically, ecologically. But the Earth is not isolated in the Cosmos. It depends on the processes that take place in the cosmic space – on black matter, waves and particles, star explosions and galactic collapses. And the fate of mankind also depends on these cosmic processes because all these cosmic waves and particles go through human bodies. The positioning of the Earth in the cosmic whole determines the conditions under which the living organisms can survive on its surface.

This dependence of mankind on cosmic events that are uncontrollable and even unknown is the source of a specifically modern anxiety. One can say: Cosmic anxiety. The anxiety of being a part of Cosmos – and not able to control it. Not accidentally our contemporary mass culture is so obsessed with the visions of asteroids coming from the black cosmic space and destroying the Earth. But this anxiety has also more subtle forms. As an example one can cite the theory of the "accursed share" that was developed by Georges Bataille.<sup>1</sup> According to this theory, the Sun always sends more energy to the Earth than the Earth, including the organisms living on its surface, can absorb. After all the efforts to use this energy for production of goods and raising the living standard of the population there also remains a non-absorbed, non-used rest of the solar energy. This rest of energy is necessarily destructive – it can be spent only through violence and war. Or, at least, through ecstatic festivals and sexual orgies that channel and absorb this rest of energy through the less dangerous activities. Thus, human culture and politics become also determined by the cosmic energies – forever shifting between order and disorder.

Now, Bataille's solar myth reminds one strongly of the interpretation of the world history as defined by the activity of the Sun, an interpretation that was formulated by Russian historian and biologist Alexander Chizhevsky in the 1920s and 1930s. During this period of time Chizhevsky's ideas spread also to the West, especially to France and the USA, and some of his texts were published in French and English – so that his ideas could reach Bataille.<sup>2</sup> However, the main text written by Chizhevsky in which his theory is extensively formulated and proved by empirical data was published only relatively recently in Russian.<sup>3</sup> Chizhevsky collected a huge empirical data – from the Roman and early Chinese sources up to the 1930s – to show the close correlation between the periods of the higher activity of the Sun and mass revolutionary movements. It is, of course, the Russian revolution in 1917 that gave the decisive impulse to his research. Chizhevsky asks: why under similar social, economic and political constellations in some cases masses become mobilized and revolutionized but in other cases they remain passive and indifferent. The answer that Chizhevsky offers is this: to be able to start a revolutionary movement the human beings should be mobilized not only on the level of the spirit but also on the level of the body. The human spirit can be mobilized through an ideology but, according to Chizhevsky the degree of mobilization of the human body, like of all the organisms living on the Earth, is dependent on the cycles of solar activity. Chizhevsky collected an incredible amount of astronomical and historical data to show the correlation between activity of the Sun and activity of revolutionary movements. As he shows the greatest revolutions coincided with the greatest activity of the Sun – and the historical process is characterized by a succession of active and passive periods corresponding to the 11 years cycles of solar activity (the highest degree of activity follows a 22 years cycle). But it seems to me that for our time the most interesting part of his results concerns the relationship between activity of the Sun and English parliamentary elections. These results show that the influence of the Sun dictates not only the choice between revolution and status quo but also between leftwing and rightwing politics in the framework of regular parliamentary processes. Thus, Chizhevsky shows that for the period between 1830 and 1924 the summary activity of the Sun during the rule of liberal governments was 155,6% higher than during the rule of conservative governments. The conservative governments never had power when the number of sunspots was over 93. The moments of change in the solar activity are almost precisely correlated to the changes in English governments.

At the end of his text Chizhevsky suggests that the knowledge of the correlation between activity of the Sun and political activity of the masses can prepare the political classes to the seemingly unexpected changes of public mood. During the financial crisis in the year 2009 specialist remembered the so-called Kondratiev waves – Nicolai Kondratiev, a student of Chizhevsky, applied his theory on the economic cycles and predicted all of them including the 2009 crisis. On the political level one is reminded of the years 1968, 1989 and, again, 2010–11. Here it is interesting to mention that the present time is the time of the weakest solar activity since the 20th century – the period of political indifference and passivity of the masses. However, the political effects of the bigger numbers of sunspots are often ambiguous. Chizhevsky specifically warns that the growth of solar activity can lead not only to the adoption of progressive agenda by the masses but also to the rise of irrational and reactionary populist movements.

1 Georges Bataille, *Accursed Share: An Essay on General Economy*, vol. 1 (New York: Zone Books, 1988).  
2 For example: A. L. Chizhevsky, *Les Eclipses et les perturbations électromagnétiques* (Paris: Hippocrate, 1938).  
3 A. L. Chizhevsky, *Zemlja v ob'ekte solnca*, "The Earth in the Embrace of the Sun" in Chizhevsky, *Kosmichesky pul's zheni* (Moscow: MML, 1995).  
4 See Vincent Barnett, *Kondratiev and the Dynamics of Economic Development* (London: Macmillan, 1998).

of the

# Sun



Left bottom corner:  
Museo Aero Solar in Isla Art Centre, Milan, Italy, 2007

Surrounding Images:  
Becoming Aerosolar – project Cuasachi, 2015  
Following Tomás Sarasano's invitation to an artistic performative workshop at the Development & Climate Days of the Red Cross Red Crescent Climate Center, which took place at the United Nations Climate Change Conference (UNFCCC—COP 20, Lima, Peru), a group of local artists of Cuzco, Peru have initiated the construction of aerosolar sculptures as vehicles to lift up cameras in order to capture and document the detrimental damages to the local nature, caused by the economic activity of oil companies. The aerosolar sculpture is named Cuasachi, meaning sun, day, sky and wind in the local Cuzco language.  
Photography by Helga Bener Torres



