WEATHER ON STEROIDS

THE ART OF CLIMATE CHANGE SCIENCE

WEATHER ON STEROIDS: THE ART OF CLIMATE CHANGE SCIENCE

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Curated by Tatiana Sizonenko.

Science Consultant Alexander (Sasha) Gershunov.

Special thanks to media partner KPBS

LA JOLLA HISTORICAL SOCIETY BOARD OF DIRECTORS

EXHIBITION PARTICIPANTS

ARTISTS:

TIERSA COSAERT; Senior Student in Sculpture, School of Arts, CSU San Marcos

JUDIT HERSKO, MFA; Associate Professor, School of Arts, CSU San Marcos

CHERYL E. LEONARD, MA; San Francisco-based composer, performer, and instrument builder

DANA MONTLACK, MFA; an installation and mixed media artist

JEAN ISAACS San Diego Dance Theater

LILLEANE PEEBLES; San Diego-based sculptress, trained by master stone-carver Giovanni Bedini at his Marina Carrara studio, Italy

OSCAR ROMO; Professor, Urban Studies and Planning Program, UC San Diego

MARCELA PAZ LUNA ROSSEL; Chilean-born, San Diego-based multimedia artist

EVA STRUBLE, MFA; Associate Professor of Painting and Printmaking, School of Art and Design, San Diego State University

PAUL TUROUNET, MFA; Professor of Art and Photography, Grossmont College

RUTH WALLEN, MFA; Faculty, MFA program at Goddard College; Lecturer in Photography, UC San Diego

ALLISON WIESE, MFA; Associate Professor and Chair, Department of Art, Architecture, and Art History, University of San Diego

SCIENTISTS:

MICHEL BOUDRIAS, PhD; Associate Professor and Chair, Department of Environmental and Ocean Studies and Chair of the University's Sustainability Task Force, University of San Diego

MICHAEL DETTINGER, PhD; Research Hydrologist for the U.S. Geological Survey's National Research Program; Resident Scientist at the University of Nevada Reno; and Research Associate at Scripps Institution of Oceanography, UC San Diego

ALEXANDER GERSHUNOV, PhD; Research Meteorologist and Senior Lecturer in Climate Sciences; Climate, Atmospheric Science and Physical Oceanography, Scripps Institution of Oceanography, UC San Diego

KRISTEN GUIRGUIS, PhD; Project Scientist, Scripps Institution of Oceanography, UC San Diego

RALPH KEELING, PhD; Program Director of the CO_2 Program, and Professor and Principal Investigator of the Atmospheric Oxygen Research Group at Scripps Institution of Oceanography, UC San Diego.

MANFREDI MANIZZA, PhD; Senior Research Associate, Geosciences Research Division, Scripps Institution of Oceanography, UC San Diego

ART MILLER, PhD; Research Oceanographer and Senior Lecturer in Climate Sciences, Section Head, Oceans and Atmosphere, Scripps Institution of Oceanography, UC San Diego

WALTER MUNK, PhD; Professor of Geophysics at the Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, UC San Diego

DAVID PIERCE, PhD; Climate, Atmospheric Science and Physical Oceanography, Scripps Institution of Oceanography, UC San Diego

RICARD SOMERVILLE, PhD; Distinguished Professor Emeritus and Research Professor; Climate, Atmospheric Science and Physical Oceanography, Scripps Institution of Oceanography, UC San Diego

SHANG-PING XIE, PhD; Professor, Climate, Atmospheric Science and Physical Oceanography, Scripps Institution of Oceanography, UC San Diego

INTRODUCTION

Weather on Steroids: the Art of Climate Change Science explores the question of consequences, challenges, and opportunities that arise from the changing climate on our planet. Science and art emanate from the laboratory and studio, respectively, and this project creates a junction between the two, merging the scientific and artistic to create a visual dialogue about the vexing problem of climate change. It draws on the region's scientific expertise at Scripps Institution of Oceanography, whose La Jolla-based investigators are at the forefront of climate research, reflecting on humanity's role in our changing environment, and envisioning new possibilities for a sustainable future. Science serves as the inspiration for the creative responses from artists, who merge subjective images with empirical observation to reveal how climate trends upset the planet's balance with extreme weather impacts. By illuminating the reality of climate change, *Weather on Steroids* aspires to proactively stimulate public dialogue about one of the most important issues of our time. A topic made more poignant in an era of global and national political fragmentation characterized by post-truth discourse, demographic fracturing, and societal disunity.

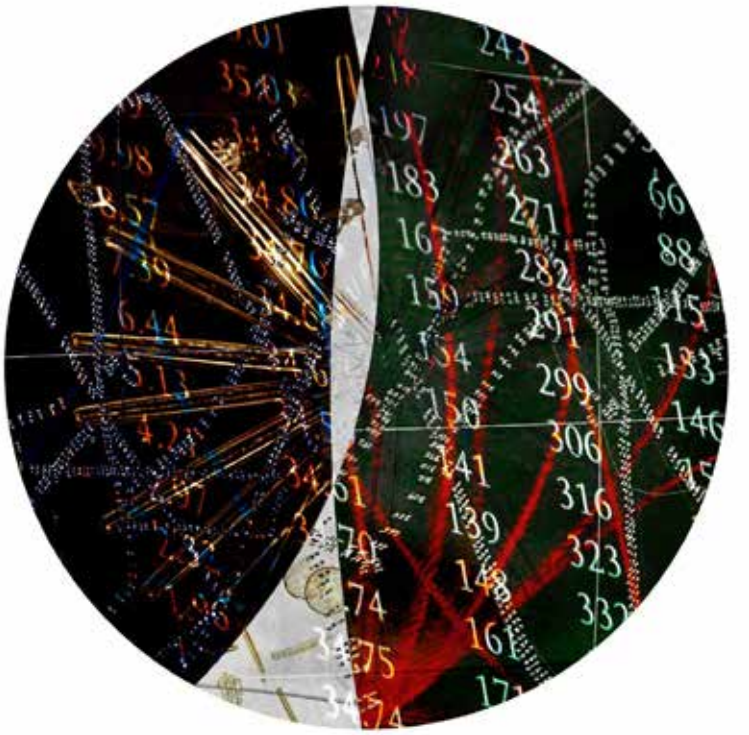
The La Jolla Historical Society Board of Directors and I are extremely grateful to exhibition curator Tatiana Sizonenko, Ph.D., and science consultant Alexander Gershunov, Ph.D. We congratulate and express our deepest appreciation to the artists and scientists who participated in this project. *Weather on Steroids* represents their vision and creativity, and the project benefits greatly from their rich interchange and collaboration. During the course of this project, it has been a great pleasure to work with all of these talented and creative professionals. With thanks also for the contributions of historical research provided by Judith Haxo, Caroline Isaacs, and Deborah Day, and for support of related programs provided by Jeffrey Kirsch, Ph.D. Our sincere appreciation goes to presenting partner Kara West at the San Diego Central Library Gallery, and to program collaborators Jean Isaacs at San Diego Dance Theater, Steve Snyder at Fleet Science Center, and Harry Helling and Cheryl Peach at Birch Aquarium.

I would also like to recognize and express our sincerest thanks to the financial underwriters of this project, whose support made this exhibition and publication possible and is so greatly appreciated. Major support for this exhibition was provided by the Climate Education Partners (CEP) funded by the National Science Foundation (NSF), and by The Ray Thomas Edwards Foundation, Donald G. Yeckel, Chairman. Additional support provided by IS Architecture, the Samuel I. & John Henry Fox Foundation, the Florence Riford Fund of the San Diego Foundation, Walter and Mary Munk, Jeffrey and Joy Kirsch, and ArtWorks San Diego. Institutional support was provided by the City of San Diego Commission for Arts and Culture and the Members of the La Jolla Historical Society.

For this catalog, our thanks to Kelly Johnston Creative Services, who managed design and production, and to Philipp Scholz Rittermann and Nick Agelidis for photography. Thanks also to the La Jolla Historical Society professional staff, Historian Carol Olten, Archivist/Curator Michael Mishler, and Business Assistant William Carey. Our deepest gratitude is extended to the many volunteer docents who work in our galleries and host this exhibition for the public.

My sincerest thanks also to the La Jolla Historical Society Board of Directors for their support, and to the Society's Members, whose patronage is so vital to our programs. It is with great pleasure that the La Jolla Historical Society presents *Weather on Steroids: the Art of Climate Change Science.*

Heath Fox
Executive Director
La Jolla Historical Society



SEEING THROUGH WATER, SEEING THROUGH WEATHER

DANA MONTLACK | 2016

Lambda prints mounted on aluminum

ABOVE:

cc19, oceanic properties of salinity, nutrient, and oxygen data from World Ocean Atlas 2001, diatom, sea star, 50 x 50 inches

OTHER INSTALLATION PRINTS:

ccH2O_5, jellyfish membrane, bathymetric chart, equations used to calculate seawater equilibrium constants

ccH20_6, copepod, equations used to calculate seawater equilibrium constants, tidal shells

ccH2O_8, Keck in Situ Underwater Microscope, bathymetric chart of La Jolla shoreline, lab notes by Alexander Gershunov

ccH2O_16, mermaid purse, ocean eddy kinetic energy model, nautical chart

ccH2O_25, fossilized sea star, salt from the Dead Sea, digital data input, sea slug sperm, Nautilus shell

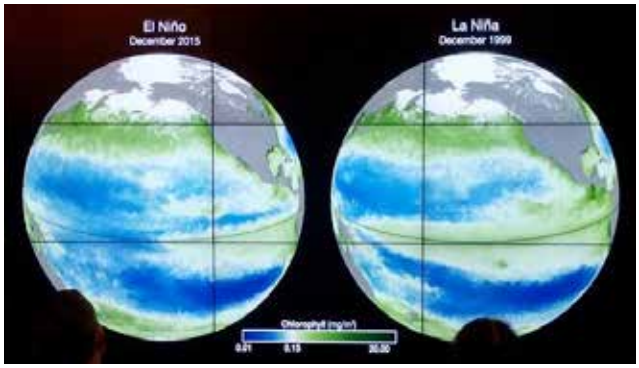
ccH2O_26, equations used to calculate seawater equilibrium constants, light reflection on water, sea-surface chlorophyll levels, bullhead shark egg case

Seeing Through Water, Seeing Through Weather brings attention to the effects of CO_2 buildup on marine ecology and biodiversity. The installation visualizes the research of Manfredi Manizza, Jules Jaffey, and Alexander Gershunov of the Scripps Institution of Oceanography, who investigate changes in marine life and the environment over time. If global warming continues to accelerate at the current rate, many forms of marine life may become extinct due to the permanent modifications in oceanic properties of salinity, nutrients, and oxygen. Images of plankton and microscopic life forms are juxtaposed with bathometric and hydrographic maps, spectrograms, and nautical charts specific to California to suggest that marine biodiversity will be greatly impacted unless global ocean warming and acidification are reversed.

EL NIÑO/LA NIÑA IMPACTS ON THE PHYSICS AND BIOLOGY OF THE PACIFIC OCEAN

Manfredi Manizza

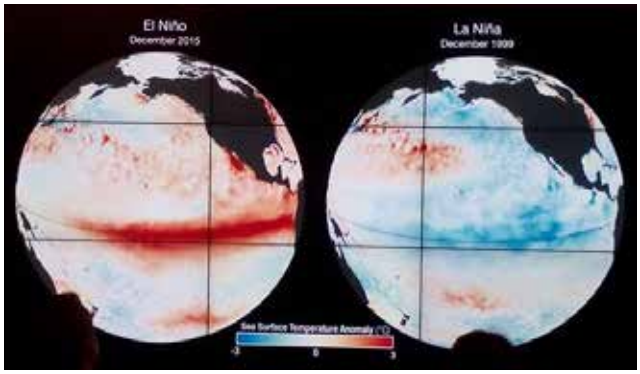
The climatic phenomenon called El Niño-Southern Oscillation (ENSO) has profound consequences for the



physical and biogeochemical processes of the Pacific Ocean. During El Niño (the child boy in Spanish) the central and eastern Equatorial Pacific Ocean shows a clear warming in its upper layers, when the cessation or reversal of trade winds suppresses oceanic upwelling that normally keeps surface waters cool in that region. El Niño also warms the sea surface in large areas of the North Pacific Ocean, notably along the California coast. The suppression of the equatorial ocean upwelling affects biological processes in the Pacific Ocean. The wind-driven vertical transport of nutrients from depth to the surface is in fact vital to supporting the photosynthetic activity of phytoplankton. During El Niño years, when upwelling is suppressed, a dramatic reduction in ocean phytoplankton occurs and can be detected by satellites that measure ocean reflectance anomalies related to the presence of phytoplankton pigments at the ocean surface.

However, when El Niño then recedes after a year or several, the opposite phenomenon, La Niña (the child girl in Spanish), eventually takes over and the climate state of the Pacific Ocean transitions from a warming to a cooling phase characterized by much colder sea surface along the equator and over large areas of the Pacific Ocean. This transition is coincident with a comeback of westward trade winds in the equatorial zone, leading to a restored upwelling regime there. This transition then also impacts the phytoplankton populations in the Equatorial band of the Pacific Ocean, given that the re-activated nutrient-bringing upwelling resulting in the "greening" of these waters. This "oscillation" between the warm and cold phases of ENSO – El Niño and La Niña – drives Pacific Ocean basin-scale variability in temperature and nutrients that make up the bottom link of the food chain, therefore driving great variability in ocean biology, including fisheries. ENSO phases also impact temperature and precipitation over North America and the globe.

The 2015/2016 El Niño was an exceptional phenomenon when compared to most previous El Niño years especially since it is was accompanied by an unprecedented large-scale warming of ocean waters across large areas of the global ocean, including the North Pacific and the California waters from the coast to off-shore. Such extreme warming of California waters in 2015 allowed an unprecedented northwards migration of marine species coming from Mexican waters such as the Wahoo, marine snakes, and Manta Rays, normally



better adapted to live in tropical water conditions. As the global ocean warms, how will ENSO cycles be impacted? This is an area of active research.

Figures. Phytoplankton concentrations derived from satellite. El Niño conditions on the left, La Niña on the right. The bottom figure is the same, but for sea surface temperatures.

CURIOS OF THE FUTURE

TIERSA COSAERT | 2016

Polymer clay, resin, mixed media; glass specimen jars and dome

Endangered cold-water fish: Coho salmon ("Oncorhynchus kisutch"), Bonytail chub ("Gila elegans")
Invading warm-water species: Yellow-bellied sea snake ("Pelamis platura"), Hopkin's Rose nudibranchs ("Okenia rosacea"), Spanish shawl nudibranch ("Flabellina iodinea")

Tiersa Cosaert's research on marine ecology has made her aware of the impact of human-induced warming, chemical waste, trash, and toxic algae on Pacific Ocean ecosystems and habitats. Climate change will affect marine fish populations both directly and indirectly. Direct influences include changes to the physical environment (thermal, chemical, etc.) that may impact physiological functions of fish including survival from larval and juvenal stages to reproductive maturity; indirect effects include alteration in habitats and reorganization of food chains that may induce significant shifts in fish distribution. Many species of native fish in California will likely become extinct within the next century if current trends continue, ceding their habitats to non-native fish. Cold-water fish will move

north in search of nutrients unsupported by warm water, while warm-water species (such as sea-snakes, nudibranchs, and jellyfish) will come to dominate areas of the California coast once foreign to them.

To express these concerns, Cosaert created glass jars with sculptures of different types of endangered species of fish "floating" in resin. The resin makes them appear as if the fishes have been preserved, and their colors are muted to reflect this. The glass dome holds a small collection of species that seem to be reacting more positively to the warm ocean waters and acidification. Their brighter colors signal their liveliness and positive adaptation to the changing environment.

