

# THE CARBON CYCLE: VISUALISATION FOR A MULTITOUCH TABLE

IAD ZHDK HS 2021

DATA VISUALIZATION DOCUMENTATION

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In the Data Visualization module, we worked on searching and analyzing data, representing it, and creating logical abstractions. We began by studying the basics of data visualization, then went deeper into the interaction of the user with the interface and data.

Our Collaboration Partner is ETH Zürich / Crowther Lab. They are known worldwide for their reforestation projects and climate crisis data collections.

\*Crowther Lab studies global ecosystems, leveraging machine learning tools to protect biodiversity and address climate change.

## TASK

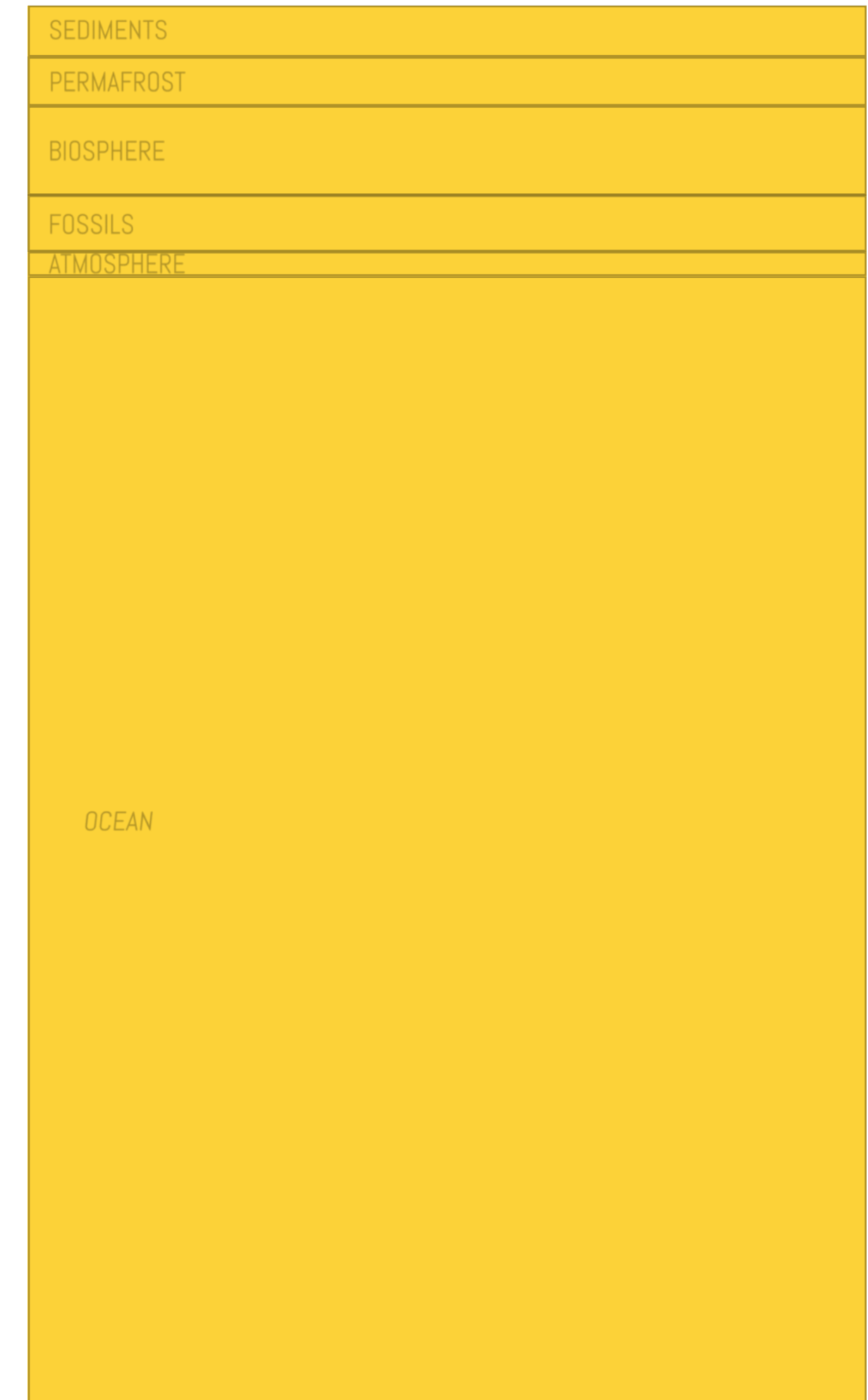
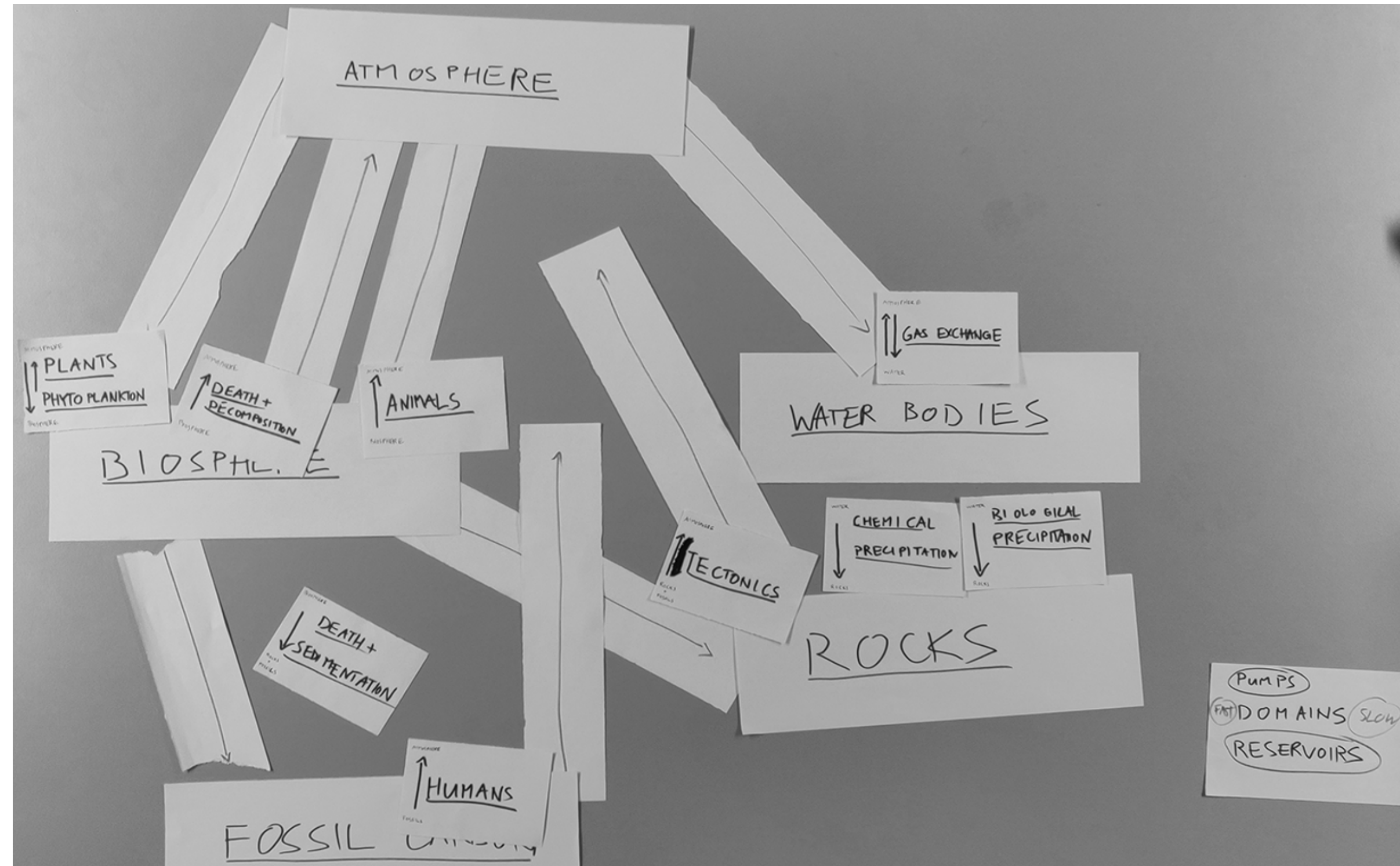
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We had to develop an application for a multitouch table which would provide useful and valuable knowledge for users about climate crises or supporting reforestation projects. The main goal is to deliver knowledge through interaction with the multitouch table.

For this we could use data provided by Crowther Lab as well as other data sets that would be relevant to our project.

Starting from the data we got from Crowther Lab, we learned of the capability of trees to store carbon. Soon we learned that parts of the absorbed carbon finds its way into the soil, making it a carbon storage as well. We started researching the maximum capacity of trees and soil.

From there we realized that there exist a lot of those reservoirs of carbon with hugely varying capacities. Discovering how carbon is moved around between these reservoirs, we found a new understanding of the role of fossil emissions.

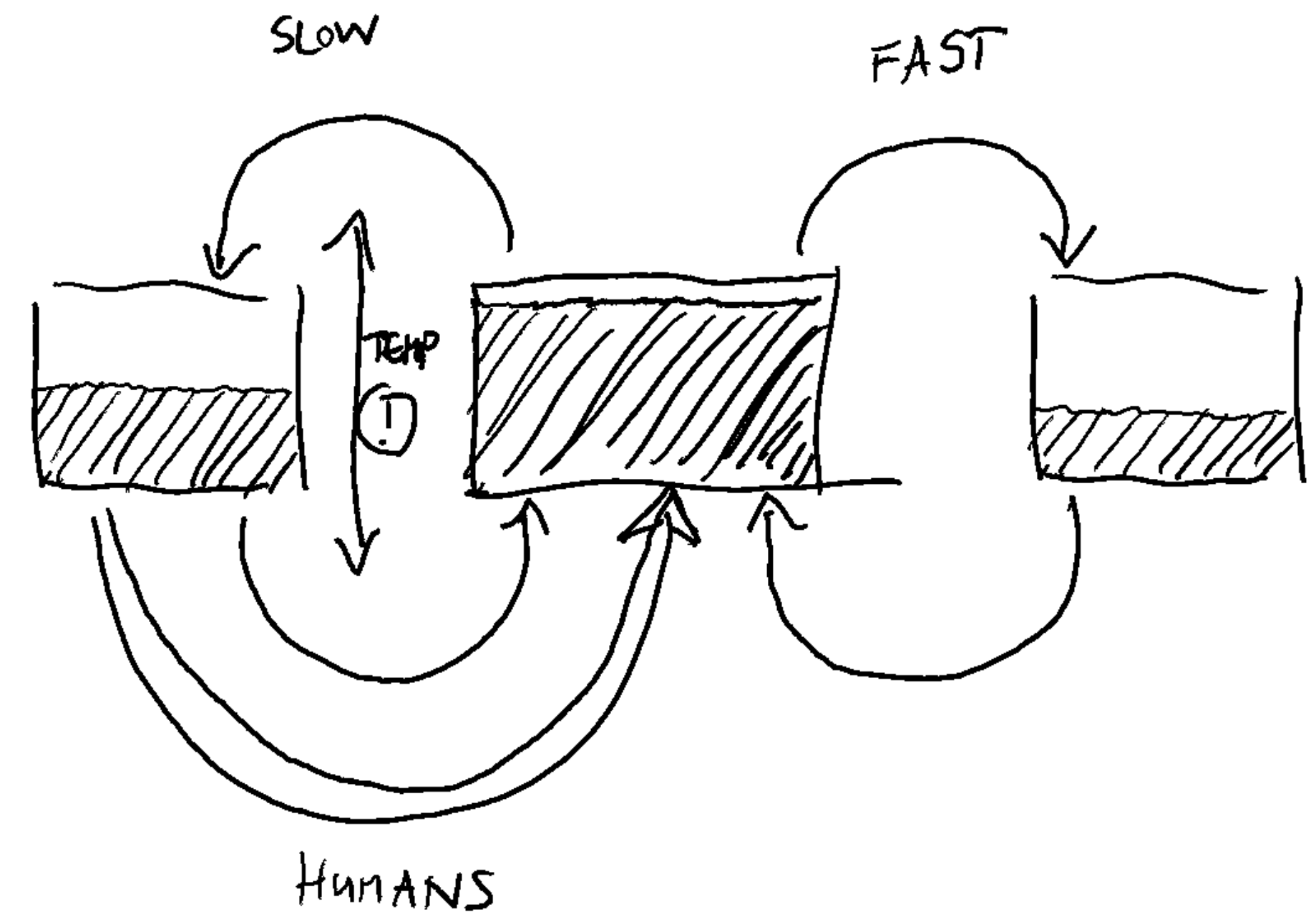


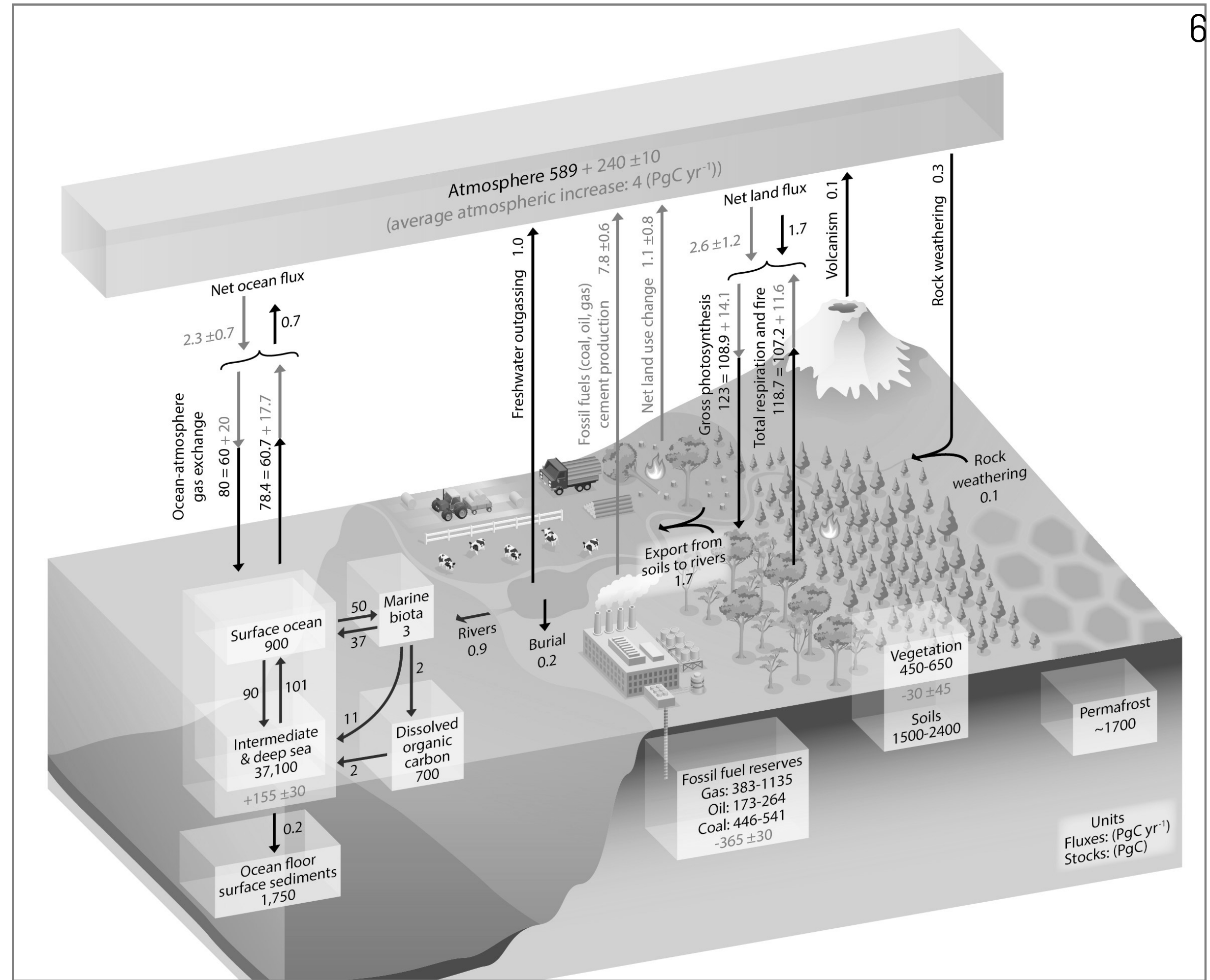
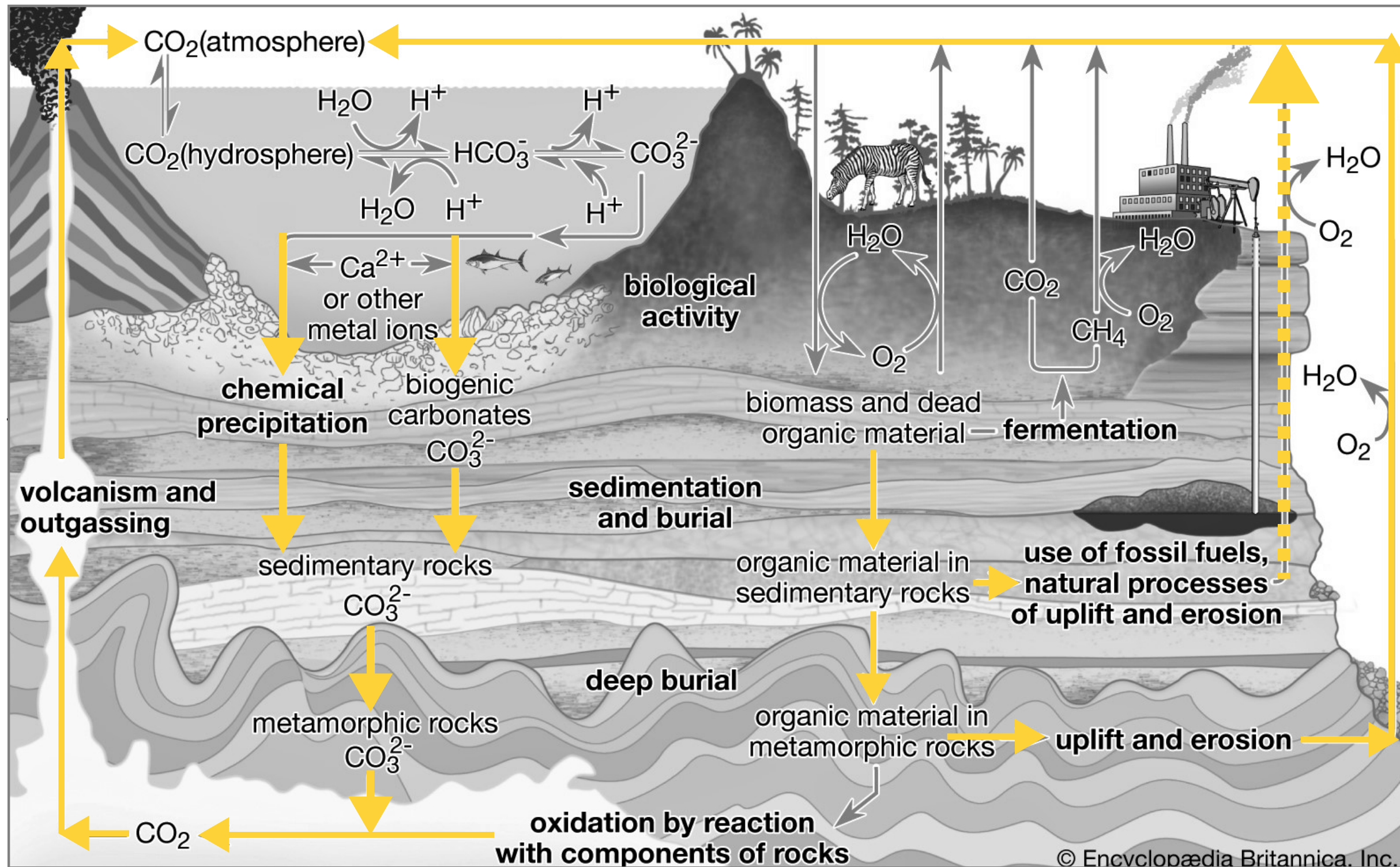
1. There is not one, but two separate natural systems on earth constantly moving around massive amounts of carbon.