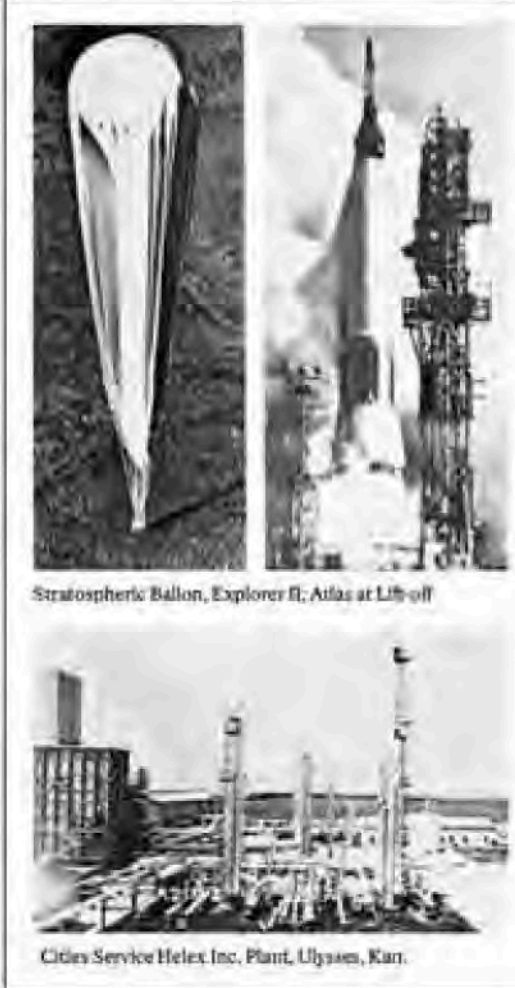


# Alter-engineered Worlds

In our late industrial times, two weighty terrestrial infrastructures appear inescapable when becoming unstuck from the earth's surface. Whether it is gasoline in propeller planes, kerosene in jet engines, propane in hot air balloons, or helium in stratospheric balloons, going up isn't possible without drifting down. The actual burning of fuel in commercial airplanes, pumping out innumerable ultrafine particles and 50 pounds of CO<sub>2</sub> for every mile traveled, is the final corrosive spatter of an already environmentally costly hydrocarbon extraction process. The second set of infrastructures – less materially manifest than the mesh of pipelines, condensate tanks, drill rigs, frack chemical impoundments, water trucks, refineries, and compressor stations that establish landscapes of oil and gas extraction – are those that maintain intellectual property. Aircrafts like the Boeing 787 Dreamliner are the vibrating embodiments of over 1000 patents and many more proprietary secrets.<sup>1</sup> The Aerocene is poised to de- and re-engineer the hydrocarbon and intellectual property infrastructures that envelop our world.

Let us consider the stratospheric helium balloon as both a seemingly innocuous form of air travel and one closely allied to the form of loft that enticed you to this exhibition and now to this page. Helium-rich natural gas is, and has always been, the only source of commercially available helium. Although not itself a greenhouse gas or toxic to biotic life, helium – the most noble gas – is implicated in the vast infrastructure for extracting natural gas (i.e. methane). For helium balloons to gently ascend into the atmosphere we also need the drilling capacities and pipeline systems of a world hungry for natural gas. During the extraction and transportation of natural gas, methane – some 14 times more potent of a greenhouse gas than CO<sub>2</sub> – is routinely released, vented and leaked into the atmosphere. These emissions amount to the largest source of methane-release in the United States, the largest producer of helium.<sup>2</sup>

The Aerocene does not entail becoming the wind and turning one's back on terra. Look elsewhere for an escapist fantasy. Instead, it engages our besmirched earth, the toxic chemical infrastructures that suffuse life, the corrosive happenings that condition both biotic and geologic beings. It does this in two ways. First and foremost, the Aerocene severs the link between aerospace exploration and petrochemical exploitation by providing an alternative to hydrocarbon-derived loft. It establishes a destination for environmentalist dreams that bristle with critique of the present but are rightfully weary of roosting among the 'viable futures' touted by industry. Every aerocenic balloon flight is a humble step toward weaning off mined deposits and extinguishing the human and ecological impacts of a world engineered around hydrocarbon extraction. Second, Saraceno harnesses the fledgling days of the Aerocene to monitor Earth's current chemical infrastructures. Equipping these balloons with sensors, they could be variously used to monitor stratospheric ozone levels, measure tropospheric particulate matter levels in the cities, travel the oceans for microplastics, assess methane releases from pipelines, track ocean acidification, or enumerate shale-field flares.<sup>3</sup> In the Aerocene, global infrastructural change emerges in tandem with hyperlocal environmental engagement and know-edge production.



Stratospheric Balloon, Explorer II, Atlas at Lift-off



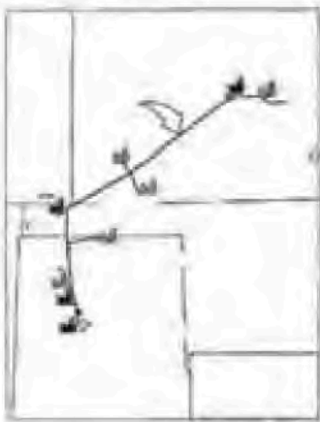
Cities Service Helium Plant, Ulysses, Kan.

But such extractive infrastructures are not limited to what industry and regulators consider as infrastructure. We must also include slow valve leaks, permitted airborne emissions, fragmented habitats from millions of miles of pipeline, and the alarming effects of endocrine disruptors released in the wrestling and refining process as fundamental aspects of the natural gas-cum-helium infrastructure. These regular excesses are precisely what Michelle Murphy has referred to as "chemical infrastructures that materially and unevenly shape human and non-human life in time and space." The inclusion of fugitive – and sometimes insensible – chemicals into our understanding of infrastructure is not a mere provocation. It is an acknowledgement, long past due, of the chemically suffused and sculpted nature of life in our contemporary moment.

The Aerocene, also past due, recognizes other unseen but much more ancient earthly infrastructures. Its dreamworlds do not run on the technological domination of natural resources. Rather, the project begins by attuning to and moving with the forces that animate our planet – more of a calculated and informed submission to global forces than a mastery over them. Conceiving of wind and solar rays as critical infrastructures for the ongoing present demands that our desires be re-engineered through forgotten supply chains: the planet's shared and circulating atmosphere. These currents of interest are not merely the aerial flows that propelled a nautical yesteryear but multiple, overlapping, dynamic, and sometimes countercurrent atmospheric strata that have only recently become modelable in their full complexity. In this way, the Aerocene denotes an epoch of slippery temporalities, of pasts-becoming-future and of futures-becoming-present. Saraceno's vision is not undergirded by restorative nostalgia for a romanticized non-technological past but a reflective nostalgia<sup>4</sup> that pulls centuries-old technologies and the fabrications of science fiction into the same frame. As balloons were already wistful novelties during the 19th century and solar balloons have not yet been fully realized for flight, tense (past perfect, future anterior, etc.) begins breaking loose when trying to locate the Aerocene. It is a chronotope without the 'golden spikes' of terrestrial eras, one that's movement is already enjoyed by the fungal, avian, insect, and bacterial species that regularly cruse within atmospheric currents. Humans are only now warming to its promise and rising to its challenge.



Stratospheric Balloon, Explorer II, Atlas at Lift-off



Navy Patrol Blimps



Louisiana wetlands facing contamination by BP oil spill in 2010

The exact instrumental payloads will be determined iteratively through a series of boots-on-the-ground workshops and in consultation with leading scientists. While the balloons will float freely, they will be tethered to the specific desires and needs of communities with whom they share airspace. The Aerocene will become a platform for civic technoscience that pluralizes how and who can make authoritative claims about the environment. The project's ability to proliferate on the ground – its uptake, reproduction and alteration by diverse winds of human ingenuity beyond the individual hand of the artist – stems from its open hardware methodology. This now brings us back to intellectual property and the infrastructures of know-edge distribution.

