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SANTA CRUZ

CRYOSPHERE: Frozen in Time

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in
DIGITAL ARTS AND NEW MEDIA

by
Christopher ivins, BFA

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ABSTRACT

CRYOSPHERE: Frozen in Time

Christopher ivins

CRYOSPHERE: Frozen in Time presents still and moving images, narrated by letters written to a past self, to articulate the encounter between the half-century-old artist and the two-and-a-half-million year old cryosphere, the solid water of Earth. Glaciers advance and recede. Memories of three short decades fast forward and rewind in funerary remembrance. The memoriam shows viewers an intimate, one-sided glimpse of love lost to a changing landscape. The three-screen installation offers a meditative space for considering ice sheets — now vanishing on a human time scale — and allows viewers to contemplate the coinciding deaths of humans and the cryosphere.

IN MEMORY OF

Dorothy J. Ivins, OTR, Anthony H. ivins, MFA, and Crispin González, MFA,

who gave me my first formal art instruction.

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I. **Stills**

Before strapping crampons to my cold weather boots, I pulled out the waterproof film camera I purchased a few weeks earlier in Hong Kong, to photograph my platoon on the towering ice bridge above. The cave was a remnant of a moulin at the terminus of Gulkana Glacier, Alaska, where two soldiers died the previous year.[1] I used my first 35MM camera to capture the image of the first glacier I ever climbed. (See Figure 1.) Thirty years later that photograph was printed and hung for the Master of Fine Arts (MFA) thesis exhibition, *Interstices,* at the University of California, Santa Cruz (UC Santa Cruz), as part of the exhibit, *CRYOSPHERE: Frozen in Time*. The exhibit presents still and moving images, narrated by letters written to a past self, to articulate the encounter between the half-century-old artist and the two-and-a-half-million year old cryosphere, the solid water of Earth.[2]

The University of Utah Department of Military Science sent me to the United States Army Northern Warfare Training Center the same summer the Department of Modern Dance sent me on a dance tour of Asia. My major was modern dance, and my minor was military science. I added my mother's maiden name, Murry as my middle name. My last name "IVINS" even looked like "MNS" on my uniform. My prior service father, Anthony H. ivins taught me

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1 See Appendix 1.

2 See Appendix 1.

to spell my name with lower case “i”s. That summer in 1988 I found myself studying time, space and energy of modern dance, and imaging the cryosphere in military science. (See Figures 2., 3., and 4.) Now I complete the requirements to earn the privilege of putting “MFA” after my name.

Figure 1. *Ice Bridge, Gulkana Glacier, Alaska,*1988, 35MM Film by Cadet Christophe ivins

Figure 2. *Crevasse, Gulkana Glacier, Alaska,*1988, 35MM Film by Cadet Christophe ivins

Figure 3. *Scaling Ice, Gulkana Glacier, Alaska,*1988, 35MM Film by Cadet Christophe ivins

Figure 4. *Cadet Christophe ivins, Gunnysack Hill, Alaska,*1988, 35MM Film
by Cadet John W. Haefner

Just as Eadweard Muybridge and Ansel Adams captured single frame black and white photographs of glaciers in Yosemite and the Teton Mountains from the 1860's and 1910's, I have captured images of glaciers from 1988. *CRYOSPHERE: Frozen in Time* features a tryptic of images depicting Mendenhall Glacier, Alaska captured on my 35MM digital camera twenty two years after I embarked on my first journey to Alaska, which also hung on the wall outside the three screen projection room at UC Santa Cruz. (See Figure 5.) On the surface of Mendenhall Glacier I captured a waterfall and moulin possibly carving another subglacial stream similar to that of Gulkana Glacier. (See Figures 6. and 7.) Till suspended on top of the ice next to my brother, Anthony G. Ivins, posed for a picture.[3] (See Figures 8. and 9.)

Figure 5. *Mendenhall Glacier, Alaska*, 2010, 35MM Digital by Christophe ivins

[3] See Appendix 1.

Figure 6. *Waterfall, Mendenhall Glacier, Alaska*, 2010, 35MM Digital by Christophe ivins

Figure 7. *Moulin, Mendenhall Glacier, Alaska*, 2010, 35MM Digital by Christophe ivins

Figure 8. *Till, Anthony G. Ivins, Mendenhall Glacier, Alaska*, 2010, 35MM Digital by Christophe ivins

Figure 9. *Christophe ivins, Mendenhall Glacier, Alaska*, 2010, 35MM Digital
by Anthony G. Ivins

II. **Heights**

In 1976 Bruce Conner directed *Crossroads*. The short film exhibited the sublime within the mushroom cloud of the 1946 nuclear bomb test at Bikini Atoll thirty years before the first screening of *Crossroads*. This beautifully simple thirty seven minute slow motion film grabs the viewer's gaze and holds it with the force of a… well, a nuclear blast. The newly visible change of landscape is poignant and needs no explanation. Many of the camera angles were shot from above.

Unfamiliar views of familiar subjects guarantees an audience. I see new perspectives whenever I travel by air. I always try to sit in a window seat. I once saw a lightning storm from above at sunset. When the airplane landed, I told my brother, Anthony, "I can die now. I just saw the most amazing thing I'll ever see." Since Anthony is a visual effects artist like me, he understood. We get a broad view of the landscape from above. Aerial views of landscapes have long been sought and gathered at great expense and risk. Perhaps the viewer's appetite for unfamiliar views drives this somewhat suicidal obsession.