2. The knowledge we want to deliver:

- the existence of two circles of carbon in nature
- understanding that natural reservoirs have limits
- continuation of artificial transport of carbon from the slow to the fast cycle evokes irreversible temperature changes

3. Knowing that there is a slow and a fast domain of the carbon cycle is crucial in understanding why the use of fossil fuels has as big an impact as it has on the environment. Though it is a simplification, this visualisation tries to convey the science behind the call for zero fossil emission.





During the research phase we managed to find only a few diagrams representing both the fast and slow cycle in them.

1. In the diagram on the left both cycles are presented with detailed process descriptions. (Slow cycle in yellow)
2. In the diagram on the right the moving of carbon is presented with the concept of reservoirs with carbon fluxes between them.

# LOGICAL ABSTRACTION

## goals:

1. Present concept of two Cycles
2. Provide knowledge about reservoirs' capacity
3. Emission and storage ratio
4. Show that since industrialization carbon mostly goes from the slow to the fast cycle

## elements:

Slow Cycle / Fast Cycle

Reservoirs (pools)

Capacity of reservoirs

Fluxes (movement / flows)

Time (during and before industrialization)

## concepts:

timescales of 2 cycles

consequences of CO2 redistribution

current CO2 capture

carbon potential of reservoirs

how does time play into our visualization?

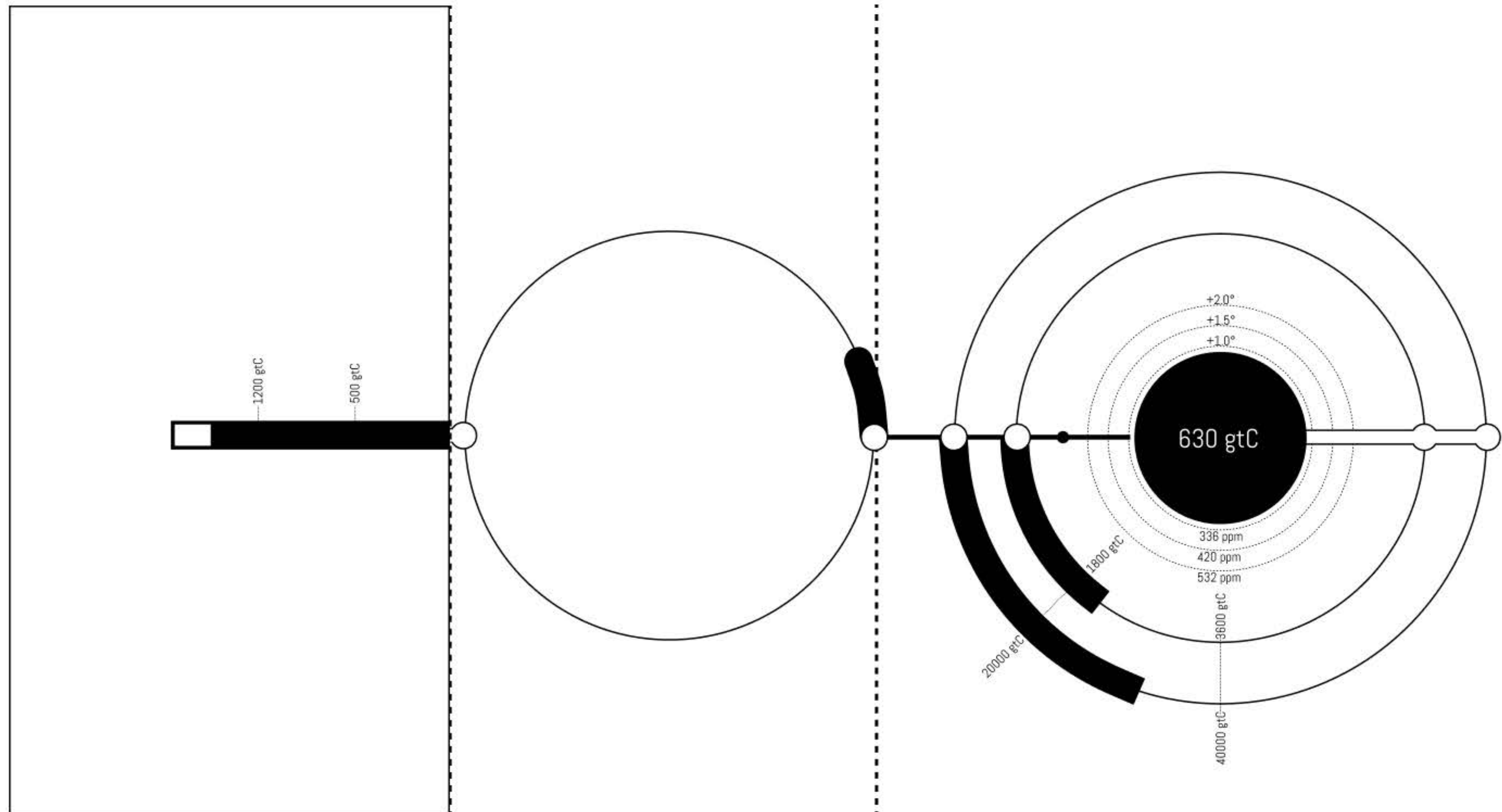
how can we visualize the recapture of the CO2?

RESERVOIRS : ROCKS  
FOSSILS  
WATER BODIES  
BIOSPHERE  
ATMOSPHERE

PUMPS : PLANTS+PHYTOPLANKTON  
DECOMPOSITION (MICROBES)  
ANIMALS  
SEDIMENTATION  
HUMANS  
GAS EXCHANGE  
CHEMICAL+BIOLOGICAL PRECIPITATION  
TECTONICS

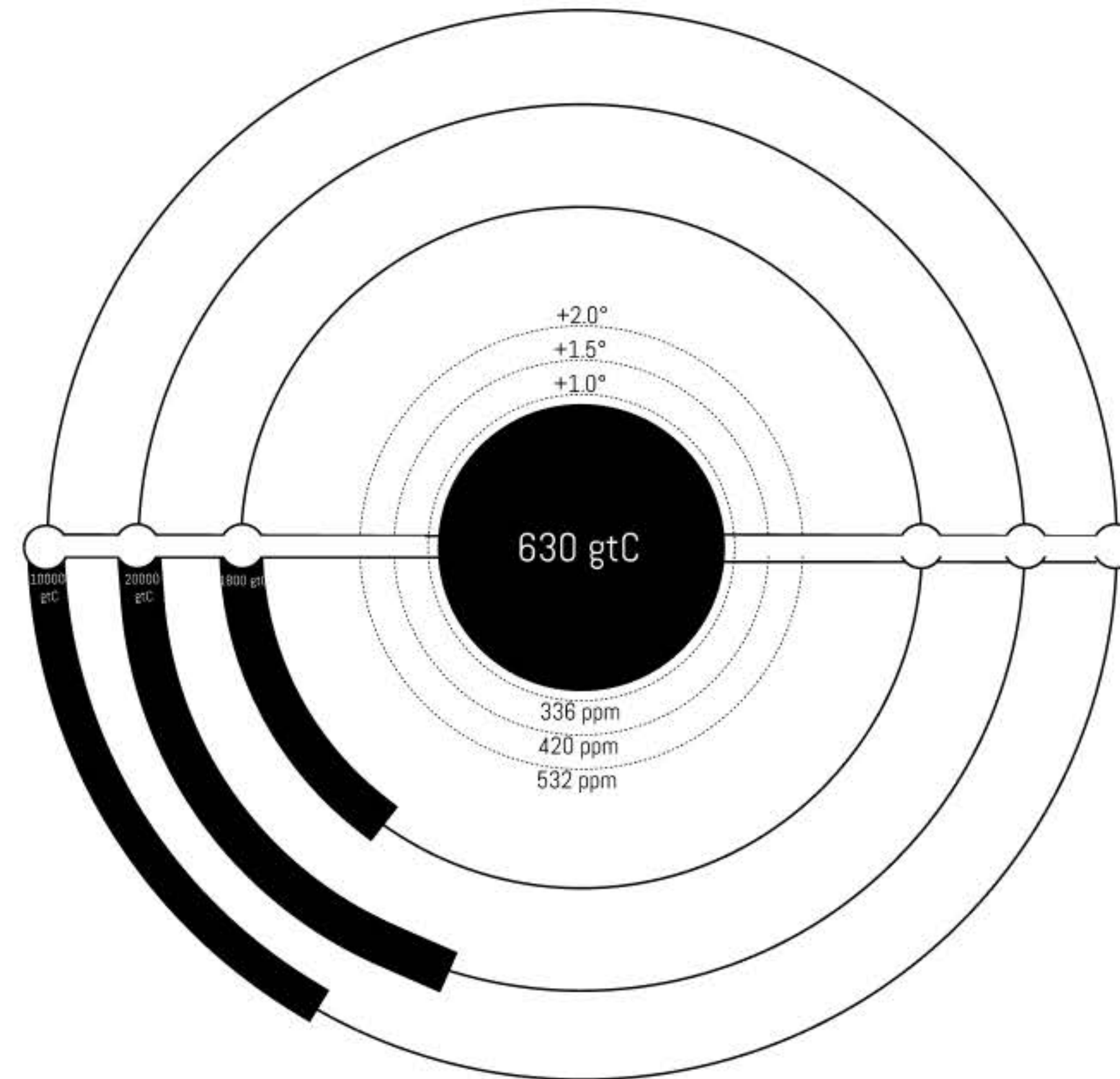
The concept that kickstarted our final product, was having stations and trains. The trains can pick up and load off carbon. The center on the right being the atmosphere station would grow and the size indicates the current mid temperature on the earth's surface. On the left is the fossil carbon train, being inactive until the start of the industrialization, which sends a small wagon around to pick up carbon and put it in the fast cycle.

We liked the temperature tracking. However, there were still too many different shapes going on.





We did some more compact structures, which didn't make things easier to understand though. The reservoirs being trains, didn't make much sense, so we dumped that part, in order to make things more uniform and simple.

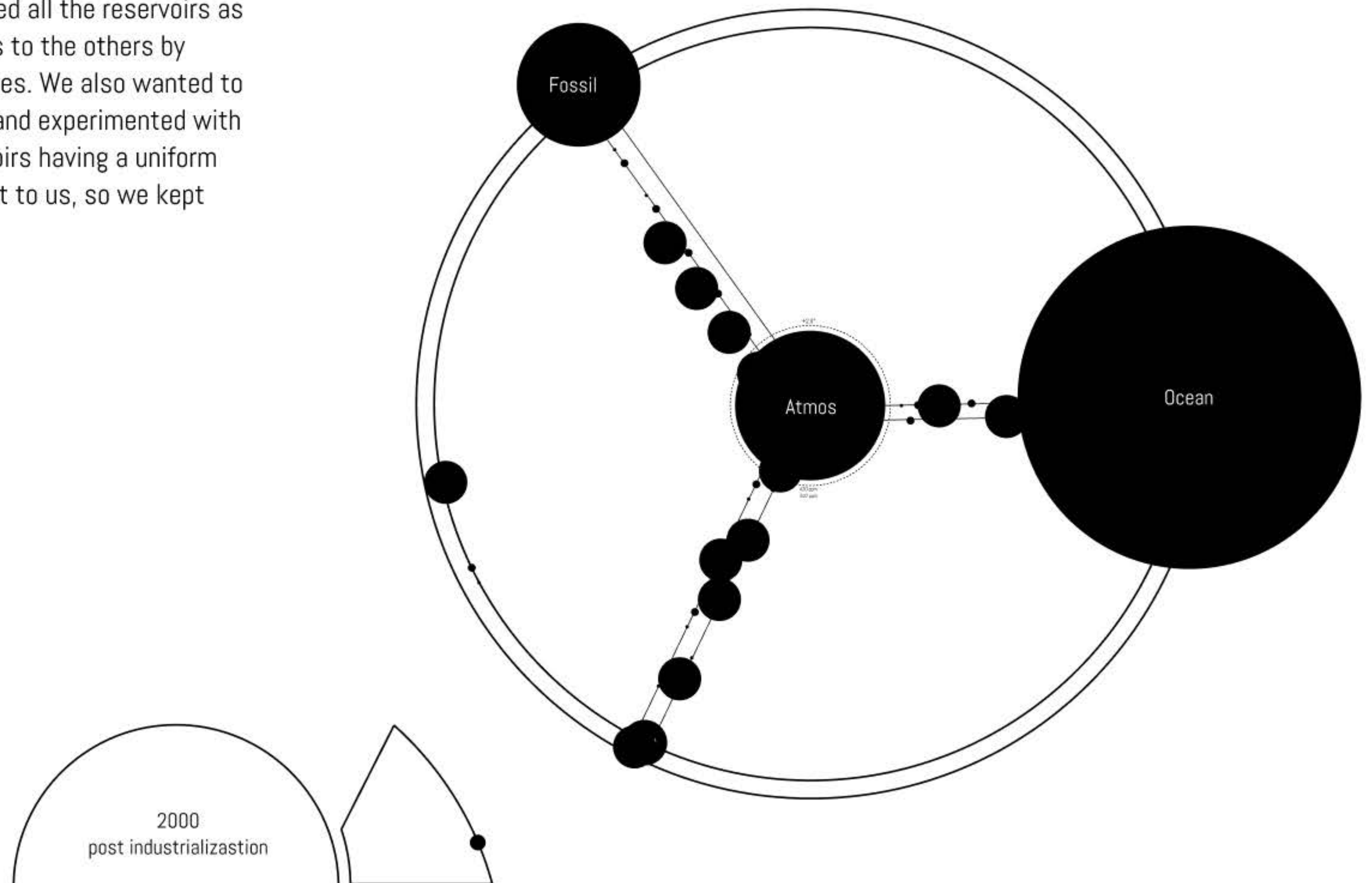


1850 ●

○

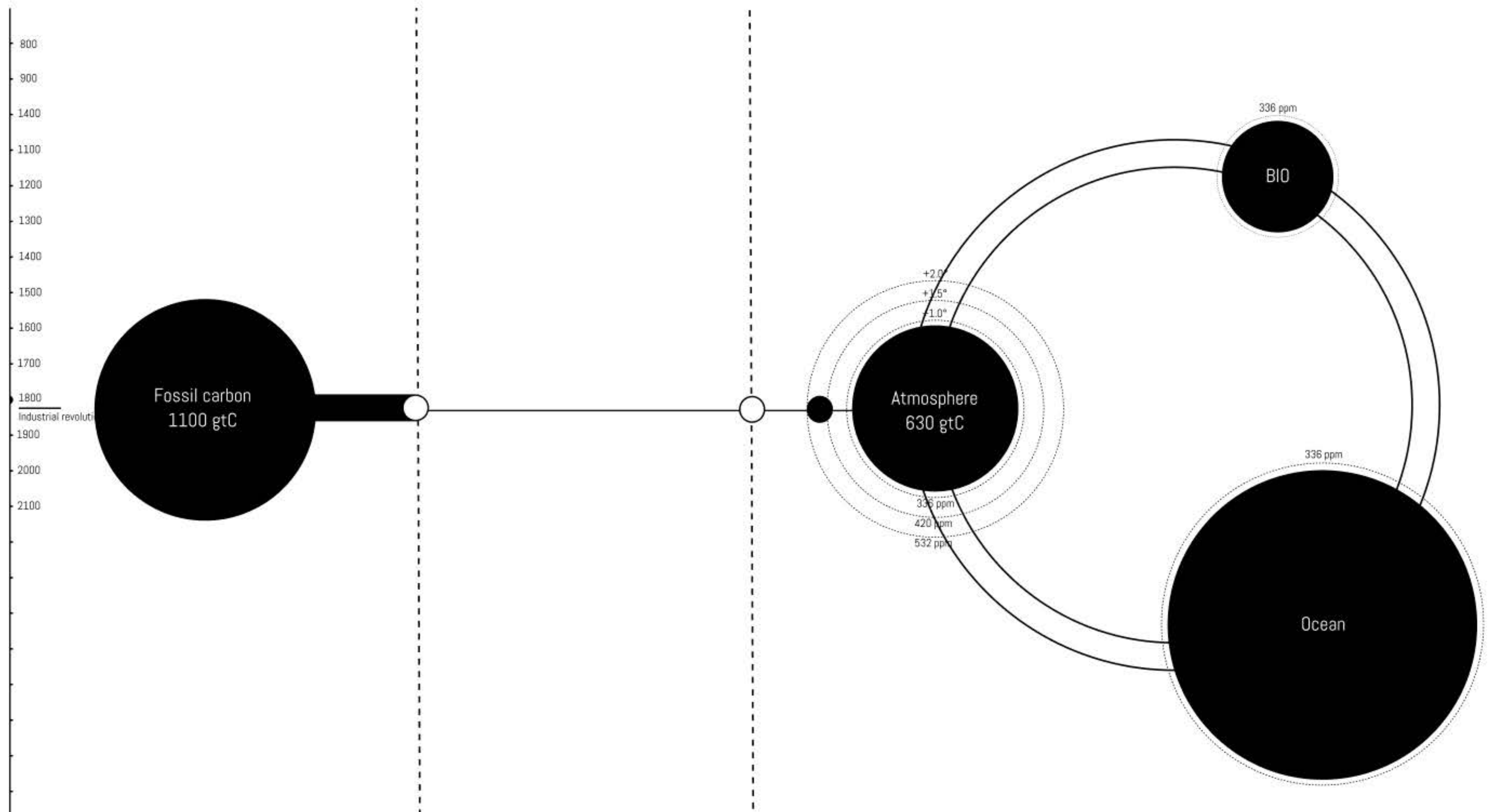
● 2050

In this Prototype we formed all the reservoirs as circles, each having acces to the others by trails, drawn in circular lines. We also wanted to have a more fun timeline and experimented with some options. The reservoirs having a uniform appearance was important to us, so we kept that and the trails.