Substituting into to the Aerocene cannot be done using the same methods and tools that constructed our current hydrocarbon-dependent planet. Placing Aerocene designs in the creative commons, gives rise to a new flow of knowledge, circulation of capital, transparency of research, and idea of property that runs in diametric opposition to those that constitute and dominate the anthropocene. Open licensing is just one, albeit gigantic, step towards a more just and socially democratized planetary atmosphere. As the Open Source Hardware Statement of Principles outlines, the bottlenecks in making material technologies truly open, easily modifiable, and adaptable to divergent contexts are not limited to licensing: "Open source hardware uses readily-available components and materials, standard processes, open infrastructure, unrestricted content, and open-source design tools to maximize the ability of individuals to make and use hardware."<sup>5</sup>

To continue our focus on stratospheric balloons, take Google's Project Loon as an example. The project involves flying a large number of stratospheric helium balloons across the Southern Hemisphere to broadcast LTE internet connections to otherwise offline communities. Sri Lanka may well achieve universal internet coverage via Loon by the time this newspaper goes to print. The project has tallied some 200 patents, which tech pundits read as a sign of its immanent success. Loon has created their own automated balloon manufacturing facility. Balloons that initially only lasted a few hours in the air now stay aloft in the upper layers of the atmosphere for over a hundred days. But the steps to exponentially increase the life of these balloons remain stuck behind the enclosure of corporate secrecy. Their production process requires specialized machines and vast amounts of capital. Beautifully simple innovations such as Google's patent #US20140252163 A1, which rotates darker or lighter sides of the balloon towards the sun to increase or decrease elevation and catch winds of different directions, will remain legally out of reach to aspiring aeronauts for the next two decades. Even more troubling is that a similar, if not more advanced, design of this kind was featured in the Journal of the Balloon Federation of America in 1978.<sup>6</sup> Patents can colonize preexisting knowledge not just safeguard hard fought and capably intensive developments.

By contrast, the Aerocene can begin with the open-licensed plans for a tetrahedron solar balloon. The balloon costs \$25 in materials – a plastic drop cloth, scissors and an ordinary iron. Its assembly process is meticulously documented, and the design has been freely available on the internet since 2009.<sup>7</sup> To keep our balloons aloft at night we could, when the sun sets, bring very small magnets into contact with magnetotactic bacterium that emit heat when exposed to magnetic fields. If any of our longer term and higher-tech balloons need extra lift during launch to reach the upper stratosphere we can collect helium being emitted from natural thermal springs such as those in Mairie de Santenay, some 334 kilometers south of Paris' Grand Palais, without need for mining. I could go on, but the point here is not to conjecture technical possibilities but to underline the knowledge infrastructures necessary for germinal collective dreaming to take place. Through open development Saraceno multiplies both those who can contribute to the project and who can directly benefit from it. In this way the Aerocene bucks the assumption of industrial capitalism, namely, that the practices and infrastructures that beckoned our present environmental crises can also get us out of it.

<sup>1</sup> Cindy Nausler Glickert, "Guarding the Gold: Protecting Boeing innovations is critical to maintaining a competitive advantage," *Boeing Pioneer* (2010): 38-42.  
<sup>2</sup> Predecessors to helium balloons were no less implicated. The 19th and early 20th centuries balloons were almost universally filled with coal gas, which is a mixture of hydrogen, methane and carbon monoxide.  
<sup>3</sup> Michelle Murphy Mitchell, "Chemical Infrastructures of the St Clair River," in *Toxicities: Health and Regulation Since 1945*, ed. Boudia and Isaac (Routledge, 2013): 105.  
<sup>4</sup> Jacob Diamant, "Native Nostalgia" (Jacana Media, 2009).  
<sup>5</sup> This last use of high-altitude and low-cost balloons has been attempted by our colleagues at SkyTruth. <http://skytruth.org/updated-skytruthing-the-broken-field-report/>  
<sup>6</sup> Open Source Hardware Association "Open Source Hardware (OSH) Statement of Principles 1.0" <http://www.oshwa.org/definition/>  
<sup>7</sup> Dick Brown, "SUNSTAT: A Balloon that Rides on Sun Beams," *Ballooning: The Journal of the Balloon Federation of America* (1987): 5-9. <http://aerocene.boudiascholarballooning.com.au/wp-content/uploads/SunstatArticleinBallooning.pdf>  
<sup>8</sup> First uploaded in 2009 <http://www.headfulofrats.com/wp-content/uploads/2009/05/tetrahedronballoon2.pdf> and updated in 2012 <http://pubtclab.org/notes/mathew-5-29-2012-solar-hot-air-balloons> This balloon building guide was written by my Public Lab collaborator Mathew Lippincott, who provided invaluable research assistance in the preparation of this essay.

Tondo Saraceno  
28 steps to be on air by sun power, 2008  
in cooperation with architect Natalja Miodragovic.

On sunny days, with little wind you can build a sculpture  
in 8 hours, that allows two people to fly for less than \$200.



In 2014, on the occasion of the exhibition “The Anthropocene Monument,” initiated by Bruno Latour and Bronislaw Szerszynski at Abattoirs (the Museum of Modern and Contemporary Art, Toulouse), Tomás Saraceno presented an inflatable sculpture – a cloud made of plastic bags, titled *Museo Aero Solar*. The latter embodies a whole social movement and a collective, united under non-authorship and open source principles.<sup>1</sup> By the side of this installation, the artist also displayed his first sketches and attempts at a bigger undertaking – the project of *Aerocene*. It was a different cloud, shaped as a sphere with silver reflections that expanded, and occupied almost all the exhibition space. The work became a central axis around which texts, research material and technical drawings, displayed together with the sculpture, were assembled, articulating the new way of aerosolar travelling.

# I bind the Sun’s throne with a burning zone\*

submitted to strict aviation laws, MIR balloons are now deflated and their silver shine is locked in storage boxes. Saraceno wishes to relaunch them, and see them circumnavigating the sky again. He even speculates at the possibility of travelling with one, and maybe even living in there, uplifted by the sun.

However, nobody is going to dwell there at the moment. The current shape of the global ecosystem makes *Aerocene*’s sculptures more similar to rescue boats than airy colonies of expansion. Diametrically opposite to Warhol’s *Silver Clouds*, presented in 1966,<sup>2</sup> Saraceno’s work informs about the time of crisis and the deteriorating condition of the Earth. Visually resembling the droplets of mercury escaped from a thermometer, they call for the reparation of our common home Earth. *Aerocene* sculptures’ trajectory uses the numerous pathways and crossings of winds and jet streams. They do not care about (national) borders and call for a united global action. Consciously referring to the Anthropocene, *Aerocene* has its own ambiguities: its perspective can be seen as apocalyptic or dystopic, but it demonstrates the will to cope with deteriorating planetary shape with somehow joyous and merry means – collaboration and communitive actions. *Aerocene* as a multi-faceted project (assembling together different applications and modes of employment, solving technical obstacles that it passes with a soft, airy jump by its inventive spirit) could be seen as a geo-engineering undertaking. But in contrast to those technocratic projects that try to fill the atmosphere with micro-particles in order to reduce the global warming, *Aerocene* is a bold gesture of a sincere concern and social sensibility. *Aerocene* declares the stratosphere as a zone to be defended (ZAD).<sup>3</sup> Its artistic imagination draws on camping in the air and floating ‘tree’ cabins.

