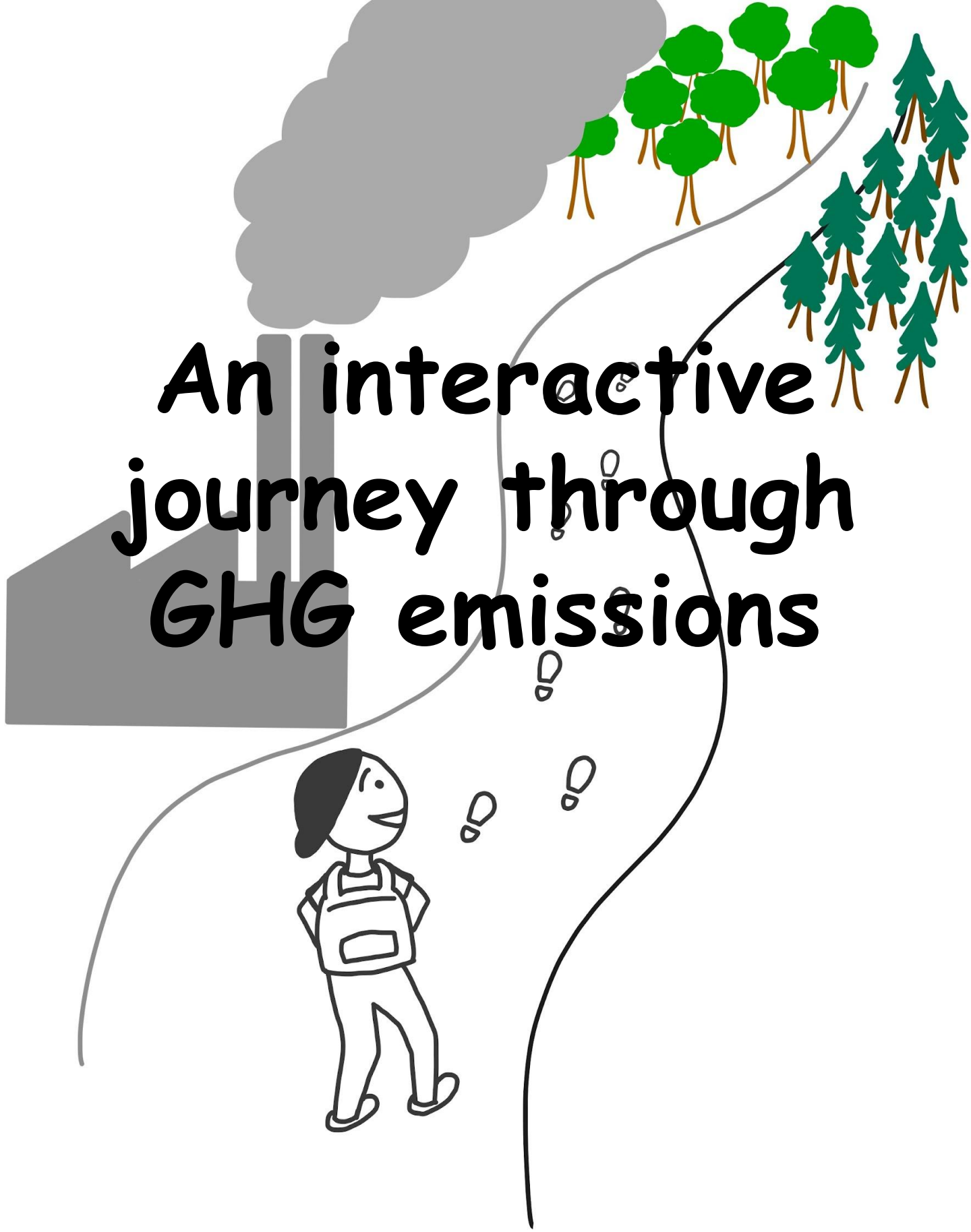

An interactive journey through GHG emissions

COM-480 Data Visualization|Data Divas

Salomé Baup - Tanguy Desjardin - Yifeng Chen

I. Introduction

The emissions of greenhouse gases (GHG) has significant implications for the environment and human society. However, despite its importance, the topic can be complex and difficult to understand, which can make it difficult for the general public to engage with the issue and take action to reduce emissions. To help address this challenge, the goal of this project is to build an interactive website where the user can extract, compare and analyze the worldwide distribution of GHG emissions in a convenient way. We hope that this website, by applying the data visualization knowledge obtained from lectures as well as other methods, can help the user raise awareness of the importance of reducing GHG emissions and the need for collective action to address climate change.