Inspired by embalming jars of the early modern Dutch botanist and anatomist Frederik Ruysch and by the research of Ralph Keeling from the Geosciences Research Division at Scripps Institution of Oceanography, Cosaert's *curios* resemble specimens from antique cabinets of curiosity and represent endangered species common to California. The installation reminds observers about the irreversible impact of climate change. Cosaert warns us what the Pacific may look like when cold-water species are gone and warm-water species continue to breed despite a limited food supply. Will the cold-water species become the curios of 2050?

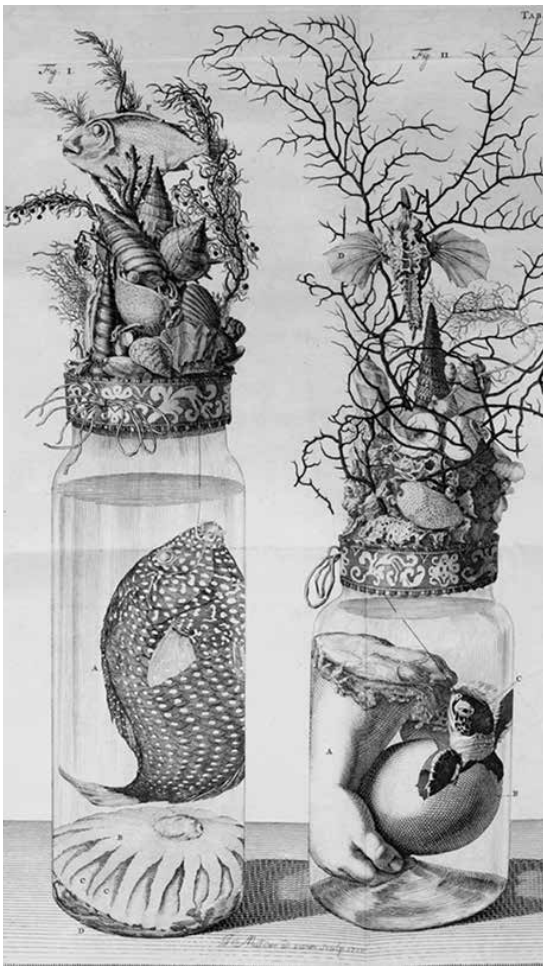


Image: Frederik Ruysch Embalming Jars

CHANGING STORMS ERODE LA JOLLA BEACHES

Shang-Ping Xie

A super El Niño took place in the winter of 2015-16. While it failed to deliver Godzilla rain storms to Southern California, the tropical Pacific warming intensified North Pacific storms and steered them towards California. Large swells from these storms caused the La Jolla beach to drop by a whopping 10 feet in the winter, exposing deeply buried rocks. Energetic waves lift and carry beach sand offshore. Thus La Jolla beaches respond to El Niño, with Rock Nino as the barometer.

The latest research at Scripps showed that global warming is likely to intensify the El Niño effect on Pacific storms and displace them east towards California. The chances for California to get more rainfall during El Niño will be higher, so will be the chances of flooding during future El Niños. The bad news is that the intensified storms will generate bigger waves that erode our beaches, although bigger waves may be good news for surfers. These changes will be visible in more frequent exposure of Rock Nino by Scripps Pier.

While the rise of global mean temperature has been the poster child of climate change, the more consequential change is in rainfall. Southern California depends on diverted water through complex water transfer systems from the northern state and Colorado River. China is following California's example by building similar water projects, only at a grander scale. How will the great monsoons of Asia change? Where will rainfall increase, and where will it decrease? These are the pressing questions confronting climate science.

400 PARTS PER MILLION

JUDIT HERSKO | 2016

Anna Schwartz: Self-Portrait with Diatoms

Aluminum and glass

The glass and metal elements contain the floating presence of unknown explorer Anna Schwartz. Created with mirror paint on glass, as well as shadows cast inside the aluminum box, this evocative portrait is set in the Antarctic ice with diatoms (microorganisms that sequester carbon in the oceans) magnified around the figure of Anna.

The Magdalen (after Georges de la Tour)

Antarctic earth and acrylic glue

Inspired by Georges de la Tour's painting "The Magdalen with the Smoking Flame" (France, circa 1638-1640), this sculpture of a pregnant woman is cast with earth that Judit Hersko obtained on her visit to Antarctica as a Fellow with the National Science Foundation Antarctic Artists and Writers Grant (2008/09).

400 Parts Per Million

Glass beads, glass orb, glue, and acrylic

This signature piece of the installation is made from one million clear glass beads and 400 lightly colored glass beads. It represents *400 Parts Per Million*, or the measure of atmospheric carbon dioxide that we recently surpassed. It consist of an acrylic shelf that holds one million glass beads, some of which are loose and some of which are cast into sculptural forms. On the shelf sits the pregnant female figure, based on Georges de la Tour's painting of Magdalen. She is gazing at a glass orb, one of the actual beakers used by scientists to collect air samples at the Mauna Loa observatory in Hawaii, where CO_2 air measurements have taken place since 1958. A tiny pile of 400 beads, which are slightly different from the rest, is placed between the figure and the beaker to remind us that we have recently surpassed 400 parts CO_2 per million air particles in the atmosphere.

Portrait of Anna Schwartz

Silicone

Cast in silicone, this portrait of Anna Schwartz includes imprints of sculptures in the shape of the planktonic snail *Limacina helicina*, or sea butterfly. Already, under present conditions, this pelagic snail cannot form its shell in some parts of the oceans due to chemical changes caused by

increased CO_2 uptake. The snail sculptures were removed during casting to suggest a fossil record of a soon-to-be extinct creature.

400 Parts Per Million is a multi-object installation that alerts the viewer about climate change and ocean acidification caused by the relentless rise in atmospheric CO_2 that has recently reached a dangerous global benchmark. It builds on Hersko's collaboration with Dr. Ralph Keeling, who is at the forefront of studying air-sea gas exchange and the carbon cycle. His father, Charles David Keeling, was the scientist whose measurements of carbon dioxide (CO_2) in the air first brought awareness to human contributions to the greenhouse effect.

The signature piece of Hersko's installation, *400 Parts Per Million*, reflects on the milestone we have surpassed in 2016 when CO_2 levels reached 400 parts per million air particles. Scientists have warned us that this milestone makes our climate increasingly volatile and decreases the likelihood of returning to acceptable levels (around 350 ppm) during our lifetimes. The figure of Mary Magdalen appearing in this piece stands for the contemplative tradition of regretful self-reflection and draws attention to human responsibility regarding climate change. This figure is repeated in the installation, but this time cast not from glass beads but from Antarctic earth. Held together by acrylic glue in a hollow cast of the Magdalen figure, this representation of humanity could seemingly crumble at any moment, suggesting the fragility and impermanence of our lives in a world ruined by environmental catastrophe.

The current exhibition also continues Hersko's interest in the history of Antarctic exploration and science as it relates to current ecological issues. The *Portrait of Anna Schwartz*, cast in silicone, is part of a narrative Hersko has been developing since 2009. She inserts into real historical events a fictitious woman explorer, Anna Schwartz, a photographer and scientist whose interest in Antarctica concerns two planktonic snails, the *Limacina helicina* (sea butterfly) and the *Clione antarctica* (sea angel). These organisms, studied by Hersko's first scientist collaborator, biological oceanographer Dr. Victoria Fabry, function as canaries in the coalmine when it comes to ocean acidification. Due to absorption of rising atmospheric CO_2, the oceans are acidifying rapidly (at least on a geological time scale) and are becoming much less hospitable to many forms of marine life. Ocean species such as fish, coral, echinoderms, mollusks, and crustaceans will have a difficult time adapting to rising acidity levels, and thus the biodiversity and health of marine ecosystems will be adversely impacted unless ocean acidification is slowed and reversed.

For this exhibition, Hersko has opened a new chapter in the narrative based on the history of the Scripps Institution of Oceanography, thus bringing it home to the California coast. *Anna Schwartz: Self-Portrait with Diatoms* is an aluminum box frame with a glass front bearing a stenciled portrait of the unknown explorer, which is collaged into the Antarctic landscape together with magnified images of diatoms. Created by mirror paint, the subtle images on the glass are only visible from certain angles but they form shadows within the aluminum box.

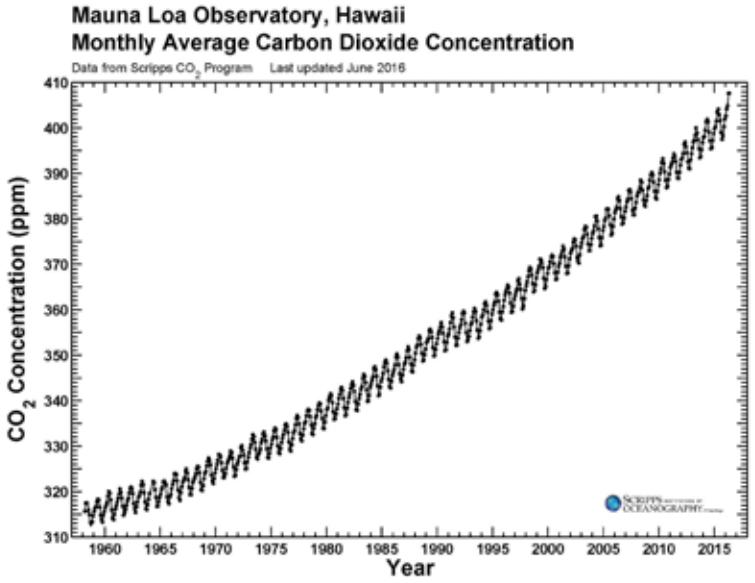
In Hersko's narrative, the aluminum box was a gift from Anna Schwartz to Easter E. Cupp, completed after Anna's return from Antarctica in 1940. Thus, this part of the exhibit highlights the life of Easter E. Cupp, the first woman to receive a PhD in Oceanography in the US (SIO 1934). Dr. Cupp's research focused on diatoms, single-celled organisms that sequester CO_2 by binding carbon atoms and then sinking to the bottom of the ocean. Hence by their own death, they have helped form over millennia the carbon-based fossil fuels that humanity is burning through in mere centuries. As a PhD student at SIO, Cupp studied the diatoms of the California coast and wrote the seminal book on diatoms of this region. However, this did not secure her a career in science. Unlike her male colleagues who could stay and work at SIO for the rest of their careers, Dr. Cupp was told that her work did not fit in and spent the rest of her professional life as a school teacher.

Utilizing storytelling, sculptural forms, and diatoms as a subject, medium, and artistic metaphor, *400 Parts Per Million* compares the invisible labor of women to that of microorganisms and elucidates the impact of climate change on Earth. Undercutting the dominant heroic narratives in the history of art and science, this work emphasizes the largely unrecognized explorations of women like Easter E. Cupp.

THE KEELING CURVE AND CARBON DIOXIDE BUILDUP

Ralph Keeling

The iconic "Keeling curve" is the continuous record of carbon dioxide concentrations in the atmosphere at Mauna Loa, Hawaii. Named after Charles D. Keeling of the Scripps Institution of Oceanography, who initiated the measurements in 1958, this saw-tooth shaped curve documents a relentless rise in CO_2 from 315 ppm in 1958 and to above 400 ppm today. This rise is caused by the buildup of excess CO_2 from the burning of fossil fuels globally. The saw-tooth pattern is caused by "breathing" of forests and other ecosystems, as part of their cycle of life. Forests take up CO_2 by photosynthesis mainly in the summer, when it is warm and sunny, and release CO_2 due to respiration at other times of the year. These changes in CO_2 are spread across the globe by the circulation of the winds. The record is a reminder that the world is finite, and we humans are changing it profoundly.



What we know about the CO_2 buildup:

1. Roughly half the CO_2 emitted from fossil-fuel burning has stayed in the atmosphere. The other half has been absorbed by the oceans and land ecosystems.
2. CO_2 will continue to build up unless large cuts in fossil-fuel burning are achieved globally.
3. The CO_2 buildup has direct consequences for our climate via the "greenhouse effect".
4. The CO_2 buildup also has direct consequences for land and marine ecosystems via impacts on photosynthesis ("CO_2 fertilization") and shell formation ("ocean acidification").

WHAT'S NEXT?

CREATIVITY VERSUS CATASTROPHE IN THE AGE OF CLIMATE CHANGE

By Tatiana Sizonenko

"Painting comprehends in itself all the forms of nature, while you [poets] have nothing but words, which are not universal as form is, and if you have the effects of the representation, we have the representation of the effects.... If poetry can terrify people by hideous fictions, painting can do as much by depicting the same things in action.... Supposing that a poet applies himself to represent beauty, ferocity, or a base, a foul or a monstrous thing, as against a painter, he may in his ways bring forth a variety of forms; but will the painter not satisfy more? Undoubtedly painting being by a long way the more intelligible and beautiful, will please most."

Leonardo da Vinci[1]

"The difference between art and science is that science is what we understand well enough to explain to a computer. Art is everything else."

Donald Knuth,
American computer scientist and mathematician

The subject of the weather has long shaped the content of casual conversation and everyday polite exchange, in America and globally. However, in recent decades, unseasonable and extreme fluctuations of weather that betray familiar expectations of climate, including drought and deluge, scourging heat and severe tempests, have increasingly become of greater concern and been frequently characterized as 'environmental and climate crisis.' Rapidly changing regional climates and weather conditions experienced in an individual human lifetime have been linked to climate change. Associated with global warming and supported by more and more research, climate change increases our uncertainties about the future and requires us to contemplate alarming scenarios. Scientists and science fiction writers have even suggested the extremes of, respectively, the extinction of humanity on Earth and our forced exile in space. Almost-unceasing drought and rising temperatures in California over the last decade have triggered chain reactions in ecosystems. For example, the bark beetle, thriving in drought driven partly by warming, has caused the death of tens of millions of pines in California's Sierra Nevada.[2] Should we hold climate change accountable for this unprecedented die-off? Attributing such extreme environmental changes to climate change is not that simple, in the public or the academic arena. *Weather on Steroids: The Art of Climate Change Science* takes the omnipresent subject of climate change as the basis for exploring ideas about its consequences, challenges, and opportunities as they can be seen in the day-to-day life of local communities in San Diego and Southern California.

Observations of climate appeared in the Ancient World, including in the writings of Greek philosophers, historians, and physicians like Hippocrates of Cos.[3] Representations of geography and weather conditions in art, however, can be securely traced only to the Renaissance and particularly the work of Leonardo da Vinci.[4] When Leonardo wrote his 15th-century treatise on painting, not only stating that the art form was superior to literature in its presentation of facts but also reformulating it as a science grounded in geometry and direct observation of nature, he could not foresee that his ideas would profoundly contribute to humanistic theory, not only of painting but of the visual arts overall, in a way that the preceding centuries had never done. For Leonardo and many latter-day European philosophers and artists, visual arts had the pivotal capacity not only to record and imitate physical geography and the natural vagaries of climate but also to fundamentally affect humanity and bring positive transformation to the world through a concerted, unified effort of like minds. Much later, the influential 20th-century artist Jean Dubuffet unequivocally declared the superiority of visual signs over words when he wrote: "Painting is.... a richer language than words.... Painting operates through signs which are not abstract and incorporeal like words. The signs of painting are much closer to the objects themselves." Relying on the elusive power of visual arts to inspire, motivate, and educate audiences in an immediate way, the premise of this exhibition is to engage visual artists to reflect both viscerally and intellectually on the reality of climate change and offer a visual jolt to conventional concepts.

