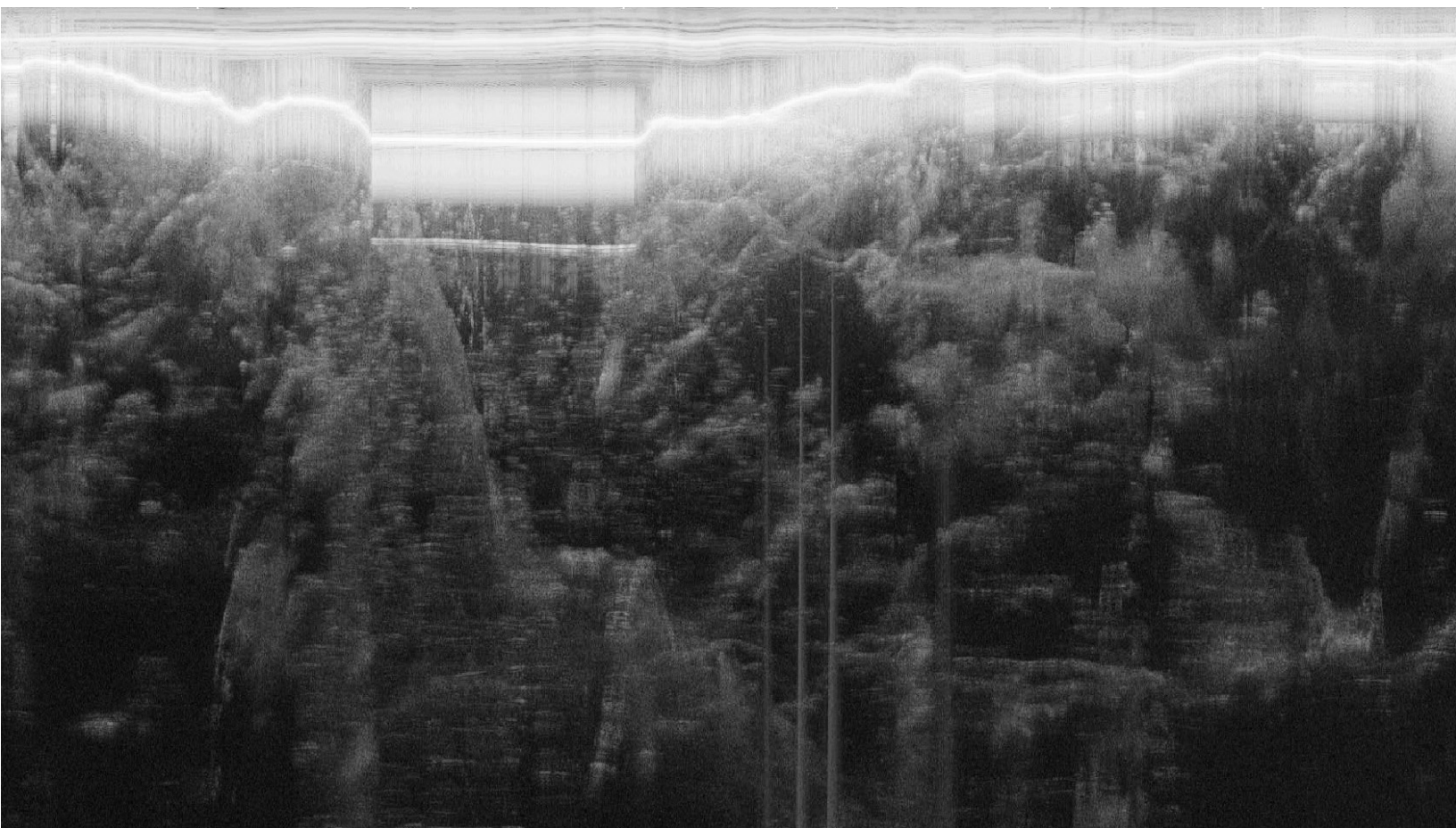# MUTATIS MUTANDIS

MUTATIS MUTANDIS (FROM LAT. "BY CHANGING THOSE THINGS THAT NEED TO BE CHANGED")
IS A MULTI-SENSORY INSTALLATION THAT USES GLACIOLOGICAL DATA TO CONTROL AN AUDIO
AND VISUAL ENVIRONMENT.

About **Mutatis Mutandis**

The multi-media work, Mutatis Mutandis, uses a wide range of temporal periods of glaciological data/statistics. A computer program, specifically written for use in this installation, is supplied with this data to control an audio environment. This same data is used to create information graphics and visualizations within the gallery space.

