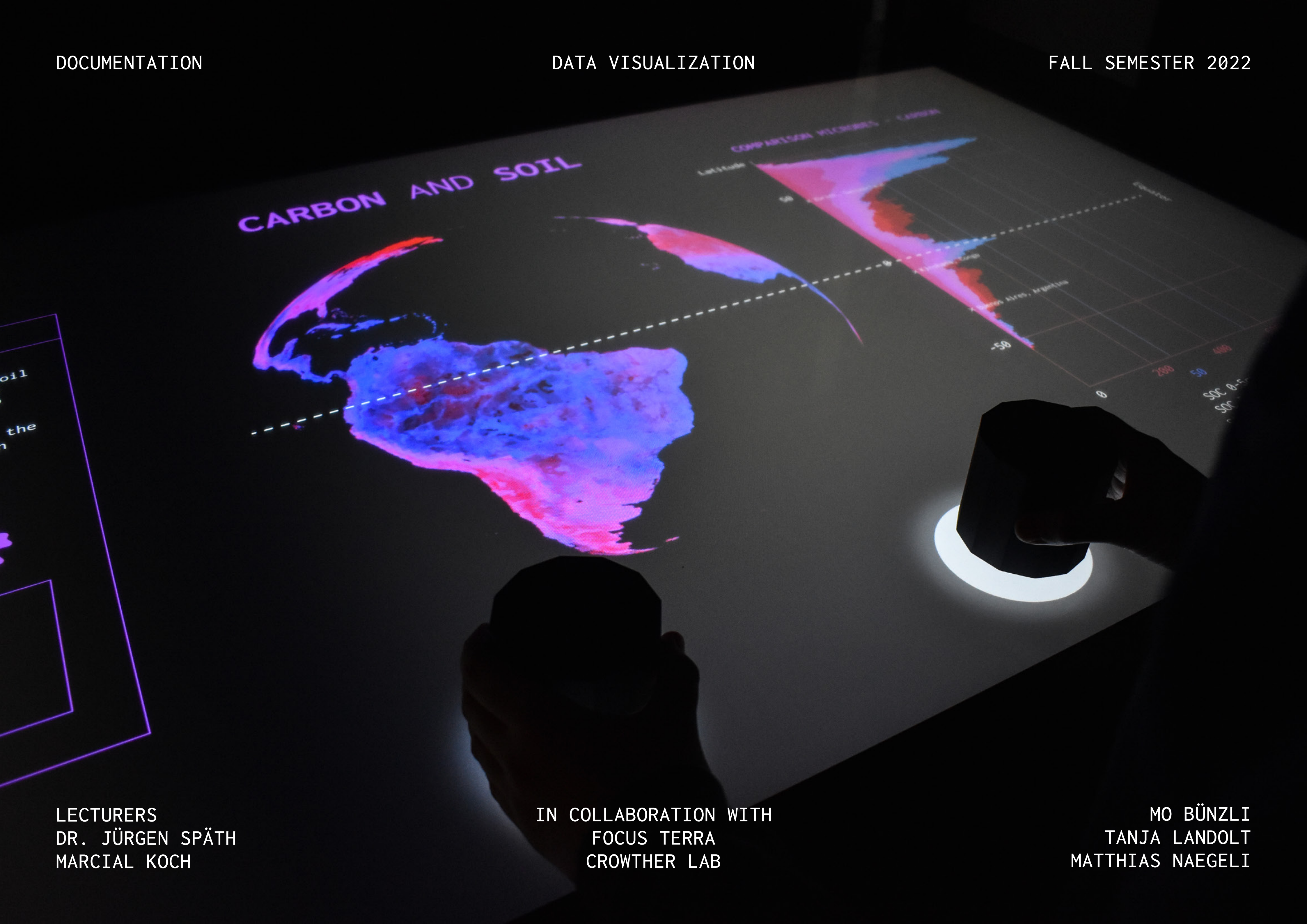
DOCUMENTATION

DATA VISUALIZATION

FALL SEMESTER 2022



LECTURERS
DR. JÜRGEN SPÄTH
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IN COLLABORATION WITH
FOCUS TERRA
CROWTHER LAB

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CONTENT

ABOUT THE PROJECT

For this Data Visualization module, we were able to do a collaboration with the Crowther Lab as well as focusTerra, both affiliated with ETH Zurich.

The Crowther Lab focuses on research about global ecology and understanding and addressing climate change. Our project topic was nature-based CO_2 storage; we were able to access the Lab's actual research data about this topic. Our goal was therefore to make this concept of nature-based CO_2 storage understandable, explorable, and actionable.

With our final project, our specific goal was to showcase the CO_2 storage potential of belowground soil communities; these communities consist of species such as fungi, bacteria, and archaea. As the role of these species is generally not very well-known and even underestimated - there is actually more belowground CO_2 storage potential than aboveground, e.g. in trees - we wanted to use our project to increase awareness of this.