Central to *Weather on Steroids: The Art of Climate Change Science* is the concept of anthropogenic climate change, or the 'geological agency' of the human race. In his influential essay "The Climate of History: Four Theses," Dipesh Chakrabarty (2009) defines geological agency as the capacity of humans to drive global environmental change and affect on a planetary scale an array of processes and features of the biophysical environment.[5] Chakrabarty's definition of climate change constitutes the fundamental basis for proclaiming the Anthropocene, a new epoch of Earth history or the era of the mutual agency of man and nature. A number of influential philosophers, historians, geographers, and scientists, including Bruno Latour, Clive Hamilton, Frans Berkhout, Andreas Malm, Alf Hornborg, and Will Steffen, insist that human agency has left a greatly increased imprint on the global environment since World War II, and at an accelerating rate.[6] The notion of the Anthropocene alters previous accounts of human history that placed a great emphasis on the environment and nature as dominating historical agents. For instance, in the work of Fernand Braudel (d.1985), a celebrated forefather of environmental history, geography and physical environment determine the long-term course of events that play a critical role in human history by constraining actions on, and by, people over *la longue dureé*, a duration long enough that they are beyond the consciousness of the actors involved.[7] However, Braudel's revolutionary view of the enduring relationship between humans and the environment first developed during World War II and has been increasingly challenged in the past few decades by the postmodern environmental question of our ability to degrade or even destroy the natural world over the span of a single human lifetime.[8]

Although human ability to induce climate change remains for some a matter of disbelief, with doubts particularly being encouraged by fossil-fuel proponents, the existing scientific literature makes it clear that the effect of humans on the Earth is occurring and accelerating. Empirical observations of the consequences of devastating human actions and environmental criticism began in the 19th century. Notably, H. G. Wells' writings in the 20th century represent the emergence of an ecological sensitivity in the age of modernity. In *The Outline of History* (1921), the celebrated sociologist and science-fiction novelist reflected presciently on the consequences of agriculture and civilization: "Finally with the appearance of human communities came what is perhaps the most powerful of all living influence upon climate. By fire and plough and axe man alters his world." [9]

Wells drew attention to the desertification resulting from modern agricultural practices, singling out forest destruction in the North Eastern United States.[10] Though his faith in science led him to speculate on the technological control of climate, he believed that the future of our civilization would be, in his words, a race between education and catastrophe. Undoubtedly, accounts of the processes of environmental change, brought on by an intensified interaction of human and natural factors, have inspired a multitude of responses in literature and film that imagine the deadly consequences of humanity's increased tampering with the natural environment launched in the modern age.

Weather on Steroids: The Art of Climate Change Science results from recognizing that our conception of nature and climate has dramatically changed since the turn of the new millennium. The natural sciences that were previously considered solid and enduring have taken on increasingly soft and open positions to produce a unique portrait of a dynamic universe, where the observer takes a more prominent role than before in shaping what is observed.[11] According to the new episteme, natural systems and the climate are also seen as self-organizing, through the constant interaction between living organisms and the environment, and the consequences of these interactions remain open rather than deterministic and might ultimately lead to collapse and to the Darwinian emergence of the most resilient forms of organization: the survival of the fittest and the simplest forms of life.[12] By employing climate change as a vital metaphor, this exhibition seeks to further investigate the interactions between social and natural systems and the consequences for these interactions for both parties over time.

The main principle of *Weather on Steroids: The Art of Climate Change Science* is to partner artistic and scientific communities to create a visual dialogue about the vexing problem of climate change. The idea was to give artists access to scientists working in the field they hoped to address. A view of nature in permanent motion and transformation suggests that there is more to explore than the discourse of greenhouse gases, eco-friendliness, resilience, or adaptation. Rather than dealing with climate change on a global scale, many of the

artists decided to bring it home and focus on the vulnerability of San Diego and Southern California to climate variability by engaging the region's scientific expertise at Scripps Institution of Oceanography at UC San Diego, one of the oldest, largest, and most important centers in the world for ocean, earth, and atmospheric science research.

In the spring of 2015, we issued an open call for artists willing to enter into dialogue with scientists to understand and explain the gigantic problem of climate change and visually explore concepts and issues that are often misunderstood by the public. Each artist has responded to a wide range of coming changes: melting ice; sea-level rise and coastal erosion; extreme weather patterns (high winds, heat waves, cold spells, and extreme rainfall); droughts and wildfires; environmental and human patterns of climate change; species adaptation; and the ecological, social, and political implications of climate change. Eleven artists—Tiersa Cosaert, Judit Hersko, Cheryl E. Leonard, Dana Montlack, Lilleane Peebles, Oscar Romo, M. Luna Rossel, Eva Struble, Paul Turounet, Ruth Wallen, and Allison Wiese— have collaborated with eleven scientists—Michel Boudrias, Michael Dettinger, Alexander Gershunov, Kristen Guirguis, Ralph Keeling, Manfredi Manizza, Art Miller, Walter Munk, David Pierce, Richard Somerville, and Shang-Ping Xie—to investigate the stakes of climate change in art and represent their versions of the delayed effects of environmental disasters that are steadily encroaching but still appear far-off in time and distance. Though artistic responses to global warming have increased in the past decade, exhibitions that combine in equal measure scientific knowledge and the intuitive and visceral language of art remain rare. The vision for this exhibition is to bring together works that are beautiful, accessible, and thought-provoking, not to be dismissed as merely art, agitprop, or science. Stimulating visual objects, comprising both artworks and non-art whose curiousness has the power to render evocatively the world's complex ideas, can incite a quest for understanding, as Leonardo and the Renaissance humanists would have aspired to, and thus open our eyes to what must be done in order to mitigate and adapt to the problem of climate change.

400 Parts Per Million by Hungarian-American artist Judit Hersko touches on the core issues of climate change and illuminates the irreversible presence of the Anthropocene age by warning us of what may come next. Hersko's aesthetically rich and provocative art installation concerns a recent benchmark in the increase of carbon dioxide levels globally. The relentless rise in atmospheric CO_2 is an ominous sign; it is a clear indicator of the impact of fossil-fuel emissions that endangers the environment on our planet globally and presses the world to act. Hersko, who has been working with scientists for years, utilizes artwork, projected scenes, and the genre of "performative lecture" to translate scientific knowledge through visual metaphors into something we can comprehend. Her current work elucidates and compares the invisible labor of both women and microorganisms such as diatoms that have been instrumental for recording the rising levels of carbon dioxide. Diatoms, which proved to be incredibly useful for climate studies, were featured in the work of Easter E. Cupp, the first woman to receive a PhD in oceanography at Scripps in 1934. Utilizing diatoms as a subject, medium, and an artistic metaphor, Hersko's installation and lecture-performance emphasize the agency of women in reversing the consequences of apocalyptic climate change, and as a result counter the dominating male narratives of the Heroic Age.

Another lesson to take away from the exhibition is a message about the endangered condition of the planet's oceans. Global warming of the oceans and their acidification from increased carbon dioxide emissions is subtle and troubling; the scope of the issue and its consequences are not yet fully understood and the role of oceans in climate remains largely overlooked. Climate discussions have mostly focused on the growing amount of carbon dioxide and the impact of greenhouse gases on atmospheric conditions. The impact of climate change on the oceans more often addresses the issue of sea-level rise and its consequences for coastline communities, yet the effects of CO_2 buildup on marine ecology and biodiversity could potentially destroy most marine life. Protecting our oceans from devastating climatic effects requires more extensive oceanographic research and far greater attention from lawmakers. The work of Dana Montlack and Tiersa Cosaert calls attention to changes that are nearly imperceptible and often happening on microscopic levels, largely going unnoticed until life forms become nearly extinct.

Working with micro lenses, Montlack captures the fragility and beauty of aquatic life. Fusing and layering images of

plankton and microscopic life forms, nautical charts, graphs, data sets, spectrograms, and timelines of environmental effects local to California, Montlack's *Seeing Through Water, Seeing Through Weather* investigates the role of the ocean in the carbon cycle and visualizes changes in marine life and the environment over time. Her richly hued photographic collages serve as a time capsule of marine life at a specific moment, which both gives them value as a microscopic record of life forms that will likely become extinct in the near future and aesthetically activates a melancholy for the loss that will happen unless a radical intervention by human agents stops the detrimental rise of carbon dioxide levels. On the other hand, Cosaert's *Curios of the Future* brings further attention to the issue of endangered marine species in California as a consequence not only of the overproduction of carbon emissions by the fossil-fuel industry but also by our own individual use of cars, planes, appliances, toxic chemicals, and plastics. Cosaert's sculptural pieces, made to resemble specimen jars or *curios*, "rare, unusual, or intriguing objects," from early modern cabinets of curiosities, encapsulate in resin her representations of endangered cold-water fish species whose habitat has been drastically affected by an unprecedented large-scale warming of the oceans. Her work reflects directly on a record northward migration of marine species and questions whether cold-water species might become the *curios* of 2050.

Extreme sea level rise, high tides, and storm surges that increasingly lead to coastal erosion, property, infrastructure, and wetland damage are a major source of anxiety globally and locally in California. As global warming accelerates, water flowing from melting ice sheets and glaciers will further expand oceans, which in turn will erode shorelines and cause the flooding of coastal communities. The San Francisco composer, performer, and instrument builder Cheryl Leonard examines the impact of these events on the San Diego region through the medium of a multi-disciplinary art installation combining sonic and visual elements. Interactive musical instruments, assembled out of natural materials from San Diego beaches and accompanied by field recordings from coastal sites at risk from high seas, reveal a probable convergence of winter storms, high tides, and long-term El Niño-Southern Oscillation cycles. Leonard's *Confluences* is a cautionary tale about the destructive power of the sea along the coast of California. Using subtle textures and intricacies of sound, the artist creates unforgettable soundscapes embodying the complexity of local tidal patterns.

Through the medium of dance, critically acclaimed San Diego choreographer Jean Isaacs addresses the vexing problem of warming oceans. On April 15, 2017, ten dancers from the award-winning San Diego Dance Theater company will present *Requiem for an Ocean*, choreography by Jean Isaacs, with original music by San Diego Dance Theater composer Steve Baker, and *Ice Maiden*, featuring Swiss Artist Anna Katarina Scheidegger. Both dance performances movingly explore our disquiet in the face of rising sea levels and melting glaciers. The choreography dramatizes plausible futures within the context of a public indifference to such obvious threats. Isaacs choreography helps us visualize and experience the potentially apocalyptic outcomes of global warming. Despite the innumerable effects of changing weather manifested in our everyday lives, climate change still remains largely an abstraction. Dance performances of *Requiem for an Ocean* and *Ice Maiden* will convey a first-hand experience like no other medium in the exhibition, bringing events already happening in distant places closer to the audience in San Diego.

Using the medium of mosaic, Marcela Paz Luna Rossel, a Chilean-American artist, explores violent weather phenomena like floods, torrential rains, wildfires, hurricanes, tornadoes, record heat, and extreme climatic events. Understanding how weather extremes will affect our planet and life on Earth is one of the challenging tasks of climate studies. Employing a female silhouette as an archetypal human being and the embodiment of Gaia, Luna poetically visualizes nurturing and destructive forces of Mother Earth. The triptych, *Dust, Dissolution, Ablaze*, exposes fast approaching future catastrophic conditions—overheating of continental landmasses and flooding of coastal zones. Assembling mosaics from a variety of found local materials, such as sand, dirt, pebbles, animal bones, seeds, wood pieces, and sea glass, Luna creates highly evocative pieces. She uses materials as primordial elements to viscerally remind us both about the danger of expanding warming oceans, which can lead to a deluge of near-Biblical magnitude for some islands atolls, as they disappear out of existence, and a condition of rising temperatures and sparse precipitation that can transform verdant meadows into severely parched lands.

Classically-trained sculptress Lilleane Peebles powerfully visualizes the Anthropocene Age with *Tipping Point Climate Change*. A small human figure made of wire tries to tip the globe made of an exquisite piece of blue gray marble quarried in Carrara. The natural white cloudiness of the stone creates the effects of the atmosphere. Landmasses of the continents are carved below the level of surrounding oceans and reflect the threat of flooding. Transparent resin, applied to the surface of the globe throughout, helps to visualize heavy rainstorms from *atmospheric rivers*, which hit the coast of California in winter and will intensify in the near future. Peebles' work offers a new reading of storms, flooding, and climate change through the classical medium of carving. The human figure is represented stepping on a book, showing a lack of respect for our planet and for knowledge. *Tipping Point* helps us realize that greed will lead us to catastrophe if science and art do not intervene.

The work of Oscar Romo, a professor in the urban studies and planning program at UC San Diego and an inventor of natural system design projects around the world, further explores the concept of *Atmospheric Rivers*, narrow regions in the atmosphere that are responsible for most of the horizontal transport of water vapor outside of the tropics. They typically generate strong winds and extreme rainfall, filling our reservoirs but also causing intense floods. The community of flood control, water supply, and reservoir operators of the West Coast states see atmospheric rivers as a key phenomenon to understand, monitor and predict as they work on mitigating the risks of major flood events while maintaining adequate water supply. Their frequency and strength over the course of a typical West Coast wet season greatly influence water resources, the course of droughts and floods, and key human endeavors and ecosystems. Romo's installation is made out of repurposed materials and symbolizes Nature's power of wind and moisture. The installation pieces comprise kinetic and stationery parts that manifest dynamic masculine and latent feminine energies that together represent the creative and destructive potential of atmospheric rivers that we are hoping to harness or contain.

Site-specific research and scientific data informs the works in this exhibition. Paul Turounet and Ruth Wallen rely on the photographic medium for objectivity to document an increasingly desiccated landscape in the areas surrounding San Diego. Turounet, known for his ongoing photographic investigations of the American social landscape and for capturing moments in passing along the American road, has recently turned his camera to National Parks in the venerable Southwest that have been profoundly affected by rising temperatures and decreased moisture. A photographic series, *Magic Circle*, explores the environmental future of the Mojave Desert. Recent scientific studies suggest that the local Joshua trees can no longer keep pace with the rate of warming. Some predictions suggest that the trees will not be able to grow and reproduce in barren soils and hot conditions. Joshua Tree National Park will likely experience a huge reduction in the number of its namesake specimen, leading to a loss of up to 90%. Through the techniques of fading and high contrast, Touronet's photographs document artistically the tremendous stress of the physical environment and inform us about deterioration, damage, and loss as a direct result of increasing heat from rising CO_2 emissions and growing vehicular smog.

Ruth Wallen, a multimedia artist who has been making photomontages about the impact of climate change on our local environment in San Diego County, addresses the heartbreaking loss of forests and the threatened habitats of endangered species caused by global warming and a lack of water. Her installation *Listen to the Trees*, comprising large photomontages and interactive screens, depicts two versions of the future for the Laguna Mountains and Torrey Pines State Park, one representing a low and the other a high greenhouse emission scenario. The installation maps out the projected events in the form of a short narrative and images. Additionally, large-scale wall photomontages constructed of images collected over a period of time reflect on these changing and disappearing natural habitats. Her photographic images, comprising both healthy and dying trees, are an eloquent plea directed at us, whose future choices will make the difference to the fate of the region's environment.

Works of Eva Struble and Allison Wiese use similar artistic strategies to advertise the message of climate change and its dramatic consequences for specific landscape sites, agriculture, and urban lifestyles in Southern California. Trained as a painter, Eva Struble's work has previously included a series of paintings relating to labor, immigration, and agriculture in

San Diego's North County, as well as a short illustrated book of stories from farm workers and day laborers. Her series of screen-printed *Future Souvenirs*, made in the style of antique flags that were once popularly sold to tourists in cities and historical sites across the U.S., details future effects on agricultural landscape in Southern California caused by heat waves, temperature level rise, and drought. Images include popular California crops—apricots, almonds, artichokes, figs, kiwis, olives, walnuts, and wine grapes—that will not tolerate further warming. Mounted throughout the gallery and on a metal circular display rack similar to those used in souvenir shops, the flags will specifically touch upon tourism, important to a city economically reliant on a source of income that will inevitably suffer from the consequences of climate change.

