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Turbulent World: An Artwork Indicating the Impact of Climate Change

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Abstract

This paper describes an artwork created in response to a question about the role of the artist in communicating climate change issues. The artwork, titled *Turbulent World*, incorporates turbulence and surprise as a means to visualize the potential instability of our culture and the environment due to climatic changes indicated by increased worldwide temperatures. The artwork makes use of a custom fluid engine that can represent any amount of turbulence and energy. A dataset encoding a simulation of rising surface-air temperatures over the next century is mapped to the turbulence system; and the visualization is updated as the months and years flow by, based on the projected temperatures at different areas of the world. That is, the increased turbulence of the system causes a representation of a map of the world to become distorted in different ways. A secondary view is overlaid, showing numerical data and providing a more dispassionate display of the inexorable increase in world temperature.

Keywords

Climate change, art-science, software art.

Introduction

Turbulent World is a time-based artwork that displays an animated atlas that changes in response to the increased deviation in world temperature over the next century. The changes are represented by visual eddies, vortices, and quakes that distort the original map. Additionally, the projected temperatures are themselves shown across the world, increasing or decreasing in size to indicate the severity of the change. The data used in the artwork was generated by a sophisticated climate model that predicts the monthly variation in surface air temperature across different regions of the world through the end of the century (Delworth et al. 2006). The various datasets that are output from this model are available at the National Climatic Data Center (NCDC), run by the National Oceanic and Atmospheric Administration (NOAA).

Motivation

Turbulent World was first created in response to a call for entries by curators Emmanuelle Namont Kouznetsov and Kathrine Worel of OFF Space for an exhibition titled "Brave New World." In their call for entries, they asked artists to think about creative responses to climate change: "What is the role of the artist as citizen in this climate? How might we reclaim our choice, our connection, our social power when immersed in a deteriorating environment?"[1] *Turbulent World* was originally featured in this show, presented within the Spare Change Artist Space in downtown San Francisco. It was installed for the duration of the exhibition, which ran from late 2013 through early 2014.

The goal of *Turbulent World* is to provide insight into a data model that represents current thinking by leading scientists about climate change. Scientific visualization often focuses on individual data samples; visualizations that effectively capture large-scale systems are more difficult to represent (Johnson 2004). Additionally, climate change represents multiple, intertwined systems and necessitates new thinking about economics, policy-making, urban development, and other activities (Folke et al. 2010). An additional issue in representing climate change is that it exists at a scale that is hard to reason about (Opdam and Wascher 2004). Despite the major implications of climate change for civilization, due to these issues in scale and complexity, people do not take the time to reflect upon climate change very often (Chia 1998). Since modeling, representing, and explaining climate change is so challenging, *Turbulent World* does not attempt to include a comprehensive information visualization of the relevant data, but rather presents one aspect (the projected surface-air temperature) in order to provide a window into this complex system.

The piece was motivated in part by scientific visualizations that were developed by the geoscientists Jeremy Weiss and Jonathan Overpeck, both affiliated with the Institute of the Environment at University of Arizona. Their research includes simulations of the coastal regions that will be affected by a rising sea level (Overpeck and Weiss 2009; Weiss, Overpeck, and Strauss 2011). Additionally, it was inspired by other artworks that explore ways to represent the impact of climate change, including Bruce Caron's *Light Blue Line* outdoor installation, which painted a blue line throughout the city of Santa Barbara at exactly seven meters above sea level, dramatically showing the potential effects of melting glaciers and sea ice decline due to climate