IN COLLABORATION WITH

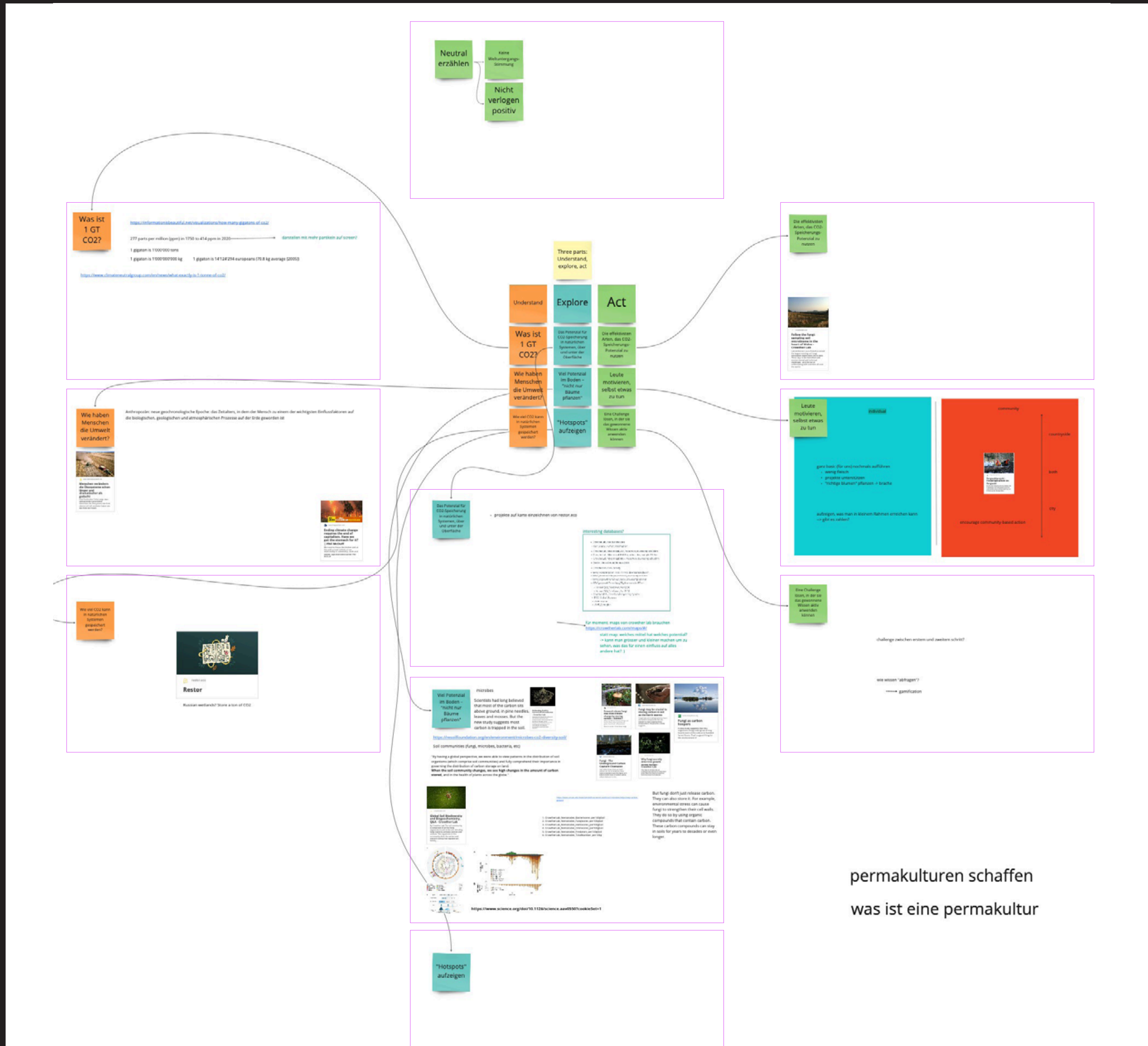
CROWTHER LAB

ETH zürich

focusTerra

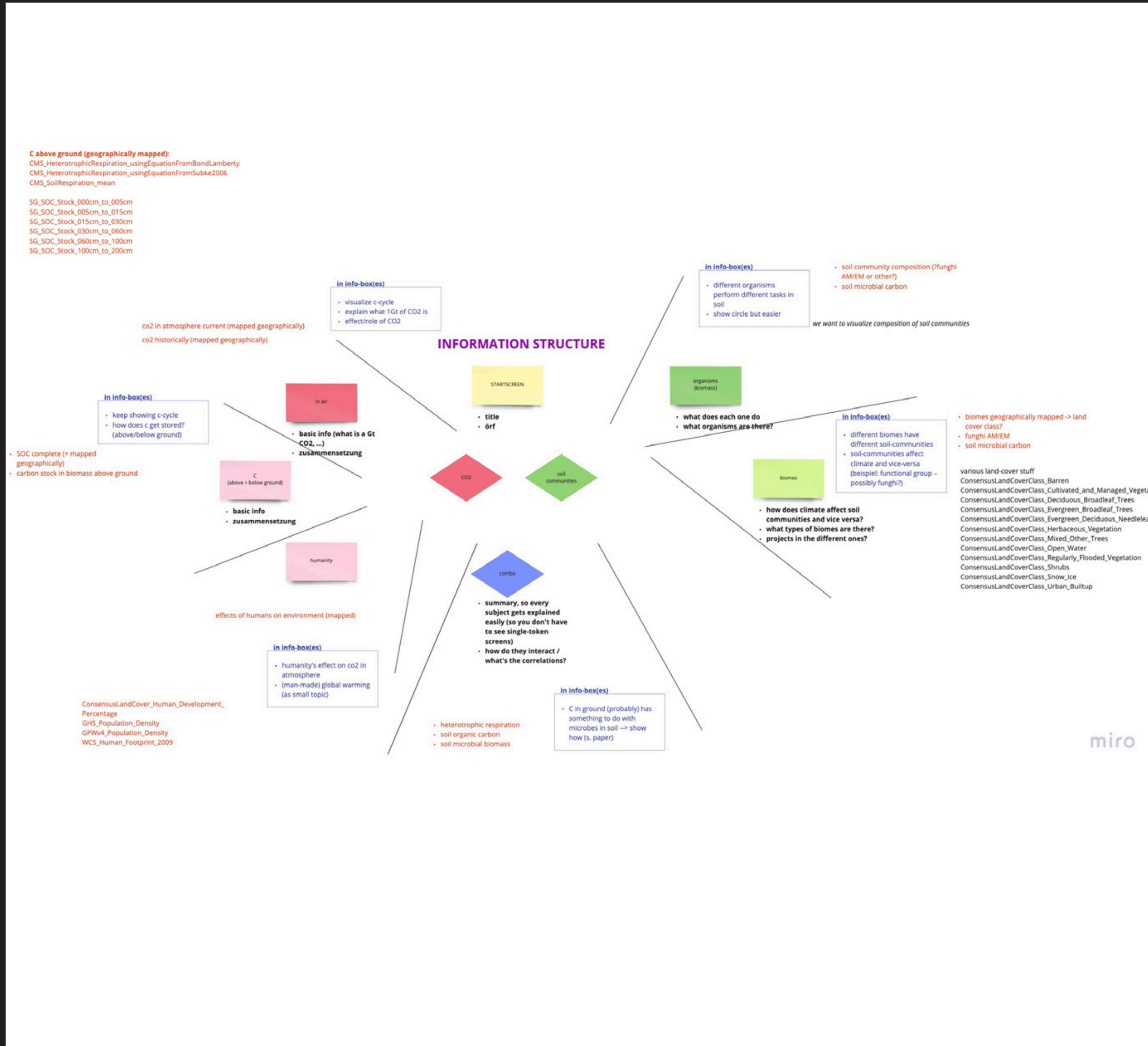
RESEARCH TOPIC

We spent a lot of time reviewing the material we were given by the Crowther Lab, and did additional research on our own to figure out how we wanted to approach this project. Since the general topic of nature-based CO2 storage is so broad and difficult to summarize, we wanted to choose a focus topic to really hone in on. Finally, we found a research paper titled “The global soil community and its influence on biogeochemistry”, the authors of which being several members of the Crowther Lab research team, which sparked our interest. The paper showed a visualization showcasing the direct correlation between belowground carbon storage and healthy soil microbial biomass; this interested us greatly, and it was also a fact none of us had previously known. In our opinion, this research shows great potential, so we decided to focus on it.



DATA COLLECTION

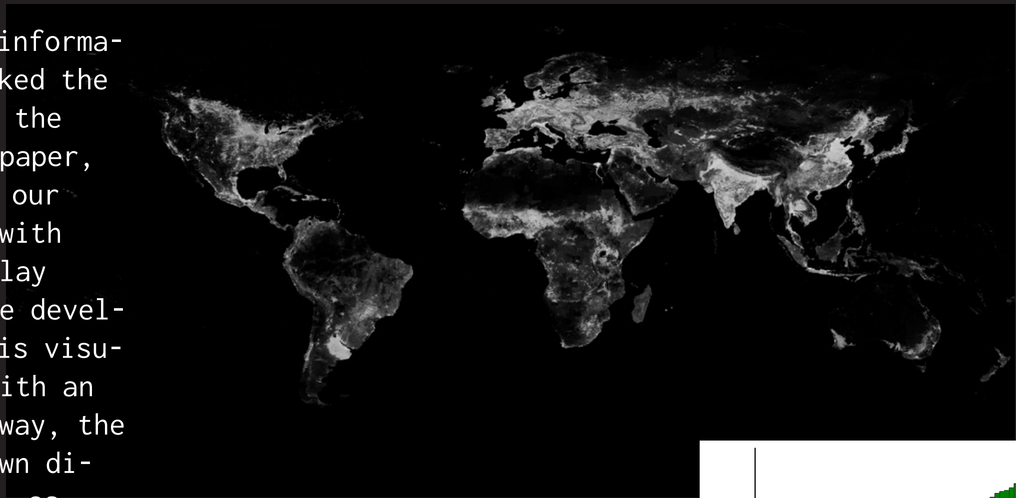
During the initial sketching and wireframing phase, we used the visualizations from the aforementioned paper in order to roughly communicate our idea. After reaching out to Tom from the Crowther Lab and requesting the specific data we needed (e.g. maps of the global below-ground CO2 storage distribution or the different makeup of soil communities across the globe), we received it in the final project week, and were able to implement it in our final proto-typing stage.

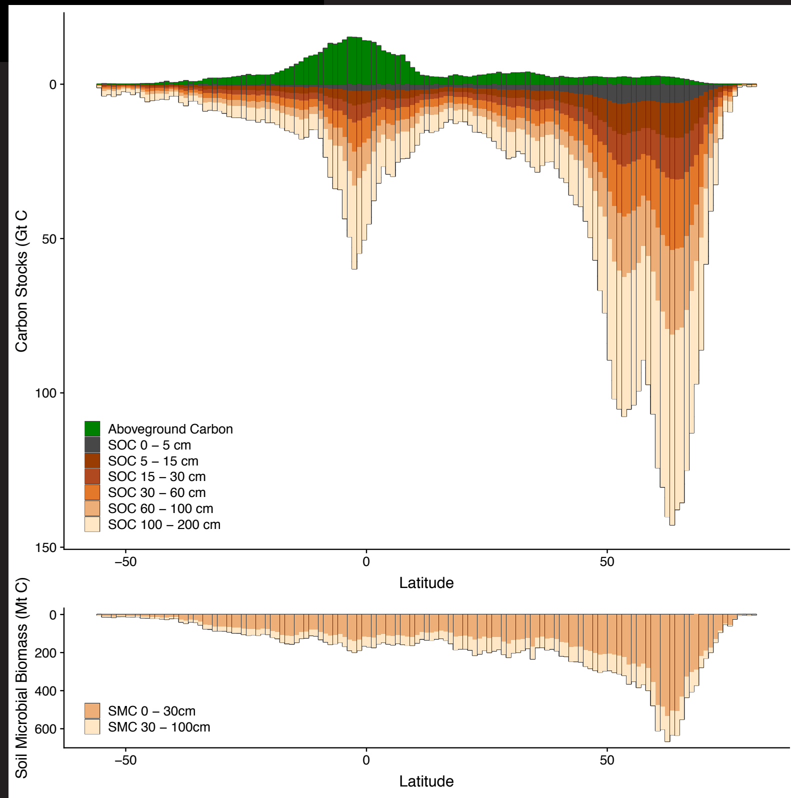


FIRST IDEAS

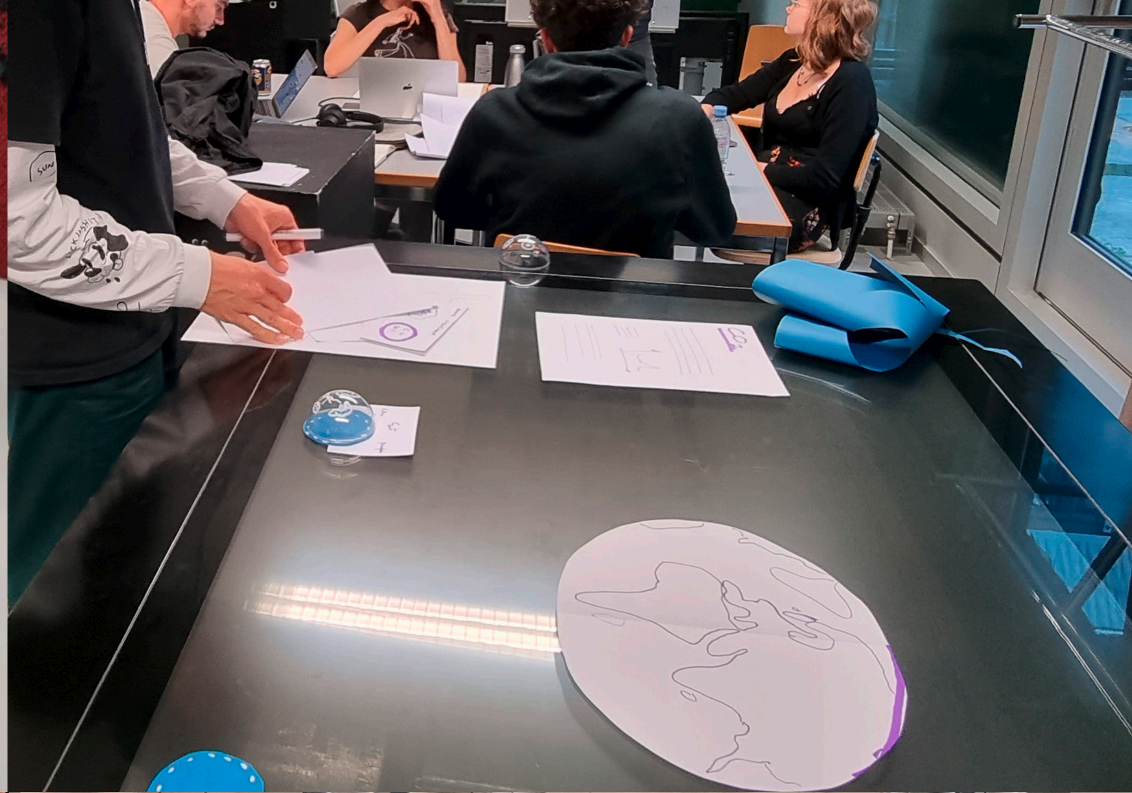
How should we show this information? Since we really liked the graph visualization from the aforementioned research paper, we decided to use it for our purposes and experiment with similar information display methods. Additionally, we developed the idea to show this visualization side-by-side with an interactive globe; this way, the information would be shown directly on a 3D world map, as well as in a more detailed view on a graph.