Allison Wiese's *For You For All* uses a technical and formal vocabulary of lush colors and stylized scenery familiar from the silkscreened Works Progress Administration posters of the mid-20th century to depict a San Diego coastal landscape affected by wildfires. The posters work together to start conversations about how our changing climate will impact our lives and those of our children and grandchildren, and what we might do to help mitigate the damage to our environment. Exploiting the ability—and portability—of art objects to deliver the right message, the project extends beyond the La Jolla Historical Society's Wisteria Cottage to shops and businesses in La Jolla during the run of the exhibition. As the exhibition's contents move outside the gallery, the posters solicit conversations in the community by playfully mirroring the work of Climate Education Partners, a collaboration of professors, scientists, researchers, educators, and communications professionals that provides locally relevant climate science so regional leaders can make informed decisions about San Diego's future. Emphasizing the role of social influence, *For You For All* contemplates the possibility of creating an effective community and aims to break an awkward silence about climate change. Wiese, who is known for installations that produce poetry out of common things by repurposing and repositioning materials to make new meanings, welcomes a dialogue about our future.

Conceived equally as education, public service, and community organizing platform, *Weather on Steroids: The Art of Climate Change Science* poses questions about the artist's role in society: what art can do and what all of us—artists, scientists, and the public included—could do in response to the challenges of our day and age. By illuminating the reality of climate change affecting Southern California's landscape and lifestyles, the exhibition produces a collaboration for the benefit of cross-cultural and public education appealing to a wide audience of all ages.

(Endnotes)

*I would like to express my sincere gratitude to Alexander Gershunov and Heath Fox for inspiring conversations and timely feedback throughout this project. Special thanks to Gareth Davies-Morris for advice and encouragement.

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11 William McNeill, "Passing Strange: The Convergence of Evolutionary Science with Scientific History," *History and Theory*, Vol. 40, No 1 (2001), 1-15.

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CONFLUENCES

CHERYL LEONARD | 2016

Physical installation: glass, wood, sand, dried kelp, string, fabric, contact microphones, headphones, ipod, mixing board
Music composition: field recordings of locations on San Diego's coast; sounds produced with sand, water, stones, shells, driftwood, and seaweed

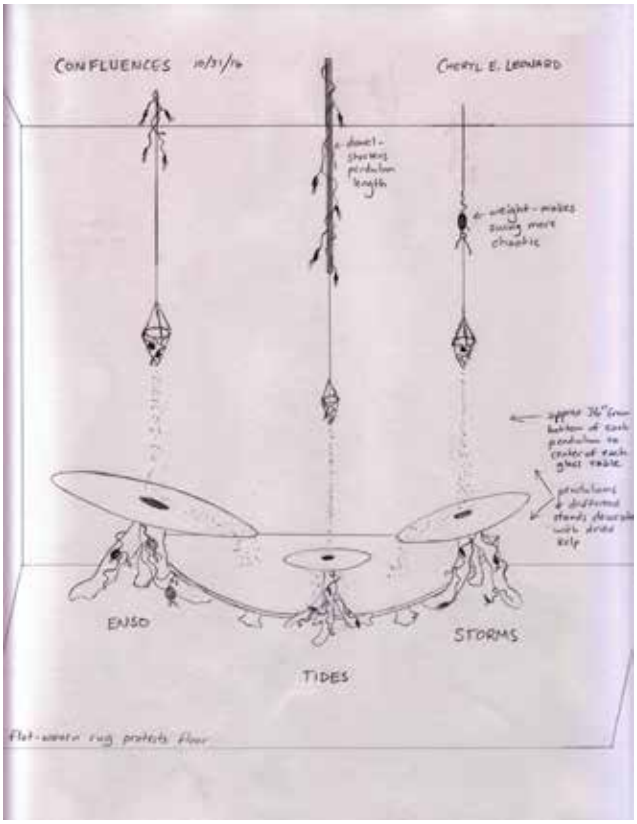
Confluences is a multi-disciplinary art installation that combines sonic and visual elements to investigate the impact of extreme sea-level events in the San Diego region caused by climate change. High tides, winter storms, and long-term El Niño-Southern Oscillation cycles can converge to produce destructive high seas along the coast of California. The effects of these convergences will be exacerbated by climate change-induced sea-level rise. Leonard's installation considers these causal factors and visualizes the increase in number and intensity of extreme sea level events as the 21st century progresses. Her piece also references local impacts of extreme sea levels such as erosion of shorelines, loss of sandy beaches and wetlands, flooding of neighborhoods, and damage to man-made structures.

Confluences is comprised of a background sound composition and a set of interactive sculptural musical instruments. Leonard's background composition is developed from audio field recordings of sites in San Diego that are

likely to be affected by high seas, including neighborhoods, beaches, intertidal zones, and wetlands. Sounds from amplified natural materials and objects (such as stones, shells, kelp, water, driftwood, sand, etc.) are layered together with the field recordings to create a cyclical yet ever-transforming aural environment.

Confluences' sculptural musical instruments abstractly embody tidal patterns, winter storms, phases of the El Niño-Southern Oscillation, and gradual sea-level rise through the use of sand, pendulums, and resonant glass and wood surfaces. Three round glass tabletops are mounted on stands crafted out of driftwood and embellished with dried kelp. The tabletops are positioned in a semi-circle above a low wood platform. The platform is a half-circle and tilts towards the viewer. All three glass tabletops tilt towards the center of the wood platform. A contact microphone is attached to the bottom surface of the platform and one to the bottom of each tabletop. A small funnel-shaped vessel, festooned with curved pieces of dried kelp, is suspended on a string above each glass tabletop, forming three pendulums. Gallery visitors are invited to add to the background soundscape by pouring sand into the hanging vessels and then setting the pendulums in motion. As sand falls onto the amplified glass surfaces, motions and patterns are given voice. Sand hits the glass tables initially and then, due to the tilt of the glass, slides down onto the wood platform, producing additional sounds. Over time sand build-up on the platform will transform its musical timbre. The size of each glass tabletop roughly correlates to the time scale (interannual, seasonal, monthly, daily, etc.) of the process it represents. The largest piece of glass corresponds to the El Niño-Southern Oscillation, the medium-sized one to winter storms, and the smallest to tides. The pitch of each glass surface reflects the amount of sea-level rise contributed by its process, with higher pitches indicating greater increases. The volume capacity of each pendulum vessel relates to the duration of each process (years, months, days, hours). Additionally, weights and magnets are incorporated into the design of the three pendulums to cause each one to swing in a unique pattern. Gradual sea-level rise is represented by both the background composition and build-up of sand on the wooden platform. Located on each side of the tabletops/platform are: a large container that holds sand for people to add to the pendulums, one or two ladles for the sand, a podium for headphones and other sound equipment, and furniture for visitors to sit on.

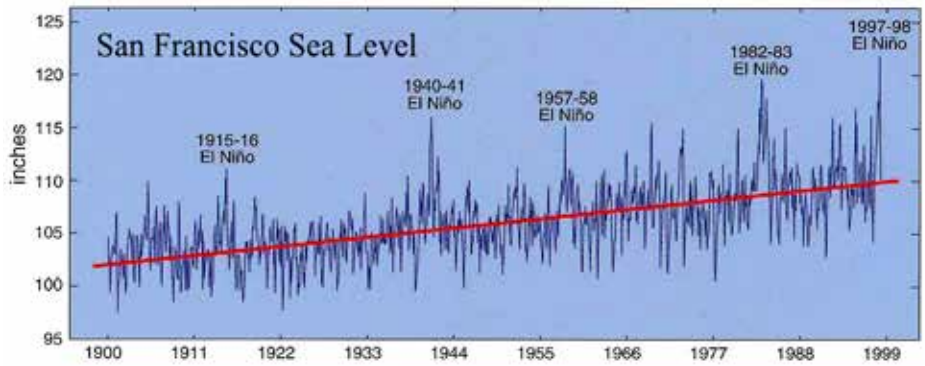
Confluences has been informed by suggestions from Art Miller, David Pierce, Alexander Gershunov, Shang-Ping Xie, Kristin Guirguis, and Sarah Giddings. In particular, the article "Climate change projections of sea level extremes along the California Coast," by Daniel R. Cayan, Peter D. Bromirski, Katharine Hayhoe, Mary Tyree, Michael D. Dettinger, and Reinhard E. Flick, has been informational on concepts and predictions of sea-level rise.



SEA LEVEL RISE AND COASTAL IMPACTS

Alexander Gershunov

Sea level rises and ebbs regularly, predictably, to the beat of the astronomical tides. Occasional storm surges elevate the seas on short time scales of hours and days. Los Niños can elevate sea level along the California coast on longer time scales of months with quasi-periodicities of two to seven years, while the Pacific Decadal Oscillation (PDO) can affect our sea level for decades at a time. Sea level also rises gradually with global warming. This occurs due to the thermal expansion of warming ocean water and to additional fresh water flowing into the global oceans from melting glaciers and ice sheets. As climate change continues and accelerates global sea level rise, the local coincidence of big swells, king tides and storm surges, particularly during El Niño and positive PDO winters, will bring more frequent and ever increasing inundations, salt water intrusions, property, infrastructure and wetland damage, beach and cliff erosion events to our coast....while the tides continue to regularly rise and fall, modulating coastal impacts.



- El Niño temporarily raises sea level by 8-10" along the California Coast
- Global warming is raising it gradually and in an accelerated way amounting globally to about 20cm (8 inches) during the 20th century (2mm / year)
- Decadal variations are also visible
- The tides are not resolved on this figure

GLOBAL SEA LEVEL RISE IS DUE TO

- Thermal Espansion of Warming Water
- Melting of Glaciers and Ice Sheets

TIPPING POINT CLIMATE CHANGE

LILLEANE PEEBLES | 2016

Carrara marble, wire

Tipping Point Climate Change, made of a block of Bardiglio Nuvoloso marble selected by the artist in Carrara, Italy, visualizes the threat of rising sea levels overwhelming the land. A 10-inch diameter sphere of blue-gray marble with white cloudiness is mounted on a rectangular piece of off-white stone with a crusty organic appearance. The landmasses on the globe appear lower than the level of the oceans to reflect the accelerating sea-level rise in a dramatic way. Lilleane Peebles has also applied transparent resin to simulate the phenomenon of Atmospheric Rivers shown as three tracks in the Northern and Southern Hemispheres. Incorporation of glass in the Arctic depicts the diminishing sea ice that still exists in the summer. A wire figure on the base pushing the globe represents man's greed and mistreatment of our planet. His rejection of scientific reports and denial of the facts is shown by the disregard of the book on which he stands. Several equations inscribed on the end of the base symbolize a solid base of scientific work that provides the data to support solutions which could at least slow the rate of change. *Tipping Point Climate Change* has been made in consultation primarily with Art Miller and Alexander Gershunov.

WHAT WE CAN EXPECT IN A GLOBALLY WARMED WORLD IN THE COMING DECADES

Arthur J. Miller

As our planet continues to warm from the invisible blanket created by the accumulation of greenhouse gases, the effects will be felt in many profound ways. Sea level will inevitably rise as the land-locked ice in glaciers melts and drains into the sea. This will jeopardize the people who live in the low lands near the sea the most. The poorest nations will be unable to adapt and will suffer catastrophic damage, while the wealthy countries fund infrastructure changes to protect themselves. The warming will be intensified in the Arctic region and sea ice will become thin and sparse, which will threaten the many marine mammals, like polar bears, walruses and seals, who rely on the floating ice for their feeding strategies. The indigenous peoples of the Arctic who hunt and fish in the polar seas and live on the frozen tundra will face the collapse of their traditional lifestyles due to loss of game and stable ground for housing. The warmer air will allow more water to evaporate from the oceans, which will provide the fuel for more energetic weather. Heavy rainstorms, like Atmospheric River events that hit our coast in winter, will intensify causing greater chance for floods and mudslides. The warming ocean surface will allow hurricanes to move further northwards and affect cities that never had to deal with them before. The storm tracks of the North Pacific will shift northwards and produce stronger storms that will drive ever-larger ocean waves that will thunderously pound our coastline with an ever-increasing intensity on top of higher sea level. The increase in carbon dioxide in the atmosphere will create imbalances in the chemistry of the ocean, driving it into a more acidic state. This will deteriorate the shells of tiny, but key, organisms that form the basis of the ocean food web and threaten commercial fisheries along our coast. This chemical imbalance will also menace coral reefs, which will be unable to properly build their skeletons in this acidified sea. The world's climate is changing, but we can still try to minimize damage if we act responsibly and develop strategies to reduce greenhouse-gas emissions now.

DUST, DISSOLUTION, ABLAZE

MARCELA PAZ LUNA ROSSEL | 2016

Mixed media and mosaic on board with a variety of local found materials such as sand, dirt, pebbles, animal bones, seeds, and wood pieces from cut trees, as well as repurposed materials, including recycled glass and ceramics

Having observed climate change issues for several years in her travels through jungles and deserts, mountains and valleys, cities and villages, Luna Rossel realized it was a unique opportunity to visualize her experiences of record rising temperatures and unusual flooding events in both hemispheres. As her "skin was alternately soaking up in torrential rains and parching in the scorching sun," and as she was getting hit by El Niño and La Niña in Latin America, she was "getting more and more intimate with a rather gloomy subject of climate change and its consequences for all of life, including humans." *Dust, Dissolution, Ablaze* is about the most urgent challenge of our time. She says: "I think of global warming as a fever, a symptom of a deeper 'illness.' A human-caused malady, certainly. And the attempts at fixing it need to go to the root cause, rather than merely trying to suppress one symptom. And the symptoms are everywhere."

In Asia, she saw villagers making tender offerings to a seemingly oblivious God, praying for the ever-elusive rains as their fields were bone dry and their water reserves way below the level for an average year. A few months later, she went to a famously parched area, the Atacama Desert in her homeland of Chile, only to find that due to some highly unusual rains, the desert was in full bloom, "a colorful and rare event, for a place that is usually rather desolate in its stark beauty." At the same time, though, she found out that the southern areas of Chile, usually so green and lush, were suffering from a terrible drought. In the jungle, she watched how the endless rains made a water curtain that veiled for hours and days on end the landscape beyond her glassless window. She says: "The rain kept me awake at night, rattling violently against the tin roof. Mold flourished in all of my belongings, while the rest of life seemed suspended, drowned in the waters spilled by raging skies." Although these apocalyptic downpours and storms may seem normal in the jungle, weather in the Chilean desert was clearly otherworldly, as a whole village got swept away by a deadly flash flood.

Dust, Dissolution, Ablaze visualizes how weather extremes may affect our planet and life on Earth. *Dust* depicts a full-size human figure standing as a mirror image of the viewer. It is "dressed" in textures and colors representing nature's elements and strata formations, as if portraying a physical map of Earth. Fragmented, it appears to be in the process of being engulfed by the surrounding desert landscape and its cracked mud texture. It is a depiction of drought. *Dissolution* is the pendant piece to *Dust* and represents a full-size human figure fully engulfed in water. The human figure dissolved within the waters serves as a poignant reference to flooding. Within a landscape of ominously empty horizons, *Ablaze* portrays a lone standing human figure filled with the bold colors commonly used to depict inflammation in the physical body. Her outstretched limbs resemble Leonardo da Vinci's *Vitruvian Man*. The human figure in the circle encompasses esoteric meanings of wholeness, totality, perfection, and those related to the Divine in many cultures and religions around the world. *Ablaze* references in total the danger of climate change to our planet.