*http://evl.uic.edu/creativecoding

[1] http://www.off-space.org/bravenewworld

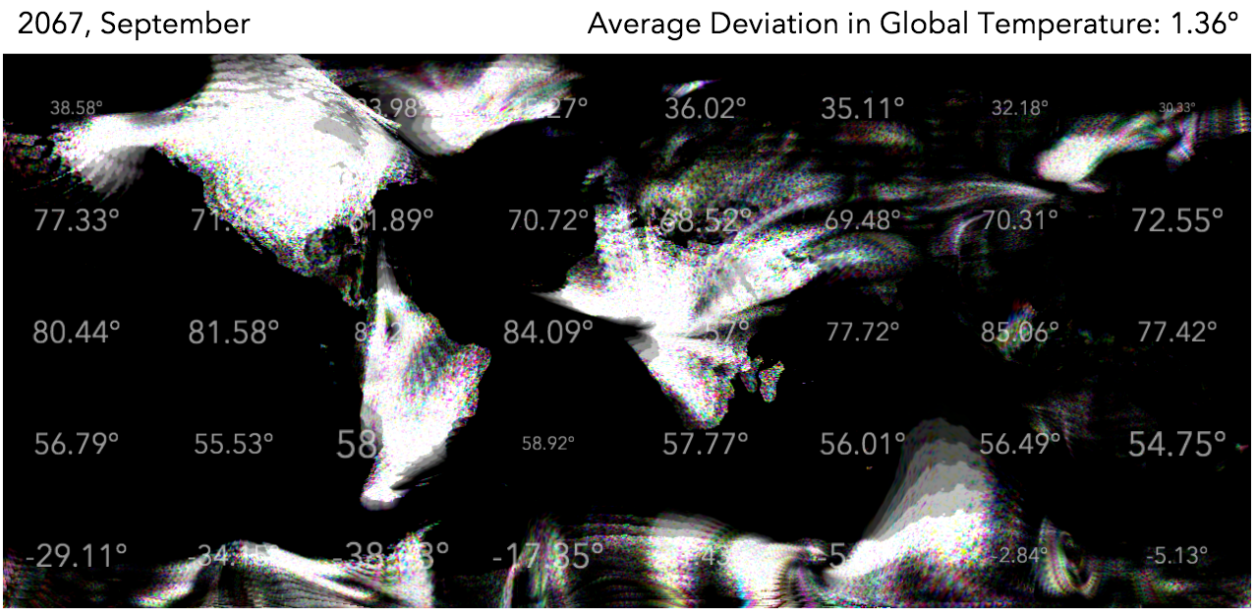

Figure 1: Screen capture from the artwork as it shows the average surface-air temperature across the world for September 2067, using the projected values generated by the CM2.1 model developed by the Geophysical Fluid Dynamics Laboratory. ©the author.

change.[2] Work by other artists and artist collectives that took part in the Brave New World show, including Amy Balkin, Gioj de Marco, Alicia Escott, Alan Hopkins, Andréanne Michon, Barbara Milman, Emmanuelle Namont Kouznetsov and Elyse Hochstadt, and Kathrine Worel, among others, also influenced the creation of *Turbulent World*.

Though a range of artists have produced works that in some way use data related to climate change as a material, or that explicitly comment on climate change, both artists and scholars can be uncertain of the cultural impact of these types of works. For example, a recent article by Adam Corner argues that through the invention of novel forms of representation artistic projects keep environmental issues "in the public eye."[3] Jonathan Rowson notes that public events, while briefly generating hope and inspiration, are also "tampered with a little sadness," since the false belief that simple awareness is useful is "part of what prevents us from facing up to the monstrous complexity and embarrassing urgency of the problem."[4]

Other commentators believe however that artworks, more than simply raising awareness, can make issues tangible and thus meaningful. An article jointly penned by the professors Elke Weber and Irena Bauman and the artist Olafur Eliasson makes the claim that art is precisely the appropriate vehicle for change. The article describes Olafur Eliasson and Minik Thorleif Rosing's 2014 work *Ice Watch*, which consists of 100 tons of ice transported from the Nuup Kangerlua fjord to Copenhagen and arranged in City Hall Square in a circle resembling a clock.[5] The spectacle of the installation literally melting away is presented as a means to permanently change perceptions about climate change. They write that the scientific community is failing because "[t]he information presented by the IPCC is overwhelming and [...] too complex to be able to translate into effective actions." Thus, they argue that "strategy plans, position papers, and limits for CO2 omissions" need to be accompanied by "art, architecture, storytelling, and other cultural activities."[6]

Description of Artwork

Unlike many other artworks that explore topics related to climate change, rather than staging a dramatic portrayal of the effects of climate change, *Turbulent World* includes a more direct representation of the data indicating a projected change in climate, as modeled by the Geophysical Fluid Dynamics Laboratory at the National Oceanic and Atmospheric Administration. The artwork begins in the current month of the current year by showing a still image of the world map using an equirectangular projection. The average surface-air temperature (SAT) for locations across the world for the current month are overlaid on top of the map in an eight-column by five-row grid containing cells of uniform size. As the animation begins, the deviations from the expected SATs (that is, if there were no increase in CO_2 into the atmosphere) are indicated by a change in size of the numbers representing the tem-

[2] http://tnms.org/lightblueline

[3] http://www.theguardian.com/sustainable-business/art-climate-change-communication

[4] http://www.rsablogs.org.uk/2014/socialbrain/

[5] http://olafureliasson.net/icewatch

[6] http://www.theguardian.com/sustainable-business/2014/oct/23/climate-change-ice-watch-installation-art-greenland-copenhagen-ipcc

peratures. The total deviation in temperature across the world (from the original baseline) in shown in the upper righthand corner. The artwork uses an interpolation of the values in the CM2.1 model (described below) in order to better fit them on the screen, but they are otherwise faithful to the model.

As the surface-air temperature deviates from the baseline values, the magnitude of the deviation within a particular cell distorts the map by either pulling the map toward the point where the number is centered, if the projected temperature rises, or pushing it away, if the temperature falls. The artwork uses the Fluid Automata system (Forbes, Höllerer, and Legrady 2013; Forbes and Odai 2012) for creating turbulent fluid effects. The overall turbulence of the fluid system becomes more chaotic as the deviation to the temperature increases. Additionally, a series of image processing techniques are used to augment the turbulence in the fluid system by changing the saturation and brightness of the map. Figure 1 shows a screenshot of the installation when displaying projected data for Septmeber 2067.