Over the past two hundred years, technology used to record our environment has developed more than the previous tens of thousands of years combined. Bird's eye views from satellite imagery became possible with the advent of electronic imaging in the complementary metal-oxide-

semiconductor (CMOS) technology patented by Frank Wanlass at Fairchild Semiconductor in 1963 — the technology which records light in my digital camera. In October 1969, Willard S. Boyle and George E. Smith of Bell Labs invented the charge-coupled device (CCD). The most accurate way to collect meaningful data of changing glaciers makes use of this technology to gather data of overhead views. “Once scientists find a suitable glacier, they must take satellite images of the ice for a minimum of five years and compare the results.”[4]

> There are various satellites used for observation of ice sheets. They have different resolutions (pixel size in the image) and swath sizes (the footprint of the image on the ground). They have different return rates (returning to take the same image). As a result, different applications are best suited to different satellites. ASTER and Landsat are some of the most widely used sensors in glaciology, due to their long history of taking images, broad swaths allowing for regional analysis, and high image resolution. ASTER also takes images as stereo-pairs, meaning that digital elevation models can be made from its images (ASTER GDEM).[5]

But now scientists are threatened by the possibility of losing use of United States federal satellites for study of the Earth below. They are now under pressure to use satellites to only study outer space, even though most satel-

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[4] John Weier. “At the Edge: Monitoring Glaciers to Watch Global Change”, April 14, 1999. earth observatory. https://earthobservatory.nasa.gov/Features/Glaciers

[5] Bethan Davies. “Observing glacier change from space.” AntarcticGlaciers.org. June 22, 2017 http://www.antarcticglaciers.org/glaciers-and-climate/observing-glacier-change-space

lites are in low Earth orbit (LOE).[6] Interruption in data collection is detrimental to the understanding of glacial displacement.

With low altitude unmanned aerial vehicle (UAV) technology becoming ubiquitous, bird's eye views are more abundant, yet still alluring to audiences. Images from these vantage points act as maps showing us where we are in the world.

> Maps are, by definition, abstractions of the reality they purport to present. They can help locate a point in space or navigate from one place to another, but such practical users are underpinned by a question far more existential: Where am I? As a result, these symbolic systems reflect the aims, knowledge gaps, and political and historical moments of their makers. We find these idiosyncrasies vividly apparent in older diagrams but recognize them less easily in maps made today, when the sheer volume of available data seems to imply both objectivity and omniscience.[7]

Map-like overhead views of familiar subjects or sites act as what Robert Smithson defines as non-site representations.[8] The pseudo-suicidal effect I experienced from above the site of a lightning storm might transfer to the audience while viewing non-site exhibitions. *CRYOSPHERE: Frozen in Time* screens my 2017 aerial approach of Palisade Glacier, California, in stop motion fashion, giving the idea of deconstructed time — interference of geologic time. Glaciers are considered by scientists to be alive because they move. If

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6 See Appendix 7.

7 “New Work: Sohei Nishino, November 4, 2014-February 26, 2017.” SFMOMA. https://www.sfmoma.org/exhibition/new-work-sohei-nishino (accessed August 29, 2018).

8 See Appendix 2.

the ice sheet does not move, it is not a glacier. Palisade Glacier's life has been turned upside down as expressed in the rolling of the images until they end on an upside down still of the glacier at sunset. (See Figure 10.) Sounds of Palisade melting and till rolling down its slopes accompany. A letter sent back in time to 2017 tells of the glacier's impending death, "Fourty-eight percent of Palisade Glacier in California has disappeared since the Little Ice Age. Most of the four thousand year old ice melted in your half-century lifetime." A letter predicts what I would learn a few days in the future after my flight. "When you returned from the ice of the Palisade peaks, you learned that Mount Ivins was named in the 2.7 million-year-old ice sheets of Antarctica — named after your brother, Erik Ivins… but you have the same last name."[9] Mount Ivins overlooks Larsen Ice Shelf.[10] (Maybe now is a good time to go back to spelling my name with a capital "I".) Hubbard Glacier, Alaska, is intercut as a stopped motion frame frozen in time, reminding me what I saw through my viewfinder that instant two years earlier. (See Figure 11.)

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9 See Appendices 5 and 6.

10 See Appendix 8.

Figure 10. *Palisade Glacier, California*, 2017, 35MM Digital Aerial by Christophe ivins

Figure 11. *Hubbard Glacier, Alaska*, 2010, 35MM Digital by Christophe ivins

III. **Projections (Fast Forward/Rewind)**

New technologies allow us to capture time-lapse longer than the general limitation of the length of a roll of film. Today time-lapse can compress time so that geologic change over the period of a year might be reviewed in six minutes or less. Through the use of computerized intervalometers, solar power, and high capacity batteries, James Balog of the Extreme Ice Survey (EIS) has been shooting time-lapses of glaciers since 2007. Balog, who has a graduate degree in geology from Boston College and in geomorphology from the Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, is featured in the 2012 internationally acclaimed, Emmy award-winning documentary *Chasing Ice*. His art shows science through a medium of new technology, allowing review 86,000 times faster than the events which are happening 170 times faster than normal. Balog's time-lapse photography is stunning and poignant art, documenting the fastest geological change ever on Earth.[11]

The compression of time gives a different perspective, and affords an altered state in which to contemplate the rapidly changing landscape in projections of *CRYOSPHERE: Frozen in Time*. In 2012 when Voyager 1 left the heliosphere into interstellar space, I captured the Teton Glaciers' experience of two "sunsets" during a solar eclipse to play back forty eight

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[11] James Balog. *Chasing Ice.* DVD. Directed by Jeff Orlowski. New York: Submarine Deluxe, January 23, 2012.

times faster than Earth, the Sun and Moon moved that day.[12] My recollection of half a lifetime ago in a human timeframe, and less than one hundredth of the glacier's existence, is narrated by letters to a past self. "The Scouts said you almost froze to death swimming a mile in ice water on the west side of the Teton Glaciers. But you see? You lived to capture this solar eclipse over the dying glaciers three decades later." "You learned to ski on the glaciers of Teton Village in Wyoming." (See Figure 12.) I had photographed the same glaciers close up six years earlier at Jenny Lake. (See Figure 13.) Motion of

Figure 12. *Solar Eclipse, Teton Glaciers, Wyoming*, 2012, 35MM Digital by Christophe ivins

12 See Appendices 1 and 4.

Figure 13. *Teton Glaciers, Jenny Lake, Wyoming*, 2012, 35MM Digital by Christophe ivins

Hubbard Glacier is intercut and accompanied by the chilling backtracked sound of a screaming woman captured on location.