Using the actual field-recorded sounds of glaciers (such as melting, calving and ice cracking), the computer program maps various sets of data onto different audio parameters in the sound recordings. Among the different types of glaciological data fed into the computer program are ice core analysis, sea level rise, elevation readings and snow pit data sets recorded by remote sensing equipment. The glacial audio is then subject to several computational algorithms that use these data sets to shape and model the audio components. This includes several types of statistical analysis including stochastic modeling, Fourier analysis and regression analysis. For example, on one of the audio channels, the data taken from Ice Core Analysis (depicting the Earth's C02 levels, see Figure 1) is used as the carrier signal in a frequency modulation (FM). The host "information" signal contains the sounds of sonar recorded glacial shifting recorded underwater off the coast of Australia. As the C02 levels vary over time, the frequency of the carrier signal changes, creating temporal crescendos or ritardandos.
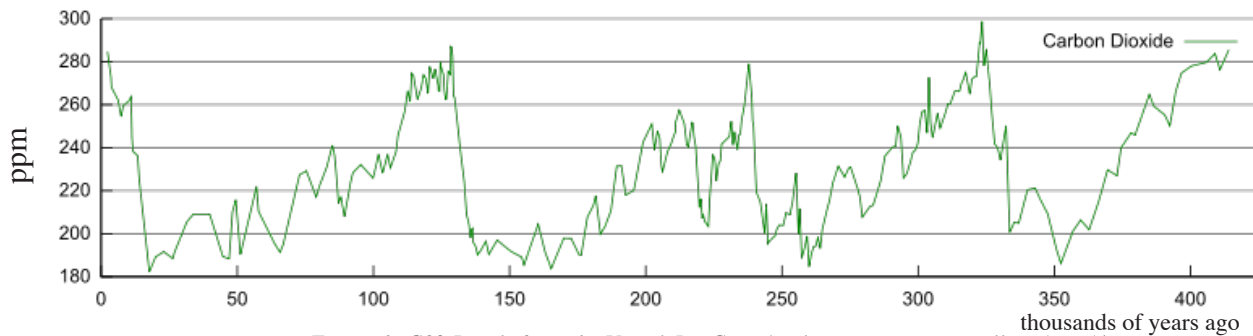

Figure 1: C02 Levels from the Vostok Ice Core Analysis in parts per million (ppm)*

Another audio channel uses sonographic imaging taken from the CReSIS database to generate an audio signal from that frequency spectrum (see Figure 2). In these ways, actual data modify actual recorded glacial environments in perceivable ways.
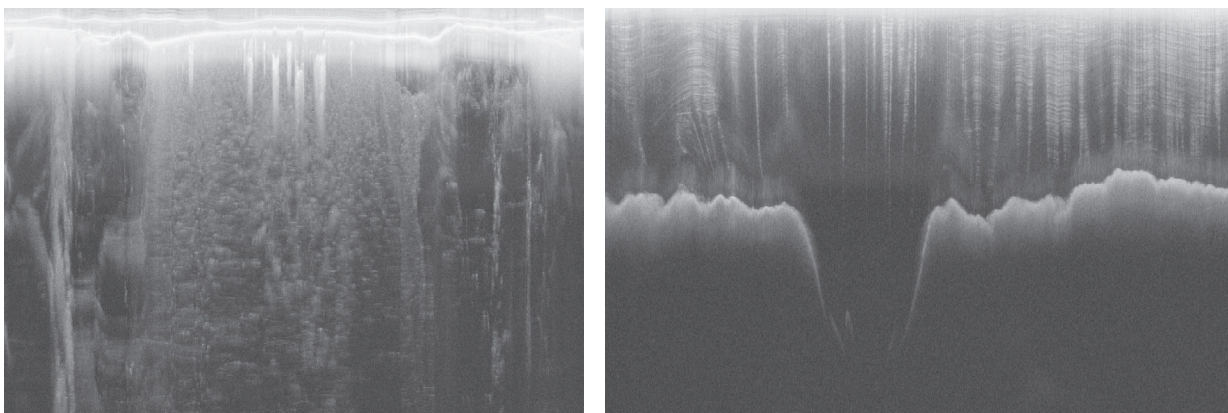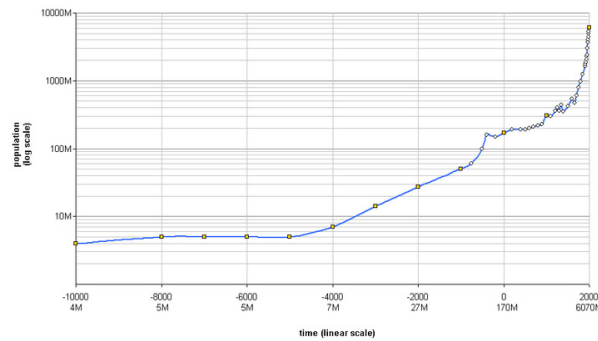

Figure 2: Greenland Echograms taken from CrESIS (Center for the Remote Sensing of Ice Sheets)**

*Petit, J.R., J. Jouzel, D. Raynaud, N.I. Barkov, J.-M. Barnola, I. Basile, M. Benders, J. Chappellaz, M. Davis, G. Delayque, M. Delmotte, V.M. Kotlyakov, M. Legrand, V.Y. Lipenkov, C. Lorius, L. Pépin, C. Ritz, E. Saltzman, and M. Stievenard. 1999. Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. Nature 399: 429-436.