Dust, Dissolution, Ablaze utilize predominantly a female silhouette, mirroring humanity in shape while symbolizing our planet through the evocative similarity to a physical world map. For Luna Rossel, the archetypal human figure is the embodiment of Mother Earth and a fleeting allusion to her own gender. Primarily employing the metaphor of water, she underscores Nature's nurturing and destructive powers. As she says: "After all, even though our planet is called Earth, we are mostly water. Water is in my veins, water is in my mouth, water is in my weeping. Water is in sorrow, water is in pleasure. Water is at birth, water is in bleeding. Essential and devastating, water." Through powerful personal experiences and assisted by the research from meteorologist Alexander Gershunov, *Dust, Dissolution, Ablaze* eloquently shows the immediate effects of water's excess and absence, drought and floods, and how climate change would affect the behavior and availability of water.

PRECIPITATION EXTREMES - DROUGHT AND FLOOD

Alexander Gershunov

California has a Mediterranean climate with mild and wet winters and warm dry summers. One of the common features of climate change in all Mediterranean climate regimes is the decrease in the frequency of precipitation. In California, this decrease is less pronounced than in other Mediterranean climate regions around the world (five in total) but still represents a major consensus among global climate model projections. This means, among other things, that as the sample size of storms making up total annual precipitation decreases, the year-to-year variability of water resources increases. This is a common vulnerability for all Mediterranean climate regimes - that water resources become even less dependable in these traditionally semi-arid regions[1].

In California, total winter precipitation is not projected to clearly change, aside for this increased volatility, because the increase in extreme precipitation events makes up for what is lost via decreasing frequency of precipitation[2]. Obviously, this comes with extra vulnerabilities for California on top of declining snowpack due to warming, e.g. increased risk of flooding, land slides, etc.

But in the other Mediterranean regimes, particularly those in the Southern Hemisphere, the decline of total precipitation driven by precipitation frequency reduction is the main vulnerability. The Southern Hemispheric regions are not projected to warm as much as regions of the Northern Hemisphere, though, where there is more land mass. In California and the Mediterranean Basin, the greater warming will also increase heat waves[3] and greater demand for moisture thus contributing to more intense droughts in the future[4].

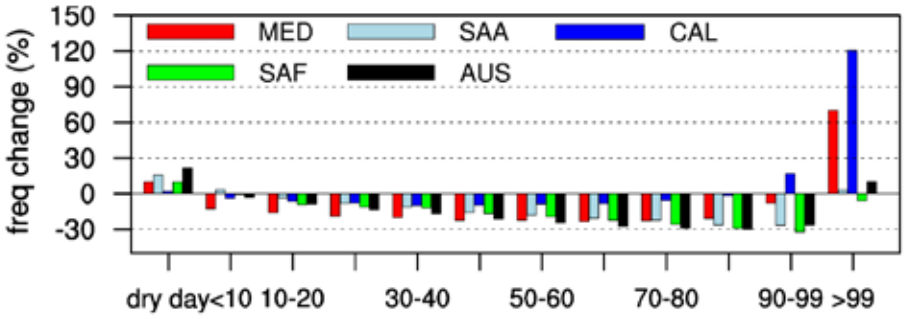


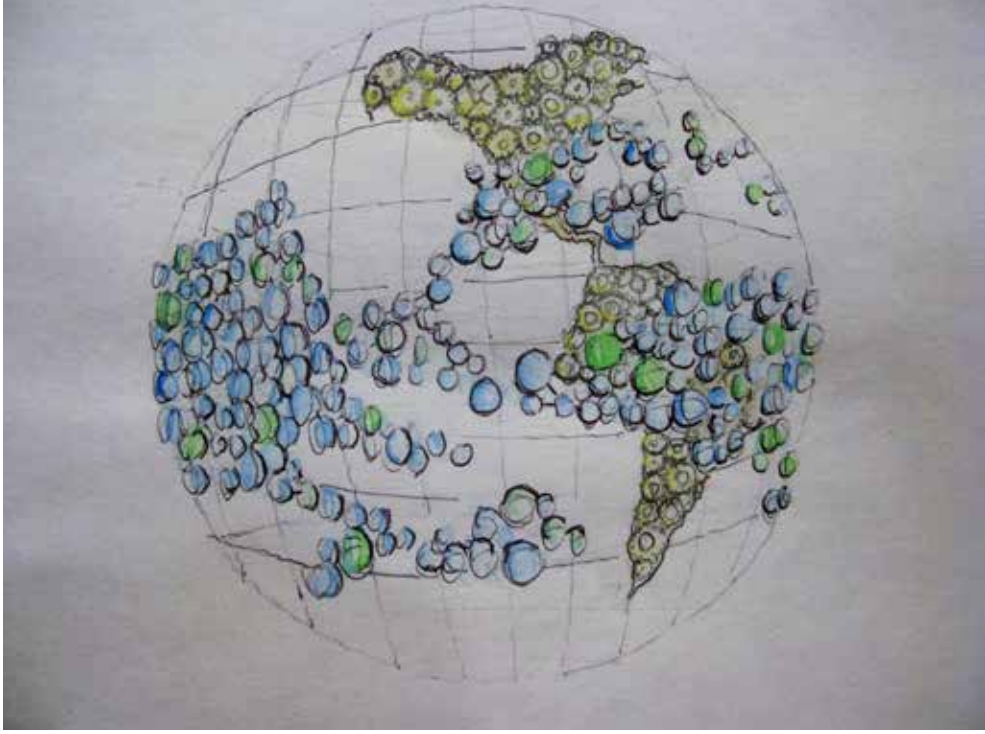
Figure depicts projected changes in winter precipitation frequency for daily precipitation events sorted into bins by percentiles of their intensity from dry days (zero precipitation) to less than the 10th percentile (drizzle), all the way to more than the 99th percentile (the most intense 1% of precipitation events).

1 Polade, S.D., D.W. Pierce, D.R. Cayan, A. Gershunov and M.D. Dettinger, 2014: The key role of dry days in changing regional climate and precipitation regimes. Nature Scientific Reports 4, 4364; DOI:10.1038/srep04364.

2 Polade, S.D., A. Gershunov, D. Cayan, M.D. Dettinger and D. Pierce. 2017: Precipitation in a warming world: Assessing projected hydro-climate of California and other Mediterranean climate regions. Nature Scientific Reports, in review.

3 Gershunov A. and K. Guirguis, 2012: California heat waves in the present and future. Geophysical Research Letters, 39, L18710, doi:10.1029/2012GL052979.

4 Cayan, D.R., T. Das, D.W. Pierce, T.P. Barnett, M. Tyree and A Gershunov, 2010: Future dryness in the southwest US and the hydrology of the early 21st century drought. PNAS, 107, 21271-21276, doi:10.1073/pnas.0912391107.



ATMOSPHERIC RIVERS

OSCAR ROMO | 2016

Mixed media, recycled and repurposed materials
Produced in consultation with Alexander Gershunov

Romo's sculptural piece explores the concept of atmospheric rivers—ribbons of water vapor in the sky that have been critical for California's water supply. The recent drought has been so severe because of record warming that has influenced this atmospheric process. A tenacious region of high pressure over the Pacific has diverted atmospheric rivers and the associated storms and rains too far north to reach the state during the past few winters, typically California's wet season. Historically, atmospheric rivers have been responsible for more than 80 percent of all major floods for the US West Coast. Current research seeks to understand how a warmer atmosphere will impact them—a key consideration for areas that so depend on these features for water. Atmospheric rivers will become moister and more intense in the future, as a warmer atmosphere can hold more water vapor. However, whether they will become more frequent visitors to the West Coast (or anywhere else that they appear) isn't totally clear. Made out of repurposed materials, Romo's piece symbolizes Nature's power. Wind and moisture manifest kinetic/male and latent/feminine energy that together represent creation or creativity that we are learning to harness in ever-greater amounts. Rather than induce a negative perception of the subject, Romo, as a practitioner of "natural systems design," argues that resilience can be accomplished through the understanding of nature and its remarkable ability to adapt and the human capacity to learn from the natural world. Re-purposed objects in the installation communicate a concern over our excessive use of energy and massive generation of waste but also demonstrate an opportunity for us to become more efficient and respectful of our natural resources by reducing, recycling, reusing, and recovering goods.

ATMOSPHERIC RIVERS

Alexander Gershunov

Atmospheric Rivers (ARs) are episodic narrow filaments of moisture-laden winds that accomplish much of the water vapor transport from the tropics to the mid-latitudes. ARs occur in the lower troposphere and, although they are transitory, at any moment they can transport an amount of water vapor that exceeds several-fold the amount of water transported instantaneously by the Mississippi River. There can be several such ARs occurring simultaneously around the globe. When they make landfall, the water vapor in ARs can very efficiently be condensed into liquid water causing extreme precipitation particularly when they encounter mountains that force the moist AR-air flow to rise. Since ARs transport moist air from west to east, they typically cause most of the extreme precipitation events along the mountainous west coast of North America, particularly California with its Sierra Nevada as well as the coastal and transverse mountain ranges.

The extreme rainfall that ARs can produce in California over a couple of days is similar to the rainfall amounts associated with land-falling hurricanes of the East and Gulf coasts. ARs provide much of the precipitation to California and they drive the volatile water resources in the State, but they do so in spurts, and so can cause floods, landslides and avalanches.

In a warming climate, ARs are expected to carry more water vapor. ARs are the mechanisms that will produce many of the stronger precipitation extremes that are projected for the region by climate models. Extreme precipitation events are also expected to be warmer in the future and to produce a much larger proportion of rain compared to snow, further enhancing their potential to cause catastrophic floods and be less amenable to regulated water storage in reservoirs.

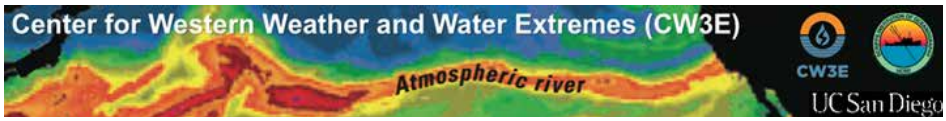


Figure. Colors show the content of atmospheric water vapor as detected from satellite on a particular day. An atmospheric river is a filament of very high water vapor content that transports tropical moisture to the midlatitudes, in this case, making landfall in California. Atmospheric rivers can cause extreme rainfall and flooding. They are expected to become more potent with climate change.

REQUIEM FOR AN OCEAN

JEAN ISAACS SAN DIEGO DANCE THEATER

Choreography: Jean Isaacs

Original Music Score: Steve Baker
Dancers: 10 members of the San Diego Dance Theater Company
Performance: April 15, 2017 at San Diego Dance Place, Liberty Station
Photograph: Manny Rotenberg

Requiem for an Ocean features original music by San Diego Dance Theater composer Steve Baker, who is inspired by John Luther Adams' *Become Ocean* and Claude Debussy's *La Mer*. A cautionary tale about the warming of our oceans, the dance will feature original text by Meagan Marshall with the core San Diego Dance Theater Company dancers. As a visual component, Isaacs has collaborated with local sculptor Arline Fisch, whose "hanging jellies" will contribute to the underwater experience.

A second dance performance is entitled *Ice Maiden* and features Swiss Artist Anna Katarina Scheidegger. Scheidegger creates before our eyes a female made of ice, and it melts throughout the evening, just as in her Swiss glacier video, which addresses our disquiet in the face of the Earth's melting glaciers. Climate expert and meteorologist Alexander Gershunov leads a post-performance discussion.

COLLABORATION OF ART AND SCIENCE IN THE ANTHROPOCENE

by Alexander (Sasha) Gershunov

Climate is intimately linked to our spiritual world, our longings, myths and religions – the regional ordering of our belief systems – the proverbial stuff that our symbolism and art are made of. The idea of reincarnation, the endless cycle of birth and rebirth, emerged in a part of our world where Life swings to the regular cycles of desiccation and deluge that is the South Asian Monsoon. At the end of the long dry season, when temperatures mount and all Life parched to the brink of extinction longs for moisture's revitalizing breath, the Hindus dream of rebirth, rejoicing when Indra[1], the king of gods, finally pours rain from skies cracked with his lightning thunderbolt. When the vengeful Yahweh, enraged at men, decides to drown all humans[2], along with the animals for good measure, he parts the firmament, meant to separate the "water above from the water below"[3], and over forty days inland seas fill leaving only the highest mountain[4] for Noah's Ark to land, we get a glimpse of what drives human mythology, fear, imagination and ingenuity. We still are, after all, like our ancient ancestors, essentially at the mercy of God's or Mother Nature's vagaries, the extremes of her capricious behaviors. Most traditional mythologies, including the Hindu, include stories of a great flood. In the Hopi tradition, for example, the previous Third World was destroyed by the Sotuknang, the Creator's assistant, in a flood and, with the divine intervention of Spider Grandmother, the righteous were spared and led on rafts to the Fourth and current, but not yet final, World.

Global climate was changing at the time such stories originated. Glaciers and ice sheets were melting and sea level rising. Particularly abruptly, within possibly decades, inland seas filled as water mounted in massive mountain lakes, ice dams broke and fertile plains became the bottoms of inland seas just as our roaming ancestors were settling down to develop farming and ranching out of hunting and gathering, evolving their first permanent settlements from nomadic camps, complex societies out of tribes and clans, religions out of totemism, philosophies from interactions with Mother Nature and ever more complex interactions with human nature, as well as developing sophisticated symbolic art out of the petroglyphs of our cave-dwelling past. Our ancestors were settling down into a more stable life of toil and study for some, greed and conquest for others, as the earth's climate was settling into a stable period of the current interglacial. We can look back at what humanity has accomplished during the last 10K years of Holocene – a period that encompasses the growth and impacts of human societies worldwide, including their recorded histories, development of major civilizations, and transition toward urban living. Much of this accomplishment during humanity's increasingly landed existence, made possible by relative climatic stability, is reflected in art.

Tens of thousands of years from now, when the world again starts slowly putting on ice sheets, what will future humanity think about our own historic and well-documented time of cyber technology and big data when for the first time humans came to the realization that we are inadvertently changing the climate of our home planet Earth within a span of a few human generations? What will future generations make of our time of collective denial and inaction as we held our warming planet, with its ecosystems, our livelihoods, and the collective wellbeing of our grandchildren in our hands? Out of a myriad elements comprising this clear yet most complex global problem ever facing humanity, they may

1 Vedic god in Hinduism, god of lightning, thunder, storms, rains and river flows. King of gods, akin to Zeus, Jupiter, Thor, Wotan, Perun, and other head deities in various heathen religions.

2 Who are adapted to a semi-arid climate not unlike that of California.

3 Genesis. This probably reflects a pre-scientific conception of the mechanism causing rainfall.

4 Mt. Ararat, or Elbrus, presumably.

well see that, in this time of global change, we were slaves to a rigid conservative ideology whose powerful proponents impose a faith in the God of Free-Market who magically fixes all problems and rights all wrongs. In our modern day and age it is easier to politicize objective science, easier to doubt or attack scientists' credibility, than to do something about climate change. Doing something about it would require anathema – regulation of the free-market God. For zealots of free market fundamentalism, it is easier to denounce climate change as a hoax perpetrated by liberals or by the Chinese or by whomever, than to admit that a deregulated market does not solve all of the world's problems. Proactive evidence-based solutions are sorely needed.