To situate the artistic project within its background – cloud- and skiescapes, a retrospective look can be taken. Art historian Hubert Damisch in his book *A*

*Theory of /Clouds/*: *Toward a History of Painting* examines the celestial domes of Correggio, a Renaissance painter. Two cycles depicting breakings and collisions of an illusionary sea of clouds, created in Parma at the first quarter of the 16<sup>th</sup> century, were already speaking and showing the epistemological change that was still yet to come with the Copernican revolution. Furthermore, baroque and its shapes of clouds takes the society from the closed world to the infinite universe. During the first quarter of 21<sup>st</sup> century, *Aerocene* is a contemporary of the Anthropocene. It makes the limits of life on the planet tangible and comprehensive, on the contrary to the harsh-real utopian ideas of techno-science. Floating in the levels of stratosphere, Tomás Saraceno’s sculptures draw the line of a certain demarcation. Similar to the yellow buoys in the water, separating safe waters from dangerous ones, *Aerocene* bears a paradoxical message: up from the sky it calls the necessity to be on the earth, well-grounded.

Within the celestial domes of Correggio and the ones of 17<sup>th</sup> century baroque, Hubert Damisch pays a special attention to the detail of “nuvola” (i.e. a cloud) that appears at the theatrical scenography from the Middle Ages. This essential element has made Christ, Virgin Mary and saints to fly, canonized by fake mechanical clouds in mystery plays of *quattrocento*. Mantegna and other painters used the “nuvola” in their sacred depiction. According to Vasari, we owe the clouds and their representations in art to Brunelleschi, one of the inventors and developers of the perspective in painting. “We notice how many painters have re-appropriated the different elements of theatre, depicted its scenography in the least problematic fashion,” notes Damisch. “Rocks that hide the dragon of Uccello [*Saint George and the Dragon*, 1470] are made of carton, the clouds of Mantegna appear as wooden model covered by a painted canvas that was used to make scenography the most

realistic. Mantegna does not seek to simulate or repeat the nature. The contrasting difference between atmospheric clouds and the mechanical-theatrical ones is a conscious gesture, referring not to the natural phenomena but to its cultural value.”<sup>4</sup> The installations and actions of Tomás Saraceno are close to being a set of such a scenography. Illusions are visible, but the cultural or social values prevail over them. The art of Tomás Saraceno is not one of engineering, design or architecture. His genius lies in his capacity to construct technological objects that make the division

between natural phenomena and a human individual disappear.

Jacques Roubaud in his short text *Sky and earth and sky and earth*, written in 1987, speaks about the “permanent condition” of skies of John Constable. “The clouds [in his paintings] are paradoxical visualisations of perpetually changing traces of a fixed skyscape. These fixed representations bring some sort of permanence to us – the fixed moment of memory. The ever-changing sky has a permanence of that sort, since “cloud castles,” once destructed, are then again rebuilt, reassembled and reshaped by the wind. This type of transformation is much more sustainable than the one of earthly objects. Decomposition of vegetation, collapse of buildings and built structures, death of living beings – all designate the irretroivable past. On the contrary, constantly forming without ever attaining a fixed form, the vapor of the sky seems to be much more long-lasting.”<sup>5</sup> Saraceno’s project *Aerocene* aims to provoke, to bring to us similar feelings. Two centuries after the start of industrial revolution, the ever-changing but ever-lasting sky and the air has too become a subject of crumbling and decomposition. *Aerocene* thus is a signal at the border of the modern world, a world where human-kind will consume the sky after it has already devoured the earth and the ocean.

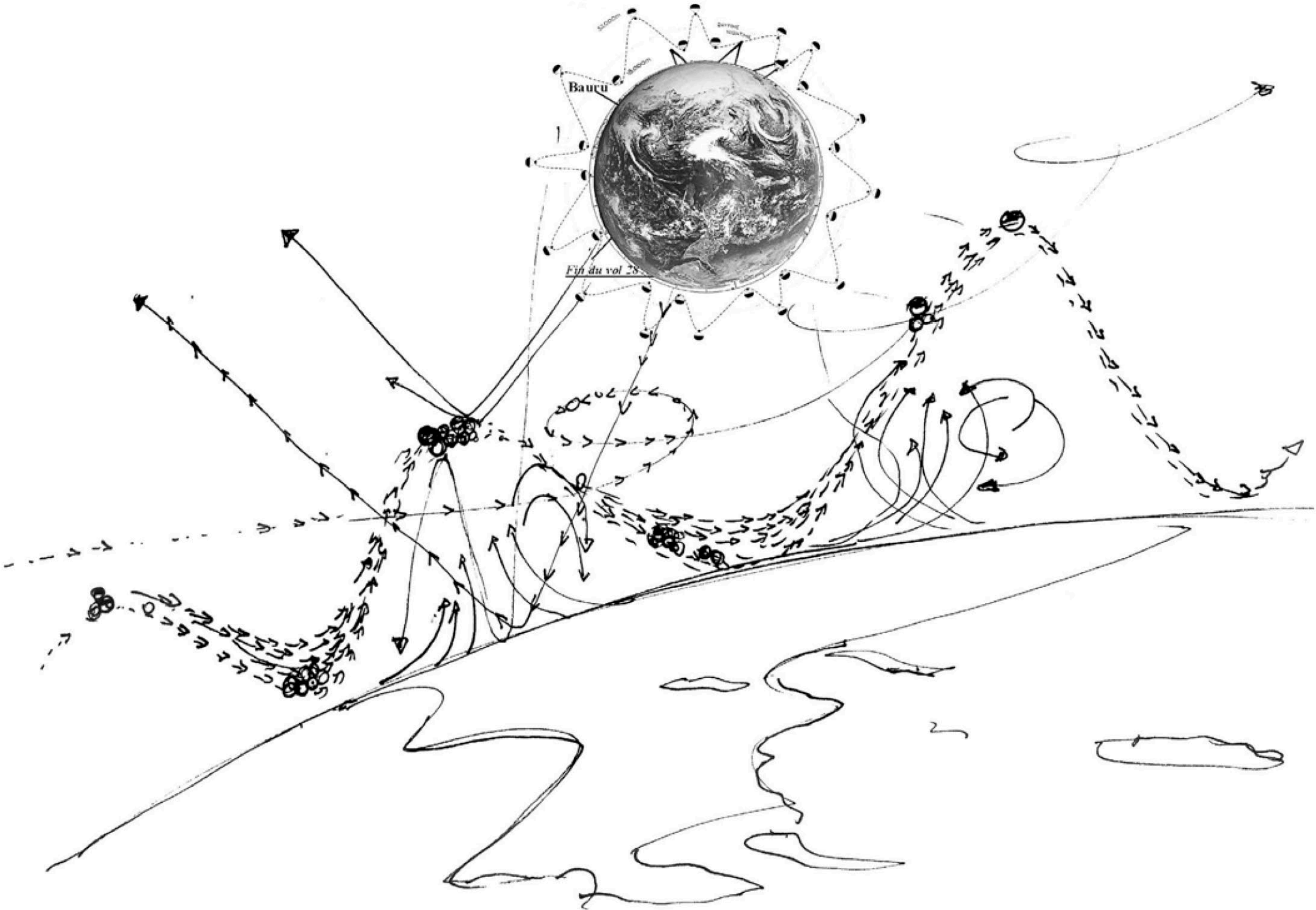
1 “Museo Aero Solar,” [HYPERLINK “http://www.museoaerosolar.wordpress.com/”](http://www.museoaerosolar.wordpress.com/) www.museoaerosolar.wordpress.com [accessed July 27, 2016]

2 Silver Clouds is an installation, made by Andy Warhol and engineer Billy Klüver, exhibited in 1966 at the Leo Castelli Gallery.