A third projection is of Hubbard Glacier calves in reverse, showing the reverse entropy of the event.[13] This simple time manipulation to see into the past allows for the most insight about the future. The reversal of time gives viewers of the memoriam an intimate, one-sided glimpse of love lost to a changing landscape.

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13 See Appendix 3.

Three rear projection screens opens the possibilities for architectural design of a a non-site in the exhibition space. Viewers can view the projections from different perspectives, even from behind. The small walkthrough space, converted from the screening room of the Digital Arts Research Center, afforded room for three eight foot screens. Two were set up diagonally from two opposite corners of the room and parallel to each other. The third covered the far corner from the entrance, parallel to the other two screens. The far screen from the entrance was boomed as low as possible and reflected the widest shots including Teton Glaciers, while the closest screen was boomed as high as possible and displayed the close-up shots of Palisade Glacier. Viewers had limited space to move through the room, and were enticed to stay on the entrance side of the projections. (See Figure 14.) I have been queried about projecting on three walls of another small room. I hope to explore other possibilities with more time, space, and energy.

Figure 14: *Christophe ivins, Cryosphere: Frozen in Time*, Interstices Exhibition, University of California, Santa Cruz, 2018, Digital Still by Kathleen Deck

IV. **Volumetrics**

In 2009 I worked the final nine months of postproduction for the movie *Avatar*, directed by James Cameron. My job title was postvisualization compositor. I had never heard of postvisualization before. I understand it is derived from Ansel Adams' previsualization and visualization. I composited existing live action footage over computer generated imagery (CGI) characters and backgrounds in development, to create visualization of live action characters already shot on set. Landscapes were manifested by the director and CGI artists' imaginations. Future worlds were postvisualized. At the time, this post-apocalyptic story was created with state of the art digital image sensors, robotic motion-controlled cameras, motion capture virtual cameras operated by humans, and custom 3D stereo camera rigs. All of this technology existed previously, but was never combined before to create a 3D movie with live action and CGI characters in CGI landscapes. Predictions of future landscapes without glaciers on Earth can also be postvisualized in 3D by imaging artists.

Artist Helen Glazer captures three-dimensional data in order to reproduce Antarctic glaciers in miniature scale. "Glazer has visited real glaciers. As a participant in the National Science Foundation's Antarctic Artist and Writers Program, she has also created scale models of them…"[14] The National Sci-

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14 Carla Giaimo, "The Artist Shrinking Antarctica's Glaciers: Using 3-D imaging, Helen Glazer brings the southernmost continent indoors." Atlantas Obscura. December, 2017. https://www.atlasobscura.com/articles/antarctica-glaciers-3d-sculptures-helen-glazer

ence Foundation's Antarctic Artist and Writers Program helped her get to Antarctica to capture image data.

The latest technology in 3D depth-mapping light field cameras enable us to capture volumetric data within images. Scientists have begun to test light-field cameras for the purposes of gathering three-dimensional image data. Testing has been done with Lytro Illum cameras for crop growth monitoring. The National Aeronautics and Space Administration (NASA) investigated the use of Lytro Illum cameras for possible integration into new Mars Rovers.

In 2017 Dr. Slawomir Tulascyk of the Earth and Planetary Sciences Department, University of California, Santa Cruz tested my Lytro Illum camera and housing in Antarctica. -20˚ Celcius temperatures proved too cold for the camera in it's current configuration. (See Figure 15.) I hope to incorporate a heater within the housing, add more cameras for better triangulation, and send the gear back to Antarctica. Professor Tulaczyk is leading a team of scientists to Thwaites Glacier for what some call the biggest field operation ever mounted in Antarctica. If volumetric motion data of Thwaites Glacier is captured, it can be used for scientific analysis, and for adding three dimensionality to *CRYOSPHERE: Frozen in Time*.

Figure 15. *Volumetric Motion Data Camera*, 2017, Digital by Christophe ivins

V. **Developments**

"Fifty years of U.S. Geological Survey (USGS) research on glacier change shows recent dramatic shrinkage of glaciers in three climatic regions of the United States. These long periods of record provide clues to the climate shifts that may be driving glacier change."[15] Based on the study of these broad view perspectives, approximately 97% of peer reviewed scientists who express a position on weather extremes endorse the scientific consensus that they can be attributed to manmade processes. Scientists also believe we may be losing as many as 140,000 species per year, the fastest extinction since the dinosaurs disappeared 66 million years ago during the Cretaceous-Paleogene Fifth mass extinction event — the same dinosaurs being burned by humans creating the current Sixth mass extinction event.[16]

On July 7, 2007 Vice President Al Gore created awareness through music on seven continents simulcast via television, radio, and live internet streaming technologies to borrow the ears of a global audience. Governor Jerry Brown of California and President Barack Obama heard those songs and answered accordingly with policies which Obama reassures us have created *The irreversible momentum of clean energy.*[17] Lately US government

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15 "Fifty-Year Record of Glacier Change Reveals Shifting Climate in the Pacific Northwest and Alaska, USA", Fact Sheet 2009-3046. USGS: science for a changing world. June, 2009. https://pubs.usgs.gov/fs/2009/3046/pdf/fs20093046.pdf

16 See Appendix 1.

17 B. Obama. *The irreversible momentum of clean energy*, January 9, 2017. Science, 10.1126/science.aam6284. 1.

websites and twitter accounts are not reliable for display of scientific data. Rogue twitter accounts apparently created by government employees sprung up after tweets about weather extremes from an official Badlands National Park account were deleted last year. These accounts continued to tweet about climate change in the poetic guidelines of less than 140 characters.[18] "The crack in this Antarctic ice shelf just grew by 11 miles. A dramatic break could be imminent."[19] This tweet foreshadowed the calving of Larsen C ice shelf, creating one of the largest icebergs in history. Glaciers advance and recede. Glacial displacement caused by increasing temperatures makes massive redistribution of water across the globe. "Earth does not always spin on an axis running through its poles. Instead, it wobbles irregularly over time, drifting toward North America throughout most of the 20th Century. That direction has changed drastically due to changes in water mass on Earth."[20] This Earth moving scientific fact has eluded many Americans.

