

STARTS Residency Private Report

Continuum (and Martian Sun Series)

Martian sunset simulator

Félicie d'Estienne d'Orves (visual artist), Dr François Forget (former scientific director at LMD
Laboratoire de Météorologie Dynamique/CNRS, France), Sean Rose (art critic)



Performance at Centre Pompidou Paris, May 2019

Video projectors, video simulator, light projectors and double screen 15M x 6M. photo©Julien Lanoo



Continuum is an audiovisual performance created by Félicie d'Estienne d'Orves in collaboration with Dr François Forget former scientific director at Dynamic meteorology laboratory (LMD) of Jussieu in the context of a Vertigo STARTS Residency programme in Paris. The core research project is a numerical simulator of a martian sunset as could be observed on Mars programmed with scientific data from the LMD Mars Climate Database Project ¹ and collected alongside other researchers specializing in Mars and its atmosphere (JPL Caltech University / Texas A&M University, USA). The main outcome of the collaboration with LMD is the integration of atmospheric scientific data so as to reproduce and very slowly animate the colorful aura of the Martian sky following the sun's position. The program was created to be manipulated and operated by the artist and scientists to experiment and seek out gradations consistent with the scenario of the Martian sunset ².

Based on this software the artist envisioned combining progressive, imperceptible frequency variations and drones from Eliane Radigue (b. 1932) French seminal composer's electronic piece *Koumé* ³ with the temporal and visual continuum of the martian sunset. The show was commissioned for the performance hall at the Centre Pompidou Paris in may 2019. Echoing *Continuum* the film, the artist and the LMD team also collaborate to produce another artworks the *Martian Sun series*, five bas-reliefs with programmed LED light and plaster topography of major sites in the search for life signatures on Mars. The motorized lighting of each bas-relief reproduces in light intensity the height of the sun on the horizon in real time at each of the sites based on prediction from the LMD Mars Climate Database Project. The sculptures were exhibit at Le Fresnoy (Tourcoing/FR) in Panorama 21 exhibition from September to December 2019.

***Index Terms* — Audiovisual performance, art installation, martian sunset, numerical simulator, television process.**

¹ <http://www-mars.lmd.jussieu.fr>

² <https://continuum.buzzinglight.com/>

³ Koumé is the Part III of the musician's *Trilogie de la mort* (1993), a piece inspired by the *Bardo Thodol*, better known as *the Tibetan Book of the Dead*. Bardo in Tibetan Buddhism is the interval between death and rebirth.

I.

INTRODUCTION

Just as the impressionists went into the fields to capture natural light, with *Continuum* and the *Martian Sun series*, the visual artist Félicie d'Estienne d'Orves works with landscapes through a 'tele-vision' process, with a distant landscape which is thousands of millions of kilometers away. Her depth of field is augmented by the sensors of the martian rovers and the astrophysician's models. The research project developed with the LMD team is an invitation to contemplate an extra-terrestrial horizon : to watch the sun setting is to experience the skyline. The closer you want to get, the further it will move back.

II.

ARTWORK

Excerpt from the Centre Pompidou Paris text presentation - *May 2019 by Sean Rose (art critic)* :

« There's no life on Mars but Mars has never ceased to inspire. A metaphor of otherness. For *Continuum* Félicie d'Estienne d'Orves has made a film of a sunset on Mars in homage to seminal electronic composer Éliane Radigue (b. 1932). Her immersive installation based on images of the Red Planet taken by NASA probes shows the sun setting for about an hour to the score of *Koumé*, part III of the musician's *Trilogie de la mort*, a piece inspired by the *Bardo Thodol*, better known as *the Tibetan Book of the Dead*. Bardo in Tibetan Buddhism is the interval between death and rebirth. The Martian landscape realized by Félicie d'Estienne d'Orves goes through different phases of colour, depicting skies progressively turning from orange to blue and into twilight – the reverse of what happens on Earth with a blue sky becoming red. Echoing these monochromatic fields is Éliane Radigue's minimalist composition, resounding like an on-going deep breath. *Continuum* is about continuity between different states of consciousness, from being to non-being to being again, over and over, the endless cycle of life and death. Time and space become a dream, like any other sense dissolving into the visual and the sonorous. *Continuum* plays with the idea of optical and cosmic illusion: on Mars so on Earth, the sun never sets. »