Having a one way trail from the Fossil reservoir to the atmosphere made sense scientifically and message wise. We kept that trail horizontal to distinguish it from the other carbon trails, that are natural, unlike the burning of fossil fuels.

This prototype was very close to what we had at the end. We left out the trails between biosphere and the ocean, since they were not important to us. We only kept in what we had data for or could gather data about.



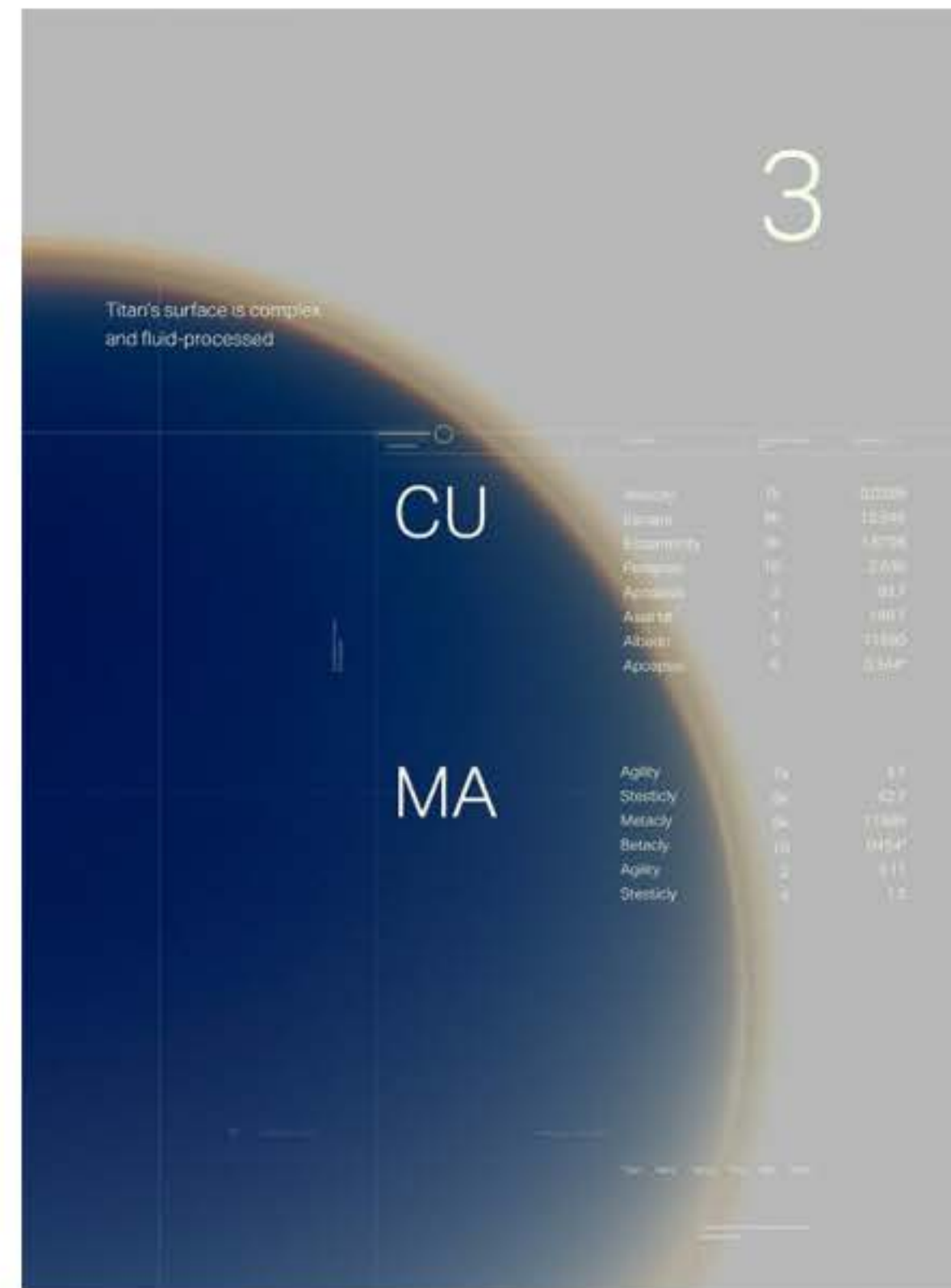
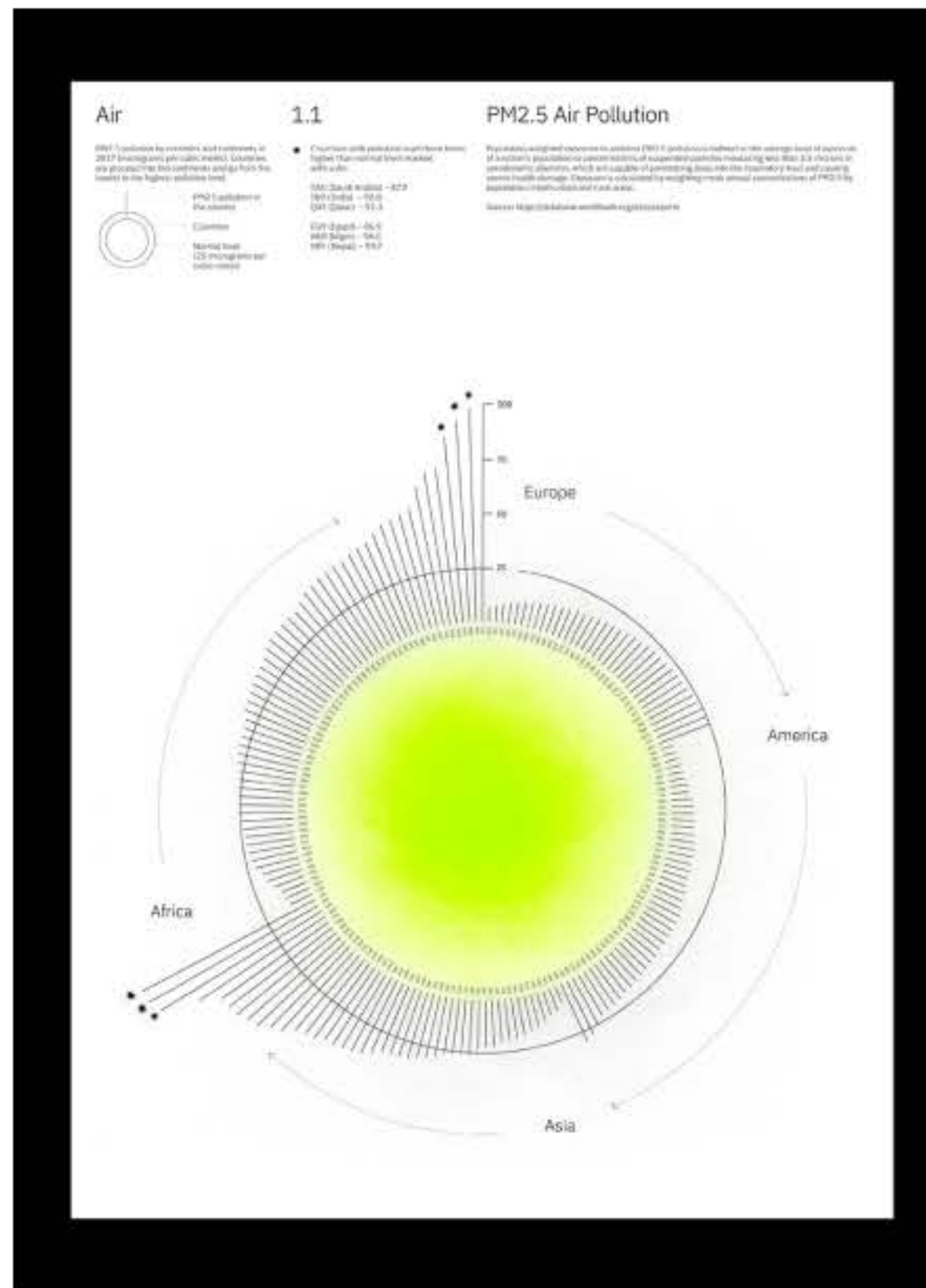
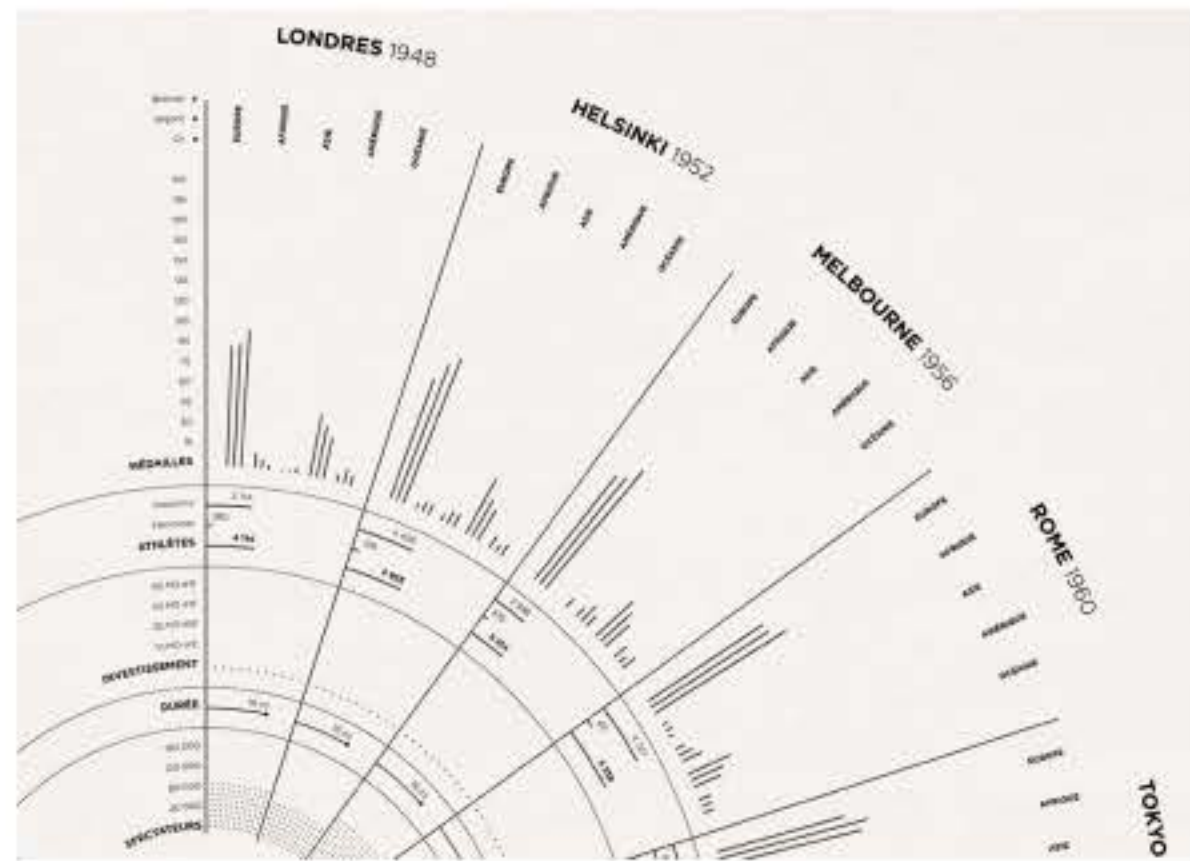
The visualization is written completely in p5.js, which we chose because of its ease of use, as well as it being known best by most of our team.

The program is written following an object oriented approach. The code is structured into meaningful classes, like reservoirs, fluxes, and gui elements.

For collaboration, we used GitHub. It was our first collaborative coding project, but there were no bigger hiccups.

```
1 function draw() {
2   background(bg);
3   // -----
4   // INPUT
5   // -----
6   //Slider
7   currentSliderValue = year_slider.value();
8   if (oldSliderValue != currentSliderValue) {
9     currentYear = year_slider.value();
10    if (oldSliderValue > currentSliderValue) {
11      // --> FOWARDS
12      addForwardFluxPoints();
13    } else {
14      // BACKWARDS <--
15      addBackwardFluxPoints();
16    }
17    oldSliderValue = currentSliderValue;
18  }
19  // CONSTANT FLUX
20  addConstantFlux();
21
22  // -----
23  // OUTPUT
24  // -----
25  // Draw Fluxes
26  drawAllFluxes();
27
28  // Draw Reservoirs
29  reservoirAtmosphere.display();
30  reservoirOcean.display();
31  reservoirTerrestrial.display();
32  reservoirFossil.display();
33
34  // Draw Infos
35  currentInfoBox.display();
36  titleBox.display();
37  timeline.display();
38
39  // Draw Button
40  buttonChangeCycle.display();
41
42  // Draw Description
43  image(descriptionPicture, 3260, 1200);
44 }
```