3 ZAD is the product of a French anti-urbanism movement: <http://zad.audiot.org/>

4 Damisch, H. (1972) *Théorie du nuage. Pour une histoire de la peinture*. Paris: Éditions du Seuil. 103.

5 Roubaud, J. (1997) *Ciel et terre et ciel et terre et ciel*. Paris: Éditions Argol. 81



Tomás Saraceno  
*Aerocene*, 2015

Artist’s view, sketch. Made for “The Anthropocene Monument,” curated by Bruno Latour, Bronislaw Szerszynski and Olivier Michelon at Les Abattoirs, Toulouse, France. *Aerocene* will circumnavigate the globe numerous times in the most synergetic and energy efficient way ever achieved.





Tomás Saraceno  
D-OAEC Aerocene launch in White Sands, 2015

One small step of Aerocene.  
One giant leap for the life kind...  
The first steps towards round the World

To be back on Earth. Feel the absence of gravity.  
Explore what it is like to be lifted up by the heat of  
the Sun! Join the Aerocene Era...  
In a time of rapidly accelerating climate change, why do  
we still blast rockets into space, burning up vast  
amounts of hydrocarbons? Is it because it is the only  
way to get there? At the Border of Art and Space, and in  
the heart of America's space landscape near the White  
Sands Missile Range, Tomás Saraceno invites you to  
assist to the launch of the aerosolar sculpture "D-OAEC  
Aerocene": Take part of a step forward towards a new  
era, where we don't need a violent explosion to reach  
the stratosphere and we will not work against the forces  
of nature, but in synergy.

Join Aerocene, an epoch lead by aerosolar sculptures  
inflated by air, carried by the wind, lifted only by the  
heat of the sun during the day and by the infrared  
of the Earth during the night... and soon we will float  
around the world to change it together.



# Saraceno's Model of Models:

Tomás Saraceno's *Aerocene* is astonishing for many reasons. Foremost is the degree to which his experiment manifests the salient principle of thermodynamics as the motor of its operation: the universe abhors a gradient.<sup>1</sup> What is so cunning and breathtaking about this project, though, is how it deploys this principle. It projects the work of habitation and mobility aloft in the most abundant but lowest quality gradients on the planet: the dynamics of aero-solar exergy gradients in the atmosphere.<sup>2</sup>

The urbanization of this extremely low-quality but massively abundant gradient is a spectacular and mesmerizing basis for form; one that will likely take years to fully comprehend and realize. It is a stunning and ingenious model of formation, one whose thermodynamic depth is perhaps barely perceptible to most observers.<sup>3</sup> But this is exactly the munificent invitation of *Aerocene*: to peer into the sublimity of its formation and thusly envision an entirely different thermodynamic model for living in this century.<sup>4</sup>

To name but just one pertinent dimension of this model of formation, in a stunning inversion Saraceno grasps the prevailing problem of radiative forcing that today, we are told, otherwise threatens qualities of life on this planet.<sup>5</sup> He immediately and generously inverts that "problem" into the very gradient that will support many aspects of life in his aero-polis. The almost-nothing of our atmosphere that threatens everything today becomes, in his model, the everything that affords nothing other than a profoundly relevant political and thermodynamic model for life in this century.

In this way Saraceno's model makes us think and think differently another basic principle of thermodynamics: the completely underestimated importance of system boundary selection.<sup>6</sup> All the key contemporary planetary dynamics – so often construed as "problems" of scarcity – such as climate change or climbing populations are in fact opportunities of abundance. The difference in this world-view

is nothing other than a difference in system boundary characterization. Whereas scarcity-mongers live in constant fear of the isolated system boundaries they unwittingly select and accept to enact the terms of their perceived doomy scarcity, the reality is that humans utilize less than ten percent of incident available solar exergy for its operations.<sup>7</sup>

Saraceno takes the latter open system boundary characterization and its superabundance as his point of departure. Within this context of superabundance, Saraceno envisions a very powerful model of living based on cunning exergy matching of maximal work from his selected, deliriously low-quality gradient. As a formation of matter, energy, and movement, *Aerocene* should thus challenge many prevailing models for reasoning and imagining our world and how we might live with it today.<sup>8</sup>

In both emblematic and literal terms – and in formal, political and scientific terms – the dynamics of his formations are entirely reliant on a non-isolated conception of the world as a system.<sup>9</sup> Further, more immediately at a human scale, his formations of people, plastic, air and the sun serve as a constant reminder – an index – of the operative system boundaries of *Aerocene*. This amends the depravity of our pervasive, seemingly invisible metabolic rifts that are a primary enabling fiction of contemporary neoliberal life. To become Aerosolar, and to enter the age of *Aerocene* is to, finally, become astutely aware of one's system boundaries as the basis of a novel polis. It is a consummate model of cosmopolitanism.

If the Romans came closest to a fully thermodynamic model of telluric civilization, Saraceno has begun to devise an analogical Aerosolar model. A deeply important dimension of the project is in the convergence of its physical and political realities as inextricably coupled systems. We too readily forget today that every political model is constitutively thermodynamic and that every thermodynamic model is deeply political.<sup>10</sup> In the case of *Aerocene* it is thoroughly provoking to imagine political systems based

**We too readily forget today that every political model is constitutively thermo- dynamic and that every thermodynamic model is deeply political. In the case of Aerocene it is thoroughly provoking to imagine political systems based entirely on insolation-based intensive properties of the atmosphere such as temperature, pressure, and density; as manifests in varied jet streams, storms, or doldrums.**

# The Magnificence of Aerocene

entirely on insolation-based intensive properties of the atmosphere such as temperature, pressure, and density; as manifests in varied jet streams, storms, or doldrums. Not since John Wellesley Powell vainly envisioned the political organization of the American West as a watershed model of the polis has such a convergent physical and political model of life emerged in modernity.

These thermodynamic, formal, and political models astutely merge in Saraceno's project. In this way, Saraceno offers us an ambitious model of contemporary formation, one far beyond timid and disabling models of isolating autonomy that stupidly constrict artistic, architectural, and urban praxis.<sup>11</sup> Instead, *Aerocene* affords us a glimpse into a model – a different model of causality – for that which could afford and accommodate life today.<sup>12</sup> It is the only truly immanent, thermodynamic model of design in the domain of architecture and urbanization, driven as it is by the intensive properties of its formation. It eclipses – by orders of magnitude and significance – the bullishly obdurate hyomorphie approaches to art, architecture, design, and urbanization that otherwise clog our current models.

The above is at most suggestive of the magnificence of *Aerocene* model and its thermodynamic depth. More than any other model for living and formation today, Saraceno challenges our current modes of imagination and reasoning and, in a gush of goodwill and optimism, offers a beguiling and ponderous alternative model for how we might best live today.

1 A gradient is an energetic difference. The universe tends to obliterate such difference, seeking an equilibrium it will never achieve. For all intents and purposes here, we live in constitutionally open and coupled systems. All forms in the universe can be understood as emerging from constitutionally open and coupled dynamics.