Description of *Continuum* series of artwork :



Performance at Centre Pompidou Paris, May 2019

Video projectors, video simulator, light projectors and double screen 15M x 6M. photo©Julien Lanoo

***Continuum* Performance** — The artistic installation is based on the rear-projection generation of a sunset on Mars projected on two screens ($16\text{ m} \times 5\text{ m}$), the first "captures" the light and the second diffuses it to create a mist effect. This projection is done on canvas using two video-projectors and rear lighting system consisting of moving lights and profiles increases the sun's glare and is controlled by the computer. The video simulation of 52 mn includes the soundtrack composed by Eliane Radigue. This music is also read and synchronized by the computer and spatialized on 8 channels.



Continuum Stand alone installation (large scale) — We also have implemented an art installation based on a 11m x 5m screens with seating as cushions on the floor, the artwork of 52 min is looped autonomously with a pause of a few minutes between each session. The video simulation of 52 mn includes the soundtrack composed by Eliane Radigue spatialized on 8 channels. On a TV monitor (55 in full HD 60hz minimum) we display the simulator relief features following the latitude and longitude on Mars with a system of equivalence between the exhibitions locations on Earth where the artwork is presented (Paris, Marseille, Bordeaux, Tourcoing, Lisbon) and sites on Mars. The screen displays technical and map pieces of information about the Martian site.



« Continuum, Martian sun series », Le Centquatre Paris, Mars 2020
Screen, frosted glass, computer, Size: 130 x 40 cm

Continuum Stand alone installation (small scale) — Art installation based on a panoramic 1,30 x 0,40 M screen with a frosted glass finish. The artwork is a looped of a 52 min sunset sequence with a pause of a few minutes between each session. The piece is display with a bench and headphones to listen to Eliane Radigue's music.



« *Martian Sun series, Gale Crater, Jezero Crater, Valles Marineris* », Cibrian Gallery, Spain April 2019
Arches paper embossed, steel, LED, electronics, Size: 25 x 33 cm. Photo©CibrianGallery

Martian sun series (paper) — Arches paper embossed, steel, LED, electronics, Size: 25 x 33 cm
 — The installation represents the topography of three major sites related to the research of biosignatures on Mars (*Gale Crater, Jezero Crater, Valles Marineris (Ophir Chasma)*). The lighting of these *bas-relief* pieces translates into light intensity the position of the sun on the horizon in real time on each of the sites. *Gale Crater* is the landing site of MSL/Curiosity. *Ophir Chasma* is a valley located in the *Valles Marineris* canyon a large tectonic crack caused by erosion, whose width is 600 km and depth is 10 km, this eroding phenomenon is deemed to be of hydrologic origin. *Jezero Crater*, is the next site to be explored by the space probe Mars 2020. A permanent lake was located there and traces of river deltas can still be found.



« *Martian Sun series, Gale and Jezero Craters* », Panorama 21, Le Fresnoy (Tourcoing/FR), Sept. Dec 2019
 Circular plaster bas-relief, steel, motorized LED, electronics, diameter 60 cm. Photo©EricFlogny