**Gogineni, Prasad. 2012. CReSIS Greenland_Radar_Depth_Sounder P3 Data, Lawrence, Kansas, USA. Digital Media. http://data.cresis.ku.edu/.

Other examples include convoluting "noise" signals into recordings of arctic ice cracking at rates consistent with human population estimates (see Figure 3) and multi-channel panning algorithms

Figure 3: Human Population Growth (log scale) from 10,000 BC to 2000 AD

The installation uses a multi-channel format employing ten speakers and six visualizations spatially arranged throughout the gallery. In this way, the audience is encouraged to explore the space both sonically and visually. The four visualization prints are interpretations of the sonographic images collected from the CReSIS database. These terrain models are windows into unseen bedrock layers which improve the development of glaciological and hydrological models. At close range the visualizations allow the viewer to perceive the sonogram as a pixelated abstraction, while it appears to be a concrete, coherent image further away. These encourage the viewer to experiment with spatial distance as a tool to evaluate perception.

Didactic labels are placed near each speaker, indicating information about the audio recordings and an account of what data is being used. Information graphics also accompany each visualization print. One video, utilizing two high-resolution projectors, display sonograms, depicting a few of the algorithms at work. This provides the audience with another visual component to broaden their understanding of the processes they are hearing.

At the premier of the installation, a large ice block, slowly melting in the center of the space, symbolized the glaciological reference point in the present moment. The audio was controlled using MAX/MSP and the data was formatted using C++.

This installation was awarded a grant from the Biodiversity Institute, the Hall Center for the Humanities and the Spencer Museum of Art at the University of Kansas. It was also presented at the New Interfaces for Musical Expression (NIME) 2012 conference at the University of Michigan, Ann Arbor.

see additional pages for more information relating to the audio components

Mutatis Mutandis Excerpts: Audio Track Commentary

AUDIO EXAMPLE 1 Sheet friction

This audio is taken from sonar technology originally developed for the International Monitoring System of the Comprehensive Nuclear-Ban-Treaty (CTBT) in the mid 20th century. Underwater recording stations off the coast of western Australia monitored low-frequency Antarctic ice shelf movements. As these frequencies are below the range of human hearing, the recordings were sped up 10x the original rate. The resulting sounds depict the vibrations of the iceberg plate after collision with the seafloor, ice shelf or another iceberg. In this installation, data taken from glacier mass balance sheet records were translated into frequency variations to modify the Antarctic ice shelf recordings. In this way, the contours of the mass balance sheet records are mapped onto the audible "pitch" of the glacial sounds.

AUDIO EXAMPLE 2 Echogram Songs

The echograms used in the audio were collected from the CReSIS (Center for the Remote Sensing of Ice Sheets) database. The echograms depict the elevation of the earth's floor located under the ice sheets of the Jakobshavn glacier in Greenland. Basically, the sounds are generated by turning the echograms into sonograms, graphs that depict frequency with respect to amplitude vs. time. This data is manipulated to generate an electrical signal that is amplified to produce a sound that is an audible representation of the original echogram.

AUDIO EXAMPLE 3 Glacial Ice-breaking

This audio manipulates the playback rates of recordings of glacial ice breaking. It interprets the rates of changes in the earth's temperature—collected from ice core analysis—and applies this data to affect the playback rate of the audio file. The data is representative of approximately 400,000 years.

AUDIO EXAMPLE 4 Glacial Calving

The audio contains the thunderous rumblings of glacier calving recorded in Antarctica.

AUDIO EXAMPLE 5 Stochastic Ice Stream

This audio contains the sounds of ice rolling down a glacial stream. The clinking and tensile-like breaking is generated using stochastic modeling. Additionally, the sounds are subjected to an increasing distortion, the rate at which it is distorted being consistent with glacier mass balance sheet records of the past 50 years.

AUDIO EXAMPLE 6 Mutatis Mutandis Presentation Space Sample

This audio file is an amalgamation of all of the audio programs as they might have sounded in a presentation space. Given that the installation was originally a 10 channel audio environment, this audio attempts to approximate the sonic landscape in a stereo format