2 Upon initial inspection, *Aerocene* seems to exploit the subtle thermal gradient on each side of Saraceno's plastic bags. Further examination will reveal not only sensible heat gradients but latent heat gradients, boundary-layer fluid dynamics, and humidity all driving the pressure differences which produce the relevant buoyancy in this case.

3 Thermodynamic depth refers to the degree of coupled subsystems in a thermodynamic system.

4 It might well be that art and architecture finally come to learn the profound difference between form and formation in this century.

5 Radiative forcing dynamics are what otherwise are characterized as climate change. The "climate change" characterization over-simplifies the topic and fetishizes carbon as the sole culprit. This occludes matters of theoretical, practical and political significance. The reality of radiative forcing dynamics provides a more varied and valid conception of how we might best design in this century.

6 Every day, in every task, in every thought, the cosmopolitan twenty-first century citizen might well inquire, what is the appropriate system boundary at hand, and why?

7 Humans collectively utilize about 16.5 terawatts of exergy annually. The incoming exergy is on the order of magnitude of 165,000 terawatts. It is difficult to construe an energetic scarcity here, but rather only a scarcity of valid models, like Saraceno's, for how to best squander this superabundance.

8 A model is at once a unique object and an example of a world-view. Every physical object carries with it an entire view of the world. Ideally, an exemplary model would be both an exemplary object and afford an exemplary view of the world. Such models are rare. The Parthenon in Rome is one; *Aerocene* appears to be analogous.

9 Any system will be open, closed, or isolated. The difference gauges the type of exchange, or lack of, amongst the system and its surroundings. Intimidated by vitality. Including complexity, modernity tended to prefer the reassuring comfort of isolated models. Oops.

10 In this sense, it would be suffice to discuss the state of any system or model.

11 Above the cobblestones, the air!

12 What causes something to appear the way it does?

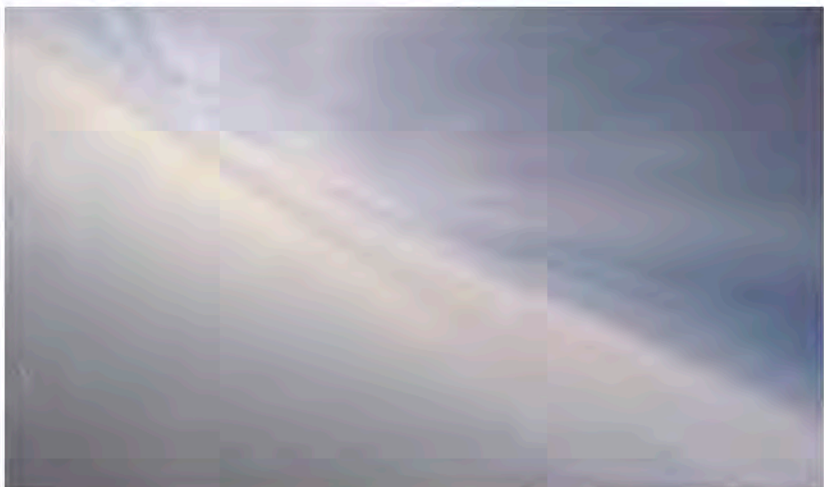


Tomás Saraceno  
Solar Flying Cooker, 2010





Tomás Saraceno  
Aerocene, Becoming Aerocolar – Free Flight, 2018  
The aerocene sculptures, launched in the spring 2015, have traveled more than 500km in less than 5 hours, and made their way from Germany to Poland following up atmospheric jet streams.



## Bronislaw Szerszynski

As society struggles to come to terms with the implications of anthropogenic climate change, it is becoming increasingly clear that any adequate response will require not just more efficient machines and renewable energy sources but an *epochal* shift in the energetic and material relationship between humans and their environment. Researchers in industrial and social ecology such as Rolf Sieferle and Marina Fischer-Kowalski, have carried out detailed analyses of the different 'socio-metabolic regimes' that have underlain different forms of human society, and these can help us understand the nature of the challenge facing humanity in the twenty-first century. Two of the main kind of metabolic regimes seen thus far in human history have been solar-based. Low-density hunter-gatherer societies engaged in passive solar energy utilisation by utilising the resource density of lightly-managed existing ecosystems, whereas agrarian societies more actively maximised useful solar energy by clearing forests and raising high-utility organisms such as crops and livestock.<sup>1</sup> The spread of this agricultural form of society enabled societies to slowly increase their populations and to support non-agricultural economic and cultural activity. But it did so by increasingly monopolising the land surface and coastal waters of the Earth, creating 'anthromes,' where natural systems are embedded in and shaped by human systems.<sup>2</sup>

The third major regime was rather different. This was the industrial metabolic regime that allowed the growth dynamic that had been made possible by the agrarian regime to continue and even accelerate, by shifting its main source of energy from the solar flux to geological stores of energy. One way to describe this was as a move from *surface* to *volume*.<sup>3</sup> For the first time, energy needs were more or less decoupled from territory, a point that Sieferle emphasises by coining fossil-fuel reserves a 'subterranean forest.'<sup>4</sup> Going down into the volume of the Earth – and thus into the deep time of the Earth's past – became not just a minor additional activity but absolutely central to the logic of society. But we have seen that this regime has been deeply perverse in its effects, especially in terms of climate change and ocean acidification, and cannot safely be sustained. So what could come next? Here we need to be imaginative.

It seems likely that one way or another we need to shift to a new kind of solar regime – one that shares with the hunter-gatherer and agrarian regimes the utilisation of the massive constant flow of solar energy through the Earth system – rather than the mining of finite stocks of energy under the earth. Nevertheless a regime that can support the greatly enlarged human population that the fossil-fuel-based regime has produced. The dominant emerging vision involves reducing energy needs through efficiency gains, and shifting from fossil-fuel use to the capturing of solar energy, either directly through photo-voltaic electricity or biofuels, or indirectly through harnessing the energy of the movement of air and water as the elemental media of the Earth dissipate the energy gradients created by the curvature of the Earth's surface and the shifting relation between Earth and Moon.

### Going up

Yet shifting from fossil fuels to solar energy in the dominant ways that are being envisaged would involve restoring the link between energy and territory. There is thus a danger that the way that we reduce the pressure on the capacity of the atmosphere and ocean safely to absorb CO<sub>2</sub> will simply redirect that pressure onto the surface area of the Earth, with even less room for non-human nature. Given that the current socioeconomic system has a structural need for ever-growing energy consumption, simply shifting back to a territory-based socio-metabolic regime without otherwise radically altering the organisation of society is likely simply to displace, not overcome, the contradictions of our current way of life.

So maybe a return to the surface is not the way forward. Maybe the fourth major socio-metabolic regime should *continue* the industrial regime's volumetric approach, but intensify it and switch it around by going not downwards but *upwards*. For more than a decade now, Tomás Saraceno has been using his art to explore the idea of inhabiting the air. In series of works such as *Air Port City*, *Cloud City*, *On Space Time Foam*, *Museo Aero Solar*, *Becoming Aerocolar* and

# Up

## What happens when we put climate change in a longer perspective? How can art and science come together to help us do that?

now *Aerocene*, Saraceno's enduring themes have been going not down but up, not fossil fuels but light and air, and not the deep past but the deep future – a vision of living spaces lifted up into a light, airy, green future, floating and casting their diffuse shadows over a land liberated for non-human life to flourish. At the moment, Saraceno's vision of cumulus cities and cirrus cities convening and dispersing in the air remains just that – a fanciful vision. But maybe its sheer apparent impossibility should prompt us to consider it as something to be actively explored – as exactly the sort of radical rethinking of how we inhabit the Earth that is needed at this time.