# VISUAL REPRESENTATION



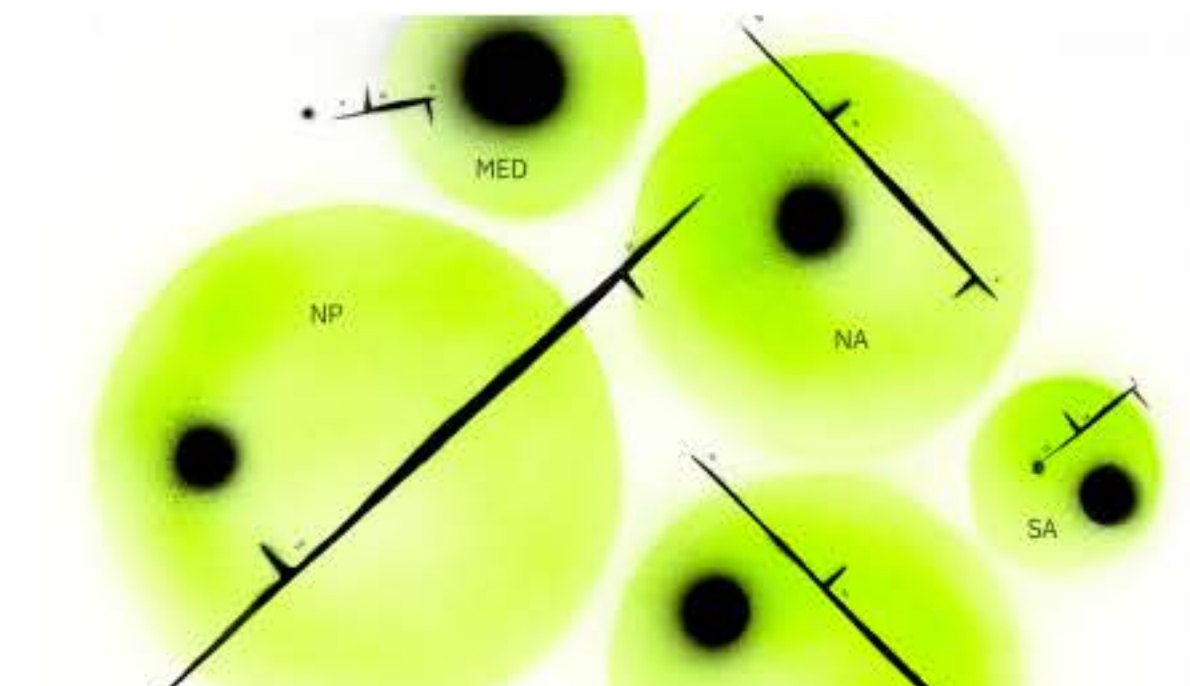
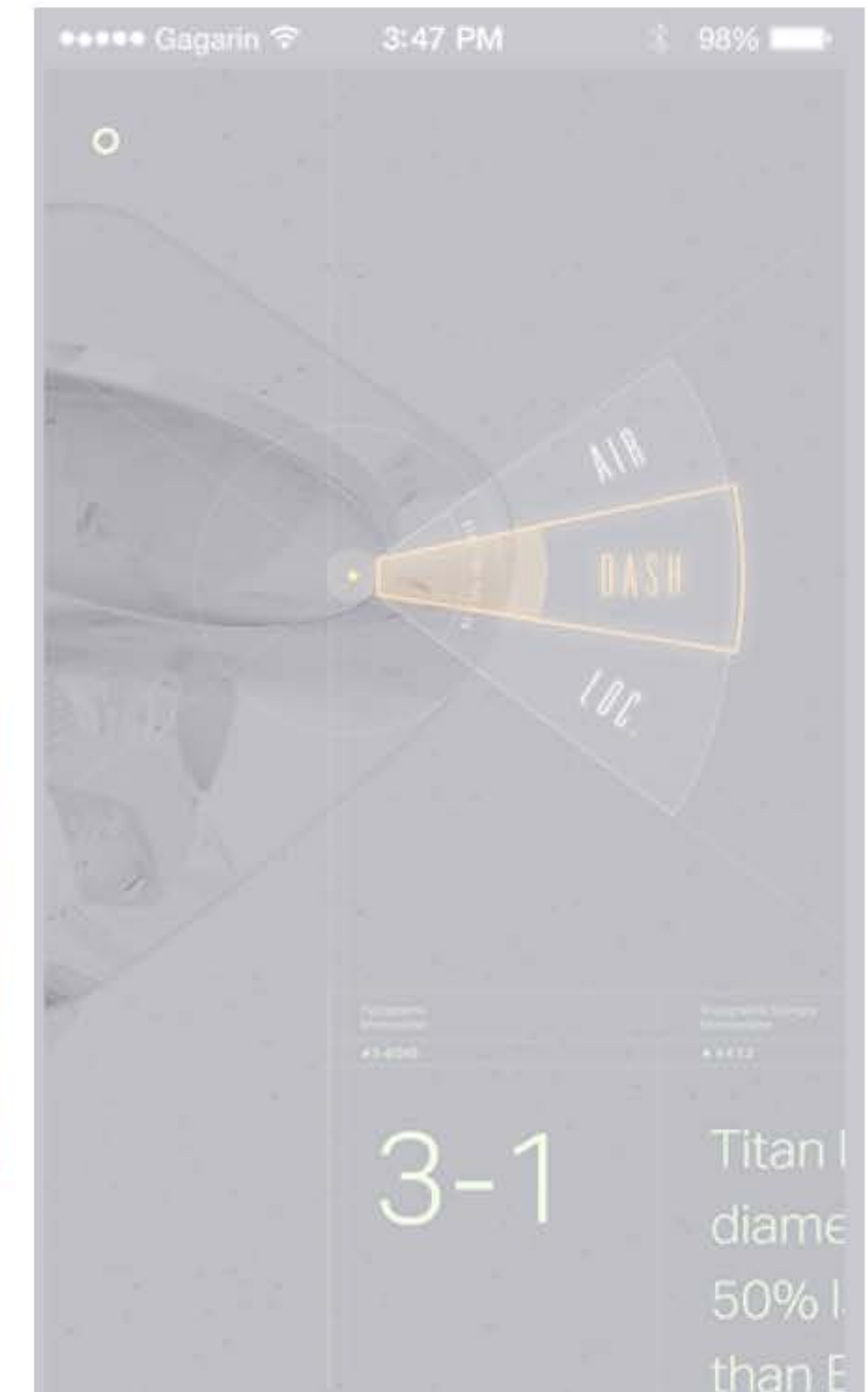
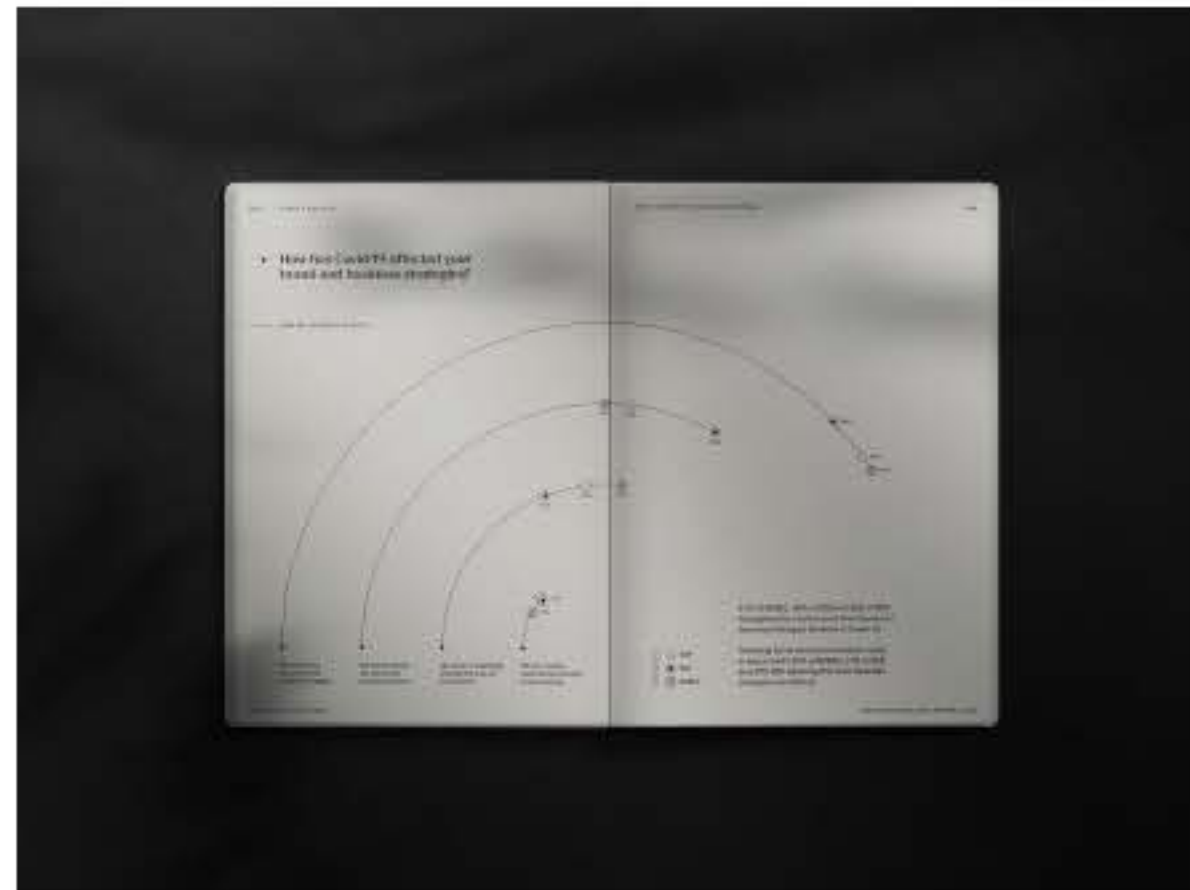
Main projects for inspiration:

13

Cell Theory by Maria Bublik

History of the Olympic Games by Agence 10h11

Titan Loop Campaign by Leonid Ershov

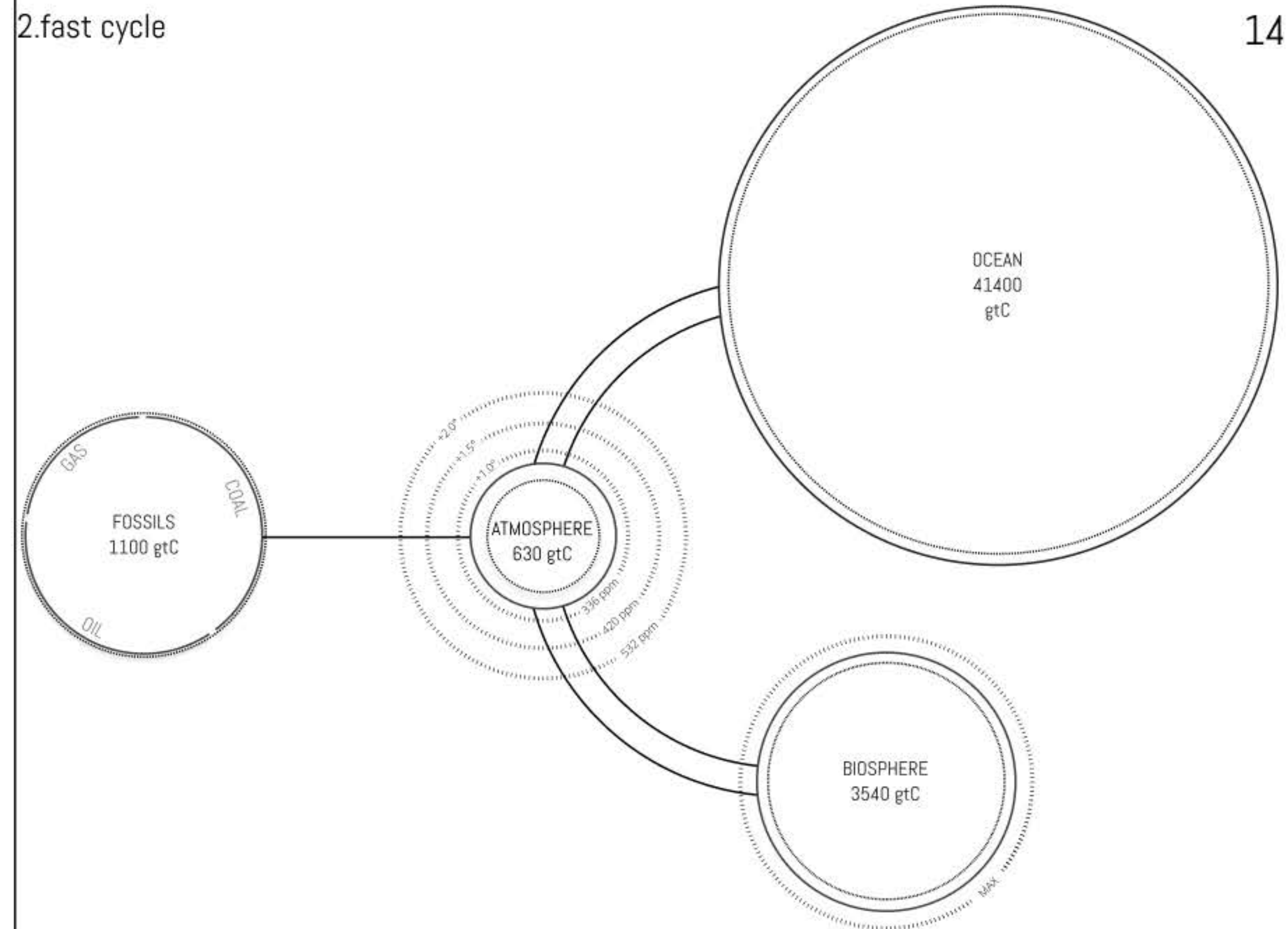


# FINAL WIREFRAME

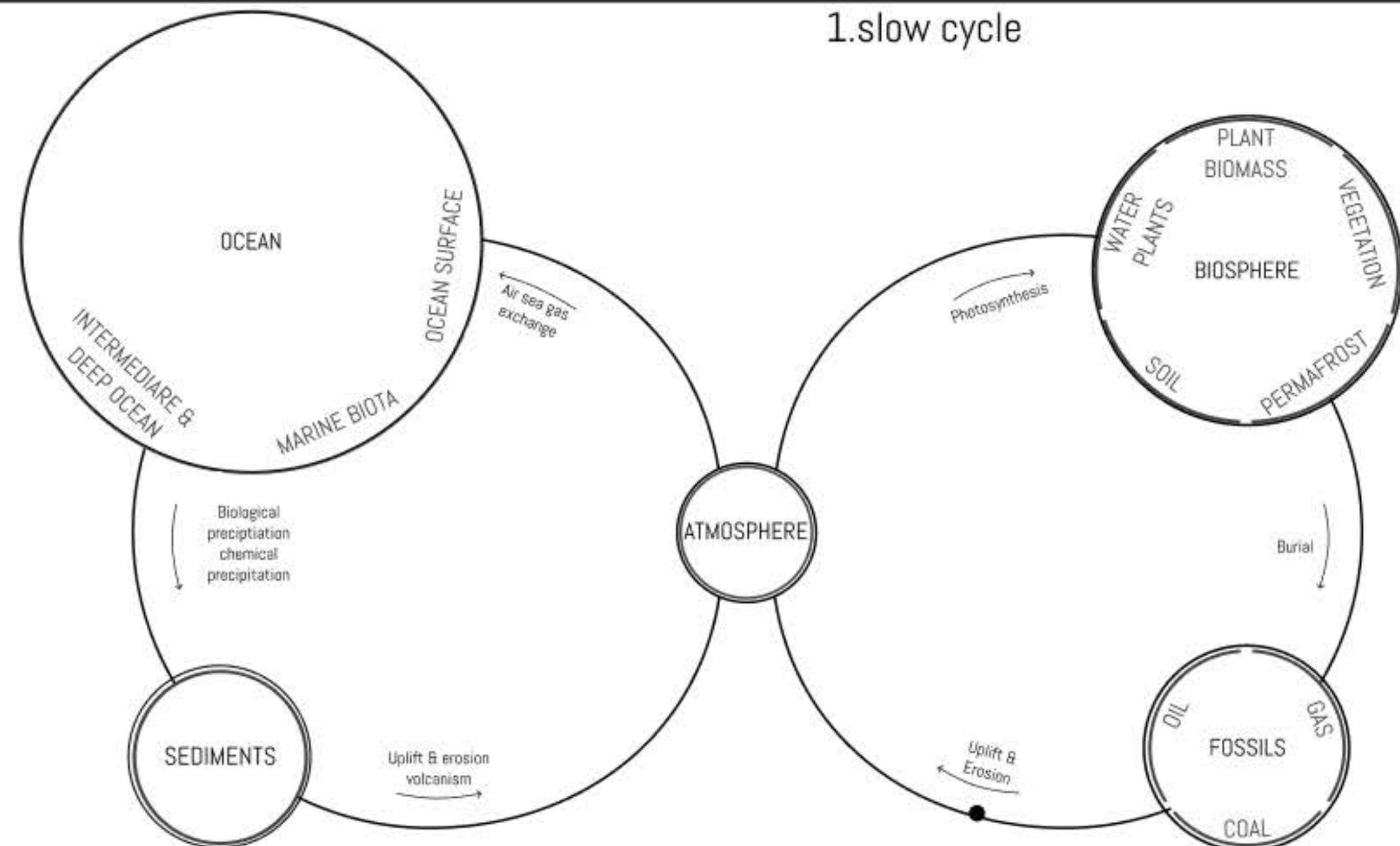
In the slow cycle the fossil reservoir is "in the process"

For the final product we decided to split the two cycles to two separate screens to increase understandability. The slow and the fast domain each get a visualization. To introduce the human scope, there is no way to influence the slow cycle, but the fast cycle can be manipulated by dragging the timeline.