II. Design pipeline

1. Dataset selection

In order to analyze the global GHG emissions, an appropriate dataset is required. There are plenty of datasets about GHG emissions on different websites, such as Kaggle or the European Commission. However, most of them are not available for our project, because time-period covering being too small or not enough countries represented. Therefore, we decided to focus on 2 available datasets, for which the detailed information is described below:

The first dataset, available at Our World In Data - CO2 and GHG emissions, presents global carbon dioxide (CO2) and greenhouse gas (GHG) emissions from 1750 to 2021. The data are sourced from a variety of international organizations, including the International Energy Agency (IEA), the United Nations Framework Convention on Climate Change (UNFCCC), and the Global Carbon Project.

The second dataset, available at Our World In Data - Emissions by sector, presents global GHG emissions by sector from 1990 to 2019. The data are sourced from the same international organizations as the first dataset and are broken down by sector: Agriculture, Land-use change & forestry, Waste, Industry, Manufacturing & Construction, Transport, Electricity & Heat, Buildings, Fugitive emissions, Oter fuel combustion, Aviation & Shipping.

Both datasets are of high quality, with data sourced from reputable international organizations and presented in a clear and accessible manner. The data are also regularly updated, ensuring that users have access to the latest information.

2. Exploratory Data Analysis

Since our goal is to help the user understand the GHG emissions, it is essential that we have a good understanding of our datasets. Therefore, exploratory data analysis was performed during the first milestone.

On both datasets, countries, years and missing values explorations were performed to find an adequate time period. Then the two datasets were merged to do some data analysis and visualization.

From this, we displayed the annual total greenhouse gas emissions, which is displayed below in Figure 1. We can observe that China gradually became the first emitter, exceeding the United States in the early 2000s and that its emissions continue to increase. The United States, now second, stayed overall constant between 1990 and 2019. Another country with continuously increasing global emissions is India, while Russia's emissions were quite high overall in the early 1990s, decreased for 20 years but are now increasing again. Trends however vary based on the sector. We then found the highest emitting sector for each country per year and compared in a barplot the highest sectors in 1990 and in 2019, for each country. It appeared than China, USA, Russia, India, Indonesia and Brazil were the highest emitters, with Electricity and Land-use-change as the highest sectors.

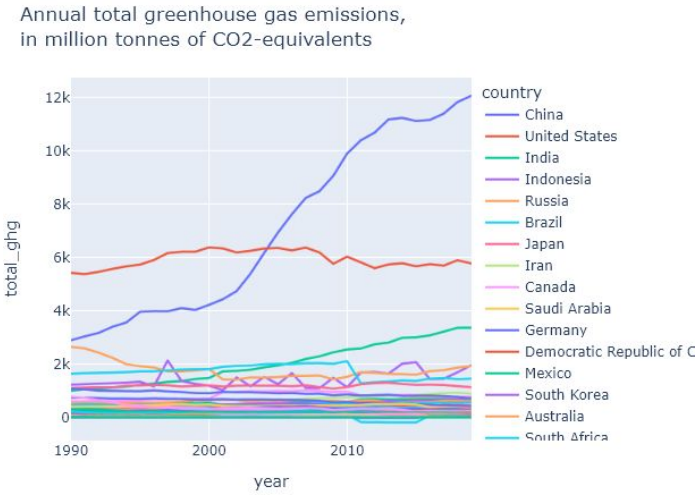

Figure 1: Graph extracted from the EDA performed in Milestone 1.

3. Website design decisions

a. Color adjustment

In the second milestone, we had selected grey as our background color and the ocean color in the world map was also grey. However, it is not natural to have the ocean with grey color, so we decide to use blue as the ocean color. Besides, we changed the background style into a worksheet style, which will present a more educational style for this website, especially attractive for kids and students. The comparison could be found in Figure 2.