Climate Change Data

The dataset for the artwork consists of the projected average surface-air temperatures across the world through December, 2099. The data was retrieved from a repository hosted by Geophysical Fluid Dynamics Laboratory at NOAA,[7] where the model was developed. Specifically, the CM2.1 model was used, which is a coupled ocean-atmosphere general circulation model using an idealized 1% increase in carbon dioxide emissions per year. That is, it models the climate as an interconnected system composed of atmosphere, land, ocean, and sea ice systems. The CM2.1 model was used to "conduct a suite of climate change simulations for the 2007 Intergovernmental Panel on Climate Change (IPCC) assessment report" (Pachauri and Reisinger 2007). A 2013 report reiterates that scientists have a "very high confidence that models reproduce the general features of the global-scale annual mean surface temperature increase over the historical period" (Flato and Marotzke 2013). That is, the CM2 model has been effective at simulating "the main features of the observed warming of the twentieth century," and is thus seen as a reasonable, though potentially conservative, model for predicting probable changes in the climate (Delworth et al. 2006). More detailed information about CM2 Global Coupled Climate Models (and the data itself) can be found at the Geophysical Fluid Dynamics Laboratory (GFDL) website.[8]

Discussion

Turbulent World was discussed during a panel interview led by the environmental poet Eric Magrane, which was partially summarized in the online magazine *Proximities*.[9] The discussion focused on the use of visual representations, whether artistic or scientific, and how they function as a tool to *communicate* the meaning of data, rather than simply to represent it. The artwork was used a means to think about the tension between telling a story from a biased perspective and presenting neutral data. Specifically, we discussed the use of scientific data as a material for data-centric artworks and artistic techniques for representing scientific data.

Participants on the panel, which also included the geoscientist Jeremy Weiss and the graphic designer Kim Daly, had differing perspectives about how visual representations should emphasis climate change data. However, the panelists agreed that, since climate change is a complicated topic involving researchers from many different fields, it is simply too big an issue to be summarized by any one visual representation. Artists and designers can only capture and illustrate pieces that can provide a window into this complex system. Providing users with a chance to see the data unfold through a artistic visualization allows them to reach their own conclusions about the data, even as the piece presents a clear provocation about the impact of the data. At the minimum, it communicates the data in a clearer way that might encourage a viewer to do further research into these types of climate change models, and, ideally, if we agree with Weber, Bauman, and Eliasson, it widens cultural space to include interconnected and interdependent experiences.

[7] http://nomads.gfdl.noaa.gov/CM2.X/

[8] http://nomads.gfdl.noaa.gov

[9] http://environment.arizona.edu/proximities/envisioning-climate-change

References

[Chia 1998] Chia, R. 1998. From complexity science to complex thinking: Organization as simple location. *Organization* 5(3):341–369.

[Delworth et al. 2006] Delworth, T. L.; Broccoli, A. J.; Rosati, A.; Stouffer, R. J.; Balaji, V.; Beesley, J. A.; Cooke, W. F.; Dixon, K. W.; Dunne, J.; Dunne, K.; et al. 2006. GFDL's CM2 global coupled climate models. Part I: Formulation and simulation characteristics. *Journal of Climate* 19(5):643–674.

[Flato and Marotzke 2013] Flato, G., and Marotzke, J. 2013. Chapter 9: Evaluation of climate models. In *Climate change 2013: The physical science basis*.

[Folke et al. 2010] Folke, C.; Carpenter, S. R.; Walker, B.; Scheffer, M.; Chapin, T.; and Rockström, J. 2010. Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society* 15(4):20.

[Forbes and Odai 2012] Forbes, A. G., and Odai, K. 2012. Iterative synaesthetic composing with multimedia signals. In *Proceedings of the International Computer Music Conference (ICMC)*, 573–578.

[Forbes, Höllerer, and Legrady 2013] Forbes, A. G.; Höllerer, T.; and Legrady, G. 2013. Generative fluid profiles for interactive media arts projects. In *Proceedings of the International Symposium on Computational Aesthetics in Graphics, Visualization, and Imaging (CAe)*, 37–43.

[Johnson 2004] Johnson, C. 2004. Top scientific visualization research problems. *Computer graphics and applications, IEEE* 24(4):13–17.

[Opdam and Wascher 2004] Opdam, P., and Wascher, D. 2004. Climate change meets habitat fragmentation: Linking landscape and biogeographical scale levels in research and conservation. *Biological conservation* 117(3):285–297.

[Overpeck and Weiss 2009] Overpeck, J. T., and Weiss, J. L. 2009. Projections of future sea level becoming more dire. *Proceedings of the National Academy of Sciences* 106(51):21461–21462.

[Pachauri and Reisinger 2007] Pachauri, R. K., and Reisinger, A., eds. 2007. *IPCC AR4, Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva, Switzerland: IPCC.

[Weiss, Overpeck, and Strauss 2011] Weiss, J. L.; Overpeck, J. T.; and Strauss, B. 2011. Implications of recent sea level rise science for low-elevation areas in coastal cities of the conterminous USA. *Climatic Change* 105(3-4):635–645.