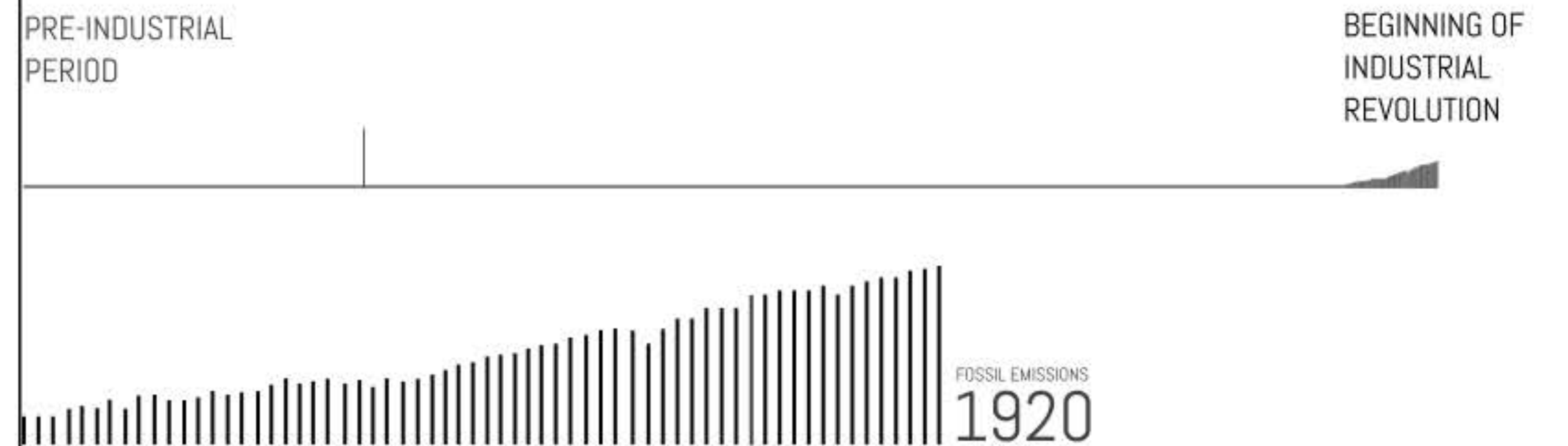
## 2.fast cycle



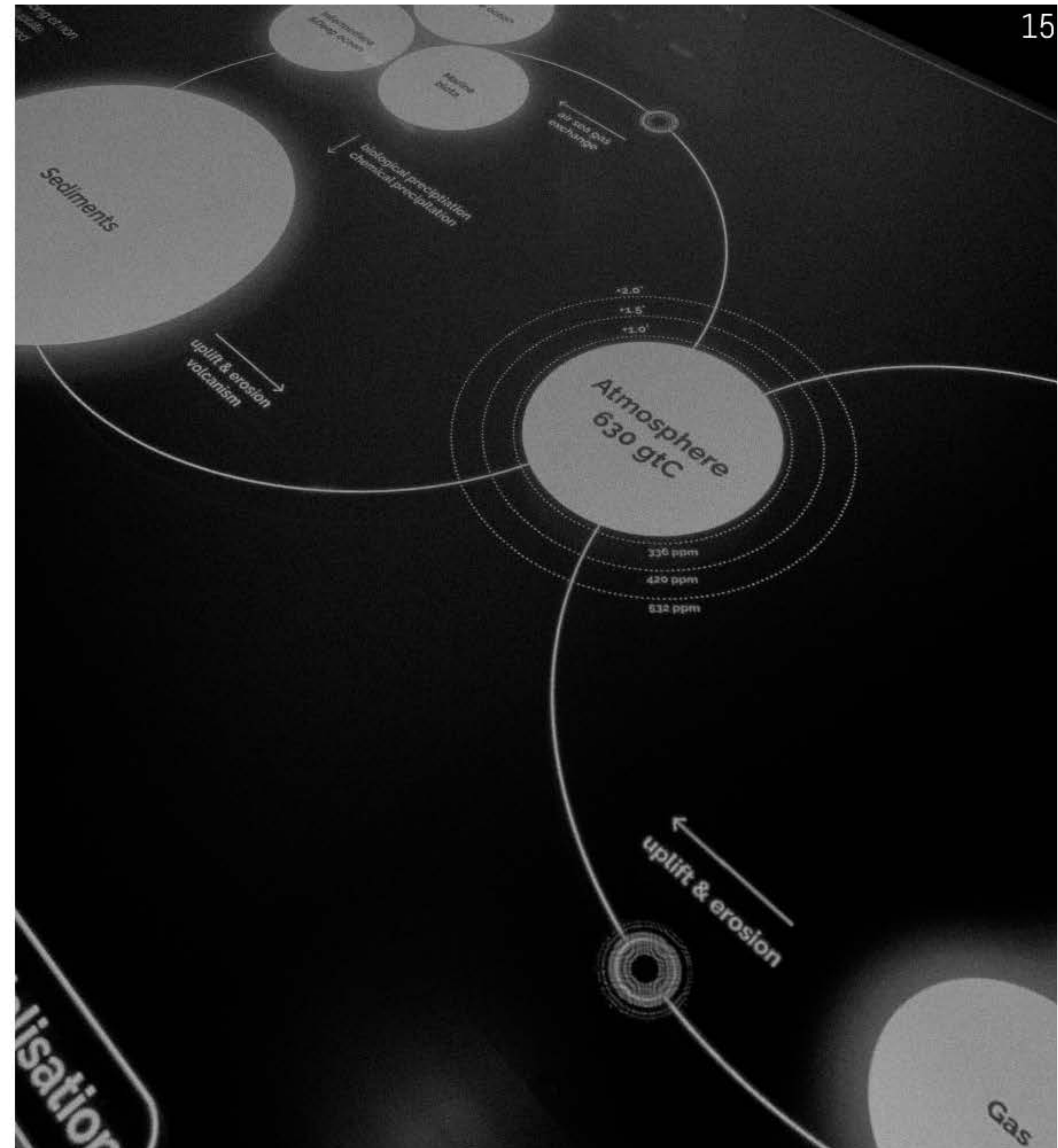
## 1.slow cycle



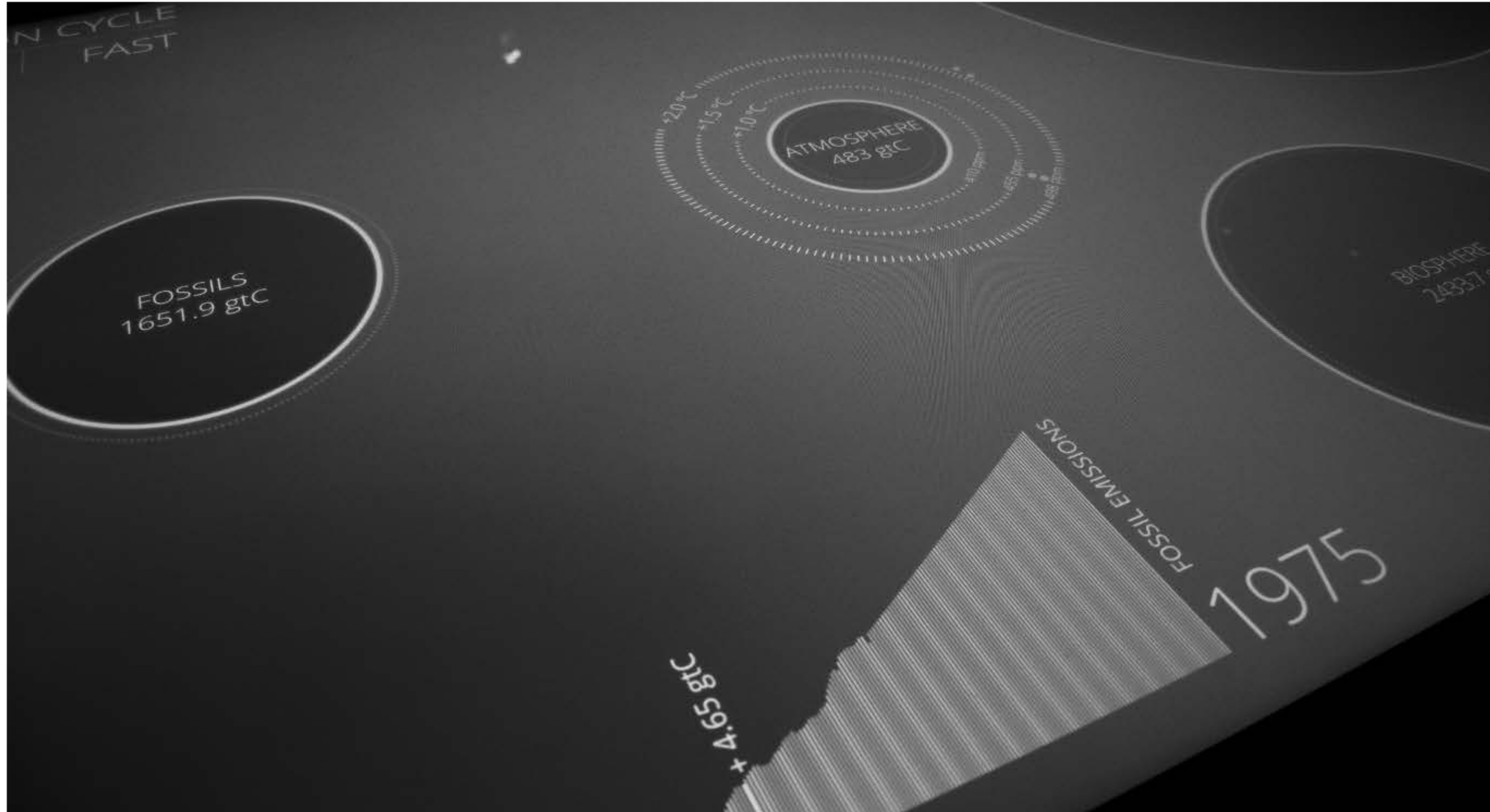
## 3.timeline: 1 slow cycle, 2 fast cycle



1. slow cycle

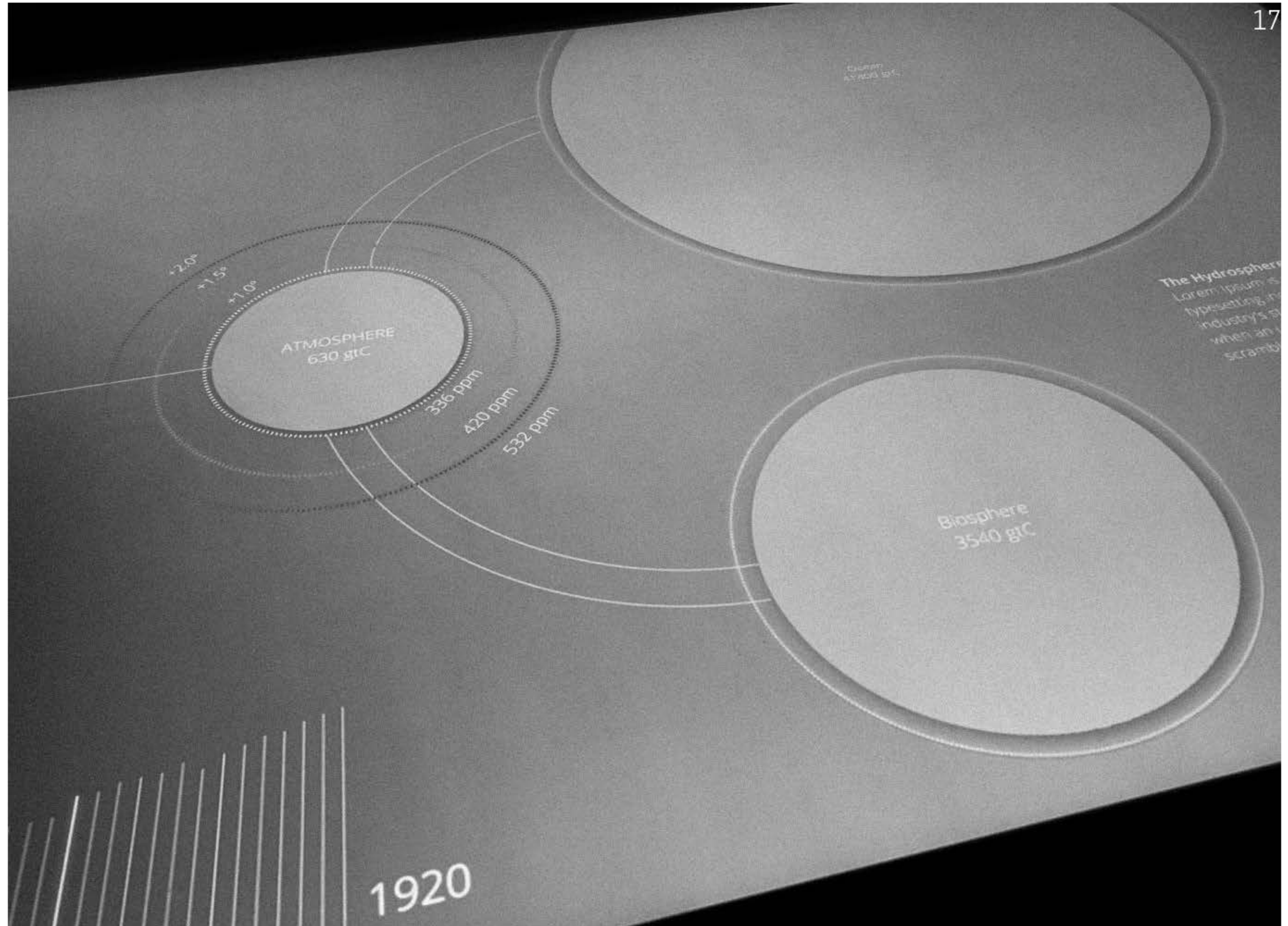


2.fast cycle





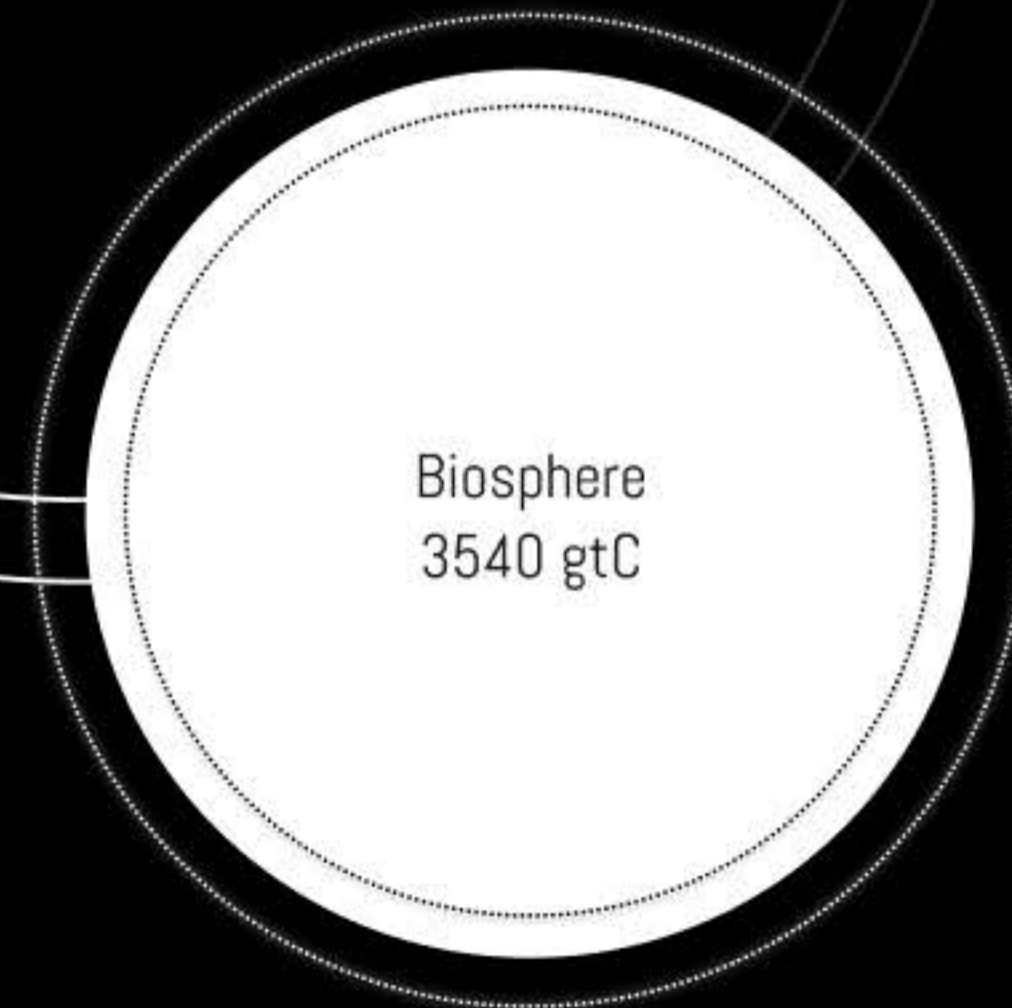
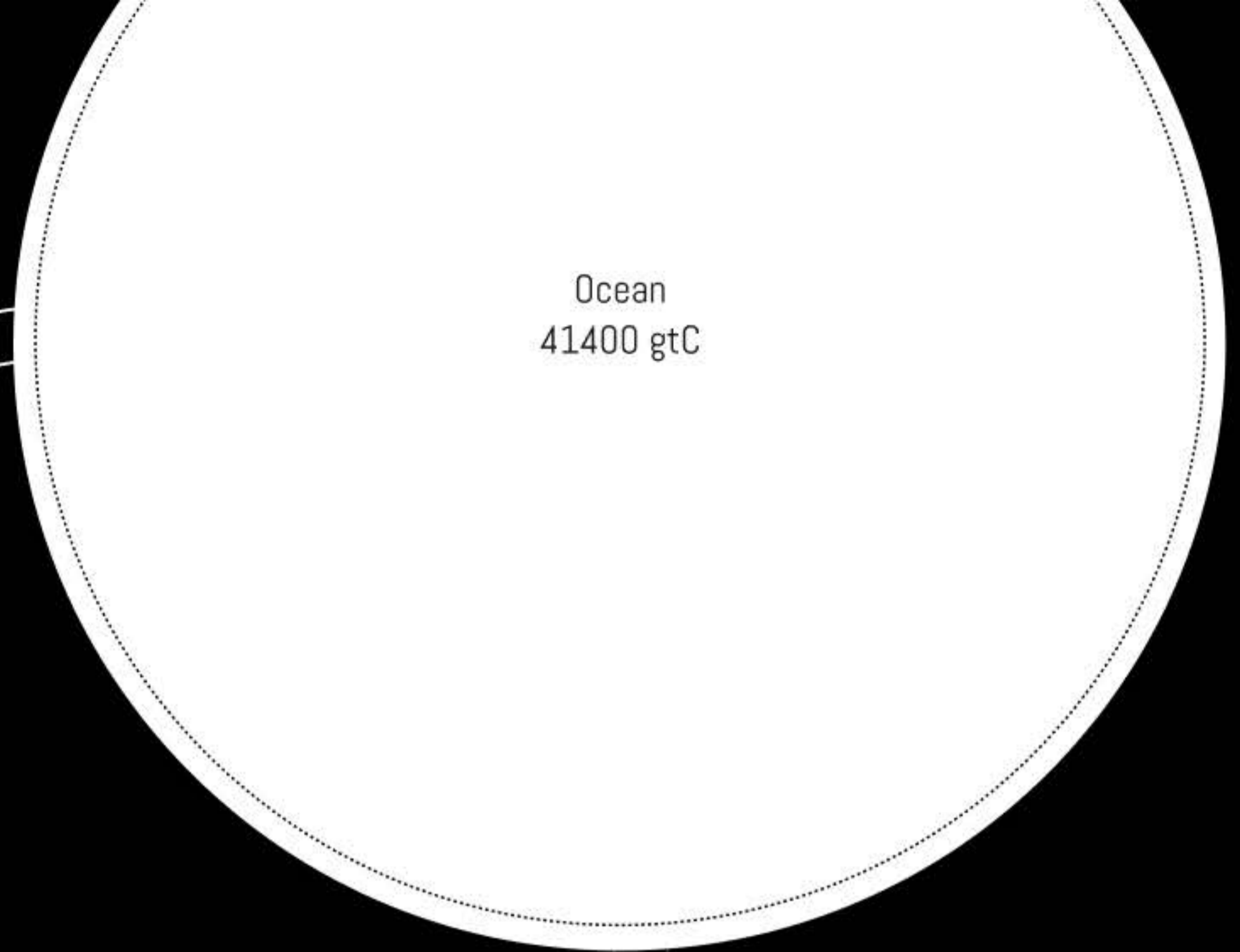
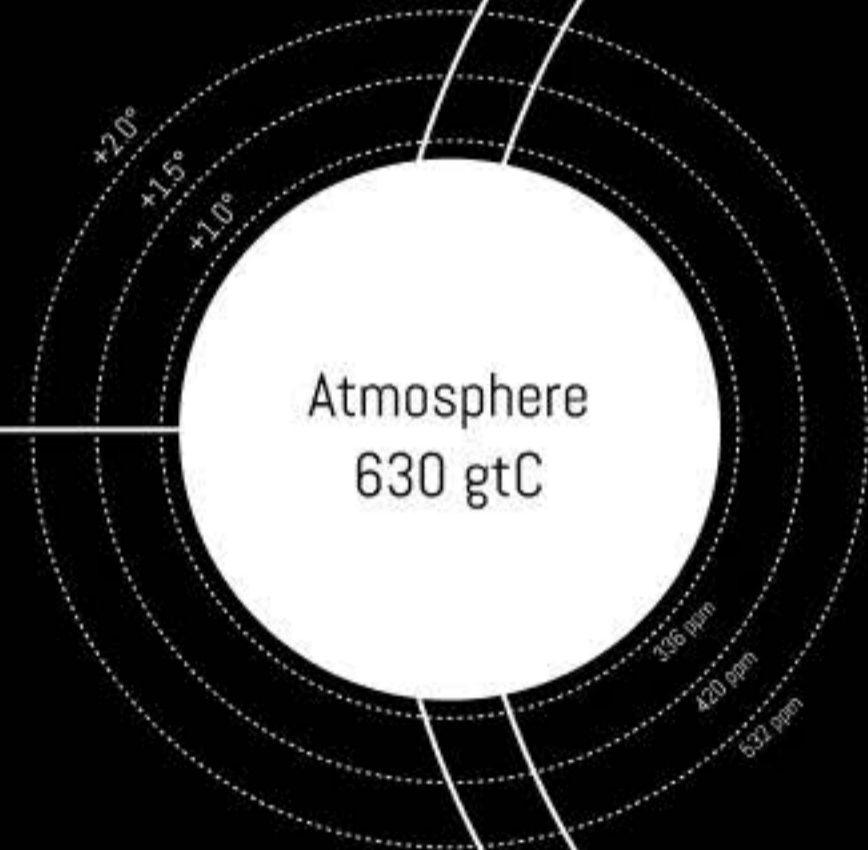
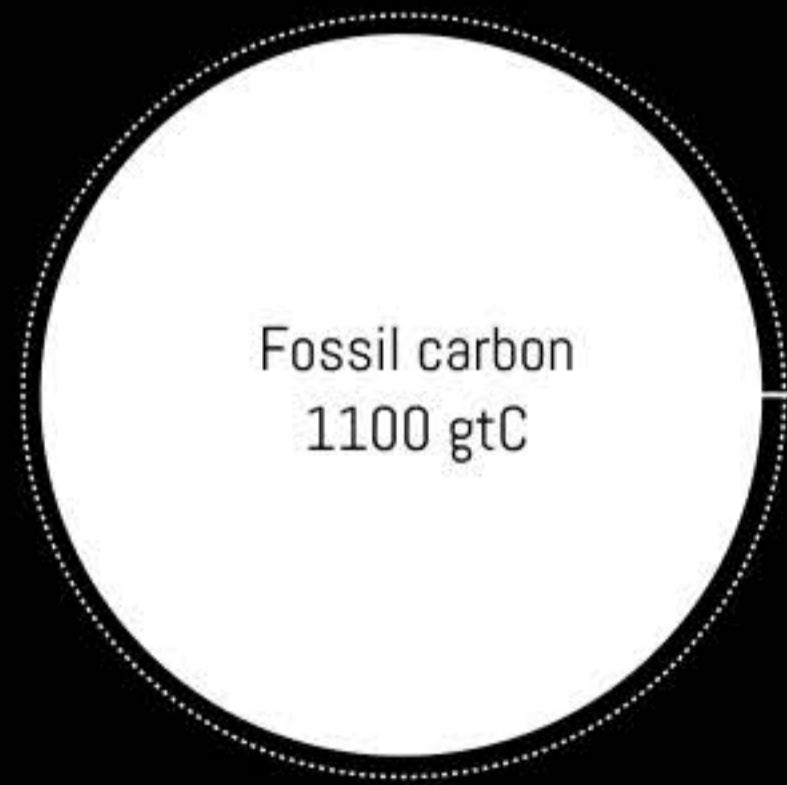
2.fast cycle