Our complex global society is mired in other problems and unsubstantiated beliefs, to be sure. But these problems are not unrelated. Our reliance on fossil fuels is not merely a major cause of climate change; it is also at the root of our energy crises, economic shocks, and national insecurity, while our foreign policy is mired in our undue attention to the Middle East and in our incessant meddling with that oil-rich part of the world, which in turn leads to global instability and fuels Islamic fundamentalism. Our traditionally coal-based energy production is not only one of the main causes of accumulated inertia of global warming; it is also one of the main causes of environmental degradation and crises of human health[5] in the United States and the world over. The co-benefits of an economy weaned off fossil fuels are abundantly clear and great. However, at this present moment in our societal evolution, we seem to be lost in the details, unable to see the big picture, to make moral sense of our big data. It is high time to seek higher ground, to once again engage art, philosophy, spirituality, morality and compassion in understanding, translating and conveying the factual/objective environmental changes that are upon us, this time of our own making and amenable to our own fixing.

How do we know the objective facts about climate change? Fossil fuels have formed from ancient plants buried in the Earth's crust over hundreds of millions of years. When we dig up and burn, in a matter of decades, these non-renewable resources – primarily coal, oil and gas – at current rates, we release more than 20 gigatonnes of carbon dioxide (CO_2) per year into the atmosphere, enhancing the natural greenhouse effect and, in effect, thickening the blanket of greenhouse gases that absorb radiation emitted by the earth's surface, upsetting the global radiative balance[6] which has been keeping the Earth's climate stable since the last ice age. The theory that burning fossil fuels warms the global climate via release of CO_2 had been postulated in 1896[7]. Based on this theory, and motivated by the Keeling Curve[8], the early generation global climate models were predicting the "fingerprint" of global warming[9] back in the 1970s, before a global warming signal was ever observed. When it finally was clearly observed and distinguished from natural variability, in the 1990's, it closely resembled that "fingerprint" long predicted by continuously evolving climate models. The global climate has continued to warm ever since quite in line with climate model predictions.

In parallel, work on proxy climate reconstruction[10] has also provided evidence that the global warming that occurred over the last century, and at an accelerated rate over the last 40 years, has been unprecedented during the Holocene ([11]10K years). This is one of the main pieces of evidence signaling the beginning of the Anthropocene – the current epoch when human activity dominates environmental change. These and other pieces of evidence for anthropogenic climate change explain the climatic change already observed. They more than validate the theory of global warming and provide scientific basis for using climate models to project climate into the future.

The consensus on the reality and anthropogenic causes of global warming is 97% among climate scientists[11], a fact usually obscured in the media. Careful studies of observations

5 Respiratory and other illness. http://www.chgeharvard.org/resource/full-cost-accounting-life-cycle-coal

6 Incoming absorbed (by the earth-climate system) solar radiation = outgoing (to space) terrestrial radiation

7 By Svante Arrhenius, a Swedish scientist, who estimated the global warming to result from a doubling of CO_2 to be on the order of 4°C.

8 Charles David Keeling's observations of rising CO_2.

9 The strongest warming of the high latitudes in winter, stronger warming over the continents and the northern hemisphere than over the oceans and the southern hemisphere.

10 The reconstruction of climate (temperature, precipitation, etc.) from natural climate recorders (tree rings, air bubbles trapped in glacial ice, corals, pollen, sediments, records of harvests, etc.) spanning time periods much longer than the instrumental record (e.g. hundreds to millions of years).

11 Cook, John; Oreskes, Naomi; Doran, Peter T.; Anderegg, William R. L.; Verheggen, Bart; Maibach, Ed W.; Carlton, J. Stuart; Lewandowsky, Stephan; Skuce, Andrew G.; Green, Sarah A. (2016), "Consensus on consensus: a synthesis of consensus estimates on human-caused global warming," *Environmental Research Letters, 11 (44)*, doi:10.1088/1748-9326/11/4/048002048002

and climate model projections indicate that climate change, in addition to the very real but popularly abstract notion of global warming, includes trends in climate extremes (e.g. drought) extreme weather events (e.g. heat waves, floods, hurricanes) that are devastating and locally felt. These changing extremes can register climate change acutely in our individual experiences. Yet the connection of regional weather extremes to global climate change is somewhat like the connection of an athlete's performance in an individual sports event to her use of steroids. The steroids are only a partial and obscure cause of any individual outcome, yet their impact is evident in the statistics of the athlete's performances over an entire season, especially when compared to pre-steroid seasons' statistics[12].

Although many impacts are attributed by climate science to the human influence on climate, the scientifically proven connection between fossil-fueled human activity and climate change has mostly gone unnoticed and/or misunderstood by mainstream humanity, even as people and societies are palpably impacted. The objective reality of anthropogenic climate change has so far eluded the attention of mainstream artists as well, but this situation is changing as climate is continuing to evolve in predictable ways, as scientific evidence for the causes of weather trends accumulates, as science identifies impacts of a changing climate on deadly heat waves, dwindling water resources, catastrophic floods, wild-fire, etc. As scientific knowledge mounts and climate change accelerates, as society feels lives, water and food supplies, health, environment, economy, impacted in unusual, often spectacular ways, as climate science continues to correctly predict the observed trends and more clearly explains their causes, art will be on the forefront of documenting change in ways that are viscerally, intuitively clear. As artists become more aware of the science of climate change, art can begin to reflect the reality, the impacts, the causes and the science of humanity impacting itself by changing the climate we have come to depend upon. The time has come for art to deliberately reflect humanity's role in our changing climate, to collaborate with science in educating humanity about the reality of climate change, about the challenges and opportunities presented by a changing climate.

12 One can explore this analogy further here: http://www2.ucar.edu/atmosnews/attribution/steroids-baseball-climate-change, and here: http://www2.ucar.edu/atmosnews/weather-on-steroids, etc.

Climate change is an opportunity to propel humanity faster, more efficiently and successfully through the next step in its evolution towards harnessing sustainable clean energy for its livelihood. The appeal of a clean future is personal, global and bright. It symbolizes the victory of friendship over greed. Art can and should play a pivotal role in this evolution. As society can benefit through the friendship of art and science, families can benefit from exhibitions such as this one and thereby strengthen the evolutionary flow of change towards which our changing climate is nudging society.

This exhibition consists of contemporary art evolved from the petroglyphs of our prehistory and inspired by the state-of-the-art scientific knowledge of today. It is an attempt to make good old-fashioned sense of our predicament and to point a way to a brighter future that does not involve reckless experiments with our climate, health and livelihood. By helping each other illuminate and communicate the two-way interactions between human activity and climate that characterize our Anthropocene, science and art collaborate to help humanity understand and step up to its role and power to determine its own evolution. Well, at least that's the hope, as this exhibition can be one local effort in a global movement of collaboration between artists and scientists in all of us united by crisis and opportunity for a more enlightened future.

LISTEN TO THE TREES

RUTH WALLEN | 2016

Photomontages, tree stumps, iPad

LEFT: The Torrey Pines State Natural Reserve

RIGHT: The Laguna Mountains, The Cleveland National Forest

In *Our Forests are Changing*, a video on the US Forest Service web site, a camera pans across California forests while bold text flashes across the screen: "Trees are dying. More than 40 million. Due to Climate Change. Drought. Bark Beetles...." Similarly a recent article in *The San Diego Union Tribune*, "State, County, Grapple with Historic Tree Die-Off," details efforts to "get rid of dead pine and oaks." San Diego County is home to more threatened and endangered species than any county in the continental U.S. How will this die-off impact our local environment? *Listen to the Trees* addresses the heartbreaking loss of our forests and the impact of that loss on other species, losses that are already occurring and will only get worse with rising greenhouse gas emissions.

Listen to the Trees focuses on two areas in San Diego County, the Laguna Mountains and Torrey Pines State Park, representative of very different local environments. Large photomontages depicting both the wonders of the forest and the dying trees serve as memorials to local threatened and endangered species. Tree stumps in the gallery space represent tree species that may disappear by the year 2100. The touch screen displays the tree rings from roughly 1950 to 2100 for the Torrey pine and 1850 to 2100 for the Jeffrey pine. Each tree contains two scenarios: one represents a high emissions scenario and the other low emissions or "enlightened government." The tree rings are indicative of actual or projected climate, just as tree stumps are often labeled with historical events that occurred in the year corresponding to a given tree ring. The interactive content embedded in tree rings reflect on the health of the trees, surrounding plants, and wildlife, as well as those human actions particularly associated with the low emissions scenario that help diminish green-house gas emissions. Installation narratives are based on actual historical and scientific data provided by Alexander Gershunov, Suraj Polade, Richard Somerville, and Michael Dettinger. In particular, Polade offered data on downscaling precipitation and temperature for the two locations based on the low and high emission scenarios, Somerville shared the concept of future "enlightened government" actions that may help slow green-house gas emissions, and Dettinger was instrumental in understanding the use of dendroclimatology to comprehend past climate and the impacts of climate change on the emergence of novel ecosystems. Darren Park Smith, a resource specialist for California State Parks, provided information about the status of Torrey pines and the impact of bark beetles.

MOUNTAIN SNOWS ARE LIFE FOR THE WESTERN US AND CLIMATE CHANGE IS DESTROYING THEM

Michael Dettinger

Mountain snow fields act as natural reservoirs for most western water-supply systems, storing precipitation from the cool season, when most precipitation falls and forms snowpacks, until the warm season when most or all snowpacks melt and release water into rivers. As much as 75 percent of water supplies in the western United States are derived from snowmelt. Snowfall and snowpacks ultimately only happen and survive to play this crucial role if the winter and spring temperatures are cold enough. So when we consider the projections of long-term and regional warming that increasing greenhouse gases will bring, the first concern that arises is for the survival of these crucial natural water supply reservoirs.

For the past twenty years, scientists at Scripps have been exploring and leading the way in understanding and measuring changes in western snowpacks that have already begun and changes that we should be expecting and preparing to accommodate. For example, Scripps scientists were among the first to recognize and document trends since the 1950s towards earlier snowmelts and more rain/less snow across the Western US. These trends can be seen in long-term measurements of the amount of water held in each spring's snowpacks, but also in measurements of streamflow timing and vegetation greenup across the region. So far, these historical trends have been modest and thus have been of limited consequence to the region's water supplies and landscapes.

Looking to the future, though, the climate is projected with a great deal of confidence to warm much more than it has so far if we keep burning fossil fuels and disposing of the resulting greenhouse-gas waste products into the global atmosphere. Based on the historical changes and a variety of computer models of climate, snowpack, and streamflow variations and changes across the west, a widespread loss of snows and ultimately many of the water supplies that depend on them are to be expected. Based on historical relations between climate and snow in western mountains, we now know that western snows are more sensitive to warming than virtually anywhere else in the US, and our Sierra Nevada snows are even more vulnerable to warming than those elsewhere

in the region (Fig. 1). Current projections are that snowpacks in the Sierra Nevada may decline to anywhere from half to one-tenth of the historical norms later this century. Computer models of future climates, snows and landscapes allow us to look far beyond the historical trends so that, together with our growing understanding of how important snows are to western waters, ecosystems, and landscapes, we now understand that the loss of snows will almost certainly impact streamflows, reservoir storage, groundwater aquifers, forest types and health, all manner of mountain fauna and flora, and human communities and economics in mountain settings in ways that we all will surely regret.

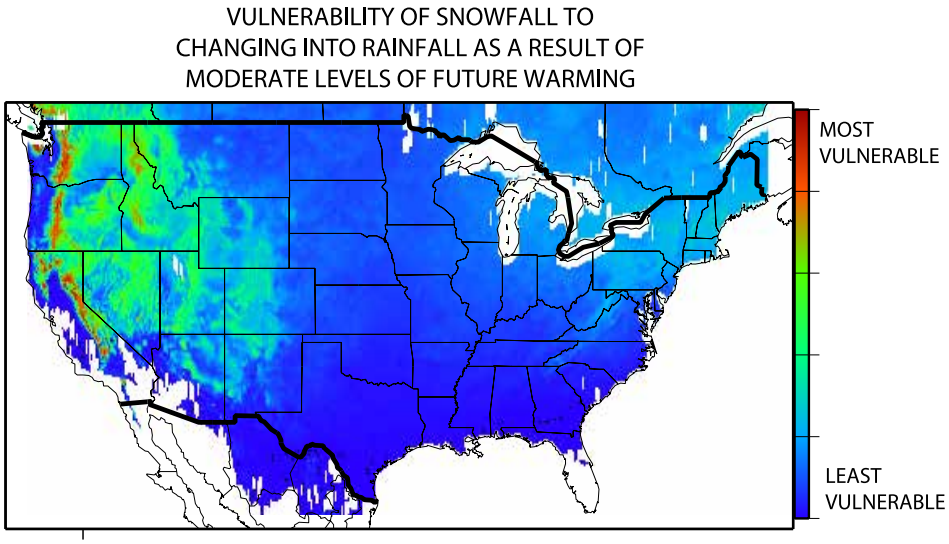


Fig. 1.—Vulnerabilities of western snowfalls to moderate (3-4ºF) warming, based on 50+ yrs of historical records of snowfall, temperatures, and precipitation (from Dettinger et al., Ecological Applications, 2015). The Sierra Nevada, Cascade Mountains, and some ranges in Idaho are much more vulnerable to loss of snowfall if warming continues, as the snow instead becomes rain, and the western US is generally more vulnerable to such changes than is the eastern US.

MAGIC CIRCLE

PAUL TUROUNET | 2015-2016

Inkjet pigments on paper

Interstate 405, Long Beach, California, 2016
Along Interstate 15, Riverside, California, 2016
Along Interstate 15, Riverside, California, 2016
Along Highway 395, Riverside, California, 2016
Joshua Tree National Monument, California, 2015
Joshua Tree National Monument, California, 2015
Joshua Tree National Monument, California, 2015

Magic Circle is a body of photographic work anchored and inspired by childhood memories of a weekend adventure called the Joshua Tree Magic Circle. An advertisement in Sunset Magazine (August 1962) for the Ethyl Corporation alluringly states: "Your passport to adventure is your family car. If you live in the West, it will slip softly through sands to a place where a lily, called a Joshua Tree, grows forty feet tall. A place called Joshua Tree National Monument, where there are 870 square miles of rock and flower and sand and clay. This is the moment you must not miss. This moment when the glorious thought dawns in a child's mind. Wonder may be born anywhere. And the key may be in your car. Come – pile the children in, and drive them to where wonder grows. Ethyl calls the wonder that surrounds you a Magic Circle – the Joshua Tree Magic Circle. Why not start exploring yours this weekend? Your service station dealer will be glad to help."

Exploring the consequences of global warming on the California landscape, Turounet navigates the maze of the superhighway traffic in *Magic Circle*, from America's Finest City, to the Magic Kingdom, to the City of Angels and, eastward, to the Inland Empire, and beyond to the Mohave and Joshua Tree. He observes: "While you sit in the traffic, you'll be able to admire the wonder that now surrounds you. Endless miles of concrete and cars and a layer of haze that hovers just above. Homes and strip malls and a grid of electrical lines in every direction to power it all. With the upward climb out of the Valley and the Empire, this is a moment you must not miss." The immediate impact of human economic activity is visible in the monumental grandeur of transmission towers that dwarf

what remains of many of the Joshua trees. Photographs from *Magic Circle* document trees tired and struggling, exhausted from the increasing heat and the growing smoggy haze of emissions from vehicles, industry, and electrical power that now creeps further and further eastward. Skeletal remains of trees caused by rising temperatures and decreased moisture will eventually crumble and dissolve into the desert sands. Turounet concludes: "This is when one hopes glorious thoughts will dawn and where another wonder may grow."