Martian sun series, Sol 24h39min 35s — The bas-reliefs are illuminated according to the height of the sun on five Martian sites. The motorized lighting follows the average length of daylight on Mars of 24 hours 39 minutes and 35 seconds. Each bas-relief corresponds to the landing site of an American probe : Gusev Crater (Spirit, 2004), Gale Crater (Curiosity, 2012), Jezero Delta (March 2020), Endeavour Crater (Opportunity, 2004), Chryse Planitia (Viking1,1976). The five rovers are located at different latitudes on Mars and correspond to different launch years. ***N°1 series, 3 artworks, rectangular Bas-reliefs Size : 115 x 75 cm*** — Plaster low-relief, steel, motorized LED, electronics. The 3 bas-reliefs with programmed LED light and plaster topography of major *Endeavour Crater (Opportunity, 2004)*, *Chryse Planitia (Viking1,1976)*, *Gusev Crater (Spirit, 2004-2010)*. The motorized lighting of each bas-relief reproduces in light intensity the height of the sun on the horizon in real time at each of the sites based on prediction from the LMD Mars Climate Database Project. ***N°2 series, 2 artworks, circular Bas-reliefs Size : diameter 60 cm*** — Plaster bas-relief, steel, motorized LED, electronics. The 2 circular bas-reliefs with programmed LED light and plaster topography of *Gale Crater (landing site of MSL/Curiosity)* and *Jezero Crater*. Each bas-relief is motorized to rotate 360° according to the length of the Martian day, the LED lights reproduces in intensity the height of the sun on the horizon in real time at each of the sites based on prediction from the LMD Mars Climate Database Project.

Félicie d'Estienne d'Orves started working on the idea of reproducing an artificial sunset for a music piece by Eliane Radigue before she saws the images of a Martian sunset, with a rather amazing bluish halo on them. She wanted to find out why this halo was this color and how she could build a video sequence of it. She first went to Caltech University in Pasadena, where she meets Dan McCleese, former scientific director at the Jet Propulsion Laboratory (site of production of Mars probes), and also Dr William Rapin (french researcher at Caltech). Back to Paris Dr Dan McLeese put her in touch with Dr Mark Lemmon - A&M University (Texas) who specializes in processing images from the probes (Dr Dan McLeese - JPL/Caltech, - Caltech and collaborated on this project). Those scientists are also collaborators of François Forget and LMD.

The first stage of the collaboration with Dr François Forget and the Dynamic meteorology laboratory (LMD) in the context of a Vertigo STARTS Residency programme in Paris enabled the artist to understand the physical action of sunsets and to assemble the visual documents, photographs available in the visible range. They first analyze and put together images from the probes to see what the sunset looked like in a sequence. It was also necessary to see how Guillaume Jacquemin (*Continuum's* programmer) could use the data from the Mars Climate Database simulator (<http://www-mars.lmd.jussieu.fr/mars/access.html>). Then, in recurrent meetings they implemented the real-time datas in the reconstruction of the Martian sunset in the simulator develop by Guillaume Jacquemin.

The artistic team developed the simulator, the lighting and video tests during a year of residencies and production. This resulted in several public presentations of the work in progress. Each installation on scale 1 allowed us to complete a production stage, from the first version of the simulator with small screens (10 x 4M), to the Pompidou Centre (16 x 5M) where we finally decided to increase the video projection by a detailed light mapping using 15 programmed light projectors (LED and motorized). At each step we were able to exchange with the LMD teams, to check the visual renderings by mail, in the laboratory or during technical tests at scale 1.

Guillaume Jacquemin has developed 5 versions of the simulator to adapt to the project to its various presentation scales (performance, stand alone large scale, small scale). The simulator enable real-time integration of atmospheric scientific data (wavelengths, turbidity, Rayleigh scattering, Mie scattering, etc.) so as to reproduce and very slowly animate the colorful aura of the Martian sky.

The program was created to be manipulated and operated by the artist and scientists to experiment and seek out gradations consistent with the scenario of the Martian sunset. (lien : <https://continuum.buzzinglight.com/sky/>). The other aspect of the IT development of the simulator was to integrate data of the Martian relief (geology) following the latitude and longitude on Mars planet. Guillaume Jacquemin used the Martian solar longitude converter of the LMD to set up a system of equivalence between the exhibitions locations on Earth where the artwork was presented (Paris, Bordeaux, Tourcoing, Lisbon) and sites on Mars (<https://continuum.buzzinglight.com/cartel/>).