The bridge between scientific facts and the minds of the public is art. As Christiane Paul put it, "Maybe art museums belong in a science

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18 "Rogue Nasa account fights Trump on climate change." BBC. January 26, 2017. https://www.bbc.com/news/world-us-canada-38756447

19 "#climatechange." Rogue NASA. https://twitter.com/RogueNASA (accessed Jan 31, 2017). See Appendix 9.

20 Carol Rasmussen. "Study solves two mysteries about wobbling Earth." Global Climate Change: Vital Signs of the Planet. April 7, 2016. https://climate.nasa.gov/news/2428/study-solves-two-mysteries-about-wobbling-earth

museum."[21] Art can captivate the viewer and then let them question. Manfred Mahr speaks of computer generated art, "If art is to reflect and embrace our social and technological world, it should also be created from the same 'material' ".[22] My brother, Dr. Erik Ivins, Senior Research Scientist and American Geophysical Union (AGU) Fellow, Sea Level and Ice Group, Jet Propulsion Laboratory, California Institute of Technology, tells me that his peers would appreciate artwork based on their collected data. In the time-based art of motion pictures, science fiction is often based on science and sometimes foreshadows advances in science, as is evident in *2001: A Space Odyssey*. The future of space travel and the landscapes beyond Earth are imagined through the eyes of artist and director Stanley Kubrick. We can use imaging technology to understand our new times and imagine our future.

In *CRYOSPHERE: Frozen in Time* memories of three short decades fast forward and rewind in funerary remembrance. The three-screen installation offers a meditative space for considering ice sheets — now vanishing on a human time scale — and allows viewers to contemplate the coinciding deaths of humans and the cryosphere.

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21 Christiane Paul. *New Media in the White Cube and Beyond, 3 Challenges for a Ubiquitous Museum.* Berkley: University of California Press, 2008.

22 Manfred Mohr. "10 Interviews: Image, *Manfred Mohr (Une Esthétique Programée).*" In *Processing: A Programming Handbook for Visual Designers and Artists, Second edition* by Casey Reas and Ben Fry. Cambridge: The MIT Press, 2014. 127.

VI. **Space and Beyond…**

Advances in science have continued to improve our understanding of our environment. The last fifty years have improved our vision exponentially. We can now see the past and visualize into the future to see the outcome of the course we choose for our planet. CCD and Near Infrared Camera and Multi-Object Spectrometer (NICMOS) sensors on the Hubble Space Telescope capture images of a young galaxy "as it existed 13.4 billion years in the past, just 400 million years after the big bang, when the universe was only three percent of its present age."[23] Humans race to outer space to populate Mars in the near future. The same technological capacity for space migration can be harnessed to engineer the preservation of the gardens at the edges of Earth's cryosphere, rather than mine them into a Martian landscape.

> Anne Quirynen compares the landscapes of Earth mines to those of uninhabitable alien environments in *Mars Analogue*. With her installation mars analog, video artist Anne Quirynen takes us from the ravaged landscape of the Minas de Riotinto in Spain to utopias of the colonization of Mars. For hundreds of years, both the planet Mars and the Minas de Riotinto have been objects in the creation of myths and of research: Minas de Riotinto is one of the oldest copper mines in the world and it is believed that these are the mines of the mythical King Solomon while today industrial archaeologists and scientists are researching the conditions of life on earth. As the consistency of the soil, due (partially) to the surface mining, is similar to that on Mars, the scarred landscape of Rio Tinto has become an analogue terrestrial site for simulation of future missions to Mars. The edited pictures and the found footage material by mars ana-

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[23] "Hubble Team Breaks Cosmic Distance Record." NASA. March 3, 2016. https://www.nasa.gov/feature/goddard/2016/hubble-team-breaks-cosmic-distance-record

> log provide a small glimpse into the role of humanity in these two ghost-like empty landscapes.[24]

On July 27th, 2018, Mars was closer to Earth than it has been in fifteen years. I captured it in the same frame as the moon and scaled the image of Mars up to approximately the same size as that of the Moon. The individual pixels representing the moon cannot be discerned by the human eye on my thirteen inch monitor, yet Mars is so far from my lens that it's diameter is only thirteen pixels. (See Figures 16. and 17.) Shortly before I shot the Moon and Mars, the European Mars Express spacecraft with its Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) instrument, may have found liquid saltwater a mile beneath Mars' frozen south pole.[25] Inspired by Anne Quirynen, I plan to use this imagery, along with that gathered by telerobotic spacecraft, in a polar comparison of Earth and Mars. Robots transmitting images to Earth, are the only Earthlings to visit the Mars site. Few humans visit the much closer polar regions of Earth. Only non-site representations can be experienced to date.