EXTREME HEAT, EXTREME HEALTH EFFECTS

Kristen Guirguis

One of the most important challenges in preparing for climate change is understanding how weather extremes will impact society. In the U.S., we experience many types of extreme weather events each year such as hurricanes, tornadoes, floods, wildfire, and extreme hot and cold temperatures. It is sometimes met with surprise that the deadliest of these weather events is extreme heat. Heat waves are known to affect, for example, cardiovascular, respiratory, and kidney function. We are all affected by heat waves, but populations with low incomes, physical and mental disabilities, preexisting diseases, the elderly, outdoor workers, and children are most likely to experience the most serious outcomes.

Climate change will increase the frequency of heat waves. For example, in California, climate model projections indicate the number of heat wave days will increase 4-8 fold, depending on how much greenhouse gas is emitted into the atmosphere. This means that whereas we have about 5 heat wave days during summer today, by the end of the 21st century a typical summer will have 20-40 heat wave days. These future heat waves will also be more intense and longer lasting. Also in California, where strong trends in heat wave activity are already observed, heat waves are trending towards a more humid variety, which could exacerbate the impact on health. Higher humidity makes it more difficult for the body to cool through evaporated perspiration during the day, and keeps air temperatures hotter at night. We will undoubtedly experience more heat waves in the future than we do today. However, there is a dramatic difference in the number of heat wave days projected depending on how we address our greenhouse gas emissions. This means the amount of warming, and the number of deadly heat waves to be endured by future generations will be decided by actions we take today.

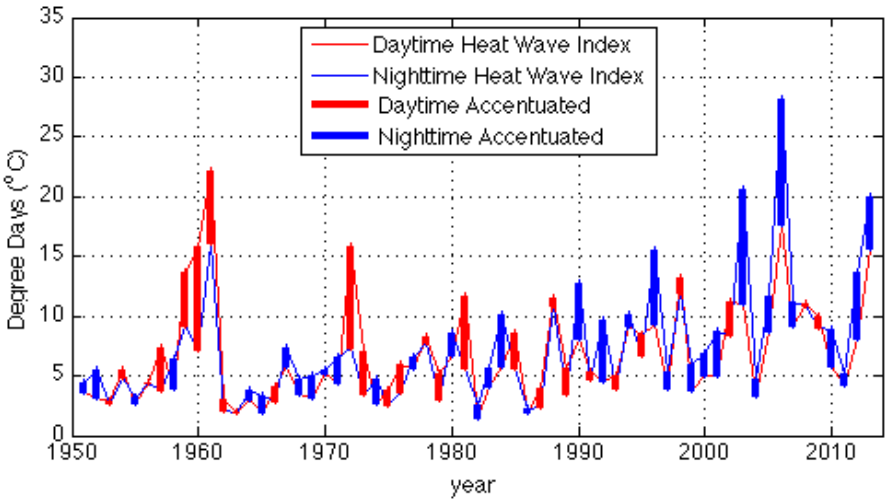


Figure 1. A graph showing heat wave activity in California since 1950. A summer heat wave index is shown in degree days, which are the sum of degrees that exceed the 95th percentile of daily temperatures during June, July and August. The red line shows the heat wave index for daytime temperatures and the blue line shows the heat wave index for nighttime temperatures. The bold blocks show whether it was a nighttime accentuated or daytime accentuated heat wave. Daytime accentuated heat waves are those that are characteristically dry while nighttime accentuated heat waves are typically more humid. The hottest heat wave occurred in 2006. This heat wave was also unusually humid with unprecedented nighttime temperatures. The devastating health toll of the 2006 heat wave included 147 reported deaths, over 1200 hospitalizations, and over 16,000 emergency department visits. An upward trend in nighttime-accentuated humid heat waves is observed since the 1980s.

YOU CAN'T GO HOME AGAIN

David Pierce

We've heard the words many times. People age, buildings decay, cities sprawl. But what happens when the very landscape itself changes? Research has shown that every year, the oceans gain 15 times as much heat energy from global warming as is consumed by all human activity. The warmer water expands, flooding into fragile coastal environments. In our mountains, winter snow dwindles as warmer temperatures convert snowfall to rain and what snow does fall melts earlier. On average in the western United States, 20% less winter precipitation ends up as mountain snow than 50 years ago. Today's toddlers will see perhaps two-thirds of the snowpack vanish in their lifetimes. The Colorado River, which supplies almost two-thirds of the water that comes out of your showerhead or kitchen faucet, will likely carry 10–20% less water by the end of this century, as higher temperatures drive greater evaporation from an increasingly parched landscape. The facts and figures are remote and dry, but what does it all mean? The beach where you played as a child will be captured by the ocean as sea levels rise. A springtime mountain meadow remembered from your youth, alive with birdsong and set against a snowcapped mountain backdrop, will be unfamiliar; some species will have moved on, while others will have succumbed to the changes. More people sharing less water will change daily lives even in our own cities, in our own yards, in our own homes. You can't go home again, indeed.

FUTURE SOUVENIRS

EVA STRUBLE | 2016

Mixed media

Future Souvenirs concerns current and future effects of climate change in San Diego. Developed in consultation with Richard Somerville, the installation addresses imminent and long-term changes in the San Diego region, such as the expected sea-level rise of 2-3 feet by 2100 and projected increase in "extreme heat days" to 100 days out of the year by the same time, up from the historical average of about 5. *Future Souvenirs* visualizes the anticipated consequences of global warming at a local level, such as the impact on local economic drivers and sources of pride—tourist sites and agricultural crops—as discussed in Somerville's book, *The Forgiving Air.*

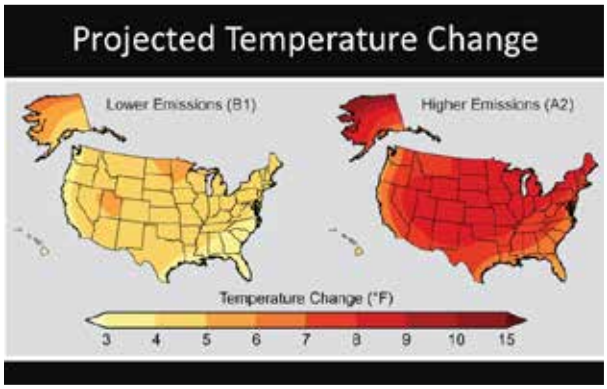
A series of 60 screen-printed *Future Souvenirs* made in the style of antique flags on triangular fabric evoke the flags that were once popular mementos for tourists visiting cities and historical sites in the U.S. and abroad. Ironically, the flag format is used to commemorate crops such as apricots, almonds, artichokes, figs, kiwis, olives, walnuts, and wine grapes that are part of San Diego's proud agricultural self-image and will inevitably suffer from heat level rise and drought. *Future Souvenirs* address climate change in a tangible way by evoking sentimental values.

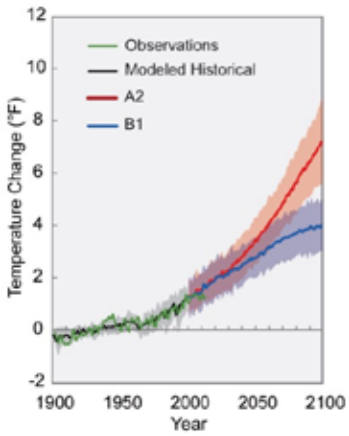
THE BIG UNKNOWN

Richard Somerville

The biggest unknown about future climate is human behavior. Everything depends on what people and their governments do. The more heat-trapping gases released into the atmosphere by human activities, the greater the increase in Earth's temperature. The graph on the left represents global average temperature rise (relative to the 1901-1960 average) for two scenarios. A2 is a scenario assuming continued increases in emissions throughout this century. B1 assumes significant emissions reductions. Shading indicates the range of results from a suite of climate models. In both A2 and B1, temperatures will rise, but the difference between the lower and higher emissions scenarios is substantial.

Thus, we who are alive now, have our hand on the thermostat that will control the climate of our children and grandchildren and future generations. The maps below show projected changes in average surface air temperature in the last three decades of this century (2071-2099) relative to these decades in the last century (1970-1999). On the right is the United States if emissions keep increasing. We'd get 7 or 8 degrees Fahrenheit more warming. On the left is the United States if emissions are greatly reduced—only about half as much warming. That's a huge difference with major consequences for trees and for us all. Meanwhile, carbon dioxide is building up in the atmosphere. The window of opportunity to make this choice will thus soon close. In Paris in 2015, governments worldwide pledged to make large reductions in emissions. Now they must keep their promises.





Source for figures: National Atmospheric and Oceanic Administration and National Climate Assessment- http://nca2014.globalchange.gov/

FOR YOU FOR ALL

ALLISON WIESE | 2016

Three silkscreened posters, unlimited edition

Employing the technical and formal vocabulary of silkscreened WPA (Works Progress Administration) posters from the mid-twentieth century, *For You For All* is a suite of three prints depicting a coastal landscape, an image of a wildfire, and a scene of communal planning/work. Working visually as a triptych, the posters invite conversations on the local consequences of climate change on our lives and those of our children and grandchildren, and what we might do to help mitigate, control, or reverse such changes to our environment. *For You For All* is envisioned as a performative project extending beyond the La Jolla Historical Society's Wisteria Cottage galleries to local shops and businesses in La Jolla that have agreed to host the silkscreened trios during the run of Weather on Steroids.

For You For All playfully mirrors the work of Climate Education Partners by serving as a platform for facilitating conversations about climate in the community "to break an

awkward silence, while also delivering the knowledge that there are scientists, business people, members of the general public, and policy makers who want to address climate change." Wiese's work is inspired by the WPA artists of the 1930s who were enlisted to advertise everything from avant-garde theater productions to syphilis treatment. She envisages the real subject of *For You For All* as the possibility of creating an effective community that is concerned with what we can be doing right now to reverse the consequences of climate change. In her words: "I welcome these conversations as the project's poetic intent threads its way through behaviors that might look a lot like marketing, propaganda, education, public service, or community organizing. Can talking about how we talk about climate change makes it easier to do the urgently necessary talk about climate change?"

For You For All is informed by the work of Climate Education Partners and of Michel Boudrias, Wiese's colleague at the University of San Diego, who address underlying impediments to action and well-informed decision-making in the face of frightening changes to our environment. She states: "I felt I could most vitally intervene as an artist in a space where scientists are carefully looking at their own relationships to civil society, and using their specialized training not just to provide information but to unthread the complexities of our beliefs, and how we share them, in an effort that allows us to feel community, communicate with one another, and make better choices." CEP's primary concern is to identify the most effective informational methods to make climate science and its implications understood by local leaders, policy makers, and San Diegans at large.

CLIMATE CHANGE FOR ALL! GETTING THE MESSAGE ACROSS TO DIVERSE AUDIENCES

Michel Boudrias

The challenge of climate change education of diverse audiences has been to balance science content with appropriate messaging to reach audiences ranging from K–12 students up to decision makers. Successful programs have integrated climate science, social and learning sciences and effective communication strategies to create innovative resources and new approaches to climate change communication in order to engage their audiences more actively. In the San Diego Region, Climate Education Partners have been working with business leaders, elected officials, tribal leaders, and other Key Influentials to increase understanding about climate change and its impacts, to increase knowledge about possible solutions for adaptation and mitigation, and to provide examples for informed decision making by regional leaders.

We have interviewed over 140 Key Influential San Diego leaders, engaged them directly in the creation of innovative educational resources like the *2050 report*, taken them on climate tours and included them as ambassadors in our activities and movies. Results of the interviews indicate that almost 90% of these leaders are concerned about climate change though almost 90% don't think their peers are, more than 50% are already doing something about the impacts, and the majority of them want more information, greater dialogue and more examples of actions taken by other community leaders.

The predicted changes to our climate in the next few decades will affect our quality of life in San Diego and we must work together to prepare for these major impacts to ensure that future generations will get to enjoy the beaches, deserts and mountains that make our region great.

Changes in temperature and precipitation will be the driving force impacting our water resources, coastal flooding, wildfires, Nature's benefits and our public health. Discover more at www.sandiego.edu/2050

CLIMATE CHANGE:

A LOOK AT 80 YEARS OF WORK AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

By Walter Munk

When I first came to Scripps Institution of Oceanography (Scripps) in 1939, scientists were congratulating themselves, because the release of CO_2 into the atmosphere appeared to counter the coming ice age. I'm afraid we have overshot!

Ice ages have come and gone long before mankind had anything to do with influencing the phenomenon. They are the result of perturbations in the earth's orbit about the sun, caused by planets (especially Jupiter). These perturbations cause the sun to be, sometimes closer to the earth and sometimes further from it, sometimes more nearly equatorial and sometimes more polar, etc. There have been 10 major ice ages in the past million years, and many minor ones.

Fifteen thousand years ago, there was lots more ice on Antarctica and Greenland than there is now; global sea level was 100 meters lower; La Jolla and Scripps Canyons were much more exposed than they are today. As a result of melting over the subsequent 5,000 years, sea level rose and submerged the outer portions of the canyons, bringing the water level closer to our current shore...a phenomenon that is now being greatly influenced by the actions of mankind.

In 1936, while on sabbatical in Norway, Roger Revelle met Norwegian meteorologists who had become concerned that the release of CO_2 into the atmosphere could have grave consequences. Roger persuaded Charles David Keeling, a young chemist, to set up a lab at Scripps. Systematic measurements of CO_2 were needed and in 1956 Keeling established a station on the top of Mauna Loa on the Big Island of Hawaii. Although he had great difficulty maintaining funding for this critical research, the Mauna Loa measurements have now been conducted for the better part of a century and show, convincingly, that CO_2 has increased at an alarming rate and has had a significant global impact. Not even the most-stubborn climate skeptic has questioned the veracity of the Keeling Curve.

Roger participated in the exploration of the atmospheric greenhouse problem from the 1950s, when it was a cottage industry for a few academics, to the 1990s, when global climate change involved industry and government on an international scale. In 1957, Roger and Hans Suess demonstrated that carbon dioxide had increased in the air as a result of the consumption of fossil fuels, in a famous article published in *Tellus*. In 1965, the President's Science Advisory Committee Panel on Environmental Pollution, under Roger's leadership, published the first authoritative report that recognized CO_2 from fossil fuels as a potential global problem.

In the 1950's, I became particularly interested in sea level rise associated with the increase in CO_2 levels; sea level rise was then less than half a millimeter per year. By the end of the 20th century the rate of sea level rise had more than doubled. It was very suspicious that this doubling occurred at the same time we changed the way we measured sea level rise. The early measurements were based on traditional tide gauges distributed all over the world. The measurements were suspicious because the "solid earth" to which the gauges were attached was, itself, moving up and down. For example, Scandinavia was rising as a result of the removal of much of the snow pack; therefore the measured sea level appeared to be going down, even though it was actually rising. It was a great improvement when, at the turn of the century, we switched to satellite altimetry, which showed a continuing and accelerating rise in the sea level which could exceed one meter by the end of the century. It is, however, difficult to predict future sea level, because we don't know enough about the melting rates of the Antarctic or Greenland glaciers in a much warmer future.

The science of Climate Change is difficult, but not nearly as challenging as getting people to work together to do something about it. Veerabhadran (Ram) Ramanathan, a distinguished professor of atmospheric and climate sciences at Scripps, discovered the greenhouse effect of CFCs (Chlorofluorocarbons used as refrigerants and propellants) and numerous other man-made trace gases. He correctly forecasted that the global warming due to carbon dioxide would be detectable by the year 2000. Ram co-chaired the

first-ever joint symposium (Sustainable Humanity, Sustainable Nature: Our Responsibility) with the Pontifical Academy of Science and the Pontifical Academy of Social Science, held at the Vatican. Mary and I had the privilege of attending. The symposium concluded that solar and wind power alone are not sufficient to meet our needs. We need to switch from fossil energy to renewable energy and, yes, nuclear power plants. We were successful in persuading Pope Francis to include Climate Change and it's devastating impact on the poor in his most recent encyclical. It was embraced world-wide and praised by His Holiness the Dalai Lama and many other world leaders.