For the third stage of development, Guillaume Jacquemin was concentrated on the software features to control of the shader over time of the scenic show for Centre Pompidou (52 min show). In particular the control of the sunset simulator through the commercial software Vezor that enables the parameters to be synchronized with the soundtrack and to programme the light show control (synchronisation with the motors, intensity and colors of the light projectors). During the last residency at the Centre Pompidou Félicie d'Estienne d'Orves with the light designer Remi Godfroy were able to finalize the visual scenario of the sunset sequence in real time. Working with a detailed timeline with many key points for all the features of the simulator and also programming the 15 light projectors of the installation.

Another significant step was the technical development of the *Martian Sun series* from April to September 2019 for the exhibition at San Sebastian Cibrian's Gallery and then at le Fresnoy (Tourcoing). For this new artwork series the LMD developed a specific system for calculating Mars ephemerides. The bas-relief series are illuminated according to the level of sunshine at different sites on Mars. The motorized lighting LED of the 5 pieces follows the average length of daylight on Mars of 24 hours 39 minutes and 35 seconds.

The electronic cards and code were developed by the 3DO team and programmer Etienne Landon in Lille. For Le Fresnoy we have also developed a motorization system which follows the daylight duration on Mars. With the 3DO team, we designed a rotary motorization system for the circular bas-reliefs on the table (*Gale Crater* and *Jezero Delta*). And a motorization system for the LED lighting on an endless screw from left to right of the wall bas-reliefs (*Endeavour Crater*, *Chryse Planitia* and *Gusev Crater*). The imperceptible incrementation of the movement takes place during the day, then at night the motors return to their 0 position.

The Le Fresnoy exhibition was also the opportunity to adapt the *Continuum* stand alone program to a small panoramic screen of 1.30 x 0.40M with a headphones sound diffusion for Eliane Radigue's music piece.



*Performance at Centre Pompidou Paris, May 2019
Video projectors, video simulator, light projectors and double screen 15M x 6M. photo©Hervé Veronese*

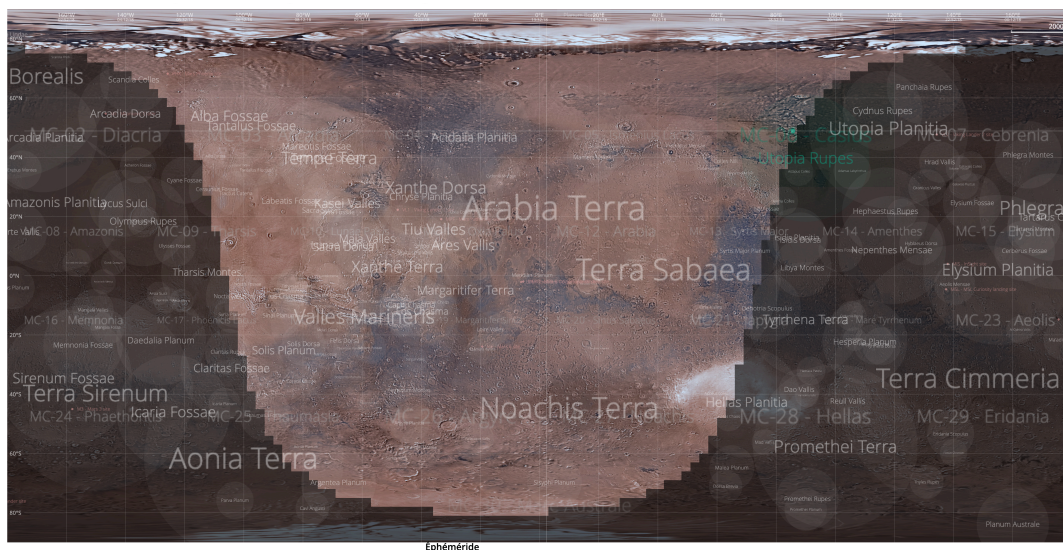
IV.