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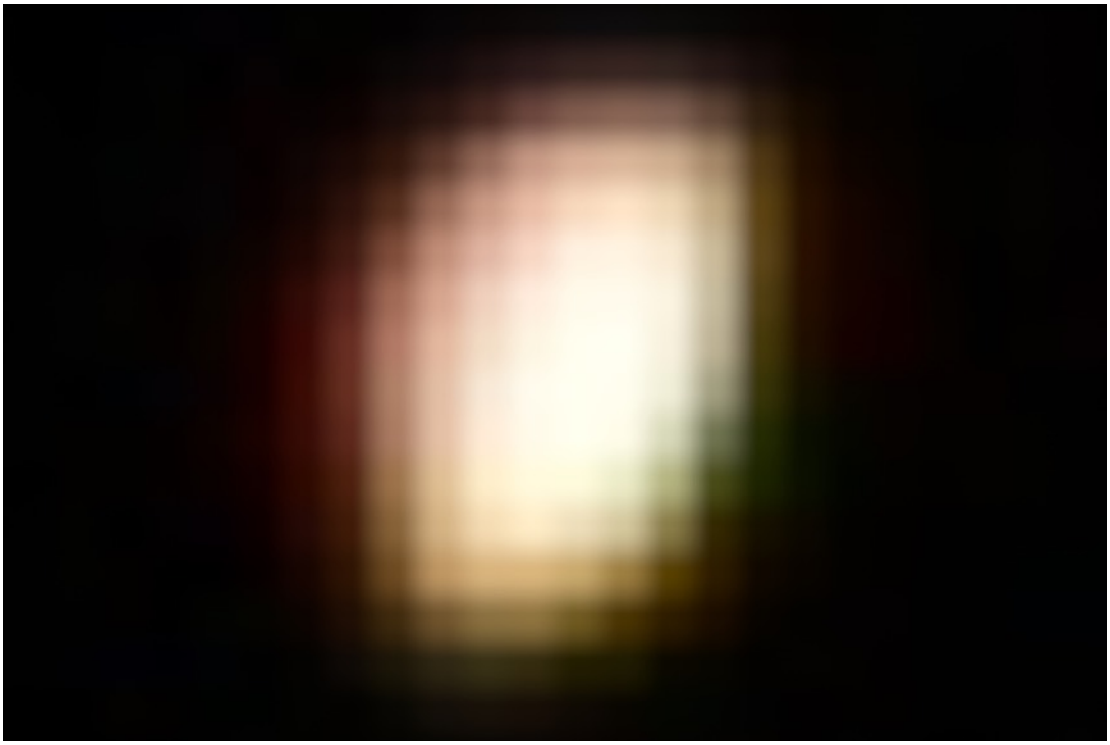
[24] Anne Quirynen, "Mars Analog." Cargo Collective, http://cargocollective.com/annequirynencargcollective/mars-analog (accessed Aug 26, 2018)

[25] "NASA Statement on Possible Subsurface Lake near Martian South Pole." NASA. July 25, 2018. https://www.jpl.nasa.gov/news/news.php?feature=7200

Figure 16. Moon, Jul 27, 2018, 35MM Digital by Christophe ivins

Figure 17. *Mars*, Jul 27, 2018, 35MM Digital by Christophe ivins



Based on NASA projections Dr. Erik Ivins' granddaughter, Petra Maple Stevens is of age to travel to Mars. At age eight she has begun the future of cryosphere imaging with her acrylic on canvas painting of *Arctic Polar Bear*. (See Figure 18.) She might continue into the future after I am gone. The accelerated end of me, my vision, and the subject of my work are coinciding in a few short decades. Ice sheets vanish into the abyss, and so do we.

Figure 18. Arctic Polar Bear, 2017, Acrylic on Canvas by Petra M. Stevens

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Appendix 1: **Terminology**

Cretaceous-Paleogene Fifth Mass Extinction Event
The Cretaceous event (58-60, 76-79) ended ~65 million years ago; within 2.5 million years to less than a year 40% of genera were lost, an estimated 76% of species. Proposed causes: A bolide impact int the Yucatán is thought to have led to a global cataclysm and caused rapid cooling. Preceding the impact, biota may have been declining owing to a variety of causes: Deccan volcanism contemporaneous with global warming; tectonicupshift altering biogeography and accelerating erosion, potentially contributing to ocean eutrophication and anoxic episodes. CO_2 spike just before extinction, drop during extinction.[26]

Cryosphere
The Cryosphere is the frozen water of the Earth system.

There are places on Earth that are so cold that water is frozen solid. These areas of snow or ice, which are subject to temperatures below 32°F for at least part of the year, compose the cryosphere. The term “cryosphere” comes from the Greek word, “krios,” which means cold.

Ice and snow on land are one part of the cryosphere. This includes the largest parts of the cryosphere, the continental ice sheets found in Greenland and Antarctica, as well as ice caps, glaciers, and areas of snow and permafrost. When continental ice flows out from land and to the sea surface, we get shelf ice.

The other part of the cryosphere is ice that is found in water. This includes frozen parts of the ocean, such as waters surrounding Antarctica and the Arctic. It also includes frozen rivers and lakes, which mainly occur in polar areas.

The components of the cryosphere play an important role in the Earth’s climate. Snow and ice reflect heat from the sun, helping

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[26] Anthony D. Barnosky, Nicholas Matzke, Susumu Tomiya, Guinevere O. U. Wogan, Brian Swartz, Tiago B. Quental, Charles Marshall, Jenny L. McGuire, Emily L. Lindsey, Kaitlin C. Maguire, Ben Mersey & Elizabeth A. Ferrer. *Has the Earth’s sixth mass extinction already arrived?.* NATURE, VOL 471, Mar 3, 2011. 51. doi: 10.1038/nature09678

to regulate our planet's temperature. Because polar regions are some of the most sensitive to climate shifts, the cryosphere may be one of the first places where scientists are able to identify global changes in climate.[27]

Heliosphere
"The solar wind, emanating from the Sun, creates a bubble that extends far past the orbits of the planets. This bubble is the heliosphere, shaped like a long wind sock as it moves with the Sun through interstellar space."[28]

Ice Sheet
A thick, subcontinental to continental-scale accumulation of glacier ice and perennial snow that spreads from a center of accumulation, typically in all directions. Also called a Continental Glacier.[29]

Moulin (Glacier Mill)
"A narrow, tubular chute or crevasse through which water enters a glacier from the surface. Occasionally, the lower end of a moulin may be exposed in the face of a glacier or at the edge of a stagnant block of ice."[30]

Terminus
"The lower-most margin, end, or extremity of a glacier. Also called Toe, End or Snout."[31]

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27 "What is the cryosphere?" National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. oceanservice.noaa.gov/facts/cryosphere.html (accessed August 30, 2018).

28 "The Heliosphere." NASA. https://www.nasa.gov/mission_pages/sunearth/science/Heliosphere.html (accessed Aug 14, 2018)

29 "Glossary of Glacier Terminology - Text Version." USGS: science for a changing world. https://pubs.usgs.gov/of/2004/1216/text.html (accessed August 14, 2018).

30 Ibid.

31 Ibid.

Till

"An unsorted and unstratified accumulation of glacial sediment, deposited directly by glacier ice. Till is a heterogeneous mixture of different sized material deposited by moving ice (lodgement till) or by the melting in-place of stagnant ice (ablation till). After deposition, some tills are reworked by water."[32]

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32 Ibid.

