

Explore: Our Changing Earth

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Abstract: The Charles Hayden Planetarium has debuted a live climate change program titled, *Explore: Our Changing Earth* to support the larger Museum of Science initiative to “Change Climate Change.” *Our Changing Earth* aims to showcase global datasets that support and demonstrate the ways that our planet has changed over long and short time scales, with emphasis on human impact in the last 150 years. Topics covered include rising sea levels, changes in ocean currents, ocean acidification, as well as extreme precipitation events, flooding, and droughts. In addition to sharing more detailed content about *Our Changing Earth*, this paper will also discuss our own best practices for telling climate stories under the dome, and ways to leave audiences feeling hopeful and ready to take action.

Introduction

In early 2022, the staff of the Charles Hayden Planetarium began developing a new live show on the topic of climate change, titled, *Explore: Our Changing Planet*, as part of a larger Museum-wide initiative around climate change. Other climate change-related exhibits at MOS look at the effects of climate change on our local community specifically. To take advantage of unique Planetarium technology and offer a different perspective, *Our Changing Earth* takes a more global approach, looking at our planet as a whole to show how interconnected Earth’s systems are. We also explore Mars and Venus to demonstrate extreme atmospheres and their effects on climate, as well as differences between long-term, natural planetary evolution, versus human-caused rapid climate change here on Earth.

We debuted this program to the public on February 19, 2022, and it will run through at

least the end of June, 2022. We intend to keep this program in our library of live shows so that we can reintroduce it in the future, and offer it to groups who specifically request content around climate change.

Program Flow

This program can be split up into five main sections; the introduction, comparing planetary atmospheres, a closer look at Earth’s recent past, effects of climate change on Earth’s oceans and atmosphere, and the conclusion. These topics combine to tell a story of how climate change is not just a problem for the future, but rather how it’s affecting our planet now. The presentation also uses National Oceanic and Atmospheric Administration (NOAA) datasets to demonstrate exactly how we know.

Introduction: We begin the presentation on the surface of the Earth, and quickly lift off

into Earth orbit. Audiences are asked to make observations of our planet, i.e. it's blue, it has liquid water on the surface, it has clouds and ice caps, land with life...etc. to prompt the discussion of the importance of Earth's atmosphere. We also examine some of the geologic changes the Earth has undergone in the last 600 million years in order to highlight the time it takes for these dramatic changes to occur.

Comparing Planetary Atmospheres: To further discuss the roles of atmospheres on climate, we visit two planets on opposite ends of the atmosphere extremes – Mars and Venus. We journey to Mars initially to see the effects of a very thin atmosphere on this planet, and how the changes in the Martian atmosphere over billions of years are what drove Mars to become the cold, dry and desolate place it is today. Our next stop is Venus to show the extreme effects of an atmosphere ninety times thicker than Earth's. We explain the leading theory on how Venus accumulated its thick atmosphere over billions of years, and the specific role of greenhouse gases in the trapping of heat.

Earth's Recent Past: To put modern humans' time on this planet, and more specifically the last 150 years, into perspective, we display a timeline of Earth's 4.5-billion-year history (Fig. 1). Then we talk about how the Earth's changes in the last 150 years are completely unlike any other changes the Earth has undergone in recorded history (Tso, 2021). We discuss the Industrial Revolution, the rise of manufacturing, and use of fossil fuels that

emit carbon dioxide, a greenhouse gas. We look at more NOAA datasets showcasing carbon emissions around the globe (Fig. 2), as well as the projected temperature anomalies from 1880 – 2200.

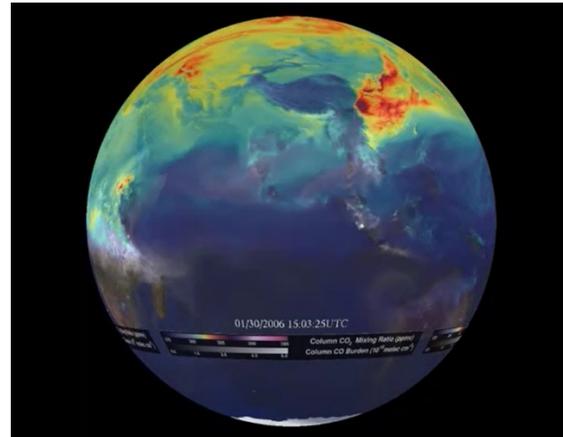


Fig. 2: Carbon dioxide emission concentration and distribution in Earth's atmosphere. Data source: NASA Goddard Space Flight Center.