CO-CREATION PROCESS

The first months of the project involved exchange of information and few meetings between the Artist, the programmer Guillaume Jacquemin, François Forget and his collaborators in order to familiarize each side with the martian sunset subject and expectations of everyone from a conceptual point of view. The artistic scope of the project was determine following the technical skill sets of each part and how could use the data from the Mars Climate Database simulator.

Guillaume Jacquemin implemented the real-time datas (wavelengths, turbidity, Rayleigh scattering, Mie scattering, etc) in the reconstruction of the Martian sunset simulator. Then on the basis of discussions about the specificities of the Martian atmosphere and photographs taken by the rovers, we agreed on a scenario of representative images of a Martian sunset.

We opted for an illustrative design with a photo-realistic approach to give the illusion that it's a real-time webcam that monitors the sunset from the martian ground. To accentuate the dramaturgy of the show we chose to accelerate the temporality of atmospheric events such as a sandstorm that should in theory last several days. Indeed the different stages of the day / night video sequence are scripted following the temporal structure of Eliane Radigue's 52 min music piece. Twilight is also reduced to an average duration of 10 min. On the other hand, the duration of the animation of the curved mouvement of the sun on the horizon is realistic.



For the the background landscape we chose the plain of *Utopia Planitia* and more specifically the landing site of the *Viking 2* probe. The site corresponds to the latitude of Paris transferred to Mars at the time of the show at the Centre Pompidou. This calculation was possible thanks to the topographic part of the simulator which displays the shadow of the sun on a satellite view of Mars (<https://continuum.buzzinglight.com/cartel/viewer.html>).

After a few months of research and development of the simulator, we weren't quite satisfied with the color rendering, especially those related to the blue halo around the sun. We had achieved full integration of the data but the programming tool used by the Martian data and the simulator proved to be incompatible for a direct exploitation of the data.

We then took the decision to augment the video image with a set of RGBW LED projectors to complete the missing color elements. For this new stage the light designer Remi Godfroy has joined the artistic team. A LMD collaborator came to participate to the last residence before Pompidou's presentation to give feedbacks on the video and lights settings.

After the finalization of the project we organized a meeting with the LMD team to decide on the future direction of the project. The Artists and LMD team will continue to develop this collaboration even beyond the scope of the Vertigo residency.

V. IMPACT

A. Research Impact

While the artistic projects have no direct effect on the scientific research, it is part of the duties of a public research institute like LMD to share his research with the public through such outreach programs. From that point of view the projects achieved by Félicie d'Estienne D'Orves during the residencies are quite unprecedented in our field of research and provide a first that may trigger other similar artistic projects.

Technically, specific "radiative transfer" studies through the Martian airborne dust were initialized in order to better simulate the color of the Martian sky based on LMD's existing numerical model, but this was later thought to be too ambitious given the time constraints.

A dedicated "ephemerid" program was written at LMD for the artistic project to accurately estimate the exact location of the sun in the sky at a given location on Mars and for a given date and time on the Earth. Interestingly it can be noted that this program has since been re-used for other (scientific) quick calculation at the NASA Insight Lander landing site.

B. Artistic Impact

In *Continuum* the main medium is light, a painter's medium, acting as both the tool and subject. Using light as a tool in an artistic research means being interested in the perception of reality and its limits, pushing back our fields of perception. Our bodies limit us (field of vision) but our gaze and mind can be projected far into space and time. How can we integrate scientific models into our tangible experiences? This was one of the challenges of this achievement with the LMD team, how using art as an interface to make the experience of martian sun tangible, to human scale. No one had asked the question of the progression of the sunset : staging it in time was not necessarily a

scientific need.

The sunset is both a constantly moving beauty and an obvious fact shared by everyone : one has the impression of knowing it by heart. The photos of the Martian sun are like the first images of the Moon's craters by Galileo Galilei, they tilt our minds and our conception of reality.