Appendix 2: **A Provisional Theory of Non-Sites**

By drawing a diagram, a ground plan of a house, a street plan to the location of a site, or a topographic map, one draws a "logical two dimensional picture." A "logical picture" differs from a natural or realistic picture in that it rarely looks like the thing it stands for. It is a two *dimensional analogy or metaphor* - A is Z.

*The Non-Site (an indoor earthwork)** [33] is a three dimensional logical picture that is *abstract*, yet it *represents* an actual site in N.J. (The Pine Barrens Plains). It is by this dimensional metaphor that one site can represent another site which does not resemble it - this *The Non-Site*. To understand this language of sites is to appreciate the metaphor between the syntactical construct and the complex of ideas, letting the former function as a three dimensional picture which doesn't look like a picture. "Expressive art" avoids the problem of logic; therefore it is not truly abstract. A logical intuition can develop in an entirely "new sense of metaphor" free of natural of realistic expressive content. Between the *actual site* in the Pine Barrens and *The Non-Site* itself exists a space of metaphoric significance. It could be that "travel" in this space is a vast metaphor. Everything between the two sites could become physical metaphorical material devoid of natural meanings and realistic assumptions. Let us say that one goes on a fictitious trip if one decides to go to the site of the *Non-Site*. The "trip" becomes invented, devised, artificial; therefore, one might call it a non-trip to a site from a Non-site. Once one arrives at the "airfield", one discovers that it is man-made in the shape of a hexagon, and that I mapped this site in terms of esthetic boundaries rather than political or economic boundaries (31 sub-division-see map).

This little theory is tentative and could be abandoned at any time. Theories like things are also abandoned. That theories are

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[33] *Non-Site #1. Smithson changed the title for this text which was initially "Some Notes on Non-Sites." It has been partially excerpted by Lawrence Alloway in "Introductions 1: Options, Milwaukee Art Center", 1979, p. 6

eternal is doubtful. Vanished theories compose the strata of many forgotten books.[34]

[34] Robert Smithson, “ESSAYS: SELECTED WRITINGS BY ROBERT SMITHSON”. ROBERT SMITHSON. From “Unpublished Writings” in *Robert Smithson: The Collected Writings, 2nd Edition,* edited by Jack Flam. Berkeley: University of California Press, 1996. http://www.robertsmithson.com/essays/provisional.htm

Appendix 3: **Entropy**

Entropy And The New Monuments

	On rising to my feet, and peering across the green glow of the Desert, I perceived that the monument against which I had slept was but one of thousands. Before me stretched long parallel avenues, clear to the for horizon of similar broad, low pillars. John Taine (Erick Temple Bell) “THE TIME STREAM"		

Many architectural concepts found in science-fiction have nothing to do with science or fiction, instead they suggest a new kind of monumentality which has much in common with the aims of some of today's artists. I am thinking in particular of Donald Judd, Robert Morris, Sol Le Witt, Dan Flavin, and of certain artists in the "Park Place Group." The artists who build structured canvases and "wall-size" paintings, such as Will Insley, Peter Hutchinson and Frank Stella are more indirectly related. The chrome and plastic fabricators such as Paul Thek, Craig Kauffman, and Larry Bell are also relevant. The works of many of these artists celebrate what Flavin calls "inactive history" or what the physicist calls "entropy" or "energy-drain." They bring to mind the Ice Age rather than the Golden Age, and would most likely confirm Vladimir Nabokov's observation that, "The future is but the obsolete in reverse." In a rather round-about way, many of the artists have provided a visible analog for the Second Law of Thermodynamics, which extrapolates the range of entropy by telling us energy is more easily lost than obtained, and that in the ultimate future the whole universe will burn out and be transformed into an all-encompassing sameness. The "blackout" that covered the Northeastern states recently, may be seen as a preview of such a future. Far from creating a mood of dread, the power failure created a mood of euphoria. An almost cosmic joy swept over all the darkened cities. Why people felt that way may never be answered.

Instead of causing us to remember the past like the old monuments, the new monuments seem to cause us to forget the future. Instead of being made of natural materials, such as mar-

ble, granite, plastic, chrome, and electric light. They are not built for the ages, but rather against the ages. They are involved in a systematic reduction of time down to fractions of seconds, rather than in representing the long spaces of centuries. Both past and future are placed into an objective present. This kind of time has little or no space; it is stationary and without movement, it is going nowhere, it is anti-Newtonian, as well as being instant, and is against the wheels of the time-clock…[35]

SELECTED INTERVIEWS WITH ROBERT SMITHSON

Entropy Made Visible (1973)

Interview with Alison Sky

On Site #4, 1973. This interview took place about two months before Smithson's death. Although published posthumously, Smithson and Sky completed the editing of the text together and Smithson provided all the illustrations.

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ALISON SKY: Isn't entropy actually metamorphosis, or a continual process in which elements are undergoing change, but in an evolutionary sense?

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35 Robert Smithson. “ESSAYS: SSELECTED WRITINGS BY ROBERT SMITHSON.” ROBERT SMITHSON. From “Unpublished Writings” in *Robert Smithson: The Collected Writings*, 2nd Edition, edited by Jack Flam. Berkley: University of California Press, 1996. © Artforum, June 1966. https://www.robertsmithson.com/essays/entropy_and.htm

SMITHSON: Yes and no. In other words, if we consider the earth in terms of geologic time we end up with what we call fluvial entropy. Geology has its entropy too, where everything is gradually wearing down. Now there may be a point where the earth's surface will collapse and break apart, so that the irreversible process will be in a sense metamorphosized, it is evolutionary, but it's not evolutionary in terms of any idealism. There is still the heat death of the sun. It may be that human beings are just different from dinosaurs rather than better. In other words there just might be a different situation. There's this need to try to transcend one's condition. I'm not a transcendentalist, so I just see things going towards a… well it's very hard to predict anything; anyway all predictions tend to be wrong. I mean even planning. I mean planning and chance almost seem to be the same thing.[36]