### Opening up

Tomás Saraceno's work can also help us envision another aspect of how we might need to alter the way we inhabit our planet. The historical displacements of one socio-metabolic regime by another have always been accompanied by dramatic shifts in ideas of the human, and of the human body's relationship with its environment and the wider cosmos. Yet the contemporary politics of low-carbon living is still closely tied to the enclosed forms of embodiment associated with industrial society and its fossil-fuel excess. Saraceno's art offers clues as to how we might break that link and find new ways of enacting and experiencing our being-in-the-world.

Michael Bakhtin's 1968 exploration of the 'carnavalesque' dimensions of medieval culture emphasised the openness of the medieval body to metabolic flows and enjoyments of matter and energy.<sup>5</sup> Teresa Brennan, in 2000, used Bakhtin's analysis as the basis for a more general argument that people who lived under pre-modern socio-metabolic regimes typically conceived themselves not as closed off from the environment, but as opened to flows of energy, affect and mental content from their surroundings. Yet with the Protestant reformation, which prepared the way for modern society, the body was progressively closed off. Bodily engagement with the world, and with the divine, were increasingly devalued in favour of interior reflection, language and speech, and the close-contact senses of touch, taste and smell were de-emphasised in favour of those of vision and hearing.<sup>6</sup>

The transition to industrial modernity also involved developing very different ways of talking about energy and movement. The word *energy* comes from the ancient Greek *energos*, meaning "being in action." This was a rich, qualitative concept that encompassed a broad range of different kinds of activity (*poiesis* and *praxis*), and relations between potentiality (*dunamis*) and actuality (*energeia*). The modern, quantitative concept of energy is very different. It has made possible huge gains in human understanding of the universe, but has done so at the expense of an awareness of the qualitative dimensions of energy.<sup>7</sup> Defined as the capacity to do 'useful work', the modern idea of energy is very much a product of the industrial metabolic regime,<sup>8</sup> and has encouraged an alienation from the contingencies of creaturely existence. As Lewis Mumford put it, in the industrial system, "[p]ower was dissociated from its natural human and geographic limitations: from the caprices of the weather, from the irregularities that definitely restrict the output of men and animal."<sup>9</sup>

Brennan also argued that the modern idea of psychic self-closure is inextricably linked with the technological domination of nature, and with the proliferation of commodities and characteristic of industrial, capitalist modernity. In an echo of Latour's 1993 argument that modernity's attempt to separate and purify nature and culture has the counteracting effect of making hybrids proliferate,<sup>10</sup> she suggests that the notion of psychic closure from wider energetic flows has helped to drive the breathtaking energetic and material profligacy of modern society, and the incessant conversion of the energies of life into dead commodities.<sup>11</sup>

Yet the current way of thinking about low-carbon, sustainable living is still grounded in the modern, industrial 'constitution' of the body, one predicated on a minimisation of the material, energetic and symbolic exchange with the environment and the rational monitoring of behaviour. A transition to a genuinely sustainable society might require not just a *technological* transition but also a more fundamental *anthropic* one, involving new ideas of what it is to be

human, with very different understandings of energy and its relationship to life – and perhaps one that echoes those of pre-modern societies.

### The Aerocene vision

The *Aerocene* sculpture – along with all the wider social practices that convene around it – gestures towards such a new vision of the human. The *Aerocene* vision is about *going up*, but also *opening up*. The *Aerocene* sculptures gains its power to rise into and inhabit the atmosphere not merely from itself but from its openness to elemental media and cosmic forces. They collect electro-magnetic energy from the sun and the Earth through its membrane; they use the weight of the atmosphere above it to rise, and pressure differentials in the atmosphere around them to move. They engage with the human bodies and collectivities that gather around them, becoming nodes in a network of bodies that make each other sensitive to the dynamics of the atmosphere. And the open body of *Aerocene* reminds us of the openness of our *own* bodies – that living things, like all dissipative systems,<sup>12</sup> depend on a constant flow of energy, matter and information across the boundary that at once divides and joins them and their environment. *Aerocene* points towards an anthropic transition that would open us up to the more-than-human world.

Inhabiting the air and opening up to the elements would also involve us recognising contingency and hazard as a necessary part of creaturely existence, rather than something that can ever be eradicated. As Tim Ingold puts it, life (*anima*) is not something carried by the wind; it is being carried by the wind (*anemos*): "life is not in things; rather, things are in life, caught up in a current of continual generation."<sup>13</sup> We need new forms of solidarity and security, predicated not on closure and independence but on the recognition of mutual vulnerability and interdependence.<sup>14</sup> The *Aerocene* provides a framework for that vision, a metaphorical – and maybe literal – lifting and opening up into the constant becoming of airy being.

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Jol Thomson  
Sasha Engelmann

# Tianhe 天河区

Nothing distinguishes me ontologically from a crystal, a plant, an animal, or the order of the world; we are drifting together toward the noise and the black depths of the universe, and our diverse systemic complexions are flowing up the entropic stream, toward the solar origin, itself adrift. Knowledge is at most the reversal of drifting, that strange conversion of times, always paid for by additional drift; but this is complexity itself, which was once called being. Virtually stable turbulence within the flow.

Michel Serres, (1982). *Hermes: Literature, Science, Philosophy*.  
The Johns Hopkins University Press, 83.

# Parables of the Celestial River

Tianhe-2 is a 33.86 petaflop supercomputer, the fastest on the planet, located in southern China in the sub-provincial city of Guangzhou in the eponymous district: *Tianhe*. Tianhe, however, is not merely a region within a Chinese province housing the world's fastest supercomputer of the same name. *Tianhe* is also the region where every star we can see with our naked eyes dances in its galactic choreography — it is where we all reside. *Tianhe* translates to English as *celestial river*, and is the Chinese equivalent for "Milky Way".

In the center of *Tianhe*, our vortical, starry-river home, is what cosmologists call an *Active Galactic Nuclei* (AGN): a luminous and spectrally saturated accretion of matter amplified by a supermassive black hole. AGN's are the largest and most persistently radiant objects in the entire cosmos and represent an active area of research in physical cosmology, not least because they are known to emanate extremely energetic particles into the domains of interstellar space.

In the core of *Tianhe-2*, are over one hundred thousand microprocessors, each a complex silicate lattice with billions of transistors. Since computation occurs via charged particles within semiconductive microprocessors, any interference by forces, or other charged particles, can cause failures in long-term savings of the computer's modelling operations, running weeks or months of computations. As processors become smaller and computation becomes more omniscient and ambient, industries have begun to apply ECC's, or Error Correction Code, to deal with the constant environmental bombardment of charged particles, the atmospheric noise that interferes with the circuitous processes of microprocessors. Given Moore's Law, the importance of ECC's to the smooth functioning of the computational future should not be underestimated.<sup>1</sup>

**天河区**  
In August 1912, the Austrian-American physicist Victor Francis Hess was lured by unexplainable phenomena into the troposphere with a series of six balloon flights. Hess studied the conductivity of air and the amount of ionization above the Earth's surface. His discoveries would win him the Nobel Prize twenty-four years later. But what he measured still mystifies physicists and astronomers alike, and is the locus of millions of dollars in research and collaboration around the globe.