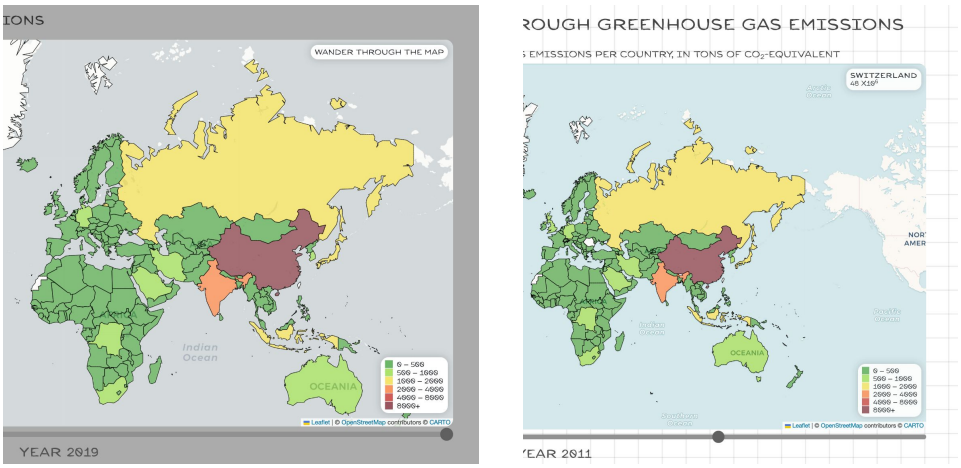

Figure 2: Color comparison between milestone 2 (left) and 3 (right)

b. Gases barplot

In the second milestone, we suggested to use a stacked barplot to present the proportion of gases in the same bar. However, the concrete GHG emissions number would be lost if a stacked barplot was used. Therefore, we decided to apply a normal barplot and the comparison is shown below:

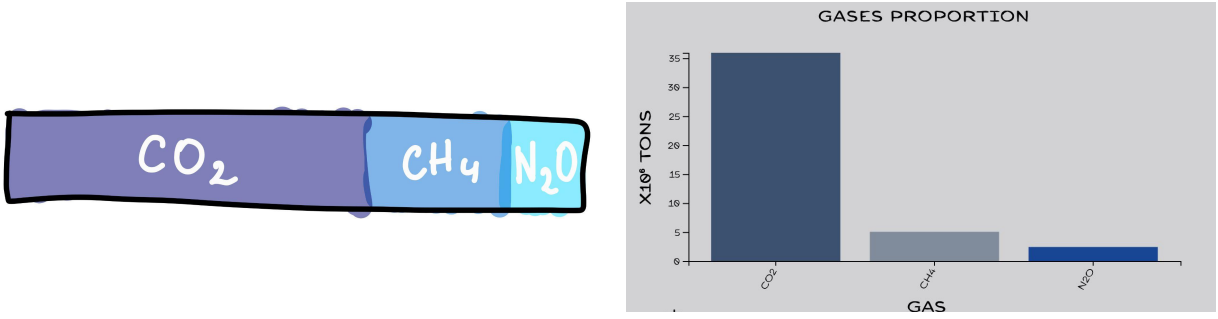

Figure 3: Comparison between stacked barplot sketch in milestone 2 (left) and barplot in milestone 3 (right)

c. No GHG emission line chart

In the first milestone, we used a line chart as one visualization tool to present the evolution of GHG emissions in each country. During the second milestone this chart idea was dropped because it uses the exact same data as the world map and we didn't want to reuse data on different visualizations. Instead, the slider in the world map is used to present the temporal evolution of GHG emissions over countries.

d. No more How To page

A How To page was proposed in the second milestone, however we realised that the screencast was already meant to demonstrate what we can do with the visualizations and how to navigate in the website.

e. News streamer

Our original idea was to put the news and the world map on the same page. However, it would distract the audience's attention if too much information is on the same page. Therefore, we decide to separate these contents into 2 pages so that it will be easier for the audience to concentrate on reading the information. The comparison could be found in Figure 4.