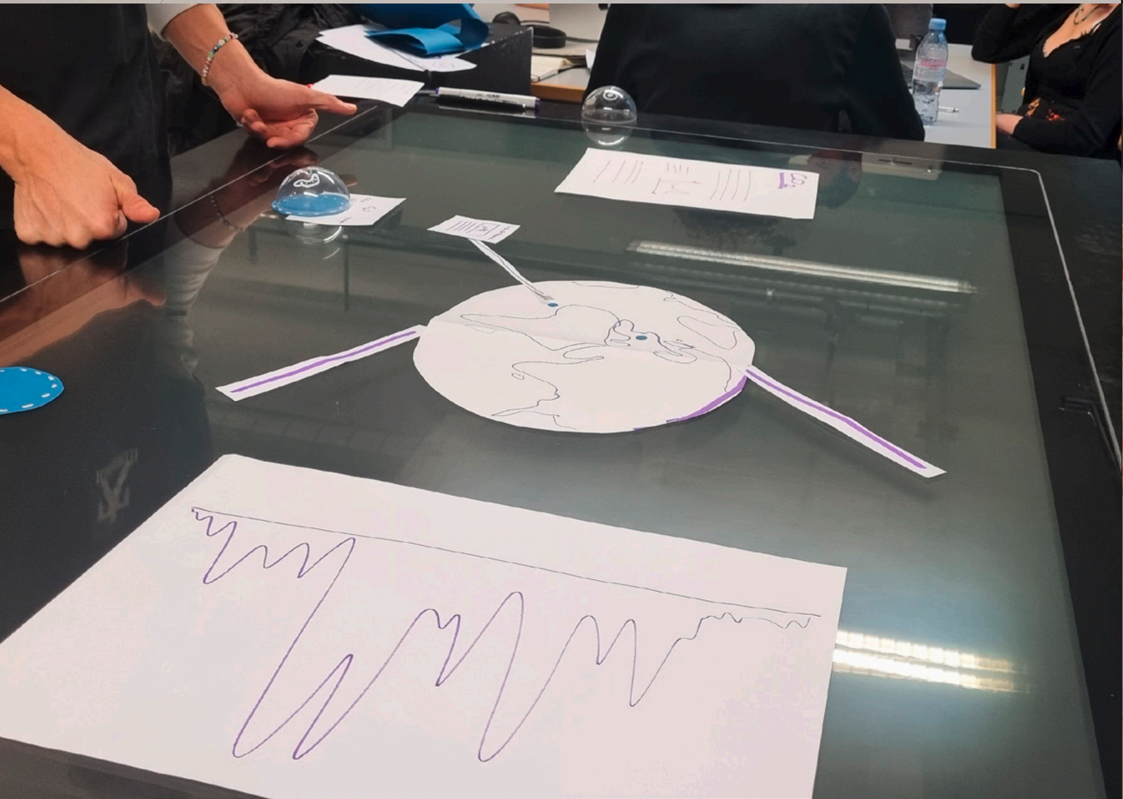
To us, the most important information to communicate would be what exactly these soil communities consist of and how they function, and also how the CO2 cycle relates to this.





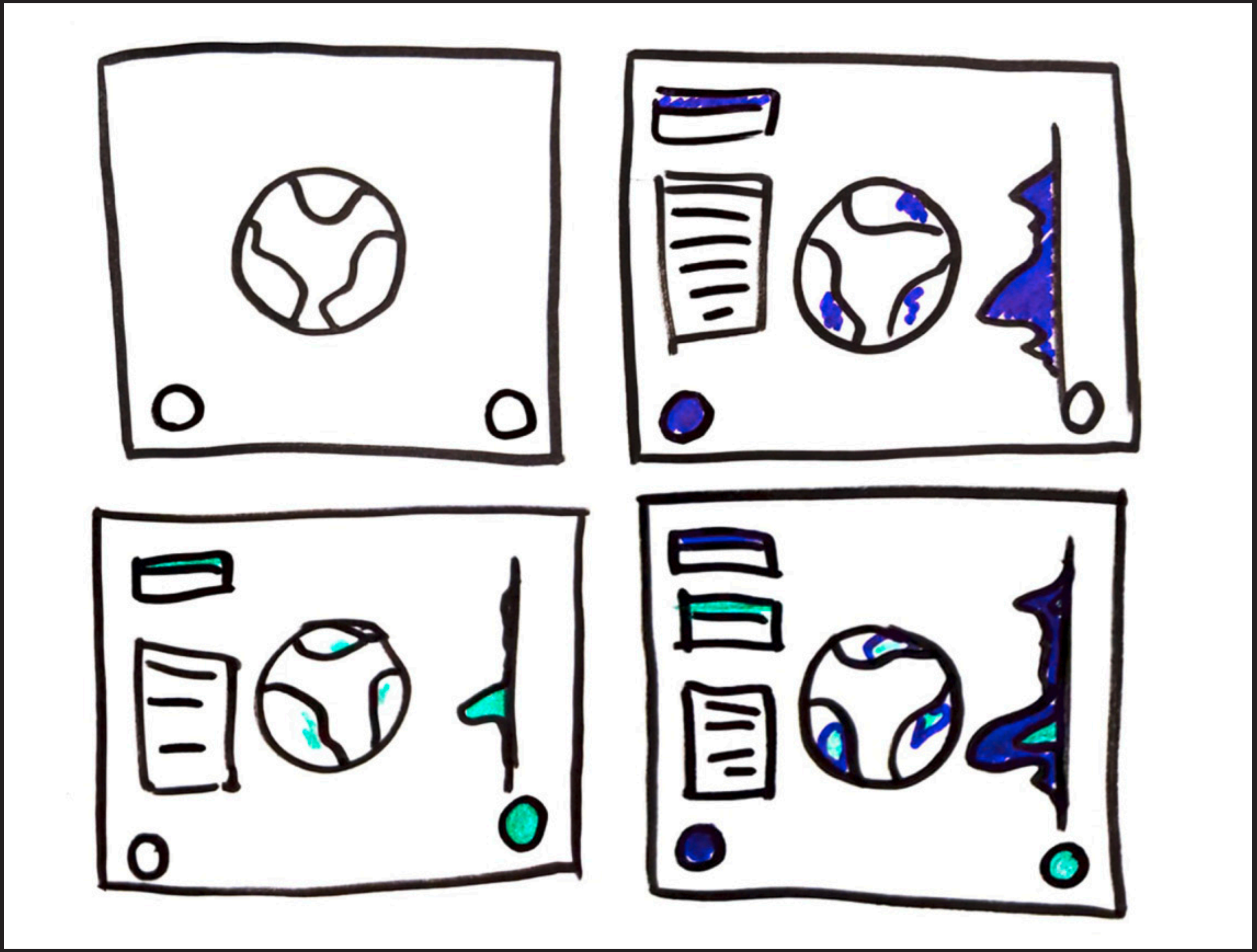
PAPER PROTOTYPE





SKETCHES

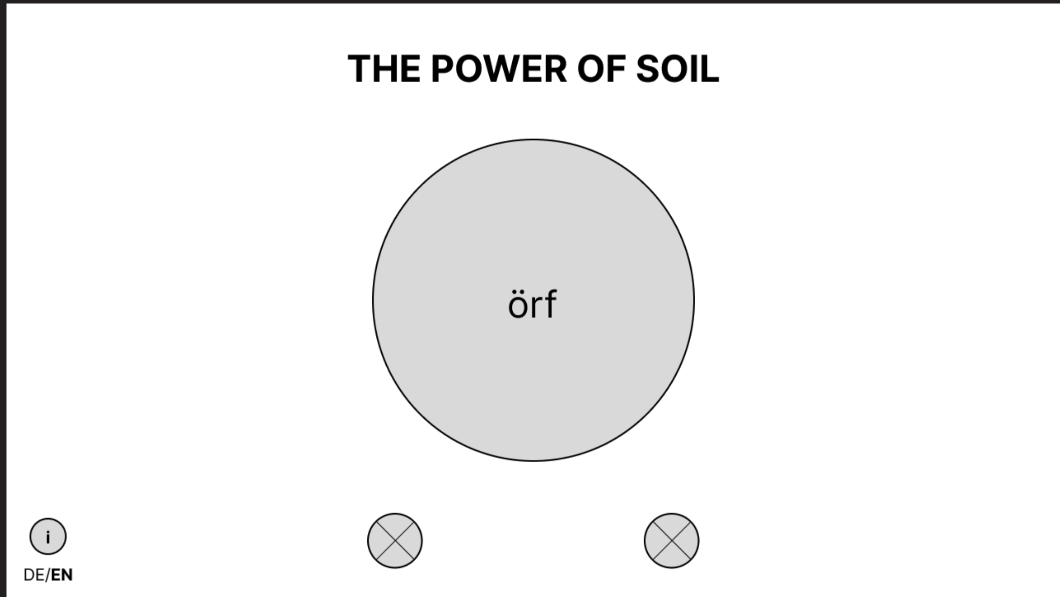
Some initial sketches we did to transport our idea. Interestingly, we landed on this layout we kept using until the end fairly quickly. Later on, we would create variations of the design, but the basic principle stayed the same.