Climate Change Effects: This section constitutes the majority and most detailed part of the presentation. Here we discuss how warming temperatures and increased CO₂ emissions are leading to:

- Rising sea levels
- Slowing of the global conveyor belt
- Ocean acidification
- Increased precipitation
- Increased intensity and frequency of storms
- Increased drought and wildfires

We also discuss elements of recent climate news, like the 2022 Intergovernmental Panel on Climate Change (IPCC) climate report.

Conclusion: After expanding on the effects of climate change, we visit one more place



Fig. 1: A simplified timeline of Earth's history, highlighting the evolution of life.

to get a final perspective of our planet – the Moon. In this section, we contemplate on the overview effect and the fragility of our planet. We emphasize that humans are resilient problem solvers, and while we are the reason behind climate change, we can also be the ones to fix it. We can never stop taking action – climate change is simple, serious, and solvable. We then direct audiences to additional information about other MOS climate exhibits, citizen science opportunities, and resources to find out more about what our local community is doing to combat and adapt to climate change.

Visuals

We used a variety of visuals to complement the program narrative, including the built-in capabilities of Digistar7, like flying to the Moon, Mars, and Venus. We used several of NOAA’s Science on a Sphere datasets to visualize the effects of climate change. We also used clips from various sources – like Dynamic Earth’s land and sea ice clip (Fig. 3), footage from divers in the Belize Barrier Reef (Fig. 4), and stock footage of storms, droughts, and fires.

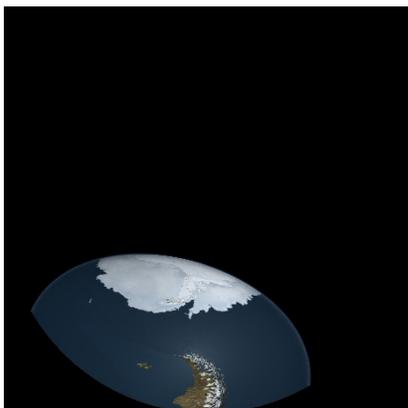


Fig. 3: Snapshot of clip from Dynamic Earth showcasing Earth’s polar ice caps. This clip is used to describe the differences between sea ice and land ice when it comes to sea level rise. Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio.



Fig. 4: Snapshot from the 360 degree-footage, Reefs of Belize. This clip is used to visually support the topic of ocean acidification. Credit: MIT & Charles Hayden Planetarium.

Challenges & Ongoing Questions

There are several questions we encountered during show development, some of which have persisted after the premiere. We have implemented some techniques to help answer these questions, but we are still learning how to best approach others.

- Do we make this program about the effects of climate change on our local community, or take a global view? We went with the latter since the Planetarium is better suited to tackle this topic holistically, with sprinkles of facts about our local situation scattered throughout
- How do we avoid being too depressing? Initially, we didn’t offer much information to audiences on solutions or action items. We eventually changed the ending of the show to center humanity and our resilience. Is this enough?
- Do our visuals provide support and a deeper understanding of the content the presenter is talking about? We could use additional

visuals to describe things like density, greenhouse gases, evaporation, and current circulation

Best Practices

After a few months of presenting this program to public audiences, we learned (anecdotally):

- Adding in stories while talking about Earth's systems makes them feel more tangible, i.e. someone in Norway finding a hat from a DOT worker in Maine, US, because the Gulf Stream carried it across the Atlantic
- To help keep spirits up and hopefulness alive, we can frame the show in a way that centers humans as problem solvers, and that we have the knowledge and means to solve climate change
- Ending the show by viewing the Earth from the Moon, emphasizing the beauty and fragility of home, and reinforcing the idea that climate change is simple, serious, and solvable may help people leave motivated instead of hopeless

Conclusion

This is the first time in decades that the Charles Hayden Planetarium is tackling the topic of climate change, and while we haven't formally evaluated *Explore: Our Changing Earth* yet, we are excited to share our initial thoughts and experiences. We are continuously looking for ways to improve this program, both content-wise and visually.

We have presented this program to the group of broader MOS staff, including the MOS Climate Team, who specialize in

educational climate change content. Many of the changes that we have implemented have been due to their constructive feedback.

We are always looking for more commentary on how people have faced this topic in their domes, and what kinds of resources they use to visually support their programs. Stories or feedback can always be sent to csullivan@mos.org, and will be greatly appreciated.

Citation

Tso, Kathryn, "Has There Been Climate Change Before?," *MIT Climate Portal*, January 4 2021, <https://climate.mit.edu/ask-mit/has-there-been-climate-change>.