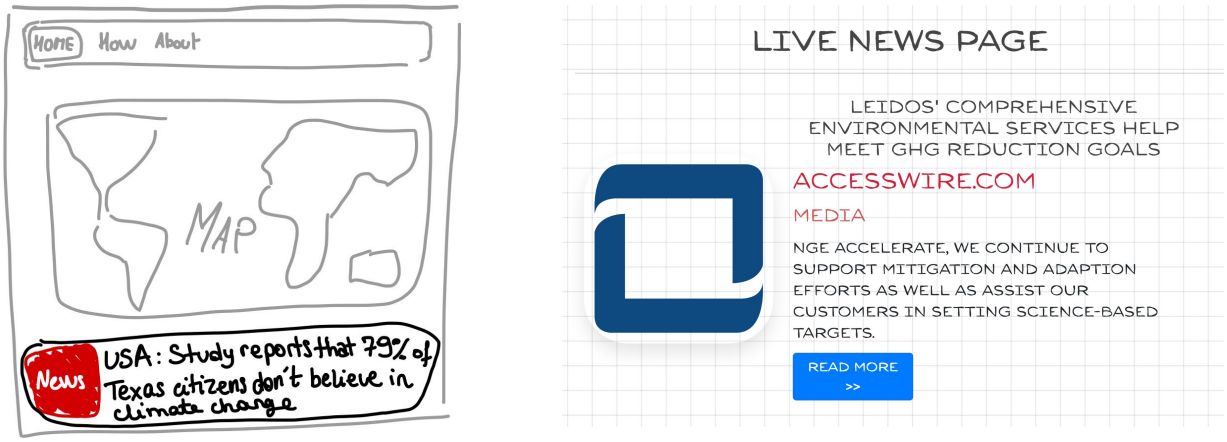

Figure 4: Comparison between news streamer sketch in milestone 2 (left) and news streamer in milestone 3 (right)

f. Barplots display

In the second milestone, we had the two barplots of GHG emissions, by sector and by gases, aligned on the same popup. However when we examined our website, we realized that an improvement could be made by allowing the user to switch between two popups containing separately the two barplots. The comparison is shown in figure 5. Therefore, the user can pay more attention on one information at the time.

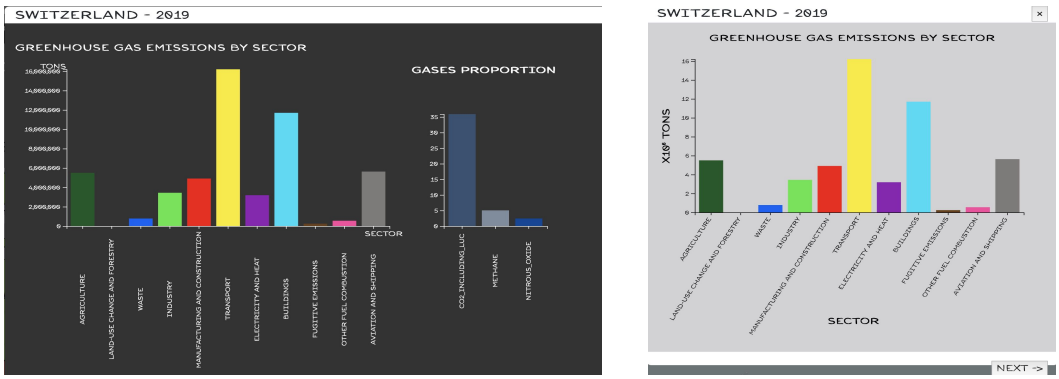

Figure 5: Comparison between detailed GHG information in milestone 2 (left) and in milestone 3 (right)

4. Final product

a. Interactive world map

This section presents our final interactive world map. Spatial and temporal information is displayed to explain the distribution of emissions around the globe in a way that is easy to understand. This map displays the data in an engaging and striking approach: colorful, interactive, with numerical information. The final version of this visualization is displayed in figure 6. The countries color represents the grading of GHG emissions for a spatial comparison between countries. In addition, the time slider allows one to travel across the years. When the user hovers on a selected country, it is highlighted and the number of GHG emissions is displayed on the top right corner. When the user clicks on the country, detailed information appears as a popup on the map as in figure 5. Sectors barplot first appear and the user can go to the second gases chart using a 'Next' button.