How do those different theories form our perceptions ? These new territories that emerged with the digital age provide new canvases for artists. There is further relevance in terms of fundamental questions in the Artist's ongoing research and artistic practice in exploring the limits of space depicted by imaging and scientific models.

ART-SCIENCE INTER-RELATIONSHIPS

Félicie d'Estienne d'Orves belong to a generation of transmedia artists that works with different technologies and sciences. Technology is a tool to view teleperceptions and man is augmented by these tools (body and mind). *"There is no reason why one shouldn't look at art through a telescope » as Robert Smithson (american land artist) said in the 70.* We must adapt our systems of representations in art and invent new process of creation with art-science collaboration and become aware of this new territories through tangible, visual and artistic experiences.

The art research constructs models of representation to supplement the observation of more remote ranges, broaden our discernable environment to give meaning to what is closer to us. Put an end to boundaries. Rediscovering the known. Perception functions on the basis of repetition, habit, destabilizing our body, questioning our prejudices, certainties.

Like observing a sunset. To watch the sun setting is to experience a sense of horizon – understand what that skyline really is: a frontier more than a limit. The horizon is endless. The closer you want to get, the further it will move back. To describe it Greek philosopher and astronomer Anaximander (c. 600 BC) forged the concept *apeiron*, 'boundless', 'infinite', 'that which has no limit'. *Apeiron* is the perpetual origin of things, not so much physical boundlessness as mental infinity.

Resuming this idea of boundaries, eliminating boundaries is arguably where artistic and scientific approaches meet.

VI.

FUTURE DIRECTION AND ACTIONS

The *Continuum* project and its development in the *Martian Sun series* has opened up many tracks of artistic production. At this stage the artistic and scientific teams still have the wish to achieve an online version of the project (app, wallpaper, twitter, instagram) that can be distributed to a wide audience and not limited to contemporary art venue. The main idea is to open a « window on Mars », a real-time view of the Martian landscape. But this track underlines the technical limits of our simulator and the implementation requires the reconstruction of a new computer code. We plan to develop features on the simulator to show new landscapes on 10 landmarks site of the planet following the season of the year.

In addition Félicie d'Estienne d'Orves wishes to continue the *Martian sun series*, to rework the rendering of the plaster bas-reliefs and create a more detailed series based on the Mola files and other available resources. Finally, she also envisages other motorized light sculptures and mirrors controlled and programmed according to Martian sites on the basis of the « ephemerid » program developed at the LMD.

VII.

CONCLUSION

A. Concluding Remarks

Experiencing what is real – we perceive the limits of space through light. Mars has been a starting point of scientific research on extraterrestrial life. Studying its environment and atmosphere help us find out whether there could be any traces of existence in extra-solar systems. The *Continuum* project was a great opportunity of art and science collaboration to share philosophical perspectives of this martian horizon and experience it with a wide audience. Collaborating with the French based scientific LMD team was an essential condition and gave strong scientific bases for the development of the project which brings together art institutions, music and sciences. The insights opened up by this collaboration will continue to emerge over time.

APPENDIX

Appendixes, if needed, appear before the acknowledgment.

ACKNOWLEDGMENT

Producers : STARTS residencies, Les Spectacles vivants - Centre Pompidou. With the support of DICRéAM/CNC, Arcadi Île-de-France, Le Fresnoy (Studio national des arts contemporains).

Scientific collaborators : Dr François Forget (former scientific director at LMD Laboratoire de Météorologie Dynamique/CNRS, France), with the participation of Dr Dan McLeese (JPL/Caltech, USA), Dr William Rapin (Caltech, USA), Dr Mark Lemmon (Texas A&M University, USA)

Artistic collaborators : Visual Artist: Félicie d'Estienne d'Orves **Music Composer :** Éliane Radigue **IT developpement :** Guillaume Jacquemin **Assistant :** Martin Saëz **Light designer :**

Remi Godfroy **Spatialisation :** Lionel Marchetti **Executive Production :** Bossa / Olivia Sappey.