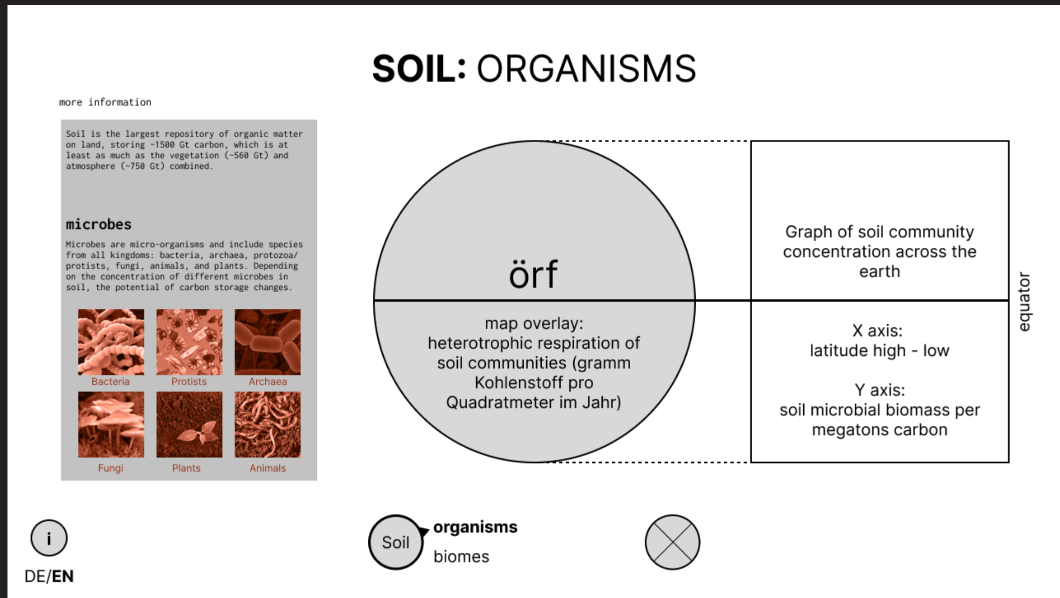


We then tidied up these functions in a wireframe.

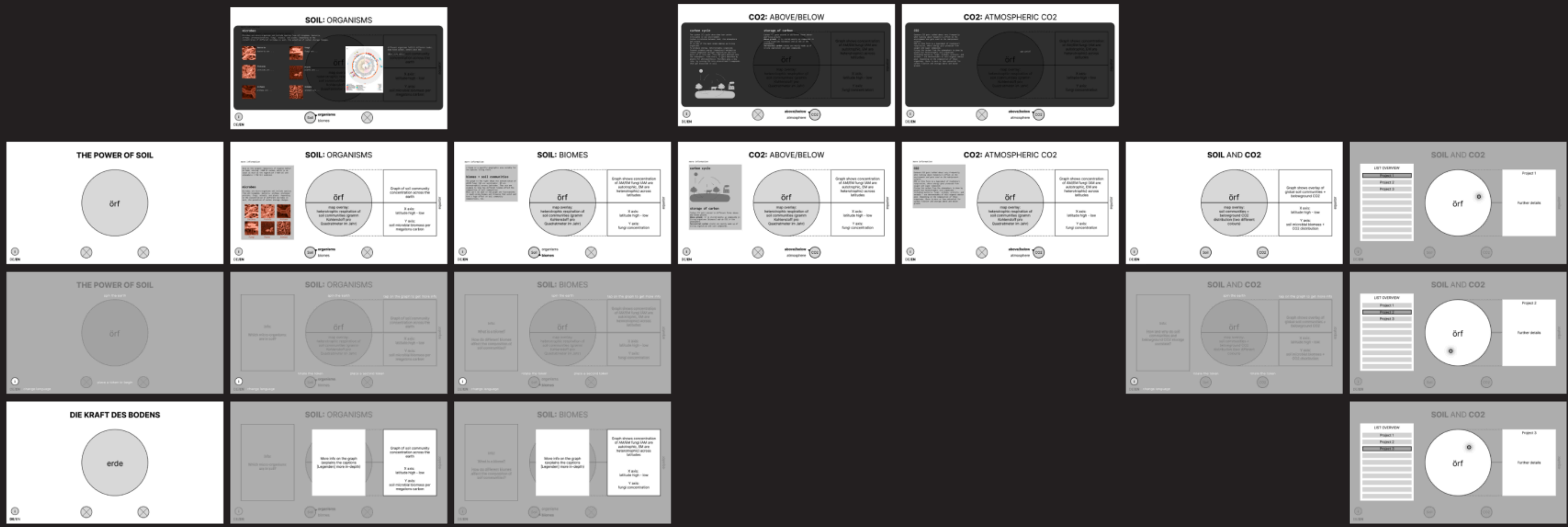
The two tokens, which function as controllers, are placed on the bottom of the screen. By rotating the tokens, submenus can be selected, and different information can be shown. In the center of the screen, there is a globe that shows essentially the same information as the graph on the right. On the left, additional text- and image-based information is displayed to give further context. There is a line to show the equator running through both the globe and the graph to further illustrate the connection between the two elements.

At this point, we had decided that there would basically be two categories of information: one about carbon, and one about soil. The two tokens take the roles of these categories.



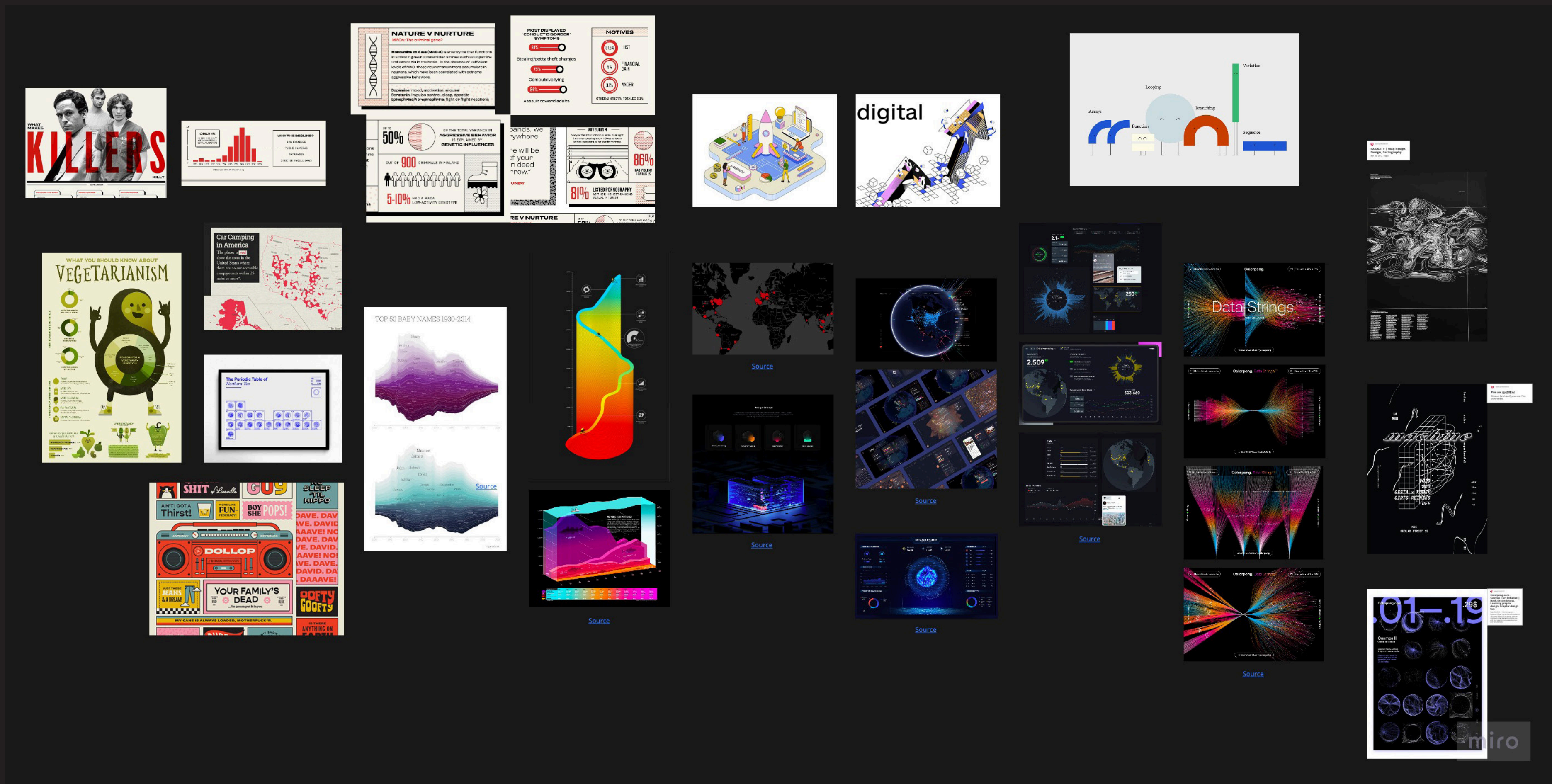


WIREFRAMES


SOIL: ORGANISMS
CO2: ABOVE/BELOW
CO2: ATMOSPHERIC CO2
THE POWER OF SOIL
SOIL: ORGANISMS
SOIL: BIOMES
CO2: ABOVE/BELOW
CO2: ATMOSPHERIC CO2
SOIL AND CO2
SOIL AND CO2
THE POWER OF SOIL
SOIL: ORGANISMS
SOIL: BIOMES
SOIL AND CO2
SOIL AND CO2
DIE KRAFT DES BODENS
SOIL: ORGANISMS
SOIL: BIOMES
SOIL AND CO2
örf
erde