# CARBON CYCLE

SLOW

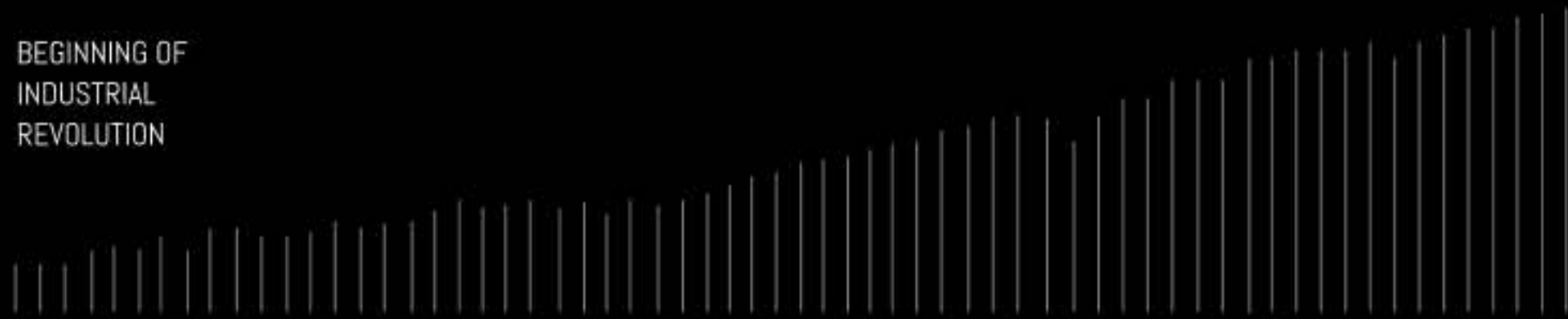
FAST



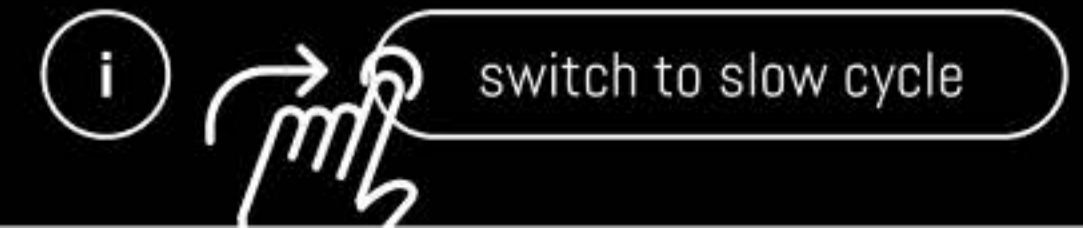
The Fast Cycle  
Lorem ipsum is simply dummy text of the printing and typesetting industry. Lorem ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book.

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Consectetur mauris lectus pellentesque suspendisse. Cras posuere pharetra, turpis nibh aliquet mauris elit dui. Egestas turpis justo convallis vitae tellus ultrices quis enim. Bibendum accumsan nisl, dictum mattis rhoncus fermentum. Eleifend blandit amet etiam facilisi morbi sed id. Pellentesque lobortis nunc ultrices purus quam. Dui urna sit dui etiam lacus. Quis ac

BEGINNING OF  
INDUSTRIAL  
REVOLUTION



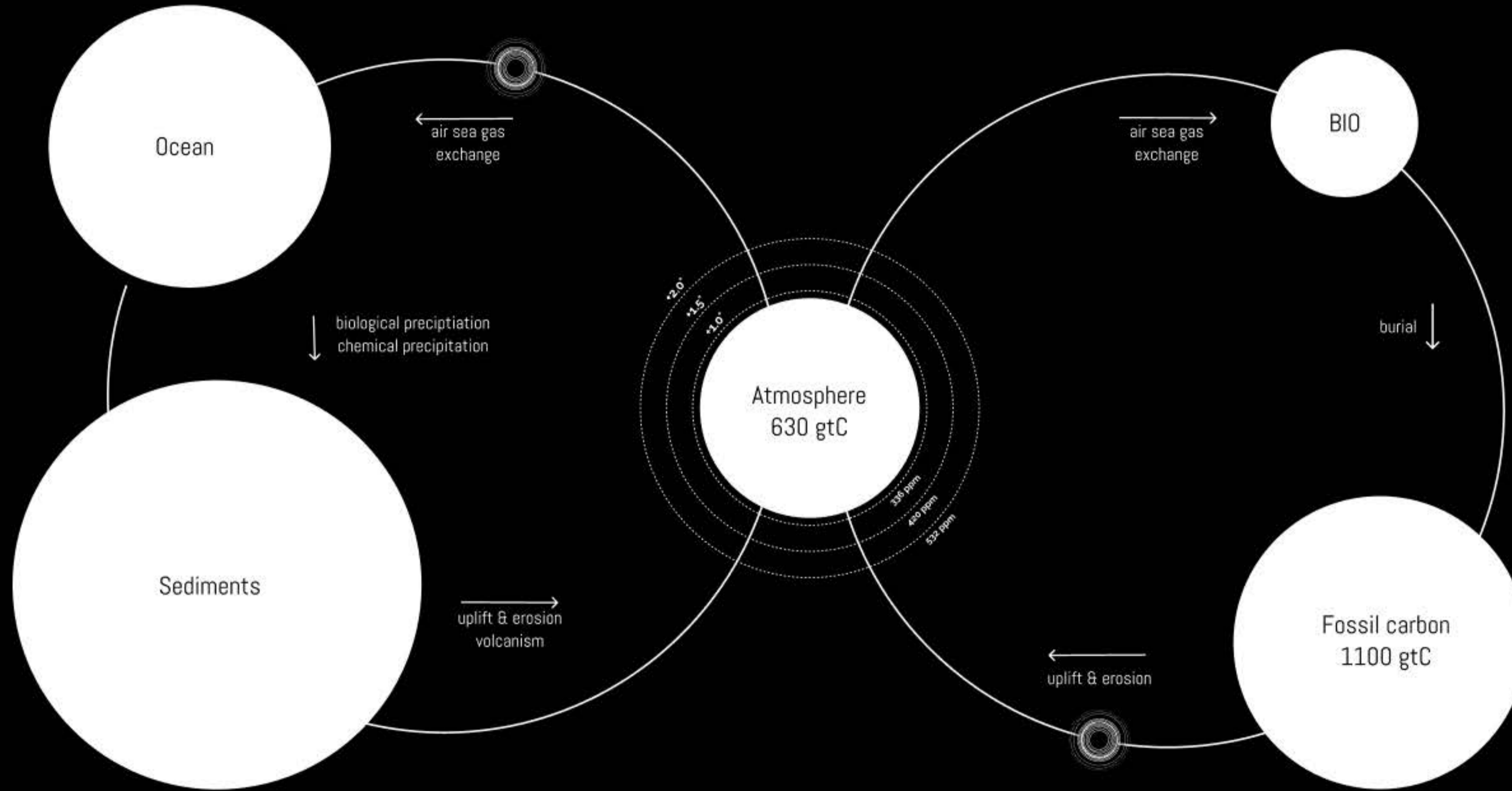
FOSSIL EMISSIONS  
1920



# CARBON CYCLE

SLOW

FAST



Info about Ocean reservoir  
In dolore ea ad et sit elit adipiscing et non. Magna consequat aute in ut voluptate proident ad laboris enim velit eiusmod officia incididunt duis. Irure occaecat excepteur adipiscing exercitation non fugiat ea sunt dolore amet.

Info about Sediments reservoir  
In dolore ea ad et sit elit adipiscing et non. Magna consequat aute in ut voluptate proident ad laboris enim velit eiusmod officia incididunt duis. Irure occaecat excepteur adipiscing exercitation non fugiat ea sunt dolore amet.

Info about Bio reservoir  
In dolore ea ad et sit elit adipiscing et non. Magna consequat aute in ut voluptate proident ad laboris enim velit eiusmod officia incididunt duis. Irure occaecat excepteur adipiscing exercitation non fugiat ea sunt dolore amet.

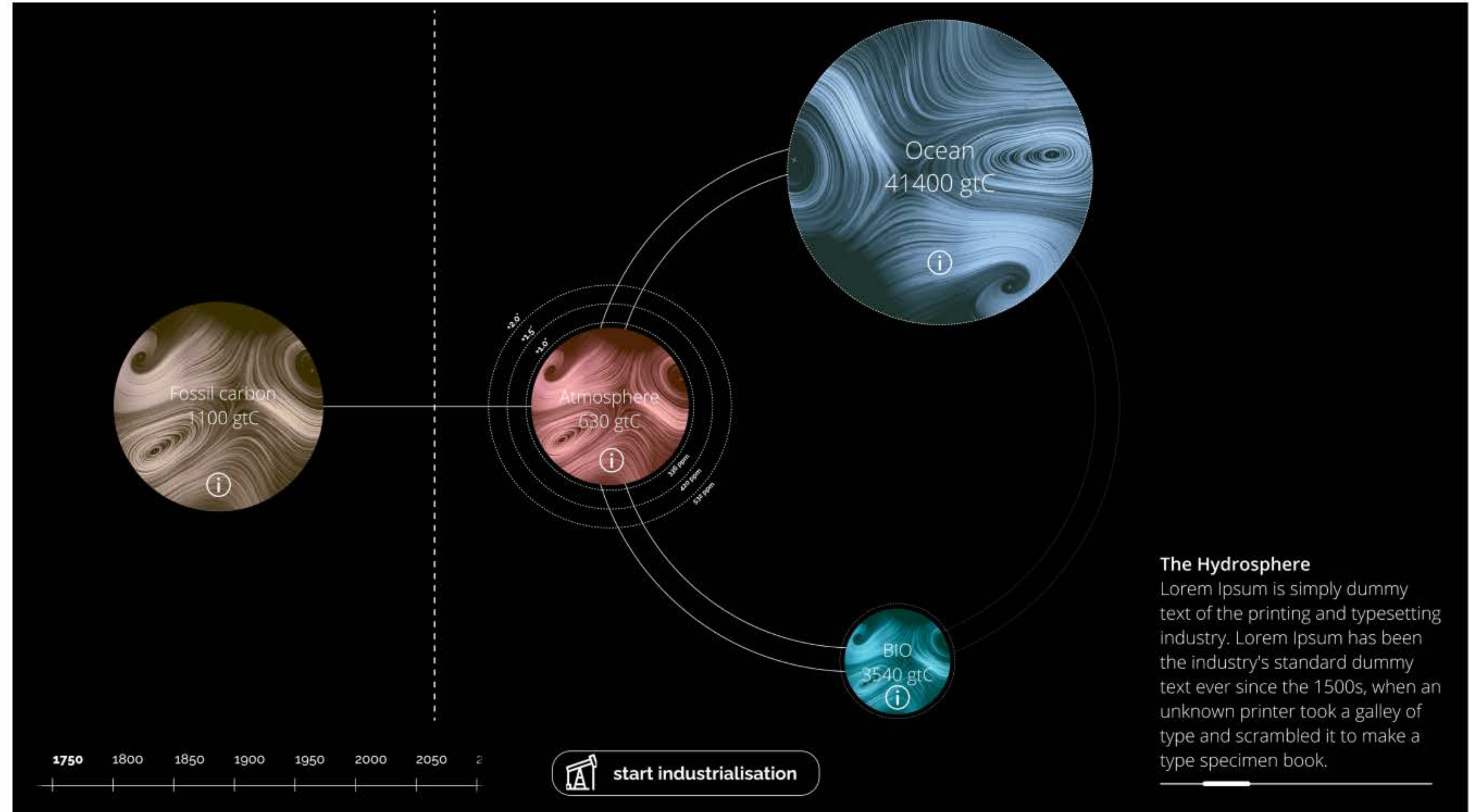
Info about Fossil carbon reservoir  
In dolore ea ad et sit elit adipiscing et non. Magna consequat aute in ut voluptate proident ad laboris enim velit eiusmod officia incididunt duis. Irure occaecat excepteur adipiscing exercitation non fugiat ea sunt dolore amet.