Reaching an altitude of 5500 metres between Vienna and Germany, Hess discovered an *increase* in radiation as he ascended past 2 km into the troposphere. This ionizing radiation was soon shown (to great scepticism) to be neither terrestrial (since it increased as one ascended away from the ground) nor solar in origin (as it was shown to radiate at night and during solar eclipses). This unknown radiation, at the dawn of human understanding of radioactivity, was posited to be *Galactic in origin*, morting the name *cosmic rays*. Decades of subsequent balloon experiments revealed an ionization maximum between 20 and 25 kilometres above Earth's surface: the *Pfotzer Curve*.

Cosmic rays and other astrophysical phenomena would also seduce the French space agency, *Centre National des Etudes Spatiales* (CNES), into the realm of the Pfotzer Curve more specifically a threshold spanning the upper troposphere and lower stratosphere, between 20 km and 32 km high.<sup>2</sup> From the 1970s CNES' long-duration, stratospheric missions employed the Montgolfiere Infrarouge (MIR) balloon. The MIR, a solar relative of the *Aerocene*, dwells in this airy milieu above the paths of airplanes both day and night by exploiting cascades of energy from our nearest star, Sol, as well as the infrared radiation emitted by the Earth — its uses no other gases than air. MIR and *Aerocene* freely ride the isopycnal surfaces of this atmospheric "critical zone,"<sup>3</sup> resonating with exotic perturbations from far beyond the Solar System's heliospheric reach, eddying in the galactic tide-pools of *Tianhe*.

A "cosmic dancer on history's stage,"<sup>4</sup> the *Aerocene* is part of a legacy of experiments, initially led by mere noise, lured by specific conditions of the upper troposphere and lower stratosphere. This unique atmospheric zone is the most critical for analyzing Earth's radiative budget, for measuring turbulence and atmospheric pollution, and for detecting high-energy cosmic rays. It is also precisely at 20 km that Google is now deploying Project Loon: a fleet of balloons that will beam LTE Internet to Earthbound smartphone users. Sri Lanka will be the first country to be "covered" by March 2016.<sup>5</sup> Indeed the Earth may soon be veiled by another lattice of processing power, borne by the very thermodynamic infrastructure that has always insulated us and our machines from the cold, dark, deep waves beyond.

The Catatumbo is a river in Venezuela where vast amounts of Ozone is regenerated on a near-nightly basis by the planet's most consistent lightning storms, storms named after the river over which they emerge an average of 300 times a year. Earth itself is wondrously illuminated by around 3 million lightning flashes *per day* (or 40 per second, 1.4 billion a year). Contrary to common understanding, the ground itself produces upward flowing "positive streamers": invitations to down-dwelling plannmas.<sup>6</sup> A bolt of lightning is: "a stuttering chatter between the ground and the sky," during which these fields of virtual potential actualize and equalize for a radiative moment.<sup>7</sup> These electromagnetic surges generate not only atmospheric plasma and Ozone, but also the atmosphere's extremely low radio frequency of 7.83 Hz: *Schumann Resonance*. This means that every atom, molecule, or crystal — the DNA in our mitochondria, the informa-

Tomás Saraceno's *Aerocene* is alive to cosmic energies in the way that the molecules of Earth's crust are alive to the charge in atmospheric storm-systems and in the way that the Earth itself is alive to the AGN in the far-off turbulence of the celestial river. The *Aerocene* is a cascade experiment with force-fields and phenomena that are far more cosmic, far more promiscuous, than most individuals of our species realize. Like Sprites, Blue Jets and Elves, like Victor Hess himself, the *Aerocene* prehends the charged matter of Earth, the atmosphere, Sol, and *Tianhe's Active Galactic Nuclei*, finding, like so many other phenomena, a path to weave between and within.

The genealogy of the *Aerocene* is composed of the buoyant search for answers to seemingly simple questions, questions that upon investigation become cosmological in scope. This fact should not be underestimated. Like the atmospheric noise that confused and drove Hess to the sky, the clapping noise of lightning on distant horizons, the quasi-noise of spacetime matter(s) patternings — these ancient and primordial static-interferences, floating or spinning now, charged and cascading, reaching and joining — these have been great lures for thought, exploration and invention, for physical and epistemological risk and renewal. Such noisy, wandering potentials are a reminder that terrestrial life is not now, nor has ever been, insulated from the vast astronomical plenum. And it is thus that we find ourselves, led by an indistinct babel, to detect the whisper of a blackhole Shiva<sup>11</sup> hinting that yes, indeed, we probably do reside within the luminous logic of a holographic supercomputer of the same name...<sup>13</sup>

## Epilogue

DR. JAMES GATES What I've come to understand is that there are these incredible pictures that contain all the information of a set of equations that are related to String Theory. And what's even more bizarre then is when you try to understand these pictures, you find out that buried in them are computer codes just like the type that you find in a browser when you surf the web. And so I'm left with the puzzle of trying to figure out whether I live in the Matrix or not.

NIEL DEGRASSE TYSON You're blowing my mind at this moment. So you're saying, are you saying your attempt to understand the fundamental operations of Nature leads you to a set of equations that are indistinguishable from the equations that drive search engines and browsers on our computers?

JG Yes that is correct.

NT Wait, wait I'm still — I have to just be silent for a minute here... So you're saying as you dig deeper and deeper [bending over and miming a digging motion] you find computer code writn in the fabric of the cosmos?

JG Into the equations that we want to use to describe the cosmos, yes.

NT Computer code.

JG Computer code. Strings and bits of ones and zeros.

NT And it's not just that it resembles computer code, you're saying it IS COMPUTER CODE?

JG ...and it's a special kind of computer code that was invented by a scientist named Claude Shannon in the 1940s. That's what we find very deeply inside the equations that occur in String Theory and in general in systems that we say are Supersymmetric.

## 天河区

- Moore's Law is the observation that approximately every two years since 1975 computational power has doubled (and we could add, miniaturized by a similar factor). It is suspected that the inherent limit to this doubling is the width of the atom itself, a limit we are already rubbing up against. See Gibbs, S. "At the limit of Moore's law: scientists develop molecule-sized transistors", *The Guardian*, July 21, 2015.
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- "Shiva" is the name given by Stephan Jay Gould to the pattern or "cycle of impasse [of objects on Earth] driven by a galactic tide, probably the Sun's vertical oscillation in the plane of the Milky Way Galaxy" Shiva-shakti is also the processual Hindu god of destruction and transformation.
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Tomás Saraceno  
Memorogue 2798 Aerocelar, 2018

The launch in White Sands and the symposium "Space without Rockets", initiated by Tomás Saraceno, were organized together with the curators Rob La Frenais and Kerry Doyle for the exhibition "Territory of the Imagination" at the Rubin Center for the Visual Arts.