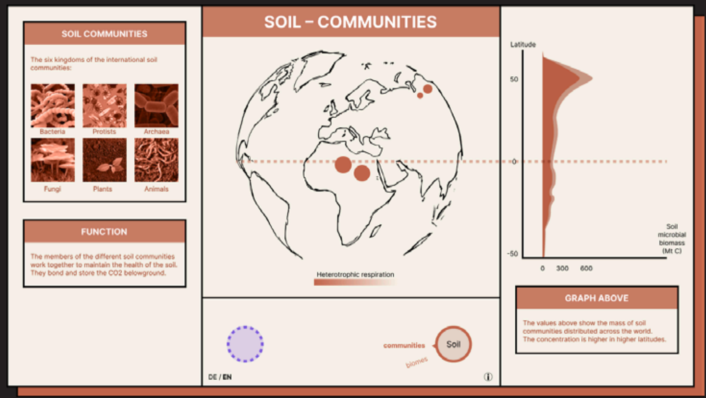
DESIGN INSPIRATION

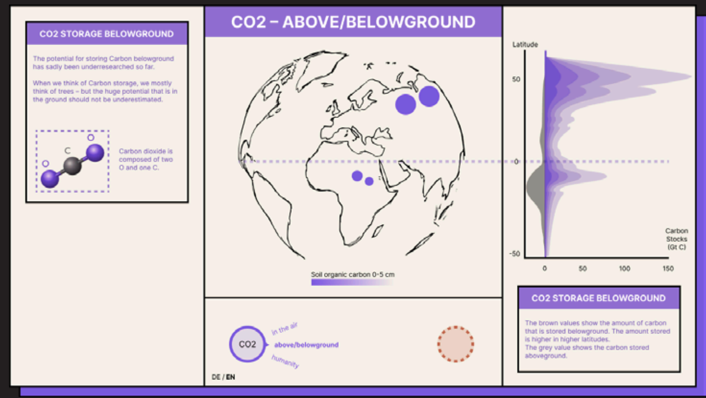
After deciding on the general layout, we looked for design inspiration online. The two visual directions that can be distinguished here interested us the most.

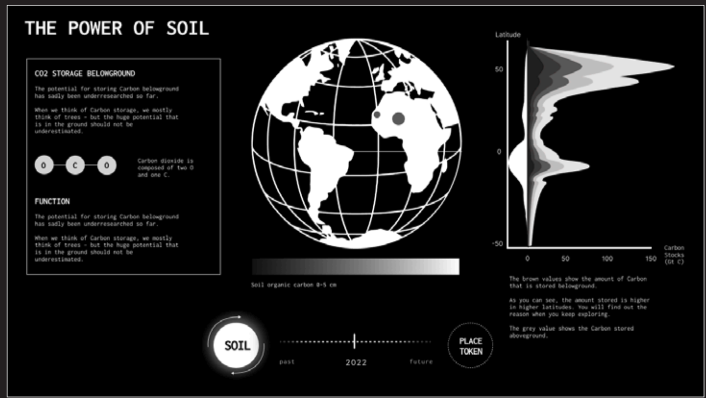


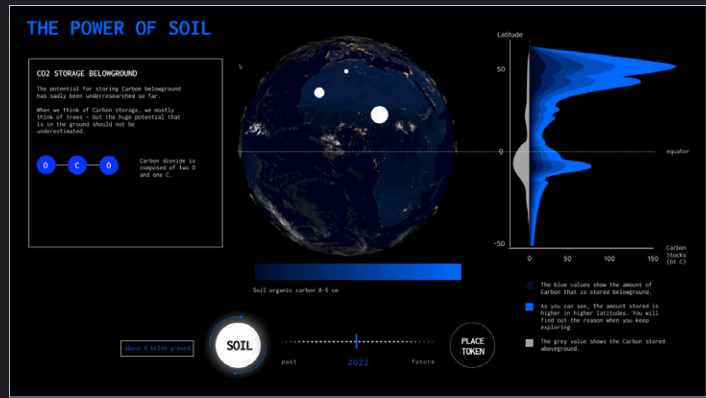
FIRST VISUALIZATIONS

We created some visualizations based on most of the previously collected inspiration – in the end, we pursued this scientific-looking, futuristic design style with a black background and colorful elements. Deciding how many UI elements to include and how to display and distinguish them ended up being quite a challenge.









FINAL CONCEPT IDEA

In the end, we had a layout and information distribution we were satisfied with.

There is a token for soil, and one for carbon. By placing the carbon token, the user can learn about the carbon stored below-ground globally, as well as the carbon in the atmosphere, and how those two differ from one another. The user will learn how the carbon cycle works as well.

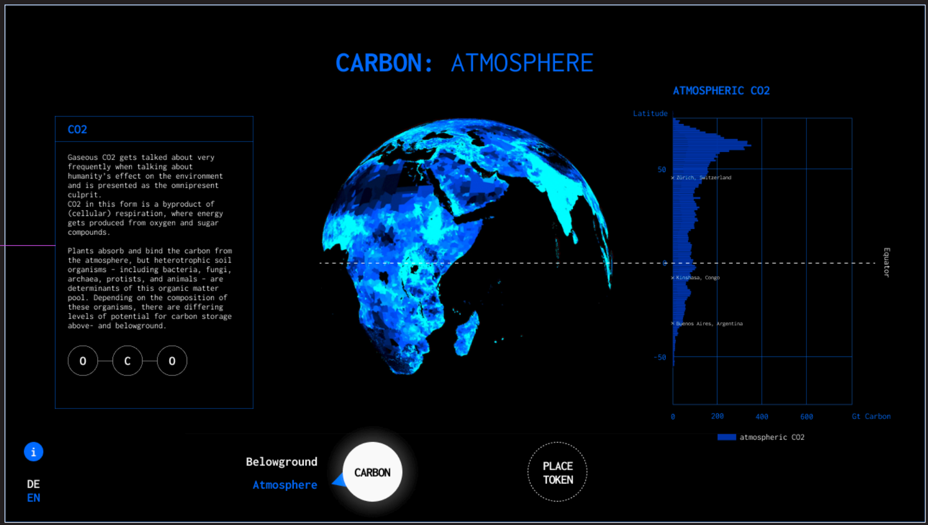
Via the soil token, the user learns about the organisms and biomes that soil communities are made up of. The map and graph show the global microbial bio-mass distribution; under the “biome” submenu, we used fungi as an example to show how dif-ferent biomes affect the compo-sition of soil communities.

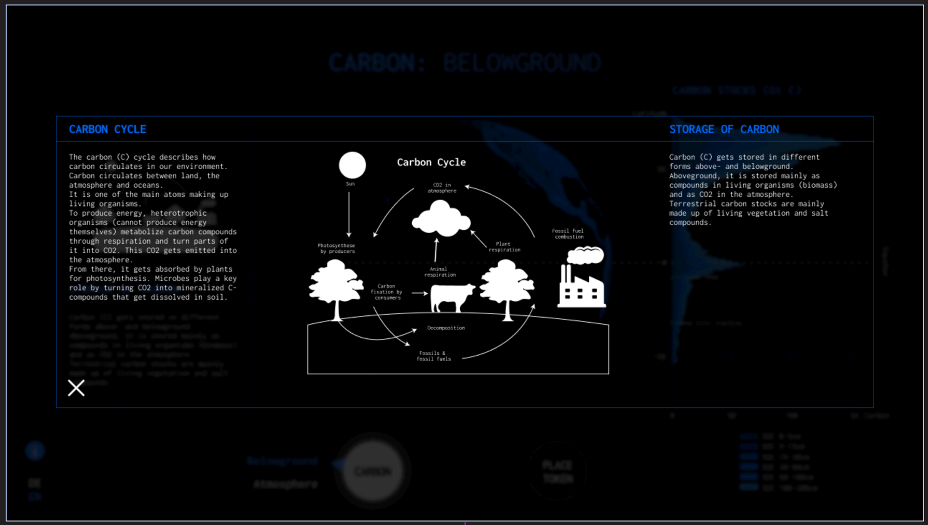
By placing both of the tokens, the information overlaps, and the correlation is demonstrated visually. The graphs and the maps overlay. Finally, the in-formation box explains how soil communities affect carbon stor-age on a global scale.

PROTOTYPE

We created a clickable prototype on Figma that shows the different possible interactions through one user flow. The maps and graphs were made using real data from the Crowther Lab.