In 2013, Janet Napolitano, President of the University of California announced the Carbon Neutrality Initiative committing all UC campuses to emitting net zero greenhouse gases from its buildings and vehicle fleet by 2025. As a member of this committee, working to combat Climate Change, I am reminded of the 1940 University of California all campus (Berkeley, Davis, and UCLA) research mandate to use science to fight the Axis powers who were sinking Allied ships at will. When the war began we really didn't know what to do, but to everyone's amazement, three and one-half years later we landed on the beaches of Normandy.

In 2015, Scripps Institution of Oceanography, under the Directorship of Margaret Leinen, established a Center for Climate Change Impacts and Adaptation to apply multidisciplinary science-based strategies for adapting to climate change. As part of my ongoing efforts to learn how previous cultures adapted to past climatic variability and change...or were wiped out if they didn't, Damien Leloup and I co-founded the Scripps Center for Marine Archaeology at UC San Diego.

I am persuaded that, if we all work together, the increase in atmospheric CO_2 can be stopped within a few decades. I hope it doesn't take another Pearl Harbor to unite us against this global enemy that threatens us ALL. My personal opinion is that it will require a miracle of love and unselfishness.

SCRIPPS INSTITUTION OF OCEANOGRAPHY IN LA JOLLA

A HISTORICAL TIMELINE

1903 – William E. Ritter, University of California, Berkeley professor, established a research lab in the Hotel del Coronado boathouse to study coastal marine life. E.W. Scripps, Ellen Browning Scripps, Dr. Fred Baker and other San Diego community leaders chartered the Marine Biological Association of San Diego (MBASD) to carry on a "biological and hydrographic survey" of coastal waters and to build and maintain a public aquarium and museum.

1905 – The "Little Green Laboratory at the Cove" was constructed on Point La Jolla at a cost of $922, most of which was raised by members of the La Jolla Improvement Society.

1907 – The MBASD acquired the property in La Jolla Shores now occupied by Scripps Institution of Oceanography for the San Diego Marine Biological Station. E. B. Scripps pledged $10,000 to build a road from La Jolla to Torrey Pines, connecting the marine lab to the town.

1910 – George H. Scripps Memorial Marine Biological Laboratory Building, designed by architect Irving J. Gill, opened. Staff consisted of Ritter as director, two scientific assistants, a part-time librarian, master of the ship Alexander Agassiz, a superintendent of grounds, and six non-resident assistants.

1912 – The Marine Biological Association transferred its property to the University of California and the institution was renamed The Scripps Institution for Biological Research of the University of California.

Little Green Laboratory circa 1905

1924 – Thomas Wayland Vaughan became the second Director. Under Vaughan, the scope of research was broadened to include physiology, chemistry, and geology as well as biology. Scripps Institution of Oceanography secured a new oceanographic vessel, built a new aquarium, and expanded the laboratory building and library.

1925 – The institution was renamed Scripps Institution of Oceanography.

1932 – Ellen Browning Scripps established a $400,000 endowment.

1936 – Harald Sverdrup became the third Director, with the goal to convert Scripps Institution of Oceanography from a marine station to a world class oceanographic institution, broadening the mission to include the study of currents and climate. He was internationally recognized as a leader in ocean science. The annual budget was $89,000, made up of gifts from the Scripps family, matched by the University of California. The staff of twenty-four included seven faculty members and two instructors. The institution had one ship, R/V Scripps, capable of only coastal cruises.

Scripps Institution of Oceanography circa 1915

1938 - Forty stations were established to sample plankton, currents, and ocean chemistry of the California Current system, establishing a strong connection between currents, water masses, and fishery spawning grounds. This monitoring lasted only three years due to the war but forged agency collaborations invaluable for larger-scale monitoring after the war. Scripps Institution of Oceanography graduate program supervision was moved from UC Berkeley to UCLA.

1939-40 – Gulf of California Expedition, the first major Scripps Institution of Oceanography expedition, investigated the oceanography and geology of the Gulf of California.

1942 – Sverdrup and co-authors Martin Johnson and Richard H. Fleming published the first modern textbook on oceanography, the authoritative and "epoch-making" *The Oceans: Their Physics, Chemistry and Biology.*

1941-45 – Research was directed to wartime needs, especially critical research in support of naval operations: wave forecasting for beach landings, research on oceanic currents, sonar and acoustics, meteorology, and ship-fouling organisms. Roger Revelle, who went on active military duty, worked to integrate oceanographic research into Navy planning. Walter Munk and Sverdrup trained naval officers in meteorology and developed wave forecasting methods used to plan amphibious landings in the European and Pacific theaters.

1946 – Scripps scientists participated in Operation Crossroads, the first postwar atomic test on Bikini Atoll. Marine Physical Laboratory (Director, Carl Eckart) was established as a successor to the wartime University of California Division of War Research to study scientific problems in underwater physics with special emphasis on underwater sound. MPL became part of Scripps Institution of Oceanography in 1948.

1948-1950 – Carl Eckart, fourth Director, oversaw the beginnings of the major postwar expansion of oceanographic research, from a staff of 47 in 1948 to a staff of 242 in 1949, funded by new support from the State of California and the Office of Naval Research (ONR).

1948 – The Marine Life Research (MLR) Program was established, part of the multi-agency California Cooperative Fisheries Program (CalCOFI) to investigate the causes of the California sardine industry collapse, focused on researching currents, plankton, chemistry and marine life in the California Current system.

1949 – CalCOFI cruises began, with monthly monitoring of a huge sampling grid out to 400 miles from shore, from the Columbia River to halfway down Baja California. Data and collections from these cruises comprise the longest regional time-series of plankton and oceanographic conditions in the world.

1950 – Midpac Expedition, the first of many large-scale expeditions to the far Pacific Ocean, studied marine biology, chemistry, and geology. This expedition discovered the Mid-Pacific Mountains and conducted the first successful measurement of heat flow through the ocean floor. T. Wayland Vaughn Aquarium opened to the public.

1951-1964 – Roger Revelle is fifth Director. During Revelle's tenure, federal funding increased significantly, a sea-going research fleet was built and numerous expeditions were launched all over the Pacific, major research efforts on California fisheries expanded in MLR, and plans were successfully made for an affiliated graduate research university that became UCSD. Land was purchased by the Scripps Estates Association, organized to provide open (no covenants) affordable housing for university staff.

1951 – Northern Holiday Expedition to the Gulf of Alaska collected many catches with the newly developed Isaacs-Kidd Midwater Trawl.

1952 – Shellback Expedition (to the eastern tropical Pacific) studied the Peru current and sampled marine life living in low-oxygen waters. Capricorn Expedition (to Bikini and the Tonga trench) was the first Scripps use of scuba divers on expeditions. The Oceanids was organized, a women's group to foster social interaction and to help the wives understand the science that was being pursued at Scripps. The organization was also called upon to supply appropriate food at various social events.

1954 – Institute of Marine Resources (Acting Director, Charles Wheelock) was established to foster research and education about marine resources including fisheries and minerals. Revelle secured a one million dollar grant from the Rockefeller Foundation to enlarge faculty and expand teaching and research in marine biology.

1956 – Charles David Keeling was recruited to Scripps Institution of Oceanography to monitor carbon dioxide in the ocean and atmosphere and began the measurements at Mauna Loa in 1958 that show the systematic rise of atmospheric carbon dioxide now celebrated as the "Keeling curve." Proposition J on city ballot authorized use of Pueblo lots 1311 for UC to establish new graduate divisions: Institute of Applied Physics and Institute of Mechanics. General Dynamics offered UC one million dollars for establishment of a graduate program in science and technology in La Jolla.

1957 – Revelle and Hans Seuss published a paper in *Tellus* on carbon dioxide exchange between atmosphere and ocean. Regents grant $2,213,520 for Scripps Institution of Oceanography growth. Harold Urey accepted appointment as UC professor-at-large, housed in La Jolla, spearheading the recruitment of outstanding scientists for the new schools.

1957 to 1958 – International Geophysical Year (IGY) included establishing 16 Pacific stations to measure sea-level fluctuations and ocean chemistry. Three Scripps Institution of Oceanography expeditions to the Pacific included Downwind, Dolphin, and Doldrums, studying geophysics, ocean currents, marine biology, and marine chemistry.

1958 – A symposium was convened on broad-scale oceanic patterns of the 1957-58 El Niño by Oscar Sette & John Isaacs: "The Changing Pacific Ocean in 1957 and 1958" (published in 1959 and 1960). This symposium initiated Jerome Namias interest in Scripps Institution of Oceanography and his move to La Jolla.

1958 – Regents authorized establishment of Institute of Technology and Engineering. Roger Revelle is appointed Director.

Scripps Institution of Oceanography circa 1955

1959 – Regents approve development of a general UC campus in La Jolla.

1959-1961 – Naga Expedition to survey marine resources of the South China Sea and Gulf of Thailand.

1960 to 1965 – International Indian Ocean Expedition was Scripps first exploration of the Indian Ocean. Several expeditions in collaboration with institutions worldwide explored the oceanography and geology of this region.

1960 – Institute of Geophysics (later renamed Institute of Geophysics and Planetary Physics or IGPP) was established with Walter Munk as Director.

1961 to 1965 – Fred Spiess was appointed acting director and then sixth Director in 1964. Under Spiess's tenure, the Physiological Research Laboratory was established and the floating platform FLIP for studying marine systems below the waves was launched.

1963 – Physiological Research Laboratory was established to study the physiology of large marine invertebrates and mammals.

1965 to 1986 – Under William Nierenberg, the seventh Director, Scripps budget increased five-fold, despite funding challenges as ONR funds dried up, graduate education was expanded and an applied ocean sciences program initiated. Large-scale computers were installed on research vessels.

1966 – Scripps Institution of Oceanography became the operating institution for the Deep Sea Drilling Project (DSDP) managed under the auspices of JOIDES (Joint Oceanographic Institutions Deep Earth Sampling). The DSDP Building was built in 1970.

1968 – Under John Isaacs, the North Pacific Buoy Program established the first unmanned deep-water "Bumblebee" buoys moored in the north Pacific to continuously record ocean conditions for understanding large-scale air-sea interaction. Alongside these were "Monster buoys" built by Convair which telemetered oceanographic data to shore.

1971 – Jerome Namias came to Scripps Institution of Oceanography permanently. He established an atmospheric science research program at Scripps and founded the Climate Research Group, focused on large-scale air-sea interactions and their relation to climate prediction. This group won a national competition to form the first Experimental Climate Prediction Center, extending climate prediction to multi-seasonal scales. The climate research group later became the Climate Research Division which included notable climate researchers like Tim Barnett, Richard Somerville, and Dan Cayan.

1972 – The North Pacific Buoy Program expanded into the North Pacific Experiment (NORPAX), a multi-institution study of the upper water column and atmosphere of the North Pacific.

1979 – Satellite Oceanography Facility opened, the first remote sensing satellite facility established at an oceanographic research center, designed to receive data telemetered from satellites, including climate-related sea-surface conditions.

1986-96 – Edward Frieman, Scripps's eighth director, expanded on Nierenberg's legacy, supporting collaborative global environmental research and promoting the development of instruments and systems of observation to monitor the ocean and atmosphere. A new curriculum in oceanography was initiated for undergraduates and prominent scholars like Veerabhaadran Ramanathan were recruited to Scripps Institution of Oceanography.

1986 – Budget over $60,000,000.

Scripps Institution of Oceanography circa 1980

1987-1988 – A new pier was completed, named the Ellen Browning Scripps Memorial Pier, one of the biggest oceanographic research piers in the world.

1992 – The new Birch Aquarium at Scripps opened with about 60 tanks of Pacific fishes and invertebrates including a 70,000-gallon kelp forest, an Explorers Gallery showcasing Scripps Institution of Oceanography research, a Tide Pool Plaza, and many educational exhibits.

1996 – The new ship R/V Roger Revelle was launched.

1998-2006 – Charles F. Kennel, ninth Director. Kennel was the founding Director of the UCSD Environment and Sustainability Initiative.

1995 – Organization of Center for Clouds, Chemistry and Climate, bringing together American and European institutions "to develop the theoretical, observational and model framework for representing cloud, aerosol and chemical processes and their related climate forcing for the prediction of global and regional climate changes."

2006-12 – Under Scripps tenth Director, Tony Haymet , Scripps developed an outreach program to encourage a clean energy industry in San Diego and worked to achieve his "five-point plan of people (including diversity, infrastructure, vessels, outreach and teaching)."

2013 - present – Margaret Leinen, Vice Chancellor for Marine Sciences, eleventh Director of Scripps Institution of Oceanography, and Dean of the Graduate School of Marine Sciences, UC San Diego.

2015 – Richard and Carol Dean Hertzberg made $5 Million gift to Scripps Institution of Oceanography for the new Center for Climate Change Impacts and Adaptation

2016 – Scripps Institution of Oceanography
California Sea Grant College Program
Center for Clouds, Chemistry, and Climate
Center for Marine Biodiversity and Conservation
Center for Marine Biotechnology and Biomedicine
Center for Observations, Modeling, and Prediction at Scripps
Climate, Atmospheric Science, and Physical Oceanography
Cooperative Institute on Marine Ecosystems and Climate

Geosciences Research Division
Institute of Geophysics and Planetary Physics Integrative Oceanography Division
Joint Center for Observational Systems Science Marine Biology Research Division
Marine Physical Laboratory
Scripps Genome Center

Additional facilities:
Research fleet: R/V Roger Revelle, R/V Sally Ride, R/V Robert Gordon Sproul, FLIP, and two emeritus vessels

Nimitz Marine Facility (MarFac) comprising 6 acres on San Diego Bay in Point Loma, the home port and technical support center for the research fleet

Birch Aquarium

SCRIPPS INSTITUTION OF OCEANOGRAPHY Collections, the largest and most complete university-based oceanographic collection in the world, with pre-eminent collections of marine vertebrates, pelagic invertebrates, benthic invertebrates, and geological samples

STUDIES AT SCRIPPS are generally grouped into the three basic academic sections of Biology, Earth Science, and Oceans and Atmosphere, with major research areas in:

Applied Ocean Sciences, Biological Oceanography, Climate Sciences Geosciences
Geophysics
Marine Biology
Marine Chemistry and Geochemistry Physical Oceanography

In addition, there are several interdisciplinary groups, specialized research units, and university institutes.

Scripps staff totals about 1,600, including about 100 faculty, 400 other scientists, and nearly 250 graduate students who actively participate in lab studies and fieldwork. There are ship crews, technicians, various specialists, and visitors from many nations involved in research and educational programs.

The institution's annual expenditures total more than $170 million. Most funding comes as contracts and grants for basic research from federal agencies, primarily the National Science Foundation, the Department of the Navy, the National Oceanic and Atmospheric Administration, NASA, and the Department of Energy. The state of California provides about 14 percent of the Scripps budget. Private gifts and endowments furnish funds critical to launching new areas of research, supporting students, purchasing equipment, and constructing new facilities.

Image to Right

DUST

MARCELA PAZ LUNA ROSSEL | 2016

Mixed media mosaic on board

Cover Image

DISSOLUTION

MARCELA PAZ LUNA ROSSEL | 2016

Mixed media mosaic on board

LA JOLLA HISTORICAL SOCIETY