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[36] Robert Smithson. “ESSAYS: SELECTED INTERVIEWS WITH ROBERT SMITHSON.” ROBERT SMITHSON. In Robert Smithson: *The Collected Writings*, 2nd Edition, edited by Jack Flam. Berkeley and Los Angeles: University of California Press, LTD. London, England; 1996. Originally published: *The Writings of Robert Smithson*, edited by Nancy Holt. New York: New York University Press, 1979. https://www.robertsmithson.com/essays/entropy.htm

Appendix 4: **Voyager**

The twin Voyager 1 and 2 spacecraft are exploring where nothing from Earth has flown before. Continuing on their more-than-39-year journey since their 1977 launches, they each are much farther away from Earth and the sun than Pluto. In August 2012, Voyager 1 made the historic entry into interstellar space, the region between stars, filled with material ejected by the death of nearby stars millions of years ago. Scientists hope to learn more about this region when Voyager 2, in the “heliosheath" — the outermost layer of the heliosphere where the solar wind is slowed by the pressure of interstellar medium — also reaches interstellar space. Both spacecraft are still sending scientific information about their surroundings through the Deep Space Network, or DSN.

The primary mission was the exploration of Jupiter and Saturn. After making a string of discoveries there — such as active volcanoes on Jupiter's moon Io and intricacies of Saturn's rings — the mission was extended. Voyager 2 went on to explore Uranus and Neptune, and is still the only spacecraft to have visited those outer planets. The adventurers' current mission, the Voyager Interstellar Mission (VIM), will explore the outermost edge of the Sun's domain. And beyond.[37]

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37 “Mission Overview.” Voyager. https://voyager.jpl.nasa.gov/mission (accessed Aug 15, 2018)

Appendix 5: **Antarctic Place-Names Committee**[38]

Secretary, Antarctic Place-Names Committee
c/o British Antarctic Survey
High Cross, Madingley Road
Cambridge CB3 OET
United Kingdom

Telephone (01223) 221415
E-mail: a.fox@bas.ac.uk

Dr. Erik Ivins,
Jet Propulsion Laboratory
M/S 300-233
4800 Oak Grove Drive
Pasadena, CA 91109

21 July 2017

Dear Dr Ivins,

ANTARCTIC PLACE-NAMES COMMITTEE

I am pleased to inform you that the UK Antarctic Place-names Committee has approved the following name for British use. The description of the name is as follows:-

Mount Ivins (65°58'00"S, 63°29'54"W)

Most prominent mountain in a series of peaks between Fleece and Leppard glaciers, Graham Land. A 4.2 km long ridge rising to about 2000 m, mainly snow covered but with extensive rock outcrops along the ridge and on the south-west flank.

Named for Dr Erik Ivins, Senior Research Scientist at the NASA Jet Propulsion Laboratory, Pasedena, California. Dr Ivins carried out influential research on glacial isostatic adjustment, with particular focus on Antarctica's response to past and present ice-sheet change.

The name will be added to the British Antarctic Territory Gazetteer (http://apc.antarctica.ac.uk/) and is available for use on all maps, charts and in all publications.