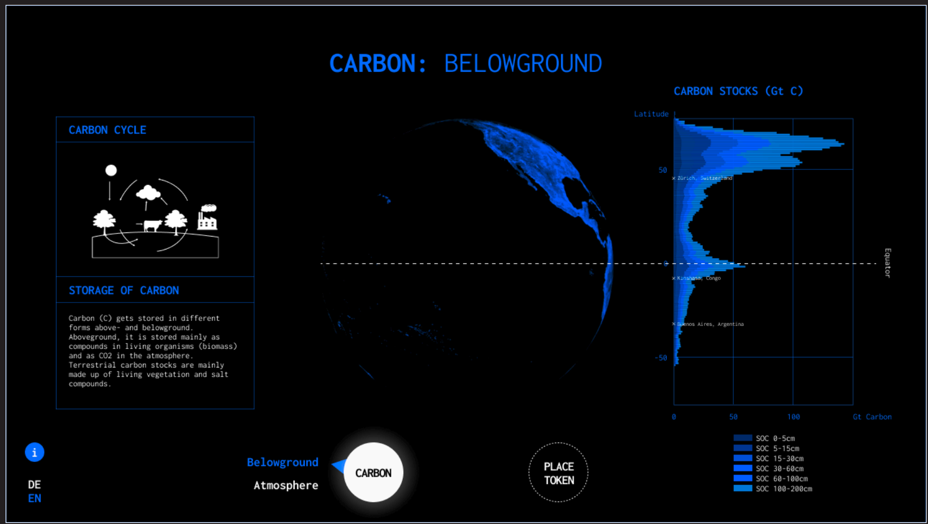
CHANGE LANGUAGE

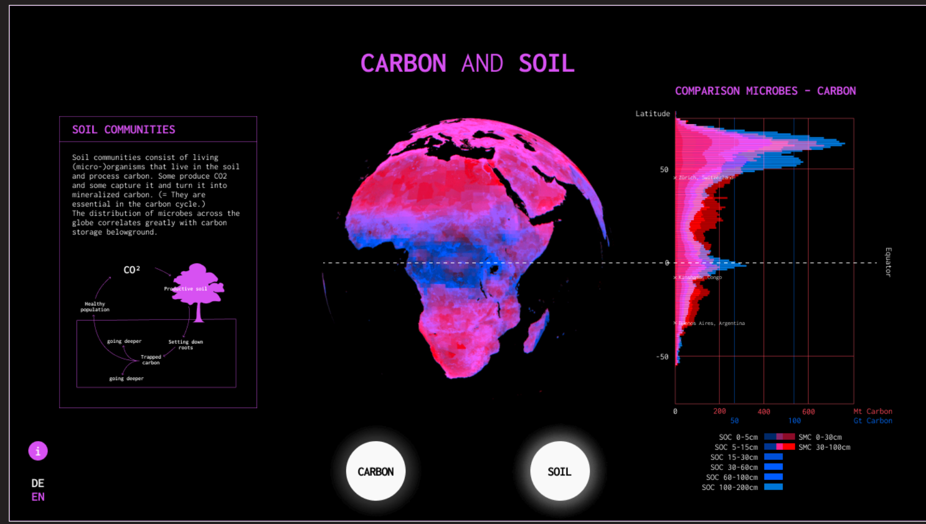


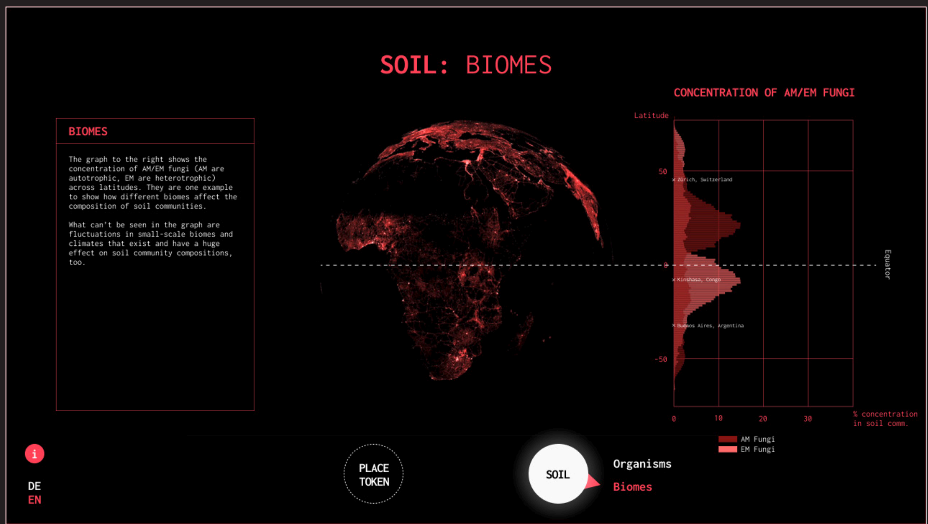


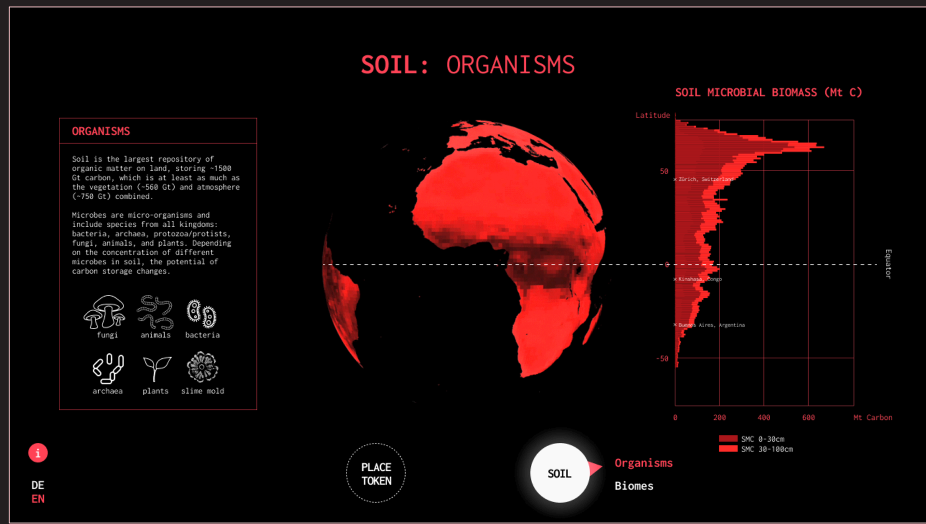
PRESS ON INFORMATION POPUP

BOTH TOKEN PLACED





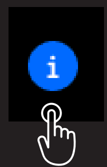


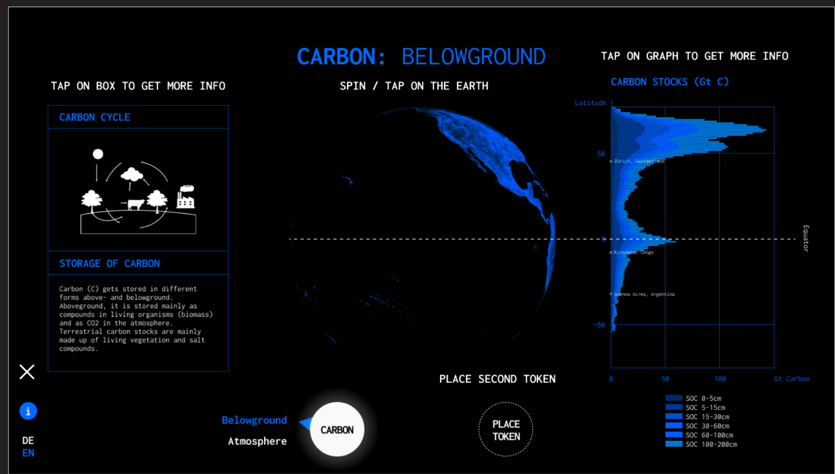


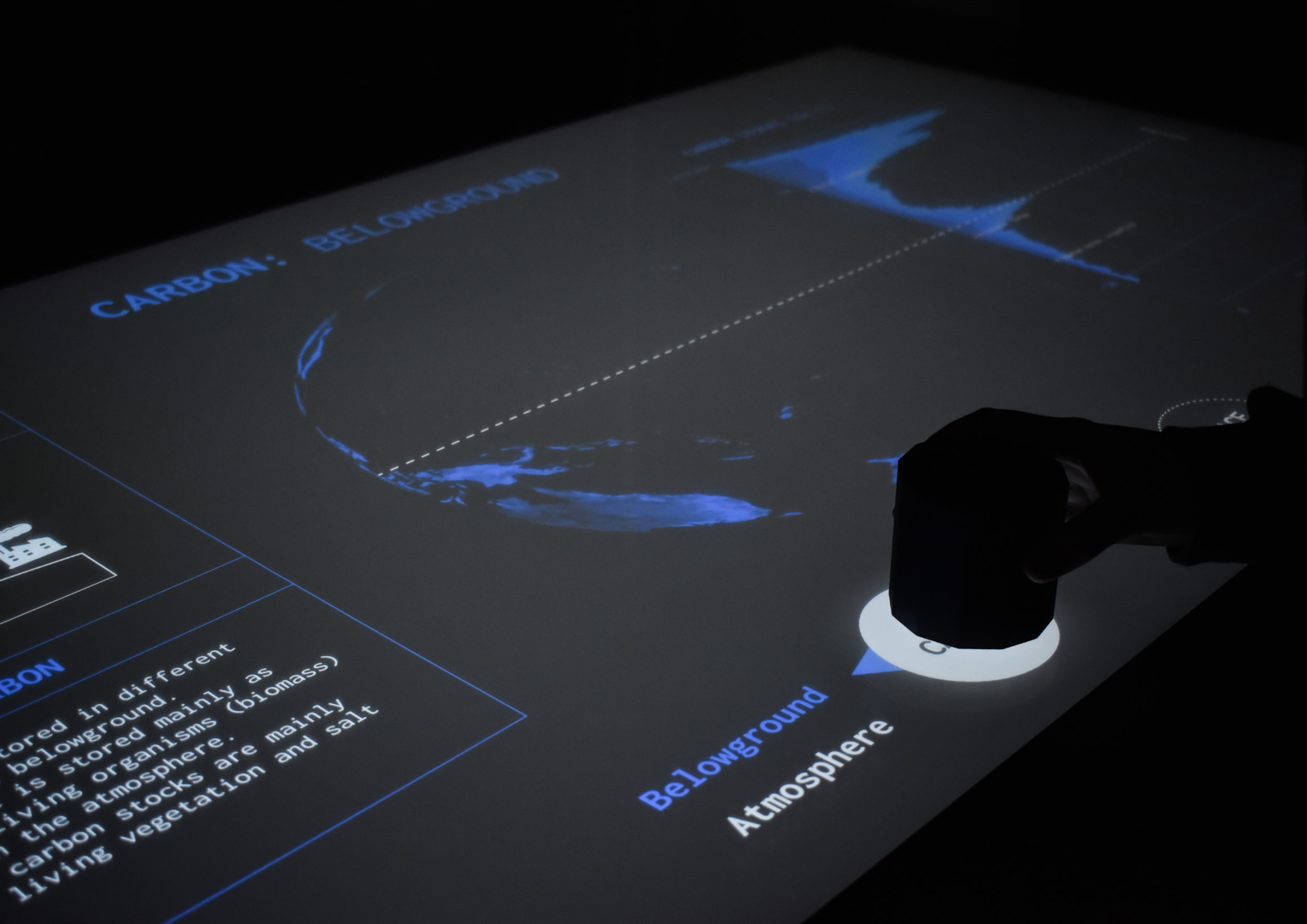
PROTOTYPE ELEMENTS

The tokens are interactive objects shaped like cylinders that are used with the touch table. They function via an Intel RealSense depth camera that is mounted on the ceiling. The camera locates the tokens' positions and is able to display them on the touch table that way. The tokens can be moved and rotated. In our case, we simply used them as controllers that activate as the tokens are placed on the screen. By rotating them, different submenus can be selected.