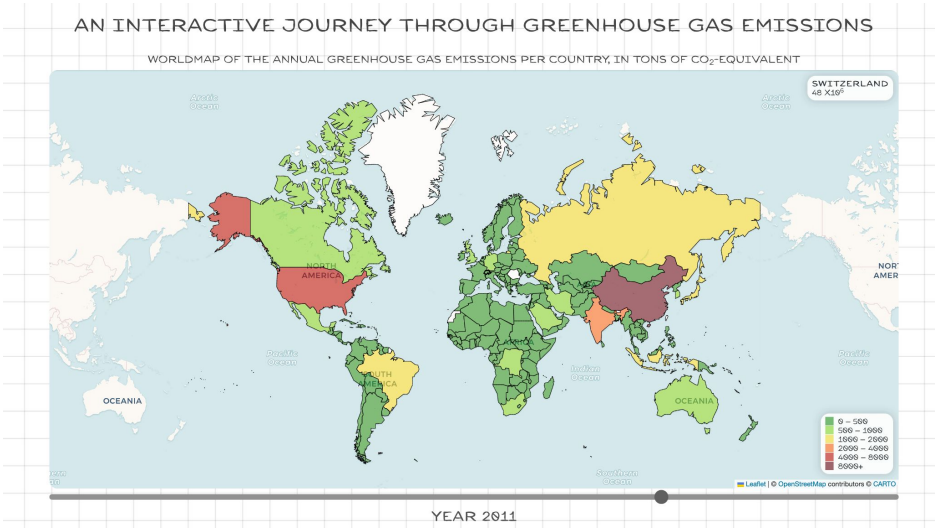

Figure 6: Final version of the interactive map

b. GHG emission counter

Below the interactive world map, a counter displays the growth of worldwide GHG emissions during the time the user spends on the main website page, which is shown in figure 7. Every second, it will increment by the quantity of GHG emitted worldwide in a second (1.17 tons of CO2 equivalent).

Figure 7: GHG emission counter

c. Lightbulb explanations

Two texts are used as information boxes on the topic of "What are CO2-equivalents?" and "Where do the different gases come from?". It gives a more educative purpose to the website.

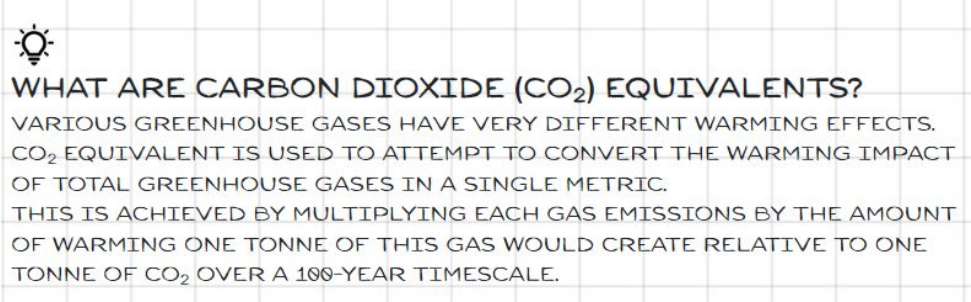

Figure 8: A lightbulb box

d. News streamer

This part includes news on the topic of GHG emissions. It displays the news as a continuous information banner, like a news streamer we can find on continuous broadcast TV news channels. Each news will contain a title, source, author, abstract and cover image, every 6 seconds a news will show up. 15 news in total are presented continuously. News are regularly updated, with date ranging from 4 weeks ago till the current date.

Figure 9: News streamer

III. Challenges

1. Datasets

These 2 datasets had to be merged based on countries and on time-period. Missing data were also present. The time period 1990-2019 was chosen as a good compromise with entries for every country. Unfortunately, some entries remain NaN at some time points, for example it is the case for Latvia, Namibia, Western Sahara and Romania.

2. GeoJSON file

The main challenge for the map was to create an appropriate GeoJSON data file. First, the name of the countries were matched between the initial geojson file and the datasets. South Sudan coordinates have also been added because they were missing in the initial file.

3. Dynamic news

In order to realize the news streamer, we needed to find an API to get access to news information from the related website. The chosen API, https://newscatcherapi.com/, is know to gather news from all around the web and is used as a hub for us to access the news.
At the beginning, we used the API https://newsapi.org/, however it doesn't allow to display the news outside of a localhost. As we wanted to provide a good accessibility, we wanted our webpage to be hosted on github. Besides, we had an issue related to the current date in the request. With the new API, we specify in the request url to start the search from the time point '4 weeks ago' to the current date.

IV. Peer assessment

Salomé

- EDA: notebook with data exploration, data analysis, graphs;
- World map: geojson creation, map visualization, interactivity, slider;
- Sectors and gases barplots: graphs creation, interactive buttons;
- Website textual content;
- Writing readme, examining and optimizing the process book.

Tanguy

- Website design, pages organization and textual content;
- GHG counter implementation;
- News streamer: found the API, implemented the request,visual design;
- Writing readme, examining and optimising the process book.

Yifeng

- Research and selection of the appropriate dataset;
- Process book organization and writing;
- Writing readme, examining and optimizing the website.