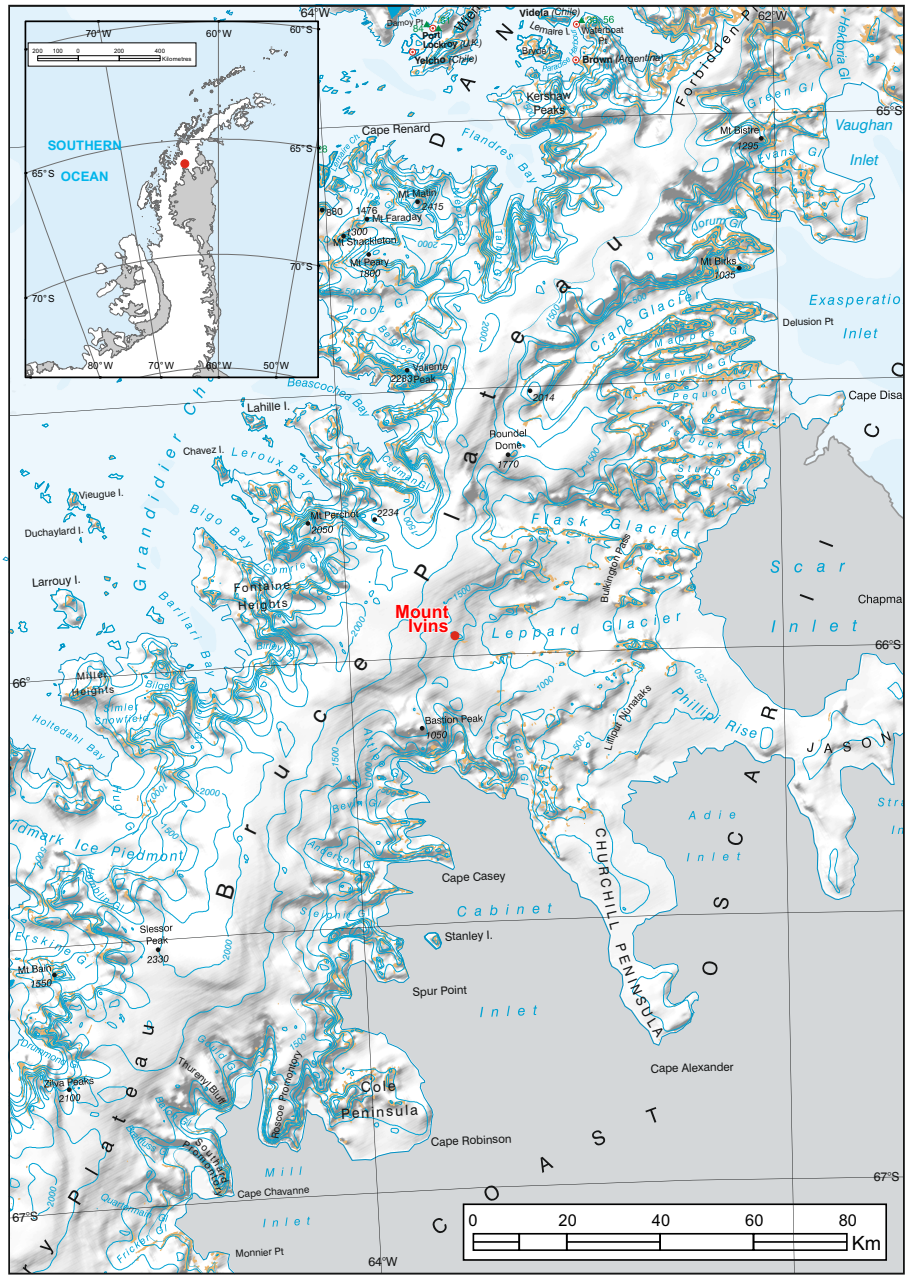
Yours sincerely,

Dr Adrian Fox
Secretary, UK Antarctic Place-names Committee

38 Adrian Fox to Erik Ivins, July 21, 2017

Appendix 6: **Mount Ivins Map**[39]

Mount Ivins



39 British Antarctic Survey. 2017.

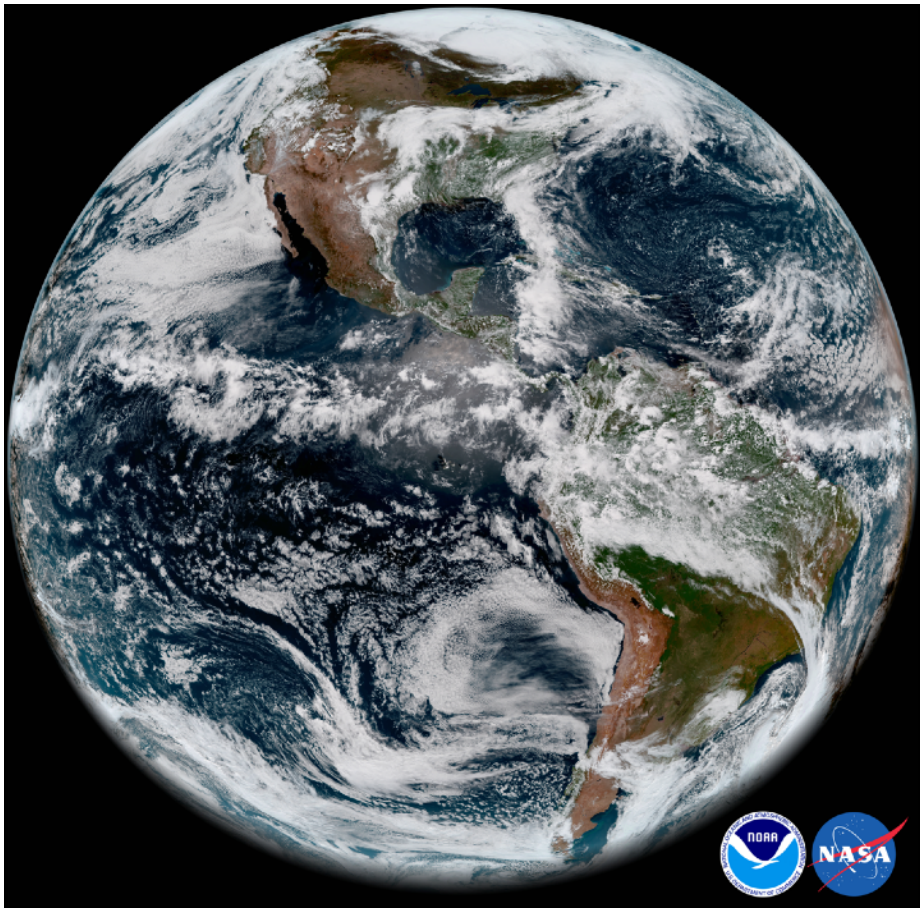
Appendix 7: **GOES-17 Releases 'First Light' Imagery from its Advanced Baseline Imager (ABI)**

Thursday, May 31, 2018

The first imagery from NOAA's GOES-17 Advanced Baseline Imager (ABI) made its public debut today.

GOES-17 took this stunning, full-disk snapshot of Earth's Western Hemisphere from its checkout position at 12:00 p.m. EDT on May 20, 2018, using the Advanced Baseline Imager (ABI) instrument. GOES-17 observes Earth from an equatorial vantage point approximately 22,300 miles above the surface. Credit: NOAA/NASA

…



This imagery was created using two visible bands (blue and red) and one near-infrared "vegetation" band that are functional with the current cooling system performance. The imagery also

incorporates input from one of the ABI's "longwave" infrared bands…

When combined as a "GeoColor" image, depicting the Earth in vivid detail and colors intuitive to human vision, these bands provide valuable information for monitoring dust, haze, smoke, clouds, fog, winds and vegetation. ABI imagery also provides information on cloud motion, helping meteorologists monitor and forecast severe weather and hurricanes. The improved resolution and faster scanning ability of the instrument compared to the previous generation of GOES allow forecasters to more rapidly detect and analyze storms as they are developing and intensifying.

GOES-17 is the second in a series of next-generation geostationary weather satellites. Like GOES-16, its sister satellite operating as GOES East, GOES-17 is designed to provide advanced imagery and atmospheric measurements of Earth from 22,300 miles above the equator.

GOES-17 launched on March 1, 2018, from NASA's Kennedy Space Center…[40]

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40 John Leslie. "GOES-17 Releases 'First Light' Imagery from its Advanced Baseline Imager (ABI)." NESDIS News & Articles. May 31, 2018. https://www.nesdis-.noaa.gov/content/goes-17-releases-%E2%80%98first-light%E2%80%99-imagery-its-advanced-baseline-imager-abi

Appendix 8: **Larsen C Ice Shelf, Antarctica**

http://wapo.st/2iQgCvG?tid=ss_tw … #climatechange[41]

41 "#climatechange." Rogue NASA. https://twitter.com/RogueNASA (accessed Jan 31, 2017).

Appendix 9: ***CRYOSPHERE: Frozen in Time***
Internet Media Data Base (IMDB) Page

https://www.imdb.com/title/tt8706228/?ref_=fn_al_tt_1