As for UI elements: There is a language selector and an information button; this opens an overlay over the entire screen that explains each interactive element. The information box as well as the graph can be tapped; then a larger overlay opens with more detailed information.






CARBON: BELOWGROUND
in different
belowground.
is stored mainly as
living organisms (biomass)
the atmosphere.
carbon stocks are mainly
living vegetation and salt
Belowground
Atmosphere

COLORS AND FONTS

We assigned the color red to the soil token because of the color's association with the earth. Carbon is blue, as is the sky; carbon is stored, among other places, in the atmosphere.

The overlay of the two elements is purple, as is the color mixture of red and blue.

For the font, we chose Inconsolata, as it fits the visual style of the project, and it has many different faces to choose from, which allowed for more flexibility.

#4862F3	**R**	**72**
	G	**98**
	B	**243**
#E75167	**R**	**72**
	G	**98**
	B	**243**
#C74CF3	**R**	**199**
	G	**76**
	B	**243**

Inconsolata: Regular

Weit hinten, hinter den Wortbergen, fern der Länder Vokalien und Konsonantien leben die Blindtexte. Abgeschieden wohnen sie in Buchstabhausen an der Küste des Semantik, eines großen Sprachozeans. Ein kleines Bächlein namens Duden fließt durch ihren Ort und versorgt sie mit den nötigen Regelialien.

Inconsolata: Medium

Weit hinten, hinter den Wortbergen, fern der Länder Vokalien und Konsonantien leben die Blindtexte. Abgeschieden wohnen sie in Buchstabhausen an der Küste des Semantik, eines großen Sprachozeans. Ein kleines Bächlein namens Duden fließt durch ihren Ort und versorgt sie mit den nötigen Regelialien.

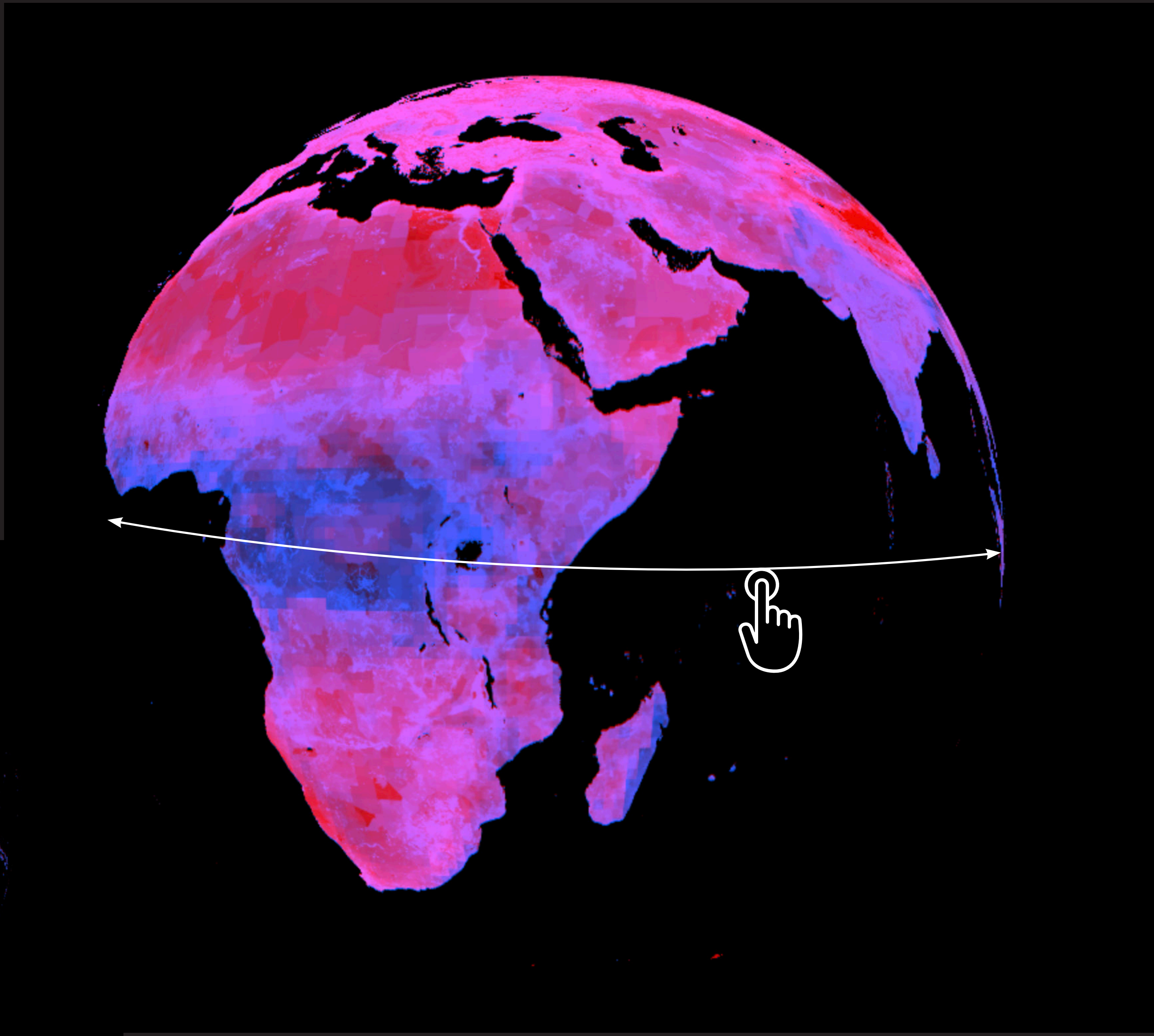
Inconsolata: Bold

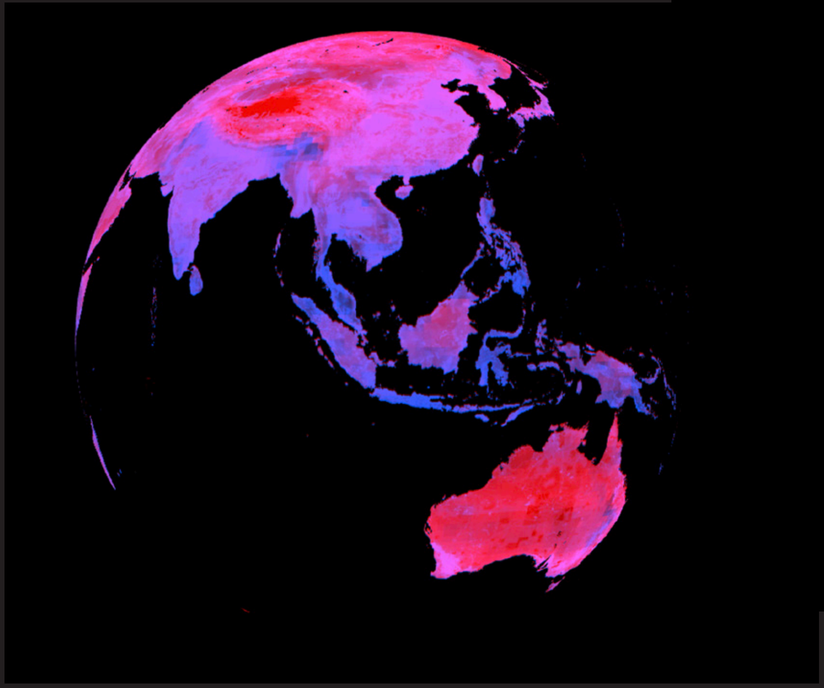
Weit hinten, hinter den Wortbergen, fern der Länder Vokalien und Konsonantien leben die Blindtexte. Abgeschieden wohnen sie in Buchstabhausen an der Küste des Semantik, eines großen Sprachozeans. Ein kleines Bächlein namens Duden fließt durch ihren Ort und versorgt sie mit den nötigen Regelialien.