PRE-INDUSTRIAL PERIOD

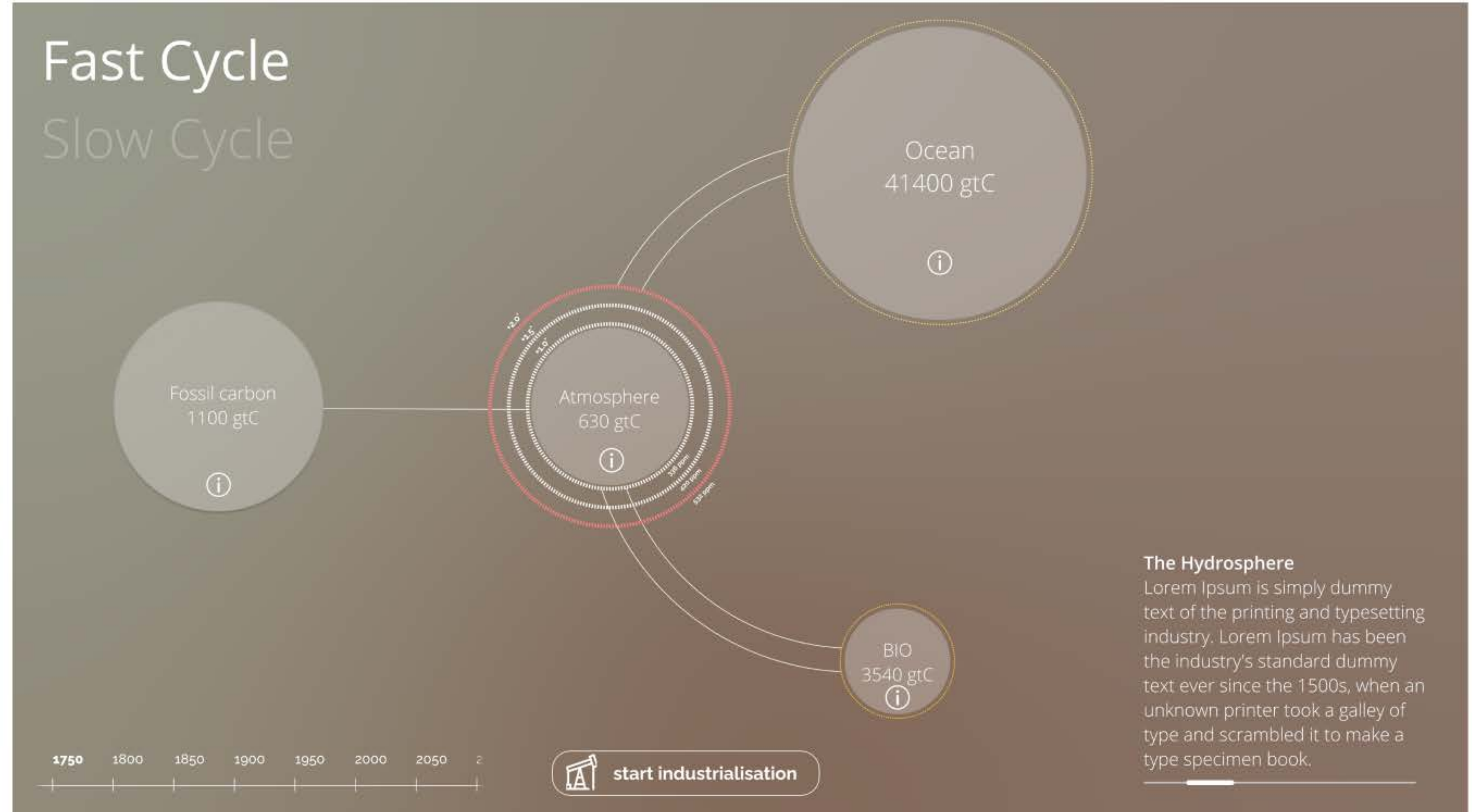
BEGINNING OF INDUSTRIAL REVOLUTION

switch to fast cycle

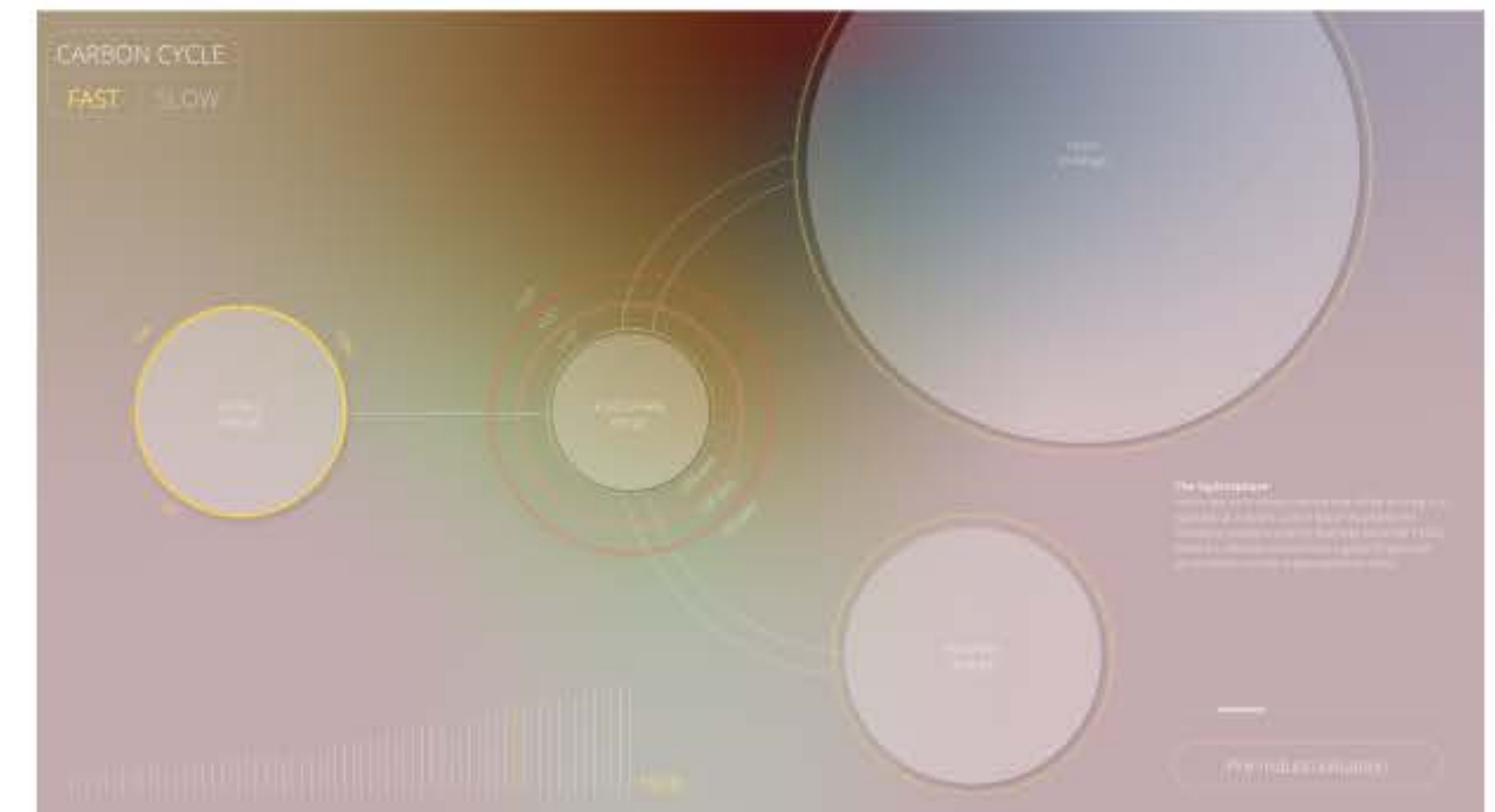
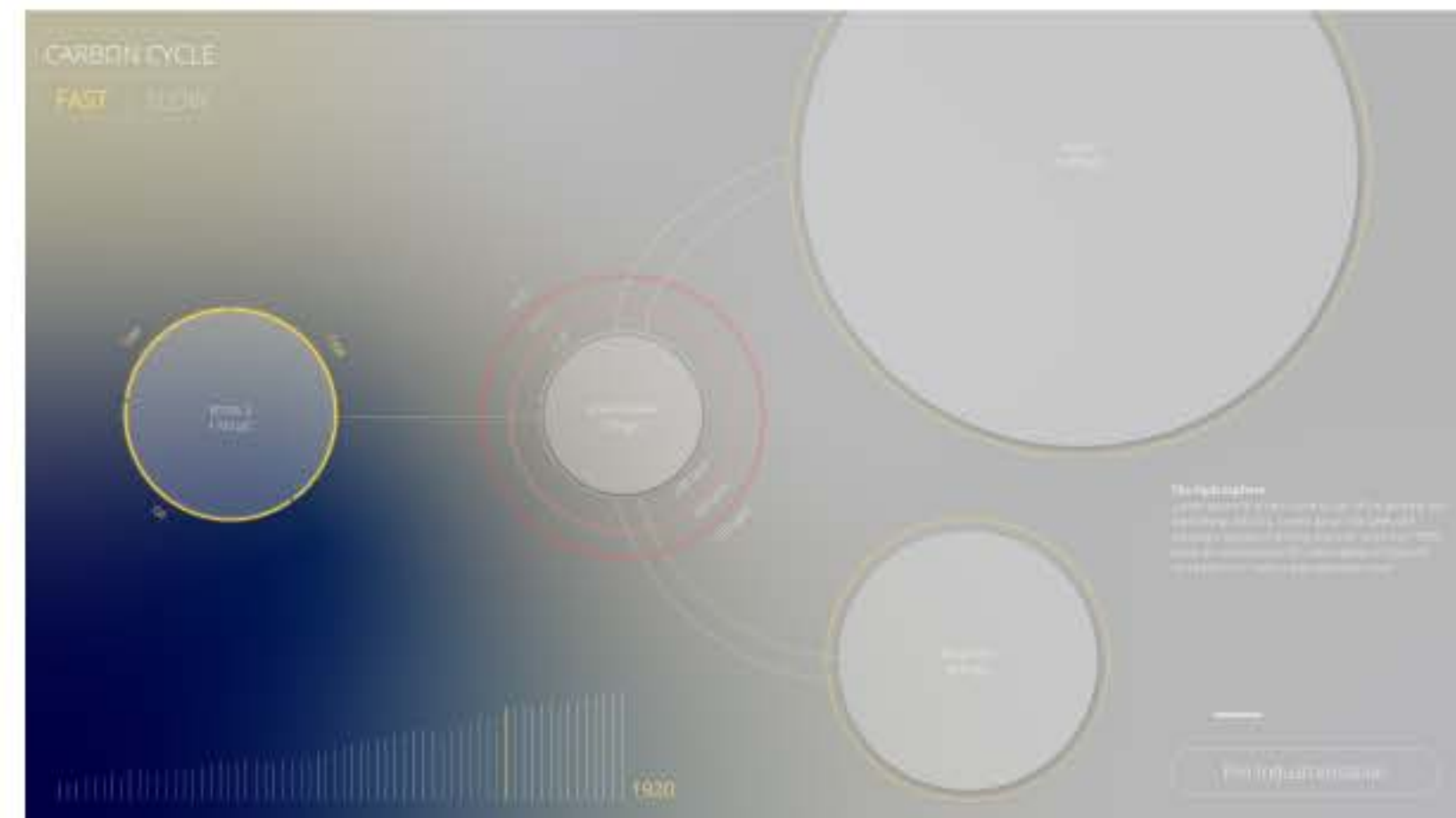
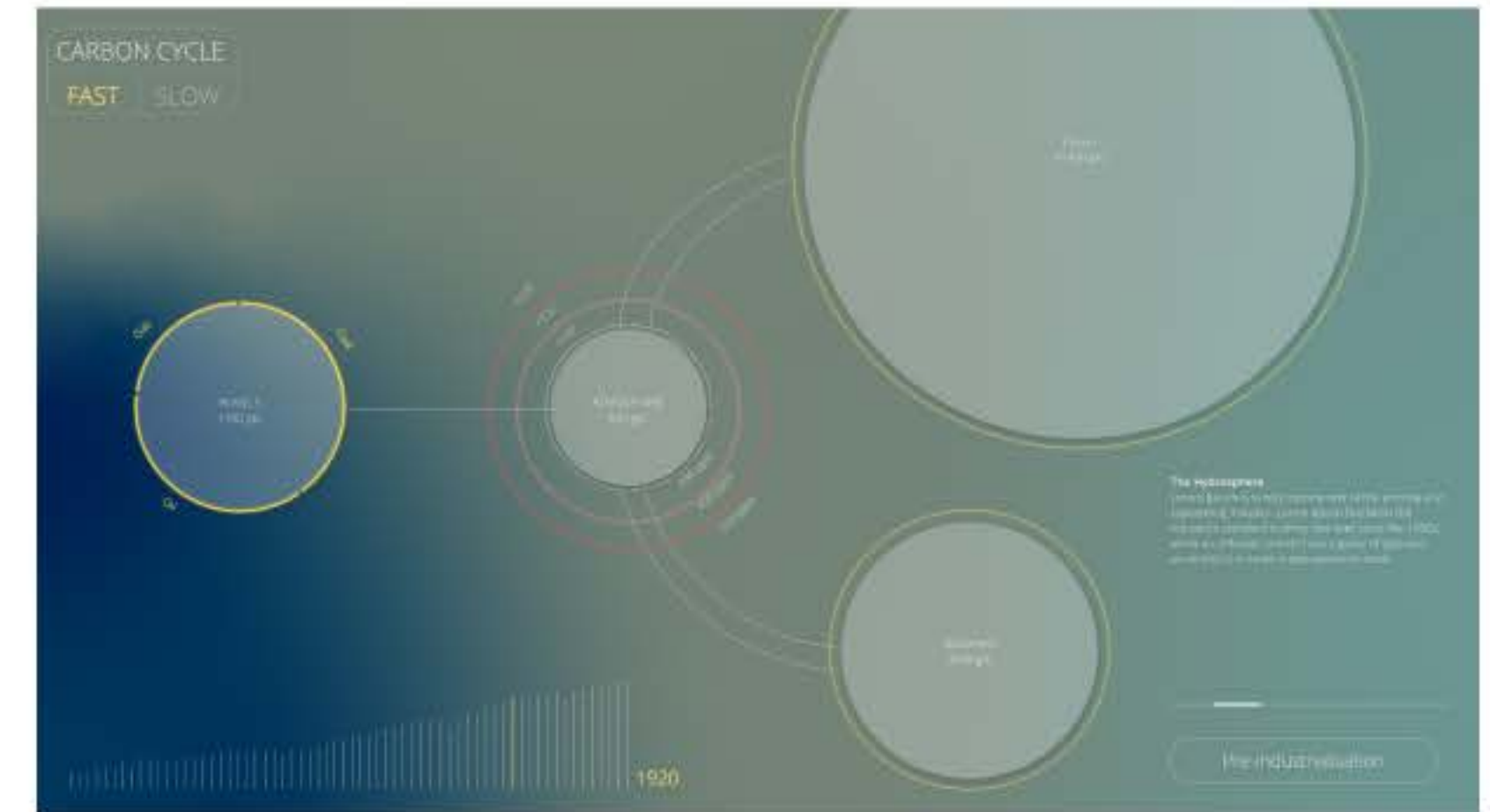
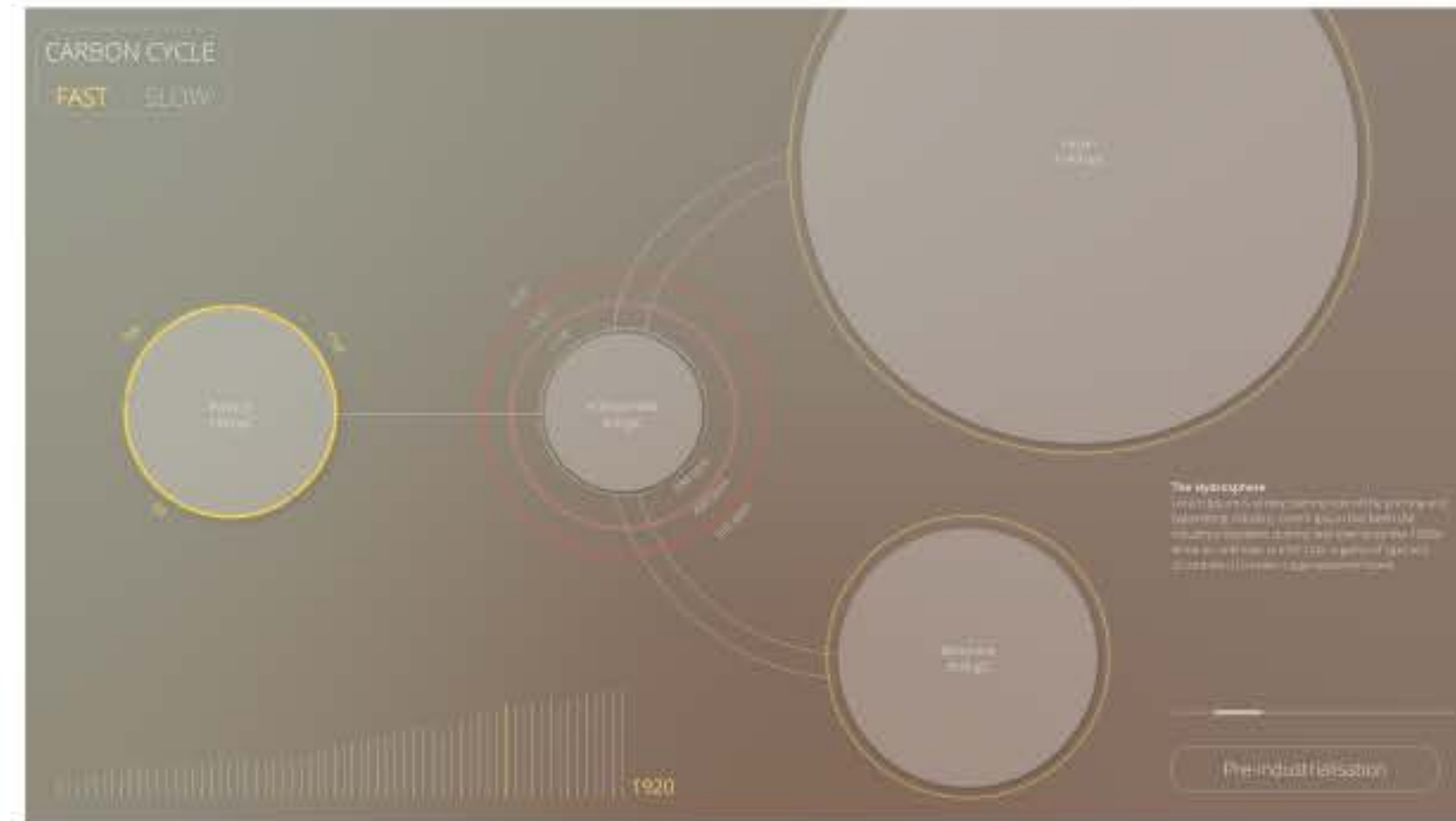
We decided early on we did not want to work with too much texture in our visualization, since we wanted to be able to program it. We limited ourselves to flat colors also to not mistaken the reservoirs for planets



Having a colorful and blurred background would be possible, so we added that.



We tried out different backgrounds to see what would look the best with our golden accent color and the multitouch table's color depiction





The User can Interact with the timeline and show look at the fluxes and reservoir sizes in that year.

The User can Interact with the timeline and show look at the fluxes and reservoir sizes in that year.

When the user clicks on the empty space, the general information about the fast carbon cycle pops up.



**Info about Fast Cycle**  
 Lorem ipsum is simply dummy text of the printing and typesetting industry. Lorem ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book.  
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SLOW CYCLE





# CARBON CYCLE

SLOW | FAST

OCEAN



PRE-INDUSTRIAL PERIOD

BEGINNING OF INDUSTRIAL REVOLUTION

FAST CYCLE

# CARBON CYCLE

SLOW | FAST

OCEAN

OCEAN SURFACE

INTERMEDIARE & DEEP OCEAN

MARINE BIOTA

Air sea gas exchange

ATMOSPHERE

Photosynthesis

PLANT BIOMASS

WATER PLANTS

VEGETATION

BIOSPHERE

SOIL

PERMAFROST

Burial

OIL

GAS

FOSSILS

COAL

SEDIMENTS

Uplift & erosion volcanism

**Ocean Reservoir**  
 Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book.  
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**Biosphere Reservoir**  
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**Fossil Reservoir**  
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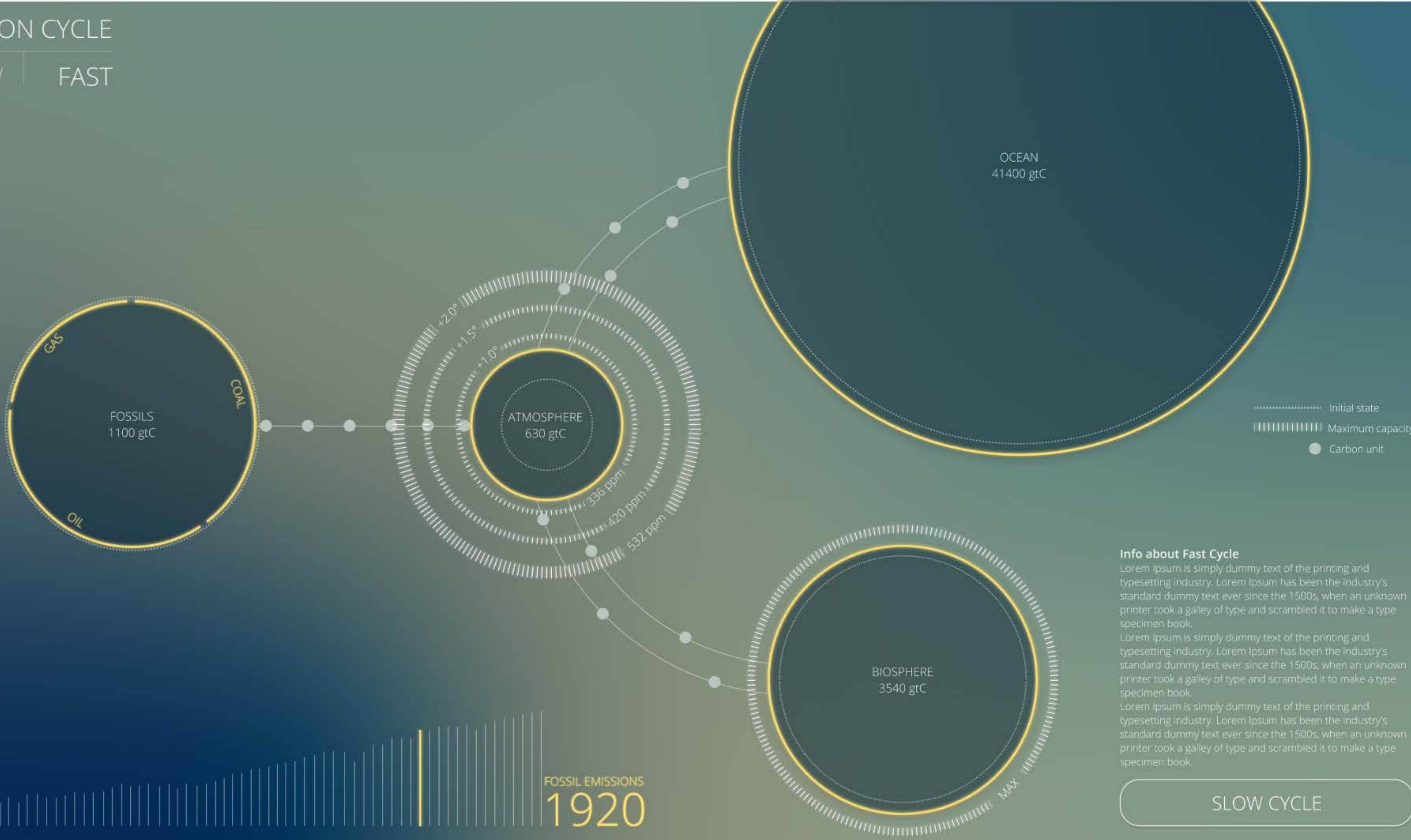
PRE-INDUSTRIAL PERIOD

BEGINNING OF INDUSTRIAL REVOLUTION

FAST CYCLE

# CARBON CYCLE

SLOW | FAST

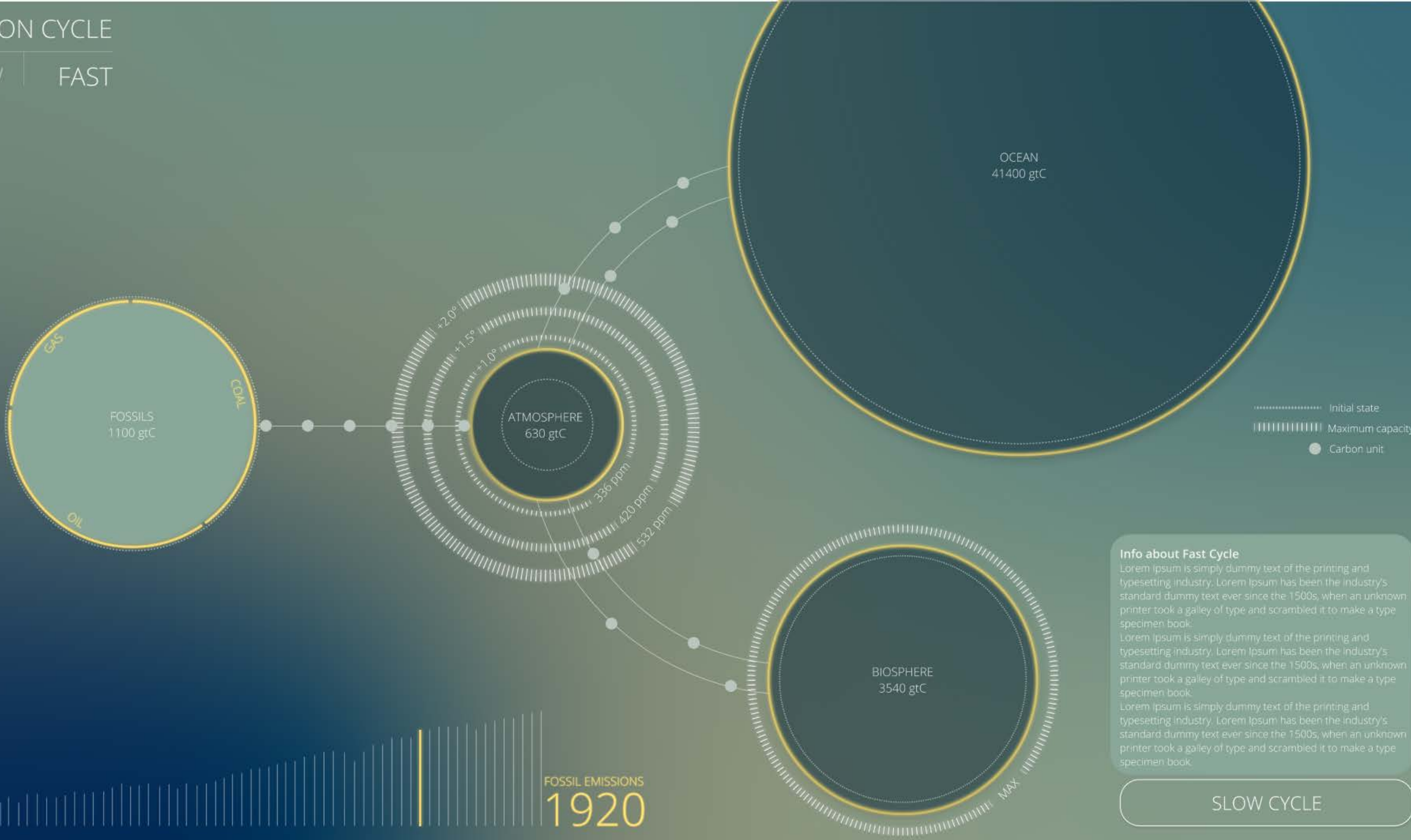


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SLOW CYCLE

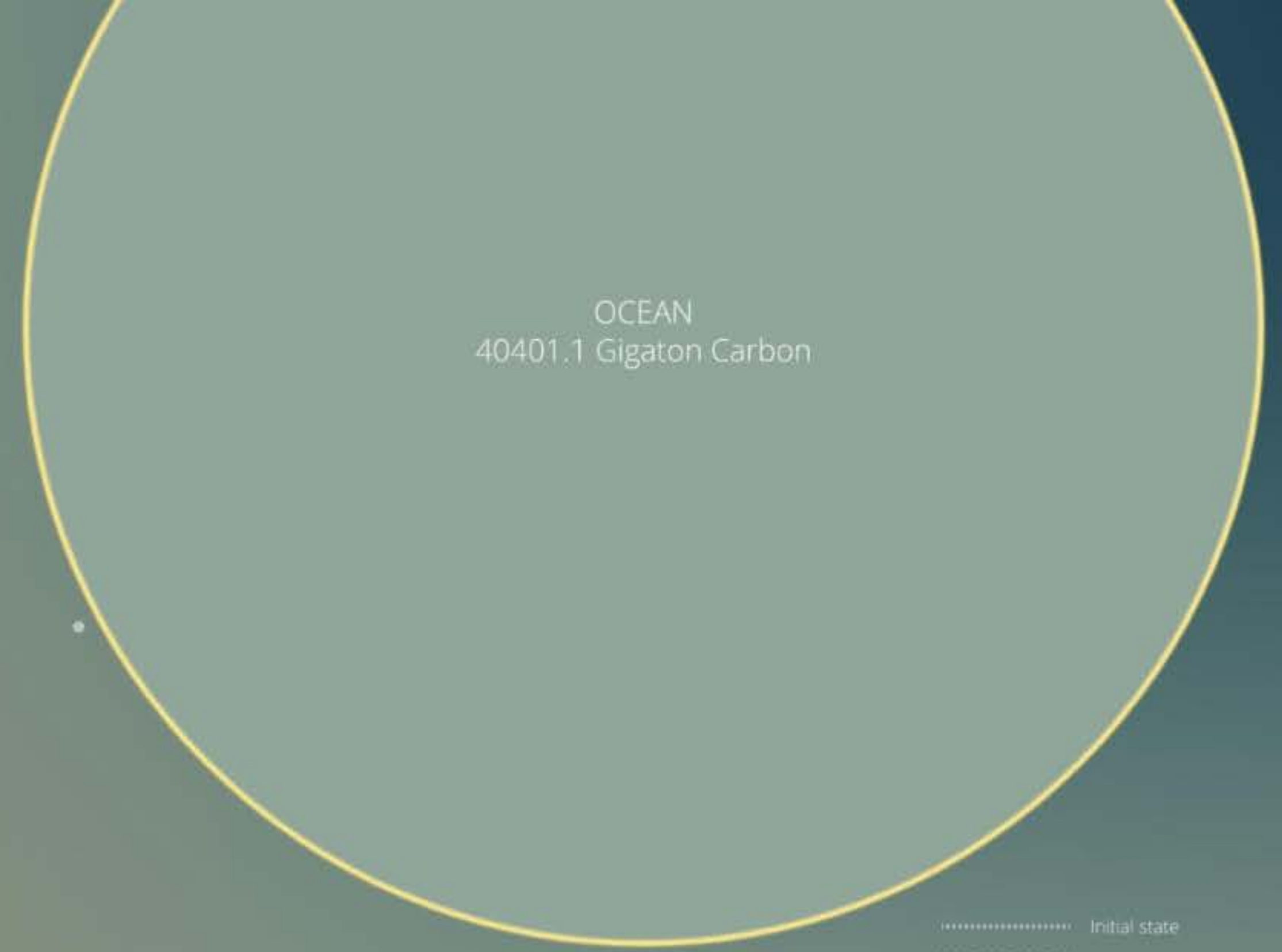
# CARBON CYCLE

SLOW | FAST



# CARBON CYCLE

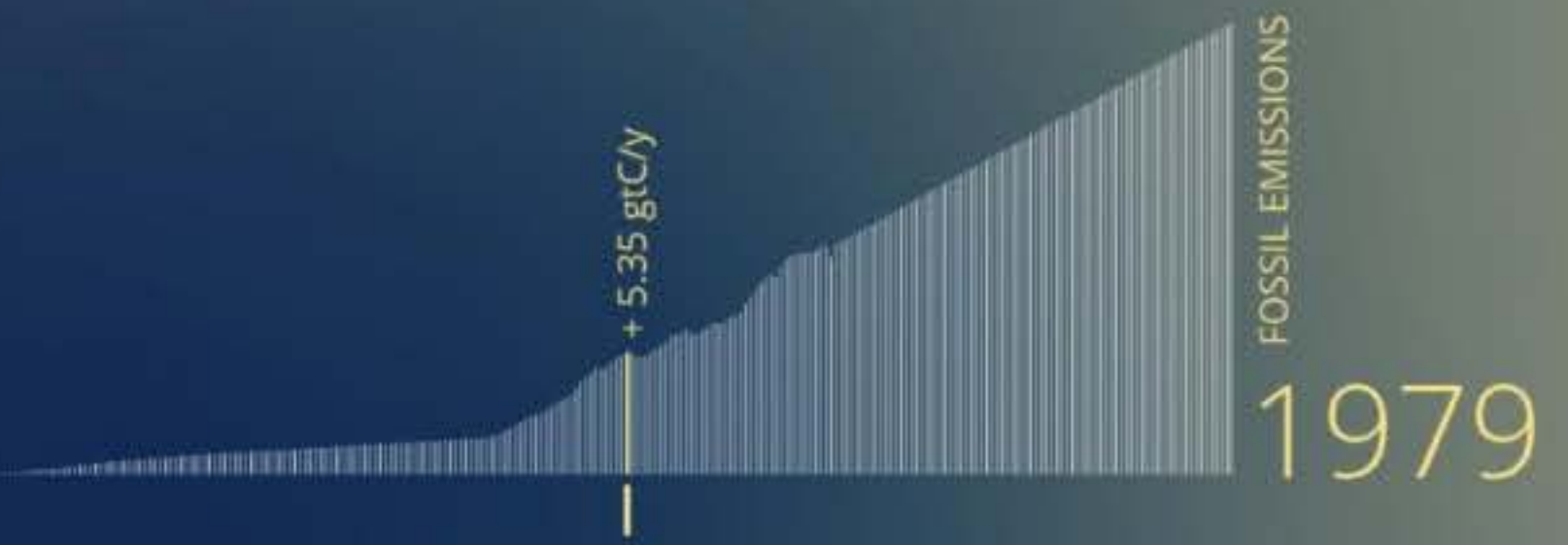
SLOW | FAST



..... Initial state  
||||| Maximum capacity  
● Carbon unit

**OCEAN**

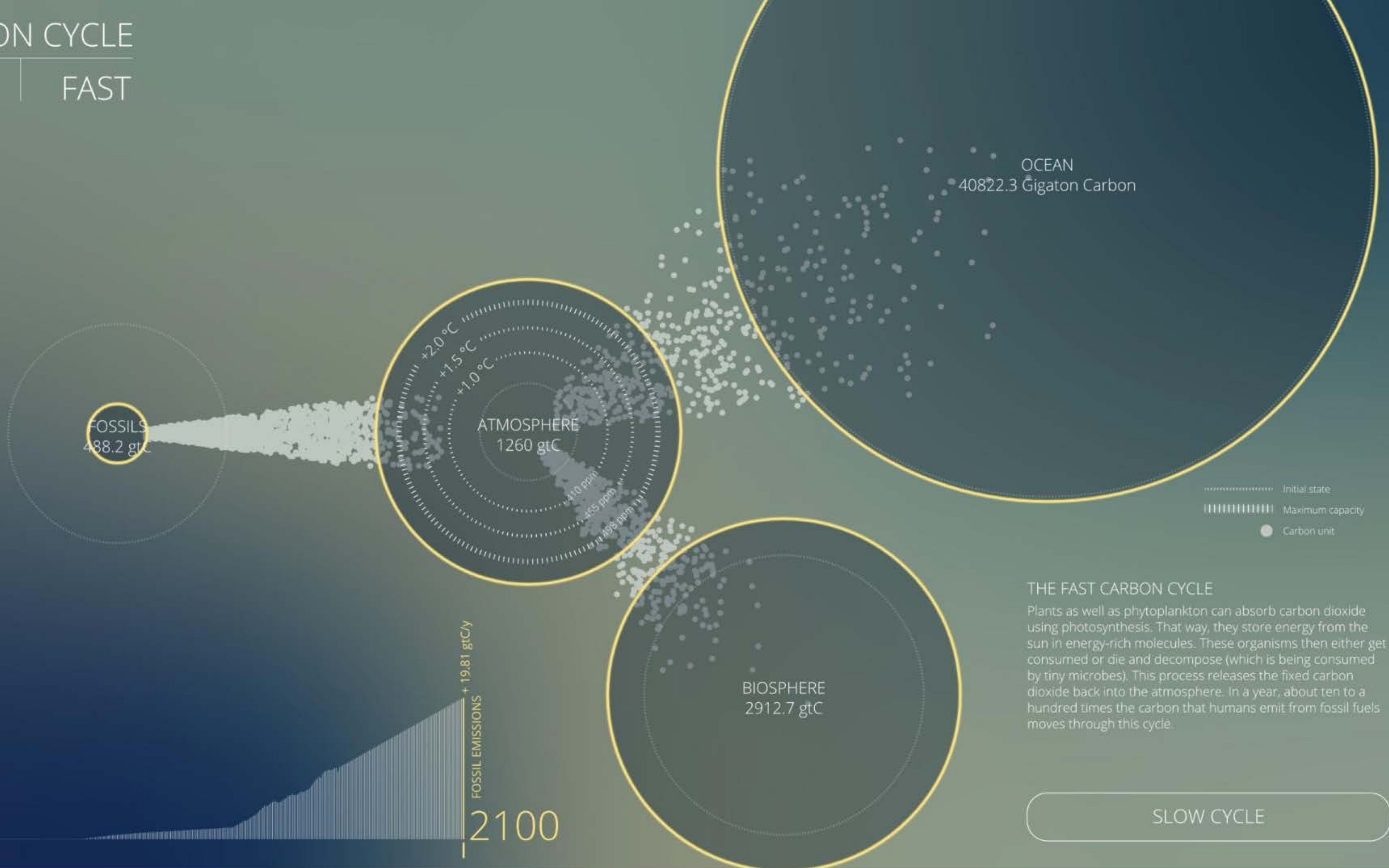
The absorption of CO<sub>2</sub> by the oceans is one of the most important forms of carbon capture, limiting the human-induced increase of carbon dioxide in the atmosphere. However, this process is limited by a number of factors. CO<sub>2</sub> absorption makes water more acidic, which affects ocean biosystems. The projected increase in ocean acidity could slow the biological deposition of for example calcium carbonates, reducing the ocean's ability to absorb CO<sub>2</sub>.



SLOW CYCLE

# CARBON CYCLE

SLOW | FAST



### THE FAST CARBON CYCLE

Plants as well as phytoplankton can absorb carbon dioxide using photosynthesis. That way, they store energy from the sun in energy-rich molecules. These organisms then either get consumed or die and decompose (which is being consumed by tiny microbes). This process releases the fixed carbon dioxide back into the atmosphere. In a year, about ten to a hundred times the carbon that humans emit from fossil fuels moves through this cycle.

SLOW CYCLE

In retrospect we might have spent too much time discussing the topic of global warming itself. It was needed however, to make such a coherent product. Deciding what to keep and what to discard of our new attained knowledge was one of the hardest things to do.

If we had more time, we would have added the slow cycle into our programmed prototype and make it more clear that the slow cycle doesn't stop during industrialization. Also we would have liked to add more details to the design in the programmed prototype. It works really well the way it is now too.

We are really proud with the outcome and see a lot of potential in it. The substance and design work well together and we got out the best of everyone in our team.