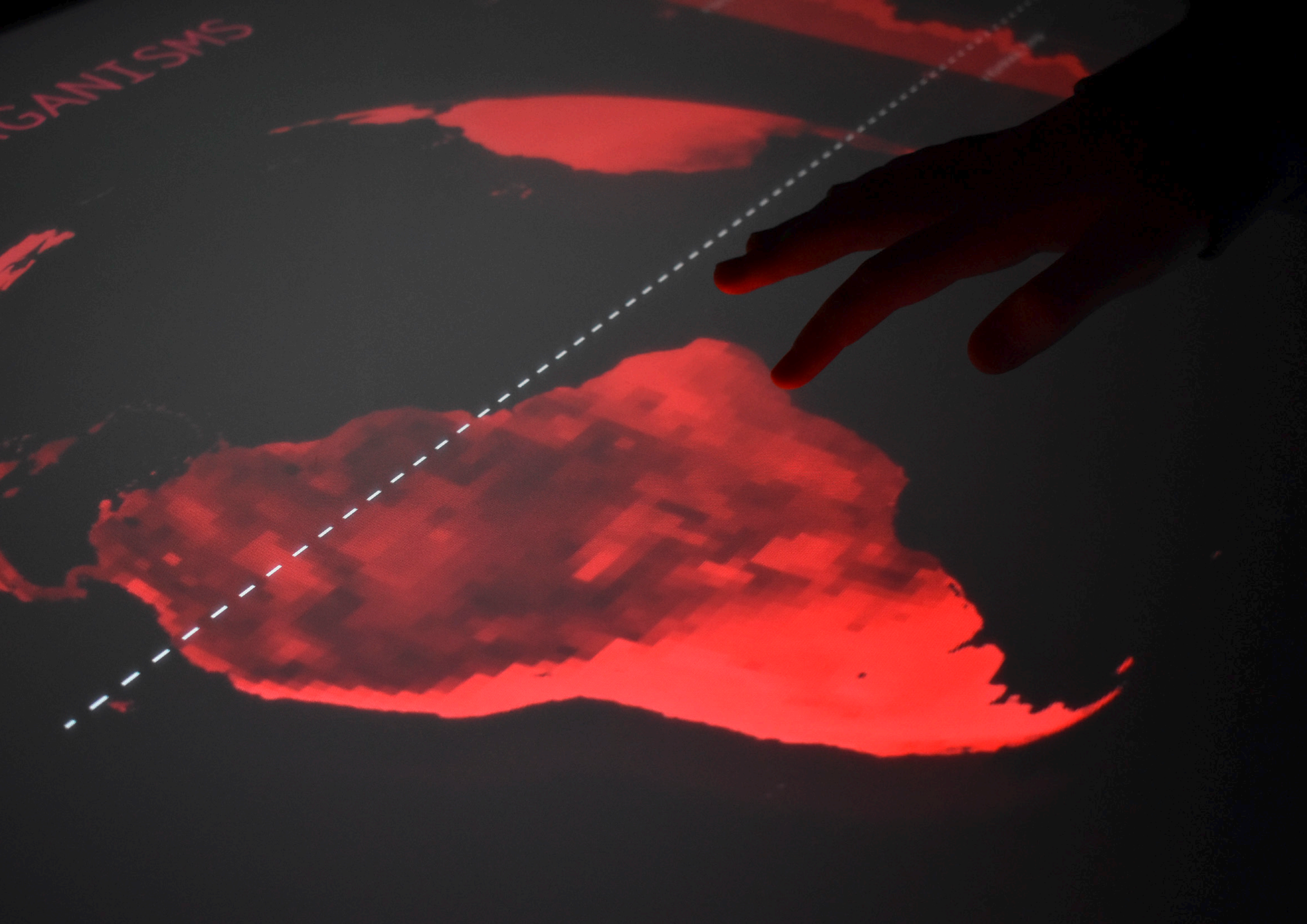
CODED ELEMENT

This page shows the element we chose to fully code: the interaction with the central globe. The user can spin it around on the Y axis, and also stop the movement by tapping.

In one iteration, we were planning to include different global projects as shown on the Crowther Lab's Restor page; in the code, we prototyped mapping the projects' locations on the globe.







CODE

This page shows the element we chose to fully code: the interaction with the central globe. The user can spin it around on the Y axis, and also stop the movement by tapping.

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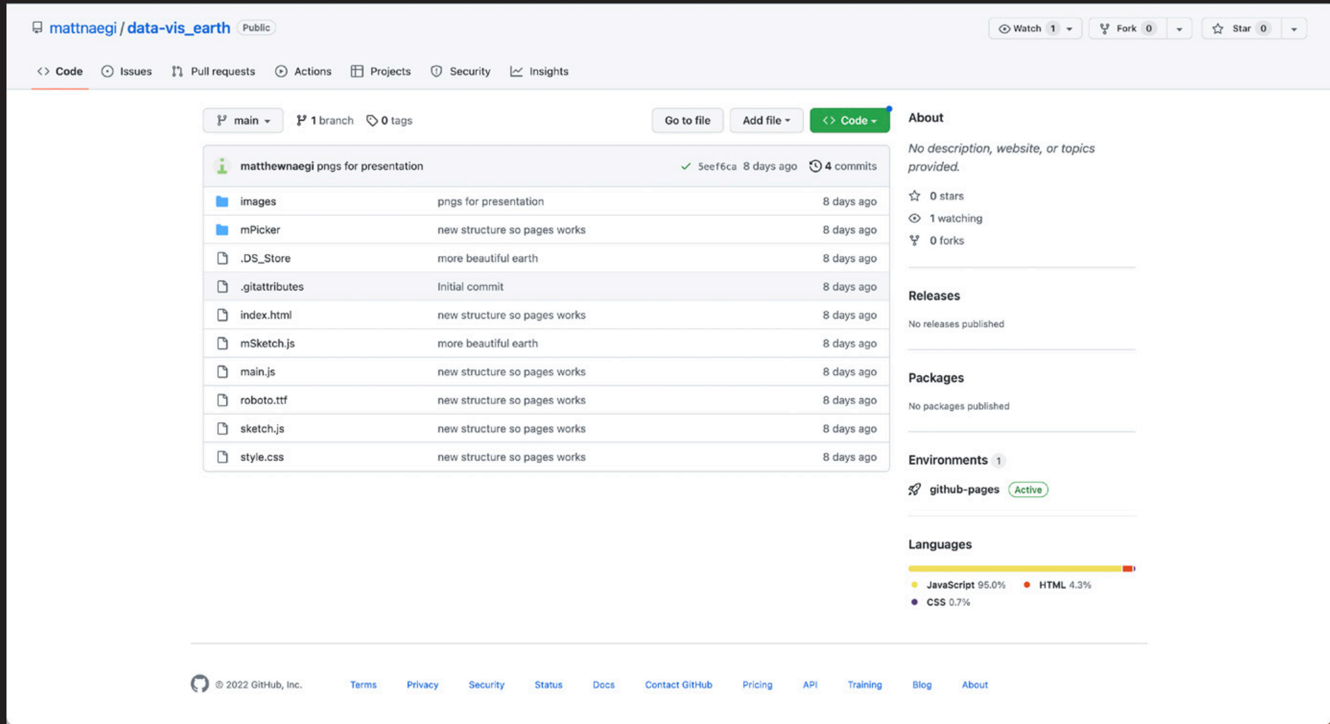

CONTROL EARTH WITH MOUSE

https://mattnaegi.github.io/data-vis_earth/

GITHUB CODE

https://github.com/mattnaegi/data-vis_earth

JAVASCRIPT CODE

```
var cameraX = 0,
  cameraY = 0,
  cameraZ = 800;
let pointsOfInterest;
let radius = 300;
let rotation = 1;
let rotationStep = 0;
const pointOfInterestSize = 5;

const SPHERE1 = 10;
const SPHERE2 = 11;
const BUTTON1 = 12;
const BUTTON2 = 13;

function preload() {
  earthTexture = loadImage("images/Crowther-
Lab_combined.png");
  cloudTexture = loadImage("images/cloud-tex-
ture.png");
  Roboto = loadFont("roboto.ttf");
}

function setup() {
  mCreateCanvas(window.innerWidth, window.
innerHeight, WEBGL);
  pg = createGraphics(400, 400);
  noStroke();
}

function draw() {
  mBackground(0);
  mResetMatrix();

  mCamera(cameraX, cameraY, cameraZ);

  rotateY(rotationStep);

  drawEarth(radius);
}

function drawEarth(earthRadius) {
  rotateY(rotation);
  rotation += rotationStep;
  //drawAxes();
  mPush();
  noStroke();
  mTexture(earthTexture);
  mSphere(SPHERE2, earthRadius, 50, 50);
  mPop();
}

function rotateEarth(deltaX) {
  rotationStep = deltaX / 40;
  console.log(rotationStep);
}

function stopRotatingEarth() {
  rotationStep = 0;
  console.log(rotationStep);
}

function drawAxes() {
  const len = radius + 100;
  push();
  stroke("white");
  strokeWeight(5);
  fill("white");
  text("(0/0/0)", 0, 0);

  stroke("red");
  line(0, 0, 0, len, 0, 0); // X axis
  text("x", len + 10, 0);

  stroke("green");
  line(0, 0, 0, 0, len, 0);
  text("y", 0, len + 10);

  stroke("yellow");
  line(0, 0, 0, 0, 0, len);
  pop();

  push();
  rotateX(radians(90));
  translate(0, len);
  rotateX(radians(-90));
  text("z", 10, 0);
  pop();
}

function pointOnSphere({ r, theta, phi }) {
  const x = r * cos(phi) * sin(theta);
  const z = r * sin(theta) * sin(phi);
  const y = -(r * cos(theta)); // because y
axis is pointing down we need the negative
value to match it with theta
  return createVector(x, y, z);
}

function create3DButton(posIndex, ID) {
  pg.textSize(50);
  pg.textureMode(NORMAL);
  pg.noFill();
  pg.strokeWeight(2);
  pg.text("BUTTON", 50, 80);
  pg.strokeWeight(10);
  pg.rect(0, 0, 350, 120);

  const point = pointsOfInterest[posIndex];
  const vector = pointOnSphere({
    r: radius,
    theta: point.theta,
    phi: point.phi,
  });

  mPush();
  mTranslate(vector.x + 50, vector.y + 30,
vector.z);
  mTexture(pg);
  mPlane(ID, 100, 100);
  mPop();

  if (objectAtMouse() == ID && mouseIs-
Pressed) {
    pg.stroke(255, 0, 0);
  } else {
    pg.stroke(255, 255, 255);
  }
}
```

CONCLUSION

In the end, we were satisfied with the outcome of our project. But as always, we were subject to time constraints, and we were not able to implement each feature we had thought of.

One aspect we had wanted to integrate was to give a timeline of the belowground carbon storage over the years; the user would be able to navigate through the years using a slider. Another aspect was the focus on the projects as shown on Restor. We would have loved to have more time to focus on these.

Furthermore, one idea that kept coming up during mentorings was that the graph should change according to the globe position; as this would have been very time-intensive, and as we only received the real data quite late in the game, we had no chance of implementing this, but would love to do this in a future iteration.

Finally, while the project has a strong visual concept we're satisfied with, it's not quite as comprehensive as we hoped, and the screen might be slightly overwhelming without any background knowledge. For sure, it would benefit from further iterations that focus on user comprehension.

The data itself was extremely interesting, and we enjoyed working with it. The collaboration with the Crowther Lab and focusTerra was fruitful as well.